DRAFT
ENVIRONMENTAL IMPACT REPORT (EIR No. 628)
FOR THE
BREA BOULEVARD CORRIDOR IMPROVEMENT PROJECT
SCH #2017051005

VOLUME 3 OF 4
(Appendices)

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GEOTECHNICAL ENGINEERING REPORTS

GEOTECHNICAL ENGINEERING REPORT, PROPOSED EARTH RETENTION SYSTEMS AND ROADWY PAVEMENT

GEOTECHNICAL ENGINEERING REPORT PROPOSED EARTH RETENTION SYSTEMS AND ROADWAY PAVEMENT BREA BOULEVARD CORRIDOR IMPROVEMENTS COUNTY OF ORANGE, CALIFORNIA

Prepared for:

COUNTY OF ORANGE – OC PUBLIC WORKS

601 North Ross Street
Santa Ana, California

Project No. 11585.005

June 22, 2021
(revision May 19, 2022)

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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June 22, 2021
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Project No. 11585.005

County of Orange, OC Public Works
601 North Ross Street
Santa Ana, California 92703-5000

Attention: Mr. Austin Morgan, P.E.

**Subject: Geotechnical Engineering Report
Proposed Earth Retention Systems and Roadway Pavement
Brea Boulevard Corridor Improvements
County of Orange, California**

In accordance with your request and authorization, Leighton Consulting, Inc. performed a geotechnical exploration for the proposed "Brea Boulevard Corridor Improvements" project, which essentially consists of widening Brea Boulevard in the northern region of the County of Orange, north of the City of Brea.

This version of the report reflects revisions to the original document to incorporate the responses to comments issued by Mark Thomas Company.

The purpose of our study was to evaluate the subsurface soil and groundwater conditions at the site and to provide preliminary geotechnical recommendations for the design and construction of new bridge structures to replace the existing bridges; design of new earth retaining wall systems; and reconstruction and rehabilitation of roadway pavement.

The results of our exploration and recommendations for the proposed earth retaining structures and roadway pavement are presented in this report to assist the project structural engineer and civil engineer in design of the project. A previous version of this report was issued on June 13, 2019. The report has since been updated to incorporate a supplemental field exploration partly due to changes of the proposed wall types and results of field percolation testing. The relevant design and construction

The recommendations presented in this report may be superseded in the future upon review of the final design plans and subsequent value engineering efforts.

We appreciate the opportunity to provide our services for this project. We trust that the information contained herein will be sufficient. If you have any questions or concerns, please contact us at your convenience. The undersigned can be reached at the phone extensions and email addresses listed below.

Respectfully submitted,

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1.0 INTRODUCTION

1.1 Project Overview

The County of Orange (County) plans to widen Brea Boulevard from Sta. 5+00 south of Canyondale Drive in the City of Brea to Sta. 85+00 north of Tonner Canyon Road in unincorporated Orange County for a total length of approximately 8,000 feet (1.52 miles). This segment of Brea Boulevard includes one traffic lane in each direction and gently rises in elevation progressing northerly/easterly toward the corporate boundary with Los Angeles County. Increase in traffic capacity will consist of adding one lane in each direction. Upon completion, this segment of Brea Boulevard will have two lanes in each direction with a raised median and paved shoulders. The portion of Brea Bouevard planned for widening is shown on Figure 1, *Site Location Map*.

To accommodate the widening and realignment of the roadway, a number of earth retaining systems will be constructed to support the necessary cuts into ascending slopes. The heights of these walls typically range from to less than 10 to 30 feet with a maximum height of approximately 55 feet to support the cut planned along the inner radius of the prominent curve of the roadway (approximate Sta. 31+50 to Sta. 34+50) as the alignment transitions from northerly to easterly and crosses Bridge 2 (55C-0122 as referenced in Table 1).

In areas of the proposed widening, fill will be required to raise grade that will be accommodated either by new slopes or retaining wall structures. A number of utility crossings and culverts will also be reconstructed to preserve their function.

The proposed road widening also includes the reconstruction of the three existing bridges that span Brea Creek along the roadway alignment within the region planned for widening. The existing bridges are referenced as follows:

Table 1 – Existing Bridge Structure Data

Bridge Identification	Approximate Location		Deck Elevation (feet)	Creek Bottom Elevation[1] (feet)
	Latitude	Longitude		
55C-0121	33.9378°	-117.8917°	393	374
55C-0122	33.9400°	-117.8906°	408	386
55C-0123	33.9411°	-117.8875°	424	404
Note: [1] Creek bottom elevation assumed to be equal to Thalweg Elevation per Hydrologic Study Report (Avila, 2019)				

1.2 Proposed Bridges

The proposed road widening includes the construction of new bridges to replace the three existing bridges referenced above. Preliminary recommendations for design of the proposed bridges were presented in the Preliminary Foundation Report (Leighton, 2019) prepared at the 35% design stage. Recommendations presented in the preliminary report will be updated based upon the findings of the supplemental field exploration discussed in this report and revised structure plans as they are developed by the project structural engineer. Recommendations specific to the bridge structures are presented in a separate report.

1.3 Proposed Earth Retaining Wall Systems

Widening of the existing roadway will require cuts into slopes that ascend from the current road elevation and fills to raise the current grade along the corridor, which require construction of earth retaining systems. A summary of the earth retaining systems is presented in Table 2. The cuts required for several wall structures will result in slopes ascending above the proposed top of wall. Cut slopes are planned to be inclined no steeper than 2H:1V.

Table 2 – Summary of Proposed Retaining Walls

Wall Information		Roadway Stationing		Wall Dimensions	
Wall No.	Type of Retaining System	Begin	End	Length	Maximum Height (feet)
1	MSE[1]	15+88.68	19+26.66	360’	9
2	Semi-Gravity Cantilever[2]	18+67.66	20+14.08	149’	8
3	Soil Nail[3]	23+20.56	25+67.25	240’	14
4	Soldier Pile	25+10.95	26+89.71	184’	9
5	Soldier Pile w/Anchors	28+39.46	29+84.08	93’4½”	23
6	Semi-Gravity Cantilever	29+02.84	30+47.95	149’10¼”	14
7	Anchor Diaphragm[3]	31+11.86	34+44.99	296’	57’6”
8	Soldier Pile w/ and without Anchors	33+38.83	40+13.44	715'1½"	29
9	Soil Nail	39+10.51	40+67.73	156’	21
10	Soldier Pile w/ Anchors	41+92.26	42+79.68	100'	24
11	Soldier Pile w/ Anchors	42+58.01	45+50.86	232’8¾”	29
12a,b[4]	Soil Nail	44+78.35	52+79.13	802'	32
12c	Soil Nail	53+07.13	54+39.13	132’	18
13	Soil Nail	57+41.19	58+60.00	138’	24
14	Soil Nail	60+37.53	70+38.71	996'	31
15	Soil Nail	62+29.98	68+79.18	648'	21
16	Semi-Gravity Cantilever[2]	31+39.80	31+89.43	55’	12
Notes:	[1] MSE – Mechanically Stabilized Earth [2] Wall system corresponding to Caltrans Standard Plans Type 1 [3] Wall Batter 1H:10V (RW-7 and all soil nail walls) [4] RW-12a and 12b joined to become one continuous wall				
	Wall data obtained from preliminary 100% Design Submittal plan set				

1.4 Description of Wall Structures

RW-1 (Retaining Wall No. 1) is located along the southbound side of the roadway and will support fill material required to raise grade for the proposed roadway widening. RW-1 was originally planned to consist of a Caltrans Type 1 semi-gravity cantilever retaining wall. However, in the design course after the 35% submittal, the manner of soil retention was changed and this wall structure will now consist of a Mechanically Stabilized Earth (MSE) retaining wall.

RW-2 is also located on the southbound side of the road and will be oriented parallel to RW-1. RW-2 is considerably shorter in length than RW-1. The purpose of RW-2 is to provide soil retention of fill material required to raise grade for an access drive. RW-2 is planned to consist of a Caltrans Type 1 semi-gravity cantilever wall structure.

RW-3 is planned to consist of a soil nail wall to support cut along the southbound side of the roadway. Based upon our geotechnical exploration, we anticipated the material to be exposed in the wall cut will be alluvial/older alluvium material.

RW-4 will be located near the top of an existing descending slope along the northbound side of the roadway. The wall structure will support a combination of new fill to raise roadway grade and existing soils below current grade. Based on the location of the wall alignment, the wall structure will be supported by drilled pier foundations (i.e. soldier piles).

RW-5 and RW-6 will be located approximately across from one another on each side of the roadway. RW-5 will be located along the northbound side of the road while RW-6 will be located along the southbound side. RW-5 was originally planned to consist of a Caltrans Type 5 wall but the wall system was changed and will now be a permanent soldier pile system due to concerns over possible effects of scour attributed to flow within the creek. RW-5 will also include earth anchors for resistance to lateral load. RW-6 will consist of a Caltrans Type 1 wall along the southbound side. Both walls will support new fill required to raise grade.

RW-7 will support a cut of significant height that is required along the inner radius of the roadway alignment. This wall was originally planned to consist of a soil nail wall structure but was subsequently changed to an earth anchor diaphragm wall structure. This change in wall structure was intended to reduce the potential for adverse effects on the existing oil well infrastructure that currently exists behind the wall alignment. However, the existing oil production infrastructure is likely located within the zone of reinforcement. Material exposed in the cut (and supported by the wall) is anticipated to be bedrock of the Fernando Formation (Tf).

RW-9 is planned to consist of a soil nail wall to support cut along the northbound side of the roadway. Based upon geotechnical exploration, we anticipate the material that will be exposed in the wall cut to consist of the older alluvial deposits followed by bedrock formation.

RW-10 and RW-11 will be located along the northbound side of the roadway. RW-10 will, in effect, comprise an extension of the wingwall for the western abutment of Bridge No. 3. The proposed RW-10 will be located behind an existing concrete wall and will allow for removal of the existing wall structure. The alignment of RW-11 will parallel the orientation of the roadway and will support a combination of new fill to raise roadway grade and existing soils below current grade. Based on the location of the wall alignments, both wall structures will be supported by drilled pier foundations (i.e. soldier piles) and include earth anchors due to wall height.

RW-12 and RW-14 will be located along the southbound side of the roadway and each wall will consist of a soil nail wall structure. Based upon geotechnical exploration, we anticipate the material to be exposed in the wall cut (and supported by the wall) will be alluvial/older alluvial material.

RW-13 will be located along a cut required to establish a new access drive north of the roadway, generally in line with roadway Sta. 57+41 to 58+60. This wall is planned to consist of a soil nail wall system. Based upon our geotechnical exploration, we anticipate the material to be exposed in the wall cut (and supported by the wall) will be alluvial/older alluvial material.

RW-15 will be located opposite RW-14 along the northbound side of the roadway. This wall was originally planned to consist of a Caltrans Type 1 semi-gravity cantilever wall but the wall type has been revised to a soil nail wall. The location of the wall requires cut into to an existing ascending slope. Material exposed in the cut is anticipated to be older alluvial materials.

RW-16 will be located near the northern extent of Bridge 2 along the southbound side of the roadway. RW-2 is planned to consist of a Caltrans Type 1 semi-gravity cantilever wall structure.

1.5 Purpose and Scope

Details regarding the proposed wall structures have been based upon the project plan set developed at the 100% design submittal and updated as final design progressed. The latest General Plan sheets for the respective retaining walls are included in Appendix A. Recommendations presented in this report were based upon understanding of the project structures; subsurface exploration consisting of borings and CPT soundings; geophysical survey (see Section 2.6.1) and geologic mapping; and evaluation of the collected data. Scour depths for use in design have been determined by others for the proposed bridge structures but no scour analysis has been performed for the wall structures located along the creek channel.

In terms of discrete tasks, our scope for service included the following:

- ***Literature Review***: In preparation of this report, we performed a review of relevant geotechnical and geological literature available in the public domain and in our in-house library. A complete list of references used in preparation of this report is presented in Section 5.0.

- ***Field Exploration:*** Our field exploration was performed in phases that included three large-diameter borings advanced by a truck-mounted drilling rig using a bucket-auger apparatus. These borings were performed in the private property (Bridge Energy parcel) along the south side of Brea Boulevard and were intended to explore the geologic conditions in which proposed wall cuts will be performed.

  Exploration also included small-diameter boreholes drilled by hollow-stem auger advanced by a truck-mounted drilling rig. These borings were primarily located along the existing roadway at accessible locations and off the roadway in the private property to better assess conditions in the various wall areas. These borings were intended to provide subsurface data that would be used in the design of foundations for bridge structures and retaining walls, expose the existing pavement section (i.e. thickness of asphalt concrete and base course), and explore the subsurface conditions below the pavement of the existing roadway.

  Additional field exploration was conducted to supplement available data and provide further exploration of various retaining wall and the channel wall areas proposed in association with the proposed bridge structures. The recent exploration consisted solely of test borings and included test boring Nos. 19 through 40 conducted during the period of September to October of 2020.

Field sampling and testing performed during drilling included drive sampling using a split-barrel sampler. In addition, bulk samples of the auger cuttings were collected at various depths below grade. Drive samples were collected from the borings using a Modified California ring-lined sampler with sampling conducted in accordance with ASTM D3550. Other samples were collected by the Standard Penetration Test (SPT) performed within the borings in accordance with ASTM D1586. The ring and SPT samplers were driven for a total penetration of 18 inches using a 140-pound automatic hammer falling freely for 30 inches for the hollow-stem auger borings; sampling of the large diameter borings was performed using the weight of the drill rig Kelly bar as the drive weight. The number of blows per 6 inches of penetration was recorded on the boring logs included in Appendix B, *Field Exploration* unless practical refusal was encountered (i.e. greater than 50 blows) for an individual 6-inch test interval.

The borings were logged in the field by a California Certified Engineering Geologist and a geotechnical engineer from our staff. Each collected soil sample was reviewed and described in general accordance with the Unified Soil Classification System. The samples were sealed and packaged for transportation to our Irvine laboratory.

Upon completion of drilling activities, the boreholes that extended to depths greater than 30 feet were backfilled with either a cement-bentonite grout or bentonite pellets in conjunction with collecting and placing all cuttings and drilling spoils in 55-gallon drums for temporary storage prior to final disposal at an appropriate waste collection facility. The large diameter bucket-auger borings and the small diameter, shallow hollow-stem auger test borings were backfilled with soil cuttings. The ground surface was patched with cold asphalt concrete (AC) to match existing site conditions.

The field exploration was supplemented by advancing a total of ten (10) Cone Penetrometer Test (CPT) soundings. The CPT soundings were performed in accordance with ASTM D 5778 and D 3441.

The approximate locations of the test borings and CPT soundings are shown on Plates 1 through 6, *Exploration Location Map* included at the end of the report. The logs of the field exploration are included in Appendix B.

Based upon the subsurface conditions encountered during exploration and the observations collected by field mapping, a number of geotechnical cross-sections were developed for the project area. The locations of the sections were intended to be representative of the proposed walls and slopes. The locations of the cross-sections are shown on Plates 1 through 6, and the individual sections are presented in ascending numerical order (referenced to project stationing) on Plates 7 through 10.

- ***Laboratory Testing:*** Geotechnical laboratory testing was performed on select soil samples collected during our field exploration to determine the relevant engineering properties of the encountered subsurface soils. The results of laboratory testing are presented in Appendix C, *Laboratory Test Results.*
- ***Geotechnical Design and Analyses*:** Geotechnical engineering analyses were conducted using data obtained from the subsurface exploration to evaluate geotechnical conditions and develop recommendations for design of the retaining walls and roadway pavement. Results of the analyses are presented in Appendix D, *Engineering Analyses*.
- ***Report Preparation*:** Relevant geotechnical data were compiled in this report along with our findings and recommendations for the proposed retaining wall structures and pavement.

2.0 GEOTECHNICAL AND GEOLOGIC OVERVIEW

2.1 Available Information

Available data relative to the existing structures and pavement within the project were very limited. Structural data regarding the existing bridges were also limited. No data were available through review of on-line sources for Bridge No. 55C-0121. Information collected for Bridge No. 55C-0122 included a General Plan and Foundation Plan for seismic retrofit planned in 1997. Similar information was obtained for Bridge No. 55C-0123 as well as a report prepared by Lim & Nascimento Engineering Corp. (Contract No. 59Y021, April 11, 1997) that provided structural data and evaluation in advance of proposed retrofit activities. The geotechnical data included a cursory discussion of subsurface conditions but specific test boring or laboratory test data were not included.

Supplemental geotechnical data in the general vicinity of the proposed project was obtained in the geotechnical report prepared by Caltrans (1991) for the Climbing Lane Widening project for State Route 57. A portion of that project area includes the Tonner Canyon Road Undercrossing, which is located in the geologic formation through which Brea Boulevard passes.

No information was available regarding the pavement history of the roadway (i.e. frequency of periodic repairs, rehabilitation events, pavement overlays, etc.).

2.2 Existing Laboratory Data

Evaluation and analyses presented in this report did not rely upon laboratory test data prepared by others and no such data is known to exist for the subject region of Brea Boulevard. Data presented in the Caltrans report (1991) was reviewed to supplement the data generated as part of the exploration conducted by our firm.

2.3 Site Topography

The portion of Brea Boulevard that is planned for widening is located on the USGS Topographic Maps for the La Habra and Yorba Linda Quadrangles. The existing roadway traverses the bottom of a distinct linear and relatively narrow west-northwest trending valley (Brea Canyon). The ephemeral, antecedent Brea Creek channel meanders from east to west through the canyon bottom, crossing beneath the alignment at three bridge locations. The lower portions of the valley floor are manifest in stair-stepped topography exhibiting a series of flat-lying benches (terrace surfaces) bracketed by intermediate slopes ascending away from the modern creek channel. The terraces represent the remnants of former alluvial plains in the valley, now abandoned due to more recent stream entrenchment. It is common for the morphology and elevation of the terrace surfaces to mirror each other on opposite sides of the canyon/creek. The roadway variably spans both older and younger age alluvial terraces through the valley. The existing roadway gradient ascends from approximate elevation (El.) 390 feet above mean sea level at Sta. 7+00.00 on the west to El. 512 feet at Sta. 107+87.94 on the east, a total rise of around 122 feet in vertical elevation.

The bounding walls of Brea Canyon ascend south and north from alluvial terrace areas and manifest in moderate to steep hummocky topographic relief. Several unimproved access roads transect hillside areas, providing access to abandoned and active oil wells on leveled cut/fill pads. Hilltop elevations south and east of the roadway reach elevations of approximately 770 feet. Canyon terrain on the north rises at least 450 feet higher than the south, achieving elevations of approximately 1,228 feet.

2.4 Regional Geologic Setting

From a regional perspective, the roadway lies within the Peninsular Ranges Geomorphic Province of Southern California. This province has a regional expanse of approximately 900 miles that extends from the Santa Monica Mountains on the northwest to the tip of Baja California to the southeast (Yerkes, et al., 1965). The province is composed of a northwest-trending series of mountain ridges and alternating sediment-filled valleys, bounded by fault zones. The faults tend to truncate, merge with, or terminate at the Transverse Ranges province to the northwest. The San Jacinto, Whittier-Elsinore, Palos Verdes, and Newport-Inglewood fault zones are most prominent within the province. Bedrock is generally composed of intrusive pre-cretaceous age igneous rocks ranging in composition from gabbro to granodiorite and Tonalite. These basement rocks are overlain by a sequence of uplifted, faulted and folded Cenozoic age sedimentary marine and non-marine formations.

Brea Canyon lies immediately northeast of the abrupt regional geographic boundary between the elevated Puente Hills block on the northwest and broad flat-lying alluvial plain of the Los Angeles Basin (LA Basin) on the southeast.

2.5 Local Geologic Setting

The Puente Hills are an uplifted block of smoothly eroded hills underlain by Miocene to Pliocene age bedrock. This striking linear southwest margin on the hills are coincident with and formed by the Whittier Fault Zone. The origins of the canyon and its orientation parallel to the Whittier Fault Zone relate directly to the tectonic history of the region. Lateral movement along the faults has deflected the north-south axis of Brea Creek a distance of approximately 4,000 to 5,000 feet to the west-northwest (Yerkes, 1972). This offset has also resulted in the juxtaposition of completely different rock formations on opposite sides of Brea Canyon.

As further discussed below, tectonics have played an important role in development of the existing topography and morphology of the project area. Brea Canyon is defined as a fault-valley; a valley subjected to and formed by past, currently inactive fault activity. Although some evidence of faulted older alluvium deposits is reportedly documented in Brea Canyon, no evidence exists for offset of any Holocene age alluvium (Yerkes, 1972). Presently-active faults are mapped as transecting the hills a short distance north of Brea Canyon, within the boundaries of the Alquist-Priolo Earthquake Fault Hazard Map for the Whittier Fault Zone published by the California Geological Survey (CGS).

2.6 Faulting and Seismicity

The tectonic regime of southern California and the site area was very different from the regime active today. Major changes relate to a transition of the North American tectonic plate boundary from subduction to a translational style of motion. This change resulted in formation of the San Andreas Fault system. Since middle- to late-Miocene time over the past 16 million years, the site area was subjected to first extensional and then compressional forces (Bjorklund, 2003). The north-south oriented compressional forces were active between 14 and 8 million years ago, and produced large depositional grabens and local volcanism. The Proto-Whittier Fault initially developed as a normal fault under this regime. Over the past 8 million years, the San Andreas and related faults matured, and the overall motion became compressional.

The former normal Whittier Fault transitioned into a reverse fault, accommodating uplift of the Puente Hills Block. Movement along the Whittier Fault has occurred since early Pliocene time, but mostly during the late Pleistocene (Yerkes, 1972). Reverse offset resulted in the emplacement of older bedrock of Miocene age north of the fault, over the top of younger Mio-Pliocene age bedrock units south of the fault zone. In accommodating some of the uplift and smaller amounts of right-lateral strike slip, two subsidiary parallel reverse faults formed southwest of the Proto-Whittier Fault, including the Tonner and Menchego Faults, respectively. The period of reverse thrusting also resulted in formation of significant folds (anticlines and synclines), which became entrapments for the oil now extracted from the Brea-Olinda Oil Field. The present day Whittier, Tonner and Menchego Faults all have a similar strike of 65 to 70 degrees (northwest). The approximate trace of these faults is depicted on Figure 2, *Regional Geology Map*.

2.6.1 Fault Exploration

In an effort to further constrain the date of last offset along the Tonner Fault, considered equivalent in last offset to that of the Menchego Fault, each currently mapped as inactive, Leighton Consulting commissioned a seismic tomography survey. The survey included three separate transects in proximity to and crossing the fault, in areas underlain by deposits of Quaternary Older Alluvium within the nearby oil field. The locations of the survey lines and results of the survey are included in Appendix B.

In theory, seismic tomography methodology reveals the distribution of subsurface geologic units and geologic structure such as faults. Different conditions are indicated by the velocity of compressional or shear waves that are introduced into the subsurface through use of a sledgehammer on an aluminum plate affixed to the ground. Unlike traditional refraction, a large amount of data is obtained and processed/analyzed using the SeisOpt Pro (Optim, 2008) computer program. SeisOpt Pro uses first arrival pulses and elevation data to produce subsurface velocity models through a nonlinear optimization technique called adaptive simulated annealing. The resulting velocity model provides a tomography image of geologic conditions. Both vertical and lateral velocity information is contained. Changes in layer velocity are revealed as gradients rather than discrete contacts, which typically are more representative of actual conditions.

A significant amount of electrical and vibrational interference was observed at the site during the survey, thought to be associated with nearby oil well pumping and drilling activities. As a result, while the tomographic profiles showed no low velocities projecting to the surface, the survey overall was not able to sufficiently overcome the background noise and offer any otherwise conclusive data. The topographic profiles are included in Appendix B.

2.6.2 Seismicity

Review of the USGS Seismic Source Parameters database has identified the presence of several faults of significance in the vicinity of the proposed roadway improvement project area. The identified faults are summarized as follows using the location of Bridge 2 as the point of reference for distance measurements:

Table 3 – Geologic Faults

Fault Name	Distance (km)	Style of Faulting	Slip Rate (mm/year)	Range of M_{max}	
				Ellsworth	Hanks-Baukin
Elsinore (Whittier)	0.11	Strike Slip	2.5	7.0	6.8
Puente Hills (Coyote Hills)	5.12	Thrust	0.7	6.90	6.60
Chino	16.4	Strike Slip	1.0	6.70	6.40
Sierra Madre (connected)	22.35	Reverse	2.0	7.30	7.20
Elysian Park	24.09	Reverse	1.3	6.70	6.50
Cucamonga	25.37	Thrust	5.0	6.70	6.50
San Joaquin Hills	27.38	Thrust	0.5	7.28	7.19
Newport Inglewood	28.12	Strike Slip	1.3	7.50	7.50
Elsinore	30.33	Strike Slip	5	7.28	7.19
Palos Verdes	39.92	Strike Slip	3	7.30	7.20
San Andreas	51.48	Strike Slip	29	7.91	8.02

The faults presented in the table above do not comprise an exhaustive, inclusive listing of all identified faults or rupture scenarios but are considered to be representative of the seismic regime. Recommendations for seismic design are presented in Section 3.1 based upon the Caltrans *Seismic Design Criteria*.

2.7 Seismic Hazards

2.7.1 Fault Rupture

To protect structures from ground surface rupture hazards along a fault, the California Geological Survey (CGS), under the State-mandated Alquist-Priolo Act of 1972, has delineated "Earthquake Fault Zones" or "Alquist-Priolo Special Studies Zones" along active or potentially active faults. Due to the proximity of the roadway alignment relative to known fault traces, detailed field exploration and evaluation was performed and was discussed in Section 2.6 of this report with regard to faulting and fault rupture.

Based on the above, the principal seismic hazard that could affect the roadway, south of Station 73+50, is ground shaking resulting from an earthquake occurring along one of several major active or potentially active faults in southern California. The shaking hazard is similar for the roadway north of Station 73+50; however, the potential for surface fault rupture is an added hazard, where the active strands cross the road. No bridge structures or retaining walls are currently proposed north of Station 73+50.

2.7.2 Liquefaction

Phenomenon and Consequences – Liquefaction is the phenomenon of the reduction in strength and stiffness of certain soil types that exist below the groundwater table when subjected to strong ground shaking such as typically associated with seismic activity. Soils most susceptible to liquefaction are saturated granular deposits that exhibit a relative density of loose to medium dense. The phenomenon occurs due to the generation of excess pore pressures in the soils resulting from the tendency for these loose granular deposits to densify during strong groundshaking, but the densification (i.e., consolidation) process is impeded due to the presence of pore water and the temporary inability of the water to drain. As a consequence, the pore pressures within the saturated soils increase above hydrostatic pressure. Liquefaction occurs when this excess pore pressure (i.e. magnitude above hydrostatic) approaches the magnitude of the in-situ lithostatic stress and, therefore, the difference between the in-situ stress and excess pore pressure approaches zero.

In general, liquefaction hazards are the most severe in the upper 50 feet below ground surface for structures supported at-grade on shallow foundations. Depending upon the depth below ground surface and the extent of the susceptible deposits, the effects of liquefaction at sites with level grade consist of the following:

- Settlement of the ground surface as pore pressure equilibrium is reestablished in the soils after groundshaking;
- Ground failure in which large, intact blocks of the non-liquefied soils above the water table (the non-liquefied crust) develop fissures. These blocks tend to oscillate during ground shaking, thereby resulting in the potential for differential horizontal displacements (i.e. "ground oscillation"); and
- Loss of bearing strength and failure of foundations.

Liquefaction will also affect deep foundations in that the soils susceptible to liquefaction temporarily lose their capability to provide foundation support (both vertical and lateral load resistance); and impart downdrag and the associated drag load on deep foundations as the liquefied deposits consolidate to reestablish equilibrium. In effect, the drag load increases load demand on the foundations.

Triggering Analysis – Evaluation of the potential for liquefaction to occur was performed using a combination of the test boring and CPT data generated from field exploration. Liquefaction triggering was evaluated using the methods by Youd et al. (2001) as programmed in the *LiqSVs* software package (test borings) and the *CLiq* software package (CPT soundings), both produced by Geologismiki (2006). Evaluation of seismic-induced settlement was performed using the method described in Zhang (2002) as programmed in the software. Analysis was performed using a groundwater table typically in the range of 20 to 25 feet below ground surface at the various boring and CPT locations; shallower depths were used where the results of field exploration indicated the presence of groundwater above a depth of 20 feet. The following input parameters were utilized in our evaluation:

- Peak ground acceleration of 0.65g for a 975-year average return period (MCE event); and

- Mean Moment magnitude of 6.72 and distance of 8.9 km determined by deaggregation of the seismic hazards using USGS online deaggregation program.

Summary of Results – Results of the analysis generally indicated the potential for liquefaction triggering was low in the vicinity of Bridge 2 and east of retaining wall RW-11 and, therefore, not a significant design consideration for these regions of the proposed roadway expansion.

The potential for liquefaction to be triggered was identified in proximity to the following structures planned for the proposed project:

- Bridge No. 1 (approximately roadway Sta. 23+00)
- RW-1 and RW-2
- RW-4
- RW-8

The potential for liquefaction identified at the CPT soundings and borings near Bridge 1 and Bridge 3 along with the associated effects will be further discussed in the geotechnical report prepared specifically for the bridge structures.

2.7.3 Lateral Spreading

Seismically-induced lateral spreading involves primarily lateral movement of earth materials due to ground shaking. For lateral spreading to occur, the liquefiable zone must be continuous, unconstrained laterally, and free to move along gently sloping ground toward an unconfined area. Due to the general absence of potentially liquefiable soils in the vicinity of Bridge 2 and east of Bridge 3 (i.e., RW-12 and easterly), the potential for lateral spreading is considered low and not a significant design consideration for the majority of the structures planned for the proposed project.

The occurrence of liquefaction near Bridge 1 and the retaining wall structures listed above and the associated effects of liquefaction on global stability are addressed in the respective sections of this report for the specific wall systems. The following table summarizes the estimated magnitude of lateral displacement attributed to liquefaction.

Table 4 – Estimated Lateral Displacement at Walls

Retaining Wall		Analyzed Section	Liquefaction Stratum[1]		Yield Acceleration (k_y)	Displacement (inches)
RW No.	Type		Top	Bottom		
1, 2	MSE, Type 1	18+00	375	370	0.16	6.9
4	Soldier Pile	26+00	374	369	0.21	4.1
8	Soldier Pile	35+00	396	391	0.18	5.5
8	Soldier Pile	38+00	392	387	0.14	8.8

Note: (1) Approximate elevations based upon ground surface at time of exploration from available topographic data on Plates 1 - 6, *Geotechnical Exploration Plan*

The lateral displacements presented in the table above have been based on stability analyses using the results of liquefaction assessment of test boring data. Due to the coarse sampling interval inherent in test boring exploration, the identification of potentially liquefiable strata generally results in the design thicknesses being equal to the sampling interval, typically 5 feet. In addition, the lack of a series of exploration points along a defined transect crossing a given wall location requires considerable extrapolation of the subsurface profile.

The potential for liquefaction to occur was based upon the available test boring data. At a number of these boring locations, no Cone Penetrometer Test (CPT) soundings were available for comparison or to refine the liquefaction assessment using the greater definition in stratigraphy that is provided by the continuous nature of the CPT log. Although the CPT may similarly identify liquefaction potential, the refinement in stratigraphy can result in zones of significantly reduced thickness and perhaps less continuity in the lateral of such deposits. Analysis of the CPT soundings performed as part of the initial exploration of the project area yielded such results in which potentially liquefiable strata were thin and generally not considered to be of significance with the exception of the area of Bridge 1.

The lateral displacements summarized in the table above are mean values thereby indicating that some variance should be expected with the maximum magnitude being potentially up to twice the stated value. The associated deformations in the proposed retaining structures and slopes supporting the roadway may be tolerable in recognition of the need to perform repairs, which may temporarily affect traffic flow. Alternatively, the foundations of the retaining structures may be designed to resist liquefaction-induced displacements and, in effect, retain the roadway alignment. However, design to provide such confinement will result in drilled shafts considerably greater in length that currently planned and perhaps shafts lager in diameter with increased reinforcement.

The necessity of design modifications or the acceptance of additional risk with respect to liquefaction is recommended to be evaluated after CPT subsurface exploration of these areas. As discussed, the CPT will provide greater detail in the subsurface profile and may reduce the significance of strata susceptible to the liquefaction resulting in either reduced risk or less demand upon structure foundations.

2.7.4 Seiches and Tsunami

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the absence of enclosed bodies of water near the site and the inland location of the site, seiches and tsunami risks at the site are considered negligible.

2.8 Subsurface Soil and Geologic Units

Based on our review of available literature and the findings of our subsurface exploration and field mapping, we find the roadway alignment is largely underlain at the surface by deposits of Pleistocene to Holocene age alluvium (see Figure 2, *Regional Geologic Map)*. The alluvium predominantly consists of weak to moderately consolidated sands and gravels. In and around the existing bridge abutments and along the roadway are localized deposits of undocumented artificial fill of variable thicknesses. The alluvium and fill are underlain by Tertiary age marine and non-marine (terrestrial) bedrock formations. North of the active Whittier Fault Zone, the bedrock consists of the Soquel Sandstone and Siltstone Yorba Shale, which are each members of the Monterey Formation. South of the active Whittier Fault Zone, within Brea Canyon, are sandstone and claystone facies assigned to the Pliocene age Fernando Formation. Geologic formational names follow those of Dibblee (2001a and 2001b). For the purposes of this report, we have grouped the facies of the Fernando Formation into a single “undifferentiated” unit.

The general stratigraphic relationships of encountered subsurface units are noted in our borings included in Appendix B. A general description of each unit is described below, based on our field and laboratory interpretations.

2.8.1 Artificial Fill Undocumented

Map Symbol: **Afu**; Recent Age - Consists of light brown silty sand with gravel and poorly graded sands, silt and gravel. Mantles site surface locally, mainly limited to abutment areas on opposite sides of existing bridges and near surface below and adjacent to the pavement. The thickness of fill varies and may exist locally in other unexplored areas along the right-of-way (ROW).

2.8.2 Quaternary Alluvium

Map Symbol: **Qa**; Holocene Age - Consists of alternating layers of clayey sand and gravel that are loose to medium dense and moist. Exposed at surface along drainages or underlies fill within the northern and southern portions of the alignment. Basal contact depths in our borings were up to approximately 12 feet below existing grade.

2.8.3 Quaternary Older Alluvium

Map Symbol: **Qoa**; Pleistocene Age - Consists of alternating lenses of brown to reddish brown and light yellow brown silty sand to sand with gravel and cobbles, and olive green clayey sand that is medium dense to dense and locally wet. Exposed at surface or underlies deposits of Quaternary Alluvium within the central portion of the alignment. Basal contact depths in borings were up to approximately 28 feet below existing grade.

2.8.4 Fernando Formation Undifferentiated

Map Symbol: **Tfs/**; Sandstone/Siltstone/Claystone Facies; Pliocene to Early Pleistocene Age - Consists of thin alternating beds of light to dark grey, yellow brown and olive brown siltstone, claystone and sandstone that is soft to hard, contains local concretionary beds, is internally sheared, petroliferous, oxidized in near surface, and harder and unoxidized at depth. Limited in occurrence to areas on lower north and south sides of Brea Canyon. Significantly folded with locally steep and overturned bedding. Observed in borings to maximum depth of drilling where encountered.

2.8.5 <u>Yorba Shale Member Monterey Formation</u>

Map Symbol: **Tmy**; Middle Miocene Age - Consists of thin alternating beds of very dense siltstone and sandstone with local gravel, blue-grey to blue-green and dark-gray to olive-grey in color, exhibiting locally steep to overturned bedding. Limited in occurrence to areas on lower north and south sides of Brea Canyon. Observed in borings to maximum depth of drilling where encountered.

Map Symbol: **Tmss**; Soquel Sandstone Member Monterey Formation; Middle Miocene Age - Consists of massive reddish-brown sandstone that is intensely weathered, conglomeratic and oxidized. It is limited in occurrence to northern alignment areas, generally north of active Wittier Fault Zone. Observed in borings to maximum depth of drilling where encountered.

2.9 <u>Groundwater</u>

Groundwater was typically encountered in the deeper test borings at depths approximately coincident with the elevation of the creek channel. Groundwater levels encountered during subsurface exploration are summarized in Table 5.

Table 5 – Summary of Groundwater Levels

Boring No.	Current Surface Elevation[1] (feet)	Groundwater	
		Depth (feet)	Approximate Elevation (feet)
LB-02	393	17	376
LB-04	430	25	405
LB-06	443	24	419
LB-07	442	25.5	416.5
LB-14	420	26.7	393.3
LB-15	465	40.9	424.1
LB-19	398	36.5	331.5
LB-27	426	31	395
LB-28	383	14.5	368.5
LB-29	385	15	370
LB-34	486	37	449
LB-37	405	56	349
CWE P-1	385	19.5	365.5
CWE P-2	388	18	370
CWE P-4	431	38.5	392.5
CWE P-5	458	42.5	415.5

(1) Estimated from available topographic data on Plates 1 - 6, *Geotechnical Exploration Plan*

Based on the available groundwater level information, the depth to groundwater used in analysis ranged from 20 to 25 feet depending upon location; shallower depths were used where groundwater was either encountered during or inferred from field exploration.

2.10 Idealized Subsurface Profiles

Based on the subsurface soil and groundwater conditions encountered during field exploration and the findings of field geologic mapping, a number of cross-sections were developed (Plates 7 through 10) to depict the subsurface conditions at select locations that were determined to be of significance for design. Table 6 presents a summary of the cross-sections that were used for analysis. Geotechnical design parameters are presented in the analyses included in Appendix D.

Table 6 – Geotechnical Analysis Sections

Wall Information		Roadway Stationing[1]		Geotechnical Cross-Section[2]
Wall No.	Type of Retaining System	Begin	End	
1	MSE	15+88.68	19+26.66	18+00
2	Semi-Gravity Cantilever	18+67.66	20+14.08	18+00
3	Soil Nail	23+20.56	25+67.25	23+50
4	Soldier Pile	25+10.95	26+89.71	26+00
5	Soldier Pile with Anchors	28+39.46	29+84.08	29+50
6	Semi-Gravity Cantilever	29+02.84	30+47.95	29+50
7	Anchor Diaphragm	31+11.86	34+44.99	33+00
8	Soldier Pile[3]	33+38.83	40+13.44	35+00
9	Soil Nail	39+10.51	40+67.73	40+00
10	Soldier Pile with Anchors	41+92.26	42+79.68	40+50
11	Soldier Pile with Anchors	42+58.01	45+50.86	42+50
12a	Soil Nail	44+78.35	52+79.13	47+00
12c	Soil Nail	53+07.13	54+39.13	53+50
13	Soil Nail	57+41.19	58+60.00	58+27
14	Soil Nail	60+37.53	70+38.71	62+00
15	Soil Nail	62+29.98	68+79.18	66+50
16	Semi-Gravity Cantilever	31+39.80	31+89.43	33+00

Notes:
(1) Refer to Geotechnical Exploration Plan (Plates 1 - 6) for wall locations.
(2) Refer to Geotechnical Cross-Sections (Plates 7 - 10) for subsurface profiles.
(3) RW-8 includes sub-horizontal earth anchors beginning at Soldier Pile No. 64 (approximate wall Sta. 16+34).

2.11 Scour Potential

The potential for scour was specifically evaluated by others for the proposed bridge structures. The results of that assessment are incorporated in the recommendations for bridge foundation design presented in the Foundation Report for Bridge Structures submitted under separate cover. We understand that analysis of scour potential for other wall structures located along the sides of the creek channel was not performed.

2.12 Corrosion Potential

For structural elements, Caltrans considers a site to be corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

- Chloride concentration is 500 parts per million or greater
- Sulfate concentration is 1,500 parts per million or greater
- pH is 5.5 or less

Testing to measure the concentrations of soluble sulfate and chloride is required when the minimum resistivity is 1,100 ohm-cm or less. Corrosion test results from this exploration are summarized in Table 7. Based on the test results, the soils are considered to be corrosive per Caltrans guidelines and the minimum resistivity exhibited by the tested samples.

Table 7 – Corrosivity Test Results

Boring No.	Depth (feet)	Approximate Station	Resistivity (Ohm-cm)	Chloride (ppm)	Sulfate (ppm)	pH
LB-03	0 to 5	31+50	320	375	1,443	6.82
LB-07	0 to 5	58+00	570	128	315	7.23
LB-14	5 to 10	37+00	715	54	1,374	7.05
LB-14	15 to 20	37+00	1,100	129	88	7.47
LB-14	25 to 30	37+00	1,099	71	293	7.81
LB-16	0 to 5	53+50	1,586	85	114	7.55
LB-18	15 to 20	64+50	3,260	34	74	7.67
LB-19	25 to 35	26+00	1,700	40	198	8.08
LB-26	10 to 20	43+50	509	220	955	7.57
LB-32	30 to 40	59+20	448	320	3,634	6.34
LB-34	20 to 30	62+00	2,000	40	132	8.23

The measured sulfate concentrations indicate special mix designs will be necessary for concrete that is in contact with the soils at the project site. Based upon guidelines provided by the American Concrete Institute (ACI 318-14), the exposure category of “S1” appears to be appropriate for the project site. However, the sample collected from a depth range of approximately 30 to 40 feet at Test Boring LB-32 (approximate El. 454 to El. 444) yielded a sulfate concentration (3,634 ppm) that results in an exposure category of “S2” for concrete in contact with these materials.

The measured concentrations of chloride were less than the Caltrans threshold of 500 ppm above which corrosion protection measures should be implemented with respect to chloride exposure.

The results of resistivity testing indicate the tested soils exhibit corrosive potential for metallic materials in contact with the soils. The appropriate provisions in design and construction should, therefore, be undertaken to reduce the potential for material degradation through corrosion processes. Of particular concern will be providing the appropriate corrosion protection for the reinforcing rods of the proposed soil nail walls and anchor tendons of the proposed diaphragm wall and other locations where anchors may ultimately be used.

2.13 Seismic Shear Wave Velocity (Vs_{30})

Shear wave velocity measurements were conducted at three of the CPT sounding locations. Testing/measurements were conducted at approximate 5-foot intervals. The results of testing indicated average shear wave velocities in soil material to be approximately 600 feet per second (fps). Shear wave velocities measured in the bedrock were typically in excess of 1,000 fps. Based upon the results of exploration and testing, the shear wave velocity used in seismic profile analyses was 310 meters per second (approximately 1,010 fps).

3.0 RETAINING WALL RECOMMENDATIONS

The findings of our field exploration and laboratory testing program have been used to conduct the geotechnical engineering analyses relevant for design of the various retaining wall structures and pavement for the proposed road widening project. Project information has been based upon the 100% concept design plan set (Mark Thomas, 2021). The current General Plan sheets for the respective walls are included in Appendix A. Geotechnical recommendations for design are provided in the following sections.

3.1 Response Spectra

Caltrans design ARS curves were developed for each of the proposed bridge locations following Caltrans *Seismic Design Criteria* (2019) using Caltrans ARS Online, V.3.0.2. The Caltrans seismic hazard corresponds to the USGS hazard data for a 975-year average return period (i.e. 5 percent chance of exceedance in 50 years). The subsurface profile was modeled by a Vs_{30} value of 310 meters/second. The response spectra curves for the site are provided on Figures 3a through 3c for Bridge Nos, 1, 2 and 3, respectively. The digitized values of the design ARS curves are also tabulated in these figures.

The results of the seismic analysis conducted in accordance with Caltrans procedures indicated a peak ground acceleration of 0.65g and a mean magnitude of 6.72. The mean site-to-source distance that corresponds to a spectral period of 1 second was 13.9 km.

3.2 Semi-Gravity Cantilever Walls

The wall type selected for RW-2, RW-6 and RW-16 consists of a cast-in-place semi-gravity cantilever retaining wall. Preliminary design is understood to be performed based upon the Caltrans *Standard Plans* for Load Factor Resistance Design (LRFD). Recommendations for design and construction are presented below.

Table 8 – Semi-Gravity Cantilever Wall Design Information

Wall Information		Roadway Stationing[1]		Wall Dimensions	
Wall No.	Type of Retaining System	Begin	End	Length	Maximum Height (feet)
2	Semi-Gravity Cantilever	18+67.66	20+14.08	149’	8
6	Semi-Gravity Cantilever	29+02.84	30+47.95	149’10¼”	14
16	Semi-Gravity Cantilever	31+39.80	31+89.43	50’	12

Notes: (1) Refer to Geotechnical Exploration Plan (Plates 1 - 6) for wall locations

(2) Refer to Geotechnical Cross-Sections (Plates 7 - 10) for profile

3.2.1 Subgrade Preparation

Footing excavation should be evaluated by the geotechnical engineer for stability and bearing suitability during construction. As a minimum, preparation of the subgrade for construction of the Type 1 walls is recommended to included overexcavation of the existing soils to a depth of 3 feet below planned bearing grade for RW-2; 2 feet below planned bearing grade for RW-6; and 3 feet for RW-16. Soils considered to be unsuitable for foundation support, if exposed at the removal bottom, should be further removed to a stable, suitable bearing subgrade as determined by the geotechnical engineer.

The lateral extent of overexcavation is recommended to be a distance equal to or greater than the depth of excavation below bearing grade as measured at the bottom of the excavation with the excavation sidewalls sloped for stability and safety.

Soils excavated as part of subgrade preparation are anticipated to be suitable for use as structural compacted backfill to support the foundations. Fill soils are recommended to be compacted to at least 90 percent of the Modified Proctor (ASTM D1557) test method at moisture contents of 1 to 2 percent above optimum moisture content. In addition to the recommended minimum extent below footings, structural compacted fill should extend to the top of the footing and to a minimum lateral extent of 4 feet horizontal beyond the toe of the wall to develop passive resistance.

3.2.2 Backfill and Compaction

Use of the Caltrans *Standard Plans* for wall design will require that the backfill material behind the wall exhibits certain minimum properties with regard to gradation, shear strength and other behavior properties. Wall backfill should conform to Section 19-3.03 of Caltrans *Standard Specifications* (2015). Wall backfill should be placed in thin, loose lifts, moisture-conditioned, and compacted to at least 90 percent of the maximum dry density obtained by the Modified Proctor test method per ASTM D1557.

3.2.3 Lateral Earth Pressure

Retaining wall design is based upon the following soil parameters: total unit weight (γ) of 120 pounds per cubic foot (pcf) and angle of internal friction (ø) of 34 degrees. The unit weight is considered to represent drained conditions. Therefore, a permanent drainage system should be included in design.

Proper drainage is recommended to be provided behind the wall in accordance with Caltrans *Standard Plan B-03* to prevent buildup of hydrostatic pressure behind the wall. The wall backfill materials should be tested by the geotechnical engineer to verify the soils meet the requirements.

3.2.4 Lateral Load Resistance

The resistance to lateral loads will be developed through sliding resistance along the base of the retaining wall and passive earth pressure from the soils in front of the retaining wall. The coefficient of sliding friction used in design is recommended to be 0.39 but may be increased to 0.62 if a footing key is included in foundation design. Passive resistance may be calculated using an equivalent fluid passive earth pressure of 420 psf/foot of footing embedment.

The recommended passive pressure value is applicable to level grade in front of the wall. The recommended value may be used in sloping grade conditions if the horizontal distance from the top of the footing to a descending slope face is maintained at a minimum three (3) times the footing thickness and the soil above the footing is ignored in the calculations. Foundations located at distances closer to a descending slope will require reduction in the passive pressure used in design. Additional recommendations can be provided on a case-by-case basis.

The passive pressure against the footing is expected to be fully mobilized at a lateral movement equal to 2 percent of the footing embedment. The mobilized passive pressure for lateral movement of less than 2 percent of the footing embedment can be linearly interpolated. As such, the passive pressure in the wall design should be determined by the structural engineer for various LRFD limit states based on the expected movement of the footing.

For service limit state, since the lateral displacement is expected to be small, the full base friction can be used in analysis based on a soil resistance factor of 1.0. The frictional resistance can be combined with the mobilized passive pressure based on lateral movement of the footing. For strength limit state, a soil resistance factor of 0.8 for base friction (φ_{τ}) and 0.5 for passive pressure (φ_{ep}) may be used to calculate the lateral resistance. For extreme limit state, the fully mobilized passive pressure and two-thirds of the base friction with a soil resistance factor of 1.0 may be used.

3.2.5 Bearing Capacity

The bearing capacity of the Caltrans Type 1 walls was verified for the effective footing width (B') and uniform bearing pressure (q) associated with the various LRFD combinations for the strength, Extreme I and Extreme II limit states stated in the *Standard Plan* for a Type 1 (Case 1) wall.

The design parameters presented in the *Standard Plan* with respect to seismic design are based upon a coefficient of lateral acceleration (k_h) of 0.20. The presumptive value is slightly less than the site-specific value (k_h= 0.22) derived for the project site on the basis of the peak ground acceleration calculated for the project site using the procedures described in the Caltrans *Seismic Design Criteria* (SDC). As a result, bearing demands (B, q) under Extreme I and Extreme II limit states should be evaluated and revised accordingly. *Deviation from the values cited in the standard plans should be submitted for our review to verify bearing capacity demands have been satisfied*.

3.2.6 Global Stability

Global stability of the semi-gravity, cantilever walls was evaluated by limit equilibrium (i.e. slope stability) analyses. Project criteria require a minimum factor of safety of 1.5 for static and 1.1 for pseudostatic conditions. Results of the analyses are presented in Appendix D and indicate global stability was satisfied for these structures.

Stability analysis indicates RW-2 (and the adjacent MSE wall RW-1) will be safe from catastrophic (i.e. "flow") failure which was modeled using the liquefied residual strength for the specific stratum and no inertial loading (k_h= 0). The potential for displacement (lateral spread) was evaluated by applying inertial loading (k_h= 0.22) in conjunction with the liquefied residual strength. Results of this analysis indicated a calculated factor of safety less than unity (FS < 1.0), thereby indicating the potential for displacement. Analysis indicated the yield acceleration (ky) was 0.16, which corresponds to a mean displacement of approximately 7 inches based upon procedures described by Bray and Travasarou (2007).

3.3 Mechanically Stabilized Earth Wall Systems

RW-1 is currently planned to consist of an MSE wall system constructed along the southbound side of the roadway. Design and construction of MSE walls are typically performed by specialty contractors with structural engineering analysis performed by consultants retained by the Contractor. In general, design is recommended to be performed in accordance with AASHTO LRFD BDS 6th Edition and the California Amendments Section 11.10 along with the FHWA Manual (NHI-10-024).

Table 9 – MSE Wall Design Information

Wall Information		Roadway Stationing(1)		Wall Dimensions	
Wall No.	Type of Retaining System	Begin	End	Length (feet)	Maximum Height (feet)
1	MSE	15+88.68	19+26.66	360	9
Notes: (1) Refer to Geotechnical Exploration Plan (Plates 1 - 6) for wall locations					

3.3.1 Subgrade Preparation

At a minimum, the upper 2 feet below MSE foundation area should be compacted to at least 90 percent of the Modified Proctor maximum dry density to provide uniform support. Preparation of the wall area may require additional overexcavation to remove existing fill where exposed at the overexcavation subgrade elevation. The foundation should be observed and accepted by the geotechnical engineer prior to initiating wall construction activities.

The geotechnical engineer shall observe and test the subgrade during compaction. Any undocumented fills, wet, loose, soft, pumping, or otherwise unsuitable soils that cannot be compacted to the specified density shall be removed and replaced with properly compacted fill.

3.3.2 Wall Backfill Material and Internal Stability

Design of the MSE wall is anticipated to be performed on the basis that the backfill material (i.e. soil within the reinforced zone of the MSE wall) will satisfy Section 47-2.02C of the Caltrans *Standard Specifications* (2018). Accordingly, the following criteria shall be used for wall backfill and reinforced fill where the MSE wall structure includes metallic reinforcement:

Table 10 – Properties of Retained Soils for MSE Walls

Soil Gradation	
Sieve Size	**Percent Passing (%)**
6-inch	100
3-inch	78 – 100
No. 4	–
No. 30	0 – 60
No. 200	0 – 15
Soil Property Requirements	
Sand Equivalent	12 minimum (CA Test 217)
Plasticity Index	6 maximum (CA Test 204)
Minimum Resistivity	2,000 ohm-cm minimum (CA Test 643)
Chlorides	Less than 250 ppm (CA Test 422)
Sulfates	Less than 500 ppm (CA Test 417)
pH	5.5 to 10.0 (CA Test 643)
Note: If 12% or less passes the No. 200 sieve and 50% or less passes No. 4, the Sand Equivalent and Plasticity Index requirements shall not apply.	

Fill material within the reinforced zone should be free of organic material and substantially free of shale or other soft, poor durability particles and shall not contain slag aggregate or recycled materials such as glass, shredded tires, Portland cement concrete rubble, asphaltic concrete rubble or other unsuitable material.

Internal design of the MSE Walls will be performed by wall vendors or specialty designers. Based upon the material characteristics presented in the table above, design of the wall for internal stability is recommended to be based upon the following:

- Reinforced soil: γ= 120 pcf, cohesion, c= 0, friction angle, ϕ= 34 degrees

3.3.3 Retained Fill and External Stability

External stability (sliding, limiting eccentricity, and bearing) of the MSE Walls will also be performed by wall vendors or specialty designers. The retained backfill soil behind the MSE wall within a 1:1 wedge behind the reinforced zone of the wall should exhibit an Expansion Index (EI) of 20 or less and Sand Equivalent (SE) greater than 30.

The following parameters are recommended for use by the wall designer in evaluation of external stability:

- Unit Weight, γ= 125 pcf
- Friction Angle of Retained Backfill, ϕ= 32 degrees
- Static (Active) Lateral Earth Pressures for Level Backfill:
  - Active earth pressure,
    Ka= 0.307
  - Active lateral earth pressure = 38 pcf (equivalent fluid)
  - Active horizontal pressure due to areal surcharge loads= Ka x vertical pressure
- Seismic Lateral Earth Pressure for Level Backfill:
  - Pseudostatic horizontal coefficient, k_h= 0.22
  - Seismic lateral earth pressure increment= 19 pcf (equivalent fluid)

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- Foundation soil: unit weight, γ= 123 pcf, cohesion, c= 200 psf, friction angle, ϕ= 28 degrees

The coefficient of friction below the MSE wall may be calculated using an equivalent friction angle of 28 degrees at the interface of the reinforced fill of the wall and the underlying soils. Passive resistance should be ignored in accordance with design guidance provided by the FHWA.

3.3.4 Compaction

Compaction of all MSE wall backfill within the zone of reinforcement should be a minimum of 90 percent relative compaction using the Modified Proctor Test in accordance with ASTM D1557. Care should be used not to damage wall facing during compaction by using light compactor or hand-held tampers within 3 feet of the panels and by proper temporary external support of the individual wall panels.

3.3.5 Bearing Capacity

Based upon the maximum design height of the wall, the minimum wall panel embedment (top of leveling pad) below finish grade is recommended to be at least 2 feet.

The maximum design height of the proposed MSE wall will be 9 feet from the top of the leveling pad. Evaluation of bearing capacity was performed for a maximum wall height (H) of 9 feet considering the foundation bearing pressures summarized in the Bearing Stress Tables (BDA 3-8, Attachment 2; H1= 9'2") for the LRFD limit states.

The analysis indicated the maximum bearing pressures are satisfied for the strength limit and extreme limit states for the indicated design height. Bearing capacity for other design heights corresponding to appropriately designed effective bearing widths (B') may be calculated using the following equations for nominal bearing capacity:

$$q_N = 2{,}500 \text{ psf} + 1{,}000 \times B' \text{ (psf)} \qquad [1]$$

Bearing capacity under the extreme limit state considering liquefaction was based upon limit equilibrium (slope stability) techniques. The results of the analysis indicate a factor of safety of at least 1.5, thereby indicating short-term stability.

3.3.6 Settlement of the MSE Walls

The maximum design height of the proposed MSE wall is 9 feet. A portion of the wall height will support fill required to raise grade. Based upon the quantity of material and the anticipated bearing stresses under service limit state (1.44 ksf, with B'= 6.1 feet), post-construction total and differential settlement of the wall is estimated to be less than 1 and ½ inch, respectively. Due to presence of granular soils underlain by bedrock material, extended long-term consolidation settlement is not anticipated.

Panel joints should typically be ¾-inch wide and typical panels are 5 feet square (area < 30 ft^2). Tolerable differential settlement along the panels is as follows, based on FHWA MSE Manual:

Joint Width	Limiting Differential Settlement	
	Area $\leq$ 30 ft^2	30 ft^2 <Area $\leq$ 75 ft^2
¾-in. (20 mm)	1/100	1/200

Differential settlement is expected to be within the indicated tolerances presented above.

3.3.7 Overturning and Eccentricity

In accordance with AASHTO LRFD Specifications (Sections 11.6.3.3, 11.6.5.1, and 11.10.5.5) for foundations on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds of the base width for the strength limit state. For seismic eccentricity evaluation of walls with foundations on soil, the location of the resultant of the reaction forces shall be within the middle two-thirds of the base for γ_{EQ}= 0.0 and within the middle eight-tenths of the base for γ_{EQ}= 1.0. For values of γ_{EQ} between 0.0 and 1.0, the resultant location restriction shall be obtained by linear interpolation.

3.3.8 Global Stability

Overall global stability of the MSE wall was evaluated in the same manner as previously described for the proposed semi-gravity cantilever wall RW-2 (Section 3.2.6 of this report) due to the proximity of these walls to one another and parallel orientation of their respective alignments.

For static and seismic case, both circular and non-circular failure surfaces were examined to determine the minimum factor of safety of the MSE wall. The minimum static and seismic factors of safety were found to exceed the minimum requirements of 1.5 and 1.0, respectively, in the absence of liquefaction. The magnitude of lateral displacement estimated in conjunction with RW-2 is considered to be applicable to the proposed MSE wall and is expected to be tolerable for the MSE wall due to the inherent flexibiltiy of this type of wall system. Global stability calculations for the MSE wall are provided in Appendix D.

3.3.9 Wall Drainage

Adequate drainage should be provided at all finished surfaces around and above the MSE Wall to maintain positive drainage. Surface drainage ditches should be lined and sized appropriately. All runoff from adjacent areas should be diverted away from the MSE wall to prevent ponding of water. The site drainage should be such that the runoff onto adjacent properties is controlled properly.

The MSE wall system is considered free-draining for purposes of design and performance. A permanent subsurface drain is, therefore, recommended to be included in wall design such as the drainage system included in Caltrans *Bridge Design Aids 3-8* (April 2013). An underdrain low and at the rear of the reinforced zone should be placed to remove water from the reinforced backfill. A typical underdrain consists of an 8-inch corrugated perforated plastic pipe in permeable material wrapped in filter fabric. Placing drainage inlets and cross-culvert pipes within the reinforced zone of the MSE wall should be avoided.

3.4 Soil Nail Wall Systems

A number of the proposed retaining wall systems will consist of soil nail wall systems due to the advantageous nature of these walls to be constructed in a top-down manner considering the need for substantial cuts into the slopes that currently exist in the area planned for road widening. The following table summarizes the soil nail wall structures; the location of each is shown on Plates 1 through 6.

Preliminary analysis of internal stability was performed using limit equilibrium (i.e. slope stability) techniques to satisfy project requirements for minimum factor of safety of 1.5 for static conditions and 1.1 for pseudostatic conditions. Pseudostatic analyses were based upon a coefficient of horizontal acceleration (k_h) of 0.33 (0.5 x PGA). Analyses included the proposed wall face batter of 10V:1H. In the analyses, the soil nails were inclined at 15 degrees below horizontal.

Table 11 – Soil Nail Wall Systems

Wall Information		Roadway Stationing		Wall Dimensions	
Project I.D. No.	**Type of Retaining System**	**Begin**	**End**	**Length (feet)**	**Maximum Height (feet)**
3	Soil Nail	23+20.56	25+67.25	240’00”	14
9	Soil Nail	39+10.51	40+67.73	156’00"	21
12a,b[1]	Soil Nail	44+78.35	52+79.13	802'00"	32
12c	Soil Nail	53+07.13	54+39.13	132’00”	18
13	Soil Nail	57+41.19	58+60.00	138’00”	24
14	Soil Nail	60+37.53	70+38.71	996'00"	31
15	Soil Nail	62+29.98	68+79.18	648'00"	21
Notes: [1] RW-12a and RW-12b combined into one continuous wall.					

3.4.1 Soil Nail Length and Spacing

Preliminary analysis of internal stability indicated a minimum soil nail length ranging from 14 to 45 feet was required to satisfy the criteria for minimum factor of safety. Based upon the materials that are anticipated to be exposed during cutting and wall construction, the maximum vertical cut performed during nail installation is recommended to be 4 to 5 feet. The recommended exposed heights are anticipated to serve as the vertical spacing between horizontal rows. The minimum horizontal spacing of the soils nails is recommended to be 4 feet but should not exceed 6 feet. The uppermost and lowest horizontal rows of soil nails are recommended to be installed 2 to 3½ feet from the top of wall and 2 to 3 feet from the bottom. In addition, nails are recommended to be located no closer than 2 feet from the ends of the wall. A summary of the preliminary analysis to evaluate the minimum required soil nail lengths is presented in Table 12. Alternate nail spacing configurations will result in changes to the minimum required lengths of the soil nails from the preliminary analysis summarized in Table 12.

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Table 12 – Preliminary Analysis of Minimum Soil Nail Length

Wall No.	Maximum Height (feet)	Section Analyzed	Vertical Spacing Sv (feet)	Horizontal Spacing Sh (feet)	Minimum Length (feet)	
					Static	Seismic
3	14	24+50	4	6	14	14
9	21	40+00	5	5	23	23
12a,b	32	47+00	5	5	39	42
12c	18	53+50	5.25	6	28	28
13	24	58+27	5	5	42	42
14	31	62+00	5	6	45	45
15	21	66+50	4	6	37	38

3.4.2 Pullout Resistance

Pullout resistance used in design depends upon the material in which the nails will be embedded and the manner in which nail construction will be performed. Inclined soil nails constructed by typical gravity flow of grout placement may be analyzed using an assumed design ultimate bond stress of 1,200 psf in the older alluvial soils (Qalo) or 2,200 psf for nails embedded in the bedrock material (Tf and Tmy) based upon general bond stress values stated in Tables 4.4 and 4.5 of FHWA guidance documents (FHWA, 2015). Design of all soil nail walls with the exception of RW-9 are recommended to be based on the 1,200 psf bond stress; design of the soil nails for RW-9 should be based upon the 1,200 psf bond stress for the portion in the alluvial soil, and may be increased to 2,200 psf for the portions that extend into bedrock.

3.4.3 Wall Deformation

Lateral movement of the top of soil nail wall during construction is estimated to be less than 0.002 to 0.003 times the wall height or approximately 1 to 1¼ inches (FHWA, 2015) for walls up to the maximum planned height of 32 feet.

Ground surface distortions at the interface between the zone of influence beyond the end of the soil nail reinforcement and the retained soil was estimated to be in the range of ¼ to ½ inch with the magnitude of distortion decreasing with depth. The extent of this zone of potential deformation

(D_{DEF}) behind the wall face depends upon the soil type and batter of the wall. Based on a wall face batter of 10V:1H, the zone of deformation (D_{DEF}) is estimated to extend approximately 35 to 45 feet from the face of the wall.

3.4.4 Bearing Capacity and Sliding Resistance

Bearing capacity is not anticipated to be a significant design consideration for the proposed soil nail walls. Evaluation of bearing capacity as part of wall design may be based upon a nominal bearing resistance of:

$$q_N = 2{,}500 \text{ psf} + 1{,}000 \text{ B' psf} \qquad [2]$$

where B' is the effective bearing width for the respective limit states.

Resistance to sliding should be evaluated solely on the sliding resistance of the bearing soils. The coefficient of sliding friction (nominal) for use in design is recommended to be 0.53 where supported by the older alluvial deposits and 0.60 where supported by the bedrock material.

Sliding stability under seismic conditions satisfies the project minimum requirement (FS = 1.1) in that the coefficient of sliding resistance stated above exceeds the design coefficient of horizontal ground acceleration (k_h= 0.33) for soil nail walls.

3.4.5 Wall Drainage

Design of the wall is based upon the presumption of drained soil conditions behind the wall and no additional load demand from the accumulation of water within the material retained by the wall. Therefore, an appropriate permanent drainage system will be required that includes proper connection to a conveyance system to properly discharge water to the storm drain or other device. The top-down manner in which the wall will be constructed requires the installation of the drainage system during construction of each section of wall as construction proceeds. A drainage system consisting of a geo-composite (e.g., drainboard) is expected to be a feasible alternative.

3.4.6 Construction Considerations

Based on the inclinations of the nails, special grouting procedures are not expected to be necessary; grout will be pumped and deposited in the boreholes by conventional tremie techniques using a small diameter grout tube.

Distortion of the existing structures in the area of the proposed wall construction are recommended to be monitored. At a minimum, an array of survey control points should be established on the existing structures within the zone of proposed soil nail installation and to an equal distance beyond to serve as baseline data for comparison.

3.4.7 Stability Testing

Field stability testing will be required to demonstrate the stability of excavation lift heights in excess of 5 feet and in areas where exposure duration exceeds one work shift. Where required, testing is recommended to be performed on the basis of the zone designations presented in Table 13. When stability testing is not performed, shotcrete must be applied during the same work shift in which excavation has occurred. Completion of the shotcrete facing may be delayed up to 24 hours if the Contractor demonstrates that the integrity of the excavated face is maintained.

Stability testing typically consists of cutting a neat excavated face no more than 5 feet in front of the location of the final wall face. The height and inclination of the excavated face should be consistent with approved project plans. The excavated face is typically at least 20 feet in length and parallel to the wall alignment. The excavated face should be left open for the duration specified in the approved plans. Stability tests are recommended to be performed in accordance with the procedures and criteria stated in Section 19-3.01D(2) of the Caltrans *Standard Specifications*.

Table 13 – Test Area Zone Designations for Soil Nail Walls

RW No.	Zone No.	Wall Station		Elevation		Test Area[1]	Notes[2]
		Begin	End	Upper	Lower		
3	1	10+00	12+51[4]	TW[3]	BW	10+75 to 11+75	Excavation in older alluvial soils
9	1	10+00	19+62[4]	TW	BW	10+70 to 11+10	Soil nails in older alluvium then bedrock
12A	1	10+00	11+75	TW	BW	11+00 to 11+75	Local dense sands and cobbles
	2	11+75	13+00	TW	BW	12+00 to 13+00	Gravels/gravelly soils; bedrock below El. 435
12B	1	13+00	15+00	TW	BW	13+50 to 14+25	Local dense sands and cobbles
	2	15+00	16+50	TW	BW	15+25 to 16+25	Gravels/gravelly soils; bedrock below El. 455
12C	1A	16+50	19+62[4]	TW	450	16+25 to 19+62	Bedrock 5 to 10 feet below TW
	1B			450	BW	16+25 to 19+62	Bedrock
13	1	10+00	11+49[4]	TW	BW	10+40 to 10+80	Local gravels and cobbles; bedrock below El. 455
14	1A	10+00	13+00	TW	475	11+00 to 12+75	Sands; locally cemented
	1B			475	BW	11+00 to 12+75	Locally cemented; Gravels and Cobbles; bedrock below El. 445 to 450 feet
	2	13+00	15+00	TW	BW	13+00 to 15+00	
	3	15+00	20+11[4]	TW	BW	15+00 to End	
15	1	10+00	13+00	TW	BW	11+00 to 12+50	Gravels, cobbles, boulders; locally cemented; bedrock below ~El. 455
	2A	13+00	16+66[4]	TW	465	14+00 to 15+00	Gravels, cobbles, boulders; locally cemented
	2B			465	BW	14+00 to 15+00	Soil nails in bedrock

Notes:

(1) Stability test recommended in the indicated range of wall station based upon wall height and/or existing grade above top of wall

(2) Generalized subsurface conditions that are anticipated to be encountered during soil nail drilling and construction

(3) TW – Top of Wall (see Wall Plans); BW – Bottom of Wall (see Wall Plans)

(4) Station corresponds to planned End of Wall

3.4.8 Load Testing

Select soil nails will be subject to Verification and Proof testing for each wall zone indicated in Table 13. The Contractor must perform load testing of soil nails designated as "verification" and soil nails designated as "proof" to verify the Contractor's soil nail installation methods and pullout resistance. Production soil nails must be represented by the "proof" soil nails within a given wall zone. Test procedures and criteria are described in greater detail in Section 46-3 of the Caltrans *Standard Specifications*.

3.4.9 Corrosion Protection

The results of corrosivity testing performed on representative samples of the material encountered at the boring locations indicates the potential exists for corrosion to occur. The cement grout used to secure the nails in the boreholes will provide both physical and chemical corrosion protection. In addition, the bars are recommended to be epoxy-coated and encapsulated with a corrugated plastic sheathing. The grout that fills the annular area around the steel bar must be low in permeability and must provide a minimum 1 inch cover.

3.5 Earth Anchor Diaphragm Wall System

Design of RW-7 as an anchor diaphragm wall is expected to be performed in accordance with the Caltrans *Bridge Design Specifications* (BDS) Section 5 (August 2004) and *Memo to Designers No. 5-12* (July 2012). Table 14 summarizes characteristics of the proposed wall structure.

Table 14 – Anchor Wall Systems

<table>
<tr><th colspan="2">Wall Information</th><th colspan="2">Roadway Stationing[1]</th><th colspan="2">Wall Dimensions</th></tr>
<tr><th>Project I.D. No.</th><th>Type of Retaining System</th><th>Begin</th><th>End</th><th>Length</th><th>Maximum Height (feet)</th></tr>
<tr><td>7</td><td>Anchor Diaphragm</td><td>31+11.86</td><td>34+44.99</td><td>296'</td><td>57'6"</td></tr>
<tr><td colspan="6">Notes: [1] Refer to Geotechnical Exploration Plan (Plates 1 - 6) for wall location</td></tr>
</table>

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3.5.1 <u>Load Demand</u>

Central to the design are the maximum ordinate of the pressure diagram (p_a) and the shape of the lateral pressure distribution. Calculation of p_a requires knowledge of the total lateral load applied to the wall face (P_{total}) to establish a calculated minimum factor of safety of 1.5 for static conditions and 1.0 for pseudostatic conditions, as well as the resultant thrust determined by Coulomb earth pressure theory (Pa) assuming coefficient of friction between wall and soil (δ) equal to zero. P_{total} determined by limit equilibrium methods shall not be less than 1.44Pa.

In addition to the magnitude of lateral thrust imparted upon the wall due to the retained earth material, the spacing of the earth anchors along the face of the wall and, in particular, the distances between uppermost anchor to the top of wall (H_1) and the lowest anchor to the bottom of the wall (H_{n+1}), will be required to calculate p_a.

- $p_a = P_{total} / (H - ⅓H_1 - ⅓H_{(n+1)})$ for multi-level anchors [4]
- $p_a = P_{total} / ⅔H$ for single level of anchors [5]

The resultant thrust determined by Coulomb earth pressure theory (Pa) for design of RW-7 is recommended to be calculated using an equivalent fluid pressure of 52 psf per foot of wall height (pcf) for static conditions and 93 pcf for seismic conditions (seismic increment 41 pcf). The seismic increment was based on a coefficient of horizontal acceleration (k_h) of 0.33 (i.e., 0.5 x PGA). The value of P_{total} may be calculated as:

- $P_{total} = 1.44 \times Pa$ [6]

The maximum ordinate (p_a) may then be calculated by either Equation [4] or [5] depending upon the number of horizontal rows of anchors.

The apparent earth pressure distribution is trapezoidal in shape where anchors are included in the design of the walls. The maximum horizontal pressure is zero at the top of the wall and increases linearly to a maximum at a distance below the top of wall equal to $⅔H_1$ and continues as a uniform horizontal pressure to a distance of $⅔H_{(n+1)}$ above the bottom of wall where the pressure distribution decreases linearly to zero at the bottom of the wall. Design recommendations and lateral earth pressure diagrams for design of RW-7 are presented in Figure 4.

3.5.2 Anchor Bond Stress

Resistance to the load demand imposed upon the wall system will be generated solely by the pullout capacity of the earth anchors embedded into the proposed wall cut. Based upon the type of material into which the anchors of RW-7 will be embedded, the ultimate bond stress recommended for use in design is 6,000 psf.

3.5.3 Minimum Unbonded Length

The unbonded length of the anchors is recommended to be calculated based upon the projection of a hypothetical failure plane projected up from the bottom of the wall at an inclination from horizontal of 55 degrees under static conditions and 40 degrees for seismic conditions. The minimum unbonded length should be equal to the greater of a distance of 5 feet or the equivalent of 20 percent of the wall height (i.e. 0.2H) behind the hypothetical failure plane. In the case of Sta. 33+00 where the wall height is approximately 54 feet, this offset line should be located a parallel distance 10.8 feet from the 40- and 55-degree projection beginning at the base of the wall. A conceptual view of the potential failure plane and offset for RW-7 are shown in Figure 4.

3.5.4 Wall Facing Bearing Capacity

The downward vertical component of the anchor thrust at RW-7 will be resisted by the bearing capacity of the wall facing section supported by the existing material. Based upon a minimum embedment depth of 24 inches below adjacent finish grade and minimum width (i.e. wall thickness) of 18 inches, the ultimate (nominal) bearing capacity is 15,000 psf for RW-7 where the wall will be supported by undisturbed, suitable bearing bedrock material, which is expected to be encountered at the bottom of the wall along the proposed roadway alignment.

3.5.5 Field Testing

All earth anchors will require field testing to verify the design capacity has been achieved. Testing is recommended to be performed on anchors designated as either “Performance” or “Proof” anchors. The Engineer shall determine the location of the anchors to be performance tested. Test procedures and criteria are described in greater detail in Section 46-2 of the Caltrans *Standard Specifications*.

Ground anchors that satisfy test acceptance criteria should be tensioned and locked off at the lock-off load shown on the plans. Immediately after lock-off, a lift-off test should be performed to demonstrate that the lock-off load was attained.

3.5.6 Unsupported Height

The maximum unsupported vertical cut prior to installation of the upper row of anchors is recommended to be no greater than 3 to 4 feet. The maximum unsupported vertical heights for excavation to subsequent elevations for anchor installation is recommended to be no greater than 5 to 6 feet but should be verified by field testing. Recommendations for stability test zones are summarized in the following table; additional details regarding test procedures are described in conjunction with soil nail walls (Section 3.4.7 of this report) and Section 19-3.01D(2) of the Caltrans *Standard Specifications*.

Table 15 – Test Area Zone Designations for Anchor Diaphragm Walls

RW No.	Zone No.	Wall Station		Elevation		Test Area(1)	Notes(2)
		Begin	End	Upper	Lower		
14	1A	10+00	End of Wall	TW(3)	450	11+20 to 11+80	Anchors will be installed in bedrock; locally cemented zones may be encountered.
	1B			450	430	10+80 to 12+20	
	1C			430	BW(4)	10+50 to 12+50	

Notes:
(1) Stability test recommended in the indicated range of wall station based upon wall height and/or existing grade above top of wall
(2) Generalized subsurface conditions that are anticipated to be encountered during soil nail drilling and construction
(3) TW – Top of Wall (see Wall Plans)
(4) BW – Bottom of Wall (see Wall Plans)

3.5.7 Drainage

Analysis to determine lateral earth pressure was based upon drained conditions behind the proposed wall. It is recommended that drainage consisting of a geosynthetic drainboard between each column of anchors be provided behind the wall, discharging to weep holes at the base of the wall.

3.5.8 Corrosion Protection

Protective measures include the use of a steel cover or adequate concrete cover of the anchor head and exposed prestressing steel. The trumpet should be welded to the bearing plate to provide a water tight seal and should be properly filled with grout to a minimum distance of 6 inches into the unbonded zone.

Protection of the unbonded zone shall extend into the trumpet but should not contact the bearing plate or anchor head during stressing. The tendons should be encapsulated and filled with grout. Encapsulation should consist of smooth sheathing in the unbonded zone and corrugated sheathing in the bonded zone. Care should be used in grouting to ensure the tendon is centralized and no voids exist around the tendon.

3.6 Soldier Pile Wall Systems

The proposed project includes the use of permanent soldier pile wall systems at five locations along the roadway:

- RW-4 along the northbound side between Bridges 1 and 2
- RW-5 along the creek channel near proposed Bridge 2
- RW-8 along outer radius of the curve in the roadway between Bridges 2 and 3
- RW10 and RW-11 along the creek channel near Bridge 3

As previously indicated in Table 2, RW-5, RW-10 and RW-11 will include earth anchors for the entire length of the respective walls. At RW-8, the majority of the wall will consist of a cantilever wall system while the region in the final 78 feet of this wall will include earth anchors and secant piles extending below the timber lagging. Design of the walls as a soldier pile wall with anchors is expected to be performed in accordance with the Caltrans *Bridge Design Specifications* (BDS) Section 5 (August 2004) and *Memo to Designers No. 5-12* (July 2012).

Table 16 – Soldier Pile Wall Systems

Wall Information		Roadway Stationing[1]		Wall Dimensions	
Wall No.	Type of Retaining System	Begin	End	Length (feet)	Maximum Height (feet)
4	Soldier Pile Wall	25+10.95	26+89.71	184’	9
5	Soldier Pile w/ Anchors	28+39.46	29+84.08	93’4½”	23
8	Soldier Pile w/ and without Anchors	33+38.83	40+13.44	715'1½"	29
10	Soldier Pile w/ Anchors	41+92.26	42+79.68	100'	24
11	Soldier Pile w/ Anchors	42+58.01	45+50.86	232’8¾”	29

Notes: [1] Refer to Geotechnical Exploration Plan (Plates 1-6) for wall locations.

3.6.1 Lateral Earth Pressure

Construction of the soldier pile walls (RW-4, RW-5, RW-8 and RW-11) has been assumed to include excavation to create a relatively level area for equipment access with the exception of RW-10, which is currently planned to be constructed in a top-down manner. The consequence of the excavation for RW-4, RW-5, RW-8 and RW-11 will be a backcut inclined for stability and safety. Based upon the extent to which excavation and backcutting will be required, lateral earth pressure is expected to be due to the backfill material and the backfill may also be the material in which the anchors are supported. Therefore, the material selected for backfill will be critical for compatibility with the wall designs based upon the recommendations in this report. The top-down construction planned for RW-10 will result in this wall retaining the onsite material exposed by cutting and not the placement of backfill as was described for the other soldier pile walls.

An alternate technique to construct the proposed soldier pile walls may include the use of lightweight cellular concrete (LCC) in place of the soil backfill. The use of LCC will significantly reduce the load demand on the wall structures, which may thereby eliminate the need for earth anchors in wall design. If selected for use, alternate recommendations for design and construction will be required, which can be provided upon request.

Recommendations presented in this report have been based upon select granular material that exhibits an equivalent fluid pressure of 40 psf per foot of wall height which should be used to calculate the horizontal pressure (*pa*) in accordance with Caltrans recommendations for anchored walls with soldier piles. Design under seismic conditions is recommended to be based upon an increase of 19 psf/foot (k_h= 0.22) in the active earth pressure. Additional recommendations follow for design of the walls based upon subsurface conditions specific to their respective locations.

RW-4 – This wall will be located near the top of an existing descending slope along the northbound traffic side of the roadway between Bridge 1 and Bridge 2. The wall structure will support a combination of new fill to raise roadway grade and existing soils below current grade. Design of RW-4 is anticipated to be performed as a freestanding cantilever retaining wall. Load demand is recommended to be calculated using an equivalent active fluid earth pressure of 40 psf per foot of retained height (pcf). Design should include approach surcharges due to traffic loading.

Resistance to lateral load may be calculated using an equivalent passive earth pressure distribution as shown in Figure 5. The passive resistance values may be increased by a factor of two if the drilled shaft foundations are maintained at a minimum on-center spacing of three diameters.

The performance of RW-4 may be affected by the occurrence of liquefaction as indicated by analysis of the subsurface profile as encountered at test boring LB-19 (Section 26+00). Analysis indicated the presence of soils potentially susceptible to liquefaction between the approximate depths of 25 to 30 feet (El. 373 to 368 feet) below current ground surface. Preliminary design of the foundations conducted by the project structural engineer (MTC) resulted in a pile tip at El. 381 feet. Depending upon the actual thickness and continuity of the identified liquefiable stratum, stability analysis indicated the potential lateral displacement of the roadway embankment in this area was approximately 4 inches. Seismically induced settlement was estimated to be approximately 2 inches. Based upon current design, the planned pile tip elevation of the RW-4 foundation will be above the zone of potential soil liquefaction and provide no resistant to lateral displacement and not be subjected to additional load demand associated with downdrag.

RW-5 – Design of RW-5 is recommended to be based upon the lateral earth pressure distributions shown in Figure 6. Due to the location of the wall, design should include traffic surcharge as necessary.

RW-8 – RW-8 was originally planned as a Caltrans Type 1 semi-gravity cantilever retaining wall However, considering the proximity of RW-8 to the existing sheet pile wall, lateral pressure surcharge would be imposed upon the existing sheet pile wall in the event that the elevation of the wall foundation bearing grade was above the elevation of the creek channel bottom. The magnitude of this surcharge pressure will be dependent upon the size (width) of the wall foundation, the grade differential between the wall bearing grade and creek bottom, and clearance between the foundation and the sheet pile wall.

Due to the age and unknown condition of the existing sheet pile wall, the objective of design was to avoid this wall and not impose additional load that could adversely affect not only the sheet pile wall but also the performance of the proposed retaining wall. As a result, RW-8 will be supported by a drilled pier (soldier pile) foundation. To avoid the potential for lateral load surcharge on the sheet pile wall, the drilled pier foundations will require isolation casing to create an annular space between the circumferential surface of drilled piers and the adjacent soils to a depth equal to the creek channel bottom.

Design of RW-8 is recommended to be based upon the lateral earth pressure distributions shown on the attached schematic diagrams (Figures 7A, 7B, 7C and 7D). Design should also include traffic surcharges as appropriate. The distributions of lateral earth pressure for RW-8 shown on the attached schematic diagrams represent four distinct regions of the wall:

- Beginning of wall (approximate mainline Sta. 33+50) to Sta. 36+50, represented by Section 35+00 (Figure 7A);
- Mainline Sta. 36+50 to mainline Sta. 38+00 represented by Section 38+00 (Figure 7B);
- Mainline Sta. 38+00 to Sta. 39+15 (Figure 7C); and
- Mainline Sta. 39+15 to the junction with Bridge 3 represented by Section 40+00 (Figure 7D).

The distinctions between these regions have been based upon the relative location of the proposed wall and existing sheet pile wall; and the subsurface stratigraphy as developed from review of test boring exploration.

The performance of RW-8 may be affected by the occurrence of liquefaction as indicated by analysis of the subsurface profile as encountered at test boring LB-23 (Section 35+00) and LB-14 (Section 38+00). Analysis indicated the presence of soils potentially susceptible to liquefaction either at or slightly above the contact with the underlying bedrock formation. Stability analysis indicated the potential lateral displacement of the roadway embankment in this area was approximately 5½ inches at Section 35+00, and 9 inches at Section 38+00, but the actual magnitude will depend upon the in-situ thicknesses and continuity of the identified liquefiable strata. Seismically induced settlement was estimated to be approximately 2 inches at Section 35+00 and 2½ inches at Section 38+00.

The planned pile tip elevations were at or slightly above the identified zones of liquefaction in the region of the proposed wall represented by the analyzed cross-sections. The wall foundations will provide no resistance to lateral displacement and not be subjected to additional load demand associated with downdrag. The wall system will, however, be subjected to the seismic settlements stated above associated with liquefaction.

RW-10 – The construction of RW-10 will allow removal of the retaining wall structure that currently exists along the creek channel that parallels the alignment of RW-10. Construction of RW-10 is understood to be performed in a top-down manner, thereby resulting in this wall supporting existing material exposed by cutting. Design of RW-10 is recommended to be based upon the lateral earth pressure distributions shown in Figure 8, which includes a somewhat greater lateral earth pressure. In addition to design to support the proposed cut, the area behind this wall includes an unimproved access drive. As such, design may require consideration of surcharges due to vehicles that travel along the drive.

RW-11 – The passive earth pressure for use in the design of the soldier piles supporting RW-11 is affected by the inclination of the descending slope in front of the wall as well as the material in which the piles will be supported and the depth to groundwater. At the planned wall location, site grades in front of the proposed wall alignment slope down toward the channel of Brea Creek. The descending grades result in significantly reduced passive earth pressure as compared to conditions with level grade in front of a wall.

Review of the site grades as indicated in the project grading plans indicate the descending slopes in front of RW-11 vary from approximately 1.375H:1V to 2H:1V. The sloping grade condition applies from finish grade in front of the wall to the bottom of the creek channel, which is approximately El. 406 feet as indicated in the grading plan. Therefore, the passive earth pressure associated with the descending slope condition is recommended to be applied to the region in front of the wall from finish grade to El. 406 feet; and level grade conditions may be assumed below El. 406 feet. A schematic diagram of the earth pressure distribution is shown on Figure 9.

Based upon the subsurface conditions encountered during field exploration, the piles are anticipated to be supported by the naturally occurring older alluvial soils (Qalo) to depths equivalent to approximately El. 392 feet followed by the bedrock of the Fernando formation (Tf). Table 17 presents the recommended equivalent passive fluid earth pressures for use in design of RW-11 considering the following conditions:

- Range of descending slopes depicted on the grading plan;
- Design groundwater table (El. 406 feet); and
- Bedrock encountered at El. 400 feet.

Table 17 – Passive Pressure for Soldier Pile Wall RW-11

Wall No.	Finish Grade to El. 406(Creek Bottom)			El. 406 to El. 400 (Alluvium)	Below El. 400
	2H:1V	1.5H:1V	1.375H:1V	Level	Level
RW-11	135	85	80	165	195
Note: Passive pressure values may be doubled for soldier piles with on-center spacing of at least three pile diameters.					

As discussed in conjunction with liquefaction analysis, the stratum of soils that extends from approximate creek bottom (El. 406) to the contact with the bedrock as identified at test boring CWE P-4 exhibited the potential for liquefaction. However, the adjacent CPT C-8 indicates the actual thickness of the stratum susceptible to liquefaction is significantly less. As identified at CPT C-8, the potential for liquefaction to occur was identified at depths of 25 to 25½ feet and 27 to 28½ feet. The thicknesses of these layers are considered to be thin and not likely to be sufficient tin lateral extent to have a significant effect on the performance of RW-11. However, as discussed in conjunction with the performance of other structures that may be affected by liquefaction, CPT exploration as close as practical to alignment of RW-11 will be beneficial to better evaluate liquefaction potential prior to completing final design.

3.6.2 Anchor Bond Stress

The pullout capacity of the earth anchors embedded into the proposed wall cut/backfill will contribute to the total resistance to lateral load imposed upon the wall system. Based upon the type of material into which the anchors of these soldier pile walls will be embedded, the anchor pullout resistance is recommended to be calculated using a unit resistance of 2,000 psf (nominal) with grout placement under gravity; or 4,000 psf (nominal) using pressure grout methods.

The unbonded zone for RW-5, RW-8, RW-10 and RW-11 is recommended to extend a distance behind the proposed wall to ensure all bonded lengths are behind a hypothetical failure plane rising up at an inclination of 53 degrees beginning at the bottom of the retaining wall. The actual extent of the unbonded zone should be determined by a parallel offset a distance equal to the greater of 5 feet or 20 percent of the wall height behind the hypothetical failure plane.

3.6.3 Axial Capacity

The use of earth anchors will result in a vertical load component associated with the tension force of the anchor where the anchors are oriented below horizontal. The magnitude of the vertical component will be dependent upon the tensile force of the anchor and angle below horizontal. Resistance to the vertical load demand will be provided by the axial capacity of the soldier pile foundations.

Drilled shaft foundations develop axial resistance by a combination of skin friction acting along the side of the piles and end bearing at the pile tip. The use of end-bearing in design requires careful control/verification during construction to ensure the borehole bottom is properly cleaned and the borehole bottom is competent to provide the estimated tip capacity. Based upon the potential for variances in the actual end-bearing conditions, pile design recommendations have been solely based upon shaft resistance.

Axial capacity design is recommended to be based upon the capacity curves presented on Figure 10 for RW-5, Figure 11 for RW-8, Figure 12 for RW-10, and Figure 13 for RW-11. The top of pile (i.e. Depth= 0 feet) in the referenced capacity curves has been assumed to be the elevation of the creek channel (i.e. Thalweg elevation per hydrology study). *Pending the findings of future scour assessment for the project, the capacity curves may require revision with a corresponding revision in tip elevation*.

Nominal resistance (Resistance Factor φ_s= 1.0) is appropriate for use under the extreme limit state per AASHTO. A reduction factor of 0.7 should be applied to the nominal capacities for the strength limit state. Tensile resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression. In accordance with AASHTO design specifications, reduction in group capacity is not required for a group of shafts where the center-to-center spacing is 2.5 pile diameters or greater.

3.6.4 Drilled Shaft Construction Considerations

Drilling operations for installation of the drilled shaft foundations of the soldier pile walls will encounter interbedded layers of non-cohesive sand and silty sands that could present borehole stability problems if dry construction techniques are used without temporary casing. In addition, groundwater is anticipated to be encountered at depths of 20 to 25 feet below current roadway grade, which could also result in borehole stability problems and adversely affect construction. As a result, drilling operations may include either the use of drilling slurry (i.e. “wet construction”) to maintain borehole stability or the use of temporary casing to prevent caving.

In general, casings may be installed by impact hammer, vibratory hammer, oscillators, rotators, or by placing in a drilled hole. Casing installed in an oversized drilled hole and grouted in place is expected to result in no reduction in skin friction.

Pile installation by wet construction should use an appropriate slurry as a drilling fluid. To maintain hole sidewall and bottom stability and mitigate potential anomalies, it is essential that positive head be maintained above the groundwater table at all times during drilling operations and concrete placement. Concrete placement should be performed using a tremie and the bottom of the tremie be kept at least 10 feet below the rising surface of the fresh concrete.

3.7 General Earthwork and Grading

Earthwork will generally consist of excavation and placement of compacted fill to support new semi-gravity and MSE retaining wall structures as well as the cuts required for construction of the soil nail and soldier pile walls. Grading will also be required construction of several fill slopes along the proposed edge of the widened roadway. Earthwork operations are recommended to be performed in accordance with the recommendations presented in this report and the project specifications as prepared by others. The *General Earthwork and Grading Guideline Specifications* included in Appendix E may be used for guidance in developing the project specifications. If conflict arises, the recommendations in Appendix E shall be superseded by the project specifications, recommendations contained in this report and/or the Grading Manual of the County of Orange, whichever is more stringent.

3.7.1 Fill Slopes

Fill slopes should be constructed in accordance with the guideline specifications (Appendix E), following typical key excavation and benching. In order to achieve adequate compaction at the slope face, we recommend that fill slopes be overfilled a minimum of 4 feet and then cut back to compacted material. After cutting back, the final slope should be rolled with compaction equipment. In addition, to minimize potential for surficial failure and erosion, cohesionless materials (sands with little to no cohesion) should not be used for the near-slope face zone (approximately an equipment width from the final grade of the slope).

The surficial stability of the fill slopes will be dependent upon the composition and cohesive characteristics of the material that comprises the fill. Portions of the materials that will be generated during site grading and excavation will consist of sands with little to no cohesion. Care must be used during site grading to select fill material with sufficient cohesion to ensure adequate surficial slope stability. Grading operations may, therefore, require processing and blending of the non-cohesive sands with fine-grained cohesive soils.

3.7.2 Fill Placement

Compaction Requirements: Fill soils to support structures and comprise earthen slopes (i.e. "structural fill") should be placed in accordance with the *General Earthwork and Grading Guideline Specifications* presented in Appendix E. Structural fill should be placed in loose lifts no greater than 6 to 8 inches in thickness and compacted with mechanical equipment designed for such purposes to a minimum of 90 percent of the maximum dry density obtained by the Modified Proctor (ASTM D1557). The soils are recommended to be moisture conditioned to a moisture content 1 to 3 percentage points above optimum moisture content.

Material Suitability: The onsite soil and the soils derived by bedrock cutting are generally anticipated to be suitable for placement as structural compacted fill provided the soils are free of organic and other deleterious materials. Oversize material (greater than 6 inches in dimension) such as cobbles, boulders, rock slabs, broken concrete and asphalt is recommended to be processed to develop material suitable for use as structural fill or may be used in the fill when placed in accordance with our recommendations described in Section 3.0 of the guide specifications in Appendix E. Organic debris, if encountered, should be removed prior to placement as fill.

Preparation of Fill Subgrades: After remedial removals and overexcavation, areas to receive fill shall be scarified, moisture-conditioned, and recompacted to 90 percent relative compaction to a minimum depth of approximately 6 to 12 inches. The actual depth to which processing will be required should be determined during grading, based on the moisture-density condition of the material at that time. In some areas, removed materials may require drying to the compactable range prior to compaction.

Benching: Where the natural slope is steeper than 5H:1V (horizontal to vertical) and where designated by the project geotechnical engineer or geologist, compacted fill material should be keyed and benched into competent bedrock or firm, suitable bearing native soil.

Backcuts associated with wall construction as well as the temporary cuts required for construction of the sol nail and soldier pile walls should be observed and geologically mapped by the engineering geologist. The purpose of this mapping is to substantiate the geologic conditions exposed in the field are generally consistent with the conditions assumed for analysis.

3.8 Temporary Excavations

All temporary excavations, including utility trenches, retaining wall excavations, and other excavations should be performed in accordance with project plans, specifications and all Occupational Safety and Health Administration (OSHA) requirements. Excavations to a depth of 5 feet or less may be excavated near vertical provided the soil conditions are evaluated and found to be suitable by the "competent person" present onsite during trenching and excavating activities as defined by OSHA regulations. However, due to the granular nature of the onsite soils, steep, unsupported excavation sidewalls may cave, thereby requiring proper back-sloping for excavation stability and safety.

No surcharge loads should be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater from the top of the slope, unless the cut is properly shored. Excavations that extend below an imaginary plane inclined at 45 degrees below the edge of any adjacent existing site foundation should be properly shored to maintain support of the adjacent structures.

Temporary excavations should be treated in accordance with the State of California version of OSHA excavation regulations, *Construction Safety Orders for Excavation General Requirements*, Article 6, Section 1541, effective October 1, 1995. The sides of excavations should be shored or sloped in accordance with OSHA regulations. OSHA allows the sides of unbraced excavations, up to a maximum height of 20 feet, to be cut to a ¾H:1V (horizontal:vertical) slope for Type A soils, 1H:1V for Type B soils, and 1½H:1V for Type C soils.

OSHA regulations are applicable in areas with no restriction of surrounding ground deformations. Shoring should be designed for areas with deformation restrictions. The soil type should be verified or revised based on geotechnical observation and testing during construction, as soil classifications may vary over short horizontal distances. Heavy construction loads, such as those resulting from stockpiles and heavy machinery, should be kept a minimum distance equivalent to the excavation height or 5 feet, whichever is greater, from the excavation unless the excavation is shored, and these surcharges are considered in the design of the shoring system, if required.

3.9 Utility Trench Backfill

Utility trenches should be backfilled with compacted fill in accordance with Sections 306-1.2 and 306-1.3 of the *Standard Specifications for Public Works Construction,* (SSPWC or *Greenbook*). Utility trenches can be backfilled with onsite material free of rubble, debris, organic and oversized material up to 3 inches in largest dimension. Prior to backfilling trenches, pipes should be bedded in and covered with either:

(1) Granular Bedding: a) ½-inch open grade aggregate; or b) a uniform sand material with a Sand Equivalent (SE) greater than or equal to (≥) 30, passing the No. 4 U.S. Standard Sieve (or as specified by the pipe manufacturer).

(2) CLSM: Controlled Low Strength Material (CLSM) conforming to Section 201-6 of the *Greenbook*. CLSM bedding should be placed to 1 foot (0.3 m) over the top of the conduit, and vibrated. CLSM should not be jetted.

Pipe bedding should extend at least 4 inches below the pipeline invert and at least 12 inches over the top of the pipeline. The bedding and shading sand is recommended to be densified in place by vibratory, lightweight compaction equipment.

Trench backfill over the pipe bedding zone may consist of native and clean fill soils. All backfill should be placed in thin lifts (appropriate for the type of compaction equipment), moisture conditioned above optimum, and mechanically compacted to at least 90 percent relative compaction, as determined by ASTM D1557.

3.10 Construction Considerations/Cautions to Contractor

Subsurface conditions in the area of soil nail wall and drilled shaft construction generally consist of existing fill to varying but typically shallow depth below grade. Native soils underlying the fill consist of older alluvial soils comprised of sand, silty to clayey sand, clay and sandy clay, which are underlain by bedrock of the Fernando and Monterey formations. Groundwater was typically encountered at depths of 20 to 25 feet below road elevation.

The alluvial soils were found to include varying concentrations of gravels and cobble- and boulder-size material. In areas underlain by sandy soils, borehole instability (i.e. caving) may be encountered; coarse gravel may present difficulty in advancing the small diameter boreholes associated with soil nail and anchor construction. Drilling difficulties will be exacerbated should the larger cobble and boulder material be encountered in both the small diameter and the large diameter drilled shaft boreholes. Similar concerns exist when drilling into bedrock material as locally cemented zones may be encountered, which will result in decreased production rates.

The depths at which groundwater was encountered is anticipated to be more significant in the drilling and construction of drilled shaft foundations, particularly in areas where the alluvial soils extend to significant depths relative to shaft length such as in the area of RW-8 and Bridge 3.

4.0 PAVEMENT DESIGN RECOMMENDATIONS

4.1 Existing Pavement Sections and Tested R-Values

At the boring locations, the existing pavement sections, where encountered, were measured to consist of approximately 4 to 15 inches of asphalt concrete (AC) over 0 to 27 inches of base course (AB). The relative pavement support characteristics of the subgrade soils were evaluated by performing R-value tests. The existing pavement sections as measured in our borings and tested R-values are summarized in Table 18.

Table 18 – Existing Pavement Sections and Tested R-values

Boring No.	Direction of Traffic Flow	Approximate Location	Pavement Sections (inches)		Tested R-value
			AC	Base	
LB-1	Eastbound	Sta. 12+00	11	4	41
LB-2*	Eastbound	Sta. 22+00	-	-	-
LB-3*	Eastbound	Sta. 31+50	-	-	-
LB-4*	Eastbound	Sta. 42+40	-	-	-
LB-5	Westbound	Sta. 47+80	15	0	-
LB-6	Eastbound	Sta. 55+30	13	4	-
LB-7*	Eastbound	Sta. 57+90	-	-	-
LB-8*	Eastbound	Sta. 65+00	-	-	-
LB-9*	Westbound	Sta. 74+60	-	-	19
LB-10	Eastbound	Sta. 79+60	12	0	-
LB-11	Eastbound	Sta. 89+80	9	27	34
LB-12	Westbound	Sta. 92+90	15	0	36
LB-13	Westbound	Sta. 100+40	13	0	-
LB-14	Westbound	Sta. 37+20	10	18.5	-
LB-38	Eastbound	Sta. 40+30	4	10	-

*Unpaved surface

4.2 Existing Pavement Condition

During our condition survey, we observed pavement distress at varying severity levels. The observed distress is summarized in Table 19. The majority of the distress consisted of longitudinal cracks (cracks approximately parallel to pavement centerline). Locations of these cracks provide an indication of the cause of the pavement distress. Longitudinal cracks not in the wheel path are non-load associated cracks and likely caused by thermal cracking while longitudinal cracks within the wheel path are typically caused by traffic.

Transverse cracks caused by thermal cracking and minor raveling were also observed. Raveling is wearing away of the pavement surface caused by the dislodging of aggregate particles and loss of asphalt binder. Block cracks are interconnected cracks that divide the pavement into approximately rectangular pieces. Block cracking is caused mainly by shrinkage of the asphalt concrete and daily temperature cycling.

We have evaluated the adequacy of the existing pavement sections using the Effective Thickness Method following the guidelines in *The Asphalt Handbook* by the Asphalt Institute. This method assumes that the pavement uses part of its total life by the time distress conditions appear. The remaining life of the pavement is represented by a thinner (i.e. equivalent) pavement section and can be used in designing the pavement for future conditions. The equivalent pavement section is obtained by applying a conversion factor to the existing pavement section based on the condition of the existing pavement observed at the time of field evaluation. The conversion factors range from 0.5 to 1.0 and a higher conversion factor indicates better pavement condition. Based on our visual survey, we have assigned to the existing pavement the conversion factors indicated in Table 19 for regions of the existing roadway. The regions indicated in Table 19 have been determined based upon field observations correlated to project plans.

Table 19 – Existing Pavement Condition and Conversion Factor

Approximate Limits	Predominant Distress	Conversion Factor
Sta. 5+40 to 20+90	Intermittent longitudinal and block cracking	0.90
Sta. 20+90 to 30+00	Longitudinal cracking in wheel path, utility patches, local potholes, block cracking, raveling	0.65
Sta. 30+00 to 33+00	Longitudinal cracking in wheel path, transverse cracking, local potholes, raveling	0.60
Sta. 33+00 to 43+00	Block cracking, local utility patches and potholes	0.70
Sta. 43+00 to 44+50	Transverse cracking, utility patches, local potholes, minor raveling	0.80
Sta. 44+50 to 54+50	Longitudinal cracking in wheel path, block cracking, local potholes, raveling	0.55
Sta. 54+50 to 62+00	Intermittent longitudinal cracking, transverse cracking, utility patches, raveling	0.70
Sta. 62+00 to 67+00	Longitudinal and transverse cracking, utility patches, minor raveling	0.75
Sta. 67+00 to 78+00	Block cracking, utility patches, raveling	0.60
Sta. 78+00 to 81+37	Alligator cracking, longitudinal cracking in wheel path, block cracking, raveling	0.55

4.3 Recommendations

4.3.1 Pavement Design

Pavement design and analysis were performed using the methodology described in the Caltrans *Highway Design Manual*. Based on the tested R-values, we have selected an R-value of 20 for our pavement design.

New pavement is expected to have a design service life expectancy of 20 years while a design service life expectancy of 10 years has been assumed for an overlay. The actual service life of the pavement (whether new or overlaid) is dependent on several factors. Major factors include truck traffic, routine pavement maintenance, adequate drainage of surface and subsurface water, and inhibition of subsurface water from entering the subgrade and pavement layers. Regular pavement maintenance, including sealing/repairing cracks and repairing localized areas of pavement distress, will extend the service life.

4.3.2 New Pavement Section

We have designed new pavement structural sections using the design R-value of 20 and a Traffic Index of 9, provided by the County of Orange. The recommended pavement sections are presented in Table 20.

Table 20 – Recommended Pavement Sections

Option 1: AC over AB (feet)	Option 2: Full-Depth AC (feet)
0.50 over 1.35 or *0.85 over 0.50	1.05
Note: AC = Asphalt Concrete; AB = Crushed Aggregate Base *Thicker AC section is recommended for consistency with the existing AC sections (as measured at the test boring locations) where new pavement will be constructed adjacent to existing pavement.	

The pavement recommendations are based upon proper field observation and testing during construction. Therefore, field observation and periodic testing, as needed during placement of the base course materials and asphalt concrete, should be undertaken to ensure that the requirements of the *Standard Specifications for Public Works Construction* (*Greenbook*) are fulfilled.

Note that since pavement rehabilitation on the existing adjacent pavement will consist of Asphalt Rubber Hot Mix (ARHM) per the section below, the upper 0.15 to 0.20 feet of the new pavement section should consist of ARHM for consistency with the rehabilitated pavement.

4.3.3 Pavement Rehabilitation

The remaining service life of the existing pavement may be extended if pavement rehabilitation is performed. We understand that two pavement rehabilitation methods are being considered for the project: 1) construct asphalt overlay over existing pavement; and 2) mill the existing pavement surface and construct an asphalt overlay (i.e. mill-and-overlay). The material used for the surface wearing course of an overlay is recommended to be ARHM (as compared to solely AC) as indicated in the Caltrans *Highway Design Manual*. Therefore, the overlay recommended in this report consists of an ARHM surface, possibly underlain by an AC binder course (where needed to achieve plan finish grade). Pavement rehabilitation recommendations are presented in Table 21. Whether pavement rehabilitation is feasible and the selection of which rehabilitation to use will depend on the finished elevations of the new pavement compared to the existing pavement and the existing features that will remain in-place, such as curbs and gutters. If the mill-and-overlay alternative is selected, the remaining AC after milling should not be less than 0.15-foot thick. AC of less than 0.15-foot thick after milling should be completely removed and replaced with new AC.

Additionally, we recommend that for any selected rehabilitation method, a pavement reinforcing layer, such as of fiberglass grids or Asphalt Rubber and Aggregate Membrane (ARAM), is placed prior to placement of the selected overlay. Application of an overlay over existing pavement cracks may not eliminate reflective cracking (the propagation of cracks to the surface). Although some degree of reflective cracking should be expected, the use of pavement reinforcing layer is expected to further reduce reflective cracking. Prior to overlay placement, cracks of ¼ inch or wider should be properly sealed with hot liquid asphalt.

Full-depth repairs are recommended locally before overlay placement. Full-depth repairs are recommended in areas where medium to high severity cracking and potholes are observed. By repairing the weakest pavement areas, the pavement life is prolonged and performance is improved. Some distressed pavement areas, however, may be removed when milling but some may remain. The actual repair areas should be determined by the geotechnical engineer after milling is complete. Proofrolling should be performed on the milled surface to evaluate and select pavement areas that require replacement. The Contractor should remove existing asphalt concrete pavement and base material at areas where full-depth repairs are required. The pavement section in Table 20 may be used for full-depth repairs. The Contractor should scarify, grade and compact the upper 6 inches of the removal bottom to a minimum of 95 percent relative compaction (per ASTM D1557) prior to placement of the new pavement section.

Table 21 – Overlay Recommendations

Approximate Limits	No Milling (feet)		0.1-foot Milling (feet)		0.2-foot Milling (feet)		0.3-foot Milling (feet)	
	ARHM	AC	ARHM	AC	ARHM	AC	ARHM	AC
Sta. 5+40 to 20+90	0.15	-	0.15	-	0.15	0.10	0.15	0.20
Sta. 20+90 to 33+00	0.15	0.20	0.15	0.20	0.15	0.25	0.15	0.30
Sta. 33+00 to 44+50	0.15	-	0.20	-	0.15	0.10	0.15	0.15
Sta. 44+50 to 54+50	0.15	0.20	0.15	0.20	0.15	0.20	0.15	0.25
Sta. 54+50 to 67+00	0.15	0.10	0.15	0.10	0.15	0.15	0.15	0.15
Sta. 67+00 to 81+37	0.20	0.30	0.20	0.30	0.20	0.30	0.20	0.35

4.3.4 Subgrade Preparation

Prior to placement of the new pavement, the subgrade soils should be scarified to a depth of 8 inches and recompacted. Based on the laboratory test results and our field observation, the subgrade soils can be scarified and recompacted in place. Loose soils, if encountered, should be removed to competent material and recompacted.

4.3.5 Fill Placement and Compaction

Soils generated at the project site by earthwork and grading activities are generally anticipated to be suitable for use as structural compacted fill to establish subgrade elevation. Onsite soils to be used as compacted structural fill should be review by the geotechnical engineer. The soils should be free of organic material or construction debris and exhibit an R-value of at least 20. Any imported fill soil should be approved by the geotechnical engineer prior to placement as fill. Fill soils and aggregate base should be placed in loose lifts not exceeding 8 inches, moisture-conditioned as necessary to optimum or slightly above, and compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D1557.

All pavement construction should be performed in accordance with the *Greenbook*. Field observation and periodic testing, as needed during placement of the base course materials and asphalt concrete, should be undertaken to ensure that the requirements of the standard specifications are fulfilled.

4.3.6 Material Recommendations

Aggregate base should consist of Crushed Aggregate Base (CAB) or Crushed Miscellaneous Base (CMB) conforming to Section 200-2 of the *Greenbook*. Existing aggregate base to be removed, if any, may be reused as CMB for the pavement reconstruction provided that it meets the requirements of Section 200-2.4 of the *Greenbook*. Existing asphalt concrete may also be pulverized and mixed with soils and/or aggregate to meet the same requirements for reuse as CMB.

Asphalt materials should conform to Section 203 of the *Greenbook*. ARHM and ARAM interlayer should meet the requirements of Sections 203-11 and 203-12, respectively, of the *Greenbook*. Fiberglass grid, if selected, should consist of GlasGrid 8501 or equivalent installed per the manufacturer's recommendations.

4.4 Corrosion Recommendations for Metal Pipe

Recommendations concerning metal pipe wall thicknesses are subsequently provided based upon the Caltrans *Highway Design Manual* Section 850-32, Figure 855.3A.

Based upon the results of corrosivity testing conducted on discrete representative bulk samples of the soils recovered from several of the test borings conducted as part of our field exploration, recommendations for the wall thicknesses are provided for generalized regions of the project site referenced to approximate roadway stationing:

- Sta. 46+00 to Sta. 70+0 (Tonner Canyon Road) in native older alluvial soils (Qoa)
    - 16-ga. Aluminum or 16-ga. Aluminized Steel (Type 2); or 14-ga. galvanized steel
- West/South of Sta. 46+00 in native older alluvial soils (Qoa)
    - Upper 10 feet below original grade (OG): 8-ga. galvanized steel
    - Depths below 10 feet below OG: 12-ga. galvanized steel

- Shallow embedment in existing fill (to depths of 5 to 10 feet below OG) will require the use of protective coating due to the highly corrosive nature of the soils as determined by testing from our boring LB-03 (approximate Sta. 31+50; south side of road near Bridge 2).

Additional testing of the soils in which metal piping will be installed is recommended to be performed to evaluate the corrosivity at the specific locations to either confirm the recommendations presented above or determine suitable alternates should greater corrosivity potential be identified.

5.0 PERCOLATION TESTING

Leighton Consulting has performed percolation testing to aid in the design of stormwater infiltration basins as part of the Best Management Practices (BMP) for the proposed project. Testing was previously performed at the approximate locations designation by Mark Thomas & Co. (MTC). The results of the initial phase of percolation testing was presented in Leighton, 2019b. As part of the supplemental field exploration referenced in this report, additional percolation testing was conducted based on suggested test locations submitted by CWE Engineering and the project plans (MTC, 2019). The borings intended for percolation testing were located as close as practical to the suggested locations but some alteration was necessary due to site and/or utility constraints.

5.1 Field Exploration

The supplemental field exploration consisted of five hollow-stem auger borings designated as CWE P-1 through CWE P-5. Four of the five borings were drilled to a depth of approximately 50 feet; Boring No. CWE P-3 was terminated at a depth of 20 feet due to the presence of bedrock formation material at shallow depth (approximately 10 feet) below current grade.

Soil samples were collected by driving split-barrel samplers following ASTM D 1586 and D 3550 test procedures for the conventional Standard Penetration Test (SPT) and relatively undisturbed samples, respectively. The samples were sealed and packaged for transportation to our laboratory. Logs of borings are presented in Appendix A, *Boring Logs*.

5.2 Percolation Tests

In-situ percolation testing was performed in general accordance with County of Orange *Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans (WQMPs)*, dated December 20, 2013. A 2-inch-diameter polyvinyl chloride (PVC) pipe with a perforated section (.020 slotted screen) was placed in the borehole and the annulus was filled with clean sand (No. 3 Monterey Sand).

After pre-soaking, the test wells were filled to a water level at least five times the boring radius above the bottom of the boring to determine the time interval for the percolation test. Once the time interval was established for each well, the percolation test was performed by measuring the drop of water level in the pipe and the time associated with the change in water level. The water drop was measured using a manual water sounder. At the end of the time interval, the wells were refilled approximately to the initial water level and the procedure repeated until the test was completed. Field data and calculated infiltration rate for each well is presented in Appendix C, *Percolation Test Results*. After the conclusion of percolation testing, the PVC pipes were removed from the test well. The test wells were backfilled with cement-bentonite grout.

5.3 Subsurface Conditions

Based on our exploration, the BMP locations are generally underlain by artificial fill (Af) and quaternary-aged young alluvial deposits (Qya) and bedrock of the Fernando formation. Exceptions to the general profile were encountered at CWE P-4 where no alluvium was above the bedrock contact (i.e., fill over bedrock); and at CWE P-5 where no fill was encountered.

Where encountered, existing fill was generally encountered to depth of 5 to 6 feet and consisted mainly of silty to clayey sand. Alluvium consisted of sand, silty sand, clayey sand, and sandy clay.

Bedrock of the Fernando formation (Tf/Tfs) consisting of silty sandstone and sandy siltstone was generally encountered at depth of 33 to 33½ feet below grade. Bedrock was encountered at a depth of approximately 5 feet below grade at CWE P-3. Detailed descriptions of the soils encountered in our borings are presented in the boring logs (Appendix A).

Groundwater was encountered in our explorations at depths ranging from 18 to 19½ feet below existing grade at borings CWE P-1 and CWE P-2. Groundwater was encountered at depths of approximately 38 ½ and 42 feet, respectively at boring CWE P-4 and CWE P-5, respectively. No groundwater was encountered at boring CWE P-3. , According to the California Geologic Survey (1997), the historically high groundwater level is on the order of 10 feet below the existing ground surface for the creek channel and undefined beyond the creek.

Fluctuations of the groundwater level, localized zones of perched water, and an increase in soil moisture should be anticipated during and following the rainy seasons or periods of locally intense rainfall or storm water runoff.

5.4 Infiltration Rates

The percolation test at each test well was performed using the falling-head method which records the drop of water level inside the test well over the specified time interval and repeated several times until consistent measurements are achieved. The measured infiltration rate for each percolation test was calculated by dividing the rate of discharge (i.e. volume of water discharged from the well during the test) by the infiltration surface area or flow area. A porosity reduction factor was applied to account for the filter pack material installed in the annulus of each test well. The flow area was determined based on the average height of water within the test well during each time interval. Detailed results of the field testing data and field infiltration rate ("observed") for the test wells are presented in Appendix C, *Percolation Test Data*. Results of the percolation testing are summarized in Table 22.

Table 22 – Field Percolation Test Results

Field Percolation Test I.D.	Test Depth(1) Interval (feet)	Depth to Groundwater (feet)	Depth to Impervious Material (feet)	Field Infiltration Rate ("Observed") (inch/hour)	Suitability Assessment Safety Factor A(5)
CWE P-1	5 to 10	19.5	23.5	4.52	2.5
CWE P-2	5 to 10	18	15	1.36	2.25
CWE P-3	5 to 20(4)	N.E.(2)	10	0.73	2.0
CWE P-4	10 to 30(4)	38.5(3)	15	2.72	2.25
CWE P-5	10 to 30(4)	42.5(3)	6.5	0.22	2.25

Notes:
(1) All depths referenced to site grade at time of exploration and testing (September, 2020)
(2) N.E. – Not Encountered. Presence of siltstone below 10 feet influences rate at which water may seep into borehole; groundwater may be present with prolonged observation of observation well
(3) Actual depth may be shallower due to presence of relatively impervious soils
(4) Depth interval influenced by presence of relatively impervious soils at planned test depth
(5) Reference: Table H Factor Category, Technical Guidance Document (TGD) for the Preparation of Conceptual/Preliminary and/or Project Water Quality Management Plans, Appendix VII, December 2013.

The observed infiltration rates must be reduced by applying an appropriate factor of safety to determine design infiltration rate that will represent long-term performance of the proposed infiltration BMP devices (OCPW, 2013). The safety factor consists of two categories of reduction factors, Suitability Assessment

(Category A) and Design (Category B). The safety for Category B will be determined by the BMP devices designer. The recommended reduction factors at each location for the Suitability Assessment Category are included in Table 22.

It should be emphasized that the infiltration rate is only representative of the tested location and depth where they are performed. Varying subsurface conditions will exist outside of the test locations, which could alter the calculated infiltration rates indicated above. The infiltration test was performed using relatively clean water free of particulates and silt. The infiltration rates will decline over time between maintenance cycles as the infiltration surface becomes occluded and particulates accumulate in the infiltrative layer.

Prior to construction of any infiltration device intended for the site, the BMP plan should be reviewed by the geotechnical consultant to verify that the geotechnical recommendations have been appropriately incorporated into the plans and not compromised by the addition of an infiltration system to the site. The designer of any infiltration system should contact the geotechnical consultant for geotechnical input during the design process as they feel necessary.

5.5 Design Considerations

The following recommendation should be considered minimal from a geotechnical viewpoint as there may be more restrictive requirements of the governing agencies. As a minimum, we recommend the following setbacks of the stormwater infiltration system.

Table 23 – Stormwater infiltration System Setbacks

Setback from	Distance
Public right-of-way limits	10 feet
Any foundation	10 feet or a 1:1 plane drawn up from the bottom of foundation, whichever is greater
Water wells used for drinking water	100 feet

In general, a vast majority of geotechnical distress issues are related to improper drainage. Distress in the form of foundation movement could occur. Soil saturation could lead to a loss of soil support of foundations and pavements, settlement or collapse, internal erosion (piping) and expansion. Offsite properties could be affected and those improvements may become subjected to seeps, springs, foundation movement or other geotechnical issues related to infiltration and water migration. Additionally, infiltration water can migrate along pipe backfill (typically sand or gravel bedding), thereby impacting improvements away from the point of infiltration. Any proposed infiltration system should not be located near existing or proposed improvements in order to reduce the geotechnical distress issues related to infiltration. Where sufficient distance from improvements cannot be achieved, additional recommendations may need to be provided.

As with all systems that are designed to concentrate surface flow and direct water into the subsurface soils, some type of nuisance water and other geotechnical water related issues should be anticipated. We recommend sufficient distances between infiltration devices and sensitive improvements be maintained. Routine maintenance should be required of any infiltration system.

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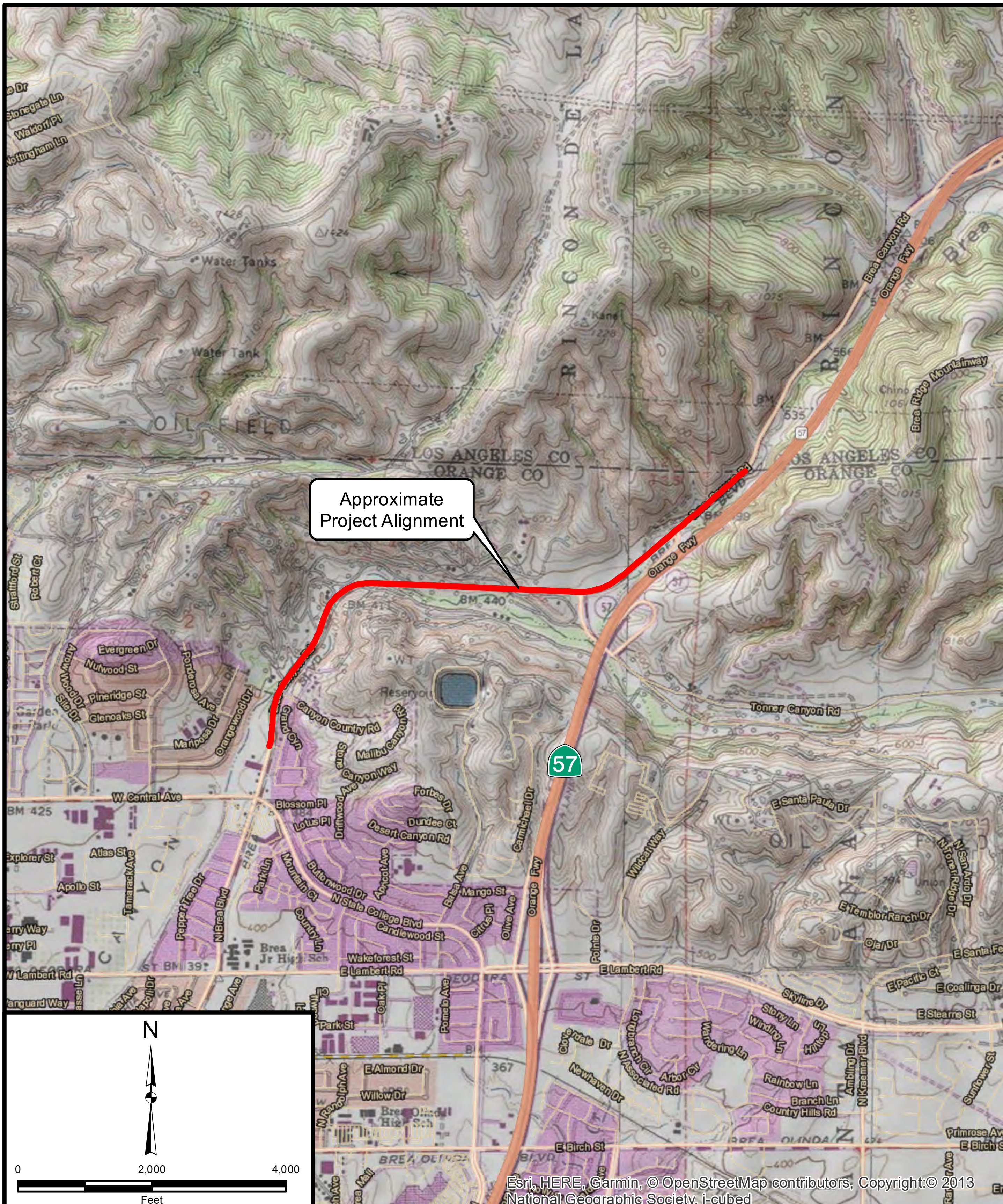


Project: 11588.001	Eng/Geol: JEH/JLH
Scale: 1 " = 2,000 '	Date: January 2019

Base Map: ESRI ArcGIS Online 2019

Author: Leighton Geomatics (mmurphy)

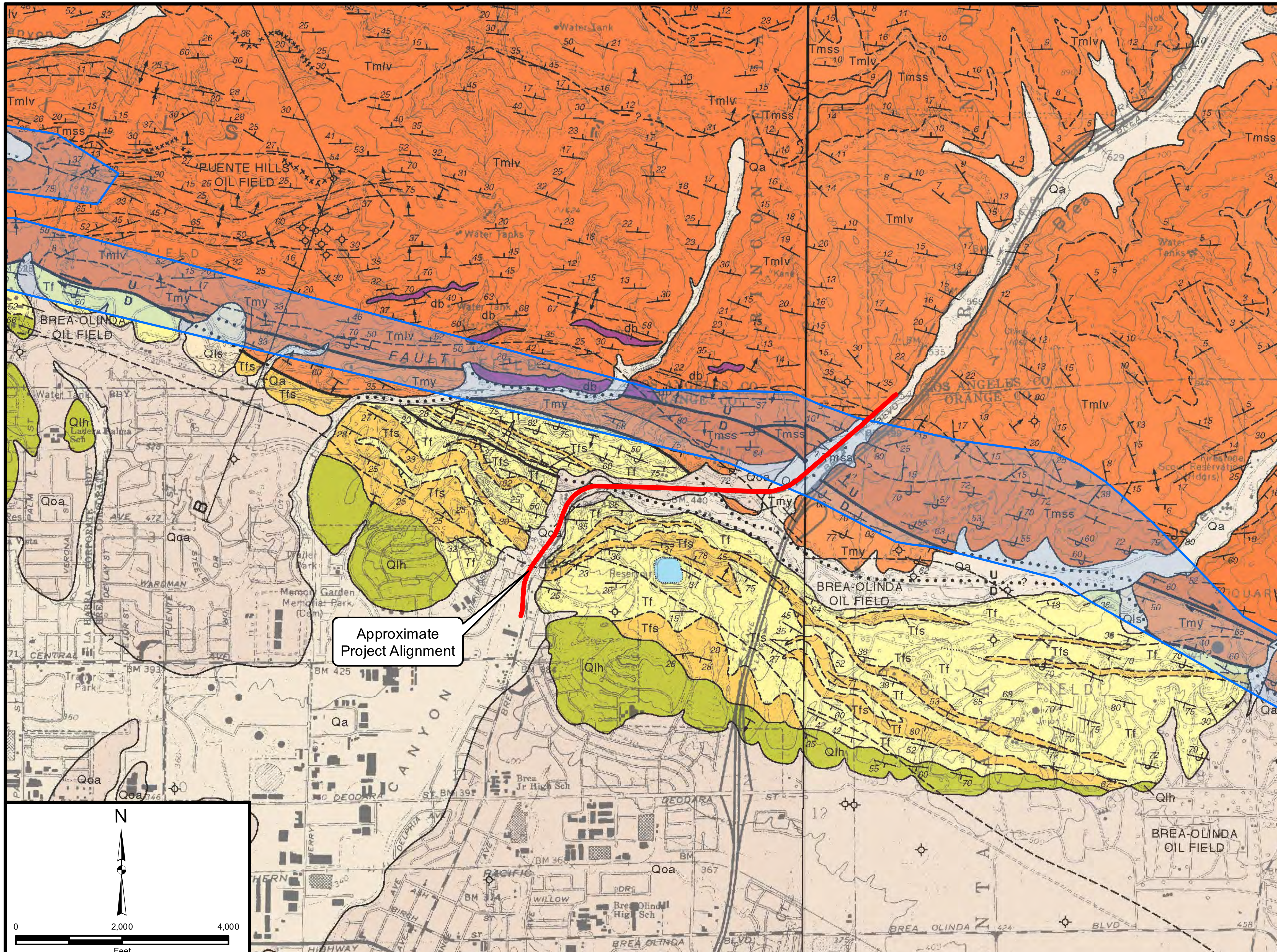
SITE LOCATION MAP

Brea Boulevard Widening
Orange County, California

Figure 1

Leighton

Map Saved as V:\Drafting\11588\001\Maps\11588-001_F01_SLM_2019-01-30.mxd on 1/30/2019 8:32:39 AM



Legend

	AP Fault Zone
af	Artificial fill, some recent areas may not be shown
Qa	Alluvial gravel, sand, and silt of valleys and floodplains
Qls	Landslide debris
Qoa	Elevated, dissected remnants of alluvial sand and gravel
Qlh	Tan to light gray sandstone and pebble conglomerate, vaguely bedded, includes abundant siliceous shale pebbles south of Puente Hills
Tfs	Sandstone facies: light gray, weathers light brown, fine to coarse-grained, bedded, locally fossiliferous; includes pebble conglomerate; locally includes minor gray siltstone
Tf	Siltstone to claystone facies: siltstone to claystone facies; gray, vaguely bedded, commonly finely sandy, micaceous, locally includes thin layers of sandstone
Tmy	Yorba Shale Member: thin-bedded, white-weathering, platy siliceous, to light gray, semi-siliceous to silty, locally with thin layers of fine-grained sandstone; locally includes few thin layers of hard, yellowish-gray dolomite
Tmss	Soquel Sandstone Member and facies: mostly bedded sandstone, light gray, weathering fan, mostly medium-grained, arkosic, locally ranging to coarse pebbly, with minor biotite; inclues minor silty clay shale
Tmlv	La Vida Shale Member: thin-bedded, cream-white weathering, platy, siliceous to semi-siliceous shale, with some thin layers of gray siltstone, also some layers of hard, yellow-gray dolomite, and thin layers of sandstone
db	Diabase: black, fine-grained, massive; forms one or more sills within lower Tmlv

GEOLOGIC SYMBOLS

not all symbols shown on each map

FORMATION CONTACT *dashed where inferred or indefinite dotted where concealed*

MEMBER CONTACT *between units of a formation* Prominent bed

CONTACT BETWEEN SURFICIAL SEDIMENTS *located only approximately in places*

FAULT: *Dashed where indefinite or inferred, dotted where concealed, queried where existence is doubtful. Parallel arrows indicate inferred relative lateral movement. Relative vertical movement is shown by U/D (U=upthrown side, D=downthrown side). Short arrow indicates dip of fault plane. Sawtooth are on upper plate of low angle thrust fault.*

FOLDS: *overturned* ANTICLINE SYNCLINE

arrow on axial trace of fold indicates direction of plunge; dotted where concealed by surficial sediments

Strike and dip of sedimentary rocks: *inclined*, *inclined (approximate)*, *overturned*, *horizontal*, *vertical*

Strike and dip of metamorphic or igneous rock foliation or flow banding or compositional layers: *inclined*, *inclined (approximate)*, *vertical*, *overturned*

OTHER SYMBOLS: *Direction of landslide movement*, *outline of water bodies shown on map*, *water well*, *oil well*, *springs*

Project: 11588.001	Eng/Geol: JEH/JLH
Scale: 1 " = 2,000 '	Date: April 2019

Base Maps: Geologic Map of the Whittier & La Habra Quadrangles by Thomas W. Dibblee, Jr., 2001 and Yorba Linda & Prado Dam Quadrangles by Thomas W. Dibblee, Jr., 2001.
Author: Leighton Geomatics (mmurphy)

REGIONAL GEOLOGY MAP

Brea Boulevard Widening
Orange County, California

Figure 2

Leighton

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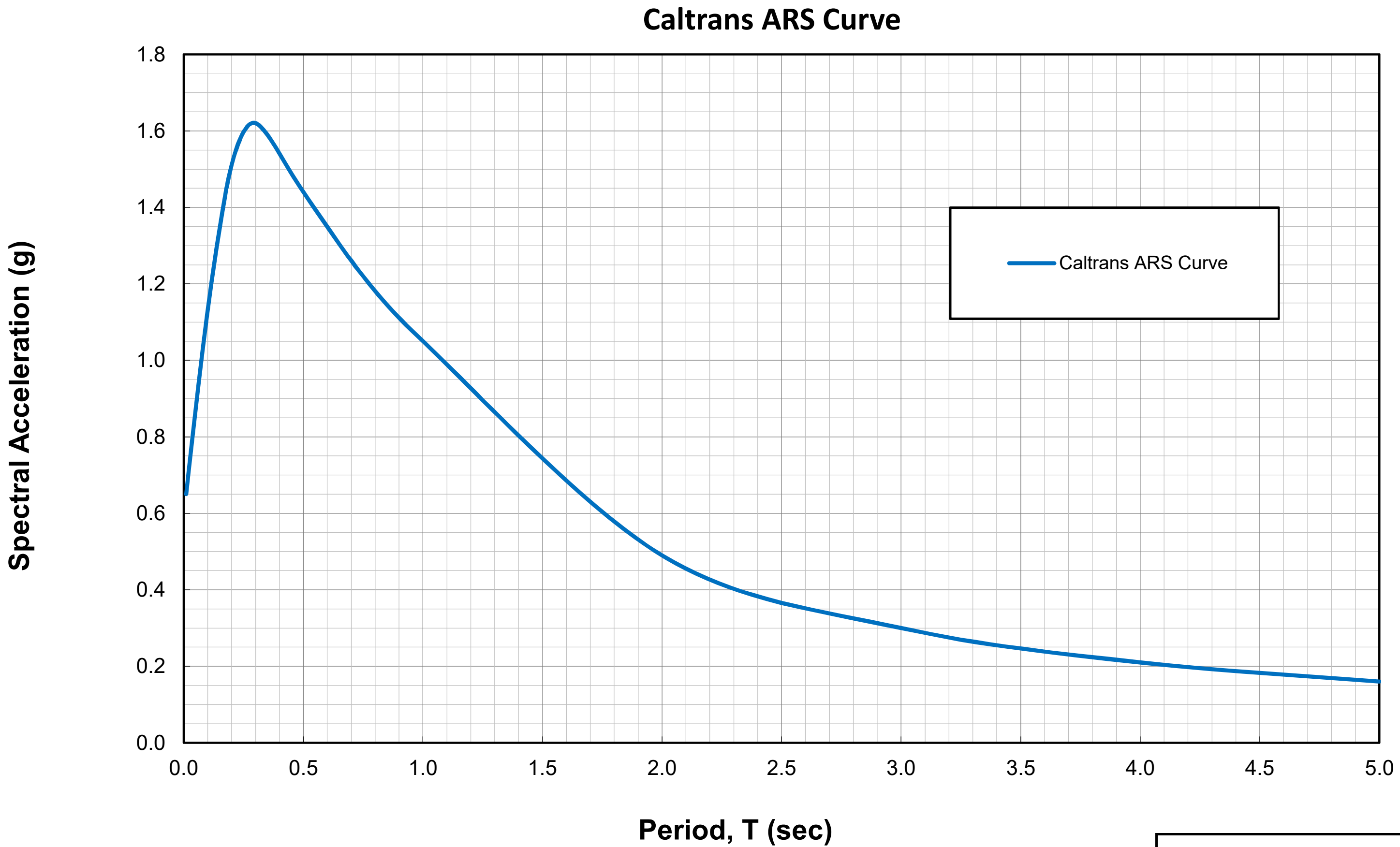

Caltrans ARS Design Envelope	
Period (sec)	Spectral Acceleration (g)
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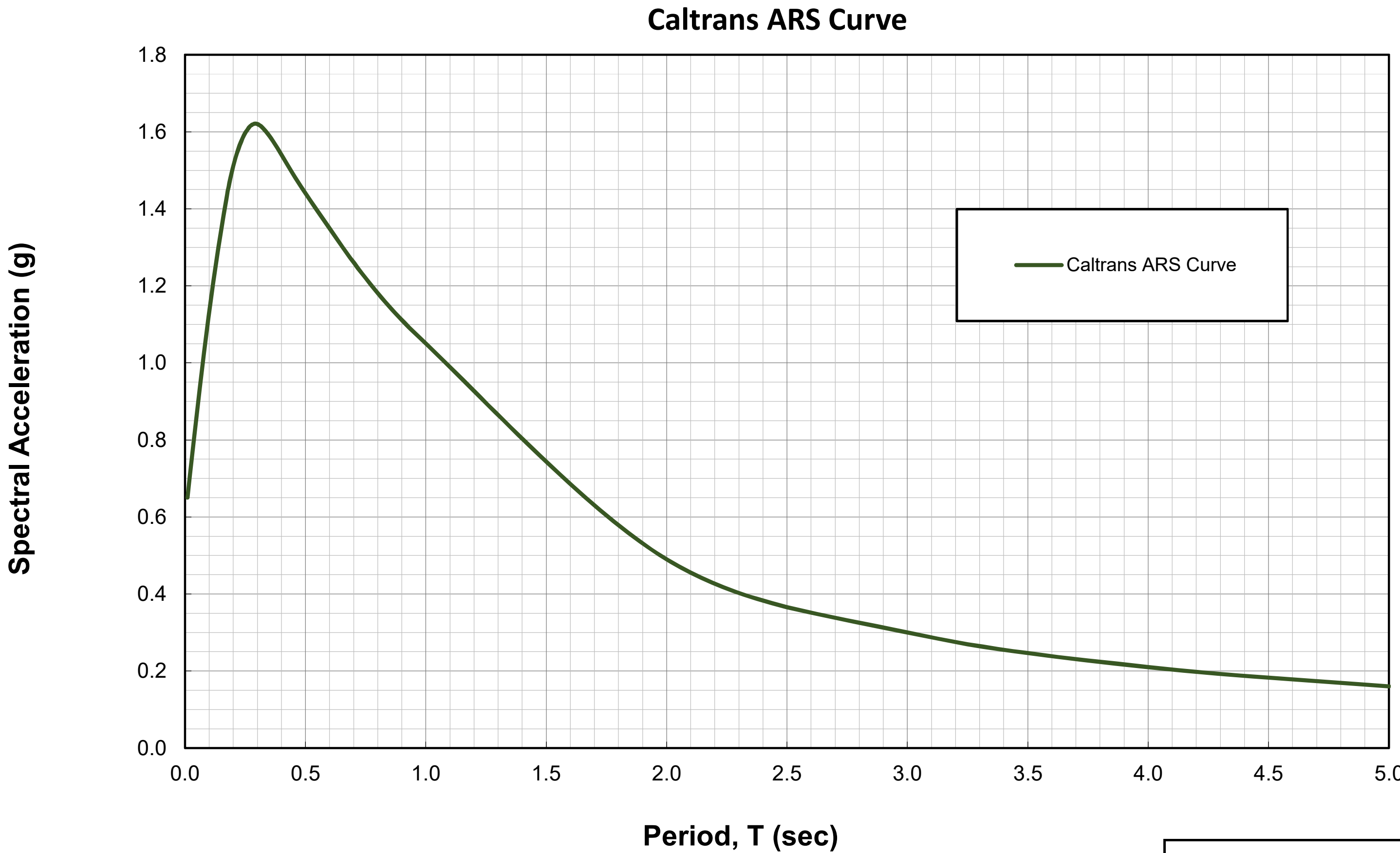
0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9378; Longitude: -117.8917
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 1
Orange County, California

Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3a



Caltrans ARS Design Envelope

Period (sec)	Spectral Acceleration (g)
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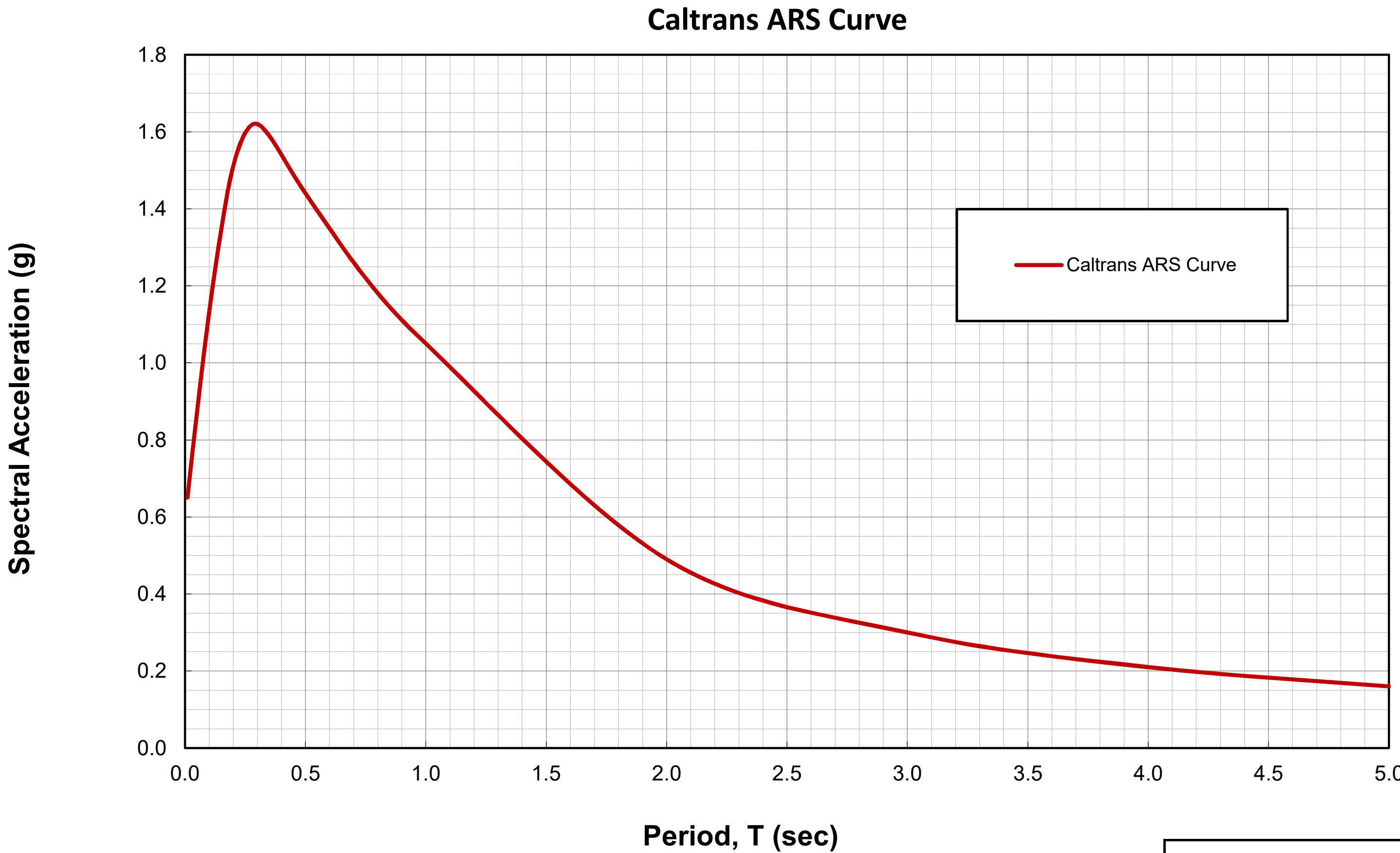
0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9400; Longitude: -117.8906
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 2
Orange County, California

Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3b



Caltrans ARS Design Envelope	
Period (sec)	Spectral Acceleration (g)
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0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9411; Longitude: -117.8875
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 3
Orange County, California

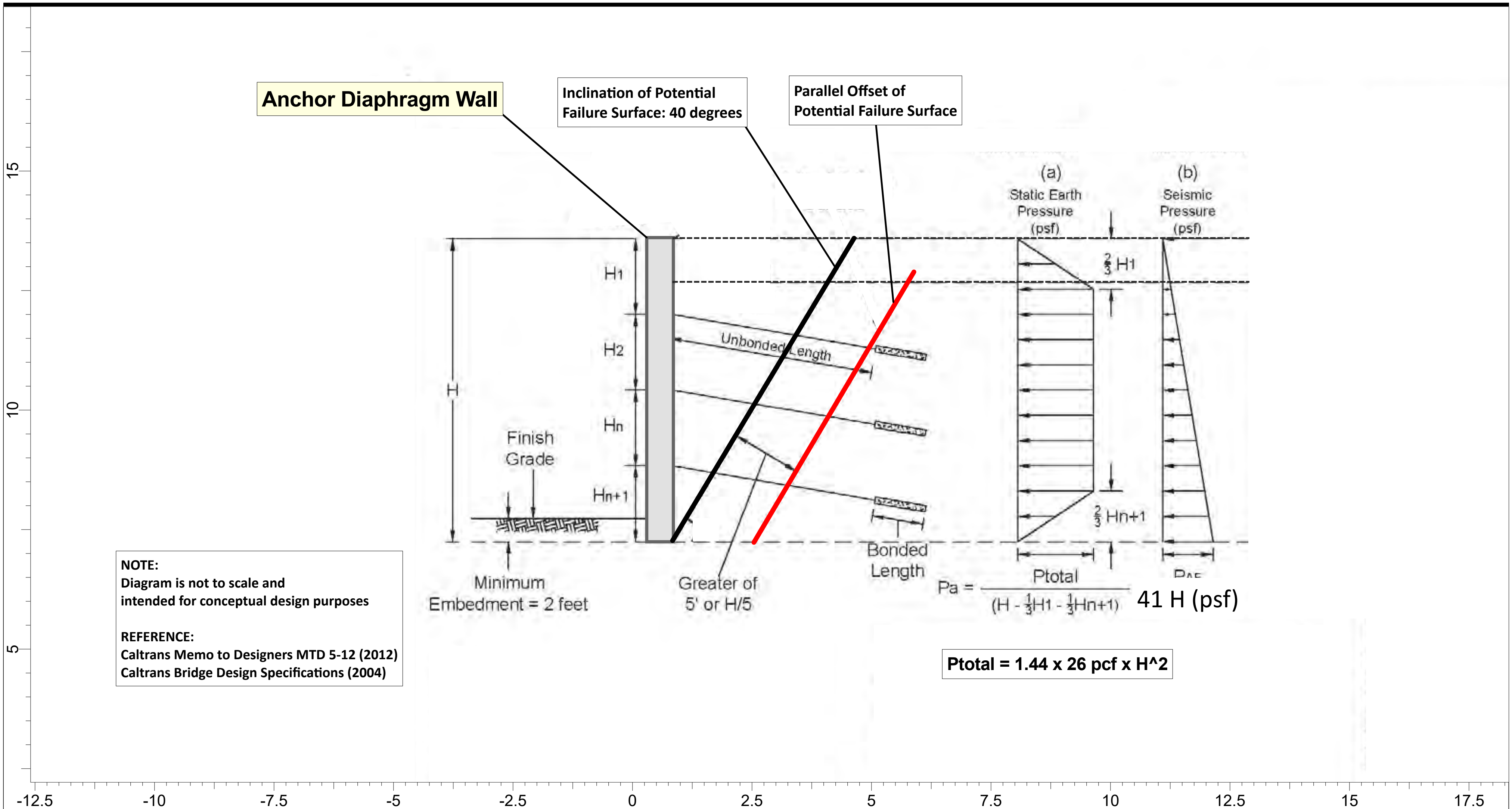
Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3c

FIGURE 4

Lateral Pressure Distribution - Earth Anchor Diaphragm Wall - RW 7

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\R E T A I N I N G W A L L S\RW-7 Anchor Diaphragm\Figure 4 - RW-7_Lateral Pressure Distributions.slim



SLIDE 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, County of Orange Public Works, Orange County, California**				
Analyzed By: JEH	Units: feet	Scale: 1:36	Project No.: **11588.001**	File Name: Figure 4 - RW-7_Lateral Pressure Distributions.slim
Date: April 2, 2019	Condition: **Schematic**			

Figure 5 - Earth Pressure Distribution - Section 26+00

Retaining Wall (RW) 04

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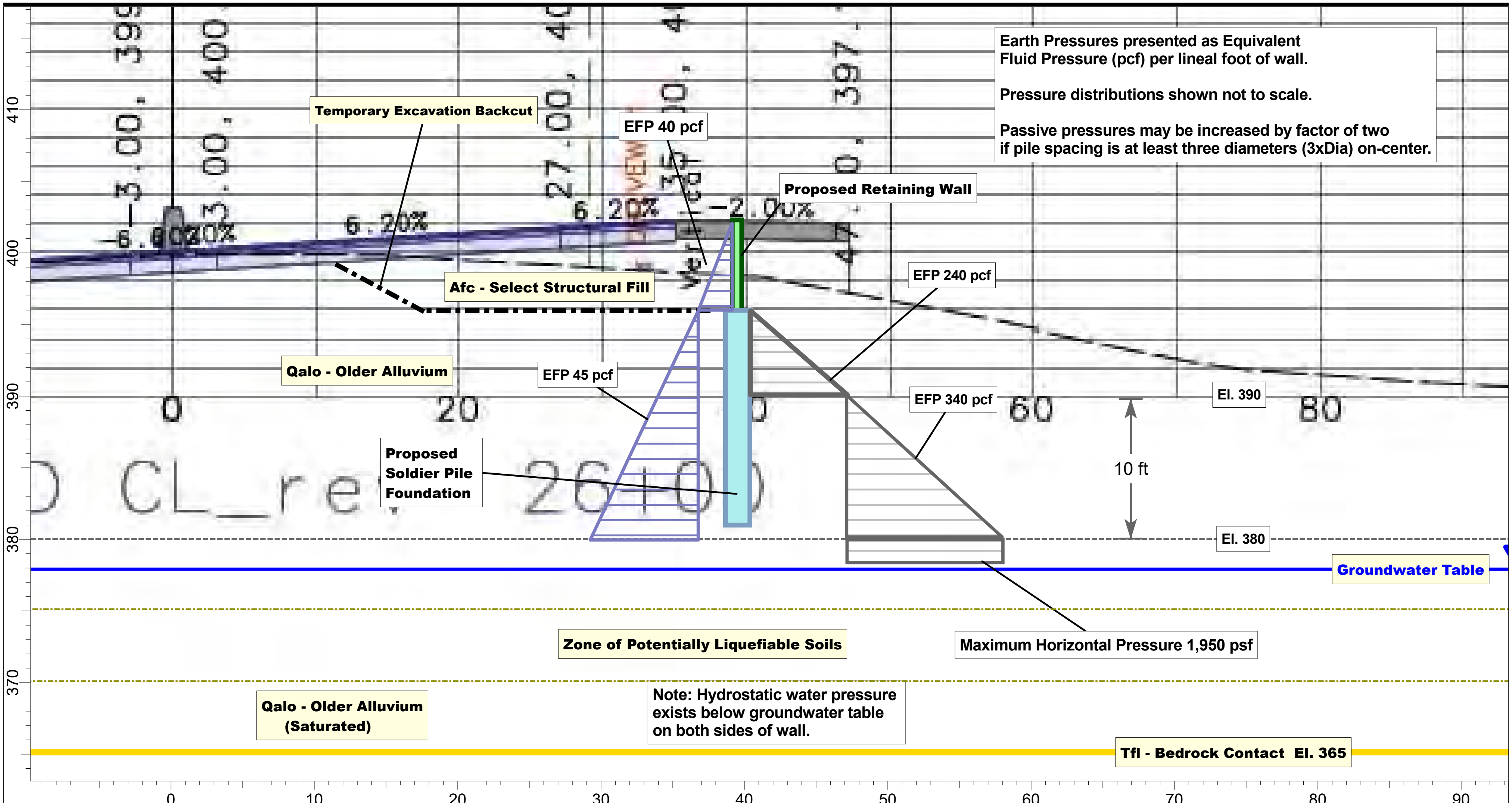

SLIDE 9.012

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Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, Califorina**				
Analyzed By: JEH	Units: feet	Scale: 1:120	Project No.: **11585.005**	File Name: Sec 26+00_RW 04_Earth Pressure_mx1.slim
Date: May 14, 2021	Condition: **Schematic**			

Figure 6 - Earth Pressure Distribution - Section 29+50

Retaining Wall (RW) 05

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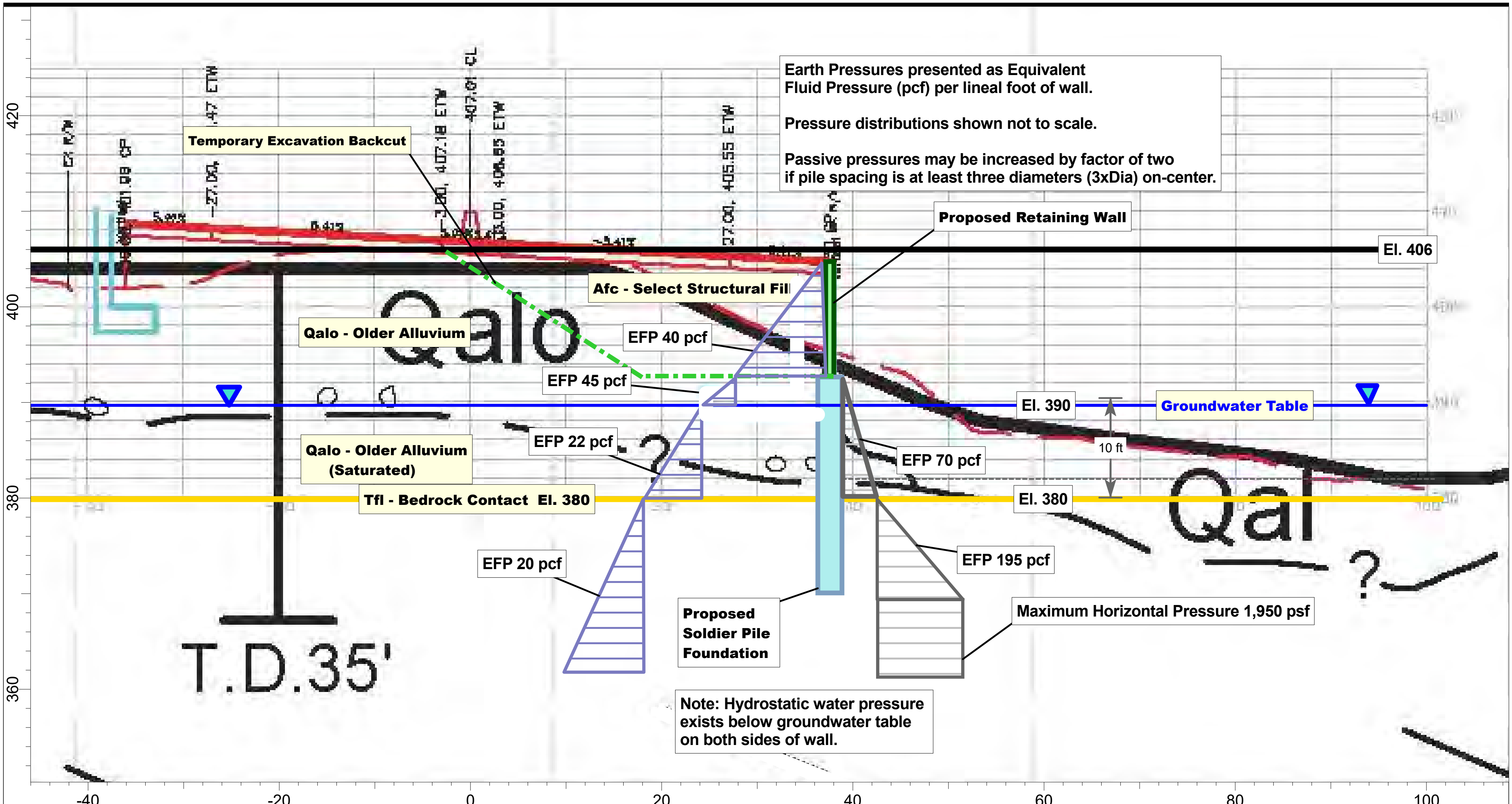

SLIDE 9.012

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Project:				
Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, Califorina				
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11585.005**	File Name: Sec 29+50_RW 05_Earth Pressure_Figure 6_05-14-21.slim
Date: May 14, 2021	Condition: **Schematic**			

Figure 7A - Earth Pressure Distribution - Section 35+00

Retaining Wall (RW) 8 - RW Sta. 10+00 to Sta. 13+25

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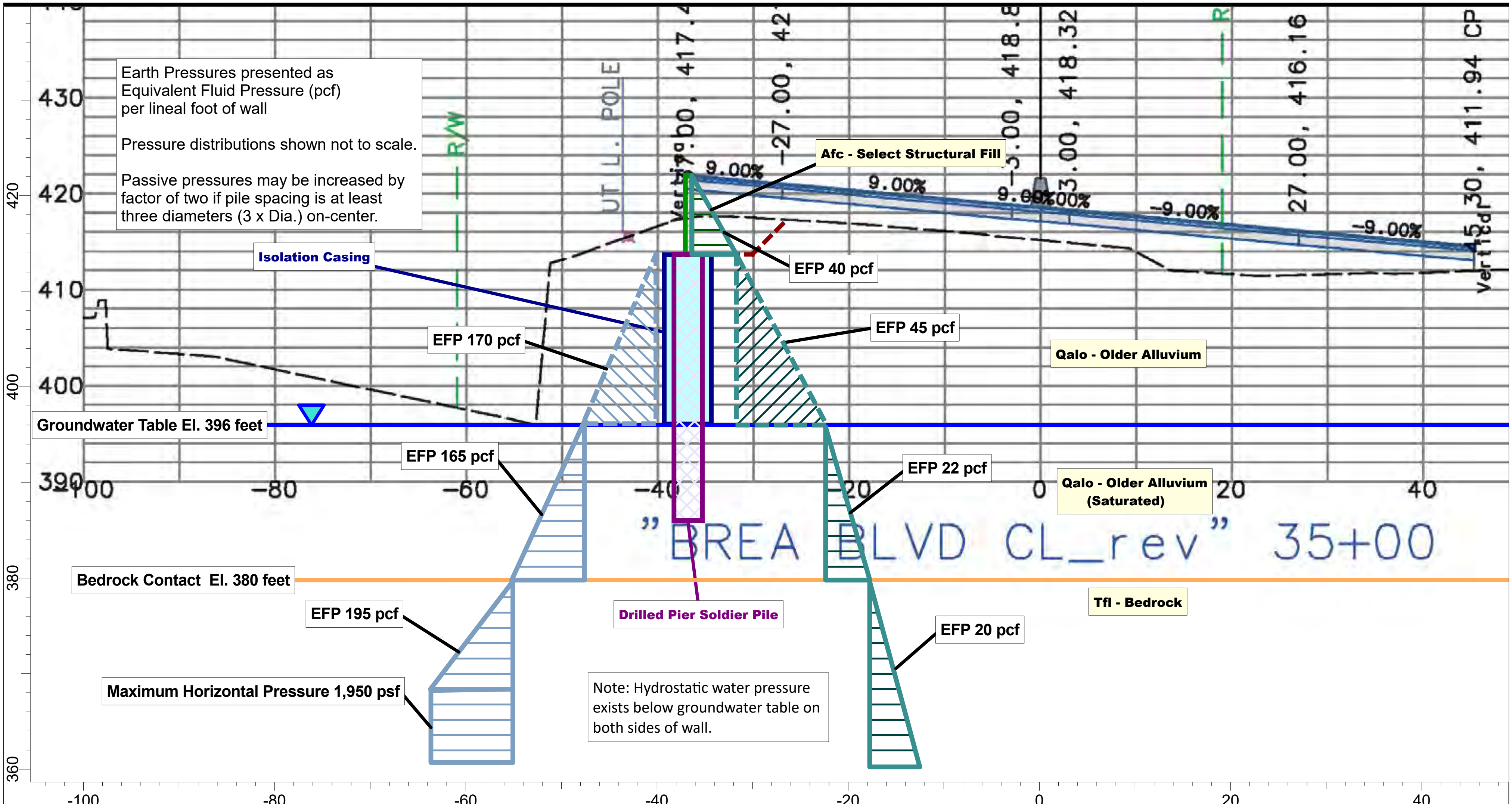

SLIDE 9.012

Leighton Consulting, Inc.
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Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**				
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11585.005**	File Name: Sec 35+00_RW-08_Earth Pressure Distribution_05-14-21.slim
Date: May 14, 2021	Condition: **Schematic**			

Figure 7B - Earth Pressure Distribution - Section 36+50

Retaining Wall (RW) 8 - RW Sta. 13+25 to 14+60 (End of Sheet Pile Wall)

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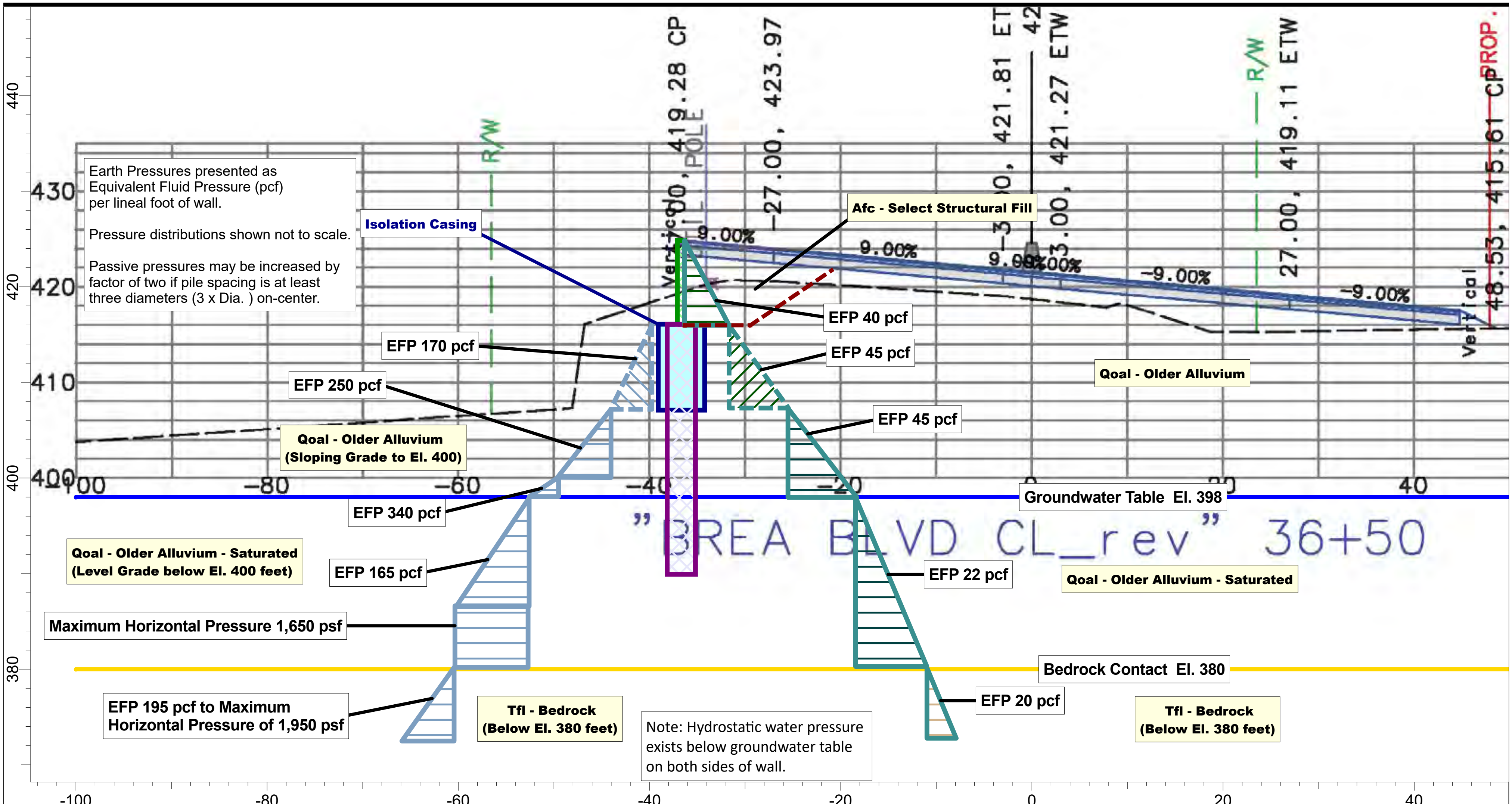

SLIDE 9.012

Leighton Consulting, Inc.
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Project: Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California			
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: 11585.005
Date: May 14, 2021	Condition: **Schematic**		File Name: Sec 36+50_RW-08_Earth Pressure Distribution_05-14-21.slim

Figure 7C - Earth Pressure Distribution - Section 38+00

Retaining Wall (RW) 8 - RW Sta. 14+60 to 15+75

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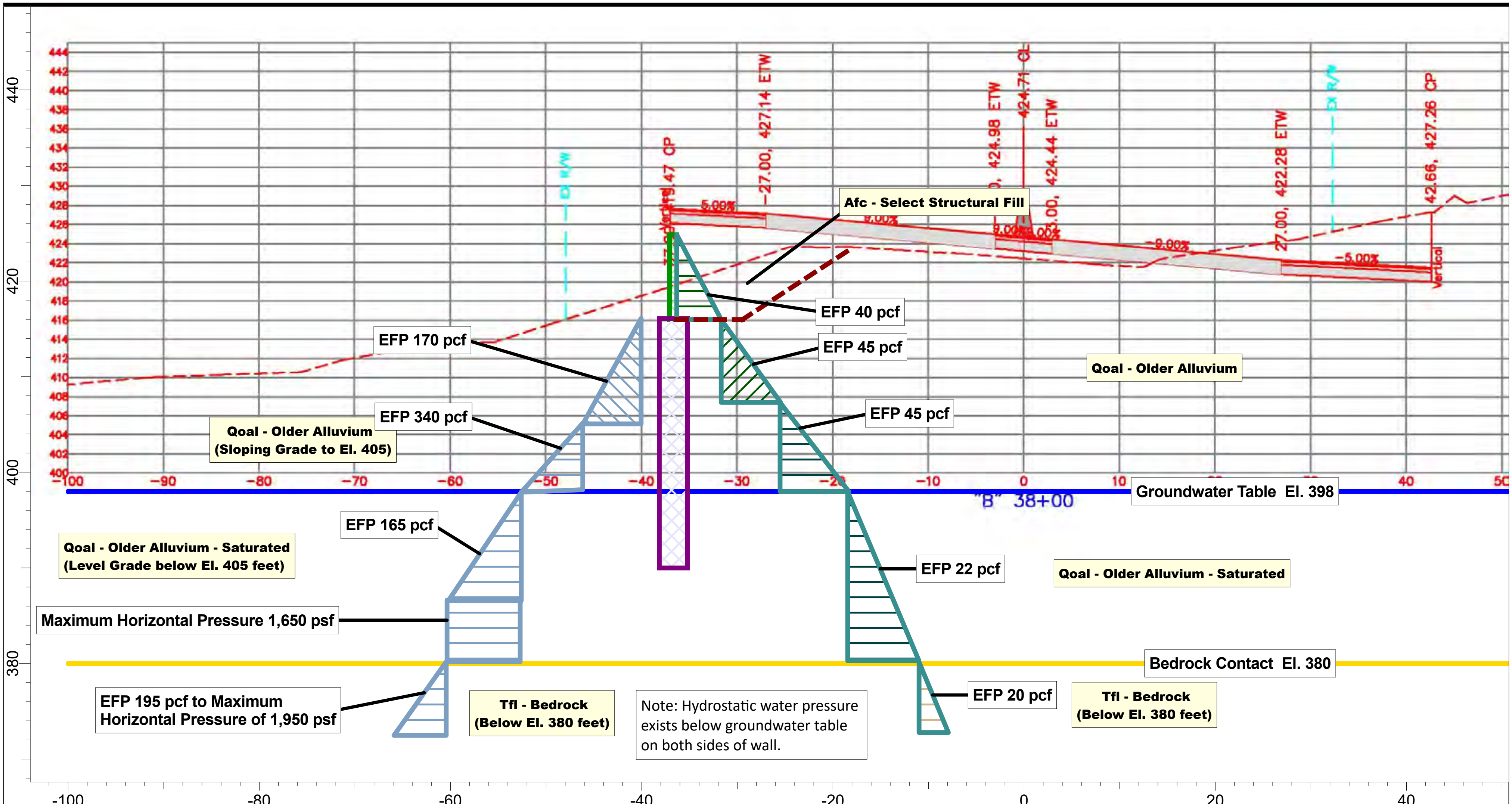

SLIDE 9.012

Leighton Consulting, Inc.
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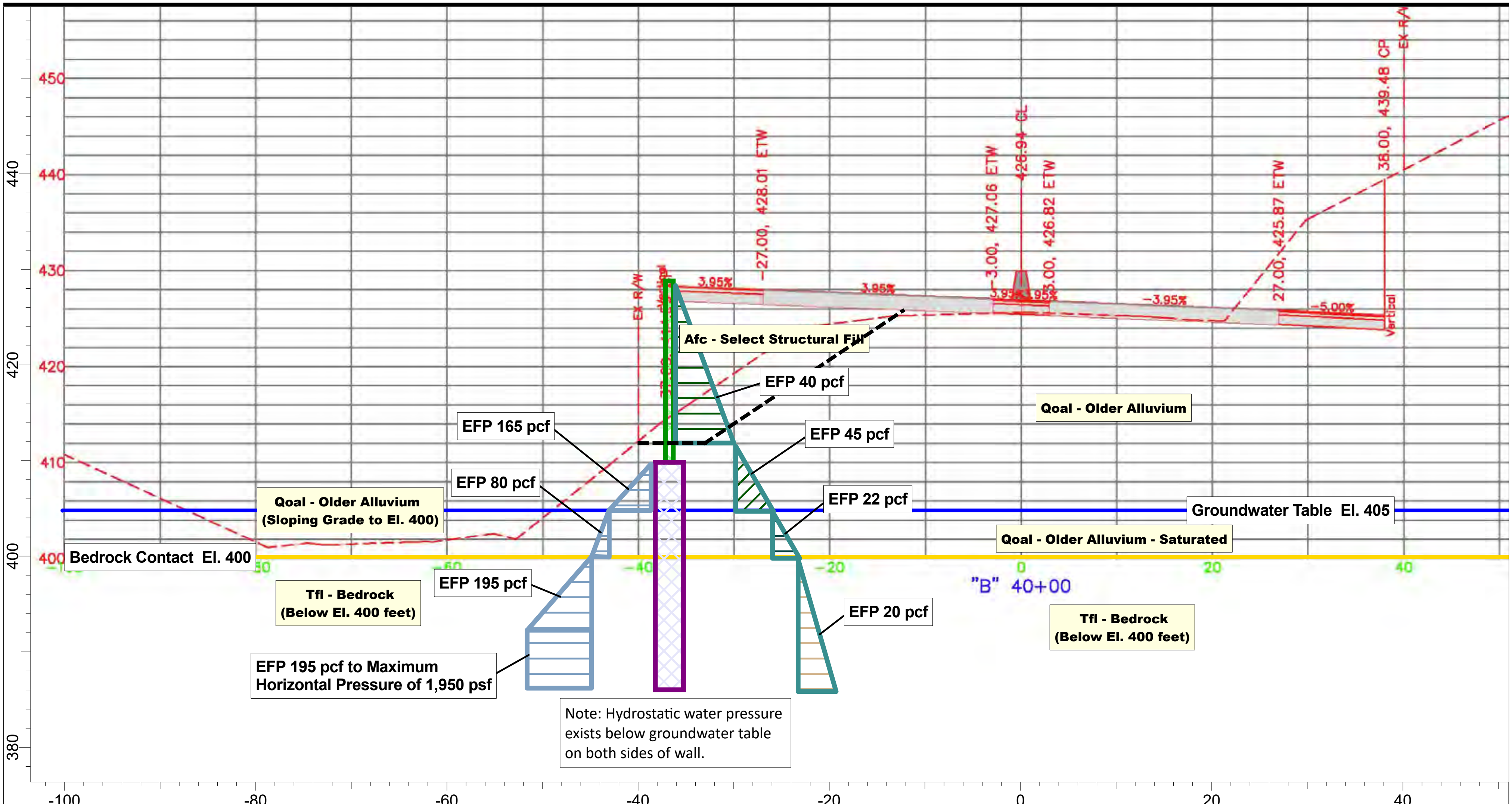
Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**			
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11588.001**
Date: May 14, 2021	Condition: **Schematic**		File Name: Sec 38+00_RW-08_Earth Pressure Distribution_05-14-21.slim

Figure 7D - Earth Pressure Distribution - Section 40+00

Retaining Wall (RW) 8 - Region Near Bridge 3 - RW Sta. 15+75 to 17+15 (End)

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\R E T A I N I N G W A L L S\RW-8 Soldier Pile\Sec 40+00_RW-08_bridge 3_Earth Pressure Distribution Fig QX.slim

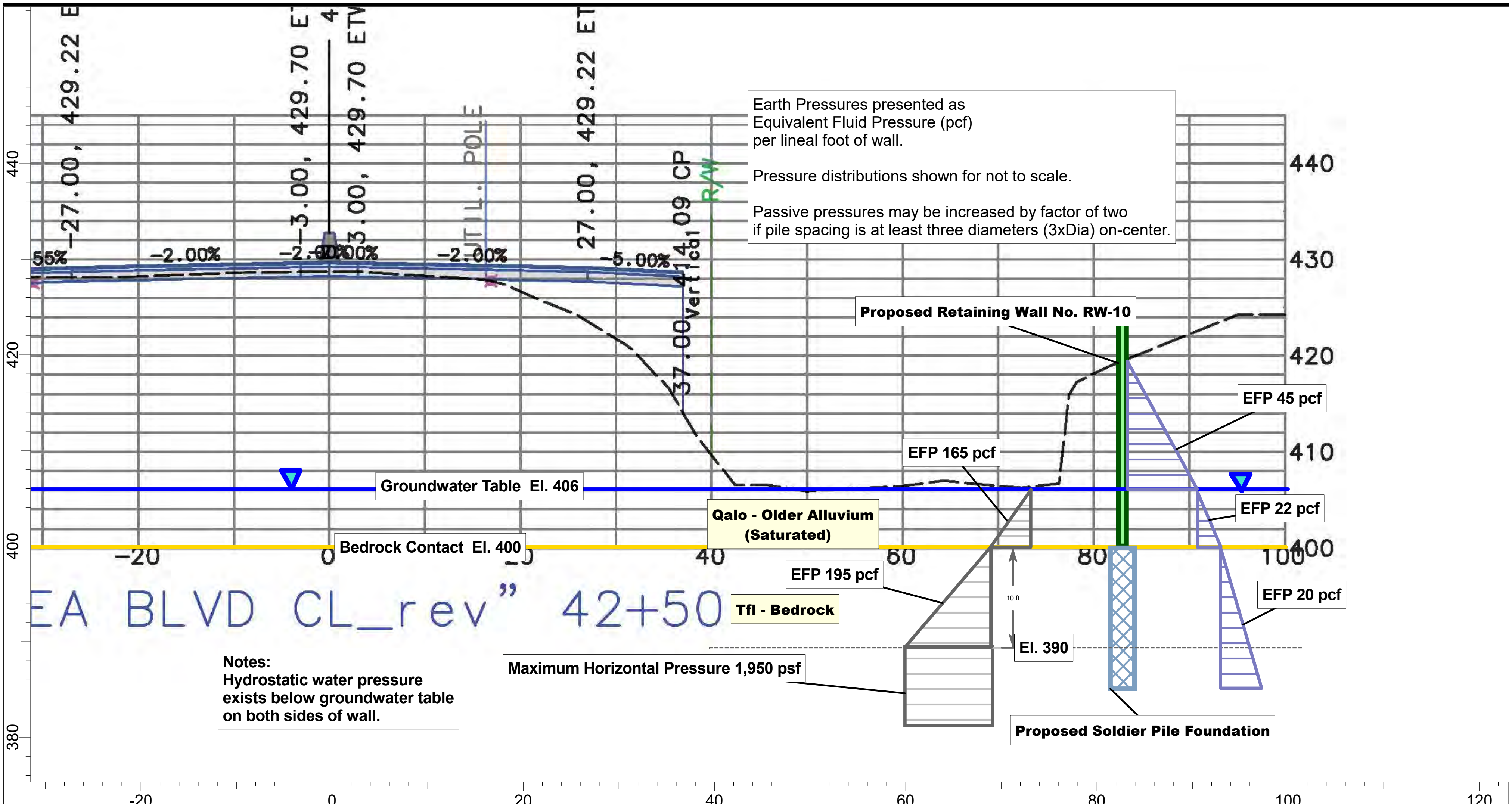


SLIDE 9.012 Leighton Consulting, Inc. A LEIGHTON GROUP COMPANY	Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**				
	Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11585.005**	File Name: Sec 40+00_RW-08_bridge 3_Earth Pressure Distribution Fig QX.slim
	Date: May 14, 2021	Condition: **Schematic**			

Figure 8 - Earth Pressure Distribution - Section 42+50

Retaining Wall RW-10

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\R E T A I N I N G W A L L S\RW-10 Soldier Pile\Figure ZZ - Sec 42+50_RW 10_Tfl El 400_Earth Pressure_.slim



SLIDE 9.012

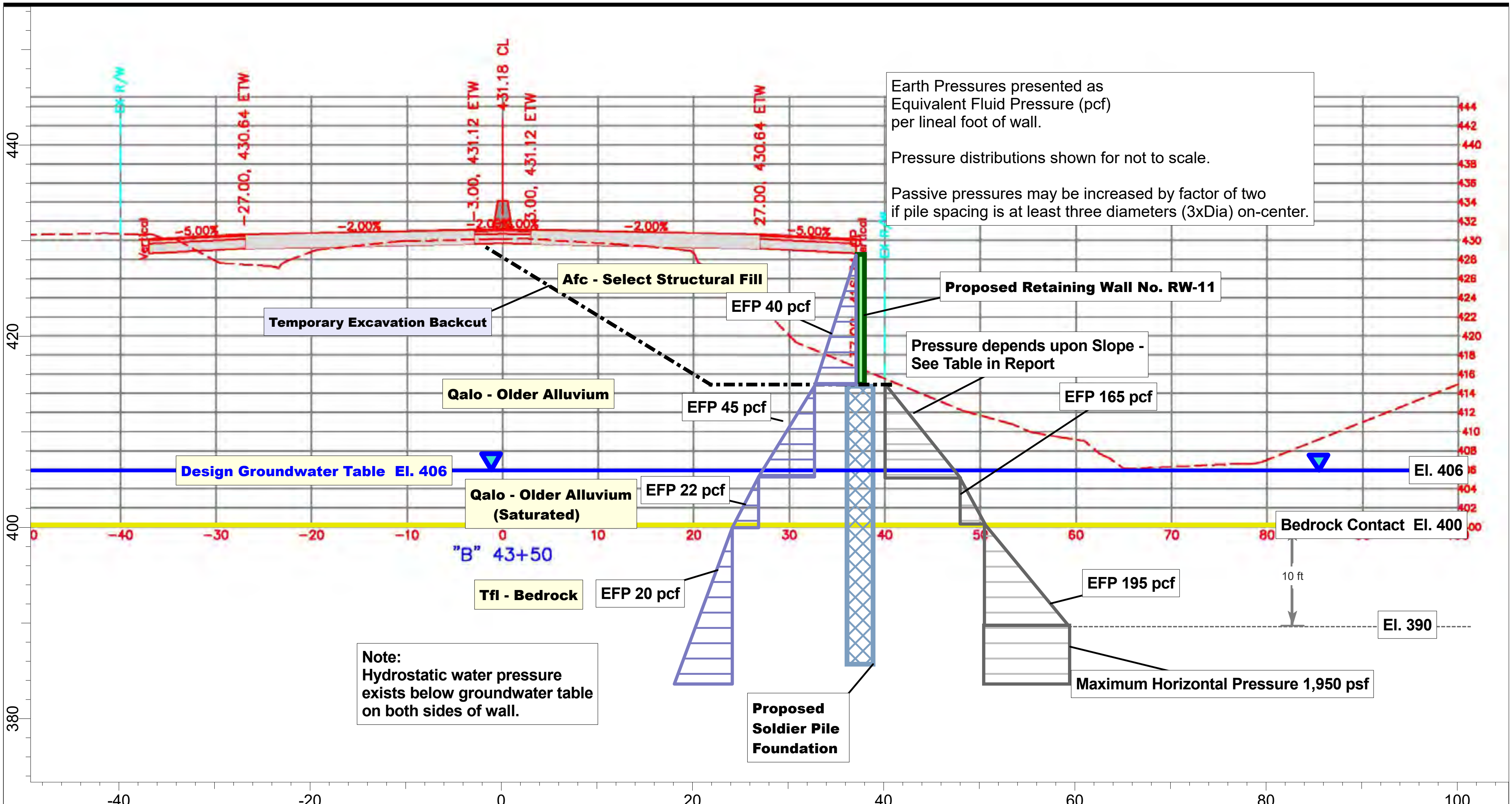
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, Califorina**				
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11585.005**	File Name: Figure ZZ - Sec 42+50_RW 10_Tfl El 400_Earth Pressure_.slim
Date: May 14, 2021	Condition: **Schematic**			

Figure 9 - Earth Pressure Distribution - Section 43+50

Retaining Wall RW-11

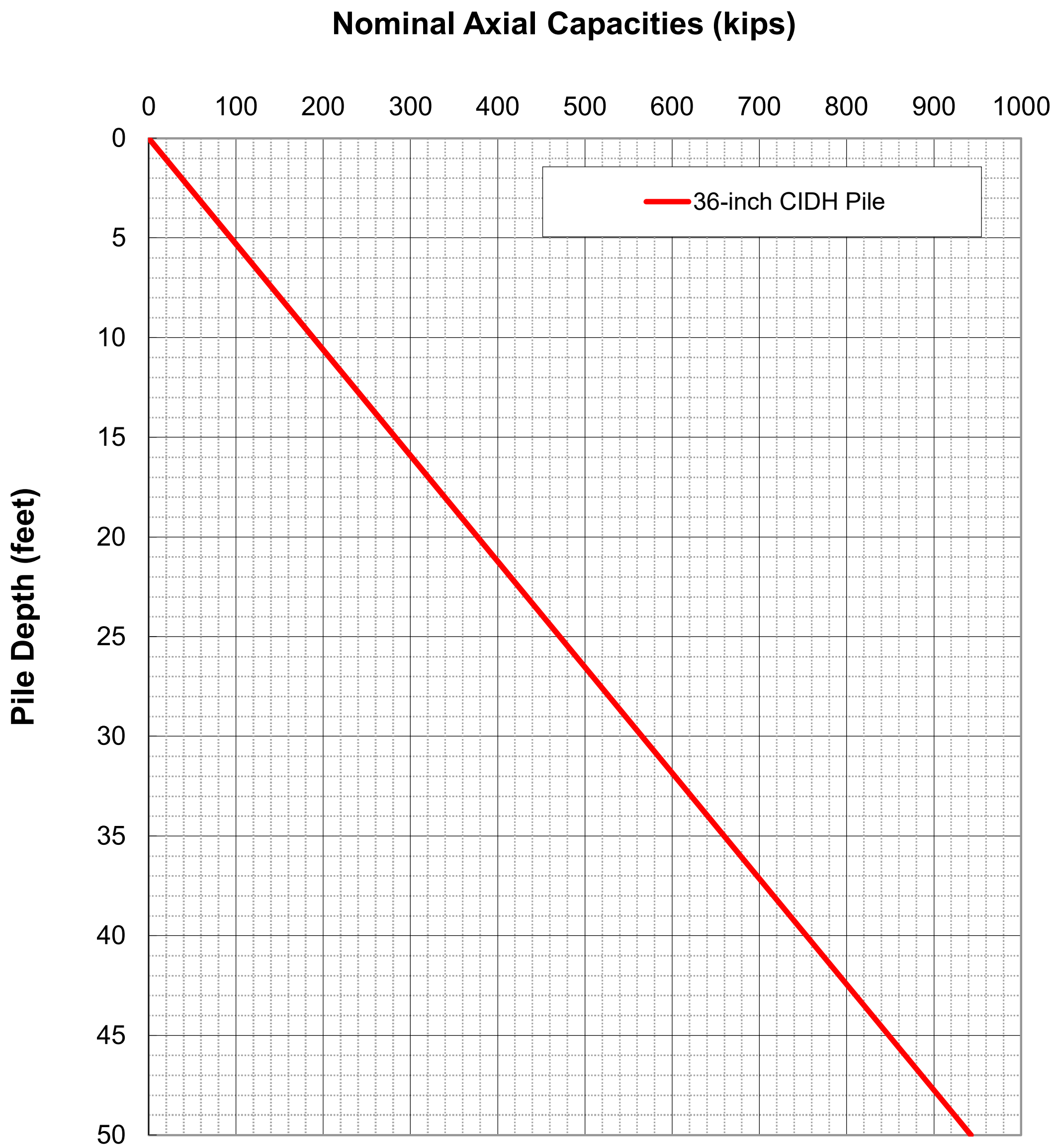
P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\R E T A I N I N G W A L L S\RW-11 Soldier Pile\Figure YY - Sec 43+50_RW 11_Earth Pressure_a.slim



Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

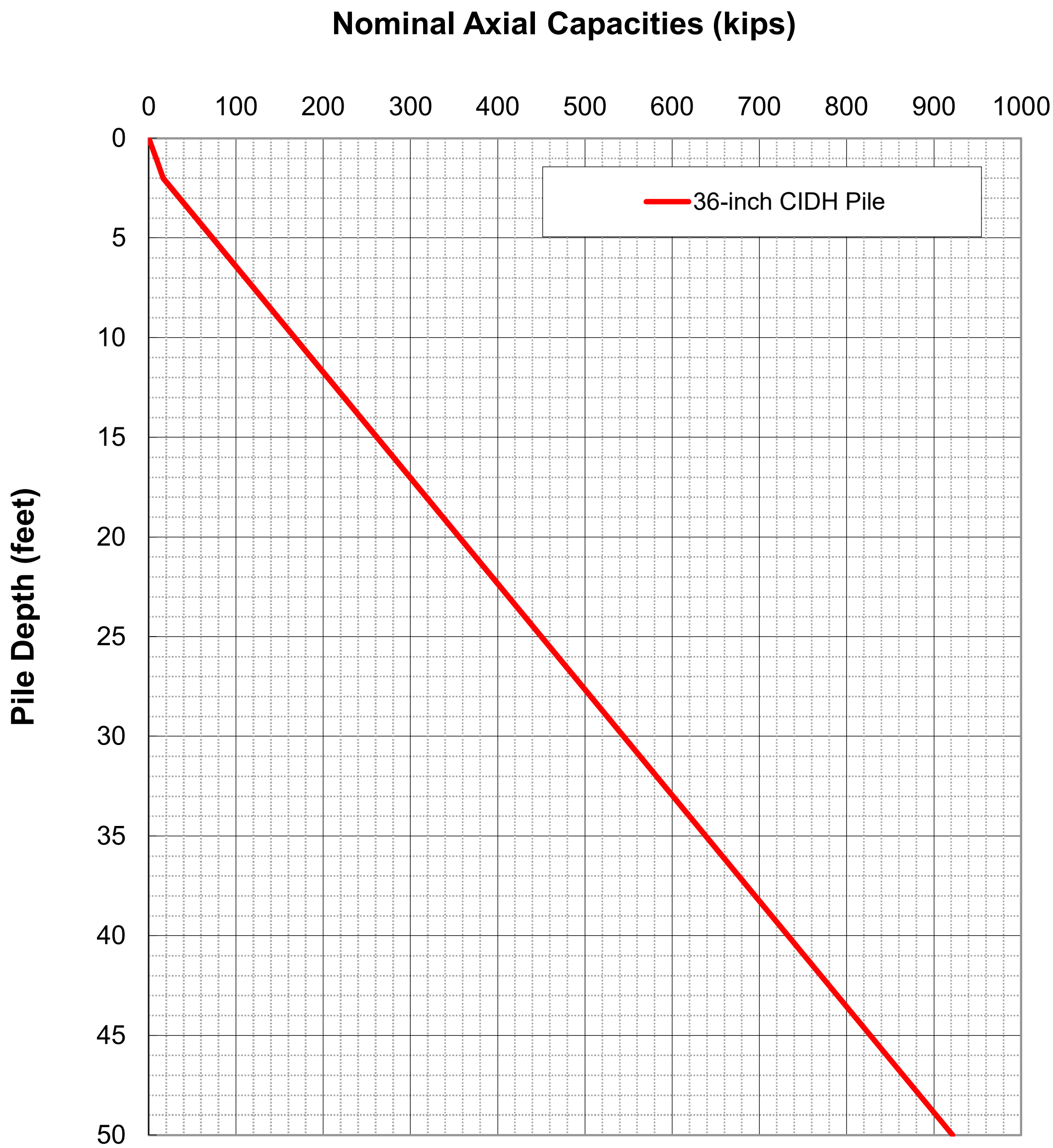
Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**

Analyzed By:	Units:	Scale:	Project No.:	File Name:
JEH	feet	1:180	**11585.005**	Figure YY - Sec 43+50_RW 11_Earth Pressure_a.slim
Date: May 12, 2021	Condition: **Schematic**			



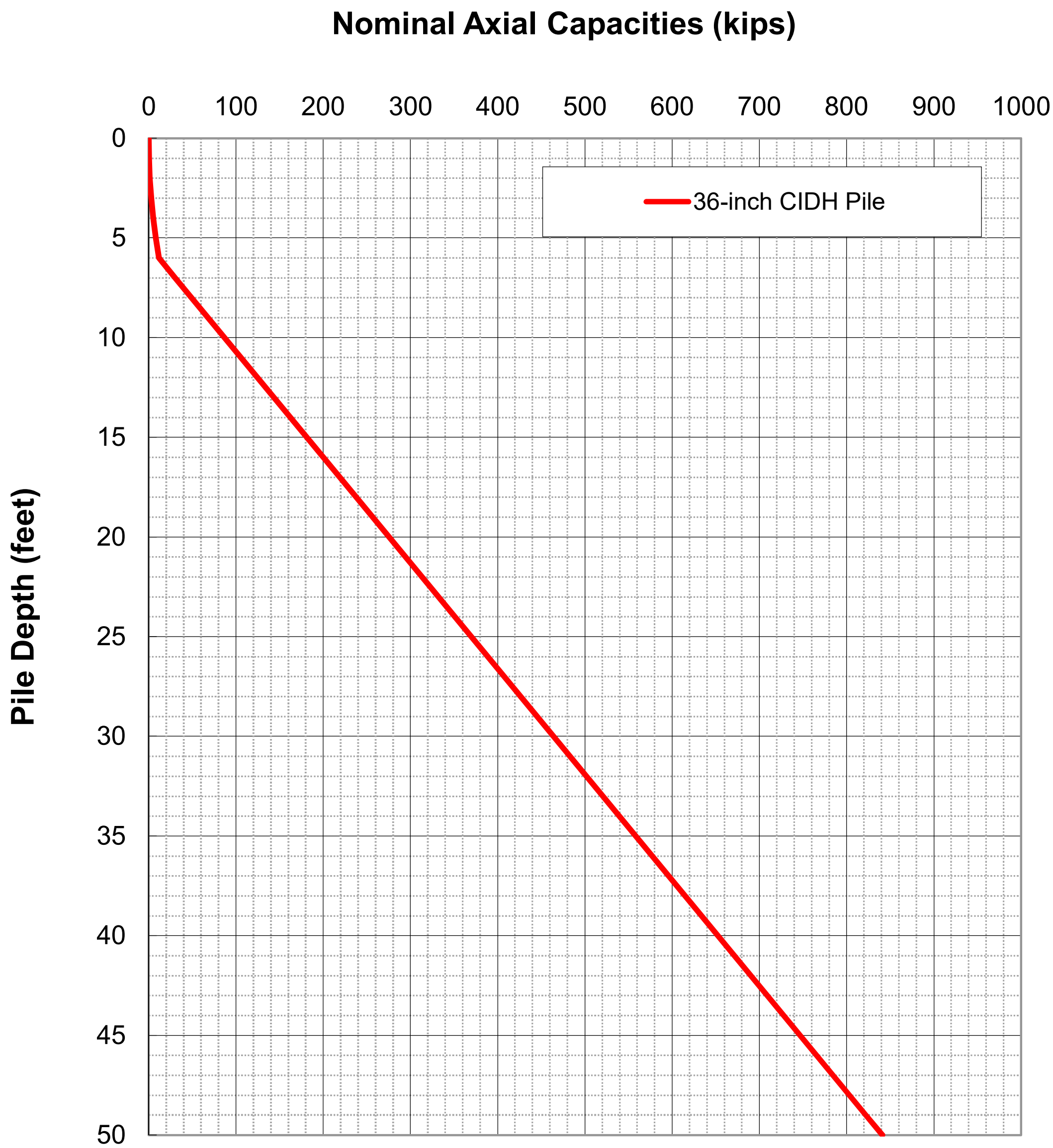
Note:
1. The top of pile (Depth = zero feet) has been assumed to be the elevation of the creek channel (i.e. Thalweg elevation per hydrology study).
2. Nominal uplift resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression.

NOMINAL AXIAL CAPACITY 36-INCH CIDH PILE WALL RW-5	PROJECT NAME : Brea Blvd Corridor PROJECT NUMBER : 11585.005 DESIGNED/CHECKED BY: CD/JEH DATE: JUNE 2021	**Figure 10**



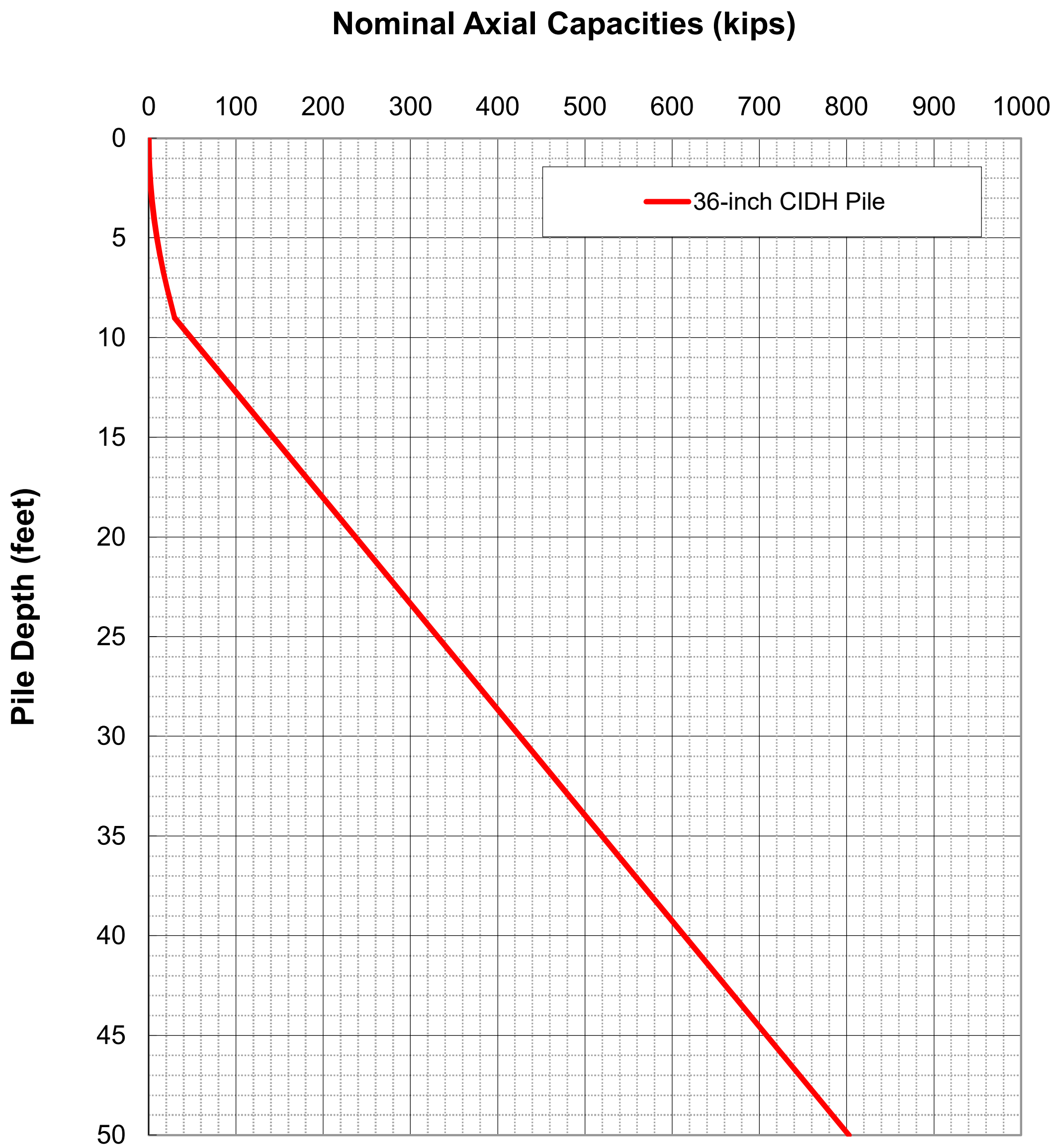
Note:
1. The top of pile (Depth = zero feet) has been assumed to be the elevation of the creek channel (i.e. Thalweg elevation per hydrology study).
2. Nominal uplift resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression.

NOMINAL AXIAL CAPACITY 36-INCH CIDH PILE BRIDGE 3 - RW-8	PROJECT NAME : Brea Blvd Corridor PROJECT NUMBER : 11585.005 DESIGNED/CHECKED BY: EDB/JEH DATE: June 2021	**Figure 11**



Note:
1. The top of pile has been assumed to be the elevation of the creek channel (i.e. Thalweg elevation per hydrology study).
2. Nominal uplift resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression.

NOMINAL AXIAL CAPACITY 36-INCH CIDH PILE BRIDGE 3 - RW-10	PROJECT NAME : Brea Blvd Corridor PROJECT NUMBER : 11585.005 DESIGNED/CHECKED BY: EDB/JEH DATE: June 2021	**Figure 12**

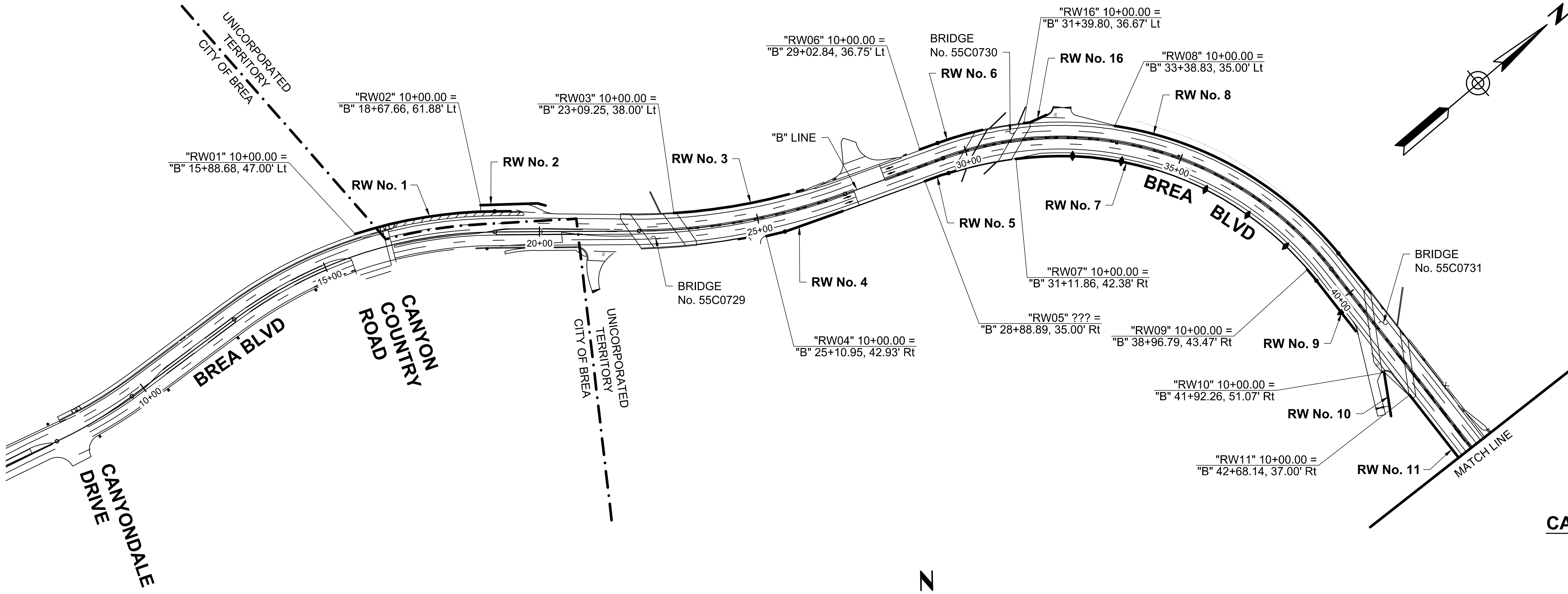


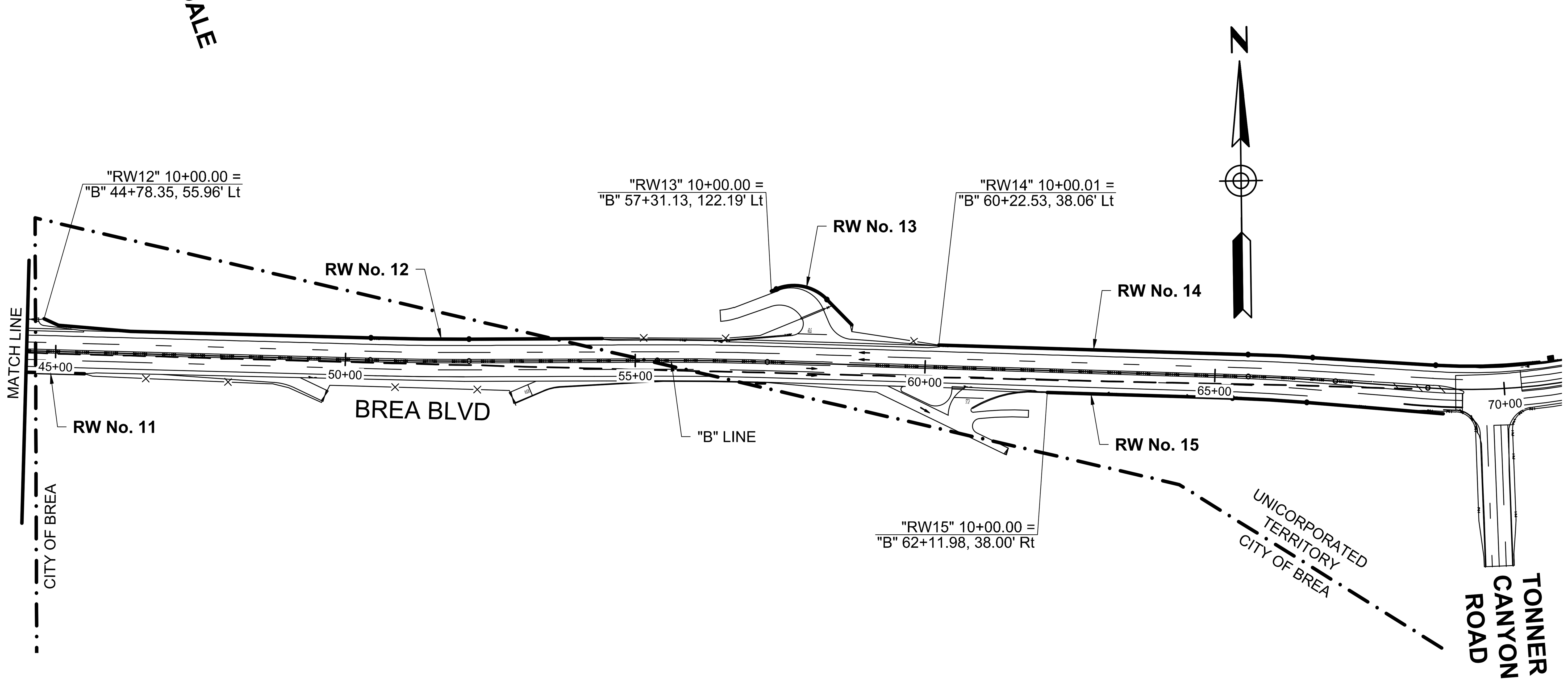
Note:
1. The top of pile (Depth = zero feet) has been assumed to be the elevation of the creek channel (i.e. Thalweg elevation per hydrology study).
2. Nominal uplift resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression.

NOMINAL AXIAL CAPACITY 36-INCH CIDH PILE BRIDGE 3 - RW-11	PROJECT NAME : Brea Blvd Corridor PROJECT NUMBER : 11585.005 DESIGNED/CHECKED BY: EDB/JEH DATE: June 2021	**Figure 13**

APPENDIX A

General Plan Sheets





INDEX TO PLANS

SHEET No.	TITLE
RW-01	RETAINING WALL INDEX MAP
RW-02 TO RW-09	RW No. 1 (MSE WALL)
RW-10	RW No. 2 (TYPE 1)
RW-11 TO RW-12	RW No. 3 (SOIL NAIL)
RW-13 TO RW-15	RW No. 4 (SOLDIER PILE)
RW-16 TO RW-18	RW No. 5 (SOLDIER PILE)
RW-19	RW No. 6 (TYPE 1)
RW-20 TO RW-27	RW No. 7 (SHGA)
RW-28 TO RW-36	RW No. 8 (SOLDIER PILE)
RW-37 TO RW-38	RW No. 9 (SOIL NAIL)
RW-39 TO RW-41	RW No. 10 (SOLDIER PILE)
RW-42 TO RW-45	RW No. 11 (SOLDIER PILE)
RW-46 TO RW-53	RW No. 12 (SOIL NAIL)
RW-54 TO RW-55	RW No. 13 (SOIL NAIL)
RW-56 TO RW-61	RW No. 14 (SOIL NAIL)
RW-62 TO RW-66	RW No. 15 (SOIL NAIL)
RW-67	RW No. 16 (TYPE 1)
RW-68 TO RW-72	SOIL NAIL WALL DETAILS No. 1 TO No. 5
RW-73 TO RW-81	SOLDIER PILE WALL DETAILS No. 1 TO No. 9
RW-82	BARRIER DETAILS
RW-83 TO RW-84	RW SIGN DETAILS No. 1 TO No. 2

CALTRANS STANDARD PLANS DATED 2018

	A3A	ABBREVIATIONS (SHEET 1 OF 3)
	A3B	ABBREVIATIONS (SHEET 2 OF 3)
	A3C	ABBREVIATIONS (SHEET 3 OF 3)
	A10A	LEGEND - LINES AND SYMBOLS (1 OF 5)
	A10B	LEGEND - LINES AND SYMBOLS (2 OF 5)
	A10C	LEGEND - LINES AND SYMBOLS (3 OF 5)
	A10D	LEGEND - LINES AND SYMBOLS (4 OF 5)
	A10E	LEGEND - LINES AND SYMBOLS (5 OF 5)
	A10F	LEGEND - SOIL (SHEET 1 OF 2)
	A10G	LEGEND - SOIL (SHEET 2 OF 2)
	A10H	LEGEND - ROCK
	A62C	LIMITS OF PAYMENT FOR EXCAVATION AND BACKFILL - BRIDGE
	A76A	CONCRETE BARRIER TYPE 60M
	B0-3	BRIDGE DETAILS
	B3-1A	RETAINING WALL TYPE 1 (CASE 1)
	B3-5	RETAINING WALL DETAILS No. 1
	B3-6	RETAINING WALL DETAILS No. 2
	B9-6	STRUCTURE APPROACH DRAINAGE DETAILS
RSP	B11-47	CABLE RAILING
	B11-58	CONCRETE BARRIER TYPE 732SW (SHEET 1 OF 2)
	B11-59	CONCRETE BARRIER TYPE 732SW (SHEET 2 OF 2)
RSP	B11-79	CONCRETE BARRIER TYPE 836 DETAILS No. 1
RSP	B11-80	CONCRETE BARRIER TYPE 836 DETAILS No. 2
	ES-7F	ELECTRICAL SYSTEMS (SIGNAL AND LIGHTING STANDARD CASE 4 SIGNAL MAST ARM LOADING, WIND VELOCITY=100 MPH AND SIGNAL MAST ARM LENGTHS 25' TO 48')
	ES-7N	ELECTRICAL SYSTEMS (SIGNAL AND LIGHTING STANDARD, DETAIL No. 2)

STANDARD PLANS No.

DETAIL No.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA

10-15-2021 DATE

VICTOR A. SHERBY, P.E.

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: Brea_RW-Keymap.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RETAINING WALL INDEX MAP

SHEET

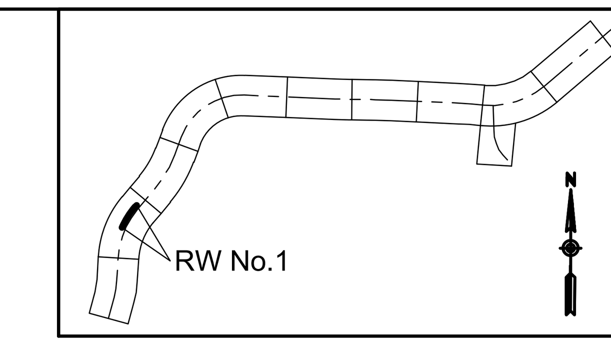
RW-01

LEGEND

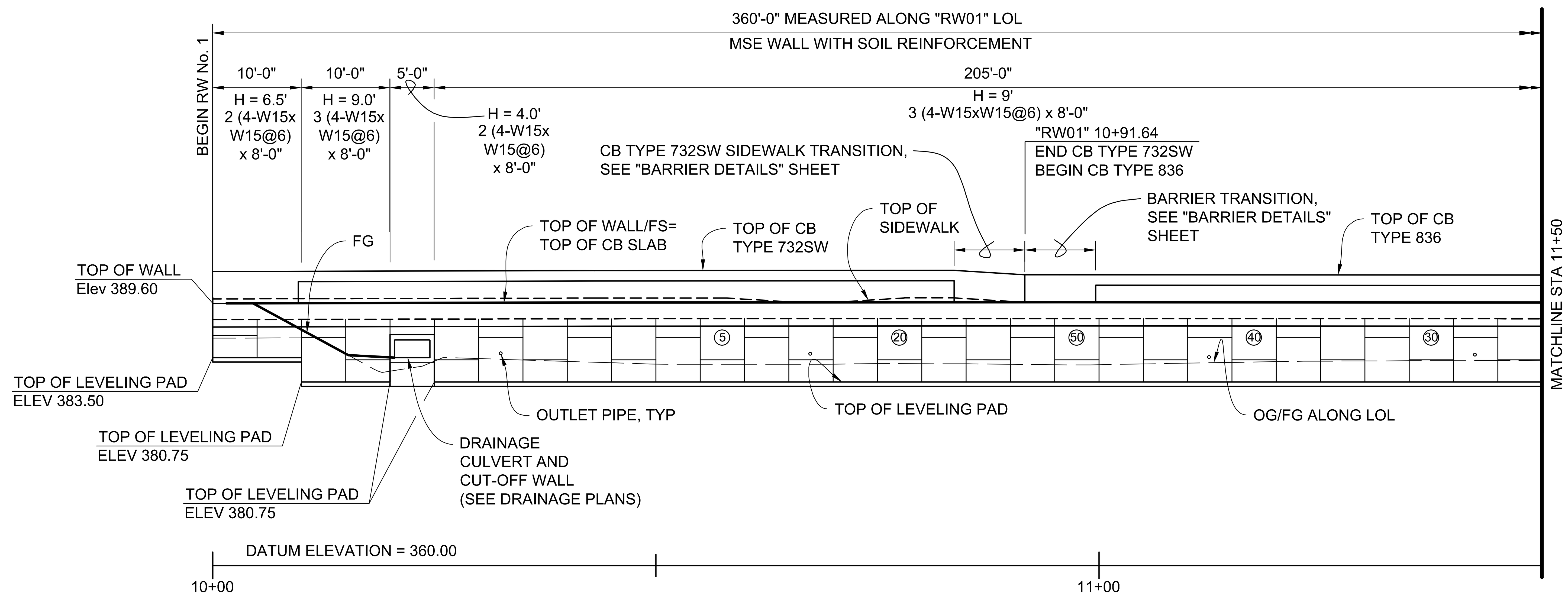
6"O	INDICATES EX. 6" OIL LINE
8"O	INDICATES EX. 8" OIL LINE
E(OH)	INDICATES EX.OH ELECTRICAL
TC(OH)	INDICATES EX. OH TELECOM
50	INDICATES INSPECTION WIRE LOCATION

INTERVAL IN YEARS FROM THE TIME OF CONSTRUCTION TO THE TIME OF REMOVAL OF INSPECTION WIRE

3 (4-W15xW15@6) x 8'-0"
- MAT LENGTH
- TRANSVERSE WIRE SPACING
- TRANSVERSE WIRE SIZE
- LONGITUDINAL WIRE SIZE
- NUMBER OF LONGITUDINAL WIRES
- NUMBER OF LEVELS



KEY MAP
1"=2000'

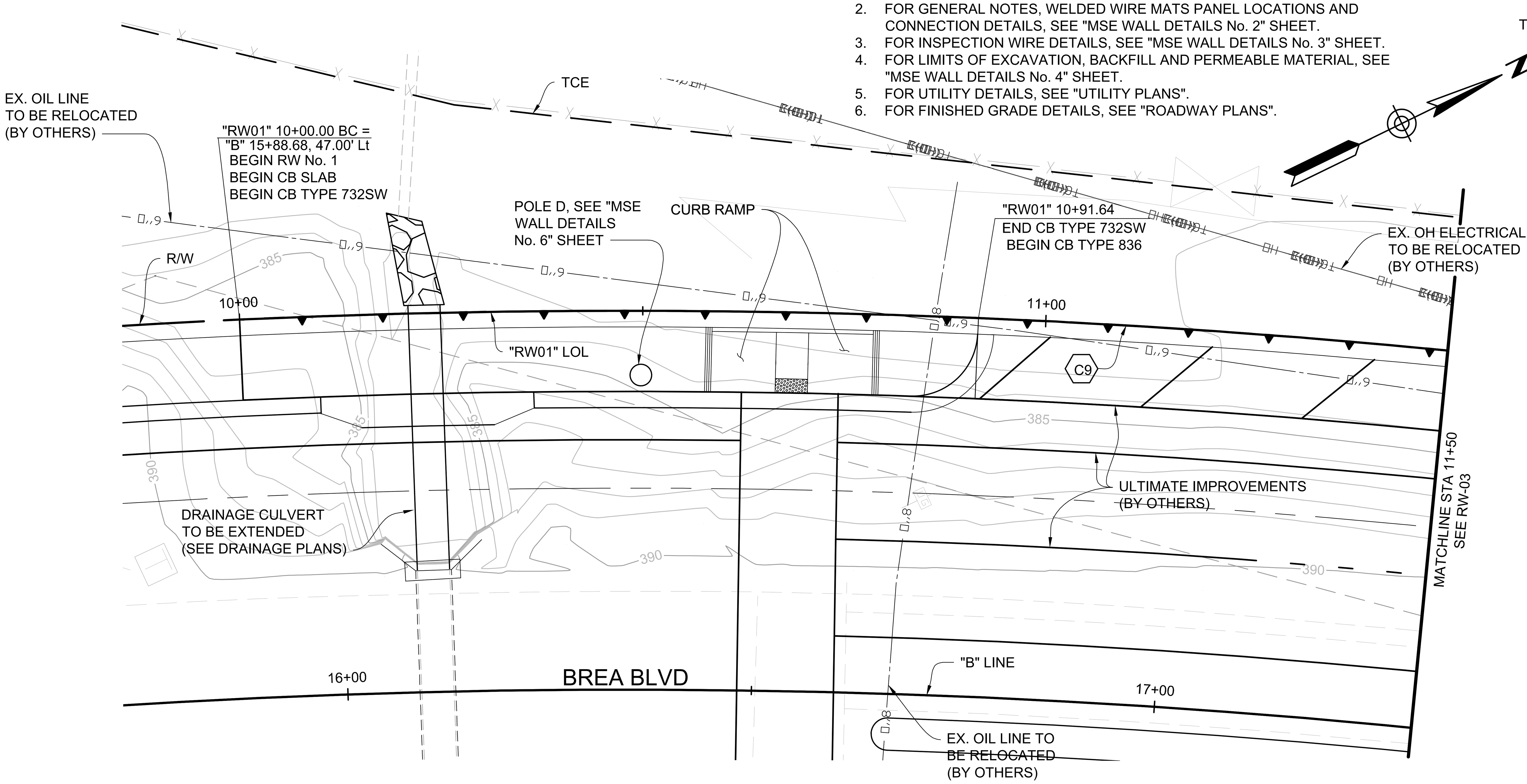


MIRRORED DEVELOPED ELEVATION
1" = 10'

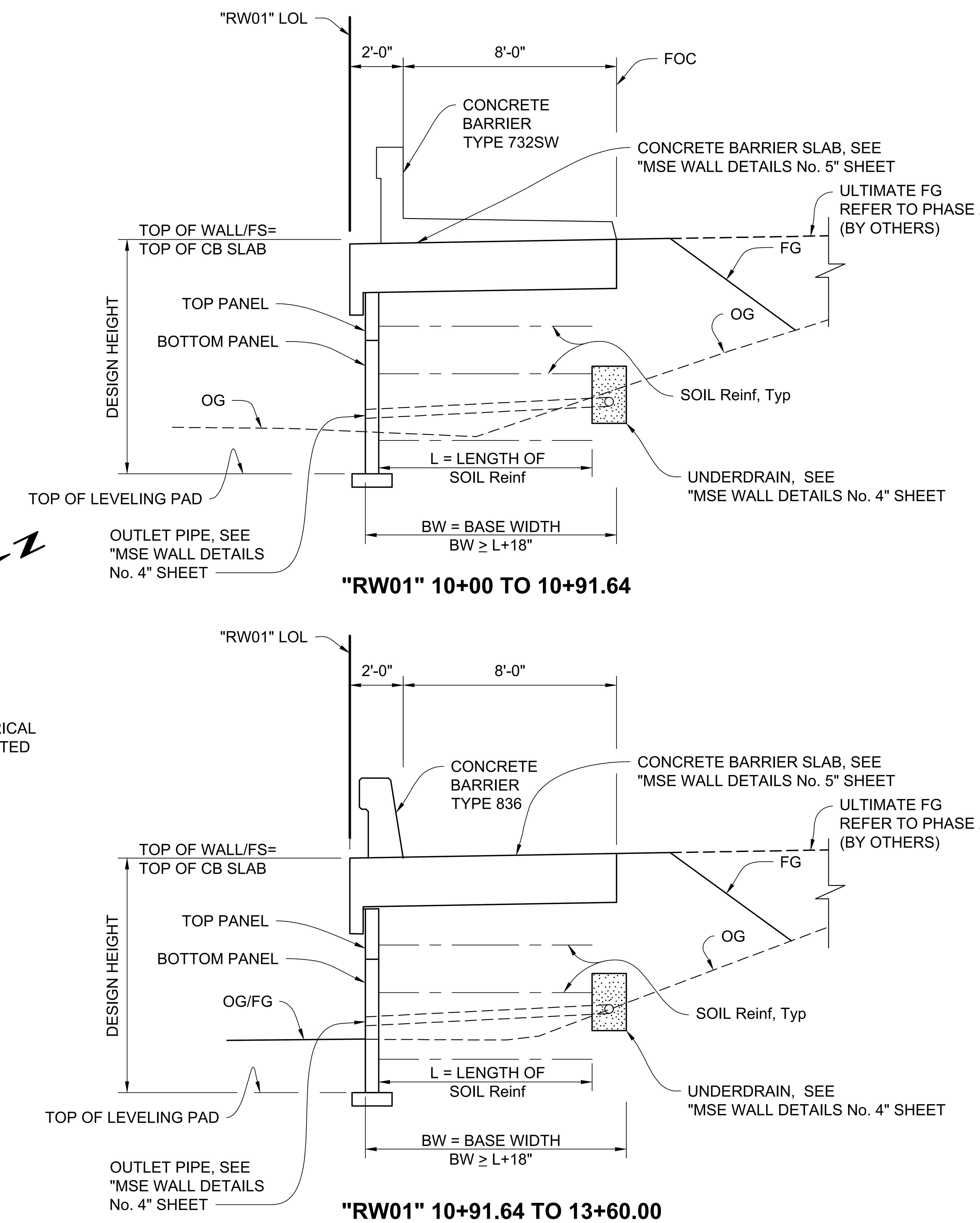
ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C9	1052.00	17°39'03"	163.34	324.08

NOTES:

1. FOR PANEL, JOINT AND LEVELING PAD DETAILS, SEE "MSE WALL DETAILS No. 1" SHEET.
2. FOR GENERAL NOTES, WELDED WIRE MATS PANEL LOCATIONS AND CONNECTION DETAILS, SEE "MSE WALL DETAILS No. 2" SHEET.
3. FOR INSPECTION WIRE DETAILS, SEE "MSE WALL DETAILS No. 3" SHEET.
4. FOR LIMITS OF EXCAVATION, BACKFILL AND PERMEABLE MATERIAL, SEE "MSE WALL DETAILS No. 4" SHEET.
5. FOR UTILITY DETAILS, SEE "UTILITY PLANS".
6. FOR FINISHED GRADE DETAILS, SEE "ROADWAY PLANS".



PLAN
1" = 10'



TYPICAL SECTION
N.T.S.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

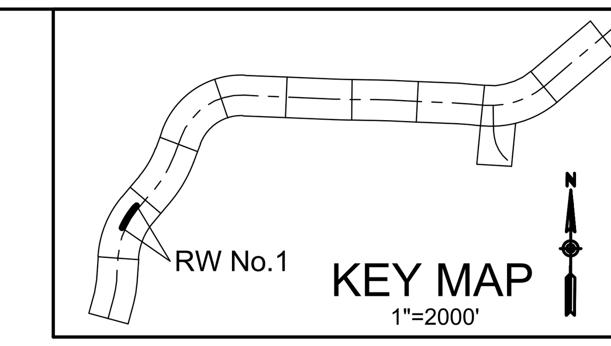
PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER — MARSHALL EUGENE MOORE — No. S6557 — Exp. 3-30-23 — STRUCTURAL — STATE OF CALIFORNIA
10-15-2021 DATE
MARSHALL E MOORE, S.E.

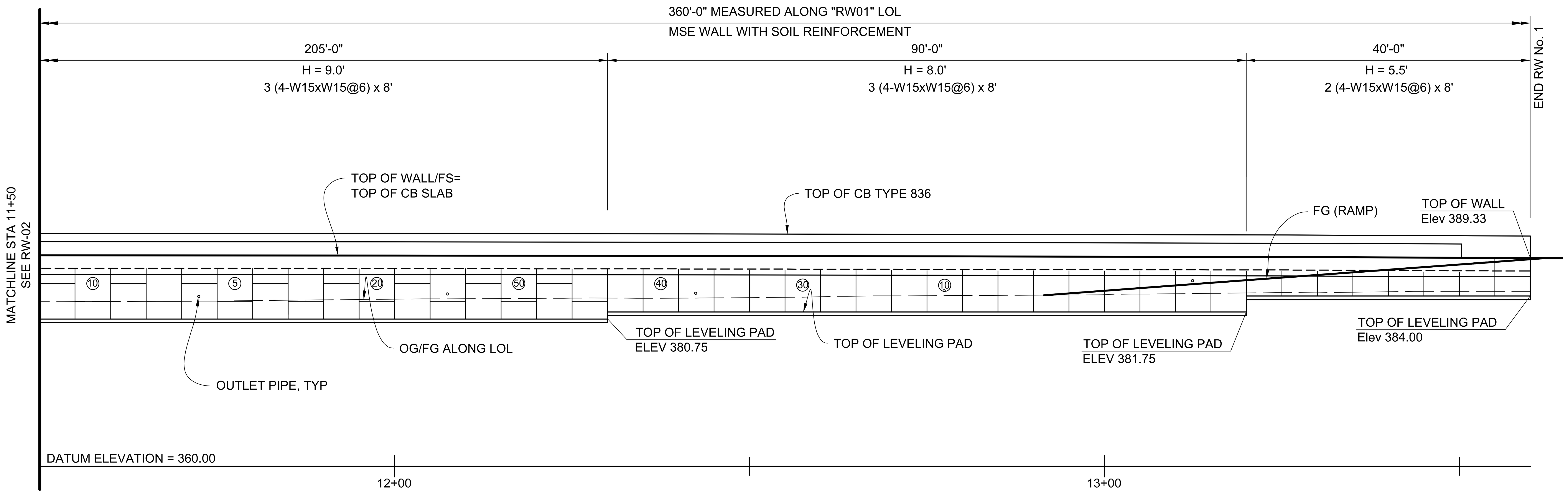
DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW01_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING
RW No. 1
GENERAL PLAN No. 1

SHEET
RW-02
92 OF 278





MIRRORED DEVELOPED ELEVATION

1" = 10'

LEGEND

6"O	INDICATES EX. 6" OIL LINE
8"O	INDICATES EX. 8" OIL LINE
E(OH)	INDICATES EX.OH ELECTRICAL
TC(OH)	INDICATES EX. OH TELECOM
50	INDICATES INSPECTION WIRE LOCATION

INTERVAL IN YEARS FROM THE TIME OF CONSTRUCTION TO THE TIME OF REMOVAL OF INSPECTION WIRE

3 (4-W15xW15@6) x 8'-0"

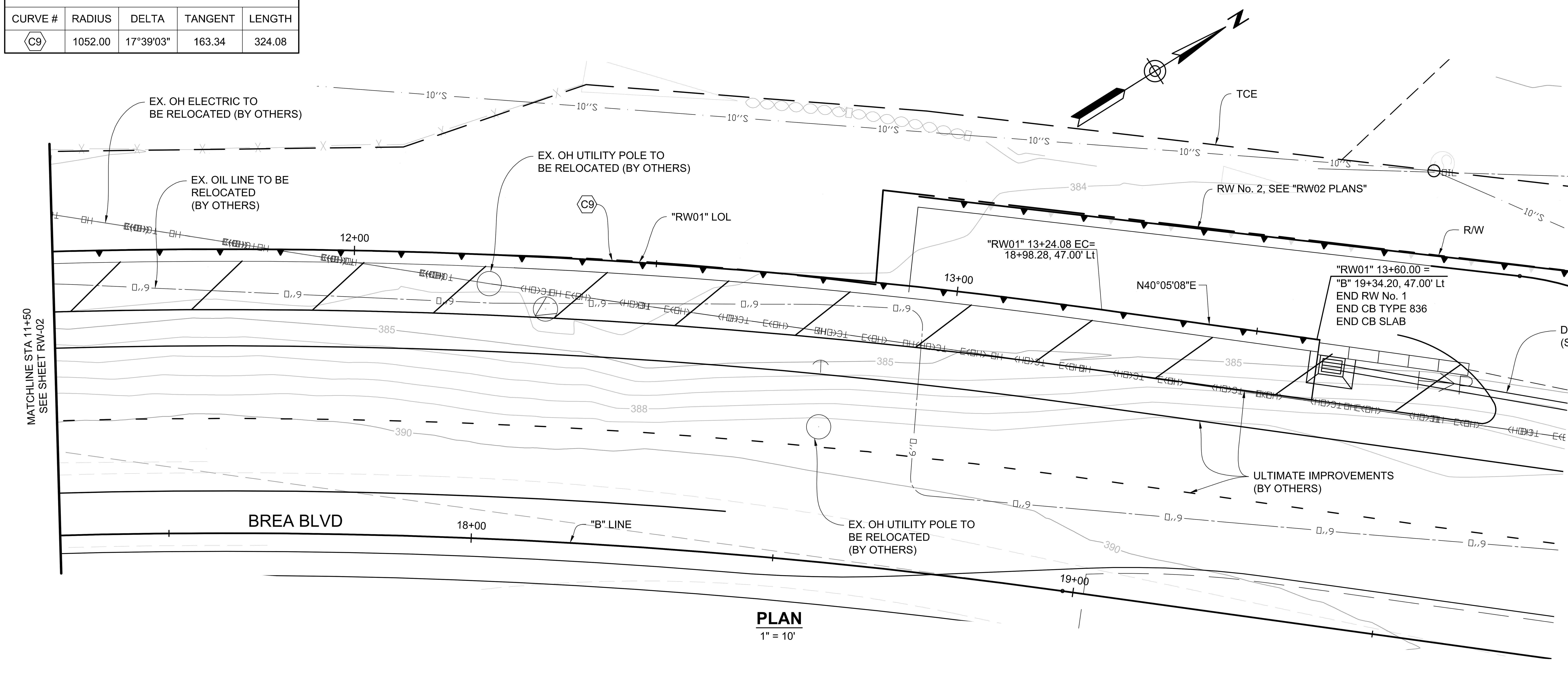
- MAT LENGTH
- TRANSVERSE WIRE SPACING
- TRANSVERSE WIRE SIZE
- LONGITUDINAL WIRE SIZE
- NUMBER OF LONGITUDINAL WIRES
- NUMBER OF LEVELS

QUANTITIES

MECHANICALLY STABILIZED EMBANKMENT	2297	SQFT
STRUCTURAL CONCRETE, BARRIER SLAB	184	CY
CONCRETE BARRIER (TYPE 732SW)	92	LF
CONCRETE BARRIER (TYPE 836)	268	LF

ALIGNMENT CURVE TABLE

CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C9	1052.00	17°39'03"	163.34	324.08



PLAN

1" = 10'

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NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA
MARSHALL E MOORE, S.E.
DATE 10-15-2021

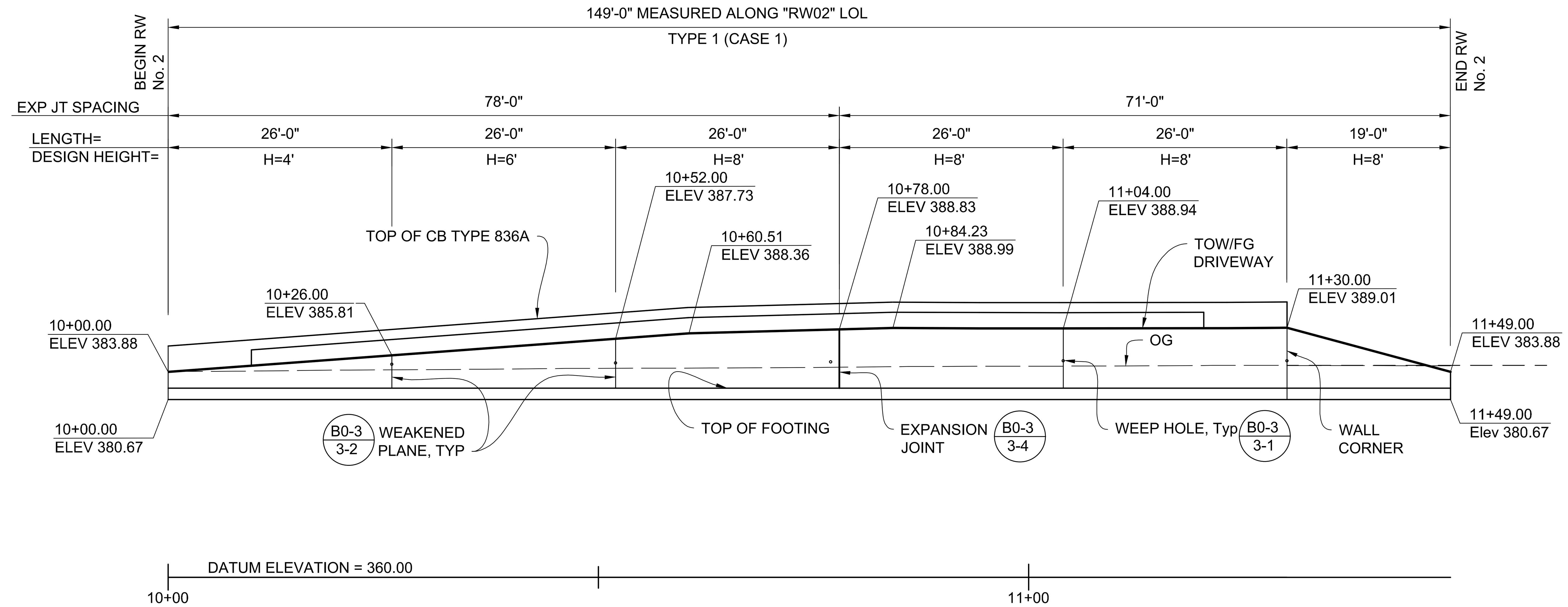
DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW01_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

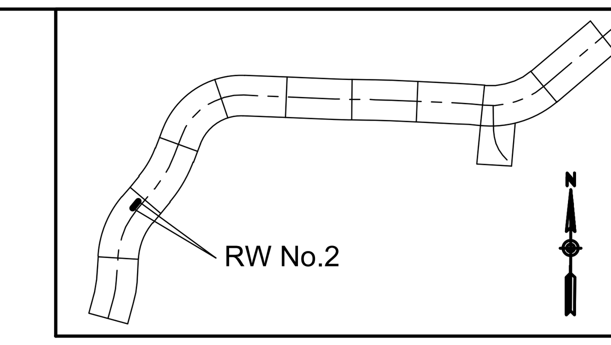
RW No. 1 GENERAL PLAN No. 2

SHEET
RW-03



MIRRORED DEVELOPED ELEVATION

1" = 10'



KEY MAP

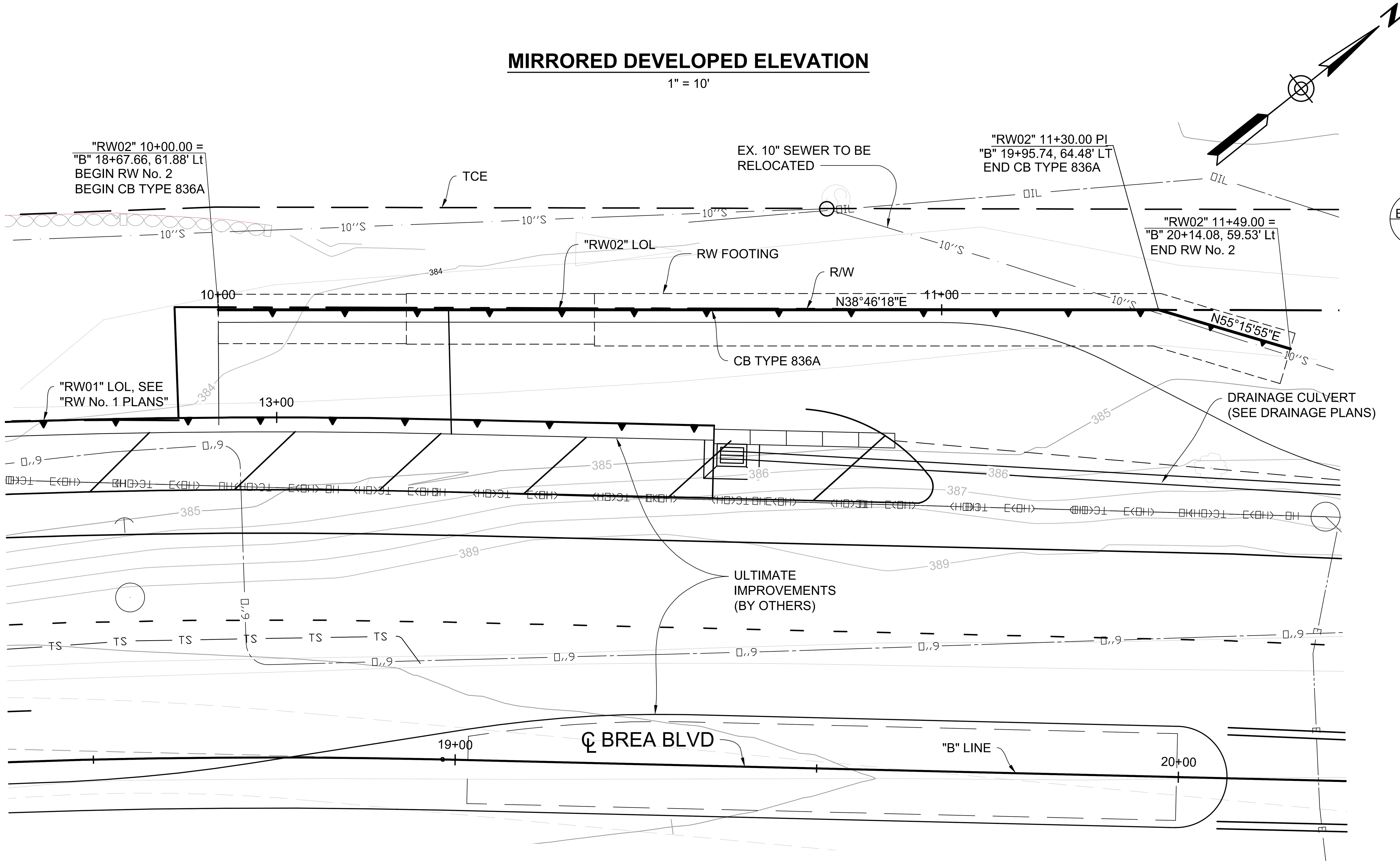
1"=2000'

QUANTITIES

STRUCTURE EXCAVATION (RETAINING WALL)	493	CY
STRUCTURE BACKFILL (RETAINING WALL)	537	CY
STRUCTURAL CONCRETE, RETAINING WALL	90	CY
BAR REINFORCING STEEL (RETAINING WALL)	12080	LB
CONCRETE BARRIER (TYPE 836A)	130	LF

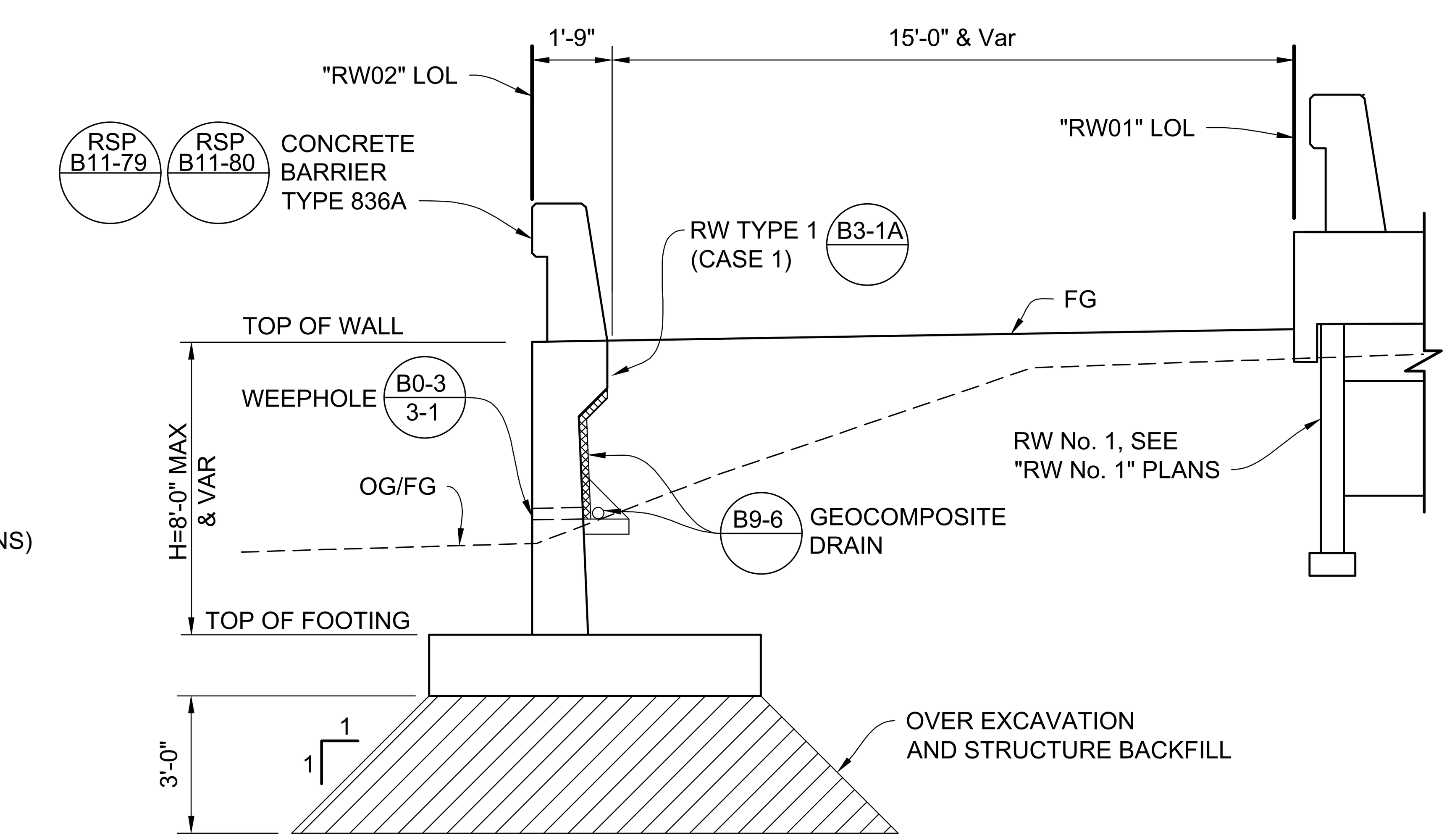
LEGEND

6"O	INDICATES EX. 6" OIL LINE
8"O	INDICATES EX. 8" OIL LINE
10"S	INDICATES EX. SEWER LINE
TC(OH)	INDICATES EX. OH TELECOM
E(OH)	INDICATES EX. OH ELECTRICAL



PLAN

1" = 10'



TYPICAL SECTION

N.T.S.

NOTE:

1. FOR UTILITY DETAILS, SEE "UTILITY PLANS".

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
MARSHALL E MOORE, S.E.
10-15-2021
DATE

REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA

DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW02_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

PREPARED BY: MARK THOMAS

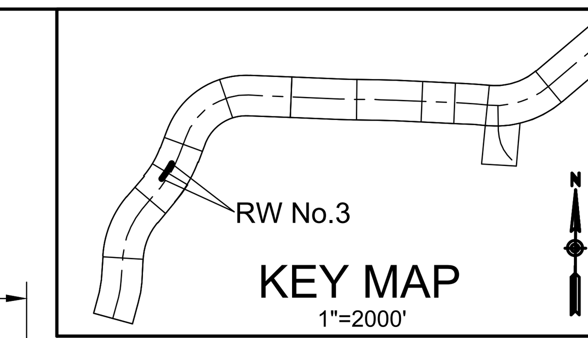
BREA BOULEVARD WIDENING

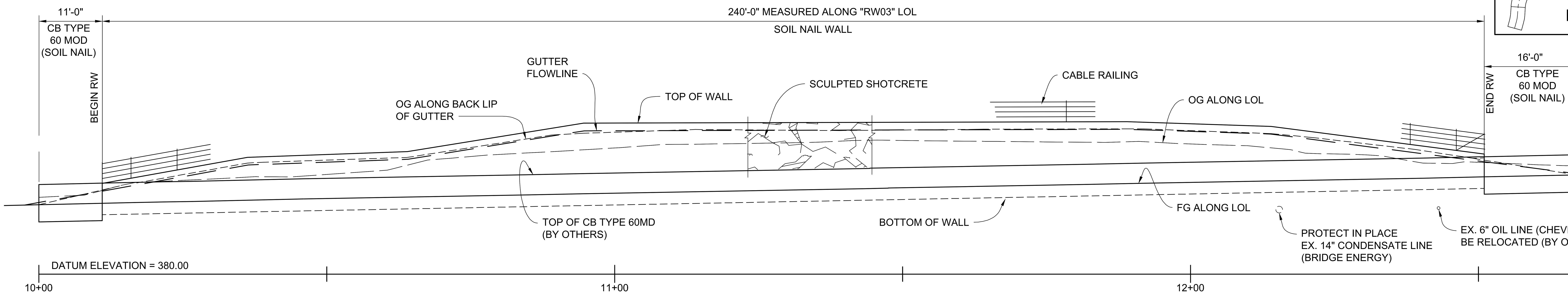
RW No. 2 GENERAL PLAN

SHEET

RW-10

100 OF 278





DEVELOPED ELEVATION

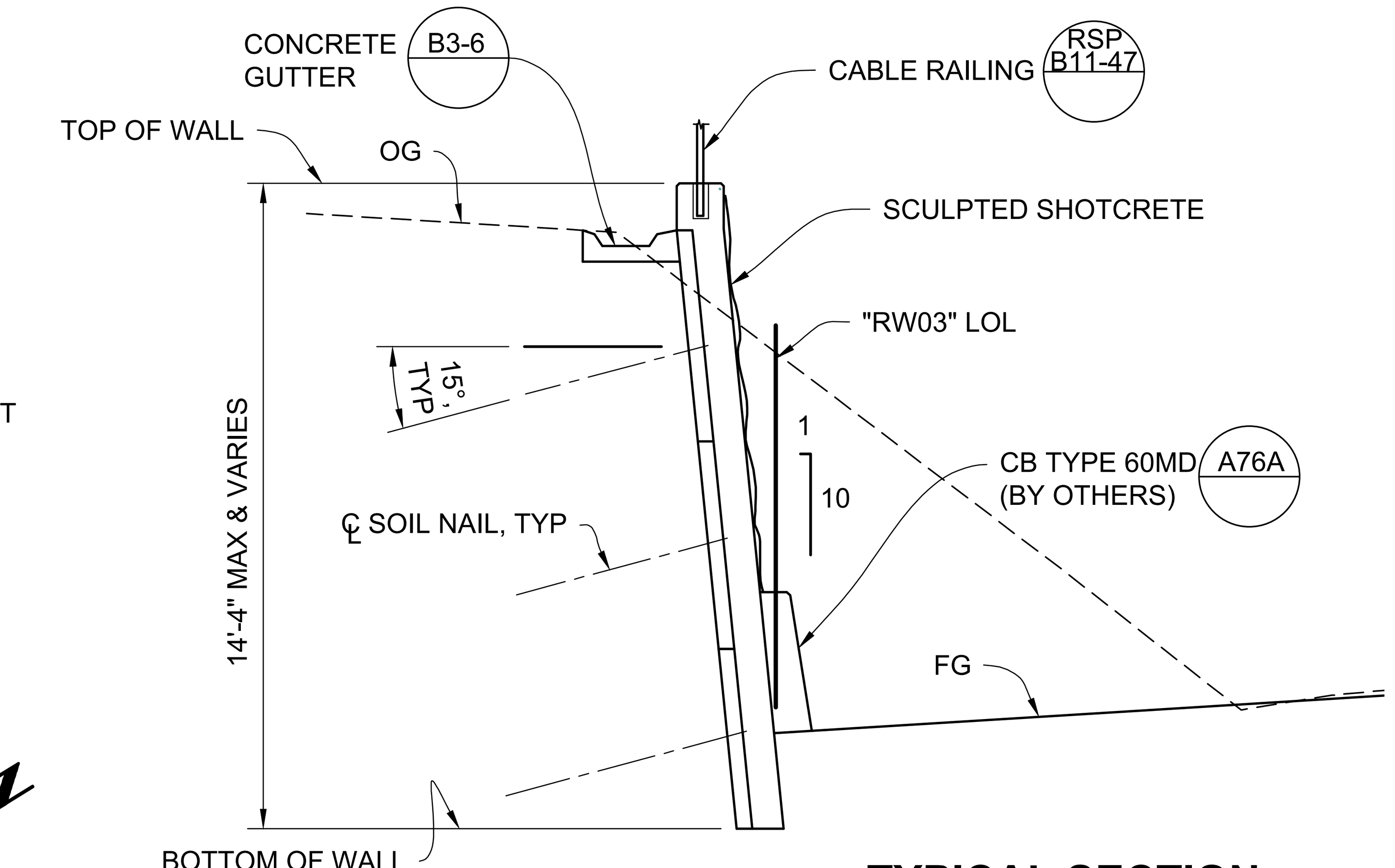
1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C10	1362.00	11°13'55"	133.93	267.00

QUANTITIES

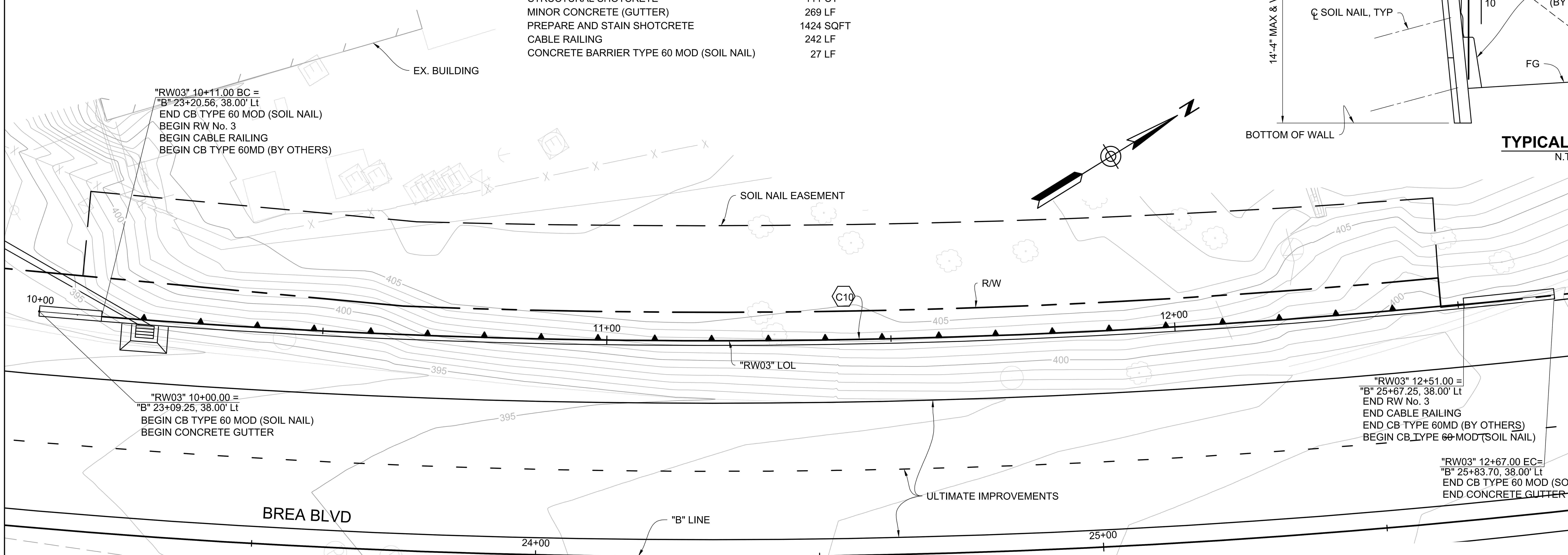
STRUCTURE EXCAVATION (SOIL NAIL WALL)	172 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	18 CY
SOIL NAIL	1378 LF
BAR REINFORCING STEEL (RETAINING WALL)	10,860 LB
SCULPTED SHOTCRETE	1424 SQFT
STRUCTURAL SHOTCRETE	111 CY
MINOR CONCRETE (GUTTER)	269 LF
PREPARE AND STAIN SHOTCRETE	1424 SQFT
CABLE RAILING	242 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	27 LF

INDEX TO PLANS



TYPICAL SECTION

N.T.S.



PLAN

1" = 10'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 3 SOIL NAIL WALL LAYOUT" SHEET.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
VICTOR A. SHERBY, P.E.
DATE 10-15-2021

DESIGNED BY: V. SHERBY
CHECKED BY: J. HICKEY
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW03_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks

PREPARED BY: MARK THOMAS

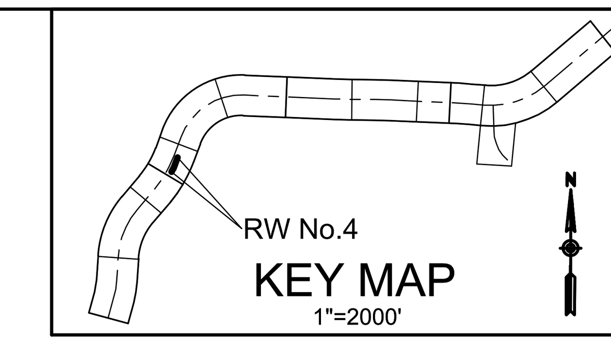
BREA BOULEVARD WIDENING

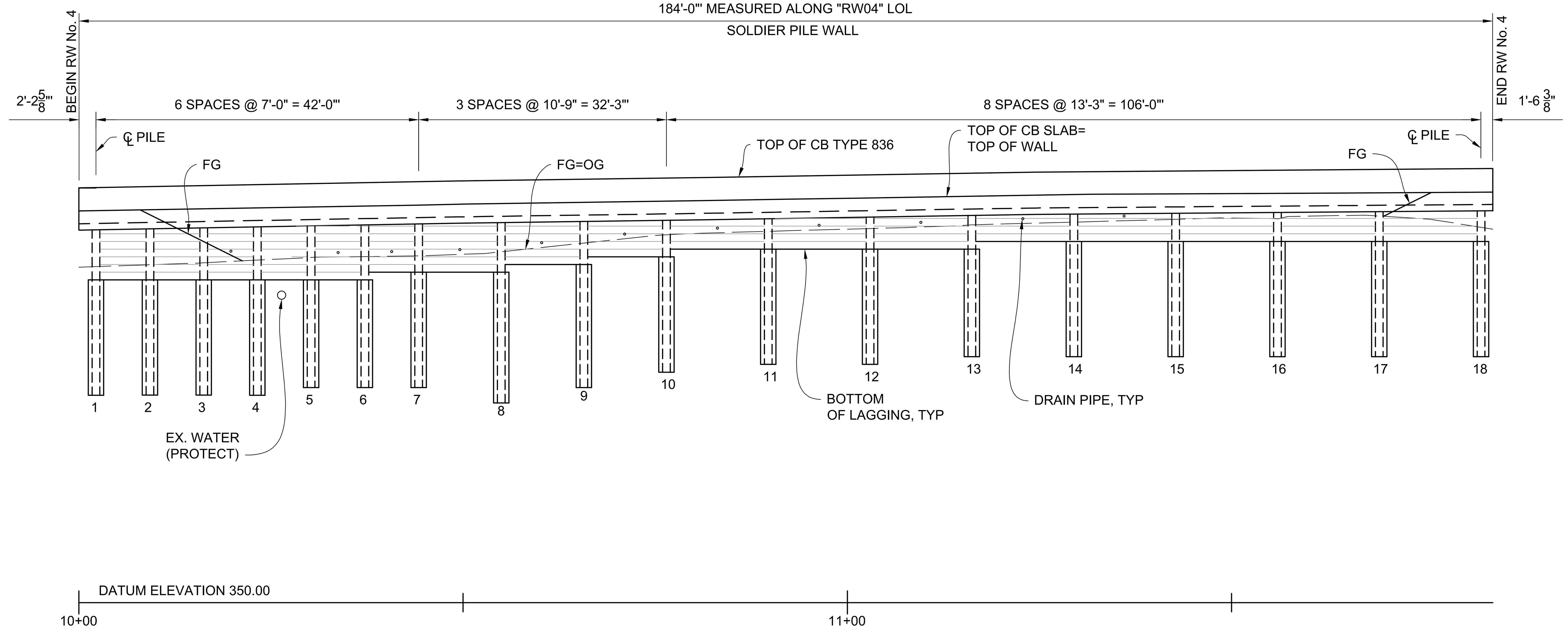
RW No. 3 GENERAL PLAN

SHEET

RW-11

101 OF 278

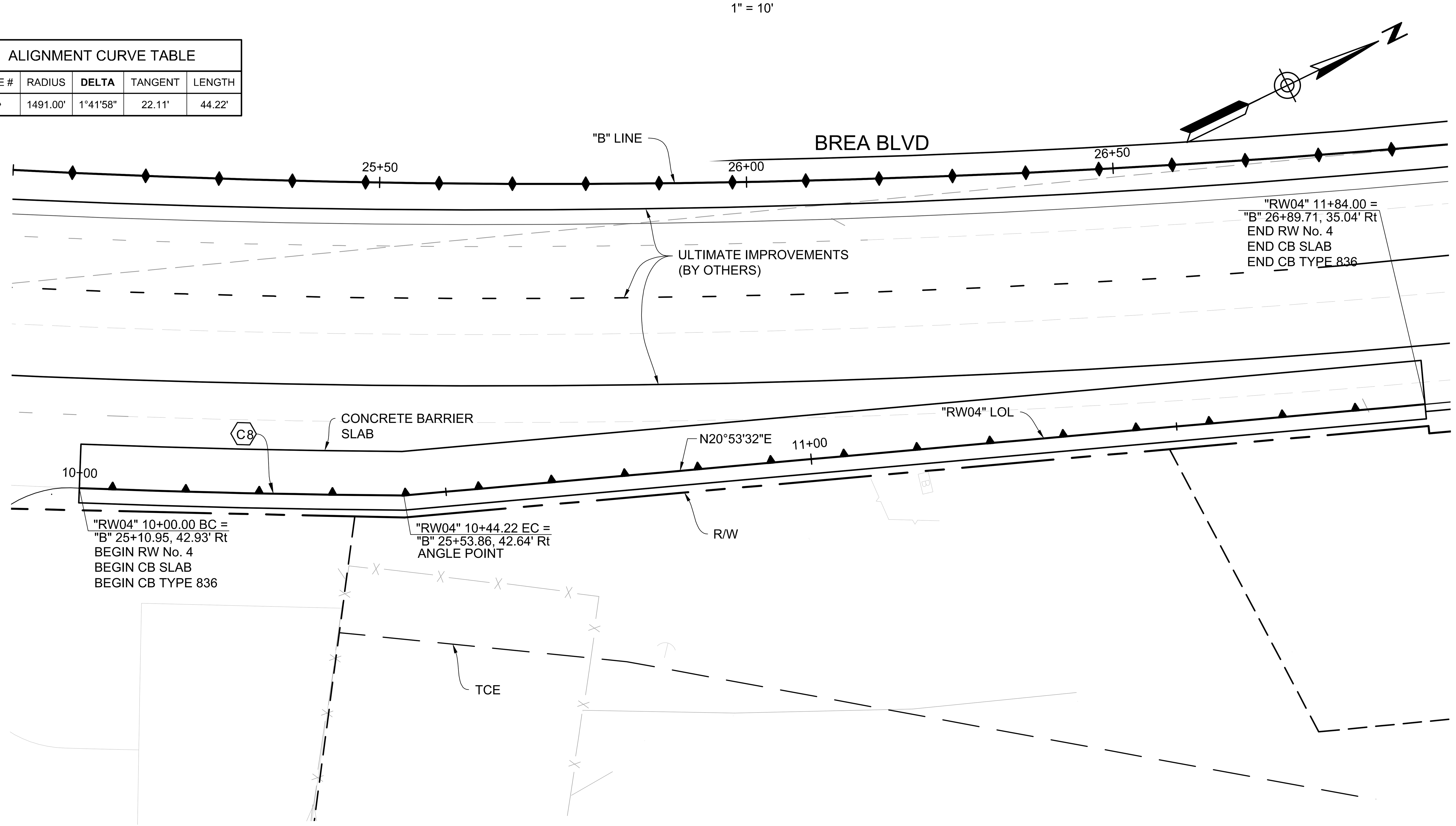




DEVELOPED ELEVATION

1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C8	1491.00'	1°41'58"	22.11'	44.22'



PLAN

1" = 10'

QUANTITIES

STRUCTURE EXCAVATION (SOLDIER PILE WALL)	54	CY
STRUCTURE BACKFILL (SOLDIER PILE WALL)	64	CY
CONCRETE BACKFILL (SOLDIER PILE WALL)	32	CY
LEAN CONCRETE BACKFILL	5	CY
STEEL SOLDIER PILE (W12 X 96)	376	LF
24" DRILLED HOLE	320	LF
STRUCTURAL CONCRETE, BARRIER SLAB	94	CY
BAR REINFORCING STEEL (RETAINING WALL)	3460	LB
STRUCTURAL SHOTCRETE	21	CY
TIMBER LAGGING	5.9	MFBM
CLEAN AND PAINT STEEL SOLDIER PILING	1	LS
MISCELLANEOUS METAL (RETAINING WALL)	730	LB
CONCRETE BARRIER (TYPE 836)	184	LF

NOTES:

1. FOR FINISHED GRADE DETAILS, SEE "ROADWAY PLANS".
2. FOR TYPICAL SECTION, SEE "RW No. 4 GENERAL NOTES" SHEET.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

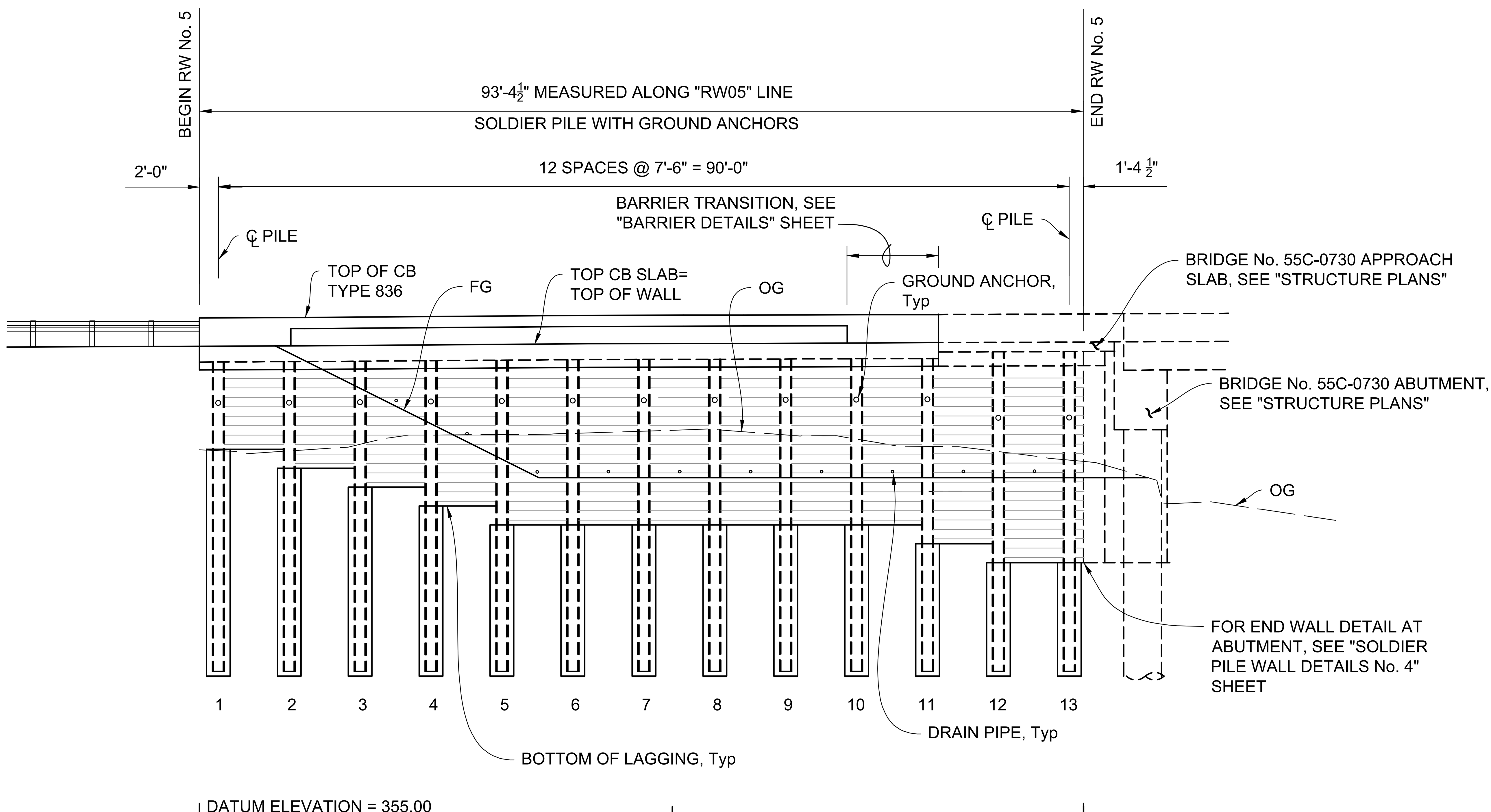
PREPARED UNDER THE RESPONSIBLE CHARGE OF:
MARSHALL E MOORE, S.E.
REGISTERED PROFESSIONAL ENGINEER, MARSHALL EUGENE MOORE, No. S6557, Exp. 9-30-23, STRUCTURAL, STATE OF CALIFORNIA
10-15-2021
DATE

DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW04_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY:
MARK THOMAS

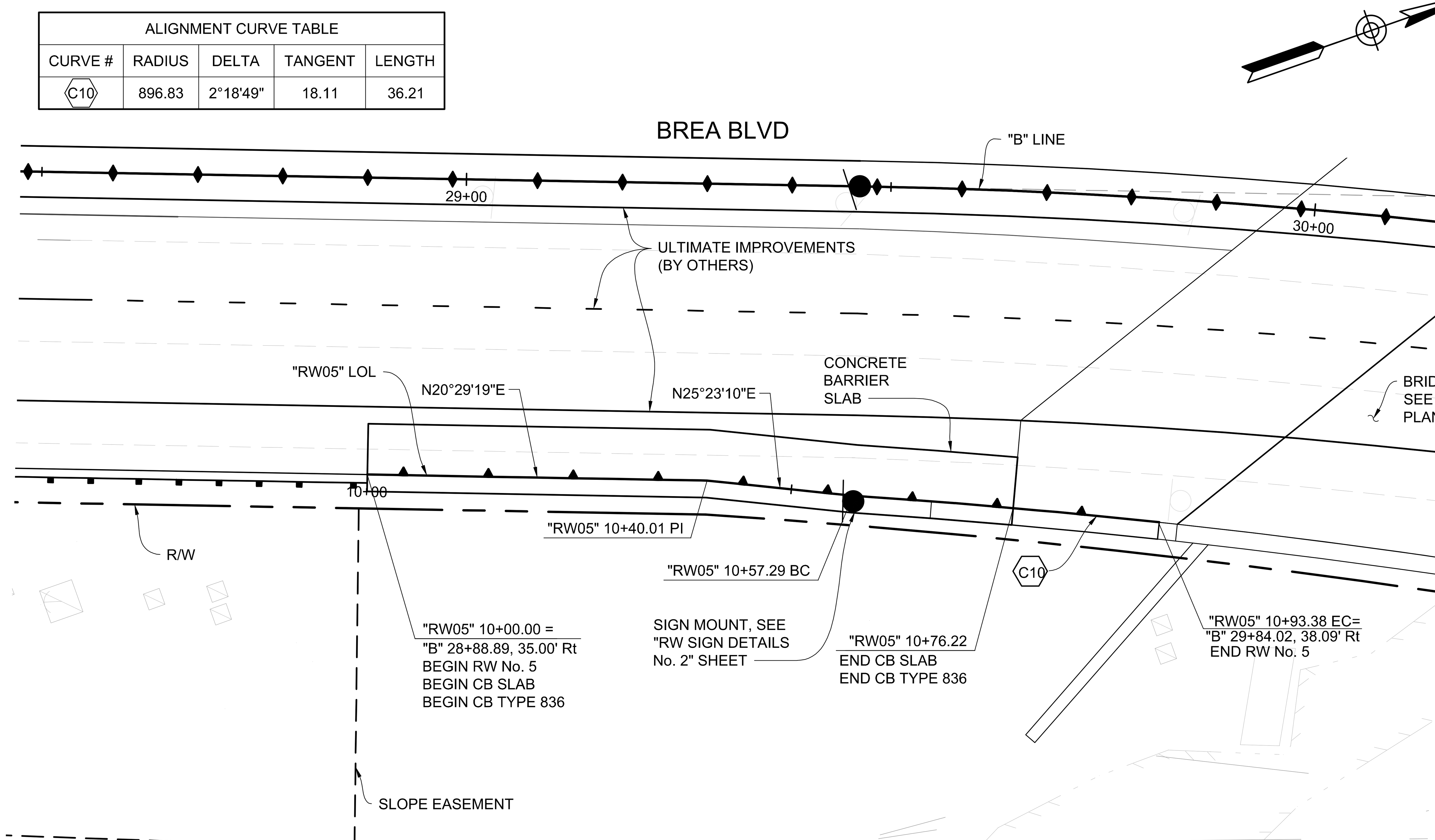
BREA BOULEVARD WIDENING
RW No. 4
GENERAL PLAN

SHEET
RW-13
103 OF 278

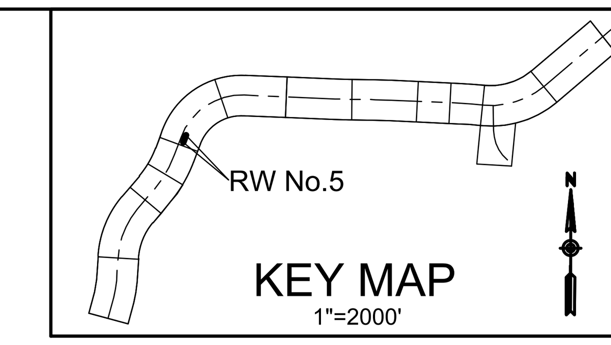


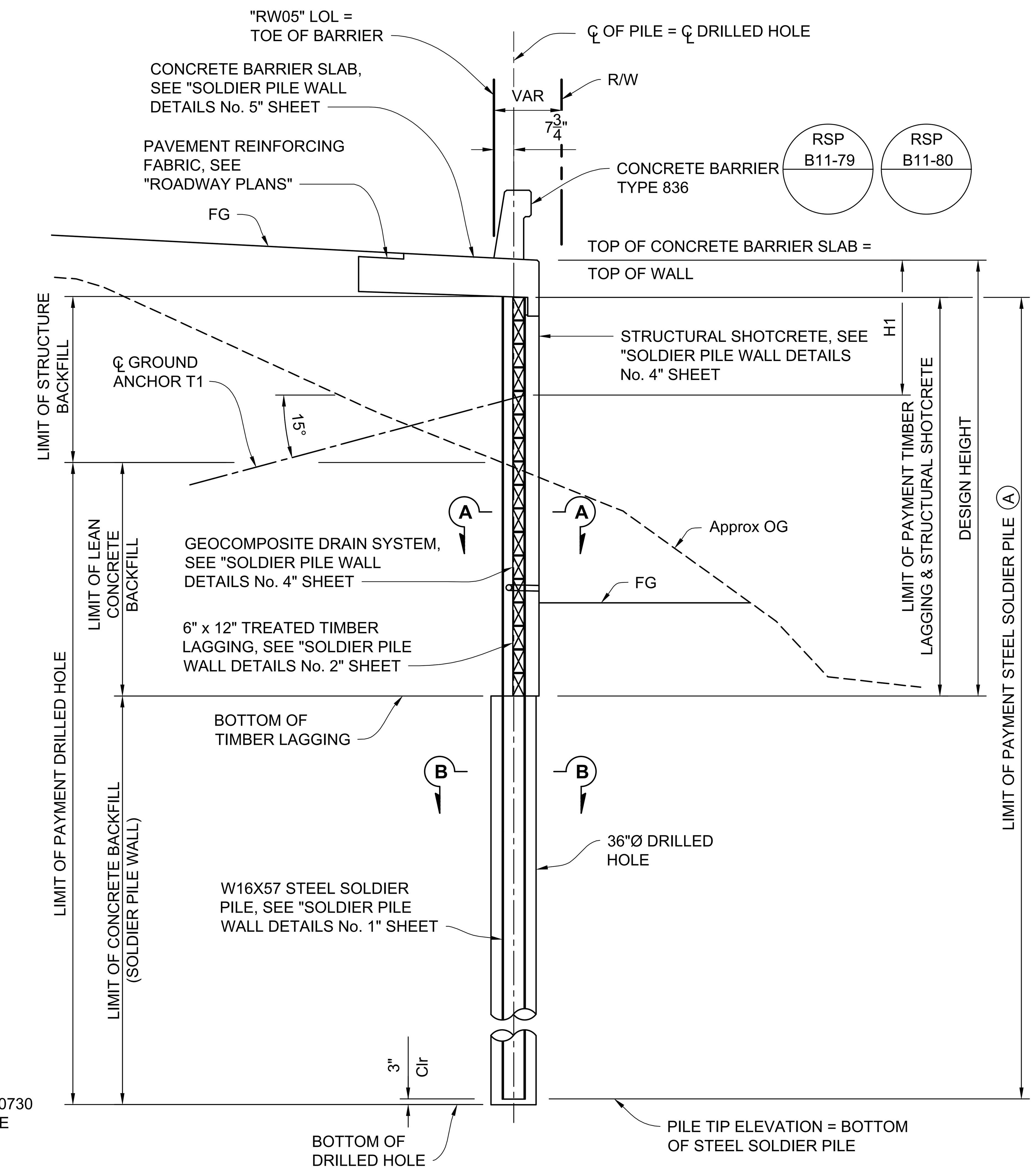
DEVELOPED ELEVATION
1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C10	896.83	2°18'49"	18.11	36.21



PLAN
1" = 10'





TYPICAL SECTION
NO SCALE

NOTES:

1. FOR "SECTION A-A", "SECTION B-B" AND NOTE A, SEE "SOLDIER PILE WALL DETAILS No. 1" SHEET.
2. FOR GROUND ANCHOR DETAILS, SEE "SOLDIER PILE WALL DETAILS No. 8" SHEET.
3. FOR FINISHED GRADE DETAILS, SEE "ROADWAY PLANS".

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
MARSHALL E MOORE, S.E.
10-15-2021
DATE

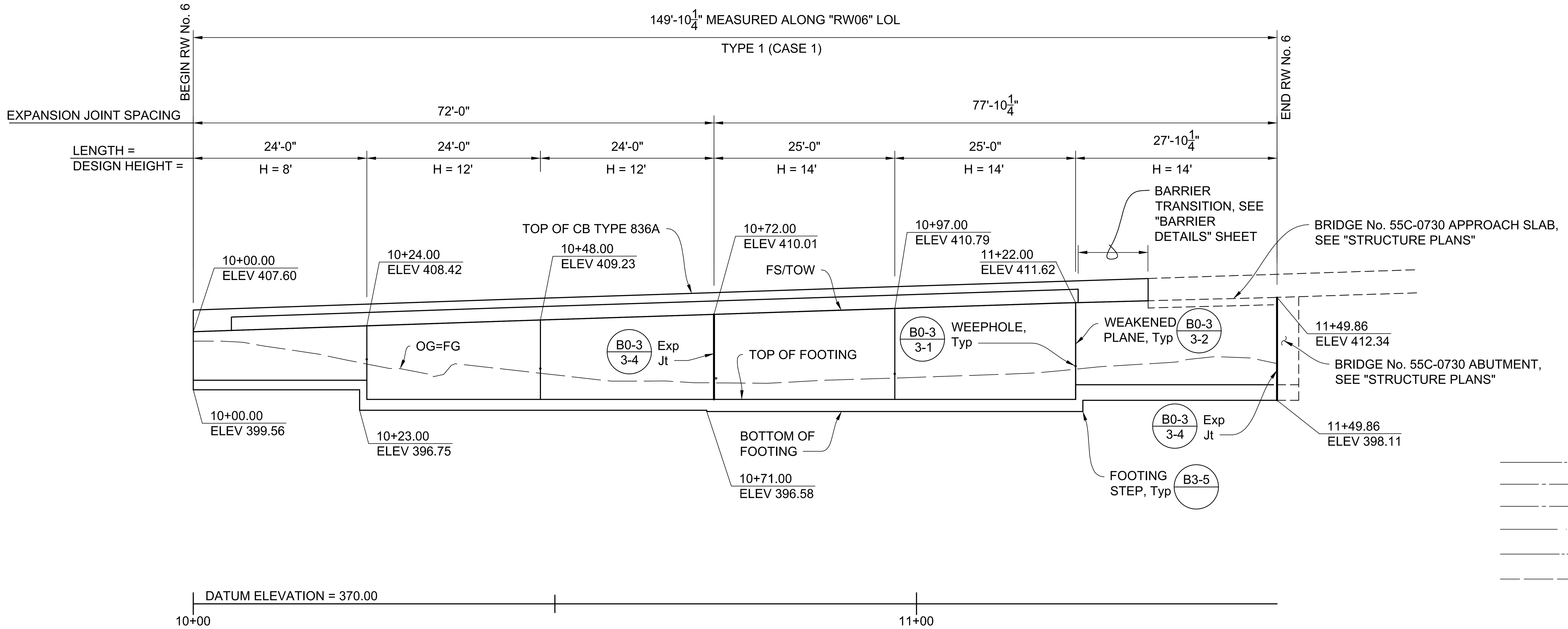
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

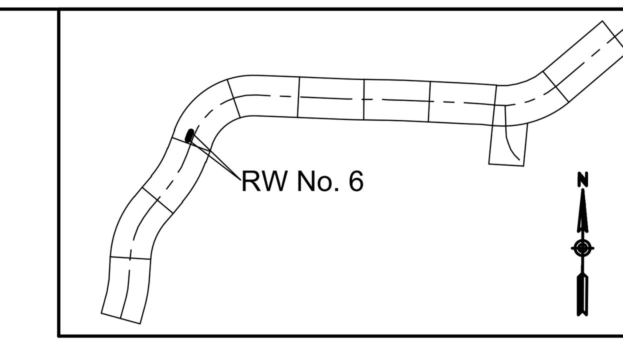
DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW05_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

BREA BOULEVARD WIDENING
RW No. 5
GENERAL PLAN

SHEET
RW-16



MIRRORED DEVELOPED ELEVATION
1" = 10'



KEY MAP
1"=2000'

QUANTITIES

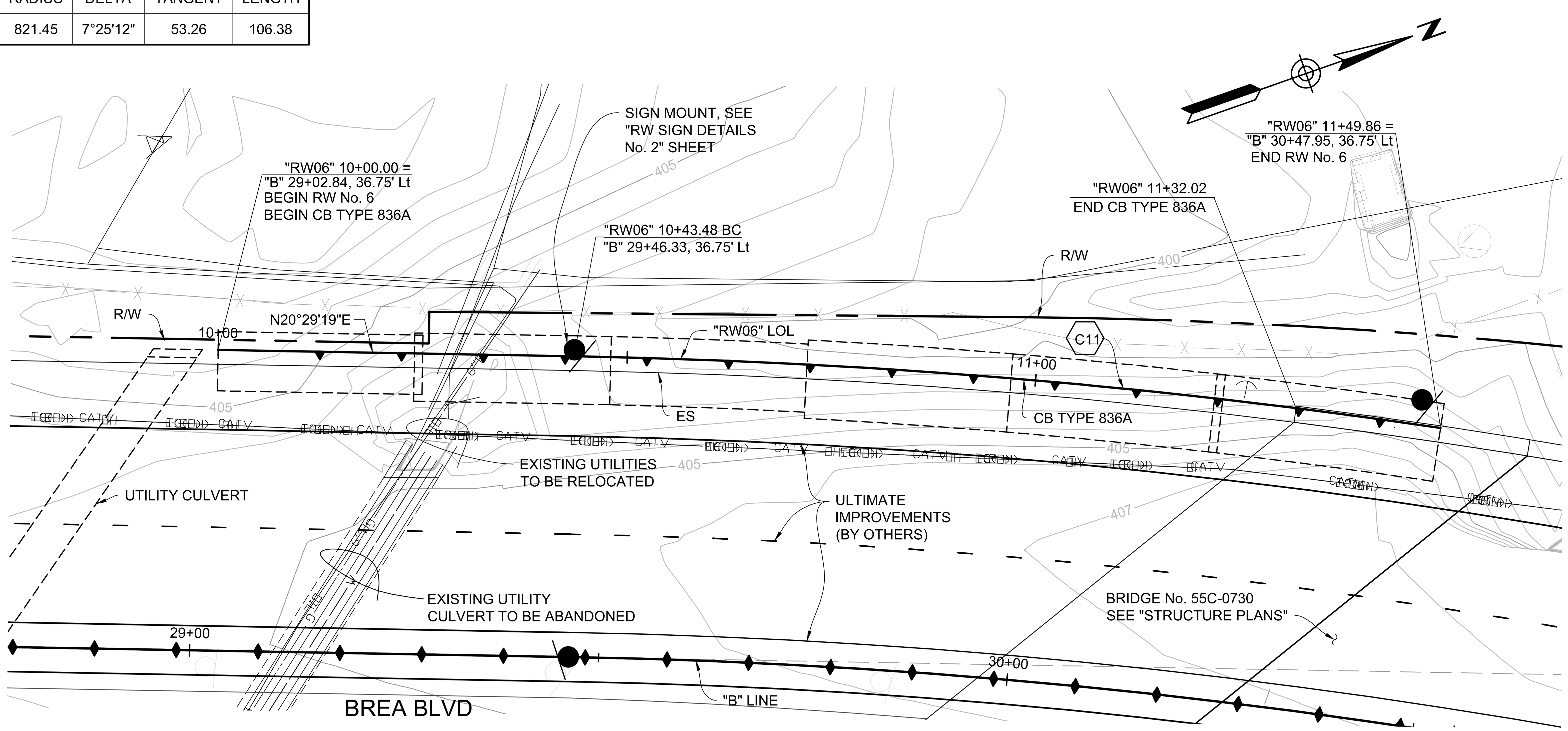
STRUCTURE EXCAVATION (RETAINING WALL)	442	CY
STRUCTURE BACKFILL (RETAINING WALL)	663	CY
STRUCTURAL CONCRETE, RETAINING WALL	163	CY
BAR REINFORCING STEEL (RETAINING WALL)	19,590	LB
CONCRETE BARRIER (TYPE 836A)	132	LF

LEGEND

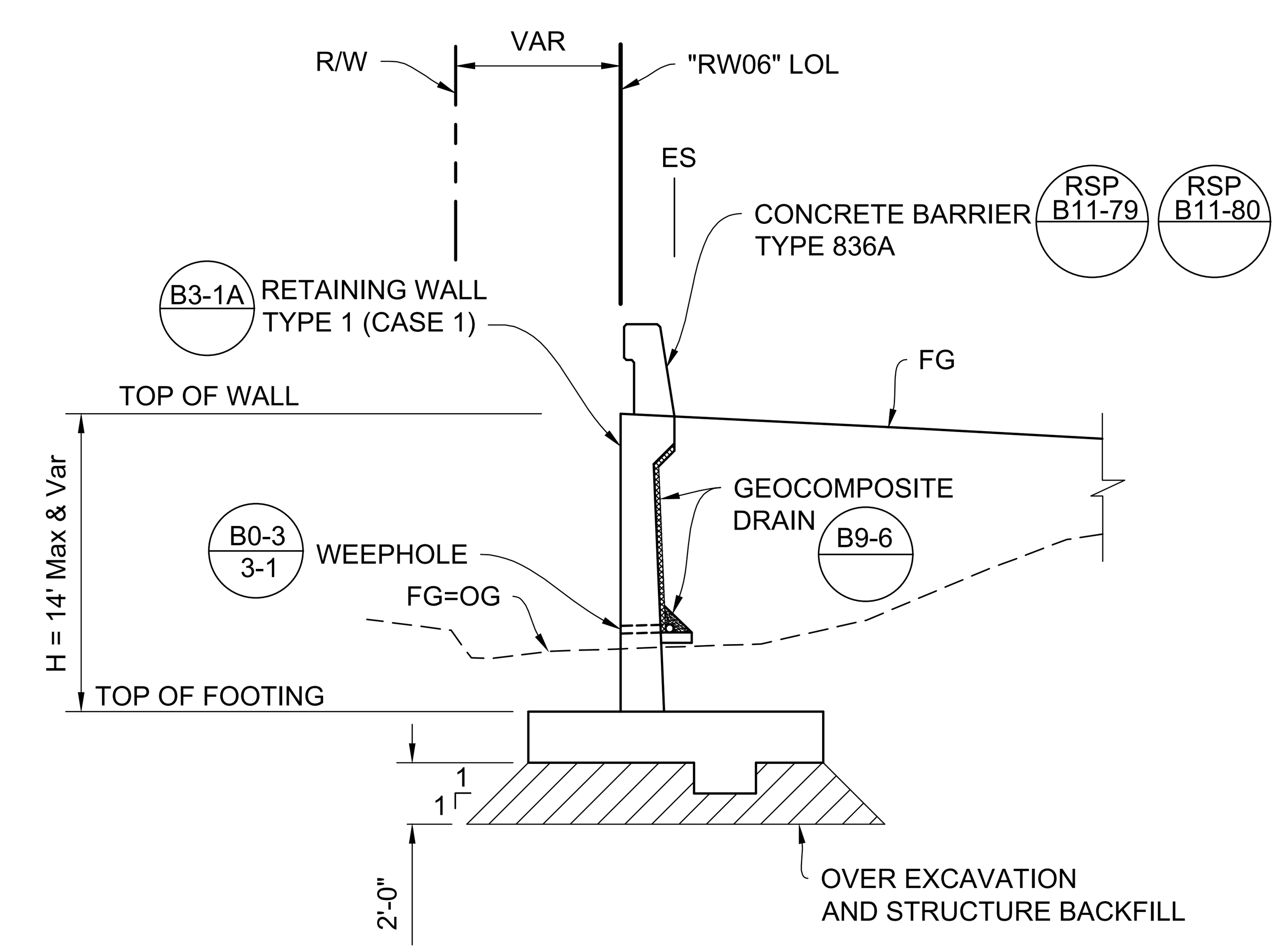
G	INDICATES EX. NATURAL GAS LINE
6"O	INDICATES EX. 6" OIL LINE
8"O	INDICATES EX. 8" OIL LINE
S	INDICATES EX. SEWER LINE
T	INDICATES EX. TELECOMMUNICATIONS
W	INDICATES EX. WATER LINE

ALIGNMENT CURVE TABLE

CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C11	821.45	7°25'12"	53.26	106.38



PLAN
1" = 10'



TYPICAL SECTION
1"=5'

NOTE:
1. FOR UTILITY DETAILS, SEE "UTILITY PLANS".

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK | DESCRIPTION | DATE | APPR

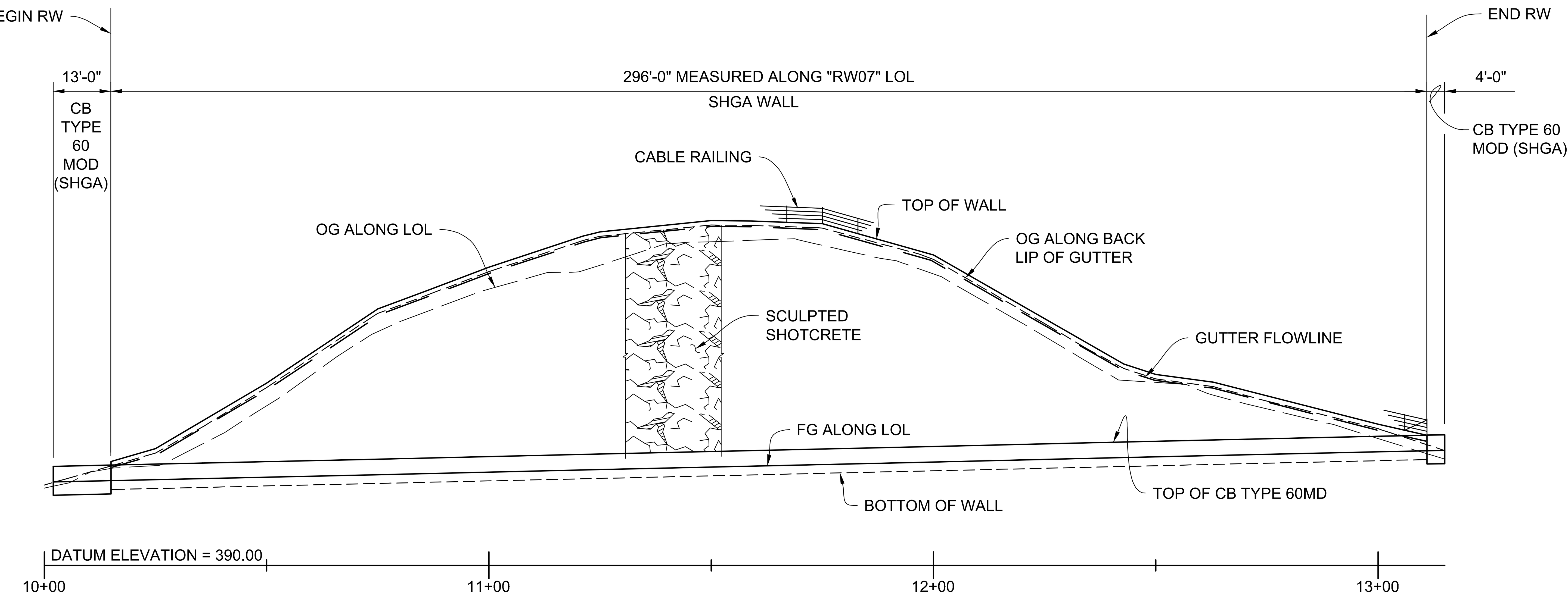
PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA
10-15-2021
DATE
MARSHALL E MOORE, S.E.

DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW06_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING
RW No. 6 GENERAL PLAN

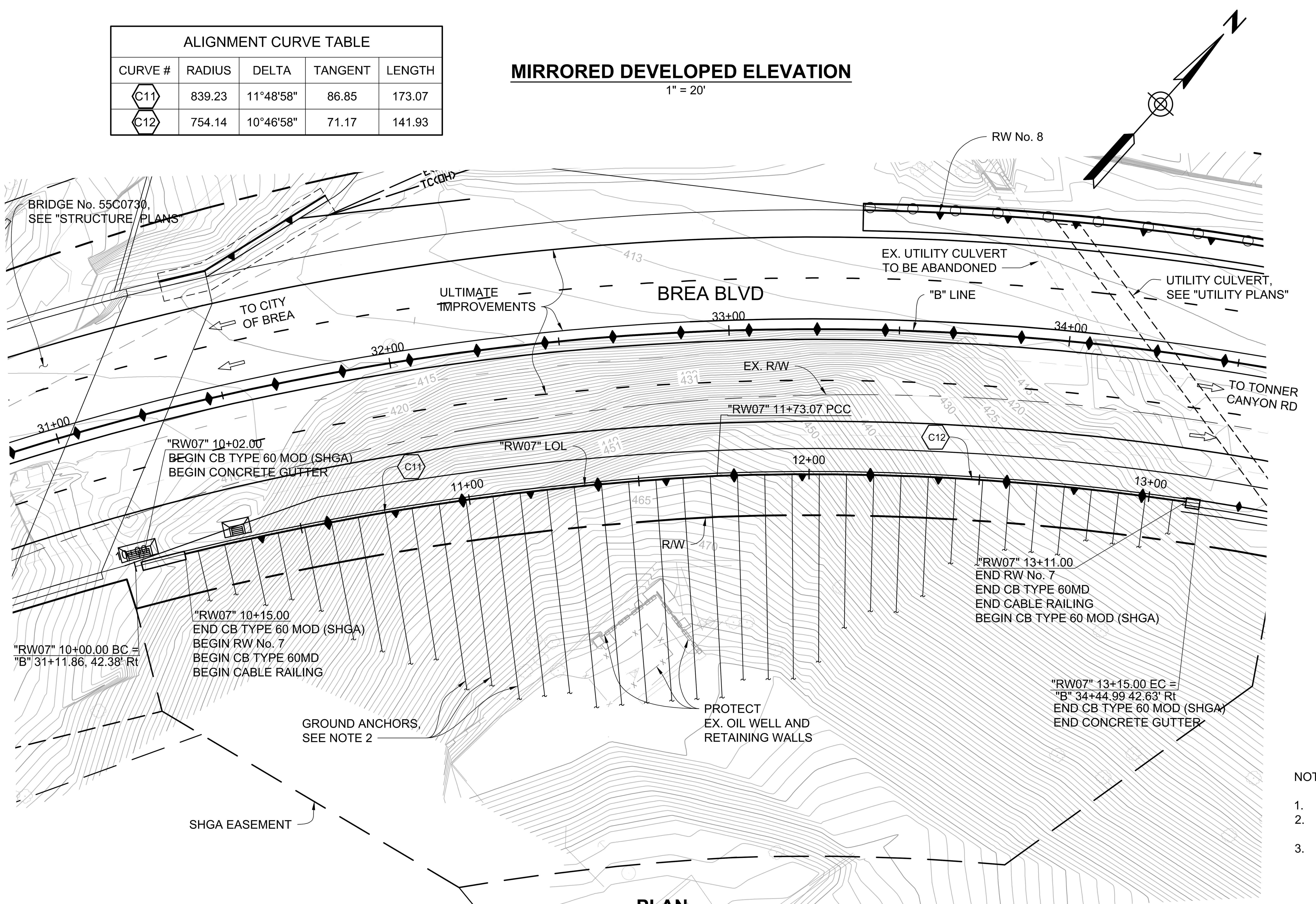
SHEET
RW-19
109 OF 278



ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C11	839.23	11°48'58"	86.85	173.07
C12	754.14	10°46'58"	71.17	141.93

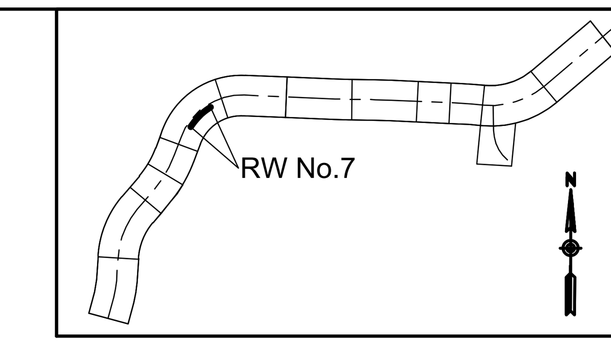
MIRRORED DEVELOPED ELEVATION

1" = 20'



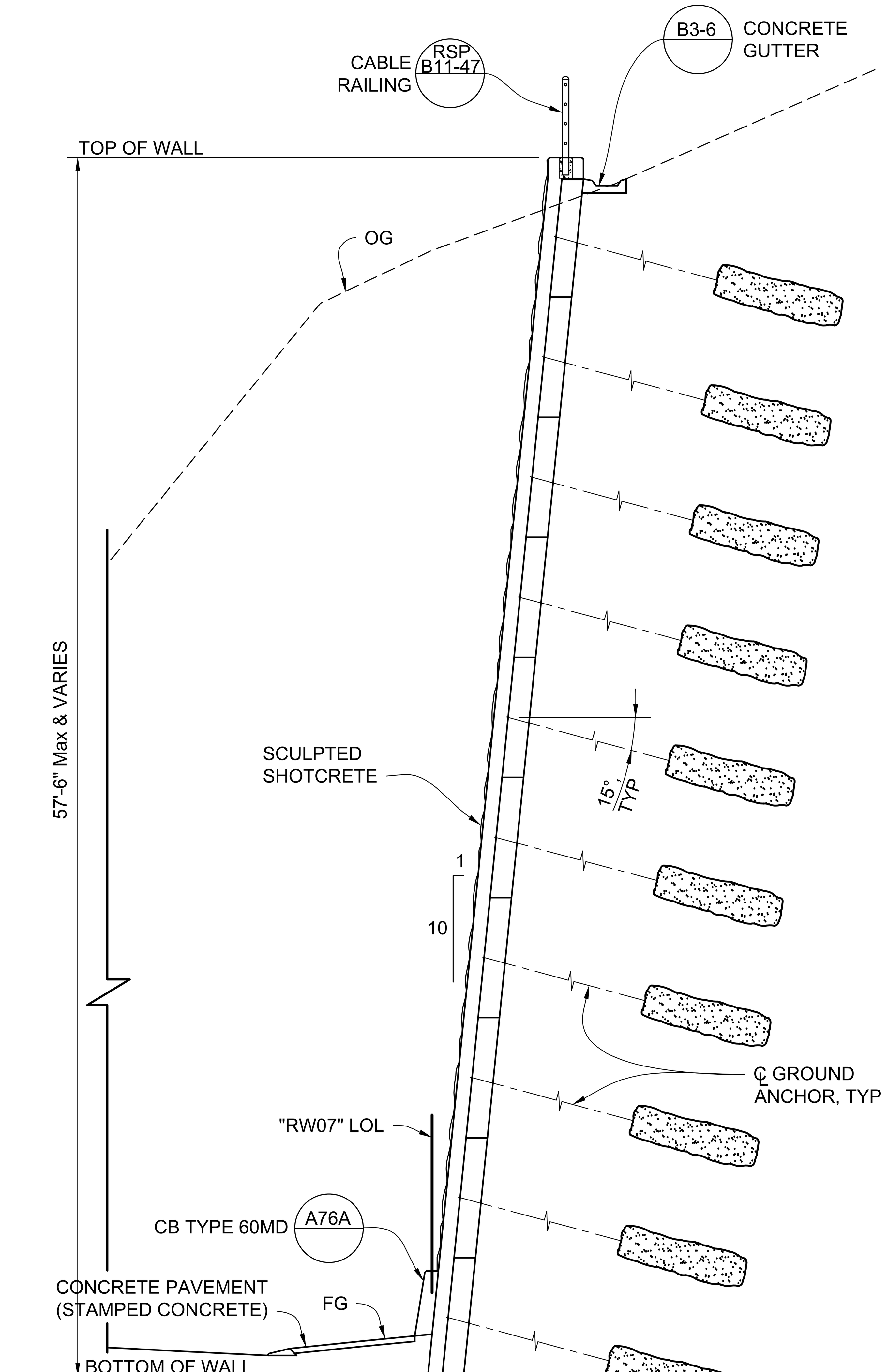
PLAN

1" = 20'



KEY MAP

1"=2000'



TYPICAL SECTION

N.T.S.

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "SHGA WALL LAYOUT" SHEET.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING OIL WELL, UTILITIES, AND ANY CONFLICTS PRIOR TO BEGINNING CONSTRUCTION.
3. FOR CONCRETE BARRIER TYPE 60 MOD (SHGA), SEE "SHGA WALL DETAILS No. 3" SHEET.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK | DESCRIPTION | DATE | APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
VICTOR A. SHERBY, P.E.
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
DATE 10-15-2021

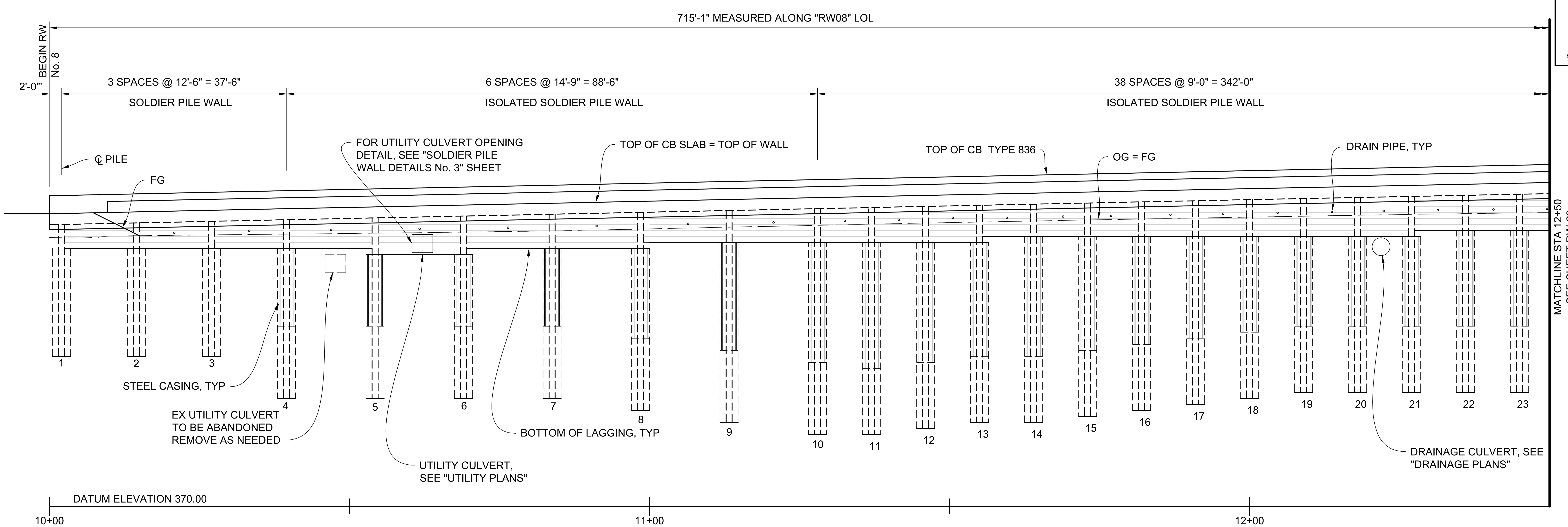
County of Orange
OC PublicWorks
DESIGNED BY: V. SHERBY
CHECKED BY: J. HICKEY
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW07_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 7 GENERAL PLAN

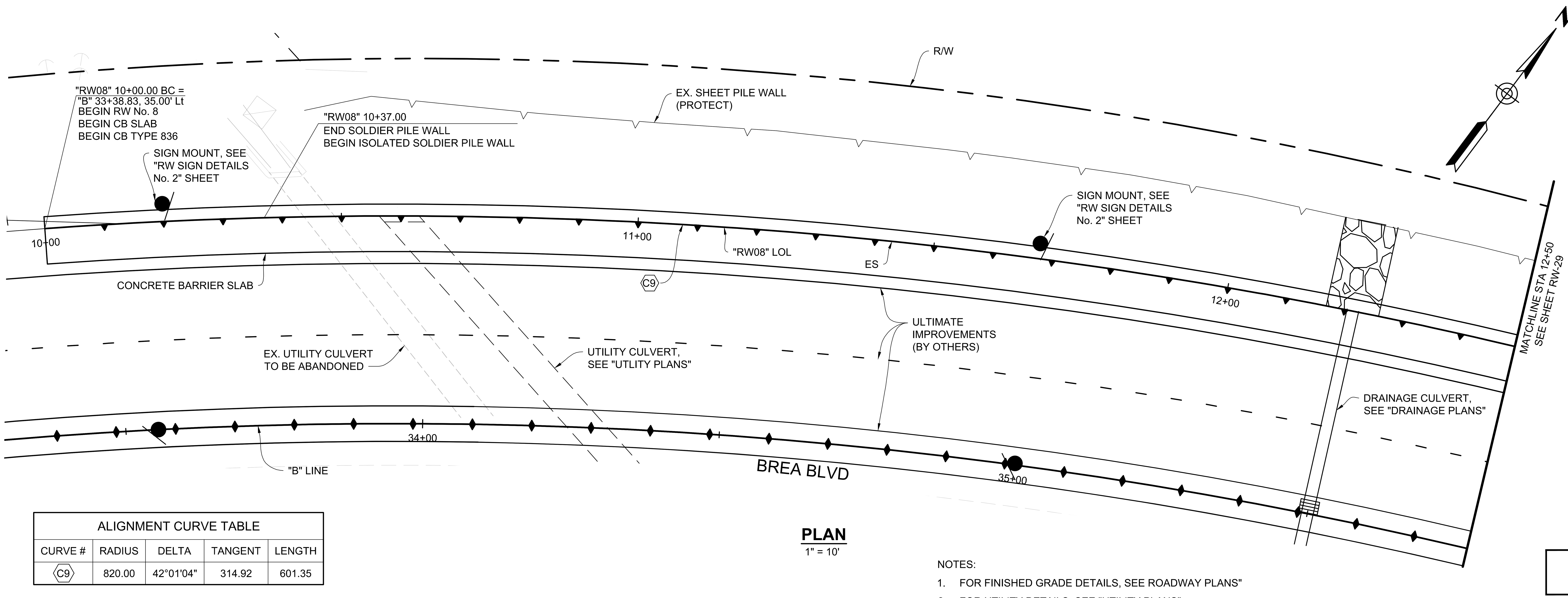
SHEET

RW-20



MIRRORED DEVELOPED ELEVATION

1" = 10'



PLAN

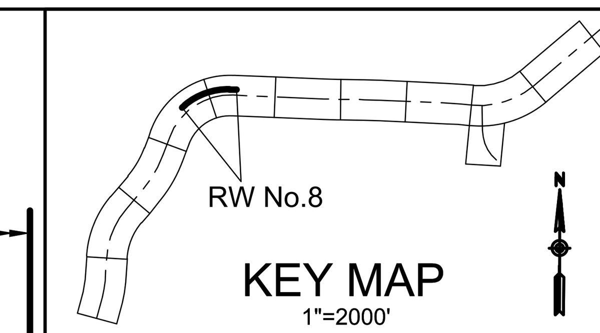
1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C9	820.00	42°01'04"	314.92	601.35

NOTES:

1. FOR FINISHED GRADE DETAILS, SEE ROADWAY PLANS"
2. FOR UTILITY DETAILS, SEE "UTILITY PLANS"

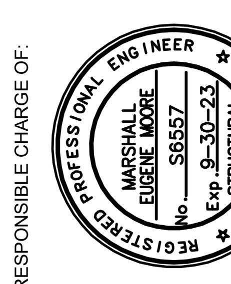
100% SUBMITTAL
NOT FOR CONSTRUCTION



COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:



10-15-2021
DATE

MARSHALL E MOORE, S.E.

DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW08_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

PREPARED BY:
MARK THOMAS

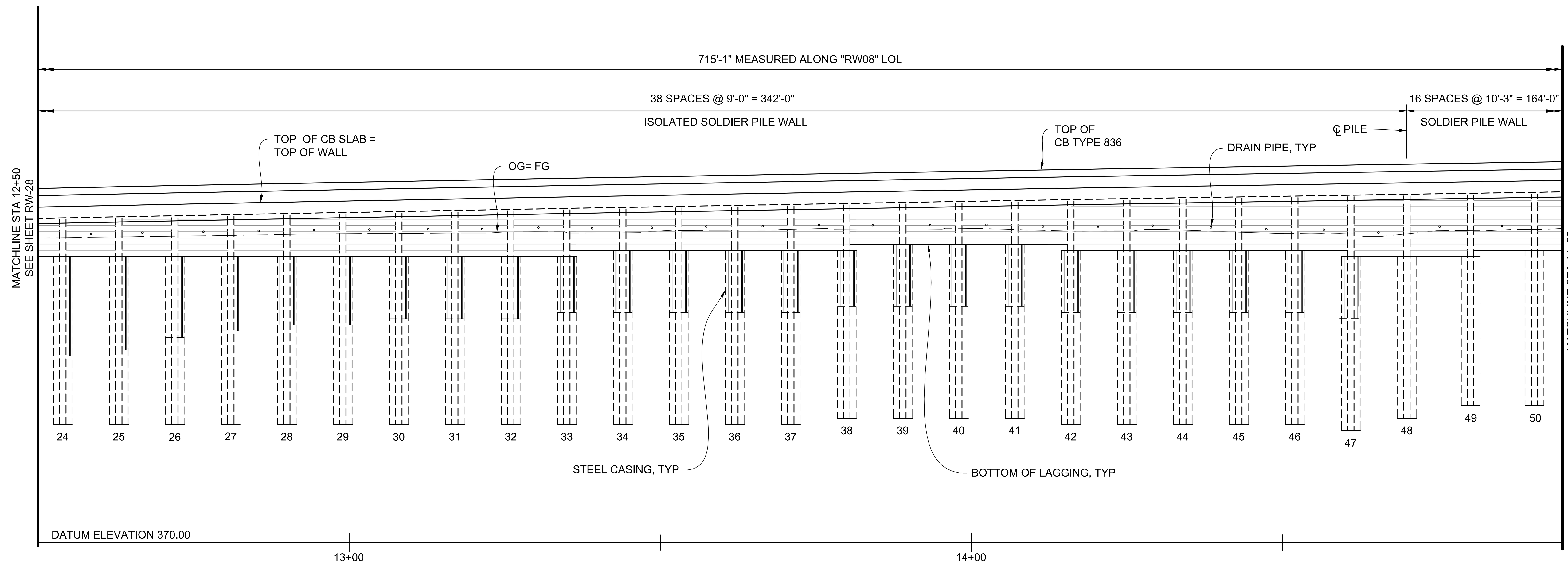
BREA BOULEVARD WIDENING

RW No. 8
GENERAL PLAN No. 1

SHEET

RW-28

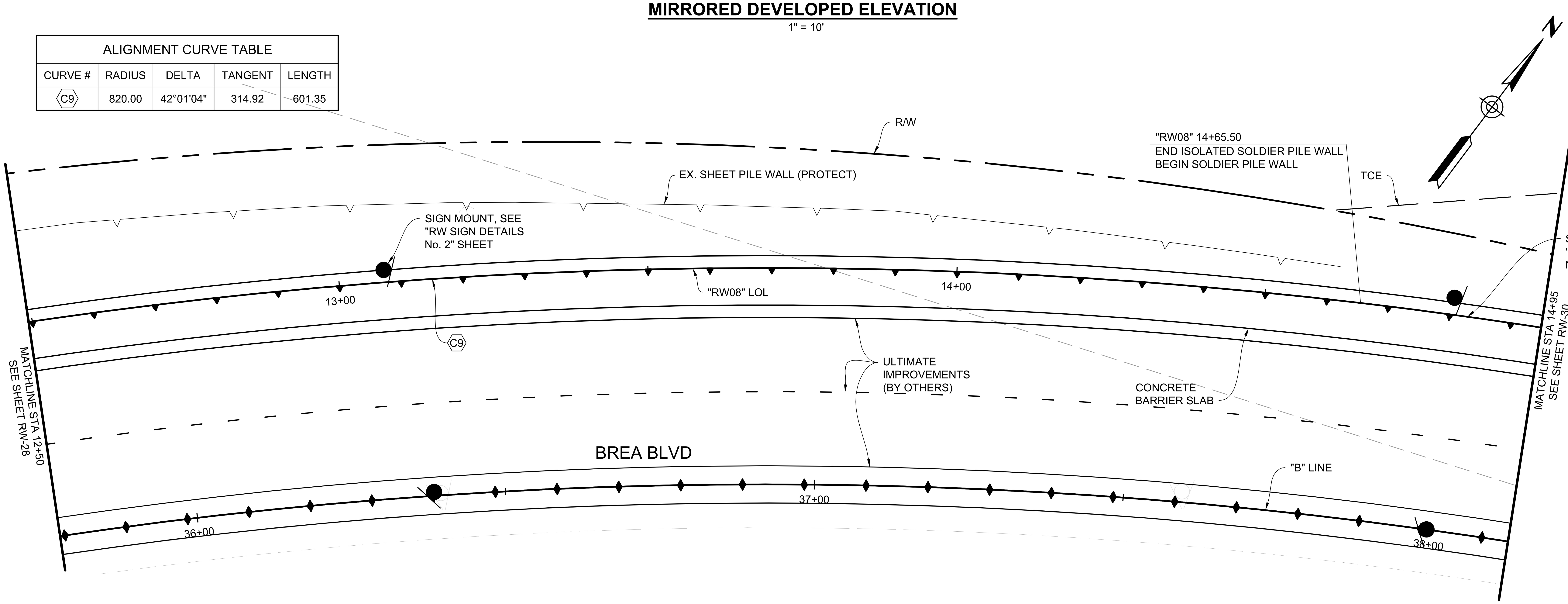
118 OF 278



MIRRORED DEVELOPED ELEVATION

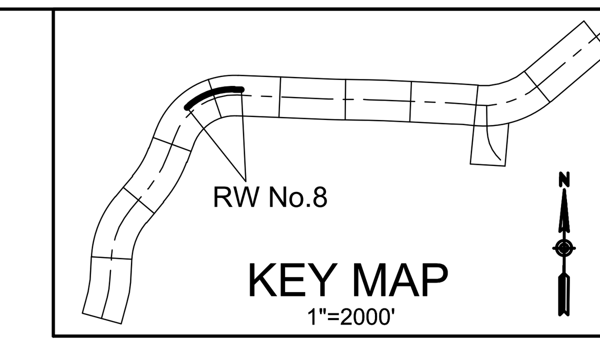
1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C9	820.00	42°01'04"	314.92	601.35



PLAN

1" = 10'



COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA

MARSHALL E MOORE, S.E.

DATE 10-15-2021

DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW08_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks

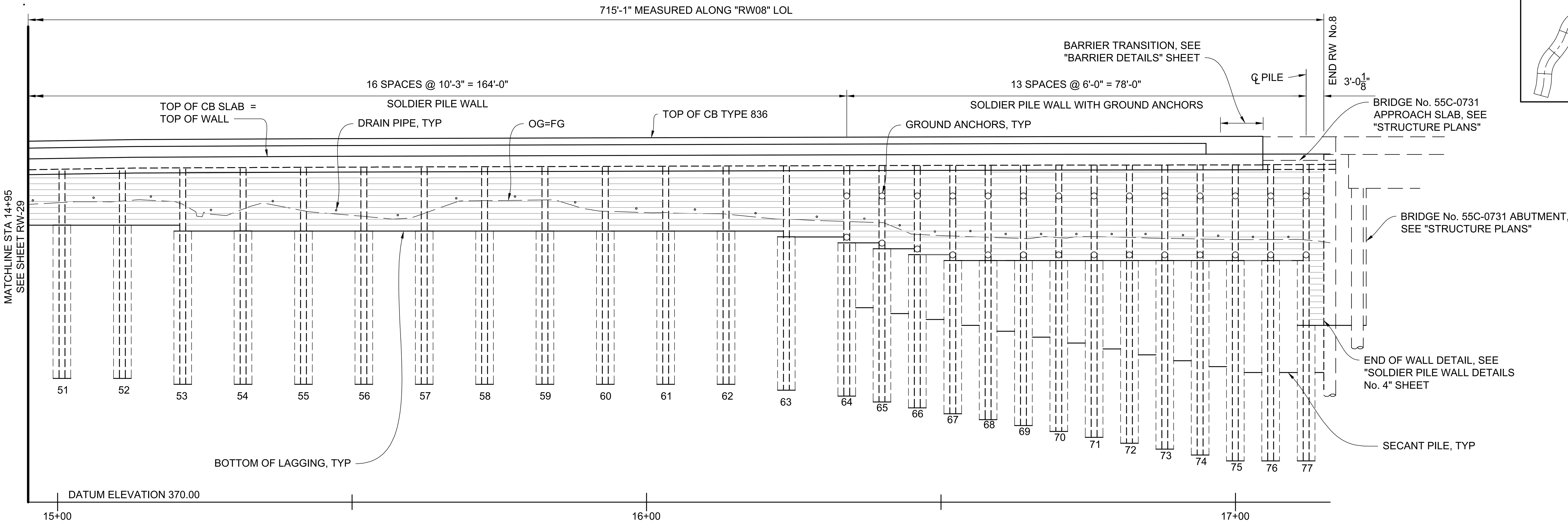
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 8
GENERAL PLAN No. 2

SHEET
RW-29

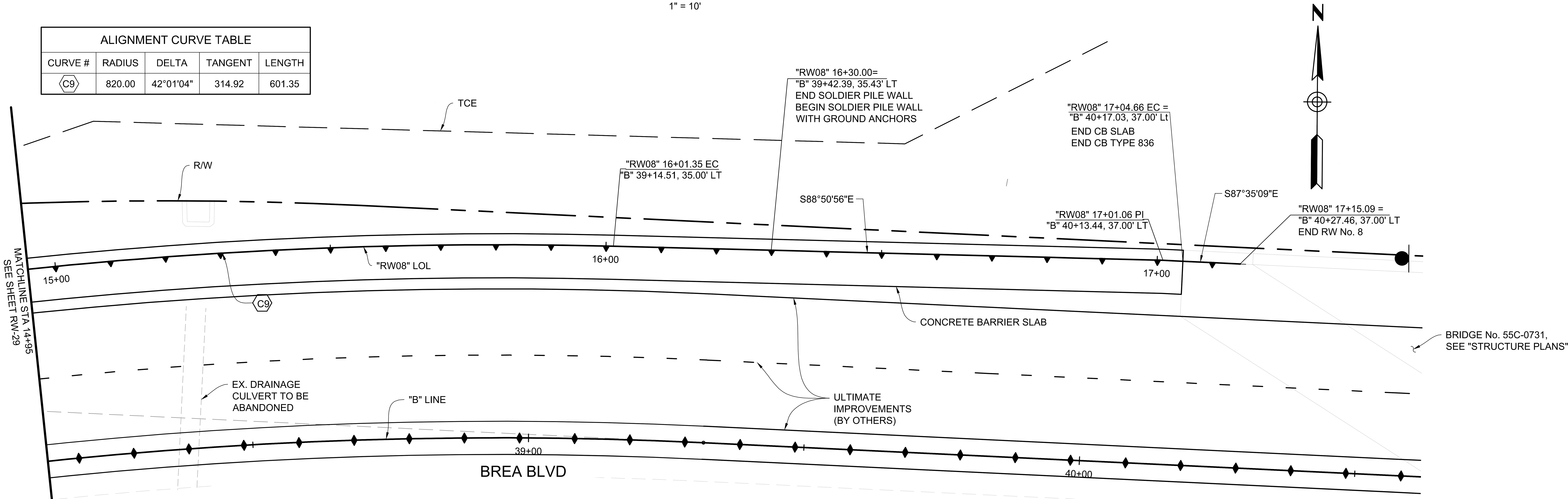
100% SUBMITTAL
NOT FOR CONSTRUCTION



MIRRORED DEVELOPED ELEVATION

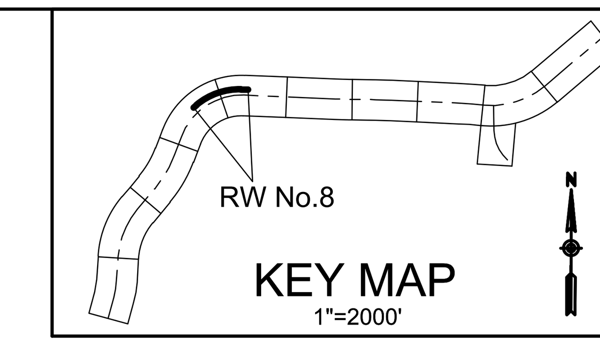
1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C9	820.00	42°01'04"	314.92	601.35



PLAN

1" = 10'



COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA

MARSHALL E MOORE, S.E.

DATE 10-15-2021

DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW08_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

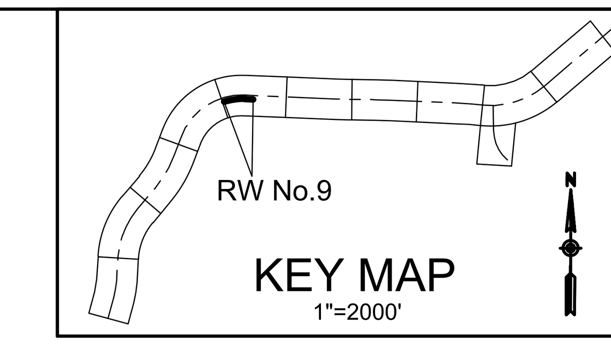
PREPARED BY: MARK THOMAS

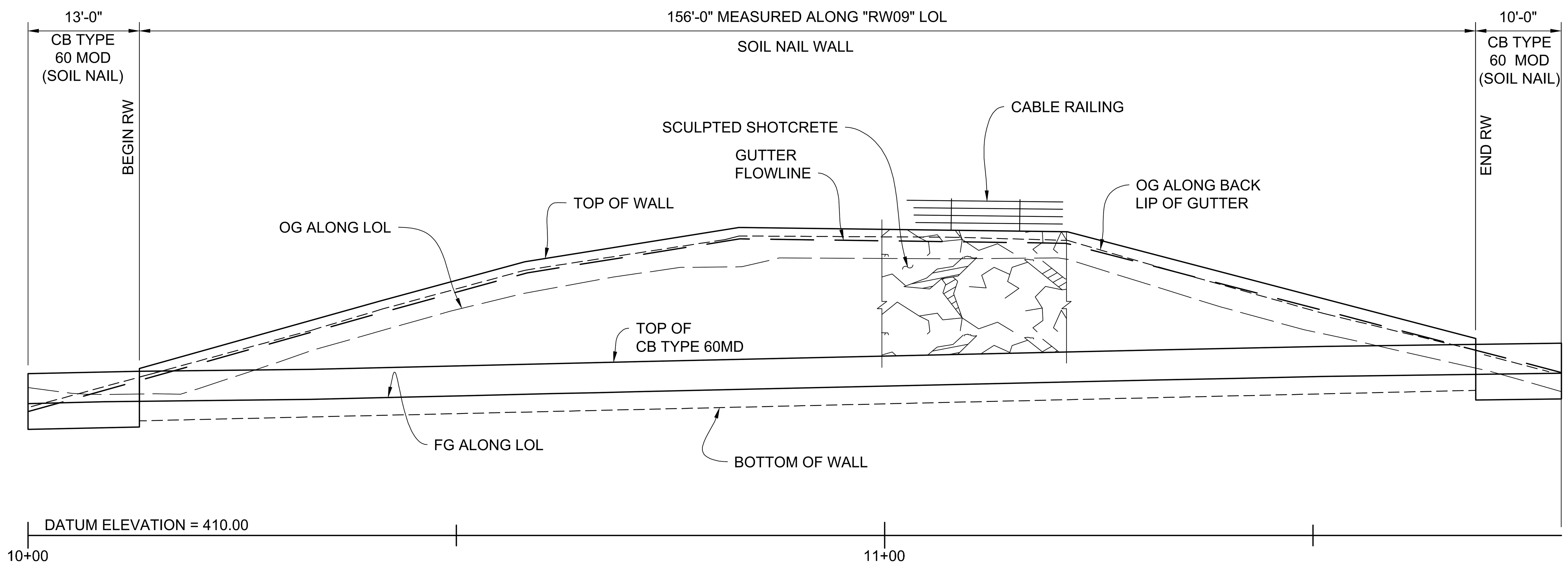
BREA BOULEVARD WIDENING

RW No. 8
GENERAL PLAN No. 3

100% SUBMITTAL
NOT FOR CONSTRUCTION

SHEET
RW-30

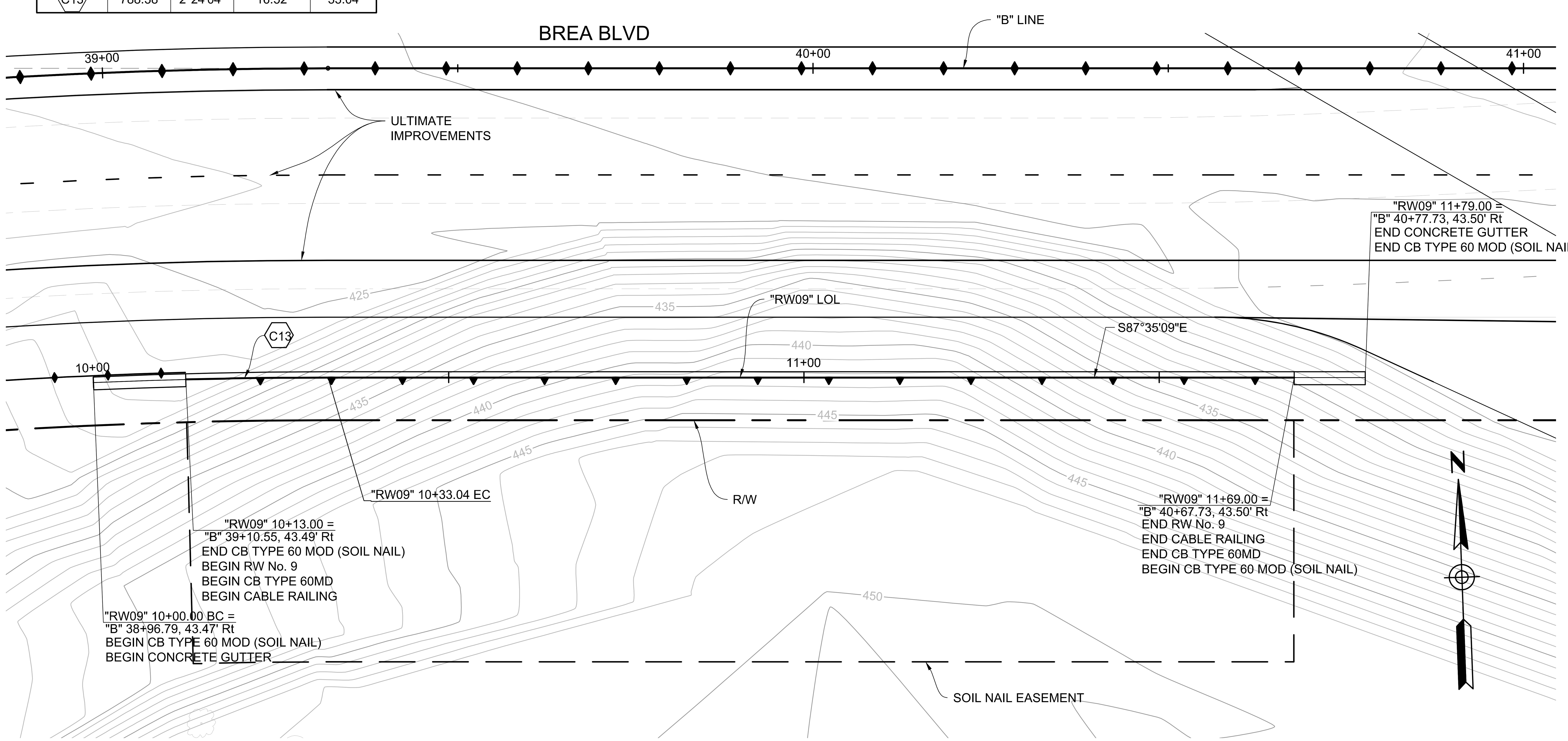




MIRRORED DEVELOPED ELEVATION

1" = 10'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C13	788.38	2°24'04"	16.52	33.04



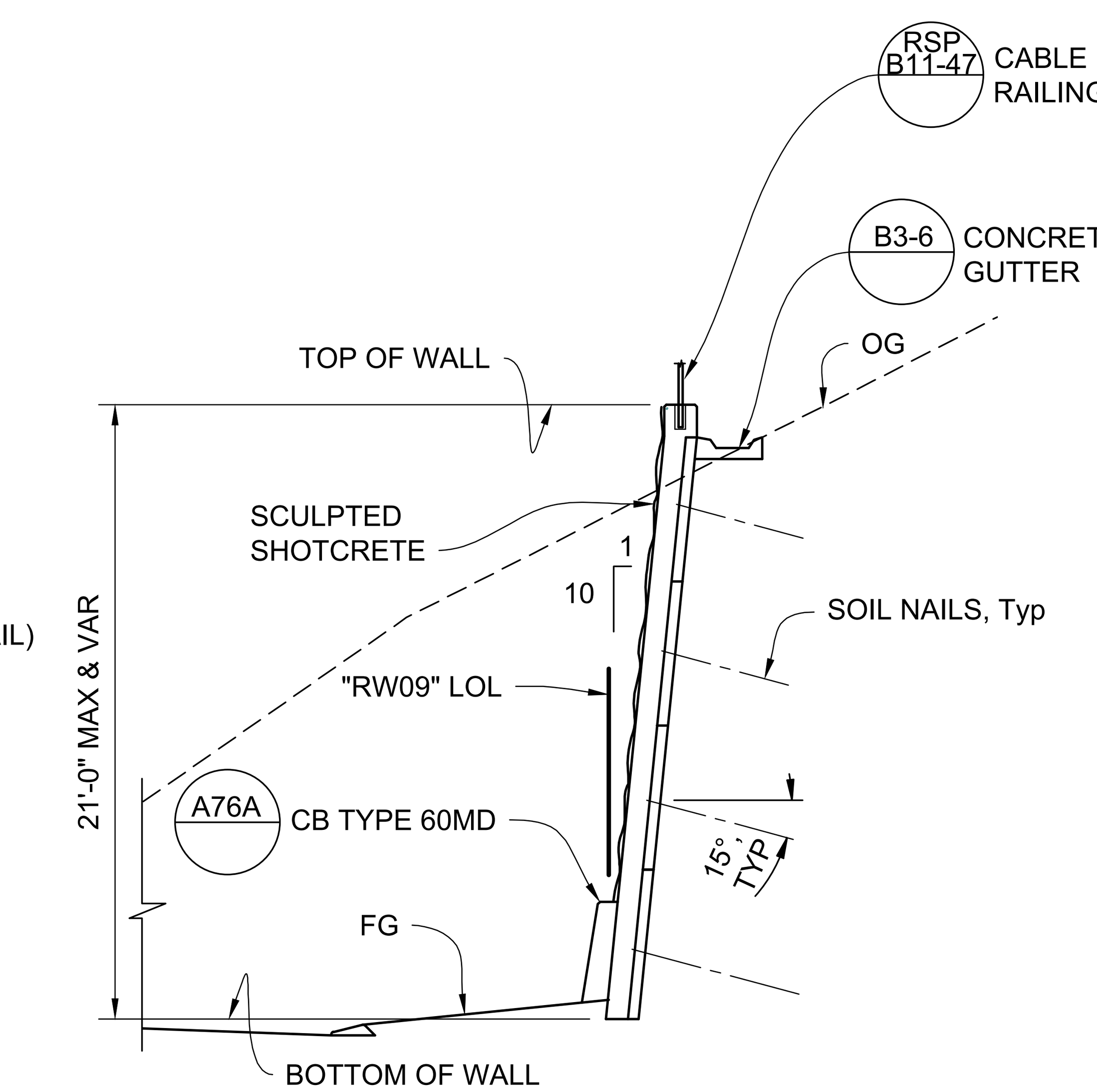
PLAN

1" = 10'

INDEX TO PLANS

QUANTITIES

STRUCTURE EXCAVATION (SOIL NAIL WALL)	160 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	12 CY
SOIL NAIL	2320 LF
BAR REINFORCING STEEL (RETAINING WALL)	9370 LB
SCULPTED SHOTCRETE	1553 SQFT
STRUCTURAL SHOTCRETE	97 CY
MINOR CONCRETE (GUTTER)(LF)	183 LF
PREPARE AND STAIN SHOTCRETE	1553 SQFT
CABLE RAILING	160 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	23 LF



TYPICAL SECTION

N.T.S.

NOTES:
1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 9 SOIL NAIL WALL LAYOUT" SHEET.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.

**100% SUBMITTAL
NOT FOR CONSTRUCTION**

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
VICTOR A. SHERBY, P.E.
DATE 10-15-2021

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW09_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

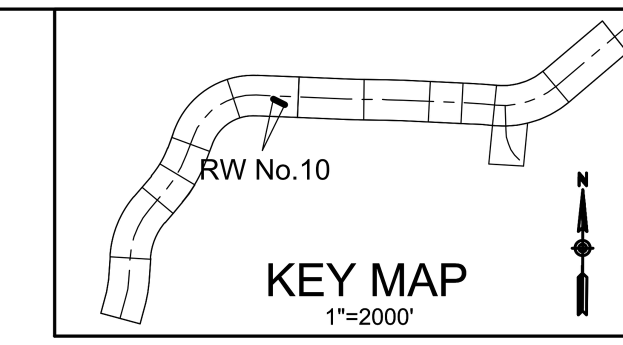
County of Orange
OC PublicWorks
PREPARED BY: MARK THOMAS

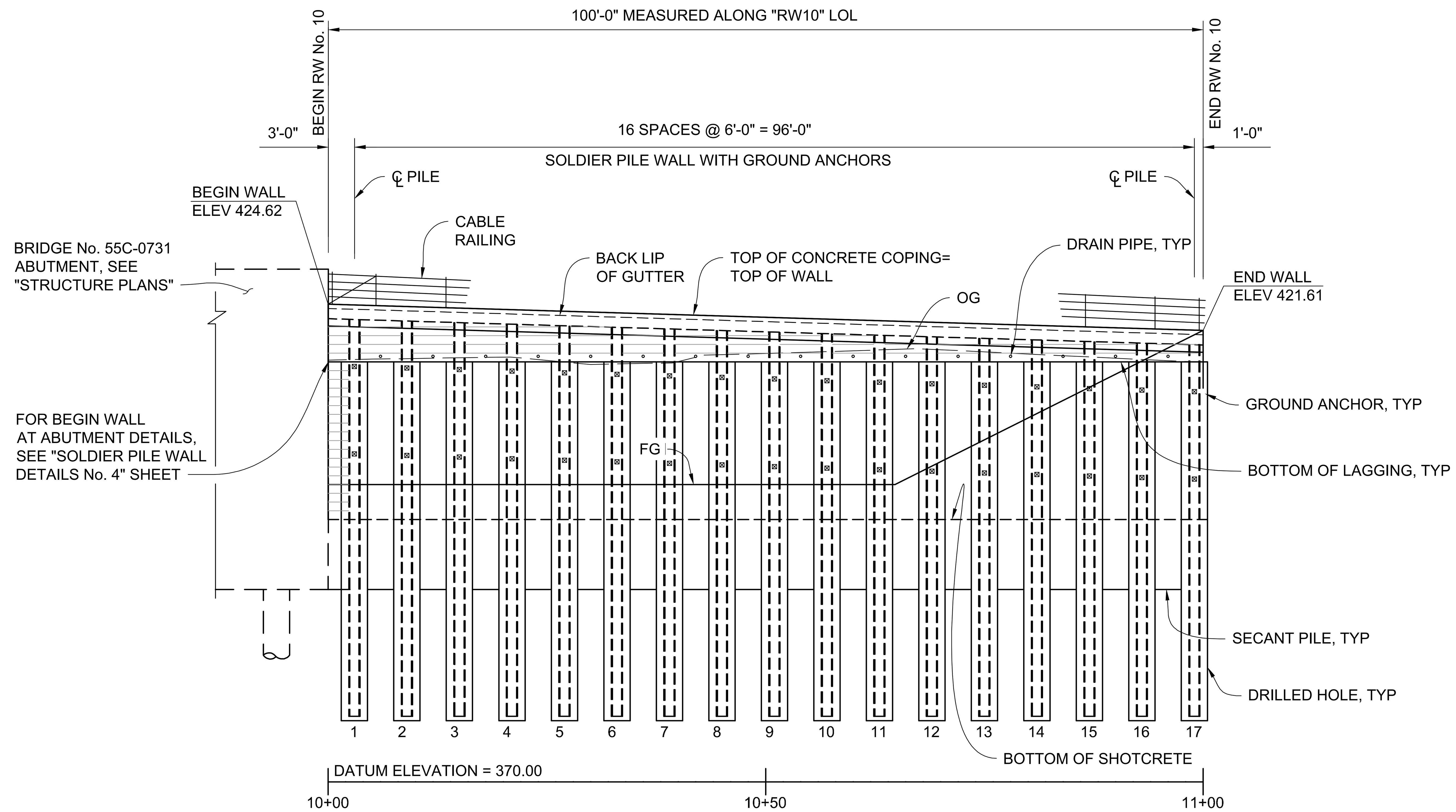
BREA BOULEVARD WIDENING

RW No. 9 GENERAL PLAN

SHEET

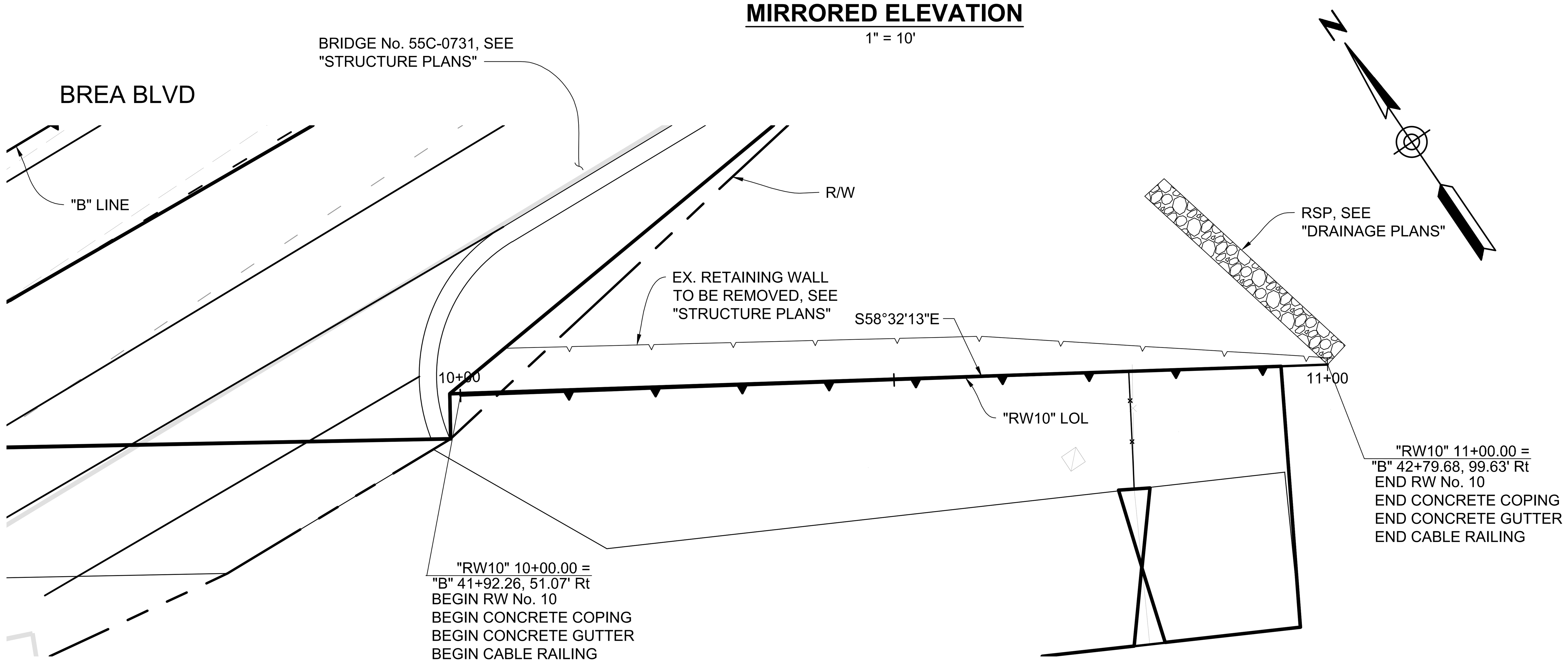
RW-37





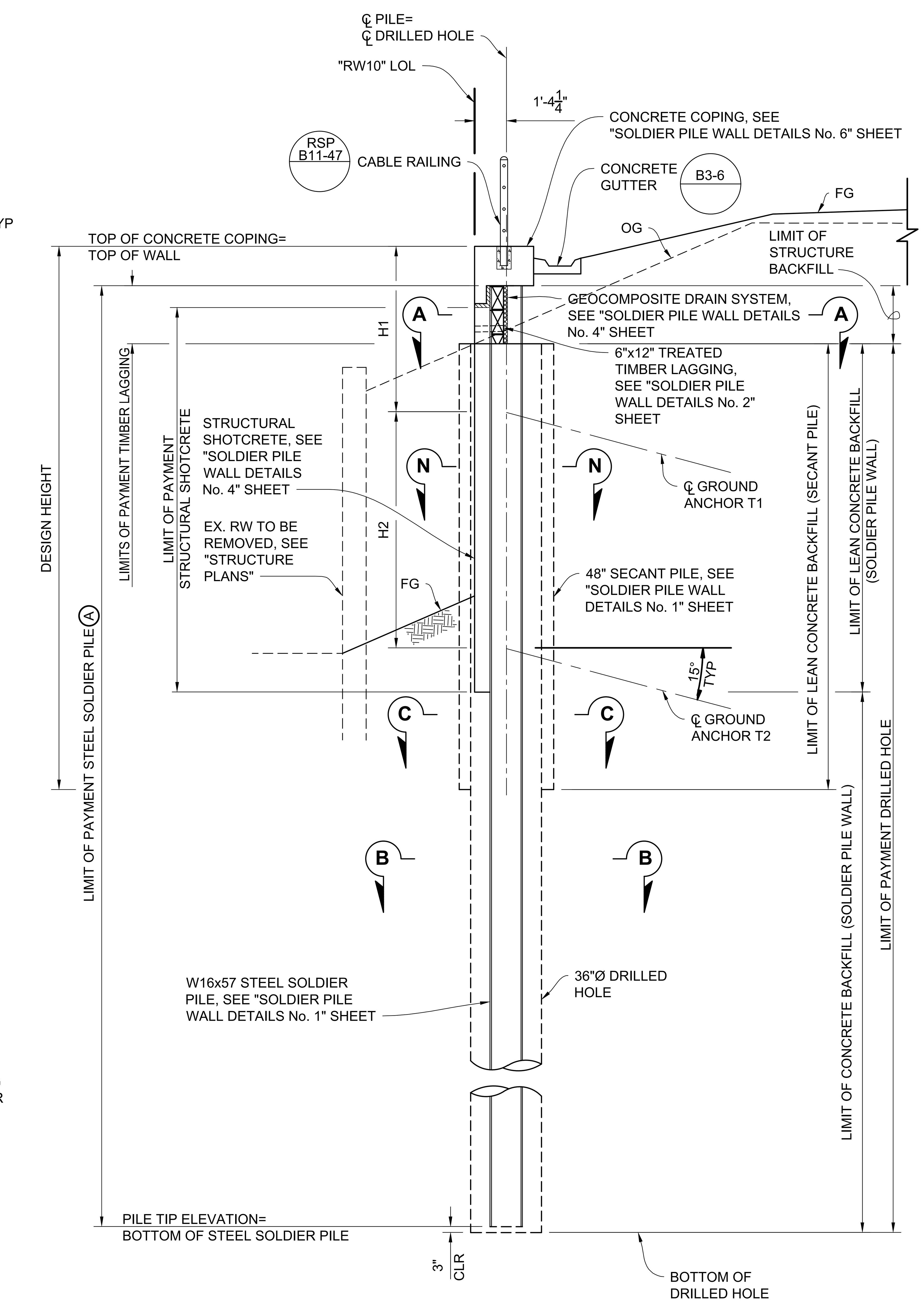
MIRRORED ELEVATION

1" = 10'



PLAN

1" = 10'



TYPICAL SECTION

N.T.S.

NOTES:

1. FOR "SECTION A-A", "SECTION B-B", AND (A) , SEE "SOLDIER PILE WALL DETAILS No. 1" SHEET.
2. FOR RCP OPENING DETAILS, SEE "SOLDIER PILE WALL DETAILS No. 3" SHEET.
3. FOR GROUND ANCHOR DETAILS, SEE "SOLDIER PILE WALL DETAILS No. 8" SHEET.
4. FOR FINISHED GRADE DETAILS, SEE "ROADWAY PLANS".
5. FOR "SECTION N-N", SEE "SOLDIER PILE WALL DETAILS No. 6" SHEET.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA
MARSHALL E MOORE, S.E.
10-15-2021
DATE

DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW10_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY:
MARK THOMAS

BREA BOULEVARD WIDENING

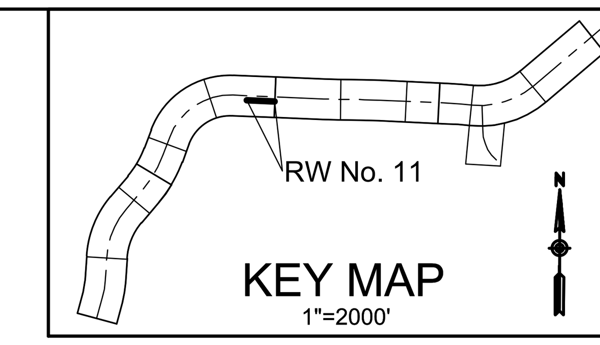
RW No. 10
GENERAL PLAN

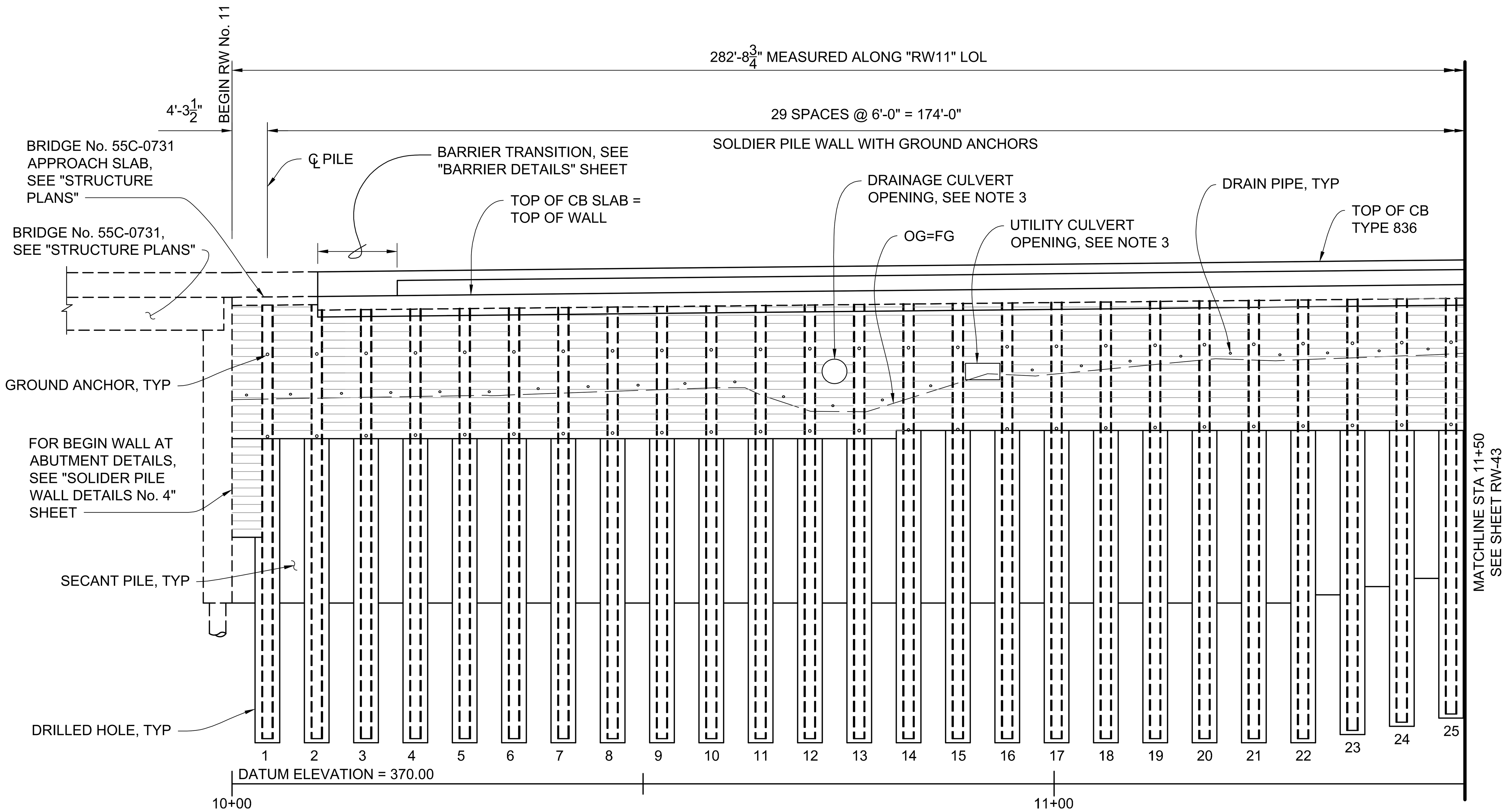
SHEET

RW-39

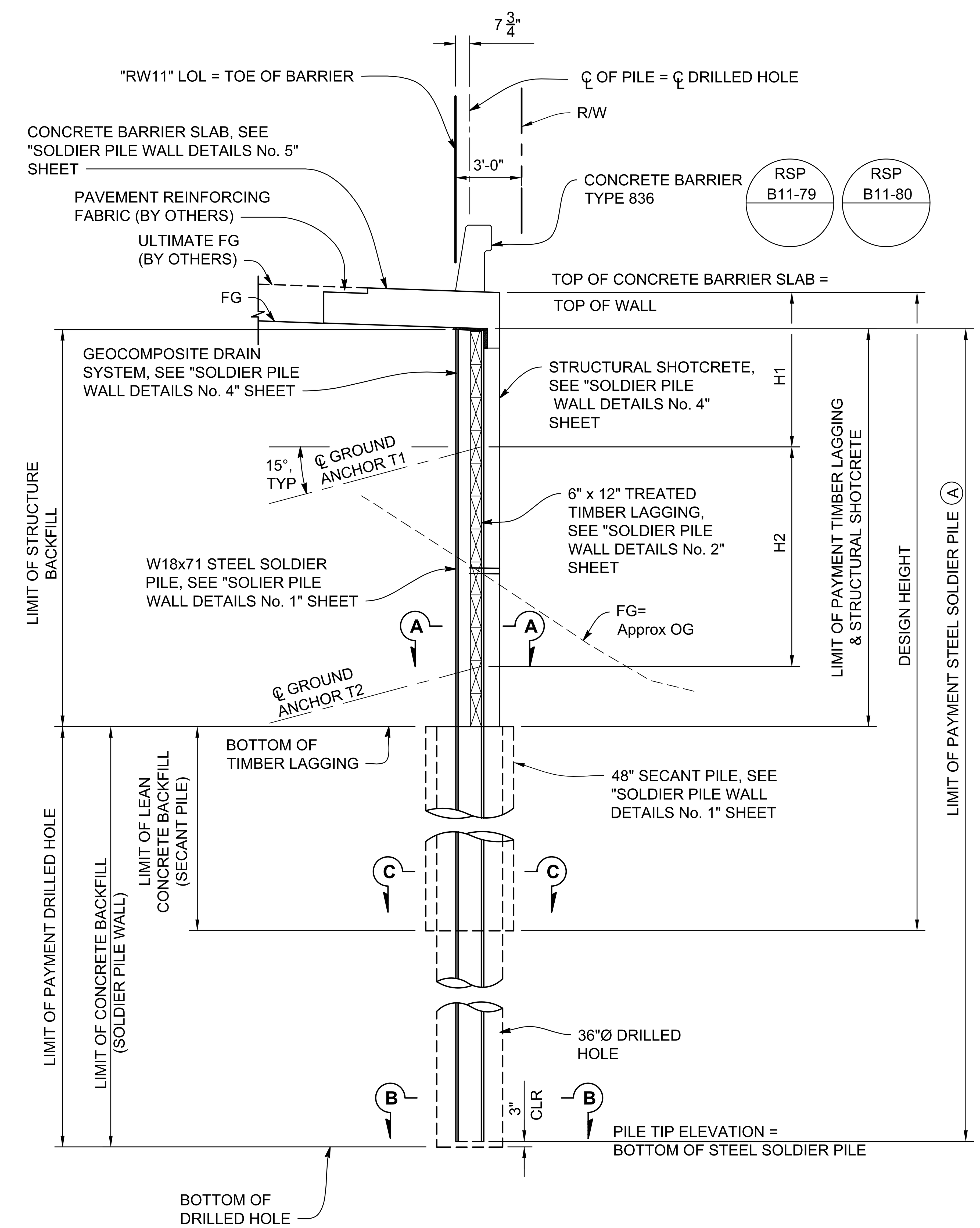
NOTES:

1. FOR "SECTION A-A", "SECTION B-B", "SECTION C-C", AND (A), SEE "SOLDIER PILE WALL DETAILS NO. 1" SHEET.
2. FOR RCP OPENING DETAILS, SEE "SOLDIER PILE WALL DETAILS NO. 3" SHEET.
3. FOR DRAINAGE CULVERT OR UTILITY CULVERT OPENING DETAILS, SEE "SOLDIER PILE WALL DETAILS NO. 3" AND "No. 9" SHEETS.
4. FOR GROUND ANCHOR DETAILS, SEE "SOLDIER PILE WALL DETAILS No. 8" SHEET.

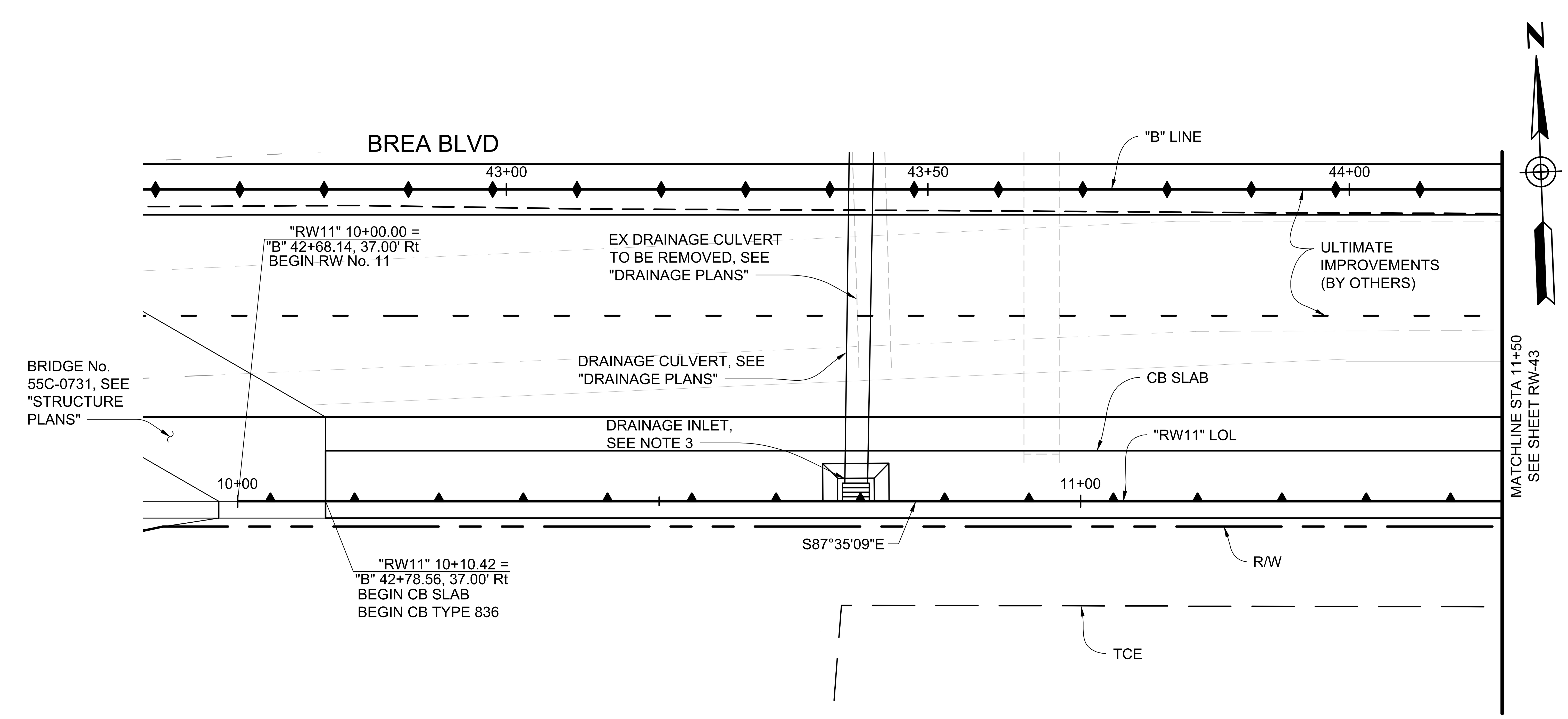




ELEVATION
1" = 10'



TYPICAL SECTION
"RW11" 10+00 TO 11+94.00
1/4" = 1'-0"



PLAN
1" = 10'

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 3-30-23 STRUCTURAL STATE OF CALIFORNIA
MARSHALL E MOORE, S.E.
DATE 10-15-2021

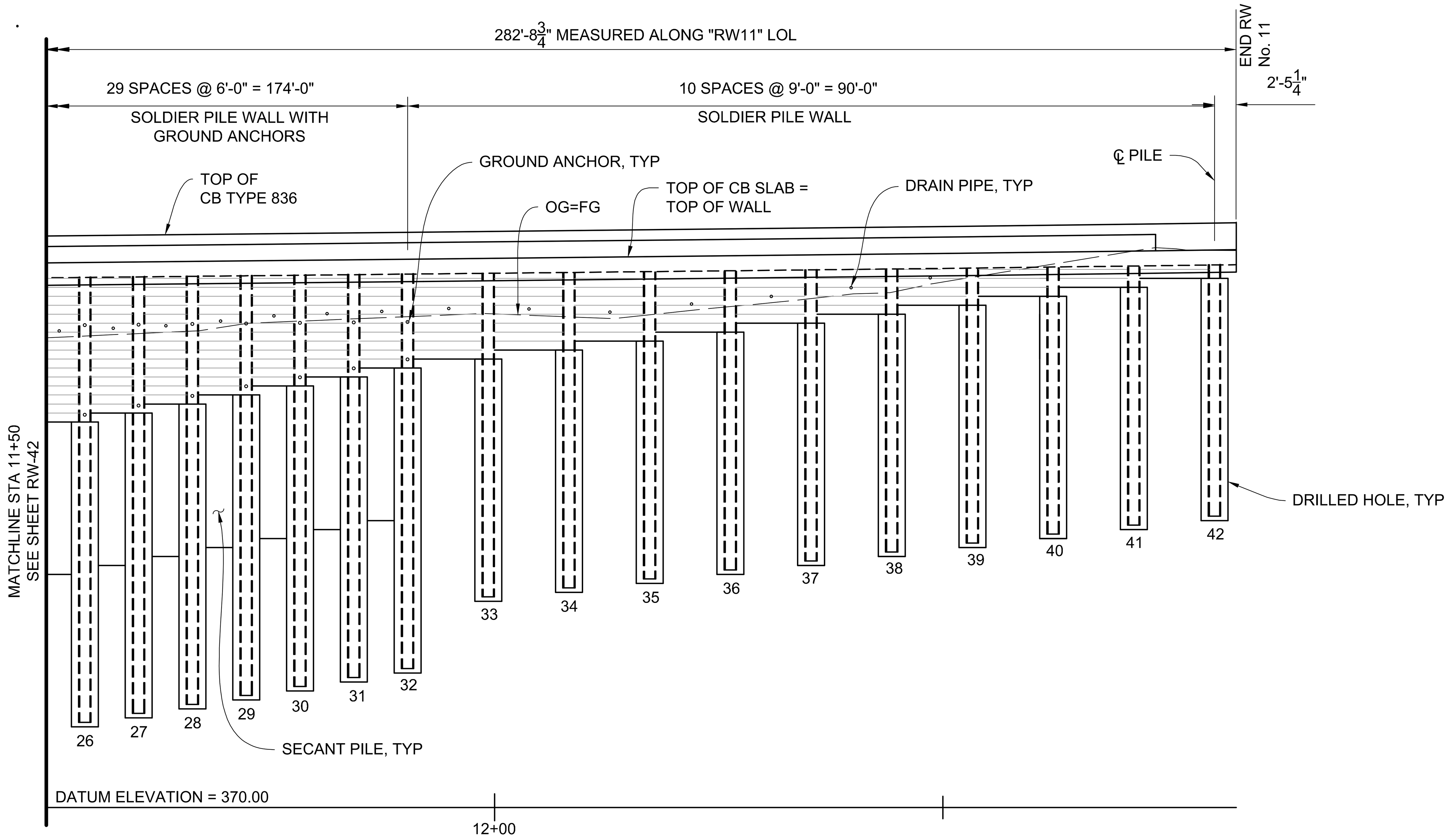
DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW11_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 11
GENERAL PLAN No. 1

SHEET
RW-42
132 OF 278

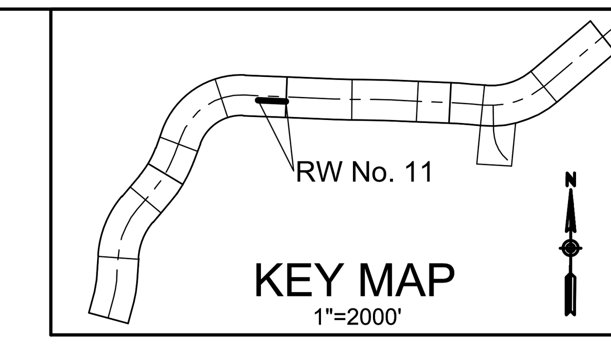


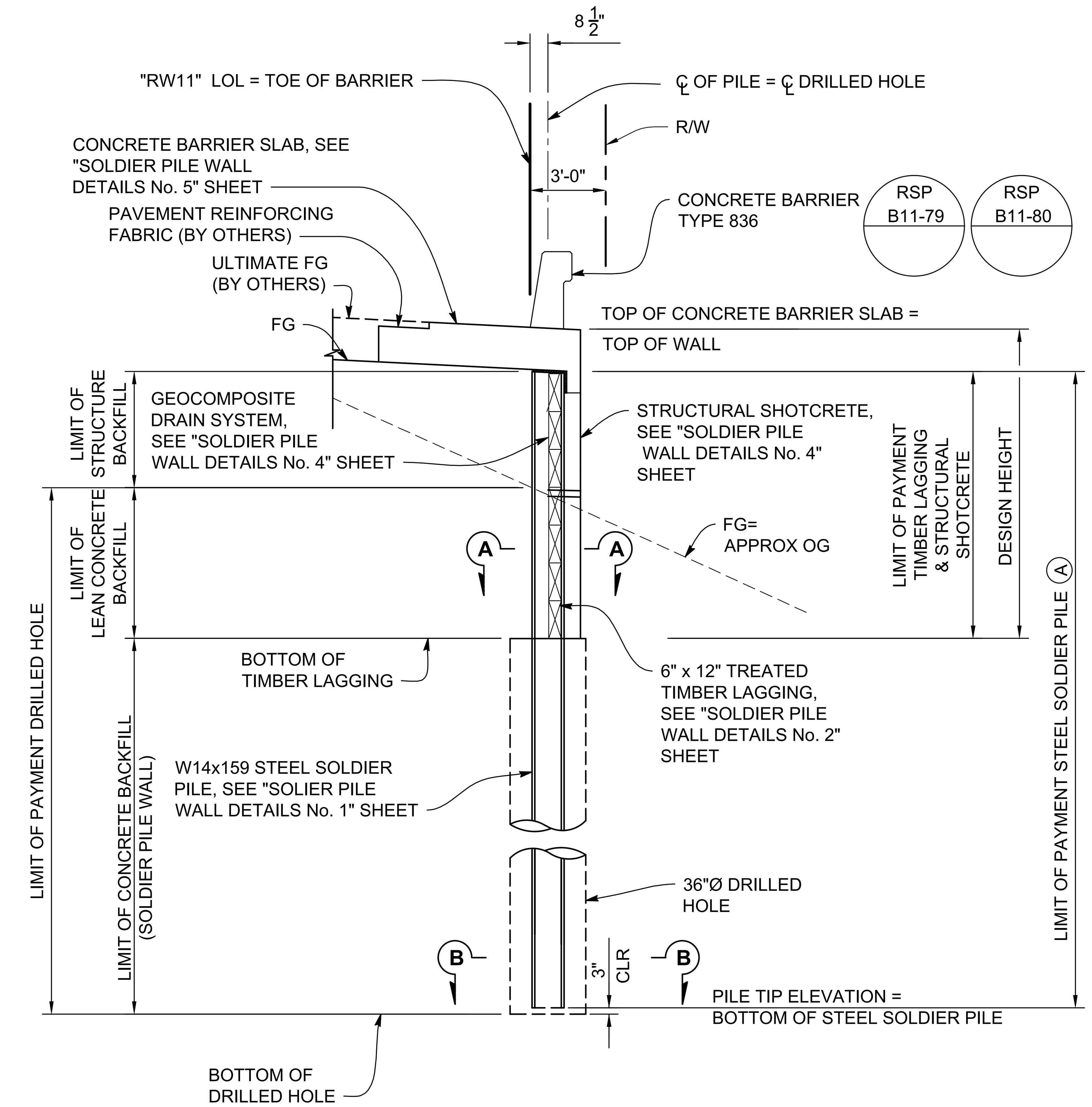
ELEVATION

1" = 10'

NOTE:

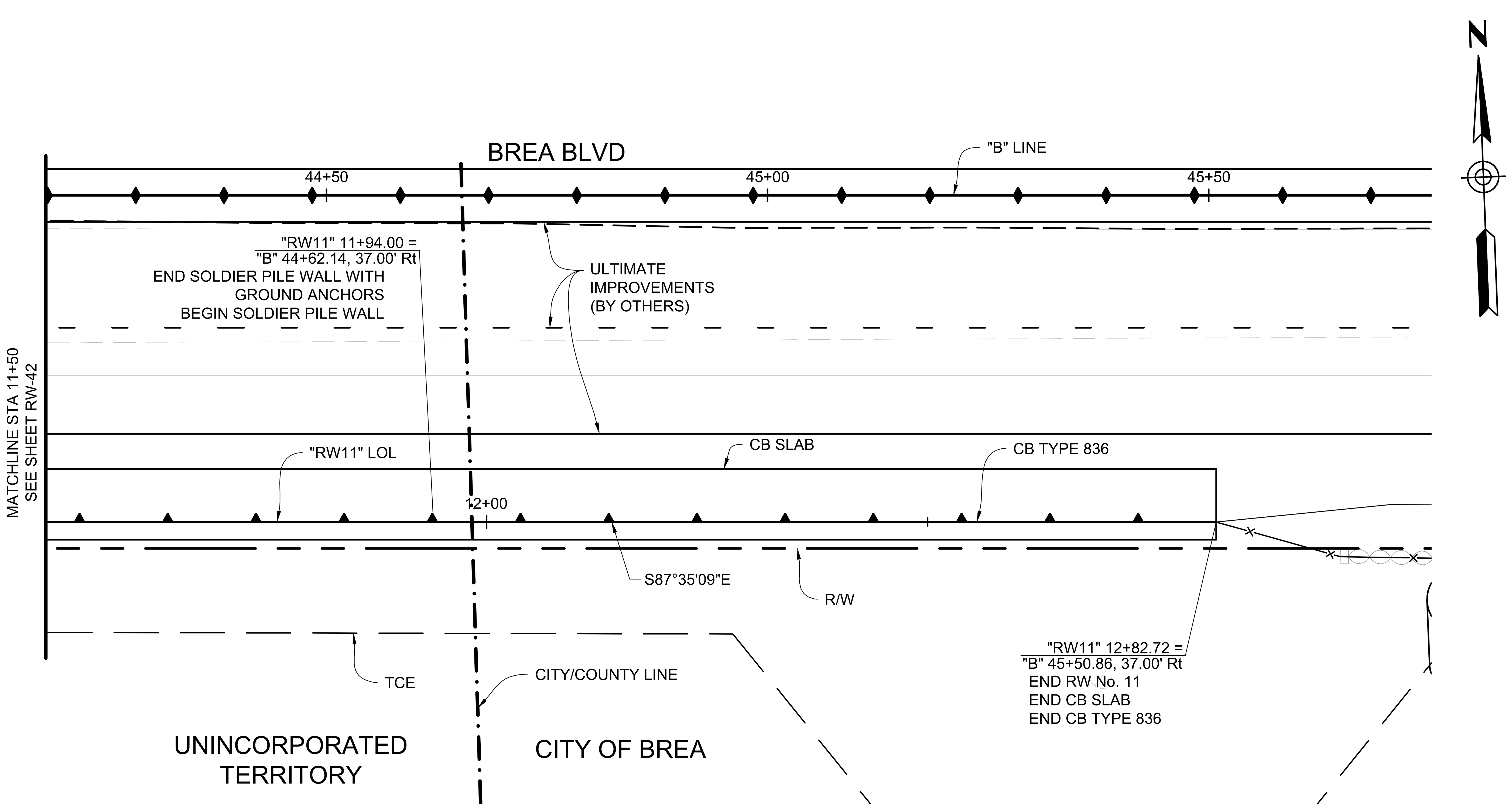
1. FOR "SECTION A-A", "SECTION B-B", AND (A), SEE "SOLDIER PILE WALL DETAILS NO. 1" SHEET.





TYPICAL SECTION
"RW11" 11+94 TO 12+82.72

1/4" = 1'-0"



PLAN

1" = 10'

100% SUBMITTAL
NOT FOR CONSTRUCTION

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
MARSHALL E MOORE, S.E.
10-15-2021
DATE

DESIGNED BY: M. MOORE
DRAWN BY: J. DOTY
CHECKED BY: T. PHAM
DRAWING NO.: ViewTitle
FILE NAME: RW11_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 11
GENERAL PLAN No. 2

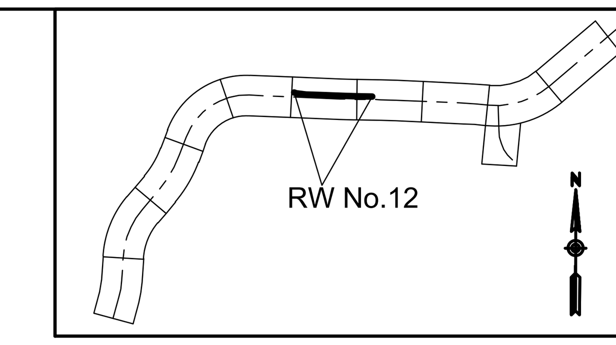
SHEET
RW-43

133 OF 278

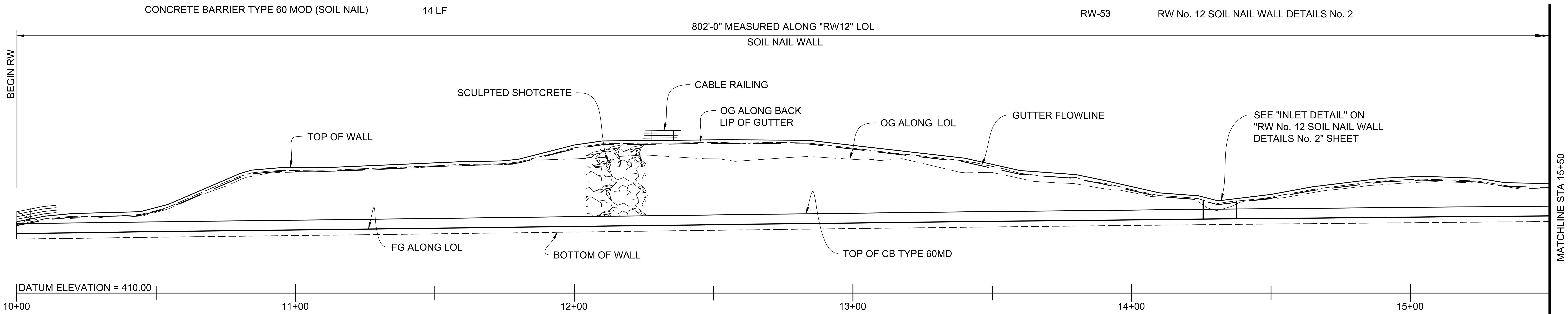
QUANTITIES

STRUCTURE EXCAVATION (SOIL NAIL WALL)	1111 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	70 CY
SOIL NAIL	23,320 LF
BAR REINFORCING STEEL (RETAINING WALL)	67,180 LB
SCULPTED SHOTCRETE	11,300 SQFT
STRUCTURAL SHOTCRETE	665 CY
8" WELDED STEEL PIPE (.188" THICK)	6 LF
MINOR CONCRETE (GUTTER)	955 LF
PREPARE AND STAIN SHOTCRETE	11,304 SQFT
CABLE RAILING	962 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	14 LF

INDEX TO PLANS

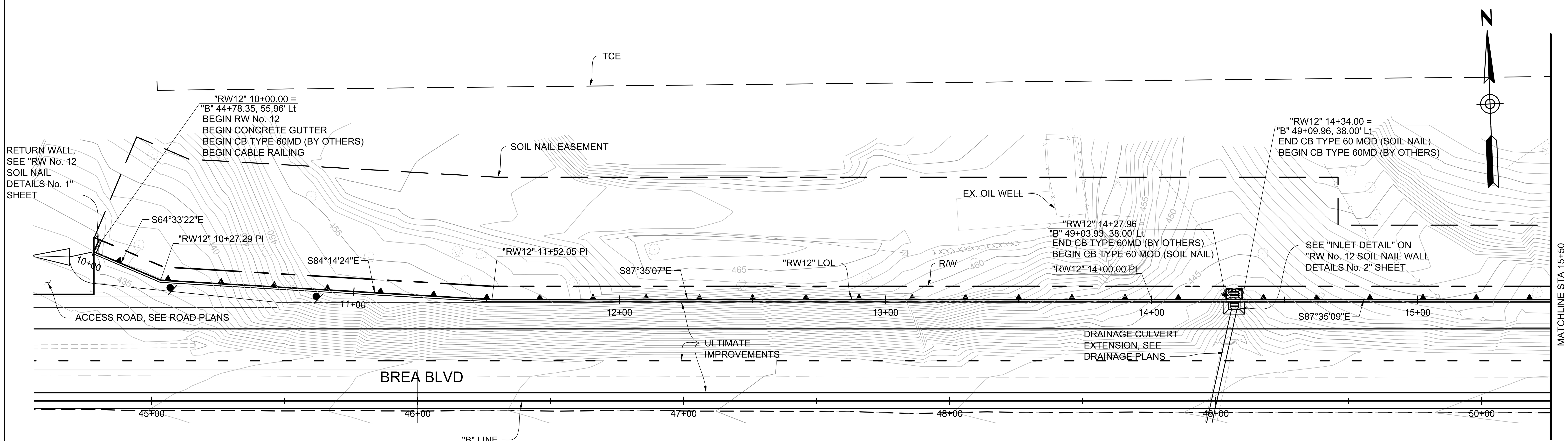


KEY MAP
1"=2000'



DEVELOPED ELEVATION

1" = 20'



PLAN

1" = 20'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 12 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.
4. FOR TYPICAL SECTION, SEE "RW No. 12 GENERAL PLAN No. 2" SHEET.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
VICTOR A. SHERBY, P.E.
10-15-2021
DATE

REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW12_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

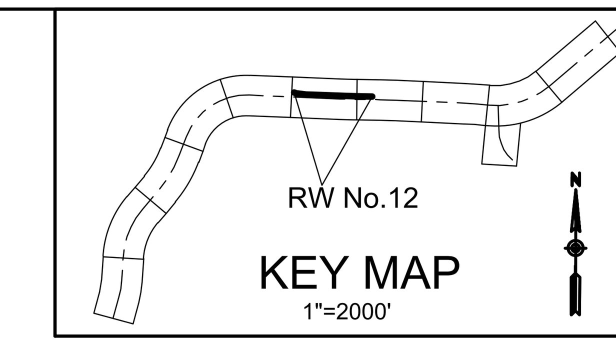
County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

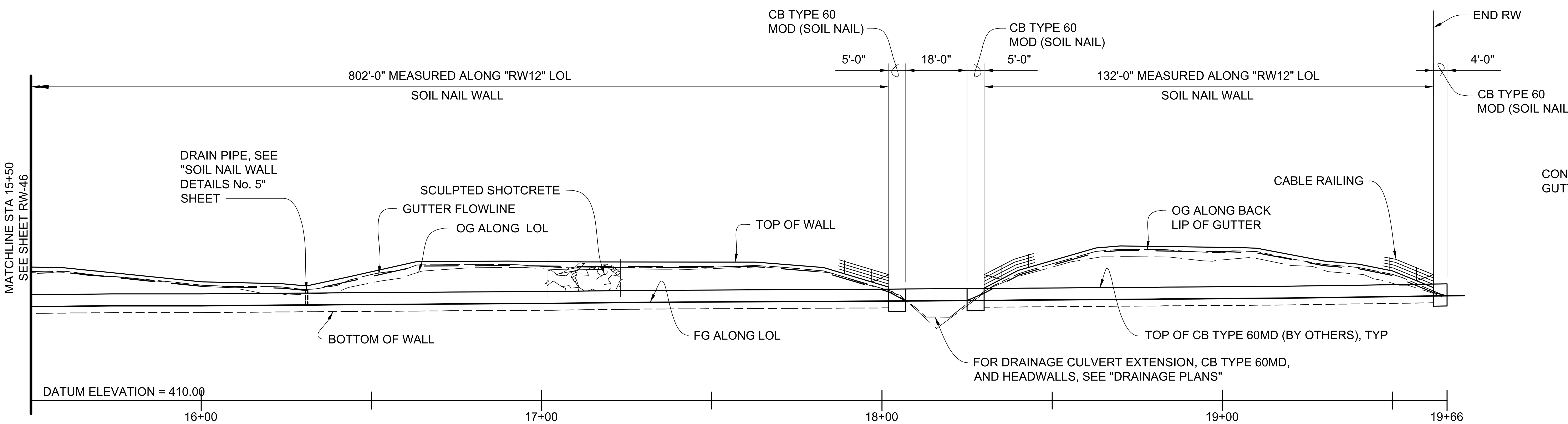
BREA BOULEVARD WIDENING

RW No. 12 GENERAL PLAN No. 1

SHEET

RW-46

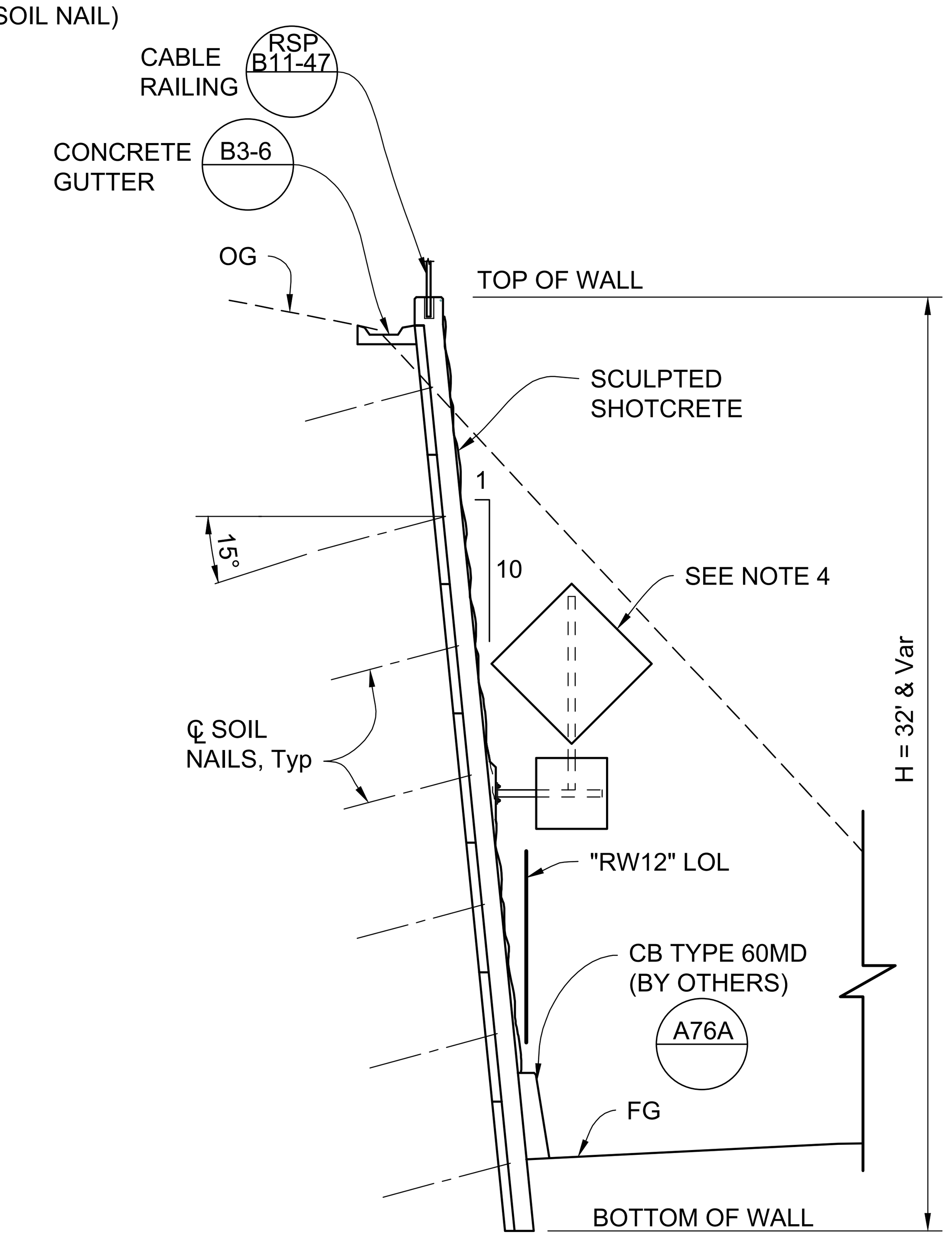




DEVELOPED ELEVATION

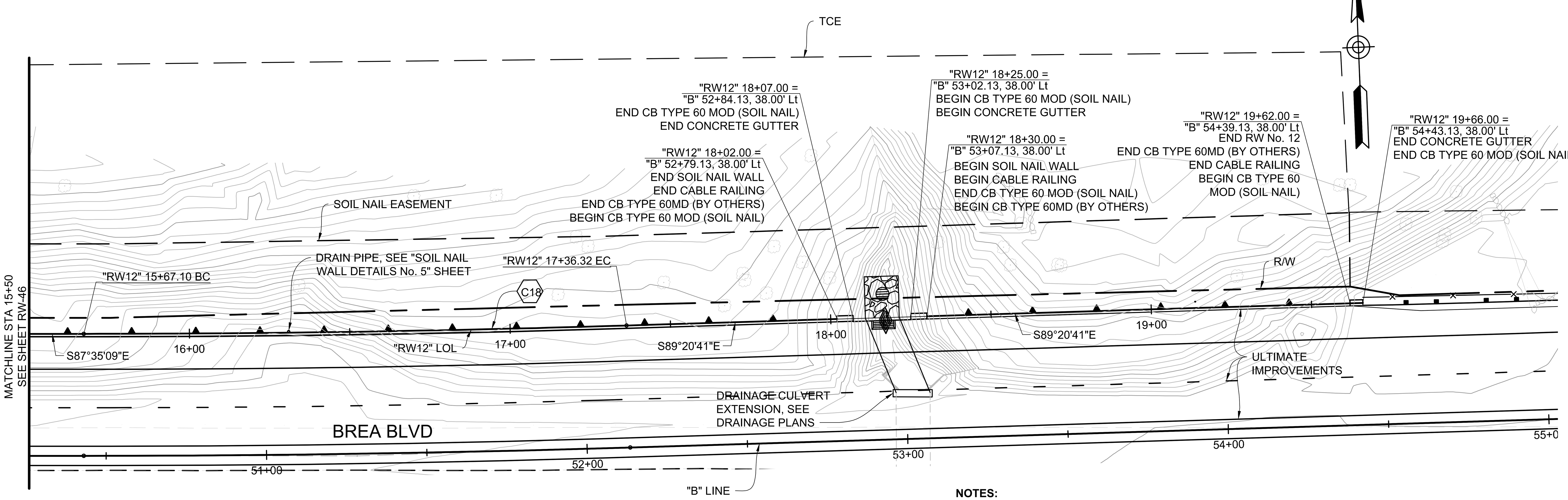
1" = 20'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C18	5512.00	1°45'32"	84.62	169.22



TYPICAL SECTION

1" = 5'



PLAN

1" = 20'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 12 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.
4. FOR LOCATION OF SIGN ANCHORAGES AND DETAILS, SEE "RETAINING WALL SIGN DETAILS No. 1" SHEET. FOR SIGN INFORMATION, SEE SIGNING AND STRIPING PLANS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

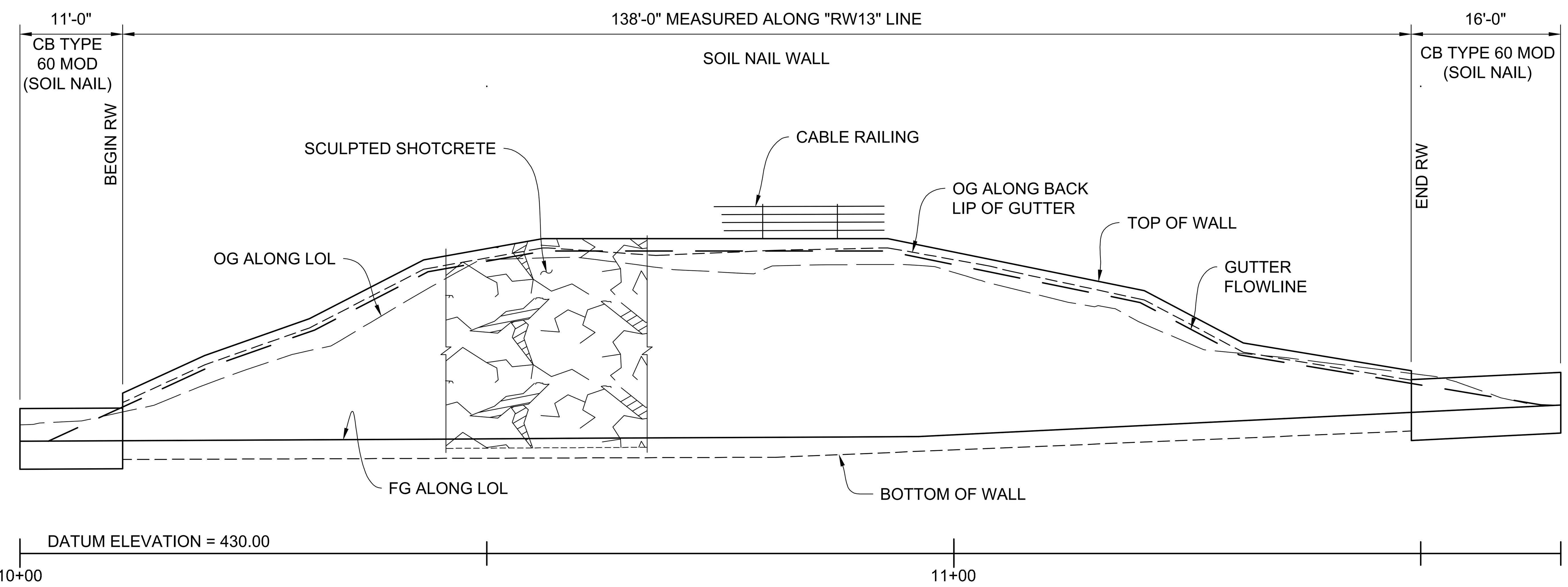
PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
VICTOR A. SHERBY, P.E.
DATE 10-15-2021

DESIGNED BY: V. SHERBY
CHECKED BY: J. HICKEY
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW12_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

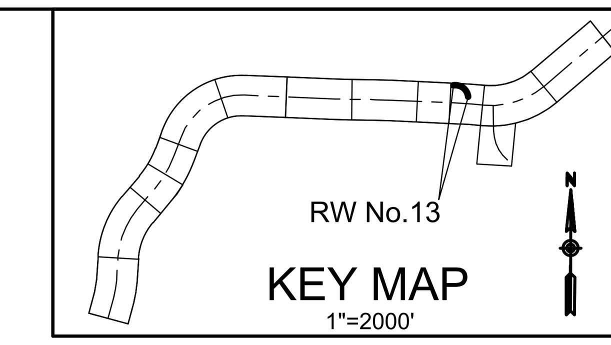
BREA BOULEVARD WIDENING
RW No. 12
GENERAL PLAN No. 2

SHEET
RW-47
137 OF 278



DEVELOPED ELEVATION

1" = 10'



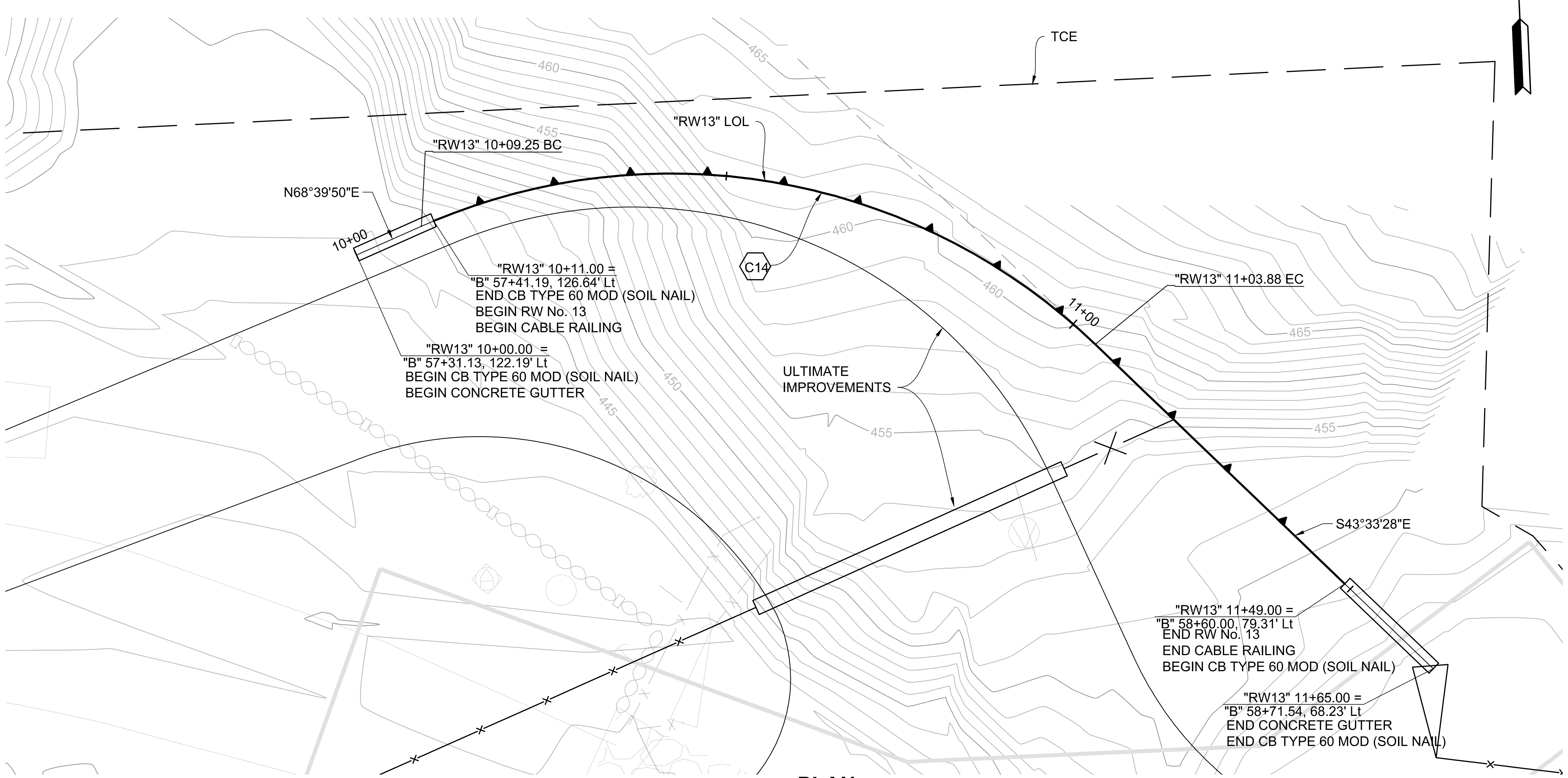
QUANTITIES

STRUCTURE EXCAVATION (SOIL NAIL WALL)	170 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	10 CY
SOIL NAIL	4263 LF
BAR REINFORCING STEEL (RETAINING WALL)	10,592 LB
SCULPTED SHOTCRETE	2298 SQFT
STRUCTURAL SHOTCRETE	100 CY
MINOR CONCRETE (GUTTER)(LF)	171 LF
PREPARE AND STAIN SHOTCRETE	2298 SQFT
CABLE RAILING	144 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	27 LF

INDEX TO PLANS

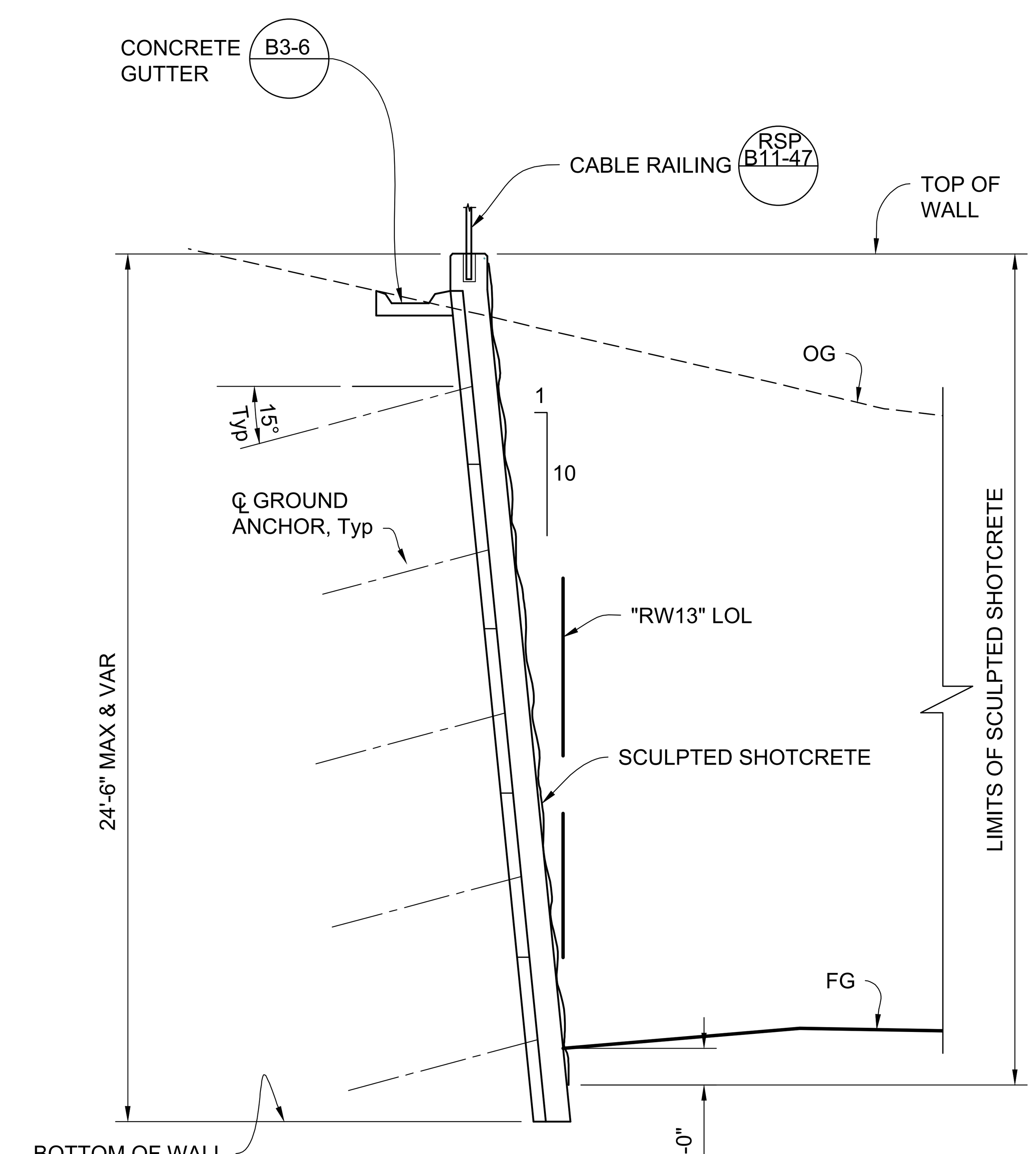
ALIGNMENT CURVE TABLE

CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C14	80.00	67°46'42"	53.74	94.64



PLAN

1" = 10'



TYPICAL SECTION

N.T.S.

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 13 SOIL NAIL WALL LAYOUT" SHEET.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA

VICTOR A. SHERBY, P.E. DATE 10-15-2021

DESIGNED BY: V. SHERBY | CHECKED BY: J. HICKEY | DRAWN BY: J. DOTY | DRAWING NO.: ViewTitle | FILE NAME: RW13_GP.dwg | PLOT DATE: 10/20/2021 | SCALE: AS SHOWN

County of Orange OC Public Works

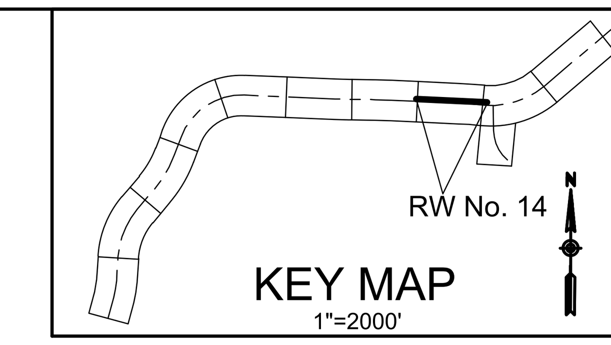
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

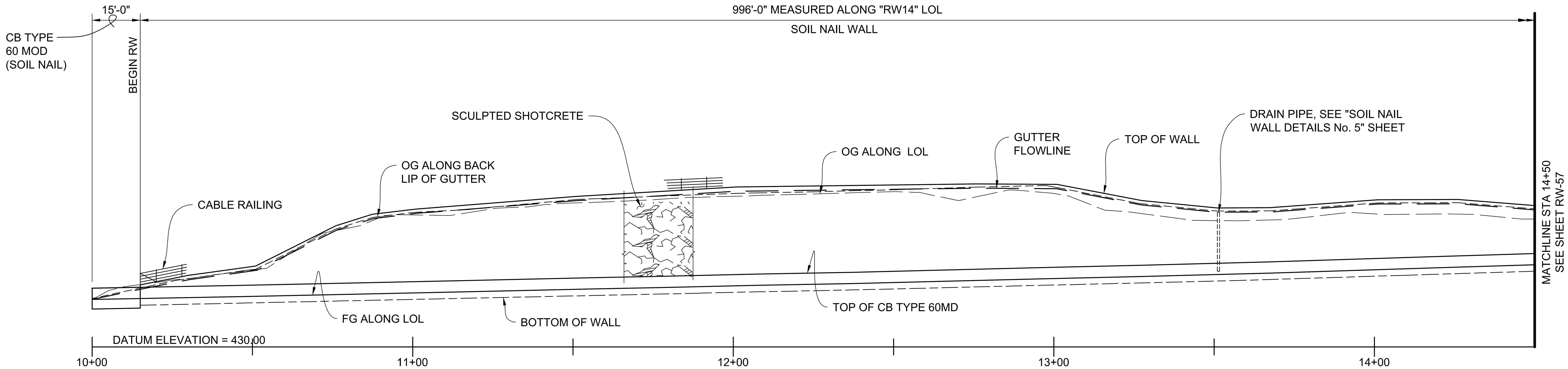
RW No. 13 GENERAL PLAN

SHEET

RW-54



COUNTY OF ORANGE CALIFORNIA



DEVELOPED ELEVATION

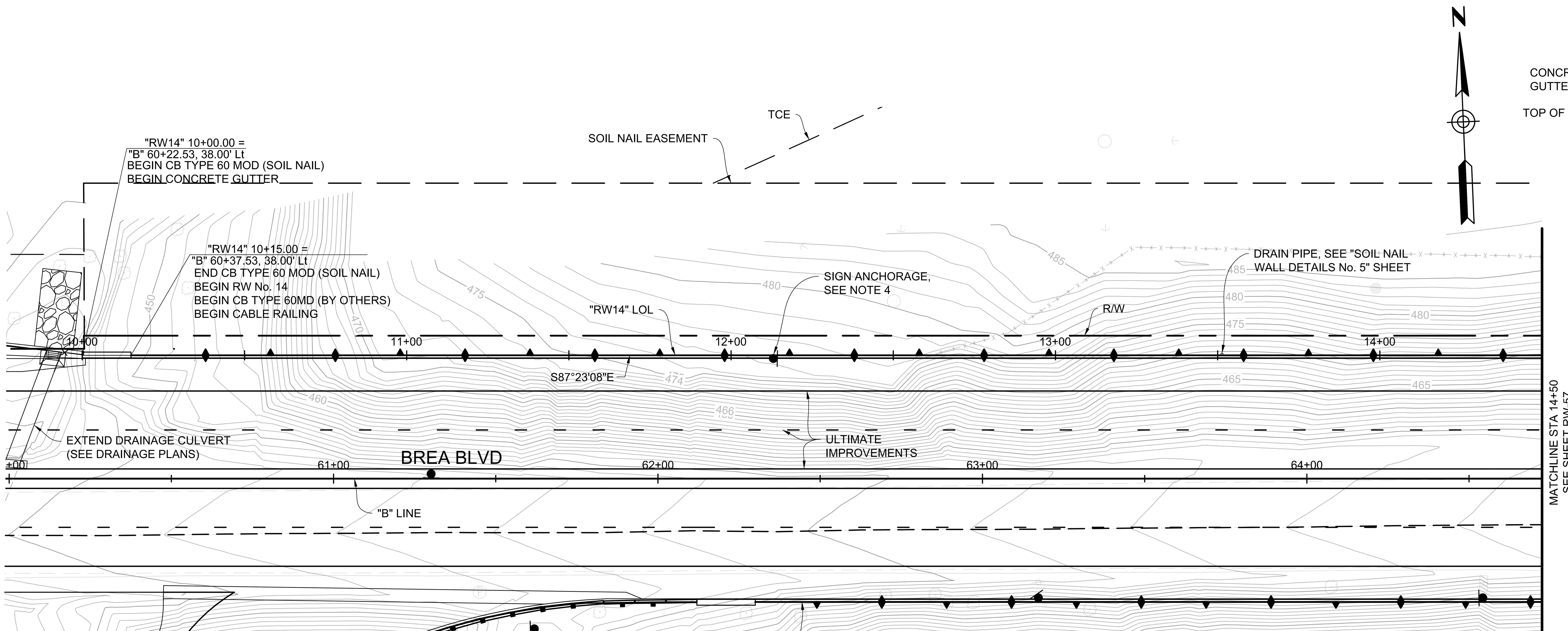
1" = 20'

INDEX TO PLANS

SHEET NO.	TITLE
RW-56	RW No. 14 GENERAL PLAN No. 1
RW-57	RW No. 14 GENERAL PLAN No. 2
RW-58	RW No. 14 SOIL NAIL WALL LAYOUT No. 1
RW-59	RW No. 14 SOIL NAIL WALL LAYOUT No. 2
RW-60	RW No. 14 SOIL NAIL WALL LAYOUT No. 3
RW-61	RW No. 14 SOIL NAIL WALL LAYOUT No. 4

QUANTITIES

STRUCTURE EXCAVATION (SOIL NAIL WALL)	1306 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	74 CY
SOIL NAIL	29,115 LF
BAR REINFORCING STEEL (RETAINING WALL)	75,650 LB
SCULPTED SHOTCRETE	14,382 SQFT
STRUCTURAL SHOTCRETE	799 CY
8" WELDED STEEL PIPE (.188" THICK)	40 LF
MINOR CONCRETE (GUTTER)(LF)	1027 LF
PREPARE AND STAIN SHOTCRETE	14,382 SQFT
CABLE RAILING	1002 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	25 LF

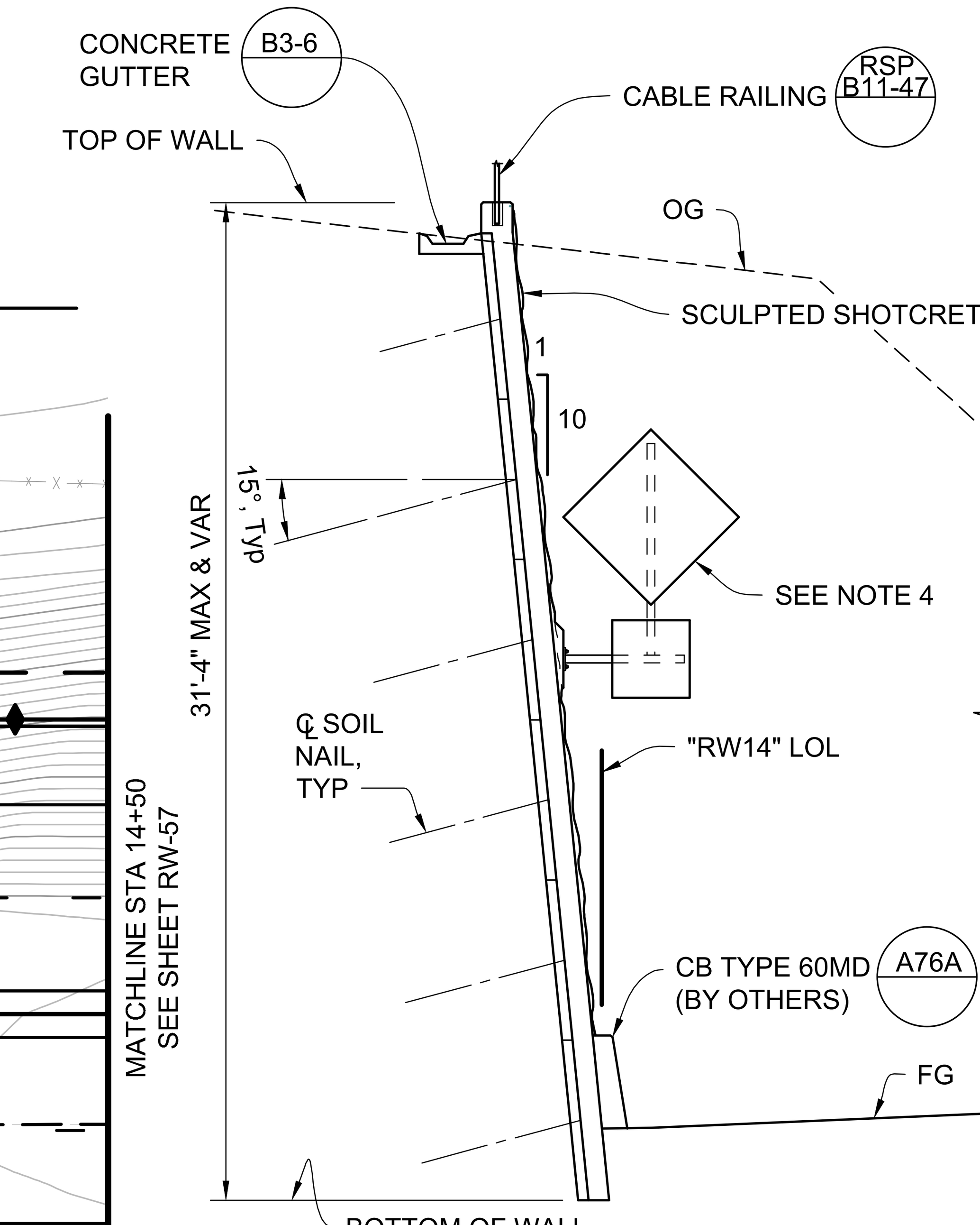


PLAN

1" = 20'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 14 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.
4. FOR LOCATION OF SIGN ANCHORAGES AND DETAILS, SEE "RETAINING WALL SIGN DETAILS No. 1" SHEET. FOR SIGN INFORMATION, SEE SIGNING AND STRIPING PLANS.



TYPICAL SECTION

N.T.S.

100% SUBMITTAL NOT FOR CONSTRUCTION

MARK | DATE | DESCRIPTION | APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
VICTOR A. SHERBY, P.E.
10-15-2021
DATE

REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW14_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

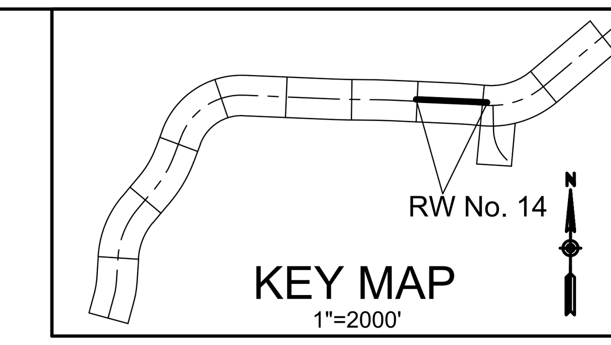
County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

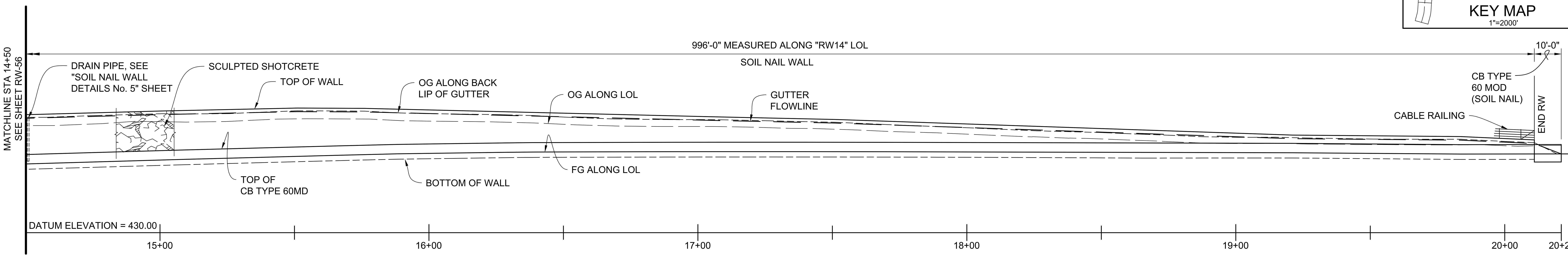
RW No. 14 GENERAL PLAN No. 1

SHEET

RW-56



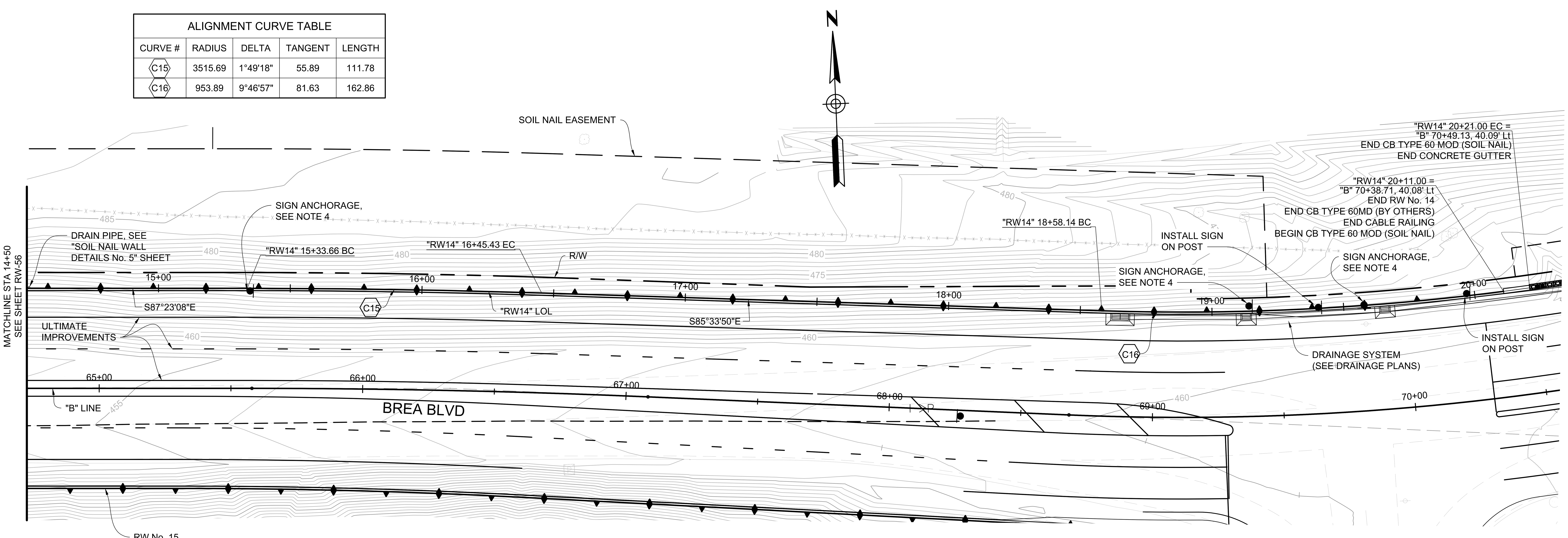
KEY MAP
1"=2000'



DEVELOPED ELEVATION

1" = 20'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C15	3515.69	1°49'18"	55.89	111.78
C16	953.89	9°46'57"	81.63	162.86



PLAN

1" = 20'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 14 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.
4. FOR LOCATION OF SIGN ANCHORAGES AND DETAILS, SEE "RETAINING WALL SIGN DETAILS No. 1" SHEET. FOR SIGN INFORMATION, SEE SIGNING AND STRIPING PLANS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

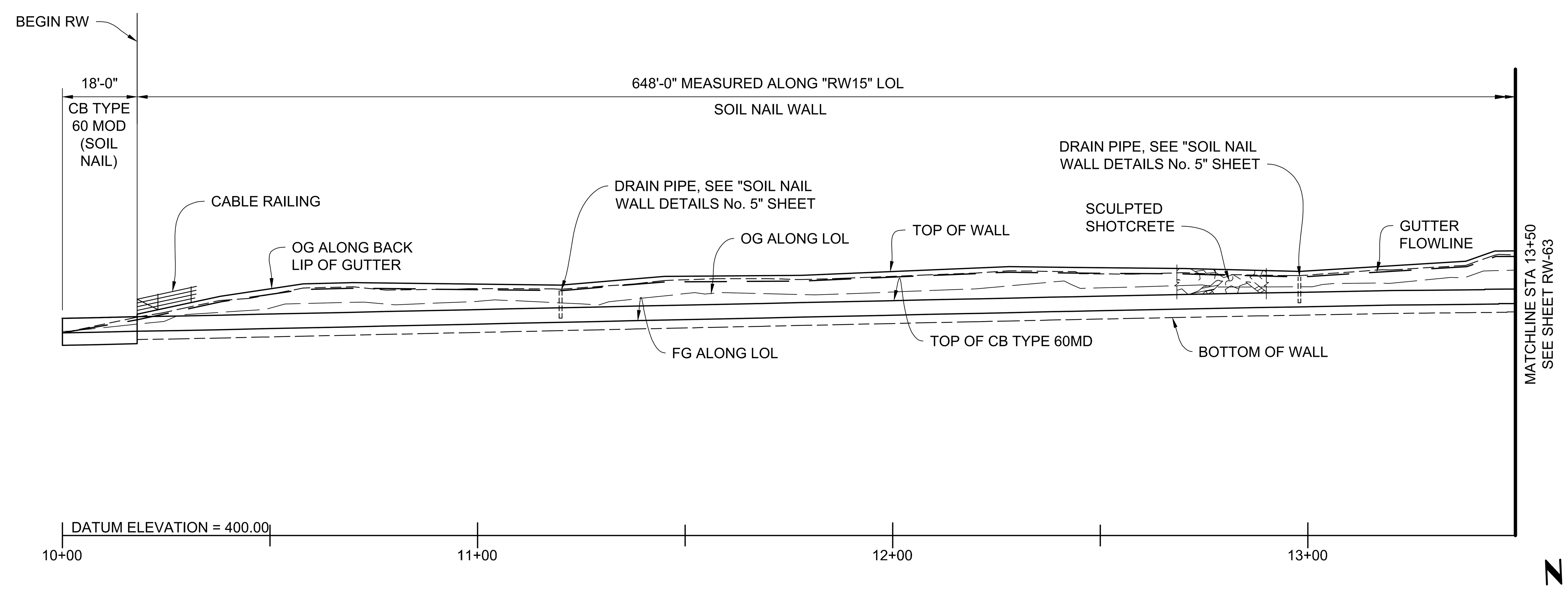
PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
VICTOR A. SHERBY, P.E. 10-15-2021 DATE

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW14_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING
RW No. 14
GENERAL PLAN No. 2

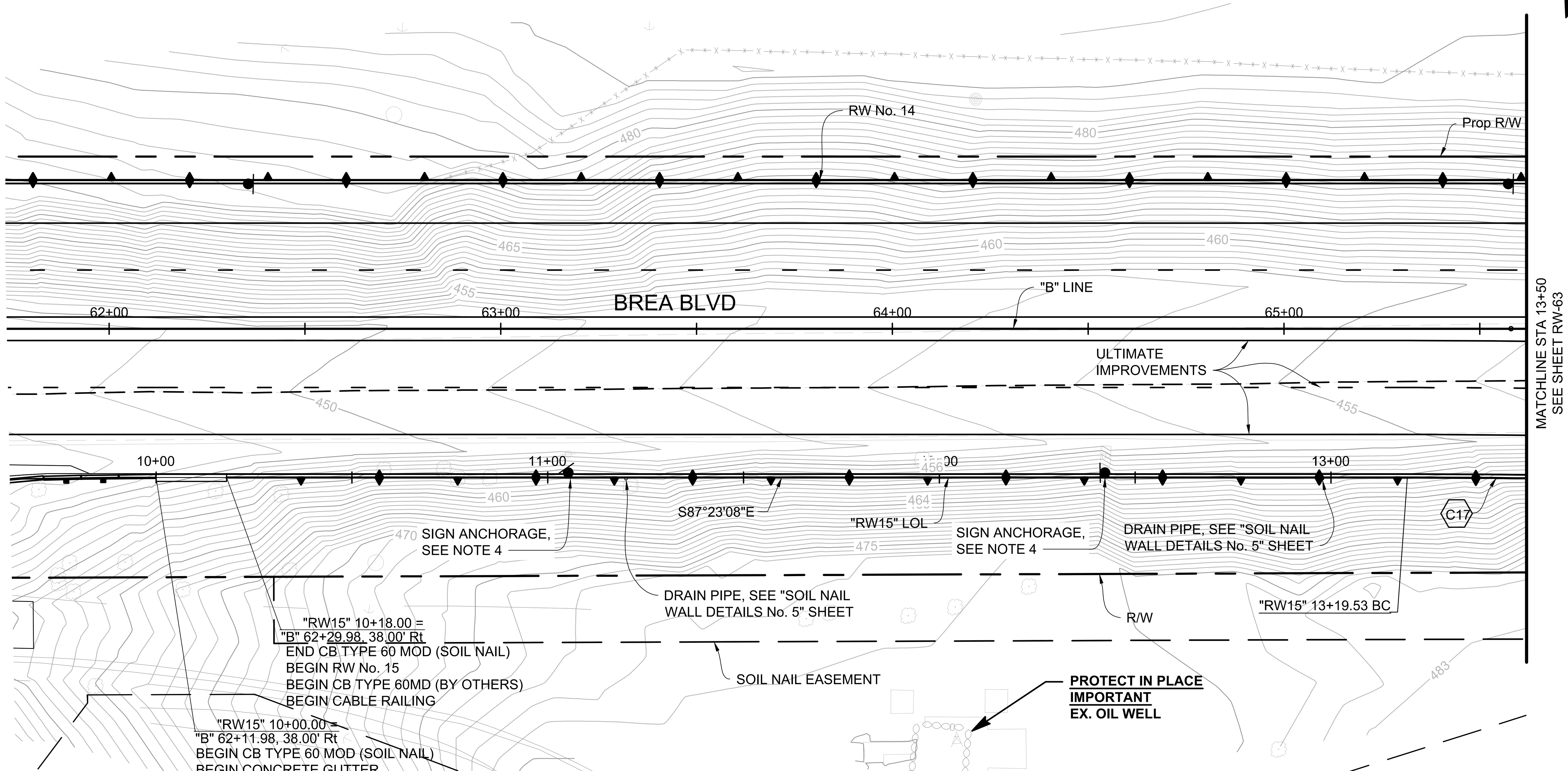
SHEET
RW-57



MIRRORED DEVELOPED ELEVATION

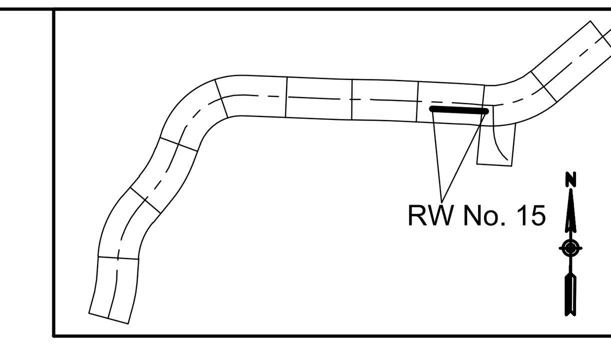
1" = 20'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C17	2465.02	2°59'22"	64.32	128.62



PLAN

1" = 20'



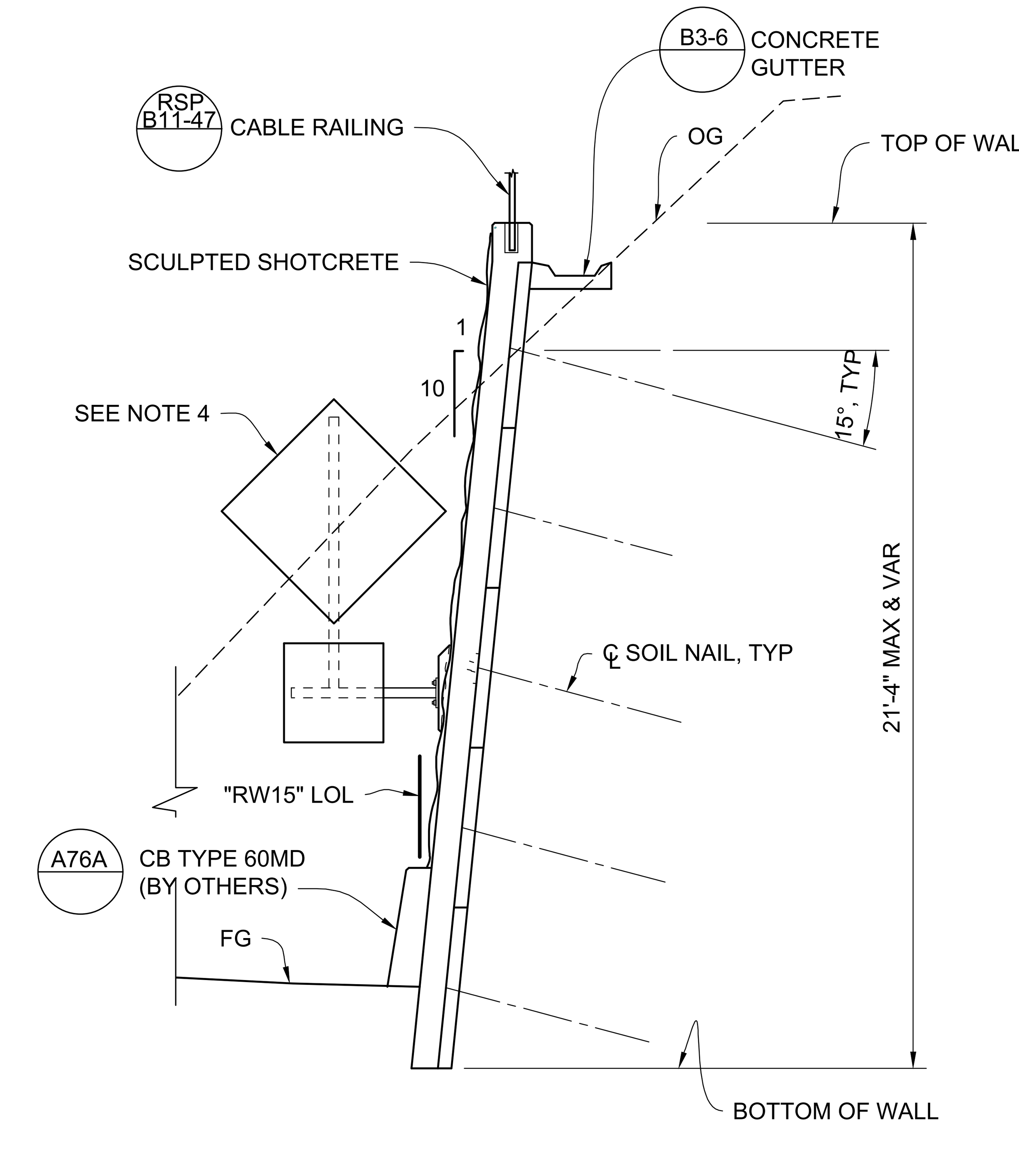
KEY MAP

1"=2000'

INDEX TO PLANS

QUANTITIES

STRUCTURE EXCAVATION (SOIL NAIL WALL)	654 CY
STRUCTURE BACKFILL (SOIL NAIL WALL)	48 CY
SOIL NAIL	12,915 LF
BAR REINFORCING STEEL (RETAINING WALL)	36,192 LB
SCULPTED SHOTCRETE	5337 SQFT
STRUCTURAL SHOTCRETE	363 CY
8" WELDED STEEL PIPE (.188" THICK)	18 LF
MINOR CONCRETE (GUTTER)	687 LF
PREPARE AND STAIN SHOTCRETE	5337 SQFT
CABLE RAILING	651 LF
CONCRETE BARRIER TYPE 60 MOD (SOIL NAIL)	36 LF



TYPICAL SECTION

N.T.S.

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 15 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.
4. FOR LOCATION OF SIGN ANCHORAGES AND DETAILS, SEE "RETAINING WALL SIGN DETAILS No. 1" SHEET. FOR SIGN INFORMATION, SEE SIGNING AND STRIPING PLANS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA
VICTOR A. SHERBY, P.E.
DATE 10-15-2021

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW15_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

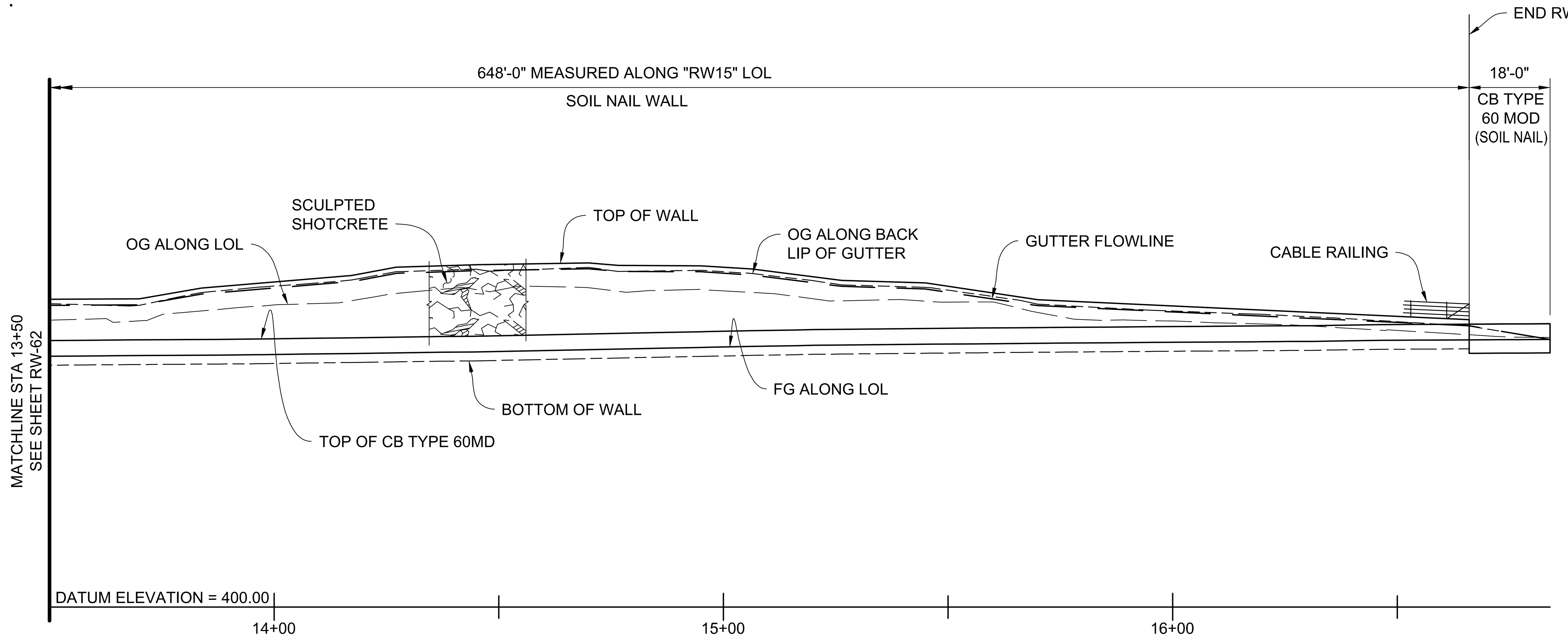
County of Orange
OC Public Works
PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 15 GENERAL PLAN No. 1

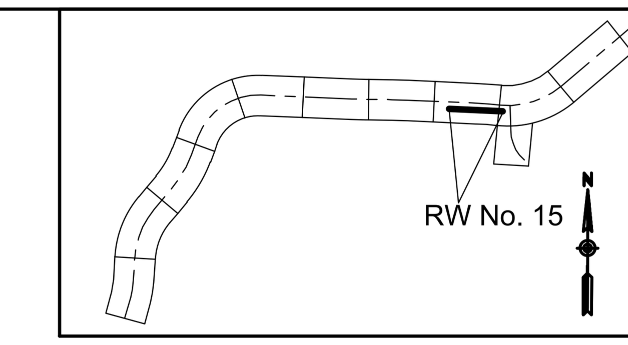
SHEET

RW-62



MIRRORED DEVELOPED ELEVATION

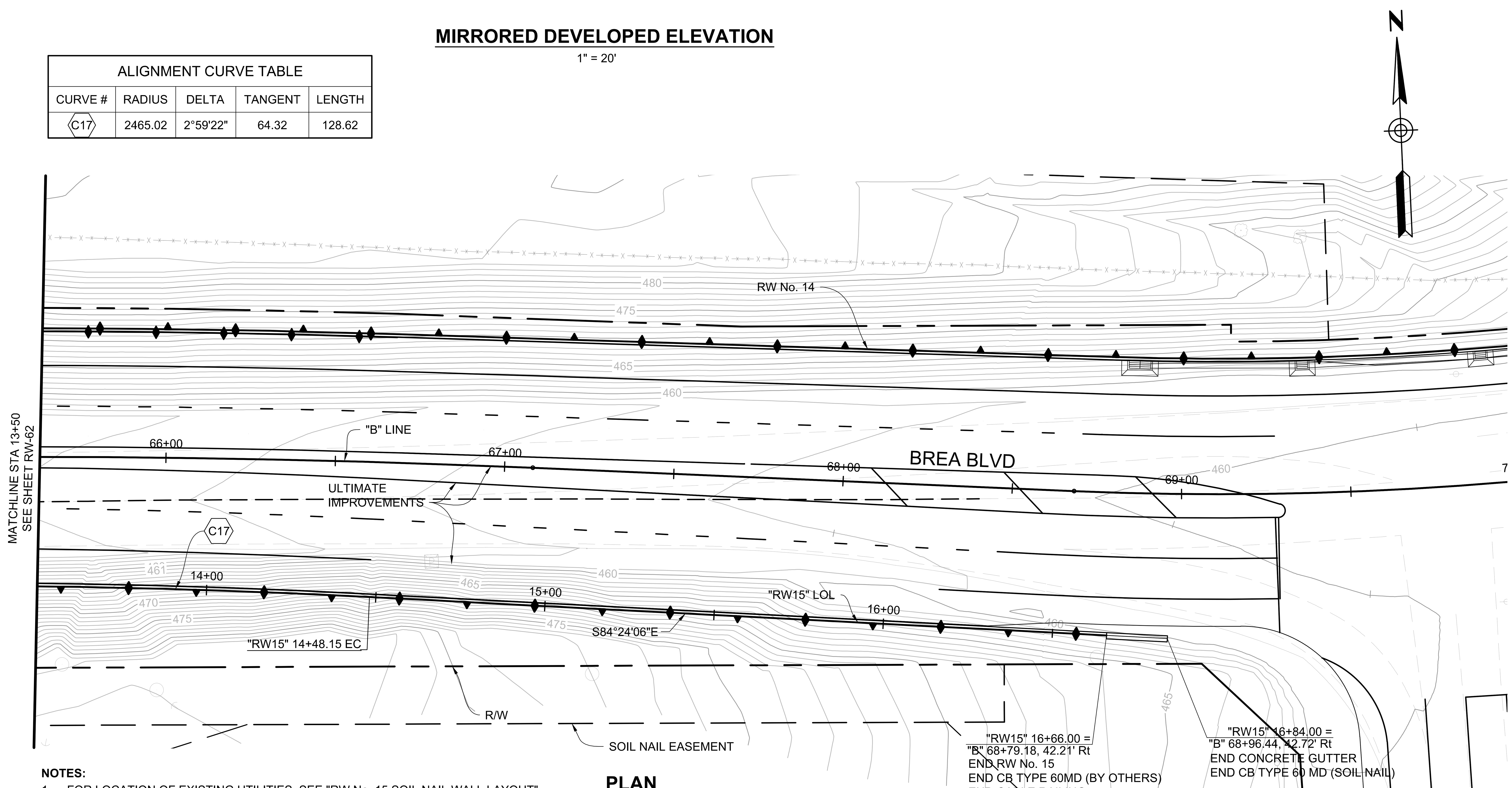
1" = 20'



KEY MAP

1"=2000'

ALIGNMENT CURVE TABLE				
CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C17	2465.02	2°59'22"	64.32	128.62



PLAN

1" = 20'

NOTES:

1. FOR LOCATION OF EXISTING UTILITIES, SEE "RW No. 15 SOIL NAIL WALL LAYOUT" SHEETS.
2. CONTRACTOR TO VERIFY LOCATION OF EXISTING UTILITIES PRIOR TO CONSTRUCTION.
3. FOR DETAILS NOT SHOWN, SEE "SOIL NAIL WALL DETAILS" SHEETS.

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER VICTOR ANSON SHERBY No. 80646 Exp. 3-31-23 CIVIL STATE OF CALIFORNIA

VICTOR A. SHERBY, P.E. 10-15-2021 DATE

DESIGNED BY: V. SHERBY
DRAWN BY: J. DOTY
CHECKED BY: J. HICKEY
DRAWING NO.: ViewTitle
FILE NAME: RW15_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC Public Works

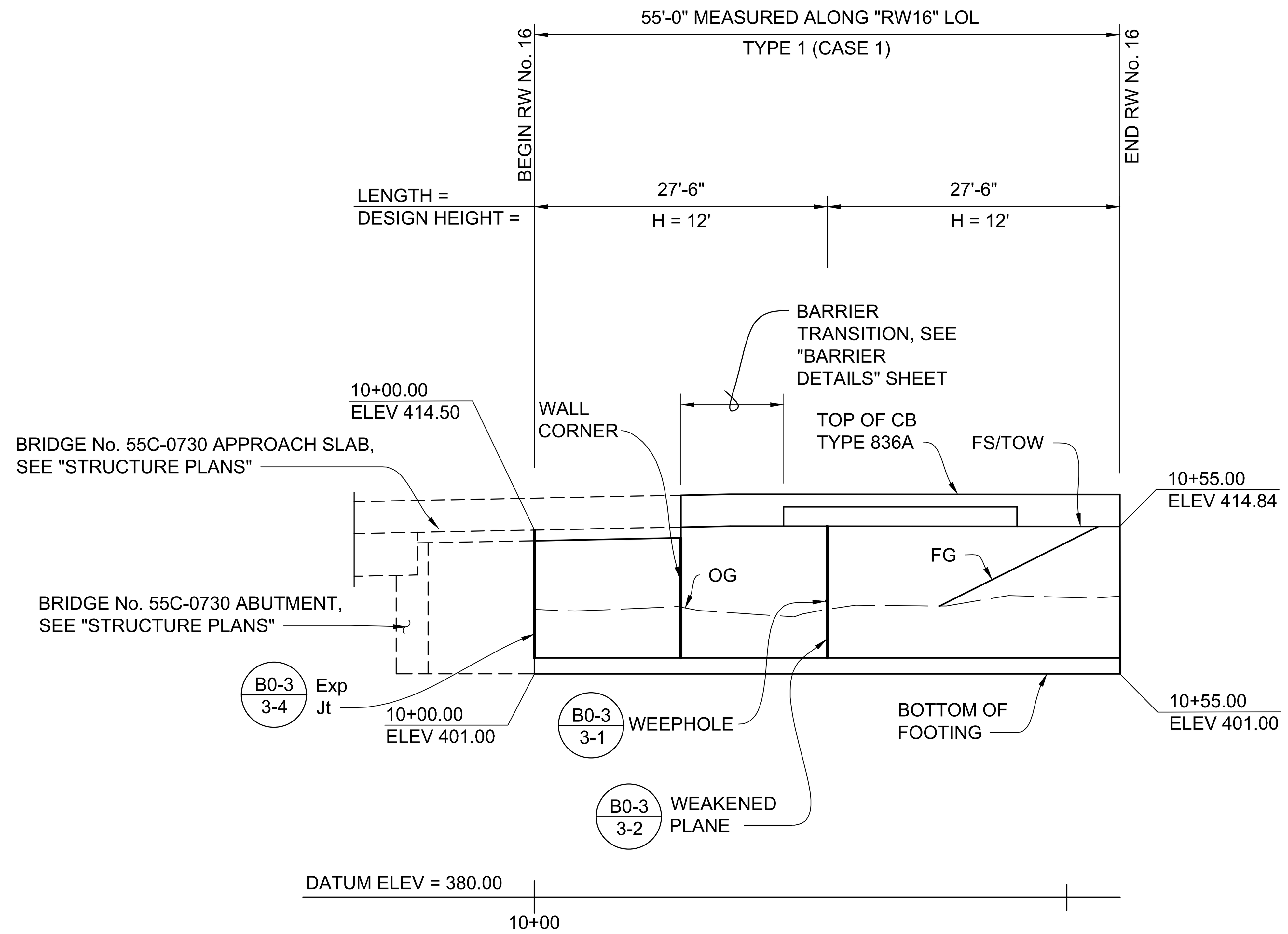
PREPARED BY:
MARK THOMAS

BREA BOULEVARD WIDENING

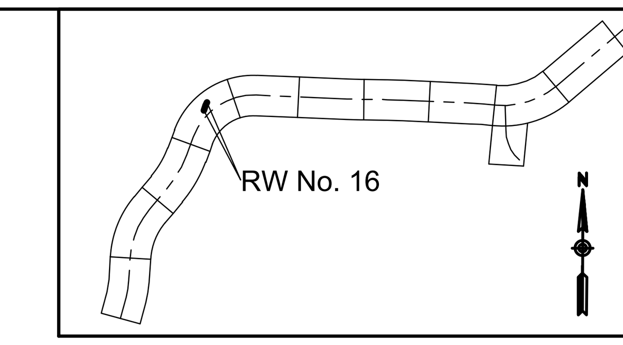
RW No. 15
GENERAL PLAN No. 2

SHEET

RW-63



MIRRORED DEVELOPED ELEVATION
1" = 10'



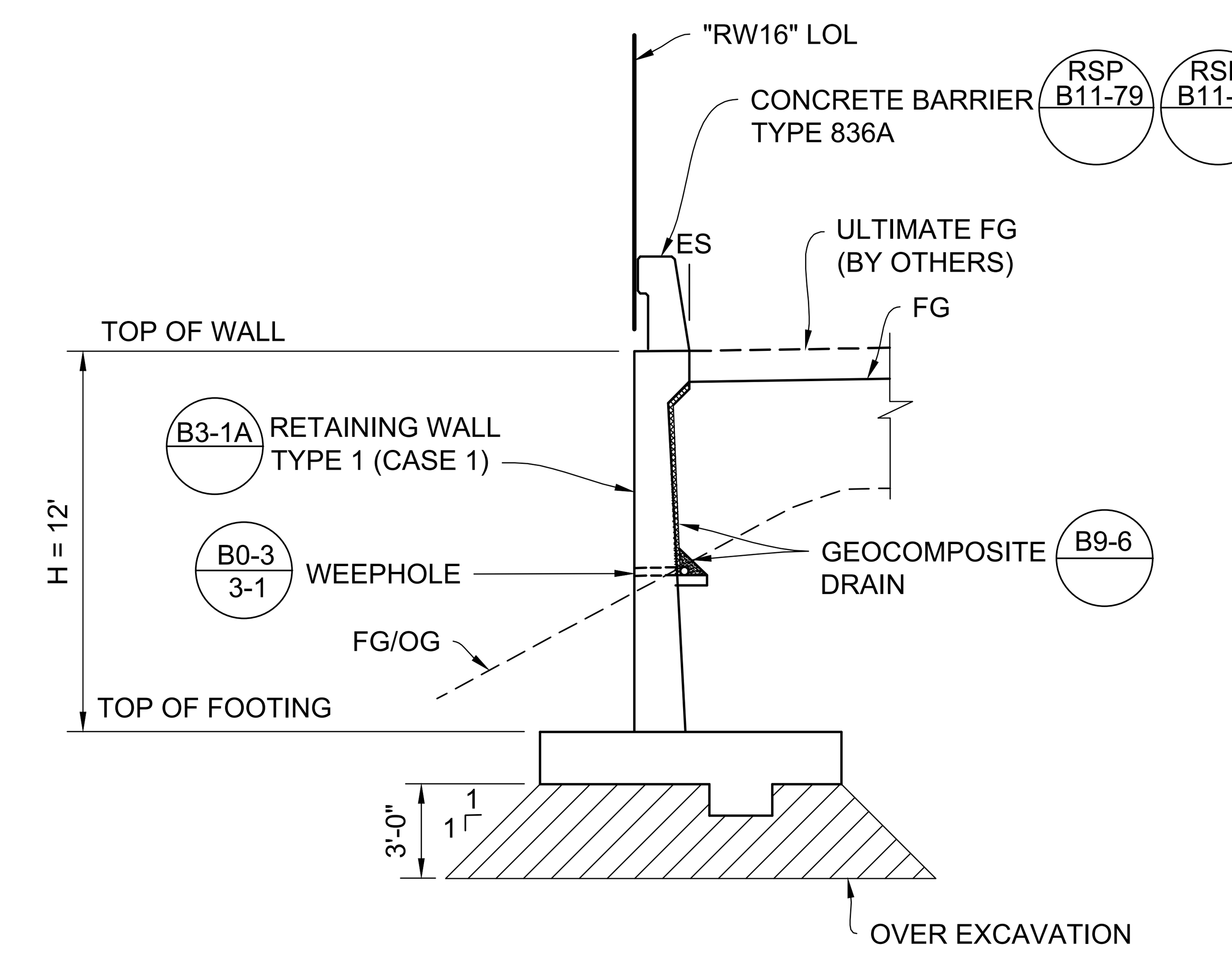
KEY MAP
1"=2000'

QUANTITIES

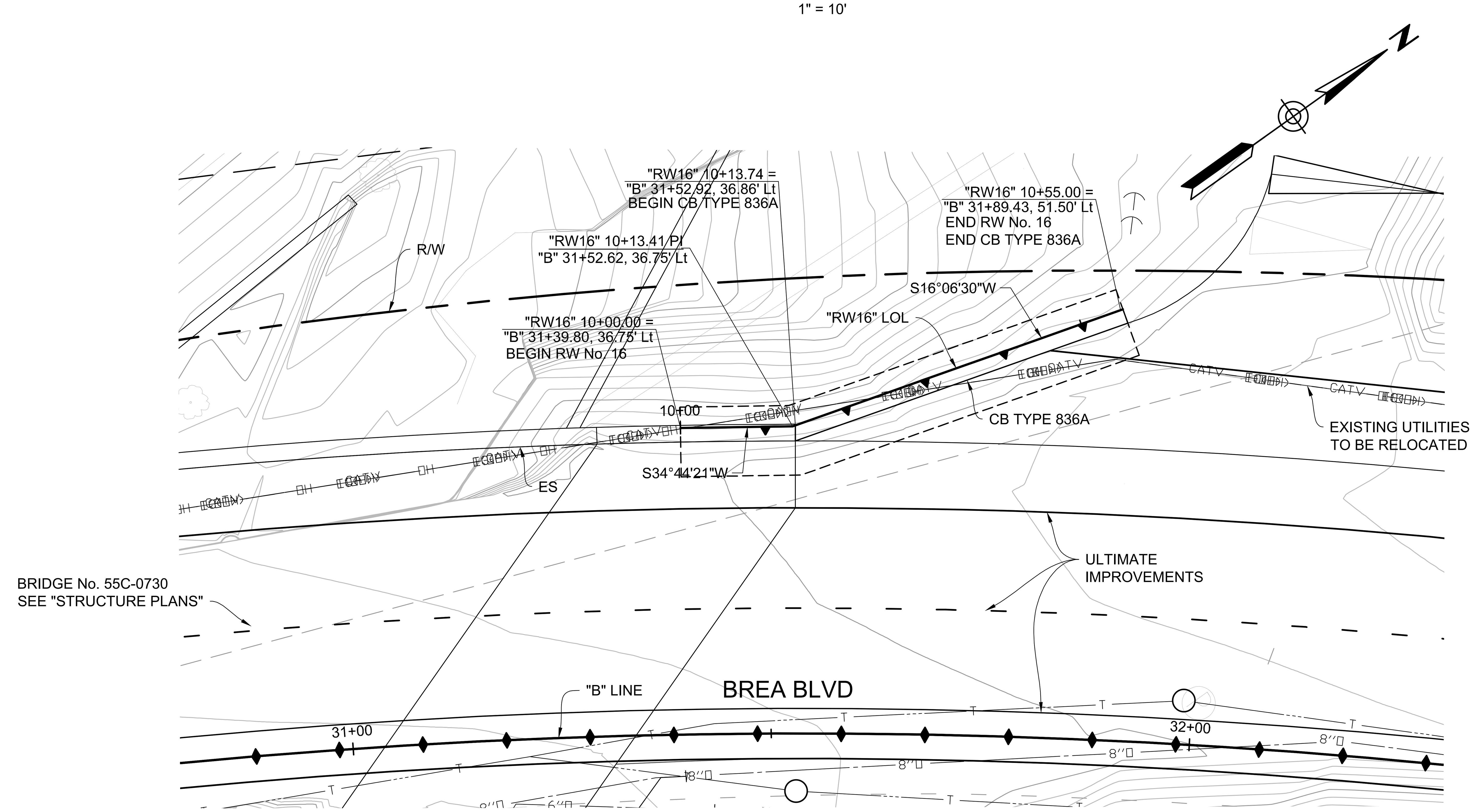
STRUCTURE EXCAVATION (RETAINING WALL)	278	CY
STRUCTURE BACKFILL (RETAINING WALL)	352	CY
STRUCTURAL CONCRETE, RETAINING WALL	59	CY
BAR REINFORCING STEEL (RETAINING WALL)	6,660	LB
CONCRETE BARRIER (TYPE 836A)	41	LF

LEGEND

G	INDICATES EX. NATURAL GAS LINE
6"O	INDICATES EX. 6" OIL LINE
8"O	INDICATES EX. 8" OIL LINE
S	INDICATES EX. SEWER LINE
T	INDICATES EX. TELECOMMUNICATIONS
W	INDICATES EX. WATER LINE



TYPICAL SECTION
1"=5'



PLAN
1" = 10'

NOTES:

1. FOR UTILITY DETAILS, SEE "UTILITY PLANS".
2. FOR FINISHED GRADE DETAILS, SEE "ROADWAY PLANS".

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MARSHALL EUGENE MOORE No. S6557 Exp. 9-30-23 STRUCTURAL STATE OF CALIFORNIA
MARSHALL E MOORE, S.E.
DATE 10-15-2021

DESIGNED BY: M. MOORE
CHECKED BY: T. PHAM
DRAWN BY: J. DOTY
DRAWING NO.: ViewTitle
FILE NAME: RW16_GP.dwg
PLOT DATE: 10/20/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks

PREPARED BY: MARK THOMAS

BREA BOULEVARD WIDENING

RW No. 16
GENERAL PLAN

SHEET
RW-67
157 OF 278

APPENDIX B

Field Exploration

APPENDIX B.1

Test Boring Logs

Hollow Stem Auger Borings

Geotechnical Exploration

GEOTECHNICAL BORING LOG LB-01

Project No.	11588.001	**Date Drilled**	7-20-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
390	0								Surface: 11 inches of asphalt over 4 inches of aggregate base	
				B-1				SC	**QUATERNARY ALLUVIUM (Qa):** @ 1.3': Clayey SAND with Gravel, yellowish brown to dark brown, moist, mostly fine to coarse sand, some fines, little fine gravel, medium plasticity	SA, RV
385	5			R-2	5 8 12	115	14		@ 5': Medium dense	
				R-3	4 5 5				@ 7.5': Loose.	
380	10			R-4	5 8 10			CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 10': Sandy lean CLAYSTONE, hard, brown, moist, mostly fines, some fine sand, medium plasticity, PP>4.5 tsf	
									TOTAL DEPTH OF BORING: 11.5 FEET. GROUNDWATER NOT ENCOUNTERED DURING DRILLING. BACKFILLED WITH SOIL CUTTINGD AND PATCHED WITH COLD ASPHALT AT SURFACE.	
375	15									
370	20									
365	25									
360	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-02

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
390	0			B-1				SP-SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Poorly-graded SAND with Silt and Gravel, light brown, moist, mostly fine to medium sand, little fine to coarse gravel, few fines, nonplastic	
									QUATERNARY OLDER ALLUVIUM (Qoa):	
385	5			R-2	4 6 8				@ 5': Medium dense	
				R-3	3 4 8	91	8	SM	@ 8': Silty SAND with Gravel, medium dense, brown, moist, mostly fine to coarse sand, little fine gravel, little fines, nonplastic	
380	10									
				R-4	5 6 7	106	9	ML	@ 11': Sandy SILT with Gravel, hard, brown, moist, mostly fines, some fine sand, little fine subrounded gravel, trace organics (roots), low plasticity, PP=4.0 tsf, (FILL)	
				R-5	3 4 9			CL	@ 14': Sandy lean CLAY with Gravel, very stiff, brown, moist, mostly fines, some fine to medium sand, little gravel, medium plasticity	AL, UC
375	15									
				R-6	3 5 7	107	21	SM	@ 17': Silty SAND with Gravel, medium dense, brown, wet, mostly fine to coarse sand, little fines, little fine gravel, nonplastic	
370	20			R-7	3 7 22			CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 20': Sandy lean CLAYSTONE, very stiff, brownish gray, very moist, mostly fines, some fine sand, few fine gravel, medium plasticity, oxide staining	UC
365	25			R-8	9 9 9			SAND-STONE	@ 25': No recovery	
				R-9	9 18 41	112	18		@ 27': Poorly-graded SANDSTONE with Silt, very dense, olive gray, wet, mostly fine sand, few fines, nonplastic	
360	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-02

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
360	30			S-10	3 10 26			SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 30': Well-graded SANDSTONE with Gravel, dense, gray, wet, mostly fine to coarse sand, little fine gravel, trace fines, nonplastic	
355	35			R-11	15 50/3"	105	22	SILT-STONE	@ 35': SILTSTONE, decomposed, dark olive gray, (SILT, hard, moist to wet, mostly fines, few fine sand, low plasticity, PP>4.5 tsf)	
350	40			S-12	9 27 46				@ 40': CLAYSTONE, decomposed, dark olive gray, (Lean CLAY with Sand, hard, moist to wet, mostly fines, little fine sand, medium plasticity, petroleum odor, PP>4.5 tsf)	
345	45			S-13	8 21 36				@ 45': Gray, (petroleum staining, PP>4.5 tsf)	
340	50			S-14	11 22 37				@ 50': (PP>4.5 tsf)	
335	55			S-15	12 28 50				@ 55': (PP>4.5 tsf)	
330	60									

SAMPLE TYPES:
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TYPE OF TESTS:
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GEOTECHNICAL BORING LOG LB-02

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
330	60			S-16	47 50			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 60': (PP>4.5 tsf) **TOTAL DEPTH OF BORING: 61 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH GRANULAR BENTONITE.**	
325	65									
320	70									
315	75									
310	80									
305	85									
300	90									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

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GEOTECHNICAL BORING LOG LB-03

Project No.	11588.001	**Date Drilled**	7-18-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
408	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Silty SAND with Gravel, light brown, moist, mostly fine to coarse sand, little fine to coarse gravel, little fines, nonplastic	CR
405									**QUATERNARY OLDER ALLUVIUM (Qoa):**	
	5			R-2	11 14 20			SC	@ 5': Clayey SAND with Gravel, dense, brown, moist, mostly fine to coarse sand, little fine gravel, little fines, medium plasticity	
400				R-3	13 11 12					
	10			R-4	8 10 9		16	CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu):** @ 10': CLAYSTONE with Sand, olive brown, moist, mostly fines, little fine sand, medium plasticity, oxide staining	
395				R-5	8 9 10				@ 12.5': No recovery	
	15			R-7	6 18 31	105	20		@ 15': CLAYSTONE, hard, dark olive gray, moist, mostly fines, trace fine sand, medium plasticity	
390										
	20			R-8	20 50/3"	112	15	SILT-STONE	@ 20': SILTSTONE, decomposed, light gray with brown, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
385										
	25			R-9	14 27 38	110	14		@ 25': (PP>4.5 tsf)	
380										
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
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GEOTECHNICAL BORING LOG LB-03

Project No.	11588.001	**Date Drilled**	7-18-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-10	14 50	108	16	SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @ 30': (PP>4.5 tsf)	
375										
	35			S-11	12 23 31			CLAY-STONE	@ 20': CLAYSTONE, decomposed, light olive gray, (Silty CLAY, hard, moist, mostly fines, few fine sand, low plasticity, tar staining, PP>4.5 tsf)	
370										
	40			S-12	10 22 28				@ 40': (PP>4.5 tsf)	
365										
	45			S-13	14 28 50			SILT-STONE	@ 45': SILTSTONE, decomposed, light olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
360										
	50			S-14	15 33 47				@ 50': (PP>4.5 tsf)	
355										
	55			S-15	15 35 50/5"				@ 55': No tar	
350										
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
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- R RING SAMPLE
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TYPE OF TESTS:
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Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			S-16	12 32 50/1"			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @ 60': (PP>4.5 tsf)	
345										
	65			R-17	20 50/4"			CLAY-STONE	@ 65': CLAYSTONE, decomposed, olive gray with brown, (Silty CLAY with Sand, moist, mostly fines, little fine SAND, petroleum odor and staining, low to medium plasticity)	
340										
	70			R-18	50 REF	105	10		@ 70': (Sandy lean CLAY, hard, dark brownish gray, moist, mostly fines, some fine sand, medium plasticity, strong petroleum odor)	
335									**TOTAL DEPTH OF BORING: 70.5 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING** **BACKFILLED WITH GRANULAR BENTONITE**	
	75									
330										
	80									
325										
	85									
320										
	90									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
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- T TUBE SAMPLE

TYPE OF TESTS:
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- AL ATTERBERG LIMITS
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- SG SPECIFIC GRAVITY
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GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
430	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Silty SAND with Gravel, light brown, moist, mostly fine to coarse sand, some fine gravel (subangular to subrounded), little fines, nonplastic, (FILL)	
									QUATERNARY ALLUVIUM (Qa):	
425	5			R-2	5 6 6	87	7		@ 5': Medium dense	
				R-3	3 3 5		8		@ 8': Loose	
420	10									
				R-4	6 7 6	102	17	CL	**QUATERNARY OLDER ALLUVIUM (Qoa):** @ 11': Sandy lean CLAY with Gravel, very stiff, brown, moist, mostly fines, some fine to medium sand, some fine to coarse gravel, medium plasticity, oxide staining, PP=3.25 tsf	
				R-5	3 5 9				@ 14': Hard, PP=4.0 tsf	UC
415	15									
				R-6	3 7 10	109	18		@ 17': Sandy lean CLAY, very stiff, brown, moist, mostly fines, some fine sand, few fine gravel, medium plasticity, PP=3.0 tsf	
410	20			R-7	7 14 15			SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 20': Silty SANDSTONE, medium dense, reddish brown, moist, mostly fine to coarse, little fines, trace fine gravel , nonplastic	DS
405	25			R-8	7 17 26	109	19		@ 25': Poorly-graded SANDSTONE with Silt, gray with brown, wet, mostly fine to medium sand, few fines, nonplastic	
400	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
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- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
400	30			R-9	5 22 45	118	14	SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 30': Well-graded SANDSTONE with Gravel, very dense, gray, wet, mostly fine to coarse sand, some fine gravel, nonplastic	
395	35			S-10	9 16 23			SILT-STONE	@ 20': SILTSTONE, decomposed, dark olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, PP>4.5 tsf)	
390	40			R-11	21 50/4"				@ 40': (PP>4.5 tsf)	Tx
385	45			S-12	13 32 50				@ 45': SILTSTONE, decomposed, light olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
380	50			R-13	26 50/3"	110	18		@ 50': (PP>4.5 tsf)	
375	55			S-14	14 29 49				@ 55': No tar	
370	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
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TYPE OF TESTS:
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GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
370	60			R-15	33 50/4"			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 60': (PP>4.5 tsf)	Tx
365	65			S-16	13 26 42			CLAY-STONE	@ 65': CLAYSTONE, decomposed, olive gray with brown, (Silty CLAY with Sand, hard, moist, mostly fines, little fine SAND, petroleum odor and staining, low to medium plasticity, PP>4.5 tsf)	
360	70			R-17	34 50/4"				@ 70': (Sandy lean CLAY, hard, dark brownish gray, moist, mostly fines, some fine sand, medium plasticity, strong petroleum odor, PP>4.5 tsf) **TOTAL DEPTH OF BORING: 70.5 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH GRANULAR BENTONITE.**	
355	75									
350	80									
345	85									
340	90									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-05

Project No. 11588.001
Project Brea Boulevard Corridor Improvements
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location

Date Drilled 7-20-18
Logged By BNS
Hole Diameter 8"
Ground Elevation 436'
Sampled By BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
435	0								Surface: 15 inches of asphalt	
				B-1				SC	**QUATERNARY OLDER ALLUVIUM (Qoa):** @ 1.3': Clayey SAND with Gravel, olive gray, moist, mostly fine to coarse sand, some fines, little fine gravel, medium plasticity, petroleum odor and staining	EI
430	5			R-2	8 13 30			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 5': Sandy SILTSTONE, hard, light greenish gray, moist, mostly fines, some fine sand, low plasticity, petroleum odor and staining, PP>4.5 tsf	DS
				R-3	15 20 35	112	14		@ 7.5': PP>4.5 tsf	
425	10			R-4	23 40 50/5"	124	9	SAND-STONE	@ 10': Silty SANDSTONE, very dense, dark gray, moist, mostly fine sand, some fines, nonplastic, strong petroleum odor and staining	
				R-5	12 18 28	111	18	CLAY-STONE	@ 12.5': Lean CLAYSTONE, hard, pale greenish gray, moist, mostly fines, few fine sand, medium plasticity, petroleum odor, PP>4.5 tsf	
420	15			R-6	18 30 40	110	19	SILT-STONE	@ 15': SILTSTONE with Sand, hard, dark gray, moist, mostly fines, little fine sand, low plasticity, strong petroleum odor, PP>4.5 tsf	
415	20			S-7	8 13 19		19		@ 20': PP>4.5 tsf	
410	25			S-8	11 25 27		14		@ 25': PP>4.5 tsf	
	30								**TOTAL DEPTH OF BORING: 26.5 FEET. GROUNDWATER NOT ENCOUNTERED DURING DRILLING. BACKFILLED WITH SOIL CUTTINGS AND PATCHED WITH COLD ASPHALT AT SURFACE.**	

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-06

Project No.	11588.001	**Date Drilled**	7-20-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	440'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
440	0								Surface: 13 inches of asphalt over 4" of aggregate base	
				B-1				SC	**QUATERNARY OLDER ALLUVIUM (Qoa):** @ 1.4': Clayey SAND, brown, moist, mostly fine to medium sand, some fines, few fine gravel, medium plasticity	
435	5			R-2	7 7 12	108	10	CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 5': Sandy lean CLAYSTONE, hard, brown with orangish brown, moist, mostly fines, some fine to coarse sand, medium plasticity, oxide staining, PP>4.5 tsf	
				R-3	10 13 16	122	9		@ 7.5': Few fine gravel, PP>4.5 tsf	
430	10			R-4	13 13 16				@ 10': PP>4.5 tsf	DS
				R-5	10 15 19	111	17		@ 12.5': Dark olive gray with pale gray, PP>4.5 tsf	
425	15			R-6	5 10 13	89	29		@ 15': Olive gray, PP>4.5 tsf	
420	20			S-7	5 5 3		16		@ 20': PP>4.5 tsf	
415	25			R-8	7 8 8			SAND-STONE	@ 25': Poorly-graded SANDSTONE with Gravel, medium dense, gray, wet, mostly medium to coarse sand, little fine gravel, trace fines, nonplastic	
									TOTAL DEPTH OF BORING: 26.5 FEET. **GROUNDWATER MEASURED AT 24 FEET.** **BACKFILLED WITH SOIL CUTTINGS AND PATCHED WITH COLD ASPHALT AT SURFACE.**	
410	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-07

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	441'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
440	0			B-1				SM	**QUATERNARY OLDER ALLUVIUM (Qoa):** Surface: unpaved / scattered gravel @ 0.1': Silty SAND with Gravel, light brown, moist, mostly fine to coarse sand, little fine subangular to subrounded gravel, little fines, nonplastic, (FILL)	CR
435	5			R-2	6 10 17	120	8	SC	@ 5': Clayey SAND, medium dense, reddish brown, moist, mostly fine to coarse sand, some fines, few fine gravel, medium plasticity	
				R-3	2 6 6	98	6	SP	@ 8': Poorly-graded SAND, medium dense, brown, moist, mostly fine to medium sand, trace fines, nonplastic @ 9.2': Pale brown	
430	10			R-4	2 3 4			SW	@ 11': Well-graded SAND with Gravel, loose, brown with gray, moist, mostly fine to coarse sand, little fine gravel, trace fines, nonplastic	
425	15			R-5	3 5 9	95	21	SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 14': Sandy SILTSTONE with Gravel, medium dense, gray, moist, mostly fines, little fine to medium sand, little fine gravel, nonplastic	
				R-6	3 6 8	108	6	SAND-STONE	@ 17': Poorly-graded SANDSTONE, medium dense, gray with brown, moist, mostly fine to medium sand, trace fines, trace fine gravel, nonplastic	
420	20			R-7	3 5 6				@ 20': Silty Clayey SANDSTONE, medium dense, brownish gray, moist, mostly fine to medium sand, little fines, low to medium plasticity	CN
415	25			R-8	2 4 8	104	22		@ 25': Silty SANDSTONE, medium dense, gray with brown, wet, mostly fine to medium sand, little fines, nonplastic	Tx
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-07

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	441'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
410	30			R-9	2 7 10			CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 30': Lean CLAYSTONE, stiff, reddish gray, moist, mostly fines, trace fine to medium sand, medium plasticity, oxide staining, PP=1.75 tsf	
405	35			S-10	1 6 9			INTER-BEDDED SAND-STONE + CLAY-STONE	@ 35': Interbedded SANDSTONE with silt and lean CLAYSTONE; SANDSTONE with Silt, medium dense, gray, wet, fine to coarse, few fines, well-graded; CLAYSTONE, stiff, gray, wet, few fine to coarse sand, medium plasticity, 6-inches thick	
400	40			S-11	5 8 11			SAND-STONE	@ 40': Well-graded SANDSTONE, medium dense, gray with reddish brown, wet, mostly fine to coarse sand, trace fines, nonplastic	
395	45			S-12	12 13 15			CLAY-STONE	@ 45': Lean CLAYSTONE, hard, dark gray, moist, mostly fines, few fine sand, medium plasticity, unoxidized; PP>4.5 tsf	
390	50			S-13					@ 50': PP>4.5 tsf	
385	55								**TOTAL DEPTH OF BORING: 51.5 FEET.** **GROUNDWATER MEASURED AT 25.5 FEET.** **BACKFILLED WITH GRANULAR BENTONITE.**	
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-08

Project No.	11588.001	**Date Drilled**	7-18-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	456'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
455	0			B-1				SC	**QUATERNARY OLDER ALLUVIUM (Qoa):** Surface: unpaved / scattered gravel @ 0.1': Clayey SAND with Gravel, gray with brown, moist, mostly fine to coarse sand, some fine to coarse subangular to subrounded gravel, little fines, low plasticity	
450	5			R-2	17 37 50/3"			CONGLO-MERATE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):** @ 5': Poorly-graded CONGOLMERATE with sand and clay, very dense, light brown to light gray, moist, mostly fine to coarse gravel, little fine to coarse sand, few fines, low plasticity	
				R-3	18 38 50/4"			SAND-STONE	@ 7.5': Silty Clayey SANDSTONE with Gravel, very dense, light gray, moist, mostly fine to coarse sand, some fine to coarse gravel, little fines, low to medium plasticity, highly micaceous @ 9': Very tough drilling / rig chatter	
445	10			R-4	50			CONGLO-MERATE	@ 10': Poorly-graded CONGLOMERATE, very dense, light olive gray, moist, mostly fine to coarse gravel, some fine to coarse sand, trace fines, nonplastic	
				R-5	16 36 50/2"			SILT-STONE	@ 12.5': Sandy lean SILTSTONE, hard, olive gray, moist, mostly fines, some fine to coarse sand, few fine gravel, medium plasticity, PP>4.5 tsf	
440	15			R-6	21 50/2"			SAND-STONE	@ 15': Silty SANDSTONE with Gravel, very dense, light olive gray, moist, mostly fine to coarse sand, little fine gravel, little fines, nonplastic	
435	20			R-7	30 50/3"			CONGLO-MERATE	@ 20': Clayey CONGLOMERATE, very dense, light olive gray, moist, mostly fine to coarse gravel, little fine to coarse sand, little fines, low plasticity	
430	25			R-8	50/3"				@ 25': Poorly-graded CONGLOMERATE with Clay, very dense, light olive gray, moist, mostly fine to coarse gravel, few fines, few fine to coarse sand, low plasticity	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-08

Project No.	11588.001	**Date Drilled**	7-18-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	456'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
425	30			R-9	23 50			SILT-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy), continued:** @ 30': Silty CLAYSTONE with Sand, hard, light olive gray, moist, mostly fines, little fine sand, low to medium plasticity, petroleum staining, PP>4.5 tsf @ 32': Drilling refusal.	
420	35								**TOTAL DEPTH OF BORING: 32 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH GRANULAR BENTONITE.**	
415	40									
410	45									
405	50									
400	55									
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-09

Project No.	11588.001	**Date Drilled**	7-19-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	464'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0			B-1				CL	**QUATERNARY ALLUVIUM (Qa):** Surface: Unpaved / scattered gravel @ 0.1': Sandy lean CLAY, brown, moist, mostly fines, some fine to coarse sand, few fine gravel, medium plasticity, oxide staining	AL, RV
460										
	5			R-2	6 8 12	108	20	SILT-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):** @ 5': SILTSTONE, brown, hard, moist, PP>4.5 tsf	
				R-3	8 12 13				@ 7.5': PP=4.0 tsf	
455										
	10			R-4	4 8 10				@ 10': Very stiff, PP=2.75 tsf	
									TOTAL DEPTH OF BORING: 11.5 FEET. **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH SOIL CUTTINGS.**	
450	15									
445	20									
440	25									
435	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-10

Project No. 11588.001
Project Brea Boulevard Corridor Improvements
Drilling Co. 2R Drilling, Inc.
Drilling Method Hollow Stem Auger - 140lb - Autohammer - 30" Drop
Location

Date Drilled 7-19-18
Logged By BNS
Hole Diameter 8"
Ground Elevation 470'
Sampled By BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
470	0								Surface: 12 inches of asphalt	
				B-1				CL	**QUATERNARY ALLUVIUM (Qa):** @ 1': Sandy lean CLAY, brown, moist, mostly fines, some fine to coarse sand, few fine to coarse gravel, medium plasticity	
465	5			R-2	5 5 8	109	17	SILT-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):** @ 5': SILTSTONE, brown, very stiff, PP=3.5 tsf	
				R-3	4 7 9	111	14		@ 7.5': PP=3.75 tsf	
460	10			R-4	7 13 19	101	21	SAND-STONE	@ 10': PP=3.0 tsf @ 11': Poorly-graded SANDSTONE with silt, medium dense, light brown, moist, mostly fine to medium sand, few fines, nonplastic	
455	15									
450	20									
445	25									
440	30									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

TOTAL DEPTH OF BORING: 11.5 FEET.
GROUNDWATER NOT ENCOUNTERED DURING DRILLING.
BACKFILLED WITH SOIL CUTTINGS.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-11

Project No.	11588.001	**Date Drilled**	7-19-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	491'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
490	0								Surface: 9 inches of asphalt over 27 inches of aggregate base	
				B-1				SC	**QUATERNARY ALLUVIUM (Qa):** @ 3': Clayey SAND with Gravel, brown, moist, mostly fine to coarse sand, some fines, little fine subangular to subrounded gravel, medium plasticity	SA, RV
485	5			R-2	6 7 8	100	17		@ 5': Medium dense	
				R-3	23 17 13			GC	@ 7.5': Clayey GRAVEL with Sand, medium dense, brown, moist, mostly fine to coarse gravel, little fine to coarse sand, little fines, medium plasticity	
480	10			R-4	11 6 9			CLAY-STONE	**MONTEREY FORMATION, SOQUEL SANDSTONE MEMBER (Tmss):** @ 11': Sandy lean CLAYSTONE with Gravel, hard, brown, moist, mostly fines, some fine to coarse sand, little fine gravel, medium plasticity, oxide staining, PP>4.5 tsf	
475	15								**TOTAL DEPTH OF BORING: 11.5 FEET. GROUNDWATER NOT ENCOUNTERED DURING DRILLING. BACKFILLED WITH SOIL CUTTINGS.**	
470	20									
465	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-12

Project No.	11588.001	**Date Drilled**	7-19-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	498'
Location		**Sampled By**	BNS

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								Surface: 15 inches of asphalt	
				B-1				SC	**QUATERNARY ALLUVIUM (Qa):** @ 1.3': Clayey SAND with Gravel, brown, moist, mostly fine to coarse sand, some fine subangular to subrounded gravel, some fines, medium plasticity	AL, RV
495										
	5			R-2	8 6 8	105	17		@ 5': Medium dense	
490				R-3	8 9 11			GC		
	10			R-4	4 6 8			CLAY-STONE	**MONTEREY FORMATION, SOQUEL SANDSTONE MEMBER (Tmss):** @ 11': Sandy lean CLAYSTONE with Gravel, very stiff, brown, moist, mostly fines, some fine to coarse sand, little fine gravel, medium plasticity, PP=3.0 tsf	
485									**TOTAL DEPTH OF BORING: 11.5 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING** **BACKFILLED WITH SOIL CUTTINGS.**	
	15									
480										
	20									
475										
	25									
470										
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-13

Project No.	11588.001	**Date Drilled**	7-19-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	511'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								Surface: 13 inches of asphalt	
510				B-1				SC	**QUATERNARY ALLUVIUM (Qa):** @ 1.1': Clayey SAND with Gravel, brown, moist, mostly fine to coarse sand, some fine to coarse gravel, some fines, medium plasticity	
				R-2	9 25 50			CONGLO-MERATE	**MONTEREY FORMATION, SOQUEL SANDSTONE MEMBER (Tmss)**	
505	5			R-3	23 32 50				@ 2.5': CONGLOMERATE, reddish brown, intensely weathered to decomposed, (Poorly-graded GRAVEL with Sand, very dense, moist, mostly fine to coarse subangular to angular gravel, little fine to coarse sand, trace fines, nonplastic, oxide staining)	
				R-4	27 35 45					
500	10			R-5	15 28 50/5"					
									TOTAL DEPTH OF BORING: 11.42 FEET. **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BOREHOLE BACKFILLED WITH SOIL CUTTINGS.**	
495	15									
490	20									
485	25									
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-14

Project No.	11588.001	**Date Drilled**	1-24-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	421'
Location	+/- ST 35 Brea Blvd.	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
421	0							Surface: 10 inches asphalt over 16.5 inches aggregate base, with 2 inches asphalt below	
			B-1				SP	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):**	MD, DS
								@2.38': SAND, light ochre, loose, dry, trace pebbles	
416	5	0.0	R-1 B-2	11 21 31			SP-SM	**QUATERNARY OLDER ALLUVIUM (Qoa):**	CN CR
							ML	@5'-10': SAND with silt, medium brown, dense, slightly moist, scant round pebbles, horizontal laminations	
							SP-SM	@6': Clayey SILT, dark brown, medium stiff, slightly moist, with alternating layers of bedrock chips	
411	10	0.0	R-2 B-3	3 5 8	95	5	SP-SM	@10': SAND, light red brown, loose, dry to slightly moist, local roots and organic structures, local large root	
							SM	@10'-15': Silty SAND, dark reddish brown, dry to slightly moist, minor round pebbles, noncohesive	
406	15	0.0	R-3 B-4	8 22 50/4"	106	5	SP	@15': SAND, light red brown, dense, dry, fine sand, some silt, locally laminated, local black siliceous shale cobble/pebbles, noncohesive	CR
401	20	0.0	R-4	20 38 50/4"	108	6	SP-GP	@20': Gravelly SAND, light brown, dense, dry, coarse sand, fine rounded gravels, massive	
							SC	@21.5': Clayey SAND, dark blue-grey, hard, moist, coarse sand, with gravels/pebbles, odorous	
		225.1	B-5 LB14-23						
396	25		R-5 B-6 LB14-25	11 11 11	108	18	CL	@25': CLAY, mottled dark olive and medium grey, stiff, root casts, medium plasticity, no odor in sample, but tailings are odorous from 25 to 30 feet	CR
		83.1					SC		
	30								

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-14

Project No.	11588.001	**Date Drilled**	1-24-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	421'
Location	+/- ST 35 Brea Blvd.	**Sampled By**	JLH

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
390	30		0.0	R-6 B-7 LB14-30	6 7 14			SP-GP	**QUATERNARY OLDER ALLUVIUM (Qoa), continued:** 30': Gravelly SAND, blue grey, medium dense, wet, coarse sand, local fine gravels, quartz-rich	DS
								GP	@34': GRAVEL layer	
385	35		0.0	R-7 LB14-35	11 33 50/5"	117	15	SP	@35': SAND with gravel, light blue grey, very dense, wet, coarse sand, fine gravels/pebbles, massive, noncohesive, quartz-rich	
380	40		3.5	R-8	26 23 44	127	8	SP-GP	@40': Gravelly SAND, dark olive, medium dense, wet, coarse sand, local fragments of black shale and green claystone	
									FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):	
375	45		31.8	R-9	25 50/3"			SILT-STONE	@45': SILTSTONE, dark blue-green to grey, medium hard, damp, massive, scattered shell fragments, unoxidized, minor organic stained fractures	
370	50		0.0	R-10	37 50/3"				@50': Minor horizontal planar partings	Tx
365	55								**TOTAL DEPTH: 51.5 FEET** **GROUNWATER ENCOUNTERED AT 26 FEET 8 INCHES DURING DRILLING** **SOIL CUTTINGS DRUMMED** **BORING BACKFILLED USING 2 BAGS PORTLAND CEMENT AND ONE BAG GROUT-WELL BENTONITE**	
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
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- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-15

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	474'
Location	ST 47 + 50	**Sampled By**	JLH

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** @0': Silty SAND, medium brown, dense, dry, scant 3/4" gravels	
									@1': 2 inches of asphalt	
								SP-GP	**QUATERNARY OLDER ALLUVIUM (Qoa):** @1.17': Gravelly SAND, light tan, loose, dry, fine sand	
									@3': Yellowish hue	
470										
	5			S-1	12 17 25			SP	@6': SAND, alternating ochre yellow and medium olive laminations, very dense, dry, medium sand, noncohesive, friable	
465										
	10			R-1	37 50/6"				@10': SAND, ochre yellow, dense, dry, medium sand, few rounded gravels and cobbles, noncohesive	
460										
	15			S-2	15 26 28			SM	@15': Silty SAND, medium yellow to olive, very dense, dry, fine sand, few caliche blebs, few bedrock chips	
455										
	20			R-2	26 50/5"			SP	@20': SAND, light to medium yellow, dense, dry, massive to finely laminated, moderate caliche blebs, local well-rounded gravels, Fe-stained bedrock clasts	
450										
	25			S-3	4 8 26				@25': SAND, dark grey, dense, moist, medium sand, unoxidized, massive, with caliche stringers	
445										
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-15

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	474'
Location	ST 47 + 50	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-3	21 50/6"	98	18	SP-GP	@30': Gravelly SAND, blue grey, with well rounded gravels that have heavy Fe rinds, locally unoxidized medium yellow brown	
								GP	@32': Gravelly layer	
440								SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @33': SANDSTONE/SHALE, medium blue grey, very moist to wet, local dark MUDSTONE and light blue SANDSTONE	
	35			S-4	39 50/4"			SILT-STONE	@35': Clayey SILTSTONE to SANDSTONE, light blue to greenish grey, medium hard, slightly damp, medium to coarse sand, minor pebbles, minor black MUDSTONE, unoxidized	
435										
	40			R-4	17 50/5"			SAND-STONE	@40': Clayey SANDSTONE, dark blue grey, soft, very moist to wet, chunks of white CaCO3, locally clayey, disorganized structure, H2S odor due to groundwater	
									TOTAL DEPTH: 40 FEET 11 INCHES **SEEPAGE AT 40 FEET 10 INCHES** **BORING BACKFILLED WITH SOIL CUTTINGS**	
430	45									
425	50									
420	55									
415	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-16

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	456'
Location	ST 53 + 50	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0	0.0	B-1 ENV1					**ARTIFICIAL FILL, UNDOCUMENTED (Afu):**	CR
455							CL	**QUATERNARY OLDER ALLUVIUM (Qoa):**	
		0.0	ENV2					@2': Silty CLAY, dark brown, firm, moist	
							SC-CL	@4': Sandy CLAY to clayey SAND, light brown, firm, moist	
	5		ENV3				CL	@4.5': Sandy CLAY, light brown, firm, slightly moist, mostly shale fragments	
450		0.0	R-1 ENV4	4 9 10			CLAY-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):**	DS
								@5': Sandy CLAYSTONE, light brown, soft, slightly moist, highly weathered, closely spaced caliche stringers	
							SAND-STONE	@8': Clayey SANDSTONE, light brown, soft, slightly moist, with caliche and organics	
445	10		S-1	5 10 16			SILT-STONE	@10': Clayey SILTSTONE, light olive brown, medium hard, dry, massive to indistinctly bedded, closely spaced Fe-stained fractures	
440	15		R-2	7 9 33				@15': Clayey SILTSTONE, light grey, medium hard, damp to dry, massive, highly weathered and fractured, Fe-stained	DS
435	20		S-2	6 14 20				@20': Increased hardness, local rootlets along fracture surfaces, deeper richness of Fe-staining along fractures	
430	25		R-3 ENV5	17 48 50/5"			CLAY-STONE	@25': CLAYSTONE, light bluish grey, damp, massive, local micro calcite filled burrows, unoxidized	Tx
	30								

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-16

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	456'
Location	ST 53 + 50	**Sampled By**	JLH

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
425	30			S-3				SILT-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy), continued:** @30': Clayey SILTSTONE, olive grey, hard, dry to slightly damp, massive	
									TOTAL DEPTH: 31.5 FEET **NO GROUNDWATER ENCOUNTERED DURING DRILLING** **BORING BACKFILLED WITH SOIL CUTTINGS**	
420	35									
415	40									
410	45									
405	50									
400	55									
	60									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-17

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	540'
Location	Niedo & Sons Trucking Yard	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
540	0		200	B-1				SC	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** @0': Clayey SAND, alternating lifts of grey and dark grey brown, slightly moist, loose to medium dense, scattered gravel-sized rounded bedrock clasts (sandstone and claystone), scant asphalt clasts, petroliferous odor	
535	5			R-1 ENV1	5 9 12					
			80					CL	@8': Silty CLAY, soft, moist, plastic, petroliferous odor	
530	10			S-1	4 8 9				@10': CLAY with sand, light to dark grey, soft, moist, massive, local asphalt lense, scant 3/4-inch gravel	
525	15			R-2 ENV2	10 11 10	109	16		@16': Large shale concretion cobble	
520	20		5.5	S-2	2 6 9				@20': CLAY with silt and sand, light grey to dark brown, soft, slightly moist, scant siltstone and claystone fragments	
515	25		16.2	R-3 ENV3	9 41 50/1"	113	10	SPg	@25': Pebbly SAND with clay, medium grey brown, very dense, slightly moist, local brown sand, sandstone clast in tip	
510	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-17

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	540'
Location	Niedo & Sons Trucking Yard	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
510	30		31	S-3	2 4 7			CL	@30': CLAY, light reddish brown to blue grey, soft, moist, plastic, massive	
									@32': CLAY with silt, light tan to cream, soft, moist to very moist, plastic, indistinct laminae with caliche	
505	35			R-4	9 11 19	110	17		@35': CLAY with sand, blue grey to brown, soft, moist, local pebbles, scant 3-inch cobbes (blue sandstone) in brown matrix	
500	40			S-4	3 5 9				@40': Cream-colored FILL with rock fragments, dark grey to blue grey, sandy, plastic	
495	45			R-5	16 31 42	91	31		@45': CLAY with sand, medium stiff, moist, ??caliche?? along laminae, igneous pebbles	
									CLAY with sand, stiff, slightly moist, variable Fe-stained orange SAND, scant light grey SHALE fragments, minor unoxidized SHALE clasts, pebble clasts	
			17.1					CL	**QUATERNARY OLDER ALLUVIUM (Qoa):**	
490	50			S-5	5 10 13				@49': Silty sandy CLAY, dark red brown, stiff, moist, massive to indistinctly laminated, minor caliche stringers	
485	55		0.0	R-6 ENV4	20 40 50/4"				@55': CLAY with sand, dark red brown, very stiff to hard, slightly moist, massive, local black oxide stringers, pin-sized caliche, local root casts	
480	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-17

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	540'
Location	Niedo & Sons Trucking Yard	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
480	60			S-6	6 9 10			SP	@60': SAND, light reddish brown, dense, slightly moist, massive, poorly graded, friable, cohesionless	
475	65			R-7	50/5"				@65': SAND, medium red brown, medium dense, slightly moist, medium SAND, white SANDSTONE cobble in shoe, massive, cohesionless	
470	70			S-7	15 41 42				@70': Clayey SAND, light reddish brown to brown, very dense, plastic, Fe-stained, local rounded pebbles, low plasticity	
									TOTAL DEPTH: 71.5 FEET **NO GROUNDWATER ENCOUNTERED DURING DRILLING** **BORING BACKFILLED WITH SOIL CUTTINGS**	
465	75									
460	80									
455	85									
450	90									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-18

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	487'
Location	ST 66	**Sampled By**	JLH

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0		B-1 ENV1					**QUATERNARY OLDER ALLUVIUM (Qoa):**	
485		5.2						@0': SAND, medium brown, loose, slightly moist, noncohesive	
			ENV2						
		0.0							
								@4': SAND, light brown, loose, slightly moist, noncohesive	
	5	0.0	ENV3 R-1 ENV4	20 50/4"			SP		
480								@6.5': SAND, light reddish brown, dense, dry, medium sand, indistinct horizontal laminae, local pin-size caliche, local moderate porosity (+/- 3mm diameter), scant bedrock chips	
	10		S-1	9 16 18			SP-SC	@10': SAND with clay, light red brown, hard, dry, medum sand, black oxidation stringers, minor caliche dots, minor bedrock chips	
475									
	15		R-2 B-2	24 43 50/4"			SP	@15': SAND, light red brown to brown, very dense, dry, medium sand, poorly graded, massive	DS CR
470								@17': SAND, yellow, medium dense, dry, fine sand, uniform	
	20		S-2	12 14 25				@20': SAND, alternating light red brown to light tan, medium dense, dry, fine to medium sand, trace pebbles, poorly graded	
465							SC	@23': Clayey SAND, light olive, very dense, slightly moist	
	25		R-3	6 27 50/5"			SP	@25': SAND, light yellow brown, dense, dry to slightly moist, fine sand, Fe-oxide XXX and staining, noncohesive, grey to light brown laminations, local woody fragments	DS
460									
	30								

Graphic Log: N S

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-18

Project No.	11588.001	**Date Drilled**	1-23-19
Project	Brea Boulevard Corridor Improvements	**Logged By**	JLH
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	487'
Location	ST 66	**Sampled By**	JLH

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			S-3	50/5"				**QUATERNARY OLDER ALLUVIUM (Qoa), continued:** @30': Clayey SAND, light to medium grey, unoxidized	
455								COBBLES SP	@31': COBBLES with clayey SAND matrix	
									@34': Concretionary SHALE, light grey, Monterey Formation - Yorba Member (Tmy)	
	35			R-4	50/3"	107	7	INTER-BEDDED CL + SPg	@35': Interbedded CLAY and gravelly SAND; CLAY, light grey, slightly moist, hard, unoxidized; Gravelly SAND, brown, Fe-stained, slightly moist, dense to very dense	
450										
	40			S-4	7 24 32				@40': Gravelly SAND, dark blue grey, very dense, very coarse sand, mafic-rich, rounded clasts of black silicified shale, massive, unoxidized	
445										
								CLAY-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):** @43': Sandy CLAYSTONE, medium grey, moist to very moist, plastic	
	45			R-5	50/6"	112	9		@45': CLAYSTONE - concretionary, light to dark grey, soft, very moist to moist, weathered, scattered caliche, massive to thinly bedded, unoxidized	
440									**TOTAL DEPTH: 46.5 FEET** **NO GROUNDWATER ENCOUNTERED DURING DRILLING** **BORING BACKFILLED WITH SOIL CUTTINGS**	
	50									
435										
	55									
430										
	60									

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SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-19

Project No.	11585.005	**Date Drilled**	10-8-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	Martini Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	398'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, brown to light reddish brown, moist, fine sand, low plasticity silt	
395										
	5			R-1	8 12 21	111	6	SP-SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': Poorly graded SAND with SILT, medium dense, light brown to mottled whiteish brown, moist, fine to medium sand, non plastic silt	
390				R-2	8 10 17			SM	@7.5': SILTY SAND, medium dense, brown to reddish brown, moist, fine sand, non plastic silt	
	10			B-1 R-3	4 7 9	93	17			
385				T-4						
	15			R-5	15 22 18			SP-SM	@15.0': Poorly graded SAND with SILT, dense, brown to light brown, moist, fine to medium sand, non plastic silt	
380										
	20			R-6	16 25 42	118	17	SM	@20.0': SILTY SAND, very dense, brown to mottled orangeish brown, moist, fine sand, low plasticity silt, manganese oxide staining	
375										
	25			B-2 S-7	2 3 6			SC	@25.0': CLAYEY SAND, medium dense, brown to light reddish brown, moist, fine sand, low plasticity clay	CR SA AL
370				T-8						
	30			R-9	22 50/2"			ML	@30.0': SANDY SILT, hard, brown, moist, low plasticity silt, fine sand	
365										
	35									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-19

Project No.	11585.005	**Date Drilled**	10-8-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	Martini Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	398'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	35			S-10	12 37 50/3"				<u>FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)</u> @35': SILTY SANDSTONE, very thickly bedded, fine grained, blueish gray, slightly weathered, hard, wet, (SILTY SAND (SM), very dense)	
360										
	40			R-11	22 50/4"				@40': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, fresh, hard, (SANDY SILT (ML), hard, low plasticity)	
355				T-12A T-12B	21 50/4"				PP > 4.5 tsf	
	45			S-13	8 50/6"					
350										
	50			R-14	15 50/4"				@50': SILTY SANDSTONE, very thickly bedded, fine grained, blueish gray to mottled brownish gray, slightly weathered, hard, hydrocarbon staining, (SILTY SAND (SM), very dense)	
345										
	55									
340										
	60			R-15	18 28 38	108	20		@60': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray to mottled blackish gray, slightly weathered, hard, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
335										
	65									
330										
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-19

Project No.	11585.005	**Date Drilled**	10-8-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	Martini Drilling	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	398'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	70			R-16	50/5"	112	20		@70': SANDY SILTSTONE, very fine grained, blueish gray to greenish gray, slightly weathered, hard, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
325									**Boring terminated at 70.5 ft.** **Groundwater encountered at 36.5 feet during drilling.**.	
	75								Backfill Details 70.5'- 30': cement bentonite grout 30'- 0': auger cuttings	
320										
	80									
315										
	85									
310										
	90									
305										
	95									
300										
	100									
295										
	105									

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SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-20

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown, moist, fine sand, low plasticity silt, fine subangular gravel	
410										
	5			R-1	20 25 29	93	4		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, dense, light brown to light yellowish brown, moist, fine sand, low plasticity silt	
				R-2	12 20 27					
405										
	10			R-3	7 9 11	104	8		@10.0': SILTY SAND, medium dense, light yellowish brown, moist, fine sand, non plastic silt	
400										
	15			R-4	7 9 10	99	7	ML	@15.0': SANDY SILT, medium dense, oliveish white, moist, non plastic silt, fine sand, carbonate nodule, manganese oxide staining	DS
395										
	20			B-2 R-5	8 14 14	108	6	SM	@20.0': SILTY SAND, medium dense, light brown, moist, fine to medium sand, low plasticity silt, trace fine subangular gravel, manganese oxide staining	
390										
	25			S-6	6 9 11			SP-SM	@25.0': Poorly graded SAND with SILT, medium dense, light reddish brown, moist, fine sand, non plastic silt	
385										
	30			R-7	16 44 50/3"	109	17		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SANDY SILTSTONE, massive, fine grained, light oliveish gray to mottled orangeish gray, moderately weathered, hard, manganese oxide staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380										
	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-20

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			S-8	13 34 50/5"					
375	40			R-9	21 50/3"	109	19		PP > 4.5 tsf	
370	45			S-10	12 30 50/1"				@45': SANDY SILTSTONE, very thickly bedded, fine grained, brownish olive, slightly weathered to moderately weathered, hard, (SANDY SILT (ML), hard, low plasticity)	
365	50			R-11	17 50/3"	108	19		@50': SANDY SILTSTONE, fine grained, oliveish gray, slightly weathered, hard, manganese oxide staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
360	55								**Boring terminated at 51 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings**.	
355	60									
350	65									
345	70									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
400	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown, moist, fine sand, low plasticity silt, fine subrounded gravel	
395	5			R-1	25 47 50/5"	111	17		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @5': SILTY SANDSTONE, very thickly bedded, fine grained, mottled orangeish olive to grayish olive, moderately weathered to intensely weathered, medium hard, moist, manganese oxide staining, moderate cementation, (SILTY SAND (SM), very dense)	
				R-2	28 50/4"					
390	10			R-3	24 40 50/5"	103	21		@10': CLAYSTONE, very thickly bedded, very fine grained, mottled orangeish olive to grayish olive, moderately weathered, hard, moist, manganese oxide staining, (Lean CLAY (CL), hard, low plasticity)	SA AL
				T-4A T-4B	23 42 50				PP > 4.5 tsf PP > 4.5 tsf	
385	15									
				R-5	42 50/3"	109	18		@18.5': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray, slightly weathered to moderately weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380	20									
				S-6	18 29 44				@23.5': SILTSTONE, very thickly bedded, very fine grained, oliveish gray, fresh to slightly weathered, hard, moist, (SILT (ML), hard, low plasticity)	SA AL
375	25									
				T-7	46 50/2"				PP > 4.5 tsf	
370	30			R-8	41 50/3"	111	17		@30': SANDY SILTSTONE, massive, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	CU
				S-9	50/5"					
365	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
365	35									
360	40			T-10	41 50/2"				PP > 4.5 tsf	
355	45									
				S-11	23 39 50/5"					
350	50			R-12	37 50/3"	109	19		@50': SANDY SILTSTONE, massive, very fine grained, dark oliveish gray to oliveish gray, fresh, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	UU
345	55			S-13	25 44 50/4"					
340	60			R-14	31 50/4"	107	21		PP > 4.5 tsf	
335	65			S-15	26 46 50/5"					
330	70									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
330	70			R-16	50/4"				@70': SANDY SILTSTONE, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
325	75			S-17	21 37 50/5"					
320	80			R-18	50/4"	109	19		PP > 4.5 tsf	
									Boring terminated at 80.5 ft. **Groundwater not encountered.** **Backfilled with auger cuttings.**	
315	85									
310	90									
305	95									
300	100									
295	105									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-23

Project No.	11585.005	**Date Drilled**	9-17-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
414	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown, moist, fine sand, low plasticity silt, fine subangular gravel	
409	5			R-1	10 15 17	102	7		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, medium dense, mottled whiteish brown to light brown, moist, fine sand, low plasticity silt, carbonate nodule, moderate cementation, manganese oxide staining	
	7.5			R-2	17 35 40				@7.5': SILTY SAND, very dense, mottled whiteish brown, moist, fine sand, low plasticity silt, carbonate nodule, strong cementation	
404	10			R-3	10 24 34	119	9		@10.0': SILTY SAND, dense, dark grayish brown, moist, fine sand, low plasticity silt, moderate cementation	
399	15			R-4	8 11 15			ML	@15.0': SANDY SILT, very stiff, blackish gray, moist, low plasticity silt, fine sand PP = 3.5 tsf	
394	20			R-5	23 50/6"	94	17	SM	@20.0': SILTY SAND, very dense, brownish black, moist, fine sand, low plasticity silt, strong cementation	
389	25			S-6	1 4 7				@25.0': SILTY SAND, medium dense, blackish blue to blackish gray, moist, fine to medium sand, low plasticity silt, hydrocarbon odor, hydrocarbon staining	
384	30			R-7	25 50/4"	116	16		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SANDY SILTSTONE, massive, very fine grained, blueish gray, fresh to slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
379	35									

Elevation scale marks: 410, 405, 400, 395, 390, 385, 380.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-23

Project No.	11585.005	**Date Drilled**	9-17-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	35			S-8	8 18 22					
375	40			R-9	35 50/5"	114	13			
370	45			S-10	14 35 50					
365	50			R-11	50/6"	116	11			
360	55			S-12	30 50/6"					
355	60			R-13	50/4"				**Boring terminated at 60.5 ft. Groundwater not encountered..**	
350	65									
345	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-24

Project No.	11585.005	**Date Drilled**	9-17-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	448'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SC	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': CLAYEY SAND, dark brown to grayish brown, moist, fine sand, low plasticity clay	
445										
	5			R-1	11 29 33	119	9	ML	**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SANDY SILT, stiff to very stiff, blackish black to oliveish brown, moist, low plasticity silt, fine sand, organic odor, hydrocarbon staining PP = 2.5 tsf	
440				R-2	35 50/4"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @7.5': SANDY SILTSTONE, massive, very fine grained, brownish olive to grayish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
	10			R-3	35 50/4"	117	12		PP > 4.5 tsf	
435										
	15			R-4	30 50/4"	115	12			DS
430										
	20			R-5	25 50/3"	118	9			
425										
	25			S-6	20 33 50					
420										
	30			R-7	50/6"	117	13			DS
415										
	35									

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SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-24

Project No.	11585.005	**Date Drilled**	9-17-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	448'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			S-8	40 50/5"					
410										
	40			R-9	35 50/6"	117	13			
405										
	45			S-10	30 26 26				@45': SILTY SANDSTONE, very thickly bedded, fine grained, oliveish gray to blueish gray, fresh to slightly weathered, hard, moist, (SILTY SAND (SM), very dense)	
400										
	50			R-11	50/6"	113	14			
									Boring terminated at 50.5 ft. Groundwater not encountered. Backfilled with auger cuttings.	
395										
	55									
390										
	60									
385										
	65									
380										
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
420	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark brown, moist, fine sand, non plastic silt	
415	5			R-1	14 35 50	124	8		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, very dense, mottled reddish olive, moist, fine sand, low plasticity silt, strong cementation, iron oxide staining	
				R-2	13 30 27				@7.5': SILTY SAND, very dense, oliveish brown, moist, fine sand, non plastic silt, manganese oxide staining	
410	10			R-3	9 21 17	108	10		@10.0': SILTY SAND, dense, reddish brown to orangeish brown, moist, fine to medium sand, low plasticity silt, manganese oxide staining	
				T-4A T-4B	15 20 17	 89	 12	CH	@12.5': Fat CLAY, hard, blackish olive, moist, medium plasticity clay, hydrocarbon odor, hydrocarbon staining PP > 4.5 tsf	
405	15			T-5A T-5B	8 13 30	100 94	12 12	SW-SM CH	@16.0': Well-graded SAND with SILT, dense, blackish olive, moist, fine to medium sand, non plastic silt, hydrocarbon odor, hydrocarbon staining @16.5': Fat CLAY, very stiff to hard, blackish olive, moist, medium plasticity clay, hydrocarbon odor, hydrocarbon staining	DS SA AL
				R-6	15 17 23				@18.5': very stiff PP = 3.5 tsf	
400	20			T-7A T-7B	9 22 40			ML	@21.0': SILT, hard, oliveish gray, moist, low plasticity silt	
395	25			S-8	6 10 11				@23.5': SILT with SAND, very stiff, oliveish gray, moist, low plasticity silt, fine sand	
390	30			R-9	20 50/5"	120	8		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @28.5': SILTY SANDSTONE, very thickly bedded, fine grained, oliveish gray, slightly weathered to moderately weathered, hard, moist, (SILTY SAND (SM), very dense)	
	35			S-10	11 15				@33.5': SANDY SILTSTONE, very thickly bedded, very fine grained, dark oliveish gray, slightly weathered, hard, moist,	

SAMPLE TYPES:

B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

TYPE OF TESTS:

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35	N S			18				(SILT with SAND (ML), hard, low plasticity)	
385										
				T-11A T-11B	17 50/6"				@38.5': SILTY SANDSTONE, very thickly bedded, fine grained, dark brownish gray, slightly weathered, hard, moist, (SILTY SAND (SM), very dense)	
	40									
380										
				R-12	26 50/5"	112	11		@43.5': SANDY SILTSTONE, massive, fine grained, dark oliveish gray to brownish gray, fresh to slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
	45									
375										
				S-13	17 31 43					
	50									
370										
				S-14	12 13 27					
	55									
365										
				R-15	50/6"	113	12		@58.5': strong hydrocarbon odor and oil staining	
	60									
360										
				S-16	18 28 40					
	65									
355										
				R-17	50/6"	113	13			
	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	70									
350										
				S-18	27 50/6"					
	75									
345										
				R-19	50/6"					
	80								**Boring terminated at 80 ft.** **Groundwater not encountered.** **Backfilled with cement bentonite grout.**	
340										
	85									
335										
	90									
330										
	95									
325										
	100									
320										
	105									

SAMPLE TYPES:
B BULK SAMPLE
C CORE SAMPLE
G GRAB SAMPLE
R RING SAMPLE
S SPLIT SPOON SAMPLE
T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-26

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	423'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark brown, moist, fine sand, non plastic silt	
420										
	5			R-1	14 13 11				**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, medium dense, dark grayish brown, moist, fine sand, low plasticity silt, weak cementation	
415										
				R-2	9 12 17			ML	@8.5': SANDY SILT, very stiff, blueish brown to gray, moist, low plasticity silt, fine sand	
	10			B-2						CR
410										
				R-3	7 9 12			CL	@13.5': Lean CLAY with SAND, very stiff, blueish gray to gray, moist, medium plasticity clay, fine sand	
	15									
405										
				R-4	11 16 17	103	21		@18.5': SANDY lean CLAY, very stiff, brownish gray to gray, moist, low plasticity clay, fine sand, hydrocarbon odor, hydrocarbon staining	UC
	20			B-3						
400										
				S-5	13 15 12					
	25									
395										
				R-6	14 23 35			SM	@28.5': SILTY SAND, dense, blackish gray to dark oliveish gray, moist, fine to medium sand, low plasticity silt, trace fine subangular gravel, hydrocarbon odor, hydrocarbon staining	
	30									
390										
				S-7	8 9				@33.5': SILTY SAND, medium dense, blackish gray to dark oliveish gray, moist, fine to medium sand, low plasticity silt,	
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-26

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	423'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35				10				hydrocarbon odor, hydrocarbon staining	
385				R-8	20 30 45				@38.5': SILTY SAND, very dense, blackish gray to dark oliveish gray, moist, fine to medium sand, low plasticity silt, hydrocarbon odor, hydrocarbon staining	
	40								**Boring terminated at 40 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings.**	
380										
	45									
375										
	50									
370										
	55									
365										
	60									
360										
	65									
355										
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-27

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	426'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
425	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, light brown, moist, fine sand, non plastic silt, fine subrounded gravel	
									QUATERNARY OLDER ALLUVIUM (Qoa) @2.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, weak cementation	
420	5			R-1	5 8 8				@5.0': SILTY SAND, medium dense, brown to whiteish brown, moist, fine to medium sand, non plastic silt, manganese oxide staining	
				R-2	5 9 10				@7.5': SILTY SAND, medium dense, brown to mottled reddish brown, moist, fine to medium sand, non plastic silt, carbonate nodule, manganese oxide staining	
415	10			R-3	7 13 15					
410	15			R-4	9 10 11				@15.0': SILTY SAND with GRAVEL, medium dense, light gray to oliveish gray, moist, fine sand, low plasticity silt, fine angular elongated gravel, possible decomposed shale	
405	20			R-5	9 10 17	113	17	CL	@20.0': SANDY lean CLAY, stiff to very stiff, light reddish brown to brown, moist, low plasticity clay, fine sand PP = 2.25 tsf	SA AL CU
400	25			S-6	3 9 9			ML	@25.0': SILT with SAND, very stiff, brown, moist, low plasticity silt, fine sand	
395	30			R-7	9 13 13			SM	@30.0': SILTY SAND, very stiff, grayish brown, wet, fine sand, non plastic silt	
	35									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-27

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	426'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35			S-8	5 8 15					
390										
	40			R-9	50/4"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @40': SANDY SILTSTONE, massive, very fine grained, blueish gray, fresh to slightly weathered, hard, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
385										
	45			S-10	20 34 50					
380										
	50			R-11	23 50/5"	114	17		PP > 4.5 tsf	UU
375									**Boring terminated at 51 ft.** **Groundwater encountered at 31 feet during drilling..** Backfill Details 51'- 25': grout 25'- 0': cutting	
	55									
370										
	60									
365										
	65									
360										
	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-28

Project No.	11585.005	**Date Drilled**	9-15-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	383'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, reddish brown, moist, fine sand, low plasticity silt	
380										
	5			R-1	9 19 29	117	12	CL	**QUATERNARY ALLUVIUM (Qa)** @5.0': SANDY lean CLAY, very stiff, mottled whiteish brown, moist, low plasticity clay, fine sand PP = 3.75 tsf	CN
375				R-2	10 15 25	118	12	SC	@7.5': CLAYEY SAND with GRAVEL, dense, brown to light brown, moist, fine sand, low plasticity clay, fine subrounded gravel, carbonate pockets, moderate cementation, manganese oxide staining	
	10			R-3	10 10 11	117	11			
370				R-4	6 7 13	111	18	CL	@12.5': Lean CLAY with SAND, stiff to very stiff, oliveish brown, moist, low plasticity clay, coarse sand, manganese nodule PP = 2.5 tsf	
	15			R-5	6 7 11	112	14	SP-SC	@15.0': Poorly graded SAND with CLAY, medium dense, blueish gray, wet, medium sand, low plasticity clay, trace gravel	
									Boring terminated at 16.5 ft. **Groundwater encountered at 14.5 feet at end of drilling.** **Backfilled with cement bentonite grout.**	
365										
	20									
360										
	25									
355										
	30									
350										
	35									

SAMPLE TYPES:
B BULK SAMPLE
C CORE SAMPLE
G GRAB SAMPLE
R RING SAMPLE
S SPLIT SPOON SAMPLE
T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-29

Project No.	11585.005	**Date Drilled**	9-15-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	385'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
385	0								Surface: Concrete, 4.5 in.	
								SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.4': SILTY SAND, reddish brown, moist, fine sand, non plastic silt	
				B-1		113	9	SM	Asphalt Concrete, 2 in. possible old road pavement @1.5': SILTY SAND, reddish brown, moist, fine sand, non plastic silt	DS MD
380	5			R-1	7 13 16	113	16	CL	**QUATERNARY ALLUVIUM (Qa)** @5.0': SANDY lean CLAY, very stiff, light brown, moist, low plasticity clay, fine sand	CN
				R-2	11 20 23	124	10	SC	@7.5': CLAYEY SAND with GRAVEL, dense, brown, moist, fine sand, low plasticity clay, fine subrounded gravel, carbonate pockets, moderate cementation	DS
375	10			R-3	7 10 10	120	13	SM	@10.0': SILTY SAND with GRAVEL, medium dense, dark reddish brown, moist, fine sand, low plasticity silt, fine subrounded gravel, carbonate pockets, manganese oxide staining	
				R-4A R-4B	7 12 14	109	20	CL	@12.5': Lean CLAY with GRAVEL, very stiff to hard, blueish gray, moist, low plasticity clay, fine subrounded gravel	CN
370 ▽	15			R-5	4 6 9					
				R-6	11 20 20					
				R-7	17 22 24					
365	20			S-8	12 40 50/2"				@20': hard	
				S-9A S-9B	20 50/6"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @24': SILTY SANDSTONE, very thickly bedded, fine to medium grained, dark brown, moderately weathered, medium hard, weak to moderate cementation, (SILTY SAND (SM), very dense)	
360	25									
				S-10	50/6"					
355	30								**Boring terminated at 30 ft.** **Groundwater encountered at 15 feet during drilling.** **Backfilled with cement bentonite grout.**	
350	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-30

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	460'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
460	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, with roots	
									QUATERNARY OLDER ALLUVIUM (Qoa) @1.0': SILTY SAND, very dense, yellowish olive to light grayish olive, moist, fine to medium sand, non plastic silt, carbonate nodule, moderate cementation, manganese oxide staining	
455	5			R-1	31 42 50/5"	114	6			
				R-2	21 33 50/3"			SP	@7.5': Poorly graded SAND, very dense, whiteish olive, moist, fine to medium sand, weak cementation	
450	10			B-1 R-3	23 43 46	109	9	ML	@10.0': SANDY SILT, very dense, light yellowish brown, moist, low plasticity silt, fine sand, weak cementation	DS
445	15			R-4	24 50/4"			SM	@15.0': SILTY SAND, very dense, oliveish white, moist, fine sand, low plasticity silt, strong cementation	
440	20			B-2 R-5	8 34 50/5"	109	17		@20.0': SILTY SAND, very dense, whiteish gray to light oliveish gray, moist, fine sand, low plasticity silt, carbonate nodule, strong cementation	
435	25			R-6	10 21 37				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @25': SANDY SILTSTONE, massive, very fine grained, blueish gray, fresh to slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
430	30			R-7	13 41 50/3"	113	18		PP > 4.5 tsf	DS
425	35									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-30

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	460'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
425	35			S-8	10 15 33					
420	40			R-9	8 27 50	110	19		PP > 4.5 tsf	
415	45			S-10	11 24 33					
410	50			R-11	23 50/4"	113	17		PP > 4.5 tsf	
									Boring terminated at 51 ft. Groundwater not encountered. Backfilled with auger cuttings.	
405	55									
400	60									
395	65									
390	70									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-31

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	474'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark brown, moist, fine sand, non plastic silt	
470								SP-SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @3.0': Poorly graded SAND with SILT, medium dense, mottled whiteish brown to dark brown, moist, fine to medium sand, low plasticity silt, carbonate nodule, manganese oxide staining	
	5			R-1	7 12 17	116	8			
465	10			R-2	14 21 30	118	13	CL	@10.0': Lean CLAY with SAND, hard, dark grayish brown, moist, low plasticity clay, fine sand, trace fine angular gravel PP > 4.5 tsf	SA AL DS
460	15			S-3	4 9 10			SM	@15.0': SILTY SAND, medium dense, brown, moist, fine to medium sand, low plasticity silt, moderate cementation, manganese oxide staining	
455	20			B-1 R-4	18 40 50/5"	102	22		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @20': SANDY SILTSTONE, very thickly bedded, very fine grained, mottled orangeish olive, moderately weathered, hard, moist, manganese oxide staining, (SILT with SAND (ML), hard, low plasticity) PP > 4.5 tsf	
450	25			S-5	10 12 11				@25': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish yellow, slightly weathered to moderately weathered, hard, moist, manganese oxide staining, (SANDY SILT (ML), very stiff to hard, low plasticity)	
445	30			B-2 R-6	10 50/6"	92	29		@30': CLAYSTONE, thickly bedded, very fine grained, dark oliveish brown, slightly weathered, hard, moist, iron oxide staining, (Lean CLAY (CL), hard, low plasticity) PP > 4.5 tsf	DS
440	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-31

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	474'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			R-7	23 50/6"	92	29		@35': SANDY SILTSTONE, massive, very fine grained, dark oliveish gray, slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
435										
	40			R-8	30 50/3"	97	25			
430										
	45			R-9	10 25 50					
425										
	50			R-10	26 50/5"	98	24			
420										
	55			S-11	13 22 27					
415										
	60			R-12	35 50/5"	96	24			
									Boring terminated at 61 ft. **Groundwater not encountered.** **Backfilled with auger cuttings.**	
410										
	65									
405										
	70									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-32

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	484'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				CL	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': SANDY lean CLAY, hard, reddish brown, moist, medium plasticity clay, fine sand, iron oxide staining	
480	5			R-1	12 26 33	122	11		PP > 4.5 tsf	
475	10			R-2	23 37 47	126	9	SM	@10.0': SILTY SAND, very dense, reddish brown to dark brown, moist, fine sand, low plasticity silt, carbonate nodule, moderate cementation	
470	15			R-3	28 32 40					
465	20			B-2 R-4	25 40 50/5"	111	8		@20.0': SILTY SAND, very dense, light orangeish olive, moist, fine sand, non plastic silt, weak cementation	
460	25			R-5	50/4"			SP-SM	@25.0': Poorly graded SAND with SILT and GRAVEL, very dense, light grayish olive, moist, fine sand, non plastic silt, fine angular gravel	
455	30			B-3 R-6	25 30 35	83	32		**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy)** @30': SANDY CLAYSTONE, very thickly bedded, very fine grained, grayish olive, slightly weathered to moderately weathered, hard, moist, iron oxide staining, (SANDY lean CLAY (CL), hard, low plasticity) PP > 4.5 tsf	CR DS
450	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-32

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	484'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			R-7	50/5"	83	32		@35': SANDY SILTSTONE, very thickly bedded, very fine grained, grayish olive, slightly weathered to moderately weathered, hard, moist, iron oxide staining, (SANDY SILT (ML), hard, low plasticity)	CR
445										
	40			R-8	20 50/6"	86	32		@40': SANDY SILTSTONE, very thickly bedded, very fine to fine grained, blackish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SILT with SAND (ML), hard, low plasticity)	
440										
	45			R-9	50/6"				@45': SILTY SANDSTONE, very thickly bedded, fine grained, dark grayish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SILTY SAND (SM), very dense)	
435										
	50			R-10	50/6"	83	33			
430										
	55			R-11	16 50/5"				@55': SANDY SILTSTONE, very thickly bedded, very fine to fine grained, dark grayish olive, slightly weathered to moderately weathered, hard, moist, (SILT with SAND (ML), hard, low plasticity)	
425										
	60			R-12	36 50/3"					
									Boring terminated at 61 ft. **Groundwater not encountered.** **Backfilled with auger cuttings**.	
420										
	65									
415										
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-33

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	444'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0		B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, with roots, trace fine subrounded gravel	
								QUATERNARY OLDER ALLUVIUM (Qoa) @2.0': SILTY SAND, medium dense, dark reddish brown, moist, fine to medium sand, non plastic silt, carbonate nodule, weak cementation, manganese oxide staining	
440	5		R-1	12 15 16	116	8			
			R-2	8 9 10				@7.5': SILTY SAND, medium dense, mottled yellowish brown, moist, fine to medium sand, non plastic silt, trace fine subangular gravel	
435	10		B-2 R-3	6 8 12	102	17		@10.0': SILTY SAND, medium dense, dark brown, moist, fine to medium sand, low plasticity silt, moderate cementation	
			R-4	8 12 21	112	16	CL	@12.5': SANDY lean CLAY, hard, oliveish brown, moist, low plasticity clay, fine sand, iron oxide staining PP > 4.5 tsf	DS
430	15		S-5	5 5 10					
425	20		R-6	16 24 22	122	11	ML	@20.0': SANDY SILT with GRAVEL, hard, oliveish brown, moist, low plasticity silt, fine sand, fine subangular gravel, decomposed siltstone fragments	
420	25		S-7	5 5 8				@25.0': SILT with SAND, very stiff, olive, moist, low plasticity silt, fine sand, manganese oxide staining	
415	30		R-8	13 20 28				@30.0': SANDY SILT, hard, dark oliveish gray, moist, low plasticity silt, fine sand, hydrocarbon staining PP = 4.5 tsf	
410	35								

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-33

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	444'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35			S-9	11 19 25					
405	40			R-10	40 50/5"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @40': SANDY SILTSTONE, massive, very fine grained, dark oliveish gray to dark gray, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard) PP > 4.5 tsf	
400	45			S-11	17 25 36					
395	50			R-12	50/6"				PP > 4.5 tsf **Boring terminated at 50.5 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings.**	
390	55									
385	60									
380	65									
375	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-34

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	486'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': SILTY SAND, brown to yellowish brown, moist, fine sand, low plasticity silt	
485										
480	5			R-1	7 50/6"				@5.0': SILTY SAND, very dense, brownish olive to light olive, moist, fine sand, low plasticity silt, carbonate nodule, strong cementation	
				R-2	15 29 43			SP-SM	@7.5': Poorly graded SAND with SILT, very dense, light olive, moist, fine sand, non plastic silt, weak cementation	
475	10			B-1 R-3	17 50/6"				@10.0': Poorly graded SAND with SILT, very dense, reddish brown, moist, fine to medium sand, non plastic silt	
470	15			R-4A R-4B	10 44 50/3"			SM	@15.0': SILTY SAND, very dense, light brown, moist, fine sand, low plasticity silt @16.0': SILTY SAND, very dense, whiteish brown, moist, fine sand, non plastic silt	
465	20			B-2 R-5	13 37 50/5"	96	6			CR DS
460	25			S-6	6 20 16			SP-SM	@25.0': Poorly graded SAND with SILT, very dense, reddish olive to brownish olive, moist, fine to medium sand, non plastic silt, iron oxide staining	
455	30			R-7	15 46 50/3"			SP	@30.0': Poorly graded SAND, very dense, brownish olive to grayish olive, moist, fine to medium sand, manganese oxide staining @30': rig chattering	
	35									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- **B** BULK SAMPLE
- **C** CORE SAMPLE
- **G** GRAB SAMPLE
- **R** RING SAMPLE
- **S** SPLIT SPOON SAMPLE
- **T** TUBE SAMPLE

TYPE OF TESTS:
- **-200** % FINES PASSING
- **AL** ATTERBERG LIMITS
- **CN** CONSOLIDATION
- **CO** COLLAPSE
- **CR** CORROSION
- **CU** UNDRAINED TRIAXIAL
- **DS** DIRECT SHEAR
- **EI** EXPANSION INDEX
- **H** HYDROMETER
- **MD** MAXIMUM DENSITY
- **PP** POCKET PENETROMETER
- **RV** R VALUE
- **SA** SIEVE ANALYSIS
- **SE** SAND EQUIVALENT
- **SG** SPECIFIC GRAVITY
- **UC** UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-34

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	486'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
450	35			S-8	5 8 15			ML	@35.0': SANDY SILT, very stiff, blueish gray, moist to wet, low plasticity silt, fine sand, organic odor	
445	40			R-9	23 50/6"	116	14		**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy)** @40': SILTY SANDSTONE, very thickly bedded, fine to medium grained, blueish gray, slightly weathered to moderately weathered, hard, trace fine subangular gravel, (SILTY SAND with GRAVEL (SM), very dense)	DS
440	45			S-10	50/6"					
435	50			R-11	8 32 50/5"				@50': SANDY SILTSTONE, very fine grained, blueish gray to dark brownish gray, slightly weathered, hard, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
									Boring terminated at 51.5 ft. **Groundwater encountered at 37 feet during drilling.** **Backfilled with auger cuttings**.	
430	55									
425	60									
420	65									
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-36

Project No.	11585.005	**Date Drilled**	9-17-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	483'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
483	0			B-1				SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': SILTY SAND, light brown to brown, moist, fine sand, low plasticity silt	
480										
	5			R-1	5 22 30			SP-SM	@5.0': Poorly graded SAND with SILT, dense, brown to light brown, moist, fine sand, non plastic silt, weak cementation	
475				R-2	16 20 21			SP	@7.5': Poorly graded SAND, dense, mottled whiteish brown, moist, fine to medium sand, carbonate nodule, iron oxide staining	
	10			B-2 R-3	10 24 36			SW	@10.0': Well-graded SAND, very dense, mottled whiteish olive, moist, fine to coarse sand, manganese oxide staining	
470										
	15			R-4	50/6"			SP-SM	@15.0': Poorly graded SAND with SILT, very dense, olive to grayish olive, moist, fine sand, non plastic silt @15': rough drilling; rod chattering	
465										
	20			R-5	50/6"				@20.0': Poorly graded SAND with SILT and GRAVEL, very dense, orangeish brown, moist, fine to medium sand, non plastic silt, fine subangular gravel, manganese oxide staining	
460										
	25			S-6	14 28 50/5"				@25.0': Poorly graded SAND with SILT, very dense, light brownish white, moist, fine to medium sand, non plastic silt	
455										
	30			R-7	10 18 20				**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy)** @30': SANDY SILTSTONE, thickly bedded, very fine grained, oliveish gray, moderately weathered, hard, (SANDY SILT (ML), very stiff to hard, low plasticity) @30': added water	
450									**Auger refusal at 33 ft.** **Boring terminated at 33 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings.**	
	35									

Graphic Log: N S

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
405	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark black to reddish brown, moist, fine sand, low plasticity silt	
400	5			R-1	9 26 33	108	7		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, dense, light brown to brown, moist, fine sand, low plasticity silt, carbonate nodule, moderate cementation	
				R-2	12 16 20				@7.5': SILTY SAND, medium dense, dark reddish brown, moist, fine sand, low plasticity silt, carbonate nodule, iron oxide staining	
395	10			R-3	10 17 24	99	24	ML	@10.0': SANDY SILT, very stiff, whiteish olive, moist, low plasticity silt, fine sand, manganese oxide staining PP = 4 tsf	
				T-4A T-4B	6 16 32				PP = 4 tsf	
390	15									
				R-5	15 19 21	99	25		@18.5': SILT, hard, grayish olive, moist, low plasticity silt, manganese oxide staining PP = 4.5 tsf	
385	20									
				S-6A S-6B	6 13 19					
380	25								@24.5': SANDY SILT, hard, blackish olive, moist, low plasticity silt, fine sand, hydrocarbon odor, hydrocarbon staining	
				T-7A T-7B	16 50/6"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @26': SILTY SANDSTONE, very thickly bedded, fine grained, blackish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SILTY SAND (SM), very dense)	
375	30			R-8	20 50/6"	109	18		@30': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	UU
370	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
370	35			S-9	11 16 22				@35': SANDY SILTSTONE, very thickly bedded, very fine grained, blackish olive to grayish olive, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
365	40			R-10	36 50/5"	119	11		PP > 4.5 tsf	
				T-11A T-11B	25 50/5"	103	18			UU
360	45			S-12	14 22 30				@45': SANDY SILTSTONE, very thickly bedded, very fine grained, grayish olive, fresh, hard, moist, hydrocarbon staining, (SILT with SAND (ML), hard, low plasticity)	
355	50			R-13	50/6"	114	14		@50': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
350	55			S-14	14 21 30					
345	60			R-15	50/5"	119	9		@60': SANDY SILTSTONE, very thickly bedded, very fine grained, dark olive to grayish olive, fresh, hard, wet, (SANDY SILT (ML), hard, low plasticity)	
340	65			S-16	17 27 31				@65': SILTY SANDSTONE, very thickly bedded, fine grained, dark olive to grayish olive, fresh, hard, wet, (SILTY SAND (SM), very dense)	
335	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
335	70			R-17	30 50/4"				@70': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, wet, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
330	75			S-18	12 21 30				@75': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, wet, hydrocarbon staining, bituminous vein, (SILT with SAND (ML), hard, low plasticity)	
325	80			R-19	10 50/6"					
									Boring terminated at 81 ft. **Groundwater encountered at 56 feet during drilling.**. Backfill Details 81'- 50': cement bentonite grout 50'- 0': auger cuttings	
320	85									
315	90									
310	95									
305	100									
300	105									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								Surface: Asphalt Concrete, 4 in. Aggregate Base, 10 in.	
425				B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @1.2': SILTY SAND with GRAVEL, yellowish brown, moist, fine sand, low plasticity silt, fine subrounded gravel	
	5			R-1	15 26 50/5"	117	9		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, very dense, light yellowish brown, moist, fine sand, non plastic silt, moderate cementation, manganese oxide staining	
420				R-2	21 32 40				@7.5': SILTY SAND with GRAVEL, very dense, brown to mottled blackish brown, moist, fine to medium sand, non plastic silt, fine subrounded gravel, moderate cementation, manganese oxide staining	
	10			B-2 R-3	12 18 24	119	10		@10.0': SILTY SAND, dense, brown, moist, fine to medium sand, low plasticity silt	
415				T-4A T-4B	4 7 10			ML	@12.5': SILT with SAND, very stiff, blackish gray to oliveish gray, moist, low plasticity silt, fine sand, hydrocarbon odor, hydrocarbon staining	
	15			T-5						
410				R-6	4 9 9	102	21		PP = 2.5 tsf	DS
	20			B-3						
405				S-7	4 13 22			CL	@23.5': Lean CLAY with SAND, hard, brownish olive, moist, low plasticity clay, fine sand	
	25									
				T-8					**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @26': SANDY SILTSTONE, very thickly bedded, very fine grained, blackish gray, slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
400				T-9A T-9B	34 50/3"					
	30			R-10	35 50/2"				@30': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray to blueish gray, slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), very stiff, low plasticity) PP = 3.75 tsf	
395										
	35									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	35			S-11	15 31 33				@35': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
390										
	40			R-12	32 50/4"	115	14		PP = 4.5 tsf	
				T-13	18 50/5"	110	13		@42': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray to brownish gray, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	CU
385										
	45									
380										
	50			R-14	30 50/4"	115	16		PP > 4.5 tsf	UU
375										
	55			S-15	19 26 42				@55': SANDY SILTSTONE, very thickly bedded, very fine grained, olive to grayish olive, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
370										
	60			R-16	50/6"	109	15		@60': SANDY SILTSTONE, massive, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
365										
	65			S-17	14 26 37					
360										
	70									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	70			R-18	40 50/2"	116	14		PP > 4.5 tsf	
355										
	75			S-19	19 31 44					
350										
	80			R-20	11 30 50/5"				@80': SANDY SILTSTONE, very fine grained, brownish olive to blackish olive, fresh to slightly weathered, hard, moist, petroleum flowing on sample surface, (SANDY SILT (ML), hard, low plasticity)	
345									**Boring terminated at 81.5 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings; paved with cold-patch asphalt concrete.**	
	85									
340										
	90									
335										
	95									
330										
	100									
325										
	105									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-39

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	485'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
485	0			B-1				SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': SILTY SAND with GRAVEL, brown to light brown, moist, fine sand, non plastic silt, fine subrounded gravel	
480	5			R-1	4 15 25	121	8		@5.0': SILTY SAND, dense, light reddish brown to brown, moist, fine sand, low plasticity silt, weak cementation	
				R-2	3 12 27			SC	@7.5': CLAYEY SAND, dense, brown to yellowish brown, moist, fine sand, low plasticity clay, moderate cementation, manganese oxide staining	
475	10			B-2 R-3	12 21 34	111	12	SM	@10.0': SILTY SAND, dense to very dense, brown, moist, fine to medium sand, low plasticity silt	
470	15			R-4	14 15 17			SW	@15.0': Well-graded SAND, medium dense to dense, yellow to brownish yellow, moist, fine to coarse sand	
465	20			R-5	22 34 50	115	8	SP	@20.0': Poorly graded SAND, very dense, light brown, moist, fine to medium sand @20': added water	
460	25			S-6	7 11 17			SC	@25.0': CLAYEY SAND, hard, yellow to light yellow, moist, fine sand, low plasticity clay	SA AL
455	30			R-7	10 22 21	109	16	ML	@30.0': SANDY SILT, hard, light olive to oliveish gray, moist, low plasticity silt, fine sand PP > 4.5 tsf	UC
450	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-39

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	485'
Location		**Sampled By**	SG

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
450	35			S-8	50/4"				**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy)** @35': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray to oliveish gray, fresh to slightly weathered, hard, moist, (SANDY SILT (ML), hard)	
445	40			R-9	16 23 34	110	20		@40': SILTY SANDSTONE, very thickly bedded, fine grained, blueish gray, fresh, hard, moist, (SILTY SAND (SM), very dense)	
440	45			S-10	11 19 30				@45': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard)	
435	50			R-11	47 50/2"	107	18		PP > 4.5 tsf	
									Boring terminated at 50.5 ft. **Groundwater not encountered.** **Backfilled with auger cuttings.**	
430	55									
425	60									
420	65									
415	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-40

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	480'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
480	0			B-1				SM	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': SILTY SAND, light brown to brown, moist, fine sand, non plastic silt	
475	5			R-1	19 30 40	125	6	SP-SM	@5.0': Poorly graded SAND with SILT, very dense, brown to mottled whiteish brown, moist, fine sand, non plastic silt, moderate cementation	
				R-2	30 37 50			SP	@7.5': Poorly graded SAND with GRAVEL, very dense, mottled whiteish brown, moist, fine to medium sand, fine subangular gravel, carbonate nodule, manganese oxide staining	
470	10			B-2 R-3	32 50/6"			SP-SM	@10.0': Poorly graded SAND with SILT, very dense, light brownish olive, moist, fine to medium sand, non plastic silt, manganese oxide staining	
465	15			R-4	50/6"				@15.0': Poorly graded SAND with SILT, very dense, olive to grayish olive, moist, fine sand, non plastic silt	
460	20			R-5	19 50/6"	116	11	SM	@20.0': SILTY SAND, very dense, mottled orangeish olive to grayish olive, moist, fine sand, non plastic silt	
455	25			S-6	3 3 7			ML	@25.0': SILT with SAND, stiff, olive, moist, low plasticity silt, fine sand, manganese oxide staining	
450	30			R-7	6 14 24	86	33		@30.0': SANDY SILT, very stiff to hard, oliveish gray, moist, low plasticity silt, fine sand, sand in blue veins	UC
445	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-40

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	480'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
445	35			S-8	14 18 24					
440	40			R-9	34 50/5"	99	23		**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy)** @40': SANDY SILTSTONE, massive, very fine grained, brownish gray to oliveish gray, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard) PP > 4.5 tsf	
435	45			S-10	24 32 43					
430	50			R-11	28 50/3"	90	33		PP > 4.5 tsf	
									Boring terminated at 51 ft. **Groundwater not encountered.** **Backfilled with auger cuttings.**	
425	55									
420	60									
415	65									
410	70									

SAMPLE TYPES:

- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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APPENDIX B.2

Test Boring Logs

Hollow Stem Auger Borings

Percolation Testing

GEOTECHNICAL BORING LOG P-1

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	384'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet: 380 (at 4 ft depth), 375 (9 ft), 370 (14 ft), 365 (19 ft), 360 (24 ft), 355 (29 ft), 350 (34 ft)

Graphic Log: N S

Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
0		B1				SM	@Surface: top soil, minor vegetation **Artificial Fill (Af):** 0': Silty SAND; orange brown mottled dark brown; moist; fine sand; bedrock fragments	
5		R1 B2	4 6 7	114	17	CL	@5': Sandy CLAY; very stiff; orange brown; moist; fine sand; low plasticity	
							Quaternary-aged young alluvial deposits (Qya): @6.5': Sandy CLAY; orange brown; moist; fine sand; low plasticity	
		R2	5 8 9	120	9	SP	@7.5': Poorly-graded SAND; medium dense; orange brown; moist; fine sand	
10		R3	5 13 25	108	14			
		R4	8 6 10				@12.5': Reddish brown; moist; fine to coarse sand	
						CL	@13.5': Lean CLAY; dark brown; moist; low to medium plasticity	
15		R5	4 9 10				@15': Medium plasticity; trace fine sand; oxidized veins throughout; petroliferous	
		S1	3 5 7				@18.5': Gray; low to medium plasticity	
20							@ 20': Lean CLAY; gray; moist; low to medium plasticity	
		S2	2 4 7				@23.5': Mottled with oxidized areas	
25								
		S3	7 17 22					
30							**Total Depth of Boring: 30 feet** **No free groundwater encountered during drilling.** **Backfilled with soil cuttings**	
35								

SAMPLE TYPES:
- **B** BULK SAMPLE
- **C** CORE SAMPLE
- **G** GRAB SAMPLE
- **R** RING SAMPLE
- **S** SPLIT SPOON SAMPLE
- **T** TUBE SAMPLE

TYPE OF TESTS:
- **-200** % FINES PASSING
- **AL** ATTERBERG LIMITS
- **CN** CONSOLIDATION
- **CO** COLLAPSE
- **CR** CORROSION
- **CU** UNDRAINED TRIAXIAL
- **DS** DIRECT SHEAR
- **EI** EXPANSION INDEX
- **H** HYDROMETER
- **MD** MAXIMUM DENSITY
- **PP** POCKET PENETROMETER
- **RV** R VALUE
- **SA** SIEVE ANALYSIS
- **SE** SAND EQUIVALENT
- **SG** SPECIFIC GRAVITY
- **UC** UNCONFINED COMPRESSIVE STRENGTH

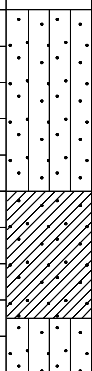
* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG P-1A

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	384'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.



Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	@Surface: top soil, minor vegetation **Artificial Fill (Af):** 0': Silty SAND; orange brown; moist; fine sand	
380	5			S1	8 4 5			SC	@5': Clayey SAND; medium dense; orange brown; moist; fine sand **Quaternary-aged young alluvial deposits (Qya):** @6.5': Clayey SAND; orange brown; moist; fine sand; oxidized veins	-200
375				S2	4 5 6			SM	@8.5': Silty SAND; medium dense; yellowish brown; moist; trace of clay	SA
	10								**Total Depth of Boring: 10 feet.** **No free groundwater encountered during drilling.** **Boring converted into a percolation test well, screen interval from 5 to 10 feet.** **Percolation testing performed on 4/30/2019.** **Percolation test well removed and boring backfilled with soil cuttings.**	
370	15									
365	20									
360	25									
355	30									
350	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG P-2

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	385'
Location		**Sampled By**	MM

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
385	0			B1				SM	@Surface: top soil, minor vegetation, deteriorated concrete access road **Artificial Fill (Af):** 0': Silty SAND; dark brown; moist; fine sand; trace fine gravel; clay nodules	
380	5			R1 B2	7 11 7	99	6	SP	@5': Poorly-graded SAND; medium dense; light brown; moist; fine to coarse sand; little fine to medium gravel, subangular to subrounded **Quaternary-aged young alluvial deposits (Qya):** @ 6': Poorly-graded SAND; medium dense; light brown; moist	
				R2	3 6 9	99	23	SM	@7.5': Silty SAND; medium dense; brown; moist; fine sand; trace coarse sand; oxidized veins; appears stratified; contains bedrock fragments	
375	10			R3	4 7 11	105	20		@10': Very moist	
				R4	5 15 21			SP	@12.5': Poorly-graded SAND; medium dense; brown to gray; wet; fine to coarse sand; little fine to medium gravel, angular to subangular	
370	15			R5	17 44 26				@ 16.3': Trace of fractured claystone bedrock	
				S1	2 3 7					
365	20								@20': Poorly-graded SAND; medium dense; brown to gray; wet; fine to coarse sand; little fine to medium gravel, angular to subangular	
				S2	50/5"				**Fernando Formation, Undifferentiated (Tf/Tfs)** @23.5': SANDSTONE with Silt; very dense; dark gray; very moist to wet; fine sand; petroliferous	
360	25								**Total Depth of Boring: 24 feet** **Groundwater encountered at 11.5 feet** **Backfilled with soil cuttings**	
355	30									
350	35									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG P-2A

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	385'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
385	0							SM	@Surface: top soil, minor vegetation, deteriorated concrete access road **Artificial Fill (Af):** 0': Silty SAND; dark brown; moist; fine sand; trace fine gravel	
380	5			S1	3 4 3				@5': Silty SAND; loose; brown; moist; fine sand; trace angular fragments of sandstone bedrock **Quaternary-aged young alluvial deposits (Qya):** @6': Silty SAND; loose; brown; moist; fine sand	-200
				S2	4 6 9				@8.5': Very moist; oxidized veins	-200
375	10								**Total Depth of Boring: 10 feet.** **No free groundwater encountered during drilling.** **Boring converted into a percolation test well, screen interval from 5 to 10 feet.** **Percolation testing performed on 4/30/2019.** **Percolation test well removed and boring backfilled with soil cuttings.**	
370	15									
365	20									
360	25									
355	30									
350	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG P-3

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	436'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
435	0			B1				SM	@Surface: top soil **Artificial Fill (Af):** 0': Silty SAND; dark brown; moist; fine sand	
430	5			R1	5 7 12	103	10		@5': Silty SAND; medium dense; orange brown; moist; fine sand; mottled	
									Quaternary-aged young alluvial deposits (Qya): @ 7': Silty SAND; medium dense; orange brown; moist; fine sand	
425	10			R2	8 11 21	105	11		@10': Brown; moist; fine sand, some clay; oxidized	
				R3	4 8 10	106	15		@12.5': Very moist	
420	15			R4	8 15 30					
				S1	5 7 10			SP	@18.5': Poorly-graded SAND; medium dense; light brown; very moist to wet; fine to coarse sand	
415	20								@20': Poorly-graded SAND; medium dense; light brown; very moist to wet; fine to coarse sand	
				S2	2 3 4			CL	@23.5': Lean CLAY; gray to brown; very moist; low to medium plasticity	
410	25									
				S3	2 6 17					
405	30								**Total Depth of Boring: 30 feet** **Groundwater encountered at 19.5 feet** **Backfilled with soil cuttings**	
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG P-3A

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	436'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
435	0							SM	@Surface: top soil **Artificial Fill (Af):** 0': Silty SAND; dark brown; moist; fine sand; some clay nodules throughout	
430	5			S1	3 3 3			SC	@5': Clayey SAND; loose; dark brown; moist; low plasticity; fine sand; trace fine gravel, subangular	-200
									Quaternary-aged young alluvial deposits (Qya): @7': Clayey SAND; dark brown; moist; low plasticity; fine sand	
				S2	3 4 6				@8.5': Clayey SAND; medium dense; dark brown; moist; fine sand; oxidized areas	SA
425	10								**Total Depth of Boring: 10 feet.** **No free groundwater encountered during drilling.** **Boring converted into a percolation test well, screen interval from 5 to 10 feet.** **Percolation testing performed on 4/30/2019.** **Percolation test well removed and boring backfilled with soil cuttings.**	
420	15									
415	20									
410	25									
405	30									
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG P-4

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	465'
Location		**Sampled By**	MM

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
465	0							SP	@Surface: overgrown vegetation **<u>Quaternary-aged young alluvial deposits (Qya):</u>** @0': Poorly-graded SAND; brown; moist; fine sand	
460	5			S1	4 3 4		14	SC	@5': Clayey SAND; loose to medium dense; brown to orangish brown; moist; fine sand; low plasticity; trace fine gravel, subangular	
455	10			S2	3 5 10		15	CL	@10': Sandy CLAY; dark brown; moist; fine sand; low plasticity	
				S3	3 5 10				@12.5': Petroliferous	
450	15			S4	5 7 10				@15': Dark reddish brown; moist; fine sand; increase in sand content	
				S5	3 7 10					
445	20								@20': Sandy CLAY; dark reddish brown; moist; fine sand; low plasticity	
				S6	3 4 8				@23.5': Lean CLAY; dark brown; moist; low plasticity; petroliferous	
440	25									
				S7	7 7 9			SM	@28.5': Silty SAND; dark brown; moist; fine sand; trace clay nodules throughout	
435	30								**Total Depth of Boring: 30 feet** **Groundwater encountered at 20 feet** **Backfilled with soil cuttings**	
430	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG P-4A

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	465'
Location		**Sampled By**	MM

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
465	0							SM	@Surface: overgrown vegetation **Quaternary-aged young alluvial deposits (Qya):**	
				S1	7 8 6				@1': Silty SAND; medium dense; brown; moist; fine sand; trace fine gravel	-200
				S2	3 3 3			SC	@3.5': Clayey SAND; loose; brown; moist; fine sand; trace medium sand	-200
460	5								**Total Depth of Boring: 5 feet.** **No free groundwater encountered during drilling.** **Boring converted into a percolation test well, screen interval from 0 to 5 feet.** **Percolation testing performed on 4/30/2019.** **Percolation test well removed and boring backfilled with soil cuttings.**	
455	10									
450	15									
445	20									
440	25									
435	30									
430	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG P-5

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	458'
Location		**Sampled By**	MM

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
458	0							SM	@Surface: vegetation **Artificial Fill (Af):** @0': Silty SAND; dark brown to light brown; moist; fine sand; trace fine gravel, subangular to subround; clay pods throughout	
455										
	5			S1	9 8 5		13		@5': Medium dense; dark brown	
450									**Quaternary-aged young alluvial deposits (Qya):** @8': Silty SAND; dark brown; moist; fine sand	
	10			S2	3 5 8		21	CL	@10': Sandy CLAY; brown; moist; fine sand; low plasticity; thin bedding distinguishable	
445				S3	3 4 6		19		@12.5': Sandy CLAY; brown with black mottling; moist; fine sand; trace fine gravel throughout; petroliferous	
	15			S4	3 7 9		20		@15': Sandy CLAY; dark brown; moist; fine sand; low plasticity	
440					3 6 9				**Total Depth Drilled: 20 feet** **Groundwater encountered at 15.5 feet** **Backfilled with soil cuttings**	
	20									
435										
	25									
430										
	30									
425										
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG P-5A

Project No.	11588.004	**Date Drilled**	4-29-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	MM
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	458'
Location		**Sampled By**	MM

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SM	@Surface: vegetation **Artificial Fill (Af):**	
				S1	15 29 20				@1': Silty SAND; dense; light brown; slighlty moist; fine sand; trace fine subangular gravel; bedrock fragments; mottled	
455										
				S2	9 15 10				@3.5': Dark brown; moist; fine sand; low plasticity clay nodules; oxidized pin points throughout	
	5								**Total Depth of Boring: 5 feet.** **No free groundwater encountered during drilling.** **Boring converted into a percolation test well, screen interval from 0 to 5 feet.** **Percolation testing performed on 4/30/2019.** **Percolation test well removed and boring backfilled with soil cuttings.**	
450										
	10									
445										
	15									
440										
	20									
435										
	25									
430										
	30									
425										
	35									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG CWE P-1

Project No.	11585.005	**Date Drilled**	9-15-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	385'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
385	0							SC	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': CLAYEY SAND, grayish brown, moist, fine sand, low plasticity clay	
380	5			R-1A	25 18	57	11	ML	@5.0': SANDY SILT, dense, light brown, moist, low plasticity silt, fine sand, weak cementation	-200
				R-1B	18			CL	**QUATERNARY ALLUVIUM (Qa)** @6.0': Lean CLAY with SAND, very stiff, mottled whiteish brown, moist, low plasticity clay, fine sand PP = 3 tsf	
				R-2	7 9 12					
375	10			R-3	10 14 14	107	4	SM	@10.0': SILTY SAND, medium dense, light brown to light orangeish brown, moist, fine to medium sand, non plastic silt, trace fine subangular gravel	-200
				R-4	10 12 15	109	4			CO
370	15			R-5	21 29 29			SW	@15.0': Well-graded SAND, very dense, light orangeish brown, moist, fine to coarse sand, trace fine subangular gravel, manganese oxide staining	
				R-6	20 30 30			SP	@18.5': Poorly graded SAND, very dense, orangeish brown, wet, medium to coarse sand, trace fine subangular gravel, manganese oxide staining	
365	20									
				S-7	4 5 12			CL	@23.5': Lean CLAY with GRAVEL, very stiff, blueish gray, wet, low plasticity clay, fine subangular gravel	
360	25									
				R-8	6 10 18				PP = 4 tsf	
355	30									
				S-9	6 12				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @33.5': CLAYSTONE, massive, very fine grained, blueish gray,	
350	35									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG CWE P-1

Project No.	11585.005	**Date Drilled**	9-15-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	385'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
350	35				18				slightly weathered to moderately weathered, hard, iron oxide staining, (Lean CLAY (CL), hard, low plasticity) PP > 4.5 tsf	
				R-10	12 36 50/5"				@38.5': CLAYSTONE, massive, very fine grained, blueish gray, fresh, hard, (Lean CLAY (CL), hard, low plasticity) PP > 4.5 tsf	
345	40									
				S-11	8 12 16					
340	45									
				R-12	11 20 50				PP > 4.5 tsf	
335	50								**Boring terminated at 50 ft.** **Groundwater encountered at 19.5 feet during drilling.** **Boring converted into a percolation test well, test performed on 09/17/2020; test well was then removed.**. Backfill Details 50'- 10': cement bentonite grout 10'- 0': auger cuttings	
330	55									
325	60									
320	65									
315	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG CWE P-2

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	388'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, grayish brown, moist, fine sand, non plastic silt	
385										
	5			R-1	3 5 7	105	6		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, medium dense, dark brown to grayish brown, moist, fine sand, low plasticity silt, trace gypsum gravel	
380				R-2	5 6 10	106	9		@7.5': SILTY SAND, medium dense, light brown, moist, fine sand, low plasticity silt	-200
	10			R-3	4 8 10	108	9		@10.0': SILTY SAND, medium dense, mottled whiteish brown to dark grayish brown, moist, fine sand, low plasticity silt	CO
375										
	15			R-4	5 11 14			CL	@15.0': Lean CLAY with SAND, very stiff, yellow to yellowish brown, moist, low plasticity clay, fine sand PP = 3 tsf	
370										
	20			R-5	4 11 17			ML	@20.0': SILT with SAND, very stiff, yellowish olive to grayish olive, wet, low plasticity silt, fine sand PP = 3 tsf	
365										
	25			S-6	6 7 7					
360										
	30			R-7	44 50/6"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SILTY SANDSTONE, very thickly bedded, fine to medium grained, yellowish olive to grayish olive, slightly weathered to moderately weathered, hard, (SILTY SAND (SM), very dense)	
355										
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG CWE P-2

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	388'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35			S-8	10 22 37				@35': SANDY SILTSTONE, massive, fine grained, blueish gray, fresh, hard, (SANDY SILT (ML), hard, low plasticity)	
350										
	40			R-9	30 50/3"				PP = 4 tsf	
345										
	45			S-10	14 40 50/5"					
340										
	50			R-11	34 50/4"				@50': SANDY SILTSTONE, fine grained, dark blueish brown to dark blueish gray, fresh, hard, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
335									**Boring terminated at 51 ft.** **Groundwater encountered at 18 feet during drilling.** **Boring converted into a percolation test well, test performed on 09/30/2020; test well was then removed.**.	
	55								Backfill Details 51'- 15': cement bentonite grout 15'- 0': auger cuttings	
330										
	60									
325										
	65									
320										
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG CWE P-3

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	401'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
400	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown to light brown, moist, fine sand, low plasticity silt, fine subangular gravel	
395	5			R-1	22 50/6"	109	18		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @5': SILTY SANDSTONE, very thickly bedded, fine grained, mottled orangeish olive to grayish olive, moderately weathered, hard, moist, manganese oxide staining, (SILTY SAND (SM), very dense) @8': Rig chattering	
390	10			B-1 R-2	25 50/6"	106	20		@10': SANDY SILTSTONE, very thickly bedded, very fine grained, mottled orangeish olive to grayish olive, slightly weathered, hard, moist, manganese oxide staining, (SILT with SAND (ML), hard, low plasticity) PP > 4.5 tsf	-200
385	15			R-3	32 50/4"	106	21		PP > 4.5 tsf	-200
				R-4	50/3"				@18.5': SANDY SILTSTONE, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380	20								**Boring terminated at 20 ft.** **Groundwater not encountered.** **Boring converted into a percolation test well, test performed on 10/01/2020; test well was then removed..** Backfill Details 20'- 3': Monterey Sand #3 3'- 0': Bentonite Chip	
375	25									
370	30									
	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG CWE P-4

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	431'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
430	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, weak cementation	
425	5			R-1	11 15 18					
				R-2	4 8 9				**QUATERNARY OLDER ALLUVIUM (Qoa)** @6.5': SILTY SAND, medium dense, brown to mottled whiteish brown, moist, fine sand, low plasticity silt, carbonate nodule, manganese oxide staining	
420	10			R-3	7 12 13	113	15			
415	15			R-4	6 9 13			ML	@15.0': SILT with SAND, very stiff, brown to light reddish brown, moist, low plasticity silt, fine sand, manganese oxide staining PP = 3.75 tsf	-200
410	20			R-5	15 21 21	119	12		@20': hard PP > 4.5 tsf	
405	25			S-6	4 6 10			SM	@25.0': SILTY SAND, very stiff, grayish olive, moist, fine sand, low plasticity silt	-200
400	30			R-7	11 50/5"	110	23		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SILTY SANDSTONE, very thickly bedded, fine grained, grayish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, with shell, (SILTY SAND (SM), very dense)	
	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG CWE P-4

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	431'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	35			S-8	50/5"				@35': SANDY SILTSTONE, massive, fine grained, grayish olive, slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), very stiff to hard, low plasticity)	
395										
390	40			R-9	50/3"				PP = 3.75 tsf	
385	45			S-10	18 29 38					
380	50			R-11	30 50/4"				PP > 4.5 tsf	
									Boring terminated at 51 ft. **Groundwater encountered at 38.5 feet at end of drilling.** **Boring converted into a percolation test well, test performed on 09/24/2020; test well was then removed..** Backfill Details 51'- 30': cement bentonite grout 30'- 0': auger cuttings	
375	55									
370	60									
365	65									
	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG CWE P-5

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	458'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
458	0							CH	**QUATERNARY OLDER ALLUVIUM (Qoa)** @0.0': Fat CLAY with SAND, hard, blackish brown, moist, medium plasticity clay, fine sand, manganese oxide staining	
455										
	5			R-1	11 17 17				PP > 4.5 tsf	
								CL	@6.5': SANDY lean CLAY, very stiff, brown to dark brown, moist, low plasticity clay, fine sand	
450				R-2	10 16 21				PP = 3.5 tsf	
	10			B-1 R-3	9 12 15	111	15		@10.0': Lean CLAY with SAND, very stiff, yellowish brown, moist, low plasticity clay, fine sand, manganese oxide staining PP = 3.5 tsf	
445										
	15			R-4	2 4 5			SC	@15.0': CLAYEY SAND, soft to medium stiff, brown to light brown, moist, low plasticity clay PP = 0.5 tsf	-200
440										
	20			R-5	7 10 11	112	16		@20.0': CLAYEY SAND, very stiff to hard, dark reddish brown, moist, fine sand, low plasticity clay PP = 4 tsf	
435										
	25			S-6	8 8 8					-200
430										
	30			R-7	30 30 50	101	24		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, slightly weathered, hard, moist, (SANDY SILT (ML), very stiff, low plasticity) PP = 3.5 tsf	
425										
	35									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG CWE P-5

Project No.	11585.005	**Date Drilled**	9-21-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	458'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35			S-8	11 19 28				@35': SILTY SANDSTONE, very thickly bedded, fine grained, blueish gray, fresh, hard, moist, (SILTY SAND (SM), very dense)	
420										
	40			R-9	7 35 50/5"				@40': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
415										
	45			S-10	20 30 43					
410										
	50			R-11	50/6"				@50': SILTY SANDSTONE, fine grained, blueish gray, fresh, hard, moist, (SILTY SAND (SM), very dense) PP > 4.5 tsf	
405									**Boring terminated at 50.5 ft.** **Groundwater encountered at 42.5 feet during drilling.** **Boring converted into a percolation test well, test performed on 09/25/2020; test well was then removed.**. Backfill Details 50.5'- 30': cement bentonite grout 30'- 0': auger cuttings	
	55									
400										
	60									
395										
	65									
390										
	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

APPENDIX B.3

Test Boring Logs

Large Diameter Bucket Auger Borings

GEOTECHNICAL BORING LOG LBA-1

Project No.	11588.001	**Date Drilled**	7-31-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	502'
Location		**Sampled By**	JMP

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0							GW	**Artificial Fill, undocumented (Afu):** @Surface: Gravel Access Road, underlain by +/- 8-inches of fill.	
									FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu):	
500										
	5			R-1	2			SILT-STONE	@5': SILTSTONE, light grey brown to yellow brown with orange oxidation, damp, few ~1/16-inch wide fractures infilled with gypsum.	
495										
			@7.6' B:N72°W, 24°SW	G-1					@7.6'-9.5': CLAY bed, 1/4- to 1/2-inch thick, olive brown, soft, internally sheared with polished surfaces, material above and below is hard and intact, gypsum on basal contact with SILTSTONE.	SA, AL, DS
	10			B-2 R-2	3				@10': SILTSTONE, light grey brown to yellow brown with orange oxidation, damp, few ~1/16-inch wide fractures infilled with gypsum.	MD DS
490			@11.2' B:N44°E, 24°NW						@11.2'-12.9': SANDSTONE bed, light grey, fine sand, continuous, pinches and swells between 1/2-inch to 8-inches thickness; basal contact is planar.	
	15			B-1					@15': SILTSTONE, light grey brown to yellow brown with orange oxidation, damp, few ~1/16-inch wide fractures infilled with gypsum.	
485			@15.9' B:N85°W, 33°SW						@15.9': Thin bed of SANDSTONE.	
			@18.9' B:N85°W, 35°SW						18.9': Very thin bed of CLAYSTONE, semi-continuous, heavily oxidized, gypsum along contact with SILTSTONE above, pinches out.	
	20			R-3	4				@20': SILTSTONE, dark grey brown, damp, unoxidized, cobble in sampler shoe.	
480										
									@22.5': Increased hardness, decreased oxidation, becoming dark greyish brown, massive; PID = 9.9 ppm.	
	25			R-6 R-4	8 4				@25': SILTSTONE, dark grey brown, damp, unoxidized.	
475										
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LBA-1

Project No.	11588.001		**Date Drilled**	7-31-18
Project	Brea Boulevard Corridor Improvements		**Logged By**	JMP
Drilling Co.	A1-Roy Drilling		**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar		**Ground Elevation**	502'
Location			**Sampled By**	JMP

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	30			R-5	6				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @30': SILTSTONE, dark grey brown, damp, unoxidized.	
470									@33': Pronounced hydrocarbon odor.	
	35									
465										
	40			R-7 B-3	8				@40': SILTSTONE, dark grey, damp, unoxidized, strong hydrocarbon odor; PID = 160 ppm from cuttings at depth recorded at the ground surface.	
460									@43': Downhole LEL=11%; H2S = 11.5 ppm recorded at depth from instruments lowered into borehole.	
	45								**TOTAL DEPTH: 43 FEET BGS - Drilling terminated due to strong odor and LEL in hole >10%; driller encountered concretion at 43 feet that was determined unsafe to drill due to LEL conditions** **No groundwater encountered during drilling** **Downhole logged to 30 feet bgs** **Peak PID reading of soil cuttings = 356 ppm** **Boring backfilled with soil cuttings upon completion of logging.** **Notes:** **Kelly Bar Weights** **0 feet to 29 feet: 4800 lbs** **30 feet to 58 feet: 3350 lbs** **59 feet to 86 feet: 2045 lbs**	
455										
	50									
450										
	55									
445										
	60									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
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- CU UNDRAINED TRIAXIAL
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- H HYDROMETER
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- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LBA-2

Project No.	11588.001	**Date Drilled**	8-1-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	481'
Location		**Sampled By**	JMP

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				SM	**QUATERNARY OLDER ALLUVIUM (Qoa):**	
480										
	5			R-1	5				@5': Silty SAND, brown, damp, fine sand, trace medium sand, few fine gravels.	
475								SM-SW	@6.8': Undulatory contact between Silty SAND (above) and coarse SAND (below).	
									@9.5': Silty SAND to SAND with gravel and cobbles, medium brown to yellow brown, damp, fine to coarse sand, fine to medium gravels, some siltstone clasts, some cobbles.	
	10			R-2 B-2	2			COBBLES	@10'-11': Abundant COBBLES, loose, silty SAND matrix, oxidized, few roots.	MD
470										
								BOULDERS	@14': Boulders.	
	15			R-3	6			SW	@15': Silty gravelly SAND, light yellow brown, damp, fine to coarse sand, fine gravels, cobbles.	
465										
	20			R-4 B-3	4			SP-SC	@19.9': Erosional contact, olive green silty clayey sand. @20': Silty clayey SAND, olive green with orange oxidation, moist, fine to medium sand, some siltstone fragments.	DS
460								COBBLES	@21.5'-23': COBBLES and coarse GRAVELS, rounded to angular.	
	25			R-5	5			CL	@25': CLAY, olive green, moist to very moist, some orange-brown oxidized sand, small clasts of siltstone.	
455								BOULDERS	@26': Large broken boulder, angular, olive green sandy CLAY matrix, some cobbles, irregular.	
			@28' B:N68°W, 45°NE @29.5'					SILT- STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy):** @28': Irregular, erosional contact with SILTSTONE, blue-grey, thinly laminated, polished bedding on upper contact.	
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

*** * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * ***

GEOTECHNICAL BORING LOG LBA-2

Project No.	11588.001	**Date Drilled**	8-1-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	481'
Location		**Sampled By**	JMP

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
450	30	B:N85°W, 85°NE	R-6	3			CLAY-STONE	**MONTEREY FORMATION, YORBA SHALE MEMBER (Tmy), continued:** @30': CLAYSTONE with fine SANDSTONE interbeds, blue-green to dark grey, unoxidized, moist, steeply inclined bedding observed in sample (+/- 45 degrees). @31.5' to 34': Concretion zone on west wall, highly fractured. @32.5': Interbedded CLAYSTONE and SANDSTONE, folded with irregular bedding.	
		@32.5' B:N65°W, 70°NE							
445	35	@35' B:N88°E, 90°	R-7 B-4	3				@35': CLAYSTONE with fine SANDSTONE interbeds, blue-green to dark grey, unoxidized, moist, near vertical bedding observed in sample.	
		@37' B:N82°W, 78°NE							
440	40	@40.5' B:N72°W, 90°	R-8	3				@40': CLAYSTONE with fine SANDSTONE interbeds, blue-green to dark grey, unoxidized, moist, near vertical bedding observed in sample.	DS
		@42' B:N85°W, 59°NE						@42': Overturned bedding.	
435	45		R-9	3				@45': CLAYSTONE with fine SANDSTONE interbeds, blue-green to dark grey, unoxidized, moist, near vertical bedding.	
430	50		R-10	4				@50': CLAYSTONE with fine SANDSTONE interbeds, blue-green to dark grey, unoxidized, moist, near vertical bedding.	
425	55								
	60								

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Graphic Log: N S

TOTAL DEPTH: 51 FEET BGS.
No groundwater encountered during drilling.
Downhole logged to 42 feet bgs, terminated downhole logging due to slight sulfer odor.
Boring backfilled with soil cuttings upon completion of logging.

Notes:

Kelly Bar Weights
0 feet to 29 feet: 4800 lbs
30 feet to 58 feet: 3350 lbs
59 feet to 86 feet: 2045 lbs

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LBA-3

Project No.	11588.001	**Date Drilled**	8-2-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	608'
Location		**Sampled By**	JMP

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu):**	
605										
	5			R-1 B-1	2			SILT-STONE	@5': SILTSTONE, light yellow brown, dry, $CaCO_3$ rich, some orange oxidation, powdery texture, heavily fractured to 7.5 feet bgs.	
			@6.5' J:N67°E, 50°NW							
600										
			@8.8' B:N74°W, 58°SW							
	10			R-2	2				@10': SILTSTONE, light yellow brown, dry, $CaCO_3$ rich, some orange oxidation, powdery texture. @11'-12': Randomly oriented concretions, rounded, heavily weathered, within dense, massive SILTSTONE.	
595										
	15			R-3	3				@15': SILTSTONE, light yellow brown, damp, $CaCO_3$ rich, some orange oxidation, powdery texture, increase in orange oxidation and density.	
590										
									@19'-21': Few gypsum stringers, tight.	
	20			R-4	4				@20': SILTSTONE, yellow brown and grey brown with orange oxidation, damp, few hard concretions. @21': Increase in density.	DS
585										
	25		@24.5' J:N5°W, 37°E	R-5 B-2	5				@25': SILTSTONE, yellow brown and grey brown with orange oxidation, damp, few hard concretions.	
580										
	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
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- T TUBE SAMPLE

TYPE OF TESTS:
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GEOTECHNICAL BORING LOG LBA-3

Project No.	11588.001	**Date Drilled**	8-2-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	608'
Location		**Sampled By**	JMP

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-6	8			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @30': SILTSTONE, yellow brown to light grey with orange oxidation, damp, dense, discontinuous 8- to 10-inch thick concretion.	
575										
			@34' J:NS, 65°E						@34': Set of two joints, 3-inches apart within SILTSTONE, orange brown to grey, dense, oxidized, massive.	
	35			R-7	6				@35': SILTSTONE, orange brown to grey brown, damp to moist, dense, oxidized, bedding observed in sample dipping approximately 30 to 35 degrees.	
570										
			@39': B:N65°W, 39°SW							
	40			R-8	6				@40': SILTSTONE, medium yellow to orange brown, damp, oxidized, some concretions.	
565										
			@43.8' B:N52°W, 41°SW							
	45			R-9	6				@45': SILTSTONE, medium yellow to orange brown, damp, oxidized.	
560										
	50			R-10	6				@50': SILTSTONE, medium yellow to orange brown, damp, oxidized, with a concretion.	
555										
	55									
550									@58': Becomes blue-green.	
			@59' J:N70°E,						@59.5': Bedrock is tight, massive, some gypsum stringers 2 to 3 inches apart.	
	60									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
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GEOTECHNICAL BORING LOG LBA-3

Project No.	11588.001	**Date Drilled**	8-2-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	JMP
Drilling Co.	A1-Roy Drilling	**Hole Diameter**	"
Drilling Method	Bucket Auger - Kelly Bar	**Ground Elevation**	608'
Location		**Sampled By**	JMP

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60		40°NW	R-11 B-3	12			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @60': SILTSTONE, dark olive grey, trace blue-green color, damp, mostly unoxidized, few gypsum stringers.	
545										
	65									
540										
	70			R-12	9				@70': SILTSTONE, dark olive grey, trace blue-green color, damp, mostly unoxidized, few gypsum stringers. @71': PID = 35 ppm from cuttings at depth recorded at the ground surface.	DS
535									@73': PID = 51 ppm from cuttings at depth recorded at the ground surface.	
	75									
530									**TOTAL DEPTH: 78 FEET BGS.** **No groundwater encountered during drilling.** **Downhole logged to 76 feet bgs.** **Boring backfilled with soil cuttings upon completion of drilling and logging.** **Notes:** **Kelly Bar Weights** **0 feet to 29 feet: 4800 lbs** **30 feet to 58 feet: 3350 lbs** **59 feet to 86 feet: 2045 lbs**	
	80									
525										
	85									
520										
	90									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
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TYPE OF TESTS:
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APPENDIX B.4

Cone Penetration Test Soundings

SUMMARY

OF

CONE PENETRATION TEST DATA

Project:

Tonner Canyon Road & SR-57
Brea, CA
August 6-7, 2018

Prepared for:

Mr. John Haertle
Leighton Consulting
17781 Cowan
Irvine, CA 92614-6009
Office (800) 253-4567 / Fax (949) 250-1114

Prepared by:

KEHOE TESTING & ENGINEERING
5415 Industrial Drive
Huntington Beach, CA 92649-1518
Office (714) 901-7270 / Fax (714) 901-7289
www.kehoetesting.com

TABLE OF CONTENTS

SUMMARY

OF

CONE PENETRATION TEST DATA

1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the project located at Tonner Canyon Road & SR-57 in Brea, California. The work was performed by Kehoe Testing & Engineering (KTE) on August 6-7, 2018. The scope of work was performed as directed by Leighton Consulting personnel.

2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at nine locations to determine the soil lithology. Groundwater measurements and hole collapse depths provided in **TABLE 2.1** are for information only. The readings indicate the apparent depth to which the hole is open and the apparent water level (if encountered) in the CPT probe hole at the time of measurement upon completion of the CPT. KTE does not warranty the accuracy of the measurements and the reported water levels may not represent the true or stabilized groundwater levels.

LOCATION	DEPTH OF CPT (ft)	COMMENTS/NOTES:
C-2	36	Refusal, hole open to 10.3 ft (dry)
C-4	34	Groundwater @ 29.0 ft
C-5	30	Hole open to 27.0 ft (dry)
C-7	33	Refusal, groundwater @ 15.0 ft
C-8	31	Refusal, hole open to 10.0 ft (dry)
C-9	55	Hole open to 18.0 ft (dry)
SC-1	29	Refusal, hole open to 12.0 ft (dry)
SC-3	65	Refusal, hole open to 3.2 ft (dry)
SC-6	6	Refusal, hole open to 4.5 ft (dry)

TABLE 2.1 - Summary of CPT Soundings

3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by **KTE** using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm^2 cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
- Pore Pressure Dissipation (at selected depths)

At locations SC-1, SC-3 & SC-6 shear wave measurements were obtained at various depths. The shear wave is generated using an air-actuated hammer, which is located inside the front jack of the CPT rig. The cone has a triaxial geophone, which recorded the shear wave signal generated by the air hammer.

The above parameters were recorded and viewed in real time using a laptop computer. Data is stored at the KTE office for up to 2 years for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring base line readings ensures that the cone electronics are operating properly.

4. CONE PENETRATION TEST DATA & INTERPRETATION

The Cone Penetration Test data is presented in graphical form in the attached Appendix. These plots were generated using the CPeT-IT program. Penetration depths are referenced to ground surface. The soil classification on the CPT plots is derived from the attached CPT Classification Chart (Robertson) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance (qc), sleeve friction (fs), and penetration pore pressure (u). The friction ratio (Rf), which is sleeve friction divided by cone resistance, is a calculated parameter that is used along with cone resistance to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

Tables of basic CPT output from the interpretation program CPeT-IT are provided for CPT data averaged over one foot intervals in the Appendix. We recommend a geotechnical engineer review the assumed input parameters and the calculated output from the CPeT-IT program. A summary of the equations used for the tabulated parameters is provided in the Appendix.

It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. In these situations, experience, judgement and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

KEHOE TESTING & ENGINEERING

Richard W. Koester, Jr.
General Manager

08/13/18-hh-9616

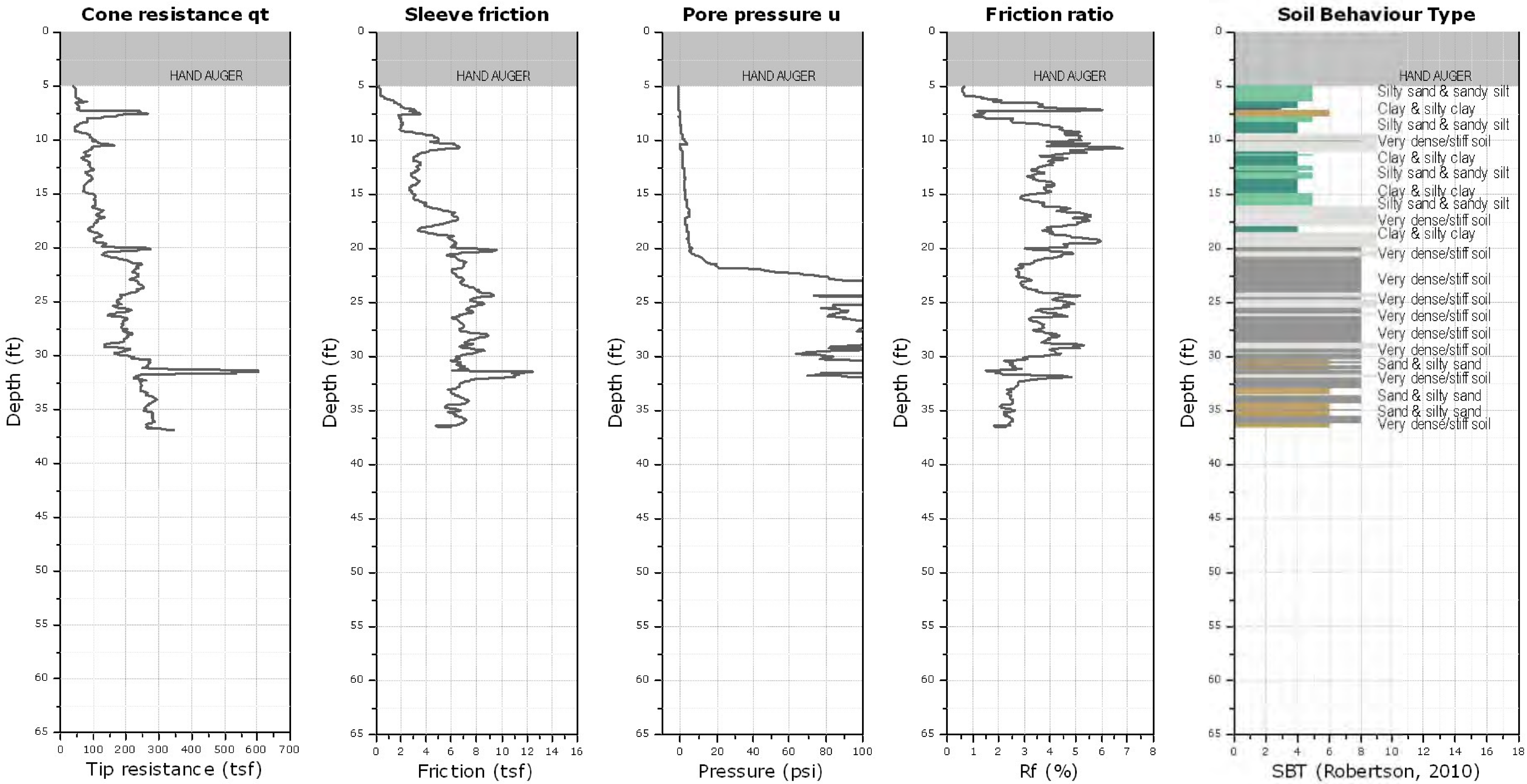
APPENDIX

Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

C-2

Project: Leighton Consulting
Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 36.95 ft, Date: 8/6/2018
Cone Type: Vertek



Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

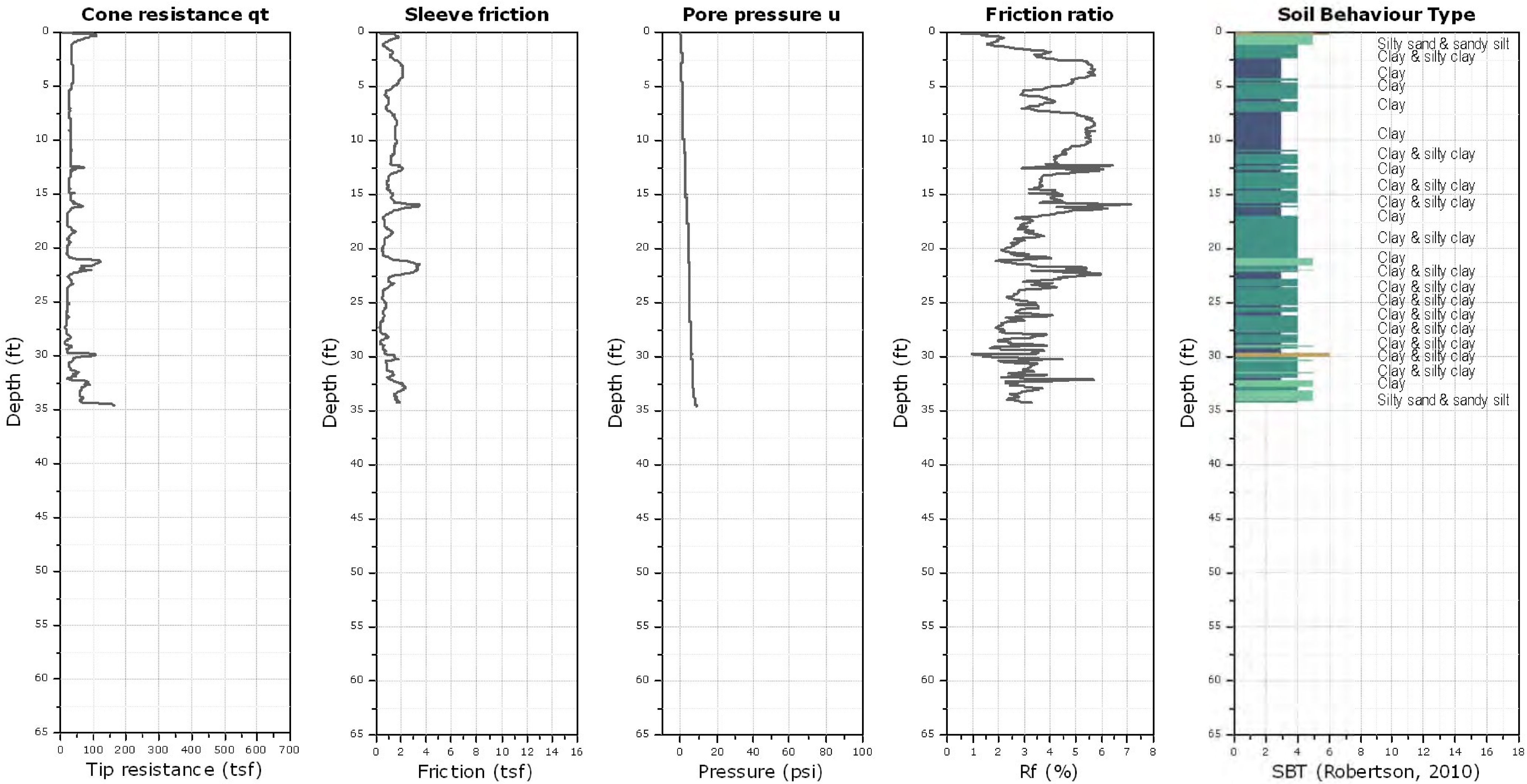
C-4

Project: Leighton Consulting

Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 34.67 ft, Date: 8/7/2018

Cone Type: Vertek

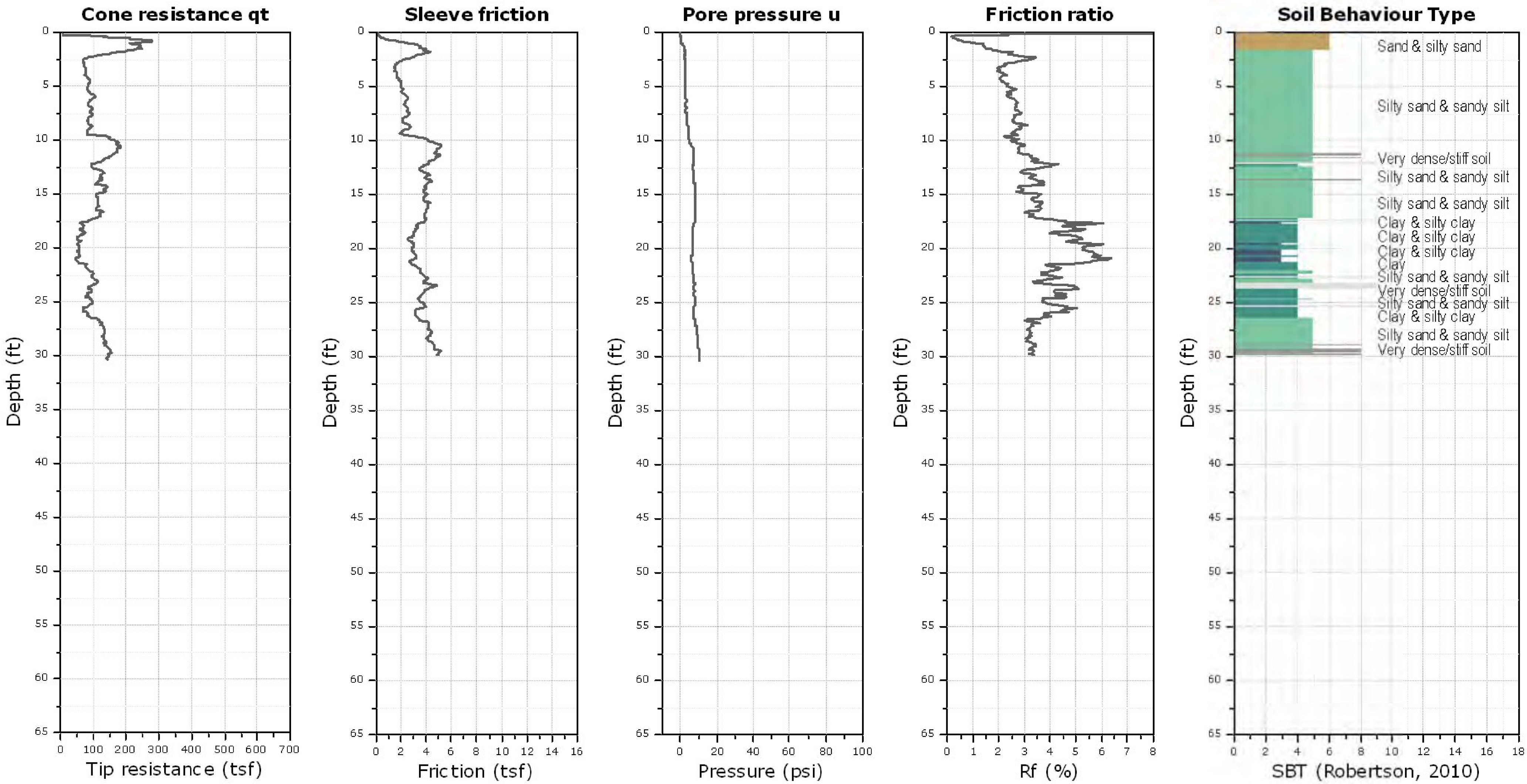


Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

C-5

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 30.33 ft, Date: 8/7/2018
Cone Type: Vertek

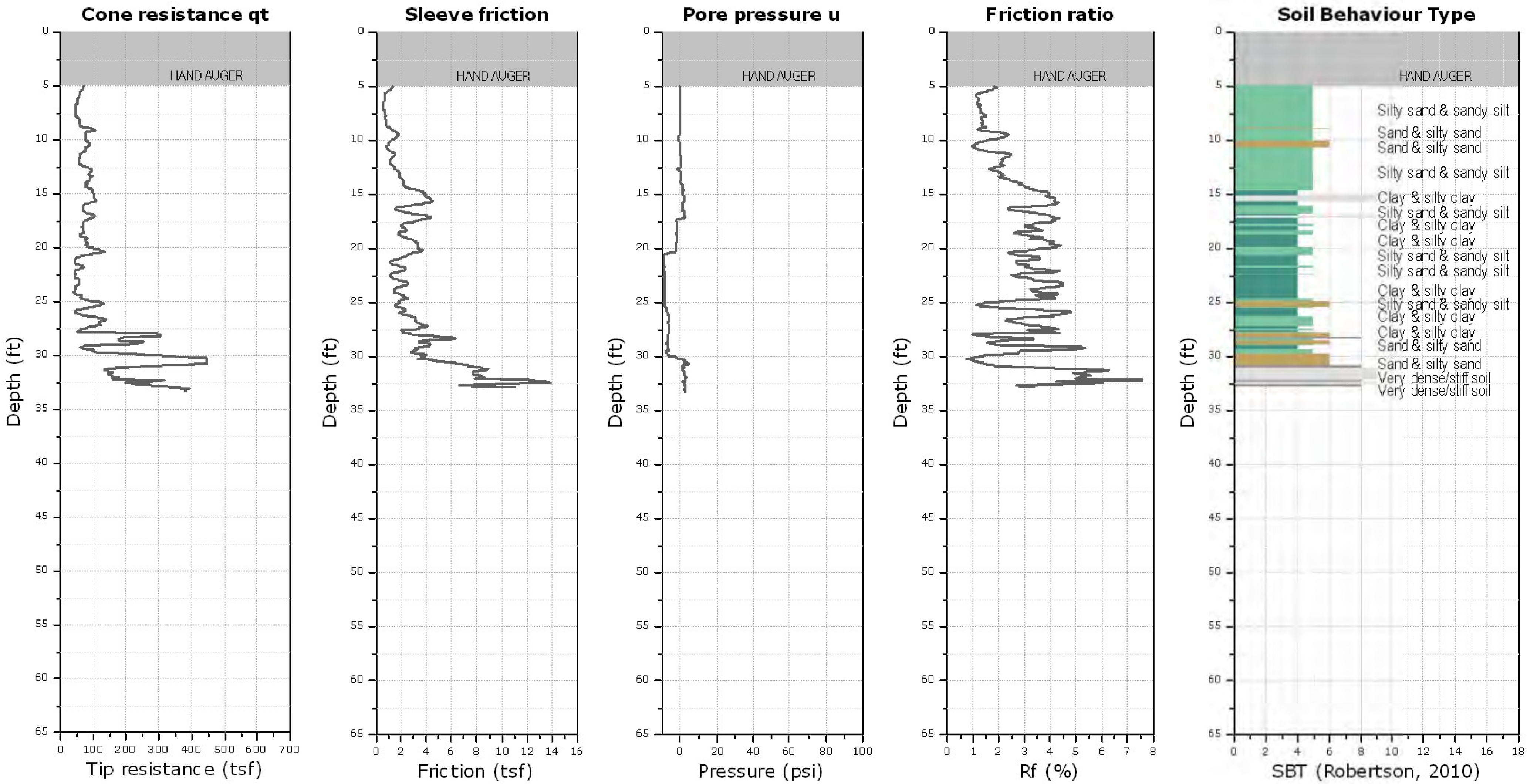


Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

C-7

Project: Leighton Consulting
Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 33.28 ft, Date: 8/6/2018
Cone Type: Vertek

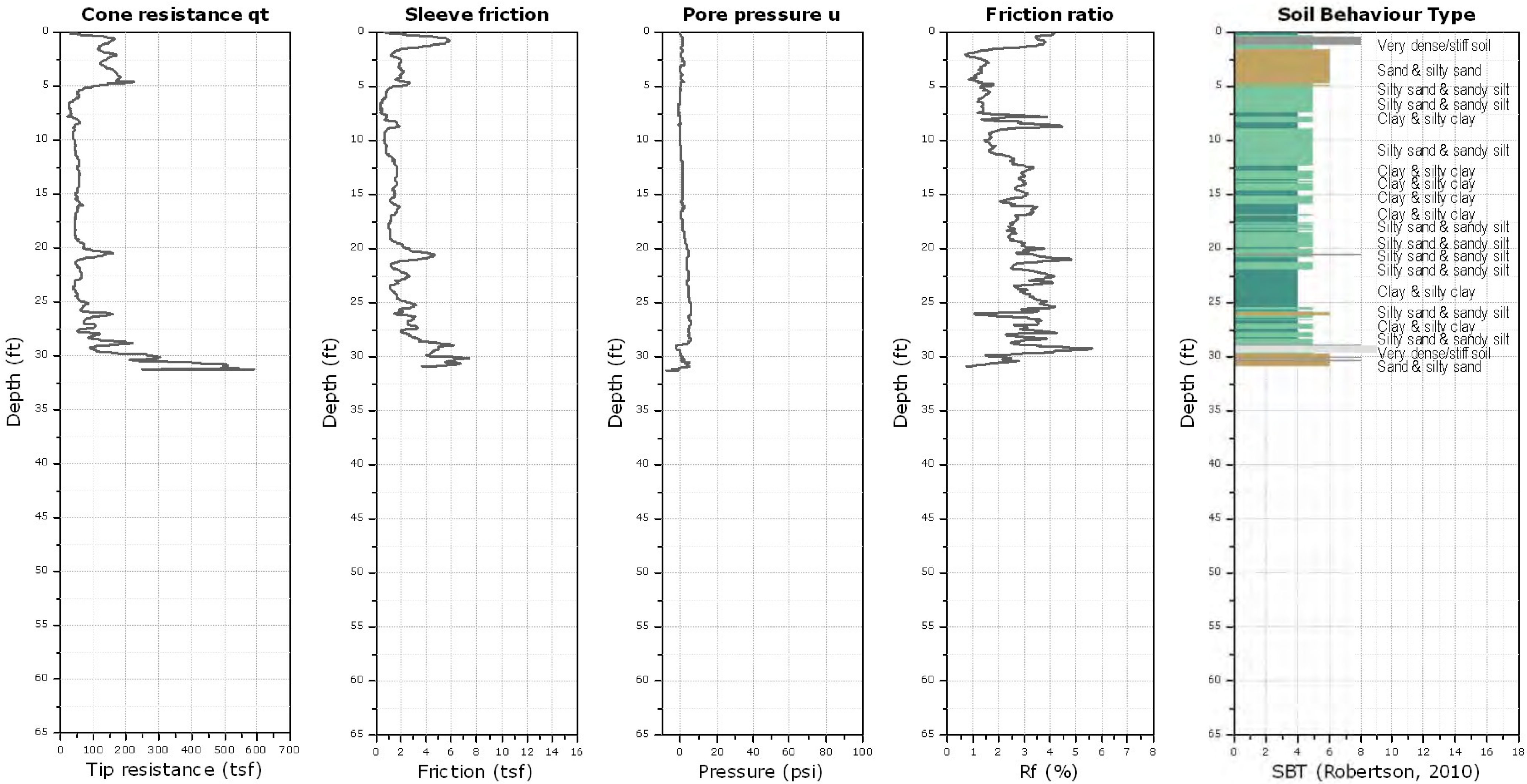


Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

C-8

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 31.31 ft, Date: 8/7/2018
Cone Type: Vertek



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rich@kehoetesting.com
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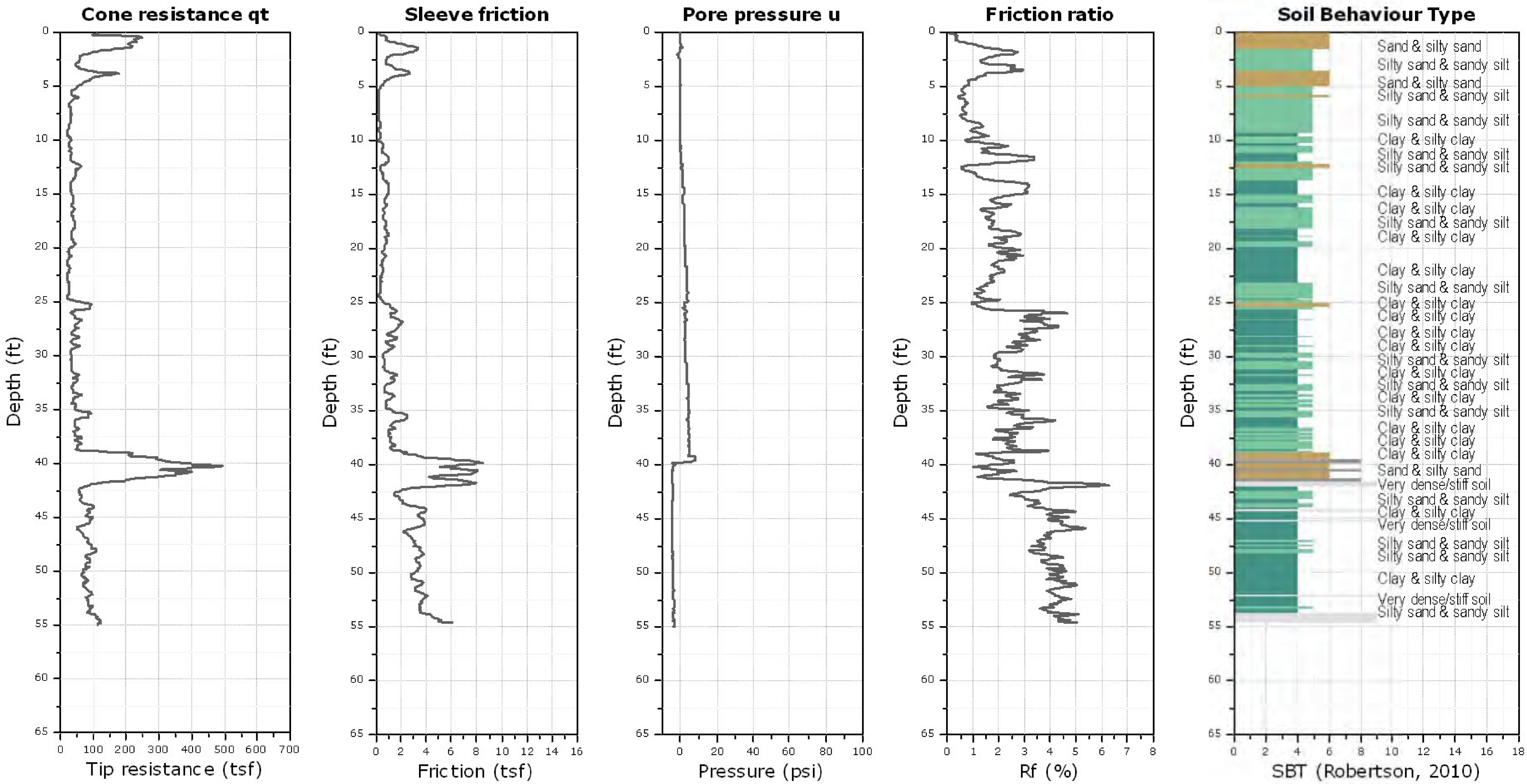
C-9

Project: Leighton Consulting

Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 55.06 ft, Date: 8/7/2018

Cone Type: Vertek



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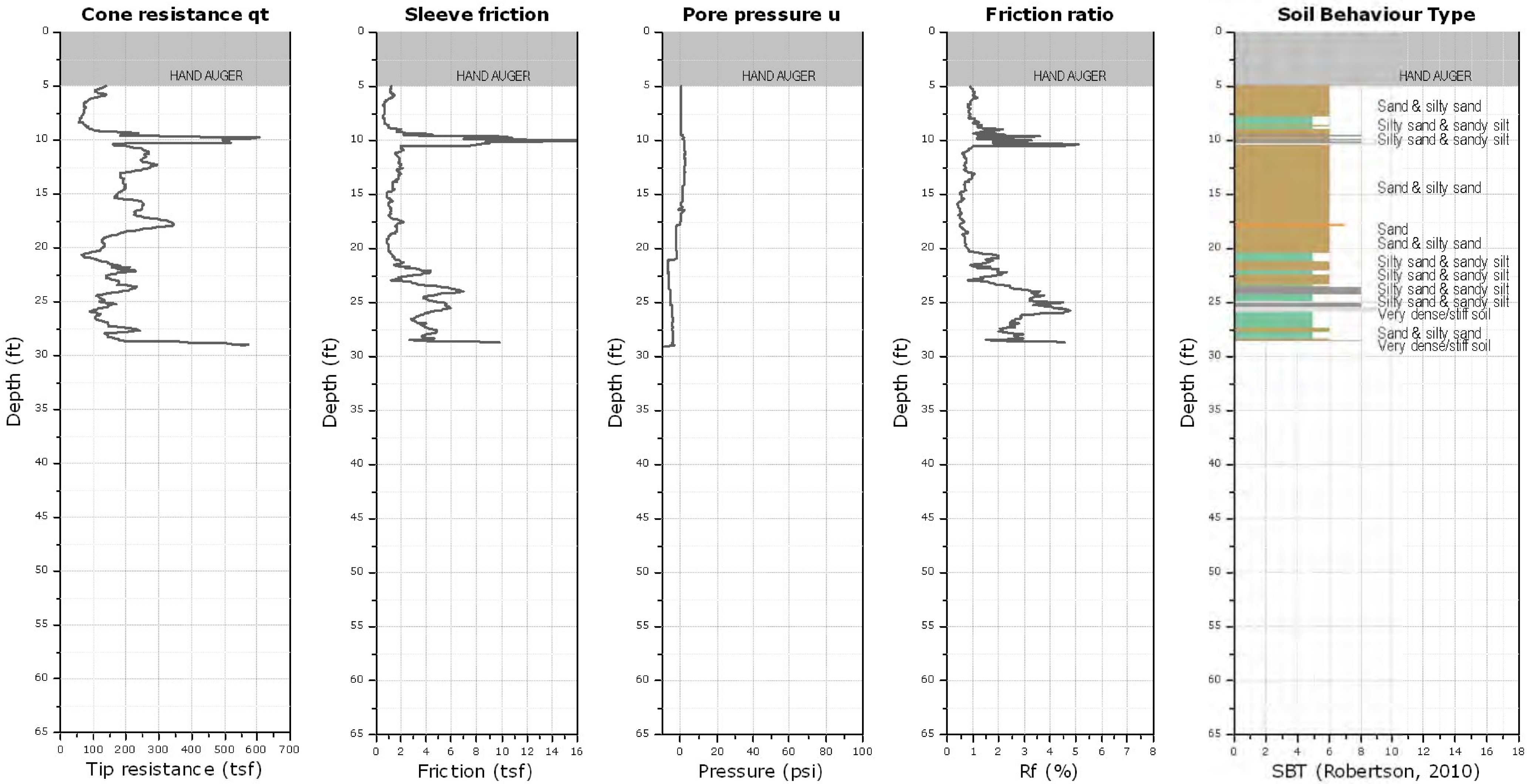
rich@kehoetesting.com
www.kehoetesting.com

SC-1

Project: **Leighton Consulting**
Total depth: 29.07 ft, Date: 8/6/2018

Location: **Tonner Canyon Road & SR-57 Brea, CA**
Cone Type: Vertek

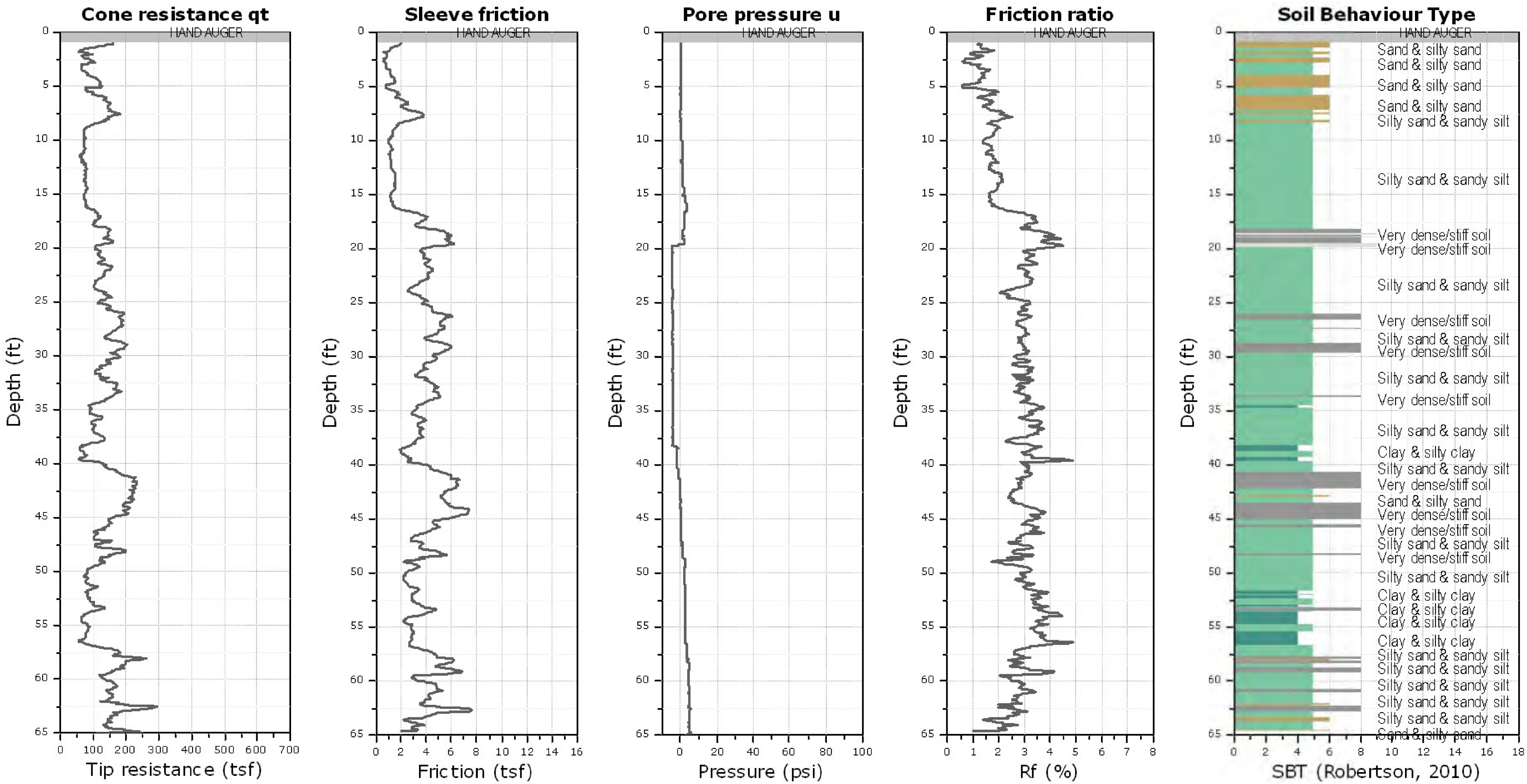


Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

SC-3

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 65.06 ft, Date: 8/7/2018
Cone Type: Vertek



Kehoe Testing and Engineering
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rich@kehoetesting.com
www.kehoetesting.com

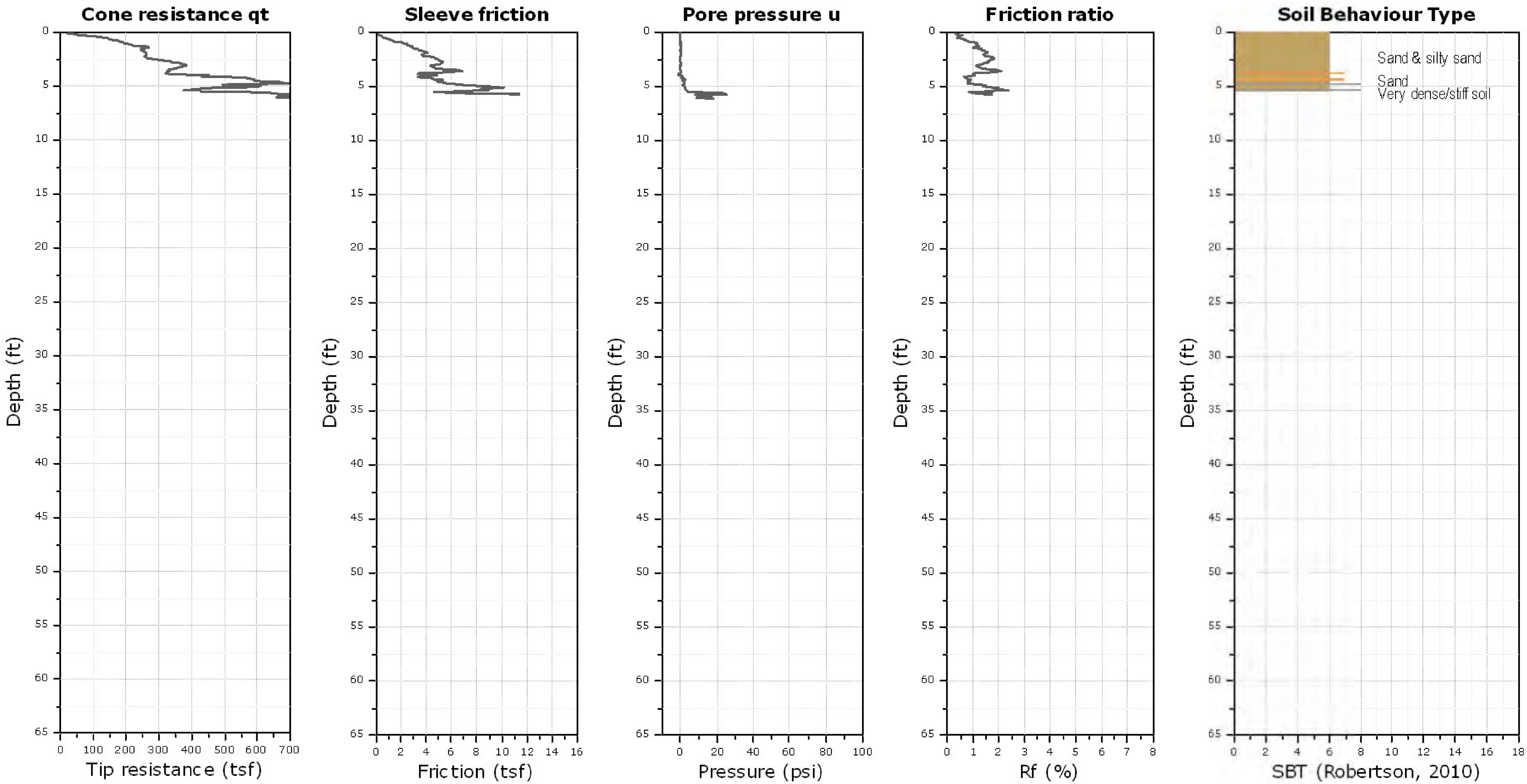
SC-6

Project: Leighton Consulting

Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 6.17 ft, Date: 8/7/2018

Cone Type: Vertek



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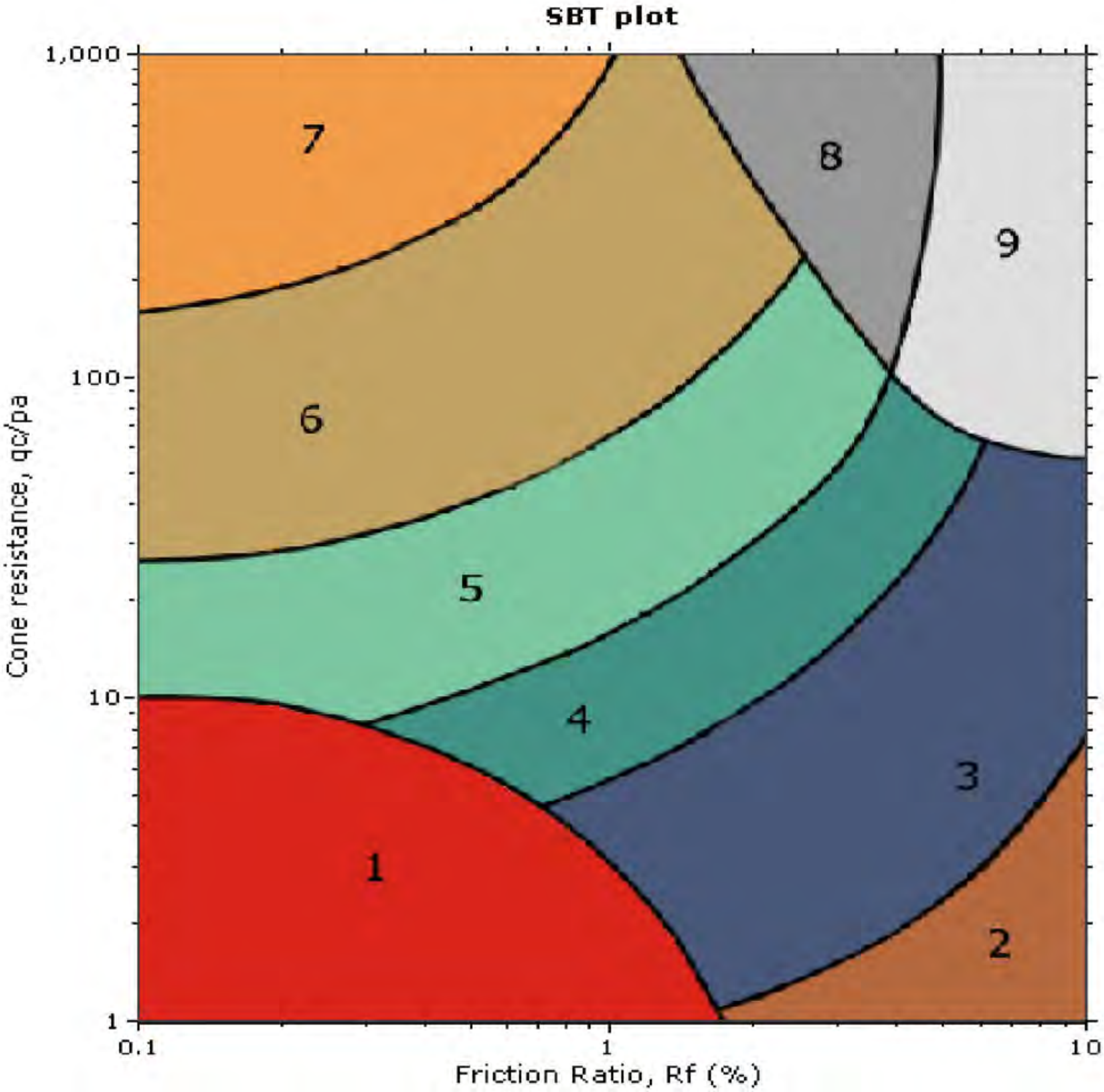


SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

	C-2	In situ data										Basic output data												
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	91.73	0.73	0.1	-1.56	91.74	0.8	6	1.9	119.1	0.06	0	0.06	1538.5	0.8	0	6	0.42	3.39	1.5	293.75	0.12	99.62	7
2	45.13	0.45	-0.2	-1.58	45.12	1	5	2.21	113.81	0.12	0	0.12	386.21	1	0	6	0.54	3.3	1.8	140.22	-0.12	71.35	7
3	34.19	0.43	-0.3	-1.5	34.18	1.25	5	2.36	112.71	0.17	0	0.17	196.89	1.25	0	6	0.61	3.04	1.98	97.84	-0.12	56	7
4	34.84	0.5	-0.4	-1.8	34.83	1.44	5	2.39	113.94	0.23	0	0.23	150.62	1.45	0	5	0.65	2.68	2.06	87.66	-0.12	49.65	7
5	38.29	0.25	-0.7	-1.94	38.28	0.64	5	2.17	108.98	0.28	0	0.28	133.65	0.65	0	6	0.58	2.15	1.89	77.31	-0.18	72.67	7
6	46.58	0.82	-0.93	-1.97	46.57	1.76	5	2.34	118.26	0.34	0	0.34	134.6	1.77	0	5	0.67	2.12	2.1	92.46	-0.2	43.79	7
7	54.01	1.83	-1.09	-2.4	54	3.39	4	2.48	124.5	0.41	0	0.41	132.09	3.41	0	5	0.74	2.03	2.28	102.73	-0.19	26.8	5
8	83.85	1.96	-0.07	-3.43	83.85	2.34	5	2.23	126.07	0.47	0	0.47	177.94	2.35	0	5	0.66	1.72	2.08	135.34	-0.01	37.48	7
9	43.83	2.94	0.4	-3.38	43.83	6.7	3	2.76	127.46	0.53	0	0.53	81.33	6.79	0	9	0.87	1.81	2.6	74.23	0.05	14.68	3
10	99.02	5.37	2.24	-3.35	99.05	5.42	9	2.46	133.86	0.6	0	0.6	164.27	5.45	0	9	0.78	1.55	2.35	144.57	0.27	18.02	3
11	81.43	5.32	1.53	-3.32	81.46	6.54	9	2.58	133.32	0.67	0	0.67	121.3	6.59	0	9	0.83	1.47	2.48	112.04	0.17	15.1	3
12	81.17	3.14	1.49	-3.15	81.19	3.87	4	2.4	129.45	0.73	0	0.73	110.1	3.9	0	4	0.77	1.33	2.33	101.21	0.15	23.92	5
13	78.79	3.35	1.89	-2.92	78.81	4.25	4	2.44	129.85	0.8	0	0.8	98.06	4.29	0	9	0.8	1.26	2.39	92.54	0.17	21.95	3
14	78.4	3.09	2.09	-2.78	78.43	3.94	4	2.42	129.25	0.86	0	0.86	90.17	3.99	0	4	0.8	1.18	2.38	86.47	0.17	23.26	5
15	92.08	2.94	2.98	-2.61	92.12	3.2	5	2.31	129.29	0.92	0	0.92	98.6	3.23	0	5	0.76	1.11	2.28	95.51	0.23	27.88	5
16	104.01	4.39	3.95	-2.46	104.07	4.22	9	2.36	132.51	0.99	0	0.99	103.99	4.26	0	9	0.79	1.05	2.36	102.6	0.29	22.2	5
17	112.18	5.98	5.16	-2.37	112.26	5.33	9	2.42	134.96	1.06	0	1.06	105.03	5.38	0	9	0.83	1	2.43	105.04	0.35	18.12	3
18	99.84	5.18	3.38	-2.21	99.89	5.19	9	2.45	133.63	1.13	0	1.13	87.76	5.25	0	9	0.84	0.95	2.47	88.61	0.22	18.43	3
19	118.71	5.1	4.27	-2.05	118.77	4.3	9	2.33	133.93	1.19	0	1.19	98.61	4.34	0	9	0.81	0.91	2.37	100.9	0.26	21.84	3
20	236.73	6.06	6.55	-1.98	236.83	2.56	5	1.98	136.88	1.26	0	1.26	186.83	2.57	0	5	0.68	0.89	2.01	197.78	0.37	35.88	7
21	175.66	6.1	12.61	-2.11	175.85	3.47	8	2.16	136.2	1.33	0	1.33	131.31	3.5	0.01	8	0.75	0.84	2.21	138.89	0.68	26.79	5
22	228.01	6.79	44.96	-1.73	228.66	2.97	8	2.04	137.37	1.4	0	1.4	162.59	2.99	0.01	8	0.71	0.82	2.09	176.12	2.32	31.22	5
23	217.96	6.93	121.87	-1.57	219.72	3.15	8	2.07	137.37	1.47	0	1.47	148.85	3.18	0.04	8	0.73	0.79	2.13	162.43	5.98	29.44	5
24	231.53	7.64	239.28	-1.13	234.97	3.25	8	2.06	137.37	1.53	0	1.53	152.08	3.27	0.07	8	0.74	0.76	2.14	167.74	11.22	28.72	5
25	176.18	7.4	119	-0.91	177.9	4.16	8	2.22	137.37	1.6	0	1.6	109.93	4.2	0.05	9	0.81	0.72	2.31	119.14	5.34	22.66	5
26	189.79	6.95	85.58	-0.83	191.02	3.64	8	2.15	137.35	1.67	0	1.67	113.22	3.67	0.03	8	0.79	0.7	2.25	124.78	3.68	25.54	5
27	187.73	6.63	108.09	-0.75	189.29	3.5	8	2.14	136.99	1.74	0	1.74	107.73	3.53	0.04	8	0.79	0.67	2.25	119.61	4.47	26.3	5
28	214.95	6.95	103.31	-0.41	216.44	3.21	8	2.08	137.37	1.81	0	1.81	118.61	3.24	0.03	5	0.77	0.66	2.19	134.2	4.11	28.58	5
29	134.63	7.39	94.46	-0.02	135.99	5.44	9	2.38	136.98	1.88	0	1.88	71.41	5.51	0.05	9	0.9	0.6	2.53	75.57	3.62	17.59	3
30	199.08	7.37	83.7	0.28	200.29	3.68	8	2.15	137.37	1.95	0	1.95	101.88	3.71	0.03	8	0.81	0.61	2.28	114.35	3.1	25.13	5
31	260.11	8.36	288.97	1.09	264.28	3.16	8	2.03	137.37	2.02	0	2.02	130.12	3.19	0.08	8	0.77	0.61	2.15	151.34	10.32	29.2	5
32	231.77	9.71	109.49	0.65	233.35	4.16	8	2.16	137.37	2.08	0	2.08	110.96	4.2	0.03	9	0.82	0.57	2.3	125	3.78	22.69	5
33	240.96	6.59	240.31	-0.07	244.42	2.69	8	1.99	137.37	2.15	0	2.15	112.54	2.72	0.07	5	0.76	0.58	2.13	133.04	8.04	33.14	7
34	285.59	6.17	545.39	-0.39	293.45	2.1	6	1.85	137.37	2.22	0	2.22	131.1	2.12	0.13	5	0.72	0.59	1.99	161.95	17.68	41.64	7
35	256.55	5.96	327.91	-0.39	261.27	2.28	6	1.91	137	2.29	0	2.29	113.09	2.3	0.09	5	0.75	0.56	2.07	137.57	10.31	38.15	7
36	276.13	0	647.02	-0.23	285.45	0	0	0	87.42	2.33	0	2.33	121.31	0	0.16	0	1	0.45	0	121.31	19.96	187.59	0

	C-4	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	38.41	1.21	0.69	0.53	38.42	3.14	4	2.57	120.61	0.06	0	0.06	635.7	3.14	0	8	0.64	6.18	2.05	223.93	0.83	30.25	5
2	32.84	1.33	1.09	0.4	32.86	4.04	4	2.69	120.93	0.12	0	0.12	270.88	4.05	0	8	0.71	4.69	2.25	145.2	0.65	23.58	5
3	35.72	1.86	0.99	0.38	35.74	5.22	3	2.74	123.63	0.18	0	0.18	194.82	5.24	0	9	0.76	3.81	2.37	127.91	0.39	18.62	3
4	37.71	1.99	0.99	0.4	37.72	5.27	3	2.73	124.23	0.24	0	0.24	153.19	5.3	0	9	0.78	3.13	2.41	110.88	0.29	18.38	3
5	34.18	1.4	1.19	0.45	34.2	4.1	4	2.68	121.43	0.31	0	0.31	110.96	4.13	0	4	0.78	2.63	2.4	84.22	0.28	22.54	5
6	24.84	0.81	1.19	0.42	24.85	3.24	4	2.72	116.61	0.36	0	0.36	67.33	3.29	0	4	0.8	2.35	2.45	54.49	0.24	25.86	5
7	27.14	1.11	1.32	0.42	27.16	4.07	4	2.76	119.14	0.42	0	0.42	63.16	4.14	0	4	0.83	2.14	2.53	54.18	0.22	21.82	3
8	28.79	1.46	1.39	0.38	28.81	5.07	3	2.8	121.31	0.48	0	0.48	58.54	5.15	0	4	0.87	1.97	2.61	52.7	0.21	18.35	3
9	27.64	1.59	1.69	0.4	27.66	5.74	3	2.85	121.83	0.54	0	0.54	49.78	5.85	0	3	0.9	1.82	2.68	46.53	0.22	16.51	3
10	28.67	1.52	1.79	0.38	28.69	5.28	3	2.81	121.58	0.61	0	0.61	46.37	5.39	0	4	0.9	1.65	2.67	43.81	0.21	17.56	3
11	31.62	1.37	2.48	0.35	31.66	4.32	4	2.72	121.07	0.67	0	0.67	46.52	4.42	0.01	4	0.88	1.5	2.61	43.94	0.27	20.42	3
12	28.86	1.55	2.58	0.34	28.9	5.35	3	2.82	121.74	0.73	0	0.73	38.74	5.49	0.01	3	0.92	1.41	2.73	37.64	0.26	17.22	3
13	30.22	1.71	2.88	0.45	30.26	5.66	3	2.82	122.6	0.79	0	0.79	37.39	5.81	0.01	3	0.94	1.32	2.75	36.68	0.26	16.49	3
14	25.49	1.01	3.18	0.55	25.54	3.95	4	2.77	118.31	0.85	0	0.85	29.13	4.09	0.01	4	0.93	1.23	2.72	28.66	0.27	20.66	3
15	30.75	1.21	3.33	0.49	30.79	3.94	4	2.71	120.13	0.91	0	0.91	32.93	4.06	0.01	4	0.91	1.15	2.68	32.5	0.26	21.03	3
16	53.24	1.33	3.53	0.47	53.29	2.5	5	2.4	122.15	0.97	0	0.97	54.01	2.55	0	5	0.8	1.07	2.39	53.09	0.26	30.74	5
17	19.31	0.95	3.87	0.63	19.36	4.88	3	2.92	117.16	1.03	0	1.03	17.85	5.15	0.02	3	1	1.03	2.94	17.85	0.27	17.19	3
18	22.59	0.85	4.07	0.63	22.65	3.76	3	2.79	116.79	1.09	0	1.09	19.87	3.95	0.01	3	0.98	0.98	2.83	19.88	0.27	20.11	3
19	25.37	1.03	4.27	0.65	25.43	4.04	3	2.77	118.43	1.14	0	1.14	21.22	4.23	0.01	3	0.98	0.93	2.83	21.25	0.27	19.55	3
20	21.96	0.63	4.37	0.65	22.02	2.85	4	2.73	114.49	1.2	0	1.2	17.32	3.02	0.02	4	0.98	0.88	2.8	17.38	0.26	22.35	5
21	41.27	1.61	4.64	0.61	41.33	3.9	4	2.61	122.92	1.26	0	1.26	31.71	4.02	0.01	4	0.93	0.85	2.68	32.1	0.26	21.15	3
22	62.38	2.57	5.16	0.59	62.46	4.12	4	2.5	127.35	1.33	0	1.33	46.06	4.21	0.01	4	0.89	0.82	2.57	47.18	0.28	21.29	3
23	31.71	1.02	5.36	0.63	31.79	3.19	4	2.63	118.89	1.39	0	1.39	21.93	3.34	0.01	4	0.96	0.77	2.75	22.15	0.28	22.33	5
24	20.44	0.78	5.36	0.73	20.51	3.79	3	2.83	115.88	1.44	0	1.44	13.2	4.08	0.02	3	1	0.73	2.98	13.2	0.27	18.73	3
25	21.06	0.55	5.36	0.77	21.13	2.58	4	2.72	113.36	1.5	0	1.5	13.08	2.78	0.02	3	1	0.7	2.88	13.08	0.26	21.69	2
26	17.6	0.6	5.46	0.75	17.68	3.39	3	2.85	113.61	1.56	0	1.56	10.35	3.72	0.02	3	1	0.68	3.04	10.35	0.25	18.76	2
27	15.35	0.44	5.56	0.76	15.43	2.88	3	2.85	111.07	1.61	0	1.61	8.56	3.21	0.03	3	1	0.66	3.07	8.56	0.25	19.04	2
28	20.11	0.35	5.66	0.77	20.19	1.71	4	2.63	109.9	1.67	0	1.67	11.1	1.87	0.02	4	1	0.63	2.85	11.1	0.24	23.26	4
29	18.05	0.48	5.76	0.79	18.13	2.67	4	2.78	112.11	1.72	0	1.72	9.51	2.95	0.03	3	1	0.61	3.01	9.51	0.24	19.89	2
30	103.71	0.78	6.06	0.67	103.8	0.75	6	1.84	119.86	1.78	0	1.78	57.17	0.77	0	6	0.69	0.7	1.98	67.28	0.24	63.6	7
31	26.85	1.12	6.55	0.59	26.94	4.16	4	2.76	119.22	1.84	0	1.84	13.61	4.47	0.02	3	1	0.57	2.99	13.61	0.26	18.05	3
32	32.73	1.69	6.65	0.61	32.82	5.14	3	2.76	122.7	1.91	0	1.91	16.22	5.46	0.02	3	1	0.56	2.99	16.22	0.25	16.53	3
33	62.66	1.88	7.31	0.65	62.77	3	5	2.4	125.09	1.97	0	1.97	30.9	3.1	0.01	4	0.94	0.56	2.6	32.16	0.27	24.84	5
34	66.19	0	7.94	0.51	66.31	0	0	0	87.42	2.01	0	2.01	31.96	0	0.01	0	1	0.53	0	31.96	0.28	59.94	0

Depth (ft)	C-5 qc (tsf)	In situ data fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	Basic output data ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	221.62	1.92	0.91	0.69	221.63	0.87	6	1.63	128.3	0.06	0	0.06	3451.6	0.87	0	6	0.37	2.82	1.35	590.04	1.02	103.2	7
2	154.44	3.22	2.58	0.95	154.48	2.08	5	2.02	131.2	0.13	0	0.13	1188.8	2.08	0	8	0.52	2.99	1.75	436.64	1.43	45.58	7
3	71.17	1.84	2.72	0.93	71.21	2.58	5	2.31	125.2	0.19	0	0.19	369.38	2.58	0	5	0.63	2.91	2.01	195.4	1.02	35.72	7
4	76.41	1.73	2.78	0.87	76.45	2.26	5	2.25	124.92	0.25	0	0.25	299.08	2.26	0	5	0.62	2.42	2	174.53	0.79	39.67	7
5	84.49	2.06	2.88	0.87	84.53	2.43	5	2.24	126.46	0.32	0	0.32	264.78	2.44	0	5	0.64	2.15	2.03	171.2	0.65	37.1	7
6	103.55	2.22	3.18	0.69	103.59	2.14	5	2.14	127.5	0.38	0	0.38	270.3	2.15	0	6	0.62	1.88	1.97	182.94	0.6	41.64	7
7	93.98	2.37	3.28	0.45	94.02	2.52	5	2.22	127.75	0.45	0	0.45	209.93	2.53	0	5	0.66	1.77	2.07	156.16	0.53	35.69	7
8	83.53	2.63	3.68	0.22	83.59	3.15	5	2.33	128.23	0.51	0	0.51	162.99	3.17	0	5	0.71	1.68	2.19	131.62	0.52	29.09	5
9	84.98	2.77	4.07	0.08	85.04	3.25	5	2.33	128.63	0.57	0	0.57	147.14	3.27	0	5	0.72	1.55	2.21	124.05	0.51	28.16	5
10	157.72	3.7	4.93	-0.03	157.79	2.34	5	2.05	132.27	0.64	0	0.64	245.46	2.35	0	6	0.63	1.37	1.97	203.9	0.55	38.9	7
11	171.55	4.94	7.55	-0.59	171.66	2.88	5	2.1	134.59	0.71	0	0.71	241.6	2.89	0	8	0.66	1.3	2.03	210.58	0.77	32.52	7
12	124	4.25	7.65	-0.99	124.11	3.42	5	2.25	132.7	0.77	0	0.77	159.36	3.45	0	8	0.72	1.25	2.19	146.04	0.71	27.23	5
13	132.45	3.75	7.36	-1.13	132.55	2.83	5	2.16	131.95	0.84	0	0.84	156.85	2.85	0	5	0.7	1.18	2.12	146.3	0.63	32.11	7
14	110.84	4.22	7.85	-0.87	110.96	3.8	5	2.31	132.37	0.91	0	0.91	121.47	3.83	0.01	8	0.76	1.13	2.28	117.08	0.62	24.5	5
15	111.4	3.85	8.05	-0.89	111.52	3.45	5	2.28	131.72	0.97	0	0.97	113.74	3.48	0.01	5	0.76	1.07	2.26	111.43	0.6	26.5	5
16	112.81	3.94	8.09	-1.07	112.93	3.49	5	2.28	131.91	1.04	0	1.04	107.8	3.52	0.01	5	0.77	1.01	2.28	107.32	0.56	26.22	5
17	122.04	3.79	8.42	-1.29	122.16	3.1	5	2.22	131.82	1.1	0	1.1	109.67	3.13	0.01	5	0.75	0.97	2.23	110.83	0.55	29.01	5
18	65.86	3.33	7.13	-1.55	65.96	5.05	4	2.55	129.37	1.17	0	1.17	55.46	5.14	0.01	4	0.89	0.92	2.59	56.06	0.44	18.46	3
19	53.18	2.99	6.91	-1.65	53.28	5.62	4	2.65	128.08	1.23	0	1.23	42.23	5.75	0.01	3	0.94	0.87	2.7	42.63	0.4	16.69	3
20	54.97	3.06	6.46	-1.49	55.06	5.55	4	2.63	128.31	1.3	0	1.3	41.46	5.69	0.01	3	0.94	0.83	2.7	41.96	0.36	16.84	3
21	47.79	3.17	6.26	-1.56	47.88	6.61	3	2.73	128.22	1.36	0	1.36	34.18	6.81	0.01	3	0.99	0.78	2.82	34.28	0.33	14.6	3
22	85.46	3.43	6.76	-1.62	85.55	4.01	4	2.4	130.23	1.43	0	1.43	59	4.08	0.01	4	0.86	0.77	2.49	61.43	0.34	22.29	5
23	108.92	4.1	7.58	-1.77	109.03	3.76	5	2.31	132.13	1.49	0	1.49	72.09	3.81	0.01	4	0.84	0.75	2.4	76.28	0.37	23.9	5
24	92.69	3.92	7.91	-1.7	92.81	4.23	4	2.4	131.41	1.56	0	1.56	58.58	4.3	0.01	4	0.88	0.71	2.5	61.43	0.37	21.38	3
25	97.07	3.25	7.94	-1.3	97.19	3.34	5	2.3	130.13	1.62	0	1.62	58.89	3.4	0.01	4	0.85	0.7	2.42	62.81	0.35	25.7	5
26	81.66	3.31	7.45	-0.94	81.77	4.05	4	2.42	129.85	1.69	0	1.69	47.45	4.13	0.01	4	0.9	0.66	2.55	49.66	0.32	21.68	3
27	125.39	3.78	8.25	-1.21	125.51	3.01	5	2.2	131.86	1.75	0	1.75	70.57	3.05	0	5	0.82	0.66	2.33	77.31	0.34	28.55	5
28	132.18	4.36	9.4	-1.54	132.32	3.3	5	2.21	133.05	1.82	0	1.82	71.7	3.34	0.01	5	0.83	0.64	2.35	78.54	0.37	26.62	5
29	135.22	4.58	9.94	-1.64	135.37	3.38	5	2.22	133.46	1.89	0	1.89	70.75	3.43	0.01	5	0.84	0.62	2.36	77.63	0.38	26.07	5
30	146.36	0	10.64	-1.85	146.51	0	0	0	87.42	1.93	0	1.93	74.89	0	0.01	0	1	0.55	0	74.89	0.4	121.28	0

	C-7	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	73.76	0.8	0	0.28	73.76	1.09	5	2.06	119.22	0.06	0	0.06	1235.6	1.09	0	6	0.47	3.89	1.63	270.89	0	77.01	7
2	54.05	0.67	-0.05	0.23	54.05	1.24	5	2.2	117.15	0.12	0	0.12	456.04	1.24	0	6	0.55	3.31	1.81	168.89	-0.03	63.9	7
3	58.05	0.7	0.1	0.22	58.05	1.21	5	2.17	117.64	0.18	0	0.18	327.11	1.21	0	6	0.56	2.72	1.84	148.83	0.04	63.55	7
4	79.7	1.06	0	0.22	79.7	1.33	5	2.08	121.44	0.24	0	0.24	334.31	1.33	0	6	0.56	2.3	1.82	172.44	0	60.9	7
5	71.86	1.27	-0.1	0.14	71.85	1.77	5	2.2	122.52	0.3	0	0.3	239.32	1.77	0	6	0.61	2.17	1.96	146.47	-0.02	47.43	7
6	54.08	0.65	-0.2	0.2	54.07	1.21	5	2.19	116.95	0.36	0	0.36	150.26	1.21	0	6	0.62	1.95	1.97	99.02	-0.04	57.34	7
7	46.48	0.61	-0.37	0.18	46.48	1.32	5	2.27	116.14	0.42	0	0.42	110.83	1.33	0	5	0.66	1.84	2.06	80.31	-0.06	51	7
8	52.75	0.7	-0.42	0.18	52.74	1.32	5	2.22	117.38	0.47	0	0.47	110.24	1.33	0	5	0.65	1.69	2.05	83.47	-0.06	51.53	7
9	103.31	1.1	-0.2	0.22	103.31	1.06	6	1.94	122.35	0.54	0	0.54	191.97	1.07	0	6	0.57	1.47	1.81	142.84	-0.03	68.64	7
10	77.73	1.38	-0.7	0.2	77.72	1.78	5	2.18	123.34	0.6	0	0.6	129.17	1.79	0	5	0.66	1.46	2.06	106.56	-0.09	44.65	7
11	74.17	0.98	0.03	0.24	74.17	1.32	5	2.11	120.68	0.66	0	0.66	111.81	1.33	0	6	0.65	1.36	2.01	94.51	0	53.45	7
12	54.22	1.33	0.7	0.2	54.23	2.45	5	2.38	122.16	0.72	0	0.72	74.47	2.48	0	5	0.76	1.34	2.3	67.87	0.07	32.69	7
13	88.46	1.71	0.3	0.16	88.47	1.93	5	2.16	125.2	0.78	0	0.78	112.27	1.95	0	5	0.69	1.23	2.1	102.1	0.03	41.68	7
14	79.77	2.59	0.66	0.18	79.78	3.24	5	2.35	127.99	0.85	0	0.85	93.41	3.28	0	5	0.77	1.19	2.31	88.69	0.06	27.35	5
15	99.69	3.75	1.69	0.18	99.72	3.76	5	2.34	131.26	0.91	0	0.91	108.49	3.8	0	5	0.77	1.12	2.31	104.87	0.13	24.53	5
16	73.94	3.76	1.29	0.16	73.96	5.08	4	2.52	130.54	0.98	0	0.98	74.78	5.15	0	9	0.85	1.07	2.51	73.89	0.1	18.63	3
17	101.63	2.41	2.45	0.16	101.66	2.37	5	2.18	128.07	1.04	0	1.04	96.74	2.4	0	5	0.73	1.01	2.18	96.3	0.17	35.33	7
18	65.49	2.18	-1.89	0.12	65.47	3.34	4	2.42	126.27	1.1	0	1.1	58.35	3.39	0	4	0.83	0.97	2.44	58.76	-0.12	25.53	5
19	69.25	2.34	-1.97	0.14	69.22	3.38	4	2.41	126.91	1.17	0	1.17	58.34	3.44	0	4	0.84	0.92	2.44	59.28	-0.12	25.31	5
20	91.19	3	-2.22	0.12	91.16	3.29	5	2.32	129.39	1.23	0	1.23	73.04	3.33	0	5	0.81	0.88	2.36	75.19	-0.13	26.57	5
21	49.15	2.22	-9.15	0.14	49.02	4.53	4	2.6	125.69	1.29	0	1.29	36.87	4.66	-0.01	4	0.93	0.83	2.68	37.39	-0.51	19.41	3
22	52.87	1.58	-8.95	0.08	52.74	3	4	2.45	123.38	1.36	0	1.36	37.89	3.08	-0.01	4	0.88	0.8	2.54	39.02	-0.48	25.78	5
23	55.92	1.37	-8.45	0.13	55.8	2.46	5	2.38	122.47	1.42	0	1.42	38.38	2.52	-0.01	4	0.86	0.78	2.47	39.99	-0.43	29.26	5
24	42.31	1.92	-8.35	0.12	42.19	4.55	4	2.65	124.25	1.48	0	1.48	27.52	4.71	-0.01	3	0.98	0.72	2.77	27.74	-0.41	18.8	3
25	117.37	2.33	-8.21	0.12	117.25	1.99	5	2.08	128.16	1.54	0	1.54	74.98	2.01	-0.01	5	0.75	0.75	2.18	82.32	-0.38	39.16	7
26	42.89	2.59	-6.78	0.1	42.79	6.05	3	2.73	126.47	1.61	0	1.61	25.63	6.29	-0.01	3	1	0.66	2.88	25.63	-0.3	15.42	3
27	120.05	2.75	-6.57	0.13	119.96	2.3	5	2.12	129.44	1.67	0	1.67	70.78	2.33	0	5	0.78	0.7	2.24	78.22	-0.28	34.99	7
28	296.97	2.53	-7.06	-0.5	296.87	0.85	6	1.54	131.05	1.74	0	1.74	169.94	0.86	0	6	0.55	0.76	1.62	212.29	-0.29	88.1	7
29	152.74	3.01	-7.05	-1.22	152.64	1.97	5	2	130.69	1.8	0	1.8	83.7	2	0	5	0.75	0.67	2.13	95.83	-0.28	40.5	7
30	277.23	3.92	-5.82	-1.28	277.15	1.42	6	1.73	134.08	1.87	0	1.87	147.28	1.43	0	6	0.64	0.7	1.83	181.12	-0.22	58.24	7
31	259.66	6.76	1.54	-2.66	259.68	2.6	8	1.96	137.37	1.94	0	1.94	133	2.62	0	5	0.73	0.64	2.08	156.33	0.06	34.66	7
32	158.52	7.88	3.25	-2.99	158.57	4.97	9	2.31	137.37	2.01	0	2.01	78.02	5.03	0	9	0.88	0.57	2.47	83.98	0.12	19.07	3
33	365.39	0	2.6	-3.78	365.43	0	0	0	87.42	2.05	0	2.05	177.24	0	0	0	1	0.52	0	177.24	0.09	267.49	0

C-8 **In situ data** **Basic output data**

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	γ (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	145.22	4.32	1.31	-0.1	145.23	2.98	5	2.16	133.21	0.07	0	0.07	2178.1	2.98	0	8	0.55	4.53	1.82	621.64	1.41	32.87	7
2	168.73	1.86	0.79	-0.3	168.74	1.1	6	1.79	127.4	0.13	0	0.13	1293.1	1.1	0	6	0.44	2.51	1.53	400.72	0.44	80.26	7
3	124.31	2.08	1.79	-0.28	124.34	1.67	6	2.01	127.47	0.19	0	0.19	640.04	1.67	0	6	0.53	2.46	1.76	288.71	0.66	53.96	7
4	174.11	2.38	1.05	-0.3	174.12	1.37	6	1.85	129.28	0.26	0	0.26	672.22	1.37	0	6	0.49	2	1.66	328.86	0.29	65.17	7
5	110.59	1.97	0.59	-0.14	110.6	1.78	5	2.07	126.79	0.32	0	0.32	342.39	1.79	0	6	0.58	1.99	1.87	207.01	0.13	49.37	7
6	53.35	0.64	0	-0.06	53.35	1.2	5	2.19	116.81	0.38	0	0.38	139.2	1.21	0	6	0.62	1.89	1.98	94.63	0	56.64	7
7	26.79	0.5	-0.6	-0.12	26.78	1.86	4	2.55	113.26	0.44	0	0.44	60.26	1.89	0	5	0.76	1.95	2.33	48.62	-0.1	36.2	7
8	45.09	1.13	0.07	-0.67	45.09	2.51	5	2.45	120.54	0.5	0	0.5	89.67	2.54	0	5	0.74	1.75	2.28	73.83	0.01	32.56	7
9	41.09	1.42	0.08	-0.75	41.09	3.46	4	2.58	121.98	0.56	0	0.56	72.6	3.51	0	4	0.8	1.67	2.43	63.91	0.01	25.13	5
10	40.28	0.7	0.1	-0.77	40.28	1.73	5	2.39	116.74	0.62	0	0.62	64.31	1.76	0	5	0.74	1.49	2.26	55.91	0.01	39.12	7
11	44.8	0.99	0.5	-0.83	44.81	2.22	5	2.42	119.58	0.68	0	0.68	65.23	2.25	0	5	0.76	1.41	2.32	58.71	0.05	33.97	7
12	55.21	1.44	1.09	-0.87	55.22	2.61	5	2.4	122.81	0.74	0	0.74	73.83	2.64	0	5	0.77	1.32	2.32	67.92	0.11	31.21	5
13	56.45	1.62	1.19	-0.91	56.46	2.87	5	2.42	123.72	0.8	0	0.8	69.61	2.91	0	5	0.79	1.25	2.36	65.58	0.11	28.98	5
14	55.28	1.49	1.49	-0.95	55.3	2.69	5	2.41	123.05	0.86	0	0.86	63.21	2.74	0	5	0.79	1.18	2.37	60.56	0.12	29.94	5
15	48.17	1.28	1.61	-0.98	48.2	2.65	5	2.45	121.6	0.92	0	0.92	51.27	2.71	0	5	0.82	1.12	2.42	49.99	0.13	29.22	5
16	63.04	1.27	1.69	-1.03	63.07	2.01	5	2.28	122.19	0.98	0	0.98	63.14	2.04	0	5	0.76	1.06	2.27	62.04	0.12	36.65	7
17	46.31	1.43	0.8	-1.16	46.32	3.09	4	2.5	122.32	1.04	0	1.04	43.35	3.16	0	4	0.86	1.01	2.51	43.27	0.06	25.78	5
18	41.14	1.06	1.39	-1.26	41.16	2.59	4	2.49	119.87	1.1	0	1.1	36.28	2.66	0	4	0.86	0.96	2.52	36.49	0.09	27.85	5
19	46.51	1.42	2.46	-1.26	46.55	3.05	4	2.5	122.29	1.17	0	1.17	38.94	3.13	0	4	0.87	0.92	2.54	39.42	0.15	25.55	5
20	69.21	2.97	3.88	-1.3	69.26	4.29	4	2.48	128.65	1.23	0	1.23	55.32	4.37	0	4	0.87	0.88	2.53	56.39	0.23	21	3
21	69.4	3.41	3.29	-1.32	69.44	4.91	4	2.53	129.68	1.29	0	1.29	52.64	5.01	0	4	0.9	0.83	2.59	53.73	0.18	18.8	3
22	57.45	1.68	4.02	-1.59	57.51	2.92	5	2.42	124.02	1.36	0	1.36	41.39	2.99	0.01	4	0.87	0.81	2.5	42.78	0.21	26.69	5
23	46.63	1.97	3.98	-1.68	46.69	4.23	4	2.6	124.7	1.42	0	1.42	31.91	4.36	0.01	4	0.95	0.76	2.7	32.41	0.2	20.06	3
24	46.48	1.28	4.67	-1.71	46.54	2.75	4	2.47	121.52	1.48	0	1.48	30.45	2.84	0.01	4	0.91	0.74	2.59	31.43	0.23	26.01	5
25	68.76	1.73	5.54	-1.7	68.84	2.52	5	2.32	124.7	1.54	0	1.54	43.64	2.58	0.01	5	0.85	0.73	2.43	46.17	0.26	29.73	5
26	107.73	2.14	6.24	-1.78	107.82	1.99	5	2.11	127.35	1.61	0	1.61	66.14	2.02	0	5	0.77	0.73	2.22	72.8	0.28	38.15	7
27	75.96	2.46	5.96	-1.8	76.05	3.23	5	2.37	127.5	1.67	0	1.67	44.55	3.3	0.01	4	0.88	0.67	2.5	47.01	0.26	25.3	5
28	116.99	2.75	4.77	-1.84	117.06	2.35	5	2.14	129.36	1.73	0	1.73	66.5	2.38	0	5	0.79	0.68	2.26	73.63	0.2	34.09	7
29	163.01	4.22	-2.62	-1.84	162.97	2.59	5	2.08	133.32	1.8	0	1.8	89.5	2.62	0	5	0.77	0.66	2.2	101	-0.1	33.19	7
30	266.55	5.17	0.87	-2.2	266.56	1.94	6	1.85	136.01	1.87	0	1.87	141.63	1.95	0	6	0.68	0.68	1.96	169.59	0.03	44.73	7
31	499.17	0	1.94	-2.48	499.2	0	0	0	87.42	1.91	0	1.91	260.01	0	0	0	1	0.55	0	260.01	0.07	385.73	0

C-9 **In situ data** **Basic output data**

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	212.33	1.72	0.1	0.95	212.34	0.81	6	1.62	127.38	0.06	0	0.06	3330.8	0.81	0	6	0.36	2.79	1.34	559.32	0.11	108.99	7
2	80.86	2.35	-1.24	0.54	80.84	2.91	5	2.31	127.33	0.13	0	0.13	633.36	2.92	0	8	0.61	3.62	1.97	276.51	-0.7	32.71	7
3	45.07	1.38	-0.1	0.52	45.07	3.05	4	2.51	121.98	0.19	0	0.19	238.42	3.07	0	5	0.68	3.25	2.16	138.07	-0.04	30.01	5
4	140.36	1.89	-0.1	0.61	140.36	1.35	6	1.91	127.06	0.25	0	0.25	556.35	1.35	0	6	0.51	2.08	1.7	274.99	-0.03	64.69	7
5	54.05	0.49	0.2	0.55	54.06	0.91	5	2.12	114.88	0.31	0	0.31	173.77	0.92	0	6	0.58	2.04	1.87	103.53	0.05	68.92	7
6	52.76	0.22	0	0.53	52.76	0.41	6	1.96	108.88	0.36	0	0.36	144.03	0.42	0	6	0.53	1.76	1.74	87.38	0	91.53	7
7	28.91	0.19	-0.3	0.58	28.9	0.65	5	2.28	106.31	0.42	0	0.42	68.32	0.66	0	6	0.65	1.84	2.06	49.44	-0.05	57.92	7
8	29.3	0.24	-0.21	0.59	29.3	0.81	5	2.32	108.08	0.47	0	0.47	61.22	0.83	0	5	0.68	1.74	2.12	47.3	-0.03	52.54	7
9	23.26	0.36	0.1	0.57	23.26	1.55	4	2.55	110.55	0.53	0	0.53	43.21	1.58	0	5	0.78	1.72	2.37	37.03	0.01	36.55	7
10	33.64	0.44	0.17	0.58	33.64	1.29	5	2.38	112.84	0.58	0	0.58	56.75	1.32	0	5	0.73	1.54	2.23	48.25	0.02	43.62	7
11	27.57	0.73	0.1	0.55	27.57	2.65	4	2.63	116.13	0.64	0	0.64	42.02	2.71	0	4	0.83	1.52	2.51	38.68	0.01	27.84	5
12	36.65	0.76	0.89	0.53	36.66	2.08	5	2.47	117.16	0.7	0	0.7	51.42	2.12	0	5	0.79	1.38	2.37	47.07	0.09	33.59	7
13	44.88	0.43	1.19	0.51	44.89	0.95	5	2.2	113.42	0.76	0	0.76	58.39	0.97	0	5	0.7	1.26	2.12	52.7	0.11	51.76	7
14	31.11	0.76	1.49	0.47	31.13	2.43	4	2.57	116.7	0.81	0	0.81	37.23	2.5	0	4	0.84	1.25	2.51	35.75	0.13	28.72	5
15	34.04	0.86	1.99	0.47	34.07	2.53	4	2.55	117.86	0.87	0	0.87	38.02	2.59	0	4	0.85	1.18	2.51	36.92	0.16	28.3	5
16	35.17	0.66	1.89	0.49	35.2	1.87	5	2.45	115.99	0.93	0	0.93	36.8	1.93	0	5	0.82	1.11	2.43	35.97	0.15	33.01	7
17	35.16	0.67	2.37	0.47	35.2	1.9	5	2.46	116.11	0.99	0	0.99	34.57	1.96	0	5	0.83	1.06	2.46	34.19	0.17	32.25	7
18	42.47	0.82	2.29	0.45	42.5	1.93	5	2.4	118.04	1.05	0	1.05	39.55	1.98	0	5	0.82	1.01	2.41	39.48	0.16	33.42	7
19	34.9	0.87	2.38	0.43	34.93	2.49	4	2.53	118	1.11	0	1.11	30.55	2.57	0.01	4	0.88	0.96	2.57	30.71	0.16	27.31	5
20	29.83	0.73	2.68	0.45	29.87	2.44	4	2.58	116.32	1.17	0	1.17	24.63	2.54	0.01	4	0.91	0.92	2.64	24.85	0.17	26.18	5
21	23.91	0.61	2.96	0.53	23.95	2.56	4	2.67	114.52	1.22	0	1.22	18.59	2.7	0.01	4	0.96	0.87	2.75	18.71	0.17	23.82	5
22	27.58	0.41	3.28	0.61	27.63	1.48	5	2.48	111.88	1.28	0	1.28	20.6	1.55	0.01	4	0.89	0.84	2.57	21.04	0.18	30.25	4
23	21.7	0.36	3.58	0.63	21.75	1.66	4	2.59	110.38	1.33	0	1.33	15.31	1.76	0.01	4	0.95	0.8	2.71	15.5	0.19	26.2	4
24	24.63	0.32	4.02	0.61	24.69	1.31	5	2.49	109.91	1.39	0	1.39	16.78	1.39	0.01	4	0.91	0.78	2.62	17.18	0.21	28.95	4
25	56.74	0.73	2.59	0.59	56.78	1.29	5	2.19	117.92	1.45	0	1.45	38.22	1.32	0	5	0.79	0.78	2.29	40.79	0.13	40.97	7
26	29.84	1.56	2.29	-0.04	29.87	5.23	3	2.8	121.89	1.51	0	1.51	18.8	5.5	0.01	3	1	0.7	2.94	18.8	0.11	16.6	3
27	51.66	1.67	2.78	-0.18	51.7	3.24	4	2.48	123.74	1.57	0	1.57	31.92	3.34	0	4	0.92	0.69	2.62	32.92	0.13	23.86	5
28	33.73	1.18	2.94	-0.22	33.77	3.5	4	2.64	120.15	1.63	0	1.63	19.71	3.67	0.01	3	1	0.65	2.81	19.72	0.13	20.86	3
29	41.4	0.74	2.87	-0.25	41.44	1.78	5	2.39	117.22	1.69	0	1.69	23.53	1.86	0.01	4	0.9	0.65	2.56	24.6	0.12	29.89	5
30	31.93	0.64	3.18	-0.3	31.98	2	4	2.5	115.52	1.75	0	1.75	17.3	2.11	0.01	4	0.96	0.62	2.71	17.61	0.13	25.75	4
31	32.88	0.97	3.28	-0.36	32.93	2.96	4	2.6	118.68	1.81	0	1.81	17.23	3.13	0.01	4	1	0.59	2.82	17.23	0.13	21.97	3
32	42.38	1.36	3.48	-0.43	42.43	3.2	4	2.54	121.73	1.87	0	1.87	21.72	3.35	0.01	4	0.99	0.57	2.75	21.88	0.13	22.26	5
33	33.75	1.07	4.07	-0.53	33.81	3.17	4	2.61	119.44	1.93	0	1.93	16.54	3.36	0.01	3	1	0.55	2.85	16.54	0.15	21.13	3
34	38.94	1.2	4.27	-0.59	39	3.08	4	2.56	120.63	1.99	0	1.99	18.62	3.25	0.01	4	1	0.53	2.8	18.62	0.15	21.94	3
35	42.5	1.36	4.74	-0.65	42.57	3.2	4	2.54	121.76	2.05	0	2.05	19.78	3.36	0.01	4	1	0.52	2.79	19.78	0.17	21.82	3
36	44.7	2.13	4.07	-0.62	44.76	4.75	4	2.64	125.14	2.11	0	2.11	20.2	4.98	0.01	3	1	0.5	2.89	20.2	0.14	17.7	3
37	42.48	1.37	4.75	-0.63	42.55	3.22	4	2.54	121.81	2.17	0	2.17	18.59	3.4	0.01	4	1	0.49	2.81	18.59	0.16	21.48	3
38	49.66	1.23	5.26	-0.71	49.74	2.47	5	2.42	121.39	2.23	0	2.23	21.28	2.59	0.01	4	0.98	0.48	2.69	21.6	0.17	25.1	5
39	200.62	3.56	4.88	-0.72	200.69	1.77	6	1.89	132.57	2.3	0	2.3	86.31	1.79	0	5	0.75	0.56	2.07	105.1	0.15	44.53	7
40	387	7.66	-2.47	-0.58	386.96	1.98	6	1.77	137.37	2.37	0	2.37	162.46	1.99	0	6	0.69	0.57	1.91	208.85	-0.08	45.01	7
41	367.23	7.98	-4.67	-0.21	367.16	2.17	8	1.81	137.37	2.44	0	2.44	149.72	2.19	0	6	0.71	0.55	1.96	190.21	-0.14	41.2	7
42	88.68	5.56	-4.17	0.22	88.62	6.28	9	2.54	133.85	2.5	0	2.5	34.41	6.46	0	3	1	0.42	2.8	34.41	-0.12	15.2	3
43	61.81	1.75	-4.07	0.47	61.75	2.84	5	2.39	124.52	2.57	0	2.57	23.07	2.96	0	4	1	0.41	2.7	23.07	-0.11	23.91	5
44	102.71	2.59	-4.67	0.57	102.65	2.53	5	2.2	128.62	2.63	0	2.63	38.04	2.59	0	4	0.92	0.43	2.47	41	-0.13	28.92	5
45	91.82	3.42	-4.95	0.45	91.75	3.73	4	2.36	130.37	2.69	0	2.69	33.05	3.84	0	4	0.99	0.4	2.65	33.4	-0.13	21.89	3
46	51.55	3.32	-4.99	0.75	51.48	6.45	3	2.7	128.75	2.76	0	2.76	17.66	6.82	-0.01	3	1	0.38	3.03	17.66	-0.13	14.52	3
47	83.73	2.97	-4.67	0.81	83.66	3.55	5	2.37	129.11	2.82	0	2.82	28.63	3.67	0	4	1	0.37	2.69	28.63	-0.12	22.06	5
48	111.03	3.41	-4.42	0.71	110.97	3.07	5	2.24	130.82	2.89	0	2.89	37.41	3.15	0	4	0.96	0.38	2.55	39.05	-0.11	25.39	5
49	87.28	3.27	-4.17	1.23	87.22	3.75	4	2.37	129.93	2.95	0	2.95	28.53	3.88	0	4	1	0.36	2.71	28.53	-0.1	21.31	3
50	69.55	3.23	-4.27	1.3	69.49	4.65	4	2.51	129.29	3.02	0	3.02	22.02	4.87	0	3	1	0.35	2.86	22.02	-0.1	18.08	3
51	80.28	2.99	-4.02	1.38	80.22	3.73	4	2.4	129.07	3.08	0	3.08	25.02	3.88	0	4	1	0.34	2.75	25.02	-0.09	20.96	3
52	92.44	3.23	-3.59	1.32	92.39	3.5	5	2.33	129.98	3.15	0	3.15	28.35	3.62	0	4	1	0.34	2.69	28.35	-0.08	22.21	5
53	85.3	3.57	-3.38	1.78	85.25	4.19	4	2.42	130.52	3.21	0	3.21	25.53	4.36	0	3	1	0.33	2.78	25.53	-0.08	19.61	3
54	103.92	4.4	-3.58	1.79	103.87	4.23	9	2.37	132.52	3.28	0	3.28	30.67	4.37	0	4	1	0.32	2.72	30.67	-0.08	19.93	3
55	112.24	0	-3.48	1.86	112.19	0	0	0	87.42	3.32	0	3.32	32.76	0	0	0	1	0.32	0	32.76	-0.08	61.08	0

SC-1 In situ data | Basic output data

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	γ (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	133.24	0.95	0.09	-0.8	133.24	0.71	6	1.74	121.88	0.06	0	0.06	2184.1	0.71	0	6	0.38	2.99	1.4	375.93	0.11	114.5	7
2	87.59	0.8	0.38	-0.92	87.6	0.91	6	1.95	119.63	0.12	0	0.12	723.95	0.92	0	6	0.47	2.8	1.62	231.4	0.22	85.64	7
3	111.74	0.77	0.3	-0.84	111.74	0.69	6	1.79	119.91	0.18	0	0.18	617.61	0.69	0	6	0.44	2.19	1.53	230.68	0.12	105.33	7
4	114.66	0.93	0.4	-1.46	114.66	0.82	6	1.83	121.42	0.24	0	0.24	474.04	0.82	0	6	0.47	2.01	1.6	217.28	0.12	91.84	7
5	147.21	1.16	0.7	-1.93	147.22	0.79	6	1.73	123.6	0.3	0	0.3	484.53	0.79	0	6	0.46	1.77	1.55	245.62	0.17	96.97	7
6	110.24	1.08	0.76	-2.09	110.25	0.98	6	1.89	122.37	0.36	0	0.36	301.51	0.98	0	6	0.52	1.74	1.71	180.66	0.15	77.13	7
7	75.12	0.63	0.45	-2.2	75.13	0.84	6	1.98	117.53	0.42	0	0.42	176.5	0.85	0	6	0.56	1.67	1.81	117.79	0.08	75.27	7
8	60.61	0.74	0.7	-2.27	60.62	1.21	5	2.15	118.11	0.48	0	0.48	124.73	1.22	0	6	0.63	1.64	1.99	93.29	0.1	56.12	7
9	92.09	3.8	0.99	-2.39	92.1	4.12	4	2.39	131.15	0.55	0	0.55	167.14	4.15	0	8	0.74	1.63	2.26	140.69	0.13	23.05	5
10	498.49	6.46	1.99	-1.11	498.52	1.3	6	1.55	137.37	0.62	0	0.62	807.64	1.3	0	6	0.45	1.28	1.5	600.44	0.23	71.92	7
11	262.06	1.94	2.63	-1.36	262.1	0.74	6	1.53	128.8	0.68	0	0.68	383.91	0.74	0	6	0.44	1.22	1.47	300.47	0.28	105.83	7
12	247.58	1.84	2.68	-1.39	247.62	0.74	6	1.55	128.25	0.75	0	0.75	331.33	0.74	0	6	0.46	1.17	1.5	273.94	0.26	103.65	7
13	206.94	1.77	2.17	-1.46	206.97	0.86	6	1.65	127.55	0.81	0	0.81	254.93	0.86	0	6	0.5	1.14	1.61	222.96	0.19	88.96	7
14	189.52	1.52	1.97	-1.53	189.54	0.8	6	1.66	126.19	0.87	0	0.87	216.4	0.8	0	6	0.51	1.1	1.63	196.87	0.16	90.6	7
15	172.51	1.31	1.59	-1.42	172.53	0.76	6	1.67	124.91	0.93	0	0.93	183.66	0.77	0	6	0.52	1.07	1.65	173.11	0.12	90.41	7
16	251.38	1.23	0.6	-1.52	251.38	0.49	6	1.42	125.37	1	0	1	251.12	0.49	0	6	0.44	1.03	1.42	242.87	0.04	133.28	7
17	227.97	1.46	0.5	-1.56	227.97	0.64	6	1.53	126.37	1.06	0	1.06	214.01	0.64	0	6	0.48	1	1.54	214.24	0.03	107.79	7
18	328.65	1.8	-2.44	-1.58	328.62	0.55	6	1.37	128.77	1.12	0	1.12	291.23	0.55	0	6	0.43	0.97	1.38	301.54	-0.16	132.41	7
19	138.38	1.24	-2.67	-1.6	138.34	0.9	6	1.79	123.96	1.19	0	1.19	115.59	0.91	0	6	0.6	0.93	1.82	121.02	-0.16	72.93	7
20	127.66	1.11	-2.26	-1.6	127.62	0.87	6	1.81	122.97	1.25	0	1.25	101.26	0.88	0	6	0.61	0.9	1.85	107.92	-0.13	71.4	7
21	99.03	1.84	-2.93	-1.69	98.99	1.86	5	2.11	126.01	1.31	0	1.31	74.5	1.88	0	5	0.74	0.85	2.17	78.79	-0.16	40.68	7
22	191.27	2.46	-6.84	-1.91	191.17	1.29	6	1.8	129.75	1.38	0	1.38	137.93	1.3	0	6	0.62	0.85	1.85	152.38	-0.36	60.72	7
23	166.47	3.26	-6.56	-2.5	166.38	1.96	6	1.98	131.48	1.44	0	1.44	114.41	1.98	0	5	0.7	0.81	2.04	125.66	-0.33	42.59	7
24	199.3	5.02	-5.76	-2.78	199.22	2.52	5	2.01	135.07	1.51	0	1.51	131	2.54	0	5	0.72	0.78	2.09	144.9	-0.27	35.39	7
25	120.12	4.3	-5.44	-3.03	120.04	3.58	5	2.27	132.7	1.58	0	1.58	75.19	3.63	0	4	0.83	0.72	2.37	80.54	-0.25	25.01	5
26	94.6	4.46	-4.74	-3.09	94.53	4.72	9	2.43	132.39	1.64	0	1.64	56.58	4.8	0	4	0.9	0.67	2.55	59.14	-0.21	19.54	3
27	143.62	3.58	-4.37	-3.08	143.56	2.5	5	2.1	131.81	1.71	0	1.71	83.06	2.53	0	5	0.77	0.69	2.21	92.58	-0.18	33.76	7
28	137.17	6.15	-4.04	-3.02	137.12	4.49	9	2.31	135.65	1.78	0	1.78	76.23	4.55	0	9	0.86	0.64	2.44	81.8	-0.16	20.78	3
29	563.9	0	-3.85	-3.12	563.85	0	0	0	87.42	1.82	0	1.82	308.95	0	0	0	1	0.58	0	308.95	-0.15	455.65	0

SC-3 In situ data — Basic output data

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	164.79	1.87	0.6	2.07	164.8	1.14	6	1.81	127.4	0.06	0	0.06	2584.5	1.14	0	6	0.42	3.26	1.49	508.1	0.67	79.98	7
2	84.59	0.92	0.88	2	84.6	1.08	6	2.01	120.55	0.12	0	0.12	681	1.09	0	6	0.5	2.89	1.67	230.85	0.51	75.07	7
3	63.71	0.76	0.31	2.41	63.71	1.2	5	2.13	118.5	0.18	0	0.18	346.86	1.2	0	6	0.55	2.63	1.82	158.13	0.12	64.66	7
4	85.39	1.23	0.58	2.39	85.4	1.44	5	2.08	122.71	0.24	0	0.24	348.23	1.44	0	6	0.56	2.27	1.83	182.9	0.17	57.76	7
5	124.33	1.55	0.91	2.45	124.34	1.25	6	1.92	125.33	0.31	0	0.31	403.7	1.25	0	6	0.52	1.91	1.73	223.59	0.21	66.83	7
6	135.16	1.94	0.31	2.19	135.17	1.43	6	1.94	127.17	0.37	0	0.37	363.45	1.44	0	6	0.54	1.77	1.77	225.07	0.06	59.69	7
7	143.36	2.95	0.85	2.09	143.38	2.06	5	2.04	130.38	0.44	0	0.44	327.77	2.06	0	6	0.59	1.69	1.89	228.36	0.14	44.03	7
8	147.93	3.05	0.35	2.21	147.93	2.06	5	2.03	130.69	0.5	0	0.5	294.11	2.07	0	6	0.6	1.57	1.91	218.15	0.05	43.81	7
9	73.33	1.54	0.89	2.23	73.34	2.1	5	2.24	123.97	0.56	0	0.56	129.2	2.11	0	5	0.68	1.54	2.12	105.77	0.11	39.46	7
10	70.85	1.26	0.89	2.17	70.87	1.78	5	2.21	122.42	0.62	0	0.62	112.47	1.79	0	5	0.68	1.43	2.1	94.93	0.1	43.71	7
11	71.12	1.19	1.39	2.15	71.14	1.68	5	2.19	122.05	0.69	0	0.69	102.75	1.69	0	5	0.68	1.34	2.1	89.51	0.15	44.89	7
12	63.37	1.15	0.89	1.99	63.38	1.81	5	2.25	121.46	0.75	0	0.75	83.91	1.83	0	5	0.71	1.28	2.17	75.93	0.09	41.14	7
13	74.26	1.37	1.29	1.93	74.28	1.85	5	2.2	123.17	0.81	0	0.81	90.96	1.87	0	5	0.71	1.21	2.15	84.03	0.12	41.46	7
14	74.54	1.52	1.69	1.82	74.57	2.03	5	2.23	123.91	0.87	0	0.87	84.73	2.06	0	5	0.73	1.15	2.19	80.3	0.14	38.41	7
15	71.48	1.36	1.39	1.74	71.5	1.91	5	2.22	123.03	0.93	0	0.93	75.77	1.93	0	5	0.73	1.1	2.2	73.23	0.11	39.37	7
16	76.87	1.9	3.34	1.62	76.92	2.48	5	2.28	125.66	0.99	0	0.99	76.37	2.51	0	5	0.76	1.05	2.27	75.25	0.24	32.94	7
17	113.9	3.22	2.29	1.68	113.94	2.83	5	2.21	130.47	1.06	0	1.06	106.54	2.86	0	5	0.74	1	2.21	106.57	0.16	31.14	5
18	101.73	4.33	1.99	1.6	101.76	4.25	9	2.37	132.35	1.13	0	1.13	89.41	4.3	0	9	0.81	0.95	2.39	90.44	0.13	21.89	3
19	135.88	5.85	1.69	1.66	135.91	4.3	9	2.3	135.26	1.19	0	1.19	112.9	4.34	0	9	0.79	0.91	2.33	115.73	0.1	21.97	3
20	104.11	5.12	-4.48	1.74	104.05	4.92	9	2.42	133.63	1.26	0	1.26	81.57	4.98	0	9	0.85	0.86	2.46	83.77	-0.26	19.25	3
21	132.46	3.92	-4.37	1.78	132.4	2.96	5	2.18	132.26	1.33	0	1.33	98.83	2.99	0	5	0.76	0.84	2.23	104.26	-0.24	29.94	5
22	150.65	4.07	-4.57	2.01	150.59	2.71	5	2.11	132.86	1.39	0	1.39	107.13	2.73	0	5	0.74	0.81	2.17	114.91	-0.24	32.55	7
23	111.53	3.61	-4.57	2.52	111.47	3.24	5	2.26	131.25	1.46	0	1.46	75.44	3.28	0	5	0.81	0.77	2.34	80.18	-0.23	27.06	5
24	119.93	3.07	-4.27	2.81	119.87	2.56	5	2.16	130.24	1.52	0	1.52	77.69	2.6	0	5	0.78	0.75	2.25	84.2	-0.2	32.65	7
25	117.39	3.95	-4.43	3.02	117.32	3.37	5	2.25	132.03	1.59	0	1.59	72.82	3.41	0	5	0.82	0.72	2.36	78.23	-0.2	26.17	5
26	178.07	4.75	-4.31	3.26	178.01	2.67	5	2.06	134.4	1.66	0	1.66	106.45	2.69	0	5	0.75	0.71	2.16	119	-0.19	33.03	7
27	187.39	5.24	-4.08	3.34	187.33	2.8	5	2.07	135.24	1.72	0	1.72	107.64	2.82	0	5	0.76	0.69	2.17	121.1	-0.17	31.82	5
28	148.54	4.96	-4.4	3.08	148.48	3.34	8	2.19	134.27	1.79	0	1.79	81.89	3.38	0	5	0.82	0.65	2.31	90.18	-0.18	26.71	5
29	199.83	4.98	-4.27	2.49	199.77	2.49	5	2.01	135.02	1.86	0	1.86	106.47	2.52	0	5	0.75	0.66	2.13	122.63	-0.17	35.03	7
30	176.76	4.66	-4.18	2.17	176.7	2.63	5	2.06	134.23	1.93	0	1.93	90.75	2.66	0	5	0.78	0.63	2.2	103.67	-0.16	32.84	7
31	116.8	3.61	-4.27	1.96	116.74	3.1	5	2.23	131.36	1.99	0	1.99	57.61	3.15	0	5	0.86	0.58	2.4	63.03	-0.15	27.2	5
32	129.67	3.69	-4.18	1.68	129.61	2.84	5	2.17	131.77	2.06	0	2.06	61.99	2.89	0	5	0.84	0.57	2.34	68.96	-0.15	29.32	5
33	166.23	4.85	-3.8	1.48	166.18	2.92	5	2.11	134.38	2.12	0	2.12	77.22	2.96	0	5	0.82	0.57	2.28	87.63	-0.13	29.67	5
34	139.06	4.43	-3.97	1.3	139.01	3.19	5	2.19	133.28	2.19	0	2.19	62.44	3.24	0	5	0.86	0.53	2.38	69.17	-0.13	26.93	5
35	90.28	3.31	-4.26	1.3	90.22	3.67	5	2.36	130.09	2.26	0	2.26	38.98	3.76	0	4	0.94	0.49	2.59	40.74	-0.14	22.73	5
36	106.69	3.62	-4.27	1.24	106.63	3.39	5	2.28	131.15	2.32	0	2.32	44.92	3.47	0	4	0.92	0.49	2.51	47.96	-0.13	24.52	5
37	101.13	3.63	-4.27	1.29	101.07	3.59	5	2.32	131.04	2.39	0	2.39	41.33	3.67	0	4	0.94	0.47	2.56	43.47	-0.13	23.28	5
38	114.56	2.82	-4.18	1.45	114.5	2.46	5	2.16	129.5	2.45	0	2.45	45.69	2.52	0	5	0.88	0.48	2.4	50.57	-0.12	30.71	5
39	73.75	2.15	-1.49	1.09	73.73	2.92	5	2.34	126.44	2.52	0	2.52	28.31	3.02	0	4	0.97	0.43	2.63	29.02	-0.04	24.76	5
40	127.67	3.48	-1.47	1.3	127.65	2.72	5	2.16	131.3	2.58	0	2.58	48.45	2.78	0	5	0.89	0.45	2.41	53.45	-0.04	29.03	5
41	184.32	5.58	-0.99	2.55	184.3	3.03	8	2.1	135.66	2.65	0	2.65	68.57	3.07	0	5	0.86	0.45	2.33	77.89	-0.03	28.43	5
42	228.43	6	0.08	4.03	228.43	2.63	5	1.99	136.72	2.72	0	2.72	83.06	2.66	0	5	0.82	0.46	2.21	98.35	0	32.69	7
43	218.46	5.53	0	5.01	218.46	2.53	5	1.99	136	2.79	0	2.79	77.44	2.56	0	5	0.83	0.45	2.22	91.5	0	33.34	7
44	194.52	6.07	0.23	5.74	194.52	3.12	8	2.1	136.41	2.85	0	2.85	67.17	3.17	0	5	0.88	0.42	2.34	75.83	0.01	27.66	5
45	160.74	5.99	0.3	5.73	160.75	3.73	8	2.21	135.84	2.92	0	2.92	54.02	3.79	0	4	0.93	0.39	2.48	57.76	0.01	23.43	5
46	133.33	4.23	0.42	5.73	133.33	3.17	5	2.2	132.85	2.99	0	2.99	43.62	3.25	0	4	0.95	0.37	2.5	46.19	0.01	25.55	5
47	102.68	3.19	0.99	5.89	102.69	3.11	5	2.27	130.14	3.05	0	3.05	32.64	3.2	0	4	0.99	0.35	2.6	33.1	0.02	24.48	5
48	190.22	3.55	1.09	6.1	190.23	1.87	6	1.92	132.43	3.12	0	3.12	59.99	1.9	0	5	0.84	0.4	2.2	71.53	0.03	39.61	7
49	120.77	3.49	3.11	5.81	120.82	2.89	5	2.2	131.2	3.18	0	3.18	36.94	2.97	0	4	0.97	0.34	2.53	38.32	0.07	26.29	5
50	80.98	2.73	2.41	4.93	81.02	3.37	5	2.36	128.43	3.25	0	3.25	23.94	3.51	0	4	1	0.33	2.74	23.94	0.05	22.03	3
51	76.52	2.57	2.48	4.63	76.56	3.36	5	2.38	127.85	3.31	0	3.31	22.11	3.51	0	4	1	0.32	2.76	22.11	0.05	21.74	3
52	81.87	3.19	3.08	4.46	81.92	3.9	4	2.4	129.59	3.38	0	3.38	23.25	4.06	0	3	1	0.31	2.79	23.25	0.07	20.22	3
53	99.71	3.43	2.78	4.56	99.75	3.44	5	2.31	130.59	3.44	0	3.44	27.97	3.56	0	4	1	0.31	2.69	27.97	0.06	22.4	5
54	73.74	3.53	2.68	4.3	73.78	4.79	4	2.5	130.08	3.51	0	3.51	20.03	5.03	0	3	1	0.3	2.9	20.03	0.06	17.59	3
55	81.27	2.57	2.88	3.83	81.31	3.16	5	2.34	127.98	3.57	0	3.57	21.76	3.3	0	4	1	0.3	2.75	21.76	0.06	22.39	5
56	76.72	2.82	3.08	3.79	76.77	3.67	4	2.4	128.51	3.64	0	3.64	20.11	3.85	0	3	1	0.29	2.82	20.11	0.06	20.43	3
57	110.89	3.45	3.51	3.94	110.94	3.11	5	2.24	130.9	3.7	0	3.7	28.97	3.22	0	4	1	0.29	2.65	28.97	0.07	23.89	5
58	236.67	4.83	4.33	4.24	236.73	2.04	6	1.9	135.21	3.77	0	3.77	61.81	2.07	0	5	0.88	0.33	2.23	72.29	0.08	37.44	7
59	194.64	4.09	4.67	4.46	194.71	2.1	6	1.96	133.52	3.84	0	3.84	49.76	2.14	0	5	0.92	0.31	2.32	55.46	0.09	34.66	7
60	133.35	3.63	4.47	4.09	133.41	2.72	5	2.15	131.72	3.9	0	3.9	33.19	2.8	0	4	1	0.27	2.56	33.19	0.08	26.5	5
61	145.66	4.65	4.77	4.54	145.73	3.19	5	2.18	133.75	3.97	0	3.97	35.72	3.28	0	4	1	0.27	2.59	35.72	0.09	24.43	5
62	131.62	5.38	4.87	4.44	131.69	4.08	9	2.29	134.57	4.04	0	4.04	31.63	4.21	0	4	1	0.26	2.7	31.63	0.09	20.48	3
63	185.34	5.65	5.27	4.22	185.41	3.05	8	2.1	135.77	4.1	0	4.1	44.18	3.12	0	4	1	0.26	2.5	44.32	0.09	26.1	5
64	145.15	2.09	4.87	4.07	145.22	1.44	6	1.92	127.89	4.17	0	4.17	33.84	1.48	0	5	0.95	0.27	2.36	36.31	0.08	37.39	7
65	127.14	0	3.27	2.63	127.19	0	0	0	87.42	4.21	0	4.21	29.2	0	0	0	1	0.25	0	29.2	0.06	56	0

SC-6 In situ data Basic output data

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	193.43	1.88	0	1.62	193.43	0.97	6	1.71	127.8	0.06	0	0.06	3024.1	0.97	0	6	0.39	3	1.41	548.84	0	92.78	7
2	262.29	4.02	0.53	0.92	262.3	1.53	6	1.77	134.13	0.13	0	0.13	2000.5	1.54	0	6	0.45	2.55	1.56	631.79	0.29	61.72	7
3	380.86	5.66	0.4	0.64	380.86	1.49	6	1.67	137.37	0.2	0	0.2	1907.6	1.49	0	6	0.44	2.07	1.52	744.76	0.14	64.11	7
4	448.75	6.05	0.52	0.49	448.76	1.35	6	1.59	137.37	0.27	0	0.27	1671.7	1.35	0	6	0.42	1.79	1.47	758.1	0.14	70.29	7
5	589.66	7.41	2.4	0.5	589.69	1.26	6	1.5	137.37	0.34	0	0.34	1748.8	1.26	0	6	0.41	1.59	1.42	886.73	0.51	75.68	7
6	683.78	0	9.36	0	683.91	0	0	0	87.42	0.38	0	0.38	1795.2	0	0	7	1	2.78	0	>1,000	1.77	2578.91	0

Tonner Canyon Rd & SR-57
Brea, CA

CPT Shear Wave Measurements

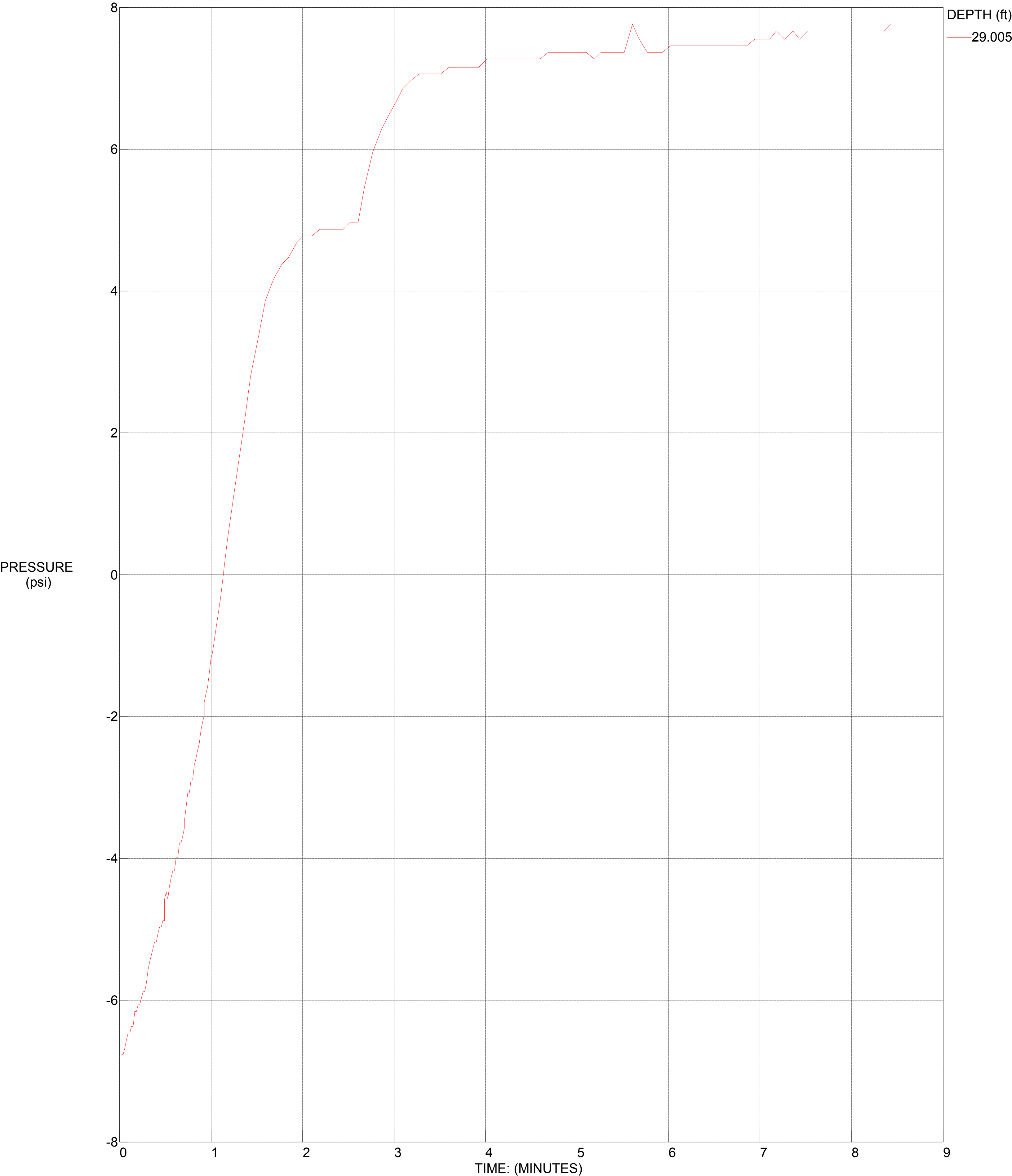
	Tip Depth (ft)	Geophone Depth (ft)	Travel Distance (ft)	S-Wave Arrival (msec)	S-Wave Velocity from Surface (ft/sec)	Interval S-Wave Velocity (ft/sec)
SC-1						
	5.09	4.09	6.46	11.12	580.91	
	10.07	9.07	10.36	17.64	587.12	597.72
	16.08	15.08	15.89	24.52	647.93	803.84
	20.05	19.05	19.70	29.16	675.42	820.68
	25.07	24.07	24.58	35.24	697.61	804.04
	29.04	28.04	28.48	38.94	731.44	1053.64
SC-3						
	5.09	4.09	6.46	10.80	598.12	
	10.07	9.07	10.36	17.02	608.51	626.55
	15.12	14.12	14.98	26.54	564.40	485.53
	20.08	19.08	19.72	32.20	612.55	838.36
	25.07	24.07	24.58	37.04	663.71	1004.04
	30.09	29.09	29.52	41.20	716.42	1185.75
	35.07	34.07	34.43	45.16	762.51	1242.01
	40.09	39.09	39.41	49.88	790.07	1053.72
	45.05	44.05	44.33	54.68	810.77	1025.91
	50.13	49.13	49.38	58.49	844.31	1325.70
	54.99	53.99	54.22	62.40	868.93	1237.15
	60.04	59.04	59.25	67.44	878.58	1102.52
	65.03	64.03	64.22	70.86	906.36	1454.26
SC-6	5.02	4.02	6.42	5.24	1224.36	

Shear Wave Source Offset = 5 ft

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

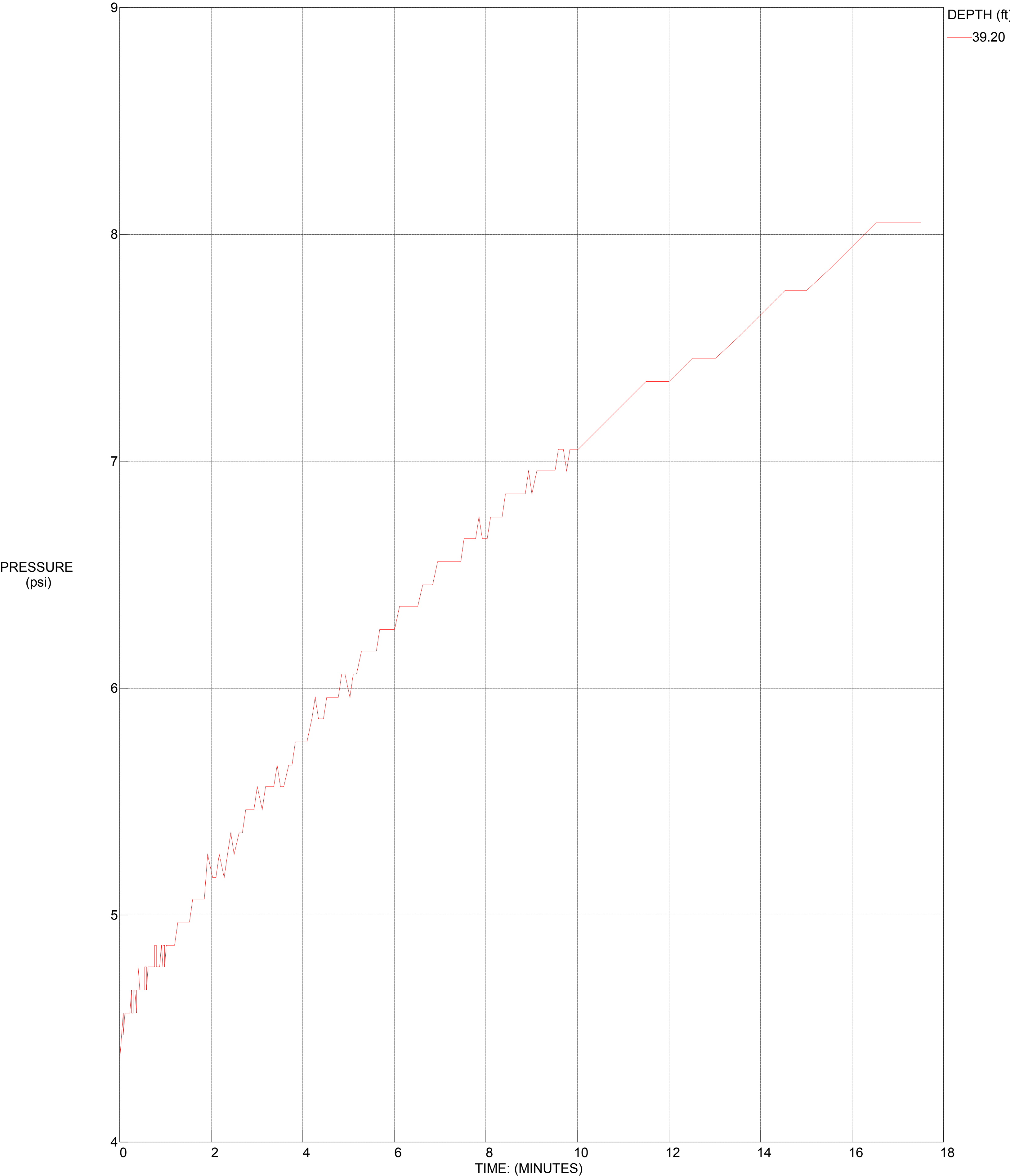
DISSIPATION

TEST ID: C-7
LOCATION: Brea
TEST DATE: Mon 06/Aug/2018
CLIENT: Leighton Consulting



DISSIPATION

TEST ID: C-9
LOCATION: Brea
TEST DATE: Tue 07/Aug/2018
CLIENT: Leighton Consulting



Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236\right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$$I_c < 3.27 \text{ and } I_c > 1.00 \text{ then } k = 10^{0.952-3.04 \cdot I_c}$$

$$I_c \leq 4.00 \text{ and } I_c > 3.27 \text{ then } k = 10^{-4.52-1.37 \cdot I_c}$$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT$_n$: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Peak drained friction angle, φ (°) ::

$$\varphi = 17.60 + 11 \cdot \log(Q_{tn})$$

(applicable only to SBT$_n$: 5, 6, 7 and 8)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$

$a = 14$ for $Q_{tn} > 14$

$a = Q_{tn}$ for $Q_{tn} \leq 14$

$M_{CPT} = a \cdot (q_t - \sigma_v)$

If $I_c \leq 2.20$

$$M_{CPT} = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT$_n$: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT$_n$: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot +7 \cdot \log(F_r))}\right]^{1.25} \text{ or user defined}$$

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT$_n$: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT$_n$: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT$_n$: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Effective Stress Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

- Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012
- Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

APPENDIX B.5

Geophysical Exploration - Seismic Tomography Survey

LINE LOCATION MAP

N

Brea Canyon Widening Project
Brea, California

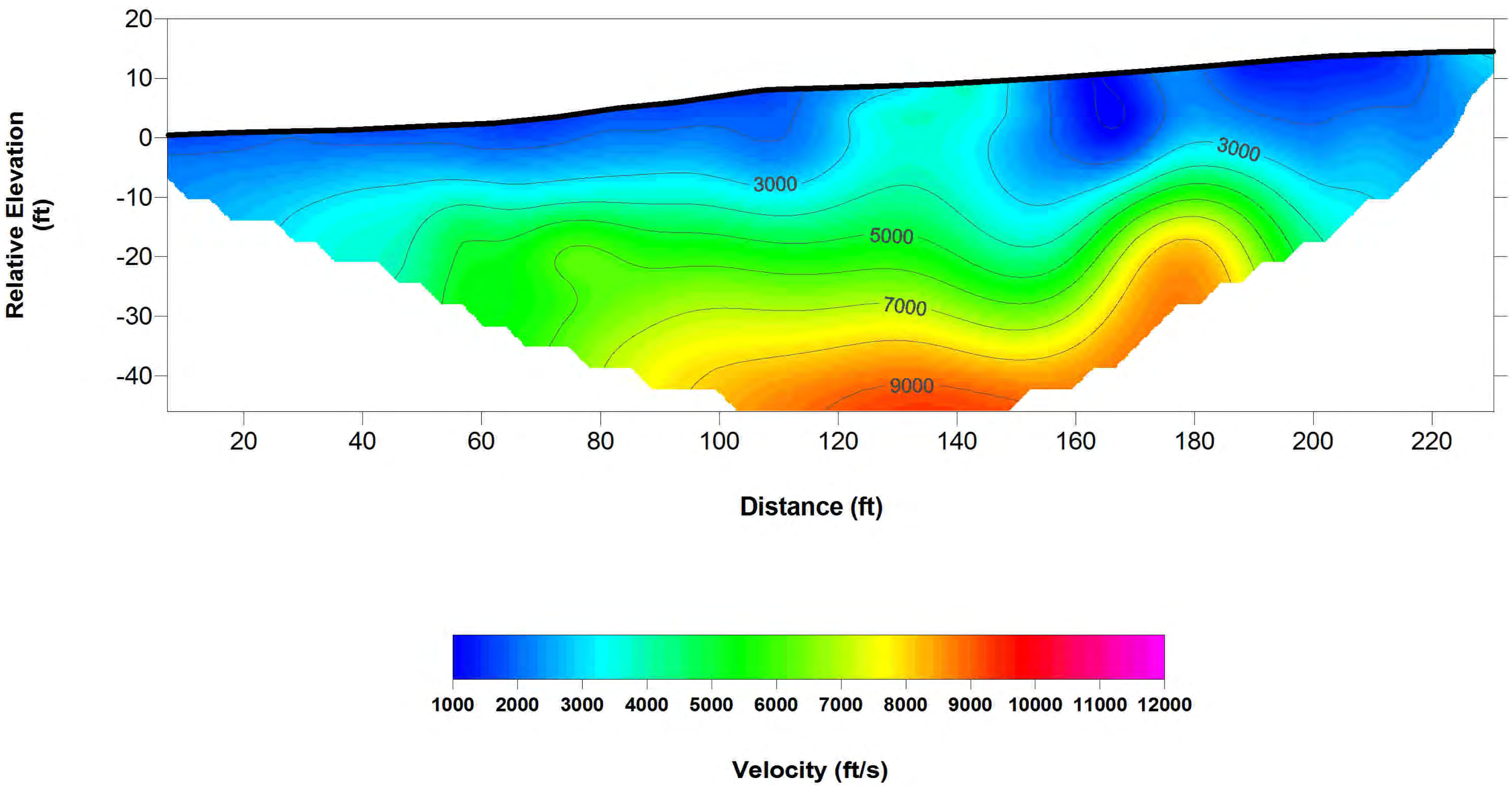
Project No.: 118479 | Date: 09/18

SOUTHWEST

Figure 2

0 150 300
approximate scale in feet

TOMOGRAPHY MODEL



P-WAVE PROFILE SL-1

Brea Canyon Widening Project
Brea, California

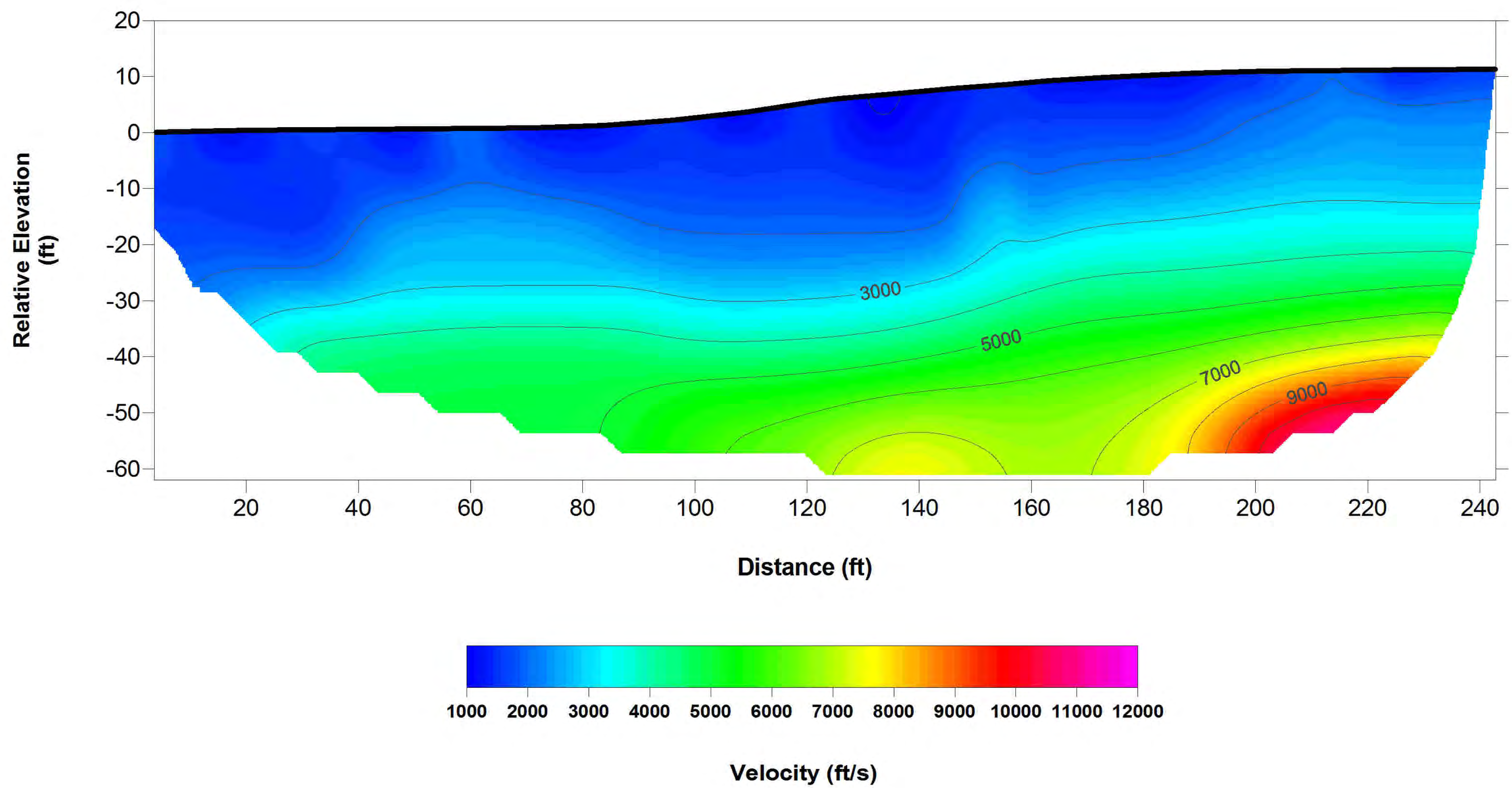
Project No.: 118479 | Date: 09/18

SOUTHWEST GEOPHYSICS INC.

Figure 4a

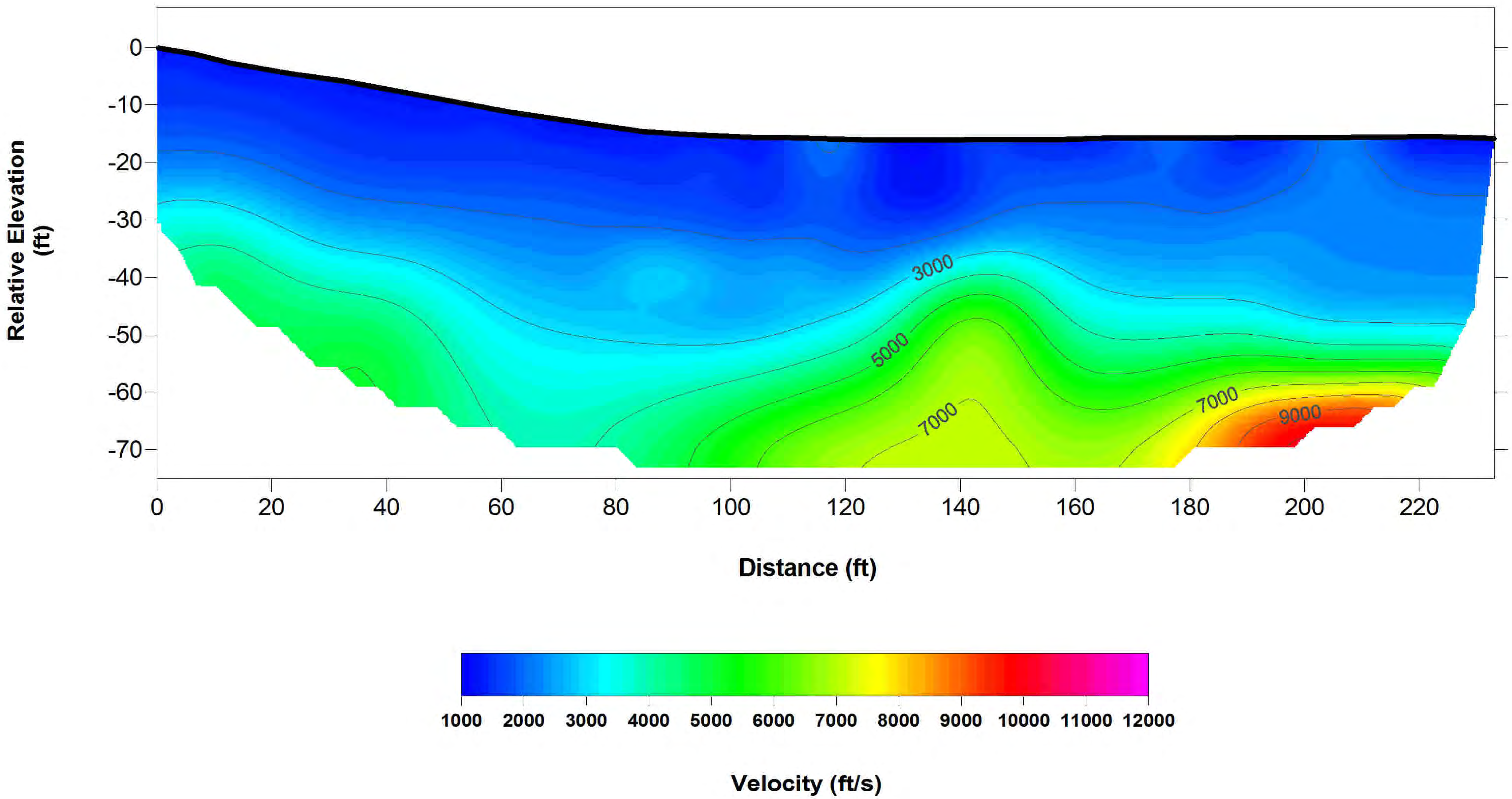
NOTE:
Contour Interval = 1,000 feet per second

TOMOGRAPHY MODEL



P-WAVE PROFILE SL-2	Brea Canyon Widening Project Brea, California Project No.: 118479 — Date: 09/18	SOUTHWEST GEOPHYSICS INC. Figure 4b	**NOTE:** **Contour Interval = 1,000 feet per second**

TOMOGRAPHY MODEL



P-WAVE PROFILE SL-3	Brea Canyon Widening Project Brea, California Project No.: 118479 Date: 09/18	SOUTHWEST GEOPHYSICS INC. Figure 4c	**NOTE:** **Contour Interval = 1,000 feet per second**

APPENDIX C

Laboratory Testing

APPENDIX C.1

Index Properties

ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	09/06/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/12/18
Boring No.:	LB-2	Checked By:	J. Ward		
Sample No.:	R-5	Depth (ft.)	14.0		
Soil Identification:	Olive brown lean clay (CL)				

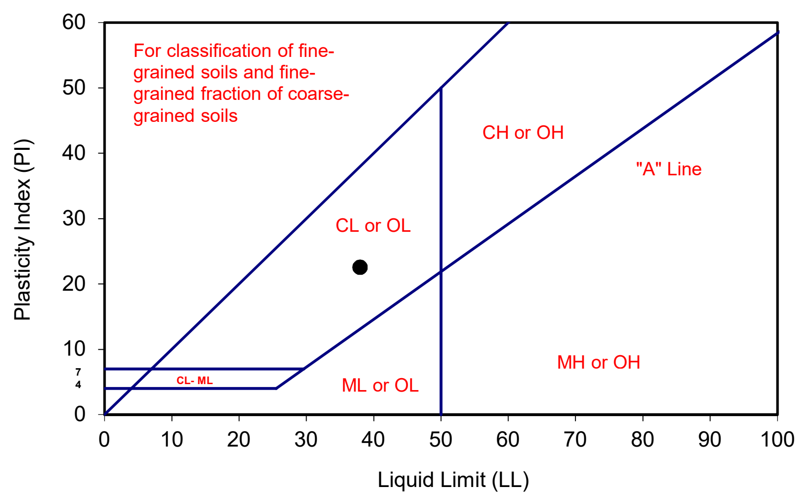
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			31	22	18	
Wet Wt. of Soil + Cont. (g)	18.55	18.26	26.92	25.49	26.71	
Dry Wt. of Soil + Cont. (g)	17.60	17.32	23.38	22.15	22.90	
Wt. of Container (g)	11.46	11.21	13.63	13.55	13.55	
Moisture Content (%) [Wn]	15.47	15.38	36.31	38.84	40.75	

Liquid Limit	**38**
Plastic Limit	**15**
Plasticity Index	**23**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 13.14

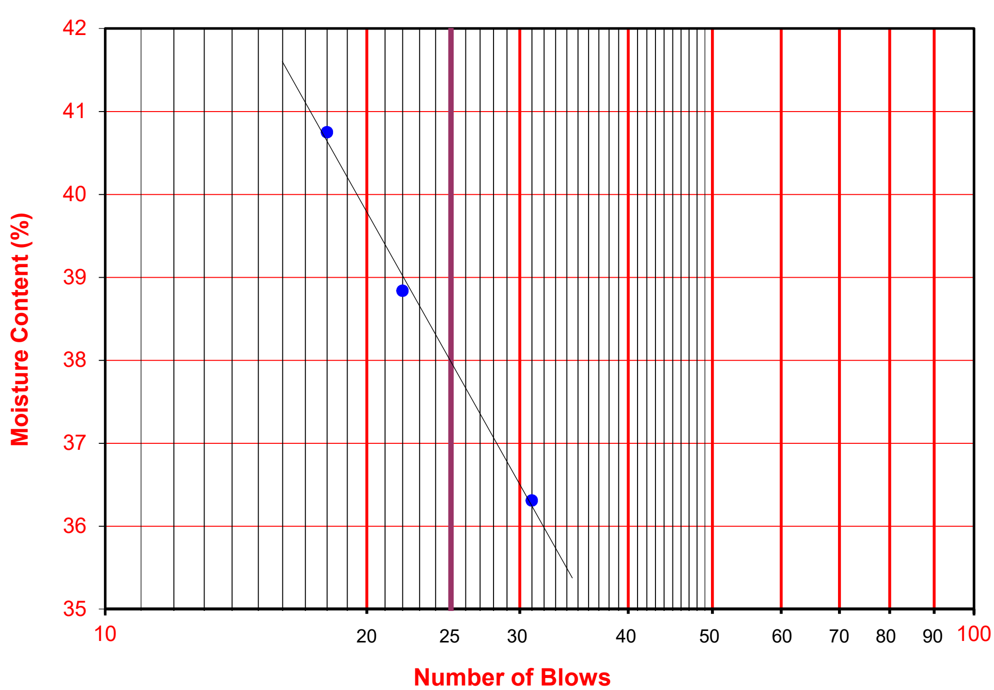
One - Point Liquid Limit Calculation

$LL = W_n(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	08/02/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/04/18
Boring No.:	LB-9	Checked By:	J. Ward		
Sample No.:	B-1	Depth (ft.)	0.0		
Soil Identification:	Brown lean clay (CL)				

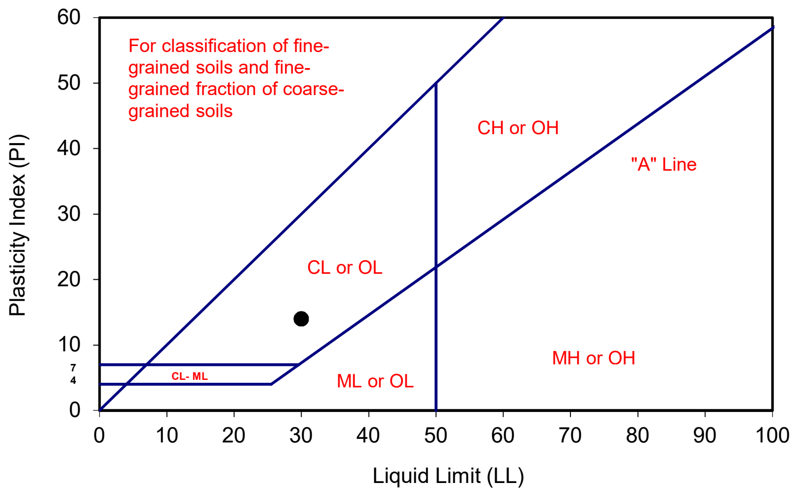
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	24	18	
Wet Wt. of Soil + Cont. (g)	18.39	18.66	27.07	28.01	28.25	
Dry Wt. of Soil + Cont. (g)	17.40	17.61	23.99	24.70	24.83	
Wt. of Container (g)	11.21	11.05	13.55	13.77	13.74	
Moisture Content (%) [Wn]	15.99	16.01	29.50	30.28	30.84	

Liquid Limit	**30**
Plastic Limit	**16**
Plasticity Index	**14**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 7.3

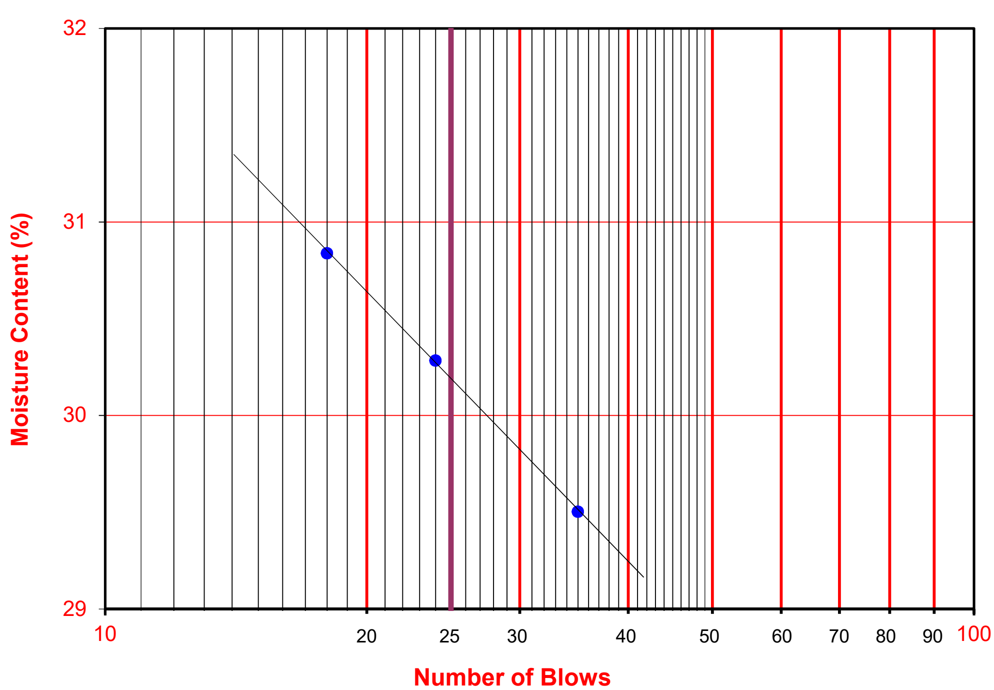
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

☐	Wet Preparation Multipoint - Wet
X	Dry Preparation Multipoint - Dry
X	Procedure A Multipoint Test
☐	Procedure B One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	08/02/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/04/18
Boring No.:	LB-12	Checked By:	J. Ward		
Sample No.:	B-1	Depth (ft.)	1.25		
Soil Identification:	Light grayish brown clayey sand (SC)				

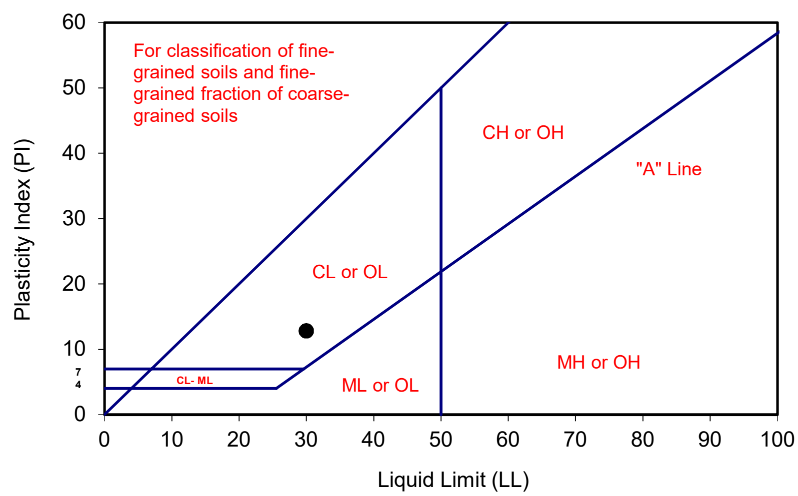
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	25	18	
Wet Wt. of Soil + Cont. (g)	18.38	18.56	26.60	26.81	29.21	
Dry Wt. of Soil + Cont. (g)	17.31	17.52	23.65	23.80	25.59	
Wt. of Container (g)	11.09	11.46	13.58	13.74	13.61	
Moisture Content (%) [Wn]	17.20	17.16	29.29	29.92	30.22	

Liquid Limit	**30**
Plastic Limit	**17**
Plasticity Index	**13**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 7.3

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



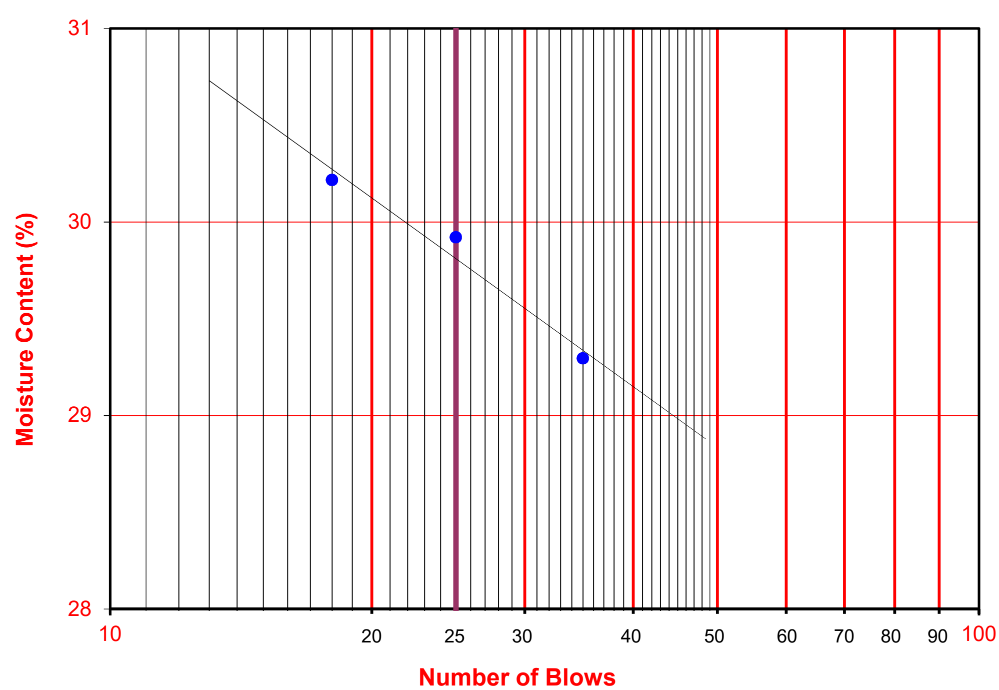
PROCEDURES USED

[ ] Wet Preparation
Multipoint - Wet

[X] Dry Preparation
Multipoint - Dry

[X] Procedure A
Multipoint Test

[ ] Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name: Brea Boulevard Corridor Improvements — Tested By: R. Manning — Date: 08/22/18

Project No. : 11588.001 — Input By: G. Bathala — Date: 08/29/18

Boring No.: LBA-1 — Checked By: J. Ward

Sample No.: G-1 — Depth (ft.) 7.6-9.5

Soil Identification: Light olive brown fat clay (CH), mica noted

Note: Material was not screened through sieve #40

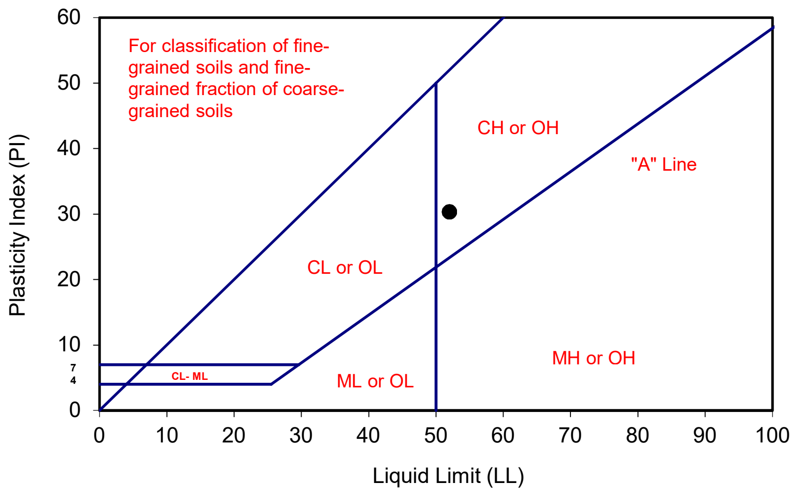
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	22	18	45
Wet Wt. of Soil + Cont. (g)	18.08	17.52	29.80	29.24	26.76	26.53
Dry Wt. of Soil + Cont. (g)	16.85	16.38	24.67	23.79	22.03	22.09
Wt. of Container (g)	11.23	11.06	13.48	13.70	13.75	11.21
Moisture Content (%) [Wn]	21.89	21.43	45.84	54.01	57.13	40.81

Liquid Limit	**52**
Plastic Limit	**22**
Plasticity Index	**30**
Classification	**CH**

PI at "A" - Line = 0.73(LL-20) = 23.36

One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.121}$$



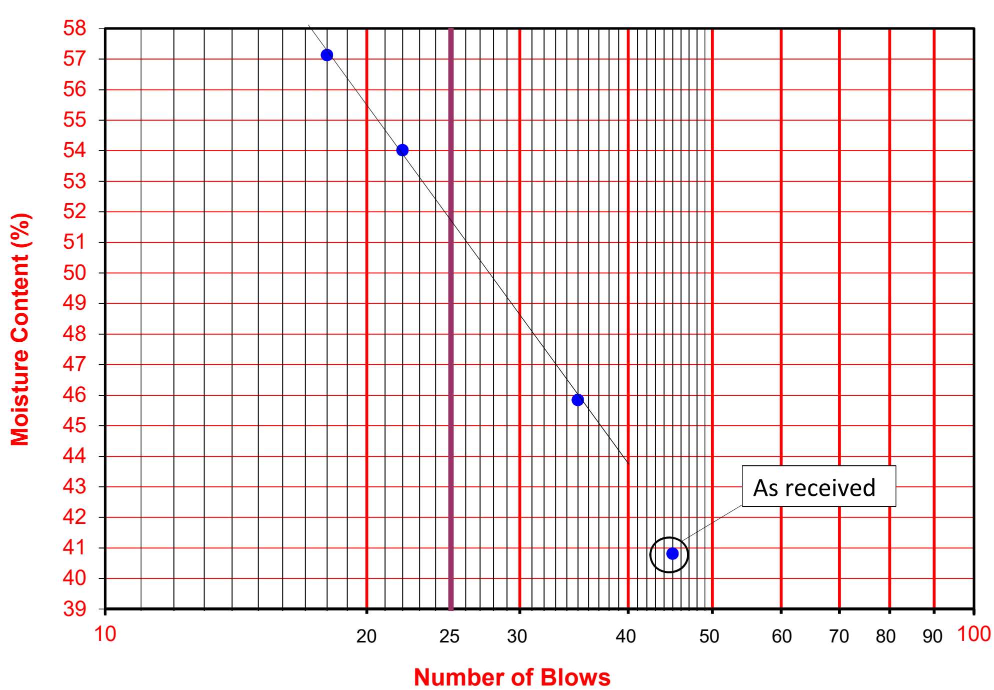
PROCEDURES USED

[ ] Wet Preparation
Multipoint - Wet

[X] Dry Preparation
Multipoint - Dry

[X] Procedure A
Multipoint Test

[ ] Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-19	Checked By:	A. Santos		
Sample No.:	S-7	Depth (ft.)	25.0		
Soil Identification:	Yellowish brown clayey sand (SC)				

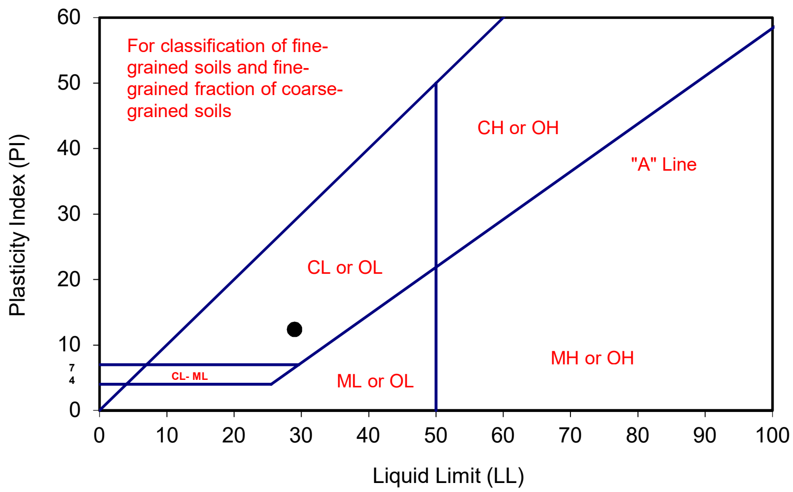
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			32	26	19	
Wet Wt. of Soil + Cont. (g)	9.63	9.71	21.38	20.66	21.85	
Dry Wt. of Soil + Cont. (g)	8.39	8.49	16.90	16.23	16.99	
Wt. of Container (g)	1.02	1.06	1.02	1.04	0.98	
Moisture Content (%) [Wn]	16.82	16.42	28.21	29.16	30.36	

Liquid Limit	**29**
Plastic Limit	**17**
Plasticity Index	**12**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 6.57

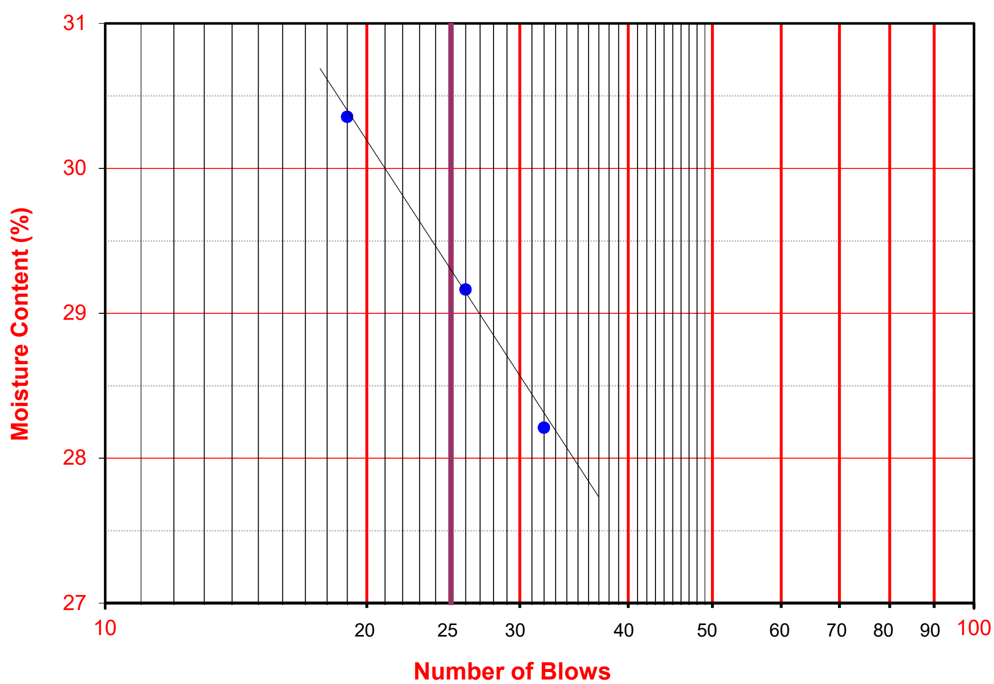
One - Point Liquid Limit Calculation

$$LL = Wn(N/25)^{0.121}$$



PROCEDURES USED

[ ]	Wet Preparation Multipoint - Wet
[X]	Dry Preparation Multipoint - Dry
[X]	Procedure A Multipoint Test
[ ]	Procedure B One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-22	Checked By:	A. Santos		
Sample No.:	R-3	Depth (ft.)	10.0		
Soil Identification:	Light brown lean clay (CL)				

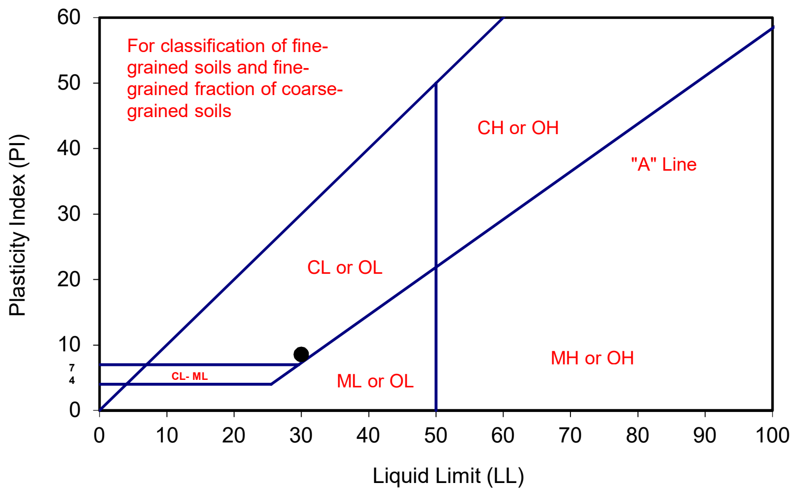
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			29	22	16	
Wet Wt. of Soil + Cont. (g)	9.21	9.27	20.51	21.20	20.30	
Dry Wt. of Soil + Cont. (g)	7.76	7.83	16.05	16.44	15.61	
Wt. of Container (g)	1.01	1.09	1.11	1.03	1.08	
Moisture Content (%) [Wn]	21.48	21.36	29.85	30.89	32.28	

Liquid Limit	**30**
Plastic Limit	**21**
Plasticity Index	**9**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 7.3

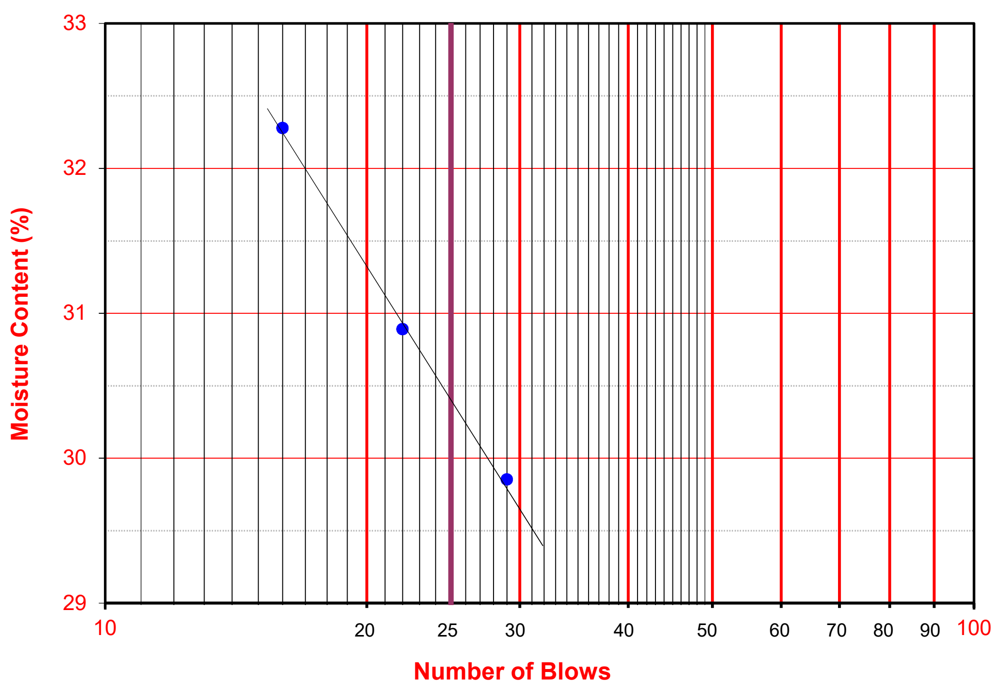
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS
ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-22	Checked By:	A. Santos		
Sample No.:	S-6	Depth (ft.)	23.5		
Soil Identification:	Gray silt (ML)				

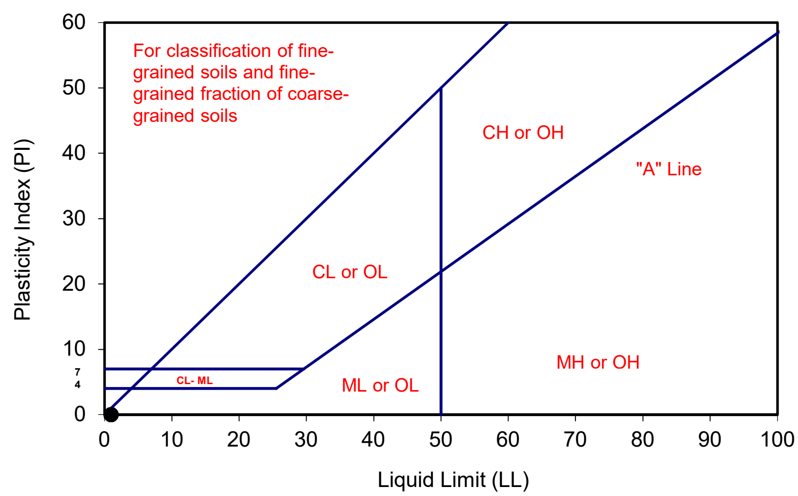
TEST NO.	PLASTIC LIMIT 1	PLASTIC LIMIT 2	LIQUID LIMIT 1	LIQUID LIMIT 2	LIQUID LIMIT 3	LIQUID LIMIT 4
Number of Blows [N]			10			
Wet Wt. of Soil + Cont. (g)	**Cannot be rolled:**		21.62	**Cannot get more than 10 blows:**		
Dry Wt. of Soil + Cont. (g)	**NonPlastic**		17.52	**NonPlastic**		
Wt. of Container (g)			1.01			
Moisture Content (%) [Wn]			24.83			

Liquid Limit	**NP**
Plastic Limit	**NP**
Plasticity Index	**NP**
Classification	**NP**

PI at "A" - Line = 0.73(LL-20) =

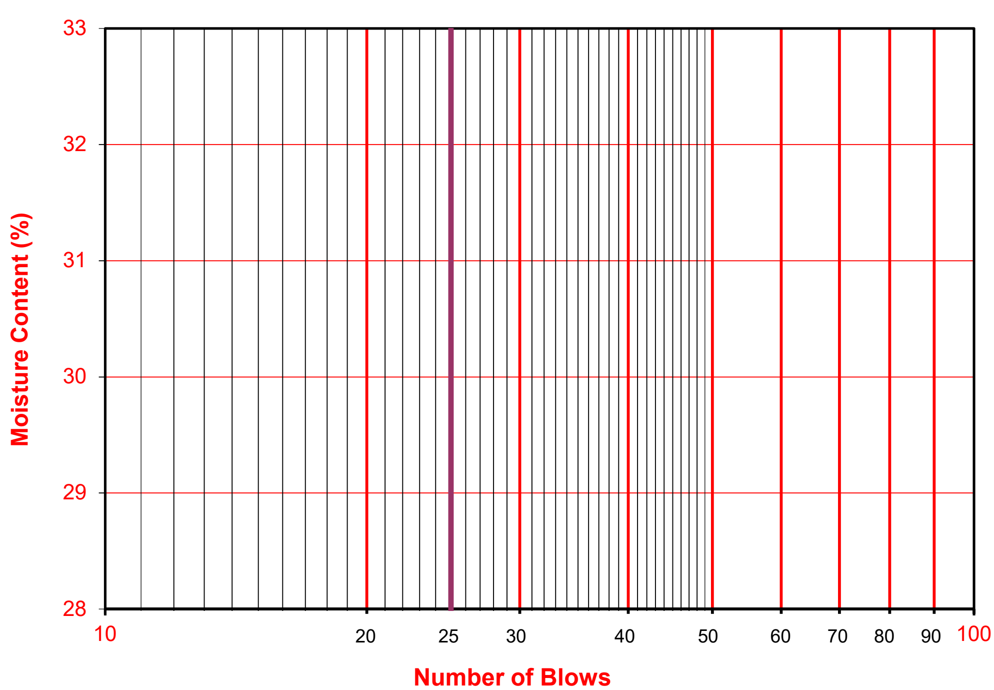
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
Multipoint - Wet
- [X] Dry Preparation
Multipoint - Dry
- [X] Procedure A
Multipoint Test
- [ ] Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-25	Checked By:	A. Santos		
Sample No.:	T-5B	Depth (ft.)	16.0		
Soil Identification:	Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons				

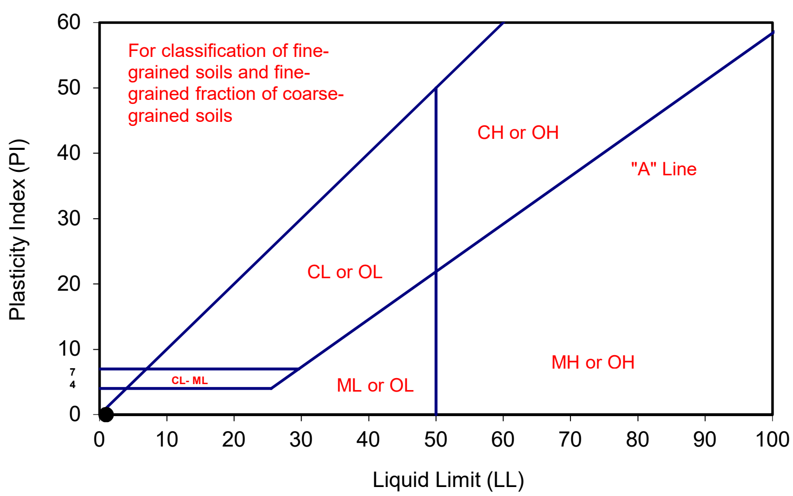
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			7			
Wet Wt. of Soil + Cont. (g)	**Cannot be rolled:**		18.28	**Cannot get more than 7 blows:**		
Dry Wt. of Soil + Cont. (g)	**NonPlastic**		15.01	**NonPlastic**		
Wt. of Container (g)			1.00			
Moisture Content (%) [Wn]			23.34			

Liquid Limit	**NP**
Plastic Limit	**NP**
Plasticity Index	**NP**
Classification	**NP**

PI at "A" - Line = 0.73(LL-20) =

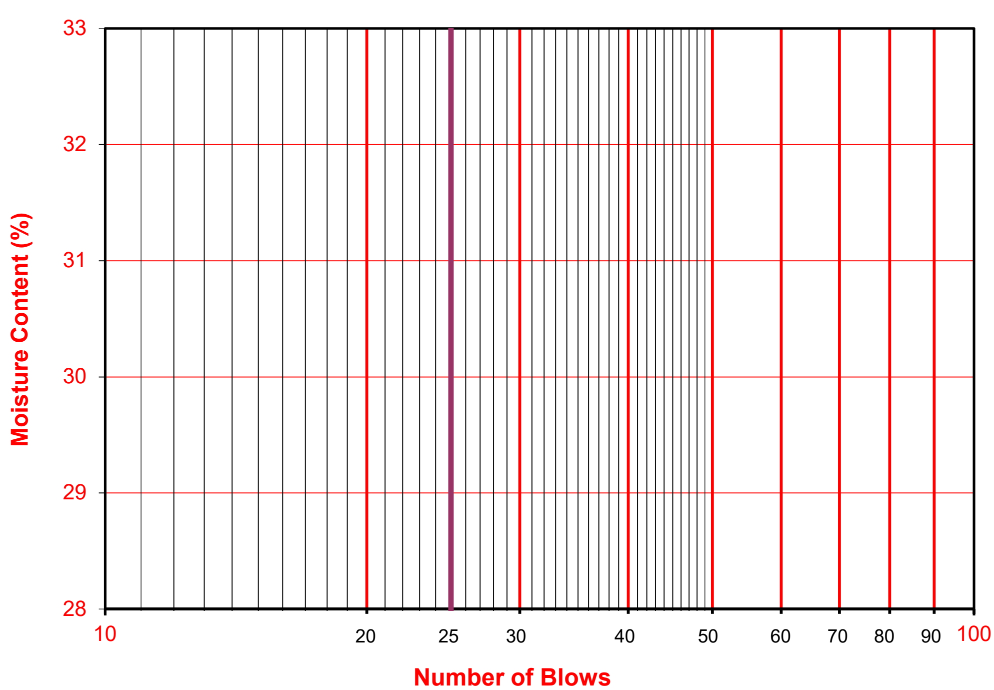
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS
ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	A. Santos	Date:	11/07/20
Boring No.:	LB-27	Checked By:	A. Santos		
Sample No.:	R-5	Depth (ft.)	20.0		
Soil Identification:	Brown sandy lean clay s(CL)				

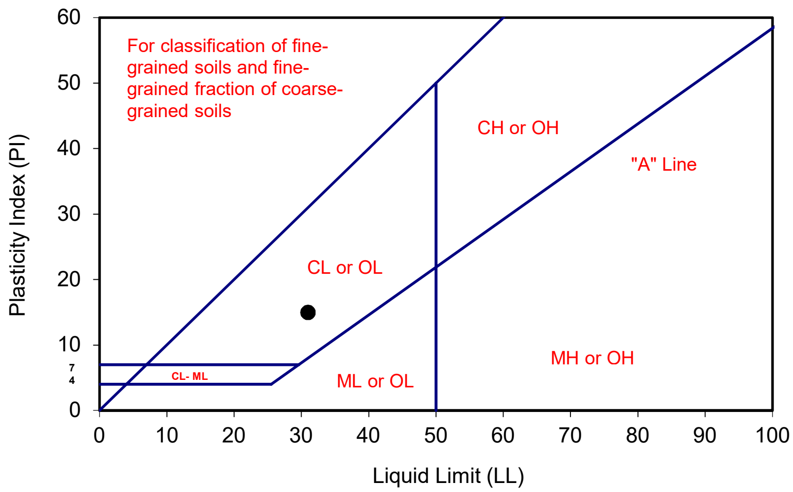
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			30	24	18	
Wet Wt. of Soil + Cont. (g)	10.07	10.08	20.91	22.08	20.16	
Dry Wt. of Soil + Cont. (g)	8.83	8.84	16.31	17.12	15.52	
Wt. of Container (g)	1.09	1.10	1.01	1.05	1.04	
Moisture Content (%) [Wn]	16.02	16.02	30.07	30.86	32.04	

Liquid Limit	**31**
Plastic Limit	**16**
Plasticity Index	**15**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 8.03

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



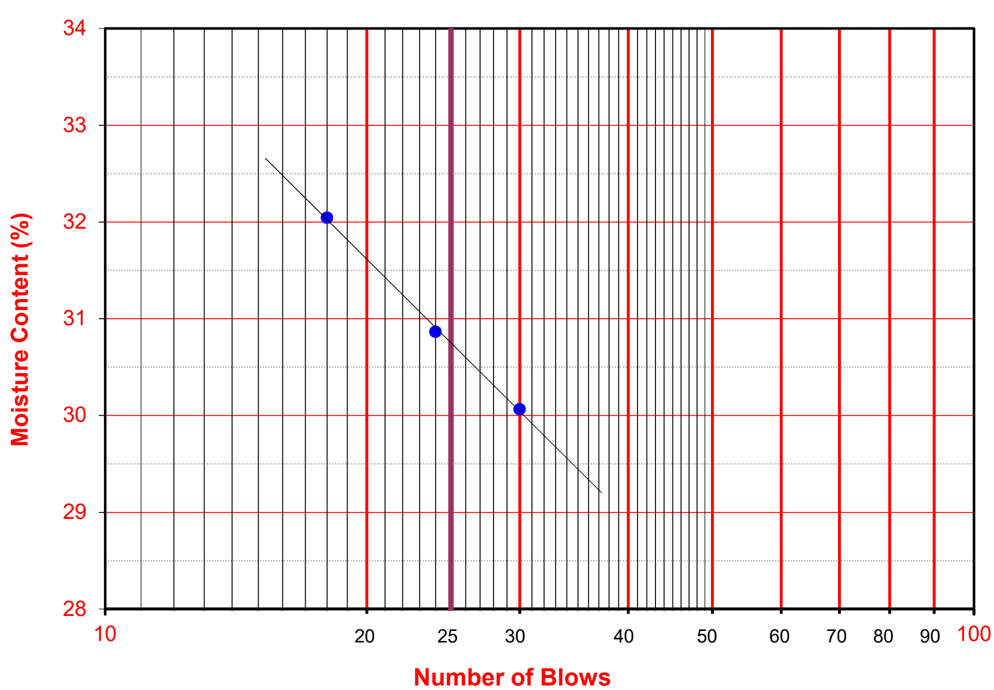
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

X Dry Preparation
Multipoint - Dry

X Procedure A
Multipoint Test

☐ Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-31	Checked By:	A. Santos		
Sample No.:	R-2	Depth (ft.)	10.0		
Soil Identification:	Dark brown lean clay with sand (CL)s				

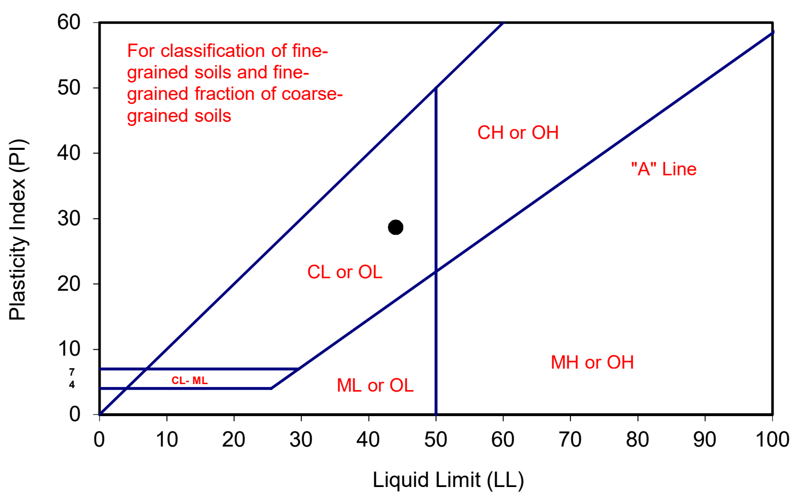
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	26	19	
Wet Wt. of Soil + Cont. (g)	9.22	9.34	19.69	20.41	19.24	
Dry Wt. of Soil + Cont. (g)	8.14	8.23	14.06	14.46	13.57	
Wt. of Container (g)	1.05	1.04	1.06	1.02	0.98	
Moisture Content (%) [Wn]	15.23	15.44	43.31	44.27	45.04	

Liquid Limit	**44**
Plastic Limit	**15**
Plasticity Index	**29**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 17.52

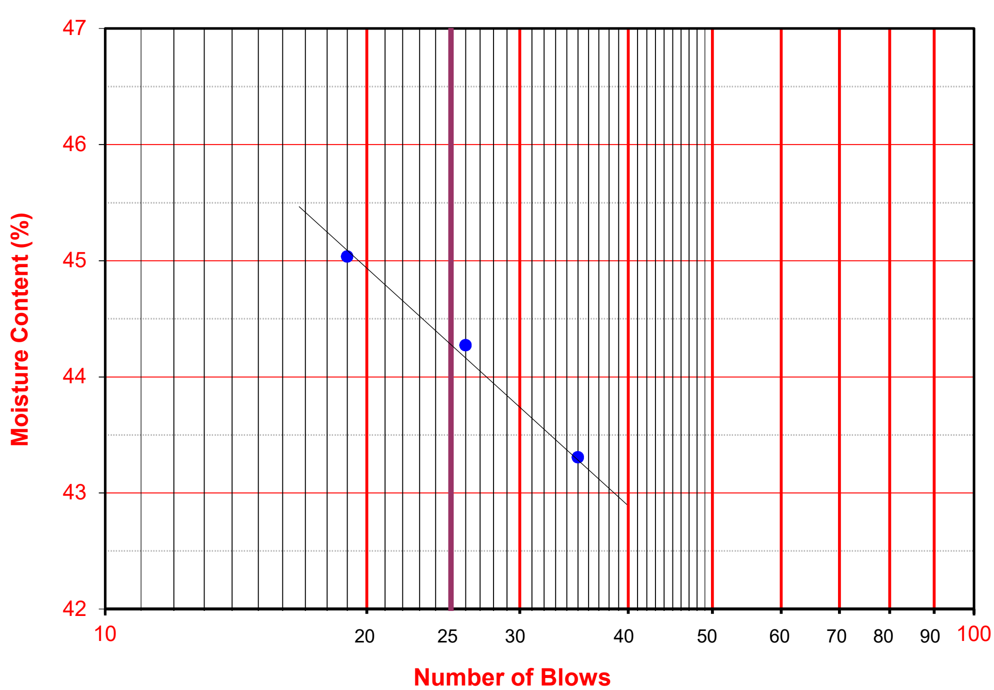
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [x] Dry Preparation
  Multipoint - Dry
- [x] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Leighton

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen
Date:	10/26/20		
Project No. :	11585.005	Input By:	G. Bathala
Date:	11/02/20		
Boring No.:	LB-39	Checked By:	A. Santos
Sample No.:	S-6	Depth (ft.)	25.0
Soil Identification:	Yellowish brown clayey sand (SC)		

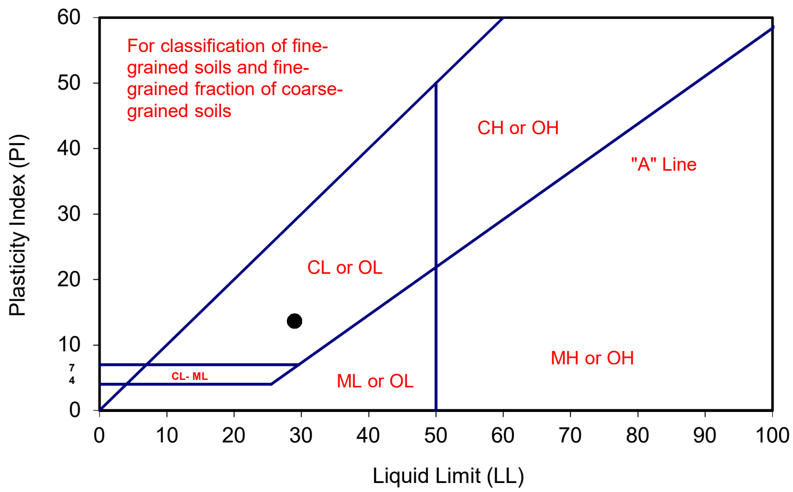
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			29	23	16	
Wet Wt. of Soil + Cont. (g)	9.69	9.81	20.50	20.83	21.57	
Dry Wt. of Soil + Cont. (g)	8.56	8.64	16.26	16.38	16.81	
Wt. of Container (g)	1.17	1.07	1.10	1.01	1.05	
Moisture Content (%) [Wn]	15.29	15.46	27.97	28.95	30.20	

Liquid Limit	**29**
Plastic Limit	**15**
Plasticity Index	**14**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 6.57

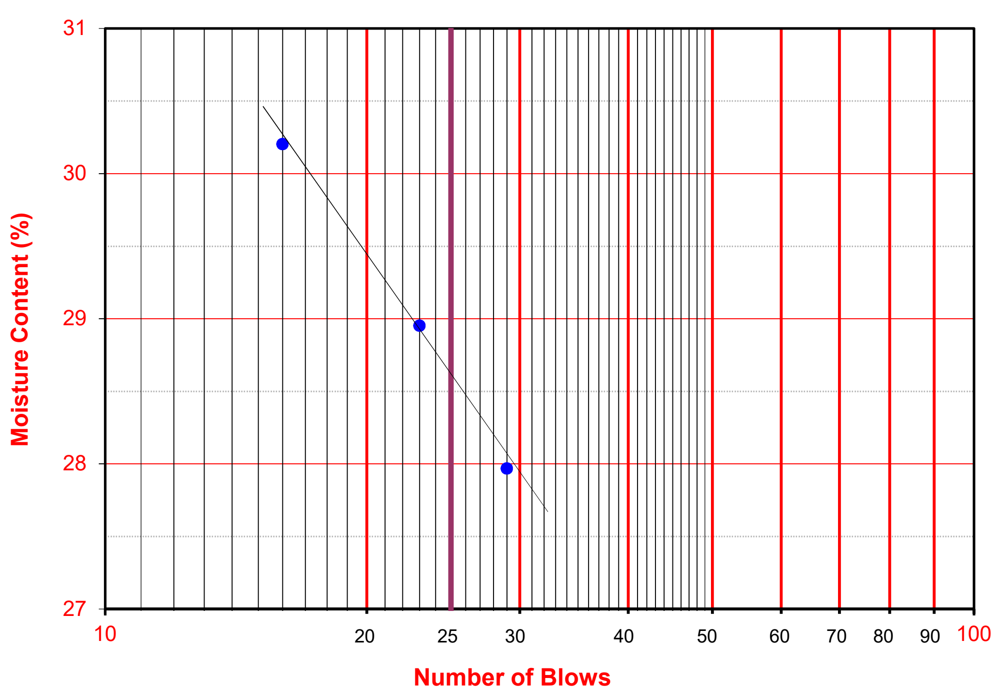
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Felter	Date:	09/06/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Location:	LB-5	Depth (ft.):	1.25		
Sample No.:	B-1				
Soil Identification:	Gray clayey sand (SC)				

Dry Wt. of Soil + Cont. (g)	1000.00
Wt. of Container No. (g)	0.00
Dry Wt. of Soil (g)	1000.00
Weight Soil Retained on #4 Sieve	0.00
Percent Passing # 4	100.00

MOLDED SPECIMEN	Before Test	After Test
Specimen Diameter (in.)	4.01	4.01
Specimen Height (in.)	1.0000	1.0285
Wt. Comp. Soil + Mold (g)	542.30	416.68
Wt. of Mold (g)	163.60	0.00
Specific Gravity (Assumed)	2.70	2.70
Container No.	O	O
Wet Wt. of Soil + Cont. (g)	759.30	580.28
Dry Wt. of Soil + Cont. (g)	678.00	501.76
Wt. of Container (g)	0.00	163.60
Moisture Content (%)	11.99	23.22
Wet Density (pcf)	114.2	122.2
Dry Density (pcf)	102.0	99.2
Void Ratio	0.653	0.700
Total Porosity	0.395	0.412
Pore Volume (cc)	81.8	87.6
Degree of Saturation (%) [S_{meas}]	**49.6**	89.6

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
09/06/18	11:36	1.0	0	0.2535
09/06/18	11:46	1.0	10	0.2535
Add Distilled Water to the Specimen				
09/06/18	12:01	1.0	15	0.2660
09/07/18	6:40	1.0	1134	0.2820
09/07/18	7:52	1.0	1206	0.2820

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**29**

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS

ASTM D 6913

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Felter	Date:	08/02/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-1	Depth (feet):	1.25		
Sample No.:	B-1				
Soil Identification:	Brown clayey sand (SC)				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	SP-04	9545	Wt. of Air-Dry Soil + Cont.(g)	0.0	0.0
Wt. Air-Dried Soil + Cont.(g)	5330.5	718.9	Wt. of Dry Soil + Cont. (g)	0.0	0.0
Wt. of Container (g)	788.1	106.9	Wt. of Container No.______(g)	1.0	1.0
Dry Wt. of Soil (g)	4542.4	612.0	Moisture Content (%)	0.0	0.0

Passing #4 Material After Wet Sieve	Container No.	9545
	Wt. of Dry Soil + Container (g)	454.9
	Wt. of Container (g)	106.9
	Dry Wt. of Soil Retained on # 200 Sieve (g)	348.0

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
1 1/2"	37.5			
1"	25.0			
3/4"	19.0	0.0		100.0
1/2"	12.5	21.3		99.5
3/8"	9.5	40.3		99.1
#4	4.75	107.0		97.6
#8	2.36		10.7	95.9
#16	1.18		25.5	93.5
#30	0.600		49.1	89.8
#50	0.300		103.1	81.2
#100	0.150		228.6	61.1
#200	0.075		345.3	42.5
PAN				

GRAVEL: **2 %**

SAND: **55 %**

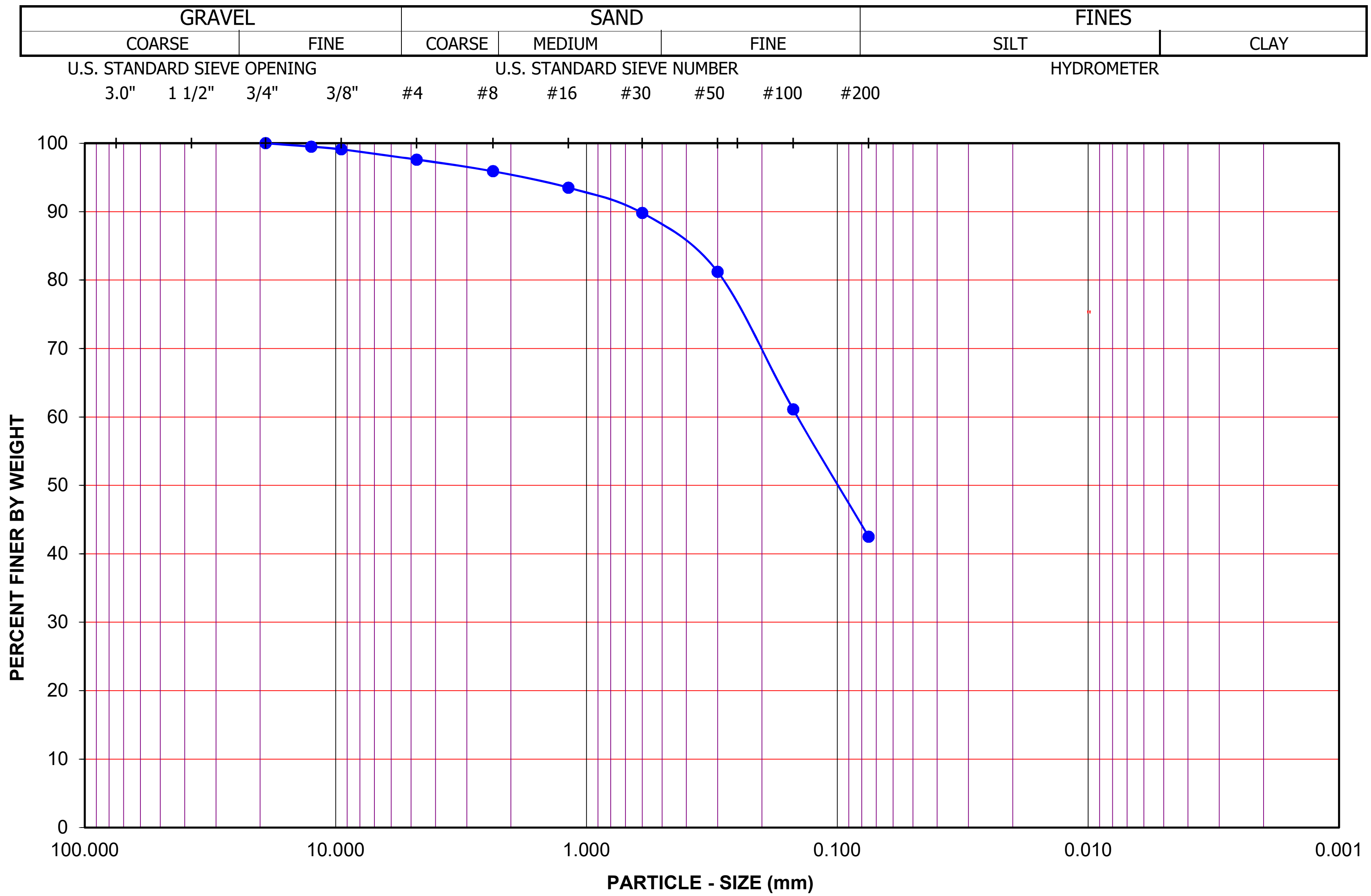
FINES: **43 %**

GROUP SYMBOL: **SC**

Cu = D60/D10 = ________

Cc = $(D30)^2/(D60*D10)$ = ________

Remarks:



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LB-1 Sample No.: B-1

Depth (feet): 1.3 Soil Type : SC

Soil Identification: Brown clayey sand (SC)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 2 : 55 : 43

Sep-18

SA LB-1, B-1 @ 1.25

Leighton

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS

ASTM D 6913

Project Name: Brea Boulevard Corridor Improvements
Project No.: 11588.001
Boring No.: LB-11
Sample No.: B-1
Soil Identification: Brown clayey sand (SC)

Tested By: S. Felter Date: 08/02/18
Checked By: J. Ward Date: 09/14/18
Depth (feet): 3.0

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	AB-10	901	Wt. of Air-Dry Soil + Cont.(g)	0.0	0.0
Wt. Air-Dried Soil + Cont.(g)	2847.8	700.3	Wt. of Dry Soil + Cont. (g)	0.0	0.0
Wt. of Container (g)	223.3	108.0	Wt. of Container No.______(g)	1.0	1.0
Dry Wt. of Soil (g)	2624.5	592.3	Moisture Content (%)	0.0	0.0

Passing #4 Material After Wet Sieve		
	Container No.	901
	Wt. of Dry Soil + Container (g)	390.3
	Wt. of Container (g)	108.0
	Dry Wt. of Soil Retained on # 200 Sieve (g)	282.3

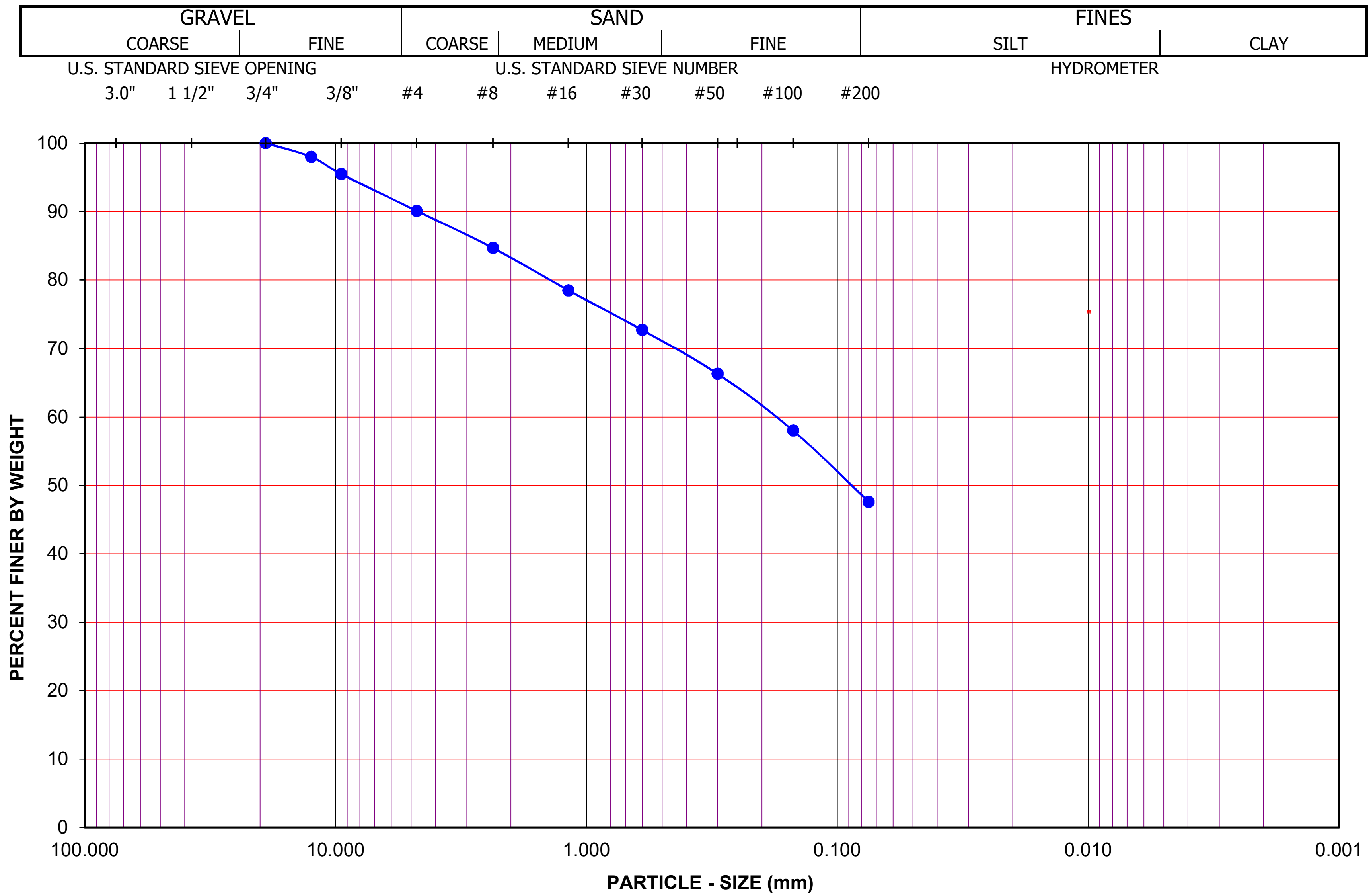
U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
1 1/2"	37.5			
1"	25.0			
3/4"	19.0	0.0		100.0
1/2"	12.5	53.3		98.0
3/8"	9.5	116.8		95.5
#4	4.75	260.6		90.1
#8	2.36		35.4	84.7
#16	1.18		76.0	78.5
#30	0.600		114.2	72.7
#50	0.300		156.4	66.3
#100	0.150		210.9	58.0
#200	0.075		279.1	47.6
PAN				

GRAVEL: **10 %**
SAND: **42 %**
FINES: **48 %**
GROUP SYMBOL: **SC**

Cu = D60/D10 = ______

Cc = $(D30)^2/(D60*D10)$ = ______

Remarks:



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LB-11   Sample No.: B-1

Depth (feet): 3.0   Soil Type : SC

Soil Identification: Brown clayey sand (SC)

GR:SA:FI : (%)   10 : 42 : 48

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

Sep-18

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	G. Berdy	Date:	08/26/18
Project No.:	11588.001	Data Input By:	J. Ward	Date:	08/28/18
Boring No.:	LBA-1				
Sample No.:	G-1	Depth (feet):	7.6-9.5		
Soil Identification:	Light olive brown fat clay (CH), mica noted				

		Soil Type
% Gravel	0	CH
% Sand	8	
% Fines	92	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	84.42	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	84.05	78.90
Wt.of Air-Dry Soil + Cont. (g)	95.55	Wt. of Container No.___ (g)	1.00	74.56	74.92
Wt. of Container	39.21	Moisture Content (%)	0.00	3.90	
Dry Wt. of Soil (g)	56.34	Wt. of Dry Soil (g)			3.98

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.08	99.9
Pan		

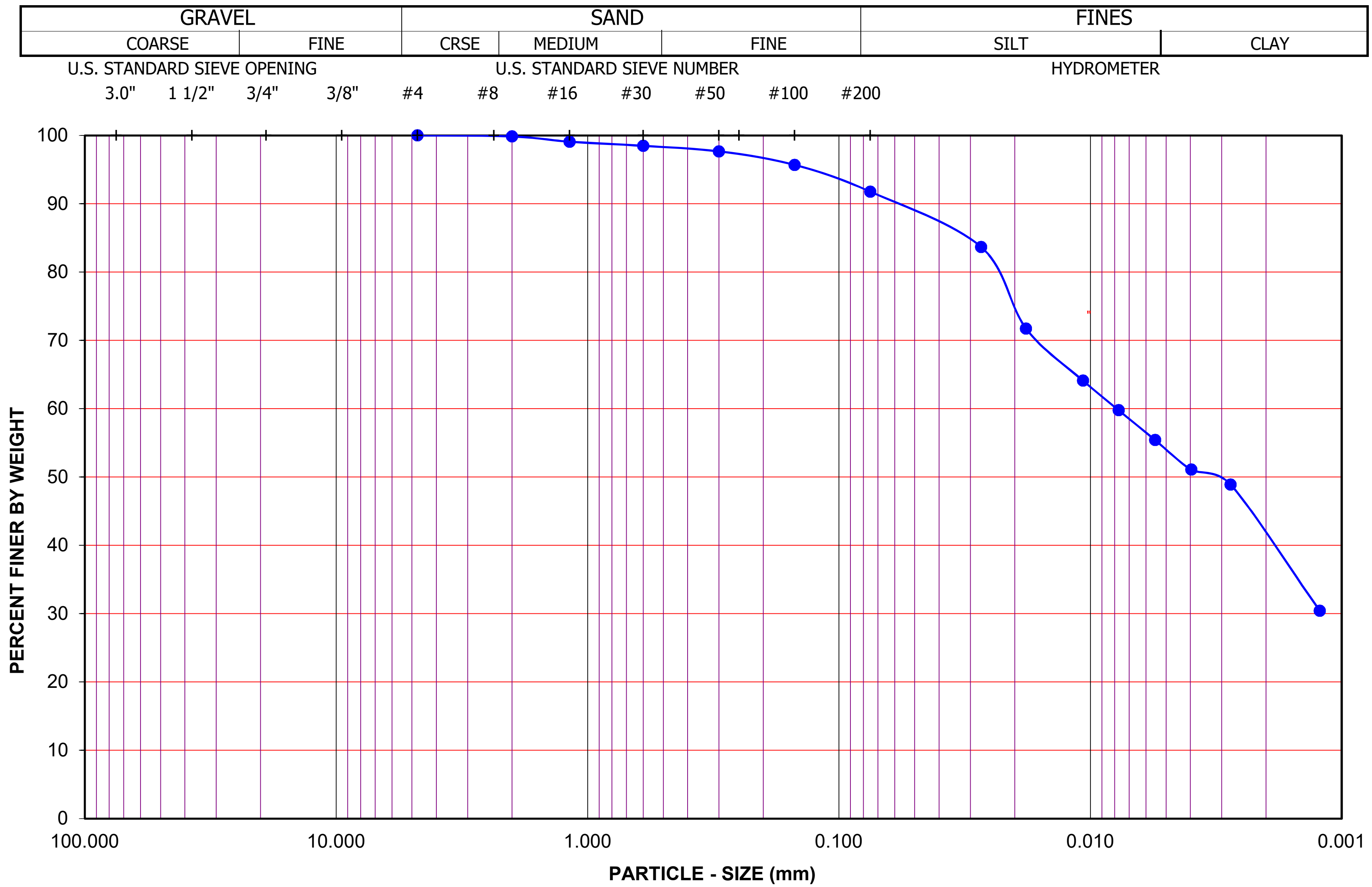
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.9
No. 16	0.35	99.2	99.1
No. 30	0.63	98.6	98.5
No. 50	1.00	97.8	97.7
No. 100	1.90	95.8	95.7
No. 200	3.69	91.9	91.8
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 47.35 Wt. of Dry Soil (g) 45.57

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
27-Aug-06	7:38	0		7.5			
	7:40	2	23.9	7.5	46.0	83.7	0.0272
	7:43	5	23.9	7.5	40.5	71.7	0.0180
	7:53	15	23.9	7.5	37.0	64.1	0.0107
	8:08	30	23.9	7.5	35.0	59.8	0.0077
	8:38	60	23.8	7.5	33.0	55.4	0.0055
	9:38	120	23.7	7.5	31.0	51.1	0.0040
	11:48	250	23.7	7.5	30.0	48.9	0.0028
28-Aug-06	7:38	1440	23.0	7.5	21.5	30.4	0.0012



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LBA-1 Sample No.: G-1

Depth (feet): 7.6-9.5 Soil Type : CH

Soil Identification: Light olive brown fat clay (CH), mica noted

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 8 : 92

Aug-18

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-19				
Sample No.:	S-7	Depth (feet):	25.0		
Soil Identification:	Yellowish brown clayey sand (SC)				

% Gravel	0	Soil Type
% Sand	57	SC
% Fines	43	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	68.08	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	68.05	117.56
Wt.of Air-Dry Soil + Cont. (g)	733.10	Wt. of Container No.___ (g)	1.00	52.93	88.03
Wt. of Container	106.40	Moisture Content (%)	0.00	0.20	
Dry Wt. of Soil (g)	626.70	Wt. of Dry Soil (g)			29.53

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	1.51	99.8
No. 10	4.93	99.2
Pan		

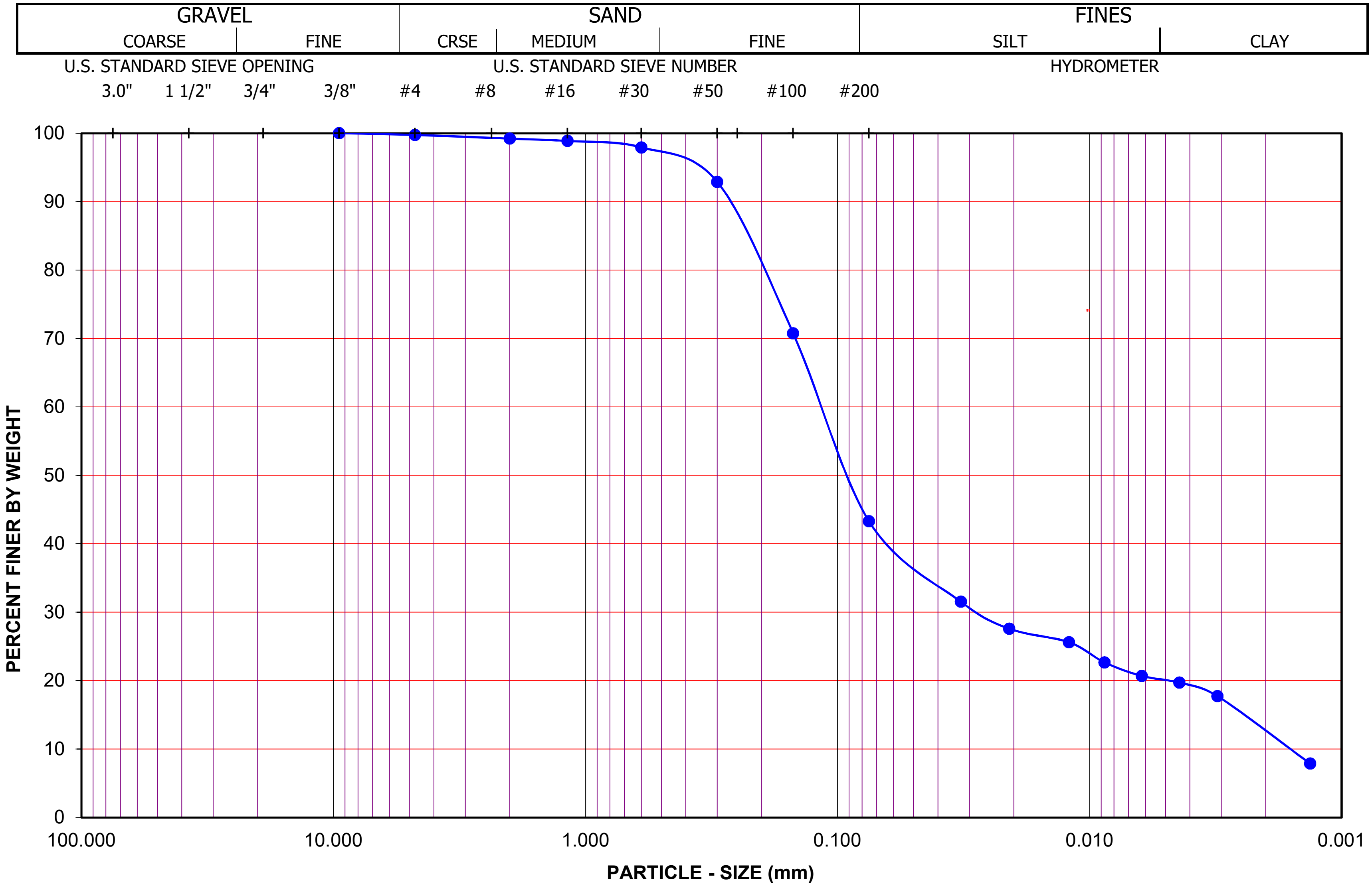
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.2
No. 16	0.17	99.7	98.9
No. 30	0.64	98.7	97.9
No. 50	3.19	93.6	92.9
No. 100	14.32	71.3	70.8
No. 200	28.15	43.6	43.3
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.04 Wt. of Dry Soil (g) 49.94

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:28	0		7.0			
	9:30	2	23.3	7.0	23.0	31.5	0.0324
	9:33	5	23.2	7.0	21.0	27.6	0.0208
	9:43	15	23.1	7.0	20.0	25.6	0.0121
	9:58	30	22.9	7.0	18.5	22.7	0.0087
	10:28	60	22.7	7.0	17.5	20.7	0.0062
	11:28	120	22.6	7.0	17.0	19.7	0.0044
	13:38	250	21.8	7.0	16.0	17.7	0.0031
29-Oct-20	9:28	1440	21.6	7.0	11.0	7.9	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-19 | Sample No.: S-7

Depth (feet): 25.0 | Soil Type : SC

Soil Identification: Yellowish brown clayey sand (SC)

GR:SA:FI : (%) 0 : 57 : 43

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings   Tested By: Y. Nguyen   Date: 10/27/20

Project No.: 11585.005   Checked By: A. Santos   Date: 11/30/20

Boring No.: LB-22

Sample No.: R-3   Depth (feet): 10.0

Soil Identification: Light brown lean clay (CL)

		Soil Type
% Gravel	**0**	
% Sand	**9**	**CL**
% Fines	**91**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.20	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.17	100.46
Wt.of Air-Dry Soil + Cont. (g)	814.60	Wt. of Container No.___ (g)	1.00	56.67	88.26
Wt. of Container	251.34	Moisture Content (%)	0.00	0.19	
Dry Wt. of Soil (g)	563.26	Wt. of Dry Soil (g)			12.20

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

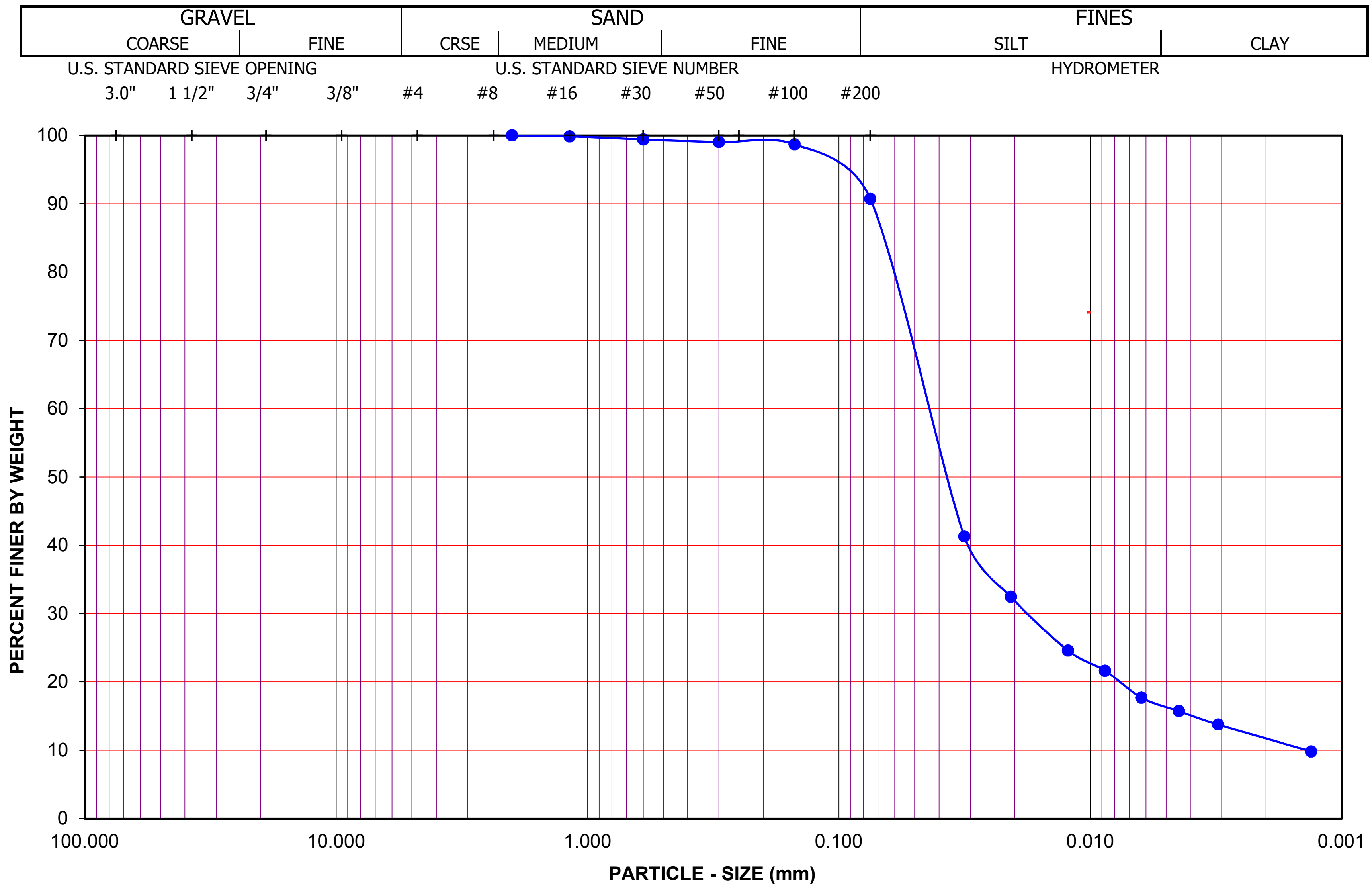
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.06	99.9	99.9
No. 30	0.30	99.4	99.4
No. 50	0.49	99.0	99.0
No. 100	0.66	98.7	98.7
No. 200	4.68	90.7	90.7
Pan			

Hydrometer   Wt. of Air-Dry Soil (g) 50.49   Wt. of Dry Soil (g) 50.39

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:20	0		7.0			
	9:22	2	22.8	7.0	28.0	41.3	0.0317
	9:25	5	22.8	7.0	23.5	32.5	0.0207
	9:35	15	22.7	7.0	19.5	24.6	0.0123
	9:50	30	22.6	7.0	18.0	21.7	0.0087
	10:20	60	22.5	7.0	16.0	17.7	0.0063
	11:20	120	22.6	7.0	15.0	15.7	0.0045
	13:30	250	22.1	7.0	14.0	13.8	0.0031
29-Oct-20	9:20	1440	21.6	7.0	12.0	9.8	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-22 Sample No.: R-3

Depth (feet): 10.0 Soil Type : CL

Soil Identification: Light brown lean clay (CL)

GR:SA:FI : (%) 0 : 9 : 91

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-22				
Sample No.:	S-6	Depth (feet):	23.5		
Soil Identification:	Gray silt (ML)				

% Gravel	**0**	**Soil Type**
% Sand	**14**	**ML**
% Fines	**86**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.76	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.72	85.10
Wt.of Air-Dry Soil + Cont. (g)	805.50	Wt. of Container No.___ (g)	1.00	57.34	74.77
Wt. of Container	108.10	Moisture Content (%)	0.00	0.26	
Dry Wt. of Soil (g)	697.40	Wt. of Dry Soil (g)			10.33

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

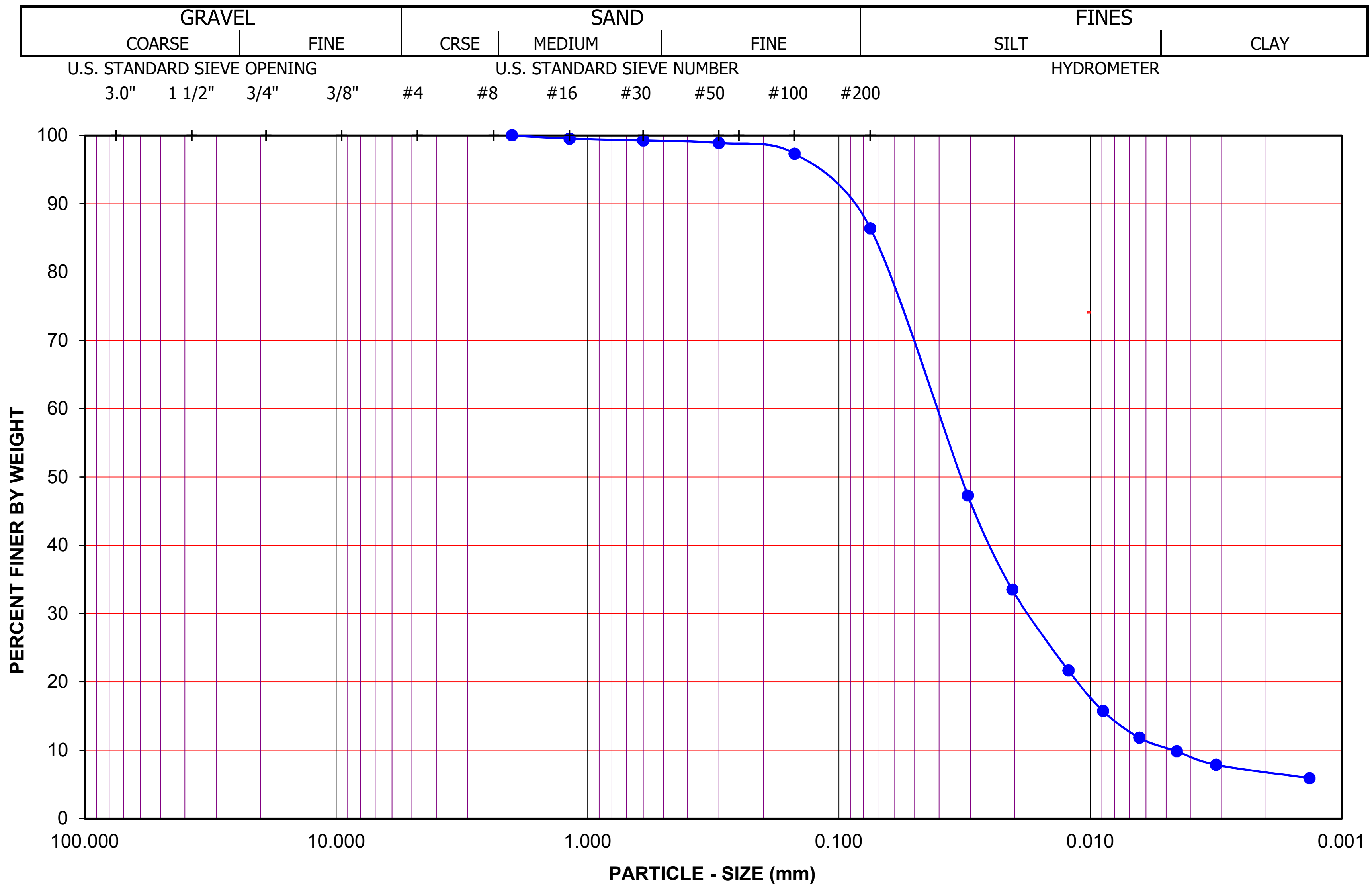
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.23	99.5	99.5
No. 30	0.37	99.3	99.3
No. 50	0.55	98.9	98.9
No. 100	1.34	97.3	97.3
No. 200	6.84	86.4	86.4
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.46 Wt. of Dry Soil (g) 50.33

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:24	0		7.0			
	9:26	2	23.0	7.0	31.0	47.3	0.0307
	9:29	5	23.1	7.0	24.0	33.5	0.0204
	9:39	15	23.0	7.0	18.0	21.7	0.0122
	9:54	30	22.8	7.0	15.0	15.8	0.0089
	10:24	60	22.6	7.0	13.0	11.8	0.0064
	11:24	120	22.6	7.0	12.0	9.9	0.0045
	13:34	250	22.0	7.0	11.0	7.9	0.0032
29-Oct-20	9:24	1440	21.5	7.0	10.0	5.9	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-22 Sample No.: S-6

Depth (feet): 23.5 Soil Type : ML

Soil Identification: Gray silt (ML)

GR:SA:FI : (%) 0 : 14 : 86

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/28/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-25				
Sample No.:	T-5B	Depth (feet):	16.0		
Soil Identification:	Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons				

		Soil Type
% Gravel	**2**	**(SW-SM)**
% Sand	**92**	
% Fines	**6**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.68	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.51	117.69
Wt.of Air-Dry Soil + Cont. (g)	643.39	Wt. of Container No.___ (g)	1.00	56.95	76.23
Wt. of Container	107.29	Moisture Content (%)	0.00	1.09	
Dry Wt. of Soil (g)	536.10	Wt. of Dry Soil (g)			41.46

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	12.69	97.6
No. 10	363.99	32.1
Pan		

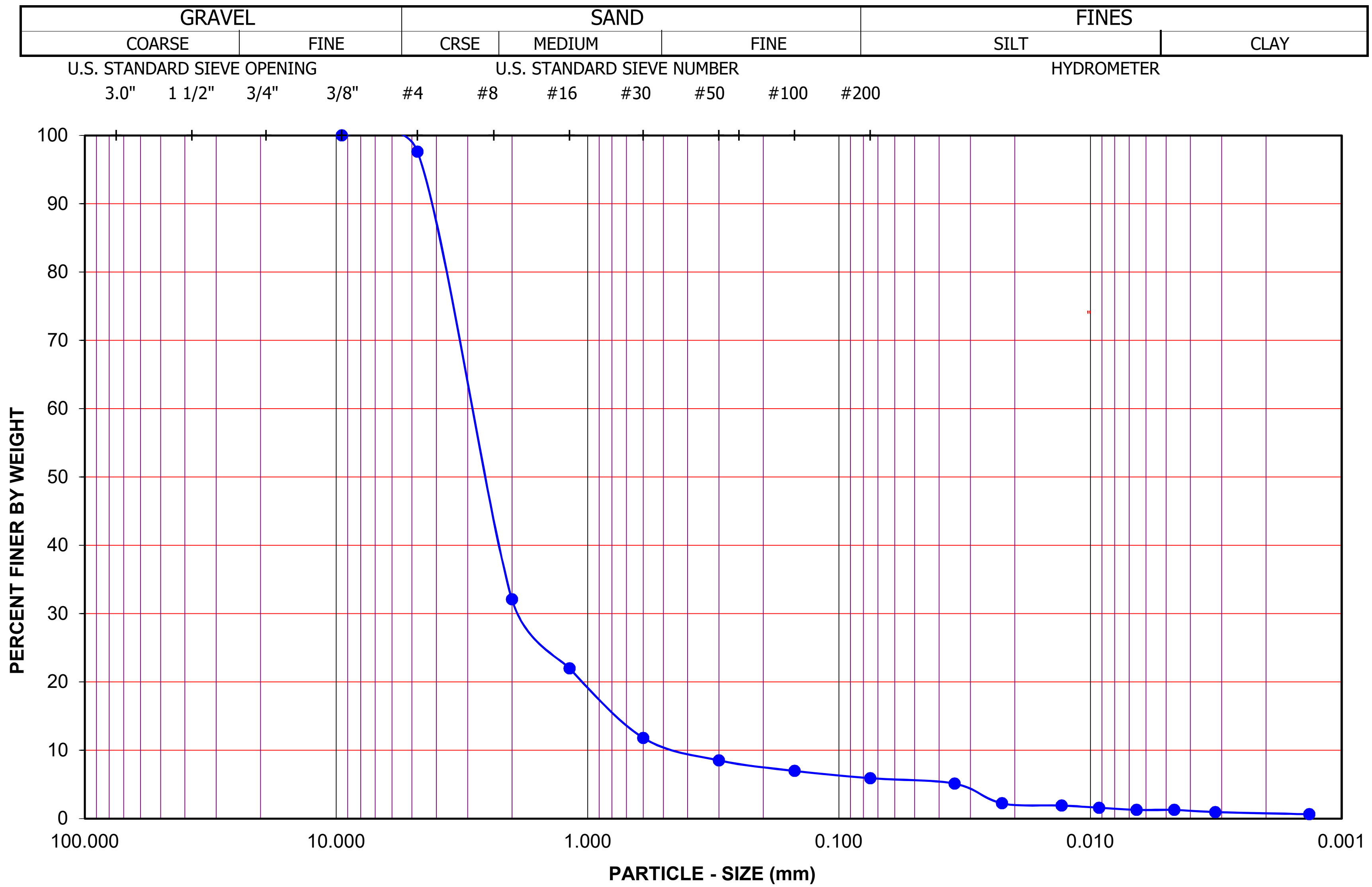
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	32.1
No. 16	15.68	68.5	22.0
No. 30	31.43	36.8	11.8
No. 50	36.53	26.6	8.5
No. 100	38.92	21.7	7.0
No. 200	40.56	18.5	5.9
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.28 Wt. of Dry Soil (g) 49.74

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Oct-20	6:38	0		8.5			
	6:40	2	21.7	8.5	16.5	5.1	0.0346
	6:43	5	21.7	8.5	12.0	2.2	0.0225
	6:53	15	21.7	8.5	11.5	1.9	0.0130
	7:08	30	21.6	8.5	11.0	1.6	0.0092
	7:38	60	21.4	8.5	10.5	1.3	0.0066
	8:38	120	21.4	8.5	10.5	1.3	0.0046
	10:48	250	22.0	8.5	10.0	1.0	0.0032
31-Oct-20	6:38	1440	21.2	8.5	9.5	0.6	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-25 | Sample No.: T-5B

Depth (feet): 16.0 | Soil Type : (SW-SM)

Soil Identification: Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 2 : 92 : 6

Nov-20

Leighton

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/19/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-27				
Sample No.:	R-5	Depth (feet):	20.0		
Soil Identification:	Brown sandy lean clay s(CL)				

		Soil Type
% Gravel	**0**	**s(CL)**
% Sand	**30**	
% Fines	**70**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	78.46	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	78.19	103.11
Wt.of Air-Dry Soil + Cont. (g)	525.44	Wt. of Container No.___ (g)	1.00	61.40	87.44
Wt. of Container	74.08	Moisture Content (%)	0.00	1.61	
Dry Wt. of Soil (g)	451.36	Wt. of Dry Soil (g)			15.67

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.20	100.0
Pan		

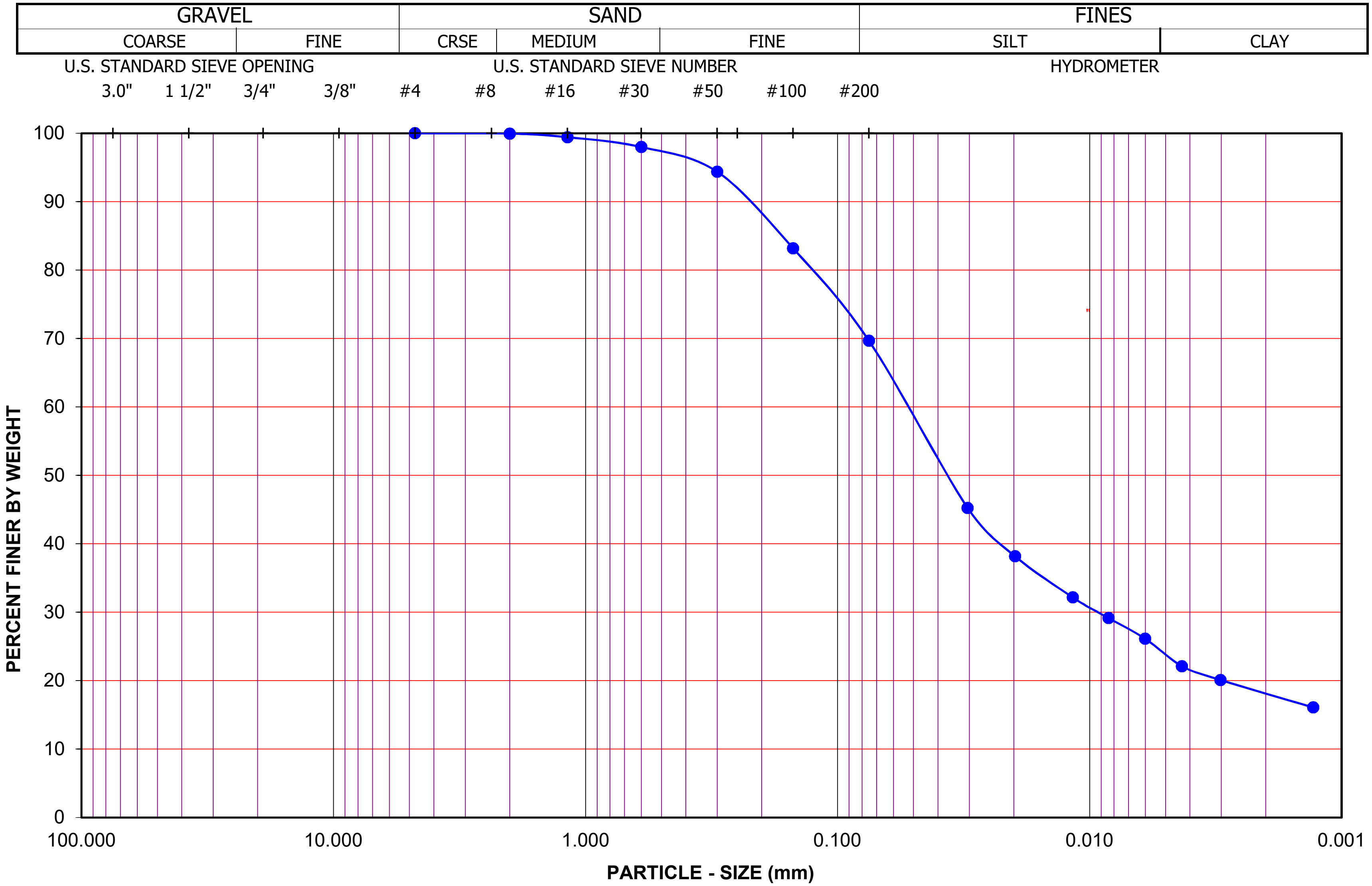
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.26	99.5	99.4
No. 30	0.97	98.0	98.0
No. 50	2.76	94.4	94.4
No. 100	8.28	83.2	83.2
No. 200	14.95	69.7	69.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.12 Wt. of Dry Soil (g) 49.33

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
23-Nov-20	9:00	0		8.0			
	9:02	2	24.0	8.0	30.5	45.2	0.0305
	9:05	5	24.0	8.0	27.0	38.2	0.0198
	9:15	15	24.0	8.0	24.0	32.2	0.0117
	9:30	30	23.8	8.0	22.5	29.1	0.0084
	10:00	60	23.5	8.0	21.0	26.1	0.0060
	11:00	120	23.0	8.0	19.0	22.1	0.0043
	13:10	250	22.9	8.0	18.0	20.1	0.0030
24-Nov-20	9:00	1440	21.6	8.0	16.0	16.1	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-27 Sample No.: R-5

Depth (feet): 20.0 Soil Type : s(CL)

Soil Identification: Brown sandy lean clay s(CL)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 30 : 70

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	YN/GEB	Date:	10/28/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-31				
Sample No.:	R-2	Depth (feet):	10.0		

Soil Identification: Dark brown lean clay with sand (CL)s

		Soil Type
% Gravel	4	(CL)s
% Sand	25	
% Fines	71	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	83.99	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	83.83	90.56
Wt.of Air-Dry Soil + Cont. (g)	711.10	Wt. of Container No.___ (g)	1.00	68.11	77.60
Wt. of Container	140.30	Moisture Content (%)	0.00	1.02	
Dry Wt. of Soil (g)	570.80	Wt. of Dry Soil (g)			12.96

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	5.98	99.0
No. 4	20.17	96.5
No. 10	35.29	93.8
Pan		

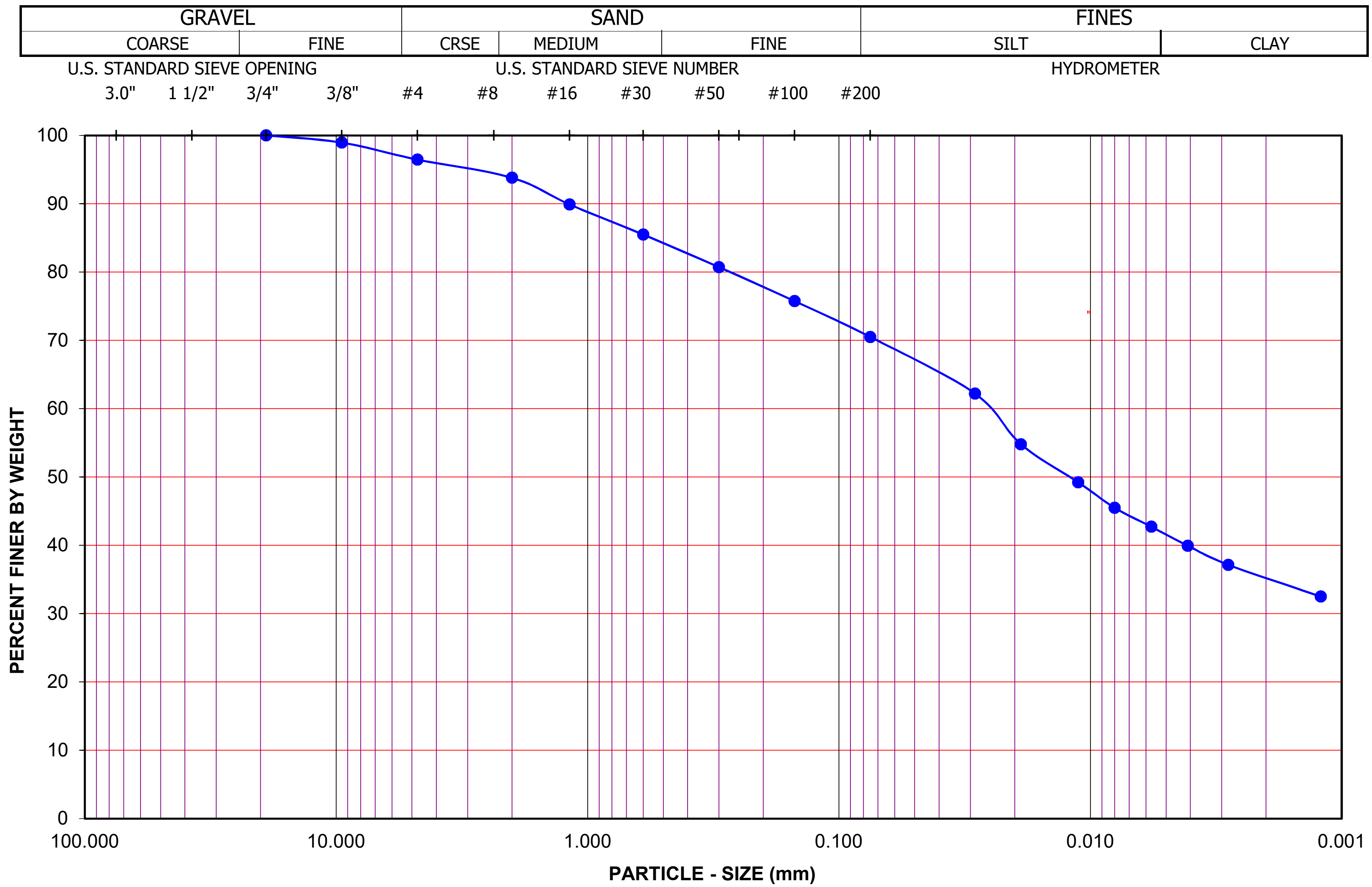
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	93.8
No. 16	2.09	95.8	89.9
No. 30	4.45	91.1	85.5
No. 50	6.99	86.0	80.7
No. 100	9.65	80.7	75.7
No. 200	12.45	75.1	70.5
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.61 Wt. of Dry Soil (g) 50.10

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Oct-20	6:42	0		8.5			
	6:44	2	21.6	8.5	42.0	62.2	0.0288
	6:47	5	21.6	8.5	38.0	54.8	0.0189
	6:57	15	21.6	8.5	35.0	49.2	0.0112
	7:12	30	21.5	8.5	33.0	45.5	0.0080
	7:42	60	21.4	8.5	31.5	42.7	0.0057
	8:42	120	21.4	8.5	30.0	39.9	0.0041
	10:52	250	22.0	8.5	28.5	37.2	0.0028
31-Oct-20	6:42	1440	21.3	8.5	26.0	32.5	0.0012



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-31 Sample No.: R-2

Depth (feet): 10.0 Soil Type : (CL)s

Soil Identification: Dark brown lean clay with sand (CL)s

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 4 : 25 : 71

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings   Tested By: Y. Nguyen   Date: 10/26/20

Project No.: 11585.005   Checked By: A. Santos   Date: 11/30/20

Boring No.: LB-39

Sample No.: S-6   Depth (feet): 25.0

Soil Identification: Yellowish brown clayey sand (SC)

		Soil Type
% Gravel	**0**	**SC**
% Sand	**58**	
% Fines	**42**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	84.75	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	84.71	118.10
Wt.of Air-Dry Soil + Cont. (g)	746.30	Wt. of Container No.___ (g)	1.00	69.47	87.44
Wt. of Container	107.30	Moisture Content (%)	0.00	0.26	
Dry Wt. of Soil (g)	639.00	Wt. of Dry Soil (g)			30.66

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.33	99.9
No. 10	0.77	99.9
Pan		

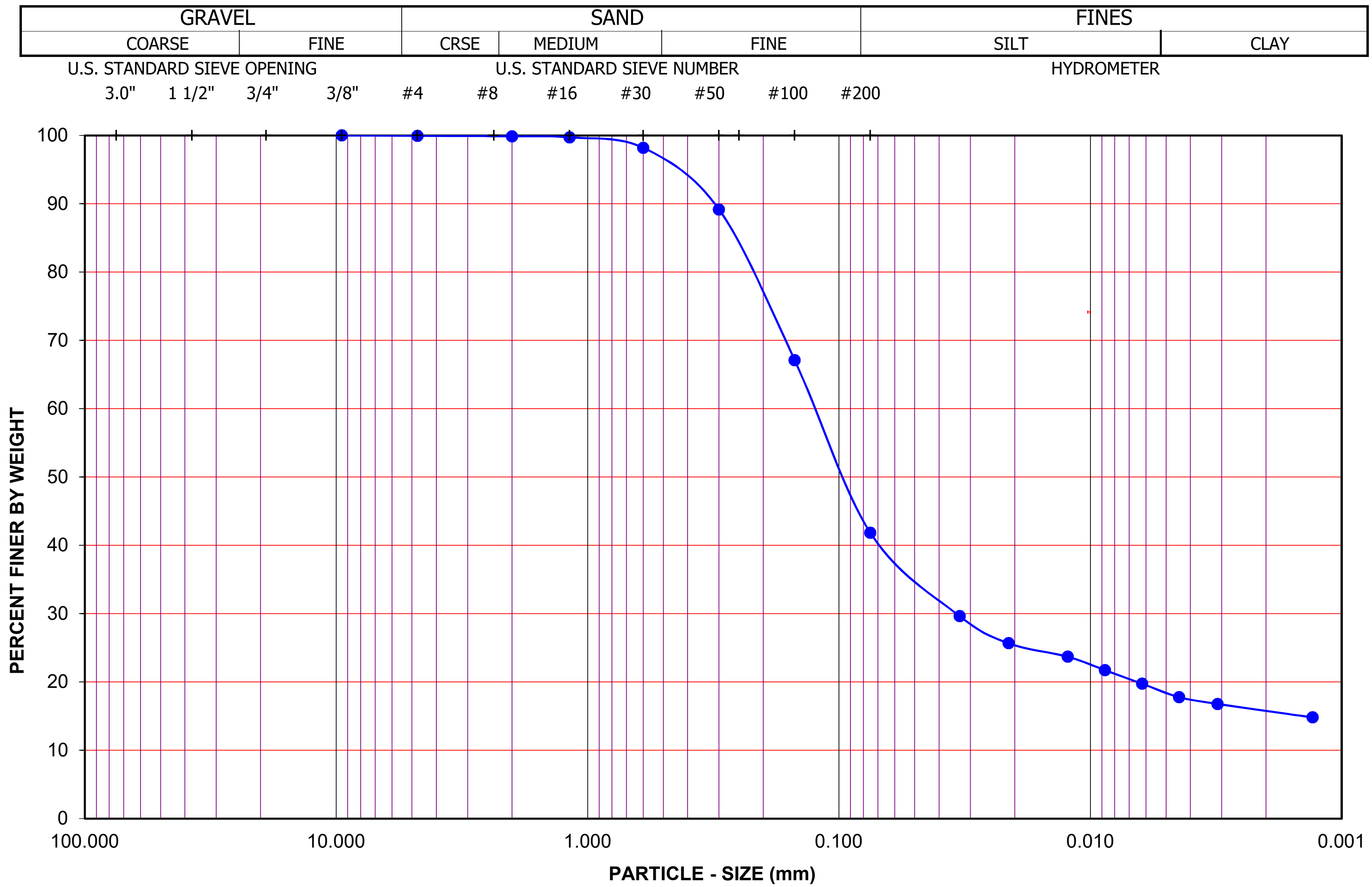
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.9
No. 16	0.08	99.8	99.7
No. 30	0.85	98.3	98.2
No. 50	5.38	89.3	89.2
No. 100	16.46	67.2	67.1
No. 200	29.16	41.9	41.8
Pan			

Hydrometer   Wt. of Air-Dry Soil (g) 50.30   Wt. of Dry Soil (g) 50.17

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:32	0		7.0			
	9:34	2	22.5	7.0	22.0	29.6	0.0331
	9:37	5	22.4	7.0	20.0	25.7	0.0212
	9:47	15	22.4	7.0	19.0	23.7	0.0123
	10:02	30	22.3	7.0	18.0	21.7	0.0087
	10:32	60	22.2	7.0	17.0	19.7	0.0062
	11:32	120	22.4	7.0	16.0	17.8	0.0044
	13:42	250	21.8	7.0	15.5	16.8	0.0031
29-Oct-20	9:32	1440	21.5	7.0	14.5	14.8	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-39 Sample No.: S-6

Depth (feet): 25.0 Soil Type : SC

Soil Identification: Yellowish brown clayey sand (SC)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 58 : 42

Nov-20

APPENDIX C.2

Compressibility

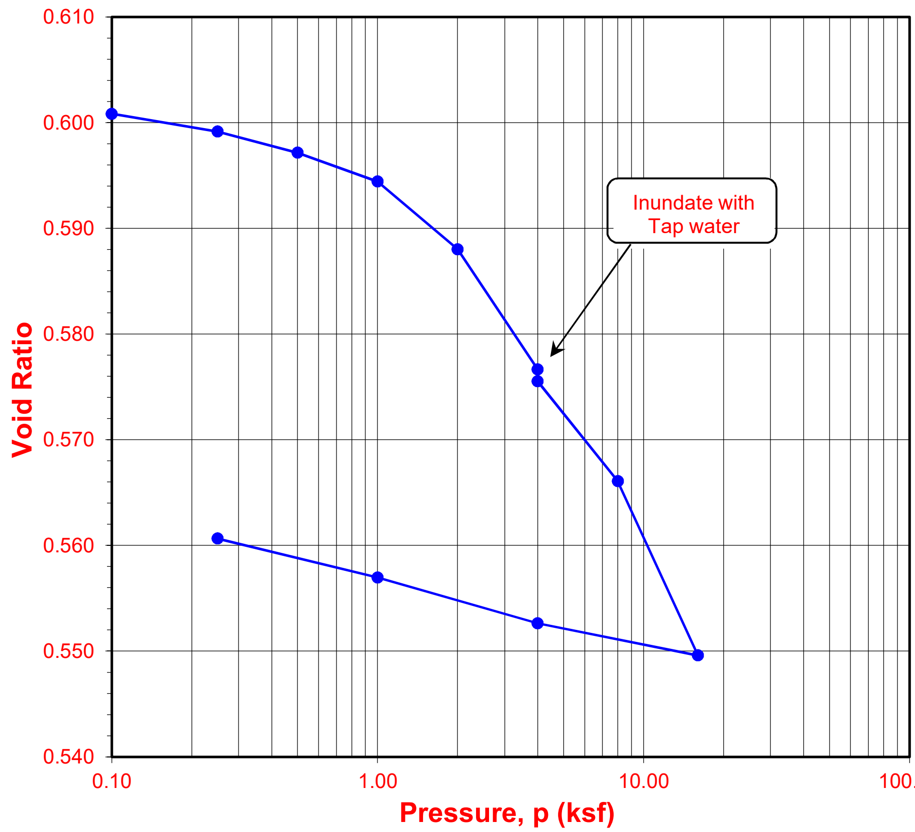
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By: G. Bathala	Date: 08/01/18
Project No.:	11588.001	Checked By: J. Ward	Date: 09/14/18
Boring No.:	LB-7	Depth (ft.): 20.0	
Sample No.:	R-7	Sample Type: Ring	
Soil Identification:	Olive brown silty sand (SM)		

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	184.72
Weight of Ring (g)	44.55
Height after consol. (in.)	0.9748
Before Test	
Wt.Wet Sample+Cont. (g)	201.24
Wt.of Dry Sample+Cont. (g)	188.33
Weight of Container (g)	67.93
Initial Moisture Content (%)	10.7
Initial Dry Density (pcf)	105.3
Initial Saturation (%)	48
Initial Vertical Reading (in.)	0.3362
After Test	
Wt.of Wet Sample+Cont. (g)	229.82
Wt. of Dry Sample+Cont. (g)	207.33
Weight of Container (g)	39.58
Final Moisture Content (%)	18.25
Final Dry Density (pcf)	105.1
Final Saturation (%)	82
Final Vertical Reading (in.)	0.3080
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

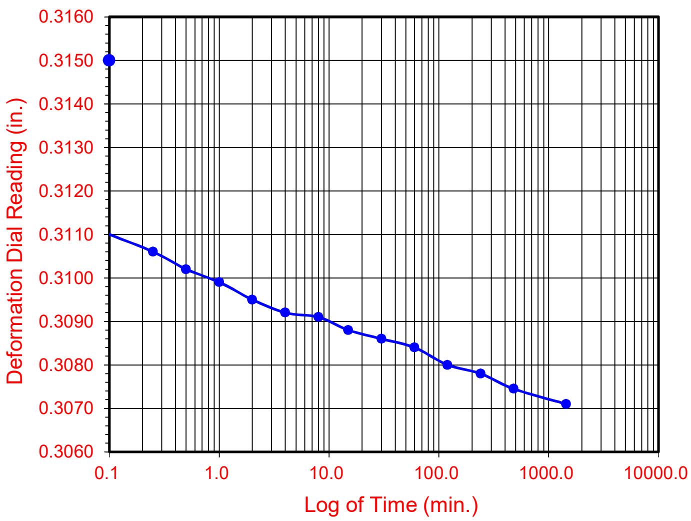


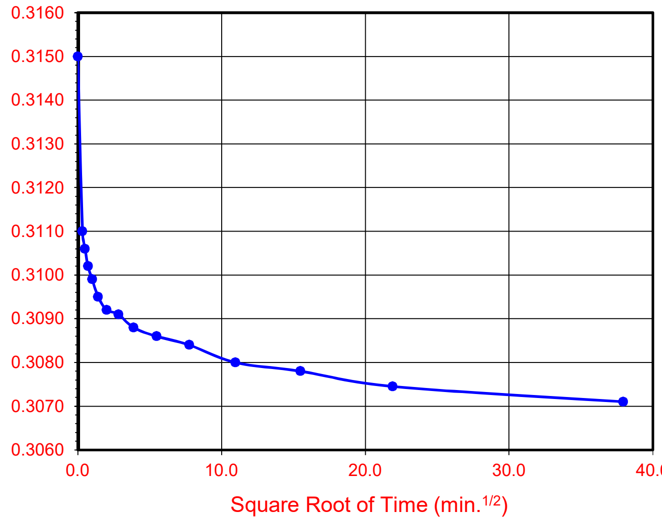
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3361	0.9999	0.00	0.01	0.601	0.01
0.25	0.3348	0.9986	0.03	0.14	0.599	0.11
0.50	0.3326	0.9964	0.12	0.36	0.597	0.24
1.00	0.3297	0.9935	0.24	0.65	0.594	0.41
2.00	0.3244	0.9882	0.37	1.18	0.588	0.81
4.00	0.3157	0.9795	0.53	2.05	0.577	1.52
4.00	0.3150	0.9788	0.53	2.12	0.576	1.59
8.00	0.3071	0.9709	0.73	2.91	0.566	2.18
16.00	0.2949	0.9587	0.92	4.13	0.550	3.21
4.00	0.2991	0.9629	0.69	3.71	0.553	3.02
1.00	0.3040	0.9678	0.47	3.22	0.557	2.75
0.25	0.3080	0.9718	0.30	2.82	0.561	2.52

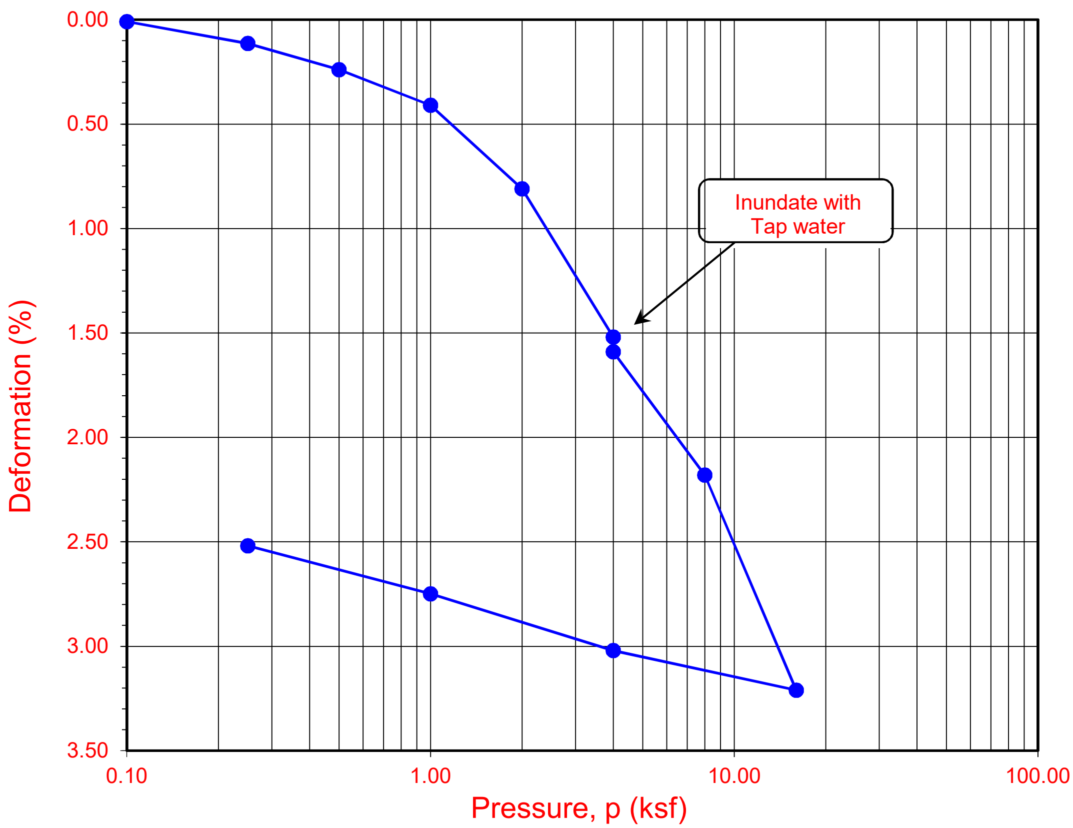
Time Readings @ 8.0 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
8/6/18	7:55:00	0.0	0.0	0.3150
8/6/18	7:55:06	0.1	0.3	0.3110
8/6/18	7:55:15	0.2	0.5	0.3106
8/6/18	7:55:30	0.5	0.7	0.3102
8/6/18	7:56:00	1.0	1.0	0.3099
8/6/18	7:57:00	2.0	1.4	0.3095
8/6/18	7:59:00	4.0	2.0	0.3092
8/6/18	8:03:00	8.0	2.8	0.3091
8/6/18	8:10:00	15.0	3.9	0.3088
8/6/18	8:25:00	30.0	5.5	0.3086
8/6/18	8:55:00	60.0	7.7	0.3084
8/6/18	9:55:00	120.0	11.0	0.3080
8/6/18	11:55:00	240.0	15.5	0.3078
8/6/18	15:55:00	480.0	21.9	0.3075
8/7/18	7:55:00	1440.0	37.9	0.3071

Time Readings @ 8.0 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-7	**R-7**	**20.0**	**10.7**	**18.3**	**105.3**	**105.1**	**0.601**	**0.561**	**48**	**82**

Soil Identification: Olive brown silty sand (SM)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11588.001

Brea Boulevard Corridor Improvements

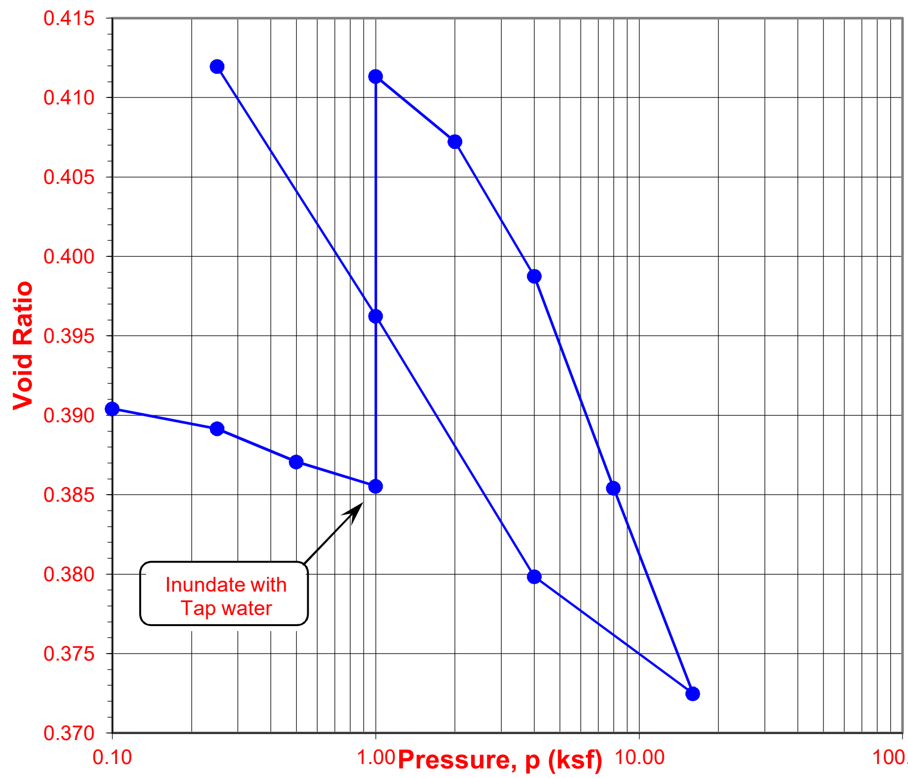
09-18

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	ACS/GB	Date:	01/31/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/14/19
Boring No.:	LB-14	Depth (ft.):	6-6.5		
Sample No.:	R-1	Sample Type:	Ring		
Soil Identification:	Dark yellowish brown sandy lean clay s(CL)				

Sample Diameter (in.):	2.415
Sample Thickness (in.):	1.000
Weight of Sample + ring (g):	203.30
Weight of Ring (g):	42.28
Height after consol. (in.):	1.0155
Before Test	
Wt. of Wet Sample+Cont. (g):	221.30
Wt. of Dry Sample+Cont. (g):	204.12
Weight of Container (g):	39.90
Initial Moisture Content (%)	10.5
Initial Dry Density (pcf)	121.2
Initial Saturation (%):	72
Initial Vertical Reading (in.)	0.2325
After Test	
Wt. of Wet Sample+Cont. (g):	285.43
Wt. of Dry Sample+Cont. (g):	263.74
Weight of Container (g):	75.86
Final Moisture Content (%)	14.90
Final Dry Density (pcf):	119.2
Final Saturation (%):	97
Final Vertical Reading (in.)	0.2178
Specific Gravity (assumed):	2.70
Water Density (pcf):	62.43

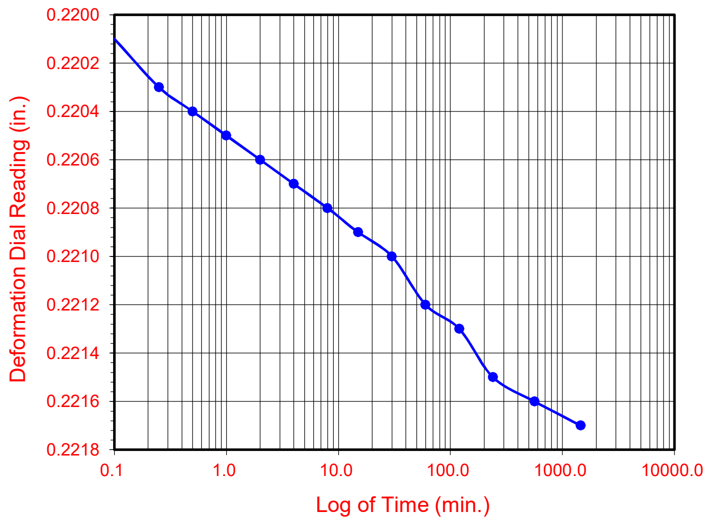


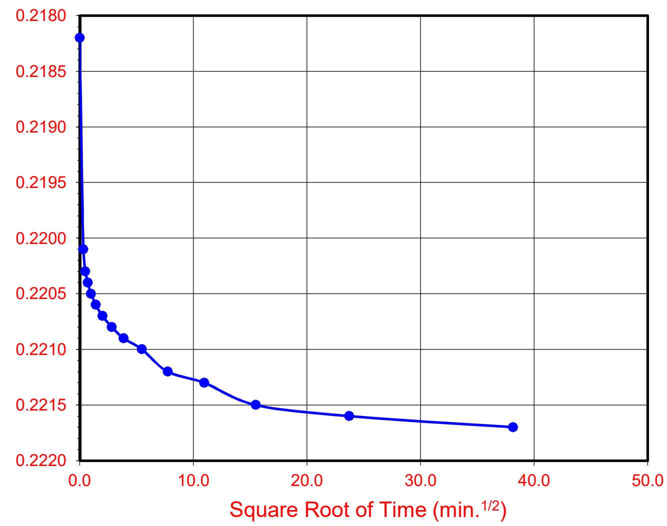
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.2325	1.0000	0.00	0.00	0.390	0.00
0.25	0.2335	0.9990	0.01	0.10	0.389	0.09
0.50	0.2354	0.9971	0.05	0.29	0.387	0.24
1.00	0.2368	0.9957	0.08	0.43	0.386	0.35
1.00	0.2183	1.0143	0.08	-1.43	0.411	-1.51
2.00	0.2217	1.0108	0.13	-1.08	0.407	-1.21
4.00	0.2286	1.0039	0.21	-0.39	0.399	-0.60
8.00	0.2394	0.9931	0.33	0.69	0.385	0.36
16.00	0.2506	0.9819	0.52	1.81	0.372	1.29
4.00	0.2426	0.9899	0.25	1.01	0.380	0.76
1.00	0.2297	1.0028	0.14	-0.28	0.396	-0.42
0.25	0.2178	1.0147	0.08	-1.47	0.412	-1.55

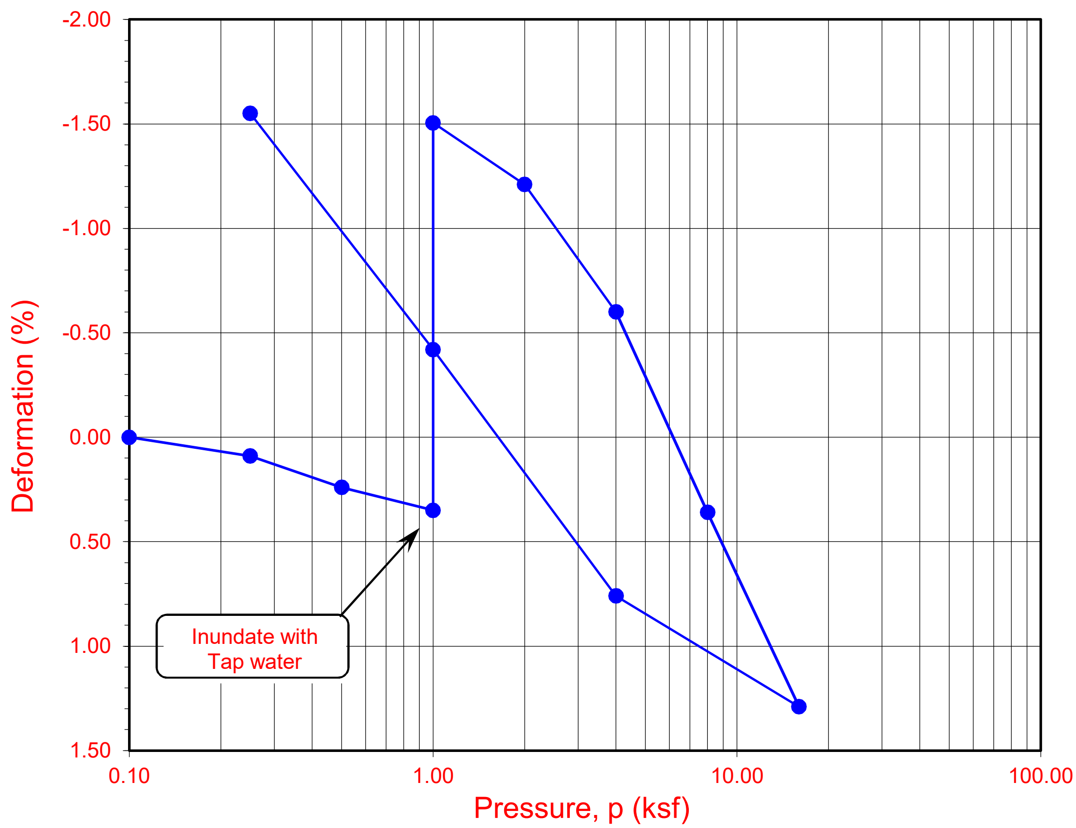
Time Readings @ 2.0 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
2/4/19	8:47:00	0.0	0.0	0.2182
2/4/19	8:47:06	0.1	0.3	0.2201
2/4/19	8:47:15	0.2	0.5	0.2203
2/4/19	8:47:30	0.5	0.7	0.2204
2/4/19	8:48:00	1.0	1.0	0.2205
2/4/19	8:49:00	2.0	1.4	0.2206
2/4/19	8:51:00	4.0	2.0	0.2207
2/4/19	8:55:00	8.0	2.8	0.2208
2/4/19	9:02:00	15.0	3.9	0.2209
2/4/19	9:17:00	30.0	5.5	0.2210
2/4/19	9:47:00	60.0	7.7	0.2212
2/4/19	10:47:00	120.0	11.0	0.2213
2/4/19	12:47:00	240.0	15.5	0.2215
2/4/19	18:10:00	563.0	23.7	0.2216
2/5/19	9:02:00	1455.0	38.1	0.2217

Time Readings @ 2.0 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-14	**R-1**	**6-6.5**	**10.5**	**14.9**	**121.2**	**119.2**	**0.390**	**0.412**	**72**	**97**

Soil Identification: Dark yellowish brown sandy lean clay s(CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

Leighton

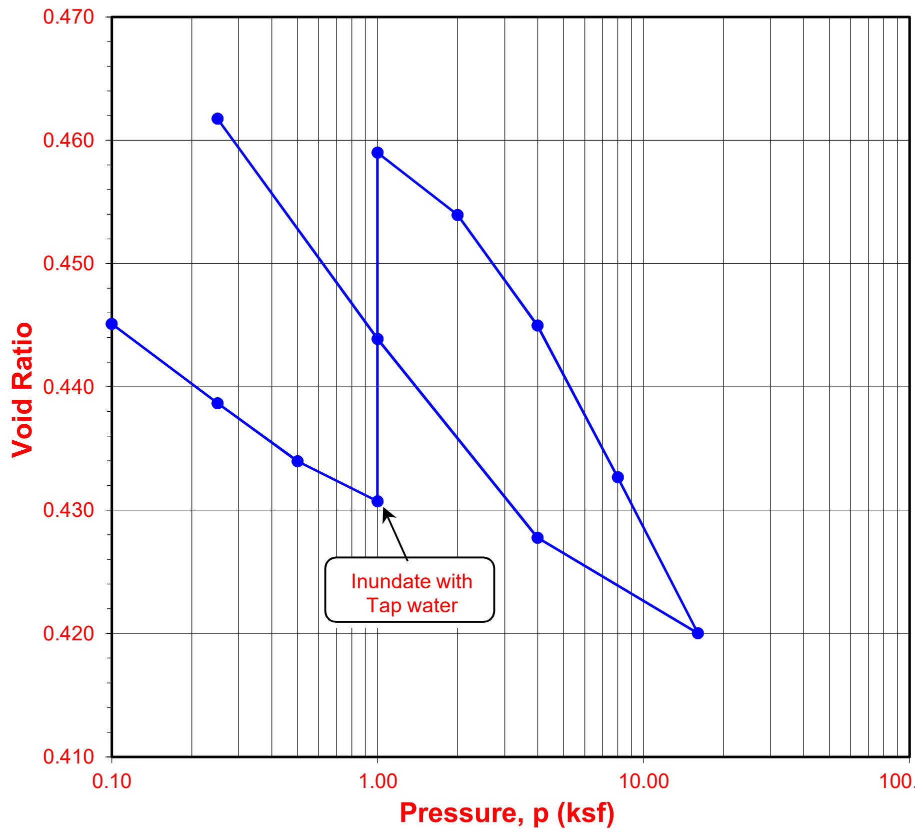
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name: Brea Boulevard Additional Borings
Project No.: 11585.005
Boring No.: LB-28
Sample No.: R-1
Soil Identification: Olive brown lean clay (CL)

Tested By: G. Bathala Date: 10/24/20
Checked By: A. Santos Date: 12/02/20
Depth (ft.): 5.0
Sample Type: Ring

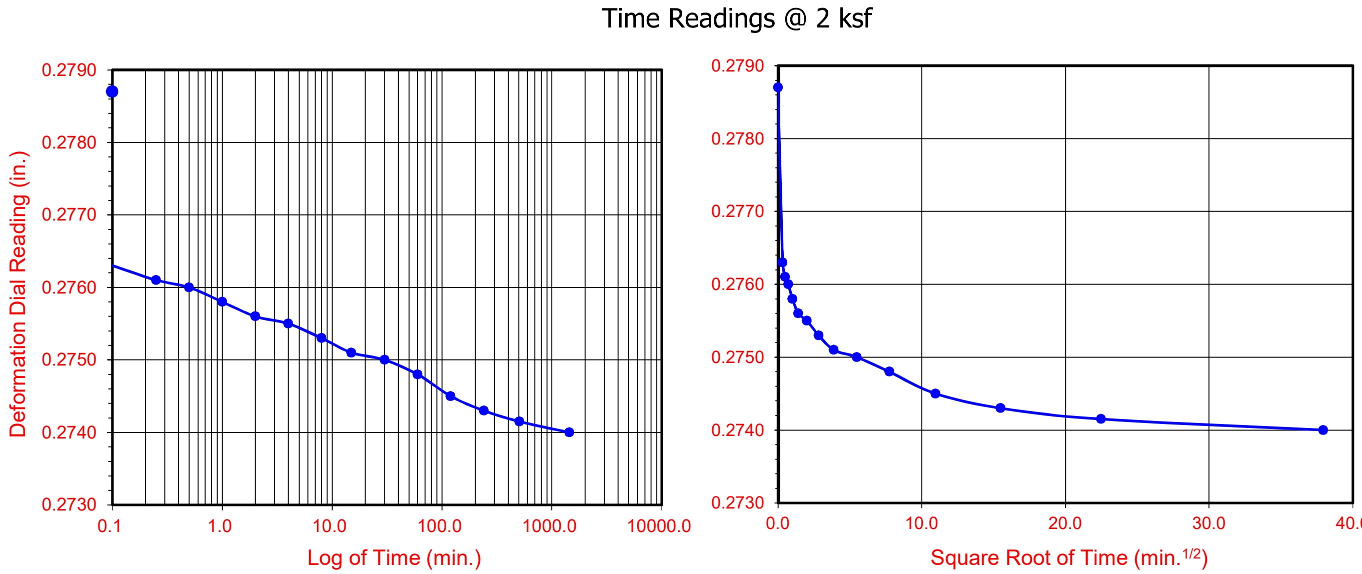
Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	195.62
Weight of Ring (g)	37.98
Height after consol. (in.)	1.0109
Before Test	
Wt.Wet Sample+Cont. (g)	183.31
Wt.of Dry Sample+Cont. (g)	169.33
Weight of Container (g)	57.18
Initial Moisture Content (%)	12.5
Initial Dry Density (pcf)	116.6
Initial Saturation (%)	75
Initial Vertical Reading (in.)	0.2718
After Test	
Wt.of Wet Sample+Cont. (g)	255.83
Wt. of Dry Sample+Cont. (g)	233.78
Weight of Container (g)	53.69
Final Moisture Content (%)	15.52
Final Dry Density (pcf)	116.9
Final Saturation (%)	95
Final Vertical Reading (in.)	0.2790
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

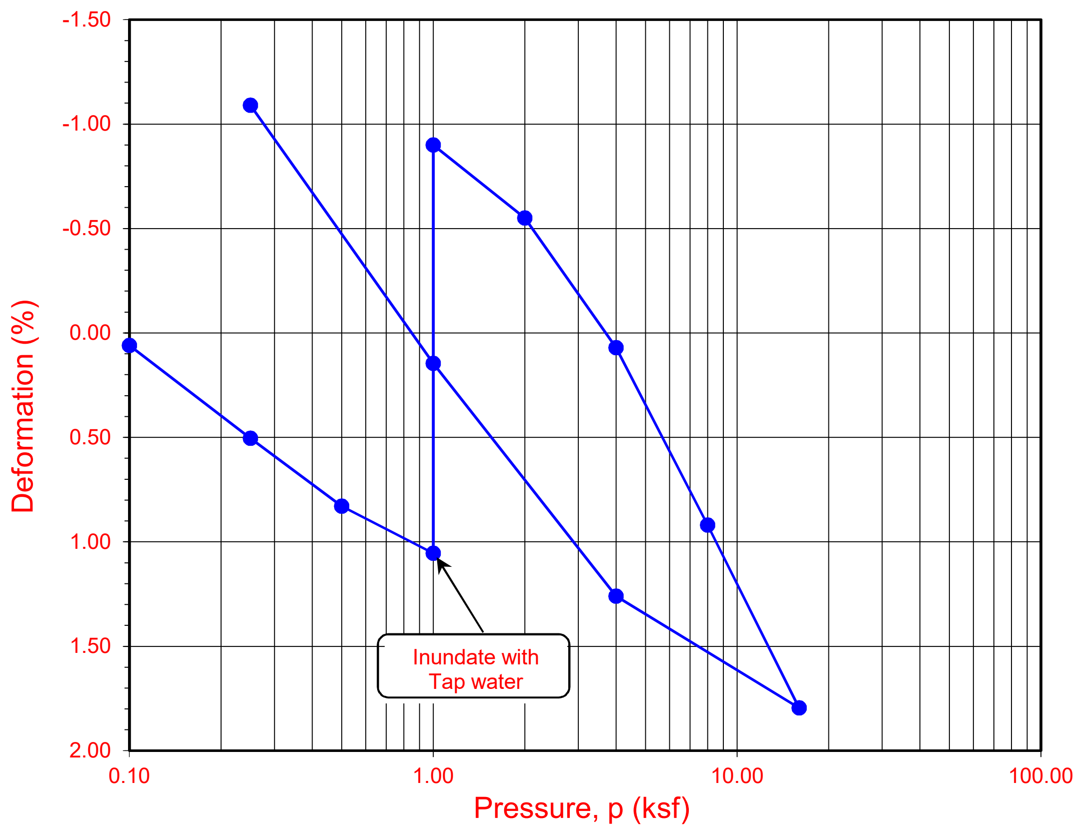


Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2712	0.9994	0.00	0.06	0.445	0.06
0.25	0.2661	0.9943	0.07	0.57	0.439	0.50
0.50	0.2622	0.9904	0.13	0.96	0.434	0.83
1.00	0.2592	0.9874	0.21	1.27	0.431	1.06
1.00	0.2787	1.0069	0.21	-0.69	0.459	-0.90
2.00	0.2740	1.0022	0.33	-0.22	0.454	-0.55
4.00	0.2665	0.9947	0.46	0.53	0.445	0.07
8.00	0.2562	0.9844	0.64	1.56	0.433	0.92
16.00	0.2453	0.9735	0.86	2.66	0.420	1.80
4.00	0.2524	0.9806	0.68	1.94	0.428	1.26
1.00	0.2654	0.9936	0.50	0.65	0.444	0.15
0.25	0.2790	1.0072	0.37	-0.72	0.462	-1.09

Time Readings @ 2 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:30:00	0.0	0.0	0.2787
10/26/20	8:30:06	0.1	0.3	0.2763
10/26/20	8:30:15	0.2	0.5	0.2761
10/26/20	8:30:30	0.5	0.7	0.2760
10/26/20	8:31:00	1.0	1.0	0.2758
10/26/20	8:32:00	2.0	1.4	0.2756
10/26/20	8:34:00	4.0	2.0	0.2755
10/26/20	8:38:00	8.0	2.8	0.2753
10/26/20	8:45:00	15.0	3.9	0.2751
10/26/20	9:00:00	30.0	5.5	0.2750
10/26/20	9:30:00	60.0	7.7	0.2748
10/26/20	10:30:00	120.0	11.0	0.2745
10/26/20	12:30:00	240.0	15.5	0.2743
10/26/20	16:55:00	505.0	22.5	0.2742
10/27/20	8:30:00	1440.0	37.9	0.2740





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-28	**R-1**	**5.0**	**12.5**	**15.5**	**116.6**	**116.9**	**0.446**	**0.462**	**75**	**95**

Soil Identification: Olive brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

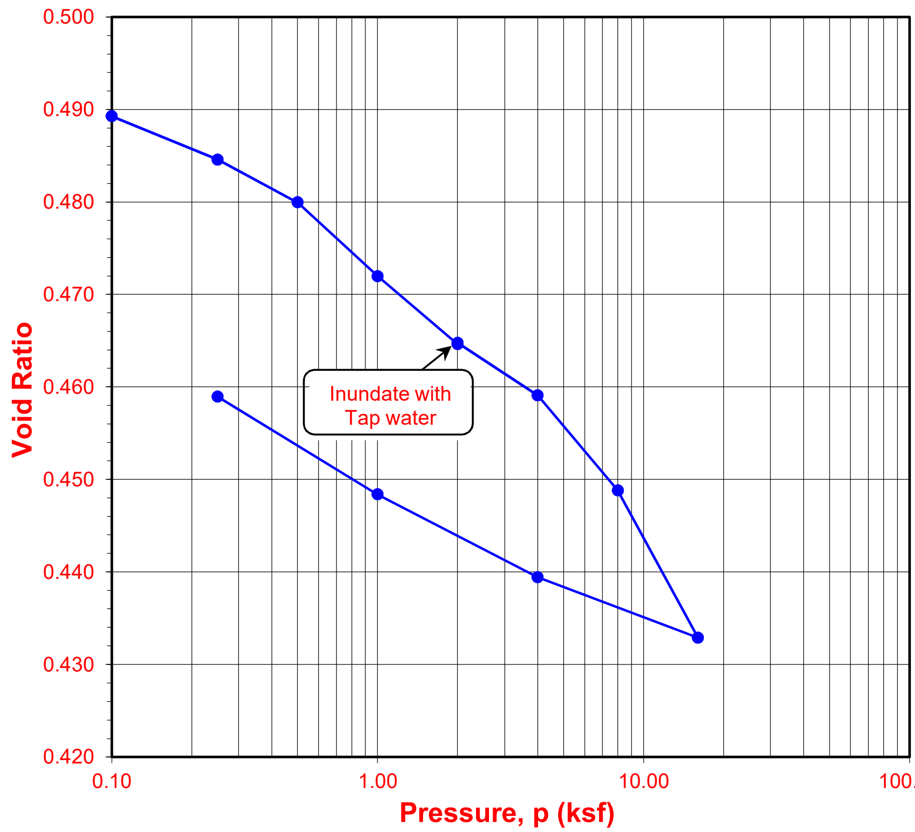
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By: G. Bathala	Date:	10/23/20
Project No.:	11585.005	Checked By: A. Santos	Date:	12/02/20
Boring No.:	LB-29	Depth (ft.): 5.0		
Sample No.:	R-1	Sample Type:	Ring	
Soil Identification:	Yellowish brown lean clay (CL)			

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	196.25
Weight of Ring (g)	37.87
Height after consol. (in.)	0.9796
Before Test	
Wt.Wet Sample+Cont. (g)	215.56
Wt.of Dry Sample+Cont. (g)	195.55
Weight of Container (g)	73.40
Initial Moisture Content (%)	16.4
Initial Dry Density (pcf)	113.2
Initial Saturation (%)	90
Initial Vertical Reading (in.)	0.2782
After Test	
Wt.of Wet Sample+Cont. (g)	262.24
Wt. of Dry Sample+Cont. (g)	242.58
Weight of Container (g)	64.91
Final Moisture Content (%)	14.06
Final Dry Density (pcf)	118.7
Final Saturation (%)	90
Final Vertical Reading (in.)	0.2543
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

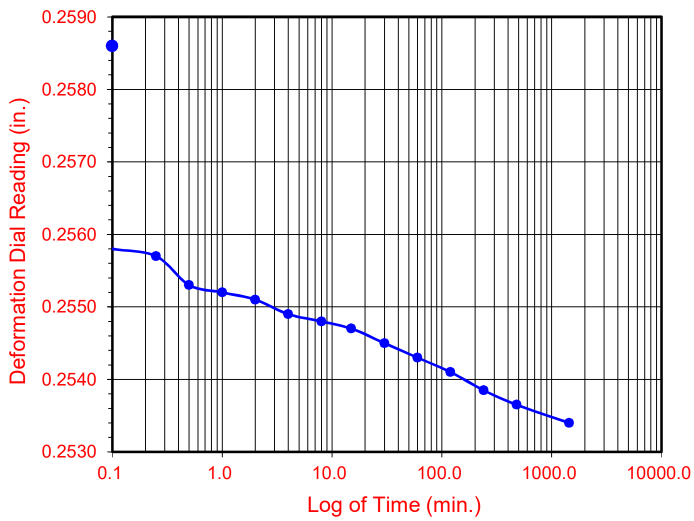


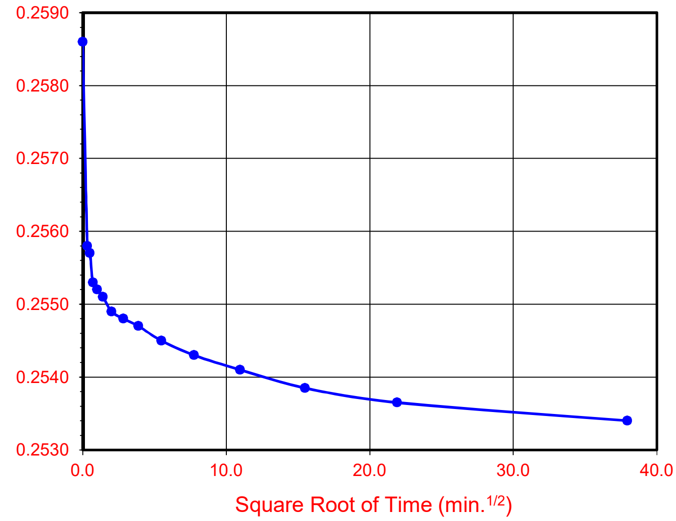
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2782	1.0000	0.00	0.00	0.489	0.00
0.25	0.2745	0.9963	0.05	0.37	0.485	0.32
0.50	0.2708	0.9926	0.11	0.74	0.480	0.63
1.00	0.2646	0.9864	0.20	1.36	0.472	1.16
2.00	0.2585	0.9803	0.31	1.97	0.465	1.66
2.00	0.2586	0.9804	0.31	1.96	0.465	1.65
4.00	0.2534	0.9752	0.45	2.48	0.459	2.03
8.00	0.2449	0.9667	0.61	3.33	0.449	2.72
16.00	0.2322	0.9540	0.81	4.60	0.433	3.79
4.00	0.2380	0.9598	0.67	4.02	0.439	3.35
1.00	0.2458	0.9676	0.49	3.24	0.448	2.75
0.25	0.2543	0.9761	0.35	2.39	0.459	2.04

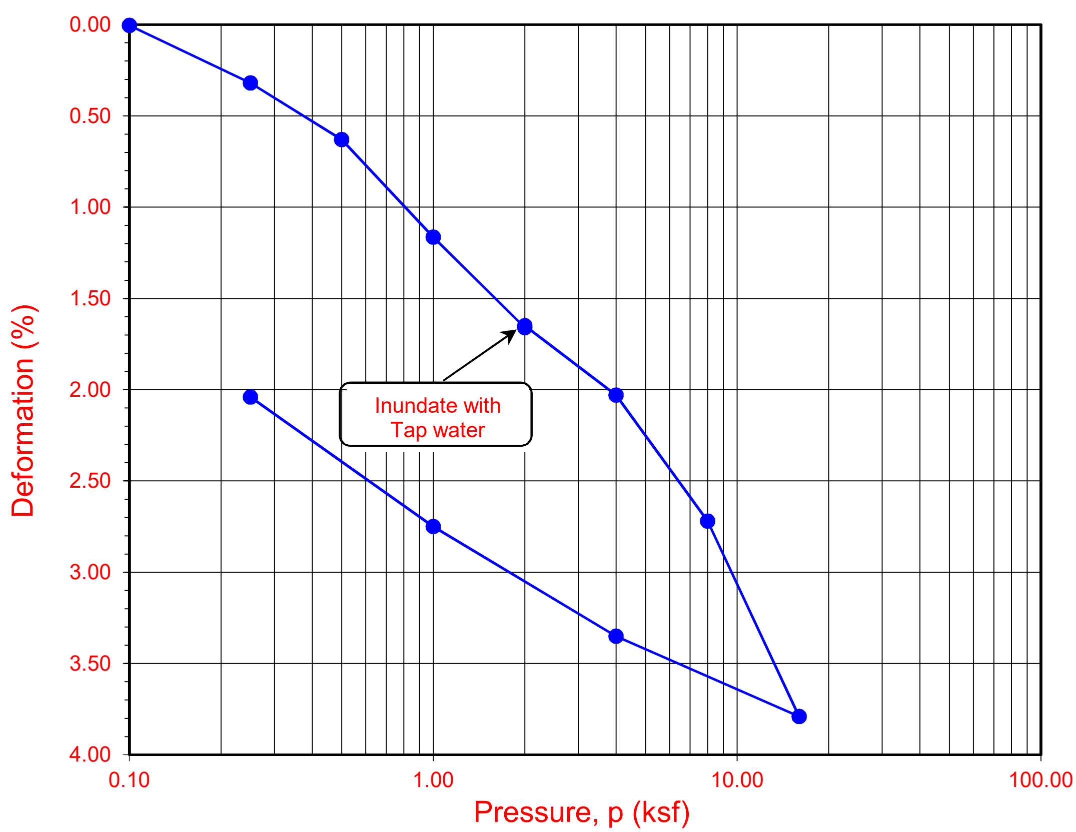
Time Readings @ 4 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:20:00	0.0	0.0	0.2586
10/26/20	8:20:06	0.1	0.3	0.2558
10/26/20	8:20:15	0.2	0.5	0.2557
10/26/20	8:20:30	0.5	0.7	0.2553
10/26/20	8:21:00	1.0	1.0	0.2552
10/26/20	8:22:00	2.0	1.4	0.2551
10/26/20	8:24:00	4.0	2.0	0.2549
10/26/20	8:28:00	8.0	2.8	0.2548
10/26/20	8:35:00	15.0	3.9	0.2547
10/26/20	8:50:00	30.0	5.5	0.2545
10/26/20	9:20:00	60.0	7.7	0.2543
10/26/20	10:20:00	120.0	11.0	0.2541
10/26/20	12:20:00	240.0	15.5	0.2539
10/26/20	16:20:00	480.0	21.9	0.2537
10/27/20	8:20:00	1440.0	37.9	0.2534

Time Readings @ 4 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-29	**R-1**	**5.0**	**16.4**	**14.1**	**113.2**	**118.7**	**0.489**	**0.459**	**90**	**90**

Soil Identification: Yellowish brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

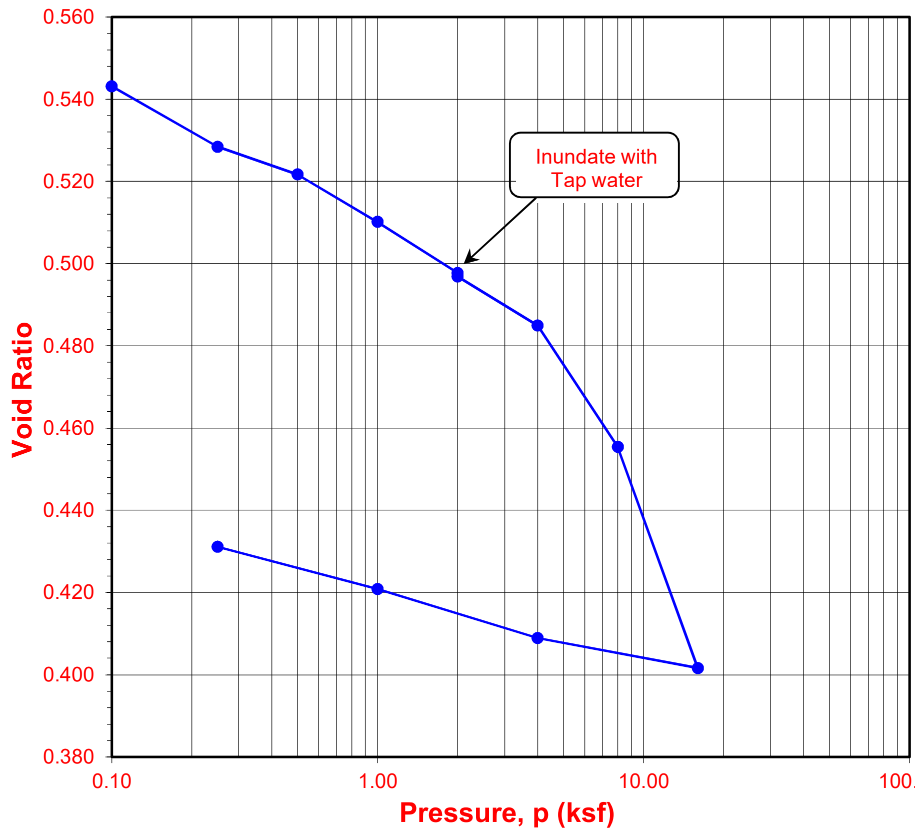
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/23/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-29	Depth (ft.):	12.5		
Sample No.:	R-4A	Sample Type:	Ring		
Soil Identification:	Grayish brown lean clay (CL)				

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	203.42
Weight of Ring (g)	45.89
Height after consol. (in.)	0.9256
Before Test	
Wt.Wet Sample+Cont. (g)	179.05
Wt.of Dry Sample+Cont. (g)	158.92
Weight of Container (g)	59.15
Initial Moisture Content (%)	20.2
Initial Dry Density (pcf)	109.0
Initial Saturation (%)	100
Initial Vertical Reading (in.)	0.3278
After Test	
Wt.of Wet Sample+Cont. (g)	237.66
Wt. of Dry Sample+Cont. (g)	215.16
Weight of Container (g)	38.57
Final Moisture Content (%)	17.21
Final Dry Density (pcf)	117.4
Final Saturation (%)	107
Final Vertical Reading (in.)	0.2501
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

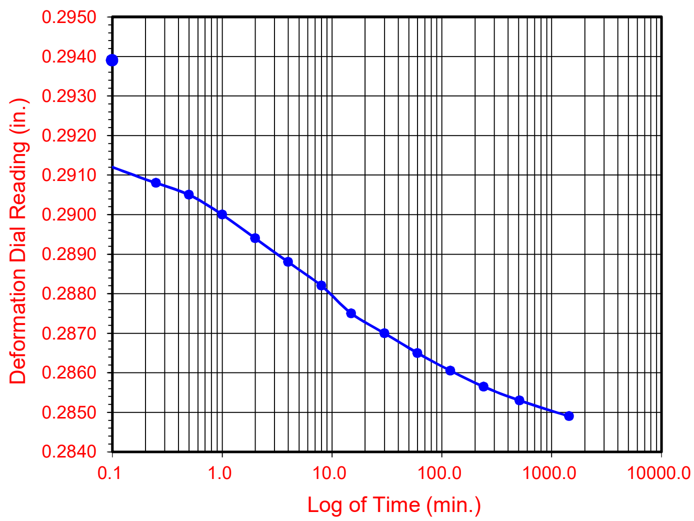


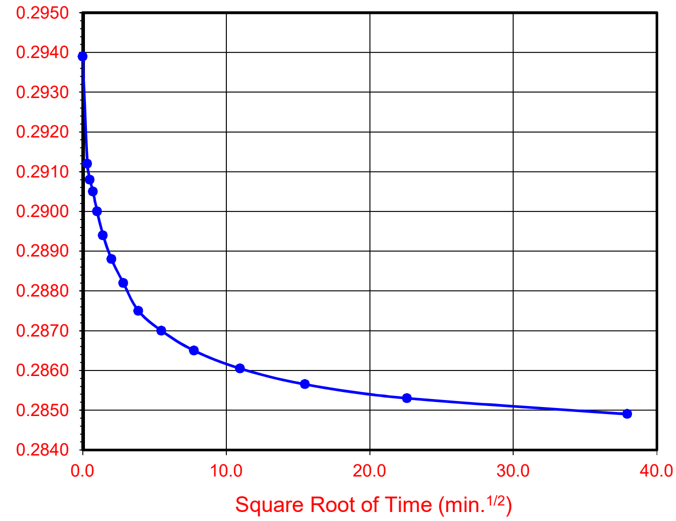
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.3258	0.9980	0.00	0.20	0.543	0.20
0.25	0.3160	0.9882	0.03	1.18	0.528	1.15
0.50	0.3114	0.9836	0.06	1.65	0.522	1.59
1.00	0.3034	0.9756	0.11	2.44	0.510	2.33
2.00	0.2945	0.9667	0.20	3.34	0.498	3.14
2.00	0.2939	0.9661	0.20	3.39	0.497	3.19
4.00	0.2849	0.9571	0.33	4.29	0.485	3.96
8.00	0.2643	0.9365	0.48	6.35	0.455	5.87
16.00	0.2276	0.8998	0.67	10.02	0.402	9.35
4.00	0.2340	0.9062	0.50	9.38	0.409	8.88
1.00	0.2429	0.9151	0.39	8.50	0.421	8.11
0.25	0.2501	0.9223	0.33	7.77	0.431	7.44

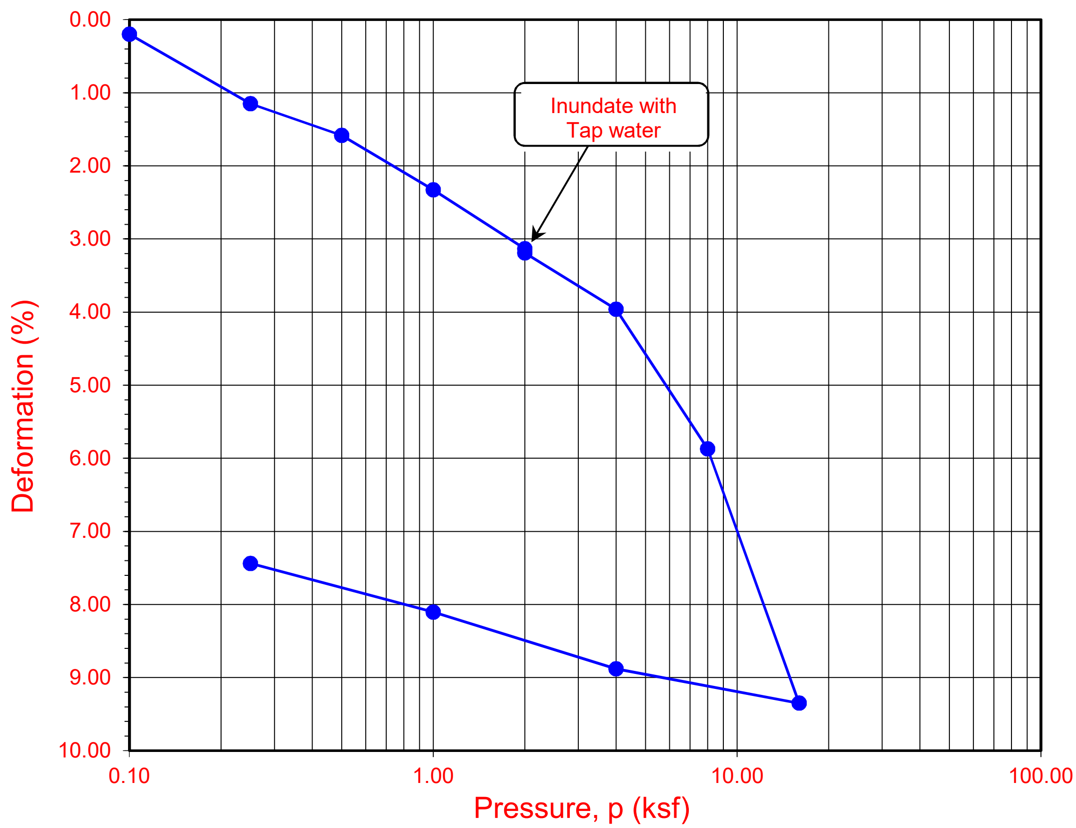
Time Readings @ 4 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:25:00	0.0	0.0	0.2939
10/26/20	8:25:06	0.1	0.3	0.2912
10/26/20	8:25:15	0.2	0.5	0.2908
10/26/20	8:25:30	0.5	0.7	0.2905
10/26/20	8:26:00	1.0	1.0	0.2900
10/26/20	8:27:00	2.0	1.4	0.2894
10/26/20	8:29:00	4.0	2.0	0.2888
10/26/20	8:33:00	8.0	2.8	0.2882
10/26/20	8:40:00	15.0	3.9	0.2875
10/26/20	8:55:00	30.0	5.5	0.2870
10/26/20	9:25:00	60.0	7.7	0.2865
10/26/20	10:25:00	120.0	11.0	0.2861
10/26/20	12:25:00	240.0	15.5	0.2857
10/26/20	16:55:00	510.0	22.6	0.2853
10/27/20	8:25:00	1440.0	37.9	0.2849

Time Readings @ 4 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-29	**R-4A**	**12.5**	**20.2**	**17.2**	**109.0**	**117.4**	**0.546**	**0.431**	**100**	**107**

Soil Identification: Grayish brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	CWE P-1	Sample Type:	Ring		
Sample No.:	R-4	Depth (ft.)	12.5		
Sample Description:	Light olive brown silty sand (SM)				

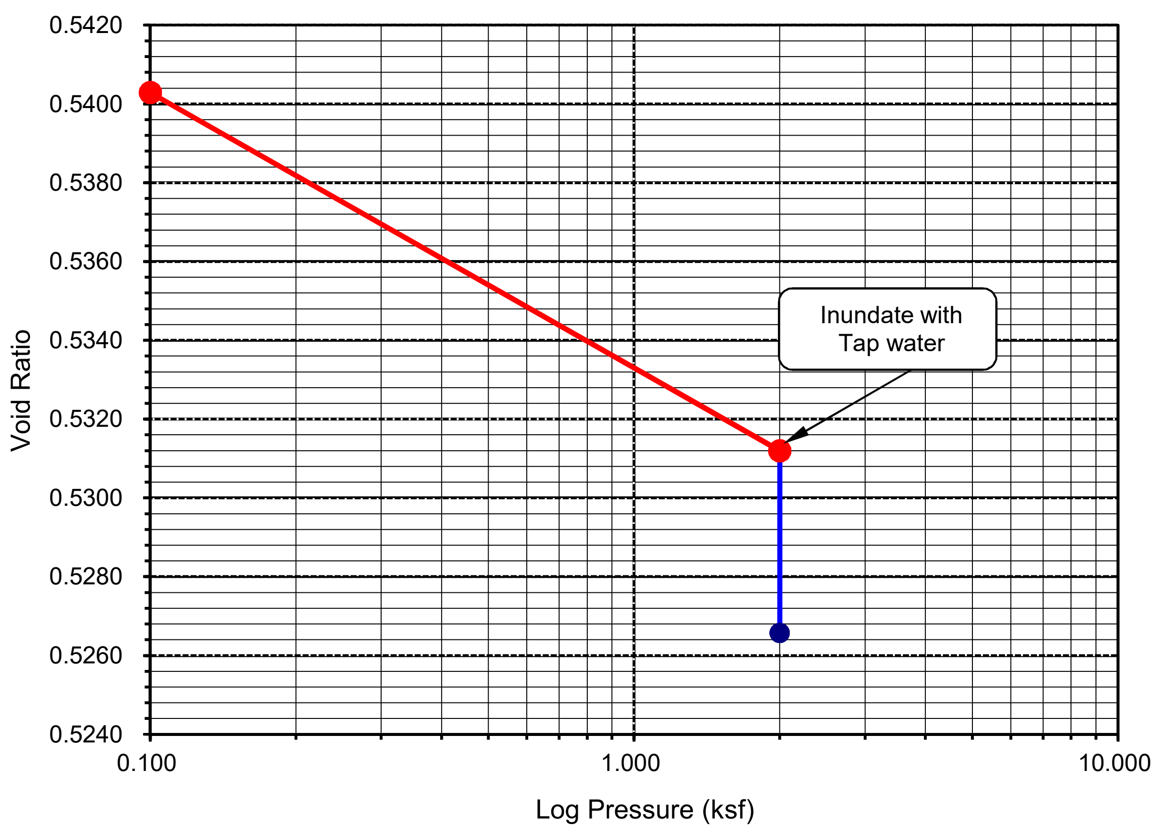
Initial Dry Density (pcf):	109.4
Initial Moisture (%):	3.85
Initial Length (in.):	1.0000
Initial Dial Reading:	0.3326
Diameter(in):	2.415

Final Dry Density (pcf):	110.4
Final Moisture (%) :	17.1
Initial Void Ratio:	0.5407
Specific Gravity(assumed):	2.70
Initial Saturation (%)	19.2

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.3323	0.9997	0.00	-0.03	0.5403	-0.03
2.000	0.3244	0.9918	0.20	-0.82	0.5312	-0.62
H2O	0.3214	0.9888	0.20	-1.12	0.5266	-0.92

Percent Swell (+) / Settlement (-) After Inundation = -0.30

Void Ratio - Log Pressure Curve



ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	CWE P-2	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.)	10.0		
Sample Description:	Olive brown silty, clayey sand (SC-SM)				

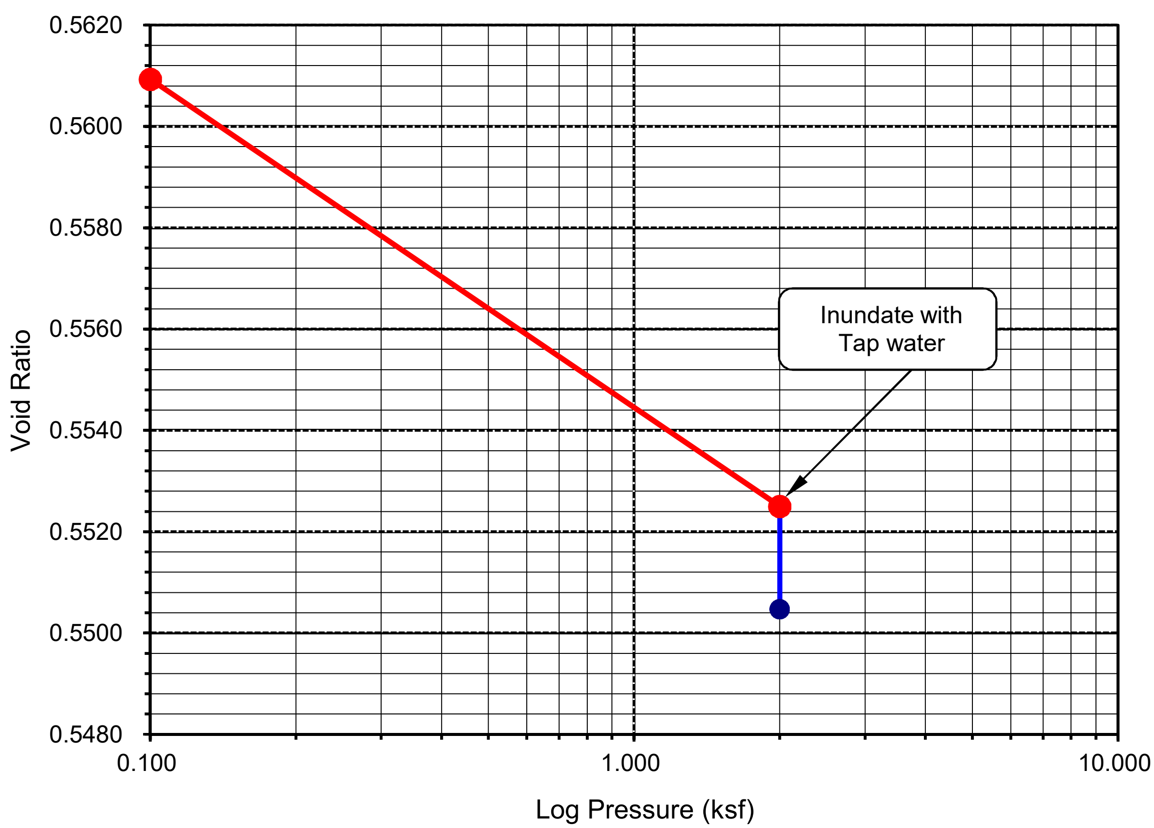
Initial Dry Density (pcf):	108.0
Initial Moisture (%):	9.40
Initial Length (in.):	1.0000
Initial Dial Reading:	0.2369
Diameter(in):	2.415

Final Dry Density (pcf):	108.7
Final Moisture (%) :	17.3
Initial Void Ratio:	0.5614
Specific Gravity(assumed):	2.70
Initial Saturation (%)	45.2

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.2366	0.9997	0.00	-0.03	0.5609	-0.03
2.000	0.2279	0.9910	0.33	-0.90	0.5525	-0.57
H2O	0.2266	0.9897	0.33	-1.03	0.5505	-0.70

Percent Swell (+) / Settlement (-) After Inundation = -0.13

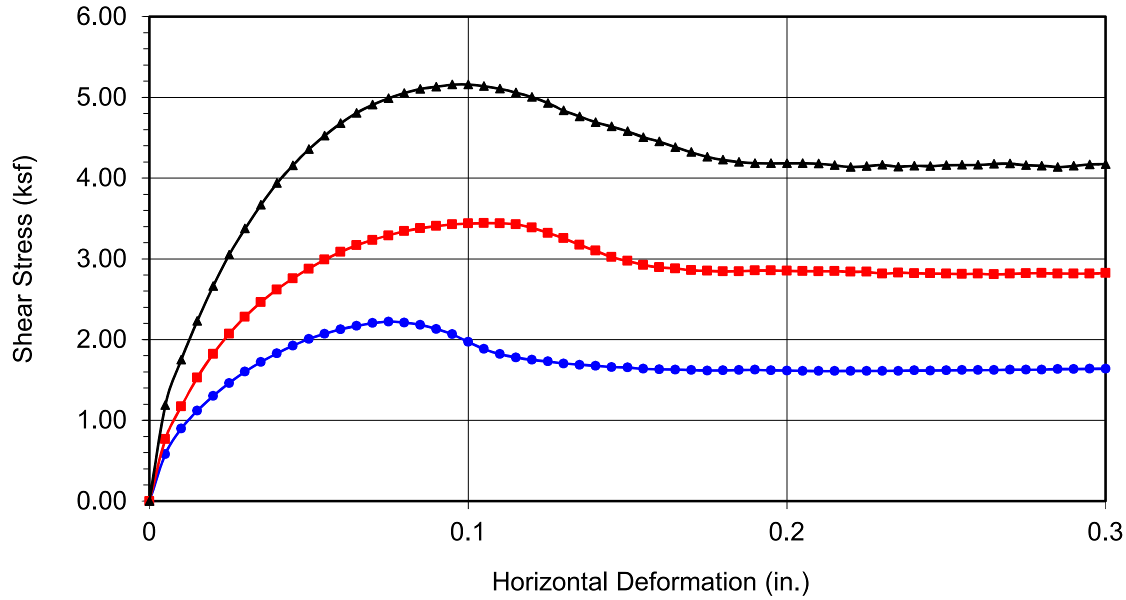
Void Ratio - Log Pressure Curve

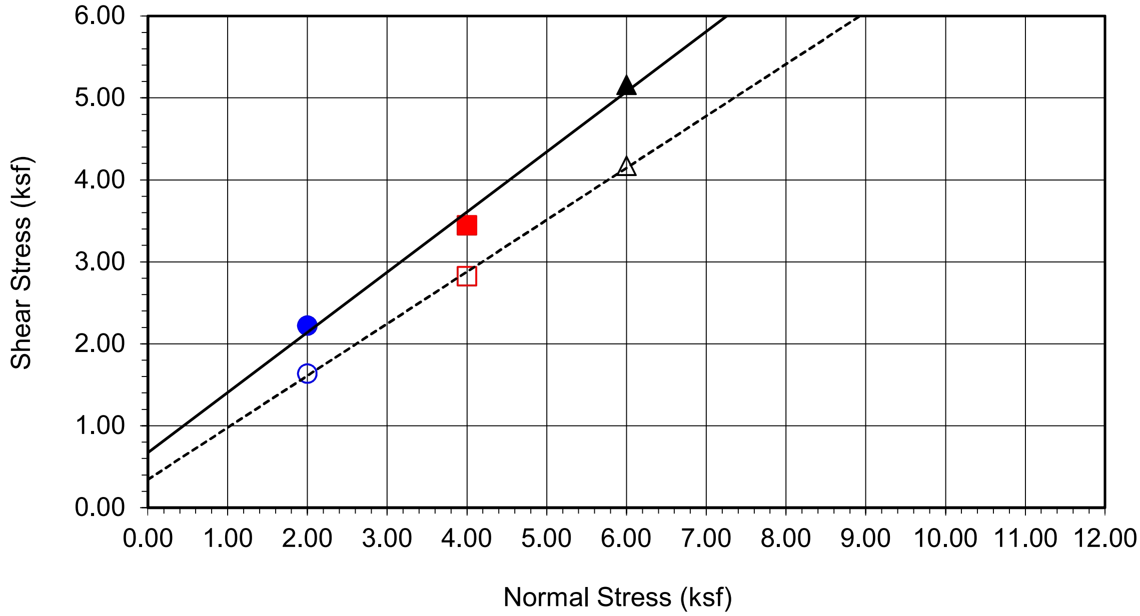


A P P E N D I X C.3

Shear Strength:

Direct Shear Tests





Boring No.	**LB-4**
Sample No.	**R-7**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Yellowish brown clayey sand (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	672	36
Ultimate	344	32

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.223	■ 3.442	▲ 5.159
Shear Stress @ End of Test (ksf)	○ 1.638	□ 2.823	△ 4.172
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.97	14.97	14.97
Dry Density (pcf)	112.4	113.8	114.4
Saturation (%)	80.9	84.1	85.3
Soil Height Before Shearing (in.)	0.9838	0.9684	0.9709
Final Moisture Content (%)	16.4	16.0	15.0

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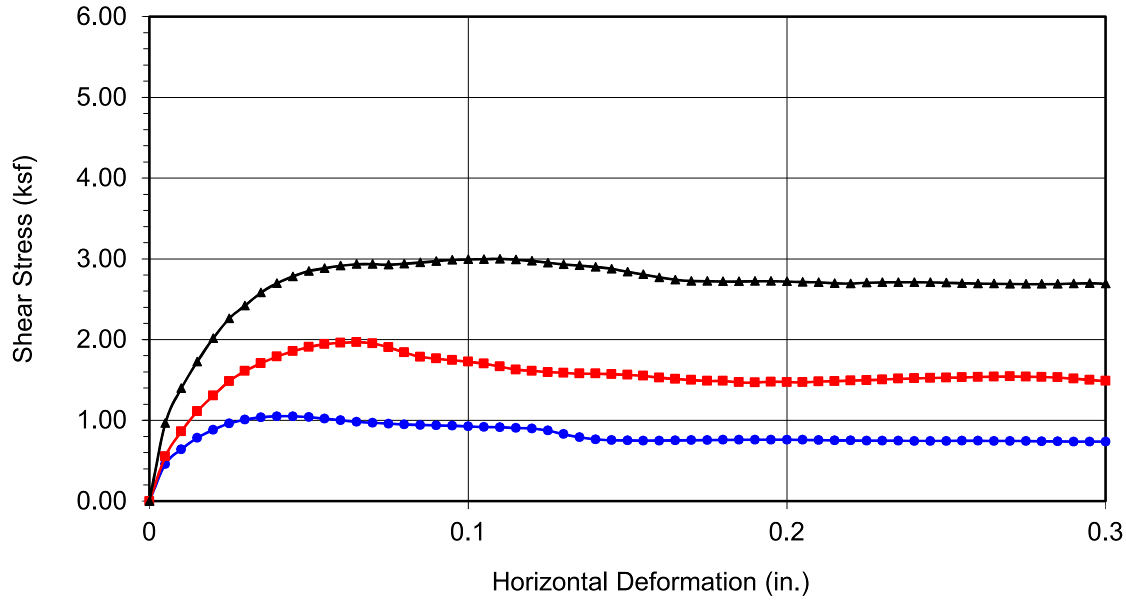
DIRECT SHEAR TEST RESULTS

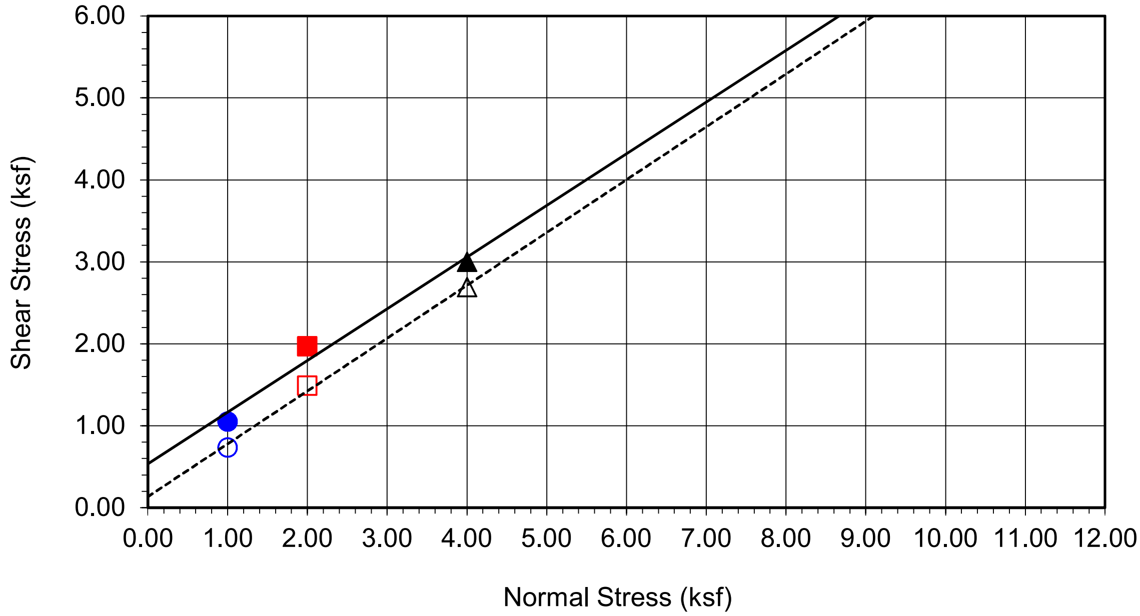
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

08-18





Boring No.	**LB-5**
Sample No.	**R-2**
Depth (ft)	**5**
Sample Type:	Ring

Soil Identification:
Dark brown silty clay (CL-ML)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	535	32
Ultimate	134	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.050	■ 1.968	▲ 2.999
Shear Stress @ End of Test (ksf)	○ 0.736	□ 1.487	△ 2.691
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.86	20.86	20.86
Dry Density (pcf)	103.1	104.1	104.1
Saturation (%)	88.6	90.9	91.0
Soil Height Before Shearing (in.)	0.9920	0.9803	0.9768
Final Moisture Content (%)	21.6	20.9	21.2

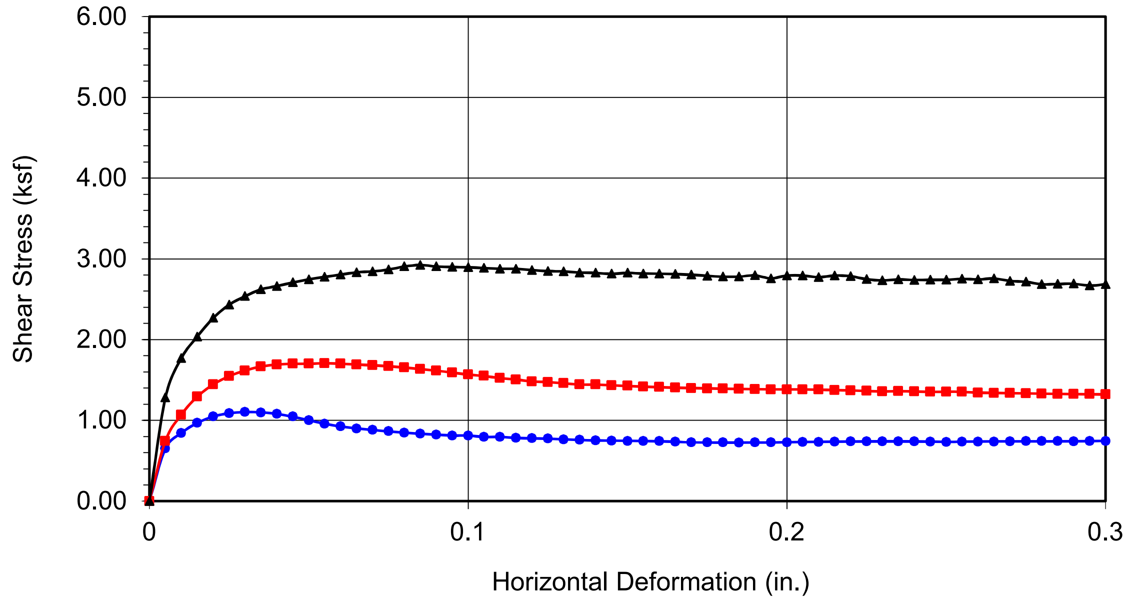
Leighton

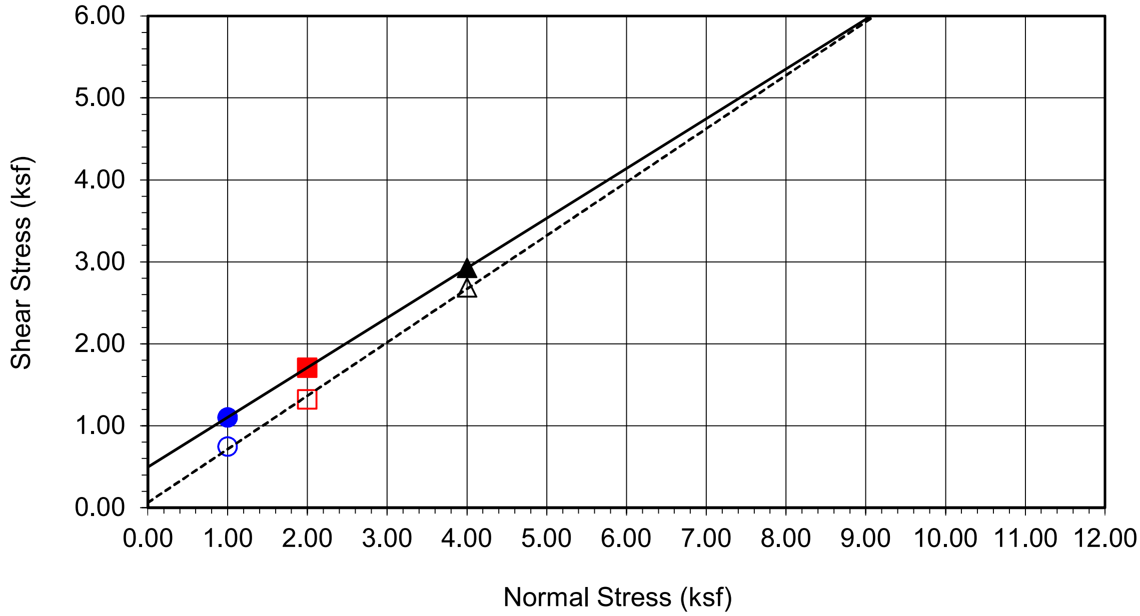
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

08-18





Boring No.	**LB-6**
Sample No.	**R-4**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:
Yellowish brown silty clay with gravel (CL-ML)g

Strength Parameters

	C (psf)	ϕ (°)
Peak	495	31
Ultimate	62	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.103	■ 1.707	▲ 2.924
Shear Stress @ End of Test (ksf)	○ 0.745	□ 1.320	△ 2.685
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.73	13.73	13.73
Dry Density (pcf)	111.8	111.8	114.0
Saturation (%)	72.9	73.1	77.4
Soil Height Before Shearing (in.)	1.0018	0.9851	0.9752
Final Moisture Content (%)	17.3	16.7	17.2

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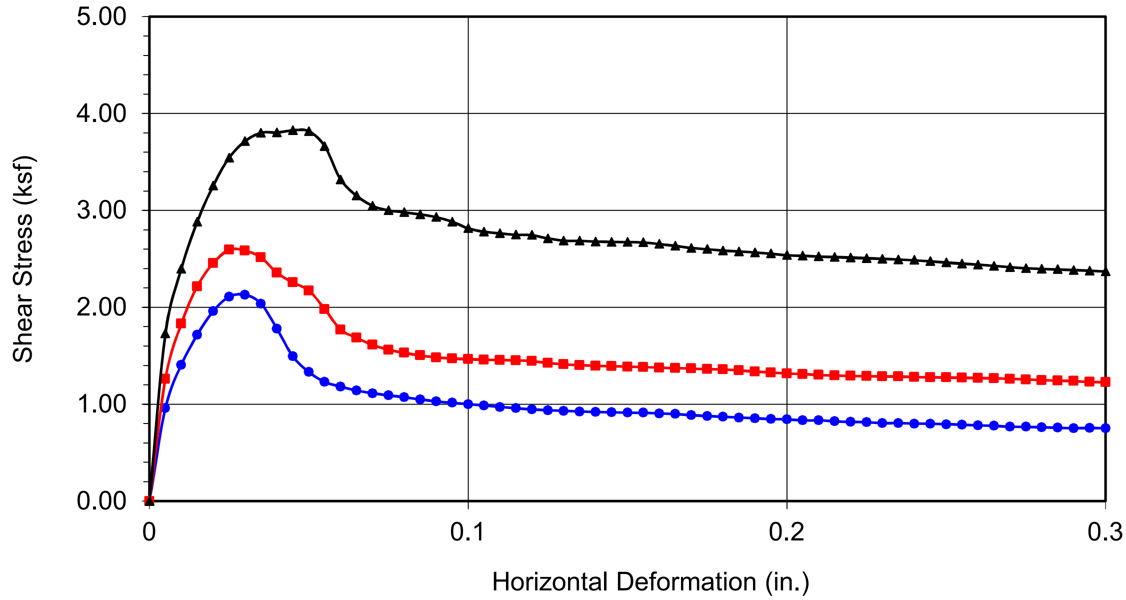
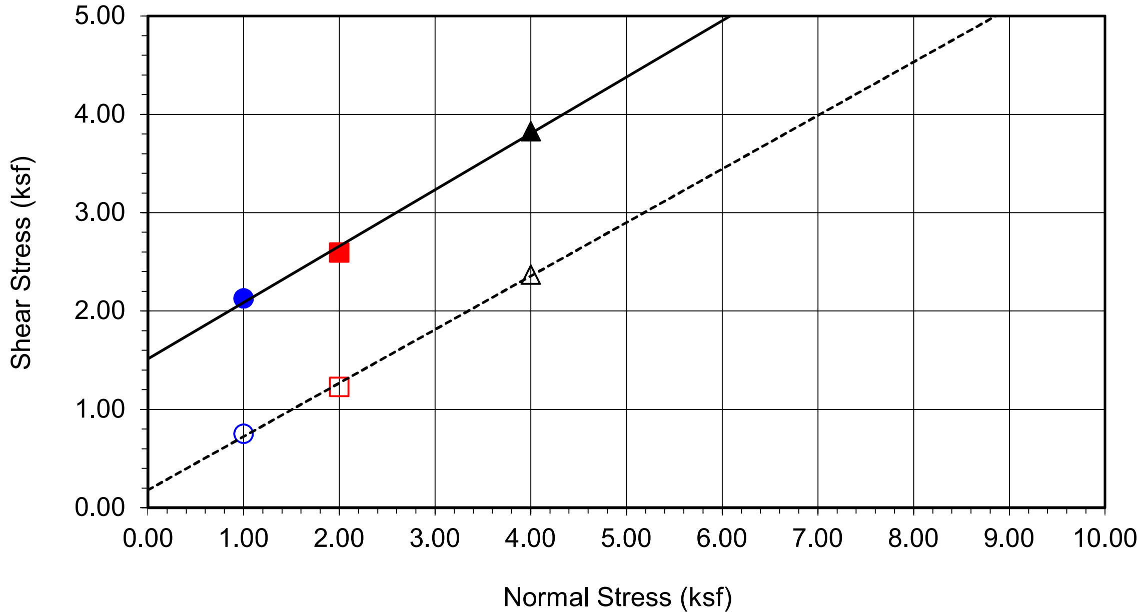
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

08-18





Boring No.	**LBA-1**
Sample No.	**R-2**
Depth (ft)	**10**
Sample Type:	Ring
Soil Identification: Olive gray silty clay'stone' (CL-ML)	

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	1512	30
Ultimate	179	29

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.128	■ 2.594	▲ 3.826
Shear Stress @ End of Test (ksf)	○ 0.751	□ 1.226	△ 2.370
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.57	16.57	16.57
Dry Density (pcf)	110.4	111.2	111.3
Saturation (%)	85.0	86.6	87.0
Soil Height Before Shearing (in.)	1.0041	1.0002	0.9941
Final Moisture Content (%)	21.7	21.2	21.2

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

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Brea Boulevard Corridor Improvements

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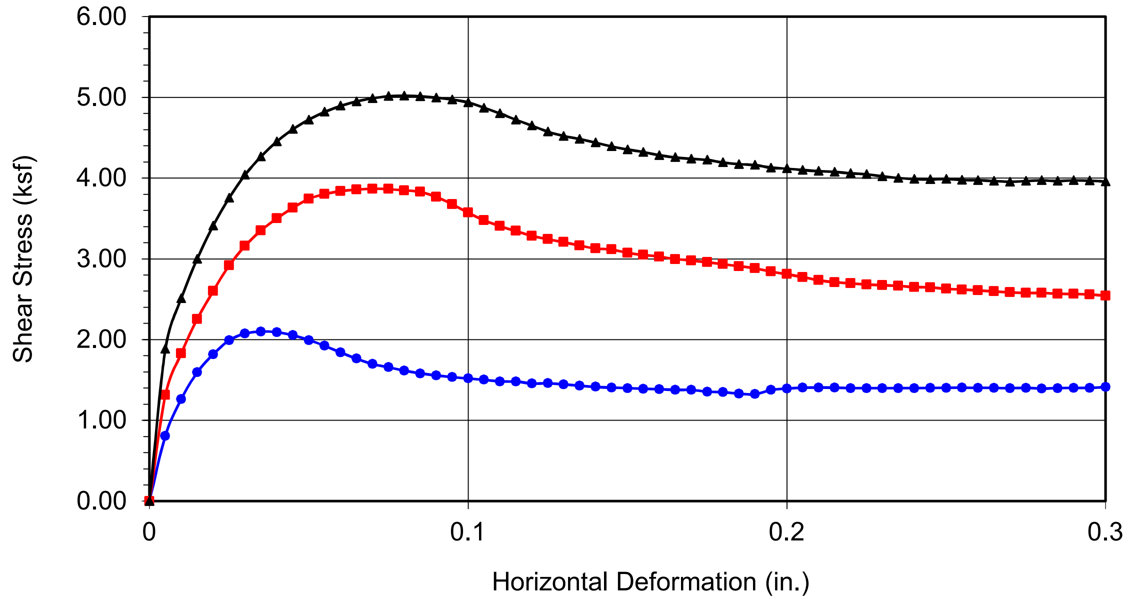

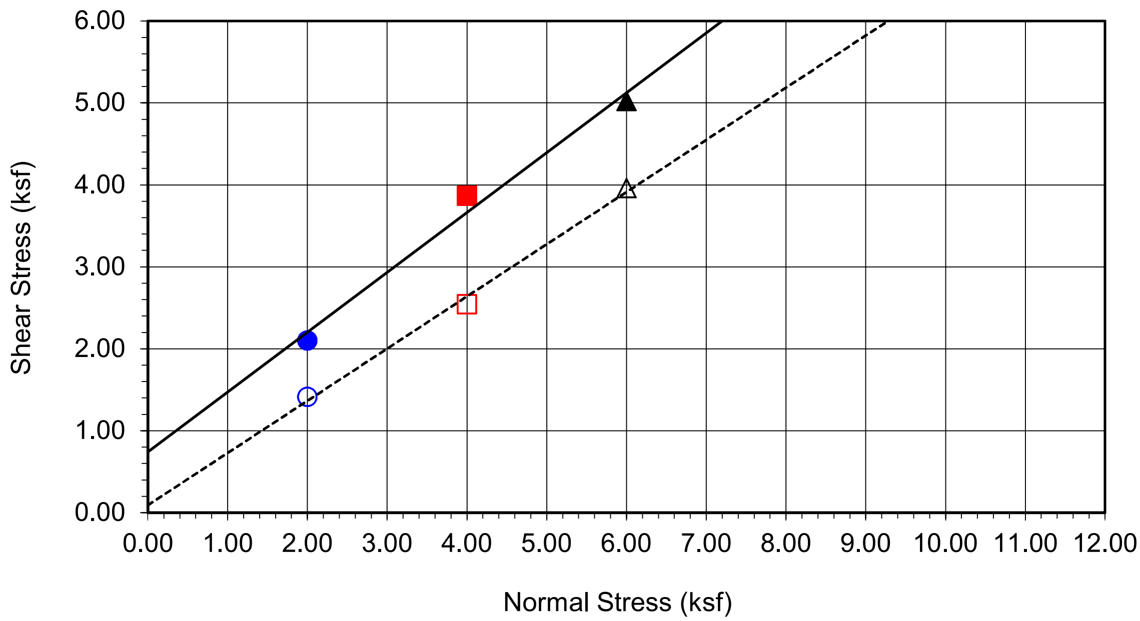

Boring No.	**LBA-2**
Sample No.	**R-4**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Light olive brown sandy silty clay'stone' s(CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	742	36
Ultimate	92	32

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.100	■ 3.867	▲ 5.021
Shear Stress @ End of Test (ksf)	○ 1.412	□ 2.543	△ 3.958
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.23	14.23	14.23
Dry Density (pcf)	104.4	105.4	106.9
Saturation (%)	62.4	64.0	66.7
Soil Height Before Shearing (in.)	0.9943	0.9879	0.9831
Final Moisture Content (%)	20.4	21.7	19.4

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

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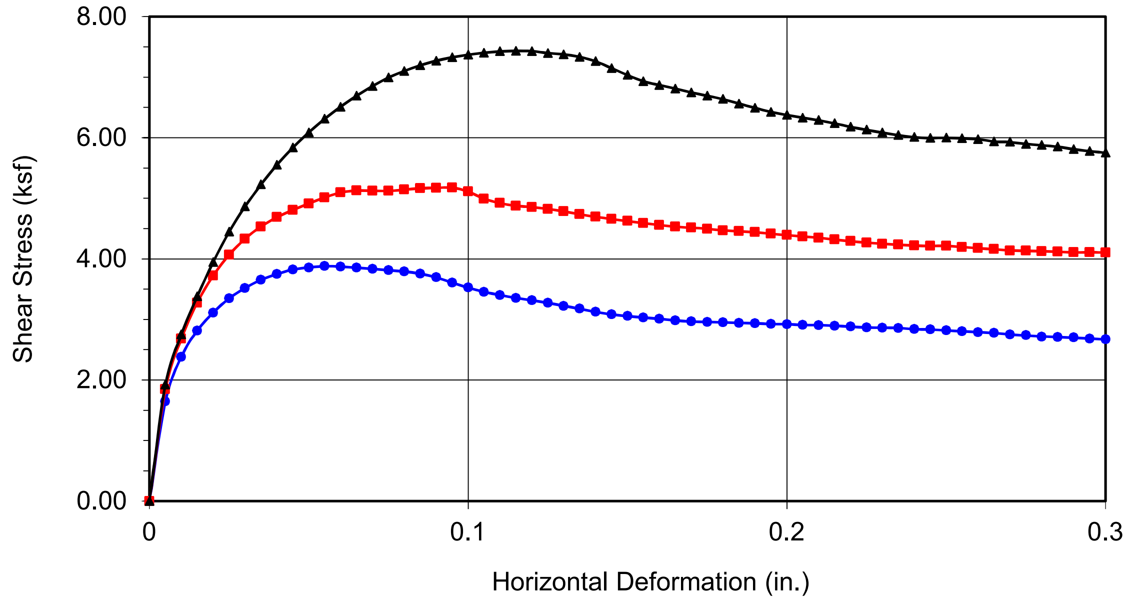

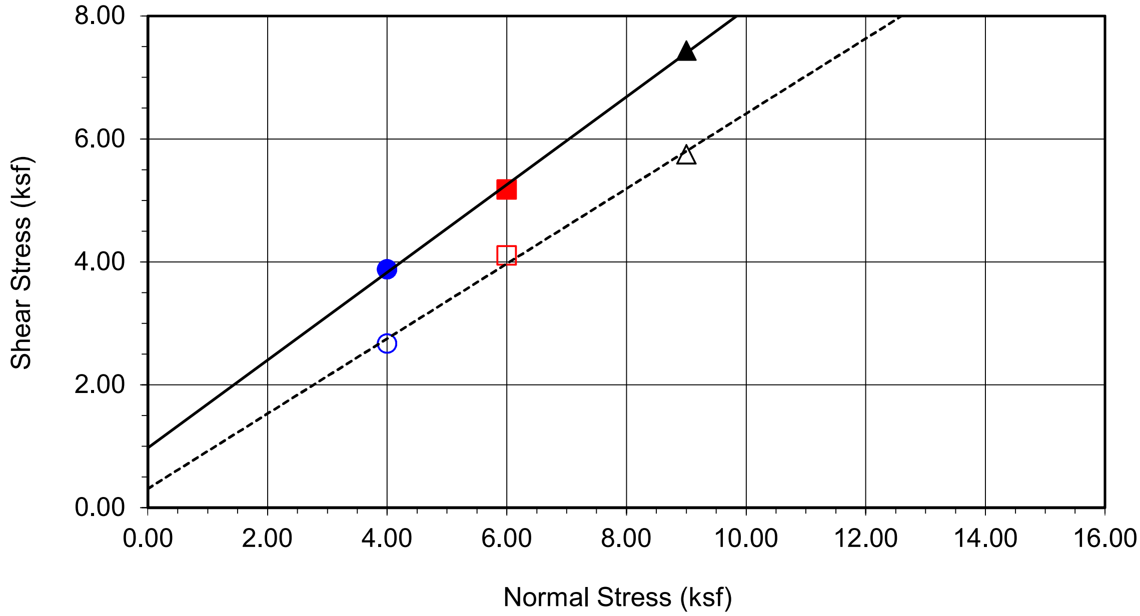

Boring No.	**LBA-2**
Sample No.	**R-8**
Depth (ft)	**40**
Sample Type:	Ring

Soil Identification:
Dark olive gray silty clay'stone'
(CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	974	36
Ultimate	310	31

Normal Stress (kip/ft²)	4.000	6.000	9.000
Peak Shear Stress (kip/ft²)	● 3.879	■ 5.175	▲ 7.432
Shear Stress @ End of Test (ksf)	○ 2.672	□ 4.103	△ 5.750
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	32.19	32.19	32.19
Dry Density (pcf)	85.8	86.9	88.1
Saturation (%)	90.0	92.5	95.1
Soil Height Before Shearing (in.)	0.9905	0.9841	0.9822
Final Moisture Content (%)	35.8	31.6	31.5

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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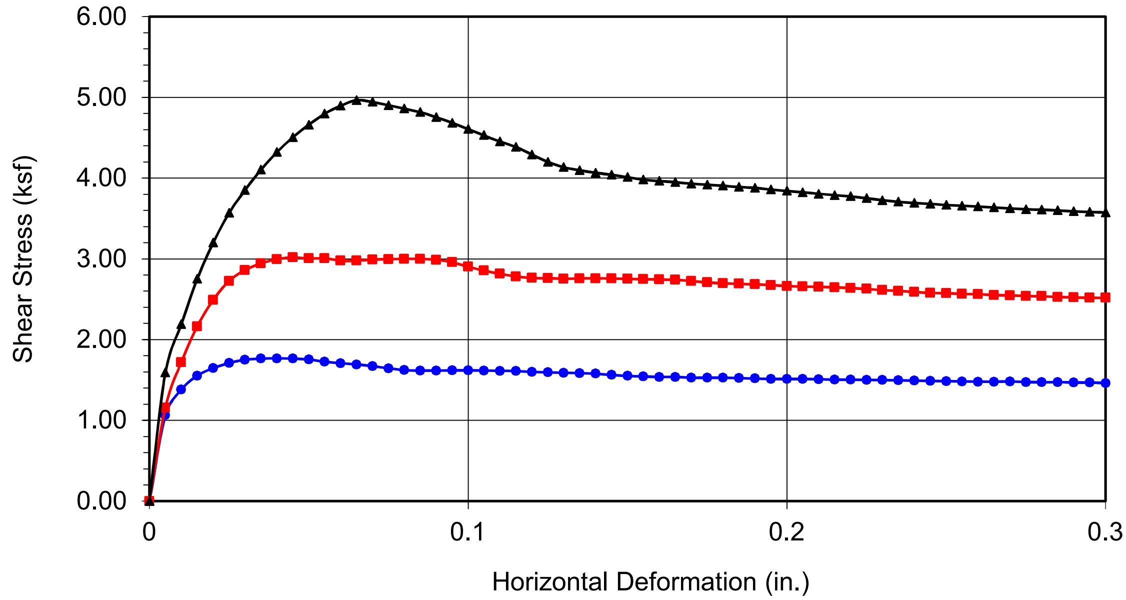

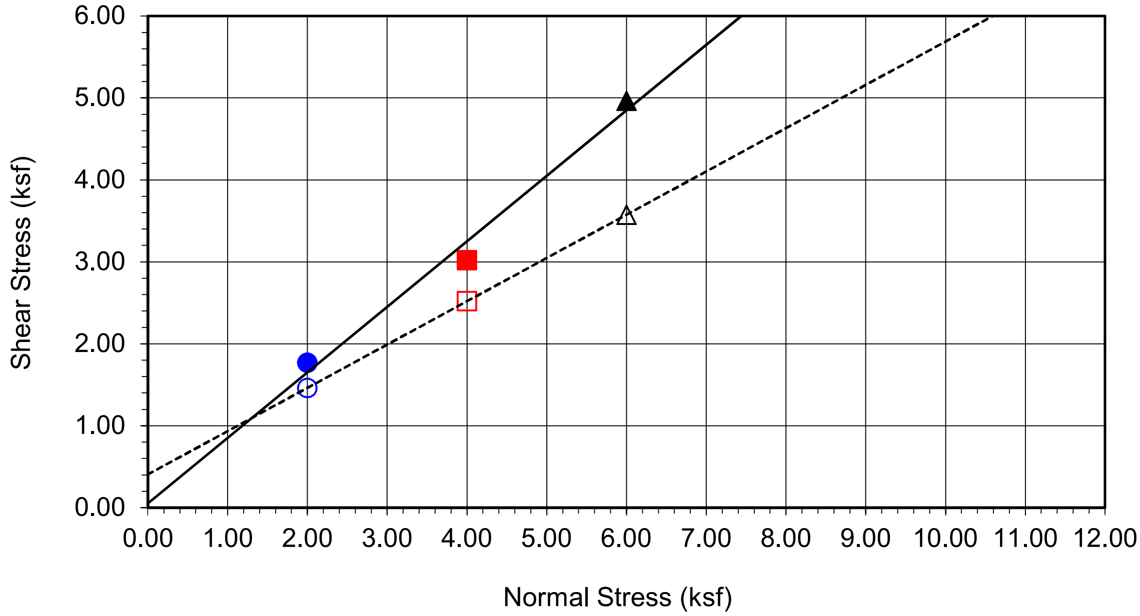

Boring No.	**LBA-3**
Sample No.	**R-4**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Light olive brown silt'stone' (ML)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	53	39
Ultimate	406	28

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.767	■ 3.018	▲ 4.964
Shear Stress @ End of Test (ksf)	○ 1.462	□ 2.518	△ 3.574
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.64	13.64	13.64
Dry Density (pcf)	95.4	101.7	104.4
Saturation (%)	48.0	56.0	60.0
Soil Height Before Shearing (in.)	0.9988	0.9932	0.9913
Final Moisture Content (%)	25.1	23.6	22.5

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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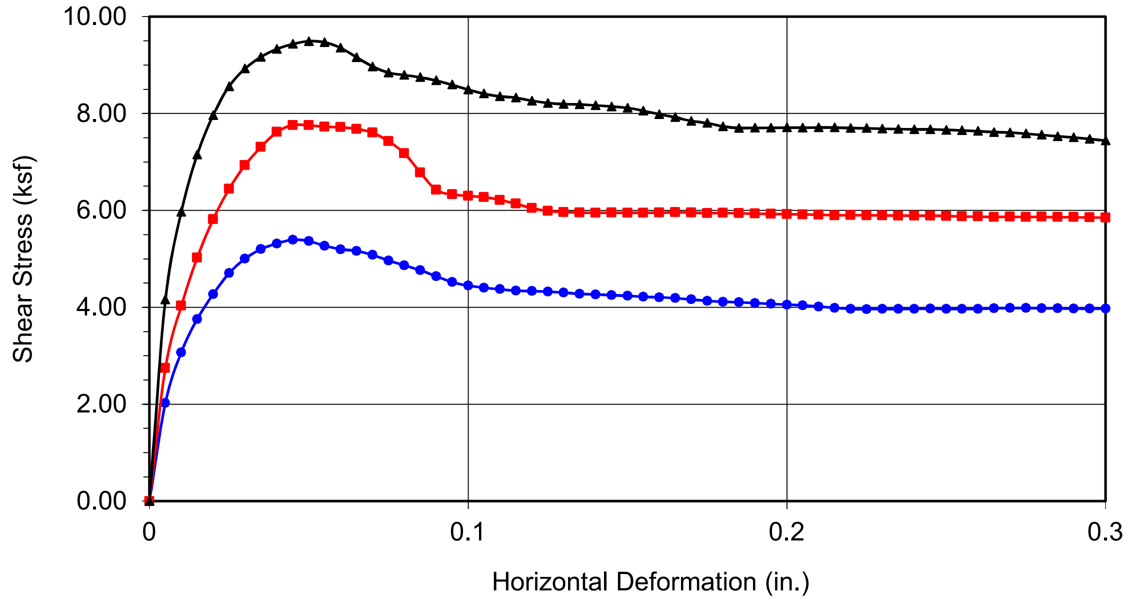

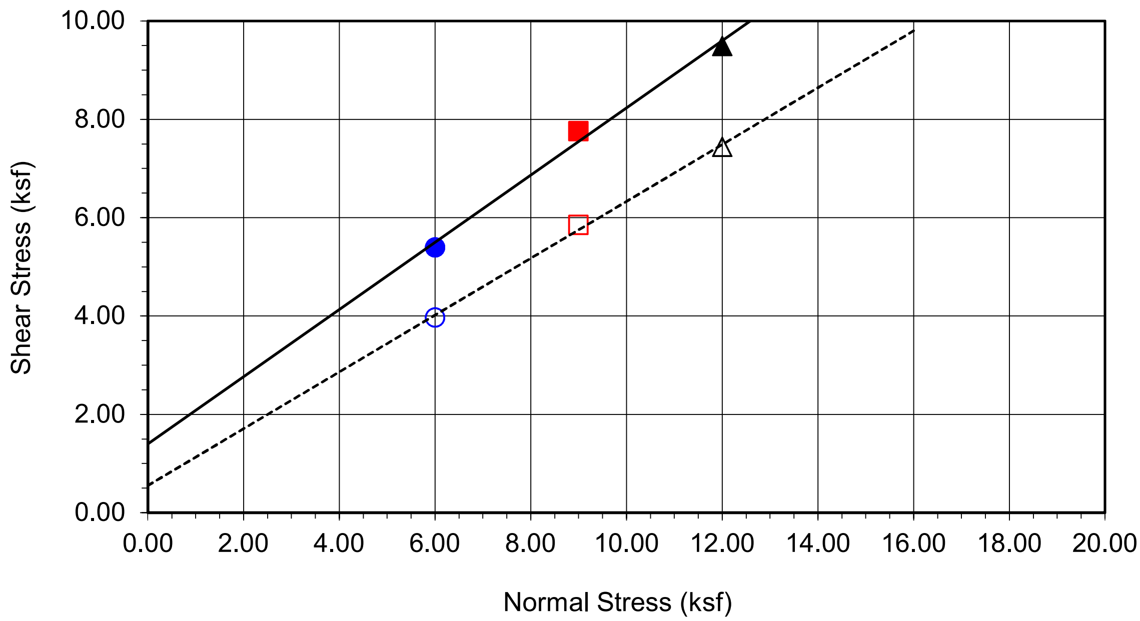

Boring No.	**LBA-3**
Sample No.	**R-12**
Depth (ft)	**60**
Sample Type:	Ring

Soil Identification:
Dark olive brown silt'stone' (ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1399	34
Ultimate	553	30

Normal Stress (kip/ft²)	6.000	9.000	12.000
Peak Shear Stress (kip/ft²)	● 5.392	■ 7.759	▲ 9.491
Shear Stress @ End of Test (ksf)	○ 3.971	□ 5.851	△ 7.438
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.93	14.93	14.93
Dry Density (pcf)	107.0	109.0	109.6
Saturation (%)	70.1	73.8	75.0
Soil Height Before Shearing (in.)	0.9887	0.9844	0.9796
Final Moisture Content (%)	19.9	19.4	19.0

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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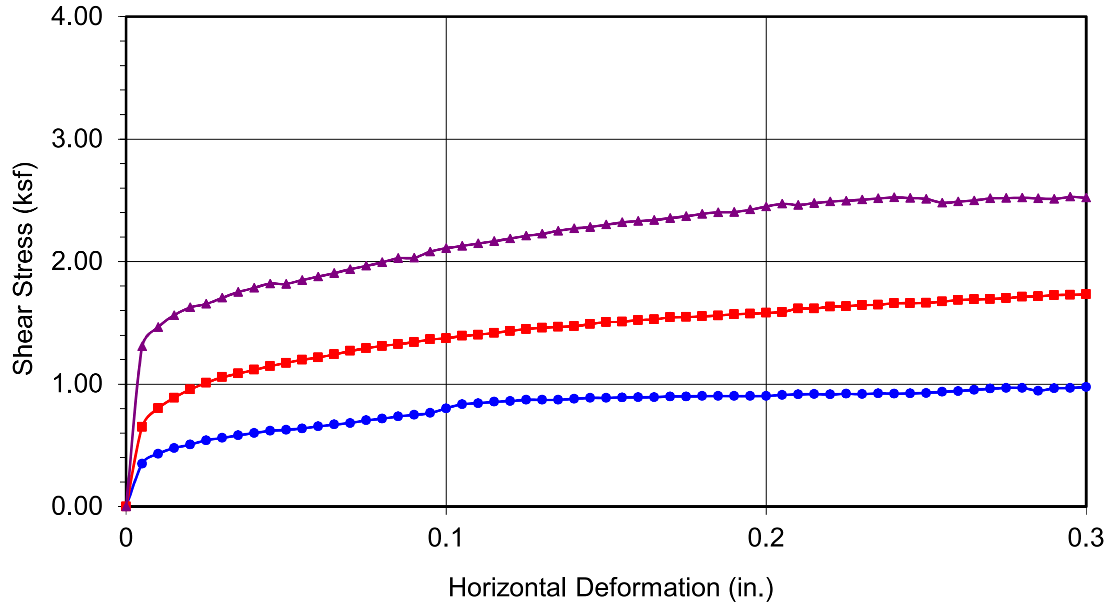

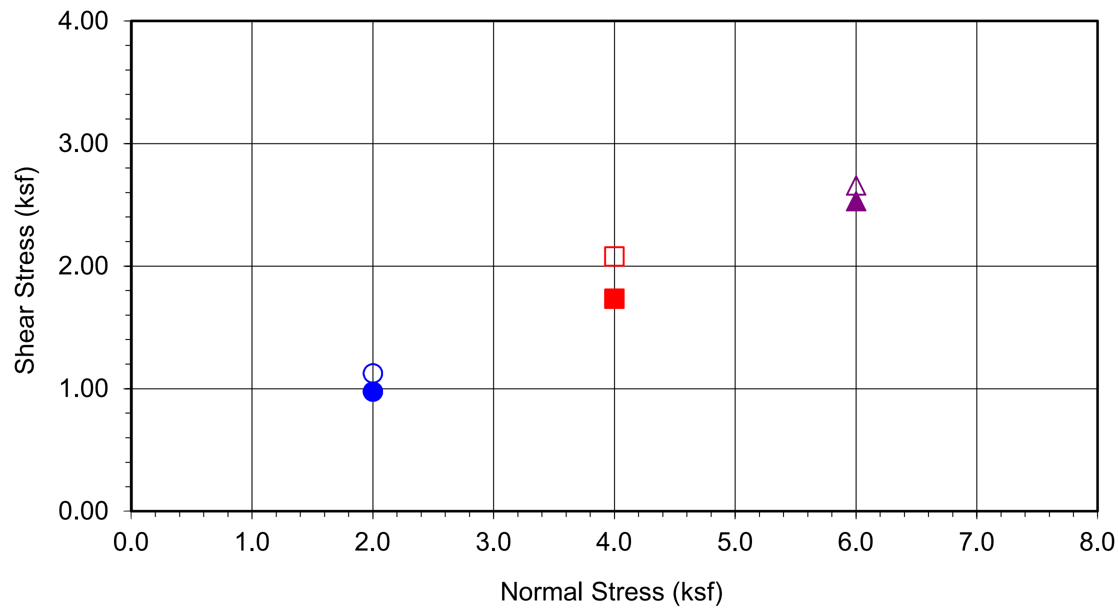

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 0.975	■ 1.732	▲ 2.528
Shear Stress @ End of Pass 9 (ksf)	○ 1.125	□ 2.078	△ 2.656
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	45.53	45.53	45.53
Dry Density (pcf)	73.9	74.4	74.5
Saturation (%)	95.9	97.0	97.3
Soil Height Before Shearing (in.)	0.8561	0.8092	0.7792
Final Moisture Content (%)	31.6	28.5	26.7

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Leighton

Boring No.:	LBA-1
Sample No.:	G-1
Depth (ft)	7.6-9.5
Sample Type:	Remold
Soil Description:	Light olive brown fat clay (CH)

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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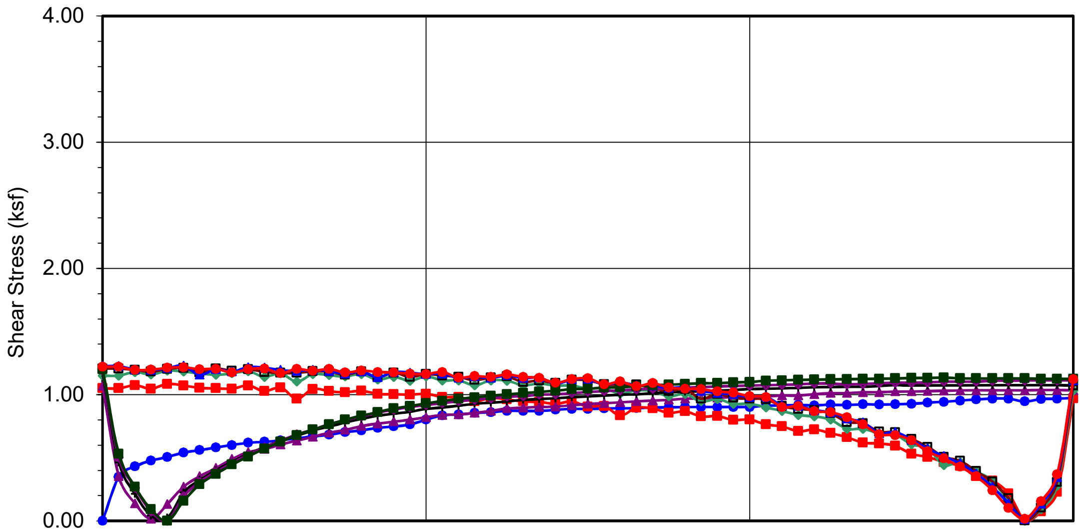
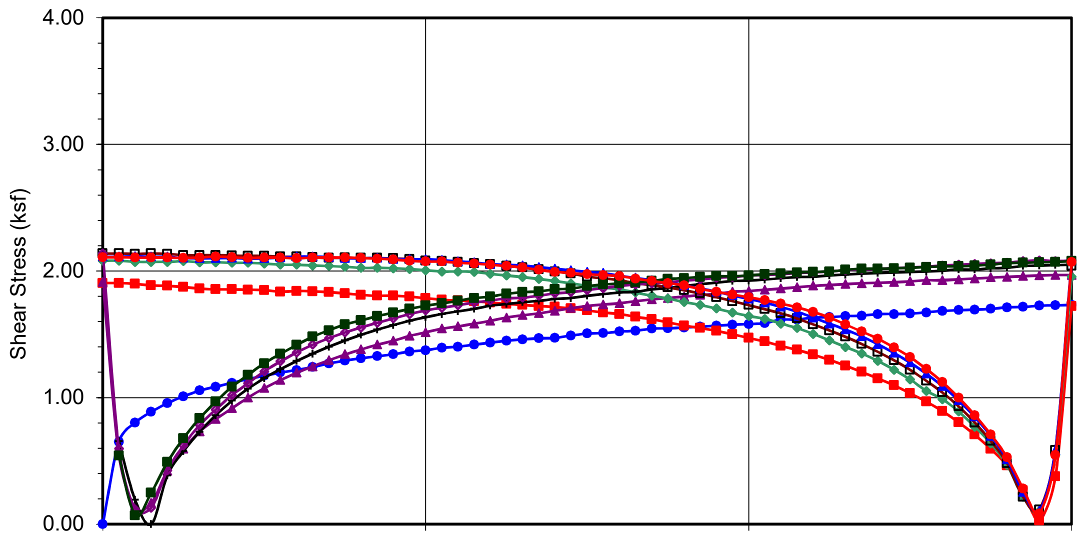
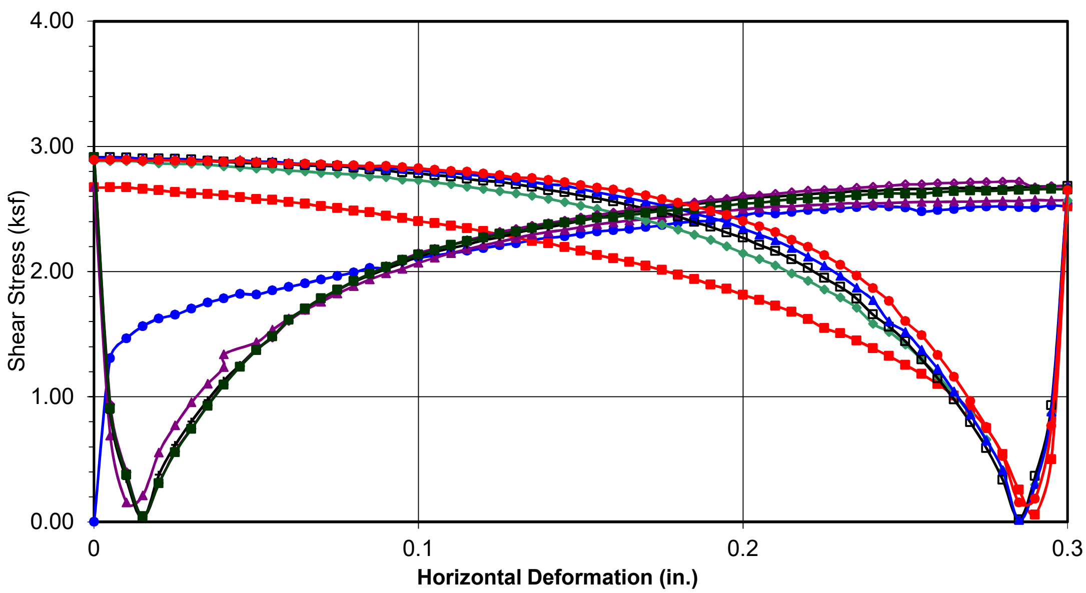


Normal Stress (ksf) 2.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	0.975
2	1.050
3	1.034
4	1.151
5	1.072
6	1.207
7	1.113
8	1.226
9	1.125
10	1.220



Normal Stress (ksf) 4.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	1.732
2	1.905
3	1.968
4	2.081
5	2.050
6	2.138
7	2.084
8	2.113
9	2.078
10	2.109



Normal Stress (ksf) 6.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	2.521
2	2.672
3	2.572
4	2.883
5	2.685
6	2.914
7	2.678
8	2.911
9	2.656
10	2.892

Pass 1-10 0.0017"/min

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Leighton

Boring No.:	LBA-1
Sample No.:	G-1
Depth (ft)	7.6-9.5
Soil Type:	Remold
Soil Description:	Light olive brown fat clay (CH)

Project No.: 11588.001

Brea Boulevard Corridor Improvements

09-18

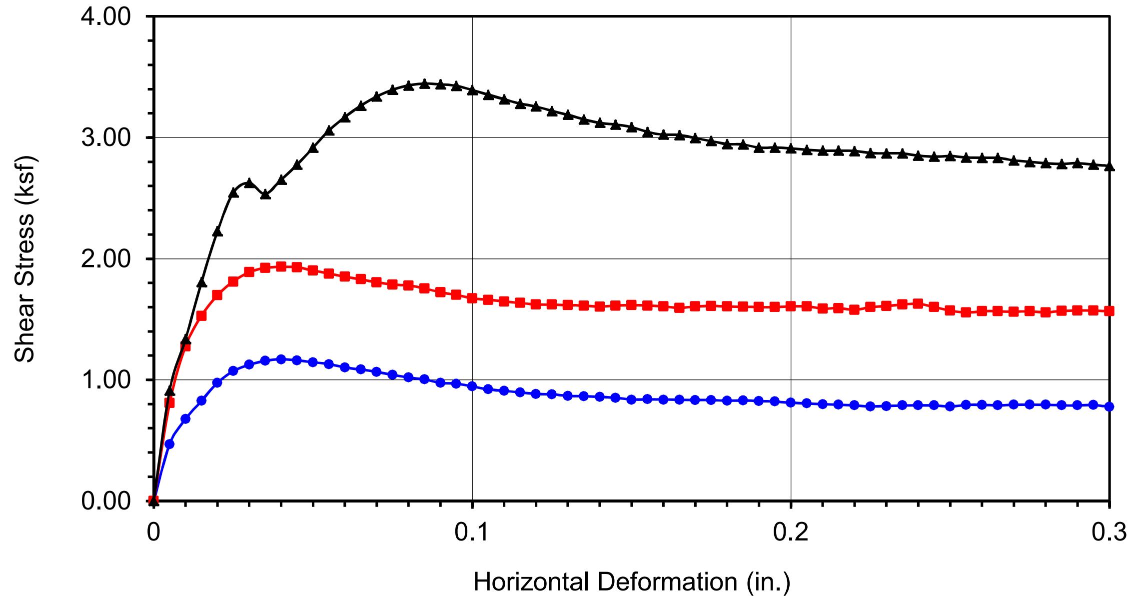
DIRECT SHEAR TEST
Consolidated Undrained

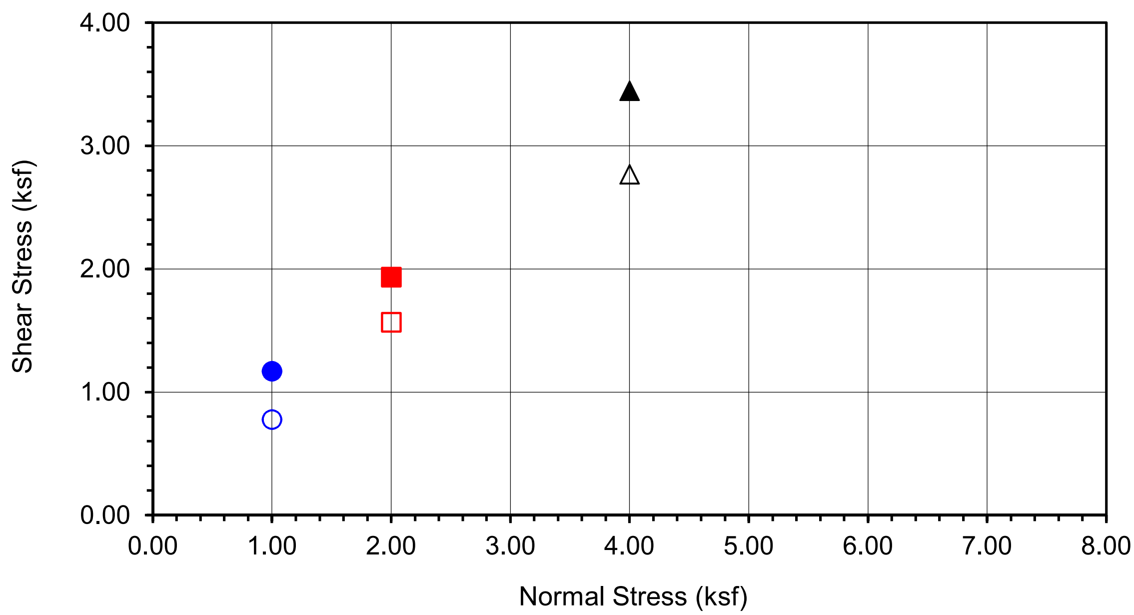
Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	02/04/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/13/19
Boring No.:	LB-14	Sample Type:	90% Remold		
Sample No.:	B-1	Depth (ft.):	2-5		

Soil Identification: Olive brown silty sand with gravel (SM)g

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	204.78	204.78	204.78
Weight of Ring(gm):	42.65	42.65	42.65
Before Shearing			
Weight of Wet Sample+Cont.(gm):	269.02	269.02	269.02
Weight of Dry Sample+Cont.(gm):	255.44	255.44	255.44
Weight of Container(gm):	68.29	68.29	68.29
Vertical Rdg.(in): Initial	0.0000	0.2872	0.2600
Vertical Rdg.(in): Final	-0.0108	0.3082	0.2780
After Shearing			
Weight of Wet Sample+Cont.(gm):	226.34	235.77	240.34
Weight of Dry Sample+Cont.(gm):	207.13	217.53	222.76
Weight of Container(gm):	57.67	68.29	73.60
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-14**
Sample No.	**B-1**
Depth (ft)	**2-5**

Sample Type:

90% Remold

Soil Identification:
Olive brown silty sand with gravel (SM)g

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.169	■ 1.933	▲ 3.446
Shear Stress @ End of Test (ksf)	○ 0.777	□ 1.566	△ 2.767
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.26	7.26	7.26
Dry Density (pcf)	125.7	125.7	125.7
Saturation (%)	57.5	57.5	57.5
Soil Height Before Shearing (in.)	0.9892	0.9790	0.9820
Final Moisture Content (%)	12.9	12.2	11.8

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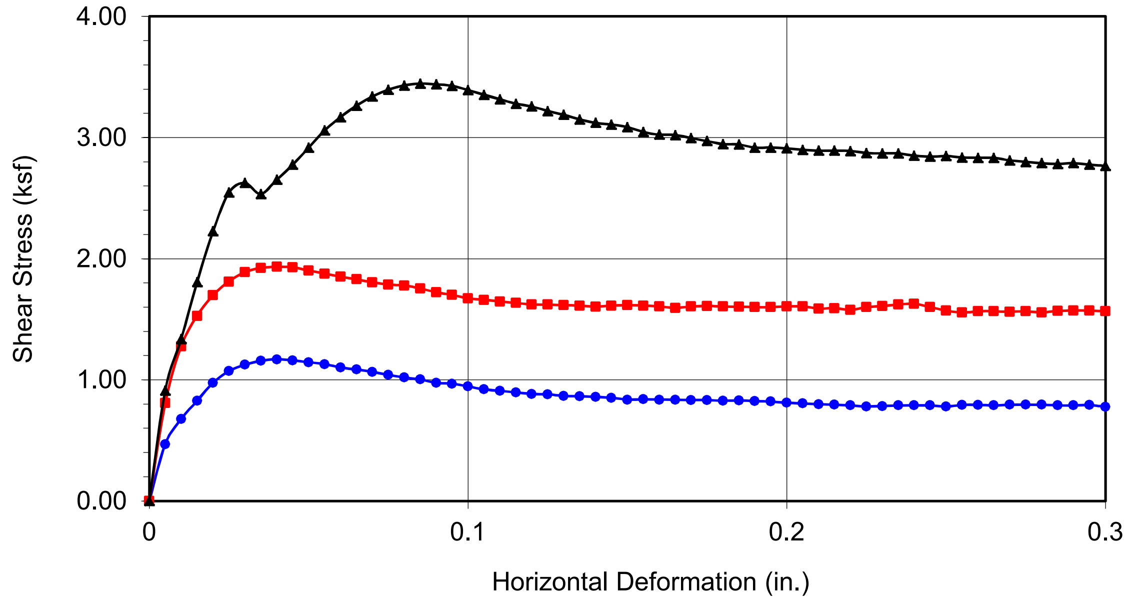
DIRECT SHEAR TEST RESULTS

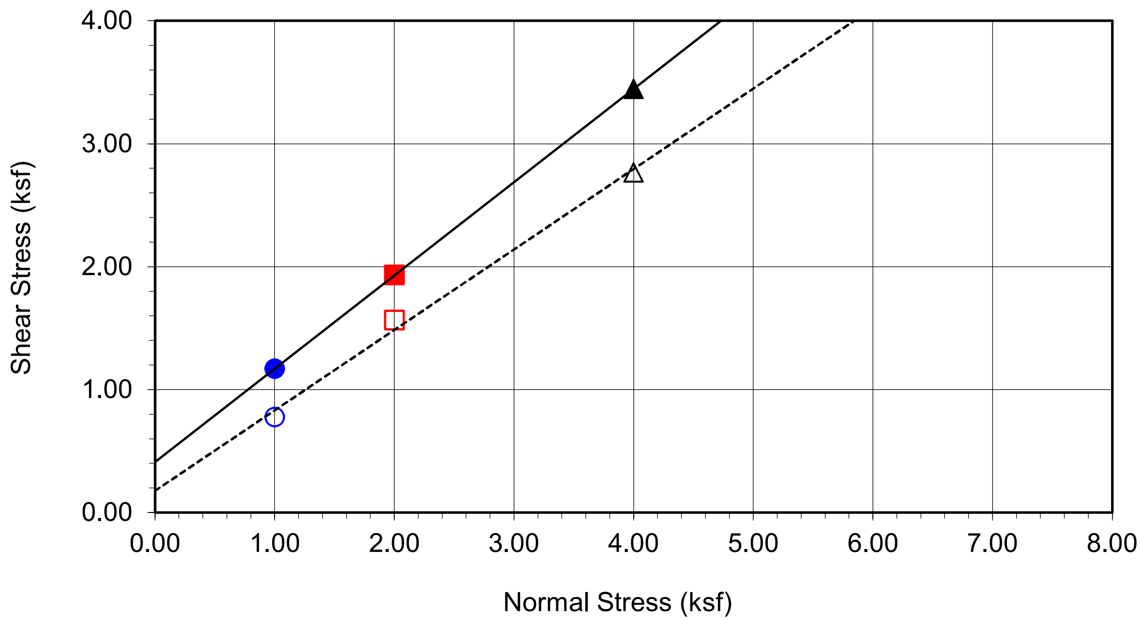
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19





Boring No.	**LB-14**
Sample No.	**B-1**
Depth (ft)	**2-5**
Sample Type:	90% Remold

Soil Identification:
Olive brown silty sand with gravel (SM)g

Strength Parameters

	C (psf)	ϕ (°)
Peak	413	37
Ultimate	177	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.169	■ 1.933	▲ 3.446
Shear Stress @ End of Test (ksf)	○ 0.777	□ 1.566	△ 2.767
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.26	7.26	7.26
Dry Density (pcf)	125.7	125.7	125.7
Saturation (%)	57.5	57.5	57.5
Soil Height Before Shearing (in.)	0.9892	0.9790	0.9820
Final Moisture Content (%)	12.9	12.2	11.8

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

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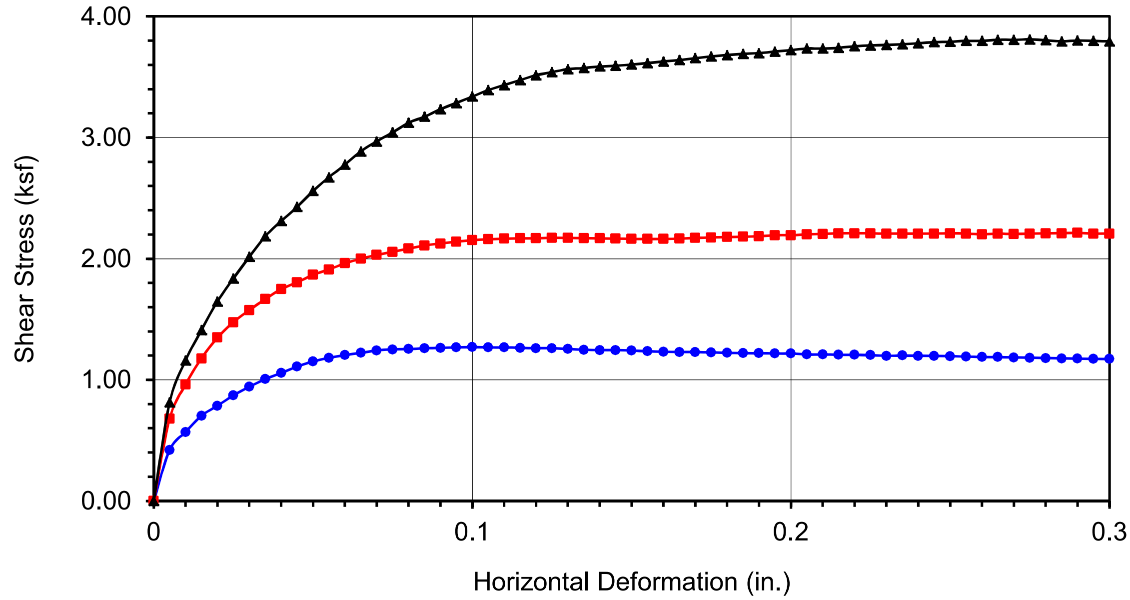
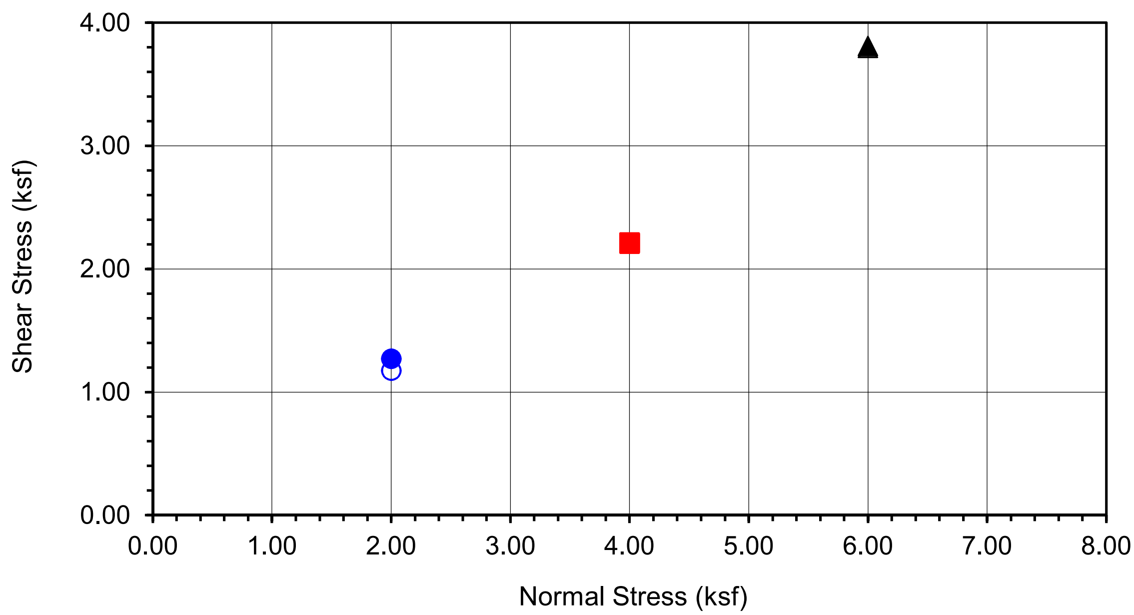
DIRECT SHEAR TEST

Consolidated Undrained

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	01/30/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/13/19
Boring No.:	LB-14	Sample Type:	Ring		
Sample No.:	R-6	Depth (ft.):	31-31.5		
Soil Identification:	Brownish gray sandy lean clay s(CL)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	186.19	190.26	185.09
Weight of Ring(gm):	43.25	46.03	38.70
Before Shearing			
Weight of Wet Sample+Cont.(gm):	191.72	191.72	191.72
Weight of Dry Sample+Cont.(gm):	161.33	161.33	161.33
Weight of Container(gm):	38.11	38.11	38.11
Vertical Rdg.(in): Initial	0.0000	0.2636	0.2734
Vertical Rdg.(in): Final	-0.0407	0.3148	0.3438
After Shearing			
Weight of Wet Sample+Cont.(gm):	208.09	198.36	214.66
Weight of Dry Sample+Cont.(gm):	173.79	166.99	187.21
Weight of Container(gm):	66.88	57.91	74.04
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-14**
Sample No.	**R-6**
Depth (ft)	**31-31.5**

Sample Type:

Ring

Soil Identification:
Brownish gray sandy lean clay s(CL)

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.270	■ 2.213	▲ 3.810
Shear Stress @ End of Test (ksf)	○ 1.173	□ 2.207	△ 3.795
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	24.66	24.66	24.66
Dry Density (pcf)	95.4	96.2	97.7
Saturation (%)	86.7	88.6	91.7
Soil Height Before Shearing (in.)	0.9593	0.9488	0.9296
Final Moisture Content (%)	32.1	28.8	24.3

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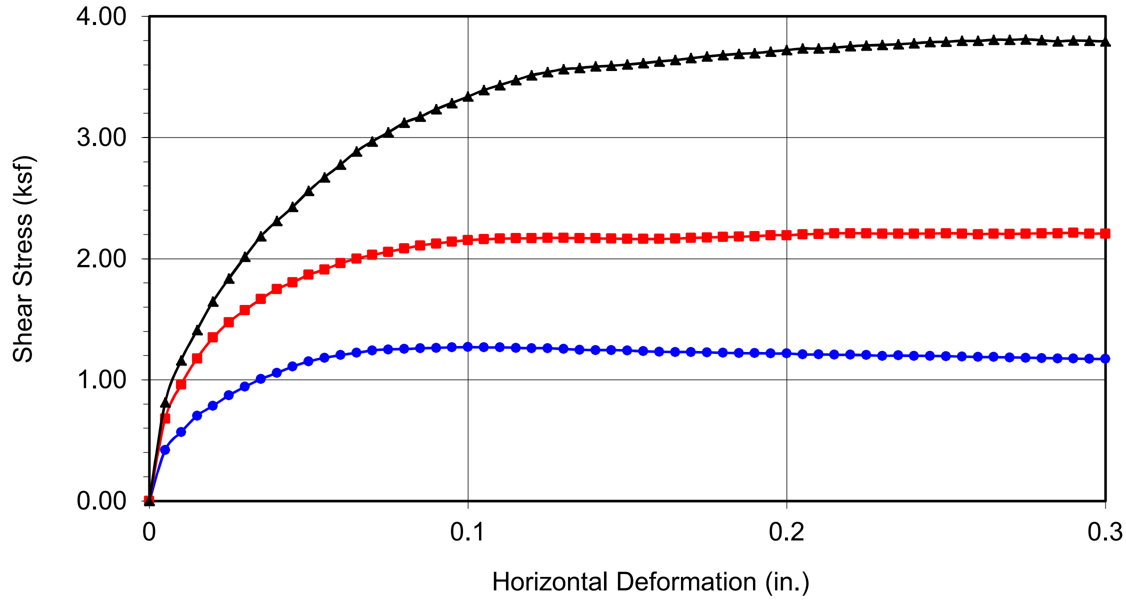
DIRECT SHEAR TEST RESULTS

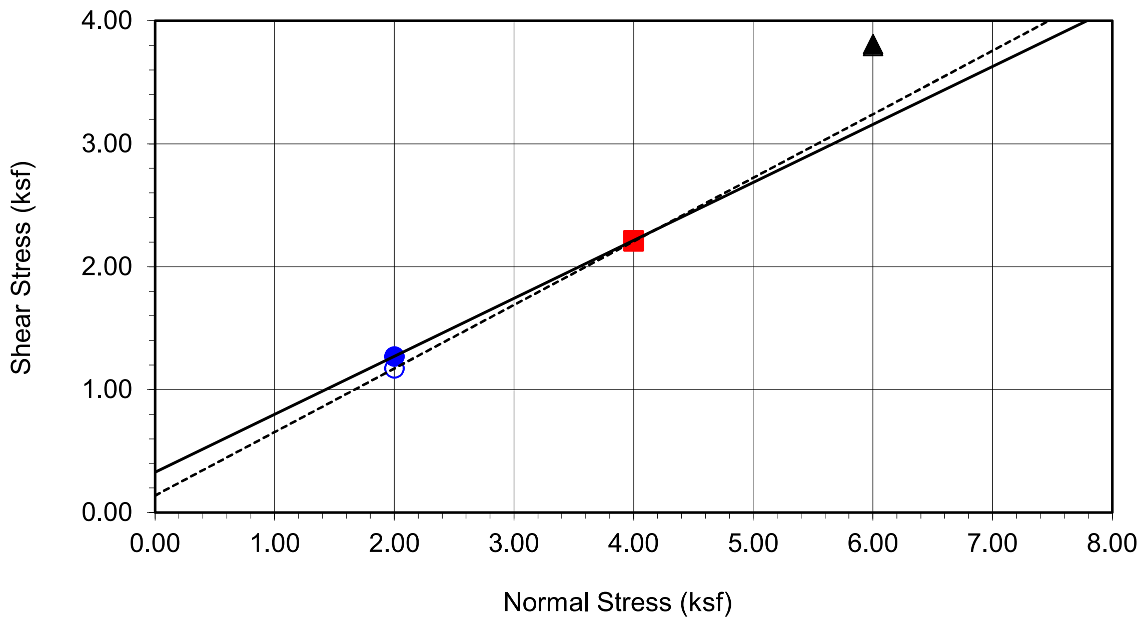
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

01-19





Boring No.	**LB-14**
Sample No.	**R-6**
Depth (ft)	**31-31.5**
Sample Type:	Ring

Soil Identification:
Brownish gray sandy lean clay s(CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	327	25
Ultimate	139	27

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.270	■ 2.213	▲ 3.810
Shear Stress @ End of Test (ksf)	○ 1.173	□ 2.207	△ 3.795
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	24.66	24.66	24.66
Dry Density (pcf)	95.4	96.2	97.7
Saturation (%)	86.7	88.6	91.7
Soil Height Before Shearing (in.)	0.9593	0.9488	0.9296
Final Moisture Content (%)	32.1	28.8	24.3

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

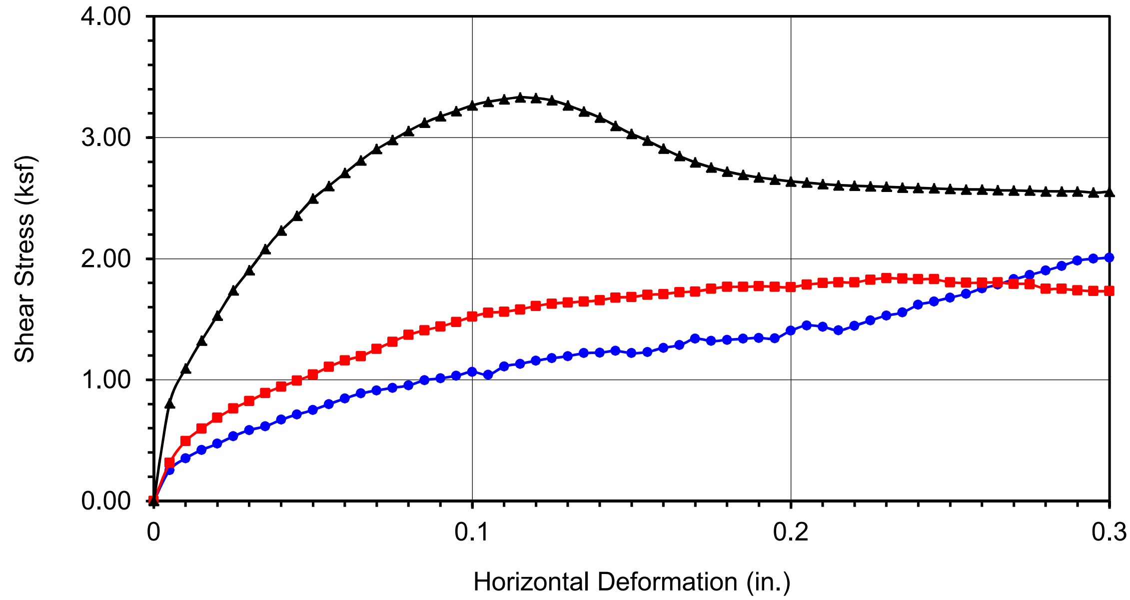
01-19

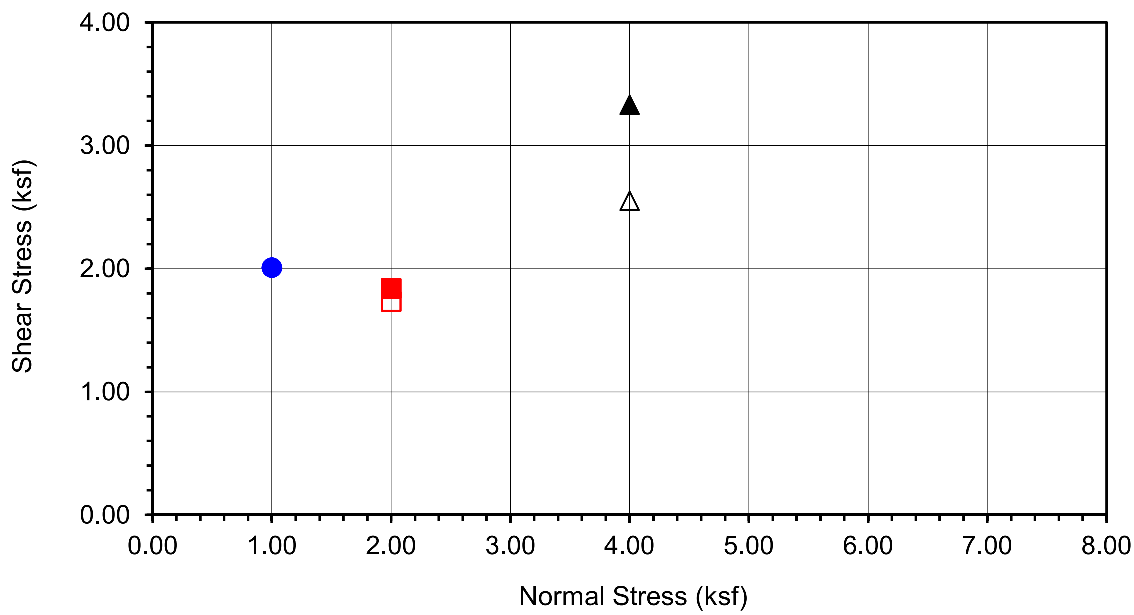
DIRECT SHEAR TEST
Consolidated Undrained

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	01/30/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/13/19
Boring No.:	LB-15	Sample Type:	Ring		
Sample No.:	R-1	Depth (ft.):	10.5-11		

Soil Identification: Brownish yellow silty sand (SM), siltstone noted

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	169.61	174.77	181.66
Weight of Ring(gm):	44.78	45.75	43.00
Before Shearing			
Weight of Wet Sample+Cont.(gm):	252.46	252.46	252.46
Weight of Dry Sample+Cont.(gm):	244.79	244.79	244.79
Weight of Container(gm):	57.65	57.65	57.65
Vertical Rdg.(in): Initial	0.2685	0.2754	0.0000
Vertical Rdg.(in): Final	0.3050	0.3451	-0.0335
After Shearing			
Weight of Wet Sample+Cont.(gm):	213.70	199.77	218.86
Weight of Dry Sample+Cont.(gm):	189.55	178.60	194.07
Weight of Container(gm):	74.00	57.80	66.97
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-15**
Sample No.	**R-1**
Depth (ft)	**10.5-11**

Sample Type:

Ring

Soil Identification:
Brownish yellow silty sand (SM), siltstone noted

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.009	■ 1.839	▲ 3.332
Shear Stress @ End of Test (ksf)	○ 2.009	□ 1.732	△ 2.553
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	4.10	4.10	4.10
Dry Density (pcf)	99.7	103.1	110.8
Saturation (%)	16.0	17.4	21.2
Soil Height Before Shearing (in.)	0.9635	0.9303	0.9665
Final Moisture Content (%)	20.9	17.5	19.5

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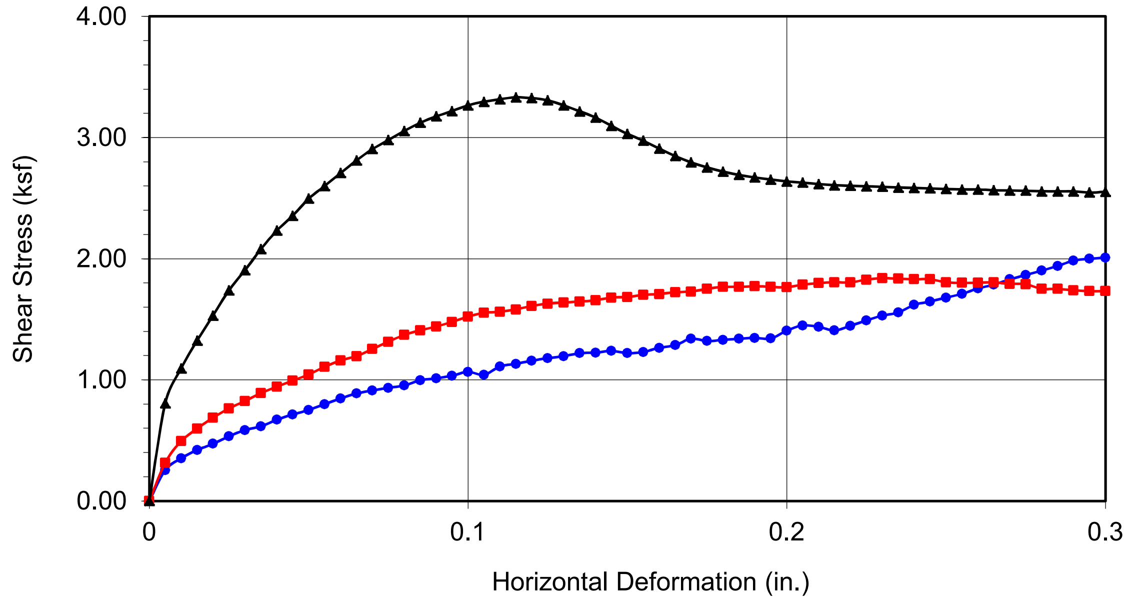
DIRECT SHEAR TEST RESULTS

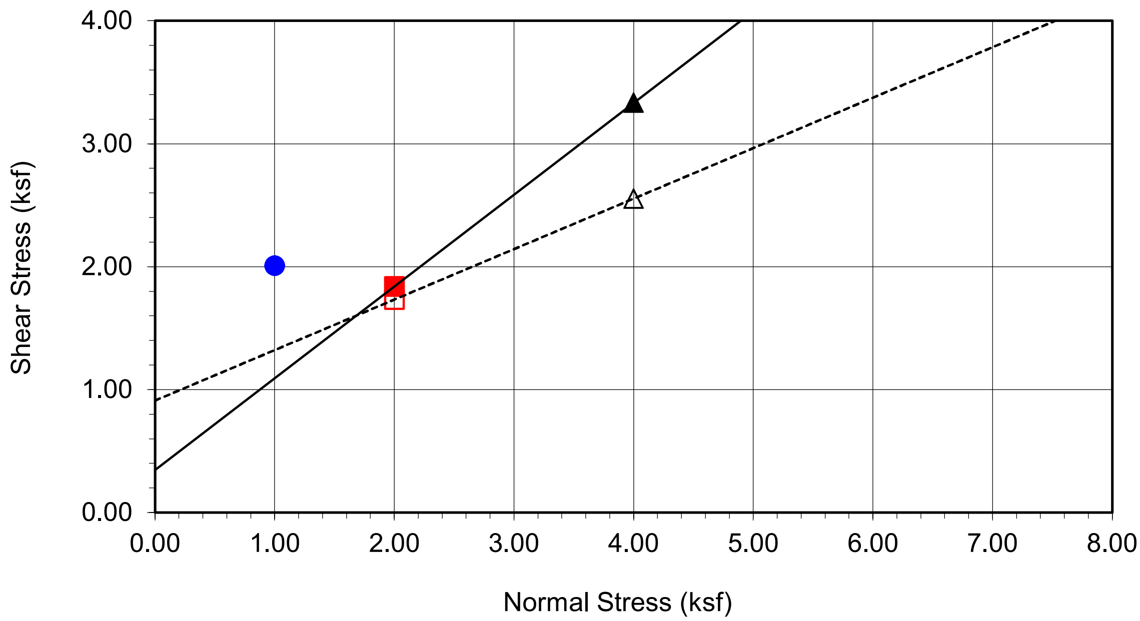
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

01-19





Boring No.	**LB-15**
Sample No.	**R-1**
Depth (ft)	**10.5-11**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty sand (SM), siltstone noted

Strength Parameters

	C (psf)	ϕ (°)
Peak	346	37
Ultimate	911	22

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.009	■ 1.839	▲ 3.332
Shear Stress @ End of Test (ksf)	○ 2.009	□ 1.732	△ 2.553
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	4.10	4.10	4.10
Dry Density (pcf)	99.7	103.1	110.8
Saturation (%)	16.0	17.4	21.2
Soil Height Before Shearing (in.)	0.9635	0.9303	0.9665
Final Moisture Content (%)	20.9	17.5	19.5

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

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DS LB-15, R-1 @ 10.5-11

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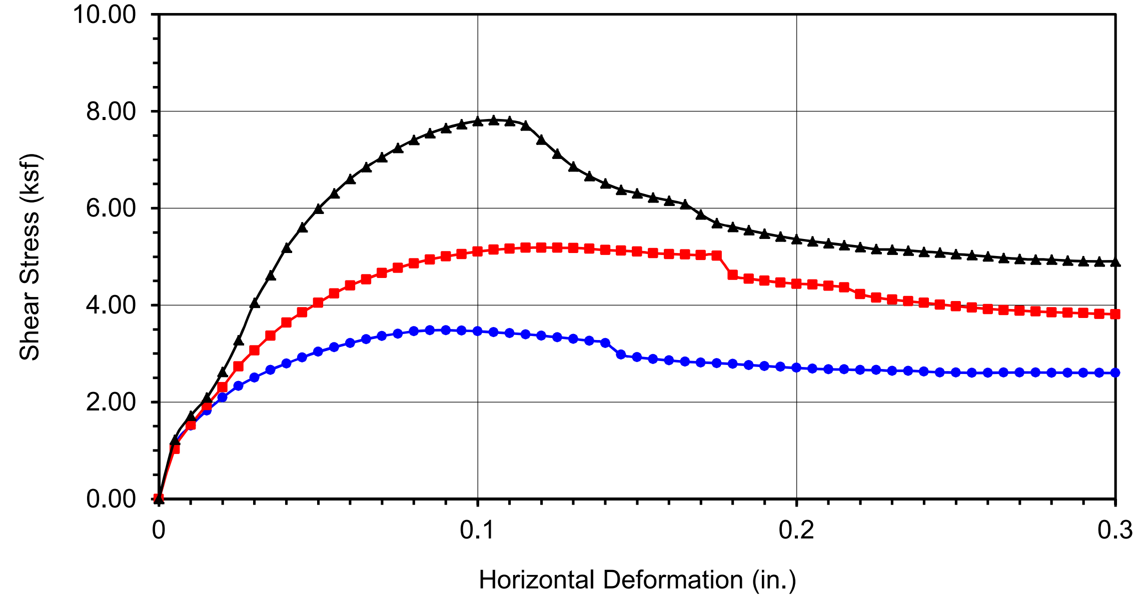
DIRECT SHEAR TEST

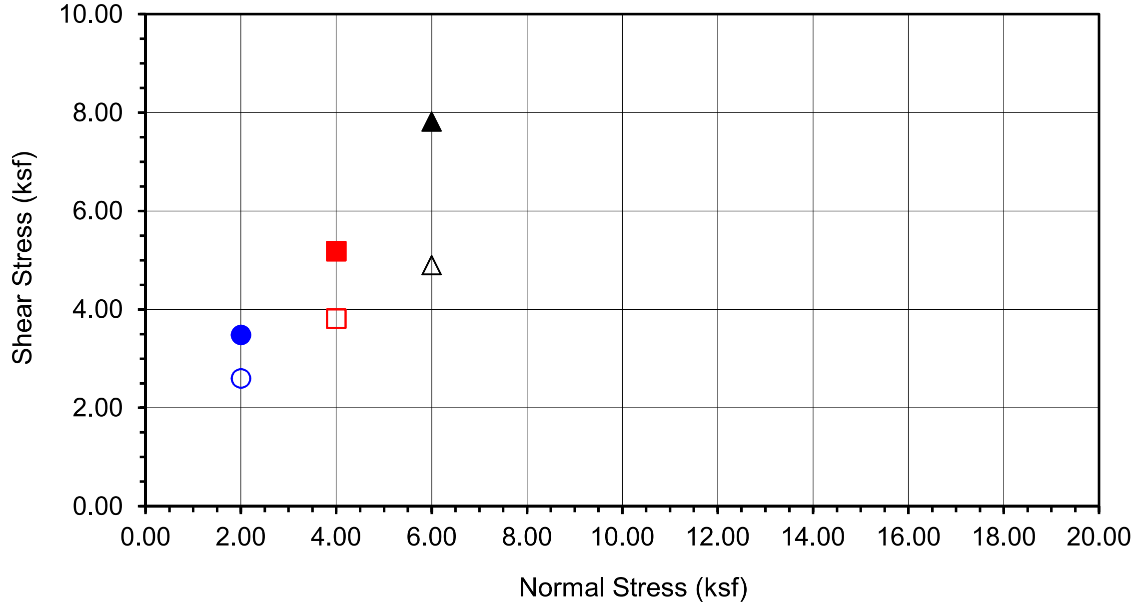
Consolidated Undrained

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	01/30/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/14/19
Boring No.:	LB-15	Sample Type:	Ring		
Sample No.:	R-2	Depth (ft.):	21-21.5		

Soil Identification: Brownish yellow silty sand (SM), siltstone noted

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	193.66	194.12	198.01
Weight of Ring(gm):	42.67	41.99	41.33
Before Shearing			
Weight of Wet Sample+Cont.(gm):	291.98	291.98	291.98
Weight of Dry Sample+Cont.(gm):	271.70	271.70	271.70
Weight of Container(gm):	68.29	68.29	68.29
Vertical Rdg.(in): Initial	0.0000	0.2453	0.2836
Vertical Rdg.(in): Final	0.0015	0.2740	0.2906
After Shearing			
Weight of Wet Sample+Cont.(gm):	220.97	197.11	223.31
Weight of Dry Sample+Cont.(gm):	195.40	172.13	199.83
Weight of Container(gm):	60.96	36.94	60.71
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-15**
Sample No.	**R-2**
Depth (ft)	**21-21.5**

<u>Sample Type:</u>

Ring

<u>Soil Identification:</u>
Brownish yellow silty sand (SM), siltstone noted

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 3.483	■ 5.187	▲ 7.819
Shear Stress @ End of Test (ksf)	○ 2.600	□ 3.810	△ 4.901
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.97	9.97	9.97
Dry Density (pcf)	114.2	115.0	118.5
Saturation (%)	56.5	57.9	63.7
Soil Height Before Shearing (in.)	1.0015	0.9713	0.9930
Final Moisture Content (%)	19.0	18.5	16.9

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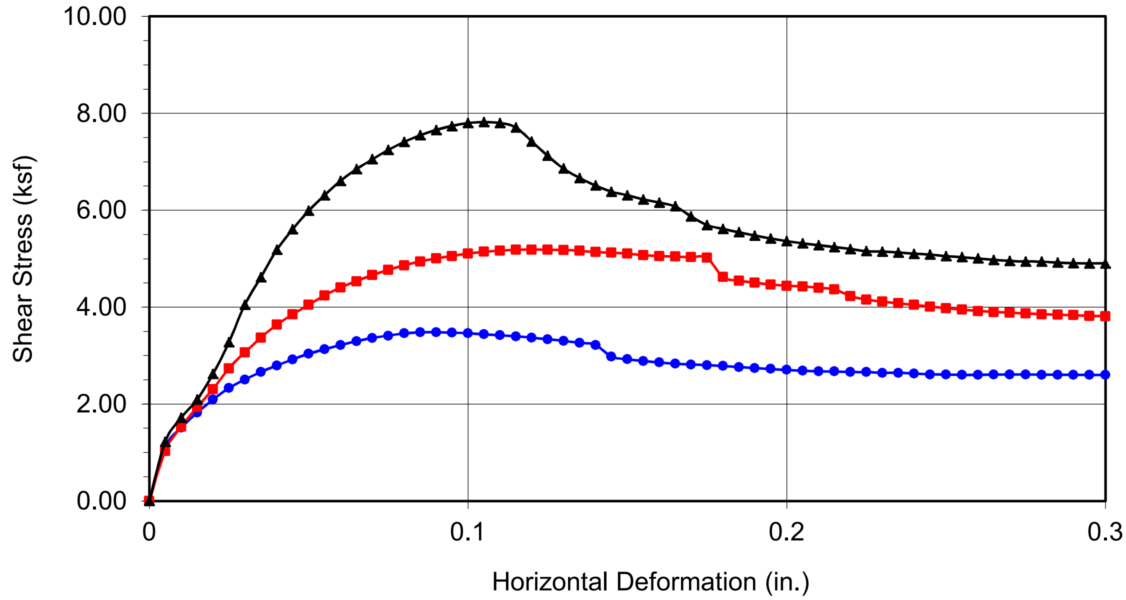
DIRECT SHEAR TEST RESULTS

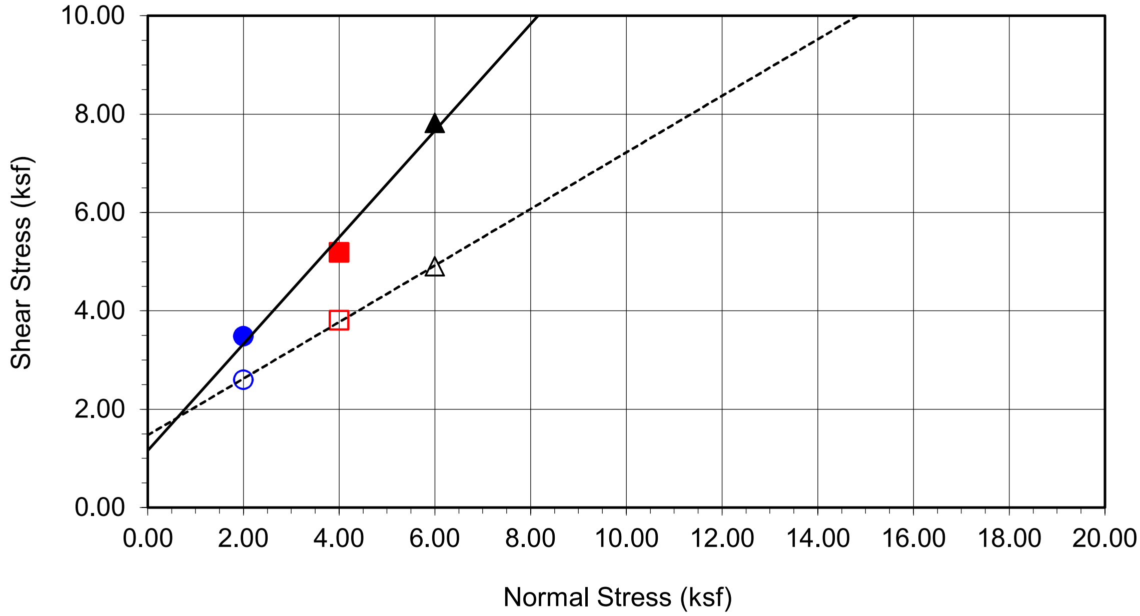
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

01-19





Boring No.	**LB-15**
Sample No.	**R-2**
Depth (ft)	**21-21.5**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty sand (SM), siltstone noted

Strength Parameters

	C (psf)	ϕ (°)
Peak	1160	47
Ultimate	1469	30

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 3.483	■ 5.187	▲ 7.819
Shear Stress @ End of Test (ksf)	○ 2.600	□ 3.810	△ 4.901
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.97	9.97	9.97
Dry Density (pcf)	114.2	115.0	118.5
Saturation (%)	56.5	57.9	63.7
Soil Height Before Shearing (in.)	1.0015	0.9713	0.9930
Final Moisture Content (%)	19.0	18.5	16.9

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

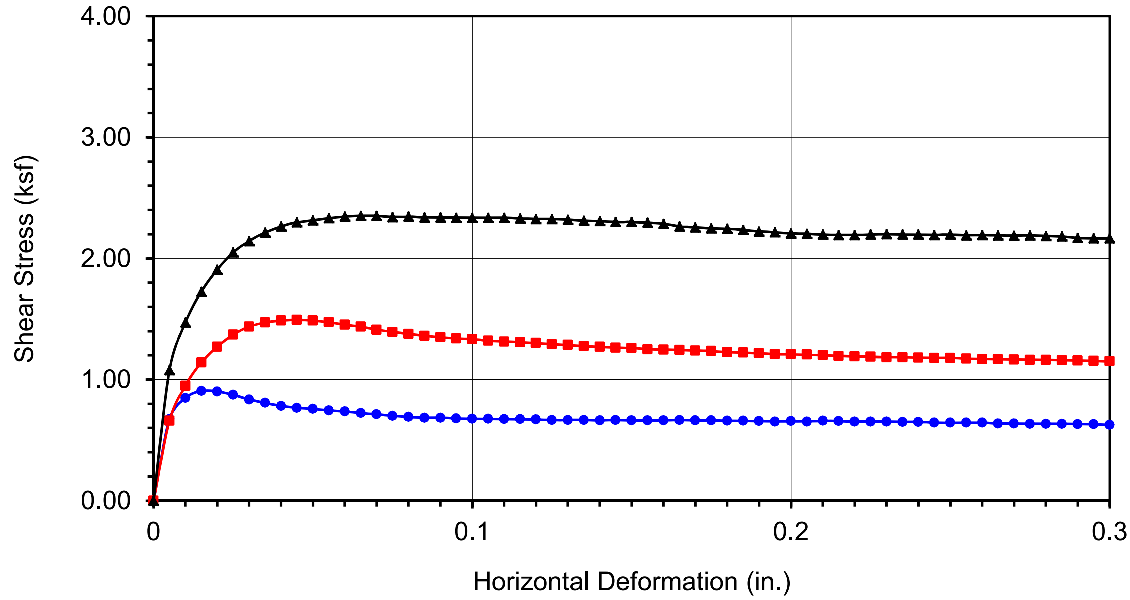
01-19

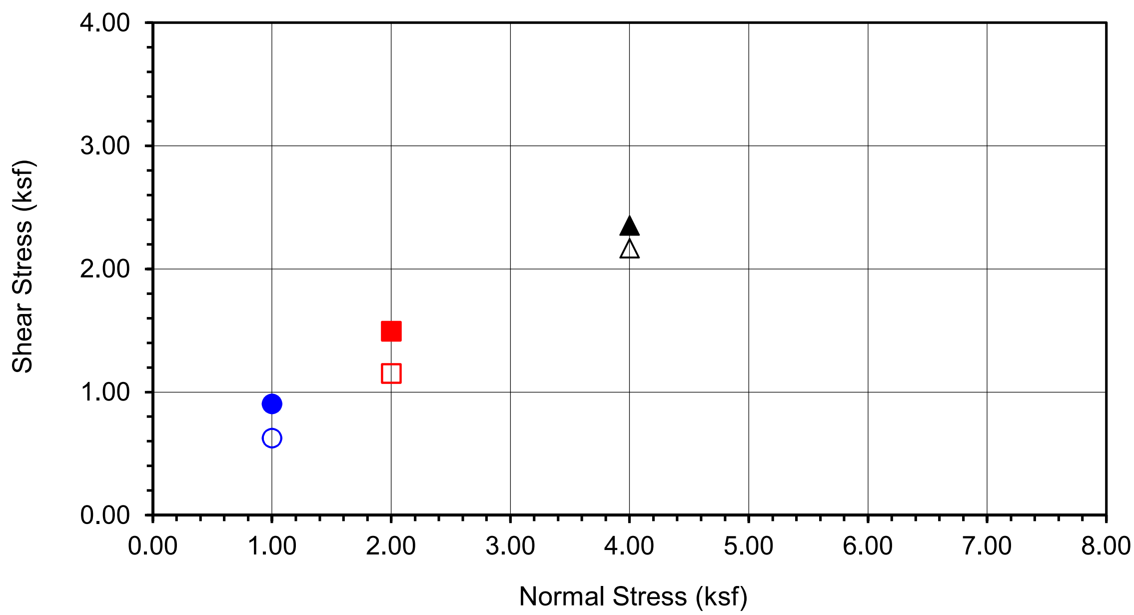
DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	01/31/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/14/19
Boring No.:	LB-16	Sample Type:	Ring		
Sample No.:	R-1	Depth (ft.):	6-6.5		
Soil Identification:	Brown lean clay (CL)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	191.44	191.24	196.65
Weight of Ring(gm):	45.38	41.66	46.32
Before Shearing			
Weight of Wet Sample+Cont.(gm):	243.99	243.99	243.99
Weight of Dry Sample+Cont.(gm):	226.74	226.74	226.74
Weight of Container(gm):	73.57	73.57	73.57
Vertical Rdg.(in): Initial	0.0000	0.2904	0.2831
Vertical Rdg.(in): Final	0.0153	0.2913	0.2922
After Shearing			
Weight of Wet Sample+Cont.(gm):	230.35	216.48	197.48
Weight of Dry Sample+Cont.(gm):	203.01	190.13	172.19
Weight of Container(gm):	73.57	57.64	39.21
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-16**
Sample No.	**R-1**
Depth (ft)	**6-6.5**

<u>Sample Type:</u>

Ring

<u>Soil Identification:</u>
Brown lean clay (CL)

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.905	■ 1.493	▲ 2.352
Shear Stress @ End of Test (ksf)	○ 0.626	□ 1.151	△ 2.166
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.26	11.26	11.26
Dry Density (pcf)	109.2	111.8	112.4
Saturation (%)	55.9	59.9	60.8
Soil Height Before Shearing (in.)	1.0153	0.9991	0.9909
Final Moisture Content (%)	21.1	19.9	19.0

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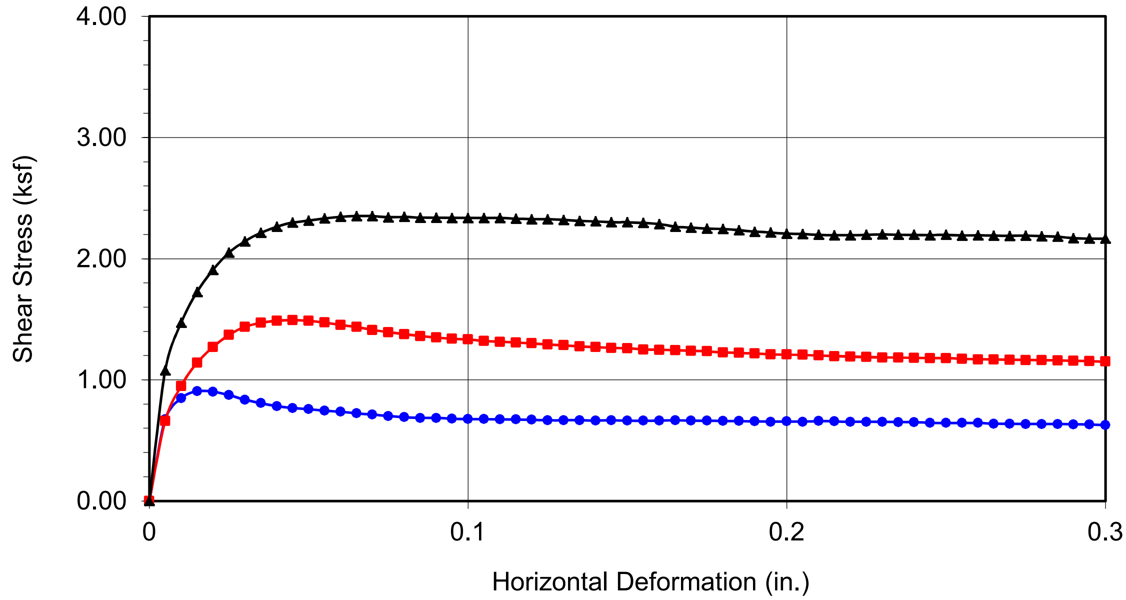
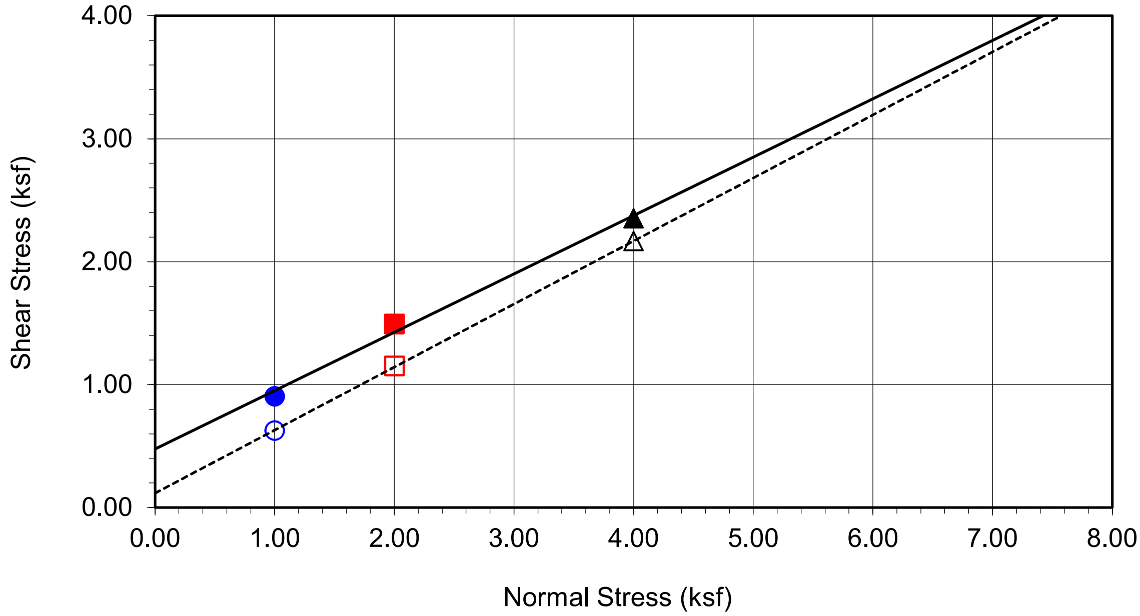
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

01-19





Boring No.	**LB-16**
Sample No.	**R-1**
Depth (ft)	**6-6.5**
Sample Type:	Ring

Soil Identification:
Brown lean clay (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	476	25
Ultimate	119	27

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.905	■ 1.493	▲ 2.352
Shear Stress @ End of Test (ksf)	○ 0.626	□ 1.151	△ 2.166
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.26	11.26	11.26
Dry Density (pcf)	109.2	111.8	112.4
Saturation (%)	55.9	59.9	60.8
Soil Height Before Shearing (in.)	1.0153	0.9991	0.9909
Final Moisture Content (%)	21.1	19.9	19.0

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

01-19

DS LB-16, R-1 @ 6-6.5

DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Leighton

Project Name: Brea Boulevard Corridor Improvements - Supplemental
Tested By: R. Manning
Date: 02/04/19

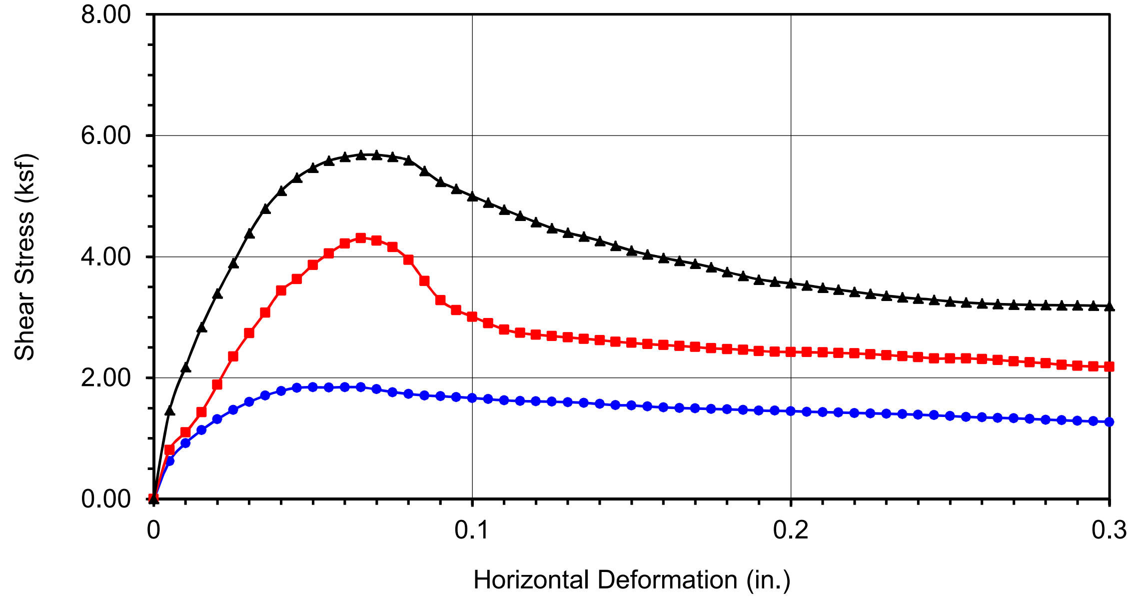
Project No.: 11588.001
Checked By: J. Ward
Date: 02/14/19

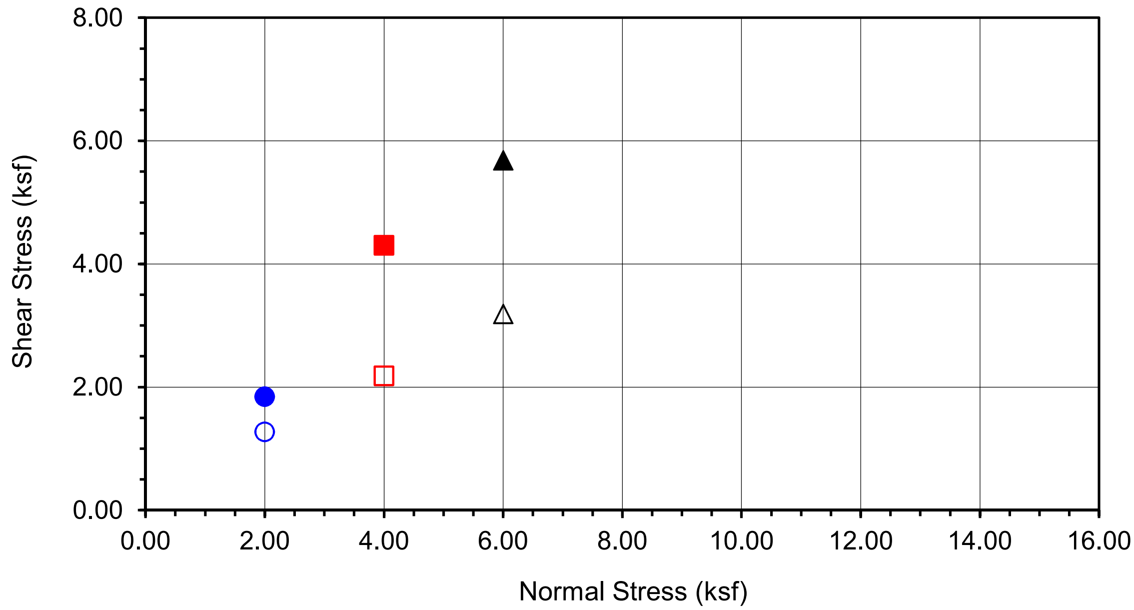
Boring No.: LB-16
Sample Type: Ring

Sample No.: R-2
Depth (ft.): 16-16.5

Soil Identification: Brownish yellow silty clay (CL-ML)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	187.98	196.79	195.83
Weight of Ring(gm):	42.68	45.78	41.96
Before Shearing			
Weight of Wet Sample+Cont.(gm):	254.97	254.97	254.97
Weight of Dry Sample+Cont.(gm):	222.66	222.66	222.66
Weight of Container(gm):	57.65	57.65	57.65
Vertical Rdg.(in): Initial	0.2676	0.2875	0.0000
Vertical Rdg.(in): Final	0.2774	0.3054	-0.0143
After Shearing			
Weight of Wet Sample+Cont.(gm):	217.65	229.67	223.86
Weight of Dry Sample+Cont.(gm):	179.70	198.59	194.28
Weight of Container(gm):	60.79	74.12	66.59
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-16**
Sample No.	**R-2**
Depth (ft)	**16-16.5**

Sample Type:

Ring

Soil Identification:

Brownish yellow silty clay (CL-ML)

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.845	■ 4.304	▲ 5.681
Shear Stress @ End of Test (ksf)	○ 1.270	□ 2.182	△ 3.188
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	19.58	19.58	19.58
Dry Density (pcf)	101.1	105.0	107.0
Saturation (%)	79.1	87.4	91.9
Soil Height Before Shearing (in.)	0.9902	0.9821	0.9857
Final Moisture Content (%)	31.9	25.0	23.2

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DIRECT SHEAR TEST RESULTS

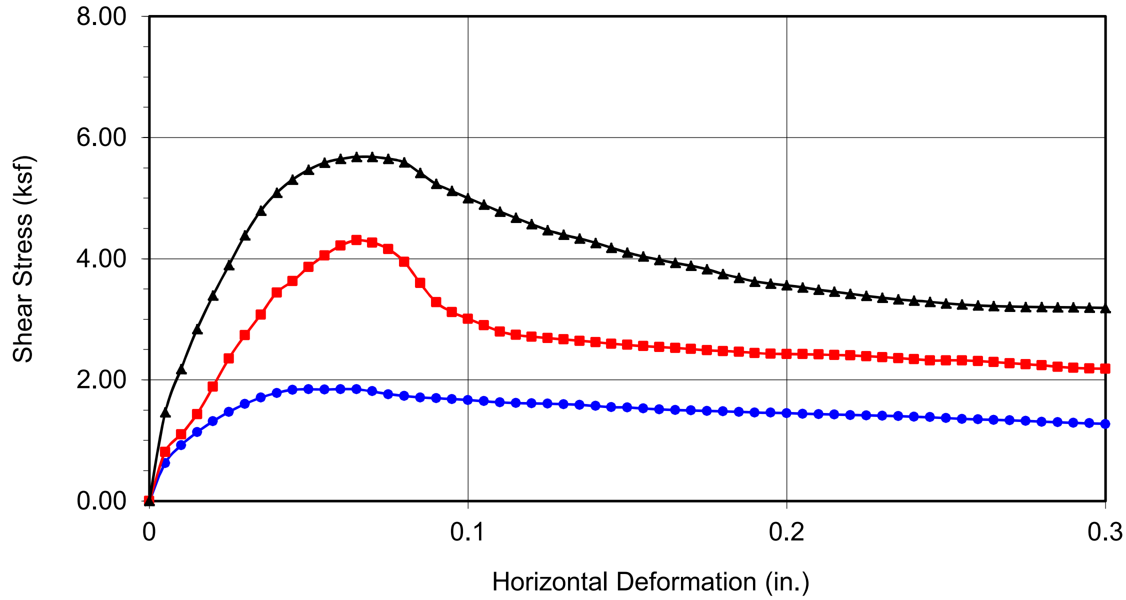
Consolidated Drained - ASTM D 3080

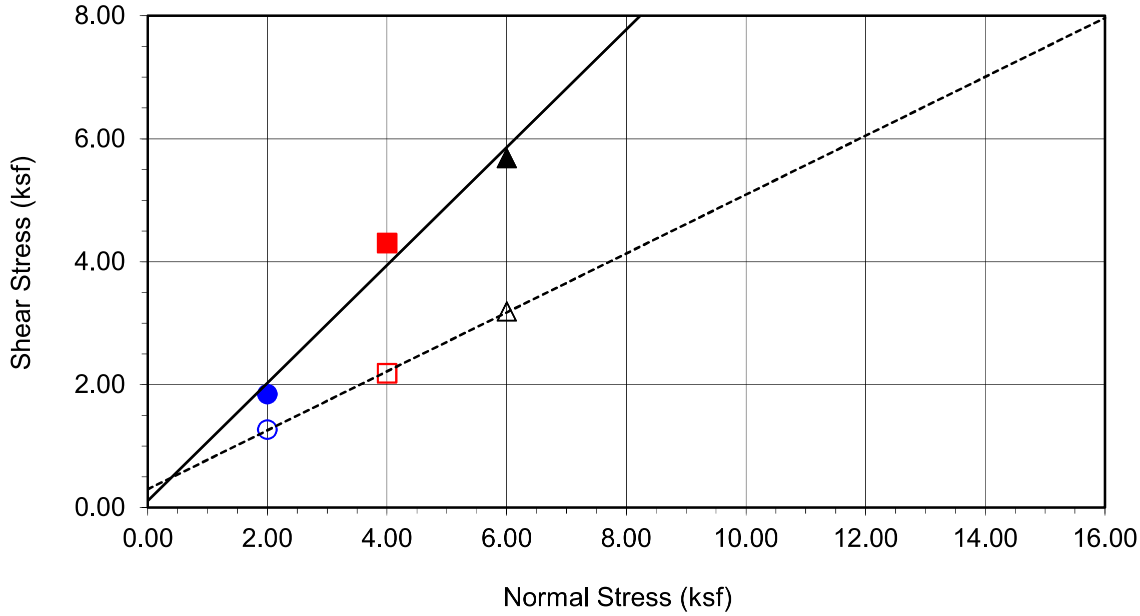
Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

DS LB-16, R-2 @ 16-16.5





Boring No.	**LB-16**
Sample No.	**R-2**
Depth (ft)	**16-16.5**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty clay (CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	107	44
Ultimate	295	26

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.845	■ 4.304	▲ 5.681
Shear Stress @ End of Test (ksf)	○ 1.270	□ 2.182	△ 3.188
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	19.58	19.58	19.58
Dry Density (pcf)	101.1	105.0	107.0
Saturation (%)	79.1	87.4	91.9
Soil Height Before Shearing (in.)	0.9902	0.9821	0.9857
Final Moisture Content (%)	31.9	25.0	23.2

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

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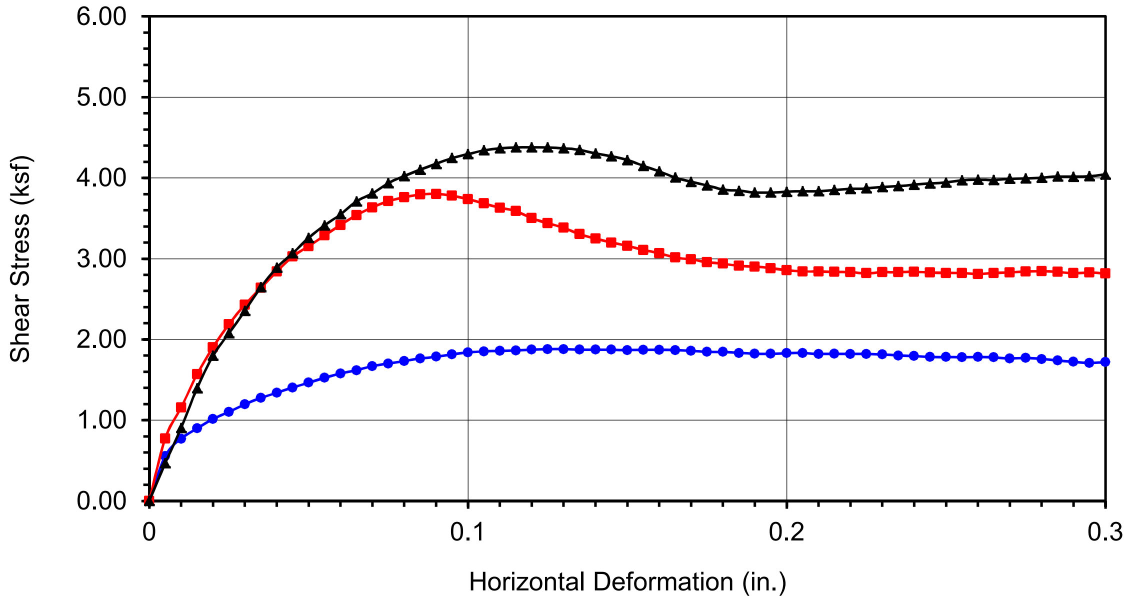
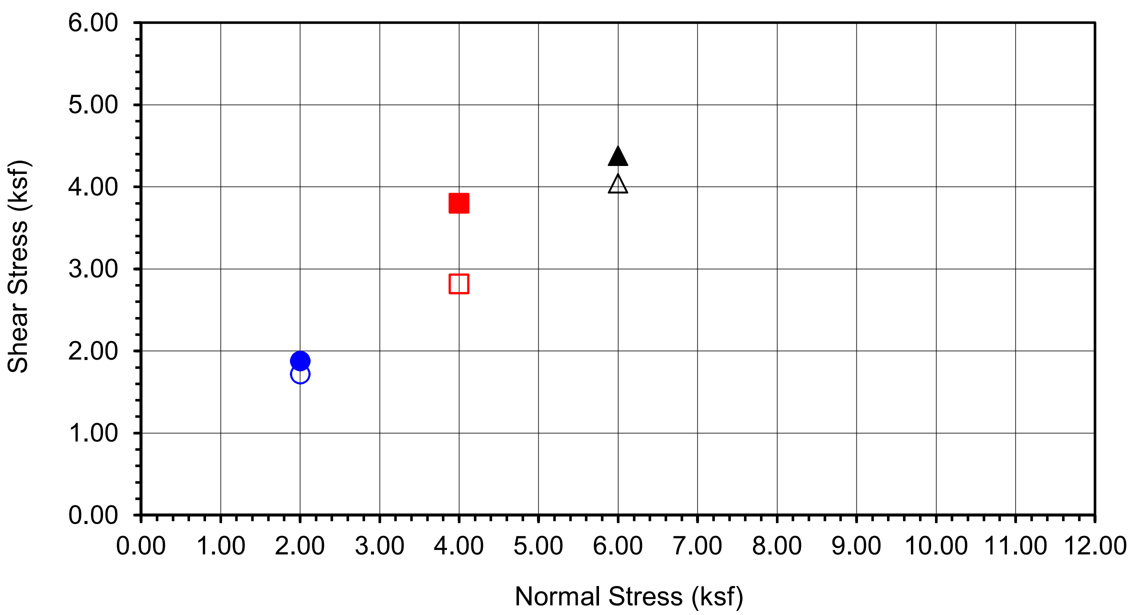
DIRECT SHEAR TEST

Consolidated Undrained

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	02/01/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/14/19
Boring No.:	LB-18	Sample Type:	Ring		
Sample No.:	R-2	Depth (ft.):	16-16.5		
Soil Identification:	Yellowish brown clayey sand (SC)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	174.74	175.94	180.70
Weight of Ring(gm):	42.18	41.27	42.91
Before Shearing			
Weight of Wet Sample+Cont.(gm):	245.40	245.40	245.40
Weight of Dry Sample+Cont.(gm):	238.81	238.81	238.81
Weight of Container(gm):	66.53	66.53	66.53
Vertical Rdg.(in): Initial	0.2505	0.2447	0.0000
Vertical Rdg.(in): Final	0.2865	0.2711	-0.0271
After Shearing			
Weight of Wet Sample+Cont.(gm):	219.11	206.98	223.37
Weight of Dry Sample+Cont.(gm):	197.17	184.49	202.48
Weight of Container(gm):	74.07	57.87	73.60
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-18**
Sample No.	**R-2**
Depth (ft)	**16-16.5**
Sample Type: Ring	
Soil Identification: Yellowish brown clayey sand (SC)	

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.880	■ 3.801	▲ 4.379
Shear Stress @ End of Test (ksf)	○ 1.720	□ 2.817	△ 4.043
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	3.83	3.83	3.83
Dry Density (pcf)	106.2	107.9	110.4
Saturation (%)	17.6	18.4	19.6
Soil Height Before Shearing (in.)	0.9640	0.9736	0.9729
Final Moisture Content (%)	17.8	17.8	16.2

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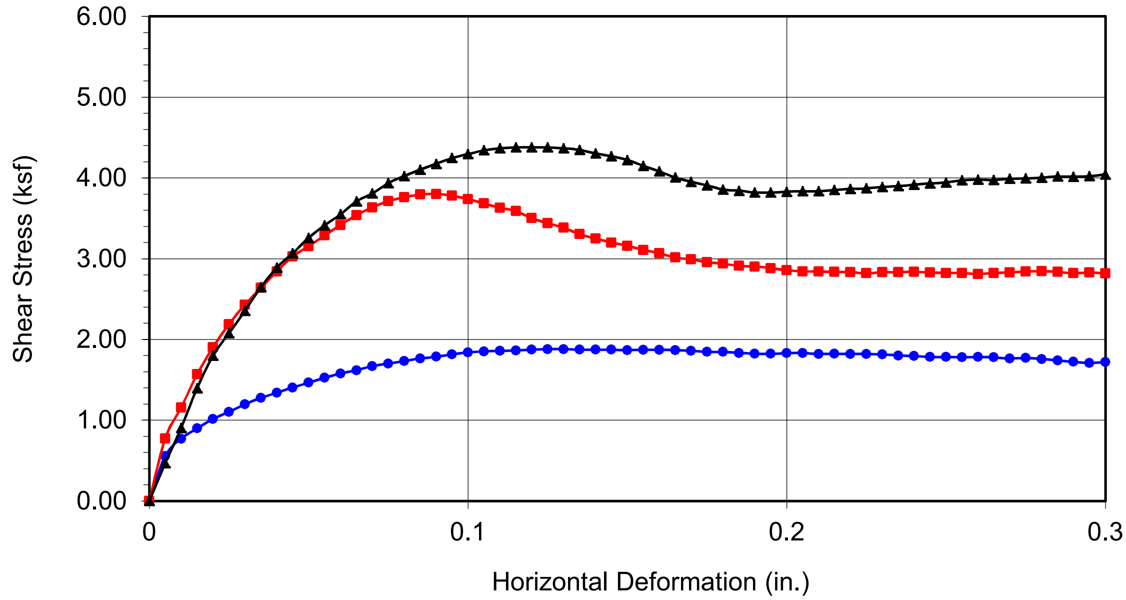
DIRECT SHEAR TEST RESULTS

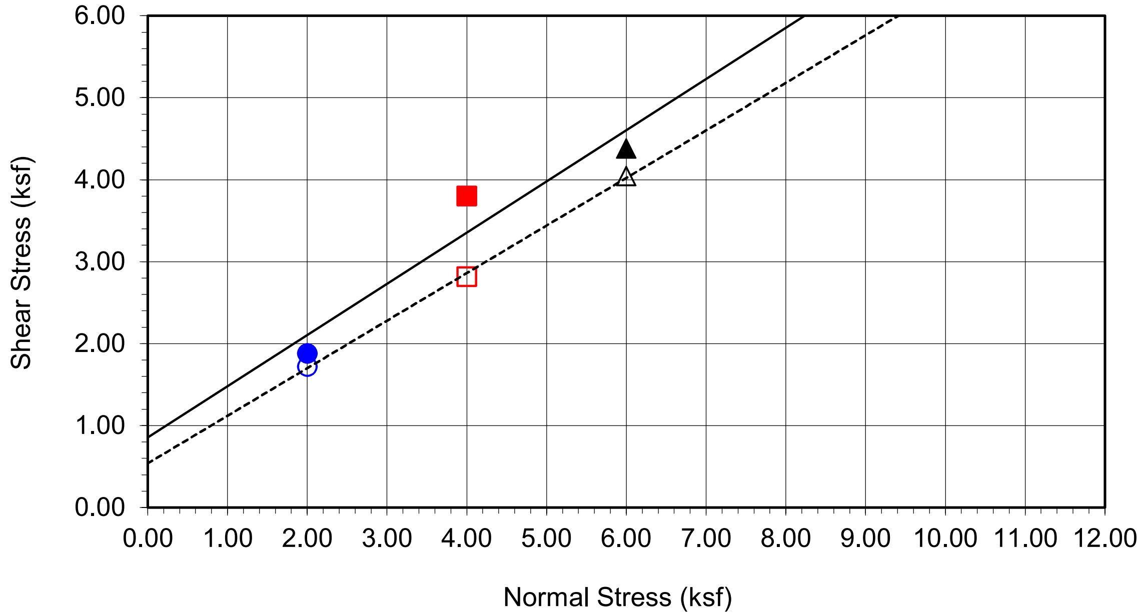
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19





Boring No.	**LB-18**
Sample No.	**R-2**
Depth (ft)	**16-16.5**
Sample Type:	Ring

Soil Identification:
Yellowish brown clayey sand (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	854	32
Ultimate	537	30

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.880	■ 3.801	▲ 4.379
Shear Stress @ End of Test (ksf)	○ 1.720	□ 2.817	△ 4.043
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	3.83	3.83	3.83
Dry Density (pcf)	106.2	107.9	110.4
Saturation (%)	17.6	18.4	19.6
Soil Height Before Shearing (in.)	0.9640	0.9736	0.9729
Final Moisture Content (%)	17.8	17.8	16.2

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

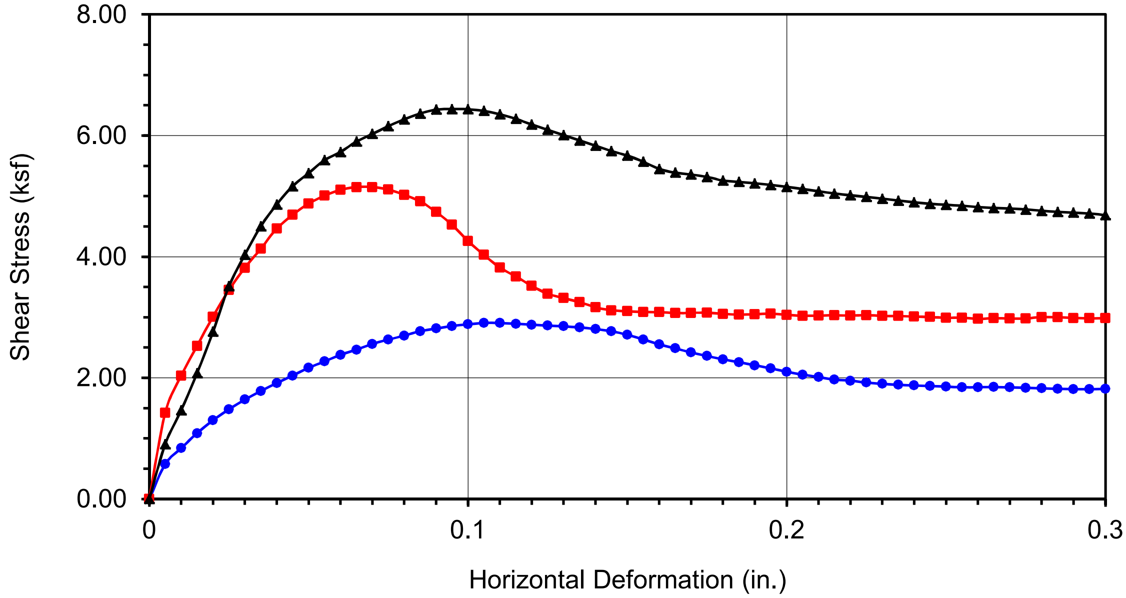
02-19

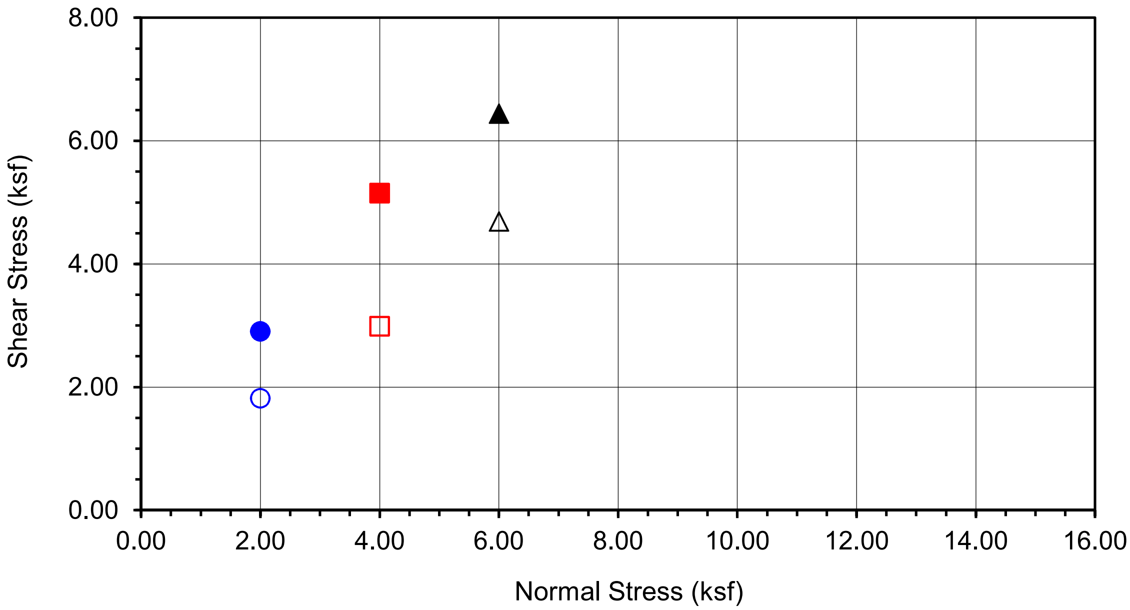
DIRECT SHEAR TEST
Consolidated Undrained

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	R. Manning	Date:	02/01/19
Project No.:	11588.001	Checked By:	J. Ward	Date:	02/14/19
Boring No.:	LB-18	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.):	26-26.5		
Soil Identification:	Brownish gray clayey sand (SC)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	190.99	200.46	201.49
Weight of Ring(gm):	41.79	44.12	44.06
Before Shearing			
Weight of Wet Sample+Cont.(gm):	254.87	254.87	254.87
Weight of Dry Sample+Cont.(gm):	236.69	236.69	236.69
Weight of Container(gm):	60.75	60.75	60.75
Vertical Rdg.(in): Initial	0.2546	0.2744	0.0000
Vertical Rdg.(in): Final	0.2741	0.2964	-0.0137
After Shearing			
Weight of Wet Sample+Cont.(gm):	222.04	229.01	222.62
Weight of Dry Sample+Cont.(gm):	199.48	208.86	200.96
Weight of Container(gm):	66.53	66.90	60.72
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-18**
Sample No.	**R-3**
Depth (ft)	**26-26.5**

<u>Sample Type:</u>

Ring

<u>Soil Identification:</u>
Brownish gray clayey sand (SC)

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.905	■ 5.149	▲ 6.438
Shear Stress @ End of Test (ksf)	○ 1.820	□ 2.987	△ 4.687
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.33	10.33	10.33
Dry Density (pcf)	112.5	117.8	118.7
Saturation (%)	55.9	64.8	66.4
Soil Height Before Shearing (in.)	0.9805	0.9780	0.9863
Final Moisture Content (%)	17.0	14.2	15.4

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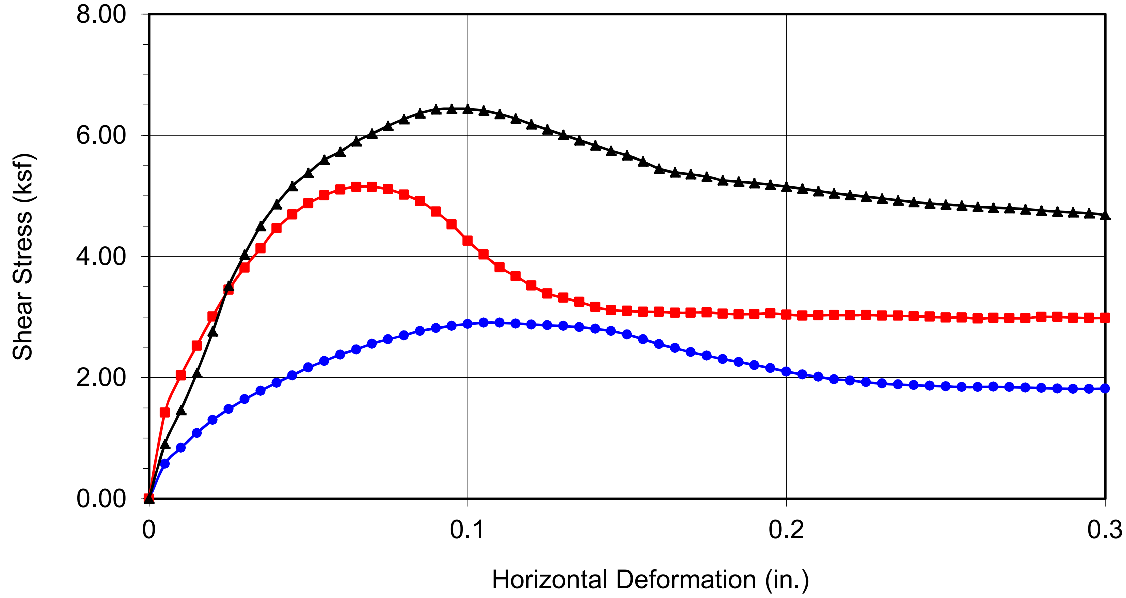

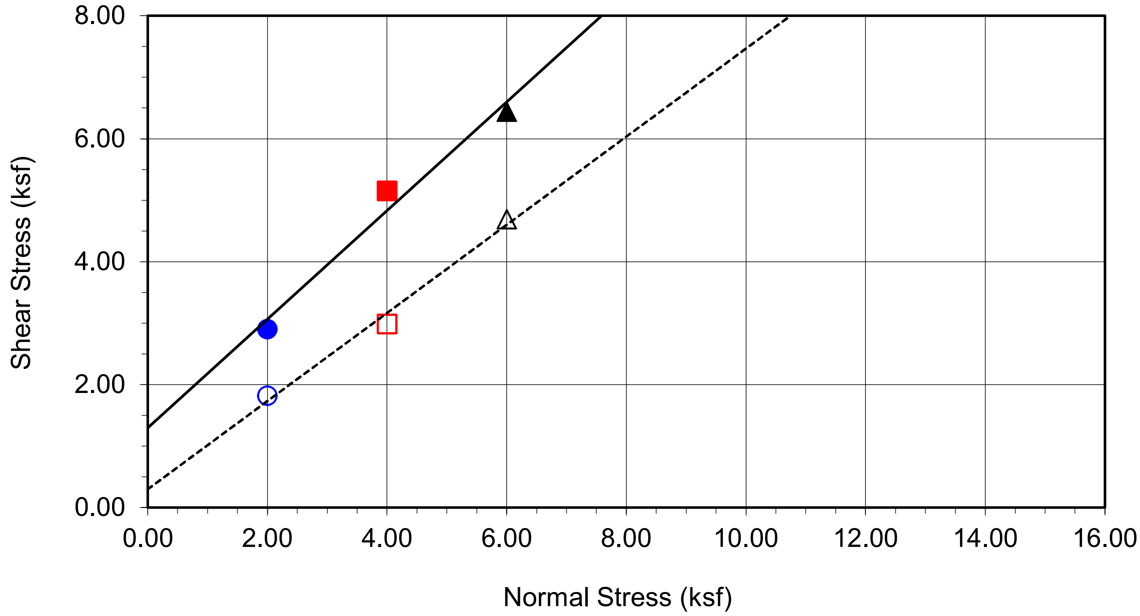

Boring No.	**LB-18**
Sample No.	**R-3**
Depth (ft)	**26-26.5**
Sample Type:	Ring
Soil Identification: Brownish gray clayey sand (SC)	

Strength Parameters

	C (psf)	ϕ (°)
Peak	1298	41
Ultimate	298	36

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.905	■ 5.149	▲ 6.438
Shear Stress @ End of Test (ksf)	○ 1.820	□ 2.987	△ 4.687
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.33	10.33	10.33
Dry Density (pcf)	112.5	117.8	118.7
Saturation (%)	55.9	64.8	66.4
Soil Height Before Shearing (in.)	0.9805	0.9780	0.9863
Final Moisture Content (%)	17.0	14.2	15.4

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

DIRECT SHEAR TEST

Consolidated Undrained

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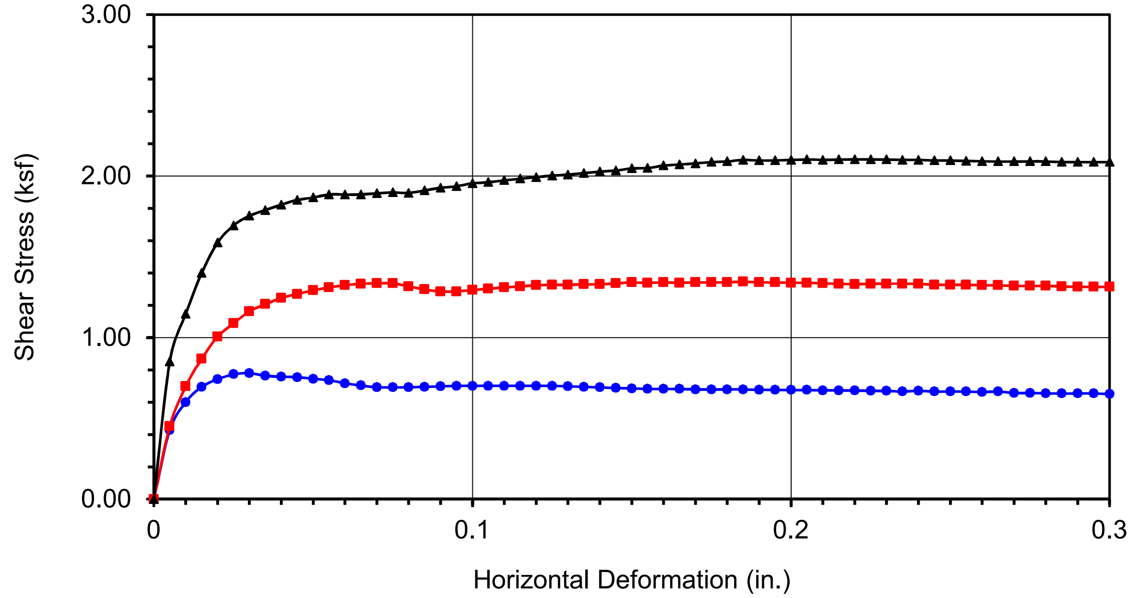
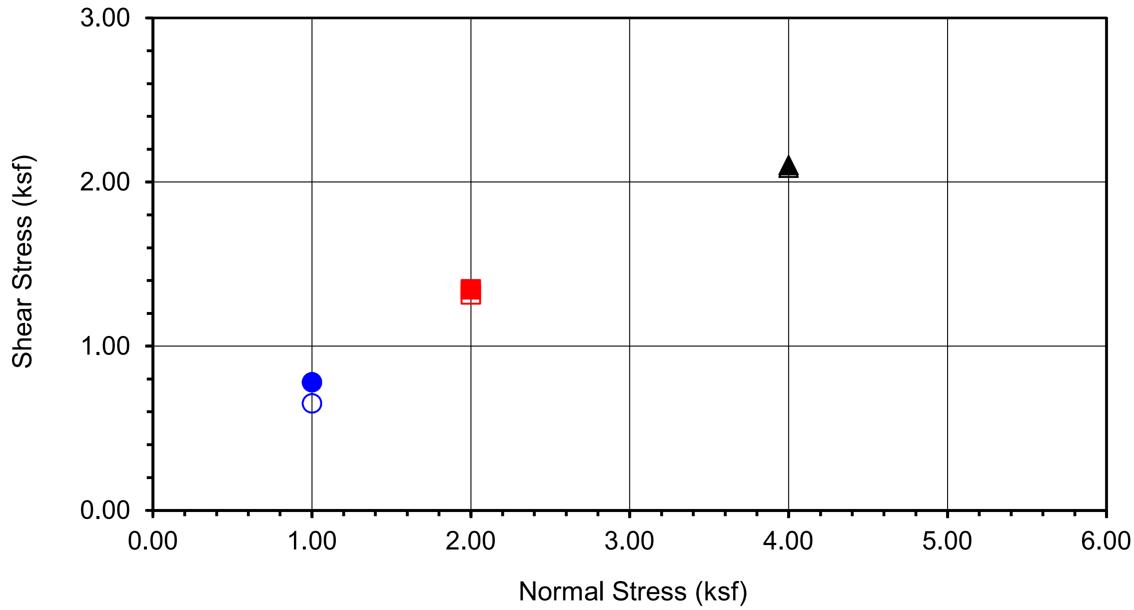
Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-20	Sample Type:	Ring		
Sample No.:	R-4	Depth (ft.):	15.0		

Soil Identification: Light olive brown silt with sand (ML)s

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	168.01	168.80	176.65
Weight of Ring(gm):	43.95	44.49	45.24
Before Shearing			
Weight of Wet Sample+Cont.(gm):	145.65	145.65	145.65
Weight of Dry Sample+Cont.(gm):	140.10	140.10	140.10
Weight of Container(gm):	57.95	57.95	57.95
Vertical Rdg.(in): Initial	0.2343	0.2475	0.0000
Vertical Rdg.(in): Final	0.2368	0.2551	-0.0122
After Shearing			
Weight of Wet Sample+Cont.(gm):	195.00	196.77	185.23
Weight of Dry Sample+Cont.(gm):	166.70	170.36	157.55
Weight of Container(gm):	57.17	56.82	38.57
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-20**
Sample No.	**R-4**
Depth (ft)	**15**

Sample Type:

Ring

Soil Identification:
Light olive brown silt with sand (ML)s

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.780	■ 1.346	▲ 2.103
Shear Stress @ End of Test (ksf)	○ 0.651	□ 1.314	△ 2.087
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	6.76	6.76	6.76
Dry Density (pcf)	96.6	96.8	102.4
Saturation (%)	24.5	24.6	28.2
Soil Height Before Shearing (in.)	0.9975	0.9924	0.9878
Final Moisture Content (%)	25.8	23.3	23.3

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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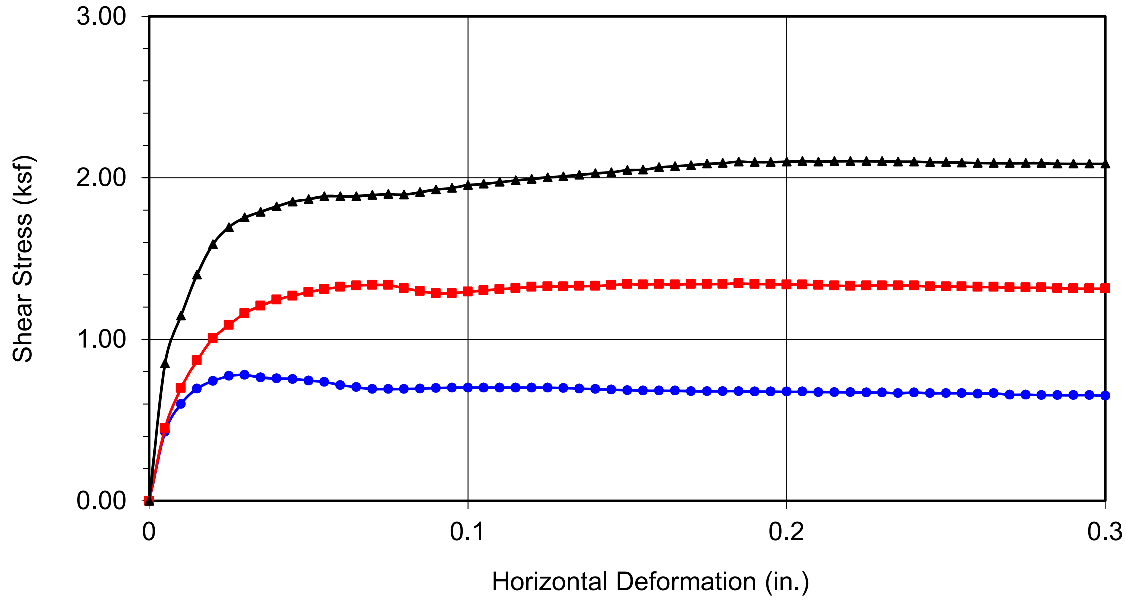

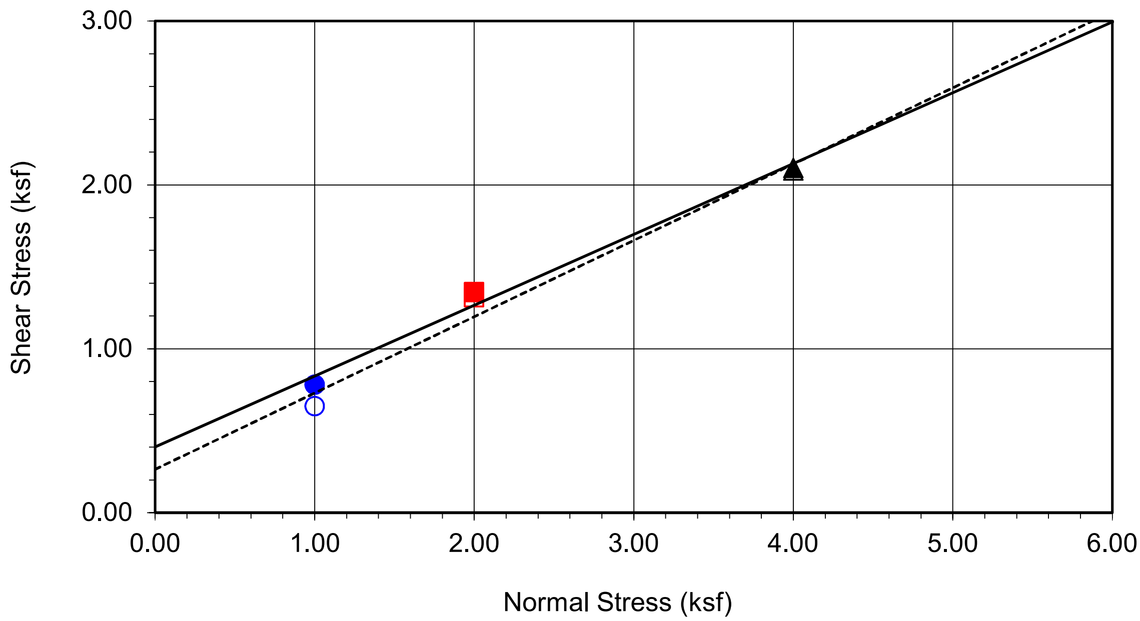

Boring No.	**LB-20**
Sample No.	**R-4**
Depth (ft)	**15**
Sample Type:	Ring

Soil Identification:
Light olive brown silt with sand (ML)s

Strength Parameters

	C (psf)	ϕ (°)
Peak	402	23
Ultimate	265	25

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.780	■ 1.346	▲ 2.103
Shear Stress @ End of Test (ksf)	○ 0.651	□ 1.314	△ 2.087
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	6.76	6.76	6.76
Dry Density (pcf)	96.6	96.8	102.4
Saturation (%)	24.5	24.6	28.2
Soil Height Before Shearing (in.)	0.9975	0.9924	0.9878
Final Moisture Content (%)	25.8	23.3	23.3

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

11-20

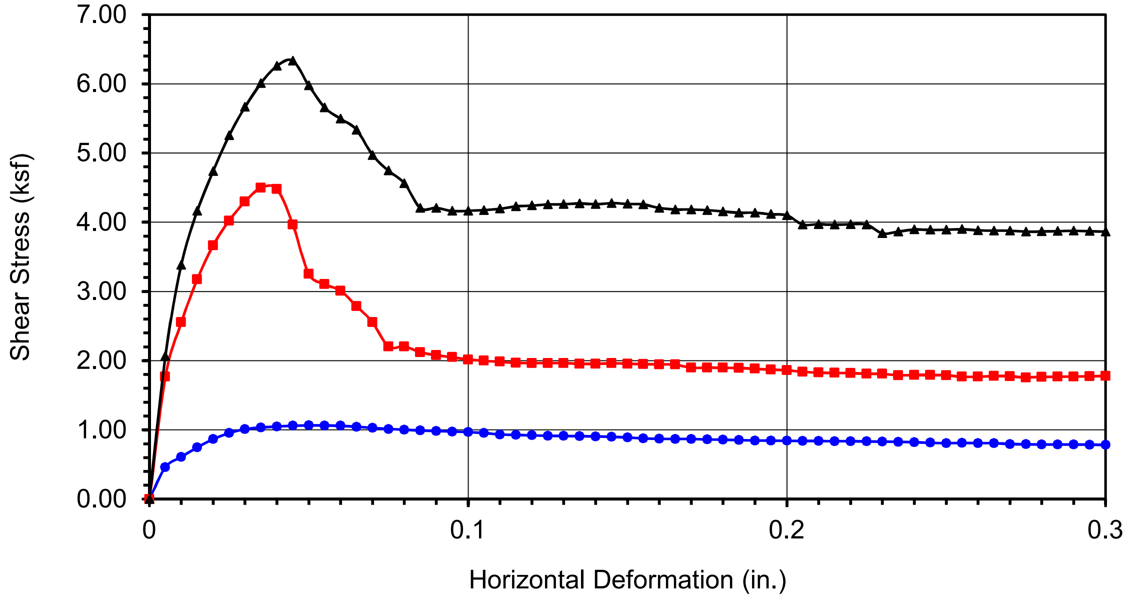
DIRECT SHEAR TEST

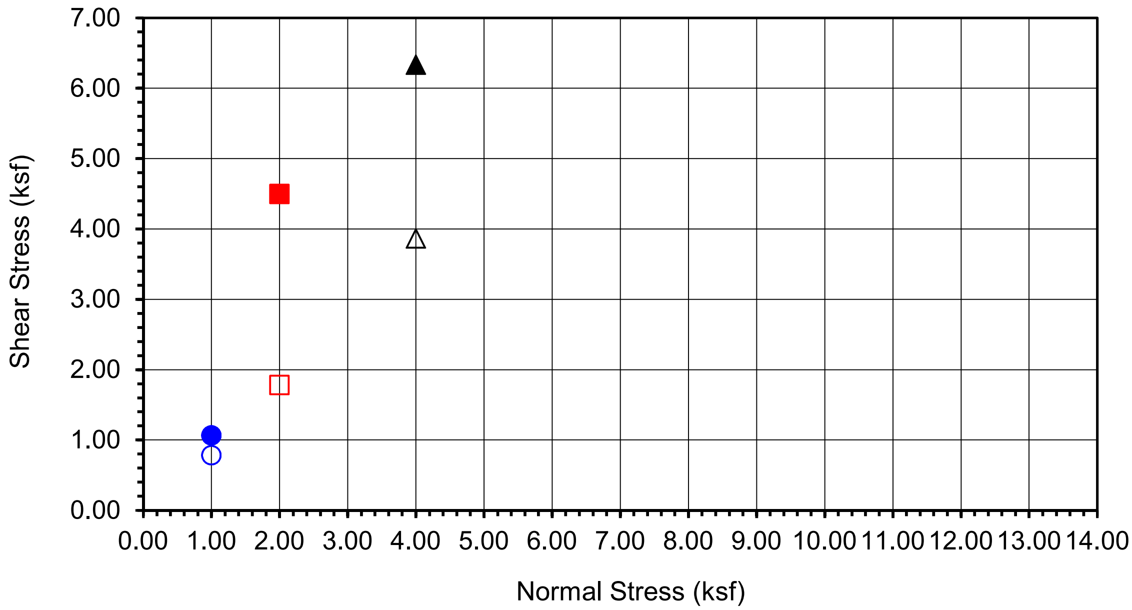
Consolidated Drained - ASTM D 3080

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/25/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-24	Sample Type:	Tube		
Sample No.:	R-4	Depth (ft.):	15.0		
Soil Identification:	Olive gray silt stone (ML)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	188.35	201.48	202.22
Weight of Ring(gm):	43.24	44.97	41.87
Before Shearing			
Weight of Wet Sample+Cont.(gm):	166.21	166.21	166.21
Weight of Dry Sample+Cont.(gm):	154.42	154.42	154.42
Weight of Container(gm):	52.02	52.02	52.02
Vertical Rdg.(in): Initial	0.0000	0.2512	0.2324
Vertical Rdg.(in): Final	-0.0035	0.2561	0.2424
After Shearing			
Weight of Wet Sample+Cont.(gm):	213.51	230.47	221.36
Weight of Dry Sample+Cont.(gm):	189.32	207.64	199.17
Weight of Container(gm):	61.21	69.39	57.95
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-24**
Sample No.	**R-4**
Depth (ft)	**15**

<u>Sample Type:</u>

Tube

<u>Soil Identification:</u>

Olive gray silt stone (ML)

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.066	■ 4.496	▲ 6.332
Shear Stress @ End of Test (ksf)	○ 0.783	□ 1.779	△ 3.864
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.51	11.51	11.51
Dry Density (pcf)	108.2	116.7	119.6
Saturation (%)	55.8	70.0	75.9
Soil Height Before Shearing (in.)	0.9965	0.9951	0.9900
Final Moisture Content (%)	18.9	16.5	15.7

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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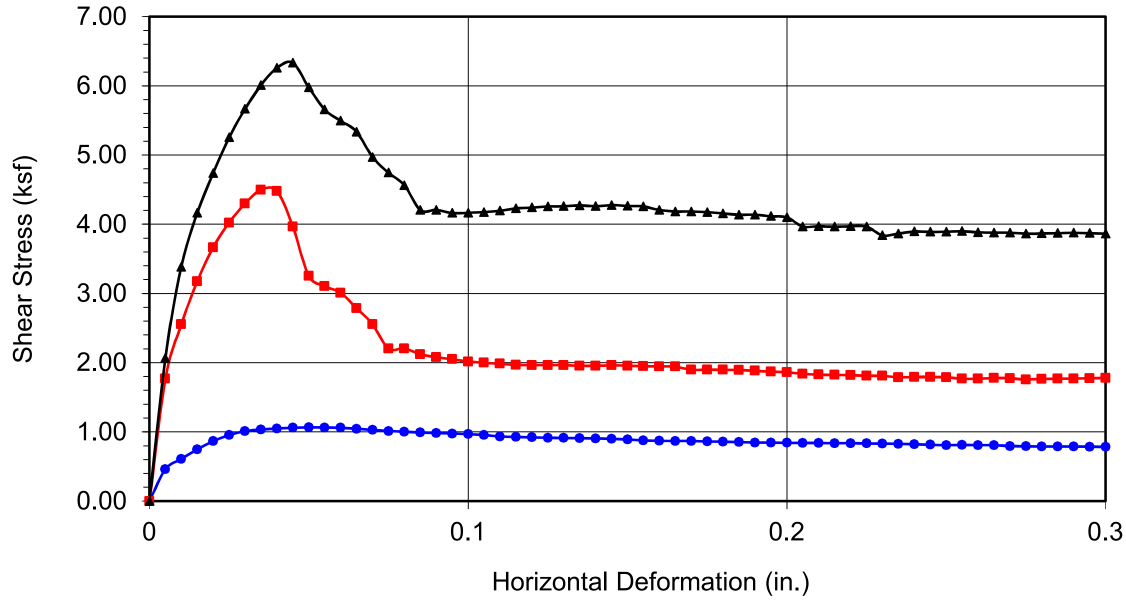

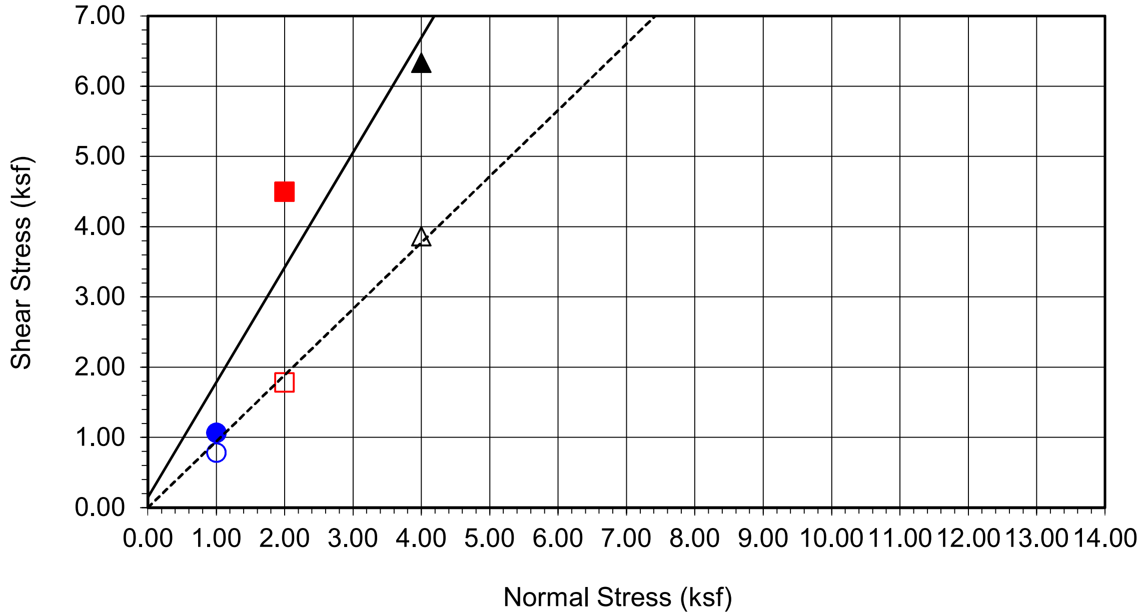

Boring No.	**LB-24**
Sample No.	**R-4**
Depth (ft)	**15**
Sample Type:	Tube

Soil Identification:
Olive gray silt stone (ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	148	59
Ultimate	0	43

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.066	■ 4.496	▲ 6.332
Shear Stress @ End of Test (ksf)	○ 0.783	□ 1.779	△ 3.864
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.51	11.51	11.51
Dry Density (pcf)	108.2	116.7	119.6
Saturation (%)	55.8	70.0	75.9
Soil Height Before Shearing (in.)	0.9965	0.9951	0.9900
Final Moisture Content (%)	18.9	16.5	15.7

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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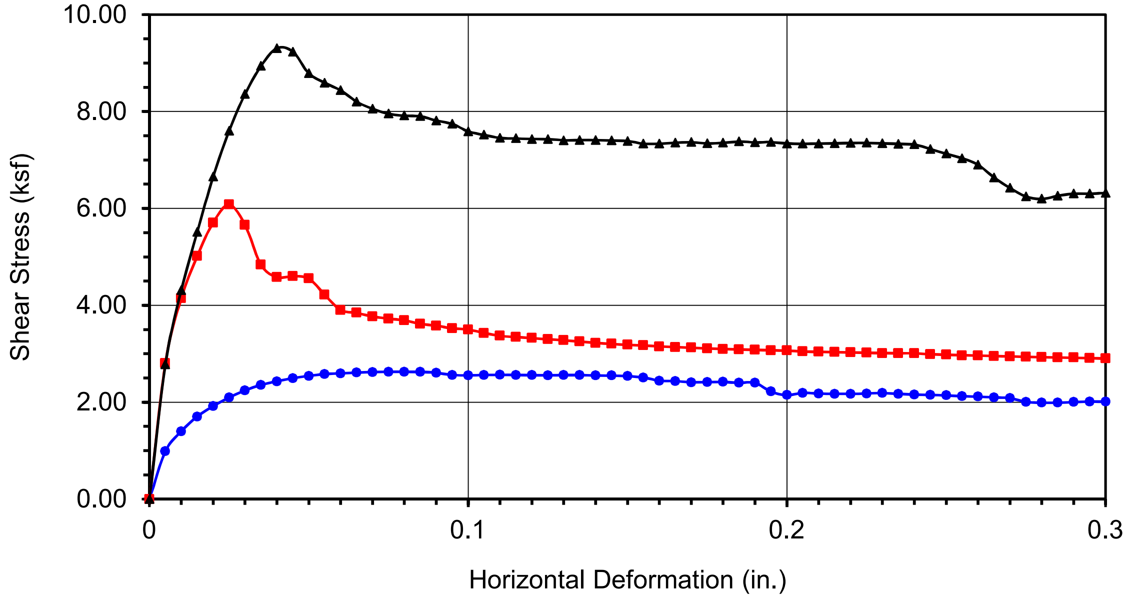
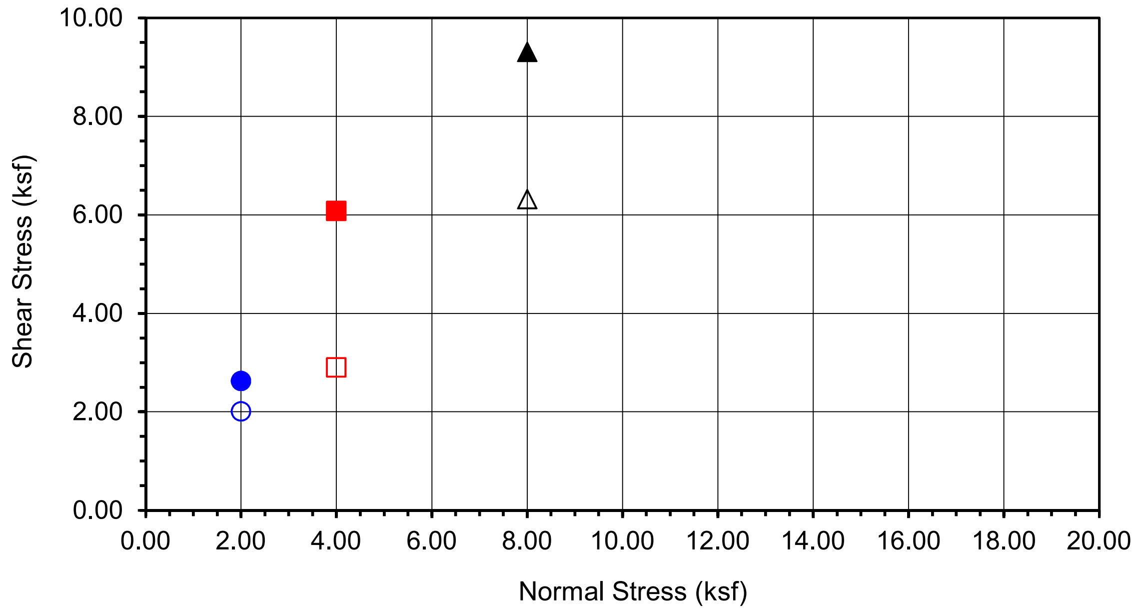
DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/25/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-24	Sample Type:	Tube		
Sample No.:	R-7	Depth (ft.):	30.0		
Soil Identification:	Olive gray silty clay stone (CL-ML)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	198.92	207.25	206.59
Weight of Ring(gm):	45.02	45.66	44.34
Before Shearing			
Weight of Wet Sample+Cont.(gm):	206.34	206.34	206.34
Weight of Dry Sample+Cont.(gm):	188.74	188.74	188.74
Weight of Container(gm):	52.65	52.65	52.65
Vertical Rdg.(in): Initial	0.0000	0.2547	0.0000
Vertical Rdg.(in): Final	-0.0105	0.2641	-0.0158
After Shearing			
Weight of Wet Sample+Cont.(gm):	234.80	243.26	220.08
Weight of Dry Sample+Cont.(gm):	209.72	222.85	199.57
Weight of Container(gm):	75.83	78.63	56.08
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-24**
Sample No.	**R-7**
Depth (ft)	**30**

<u>Sample Type:</u>

Tube

<u>Soil Identification:</u>
Olive gray silty clay stone (CL-ML)

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.628	■ 6.077	▲ 9.306
Shear Stress @ End of Test (ksf)	○ 2.012	□ 2.902	△ 6.319
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.93	12.93	12.93
Dry Density (pcf)	113.3	119.0	119.5
Saturation (%)	71.7	83.8	85.0
Soil Height Before Shearing (in.)	0.9895	0.9906	0.9842
Final Moisture Content (%)	18.7	14.2	14.3

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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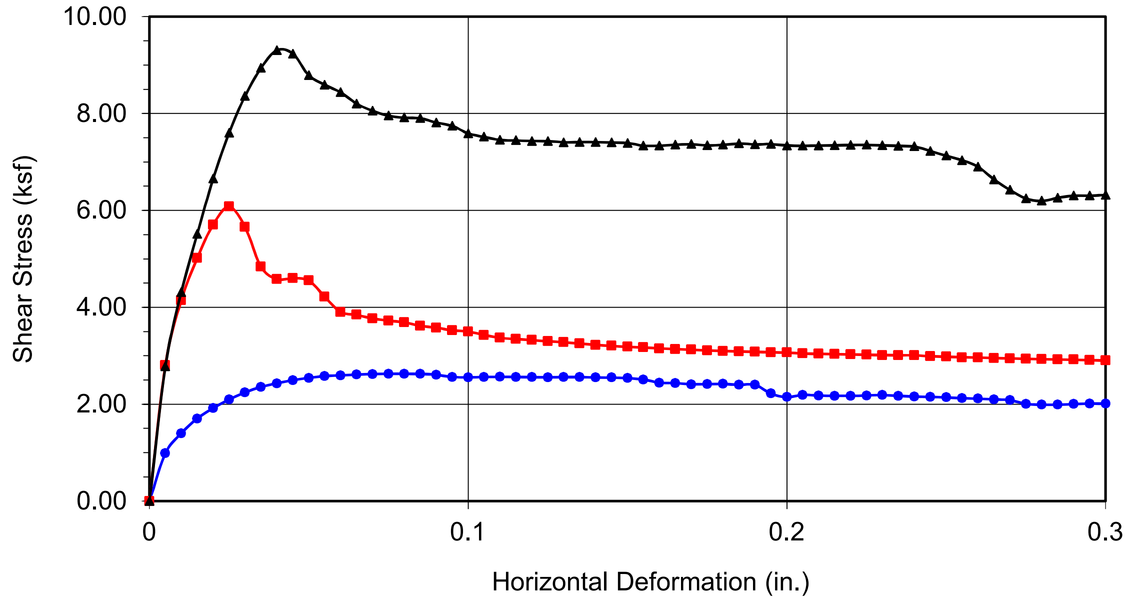

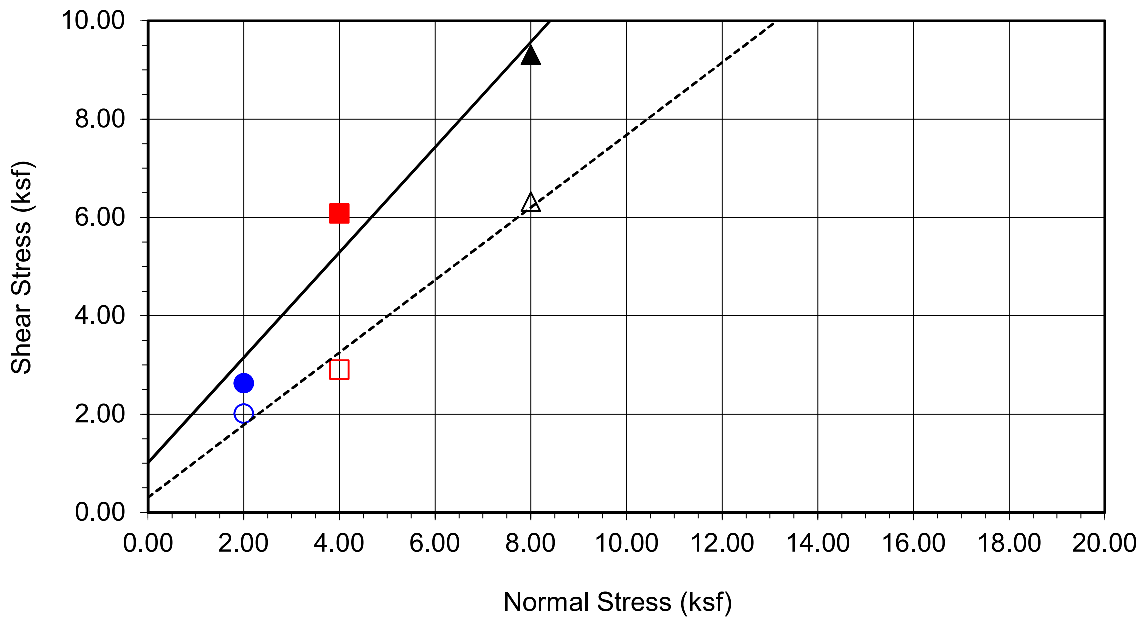

Boring No.	**LB-24**
Sample No.	**R-7**
Depth (ft)	**30**
Sample Type:	Tube

Soil Identification:
Olive gray silty clay stone (CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1014	47
Ultimate	304	36

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.628	■ 6.077	▲ 9.306
Shear Stress @ End of Test (ksf)	○ 2.012	□ 2.902	△ 6.319
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.93	12.93	12.93
Dry Density (pcf)	113.3	119.0	119.5
Saturation (%)	71.7	83.8	85.0
Soil Height Before Shearing (in.)	0.9895	0.9906	0.9842
Final Moisture Content (%)	18.7	14.2	14.3

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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DIRECT SHEAR TEST

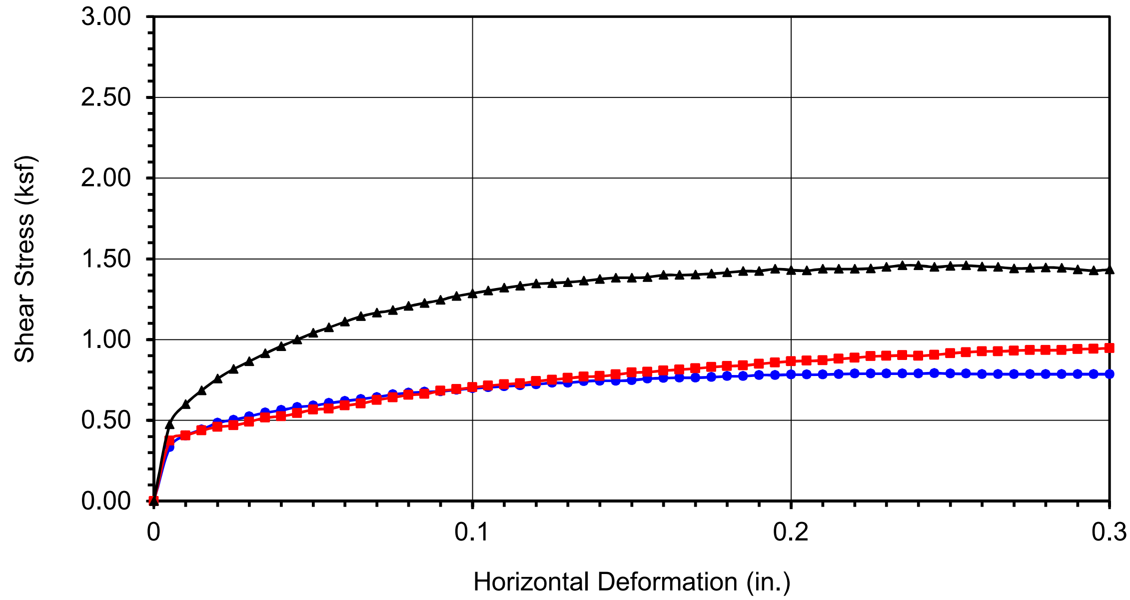
Consolidated Drained - ASTM D 3080

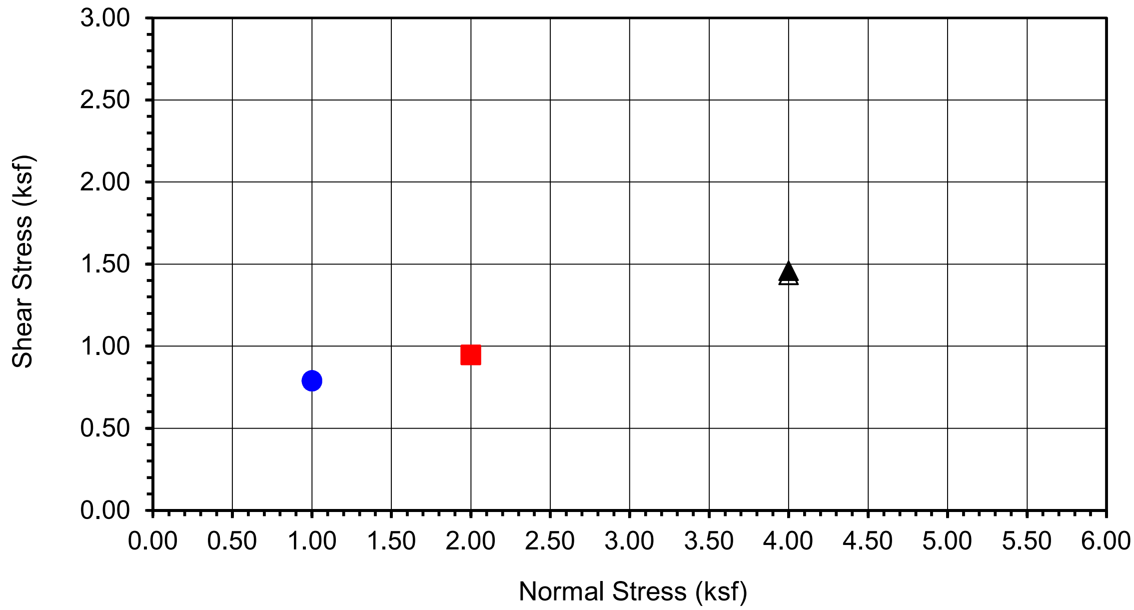
Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-25	Sample Type:	Tube		
Sample No.:	T-5A	Depth (ft.):	15.0		

Soil Identification: Very dark gray fat clay (CH), noted hydrocarbon smell

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	169.64	177.96	176.90
Weight of Ring(gm):	37.56	42.60	39.22
Before Shearing			
Weight of Wet Sample+Cont.(gm):	176.00	176.00	176.00
Weight of Dry Sample+Cont.(gm):	164.08	164.08	164.08
Weight of Container(gm):	65.91	65.91	65.91
Vertical Rdg.(in): Initial	0.2715	0.2587	0.0000
Vertical Rdg.(in): Final	0.3038	0.3029	-0.0688
After Shearing			
Weight of Wet Sample+Cont.(gm):	187.56	197.72	194.00
Weight of Dry Sample+Cont.(gm):	173.27	183.62	179.95
Weight of Container(gm):	55.56	64.17	58.20
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-25**
Sample No.	**T-5A**
Depth (ft)	**15**

Sample Type:

Tube

Soil Identification:
Very dark gray fat clay (CH), noted hydrocarbon smell

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.792	■ 0.946	▲ 1.459
Shear Stress @ End of Test (ksf)	○ 0.786	□ 0.946	△ 1.434
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.14	12.14	12.14
Dry Density (pcf)	98.0	100.4	102.1
Saturation (%)	45.5	48.3	50.4
Soil Height Before Shearing (in.)	0.9677	0.9558	0.9312
Final Moisture Content (%)	12.1	11.8	11.5

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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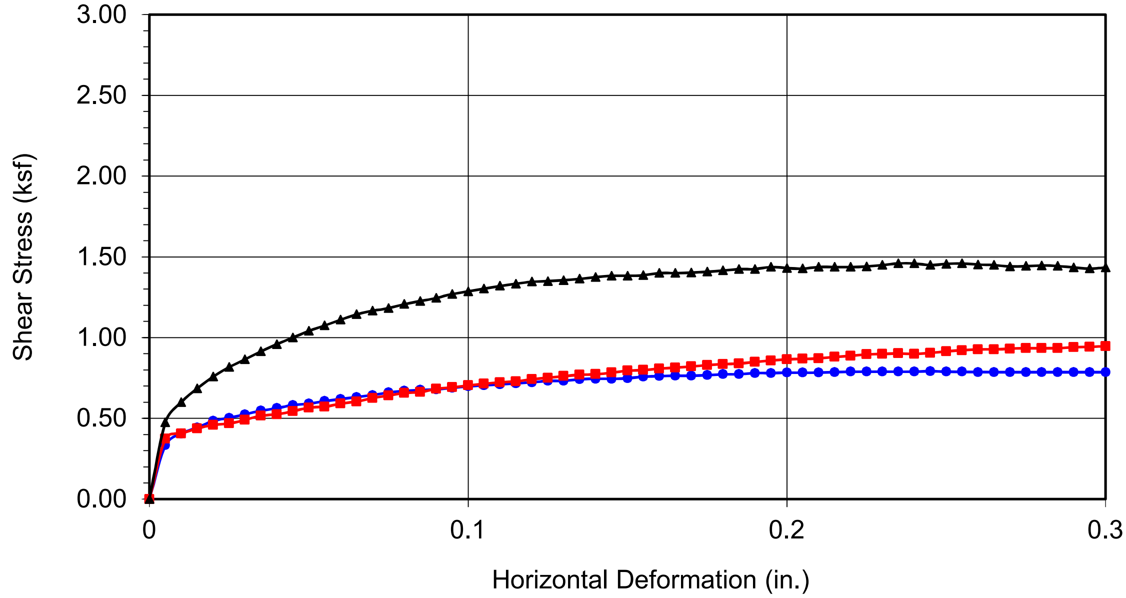

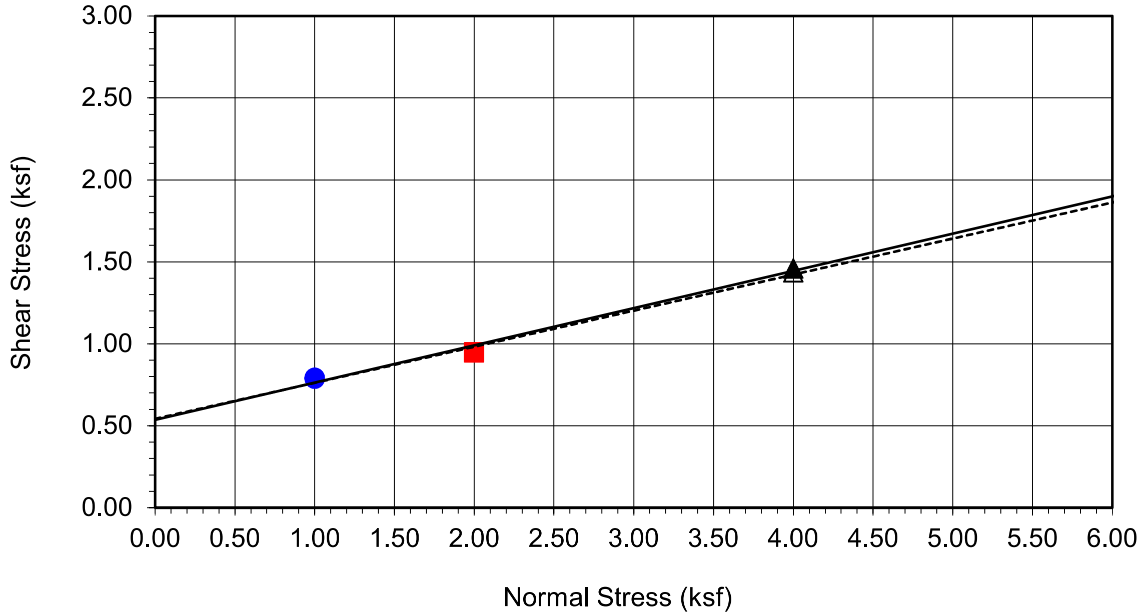

Boring No.	**LB-25**
Sample No.	**T-5A**
Depth (ft)	**15**
Sample Type:	Tube
Soil Identification: Very dark gray fat clay (CH), noted hydrocarbon smell	

Strength Parameters

	C (psf)	ϕ (°)
Peak	536	13
Ultimate	542	12

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.792	■ 0.946	▲ 1.459
Shear Stress @ End of Test (ksf)	○ 0.786	□ 0.946	△ 1.434
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.14	12.14	12.14
Dry Density (pcf)	98.0	100.4	102.1
Saturation (%)	45.5	48.3	50.4
Soil Height Before Shearing (in.)	0.9677	0.9558	0.9312
Final Moisture Content (%)	12.1	11.8	11.5

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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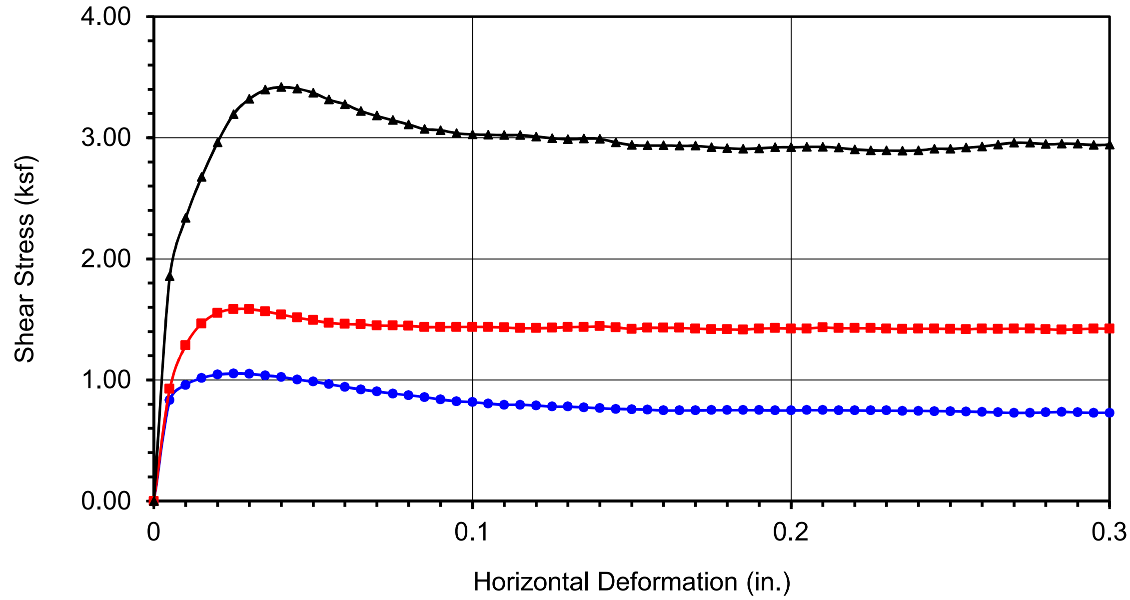
DIRECT SHEAR TEST

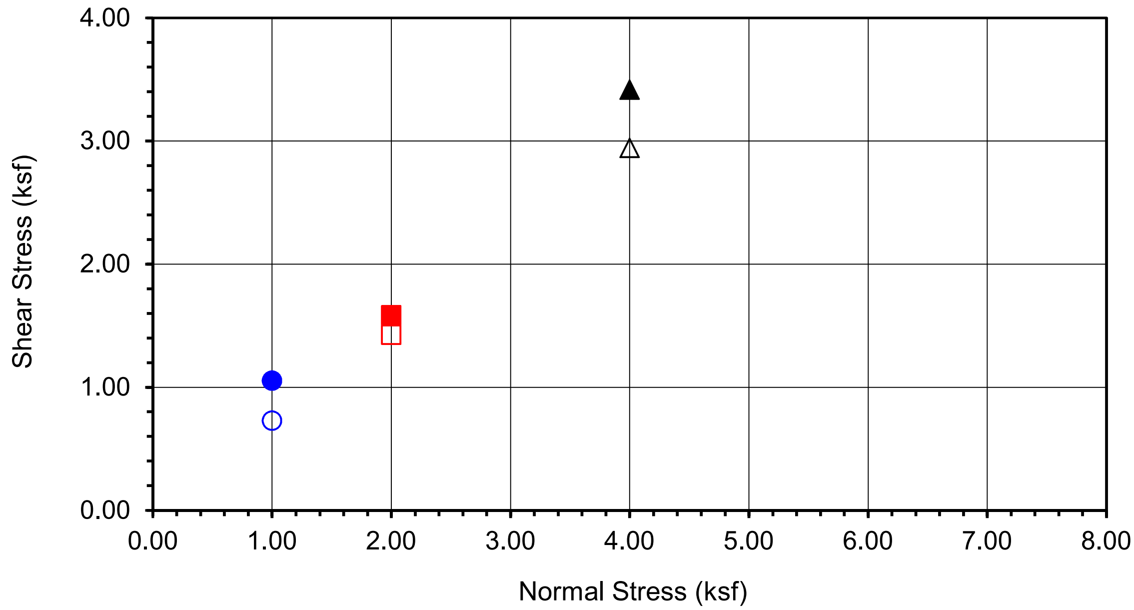
Consolidated Undrained

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-29	Sample Type:	90% Remold		
Sample No.:	B-1	Depth (ft.):	2-5		

Soil Identification: Olive brown silty sand (SM)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	193.68	194.38	196.06
Weight of Ring(gm):	45.33	45.70	45.74
Before Shearing			
Weight of Wet Sample+Cont.(gm):	180.36	180.36	180.36
Weight of Dry Sample+Cont.(gm):	170.04	170.04	170.04
Weight of Container(gm):	61.22	61.22	61.22
Vertical Rdg.(in): Initial	0.0000	0.2719	0.2655
Vertical Rdg.(in): Final	-0.0085	0.2832	0.2807
After Shearing			
Weight of Wet Sample+Cont.(gm):	209.10	206.35	212.96
Weight of Dry Sample+Cont.(gm):	188.59	186.01	194.15
Weight of Container(gm):	55.54	52.02	58.19
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-29**
Sample No.	**B-1**
Depth (ft)	**2-5**

Sample Type:

90% Remold

Soil Identification:
Olive brown silty sand (SM)

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.053	■ 1.584	▲ 3.417
Shear Stress @ End of Test (ksf)	○ 0.729	□ 1.424	△ 2.943
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.48	9.48	9.48
Dry Density (pcf)	112.7	112.9	114.2
Saturation (%)	51.6	52.0	53.8
Soil Height Before Shearing (in.)	0.9915	0.9887	0.9848
Final Moisture Content (%)	15.4	15.2	13.8

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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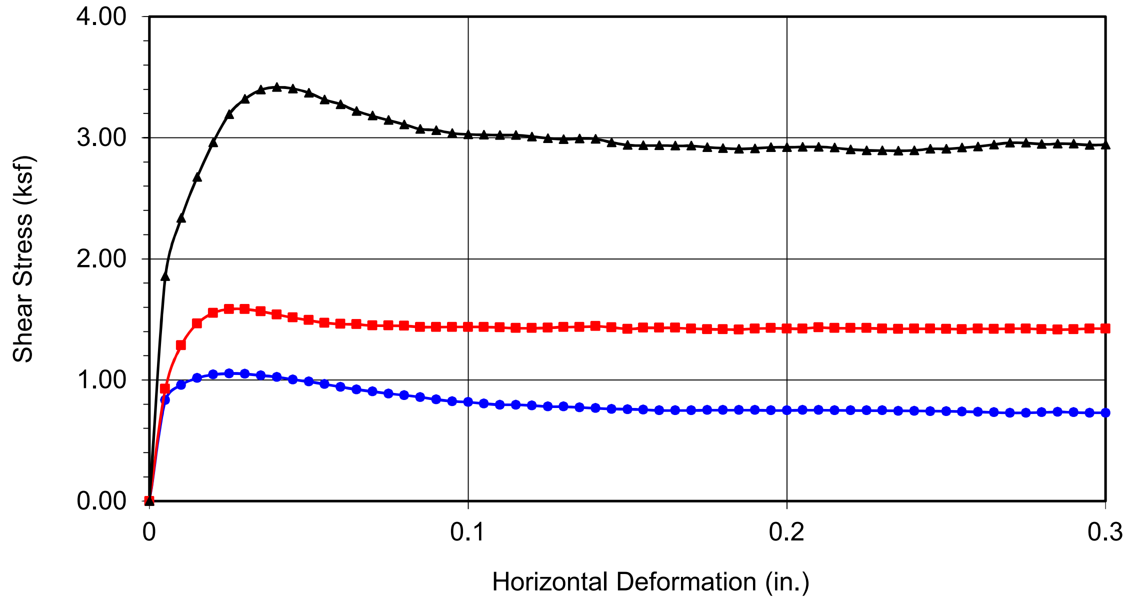

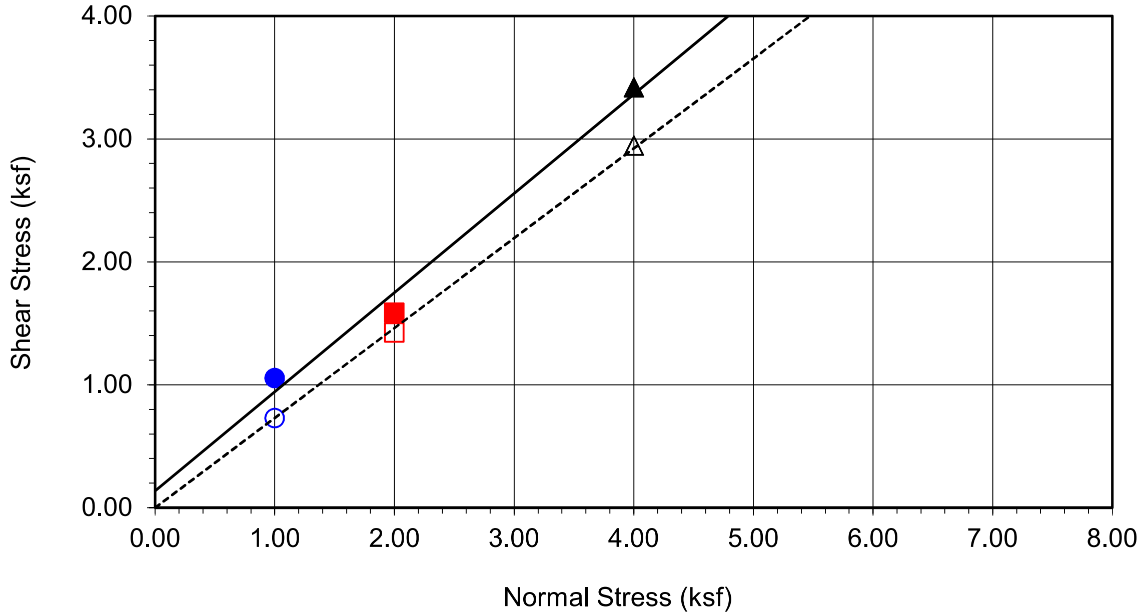

Boring No.	**LB-29**
Sample No.	**B-1**
Depth (ft)	**2-5**
Sample Type:	90% Remold

Soil Identification:
Olive brown silty sand (SM)

Strength Parameters

	C (psf)	ϕ (°)
Peak	137	39
Ultimate	0	36

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.053	■ 1.584	▲ 3.417
Shear Stress @ End of Test (ksf)	○ 0.729	□ 1.424	△ 2.943
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.48	9.48	9.48
Dry Density (pcf)	112.7	112.9	114.2
Saturation (%)	51.6	52.0	53.8
Soil Height Before Shearing (in.)	0.9915	0.9887	0.9848
Final Moisture Content (%)	15.4	15.2	13.8

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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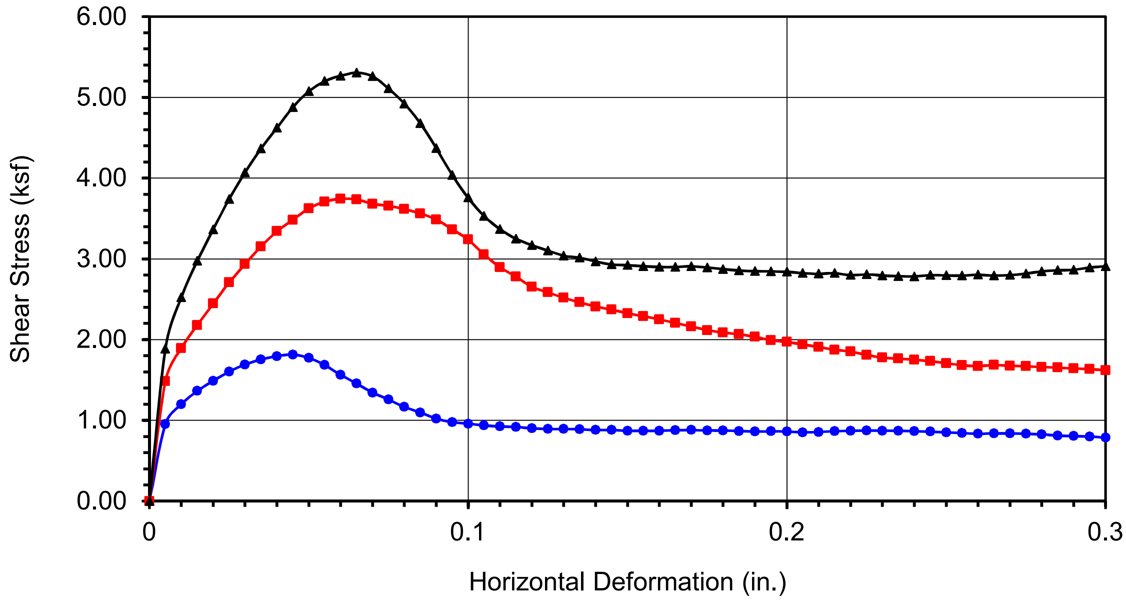
DIRECT SHEAR TEST

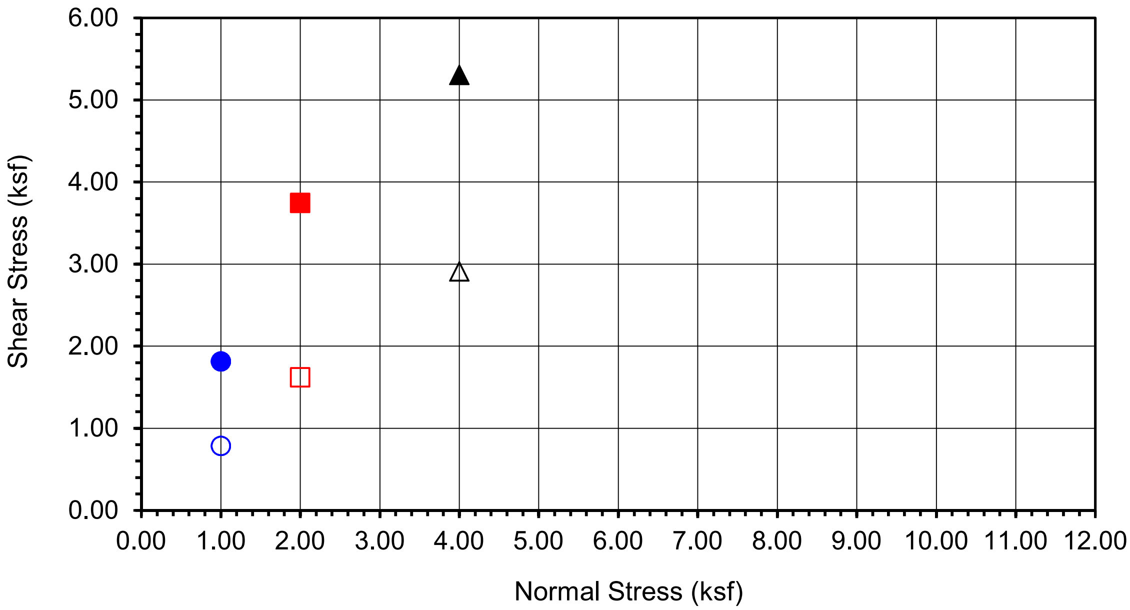
Consolidated Undrained

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/30/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-29	Sample Type:	Ring		
Sample No.:	R-2	Depth (ft.):	7.5		

Soil Identification: Dark yellowish brown clayey sand stone (SC)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	206.41	209.19	211.62
Weight of Ring(gm):	43.86	45.53	45.52
Before Shearing			
Weight of Wet Sample+Cont.(gm):	190.98	190.98	190.98
Weight of Dry Sample+Cont.(gm):	178.83	178.83	178.83
Weight of Container(gm):	59.82	59.82	59.82
Vertical Rdg.(in): Initial	0.2478	0.0000	0.2834
Vertical Rdg.(in): Final	0.2549	-0.0090	0.2936
After Shearing			
Weight of Wet Sample+Cont.(gm):	220.41	221.42	226.49
Weight of Dry Sample+Cont.(gm):	201.15	202.82	208.88
Weight of Container(gm):	55.81	57.31	59.13
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-29**
Sample No.	**R-2**
Depth (ft)	**7.5**

Sample Type:

Ring

Soil Identification:
Dark yellowish brown clayey sand stone (SC)

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.814	■ 3.744	▲ 5.304
Shear Stress @ End of Test (ksf)	○ 0.786	□ 1.619	△ 2.908
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.21	10.21	10.21
Dry Density (pcf)	122.7	123.5	125.3
Saturation (%)	73.7	75.6	79.9
Soil Height Before Shearing (in.)	0.9929	0.9910	0.9898
Final Moisture Content (%)	13.3	12.8	11.8

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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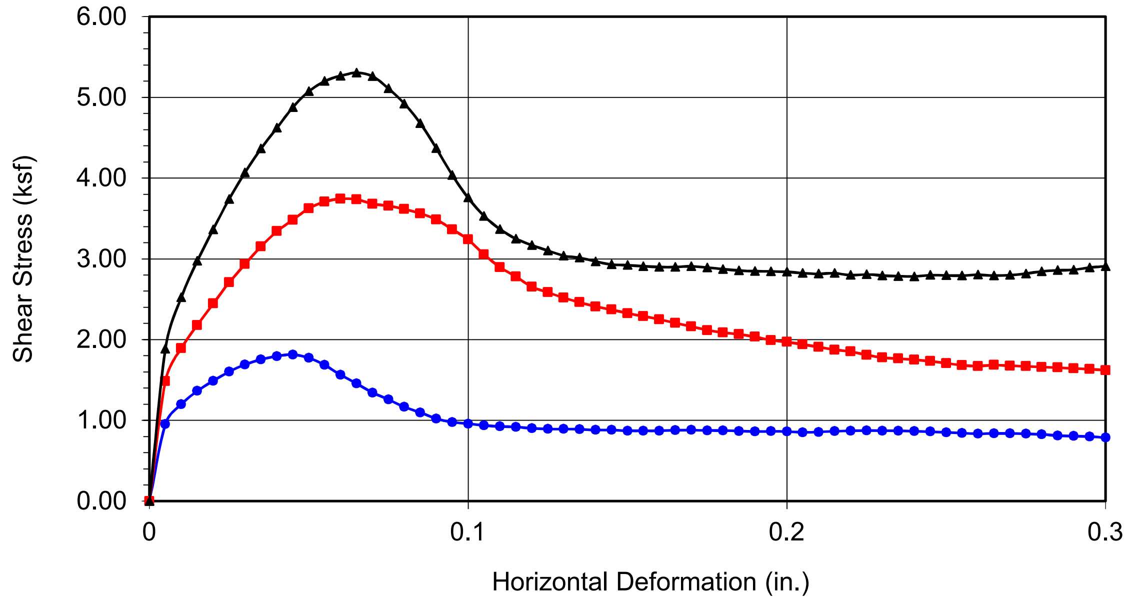

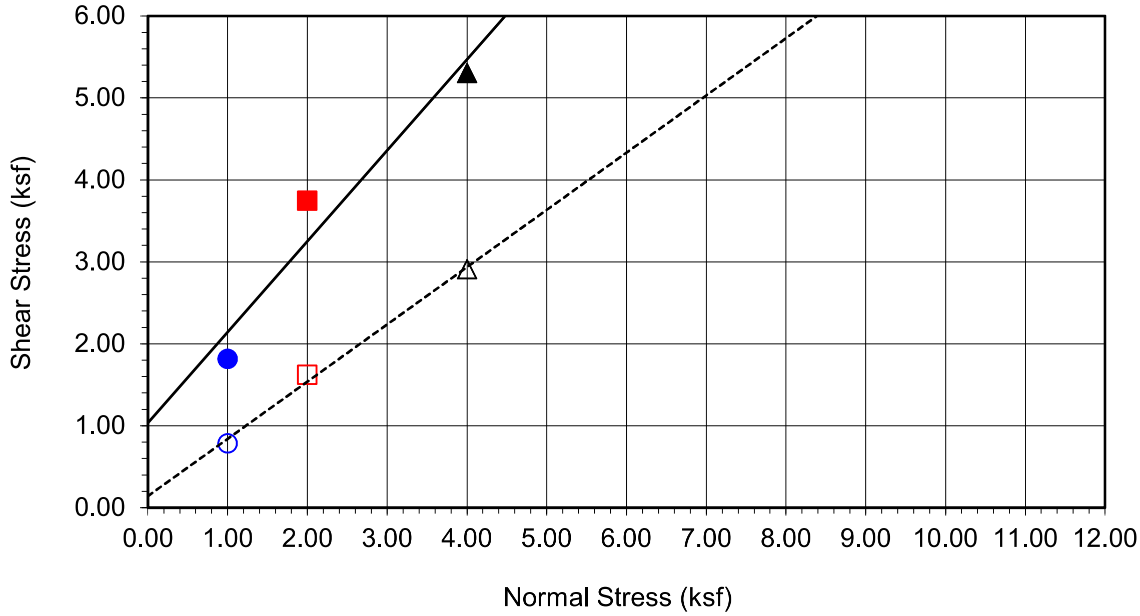

Boring No.	**LB-29**
Sample No.	**R-2**
Depth (ft)	**7.5**
Sample Type:	Ring

Soil Identification:
Dark yellowish brown clayey sand stone (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1034	48
Ultimate	142	35

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.814	■ 3.744	▲ 5.304
Shear Stress @ End of Test (ksf)	○ 0.786	□ 1.619	△ 2.908
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.21	10.21	10.21
Dry Density (pcf)	122.7	123.5	125.3
Saturation (%)	73.7	75.6	79.9
Soil Height Before Shearing (in.)	0.9929	0.9910	0.9898
Final Moisture Content (%)	13.3	12.8	11.8

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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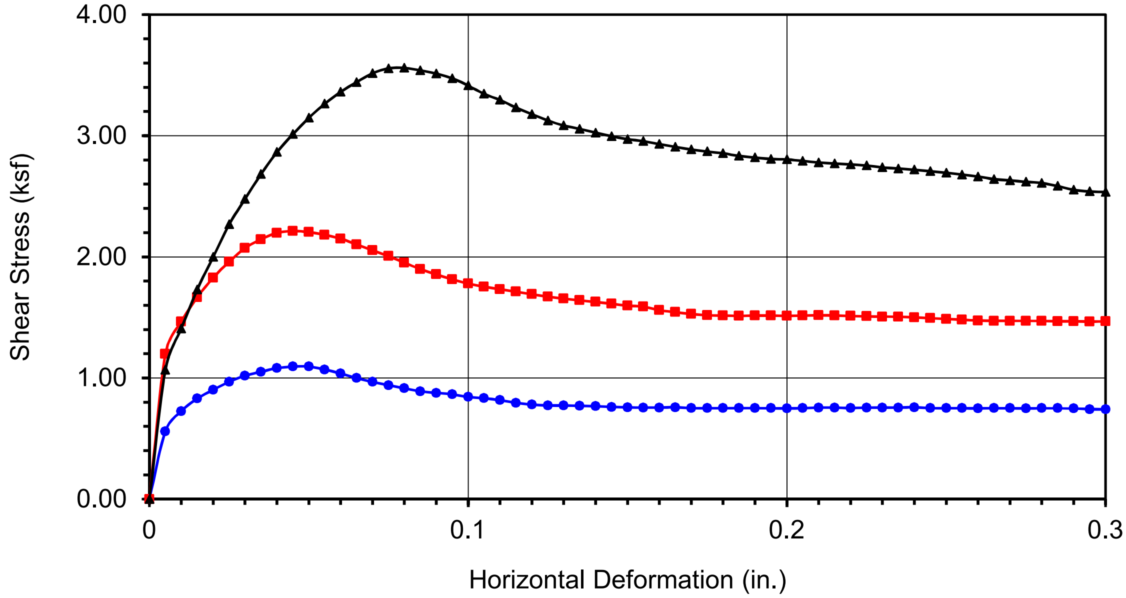
DIRECT SHEAR TEST

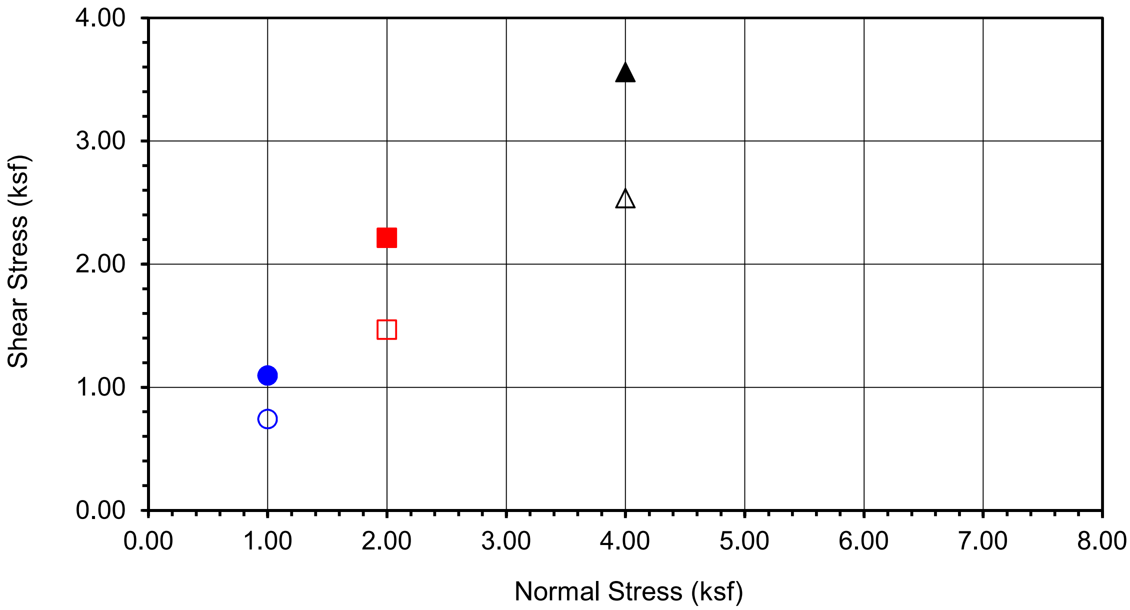
Consolidated Undrained

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/30/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-30	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.):	10.0		

Soil Identification: Yellowish brown sandy silt s(ML)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	184.04	187.80	182.89
Weight of Ring(gm):	42.65	44.97	37.80
Before Shearing			
Weight of Wet Sample+Cont.(gm):	247.97	247.97	247.97
Weight of Dry Sample+Cont.(gm):	231.95	231.95	231.95
Weight of Container(gm):	62.61	62.61	62.61
Vertical Rdg.(in): Initial	0.2478	0.0000	0.2238
Vertical Rdg.(in): Final	0.2526	-0.0125	0.2383
After Shearing			
Weight of Wet Sample+Cont.(gm):	214.91	210.56	232.52
Weight of Dry Sample+Cont.(gm):	188.87	184.56	205.09
Weight of Container(gm):	59.53	56.81	77.78
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-30**
Sample No.	**R-3**
Depth (ft)	**10**
Sample Type: Ring	
Soil Identification: Yellowish brown sandy silt s(ML)	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.094	■ 2.213	▲ 3.559
Shear Stress @ End of Test (ksf)	○ 0.742	□ 1.468	△ 2.534
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.46	9.46	9.46
Dry Density (pcf)	107.4	108.5	110.2
Saturation (%)	44.9	46.2	48.3
Soil Height Before Shearing (in.)	0.9952	0.9875	0.9855
Final Moisture Content (%)	20.1	20.4	21.5

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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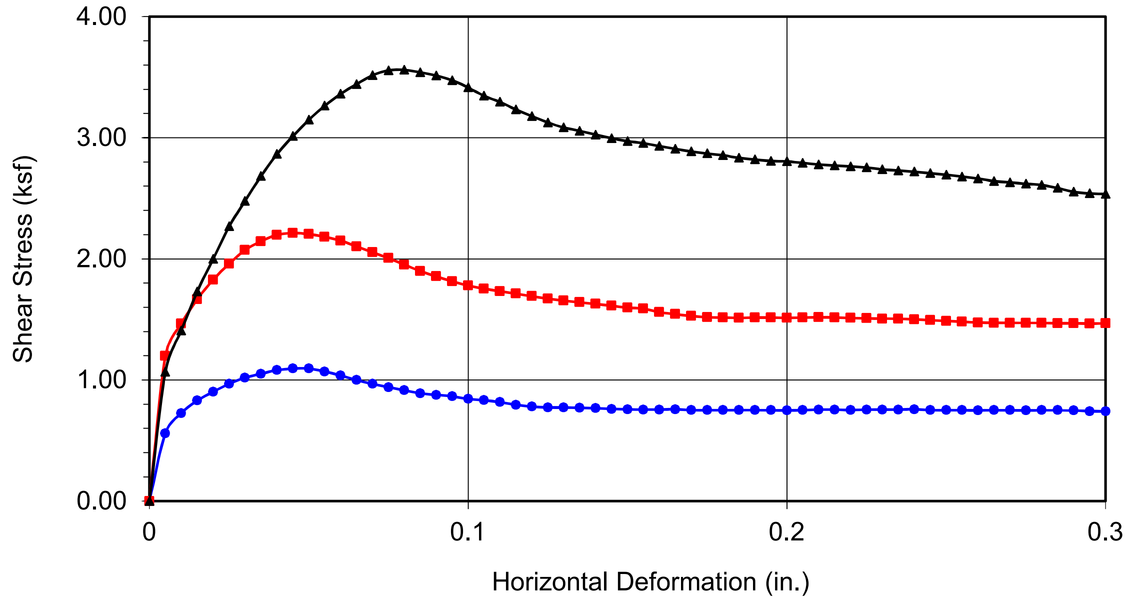

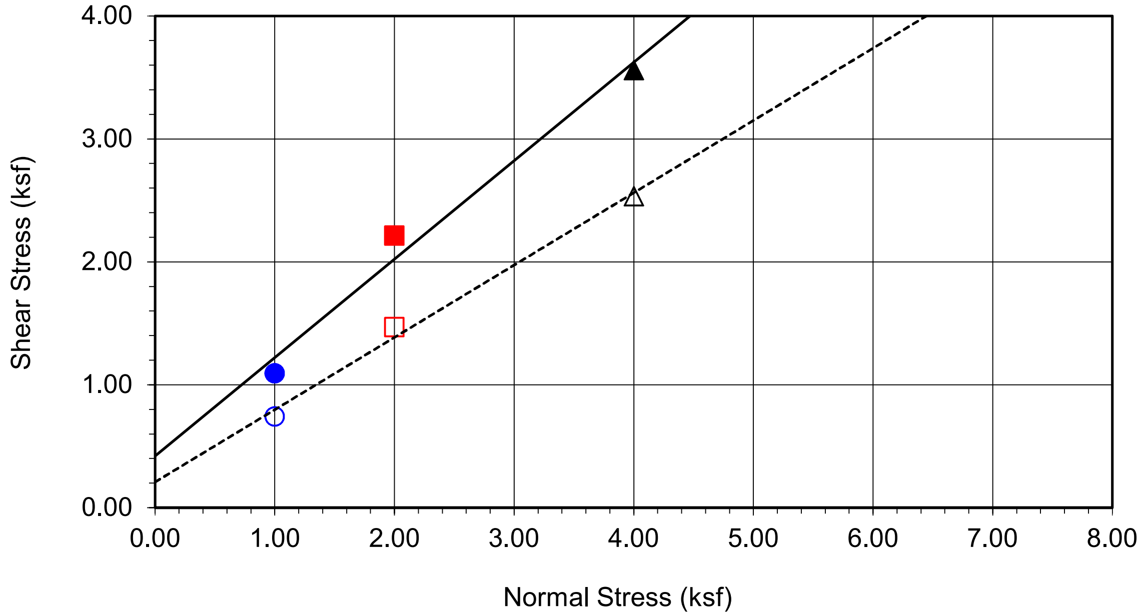

Boring No.	**LB-30**
Sample No.	**R-3**
Depth (ft)	**10**
Sample Type:	Ring
Soil Identification: Yellowish brown sandy silt s(ML)	

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	421	39
Ultimate	209	30

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.094	■ 2.213	▲ 3.559
Shear Stress @ End of Test (ksf)	○ 0.742	□ 1.468	△ 2.534
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.46	9.46	9.46
Dry Density (pcf)	107.4	108.5	110.2
Saturation (%)	44.9	46.2	48.3
Soil Height Before Shearing (in.)	0.9952	0.9875	0.9855
Final Moisture Content (%)	20.1	20.4	21.5

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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DIRECT SHEAR TEST
Consolidated Undrained

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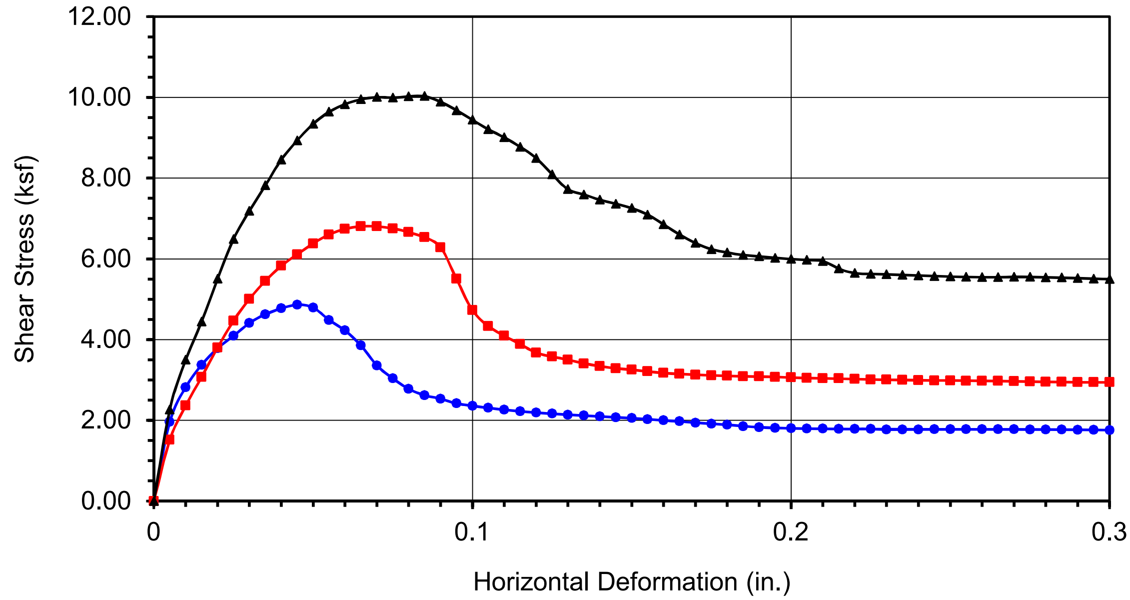
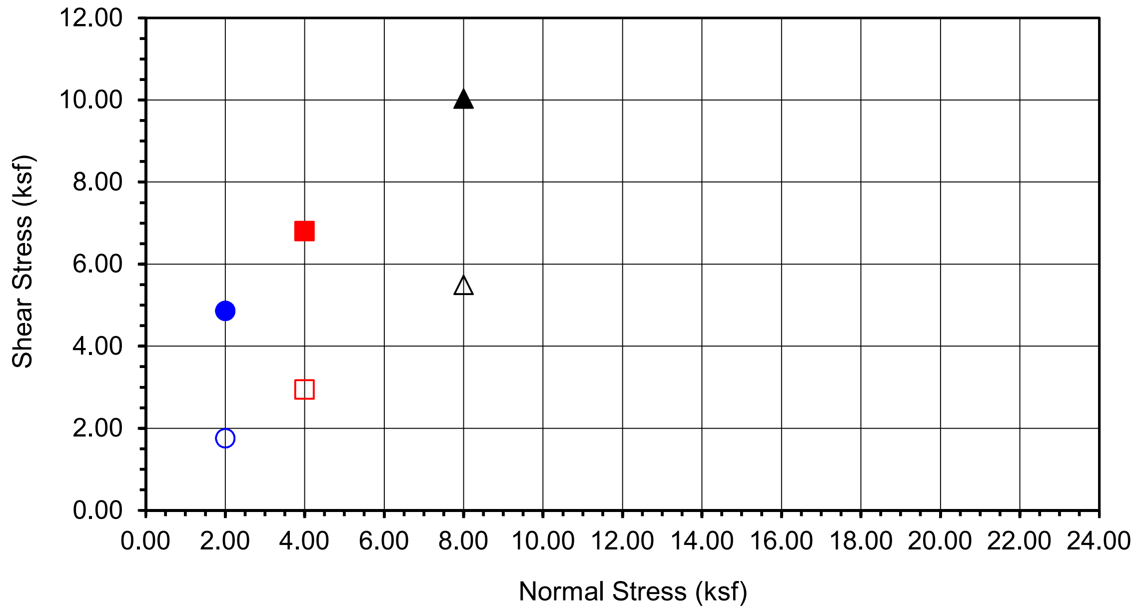
Project Name: Brea Boulevard Additional Borings
Project No.: 11585.005
Boring No.: LB-30
Sample No.: R-7
Soil Identification: Olive gray silt stone (ML)

Tested By: G. Bathala
Checked By: A. Santos
Sample Type: Ring
Depth (ft.): 30.0

Date: 11/03/20
Date: 12/01/20

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	201.09	205.48	207.23
Weight of Ring(gm):	40.85	44.43	45.95
Before Shearing			
Weight of Wet Sample+Cont.(gm):	176.79	176.79	176.79
Weight of Dry Sample+Cont.(gm):	158.50	158.50	158.50
Weight of Container(gm):	57.19	57.19	57.19
Vertical Rdg.(in): Initial	0.0000	0.2662	0.2692
Vertical Rdg.(in): Final	-0.0017	0.2741	0.2857
After Shearing			
Weight of Wet Sample+Cont.(gm):	201.58	220.14	222.23
Weight of Dry Sample+Cont.(gm):	172.92	191.98	194.85
Weight of Container(gm):	38.57	56.82	59.53
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-30**
Sample No.	**R-7**
Depth (ft)	**30**

Sample Type:

Ring

Soil Identification:
Olive gray silt stone (ML)

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 4.863	■ 6.803	▲10.029
Shear Stress @ End of Test (ksf)	○ 1.757	□ 2.943	△ 5.495
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	18.05	18.05	18.05
Dry Density (pcf)	112.9	113.5	113.6
Saturation (%)	98.8	100.4	100.8
Soil Height Before Shearing (in.)	0.9983	0.9921	0.9835
Final Moisture Content (%)	21.3	20.8	20.2

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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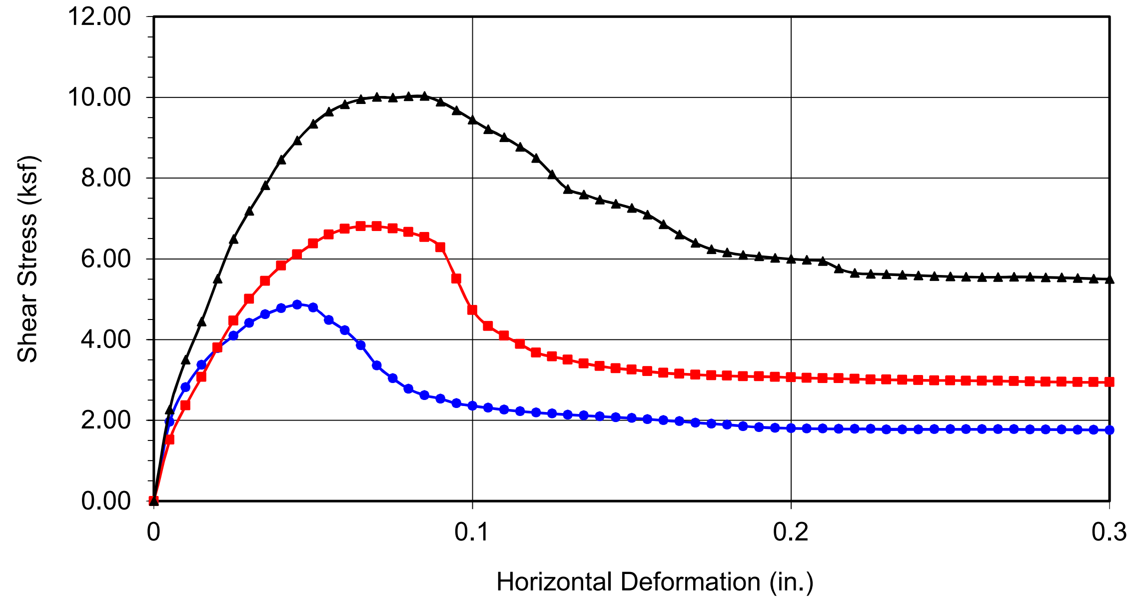

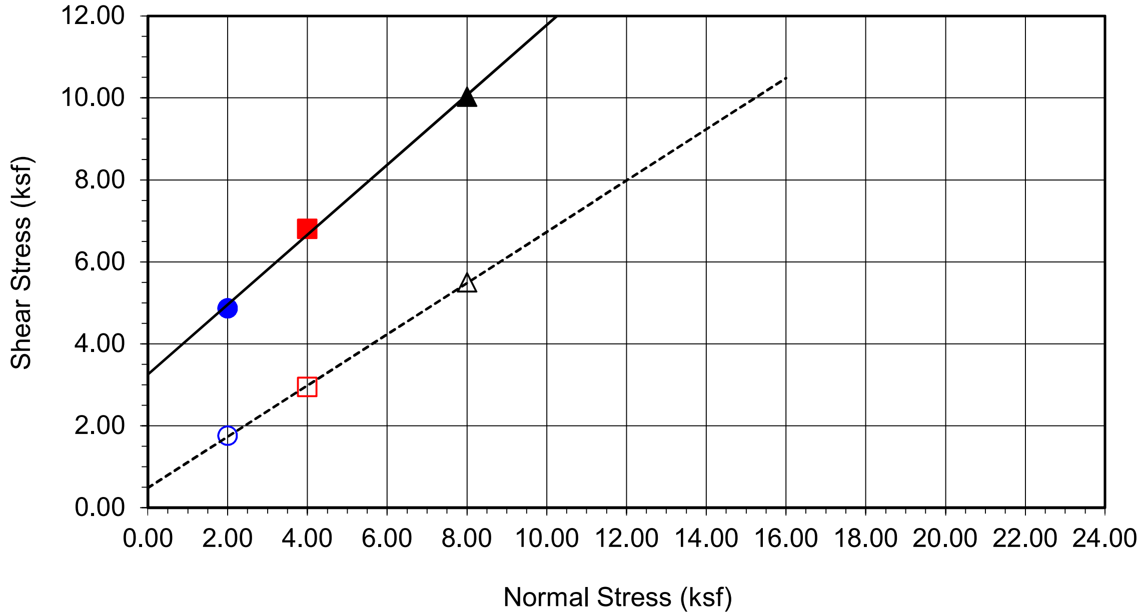

Boring No.	**LB-30**
Sample No.	**R-7**
Depth (ft)	**30**
Sample Type:	Ring
Soil Identification: Olive gray silt stone (ML)	

Strength Parameters

	C (psf)	ϕ (°)
Peak	3250	40
Ultimate	481	32

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 4.863	■ 6.803	▲10.029
Shear Stress @ End of Test (ksf)	○ 1.757	□ 2.943	△ 5.495
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	18.05	18.05	18.05
Dry Density (pcf)	112.9	113.5	113.6
Saturation (%)	98.8	100.4	100.8
Soil Height Before Shearing (in.)	0.9983	0.9921	0.9835
Final Moisture Content (%)	21.3	20.8	20.2

Leighton

DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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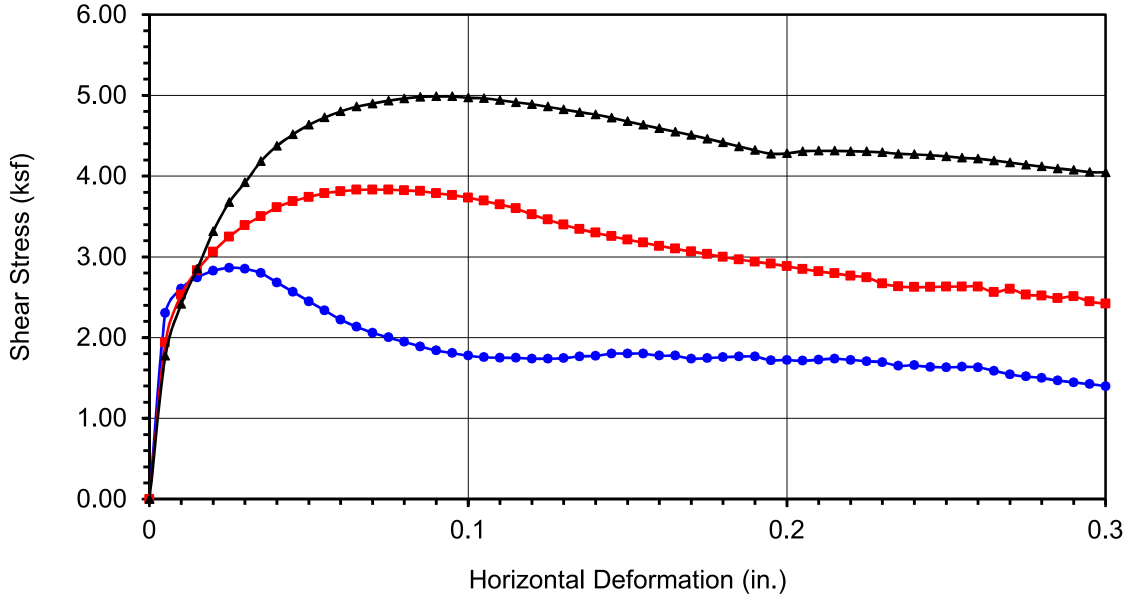
DIRECT SHEAR TEST

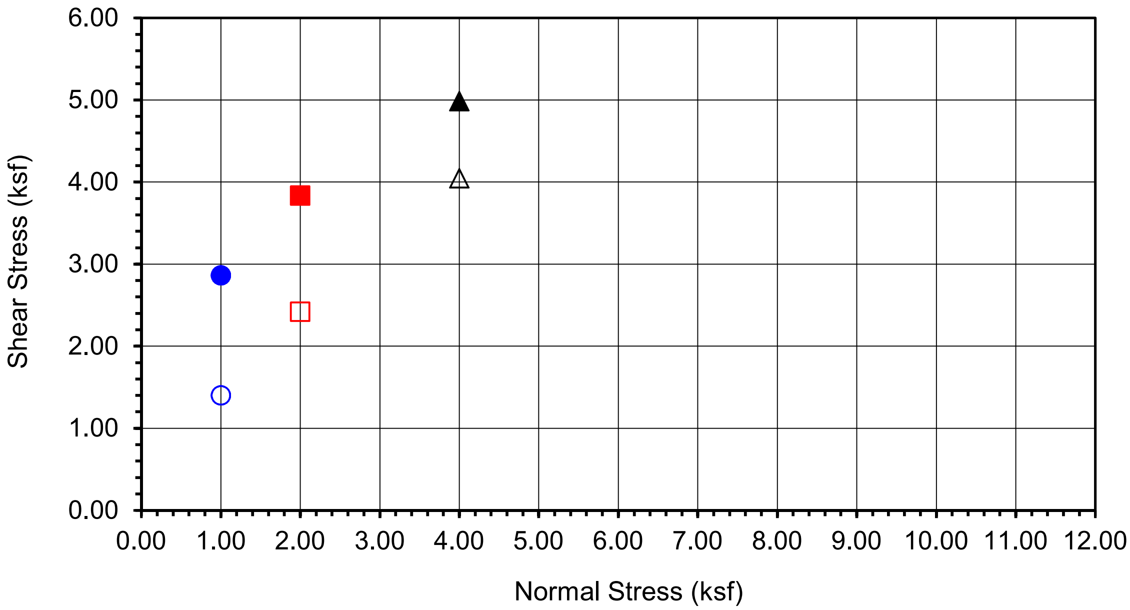
Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-31	Sample Type:	Tube		
Sample No.:	R-2	Depth (ft.):	10.0		

Soil Identification: Dark brown lean clay with sand (CL)s

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	199.67	202.63	202.66
Weight of Ring(gm):	39.39	42.05	41.58
Before Shearing			
Weight of Wet Sample+Cont.(gm):	185.45	185.45	185.45
Weight of Dry Sample+Cont.(gm):	171.25	171.25	171.25
Weight of Container(gm):	62.61	62.61	62.61
Vertical Rdg.(in): Initial	0.2463	0.0000	0.0000
Vertical Rdg.(in): Final	0.2302	0.0143	0.0046
After Shearing			
Weight of Wet Sample+Cont.(gm):	220.62	218.76	228.36
Weight of Dry Sample+Cont.(gm):	195.90	193.30	204.69
Weight of Container(gm):	57.32	53.70	68.91
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-31**
Sample No.	**R-2**
Depth (ft)	**10**
Sample Type: Tube	
Soil Identification: Dark brown lean clay with sand (CL)s	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.864	■ 3.832	▲ 4.986
Shear Stress @ End of Test (ksf)	○ 1.399	□ 2.418	△ 4.046
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.07	13.07	13.07
Dry Density (pcf)	117.9	118.1	118.5
Saturation (%)	82.1	82.6	83.5
Soil Height Before Shearing (in.)	1.0161	1.0143	1.0046
Final Moisture Content (%)	17.8	18.2	17.4

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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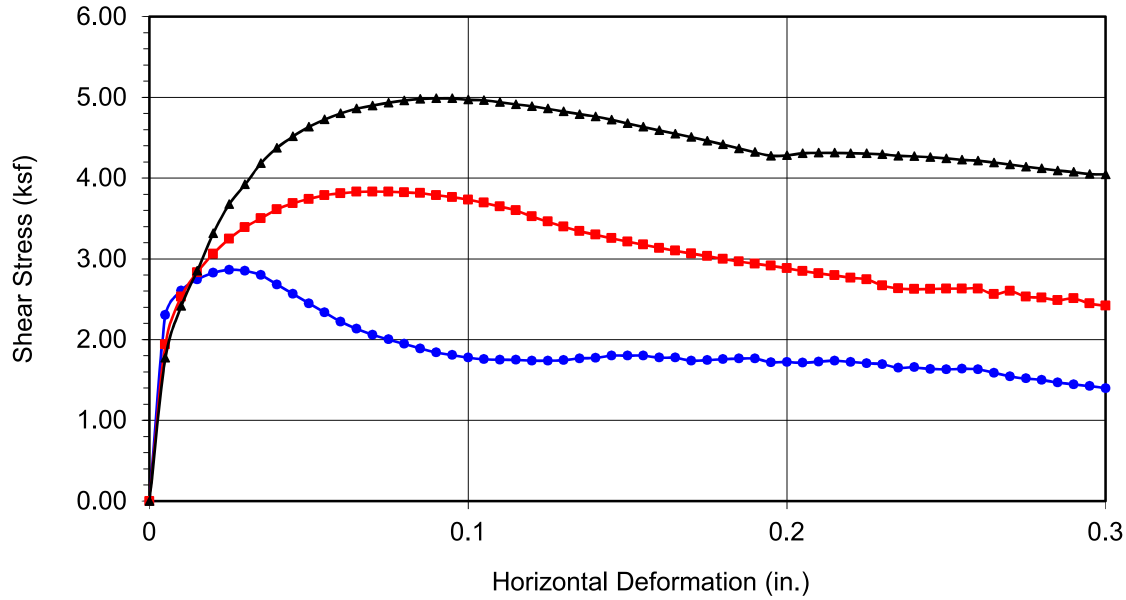

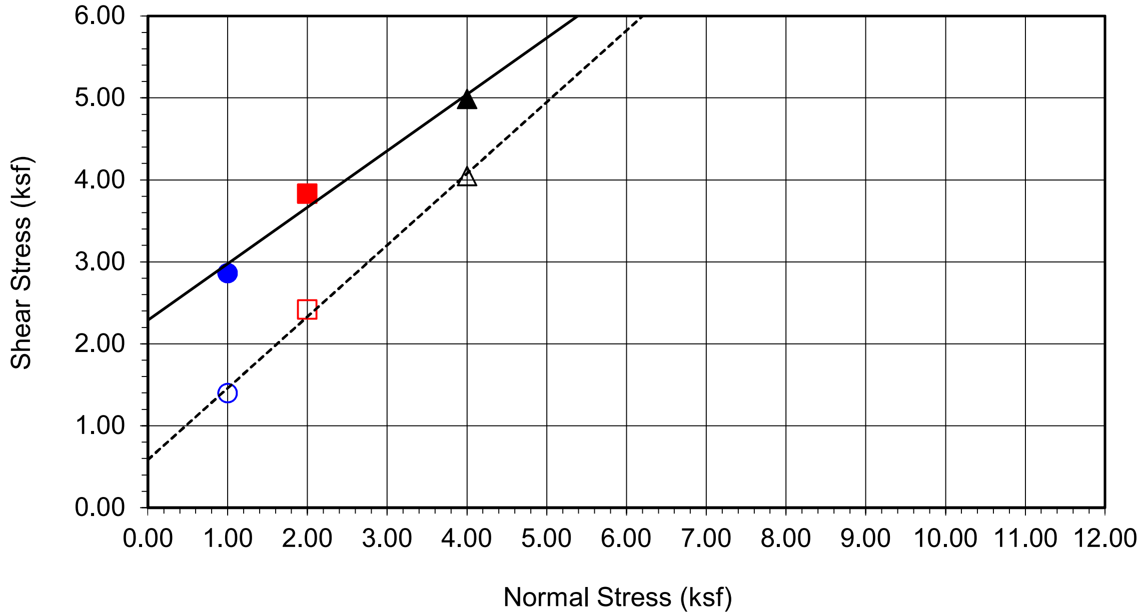

Boring No.	**LB-31**
Sample No.	**R-2**
Depth (ft)	**10**
Sample Type:	Tube
Soil Identification: Dark brown lean clay with sand (CL)s	

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	2287	35
Ultimate	585	41

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.864	■ 3.832	▲ 4.986
Shear Stress @ End of Test (ksf)	○ 1.399	□ 2.418	△ 4.046
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.07	13.07	13.07
Dry Density (pcf)	117.9	118.1	118.5
Saturation (%)	82.1	82.6	83.5
Soil Height Before Shearing (in.)	1.0161	1.0143	1.0046
Final Moisture Content (%)	17.8	18.2	17.4

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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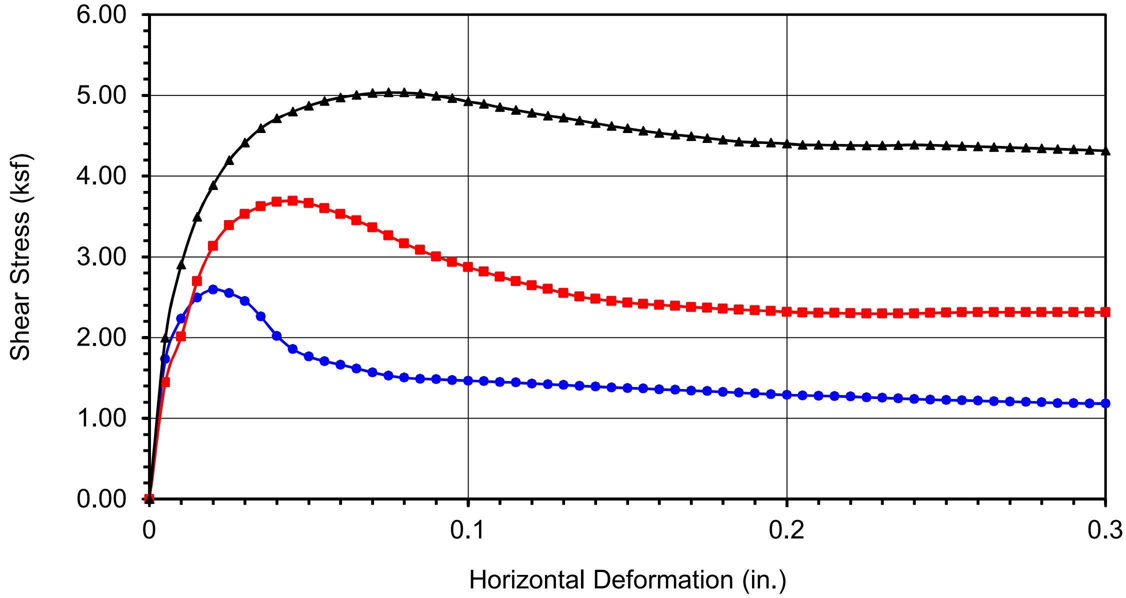
DIRECT SHEAR TEST

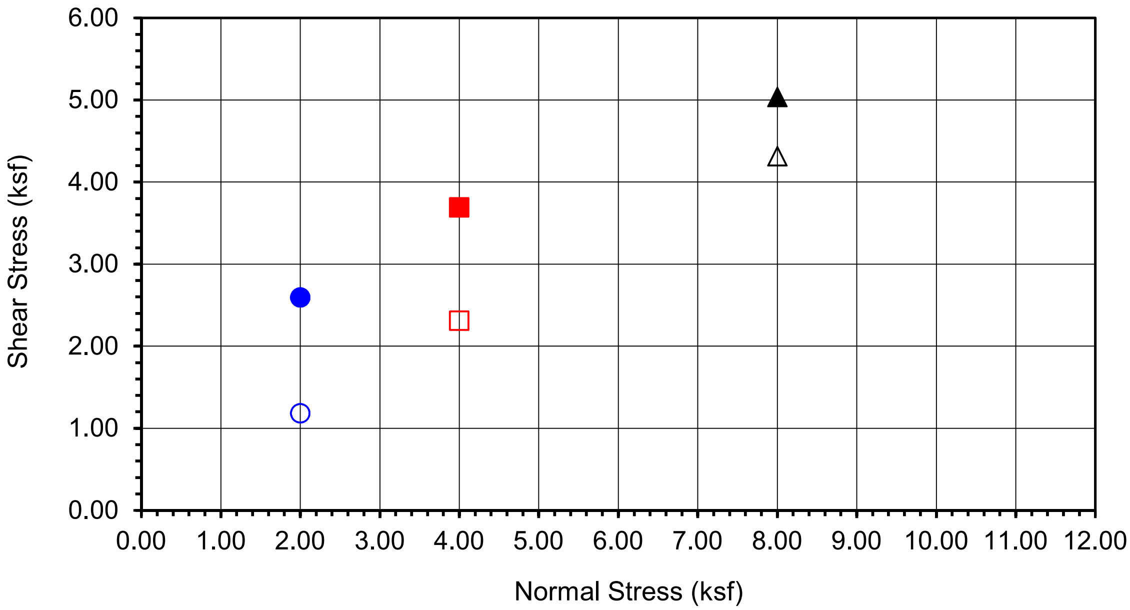
Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/28/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/01/20
Boring No.:	LB-31	Sample Type:	Ring		
Sample No.:	R-6	Depth (ft.):	30.0		

Soil Identification: Dark olive brown lean clay stone (CL)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	184.58	184.84	187.05
Weight of Ring(gm):	43.14	42.16	44.10
Before Shearing			
Weight of Wet Sample+Cont.(gm):	202.91	202.91	202.91
Weight of Dry Sample+Cont.(gm):	169.17	169.17	169.17
Weight of Container(gm):	53.71	53.71	53.71
Vertical Rdg.(in): Initial	0.2517	0.0000	0.0000
Vertical Rdg.(in): Final	0.2516	-0.0046	-0.0165
After Shearing			
Weight of Wet Sample+Cont.(gm):	202.40	200.32	207.79
Weight of Dry Sample+Cont.(gm):	166.00	164.09	172.24
Weight of Container(gm):	58.19	55.54	64.16
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-31**
Sample No.	**R-6**
Depth (ft)	**30**

Sample Type:

Ring

Soil Identification:
Dark olive brown lean clay stone (CL)

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.594	■ 3.691	▲ 5.033
Shear Stress @ End of Test (ksf)	○ 1.182	□ 2.311	△ 4.313
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	29.22	29.22	29.22
Dry Density (pcf)	91.0	91.8	92.0
Saturation (%)	92.6	94.4	94.8
Soil Height Before Shearing (in.)	1.0001	0.9954	0.9835
Final Moisture Content (%)	33.8	33.4	32.9

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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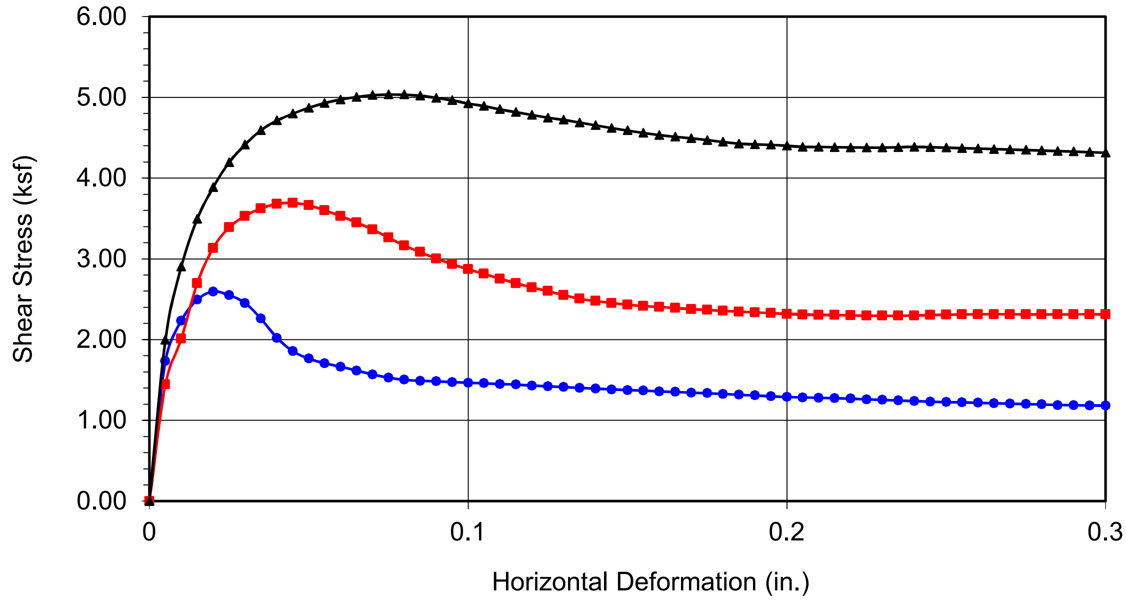

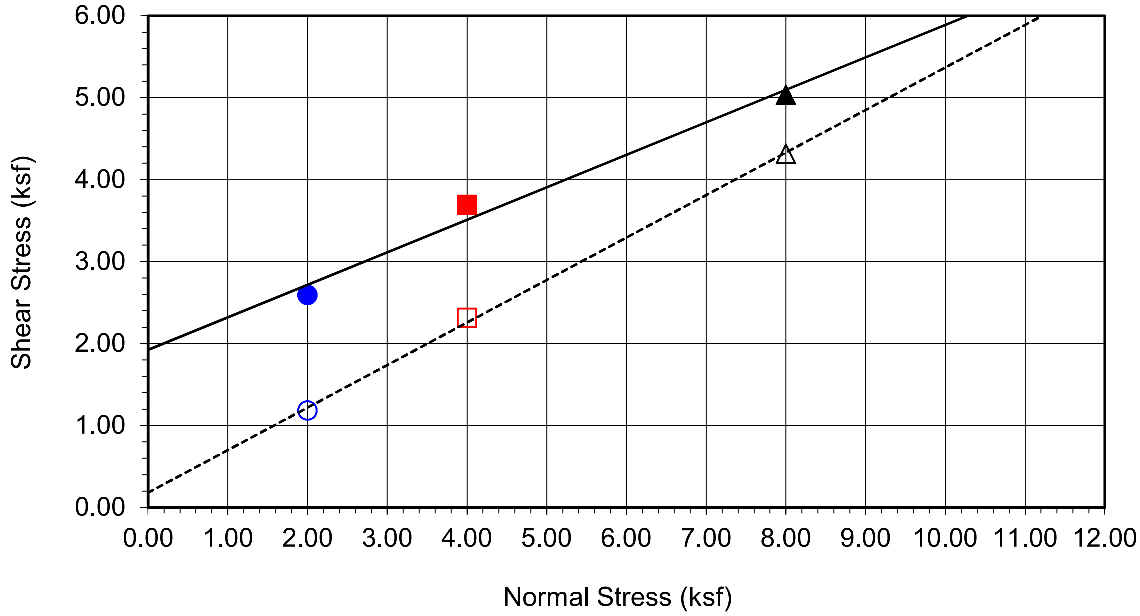

Boring No.	**LB-31**
Sample No.	**R-6**
Depth (ft)	**30**
Sample Type:	Ring

Soil Identification:
Dark olive brown lean clay stone (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1923	22
Ultimate	181	27

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.594	■ 3.691	▲ 5.033
Shear Stress @ End of Test (ksf)	○ 1.182	□ 2.311	△ 4.313
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	29.22	29.22	29.22
Dry Density (pcf)	91.0	91.8	92.0
Saturation (%)	92.6	94.4	94.8
Soil Height Before Shearing (in.)	1.0001	0.9954	0.9835
Final Moisture Content (%)	33.8	33.4	32.9

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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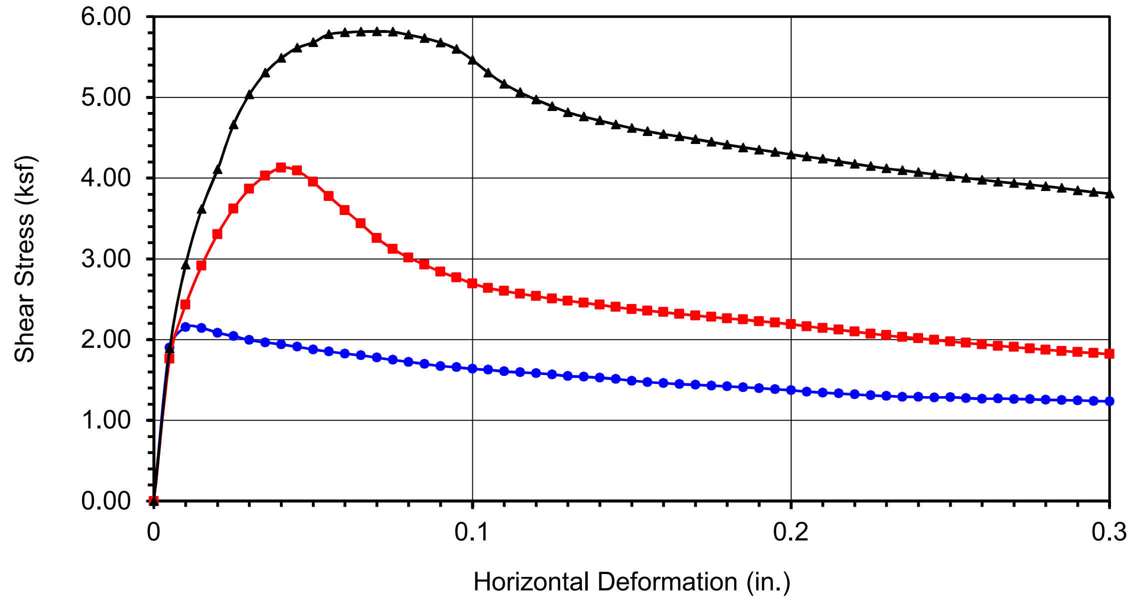
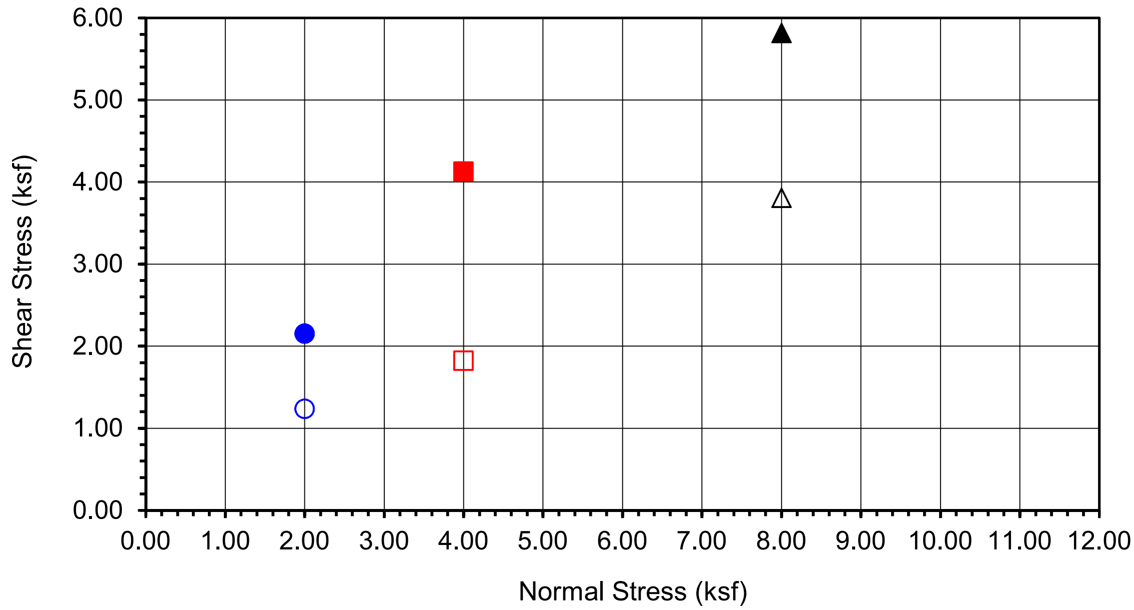
DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/28/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-32	Sample Type:	Ring		
Sample No.:	R-6	Depth (ft.):	30.0		
Soil Identification:	Olive gray lean clay stone (CL)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	166.63	181.46	179.40
Weight of Ring(gm):	43.54	46.84	42.89
Before Shearing			
Weight of Wet Sample+Cont.(gm):	134.75	134.75	134.75
Weight of Dry Sample+Cont.(gm):	116.09	116.09	116.09
Weight of Container(gm):	57.32	57.32	57.32
Vertical Rdg.(in): Initial	0.2367	0.0000	0.2485
Vertical Rdg.(in): Final	0.2367	-0.0104	0.2634
After Shearing			
Weight of Wet Sample+Cont.(gm):	193.64	197.20	195.00
Weight of Dry Sample+Cont.(gm):	152.47	158.74	156.97
Weight of Container(gm):	62.60	59.82	56.82
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-32**
Sample No.	**R-6**
Depth (ft)	**30**
Sample Type: Ring	
Soil Identification: Olive gray lean clay stone (CL)	

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.153	■ 4.128	▲ 5.816
Shear Stress @ End of Test (ksf)	○ 1.236	□ 1.820	△ 3.807
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	31.75	31.75	31.75
Dry Density (pcf)	77.7	85.0	86.2
Saturation (%)	73.3	87.2	89.7
Soil Height Before Shearing (in.)	1.0000	0.9896	0.9851
Final Moisture Content (%)	45.8	38.9	38.0

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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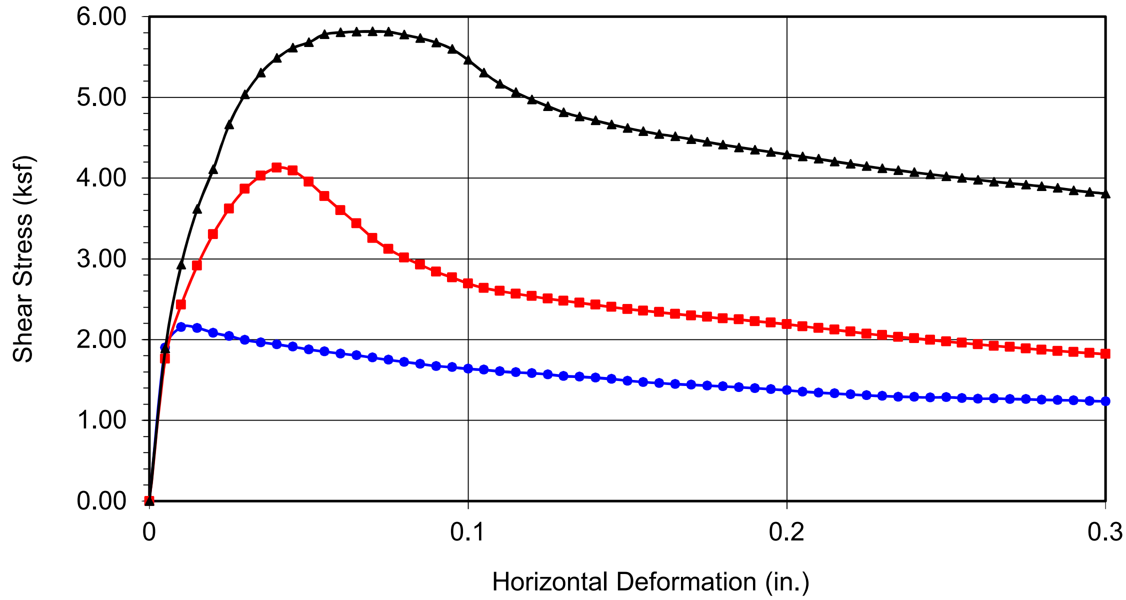

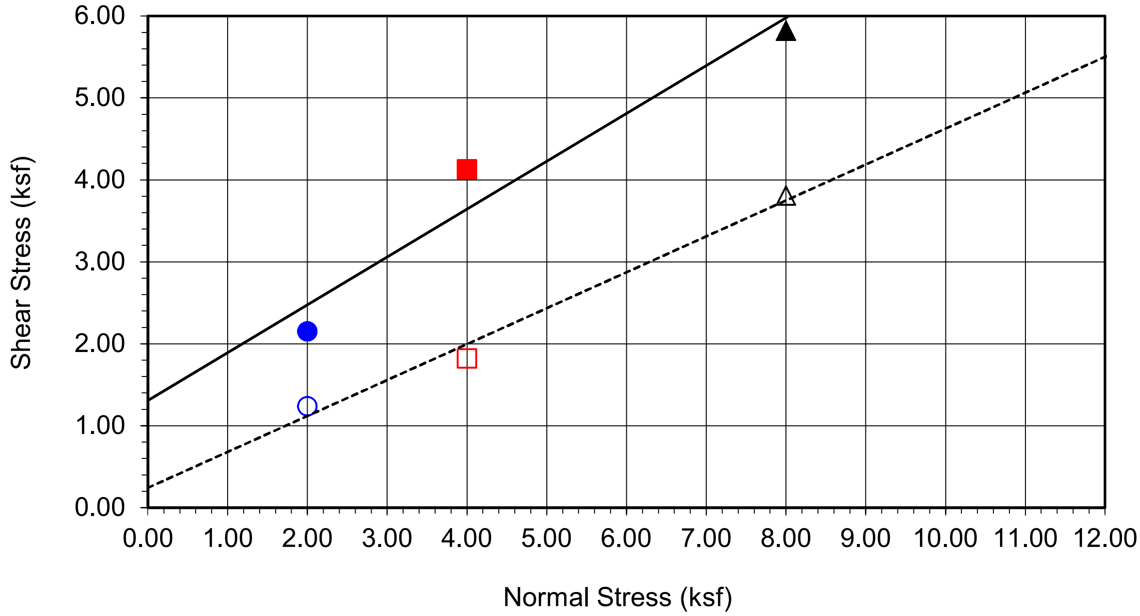

Boring No.	**LB-32**
Sample No.	**R-6**
Depth (ft)	**30**
Sample Type:	Ring

Soil Identification:
Olive gray lean clay stone (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1309	30
Ultimate	243	24

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.153	■ 4.128	▲ 5.816
Shear Stress @ End of Test (ksf)	○ 1.236	□ 1.820	△ 3.807
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	31.75	31.75	31.75
Dry Density (pcf)	77.7	85.0	86.2
Saturation (%)	73.3	87.2	89.7
Soil Height Before Shearing (in.)	1.0000	0.9896	0.9851
Final Moisture Content (%)	45.8	38.9	38.0

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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DIRECT SHEAR TEST

Consolidated Drained - ASTM D 3080

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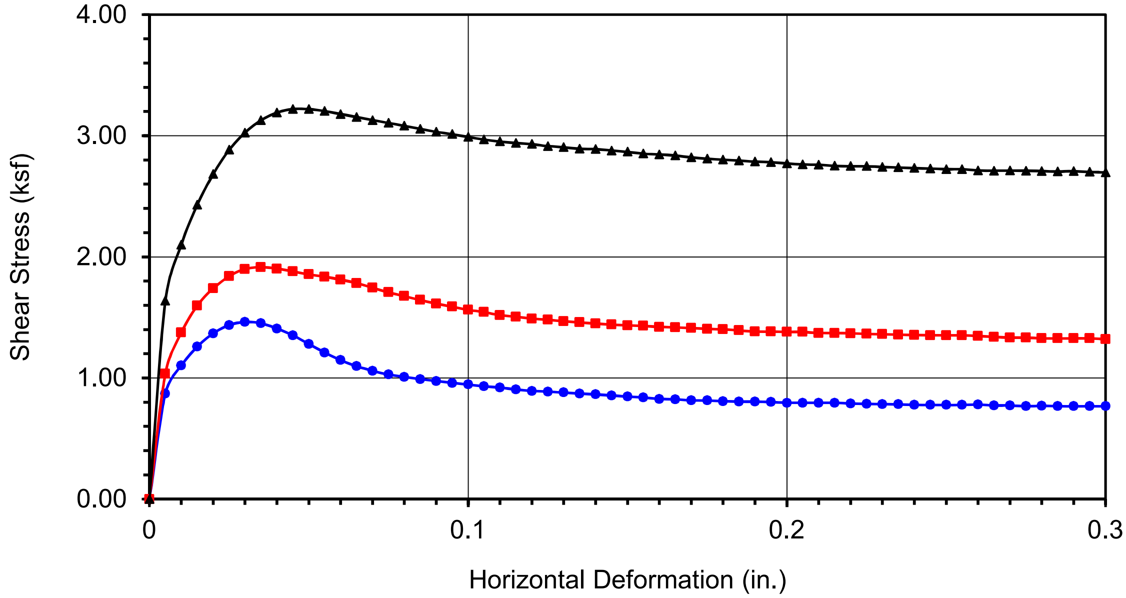
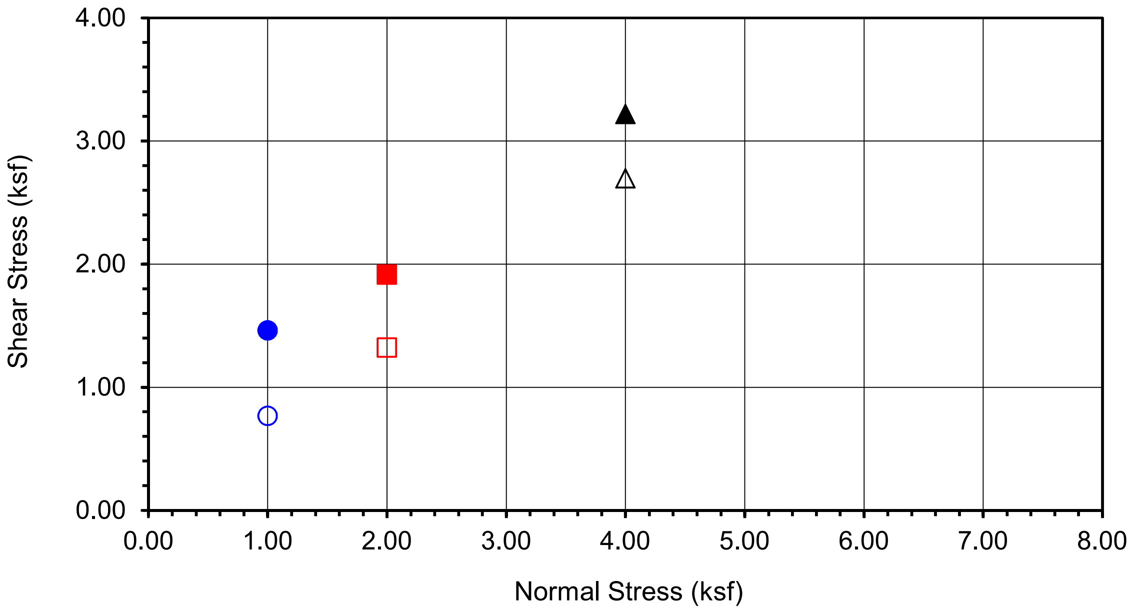
Project Name: Brea Boulevard Additional Borings
Project No.: 11585.005
Boring No.: LB-33
Sample No.: R-4
Soil Identification: Olive brown lean clay (CL)

Tested By: G. Bathala — Date: 10/29/20
Checked By: A. Santos — Date: 12/02/20
Sample Type: Ring
Depth (ft.): 12.5

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	200.46	199.45	199.38
Weight of Ring(gm):	44.09	42.71	41.77
Before Shearing			
Weight of Wet Sample+Cont.(gm):	190.23	190.23	190.23
Weight of Dry Sample+Cont.(gm):	171.82	171.82	171.82
Weight of Container(gm):	58.19	58.19	58.19
Vertical Rdg.(in): Initial	0.0000	0.2571	0.2534
Vertical Rdg.(in): Final	-0.0002	0.2694	0.2697
After Shearing			
Weight of Wet Sample+Cont.(gm):	196.15	222.11	213.09
Weight of Dry Sample+Cont.(gm):	171.23	196.69	188.35
Weight of Container(gm):	38.58	64.17	55.54
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-33**
Sample No.	**R-4**
Depth (ft)	**12.5**
Sample Type: Ring	
Soil Identification: Olive brown lean clay (CL)	

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.462	■ 1.915	▲ 3.219
Shear Stress @ End of Test (ksf)	○ 0.767	□ 1.320	△ 2.697
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.20	16.20	16.20
Dry Density (pcf)	111.9	112.2	112.8
Saturation (%)	86.4	87.0	88.5
Soil Height Before Shearing (in.)	0.9998	0.9877	0.9837
Final Moisture Content (%)	18.8	19.2	18.6

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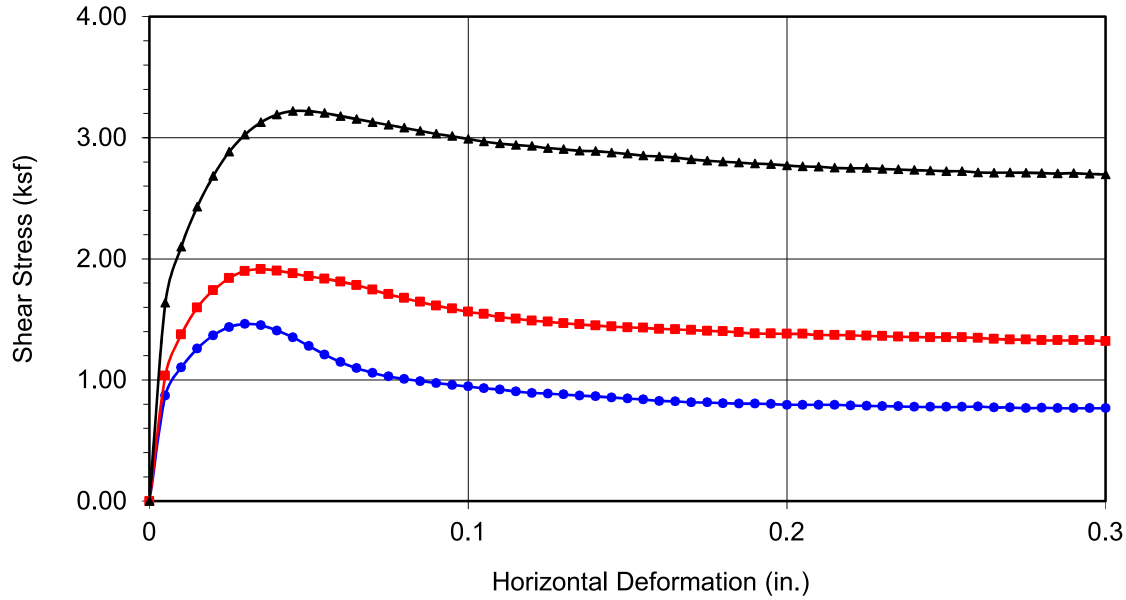
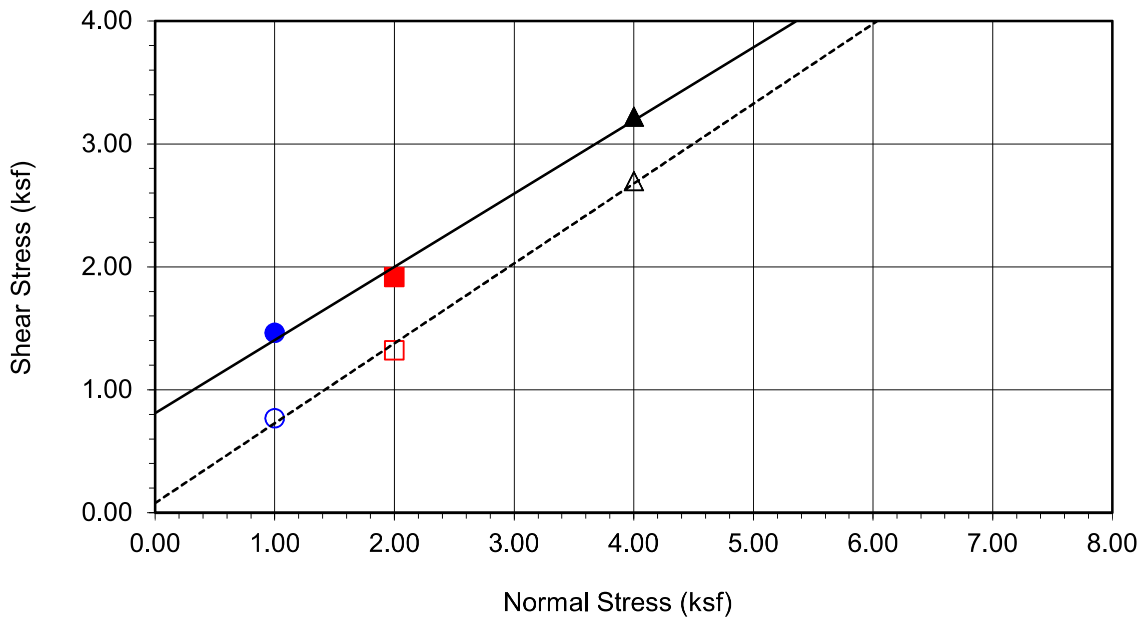
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-33**
Sample No.	**R-4**
Depth (ft)	**12.5**
Sample Type:	Ring

Soil Identification:
Olive brown lean clay (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	810	31
Ultimate	78	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.462	■ 1.915	▲ 3.219
Shear Stress @ End of Test (ksf)	○ 0.767	□ 1.320	△ 2.697
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.20	16.20	16.20
Dry Density (pcf)	111.9	112.2	112.8
Saturation (%)	86.4	87.0	88.5
Soil Height Before Shearing (in.)	0.9998	0.9877	0.9837
Final Moisture Content (%)	18.8	19.2	18.6

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

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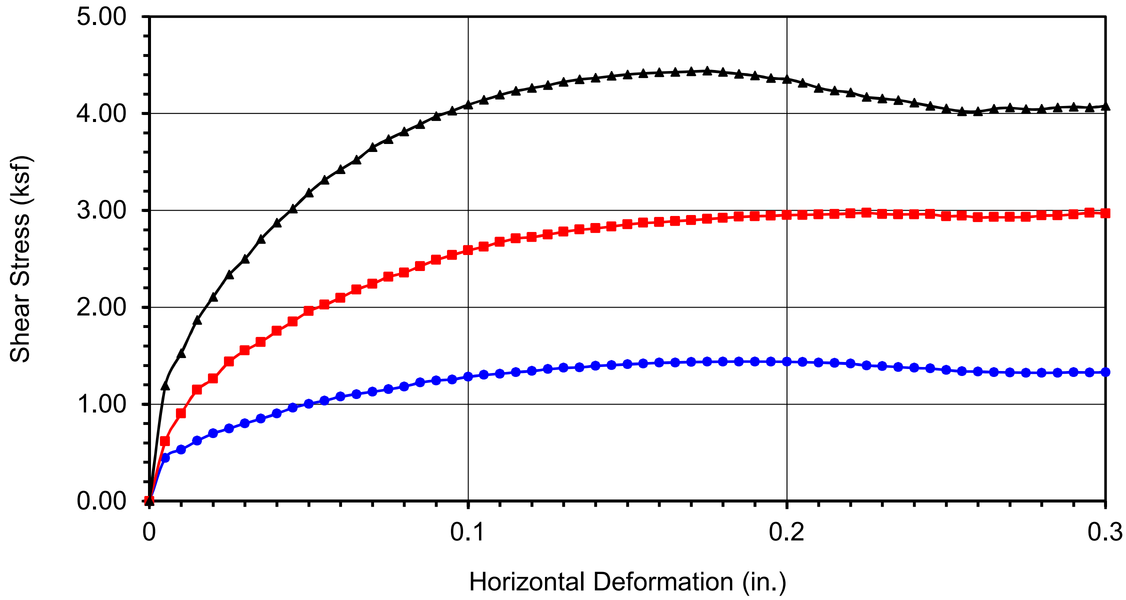
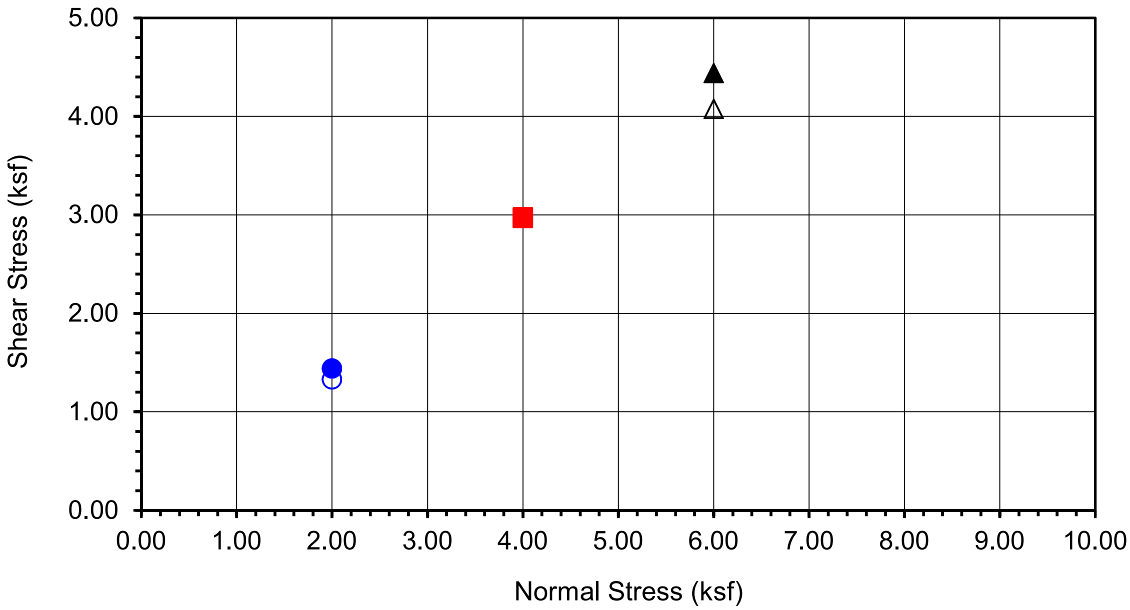
DIRECT SHEAR TEST
Consolidated Undrained

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/31/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-34	Sample Type:	Ring		
Sample No.:	R-5	Depth (ft.):	20.0		
Soil Identification:	Olive yellow silty sand (SM)				

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	163.07	162.57	169.40
Weight of Ring(gm):	43.96	43.23	42.98
Before Shearing			
Weight of Wet Sample+Cont.(gm):	166.54	166.54	166.54
Weight of Dry Sample+Cont.(gm):	160.19	160.19	160.19
Weight of Container(gm):	52.02	52.02	52.02
Vertical Rdg.(in): Initial	0.0000	0.2656	0.2547
Vertical Rdg.(in): Final	-0.0568	0.3111	0.3070
After Shearing			
Weight of Wet Sample+Cont.(gm):	202.43	192.85	195.11
Weight of Dry Sample+Cont.(gm):	179.67	171.14	173.53
Weight of Container(gm):	69.37	61.22	57.96
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-34**
Sample No.	**R-5**
Depth (ft)	**20**

Sample Type:

Ring

Soil Identification:
Olive yellow silty sand (SM)

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.440	■ 2.974	▲ 4.439
Shear Stress @ End of Test (ksf)	○ 1.330	□ 2.968	△ 4.077
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	5.87	5.87	5.87
Dry Density (pcf)	93.6	93.7	99.3
Saturation (%)	19.8	19.9	22.7
Soil Height Before Shearing (in.)	0.9432	0.9545	0.9477
Final Moisture Content (%)	20.6	19.8	18.7

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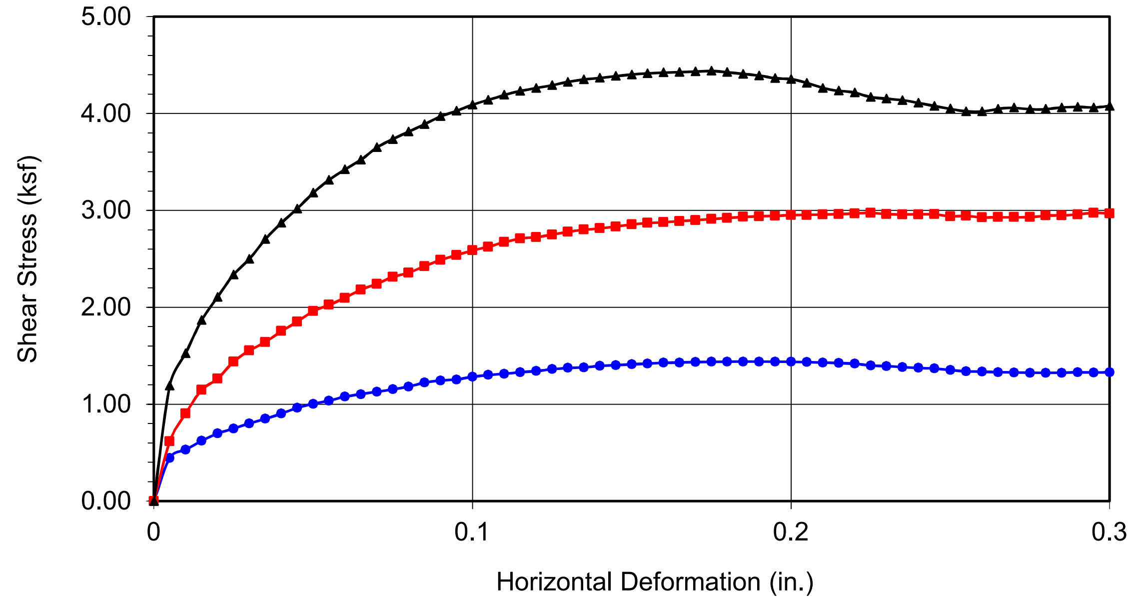
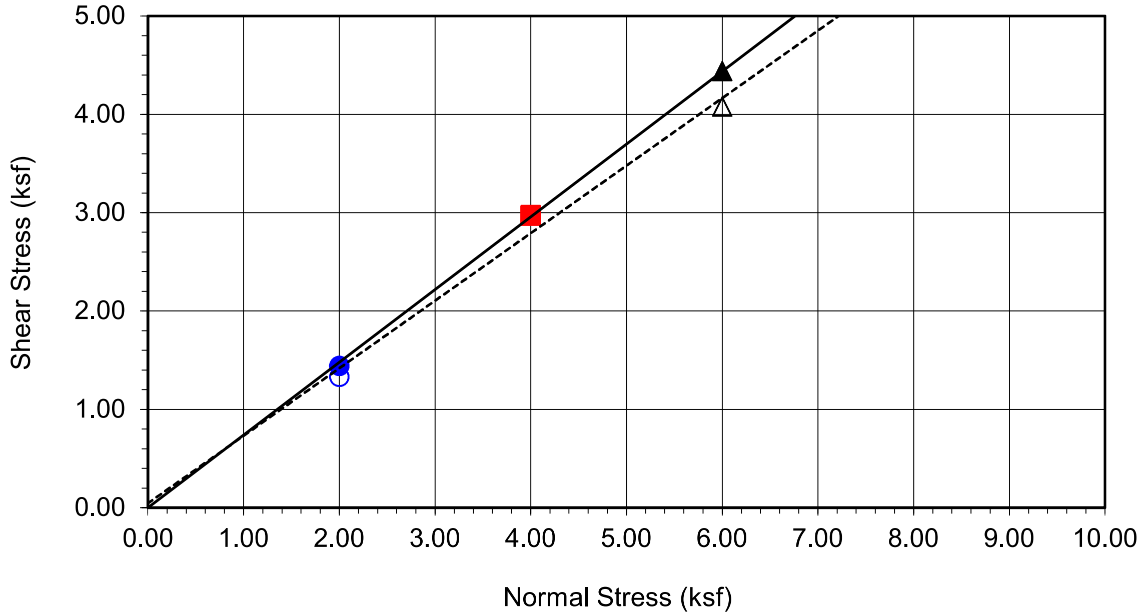
DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-34**
Sample No.	**R-5**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Olive yellow silty sand (SM)

Strength Parameters

	C (psf)	ϕ (°)
Peak	0	36
Ultimate	45	34

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.440	■ 2.974	▲ 4.439
Shear Stress @ End of Test (ksf)	○ 1.330	□ 2.968	△ 4.077
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	5.87	5.87	5.87
Dry Density (pcf)	93.6	93.7	99.3
Saturation (%)	19.8	19.9	22.7
Soil Height Before Shearing (in.)	0.9432	0.9545	0.9477
Final Moisture Content (%)	20.6	19.8	18.7

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DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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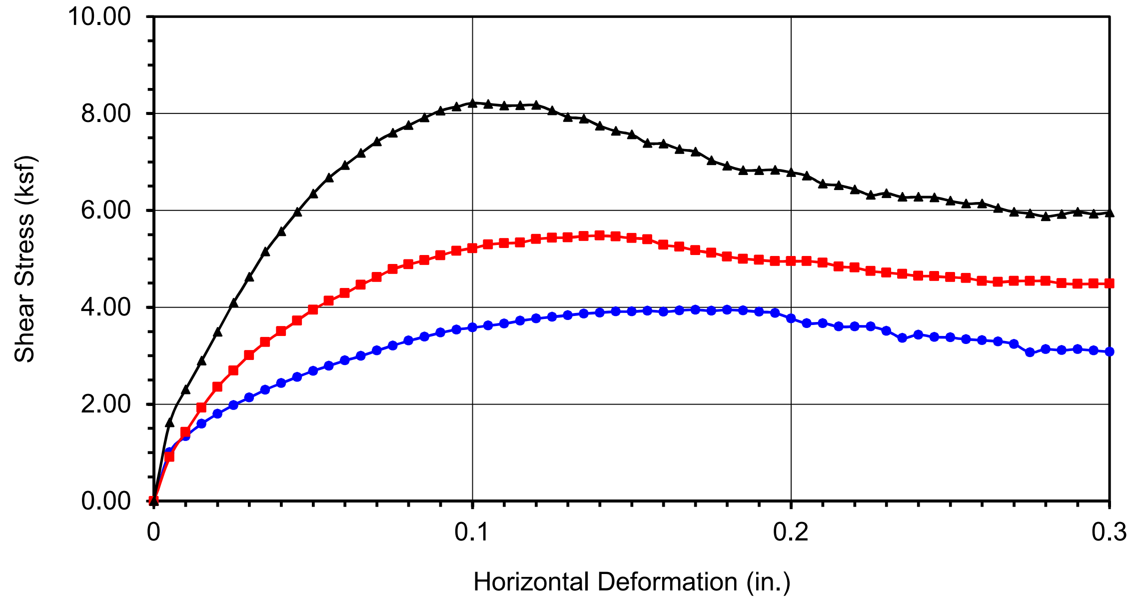
DIRECT SHEAR TEST

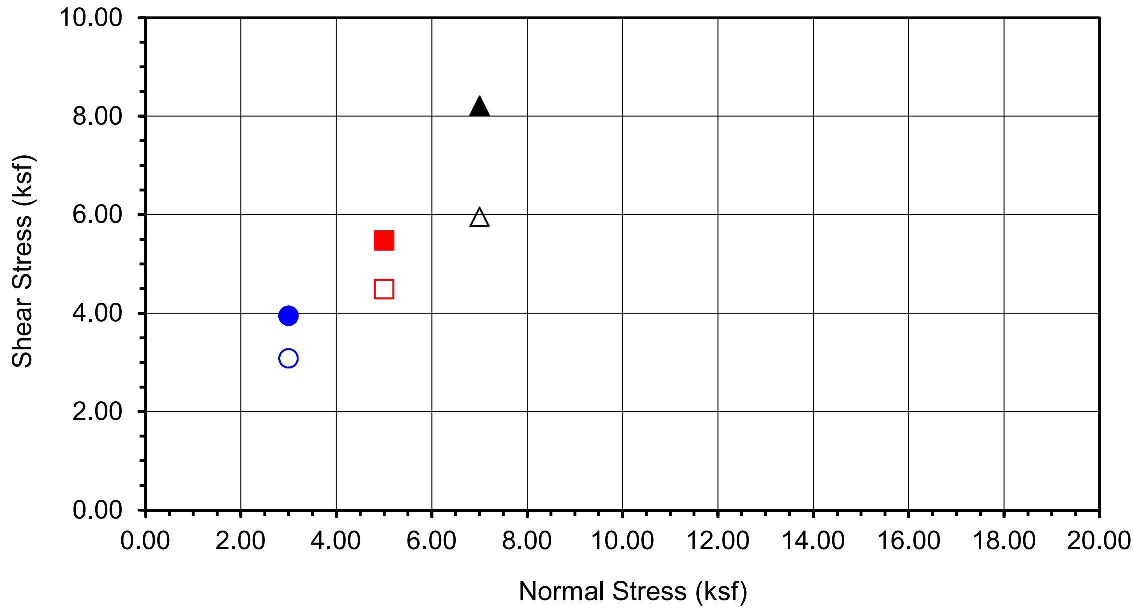
Consolidated Undrained

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/03/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-34	Sample Type:	Ring		
Sample No.:	R-9	Depth (ft.):	40.0		

Soil Identification: Greenish gray silty, clayey sand with gravel (SC-SM)g

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	200.21	204.40	208.04
Weight of Ring(gm):	44.22	43.67	45.44
Before Shearing			
Weight of Wet Sample+Cont.(gm):	117.58	117.58	117.58
Weight of Dry Sample+Cont.(gm):	109.50	109.50	109.50
Weight of Container(gm):	53.70	53.70	53.70
Vertical Rdg.(in): Initial	0.2496	0.2534	0.0000
Vertical Rdg.(in): Final	0.2709	0.2818	-0.0238
After Shearing			
Weight of Wet Sample+Cont.(gm):	221.92	221.25	226.57
Weight of Dry Sample+Cont.(gm):	199.46	200.65	205.92
Weight of Container(gm):	68.91	64.17	69.37
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-34**
Sample No.	**R-9**
Depth (ft)	**40**

Sample Type:

Ring

Soil Identification:
Greenish gray silty, clayey sand with gravel (SC-SM)g

Normal Stress (kip/ft²)	3.000	5.000	7.000
Peak Shear Stress (kip/ft²)	● 3.949	■ 5.476	▲ 8.212
Shear Stress @ End of Test (ksf)	○ 3.084	□ 4.486	△ 5.954
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.48	14.48	14.48
Dry Density (pcf)	113.3	116.8	118.1
Saturation (%)	80.2	88.1	91.6
Soil Height Before Shearing (in.)	0.9787	0.9716	0.9762
Final Moisture Content (%)	17.2	15.1	15.1

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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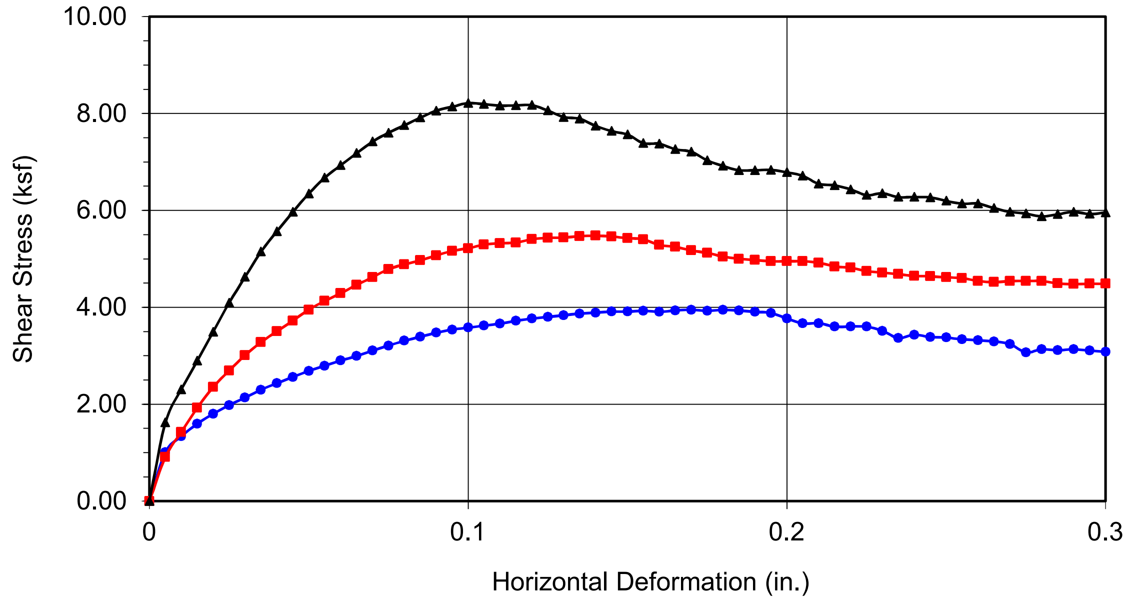

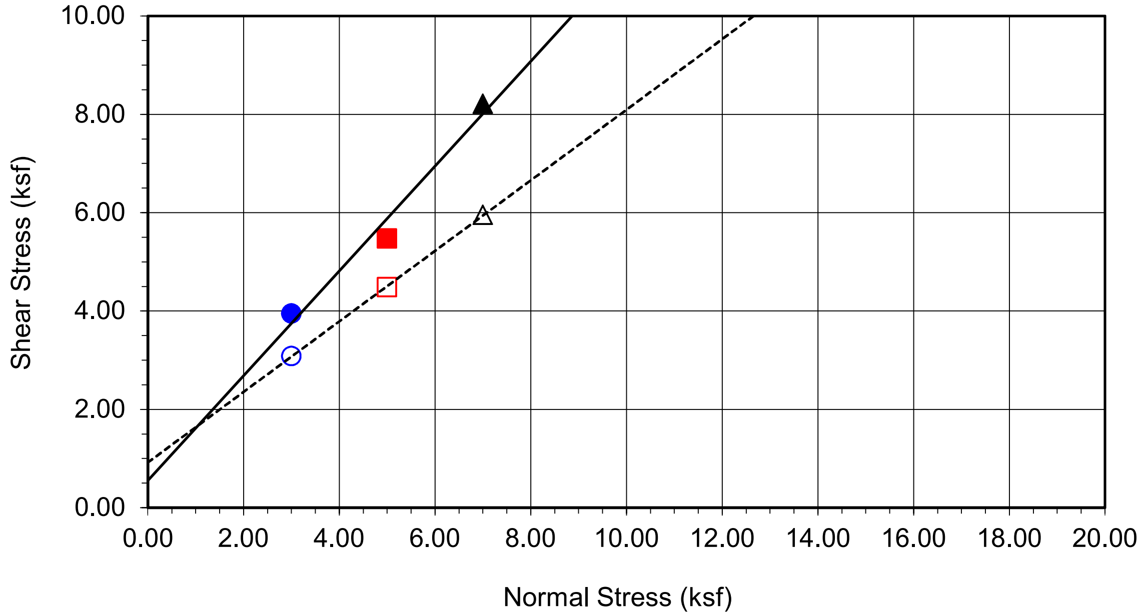

Boring No.	**LB-34**
Sample No.	**R-9**
Depth (ft)	**40**
Sample Type:	Ring
Soil Identification: Greenish gray silty, clayey sand with gravel (SC-SM)g	

Strength Parameters

	C (psf)	ϕ (°)
Peak	550	47
Ultimate	920	36

Normal Stress (kip/ft²)	3.000	5.000	7.000
Peak Shear Stress (kip/ft²)	● 3.949	■ 5.476	▲ 8.212
Shear Stress @ End of Test (ksf)	○ 3.084	□ 4.486	△ 5.954
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.48	14.48	14.48
Dry Density (pcf)	113.3	116.8	118.1
Saturation (%)	80.2	88.1	91.6
Soil Height Before Shearing (in.)	0.9787	0.9716	0.9762
Final Moisture Content (%)	17.2	15.1	15.1

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DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

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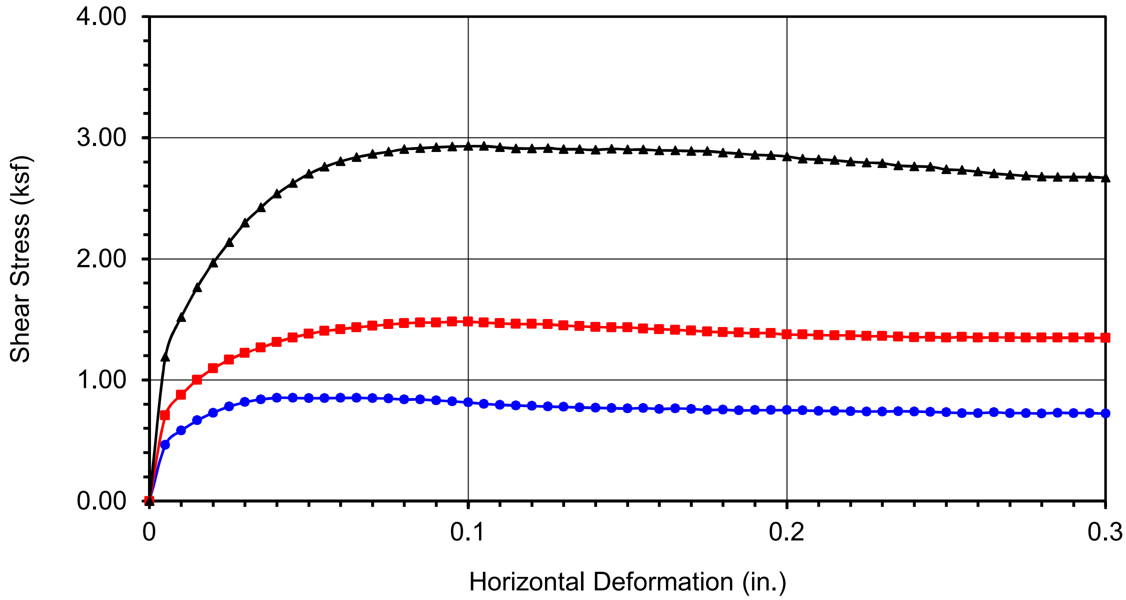
DIRECT SHEAR TEST

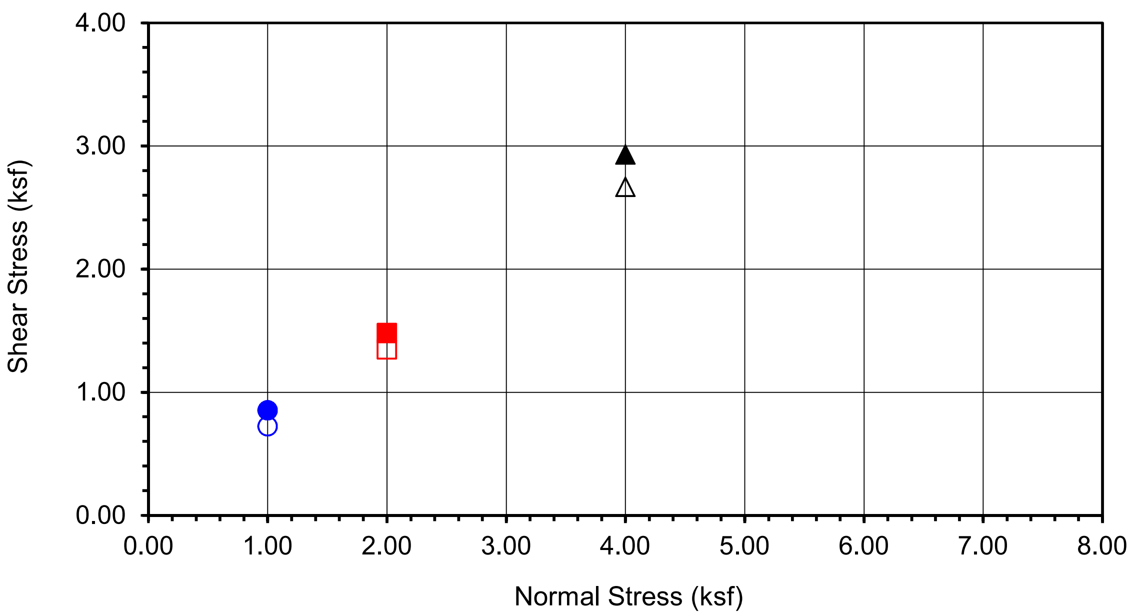
Consolidated Drained - ASTM D 3080

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/29/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-38	Sample Type:	Ring		
Sample No.:	R-6	Depth (ft.):	18.5		

Soil Identification: Dark olive gray silt (ML), noted hydrocarbon smell

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	188.12	194.19	198.82
Weight of Ring(gm):	43.73	45.24	46.18
Before Shearing			
Weight of Wet Sample+Cont.(gm):	166.40	166.40	166.40
Weight of Dry Sample+Cont.(gm):	149.56	149.56	149.56
Weight of Container(gm):	68.91	68.91	68.91
Vertical Rdg.(in): Initial	0.0000	0.2510	0.0000
Vertical Rdg.(in): Final	-0.0139	0.2660	-0.0237
After Shearing			
Weight of Wet Sample+Cont.(gm):	209.62	221.22	208.36
Weight of Dry Sample+Cont.(gm):	182.67	196.40	186.79
Weight of Container(gm):	64.90	73.39	57.28
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**LB-38**
Sample No.	**R-6**
Depth (ft)	**18.5**

Sample Type:

Ring

Soil Identification:
Dark olive gray silt (ML), noted hydrocarbon smell

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.852	■ 1.481	▲ 2.930
Shear Stress @ End of Test (ksf)	○ 0.723	□ 1.346	△ 2.669
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.88	20.88	20.88
Dry Density (pcf)	99.3	102.5	105.0
Saturation (%)	80.9	87.4	93.2
Soil Height Before Shearing (in.)	0.9861	0.9850	0.9763
Final Moisture Content (%)	22.9	20.2	16.7

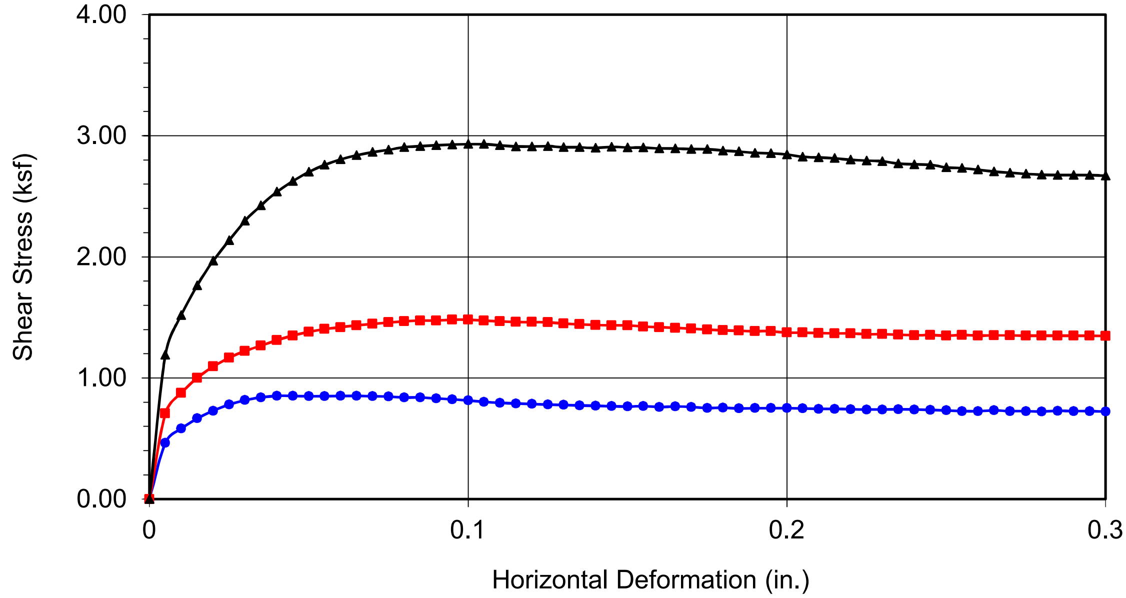
Leighton

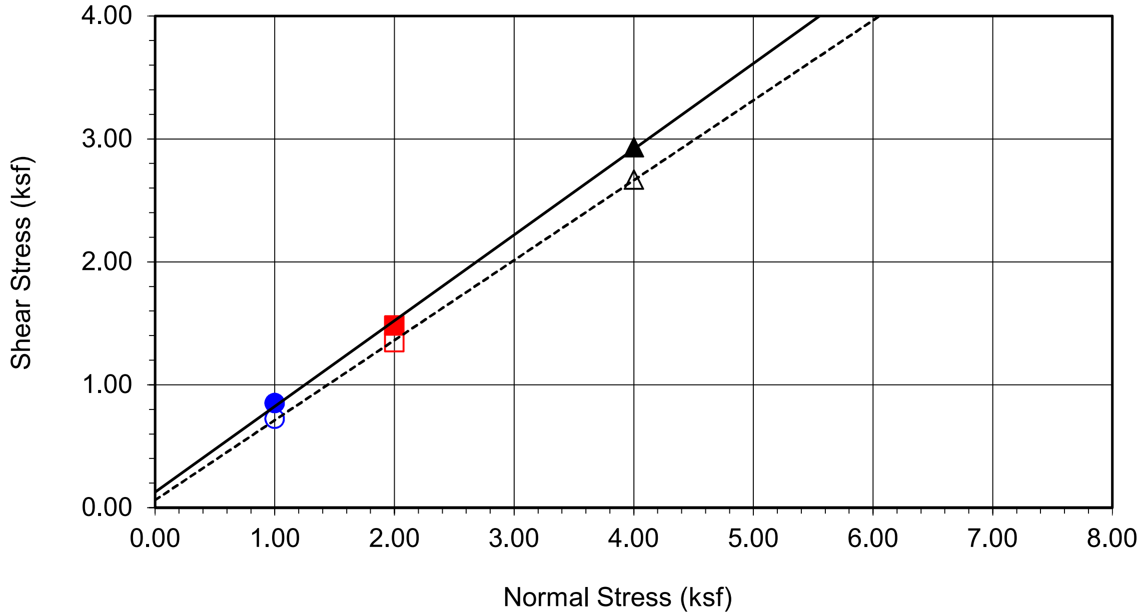
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-38**
Sample No.	**R-6**
Depth (ft)	**18.5**
Sample Type:	Ring

Soil Identification:
Dark olive gray silt (ML), noted hydrocarbon smell

Strength Parameters

	C (psf)	ϕ (°)
Peak	128	35
Ultimate	62	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.852	■ 1.481	▲ 2.930
Shear Stress @ End of Test (ksf)	○ 0.723	□ 1.346	△ 2.669
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.88	20.88	20.88
Dry Density (pcf)	99.3	102.5	105.0
Saturation (%)	80.9	87.4	93.2
Soil Height Before Shearing (in.)	0.9861	0.9850	0.9763
Final Moisture Content (%)	22.9	20.2	16.7

Leighton

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11585.005

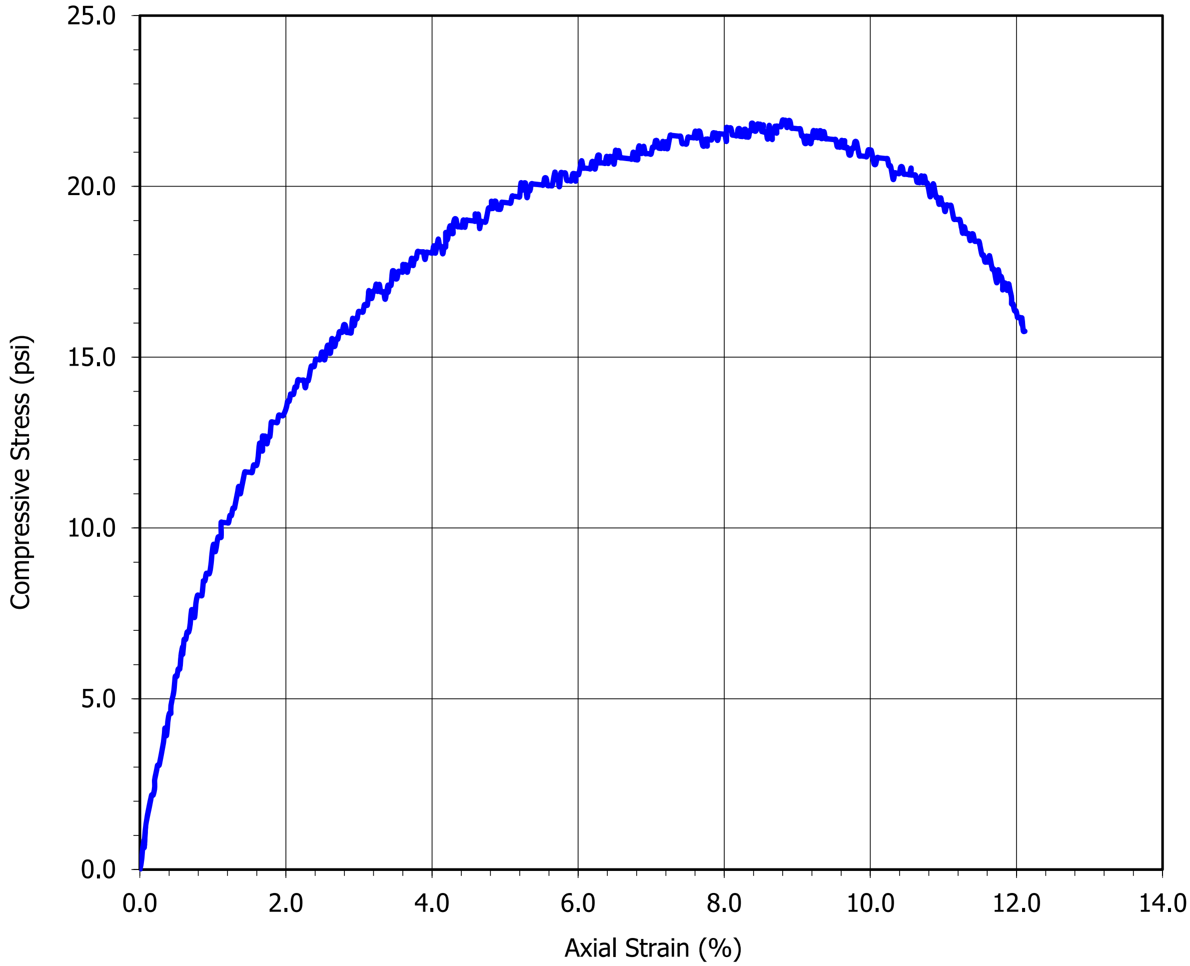
Brea Boulevard Additional Borings

10-20

APPENDIX C.4

Shear Strength:

Uniaxial Compression



Boring No.:	LB-2
Sample No.:	R-5
Depth (ft):	14.0
Soil Type:	Ring
Sample Description:	Olive brown lean clay (CL)

Sample Diameter (in.)	2.413
Sample Height (in.)	4.944
Initial Moisture Content (%)	19.26
Dry Density (pcf)	105.7
Specific Gravity (assumed)	2.70
Saturation (%)	87.6
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.05

At Failure

Compressive Strength (psi)	**21.94**
Axial Strain (%)	8.80

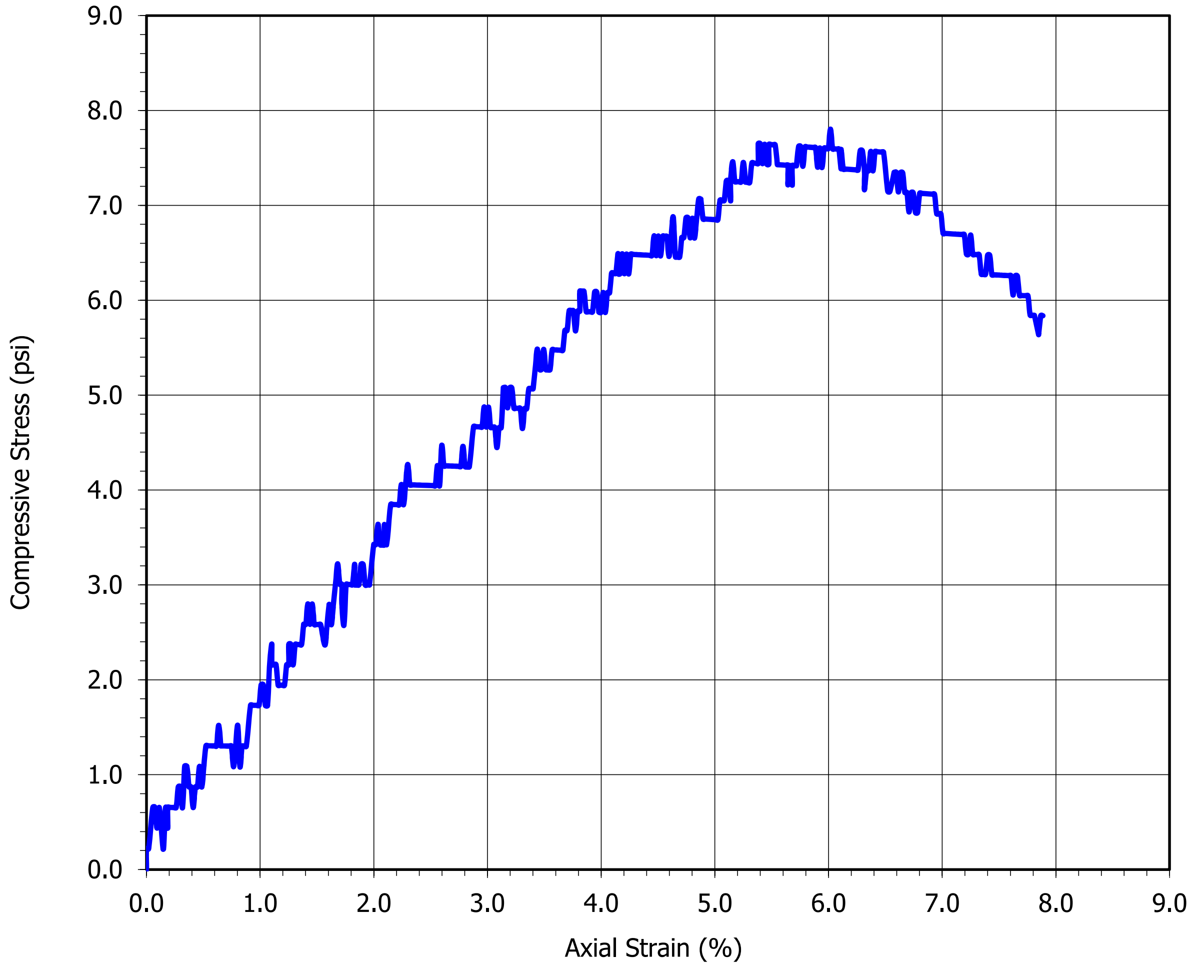
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-2
Sample No.:	R-7
Depth (ft):	20.0
Soil Type:	Ring
Sample Description:	Olive silty sand (SM)

Sample Diameter (in.)	2.414
Sample Height (in.)	5.352
Initial Moisture Content (%)	20.55
Dry Density (pcf)	107.2
Specific Gravity (assumed)	2.70
Saturation (%)	97.1
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.22

At Failure

Compressive Strength (psi)	**7.80**
Axial Strain (%)	6.02

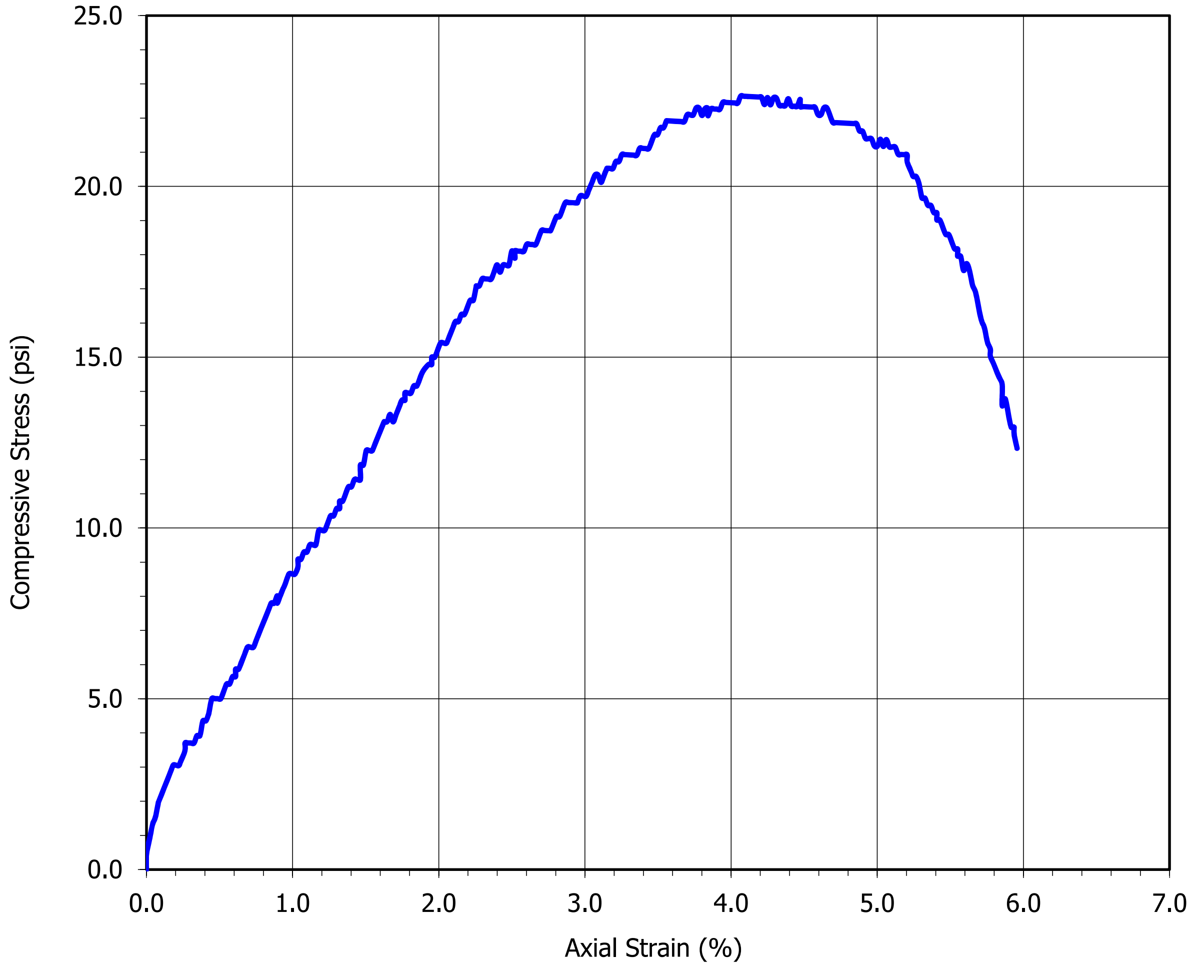
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-4
Sample No.:	R-5
Depth (ft):	14.0
Soil Type:	Ring
Sample Description:	Olive brown clayey sand (SC)

Sample Diameter (in.)	2.414
Sample Height (in.)	4.919
Initial Moisture Content (%)	17.80
Dry Density (pcf)	109.0
Specific Gravity (assumed)	2.70
Saturation (%)	88.1
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.04

At Failure

Compressive Strength (psi)	**22.64**
Axial Strain (%)	4.07

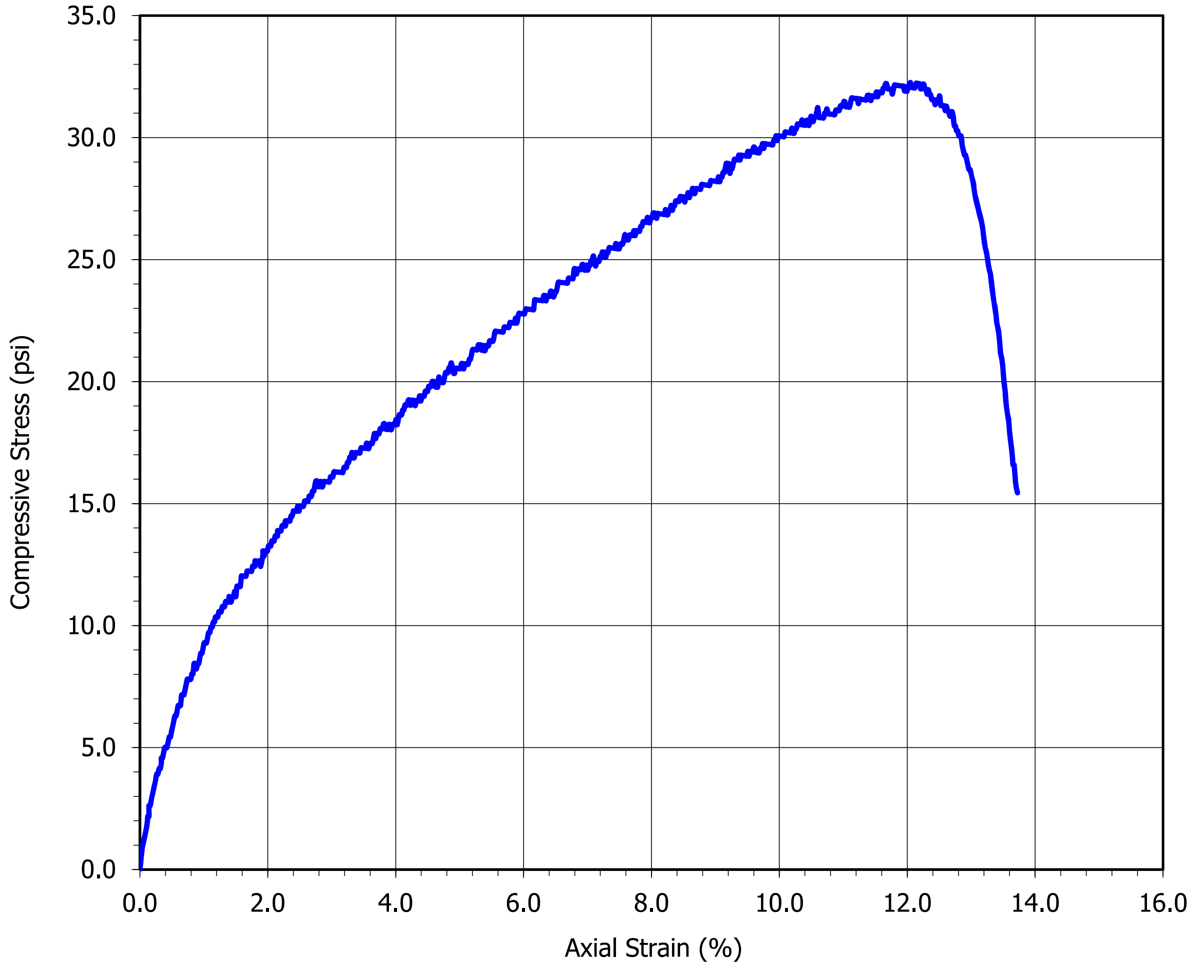
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-26
Sample No.:	R-4
Depth (ft):	18.5
Soil Type:	Ring
Sample Description:	Dark olive lean clay (CL)

Sample Diameter (in.)	2.415
Sample Height (in.)	5.669
Initial Moisture Content (%)	20.92
Dry Density (pcf)	103.4
Specific Gravity (assumed)	2.70
Saturation (%)	89.8
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.35

At Failure

Compressive Strength (psi)	**32.26**
Axial Strain (%)	12.05

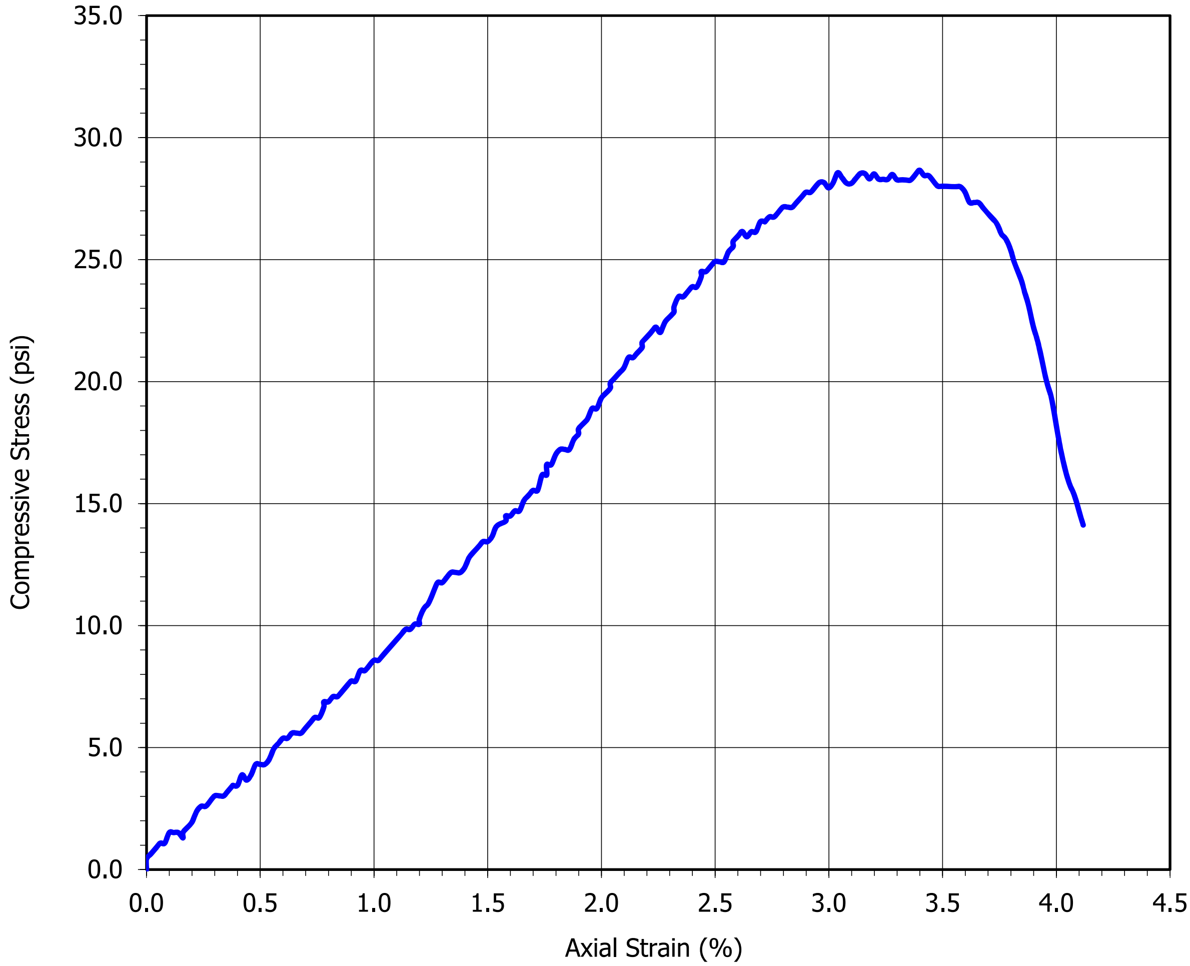
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20



Boring No.:	LB-39
Sample No.:	R-7
Depth (ft):	30
Soil Type:	Ring
Sample Description:	Light olive (SP-SM) & ML

Sample Diameter (in.)	2.425
Sample Height (in.)	5.002
Initial Moisture Content (%)	16.19
Dry Density (pcf)	108.8
Specific Gravity (assumed)	2.70
Saturation (%)	79.6
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.06

At Failure

Compressive Strength (psi)	**28.66**
Axial Strain (%)	3.40

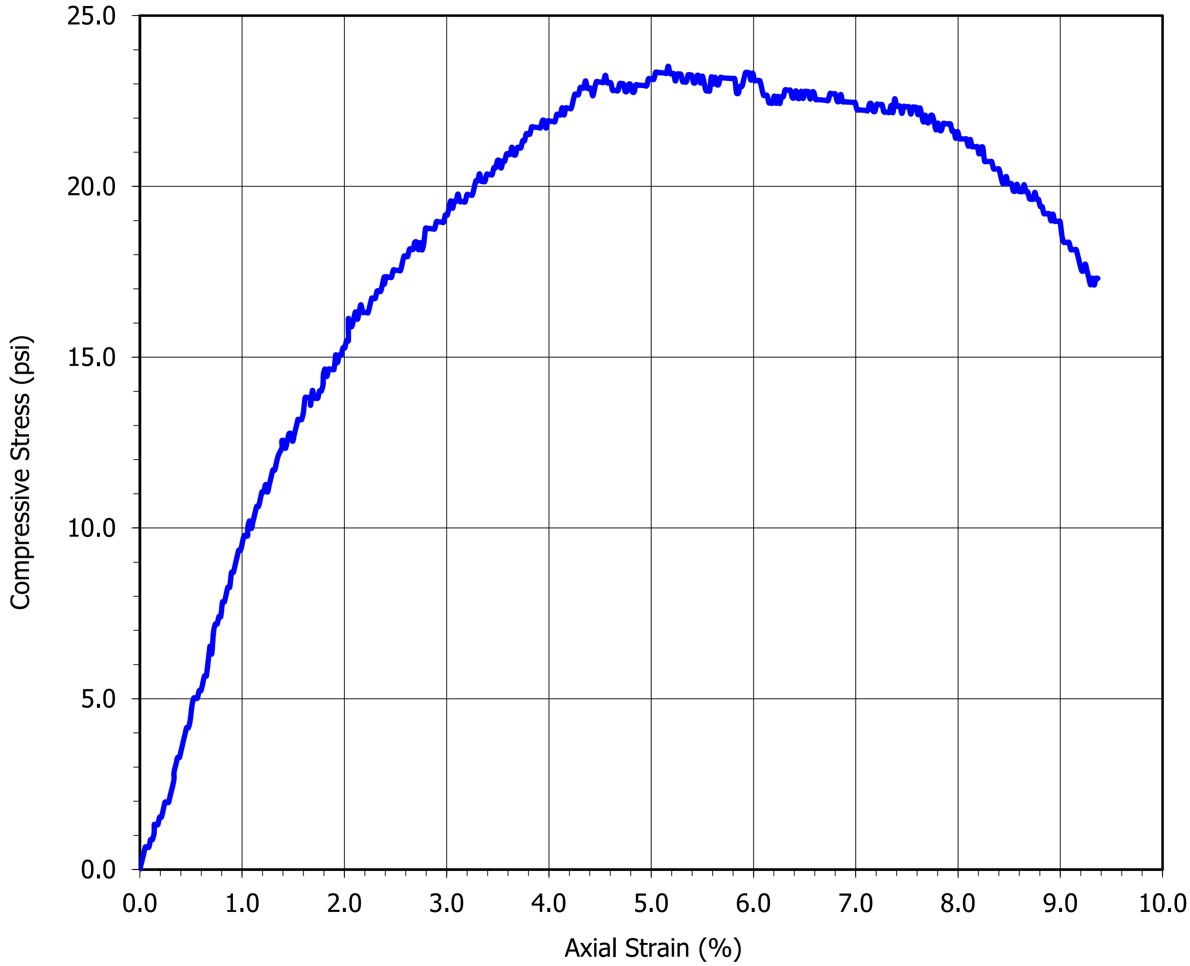
Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20



Boring No.:	LB-40
Sample No.:	R-7
Depth (ft):	30
Soil Type:	Ring
Sample Description:	Dark olive gray silt (ML)

Sample Diameter (in.)	2.409
Sample Height (in.)	5.690
Initial Moisture Content (%)	33.47
Dry Density (pcf)	85.9
Specific Gravity (assumed)	2.70
Saturation (%)	94.0
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.36

At Failure

Compressive Strength (psi)	**23.52**
Axial Strain (%)	5.17

Leighton

Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20

APPENDIX C.5

Shear Strength:

Triaxial Compression

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4	Sample Type:	Ring		
Sample No.:	R-11				
Depth (ft.):	40.0				
Soil Description	Dark olive silt'stone' (ML)				

Diameter (in)	2.402	2.400	2.401	Avg. =	2.401
Height (in)	5.102	5.103	5.103	Avg. =	5.103

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.528	4.522	4.468	
Moisture Content (%)	18.09			21.80
Wt. Wet Sample + Cont. (g)	179.60			858.30
Wt. Dry Sample + Cont. (g)	159.00			718.00
Wt. Container (g)	45.10			74.40
Density and Saturation				
Wt. Wet Sample + Cont. (g)	763.20			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	125.8			132.6
Dry Density (pcf)	106.6			108.9
Void Ratio	0.581			0.547
% Saturation	84.1			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

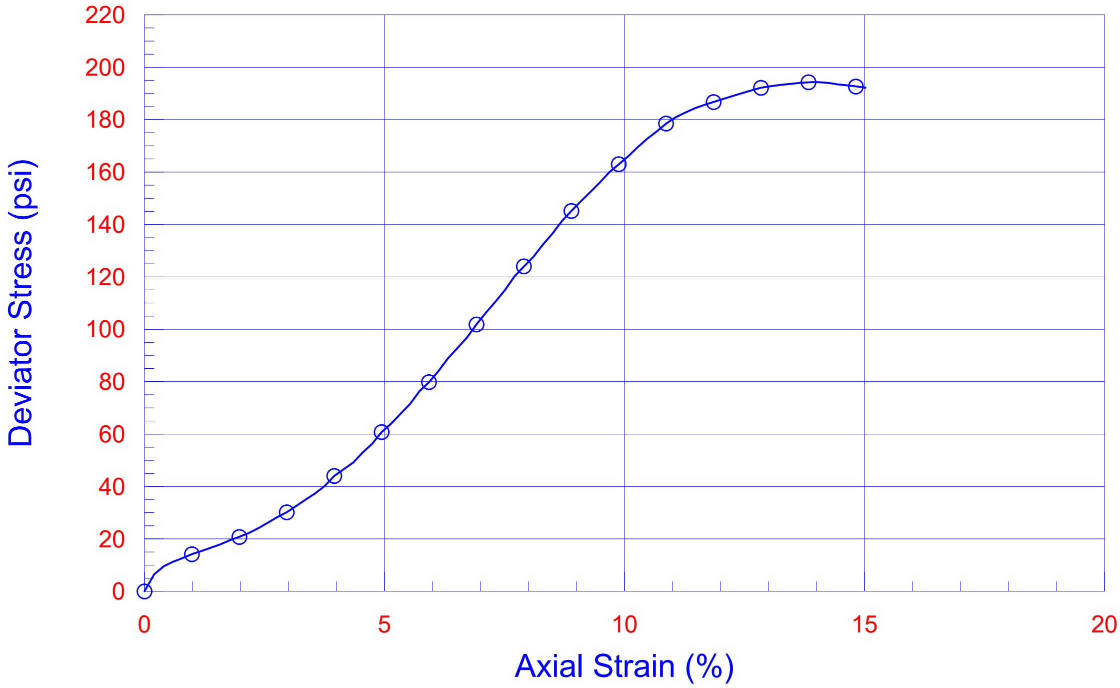
		Burette Area (sq. in.)=	0.397
		Initial Burette Ht.(cm)=	26.0
		Final Burette Ht.(cm)=	9.8
		Volume of water during saturation (cc):	41.5
B Value (%) =	95	Change in Height (in)=	0.003

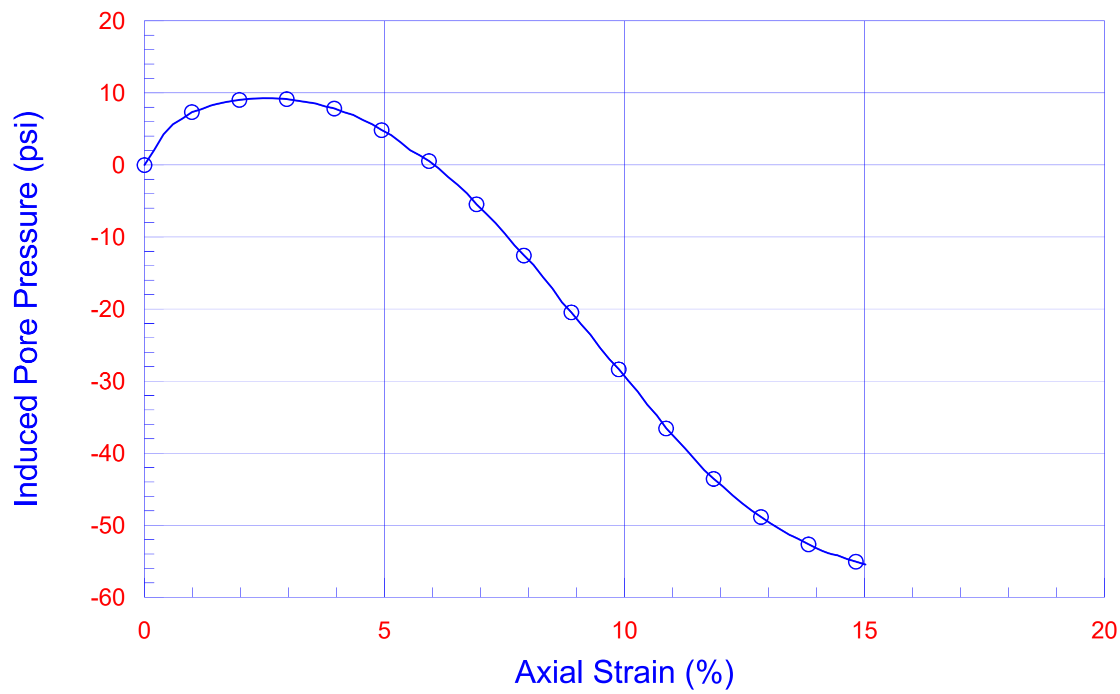
Consolidation

Cell Pressure (psi) =	96.35	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	81.35	Initial Burette Ht.(cm)=	3.8
Eff. Consol. Stress (psi) =	15.00	Final Burette Ht.(cm)=	6.7
Change in Height (in) =	0.0390	Final Height (in)=	5.061

Shear

		At Failure	
Rate of Deformation (in/min)=	0.0052	Deviator Stress (psi) =	194.3
Time to 50% primary Consolidation =	4.50 min	Eff. Minor Principal stress (psi) =	68.3
Failure Criterion:		Eff. Major Principal stress (psi) =	262.6
Maximum deviator stress, to 15% axial strain		Axial Strain (%) =	14.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-11	40.0	15.0	194.3
□					
△					

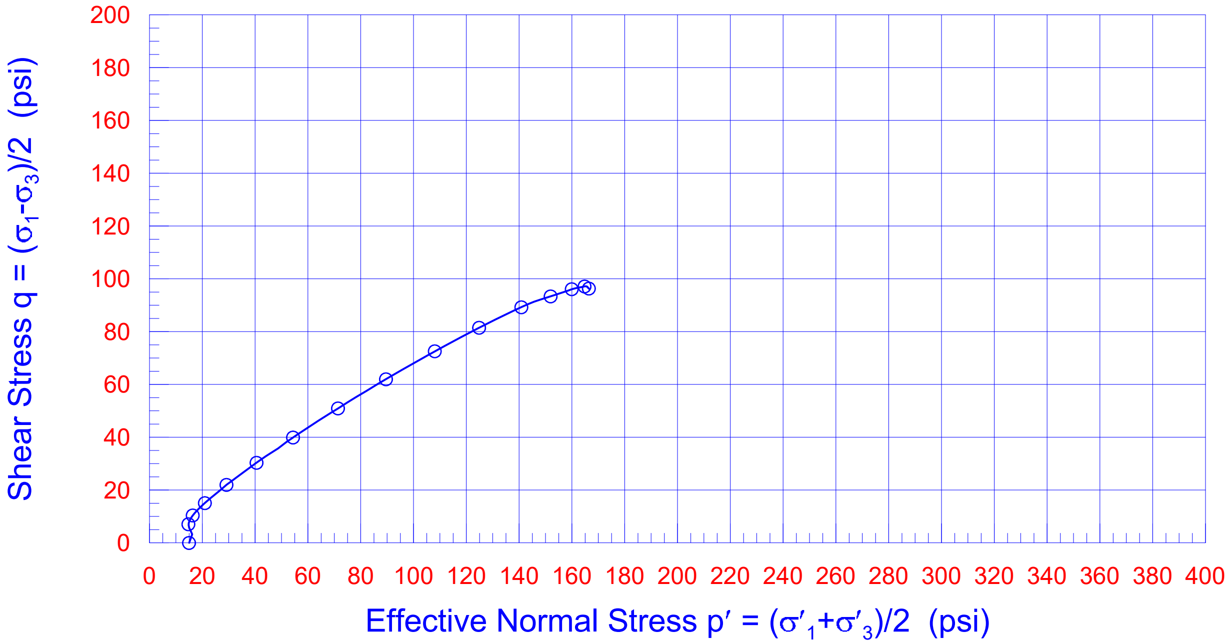
Leighton

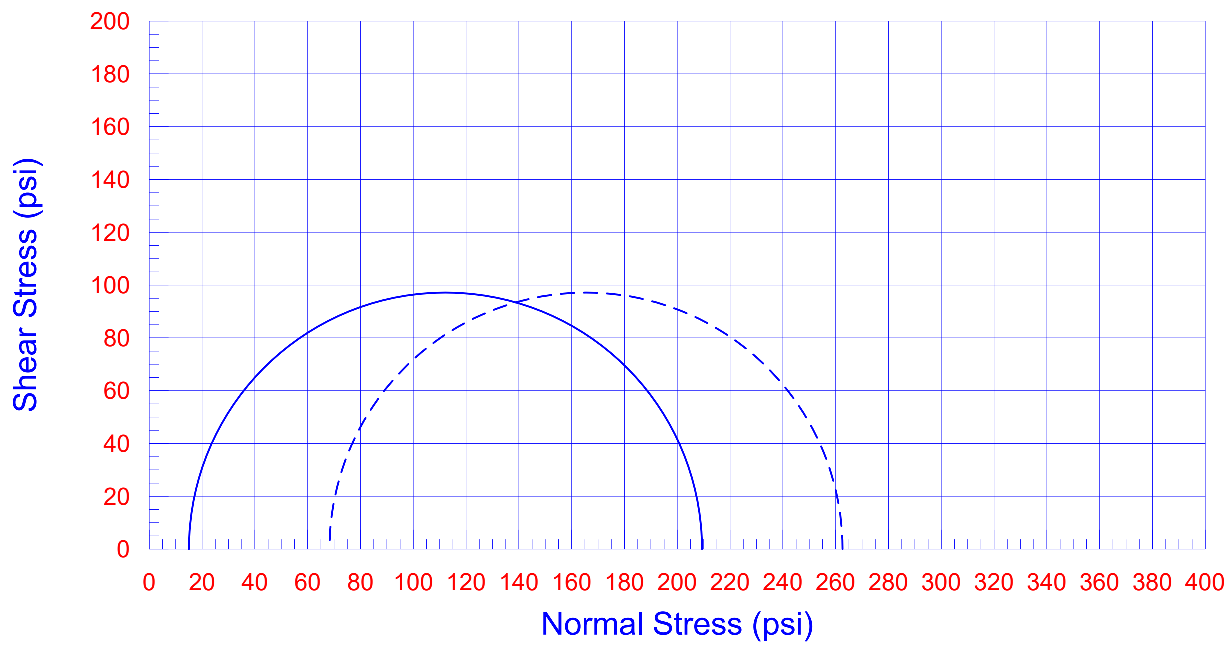
Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

09-18





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-11	40.0	15.0	194.3
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

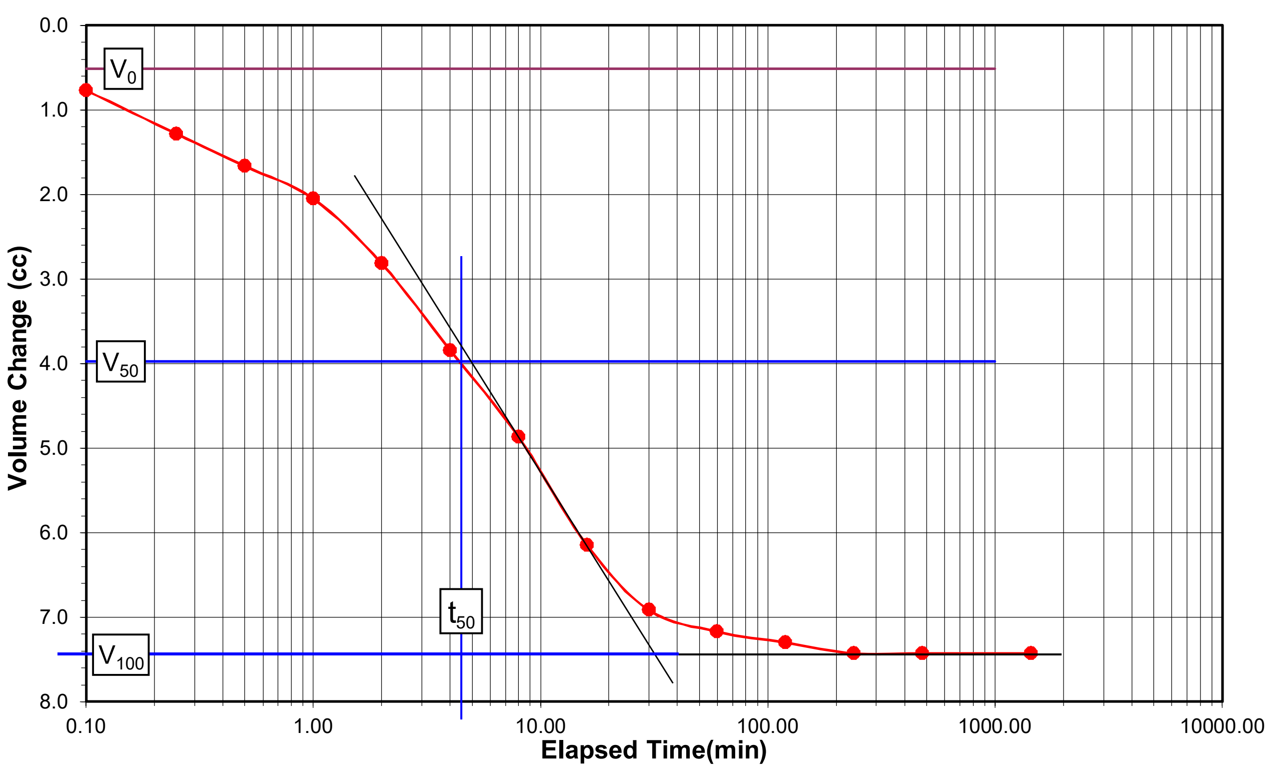
09-18

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	40.0
Boring No.:	LB-4	Eff. Stress (psi):	15.00
Sample No.:	R-11	Burette Area:	0.397 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/28/18	9:20:00			Initial Burette	3.80	
08/28/18	9:20:06	0.10	0.32		4.10	0.8
08/28/18	9:20:15	0.25	0.50		4.30	1.3
08/28/18	9:20:30	0.50	0.71		4.45	1.7
08/28/18	9:21:00	1.00	1.00		4.60	2.0
08/28/18	9:22:00	2.00	1.41		4.90	2.8
08/28/18	9:24:00	4.00	2.00		5.30	3.8
08/28/18	9:28:00	8.00	2.83		5.70	4.9
08/28/18	9:36:00	16.00	4.00		6.20	6.1
08/28/18	9:50:00	30.00	5.48		6.50	6.9
08/28/18	10:20:00	60.00	7.75		6.60	7.2
08/28/18	11:20:00	120.00	10.95		6.65	7.3
08/28/18	13:20:00	240.00	15.49		6.70	7.4
08/28/18	17:20:00	480.00	21.91		6.70	7.4
08/29/18	9:20:00	1440.00	37.95		6.70	7.4



V_0	(cc)	0.51
V_{100}	(cc)	7.43
V_{50}	(cc)	3.97
t_{50}	(min)	4.50
Height After Consolidation	(in)	5.061
Strain Rate	(in/min)	**0.0045**
Duration of Test*	(hr)	2.8

*Based on a total strain of 15%

Height (ft)		5.102
		5.103
		5.103
Average		5.103
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2880	0.2930
Final Rdg. (in)	0.2910	0.3320

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4				
Sample No.:	R-11				
Depth (ft.):	40.0				
Sample Type:	Ring				

15.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4	Sample Type:	Ring		
Sample No.:	R-15				
Depth (ft.):	60.0				
Soil Description	Dark olive silt (ML)				

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Diameter (in)	2.423	2.423	2.423	Avg. = 2.423
Height (in)	5.480	5.481	5.482	Avg. = 5.481
Area (in²)	4.611	4.601	4.516	
Moisture Content (%)	16.82			22.13
Wt. Wet Sample + Cont. (g)	110.00			924.60
Wt. Dry Sample + Cont. (g)	104.50			770.80
Wt. Container (g)	71.80			75.80
Density and Saturation				
Wt. Wet Sample + Cont. (g)	822.50			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	124.0			134.6
Dry Density (pcf)	106.1			110.2
Void Ratio	0.588			0.529
% Saturation	77.3			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

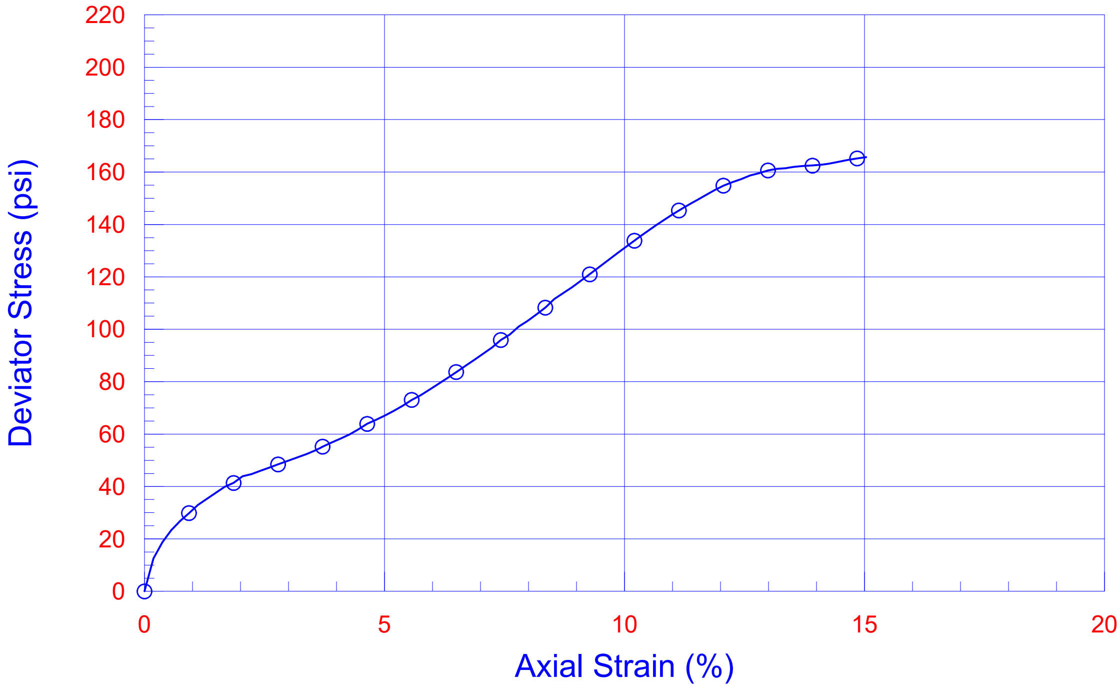
		Burette Area (sq. in.)=	0.358
		Initial Burette Ht.(cm)=	25.0
		Final Burette Ht.(cm)=	3.5
		Volume of water during saturation (cc):	49.7
B Value (%) =	95	Change in Height (in)=	0.006

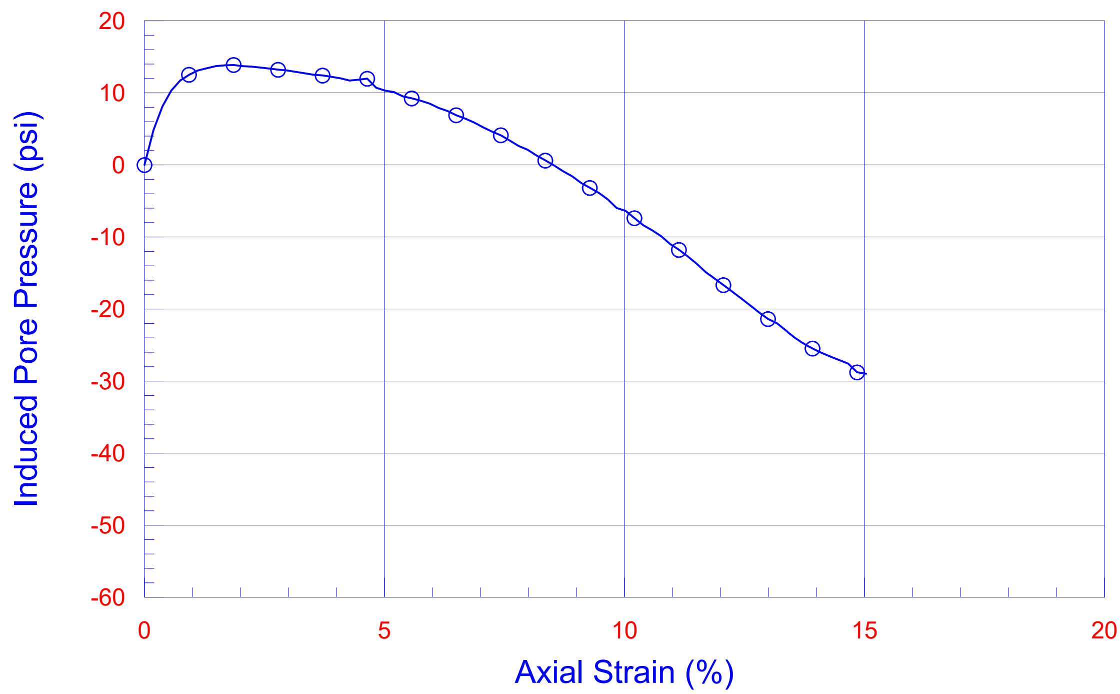
Consolidation

Cell Pressure (psi) =	111.37	Burette Area (sq. in.)=	0.3580
Back Pressure(psi) =	81.37	Initial Burette Ht.(cm)=	3.9
Eff. Consol. Stress (psi) =	30.00	Final Burette Ht.(cm)=	9.95
Change in Height (in) =	0.0860	Final Height (in)=	5.389

Shear

		At Failure	
Rate of Deformation (in/min)=	0.0052	Deviator Stress (psi) =	165.7
Time to 50% primary Consolidation =	2.00 min	Eff. Minor Principal stress (psi) =	59.0
Failure Criterion:		Eff. Major Principal stress (psi) =	224.7
Maximum deviator stress, to 15% axial strain		Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-15	60.0	30.0	165.7
□					
△					

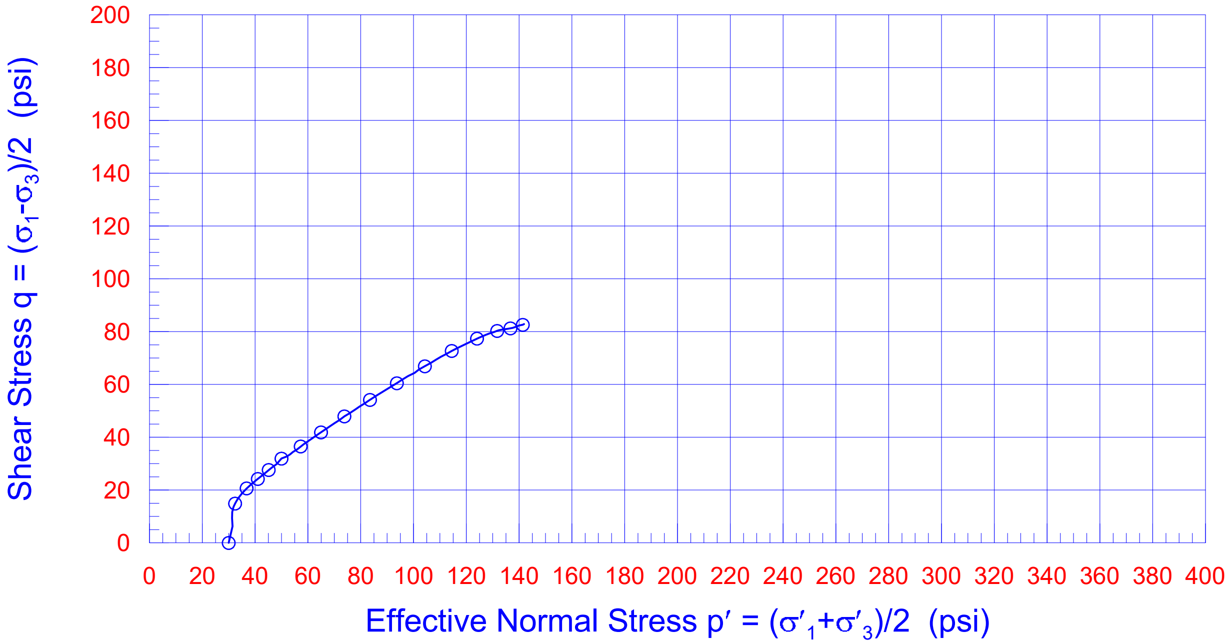
Leighton

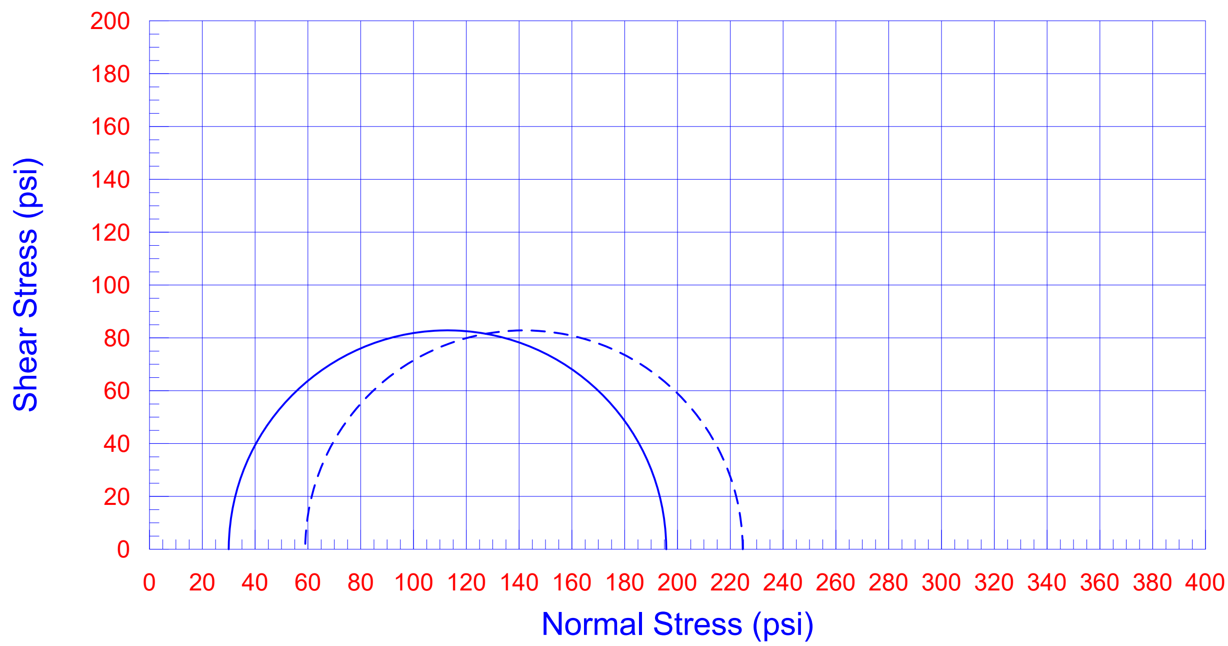
Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test ASTM D 4767

09-18





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-15	60.0	30.0	165.7
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

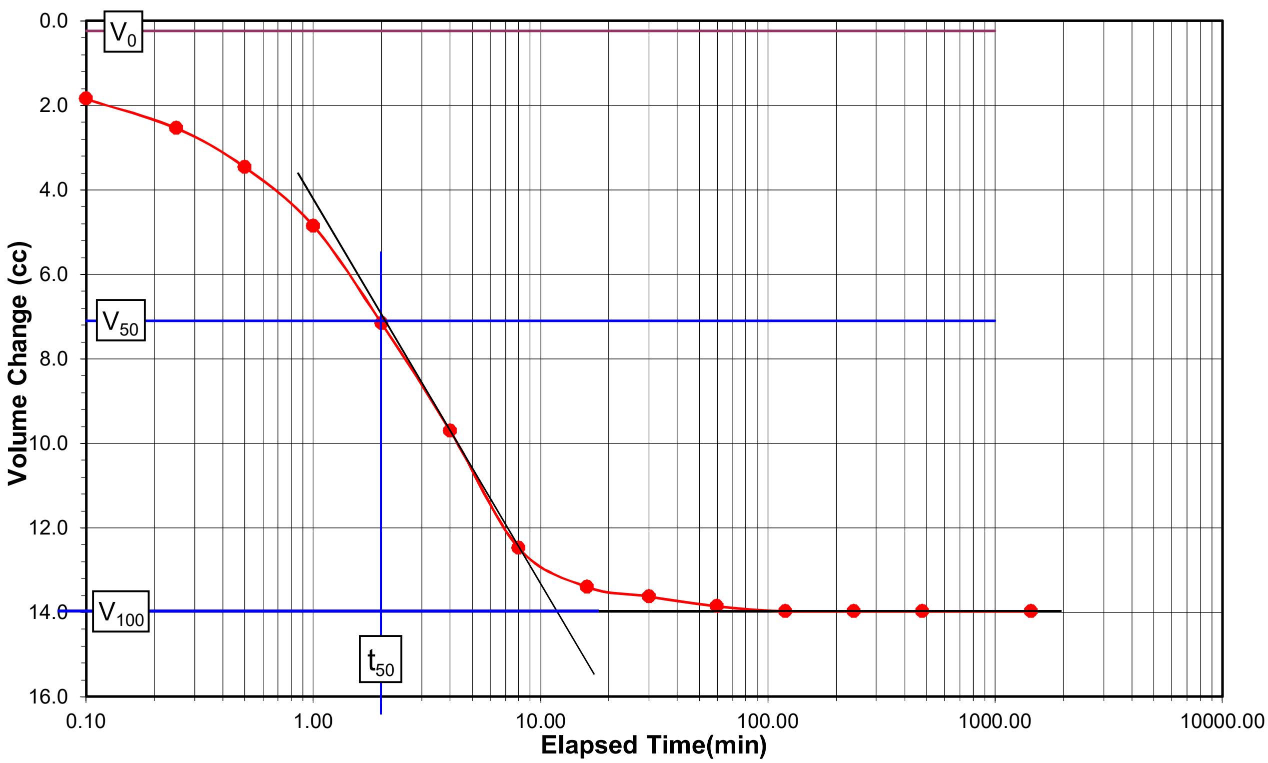
09-18

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	60.0
Boring No.:	LB-4	Eff. Stress (psi):	30.00
Sample No.:	R-15	Burette Area:	0.358 in^2

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/28/18	9:40:00			Initial Burette	3.90	
08/28/18	9:40:06	0.10	0.32		4.70	1.8
08/28/18	9:40:15	0.25	0.50		5.00	2.5
08/28/18	9:40:30	0.50	0.71		5.40	3.5
08/28/18	9:41:00	1.00	1.00		6.00	4.9
08/28/18	9:42:00	2.00	1.41		7.00	7.2
08/28/18	9:44:00	4.00	2.00		8.10	9.7
08/28/18	9:48:00	8.00	2.83		9.30	12.5
08/28/18	9:56:00	16.00	4.00		9.70	13.4
08/28/18	10:10:00	30.00	5.48		9.80	13.6
08/28/18	10:40:00	60.00	7.75		9.90	13.9
08/28/18	11:40:00	120.00	10.95		9.95	14.0
08/28/18	13:40:00	240.00	15.49		9.95	14.0
08/28/18	17:40:00	480.00	21.91		9.95	14.0
08/29/18	9:40:00	1440.00	37.95		9.95	14.0



V_0	(cc)	0.23
V_{100}	(cc)	13.97
V_{50}	(cc)	7.10
t_{50}	(min)	2.00
Height After Consolidation (in)		5.389
Strain Rate	(in/min)	**0.0108**
Duration of Test*	(hr)	1.3

*Based on a total strain of 15%

Height (ft)		5.480
		5.481
		5.482
Average		5.481
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1620	0.1220
Final Rdg. (in)	0.1680	0.2080

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4				
Sample No.:	R-15				
Depth (ft.):	60.0				
Sample Type:	Ring				

30.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/21/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/15/18
Boring No.:	LB-7	Sample Type:	Ring		
Sample No.:	R-9				
Depth (ft.):	30.0				
Soil Description	Brown lean clay (CL)				

Diameter (in)	2.421	2.420	2.420	Avg. =	2.420
Height (in)	5.501	5.501	5.502	Avg. =	5.501

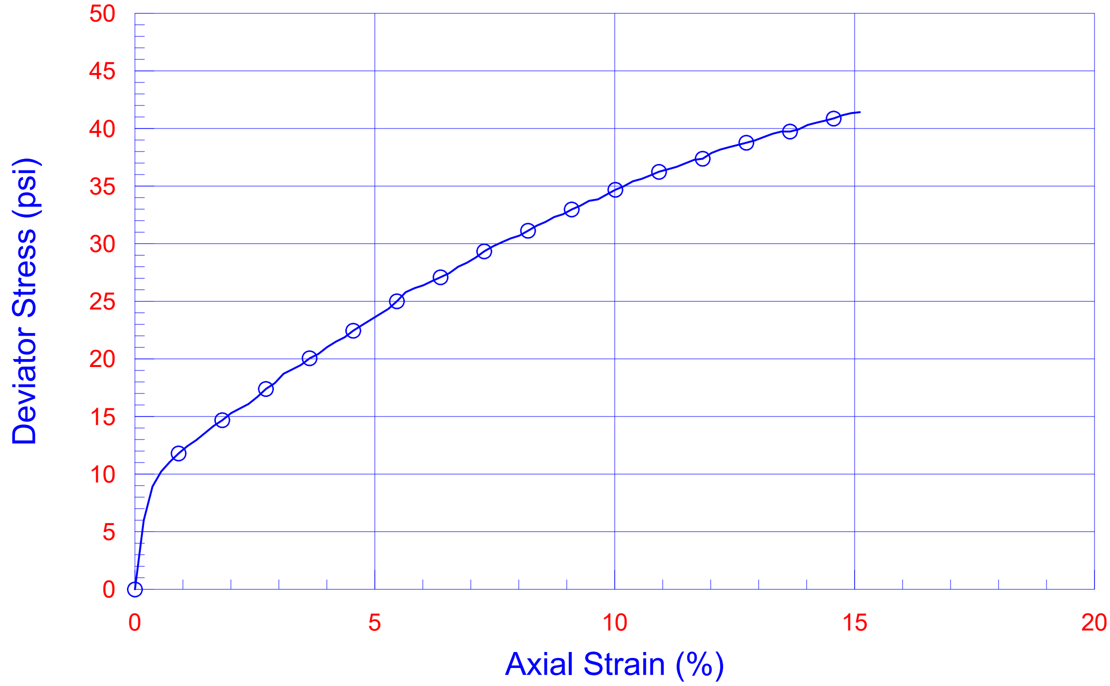
	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.601	4.599	4.528	
Moisture Content (%)	21.69			20.63
Wt. Wet Sample + Cont. (g)	89.30			915.60
Wt. Dry Sample + Cont. (g)	83.40			771.90
Wt. Container (g)	56.20			75.20
Density and Saturation				
Wt. Wet Sample + Cont. (g)	848.40			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	127.7			128.8
Dry Density (pcf)	104.9			106.8
Void Ratio	0.606			0.578
% Saturation	96.7			96.3

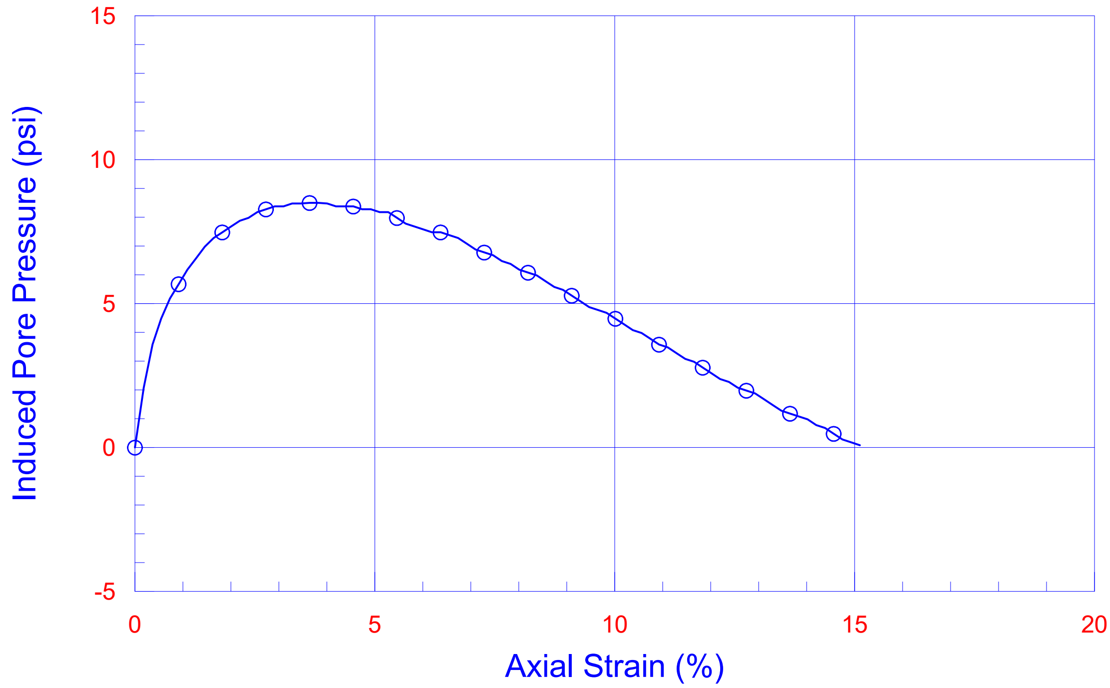
Specific Gravity (assumed) = 2.70

Back Pressure Saturation			
		Burette Area (sq. in.)=	0.357
		Initial Burette Ht.(cm)=	25.5
		Final Burette Ht.(cm)=	23.5
		Volume of water during saturation (cc):	4.6
B Value (%) =	96	Change in Height (in)=	0.001

Consolidation			
Cell Pressure (psi) =	84.12	Burette Area (sq. in.)=	0.3570
Back Pressure(psi) =	71.12	Initial Burette Ht.(cm)=	4.8
Eff. Consol. Stress (psi) =	13.00	Final Burette Ht.(cm)=	7.8
Change in Height (in) =	0.0070	Final Height (in)=	5.493

Shear		At Failure	
Rate of Deformation (in/min)=	0.0052	Deviator Stress (psi) =	41.4
Time to 50% primary Consolidation =	40.00 min	Eff. Minor Principal stress (psi) =	12.9
Failure Criterion:		Eff. Major Principal stress (psi) =	54.3
Maximum deviator stress, to 15% axial strain		Axial Strain (%) =	15.1





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-7	R-9	30.0	13.0	41.4
□					
△					

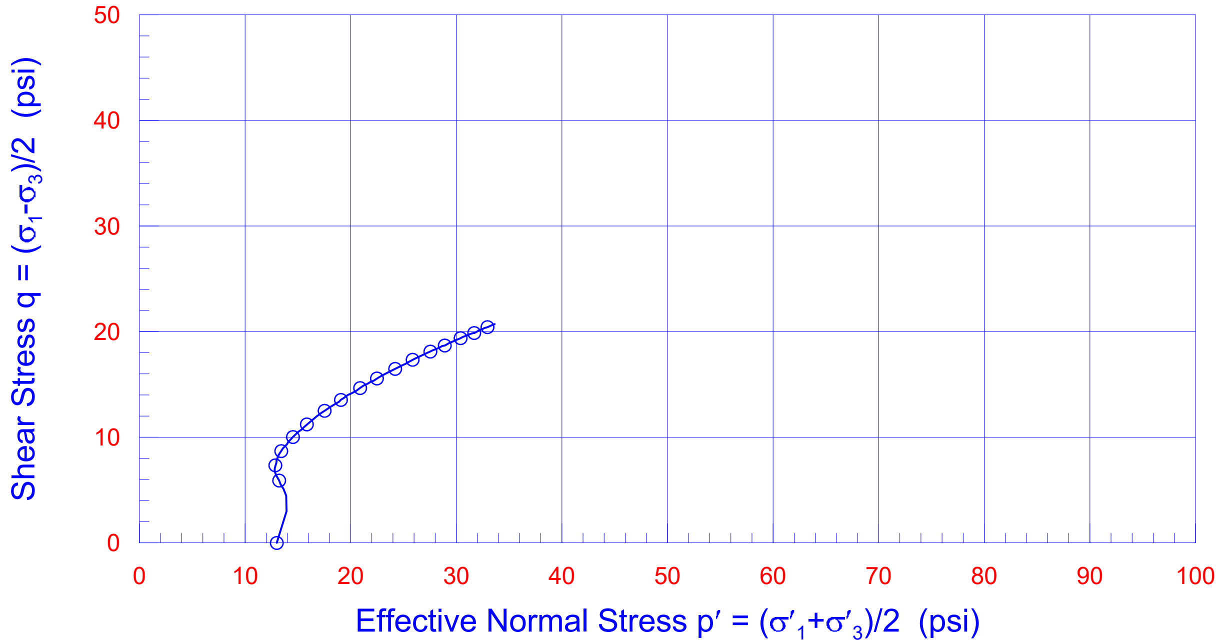
Leighton

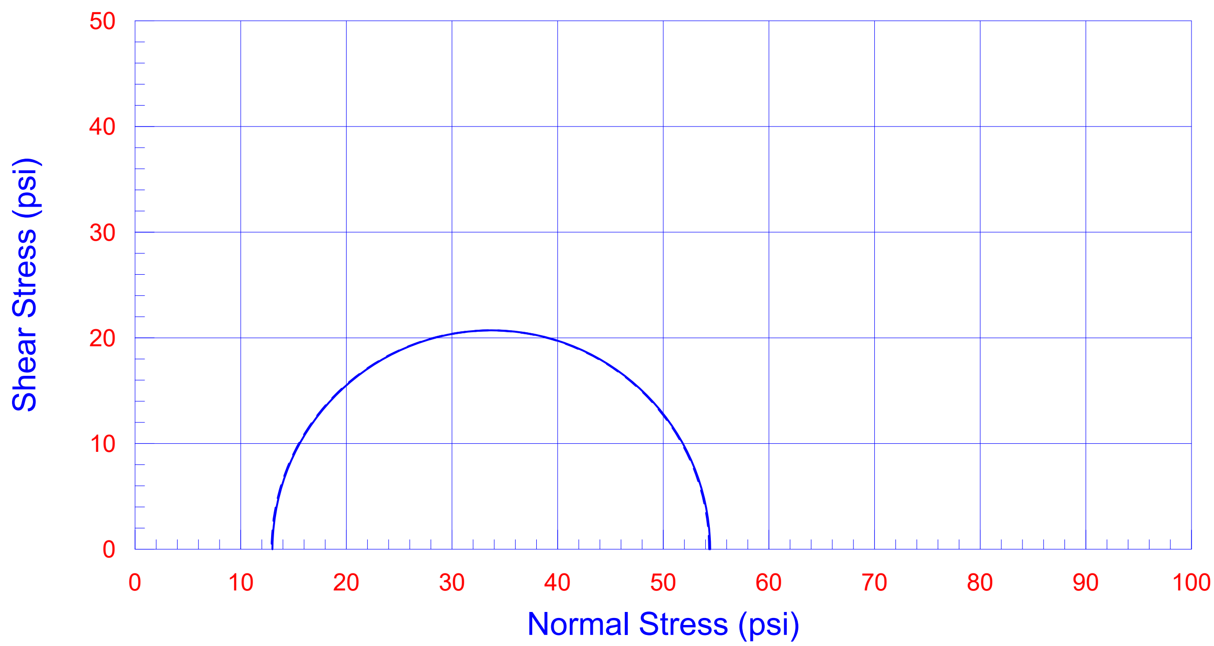
Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test ASTM D 4767

09-18





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-7	R-9	30.0	13.0	41.4
□					
△					

——— Mohr Circle based on Total Stress
– – – – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test ASTM D 4767

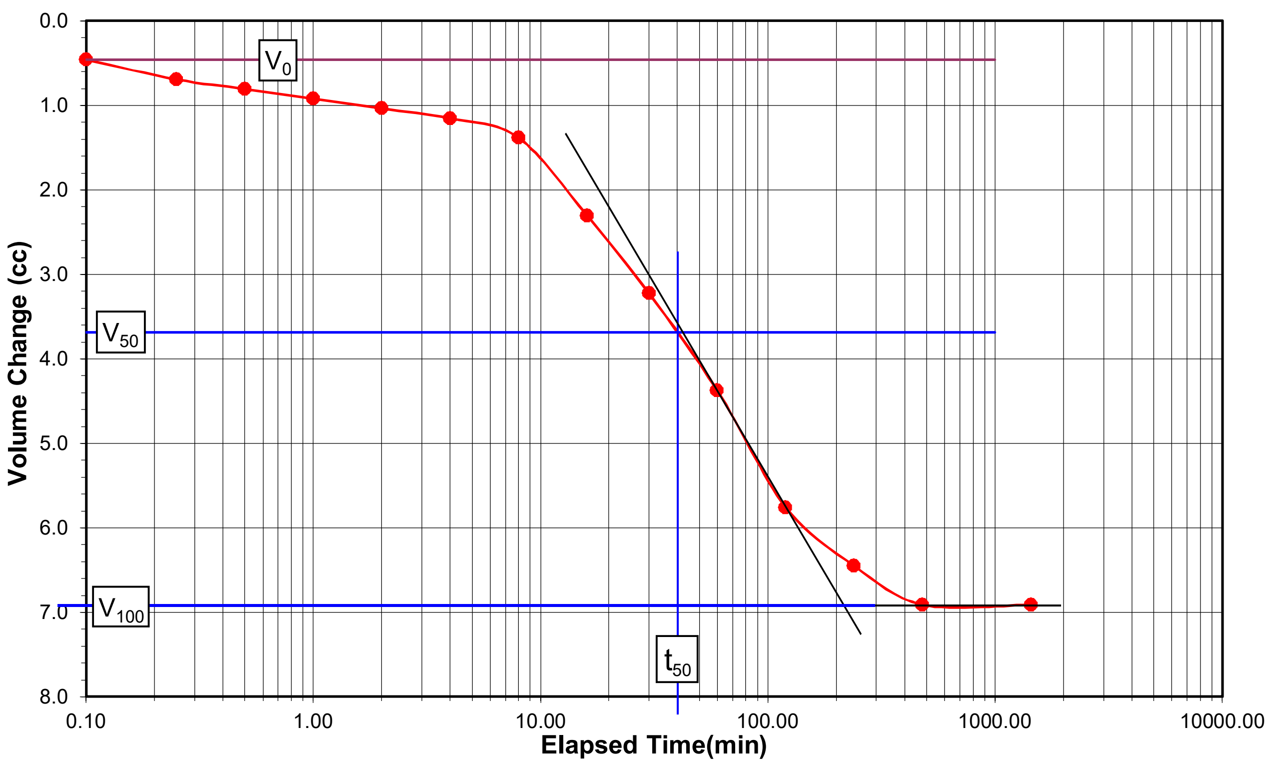
09-18

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	30.0
Boring No.:	LB-7	Eff. Stress (psi):	13.00
Sample No.:	R-9	Burette Area:	0.357 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/27/18	8:00:00			Initial Burette	4.80	
08/27/18	8:00:06	0.10	0.32		5.00	0.5
08/27/18	8:00:15	0.25	0.50		5.10	0.7
08/27/18	8:00:30	0.50	0.71		5.15	0.8
08/27/18	8:01:00	1.00	1.00		5.20	0.9
08/27/18	8:02:00	2.00	1.41		5.25	1.0
08/27/18	8:04:00	4.00	2.00		5.30	1.2
08/27/18	8:08:00	8.00	2.83		5.40	1.4
08/27/18	8:16:00	16.00	4.00		5.80	2.3
08/27/18	8:30:00	30.00	5.48		6.20	3.2
08/27/18	9:00:00	60.00	7.75		6.70	4.4
08/27/18	10:00:00	120.00	10.95		7.30	5.8
08/27/18	12:00:00	240.00	15.49		7.60	6.4
08/27/18	16:00:00	480.00	21.91		7.80	6.9
08/28/18	8:00:00	1440.00	37.95		7.80	6.9



V_0	(cc)	0.46
V_{100}	(cc)	6.91
V_{50}	(cc)	3.69
t_{50}	(min)	40.00
Height After Consolidation (in)		5.493
Strain Rate	(in/min)	**0.0005**
Duration of Test*	(hr)	25.0

*Based on a total strain of 15%

Height (ft)		5.501
		5.501
		5.502
Average		5.501
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2260	0.2290
Final Rdg. (in)	0.2270	0.2360

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/21/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/15/18
Boring No.:	LB-7				
Sample No.:	R-9				
Depth (ft.):	30.0				
Sample Type:	Ring				

13.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	02/05/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-14	Sample Type:	Ring		
Sample No.:	R-10				
Depth (ft.):	51-51.5				
Soil Description	Olive gray sandy siltstone s(ML)				

Diameter (in)	2.423	2.423	2.423	Avg. =	2.423
Height (in)	5.041	5.040	5.040	Avg. =	5.040

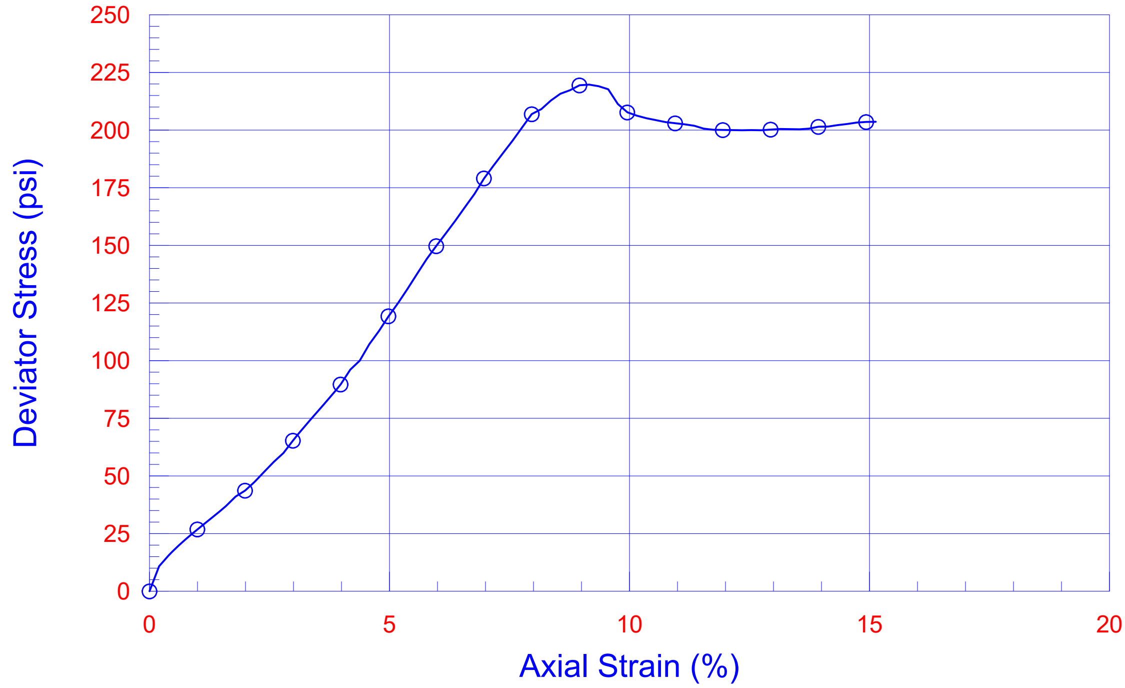
	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.611	4.627	4.561	
Moisture Content (%)	18.38			19.01
Wt. Wet Sample + Cont. (g)	242.60			928.70
Wt. Dry Sample + Cont. (g)	216.80			797.60
Wt. Container (g)	76.40			108.10
Density and Saturation				
Wt. Wet Sample + Cont. (g)	812.10			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	133.1			135.8
Dry Density (pcf)	112.5			114.1
Void Ratio	0.498			0.477
% Saturation	99.6			100.0

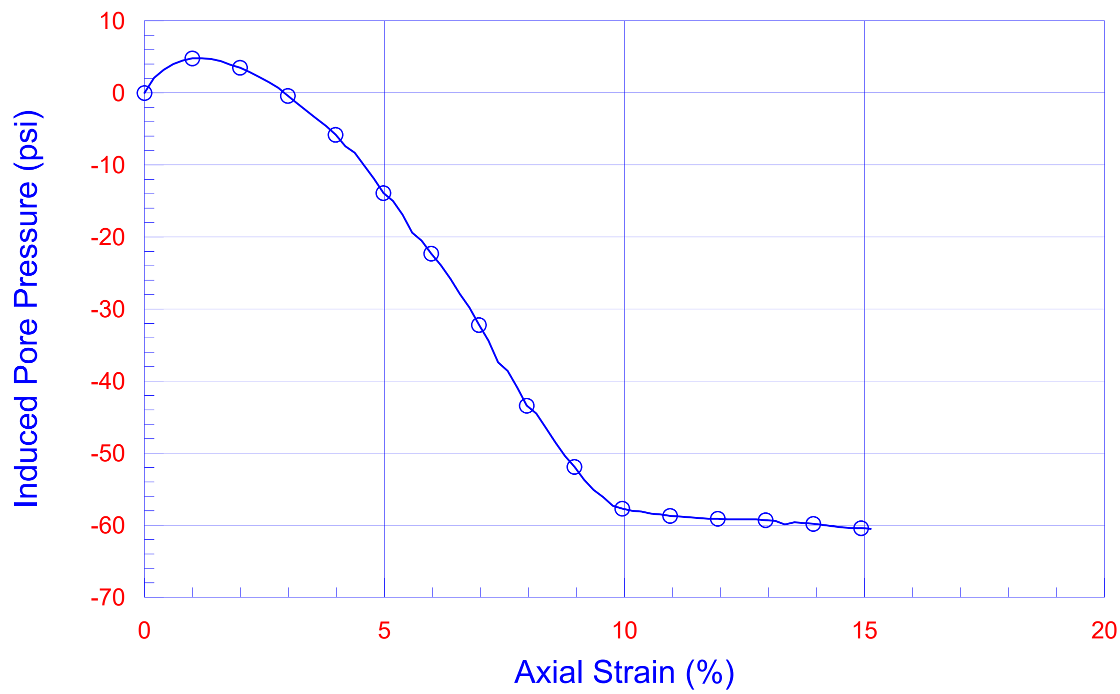
Specific Gravity (assumed) = 2.70

Back Pressure Saturation			
		Burette Area (sq. in.)=	0.361
		Initial Burette Ht.(cm)=	24.0
		Final Burette Ht.(cm)=	15.7
		Volume of water during saturation (cc):	19.3
B Value (%) =	95	Change in Height (in)=	-0.009

Consolidation			
Cell Pressure (psi) =	105.40	Burette Area (sq. in.)=	0.3610
Back Pressure(psi) =	90.40	Initial Burette Ht.(cm)=	4.5
Eff. Consol. Stress (psi) =	15.00	Final Burette Ht.(cm)=	7.7
Change in Height (in) =	0.0260	Final Height (in)=	5.023

Shear		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	219.8
Time to 50% primary Consolidation =	6.20 min	Eff. Minor Principal stress (psi) =	68.7
Failure Criterion:		Eff. Major Principal stress (psi) =	288.5
Maximum deviator stress to 15% axial strain		Axial Strain (%) =	9.2





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-14	R-10	51-51.5	15.0	219.8
□					
△					

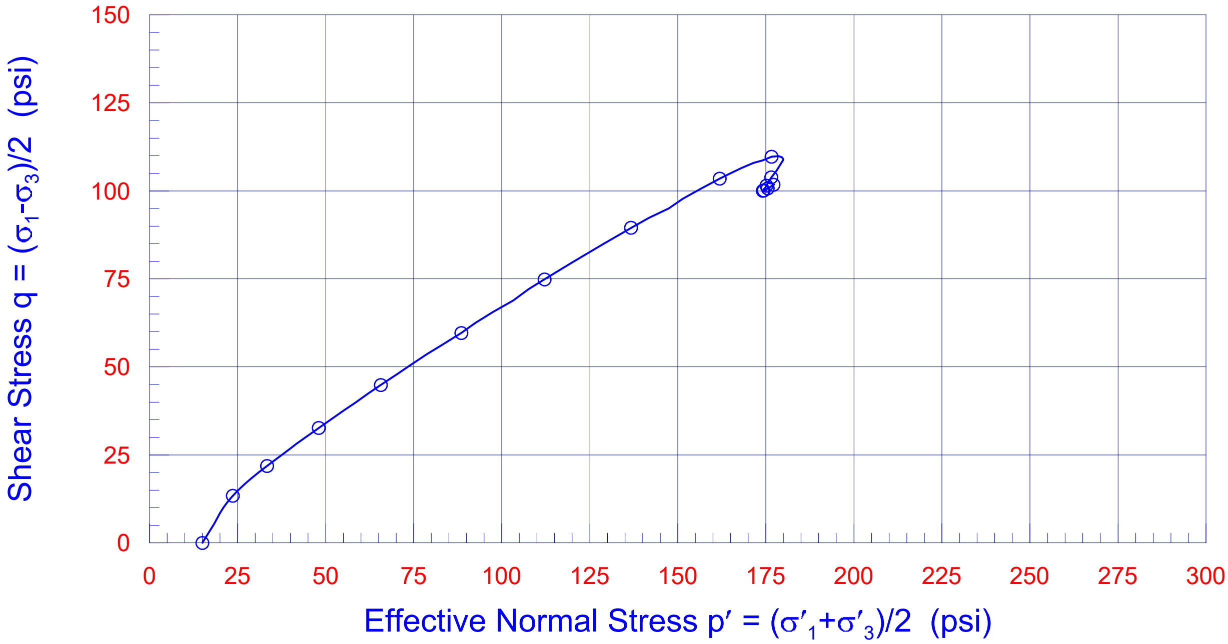
Leighton

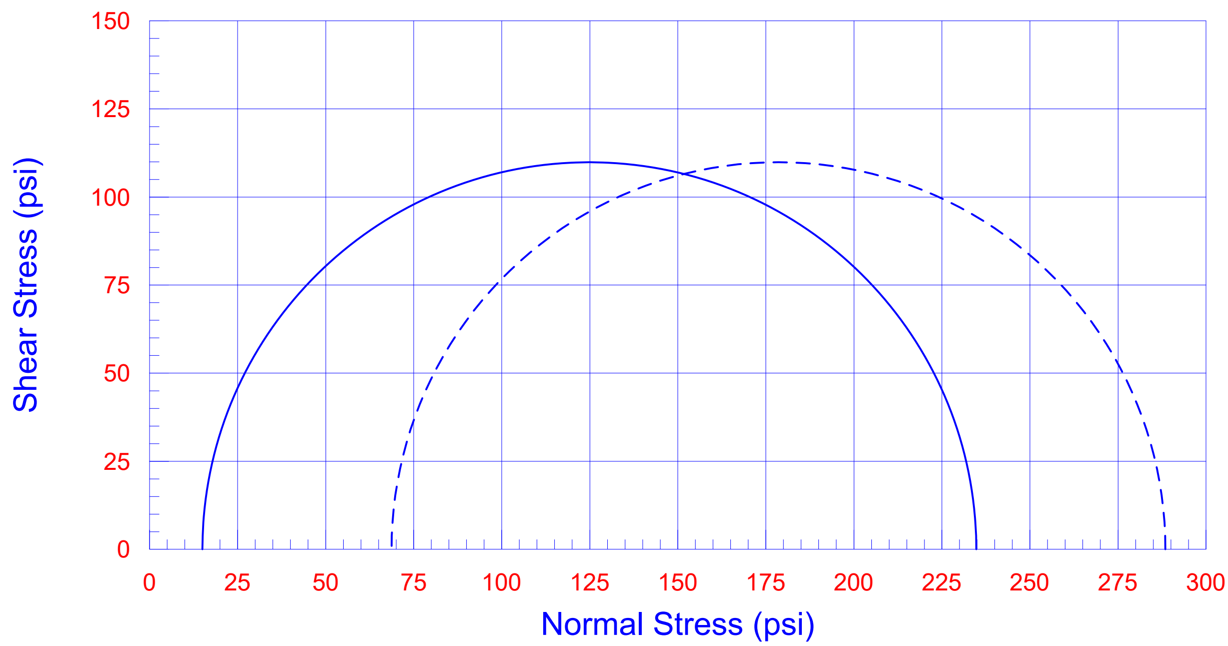
Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test ASTM D 4767

02/19





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-14	R-10	51-51.5	15.0	219.8
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001
Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

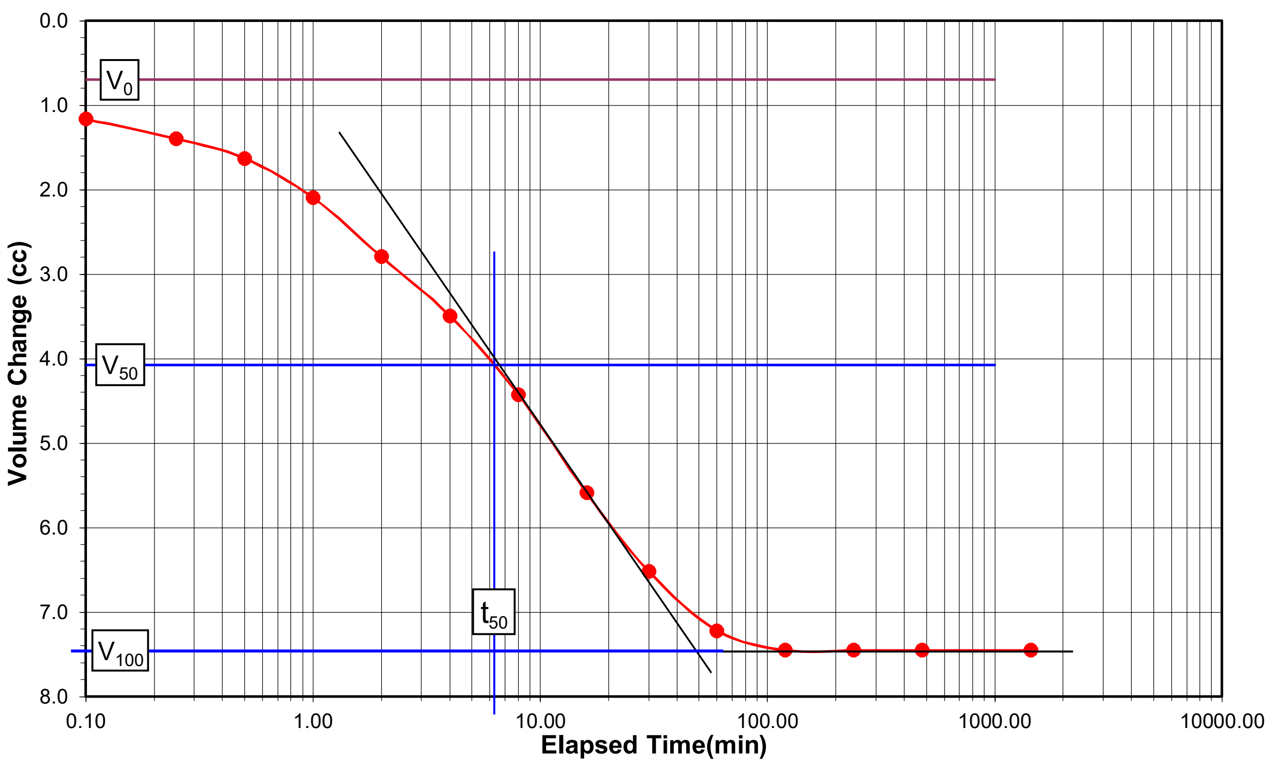
02-19

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	51-51.5
Boring No.:	LB-14	Eff. Stress (psi):	15.00
Sample No.:	R-10	Burette Area:	0.361 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
02/11/19	9:09:00			Initial Burette	4.50	
02/11/19	9:09:06	0.10	0.32		5.00	1.2
02/11/19	9:09:15	0.25	0.50		5.10	1.4
02/11/19	9:09:30	0.50	0.71		5.20	1.6
02/11/19	9:10:00	1.00	1.00		5.40	2.1
02/11/19	9:11:00	2.00	1.41		5.70	2.8
02/11/19	9:13:00	4.00	2.00		6.00	3.5
02/11/19	9:17:00	8.00	2.83		6.40	4.4
02/11/19	9:25:00	16.00	4.00		6.90	5.6
02/11/19	9:39:00	30.00	5.48		7.30	6.5
02/11/19	10:09:00	60.00	7.75		7.60	7.2
02/11/19	11:09:00	120.00	10.95		7.70	7.5
02/11/19	13:09:00	240.00	15.49		7.70	7.5
02/11/19	17:09:00	480.00	21.91		7.70	7.5
02/12/19	9:09:00	1440.00	37.95		7.70	7.5



V_0	(cc)	0.70
V_{100}	(cc)	7.45
V_{50}	(cc)	4.07
t_{50}	(min)	6.20
Height After Consolidation (in)		5.023
Strain Rate	(in/min)	**0.0032**
Duration of Test*	(hr)	3.9

*Based on a total strain of 15%

Height (ft)		5.041
		5.040
		5.040
Average		5.040
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1630	0.1520
Final Rdg. (in)	0.1540	0.1780

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	02/05/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-14				
Sample No.:	R-10				
Depth (ft.):	51-51.5				
Sample Type:	Ring				

15 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/03/20
Boring No.:	LB-22	Sample Type:	Ring		
Sample No.:	R-8				
Depth (ft.):	30.0				
Soil Description	Gray silt (ML)				

Diameter (in)	2.425	2.425	2.425	Avg. =	2.425
Height (in)	5.516	5.515	5.515	Avg. =	5.515

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.619	4.627	4.556	
Moisture Content (%)	16.67			20.56
Wt. Wet Sample + Cont. (g)	112.20			943.40
Wt. Dry Sample + Cont. (g)	105.90			795.40
Wt. Container (g)	68.10			75.70
Density and Saturation				
Wt. Wet Sample + Cont. (g)	862.30			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	129.0			136.1
Dry Density (pcf)	110.5			112.9
Void Ratio	0.524			0.493
% Saturation	85.8			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

		Burette Area (sq. in.)=	0.397
		Initial Burette Ht.(cm)=	23.5
		Final Burette Ht.(cm)=	20.3
		Volume of water during saturation (cc):	8.2
B Value (%) =	98	Change in Height (in)=	-0.005

Consolidation

Cell Pressure (psi) =	115.76	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	90.76	Initial Burette Ht.(cm)=	5.3
Eff. Consol. Stress (psi) =	25.00	Final Burette Ht.(cm)=	9.1
Change in Height (in) =	0.0440	Final Height (in)=	5.476

Shear

Rate of Deformation (in/min)= 0.0024

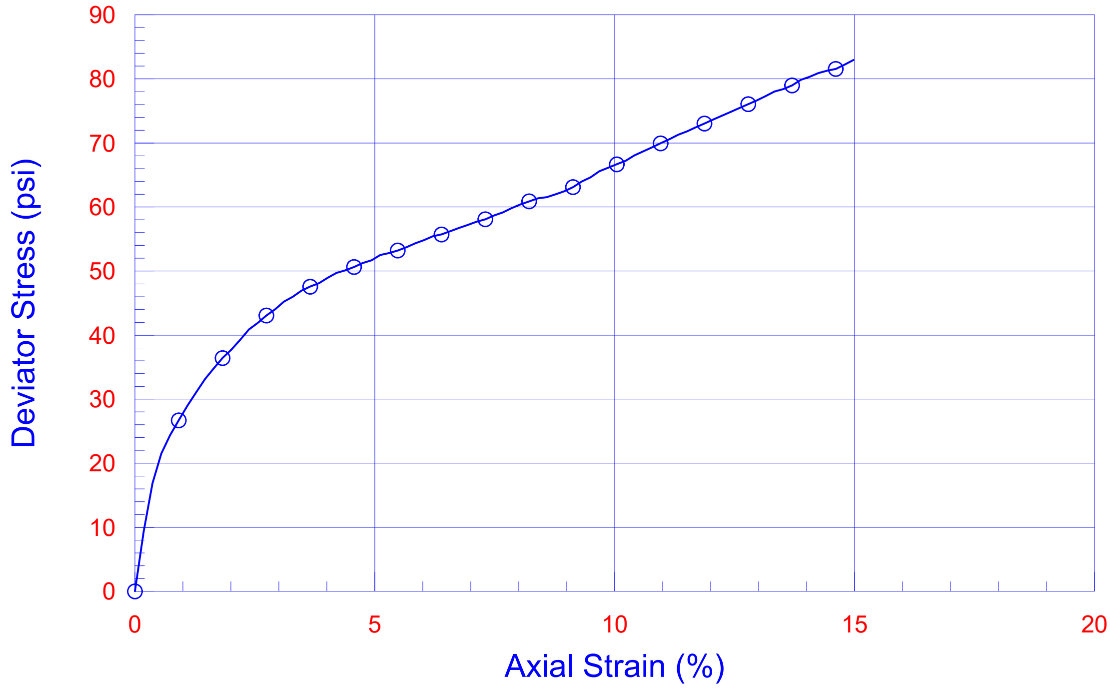
Time to 50% primary Consolidation = 7.2 min

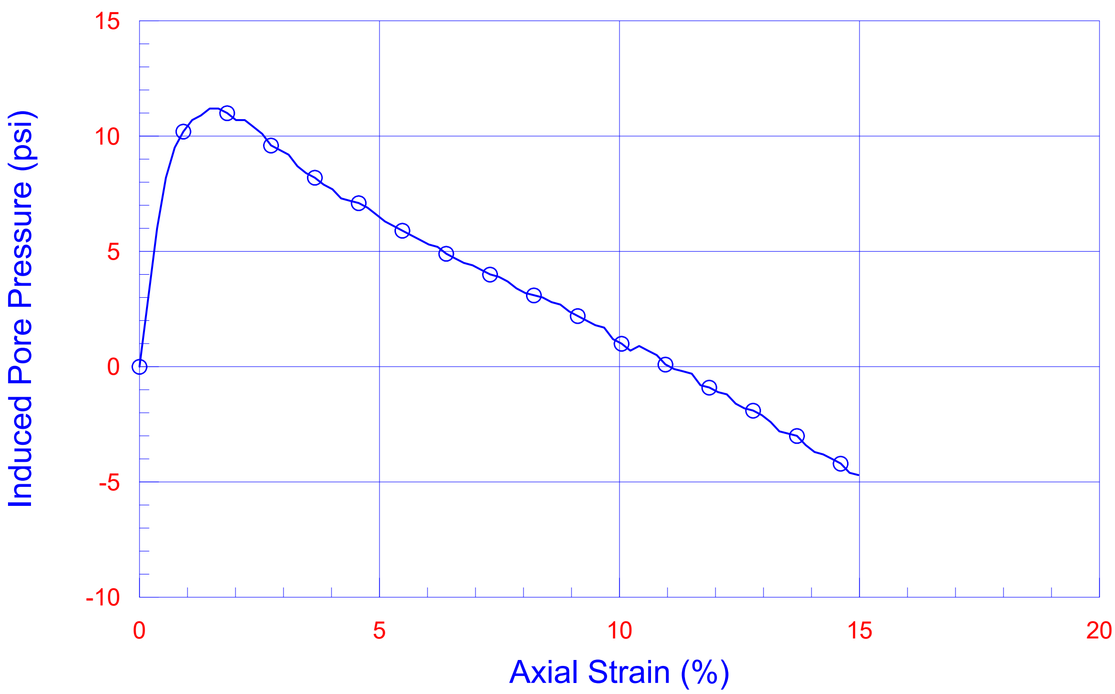
<u>Failure Criterion:</u>

Maximum deviator stress up to axail strain = 15%

<u>At Failure</u>

Deviator Stress (psi) =	83.0
Eff. Minor Principal stress (psi) =	29.7
Eff. Major Principal stress (psi) =	112.7
Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-22	R-8	30.0	25.0	83.0
□					
△					

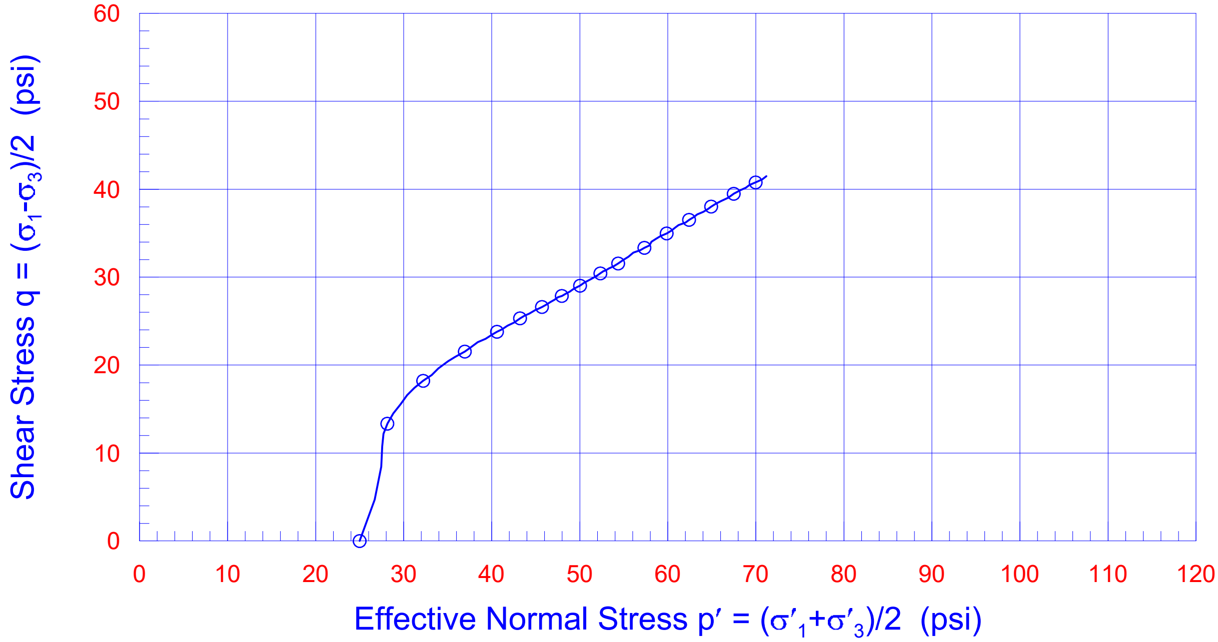
Leighton

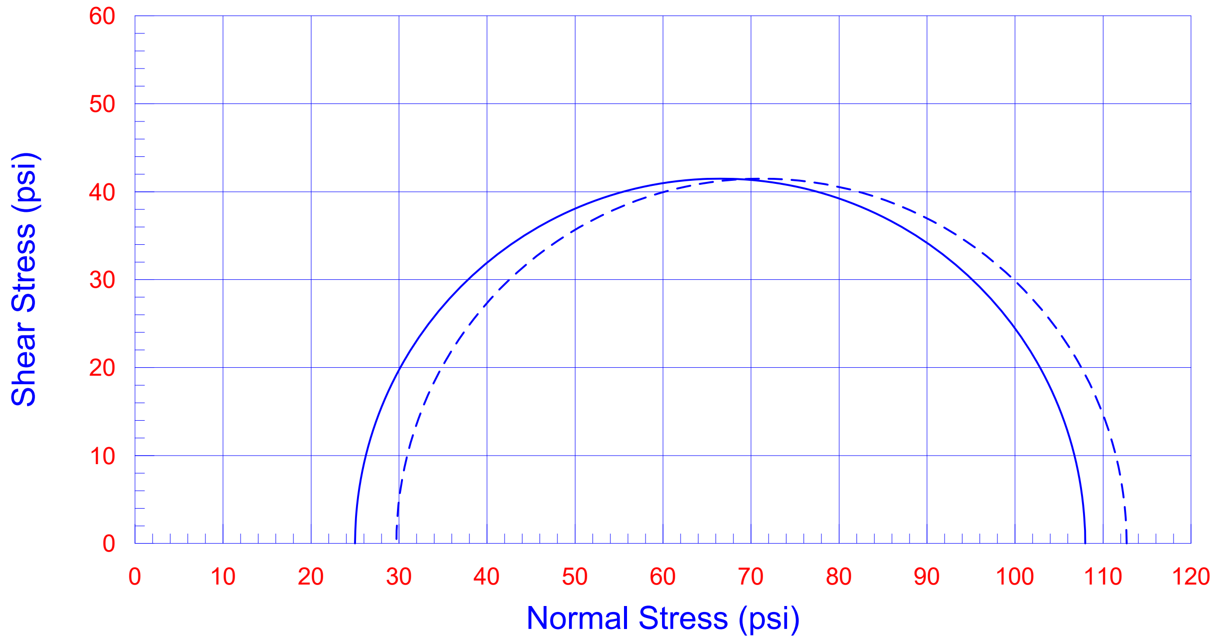
Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

12-20





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-22	R-8	30.0	25.0	83.0
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

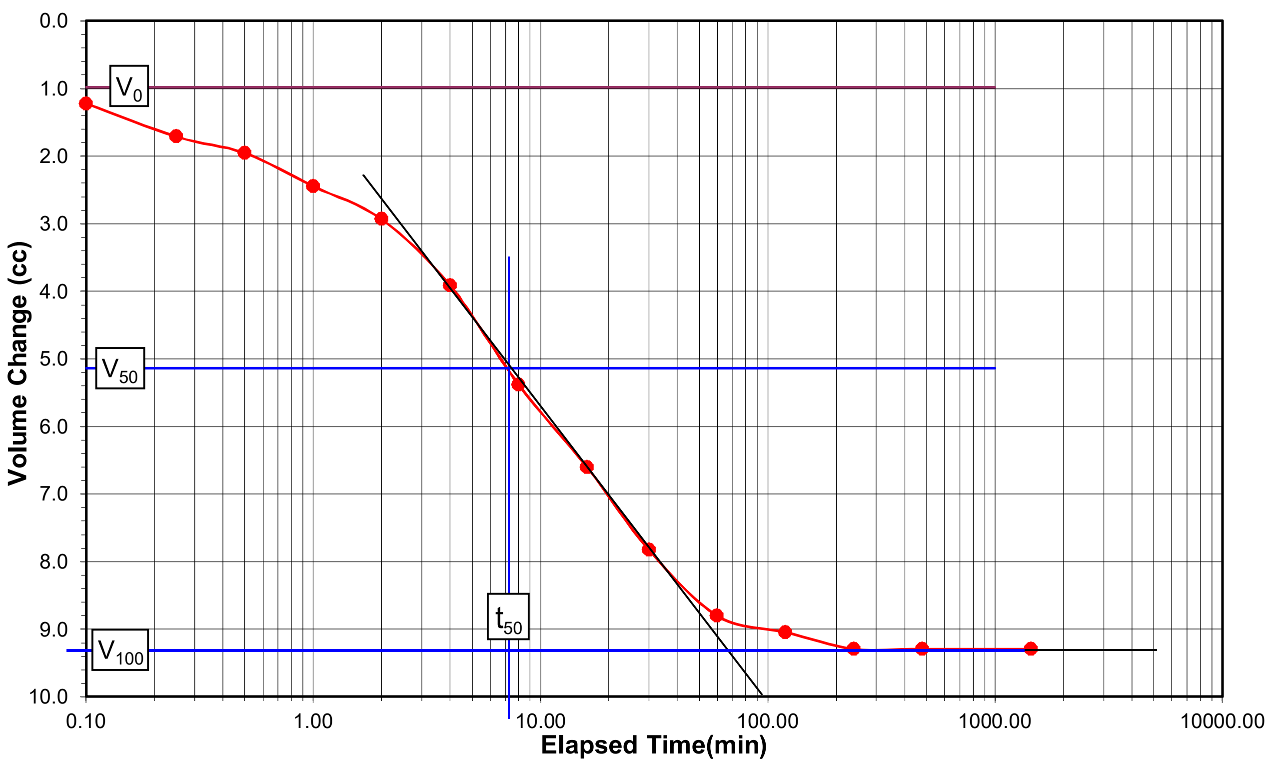
12-20

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	30.0
Boring No.:	LB-22	Eff. Stress (psi):	25.00
Sample No.:	R-8	Burette Area:	0.379 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/13/20	8:48:00			Initial Burette	5.30	
11/13/20	8:48:06	0.10	0.32		5.80	1.22
11/13/20	8:48:15	0.25	0.50		6.00	1.71
11/13/20	8:48:30	0.50	0.71		6.10	1.96
11/13/20	8:49:00	1.00	1.00		6.30	2.45
11/13/20	8:50:00	2.00	1.41		6.50	2.93
11/13/20	8:52:00	4.00	2.00		6.90	3.91
11/13/20	8:56:00	8.00	2.83		7.50	5.38
11/13/20	9:04:00	16.00	4.00		8.00	6.60
11/13/20	9:18:00	30.00	5.48		8.50	7.82
11/13/20	9:48:00	60.00	7.75		8.90	8.80
11/13/20	10:48:00	120.00	10.95		9.00	9.05
11/13/20	12:48:00	240.00	15.49		9.10	9.29
11/13/20	16:46:00	478.00	21.86		9.10	9.29
11/14/20	8:48:00	1440.00	37.95		9.10	9.29



V_0	(cc)	0.98
V_{100}	(cc)	9.29
V_{50}	(cc)	5.13
t_{50}	(min)	7.20
Height After Consolidation (in)		5.476
Strain Rate	(in/min)	**0.0030**
Duration of Test*	(hr)	4.5

*Based on a total strain of 15%

Height (ft)		5.516
		5.515
		5.515
Average		5.515
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.3200	0.3140
Final Rdg. (in)	0.3150	0.3580

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-22				
Sample No.:	R-8				
Depth (ft.):	30.0				
Sample Type:	Ring				

16 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/03/20
Boring No.:	LB-27	Sample Type:	Ring		
Sample No.:	R-5				
Depth (ft.):	20				
Soil Description	Brown lean clay (CL)				

Diameter (in)	2.415	2.415	2.415	Avg. =	2.415
Height (in)	5.243	5.244	5.244	Avg. =	5.244

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.581	4.574	3.982	
Moisture Content (%)	17.11			17.48
Wt. Wet Sample + Cont. (g)	158.00			905.50
Wt. Dry Sample + Cont. (g)	143.20			781.90
Wt. Container (g)	56.70			74.70
Density and Saturation				
Wt. Wet Sample + Cont. (g)	837.40			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	132.8			154.6
Dry Density (pcf)	113.4			131.6
Void Ratio	0.486			0.280
% Saturation	95.1			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

Burette Area (sq. in.)=	0.408
Initial Burette Ht.(cm)=	24.0
Final Burette Ht.(cm)=	22.8
Volume of water during saturation (cc):	3.2
Change in Height (in)=	0.004

B Value (%) = 95

Consolidation

Cell Pressure (psi) =	108.66	Burette Area (sq. in.)=	0.0380
Back Pressure(psi) =	90.66	Initial Burette Ht.(cm)=	1.5
Eff. Consol. Stress (psi) =	18.00	Final Burette Ht.(cm)=	220.0
Change in Height (in) =	0.0420	Final Height (in)=	5.198

Shear

Rate of Deformation (in/min)= 0.0024

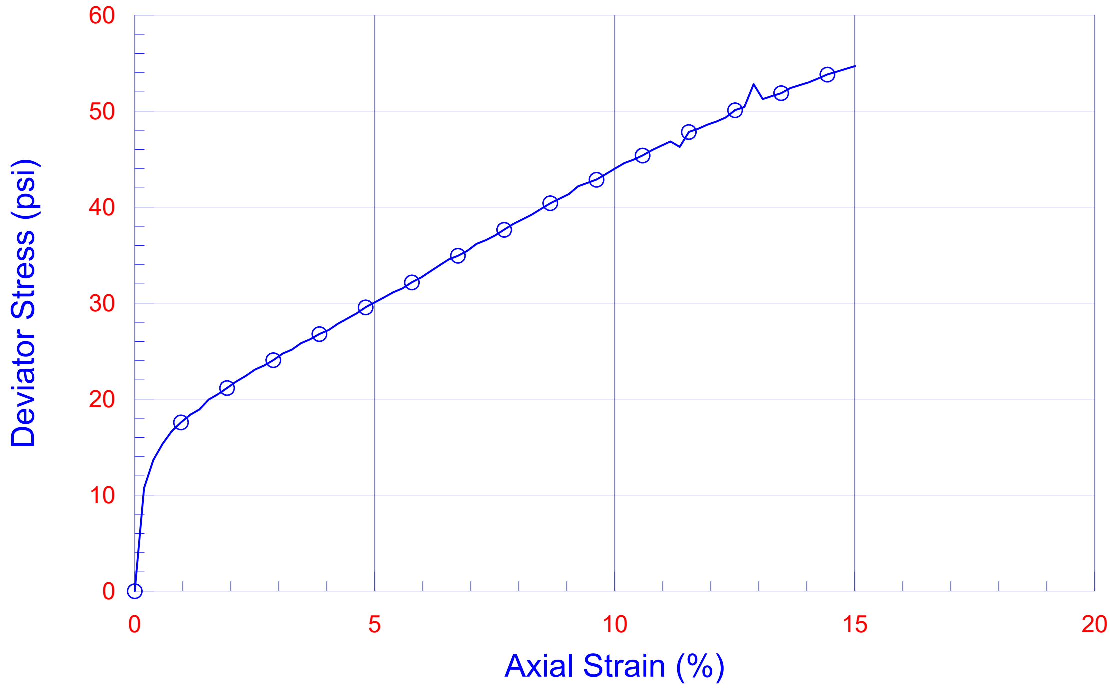
Time to 50% primary Consolidation = 130 min

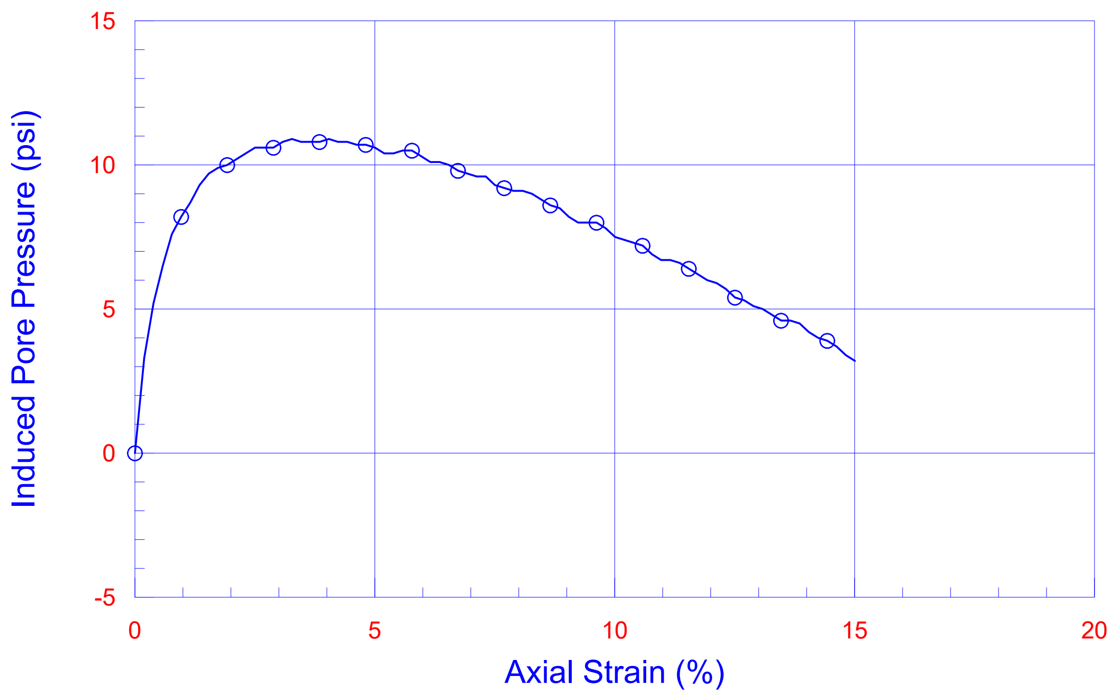
Failure Criterion:

Maximum deviator stress up to axail strain = 15%

At Failure

Deviator Stress (psi) =	54.7
Eff. Minor Principal stress (psi) =	14.8
Eff. Major Principal stress (psi) =	69.5
Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-27	R-5	20	18.0	54.7
□					
△					

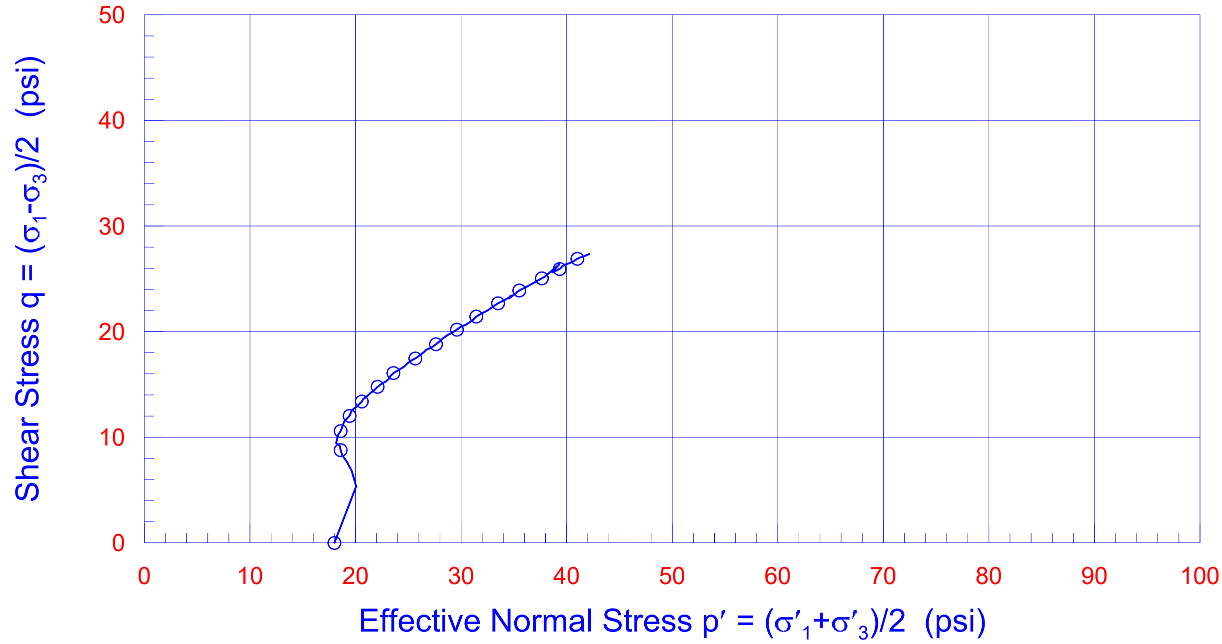
Leighton

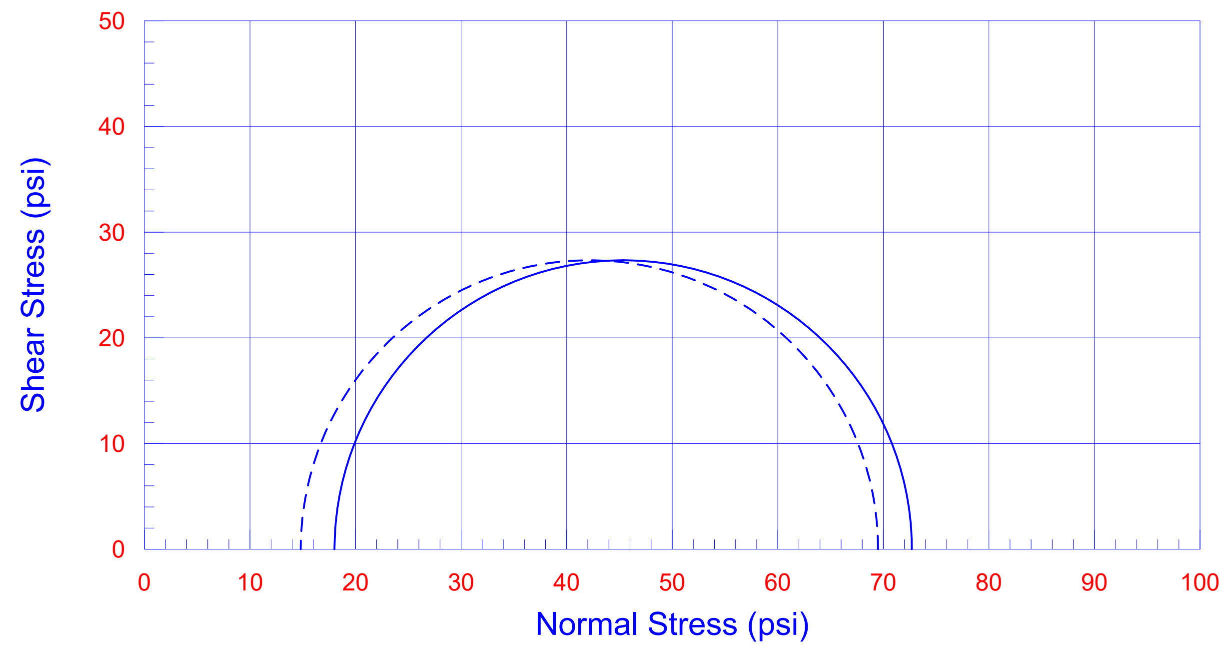
Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

12-20





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-27	R-5	20	18.0	54.7
□					
△					

——— Mohr Circle based on Total Stress

– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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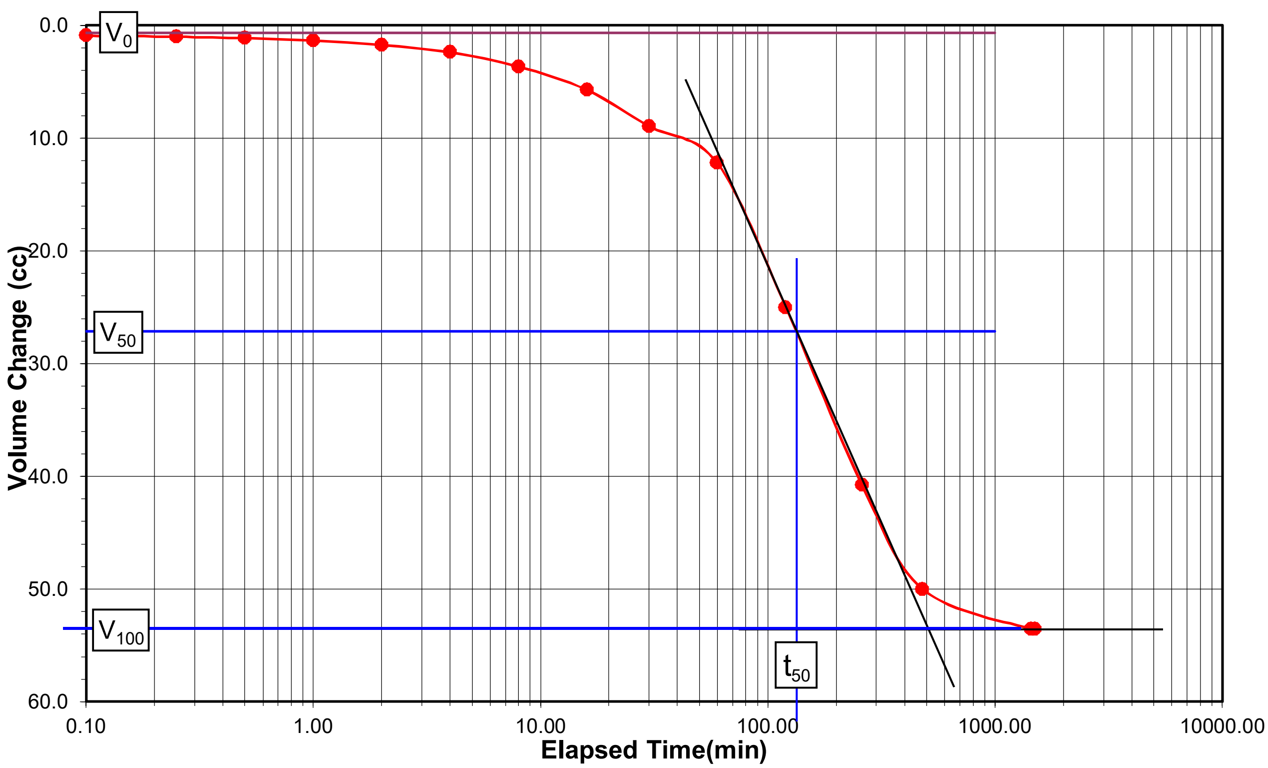
CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	20.0
Boring No.:	LB-27	Eff. Stress (psi):	18.00
Sample No.:	R-5	Burette Area:	0.038 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/12/20	8:36:00			Initial Burette	1.50	
11/12/20	8:36:06	0.10	0.32		5.20	0.91
11/12/20	8:36:15	0.25	0.50		5.60	1.01
11/12/20	8:36:30	0.50	0.71		6.10	1.13
11/12/20	8:37:00	1.00	1.00		7.00	1.35
11/12/20	8:38:00	2.00	1.41		8.50	1.72
11/12/20	8:40:00	4.00	2.00		11.20	2.38
11/12/20	8:44:00	8.00	2.83		16.40	3.65
11/12/20	8:52:00	16.00	4.00		24.80	5.71
11/12/20	9:06:00	30.00	5.48		38.00	8.95
11/12/20	9:36:00	60.00	7.75		51.30	12.21
11/12/20	10:36:00	120.00	10.95		103.50	25.01
11/12/20	12:56:00	260.00	16.12		167.90	40.79
11/12/20	16:36:00	480.00	21.91		205.50	50.01
11/13/20	8:36:00	1440.00	37.95		220.00	53.57
11/13/20	9:36:00	1500.00	38.73		220.00	53.57



V_0	(cc)	0.66
V_{100}	(cc)	53.57
V_{50}	(cc)	27.12
t_{50}	(min)	130.00
Height After Consolidation (in)		5.198
Strain Rate	(in/min)	**0.0002**
Duration of Test*	(hr)	81.3

*Based on a total strain of 15%

Height (ft)		5.244
		5.244
		5.243
Average		5.244
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1980	0.1980
Final Rdg. (in)	0.2020	0.2400

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-27				
Sample No.:	R-5				
Depth (ft.):	20.0				
Sample Type:	Ring				

18 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	11/03/20
Boring No.:	LB-38	Sample Type:	Tube		
Sample No.:	T13A				
Depth (ft.):	42.0				
Soil Description	Gray silt (ML)				

Diameter (in)	2.409	2.409	2.408	Avg. =	2.409
Height (in)	4.535	4.533	4.536	Avg. =	4.535

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.557	4.565	4.522	
Moisture Content (%)	12.55			16.09
Wt. Wet Sample + Cont. (g)	674.20			771.20
Wt. Dry Sample + Cont. (g)	599.00			674.70
Wt. Container (g)	0.00			74.80
Density and Saturation				
Wt. Wet Sample + Cont. (g)	855.80			Calculated from initial dry weight and final moisture content
Wt. Container (g)	181.60			
Wet Density (pcf)	124.3			129.0
Dry Density (pcf)	110.4			111.2
Void Ratio	0.526			0.516
% Saturation	64.5			84.2

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

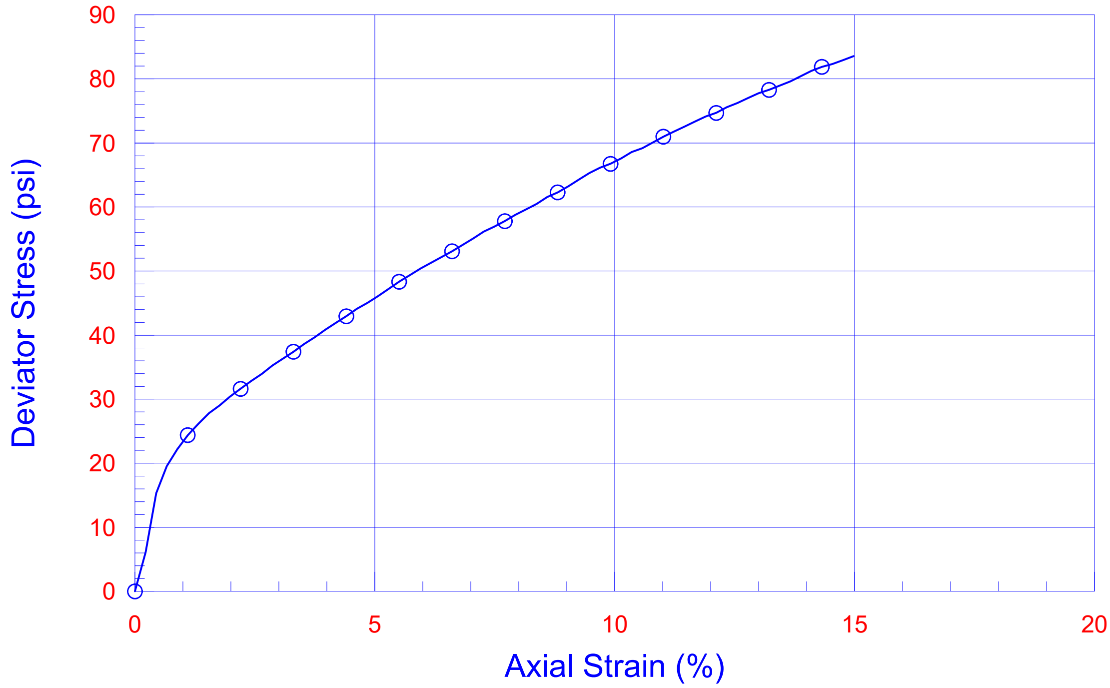
		Burette Area (sq. in.)=	0.397
		Initial Burette Ht.(cm)=	24.3
		Final Burette Ht.(cm)=	14.0
		Volume of water during saturation (cc):	26.4
B Value (%) =	97	Change in Height (in)=	-0.004

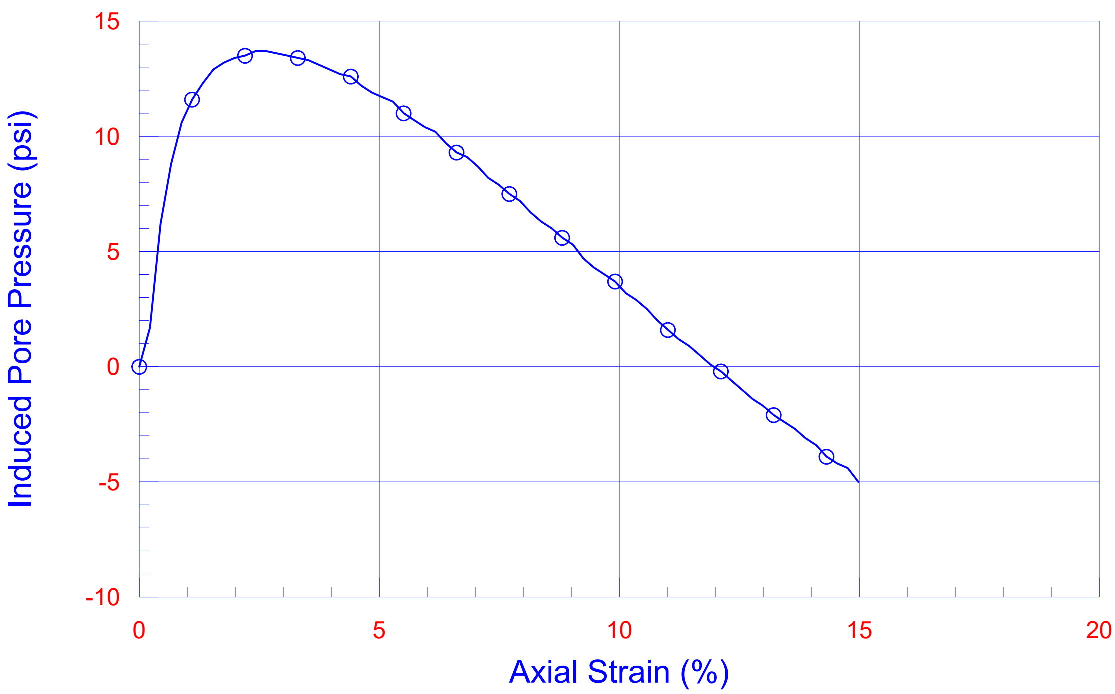
Consolidation

Cell Pressure (psi) =	116.70	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	91.70	Initial Burette Ht.(cm)=	4.9
Eff. Consol. Stress (psi) =	25.00	Final Burette Ht.(cm)=	6.1
Change in Height (in) =	-0.0010	Final Height (in)=	4.540

Shear

		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	83.6
Time to 50% primary Consolidation =	2.8 min	Eff. Minor Principal stress (psi) =	30.0
Failure Criterion:		Eff. Major Principal stress (psi) =	113.6
Maximum deviator stress up to axial strain = 15%		Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-38	T13A	42.0	25.0	83.6
□					
△					

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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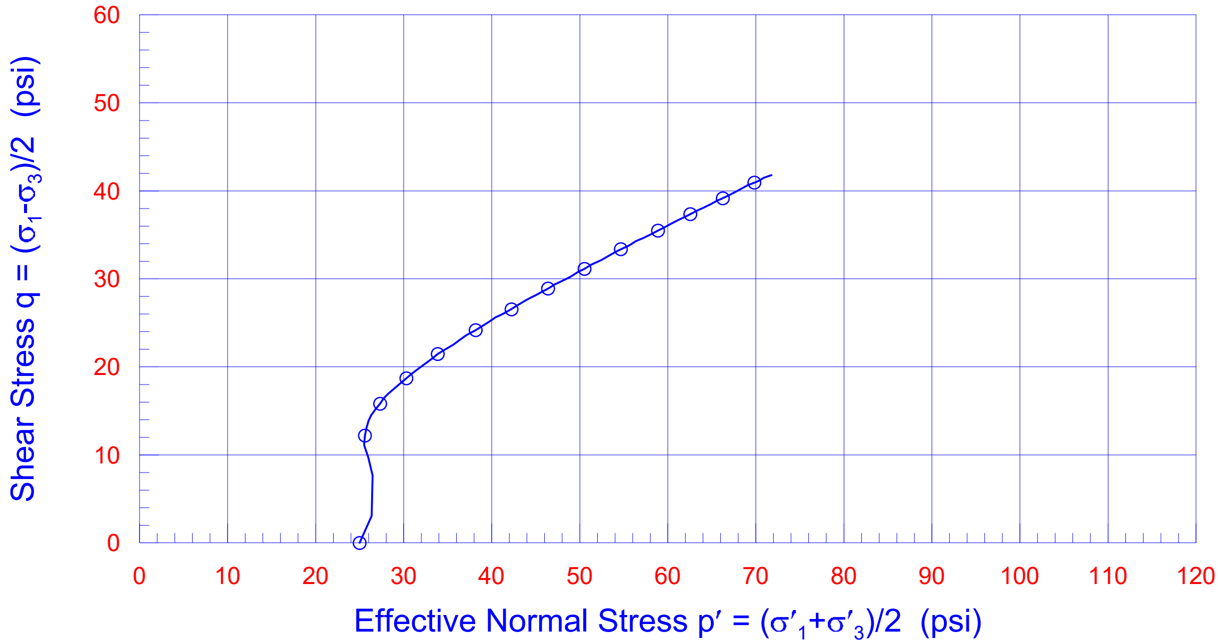
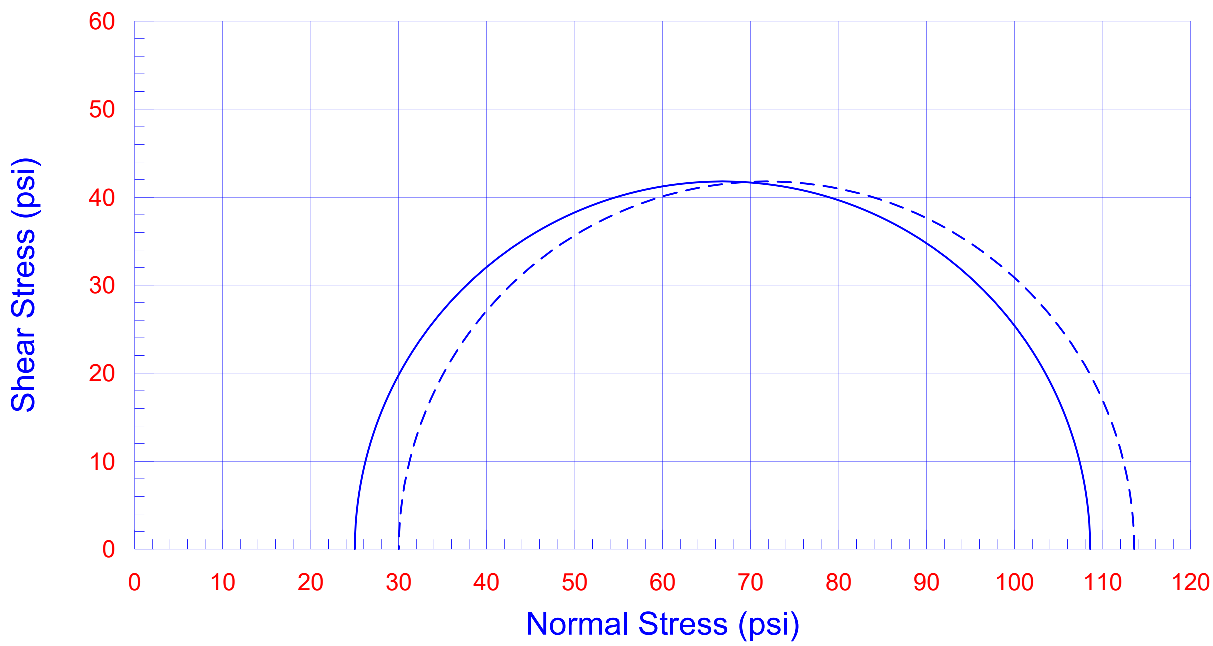




	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-38	T13A	42.0	25.0	83.6
□					
△					

——— Mohr Circle based on Total Stress

– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

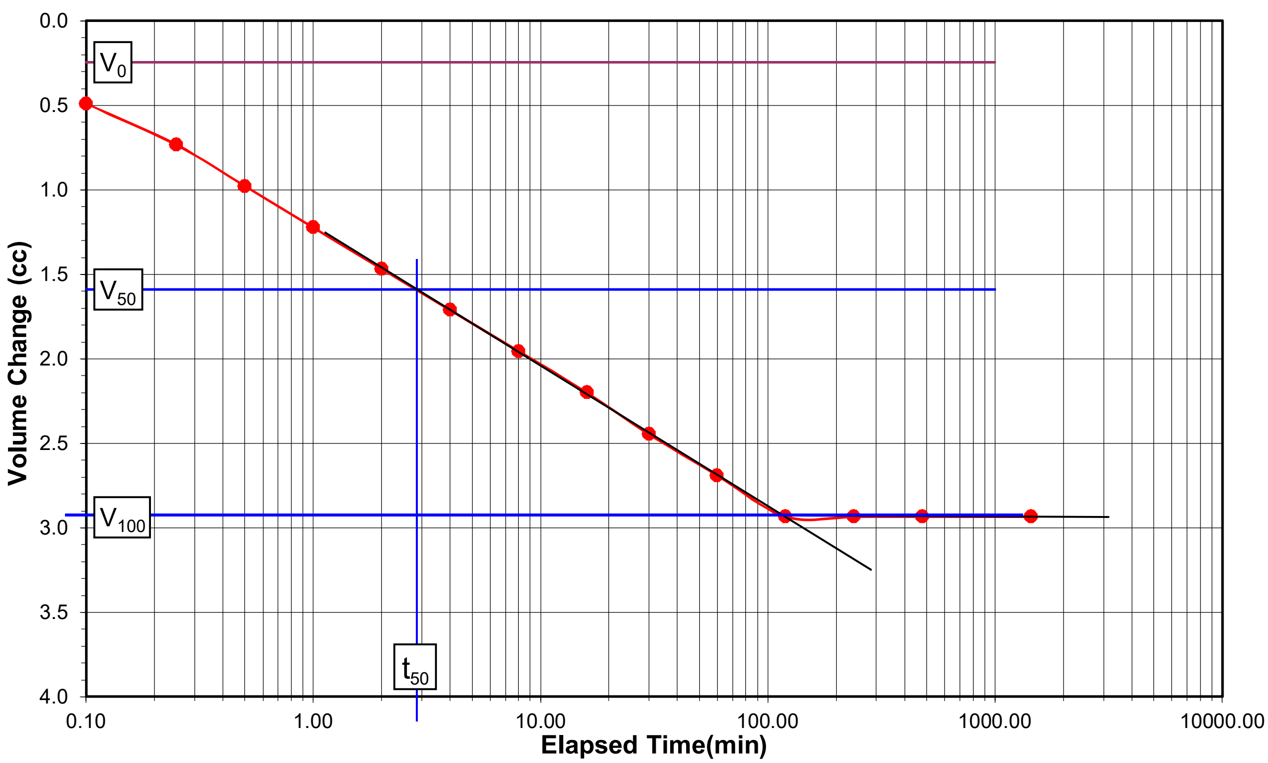
12-20

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	42.0
Boring No.:	LB-38	Eff. Stress (psi):	25.00
Sample No.:	T13A	Burette Area:	0.379 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/20/20	10:47:00			Initial Burette	4.90	
11/20/20	10:47:06	0.10	0.32		5.10	0.49
11/20/20	10:47:15	0.25	0.50		5.20	0.73
11/20/20	10:47:30	0.50	0.71		5.30	0.98
11/20/20	10:48:00	1.00	1.00		5.40	1.22
11/20/20	10:49:00	2.00	1.41		5.50	1.47
11/20/20	10:51:00	4.00	2.00		5.60	1.71
11/20/20	10:55:00	8.00	2.83		5.70	1.96
11/20/20	11:03:00	16.00	4.00		5.80	2.20
11/20/20	11:17:00	30.00	5.48		5.90	2.45
11/20/20	11:47:00	60.00	7.75		6.00	2.69
11/20/20	12:47:00	120.00	10.95		6.10	2.93
11/20/20	14:47:00	240.00	15.49		6.10	2.93
11/20/20	18:47:00	480.00	21.91		6.10	2.93
11/21/20	10:47:00	1440.00	37.95		6.10	2.93



V_0	(cc)	0.24
V_{100}	(cc)	2.93
V_{50}	(cc)	1.59
t_{50}	(min)	2.80
Height After Consolidation (in)		4.540
Strain Rate	(in/min)	**0.0065**
Duration of Test*	(hr)	1.8

*Based on a total strain of 15%

Height (ft)		4.535
		4.533
		4.536
Average		4.535
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2610	0.2540
Final Rdg. (in)	0.2570	0.2530

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-33				
Sample No.:	T13A				
Depth (ft.):	42.0				
Sample Type:	Ring				

25 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	01/31/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-16	Sample Type:	Ring		
Sample No.:	R-3				
Depth (ft.):	26-26.5				
Soil Description	Olive gray siltstone (ML)				

Diameter (in)	2.424	2.424	2.424	Avg. =	2.424
Height (in)	5.412	5.413	5.413	Avg. =	5.413

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.615	4.729	4.661	
Moisture Content (%)	18.65			27.39
Wt. Wet Sample + Cont. (g)	162.60			933.20
Wt. Dry Sample + Cont. (g)	145.20			748.50
Wt. Container (g)	51.90			74.25
Density and Saturation				
Wt. Wet Sample + Cont. (g)	832.90			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	127.0			134.0
Dry Density (pcf)	107.1			105.2
Void Ratio	0.574			0.602
% Saturation	87.8			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

Burette Area (sq. in.)=	0.358
Initial Burette Ht.(cm)=	24.0
Final Burette Ht.(cm)=	7.0
Volume of water during saturation (cc):	39.3
Change in Height (in)=	-0.068

B Value (%) = 95

Consolidation

Cell Pressure (psi) =	102.45	Burette Area (sq. in.)=	0.3580
Back Pressure(psi) =	90.45	Initial Burette Ht.(cm)=	6.6
Eff. Consol. Stress (psi) =	12.00	Final Burette Ht.(cm)=	10.1
Change in Height (in) =	0.0250	Final Height (in)=	5.456

Shear

Rate of Deformation (in/min)= 0.0024

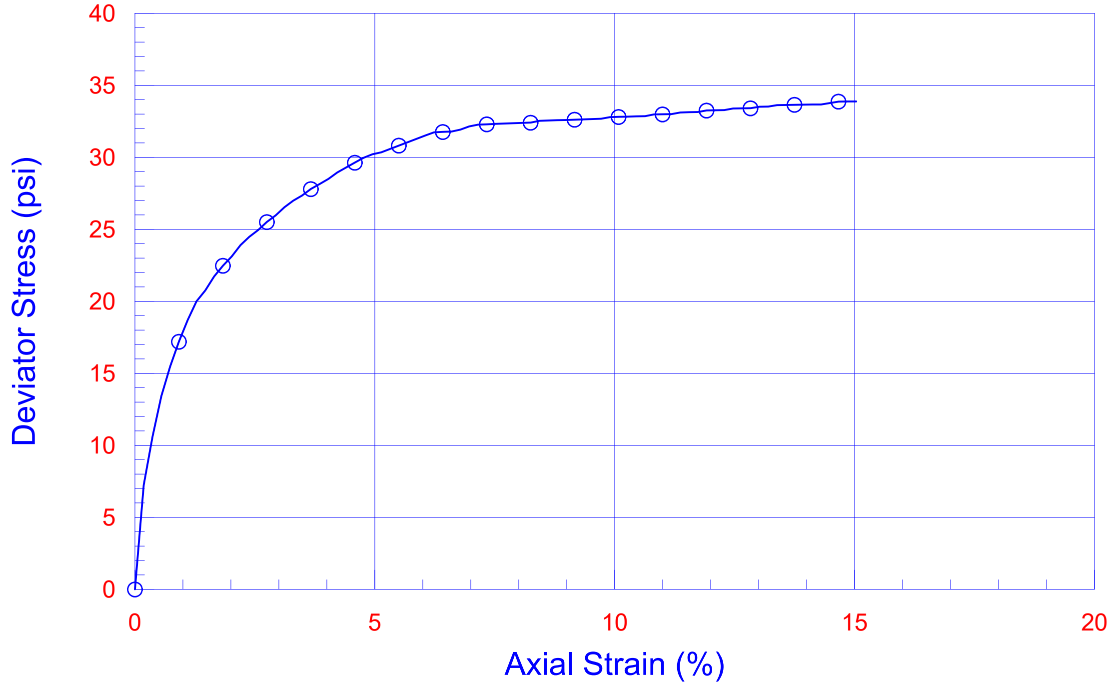
Time to 50% primary Consolidation = 71.00 min

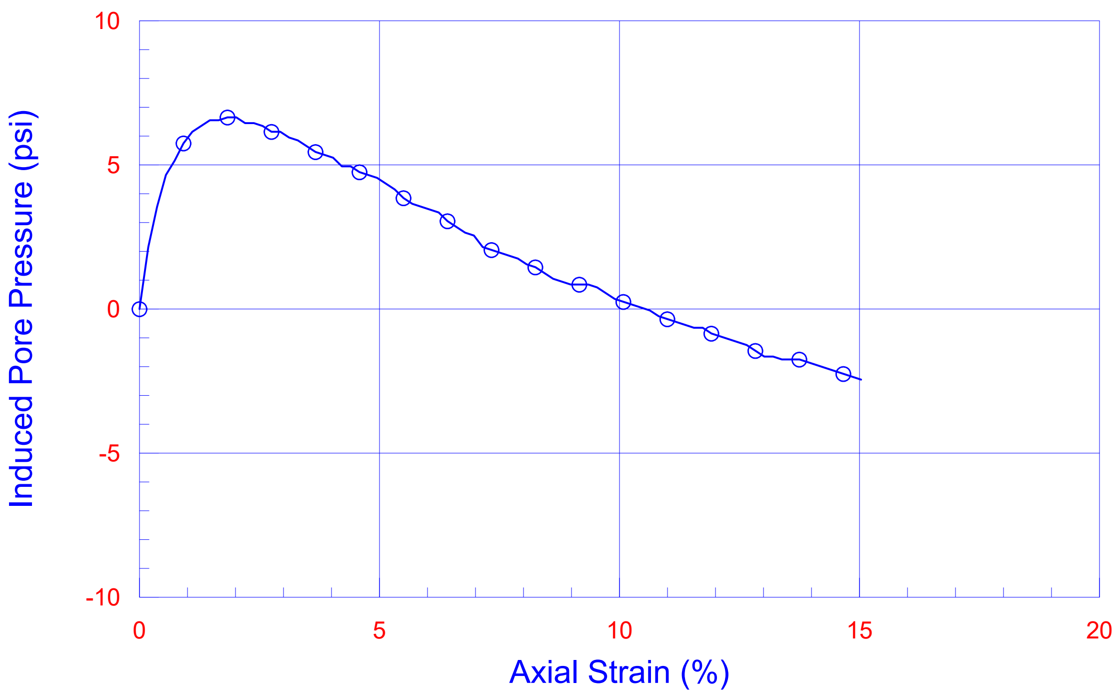
Failure Criterion:

Maximum deviator stress to 15% axial strain

At Failure

Deviator Stress (psi) =	33.9
Eff. Minor Principal stress (psi) =	14.5
Eff. Major Principal stress (psi) =	48.3
Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-16	R-3	26-26.5	12.0	33.9
□					
△					

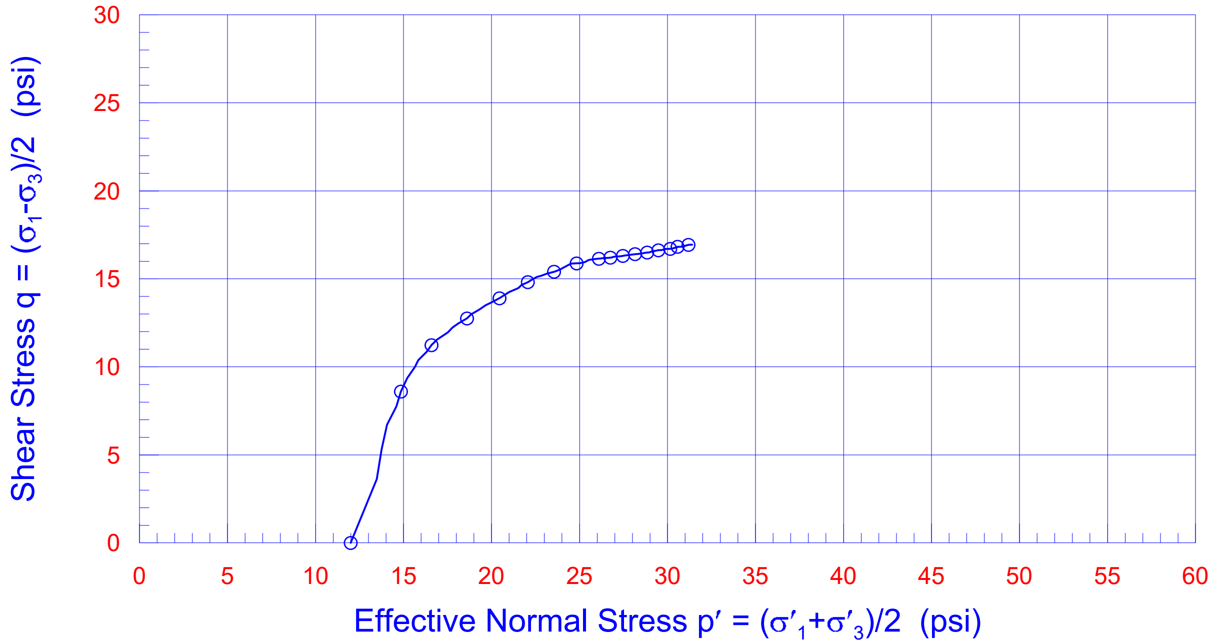
Leighton

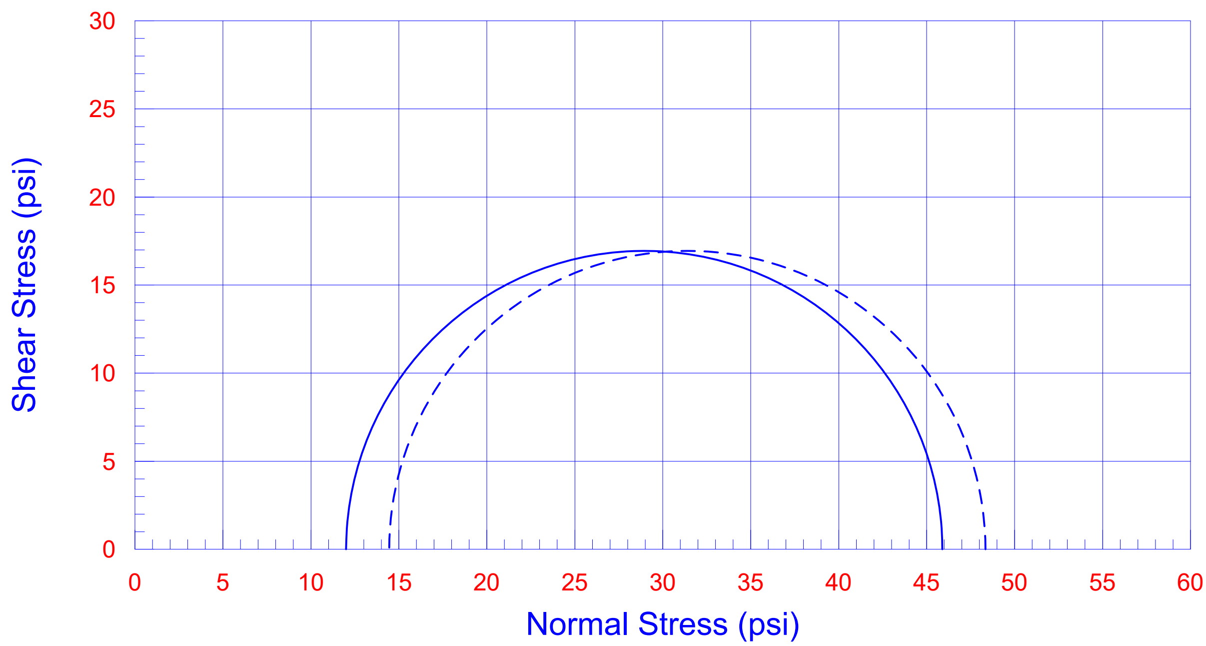
Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

02/19





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-16	R-3	26-26.5	12.0	33.9
□					
△					

——— Mohr Circle based on Total Stress

– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

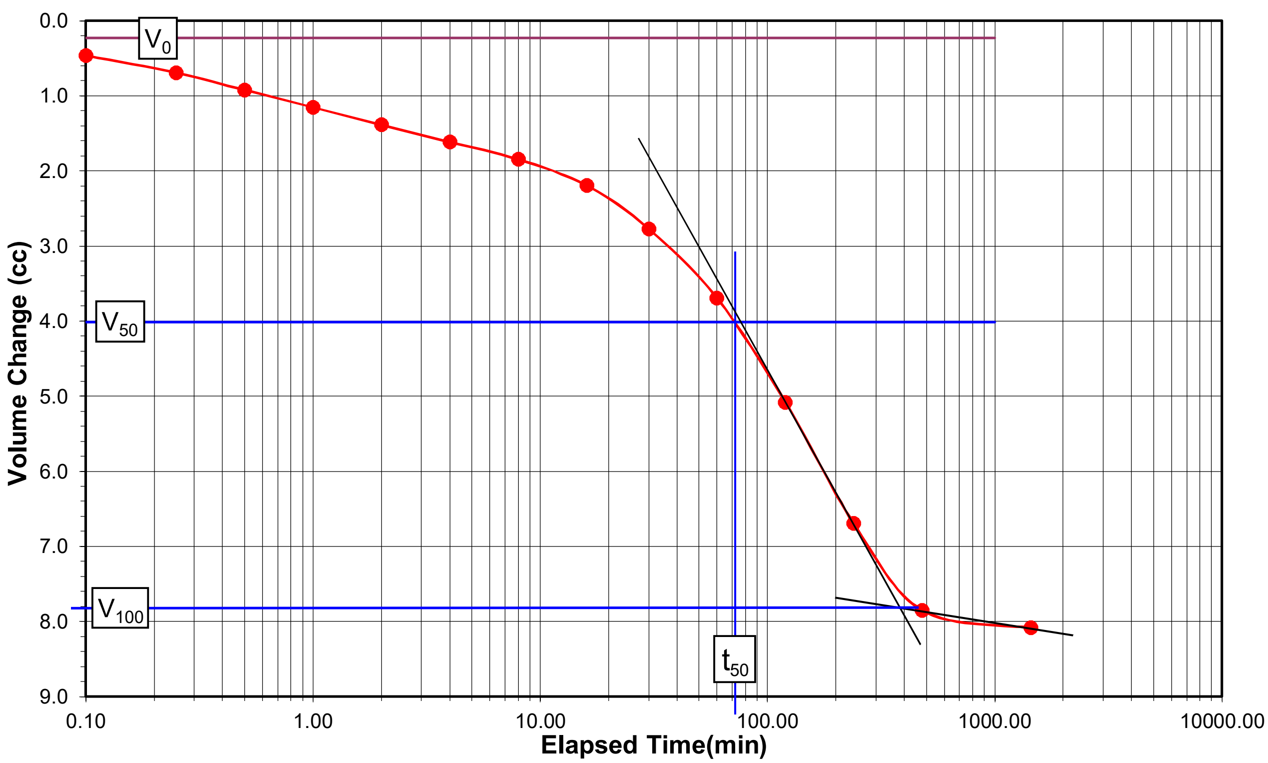
02-19

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	26-26.5
Boring No.:	LB-16	Eff. Stress (psi):	12.00
Sample No.:	R-3	Burette Area:	0.358 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
02/06/19	9:22:00			Initial Burette	6.60	
02/06/19	9:22:06	0.10	0.32		6.80	0.5
02/06/19	9:22:15	0.25	0.50		6.90	0.7
02/06/19	9:22:30	0.50	0.71		7.00	0.9
02/06/19	9:23:00	1.00	1.00		7.10	1.2
02/06/19	9:24:00	2.00	1.41		7.20	1.4
02/06/19	9:26:00	4.00	2.00		7.30	1.6
02/06/19	9:30:00	8.00	2.83		7.40	1.8
02/06/19	9:38:00	16.00	4.00		7.55	2.2
02/06/19	9:52:00	30.00	5.48		7.80	2.8
02/06/19	10:22:00	60.00	7.75		8.20	3.7
02/06/19	11:22:00	120.00	10.95		8.80	5.1
02/06/19	13:22:00	240.00	15.49		9.50	6.7
02/06/19	17:22:00	480.00	21.91		10.00	7.9
02/07/19	9:22:00	1440.00	37.95		10.10	8.1



V_0	(cc)	0.23
V_{100}	(cc)	7.80
V_{50}	(cc)	4.02
t_{50}	(min)	71.00
Height After Consolidation (in)		5.456
Strain Rate	(in/min)	**0.0003**
Duration of Test*	(hr)	44.4

*Based on a total strain of 15%

Height (ft)		5.412
		5.413
		5.413
Average		5.413
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.3100	0.2410
Final Rdg. (in)	0.2420	0.2660

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	01/31/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-16				
Sample No.:	R-3				
Depth (ft.):	26-26.5				
Sample Type:	Ring				

12 psi

Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/12/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-22	Sample Type:	Ring		
Sample No.:	R-12	Depth(ft):	50.0		
Sample Description:	Gray silt (ML)				

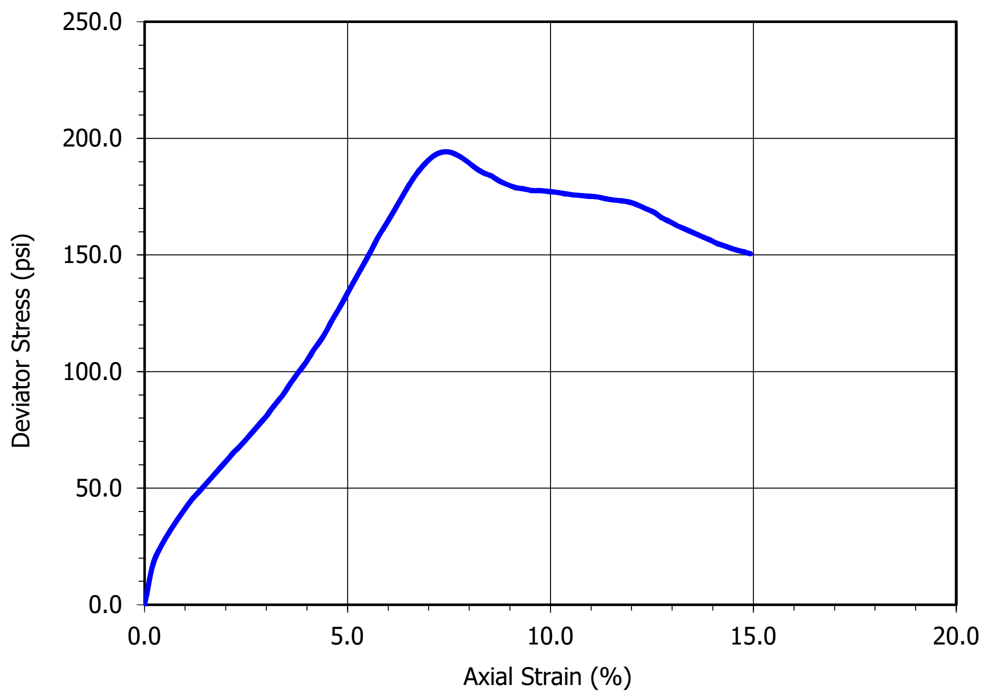
Diameter (in)	1	2.425
	2	2.425
	3	2.425
	Average	2.425
Height (in)	1	5.026
	2	5.025
	3	5.027
	Average	5.026
Weight of Sample + Tube / Rings (g)		790.8
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		877.6
Weight of Dry Sample + Container (g)		749.3
Weight of Container (g)		88.3
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	19.41
Dry Density (pcf)	108.7
Void Ratio	0.550
% Saturation	95.3

At Failure*	
Deviator stress (psi)	**194.17**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**236.17**
Axial strain (%)	**7.36**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos
Date:	11/11/20		
Project No:	11585.005	Checked by:	J. Ward
Date:	12/02/20		
Boring No.:	LB-27	Sample Type:	Ring
Sample No.:	R-11	Depth(ft):	50.0
Sample Description:	Gray silt (ML)		

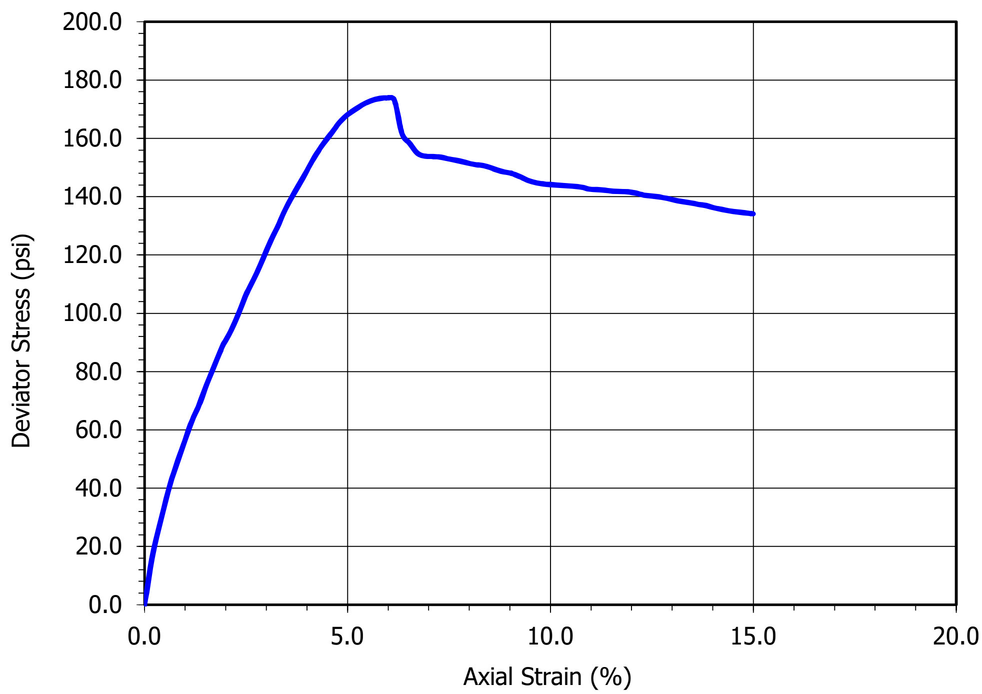
Diameter (in)	1	2.425
	2	2.425
	3	2.425
	Average	2.425
Height (in)	1	5.202
	2	5.202
	3	5.205
	Average	5.203
Weight of Sample + Tube / Rings (g)		841.3
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		915.5
Weight of Dry Sample + Container (g)		794.7
Weight of Container (g)		75.0
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	16.78
Dry Density (pcf)	114.2
Void Ratio	0.475
% Saturation	95.3

At Failure*	
Deviator stress (psi)	**173.88**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**215.88**
Axial strain (%)	**5.96**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/12/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-37	Sample Type:	Ring		
Sample No.:	R-8	Depth(ft):	30.0		
Sample Description:	Gray silt (ML)				

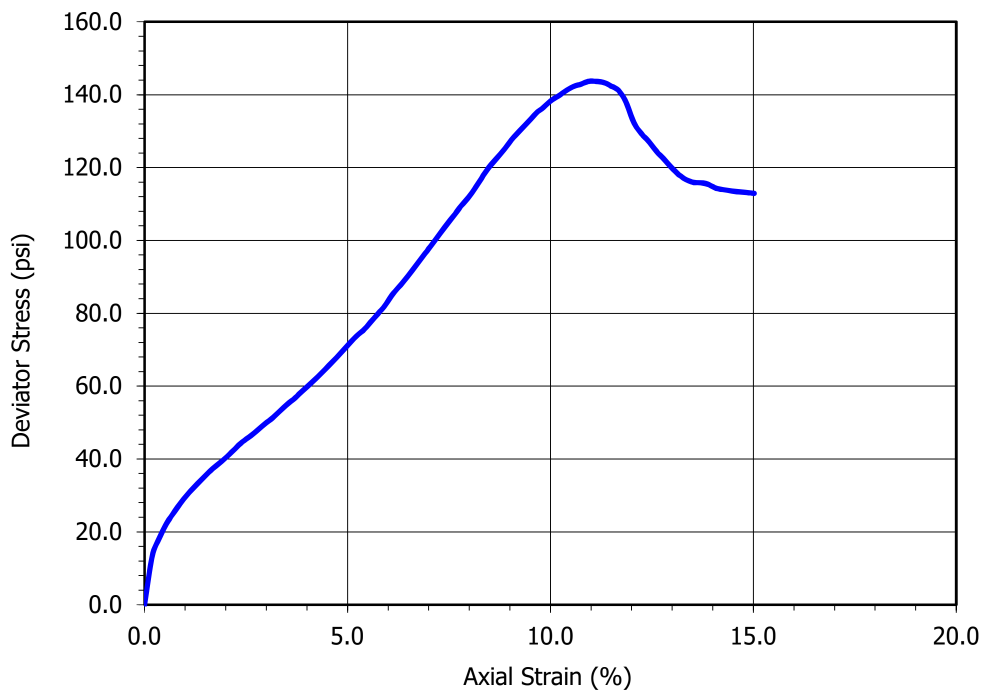
Diameter (in)	1	2.423
	2	2.423
	3	2.423
	Average	2.423
Height (in)	1	5.392
	2	5.393
	3	5.393
	Average	5.393
Weight of Sample + Tube / Rings (g)		842.2
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		915.7
Weight of Dry Sample + Container (g)		786.1
Weight of Container (g)		74.1
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		25.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	18.20
Dry Density (pcf)	109.2
Void Ratio	0.543
% Saturation	90.4

At Failure*	
Deviator stress (psi)	**143.67**
Minor principal total stress (psi)	**25.00**
Major principal total stress (psi)	**168.67**
Axial strain (%)	**10.94**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/12/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-37	Sample Type:	Tube		
Sample No.:	T-11B	Depth(ft):	43.0		
Sample Description:	Dark gray silt (ML)				

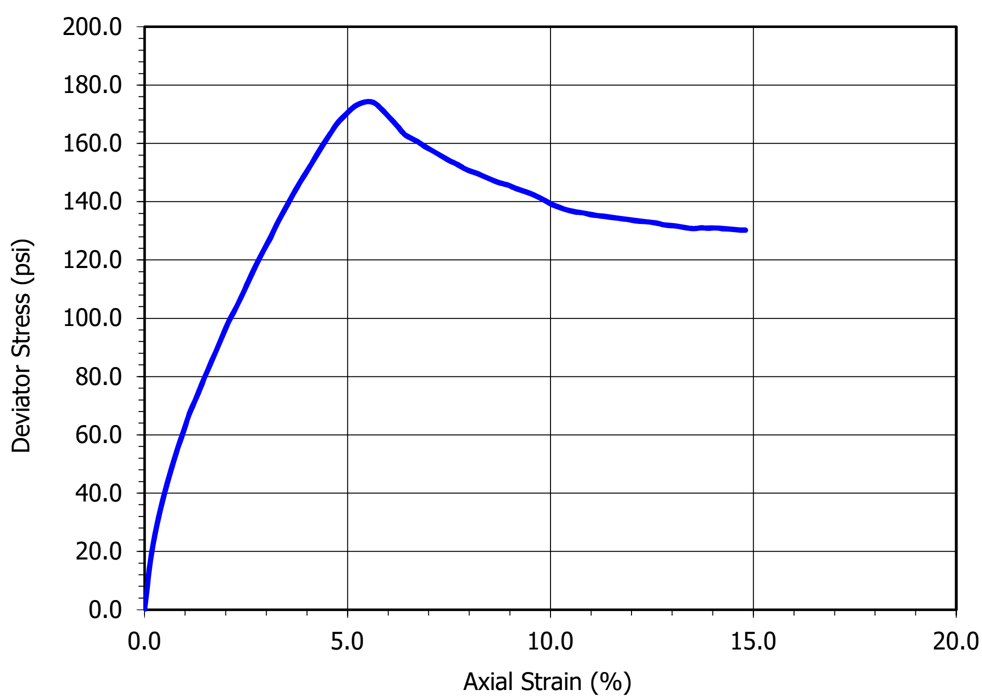
Diameter (in)	1	2.416
	2	2.416
	3	2.416
	Average	2.416
Height (in)	1	5.472
	2	5.470
	3	5.470
	Average	5.471
Weight of Sample + Tube / Rings (g)		797.5
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		873.2
Weight of Dry Sample + Container (g)		751.2
Weight of Container (g)		78.5
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		35.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	18.14
Dry Density (pcf)	102.5
Void Ratio	0.643
% Saturation	76.1

At Failure*	
Deviator stress (psi)	**174.32**
Minor principal total stress (psi)	**35.00**
Major principal total stress (psi)	**209.32**
Axial strain (%)	**5.48**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos
Date:	11/12/20		
Project No:	11585.005	Checked by:	J. Ward
Date:	12/02/20		
Boring No.:	LB-38	Sample Type:	Ring
Sample No.:	R-14	Depth(ft):	43.0
Sample Description:	Gray silt (ML)		

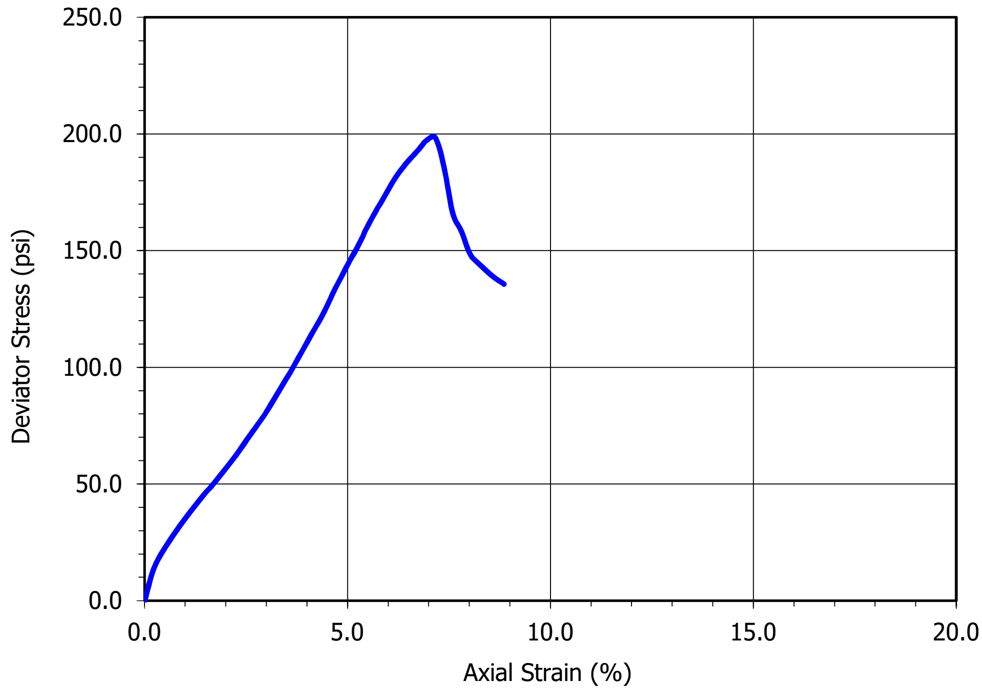
Diameter (in)	1	2.423
	2	2.423
	3	2.423
	Average	2.423
Height (in)	1	4.740
	2	4.741
	3	4.744
	Average	4.742
Weight of Sample + Tube / Rings (g)		764.8
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		852.0
Weight of Dry Sample + Container (g)		744.4
Weight of Container (g)		87.9
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	16.39
Dry Density (pcf)	114.5
Void Ratio	0.472
% Saturation	93.8

At Failure*	
Deviator stress (psi)	**198.23**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**240.23**
Axial strain (%)	**7.17**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



APPENDIX C.6

Pavement Support and Earthwork

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Dansby	Date:	09/11/18
Project No.:	11588.001	Input By:	J. Ward	Date:	09/14/18
Boring No.:	LBA-1	Depth (ft.):	10-15		
Sample No.:	B-1				
Soil Identification:	Light olive brown silty clay (CL-ML)				

Preparation Method: [X] Moist [ ] Dry — [X] Mechanical Ram [ ] Manual Ram

Mold Volume (ft³) 0.03330 — *Ram Weight = 10 lb.; Drop = 18 in.*

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3658	3732	3796	3787		
Weight of Mold (g)	1848	1848	1848	1848		
Net Weight of Soil (g)	1810	1884	1948	1939		
Wet Weight of Soil + Cont. (g)	678.0	701.7	456.4	447.7		
Dry Weight of Soil + Cont. (g)	639.0	650.6	399.5	383.9		
Weight of Container (g)	228.5	230.1	39.2	39.1		
Moisture Content (%)	9.50	12.15	15.79	18.50		
Wet Density (pcf)	119.8	124.7	129.0	128.4		
Dry Density (pcf)	109.4	111.2	111.4	108.3		

Maximum Dry Density (pcf) 112.0 **Optimum Moisture Content (%)** 14.5

PROCEDURE USED

[X] **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

[ ] **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

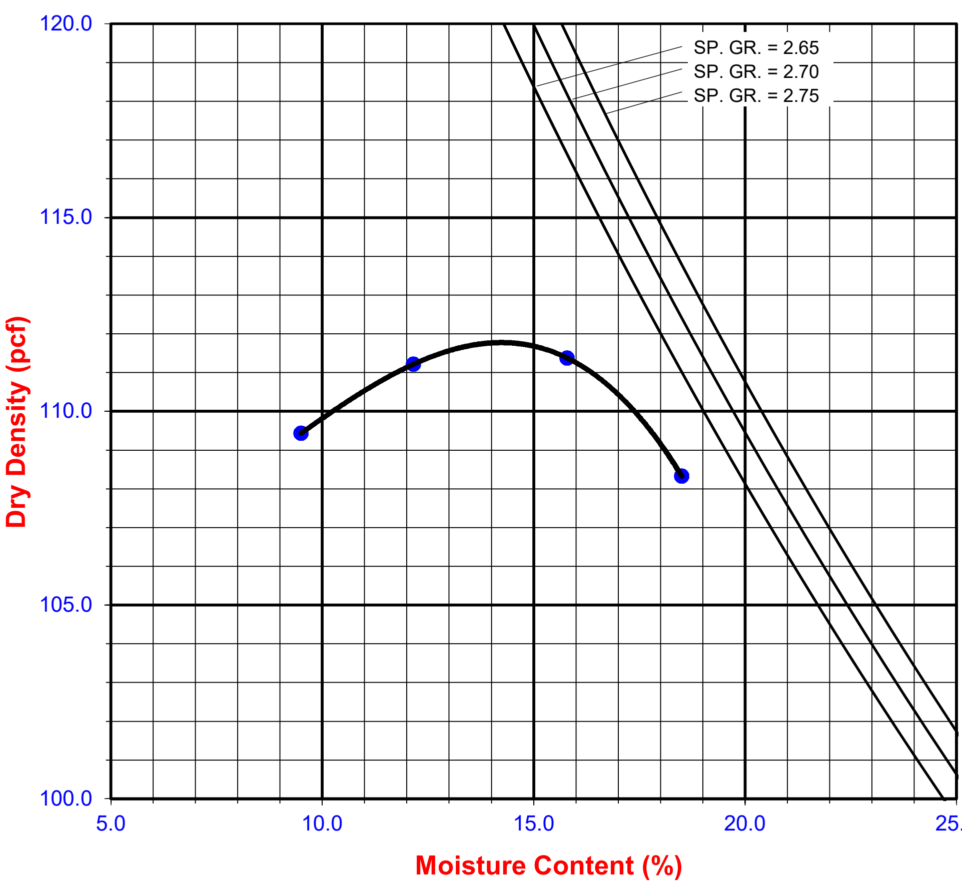
[ ] **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Dansby	Date:	09/12/18
Project No.:	11588.001	Input By:	J. Ward	Date:	09/14/18
Boring No.:	LBA-2	Depth (ft.):	10-15		
Sample No.:	B-2				
Soil Identification:	Light brown silty, clayey sand (SC-SM)				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)	
Preparation Method:	X	Moist	#3/4	
		Dry	#3/8	6.8
Compaction Method	X	Mechanical Ram	#4	
		Manual Ram		

Rammer Weight (lb.) = 10.0
Height of Drop (in.) = 18.0
Mold Volume (ft³) 0.03330

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3800	3882	3951	3877		
Weight of Mold (g)	1848	1848	1848	1848		
Net Weight of Soil (g)	1952	2034	2103	2029		
Wet Weight of Soil + Cont. (g)	437.2	468.5	471.7	526.6		
Dry Weight of Soil + Cont. (g)	418.9	439.0	432.7	473.1		
Weight of Container (g)	40.0	38.9	38.8	39.1		
Moisture Content (%)	4.83	7.37	9.90	12.33		
Wet Density (pcf)	129.2	134.7	139.2	134.3		
Dry Density (pcf)	123.3	125.4	126.7	119.6		

Maximum Dry Density (pcf)	**127.0**	**Optimum Moisture Content (%)**	**9.5**
Corrected Dry Density (pcf)	**129.0**	**Corrected Moisture Content (%)**	**9.0**

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

X **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

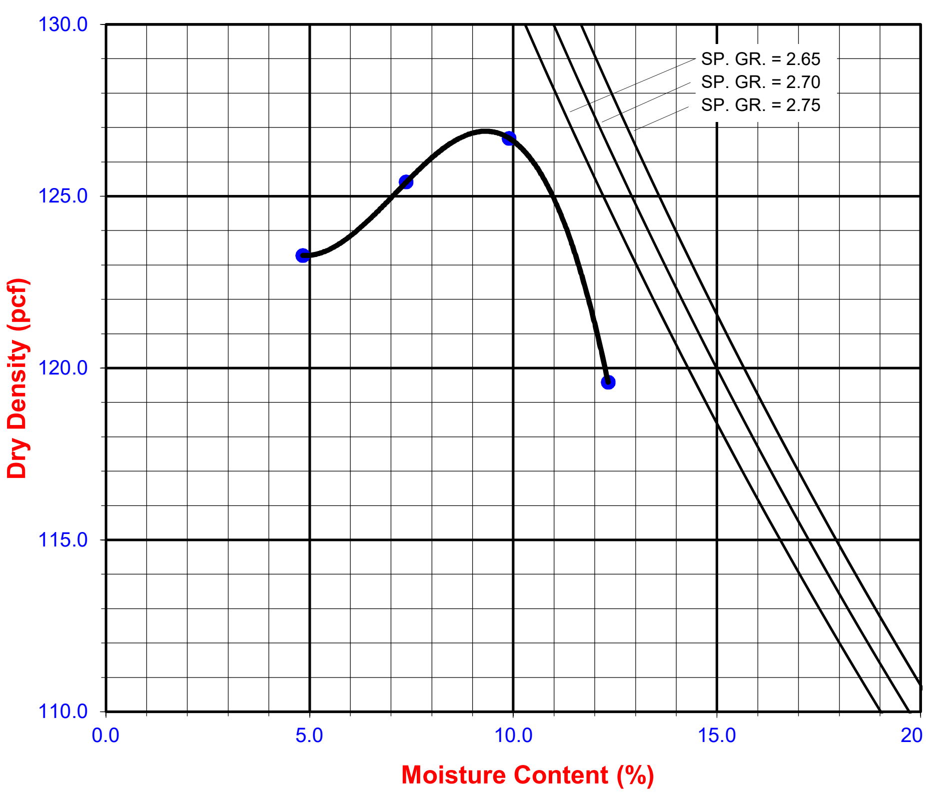
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	S. Dansby	Date:	01/30/19
Project No.:	11588.001	Input By:	J. Ward	Date:	02/01/19
Boring No.:	LB-14	Depth (ft.):	2-5		
Sample No.:	B-1				
Soil Identification:	Olive brown silty sand with gravel (SM)g				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)	
Preparation Method:	X	Moist	#3/4	
		Dry	#3/8	5.1
Compaction Method	X	Mechanical Ram	#4	
		Manual Ram		

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) 0.03320

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3927	4054	4014			
Weight of Mold (g)	1830	1830	1830			
Net Weight of Soil (g)	2097	2224	2184			
Wet Weight of Soil + Cont. (g)	588.5	461.6	493.0			
Dry Weight of Soil + Cont. (g)	569.9	438.1	457.0			
Weight of Container (g)	39.3	39.2	39.3			
Moisture Content (%)	3.51	5.89	8.62			
Wet Density (pcf)	139.2	147.7	145.0			
Dry Density (pcf)	134.5	139.5	133.5			

Maximum Dry Density (pcf) 139.5 **Optimum Moisture Content (%)** 5.9

Corrected Dry Density (pcf) 140.7 **Corrected Moisture Content (%)** 5.7

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☒ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

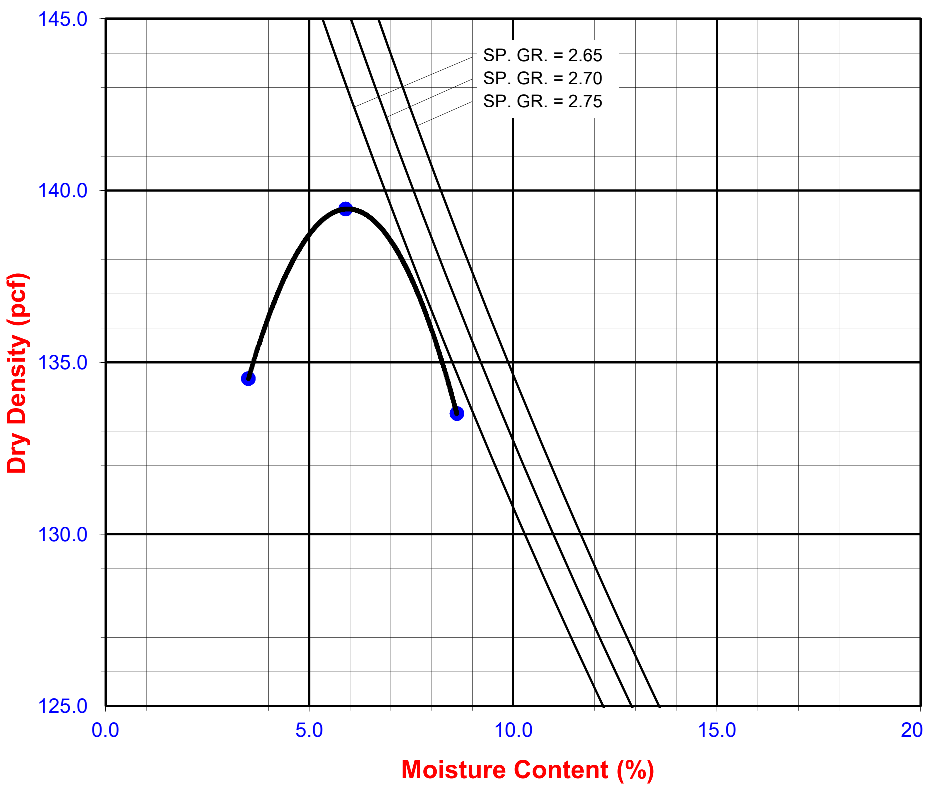
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name:	Brea Boulevard Additonal Borings	Tested By:	J. Gonzalez	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	10/28/20
Boring No.:	LB-29	Depth (ft.):	2-5		
Sample No.:	B-1				
Soil Identification:	Olive brown silty sand (SM)				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)	
Preparation Method:	X	Moist		
		Dry	#3/4	
Compaction Method	X	Mechanical Ram	#3/8	
		Manual Ram	#4	15.2

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) 0.03330

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3835	3926	3889			
Weight of Mold (g)	1868	1868	1868			
Net Weight of Soil (g)	1967	2058	2021			
Wet Weight of Soil + Cont. (g)	331.2	311.0	293.7			
Dry Weight of Soil + Cont. (g)	311.0	286.6	264.9			
Weight of Container (g)	39.2	38.6	39.9			
Moisture Content (%)	7.43	9.84	12.80			
Wet Density (pcf)	130.2	136.2	133.8			
Dry Density (pcf)	121.2	124.0	118.6			

Maximum Dry Density (pcf) 124.1 **Optimum Moisture Content (%)** 9.8

Corrected Dry Density (pcf) 129.3 **Corrected Moisture Content (%)** 8.5

☒ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

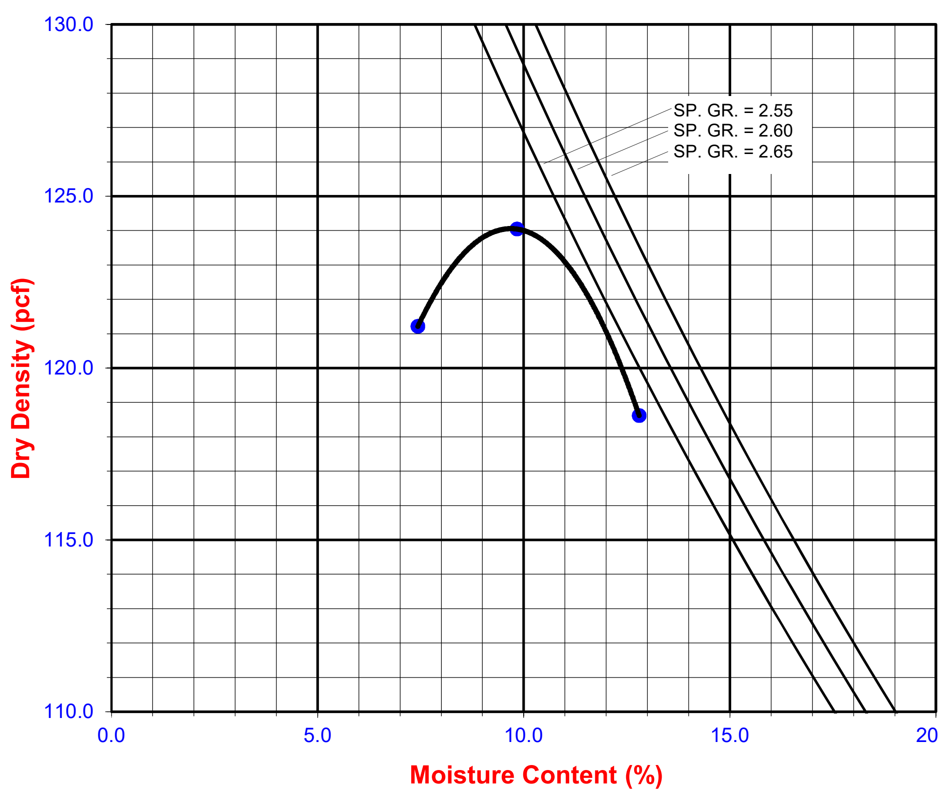
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



Leighton

R-VALUE TEST RESULTS

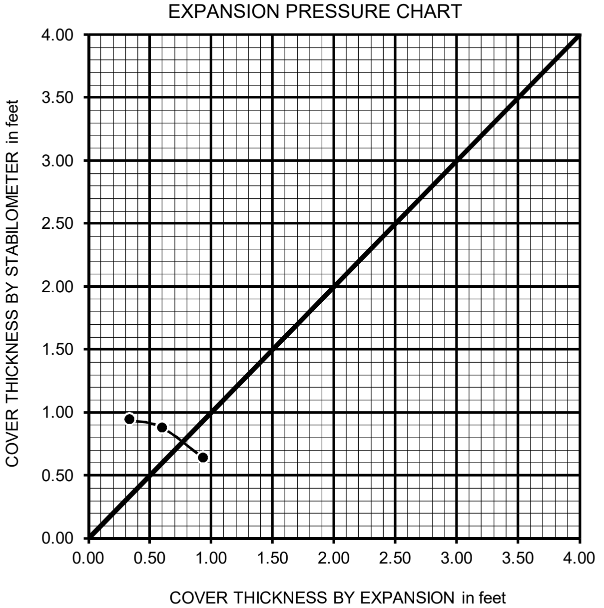
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-1	DEPTH (FT.):	1.25
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

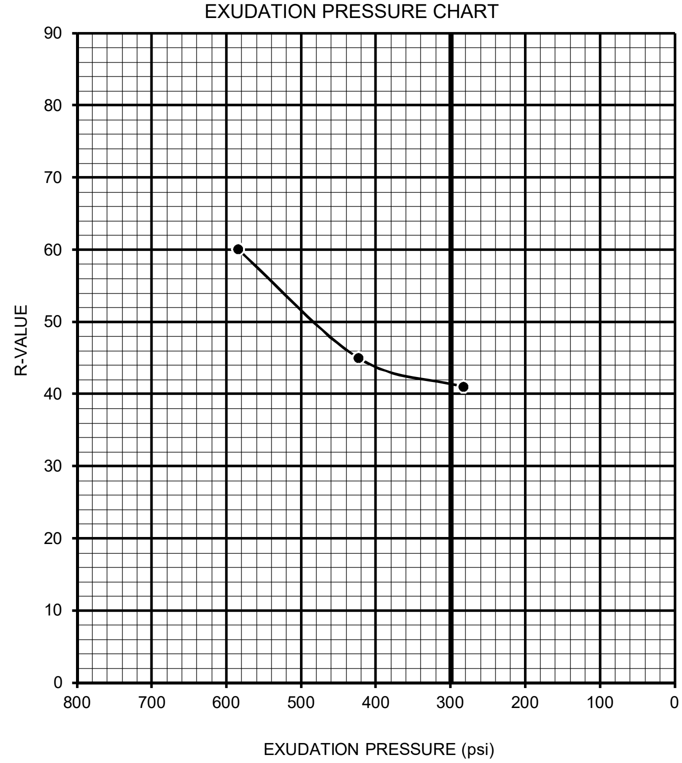
TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	12.9	13.8	14.3
HEIGHT OF SAMPLE, Inches	2.45	2.45	2.47
DRY DENSITY, pcf	116.6	115.0	114.4
COMPACTOR PRESSURE, psi	250	150	50
EXUDATION PRESSURE, psi	584	423	282
EXPANSION, Inches x 10exp-4	28	18	10
STABILITY Ph 2,000 lbs (160 psi)	46	64	70
TURNS DISPLACEMENT	4.07	4.53	4.70
R-VALUE UNCORRECTED	60	45	41
R-VALUE CORRECTED	60	45	41

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.64	0.88	0.94
EXPANSION PRESSURE THICKNESS, ft.	0.93	0.60	0.33

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	51
R-VALUE BY EXUDATION:	41
EQUILIBRIUM R-VALUE:	41

Leighton

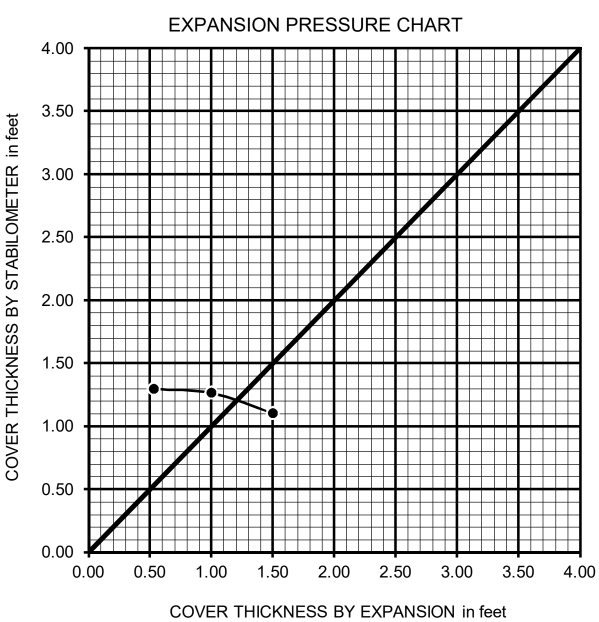
R-VALUE TEST RESULTS

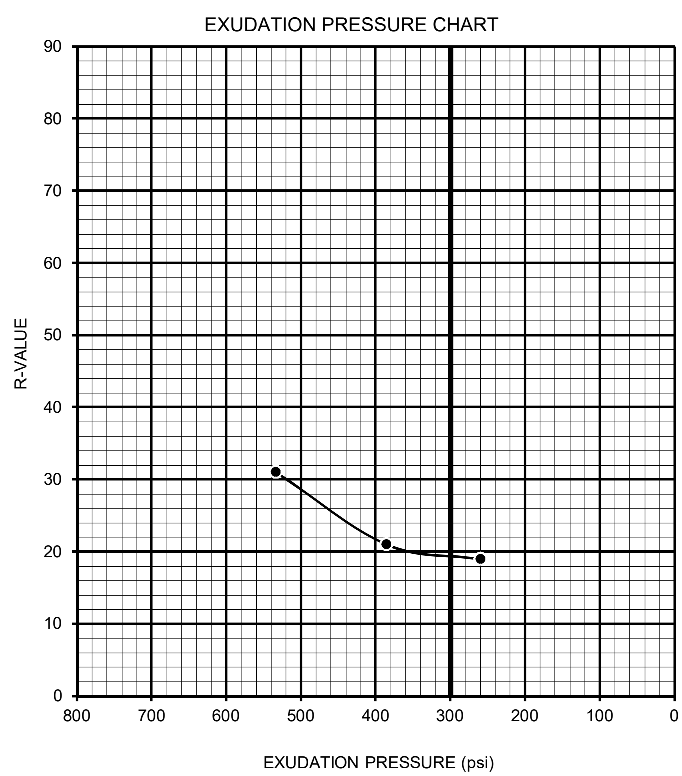
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-9	DEPTH (FT.):	
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown lean clay (CL)	DATE COMPLETED:	8/8/2018

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	20.0	21.0	21.5
HEIGHT OF SAMPLE, Inches	2.46	2.55	2.51
DRY DENSITY, pcf	108.1	106.8	104.8
COMPACTOR PRESSURE, psi	200	150	100
EXUDATION PRESSURE, psi	533	386	259
EXPANSION, Inches x 10exp-4	45	30	16
STABILITY Ph 2,000 lbs (160 psi)	98	112	118
TURNS DISPLACEMENT	3.58	3.94	3.80
R-VALUE UNCORRECTED	31	21	19
R-VALUE CORRECTED	31	21	19

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.10	1.26	1.30
EXPANSION PRESSURE THICKNESS, ft.	1.50	1.00	0.53





R-VALUE BY EXPANSION:	25
R-VALUE BY EXUDATION:	19
EQUILIBRIUM R-VALUE:	19

Leighton

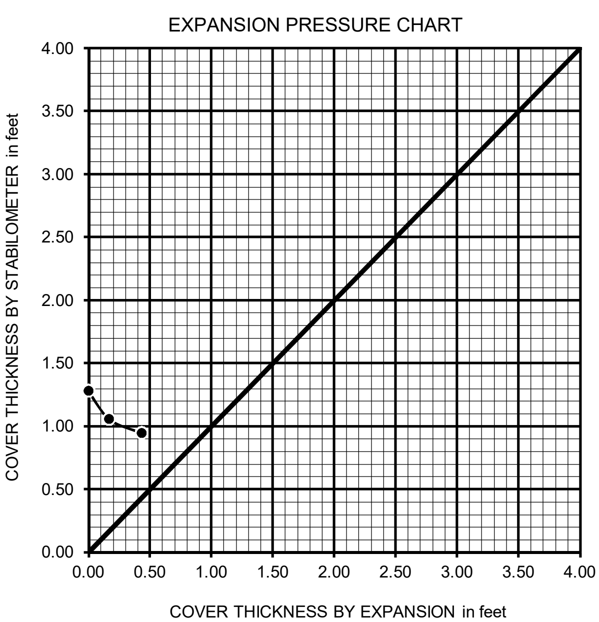
R-VALUE TEST RESULTS

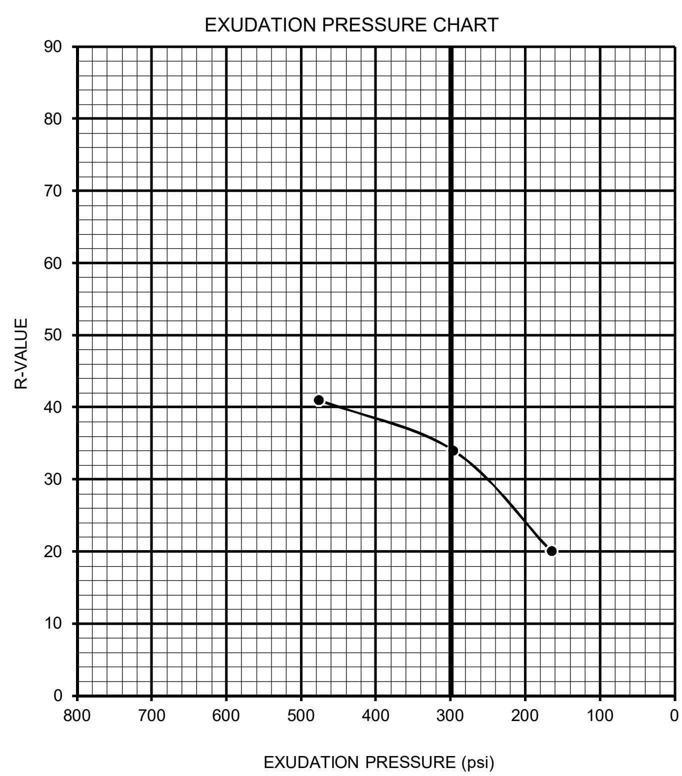
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-11	DEPTH (FT.):	3.0
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	17.0	17.4	18.4
HEIGHT OF SAMPLE, Inches	2.51	2.58	2.65
DRY DENSITY, pcf	109.4	107.4	106.2
COMPACTOR PRESSURE, psi	150	100	50
EXUDATION PRESSURE, psi	476	296	165
EXPANSION, Inches x 10exp-4	13	5	0
STABILITY Ph 2,000 lbs (160 psi)	72	91	119
TURNS DISPLACEMENT	4.31	3.99	3.88
R-VALUE UNCORRECTED	41	32	18
R-VALUE CORRECTED	41	34	20

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.94	1.06	1.28
EXPANSION PRESSURE THICKNESS, ft.	0.43	0.17	0.00





R-VALUE BY EXPANSION:	49
R-VALUE BY EXUDATION:	34
EQUILIBRIUM R-VALUE:	34

Leighton

R-VALUE TEST RESULTS

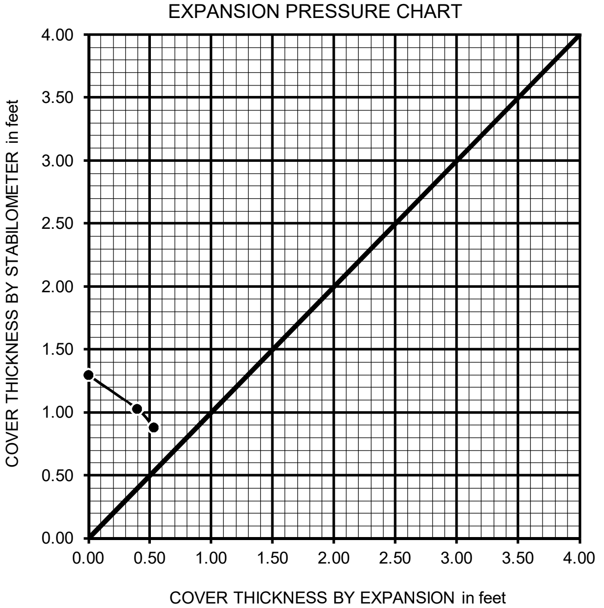
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-12	DEPTH (FT.):	1.3
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Light grayish brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

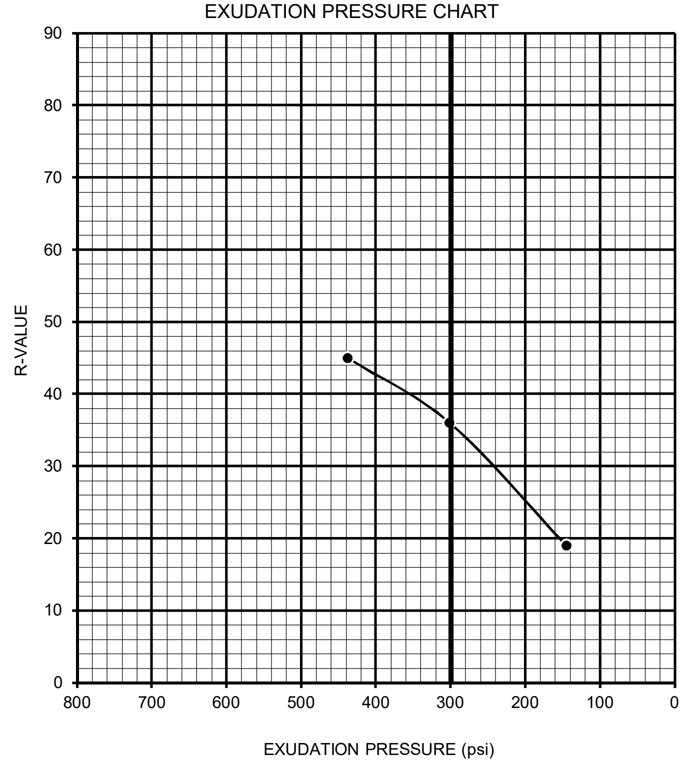
TEST SPECIMEN	**a**	**b**	**c**
MOISTURE AT COMPACTION %	11.5	12.0	12.9
HEIGHT OF SAMPLE, Inches	2.44	2.54	2.50
DRY DENSITY, pcf	117.5	114.0	115.1
COMPACTOR PRESSURE, psi	150	100	50
EXUDATION PRESSURE, psi	438	301	145
EXPANSION, Inches x 10exp-4	16	12	0
STABILITY Ph 2,000 lbs (160 psi)	67	85	118
TURNS DISPLACEMENT	4.11	3.98	3.87
R-VALUE UNCORRECTED	46	36	19
R-VALUE CORRECTED	45	36	19

DESIGN CALCULATION DATA	**a**	**b**	**c**
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.88	1.02	1.30
EXPANSION PRESSURE THICKNESS, ft.	0.53	0.40	0.00

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	56
R-VALUE BY EXUDATION:	36
EQUILIBRIUM R-VALUE:	36

APPENDIX C.7

Corrosivity

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By :	G. Berdy	Date:	07/30/18
Project No. :	11588.001	Data Input By:	J. Ward	Date:	09/12/18

Boring No.	LB-3	LB-7		
Sample No.	B-1	B-1		
Sample Depth (ft)	0.0	0.0		
Soil Identification:	Olive brown SC-SM	Dark brown SC		
Wet Weight of Soil + Container (g)	212.56	211.74		
Dry Weight of Soil + Container (g)	206.10	203.08		
Weight of Container (g)	39.33	60.22		
Moisture Content (%)	3.87	6.06		
Weight of Soaked Soil (g)	100.24	100.80		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	2	91		
Crucible No.	5, 7 & 24	24		
Furnace Temperature (°C)	860	860		
Time In / Time Out	9:00/9:45	8:15/9:00		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	56.1147	17.0939		
Wt. of Crucible (g)	56.0810	17.0867		
Wt. of Residue (g) (A)	0.0337	0.0072		
PPM of Sulfate (A) x 41150	1386.76	296.28		
PPM of Sulfate, Dry Weight Basis	**1443**	**315**		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	5	15		
ml of AgNO3 Soln. Used in Titration (C)	0.8	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	360	120		
PPM of Chloride, Dry Wt. Basis	**375**	**128**		

pH TEST, DOT California Test 643

pH Value	**6.82**	**7.23**		
Temperature °C	22.8	22.7		

SOIL RESISTIVITY TEST
DOT CA TEST 643

Project Name:	Brea Boulevard Corridor Improvements	Tested By :	G. Berdy	Date: 09/11/18
Project No. :	11588.001	Data Input By:	J. Ward	Date: 09/12/18
Boring No.:	LB-3	Depth (ft.) :	0.0	
Sample No. :	B-1			

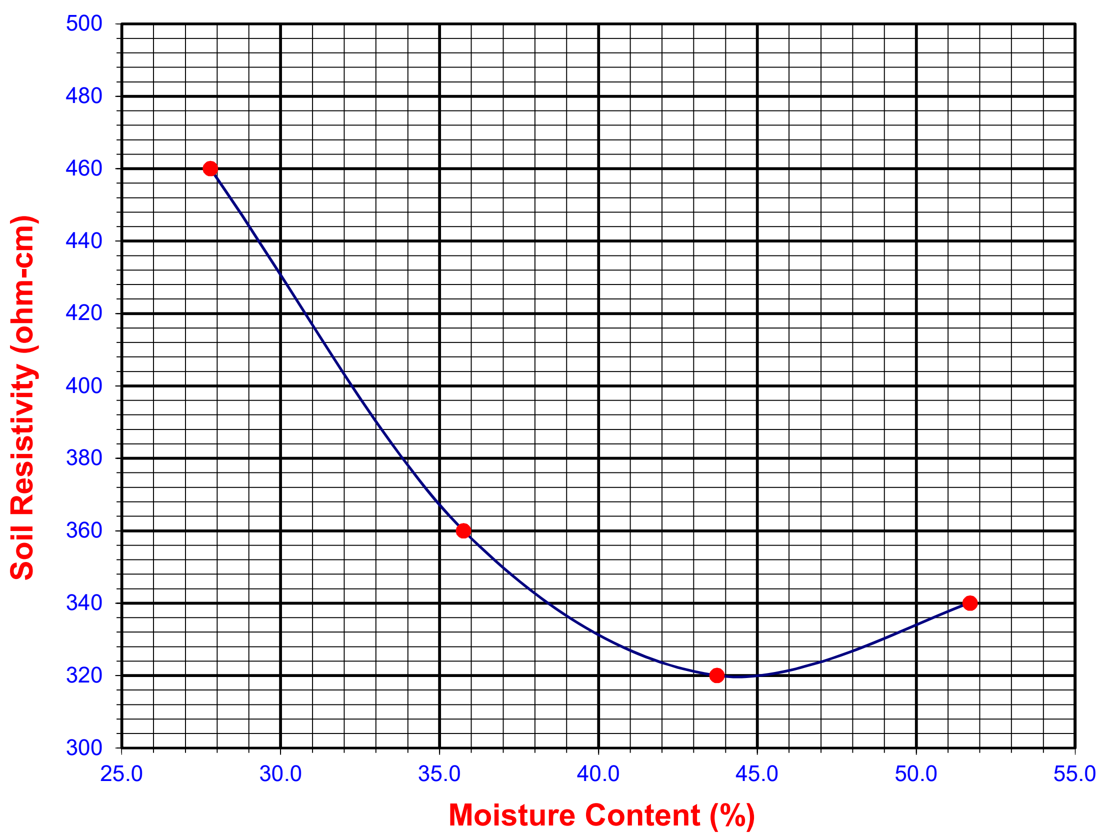
Soil Identification:* Olive brown SC-SM

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	27.79	460	460
2	40	35.76	360	360
3	50	43.73	320	320
4	60	51.70	340	340
5				

Moisture Content (%) (MCi)	3.87
Wet Wt. of Soil + Cont. (g)	212.56
Dry Wt. of Soil + Cont. (g)	206.10
Wt. of Container (g)	39.33
Container No.	
Initial Soil Wt. (g) (Wt)	130.31
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
320	**44.4**	**1443**	**375**	**6.82**	**22.8**



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Brea Boulevard Corridor Improvements	Tested By :	G. Berdy	Date:	08/01/18
Project No. :	11588.001	Data Input By:	J. Ward	Date:	09/12/18
Boring No.:	LB-7	Depth (ft.) :	0.0		
Sample No. :	B-1				

Soil Identification:* Dark brown SC

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	30.52	610	610
2	40	38.68	580	580
3	50	46.83	570	570
4	60	54.98	580	580
5				

Moisture Content (%) (MCi)	6.06
Wet Wt. of Soil + Cont. (g)	211.74
Dry Wt. of Soil + Cont. (g)	203.08
Wt. of Container (g)	60.22
Container No.	
Initial Soil Wt. (g) (Wt)	130.08
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
570	**46.8**	**315**	**128**	**7.23**	**22.7**

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By :	G. Berdy	Date:	10/27/20
Project No. :	11585.005	Checked By:	A. Santos	Date:	12/02/20

Boring No.	LB-19	LB-26	LB-32	LB-34
Sample No.	B-2	B-2	B-3	B-2
Sample Depth (ft)	25-35	10-20	30-40	20-30
Soil Identification:	Olive brown (SC)	Dark brown (CL)	Dark brown (ML)	Yellowish brown SM
Wet Weight of Soil + Container (g)	0.00	0.00	0.00	0.00
Dry Weight of Soil + Container (g)	0.00	0.00	0.00	0.00
Weight of Container (g)	1.00	1.00	1.00	1.00
Moisture Content (%)	0.00	0.00	0.00	0.00
Weight of Soaked Soil (g)	100.10	100.33	100.39	100.39

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	16	94	200A	306
Crucible No.	4	9	14/17	11
Furnace Temperature (°C)	860	860	860	860
Time In / Time Out	7:15/8:00	7:15/8:00	7:15/8:00	7:15/8:00
Duration of Combustion (min)	45	45	45	45
Wt. of Crucible + Residue (g)	21.0709	21.2313	43.9918	18.0327
Wt. of Crucible (g)	21.0661	21.2081	43.9035	18.0295
Wt. of Residue (g) (A)	0.0048	0.0232	0.0883	0.0032
PPM of Sulfate (A) x 41150	197.52	954.68	3633.54	131.68
PPM of Sulfate, Dry Weight Basis	**198**	**955**	**3634**	**132**

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30	30	15	15
ml of AgNO3 Soln. Used in Titration (C)	0.6	2.4	1.8	0.4
PPM of Chloride (C -0.2) * 100 * 30 / B	40	220	320	40
PPM of Chloride, Dry Wt. Basis	**40**	**220**	**320**	**40**

pH TEST, DOT California Test 643

pH Value	**8.08**	**7.57**	**6.34**	**8.23**
Temperature °C	19.8	19.8	19.8	19.6

SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-19	Depth (ft.) :	25-35
Sample No. :	B-2		

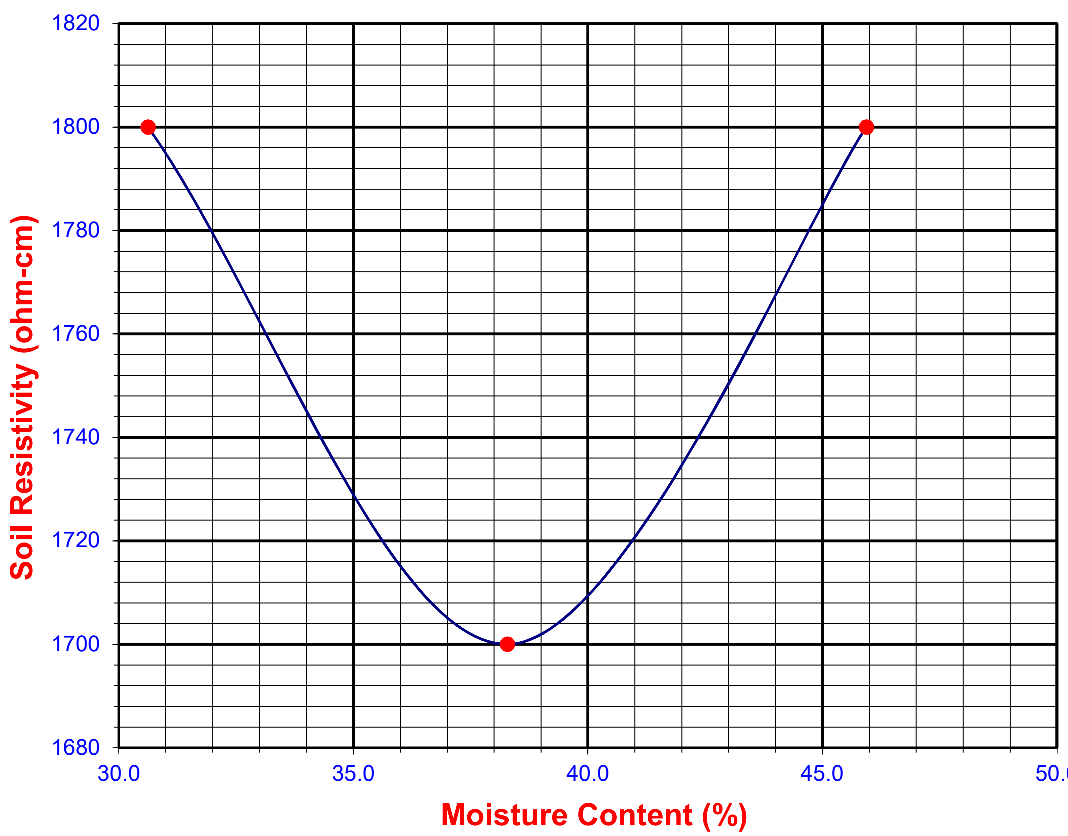
Soil Identification:* Olive brown (SC)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	40	30.63	1800	1800
2	50	38.28	1700	1700
3	60	45.94	1800	1800
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.61
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
1700	**38.3**	**198**	**40**	**8.08**	**19.8**



SOIL RESISTIVITY TEST

DOT CA TEST 643

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-26	Depth (ft.) :	10-20
Sample No. :	B-2		

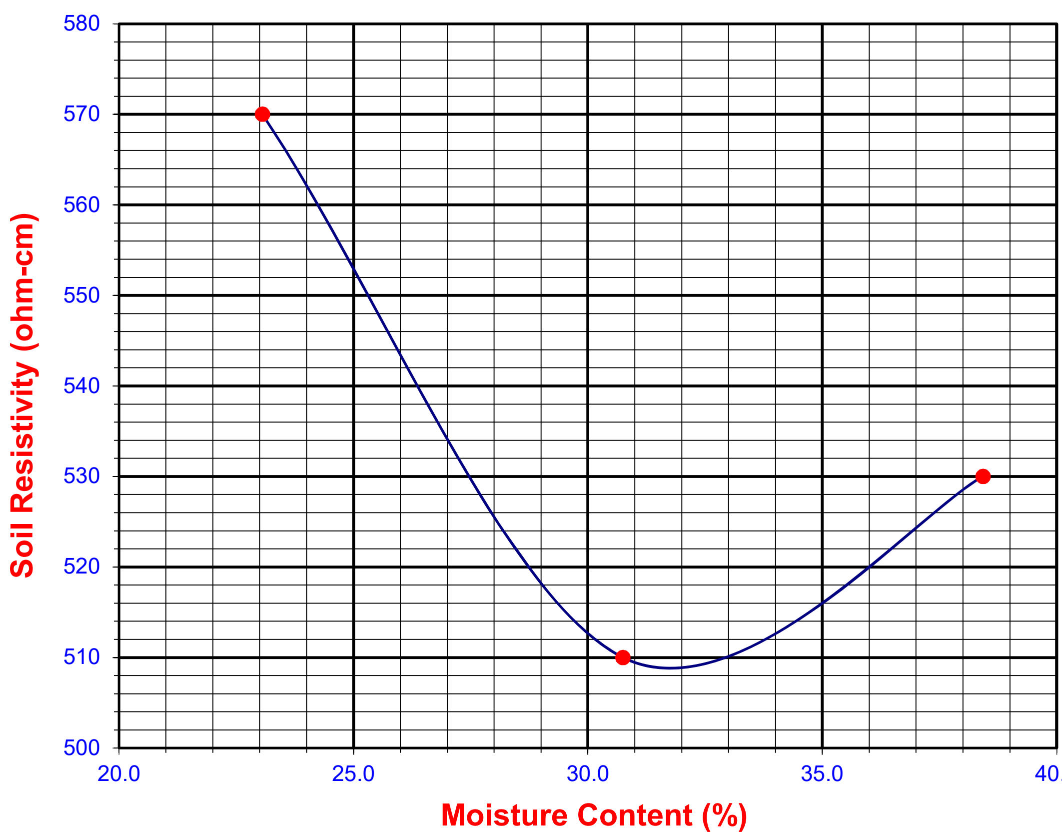
Soil Identification:* Dark brown (CL)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	23.06	570	570
2	40	30.75	510	510
3	50	38.43	530	530
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.10
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
509	**31.8**	**955**	**220**	**7.57**	**19.8**



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-32	Depth (ft.) :	30-40
Sample No. :	B-3		

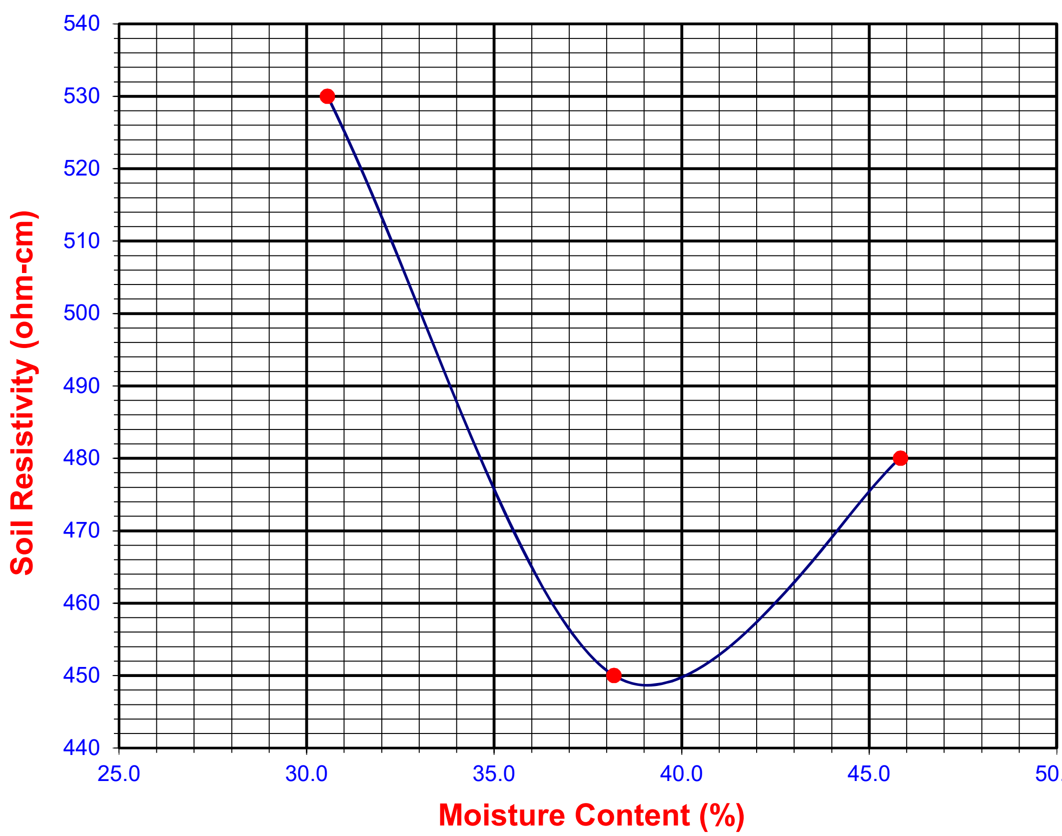
Soil Identification:* Dark brown (ML)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	40	30.56	530	530
2	50	38.20	450	450
3	60	45.84	480	480
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.90
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
448	**39.2**	**3634**	**320**	**6.34**	**19.8**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-34	Depth (ft.) :	20-30
Sample No. :	B-2		

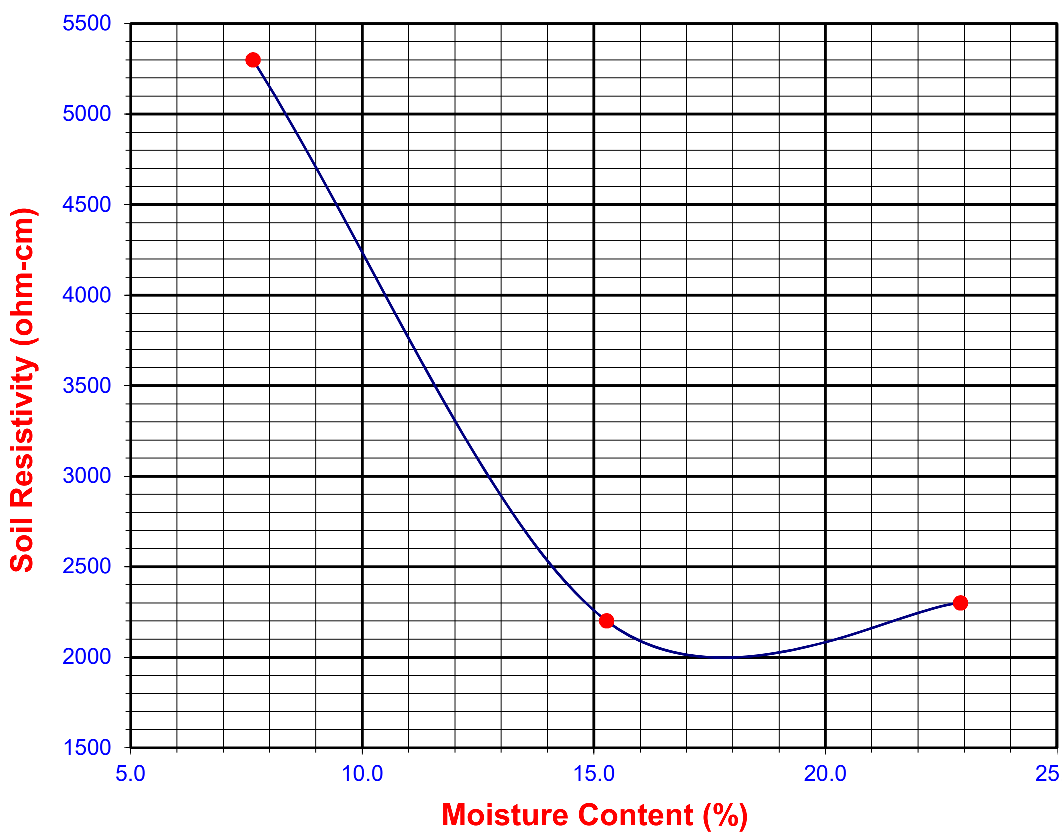
Soil Identification:* Yellowish brown SM

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	7.64	5300	5300
2	20	15.28	2200	2200
3	30	22.92	2300	2300
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.90
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2000	**18.0**	**132**	**40**	**8.23**	**19.6**



APPENDIX D

Engineering Analyses

APPENDIX D.1

CALTRANS ARS Analysis

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9381 **Longitude:** -117.8917 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1.01	1	0.66	0.65
0.10	1.1	1.13	1.04	1.01	1	1.15	1.13
0.20	1.39	1.5	1.01	1.01	1	1.4	1.51
0.30	1.38	1.6	1.01	1.01	1	1.4	1.62
0.50	1.21	1.42	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.77	0.86	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.4	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.12	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.15	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.9

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.9 Update

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9399 **Longitude:** -117.8906 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1	1	0.67	0.65
0.10	1.11	1.13	1.04	1	1	1.15	1.13
0.20	1.39	1.5	1.01	1	1	1.4	1.51
0.30	1.39	1.61	1.01	1.01	1	1.4	1.62
0.50	1.21	1.43	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.77	0.87	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.4	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.12	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.14	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.8

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.8 Update

CA.GOV

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9410 **Longitude:** -117.8875 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1	1	0.67	0.65
0.10	1.11	1.13	1.04	1	1	1.16	1.13
0.20	1.4	1.5	1.01	1	1	1.41	1.51
0.30	1.39	1.61	1.01	1.01	1	1.4	1.62
0.50	1.21	1.43	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.78	0.87	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.41	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.11	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.14	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.8

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.8 Update

APPENDIX D.2

Liquefaction Analysis

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

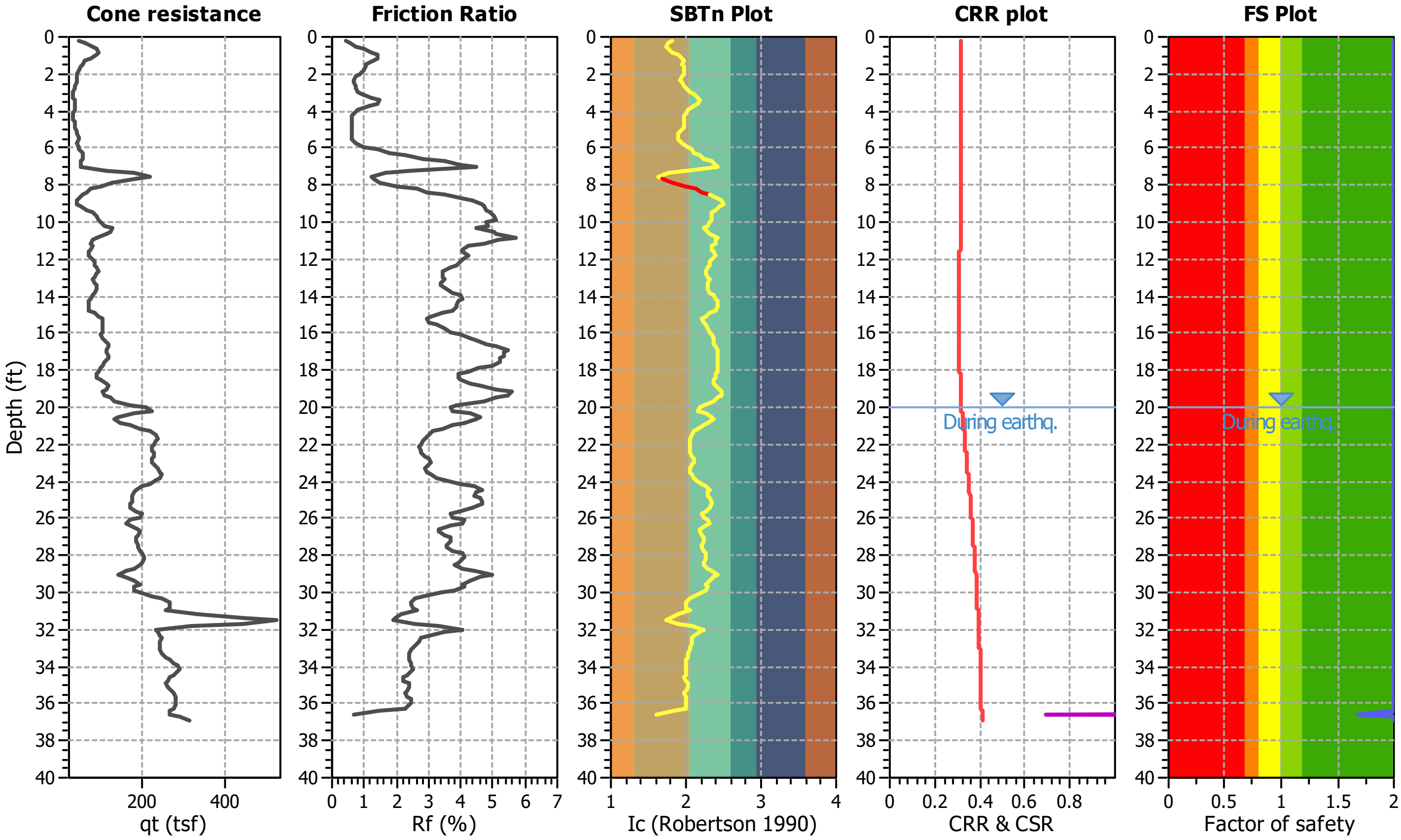
LIQUEFACTION ANALYSIS REPORT

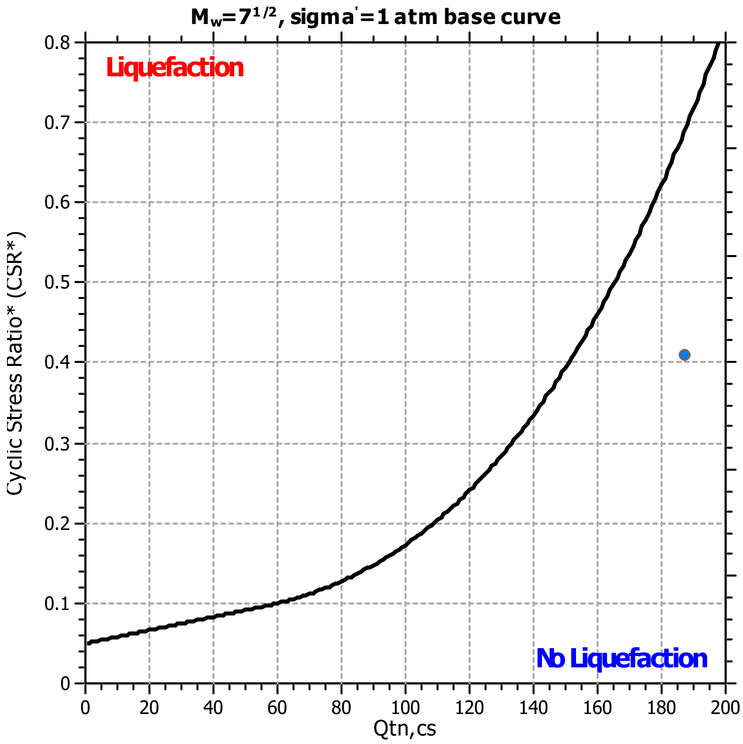
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

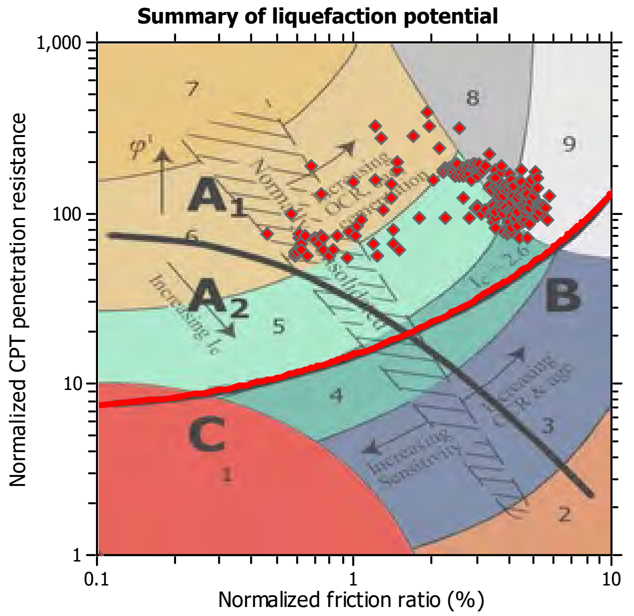
CPT file : C-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

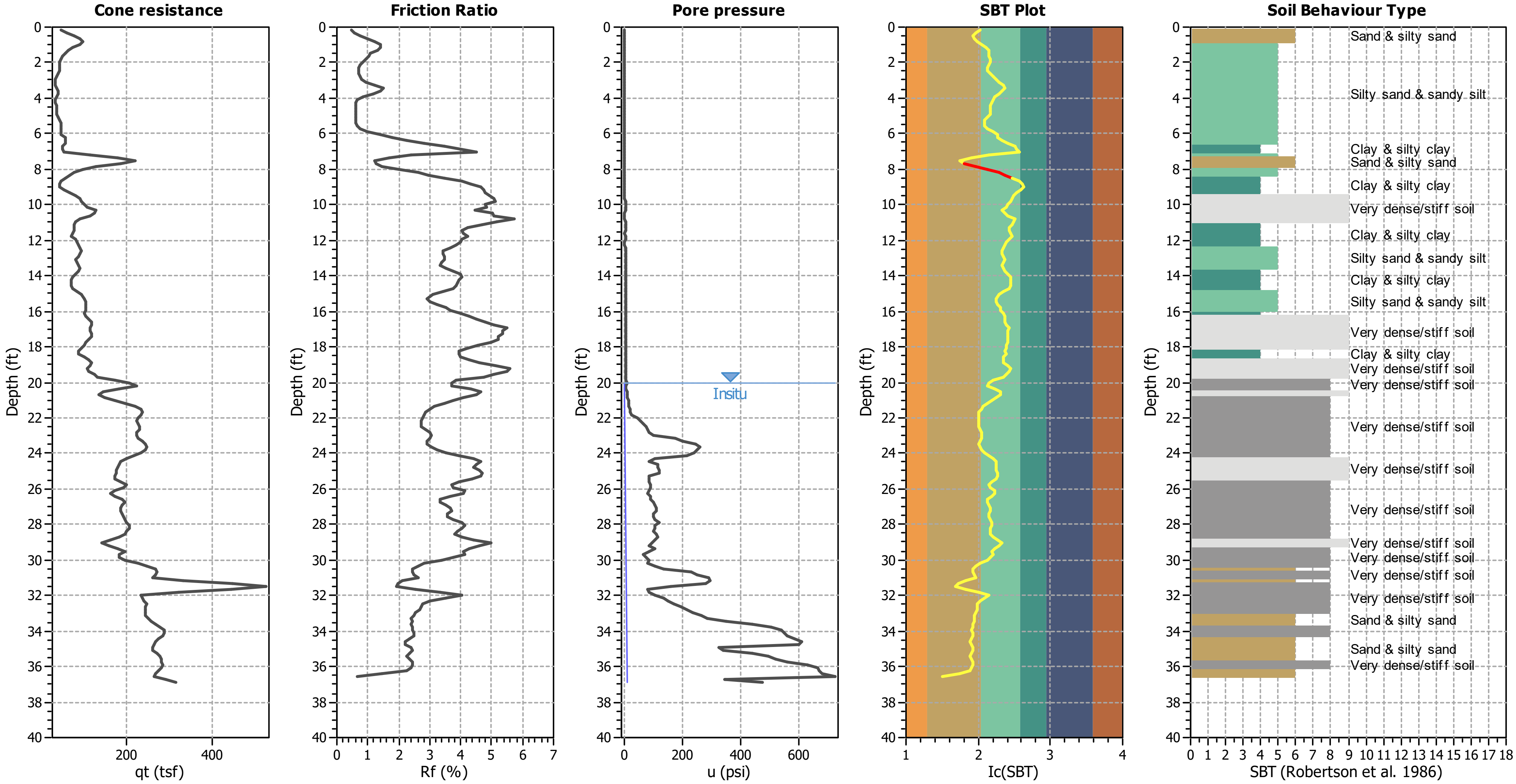






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



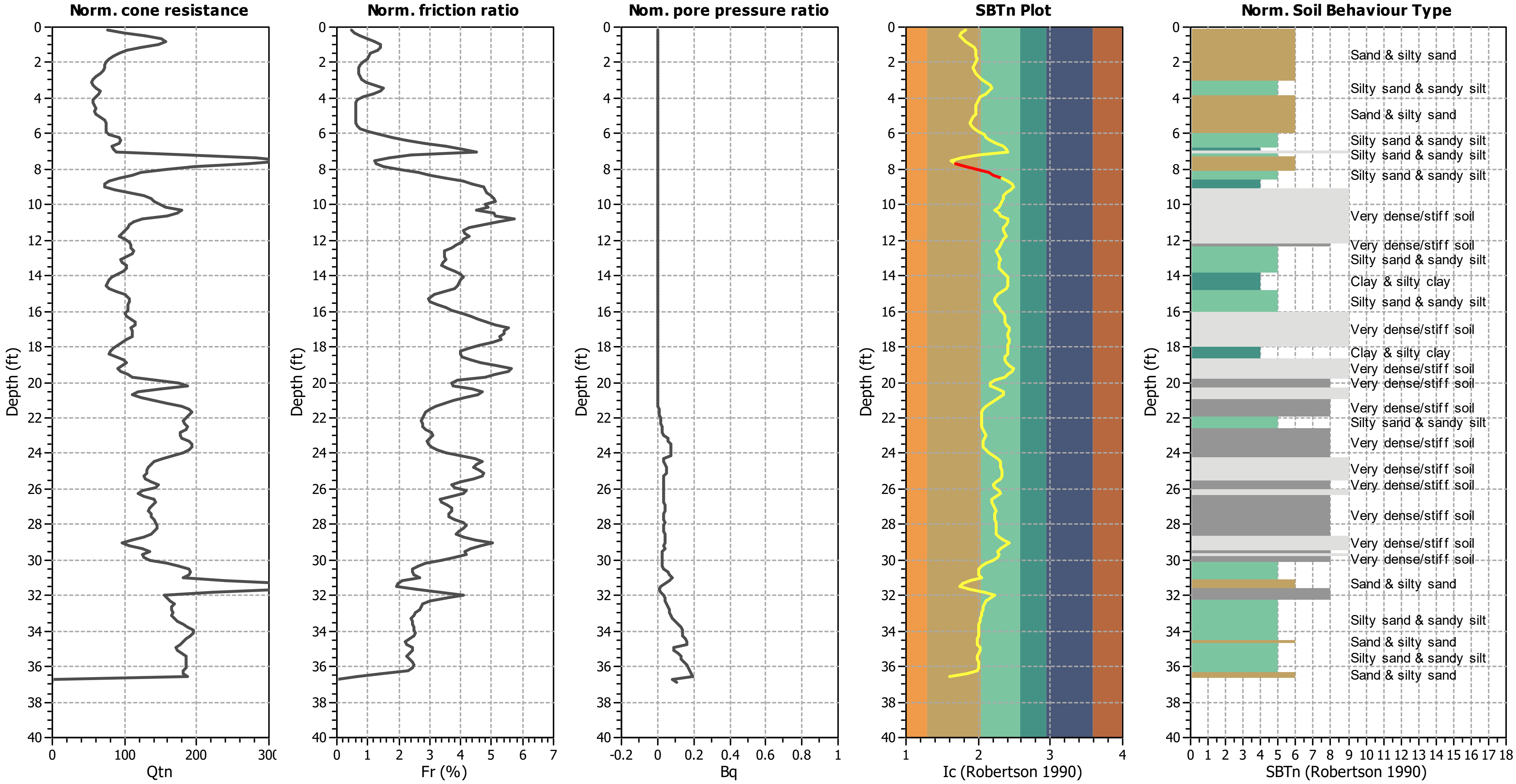
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



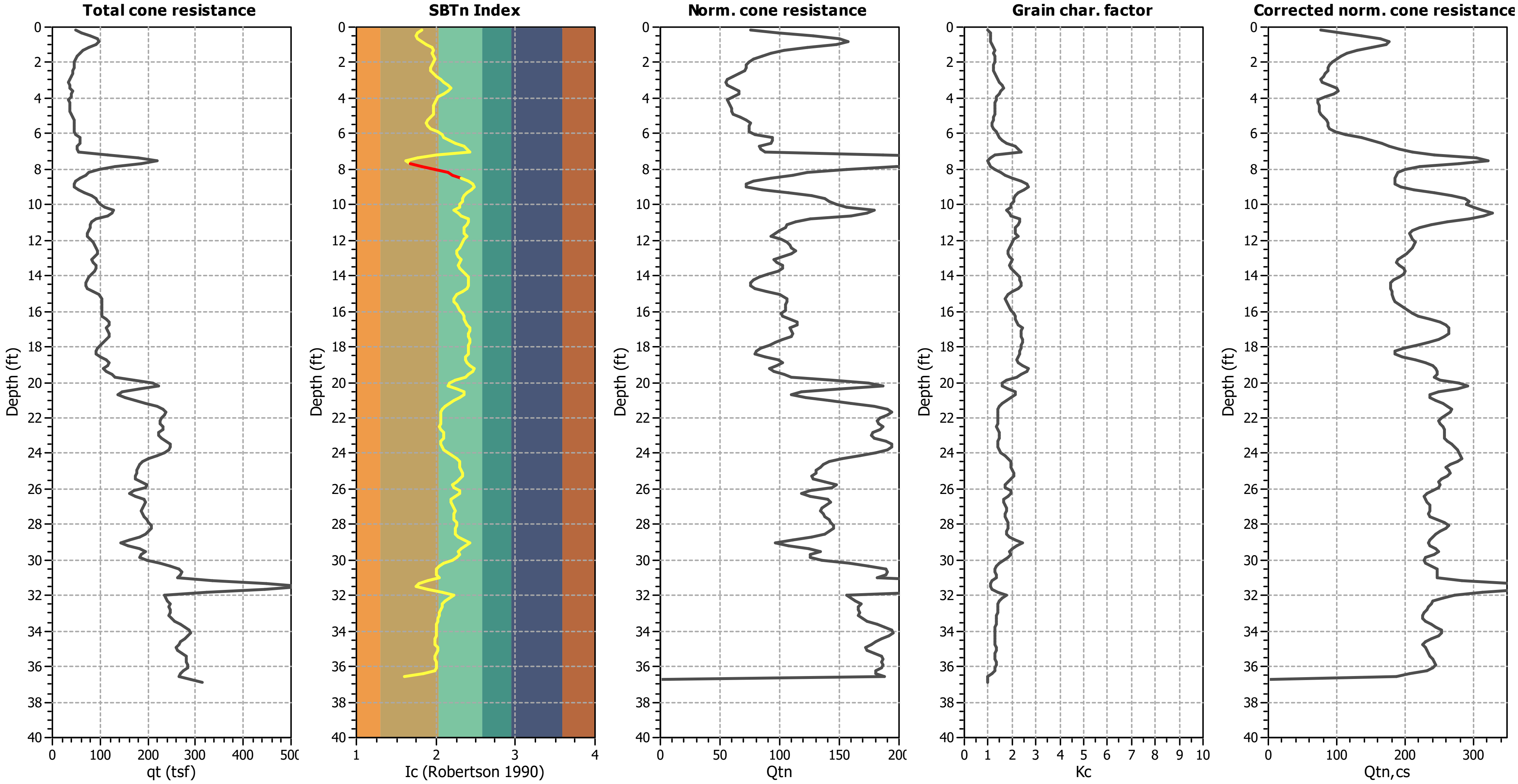
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

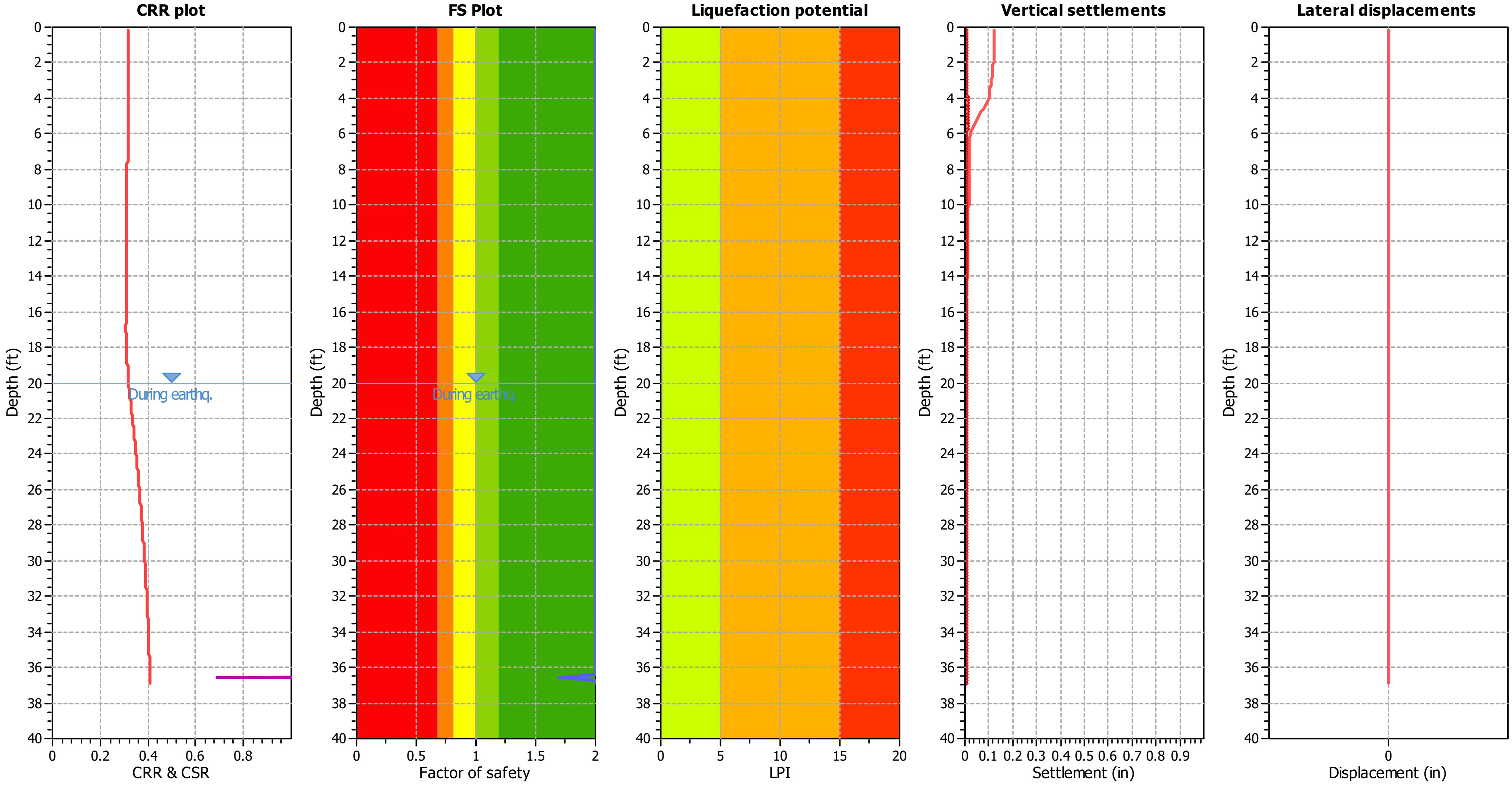
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

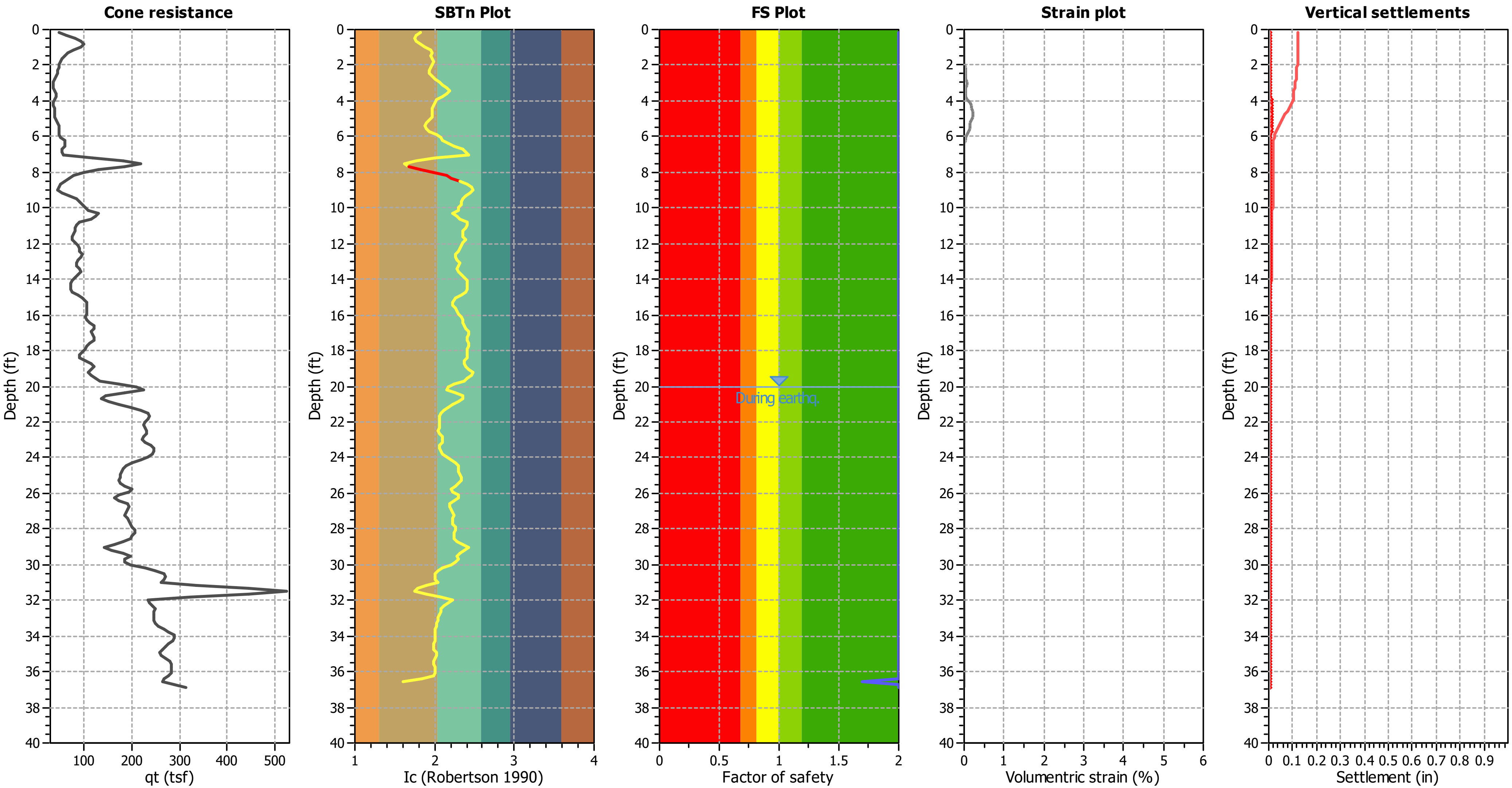
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

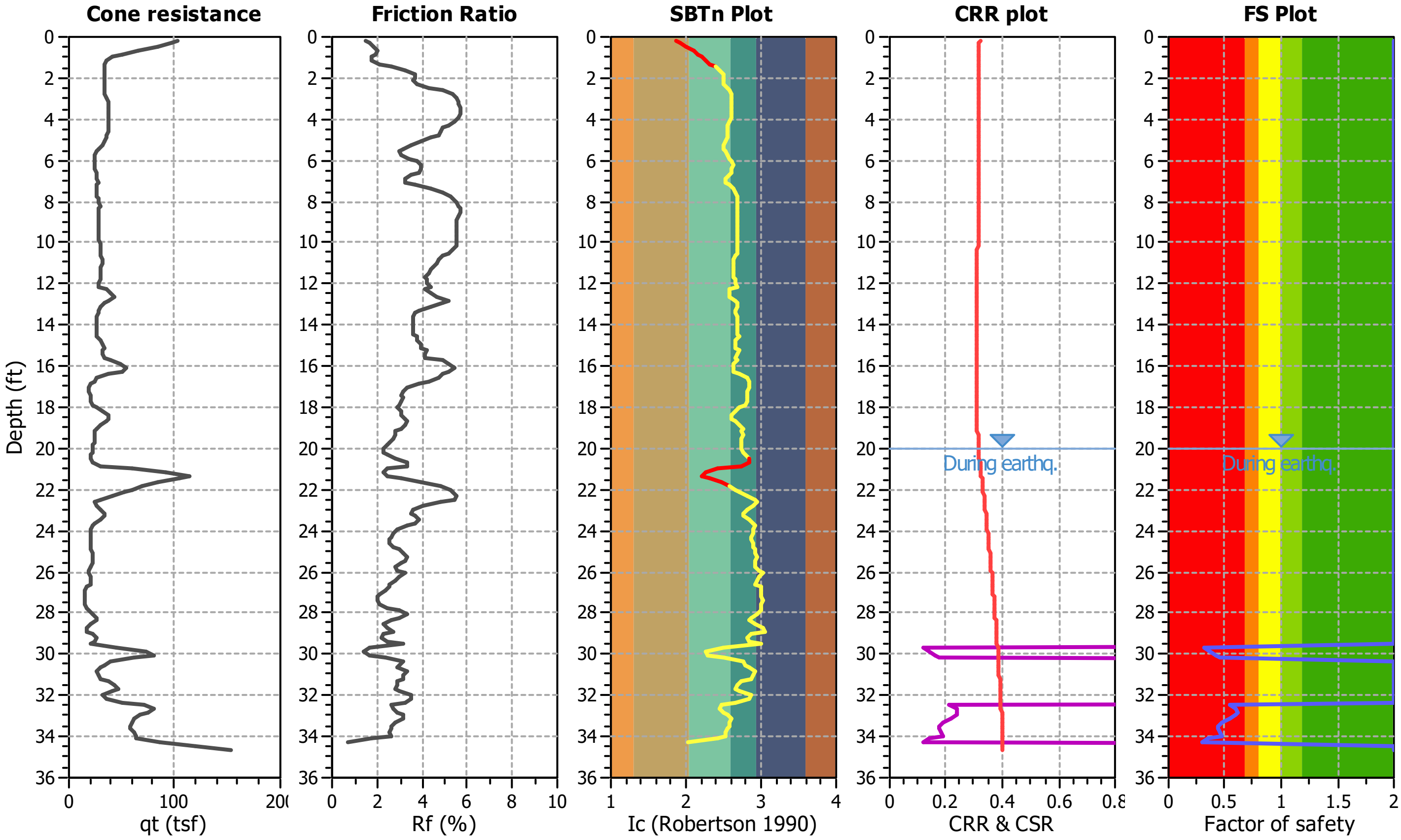
LIQUEFACTION ANALYSIS REPORT

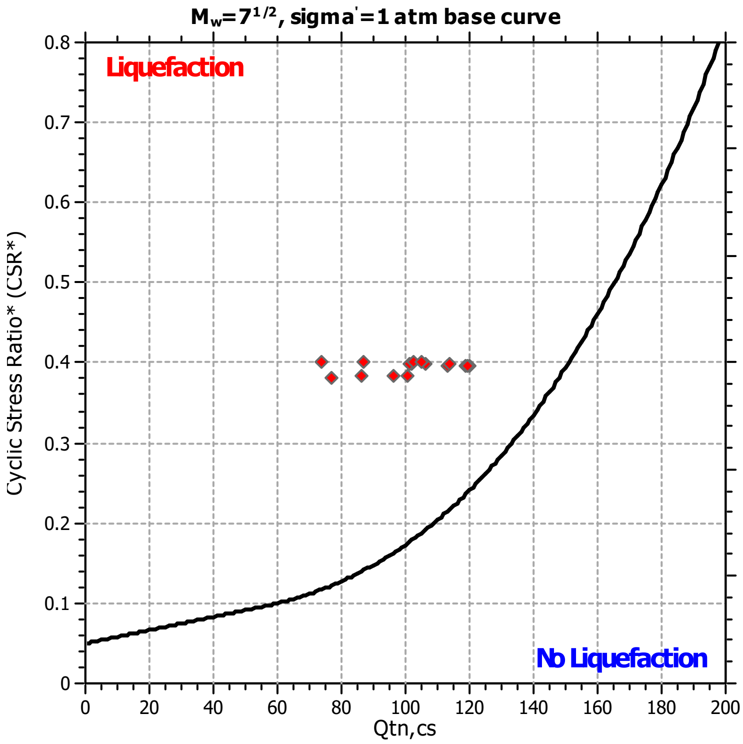
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

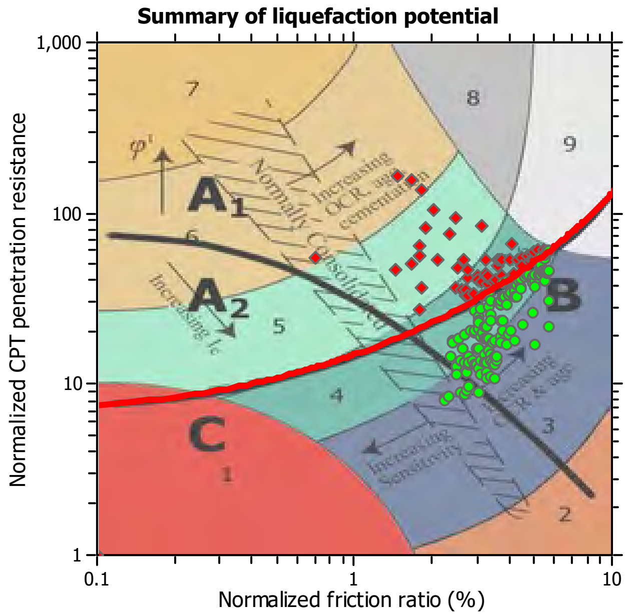
CPT file : C-4

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	29.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

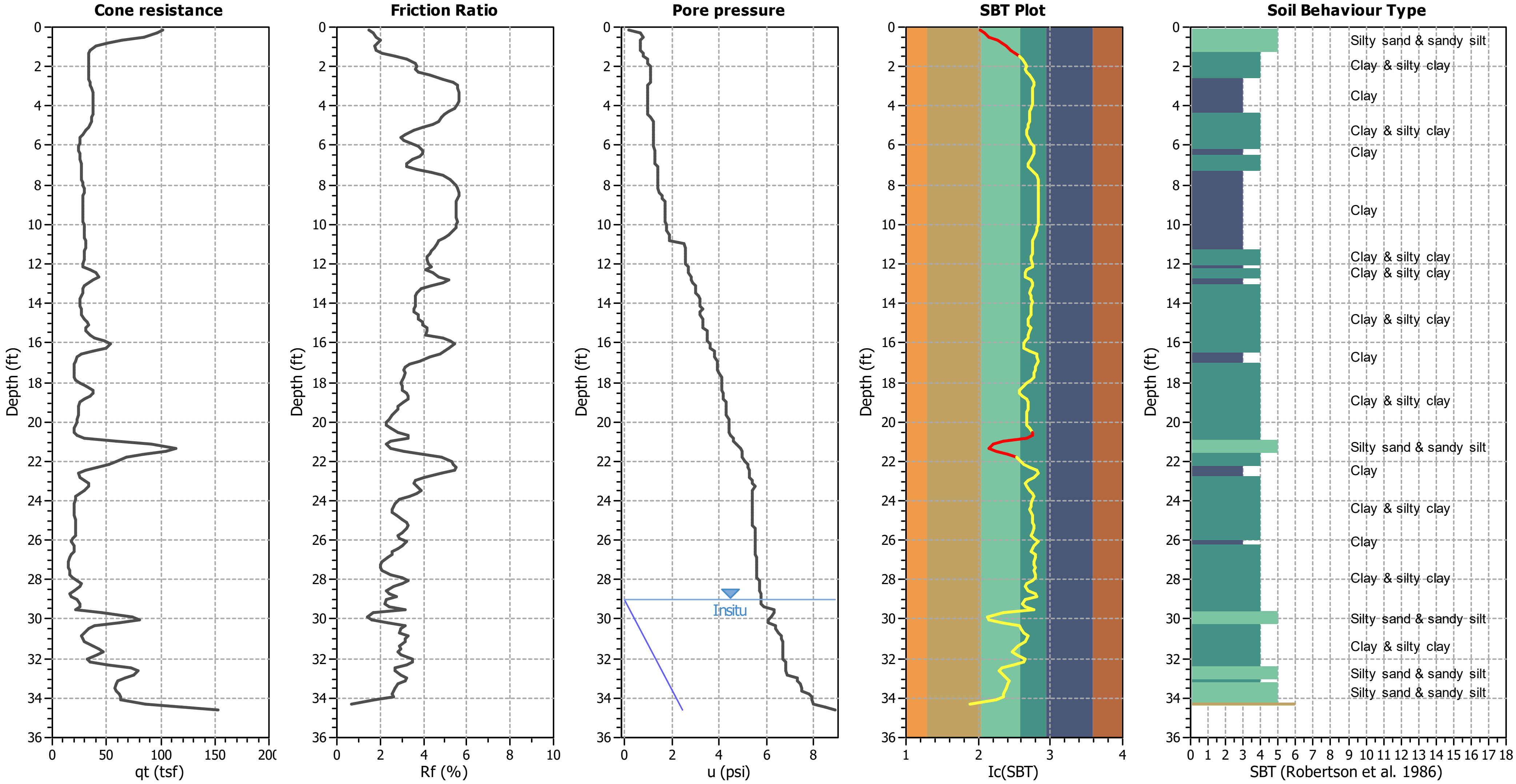






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



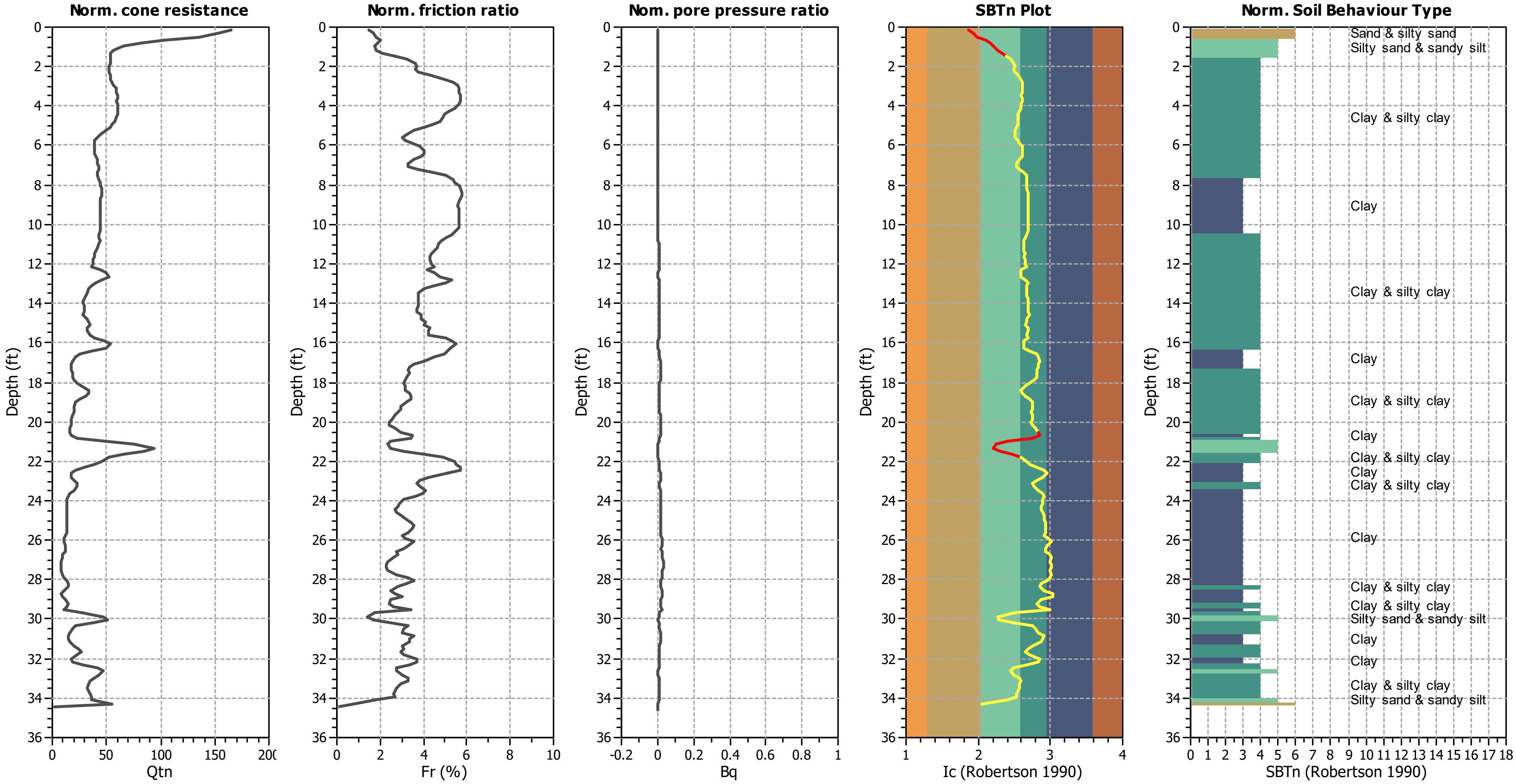
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



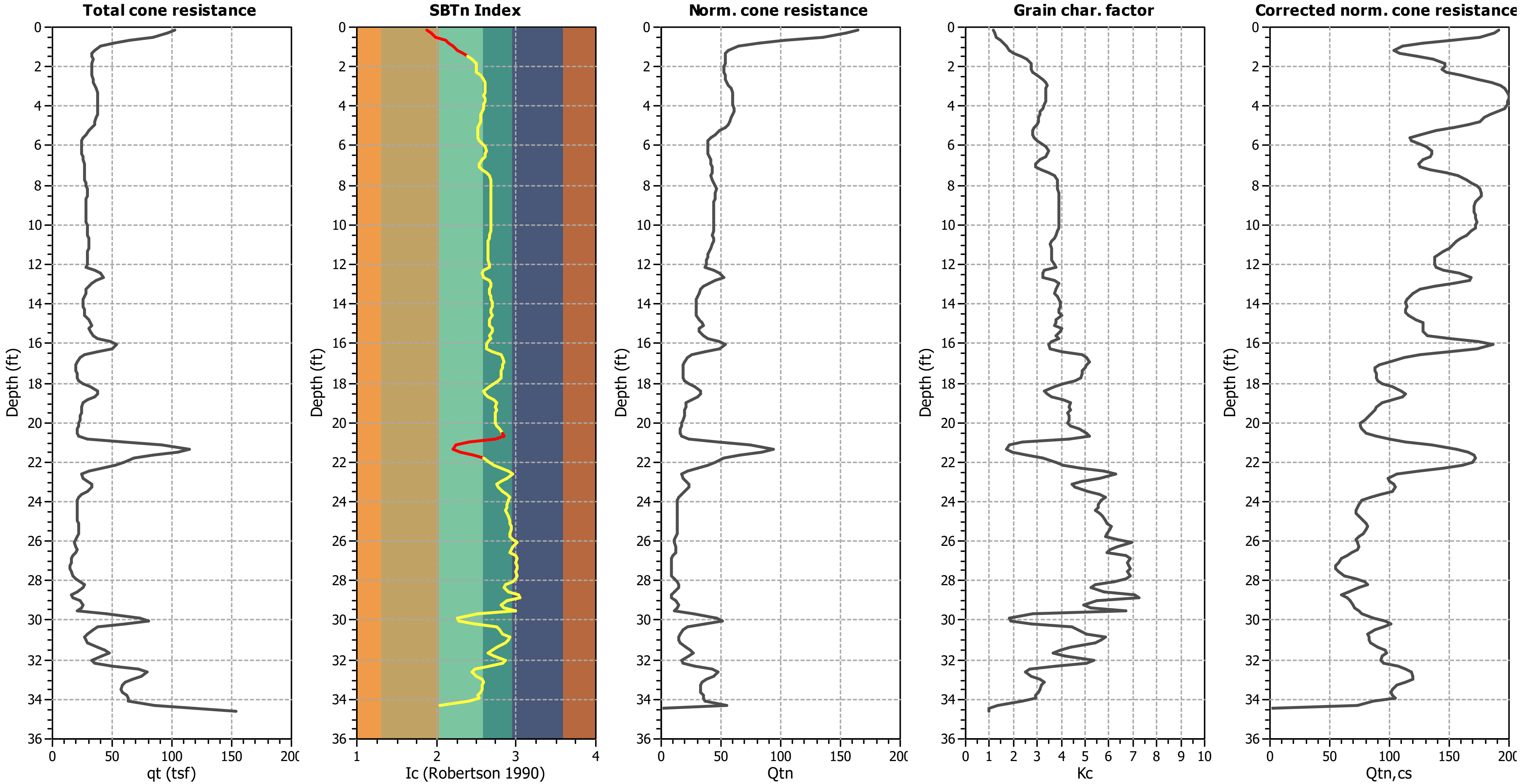
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

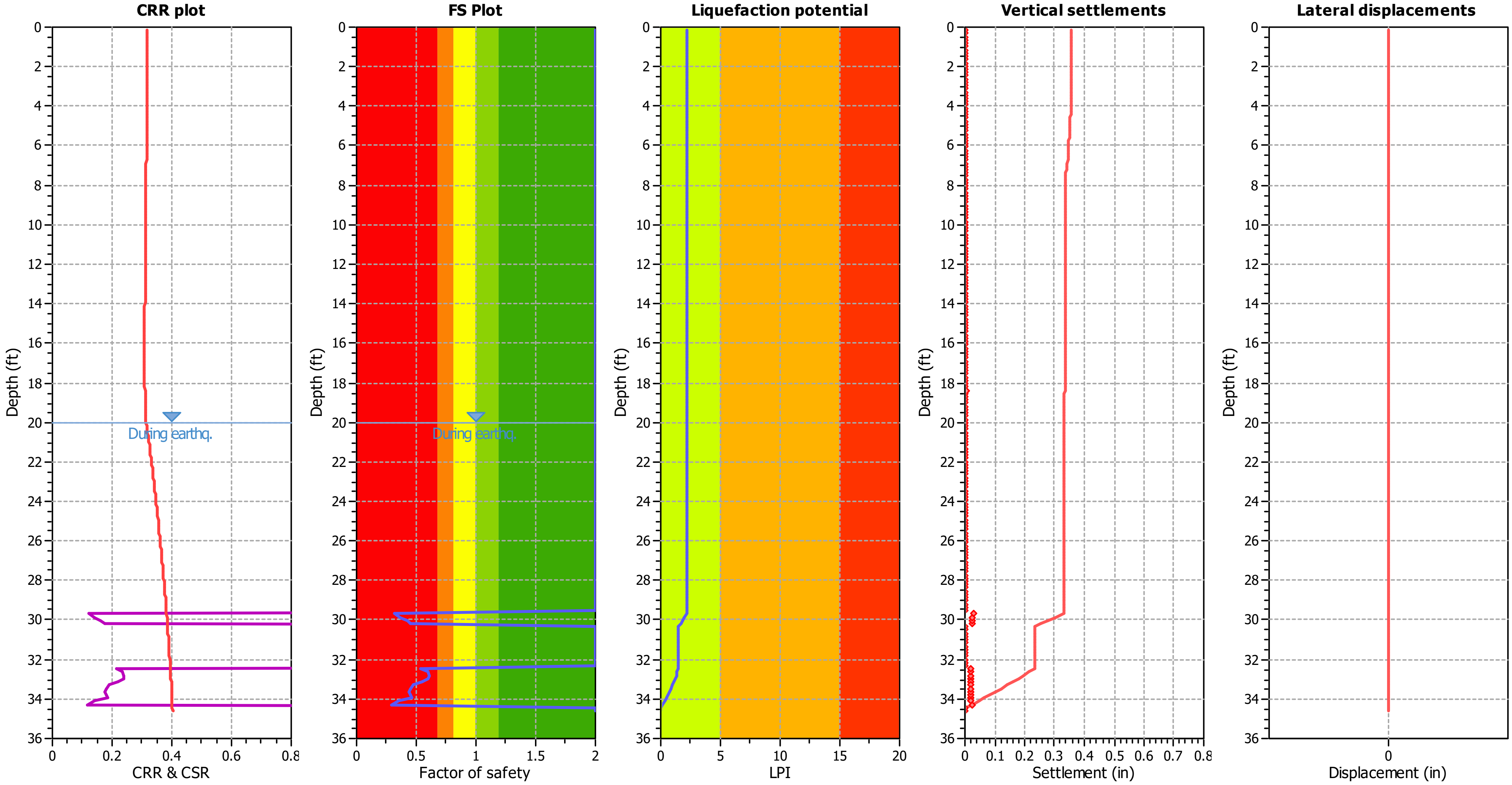
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

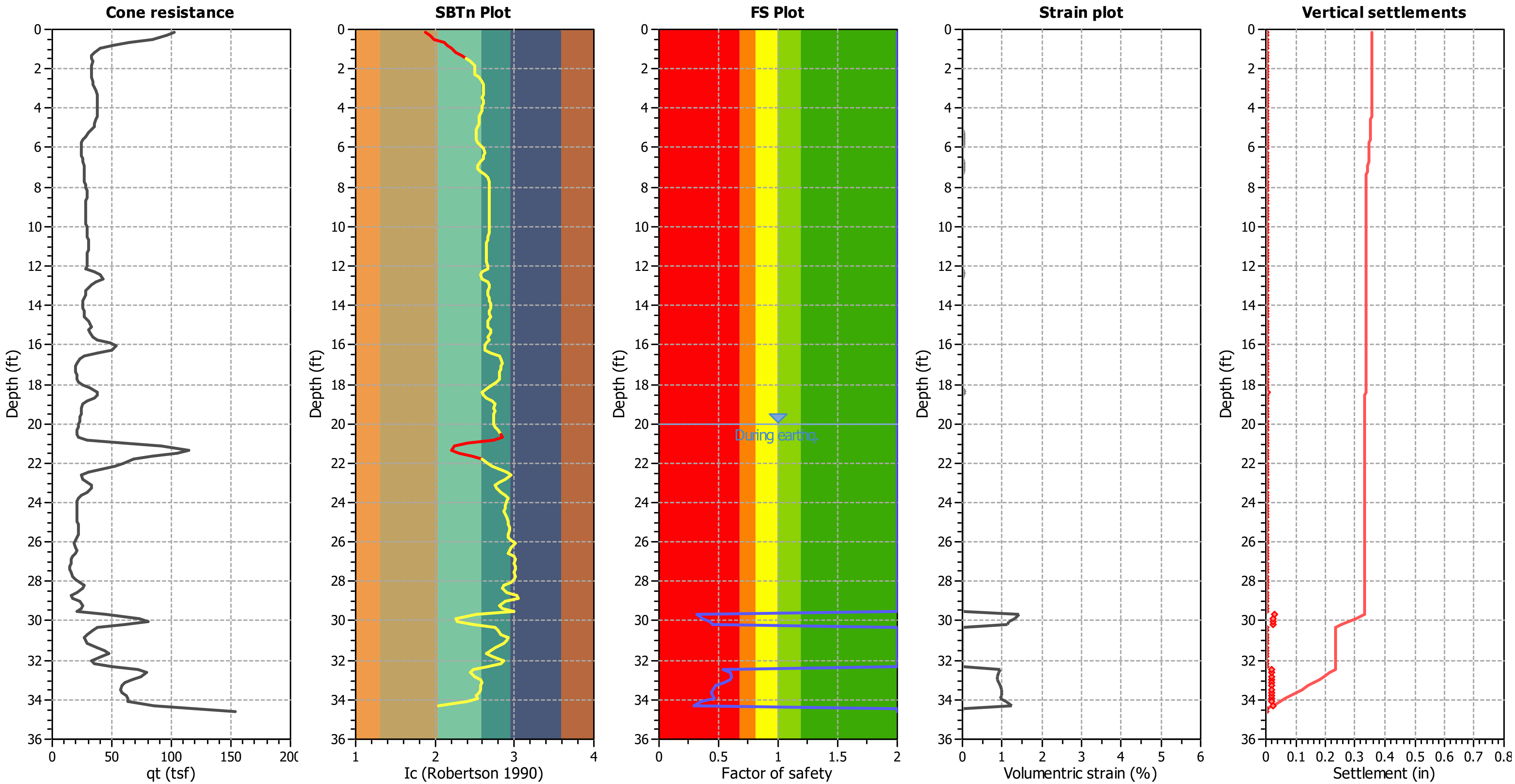
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

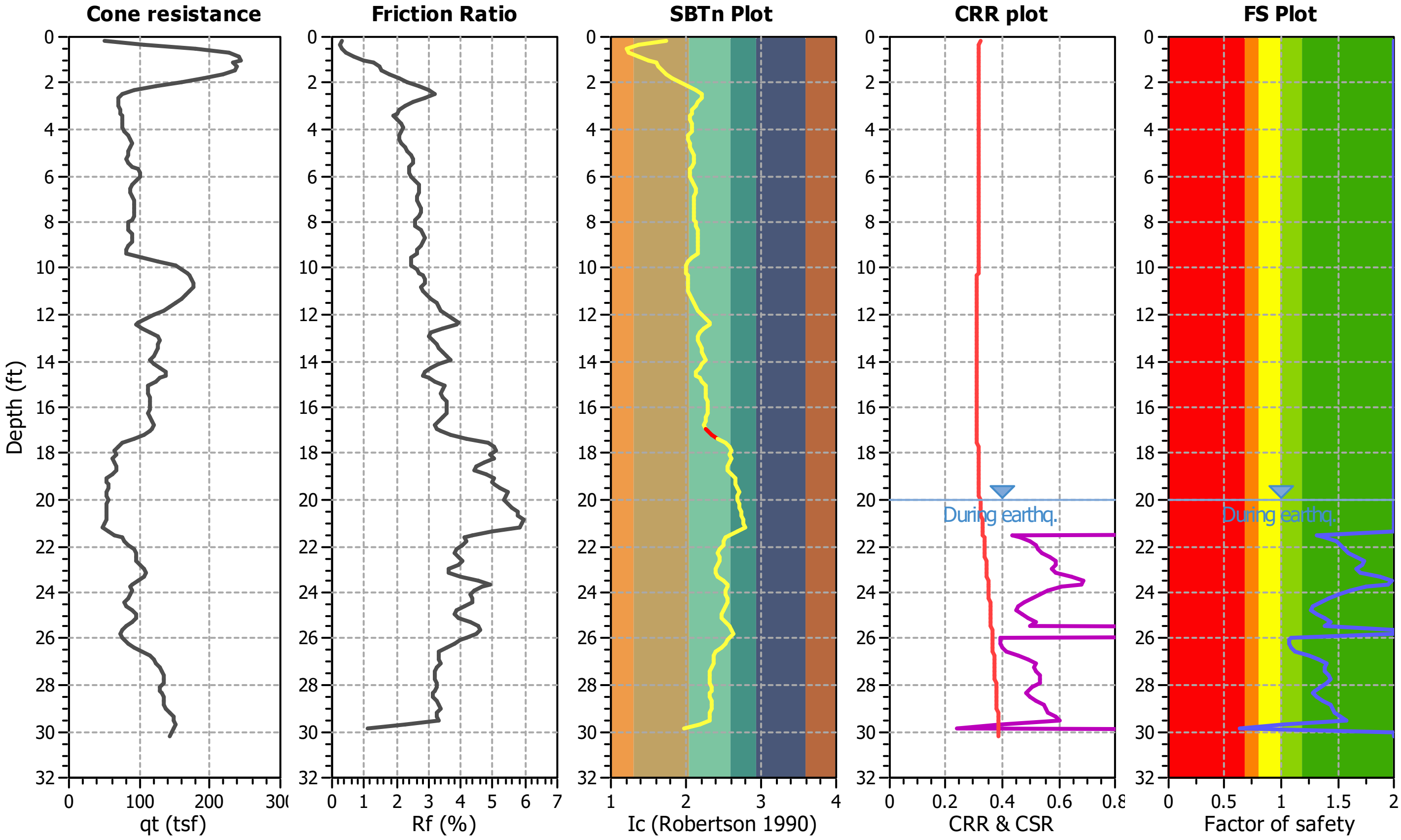
LIQUEFACTION ANALYSIS REPORT

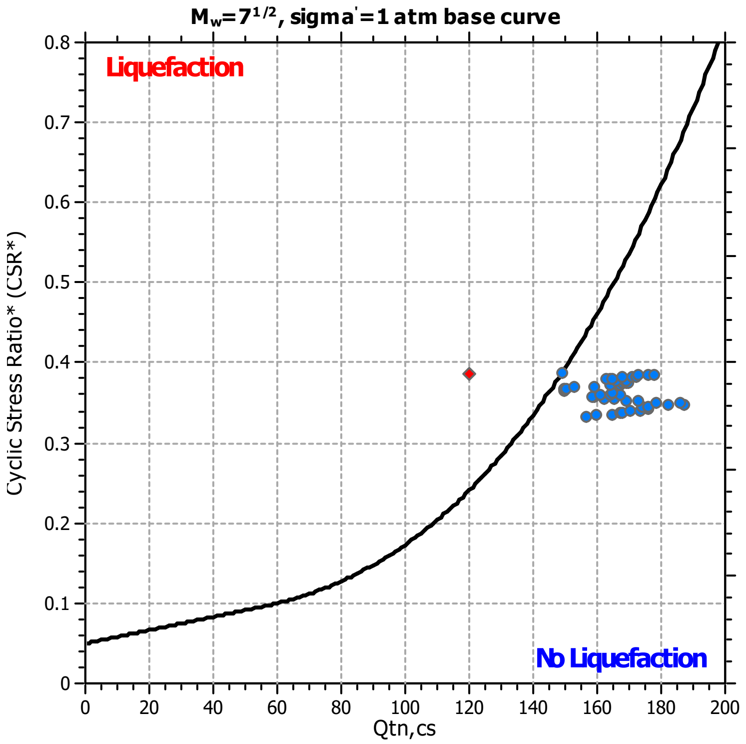
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

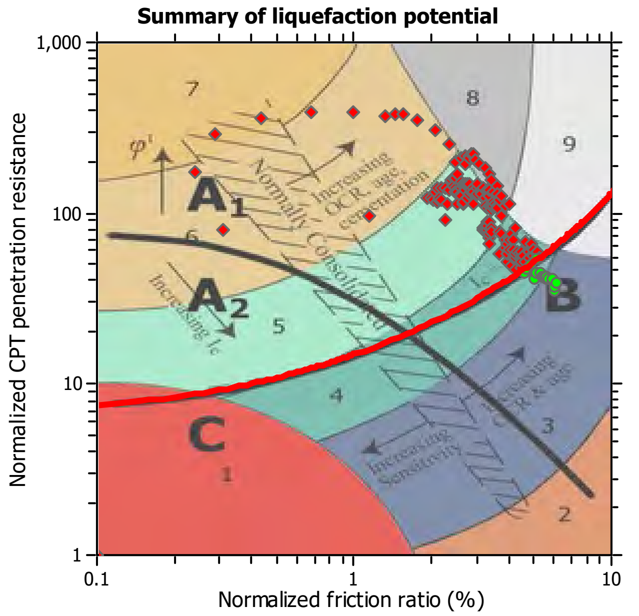
CPT file : C-5

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	29.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

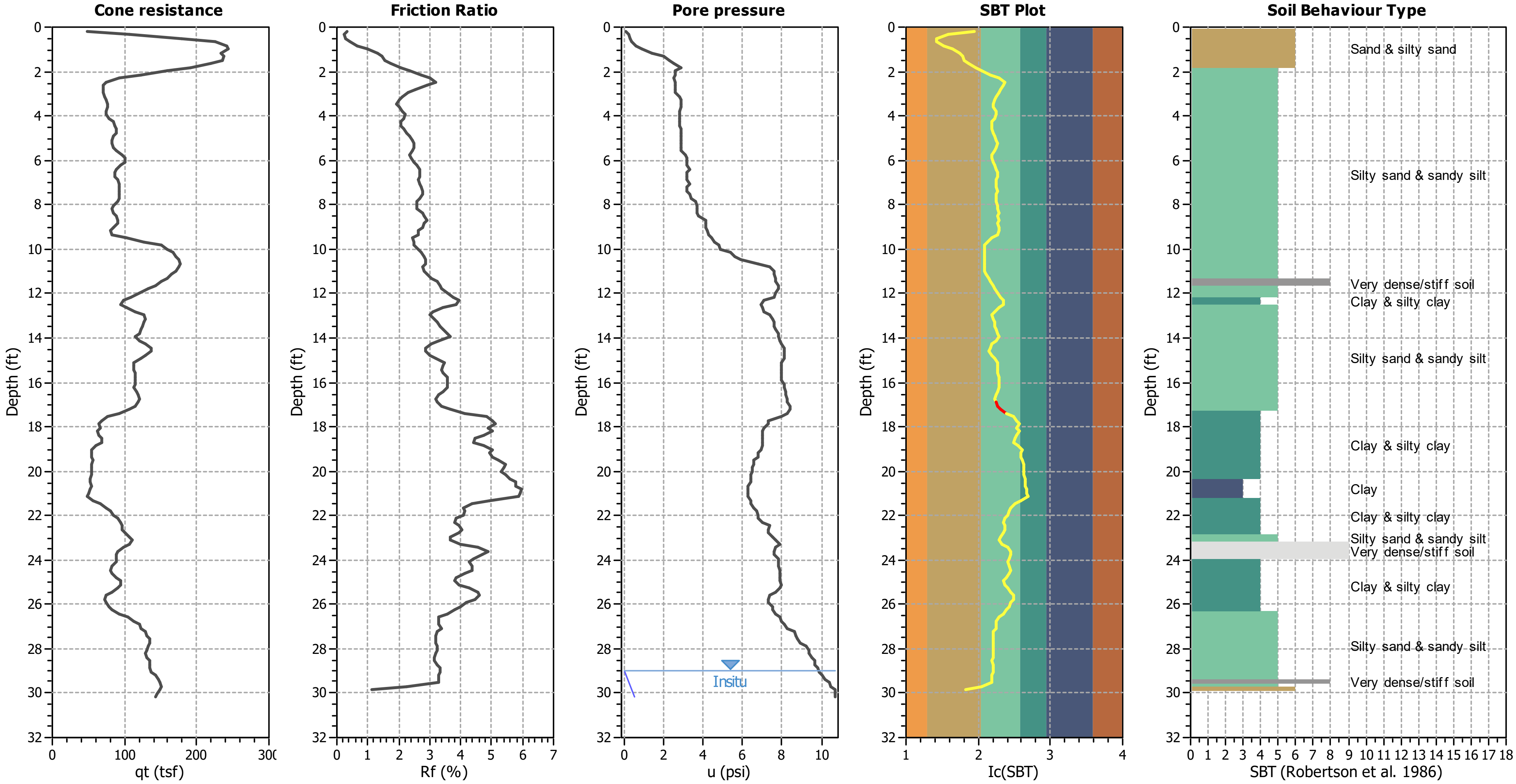






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



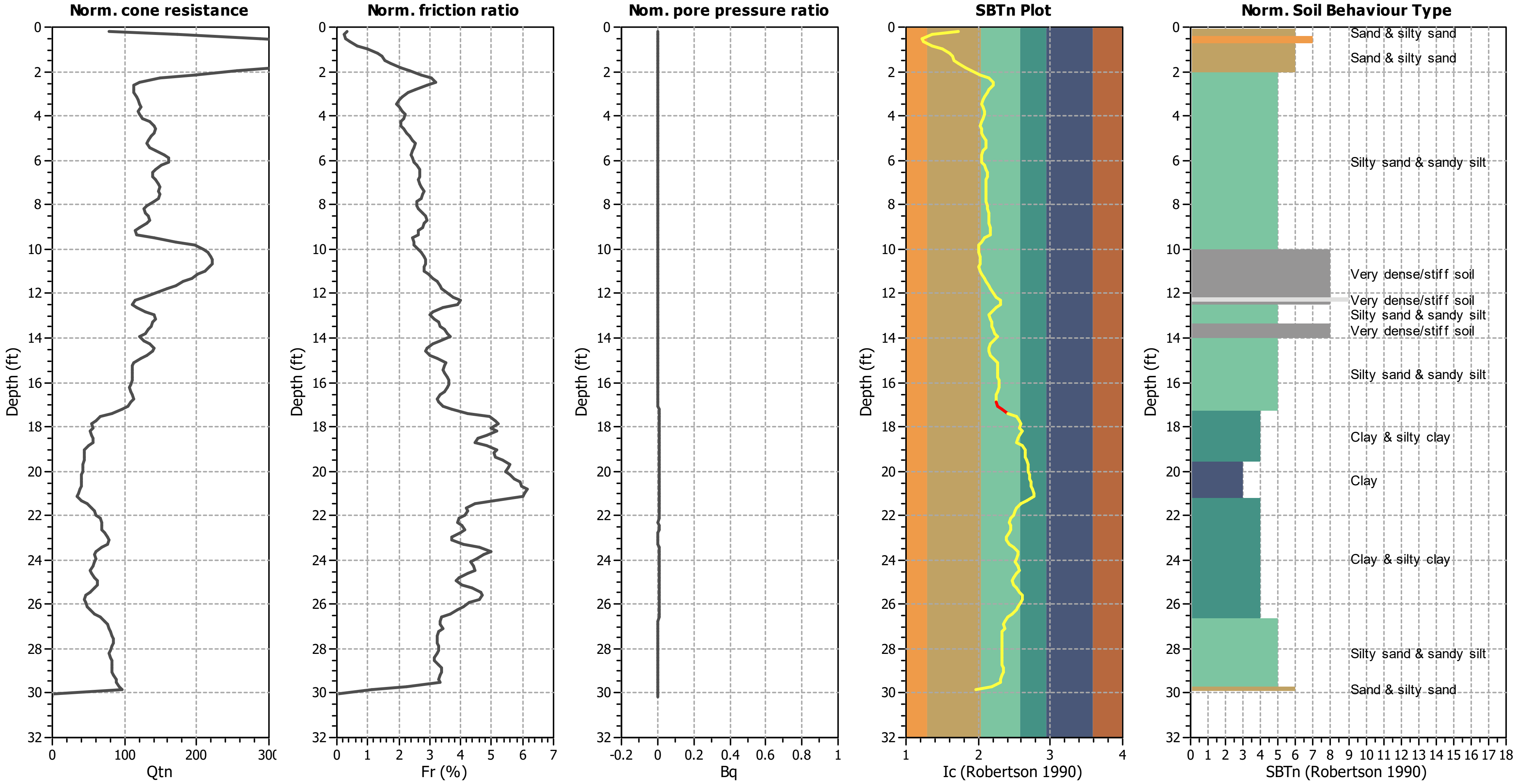
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



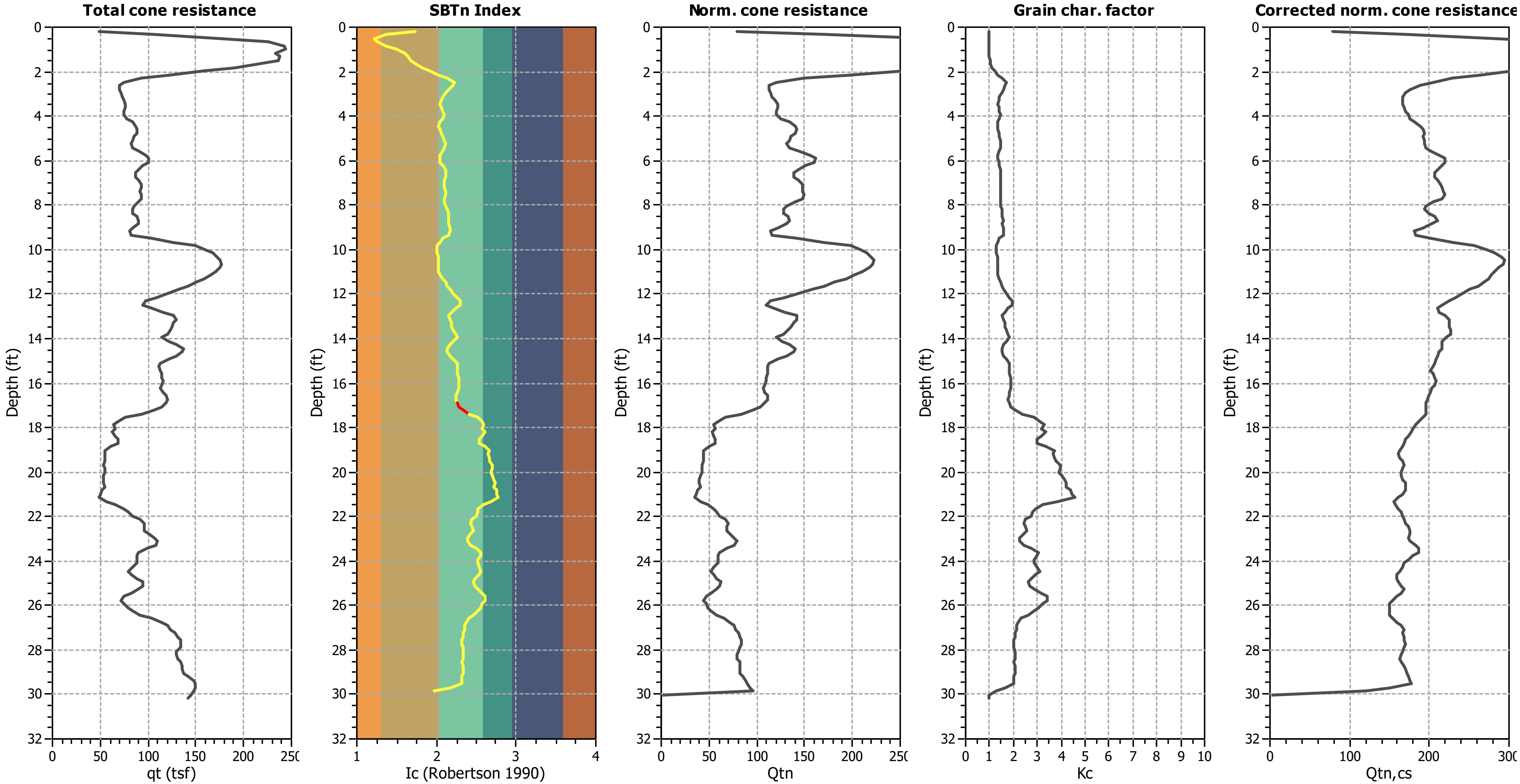
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

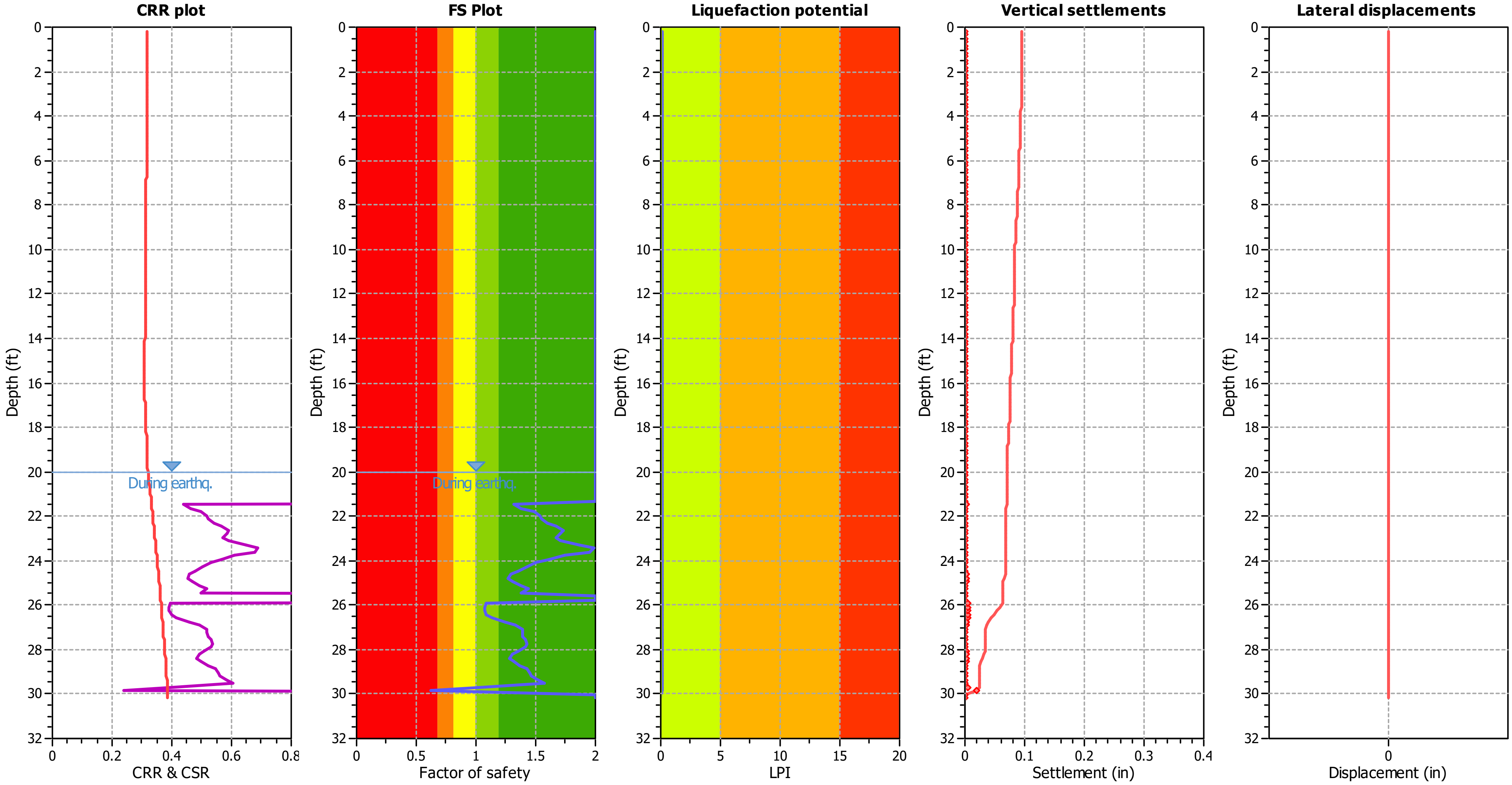
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

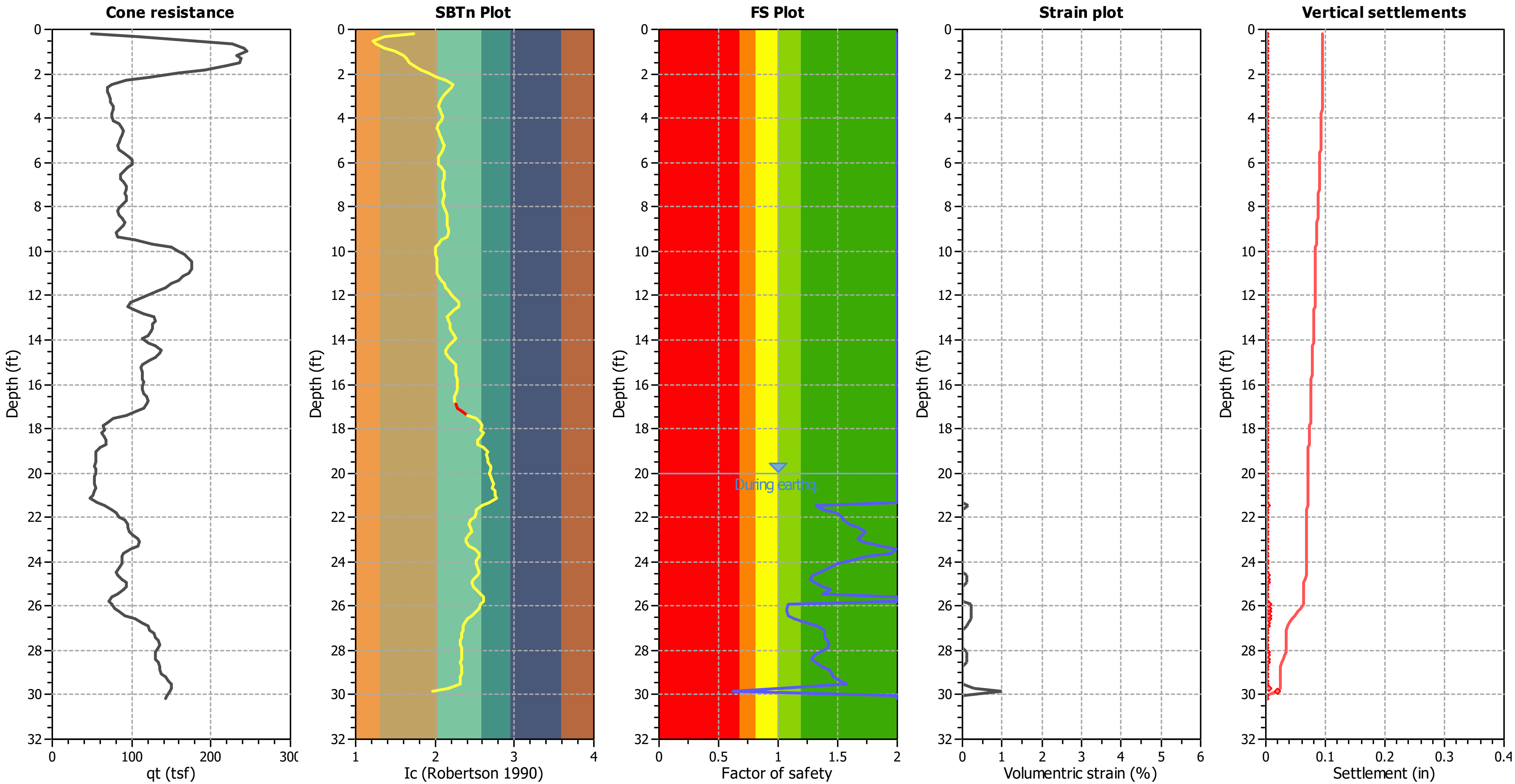
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

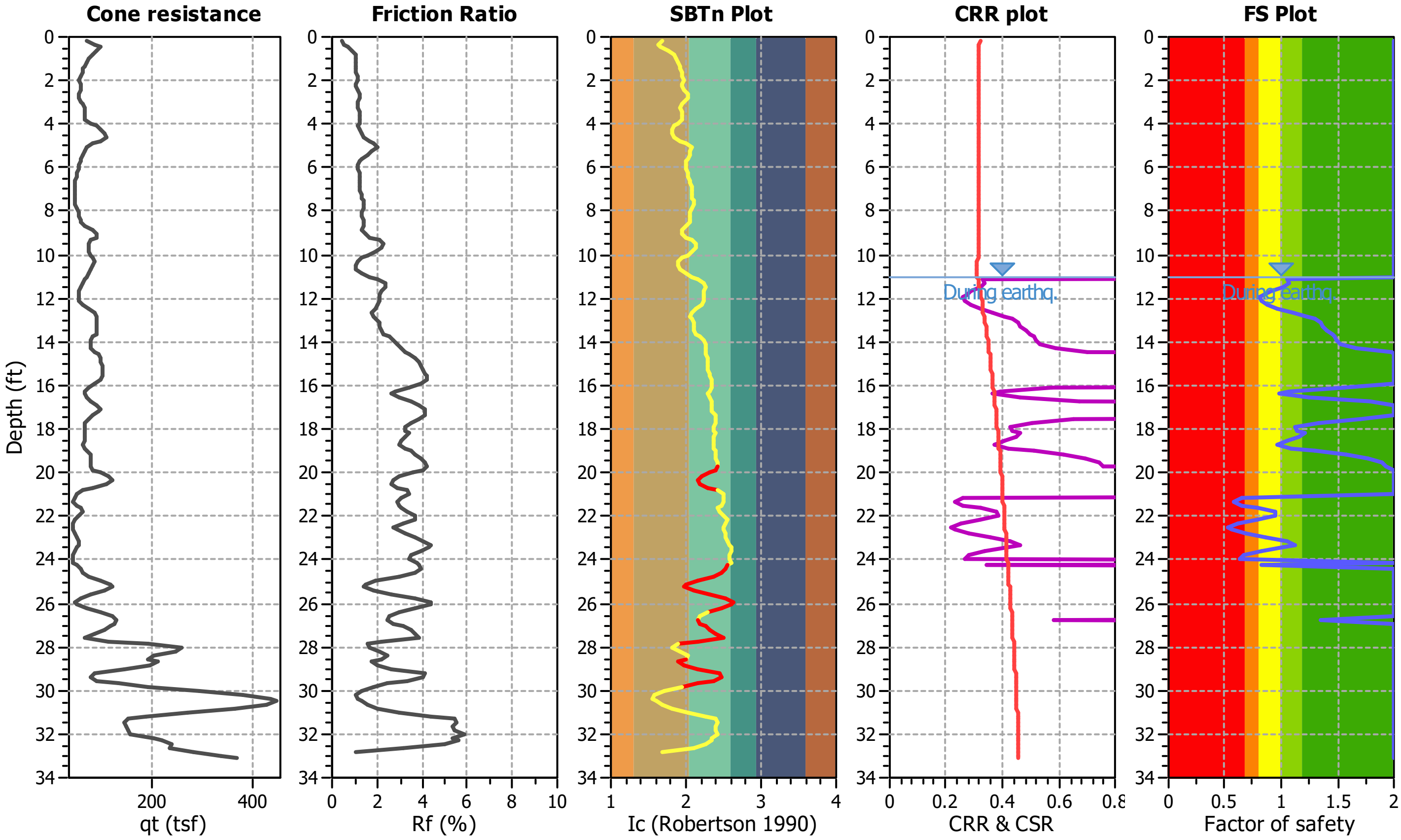
LIQUEFACTION ANALYSIS REPORT

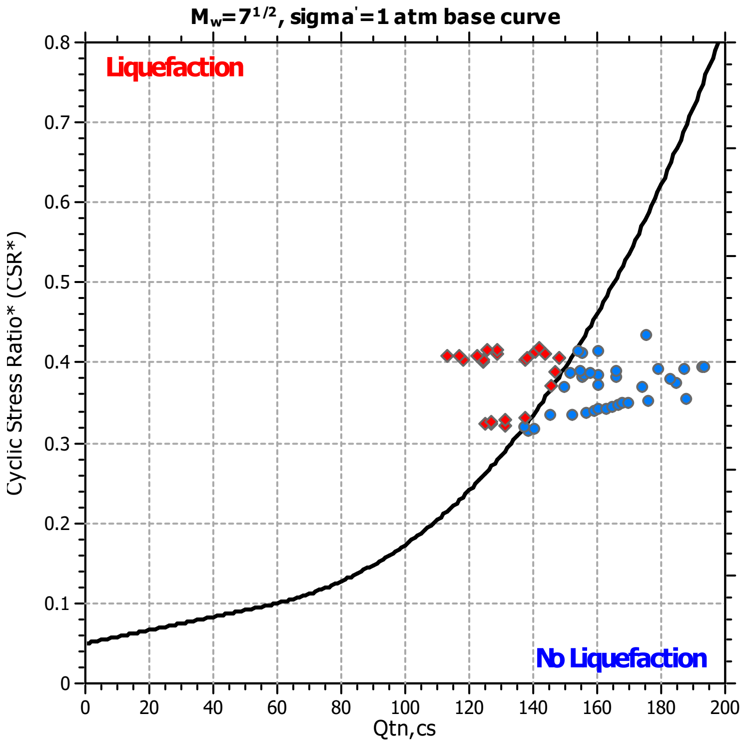
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

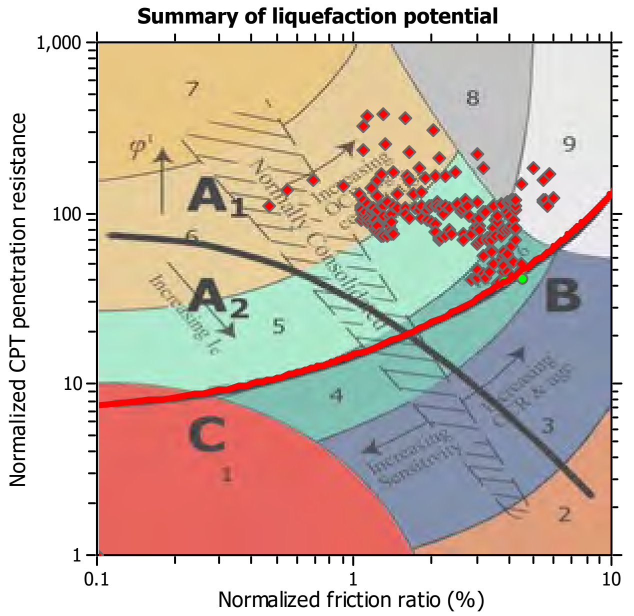
CPT file : C-7

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	11.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	11.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

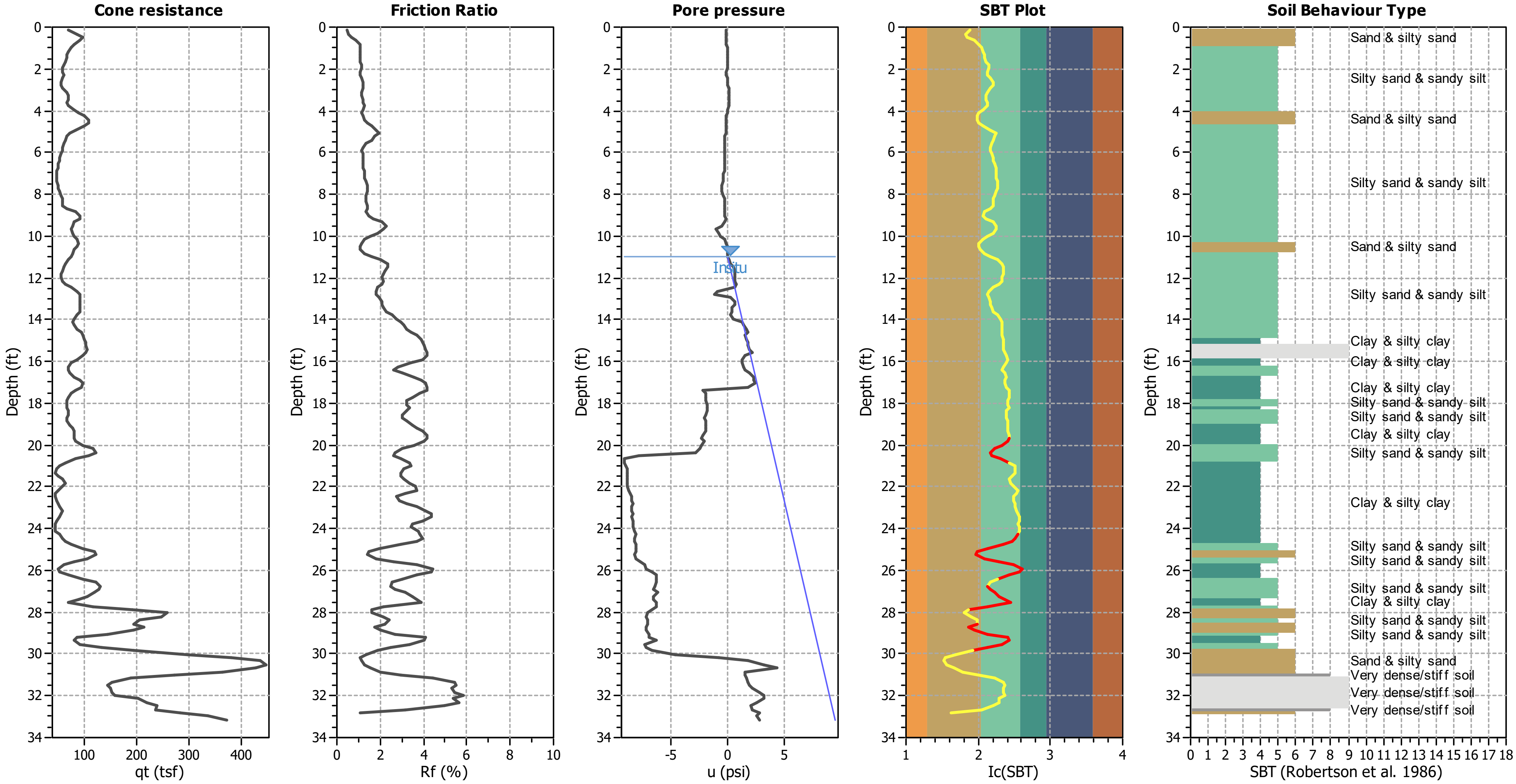






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



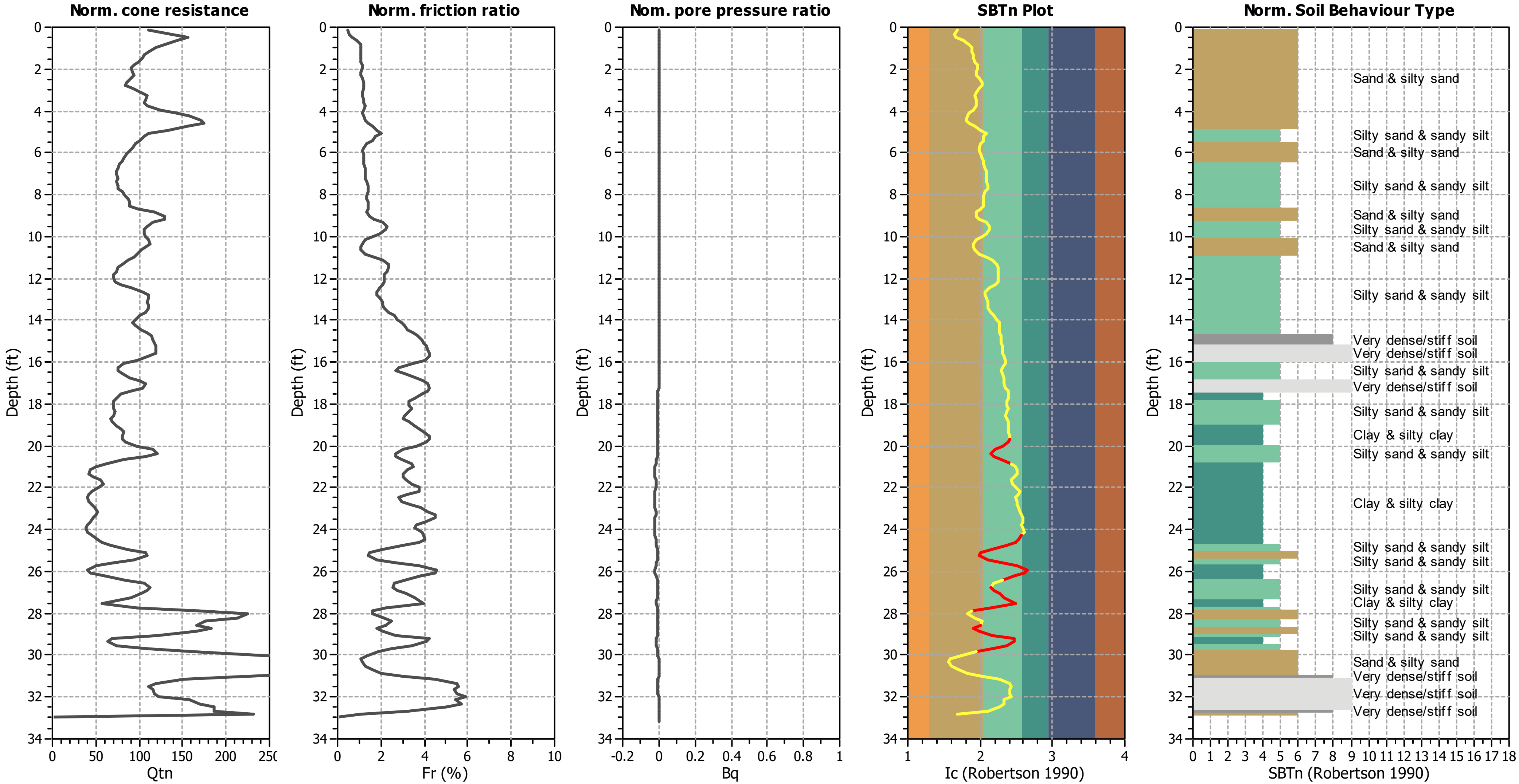
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



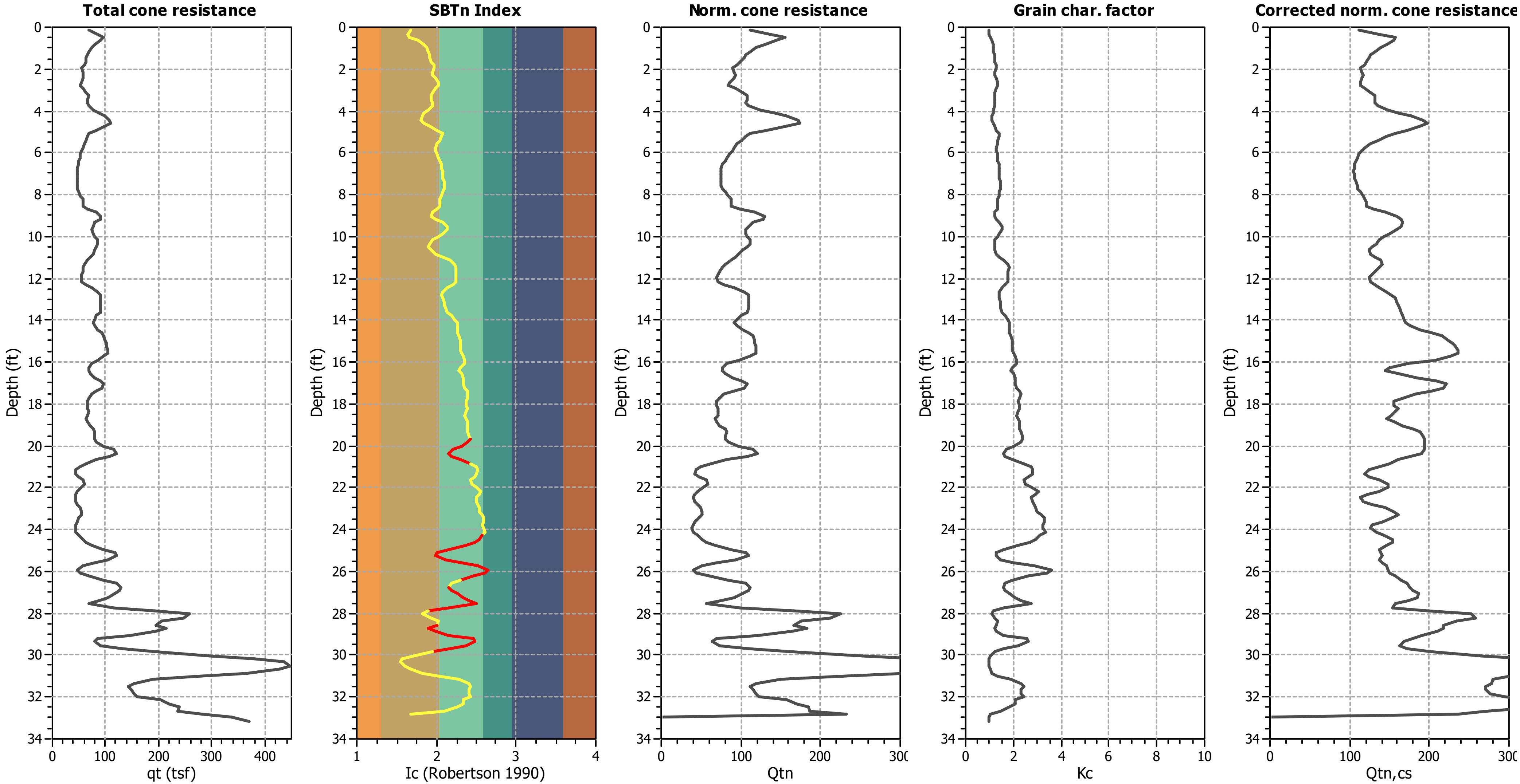
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

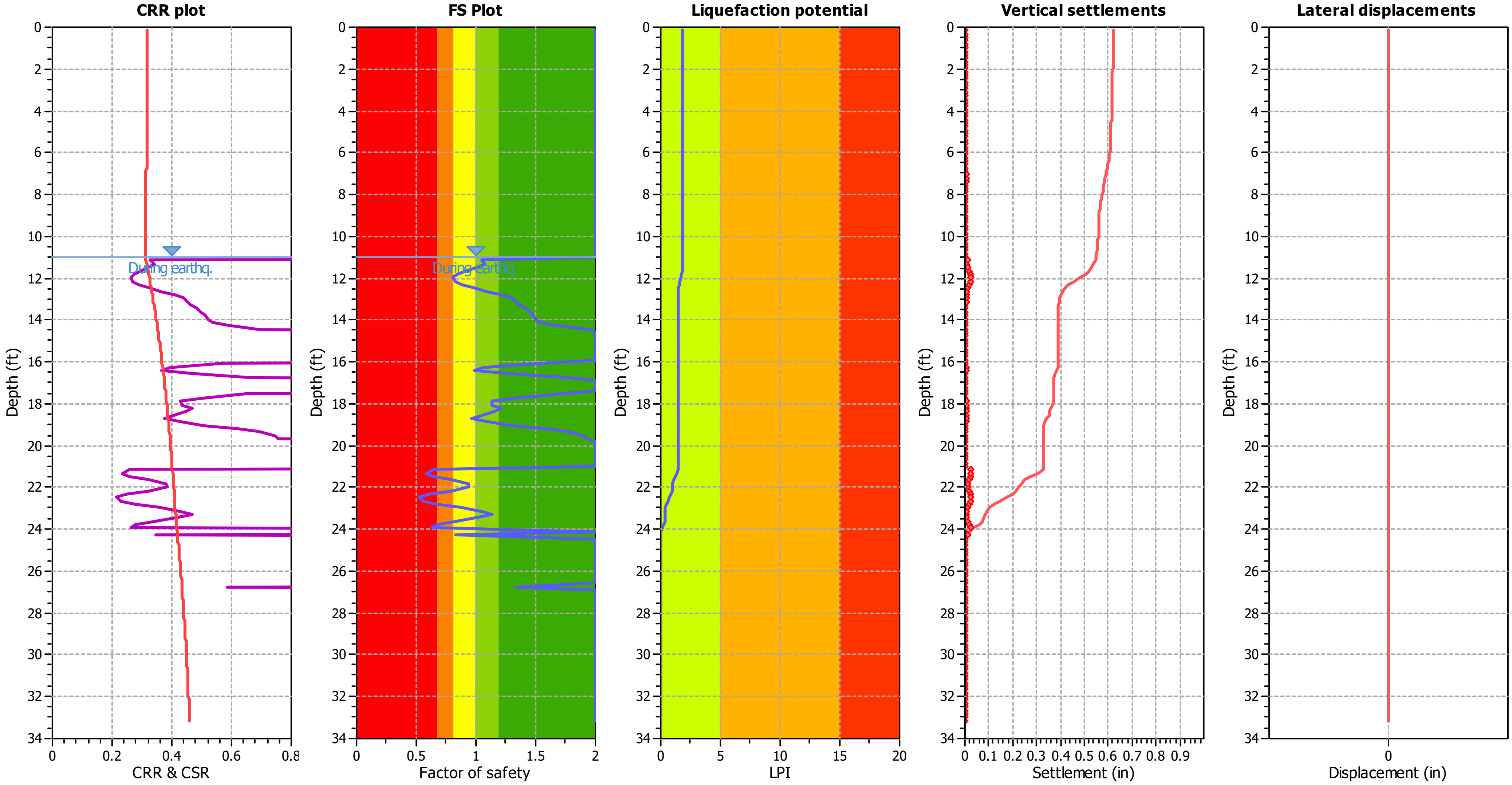
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

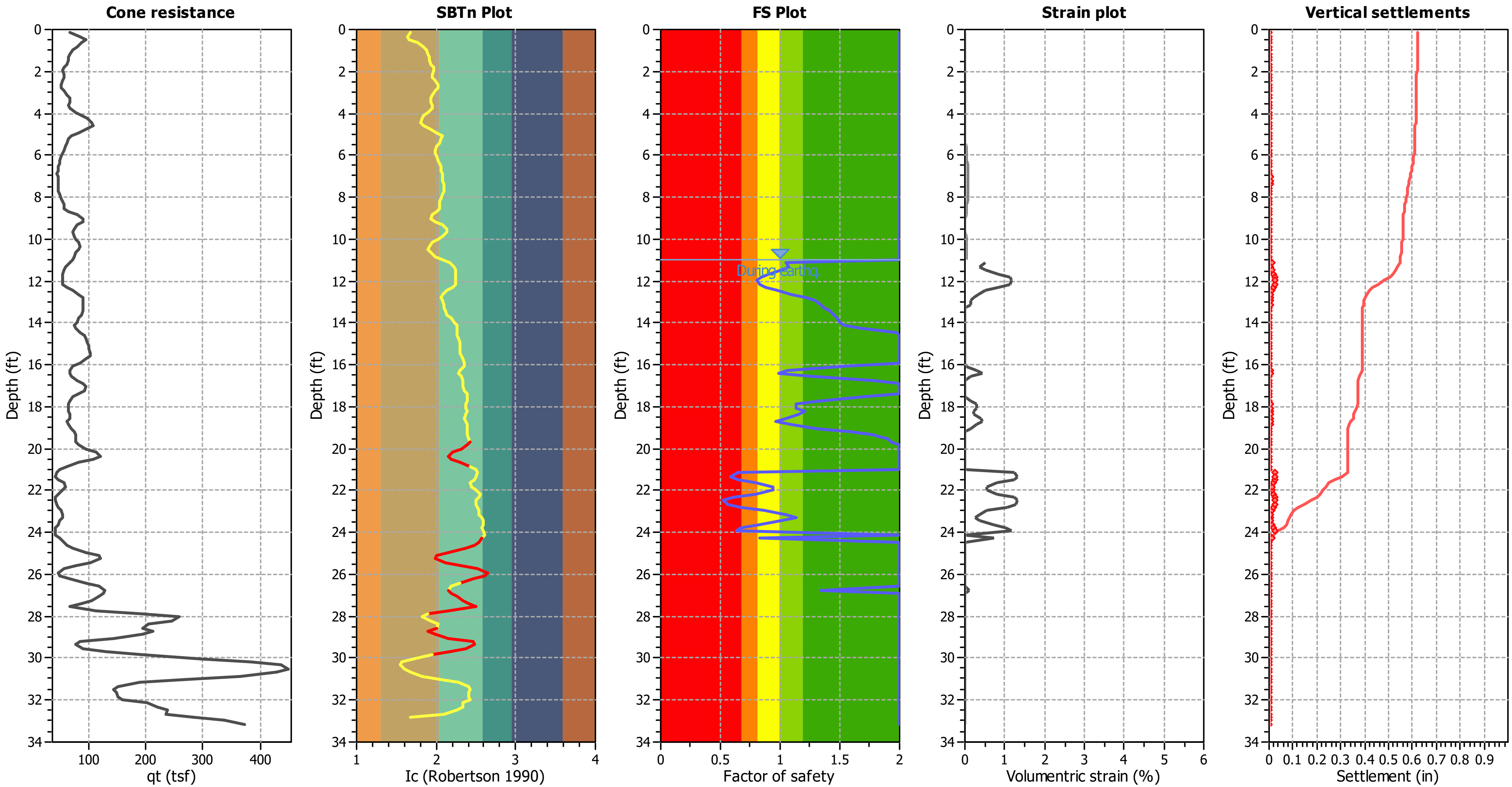
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
FS: Calculated Factor of Safety against liquefaction
Volumentric strain: Post-liquefaction volumentric strain

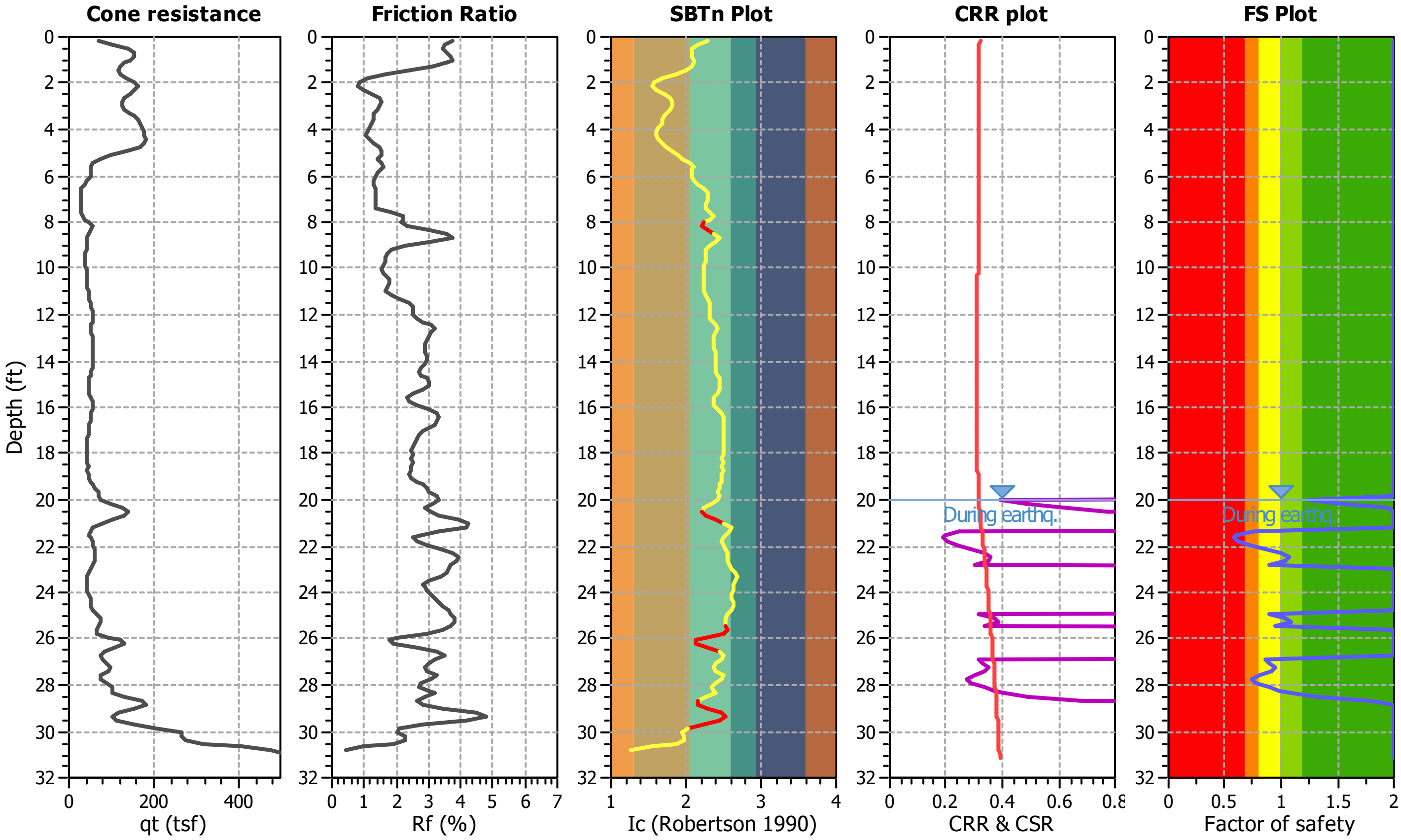
LIQUEFACTION ANALYSIS REPORT

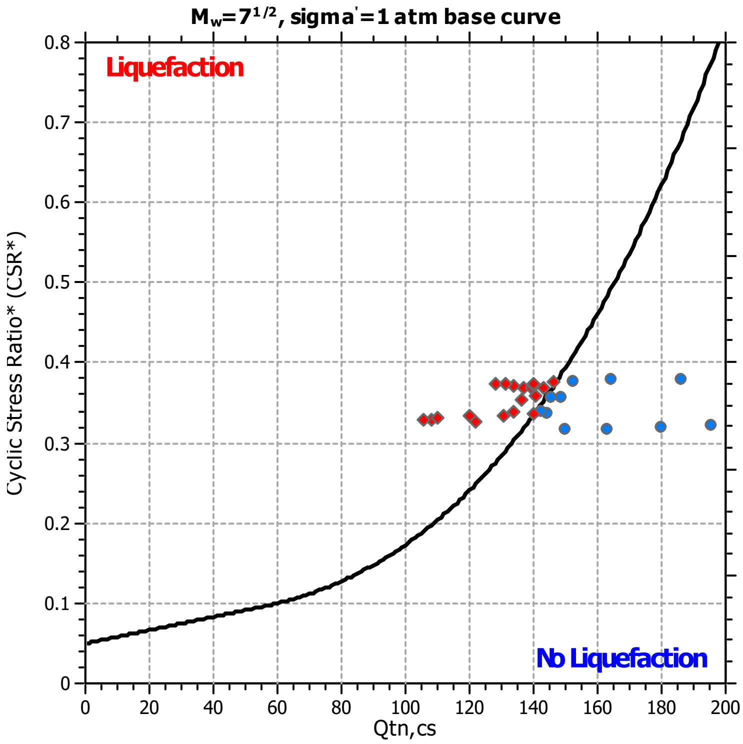
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

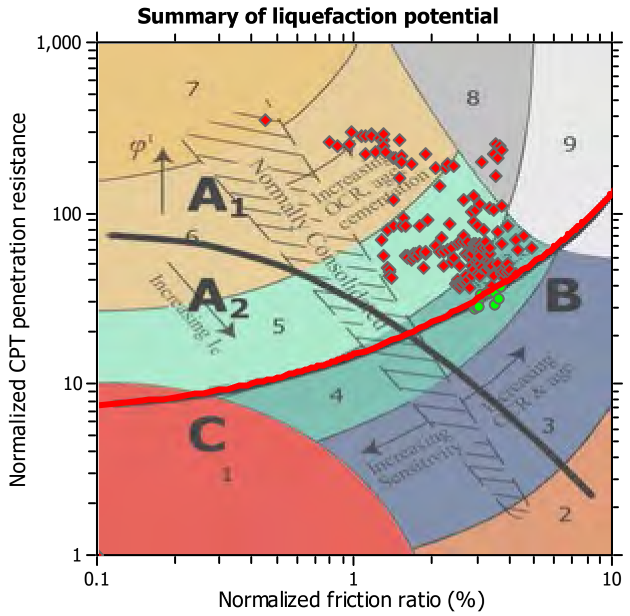
CPT file : C-8

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	25.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

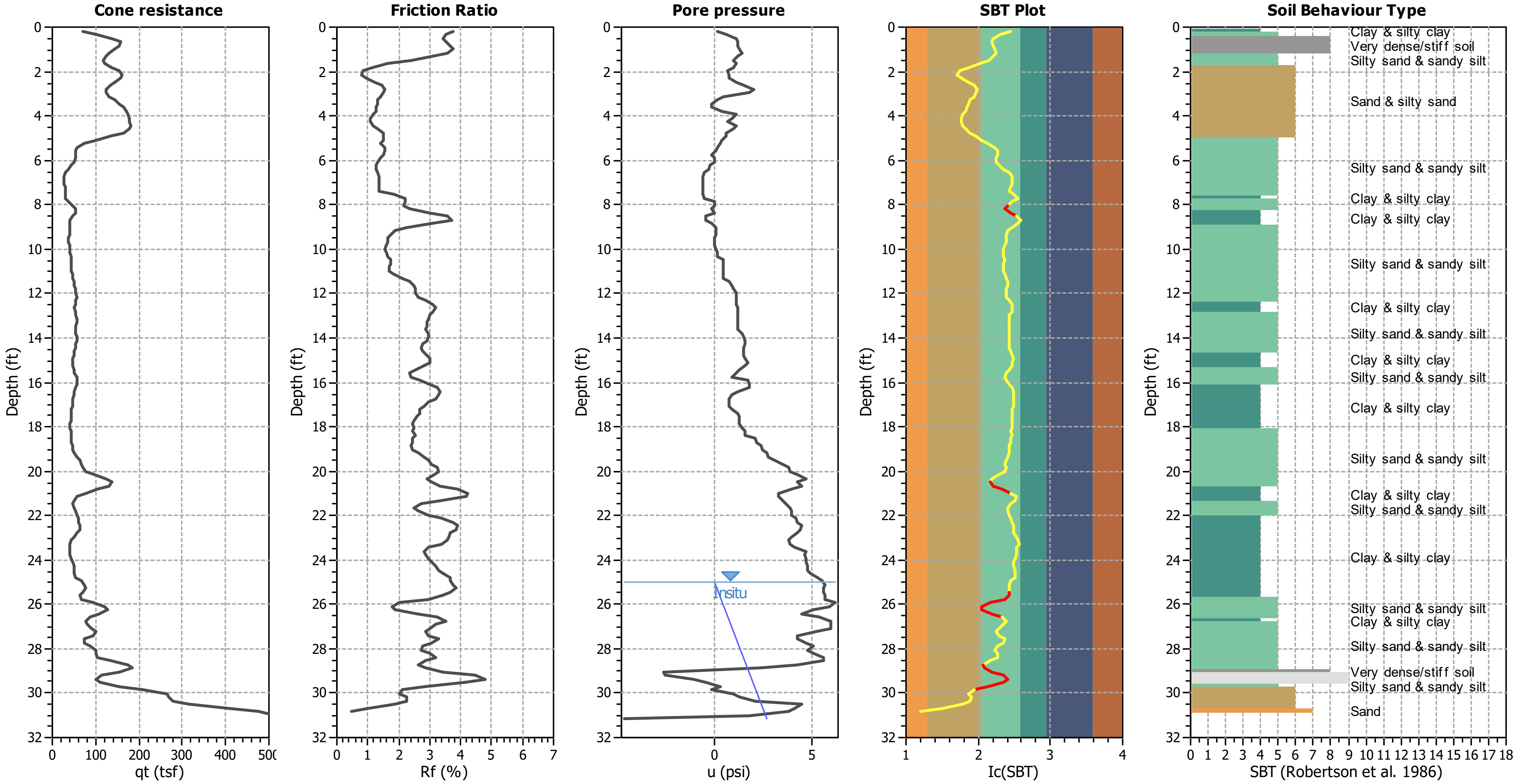






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



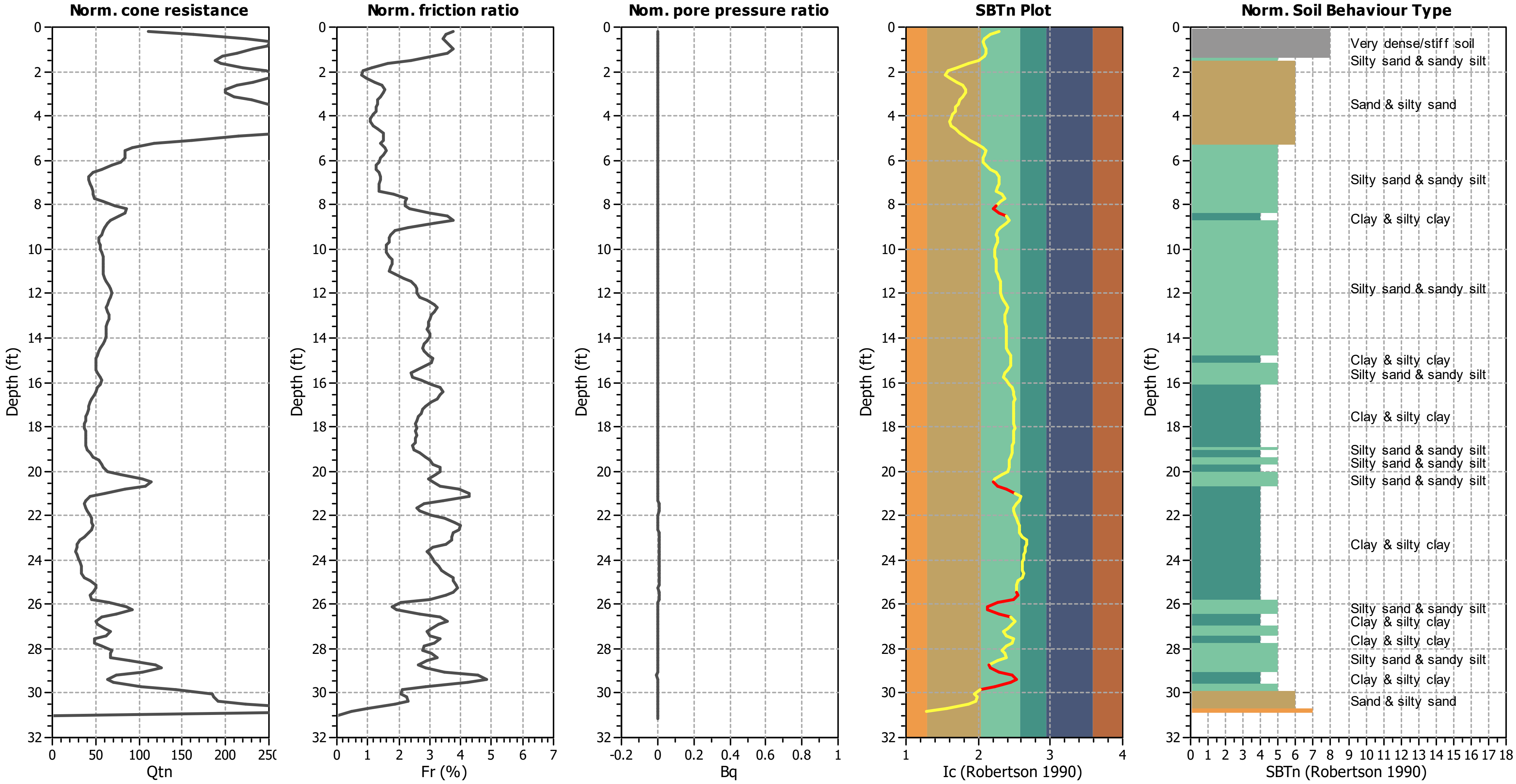
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



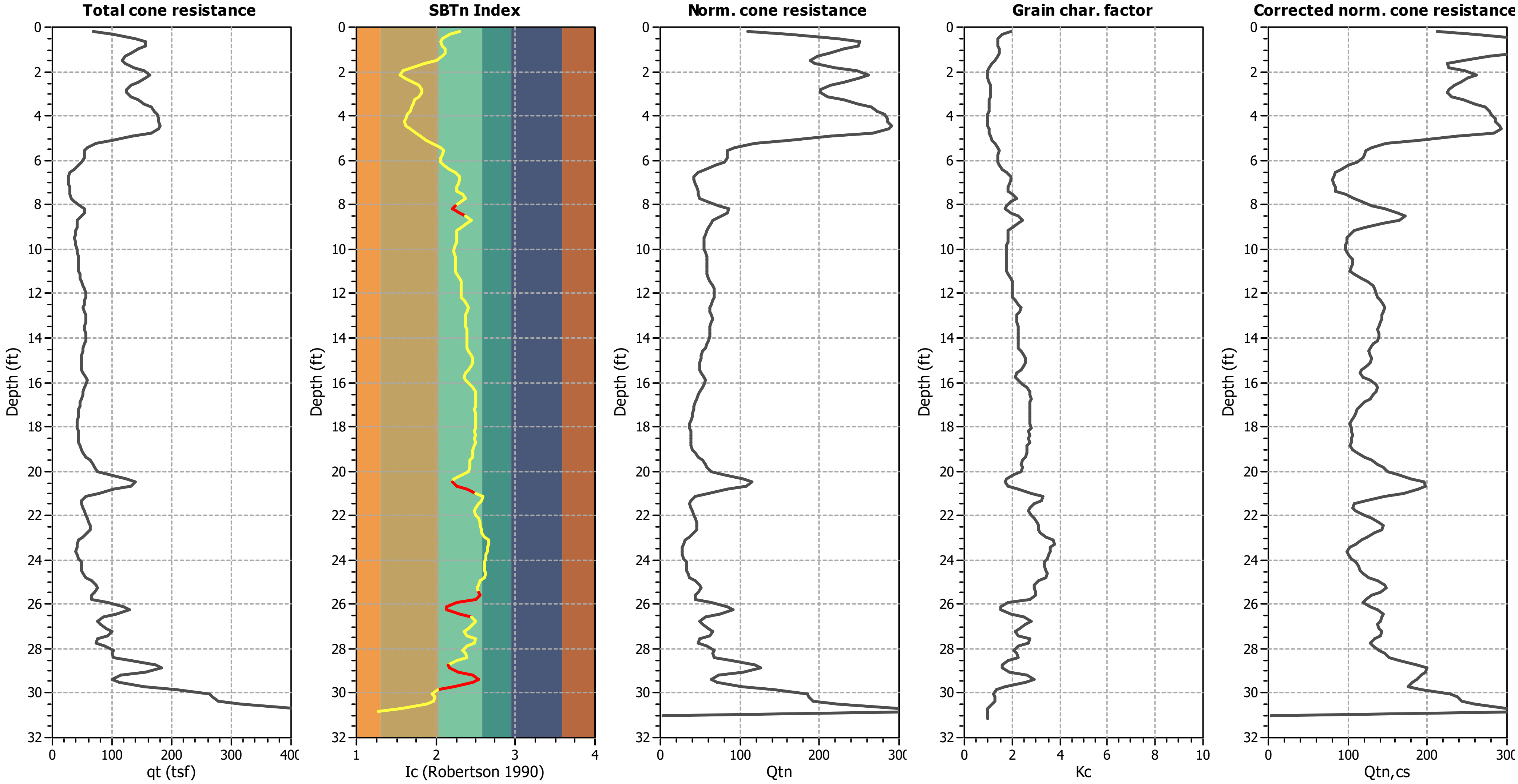
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

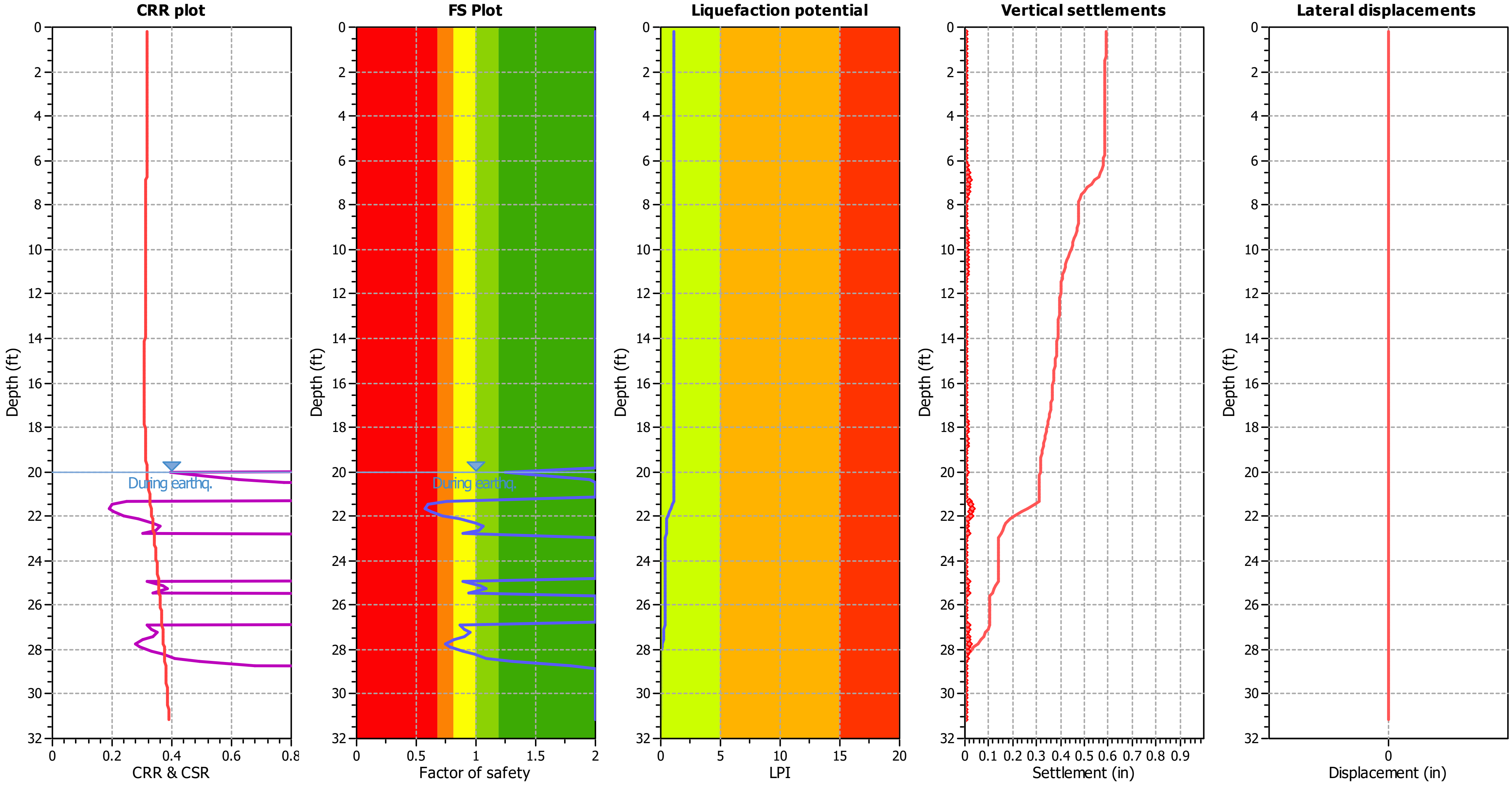
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

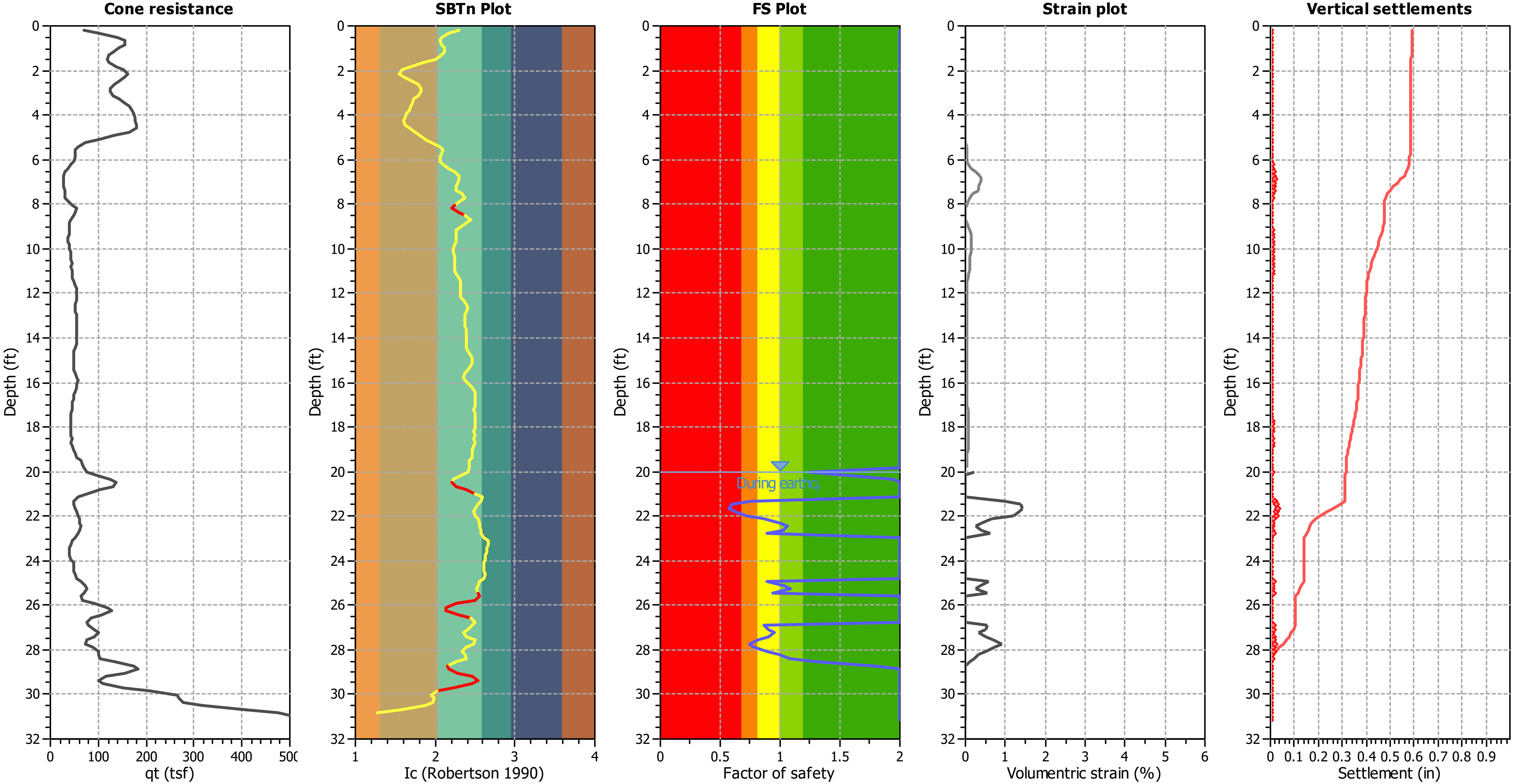
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

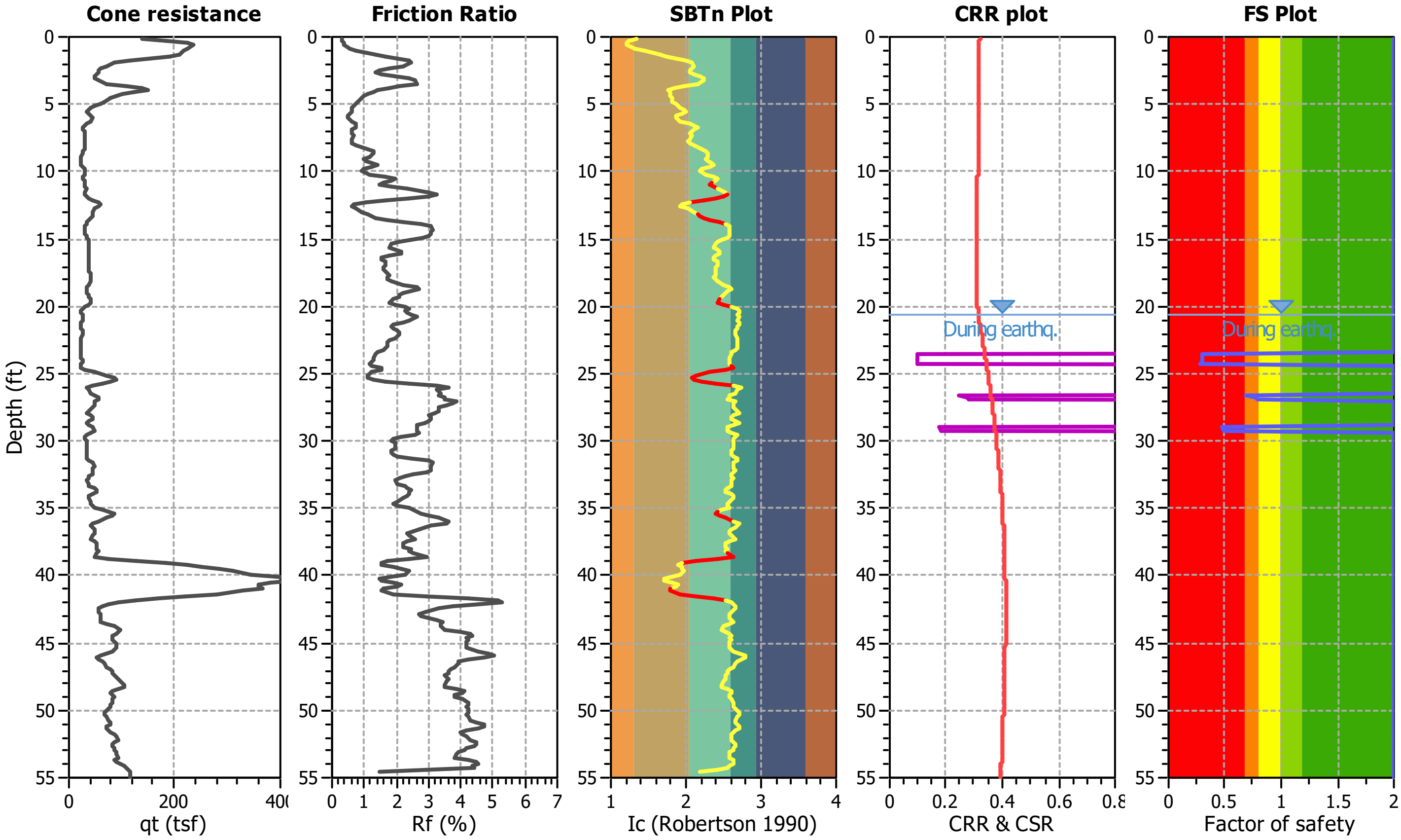
LIQUEFACTION ANALYSIS REPORT

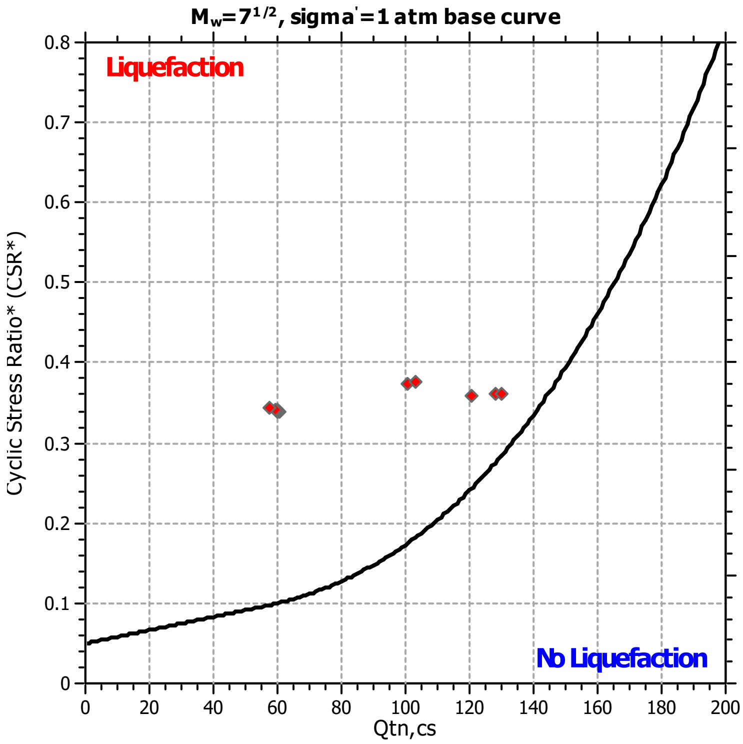
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

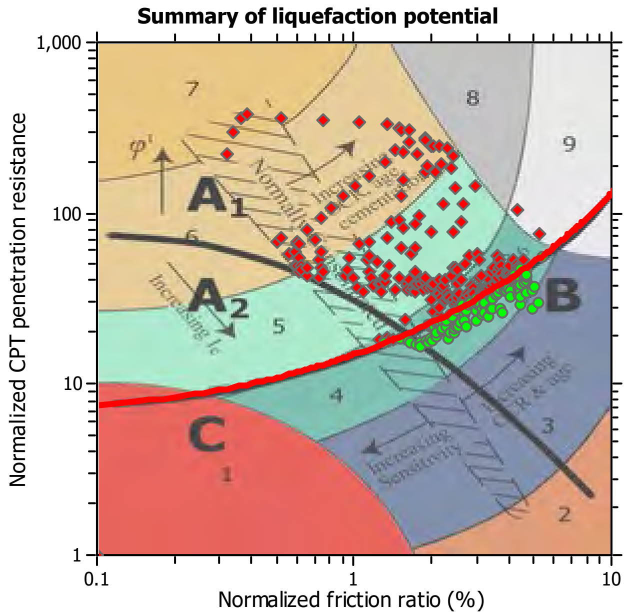
CPT file : C-9

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.60 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.60 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	30.00 ft
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

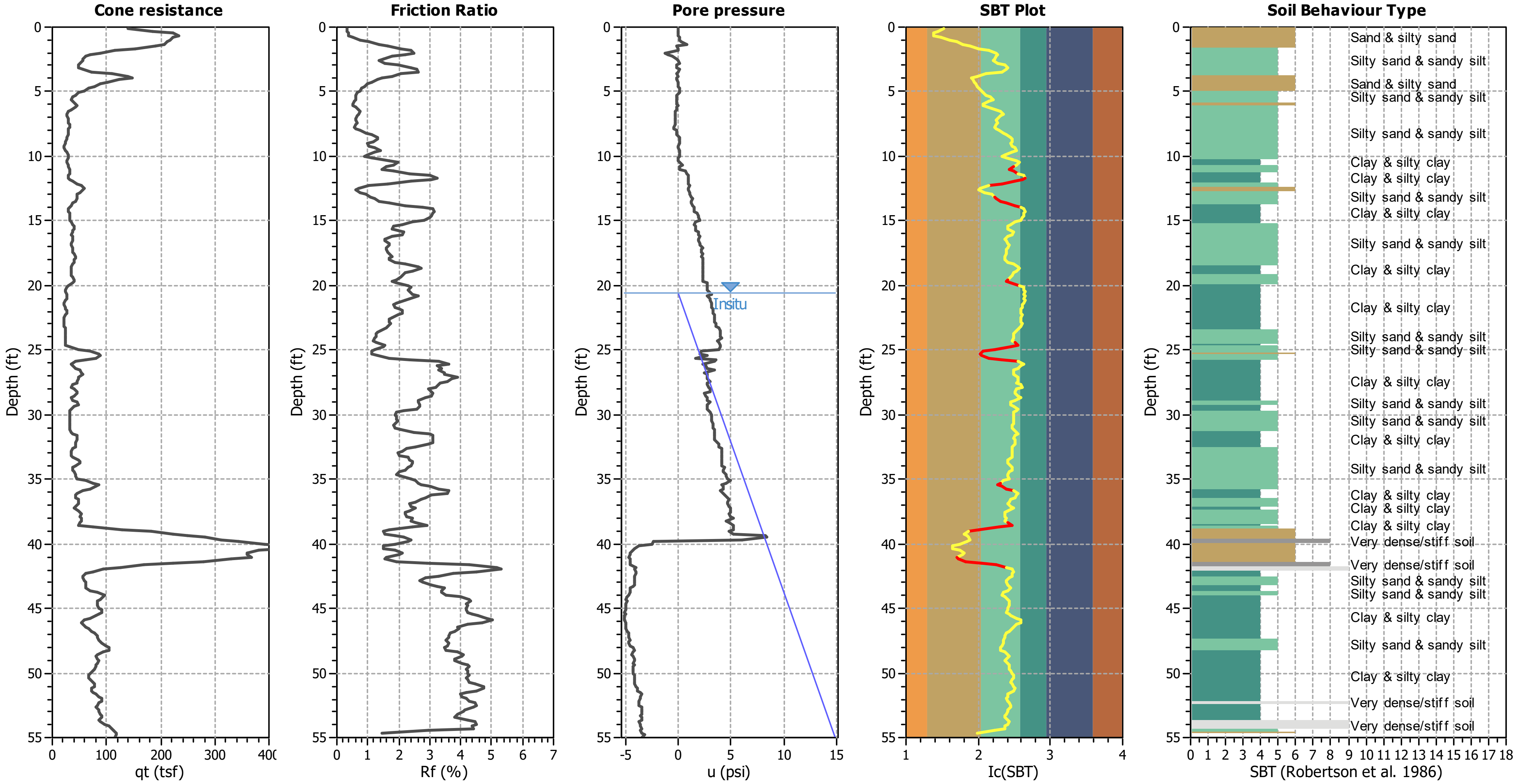






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



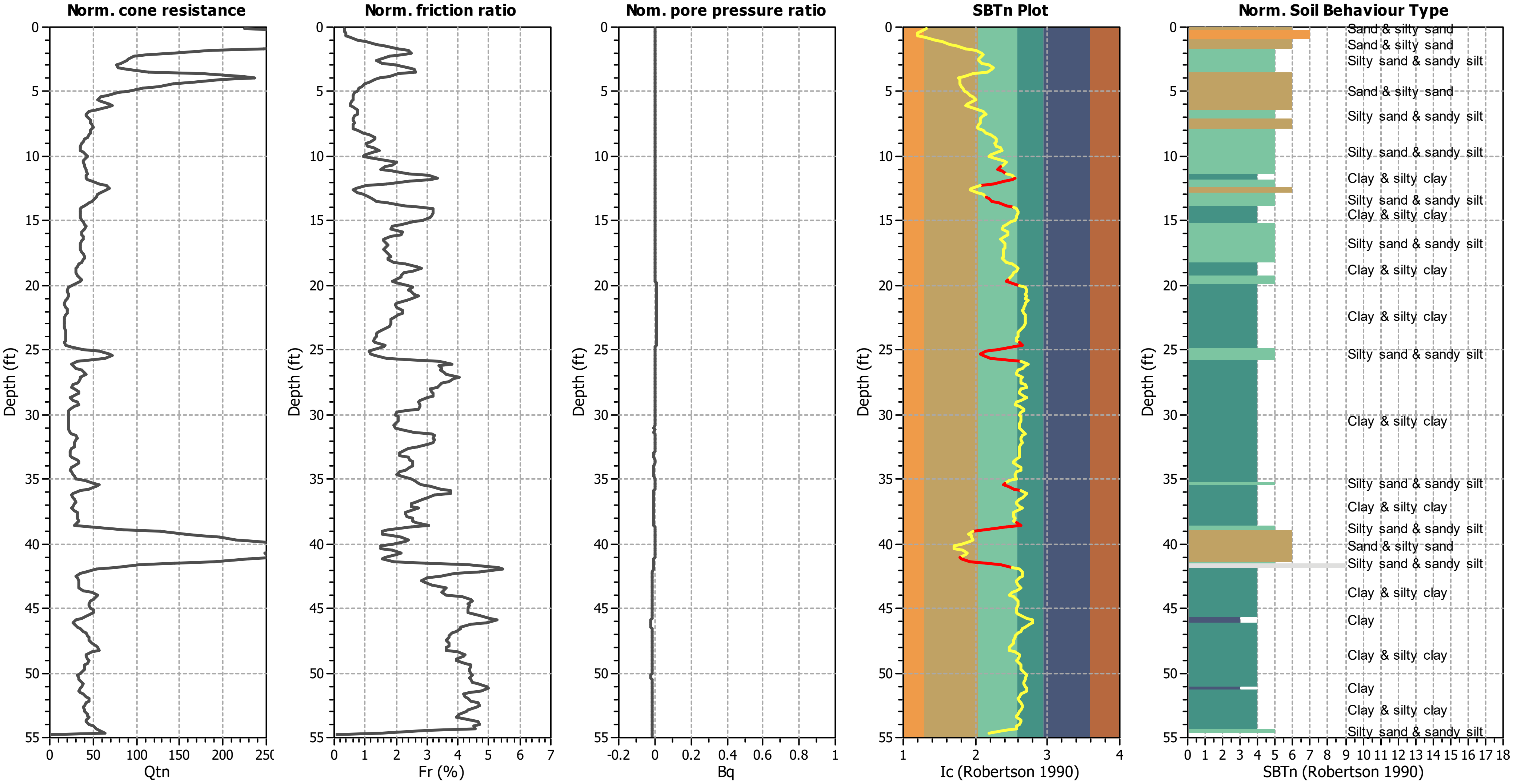
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



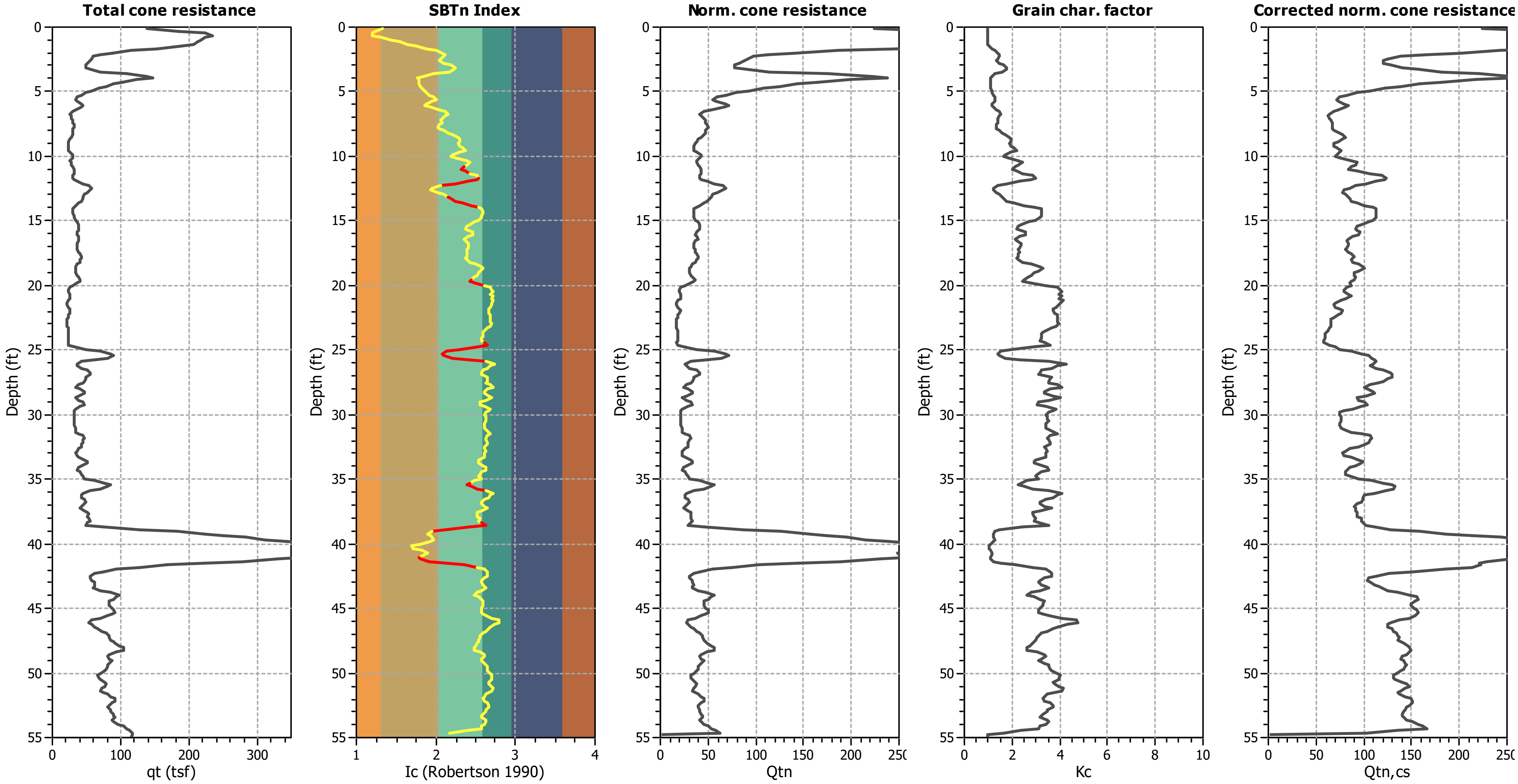
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

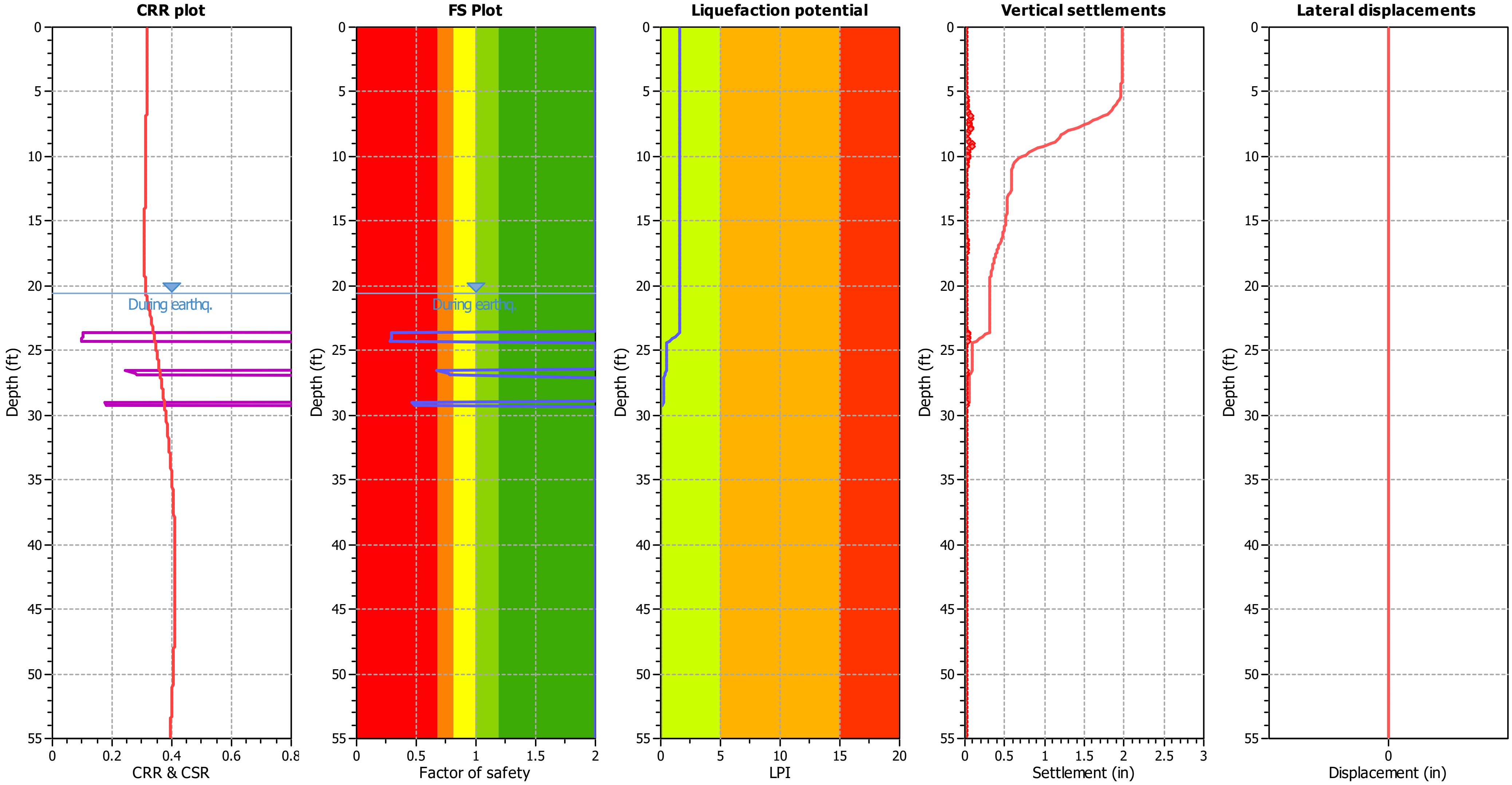
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

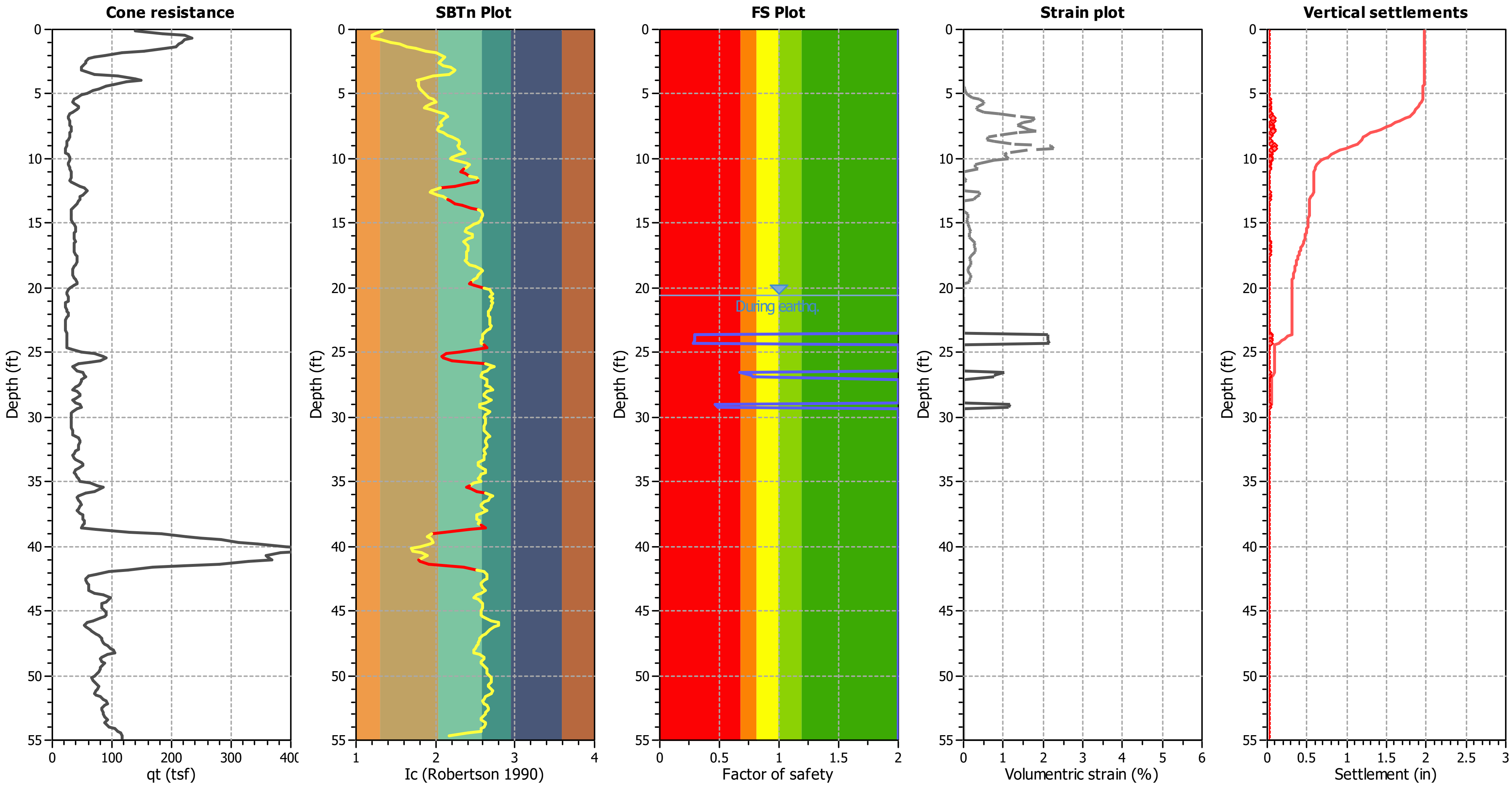
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

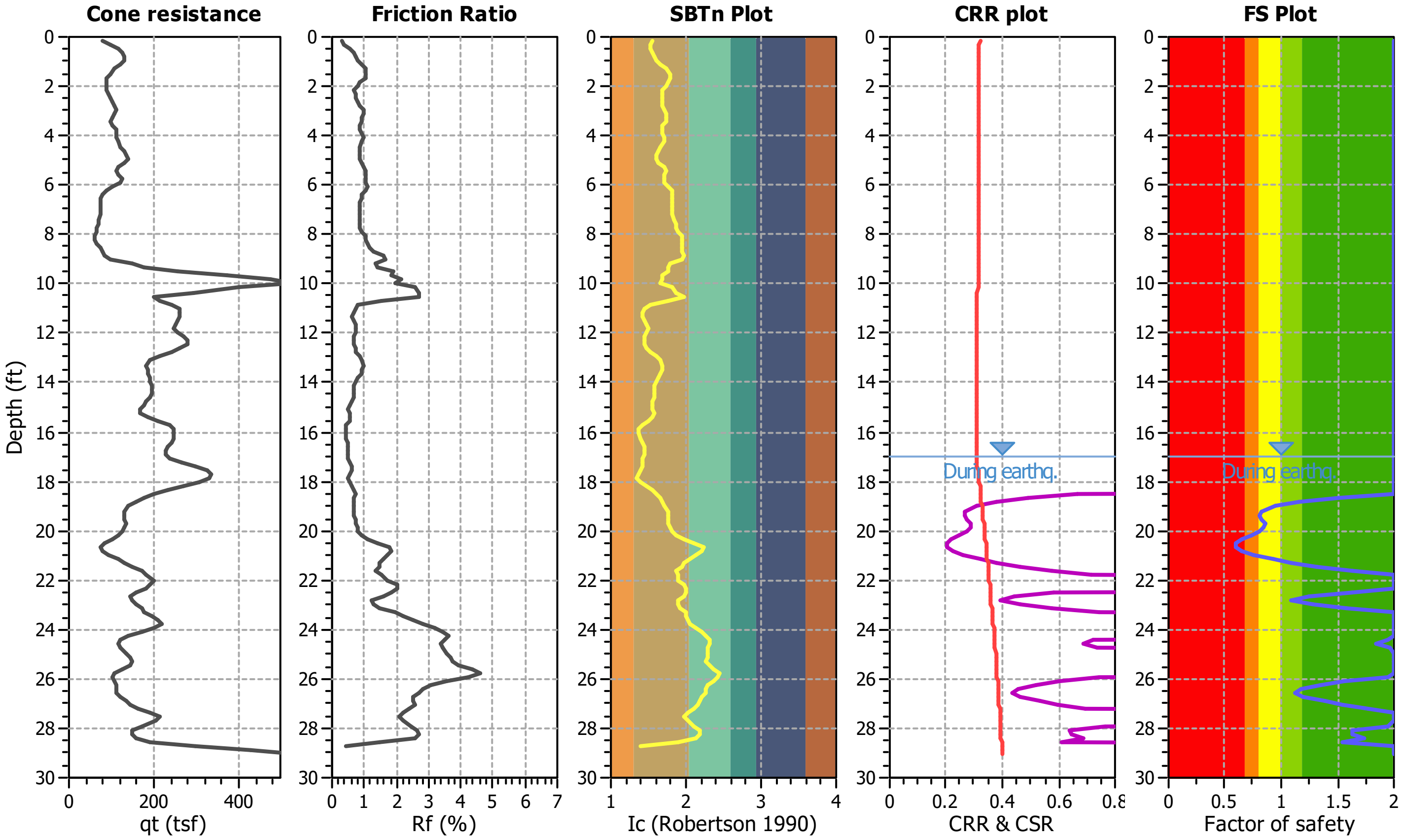
LIQUEFACTION ANALYSIS REPORT

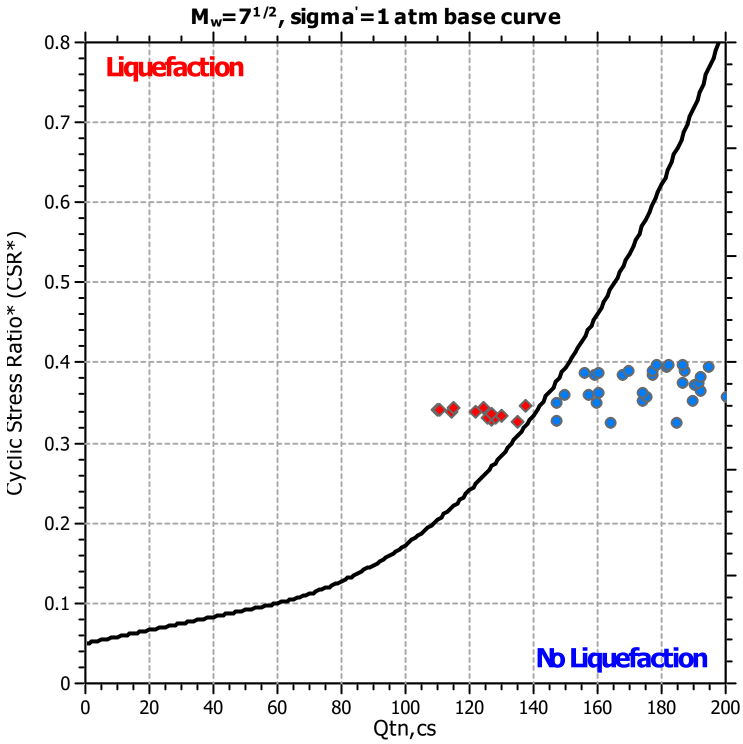
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

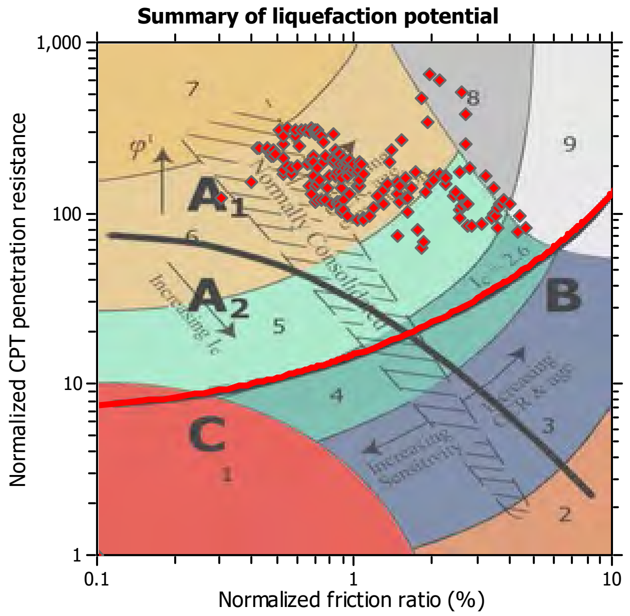
CPT file : SC-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	17.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
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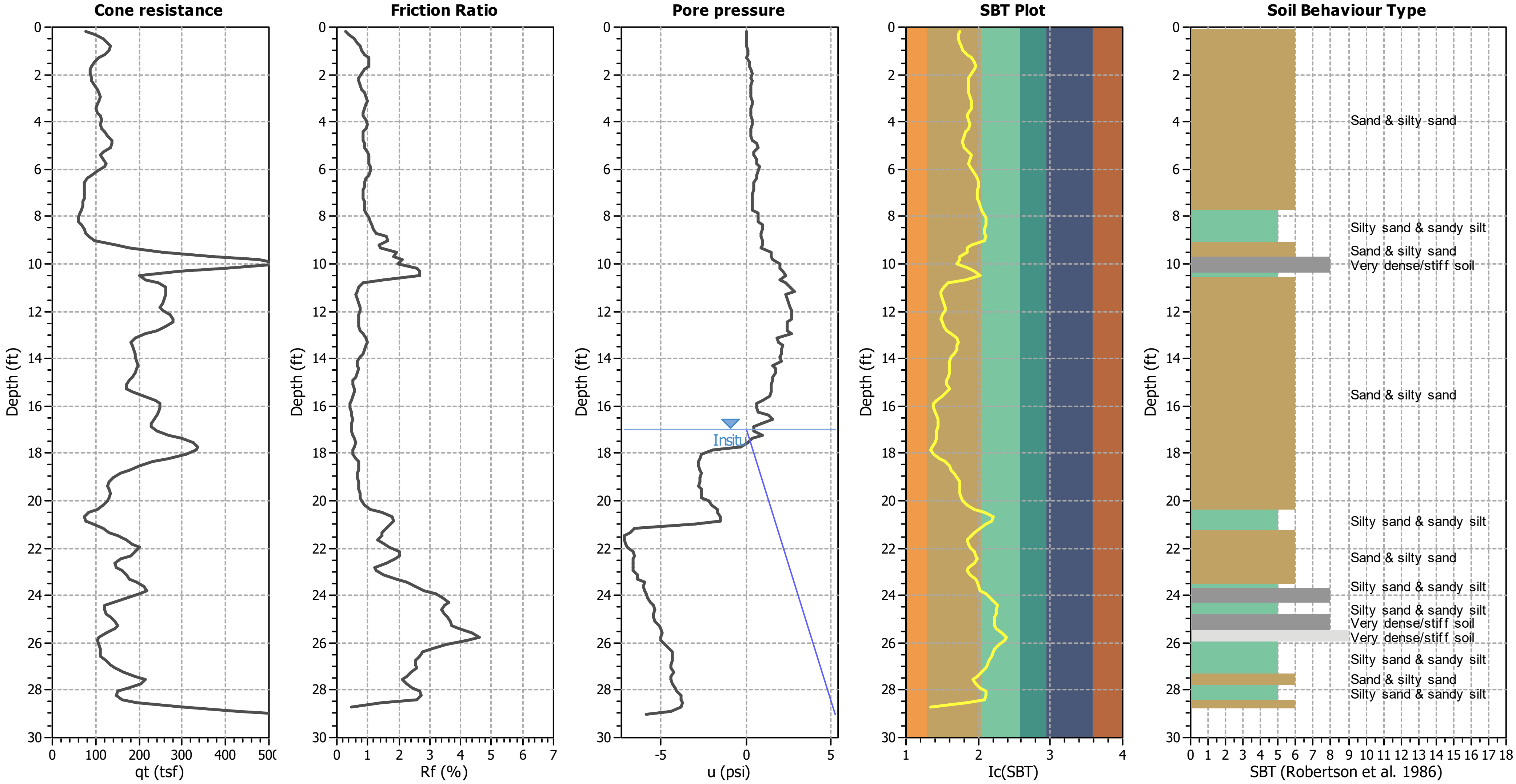
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



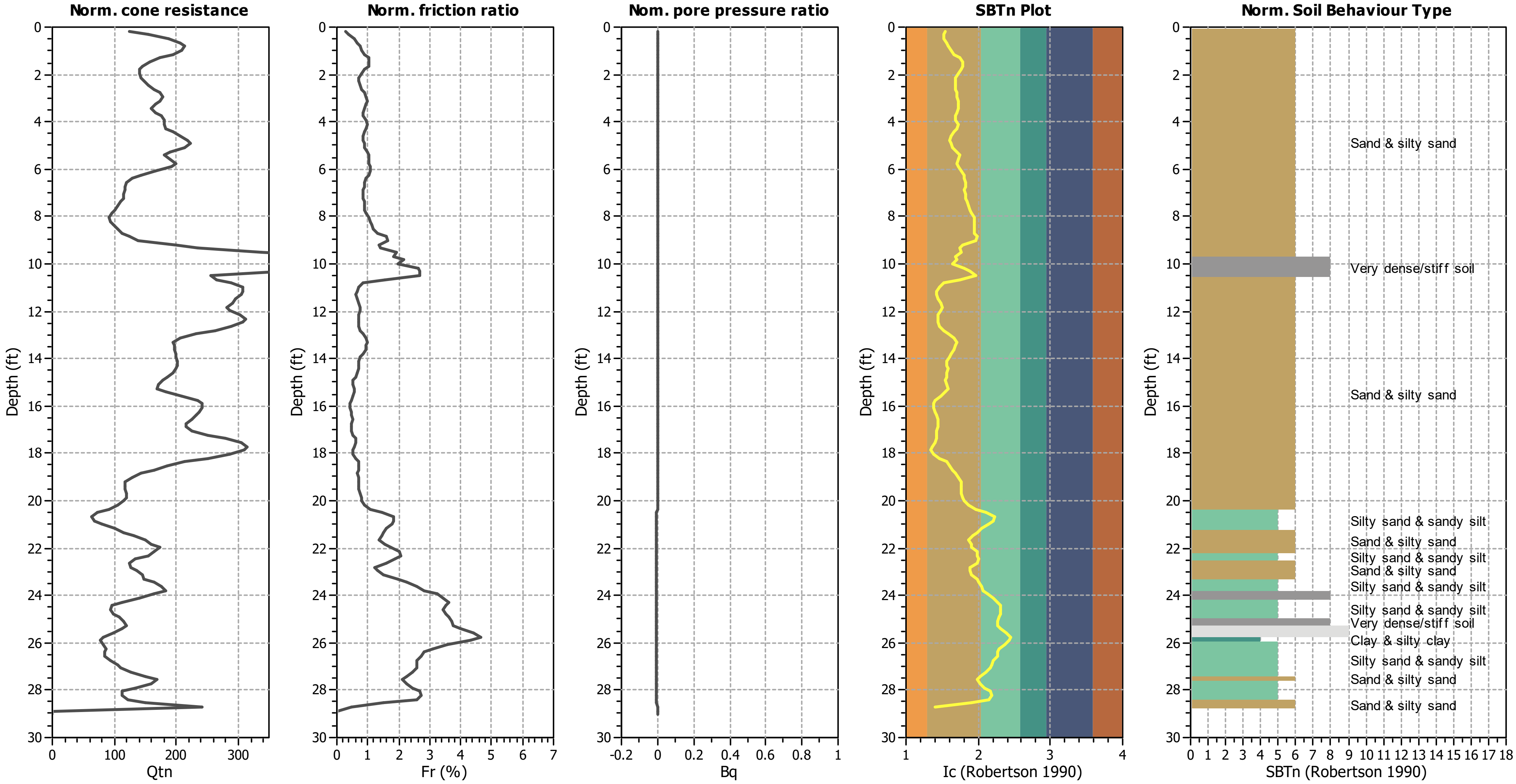
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
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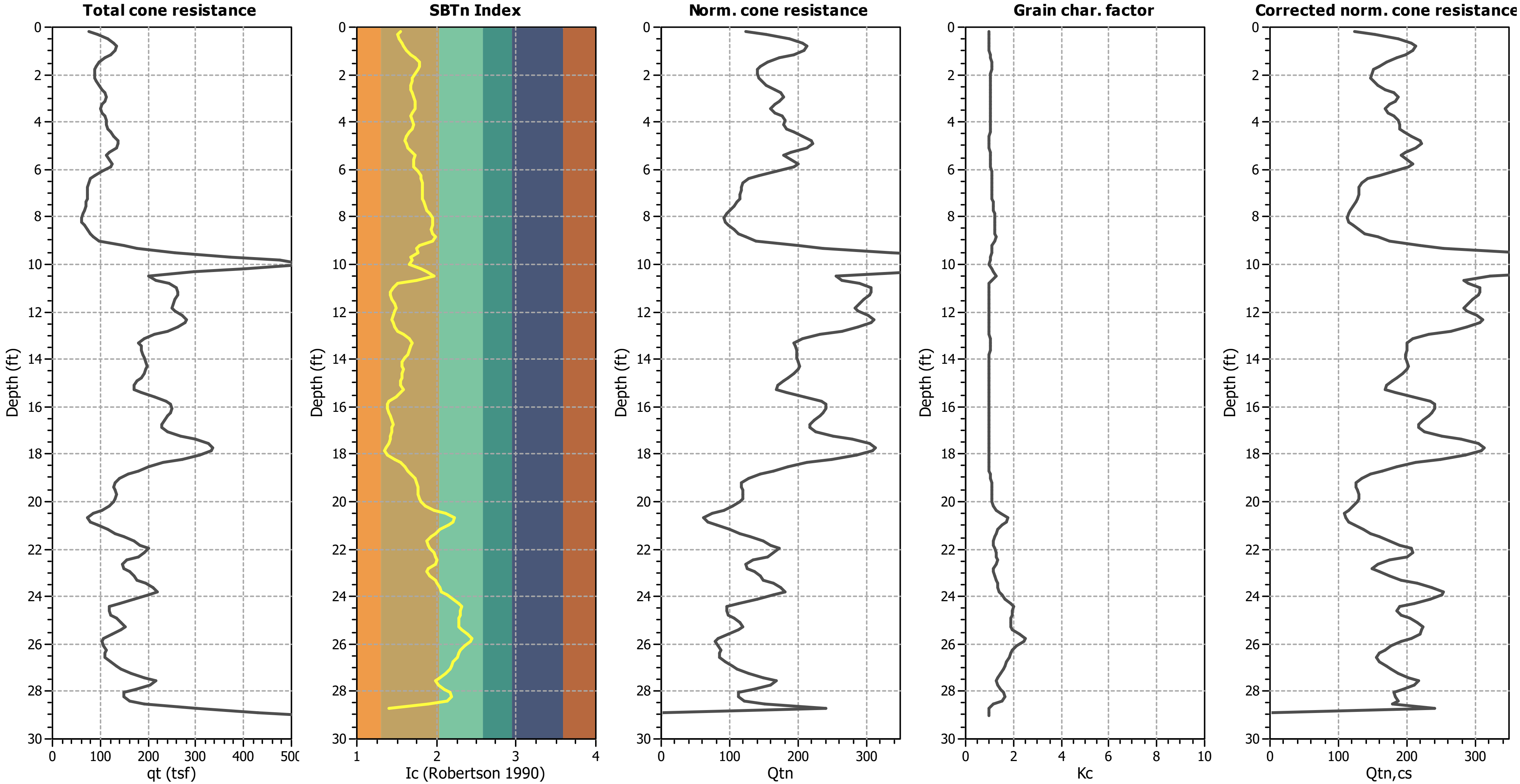
9. Very stiff fine grained

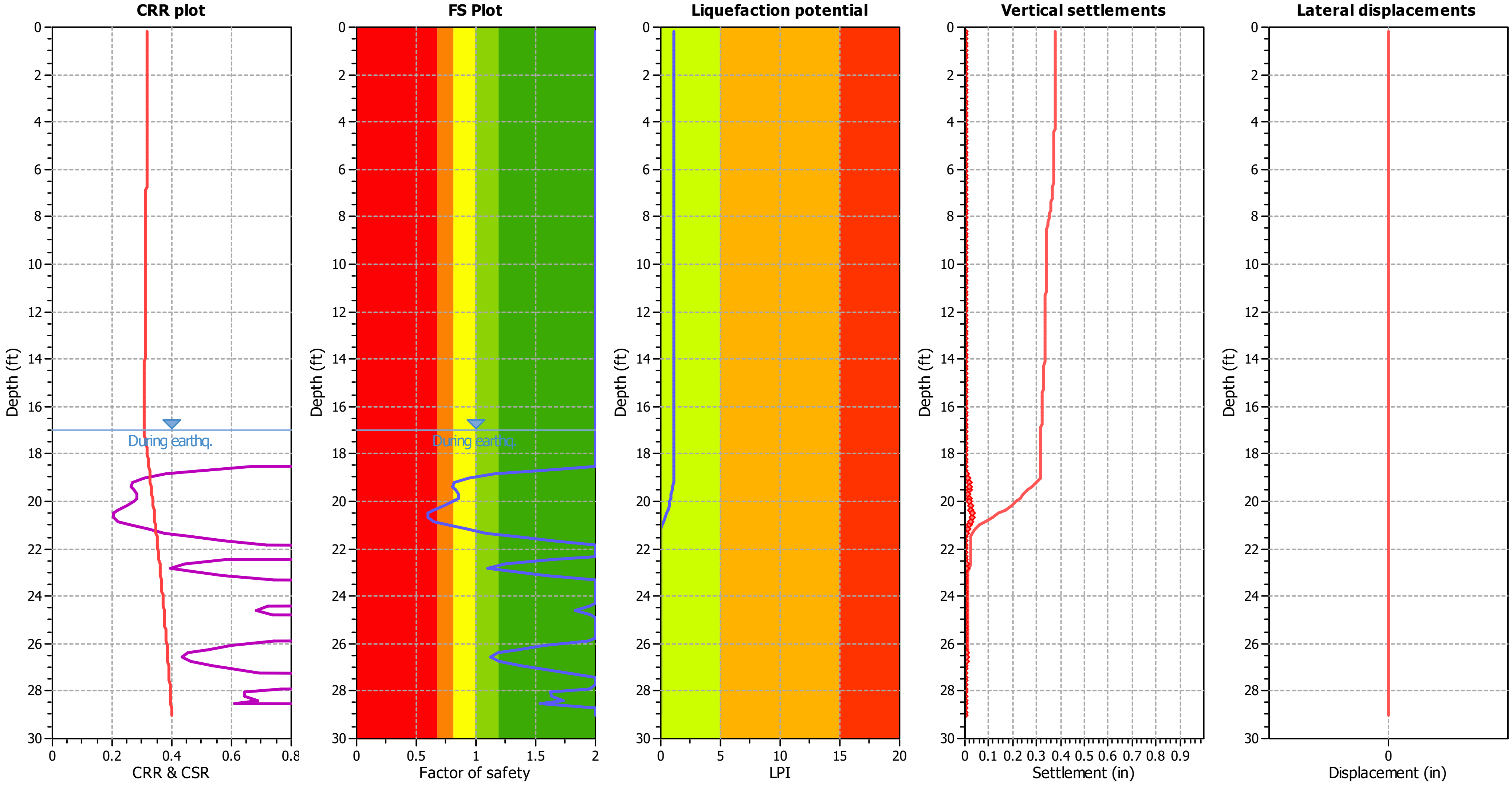
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
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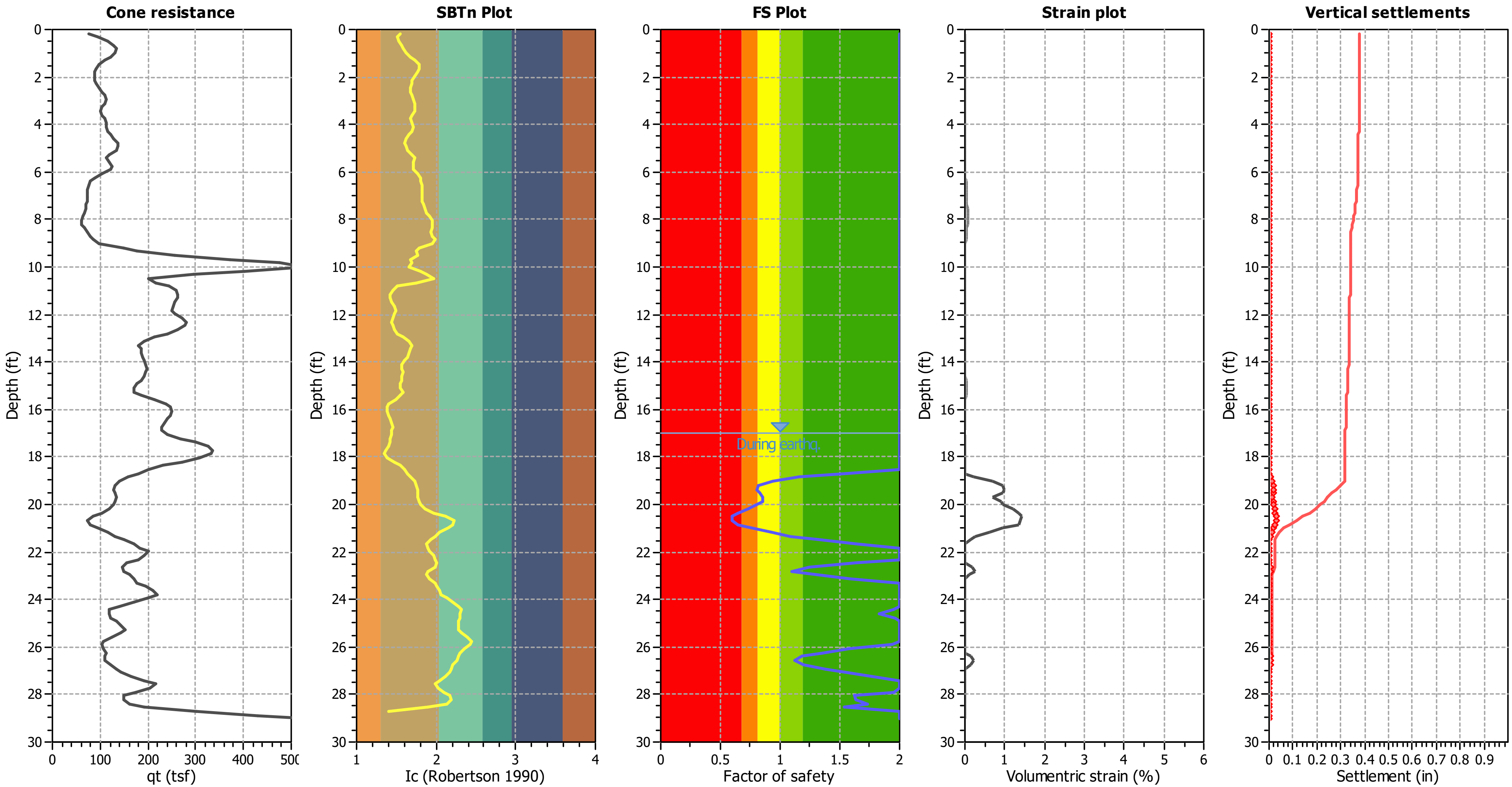
LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

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Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

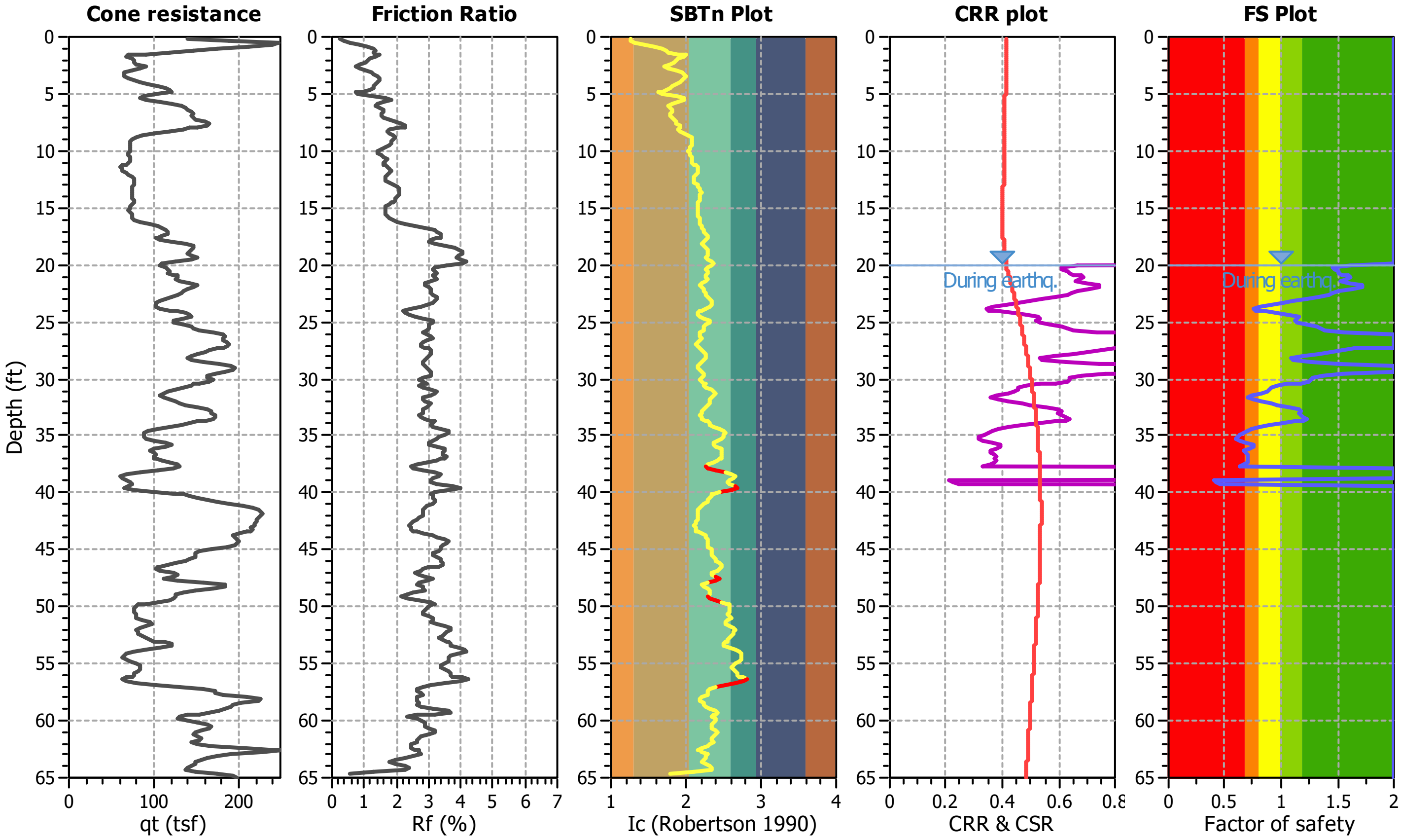
LIQUEFACTION ANALYSIS REPORT

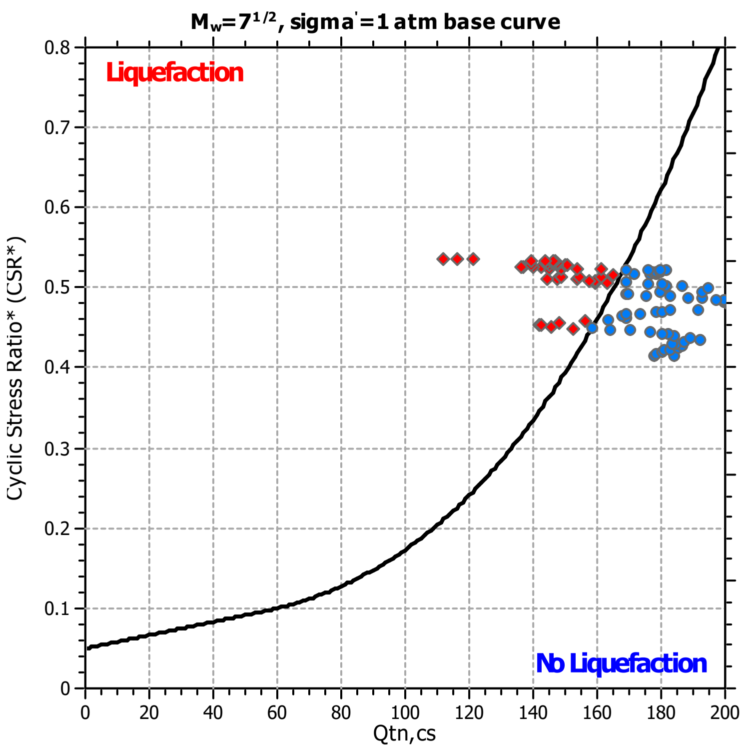
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

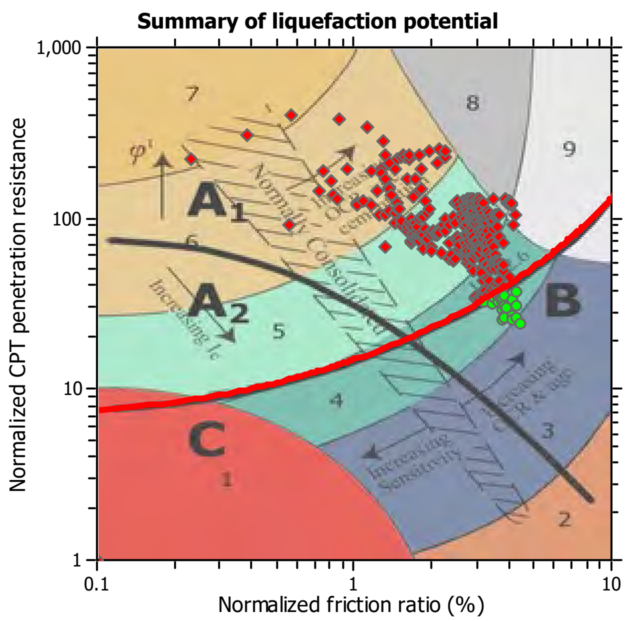
CPT file : SC-3

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	25.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	40.00 ft
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
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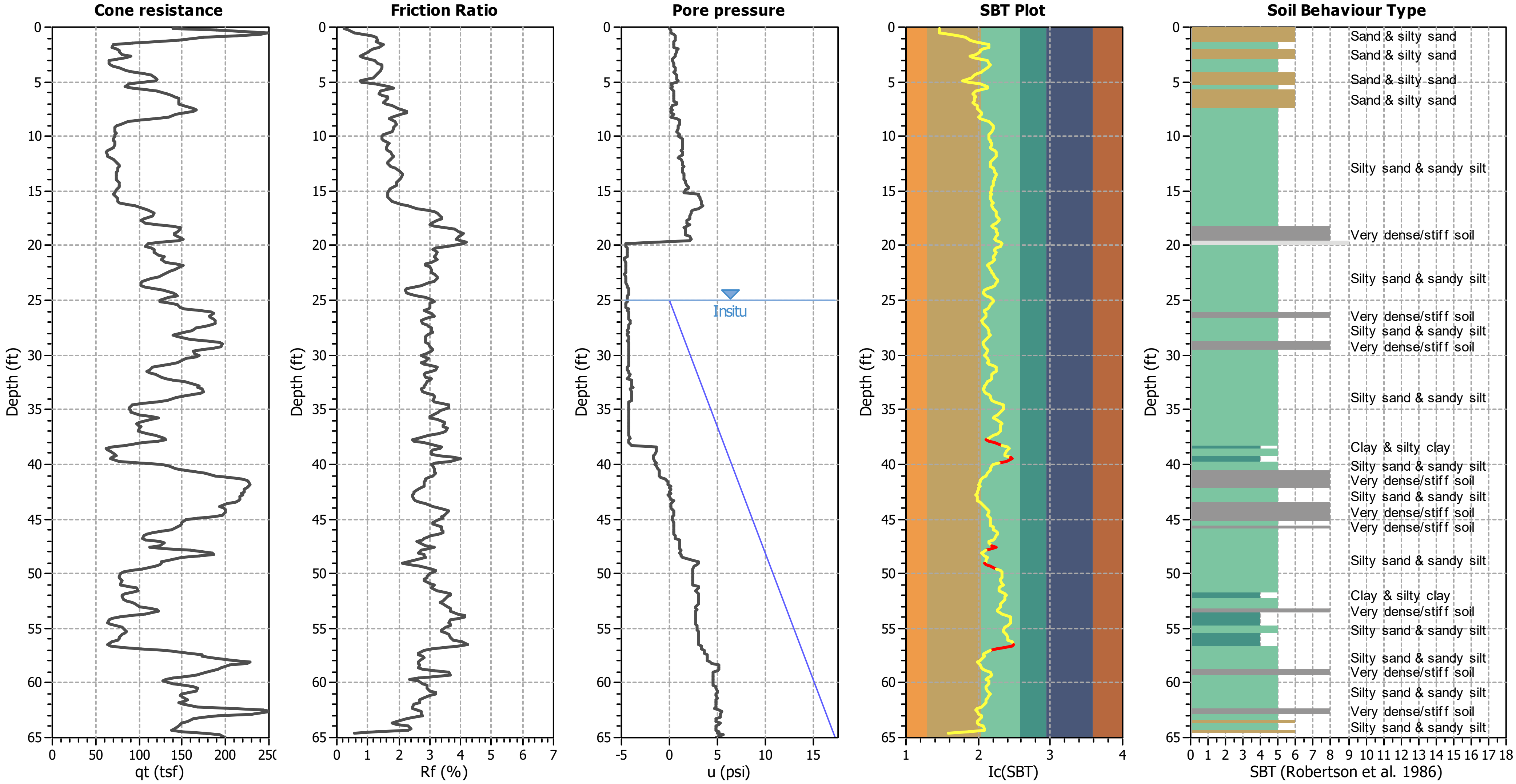
CPT basic interpretation plots



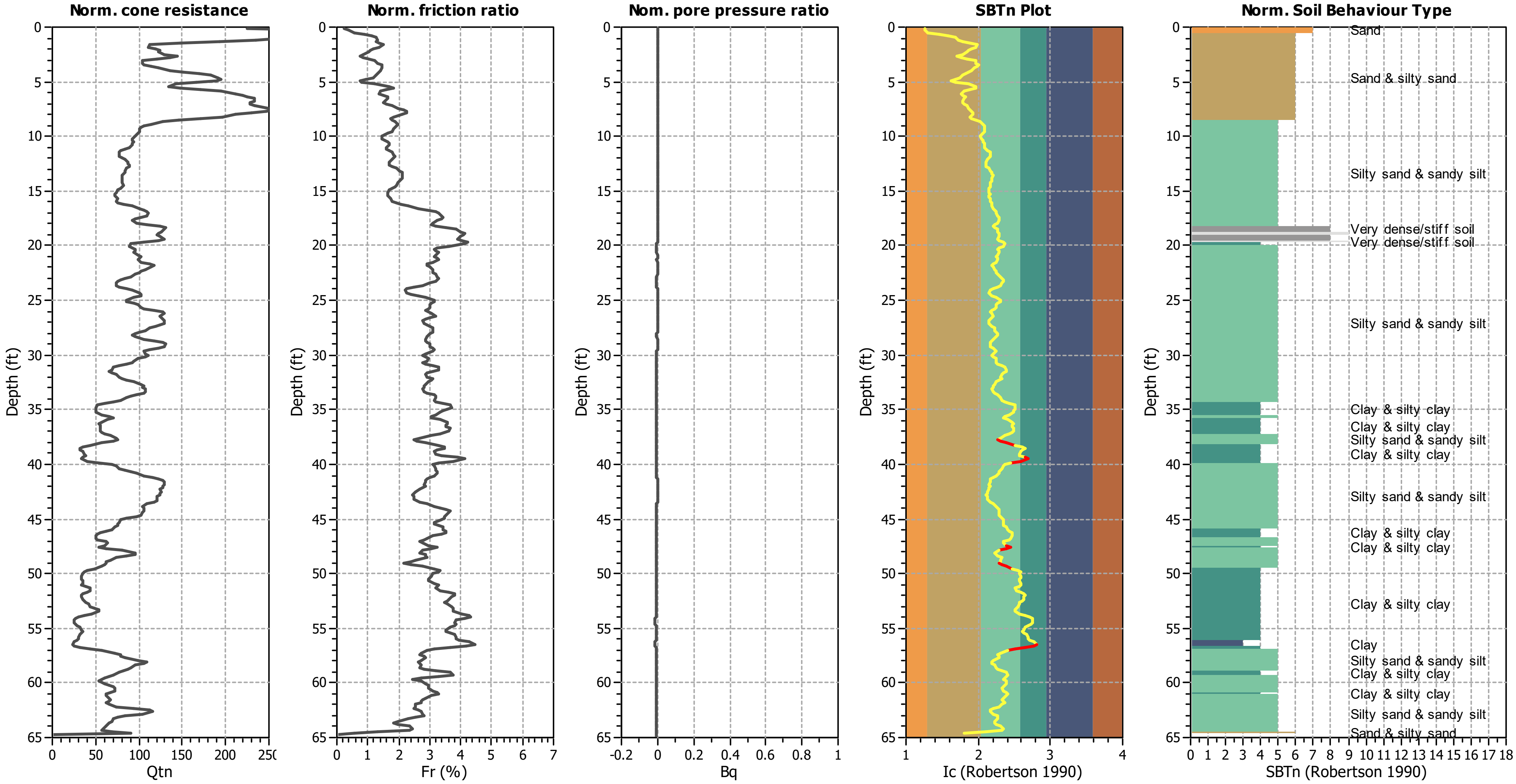
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



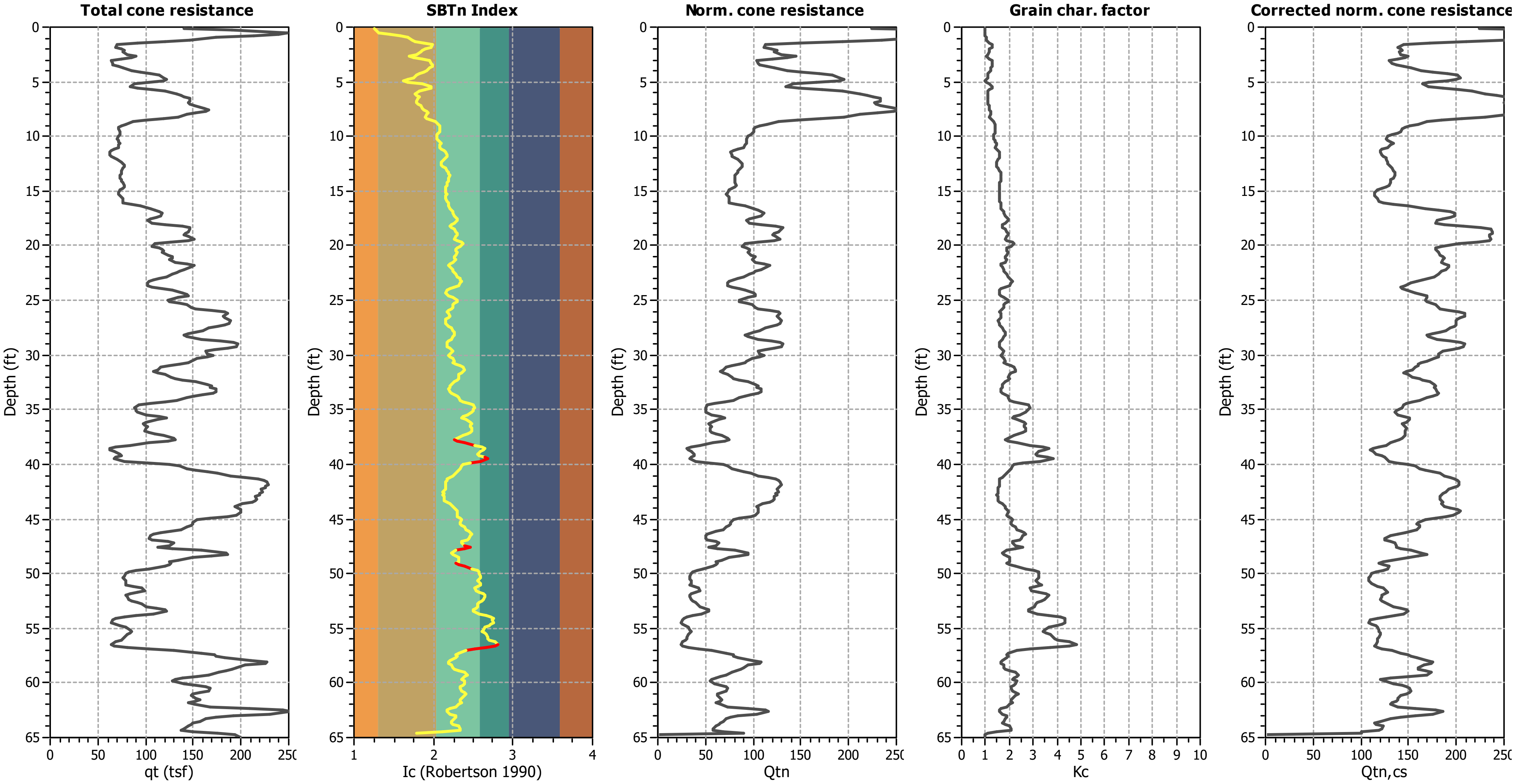
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
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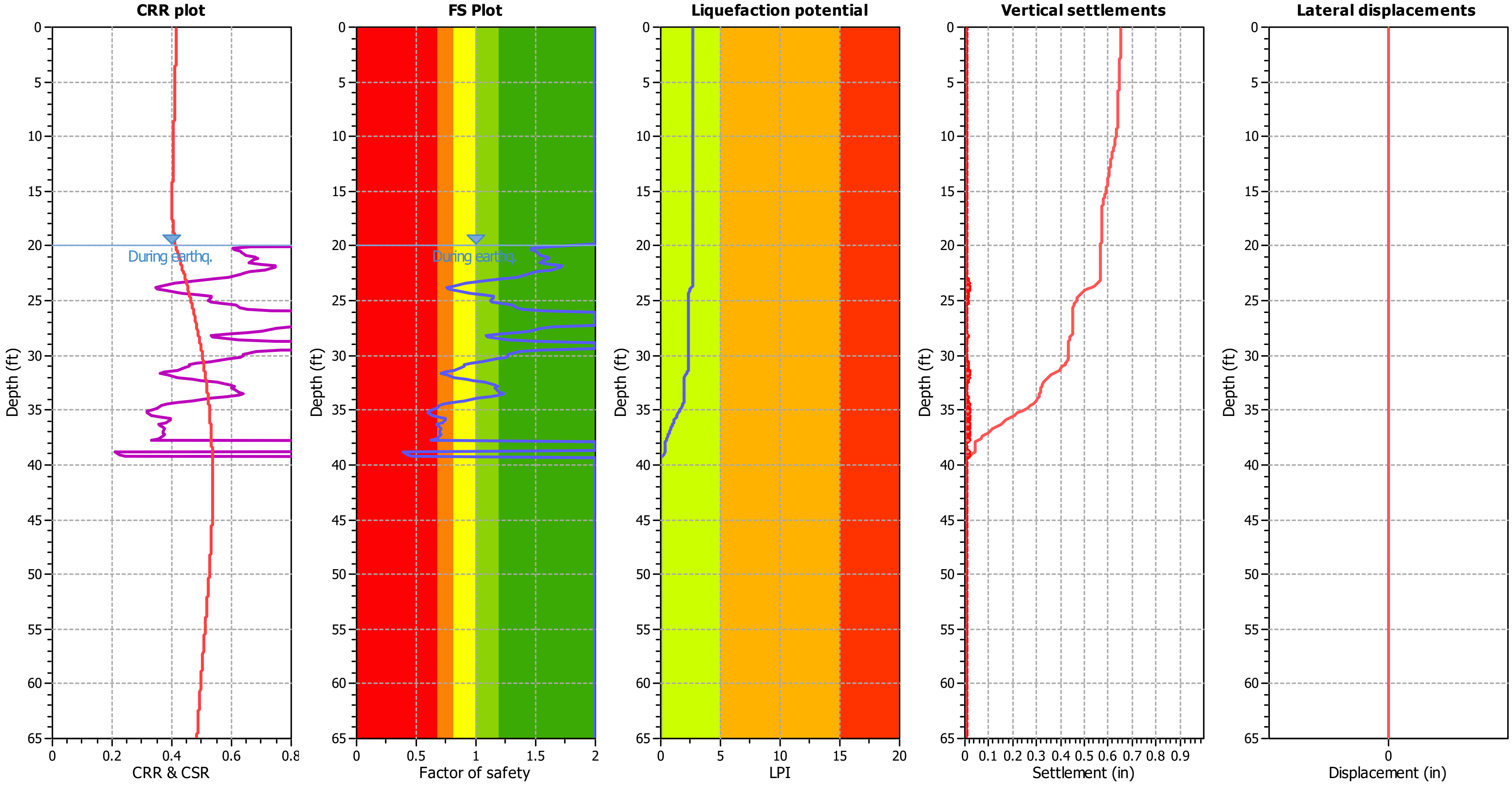
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

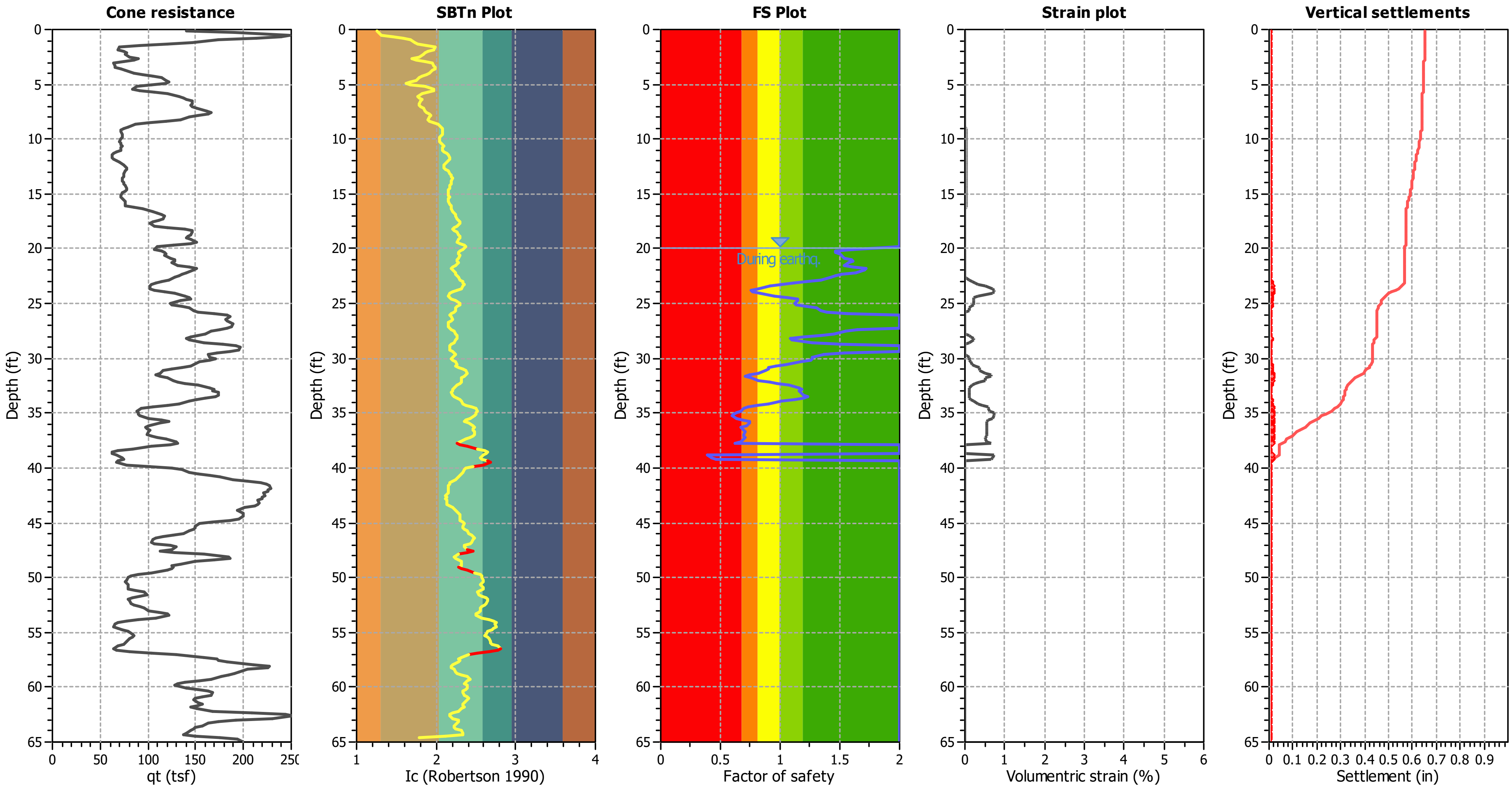
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

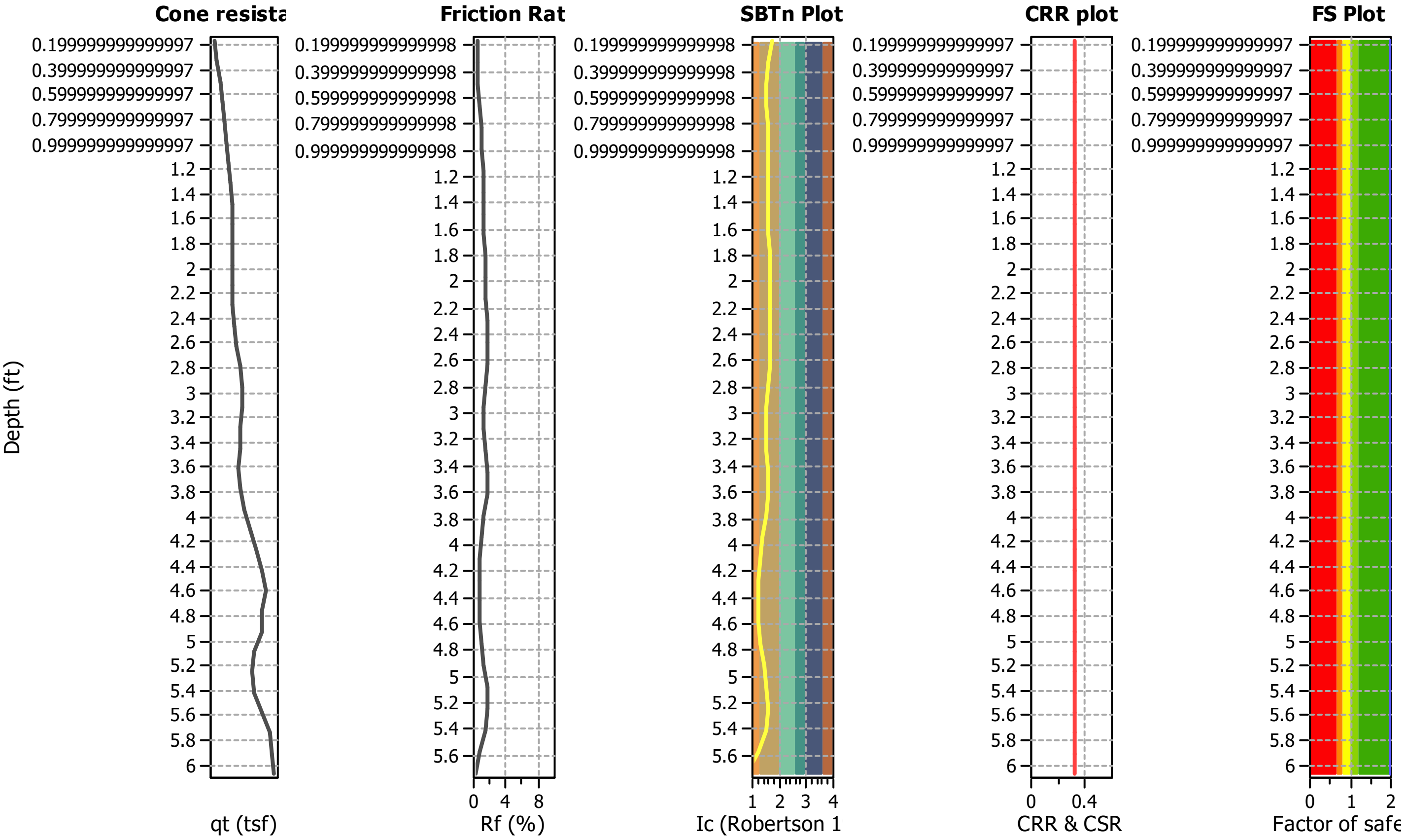
LIQUEFACTION ANALYSIS REPORT

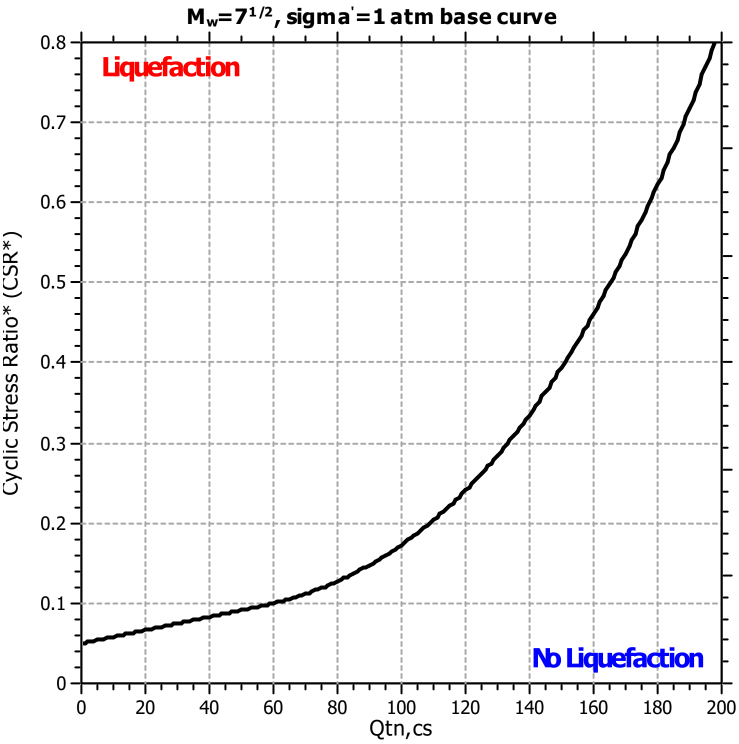
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

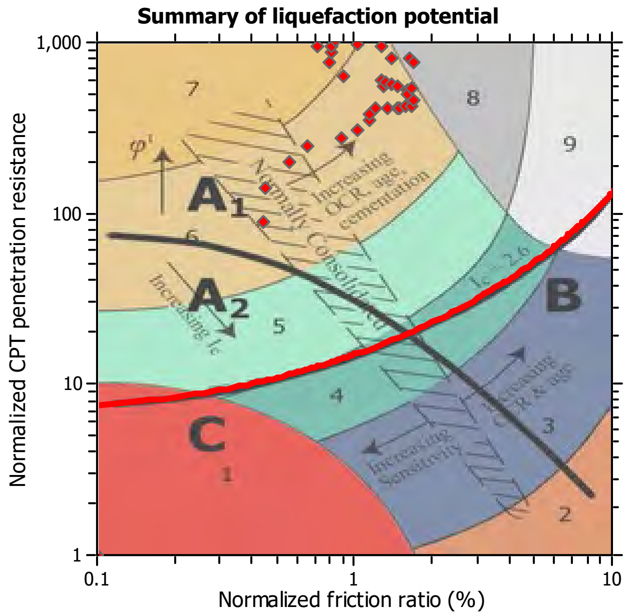
CPT file : SC-6

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	45.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	45.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

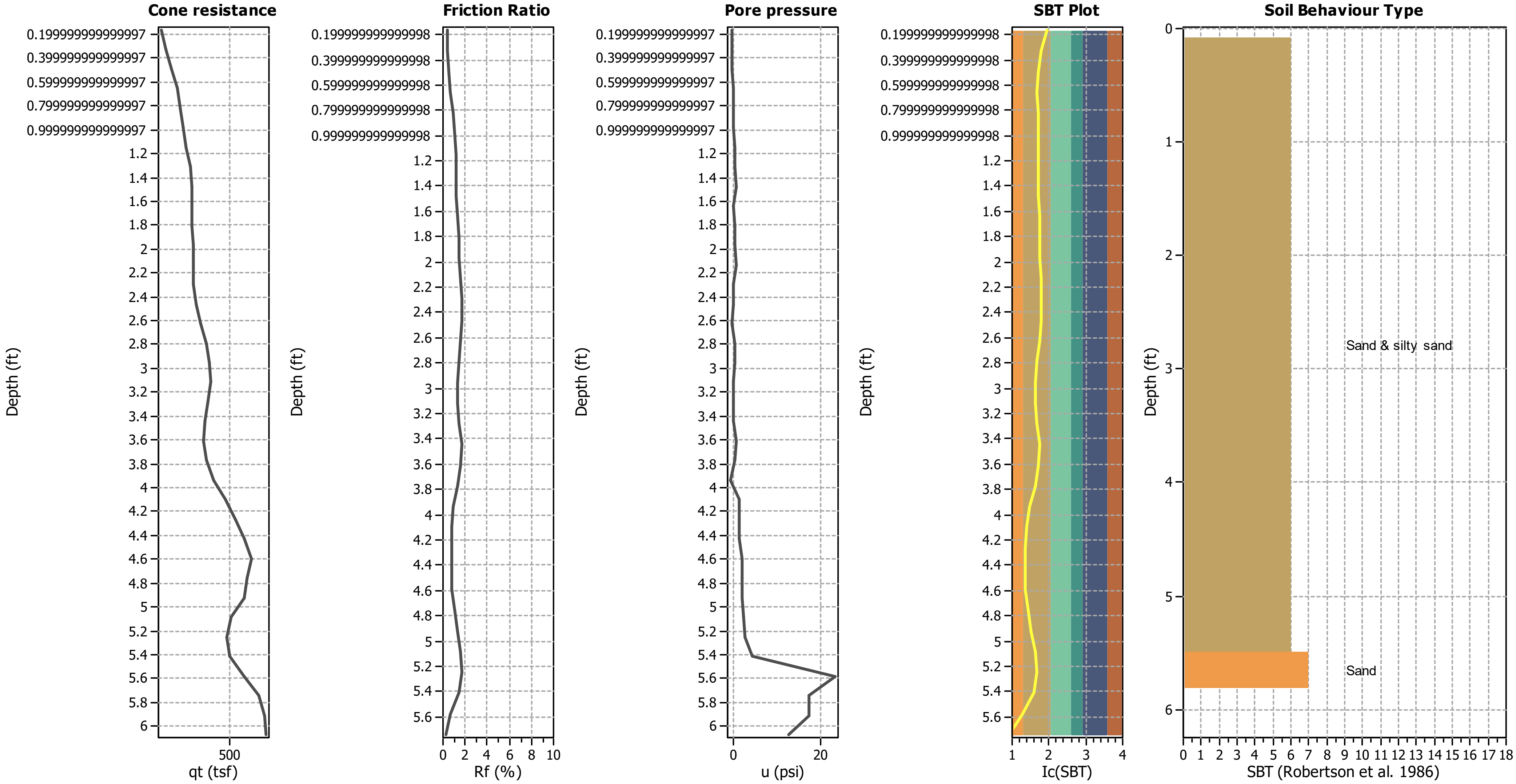






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



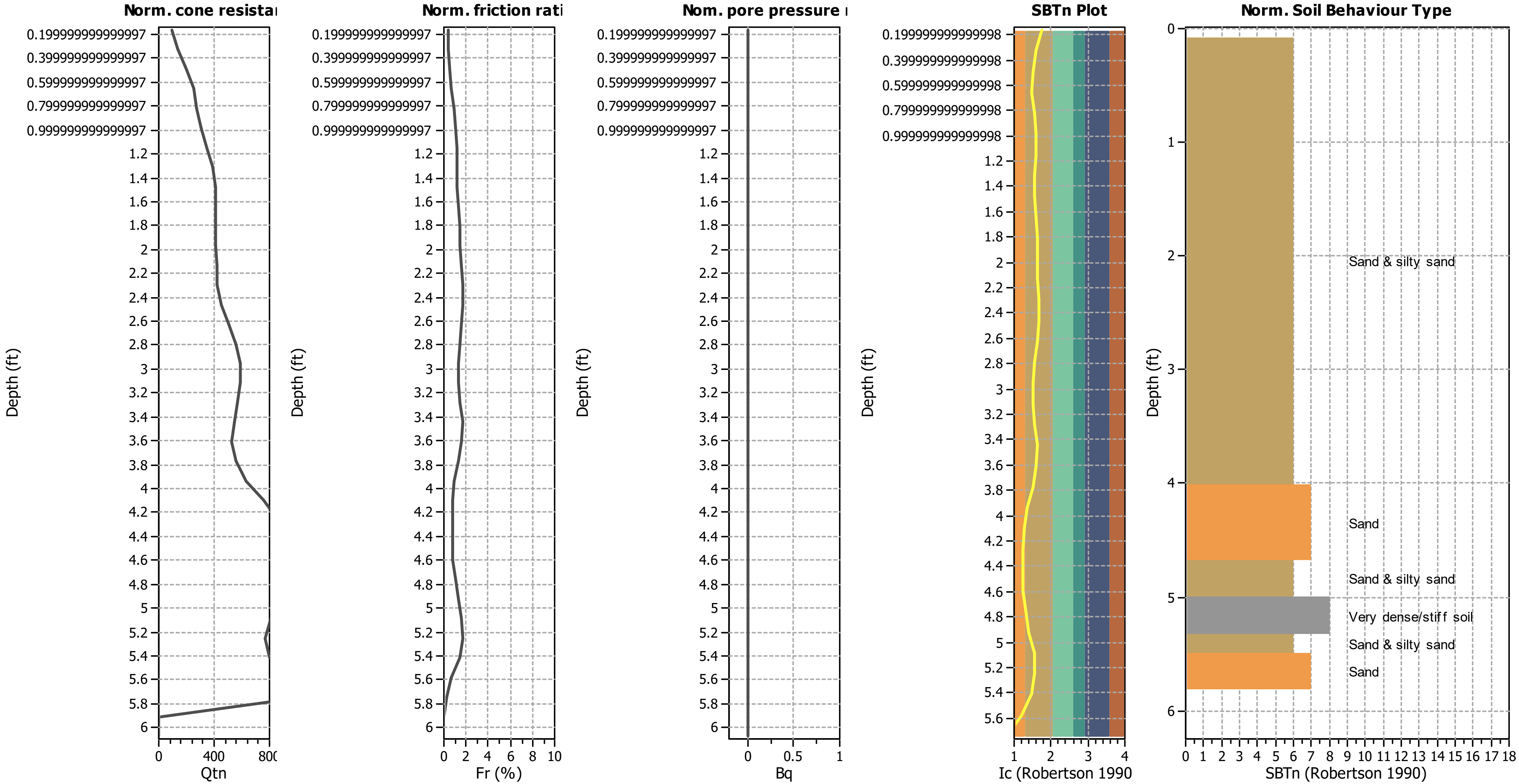
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots (normalized)



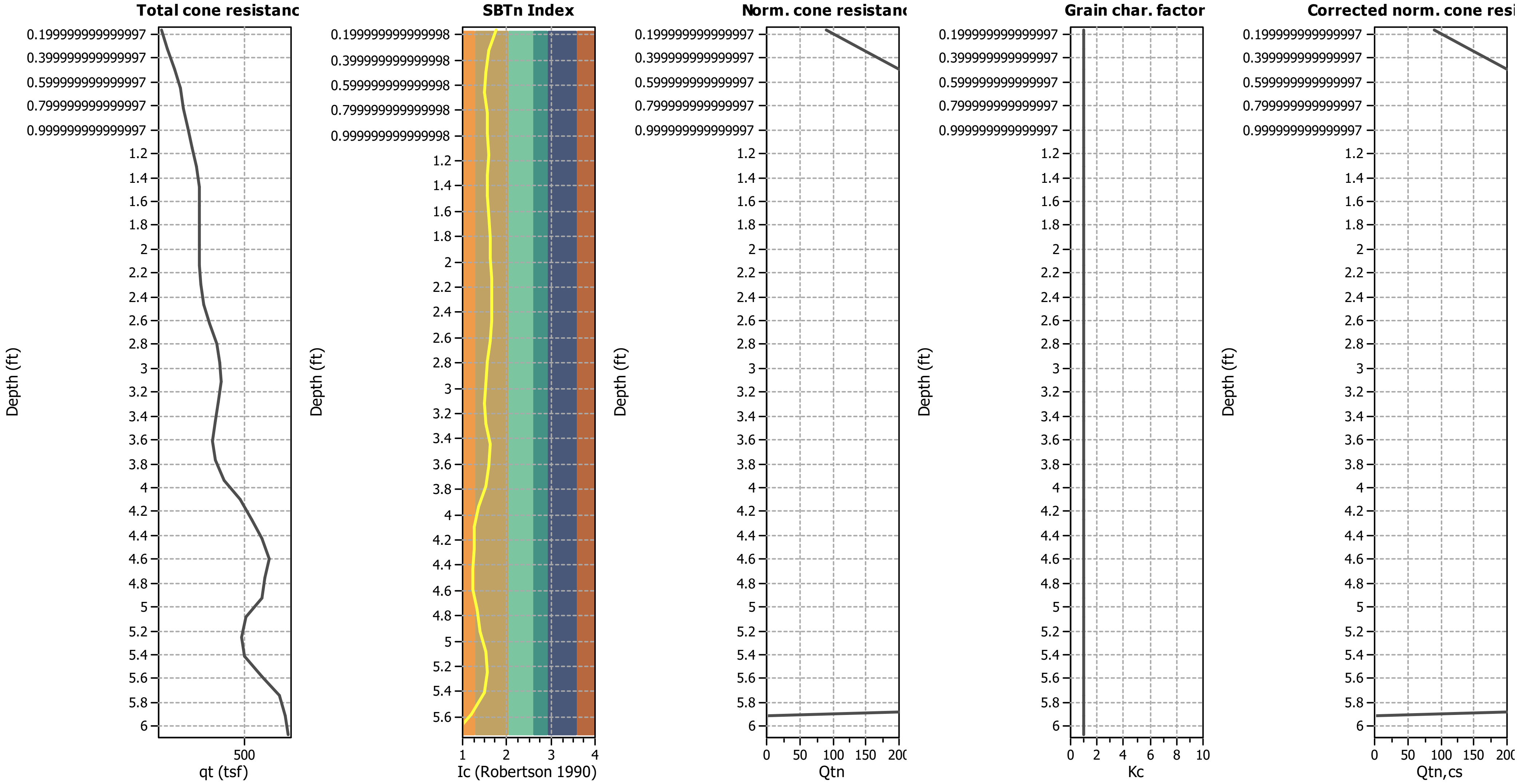
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
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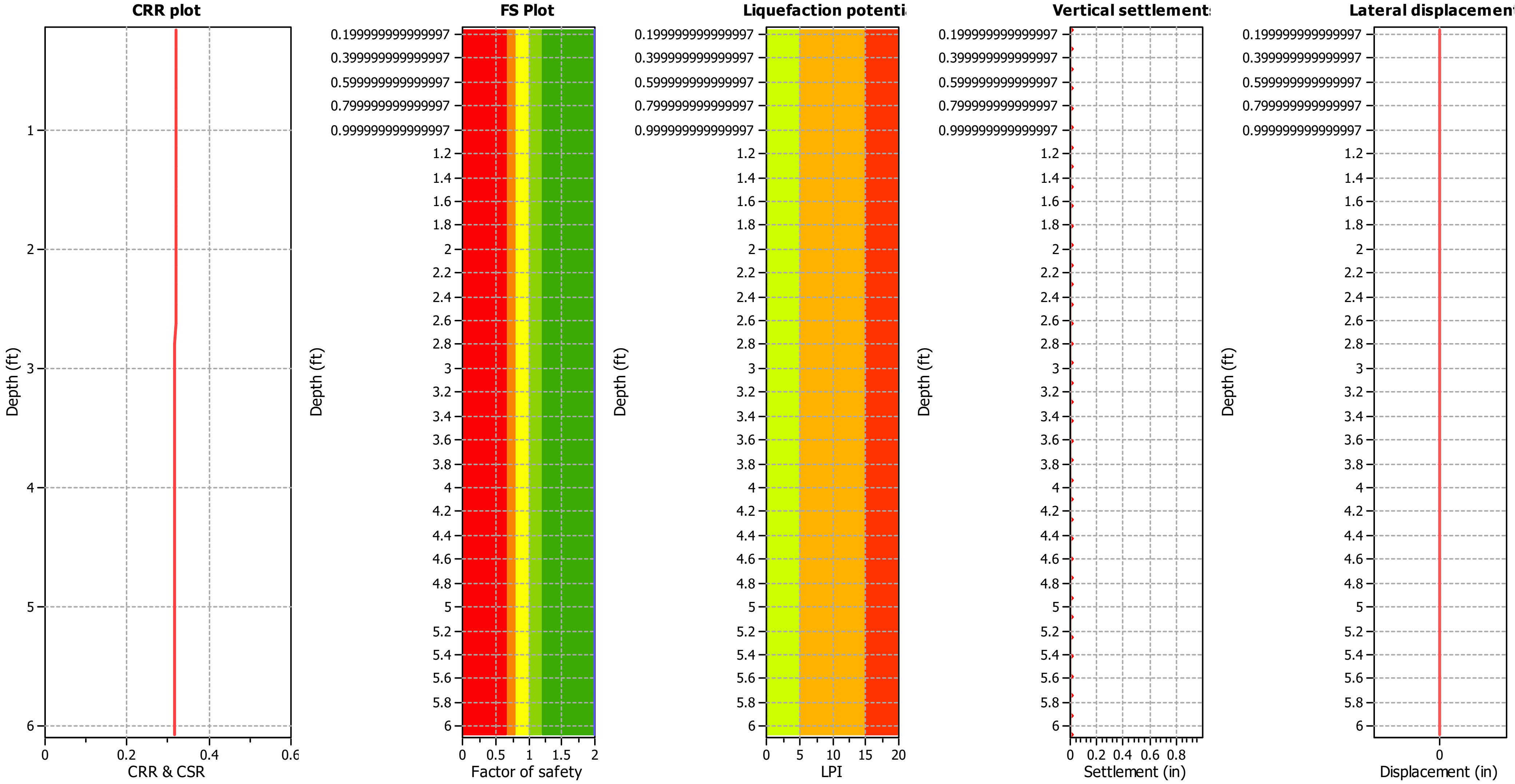
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
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Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

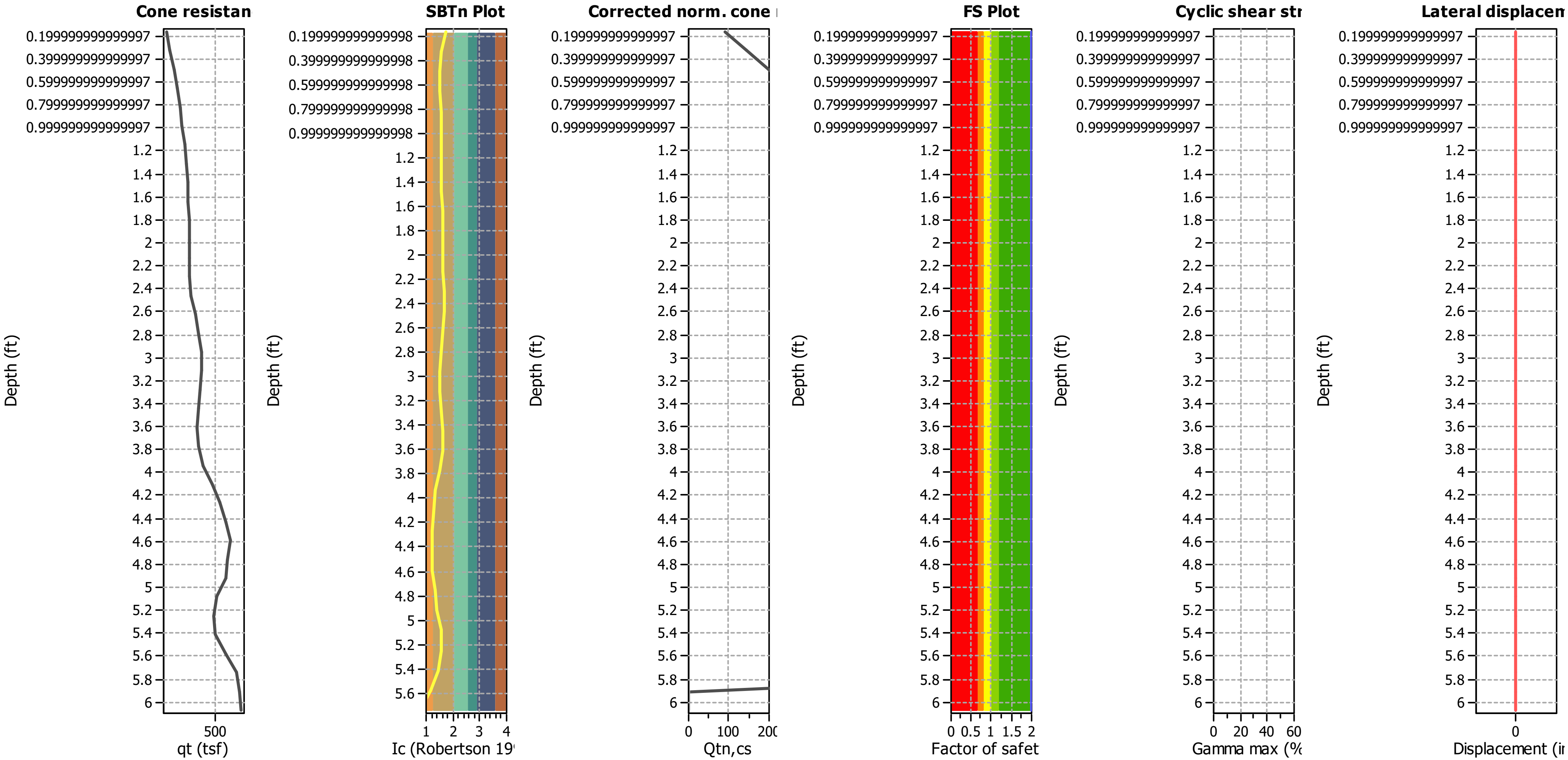
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

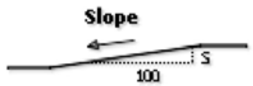


Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

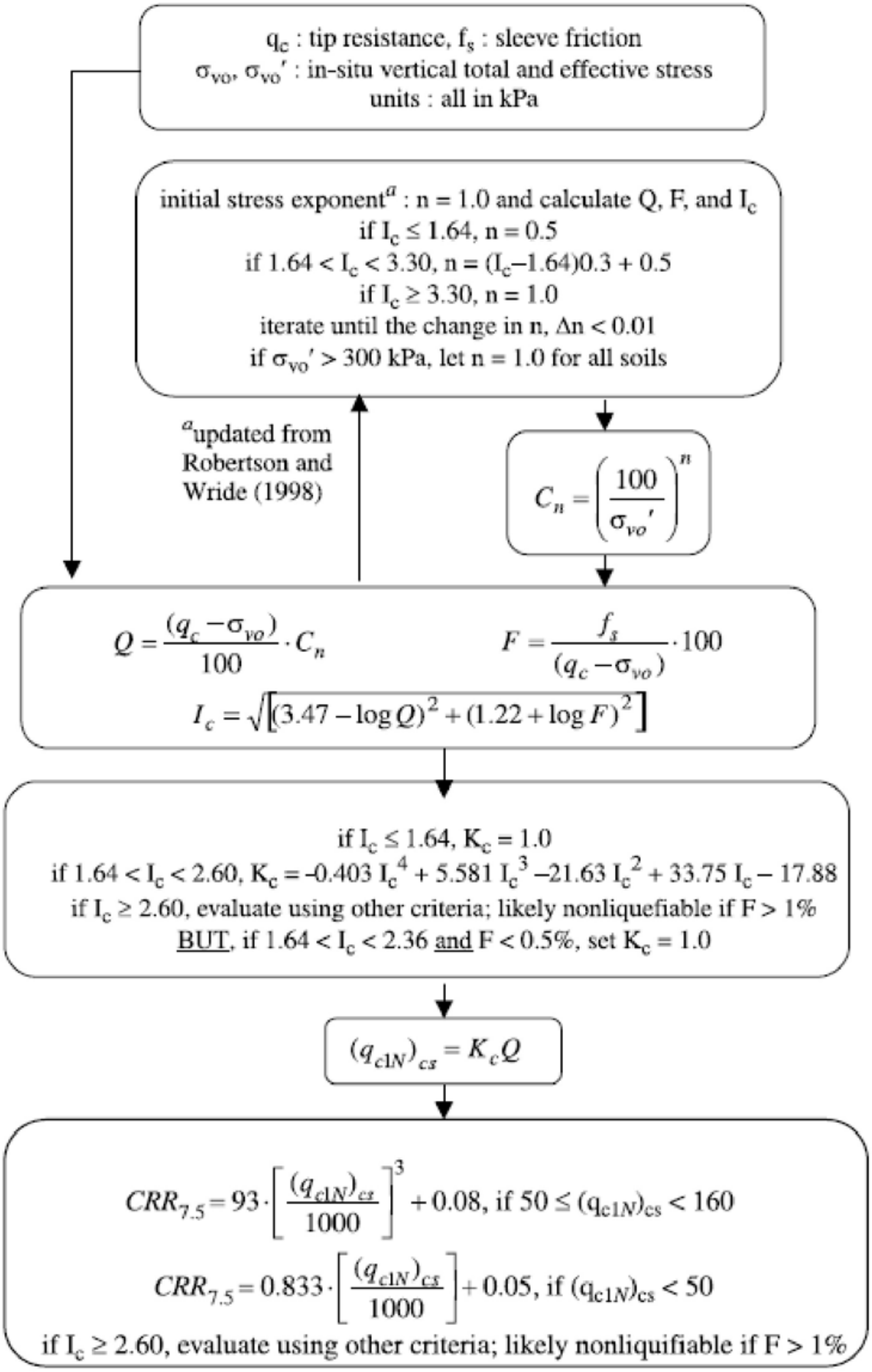
F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

Surface condition



Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

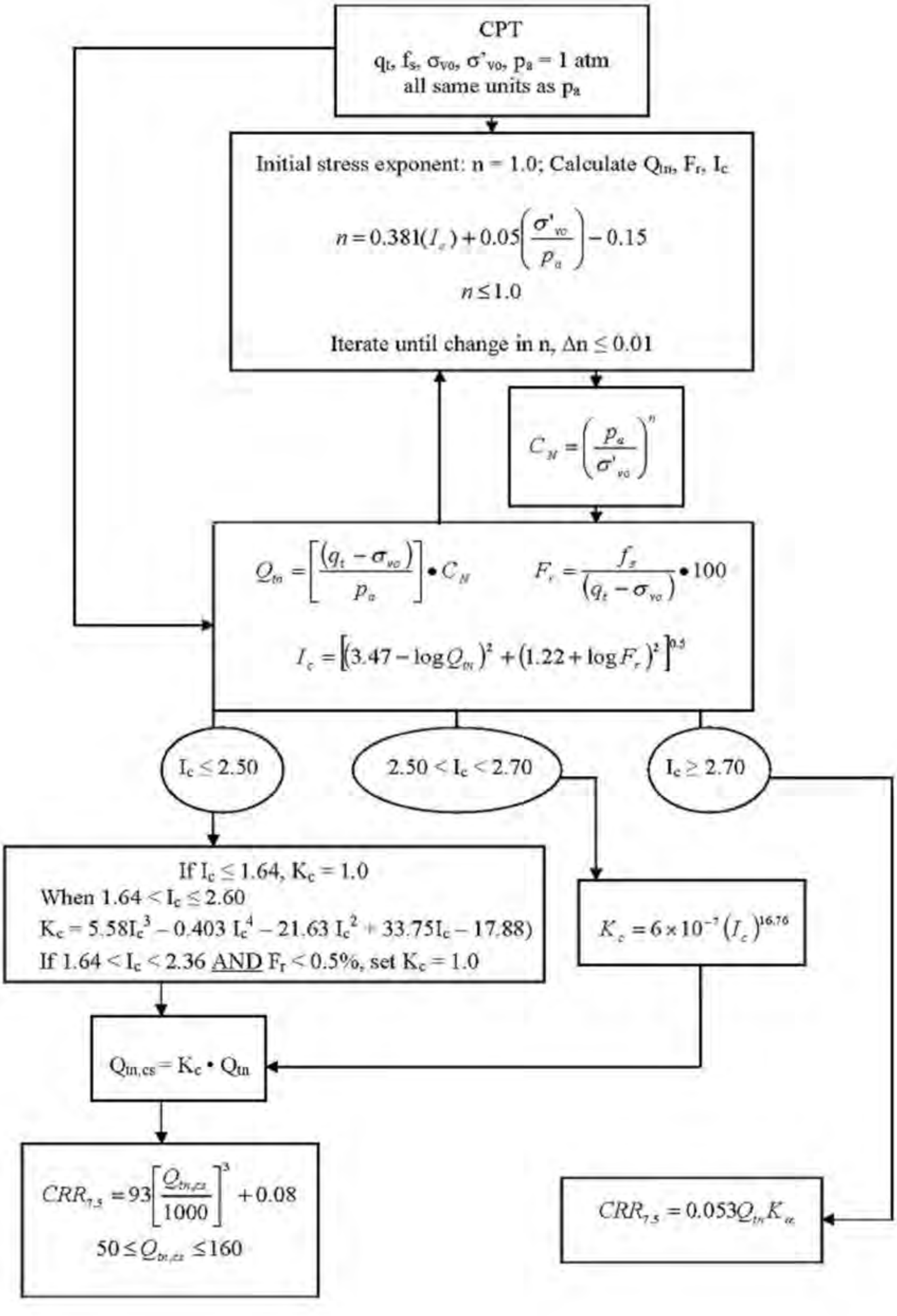
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

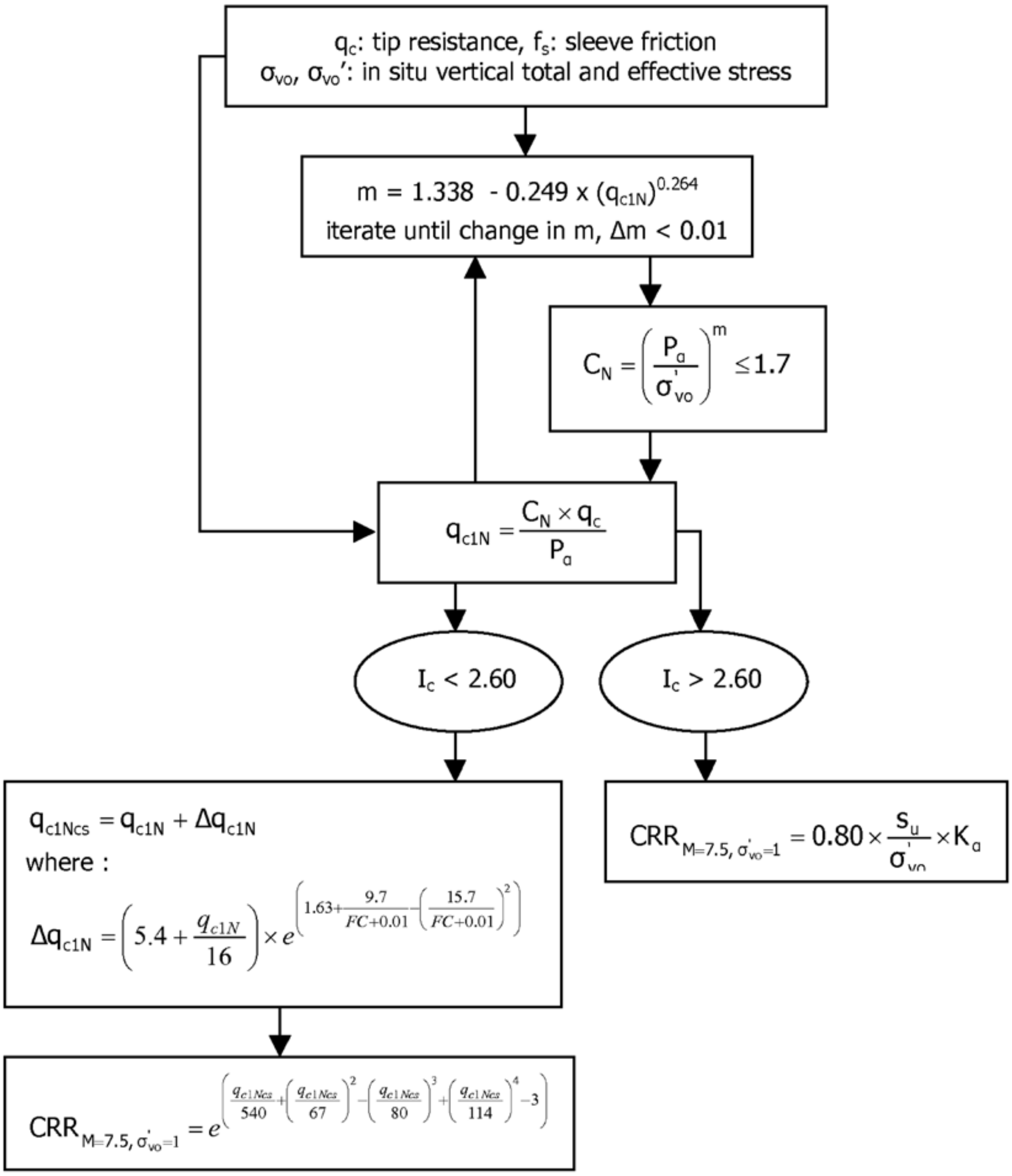
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)

CPT

q_t, f_s, I_c

↓

$I_c < I_c$ cut-off

↓

Initial estimate using raw tip measurements, friction ratio. Calculate $q_{t,1}$. Repeat until an acceptable convergence tolerance is achieved.

$$c = f_1 \cdot \left(\frac{R_f}{f_3}\right)^{f_2}$$

↓

$$C_q = \left(\frac{P_a}{\sigma'_v}\right)^c$$

↓

$$q_{t,1} = C_q \cdot q_t$$

(↑ back to the initial estimate until convergence)

↓

$$CRR = \exp\left[\frac{q_{t,1}^{1.045} + q_{t,1}\cdot(0.110\cdot R_f) + (0.001\cdot R_f) + c\cdot(1 + 0.850\cdot R_f) - 0.848\cdot\ln(M_w) - 0.002\cdot\ln(\sigma'_v) - 20.923 + 1.632\cdot\Phi^{-1}(P_L)}{7.177}\right]$$

Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65\frac{\sigma_v}{\sigma'_v}\frac{a_{\max}}{g} r_d \frac{1}{MSF}\frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z)+\beta(z)\cdot M\right]$$

$$\alpha(z) = -1.012 - 1.126\sin\left(\frac{z}{11.73}+5.133\right)$$

$$\beta(z) = 0.106 + 0.118\sin\left(\frac{z}{11.28}+5.142\right)$$

$$K_\sigma = 1 - C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right) \leq 1.1$$

$$C_\sigma = \frac{1}{37.3-8.27\left(q_{c1Ncs}\right)^{0.264}} \leq 0.3$$

$$MSF = 1+\left(MSF_{max}-1\right)\left(8.64\exp\left(\frac{-M}{4}\right)-1.325\right)$$

$$MSF_{max} = 1.09+\left(\frac{q_{c1Ncs}}{180}\right)^3 \leq 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113}+\left(\frac{q_{c1Ncs}}{1000}\right)^2-\left(\frac{q_{c1Ncs}}{140}\right)^3+\left(\frac{q_{c1Ncs}}{137}\right)^4-2.80\right)$$

$$q_{c1Ncs} = q_{c1N} + \Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9+\frac{q_{c1N}}{14.6}\right)\exp\left(1.63-\frac{9.7}{FC+2}-\left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_N \frac{q_c}{P_a}$$

$$C_N = \left(\frac{P_a}{\sigma'_v}\right)^m \leq 1.7$$

$$m = 1.338 - 0.249\left(q_{c1Ncs}\right)^{0.264} \quad \textit{with} \quad 0.264 \leq m \leq 0.782$$

$$FC = 80\left(I_C + C_{FC}\right) - 137 \quad \textit{with} \quad 0\% \leq FC \leq 100\%$$

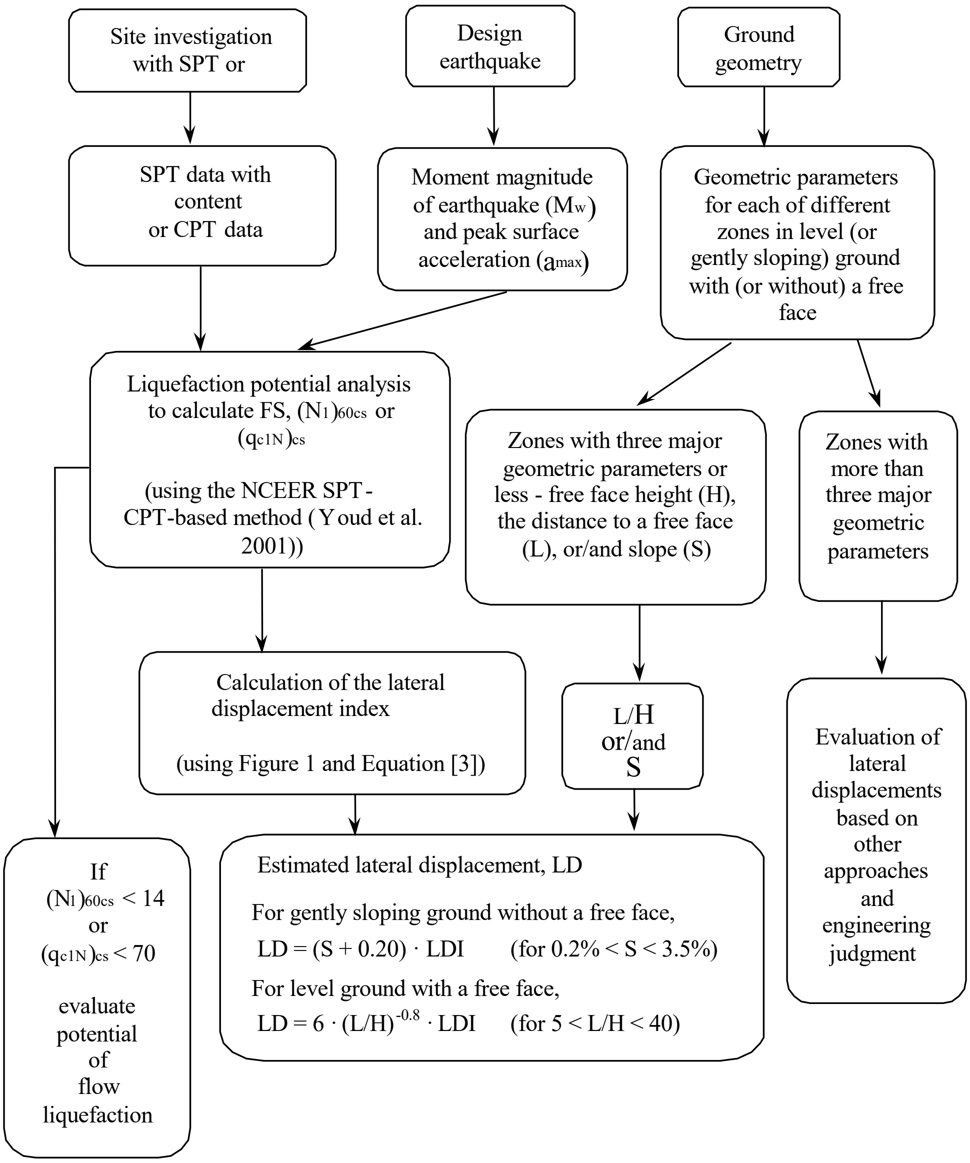
$$I_c = \left[\left(3.47-\log(Q)\right)^2+\left(1.22+\log(F)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c-\sigma_{vo}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vo}}\right)^n \quad \textit{with}\; 0.5 \leq n \leq 1.0 \; \textit{per Robertson \& Wride}\,(1998)$$

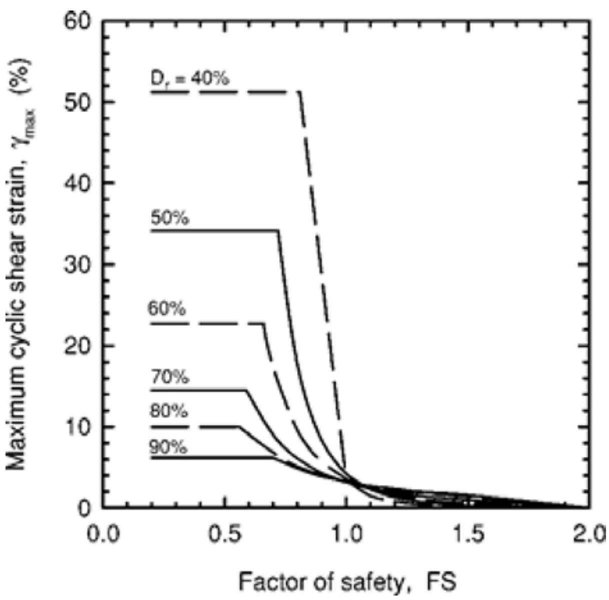
$$F = \left(\frac{f_s}{q_c-\sigma_{vo}}\right)\cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max} \, dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{a_{max}}{g} \cdot \sigma_{v0} \cdot r_d$$

$\downarrow$

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

$\downarrow$

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + a \cdot e^{bR}}{1 + a}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0} \text{ (Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$a = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

$\downarrow$

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

$\downarrow$

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

$\downarrow$

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

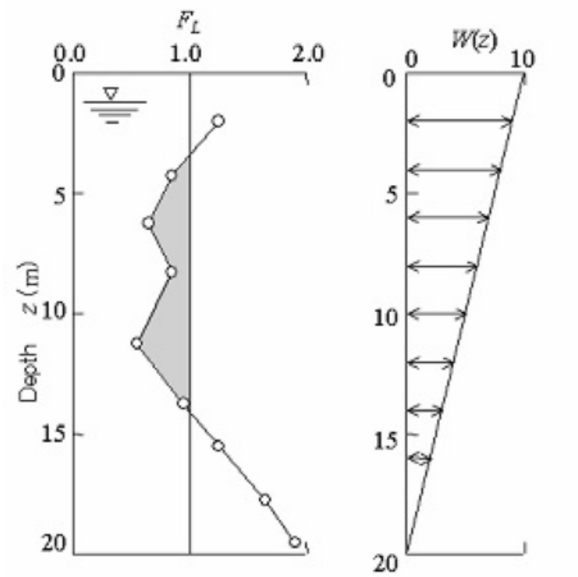
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$Ln(Ds) = c1 + c2 * LBS + 0.58 * Ln\left(Tanh\left(\frac{HL}{6}\right)\right) +$$
$$4.59 * Ln(Q) - 0.42 * Ln(Q)^2 - 0.02 * B +$$
$$0.84 * Ln(CAVdp) + 0.41 * Ln(Sa1) + \varepsilon$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for LBS ≤ 16, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0, W is a foundation-weighting factor wherein W = 0.0 for z less than Df, which is the embedment depth of the foundation, and W = 1.0 otherwise. The shear strain parameter (ε_shear) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

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Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

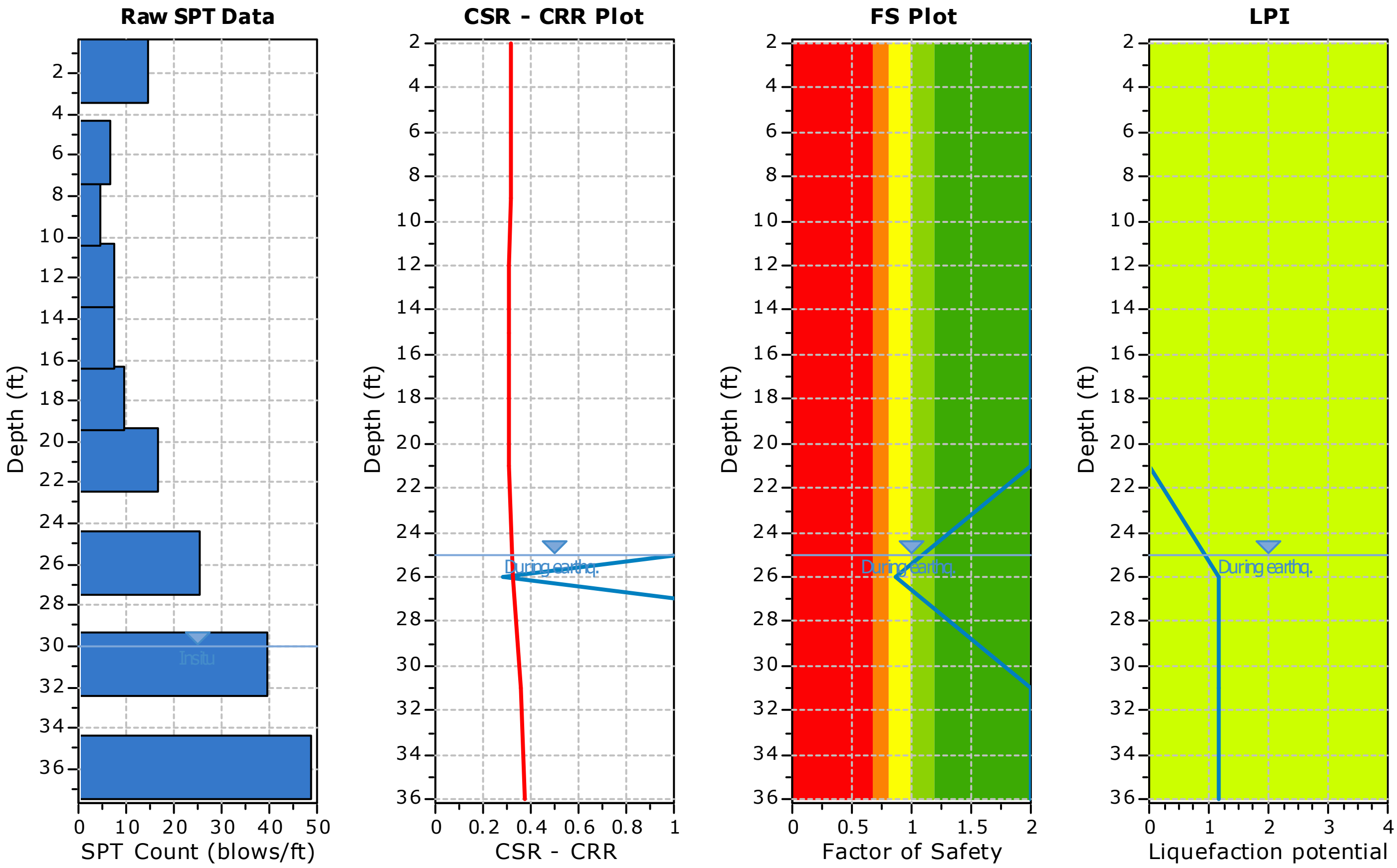
SPT BASED LIQUEFACTION ANALYSIS REPORT

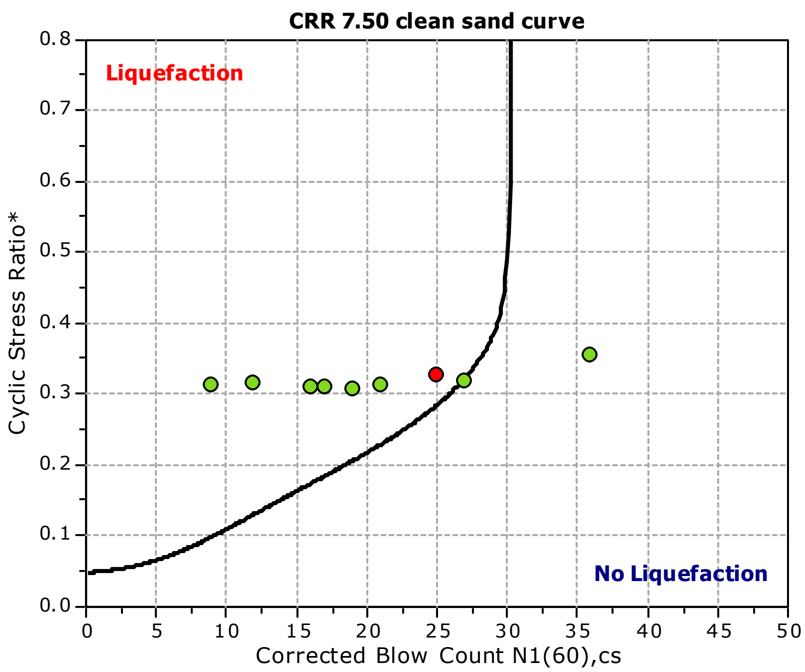
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-04**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	25.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

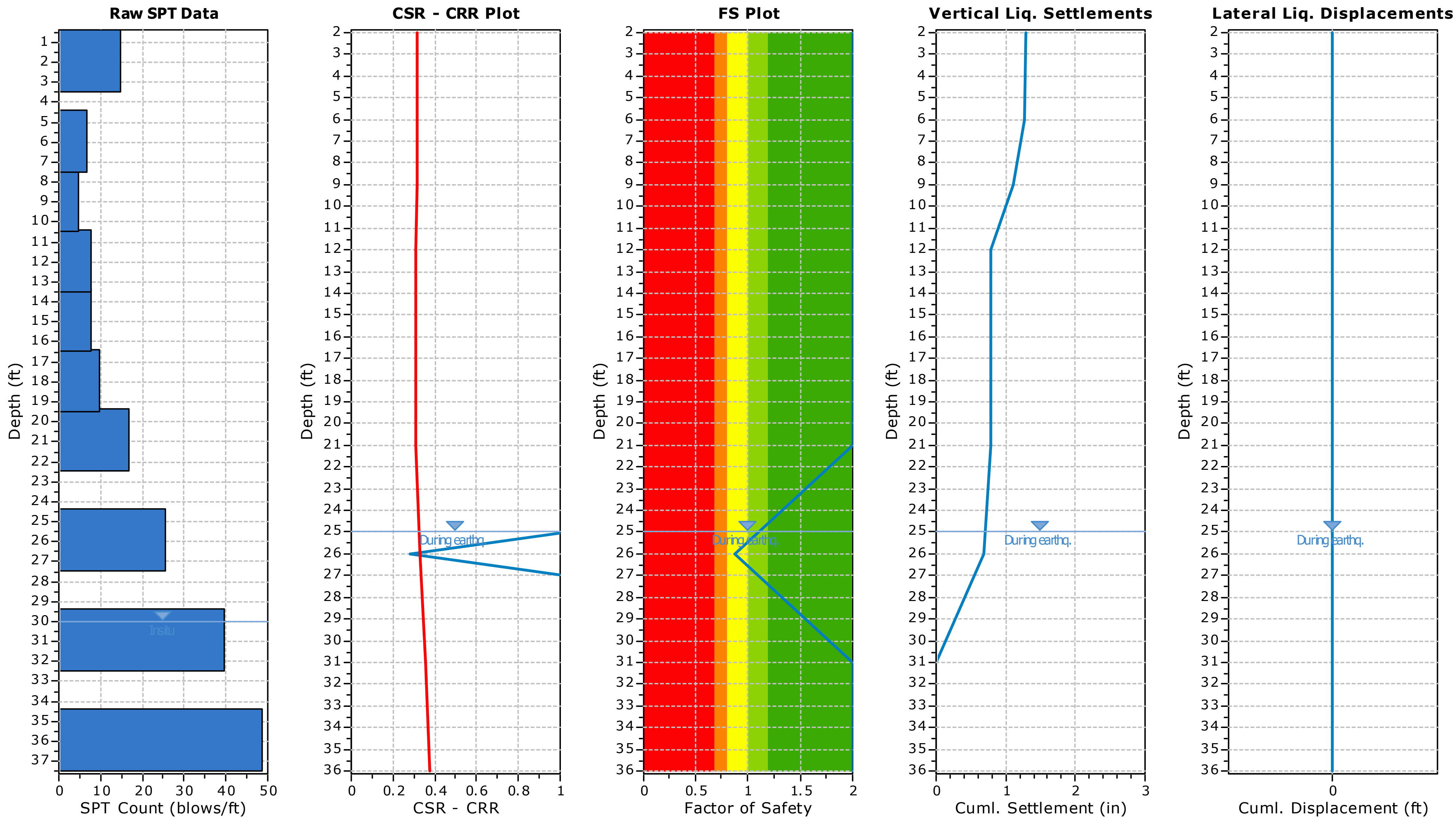




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	7	15.00	93.00	3.00	Yes
9.00	5	15.00	95.00	3.00	Yes
12.00	8	80.00	119.00	3.00	No
15.00	8	80.00	120.00	3.00	No
18.00	10	70.00	129.00	3.00	No
21.00	17	15.00	125.00	5.00	Yes
26.00	26	5.00	130.00	5.00	Yes
31.00	40	5.00	135.00	5.00	Yes
36.00	49	80.00	130.00	5.00	No

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	7	93.00	0.31	0.00	0.31	1.48	1.20	1.00	0.75	1.00	9	15.00	2.50	1.05	12	4.000
9.00	5	95.00	0.45	0.00	0.45	1.35	1.20	1.00	0.75	1.00	6	15.00	2.50	1.05	9	4.000
12.00	8	119.00	0.63	0.00	0.63	1.23	1.20	1.00	0.85	1.00	10	80.00	5.00	1.20	17	4.000
15.00	8	120.00	0.81	0.00	0.81	1.12	1.20	1.00	0.85	1.00	9	80.00	5.00	1.20	16	4.000
18.00	10	129.00	1.00	0.00	1.00	1.03	1.20	1.00	0.95	1.00	12	70.00	5.00	1.20	19	4.000
21.00	17	125.00	1.19	0.00	1.19	0.95	1.20	1.00	0.95	1.00	18	15.00	2.50	1.05	21	4.000
26.00	26	130.00	1.51	0.00	1.51	0.84	1.20	1.00	0.95	1.00	25	5.00	0.00	1.00	25	0.285
31.00	40	135.00	1.85	0.03	1.82	0.75	1.20	1.00	1.00	1.00	36	5.00	0.00	1.00	36	4.000
36.00	49	130.00	2.18	0.19	1.99	0.71	1.20	1.00	1.00	1.00	42	80.00	5.00	1.20	55	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	93.00	0.31	0.00	0.31	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
9.00	95.00	0.45	0.00	0.45	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000
12.00	119.00	0.63	0.00	0.63	0.97	1.00	0.412	1.32	0.311	1.00	0.311	2.000
15.00	120.00	0.81	0.00	0.81	0.97	1.00	0.409	1.32	0.309	1.00	0.309	2.000
18.00	129.00	1.00	0.00	1.00	0.96	1.00	0.406	1.32	0.307	1.00	0.307	2.000
21.00	125.00	1.19	0.00	1.19	0.95	1.00	0.403	1.32	0.304	0.98	0.312	2.000
26.00	130.00	1.51	0.03	1.48	0.94	1.00	0.405	1.32	0.306	0.93	0.327	0.872
31.00	135.00	1.85	0.19	1.66	0.92	1.00	0.430	1.32	0.325	0.91	0.356	2.000
36.00	130.00	2.18	0.34	1.83	0.88	1.00	0.443	1.32	0.335	0.90	0.374	2.000

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
12.00	2.000	0.00	8.17	3.00	0.00
15.00	2.000	0.00	7.71	3.00	0.00
18.00	2.000	0.00	7.26	3.00	0.00
21.00	2.000	0.00	6.80	3.00	0.00
26.00	0.872	0.13	6.04	5.00	1.18
31.00	2.000	0.00	5.28	5.00	0.00
36.00	2.000	0.00	4.51	5.00	0.00

Overall potential I_L : 1.18

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	9	0.13	0.21	463.38	0.14	13024.08	0.00	0.00	8.77	0.21	3.00	0.150
9.00	6	0.19	0.30	509.69	0.14	10354.34	0.00	0.01	8.77	0.47	3.00	0.338
12.00	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
15.00	9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
18.00	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
21.00	18	0.48	0.80	1100.25	0.17	5771.52	0.00	0.00	8.77	0.09	5.00	0.102

Cumulative settlemetns: 0.620

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
26.00	0.00	5.00	1.13	5.00	0.676
31.00	0.00	5.00	0.00	5.00	0.000
36.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.676

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	9	42.00	0.00	3.00	0.000	0.00
9.00	6	34.29	0.00	3.00	0.000	0.00
12.00	10	44.27	0.00	3.00	0.000	0.00
15.00	9	42.00	0.00	3.00	0.000	0.00
18.00	12	48.50	0.00	3.00	0.000	0.00
21.00	18	59.40	0.00	5.00	0.000	0.00
26.00	25	70.00	4.76	5.00	0.000	0.00
31.00	36	84.00	0.00	5.00	0.000	0.00
36.00	42	90.73	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

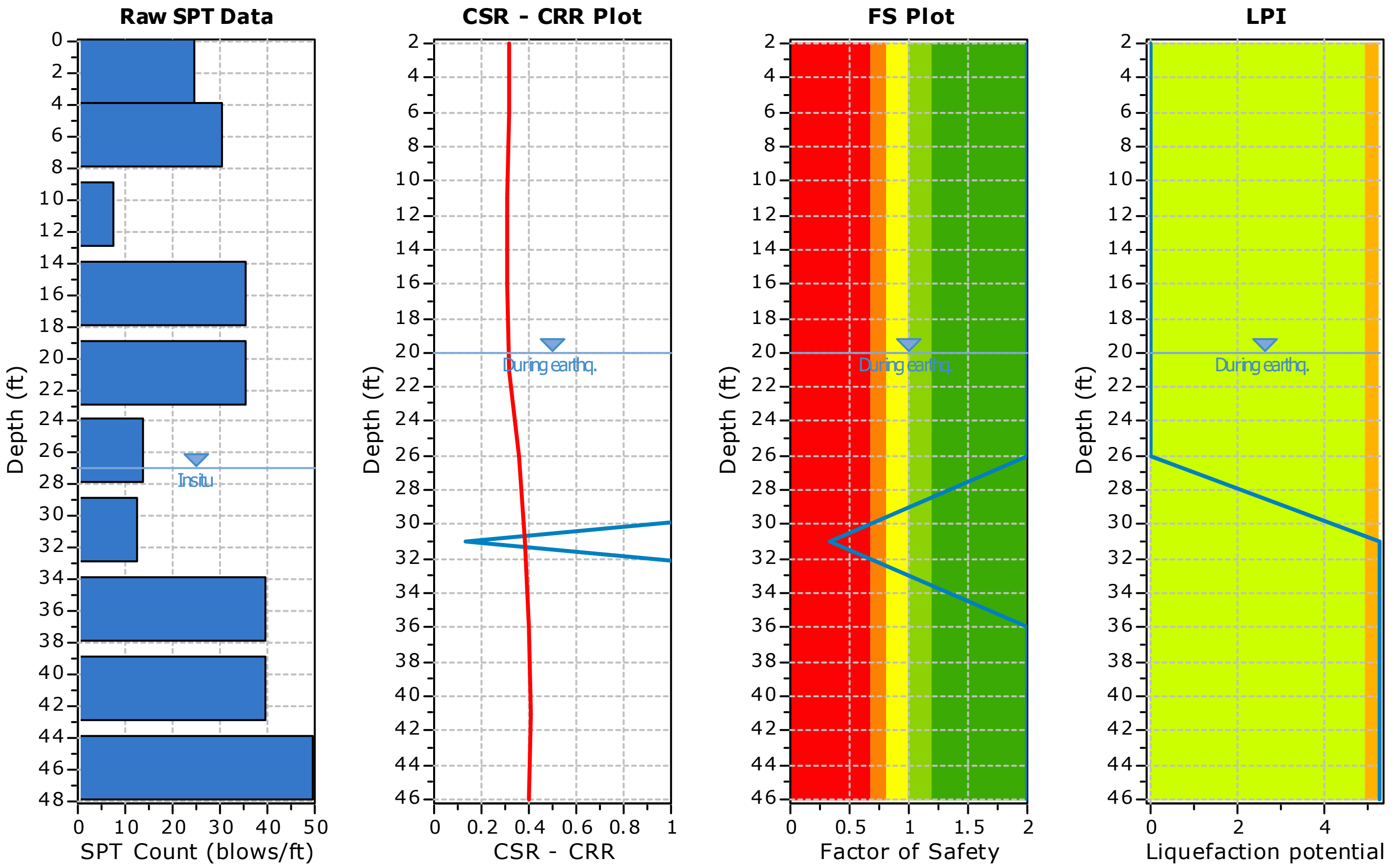
SPT BASED LIQUEFACTION ANALYSIS REPORT

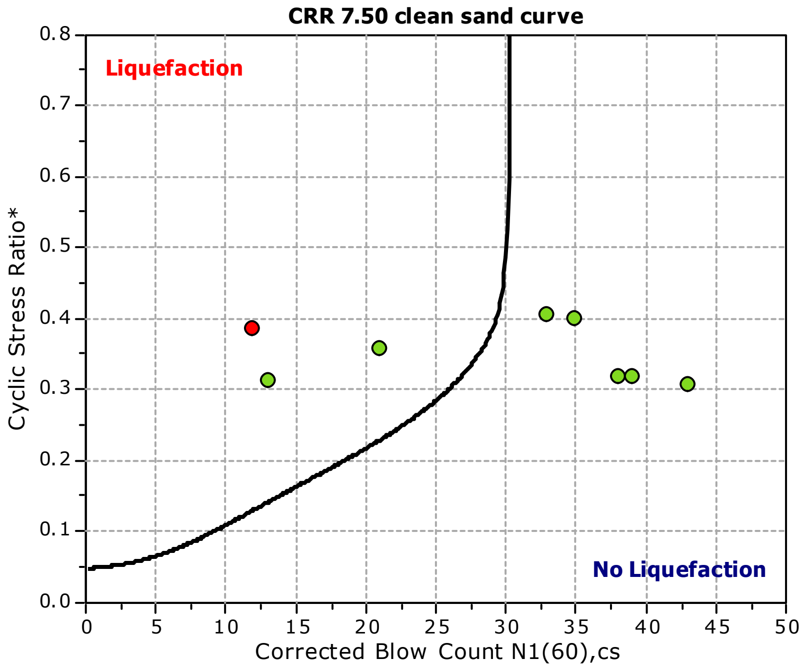
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-14**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	27.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





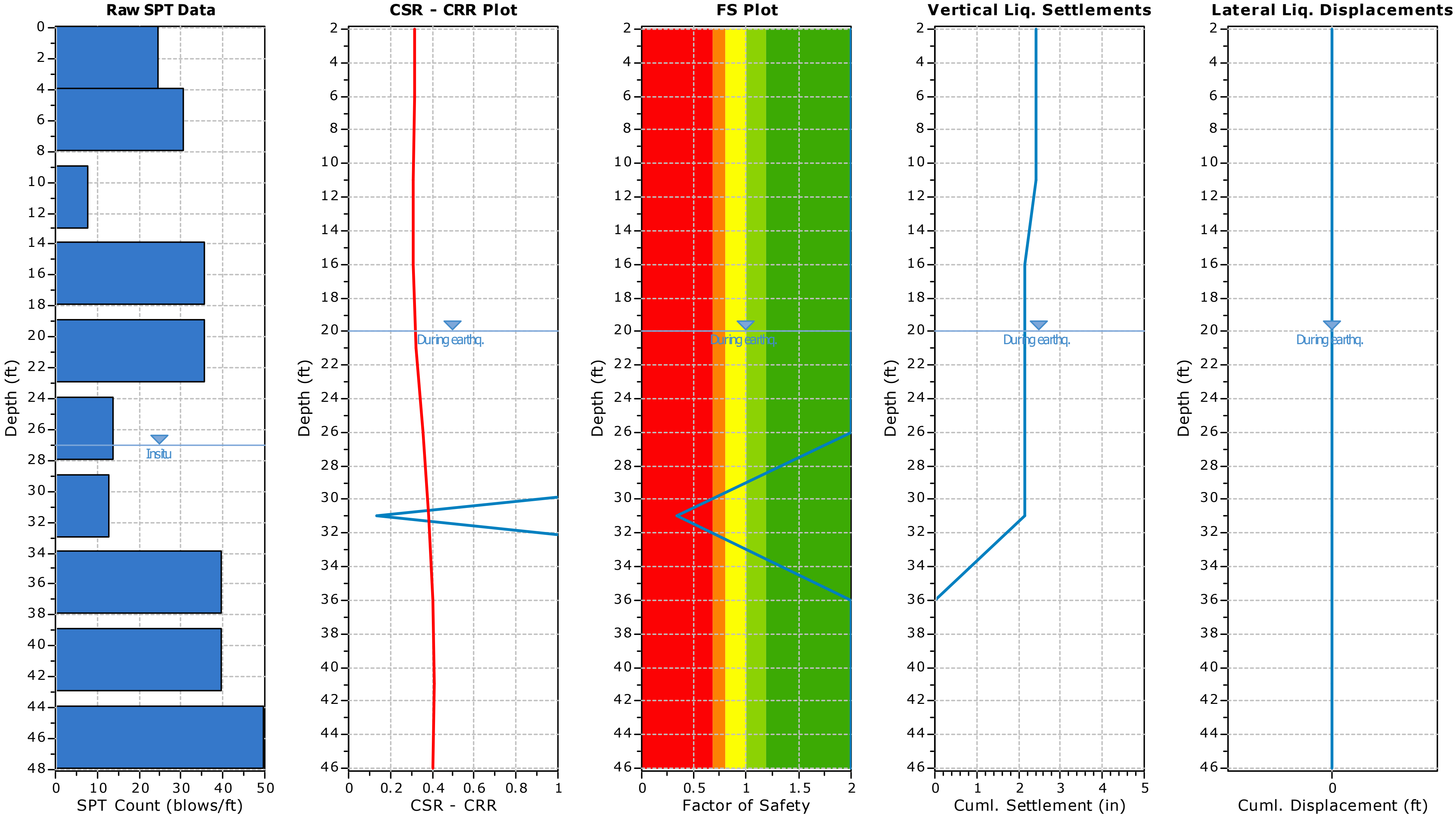
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	5.00	125.00	5.00	No
6.00	31	35.00	134.00	5.00	Yes
11.00	8	15.00	100.00	5.00	Yes
16.00	36	15.00	111.00	5.00	Yes
21.00	36	5.00	114.00	5.00	Yes
26.00	14	80.00	127.00	5.00	No
31.00	13	5.00	120.00	5.00	Yes
36.00	40	5.00	135.00	5.00	Yes
41.00	40	5.00	137.00	4.00	Yes
46.00	50	75.00	130.00	6.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	5.00	0.00	1.00	38	4.000
6.00	31	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	39	35.00	5.00	1.20	52	4.000
11.00	8	100.00	0.64	0.00	0.64	1.22	1.20	1.00	0.85	1.00	10	15.00	2.50	1.05	13	4.000
16.00	36	111.00	0.92	0.00	0.92	1.06	1.20	1.00	0.85	1.00	39	15.00	2.50	1.05	43	4.000
21.00	36	114.00	1.21	0.00	1.21	0.94	1.20	1.00	0.95	1.00	39	5.00	0.00	1.00	39	4.000
26.00	14	127.00	1.52	0.00	1.52	0.83	1.20	1.00	0.95	1.00	13	80.00	5.00	1.20	21	4.000
31.00	13	120.00	1.82	0.12	1.70	0.78	1.20	1.00	1.00	1.00	12	5.00	0.00	1.00	12	0.131
36.00	40	135.00	2.16	0.28	1.88	0.74	1.20	1.00	1.00	1.00	35	5.00	0.00	1.00	35	4.000
41.00	40	137.00	2.50	0.44	2.07	0.70	1.20	1.00	1.00	1.00	33	5.00	0.00	1.00	33	4.000
46.00	50	130.00	2.83	0.59	2.24	0.66	1.20	1.00	1.00	1.00	40	75.00	5.00	1.20	53	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
11.00	100.00	0.64	0.00	0.64	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000
16.00	111.00	0.92	0.00	0.92	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000
21.00	114.00	1.21	0.03	1.17	0.95	1.00	0.414	1.32	0.313	0.98	0.319	2.000
26.00	127.00	1.52	0.19	1.34	0.94	1.00	0.452	1.32	0.341	0.95	0.358	2.000
31.00	120.00	1.82	0.34	1.48	0.92	1.00	0.476	1.32	0.360	0.94	0.385	0.341
36.00	135.00	2.16	0.50	1.66	0.88	1.00	0.485	1.32	0.367	0.91	0.401	2.000
41.00	137.00	2.50	0.66	1.85	0.84	1.00	0.482	1.32	0.364	0.89	0.407	2.000
46.00	130.00	2.83	0.81	2.02	0.79	1.00	0.470	1.32	0.355	0.88	0.404	2.000

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction
*** User FS:	1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
11.00	2.000	0.00	8.32	5.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	2.000	0.00	6.04	5.00	0.00
31.00	0.341	0.66	5.28	5.00	5.30
36.00	2.000	0.00	4.51	5.00	0.00
41.00	2.000	0.00	3.75	5.00	0.00
46.00	2.000	0.00	2.99	5.00	0.00

Overall potential I_L : 5.30

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000
6.00	39	0.16	0.26	856.14	0.14	11208.42	0.00	0.00	8.77	0.01	5.00	0.011
11.00	10	0.27	0.43	689.87	0.15	8341.68	0.00	0.00	8.77	0.21	5.00	0.248
16.00	39	0.38	0.62	1229.83	0.16	6726.14	0.00	0.00	8.77	0.02	5.00	0.022

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.282

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	0.00	5.00	0.000
31.00	0.00	5.00	3.55	5.00	2.131
36.00	0.00	5.00	0.00	5.00	0.000
41.00	0.00	5.00	0.00	4.00	0.000
46.00	0.00	5.00	0.00	6.00	0.000

Cumulative settlements: 2.131

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	39	87.43	0.00	5.00	0.000	0.00
11.00	10	44.27	0.00	5.00	0.000	0.00
16.00	39	87.43	0.00	5.00	0.000	0.00
21.00	39	87.43	0.00	5.00	0.000	0.00
26.00	13	50.48	0.00	5.00	0.000	0.00
31.00	12	48.50	34.10	5.00	0.000	0.00
36.00	35	82.83	0.00	5.00	0.000	0.00
41.00	33	80.42	0.00	4.00	0.000	0.00
46.00	40	88.54	0.00	6.00	0.000	0.00

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

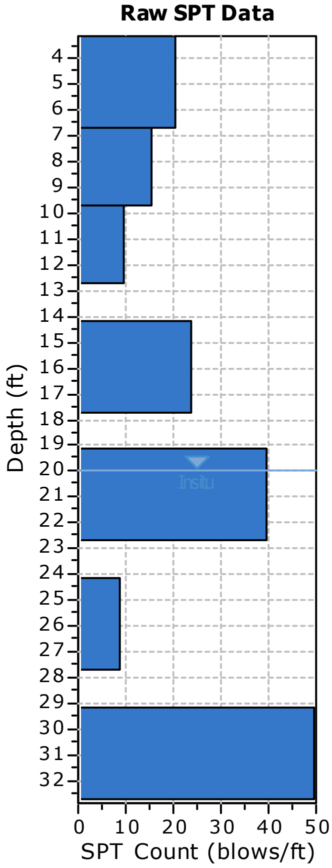
SPT BASED LIQUEFACTION ANALYSIS REPORT

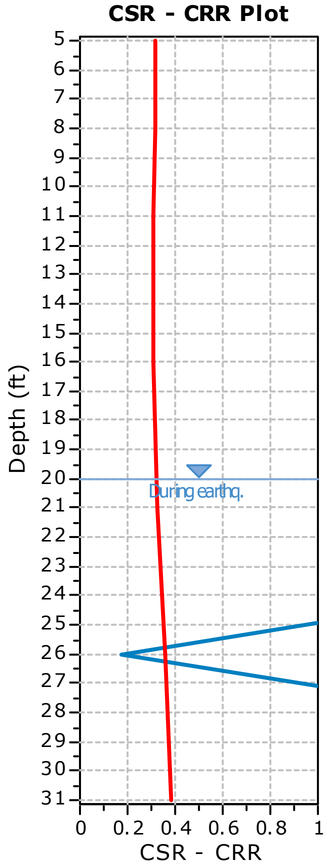
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-19**

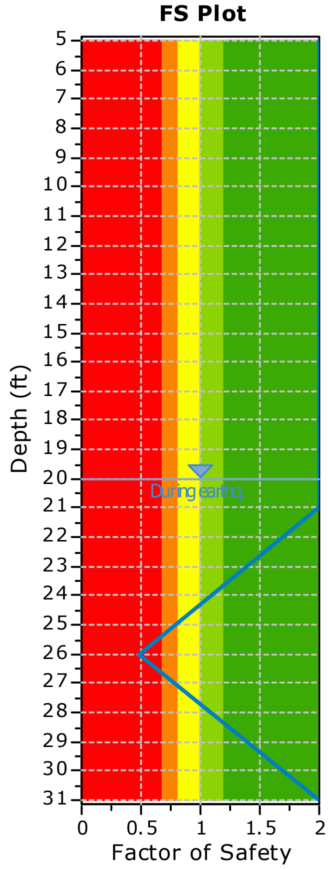
Location : Orange County, California

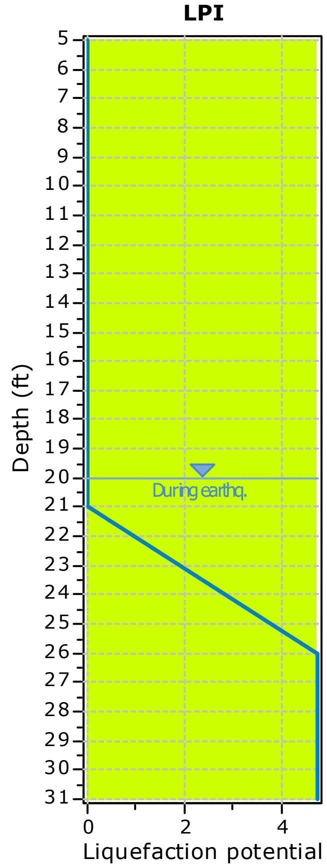
:: Input parameters and analysis properties ::

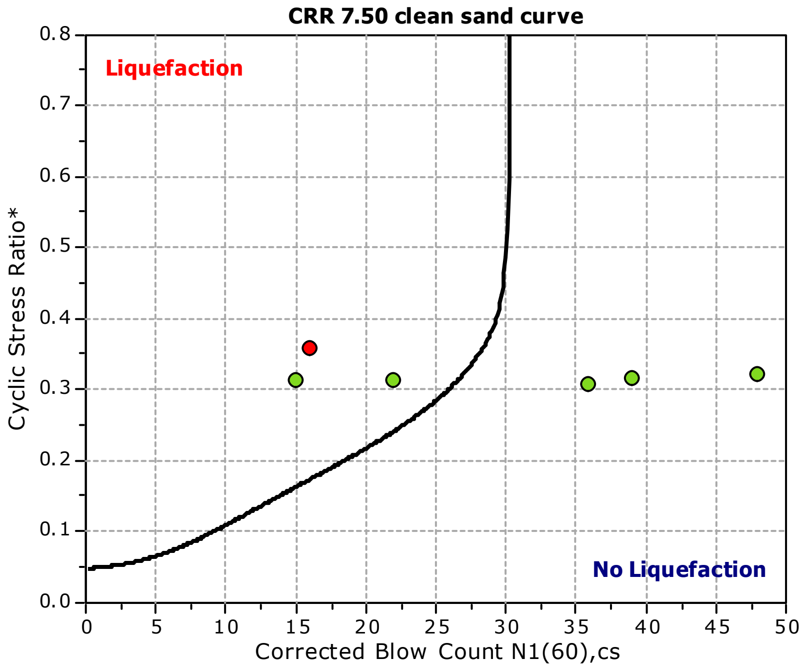
Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		











F.S. color scheme

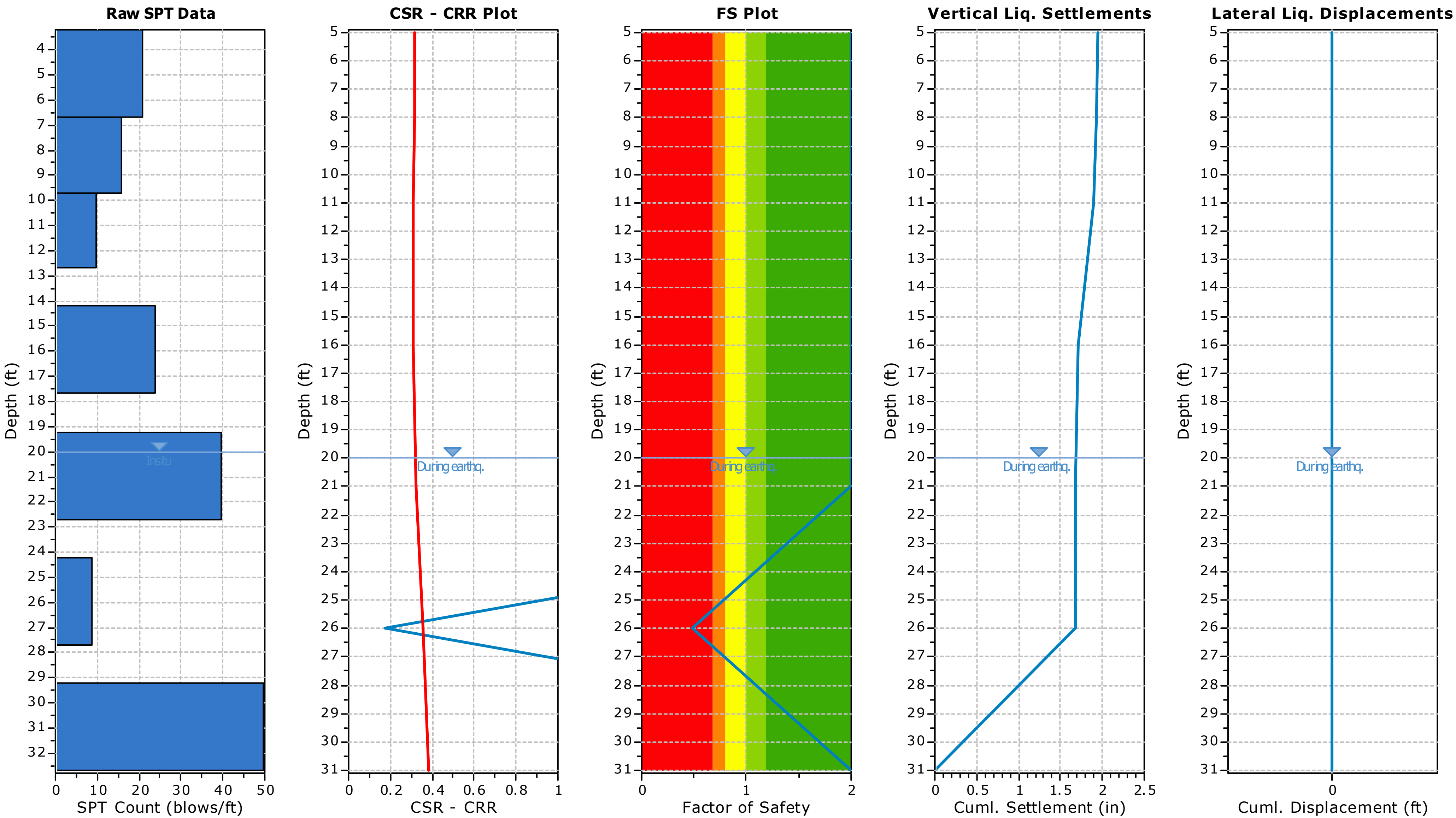
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

This software is registered to: Leighton Group, Inc

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
5.00	21	35.00	118.00	5.00	Yes
8.00	16	15.00	118.00	3.00	Yes
11.00	10	15.00	109.00	5.00	Yes
16.00	24	35.00	110.00	5.00	Yes
21.00	40	15.00	138.00	5.00	Yes
26.00	9	35.00	120.00	5.00	Yes
31.00	50	65.00	130.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
5.00	21	118.00	0.30	0.00	0.30	1.49	1.20	1.00	0.75	1.00	28	35.00	5.00	1.20	39	4.000
8.00	16	118.00	0.47	0.00	0.47	1.34	1.20	1.00	0.75	1.00	19	15.00	2.50	1.05	22	4.000
11.00	10	109.00	0.64	0.00	0.64	1.22	1.20	1.00	0.85	1.00	12	15.00	2.50	1.05	15	4.000
16.00	24	110.00	0.91	0.00	0.91	1.07	1.20	1.00	0.85	1.00	26	35.00	5.00	1.20	36	4.000
21.00	40	138.00	1.26	0.03	1.22	0.93	1.20	1.00	0.95	1.00	43	15.00	2.50	1.05	48	4.000
26.00	9	120.00	1.56	0.19	1.37	0.88	1.20	1.00	0.95	1.00	9	35.00	5.00	1.20	16	0.174
31.00	50	130.00	1.88	0.34	1.54	0.83	1.20	1.00	1.00	1.00	50	65.00	5.00	1.20	65	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
5.00	118.00	0.30	0.00	0.30	0.99	1.00	0.418	1.32	0.316	1.00	0.316	2.000
8.00	118.00	0.47	0.00	0.47	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000
11.00	109.00	0.64	0.00	0.64	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000
16.00	110.00	0.91	0.00	0.91	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000
21.00	138.00	1.26	0.03	1.22	0.95	1.00	0.413	1.32	0.312	0.97	0.321	2.000
26.00	120.00	1.56	0.19	1.37	0.94	1.00	0.451	1.32	0.340	0.95	0.358	0.486
31.00	130.00	1.88	0.34	1.54	0.92	1.00	0.473	1.32	0.357	0.93	0.385	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio (adjusted for improvement)
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
5.00	2.000	0.00	9.24	3.00	0.00
8.00	2.000	0.00	8.78	3.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.486	0.51	6.04	5.00	4.73
31.00	2.000	0.00	5.28	5.00	0.00

Overall potential I_L : 4.73

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
5.00	28	0.12	0.20	673.92	0.14	13313.33	0.00	0.00	8.77	0.01	5.00	0.017
8.00	19	0.20	0.32	704.35	0.14	10041.87	0.00	0.00	8.77	0.06	3.00	0.041
11.00	12	0.26	0.43	719.34	0.15	8400.61	0.00	0.00	8.77	0.15	5.00	0.177
16.00	26	0.37	0.61	1152.80	0.16	6770.36	0.00	0.00	8.77	0.03	5.00	0.031

Cumulative settlemetns: 0.266

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	2.81	5.00	1.684
31.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.684

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
5.00	28	74.08	0.00	5.00	0.000	0.00
8.00	19	61.02	0.00	3.00	0.000	0.00
11.00	12	48.50	0.00	5.00	0.000	0.00
16.00	26	71.39	0.00	5.00	0.000	0.00
21.00	43	100.00	0.00	5.00	0.000	0.00
26.00	9	42.00	51.20	5.00	0.000	0.00
31.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

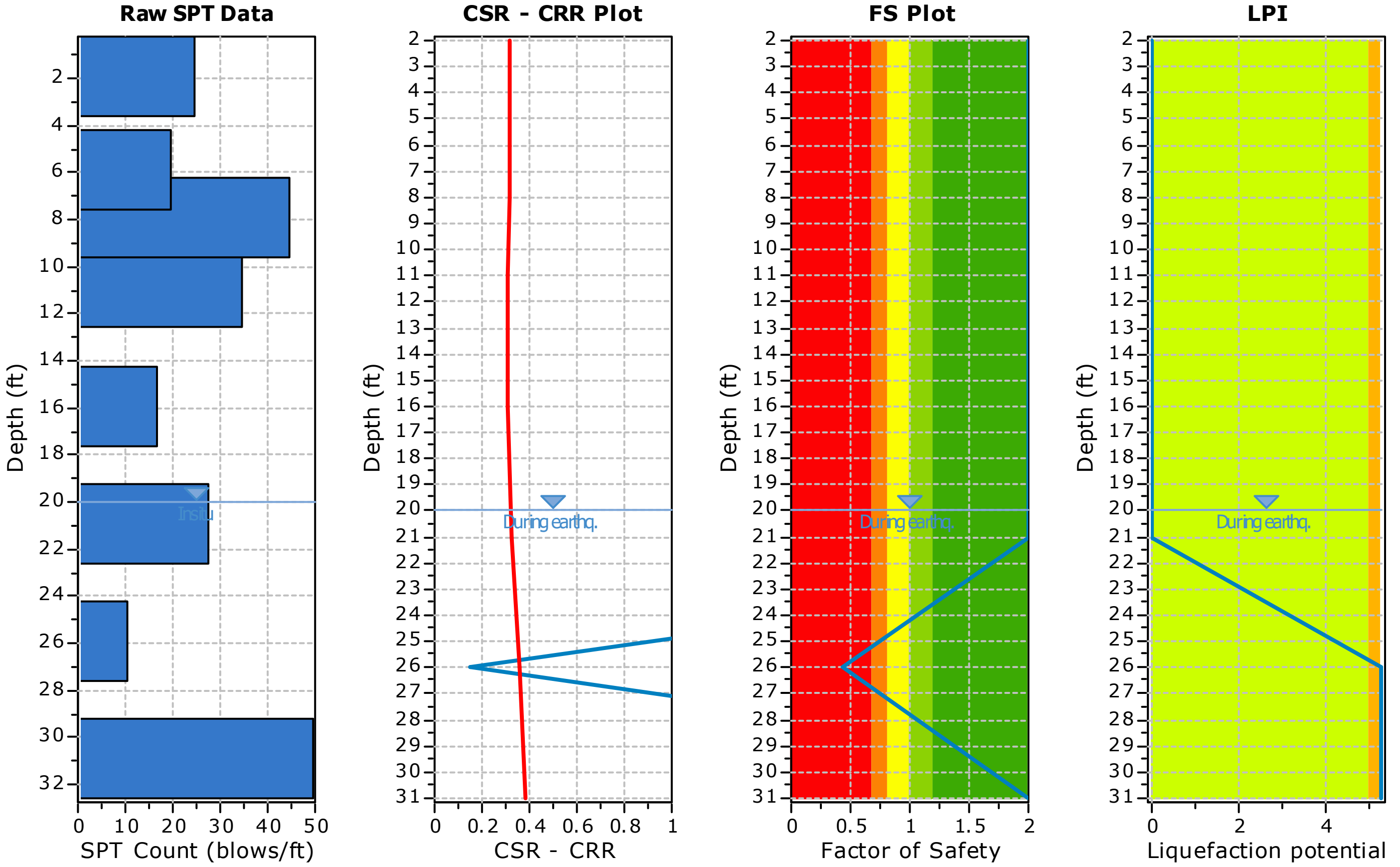
SPT BASED LIQUEFACTION ANALYSIS REPORT

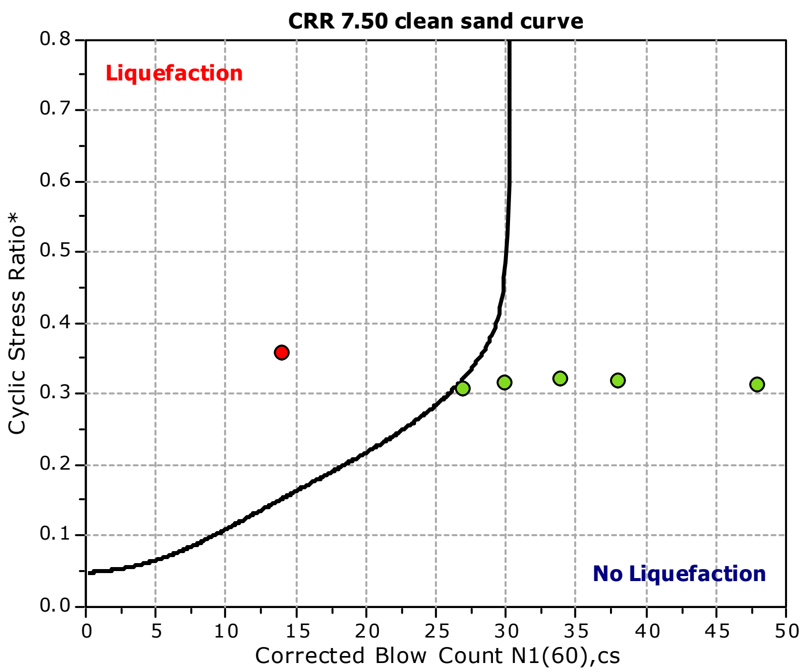
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-23**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

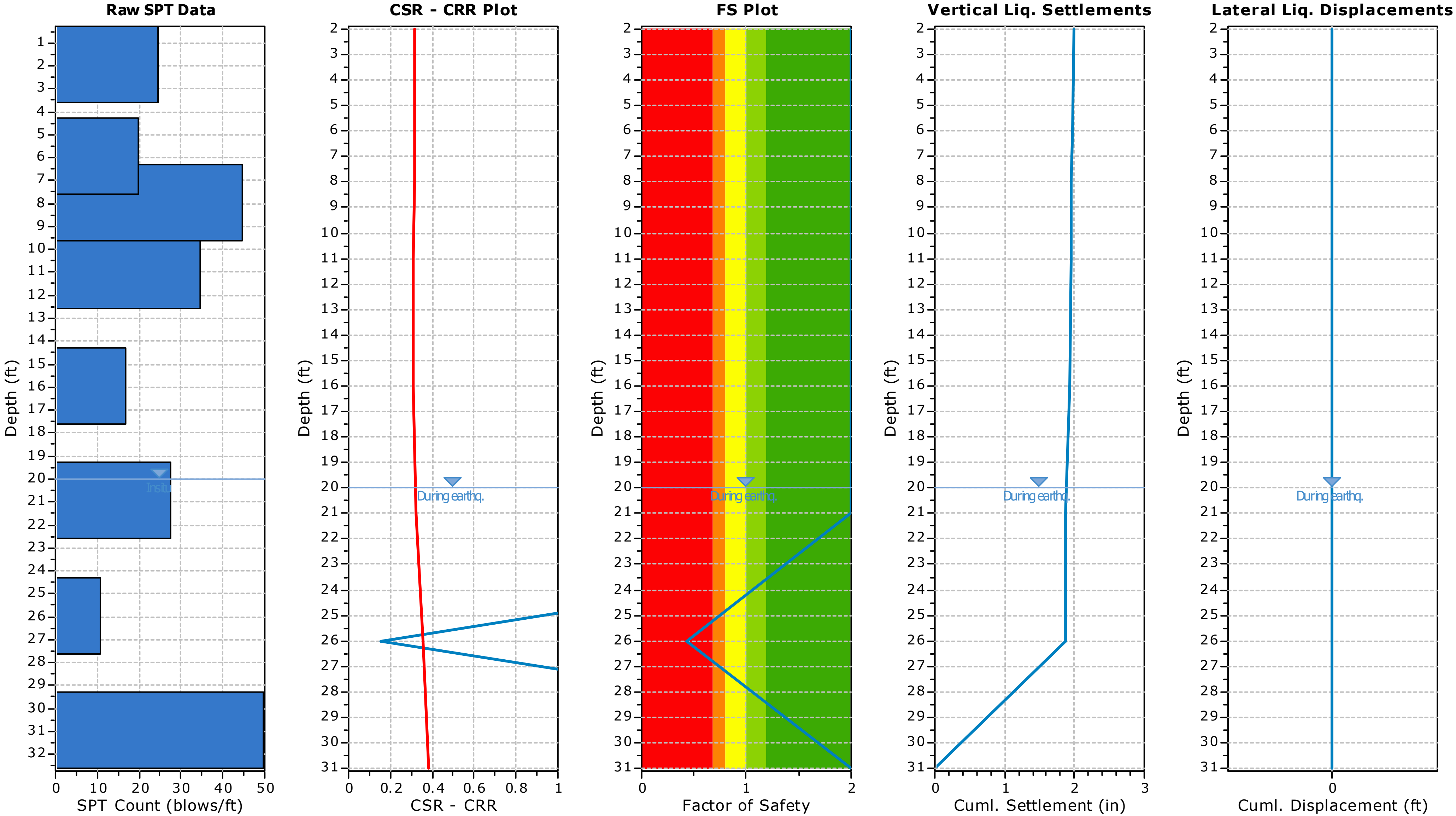




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	5.00	125.00	5.00	Yes
6.00	20	15.00	109.00	2.00	Yes
8.00	45	15.00	125.00	3.00	Yes
11.00	35	15.00	130.00	5.00	Yes
16.00	17	65.00	125.00	5.00	Yes
21.00	28	15.00	110.00	5.00	Yes
26.00	11	15.00	120.00	5.00	Yes
31.00	50	85.00	135.00	5.00	Yes

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	5.00	0.00	1.00	38	4.000
6.00	20	109.00	0.34	0.00	0.34	1.44	1.20	1.00	0.75	1.00	26	15.00	2.50	1.05	30	4.000
8.00	45	125.00	0.47	0.00	0.47	1.34	1.20	1.00	0.75	1.00	54	15.00	2.50	1.05	59	4.000
11.00	35	130.00	0.66	0.00	0.66	1.20	1.20	1.00	0.85	1.00	43	15.00	2.50	1.05	48	4.000
16.00	17	125.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	18	65.00	5.00	1.20	27	4.000
21.00	28	110.00	1.25	0.03	1.22	0.94	1.20	1.00	0.95	1.00	30	15.00	2.50	1.05	34	4.000
26.00	11	120.00	1.55	0.19	1.36	0.88	1.20	1.00	0.95	1.00	11	15.00	2.50	1.05	14	0.153
31.00	50	135.00	1.89	0.34	1.54	0.83	1.20	1.00	1.00	1.00	50	85.00	5.00	1.20	65	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	109.00	0.34	0.00	0.34	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●
8.00	125.00	0.47	0.00	0.47	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000	●
11.00	130.00	0.66	0.00	0.66	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
16.00	125.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
21.00	110.00	1.25	0.03	1.22	0.95	1.00	0.413	1.32	0.312	0.97	0.321	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
26.00	120.00	1.55	0.19	1.36	0.94	1.00	0.451	1.32	0.340	0.95	0.358	0.426	●
31.00	135.00	1.89	0.34	1.54	0.92	1.00	0.473	1.32	0.357	0.93	0.385	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.426	0.57	6.04	5.00	5.28
31.00	2.000	0.00	5.28	5.00	0.00

Overall potential I_L : 5.28

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.05	0.08	434.91	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.014
6.00	26	0.14	0.23	665.83	0.14	12161.96	0.00	0.00	8.77	0.03	2.00	0.013
8.00	54	0.19	0.31	974.43	0.14	10093.28	0.00	0.00	8.77	0.01	3.00	0.006
11.00	43	0.27	0.44	1082.72	0.15	8189.77	0.00	0.00	8.77	0.01	5.00	0.016
16.00	18	0.40	0.65	1084.13	0.16	6495.96	0.00	0.00	8.77	0.05	5.00	0.057

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.105

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	3.13	5.00	1.878
31.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.878

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	26	71.39	0.00	2.00	0.000	0.00
8.00	54	100.00	0.00	3.00	0.000	0.00
11.00	43	100.00	0.00	5.00	0.000	0.00
16.00	18	59.40	0.00	5.00	0.000	0.00
21.00	30	76.68	0.00	5.00	0.000	0.00
26.00	11	46.43	34.10	5.00	0.000	0.00
31.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

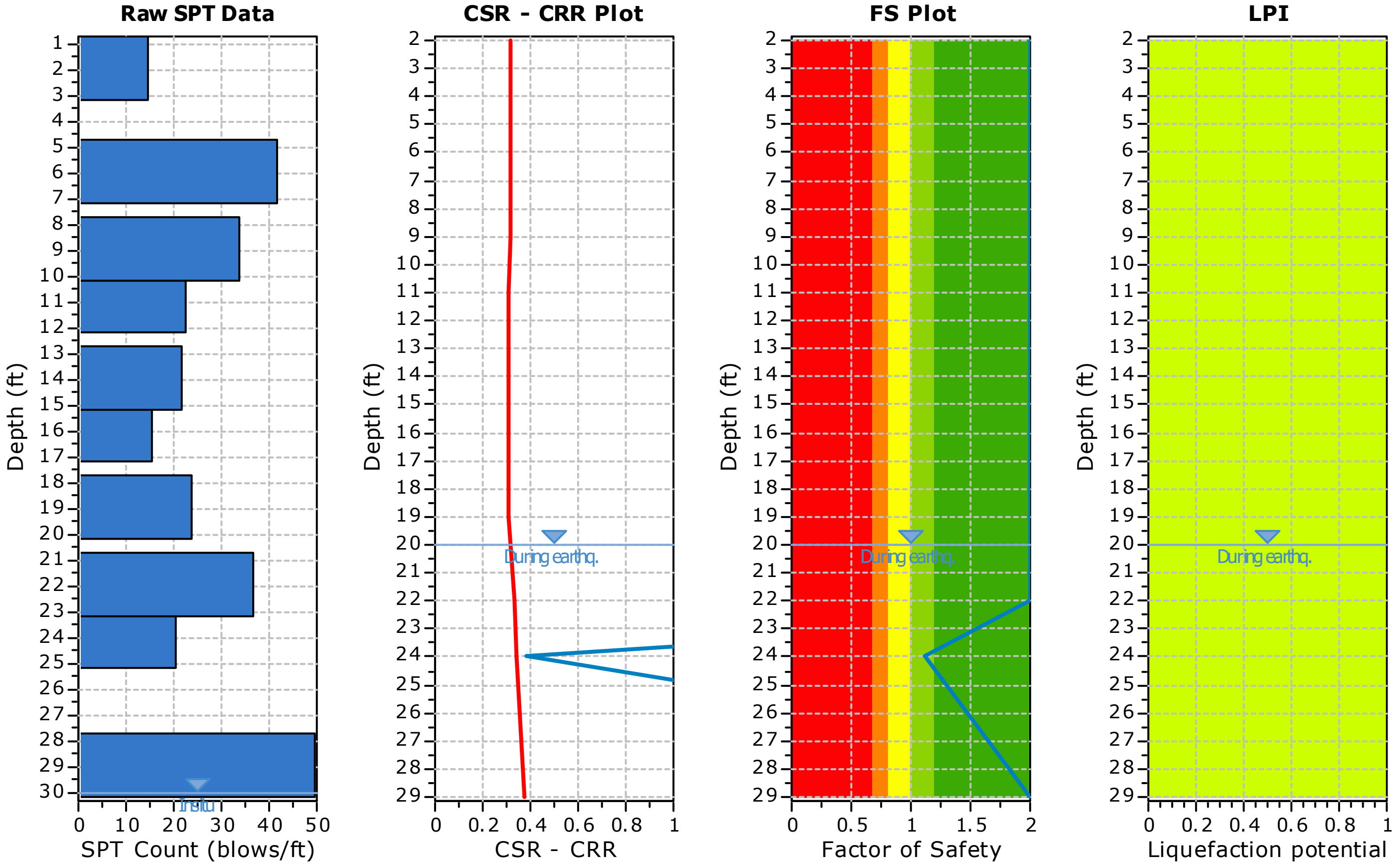
SPT BASED LIQUEFACTION ANALYSIS REPORT

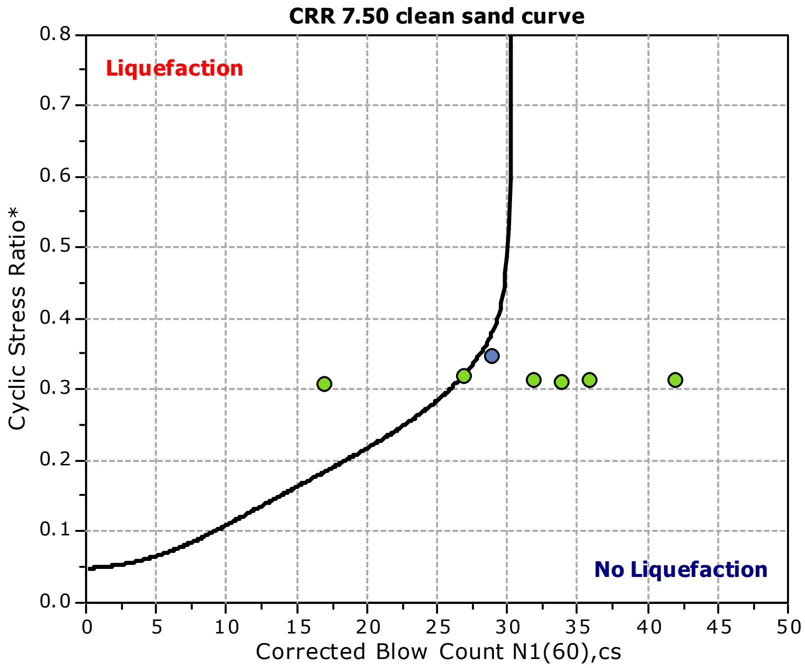
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-25**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

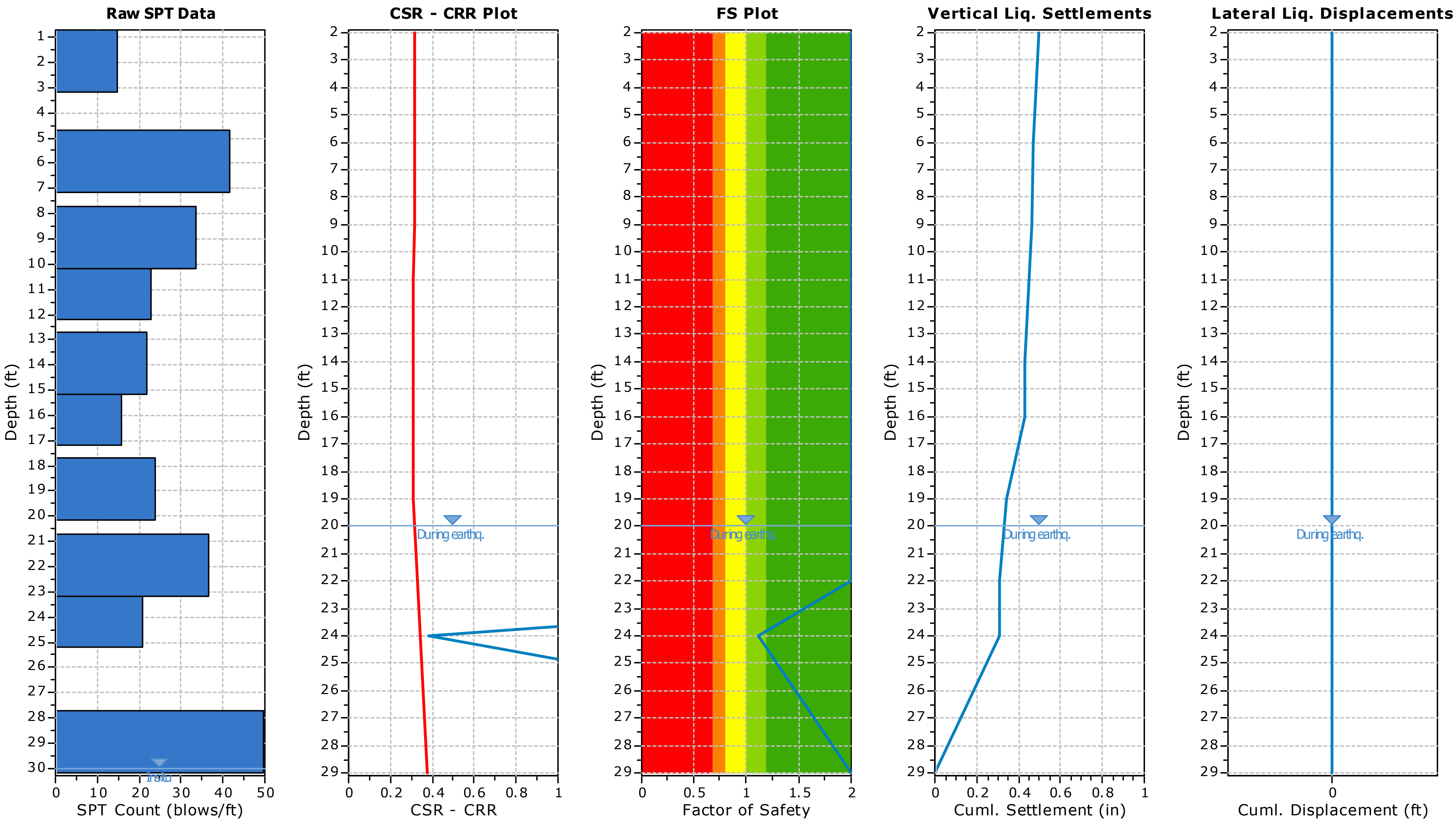




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	42	15.00	134.00	3.00	Yes
9.00	34	15.00	130.00	3.00	Yes
11.00	23	15.00	119.00	3.00	Yes
14.00	22	85.00	112.00	3.00	No
16.00	16	6.00	105.00	3.00	Yes
19.00	24	80.00	120.00	4.00	Yes
22.00	37	70.00	125.00	3.00	Yes
24.00	21	60.00	120.00	6.00	Yes
29.00	50	50.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	42	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	53	15.00	2.50	1.05	58	4.000
9.00	34	130.00	0.58	0.00	0.58	1.26	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
11.00	23	119.00	0.70	0.00	0.70	1.18	1.20	1.00	0.85	1.00	28	15.00	2.50	1.05	32	4.000
14.00	22	112.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	24	85.00	5.00	1.20	34	4.000
16.00	16	105.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	17	6.00	0.03	1.00	17	4.000
19.00	24	120.00	1.16	0.00	1.16	0.96	1.20	1.00	0.95	1.00	26	80.00	5.00	1.20	36	4.000
22.00	37	125.00	1.34	0.00	1.34	0.89	1.20	1.00	0.95	1.00	38	70.00	5.00	1.20	51	4.000
24.00	21	120.00	1.46	0.00	1.46	0.85	1.20	1.00	0.95	1.00	20	60.00	5.00	1.20	29	0.384
29.00	50	130.00	1.79	0.00	1.79	0.76	1.20	1.00	0.95	1.00	43	50.00	5.00	1.20	57	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
9.00	130.00	0.58	0.00	0.58	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
11.00	119.00	0.70	0.00	0.70	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
14.00	112.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000	●
16.00	105.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
19.00	120.00	1.16	0.00	1.16	0.96	1.00	0.405	1.32	0.306	0.98	0.312	2.000	●
22.00	125.00	1.34	0.06	1.28	0.95	1.00	0.422	1.32	0.318	0.96	0.331	2.000	●
24.00	120.00	1.46	0.12	1.34	0.95	1.00	0.437	1.32	0.330	0.95	0.346	1.110	●
29.00	130.00	1.79	0.28	1.51	0.93	1.00	0.464	1.32	0.350	0.93	0.376	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction
*** User FS:	1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
11.00	2.000	0.00	8.32	2.00	0.00
14.00	2.000	0.00	7.87	3.00	0.00
16.00	2.000	0.00	7.56	2.00	0.00
19.00	2.000	0.00	7.10	3.00	0.00
22.00	2.000	0.00	6.65	3.00	0.00
24.00	1.110	0.00	6.34	2.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	53	0.16	0.26	882.21	0.14	11294.86	0.00	0.00	8.77	0.01	3.00	0.005
9.00	38	0.24	0.39	971.10	0.15	8846.65	0.00	0.00	8.77	0.02	3.00	0.012
11.00	28	0.29	0.47	973.26	0.15	7913.67	0.00	0.00	8.77	0.03	3.00	0.022
14.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
16.00	17	0.40	0.65	928.96	0.16	6497.96	0.00	0.00	8.77	0.13	3.00	0.092
19.00	26	0.47	0.77	1298.38	0.17	5869.90	0.00	0.00	8.77	0.03	4.00	0.028

Cumulative settlemetns: 0.187

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
22.00	0.00	5.00	0.00	3.00	0.000
24.00	0.00	5.00	0.43	6.00	0.312
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.312

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	53	100.00	0.00	3.00	0.000	0.00
9.00	38	86.30	0.00	3.00	0.000	0.00
11.00	28	74.08	0.00	3.00	0.000	0.00
14.00	24	68.59	0.00	3.00	0.000	0.00
16.00	17	57.72	0.00	3.00	0.000	0.00
19.00	26	71.39	0.00	4.00	0.000	0.00
22.00	38	86.30	0.00	3.00	0.000	0.00
24.00	20	62.61	2.26	6.00	0.000	0.00
29.00	43	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

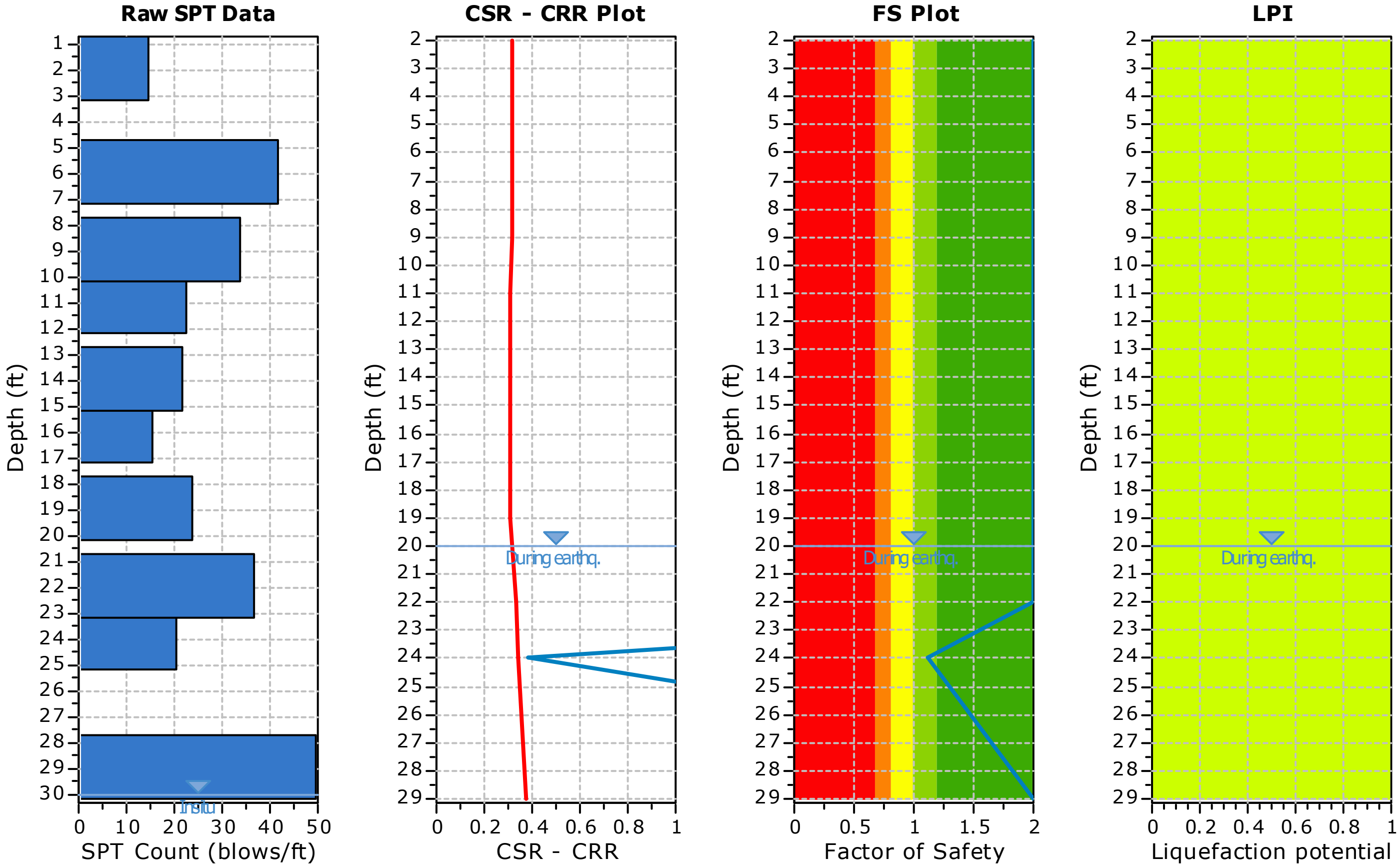
SPT BASED LIQUEFACTION ANALYSIS REPORT

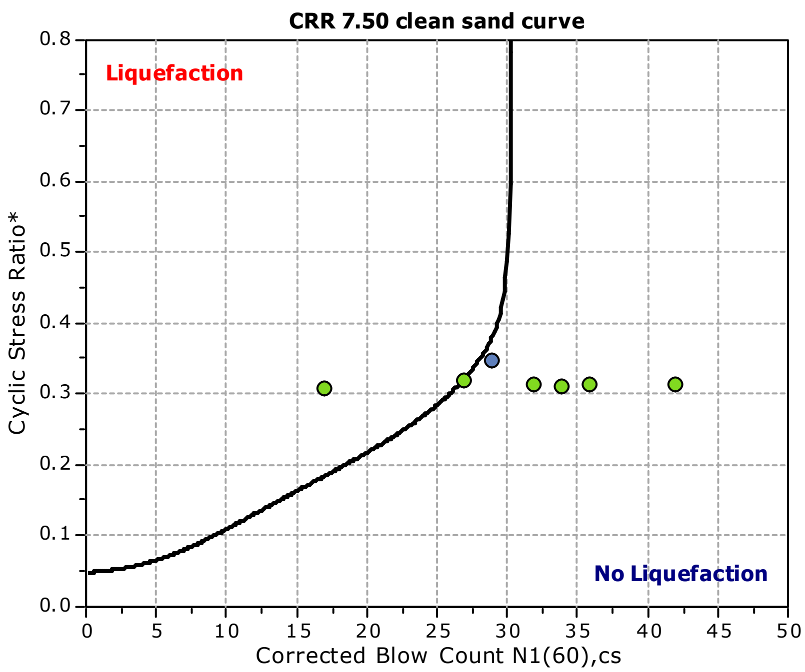
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-25**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





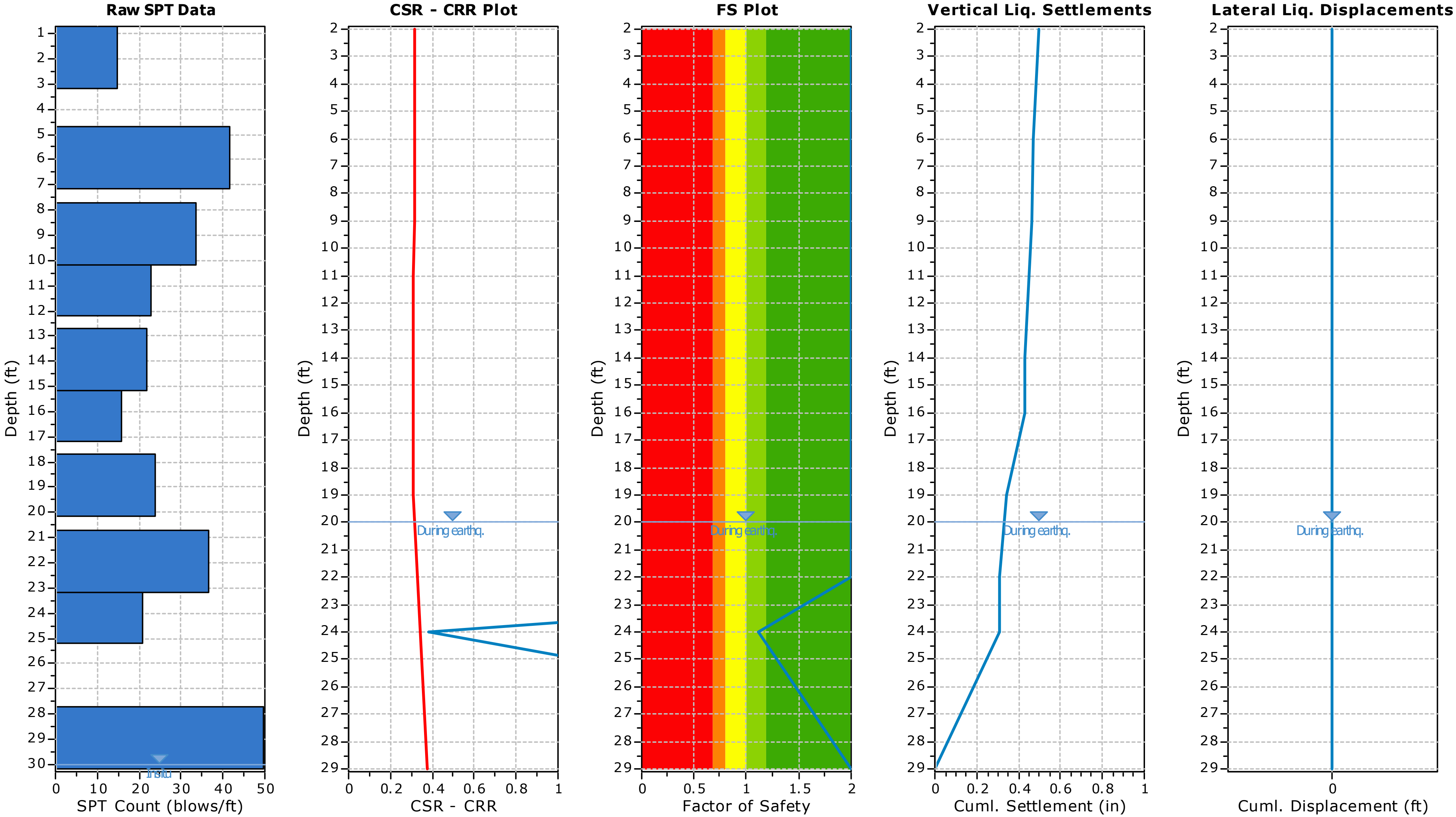
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	42	15.00	134.00	3.00	Yes
9.00	34	15.00	130.00	3.00	Yes
11.00	23	15.00	119.00	3.00	Yes
14.00	22	85.00	112.00	3.00	No
16.00	16	6.00	105.00	3.00	Yes
19.00	24	80.00	120.00	4.00	Yes
22.00	37	70.00	125.00	3.00	Yes
24.00	21	60.00	120.00	6.00	Yes
29.00	50	50.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	42	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	53	15.00	2.50	1.05	58	4.000
9.00	34	130.00	0.58	0.00	0.58	1.26	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
11.00	23	119.00	0.70	0.00	0.70	1.18	1.20	1.00	0.85	1.00	28	15.00	2.50	1.05	32	4.000
14.00	22	112.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	24	85.00	5.00	1.20	34	4.000
16.00	16	105.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	17	6.00	0.03	1.00	17	4.000
19.00	24	120.00	1.16	0.00	1.16	0.96	1.20	1.00	0.95	1.00	26	80.00	5.00	1.20	36	4.000
22.00	37	125.00	1.34	0.00	1.34	0.89	1.20	1.00	0.95	1.00	38	70.00	5.00	1.20	51	4.000
24.00	21	120.00	1.46	0.00	1.46	0.85	1.20	1.00	0.95	1.00	20	60.00	5.00	1.20	29	0.384
29.00	50	130.00	1.79	0.00	1.79	0.76	1.20	1.00	0.95	1.00	43	50.00	5.00	1.20	57	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
9.00	130.00	0.58	0.00	0.58	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
11.00	119.00	0.70	0.00	0.70	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
14.00	112.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000	●
16.00	105.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
19.00	120.00	1.16	0.00	1.16	0.96	1.00	0.405	1.32	0.306	0.98	0.312	2.000	●
22.00	125.00	1.34	0.06	1.28	0.95	1.00	0.422	1.32	0.318	0.96	0.331	2.000	●
24.00	120.00	1.46	0.12	1.34	0.95	1.00	0.437	1.32	0.330	0.95	0.346	1.110	●
29.00	130.00	1.79	0.28	1.51	0.93	1.00	0.464	1.32	0.350	0.93	0.376	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction
*** User FS:	1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
11.00	2.000	0.00	8.32	2.00	0.00
14.00	2.000	0.00	7.87	3.00	0.00
16.00	2.000	0.00	7.56	2.00	0.00
19.00	2.000	0.00	7.10	3.00	0.00
22.00	2.000	0.00	6.65	3.00	0.00
24.00	1.110	0.00	6.34	2.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	53	0.16	0.26	882.21	0.14	11294.86	0.00	0.00	8.77	0.01	3.00	0.005
9.00	38	0.24	0.39	971.10	0.15	8846.65	0.00	0.00	8.77	0.02	3.00	0.012
11.00	28	0.29	0.47	973.26	0.15	7913.67	0.00	0.00	8.77	0.03	3.00	0.022
14.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	a	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
16.00	17	0.40	0.65	928.96	0.16	6497.96	0.00	0.00	8.77	0.13	3.00	0.092
19.00	26	0.47	0.77	1298.38	0.17	5869.90	0.00	0.00	8.77	0.03	4.00	0.028

Cumulative settlemetns: 0.187

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
a, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
22.00	0.00	5.00	0.00	3.00	0.000
24.00	0.00	5.00	0.43	6.00	0.312
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.312

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	53	100.00	0.00	3.00	0.000	0.00
9.00	38	86.30	0.00	3.00	0.000	0.00
11.00	28	74.08	0.00	3.00	0.000	0.00
14.00	24	68.59	0.00	3.00	0.000	0.00
16.00	17	57.72	0.00	3.00	0.000	0.00
19.00	26	71.39	0.00	4.00	0.000	0.00
22.00	38	86.30	0.00	3.00	0.000	0.00
24.00	20	62.61	2.26	6.00	0.000	0.00
29.00	43	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

SPT BASED LIQUEFACTION ANALYSIS REPORT

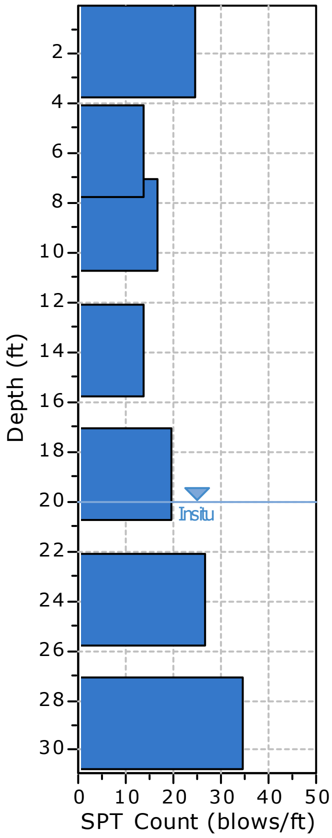
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-26**

Location : Orange County, California

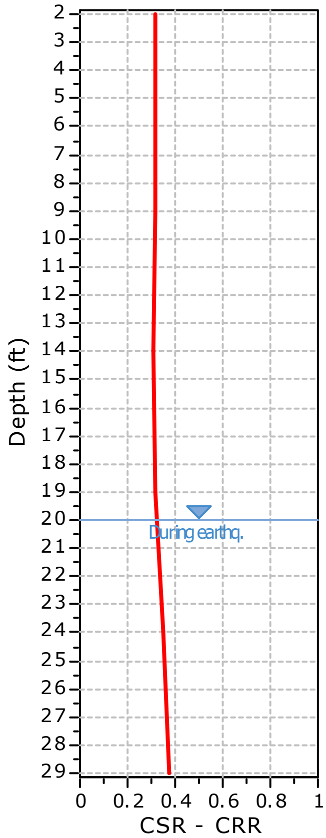
:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

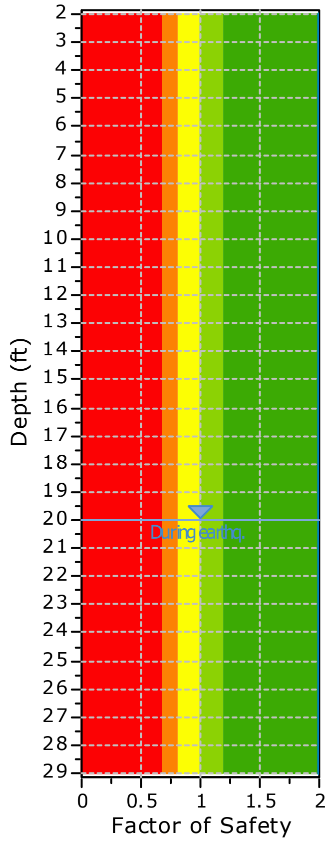
Raw SPT Data



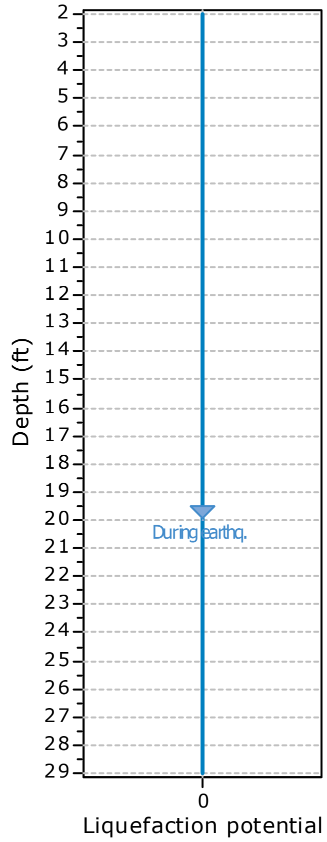
CSR - CRR Plot



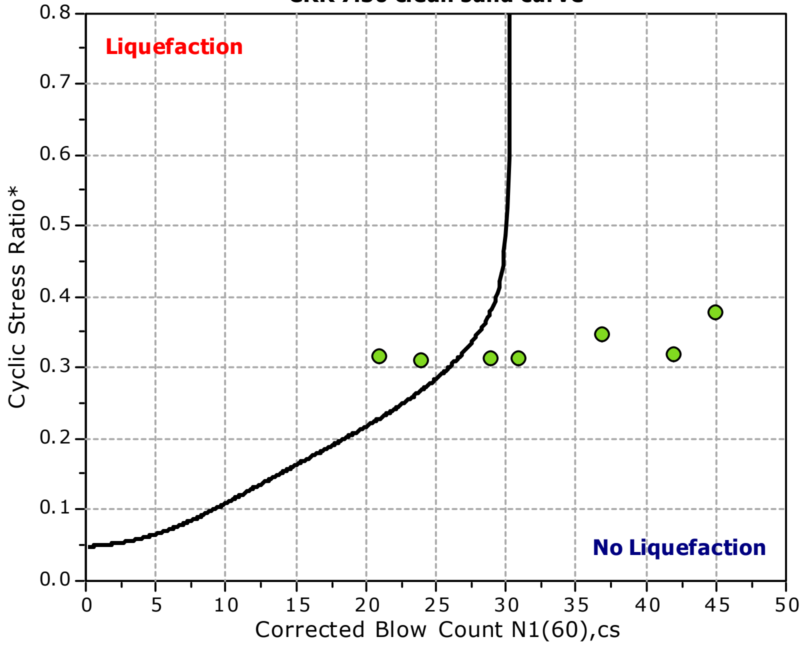
FS Plot



LPI



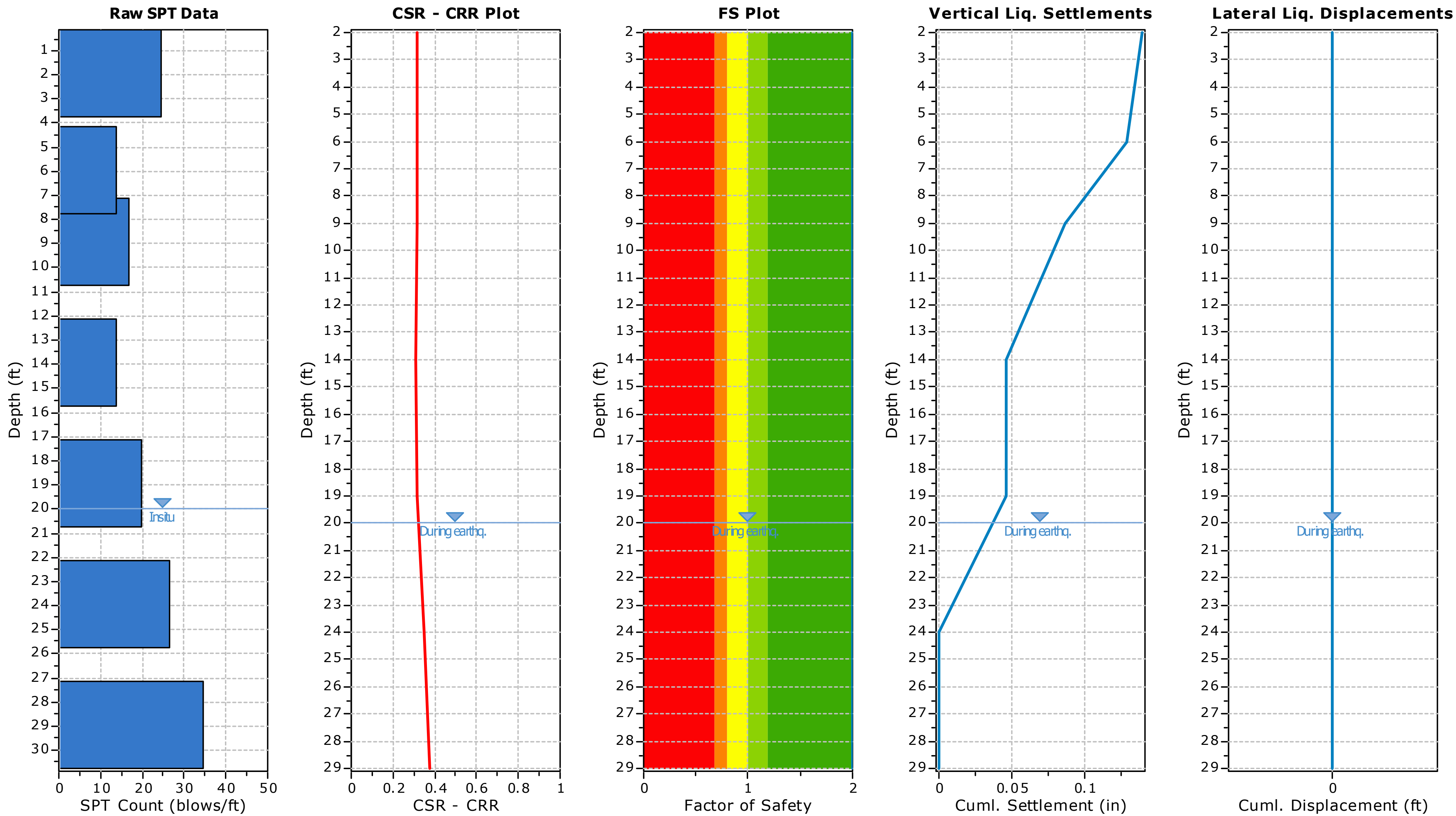
CRR 7.50 clean sand curve



F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	15.00	125.00	5.00	Yes
6.00	14	15.00	120.00	3.00	Yes
9.00	17	60.00	125.00	5.00	Yes
14.00	14	75.00	125.00	5.00	No
19.00	20	60.00	125.00	5.00	Yes
24.00	27	60.00	125.00	5.00	Yes
29.00	35	35.00	125.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
6.00	14	120.00	0.37	0.00	0.37	1.42	1.20	1.00	0.75	1.00	18	15.00	2.50	1.05	21	4.000
9.00	17	125.00	0.55	0.00	0.55	1.28	1.20	1.00	0.75	1.00	20	60.00	5.00	1.20	29	4.000
14.00	14	125.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	16	75.00	5.00	1.20	24	4.000
19.00	20	125.00	1.18	0.00	1.18	0.95	1.20	1.00	0.95	1.00	22	60.00	5.00	1.20	31	4.000
24.00	27	125.00	1.49	0.12	1.37	0.88	1.20	1.00	0.95	1.00	27	60.00	5.00	1.20	37	4.000
29.00	35	125.00	1.80	0.28	1.52	0.83	1.20	1.00	0.95	1.00	33	35.00	5.00	1.20	45	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	120.00	0.37	0.00	0.37	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●
9.00	125.00	0.55	0.00	0.55	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
14.00	125.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000	●
19.00	125.00	1.18	0.00	1.18	0.96	1.00	0.405	1.32	0.306	0.98	0.313	2.000	●
24.00	125.00	1.49	0.12	1.37	0.95	1.00	0.436	1.32	0.329	0.95	0.346	2.000	●
29.00	125.00	1.80	0.28	1.52	0.93	1.00	0.463	1.32	0.350	0.93	0.376	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio (adjusted for improvement)
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
14.00	2.000	0.00	7.87	5.00	0.00
19.00	2.000	0.00	7.10	5.00	0.00
24.00	2.000	0.00	6.34	5.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.05	0.08	449.66	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.011
6.00	18	0.15	0.24	609.86	0.14	11716.67	0.00	0.00	8.77	0.06	3.00	0.042
9.00	20	0.23	0.37	835.56	0.15	9136.52	0.00	0.00	8.77	0.03	5.00	0.040
14.00	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000
19.00	22	0.48	0.79	1247.23	0.17	5802.34	0.00	0.00	8.77	0.04	5.00	0.047

Cumulative settlemetns: 0.140

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
24.00	0.00	5.00	0.00	5.00	0.000
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.000

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	18	59.40	0.00	3.00	0.000	0.00
9.00	20	62.61	0.00	5.00	0.000	0.00
14.00	16	56.00	0.00	5.00	0.000	0.00
19.00	22	65.67	0.00	5.00	0.000	0.00
24.00	27	72.75	0.00	5.00	0.000	0.00
29.00	33	80.42	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

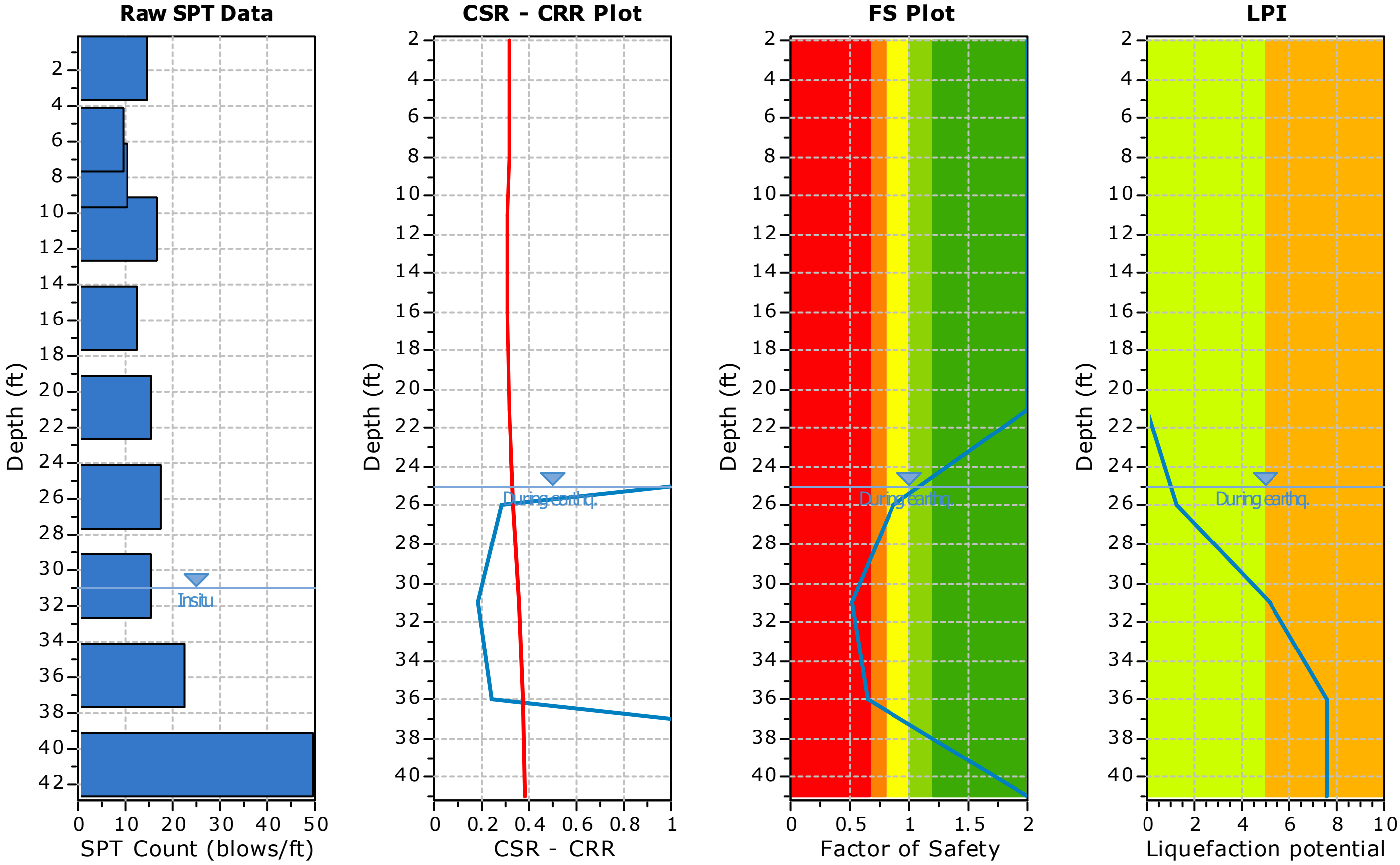
SPT BASED LIQUEFACTION ANALYSIS REPORT

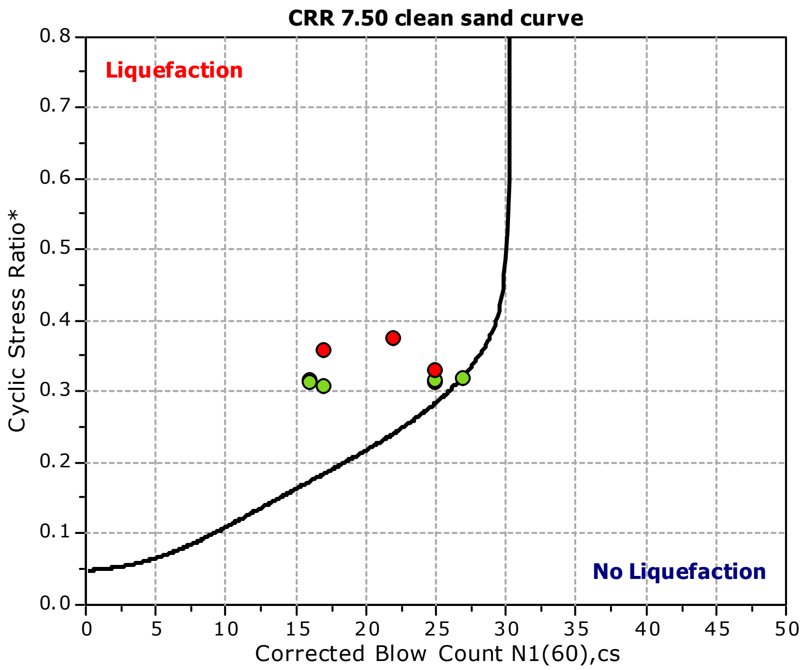
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-27**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	31.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	25.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





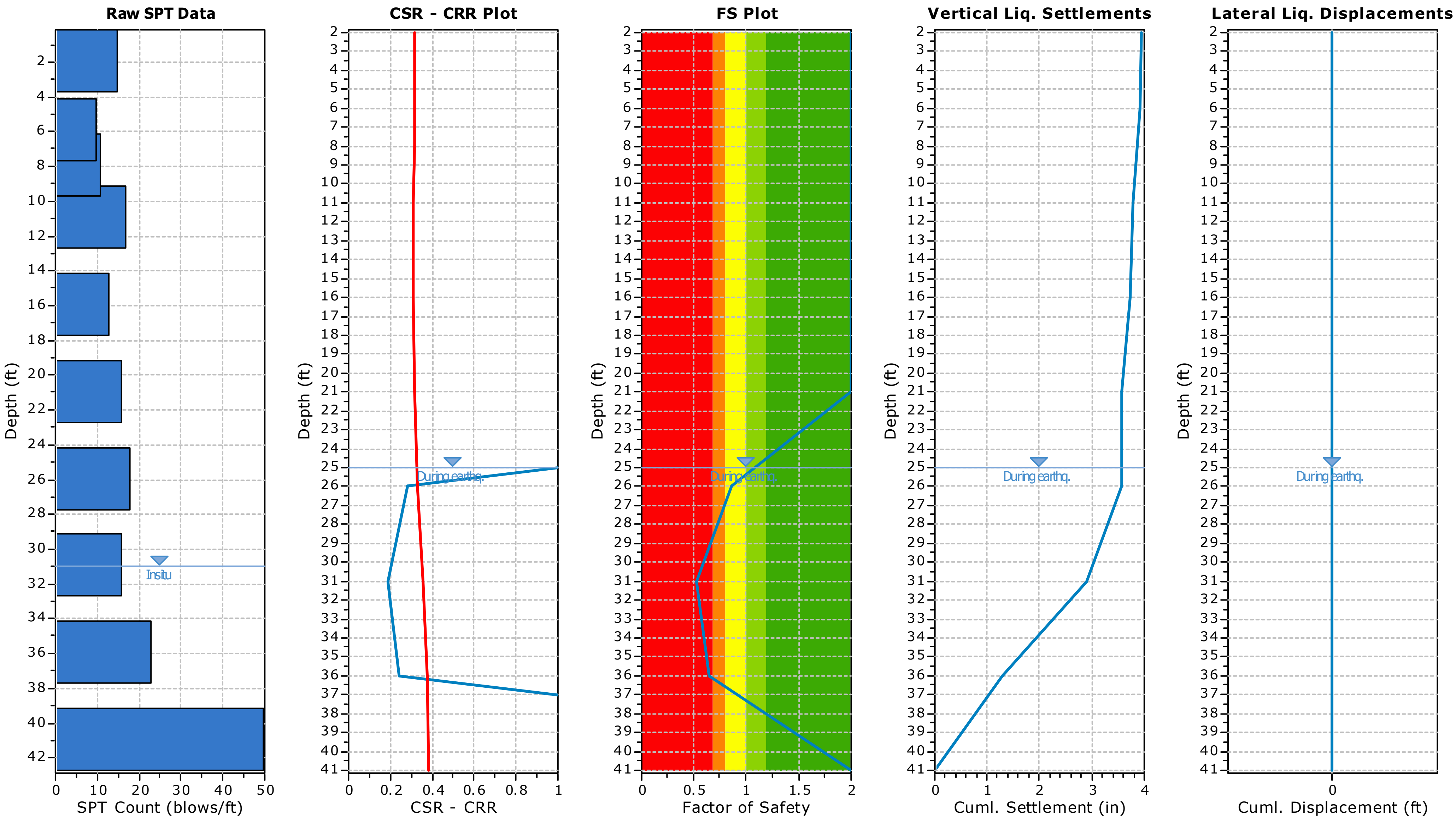
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	10	15.00	120.00	2.00	Yes
8.00	11	15.00	120.00	3.00	Yes
11.00	17	15.00	120.00	5.00	Yes
16.00	13	15.00	120.00	5.00	Yes
21.00	16	70.00	132.00	5.00	No
26.00	18	70.00	125.00	5.00	Yes
31.00	16	15.00	125.00	5.00	Yes
36.00	23	15.00	125.00	5.00	Yes
41.00	50	30.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	10	120.00	0.36	0.00	0.36	1.43	1.20	1.00	0.75	1.00	13	15.00	2.50	1.05	16	4.000
8.00	11	120.00	0.48	0.00	0.48	1.33	1.20	1.00	0.75	1.00	13	15.00	2.50	1.05	16	4.000
11.00	17	120.00	0.66	0.00	0.66	1.21	1.20	1.00	0.85	1.00	21	15.00	2.50	1.05	25	4.000
16.00	13	120.00	0.96	0.00	0.96	1.04	1.20	1.00	0.85	1.00	14	15.00	2.50	1.05	17	4.000
21.00	16	132.00	1.29	0.00	1.29	0.91	1.20	1.00	0.95	1.00	17	70.00	5.00	1.20	25	4.000
26.00	18	125.00	1.60	0.00	1.60	0.81	1.20	1.00	0.95	1.00	17	70.00	5.00	1.20	25	0.285
31.00	16	125.00	1.92	0.00	1.92	0.73	1.20	1.00	1.00	1.00	14	15.00	2.50	1.05	17	0.185
36.00	23	125.00	2.23	0.16	2.07	0.70	1.20	1.00	1.00	1.00	19	15.00	2.50	1.05	22	0.242
41.00	50	130.00	2.55	0.31	2.24	0.66	1.20	1.00	1.00	1.00	40	30.00	4.71	1.15	51	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cyclic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	120.00	0.36	0.00	0.36	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
8.00	120.00	0.48	0.00	0.48	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000	●
11.00	120.00	0.66	0.00	0.66	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
16.00	120.00	0.96	0.00	0.96	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
21.00	132.00	1.29	0.00	1.29	0.95	1.00	0.403	1.32	0.304	0.96	0.317	2.000	●
26.00	125.00	1.60	0.03	1.57	0.94	1.00	0.404	1.32	0.305	0.92	0.330	0.863	●
31.00	125.00	1.92	0.19	1.73	0.92	1.00	0.429	1.32	0.324	0.91	0.357	0.517	●
36.00	125.00	2.23	0.34	1.88	0.88	1.00	0.441	1.32	0.333	0.89	0.374	0.646	●
41.00	130.00	2.55	0.50	2.05	0.84	1.00	0.442	1.32	0.334	0.88	0.381	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.863	0.14	6.04	5.00	1.26
31.00	0.517	0.48	5.28	5.00	3.88
36.00	0.646	0.35	4.51	5.00	2.43
41.00	2.000	0.00	3.75	5.00	0.00

Overall potential I_L : 7.58

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	13	0.15	0.24	553.18	0.14	11814.04	0.00	0.00	8.77	0.11	2.00	0.052
8.00	13	0.20	0.32	638.76	0.14	9941.12	0.00	0.00	8.77	0.12	3.00	0.084
11.00	21	0.27	0.44	869.15	0.15	8212.09	0.00	0.00	8.77	0.05	5.00	0.058
16.00	14	0.39	0.64	921.79	0.16	6558.69	0.00	0.00	8.77	0.13	5.00	0.152

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
21.00	17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000

Cumulative settlemetns: 0.375

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
26.00	0.00	5.00	1.13	5.00	0.676
31.00	0.00	5.00	2.67	5.00	1.602
36.00	0.00	5.00	2.16	5.00	1.297
41.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 3.575

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	13	50.48	0.00	2.00	0.000	0.00
8.00	13	50.48	0.00	3.00	0.000	0.00
11.00	21	64.16	0.00	5.00	0.000	0.00
16.00	14	52.38	0.00	5.00	0.000	0.00
21.00	17	57.72	0.00	5.00	0.000	0.00
26.00	17	57.72	6.88	5.00	0.000	0.00
31.00	14	52.38	34.10	5.00	0.000	0.00
36.00	19	61.02	22.70	5.00	0.000	0.00
41.00	40	88.54	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

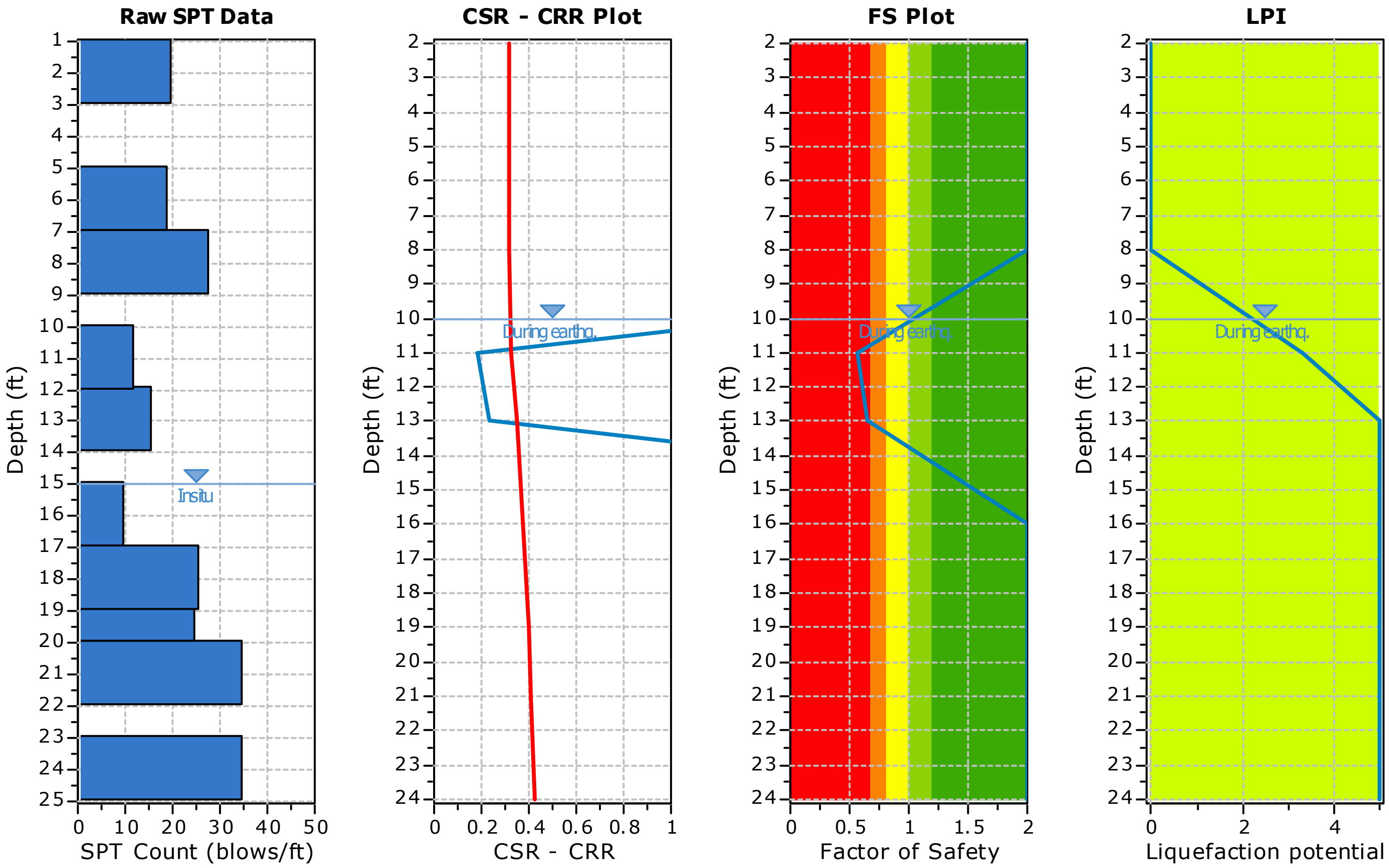
SPT BASED LIQUEFACTION ANALYSIS REPORT

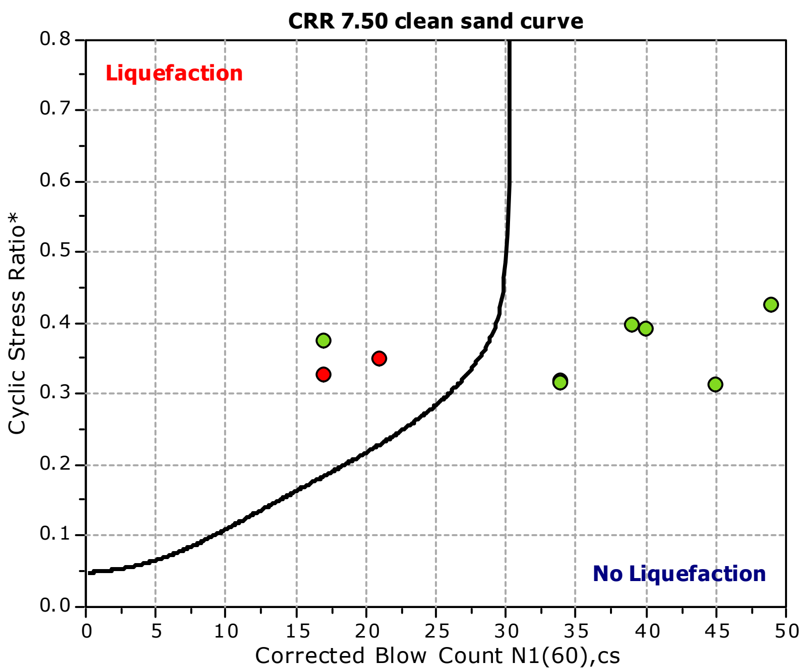
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-29**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	15.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	10.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





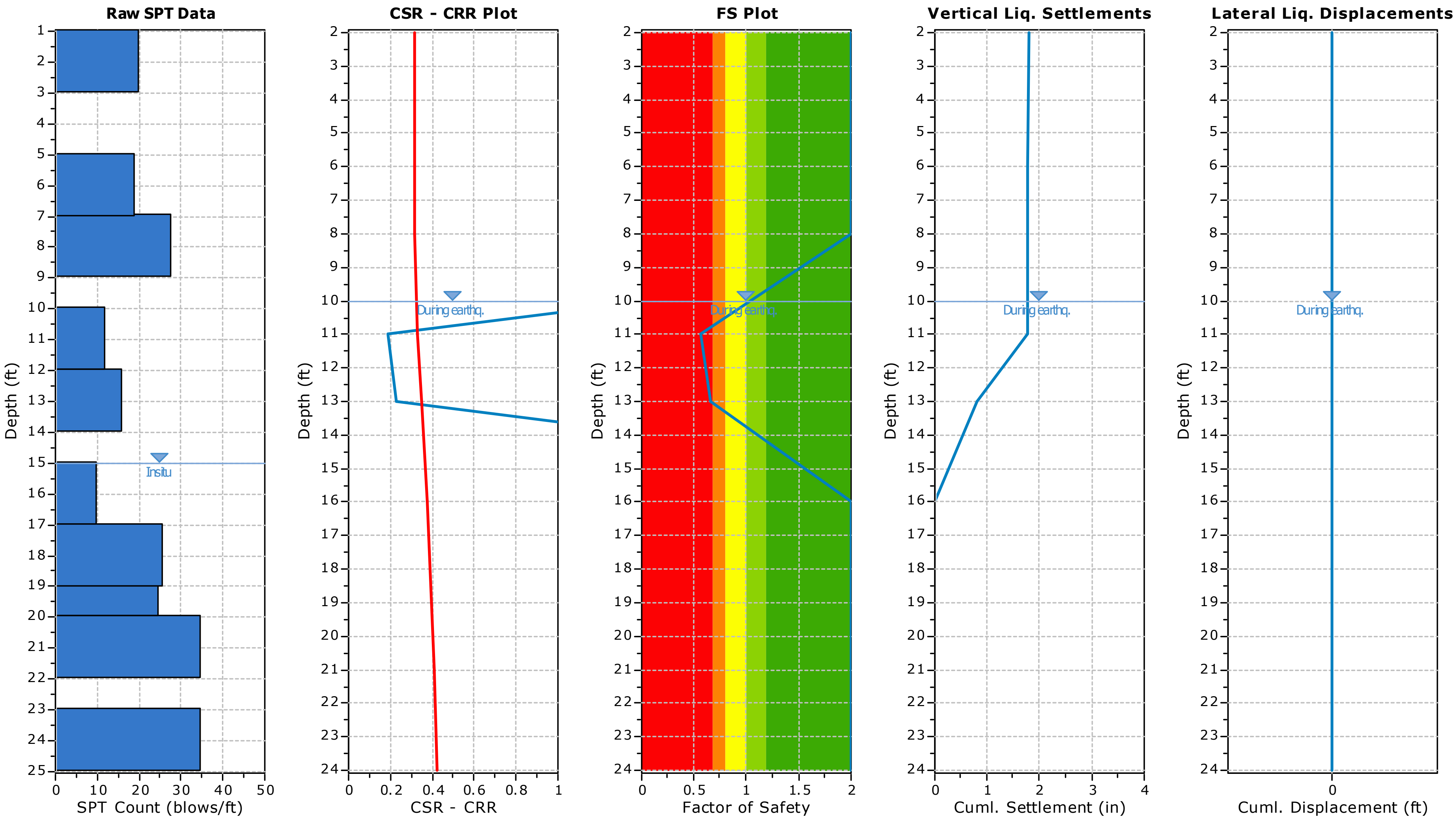
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	20	15.00	125.00	5.00	Yes
6.00	19	75.00	131.00	3.00	No
8.00	28	35.00	136.00	3.00	Yes
11.00	12	15.00	135.00	3.00	Yes
13.00	16	15.00	131.00	3.00	Yes
16.00	10	65.00	125.00	3.00	No
18.00	26	65.00	125.00	2.00	No
19.00	25	65.00	125.00	2.00	No
21.00	35	65.00	125.00	5.00	No
24.00	35	35.00	125.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	20	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	30	15.00	2.50	1.05	34	4.000
6.00	19	131.00	0.39	0.00	0.39	1.41	1.20	1.00	0.75	1.00	24	75.00	5.00	1.20	34	4.000
8.00	28	136.00	0.52	0.00	0.52	1.30	1.20	1.00	0.75	1.00	33	35.00	5.00	1.20	45	4.000
11.00	12	135.00	0.73	0.00	0.73	1.17	1.20	1.00	0.85	1.00	14	15.00	2.50	1.05	17	0.185
13.00	16	131.00	0.86	0.00	0.86	1.09	1.20	1.00	0.85	1.00	18	15.00	2.50	1.05	21	0.229
16.00	10	125.00	1.04	0.03	1.01	1.02	1.20	1.00	0.85	1.00	10	65.00	5.00	1.20	17	4.000
18.00	26	125.00	1.17	0.09	1.08	0.99	1.20	1.00	0.95	1.00	29	65.00	5.00	1.20	40	4.000
19.00	25	125.00	1.23	0.12	1.11	0.98	1.20	1.00	0.95	1.00	28	65.00	5.00	1.20	39	4.000
21.00	35	125.00	1.36	0.19	1.17	0.95	1.20	1.00	0.95	1.00	38	65.00	5.00	1.20	51	4.000
24.00	35	125.00	1.54	0.28	1.26	0.92	1.20	1.00	0.95	1.00	37	35.00	5.00	1.20	49	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	131.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
8.00	136.00	0.52	0.00	0.52	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000	●
11.00	135.00	0.73	0.03	0.69	0.98	1.00	0.431	1.32	0.326	1.00	0.326	0.567	●
13.00	131.00	0.86	0.09	0.76	0.97	1.00	0.461	1.32	0.348	1.00	0.348	0.658	●
16.00	125.00	1.04	0.19	0.86	0.97	1.00	0.498	1.32	0.376	1.00	0.376	2.000	●
18.00	125.00	1.17	0.25	0.92	0.96	1.00	0.517	1.32	0.390	1.00	0.390	2.000	●
19.00	125.00	1.23	0.28	0.95	0.96	1.00	0.525	1.32	0.397	1.00	0.397	2.000	●
21.00	125.00	1.36	0.34	1.01	0.95	1.00	0.540	1.32	0.408	1.00	0.408	2.000	●
24.00	125.00	1.54	0.44	1.11	0.95	1.00	0.557	1.32	0.421	0.99	0.424	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	0.567	0.43	8.32	3.00	3.29
13.00	0.658	0.34	8.02	2.00	1.67
16.00	2.000	0.00	7.56	3.00	0.00
18.00	2.000	0.00	7.26	2.00	0.00
19.00	2.000	0.00	7.10	1.00	0.00
21.00	2.000	0.00	6.80	2.00	0.00
24.00	2.000	0.00	6.34	3.00	0.00

Overall potential I_L : 4.96

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	30	0.05	0.08	419.08	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.017
6.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
8.00	33	0.22	0.35	941.17	0.14	9442.33	0.00	0.00	8.77	0.01	3.00	0.010

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.027

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
11.00	0.00	5.00	2.67	3.00	0.961
13.00	0.00	5.00	2.25	3.00	0.808
16.00	0.00	5.00	0.00	3.00	0.000
18.00	0.00	5.00	0.00	2.00	0.000
19.00	0.00	5.00	0.00	2.00	0.000
21.00	0.00	5.00	0.00	5.00	0.000
24.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.769

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	30	76.68	0.00	5.00	0.000	0.00
6.00	24	68.59	0.00	3.00	0.000	0.00
8.00	33	80.42	0.00	3.00	0.000	0.00
11.00	14	52.38	34.10	3.00	0.000	0.00
13.00	18	59.40	22.70	3.00	0.000	0.00
16.00	10	44.27	0.00	3.00	0.000	0.00
18.00	29	75.39	0.00	2.00	0.000	0.00
19.00	28	74.08	0.00	2.00	0.000	0.00
21.00	38	86.30	0.00	5.00	0.000	0.00
24.00	37	85.16	0.00	5.00	0.000	0.00

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

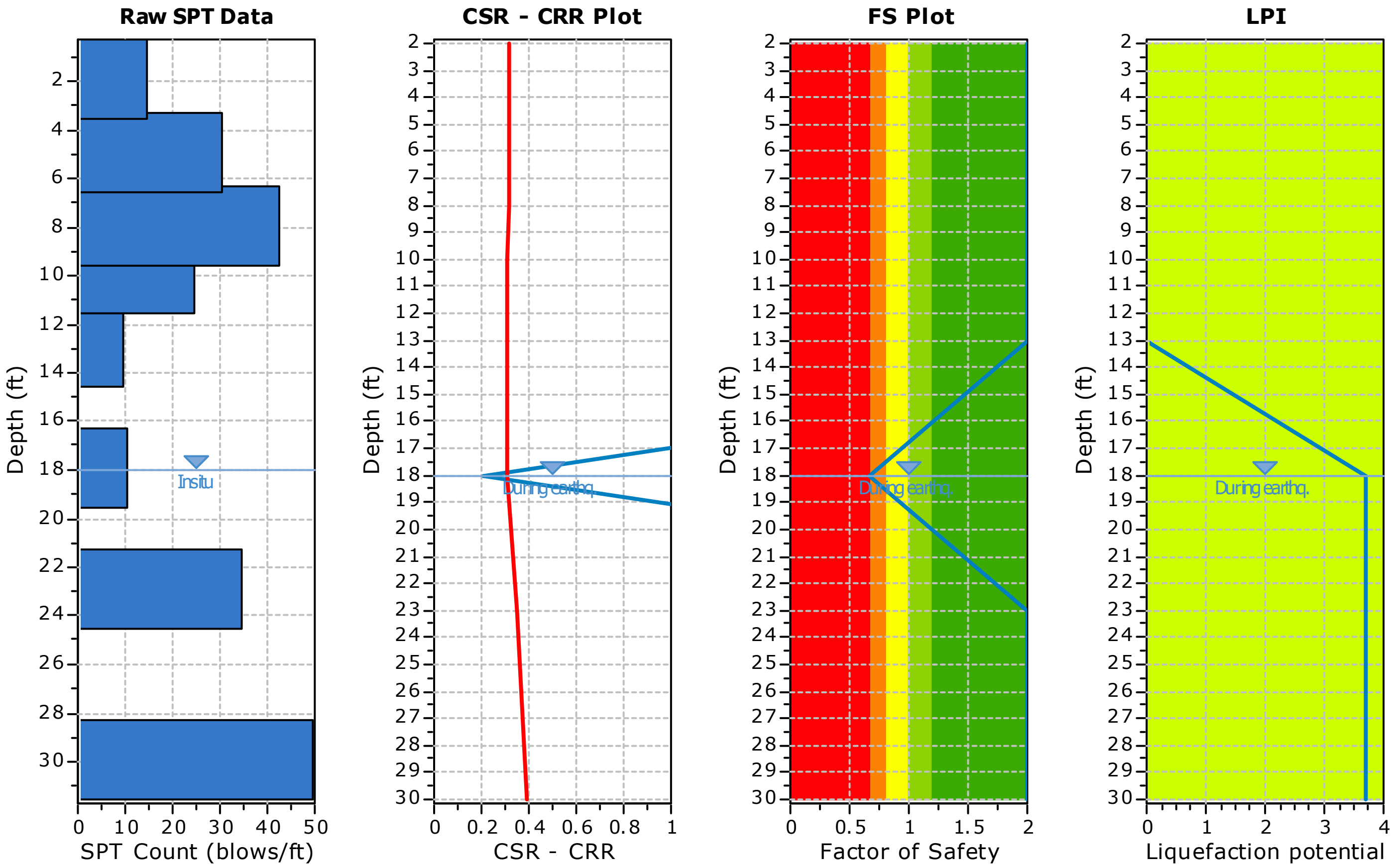
SPT BASED LIQUEFACTION ANALYSIS REPORT

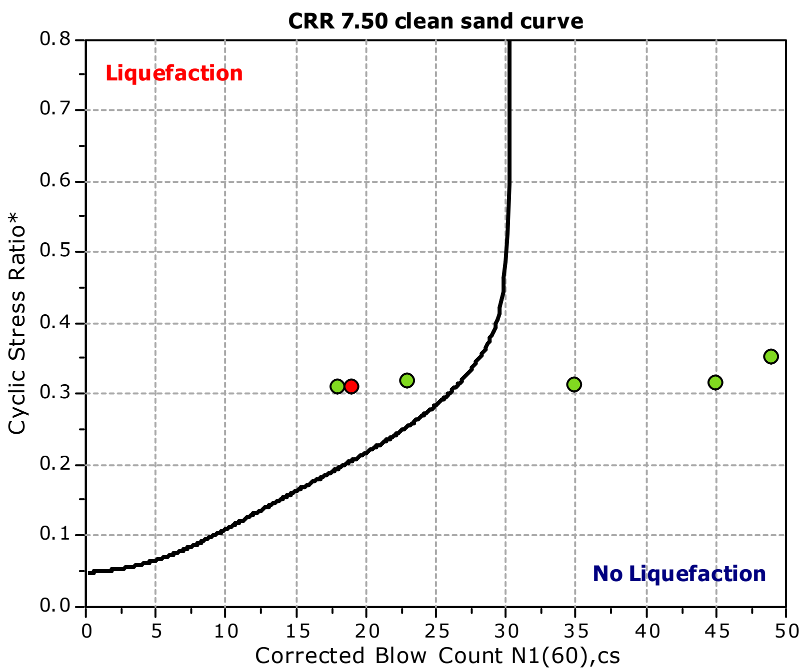
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-38**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	18.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	18.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

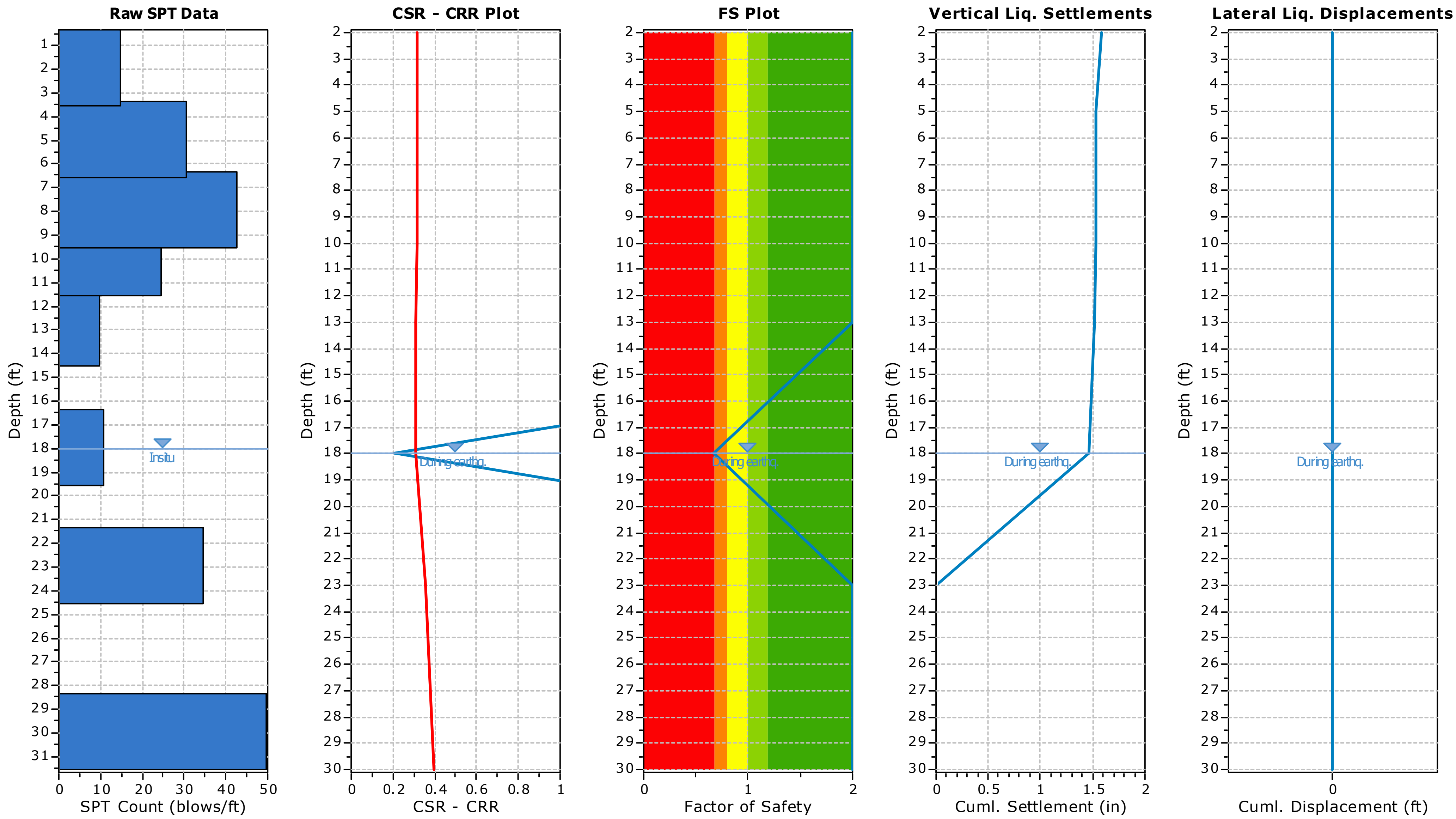




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	5.00	120.00	5.00	Yes
5.00	31	15.00	127.00	3.00	Yes
8.00	43	15.00	125.00	2.00	Yes
10.00	25	15.00	131.00	2.00	Yes
13.00	10	60.00	120.00	2.00	Yes
18.00	11	60.00	123.00	5.00	Yes
23.00	35	70.00	125.00	3.00	No
30.00	50	60.00	130.00	5.00	No

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	5.00	0.00	1.00	23	4.000
5.00	31	127.00	0.31	0.00	0.31	1.47	1.20	1.00	0.75	1.00	41	15.00	2.50	1.05	45	4.000
8.00	43	125.00	0.50	0.00	0.50	1.32	1.20	1.00	0.75	1.00	51	15.00	2.50	1.05	56	4.000
10.00	25	131.00	0.63	0.00	0.63	1.23	1.20	1.00	0.85	1.00	31	15.00	2.50	1.05	35	4.000
13.00	10	120.00	0.81	0.00	0.81	1.12	1.20	1.00	0.85	1.00	11	60.00	5.00	1.20	18	4.000
18.00	11	123.00	1.12	0.00	1.12	0.98	1.20	1.00	0.95	1.00	12	60.00	5.00	1.20	19	0.206
23.00	35	125.00	1.43	0.16	1.27	0.92	1.20	1.00	0.95	1.00	37	70.00	5.00	1.20	49	4.000
30.00	50	130.00	1.88	0.37	1.51	0.84	1.20	1.00	1.00	1.00	50	60.00	5.00	1.20	65	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
5.00	127.00	0.31	0.00	0.31	0.99	1.00	0.418	1.32	0.316	1.00	0.316	2.000
8.00	125.00	0.50	0.00	0.50	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000
10.00	131.00	0.63	0.00	0.63	0.98	1.00	0.414	1.32	0.312	1.00	0.312	2.000
13.00	120.00	0.81	0.00	0.81	0.97	1.00	0.411	1.32	0.310	1.00	0.310	2.000
18.00	123.00	1.12	0.00	1.12	0.96	1.00	0.406	1.32	0.307	0.99	0.310	0.665

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
23.00	125.00	1.43	0.16	1.27	0.95	1.00	0.450	1.32	0.340	0.96	0.353	2.000	●
30.00	130.00	1.88	0.37	1.51	0.92	1.00	0.485	1.32	0.367	0.93	0.394	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	3.00	0.00
5.00	2.000	0.00	9.24	3.00	0.00
8.00	2.000	0.00	8.78	3.00	0.00
10.00	2.000	0.00	8.48	2.00	0.00
13.00	2.000	0.00	8.02	3.00	0.00
18.00	0.665	0.33	7.26	5.00	3.70
23.00	2.000	0.00	6.49	5.00	0.00
30.00	2.000	0.00	5.43	7.00	0.00

Overall potential I_L : 3.70

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	360.45	0.13	22838.69	0.00	0.00	8.77	0.03	5.00	0.041
5.00	41	0.13	0.21	725.18	0.14	12910.50	0.00	0.00	8.77	0.01	3.00	0.008
8.00	51	0.21	0.33	987.85	0.14	9723.94	0.00	0.00	8.77	0.01	2.00	0.004
10.00	31	0.26	0.42	949.20	0.15	8452.59	0.00	0.00	8.77	0.02	2.00	0.012
13.00	11	0.33	0.54	862.47	0.16	7267.93	0.00	0.00	8.77	0.11	2.00	0.051

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.116

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
18.00	0.00	5.00	2.44	5.00	1.462
23.00	0.00	5.00	0.00	3.00	0.000
30.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.462

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
5.00	41	89.64	0.00	3.00	0.000	0.00
8.00	51	100.00	0.00	2.00	0.000	0.00
10.00	31	77.95	0.00	2.00	0.000	0.00
13.00	11	46.43	0.00	2.00	0.000	0.00
18.00	12	48.50	34.10	5.00	0.000	0.00
23.00	37	85.16	0.00	3.00	0.000	0.00
30.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

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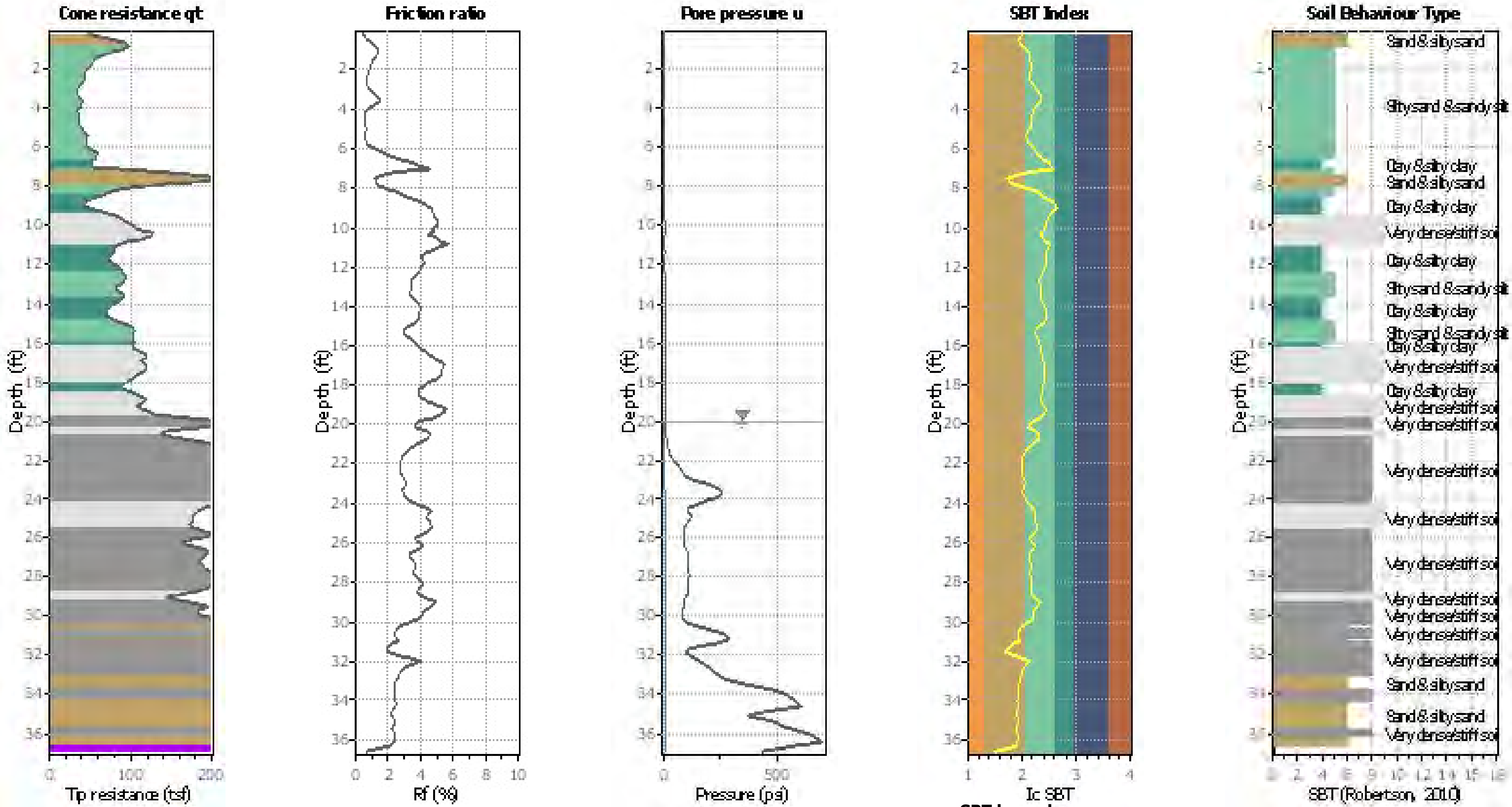
APPENDIX D.3

CPT Interpretations and Property Correlations

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



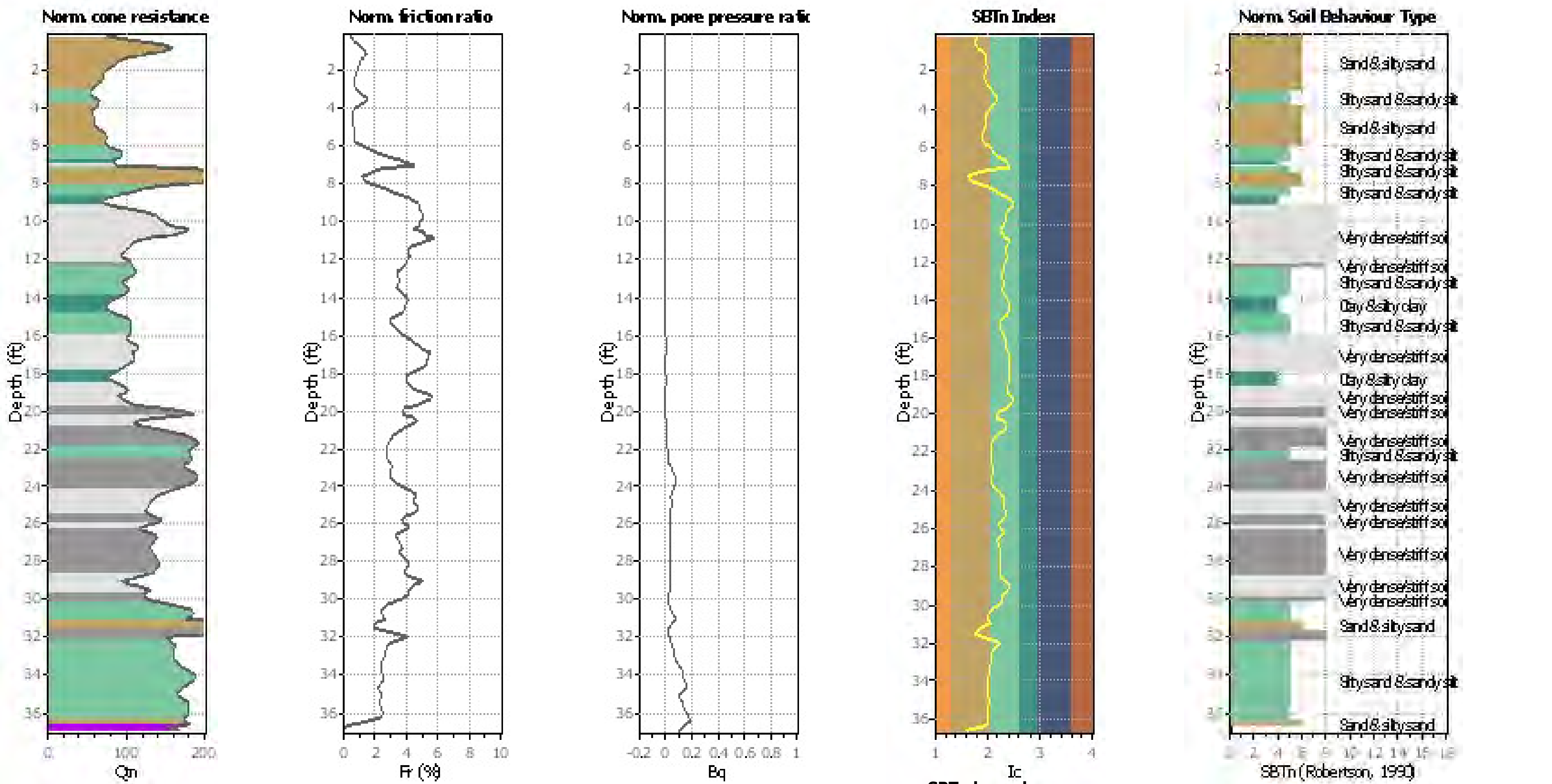
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
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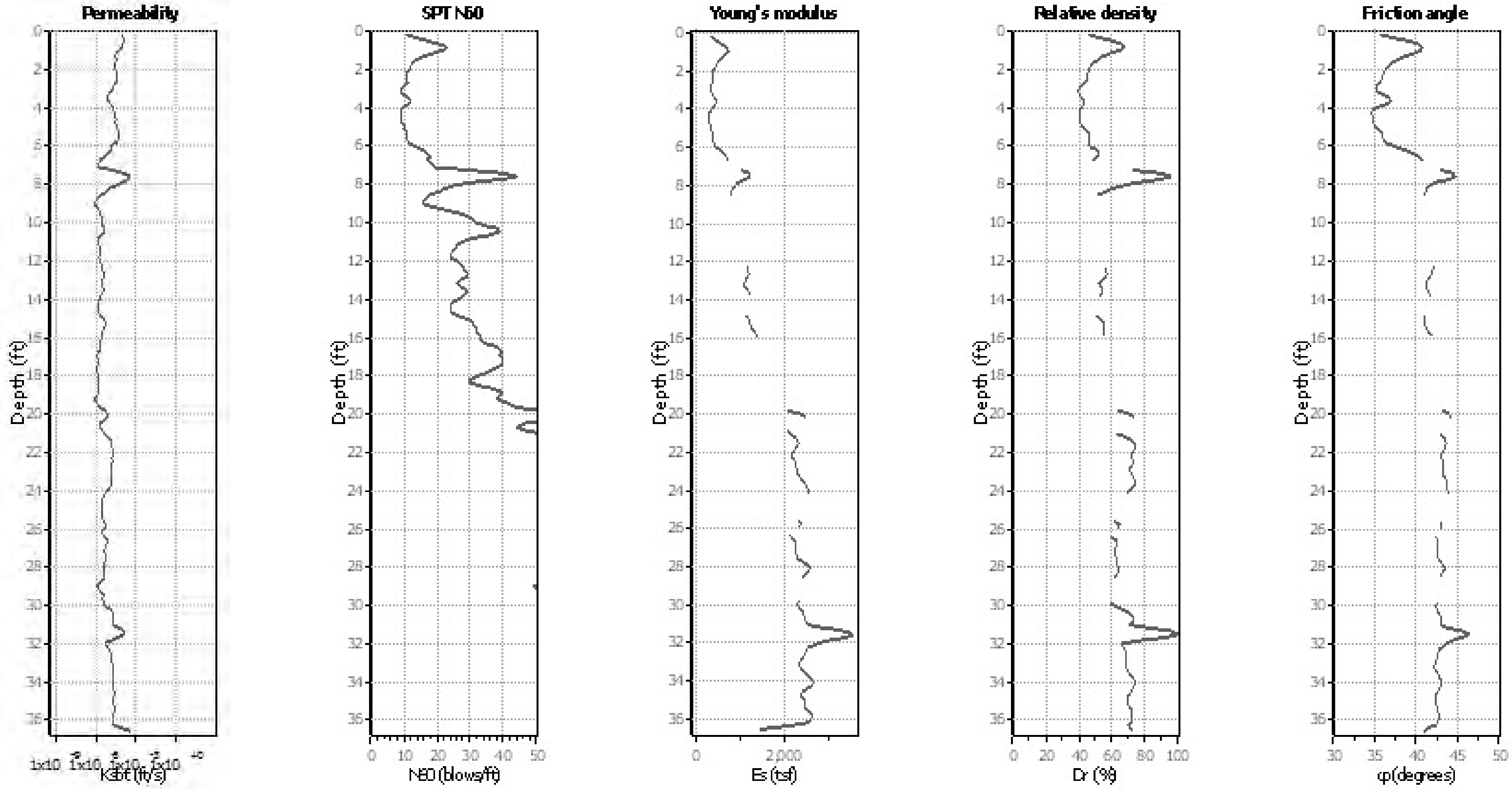
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



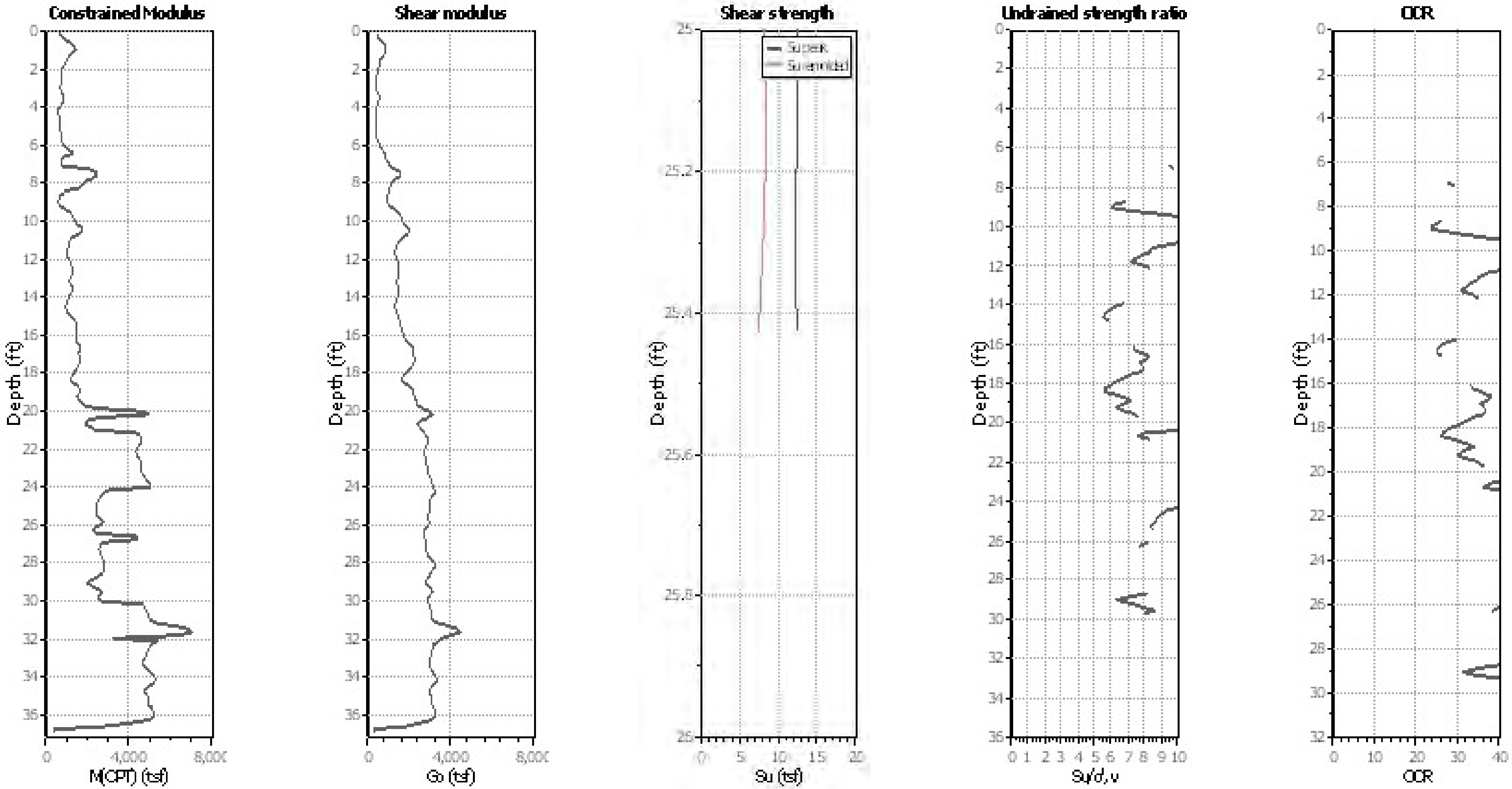
Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



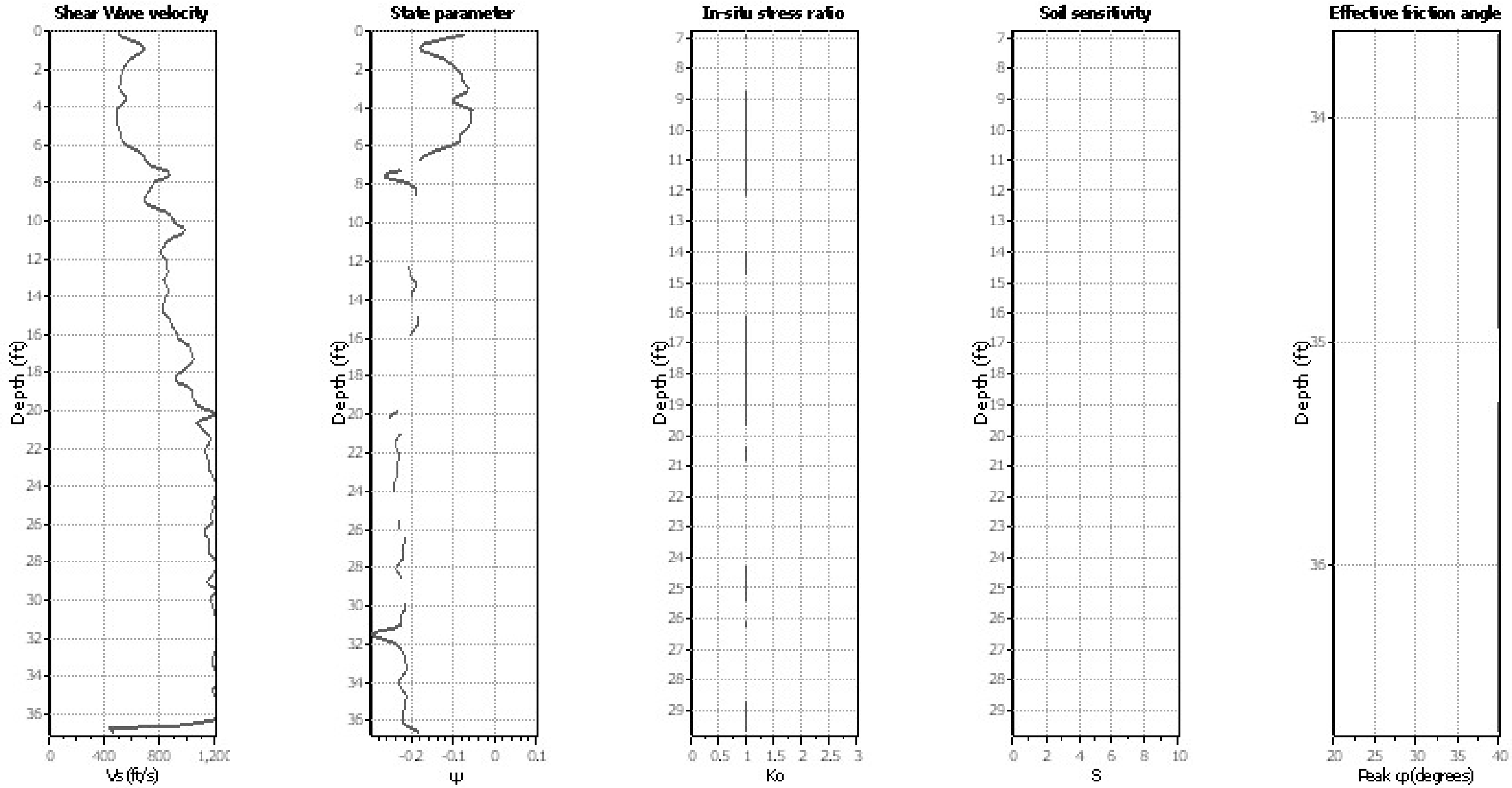
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

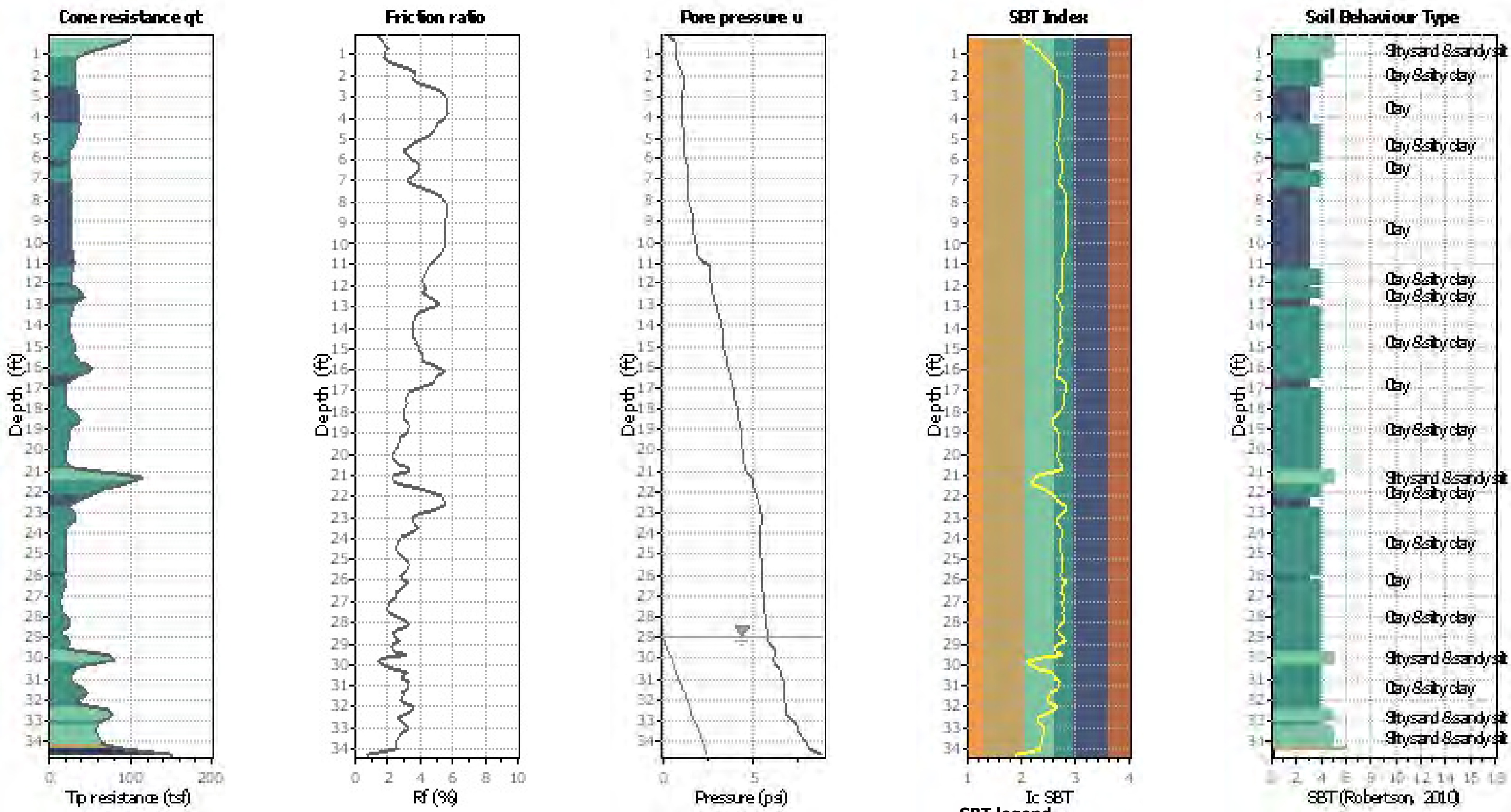
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



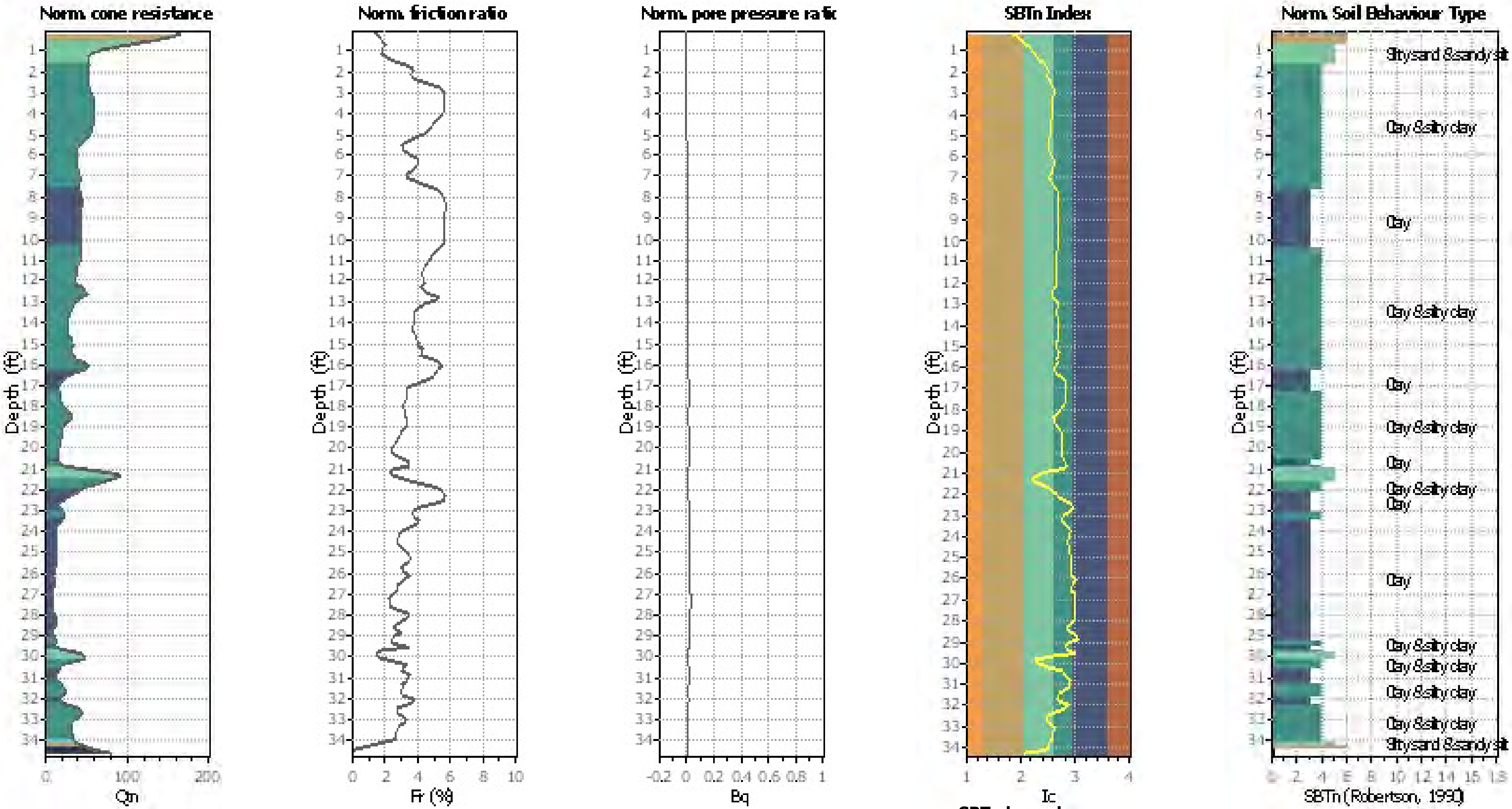
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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Engineering Consultants, Irvine California
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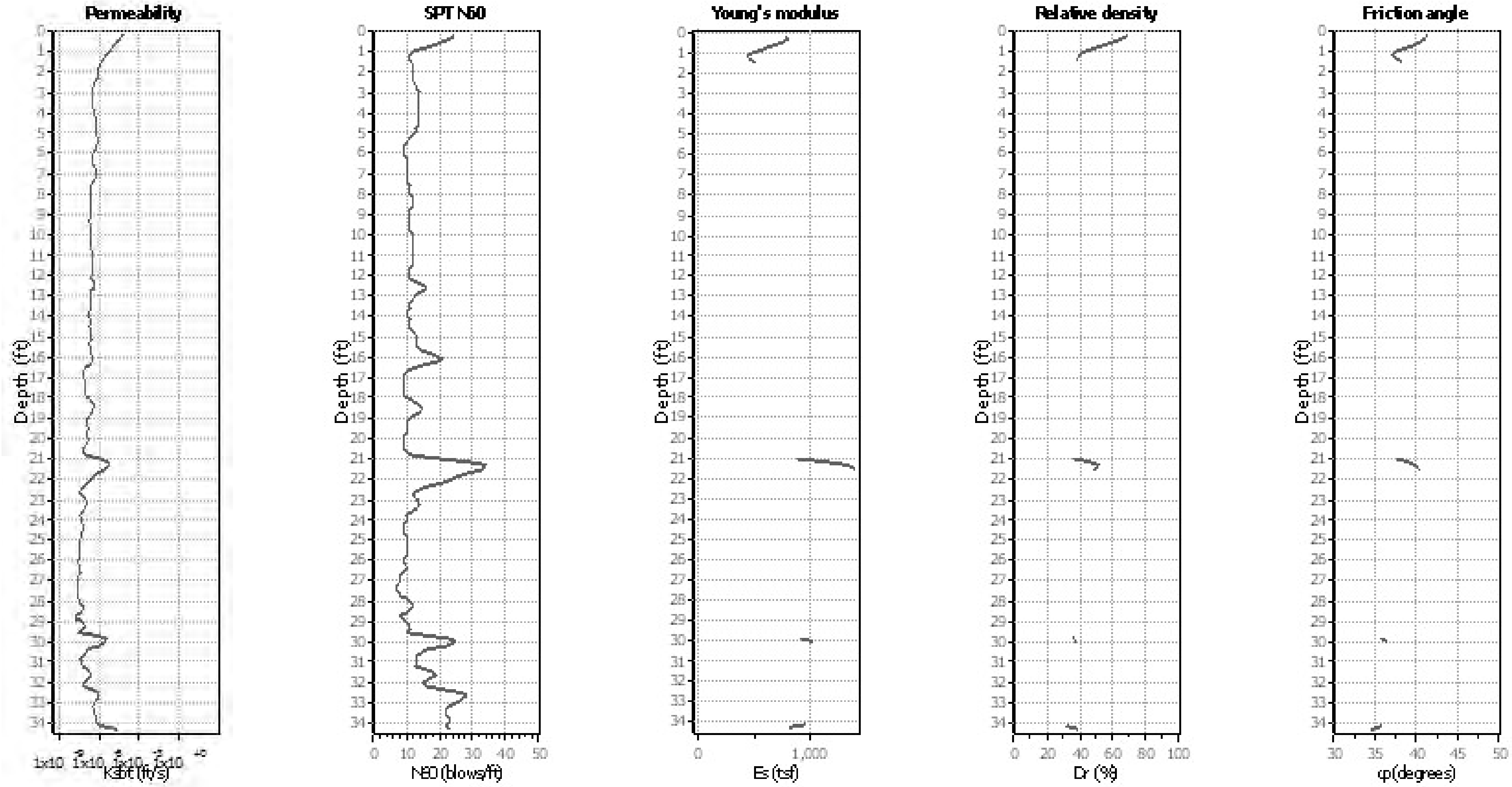
CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



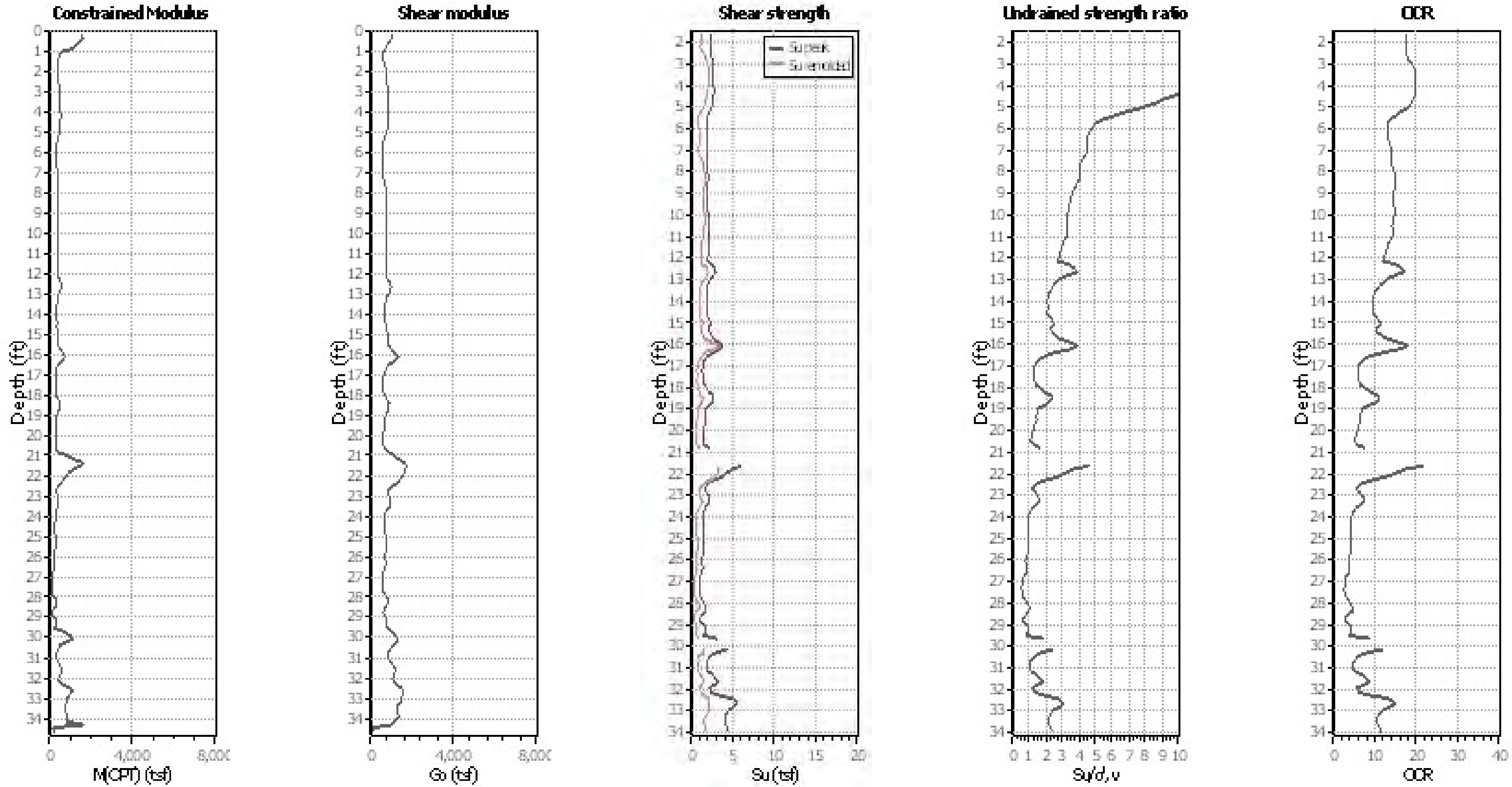
Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

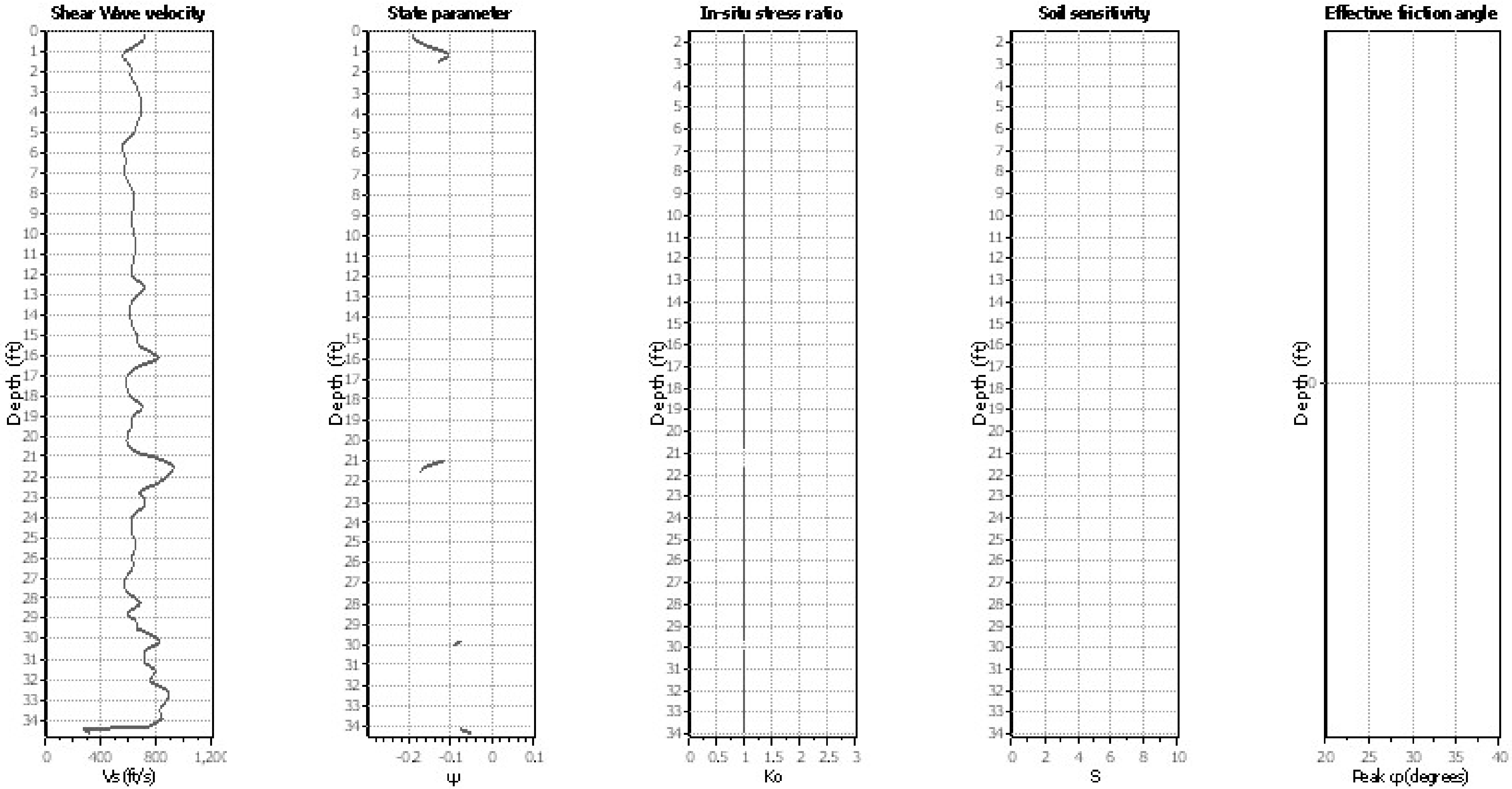


Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

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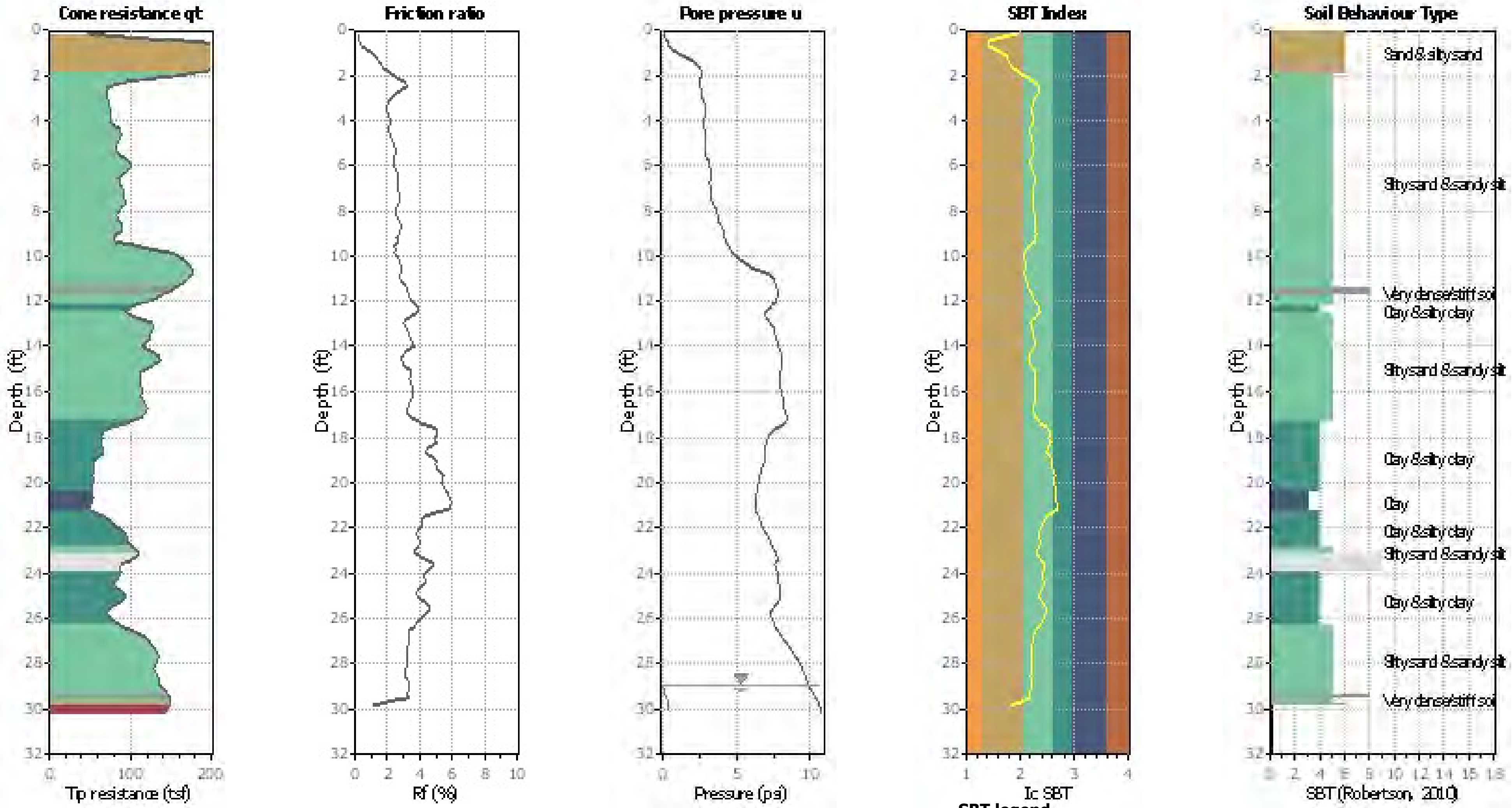
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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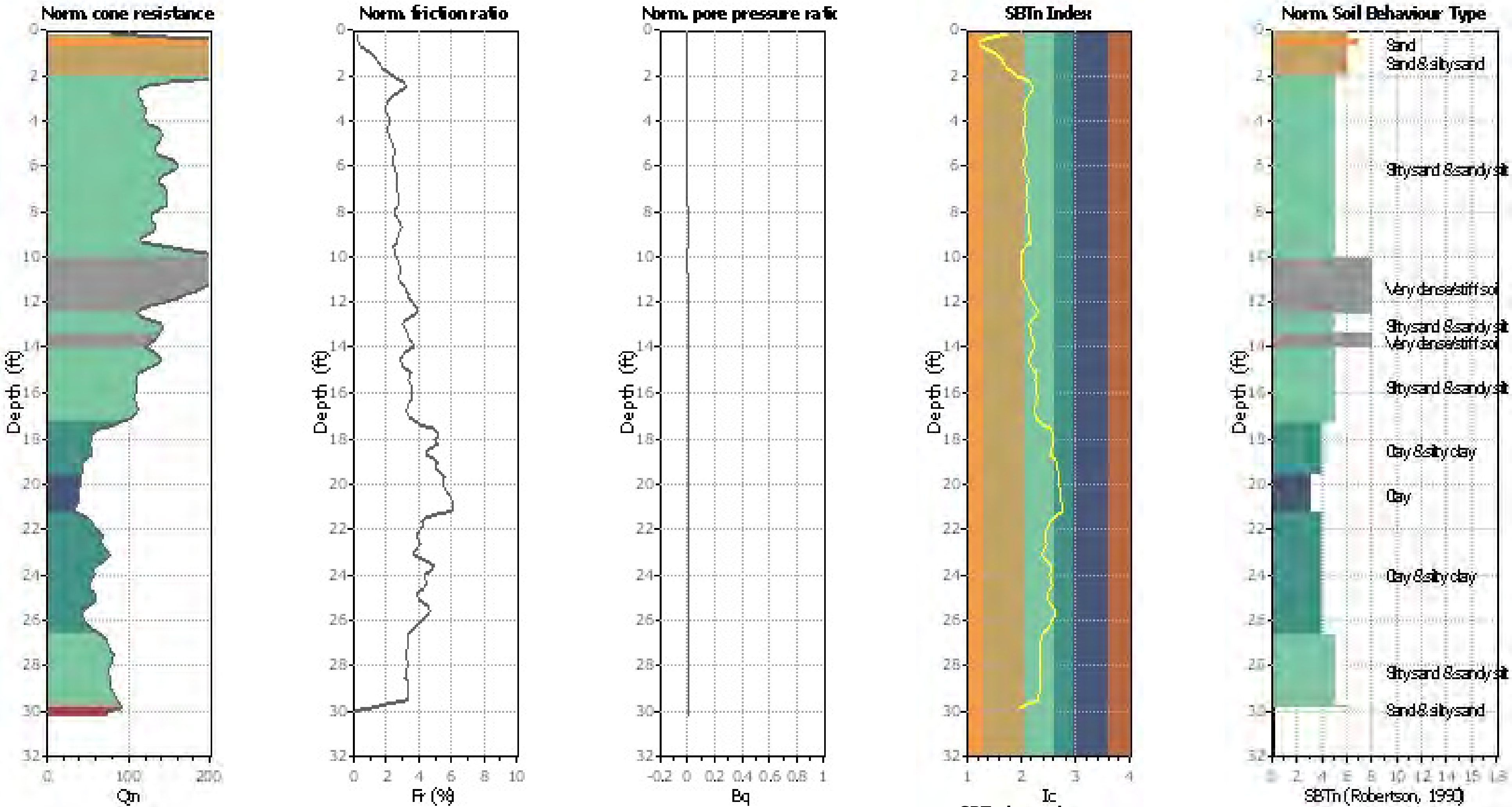
CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



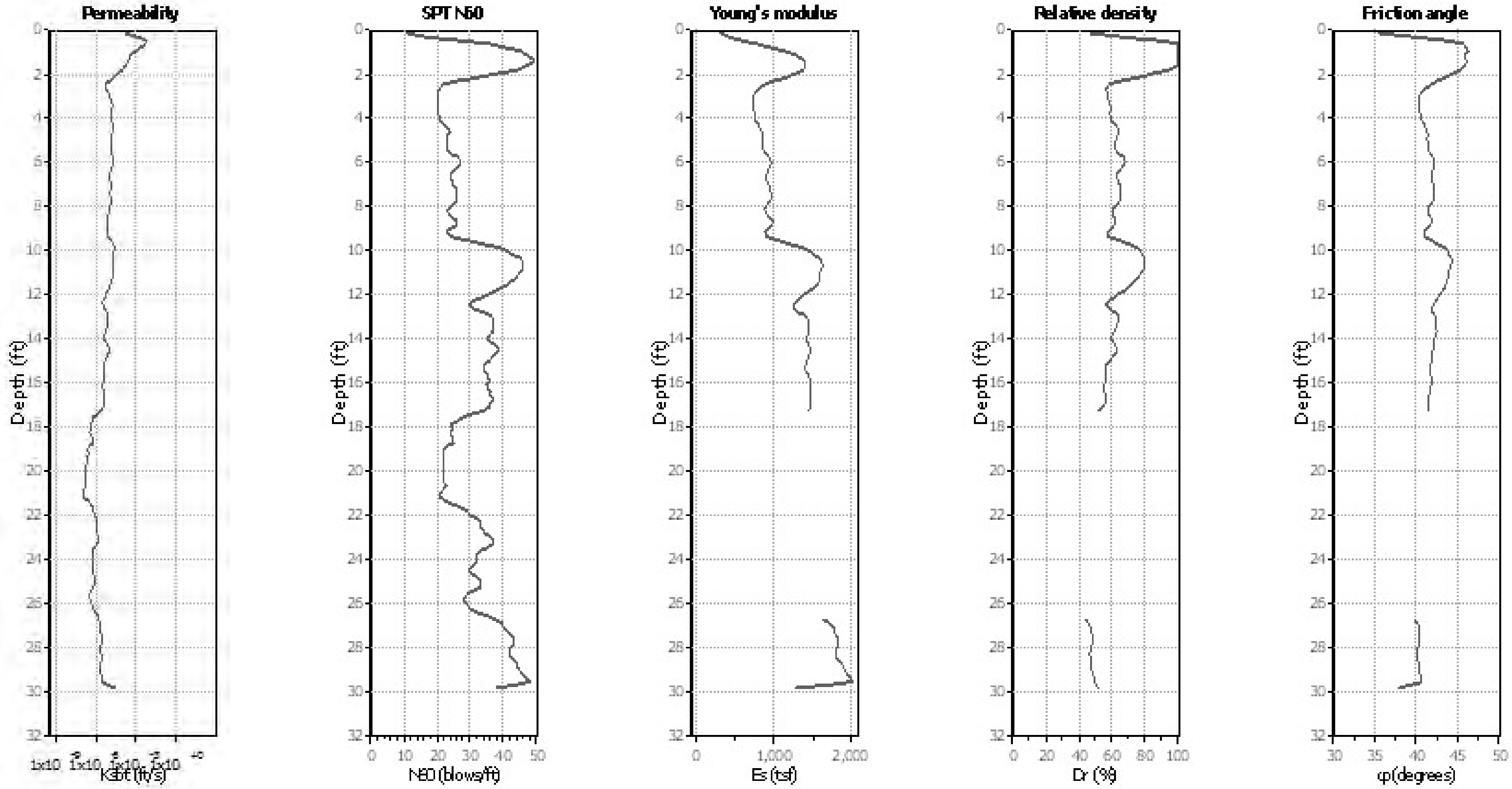
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

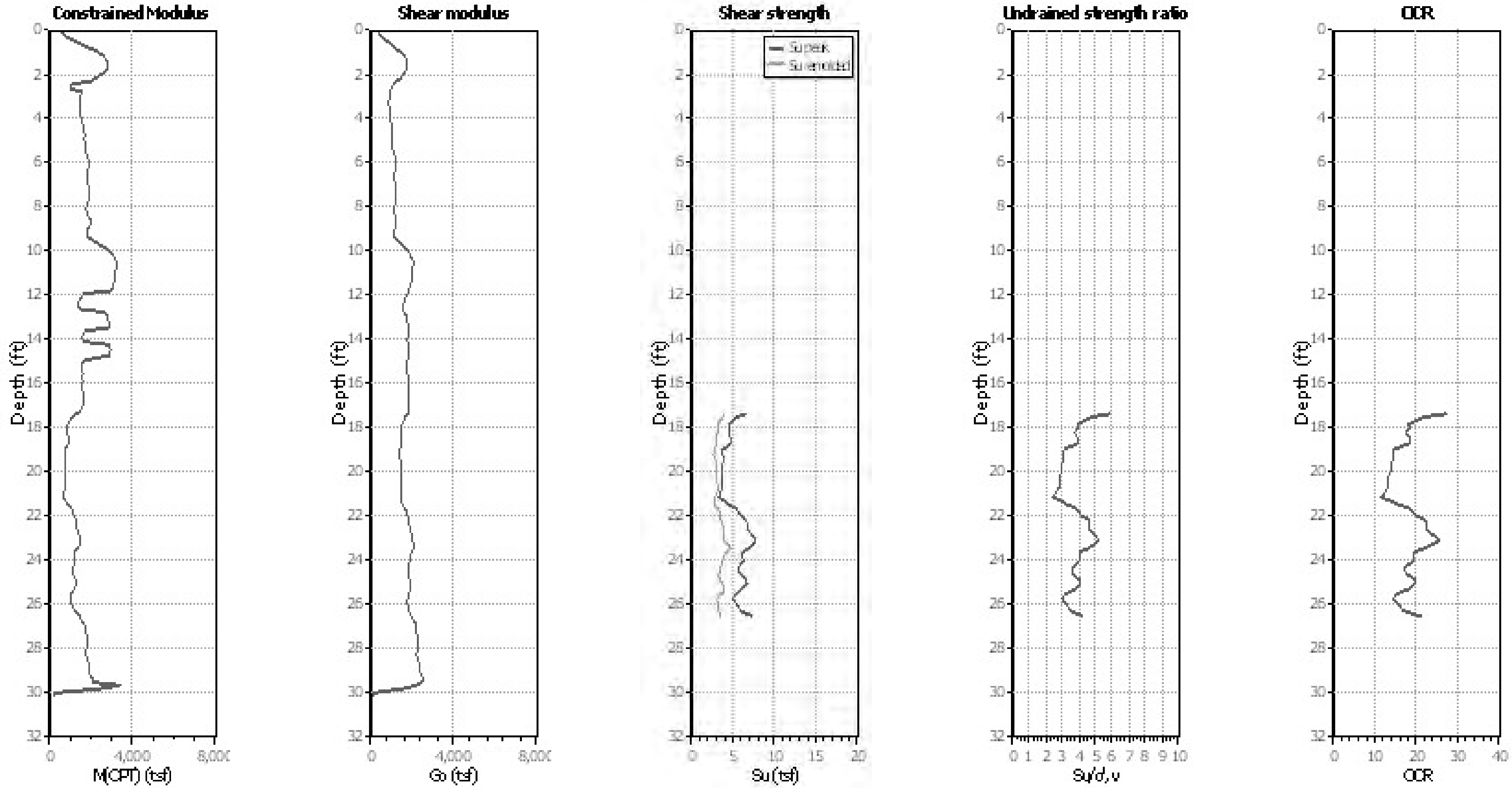


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



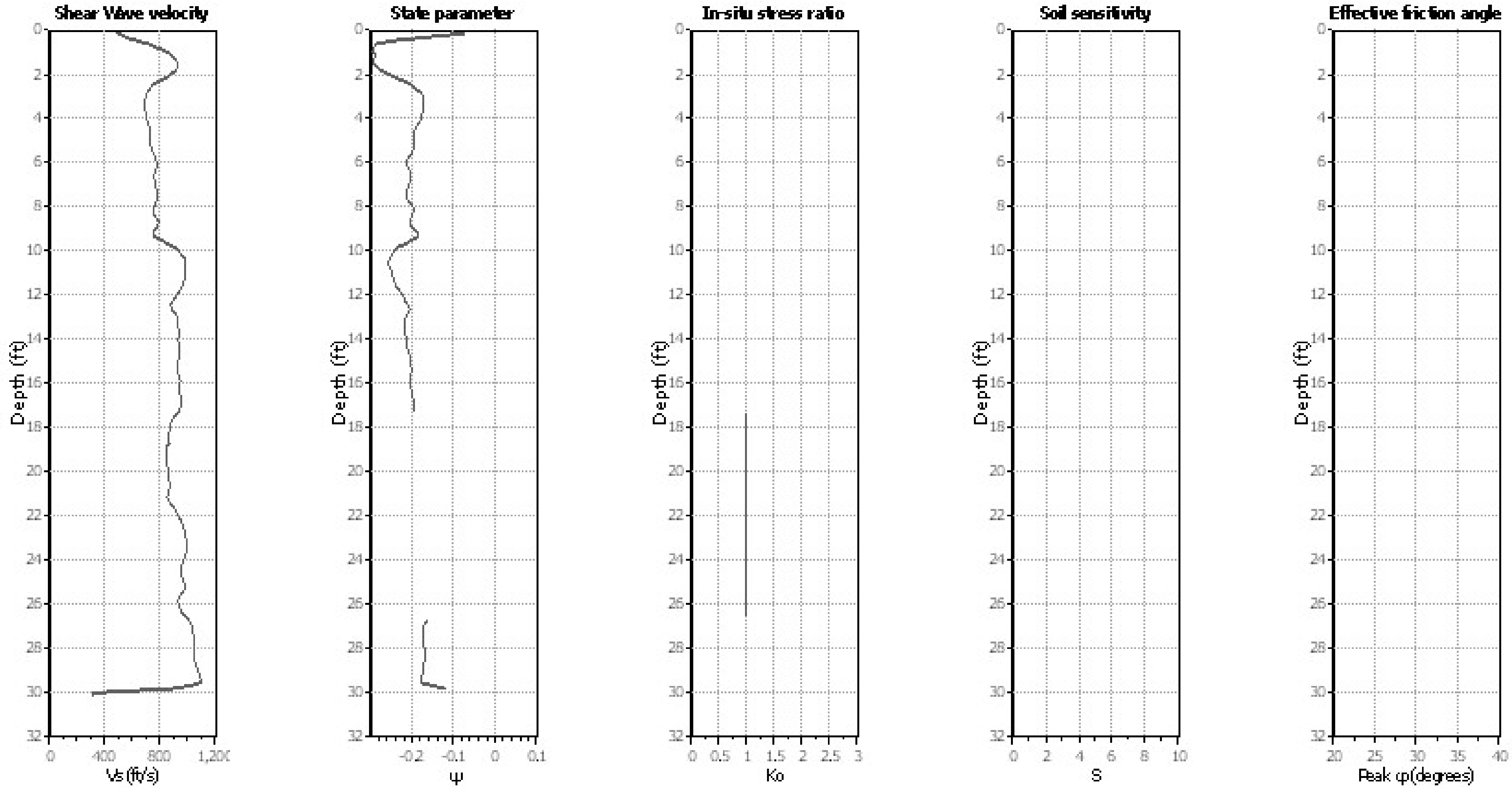
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



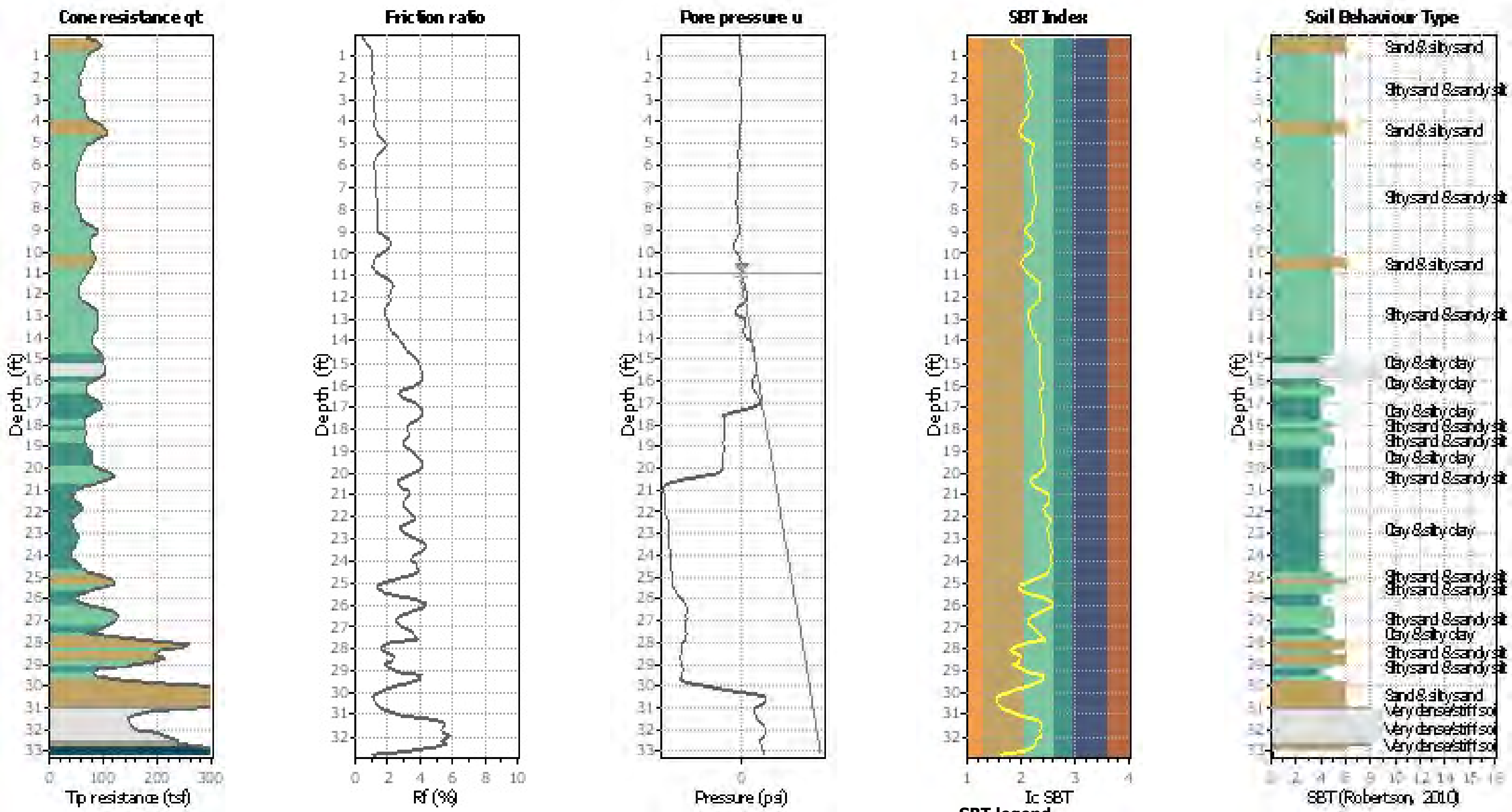
Calculation parameters

Soil Sensitivity factor, N_S: 350.00
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



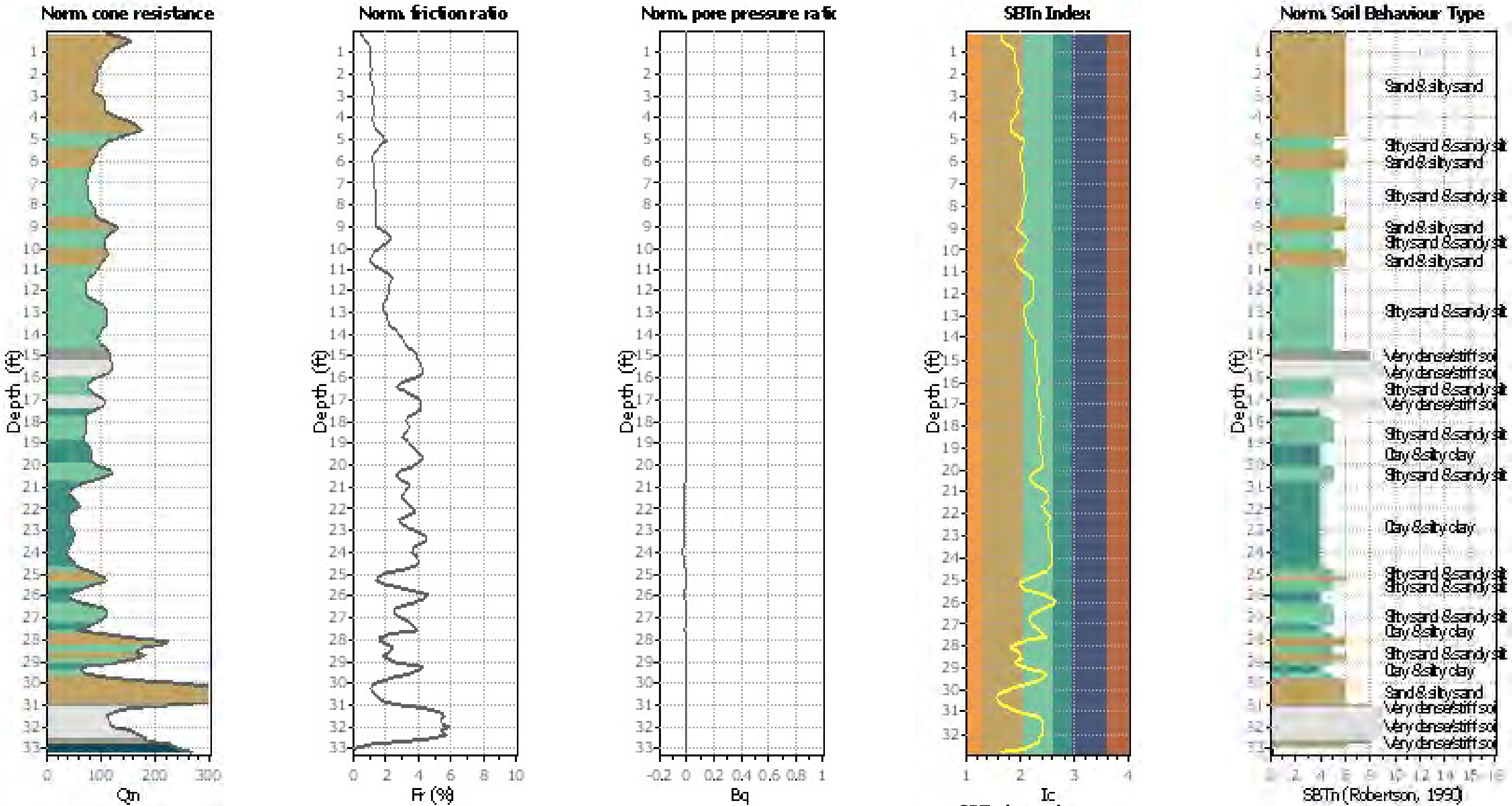
SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



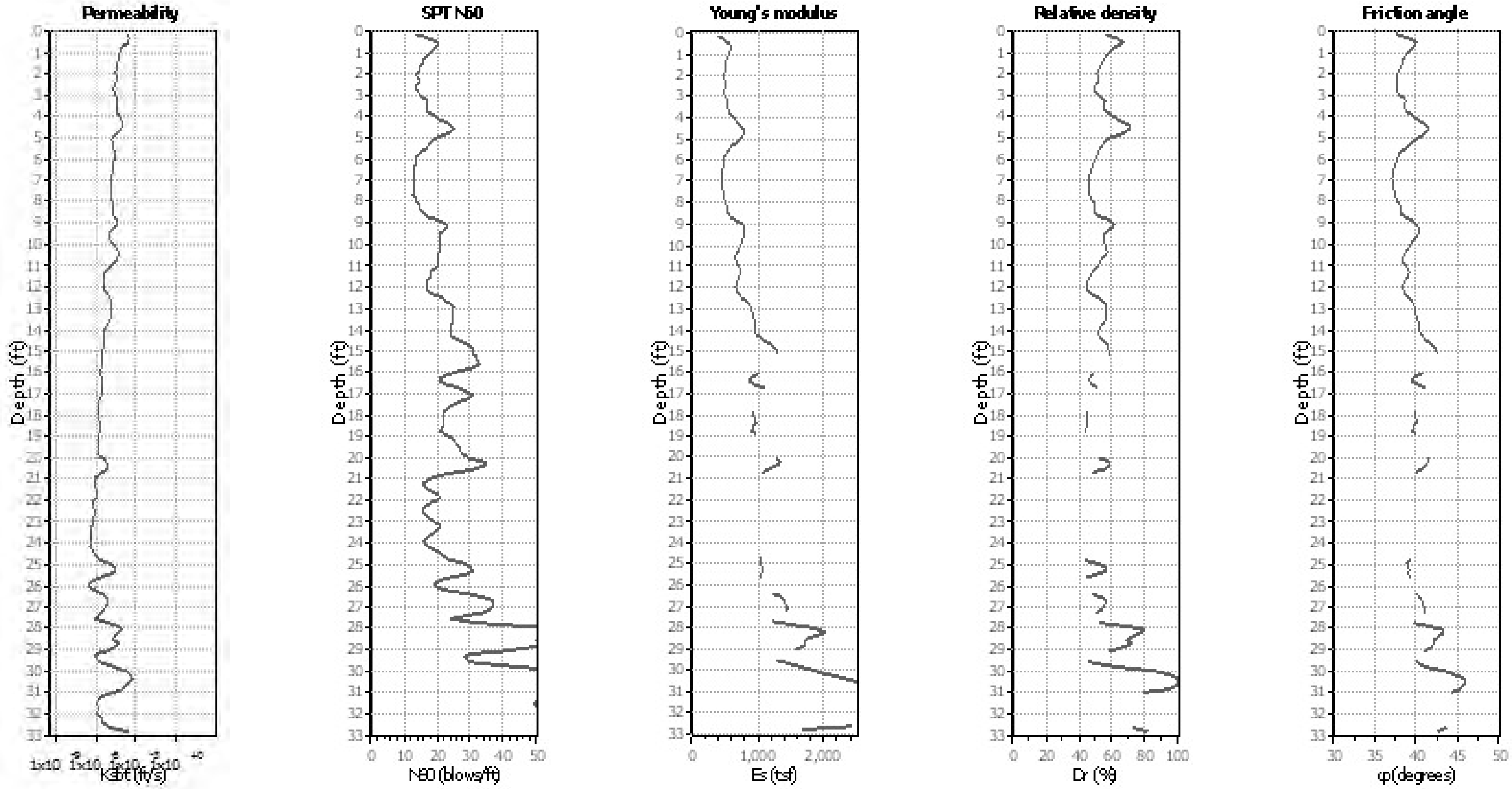
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

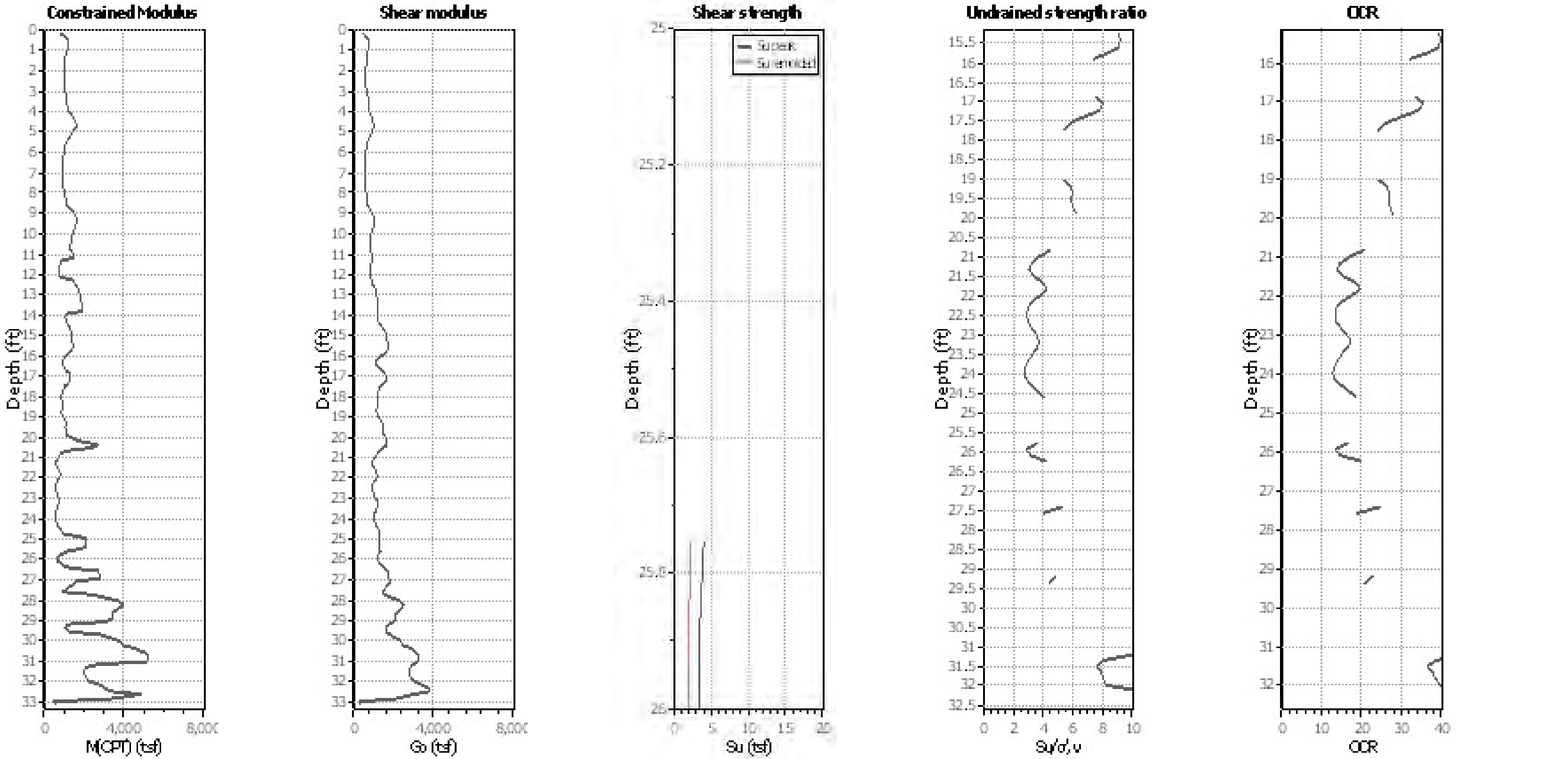


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

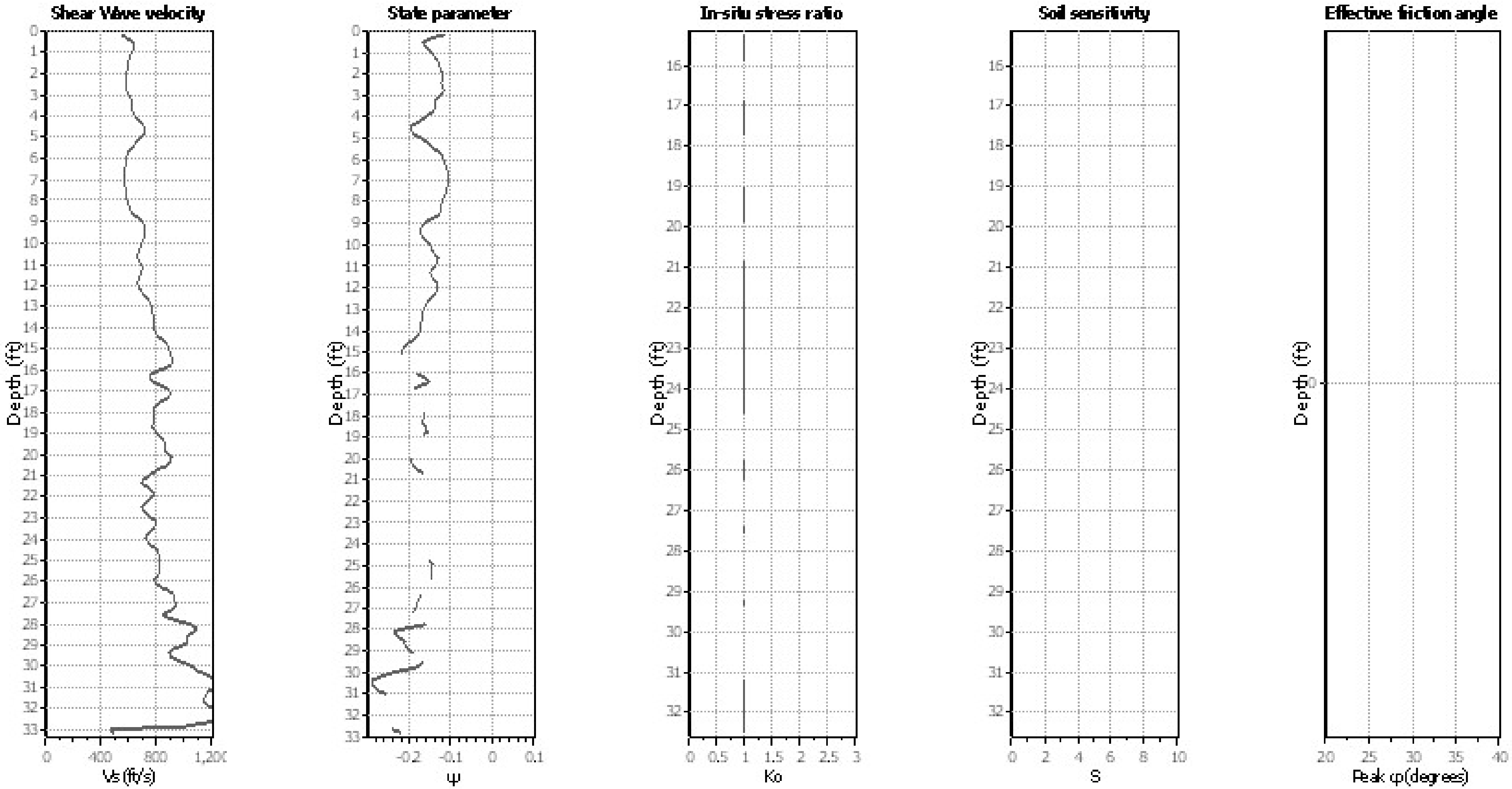


Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

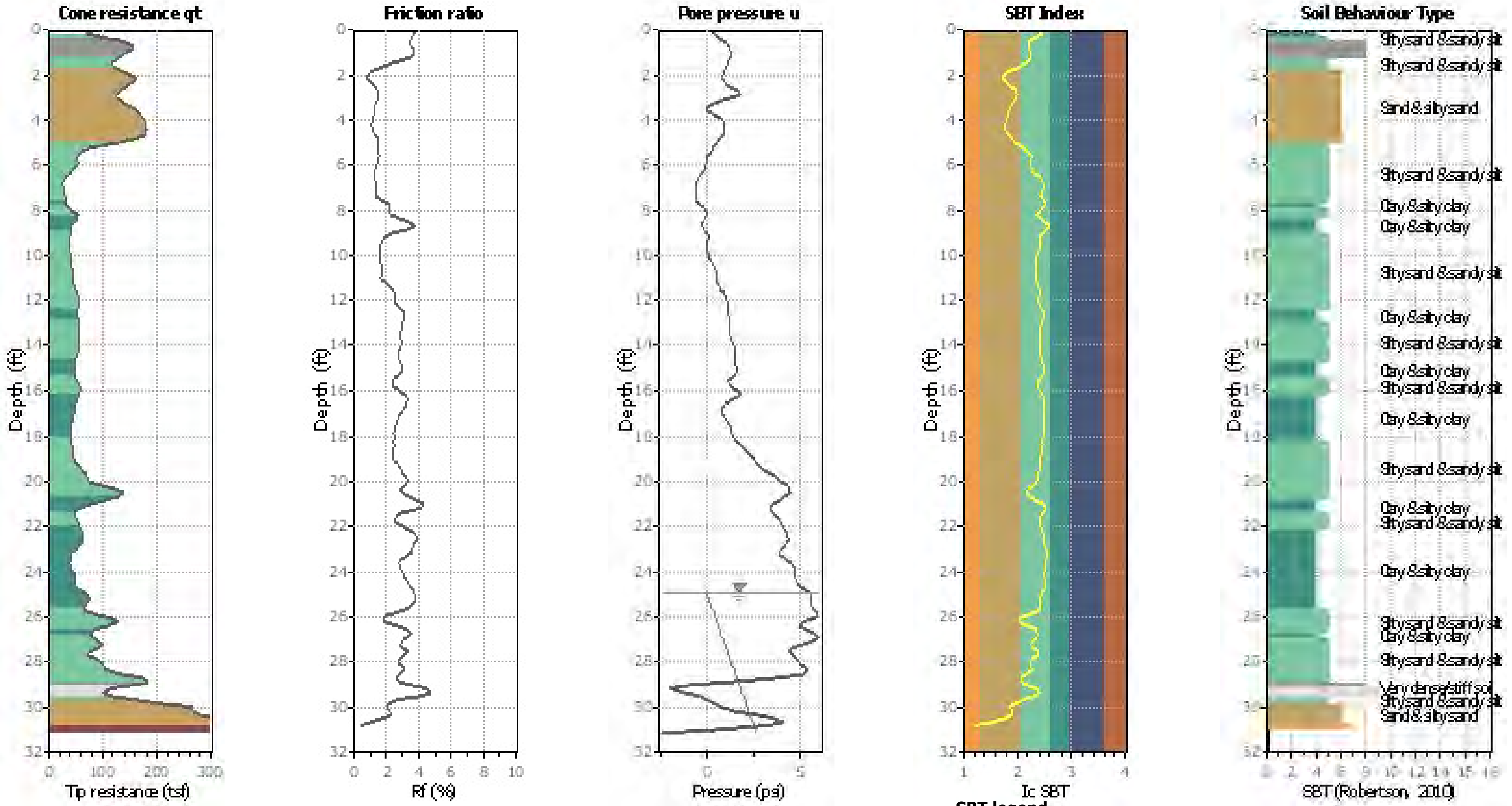
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8

Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



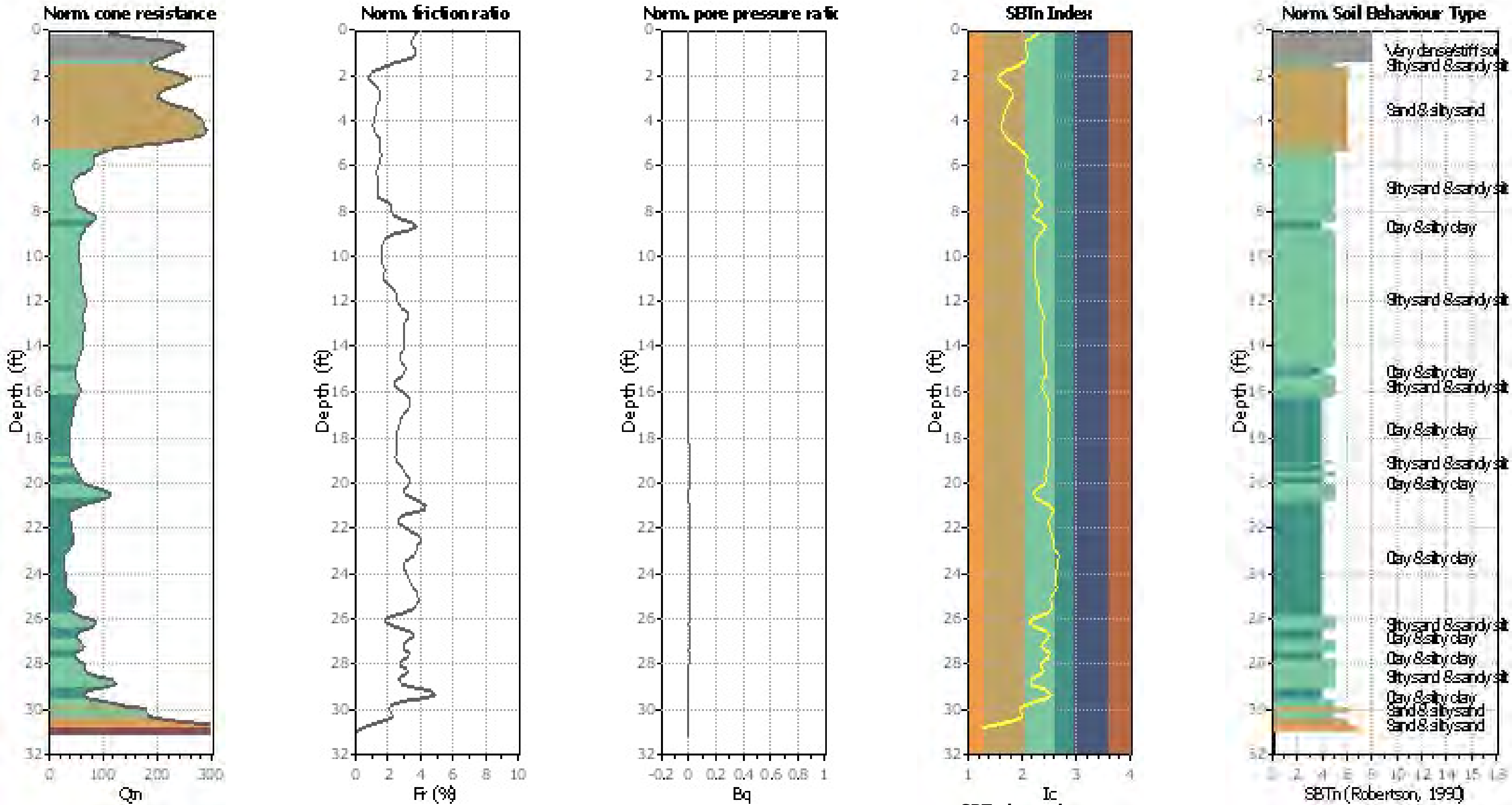
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



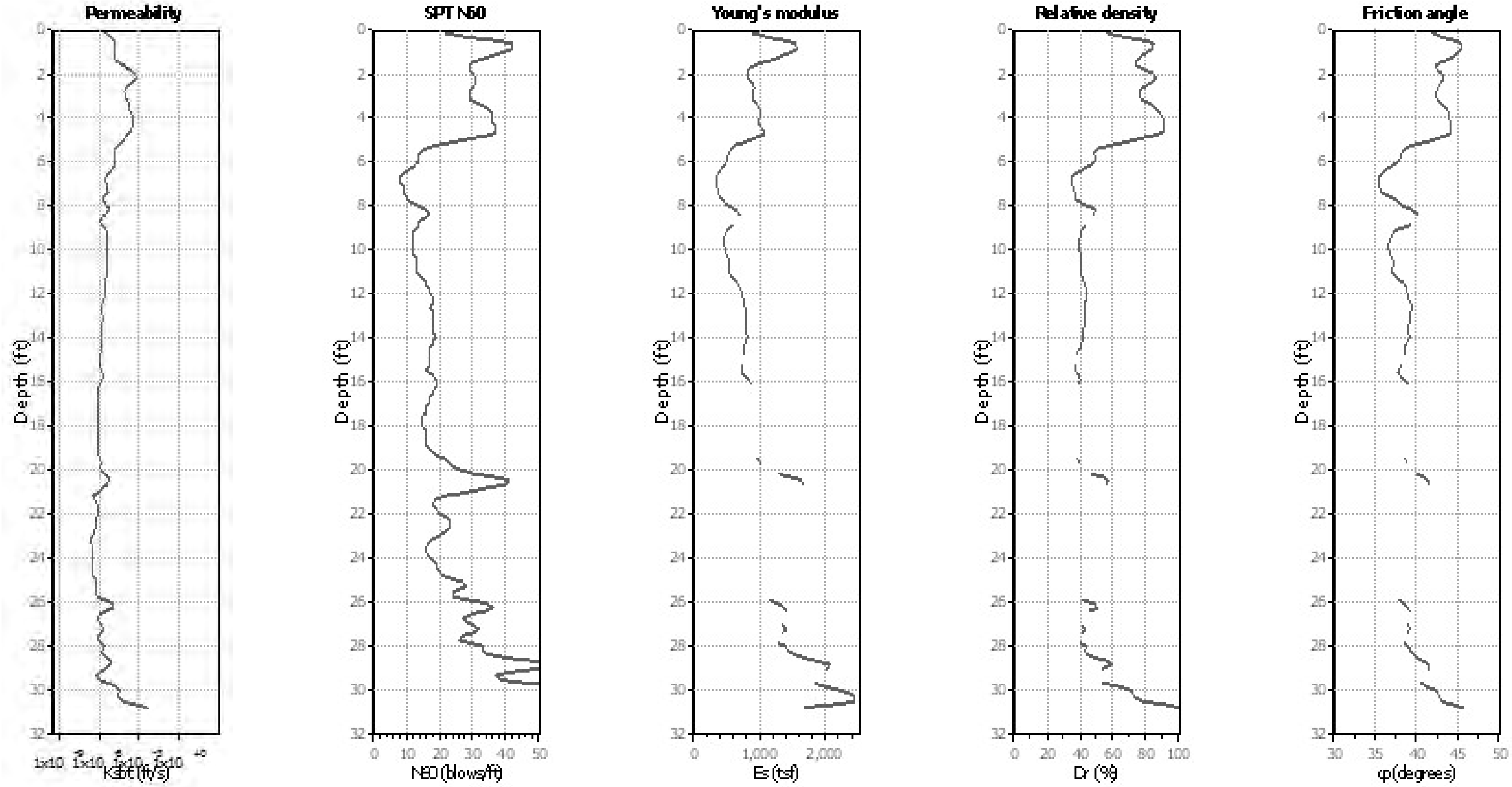
SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

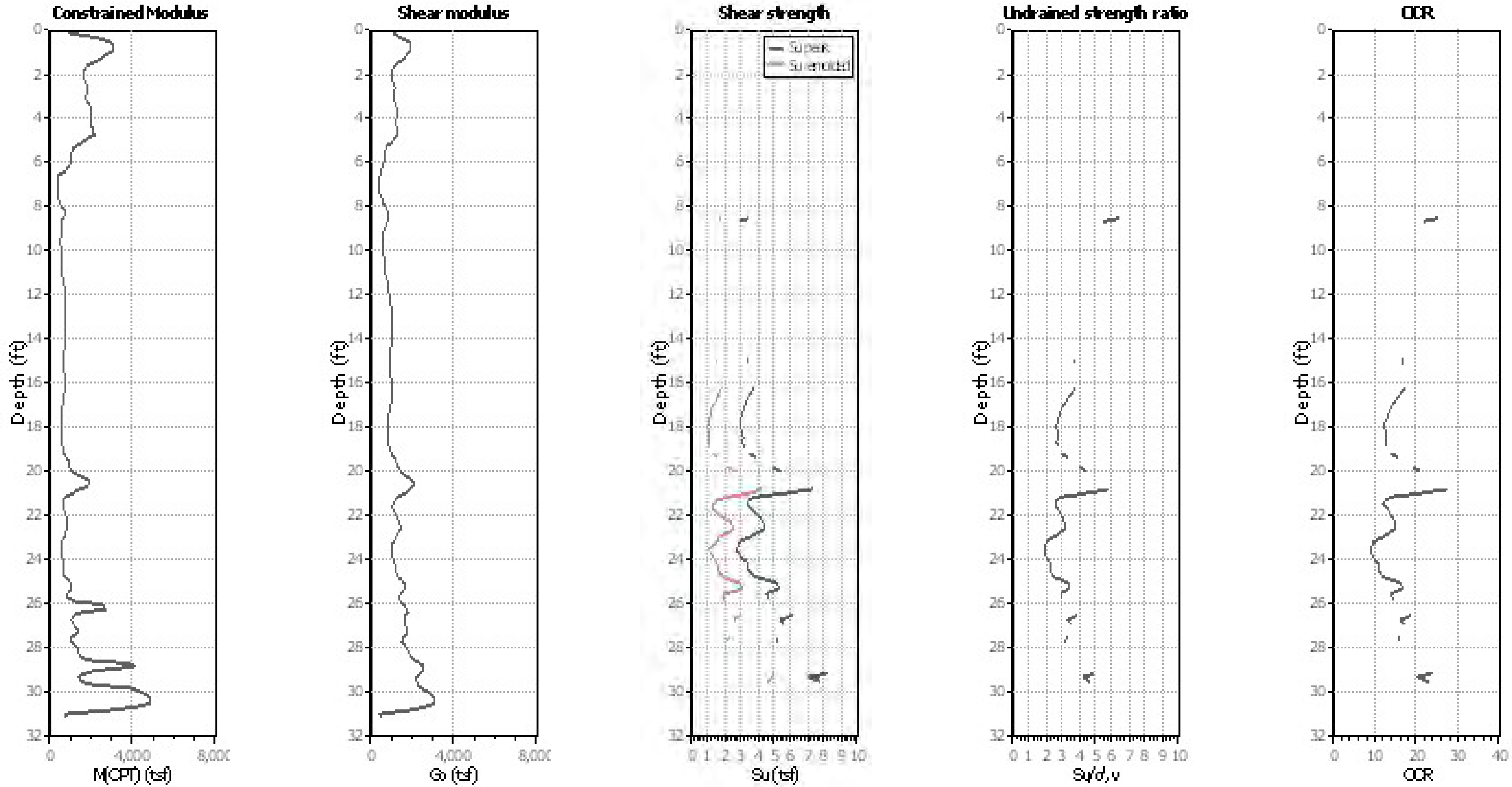


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



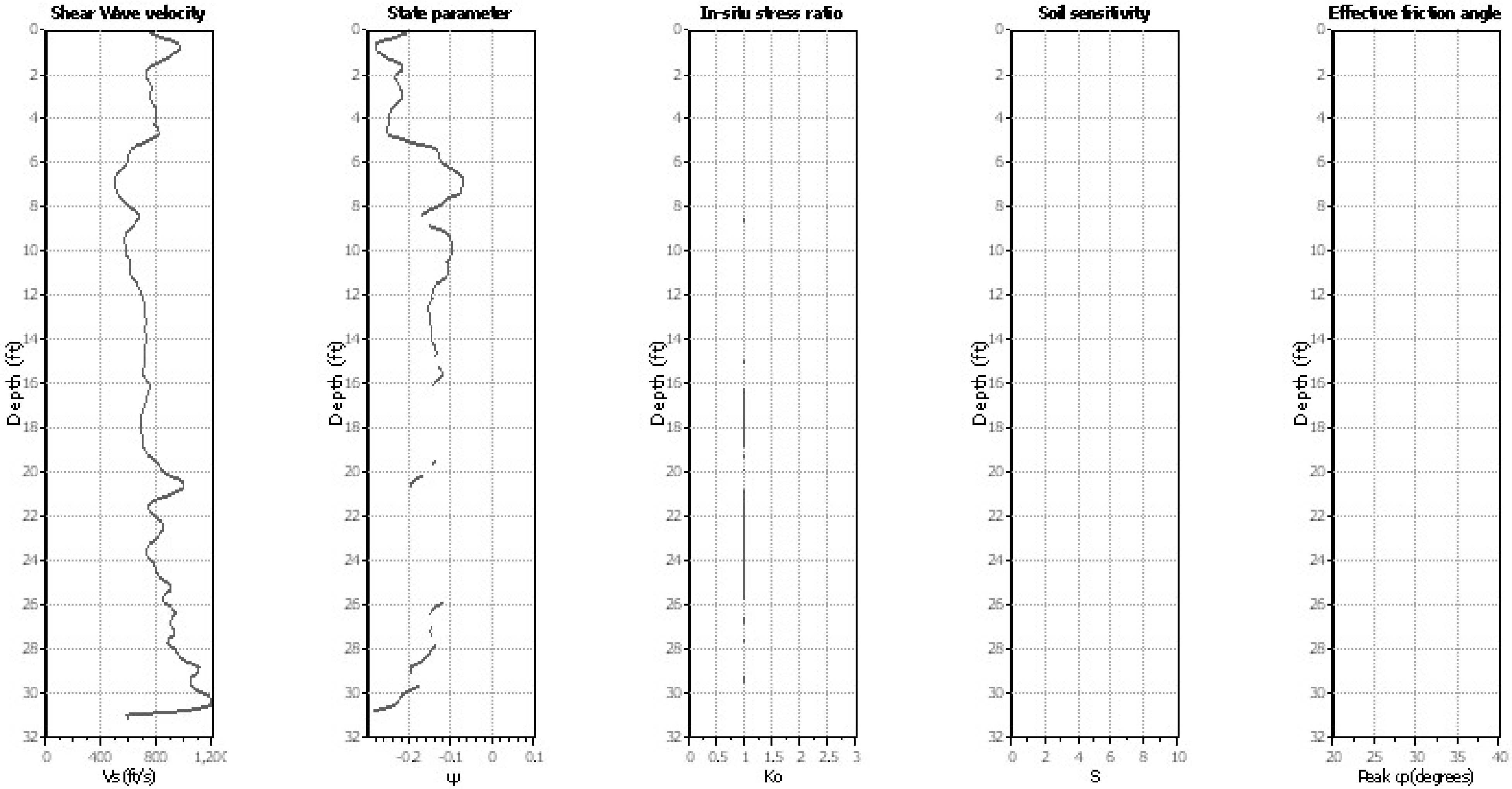
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



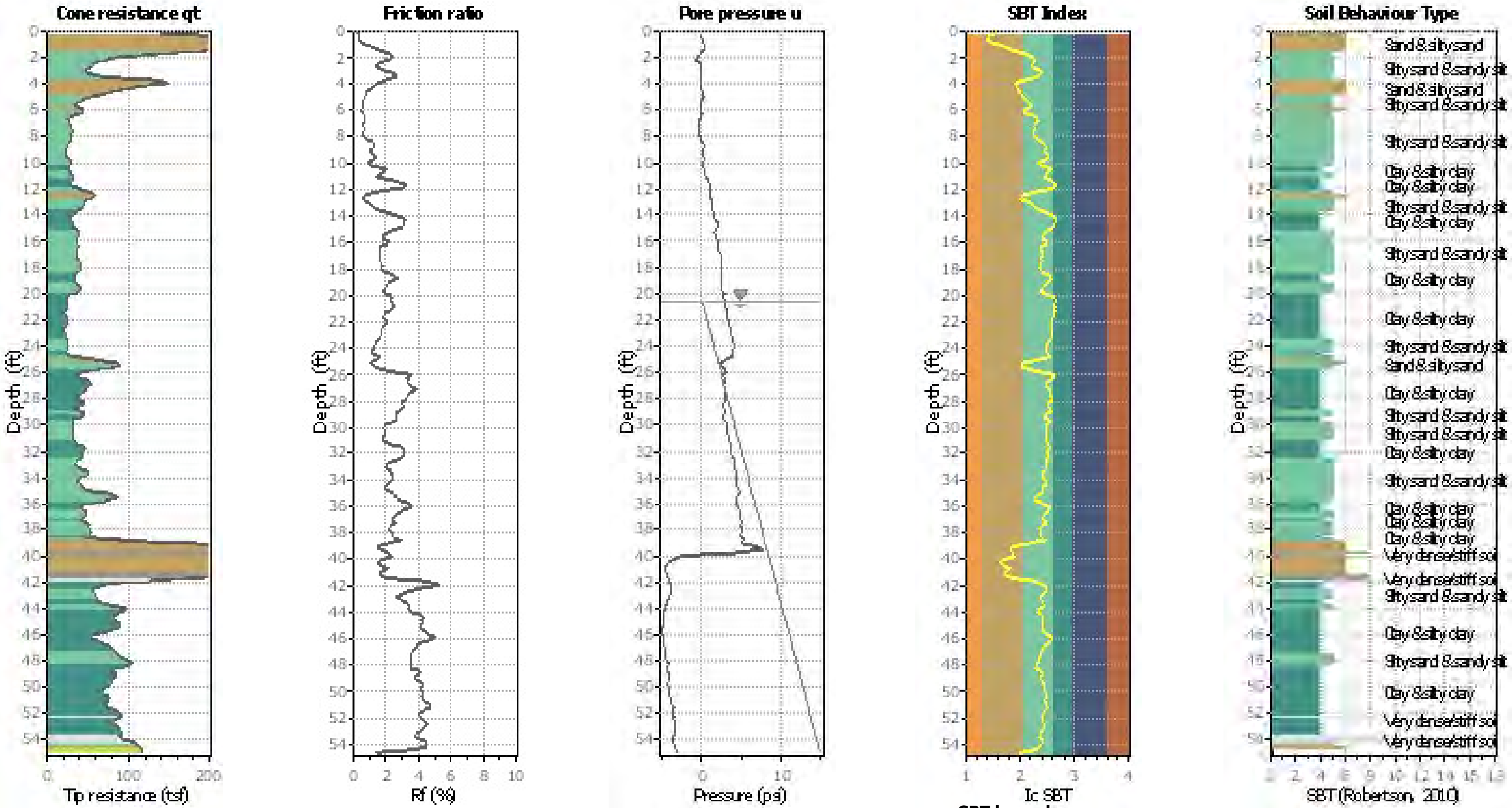
Calculation parameters

Soil Sensitivity factor, N_S: 350.00
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



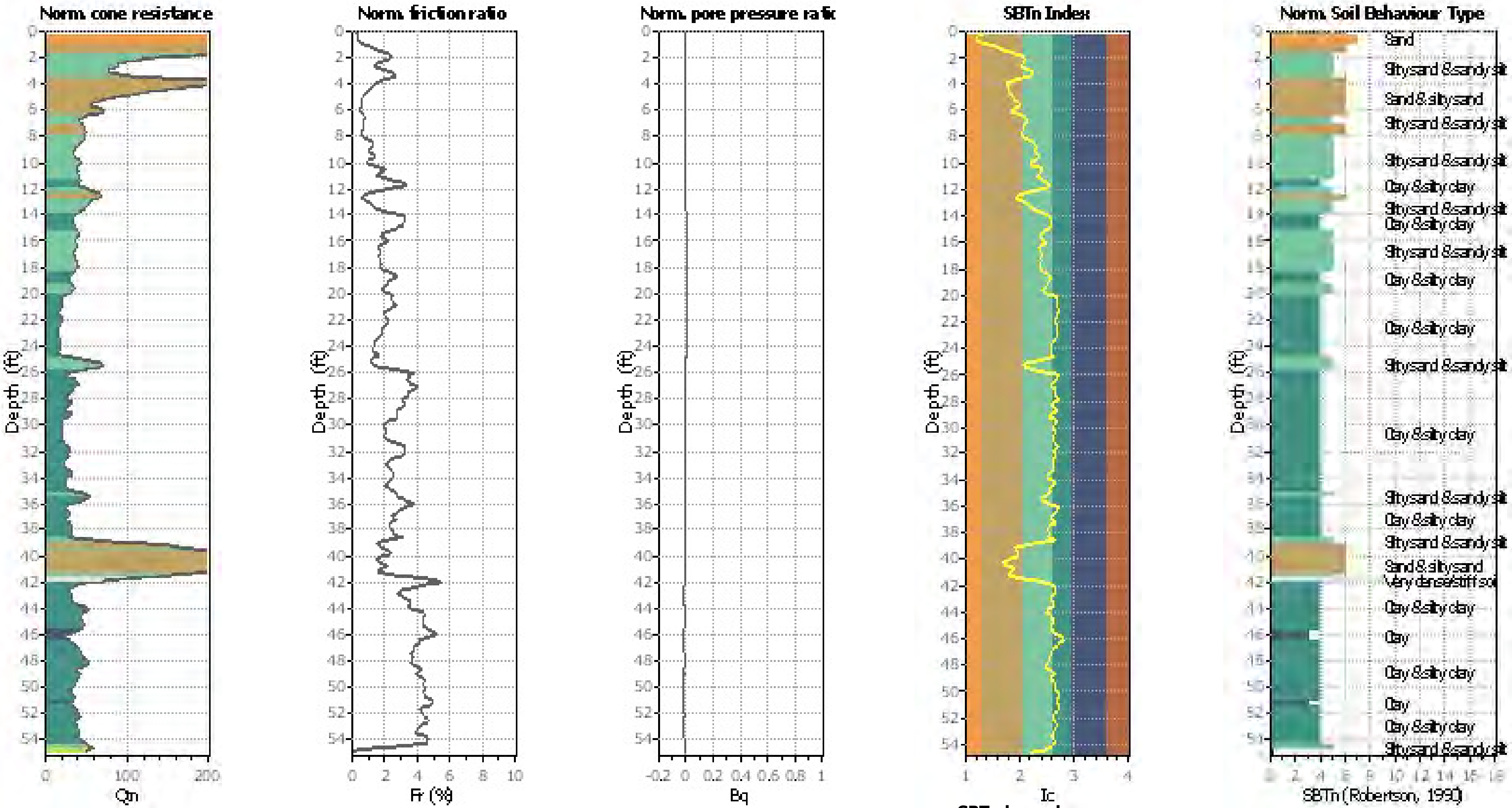
SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



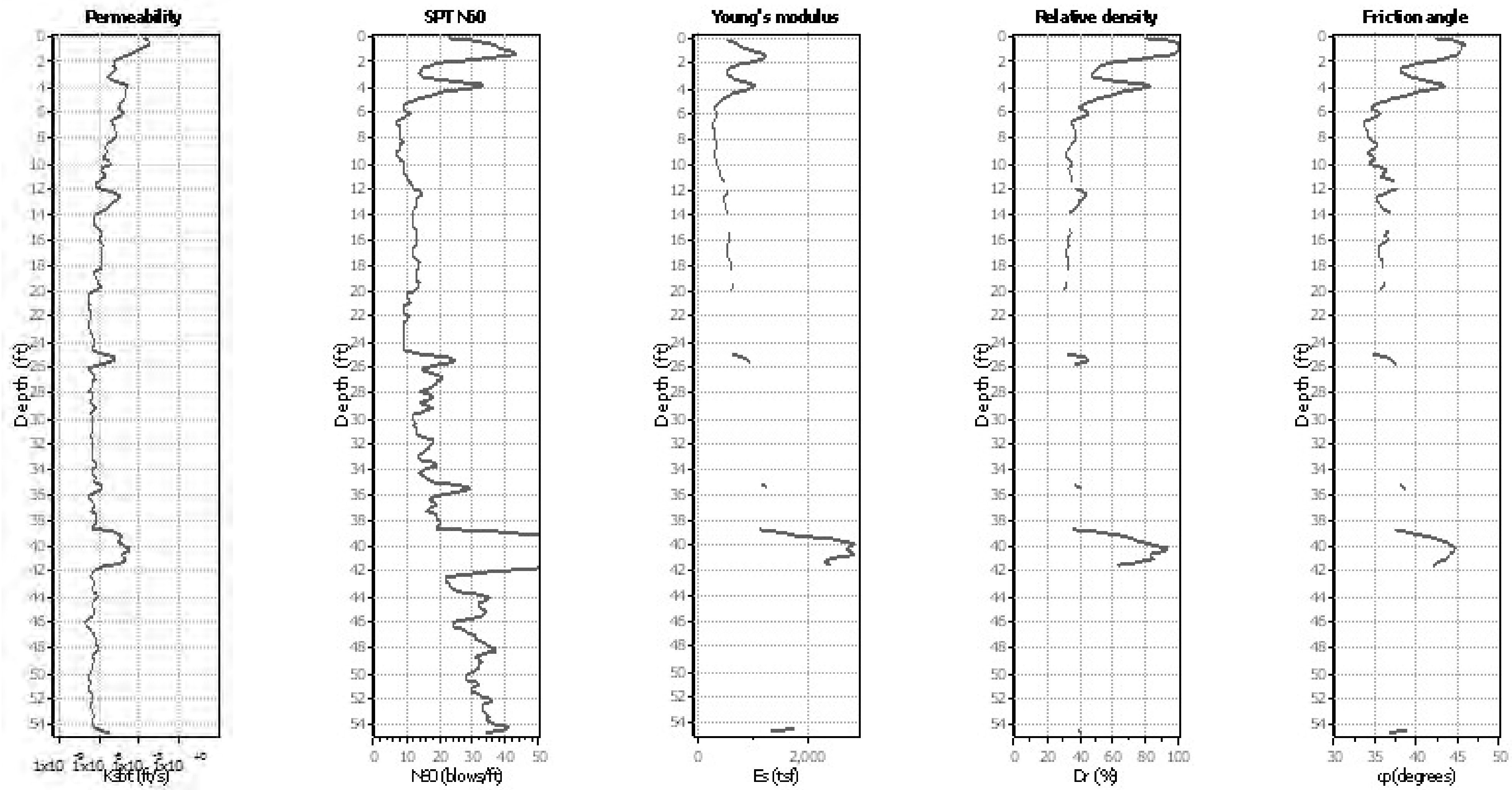
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

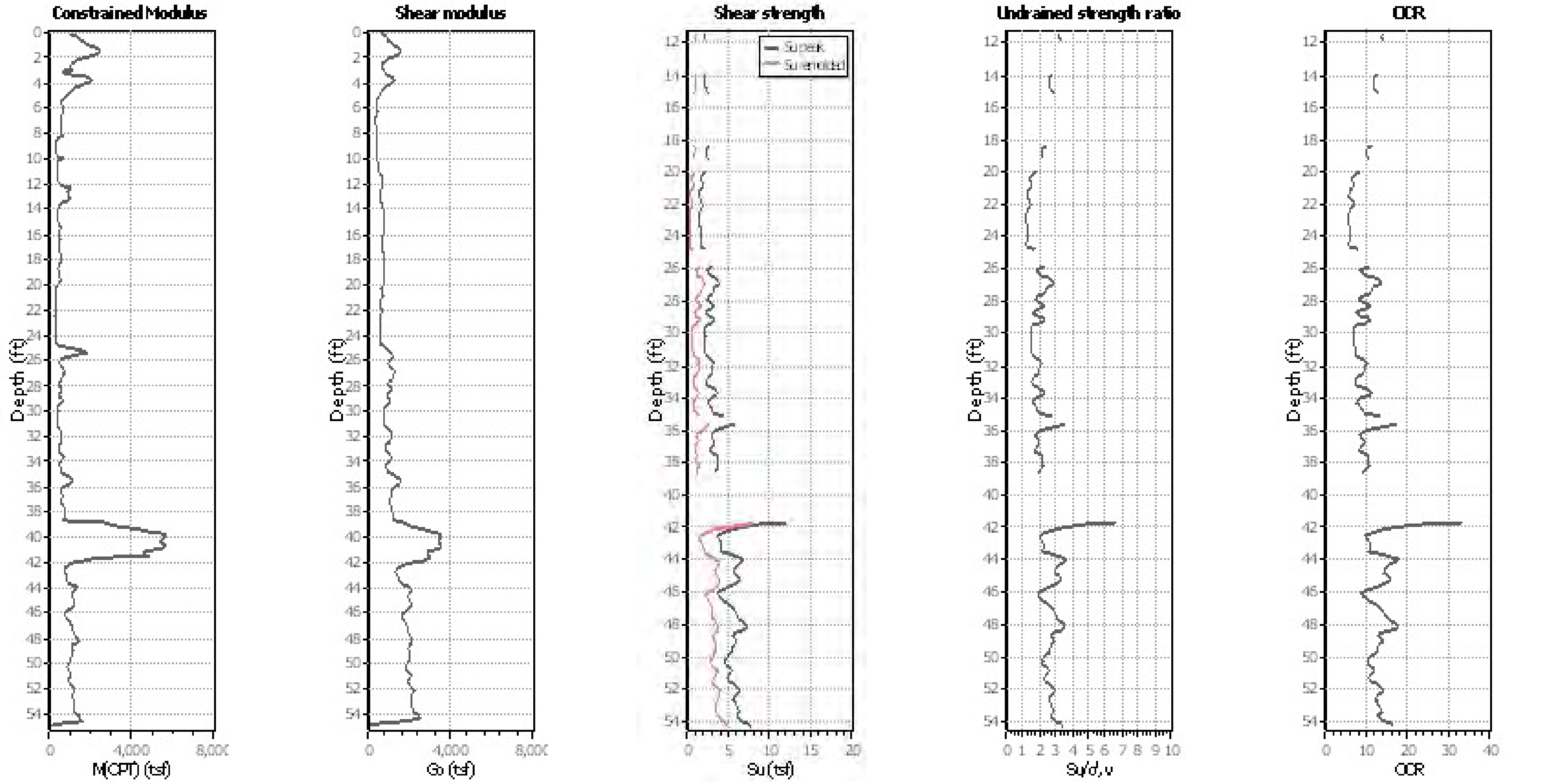


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



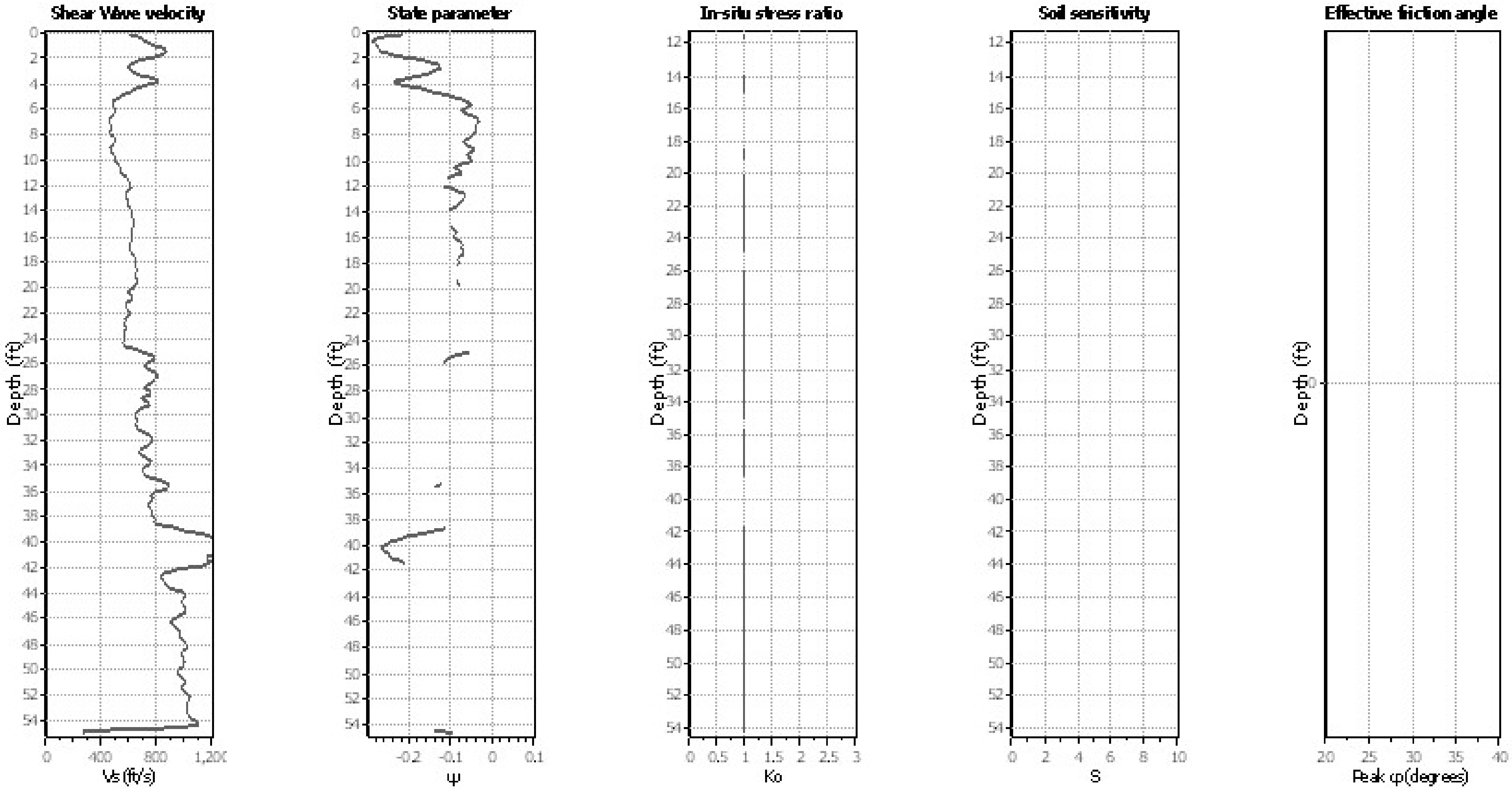
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

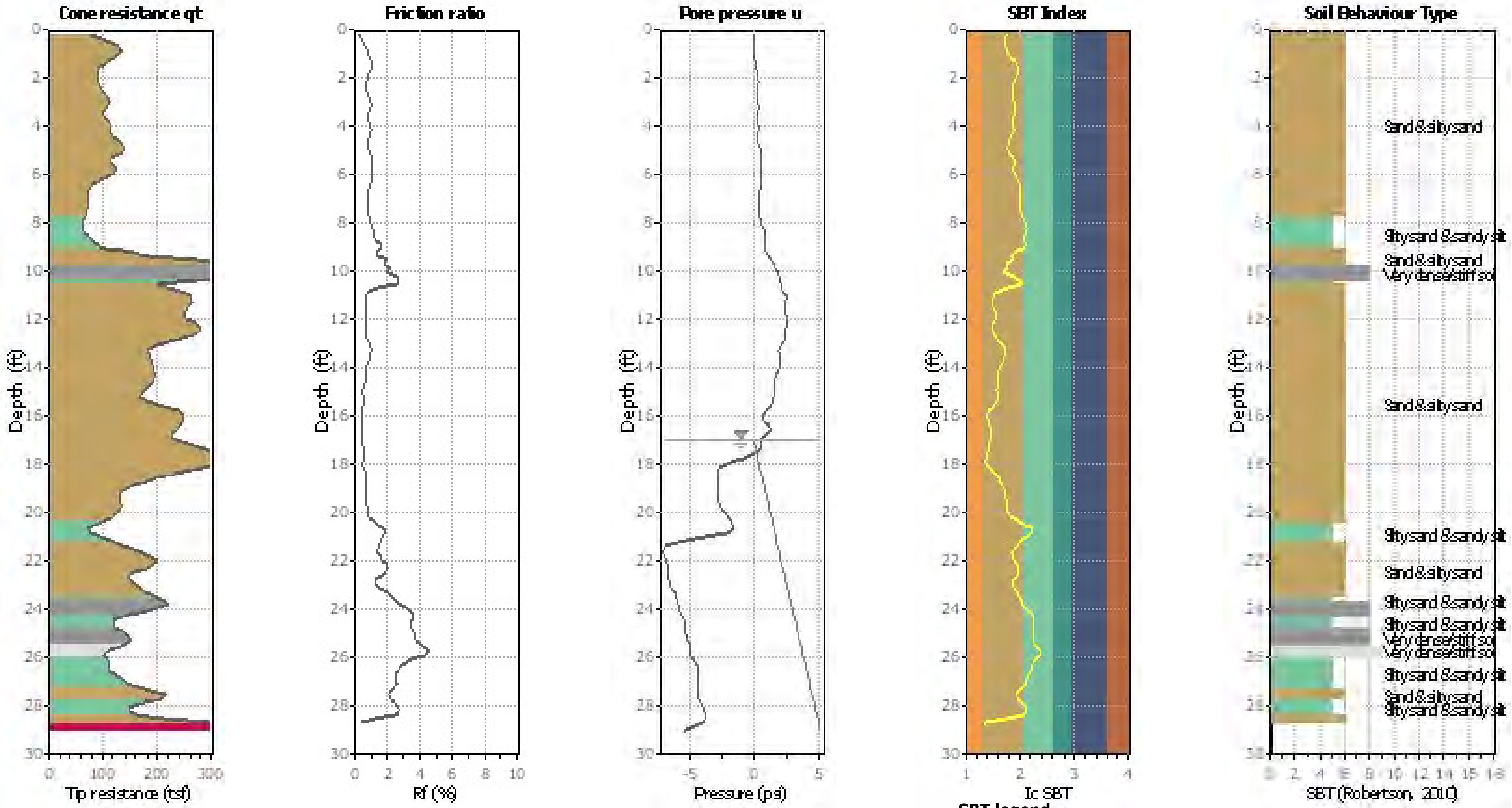
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



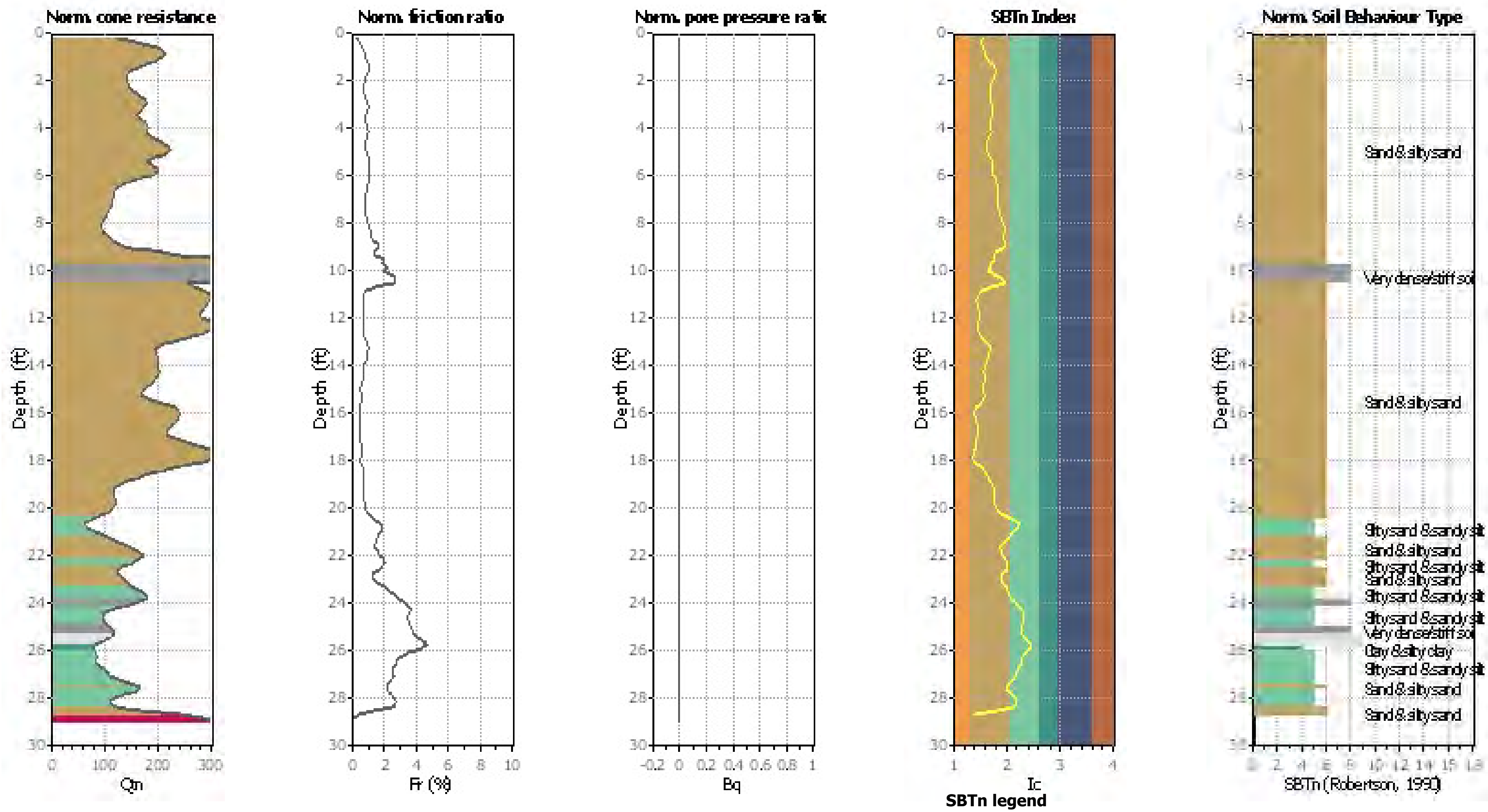
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

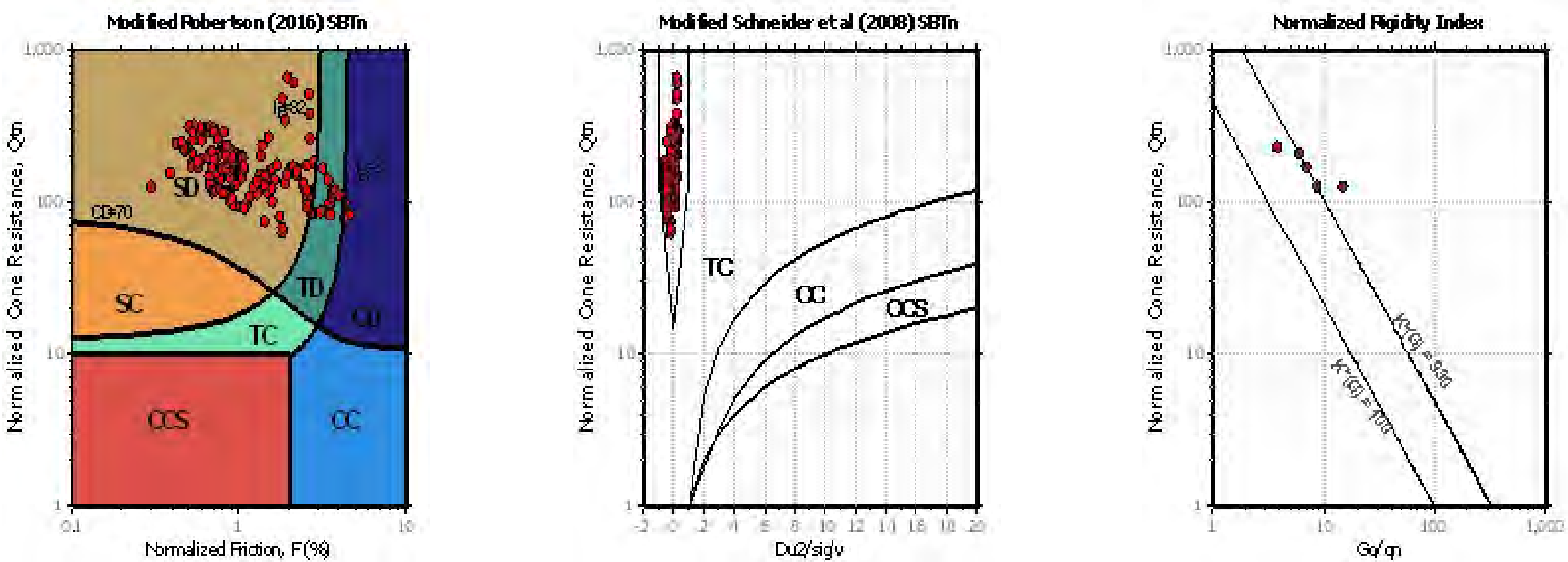
Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Updated SBTn plots



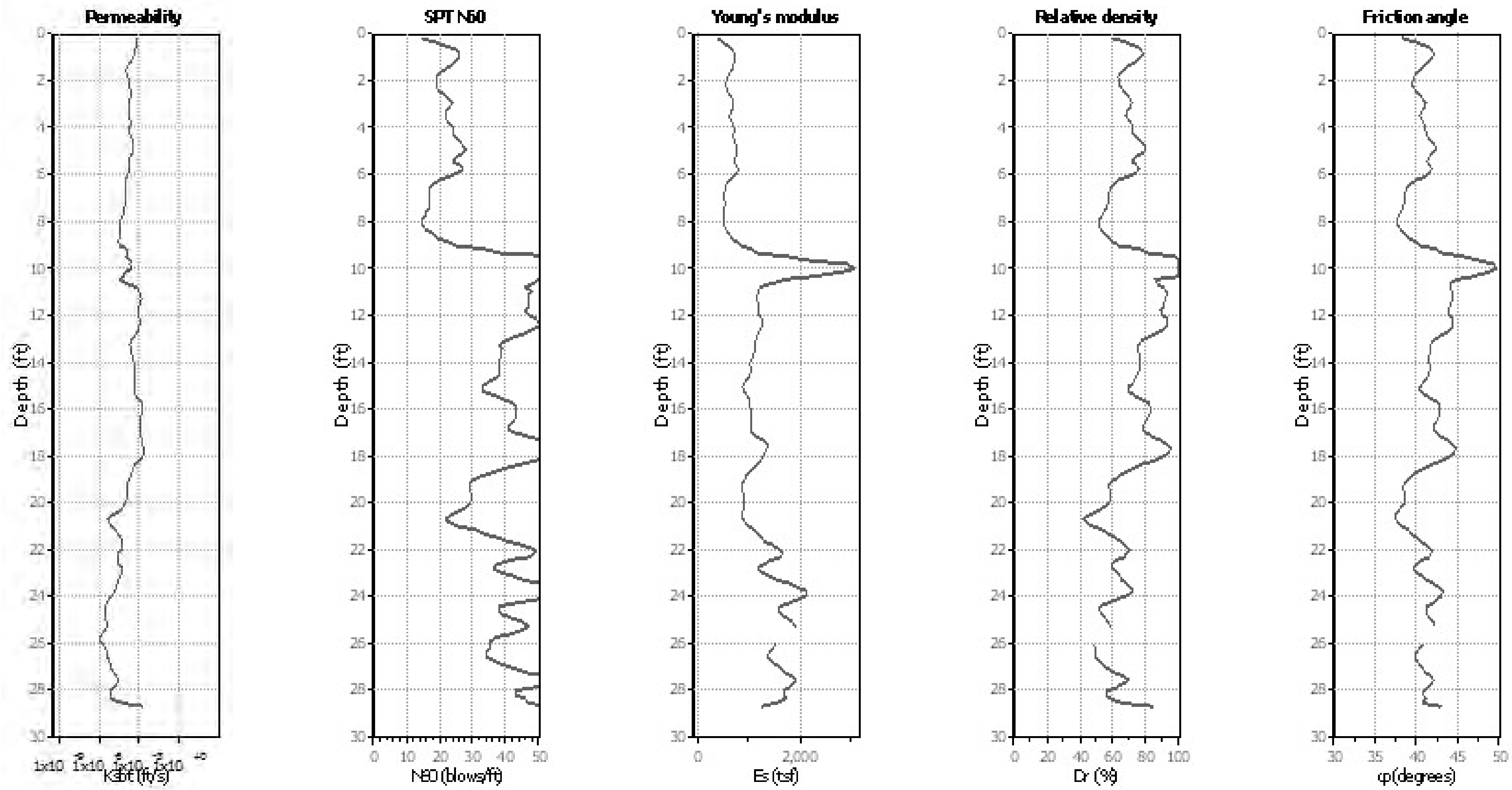
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

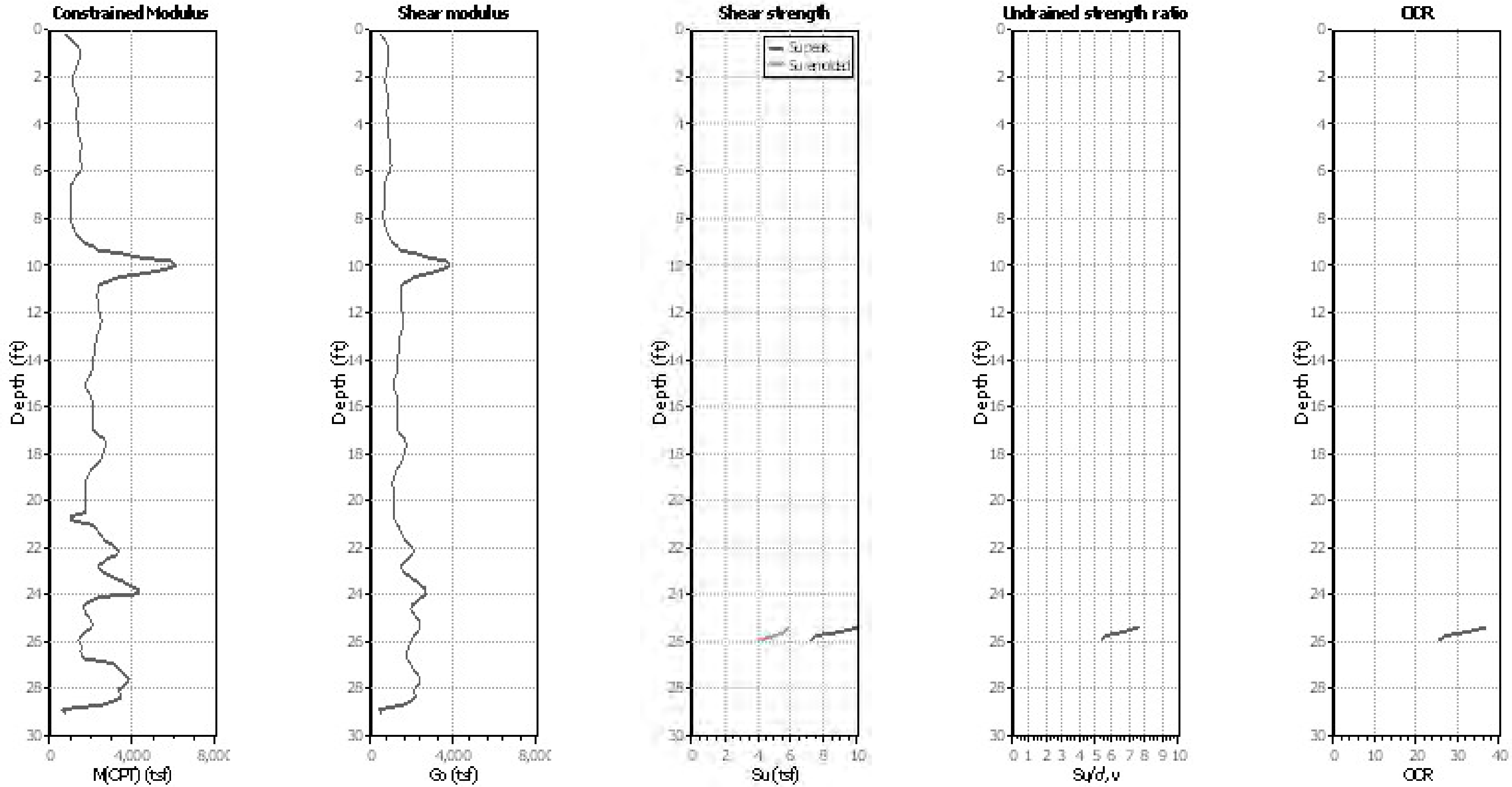


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

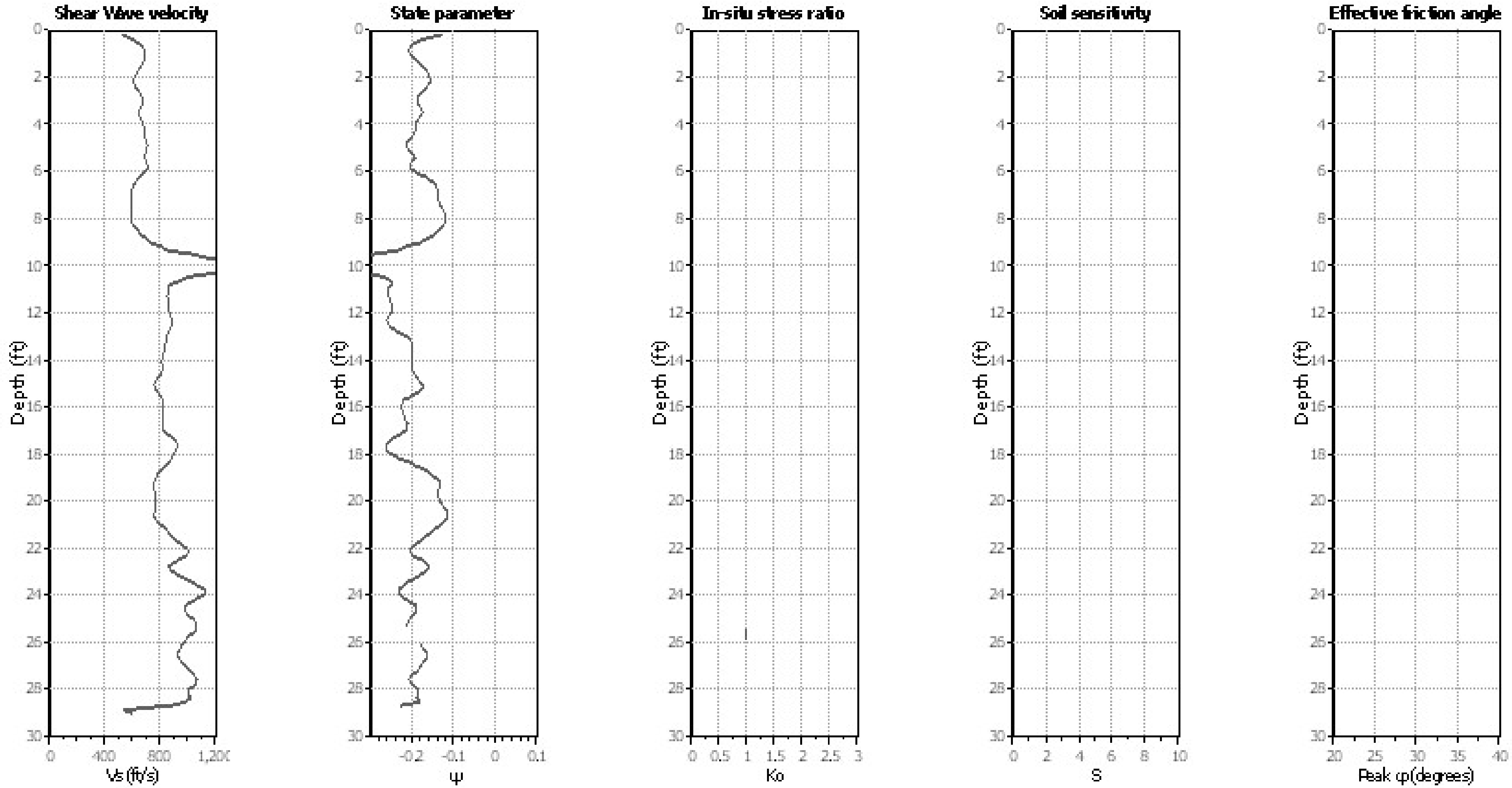


Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



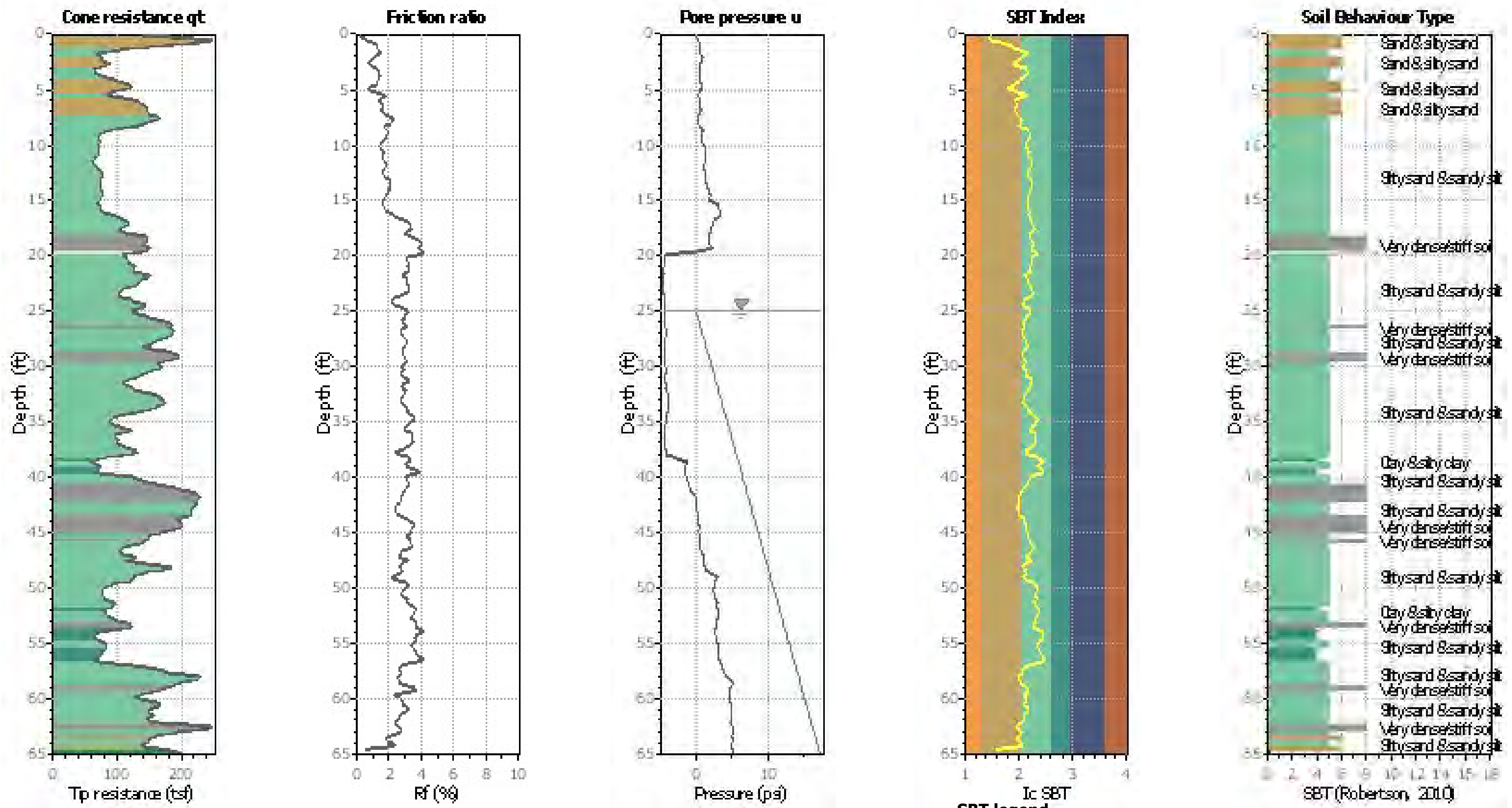
Calculation parameters

Soil Sensitivity factor, N_S: 350.00
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



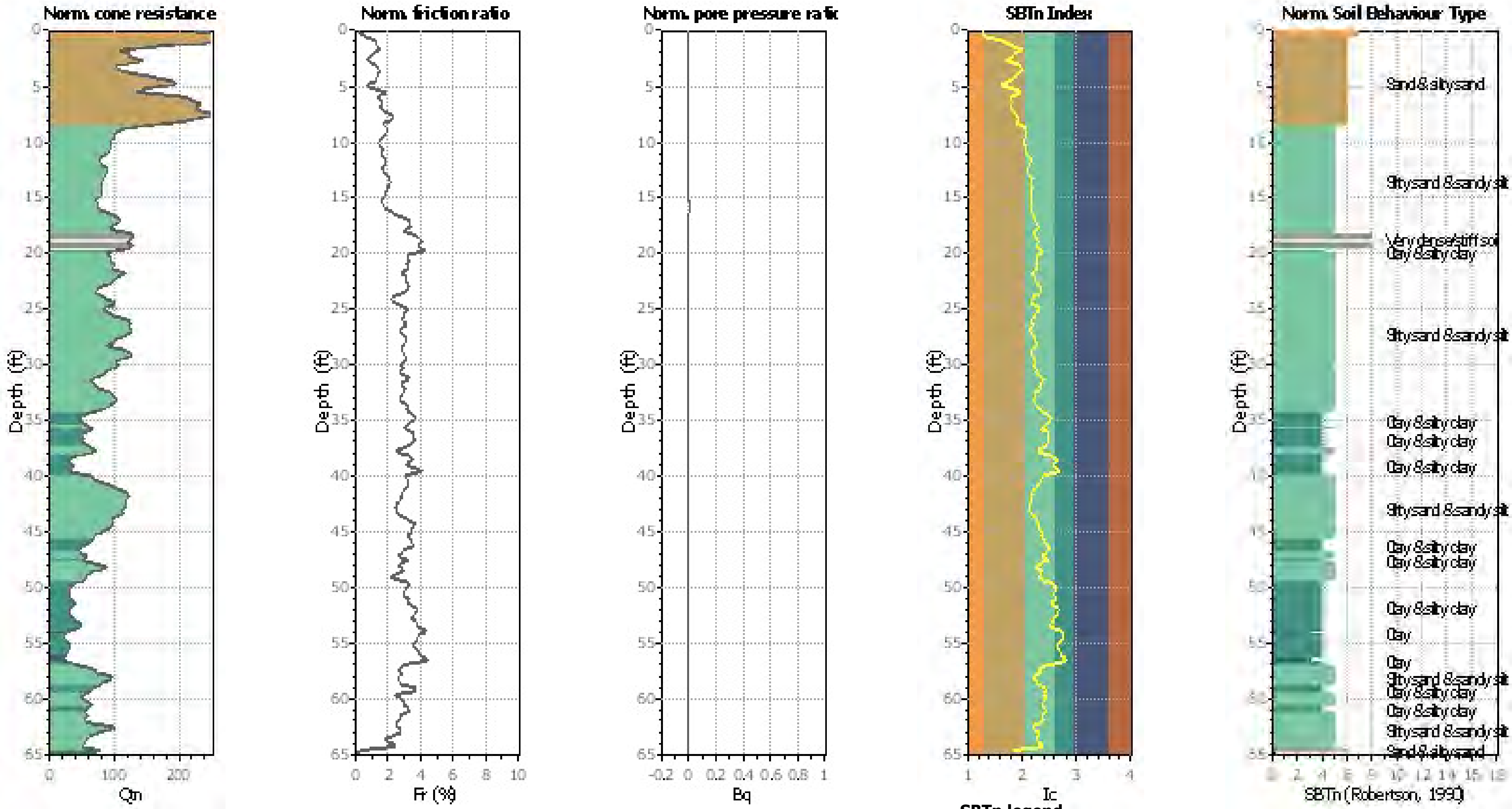
SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

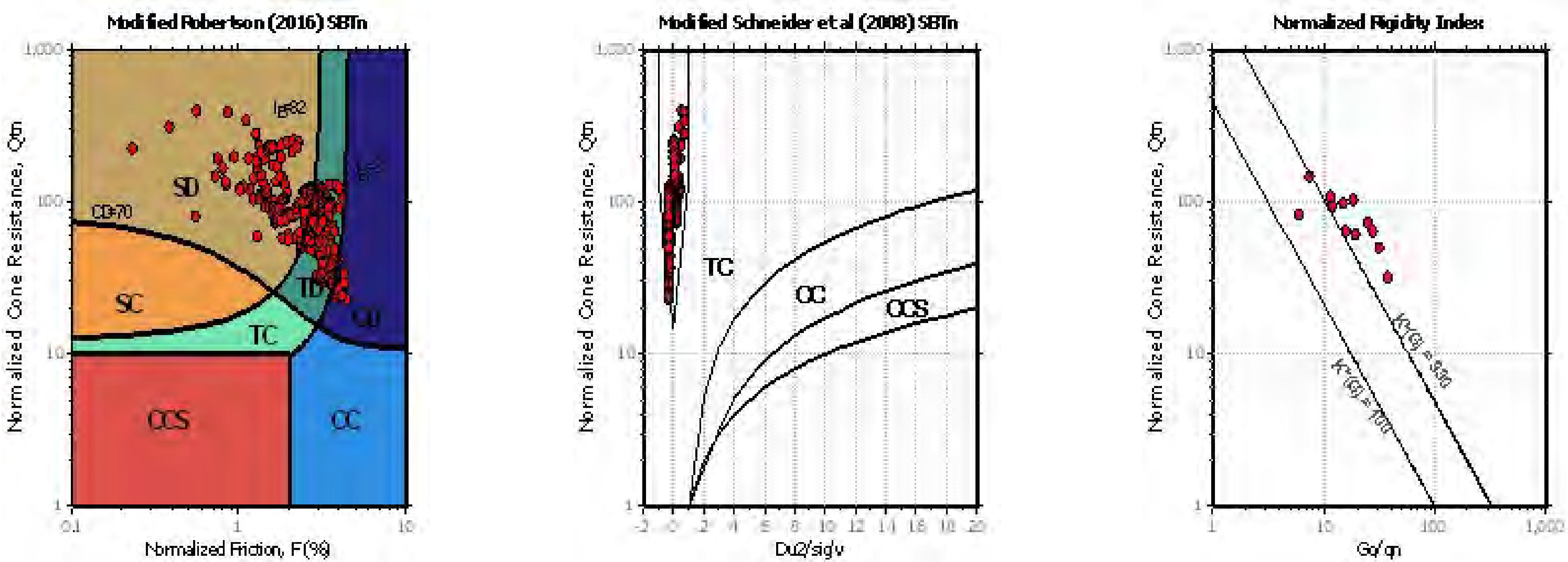
Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Updated SBTn plots



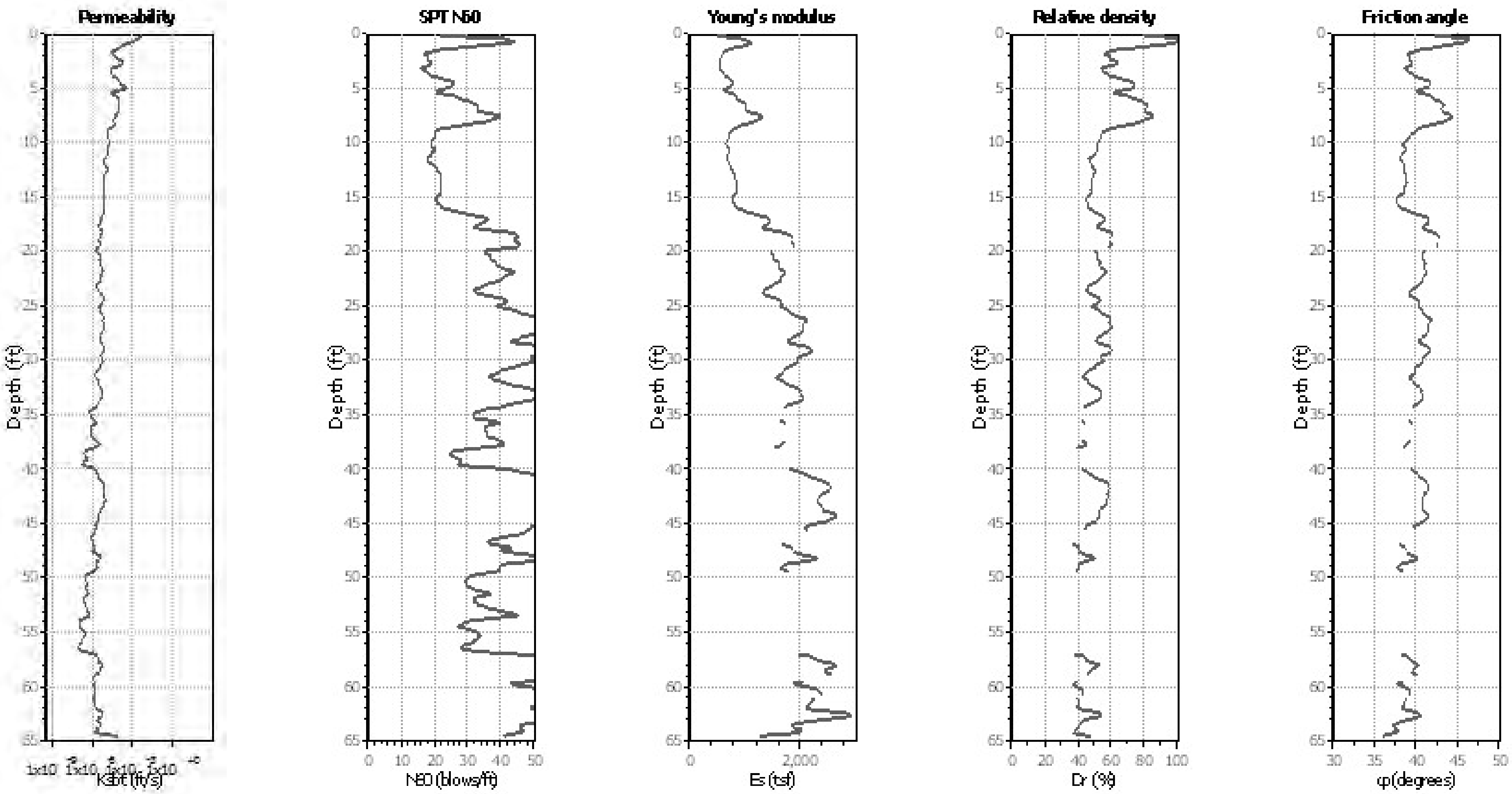
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



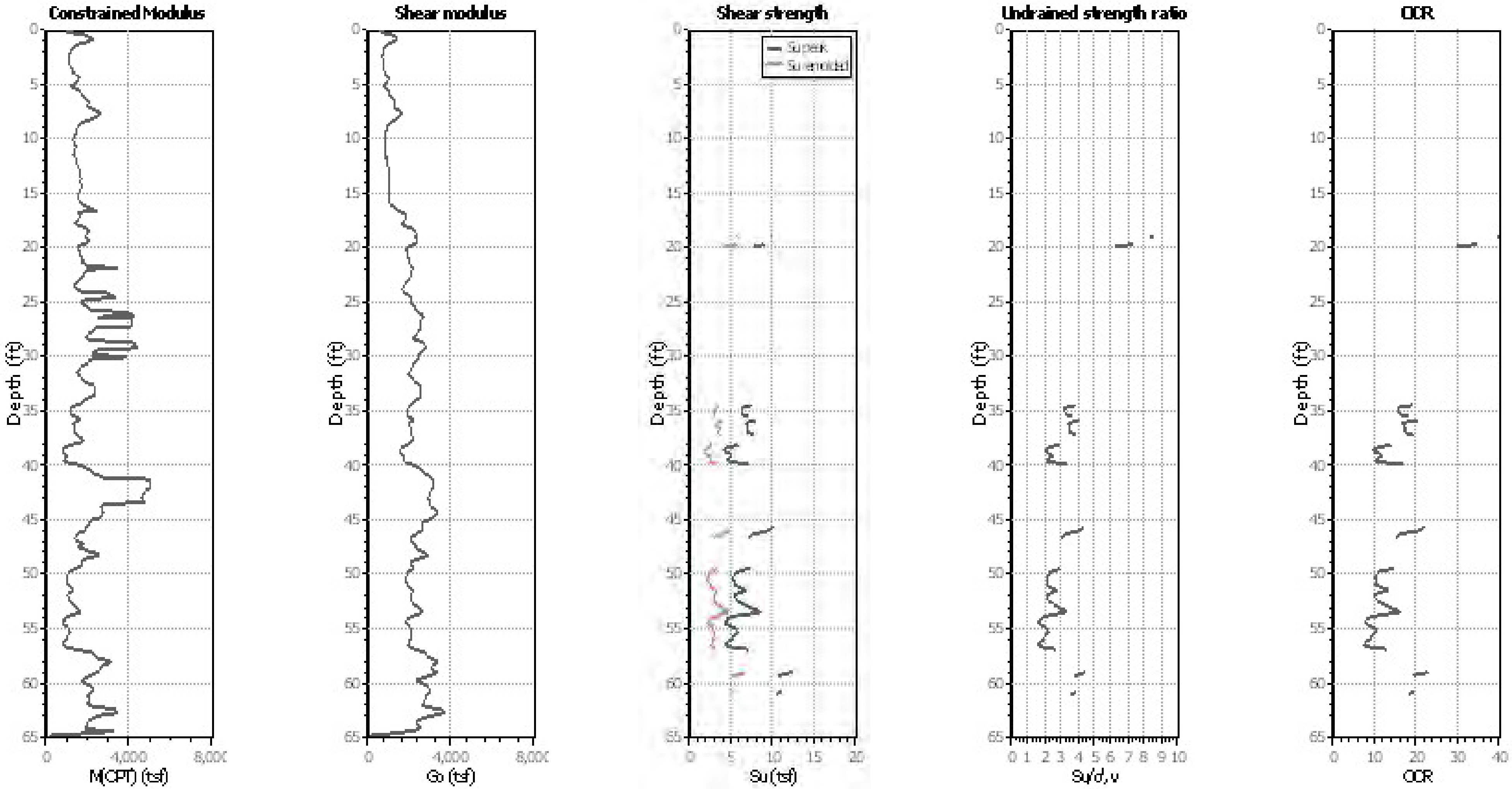
Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



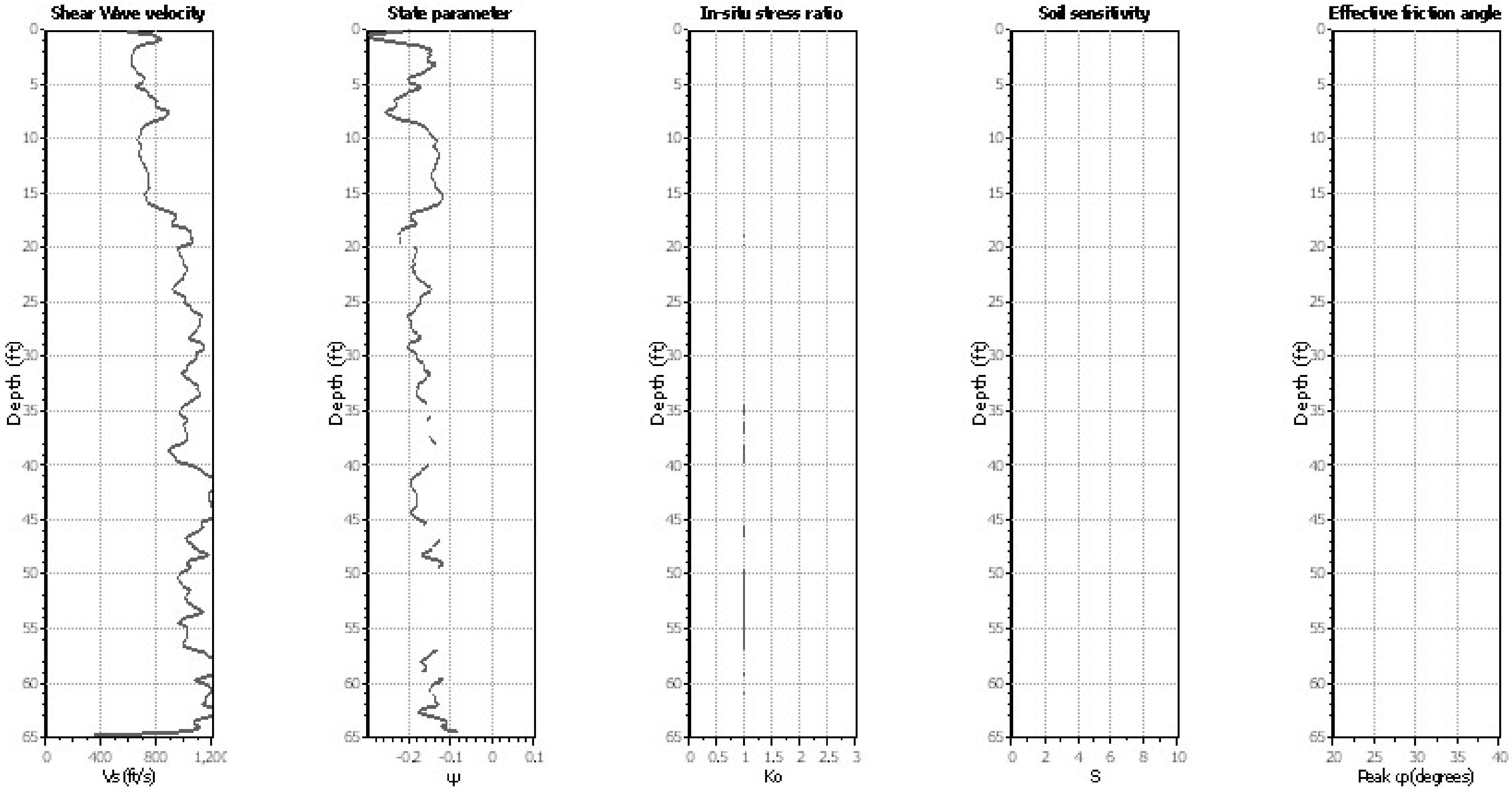
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

APPENDIX D.4

Bearing Capacity

RW - 2 Caltrans Type 1

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements April 1, 2019

Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **STRENGTH**

Design Height 8 feet

Section 18+00

φ_b = 0.45

q_o = 2.3 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w) 9 feet

Footing Data

D_f	Depth	1.333	feet
B'	Width	3.6	feet
L	Length	149	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 3.00 feet

Depth of Failure Surface (H_f)
$H_f = [\,B / (2\cos(\pi/4 + ø/2))]\ e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 5.34 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$ $N_{qm} = N_q\,s_q\,d_q\,i_q$ $N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1)\cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0	
Sc = 1 + (0.2 B / L)	N.A.
Sγ = 1.0	N.A.
Sq = 1.0	N.A.
ø > 0	
Sc = 1 + (B / L)(Nq / Nc)	1.014
Sγ = 1 - 0.4(B / L)	0.990
Sq = 1 + (B / L) tan(ø)	1.013

FIGURE D.4-1

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees 90

1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = 1.98

$\varnothing = 0$

$ic = 1 - (nH / c B L Nc)$	N.A.
$Iq = 1$	N.A.
$I\gamma = 1$	N.A.

$\varnothing > 0$

$iq = [1 - H / (V + cBL \cot \varnothing)]^{n}$	1.000
$i\gamma = [1 - H / (V + cBL \cot \varnothing)]^{n+1}$	1.000
$ic = iq - [(1 - iq) / (Nq - 1)]$	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 0.370

dq : 1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q.

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c N_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$		$N_{qm} = N_q s_q d_q i_q$		$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.014	sq	1.013	sγ	0.990
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,231.8	+	2,444.5	+	3,665.3

q_N = 11,341.6 psf

$\varphi_b q_N$ = 5,104 psf

LRFD Demand (Extreme Limit)

q_o 2300 psf

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Capacity : Demand Ratio 2.22

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	1.333	3.6

1.5 B + Df = 6.733

Is $D_w > (1.5B + D_f)$? **Yes**

RW - 2 Caltrans Type 1

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements April 1, 2019
Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **E X T R E M E I**

Design Height 8 feet

Section 18+00

φ_b = 1
q_o = 2.2 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w) 9 feet

Footing Data

D_f	Depth	1.333	feet
B'	Width	3.9	feet
L	Length	149	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 3.25 feet

Depth of Failure Surface (H_f)
$H_f = [\, B / (2\cos(\pi/4 + ø/2)]\, e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 5.78 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\, N_{cm} + \gamma D_f\, N_{qm}\, C_{wq} + 0.5\gamma\, B\, N_{\gamma m}\, C_{w\gamma}$$

$N_{cm} = N_c\, s_c\, i_c$ $N_{qm} = N_q\, s_q\, d_q\, i_q$ $N_{\gamma m} = N_\gamma\, S_\gamma\, i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1) \cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\, B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.015
$S\gamma = 1 - 0.4(B / L)$	0.990
$Sq = 1 + (B / L) \tan(ø)$	1.014

FIGURE D.4-2

RW - 2 Caltrans Type 1

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees: 90

1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = **1.97**

$\phi = 0$

$ic = 1 - (nH / c\,B\,L\,Nc)$	N.A.
$Iq = 1$	N.A.
$I\gamma = 1$	N.A.

$\phi > 0$

$iq = [1 - H / (V + cBL \cot\phi)]^n$	1.000
$i\gamma = [1 - H / (V + cBL \cot\phi)]^{n+1}$	1.000
$ic = iq - [(1 - iq) / (Nq - 1)]$	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65: 0.342

dq : 1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$		$N_{qm} = N_q\,s_q\,d_q\,i_q$		$N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.015	sq	1.014	sγ	0.990
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c\,N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,237.7	+	2,447.0	+	3,967.5

q_N = 11,652.3 psf

$\varphi_b q_N$ = 11,652 psf

LRFD Demand (Extreme Limit)

q_o 2200 psf

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Capacity : Demand Ratio 5.30

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	1.333	3.9

1.5 B + Df = 7.183

Is D_w > (1.5B + D_f) ? **Yes**

FIGURE D.4-2

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019
Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **EXTREME II**

Design Height 8 feet

Section 18+00

φ_b = 1
q_o = 3.1 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w) 9 feet

Footing Data

D_f	Depth	1.333	feet
B'	Width	2.8	feet
L	Length	180	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 2.33 feet

Depth of Failure Surface (H_f)
$H_f = [B / (2\cos(\pi/4 + ø/2)] e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 4.15 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c N_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$ $N_{qm} = N_q s_q d_q i_q$ $N_{\gamma m} = N_\gamma S_\gamma i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1) \cot(ø)$	25.80
$N\gamma = 2.0 (Nq + 1) \tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2 B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.009
$S\gamma = 1 - 0.4(B / L)$	0.994
$Sq = 1 + (B / L) \tan(ø)$	1.008

FIGURE D.4-3

Inclination Factors

Angle of Force Resultant with Long
Dimension of Footing (θ) degrees 90
1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = 1.98

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V+ cBL \cot ø)]^n$	1.000
$iγ = [1 - H / (V+ cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 0.476

dq : 1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q.

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$		$N_{qm} = N_q\,s_q\,d_q\,i_q$		$N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.009	sq	1.008	sγ	0.994
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c\,N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,206.5	+	2,433.4	+	2,860.7

q_N =	**10,500.6**	**psf**
$\varphi_b q_N$ =	**10,501**	**psf**

LRFD Demand (Extreme Limit)

q_o 3100 psf

Capacity : Demand Ratio 3.39

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
>1.5B + D_f	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	1.333	2.8

1.5 B + Df = 5.533

Is D_w > (1.5B + D_f) ? **Yes**

FIGURE D.4-3

RW - 6 Caltrans Type 1

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019
Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **S T R E N G T H**

Design Height 14 feet

Section 29+50

φ_b = 0.45
q_o = 3.8 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	396.5
Design Groundwater Elevation	380

Depth to Water Table below Foundation Bearing Grade (d_w): 16.5 feet

Footing Data

D_f	Depth	1.666	feet
B'	Width	4.3	feet
L	Length	143	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 3.58 feet

Depth of Failure Surface (H_f)
$H_f = [\, B / (2\cos(\pi/4 + ø/2)]\ e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 6.37 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$$N_{cm} = N_c\,s_c\,i_c \qquad N_{qm} = N_q\,s_q\,d_q\,i_q \qquad N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø}\ \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1)\cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\,B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.017
$S\gamma = 1 - 0.4(B / L)$	0.988
$Sq = 1 + (B / L)\tan(ø)$	1.016

FIGURE D4-4

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees — 90

1.57 (radians)

Exponent (n)

$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$

n = **1.97**

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V + cBL \cot ø)]^n$	1.000
$i\gamma = [1 - H / (V + cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 — 0.387

dq : 1

$q_N = c N_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$

$N_{cm} = N_c s_c i_c$		$N_{qm} = N_q s_q d_q i_q$		$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.017	sq	1.016	sγ	0.988
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,249.2	+	3,064.6	+	4,367.6
q_N =	**12,681.4**	**psf**			
$\varphi_b q_N$ =	**5,707**	**psf**			

LRFD Demand (Extreme Limit)

q_o 3800 psf

Capacity : Demand Ratio 1.50

FIGURE D4-4

RW - 6 Caltrans Type 1

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019
Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **E X T R E M E I**

Design Height 14 feet

Section 29+50

φ_b = 1
q_o = 5.3 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	396.5
Design Groundwater Elevation	380

Depth to Water Table below Foundation Bearing Grade (d_w) 16.5 feet

Footing Data

D_f	Depth	1.666	feet
B'	Width	3.2	feet
L	Length	149	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 2.66 feet

Depth of Failure Surface (H_f)
$H_f = [\,B / (2\cos(\pi/4 + ø/2)]\, e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 4.74 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$ $N_{qm} = N_q\,s_q\,d_q\,i_q$ $N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø}\tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1)\cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0

Sc = 1 + (0.2 B / L)	N.A.
Sγ = 1.0	N.A.
Sq = 1.0	N.A.

ø > 0

Sc = 1 + (B / L)(Nq / Nc)	1.012
Sγ = 1 - 0.4(B / L)	0.991
Sq = 1 + (B / L) tan(ø)	1.011

FIGURE D4-5

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees — 90

1.57 (radians)

Exponent (n)

$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$

n = 1.98

ø = 0

$ic = 1 - (nH / c\,B\,L\,Nc)$	N.A.
$Iq = 1$	N.A.
$I\gamma = 1$	N.A.

ø > 0

$iq = [1 - H / (V + cBL \cot ø)]^{n}$	1.000
$i\gamma = [1 - H / (V + cBL \cot ø)]^{n+1}$	1.000
$ic = iq - [(1 - iq) / (Nq - 1)]$	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 — 0.521

dq : 1

$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$

$N_{cm} = N_c\,s_c\,i_c$		$N_{qm} = N_q\,s_q\,d_q\,i_q$		$N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.012	sq	1.011	sγ	0.991
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c\,N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,223.9	+	3,050.8	+	3,261.6

q_N = 11,536.3 psf

$\varphi_b q_N$ = 11,536 psf

LRFD Demand (Extreme Limit)

q_o 5300 psf

Capacity : Demand Ratio 2.18

FIGURE D4-5

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements April 1, 2019
Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **E X T R E M E II**

Design Height 14 feet

Section 29+50

φ_b = 1
q_o = 3.3 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation: 396.5
Design Groundwater Elevation: 380

Depth to Water Table below Foundation Bearing Grade (d_w): 16.5 feet

Footing Data

D_f	Depth	1.666	feet
B'	Width	5.2	feet
L	Length	180	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 4.33 feet

Depth of Failure Surface (H_f)
$H_f = [\,B / (2\cos(\pi/4 + ø/2)]\, e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 7.71 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$ $N_{qm} = N_q\,s_q\,d_q\,i_q$ $N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1)\cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\,B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.016
$S\gamma = 1 - 0.4(B / L)$	0.988
$Sq = 1 + (B / L)\tan(ø)$	1.015

FIGURE D4-6

Inclination Factors

Angle of Force Resultant with Long
Dimension of Footing (θ) degrees 90
1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = 1.97

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V+ cBL \cot ø)]^n$	1.000
$iγ = [1 - H / (V+ cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 0.320

dq : 1

$$q_N = c N_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$		$N_{qm} = N_q s_q d_q i_q$		$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.016	sq	1.015	sγ	0.988
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,245.7	+	3,062.7	+	5,284.3

q_N = 13,592.7 psf

$\varphi_b q_N$ = 13,593 psf

LRFD Demand (Extreme Limit)

q_o 3300 psf

Capacity : Demand Ratio 4.12

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019

Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **STRENGTH**

Design Height 9 feet

Section 18+00

φ_b = 0.65

q_o = 2.44 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w) 9 feet

Footing Data

D_f	Depth	0	feet
B'	Width	6.25	feet
L	Length	360	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 5.20 feet

Depth of Failure Surface (H_f)
$H_f = [\, B / (2\cos(\pi/4 + ø/2)]\ e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 9.26 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$ $N_{qm} = N_q\,s_q\,d_q\,i_q$ $N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø}\ \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1)\cot(ø)$	25.80
$N\gamma = 2.0\,(Nq + 1)\tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\,B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.010
$S\gamma = 1 - 0.4(B / L)$	0.993
$Sq = 1 + (B / L)\tan(ø)$	1.009

Inclination Factors

Angle of Force Resultant with Long
Dimension of Footing (θ) degrees   90
1.57   (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = **1.98**

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V + cBL \cot ø)]^{n}$	1.000
$iγ = [1 - H / (V + cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65   0.000

dq :   1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q.

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c\, N_{cm} + \gamma D_f\, N_{qm}\, C_{wq} + 0.5\gamma\, B\, N_{\gamma m}\, C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$		$N_{qm} = N_q s_q d_q i_q$		$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.010	sq	1.009	sγ	0.993
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c\,N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,211.8	+	0.0	+	6,380.9

q_N = 11,592.7 psf

$\varphi_b q_N$ = 7,535 psf

LRFD Demand (Extreme Limit)

q_o 2440 psf

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Capacity : Demand Ratio 3.09

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	0	6.25

1.5 B + Df = 9.375

Is D_w > (1.5B + D_f) ?   **Yes**

FIGURE D4-7

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019

Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **E X T R E M E I**

Design Height 8 feet

Section 18+00

φ_b = 1

q_o = 1.62 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w) 9 feet

Footing Data

D_f	Depth	0	feet
B'	Width	5.43	feet
L	Length	149	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)
H_{CW} = 4.52 feet

Depth of Failure Surface (H_f)
$H_f = [B / (2\cos(\pi/4 + ø/2)] e^{(\pi/4 + ø/2)\tan ø} \cos(ø)$
H_f = 8.05 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\,N_{cm} + \gamma D_f\,N_{qm}\,C_{wq} + 0.5\gamma\,B\,N_{\gamma m}\,C_{w\gamma}$$

$N_{cm} = N_c\,s_c\,i_c$ $N_{qm} = N_q\,s_q\,d_q\,i_q$ $N_{\gamma m} = N_\gamma\,S_\gamma\,i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1) \cot(ø)$	25.80
$N\gamma = 2.0 (Nq + 1) \tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\,B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.021
$S\gamma = 1 - 0.4(B / L)$	0.985
$Sq = 1 + (B / L) \tan(ø)$	1.019

FIGURE D.4-8

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees 90

1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta + [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = 1.96

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V+ cBL \cot ø)]^{n}$	1.000
$iγ = [1 - H / (V+ cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 0.000

dq : 1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q.

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c N_{cm} + \gamma D_f N_{qm} C_{wq} + 0.5\gamma B N_{\gamma m} C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$	
Nc	25.80
sc	1.021
ic	1.000

$N_{qm} = N_q s_q d_q i_q$	
Nq	14.72
sq	1.019
iq	1.000
dq	1
C_{wq}	1

$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nγ	16.72
sγ	0.985
iγ	1.000
$C_{w\gamma}$	1

q_N =	$c N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,268.0	+	0.0	+	5,501.1

q_N = 10,769.1 psf

$\varphi_b q_N$ = 10,769 psf

LRFD Demand (Extreme Limit)

q_o 1620 psf

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Capacity : Demand Ratio 6.65

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	0	5.43

1.5 B + Df = 8.145

Is D_w > (1.5B + D_f) ? **Yes**

FIGURE D.4-8

ATTACHMENT 2

BEARING STRESSES TABLES

This table summarizes the bearing pressure demand of the reinforced soil block of the MSE for load cases 1 and 2 under each limit state. The stresses are reported using the Meyerhof distribution with the vertical bearing stress, *q*, over the effective base width, *B´*.

Applied Bearing Stresses for Load Case 1

H1 (H)	6´-8″ (5´-0″)	9´-2″ (7´-6″)	11´-8″ (10´-0″)	14´-2″ (12´-6″)
BW (L)	9´-6″ (8´-0″)	9´-6″ (8´-0″)	9´-6” (8´-0″)	11´-6” (10´-0″)
Service *q*, *B´*	0.94 ksf, 6.84 ft.	1.44 ksf, 6.10 ft.	2.16 ksf, 5.18 ft.	2.47 ksf, 6.87 ft.
Strength *q*, *B´*	1.71 ksf, 7.00 ft.	2.44 ksf, 6.25 ft.	3.50 ksf, 5.29 ft.	3.93 ksf, 6.92 ft.
Extreme *q*, *B´*	0.97 ksf, 6.63 ft.	1.62 ksf, 5.43 ft.	2.92 ksf, 3.83 ft.	3.35 ksf, 5.08 ft.

H1 (H)	16´-8″ (15´-0″)	19´-2″ (17´-6″)	21´-8″ (20´-0″)	24´-2″ (22´-6″)
BW (L)	13´-6″ (12´-0″)	15´-6″ (14´-0”)	17´-6″ (16´-0”)	18´-6″ (17´-0”)
Service *q*, *B´*	2.80 ksf, 8.58 ft.	3.12 ksf, 10.31 ft.	3.49 ksf, 11.90 ft.	4.01 ksf, 12.31 ft.
Strength *q*, *B´*	4.37 ksf, 8.56 ft.	4.82 ksf, 10.25 ft.	5.33 ksf, 11.79 ft.	6.07 ksf, 12.13 ft.
Extreme *q*, *B´*	3.79 ksf, 6.34 ft.	4.22 ksf, 7.63 ft.	4.72 ksf, 8.82 ft.	5.74 ksf, 8.58 ft.

H1 (H)	26´-8″ (25´-0″)	29´-2″ (27´-6″)	31´-8″ (30´-0″)	34´-2” (32´-6″)
BW (L)	20´-6″ (19´-0″)	21´-6″ (20´-0″)	23´-6″ (22´-0″)	25´-6″ (24´-0″)
Service *q*, *B´*	4.33 ksf, 14.04 ft.	4.86 ksf, 14.40 ft.	5.21 ksf, 16.06 ft.	5.54 ksf, 17.76 ft..
Strength *q*, *B´*	6.52 ksf, 13.82 ft.	7.29 ksf, 14.12 ft.	7.76 ksf, 15.74 ft.	8.22 ksf, 17.40 ft.
Extreme *q*, *B´*	6.16 ksf, 9.87 ft.	7.30 ksf, 9.59 ft.	7.72 ksf, 10.83 ft.	8.13 ksf, 12.11 ft.

H1 (H)	36´-8″ (35´-0″)	39´-2″ (37´-6″)	41´-8″ (40´-0″)	44´-2″ (42´-6″)
BW (L)	26´-6″ (25´-0″)	29´-6″ (28´-0″)	30´-6″ (29´-0″)	33´-6″ (32´-0″)
Service *q*, *B´*	6.05 ksf, 18.17 ft.	6.24 ksf, 21.08 ft.	6.74 ksf, 21.51 ft.	6.94 ksf, 24.44 ft.
Strength *q*, *B´*	8.96 ksf, 17.74 ft.	9.18 ksf, 20.63 ft.	9.90 ksf, 21.00 ft.	10.14 ksf, 23.91 ft.
Extreme *q*, *B´*	9.29 ksf, 11.84 ft.	9.03 ksf, 14.57 ft.	10.11 ksf, 14.34 ft.	9.93 ksf, 17.09 ft.

Applied Bearing Stresses for Load Case 2

H1 (H)	5´-0″	7´-6″	10´-0″	12´-6″
BW (L)	9´-6″ (8´-0″)	9´-6″ (8´-0”)	11´-6″ (10´-0″)	14´-0″ (12´-6″)
Service *q*, *B´*	0.99 ksf, 7.94 ft.	1.53 ksf, 7.20 ft.	2.08 ksf, 8.77 ft.	2.60 ksf, 10.97 ft.
Strength *q*, *B´*	1.35 ksf, 8.00 ft.	2.14 ksf, 7.08 ft.	2.92 ksf, 8.60 ft.	3.65 ksf, 10.75 ft.
Extreme *q*, *B´*	1.20 ksf, 6.95 ft.	2.41 ksf, 5.00 ft.	3.51 ksf, 5.71 ft.	4.38 ksf, 7.14 ft.

H1 (H)	15´-0″	17´-6″	20´-0″	22´-6″
BW (L)	16´-6″ (15´-0″)	19´-0″ (17´-6″)	21´-6″ (20´-0″)	24´-0″ (22´-6″)
Service *q*, *B´*	3.12 ksf, 13.16 ft.	3.64 ksf, 15.35 ft.	4.16 ksf, 17.55 ft.	4.68 ksf, 19.74 ft.
Strength *q*, *B´*	4.38 ksf, 12.90 ft.	5.11 ksf, 15.06 ft.	5.84 ksf, 17.21 ft.	6.57 ksf, 19.36 ft.
Extreme *q*, *B´*	5.26 ksf, 8.57 ft.	6.13 ksf, 9.99 ft.	7.01 ksf, 11.42 ft.	7.89 ksf, 12.85 ft.

H1 (H)	25´-0″	27´-6″	30´-0″	32´-6″
BW (L)	26´-6″ (25´-0″)	29´-0″ (27´-6″)	31´-6″ (30´-0″)	34´-0″ (32´-6″)
Service *q*, *B´*	5.20 ksf, 21.93 ft.	5.72 ksf, 24.13 ft.	6.24 ksf, 26.32 ft.	6.76 ksf, 28.51ft.
Strength *q*, *B´*	7.30 ksf, 21.51ft.	8.03 ksf, 23.66 ft.	8.76 ksf, 25.81 ft.	9.48 ksf, 27.96 ft.
Extreme *q*, *B´*	8.76 ksf, 14.28 ft.	9.64 ksf, 15.71 ft	10.52 ksf, 17.13 ft.	11.39 ksf, 18.56 ft.

H1 (H)	35´-0″	37´-6″	40´-0″	42´-6″
BW (L)	36´-6″ (35´-0″)	39´-0″ (37´-6″)	41´-6″ (40´-0″)	44´-0″ (42´-6″)
Service *q*, *B´*	7.28 ksf, 30.70 ft.	7.80 ksf, 32.90 ft.	8.32 ksf, 35.09 ft.	8.84 ksf, 37.28
Strength *q*, *B´*	10.21 ksf, 30.11 ft.	10.94 ksf, 32.26 ft.	11.67 ksf, 34.41 ft.	12.40 ksf, 36.56 ft.
Extreme *q*, *B´*	12.27 ksf, 19.99 ft.	13.14 ksf, 21.42 ft.	13.66 ksf, 23.31 ft.	14.02 ksf, 25.43 ft.

RW Soil Nail Protoype

AASHTO Bearing Capacity Analysis - Shallow Foundation Level Grade

Project Name: Proposed Brea Boulevard Corridor Improvements — April 1, 2019

Structure Identification: Brea Boulevard
County of Orange, California

LRFD Limit State: **EXTREME I**

Design Height: Variable 9 feet

Section varies

φ_b = 1

q_o = 1 ksf

Foundation Soil Data

	γ (pcf)	c (psf)	ø (°)	Kp
Bearing Soils	123	200	28	2.77

Note: Cohesion is approximate average value to depth of failure surface (H_f)

Foundation Bearing Grade/Elevation	381
Design Groundwater Elevation	372

Depth to Water Table below Foundation Bearing Grade (d_w): 9 feet

Footing Data

D_f	Depth	0	feet
B'	Width	1	feet
L	Length	300	feet
H	Horizontal Load	0	kips
V	Vertical Load	0	kips

Height of Central Wedge (H_{CW}) below Footing (feet)

H_{CW} = 0.83 feet

Depth of Failure Surface (H_f)

$H_f = [\ B\ /\ (2\cos(\pi/4 + ø/2)]\ e^{(\pi/4\ +\ ø/2)\tan ø}\ \cos(ø)$

H_f = 1.48 feet

AASHTO Bearing Capacity Equation 10.6.3.1.2a-1

$$q_N = c\ N_{cm} + \gamma D_f\ N_{qm}\ C_{wq} + 0.5\gamma\ B\ N_{\gamma m}\ C_{w\gamma}$$

$N_{cm} = N_c\ s_c\ i_c$ $\quad N_{qm} = N_q\ s_q\ d_q\ i_q$ $\quad N_{\gamma m} = N_\gamma\ S_\gamma\ i_\gamma$

Bearing Capacity Factors

	Level
$Nq = e^{\pi \tan ø} \tan^2(45 + ø/2)$	14.72
$Nc = (Nq - 1) \cot(ø)$	25.80
$N\gamma = 2.0\ (Nq + 1) \tan(ø)$	16.72

Shape Factors

ø = 0

$Sc = 1 + (0.2\ B / L)$	N.A.
$S\gamma = 1.0$	N.A.
$Sq = 1.0$	N.A.

ø > 0

$Sc = 1 + (B / L)(Nq / Nc)$	1.002
$S\gamma = 1 - 0.4(B / L)$	0.999
$Sq = 1 + (B / L) \tan(ø)$	1.002

FIGURE D.4-9

Inclination Factors

Angle of Force Resultant with Long Dimension of Footing (θ) degrees 90

1.57 (radians)

Exponent (n)

$$n = [(2 + L/B) / (1 + L/B)] \cos^2\theta \; + \; [(2 + B/L) / (1 + B/L)] \sin^2\theta$$

n = $\boxed{2.00}$

ø = 0

ic = 1 - (nH / c B L Nc)	N.A.
Iq = 1	N.A.
Iγ = 1	N.A.

ø > 0

$iq = [1 - H / (V + cBL \cot ø)]^n$	1.000
$i\gamma = [1 - H / (V + cBL \cot ø)]^{n+1}$	1.000
ic = iq - [(1 - iq) / (Nq - 1)]	1.000

Depth Factor

dq : D_f / B

See Table 10.6.3.1.2a-4 p. 10-65 $\boxed{0.000}$

dq : 1

Table 10.6.3.1.2a-4 Depth Correction Factor d_q.

Friction Angle, ϕ_f (deg.)	D_f/B	d_q
32	1	1.20
	2	1.30
	4	1.35
	8	1.40
37	1	1.20
	2	1.25
	4	1.30
	8	1.35
42	1	1.15
	2	1.20
	4	1.25
	8	1.30

The depth correction factor should be used only when the soils above the footing bearing elevation are as competent as the soils beneath the footing level; otherwise, the depth correction factor should be taken as 1.0.

Linear interpolations may be made for friction angles in between those values shown in Table 4.

$$q_N = c\, N_{cm} \;+ \gamma D_f\, N_{qm}\, C_{wq} \;+ 0.5\gamma\, B\, N_{\gamma m}\, C_{w\gamma}$$

$N_{cm} = N_c s_c i_c$		$N_{qm} = N_q s_q d_q i_q$		$N_{\gamma m} = N_\gamma S_\gamma i_\gamma$	
Nc	25.80	Nq	14.72	Nγ	16.72
sc	1.002	sq	1.002	sγ	0.999
ic	1.000	iq	1.000	iγ	1.000
		dq	1		
		C_{wq}	1	$C_{w\gamma}$	1

q_N =	$c\,N_{cm}$	+	$\gamma D_f N_{qm} C_{wq}$	+	$0.5\gamma B N_{\gamma m} C_{w\gamma}$
q_N =	5,170.5	+	0.0	+	1,026.7

q_N = 6,197.2 psf

$\varphi_b q_N$ = 6,197 psf

LRFD Demand (Extreme Limit)

q_o 1000 psf

Table 10.6.3.1.2a-2 Coefficients C_{wq} and $C_{w\gamma}$ for Various Groundwater Depths.

D_w	C_{wq}	$C_{w\gamma}$
0.0	0.5	0.5
D_f	1.0	0.5
$>1.5B + D_f$	1.0	1.0

Where the position of groundwater is at a depth less than 1.5 times the footing width below the footing base, the bearing resistance is affected. The highest anticipated groundwater level should be used in design.

Capacity : Demand Ratio 6.20

Relation of Depth to GW relative to Footing Embedment Depth

D_W	D_f	B
9	0	1

1.5 B + Df = 1.5

Is D_w > (1.5B + D_f) ? **Yes**

APPENDIX D.5

Slope Stability Analysis

Appendix D - Slope Stability Analysis

Global stability of the proposed wall structures and evaluation of the lengths for the proposed soil nail walls were performed by limit equilibrium slope stability analysis. Analyses were performed for the sections summarized in Table D-2. The locations of the analyzed cross-sections are shown on Plate 1.

Slope stability analyses were conducted using the computer program *SLIDE 2018 v8.022* (Rocscience, 2019). *SLIDE* performs stability calculations using two-dimensional (2D) limit equilibrium techniques based on vertical slice equilibrium. Algorithms programmed into the software include techniques for optimization of non-circular failure surfaces identified by search routines to refine location and shape of the critical surfaces and increase the potential that the surface of minimum factor-of-safety is identified.

Geologic Model: The model

programmed into *SLIDE* was developed at the indicated cross-sections. The stratigraphy was determined from the results of field exploration and the subsurface conditions identified at the test borings and Cone Penetrometer Test (CPT) sounding locations.

The stability analyses that follow provide color-coded cross-sections along with a summary table for each analysis that summarizes the relevant engineering properties and program input such as the limits and constraints of the search for the critical surface (i.e., surface with lowest calculated factor-of-safety) for the various analysis scenarios. Additional details of the analyses are presented in the text files that follow each graphical output.

Material Strength Parameters: Strength parameters of the materials encountered during field exploration were determined by direct shear testing and triaxial compression testing on representative relatively undisturbed samples. Peak shear strengths were used in modeling transient loading conditions (i.e., pseudostatic analysis) while the ultimate (end-of-shearing) strength parameters were used for long-term, static conditions. The strength along bedding planes was modeled using the results of residual/reshear direct shear testing on a sample of the bedding plane material remolded at a moisture content approximately 85% of Liquid Limit. The results of laboratory tests are presented in Appendix B. The following table summarizes the values used in analysis.

Table D-1 Summary of Shear Strength Parameters Used in Slope Stability Analysis

Material Description	Static		PseudoStatic[1]	
	c' (psf)	ø'	c' (psf)	ø'
Tf – Fernando Formation				
(Cross-Bedding)	300	31°	600	34°
(Along Bedding)	200	15°	200	15°
Tm – Monterey Formation				
(Cross-Bedding)	250	28°	550	32°
(Along Bedding)	200	15°	200	15°
Qalo/Qal – Alluvium & Older Alluvial Soil	200	28°	300	30°
Afc - Structural Fill (compacted/engineered)	100	32°	100	32°

Notes:

1) PseudoStatic analysis conducted based on k_h = 0.22 for global stability; 0.33 for pullout analyses of earth anchors soil nails.

Anisotropic shear strength models were typically used for the bedrock material to capture the variance in shear strength across along and across bedding planes. The range of bedding attitudes considered in each model is described in the graphical output of the analyses (e.g., see “Anisotropic Function” inserts in the graphics). The nomenclature of the Anisotropic Function identifies the materials designation, conveys the range of bedding dip angle (e.g., Tf_40 to 45 out) and relative direction, either into slope (“In”) or out-of-slope (“Out”) relative to the inclination of the slope being analyzed.

Stability Analysis Methodology:

Slope stability analyses were performed to calculate the factor of safety for static and pseudostatic conditions (k_h 0.22). Analysis criteria were a minimum factor of safety of 1.5 for static conditions and 1.1 for pseudostatic. The critical surfaces were located by invoking circular and non-circular search routines programmed in the software. Non-circular surface searches were performed in the bedrock material that exhibited adverse bedding orientations. Circular searches were performed in isotropic (soil) material or anisotropic (bedrock) material in which the bedding attitudes were favorable with respect to the probable direction of movement.

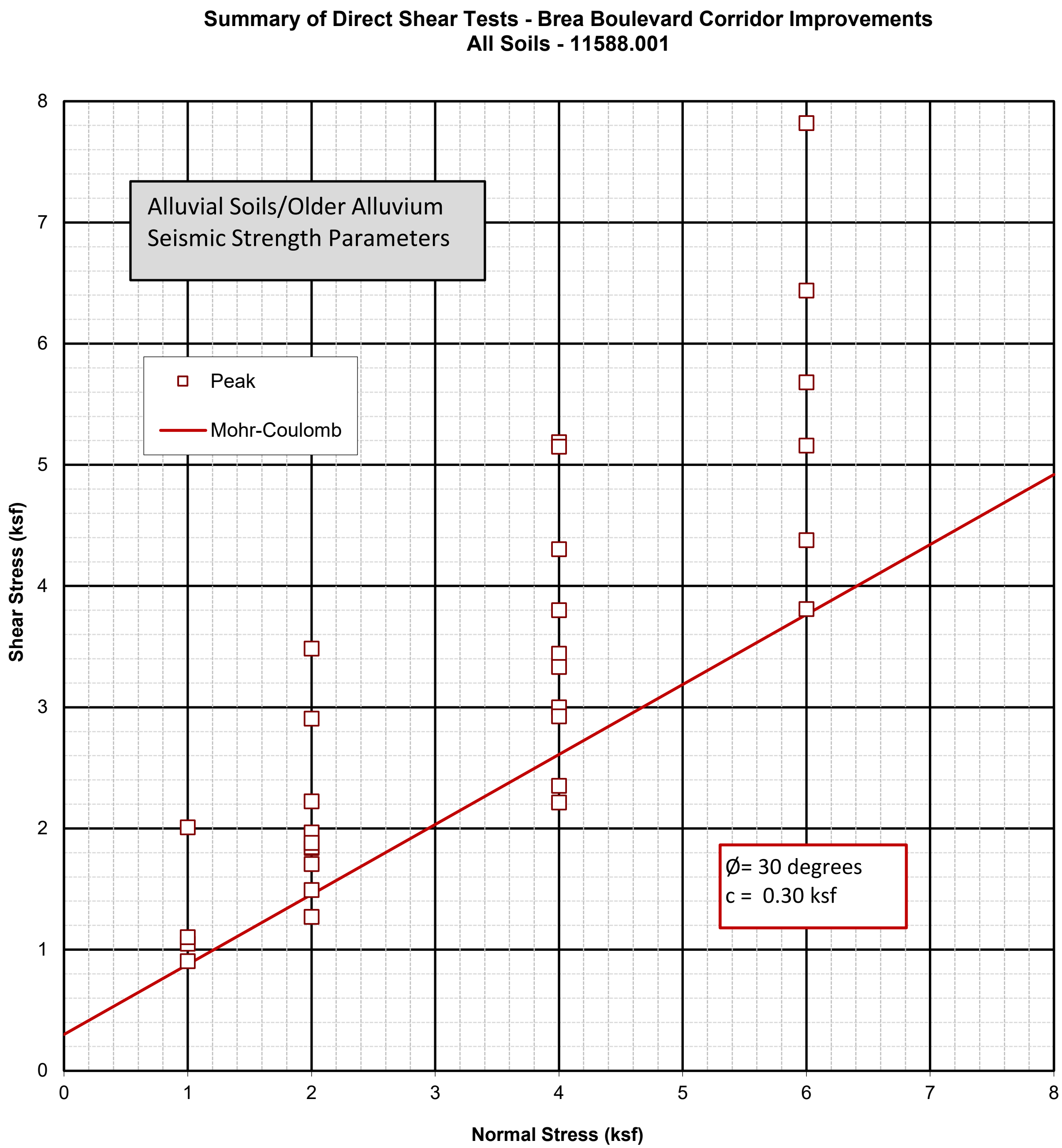
The analyses typically consisted of generating several thousand trial surfaces based upon specific search parameters input to the program. The factor-of-safety for each surface was calculated using Janbu’s method and Spencer’s method of General Limit Equilibrium (GLE) for non-circular surfaces; Bishops’s method and Spencer’s method were used for circular surfaces. The results of the analyses a are summarized in Table D-2

Table D-2

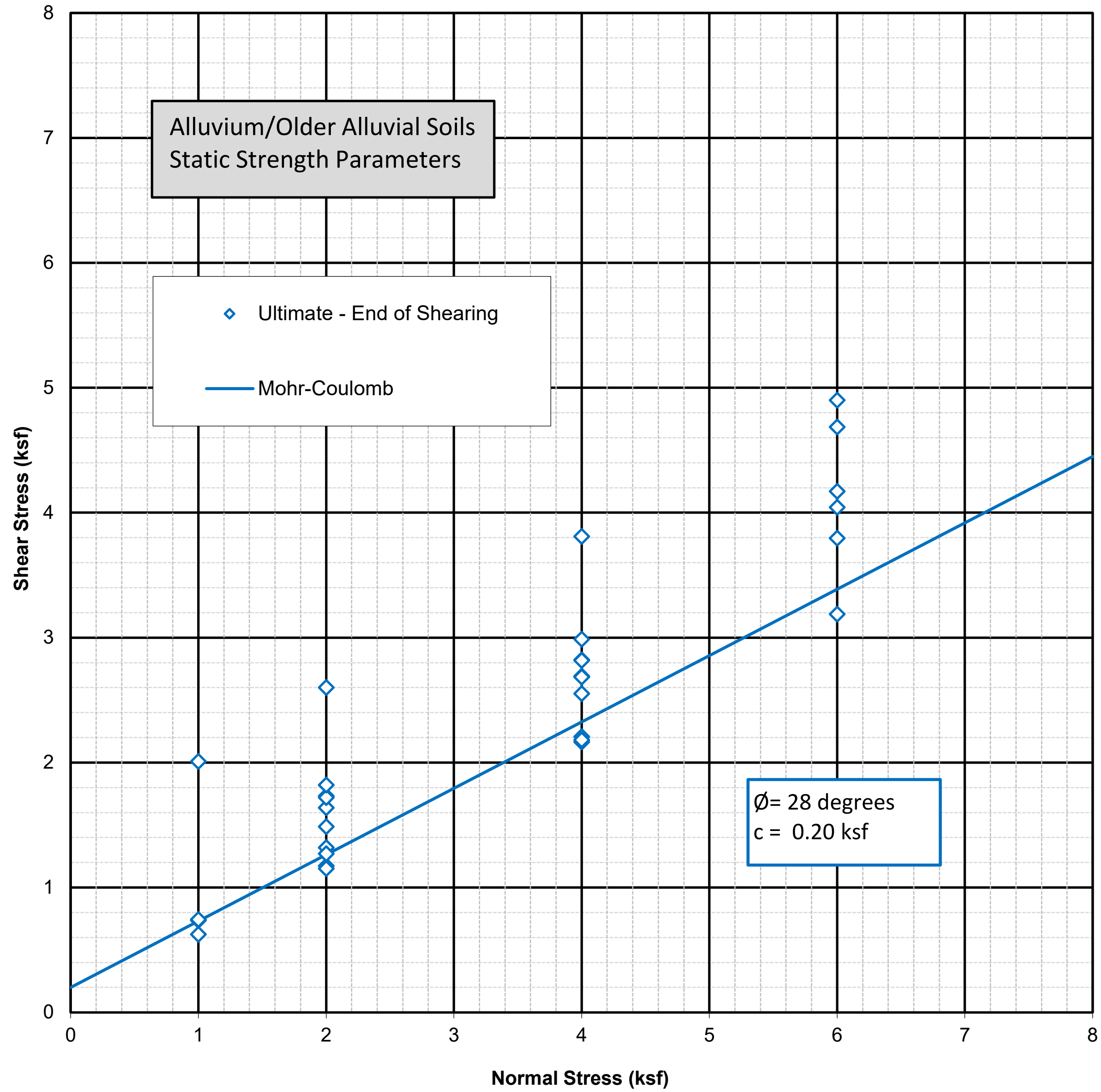
Summary of Slope Stability Analyses
Proposed Widening of Brea Boulevard
County of Orange, California
Project No. 11585.005

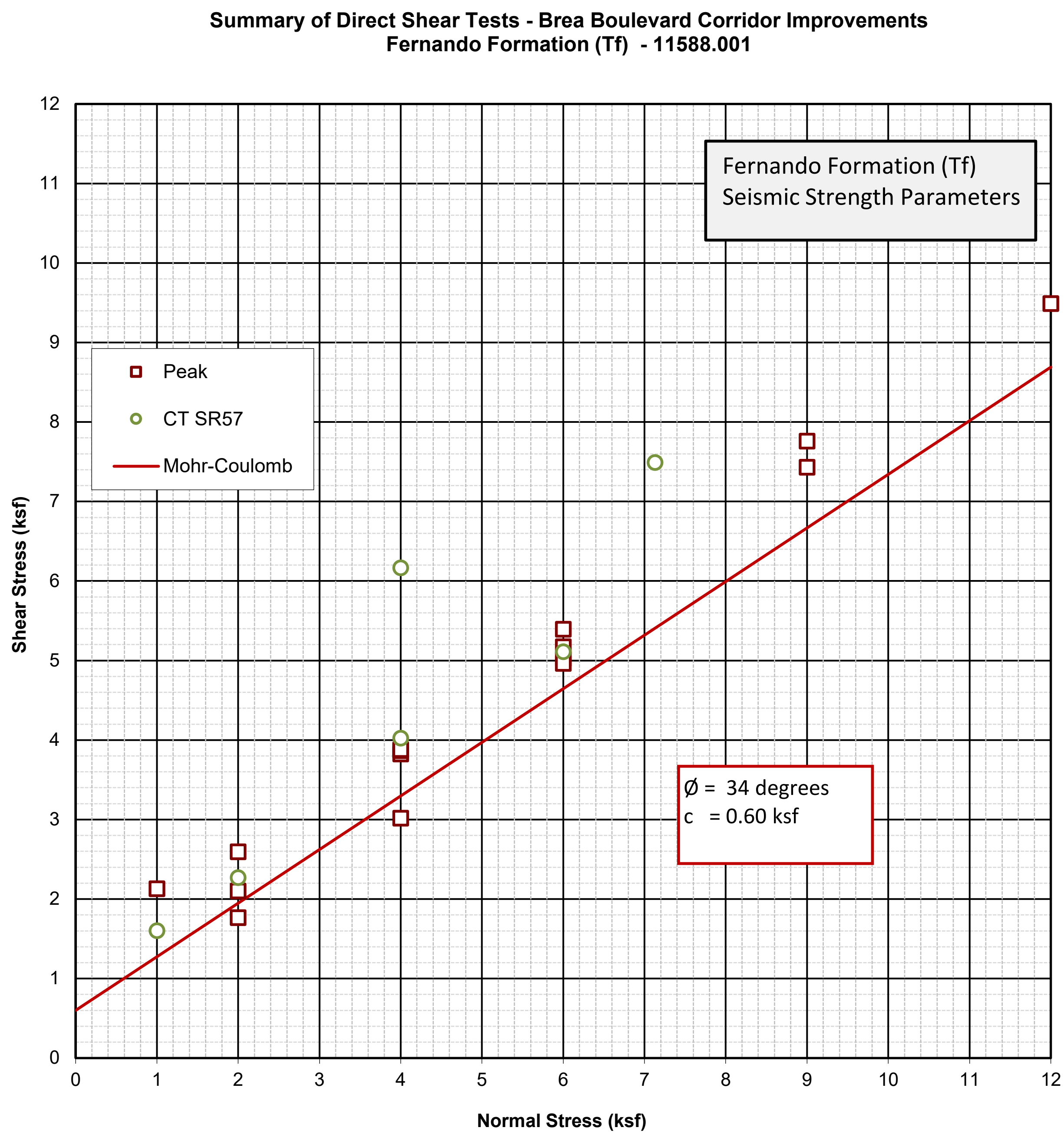
June 21, 2021

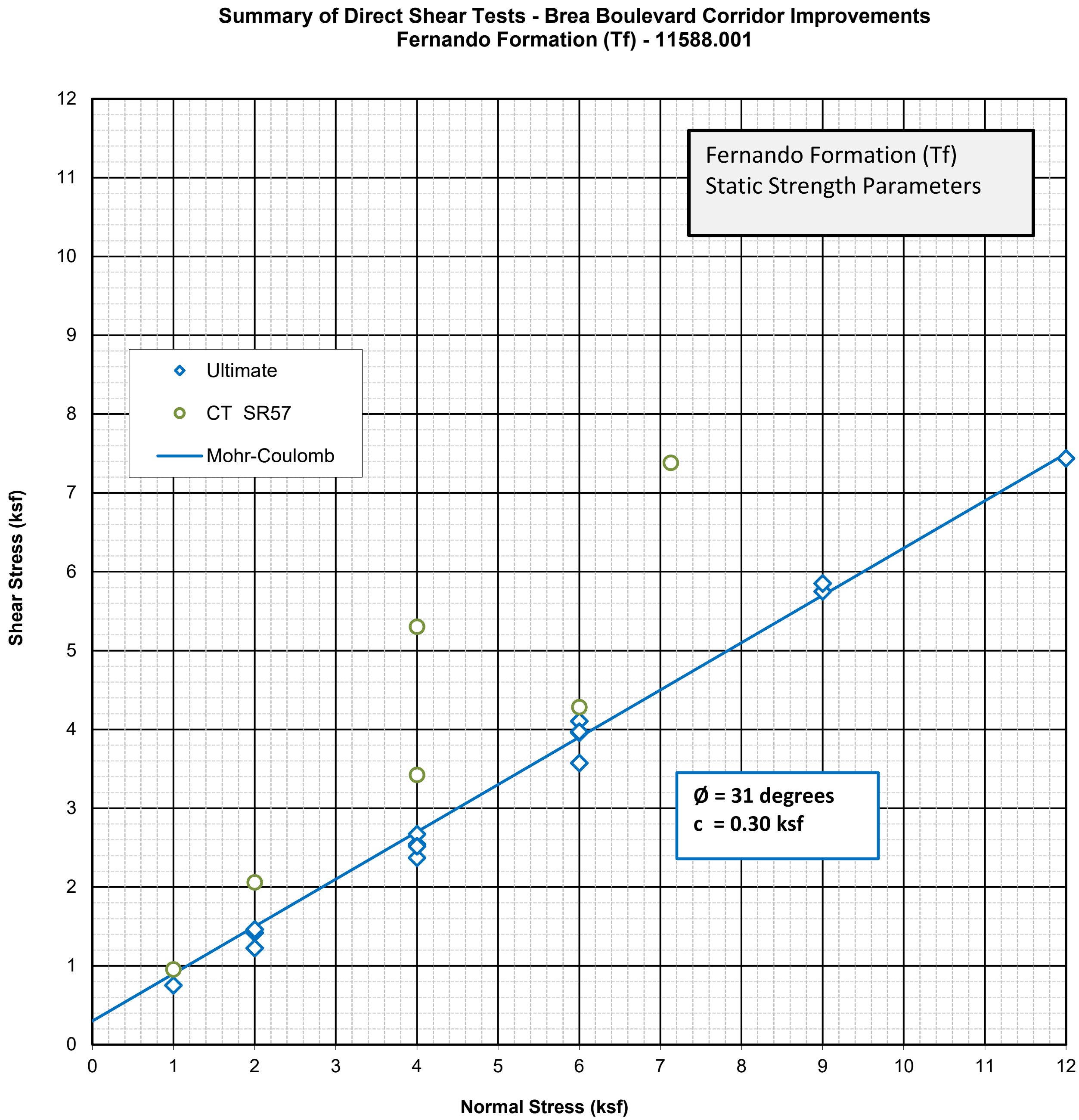
Section ID	Analysis Description	Factor of Safety Static	Factor of Safety Pseudo	File Name	Notes Sv (feet)	Sh (feet)	T_{PO}max (kips)
Appendix D - Global and Local Stability Analyses							
18+00	Global Stability Analysis	2.31		Sec 18+00_Global_c1		Not Applicable	
RW-1	*(Liquefaction not triggered)*		1.61	Sec 18+00_Global_c1_k022			
	(Liquefaction triggered)		0.96	Sec 18+00_Global_k022_LQ Sr_c1			
	(Flow Failure Analysis)		1.73	Sec 18+00_Global_LQ_blk SrfAlt_a3_k zero			
	(Yield Acceleration Analysis)		1.01	Sec 18+00_LQ_blk SrfAlt_a2_ky			
24+50	Soil Nail Load Demand - Dia 4 in.	1.51		Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1	4	6	6.60
RW-3	L = 14 feet		1.22	Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1_k033	4	6	3.40
26+00	Global Stability Analysis					Not Applicable	
RW-4	*(Yield Acceleration Analysis)*		1.06	Sec 26+00_Global_Blk Srf Alt_LQ_b1_rev ky			
29+50	Global Stability Analysis	3.64		Sec 29+50_RW-6_Global_path SrfAlt_a1		Not Applicable	
RW-6			2.31	Sec 29+50_RW-6_Global_path SrfAlt_a1_k022			
33+00	Global Stability Analysis	1.56		Sec 33+00_Global_a1		Not Applicable	
RW-7			1.24	Sec 33+00_Global_a1_k022			
35+00	Global Stability Analysis					Not Applicable	
RW-8	*(Yield Acceleration Analysis)*		1.00	Sec 35+00_LQ Blk Srf Alt_a1_ky			
38+00	Global Stability Analysis		1.0	11585_Sec 38+00_Cut Slope_Blk SrfA_LQ_c2_ky			
RW-8	*(Yield Acceleration Analysis)*						
40+00	Soil Nail Load Demand - Dia 6 in.	1.58		Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt_z2	5	5	27.45
RW-9	L = 30 feet		1.41	Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt_z2_k033			7.99
47+00	Soil Nail Load Demand - Dia 6 in.	1.51		Sec47+00_10-1_SN_Demand_D6_p36 B8 q2200_path_p9 bts	5	5	35.37
RW-12A	L 39 feet		1.16	Sec47+00_10-1_SN_Demand_D6_p36 B8 q2200_path_p9 bts_k033			8.75
	Soil Nail Load Demand - Dia 6 in.	1.51		Sec 47+00_10-1_SN_Demand_D6_p36 B8 q2200_path_p9 ts	5	5	51.27
	L 39 feet (static) L 42 feet (pseudo)		1.10	Sec 47+00_10-1_SN_Demand_D6_p36 B8 q2200_path_p9 ts			30.02
53+50	Soil Nail Load Demand - Dia 4 in.	1.53		Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var	5.25	6	24.89
RW-12C	L 28 feet		1.42				21.21
58+27	Soil Nail Load Demand - Dia 6 in.	1.56		Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2	5	5	31.94
RW-13	L 42 feet		1.11	Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2_k033			16.99
62+00	Soil Nail Load Demand - Dia 6 in.	1.54		Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1	5	6	47.99
RW-14	L 45 feet		1.14	Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1_k033			28.60
66+50	Soil Nail Load Demand - Dia 6 in.	1.51		Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1	4	6	42.15
RW-15	L 37 feet (static) L 38 feet (pseudo)		1.10	Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1_k033 x			24.51


Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
All Soils - 11588.001
Alluvial Soils/Older Alluvium
Seismic Strength Parameters
Peak
Mohr-Coulomb
Ø= 30 degrees
c = 0.30 ksf
Shear Stress (ksf)
Normal Stress (ksf)
0
1
2
3
4
5
6
7
8

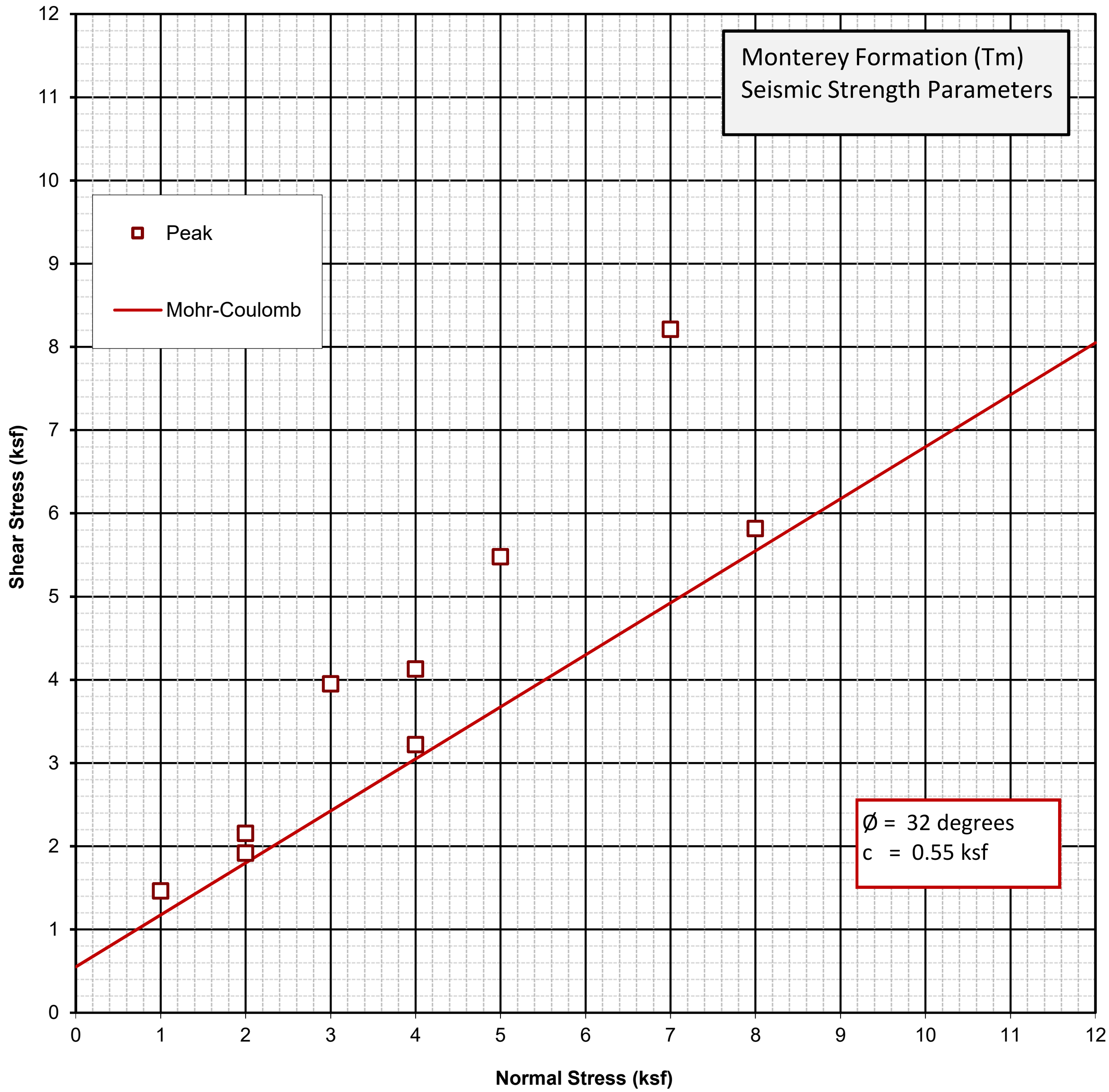
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
All Soils - 11588.001



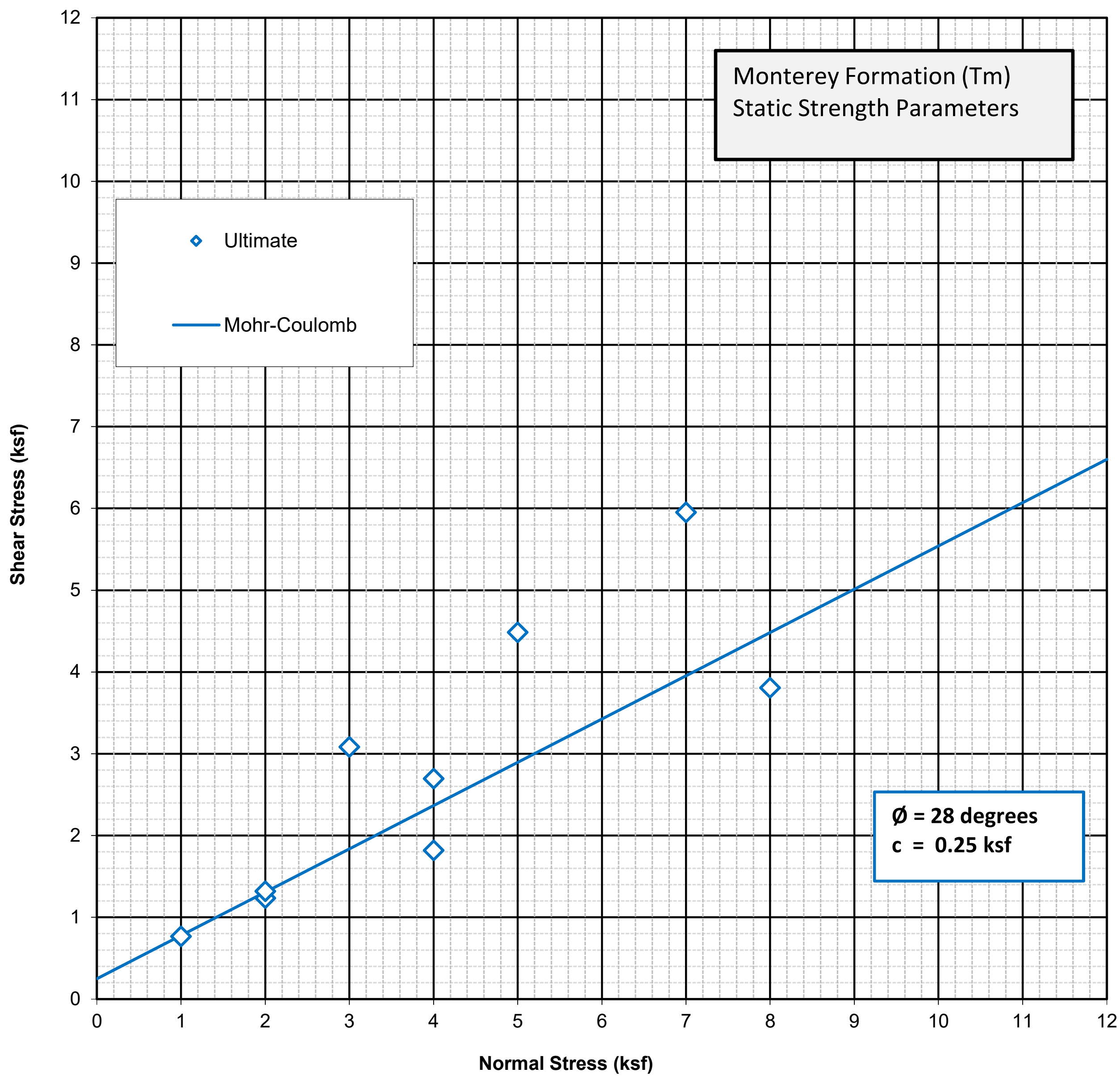

Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Fernando Formation (Tf) - 11588.001
Fernando Formation (Tf)
Seismic Strength Parameters
Peak
CT SR57
Mohr-Coulomb
Ø = 34 degrees
c = 0.60 ksf
Shear Stress (ksf)
Normal Stress (ksf)
0
1
2
3
4
5
6
7
8
9
10
11
12


Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Fernando Formation (Tf) - 11588.001
Fernando Formation (Tf)
Static Strength Parameters
Ultimate
CT SR57
Mohr-Coulomb
Ø = 31 degrees
c = 0.30 ksf
Shear Stress (ksf)
Normal Stress (ksf)
0
1
2
3
4
5
6
7
8
9
10
11
12

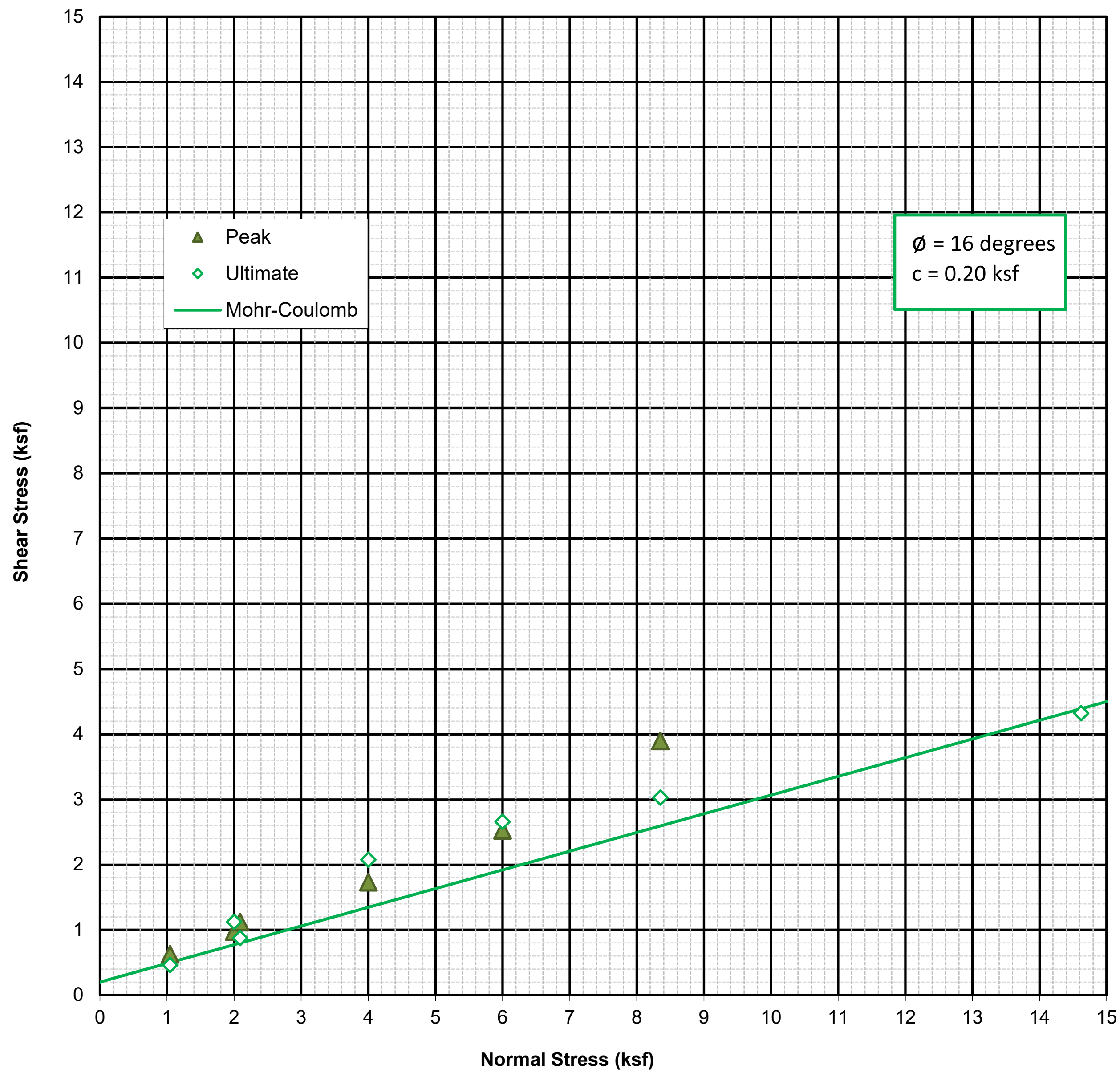
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Monterey Formation (Tm) - 11585.005



Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Monterey Formation (Tm) - 11585.005



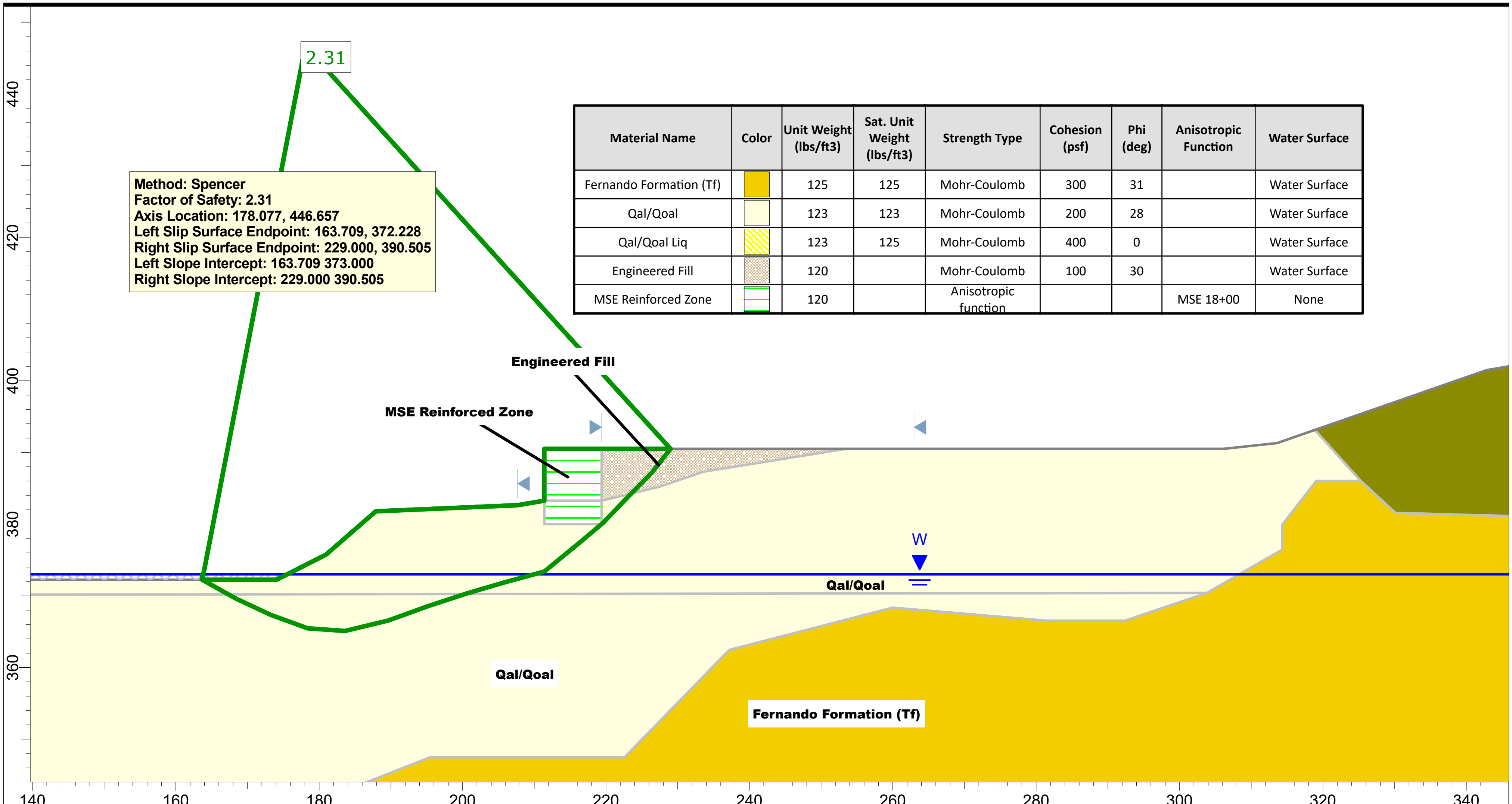
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Residual/Reshear- 11588.001



MSE Wall - RW-1 - Section 18+00

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 18+00\Sec 18+00_Global_c1\Sec 18+00_Global_c1.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Fernando Formation (Tf)		125	125	Mohr-Coulomb	300	31		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	200	28		Water Surface
Qal/Qoal Liq		123	125	Mohr-Coulomb	400	0		Water Surface
Engineered Fill		120		Mohr-Coulomb	100	30		Water Surface
MSE Reinforced Zone		120		Anisotropic function			MSE 18+00	None

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project:
Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California

Analyzed By: CD/JEH	*Units:* feet	*Scale:* 1:240	*Project No.:* **11588.001**	*File Name:* Master Scenario
Date: June 2019	*Condition:* **Static**			

Slide Analysis Information

Sec 18+00_Global_c1

Project Summary

File Name:	Sec 18+00_Global_c1.slmd
Slide Modeler Version:	8.022
Compute Time:	00h:00m:03.15s
Project Title:	Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California
Analysis:	MSE Wall - RW-1 - Section 18+00
Author:	CD/JEH
Company:	Leighton Consulting, Inc.
Date Created:	June 2019

Comments

Static

11588.001

Global Stability

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used

	Janbu corrected
	Spencer
Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Fernando Formation (Tf)	Qal/Qoal	Engineered Fill	Existing Fill	MSE Reinforced Zone
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Anisotropic function
Unsaturated Unit Weight [lbs/ft3]	125	123			
Saturated Unit Weight [lbs/ft3]	125	123			
Cohesion [psf]	300	200	100	21	
Friction Angle [°]	31	28	30	35	
Water Surface	Water Table	Water Table	Water Table	Water Table	None
Hu Value	Automatically Calculated	Automatically Calculated	Automatically Calculated	1	
Ru Value					0

Anisotropic Functions

Name: MSE 18+00

Angle From	Angle To	c	phi
-90	0	3000	35
0	3	0	34
3	90	3000	35

Global Minimums

Method: janbu corrected

FS	2.158550
Axis Location:	179.035, 442.506
Left Slip Surface Endpoint:	166.743, 372.228
Right Slip Surface Endpoint:	227.882, 390.505
Left Slope Intercept:	166.743 373.000
Right Slope Intercept:	227.882 390.505
Resisting Horizontal Force:	47064.6 lb
Driving Horizontal Force:	21803.8 lb
Total Slice Area:	685.442 ft2
Surface Horizontal Width:	61.1393 ft
Surface Average Height:	11.2111 ft

Method: spencer

FS	2.313080
Axis Location:	178.077, 446.657
Left Slip Surface Endpoint:	163.709, 372.228
Right Slip Surface Endpoint:	229.000, 390.505
Left Slope Intercept:	163.709 373.000
Right Slope Intercept:	229.000 390.505
Resisting Moment:	3.85582e+06 lb-ft
Driving Moment:	1.66697e+06 lb-ft
Resisting Horizontal Force:	43944.1 lb
Driving Horizontal Force:	18998.1 lb
Total Slice Area:	640.291 ft2
Surface Horizontal Width:	65.2909 ft
Surface Average Height:	9.80675 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
166.743	372.228
171.964	368.313
177.113	364.699
182.545	362.887
187.521	364.259
192.406	366.124
195.751	367.346
199.085	368.447
202.321	369.402
205.365	370.194
208.939	371.064
211.405	371.724
216.165	376.52
218.189	378.657
220.799	381.582
223.986	385.658
227.882	390.505

Method: spencer

X	Y
163.709	372.228
168.359	369.64
173.277	367.339
178.396	365.467
183.609	365.101
189.615	366.56
195.254	368.594
200.76	370.389
206.231	371.981
211.408	373.385
216.613	377.65
219.606	380.18
222.597	383.32
226.459	387.241
229	390.505

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4577
Number of Invalid Surfaces: 450

Error Codes:

Error Code -108 reported for 17 surfaces
Error Code -111 reported for 293 surfaces
Error Code -112 reported for 23 surfaces
Error Code -121 reported for 33 surfaces
Error Code -124 reported for 76 surfaces
Error Code -1000 reported for 8 surfaces

Method: spencer

Number of Valid Surfaces: 4072
Number of Invalid Surfaces: 955

Error Codes:

Error Code -108 reported for 81 surfaces
Error Code -111 reported for 706 surfaces
Error Code -112 reported for 42 surfaces
Error Code -121 reported for 33 surfaces
Error Code -124 reported for 76 surfaces
Error Code -1000 reported for 17 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

- **Global Minimum Query (janbu corrected) - Safety Factor: 2.15855**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.61067	440.054	-36.863	Qal/Qoal	200	28	133.832	288.883	276.407	109.242	167.165	176.058	66.8163
2	2.61067	1068.64	-36.863	Qal/Qoal	200	28	170.289	367.578	546.56	231.391	315.169	418.875	187.484
3	2.57437	1653.79	-35.0673	Qal/Qoal	200	28	202.62	437.365	795.264	348.847	446.417	653.033	304.186
4	2.57437	2402.86	-35.0673	Qal/Qoal	200	28	256.537	553.748	1126.91	461.61	665.303	946.834	485.224
5	2.71624	3419.86	-18.4479	Qal/Qoal	200	28	294.214	635.076	1364.52	546.262	818.259	1266.38	720.114
6	2.71624	4238.69	-18.4479	Qal/Qoal	200	28	360.388	777.915	1689.7	602.802	1086.9	1569.48	966.681
7	2.48793	4582.5	15.4198	Qal/Qoal	200	28	369.225	796.991	1732.44	609.662	1122.78	1834.28	1224.62
8	2.48793	5034.97	15.4198	Qal/Qoal	200	28	420.805	908.329	1899.01	566.843	1332.17	2015.08	1448.24
9	2.44259	5128.62	20.8995	Qal/Qoal	200	28	438.359	946.219	1919.77	516.332	1403.43	2087.16	1570.82
10	2.44259	4887.74	20.8995	Qal/Qoal	200	28	429.317	926.702	1824.86	458.131	1366.73	1988.79	1530.66
11	1.67259	3206.59	20.0566	Qal/Qoal	200	28	423.023	913.116	1751.16	409.978	1341.18	1905.6	1495.62
12	1.67259	3095.93	20.0566	Qal/Qoal	200	28	416.721	899.513	1687.47	371.874	1315.59	1839.61	1467.74
13	1.66704	2981.51	18.2716	Qal/Qoal	200	28	414.318	894.327	1641.49	335.649	1305.84	1778.28	1442.64
14	1.66704	2883.52	18.2716	Qal/Qoal	200	28	408.783	882.378	1584.67	301.304	1283.37	1719.64	1418.33
15	1.61757	2709.89	16.4491	Qal/Qoal	200	28	407.179	878.916	1546.09	269.23	1276.86	1666.31	1397.08
16	1.61757	2628.87	16.4491	Qal/Qoal	200	28	402.544	868.911	1497.47	239.429	1258.04	1616.32	1376.89
17	3.04422	4747.64	14.5918	Qal/Qoal	200	28	400.031	863.487	1447.64	199.803	1247.84	1551.78	1351.98
18	1.78693	2675.05	13.6712	Qal/Qoal	200	28	396.116	855.037	1393.46	161.516	1231.95	1489.82	1328.3
19	1.78693	2608.69	13.6712	Qal/Qoal	200	28	393.799	850.034	1356.93	134.393	1222.54	1452.72	1318.32
20	2.46599	3538.6	14.9853	Qal/Qoal	200	28	393.545	849.487	1321.74	100.238	1221.51	1427.09	1326.85
21	1.2667	2783.1	45.2187	Qal/Qoal	200	28	492.64	1063.39	1663.61	39.8192	1623.79	2160.03	2120.21
22	1.74662	3516.58	45.2187	Qal/Qoal	200	28	464.648	1002.97	1510.16	0	1510.16	1978.37	1978.37
23	1.74662	3138.46	45.2187	Qal/Qoal	200	28	422.553	912.102	1339.27	0	1339.27	1765.06	1765.06
24	2.02417	3152.1	46.5485	Qal/Qoal	200	28	372.227	803.471	1134.96	0	1134.96	1527.87	1527.87
25	1.21128	1625.97	48.2525	Qal/Qoal	200	28	326.471	704.705	949.212	0	949.212	1315.02	1315.02
26	1.39926	1641.01	48.2525	Qal/Qoal	200	28	294.254	635.162	818.424	0	818.424	1148.14	1148.14
27	1.95192	1803.61	51.9815	Qal/Qoal	200	28	239.251	516.436	595.129	0	595.129	901.152	901.152
28	1.23494	835.327	51.9815	Engineered Fill	100	30	166.155	358.654	448.001	0	448.001	660.528	660.528
29	1.94786	849.707	51.2094	Engineered Fill	100	30	120.064	259.165	275.682	0	275.682	425.062	425.062
30	1.94786	283.236	51.2094	Engineered Fill	100	30	62.7703	135.493	61.4754	0	61.4754	139.572	139.572

- **Global Minimum Query (spencer) - Safety Factor: 2.31308**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.32507	297.041	-29.0983	Qal/Qoal	200	28	126.69	293.043	263.531	88.5418	174.989	193.021	104.479
2	2.32507	667.111	-29.0983	Qal/Qoal	200	28	156.636	362.311	474.551	169.289	305.262	387.375	218.086
3	2.45913	1075.24	-25.0677	Qal/Qoal	200	28	175.195	405.24	631.549	245.551	385.998	549.602	304.051
4	2.45913	1423.16	-25.0677	Qal/Qoal	200	28	199.806	462.167	810.391	317.327	493.064	716.932	399.605
5	2.55947	1861.23	-20.0953	Qal/Qoal	200	28	214.875	497.023	941.05	382.43	558.62	862.436	480.006
6	2.55947	2474.41	-20.0953	Qal/Qoal	200	28	269.696	623.828	1237.97	440.861	797.105	1139.3	698.435
7	2.60608	3118.96	-4.01044	Qal/Qoal	200	28	276.885	640.456	1304.15	475.777	828.378	1284.74	808.965
8	2.60608	3757.11	-4.01044	Qal/Qoal	200	28	335.762	776.644	1571.69	487.178	1084.51	1548.15	1060.97
9	2.00231	3343.09	13.6477	Qal/Qoal	200	28	339.12	784.412	1576.83	477.71	1099.12	1659.17	1181.46
10	2.00231	3652.44	13.6477	Qal/Qoal	200	28	379.626	878.106	1722.71	447.373	1275.33	1814.88	1367.51
11	2.00231	3812.71	13.6477	Qal/Qoal	200	28	403.97	934.415	1798.27	417.036	1381.24	1896.36	1479.32
12	2.81907	5149.66	19.8418	Qal/Qoal	200	28	378.213	874.838	1639.31	370.129	1269.18	1775.79	1405.66
13	2.81907	4839.45	19.8418	Qal/Qoal	200	28	369.735	855.227	1538.96	306.652	1232.3	1672.37	1365.72
14	1.83532	2991.18	18.0521	Qal/Qoal	200	28	368.305	851.918	1482.33	256.251	1226.08	1602.37	1346.12
15	1.83532	2874.16	18.0521	Qal/Qoal	200	28	363.379	840.524	1423.58	218.924	1204.65	1542.01	1323.09
16	1.83532	2757.15	18.0521	Qal/Qoal	200	28	358.453	829.13	1364.82	181.598	1183.22	1481.65	1300.05
17	1.82371	2630.95	16.2253	Qal/Qoal	200	28	358.862	830.077	1331.38	146.376	1185	1435.81	1289.43
18	1.82371	2529.69	16.2253	Qal/Qoal	200	28	354.589	820.193	1279.68	113.26	1166.42	1382.86	1269.6
19	1.82371	2428.44	16.2253	Qal/Qoal	200	28	350.316	810.31	1227.97	80.1437	1147.83	1329.91	1249.77
20	1.87873	2401.54	15.1744	Qal/Qoal	200	28	349.026	807.326	1189.9	47.688	1142.21	1284.56	1236.87
21	1.87873	2340.32	15.1744	Qal/Qoal	200	28	349.298	807.955	1159.29	15.8928	1143.4	1254.02	1238.13
22	1.42032	1739.14	15.1744	Qal/Qoal	200	28	348.375	805.819	1139.38	0	1139.38	1233.86	1233.86
23	2.60206	5055.54	39.3343	Qal/Qoal	200	28	413.796	957.144	1423.98	0	1423.98	1763.08	1763.08
24	2.60206	4373.53	39.3343	Qal/Qoal	200	28	368.467	852.293	1226.79	0	1226.79	1528.74	1528.74
25	2.78742	3915.8	40.1963	Qal/Qoal	200	28	318.274	736.194	1008.43	0	1008.43	1277.36	1277.36
26	0.20642	259.905	40.1963	Qal/Qoal	200	28	293.3	678.426	899.788	0	899.788	1147.61	1147.61
27	2.99056	3159.22	46.4022	Qal/Qoal	200	28	244.2	564.854	686.191	0	686.191	942.646	942.646
28	0.932725	752.182	45.434	Qal/Qoal	200	28	206.067	476.649	520.3	0	520.3	729.513	729.513
29	2.92936	1670	45.434	Engineered Fill	100	30	136.475	315.677	373.565	0	373.565	512.123	512.123
30	2.54081	497.55	52.0991	Engineered Fill	100	30	67.212	155.467	96.0712	0	96.0712	182.406	182.406

Interslice Data

- **Global Minimum Query (janbu corrected) - Safety Factor: 2.15855**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	166.743	372.228	18.5947	0	0
2	169.353	370.27	916.569	0	0
3	171.964	368.313	2464.26	0	0
4	174.538	366.506	4472.34	0	0
5	177.113	364.699	7226.79	0	0
6	179.829	363.793	9322.05	0	0
7	182.545	362.887	11905.1	0	0
8	185.033	363.573	11703.6	0	0
9	187.521	364.259	11525.6	0	0
10	189.964	365.192	10885.7	0	0
11	192.406	366.124	10310.7	0	0
12	194.079	366.735	10001.8	0	0
13	195.751	367.346	9720.4	0	0
14	197.418	367.896	9559.22	0	0
15	199.085	368.447	9419.39	0	0
16	200.703	368.924	9388.86	0	0
17	202.321	369.402	9373.5	0	0
18	205.365	370.194	9535.03	0	0
19	207.152	370.629	9690.08	0	0
20	208.939	371.064	9856.56	0	0
21	211.405	371.724	10027.1	0	0
22	212.671	373	8574.3	0	0
23	214.418	374.76	6788.62	0	0
24	216.165	376.52	5224.68	0	0
25	218.189	378.657	3609.42	0	0
26	219.4	380.014	2746.11	0	0
27	220.799	381.582	1905.43	0	0
28	222.751	384.078	921.479	0	0
29	223.986	385.658	434.34	0	0
30	225.934	388.082	17.5788	0	0
31	227.882	390.505	0	0	0

- **Global Minimum Query (spencer) - Safety Factor: 2.31308**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	163.709	372.228	18.5947	0	0
2	166.034	370.934	635.578	151.75	13.4285
3	168.359	369.64	1613.85	385.321	13.4285
4	170.818	368.49	2771.12	661.629	13.4285
5	173.277	367.339	4194.62	1001.5	13.4284
6	175.837	366.403	5644.38	1347.64	13.4284
7	178.396	365.467	7493.88	1789.23	13.4285
8	181.002	365.284	8453.74	2018.4	13.4284
9	183.609	365.101	9615.93	2295.89	13.4285
10	185.611	365.587	9528.34	2274.97	13.4284
11	187.613	366.074	9450.94	2256.49	13.4284
12	189.615	366.56	9385.54	2240.88	13.4285
13	192.435	367.577	8784.15	2097.29	13.4285
14	195.254	368.594	8260.95	1972.37	13.4284
15	197.089	369.192	8050.21	1922.06	13.4285
16	198.924	369.791	7865.57	1877.97	13.4284
17	200.76	370.389	7707.04	1840.12	13.4284
18	202.583	370.92	7654.93	1827.68	13.4285
19	204.407	371.45	7622.46	1819.93	13.4285
20	206.231	371.981	7609.64	1816.87	13.4285
21	208.109	372.49	7659.07	1828.67	13.4285
22	209.988	373	7724.6	1844.32	13.4285
23	211.408	373.385	7780.5	1857.66	13.4285
24	214.011	375.518	5820.79	1389.76	13.4284
25	216.613	377.65	4163.61	994.098	13.4285
26	219.4	380.005	2675.67	638.839	13.4285
27	219.606	380.18	2579.27	615.824	13.4285
28	222.597	383.32	1154.49	275.643	13.4284
29	223.53	384.267	853.984	203.896	13.4285
30	226.459	387.241	142.758	34.0848	13.4285
31	229	390.505	0	0	0

Entity Information

Group: Group 1

Shared Entities

Type	Coordinates	
	X	Y
External Boundary	23.834	386.339
	23.834	373
	23.834	370
	23.834	356.753
	23.834	249.213
	503.688	249.213
	503.688	397.171
	503.688	408.264
	414.155	408.264
	395.692	406.373
	364.168	405.057
	342.86	401.481
	318.874	393.136
	313.607	391.303
	306.16	390.505
	253.455	390.505
	219.4	390.505
	211.409	390.505
	211.409	383.266
	207.675	382.644
	187.903	381.784
	180.966	375.748
	175.55	373
	174.029	372.228
	138.434	372.228
	136.669	373
	127.585	376.974
	113.006	379.517
	X	Y
Material Boundary	23.834	356.753
	38.26	349.023
	46.516	344.105
	176.877	340.177
	195.446	347.476
	222.595	347.476
	237.194	362.459
	259.989	368.35
	281.466	366.543
	292.389	366.543
	303.816	370.408
	308.317	373
	314.319	376.457
	314.319	379.927
	319.077	386.014
	325.283	386.014
	330.105	381.564
	354.67	380.889
	391.468	399.113
	503.688	397.171
	X	Y
Material Boundary	318.874	393.136
	325.283	386.014

Material Boundary	X: 211.409, 219.4, 227.468, 233.602, 253.455; Y: 383.266, 383.266, 385.222, 387.323, 390.505

X	Y
211.409	383.266
219.4	383.266
227.468	385.222
233.602	387.323
253.455	390.505

Material Boundary

X	Y
211.409	383.266
211.409	380
219.4	380
219.4	381.036
219.4	383.266
219.4	390.505

Material Boundary

X	Y
23.834	370
303.816	370.408

Material Boundary

X	Y
23.834	373
136.669	373

Material Boundary

X	Y
175.55	373
308.317	373

Scenario-based Entities

Type	Coordinates	Master Scenario
Water Table	X / Y: 23.834 / 373; 503.688 / 373	Assigned to materials: Fernando Formation (Tf), Qal/Qoal, Engineered Fill, Existing Fill

X	Y
23.834	373
503.688	373

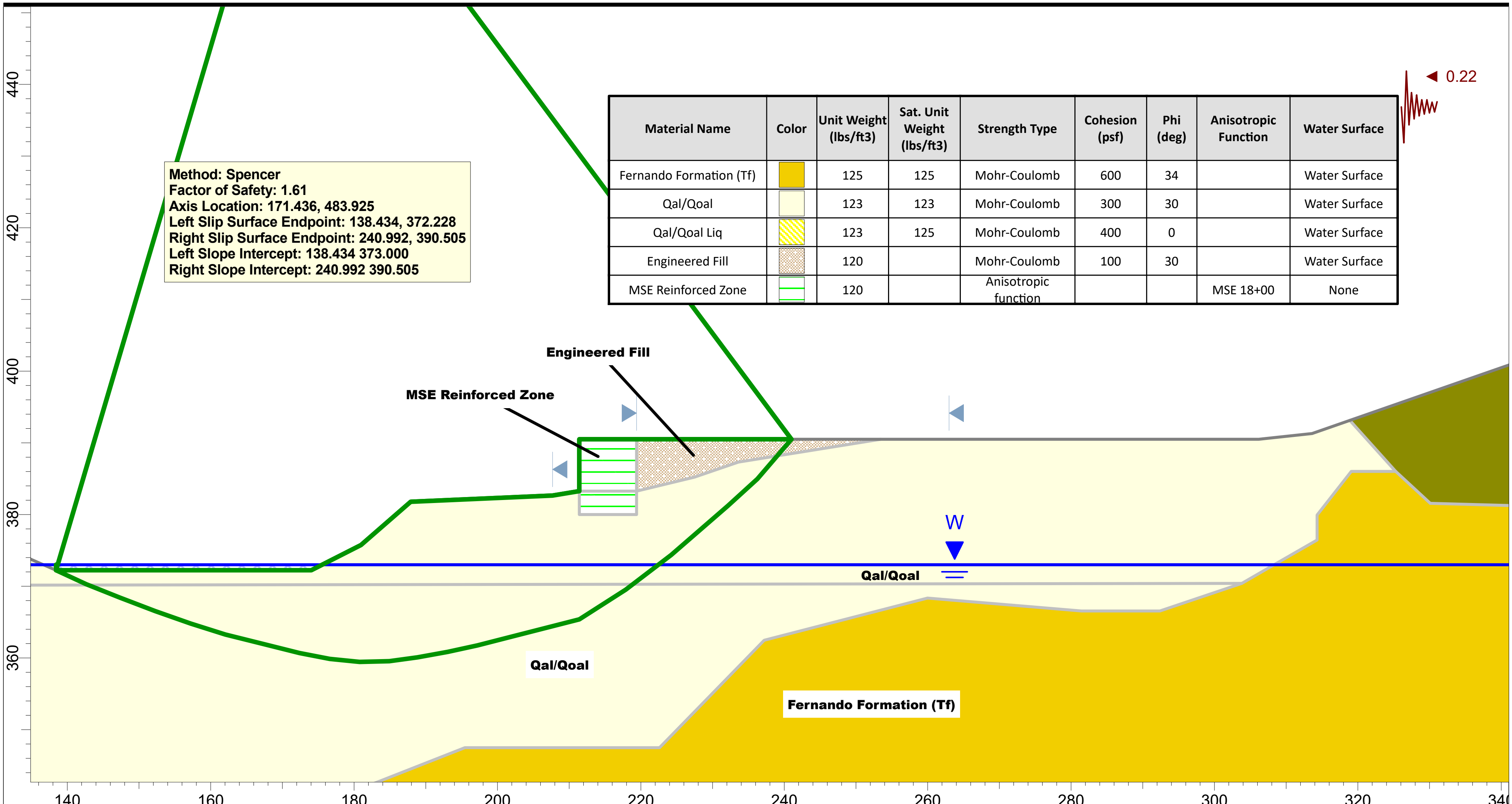
Assigned to materials:

- Fernando Formation (Tf)
- Qal/Qoal
- Engineered Fill
- Existing Fill

MSE Wall - RW-1 - Section 18+00

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 18+00\Sec 18+00_Global_c1_k022.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Fernando Formation (Tf)		125	125	Mohr-Coulomb	600	34		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal Liq		123	125	Mohr-Coulomb	400	0		Water Surface
Engineered Fill		120		Mohr-Coulomb	100	30		Water Surface
MSE Reinforced Zone		120		Anisotropic function			MSE 18+00	None

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**

Analyzed By: CD/JEH	Units: feet	Scale: 1:240	Project No.: **11588.001**	File Name: Master Scenario
Date: June 2019	Condition: **Pseudostatic**			

Slide Analysis Information

Sec 18+00_Global_c1_k022

Project Summary

File Name:	Sec 18+00_Global_c1_k022.slmd
Slide Modeler Version:	8.022
Compute Time:	00h:00m:03.89s
Project Title:	Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California
Analysis:	MSE Wall - RW-1 - Section 18+00
Author:	CD/JEH
Company:	Leighton Consulting, Inc.
Date Created:	June 2019

Comments

Pseudostatic

11588.001

Global Stability

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used

	Janbu corrected
	Spencer
Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Seismic Load Coefficient (Horizontal): 0.22

Materials

Property	Fernando Formation (Tf)	Qal/Qoal	Engineered Fill	Existing Fill	MSE Reinforced Zone
Color					
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Anisotropic function
Unsaturated Unit Weight [lbs/ft3]	125	123			
Saturated Unit Weight [lbs/ft3]	125	123			
Cohesion [psf]	600	300	100	21	
Friction Angle [°]	34	30	30	35	
Water Surface	Water Table	Water Table	Water Table	Water Table	None
Hu Value	Automatically Calculated	Automatically Calculated	Automatically Calculated	1	
Ru Value					0

Anisotropic Functions

Name: MSE 18+00

Angle From	Angle To	c	phi
-90	0	3000	35
0	3	0	34
3	90	3000	35

Global Minimums

Method: janbu corrected

FS	1.510760
Axis Location:	175.505, 459.264
Left Slip Surface Endpoint:	154.833, 372.228
Right Slip Surface Endpoint:	232.731, 390.505
Left Slope Intercept:	154.833 373.000
Right Slope Intercept:	232.731 390.505
Resisting Horizontal Force:	73017.1 lb
Driving Horizontal Force:	48331.3 lb
Total Slice Area:	1004.46 ft2
Surface Horizontal Width:	77.8976 ft
Surface Average Height:	12.8946 ft

Method: spencer

FS	1.606950
Axis Location:	171.436, 483.925
Left Slip Surface Endpoint:	138.434, 372.228
Right Slip Surface Endpoint:	240.992, 390.505
Left Slope Intercept:	138.434 373.000
Right Slope Intercept:	240.992 390.505
Resisting Moment:	1.24394e+07 lb-ft
Driving Moment:	7.741e+06 lb-ft
Resisting Horizontal Force:	93702.7 lb
Driving Horizontal Force:	58310.9 lb
Total Slice Area:	1375.78 ft2
Surface Horizontal Width:	102.558 ft
Surface Average Height:	13.4146 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
154.833	372.228
160.172	369.02
166.24	365.893
172.567	362.634
177.536	360.296
182.743	359.395
188.984	360.61
195.177	362.786
201.01	364.835
206.343	366.709
211.406	368.488
217.047	374.062
221.357	378.321
225.269	382.469
229.454	386.976
232.731	390.505

Method: spencer

X	Y
138.434	372.228
142.647	370.275
147.324	368.424
152.267	366.539
157.2	364.796
162.052	363.261
167.189	361.977
172.389	360.68
176.608	359.871
180.766	359.451
184.907	359.552
188.833	360.088
193.068	360.842
197.19	361.746
201.956	362.964
211.41	365.381
217.901	369.527
224.238	374.362
232.153	381.236
236.246	384.975
240.992	390.505

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4694
Number of Invalid Surfaces: 337

Error Codes:

Error Code -108 reported for 12 surfaces
Error Code -111 reported for 193 surfaces
Error Code -112 reported for 13 surfaces
Error Code -121 reported for 33 surfaces
Error Code -124 reported for 76 surfaces
Error Code -1000 reported for 10 surfaces

Method: spencer

Number of Valid Surfaces: 2895
Number of Invalid Surfaces: 2136

Error Codes:

Error Code -108 reported for 65 surfaces
Error Code -111 reported for 1927 surfaces
Error Code -112 reported for 16 surfaces
Error Code -121 reported for 33 surfaces
Error Code -124 reported for 76 surfaces
Error Code -1000 reported for 19 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.51076**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.66925	391.894	-31.0023	Qal/Qoal	300	30	288.726	436.195	334.109	98.2125	235.896	160.609	62.3969
2	2.66925	918.511	-31.0023	Qal/Qoal	300	30	338.116	510.812	563.439	198.301	365.138	360.261	161.96
3	3.03438	1635.23	-27.258	Qal/Qoal	300	30	369.51	558.241	744.409	297.122	447.287	554.033	256.911
4	3.03438	2218.71	-27.258	Qal/Qoal	300	30	415.488	627.702	962.272	394.675	567.597	748.208	353.533
5	2.10873	1885.53	-27.258	Qal/Qoal	300	30	454.452	686.568	1146.9	477.348	669.555	912.764	435.416
6	2.10873	2167.33	-27.258	Qal/Qoal	300	30	486.404	734.84	1298.31	545.142	753.163	1047.7	502.563
7	2.10873	2449.12	-27.258	Qal/Qoal	300	30	518.356	783.112	1449.71	612.936	836.772	1182.65	569.709
8	2.48445	3246.13	-25.1937	Qal/Qoal	300	30	541.942	818.744	1581.79	683.299	898.491	1326.84	643.545
9	2.48445	3822.6	-25.1937	Qal/Qoal	300	30	617.385	932.72	1852.13	756.229	1095.9	1561.7	805.467
10	2.6037	4674.67	-9.81887	Qal/Qoal	300	30	620.711	937.745	1911.36	806.754	1104.61	1803.93	997.181
11	2.6037	5312.53	-9.81887	Qal/Qoal	300	30	709.959	1072.58	2173.02	834.873	1338.14	2050.14	1215.27
12	3.12036	7274.17	11.0129	Qal/Qoal	300	30	714.881	1080.01	2181.01	829.985	1351.02	2320.13	1490.15
13	3.12036	8023.79	11.0129	Qal/Qoal	300	30	813.271	1228.66	2400.57	792.092	1608.48	2558.85	1766.76
14	3.09689	7901.95	19.3589	Qal/Qoal	300	30	778.372	1175.93	2256.36	739.197	1517.16	2529.84	1790.64
15	3.09689	7538.79	19.3589	Qal/Qoal	300	30	761.893	1151.04	2145.34	671.3	1474.04	2413.03	1741.73
16	2.91623	6767	19.3589	Qal/Qoal	300	30	745.895	1126.87	2037.56	605.383	1432.18	2299.63	1694.25
17	2.91623	6444.97	19.3589	Qal/Qoal	300	30	730.377	1103.42	1933.02	541.447	1391.57	2189.64	1648.19
18	2.66648	5611.19	19.3589	Qal/Qoal	300	30	715.525	1080.99	1832.96	480.249	1352.71	2084.36	1604.11
19	2.66648	5341.96	19.3589	Qal/Qoal	300	30	701.336	1059.55	1737.37	421.789	1315.58	1983.78	1561.99
20	2.53146	4833.22	19.3589	Qal/Qoal	300	30	688.943	1040.83	1647.96	364.808	1283.15	1890.02	1525.21
21	2.53146	4674.14	19.3589	Qal/Qoal	300	30	686.493	1037.13	1586.05	309.308	1276.74	1827.25	1517.94
22	2.28323	5791.74	44.6576	Qal/Qoal	300	30	772.412	1166.93	1712.73	211.167	1501.57	2475.97	2264.8
23	2.28323	5160.91	44.6576	Qal/Qoal	300	30	735.623	1111.35	1475.69	70.3859	1405.3	2202.57	2132.18
24	1.07456	2209.62	44.6576	Qal/Qoal	300	30	699.334	1056.53	1310.34	0	1310.34	2001.37	2001.37
25	2.15497	4008.34	44.6576	Qal/Qoal	300	30	646.053	976.031	1170.92	0	1170.92	1809.3	1809.3
26	2.15497	3464.49	44.6576	Qal/Qoal	300	30	577.537	872.52	991.633	0	991.633	1562.31	1562.31
27	3.91225	4791.3	46.6781	Qal/Qoal	300	30	463.743	700.604	693.868	0	693.868	1185.6	1185.6
28	2.72296	2155.61	47.1223	Qal/Qoal	300	30	346.958	524.171	388.277	0	388.277	761.94	761.94
29	1.46158	757.07	47.1223	Engineered Fill	100	30	182.887	276.299	305.359	0	305.359	502.323	502.323
30	3.27723	694.012	47.1223	Engineered Fill	100	30	101.864	153.892	93.3433	0	93.3433	203.047	203.047

- **Global Minimum Query (spencer) - Safety Factor: 1.60695**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.21323	708.901	-24.8649	Qal/Qoal	300	30	313.711	504.118	462.632	109.088	353.544	317.246	208.158
2	4.67664	1880.98	-21.5988	Qal/Qoal	300	30	361.054	580.195	713.086	227.776	485.31	570.144	342.368
3	2.47146	1418.7	-20.8733	Qal/Qoal	300	30	402.932	647.491	916.817	314.946	601.871	763.168	448.222
4	2.47146	1705.19	-20.8733	Qal/Qoal	300	30	434.33	697.947	1063.02	373.755	689.264	897.396	523.641
5	2.46668	1977.04	-19.4542	Qal/Qoal	300	30	451.994	726.332	1168.77	430.342	738.43	1009.12	578.777
6	2.46668	2241.39	-19.4542	Qal/Qoal	300	30	479.966	771.282	1300.99	484.71	816.285	1131.46	646.752
7	4.85201	5126.91	-17.5568	Qal/Qoal	300	30	500.085	803.611	1432.07	559.79	872.279	1273.85	714.058
8	2.56858	3058.06	-14.0378	Qal/Qoal	300	30	500.508	804.292	1501.18	627.723	873.459	1376.04	748.317
9	2.56858	3260.96	-14.0378	Qal/Qoal	300	30	518.607	833.375	1591.63	667.797	923.831	1461.96	794.165
10	5.19999	7221.91	-14.0073	Qal/Qoal	300	30	545.64	876.816	1727.38	728.307	999.075	1591.26	862.957
11	4.21881	6525.5	-10.8463	Qal/Qoal	300	30	557.037	895.131	1824.8	794	1030.8	1718.07	924.069
12	4.15783	7635.52	-5.76958	Qal/Qoal	300	30	613.921	986.541	2021.45	832.326	1189.12	1959.42	1127.09
13	4.14081	9104.45	1.38856	Qal/Qoal	300	30	683.647	1098.59	2225.5	842.302	1383.19	2242.07	1399.76
14	3.92642	10129.5	7.77988	Qal/Qoal	300	30	766.17	1231.2	2435.31	822.433	1612.88	2539.99	1717.56
15	4.23476	11173.6	10.0895	Qal/Qoal	300	30	778.882	1251.62	2430.44	782.186	1648.25	2569.03	1786.85
16	4.12192	10547.9	12.3711	Qal/Qoal	300	30	750.677	1206.3	2300.23	730.469	1569.76	2464.88	1734.41
17	2.38283	5917.28	14.3405	Qal/Qoal	300	30	726.3	1167.13	2185.16	683.255	1501.91	2370.84	1687.59
18	2.38283	5769.12	14.3405	Qal/Qoal	300	30	720.469	1157.76	2130.92	645.243	1485.68	2315.11	1669.87
19	3.15153	7402.66	14.3405	Qal/Qoal	300	30	713.699	1146.88	2067.93	601.1	1466.83	2250.39	1649.29
20	3.15153	7146.06	14.3405	Qal/Qoal	300	30	706.246	1134.9	1996.92	550.825	1446.09	2177.47	1626.64
21	3.15153	6988.28	14.3405	Qal/Qoal	300	30	708.717	1138.87	1953.52	500.55	1452.97	2134.71	1634.16
22	3.24529	9512.76	32.5653	Qal/Qoal	300	30	785.463	1262.2	2077.32	410.744	1666.58	2578.98	2168.23
23	3.24529	8685.4	32.5653	Qal/Qoal	300	30	762.354	1225.06	1883.67	281.409	1602.26	2370.56	2089.15
24	4.55244	10664.3	37.3435	Qal/Qoal	300	30	694.303	1115.71	1521.22	108.368	1412.85	2050.97	1942.6
25	1.78478	3659.72	37.3435	Qal/Qoal	300	30	658.218	1057.72	1312.41	0	1312.41	1814.63	1814.63
26	3.95778	6955.83	40.9708	Qal/Qoal	300	30	563.849	906.077	1049.76	0	1049.76	1539.4	1539.4
27	3.95778	5297.25	40.9708	Qal/Qoal	300	30	467.671	751.524	782.062	0	782.062	1188.18	1188.18
28	4.09212	3686.12	42.4189	Qal/Qoal	300	30	361.593	581.062	486.813	0	486.813	817.212	817.212
29	2.75875	1310.25	49.3603	Qal/Qoal	300	30	247.768	398.151	170.002	0	170.002	458.673	458.673
30	1.98796	276.263	49.3603	Engineered Fill	100	30	78.6749	126.427	45.7722	0	45.7722	137.435	137.435

Interslice Data

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.51076**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	154.833	372.228	18.5947	0	0
2	157.502	370.624	1309.92	0	0
3	160.172	369.02	3014.15	0	0
4	163.206	367.457	5060.69	0	0
5	166.24	365.893	7470.06	0	0
6	168.349	364.807	9358.14	0	0
7	170.458	363.72	11421.4	0	0
8	172.567	362.634	13660	0	0
9	175.051	361.465	16287.3	0	0
10	177.536	360.296	19269.7	0	0
11	180.139	359.846	20847.2	0	0
12	182.743	359.395	22653.1	0	0
13	185.863	360.003	22136.3	0	0
14	188.984	360.61	21652.7	0	0
15	192.081	361.698	20061.3	0	0
16	195.177	362.786	18615.6	0	0
17	198.094	363.811	17387.2	0	0
18	201.01	364.835	16288	0	0
19	203.676	365.772	15395.9	0	0
20	206.343	366.709	14611.7	0	0
21	208.874	367.598	13965.3	0	0
22	211.406	368.488	13402.3	0	0
23	213.689	370.744	10167.8	0	0
24	215.972	373	7516.25	0	0
25	217.047	374.062	6450.03	0	0
26	219.202	376.191	4577.78	0	0
27	221.357	378.321	3047.55	0	0
28	225.269	382.469	1073.52	0	0
29	227.992	385.401	480.51	0	0
30	229.454	386.976	121.851	0	0
31	232.731	390.505	0	0	0

- **Global Minimum Query (spencer) - Safety Factor: 1.60695**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	138.434	372.228	18.5947	0	0
2	142.647	370.275	2113.76	627.76	16.5408
3	147.324	368.424	4758.3	1413.16	16.5408
4	149.795	367.481	6332.26	1880.6	16.5407
5	152.267	366.539	8058.57	2393.3	16.5408
6	154.733	365.668	9783.02	2905.44	16.5408
7	157.2	364.796	11633.5	3455.01	16.5408
8	162.052	363.261	15181.8	4508.82	16.5408
9	164.621	362.619	16786	4985.23	16.5408
10	167.189	361.977	18450	5479.44	16.5408
11	172.389	360.68	21994.4	6532.08	16.5408
12	176.608	359.871	24427.9	7254.79	16.5408
13	180.766	359.451	26149.9	7766.2	16.5408
14	184.907	359.552	26754.4	7945.73	16.5408
15	188.833	360.088	26227.8	7789.34	16.5408
16	193.068	360.842	25236.6	7494.96	16.5408
17	197.19	361.746	23930.7	7107.13	16.5408
18	199.573	362.355	23028.4	6839.16	16.5408
19	201.956	362.964	22177.9	6586.56	16.5408
20	205.107	363.77	21132.4	6276.08	16.5408
21	208.259	364.575	20177.2	5992.37	16.5407
22	211.41	365.381	19299.4	5731.68	16.5408
23	214.655	367.454	15450	4588.46	16.5408
24	217.901	369.527	12109	3596.23	16.5408
25	222.453	373	7639.7	2268.9	16.5408
26	224.238	374.362	6222.12	1847.9	16.5408
27	228.196	377.799	3315.52	984.67	16.5408
28	232.153	381.236	1313.19	390.002	16.5408
29	236.246	384.975	161.691	48.0203	16.5408
30	239.004	388.189	10.5493	3.13302	16.5408
31	240.992	390.505	0	0	0

Entity Information

Group: Group 1

Shared Entities

Type	Coordinates X	Coordinates Y
External Boundary	23.834	386.339
	23.834	373
	23.834	370
	23.834	356.753
	23.834	249.213
	503.688	249.213
	503.688	397.171
	503.688	408.264
	414.155	408.264
	395.692	406.373
	364.168	405.057
	342.86	401.481
	318.874	393.136
	313.607	391.303
	306.16	390.505
	253.455	390.505
	219.4	390.505
	211.409	390.505
	211.409	383.266
	207.675	382.644
	187.903	381.784
	180.966	375.748
	175.55	373
	174.029	372.228
	138.434	372.228
	136.669	373
	127.585	376.974
	113.006	379.517
Material Boundary	23.834	356.753
	38.26	349.023
	46.516	344.105
	176.877	340.177
	195.446	347.476
	222.595	347.476
	237.194	362.459
	259.989	368.35
	281.466	366.543
	292.389	366.543
	303.816	370.408
	308.317	373
	314.319	376.457
	314.319	379.927
	319.077	386.014
	325.283	386.014
	330.105	381.564
	354.67	380.889
	391.468	399.113
	503.688	397.171
Material Boundary	318.874	393.136
	325.283	386.014

Material Boundary	X / Y: 211.409, 383.266; 219.4, 383.266; 227.468, 385.222; 233.602, 387.323; 253.455, 390.505

X	Y
211.409	383.266
219.4	383.266
227.468	385.222
233.602	387.323
253.455	390.505

Material Boundary

X	Y
211.409	383.266
211.409	380
219.4	380
219.4	381.036
219.4	383.266
219.4	390.505

Material Boundary

X	Y
23.834	370
303.816	370.408

Material Boundary

X	Y
23.834	373
136.669	373

Material Boundary

X	Y
175.55	373
308.317	373

Scenario-based Entities

Type	Coordinates	Master Scenario
Water Table	X / Y: 23.834, 373; 503.688, 373	Assigned to materials: Fernando Formation (Tf); Qal/Qoal; Engineered Fill; Existing Fill

X	Y
23.834	373
503.688	373

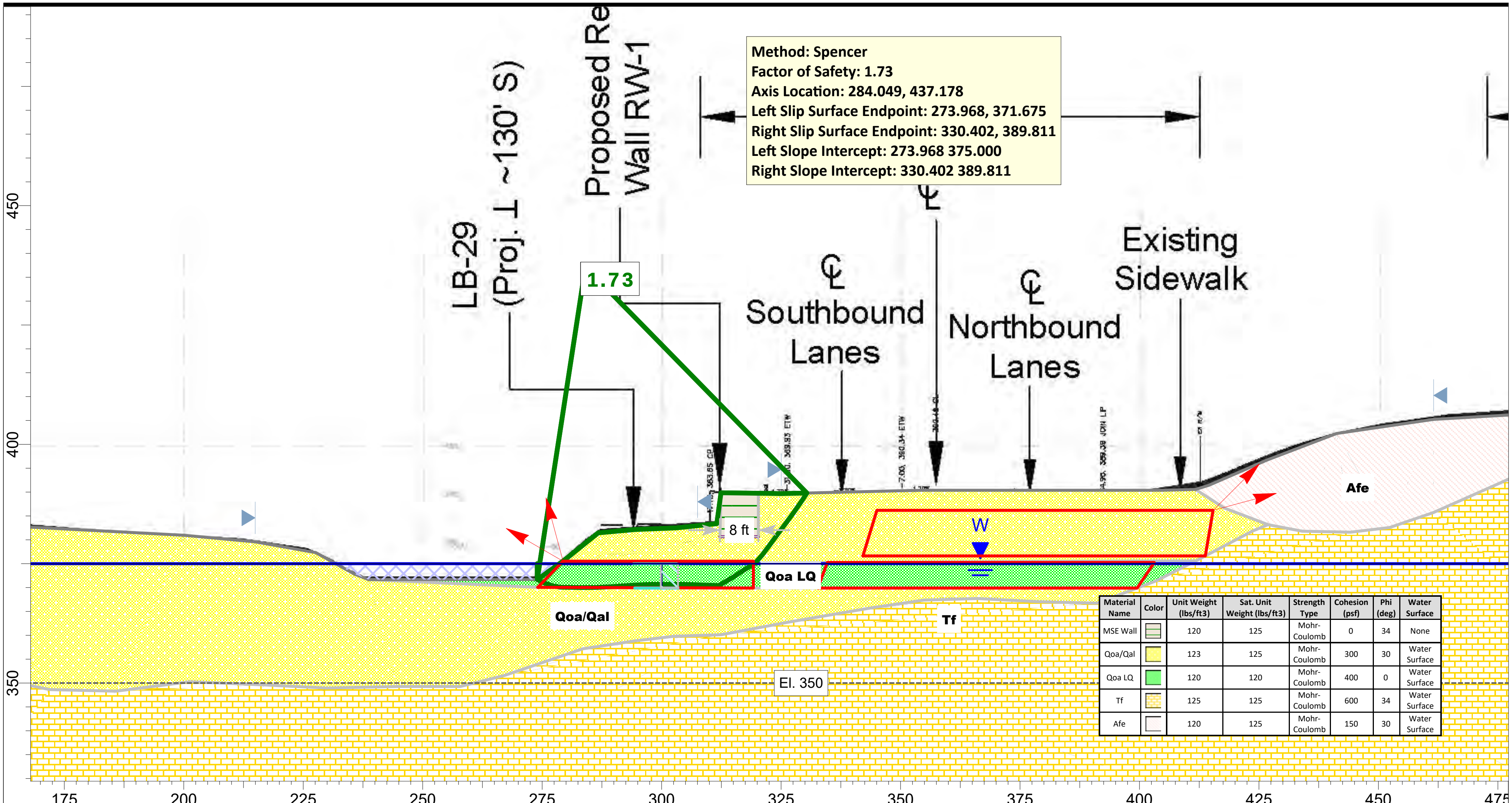
Assigned to materials:

- Fernando Formation (Tf)
- Qal/Qoal
- Engineered Fill
- Existing Fill

Section 18+00 Global Stability - Liquefaction - Flow Failure - RW 01

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 18+00\Sec 18+00_LQ_blk SrfAlt_a3_k zero.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
MSE Wall		120	125	Mohr-Coulomb	0	34	None
Qoa/Qal		123	125	Mohr-Coulomb	300	30	Water Surface
Qoa LQ		120	120	Mohr-Coulomb	400	0	Water Surface
Tf		125	125	Mohr-Coulomb	600	34	Water Surface
Afe		120	125	Mohr-Coulomb	150	30	Water Surface

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**				
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**	*File Name:* Sec 18+00_LQ_blk SrfAlt_a3_k zero.slim
Date: February 28, 2021	*Condition:* **Liquefaction**			

Slide Analysis Information

Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:07.711s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	February 28, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	105
Left Projection Angle (End Angle) [deg]:	150
Right Projection Angle (Start Angle) [deg]:	15
Right Projection Angle (End Angle) [deg]:	45
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

MSE Wall	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	0
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Qoa/Qal	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	123
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated
Qoa LQ	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Cohesion [psf]	400
Friction Angle [deg]	0
Water Surface	Water Table
Hu Value	Automatically Calculated
Tf	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated
Afe	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	150
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated

Global Minimums

Method: janbu corrected

FS	1.728480
Axis Location:	281.486, 431.730
Left Slip Surface Endpoint:	273.968, 371.675
Right Slip Surface Endpoint:	325.019, 389.683
Left Slope Intercept:	273.968 375.000
Right Slope Intercept:	325.019 389.683
Resisting Horizontal Force:	23168.6 lb
Driving Horizontal Force:	13404 lb
Total Slice Area:	526.056 ft2
Surface Horizontal Width:	51.051 ft
Surface Average Height:	10.3045 ft

Method: spencer

FS	1.726880
Axis Location:	284.049, 437.178
Left Slip Surface Endpoint:	273.968, 371.675
Right Slip Surface Endpoint:	330.402, 389.811
Left Slope Intercept:	273.968 375.000
Right Slope Intercept:	330.402 389.811
Resisting Moment:	1.94096e+06 lb-ft
Driving Moment:	1.12397e+06 lb-ft
Resisting Horizontal Force:	24322.9 lb
Driving Horizontal Force:	14084.9 lb
Total Slice Area:	597.182 ft2
Surface Horizontal Width:	56.4345 ft
Surface Average Height:	10.5819 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
273.968	371.675
275.853	370.748
278.516	370.076
281.159	370.027
283.697	370.037
286.433	370.048
289.232	370.059
292.209	370.071
295.174	370.083
297.808	370.094
300.3	370.104
302.71	370.114
304.291	370.12
305.871	370.126
307.452	370.133
309.032	370.139
310.494	370.145
311.904	370.467
313.1	371.981
314.295	373.516
315.443	375.039
316.837	377.168
317.746	378.557
318.603	379.868
319.9	381.851
321.355	384.078
322.276	385.486
323.196	386.895
324.117	388.303
325.019	389.683

Method: spencer

X	Y
273.968	371.675
275.396	371.018
277.078	370.405
278.765	370.075
280.412	370.058
283.301	370.014
286.291	370.021
289.248	370.186
292.133	370.386
295.017	370.568
297.849	370.68
300.681	370.693
303.513	370.71
306.345	370.628
309.178	370.515
312.01	370.445
313.426	371.294
314.842	372.119
317.213	373.662
319.588	375.124
321.047	376.833
322.506	378.746
324.209	381.074
326.153	383.683
327.637	385.699
328.549	387.036
329.461	388.341
330.402	389.811

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4785
Number of Invalid Surfaces:	243
Error Codes	
Error Code -108 reported for 11 surfaces	
Error Code -111 reported for 1 surface	
Error Code -112 reported for 217 surfaces	
Error Code -120 reported for 2 surfaces	
Error Code -1000 reported for 12 surfaces	

Method: spencer

Number of Valid Surfaces:	4682
Number of Invalid Surfaces:	346
Error Codes	
Error Code -108 reported for 112 surfaces	
Error Code -111 reported for 1 surface	
Error Code -112 reported for 217 surfaces	
Error Code -120 reported for 2 surfaces	
Error Code -1000 reported for 14 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-120 = Tensile effecve norma l stress on the base of a slice exceeds the tensile strength of the material. The stress state on the base of the surface violates the strength criterion.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.72848

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.942578	239.953	-26.1926	Qoa LQ	400	0	231.417	400	377.724	221.94	155.784	263.889	41.9495
2	0.942578	328.726	-26.1926	Qoa LQ	400	0	231.417	400	471.905	250.872	221.033	358.071	107.199
3	1.3314	590.113	-14.1673	Qoa LQ	400	0	231.417	400	506.428	275.824	230.604	448.011	172.187
4	1.3314	716.292	-14.1673	Qoa LQ	400	0	231.417	400	601.2	296.796	304.404	542.783	245.987
5	0.880881	545.276	-1.05976	Qoa LQ	400	0	231.417	400	623.642	307.79	315.852	619.362	311.572
6	0.880881	619.172	-1.05976	Qoa LQ	400	0	231.417	400	707.532	308.807	398.725	703.251	394.444
7	0.880881	698.142	-1.05976	Qoa LQ	400	0	231.417	400	797.18	309.824	487.356	792.899	483.075
8	1.26926	1142.65	0.231109	Qoa LQ	400	0	231.417	400	899.233	310.172	589.061	900.166	589.994
9	1.26926	1302.25	0.231109	Qoa LQ	400	0	231.417	400	1024.98	309.853	715.129	1025.92	716.062
10	0.911849	1034.06	0.231109	Qoa LQ	400	0	231.417	400	1133.02	309.578	823.44	1133.95	824.373
11	0.911849	1116.43	0.231109	Qoa LQ	400	0	231.417	400	1223.35	309.349	914.001	1224.28	914.934
12	0.911849	1198.81	0.231109	Qoa LQ	400	0	231.417	400	1313.69	309.119	1004.57	1314.63	1005.51
13	0.933108	1294.17	0.231109	Qoa LQ	400	0	231.417	400	1385.94	308.887	1077.05	1386.87	1077.98
14	0.933108	1307.37	0.231109	Qoa LQ	400	0	231.417	400	1400.08	308.652	1091.43	1401.02	1092.37
15	0.933108	1316.67	0.231109	Qoa LQ	400	0	231.417	400	1410.05	308.417	1101.63	1410.98	1102.57
16	0.992261	1410.34	0.231109	Qoa LQ	400	0	231.417	400	1420.33	308.175	1112.16	1421.26	1113.09
17	0.992261	1420.85	0.231109	Qoa LQ	400	0	231.417	400	1430.92	307.925	1123	1431.86	1123.93
18	0.992261	1431.36	0.231109	Qoa LQ	400	0	231.417	400	1441.51	307.676	1133.84	1442.45	1134.77
19	1.48261	2158.29	0.231109	Qoa LQ	400	0	231.417	400	1454.73	307.364	1147.37	1455.66	1148.3
20	1.48261	2180	0.231109	Qoa LQ	400	0	231.417	400	1469.37	306.991	1162.38	1470.31	1163.31
21	0.877986	1296.56	0.231109	Qoa LQ	400	0	231.417	400	1475.73	306.694	1169.04	1476.66	1169.97
22	0.877986	1299.97	0.231109	Qoa LQ	400	0	231.417	400	1479.61	306.473	1173.14	1480.55	1174.07
23	0.877986	1303.38	0.231109	Qoa LQ	400	0	231.417	400	1483.5	306.252	1177.25	1484.43	1178.18
24	1.24597	1855.51	0.231109	Qoa LQ	400	0	231.417	400	1488.21	305.985	1182.22	1489.14	1183.15
25	1.24597	1862.38	0.231109	Qoa LQ	400	0	231.417	400	1493.72	305.671	1188.05	1494.65	1188.98
26	1.20526	1808.08	0.231109	Qoa LQ	400	0	231.417	400	1499.15	305.363	1193.78	1500.08	1194.72
27	1.20526	1814.51	0.231109	Qoa LQ	400	0	231.417	400	1504.48	305.059	1199.42	1505.42	1200.36
28	0.790241	1193.63	0.231109	Qoa LQ	400	0	231.417	400	1509.46	304.808	1204.66	1510.4	1205.59
29	0.790241	1200.51	0.231109	Qoa LQ	400	0	231.417	400	1518.16	304.609	1213.55	1519.09	1214.48
30	1.58048	2424.08	0.231109	Qoa LQ	400	0	231.417	400	1532.75	304.311	1228.44	1533.69	1229.38
31	1.58048	2454.84	0.231109	Qoa LQ	400	0	231.417	400	1552.21	303.913	1248.3	1553.14	1249.23
32	1.58048	2485.59	0.231109	Qoa LQ	400	0	231.417	400	1571.67	303.515	1268.16	1572.61	1269.09
33	1.46119	2325.35	0.231109	Qoa LQ	400	0	231.417	400	1590.4	303.132	1287.27	1591.33	1288.2
34	1.41083	2297.54	12.8519	Qoa LQ	400	0	231.417	400	1571.37	292.906	1278.47	1624.17	1331.26
35	1.19552	2577.79	51.7069	Qoa LQ	400	0	231.417	400	1839.12	235.621	1603.5	2132.22	1896.59
36	1.19552	2471.85	52.0796	Qoa LQ	400	0	231.417	400	1746.23	140.5	1605.73	2043.28	1902.78
37	1.11859	2107.98	52.9998	Qoa LQ	400	0	231.417	400	1552.27	46.3076	1505.96	1859.36	1813.06
38	0.0290939	52.1409	52.9998	Qoa LQ	400	0	231.417	400	1459.92	0	1459.92	1767.02	1767.02
39	0.0831038	148.102	56.791	Qoa LQ	400	0	231.417	400	1399.67	0	1399.67	1753.19	1753.19
40	1.31078	2163.06	56.791	Qoa/Qal	300	30	466.978	807.162	878.431	0	878.431	1591.8	1591.8
41	0.909335	1309.23	56.791	Qoa/Qal	300	30	421.69	728.883	742.849	0	742.849	1387.04	1387.04
42	0.856699	1089.95	56.8284	Qoa/Qal	300	30	385.444	666.233	634.334	0	634.334	1223.99	1223.99
43	0.524446	598.481	56.8284	Qoa/Qal	300	30	357.245	617.491	549.91	0	549.91	1096.43	1096.43
44	0.772165	787.507	56.8284	MSE Wall	0	34	241.811	417.966	619.659	0	619.659	989.586	989.586
45	0.360392	329.747	56.8284	MSE Wall	0	34	216.939	374.975	555.924	0	555.924	887.801	887.801
46	1.09529	875.84	56.8284	Qoa/Qal	300	30	283.781	490.509	329.971	0	329.971	764.103	764.103
47	0.920512	559.914	56.8284	Qoa/Qal	300	30	242.614	419.353	206.726	0	206.726	577.88	577.88
48	0.920507	399.021	56.8284	Qoa/Qal	300	30	205.017	354.367	94.1669	0	94.1669	407.805	407.805
49	0.920502	238.13	56.8284	Qoa/Qal	300	30	167.42	289.382	-18.3915	0	-18.3915	237.73	237.73
50	0.902187	77.2745	56.8284	Qoa/Qal	300	30	130.197	225.043	-129.83	0	-129.83	69.3476	69.3476

Global Minimum Query (spencer) - Safety Factor: 1.72688

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.42798	394.263	-24.7078	Qoa LQ	400	0	231.632	400	458.484	227.974	230.51	351.907	123.933
2	1.68197	699.48	-20.0175	Qoa LQ	400	0	231.632	400	569.048	267.591	301.457	484.661	217.07
3	0.843715	433.83	-11.0812	Qoa LQ	400	0	231.632	400	611.337	291.865	319.472	565.972	274.107
4	0.843715	479.969	-11.0812	Qoa LQ	400	0	231.632	400	663.887	302.176	361.711	618.521	316.345
5	1.6467	1116.06	-0.576636	Qoa LQ	400	0	231.632	400	711.987	307.849	404.138	709.656	401.807
6	0.962922	778.129	-0.876784	Qoa LQ	400	0	231.632	400	844.309	308.826	535.483	840.764	531.938
7	0.962922	872.138	-0.876784	Qoa LQ	400	0	231.632	400	942.139	309.746	632.393	938.594	628.848
8	0.962922	966.148	-0.876784	Qoa LQ	400	0	231.632	400	1039.96	310.665	729.298	1036.42	725.753
9	0.996776	1098.08	0.139375	Qoa LQ	400	0	231.632	400	1131.65	311.049	820.596	1132.21	821.16
10	0.996776	1196.7	0.139375	Qoa LQ	400	0	231.632	400	1230.55	310.898	919.656	1231.12	920.219
11	0.996776	1295.33	0.139375	Qoa LQ	400	0	231.632	400	1329.46	310.747	1018.72	1330.03	1019.28
12	1.47856	2048.3	3.18286	Qoa LQ	400	0	231.632	400	1393.05	308.106	1084.95	1405.93	1097.83
13	1.47856	2066.62	3.18286	Qoa LQ	400	0	231.632	400	1405.35	302.975	1102.38	1418.23	1115.26
14	0.961419	1348.3	3.97422	Qoa LQ	400	0	231.632	400	1404.22	298.326	1105.9	1420.31	1121.99
15	0.961419	1350.91	3.97422	Qoa LQ	400	0	231.632	400	1406.92	294.158	1112.76	1423.01	1128.85
16	0.961419	1353.52	3.97422	Qoa LQ	400	0	231.632	400	1409.61	289.99	1119.62	1425.7	1135.71
17	1.44213	2035.98	3.6103	Qoa LQ	400	0	231.632	400	1416.18	285.067	1131.12	1430.8	1145.73
18	1.44213	2042.34	3.6103	Qoa LQ	400	0	231.632	400	1420.56	279.389	1141.17	1435.17	1155.78
19	0.944046	1336.69	2.26494	Qoa LQ	400	0	231.632	400	1430.15	275.385	1154.76	1439.31	1163.92
20	0.944046	1336.84	2.26494	Qoa LQ	400	0	231.632	400	1430.31	273.055	1157.25	1439.47	1166.41
21	0.944046	1336.99	2.26494	Qoa LQ	400	0	231.632	400	1430.45	270.726	1159.73	1439.61	1168.89
22	1.41607	2009.97	0.265303	Qoa LQ	400	0	231.632	400	1448.37	269.356	1179.01	1449.44	1180.09
23	1.41607	2018.7	0.265303	Qoa LQ	400	0	231.632	400	1454.53	268.947	1185.59	1455.61	1186.66
24	0.94405	1350.58	0.340822	Qoa LQ	400	0	231.632	400	1459.03	268.567	1190.46	1460.41	1191.84
25	0.94405	1354.32	0.340822	Qoa LQ	400	0	231.632	400	1462.99	268.217	1194.77	1464.37	1196.15
26	0.94405	1358.54	0.340822	Qoa LQ	400	0	231.632	400	1467.46	267.866	1199.59	1468.84	1200.97
27	0.944053	1369.78	-1.65449	Qoa LQ	400	0	231.632	400	1494.36	268.542	1225.81	1487.67	1219.12
28	0.944053	1384.27	-1.65449	Qoa LQ	400	0	231.632	400	1509.77	270.243	1239.53	1503.08	1232.84
29	0.944053	1398.76	-1.65449	Qoa LQ	400	0	231.632	400	1525.18	271.945	1253.23	1518.49	1246.54
30	1.41608	2126.67	-2.29521	Qoa LQ	400	0	231.632	400	1550.33	274.566	1275.77	1541.05	1266.48
31	1.41608	2161.98	-2.29521	Qoa LQ	400	0	231.632	400	1575.4	278.108	1297.29	1566.11	1288
32	1.41607	2195.39	-1.40365	Qoa LQ	400	0	231.632	400	1592.18	280.962	1311.21	1586.5	1305.54
33	1.41607	2318.92	-1.40365	Qoa LQ	400	0	231.632	400	1679.7	283.127	1396.57	1674.02	1390.89
34	1.416	3176.7	30.952	Qoa LQ	400	0	231.632	400	1977.07	257.714	1719.35	2115.98	1858.27
35	1.416	3103.65	30.2094	Qoa LQ	400	0	231.632	400	1937.24	205.497	1731.75	2072.11	1866.61
36	1.18545	2482.24	33.0498	Qoa LQ	400	0	231.632	400	1816.27	155.709	1660.57	1966.98	1811.28
37	1.18545	2370.15	33.0498	Qoa LQ	400	0	231.632	400	1729.28	107.579	1621.7	1879.99	1772.41
38	1.08691	2077.1	31.6216	Qoa LQ	400	0	231.632	400	1662.58	62.6345	1599.95	1805.2	1742.57
39	1.08691	1987.83	31.6216	Qoa LQ	400	0	231.632	400	1586.69	20.8742	1565.82	1729.31	1708.44
40	0.20132	358.391	31.6216	Qoa LQ	400	0	231.632	400	1541.71	0	1541.71	1684.34	1684.34
41	0.0515343	91.161	49.516	Qoa LQ	400	0	231.632	400	1321.75	0	1321.75	1593.1	1593.1
42	1.40759	2361.79	49.516	Qoa/Qal	300	30	506.736	875.073	996.054	0	996.054	1589.7	1589.7
43	1.4591	2142.56	52.6641	Qoa/Qal	300	30	443.074	765.136	805.637	0	805.637	1386.5	1386.5
44	1.70306	2051.98	53.816	Qoa/Qal	300	30	381.355	658.554	621.033	0	621.033	1142.39	1142.39
45	0.972224	952.066	53.2936	Qoa/Qal	300	30	336.238	580.642	486.087	0	486.087	937.08	937.08
46	0.972224	797.37	53.2936	Qoa/Qal	300	30	302.631	522.608	385.569	0	385.569	791.486	791.486
47	1.48402	919.419	53.6458	Qoa/Qal	300	30	259.188	447.587	255.628	0	255.628	607.772	607.772
48	0.911709	380.039	55.7057	Qoa/Qal	300	30	211.471	365.184	112.903	0	112.903	422.973	422.973
49	0.911713	234.349	55.06	Qoa/Qal	300	30	180.223	311.223	19.4382	0	19.4382	277.398	277.398
50	0.941566	83.8562	57.3692	Qoa/Qal	300	30	142.185	245.536	-94.3343	0	-94.3343	127.731	127.731

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.72848

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	273.968	371.675	344.935	0	0
2	274.911	371.211	535.982	0	0
3	275.853	370.748	1087.69	0	0
4	277.185	370.412	1680.53	0	0
5	278.516	370.076	2249.47	0	0
6	279.397	370.059	2480.46	0	0
7	280.278	370.043	2712.52	0	0
8	281.159	370.027	2946.05	0	0
9	282.428	370.032	3259.22	0	0
10	283.697	370.037	3571.75	0	0
11	284.609	370.041	3795.87	0	0
12	285.521	370.044	4019.66	0	0
13	286.433	370.048	4243.12	0	0
14	287.366	370.052	4471.52	0	0
15	288.299	370.055	4699.87	0	0
16	289.232	370.059	4928.17	0	0
17	290.224	370.063	5170.91	0	0
18	291.217	370.067	5413.61	0	0
19	292.209	370.071	5656.26	0	0
20	293.691	370.077	6018.75	0	0
21	295.174	370.083	6381.15	0	0
22	296.052	370.087	6595.74	0	0
23	296.93	370.09	6810.31	0	0
24	297.808	370.094	7024.87	0	0
25	299.054	370.099	7329.33	0	0
26	300.3	370.104	7633.77	0	0
27	301.505	370.109	7928.23	0	0
28	302.71	370.114	8222.66	0	0
29	303.501	370.117	8415.7	0	0
30	304.291	370.12	8608.7	0	0
31	305.871	370.126	8994.62	0	0
32	307.452	370.133	9380.42	0	0
33	309.032	370.139	9766.09	0	0
34	310.494	370.145	10122.5	0	0
35	311.904	370.467	9969.97	0	0
36	313.1	371.981	7484.55	0	0
37	314.295	373.516	5104.13	0	0
38	315.414	375	3079.99	0	0
39	315.443	375.039	3030.91	0	0
40	315.526	375.166	2874.02	0	0
41	316.837	377.168	1777.26	0	0
42	317.746	378.557	1160.2	0	0
43	318.603	379.868	686.085	0	0
44	319.127	380.67	447.581	0	0
45	319.9	381.851	-82.4014	0	0
46	320.26	382.403	-304.317	0	0
47	321.355	384.078	-520.948	0	0
48	322.276	385.486	-570.452	0	0
49	323.196	386.895	-498.89	0	0
50	324.117	388.303	-306.266	0	0
51	325.019	389.683	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.72688

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	273.968	371.675	344.935	0	0
2	275.396	371.018	810.273	108.254	7.60976
3	277.078	370.405	1676.29	223.956	7.60978
4	277.922	370.24	2003.3	267.646	7.6098
5	278.765	370.075	2316.81	309.532	7.60981
6	280.412	370.058	2710.04	362.068	7.60979
7	281.375	370.043	2945.53	393.529	7.60977
8	282.338	370.029	3182.45	425.183	7.60979
9	283.301	370.014	3420.82	457.03	7.60979
10	284.298	370.016	3648.96	487.51	7.60979
11	285.294	370.019	3876.86	517.958	7.60979
12	286.291	370.021	4104.52	548.374	7.60979
13	287.77	370.103	4332.47	578.828	7.60978
14	289.248	370.186	4559.4	609.147	7.60979
15	290.21	370.252	4688.3	626.368	7.60979
16	291.171	370.319	4817.02	643.565	7.60978
17	292.133	370.386	4945.56	660.739	7.60979
18	293.575	370.477	5150.74	688.152	7.6098
19	295.017	370.568	5355.53	715.511	7.60978
20	295.961	370.605	5520.8	737.592	7.60979
21	296.905	370.643	5686.06	759.672	7.6098
22	297.849	370.68	5851.32	781.751	7.6098
23	299.265	370.687	6169.83	824.305	7.6098
24	300.681	370.693	6488.3	866.853	7.60979
25	301.625	370.699	6698.78	894.973	7.60979
26	302.569	370.704	6909.24	923.091	7.60979
27	303.513	370.71	7119.67	951.205	7.60979
28	304.457	370.683	7379.09	985.864	7.60979
29	305.401	370.655	7638.93	1020.58	7.60979
30	306.345	370.628	7899.19	1055.35	7.60978
31	307.761	370.571	8315.19	1110.93	7.60979
32	309.178	370.515	8732.62	1166.7	7.6098
33	310.594	370.48	9115.87	1217.9	7.60978
34	312.01	370.445	9502.16	1269.51	7.60978
35	313.426	371.294	8151.22	1089.02	7.60977
36	314.842	372.119	6882.07	919.461	7.60979
37	316.027	372.89	5755.75	768.982	7.60979
38	317.213	373.662	4696.52	627.467	7.6098
39	318.3	374.331	3835.63	512.449	7.60978
40	319.386	375	3025.52	404.217	7.60979
41	319.588	375.124	2881.05	384.915	7.60979
42	319.639	375.184	2813.19	375.848	7.60977
43	321.047	376.833	1883.96	251.702	7.6098
44	322.506	378.746	989.381	132.184	7.60981
45	324.209	381.074	192.898	25.7716	7.60978
46	325.181	382.379	-114.079	-15.2412	7.60978
47	326.153	383.683	-322.65	-43.1067	7.60977
48	327.637	385.699	-453.42	-60.578	7.60979
49	328.549	387.036	-411.548	-54.9839	7.6098
50	329.461	388.341	-272.604	-36.4205	7.60978
51	330.402	389.811	0	0	0

Entity Information

Water Table

X	Y
100	375
633.426	375

Block Search Window

X	Y
274.09	370.07
319.206	369.912
319.206	375.522
279.387	375.522

Block Search Window

X	Y
332.694	369.912
399.531	369.912
403.096	375.253
334.666	375.253

Block Search Window

X	Y
342.126	376.639
413.786	376.639
415.412	386.176
345.057	386.176

External Boundary

X	Y
100	250
633.426	250.033
633.426	398.713
633.426	409.614
576.255	410.139
513.315	409.614
495.832	408.041
488.664	406.817
461.564	405.243
441.284	402.271
426.598	396.676
414.534	391.431
411.737	390.557
404.569	390.382
354.391	390.382
325.019	389.683
320.26	389.749
312.431	389.858
311.557	383.389
303.165	382.515
294.423	382.165
286.73	381.466
279.387	375.522
278.648	374.997
273.968	371.675
238.651	371.675
235.721	372.825
227.598	377.338
214.962	379.594
200.07	380.948
149.076	383.656
100	387.717
100	358.498

Material Boundary

X	Y
100	358.498
110.48	355.208
125.613	356.524
134.495	356.195
149.629	353.235
171.999	348.629
185.816	348.3
201.279	350.274
217.07	349.616
229.9	348.958
244.704	349.287
257.863	349.287
267.075	351.59
283.524	357.182
294.38	358.827
302.605	359.814
312.474	360.143
326.62	362.775
343.727	365.736
354.913	367.381
366.098	367.71
378.599	367.052
391.1	366.723
399.531	369.912
403.273	371.328
411.826	375.605
423.67	381.856
426.9	383.172

Material Boundary

X	Y
411.737	390.557
417.77	386.668
426.9	383.172
434.087	381.812
444.189	381.618
452.348	382.589
461.478	385.697
475.465	391.913
486.149	396.77
491.977	399.878
497.028	400.072
509.849	399.878
555.694	399.295
593.381	398.713
633.426	398.713

Material Boundary

X	Y
312.431	389.858
312.2	380.67
320.26	380.67
320.26	389.749

Material Boundary

X	Y
278.648	374.997
411.826	375.605

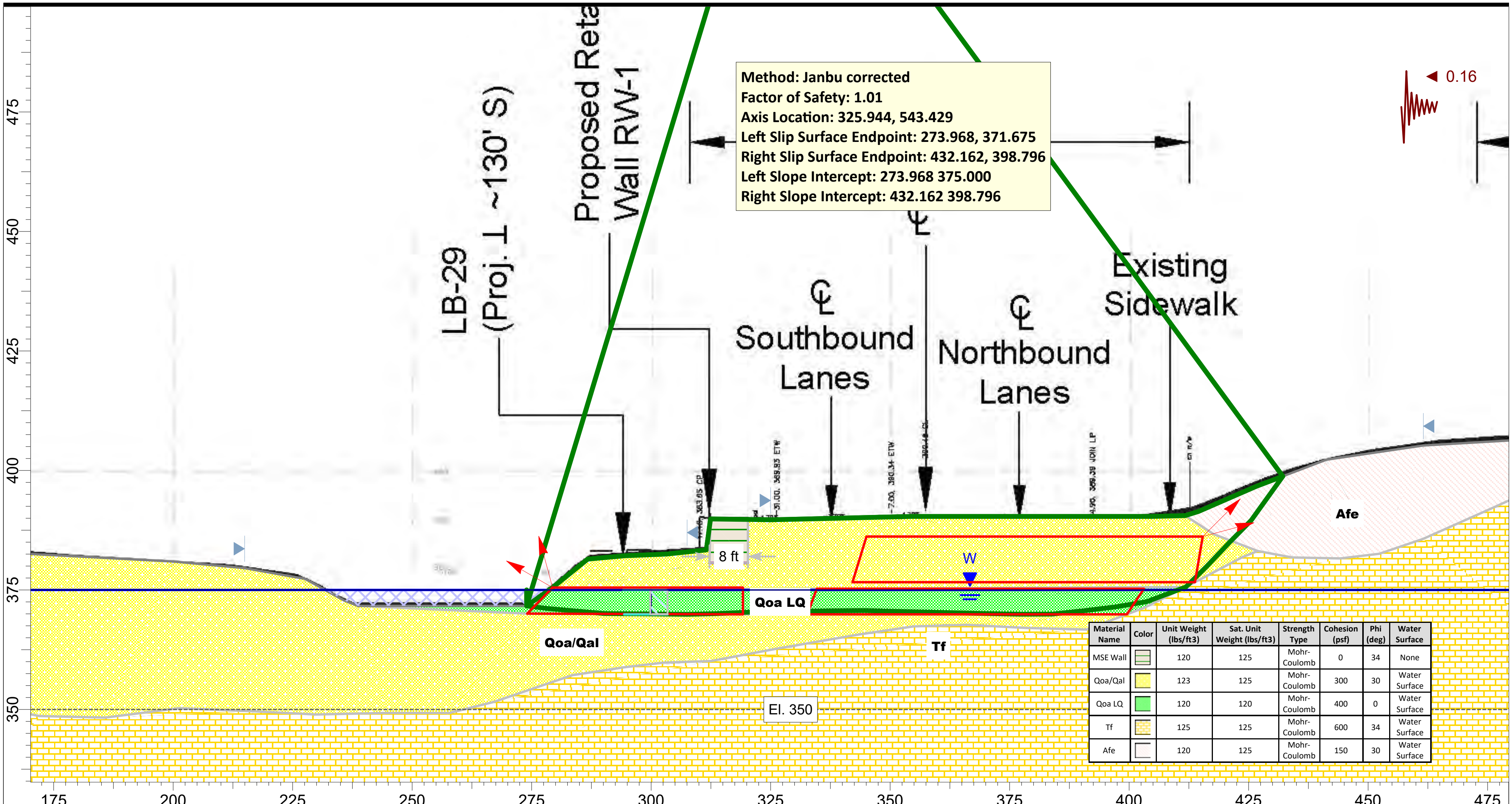
Material Boundary

X	Y
238.651	371.675
274.09	370.07
299.822	369.912
399.531	369.912

Section 18+00 Global Stability - Liquefaction - Yield Acceleration - RW 01

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 18+00\Sec 18+00_LQ_blk SrfAlt_a2_ky.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
MSE Wall		120	125	Mohr-Coulomb	0	34	None
Qoa/Qal		123	125	Mohr-Coulomb	300	30	Water Surface
Qoa LQ		120	120	Mohr-Coulomb	400	0	Water Surface
Tf		125	125	Mohr-Coulomb	600	34	Water Surface
Afe		120	125	Mohr-Coulomb	150	30	Water Surface

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**
Date: February 28, 2021	*Condition:* **PseudoStatic**		*File Name:* Sec 18+00_LQ_blk SrfAlt_a2_ky.slim

Slide Analysis Information

Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:08.339s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	February 28, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	105
Left Projection Angle (End Angle) [deg]:	150
Right Projection Angle (Start Angle) [deg]:	15
Right Projection Angle (End Angle) [deg]:	45
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.16

Materials

MSE Wall	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	0
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Qoa/Qal	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	123
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated
Qoa LQ	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Cohesion [psf]	400
Friction Angle [deg]	0
Water Surface	Water Table
Hu Value	Automatically Calculated
Tf	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated
Afe	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	150
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated

Global Minimums

Method: janbu corrected

FS	1.007690
Axis Location:	325.944, 543.429
Left Slip Surface Endpoint:	273.968, 371.675
Right Slip Surface Endpoint:	432.162, 398.796
Left Slope Intercept:	273.968 375.000
Right Slope Intercept:	432.162 398.796
Resisting Horizontal Force:	68526.5 lb
Driving Horizontal Force:	68003.4 lb
Total Slice Area:	2495.69 ft2
Surface Horizontal Width:	158.194 ft
Surface Average Height:	15.7762 ft

Method: spencer

FS	0.976146
Axis Location:	325.944, 543.429
Left Slip Surface Endpoint:	273.968, 371.675
Right Slip Surface Endpoint:	432.162, 398.796
Left Slope Intercept:	273.968 375.000
Right Slope Intercept:	432.162 398.796
Resisting Moment:	1.22188e+07 lb-ft
Driving Moment:	1.25174e+07 lb-ft
Resisting Horizontal Force:	64745.1 lb
Driving Horizontal Force:	66327.2 lb
Total Slice Area:	2495.69 ft2
Surface Horizontal Width:	158.194 ft
Surface Average Height:	15.7762 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
273.968	371.675
278.285	371.145
284.207	370.6
290.129	370.084
294.491	370.041
298.854	369.998
303.217	369.955
307.581	369.912
313.687	370.065
319.793	370.328
325.83	370.535
332.101	370.593
338.362	370.652
344.623	370.71
351.179	370.543
357.734	370.377
364.28	370.211
370.828	370.07
377.386	369.929
383.943	369.962
390.519	370.666
397.096	371.465
403.672	372.563
407.757	374.088
411.875	375.626
416.336	380.042
420.934	384.878
425.532	389.555
428.847	394.186
432.162	398.796

Method: spencer

X	Y
273.968	371.675
278.285	371.145
284.207	370.6
290.129	370.084
294.491	370.041
298.854	369.998
303.217	369.955
307.581	369.912
313.687	370.065
319.793	370.328
325.83	370.535
332.101	370.593
338.362	370.652
344.623	370.71
351.179	370.543
357.734	370.377
364.28	370.211
370.828	370.07
377.386	369.929
383.943	369.962
390.519	370.666
397.096	371.465
403.672	372.563
407.757	374.088
411.875	375.626
416.336	380.042
420.934	384.878
425.532	389.555
428.847	394.186
432.162	398.796

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	3865
Number of Invalid Surfaces:	1156
Error Codes	
Error Code -112 reported for 1135 surfaces	
Error Code -120 reported for 12 surfaces	
Error Code -1000 reported for 9 surfaces	

Method: spencer

Number of Valid Surfaces:	3656
Number of Invalid Surfaces:	1365
Error Codes	
Error Code -108 reported for 7 surfaces	
Error Code -111 reported for 210 surfaces	
Error Code -112 reported for 1134 surfaces	
Error Code -120 reported for 4 surfaces	
Error Code -1000 reported for 10 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-120 = Tensile effecve norma l stress on the base of a slice exceeds the tensile strength of the material. The stress state on the base of the surface violates the strength criterion.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.00769

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.3171	1414.11	-7.00241	Qoa LQ	400	0	396.947	400	378.925	224.018	154.907	330.169	106.151
2	2.96087	1730.37	-5.25176	Qoa LQ	400	0	396.947	400	622.85	249.053	373.797	586.363	337.31
3	2.96087	2689.26	-5.25176	Qoa LQ	400	0	396.947	400	946.707	266.036	680.671	910.22	644.184
4	2.96087	3647.75	-4.98234	Qoa LQ	400	0	396.947	400	1268.44	282.581	985.863	1233.84	951.258
5	2.96087	4118.68	-4.98234	Qoa LQ	400	0	396.947	400	1427.49	298.688	1128.81	1392.89	1094.2
6	4.36279	6325.93	-0.564382	Qoa LQ	400	0	396.947	400	1454.09	308.082	1146.01	1450.18	1142.1
7	4.36279	6499.54	-0.564382	Qoa LQ	400	0	396.947	400	1493.89	310.764	1183.12	1489.98	1179.21
8	4.36279	6615.53	-0.564382	Qoa LQ	400	0	396.947	400	1520.47	313.445	1207.03	1516.56	1203.12
9	4.36412	6810.47	-0.565304	Qoa LQ	400	0	396.947	400	1564.68	316.13	1248.55	1560.77	1244.64
10	3.05292	4903.05	1.43166	Qoa LQ	400	0	396.947	400	1595.57	315.093	1280.47	1605.49	1290.4
11	3.05292	6273.22	1.43166	Qoa LQ	400	0	396.947	400	2044.37	310.332	1734.04	2054.29	1743.96
12	3.05292	7263.44	2.46531	Qoa LQ	400	0	396.947	400	2361.17	303.85	2057.32	2378.26	2074.41
13	3.05292	7199.61	2.46531	Qoa LQ	400	0	396.947	400	2340.26	295.648	2044.61	2357.35	2061.7
14	3.0187	7130.22	1.97011	Qoa LQ	400	0	396.947	400	2347.64	288.307	2059.33	2361.29	2072.98
15	3.0187	7091.15	1.97011	Qoa LQ	400	0	396.947	400	2334.69	281.828	2052.87	2348.35	2066.52
16	3.13567	7357.31	0.53085	Qoa LQ	400	0	396.947	400	2342.45	277.682	2064.77	2346.13	2068.45
17	3.13567	7375.03	0.53085	Qoa LQ	400	0	396.947	400	2348.1	275.869	2072.23	2351.78	2075.91
18	3.13036	7380.2	0.53166	Qoa LQ	400	0	396.947	400	2353.74	274.056	2079.68	2357.42	2083.37
19	3.13036	7397.84	0.53166	Qoa LQ	400	0	396.947	400	2359.37	272.243	2087.13	2363.06	2090.81
20	3.13036	7415.48	0.53166	Qoa LQ	400	0	396.947	400	2365.01	270.431	2094.58	2368.69	2098.26
21	3.13036	7433.12	0.53166	Qoa LQ	400	0	396.947	400	2370.64	268.618	2102.02	2374.33	2105.71
22	3.27783	7824.51	-1.4526	Qoa LQ	400	0	396.947	400	2397.71	270.305	2127.4	2387.64	2117.34
23	3.27783	7888.51	-1.4526	Qoa LQ	400	0	396.947	400	2417.23	275.492	2141.74	2407.17	2131.67
24	3.27783	7952.5	-1.4526	Qoa LQ	400	0	396.947	400	2436.75	280.678	2156.08	2426.69	2146.01
25	3.27783	8000.15	-1.4526	Qoa LQ	400	0	396.947	400	2451.29	285.865	2165.42	2441.22	2155.36
26	3.27283	8020.42	-1.45314	Qoa LQ	400	0	396.947	400	2461.22	291.049	2170.17	2451.15	2160.1
27	3.27283	8052.88	-1.45314	Qoa LQ	400	0	396.947	400	2471.13	296.229	2174.91	2461.07	2164.84
28	3.27421	8086.36	-1.23872	Qoa LQ	400	0	396.947	400	2478.75	301.029	2177.73	2470.17	2169.14
29	3.27421	8114.04	-1.23872	Qoa LQ	400	0	396.947	400	2487.21	305.446	2181.76	2478.62	2173.18
30	3.27878	8152.97	-1.22896	Qoa LQ	400	0	396.947	400	2495.56	309.85	2185.71	2487.04	2177.19
31	3.27878	8180.5	-1.22896	Qoa LQ	400	0	396.947	400	2503.95	314.239	2189.71	2495.44	2181.2
32	3.27878	8190.94	0.288427	Qoa LQ	400	0	396.947	400	2496.06	315.919	2180.14	2498.06	2182.14
33	3.27878	8184.3	0.288427	Qoa LQ	400	0	396.947	400	2494.04	314.889	2179.15	2496.03	2181.14
34	3.28789	8134.17	6.11261	Qoa LQ	400	0	396.947	400	2429.19	303.388	2125.81	2471.7	2168.32
35	3.28789	7995.1	6.11261	Qoa LQ	400	0	396.947	400	2386.9	281.417	2105.48	2429.41	2147.99
36	2.19212	5249.13	6.92348	Qoa LQ	400	0	396.947	400	2343.77	262.126	2081.64	2391.97	2129.84
37	2.19212	5179.04	6.92348	Qoa LQ	400	0	396.947	400	2311.8	245.516	2066.28	2360	2114.48
38	2.19212	5108.95	6.92348	Qoa LQ	400	0	396.947	400	2279.82	228.906	2050.92	2328.03	2099.12
39	3.28817	7502.45	9.48029	Qoa LQ	400	0	396.947	400	2211.82	203.469	2008.35	2278.1	2074.63
40	3.28817	7285.64	9.48029	Qoa LQ	400	0	396.947	400	2145.88	169.206	1976.67	2212.17	2042.96
41	4.08504	8557.88	20.4751	Qoa LQ	400	0	396.947	400	1938.79	104.485	1834.3	2087	1982.52
42	2.44175	4781.33	20.4783	Qoa LQ	400	0	396.947	400	1801.99	28.4447	1773.54	1950.23	1921.78
43	1.67589	3137.66	20.4783	Qoa LQ	400	0	396.947	400	1716.06	0	1716.06	1864.3	1864.3
44	4.4616	7381.68	44.7082	Qoa/Qal	300	30	779.752	785.748	841.341	0	841.341	1613.19	1613.19
45	2.29883	3201.14	46.4433	Qoa/Qal	300	30	670.136	675.289	650.018	0	650.018	1354.8	1354.8
46	2.29883	2786.36	46.4433	Qoa/Qal	300	30	606.9	611.567	539.65	0	539.65	1177.92	1177.92
47	0.413462	457.587	45.4912	Qoa/Qal	300	30	577.308	581.747	488.001	0	488.001	1075.29	1075.29
48	4.1842	3954.71	45.4912	Afe	150	30	427.731	431.02	486.741	0	486.741	921.87	921.87
49	3.31504	1997.64	54.4039	Afe	150	30	268.069	270.13	208.07	0	208.07	582.559	582.559
50	3.31505	665.69	54.2787	Afe	150	30	143.479	144.582	-9.38348	0	-9.38348	190.132	190.132

Global Minimum Query (spencer) - Safety Factor: 0.976146

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.3171	1414.11	-7.00241	Qoa LQ	400	0	409.775	400	579.898	224.018	355.88	529.566	305.548
2	2.96087	1730.37	-5.25176	Qoa LQ	400	0	409.775	400	771.124	249.053	522.071	733.458	484.405
3	2.96087	2689.26	-5.25176	Qoa LQ	400	0	409.775	400	1085.85	266.036	819.817	1048.19	782.151
4	2.96087	3647.75	-4.98234	Qoa LQ	400	0	409.775	400	1396.15	282.581	1113.56	1360.42	1077.84
5	2.96087	4118.68	-4.98234	Qoa LQ	400	0	409.775	400	1550.59	298.688	1251.91	1514.87	1216.18
6	4.36279	6325.93	-0.564382	Qoa LQ	400	0	409.775	400	1528.08	308.082	1220	1524.04	1215.96
7	4.36279	6499.54	-0.564382	Qoa LQ	400	0	409.775	400	1565.57	310.764	1254.81	1561.54	1250.77
8	4.36279	6615.53	-0.564382	Qoa LQ	400	0	409.775	400	1590.62	313.445	1277.17	1586.58	1273.14
9	4.36412	6810.47	-0.565304	Qoa LQ	400	0	409.775	400	1632.28	316.13	1316.15	1628.24	1312.11
10	3.05292	4903.05	1.43166	Qoa LQ	400	0	409.775	400	1638.74	315.093	1323.65	1648.98	1333.89
11	3.05292	6273.22	1.43166	Qoa LQ	400	0	409.775	400	2055.96	310.332	1745.63	2066.2	1755.87
12	3.05292	7263.44	2.46531	Qoa LQ	400	0	409.775	400	2334.11	303.85	2030.26	2351.76	2047.91
13	3.05292	7199.61	2.46531	Qoa LQ	400	0	409.775	400	2314.81	295.648	2019.16	2332.45	2036.8
14	3.0187	7130.22	1.97011	Qoa LQ	400	0	409.775	400	2329.38	288.307	2041.07	2343.48	2055.17
15	3.0187	7091.15	1.97011	Qoa LQ	400	0	409.775	400	2317.39	281.828	2035.56	2331.49	2049.66
16	3.13567	7357.31	0.53085	Qoa LQ	400	0	409.775	400	2347.38	277.682	2069.7	2351.17	2073.49
17	3.13567	7375.03	0.53085	Qoa LQ	400	0	409.775	400	2352.66	275.869	2076.79	2356.46	2080.59
18	3.13036	7380.2	0.53166	Qoa LQ	400	0	409.775	400	2357.92	274.056	2083.86	2361.72	2087.67
19	3.13036	7397.84	0.53166	Qoa LQ	400	0	409.775	400	2363.19	272.243	2090.94	2366.99	2094.75
20	3.13036	7415.48	0.53166	Qoa LQ	400	0	409.775	400	2368.46	270.431	2098.03	2372.26	2101.83
21	3.13036	7433.12	0.53166	Qoa LQ	400	0	409.775	400	2373.72	268.618	2105.11	2377.53	2108.91
22	3.27783	7824.51	-1.4526	Qoa LQ	400	0	409.775	400	2431.87	270.305	2161.57	2421.48	2151.18
23	3.27783	7888.51	-1.4526	Qoa LQ	400	0	409.775	400	2450.38	275.492	2174.89	2439.99	2164.5
24	3.27783	7952.5	-1.4526	Qoa LQ	400	0	409.775	400	2468.88	280.678	2188.2	2458.49	2177.81
25	3.27783	8000.15	-1.4526	Qoa LQ	400	0	409.775	400	2482.66	285.865	2196.79	2472.27	2186.4
26	3.27283	8020.42	-1.45314	Qoa LQ	400	0	409.775	400	2492.08	291.049	2201.03	2481.68	2190.64
27	3.27283	8052.88	-1.45314	Qoa LQ	400	0	409.775	400	2501.48	296.229	2205.25	2491.08	2194.85
28	3.27421	8086.36	-1.23872	Qoa LQ	400	0	409.775	400	2505	301.029	2203.97	2496.14	2195.11
29	3.27421	8114.04	-1.23872	Qoa LQ	400	0	409.775	400	2512.99	305.446	2207.55	2504.13	2198.69
30	3.27878	8152.97	-1.22896	Qoa LQ	400	0	409.775	400	2520.73	309.85	2210.88	2511.94	2202.09
31	3.27878	8180.5	-1.22896	Qoa LQ	400	0	409.775	400	2528.68	314.239	2214.44	2519.88	2205.65
32	3.27878	8190.94	0.288427	Qoa LQ	400	0	409.775	400	2495.15	315.919	2179.23	2497.21	2181.29
33	3.27878	8184.3	0.288427	Qoa LQ	400	0	409.775	400	2493.25	314.889	2178.36	2495.31	2180.43
34	3.28789	8134.17	6.11261	Qoa LQ	400	0	409.775	400	2339.23	303.388	2035.84	2383.11	2079.72
35	3.28789	7995.1	6.11261	Qoa LQ	400	0	409.775	400	2301.1	281.417	2019.68	2344.98	2063.56
36	2.19212	5249.13	6.92348	Qoa LQ	400	0	409.775	400	2250.08	262.126	1987.95	2299.83	2037.71
37	2.19212	5179.04	6.92348	Qoa LQ	400	0	409.775	400	2221.41	245.516	1975.89	2271.16	2025.65
38	2.19212	5108.95	6.92348	Qoa LQ	400	0	409.775	400	2192.74	228.906	1963.83	2242.49	2013.59
39	3.28817	7502.45	9.48029	Qoa LQ	400	0	409.775	400	2095.95	203.469	1892.48	2164.38	1960.91
40	3.28817	7285.64	9.48029	Qoa LQ	400	0	409.775	400	2037.8	169.206	1868.6	2106.23	1937.02
41	4.08504	8557.88	20.4751	Qoa LQ	400	0	409.775	400	1723.39	104.485	1618.91	1876.4	1771.91
42	2.44175	4781.33	20.4783	Qoa LQ	400	0	409.775	400	1611.07	28.4447	1582.62	1764.1	1735.66
43	1.67589	3137.66	20.4783	Qoa LQ	400	0	409.775	400	1540.54	0	1540.54	1693.57	1693.57
44	4.4616	7381.68	44.7082	Qoa/Qal	300	30	772.281	753.859	786.106	0	786.106	1550.56	1550.56
45	2.29883	3201.14	46.4433	Qoa/Qal	300	30	669.595	653.622	612.492	0	612.492	1316.7	1316.7
46	2.29883	2786.36	46.4433	Qoa/Qal	300	30	613.914	599.27	518.35	0	518.35	1164	1164
47	0.413462	457.587	45.4912	Qoa/Qal	300	30	590.154	576.076	478.177	0	478.177	1078.54	1078.54
48	4.1842	3954.71	45.4912	Afe	150	30	418.282	408.304	447.396	0	447.396	872.912	872.912
49	3.31504	1997.64	54.4039	Afe	150	30	267.19	260.816	191.938	0	191.938	565.198	565.198
50	3.31505	665.69	54.2787	Afe	150	30	163.054	159.165	15.8737	0	15.8737	242.61	242.61

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.00769

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	273.968	371.675	344.935	0	0
2	278.285	371.145	2200.12	0	0
3	281.246	370.873	3333.57	0	0
4	284.207	370.6	4399.14	0	0
5	287.168	370.342	5381.11	0	0
6	290.129	370.084	6328.79	0	0
7	294.491	370.041	7203.6	0	0
8	298.854	369.998	8052.35	0	0
9	303.217	369.955	8883.67	0	0
10	307.581	369.912	9686.4	0	0
11	310.634	369.988	10056.9	0	0
12	313.687	370.065	10173.9	0	0
13	316.74	370.196	9978.06	0	0
14	319.793	370.328	9795.21	0	0
15	322.811	370.432	9672.98	0	0
16	325.83	370.535	9558.35	0	0
17	328.966	370.564	9624.43	0	0
18	332.101	370.593	9687.51	0	0
19	335.232	370.623	9747.38	0	0
20	338.362	370.652	9804.28	0	0
21	341.493	370.681	9858.18	0	0
22	344.623	370.71	9909.1	0	0
23	347.901	370.627	10227.2	0	0
24	351.179	370.543	10536.7	0	0
25	354.456	370.46	10837.6	0	0
26	357.734	370.377	11132.1	0	0
27	361.007	370.294	11421.8	0	0
28	364.28	370.211	11707.2	0	0
29	367.554	370.14	11958.1	0	0
30	370.828	370.07	12205.2	0	0
31	374.107	369.999	12447.4	0	0
32	377.386	369.929	12685.8	0	0
33	380.665	369.945	12705.2	0	0
34	383.943	369.962	12725.7	0	0
35	387.231	370.314	11943.8	0	0
36	390.519	370.666	11199.1	0	0
37	392.711	370.932	10652.1	0	0
38	394.903	371.198	10124.8	0	0
39	397.096	371.465	9617.25	0	0
40	400.384	372.014	8577.45	0	0
41	403.672	372.563	7608.55	0	0
42	407.757	374.088	4990.35	0	0
43	410.199	375	3603.25	0	0
44	411.875	375.626	2728.04	0	0
45	416.336	380.042	1496.39	0	0
46	418.635	382.46	1035.64	0	0
47	420.934	384.878	754.949	0	0
48	421.347	385.298	727.943	0	0
49	425.532	389.555	-91.1769	0	0
50	428.847	394.186	-438.178	0	0
51	432.162	398.796	0	0	0

Global Minimum Query (spencer) - Safety Factor: 0.976146

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	273.968	371.675	344.935	0	0
2	278.285	371.145	2270.37	872.084	21.0125
3	281.246	370.873	3419.26	1313.39	21.0125
4	284.207	370.6	4497.79	1727.67	21.0125
5	287.168	370.342	5487.82	2107.96	21.0126
6	290.129	370.084	6442.37	2474.61	21.0125
7	294.491	370.041	7283.66	2797.76	21.0125
8	298.854	369.998	8098.78	3110.86	21.0125
9	303.217	369.955	8896.41	3417.25	21.0126
10	307.581	369.912	9665.34	3712.6	21.0125
11	310.634	369.988	10006.8	3843.78	21.0126
12	313.687	370.065	10097.3	3878.51	21.0125
13	316.74	370.196	9879.32	3794.8	21.0126
14	319.793	370.328	9674.14	3715.98	21.0125
15	322.811	370.432	9528.41	3660.01	21.0126
16	325.83	370.535	9390.18	3606.91	21.0125
17	328.966	370.564	9429.73	3622.11	21.0126
18	332.101	370.593	9466.3	3636.15	21.0125
19	335.232	370.623	9499.72	3648.99	21.0126
20	338.362	370.652	9530.17	3660.68	21.0125
21	341.493	370.681	9557.64	3671.24	21.0126
22	344.623	370.71	9582.13	3680.65	21.0126
23	347.901	370.627	9875.52	3793.34	21.0126
24	351.179	370.543	10160.2	3902.69	21.0126
25	354.456	370.46	10436.2	4008.7	21.0125
26	357.734	370.377	10705.7	4112.23	21.0126
27	361.007	370.294	10970.5	4213.92	21.0125
28	364.28	370.211	11230.8	4313.93	21.0126
29	367.554	370.14	11456	4400.44	21.0126
30	370.828	370.07	11677.4	4485.47	21.0126
31	374.107	369.999	11893.8	4568.59	21.0125
32	377.386	369.929	12106.3	4650.23	21.0126
33	380.665	369.945	12098.2	4647.1	21.0125
34	383.943	369.962	12091.1	4644.38	21.0126
35	387.231	370.314	11313.3	4345.6	21.0125
36	390.519	370.666	10571.1	4060.53	21.0126
37	392.711	370.932	10030.6	3852.91	21.0126
38	394.903	371.198	9508.92	3652.52	21.0125
39	397.096	371.465	9006.09	3459.38	21.0126
40	400.384	372.014	8002.25	3073.79	21.0126
41	403.672	372.563	7065.02	2713.78	21.0125
42	407.757	374.088	4741.01	1821.1	21.0126
43	410.199	375	3507.47	1347.27	21.0125
44	411.875	375.626	2728.01	1047.87	21.0125
45	416.336	380.042	1520.81	584.166	21.0125
46	418.635	382.46	1067.11	409.895	21.0126
47	420.934	384.878	779.383	299.373	21.0126
48	421.347	385.298	749.048	287.721	21.0126
49	425.532	389.555	-37.8964	-14.5566	21.0126
50	428.847	394.186	-360.653	-138.532	21.0125
51	432.162	398.796	0	0	0

Entity Information

Water Table

X	Y
100	375
633.426	375

Block Search Window

X	Y
274.09	370.07
319.206	369.912
319.206	375.522
279.387	375.522

Block Search Window

X	Y
332.694	369.912
399.531	369.912
403.096	375.253
334.666	375.253

Block Search Window

X	Y
342.126	376.639
413.786	376.639
415.412	386.176
345.057	386.176

External Boundary

X	Y
100	250
633.426	250.033
633.426	398.713
633.426	409.614
576.255	410.139
513.315	409.614
495.832	408.041
488.664	406.817
461.564	405.243
441.284	402.271
426.598	396.676
414.534	391.431
411.737	390.557
404.569	390.382
354.391	390.382
325.019	389.683
320.26	389.749
312.431	389.858
311.557	383.389
303.165	382.515
294.423	382.165
286.73	381.466
279.387	375.522
278.648	374.997
273.968	371.675
238.651	371.675
235.721	372.825
227.598	377.338
214.962	379.594
200.07	380.948
149.076	383.656
100	387.717
100	358.498

Material Boundary

X	Y
100	358.498
110.48	355.208
125.613	356.524
134.495	356.195
149.629	353.235
171.999	348.629
185.816	348.3
201.279	350.274
217.07	349.616
229.9	348.958
244.704	349.287
257.863	349.287
267.075	351.59
283.524	357.182
294.38	358.827
302.605	359.814
312.474	360.143
326.62	362.775
343.727	365.736
354.913	367.381
366.098	367.71
378.599	367.052
391.1	366.723
399.531	369.912
403.273	371.328
411.826	375.605
423.67	381.856
426.9	383.172

Material Boundary

X	Y
411.737	390.557
417.77	386.668
426.9	383.172
434.087	381.812
444.189	381.618
452.348	382.589
461.478	385.697
475.465	391.913
486.149	396.77
491.977	399.878
497.028	400.072
509.849	399.878
555.694	399.295
593.381	398.713
633.426	398.713

Material Boundary

X	Y
312.431	389.858
312.2	380.67
320.26	380.67
320.26	389.749

Material Boundary

X	Y
278.648	374.997
411.826	375.605

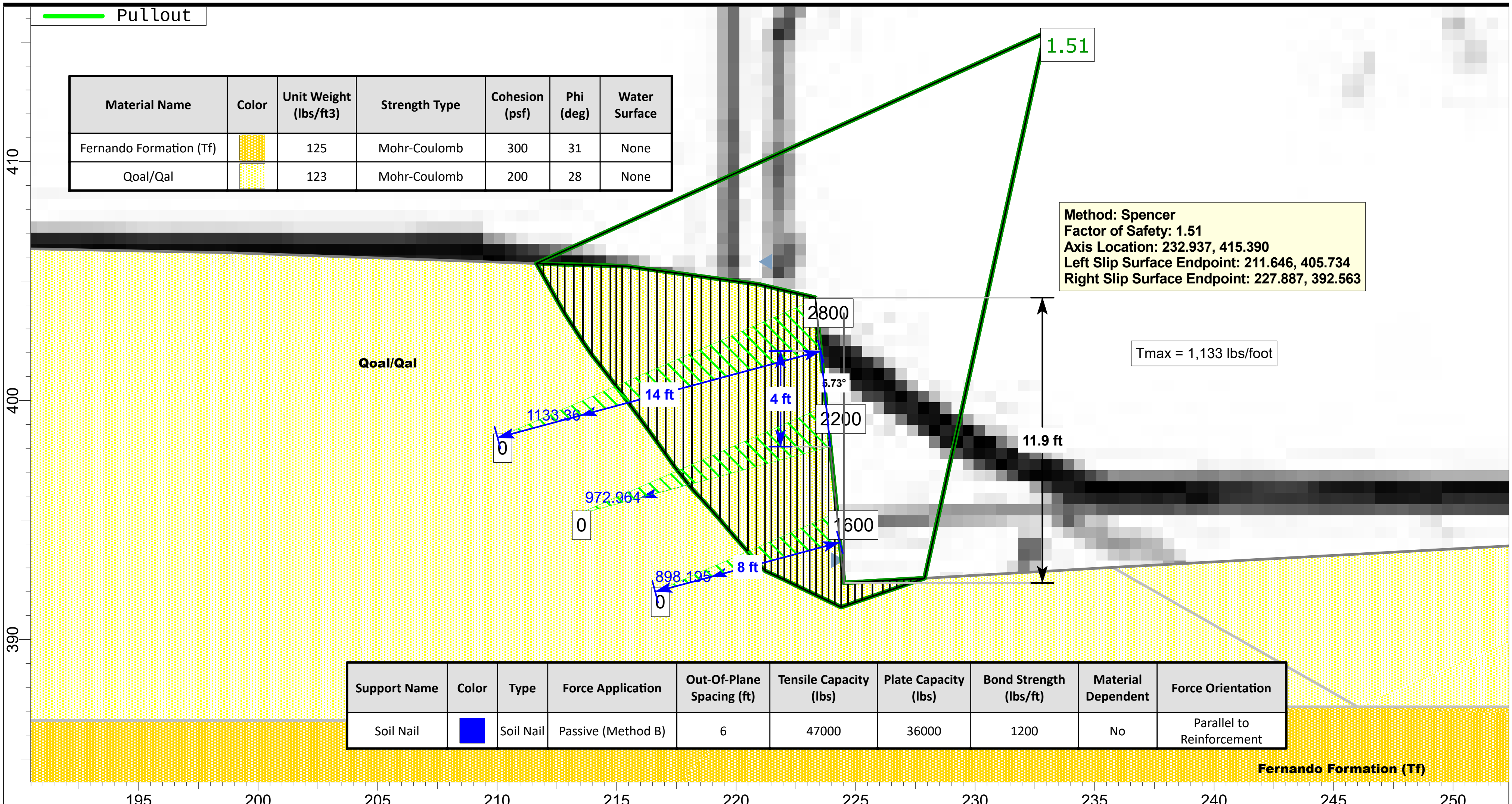
Material Boundary

X	Y
238.651	371.675
274.09	370.07
299.822	369.912
399.531	369.912

Section 24+50 - Retaining Wall 3 - Soil Nail Wall

Soil Nail Load Demand - Dia. 4 inches - Sv 4 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 24+50_10-1_Demand_RW-3\Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fernando Formation (Tf)		125	Mohr-Coulomb	300	31	None
Qoal/Qal		123	Mohr-Coulomb	200	28	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	6	47000	36000	1200	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA**			
Analyzed By: JEH	Units: feet	Scale: 1:72	Project No.: **11588.001**
Date: May 31, 2019	Condition: **Static**		File Name: Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA

Project Summary

Slide Modeler Version:	8.022
Compute Time:	00h:00m:12.378s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Fernando Formation (Tf)	Qoal/Qal
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123
Cohesion [psf]	300	200
Friction Angle [°]	31	28
Water Surface	None	None
Ru Value	0	0

Support

Soil Nail

Support Type: Soil Nail
Force Application: Passive
Force Orientation: Parallel to Reinforcement
Out-of-Plane Spacing: 6 ft
Tensile Capacity: 47000 lb
Plate Capacity: 36000 lb
Bond Strength: 1200 lb/ft

Global Minimums

Method: janbu corrected

FS	1.522620
Axis Location:	231.907, 414.769
Left Slip Surface Endpoint:	210.800, 405.763
Right Slip Surface Endpoint:	226.448, 392.480
Resisting Horizontal Force:	11151.7 lb
Driving Horizontal Force:	7324.02 lb
Passive Horizontal Support Force:	2914.54 lb
Maximum Single Support Force:	1102.5 lb
Total Support Force:	3017.35 lb
Total Slice Area:	101.334 ft2
Surface Horizontal Width:	15.6479 ft
Surface Average Height:	6.47589 ft

Method: spencer

FS	1.508150
Axis Location:	232.937, 415.390
Left Slip Surface Endpoint:	211.646, 405.734
Right Slip Surface Endpoint:	227.887, 392.563
Resisting Moment:	295864 lb-ft
Driving Moment:	196177 lb-ft
Resisting Horizontal Force:	10619.3 lb
Driving Horizontal Force:	7041.28 lb
Passive Support Moment:	42342.7 lb-ft
Passive Horizontal Support Force:	2902.14 lb
Maximum Single Support Force:	1133.36 lb
Total Support Force:	3004.52 lb
Total Slice Area:	98.5222 ft2
Surface Horizontal Width:	16.2413 ft
Surface Average Height:	6.06614 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
210.8	405.763
211.257	405.176
211.616	404.733
211.992	404.27
212.368	403.793
212.878	403.129
213.408	402.436
213.895	401.794
214.457	401.049
214.846	400.534
215.234	400.017
215.622	399.499
216.009	398.986
216.348	398.569
216.686	398.169
217.025	397.757
217.364	397.334
217.702	396.898
218.041	396.451
218.548	395.922
219.056	395.415
219.563	394.899
220.163	394.284
220.789	393.621
221.415	392.946
222.137	392.307
222.587	391.903
223.038	391.484
223.485	391.062
223.931	390.746
224.858	391.122
225.388	391.577
225.918	392.027
226.448	392.48

Method: spencer

X	Y
211.646	405.734
211.941	405.21
212.237	404.685
212.533	404.161
212.829	403.636
213.209	403.05
213.589	402.464
213.971	401.907
214.357	401.42
214.743	400.919
215.229	400.271
215.591	399.776
215.957	399.282
216.324	398.776
216.69	398.27
217.057	397.753
217.423	397.235
217.789	396.771
218.155	396.304
218.546	395.887
218.936	395.456
219.327	395.013
219.717	394.556
220.106	394.11
220.496	393.67
221.21	392.876
222.014	392.504
222.819	392.108
223.608	391.736
224.396	391.356
225.269	391.661
226.141	391.962
227.014	392.263
227.887	392.563

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4772
Number of Invalid Surfaces: 247

Error Codes:

Error Code -108 reported for 14 surfaces
Error Code -111 reported for 123 surfaces
Error Code -121 reported for 79 surfaces
Error Code -124 reported for 23 surfaces
Error Code -1000 reported for 8 surfaces

Method: spencer

Number of Valid Surfaces: 4008
Number of Invalid Surfaces: 1011

Error Codes:

Error Code -108 reported for 57 surfaces
Error Code -111 reported for 841 surfaces
Error Code -112 reported for 2 surfaces
Error Code -121 reported for 79 surfaces
Error Code -124 reported for 23 surfaces
Error Code -1000 reported for 9 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.52262

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.457319	16.0789	-52.1165	Qoal/Qal	200	28	97.3817	148.275	-97.2799	0	-97.2799	27.887	27.887
2	0.35945	34.7793	-50.9171	Qoal/Qal	200	28	113.504	172.823	-51.113	0	-51.113	88.638	88.638
3	0.3758	56.7208	-50.9586	Qoal/Qal	200	28	126.448	192.532	-14.0449	0	-14.0449	141.875	141.875
4	0.3758	77.9127	-51.7207	Qoal/Qal	200	28	138.776	211.303	21.257	0	21.257	197.108	197.108
5	0.255144	65.2842	-52.4576	Qoal/Qal	200	28	149.045	226.938	50.6635	0	50.6635	244.605	244.605
6	0.255144	75.4646	-52.4576	Qoal/Qal	200	28	158.454	241.265	77.6088	0	77.6088	283.794	283.794
7	0.264702	89.0926	-52.6606	Qoal/Qal	200	28	167.676	255.306	104.016	0	104.016	323.808	323.808
8	0.264702	100.133	-52.6606	Qoal/Qal	200	28	177.488	270.246	132.114	0	132.114	364.768	364.768
9	0.243543	101.905	-52.8	Qoal/Qal	200	28	186.623	284.156	158.274	0	158.274	404.14	404.14
10	0.243543	111.299	-52.8	Qoal/Qal	200	28	195.682	297.95	184.217	0	184.217	442.019	442.019
11	0.28133	140.291	-52.9326	Qoal/Qal	200	28	205.147	312.361	211.32	0	211.32	482.894	482.894
12	0.28133	152.889	-52.9326	Qoal/Qal	200	28	215.647	328.349	241.389	0	241.389	526.863	526.863
13	0.388254	231.719	-53.0096	Qoal/Qal	200	28	227.954	347.087	276.631	0	276.631	579.241	579.241
14	0.388262	255.816	-53.079	Qoal/Qal	200	28	242.291	368.917	317.687	0	317.687	640.142	640.142
15	0.388269	279.666	-53.1421	Qoal/Qal	200	28	375.937	572.409	700.398	0	700.398	1201.87	1201.87
16	0.386848	300.841	-52.9777	Qoal/Qal	200	28	270.427	411.758	398.259	0	398.259	756.838	756.838
17	0.338612	280.631	-50.932	Qoal/Qal	200	28	289.149	440.264	451.871	0	451.871	808.075	808.075
18	0.338616	295.72	-49.7439	Qoal/Qal	200	28	303.767	462.522	493.732	0	493.732	852.479	852.479
19	0.33862	310.697	-50.5652	Qoal/Qal	200	28	311.717	474.627	516.498	0	516.498	895.52	895.52
20	0.338623	326.167	-51.3589	Qoal/Qal	200	28	319.875	487.048	539.859	0	539.859	939.97	939.97
21	0.338627	342.129	-52.1259	Qoal/Qal	200	28	328.234	499.776	563.796	0	563.796	985.825	985.825
22	0.33863	358.585	-52.8675	Qoal/Qal	200	28	458.113	697.532	935.721	0	935.721	1540.74	1540.74
23	0.253742	278.537	-46.1937	Qoal/Qal	200	28	371.554	565.735	687.847	0	687.847	1075.21	1075.21

24	0.253742	285.711	-46.1937	Qoal/ Qal	200	28	378.68	576.586	708.255	0	708.255	1103.05	1103.05
25	0.253742	292.714	-44.988	Qoal/ Qal	200	28	390.11	593.989	740.986	0	740.986	1130.93	1130.93
26	0.253742	299.547	-44.988	Qoal/ Qal	200	28	396.978	604.446	760.651	0	760.651	1157.46	1157.46
27	0.253742	306.448	-45.4756	Qoal/ Qal	200	28	402.052	612.172	775.182	0	775.182	1183.97	1183.97
28	0.253742	313.417	-45.4756	Qoal/ Qal	200	28	409.023	622.787	795.146	0	795.146	1211.02	1211.02
29	0.299773	379.297	-45.7008	Qoal/ Qal	200	28	415.768	633.057	814.463	0	814.463	1240.53	1240.53
30	0.299773	389.113	-45.7008	Qoal/ Qal	200	28	424.062	645.685	838.212	0	838.212	1272.78	1272.78
31	0.312982	416.942	-46.6599	Qoal/ Qal	200	28	428.696	652.741	851.484	0	851.484	1305.77	1305.77
32	0.312982	428.062	-46.6599	Qoal/ Qal	200	28	437.612	666.317	877.015	0	877.015	1340.75	1340.75
33	0.626052	888.819	-47.1696	Qoal/ Qal	200	28	515.938	785.577	1101.31	0	1101.31	1657.88	1657.88
34	0.36105	529.593	-41.4704	Qoal/ Qal	200	28	485.144	738.69	1013.13	0	1013.13	1441.9	1441.9
35	0.36105	539.97	-41.4704	Qoal/ Qal	200	28	492.71	750.21	1034.79	0	1034.79	1470.25	1470.25
36	0.225257	342.181	-41.8895	Qoal/ Qal	200	28	497.085	756.872	1047.32	0	1047.32	1493.17	1493.17
37	0.225257	346.302	-41.8895	Qoal/ Qal	200	28	501.884	764.178	1061.06	0	1061.06	1511.21	1511.21
38	0.225257	350.532	-42.9793	Qoal/ Qal	200	28	501.945	764.271	1061.24	0	1061.24	1528.97	1528.97
39	0.225257	354.871	-42.9793	Qoal/ Qal	200	28	506.948	771.889	1075.57	0	1075.57	1547.96	1547.96
40	0.223377	356.23	-43.3369	Qoal/ Qal	200	28	510.328	777.035	1085.24	0	1085.24	1566.77	1566.77
41	0.223377	343.737	-43.3369	Qoal/ Qal	200	28	495.846	754.985	1043.77	0	1043.77	1511.64	1511.64
42	0.446754	522.194	-35.2334	Qoal/ Qal	200	28	427.866	651.477	849.104	0	849.104	1151.3	1151.3
43	0.463209	286.796	22.0608	Qoal/ Qal	200	28	408.776	622.41	794.437	0	794.437	628.776	628.776
44	0.463209	85.6295	22.0608	Qoal/ Qal	200	28	230.409	350.826	283.663	0	283.663	190.286	190.286
45	0.264901	37.7874	40.6865	Qoal/ Qal	200	28	265.509	404.269	384.172	0	384.172	155.908	155.908
46	0.264901	30.8661	40.6865	Qoal/ Qal	200	28	252.137	383.909	345.88	0	345.88	129.112	129.112
47	0.264941	23.9998	40.2885	Qoal/ Qal	200	28	237.321	361.349	303.454	0	303.454	102.273	102.273
48	0.264941	17.1801	40.2885	Qoal/ Qal	200	28	224.233	341.421	265.974	0	265.974	75.8883	75.8883
49	0.264973	10.3289	40.5368	Qoal/ Qal	200	28	211.934	322.695	230.755	0	230.755	49.5107	49.5107
50	0.264973	3.44296	40.5368	Qoal/ Qal	200	28	198.667	302.494	192.762	0	192.762	22.8641	22.8641

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

5	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
29	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
32	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
33	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.50815

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.29587	9.34759	-60.524	Qoal/ Qal	200	28	88.5303	133.517	-125.036	0	-125.036	31.5938	31.5938
2	0.29587	28.1076	-60.6133	Qoal/ Qal	200	28	102.154	154.064	-86.3928	0	-86.3928	95.0003	95.0003

3	0.29587	46.8811	-60.5495	Qoal/ Qal	200	28	116.028	174.988	-47.0412	0	-47.0412	158.452	158.452
4	0.29587	65.638	-60.5707	Qoal/ Qal	200	28	129.744	195.674	-8.13617	0	-8.13617	221.848	221.848
5	0.379767	109.728	-57.0779	Qoal/ Qal	200	28	151.815	228.959	54.4641	0	54.4641	288.935	288.935
6	0.380001	136.669	-57.0401	Qoal/ Qal	200	28	168.043	253.435	100.496	0	100.496	359.656	359.656
7	0.382423	163.893	-55.534	Qoal/ Qal	200	28	187.435	282.68	155.498	0	155.498	428.565	428.565
8	0.385261	189.299	-51.6353	Qoal/ Qal	200	28	211.6	319.125	224.042	0	224.042	491.354	491.354
9	0.386129	212.634	-52.3772	Qoal/ Qal	200	28	224.203	338.132	259.788	0	259.788	550.682	550.682
10	0.243193	145.98	-53.1091	Qoal/ Qal	200	28	234.222	353.242	288.206	0	288.206	600.264	600.264
11	0.243193	155.455	-53.1091	Qoal/ Qal	200	28	243.569	367.338	314.716	0	314.716	639.227	639.227
12	0.36198	248.991	-53.817	Qoal/ Qal	200	28	380.942	574.517	704.364	0	704.364	1225.18	1225.18
13	0.366389	272.28	-53.4605	Qoal/ Qal	200	28	267.396	403.273	382.3	0	382.3	743.145	743.145
14	0.36639	292.559	-54.0778	Qoal/ Qal	200	28	278.565	420.118	413.983	0	413.983	798.491	798.491
15	0.36639	313.092	-54.0778	Qoal/ Qal	200	28	291.856	440.162	451.68	0	451.68	854.533	854.533
16	0.366379	333.877	-54.6948	Qoal/ Qal	200	28	303.033	457.019	483.382	0	483.382	911.289	911.289
17	0.366379	354.934	-54.6948	Qoal/ Qal	200	28	316.561	477.421	521.753	0	521.753	968.762	968.762
18	0.36595	374.357	-51.757	Qoal/ Qal	200	28	340.814	513.999	590.546	0	590.546	1022.98	1022.98
19	0.36595	393.072	-51.9372	Qoal/ Qal	200	28	463.486	699.006	938.494	0	938.494	1530.39	1530.39
20	0.390769	438.493	-46.8506	Qoal/ Qal	200	28	383.858	578.916	712.637	0	712.637	1122.13	1122.13
21	0.390769	456.289	-47.7703	Qoal/ Qal	200	28	392.019	591.223	735.783	0	735.783	1167.67	1167.67
22	0.390252	474.099	-48.6586	Qoal/ Qal	200	28	400.45	603.938	759.697	0	759.697	1214.86	1214.86
23	0.390252	493.157	-49.5167	Qoal/ Qal	200	28	409.144	617.051	784.359	0	784.359	1263.69	1263.69
24	0.389499	511.265	-48.8146	Qoal/ Qal	200	28	424.389	640.042	827.599	0	827.599	1312.62	1312.62
25	0.389499	529.921	-48.4964	Qoal/ Qal	200	28	437.826	660.307	865.71	0	865.71	1360.52	1360.52
26	0.356959	501.787	-48.0376	Qoal/ Qal	200	28	451.279	680.596	903.871	0	903.871	1405.73	1405.73
27	0.356959	516.699	-48.0376	Qoal/ Qal	200	28	571.222	861.488	1244.08	0	1244.08	1879.32	1879.32
28	0.268211	394.448	-24.8368	Qoal/ Qal	200	28	559.763	844.207	1211.58	0	1211.58	1470.66	1470.66
29	0.268211	396.449	-24.8368	Qoal/ Qal	200	28	562.025	847.618	1217.99	0	1217.99	1478.12	1478.12
30	0.268211	398.451	-24.8368	Qoal/ Qal	200	28	564.287	851.03	1224.41	0	1224.41	1485.59	1485.59
31	0.268212	400.583	-26.2011	Qoal/ Qal	200	28	561.717	847.154	1217.12	0	1217.12	1493.53	1493.53
32	0.268212	402.843	-26.2011	Qoal/ Qal	200	28	564.25	850.973	1224.3	0	1224.3	1501.96	1501.96
33	0.268212	405.103	-26.2011	Qoal/ Qal	200	28	566.781	854.791	1231.48	0	1231.48	1510.39	1510.39
34	0.262878	399.152	-25.2292	Qoal/ Qal	200	28	572.783	863.842	1248.51	0	1248.51	1518.39	1518.39
35	0.262878	400.682	-25.2292	Qoal/ Qal	200	28	574.542	866.495	1253.5	0	1253.5	1524.21	1524.21
36	0.262878	353.041	-25.2292	Qoal/ Qal	200	28	519.751	783.862	1098.08	0	1098.08	1342.98	1342.98

37	0.262768	272.309	-25.7379	Qoal/ Qal	200	28	425.63	641.914	831.12	0	831.12	1036.31	1036.31
38	0.262768	191.787	-25.7379	Qoal/ Qal	200	28	333.288	502.648	569.198	0	569.198	729.87	729.87
39	0.262768	111.265	-25.7379	Qoal/ Qal	200	28	240.946	363.382	307.277	0	307.277	423.433	423.433
40	0.290909	43.155	19.2709	Qoal/ Qal	200	28	210.911	318.085	222.085	0	222.085	148.345	148.345
41	0.290909	31.3962	19.2709	Qoal/ Qal	200	28	194.656	293.571	175.981	0	175.981	107.924	107.924
42	0.290909	28.3589	19.2709	Qoal/ Qal	200	28	190.458	287.239	164.072	0	164.072	97.4836	97.4836
43	0.436364	36.9079	18.9891	Qoal/ Qal	200	28	184.859	278.796	148.193	0	148.193	84.5805	84.5805
44	0.436364	30.203	18.9891	Qoal/ Qal	200	28	178.694	269.498	130.706	0	130.706	69.2149	69.2149
45	0.290909	16.4025	19.0662	Qoal/ Qal	200	28	173.651	261.891	116.401	0	116.401	56.3835	56.3835
46	0.290909	13.4069	19.0662	Qoal/ Qal	200	28	169.517	255.656	104.674	0	104.674	46.086	46.086
47	0.290909	10.4112	19.0662	Qoal/ Qal	200	28	165.382	249.421	92.9481	0	92.9481	35.7885	35.7885
48	0.290909	7.42783	18.9456	Qoal/ Qal	200	28	161.113	242.982	80.8376	0	80.8376	25.5331	25.5331
49	0.290909	4.4567	18.9456	Qoal/ Qal	200	28	157.016	236.804	69.2181	0	69.2181	15.3198	15.3198
50	0.290909	1.48557	18.9456	Qoal/ Qal	200	28	152.92	230.626	57.5987	0	57.5987	5.10662	5.10662

Query 1 (spencer) - Safety Factor: 1.50815

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.29587	9.34759	-60.524	Qoal/ Qal	200	28	88.5303	133.517	-125.036	0	-125.036	31.5938	31.5938
2	0.29587	28.1076	-60.6133	Qoal/ Qal	200	28	102.154	154.064	-86.3928	0	-86.3928	95.0003	95.0003
3	0.29587	46.8811	-60.5495	Qoal/ Qal	200	28	116.028	174.988	-47.0412	0	-47.0412	158.452	158.452
4	0.29587	65.638	-60.5707	Qoal/ Qal	200	28	129.744	195.674	-8.13617	0	-8.13617	221.848	221.848
5	0.379767	109.728	-57.0779	Qoal/ Qal	200	28	151.815	228.959	54.4641	0	54.4641	288.935	288.935
6	0.380001	136.669	-57.0401	Qoal/ Qal	200	28	168.043	253.435	100.496	0	100.496	359.656	359.656
7	0.382423	163.893	-55.534	Qoal/ Qal	200	28	187.435	282.68	155.498	0	155.498	428.565	428.565
8	0.385261	189.299	-51.6353	Qoal/ Qal	200	28	211.6	319.125	224.042	0	224.042	491.354	491.354
9	0.386129	212.634	-52.3772	Qoal/ Qal	200	28	224.203	338.132	259.788	0	259.788	550.682	550.682
10	0.243193	145.98	-53.1091	Qoal/ Qal	200	28	234.222	353.242	288.206	0	288.206	600.264	600.264
11	0.243193	155.455	-53.1091	Qoal/ Qal	200	28	243.569	367.338	314.716	0	314.716	639.227	639.227
12	0.36198	248.991	-53.817	Qoal/ Qal	200	28	380.942	574.517	704.364	0	704.364	1225.18	1225.18
13	0.366389	272.28	-53.4605	Qoal/ Qal	200	28	267.396	403.273	382.3	0	382.3	743.145	743.145
14	0.36639	292.559	-54.0778	Qoal/ Qal	200	28	278.565	420.118	413.983	0	413.983	798.491	798.491
15	0.36639	313.092	-54.0778	Qoal/ Qal	200	28	291.856	440.162	451.68	0	451.68	854.533	854.533
16	0.366379	333.877	-54.6948	Qoal/ Qal	200	28	303.033	457.019	483.382	0	483.382	911.289	911.289
17	0.366379	354.934	-54.6948	Qoal/ Qal	200	28	316.561	477.421	521.753	0	521.753	968.762	968.762

18	0.36595	374.357	-51.757	Qoal/ Qal	200	28	340.814	513.999	590.546	0	590.546	1022.98	1022.98
19	0.36595	393.072	-51.9372	Qoal/ Qal	200	28	463.486	699.006	938.494	0	938.494	1530.39	1530.39
20	0.390769	438.493	-46.8506	Qoal/ Qal	200	28	383.858	578.916	712.637	0	712.637	1122.13	1122.13
21	0.390769	456.289	-47.7703	Qoal/ Qal	200	28	392.019	591.223	735.783	0	735.783	1167.67	1167.67
22	0.390252	474.099	-48.6586	Qoal/ Qal	200	28	400.45	603.938	759.697	0	759.697	1214.86	1214.86
23	0.390252	493.157	-49.5167	Qoal/ Qal	200	28	409.144	617.051	784.359	0	784.359	1263.69	1263.69
24	0.389499	511.265	-48.8146	Qoal/ Qal	200	28	424.389	640.042	827.599	0	827.599	1312.62	1312.62
25	0.389499	529.921	-48.4964	Qoal/ Qal	200	28	437.826	660.307	865.71	0	865.71	1360.52	1360.52
26	0.356959	501.787	-48.0376	Qoal/ Qal	200	28	451.279	680.596	903.871	0	903.871	1405.73	1405.73
27	0.356959	516.699	-48.0376	Qoal/ Qal	200	28	571.222	861.488	1244.08	0	1244.08	1879.32	1879.32
28	0.268211	394.448	-24.8368	Qoal/ Qal	200	28	559.763	844.207	1211.58	0	1211.58	1470.66	1470.66
29	0.268211	396.449	-24.8368	Qoal/ Qal	200	28	562.025	847.618	1217.99	0	1217.99	1478.12	1478.12
30	0.268211	398.451	-24.8368	Qoal/ Qal	200	28	564.287	851.03	1224.41	0	1224.41	1485.59	1485.59
31	0.268212	400.583	-26.2011	Qoal/ Qal	200	28	561.717	847.154	1217.12	0	1217.12	1493.53	1493.53
32	0.268212	402.843	-26.2011	Qoal/ Qal	200	28	564.25	850.973	1224.3	0	1224.3	1501.96	1501.96
33	0.268212	405.103	-26.2011	Qoal/ Qal	200	28	566.781	854.791	1231.48	0	1231.48	1510.39	1510.39
34	0.262878	399.152	-25.2292	Qoal/ Qal	200	28	572.783	863.842	1248.51	0	1248.51	1518.39	1518.39
35	0.262878	400.682	-25.2292	Qoal/ Qal	200	28	574.542	866.495	1253.5	0	1253.5	1524.21	1524.21
36	0.262878	353.041	-25.2292	Qoal/ Qal	200	28	519.751	783.862	1098.08	0	1098.08	1342.98	1342.98
37	0.262768	272.309	-25.7379	Qoal/ Qal	200	28	425.63	641.914	831.12	0	831.12	1036.31	1036.31
38	0.262768	191.787	-25.7379	Qoal/ Qal	200	28	333.288	502.648	569.198	0	569.198	729.87	729.87
39	0.262768	111.265	-25.7379	Qoal/ Qal	200	28	240.946	363.382	307.277	0	307.277	423.433	423.433
40	0.290909	43.155	19.2709	Qoal/ Qal	200	28	210.911	318.085	222.085	0	222.085	148.345	148.345
41	0.290909	31.3962	19.2709	Qoal/ Qal	200	28	194.656	293.571	175.981	0	175.981	107.924	107.924
42	0.290909	28.3589	19.2709	Qoal/ Qal	200	28	190.458	287.239	164.072	0	164.072	97.4836	97.4836
43	0.436364	36.9079	18.9891	Qoal/ Qal	200	28	184.859	278.796	148.193	0	148.193	84.5805	84.5805
44	0.436364	30.203	18.9891	Qoal/ Qal	200	28	178.694	269.498	130.706	0	130.706	69.2149	69.2149
45	0.290909	16.4025	19.0662	Qoal/ Qal	200	28	173.651	261.891	116.401	0	116.401	56.3835	56.3835
46	0.290909	13.4069	19.0662	Qoal/ Qal	200	28	169.517	255.656	104.674	0	104.674	46.086	46.086
47	0.290909	10.4112	19.0662	Qoal/ Qal	200	28	165.382	249.421	92.9481	0	92.9481	35.7885	35.7885
48	0.290909	7.42783	18.9456	Qoal/ Qal	200	28	161.113	242.982	80.8376	0	80.8376	25.5331	25.5331
49	0.290909	4.4567	18.9456	Qoal/ Qal	200	28	157.016	236.804	69.2181	0	69.2181	15.3198	15.3198
50	0.290909	1.48557	18.9456	Qoal/ Qal	200	28	152.92	230.626	57.5987	0	57.5987	5.10662	5.10662

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.52262

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	210.8	405.763	0	0	0
2	211.257	405.176	-104.303	0	0
3	211.616	404.733	-170.093	0	0
4	211.992	404.27	-226.882	0	0
5	212.368	403.793	-271.941	0	0
6	212.623	403.461	-295.358	0	0
7	212.878	403.129	-312.369	0	0
8	213.143	402.783	-323.241	0	0
9	213.408	402.436	-327.111	0	0
10	213.651	402.115	-324.419	0	0
11	213.895	401.794	-315.738	0	0
12	214.176	401.421	-298.104	0	0
13	214.457	401.049	-272.397	0	0
14	214.846	400.534	-223.465	0	0
15	215.234	400.017	-158.847	0	0
16	215.622	399.499	-690.582	0	0
17	216.009	398.986	-596.988	0	0
18	216.348	398.569	-512.093	0	0
19	216.686	398.169	-423.484	0	0
20	217.025	397.757	-322.511	0	0
21	217.364	397.334	-208.458	0	0
22	217.702	396.898	-80.5923	0	0
23	218.041	396.451	-479.59	0	0
24	218.295	396.186	-397.382	0	0
25	218.548	395.922	-311.689	0	0
26	218.802	395.668	-228.486	0	0
27	219.056	395.415	-142.14	0	0
28	219.31	395.157	-50.0946	0	0
29	219.563	394.899	45.2293	0	0
30	219.863	394.591	163.553	0	0
31	220.163	394.284	286.542	0	0
32	220.476	393.953	426.978	0	0
33	220.789	393.621	572.93	0	0
34	221.415	392.946	342.935	0	0
35	221.776	392.627	480.884	0	0
36	222.137	392.307	622.857	0	0
37	222.362	392.105	715.977	0	0
38	222.587	391.903	810.731	0	0
39	222.813	391.693	913.853	0	0
40	223.038	391.484	1018.79	0	0
41	223.261	391.273	1126.91	0	0
42	223.485	391.062	1229.71	0	0
43	223.931	390.746	1295.38	0	0
44	224.395	390.934	945.903	0	0
45	224.858	391.122	779.725	0	0
46	225.123	391.35	617.813	0	0
47	225.388	391.577	468.369	0	0
48	225.653	391.802	333.686	0	0
49	225.918	392.027	211.089	0	0
50	226.183	392.253	99.3803	0	0
51	226.448	392.48	0	0	0

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A
28	N/A	N/A	N/A	N/A	N/A
29	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A
31	N/A	N/A	N/A	N/A	N/A
32	N/A	N/A	N/A	N/A	N/A
33	N/A	N/A	N/A	N/A	N/A
34	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.50815

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	211.646	405.734	0	0	0
2	211.941	405.21	-91.645	0	0
3	212.237	404.685	-167.258	0	0
4	212.533	404.161	-226.237	0	0
5	212.829	403.636	-268.891	0	0
6	213.209	403.05	-294.6	0	0
7	213.589	402.464	-299.561	0	0
8	213.971	401.907	-284.607	0	0
9	214.357	401.42	-257.088	0	0
10	214.743	400.919	-213.509	0	0
11	214.986	400.595	-177.088	0	0
12	215.229	400.271	-134.351	0	0
13	215.591	399.776	-649.542	0	0
14	215.957	399.282	-558.49	0	0
15	216.324	398.776	-451.189	0	0
16	216.69	398.27	-329.692	0	0
17	217.057	397.753	-190.635	0	0
18	217.423	397.235	-36.6838	0	0
19	217.789	396.771	112.799	0	0
20	218.155	396.304	-241.374	0	0
21	218.546	395.887	-94.3006	0	0
22	218.936	395.456	69.273	0	0
23	219.327	395.013	249.974	0	0
24	219.717	394.556	448.911	0	0
25	220.106	394.11	652.018	0	0
26	220.496	393.67	862.566	0	0
27	220.853	393.273	1060.28	0	0
28	221.21	392.876	774.972	0	0
29	221.478	392.752	775.243	0	0
30	221.746	392.628	775.704	0	0
31	222.014	392.504	776.354	0	0
32	222.283	392.372	786.334	0	0
33	222.551	392.24	796.583	0	0
34	222.819	392.108	807.1	0	0
35	223.082	391.984	811.175	0	0
36	223.345	391.86	815.404	0	0
37	223.608	391.736	814.788	0	0
38	223.871	391.61	808.229	0	0
39	224.133	391.483	792.755	0	0
40	224.396	391.356	768.367	0	0
41	224.687	391.458	684.423	0	0
42	224.978	391.56	609.897	0	0
43	225.269	391.661	537.804	0	0
44	225.705	391.812	434.885	0	0
45	226.141	391.962	337.283	0	0
46	226.432	392.062	275.063	0	0
47	226.723	392.163	215.225	0	0
48	227.014	392.263	157.768	0	0
49	227.305	392.363	102.827	0	0
50	227.596	392.463	50.2374	0	0
51	227.887	392.563	0	0	0

Query 1 (spencer) - Safety Factor: 1.50815

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	211.646	405.734	0	0	0
2	211.941	405.21	-91.645	0	0
3	212.237	404.685	-167.258	0	0
4	212.533	404.161	-226.237	0	0
5	212.829	403.636	-268.891	0	0
6	213.209	403.05	-294.6	0	0
7	213.589	402.464	-299.561	0	0
8	213.971	401.907	-284.607	0	0
9	214.357	401.42	-257.088	0	0
10	214.743	400.919	-213.509	0	0
11	214.986	400.595	-177.088	0	0
12	215.229	400.271	-134.351	0	0
13	215.591	399.776	-649.542	0	0
14	215.957	399.282	-558.49	0	0
15	216.324	398.776	-451.189	0	0
16	216.69	398.27	-329.692	0	0
17	217.057	397.753	-190.635	0	0
18	217.423	397.235	-36.6838	0	0
19	217.789	396.771	112.799	0	0
20	218.155	396.304	-241.374	0	0
21	218.546	395.887	-94.3006	0	0
22	218.936	395.456	69.273	0	0
23	219.327	395.013	249.974	0	0
24	219.717	394.556	448.911	0	0
25	220.106	394.11	652.018	0	0
26	220.496	393.67	862.566	0	0
27	220.853	393.273	1060.28	0	0
28	221.21	392.876	774.972	0	0
29	221.478	392.752	775.243	0	0
30	221.746	392.628	775.704	0	0
31	222.014	392.504	776.354	0	0
32	222.283	392.372	786.334	0	0
33	222.551	392.24	796.583	0	0
34	222.819	392.108	807.1	0	0
35	223.082	391.984	811.175	0	0
36	223.345	391.86	815.404	0	0
37	223.608	391.736	814.788	0	0
38	223.871	391.61	808.229	0	0
39	224.133	391.483	792.755	0	0
40	224.396	391.356	768.367	0	0
41	224.687	391.458	684.423	0	0
42	224.978	391.56	609.897	0	0
43	225.269	391.661	537.804	0	0
44	225.705	391.812	434.885	0	0
45	226.141	391.962	337.283	0	0
46	226.432	392.062	275.063	0	0
47	226.723	392.163	215.225	0	0
48	227.014	392.263	157.768	0	0
49	227.305	392.363	102.827	0	0
50	227.596	392.463	50.2374	0	0
51	227.887	392.563	0	0	0

Entity Information

External Boundary

X	Y
100	250
500	250
500	442
496.363	441.663
488.917	433.224
483.557	423.197
471.147	402.349
464.992	394.804
459.929	391.925
453.476	388.251
449.414	384.866
446.923	382.791
439.279	377.728
421.21	377.728
419.126	378.423
409.396	381.898
401.256	383.188
393.314	384.578
383.584	385.869
371.969	386.365
358.467	387.259
343.377	388.45
330.868	389.84
313.495	390.634
302.368	396.667
263.161	394.503
235.754	393.018
224.515	392.368
223.317	404.304
220.963	404.861
215.406	405.621
211.749	405.73
198.834	406.185
149.124	407.154
100	409.147
100	388.607

Material Boundary

X	Y
100	388.607
128.687	389.462
139.508	388.607
150.614	387.184
166.845	387.468
188.488	386.614
205.289	386.614
219.242	385.76
232.911	387.184
246.01	387.184
257.686	387.184
265.374	386.329
277.335	388.038
285.877	386.329
300.401	384.621
311.791	385.19
324.606	382.343
343.685	378.641
350.235	376.078
374.155	375.793
380.135	373.515
399.784	373.8
408.896	370.098
426.552	364.972
433.102	364.118
442.214	369.813
449.414	384.866

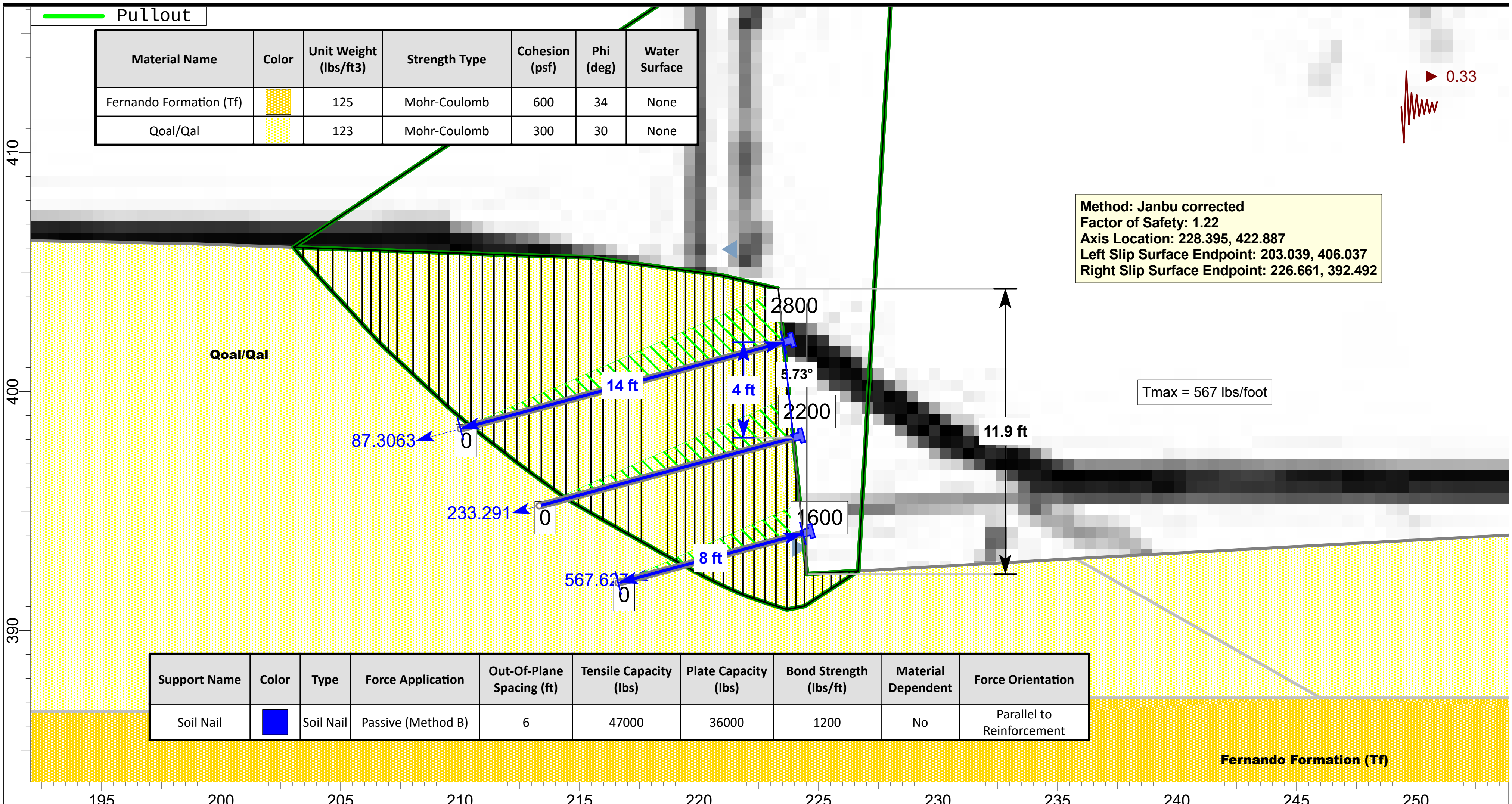
Material Boundary

X	Y
235.754	393.018
246.01	387.184

Section 24+50 - Retaining Wall 3 - Soil Nail Wall

Soil Nail Load Demand - Dia. 4 inches - Sv 4 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 24+50_10-1_Demand_RW-3\Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1_k033.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fernando Formation (Tf)		125	Mohr-Coulomb	600	34	None
Qoal/Qal		123	Mohr-Coulomb	300	30	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	6	47000	36000	1200	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project:	**Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA**
Analyzed By:	JEH
Units:	feet
Scale:	1:72
Project No.:	**11588.001**
File Name:	Sec 24+50_10-1_SN_Dia 4 B8 60k p3600 q1200_path SrfAlt_p1_k033.slim
Date:	May 31, 2019
Condition:	**PseudoStatic**

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA

Project Summary

Slide Modeler Version:	8.022
Compute Time:	00h:00m:15.775s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.33

Materials

Property	Fernando Formation (Tf)	Qoal/Qal
Color		
Strength Type	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123
Cohesion [psf]	600	300
Friction Angle [°]	34	30
Water Surface	None	None
Ru Value	0	0

Support

Soil Nail

Support Type: Soil Nail
Force Application: Passive
Force Orientation: Parallel to Reinforcement
Out-of-Plane Spacing: 6 ft
Tensile Capacity: 47000 lb
Plate Capacity: 36000 lb
Bond Strength: 1200 lb/ft

Global Minimums

Method: janbu corrected

FS	1.216410
Axis Location:	228.395, 422.887
Left Slip Surface Endpoint:	203.039, 406.037
Right Slip Surface Endpoint:	226.661, 392.492
Resisting Horizontal Force:	17627.8 lb
Driving Horizontal Force:	14491.7 lb
Passive Horizontal Support Force:	857.96 lb
Maximum Single Support Force:	567.628 lb
Total Support Force:	888.225 lb
Total Slice Area:	180.147 ft2
Surface Horizontal Width:	23.6222 ft
Surface Average Height:	7.6262 ft

Method: spencer

FS	1.486030
Axis Location:	227.884, 428.803
Left Slip Surface Endpoint:	199.654, 406.156
Right Slip Surface Endpoint:	229.064, 392.631
Resisting Moment:	876057 lb-ft
Driving Moment:	589529 lb-ft
Resisting Horizontal Force:	21807.7 lb
Driving Horizontal Force:	14675.2 lb
Passive Support Moment:	24498.5 lb-ft
Passive Horizontal Support Force:	728.609 lb
Maximum Single Support Force:	724.426 lb
Total Support Force:	754.312 lb
Total Slice Area:	212.792 ft2
Surface Horizontal Width:	29.4093 ft
Surface Average Height:	7.23556 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
203.039	406.037
203.44	405.542
204.058	404.837
204.676	404.166
205.294	403.496
205.912	402.825
206.643	402.032
207.368	401.346
208.038	400.723
208.707	400.1
209.502	399.359
210.458	398.542
211.414	397.792
212.37	397.041
213.404	396.284
214.437	395.527
215.47	394.921
216.503	394.338
217.591	393.726
218.678	393.115
219.436	392.689
220.193	392.271
221.014	391.869
221.841	391.503
222.758	391.18
223.676	390.885
224.422	391.028
225.168	391.516
225.915	392.004
226.661	392.492

Method: spencer

X	Y
199.654	406.156
200.143	405.352
200.631	404.55
201.473	403.236
202.314	402.284
203.35	401.199
204.678	400.194
206.012	399.241
206.818	398.72
207.625	398.247
208.853	397.557
210.097	396.89
211.342	396.224
212.604	395.635
213.879	395.077
215.205	394.616
216.528	394.155
217.602	393.788
218.694	393.417
220.004	392.972
221.312	392.537
222.603	392.253
223.803	392.021
225.208	392.054
226.522	392.241
227.793	392.422
229.064	392.631

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4869
Number of Invalid Surfaces: 150

Error Codes:

Error Code -108 reported for 1 surface
Error Code -111 reported for 37 surfaces
Error Code -121 reported for 79 surfaces
Error Code -124 reported for 23 surfaces
Error Code -1000 reported for 10 surfaces

Method: spencer

Number of Valid Surfaces: 1280
Number of Invalid Surfaces: 3739

Error Codes:

Error Code -108 reported for 40 surfaces
Error Code -111 reported for 3590 surfaces
Error Code -121 reported for 79 surfaces
Error Code -124 reported for 23 surfaces
Error Code -1000 reported for 7 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.21641

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.401693	11.8756	-50.9329	Qoal/ Qal	300	30	161.372	196.295	-179.623	0	-179.623	19.1796	19.1796
2	0.617915	62.5099	-48.7769	Qoal/ Qal	300	30	187.668	228.281	-124.221	0	-124.221	89.9753	89.9753
3	0.617929	113.138	-47.3356	Qoal/ Qal	300	30	216.311	263.123	-63.8725	0	-63.8725	170.834	170.834
4	0.617942	162.448	-47.3356	Qoal/ Qal	300	30	240.873	293.001	-12.1234	0	-12.1234	249.234	249.234
5	0.617915	211.745	-47.3356	Qoal/ Qal	300	30	265.435	322.878	39.6254	0	39.6254	327.633	327.633
6	0.365618	148.505	-47.3356	Qoal/ Qal	300	30	284.982	346.655	80.8086	0	80.8086	390.026	390.026
7	0.365618	165.767	-47.3356	Qoal/ Qal	300	30	299.515	364.333	111.428	0	111.428	436.414	436.414
8	0.362406	180.225	-43.4221	Qoal/ Qal	300	30	327.752	398.681	170.921	0	170.921	481.1	481.1
9	0.362406	194.944	-43.4221	Qoal/ Qal	300	30	340.842	414.604	198.501	0	198.501	521.068	521.068
10	0.669423	398.373	-42.9513	Qoal/ Qal	300	30	361.166	439.326	241.32	0	241.32	577.539	577.539
11	0.669438	447.755	-42.9513	Qoal/ Qal	300	30	385.062	468.393	291.664	0	291.664	650.129	650.129
12	0.397479	289.215	-42.9513	Qoal/ Qal	300	30	404.103	491.555	331.783	0	331.783	707.973	707.973
13	0.397479	306.621	-42.9513	Qoal/ Qal	300	30	418.292	508.814	361.677	0	361.677	751.075	751.075
14	0.478055	390.765	-40.5264	Qoal/ Qal	300	30	444.723	540.966	417.365	0	417.365	797.55	797.55
15	0.478055	413.806	-40.5264	Qoal/ Qal	300	30	474.354	577.009	479.794	0	479.794	885.31	885.31
16	0.478043	435.855	-38.1357	Qoal/ Qal	300	30	488.02	593.633	508.587	0	508.587	891.735	891.735
17	0.478043	456.933	-38.1357	Qoal/ Qal	300	30	503.053	611.919	540.26	0	540.26	935.211	935.211
18	0.478046	478.02	-38.1357	Qoal/ Qal	300	30	518.092	630.212	571.943	0	571.943	978.701	978.701
19	0.478046	499.213	-38.1357	Qoal/ Qal	300	30	533.207	648.598	603.789	0	603.789	1022.41	1022.41
20	0.516668	562.556	-36.2264	Qoal/ Qal	300	30	558.92	679.876	657.966	0	657.966	1067.43	1067.43
21	0.516668	585.632	-36.2264	Qoal/ Qal	300	30	574.44	698.755	690.664	0	690.664	1111.5	1111.5
22	0.51667	608.703	-36.21	Qoal/ Qal	300	30	590.051	717.744	723.553	0	723.553	1155.56	1155.56
23	0.51667	631.764	-36.21	Qoal/ Qal	300	30	605.564	736.614	756.237	0	756.237	1199.6	1199.6
24	0.516616	652.375	-30.4163	Qoal/ Qal	300	30	691.288	840.89	936.85	0	936.85	1342.69	1342.69
25	0.516616	670.641	-30.4163	Qoal/ Qal	300	30	667.159	811.539	886.012	0	886.012	1277.69	1277.69
26	0.516611	686.392	-29.4404	Qoal/ Qal	300	30	684.347	832.446	922.223	0	922.223	1308.47	1308.47
27	0.516611	700.43	-29.4404	Qoal/ Qal	300	30	694.408	844.685	943.421	0	943.421	1335.35	1335.35
28	0.543559	752.085	-29.3516	Qoal/ Qal	300	30	705.267	857.894	966.301	0	966.301	1362.91	1362.91

29	0.543559	767.552	-29.3516	Qoal/ Qal	300	30	715.811	870.72	988.517	0	988.517	1391.06	1391.06
30	1.08711	1581.5	-29.3516	Qoal/ Qal	300	30	731.627	889.959	1021.84	0	1021.84	1433.28	1433.28
31	0.378945	565.817	-29.3516	Qoal/ Qal	300	30	745.847	907.256	1051.8	0	1051.8	1471.23	1471.23
32	0.378945	573.334	-29.3516	Qoal/ Qal	300	30	877.47	1067.36	1329.11	0	1329.11	1822.56	1822.56
33	0.378933	580.729	-28.8397	Qoal/ Qal	300	30	763.933	929.256	1089.9	0	1089.9	1510.57	1510.57
34	0.378933	588.039	-28.8397	Qoal/ Qal	300	30	771.114	937.991	1105.03	0	1105.03	1529.65	1529.65
35	0.410465	644.593	-26.11	Qoal/ Qal	300	30	796.925	969.387	1159.41	0	1159.41	1549.99	1549.99
36	0.410465	651.899	-26.11	Qoal/ Qal	300	30	803.712	977.643	1173.71	0	1173.71	1567.62	1567.62
37	0.413085	661.661	-23.8736	Qoal/ Qal	300	30	824.606	1003.06	1217.73	0	1217.73	1582.69	1582.69
38	0.413085	665.984	-23.8736	Qoal/ Qal	300	30	828.674	1008.01	1226.3	0	1226.3	1593.07	1593.07
39	0.458819	743.616	-19.4032	Qoal/ Qal	300	30	863.908	1050.87	1300.54	0	1300.54	1604.82	1604.82
40	0.458819	746.609	-19.4032	Qoal/ Qal	300	30	866.542	1054.07	1306.09	0	1306.09	1611.3	1611.3
41	0.458809	749.196	-17.8504	Qoal/ Qal	300	30	880.113	1070.58	1334.68	0	1334.68	1618.11	1618.11
42	0.458809	674.396	-17.8504	Qoal/ Qal	300	30	813.454	989.494	1194.24	0	1194.24	1456.2	1456.2
43	0.37323	364.935	10.8742	Qoal/ Qal	300	30	786.136	956.264	1136.68	0	1136.68	985.664	985.664
44	0.37323	190.933	10.8742	Qoal/ Qal	300	30	541.377	658.536	621.001	0	621.001	517.001	517.001
45	0.373107	61.4455	33.1849	Qoal/ Qal	300	30	482.337	586.72	496.613	0	496.613	181.161	181.161
46	0.373107	45.9372	33.1849	Qoal/ Qal	300	30	453.04	551.082	434.886	0	434.886	138.595	138.595
47	0.373116	35.7299	33.1849	Qoal/ Qal	300	30	433.754	527.623	394.256	0	394.256	110.579	110.579
48	0.373116	25.5213	33.1849	Qoal/ Qal	300	30	414.47	504.165	353.624	0	353.624	82.5584	82.5584
49	0.373114	15.3127	33.1849	Qoal/ Qal	300	30	395.184	480.706	312.993	0	312.993	54.5403	54.5403
50	0.373114	5.10423	33.1849	Qoal/ Qal	300	30	375.899	457.247	272.36	0	272.36	26.5206	26.5206

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	Qoal/ Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.48603

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.48848	23.6405	-58.7231	Qoal/ Qal	300	30	193.651	287.772	-21.1802	0	-21.1802	297.61	297.61
2	0.488489	70.8515	-58.6472	Qoal/ Qal	300	30	201.19	298.974	-1.77664	0	-1.77664	328.437	328.437
3	0.841566	229.163	-57.3703	Qoal/ Qal	300	30	213.421	317.15	29.7046	0	29.7046	363.04	363.04

4	0.841494	343.368	-48.5273	Qoal/ Qal	300	30	245.338	364.579	111.854	0	111.854	389.425	389.425
5	0.517679	257.29	-46.3333	Qoal/ Qal	300	30	260.66	387.349	151.293	0	151.293	424.376	424.376
6	0.517679	290.663	-46.3333	Qoal/ Qal	300	30	267.694	397.801	169.396	0	169.396	449.848	449.848
7	0.442754	271.559	-37.0995	Qoal/ Qal	300	30	305.455	453.915	266.588	0	266.588	497.597	497.597
8	0.442754	288.944	-37.0995	Qoal/ Qal	300	30	310.869	461.961	280.525	0	280.525	515.63	515.63
9	0.442754	306.33	-37.0995	Qoal/ Qal	300	30	316.284	470.007	294.461	0	294.461	533.66	533.66
10	0.666785	493.005	-35.5583	Qoal/ Qal	300	30	329.509	489.66	328.502	0	328.502	564.044	564.044
11	0.666785	530.169	-35.5583	Qoal/ Qal	300	30	337.495	501.527	349.055	0	349.055	590.306	590.306
12	0.806587	688.244	-32.8617	Qoal/ Qal	300	30	359.275	533.894	405.116	0	405.116	637.201	637.201
13	0.806469	734.659	-30.4267	Qoal/ Qal	300	30	381.684	567.194	462.794	0	462.794	686.966	686.966
14	0.613923	588.262	-29.3044	Qoal/ Qal	300	30	396.185	588.743	500.119	0	500.119	722.487	722.487
15	0.613923	612.649	-29.3044	Qoal/ Qal	300	30	402.838	598.629	517.24	0	517.24	743.343	743.343
16	0.622307	645.308	-28.2024	Qoal/ Qal	300	30	416.668	619.181	552.838	0	552.838	776.275	776.275
17	0.622307	669.173	-28.2024	Qoal/ Qal	300	30	423.272	628.995	569.836	0	569.836	796.815	796.815
18	0.622306	693.014	-28.1591	Qoal/ Qal	300	30	430.176	639.254	587.607	0	587.607	817.869	817.869
19	0.622306	716.833	-28.1591	Qoal/ Qal	300	30	436.774	649.06	604.589	0	604.589	838.384	838.384
20	0.631107	749.627	-25.003	Qoal/ Qal	300	30	467.61	694.883	683.957	0	683.957	902.037	902.037
21	0.631107	770.959	-25.003	Qoal/ Qal	300	30	473.931	704.275	700.225	0	700.225	921.252	921.252
22	0.637396	799.628	-23.6279	Qoal/ Qal	300	30	492.171	731.381	747.174	0	747.174	962.484	962.484
23	0.637396	819.999	-23.6279	Qoal/ Qal	300	30	512.281	761.265	798.934	0	798.934	1023.04	1023.04
24	0.663316	872.559	-19.196	Qoal/ Qal	300	30	549.183	816.103	893.918	0	893.918	1085.12	1085.12
25	0.663316	889.788	-19.196	Qoal/ Qal	300	30	554.865	824.546	908.541	0	908.541	1101.72	1101.72
26	0.440862	600.531	-19.1848	Qoal/ Qal	300	30	559.532	831.481	920.553	0	920.553	1115.24	1115.24
27	0.440862	605.844	-19.1848	Qoal/ Qal	300	30	562.169	835.4	927.34	0	927.34	1122.94	1122.94
28	0.440862	610.893	-19.1848	Qoal/ Qal	300	30	564.674	839.123	933.788	0	933.788	1130.26	1130.26
29	0.537007	750.825	-18.8576	Qoal/ Qal	300	30	571.26	848.91	950.74	0	950.74	1145.85	1145.85
30	0.537007	758.088	-18.8576	Qoal/ Qal	300	30	574.247	853.348	958.429	0	958.429	1154.56	1154.56
31	0.546021	778.233	-18.7788	Qoal/ Qal	300	30	578.197	859.218	968.594	0	968.594	1165.19	1165.19
32	0.546021	785.687	-18.7788	Qoal/ Qal	300	30	581.218	863.707	976.371	0	976.371	1173.99	1173.99
33	0.436562	633.541	-18.7665	Qoal/ Qal	300	30	584.086	867.969	983.75	0	983.75	1182.21	1182.21
34	0.436562	638.3	-18.7665	Qoal/ Qal	300	30	586.499	871.555	989.964	0	989.964	1189.24	1189.24
35	0.436562	643.059	-18.7665	Qoal/ Qal	300	30	588.913	875.142	996.176	0	996.176	1196.27	1196.27
36	0.653973	972.025	-18.3992	Qoal/ Qal	300	30	975.821	1450.1	1992.04	0	1992.04	2316.63	2316.63
37	0.653973	981.582	-18.3992	Qoal/ Qal	300	30	599.748	891.244	1024.06	0	1024.06	1223.57	1223.57

38	0.645564	971.602	-12.4282	Qoal/ Qal	300	30	689.351	1024.4	1254.69	0	1254.69	1406.61	1406.61
39	0.645564	970.77	-12.4282	Qoal/ Qal	300	30	689.006	1023.88	1253.8	0	1253.8	1405.65	1405.65
40	0.600207	901.211	-10.9212	Qoal/ Qal	300	30	715.617	1063.43	1322.3	0	1322.3	1460.38	1460.38
41	0.600207	757.832	-10.9212	Qoal/ Qal	300	30	648.372	963.5	1149.21	0	1149.21	1274.32	1274.32
42	0.468096	293.687	1.34695	Qoal/ Qal	300	30	681.661	1012.97	1234.9	0	1234.9	1218.87	1218.87
43	0.468096	55.5827	1.34695	Qoal/ Qal	300	30	442.924	658.198	620.417	0	620.417	610.002	610.002
44	0.468096	19.9244	1.34695	Qoal/ Qal	300	30	407.17	605.067	528.393	0	528.393	518.819	518.819
45	0.657307	26.3872	8.09046	Qoal/ Qal	300	30	552.679	821.298	902.915	0	902.915	824.351	824.351
46	0.657307	21.9064	8.09046	Qoal/ Qal	300	30	547.635	813.802	889.931	0	889.931	812.084	812.084
47	0.635391	16.9164	8.09137	Qoal/ Qal	300	30	542.705	806.476	877.243	0	877.243	800.088	800.088
48	0.635391	12.7286	8.09137	Qoal/ Qal	300	30	537.828	799.228	864.689	0	864.689	788.227	788.227
49	0.635391	7.97603	9.3646	Qoal/ Qal	300	30	579.6	861.303	972.206	0	972.206	876.622	876.622
50	0.635391	2.65868	9.3646	Qoal/ Qal	300	30	572.634	850.951	954.275	0	954.275	859.84	859.84

Query 1 (spencer) - Safety Factor: 1.48603

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.48848	23.6405	-58.7231	Qoal/ Qal	300	30	193.651	287.772	-21.1802	0	-21.1802	297.61	297.61
2	0.488489	70.8515	-58.6472	Qoal/ Qal	300	30	201.19	298.974	-1.77664	0	-1.77664	328.437	328.437
3	0.841566	229.163	-57.3703	Qoal/ Qal	300	30	213.421	317.15	29.7046	0	29.7046	363.04	363.04
4	0.841494	343.368	-48.5273	Qoal/ Qal	300	30	245.338	364.579	111.854	0	111.854	389.425	389.425
5	0.517679	257.29	-46.3333	Qoal/ Qal	300	30	260.66	387.349	151.293	0	151.293	424.376	424.376
6	0.517679	290.663	-46.3333	Qoal/ Qal	300	30	267.694	397.801	169.396	0	169.396	449.848	449.848
7	0.442754	271.559	-37.0995	Qoal/ Qal	300	30	305.455	453.915	266.588	0	266.588	497.597	497.597
8	0.442754	288.944	-37.0995	Qoal/ Qal	300	30	310.869	461.961	280.525	0	280.525	515.63	515.63
9	0.442754	306.33	-37.0995	Qoal/ Qal	300	30	316.284	470.007	294.461	0	294.461	533.66	533.66
10	0.666785	493.005	-35.5583	Qoal/ Qal	300	30	329.509	489.66	328.502	0	328.502	564.044	564.044
11	0.666785	530.169	-35.5583	Qoal/ Qal	300	30	337.495	501.527	349.055	0	349.055	590.306	590.306
12	0.806587	688.244	-32.8617	Qoal/ Qal	300	30	359.275	533.894	405.116	0	405.116	637.201	637.201
13	0.806469	734.659	-30.4267	Qoal/ Qal	300	30	381.684	567.194	462.794	0	462.794	686.966	686.966
14	0.613923	588.262	-29.3044	Qoal/ Qal	300	30	396.185	588.743	500.119	0	500.119	722.487	722.487
15	0.613923	612.649	-29.3044	Qoal/ Qal	300	30	402.838	598.629	517.24	0	517.24	743.343	743.343
16	0.622307	645.308	-28.2024	Qoal/ Qal	300	30	416.668	619.181	552.838	0	552.838	776.275	776.275
17	0.622307	669.173	-28.2024	Qoal/ Qal	300	30	423.272	628.995	569.836	0	569.836	796.815	796.815
18	0.622306	693.014	-28.1591	Qoal/ Qal	300	30	430.176	639.254	587.607	0	587.607	817.869	817.869

19	0.622306	716.833	-28.1591	Qoal/ Qal	300	30	436.774	649.06	604.589	0	604.589	838.384	838.384
20	0.631107	749.627	-25.003	Qoal/ Qal	300	30	467.61	694.883	683.957	0	683.957	902.037	902.037
21	0.631107	770.959	-25.003	Qoal/ Qal	300	30	473.931	704.275	700.225	0	700.225	921.252	921.252
22	0.637396	799.628	-23.6279	Qoal/ Qal	300	30	492.171	731.381	747.174	0	747.174	962.484	962.484
23	0.637396	819.999	-23.6279	Qoal/ Qal	300	30	512.281	761.265	798.934	0	798.934	1023.04	1023.04
24	0.663316	872.559	-19.196	Qoal/ Qal	300	30	549.183	816.103	893.918	0	893.918	1085.12	1085.12
25	0.663316	889.788	-19.196	Qoal/ Qal	300	30	554.865	824.546	908.541	0	908.541	1101.72	1101.72
26	0.440862	600.531	-19.1848	Qoal/ Qal	300	30	559.532	831.481	920.553	0	920.553	1115.24	1115.24
27	0.440862	605.844	-19.1848	Qoal/ Qal	300	30	562.169	835.4	927.34	0	927.34	1122.94	1122.94
28	0.440862	610.893	-19.1848	Qoal/ Qal	300	30	564.674	839.123	933.788	0	933.788	1130.26	1130.26
29	0.537007	750.825	-18.8576	Qoal/ Qal	300	30	571.26	848.91	950.74	0	950.74	1145.85	1145.85
30	0.537007	758.088	-18.8576	Qoal/ Qal	300	30	574.247	853.348	958.429	0	958.429	1154.56	1154.56
31	0.546021	778.233	-18.7788	Qoal/ Qal	300	30	578.197	859.218	968.594	0	968.594	1165.19	1165.19
32	0.546021	785.687	-18.7788	Qoal/ Qal	300	30	581.218	863.707	976.371	0	976.371	1173.99	1173.99
33	0.436562	633.541	-18.7665	Qoal/ Qal	300	30	584.086	867.969	983.75	0	983.75	1182.21	1182.21
34	0.436562	638.3	-18.7665	Qoal/ Qal	300	30	586.499	871.555	989.964	0	989.964	1189.24	1189.24
35	0.436562	643.059	-18.7665	Qoal/ Qal	300	30	588.913	875.142	996.176	0	996.176	1196.27	1196.27
36	0.653973	972.025	-18.3992	Qoal/ Qal	300	30	975.821	1450.1	1992.04	0	1992.04	2316.63	2316.63
37	0.653973	981.582	-18.3992	Qoal/ Qal	300	30	599.748	891.244	1024.06	0	1024.06	1223.57	1223.57
38	0.645564	971.602	-12.4282	Qoal/ Qal	300	30	689.351	1024.4	1254.69	0	1254.69	1406.61	1406.61
39	0.645564	970.77	-12.4282	Qoal/ Qal	300	30	689.006	1023.88	1253.8	0	1253.8	1405.65	1405.65
40	0.600207	901.211	-10.9212	Qoal/ Qal	300	30	715.617	1063.43	1322.3	0	1322.3	1460.38	1460.38
41	0.600207	757.832	-10.9212	Qoal/ Qal	300	30	648.372	963.5	1149.21	0	1149.21	1274.32	1274.32
42	0.468096	293.687	1.34695	Qoal/ Qal	300	30	681.661	1012.97	1234.9	0	1234.9	1218.87	1218.87
43	0.468096	55.5827	1.34695	Qoal/ Qal	300	30	442.924	658.198	620.417	0	620.417	610.002	610.002
44	0.468096	19.9244	1.34695	Qoal/ Qal	300	30	407.17	605.067	528.393	0	528.393	518.819	518.819
45	0.657307	26.3872	8.09046	Qoal/ Qal	300	30	552.679	821.298	902.915	0	902.915	824.351	824.351
46	0.657307	21.9064	8.09046	Qoal/ Qal	300	30	547.635	813.802	889.931	0	889.931	812.084	812.084
47	0.635391	16.9164	8.09137	Qoal/ Qal	300	30	542.705	806.476	877.243	0	877.243	800.088	800.088
48	0.635391	12.7286	8.09137	Qoal/ Qal	300	30	537.828	799.228	864.689	0	864.689	788.227	788.227
49	0.635391	7.97603	9.3646	Qoal/ Qal	300	30	579.6	861.303	972.206	0	972.206	876.622	876.622
50	0.635391	2.65868	9.3646	Qoal/ Qal	300	30	572.634	850.951	954.275	0	954.275	859.84	859.84

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.21641

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	203.039	406.037	0	0	0
2	203.44	405.542	-153.177	0	0
3	204.058	404.837	-342.178	0	0
4	204.676	404.166	-488.313	0	0
5	205.294	403.496	-599.454	0	0
6	205.912	402.825	-675.594	0	0
7	206.278	402.429	-704.166	0	0
8	206.643	402.032	-720.486	0	0
9	207.006	401.689	-727.374	0	0
10	207.368	401.346	-724.936	0	0
11	208.038	400.723	-697.487	0	0
12	208.707	400.1	-639.202	0	0
13	209.105	399.73	-590.005	0	0
14	209.502	399.359	-529.938	0	0
15	209.98	398.951	-454.123	0	0
16	210.458	398.542	-433.046	0	0
17	210.936	398.167	-343.814	0	0
18	211.414	397.792	-243.3	0	0
19	211.892	397.416	-131.501	0	0
20	212.37	397.041	-8.35868	0	0
21	212.887	396.662	122.472	0	0
22	213.404	396.284	264.857	0	0
23	213.92	395.906	418.652	0	0
24	214.437	395.527	583.988	0	0
25	214.954	395.224	512.701	0	0
26	215.47	394.921	640.067	0	0
27	215.987	394.629	763.467	0	0
28	216.503	394.338	892.212	0	0
29	217.047	394.032	1032.4	0	0
30	217.591	393.726	1178.45	0	0
31	218.678	393.115	1488.13	0	0
32	219.057	392.902	1601.6	0	0
33	219.436	392.689	1249.87	0	0
34	219.815	392.48	1364.34	0	0
35	220.193	392.271	1481.5	0	0
36	220.604	392.07	1583.27	0	0
37	221.014	391.869	1687.39	0	0
38	221.427	391.686	1769.95	0	0
39	221.841	391.503	1853.73	0	0
40	222.299	391.342	1892.22	0	0
41	222.758	391.18	1931.32	0	0
42	223.217	391.032	1950.86	0	0
43	223.676	390.885	1957.15	0	0
44	224.049	390.956	1687.35	0	0
45	224.422	391.028	1493.22	0	0
46	224.795	391.272	1202.95	0	0
47	225.168	391.516	934.13	0	0
48	225.542	391.76	679.421	0	0
49	225.915	392.004	438.829	0	0
50	226.288	392.248	212.356	0	0
51	226.661	392.492	0	0	0

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.48603

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	199.654	406.156	0	0	0
2	200.143	405.352	-103.825	-121.926	49.5842
3	200.631	404.55	-180.148	-211.555	49.5842
4	201.473	403.236	-245.087	-287.816	49.5843
5	202.314	402.284	-231.735	-272.136	49.5842
6	202.832	401.741	-199.714	-234.532	49.5842
7	203.35	401.199	-150.502	-176.741	49.5843
8	203.793	400.864	-106.863	-125.493	49.5841
9	204.235	400.529	-55.2169	-64.8434	49.5842
10	204.678	400.194	4.4356	5.2089	49.5842
11	205.345	399.718	103.992	122.122	49.5842
12	206.012	399.241	220.284	258.689	49.5843
13	206.818	398.72	368.699	432.978	49.5842
14	207.625	398.247	522.527	613.624	49.5842
15	208.239	397.902	645.757	758.338	49.5842
16	208.853	397.557	778.85	914.635	49.5842
17	209.475	397.224	916.995	1076.86	49.5841
18	210.097	396.89	1064.58	1250.18	49.5842
19	210.72	396.557	1221.31	1434.23	49.5841
20	211.342	396.224	1387.45	1629.33	49.5841
21	211.973	395.929	1541.02	1809.68	49.5842
22	212.604	395.635	1702.43	1999.24	49.5843
23	213.241	395.356	1860.95	2185.38	49.5841
24	213.879	395.077	2008.37	2358.51	49.5842
25	214.542	394.846	2138.47	2511.3	49.5843
26	215.205	394.616	2273.87	2670.3	49.5842
27	215.646	394.462	2366.58	2779.17	49.5842
28	216.087	394.309	2460.91	2889.95	49.5843
29	216.528	394.155	2556.8	3002.56	49.5843
30	217.065	393.972	2672.18	3138.05	49.5842
31	217.602	393.788	2789.77	3276.14	49.5842
32	218.148	393.603	2910.7	3418.16	49.5843
33	218.694	393.417	3033.89	3562.82	49.5842
34	219.131	393.269	3133.89	3680.26	49.5843
35	219.567	393.121	3235.33	3799.38	49.5842
36	220.004	392.972	3338.21	3920.2	49.5843
37	220.658	392.755	2983.28	3503.39	49.5842
38	221.312	392.537	3137.76	3684.8	49.5842
39	221.957	392.395	3191.87	3748.34	49.5842
40	222.603	392.253	3245.81	3811.68	49.5842
41	223.203	392.137	3266.83	3836.37	49.5842
42	223.803	392.021	3260.85	3829.34	49.5842
43	224.271	392.032	3025.09	3552.48	49.5842
44	224.739	392.043	2829.27	3322.53	49.5842
45	225.208	392.054	2639.44	3099.6	49.5842
46	225.865	392.147	2200.5	2584.14	49.5843
47	226.522	392.241	1764.61	2072.26	49.5843
48	227.158	392.331	1346.12	1580.81	49.5843
49	227.793	392.422	930.484	1092.7	49.5841
50	228.428	392.526	462.971	543.685	49.5842
51	229.064	392.631	0	0	0

Query 1 (spencer) - Safety Factor: 1.48603

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	199.654	406.156	0	0	0
2	200.143	405.352	-103.825	-121.926	49.5842
3	200.631	404.55	-180.148	-211.555	49.5842
4	201.473	403.236	-245.087	-287.816	49.5843
5	202.314	402.284	-231.735	-272.136	49.5842
6	202.832	401.741	-199.714	-234.532	49.5842
7	203.35	401.199	-150.502	-176.741	49.5843
8	203.793	400.864	-106.863	-125.493	49.5841
9	204.235	400.529	-55.2169	-64.8434	49.5842
10	204.678	400.194	4.4356	5.2089	49.5842
11	205.345	399.718	103.992	122.122	49.5842
12	206.012	399.241	220.284	258.689	49.5843
13	206.818	398.72	368.699	432.978	49.5842
14	207.625	398.247	522.527	613.624	49.5842
15	208.239	397.902	645.757	758.338	49.5842
16	208.853	397.557	778.85	914.635	49.5842
17	209.475	397.224	916.995	1076.86	49.5841
18	210.097	396.89	1064.58	1250.18	49.5842
19	210.72	396.557	1221.31	1434.23	49.5841
20	211.342	396.224	1387.45	1629.33	49.5841
21	211.973	395.929	1541.02	1809.68	49.5842
22	212.604	395.635	1702.43	1999.24	49.5843
23	213.241	395.356	1860.95	2185.38	49.5841
24	213.879	395.077	2008.37	2358.51	49.5842
25	214.542	394.846	2138.47	2511.3	49.5843
26	215.205	394.616	2273.87	2670.3	49.5842
27	215.646	394.462	2366.58	2779.17	49.5842
28	216.087	394.309	2460.91	2889.95	49.5843
29	216.528	394.155	2556.8	3002.56	49.5843
30	217.065	393.972	2672.18	3138.05	49.5842
31	217.602	393.788	2789.77	3276.14	49.5842
32	218.148	393.603	2910.7	3418.16	49.5843
33	218.694	393.417	3033.89	3562.82	49.5842
34	219.131	393.269	3133.89	3680.26	49.5843
35	219.567	393.121	3235.33	3799.38	49.5842
36	220.004	392.972	3338.21	3920.2	49.5843
37	220.658	392.755	2983.28	3503.39	49.5842
38	221.312	392.537	3137.76	3684.8	49.5842
39	221.957	392.395	3191.87	3748.34	49.5842
40	222.603	392.253	3245.81	3811.68	49.5842
41	223.203	392.137	3266.83	3836.37	49.5842
42	223.803	392.021	3260.85	3829.34	49.5842
43	224.271	392.032	3025.09	3552.48	49.5842
44	224.739	392.043	2829.27	3322.53	49.5842
45	225.208	392.054	2639.44	3099.6	49.5842
46	225.865	392.147	2200.5	2584.14	49.5843
47	226.522	392.241	1764.61	2072.26	49.5843
48	227.158	392.331	1346.12	1580.81	49.5843
49	227.793	392.422	930.484	1092.7	49.5841
50	228.428	392.526	462.971	543.685	49.5842
51	229.064	392.631	0	0	0

Entity Information

External Boundary

X	Y
100	250
500	250
500	442
496.363	441.663
488.917	433.224
483.557	423.197
471.147	402.349
464.992	394.804
459.929	391.925
453.476	388.251
449.414	384.866
446.923	382.791
439.279	377.728
421.21	377.728
419.126	378.423
409.396	381.898
401.256	383.188
393.314	384.578
383.584	385.869
371.969	386.365
358.467	387.259
343.377	388.45
330.868	389.84
313.495	390.634
302.368	396.667
263.161	394.503
235.754	393.018
224.515	392.368
223.317	404.304
220.963	404.861
215.406	405.621
211.749	405.73
198.834	406.185
149.124	407.154
100	409.147
100	388.607

Material Boundary

X	Y
100	388.607
128.687	389.462
139.508	388.607
150.614	387.184
166.845	387.468
188.488	386.614
205.289	386.614
219.242	385.76
232.911	387.184
246.01	387.184
257.686	387.184
265.374	386.329
277.335	388.038
285.877	386.329
300.401	384.621
311.791	385.19
324.606	382.343
343.685	378.641
350.235	376.078
374.155	375.793
380.135	373.515
399.784	373.8
408.896	370.098
426.552	364.972
433.102	364.118
442.214	369.813
449.414	384.866

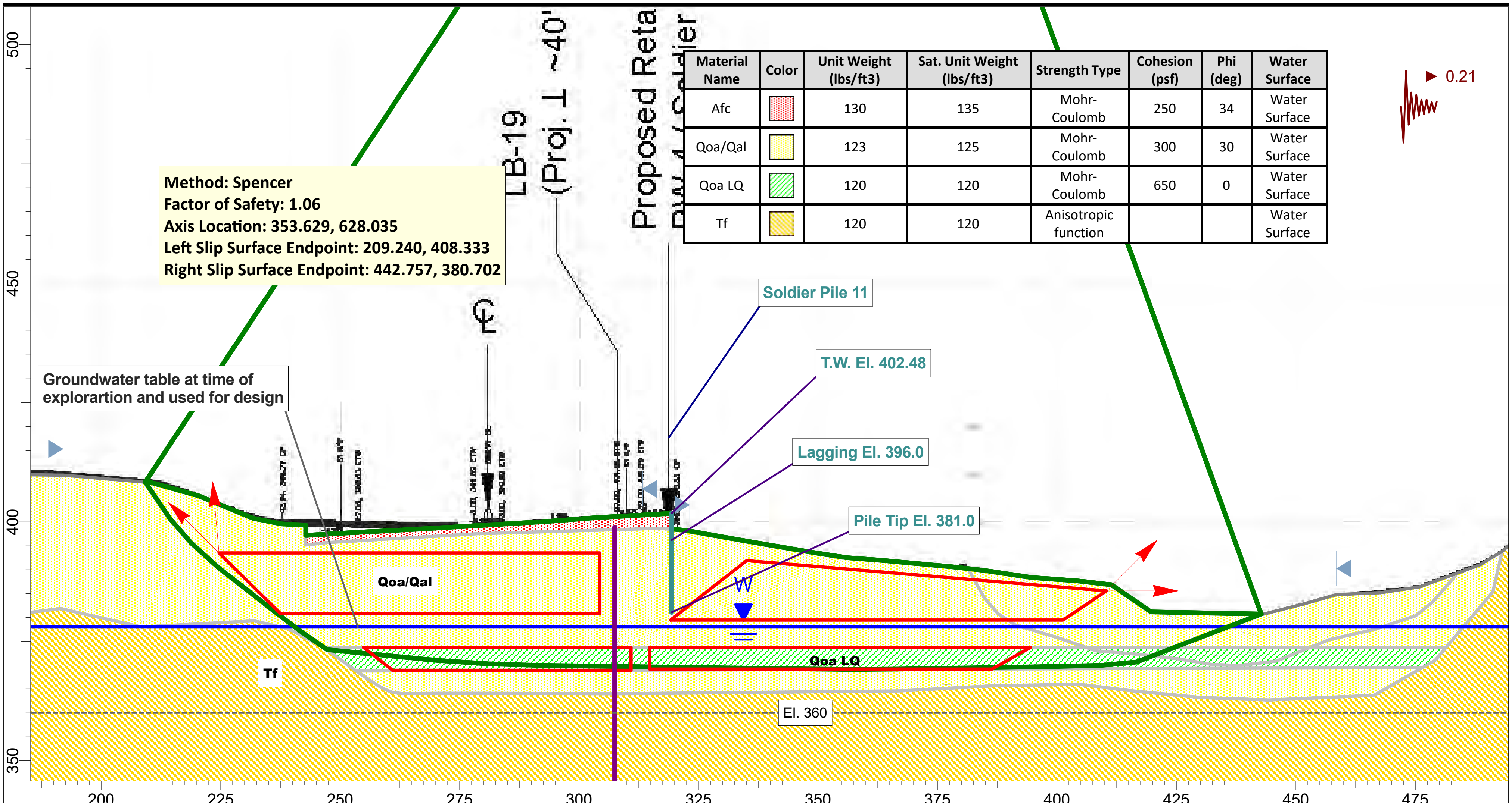
Material Boundary

X	Y
235.754	393.018
246.01	387.184

Section 26+00 Global Stability - Retaining Wall 4 - Yield Acceleration

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 26+00\Sec 26+00_Global_Blk Srf Alt_LQ_b1_rev ky.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Afc		130	135	Mohr-Coulomb	250	34	Water Surface
Qoa/Qal		123	125	Mohr-Coulomb	300	30	Water Surface
Qoa LQ		120	120	Mohr-Coulomb	650	0	Water Surface
Tf		120	120	Anisotropic function			Water Surface

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**
Date: February 18, 2021	*Condition:* **PseudoStatic**		*File Name:* Sec 26+00_Global_Blk Srf Alt_LQ_b1_rev ky.slim

Slide Analysis Information

Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:08.658s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	February 18, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	95
Left Projection Angle (End Angle) [deg]:	135
Right Projection Angle (Start Angle) [deg]:	0
Right Projection Angle (End Angle) [deg]:	45
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.21

Materials

Afc	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	130
Saturated Unit Weight [lbs/ft3]	135
Cohesion [psf]	250
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated
Qoa/Qal	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	123
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated
Qoa LQ	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Cohesion [psf]	650
Friction Angle [deg]	0
Water Surface	Water Table
Hu Value	Automatically Calculated
Tf	
Color	
Strength Type	Anisotropic function
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Water Surface	Water Table
Hu Value	Automatically Calculated

Anisotropic Functions

Name: TF_2600_20 to 25 Out

Angle From	Angle To	c	phi
-90	-25	600	34
-25	-20	200	15
-20	90	600	34

Global Minimums

Method: janbu corrected

FS	1.049350
Axis Location:	351.889, 612.831
Left Slip Surface Endpoint:	216.630, 406.515
Right Slip Surface Endpoint:	435.786, 380.835
Resisting Horizontal Force:	155195 lb
Driving Horizontal Force:	147896 lb
Total Slice Area:	4768.94 ft2
Surface Horizontal Width:	219.156 ft
Surface Average Height:	21.7605 ft

Method: spencer

FS	1.058040
Axis Location:	353.629, 628.035
Left Slip Surface Endpoint:	209.240, 408.333
Right Slip Surface Endpoint:	442.757, 380.702
Resisting Moment:	4.57181e+07 lb-ft
Driving Moment:	4.32102e+07 lb-ft
Resisting Horizontal Force:	163259 lb
Driving Horizontal Force:	154303 lb
Total Slice Area:	4925.64 ft2
Surface Horizontal Width:	233.517 ft
Surface Average Height:	21.0933 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
216.63	406.515
221.336	398.796
226.042	393.109
232.115	387.051
239.392	380.468
246.67	373.684
253.224	372.661
259.729	371.885
266.007	370.984
272.277	370.22
281.938	369.502
290.4	369.552
298.863	369.309
307.325	369.14
315.788	369.081
324.25	369.14
330.372	369.074
336.494	369.018
342.743	369.16
348.993	369.193
357.428	369.19
366.589	369.461
374.089	369.89
381.59	370.091
388.731	370.044
394.896	369.797
401.033	369.594
411.543	369.84
422.052	374.258
426.524	376.454
430.995	378.496
435.786	380.835

Method: spencer

X	Y
209.24	408.333
214.404	400.674
218.829	395.593
224.54	390.426
230.298	385.906
236.056	381.386
241.479	377.274
247.289	373.248
258.892	372.102
270.523	370.966
280.993	370.273
291.644	369.946
301.005	369.821
310.366	369.697
319.727	369.573
329.088	369.449
338.449	369.324
347.81	369.2
357.171	369.084
366.532	369.16
375.986	369.318
387.812	369.516
394.187	369.622
400.56	369.729
409.259	369.93
416.655	370.635
421.906	372.66
427.158	374.686
434.958	377.694
442.757	380.702

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4998
Number of Invalid Surfaces:	24

Error Codes

Error Code -111 reported for 4 surfaces
Error Code -112 reported for 11 surfaces
Error Code -1000 reported for 9 surfaces

Method: spencer

Number of Valid Surfaces:	4973
Number of Invalid Surfaces:	49

Error Codes

Error Code -108 reported for 1 surface
Error Code -111 reported for 26 surfaces
Error Code -112 reported for 11 surfaces
Error Code -1000 reported for 11 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.04935

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.70585	1845.19	-58.6342	Qoa/Qal	300	30	257.019	269.703	-52.4765	0	-52.4765	369.153	369.153
2	4.70595	4713.5	-50.3925	Qoa/Qal	300	30	492.02	516.301	374.645	0	374.645	969.237	969.237
3	6.07313	8805.03	-44.9284	Qoa/Qal	300	30	686.378	720.251	727.896	0	727.896	1412.56	1412.56
4	3.63859	6672.53	-42.1291	Qoa/Qal	300	30	849.231	891.141	1023.89	0	1023.89	1792.01	1792.01
5	3.63859	7846.86	-42.1291	Qoa/Qal	300	30	965.693	1013.35	1235.56	0	1235.56	2109.02	2109.02
6	2.64778	6573.96	-42.992	Qoa/Qal	300	30	1072.1	1125	1428.95	0	1428.95	2428.41	2428.41
7	4.55777	12265.2	-42.992	Qoa/Qal	300	30	1099.12	1153.36	1610.62	132.563	1478.05	2635.27	2502.71
8	0.0716133	210.025	-42.992	Qoa LQ	650	0	619.431	650	2323.86	267.215	2056.65	2901.33	2634.11
9	3.27696	9761.92	-8.87651	Qoa LQ	650	0	619.431	650	2876.95	285.266	2591.68	2973.69	2688.42
10	3.27696	10038.1	-8.87651	Qoa LQ	650	0	619.431	650	2961.23	317.201	2644.03	3057.97	2740.77
11	3.25291	10213.3	-6.80121	Qoa LQ	650	0	619.431	650	3061.85	345.273	2716.57	3135.72	2790.45
12	3.25291	10435.9	-6.80121	Qoa LQ	650	0	619.431	650	3130.29	369.481	2760.8	3204.16	2834.68
13	6.27791	20826.9	-8.16322	Qoa LQ	650	0	619.431	650	3223.8	409.683	2814.12	3312.66	2902.97
14	6.26979	21697.2	-6.94907	Qoa LQ	650	0	619.431	650	3380.99	461.622	2919.37	3456.49	2994.87
15	9.66056	34846.1	-4.25359	Qoa LQ	650	0	619.431	650	3558.47	507.882	3050.59	3604.54	3096.66
16	4.23128	15654.5	0.342576	Qoa LQ	650	0	619.431	650	3703.61	529.51	3174.1	3699.91	3170.4
17	4.23128	15774.3	0.342576	Qoa LQ	650	0	619.431	650	3731.95	527.931	3204.02	3728.25	3200.32
18	4.23127	15934.2	-1.64263	Qoa LQ	650	0	619.431	650	3747.1	530.928	3216.17	3764.86	3233.93
19	4.23127	16164.5	-1.64263	Qoa LQ	650	0	619.431	650	3801.5	538.5	3263	3819.27	3280.77
20	4.23127	16395.1	-1.14863	Qoa LQ	650	0	619.431	650	3861.66	544.932	3316.72	3874.08	3329.14
21	4.23127	16596.3	-1.14863	Qoa LQ	650	0	619.431	650	3909.2	550.226	3358.97	3921.62	3371.39
22	4.23128	16754.2	-0.397945	Qoa LQ	650	0	619.431	650	3955.07	553.79	3401.28	3959.37	3405.58
23	4.23128	16897.7	-0.397945	Qoa LQ	650	0	619.431	650	3988.98	555.624	3433.36	3993.29	3437.66
24	4.23127	16747	0.397612	Qoa LQ	650	0	619.431	650	3962.45	555.625	3406.82	3958.15	3402.52
25	4.23127	15101.6	0.397612	Qoa LQ	650	0	619.431	650	3573.56	553.792	3019.77	3569.27	3015.47
26	6.12176	21220.8	-0.618899	Qoa LQ	650	0	619.431	650	3459.39	554.939	2904.45	3466.08	2911.14
27	6.12176	20449.8	-0.521919	Qoa LQ	650	0	619.431	650	3334.56	558.743	2775.81	3340.2	2781.46
28	6.24947	20025.9	1.30471	Qoa LQ	650	0	619.431	650	3219.28	556.042	2663.24	3205.17	2649.13
29	6.24946	19140.3	0.299752	Qoa LQ	650	0	619.431	650	3066.12	550.581	2515.54	3062.88	2512.3
30	4.21772	12463.9	-0.0161732	Qoa LQ	650	0	619.431	650	2954.94	549.598	2405.34	2955.11	2405.51
31	4.21772	12136.2	-0.0161732	Qoa LQ	650	0	619.431	650	2877.26	549.672	2327.59	2877.44	2327.77
32	4.5801	12912	1.69399	Qoa LQ	650	0	619.431	650	2838.46	545.483	2292.97	2820.14	2274.65
33	4.5801	12632.6	1.69399	Qoa LQ	650	0	619.431	650	2777.46	537.031	2240.43	2759.14	2222.11
34	3.75031	10089.9	3.27225	Qoa LQ	650	0	619.431	650	2727.77	526.115	2201.66	2692.36	2166.24
35	3.75031	9834.34	3.27225	Qoa LQ	650	0	619.431	650	2659.62	512.735	2146.88	2624.2	2111.47
36	3.75031	9604.36	1.53571	Qoa LQ	650	0	619.431	650	2578.47	502.908	2075.56	2561.86	2058.95
37	3.75031	9381.27	1.53571	Qoa LQ	650	0	619.431	650	2518.98	496.634	2022.35	2502.37	2005.74
38	3.57079	8730.1	-0.379296	Qoa LQ	650	0	619.431	650	2440.54	494.235	1946.3	2444.64	1950.41
39	3.57079	8530.26	-0.379296	Qoa LQ	650	0	619.431	650	2384.58	495.71	1888.87	2388.68	1892.97
40	6.16418	14274.1	-2.2941	Qoa LQ	650	0	619.431	650	2289.5	504.152	1785.35	2314.31	1810.16
41	6.13764	13874.5	-1.89588	Qoa LQ	650	0	619.431	650	2238.94	518.195	1720.74	2259.44	1741.24
42	5.25475	11625	1.34061	Qoa LQ	650	0	619.431	650	2227.57	520.697	1706.87	2213.07	1692.37
43	5.25475	11181.1	1.34061	Qoa LQ	650	0	619.431	650	2143.09	513.024	1630.07	2128.6	1615.57
44	4.65203	8185.45	22.8003	Qoa LQ	650	0	619.431	650	2034.11	448.173	1585.93	1773.72	1325.54
45	4.65203	5326.02	22.8003	Qoa LQ	650	0	619.431	650	1419.45	326.146	1093.3	1159.06	832.911
46	1.20559	1063.06	22.8003	Qoa/Qal	300	30	838.312	879.683	1253.36	249.32	1004.04	900.958	651.638
47	4.47138	3157.58	26.1597	Qoa/Qal	300	30	816.256	856.538	1128.94	164.985	963.952	728.003	563.018
48	3.38541	1567.7	24.5435	Qoa/Qal	300	30	699.435	733.952	799.854	48.2277	751.626	480.461	432.233
49	1.08596	359.14	24.5435	Qoa/Qal	300	30	636.461	667.87	637.169	0	637.169	346.533	346.533
50	4.79095	716.105	26.0226	Qoa/Qal	300	30	513.603	538.949	413.871	0	413.871	163.119	163.119

Global Minimum Query (spencer) - Safety Factor: 1.05804

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.16457	2113.18	-56.0065	Qoa/Qal	300	30	294.593	311.692	20.2504	0	20.2504	457.11	457.11
2	4.42504	4564.11	-48.9509	Qoa/Qal	300	30	504.383	533.657	404.706	0	404.706	983.929	983.929
3	5.7109	8350.17	-42.1367	Qoa/Qal	300	30	695.123	735.468	754.253	0	754.253	1383.15	1383.15
4	5.75793	10188.4	-38.1325	Qoa/Qal	300	30	840.424	889.202	1020.53	0	1020.53	1680.27	1680.27
5	5.75793	11941.5	-38.1325	Qoa/Qal	300	30	945.461	1000.34	1213.02	0	1213.02	1955.22	1955.22
6	4.46588	10924.1	-37.167	Qoa/Qal	300	30	1088.46	1151.63	1475.06	0	1475.06	2300.26	2300.26
7	0.957464	2564.42	-37.167	Qoa/Qal	300	30	1159.65	1226.95	1628.17	22.6423	1605.53	2507.34	2484.7
8	5.08457	14028.4	-34.7182	Qoa/Qal	300	30	1168.52	1236.34	1777	155.211	1621.79	2586.67	2431.46
9	0.725302	2147.52	-34.7182	Qoa LQ	650	0	614.344	650	2135.98	280.812	1855.16	2561.66	2280.84
10	5.80113	17682.1	-5.64087	Qoa LQ	650	0	614.344	650	2903.49	314.369	2589.13	2964.17	2649.81
11	5.80113	18312.7	-5.64087	Qoa LQ	650	0	614.344	650	3003.42	350.124	2653.3	3064.1	2713.98
12	5.81584	18984.4	-5.58057	Qoa LQ	650	0	614.344	650	3103.73	385.73	2718	3163.76	2778.03
13	5.81584	19611.2	-5.58057	Qoa LQ	650	0	614.344	650	3202.84	421.19	2781.65	3262.86	2841.67
14	5.23509	18147.5	-3.78521	Qoa LQ	650	0	614.344	650	3336.13	449.726	2886.4	3376.77	2927.04
15	5.23509	18563.2	-3.78521	Qoa LQ	650	0	614.344	650	3409.76	471.338	2938.42	3450.4	2979.06
16	5.32518	19253.2	-1.76206	Qoa LQ	650	0	614.344	650	3528.58	487.256	3041.32	3547.48	3060.22
17	5.32518	19568.1	-1.76206	Qoa LQ	650	0	614.344	650	3583.93	497.478	3086.45	3602.83	3105.35
18	4.68055	17449.2	-0.760559	Qoa LQ	650	0	614.344	650	3661.59	504.528	3157.07	3669.75	3165.22
19	4.68055	17699.4	-0.760559	Qoa LQ	650	0	614.344	650	3711.84	508.405	3203.43	3720	3211.59
20	4.68055	17945.9	-0.760559	Qoa LQ	650	0	614.344	650	3761.36	512.282	3249.08	3769.52	3257.23
21	4.68055	18146.8	-0.760559	Qoa LQ	650	0	614.344	650	3801.74	516.16	3285.58	3809.89	3293.73
22	4.68055	18339.1	-0.760559	Qoa LQ	650	0	614.344	650	3840.36	520.037	3320.32	3848.52	3328.48
23	4.68055	18377.9	-0.760559	Qoa LQ	650	0	614.344	650	3848.16	523.914	3324.24	3856.31	3332.4
24	4.68055	16474.9	-0.760559	Qoa LQ	650	0	614.344	650	3465.87	527.791	2938.07	3474.02	2946.23
25	4.68055	16073	-0.760559	Qoa LQ	650	0	614.344	650	3385.11	531.668	2853.44	3393.27	2861.6
26	4.68055	15629.9	-0.760559	Qoa LQ	650	0	614.344	650	3296.09	535.546	2760.55	3304.25	2768.7
27	4.68055	15193.8	-0.760559	Qoa LQ	650	0	614.344	650	3208.5	539.423	2669.08	3216.66	2677.24
28	4.68056	14768.7	-0.760559	Qoa LQ	650	0	614.344	650	3123.09	543.3	2579.79	3131.25	2587.95
29	4.68056	14343.6	-0.760559	Qoa LQ	650	0	614.344	650	3037.71	547.177	2490.53	3045.86	2498.68
30	4.68034	13928.9	-0.711697	Qoa LQ	650	0	614.344	650	2955.69	550.93	2404.76	2963.32	2412.39
31	4.68034	13550.7	-0.711697	Qoa LQ	650	0	614.344	650	2879.72	554.558	2325.16	2887.35	2332.79
32	4.68035	13290.8	0.468276	Qoa LQ	650	0	614.344	650	2855.82	555.178	2300.64	2850.8	2295.62
33	4.68035	13056.2	0.468276	Qoa LQ	650	0	614.344	650	2808.41	552.791	2255.62	2803.39	2250.6
34	4.72719	12904.3	0.957301	Qoa LQ	650	0	614.344	650	2763.49	549.133	2214.36	2753.23	2204.1
35	4.72719	12606.8	0.957301	Qoa LQ	650	0	614.344	650	2703.83	544.204	2159.62	2693.56	2149.36
36	5.9129	15327.9	0.957301	Qoa LQ	650	0	614.344	650	2633.13	538.657	2094.47	2622.86	2084.21
37	5.9129	14750.6	0.957301	Qoa LQ	650	0	614.344	650	2540.58	532.492	2008.09	2530.32	1997.82
38	6.37543	15127.3	0.957301	Qoa LQ	650	0	614.344	650	2425.05	526.085	1898.97	2414.79	1888.7
39	6.37207	14454.6	0.958535	Qoa LQ	650	0	614.344	650	2326.17	519.435	1806.74	2315.89	1796.46
40	4.34995	9601.83	1.32631	Qoa LQ	650	0	614.344	650	2276.18	512.967	1763.21	2261.96	1748.99
41	4.34995	9317.98	1.32631	Qoa LQ	650	0	614.344	650	2214.22	506.682	1707.54	2200	1693.31
42	3.69766	7521.55	5.44051	Qoa LQ	650	0	614.344	650	2199.09	492.552	1706.54	2140.58	1648.03
43	3.69766	6373.57	5.44051	Qoa LQ	650	0	614.344	650	1898.44	470.577	1427.87	1839.93	1369.36
44	5.25166	6525.49	21.091	Qoa LQ	650	0	614.344	650	1756.12	396.394	1359.73	1519.18	1122.79
45	2.8282	2756.11	21.091	Qoa LQ	650	0	614.344	650	1473.98	299.165	1174.81	1237.03	937.868
46	2.42353	2046.63	21.091	Qoa/Qal	300	30	1063.04	1124.74	1664.46	235.969	1428.49	1254.46	1018.49
47	3.8997	2669.9	21.091	Qoa/Qal	300	30	979.491	1036.34	1435.26	159.879	1275.38	1057.48	897.602
48	3.8997	1901.05	21.091	Qoa/Qal	300	30	876.436	927.304	1152.55	66.0248	1086.52	814.516	748.492
49	0.793758	292.772	21.091	Qoa/Qal	300	30	814.42	861.689	982.42	9.54632	972.873	668.308	658.762
50	7.00566	1221.71	21.091	Qoa/Qal	300	30	637.519	674.521	648.689	0	648.689	402.806	402.806

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.04935

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	216.63	406.515	0	0	0
2	221.336	398.796	-1292.95	0	0
3	226.042	393.109	-613.976	0	0
4	232.115	387.051	1249.27	0	0
5	235.754	383.759	2761.97	0	0
6	239.392	380.468	4771.09	0	0
7	242.04	378	6685.64	0	0
8	246.598	373.751	10822.6	0	0
9	246.67	373.684	10975.1	0	0
10	249.947	373.172	12357.1	0	0
11	253.224	372.661	13840.3	0	0
12	256.476	372.273	15048.3	0	0
13	259.729	371.885	16329.6	0	0
14	266.007	370.984	19506	0	0
15	272.277	370.22	22551	0	0
16	281.938	369.502	26115.7	0	0
17	286.169	369.527	26545.8	0	0
18	290.4	369.552	27000.3	0	0
19	294.631	369.431	28037.5	0	0
20	298.863	369.309	29129.7	0	0
21	303.094	369.225	30136.6	0	0
22	307.325	369.14	31189.8	0	0
23	311.557	369.11	32060.8	0	0
24	315.788	369.081	32962.8	0	0
25	320.019	369.11	33599.7	0	0
26	324.25	369.14	33902.4	0	0
27	330.372	369.074	34589.1	0	0
28	336.494	369.018	35071.1	0	0
29	342.743	369.16	34736.5	0	0
30	348.993	369.193	34573.9	0	0
31	353.211	369.192	34440	0	0
32	357.428	369.19	34237.2	0	0
33	362.008	369.326	33572.7	0	0
34	366.589	369.461	32857.9	0	0
35	370.339	369.676	31942.3	0	0
36	374.089	369.89	30987.8	0	0
37	377.839	369.991	30295.9	0	0
38	381.59	370.091	29563.2	0	0
39	385.161	370.068	29121.9	0	0
40	388.731	370.044	28637.4	0	0
41	394.896	369.797	28174.2	0	0
42	401.033	369.594	27533.9	0	0
43	406.288	369.717	26269.1	0	0
44	411.543	369.84	24921.4	0	0
45	416.195	371.795	19624	0	0
46	420.847	373.751	14928.2	0	0
47	422.052	374.258	13450.6	0	0
48	426.524	376.454	7785.74	0	0
49	429.909	378	4381.67	0	0
50	430.995	378.496	3412.32	0	0
51	435.786	380.835	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.05804

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	209.24	408.333	0	0	0
2	214.404	400.674	-922.594	-247.601	15.0228
3	218.829	395.593	-139.487	-37.4349	15.0228
4	224.54	390.426	1541.36	413.663	15.0228
5	230.298	385.906	3454.66	927.146	15.0228
6	236.056	381.386	6001.39	1610.62	15.0227
7	240.522	378	8428.7	2262.05	15.0227
8	241.479	377.274	9038.77	2425.78	15.0228
9	246.564	373.751	12303.9	3302.06	15.0228
10	247.289	373.248	13382.7	3591.59	15.0228
11	253.09	372.675	15195.7	4078.16	15.0228
12	258.892	372.102	17198.4	4615.63	15.0228
13	264.707	371.534	19375.9	5200.02	15.0228
14	270.523	370.966	21741.4	5834.84	15.0227
15	275.758	370.62	23491.7	6304.58	15.0227
16	280.993	370.273	25354.8	6804.59	15.0228
17	286.319	370.109	26704.5	7166.83	15.0228
18	291.644	369.946	28129.4	7549.24	15.0228
19	296.324	369.883	29145.8	7822.01	15.0228
20	301.005	369.821	30217.8	8109.71	15.0228
21	305.685	369.759	31344.7	8412.14	15.0228
22	310.366	369.697	32516.3	8726.56	15.0228
23	315.047	369.635	33730.6	9052.46	15.0228
24	319.727	369.573	34953.6	9380.68	15.0228
25	324.408	369.511	35753.2	9595.27	15.0228
26	329.088	369.449	36463.4	9785.87	15.0228
27	333.769	369.386	37075	9950	15.0228
28	338.449	369.324	37589.5	10088.1	15.0228
29	343.13	369.262	38009.5	10200.8	15.0228
30	347.81	369.2	38335	10288.2	15.0228
31	352.491	369.142	38556.5	10347.6	15.0228
32	357.171	369.084	38694.3	10384.6	15.0228
33	361.851	369.122	38500.7	10332.6	15.0227
34	366.532	369.16	38259.8	10268	15.0228
35	371.259	369.239	37847.2	10157.3	15.0228
36	375.986	369.318	37377	10031.1	15.0228
37	381.899	369.417	36703.1	9850.2	15.0228
38	387.812	369.516	35917.1	9639.27	15.0228
39	394.187	369.622	34918.8	9371.35	15.0228
40	400.56	369.729	33791.6	9068.84	15.0228
41	404.909	369.83	32906.4	8831.26	15.0228
42	409.259	369.93	31967.8	8579.37	15.0228
43	412.957	370.283	30501.2	8185.78	15.0228
44	416.655	370.635	28899.5	7755.9	15.0228
45	421.906	372.66	23486.5	6303.18	15.0227
46	424.735	373.751	20719.9	5560.72	15.0228
47	427.158	374.686	17017.6	4567.1	15.0228
48	431.058	376.19	11599.8	3113.1	15.0228
49	434.958	377.694	6847.68	1837.75	15.0228
50	435.751	378	5961.94	1600.04	15.0228
51	442.757	380.702	0	0	0

Entity Information

Water Table

X	Y
100	378
568.805	378

Block Search Window

X	Y
260.99	368.904
310.888	368.904
310.888	373.751
254.85	373.751

Block Search Window

X	Y
314.787	369.176
386.42	369.176
394.537	373.751
314.787	373.751

Block Search Window

X	Y
237.501	380.806
304.362	380.806
304.362	393.493
224.656	393.493

Block Search Window

X	Y
319.147	379.444
401.307	379.444
410.374	385.538
335.075	391.879

External Boundary

X	Y
100	250
568.805	249.511
568.805	443.526
545.705	436.637
538.167	434.205
534.115	432.26
529.738	429.261
524.388	424.317
514.419	414.266
500.802	400.73
493.183	393.841
488.563	391.004
482.565	388.815
475.918	386.384
467.732	385.168
458.492	384.763
451.683	382.817
443.281	380.692
419.685	381.142
411.4	386.816
404.465	387.627
394.649	388.347
385.012	389.788
381.382	390.207
377.988	390.599
363.308	391.949
356.103	392.49
349.079	393.571
334.309	396.092
323.142	398.073
321.604	398.256
319.359	398.524
319.359	401.766
303.509	400.865
293.152	400.055
267.035	398.524
253.886	397.803
242.813	397.173
242.813	399.321
237.696	399.562
231.79	400.743
220.374	405.467
210.532	408.223
192.03	409.798
153.45	410.191
100	412
100	396.815

Material Boundary

X	Y
100	396.815
114.969	392.67
132.507	381.51
148.45	381.51
168.858	378.959
191.498	381.828
208.399	378.002
231.995	379.277
239.177	377.625
246.563	373.751
253.36	368.755
255.676	367.191
257.968	365.684
259.475	364.836
261.077	364.239
263.023	364.03
264.751	364.043
270.813	364.089
277.657	364.089
288.571	364.073
307.31	363.989
347.786	364.403
367.147	364.601
387.036	365.689
404.743	365.964
415.666	364.609
429.999	363.218
444.365	362.696
466.367	363.653
476.467	369.461
479.122	370.987
481.456	373.751
491.239	385.336
493.183	393.841

Material Boundary

X	Y
253.36	368.755
476.467	369.461

Material Boundary

X	Y
246.563	373.751
307.46	373.751
406.011	373.751
453.078	373.751
481.456	373.751

Material Boundary

X	Y
242.813	397.173
242.813	395.178
247.345	395.664
278.677	397.505
316.769	398.635
321.604	398.256

Material Boundary

X	Y
381.382	390.207
384.805	384.114
387.647	380.798
391.199	378.43
399.962	375.825
406.011	373.751
408.251	372.983
417.013	372.272
425.302	371.325
432.407	370.141
438.091	369.904
445.906	370.852
453.078	373.751
457.037	375.351
466.51	377.483
475.036	380.325
478.588	383.167
483.325	388.614

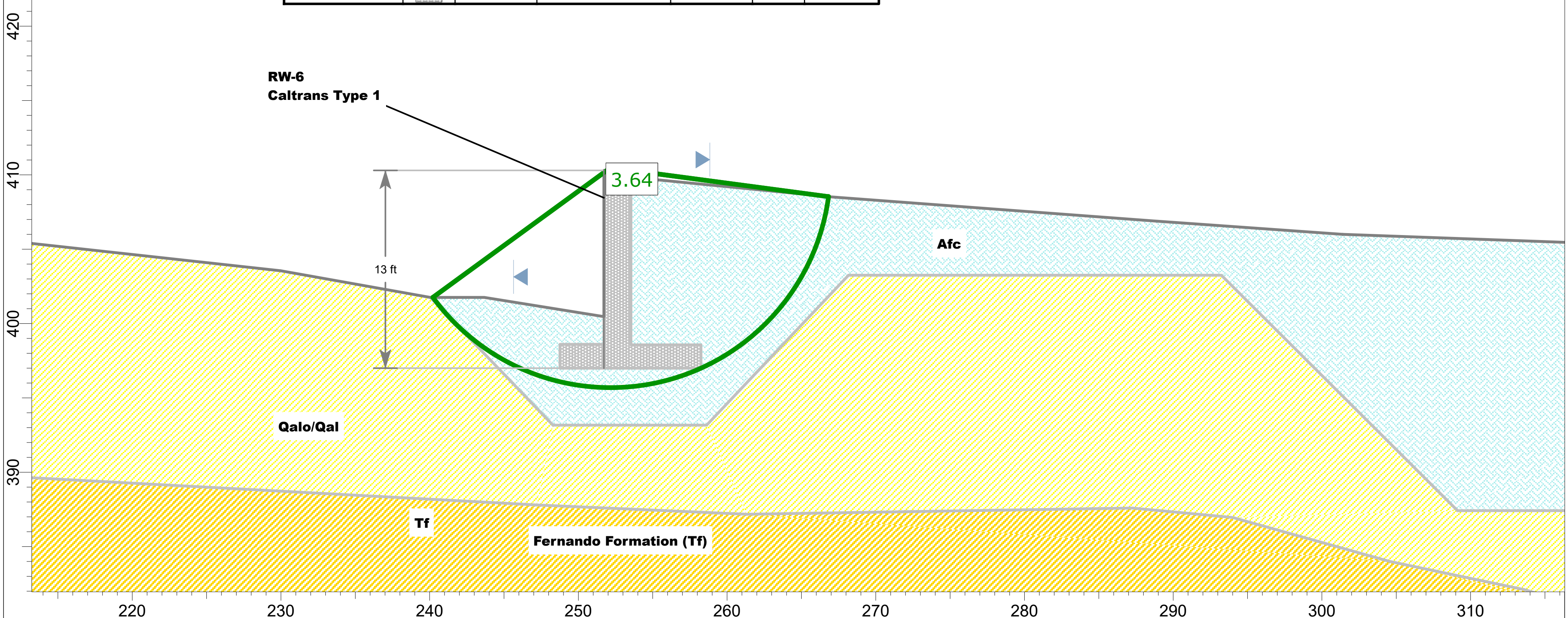
Section 29+50 - RW-6

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 29+50_RW-6_Type 1\Sce 29+50_RW-6_Global_path SrfAlt_a1.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Tf		125	Mohr-Coulomb	300	31	None
Qalo/Qal		123	Mohr-Coulomb	200	28	None
Afc		125	Mohr-Coulomb	100	32	None
Concrete		150	Mohr-Coulomb	5000	40	None

Method: Spencer
Factor of Safety: 3.64
Center: 252.160, 410.486
Radius: 14.792
Left Slip Surface Endpoint: 240.215, 401.762
Right Slip Surface Endpoint: 266.823, 408.537



SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project:	Proposed Widening of Brea Boulevard - Orange County Public Works - County of Orange, CA
Analyzed By:	JEH
Units:	feet
Scale:	1:120
Project No.:	11588.001
File Name:	Sce 29+50_RW-6_Global_path SrfAlt_a1.slim
Date:	May 31, 2019
Condition:	Static

Slide Analysis Information

Proposed Widening of Brea Boulevard - Orange County Public Works - County of Orange, CA

Project Summary

Slide Modeler Version: 8.022

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type: Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Tf	Qalo/Qal	Afc	Concrete
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123	125	150
Cohesion [psf]	300	200	100	5000
Friction Angle [°]	31	28	32	40
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: janbu corrected

FS	3.367270
Center:	252.152, 410.487
Radius:	14.800
Left Slip Surface Endpoint:	240.198, 401.762
Right Slip Surface Endpoint:	266.823, 408.537
Resisting Horizontal Force:	19850.9 lb
Driving Horizontal Force:	5895.25 lb
Total Slice Area:	203.288 ft2
Surface Horizontal Width:	26.6253 ft
Surface Average Height:	7.63512 ft

Method: spencer

FS	3.638920
Center:	252.160, 410.486
Radius:	14.792
Left Slip Surface Endpoint:	240.215, 401.762
Right Slip Surface Endpoint:	266.823, 408.537
Resisting Moment:	318874 lb-ft
Driving Moment:	87628.7 lb-ft
Resisting Horizontal Force:	18432.7 lb
Driving Horizontal Force:	5065.44 lb
Total Slice Area:	203.109 ft2
Surface Horizontal Width:	26.6084 ft
Surface Average Height:	7.63327 ft

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 5199
Number of Invalid Surfaces: 0

Method: spencer

Number of Valid Surfaces: 5063
Number of Invalid Surfaces: 136

Error Codes:

Error Code -108 reported for 1 surface
Error Code -111 reported for 125 surfaces
Error Code -112 reported for 10 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 3.36727

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.783815	48.1688	-51.4398	Afc	100	32	55.0497	185.367	136.616	0	136.616	67.5581	67.5581
2	1.00832	190.159	-46.1848	Afc	100	32	81.9441	275.928	281.544	0	281.544	196.139	196.139
3	0.8869	268.38	-41.0863	Afc	100	32	104.203	350.881	401.494	0	401.494	310.635	310.635
4	0.8869	347.77	-36.6672	Afc	100	32	120.597	406.084	489.837	0	489.837	400.053	400.053
5	0.8869	406.282	-32.4907	Afc	100	32	131.638	443.262	549.334	0	549.334	465.502	465.502
6	0.8869	448.46	-28.5011	Afc	100	32	138.748	467.201	587.645	0	587.645	512.307	512.307
7	0.8869	481.898	-24.6579	Afc	100	32	143.867	484.439	615.231	0	615.231	549.188	549.188
8	0.8869	507.444	-20.9302	Afc	100	32	147.248	495.824	633.45	0	633.45	577.132	577.132
9	0.8869	525.729	-17.2936	Afc	100	32	149.073	501.97	643.286	0	643.286	596.873	596.873
10	0.8869	550.09	-13.7278	Afc	100	32	152.311	512.873	660.735	0	660.735	623.527	623.527
11	0.8869	577.719	-10.2156	Afc	100	32	156.265	526.186	682.041	0	682.041	653.88	653.88
12	0.8869	576.566	-6.74197	Afc	100	32	154.013	518.604	669.907	0	669.907	651.7	651.7
13	0.8869	623.64	-3.29317	Afc	100	32	162.069	545.731	713.319	0	713.319	703.993	703.993
14	0.8869	1914.54	0.143679	Afc	100	32	430.069	1448.16	2157.52	0	2157.52	2158.6	2158.6
15	0.8869	1911.34	3.58104	Afc	100	32	424.258	1428.59	2126.18	0	2126.18	2152.73	2152.73
16	0.8869	1591.4	7.03142	Afc	100	32	353.859	1191.54	1746.84	0	1746.84	1790.48	1790.48
17	0.8869	1561.78	10.5077	Afc	100	32	343.608	1157.02	1691.58	0	1691.58	1755.31	1755.31
18	0.8869	1530.7	14.0238	Afc	100	32	333.169	1121.87	1635.33	0	1635.33	1718.54	1718.54
19	0.8869	1493.15	17.5948	Afc	100	32	321.525	1082.66	1572.59	0	1572.59	1674.55	1674.55
20	0.8869	1448.77	21.2383	Afc	100	32	308.608	1039.16	1502.98	0	1502.98	1622.91	1622.91
21	0.8869	1373.53	24.9746	Afc	100	32	289.824	975.916	1401.76	0	1401.76	1536.75	1536.75
22	0.8869	1302.67	28.8288	Afc	100	32	272.023	915.976	1305.84	0	1305.84	1455.56	1455.56
23	0.8869	1234.21	32.8323	Afc	100	32	254.74	857.777	1212.7	0	1212.7	1377.07	1377.07
24	0.8869	1155.72	37.0267	Afc	100	32	235.62	793.396	1109.67	0	1109.67	1287.39	1287.39
25	0.8869	1065.51	41.4693	Afc	100	32	214.375	721.857	995.175	0	995.175	1184.63	1184.63
26	0.8869	961.029	46.2441	Afc	100	32	190.579	641.73	866.953	0	866.953	1065.99	1065.99
27	0.8869	838.229	51.4851	Afc	100	32	163.574	550.797	721.424	0	721.424	926.954	926.954
28	0.8869	689.8	57.434	Afc	100	32	132.217	445.212	552.455	0	552.455	759.468	759.468
29	0.8869	499.441	64.6359	Afc	100	32	94.1056	316.879	347.079	0	347.079	545.586	545.586
30	0.8869	195.448	75.5372	Afc	100	32	39.5904	133.311	53.3093	0	53.3093	206.805	206.805

Global Minimum Query (spencer) - Safety Factor: 3.63892

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.00811	77.7952	-50.7694	Afc	100	32	62.0517	225.801	201.323	0	201.323	125.323	125.323
2	0.534707	101.15	-46.1848	Afc	100	32	87.8821	319.796	351.747	0	351.747	260.153	260.153
3	0.915515	252.729	-42.2912	Afc	100	32	105.181	382.745	452.487	0	452.487	356.809	356.809
4	0.915515	340.801	-37.6535	Afc	100	32	122.338	445.178	552.4	0	552.4	458.005	458.005
5	0.915515	408.726	-33.2917	Afc	100	32	133.72	486.595	618.682	0	618.682	530.873	530.873
6	0.915515	455.546	-29.1395	Afc	100	32	139.867	508.966	654.483	0	654.483	576.507	576.507
7	0.915515	492.484	-25.1499	Afc	100	32	143.858	523.486	677.719	0	677.719	610.179	610.179
8	0.915515	520.628	-21.2875	Afc	100	32	146.049	531.46	690.481	0	690.481	633.576	633.576
9	0.915515	540.719	-17.5245	Afc	100	32	146.677	533.745	694.137	0	694.137	647.821	647.821
10	0.915515	566.035	-13.8383	Afc	100	32	148.587	540.698	705.265	0	705.265	668.663	668.663
11	0.915515	595.378	-10.21	Afc	100	32	151.387	550.887	721.569	0	721.569	694.303	694.303
12	0.915515	594.033	-6.62278	Afc	100	32	148.011	538.602	701.911	0	701.911	684.726	684.726
13	0.915515	765.851	-3.06157	Afc	100	32	178.834	650.763	881.405	0	881.405	871.84	871.84
14	0.915515	1975.43	0.487784	Afc	100	32	407.841	1484.1	2215.02	0	2215.02	2218.49	2218.49
15	0.915515	1927	4.03902	Afc	100	32	390.649	1421.54	2114.91	0	2114.91	2142.49	2142.49
16	0.915515	1633.12	7.60594	Afc	100	32	328.784	1196.42	1754.64	0	1754.64	1798.55	1798.55
17	0.915515	1605.43	11.2029	Afc	100	32	317.344	1154.79	1688.01	0	1688.01	1750.86	1750.86
18	0.915515	1570.86	14.8454	Afc	100	32	304.915	1109.56	1615.64	0	1615.64	1696.46	1696.46
19	0.915515	1529.07	18.5506	Afc	100	32	291.447	1060.55	1537.2	0	1537.2	1635.01	1635.01
20	0.915515	1479.65	22.3385	Afc	100	32	276.87	1007.51	1452.31	0	1452.31	1566.08	1566.08
21	0.858629	1302.04	26.108	Afc	100	32	255.718	930.538	1329.13	0	1329.13	1454.45	1454.45
22	0.858629	1243.77	29.8784	Afc	100	32	239.9	872.976	1237.02	0	1237.02	1374.85	1374.85
23	0.858629	1177.38	33.7981	Afc	100	32	222.848	810.927	1137.73	0	1137.73	1286.9	1286.9
24	0.858629	1101.58	37.9077	Afc	100	32	204.387	743.748	1030.22	0	1030.22	1189.37	1189.37
25	0.858629	1014.75	42.2634	Afc	100	32	184.306	670.675	913.27	0	913.27	1080.76	1080.76
26	0.858629	914.478	46.9477	Afc	100	32	162.307	590.624	785.163	0	785.163	958.898	958.898
27	0.858629	796.907	52.0919	Afc	100	32	137.942	501.96	643.271	0	643.271	820.414	820.414
28	0.858629	655.11	57.9334	Afc	100	32	110.462	401.961	483.239	0	483.239	659.558	659.558
29	0.858629	473.643	65.0059	Afc	100	32	78.3716	285.188	296.364	0	296.364	464.478	464.478
30	0.858629	185.132	75.6866	Afc	100	32	36.0514	131.188	49.9118	0	49.9118	191.209	191.209

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 3.36727

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	240.198	401.762	0	0	0
2	240.981	400.779	181.293	0	0
3	241.99	399.728	567.099	0	0
4	242.877	398.955	978.168	0	0
5	243.764	398.294	1418.01	0	0
6	244.65	397.729	1855.35	0	0
7	245.537	397.248	2272.28	0	0
8	246.424	396.841	2661.64	0	0
9	247.311	396.501	3018.65	0	0
10	248.198	396.225	3340.17	0	0
11	249.085	396.009	3630.35	0	0
12	249.972	395.849	3890.2	0	0
13	250.859	395.744	4109.11	0	0
14	251.746	395.693	4301.95	0	0
15	252.633	395.695	4712.3	0	0
16	253.519	395.751	5003.81	0	0
17	254.406	395.86	5154.3	0	0
18	255.293	396.025	5207.72	0	0
19	256.18	396.246	5167.06	0	0
20	257.067	396.527	5035.13	0	0
21	257.954	396.872	4814.97	0	0
22	258.841	397.285	4515.68	0	0
23	259.728	397.773	4140.81	0	0
24	260.615	398.346	3692.71	0	0
25	261.502	399.015	3177.81	0	0
26	262.388	399.798	2604.71	0	0
27	263.275	400.725	1985.64	0	0
28	264.162	401.839	1339.58	0	0
29	265.049	403.228	700.061	0	0
30	265.936	405.099	141.574	0	0
31	266.823	408.537	0	0	0

Global Minimum Query (spencer) - Safety Factor: 3.63892

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	240.215	401.762	0	0	0
2	241.223	400.527	311.184	48.6272	8.8815
3	241.757	399.97	554.241	86.6086	8.88151
4	242.673	399.137	1027.45	160.554	8.88147
5	243.588	398.431	1529.76	239.049	8.88154
6	244.504	397.83	2024.24	316.318	8.8815
7	245.419	397.319	2486.44	388.544	8.88151
8	246.335	396.889	2909.56	454.664	8.88153
9	247.25	396.533	3289.69	514.064	8.88151
10	248.166	396.244	3624.76	566.424	8.88151
11	249.082	396.018	3919.96	612.554	8.88152
12	249.997	395.853	4177.66	652.823	8.88151
13	250.913	395.747	4387.89	685.675	8.88152
14	251.828	395.698	4594.92	718.026	8.88151
15	252.744	395.706	4951.36	773.725	8.88151
16	253.659	395.77	5172.59	808.295	8.8815
17	254.575	395.893	5259.34	821.852	8.88151
18	255.49	396.074	5244.04	819.461	8.88151
19	256.406	396.317	5131.38	801.855	8.8815
20	257.321	396.624	4926.16	769.787	8.88151
21	258.237	397	4633.49	724.053	8.88151
22	259.095	397.421	4293.96	670.997	8.88152
23	259.954	397.914	3889.89	607.855	8.88152
24	260.813	398.489	3427.48	535.596	8.88151
25	261.671	399.157	2914.31	455.406	8.88152
26	262.53	399.938	2360.08	368.799	8.88152
27	263.388	400.857	1777.93	277.829	8.88152
28	264.247	401.959	1187.18	185.515	8.88151
29	265.106	403.33	619.805	96.854	8.88151
30	265.964	405.172	141.302	22.0806	8.88152
31	266.823	408.537	0	0	0

Entity Information

External Boundary

X	Y
100	415
100	390.335
100	300
665.572	300
665.572	521.584
643.556	520.882
635.358	519.711
624.35	516.9
608.189	515.729
585.704	513.621
577.272	511.513
570.012	507.297
561.111	501.676
549.869	492.541
530.195	479.425
504.431	463.498
487.099	452.022
459.227	430.005
438.85	416.421
429.95	409.863
425.734	404.71
417.302	390.891
414.764	388.541
410.978	385.035
403.717	382.459
398.564	381.054
388.961	380.82
383.106	381.991
371.161	384.333
360.153	385.27
343.523	387.378
324.317	395.107
324.317	405.178
301.397	405.998
288.694	406.905
267.017	408.518
253.533	409.846
253.533	410.303
251.71	410.303
251.71	400.469
243.676	401.762
240.038	401.762
229.983	403.548
196.564	407.216
150.289	414.267
138.83	416.471
124.286	415.149

Material Boundary

X	Y
240.038	401.762
248.287	393.165
258.621	393.165
268.167	403.249

Material Boundary

X	Y
251.71	400.469
251.71	398.599
248.763	398.599
248.763	397
258.24	397
258.24	398.568
253.533	398.568
253.533	409.846

Material Boundary

X	Y
100	390.335
200.192	390.335
247.199	387.805
261.323	387.173
287.251	387.594
293.996	386.962
304.536	384.011
313.6	382.114
320.135	380.216
332.993	380.006
339.317	379.373
343.744	378.741
353.019	378.108
362.505	372.839
382.319	371.363
387.589	369.466
394.756	371.363
397.286	371.995
407.193	376.422
412.674	381.903
414.764	388.541

Material Boundary

X	Y
268.167	403.249
293.241	403.249
309.125	387.42
324.249	387.42
324.317	395.107

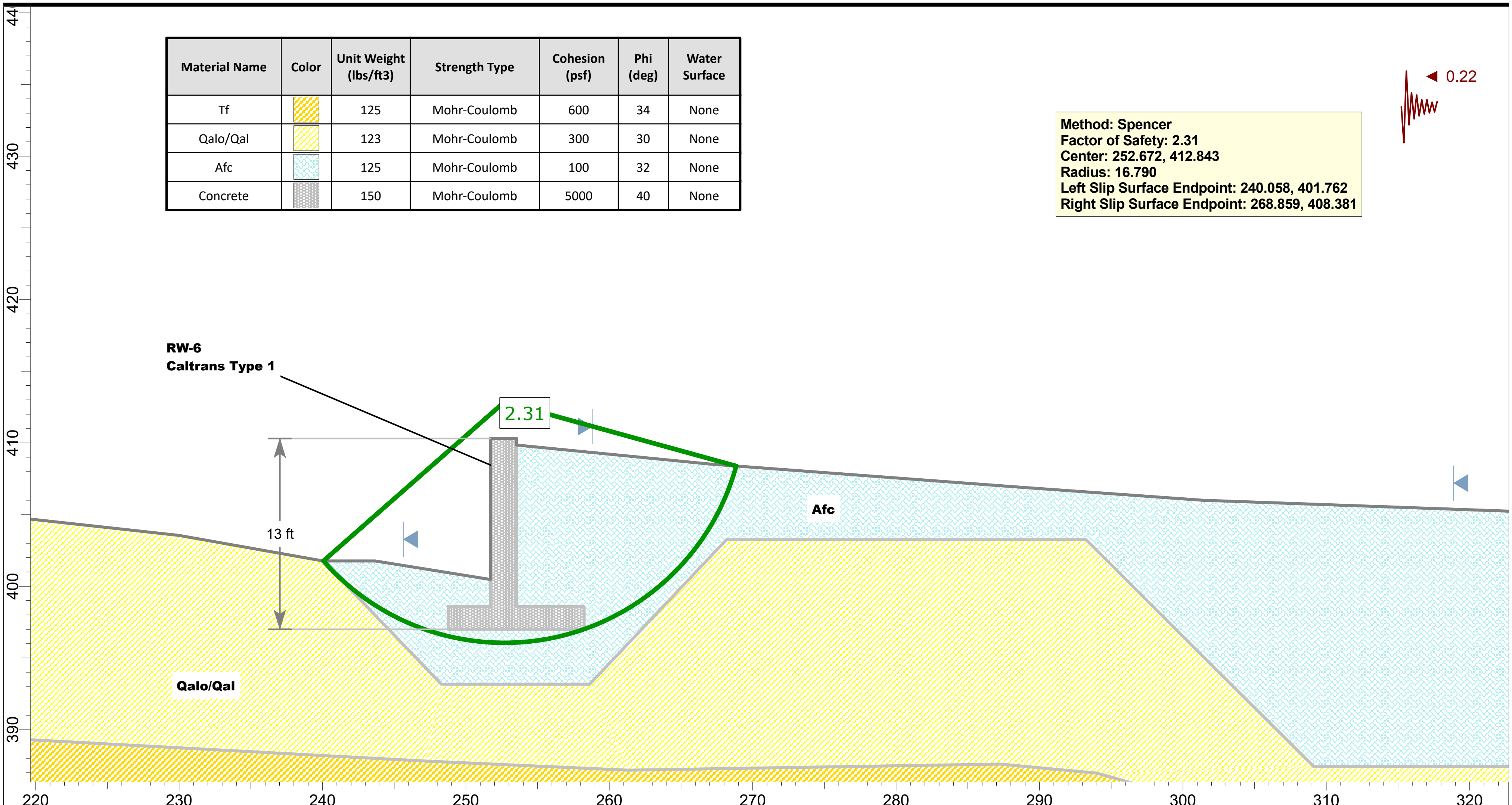
Section 29+50 - RW-6

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 29+50_RW-6_Type 1\Sce 29+50_RW-6_Global_path SrfAlt_a1_k022.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Tf		125	Mohr-Coulomb	600	34	None
Qalo/Qal		123	Mohr-Coulomb	300	30	None
Afc		125	Mohr-Coulomb	100	32	None
Concrete		150	Mohr-Coulomb	5000	40	None

Method: Spencer
Factor of Safety: 2.31
Center: 252.672, 412.843
Radius: 16.790
Left Slip Surface Endpoint: 240.058, 401.762
Right Slip Surface Endpoint: 268.859, 408.381



SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard - Orange County Public Works - County of Orange, CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:120	*Project No.:* **11588.001**
Date: May 31, 2019	*Condition:* **PseudoStatic**		*File Name:* Sce 29+50_RW-6_Global_path SrfAlt_a1_k022.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard - Orange County Public Works - County of Orange, CA

Project Summary

Slide Modeler Version:	8.022
Compute Time:	00h:00m:01.81s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Circular
Search Method:	Auto Refine Search
Divisions along slope:	20
Circles per division:	10
Number of iterations:	10
Divisions to use in next iteration:	50%
Composite Surfaces:	Disabled
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.22

Materials

Property	Tf	Qalo/Qal	Afc	Concrete
Color				
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123	125	150
Cohesion [psf]	600	300	100	5000
Friction Angle [°]	34	30	32	40
Water Surface	None	None	None	None
Ru Value	0	0	0	0

Global Minimums

Method: janbu corrected

FS	1.928690
Center:	252.714, 412.836
Radius:	16.773
Left Slip Surface Endpoint:	240.117, 401.762
Right Slip Surface Endpoint:	268.884, 408.379
Resisting Horizontal Force:	20434.4 lb
Driving Horizontal Force:	10595 lb
Total Slice Area:	212.415 ft2
Surface Horizontal Width:	28.7672 ft
Surface Average Height:	7.38392 ft

Method: spencer

FS	2.309070
Center:	252.672, 412.843
Radius:	16.790
Left Slip Surface Endpoint:	240.058, 401.762
Right Slip Surface Endpoint:	268.859, 408.381
Resisting Moment:	370816 lb-ft
Driving Moment:	160591 lb-ft
Resisting Horizontal Force:	19466.8 lb
Driving Horizontal Force:	8430.58 lb
Total Slice Area:	212.556 ft2
Surface Horizontal Width:	28.8013 ft
Surface Average Height:	7.38009 ft

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 5650
Number of Invalid Surfaces: 1

Error Codes:

Error Code -112 reported for 1 surface

Method: spencer

Number of Valid Surfaces: 5406
Number of Invalid Surfaces: 245

Error Codes:

Error Code -111 reported for 245 surfaces

Error Codes

The following errors were encountered during the computation:

-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.92869

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.958908	60.1615	-46.3112	Afc	100	32	114.298	220.445	192.752	0	192.752	73.099	73.099
2	0.958908	171.605	-41.7438	Afc	100	32	160.133	308.846	334.223	0	334.223	191.33	191.33
3	0.958908	266.958	-37.4838	Afc	100	32	194.575	375.275	440.533	0	440.533	291.318	291.318
4	0.958908	348.234	-33.4559	Afc	100	32	220.89	426.028	521.754	0	521.754	375.794	375.794
5	0.958908	405.05	-29.6083	Afc	100	32	235.894	454.967	568.066	0	568.066	434.014	434.014
6	0.958908	447.119	-25.9031	Afc	100	32	244.763	472.071	595.437	0	595.437	476.571	476.571
7	0.958908	480.113	-22.3114	Afc	100	32	250.211	482.579	612.255	0	612.255	509.578	509.578
8	0.958908	504.774	-18.8103	Afc	100	32	252.698	487.377	619.934	0	619.934	533.858	533.858
9	0.958908	521.66	-15.3809	Afc	100	32	252.56	487.11	619.506	0	619.506	550.03	550.03
10	0.958908	568.895	-12.0073	Afc	100	32	263.814	508.816	654.242	0	654.242	598.132	598.132
11	0.958908	572.02	-8.67556	Afc	100	32	259.031	499.591	639.479	0	639.479	599.955	599.955
12	0.958908	567.696	-5.37327	Afc	100	32	252.001	486.031	617.778	0	617.778	594.076	594.076
13	0.958908	1892.69	-2.08887	Afc	100	32	700.325	1350.71	2001.55	0	2001.55	1976.01	1976.01
14	0.958908	2021.44	1.18866	Afc	100	32	729.506	1406.99	2091.62	0	2091.62	2106.75	2106.75
15	0.958908	1676.96	4.4701	Afc	100	32	601.88	1160.84	1697.69	0	1697.69	1744.75	1744.75
16	0.958908	1653.31	7.76635	Afc	100	32	582.489	1123.44	1637.84	0	1637.84	1717.29	1717.29
17	0.958908	1622.89	11.0888	Afc	100	32	561.438	1082.84	1572.87	0	1572.87	1682.9	1682.9
18	0.958908	1585.5	14.4496	Afc	100	32	538.676	1038.94	1502.62	0	1502.62	1641.42	1641.42
19	0.958908	1537.07	17.8622	Afc	100	32	512.983	989.385	1423.32	0	1423.32	1588.63	1588.63
20	0.958908	1450.96	21.3419	Afc	100	32	476.538	919.095	1310.82	0	1310.82	1497.02	1497.02
21	0.958908	1390.51	24.9066	Afc	100	32	448.369	864.765	1223.88	0	1223.88	1432.07	1432.07
22	0.958908	1321.2	28.578	Afc	100	32	418.071	806.33	1130.36	0	1130.36	1358.09	1358.09
23	0.958908	1242.12	32.3832	Afc	100	32	385.465	743.442	1029.72	0	1029.72	1274.18	1274.18
24	0.958908	1152.05	36.3571	Afc	100	32	350.314	675.647	921.23	0	921.23	1179.1	1179.1
25	0.958908	1049.27	40.5472	Afc	100	32	312.307	602.343	803.916	0	803.916	1071.1	1071.1
26	0.958908	931.27	45.0208	Afc	100	32	271.019	522.712	676.48	0	676.48	947.696	947.696
27	0.958908	794.239	49.881	Afc	100	32	225.846	435.586	537.049	0	537.049	805.069	805.069
28	0.958908	631.716	55.3019	Afc	100	32	175.868	339.195	382.792	0	382.792	636.796	636.796
29	0.958908	432.22	61.6291	Afc	100	32	119.793	231.044	209.715	0	209.715	431.537	431.537
30	0.958908	160.762	69.8344	Afc	100	32	54.2052	104.545	7.27357	0	7.27357	154.872	154.872

Global Minimum Query (spencer) - Safety Factor: 2.30907

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.319959	7.07851	-47.8892	Afc	100	32	150.079	346.543	394.551	0	394.551	228.519	228.519
2	0.361207	24.4809	-46.1848	Afc	100	32	177.567	410.015	496.129	0	496.129	311.062	311.062
3	1.02905	155.454	-42.8972	Afc	100	32	211.094	487.431	620.019	0	620.019	423.878	423.878
4	1.02905	269.15	-38.2631	Afc	100	32	239.573	553.191	725.257	0	725.257	536.304	536.304
5	1.02905	365.615	-33.9102	Afc	100	32	255.635	590.278	784.609	0	784.609	612.764	612.764
6	1.02905	434.436	-29.771	Afc	100	32	259.341	598.837	798.307	0	798.307	649.955	649.955
7	1.02905	482.983	-25.7973	Afc	100	32	256.86	593.107	789.137	0	789.137	664.981	664.981
8	1.02905	520.348	-21.9534	Afc	100	32	252.498	583.036	773.018	0	773.018	671.241	671.241
9	1.02905	547.497	-18.2113	Afc	100	32	246.479	569.137	750.775	0	750.775	669.683	669.683
10	1.02905	573.47	-14.5484	Afc	100	32	241.701	558.104	733.12	0	733.12	670.394	670.394
11	1.02905	614.953	-10.9456	Afc	100	32	242.871	560.806	737.443	0	737.443	690.473	690.473
12	1.02905	615.029	-7.38621	Afc	100	32	232.092	535.916	697.611	0	697.611	667.524	667.524
13	1.02905	1138.24	-3.85543	Afc	100	32	369.975	854.298	1207.13	0	1207.13	1182.2	1182.2
14	1.02905	2174.24	-0.339307	Afc	100	32	634.169	1464.34	2183.4	0	2183.4	2179.65	2179.65
15	1.02905	1964.34	3.17553	Afc	100	32	554.544	1280.48	1889.16	0	1889.16	1919.93	1919.93
16	1.02905	1784.92	6.70242	Afc	100	32	488.664	1128.36	1645.71	0	1645.71	1703.14	1703.14
17	1.02905	1752.13	10.2551	Afc	100	32	462.455	1067.84	1548.87	0	1548.87	1632.54	1632.54
18	1.02905	1710.81	13.8483	Afc	100	32	435.752	1006.18	1450.2	0	1450.2	1557.62	1557.62
19	1.02905	1660.59	17.4983	Afc	100	32	408.42	943.07	1349.2	0	1349.2	1477.96	1477.96
20	0.966023	1467.33	21.1066	Afc	100	32	372.801	860.823	1217.58	0	1217.58	1361.48	1361.48
21	0.966023	1406.23	24.688	Afc	100	32	345.948	798.817	1118.35	0	1118.35	1277.38	1277.38
22	0.966023	1336.42	28.376	Afc	100	32	318.297	734.969	1016.16	0	1016.16	1188.09	1188.09
23	0.966023	1256.7	32.1978	Afc	100	32	289.68	668.891	910.42	0	910.42	1092.83	1092.83
24	0.966023	1165.82	36.1886	Afc	100	32	259.981	600.314	800.67	0	800.67	990.867	990.867
25	0.966023	1062.03	40.396	Afc	100	32	229.064	528.924	686.422	0	686.422	881.343	881.343
26	0.966023	942.813	44.8878	Afc	100	32	196.764	454.341	567.064	0	567.064	763.058	763.058
27	0.966023	804.288	49.7675	Afc	100	32	162.874	376.087	441.832	0	441.832	634.346	634.346
28	0.966023	639.91	55.2102	Afc	100	32	127.127	293.544	309.735	0	309.735	492.716	492.716
29	0.966023	437.919	61.5637	Afc	100	32	89.3005	206.201	169.957	0	169.957	334.865	334.865
30	0.966023	162.93	69.8078	Afc	100	32	49.1096	113.397	21.4402	0	21.4402	154.972	154.972

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.92869

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	240.117	401.762	0	0	0
2	241.076	400.758	299.345	0	0
3	242.035	399.902	714.424	0	0
4	242.994	399.167	1182.38	0	0
5	243.953	398.534	1666.52	0	0
6	244.912	397.989	2132.74	0	0
7	245.87	397.523	2566.68	0	0
8	246.829	397.129	2962.68	0	0
9	247.788	396.803	3317.42	0	0
10	248.747	396.539	3629.22	0	0
11	249.706	396.335	3912.37	0	0
12	250.665	396.189	4149.98	0	0
13	251.624	396.099	4343.37	0	0
14	252.583	396.064	4726.68	0	0
15	253.542	396.083	5000.44	0	0
16	254.501	396.158	5131.35	0	0
17	255.46	396.289	5160.34	0	0
18	256.418	396.477	5092.68	0	0
19	257.377	396.724	4933.86	0	0
20	258.336	397.033	4690.36	0	0
21	259.295	397.408	4376.54	0	0
22	260.254	397.853	3992.88	0	0
23	261.213	398.375	3547.38	0	0
24	262.172	398.984	3049.52	0	0
25	263.131	399.69	2510.81	0	0
26	264.09	400.51	1945.88	0	0
27	265.049	401.469	1374.23	0	0
28	266.008	402.607	823.666	0	0
29	266.966	403.992	337.787	0	0
30	267.925	405.768	-4.85762	0	0
31	268.884	408.379	0	0	0

Global Minimum Query (spencer) - Safety Factor: 2.30907

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	240.058	401.762	0	0	0
2	240.378	401.408	186.214	67.9025	20.0343
3	240.739	401.032	431.865	157.478	20.0342
4	241.768	400.075	1208.15	440.549	20.0343
5	242.797	399.264	1984.58	723.672	20.0343
6	243.826	398.572	2710.48	988.368	20.0342
7	244.855	397.983	3352.22	1222.38	20.0343
8	245.884	397.486	3903.32	1423.33	20.0342
9	246.913	397.071	4369.82	1593.44	20.0342
10	247.942	396.733	4757.68	1734.87	20.0342
11	248.971	396.466	5076.51	1851.13	20.0342
12	250	396.267	5338.39	1946.63	20.0343
13	251.029	396.133	5535.44	2018.48	20.0342
14	252.058	396.064	5750.2	2096.79	20.0342
15	253.087	396.058	5939.02	2165.65	20.0343
16	254.117	396.115	5970.77	2177.22	20.0342
17	255.146	396.236	5882.9	2145.18	20.0342
18	256.175	396.422	5685.87	2073.34	20.0343
19	257.204	396.676	5390.89	1965.77	20.0342
20	258.233	397	5008.94	1826.5	20.0343
21	259.199	397.373	4592.95	1674.8	20.0342
22	260.165	397.817	4121.79	1503	20.0343
23	261.131	398.339	3605.61	1314.78	20.0343
24	262.097	398.947	3055.72	1114.26	20.0342
25	263.063	399.654	2485.02	906.154	20.0342
26	264.029	400.476	1908.82	696.044	20.0342
27	264.995	401.438	1346.19	490.883	20.0342
28	265.961	402.58	822.395	299.884	20.0342
29	266.927	403.97	373.986	136.373	20.0342
30	267.893	405.754	60.887	22.2023	20.0343
31	268.859	408.381	0	0	0

Entity Information

External Boundary

X	Y
100	415
100	390.335
100	300
665.572	300
665.572	521.584
643.556	520.882
635.358	519.711
624.35	516.9
608.189	515.729
585.704	513.621
577.272	511.513
570.012	507.297
561.111	501.676
549.869	492.541
530.195	479.425
504.431	463.498
487.099	452.022
459.227	430.005
438.85	416.421
429.95	409.863
425.734	404.71
417.302	390.891
414.764	388.541
410.978	385.035
403.717	382.459
398.564	381.054
388.961	380.82
383.106	381.991
371.161	384.333
360.153	385.27
343.523	387.378
324.317	395.107
324.317	405.178
301.397	405.998
288.694	406.905
267.017	408.518
253.533	409.846
253.533	410.303
251.71	410.303
251.71	400.469
243.676	401.762
240.038	401.762
229.983	403.548
196.564	407.216
150.289	414.267
138.83	416.471
124.286	415.149

Material Boundary

X	Y
240.038	401.762
248.287	393.165
258.621	393.165
268.167	403.249

Material Boundary

X	Y
251.71	400.469
251.71	398.599
248.763	398.599
248.763	397
258.24	397
258.24	398.568
253.533	398.568
253.533	409.846

Material Boundary

X	Y
100	390.335
200.192	390.335
247.199	387.805
261.323	387.173
287.251	387.594
293.996	386.962
304.536	384.011
313.6	382.114
320.135	380.216
332.993	380.006
339.317	379.373
343.744	378.741
353.019	378.108
362.505	372.839
382.319	371.363
387.589	369.466
394.756	371.363
397.286	371.995
407.193	376.422
412.674	381.903
414.764	388.541

Material Boundary

X	Y
268.167	403.249
293.241	403.249
309.125	387.42
324.249	387.42
324.317	395.107

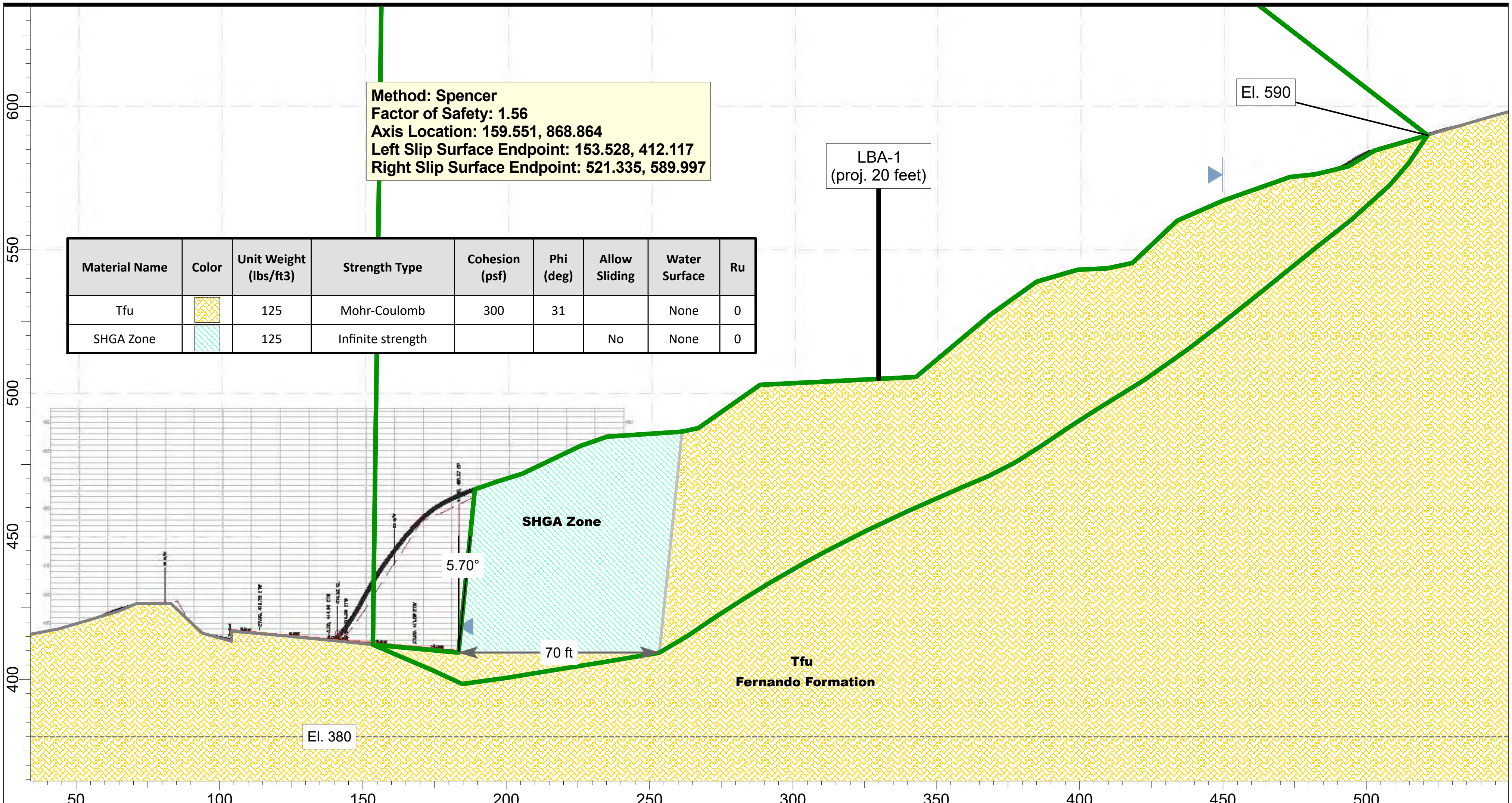
Section 33+00

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 33+00_SHGA\Sec 33+00_Global_a1.slim

Method: Spencer
Factor of Safety: 1.56
Axis Location: 159.551, 868.864
Left Slip Surface Endpoint: 153.528, 412.117
Right Slip Surface Endpoint: 521.335, 589.997

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Ru
Tfu		125	Mohr-Coulomb	300	31		None	0
SHGA Zone		125	Infinite strength			No	None	0



SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:600	*Project No.:* **11588.001**
Date: May 31, 2019	*Condition:* **Static**		*File Name:* Sec 33+00_Global_a1.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, CA

Project Summary

Slide Modeler Version:	8.022
Compute Time:	00h:00m:09.169s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	80
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Tfu	SHGA Zone
Color		
Strength Type	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	125	125
Allow Sliding Along Boundary		No
Cohesion [psf]	300	
Friction Angle [°]	31	
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: janbu corrected

FS	1.463760
Axis Location:	150.470, 824.670
Left Slip Surface Endpoint:	148.665, 412.608
Right Slip Surface Endpoint:	479.037, 575.989
Resisting Horizontal Force:	1.09063e+06 lb
Driving Horizontal Force:	745089 lb
Total Slice Area:	15312 ft2
Surface Horizontal Width:	330.372 ft
Surface Average Height:	46.3478 ft

Method: spencer

FS	1.563540
Axis Location:	159.551, 868.864
Left Slip Surface Endpoint:	153.528, 412.117
Right Slip Surface Endpoint:	521.335, 589.997
Resisting Moment:	6.33787e+08 lb-ft
Driving Moment:	4.05354e+08 lb-ft
Resisting Horizontal Force:	1.24976e+06 lb
Driving Horizontal Force:	799316 lb
Total Slice Area:	17901 ft2
Surface Horizontal Width:	367.807 ft
Surface Average Height:	48.6695 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
148.665	412.608
159.825	404.055
172.634	394.028
185.442	385
200.3	389.317
215.158	394.5
232.561	400.803
242.083	404.454
251.775	408.224
260.864	414.405
271.974	423.015
282.433	431.107
290.768	437.429
297.633	442.397
304.499	447.125
317.351	455.527
330.203	463.48
342.203	470.487
352.534	476.158
362.865	481.468
374.278	487.757
390.511	498.848
406.744	509.395
422.033	518.796
433.121	526.462
444.101	537.858
450.4	544.175
456.699	550.273
467.857	563.025
479.037	575.989

Method: spencer

X	Y
153.528	412.117
164.296	407.484
174.496	403.111
184.696	398.389
200.587	400.587
216.478	403.209
234.71	406.134
253.399	409.328
263.099	415.06
272.798	421.649
282.497	427.899
291.699	433.546
303.59	440.426
311.224	444.577
325.514	451.848
339.805	458.621
358.992	467.043
368.34	471.012
377.689	475.822
386.968	481.746
396.594	488.243
406.22	494.405
422.749	504.648
437.765	515.22
450.172	524.773
461.412	533.724
471.354	541.72
481.297	549.817
494.642	560.353
507.987	572.363
514.661	580.105
521.335	589.997

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4929
Number of Invalid Surfaces: 93

Error Codes:

Error Code -99 reported for 25 surfaces
Error Code -108 reported for 1 surface
Error Code -111 reported for 4 surfaces
Error Code -121 reported for 43 surfaces
Error Code -124 reported for 10 surfaces
Error Code -1000 reported for 10 surfaces

Method: spencer

Number of Valid Surfaces: 4420
Number of Invalid Surfaces: 602

Error Codes:

Error Code -99 reported for 25 surfaces
Error Code -108 reported for 28 surfaces
Error Code -111 reported for 486 surfaces
Error Code -121 reported for 43 surfaces
Error Code -124 reported for 10 surfaces
Error Code -1000 reported for 10 surfaces

Error Codes

The following errors were encountered during the computation:

-99 = Slip surface intersects an infinite strength material. If infinite strength regions are defined for a model, a large number of potential slip surfaces may show this error code. This is Normal.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.46376

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.72016	575.415	-37.4656	Tfu	300	31	401.73	588.037	479.375	0	479.375	171.499	171.499
2	3.72016	1726.25	-37.4656	Tfu	300	31	591.766	866.203	942.319	0	942.319	488.805	488.805
3	3.72016	2884.26	-37.4656	Tfu	300	31	782.988	1146.11	1408.16	0	1408.16	808.095	808.095
4	4.26939	4766.33	-38.057	Tfu	300	31	1003.25	1468.52	1944.74	0	1944.74	1159.31	1159.31
5	4.26939	6340.21	-38.057	Tfu	300	31	1232.16	1803.59	2502.4	0	2502.4	1537.75	1537.75
6	4.26939	7914.09	-38.057	Tfu	300	31	1461.07	2138.66	3060.04	0	3060.04	1916.18	1916.18
7	4.26933	9398.95	-35.1788	Tfu	300	31	1595.53	2335.47	3387.59	0	3387.59	2262.95	2262.95
8	4.26933	10795	-35.1788	Tfu	300	31	1788.71	2618.24	3858.2	0	3858.2	2597.4	2597.4
9	4.26933	14823.3	-35.1788	Tfu	300	31	2346.12	3434.16	5216.13	0	5216.13	3562.42	3562.42
10	4.95272	41620.4	16.2014	Tfu	300	31	3246.2	4751.66	7408.8	0	7408.8	8351.99	8351.99
11	4.95272	49841.7	16.2014	Tfu	300	31	3851.47	5637.63	8883.3	0	8883.3	10002.4	10002.4
12	4.95272	49990.7	16.2014	Tfu	300	31	3862.43	5653.67	8910.02	0	8910.02	10032.3	10032.3
13	4.95272	49973.7	19.2314	Tfu	300	31	3776.52	5527.92	8700.71	0	8700.71	10018.2	10018.2
14	4.95272	50079.7	19.2314	Tfu	300	31	3784.16	5539.1	8719.32	0	8719.32	10039.4	10039.4
15	4.95272	50472.3	19.2314	Tfu	300	31	3812.43	5580.48	8788.2	0	8788.2	10118.2	10118.2
16	4.35081	44647.6	19.9091	Tfu	300	31	3818.63	5589.56	8803.32	0	8803.32	10186.3	10186.3
17	4.35081	44920	19.9091	Tfu	300	31	3840.85	5622.08	8857.43	0	8857.43	10248.5	10248.5
18	4.35081	45151.9	19.9091	Tfu	300	31	3859.77	5649.78	8903.52	0	8903.52	10301.4	10301.4
19	4.35081	45158.1	19.9091	Tfu	300	31	3860.27	5650.51	8904.73	0	8904.73	10302.8	10302.8
20	4.76114	49274.5	20.9765	Tfu	300	31	3819.32	5590.57	8804.98	0	8804.98	10269.3	10269.3
21	4.76114	48499.5	20.9765	Tfu	300	31	3762.01	5506.68	8665.38	0	8665.38	10107.7	10107.7
22	4.84581	48430.2	21.2549	Tfu	300	31	3686.68	5396.41	8481.86	0	8481.86	9915.89	9915.89
23	4.84581	47482.1	21.2549	Tfu	300	31	3617.94	5295.8	8314.4	0	8314.4	9721.7	9721.7
24	4.54458	43293.3	34.2168	Tfu	300	31	3179.42	4653.91	7246.12	0	7246.12	9408.22	9408.22
25	4.54458	41708.1	34.2168	Tfu	300	31	3068.8	4491.98	6976.64	0	6976.64	9063.51	9063.51
26	3.70338	32833.9	37.7754	Tfu	300	31	2878.55	4213.51	6513.18	0	6513.18	8744.04	8744.04
27	3.70338	31922	37.7754	Tfu	300	31	2802.86	4102.72	6328.8	0	6328.8	8501	8501
28	3.70338	31609.2	37.7754	Tfu	300	31	2776.9	4064.72	6265.56	0	6265.56	8417.64	8417.64
29	3.48631	29644.2	37.7292	Tfu	300	31	2768.17	4051.93	6244.25	0	6244.25	8385.98	8385.98
30	3.48631	29536.3	37.7292	Tfu	300	31	2758.65	4038	6221.08	0	6221.08	8355.45	8355.45
31	3.48631	29428.4	37.7292	Tfu	300	31	2749.13	4024.07	6197.9	0	6197.9	8324.91	8324.91
32	4.1672	35050.8	37.1803	Tfu	300	31	2753.48	4030.44	6208.49	0	6208.49	8297	8297
33	4.1672	34729	37.1803	Tfu	300	31	2729.62	3995.51	6150.35	0	6150.35	8220.76	8220.76
34	3.43283	27607.4	35.8887	Tfu	300	31	2669.86	3908.03	6004.76	0	6004.76	7936.61	7936.61
35	3.43283	26615.8	35.8887	Tfu	300	31	2579.56	3775.86	5784.81	0	5784.81	7651.32	7651.32
36	3.43286	25650	34.5535	Tfu	300	31	2520.62	3689.59	5641.21	0	5641.21	7377.06	7377.06
37	3.43286	24709.8	34.5535	Tfu	300	31	2434.01	3562.81	5430.23	0	5430.23	7106.43	7106.43
38	4.28404	29557.8	33.1741	Tfu	300	31	2367.19	3465	5267.44	0	5267.44	6814.96	6814.96
39	4.28404	28173.6	33.1741	Tfu	300	31	2263.82	3313.69	5015.62	0	5015.62	6495.56	6495.56
40	4.28404	26789.4	33.1741	Tfu	300	31	2160.44	3162.37	4763.78	0	4763.78	6176.14	6176.14
41	4.2841	25445.7	31.7499	Tfu	300	31	2084.62	3051.39	4579.08	0	4579.08	5869.08	5869.08
42	4.2841	24141.6	31.7499	Tfu	300	31	1986.07	2907.13	4338.98	0	4338.98	5567.99	5567.99
43	4.2841	22837.5	31.7499	Tfu	300	31	1887.52	2762.87	4098.89	0	4098.89	5266.91	5266.91
44	3.99994	20180.4	30.2805	Tfu	300	31	1816.72	2659.24	3926.42	0	3926.42	4987.19	4987.19

45	3.99994	19113.3	30.2805	Tfu	300	31	1729.31	2531.29	3713.5	0	3713.5	4723.24	4723.24
46	3.99994	18046.3	30.2805	Tfu	300	31	1641.9	2403.35	3500.57	0	3500.57	4459.26	4459.26
47	5.16529	22731.9	28.7657	Tfu	300	31	1625.23	2378.94	3459.94	0	3459.94	4352.15	4352.15
48	5.16529	23670.2	28.7657	Tfu	300	31	1685.47	2467.12	3606.7	0	3606.7	4531.98	4531.98
49	5.16532	24696.7	27.2056	Tfu	300	31	1773.04	2595.3	3820.01	0	3820.01	4731.45	4731.45
50	5.16532	25781.4	27.2056	Tfu	300	31	1843.55	2698.51	3991.78	0	3991.78	4939.46	4939.46
51	3.80451	19649.5	28.8536	Tfu	300	31	1877.27	2747.88	4073.96	0	4073.96	5108.29	5108.29
52	3.80451	20151.5	28.8536	Tfu	300	31	1921	2811.88	4180.48	0	4180.48	5238.9	5238.9
53	3.80451	20485.3	28.8536	Tfu	300	31	1950.09	2854.46	4251.34	0	4251.34	5325.79	5325.79
54	4.05827	22041.2	34.3418	Tfu	300	31	1878.72	2749.99	4077.46	0	4077.46	5361.04	5361.04
55	4.05827	22105.1	34.3418	Tfu	300	31	1883.7	2757.29	4089.63	0	4089.63	5376.61	5376.61
56	4.05827	22118.8	34.3418	Tfu	300	31	1884.78	2758.86	4092.23	0	4092.23	5379.95	5379.95
57	4.05827	21500.5	34.3418	Tfu	300	31	1836.5	2688.2	3974.63	0	3974.63	5229.37	5229.37
58	5.41107	27470.6	33.014	Tfu	300	31	1786.41	2614.87	3852.59	0	3852.59	5013.32	5013.32
59	5.41107	26098.8	33.014	Tfu	300	31	1705.18	2495.98	3654.73	0	3654.73	4762.68	4762.68
60	5.41107	24073.9	33.014	Tfu	300	31	1585.3	2320.5	3362.66	0	3362.66	4392.72	4392.72
61	3.82208	15713.3	31.5883	Tfu	300	31	1494.66	2187.83	3141.87	0	3141.87	4060.98	4060.98
62	3.82208	14891.2	31.5883	Tfu	300	31	1424.93	2085.76	2972	0	2972	3848.22	3848.22
63	3.82208	14152.7	31.5883	Tfu	300	31	1362.29	1994.07	2819.4	0	2819.4	3657.1	3657.1
64	3.82208	14023.6	31.5883	Tfu	300	31	1351.33	1978.03	2792.72	0	2792.72	3623.69	3623.69
65	3.69608	14061.5	34.6561	Tfu	300	31	1359.71	1990.29	2813.11	0	2813.11	3753.08	3753.08
66	3.69608	14488.3	34.6561	Tfu	300	31	1396.19	2043.69	2901.98	0	2901.98	3867.17	3867.17
67	3.69608	14915.1	34.6561	Tfu	300	31	1432.67	2097.09	2990.87	0	2990.87	3981.27	3981.27
68	3.66009	14676.7	46.0649	Tfu	300	31	1277.14	1869.43	2611.97	0	2611.97	3937.49	3937.49
69	3.66009	13707.8	46.0649	Tfu	300	31	1202.16	1759.68	2429.32	0	2429.32	3677.02	3677.02
70	3.66009	12708.5	46.0649	Tfu	300	31	1124.84	1646.5	2240.95	0	2240.95	3408.4	3408.4
71	3.14939	10157.1	45.0846	Tfu	300	31	1065.98	1560.34	2097.55	0	2097.55	3166.69	3166.69
72	3.14939	9458.78	45.0846	Tfu	300	31	1002.51	1467.44	1942.95	0	1942.95	2948.43	2948.43
73	3.14941	8711.35	44.0696	Tfu	300	31	944.54	1382.58	1801.71	0	1801.71	2716.06	2716.06
74	3.14941	7948.71	44.0696	Tfu	300	31	874.492	1280.05	1631.07	0	1631.07	2477.61	2477.61
75	3.71932	8253.82	48.8136	Tfu	300	31	746.544	1092.76	1319.38	0	1319.38	2172.56	2172.56
76	3.71932	6887.94	48.8136	Tfu	300	31	645.692	945.138	1073.69	0	1073.69	1811.61	1811.61
77	3.71932	5522.05	48.8136	Tfu	300	31	544.841	797.516	828.005	0	828.005	1450.67	1450.67
78	3.72665	4148.47	49.2265	Tfu	300	31	440.679	645.048	574.257	0	574.257	1085.27	1085.27
79	3.72665	2693.05	49.2265	Tfu	300	31	333.945	488.816	314.242	0	314.242	701.484	701.484
80	3.72665	915.164	49.2265	Tfu	300	31	203.565	297.97	-3.37896	0	-3.37896	232.674	232.674

Global Minimum Query (spencer) - Safety Factor: 1.56354

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.38376	600.121	-23.2779	Tfu	300	31	427.874	668.998	614.116	0	614.116	430.04	430.04
2	5.38376	1820.86	-23.2779	Tfu	300	31	617.405	965.338	1107.31	0	1107.31	841.694	841.694
3	5.10016	2852.35	-23.2056	Tfu	300	31	800.27	1251.25	1583.15	0	1583.15	1240.06	1240.06
4	5.10016	3946.76	-23.2056	Tfu	300	31	979.143	1530.93	2048.62	0	2048.62	1628.85	1628.85
5	5.1	5096.63	-24.8412	Tfu	300	31	1238.13	1935.87	2722.55	0	2722.55	2149.37	2149.37
6	5.1	7362.83	-24.8412	Tfu	300	31	1633.3	2553.73	3750.85	0	3750.85	2994.73	2994.73
7	3.97274	21634.3	7.87385	Tfu	300	31	2443.69	3820.8	5859.59	0	5859.59	6197.54	6197.54
8	3.97274	33504.9	7.87385	Tfu	300	31	3665.38	5730.97	9038.65	0	9038.65	9545.56	9545.56
9	3.97274	34023.1	7.87385	Tfu	300	31	3718.72	5814.36	9177.43	0	9177.43	9691.72	9691.72
10	3.97274	34406.8	7.87385	Tfu	300	31	3758.2	5876.1	9280.19	0	9280.19	9799.93	9799.93
11	3.97276	34724.1	9.36942	Tfu	300	31	3704.45	5792.06	9140.32	0	9140.32	9751.56	9751.56
12	3.97276	35103	9.36942	Tfu	300	31	3742.53	5851.6	9239.41	0	9239.41	9856.93	9856.93
13	3.97276	35707.8	9.36942	Tfu	300	31	3803.33	5946.66	9397.62	0	9397.62	10025.2	10025.2
14	3.97276	36324	9.36942	Tfu	300	31	3865.25	6043.48	9558.75	0	9558.75	10196.5	10196.5
15	4.55792	42439.1	9.11433	Tfu	300	31	3947.67	6172.34	9773.21	0	9773.21	10406.5	10406.5
16	4.55792	43261.9	9.11433	Tfu	300	31	4020.04	6285.5	9961.55	0	9961.55	10606.5	10606.5
17	4.55792	43944.6	9.11433	Tfu	300	31	4080.09	6379.39	10117.8	0	10117.8	10772.4	10772.4
18	4.55792	44437.9	9.11433	Tfu	300	31	4123.48	6447.22	10230.7	0	10230.7	10892.2	10892.2
19	4.67236	45741	9.6994	Tfu	300	31	4102.59	6414.56	10176.3	0	10176.3	10877.6	10877.6
20	4.67236	45459.1	9.6994	Tfu	300	31	4078.62	6377.08	10114	0	10114	10811.1	10811.1
21	4.67236	45172.7	9.6994	Tfu	300	31	4054.27	6339.02	10050.6	0	10050.6	10743.6	10743.6
22	4.67236	44886.3	9.6994	Tfu	300	31	4029.93	6300.95	9987.27	0	9987.27	10676.1	10676.1
23	4.84999	45672.5	30.5789	Tfu	300	31	2921.65	4568.12	7103.35	0	7103.35	8829.76	8829.76

24	4.84999	44158.7	30.5789	Tfu	300	31	2830.93	4426.28	6867.28	0	6867.28	8540.08	8540.08
25	4.8495	42862.5	34.1915	Tfu	300	31	2611.8	4083.66	6297.07	0	6297.07	8071.49	8071.49
26	4.8495	42455.1	34.1915	Tfu	300	31	2588.69	4047.52	6236.93	0	6236.93	7995.64	7995.64
27	4.84904	42570.9	32.8003	Tfu	300	31	2649.22	4142.16	6394.44	0	6394.44	8101.76	8101.76
28	4.84904	42742.1	32.8003	Tfu	300	31	2659.14	4157.67	6420.25	0	6420.25	8133.96	8133.96
29	4.60146	40758.9	31.5322	Tfu	300	31	2721.22	4254.74	6581.8	0	6581.8	8251.48	8251.48
30	4.60146	40590.1	31.5322	Tfu	300	31	2710.71	4238.31	6554.45	0	6554.45	8217.67	8217.67
31	3.96337	33874.7	30.056	Tfu	300	31	2688.99	4204.35	6497.93	0	6497.93	8053.93	8053.93
32	3.96337	32837.4	30.056	Tfu	300	31	2612.32	4084.47	6298.42	0	6298.42	7810.05	7810.05
33	3.96337	31800.2	30.056	Tfu	300	31	2535.66	3964.6	6098.9	0	6098.9	7566.17	7566.17
34	3.81702	29677.2	28.5344	Tfu	300	31	2517.08	3935.56	6050.58	0	6050.58	7419.2	7419.2
35	3.81702	28778.7	28.5344	Tfu	300	31	2446.54	3825.26	5867.02	0	5867.02	7197.29	7197.29
36	4.76352	34704	26.9675	Tfu	300	31	2423.71	3789.56	5807.61	0	5807.61	7040.82	7040.82
37	4.76352	33403.7	26.9675	Tfu	300	31	2339.98	3658.65	5589.73	0	5589.73	6780.34	6780.34
38	4.76352	32103.4	26.9675	Tfu	300	31	2256.25	3527.73	5371.85	0	5371.85	6519.85	6519.85
39	4.76365	30853.5	25.3559	Tfu	300	31	2225.64	3479.87	5292.2	0	5292.2	6346.91	6346.91
40	4.76365	29652.1	25.3559	Tfu	300	31	2146.42	3356.01	5086.05	0	5086.05	6103.22	6103.22
41	4.76365	28450.8	25.3559	Tfu	300	31	2067.2	3232.15	4879.91	0	4879.91	5859.53	5859.53
42	4.79672	27613.9	23.7001	Tfu	300	31	2046.27	3199.42	4825.44	0	4825.44	5723.7	5723.7
43	4.79672	28267.2	23.7001	Tfu	300	31	2090.12	3267.98	4939.54	0	4939.54	5857.04	5857.04
44	4.79672	29418.6	23.7001	Tfu	300	31	2167.38	3388.78	5140.59	0	5140.59	6092.01	6092.01
45	4.79672	30569.9	23.7001	Tfu	300	31	2244.64	3509.58	5341.64	0	5341.64	6326.97	6326.97
46	4.67416	30916	23.0053	Tfu	300	31	2345.07	3666.61	5602.97	0	5602.97	6598.65	6598.65
47	4.67416	32048.6	23.0053	Tfu	300	31	2423.87	3789.81	5808.01	0	5808.01	6837.15	6837.15
48	4.67415	32925.1	27.2268	Tfu	300	31	2341.08	3660.37	5592.6	0	5592.6	6797.14	6797.14
49	4.67415	33472.9	27.2268	Tfu	300	31	2376.89	3716.37	5685.78	0	5685.78	6908.75	6908.75
50	4.63985	33600.2	32.5513	Tfu	300	31	2225.13	3479.08	5290.88	0	5290.88	6711.25	6711.25
51	4.63985	33709.7	32.5513	Tfu	300	31	2231.79	3489.49	5308.21	0	5308.21	6732.83	6732.83
52	4.81291	34131.9	34.0197	Tfu	300	31	2136.63	3340.7	5060.58	0	5060.58	6502.82	6502.82
53	4.81291	33018	34.0197	Tfu	300	31	2072.79	3240.89	4894.46	0	4894.46	6293.61	6293.61
54	4.81292	31894	32.6228	Tfu	300	31	2049.55	3204.55	4833.98	0	4833.98	6145.87	6145.87
55	4.81292	30294.1	32.6228	Tfu	300	31	1955.88	3058.09	4590.23	0	4590.23	5842.16	5842.16
56	4.13236	24664.5	31.7868	Tfu	300	31	1886.58	2949.75	4409.93	0	4409.93	5579.06	5579.06
57	4.13236	23673.9	31.7868	Tfu	300	31	1818.16	2842.77	4231.88	0	4231.88	5358.61	5358.61
58	4.13236	22802.9	31.7868	Tfu	300	31	1758.02	2748.73	4075.37	0	4075.37	5164.82	5164.82
59	4.13236	22796.3	31.7868	Tfu	300	31	1757.55	2748	4074.15	0	4074.15	5163.32	5163.32
60	5.00526	28398.6	35.1482	Tfu	300	31	1717.1	2684.75	3968.89	0	3968.89	5177.85	5177.85
61	5.00526	29141.4	35.1482	Tfu	300	31	1757.32	2747.64	4073.56	0	4073.56	5310.83	5310.83
62	5.00526	29465.6	35.1482	Tfu	300	31	1774.88	2775.09	4119.25	0	4119.25	5368.89	5368.89
63	4.13567	23701.5	37.5942	Tfu	300	31	1671.14	2612.89	3849.31	0	3849.31	5135.99	5135.99
64	4.13567	22998.6	37.5942	Tfu	300	31	1626.81	2543.58	3733.93	0	3733.93	4986.48	4986.48
65	4.13567	22295	37.5942	Tfu	300	31	1582.43	2474.2	3618.48	0	3618.48	4836.86	4836.86
66	3.74663	19476.9	38.5323	Tfu	300	31	1510.96	2362.44	3432.48	0	3432.48	4635.74	4635.74
67	3.74663	18698.8	38.5323	Tfu	300	31	1457.6	2279.02	3293.64	0	3293.64	4454.41	4454.41
68	3.74663	17920.7	38.5323	Tfu	300	31	1404.24	2195.59	3154.79	0	3154.79	4273.07	4273.07
69	4.97117	22564.7	38.809	Tfu	300	31	1336.03	2088.93	2977.28	0	2977.28	4051.82	4051.82
70	4.97117	21170.4	38.809	Tfu	300	31	1264.29	1976.77	2790.6	0	2790.6	3807.45	3807.45
71	4.97117	19630.3	39.1572	Tfu	300	31	1178.97	1843.37	2568.6	0	2568.6	3528.68	3528.68
72	4.97117	17506.2	39.1572	Tfu	300	31	1070.29	1673.44	2285.8	0	2285.8	3157.38	3157.38
73	4.44836	13943.9	38.2921	Tfu	300	31	984.075	1538.64	2061.43	0	2061.43	2838.39	2838.39
74	4.44836	12577.5	38.2921	Tfu	300	31	904.851	1414.77	1855.28	0	1855.28	2569.69	2569.69
75	4.44836	11235.1	38.2921	Tfu	300	31	827.011	1293.06	1652.74	0	1652.74	2305.69	2305.69
76	4.44849	10341.3	41.9858	Tfu	300	31	735.663	1150.24	1415.04	0	1415.04	2077.1	2077.1
77	4.44849	9594.35	41.9858	Tfu	300	31	694.908	1086.52	1308.98	0	1308.98	1934.37	1934.37
78	4.44849	8389.04	41.9858	Tfu	300	31	629.142	983.688	1137.85	0	1137.85	1704.05	1704.05
79	6.67398	9041.99	49.2362	Tfu	300	31	452.047	706.793	677.018	0	677.018	1201.39	1201.39
80	6.67385	3312.91	55.9936	Tfu	300	31	247.507	386.988	144.771	0	144.771	511.627	511.627

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.46376

Slice Number	X coordinate	Y coordinate - Bottom	Interslice Normal Force	Interslice Shear Force	Interslice Force Angle

	[ft]	[ft]	[lbs]	[lbs]	[degrees]
1	148.665	412.608	0	0	0
2	152.385	409.757	2942.88	0	0
3	156.105	406.906	7951.22	0	0
4	159.825	404.055	15037.9	0	0
5	164.095	400.713	26055.5	0	0
6	168.364	397.37	39967.7	0	0
7	172.634	394.028	56774.5	0	0
8	176.903	391.019	74152.9	0	0
9	181.172	388.009	93817.4	0	0
10	185.442	385	120078	0	0
11	190.394	386.439	126373	0	0
12	195.347	387.878	133707	0	0
13	200.3	389.317	141060	0	0
14	205.252	391.045	145753	0	0
15	210.205	392.773	150454	0	0
16	215.158	394.5	155184	0	0
17	219.509	396.076	158834	0	0
18	223.86	397.652	162501	0	0
19	228.21	399.228	166182	0	0
20	232.561	400.803	169863	0	0
21	237.322	402.629	172969	0	0
22	242.083	404.454	176041	0	0
23	246.929	406.339	178895	0	0
24	251.775	408.224	181713	0	0
25	256.32	411.314	174558	0	0
26	260.864	414.405	167705	0	0
27	264.568	417.275	160255	0	0
28	268.271	420.145	153038	0	0
29	271.974	423.015	145901	0	0
30	275.461	425.712	139236	0	0
31	278.947	428.41	132599	0	0
32	282.433	431.107	125989	0	0
33	286.6	434.268	118466	0	0
34	290.768	437.429	111022	0	0
35	294.201	439.913	105773	0	0
36	297.633	442.397	100743	0	0
37	301.066	444.761	96532.6	0	0
38	304.499	447.125	92507.3	0	0
39	308.783	449.925	88450.4	0	0
40	313.067	452.726	84631.8	0	0
41	317.351	455.527	81051.3	0	0
42	321.635	458.178	78330.6	0	0
43	325.919	460.829	75801.1	0	0
44	330.203	463.48	73462.8	0	0
45	334.203	465.815	71956.3	0	0
46	338.203	468.151	70578.3	0	0
47	342.203	470.487	69329	0	0
48	347.369	473.322	68371.4	0	0
49	352.534	476.158	67325.9	0	0
50	357.699	478.813	66841.5	0	0
51	362.865	481.468	66285.1	0	0
52	366.669	483.564	65277.7	0	0
53	370.474	485.661	64222.5	0	0
54	374.278	487.757	63135.4	0	0
55	378.336	490.53	59870.8	0	0
56	382.395	493.302	56593.8	0	0
57	386.453	496.075	53314.2	0	0
58	390.511	498.848	50154	0	0
59	395.922	502.364	46803.4	0	0
60	401.333	505.879	43684.9	0	0
61	406.744	509.395	40909.1	0	0
62	410.566	511.746	39549.7	0	0
63	414.388	514.096	38308.4	0	0

64	418.211	516.446	37173.3	0	0
65	422.033	518.796	36056.8	0	0
66	425.729	521.351	34169.2	0	0
67	429.425	523.907	32196.8	0	0
68	433.121	526.462	30139.4	0	0
69	436.781	530.26	25147.1	0	0
70	440.441	534.059	20559.3	0	0
71	444.101	537.858	16388.5	0	0
72	447.251	541.017	13303.6	0	0
73	450.4	544.175	10496.2	0	0
74	453.549	547.224	8140.53	0	0
75	456.699	550.273	6072.43	0	0
76	460.418	554.523	3392.67	0	0
77	464.137	558.774	1361.62	0	0
78	467.857	563.025	-20.717	0	0
79	471.583	567.346	-770.323	0	0
80	475.31	571.667	-815.793	0	0
81	479.037	575.989	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.56354

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	153.528	412.117	0	0	0
2	158.912	409.8	3725.96	1715.17	24.718
3	164.296	407.484	9614.63	4425.9	24.718
4	169.396	405.298	17157.8	7898.22	24.718
5	174.496	403.111	26630.9	12259	24.718
6	179.596	400.75	39373.3	18124.7	24.718
7	184.696	398.389	56558.9	26035.7	24.718
8	188.669	398.939	63047.7	29022.7	24.718
9	192.642	399.488	72643.4	33439.9	24.718
10	196.615	400.037	82374.8	37919.5	24.718
11	200.587	400.587	92206.6	42445.4	24.718
12	204.56	401.242	100932	46462	24.718
13	208.533	401.898	109744	50518.3	24.718
14	212.506	402.553	118693	54638	24.7181
15	216.478	403.209	127783	58822.4	24.7181
16	221.036	403.94	138630	63815.5	24.718
17	225.594	404.671	149669	68897.1	24.718
18	230.152	405.403	160867	74052	24.7181
19	234.71	406.134	172181	79260	24.718
20	239.382	406.932	183223	84342.9	24.718
21	244.055	407.731	194203	89397.2	24.718
22	248.727	408.53	205119	94422.5	24.7181
23	253.399	409.328	215973	99418.6	24.718
24	258.249	412.194	209786	96570.5	24.718
25	263.099	415.06	203835	93831.2	24.718
26	267.949	418.355	195754	90111.4	24.718
27	272.798	421.649	187760	86431.2	24.7179
28	277.647	424.774	180623	83146.1	24.718
29	282.497	427.899	173454	79846	24.718
30	287.098	430.723	167393	77055.9	24.718
31	291.699	433.546	161361	74279.2	24.718
32	295.663	435.84	157116	72325.1	24.718
33	299.626	438.133	153025	70441.8	24.718
34	303.59	440.426	149087	68629.2	24.718
35	307.407	442.502	146137	67271.3	24.7181
36	311.224	444.577	143299	65964.8	24.718
37	315.987	447.001	140769	64799.9	24.7179
38	320.751	449.425	138367	63694.5	24.718
39	325.514	451.848	136095	62648.5	24.718
40	330.278	454.106	134750	62029.5	24.718
41	335.041	456.363	133494	61451	24.7179

42	339.805	458.621	132325	60913	24.718
43	344.602	460.726	131980	60754.1	24.7179
44	349.399	462.832	131605	60581.5	24.718
45	354.195	464.938	131177	60384.6	24.718
46	358.992	467.043	130696	60163.4	24.7181
47	363.666	469.028	130538	60090.5	24.718
48	368.34	471.012	130341	59999.9	24.718
49	373.014	473.417	127834	58845.7	24.718
50	377.689	475.822	125270	57665.4	24.718
51	382.328	478.784	119924	55204.5	24.718
52	386.968	481.746	114558	52734.2	24.7179
53	391.781	484.995	108400	49899.9	24.7181
54	396.594	488.243	102476	47172.6	24.718
55	401.407	491.324	97448	44858.2	24.718
56	406.22	494.405	92720.5	42682	24.718
57	410.352	496.966	89223.4	41072.1	24.718
58	414.485	499.526	85899.5	39542.1	24.718
59	418.617	502.087	82727.9	38082.1	24.718
60	422.749	504.648	79557.4	36622.6	24.718
61	427.755	508.172	74165.4	34140.5	24.718
62	432.76	511.696	68605.9	31581.3	24.718
63	437.765	515.22	62973.2	28988.4	24.718
64	441.901	518.405	57627.5	26527.6	24.718
65	446.036	521.589	52465.8	24151.5	24.718
66	450.172	524.773	47488.2	21860.2	24.718
67	453.919	527.757	42907.9	19751.8	24.718
68	457.665	530.74	38542	17742	24.718
69	461.412	533.724	34390.4	15830.9	24.718
70	466.383	537.722	29128.3	13408.6	24.718
71	471.354	541.72	24255.9	11165.7	24.718
72	476.326	545.769	19718.6	9077.04	24.718
73	481.297	549.817	15785.9	7266.69	24.7179
74	485.745	553.329	12923.4	5949.01	24.718
75	490.193	556.841	10432.5	4802.4	24.7181
76	494.642	560.353	8306.81	3823.87	24.718
77	499.09	564.357	5914.41	2722.58	24.718
78	503.539	568.36	3765.28	1733.27	24.718
79	507.987	572.363	2008.72	924.675	24.7181
80	514.661	580.105	-215.616	-99.2544	24.718
81	521.335	589.997	0	0	0

Entity Information

External Boundary

X	Y
0	300
982.697	300
982.697	676.698
955.407	668.834
939.217	660.046
927.653	655.883
843.468	651.257
792.124	647.094
750.032	642.931
700.538	635.53
674.635	631.83
656.133	623.966
642.719	620.728
607.102	616.565
582.587	607.314
544.195	596.675
503.027	584.649
493.776	579.098
482.212	576.323
473.424	575.398
449.833	567.072
434.106	560.134
418.38	545.332
409.591	543.482
399.415	543.019
385.076	538.856
368.886	527.292
342.983	505.552
288.549	502.81
267.066	487.714
261.336	486.461
235.208	484.737
225.956	481.499
205.604	471.785
197.026	469.107
189.09	466.356
183.401	409.34
156.253	411.841
140.996	413.384
122.053	415.269
104.225	416.812
104.225	413.298
94.025	416.127
83.14	426.455
71	426.455
64.525	423.68
44.172	417.666
32.146	415.354
10.868	413.503
0	410.266

Material Boundary

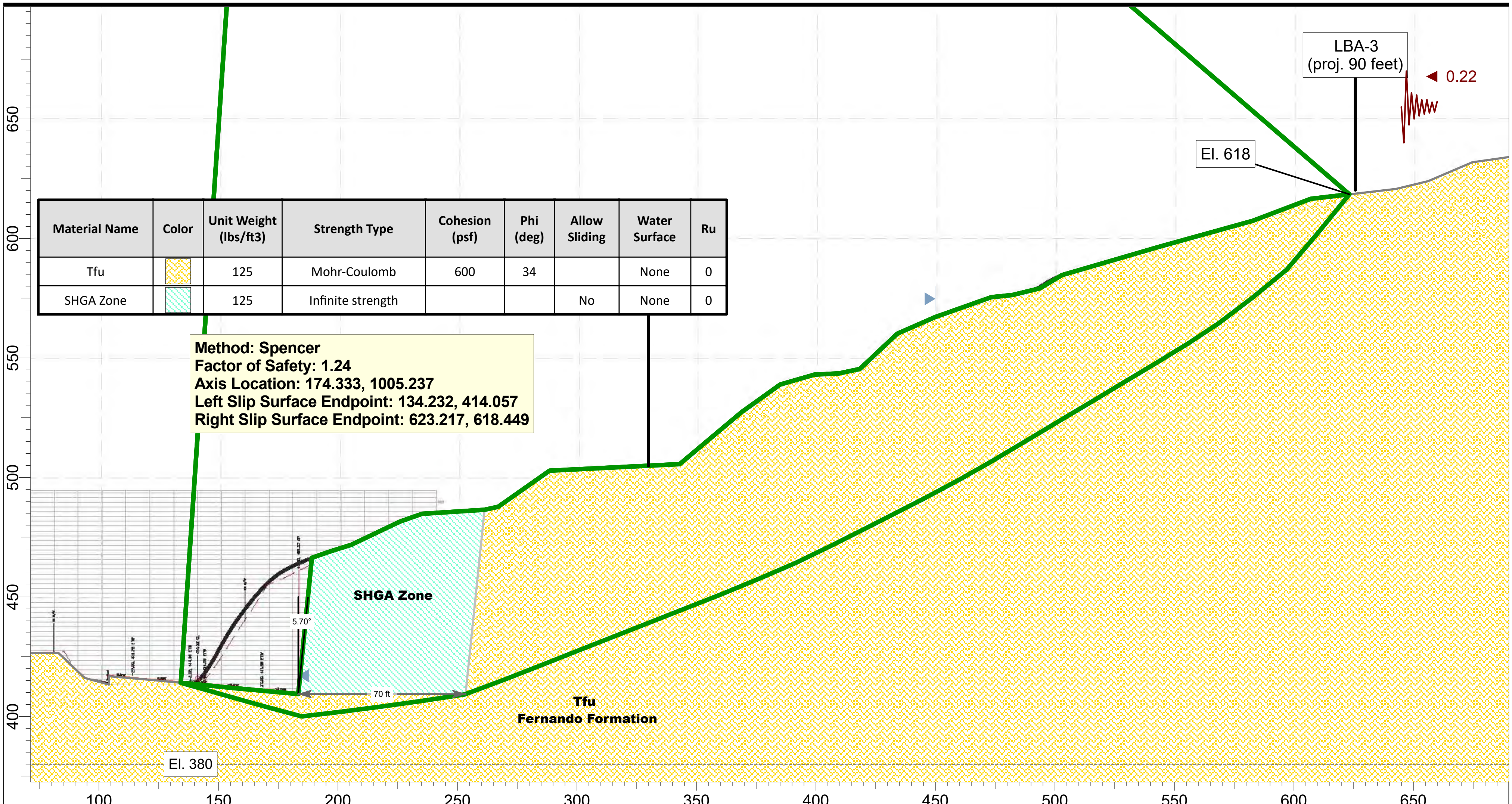
X	Y
183.401	409.34
253.416	409.34
261.336	486.461

Section 33+00

Global Stability

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 33+00_SHGA\Sec 33+00_Global_a1_k022.slim

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Allow Sliding	Water Surface	Ru
Tfu		125	Mohr-Coulomb	600	34		None	0
SHGA Zone		125	Infinite strength			No	None	0



SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, CA**			
Analyzed By: JEH	Units: feet	Scale: 1:720	Project No.: **11588.001**
Date: May 31, 2019	Condition: **PseudoStatic**		File Name: Sec 33+00_Global_a1_k022.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, CA

Project Summary

Slide Modeler Version:	8.022
Compute Time:	00h:00m:08.998s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical

Analysis Methods Used
Janbu corrected
Spencer

Number of slices:	80
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Seismic Loading

Advanced seismic analysis: No
Staged pseudostatic analysis: No

Seismic Load Coefficient (Horizontal): 0.22

Materials

Property	Tfu	SHGA Zone
Color		
Strength Type	Mohr-Coulomb	Infinite strength
Unit Weight [lbs/ft3]	125	125
Allow Sliding Along Boundary		No
Cohesion [psf]	600	
Friction Angle [°]	34	
Water Surface	None	None
Ru Value	0	0

Global Minimums

Method: janbu corrected

FS	1.152550
Axis Location:	159.949, 888.384
Left Slip Surface Endpoint:	148.197, 412.656
Right Slip Surface Endpoint:	533.480, 593.545
Resisting Horizontal Force:	1.60611e+06 lb
Driving Horizontal Force:	1.39353e+06 lb
Total Slice Area:	20327.4 ft2
Surface Horizontal Width:	385.283 ft
Surface Average Height:	52.7596 ft

Method: spencer

FS	1.235430
Axis Location:	174.333, 1005.237
Left Slip Surface Endpoint:	134.232, 414.057
Right Slip Surface Endpoint:	623.217, 618.449
Resisting Moment:	1.39338e+09 lb-ft
Driving Moment:	1.12785e+09 lb-ft
Resisting Horizontal Force:	2.17273e+06 lb
Driving Horizontal Force:	1.75868e+06 lb
Total Slice Area:	27466.4 ft2
Surface Horizontal Width:	488.985 ft
Surface Average Height:	56.1702 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
148.197	412.656
162.361	403.421
174.09	396.489
185.82	390.187
197.783	392.234
209.747	394.281
227.556	399.651
245.365	405.43
262.522	413.617
279.679	421.806
296.079	429.633
312.478	437.46
327.827	444.785
343.176	452.111
358.525	459.437
373.874	466.763
388.205	475.127
402.536	484.271
417.089	493.557
430.318	502.012
443.546	512.436
455.913	522.494
468.28	532.553
480.752	542.697
493.03	552.682
505.307	563.981
519.394	577.921
533.48	593.545

Method: spencer

X	Y
134.232	414.057
145.82	410.783
157.408	407.509
168.996	404.235
184.873	399.998
201.066	401.909
217.704	404.029
234.981	406.446
253.039	409.2
269.977	415.486
288.227	422.671
301.074	427.729
313.92	432.787
330.062	439.143
346.204	445.498
361.312	451.446
376.419	457.699
391.527	464.202
406.635	471.538
421.743	479.158
433.297	485.046
444.851	490.934
460.021	499.042
473.967	506.964
492.487	518.006
505.024	525.481
517.561	532.956
529.328	540.041
542.998	548.272
555.615	555.948
568.426	564.409
582.666	575.194
597.023	586.94
610.12	602.372
623.217	618.449

Valid/Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4926
Number of Invalid Surfaces: 89

Error Codes:

Error Code -99 reported for 25 surfaces
Error Code -111 reported for 3 surfaces
Error Code -121 reported for 43 surfaces
Error Code -124 reported for 10 surfaces
Error Code -1000 reported for 8 surfaces

Method: spencer

Number of Valid Surfaces: 3179
Number of Invalid Surfaces: 1836

Error Codes:

Error Code -99 reported for 25 surfaces
Error Code -108 reported for 34 surfaces
Error Code -111 reported for 1718 surfaces
Error Code -121 reported for 43 surfaces
Error Code -124 reported for 10 surfaces

Error Code -1000 reported for 6 surfaces

Error Codes

The following errors were encountered during the computation:

-99 = Slip surface intersects an infinite strength material. If infinite strength regions are defined for a model, a large number of potential slip surfaces may show this error code. This is Normal.
-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.15255

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	4.72131	767.455	-33.1044	Tfu	600	34	1025.58	1182.03	862.895	0	862.895	194.217	194.217
2	4.72131	2303.45	-33.1044	Tfu	600	34	1342.71	1547.54	1404.79	0	1404.79	529.341	529.341
3	4.72131	3857.2	-33.1044	Tfu	600	34	1663.51	1917.28	1952.95	0	1952.95	868.336	868.336
4	5.86468	6832.65	-30.5838	Tfu	600	34	1885.43	2173.05	2332.14	0	2332.14	1217.82	1217.82
5	5.86468	8977.54	-30.5838	Tfu	600	34	2221.04	2559.86	2905.62	0	2905.62	1592.95	1592.95
6	5.86468	11006.8	-28.2459	Tfu	600	34	2413.78	2782	3234.95	0	3234.95	1938.2	1938.2
7	5.86468	16618.3	-28.2459	Tfu	600	34	3248.66	3744.24	4661.52	0	4661.52	2916.26	2916.26
8	5.98179	50030.4	9.70775	Tfu	600	34	4901.38	5649.09	7485.58	0	7485.58	8324.07	8324.07
9	5.98179	57282.2	9.70775	Tfu	600	34	5543.53	6389.2	8582.85	0	8582.85	9531.19	9531.19
10	3.98786	38577.9	9.70922	Tfu	600	34	5595.23	6448.78	8671.17	0	8671.17	9628.51	9628.51
11	3.98786	38858.7	9.70922	Tfu	600	34	5632.52	6491.76	8734.89	0	8734.89	9698.61	9698.61
12	3.98786	39315.7	9.70922	Tfu	600	34	5693.23	6561.73	8838.63	0	8838.63	9812.73	9812.73
13	4.45232	44452.4	16.7787	Tfu	600	34	5370.98	6190.32	8287.98	0	8287.98	9907.4	9907.4
14	4.45232	44888	16.7787	Tfu	600	34	5419.31	6246.02	8370.56	0	8370.56	10004.5	10004.5
15	4.45232	45323.6	16.7787	Tfu	600	34	5467.62	6301.71	8453.14	0	8453.14	10101.7	10101.7
16	4.45232	45738.8	16.7787	Tfu	600	34	5513.69	6354.8	8531.84	0	8531.84	10194.3	10194.3
17	5.93643	61207.4	17.9804	Tfu	600	34	5467.06	6301.06	8452.17	0	8452.17	10226.5	10226.5
18	5.93643	61003.3	17.9804	Tfu	600	34	5450.27	6281.71	8423.49	0	8423.49	10192.3	10192.3
19	5.93643	59916.5	17.9804	Tfu	600	34	5360.91	6178.72	8270.8	0	8270.8	10010.6	10010.6
20	4.28926	42407.4	25.5079	Tfu	600	34	4879.59	5623.97	7448.35	0	7448.35	9776.61	9776.61
21	4.28926	41461.8	25.5079	Tfu	600	34	4779.78	5508.93	7277.78	0	7277.78	9558.43	9558.43
22	4.28926	40516.2	25.5079	Tfu	600	34	4679.95	5393.88	7107.22	0	7107.22	9340.23	9340.23
23	4.28926	39584.1	25.5079	Tfu	600	34	4581.55	5280.47	6939.08	0	6939.08	9125.14	9125.14
24	5.71901	51773.2	25.5143	Tfu	600	34	4501.64	5188.36	6802.53	0	6802.53	8951.08	8951.08
25	5.71901	52070.2	25.5143	Tfu	600	34	4525.15	5215.46	6842.71	0	6842.71	9002.48	9002.48
26	5.71901	52991.8	25.5143	Tfu	600	34	4598.12	5299.56	6967.37	0	6967.37	9161.97	9161.97
27	5.46643	51512.8	25.5143	Tfu	600	34	4669.46	5381.79	7089.3	0	7089.3	9317.95	9317.95
28	5.46643	52181.2	25.5143	Tfu	600	34	4724.83	5445.6	7183.9	0	7183.9	9438.97	9438.97
29	5.46643	51058.8	25.5143	Tfu	600	34	4631.86	5338.45	7025.04	0	7025.04	9235.75	9235.75
30	5.46642	49464.2	25.5143	Tfu	600	34	4499.78	5186.22	6799.36	0	6799.36	8947.02	8947.02
31	5.46642	47869.6	25.5143	Tfu	600	34	4367.71	5034	6573.67	0	6573.67	8658.3	8658.3
32	5.46642	46275	25.5143	Tfu	600	34	4235.63	4881.77	6347.99	0	6347.99	8369.58	8369.58
33	5.11631	41866.5	25.5143	Tfu	600	34	4107.78	4734.42	6129.53	0	6129.53	8090.09	8090.09
34	5.11631	40469.6	25.5143	Tfu	600	34	3984.16	4591.94	5918.3	0	5918.3	7819.86	7819.86
35	5.11631	39072.7	25.5143	Tfu	600	34	3860.54	4449.47	5707.07	0	5707.07	7549.63	7549.63
36	5.11631	37675.8	25.5143	Tfu	600	34	3736.92	4306.99	5495.84	0	5495.84	7279.4	7279.4
37	5.11631	36279	25.5143	Tfu	600	34	3613.3	4164.51	5284.61	0	5284.61	7009.17	7009.17
38	5.11631	34883.9	25.5143	Tfu	600	34	3489.84	4022.22	5073.66	0	5073.66	6739.3	6739.3
39	5.11632	34873.2	25.5143	Tfu	600	34	3488.9	4021.13	5072.03	0	5072.03	6737.22	6737.22
40	5.11632	36057.7	25.5143	Tfu	600	34	3593.72	4141.94	5251.14	0	5251.14	6966.36	6966.36
41	5.11632	37242.2	25.5143	Tfu	600	34	3698.55	4262.76	5430.27	0	5430.27	7195.52	7195.52
42	5.11632	38426.7	25.5143	Tfu	600	34	3803.37	4383.57	5609.38	0	5609.38	7424.65	7424.65

43	5.11632	39611.2	25.5143	Tfu	600	34	3908.19	4504.39	5788.48	0	5788.48	7653.8	7653.8
44	5.11632	40601.3	25.5143	Tfu	600	34	3995.82	4605.38	5938.21	0	5938.21	7845.34	7845.34
45	4.77704	38457.4	30.2683	Tfu	600	34	3853.5	4441.35	5695.04	0	5695.04	7943.98	7943.98
46	4.77704	38830.1	30.2683	Tfu	600	34	3887.13	4480.11	5752.5	0	5752.5	8021.07	8021.07
47	4.77704	38943.4	30.2683	Tfu	600	34	3897.35	4491.89	5769.96	0	5769.96	8044.5	8044.5
48	4.77704	38101.1	32.5412	Tfu	600	34	3729.63	4298.59	5483.39	0	5483.39	7863.2	7863.2
49	4.77704	37109.2	32.5412	Tfu	600	34	3642.28	4197.91	5334.12	0	5334.12	7658.19	7658.19
50	4.77704	35968.2	32.5412	Tfu	600	34	3541.79	4082.09	5162.41	0	5162.41	7422.36	7422.36
51	4.85107	34838.4	32.5412	Tfu	600	34	3395.47	3913.45	4912.4	0	4912.4	7078.98	7078.98
52	4.85107	33167.5	32.5412	Tfu	600	34	3250.57	3746.45	4664.8	0	4664.8	6738.93	6738.93
53	4.85107	31859.6	32.5412	Tfu	600	34	3137.15	3615.72	4470.99	0	4470.99	6472.74	6472.74
54	4.40948	28311.1	32.5837	Tfu	600	34	3073.87	3542.79	4362.88	0	4362.88	6327.47	6327.47
55	4.40948	28969.3	32.5837	Tfu	600	34	3136.64	3615.13	4470.12	0	4470.12	6474.82	6474.82
56	4.40948	29703.5	32.5837	Tfu	600	34	3206.66	3695.84	4589.78	0	4589.78	6639.24	6639.24
57	4.40948	30244.9	38.2384	Tfu	600	34	3057.78	3524.25	4335.38	0	4335.38	6744.94	6744.94
58	4.40948	29850.4	38.2384	Tfu	600	34	3022.48	3483.56	4275.07	0	4275.07	6656.81	6656.81
59	4.40948	29007.4	38.2384	Tfu	600	34	2947.04	3396.61	4146.14	0	4146.14	6468.43	6468.43
60	4.12234	26329.1	39.1221	Tfu	600	34	2841.75	3275.26	3966.22	0	3966.22	6277.48	6277.48
61	4.12234	25517.4	39.1221	Tfu	600	34	2764.85	3186.63	3834.83	0	3834.83	6083.54	6083.54
62	4.12234	24565.3	39.1221	Tfu	600	34	2674.65	3082.67	3680.69	0	3680.69	5856.04	5856.04
63	4.12234	23587.4	39.1221	Tfu	600	34	2582	2975.88	3522.4	0	3522.4	5622.39	5622.39
64	4.12234	22609.4	39.1221	Tfu	600	34	2489.35	2869.1	3364.07	0	3364.07	5388.71	5388.71
65	4.12234	21631.4	39.1221	Tfu	600	34	2396.7	2762.32	3205.76	0	3205.76	5155.05	5155.05
66	4.15741	20824.9	39.1221	Tfu	600	34	2303.66	2655.08	3046.77	0	3046.77	4920.38	4920.38
67	4.15741	19674.6	39.1221	Tfu	600	34	2195.6	2530.54	2862.14	0	2862.14	4647.87	4647.87
68	4.15741	18159.9	39.1221	Tfu	600	34	2053.31	2366.54	2619.01	0	2619.01	4289.01	4289.01
69	4.09253	16440.7	39.1221	Tfu	600	34	1916.3	2208.63	2384.89	0	2384.89	3943.45	3943.45
70	4.09253	15222.4	39.1221	Tfu	600	34	1800.03	2074.63	2186.22	0	2186.22	3650.23	3650.23
71	4.09253	14022.1	39.1221	Tfu	600	34	1685.49	1942.61	1990.5	0	1990.5	3361.34	3361.34
72	4.09253	12961.7	42.6234	Tfu	600	34	1517.88	1749.43	1704.1	0	1704.1	3101.01	3101.01
73	4.09253	12278.7	42.6234	Tfu	600	34	1455.43	1677.46	1597.4	0	1597.4	2936.84	2936.84
74	4.09253	11508.1	42.6234	Tfu	600	34	1384.98	1596.26	1477.02	0	1477.02	2751.62	2751.62
75	4.69544	11560.5	44.7	Tfu	600	34	1220.91	1407.16	1196.66	0	1196.66	2404.85	2404.85
76	4.69544	9638.35	44.7	Tfu	600	34	1071.79	1235.29	941.855	0	941.855	2002.48	2002.48
77	4.69544	7716.22	44.7	Tfu	600	34	922.667	1063.42	687.048	0	687.048	1600.1	1600.1
78	4.69554	5629.41	47.9626	Tfu	600	34	727.569	838.56	353.68	0	353.68	1160.67	1160.67
79	4.69554	3377.65	47.9626	Tfu	600	34	560.501	646.006	68.206	0	68.206	689.89	689.89
80	4.69554	1125.88	47.9626	Tfu	600	34	393.433	453.451	-217.268	0	-217.268	219.111	219.111

Global Minimum Query (spencer) - Safety Factor: 1.23543

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	5.794	384.008	-15.7766	Tfu	600	34	1422.51	1757.41	1715.93	0	1715.93	1314.03	1314.03
2	5.794	1149.66	-15.7766	Tfu	600	34	1628.42	2011.8	2093.08	0	2093.08	1633	1633
3	5.794	1910.95	-15.7766	Tfu	600	34	1833.15	2264.73	2468.07	0	2468.07	1950.15	1950.15
4	5.794	2672.9	-15.7766	Tfu	600	34	2038.07	2517.89	2843.39	0	2843.39	2267.57	2267.57
5	5.79406	3459.83	-15.7766	Tfu	600	34	2249.69	2779.33	3230.98	0	3230.98	2595.37	2595.37
6	5.79406	4258.85	-15.7766	Tfu	600	34	2464.56	3044.79	3624.56	0	3624.56	2928.24	2928.24
7	5.29226	4560.81	-14.9421	Tfu	600	34	2520.18	3113.51	3726.43	0	3726.43	3053.87	3053.87
8	5.29226	5172.58	-14.9421	Tfu	600	34	2689.64	3322.86	4036.81	0	4036.81	3319.03	3319.03
9	5.29226	7154.29	-14.9421	Tfu	600	34	3238.56	4001.01	5042.21	0	5042.21	4177.95	4177.95
10	5.39757	33448.3	6.72985	Tfu	600	34	4366.86	5394.95	7108.79	0	7108.79	7624.09	7624.09
11	5.39757	45034.1	6.72985	Tfu	600	34	5647.68	6977.31	9454.75	0	9454.75	10121.2	10121.2
12	5.39757	45831.6	6.72985	Tfu	600	34	5735.84	7086.23	9616.24	0	9616.24	10293.1	10293.1
13	5.54622	47827	7.26181	Tfu	600	34	5735.3	7085.56	9615.23	0	9615.23	10346	10346
14	5.54622	48959.8	7.26181	Tfu	600	34	5855.43	7233.97	9835.26	0	9835.26	10581.4	10581.4
15	5.54622	50305.1	7.26181	Tfu	600	34	5998.09	7410.22	10096.6	0	10096.6	10860.9	10860.9
16	5.75896	53632.5	7.96421	Tfu	600	34	6031.58	7451.59	10157.9	0	10157.9	11001.7	11001.7
17	5.75896	54946.3	7.96421	Tfu	600	34	6163.26	7614.28	10399.1	0	10399.1	11261.4	11261.4
18	5.75896	55866.7	7.96421	Tfu	600	34	6255.51	7728.25	10568.1	0	10568.1	11443.2	11443.2
19	6.01929	58698.8	8.66986	Tfu	600	34	6174.16	7627.74	10419	0	10419	11360.5	11360.5
20	6.01929	58308	8.66986	Tfu	600	34	6137.36	7582.28	10351.7	0	10351.7	11287.5	11287.5
21	6.01929	57916.2	8.66986	Tfu	600	34	6100.49	7536.73	10284.1	0	10284.1	11214.3	11214.3

22	8.46868	79840.6	20.3621	Tfu	600	34	4603.02	5686.71	7541.35	0	7541.35	9249.73	9249.73
23	8.46868	78073.1	20.3621	Tfu	600	34	4513.42	5576.02	7377.26	0	7377.26	9052.39	9052.39
24	9.12512	86327.2	21.4904	Tfu	600	34	4510.82	5572.8	7372.48	0	7372.48	9148.46	9148.46
25	9.12512	89543.2	21.4904	Tfu	600	34	4658.42	5755.15	7642.82	0	7642.82	9476.92	9476.92
26	6.42338	63442.5	21.4904	Tfu	600	34	4685.21	5788.25	7691.9	0	7691.9	9536.54	9536.54
27	6.42338	61675.9	21.4904	Tfu	600	34	4570.04	5645.96	7480.94	0	7480.94	9280.24	9280.24
28	6.42336	59905	21.4904	Tfu	600	34	4454.58	5503.32	7269.47	0	7269.47	9023.31	9023.31
29	6.42336	58134.2	21.4904	Tfu	600	34	4339.13	5360.69	7058	0	7058	8766.4	8766.4
30	5.38063	47334.1	21.4904	Tfu	600	34	4233.04	5229.63	6863.71	0	6863.71	8530.33	8530.33
31	5.38063	46091.6	21.4904	Tfu	600	34	4136.33	5110.15	6686.57	0	6686.57	8315.12	8315.12
32	5.38063	44849.1	21.4904	Tfu	600	34	4039.62	4990.67	6509.44	0	6509.44	8099.91	8099.91
33	5.38063	43606.5	21.4904	Tfu	600	34	3942.91	4871.19	6332.31	0	6332.31	7884.7	7884.7
34	5.38063	42364	21.4904	Tfu	600	34	3846.2	4751.71	6155.16	0	6155.16	7669.47	7669.47
35	5.38063	41633.1	21.4904	Tfu	600	34	3789.3	4681.42	6050.97	0	6050.97	7542.88	7542.88
36	5.03585	40210.8	21.4904	Tfu	600	34	3892.9	4809.4	6240.7	0	6240.7	7773.4	7773.4
37	5.03585	41623.3	21.4904	Tfu	600	34	4010.35	4954.51	6455.82	0	6455.82	8034.77	8034.77
38	5.03585	43035.7	21.4904	Tfu	600	34	4127.82	5099.63	6670.97	0	6670.97	8296.17	8296.17
39	5.03585	44416.2	22.4829	Tfu	600	34	4157.83	5136.71	6725.95	0	6725.95	8446.72	8446.72
40	5.03585	45716.1	22.4829	Tfu	600	34	4263.62	5267.41	6919.72	0	6919.72	8684.28	8684.28
41	5.03585	46718.7	22.4829	Tfu	600	34	4345.23	5368.23	7069.19	0	7069.19	8867.52	8867.52
42	5.03594	47645.5	23.2917	Tfu	600	34	4348.71	5372.53	7075.57	0	7075.57	8947.68	8947.68
43	5.03594	48492	23.2917	Tfu	600	34	4416.42	5456.18	7199.58	0	7199.58	9100.84	9100.84
44	5.03594	48395	23.2917	Tfu	600	34	4408.67	5446.6	7185.37	0	7185.37	9083.29	9083.29
45	7.55419	71565.8	25.8975	Tfu	600	34	4132.5	5105.42	6679.55	0	6679.55	8685.97	8685.97
46	7.55419	69375.7	25.8975	Tfu	600	34	4022.05	4968.96	6477.26	0	6477.26	8430.04	8430.04
47	7.5539	66386.8	26.7668	Tfu	600	34	3805.66	4701.63	6080.92	0	6080.92	8000.53	8000.53
48	7.5539	64716.9	26.7668	Tfu	600	34	3722.98	4599.48	5929.47	0	5929.47	7807.38	7807.38
49	5.77695	50971.5	27.0032	Tfu	600	34	3800.98	4695.85	6072.36	0	6072.36	8009.32	8009.32
50	5.77695	52772.2	27.0032	Tfu	600	34	3916.99	4839.17	6284.82	0	6284.82	8280.91	8280.91
51	5.77695	53801.5	27.0032	Tfu	600	34	3983.29	4921.08	6406.26	0	6406.26	8436.13	8436.13
52	5.77695	53536.4	27.0032	Tfu	600	34	3966.21	4899.98	6374.99	0	6374.99	8396.15	8396.15
53	5.05661	46586.7	28.1224	Tfu	600	34	3860.19	4768.99	6180.79	0	6180.79	8243.88	8243.88
54	5.05661	46143.4	28.1224	Tfu	600	34	3828.32	4729.62	6122.42	0	6122.42	8168.47	8168.47
55	5.05661	45563.2	28.1224	Tfu	600	34	3786.62	4678.1	6046.04	0	6046.04	8069.8	8069.8
56	6.97327	61779.7	29.5992	Tfu	600	34	3625.7	4479.3	5751.29	0	5751.29	7810.91	7810.91
57	6.97327	60467.5	29.5992	Tfu	600	34	3559.39	4397.38	5629.86	0	5629.86	7651.81	7651.81
58	6.17307	51680.7	30.8049	Tfu	600	34	3374.23	4168.62	5290.7	0	5290.7	7302.54	7302.54
59	6.17307	49483.7	30.8049	Tfu	600	34	3251.95	4017.56	5066.73	0	5066.73	7005.66	7005.66
60	6.17307	47750.5	30.8049	Tfu	600	34	3155.49	3898.39	4890.06	0	4890.06	6771.48	6771.48
61	6.26866	47311.3	30.8049	Tfu	600	34	3090.89	3818.58	4771.74	0	4771.74	6614.64	6614.64
62	6.26866	47215.8	30.8049	Tfu	600	34	3085.66	3812.12	4762.16	0	4762.16	6601.95	6601.95
63	6.26866	46073.2	30.8049	Tfu	600	34	3023.04	3734.75	4647.47	0	4647.47	6449.91	6449.91
64	6.26866	44579.4	30.8049	Tfu	600	34	2941.17	3633.61	4497.52	0	4497.52	6251.15	6251.15
65	5.88355	40469	31.0524	Tfu	600	34	2847.62	3518.04	4326.18	0	4326.18	6040.75	6040.75
66	5.88355	39127.6	31.0524	Tfu	600	34	2769.71	3421.78	4183.46	0	4183.46	5851.11	5851.11
67	6.83498	43770.8	31.0524	Tfu	600	34	2685.49	3317.74	4029.2	0	4029.2	5646.16	5646.16
68	6.83498	41960.6	31.0524	Tfu	600	34	2594.98	3205.91	3863.42	0	3863.42	5425.87	5425.87
69	6.30846	37081.7	31.3153	Tfu	600	34	2493.45	3080.48	3677.45	0	3677.45	5194.41	5194.41
70	6.30846	35435.2	31.3153	Tfu	600	34	2404.73	2970.88	3514.97	0	3514.97	4977.95	4977.95
71	6.40566	34161.5	33.4419	Tfu	600	34	2218.94	2741.34	3174.68	0	3174.68	4640.13	4640.13
72	6.40566	32195.5	33.4419	Tfu	600	34	2119.17	2618.09	2991.94	0	2991.94	4391.5	4391.5
73	7.11968	33170	37.1409	Tfu	600	34	1869.28	2309.37	2534.24	0	2534.24	3950.07	3950.07
74	7.11968	30126.7	37.1409	Tfu	600	34	1740.8	2150.64	2298.92	0	2298.92	3617.43	3617.43
75	7.1787	27429.6	39.2877	Tfu	600	34	1556.58	1923.05	1961.5	0	1961.5	3234.99	3234.99
76	7.1787	24590.3	39.2877	Tfu	600	34	1443.04	1782.78	1753.54	0	1753.54	2934.15	2934.15
77	6.54835	18989.4	49.68	Tfu	600	34	1075.87	1329.17	1081.03	0	1081.03	2348.76	2348.76
78	6.54835	14547.9	49.68	Tfu	600	34	922.202	1139.32	799.569	0	799.569	1886.22	1886.22
79	6.54846	8929.68	50.831	Tfu	600	34	714.895	883.203	419.865	0	419.865	1297.38	1297.38
80	6.54846	2976.56	50.831	Tfu	600	34	514.683	635.855	53.1576	0	53.1576	684.92	684.92

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.15255

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	148.197	412.656	0	0	0
2	152.918	409.577	7558.8	0	0
3	157.64	406.499	18016	0	0
4	162.361	403.421	31405.1	0	0
5	168.226	399.955	49566.4	0	0
6	174.09	396.489	71305.2	0	0
7	179.955	393.338	93902.3	0	0
8	185.82	390.187	124888	0	0
9	191.801	391.211	136928	0	0
10	197.783	392.234	150274	0	0
11	201.771	392.916	159240	0	0
12	205.759	393.599	168257	0	0
13	209.747	394.281	177355	0	0
14	214.199	395.623	181496	0	0
15	218.651	396.966	185654	0	0
16	223.104	398.308	189832	0	0
17	227.556	399.651	194027	0	0
18	233.492	401.577	198269	0	0
19	239.429	403.504	202507	0	0
20	245.365	405.43	206722	0	0
21	249.655	407.477	204070	0	0
22	253.944	409.524	201526	0	0
23	258.233	411.57	199091	0	0
24	262.522	413.617	196763	0	0
25	268.241	416.346	193769	0	0
26	273.96	419.076	190741	0	0
27	279.679	421.806	187607	0	0
28	285.146	424.415	184512	0	0
29	290.612	427.024	181340	0	0
30	296.079	429.633	178298	0	0
31	301.545	432.242	175438	0	0
32	307.012	434.851	172763	0	0
33	312.478	437.46	170270	0	0
34	317.594	439.902	168104	0	0
35	322.711	442.344	166098	0	0
36	327.827	444.785	164253	0	0
37	332.943	447.227	162568	0	0
38	338.059	449.669	161045	0	0
39	343.176	452.111	159681	0	0
40	348.292	454.553	158319	0	0
41	353.408	456.995	156821	0	0
42	358.525	459.437	155187	0	0
43	363.641	461.879	153416	0	0
44	368.757	464.321	151509	0	0
45	373.874	466.763	149488	0	0
46	378.651	469.551	144430	0	0
47	383.428	472.339	139298	0	0
48	388.205	475.127	134144	0	0
49	392.982	478.175	127708	0	0
50	397.759	481.223	121508	0	0
51	402.536	484.271	115580	0	0
52	407.387	487.366	109961	0	0
53	412.238	490.462	104741	0	0
54	417.089	493.557	99831.3	0	0
55	421.499	496.375	95503.4	0	0
56	425.908	499.194	91018.4	0	0
57	430.318	502.012	86358	0	0
58	434.727	505.486	78761.7	0	0
59	439.137	508.961	71298.7	0	0
60	443.546	512.436	64120.7	0	0
61	447.668	515.789	57299.8	0	0

62	451.791	519.141	50766.1	0	0
63	455.913	522.494	44569.1	0	0
64	460.035	525.847	38718	0	0
65	464.158	529.2	33212.8	0	0
66	468.28	532.553	28053.6	0	0
67	472.437	535.934	23200.8	0	0
68	476.595	539.315	18754.9	0	0
69	480.752	542.697	14844.7	0	0
70	484.845	546.025	11503.5	0	0
71	488.937	549.354	8593.17	0	0
72	493.03	552.682	6107.44	0	0
73	497.122	556.448	3343.74	0	0
74	501.215	560.215	864.521	0	0
75	505.307	563.981	-1293.75	0	0
76	510.003	568.628	-3393.18	0	0
77	514.698	573.274	-4619.13	0	0
78	519.394	577.921	-4971.59	0	0
79	524.089	583.129	-4473.94	0	0
80	528.785	588.337	-2815.76	0	0
81	533.48	593.545	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.23543

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	134.232	414.057	0	0	0
2	140.026	412.42	10966.5	7230.12	33.3965
3	145.82	410.783	23575	15542.8	33.3965
4	151.614	409.146	37816.1	24931.8	33.3965
5	157.408	407.509	53691.2	35398.1	33.3965
6	163.202	405.872	71254	46977	33.3964
7	168.996	404.235	90530.3	59685.7	33.3965
8	174.289	402.823	108127	71287.3	33.3966
9	179.581	401.41	126925	83680.4	33.3965
10	184.873	399.998	149612	98637.5	33.3964
11	190.271	400.635	161296	106341	33.3965
12	195.668	401.272	175850	115936	33.3964
13	201.066	401.909	190602	125662	33.3965
14	206.612	402.616	205094	135217	33.3966
15	212.158	403.322	219848	144943	33.3964
16	217.704	404.029	234912	154875	33.3964
17	223.463	404.835	249664	164601	33.3965
18	229.222	405.64	264692	174509	33.3965
19	234.981	406.446	279912	184543	33.3964
20	241.001	407.364	294599	194226	33.3964
21	247.02	408.282	309213	203861	33.3965
22	253.039	409.2	323753	213447	33.3965
23	261.508	412.343	321466	211939	33.3964
24	269.977	415.486	319326	210528	33.3964
25	279.102	419.079	315008	207682	33.3965
26	288.227	422.671	310359	204617	33.3965
27	294.65	425.2	307044	202431	33.3965
28	301.074	427.729	303911	200366	33.3965
29	307.497	430.258	300961	198421	33.3965
30	313.92	432.787	298194	196596	33.3964
31	319.301	434.906	296017	195161	33.3965
32	324.682	437.024	293968	193810	33.3964
33	330.062	439.143	292047	192543	33.3964
34	335.443	441.261	290254	191361	33.3964
35	340.823	443.38	288590	190264	33.3964
36	346.204	445.498	287001	189216	33.3963
37	351.24	447.481	285385	188151	33.3964
38	356.276	449.463	283623	186990	33.3965
39	361.312	451.446	281716	185732	33.3964

40	366.347	453.53	278865	183853	33.3965
41	371.383	455.614	275857	181869	33.3964
42	376.419	457.699	272727	179806	33.3964
43	381.455	459.866	268806	177221	33.3964
44	386.491	462.034	264770	174560	33.3964
45	391.527	464.202	260747	171908	33.3965
46	399.081	467.87	251722	165958	33.3965
47	406.635	471.538	243086	160264	33.3964
48	414.189	475.348	234059	154313	33.3965
49	421.743	479.158	225351	148572	33.3965
50	427.52	482.102	218219	143870	33.3965
51	433.297	485.046	210736	138936	33.3964
52	439.074	487.99	203051	133870	33.3966
53	444.851	490.934	195419	128838	33.3965
54	449.908	493.636	187986	123937	33.3964
55	454.964	496.339	180646	119098	33.3964
56	460.021	499.042	173431	114341	33.3964
57	466.994	503.003	162340	107029	33.3964
58	473.967	506.964	151556	99919.6	33.3965
59	480.14	510.645	141543	93317.9	33.3965
60	486.313	514.325	132083	87080.7	33.3964
61	492.487	518.006	123058	81131.1	33.3965
62	498.755	521.743	114191	75284.8	33.3964
63	505.024	525.481	105347	69454.4	33.3965
64	511.293	529.219	96791.3	63813.5	33.3965
65	517.561	532.956	88611.2	58420.4	33.3964
66	523.445	536.499	81136.6	53492.6	33.3965
67	529.328	540.041	74004.3	48790.3	33.3965
68	536.163	544.157	66148.4	43610.9	33.3964
69	542.998	548.272	58754.2	38736.1	33.3965
70	549.307	552.11	52212.3	34423.1	33.3965
71	555.615	555.948	46096.7	30391.1	33.3965
72	562.021	560.178	39364.5	25952.6	33.3964
73	568.426	564.409	33198.9	21887.7	33.3965
74	575.546	569.801	25544.2	16841	33.3964
75	582.666	575.194	18913.2	12469.3	33.3965
76	589.845	581.067	12532.9	8262.79	33.3964
77	597.023	586.94	7183.43	4735.96	33.3964
78	603.572	594.656	1709.64	1127.15	33.3965
79	610.12	602.372	-1621.5	-1069.04	33.3965
80	616.668	610.41	-2279.47	-1502.83	33.3964
81	623.217	618.449	0	0	0

Entity Information

External Boundary

X	Y
0	300
982.697	300
982.697	676.698
955.407	668.834
939.217	660.046
927.653	655.883
843.468	651.257
792.124	647.094
750.032	642.931
700.538	635.53
674.635	631.83
656.133	623.966
642.719	620.728
607.102	616.565
582.587	607.314
544.195	596.675
503.027	584.649
493.776	579.098
482.212	576.323
473.424	575.398
449.833	567.072
434.106	560.134
418.38	545.332
409.591	543.482
399.415	543.019
385.076	538.856
368.886	527.292
342.983	505.552
288.549	502.81
267.066	487.714
261.336	486.461
235.208	484.737
225.956	481.499
205.604	471.785
197.026	469.107
189.09	466.356
183.401	409.34
156.253	411.841
140.996	413.384
122.053	415.269
104.225	416.812
104.225	413.298
94.025	416.127
83.14	426.455
71	426.455
64.525	423.68
44.172	417.666
32.146	415.354
10.868	413.503
0	410.266

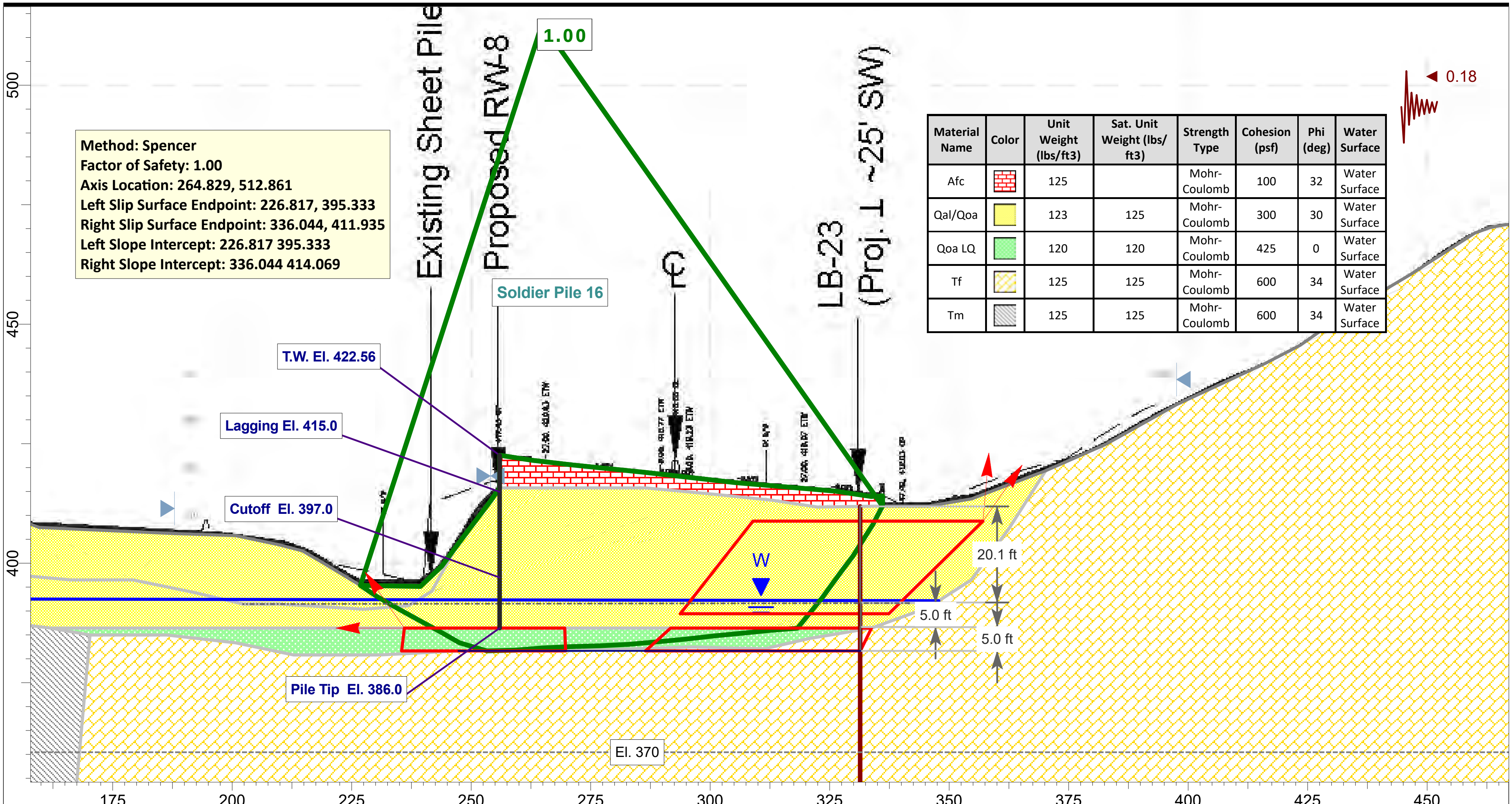
Material Boundary

X	Y
183.401	409.34
253.416	409.34
261.336	486.461

Section 35+00 Global Stability - Liquefaction - Yield Acceleration - RW 8

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 35+00\Sec 35+00_LQ Blk Srf_a1_ky.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Afc		125		Mohr-Coulomb	100	32	Water Surface
Qal/Qoa		123	125	Mohr-Coulomb	300	30	Water Surface
Qoa LQ		120	120	Mohr-Coulomb	425	0	Water Surface
Tf		125	125	Mohr-Coulomb	600	34	Water Surface
Tm		125	125	Mohr-Coulomb	600	34	Water Surface

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: **11585.005**
Date: March 29, 2021	Condition: **PseudoStatic**		File Name: Sec 35+00_LQ Blk Srf_a1_ky.slim

Slide Analysis Information

Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA

Project Summary

Slide Modeler Version:	9.012
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	March 29, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	125
Left Projection Angle (End Angle) [deg]:	180
Right Projection Angle (Start Angle) [deg]:	55
Right Projection Angle (End Angle) [deg]:	85
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.18

Materials

Afc	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	100
Friction Angle [deg]	32
Water Surface	Water Table
Hu Value	Automatically Calculated
Qal/Qoa	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	123
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated
Qoa LQ	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Cohesion [psf]	425
Friction Angle [deg]	0
Water Surface	Water Table
Hu Value	Automatically Calculated
Tf	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated
Tm	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	Water Table
Hu Value	Automatically Calculated

Global Minimums

Method: janbu corrected

FS	0.830886
Axis Location:	261.401, 511.159
Left Slip Surface Endpoint:	226.817, 395.333
Right Slip Surface Endpoint:	333.312, 413.996
Resisting Horizontal Force:	61485.5 lb
Driving Horizontal Force:	73999.9 lb
Total Slice Area:	2751.98 ft2
Surface Horizontal Width:	106.495 ft
Surface Average Height:	25.8414 ft

Method: spencer

FS	0.998177
Axis Location:	264.829, 512.861
Left Slip Surface Endpoint:	226.817, 395.333
Right Slip Surface Endpoint:	336.044, 411.935
Left Slope Intercept:	226.817 395.333
Right Slope Intercept:	336.044 414.069
Resisting Moment:	1.01569e+07 lb-ft
Driving Moment:	1.01755e+07 lb-ft
Resisting Horizontal Force:	68645.5 lb
Driving Horizontal Force:	68770.9 lb
Total Slice Area:	2880.82 ft2
Surface Horizontal Width:	109.227 ft
Surface Average Height:	26.3746 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
226.817	395.333
232	391.948
237.112	388.787
240.616	386.521
244.119	384.133
247.623	381.69
253.325	381.663
259.034	381.637
264.835	382.199
270.644	382.763
276.357	383.511
282.07	384.26
287.81	384.812
293.55	385.364
299.189	385.721
304.827	386.077
310.466	386.237
316.104	386.404
318.493	390.198
320.881	393.91
322.628	396.583
324.374	399.3
326.089	402.181
327.805	405.047
330.558	409.553
333.312	413.996

Method: spencer

X	Y
226.817	395.333
230.177	393.054
234.954	390.315
239.147	388.018
243.34	385.741
247.534	383.332
253.267	381.636
259.103	381.78
264.985	382.258
270.973	382.536
276.963	382.704
282.952	383
288.942	383.53
294.931	384.118
300.92	384.799
306.909	385.369
312.577	385.938
318.244	386.381
320.824	389.549
323.404	392.731
325.61	395.777
327.787	398.744
329.86	401.498
331.933	404.783
334.034	408.117
336.044	411.935
336.045	414.069

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	3837
Number of Invalid Surfaces:	1181

Error Codes

Error Code -108 reported for 2 surfaces
Error Code -110 reported for 678 surfaces
Error Code -111 reported for 372 surfaces
Error Code -112 reported for 120 surfaces
Error Code -1000 reported for 9 surfaces

Method: spencer

Number of Valid Surfaces:	3386
Number of Invalid Surfaces:	1632

Error Codes

Error Code -108 reported for 16 surfaces
Error Code -110 reported for 678 surfaces
Error Code -111 reported for 795 surfaces
Error Code -112 reported for 136 surfaces
Error Code -1000 reported for 7 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-110 = The water table or a piezoline does not span the slip region for a given slip surface, when Water Surfaces is specified as the method of pore pressure calculation. If this error occurs, check that the water table or piezoline(s) span the appropriate soil cells.

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.830886

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.29376	205.804	-33.1452	Qal/Qoa	300	30	827.984	687.96	671.966	0	671.966	131.28	131.28
2	2.29376	617.413	-33.1452	Qal/Qoa	300	30	1071.82	890.561	1022.88	0	1022.88	322.966	322.966
3	0.59548	227.816	-33.1452	Qal/Qoa	300	30	1209.49	1004.95	1233.1	12.0889	1221.01	443.279	431.19
4	2.556	1284.05	-31.7316	Qal/Qoa	300	30	1226.83	1019.35	1319.31	73.3581	1245.96	560.676	487.318
5	2.556	1775.37	-31.7316	Qal/Qoa	300	30	1348.24	1120.24	1592.39	171.699	1420.69	758.671	586.972
6	1.75177	1505.97	-32.8949	Qal/Qoa	300	30	1512.45	1256.68	1913.13	256.122	1657.01	934.875	678.753
7	1.75177	1841.2	-32.8949	Qal/Qoa	300	30	1675.2	1391.9	2217.85	326.627	1891.23	1134.33	807.701
8	0.171906	212.027	-34.2832	Qal/Qoa	300	30	1968.01	1635.19	2678.15	365.527	2312.62	1336.51	970.984
9	3.33163	5273.43	-34.2832	Qoa LQ	425	0	511.502	425	1958.34	439.85	1518.49	1609.64	1169.79
10	1.75177	3759.37	-34.8877	Qoa LQ	425	0	511.502	425	2530.12	548.538	1981.58	2173.45	1624.92
11	1.75177	4524.17	-34.8877	Qoa LQ	425	0	511.502	425	2966.71	624.563	2342.15	2610.05	1985.48
12	2.85144	8659.88	-0.27092	Qoa LQ	425	0	511.502	425	3039.63	662.836	2376.79	3037.21	2374.38
13	2.85144	9987.99	-0.27092	Qoa LQ	425	0	511.502	425	3505.4	663.358	2842.04	3502.98	2839.62
14	1.90282	7412.16	-0.263062	Qoa LQ	425	0	511.502	425	3897.89	663.785	3234.1	3895.54	3231.76
15	1.90282	8922.63	-0.263062	Qoa LQ	425	0	511.502	425	4691.69	664.117	4027.58	4689.34	4025.23
16	1.90282	9519.63	-0.263062	Qoa LQ	425	0	511.502	425	5005.44	664.449	4340.99	5003.09	4338.64
17	2.90045	14328.5	5.54061	Qoa LQ	425	0	511.502	425	4886.68	655.674	4231.01	4936.3	4280.63
18	2.90045	14078.5	5.54061	Qoa LQ	425	0	511.502	425	4800.48	637.792	4162.69	4850.1	4212.31
19	1.9363	9275.05	5.54012	Qoa LQ	425	0	511.502	425	4736.65	622.883	4113.77	4786.27	4163.38
20	1.9363	9176.96	5.54012	Qoa LQ	425	0	511.502	425	4686	610.947	4075.05	4735.61	4124.66
21	1.9363	9078.87	5.54012	Qoa LQ	425	0	511.502	425	4635.34	599.01	4036.33	4684.95	4085.94
22	2.85658	13203.2	7.46375	Qoa LQ	425	0	511.502	425	4549.86	581.206	3968.65	4616.87	4035.67
23	2.85658	12970.8	7.46375	Qoa LQ	425	0	511.502	425	4468.53	557.533	3911	4535.55	3978.01
24	1.90439	8518.25	7.46375	Qoa LQ	425	0	511.502	425	4400.8	537.806	3863	4467.81	3930.01
25	1.90439	8415.08	7.46375	Qoa LQ	425	0	511.502	425	4346.63	522.025	3824.6	4413.64	3891.61
26	1.90439	8311.91	7.46375	Qoa LQ	425	0	511.502	425	4292.45	506.243	3786.2	4359.46	3853.22
27	2.86997	12348.6	5.49584	Qoa LQ	425	0	511.502	425	4249.69	489.576	3760.11	4298.9	3809.33
28	2.86997	12147.6	5.49584	Qoa LQ	425	0	511.502	425	4179.66	472.024	3707.64	4228.88	3756.85
29	1.91331	7982.37	5.49584	Qoa LQ	425	0	511.502	425	4119.02	457.397	3661.62	4168.24	3710.84
30	1.91331	7888.66	5.49584	Qoa LQ	425	0	511.502	425	4070.04	445.695	3624.34	4119.25	3673.56
31	1.91331	7794.95	5.49584	Qoa LQ	425	0	511.502	425	4021.06	433.993	3587.07	4070.28	3636.28
32	2.81931	11331	3.61763	Qoa LQ	425	0	511.502	425	3984.23	422.423	3561.81	4016.57	3594.15
33	2.81931	11159	3.61763	Qoa LQ	425	0	511.502	425	3923.24	410.985	3512.25	3955.58	3544.59
34	1.87954	7343.76	3.61763	Qoa LQ	425	0	511.502	425	3872.39	401.453	3470.94	3904.73	3503.28
35	1.87954	7267.34	3.61763	Qoa LQ	425	0	511.502	425	3831.73	393.827	3437.91	3864.07	3470.25
36	1.87954	7190.95	3.61763	Qoa LQ	425	0	511.502	425	3791.09	386.201	3404.89	3823.43	3437.23
37	2.8193	10670.2	1.6212	Qoa LQ	425	0	511.502	425	3769.11	379.741	3389.36	3783.58	3403.84
38	2.8193	10560.6	1.6212	Qoa LQ	425	0	511.502	425	3730.21	374.446	3355.76	3744.69	3370.24
39	2.8193	10450.7	1.69635	Qoa LQ	425	0	511.502	425	3690.54	369.035	3321.5	3705.69	3336.65
40	2.8193	10340.8	1.69635	Qoa LQ	425	0	511.502	425	3651.57	363.509	3288.06	3666.72	3303.21
41	2.38826	8117.81	57.8141	Qal/Qoa	300	30	1167.09	969.716	1402.2	242.222	1159.98	3256.52	3014.3
42	1.27434	3847.69	57.2374	Qal/Qoa	300	30	1117.15	928.228	1149.97	61.8441	1088.12	2885.94	2824.09
43	1.11392	3093.26	57.2374	Qal/Qoa	300	30	1059.12	880.012	1004.61	0	1004.61	2650.41	2650.41
44	1.74663	4351.48	56.8439	Qal/Qoa	300	30	975.212	810.29	883.85	0	883.85	2376.62	2376.62
45	1.74614	3739.5	57.2752	Qal/Qoa	300	30	854.337	709.857	709.893	0	709.893	2039.4	2039.4
46	1.71546	3051.84	59.2231	Qal/Qoa	300	30	707.874	588.163	499.112	0	499.112	1687.67	1687.67
47	1.71546	2402.9	59.0983	Qal/Qoa	300	30	593.009	492.723	333.805	0	333.805	1324.58	1324.58
48	2.75364	2493.15	58.5696	Qal/Qoa	300	30	445.149	369.868	121.015	0	121.015	849.417	849.417
49	1.43925	642.049	58.2125	Qal/Qoa	300	30	303.992	252.583	-82.1293	0	-82.1293	408.398	408.398
50	1.31439	190.428	58.2125	Afc	100	32	99.4064	82.5954	-27.8533	0	-27.8533	132.551	132.551

Global Minimum Query (spencer) - Safety Factor: 0.998177

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.36049	459.305	-34.1494	Qal/Qoa	300	30	1251.2	1248.92	1643.57	0	1643.57	794.872	794.872
2	1.24954	394.983	-29.824	Qal/Qoa	300	30	1235.48	1233.23	1616.4	0	1616.4	908.143	908.143
3	1.7634	740.959	-29.824	Qal/Qoa	300	30	1357.1	1354.63	1858.1	31.4307	1826.67	1080.12	1048.69
4	1.7634	957.279	-29.824	Qal/Qoa	300	30	1464.06	1461.39	2105.89	94.3123	2011.58	1266.61	1172.29
5	2.09661	1412.68	-28.7151	Qal/Qoa	300	30	1488.04	1485.33	2214.53	161.471	2053.06	1399.34	1237.87
6	2.09661	1704.5	-28.7151	Qal/Qoa	300	30	1601.24	1598.32	2481.67	232.907	2248.76	1604.46	1371.56
7	2.97305	3367.88	-28.501	Qal/Qoa	300	30	1944.12	1940.58	3160.41	318.825	2841.58	2104.79	1785.97
8	1.22015	1852.37	-28.501	Qoa LQ	425	0	425.776	425	2115.19	389.626	1725.56	1884	1494.37
9	2.09667	3887.97	-29.8827	Qoa LQ	425	0	425.776	425	2534.42	447.701	2086.72	2289.76	1842.05
10	2.09667	4913.12	-29.8827	Qoa LQ	425	0	425.776	425	3088.07	522.645	2565.43	2843.41	2320.77
11	1.911	5314.93	-16.4768	Qoa LQ	425	0	425.776	425	3147.94	577.645	2570.3	3022.01	2444.37
12	1.911	6042.35	-16.4768	Qoa LQ	425	0	425.776	425	3542.12	612.701	2929.42	3416.18	2803.48
13	1.911	6764.12	-16.4768	Qoa LQ	425	0	425.776	425	3933.22	647.756	3285.46	3807.28	3159.53
14	1.94533	7564.94	1.40873	Qoa LQ	425	0	425.776	425	3775.09	663.683	3111.4	3785.56	3121.88
15	1.94533	9106.74	1.40873	Qoa LQ	425	0	425.776	425	4522.36	660.479	3861.89	4532.84	3872.36
16	1.94533	9703.71	1.40873	Qoa LQ	425	0	425.776	425	4811.7	657.276	4154.43	4822.17	4164.9
17	2.9413	14482.2	4.64878	Qoa LQ	425	0	425.776	425	4653.23	648.048	4005.18	4687.85	4039.8
18	2.9413	14242.6	4.64878	Qoa LQ	425	0	425.776	425	4577.62	632.794	3944.83	4612.25	3979.45
19	1.9959	9552.63	2.65629	Qoa LQ	425	0	425.776	425	4584.04	622.166	3961.87	4603.79	3981.62
20	1.9959	9472.6	2.65629	Qoa LQ	425	0	425.776	425	4546.46	616.164	3930.3	4566.21	3950.05
21	1.9959	9392.57	2.65629	Qoa LQ	425	0	425.776	425	4508.88	610.162	3898.72	4528.64	3918.47
22	1.9966	9323.24	1.60989	Qoa LQ	425	0	425.776	425	4505.35	605.299	3900.05	4517.31	3912.01
23	1.9966	9259.04	1.60989	Qoa LQ	425	0	425.776	425	4475.06	601.574	3873.49	4487.03	3885.45
24	1.9966	9194.86	1.60989	Qoa LQ	425	0	425.776	425	4444.78	597.848	3846.93	4456.75	3858.9
25	2.99485	13660.2	2.83161	Qoa LQ	425	0	425.776	425	4368.28	591.196	3777.08	4389.33	3798.14
26	2.99485	13492.8	2.83161	Qoa LQ	425	0	425.776	425	4315.95	581.617	3734.33	4337.01	3755.39
27	1.99641	8892.21	5.05675	Qoa LQ	425	0	425.776	425	4206.04	571.205	3634.84	4243.72	3672.51
28	1.99641	8799.05	5.05675	Qoa LQ	425	0	425.776	425	4162.81	559.958	3602.85	4200.49	3640.53
29	1.99641	8702.38	5.05675	Qoa LQ	425	0	425.776	425	4117.96	548.711	3569.25	4155.64	3606.93
30	1.99639	8601.67	5.60459	Qoa LQ	425	0	425.776	425	4056.52	536.863	3519.66	4098.3	3561.44
31	1.99639	8498.73	5.60459	Qoa LQ	425	0	425.776	425	4008.88	524.414	3484.47	4050.66	3526.25
32	1.99639	8395.78	5.60459	Qoa LQ	425	0	425.776	425	3961.24	511.966	3449.28	4003.03	3491.06
33	2.99456	12392.2	6.48665	Qoa LQ	425	0	425.776	425	3876.13	494.951	3381.18	3924.54	3429.59
34	2.99456	12143.8	6.48665	Qoa LQ	425	0	425.776	425	3799.85	473.37	3326.48	3848.26	3374.89
35	2.9946	11905.6	5.43628	Qoa LQ	425	0	425.776	425	3753.22	453.519	3299.7	3793.74	3340.22
36	2.9946	11682.2	5.43628	Qoa LQ	425	0	425.776	425	3684.24	435.401	3248.84	3724.76	3289.36
37	2.83372	10869.1	5.7285	Qoa LQ	425	0	425.776	425	3616.5	417.314	3199.19	3659.21	3241.9
38	2.83372	10689.4	5.7285	Qoa LQ	425	0	425.776	425	3557.93	399.258	3158.68	3600.65	3201.39
39	2.83382	10521.1	4.46842	Qoa LQ	425	0	425.776	425	3533.56	383.162	3150.4	3566.83	3183.67
40	2.83382	10363.6	4.46842	Qoa LQ	425	0	425.776	425	3481.93	369.026	3112.91	3515.21	3146.18
41	0.0190926	69.2642	50.8449	Qoa LQ	425	0	425.776	425	2260.42	361.225	1899.19	2783.31	2422.08
42	2.56061	8748.66	50.8449	Qal/Qoa	300	30	1096.9	1094.9	1639.04	262.236	1376.81	2986.13	2723.89
43	2.12728	6449.96	50.9709	Qal/Qoa	300	30	1056.98	1055.05	1389.78	81.9852	1307.79	2693.68	2611.7
44	0.452449	1276.02	50.9709	Qal/Qoa	300	30	1029.36	1027.48	1260.03	0	1260.03	2529.86	2529.86
45	2.20624	5702.13	54.0822	Qal/Qoa	300	30	907.316	905.662	1049.04	0	1049.04	2301.63	2301.63
46	2.17686	4759.38	53.7383	Qal/Qoa	300	30	804.474	803.007	871.234	0	871.234	1967.93	1967.93
47	2.07328	3721.68	53.0265	Qal/Qoa	300	30	706.622	705.334	702.06	0	702.06	1640.68	1640.68
48	2.07327	2871.01	57.7382	Qal/Qoa	300	30	543.333	542.343	419.749	0	419.749	1280.49	1280.49
49	2.10028	1972.97	57.7929	Qal/Qoa	300	30	431.68	430.893	226.714	0	226.714	912.022	912.022
50	2.01044	995.155	62.2294	Qal/Qoa	300	30	296.733	296.192	-6.59535	0	-6.59535	556.911	556.911

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.830886

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	226.817	395.333	0	0	0
2	229.111	393.835	3014.63	0	0
3	231.405	392.337	7083.09	0	0
4	232	391.948	8297.17	0	0
5	234.556	390.368	13528.1	0	0
6	237.112	388.787	19436.3	0	0
7	238.864	387.654	24186	0	0
8	240.616	386.521	29527.7	0	0
9	240.787	386.404	30167.7	0	0
10	244.119	384.133	35501.5	0	0
11	245.871	382.911	38880.2	0	0
12	247.623	381.69	42654.6	0	0
13	250.474	381.676	42707.4	0	0
14	253.325	381.663	42527.4	0	0
15	255.228	381.654	42275.4	0	0
16	257.131	381.645	41758.4	0	0
17	259.034	381.637	41136.7	0	0
18	261.934	381.918	38780.3	0	0
19	264.835	382.199	36493.1	0	0
20	266.771	382.387	35000.5	0	0
21	268.707	382.575	33535.1	0	0
22	270.644	382.763	32096.9	0	0
23	273.5	383.137	29591.1	0	0
24	276.357	383.511	27157.5	0	0
25	278.261	383.761	25575.2	0	0
26	280.166	384.01	24025	0	0
27	282.07	384.26	22506.9	0	0
28	284.94	384.536	20691.5	0	0
29	287.81	384.812	18931.6	0	0
30	289.723	384.996	17790.4	0	0
31	291.637	385.18	16675	0	0
32	293.55	385.364	15585.6	0	0
33	296.369	385.542	14388.7	0	0
34	299.189	385.721	13233.7	0	0
35	301.068	385.84	12487	0	0
36	302.948	385.958	11758.8	0	0
37	304.827	386.077	11049.2	0	0
38	307.646	386.157	10380.8	0	0
39	310.466	386.237	9735.12	0	0
40	313.285	386.32	9098.76	0	0
41	316.104	386.404	8485.44	0	0
42	318.493	390.198	4705.01	0	0
43	319.767	392.179	3268.29	0	0
44	320.881	393.91	2243.03	0	0
45	322.628	396.583	930.96	0	0
46	324.374	399.3	-64.6985	0	0
47	326.089	402.181	-743.989	0	0
48	327.805	405.047	-1037.77	0	0
49	330.558	409.553	-711.816	0	0
50	331.997	411.875	-165.5	0	0
51	333.312	413.996	0	0	0

Global Minimum Query (spencer) - Safety Factor: 0.998177

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	226.817	395.333	0	0	0
2	230.177	393.054	7868.38	2212.65	15.7064
3	231.427	392.337	10498.9	2952.37	15.7064
4	233.19	391.326	14636.9	4116.02	15.7064
5	234.954	390.315	19175.1	5392.2	15.7064
6	237.05	389.167	24584.3	6913.28	15.7064
7	239.147	388.018	30485	8572.62	15.7064
8	242.12	386.404	40760.5	11462.2	15.7064
9	243.34	385.741	42348	11908.6	15.7064
10	245.437	384.537	45594.3	12821.5	15.7064
11	247.534	383.332	49323.2	13870.1	15.7064
12	249.445	382.767	50959.4	14330.2	15.7064
13	251.356	382.201	52687.5	14816.1	15.7064
14	253.267	381.636	54506.8	15327.7	15.7064
15	255.212	381.684	53792.8	15126.9	15.7063
16	257.157	381.732	52765.5	14838.1	15.7064
17	259.103	381.78	51616.9	14515.1	15.7064
18	262.044	382.019	49149.5	13821.2	15.7064
19	264.985	382.258	46743.3	13144.6	15.7064
20	266.981	382.351	45449.2	12780.7	15.7064
21	268.977	382.443	44172.9	12421.8	15.7064
22	270.973	382.536	42914.5	12067.9	15.7064
23	272.969	382.592	41833.6	11763.9	15.7064
24	274.966	382.648	40766	11463.7	15.7064
25	276.963	382.704	39711.6	11167.2	15.7064
26	279.958	382.852	37880.8	10652.4	15.7064
27	282.952	383	36087.9	10148.2	15.7064
28	284.949	383.177	34594.3	9728.19	15.7064
29	286.945	383.354	33125.1	9315.04	15.7064
30	288.942	383.53	31681.2	8909.01	15.7064
31	290.938	383.726	30188.2	8489.17	15.7064
32	292.934	383.922	28723.1	8077.16	15.7064
33	294.931	384.118	27285.8	7672.98	15.7064
34	297.925	384.459	25010.5	7033.14	15.7064
35	300.92	384.799	22805.8	6413.18	15.7064
36	303.915	385.084	20868.2	5868.31	15.7064
37	306.909	385.369	18990.5	5340.27	15.7064
38	309.743	385.653	17212.5	4840.29	15.7064
39	312.577	385.938	15483.5	4354.09	15.7064
40	315.41	386.159	14013.8	3940.78	15.7064
41	318.244	386.381	12583.8	3538.66	15.7064
42	318.263	386.404	12526.5	3522.54	15.7064
43	320.824	389.549	8606.2	2420.13	15.7064
44	322.951	392.173	6046.58	1700.34	15.7063
45	323.404	392.731	5579.34	1568.95	15.7064
46	325.61	395.777	3359.53	944.725	15.7064
47	327.787	398.744	1668.59	469.219	15.7063
48	329.86	401.498	530.239	149.107	15.7064
49	331.933	404.783	-238.716	-67.1288	15.7064
50	334.034	408.117	-443.135	-124.613	15.7064
51	336.044	411.935	0	0	0

Entity Information

Water Table

X	Y
100	393.246
111.262	393.246
126.31	392.526
347.806	392.128

Block Search Window

X	Y
235.431	381.637
269.733	381.637
269.558	386.404
236.014	386.404

Block Search Window

X	Y
286.476	381.637
331.421	381.637
333.73	386.404
291.726	386.404

Block Search Window

X	Y
293.747	389.412
337.366	389.412
357.063	408.799
308.935	408.799

External Boundary

X	Y
100	250
158.077	250
1070.58	250
1070.58	667.577
1057.02	664.689
1047.6	661.927
1040.44	659.164
1034.04	656.151
1027.26	654.142
999.257	653.137
955.939	652.007
949.033	650.249
936.728	649.37
916.764	647.864
912.494	647.236
906.719	644.097
898.306	638.698
892.656	636.438
888.01	635.433
872.064	634.805
855.49	633.675
851.849	632.294
842.934	629.406
834.898	626.267
828.996	623.505
824.351	622.249
806.898	620.115
794.467	615.595
786.808	612.33
781.534	609.944
764.709	608.689
753.785	608.186
749.14	606.429
740.225	602.285
730.557	597.388
725.785	593.998
719.884	588.222
713.983	582.195
709.463	578.68
705.193	575.917
699.292	572.402
691.884	568.258
683.471	562.733
674.933	557.334
666.772	551.433
658.861	547.289
652.458	544.778
645.929	542.518
634.879	539.756
628.476	537.872
619.059	537.37
606	536.742
594.574	536.114
582.52	535.989
577.498	534.357
573.857	533.478
569.085	531.594

565.193	528.832
557.157	523.056
551.256	518.285
542.843	512.886
538.323	509.747
528.153	501.585
521.875	498.07
513.713	492.796
507.309	488.778
499.776	482.5
492.117	477.854
485.713	474.464
480.816	472.832
476.17	471.702
470.269	471.074
466.377	470.823
463.112	470.195
459.973	469.065
446.538	460.401
433.229	452.491
423.435	445.585
416.152	441.818
397.569	433.155
382.753	424.868
370.197	419.343
354.627	413.442
345.713	411.935
336.044	411.935
336.044	414.069
333.659	413.944
326.125	415.074
305.282	416.832
286.527	418.968
271.122	420.536
262.745	421.509
255.949	422.56
255.949	415.746
254.035	412.982
249.357	406.815
246.949	403.573
243.828	399.373
239.363	395.12
226.817	395.333
218.737	400.224
214.697	402.563
209.806	403.839
200.663	405.752
187.904	406.178
159.623	407.453
152.318	410.212
145.649	410.212
130.978	411.99
119.203	413.822
110.972	415.102
100	416.436
100	393.246

Material Boundary

X	Y
255.949	415.746
266.398	415.746
286.492	415.746
301.037	414.388
312.753	413.198
318.703	412.283
322.456	411.734
336.044	411.935

Material Boundary

X	Y
119.203	413.822
122.348	408.73
130.991	402.969
135.672	402.609
140.714	399.728
150.077	397.927
166.281	396.487
179.245	396.487
192.044	393.855
202.292	391.445
209.854	391.445
227.499	390.365
236.862	391.085
241.733	394.109
246.949	403.573

Material Boundary

X	Y
100	393.246
114.786	393.246
126.31	392.526
132.071	389.645
140.714	387.844
150.437	387.844
161.96	386.404
170.242	384.963
186.302	384.963
200.655	383.33
212.854	380.799
230.809	380.799
247.313	381.637
269.733	381.637
296.279	382.443
311.404	382.083
320.766	384.243
333.73	386.404
345.614	390.725
354.616	396.487
362.539	407.29
370.197	419.343

Material Boundary

X	Y
158.077	250
170.242	384.963

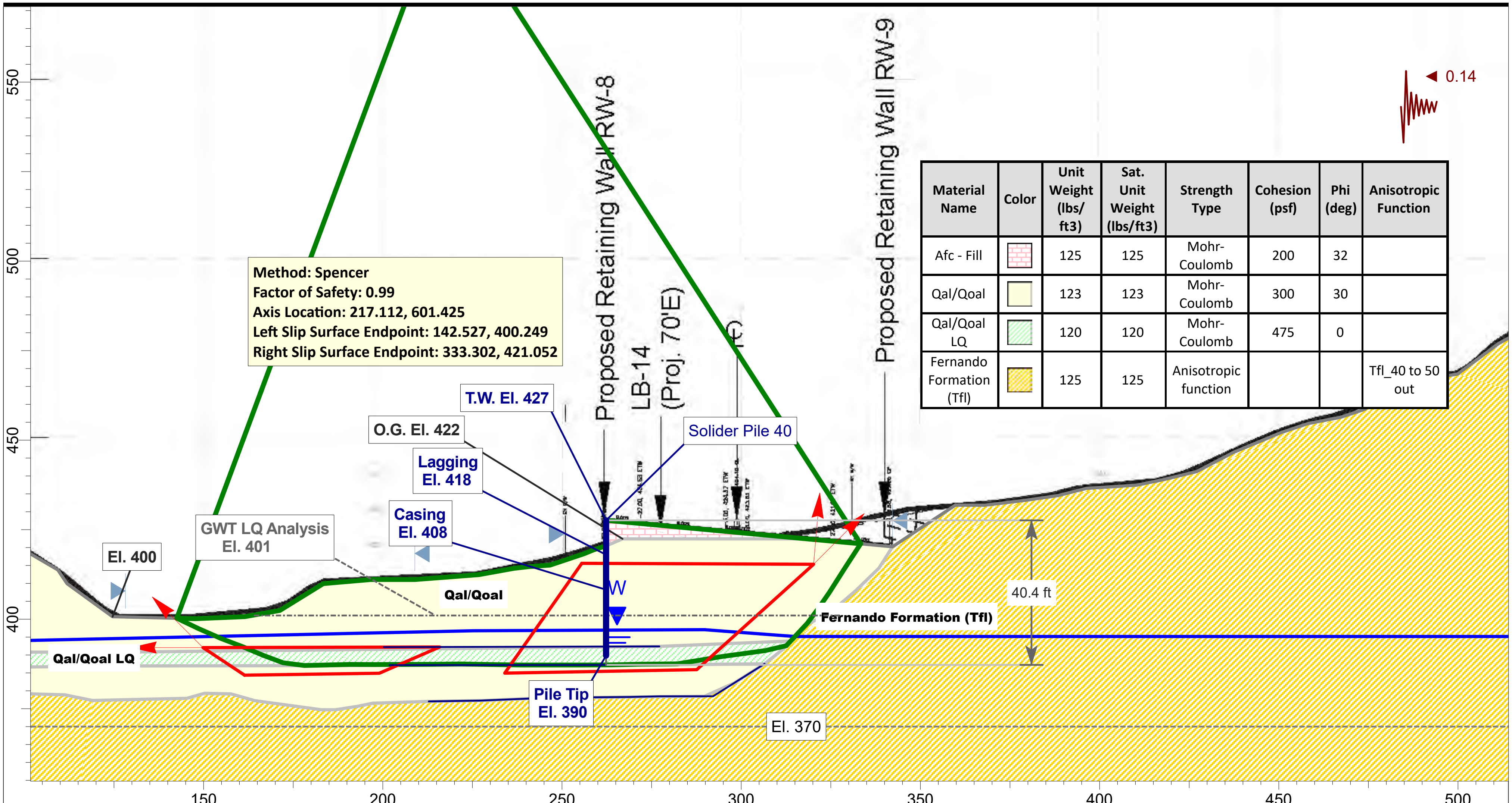
Material Boundary

X	Y
161.96	386.404
333.73	386.404

Section 38+00 Global Stability - Liquefaction - Yield Acceleration

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 38+00\11585_Sec 38+00_Cut Slope_Blk SrfA_LQ_c2_ky.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function
Afc - Fill		125	125	Mohr-Coulomb	200	32	
Qal/Qoal		123	123	Mohr-Coulomb	300	30	
Qal/Qoal LQ		120	120	Mohr-Coulomb	475	0	
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 out

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA			
Analyzed By: JEH	Units: feet	Scale: 1:480	Project No.: 11585.005
Date: March 26, 2021	Condition: PseudoStatic		File Name: 11585_Sec 38+00_Cut Slope_Blk SrfA_LQ_c2_ky.slim

Slide Analysis Information

Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA

Project Summary

Slide Modeler Version:	9.012
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	March 26, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	135
Left Projection Angle (End Angle) [deg]:	180
Right Projection Angle (Start Angle) [deg]:	45
Right Projection Angle (End Angle) [deg]:	85
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.14

Materials

Afc - Fill	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Cohesion [psf]	200
Friction Angle [deg]	32
Water Surface	Water Table
Hu Value	Automatically Calculated
Qal/Qoal	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	123
Saturated Unit Weight [lbs/ft3]	123
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	Water Table
Hu Value	Automatically Calculated
Qal/Qoal LQ	
Color	
Strength Type	Mohr-Coulomb
Unsaturated Unit Weight [lbs/ft3]	120
Saturated Unit Weight [lbs/ft3]	120
Cohesion [psf]	475
Friction Angle [deg]	0
Water Surface	Water Table
Hu Value	Automatically Calculated
Fernando Formation (Tfl)	
Color	
Strength Type	Anisotropic function
Unsaturated Unit Weight [lbs/ft3]	125
Saturated Unit Weight [lbs/ft3]	125
Water Surface	Water Table
Hu Value	Automatically Calculated

Anisotropic Functions

Name: Tfl_40 to 50 out

Angle From	Angle To	c	phi
-90	40	600	34
40	50	200	15
50	90	600	34

Global Minimums

Method: janbu corrected

FS	0.959676
Axis Location:	217.112, 601.425
Left Slip Surface Endpoint:	142.527, 400.249
Right Slip Surface Endpoint:	333.302, 421.052
Resisting Horizontal Force:	107660 lb
Driving Horizontal Force:	112184 lb
Total Slice Area:	4633.08 ft2
Surface Horizontal Width:	190.775 ft
Surface Average Height:	24.2856 ft

Method: spencer

FS	0.985564
Axis Location:	217.112, 601.425
Left Slip Surface Endpoint:	142.527, 400.249
Right Slip Surface Endpoint:	333.302, 421.052
Resisting Moment:	2.48534e+07 lb-ft
Driving Moment:	2.52175e+07 lb-ft
Resisting Horizontal Force:	105323 lb
Driving Horizontal Force:	106866 lb
Total Slice Area:	4633.08 ft2
Surface Horizontal Width:	190.775 ft
Surface Average Height:	24.2856 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
142.527	400.249
148.711	397.302
154.895	394.6
161.08	392.21
166.612	389.88
172.145	387.818
178.09	387.072
184.051	387.191
190.853	387.366
197.654	387.34
204.988	387.372
213.355	387.389
221.722	387.5
230.089	387.318
238.456	387.182
246.823	387.181
255.19	387.19
263.558	387.218
271.925	387.42
282.159	387.524
288.365	388.539
294.572	389.554
300.671	390.389
306.762	391.224
312.583	392.584
318.403	398.821
321.494	402.973
324.584	407.453
328.943	414.316
333.302	421.052

Method: spencer

X	Y
142.527	400.249
148.711	397.302
154.895	394.6
161.08	392.21
166.612	389.88
172.145	387.818
178.09	387.072
184.051	387.191
190.853	387.366
197.654	387.34
204.988	387.372
213.355	387.389
221.722	387.5
230.089	387.318
238.456	387.182
246.823	387.181
255.19	387.19
263.558	387.218
271.925	387.42
282.159	387.524
288.365	388.539
294.572	389.554
300.671	390.389
306.762	391.224
312.583	392.584
318.403	398.821
321.494	402.973
324.584	407.453
328.943	414.316
333.302	421.052

Global Minimum Support Data

No Supports Present

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4846
Number of Invalid Surfaces:	172

Error Codes

Error Code -108 reported for 1 surface
Error Code -111 reported for 29 surfaces
Error Code -112 reported for 133 surfaces
Error Code -1000 reported for 9 surfaces

Method: spencer

Number of Valid Surfaces:	4343
Number of Invalid Surfaces:	675

Error Codes

Error Code -108 reported for 9 surfaces
Error Code -111 reported for 524 surfaces
Error Code -112 reported for 135 surfaces
Error Code -1000 reported for 7 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.959676

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	6.18422	1066.72	-25.4792	Qal/Qoal	300	30	597.585	573.488	473.696	0	473.696	188.928	188.928
2	4.82758	2386.63	-23.5993	Qal/Qoal	300	30	844.908	810.838	884.797	0	884.797	515.679	515.679
3	1.35664	917.623	-23.5993	Qal/Qoal	300	30	980.409	940.875	1129.43	19.403	1110.03	701.116	681.713
4	3.09211	2466.69	-21.127	Qal/Qoal	300	30	988.558	948.695	1201.77	78.2007	1123.57	819.786	741.585
5	3.09211	2970.17	-21.127	Qal/Qoal	300	30	1055.62	1013.05	1392.01	156.968	1235.04	984.107	827.139
6	2.41583	2717.49	-22.8402	Qal/Qoal	300	30	1162.76	1115.87	1642.87	229.741	1413.13	1153.13	923.392
7	3.11704	4132.22	-22.8402	Qal/Qoal LQ	475	0	494.959	475	1546.19	306.213	1239.98	1337.72	1031.51
8	5.53287	8994.9	-20.4411	Qal/Qoal LQ	475	0	494.959	475	1820.84	417.402	1403.44	1636.36	1218.96
9	5.94439	12628.4	-7.15325	Qal/Qoal LQ	475	0	494.959	475	2190.13	512.857	1677.27	2128.01	1615.15
10	5.96135	15574.1	1.14906	Qal/Qoal LQ	475	0	494.959	475	2602.01	540.568	2061.44	2611.94	2071.37
11	3.40086	9533.02	1.47028	Qal/Qoal LQ	475	0	494.959	475	2789.68	540.546	2249.14	2802.39	2261.84
12	3.40086	9620.76	1.47028	Qal/Qoal LQ	475	0	494.959	475	2815.48	539.772	2275.71	2828.18	2288.41
13	3.40086	9728.97	-0.219821	Qal/Qoal LQ	475	0	494.959	475	2862.75	542.127	2320.62	2860.85	2318.72
14	3.40086	9852.01	-0.219821	Qal/Qoal LQ	475	0	494.959	475	2898.93	547.611	2351.32	2897.03	2349.42
15	3.66652	10653	0.253014	Qal/Qoal LQ	475	0	494.959	475	2903.16	552.366	2350.79	2905.35	2352.98
16	3.66652	10645.5	0.253014	Qal/Qoal LQ	475	0	494.959	475	2901.11	556.392	2344.72	2903.3	2346.91
17	4.18358	12140.3	0.116293	Qal/Qoal LQ	475	0	494.959	475	2900.83	561.012	2339.82	2901.84	2340.83
18	4.18358	12226	0.116293	Qal/Qoal LQ	475	0	494.959	475	2921.32	566.228	2355.09	2922.32	2356.1
19	4.18358	12370.9	0.756409	Qal/Qoal LQ	475	0	494.959	475	2950.11	569.986	2380.12	2956.65	2386.66
20	4.18358	12504.1	0.756409	Qal/Qoal LQ	475	0	494.959	475	2981.92	572.286	2409.64	2988.46	2416.17
21	4.18358	12673.9	-1.24416	Qal/Qoal LQ	475	0	494.959	475	3040.82	579.143	2461.67	3030.07	2450.92
22	4.18358	12952.6	-1.24416	Qal/Qoal LQ	475	0	494.959	475	3107.42	587.749	2519.67	3096.67	2508.92
23	4.18358	13378.3	-0.932532	Qal/Qoal LQ	475	0	494.959	475	3206.32	593.826	2612.5	3198.27	2604.44
24	4.18358	13788.3	-0.932532	Qal/Qoal LQ	475	0	494.959	475	3304.34	599.192	2705.15	3296.28	2697.09
25	4.18358	14058.6	-0.00768899	Qal/Qoal LQ	475	0	494.959	475	3360.49	602.451	2758.04	3360.43	2757.98
26	4.18358	14229.1	-0.00768899	Qal/Qoal LQ	475	0	494.959	475	3401.25	603.603	2797.65	3401.18	2797.58
27	4.18358	14688.8	0.0630096	Qal/Qoal LQ	475	0	494.959	475	3510.48	604.593	2905.89	3511.03	2906.43
28	4.18358	15403.5	0.0630096	Qal/Qoal LQ	475	0	494.959	475	3681.32	605.423	3075.89	3681.86	3076.44
29	4.18358	16170.5	0.191076	Qal/Qoal LQ	475	0	494.959	475	3863.49	605.961	3257.53	3865.14	3259.18
30	4.18358	18010.2	0.191076	Qal/Qoal LQ	475	0	494.959	475	4303.23	606.207	3697.02	4304.88	3698.67
31	4.18358	20575.4	1.38483	Qal/Qoal LQ	475	0	494.959	475	4905.49	603.734	4301.75	4917.45	4313.72
32	4.18358	20317.7	1.38483	Qal/Qoal LQ	475	0	494.959	475	4843.86	598.54	4245.32	4855.83	4257.29
33	5.11705	24529.2	0.580487	Qal/Qoal LQ	475	0	494.959	475	4788.32	595.008	4193.31	4793.33	4198.32
34	5.11705	24193.7	0.580487	Qal/Qoal LQ	475	0	494.959	475	4722.75	593.139	4129.61	4727.77	4134.63
35	3.1032	14419.4	9.28738	Qal/Qoal LQ	475	0	494.959	475	4561.01	576.786	3984.22	4641.95	4065.16

36	3.1032	14118.3	9.28738	Qal/Qoal LQ	475	0	494.959	475	4463.98	545.949	3918.03	4544.92	3998.97
37	6.20639	27333.3	9.28738	Qal/Qoal LQ	475	0	494.959	475	4318.45	488.493	3829.96	4399.39	3910.9
38	3.04975	13004.8	7.79818	Qal/Qoal LQ	475	0	494.959	475	4192.52	422.749	3769.77	4260.3	3837.56
39	3.04975	12743.7	7.79818	Qal/Qoal LQ	475	0	494.959	475	4106.89	382.799	3724.09	4174.67	3791.87
40	3.04522	12464.1	7.80744	Qal/Qoal LQ	475	0	494.959	475	4021.19	342.863	3678.33	4089.06	3746.2
41	3.04522	12203.5	7.80744	Qal/Qoal LQ	475	0	494.959	475	3935.63	302.942	3632.69	4003.5	3700.55
42	5.82087	22405.4	13.1527	Qal/Qoal LQ	475	0	494.959	475	3726.81	227.385	3499.43	3842.47	3615.09
43	1.25864	4588.26	46.9732	Qal/Qoal LQ	475	0	494.959	475	3084.51	127.052	2957.46	3614.79	3487.74
44	1.16033	4030.95	46.9732	Fernando Formation (Tfl)	200	15	886.428	850.684	2469.46	41.0714	2428.38	3419.14	3378.07
45	2.88627	9190.29	46.9732	Fernando Formation (Tfl)	200	15	833.67	800.053	2239.43	0	2239.43	3132.59	3132.59
46	0.515601	1515.99	46.9732	Qal/Qoal	300	30	1237.69	1187.78	1537.68	0	1537.68	2863.7	2863.7
47	3.0904	8129.12	53.3416	Qal/Qoal	300	30	1021.62	980.421	1178.52	0	1178.52	2551.21	2551.21
48	3.0904	6380.14	55.4021	Qal/Qoal	300	30	808.654	776.046	824.535	0	824.535	1996.84	1996.84
49	4.35894	5774.17	57.5786	Qal/Qoal	300	30	554.252	531.902	401.666	0	401.666	1274.31	1274.31
50	4.35894	1913.35	57.0911	Qal/Qoal	300	30	290.77	279.045	-36.2946	0	-36.2946	413.014	413.014

Global Minimum Query (spencer) - Safety Factor: 0.985564

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	6.18422	1066.72	-25.4792	Qal/Qoal	300	30	705.993	695.801	685.548	0	685.548	349.12	349.12
2	4.82758	2386.63	-23.5993	Qal/Qoal	300	30	997.604	983.203	1183.34	0	1183.34	747.514	747.514
3	1.35664	917.623	-23.5993	Qal/Qoal	300	30	1163.13	1146.34	1485.31	19.403	1465.91	977.167	957.764
4	3.09211	2466.69	-21.127	Qal/Qoal	300	30	1155.11	1138.43	1530.4	78.2007	1452.2	1084.06	1005.86
5	3.09211	2970.17	-21.127	Qal/Qoal	300	30	1238.02	1220.15	1750.71	156.968	1593.74	1272.32	1115.36
6	2.41583	2717.49	-22.8402	Qal/Qoal	300	30	1386.86	1366.84	2077.56	229.741	1847.82	1493.44	1263.69
7	3.11704	4132.22	-22.8402	Qal/Qoal LQ	475	0	481.958	475	1706.47	306.213	1400.26	1503.48	1197.27
8	5.53287	8994.9	-20.4411	Qal/Qoal LQ	475	0	481.958	475	1979.09	417.402	1561.69	1799.46	1382.06
9	5.94439	12628.4	-7.15325	Qal/Qoal LQ	475	0	481.958	475	2267.06	512.857	1754.2	2206.57	1693.72
10	5.96135	15574.1	1.14906	Qal/Qoal LQ	475	0	481.958	475	2614.02	540.568	2073.45	2623.68	2083.12
11	3.40086	9533.02	1.47028	Qal/Qoal LQ	475	0	481.958	475	2793.87	540.546	2253.32	2806.24	2265.69
12	3.40086	9620.76	1.47028	Qal/Qoal LQ	475	0	481.958	475	2818.92	539.772	2279.15	2831.29	2291.52
13	3.40086	9728.97	-0.219821	Qal/Qoal LQ	475	0	481.958	475	2878.79	542.127	2336.66	2876.94	2334.81
14	3.40086	9852.01	-0.219821	Qal/Qoal LQ	475	0	481.958	475	2914.11	547.611	2366.49	2912.26	2364.65
15	3.66652	10653	0.253014	Qal/Qoal LQ	475	0	481.958	475	2914.26	552.366	2361.89	2916.39	2364.02
16	3.66652	10645.5	0.253014	Qal/Qoal LQ	475	0	481.958	475	2912.27	556.392	2355.88	2914.4	2358.01
17	4.18358	12140.3	0.116293	Qal/Qoal LQ	475	0	481.958	475	2913.14	561.012	2352.13	2914.12	2353.11
18	4.18358	12226	0.116293	Qal/Qoal LQ	475	0	481.958	475	2933.1	566.228	2366.87	2934.08	2367.85
19	4.18358	12370.9	0.756409	Qal/Qoal LQ	475	0	481.958	475	2955.73	569.986	2385.74	2962.09	2392.1
20	4.18358	12504.1	0.756409	Qal/Qoal LQ	475	0	481.958	475	2986.7	572.286	2414.42	2993.07	2420.78
21	4.18358	12673.9	-1.24416	Qal/Qoal LQ	475	0	481.958	475	3061.68	579.143	2482.54	3051.21	2472.07
22	4.18358	12952.6	-1.24416	Qal/Qoal LQ	475	0	481.958	475	3126.92	587.749	2539.17	3116.45	2528.7
23	4.18358	13378.3	-0.932532	Qal/Qoal LQ	475	0	481.958	475	3220.83	593.826	2627.01	3212.99	2619.16

24	4.18358	13788.3	-0.932532	Qal/Qoal LQ	475	0	481.958	475	3316.72	599.192	2717.53	3308.87	2709.68
25	4.18358	14058.6	-0.00768899	Qal/Qoal LQ	475	0	481.958	475	3362.57	602.451	2760.12	3362.51	2760.06
26	4.18358	14229.1	-0.00768899	Qal/Qoal LQ	475	0	481.958	475	3402.32	603.603	2798.72	3402.26	2798.66
27	4.18358	14688.8	0.0630096	Qal/Qoal LQ	475	0	481.958	475	3508.19	604.593	2903.6	3508.72	2904.13
28	4.18358	15403.5	0.0630096	Qal/Qoal LQ	475	0	481.958	475	3674.77	605.423	3069.35	3675.3	3069.88
29	4.18358	16170.5	0.191076	Qal/Qoal LQ	475	0	481.958	475	3851.01	605.961	3245.05	3852.62	3246.66
30	4.18358	18010.2	0.191076	Qal/Qoal LQ	475	0	481.958	475	4279.73	606.207	3673.52	4281.34	3675.13
31	4.18358	20575.4	1.38483	Qal/Qoal LQ	475	0	481.958	475	4849.76	603.734	4246.03	4861.41	4257.68
32	4.18358	20317.7	1.38483	Qal/Qoal LQ	475	0	481.958	475	4789.93	598.54	4191.39	4801.58	4203.04
33	5.11705	24529.2	0.580487	Qal/Qoal LQ	475	0	481.958	475	4747.18	595.008	4152.17	4752.06	4157.06
34	5.11705	24193.7	0.580487	Qal/Qoal LQ	475	0	481.958	475	4683.34	593.139	4090.2	4688.22	4095.08
35	3.1032	14419.4	9.28738	Qal/Qoal LQ	475	0	481.958	475	4411.92	576.786	3835.13	4490.73	3913.95
36	3.1032	14118.3	9.28738	Qal/Qoal LQ	475	0	481.958	475	4319.91	545.949	3773.96	4398.73	3852.78
37	6.20639	27333.3	9.28738	Qal/Qoal LQ	475	0	481.958	475	4181.89	488.493	3693.4	4260.71	3772.21
38	3.04975	13004.8	7.79818	Qal/Qoal LQ	475	0	481.958	475	4080.18	422.749	3657.43	4146.19	3723.44
39	3.04975	12743.7	7.79818	Qal/Qoal LQ	475	0	481.958	475	3998.61	382.799	3615.81	4064.61	3681.81
40	3.04522	12464.1	7.80744	Qal/Qoal LQ	475	0	481.958	475	3916.89	342.863	3574.03	3982.97	3640.11
41	3.04522	12203.5	7.80744	Qal/Qoal LQ	475	0	481.958	475	3835.39	302.942	3532.45	3901.48	3598.54
42	5.82087	22405.4	13.1527	Qal/Qoal LQ	475	0	481.958	475	3580.03	227.385	3352.65	3692.65	3465.27
43	1.25864	4588.26	46.9732	Qal/Qoal LQ	475	0	481.958	475	2630.5	127.052	2503.45	3146.85	3019.8
44	1.16033	4030.95	46.9732	Fernando Formation (Tfl)	200	15	802.811	791.222	2247.54	41.0714	2206.47	3107.65	3066.57
45	2.88627	9190.29	46.9732	Fernando Formation (Tfl)	200	15	758.377	747.429	2043.03	0	2043.03	2855.53	2855.53
46	0.515601	1515.99	46.9732	Qal/Qoal	300	30	1192.12	1174.91	1515.38	0	1515.38	2792.58	2792.58
47	3.0904	8129.12	53.3416	Qal/Qoal	300	30	978.814	964.684	1151.27	0	1151.27	2466.44	2466.44
48	3.0904	6380.14	55.4021	Qal/Qoal	300	30	780.498	769.231	812.732	0	812.732	1944.22	1944.22
49	4.35894	5774.17	57.5786	Qal/Qoal	300	30	546.561	538.671	413.391	0	413.391	1273.92	1273.92
50	4.35894	1913.35	57.0911	Qal/Qoal	300	30	307.54	303.1	5.36999	0	5.36999	480.592	480.592

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.959676

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	142.527	400.249	0	0	0
2	148.711	397.302	5155.54	0	0
3	153.539	395.193	11001.8	0	0
4	154.895	394.6	12949.5	0	0
5	157.987	393.405	17273.3	0	0
6	161.08	392.21	21973.1	0	0
7	163.495	391.193	26235.5	0	0
8	166.612	389.88	29318.8	0	0
9	172.145	387.818	34711	0	0
10	178.09	387.072	37689	0	0
11	184.051	387.191	38318.4	0	0
12	187.452	387.279	38520.7	0	0
13	190.853	387.366	38708.5	0	0
14	194.254	387.353	39164.2	0	0
15	197.654	387.34	39603.2	0	0
16	201.321	387.356	39984.3	0	0
17	204.988	387.372	40366.5	0	0
18	209.171	387.381	40832.5	0	0
19	213.355	387.389	41286.2	0	0
20	217.538	387.445	41581.6	0	0
21	221.722	387.5	41856.5	0	0
22	225.905	387.409	42548.7	0	0
23	230.089	387.318	43207.9	0	0
24	234.273	387.25	43743.5	0	0
25	238.456	387.182	44228.4	0	0
26	242.64	387.181	44452.3	0	0
27	246.823	387.181	44652.3	0	0
28	251.007	387.185	44770	0	0
29	255.19	387.19	44786.8	0	0
30	259.374	387.204	44659.2	0	0
31	263.558	387.218	44268	0	0
32	267.741	387.319	43081.5	0	0
33	271.925	387.42	41937.4	0	0
34	277.042	387.472	40934	0	0
35	282.159	387.524	39980.9	0	0
36	285.262	388.031	37272.2	0	0
37	288.365	388.539	34655	0	0
38	294.572	389.554	29694.6	0	0
39	297.621	389.971	27719.5	0	0
40	300.671	390.389	25816.7	0	0
41	303.716	390.807	23986.9	0	0
42	306.762	391.224	22229.4	0	0
43	312.583	392.584	17070.8	0	0
44	313.841	393.933	12928	0	0
45	315.001	395.176	10381.7	0	0
46	317.888	398.268	4715.31	0	0
47	318.403	398.821	4328.65	0	0
48	321.494	402.973	1636.32	0	0
49	324.584	407.453	-307.616	0	0
50	328.943	414.316	-1317.2	0	0
51	333.302	421.052	0	0	0

Global Minimum Query (spencer) - Safety Factor: 0.985564

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	142.527	400.249	0	0	0
2	148.711	397.302	6237	1092.36	9.93413
3	153.539	395.193	13214.6	2314.44	9.93418
4	154.895	394.6	15544.4	2722.49	9.93418
5	157.987	393.405	20599.4	3607.83	9.93417
6	161.08	392.21	26103.5	4571.82	9.93414
7	163.495	391.193	31187.4	5462.24	9.93417
8	166.612	389.88	34351.6	6016.42	9.93416
9	172.145	387.818	39840.2	6977.7	9.93415
10	178.09	387.072	42628.4	7466.05	9.93417
11	184.051	387.191	43008.6	7532.64	9.93418
12	187.452	387.279	43069.2	7543.25	9.93417
13	190.853	387.366	43115.3	7551.32	9.93417
14	194.254	387.353	43429.9	7606.42	9.93417
15	197.654	387.34	43727.7	7658.58	9.93417
16	201.321	387.356	43956.3	7698.61	9.93416
17	204.988	387.372	44185.9	7738.82	9.93416
18	209.171	387.381	44477.8	7789.95	9.93416
19	213.355	387.389	44757.6	7838.95	9.93416
20	217.538	387.445	44878.7	7860.17	9.93417
21	221.722	387.5	44979.5	7877.82	9.93416
22	225.905	387.409	45499.7	7968.92	9.93415
23	230.089	387.318	45986.7	8054.23	9.93417
24	234.273	387.25	46349.4	8117.75	9.93417
25	238.456	387.182	46661.3	8172.37	9.93416
26	242.64	387.181	46711.3	8181.12	9.93415
27	246.823	387.181	46737.4	8185.71	9.93417
28	251.007	387.185	46681.2	8175.86	9.93416
29	255.19	387.19	46524.1	8148.35	9.93417
30	259.374	387.204	46222.8	8095.58	9.93417
31	263.558	387.218	45658	7996.66	9.93417
32	267.741	387.319	44303.3	7759.39	9.93417
33	271.925	387.42	42990.7	7529.5	9.93417
34	277.042	387.472	41776.7	7316.88	9.93417
35	282.159	387.524	40613	7113.07	9.93418
36	285.262	388.031	37851	6629.32	9.93417
37	288.365	388.539	35177.9	6161.14	9.93416
38	294.572	389.554	30098.1	5271.46	9.93417
39	297.621	389.971	28043.1	4911.54	9.93417
40	300.671	390.389	26058.8	4564	9.93416
41	303.716	390.807	24146	4228.99	9.93417
42	306.762	391.224	22303.8	3906.34	9.93416
43	312.583	392.584	17102.9	2995.44	9.93415
44	313.841	393.933	13520	2367.92	9.93414
45	315.001	395.176	11093.2	1942.89	9.93416
46	317.888	398.268	5677.88	994.437	9.93416
47	318.403	398.821	5243.2	918.308	9.93418
48	321.494	402.973	2349.58	411.511	9.93416
49	324.584	407.453	227.279	39.8062	9.93416
50	328.943	414.316	-1035.72	-181.399	9.93419
51	333.302	421.052	0	0	0

Entity Information

Water Table

X	Y
100	394.014
225.214	396.771
289.726	397.047
314.967	395.176
1202.42	395.176

Block Search Window

X	Y
255.522	415.597
234.027	384.937
287.594	385.906
320.188	415.31

Block Search Window

X	Y
161.408	384.359
199.019	384.891
215.849	392.24
149.816	392.065

External Boundary

X	Y
100	419.225
100	390.799
100	386.622
100	379.205
100	250
1202.42	250
1202.42	674.132
1194.6	669.889
1182.77	664.976
1169.59	662.743
1151.72	660.287
1147.93	659.84
1109.07	659.17
1091.21	661.627
1073.79	662.743
1056.37	663.413
1042.3	662.297
1032.25	660.957
1020.87	655.821
994.291	656.267
959.008	655.151
932.211	654.034
924.172	651.354
917.249	646.665
905.19	635.499
897.374	635.276
873.704	634.16
853.382	633.49
840.207	631.927
827.255	628.13
820.779	625.674
805.147	612.722
801.575	612.052
779.02	609.819
766.292	601.556
752.446	599.323
746.64	596.644
724.086	583.468
707.338	574.313
696.619	566.05
682.997	554.885
668.035	544.389
635.879	542.156
631.636	540.146
618.684	538.36
605.508	535.903
598.586	532.777
595.459	531.214
552.137	502.407
523.554	483.649
511.272	476.949
499.883	468.464
484.698	466.007
473.979	458.638
467.28	456.405
458.124	454.618
450.755	452.162
437.356	446.579
427.084	441.22
417.928	438.987
410.335	437.424
396.267	436.53
388.451	434.521
379.295	433.181
367.907	431.841

359.725	431.841
342.226	420.229
318.218	422.442
262.281	427.598
262.281	420.452
258.708	419.335
257.023	418.633
256.028	418.219
250.458	416.362
246.649	415.093
240.62	414.646
236.6	414.199
226.775	412.413
208.91	411.073
196.628	411.073
183.371	409.92
171.266	402.427
161.467	400.698
147.634	400.121
124.578	400.698
111.897	409.92
109.314	413.745

Material Boundary

X	Y
100	379.205
111.323	378.859
118.937	377.302
145.324	377.908
150.255	379.292
157.609	379.119
164.357	377.215
182.871	374.707
186.764	374.707
192.993	375.658
197.146	376.523
212.805	377.042
220.216	377.155
227.295	377.263
241.179	377.829
262.024	378.189
270.958	378.307
289.762	378.466
298.004	382.156
306.501	387.511
311.865	391.75
313.807	393.895
317.661	398.152
324.755	401.786
332.023	408.015
338.425	414.244
342.226	420.229

Material Boundary

X	Y
257.023	418.633
262.281	420.452
266.868	422.442
286.344	422.442
310.605	422.442
318.218	422.442

Material Boundary

X	Y
100	390.799
126.558	390.799
277.137	392.405
313.807	393.895

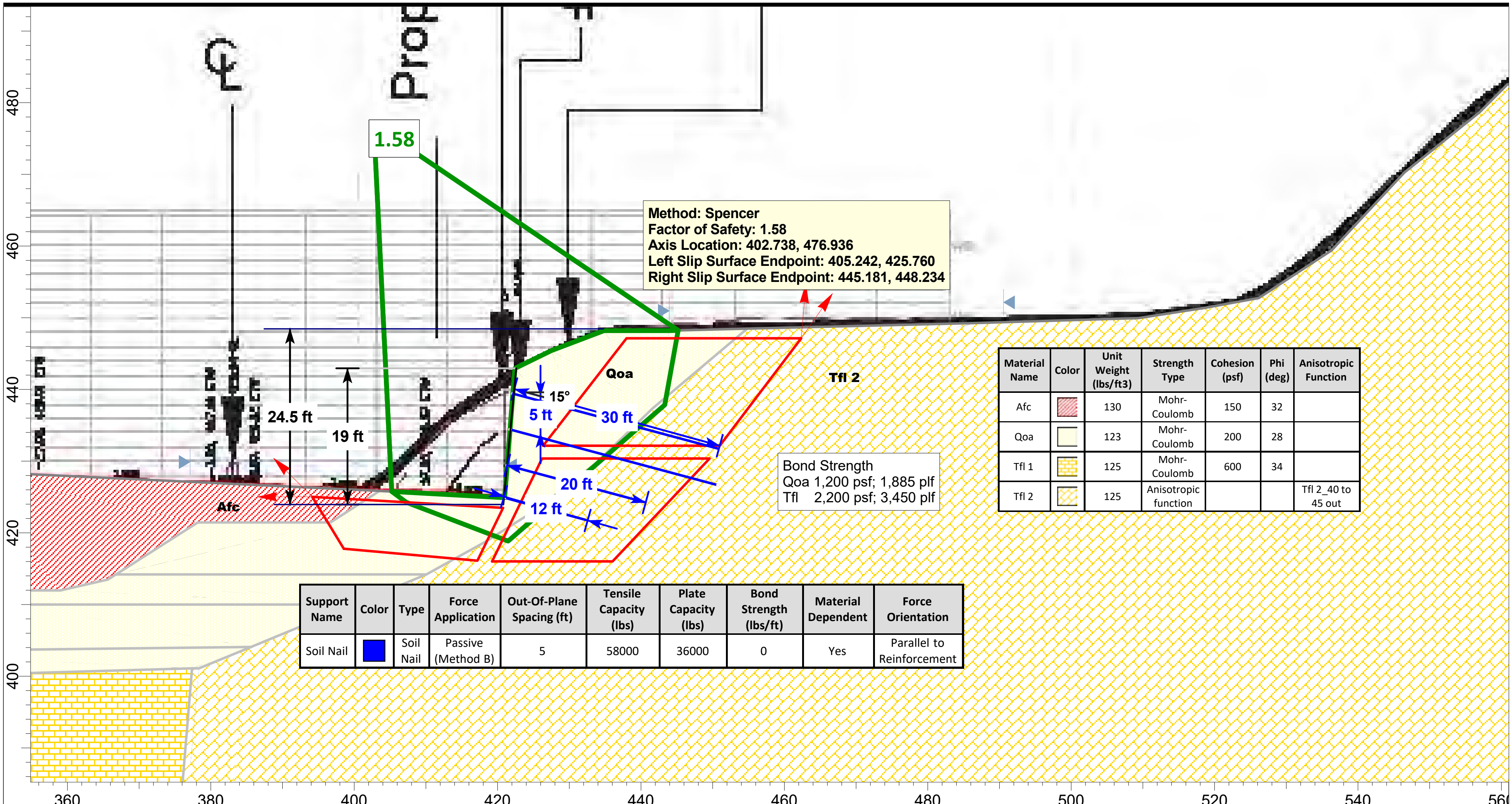
Material Boundary

X	Y
100	386.622
125.961	386.942
277.137	387.232
306.501	387.511

Section 40+00 - Retaining Wall 9 - Soil Nail Wall

Soil Nail Load Demand Analysis - Dia 6 in. - Sh 5 ft Sv 5 ft

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 40+00_RW-9_Demand\Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt__z2.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function
Afc		130	Mohr-Coulomb	150	32	
Qoa		123	Mohr-Coulomb	200	28	
Tfl 1		125	Mohr-Coulomb	600	34	
Tfl 2		125	Anisotropic function			Tfl 2_40 to 45 out

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	5	58000	36000	0	Yes	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California			
Analyzed By: JEH	Units: feet	Scale: 1:240	Project No.: 11585.005
Date: May 14, 2021	Condition: Static		File Name: Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt__z2.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California

Project Summary

Slide Modeler Version:	9.012
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 14, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	135
Left Projection Angle (End Angle) [deg]:	180
Right Projection Angle (Start Angle) [deg]:	55
Right Projection Angle (End Angle) [deg]:	85
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Afc	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	150
Friction Angle [deg]	32
Water Surface	None
Ru Value	0
Qoa	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	None
Ru Value	0
Tfl 1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Tfl 2	
Color	
Strength Type	Anisotropic function
Unit Weight [lbs/ft3]	125
Water Surface	None
Ru Value	0

Anisotropic Functions

Name: Tfl 2_40 to 45 out

Angle From	Angle To	c	phi
-90	40	300	31
40	45	200	15
45	90	300	31

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	5
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Default Bond Strength [lb/ft]	0
Material Dependent	Yes

Bond Strength Dependency

Material	Bond Strength [lbs/ft]
Qoa	1885
Tfl 2	3450

Global Minimums

Method: janbu corrected

FS	1.427200
Axis Location:	410.260, 488.931
Left Slip Surface Endpoint:	407.283, 425.647
Right Slip Surface Endpoint:	459.101, 448.579
Resisting Horizontal Force:	60103.7 lb
Driving Horizontal Force:	42113.1 lb
Passive Horizontal Support Force:	19166.1 lb
Maximum Single Support Force:	8344.94 lb
Total Support Force:	19844.4 lb
Total Slice Area:	666.216 ft2
Surface Horizontal Width:	51.8181 ft
Surface Average Height:	12.8568 ft

Method: spencer

FS	1.576020
Axis Location:	402.738, 476.936
Left Slip Surface Endpoint:	405.242, 425.760
Right Slip Surface Endpoint:	445.181, 448.234
Resisting Moment:	2.87349e+06 lb-ft
Driving Moment:	1.82326e+06 lb-ft
Resisting Horizontal Force:	54471.7 lb
Driving Horizontal Force:	34562.9 lb
Passive Support Moment:	1.13871e+06 lb-ft
Passive Horizontal Support Force:	29506.9 lb
Maximum Single Support Force:	11074.4 lb
Total Support Force:	30553.4 lb
Total Slice Area:	457.575 ft2
Surface Horizontal Width:	39.9383 ft
Surface Average Height:	11.457 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
407.283	425.647
408.703	424.599
410.124	423.551
411.545	422.534
412.966	421.54
414.444	420.497
416.008	419.342
418.241	417.741
420.217	416.401
422.191	415.583
423.963	417.07
425.729	418.553
427.496	420.043
429.262	421.526
431.028	423.009
432.795	424.491
434.561	425.98
436.327	427.469
438.094	428.952
440.574	431.1
441.832	432.163
443.077	433.211
444.767	434.891
446.437	436.512
448.091	438.114
449.729	439.728
451.884	441.839
454.039	443.875
455.726	445.424
457.414	447.031
459.101	448.579

Method: spencer

X	Y
405.242	425.76
407.289	424.254
421.471	418.843
443.326	437.843
445.181	448.234

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 4

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
422.145, 439.406	30	22.1515	7.84846	22.1515	7.84846	5415.44
421.745, 434.406	30	17.9059	12.0941	17.9059	12.0941	8344.94
420.983, 424.888	12	9.60733	2.39267	9.60733	2.39267	1650.94
421.344, 429.406	20	13.5752	6.42475	13.5752	6.42475	4433.08

Method: spencer

Number of Supports: 4

Soil Nail						
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
422.145, 439.406	30	18.1851	11.8149	18.1851	11.8149	8152.31
421.745, 434.406	30	13.9502	16.0498	13.9502	16.0498	11074.4
420.983, 424.888	12	5.86918	6.13082	5.86918	6.13082	4230.26
421.344, 429.406	20	9.71529	10.2847	9.71529	10.2847	7096.45

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4414
Number of Invalid Surfaces:	618

Error Codes

Error Code -105 reported for 597 surfaces

Error Code -1000 reported for 21 surfaces

Method: spencer

Number of Valid Surfaces:	3435
Number of Invalid Surfaces:	1597

Error Codes

Error Code -105 reported for 597 surfaces

Error Code -108 reported for 2 surfaces

Error Code -111 reported for 988 surfaces

Error Code -112 reported for 1 surface

Error Code -1000 reported for 9 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.4272

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.42092	84.7367	-36.4221	Qoa	200	28	231.25	330.04	244.569	0	244.569	73.9398	73.9398
2	1.42092	254.21	-36.4221	Qoa	200	28	294.542	420.37	414.455	0	414.455	197.125	197.125
3	1.42075	420.816	-35.5735	Qoa	200	28	352.197	502.655	569.212	0	569.212	317.31	317.31
4	1.42074	582.748	-34.9967	Qoa	200	28	408.401	582.87	720.077	0	720.077	434.147	434.147
5	1.4784	777.012	-35.19	Qoa	200	28	469.673	670.317	884.54	0	884.54	553.345	553.345
6	0.781997	482.89	-36.4498	Qoa	200	28	527.515	752.87	1039.8	0	1039.8	650.176	650.176
7	0.781997	534.276	-36.4498	Qoa	200	28	562.401	802.659	1133.44	0	1133.44	718.044	718.044
8	1.46422	1135.74	-35.6481	Qoa	200	28	604.041	862.088	1245.21	0	1245.21	811.986	811.986
9	0.768592	666.768	-35.6481	Tfl 2	300	31	855.357	1220.76	1532.41	0	1532.41	918.948	918.948
10	0.988187	927.8	-34.1385	Tfl 2	300	31	876.73	1251.27	1583.18	0	1583.18	988.73	988.73
11	0.988187	1005.14	-34.1385	Tfl 2	300	31	924.439	1319.36	1696.5	0	1696.5	1069.7	1069.7
12	0.986982	1102.89	-22.5043	Tfl 2	300	31	839.321	1197.88	1494.32	0	1494.32	1146.58	1146.58
13	0.986982	2199.59	-22.5043	Tfl 2	300	31	1416.19	2021.18	2864.52	0	2864.52	2277.79	2277.79
14	0.885813	2918.9	40.0118	Tfl 2	200	15	648.082	924.942	2705.52	0	2705.52	3249.55	3249.55
15	0.885813	2925.36	40.0118	Tfl 2	200	15	649.25	926.61	2711.74	0	2711.74	3256.76	3256.76
16	0.883151	2882.4	40.0119	Tfl 2	200	15	643.047	917.756	2678.7	0	2678.7	3218.51	3218.51
17	0.883151	2848.3	40.0119	Tfl 2	200	15	636.855	908.92	2645.72	0	2645.72	3180.33	3180.33
18	0.883148	2814.17	40.1485	Tfl 2	200	15	630.214	899.442	2610.35	0	2610.35	3141.96	3141.96
19	0.883148	2779.89	40.1485	Tfl 2	200	15	623.994	890.564	2577.22	0	2577.22	3103.58	3103.58
20	1.76633	5437.74	40.0234	Tfl 2	200	15	613.31	875.316	2520.31	0	2520.31	3035.37	3035.37
21	1.76633	5261.37	40.0104	Tfl 2	200	15	627.338	895.337	2595.03	0	2595.03	3121.63	3121.63
22	0.883167	2564.57	40.0104	Tfl 2	200	15	585.336	835.391	2371.31	0	2371.31	2862.64	2862.64
23	0.883167	2520.5	40.0104	Tfl 2	200	15	577.333	823.97	2328.68	0	2328.68	2813.3	2813.3
24	0.883152	2476.22	40.1253	Tfl 2	200	15	568.962	812.022	2284.09	0	2284.09	2763.63	2763.63
25	0.883152	2431.97	40.1253	Tfl 2	200	15	719.046	1026.22	3083.5	0	3083.5	3689.54	3689.54
26	0.883152	2379.8	40.1253	Tfl 2	200	15	551.466	787.052	2190.91	0	2190.91	2655.7	2655.7
27	0.883152	2301.2	40.1253	Tfl 2	200	15	537.203	766.696	2114.94	0	2114.94	2567.71	2567.71
28	0.883153	2220.68	40.0259	Tfl 2	200	15	522.861	746.227	2038.55	0	2038.55	2477.68	2477.68
29	0.883153	2140.31	40.0259	Tfl 2	200	15	508.267	725.399	1960.81	0	1960.81	2387.69	2387.69
30	1.24044	2867.98	40.8802	Tfl 2	200	15	699.289	998.025	2978.27	0	2978.27	3583.59	3583.59
31	1.24044	2704.46	40.8802	Tfl 2	200	15	467.174	666.751	1741.94	0	1741.94	2146.33	2146.33
32	1.2575	2576.72	40.214	Tfl 2	200	15	447.799	639.099	1638.74	0	1638.74	2017.35	2017.35
33	1.24484	2389.29	40.0949	Tfl 2	200	15	427.281	609.815	1529.45	0	1529.45	1889.19	1889.19
34	0.845112	1523.81	44.8357	Tfl 2	200	15	594.78	848.87	2421.62	0	2421.62	3013	3013
35	0.845112	1437.26	44.8357	Tfl 2	200	15	382.116	545.356	1288.89	0	1288.89	1668.82	1668.82
36	0.835223	1337.61	44.1225	Tfl 2	200	15	368.154	525.43	1214.52	0	1214.52	1571.57	1571.57
37	0.835223	1256.34	44.1225	Tfl 2	200	15	352.897	503.655	1133.26	0	1133.26	1475.51	1475.51
38	0.826978	1163.92	44.0893	Tfl 2	200	15	337.789	482.093	1052.79	0	1052.79	1380.01	1380.01
39	0.826978	1084.35	44.0893	Tfl 2	200	15	322.699	460.556	972.408	0	972.408	1285.01	1285.01
40	0.818841	994.568	44.5826	Tfl 2	200	15	306.67	437.68	887.036	0	887.036	1189.27	1189.27
41	0.818841	915.141	44.5826	Tfl 2	200	15	291.501	416.03	806.236	0	806.236	1093.52	1093.52
42	1.07758	1083.72	44.4047	Tfl 2	200	15	274.283	391.457	714.526	0	714.526	983.168	983.168
43	1.07758	947.049	44.4047	Tfl 2	200	15	254.429	363.121	608.777	0	608.777	857.973	857.973
44	2.15517	1494.12	43.3784	Tfl 2	200	15	226.702	323.549	461.093	0	461.093	675.312	675.312
45	0.843547	442.59	42.5548	Tfl 2	200	15	201.075	286.975	324.594	0	324.594	509.2	509.2
46	0.843547	363.622	42.5548	Tfl 2	200	15	186.266	265.839	245.716	0	245.716	416.726	416.726
47	0.84354	282.628	43.6096	Tfl 2	200	15	170.072	242.726	159.457	0	159.457	321.468	321.468
48	0.84354	200.102	43.6096	Tfl 2	200	15	154.686	220.768	77.5086	0	77.5086	224.864	224.864
49	0.843542	119.13	42.5422	Tfl 2	200	15	140.426	200.417	1.55488	0	1.55488	130.422	130.422
50	0.843542	39.71	42.5422	Tfl 2	200	15	125.532	179.159	-77.7809	0	-77.7809	37.4176	37.4176

Global Minimum Query (spencer) - Safety Factor: 1.57602

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.68209	19.4829	-36.3659	Qoa	200	28	181.646	286.277	162.264	0	162.264	28.5102	28.5102
2	0.68209	58.4486	-36.3659	Qoa	200	28	207.286	326.687	238.264	0	238.264	85.6296	85.6296
3	0.68209	97.4144	-36.3659	Qoa	200	28	232.926	367.096	314.263	0	314.263	142.749	142.749
4	0.820173	154.052	-20.8818	Qoa	200	28	218.365	344.147	271.1	0	271.1	187.794	187.794
5	0.820173	181.031	-20.8818	Qoa	200	28	231.1	364.219	308.852	0	308.852	220.688	220.688
6	0.820173	208.01	-20.8818	Qoa	200	28	243.837	384.292	346.603	0	346.603	253.58	253.58
7	0.820173	234.989	-20.8818	Qoa	200	28	256.574	404.365	384.354	0	384.354	286.472	286.472
8	0.820173	261.968	-20.8818	Qoa	200	28	269.31	424.438	422.105	0	422.105	319.364	319.364
9	0.820173	288.947	-20.8818	Qoa	200	28	282.046	444.51	459.857	0	459.857	352.257	352.257
10	0.820173	315.926	-20.8818	Qoa	200	28	294.782	464.583	497.608	0	497.608	385.149	385.149
11	0.820173	342.905	-20.8818	Qoa	200	28	307.519	484.656	535.359	0	535.359	418.041	418.041
12	0.820173	369.884	-20.8818	Qoa	200	28	320.255	504.729	573.112	0	573.112	450.935	450.935
13	0.820173	396.863	-20.8818	Qoa	200	28	332.991	524.801	610.863	0	610.863	483.827	483.827
14	0.820173	423.843	-20.8818	Qoa	200	28	345.728	544.874	648.614	0	648.614	516.719	516.719
15	0.820173	450.822	-20.8818	Qoa	200	28	358.464	564.947	686.366	0	686.366	549.612	549.612
16	0.820173	477.801	-20.8818	Qoa	200	28	371.201	585.02	724.117	0	724.117	582.504	582.504
17	0.820173	504.78	-20.8818	Qoa	200	28	383.937	605.092	761.868	0	761.868	615.396	615.396
18	0.820173	531.759	-20.8818	Qoa	200	28	396.673	625.165	799.619	0	799.619	648.289	648.289
19	0.939785	643.371	-20.8818	Tfl 2	300	31	528.141	832.361	885.998	0	885.998	684.513	684.513
20	0.939785	864.323	-20.8818	Tfl 2	300	31	633.026	997.662	1161.11	0	1161.11	919.607	919.607
21	0.809465	1680.46	41.0021	Tfl 2	200	15	418.088	658.915	1712.69	0	1712.69	2076.16	2076.16
22	0.809465	2292.25	41.0021	Tfl 2	200	15	530.045	835.362	2371.2	0	2371.2	2832	2832
23	0.809465	2276.9	41.0021	Tfl 2	200	15	527.235	830.933	2354.67	0	2354.67	2813.03	2813.03
24	0.809465	2245.79	41.0021	Tfl 2	200	15	521.542	821.96	2321.19	0	2321.19	2774.59	2774.59
25	0.809465	2214.68	41.0021	Tfl 2	200	15	515.849	812.989	2287.71	0	2287.71	2736.16	2736.16
26	0.809465	2183.7	41.0021	Tfl 2	200	15	510.181	804.055	2254.37	0	2254.37	2697.89	2697.89
27	0.809465	2152.79	41.0021	Tfl 2	200	15	633.931	999.088	2982.23	0	2982.23	3533.34	3533.34
28	0.809465	2120.63	41.0021	Tfl 2	200	15	498.639	785.865	2186.48	0	2186.48	2619.98	2619.98
29	0.809465	2082.07	41.0021	Tfl 2	200	15	491.582	774.743	2144.97	0	2144.97	2572.32	2572.32
30	0.809465	2042.59	41.0021	Tfl 2	200	15	484.357	763.357	2102.48	0	2102.48	2523.56	2523.56
31	0.809465	2003.11	41.0021	Tfl 2	200	15	477.133	751.971	2059.98	0	2059.98	2474.78	2474.78
32	0.809465	1963.64	41.0021	Tfl 2	200	15	683.09	1076.56	3271.37	0	3271.37	3865.22	3865.22
33	0.809465	1924.16	41.0021	Tfl 2	200	15	462.684	729.2	1975	0	1975	2377.24	2377.24
34	0.809465	1884.68	41.0021	Tfl 2	200	15	455.46	717.814	1932.51	0	1932.51	2328.46	2328.46
35	0.809465	1845.2	41.0021	Tfl 2	200	15	448.235	706.428	1890.01	0	1890.01	2279.69	2279.69
36	0.809465	1805.84	41.0021	Tfl 2	200	15	441.032	695.076	1847.65	0	1847.65	2231.06	2231.06
37	0.809465	1763.33	41.0021	Tfl 2	200	15	765.936	1207.13	3758.66	0	3758.66	4424.52	4424.52
38	0.809465	1697.84	41.0021	Tfl 2	200	15	421.269	663.928	1731.4	0	1731.4	2097.64	2097.64
39	0.809465	1627.9	41.0021	Tfl 2	200	15	408.47	643.757	1656.12	0	1656.12	2011.22	2011.22
40	0.809465	1557.96	41.0021	Tfl 2	200	15	395.671	623.586	1580.84	0	1580.84	1924.82	1924.82
41	0.809465	1488.02	41.0021	Tfl 2	200	15	382.873	603.415	1505.57	0	1505.57	1838.42	1838.42
42	0.809465	1418.09	41.0021	Tfl 2	200	15	370.074	583.244	1430.28	0	1430.28	1752.01	1752.01
43	0.809465	1348.15	41.0021	Tfl 2	200	15	602.175	949.04	2795.46	0	2795.46	3318.96	3318.96
44	0.809465	1278.21	41.0021	Tfl 2	200	15	344.477	542.902	1279.73	0	1279.73	1579.2	1579.2
45	0.809465	1208.27	41.0021	Tfl 2	200	15	331.677	522.73	1204.44	0	1204.44	1492.79	1492.79
46	0.809465	1138.23	41.0021	Tfl 2	200	15	318.861	502.532	1129.07	0	1129.07	1406.27	1406.27
47	0.809465	1068.13	41.0021	Tfl 2	200	15	306.034	482.315	1053.61	0	1053.61	1319.66	1319.66
48	0.199714	240.95	79.8818	Tfl 2	300	31	207.403	326.872	44.7225	0	44.7225	1206.94	1206.94
49	0.827302	704.767	79.8818	Qoa	200	28	143.37	225.953	48.8109	0	48.8109	852.207	852.207
50	0.827302	234.829	79.8818	Qoa	200	28	77.0527	121.437	-147.756	0	-147.756	284.022	284.022

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.4272

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	407.283	425.647	0	0	0
2	408.703	424.599	612.55	0	0
3	410.124	423.551	1500.69	0	0
4	411.545	422.534	2621.43	0	0
5	412.966	421.54	3966.56	0	0
6	414.444	420.497	5641.27	0	0
7	415.226	419.92	6688.94	0	0
8	416.008	419.342	7820.27	0	0
9	417.472	418.292	10086.5	0	0
10	418.241	417.741	11643.8	0	0
11	419.229	417.071	13643.5	0	0
12	420.217	416.401	15770.3	0	0
13	421.204	415.992	17279.2	0	0
14	422.191	415.583	19965.4	0	0
15	423.077	416.326	18575.8	0	0
16	423.963	417.07	17182.7	0	0
17	424.846	417.811	15812.3	0	0
18	425.729	418.553	14460.5	0	0
19	426.612	419.298	13119.1	0	0
20	427.496	420.043	11796.5	0	0
21	429.262	421.526	9232.09	0	0
22	431.028	423.009	7794.9	0	0
23	431.911	423.75	6597.25	0	0
24	432.795	424.491	5423.53	0	0
25	433.678	425.236	4267.97	0	0
26	434.561	425.98	5912.85	0	0
27	435.444	426.724	4809.91	0	0
28	436.327	427.469	3749.86	0	0
29	437.21	428.21	2738.28	0	0
30	438.094	428.952	1770.38	0	0
31	439.334	430.026	5633.93	0	0
32	440.574	431.1	4391.6	0	0
33	441.832	432.163	3259.62	0	0
34	443.077	433.211	2233.14	0	0
35	443.922	434.051	4715.53	0	0
36	444.767	434.891	3982.51	0	0
37	445.602	435.702	3331.99	0	0
38	446.437	436.512	2733.48	0	0
39	447.264	437.313	2192.86	0	0
40	448.091	438.114	1703.1	0	0
41	448.91	438.921	1259.43	0	0
42	449.729	439.728	867.509	0	0
43	450.807	440.783	433.723	0	0
44	451.884	441.839	88.3604	0	0
45	454.039	443.875	-321.112	0	0
46	454.883	444.65	-388.66	0	0
47	455.726	445.424	-408.659	0	0
48	456.57	446.228	-381.302	0	0
49	457.414	447.031	-302.162	0	0
50	458.257	447.805	-174.979	0	0
51	459.101	448.579	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.57602

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	405.242	425.76	0	0	0
2	405.924	425.258	205.347	0	0
3	406.607	424.756	466.346	0	0
4	407.289	424.254	782.999	0	0
5	408.109	423.941	1046.85	0	0
6	408.929	423.628	1332.95	0	0
7	409.749	423.315	1641.31	0	0
8	410.569	423.002	1971.93	0	0
9	411.39	422.689	2324.79	0	0
10	412.21	422.376	2699.91	0	0
11	413.03	422.063	3097.29	0	0
12	413.85	421.751	3516.92	0	0
13	414.67	421.438	3958.8	0	0
14	415.49	421.125	4422.94	0	0
15	416.311	420.812	4909.33	0	0
16	417.131	420.499	5417.97	0	0
17	417.951	420.186	5948.87	0	0
18	418.771	419.873	6502.02	0	0
19	419.591	419.56	7077.43	0	0
20	420.531	419.202	7891.23	0	0
21	421.471	418.843	8902.18	0	0
22	422.28	419.547	8035.23	0	0
23	423.09	420.251	6795.48	0	0
24	423.899	420.954	5565.08	0	0
25	424.709	421.658	4353.64	0	0
26	425.518	422.362	3161.15	0	0
27	426.328	423.065	1987.54	0	0
28	427.137	423.769	2991.1	0	0
29	427.947	424.473	1855.92	0	0
30	428.756	425.177	744.246	0	0
31	429.565	425.88	-343.374	0	0
32	430.375	426.584	-1406.94	0	0
33	431.184	427.288	1193.02	0	0
34	431.994	427.991	177.575	0	0
35	432.803	428.695	-813.819	0	0
36	433.613	429.399	-1781.16	0	0
37	434.422	430.103	-2724.51	0	0
38	435.232	430.806	2037.63	0	0
39	436.041	431.51	1160.09	0	0
40	436.851	432.214	325.169	0	0
41	437.66	432.917	-467.133	0	0
42	438.47	433.621	-1216.82	0	0
43	439.279	434.325	-1923.88	0	0
44	440.089	435.029	1592.65	0	0
45	440.898	435.732	970.827	0	0
46	441.707	436.436	391.621	0	0
47	442.517	437.14	-144.909	0	0
48	443.326	437.843	-638.722	0	0
49	443.526	438.963	-647.368	0	0
50	444.353	443.598	-755.089	0	0
51	445.181	448.234	0	0	0

Entity Information

Block Search Window

X	Y
426.347	432.148
450.981	432.148
462.346	447.124
437.992	447.124

Block Search Window

X	Y
419.24	416.007
436.033	416.007
449.575	430.362
426.203	430.362

Block Search Window

X	Y
398.555	417.786
417.192	416.11
420.776	423.482
394.152	425.018

External Boundary

X	Y
100	428
100	414.768
100	398.753
100	394.507
100	390
100	250
364.868	250
1222	250
1222	390
1222	698
1198.96	698.006
1184.97	696.257
1175.52	694.508
1161.53	687.511
1151.03	688.21
1146.13	689.61
1131.09	695.557
1108.35	695.208
1104.5	693.808
1085.26	685.411
1076.86	682.263
1063.91	666.519
1060.76	665.119
1035.92	663.72
1028.23	659.521
1022.98	658.472
1007.59	657.072
997.789	654.273
993.241	650.075
983.444	639.929
975.398	633.981
970.15	633.981
953.006	632.232
933.764	632.232
911.722	631.882
893.529	625.934
882.684	621.386
873.237	615.089
862.391	609.141
856.794	603.893
849.796	598.295
845.248	595.846
834.402	594.097
827.055	593.747
821.807	591.998
807.463	583.251
799.766	578.003

794.518	571.356
786.471	563.309
779.824	558.061
768.628	554.212
754.983	552.463
737.84	552.463
721.396	551.413
711.25	545.816
699.005	538.119
687.459	529.722
675.914	523.774
672.765	522.375
657.721	521.325
648.625	520.276
640.928	516.427
632.881	511.179
616.787	502.782
599.993	491.587
597.544	491.237
585.299	489.138
576.902	488.088
570.255	486.339
560.809	482.49
556.96	478.642
546.464	470.245
536.318	459.399
526.172	452.752
518.475	451.352
509.379	449.953
486.288	449.253
454.813	448.473
443.954	448.204
434.858	448.204
427.511	445.405
422.426	442.928
420.983	424.888
403.555	425.854
345.642	428.611
345.642	415.666
342.843	412.867
341.808	411.961
339.567	410
337.246	407.969
328.849	403.421
327.002	402.394
323.951	401.672
309.256	401.672
295.612	402.371
279.168	403.771
268.322	407.269
262.602	409.288
256.427	411.468
249.08	418.465
244.182	424.063
238.934	428

Material Boundary

X	Y
341.808	411.961
359.024	411.961

Material Boundary

X	Y
378.18	421.444
396.693	421.444
403.555	425.854

Material Boundary

X	Y
365.63	413.472
366.764	414.192
378.18	421.444

Material Boundary

X	Y
352.757	410
399.925	410
404.799	410

Material Boundary

X	Y
339.567	410
352.757	410

Material Boundary

X	Y
359.024	411.961
365.63	413.472

Material Boundary

X	Y
418.352	418.779
425.355	423.194
433.632	429.648
441.629	437.364
454.813	448.473

Material Boundary

X	Y
100	398.753
339.367	400
377.393	401.088
378.357	401.088
385.616	404.088
399.925	410
410.07	414.192
418.352	418.779

Material Boundary

X	Y
364.868	250
377.393	401.088

Material Boundary

X	Y
366.764	414.192
410.07	414.192

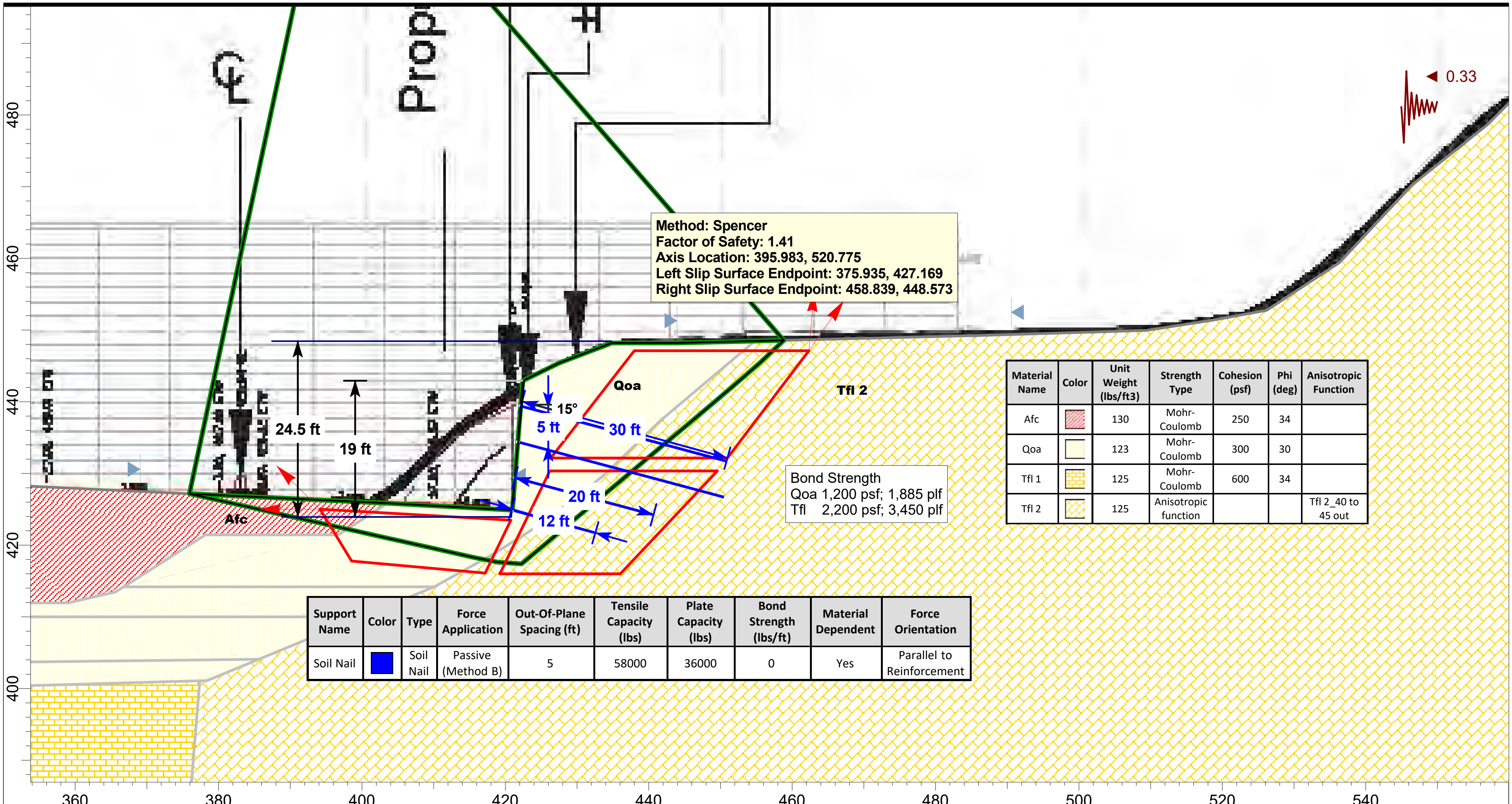
Material Boundary

X	Y
328.849	403.421
385.616	404.088
385.679	404.088

Section 40+00 - Retaining Wall 9 - Soil Nail Wall

Soil Nail Load Demand Analysis - Dia 6 in. - Sh 5 ft Sv 5 ft

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 40+00_RW-9_Demand\Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt__z2_k033.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function
Afc		130	Mohr-Coulomb	250	34	
Qoa		123	Mohr-Coulomb	300	30	
Tfl 1		125	Mohr-Coulomb	600	34	
Tfl 2		125	Anisotropic function			Tfl 2_40 to 45 out

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	5	58000	36000	0	Yes	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**

Analyzed By:	Units:	Scale:	Project No.:	File Name:
JEH	feet	1:240	**11585.005**	Sec 40+00_10-1_SN_rev_Demand_D6 p36 B8 q_Blk SrfAlt__z2_k033.slim

Date: May 14, 2021

Condition: **PseudoStatic**

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:09.784s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 14, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [deg]:	135
Left Projection Angle (End Angle) [deg]:	180
Right Projection Angle (Start Angle) [deg]:	55
Right Projection Angle (End Angle) [deg]:	85
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.33

Materials

Afc	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	130
Cohesion [psf]	250
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Qoa	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	None
Ru Value	0
Tfl 1	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Tfl 2	
Color	
Strength Type	Anisotropic function
Unit Weight [lbs/ft3]	125
Water Surface	None
Ru Value	0

Anisotropic Functions

Name: Tfl 2_40 to 45 out

Angle From	Angle To	c	phi
-90	40	600	34
40	45	200	15
45	90	600	34

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	5
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Default Bond Strength [lb/ft]	0
Material Dependent	Yes

Bond Strength Dependency

Material	Bond Strength [lbs/ft]
Qoa	1885
Tfl 2	3450

Global Minimums

Method: janbu corrected

FS	1.053240
Axis Location:	410.263, 495.678
Left Slip Surface Endpoint:	403.869, 425.837
Right Slip Surface Endpoint:	462.300, 448.659
Resisting Horizontal Force:	71014.5 lb
Driving Horizontal Force:	67424.5 lb
Passive Horizontal Support Force:	16762.6 lb
Maximum Single Support Force:	7728.56 lb
Total Support Force:	17355.3 lb
Total Slice Area:	732.198 ft2
Surface Horizontal Width:	58.4305 ft
Surface Average Height:	12.5311 ft

Method: spencer

FS	1.412590
Axis Location:	395.983, 520.775
Left Slip Surface Endpoint:	375.935, 427.169
Right Slip Surface Endpoint:	458.839, 448.573
Resisting Moment:	8.43805e+06 lb-ft
Driving Moment:	5.97344e+06 lb-ft
Resisting Horizontal Force:	84477 lb
Driving Horizontal Force:	59802.8 lb
Passive Support Moment:	1.87736e+06 lb-ft
Passive Horizontal Support Force:	23357.3 lb
Maximum Single Support Force:	9439.3 lb
Total Support Force:	24184.9 lb
Total Slice Area:	731.823 ft2
Surface Horizontal Width:	82.904 ft
Surface Average Height:	8.82736 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
403.869	425.837
405.681	424.756
407.494	423.726
409.306	422.696
411.118	421.666
412.96	420.619
414.937	419.495
417.147	418.239
419.358	417.246
422.013	416.23
423.948	416.151
426.56	418.343
429.172	420.535
431.784	422.727
434.397	424.919
437.009	427.111
439.621	429.303
442.192	431.467
444.77	433.637
447.337	435.798
449.904	437.959
451.806	439.601
453.677	441.216
455.549	442.832
457.859	444.825
460.168	446.819
462.3	448.659

Method: spencer

X	Y
375.935	427.169
380.044	426.25
384.153	425.33
388.263	424.411
392.372	423.492
395.738	422.739
399.498	421.898
403.013	421.112
405.456	420.565
407.824	420.035
412.16	419.065
415.526	418.312
418.893	417.645
422.26	417.386
425.687	420.262
429.113	423.137
432.539	426.012
435.965	428.887
439.401	431.771
442.839	434.656
446.259	437.527
449.558	440.3
451.53	441.975
453.502	443.692
455.435	445.376
458.839	448.573

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 4

Soil Nail						
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
422.145, 439.406	30	23.1495	6.85052	23.1495	6.85052	4726.86
421.745, 434.406	30	18.7992	11.2008	18.7992	11.2008	7728.56
420.983, 424.888	12	10.4607	1.53931	10.4607	1.53931	1062.13
421.344, 429.406	20	14.438	5.56197	14.438	5.56197	3837.76

Method: spencer

Number of Supports: 4

Soil Nail						
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
422.145, 439.406	30	20.6814	9.31861	20.6814	9.31861	6429.84
421.745, 434.406	30	16.3199	13.6801	16.3199	13.6801	9439.3
420.983, 424.888	12	7.98977	4.01023	7.98977	4.01023	2767.06
421.344, 429.406	20	11.9583	8.04167	11.9583	8.04167	5548.75

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4222
Number of Invalid Surfaces:	799
Error Codes	
Error Code -105 reported for 603 surfaces	
Error Code -120 reported for 186 surfaces	
Error Code -1000 reported for 10 surfaces	

Method: spencer

Number of Valid Surfaces:	1737
Number of Invalid Surfaces:	3284
Error Codes	
Error Code -105 reported for 603 surfaces	
Error Code -108 reported for 10 surfaces	
Error Code -111 reported for 2654 surfaces	
Error Code -120 reported for 8 surfaces	
Error Code -1000 reported for 9 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-120 = Tensile effecve normaàl stress on the base of a slice exceeds the tensile strength of the material. The stress state on the base of the surface violates the strength criterion.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.05324

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.90609	27.3115	-30.8093	Qoa	300	30	466.449	491.283	331.311	0	331.311	53.1488	53.1488
2	0.90609	81.9344	-30.8093	Qoa	300	30	517.598	545.155	424.621	0	424.621	115.956	115.956
3	1.81218	322.093	-29.6137	Qoa	300	30	576.87	607.583	532.748	0	532.748	204.857	204.857
4	0.906032	238.731	-29.6137	Qoa	300	30	647.808	682.297	662.158	0	662.158	293.946	293.946
5	0.906032	290.526	-29.6137	Qoa	300	30	695.097	732.104	748.426	0	748.426	353.336	353.336
6	0.906028	342.319	-29.6137	Qoa	300	30	742.386	781.911	834.695	0	834.695	412.725	412.725
7	0.906028	394.113	-29.6137	Qoa	300	30	789.676	831.718	920.963	0	920.963	472.114	472.114
8	0.921091	453.757	-29.6137	Qoa	300	30	837.358	881.939	1007.95	0	1007.95	532.001	532.001
9	0.921091	507.288	-29.6137	Qoa	300	30	885.434	932.574	1095.66	0	1095.66	592.378	592.378
10	0.988296	603.832	-29.6137	Qoa	300	30	935.264	985.057	1186.55	0	1186.55	654.954	654.954
11	0.988296	665.459	-29.6137	Qoa	300	30	986.846	1039.39	1280.65	0	1280.65	719.733	719.733
12	1.10547	817.357	-29.6008	Qoa	300	30	1041.19	1096.63	1379.79	0	1379.79	788.294	788.294
13	1.10547	894.419	-29.6008	Qoa	300	30	1098.84	1157.35	1484.97	0	1484.97	860.718	860.718
14	0.127071	107.631	-24.186	Qoa	300	30	1021.4	1075.78	1343.69	0	1343.69	884.953	884.953
15	1.04193	913.11	-24.186	Tfl 2	600	34	1642.36	1729.8	1675	0	1675	937.372	937.372
16	1.04193	967.937	-24.186	Tfl 2	600	34	1691.3	1781.34	1751.41	0	1751.41	991.809	991.809
17	1.32738	1305.35	-20.9505	Tfl 2	600	34	1632.98	1719.92	1660.35	0	1660.35	1035.12	1035.12
18	1.32738	2199.24	-20.9505	Tfl 2	600	34	2220.12	2338.32	2577.17	0	2577.17	1727.14	1727.14
19	0.967331	3066.89	-2.32094	Tfl 2	600	34	2675.26	2817.69	3287.86	0	3287.86	3179.43	3179.43
20	0.967331	3254.98	-2.32094	Tfl 2	600	34	2803.39	2952.64	3487.93	0	3487.93	3374.3	3374.3
21	2.61222	8724.71	40.0001	Tfl 2	200	15	844.423	889.38	2572.8	0	2572.8	3281.36	3281.36
22	1.30609	4250.28	40.0004	Tfl 2	200	15	826.698	870.711	2503.12	0	2503.12	3196.82	3196.82
23	1.30609	4159.86	40.0004	Tfl 2	200	15	812.391	855.643	2446.9	0	2446.9	3128.58	3128.58
24	1.30609	4063.53	40.0004	Tfl 2	200	15	797.151	839.591	2386.98	0	2386.98	3055.88	3055.88
25	1.30609	3967.2	40.0004	Tfl 2	200	15	827.438	871.491	2506.04	0	2506.04	3200.35	3200.35
26	2.61219	7645.51	40.0004	Tfl 2	200	15	759.057	799.469	2237.25	0	2237.25	2874.18	2874.18
27	1.30609	3662.17	40.0004	Tfl 2	200	15	895.2	942.86	2772.39	0	2772.39	3523.56	3523.56
28	1.30609	3491.53	40.0004	Tfl 2	200	15	706.651	744.273	2031.26	0	2031.26	2624.22	2624.22
29	1.3061	3315.9	40.0004	Tfl 2	200	15	678.863	715.006	1922.03	0	1922.03	2491.67	2491.67
30	1.3061	3140.26	40.0004	Tfl 2	200	15	651.075	685.738	1812.8	0	1812.8	2359.12	2359.12
31	1.28537	2918.67	40.0908	Tfl 2	200	15	953.465	1004.23	3001.42	0	3001.42	3804.05	3804.05
32	1.28537	2747.97	40.0908	Tfl 2	200	15	595.66	627.373	1594.98	0	1594.98	2096.41	2096.41
33	1.28915	2584.3	40.0908	Tfl 2	200	15	568.145	598.393	1486.83	0	1486.83	1965.09	1965.09
34	1.28915	2413.24	40.0908	Tfl 2	200	15	742.211	781.726	2171.03	0	2171.03	2795.83	2795.83
35	1.28352	2236.43	40.0908	Tfl 2	200	15	513.991	541.356	1273.96	0	1273.96	1706.64	1706.64
36	1.28352	2070.88	40.0908	Tfl 2	200	15	487.353	513.3	1169.25	0	1169.25	1579.51	1579.51
37	1.28352	1905.33	40.0908	Tfl 2	200	15	460.716	485.244	1064.55	0	1064.55	1452.38	1452.38
38	1.28352	1739.77	40.0908	Tfl 2	200	15	434.078	457.188	959.84	0	959.84	1325.25	1325.25
39	0.950701	1180.72	40.7989	Tfl 2	200	15	408.683	430.441	860.02	0	860.02	1212.77	1212.77
40	0.950701	1087.48	40.7989	Tfl 2	200	15	388.524	409.209	780.78	0	780.78	1116.13	1116.13
41	0.935903	979.477	40.7989	Tfl 2	200	15	368.524	388.144	702.161	0	702.161	1020.25	1020.25
42	0.935903	889.118	40.7989	Tfl 2	200	15	348.679	367.243	624.159	0	624.159	925.119	925.119
43	0.935902	798.758	40.7989	Tfl 2	200	15	328.835	346.342	546.156	0	546.156	829.987	829.987
44	0.935902	707.956	40.7989	Tfl 2	200	15	308.894	325.339	467.772	0	467.772	734.391	734.391
45	1.15473	747.032	40.7989	Tfl 2	200	15	286.385	301.632	379.297	0	379.297	626.488	626.488
46	1.15473	607.298	40.7989	Tfl 2	200	15	261.513	275.436	281.532	0	281.532	507.254	507.254
47	1.15473	467.565	40.7989	Tfl 2	200	15	236.641	249.24	183.765	0	183.765	388.02	388.02
48	1.15473	327.832	40.7989	Tfl 2	200	15	211.769	223.043	85.9988	0	85.9988	268.785	268.785
49	1.06588	178.588	40.7989	Tfl 2	200	15	187.853	197.855	-8.00599	0	-8.00599	154.138	154.138
50	1.06588	59.5293	40.7989	Tfl 2	200	15	164.895	173.674	-98.25	0	-98.25	44.0778	44.0778

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	Tfl 2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.41259

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.3697	21.474	-12.6095	Afc	250	34	281.673	397.888	219.253	0	219.253	156.243	156.243
2	1.3697	64.4219	-12.6095	Afc	250	34	303.419	428.606	264.794	0	264.794	196.919	196.919
3	1.3697	107.37	-12.6095	Afc	250	34	325.164	459.324	310.335	0	310.335	237.596	237.596
4	1.3697	150.318	-12.6095	Afc	250	34	346.91	490.042	355.876	0	355.876	278.272	278.272
5	1.3697	193.265	-12.6095	Afc	250	34	368.655	520.759	401.417	0	401.417	318.949	318.949
6	1.3697	236.213	-12.6095	Afc	250	34	390.401	551.477	446.959	0	446.959	359.626	359.626
7	2.05462	434.863	-12.6095	Afc	250	34	417.584	589.875	503.885	0	503.885	410.471	410.471
8	2.05462	531.502	-12.6095	Afc	250	34	450.204	635.954	572.199	0	572.199	471.489	471.489
9	1.36974	408.022	-12.6095	Afc	250	34	477.387	674.352	629.128	0	629.128	522.336	522.336
10	1.36974	450.973	-12.6095	Afc	250	34	499.134	705.071	674.671	0	674.671	563.015	563.015
11	1.36974	493.923	-12.6095	Afc	250	34	520.88	735.79	720.213	0	720.213	603.692	603.692
12	1.68286	665.631	-12.6095	Afc	250	34	545.112	770.02	770.964	0	770.964	649.022	649.022
13	1.68286	730.462	-12.6095	Afc	250	34	571.83	807.761	826.912	0	826.912	698.993	698.993
14	2.20354	1054.49	-12.6095	Afc	250	34	602.68	851.34	891.526	0	891.526	756.706	756.706
15	1.55667	804.589	-12.6095	Qoa	300	30	586.971	829.149	916.51	0	916.51	785.205	785.205
16	1.75759	957.446	-12.6095	Qoa	300	30	602.35	850.874	954.143	0	954.143	819.397	819.397
17	1.75759	1009.43	-12.6095	Qoa	300	30	618.661	873.915	994.048	0	994.048	855.654	855.654
18	1.22164	733.133	-12.6095	Qoa	300	30	632.89	894.014	1028.86	0	1028.86	887.285	887.285
19	1.22164	763.453	-12.6095	Qoa	300	30	646.578	913.35	1062.35	0	1062.35	917.71	917.71
20	2.36757	1567.54	-12.6095	Qoa	300	30	667.063	942.287	1112.48	0	1112.48	963.254	963.254
21	1.44526	1013.92	-12.6095	Qoa	300	30	688.825	973.028	1165.72	0	1165.72	1011.63	1011.63
22	1.44526	1057.15	-12.6095	Qoa	300	30	705.323	996.332	1206.08	0	1206.08	1048.3	1048.3
23	1.44526	1100.38	-12.6095	Qoa	300	30	721.821	1019.64	1246.45	0	1246.45	1084.98	1084.98
24	1.68342	1336.22	-12.6095	Qoa	300	30	739.677	1044.86	1290.14	0	1290.14	1124.67	1124.67
25	1.68342	1394.87	-12.6095	Qoa	300	30	758.894	1072.01	1337.15	0	1337.15	1167.39	1167.39
26	1.46021	1254.08	-11.2136	Qoa	300	30	753.875	1064.92	1324.87	0	1324.87	1175.42	1175.42
27	1.90677	1696.76	-11.2136	Tfl 2	600	34	1226.9	1733.1	1679.88	0	1679.88	1436.65	1436.65
28	1.68347	1534.51	-4.39013	Tfl 2	600	34	1082.73	1529.46	1377.98	0	1377.98	1294.85	1294.85
29	1.68347	2805.71	-4.39013	Tfl 2	600	34	1509.79	2132.71	2272.34	0	2272.34	2156.43	2156.43
30	1.7131	5293.53	40.0031	Tfl 2	200	15	483.104	682.428	1800.44	0	1800.44	2205.86	2205.86
31	1.7131	5185.62	40.0031	Tfl 2	200	15	475.987	672.374	1762.93	0	1762.93	2162.37	2162.37
32	1.7131	5057.94	40.0031	Tfl 2	200	15	467.566	660.479	1718.53	0	1718.53	2110.91	2110.91
33	1.7131	4913.78	40.0031	Tfl 2	200	15	560.529	791.797	2208.61	0	2208.61	2679	2679
34	1.7131	4748.11	40.0031	Tfl 2	200	15	447.132	631.614	1610.8	0	1610.8	1986.03	1986.03
35	1.7131	4582.36	40.0031	Tfl 2	200	15	436.2	616.172	1553.17	0	1553.17	1919.23	1919.23
36	1.71313	4416.76	40.0031	Tfl 2	200	15	629.486	889.206	2572.15	0	2572.15	3100.41	3100.41
37	1.71313	4223.15	40.0031	Tfl 2	200	15	412.504	582.699	1428.25	0	1428.25	1774.42	1774.42
38	1.71812	3940.55	40.0031	Tfl 2	200	15	739.503	1044.61	3152.14	0	3152.14	3772.72	3772.72
39	1.71812	3636.59	40.0031	Tfl 2	200	15	373.125	527.072	1220.65	0	1220.65	1533.77	1533.77
40	1.71885	3333.99	40.0031	Tfl 2	200	15	353.132	498.831	1115.25	0	1115.25	1411.6	1411.6
41	1.71885	3029.6	40.0031	Tfl 2	200	15	568.976	803.73	2253.15	0	2253.15	2730.63	2730.63
42	1.71014	2712.16	40.0074	Tfl 2	200	15	313.155	442.359	904.495	0	904.495	1167.33	1167.33
43	1.71014	2417.28	40.0074	Tfl 2	200	15	293.674	414.841	801.797	0	801.797	1048.28	1048.28
44	1.64905	2053.16	40.064	Tfl 2	200	15	274.516	387.779	700.799	0	700.799	931.669	931.669
45	1.64905	1780.15	40.064	Tfl 2	200	15	255.827	361.378	602.27	0	602.27	817.422	817.422
46	1.97234	1768.69	40.3292	Tfl 2	200	15	234.728	331.574	491.042	0	491.042	690.311	690.311
47	1.97233	1369.03	41.0417	Tfl 2	200	15	210.884	297.893	365.34	0	365.34	548.929	548.929
48	1.93306	948.326	41.074	Tfl 2	200	15	188.158	265.79	245.531	0	245.531	409.521	409.521
49	1.70193	496.546	43.1996	Tfl 2	200	15	164.115	231.827	118.78	0	118.78	272.891	272.891
50	1.70193	165.515	43.1996	Tfl 2	200	15	143.049	202.069	7.72225	0	7.72225	142.052	142.052

Query 1 (spencer) - Safety Factor: 1.41259

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.3697	21.474	-12.6095	Afc	250	34	281.673	397.888	219.253	0	219.253	156.243	156.243
2	1.3697	64.4219	-12.6095	Afc	250	34	303.419	428.606	264.794	0	264.794	196.919	196.919
3	1.3697	107.37	-12.6095	Afc	250	34	325.164	459.324	310.335	0	310.335	237.596	237.596
4	1.3697	150.318	-12.6095	Afc	250	34	346.91	490.042	355.876	0	355.876	278.272	278.272
5	1.3697	193.265	-12.6095	Afc	250	34	368.655	520.759	401.417	0	401.417	318.949	318.949
6	1.3697	236.213	-12.6095	Afc	250	34	390.401	551.477	446.959	0	446.959	359.626	359.626
7	2.05462	434.863	-12.6095	Afc	250	34	417.584	589.875	503.885	0	503.885	410.471	410.471
8	2.05462	531.502	-12.6095	Afc	250	34	450.204	635.954	572.199	0	572.199	471.489	471.489
9	1.36974	408.022	-12.6095	Afc	250	34	477.387	674.352	629.128	0	629.128	522.336	522.336
10	1.36974	450.973	-12.6095	Afc	250	34	499.134	705.071	674.671	0	674.671	563.015	563.015
11	1.36974	493.923	-12.6095	Afc	250	34	520.88	735.79	720.213	0	720.213	603.692	603.692
12	1.68286	665.631	-12.6095	Afc	250	34	545.112	770.02	770.964	0	770.964	649.022	649.022
13	1.68286	730.462	-12.6095	Afc	250	34	571.83	807.761	826.912	0	826.912	698.993	698.993
14	2.20354	1054.49	-12.6095	Afc	250	34	602.68	851.34	891.526	0	891.526	756.706	756.706
15	1.55667	804.589	-12.6095	Qoa	300	30	586.971	829.149	916.51	0	916.51	785.205	785.205
16	1.75759	957.446	-12.6095	Qoa	300	30	602.35	850.874	954.143	0	954.143	819.397	819.397
17	1.75759	1009.43	-12.6095	Qoa	300	30	618.661	873.915	994.048	0	994.048	855.654	855.654
18	1.22164	733.133	-12.6095	Qoa	300	30	632.89	894.014	1028.86	0	1028.86	887.285	887.285
19	1.22164	763.453	-12.6095	Qoa	300	30	646.578	913.35	1062.35	0	1062.35	917.71	917.71
20	2.36757	1567.54	-12.6095	Qoa	300	30	667.063	942.287	1112.48	0	1112.48	963.254	963.254
21	1.44526	1013.92	-12.6095	Qoa	300	30	688.825	973.028	1165.72	0	1165.72	1011.63	1011.63
22	1.44526	1057.15	-12.6095	Qoa	300	30	705.323	996.332	1206.08	0	1206.08	1048.3	1048.3
23	1.44526	1100.38	-12.6095	Qoa	300	30	721.821	1019.64	1246.45	0	1246.45	1084.98	1084.98
24	1.68342	1336.22	-12.6095	Qoa	300	30	739.677	1044.86	1290.14	0	1290.14	1124.67	1124.67
25	1.68342	1394.87	-12.6095	Qoa	300	30	758.894	1072.01	1337.15	0	1337.15	1167.39	1167.39
26	1.46021	1254.08	-11.2136	Qoa	300	30	753.875	1064.92	1324.87	0	1324.87	1175.42	1175.42
27	1.90677	1696.76	-11.2136	Tfl 2	600	34	1226.9	1733.1	1679.88	0	1679.88	1436.65	1436.65
28	1.68347	1534.51	-4.39013	Tfl 2	600	34	1082.73	1529.46	1377.98	0	1377.98	1294.85	1294.85
29	1.68347	2805.71	-4.39013	Tfl 2	600	34	1509.79	2132.71	2272.34	0	2272.34	2156.43	2156.43
30	1.7131	5293.53	40.0031	Tfl 2	200	15	483.104	682.428	1800.44	0	1800.44	2205.86	2205.86
31	1.7131	5185.62	40.0031	Tfl 2	200	15	475.987	672.374	1762.93	0	1762.93	2162.37	2162.37
32	1.7131	5057.94	40.0031	Tfl 2	200	15	467.566	660.479	1718.53	0	1718.53	2110.91	2110.91
33	1.7131	4913.78	40.0031	Tfl 2	200	15	560.529	791.797	2208.61	0	2208.61	2679	2679
34	1.7131	4748.11	40.0031	Tfl 2	200	15	447.132	631.614	1610.8	0	1610.8	1986.03	1986.03
35	1.7131	4582.36	40.0031	Tfl 2	200	15	436.2	616.172	1553.17	0	1553.17	1919.23	1919.23
36	1.71313	4416.76	40.0031	Tfl 2	200	15	629.486	889.206	2572.15	0	2572.15	3100.41	3100.41
37	1.71313	4223.15	40.0031	Tfl 2	200	15	412.504	582.699	1428.25	0	1428.25	1774.42	1774.42
38	1.71812	3940.55	40.0031	Tfl 2	200	15	739.503	1044.61	3152.14	0	3152.14	3772.72	3772.72
39	1.71812	3636.59	40.0031	Tfl 2	200	15	373.125	527.072	1220.65	0	1220.65	1533.77	1533.77
40	1.71885	3333.99	40.0031	Tfl 2	200	15	353.132	498.831	1115.25	0	1115.25	1411.6	1411.6
41	1.71885	3029.6	40.0031	Tfl 2	200	15	568.976	803.73	2253.15	0	2253.15	2730.63	2730.63
42	1.71014	2712.16	40.0074	Tfl 2	200	15	313.155	442.359	904.495	0	904.495	1167.33	1167.33
43	1.71014	2417.28	40.0074	Tfl 2	200	15	293.674	414.841	801.797	0	801.797	1048.28	1048.28
44	1.64905	2053.16	40.064	Tfl 2	200	15	274.516	387.779	700.799	0	700.799	931.669	931.669
45	1.64905	1780.15	40.064	Tfl 2	200	15	255.827	361.378	602.27	0	602.27	817.422	817.422
46	1.97234	1768.69	40.3292	Tfl 2	200	15	234.728	331.574	491.042	0	491.042	690.311	690.311
47	1.97233	1369.03	41.0417	Tfl 2	200	15	210.884	297.893	365.34	0	365.34	548.929	548.929
48	1.93306	948.326	41.074	Tfl 2	200	15	188.158	265.79	245.531	0	245.531	409.521	409.521
49	1.70193	496.546	43.1996	Tfl 2	200	15	164.115	231.827	118.78	0	118.78	272.891	272.891
50	1.70193	165.515	43.1996	Tfl 2	200	15	143.049	202.069	7.72225	0	7.72225	142.052	142.052

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.05324

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	403.869	425.837	0	0	0
2	404.775	425.296	627.61	0	0
3	405.681	424.756	1337.79	0	0
4	407.494	423.726	2912.11	0	0
5	408.4	423.211	3809.81	0	0
6	409.306	422.696	4781.23	0	0
7	410.212	422.181	5826.38	0	0
8	411.118	421.666	6945.25	0	0
9	412.039	421.142	8158.29	0	0
10	412.96	420.619	9447.53	0	0
11	413.948	420.057	10915.6	0	0
12	414.937	419.495	12471.3	0	0
13	416.042	418.867	14314.4	0	0
14	417.147	418.239	16267	0	0
15	417.275	418.182	16448.7	0	0
16	418.316	417.714	18784	0	0
17	419.358	417.246	21192.1	0	0
18	420.686	416.738	23952	0	0
19	422.013	416.23	27726.7	0	0
20	422.98	416.191	29645.4	0	0
21	423.948	416.151	31644.1	0	0
22	426.56	418.343	25513.9	0	0
23	427.866	419.439	22537	0	0
24	429.172	420.535	19631.4	0	0
25	430.478	421.631	16801.6	0	0
26	431.784	422.727	14969.3	0	0
27	434.397	424.919	9689.22	0	0
28	435.703	426.015	10518.9	0	0
29	437.009	427.111	8139.84	0	0
30	438.315	428.207	5899.13	0	0
31	439.621	429.303	3796.79	0	0
32	440.906	430.385	8587.03	0	0
33	442.192	431.467	6783.35	0	0
34	443.481	432.552	5110.02	0	0
35	444.77	433.637	7687.13	0	0
36	446.054	434.718	6286.92	0	0
37	447.337	435.798	5017.45	0	0
38	448.621	436.879	3878.72	0	0
39	449.904	437.959	2870.75	0	0
40	450.855	438.78	2196.06	0	0
41	451.806	439.601	1596.42	0	0
42	452.741	440.408	1079.4	0	0
43	453.677	441.216	635.106	0	0
44	454.613	442.024	263.534	0	0
45	455.549	442.832	-34.9595	0	0
46	456.704	443.828	-301.474	0	0
47	457.859	444.825	-455.53	0	0
48	459.013	445.822	-497.127	0	0
49	460.168	446.819	-426.265	0	0
50	461.234	447.739	-261.042	0	0
51	462.3	448.659	0	0	0

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.41259

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	375.935	427.169	0	0	0
2	377.305	426.862	445.902	192.545	23.3552
3	378.675	426.556	921.37	397.857	23.3552
4	380.044	426.25	1426.4	615.936	23.3552
5	381.414	425.943	1961.01	846.782	23.3551
6	382.784	425.637	2525.17	1090.4	23.3553
7	384.153	425.33	3118.91	1346.78	23.3552
8	386.208	424.871	4064.97	1755.3	23.3552
9	388.263	424.411	5077.57	2192.55	23.3552
10	389.632	424.105	5789.6	2500.01	23.3552
11	391.002	423.798	6531.19	2820.24	23.3552
12	392.372	423.492	7302.35	3153.23	23.3552
13	394.055	423.116	8290.27	3579.83	23.3552
14	395.738	422.739	9322.83	4025.69	23.3552
15	397.941	422.246	10742.3	4638.65	23.3552
16	399.498	421.898	11709.7	5056.37	23.3552
17	401.255	421.505	12827.6	5539.08	23.3551
18	403.013	421.112	13972.7	6033.54	23.3551
19	404.235	420.838	14785	6384.34	23.3553
20	405.456	420.565	15613.3	6741.99	23.3552
21	407.824	420.035	17264.5	7455.01	23.3552
22	409.269	419.712	18302.4	7903.15	23.3551
23	410.714	419.389	19362.8	8361.06	23.3552
24	412.16	419.065	20445.9	8828.75	23.3552
25	413.843	418.689	21736	9385.82	23.3552
26	415.526	418.312	23056.8	9956.15	23.3552
27	416.987	418.023	24127.3	10418.4	23.3552
28	418.893	417.645	26541.8	11461	23.3551
29	420.577	417.516	28036.2	12106.3	23.3551
30	422.26	417.386	29945.7	12930.9	23.3552
31	423.973	418.824	26438.1	11416.2	23.3551
32	425.687	420.262	23007.9	9935.03	23.3551
33	427.4	421.699	19669.1	8493.34	23.3552
34	429.113	423.137	17722.3	7652.67	23.3552
35	430.826	424.574	14605.7	6306.88	23.3551
36	432.539	426.012	11607.9	5012.4	23.3551
37	434.252	427.45	11325.1	4890.3	23.3552
38	435.965	428.887	8584.83	3707.02	23.3552
39	437.683	430.329	10464.7	4518.77	23.3552
40	439.401	431.771	8145.73	3517.41	23.3552
41	441.12	433.213	6043.81	2609.78	23.3552
42	442.839	434.656	7168.68	3095.51	23.3552
43	444.549	436.091	5510.93	2379.68	23.3552
44	446.259	437.527	4064.59	1755.13	23.3552
45	447.908	438.913	2867.83	1238.36	23.3552
46	449.558	440.3	1866.98	806.182	23.3552
47	451.53	441.975	924.082	399.028	23.3552
48	453.502	443.692	260.929	112.672	23.3552
49	455.435	445.376	-101.962	-44.0282	23.3552
50	457.137	446.975	-176.343	-76.1466	23.3552
51	458.839	448.573	0	0	0

Query 1 (spencer) - Safety Factor: 1.41259

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	375.935	427.169	0	0	0
2	377.305	426.862	445.902	192.545	23.3552
3	378.675	426.556	921.37	397.857	23.3552
4	380.044	426.25	1426.4	615.936	23.3552
5	381.414	425.943	1961.01	846.782	23.3551
6	382.784	425.637	2525.17	1090.4	23.3553
7	384.153	425.33	3118.91	1346.78	23.3552
8	386.208	424.871	4064.97	1755.3	23.3552
9	388.263	424.411	5077.57	2192.55	23.3552
10	389.632	424.105	5789.6	2500.01	23.3552
11	391.002	423.798	6531.19	2820.24	23.3552
12	392.372	423.492	7302.35	3153.23	23.3552
13	394.055	423.116	8290.27	3579.83	23.3552
14	395.738	422.739	9322.83	4025.69	23.3552
15	397.941	422.246	10742.3	4638.65	23.3552
16	399.498	421.898	11709.7	5056.37	23.3552
17	401.255	421.505	12827.6	5539.08	23.3551
18	403.013	421.112	13972.7	6033.54	23.3551
19	404.235	420.838	14785	6384.34	23.3553
20	405.456	420.565	15613.3	6741.99	23.3552
21	407.824	420.035	17264.5	7455.01	23.3552
22	409.269	419.712	18302.4	7903.15	23.3551
23	410.714	419.389	19362.8	8361.06	23.3552
24	412.16	419.065	20445.9	8828.75	23.3552
25	413.843	418.689	21736	9385.82	23.3552
26	415.526	418.312	23056.8	9956.15	23.3552
27	416.987	418.023	24127.3	10418.4	23.3552
28	418.893	417.645	26541.8	11461	23.3551
29	420.577	417.516	28036.2	12106.3	23.3551
30	422.26	417.386	29945.7	12930.9	23.3552
31	423.973	418.824	26438.1	11416.2	23.3551
32	425.687	420.262	23007.9	9935.03	23.3551
33	427.4	421.699	19669.1	8493.34	23.3552
34	429.113	423.137	17722.3	7652.67	23.3552
35	430.826	424.574	14605.7	6306.88	23.3551
36	432.539	426.012	11607.9	5012.4	23.3551
37	434.252	427.45	11325.1	4890.3	23.3552
38	435.965	428.887	8584.83	3707.02	23.3552
39	437.683	430.329	10464.7	4518.77	23.3552
40	439.401	431.771	8145.73	3517.41	23.3552
41	441.12	433.213	6043.81	2609.78	23.3552
42	442.839	434.656	7168.68	3095.51	23.3552
43	444.549	436.091	5510.93	2379.68	23.3552
44	446.259	437.527	4064.59	1755.13	23.3552
45	447.908	438.913	2867.83	1238.36	23.3552
46	449.558	440.3	1866.98	806.182	23.3552
47	451.53	441.975	924.082	399.028	23.3552
48	453.502	443.692	260.929	112.672	23.3552
49	455.435	445.376	-101.962	-44.0282	23.3552
50	457.137	446.975	-176.343	-76.1466	23.3552
51	458.839	448.573	0	0	0

Entity Information

Block Search Window

X	Y
426.347	432.148
450.981	432.148
462.346	447.124
437.992	447.124

Block Search Window

X	Y
419.24	416.007
436.033	416.007
449.575	430.362
426.203	430.362

Block Search Window

X	Y
398.555	417.786
417.192	416.11
420.776	423.482
394.152	425.018

External Boundary

X	Y
100	428
100	414.768
100	398.753
100	394.507
100	390
100	250
364.868	250
1222	250
1222	390
1222	698
1198.96	698.006
1184.97	696.257
1175.52	694.508
1161.53	687.511
1151.03	688.21
1146.13	689.61
1131.09	695.557
1108.35	695.208
1104.5	693.808
1085.26	685.411
1076.86	682.263
1063.91	666.519
1060.76	665.119
1035.92	663.72
1028.23	659.521
1022.98	658.472
1007.59	657.072
997.789	654.273
993.241	650.075
983.444	639.929
975.398	633.981
970.15	633.981
953.006	632.232
933.764	632.232
911.722	631.882
893.529	625.934
882.684	621.386
873.237	615.089
862.391	609.141
856.794	603.893
849.796	598.295
845.248	595.846
834.402	594.097
827.055	593.747
821.807	591.998
807.463	583.251
799.766	578.003

794.518	571.356
786.471	563.309
779.824	558.061
768.628	554.212
754.983	552.463
737.84	552.463
721.396	551.413
711.25	545.816
699.005	538.119
687.459	529.722
675.914	523.774
672.765	522.375
657.721	521.325
648.625	520.276
640.928	516.427
632.881	511.179
616.787	502.782
599.993	491.587
597.544	491.237
585.299	489.138
576.902	488.088
570.255	486.339
560.809	482.49
556.96	478.642
546.464	470.245
536.318	459.399
526.172	452.752
518.475	451.352
509.379	449.953
486.288	449.253
454.813	448.473
443.954	448.204
434.858	448.204
427.511	445.405
422.426	442.928
420.983	424.888
403.555	425.854
345.642	428.611
345.642	415.666
342.843	412.867
341.808	411.961
339.567	410
337.246	407.969
328.849	403.421
327.002	402.394
323.951	401.672
309.256	401.672
295.612	402.371
279.168	403.771
268.322	407.269
262.602	409.288
256.427	411.468
249.08	418.465
244.182	424.063
238.934	428

Material Boundary

X	Y
341.808	411.961
359.024	411.961

Material Boundary

X	Y
378.18	421.444
396.693	421.444
403.555	425.854

Material Boundary

X	Y
365.63	413.472
366.764	414.192
378.18	421.444

Material Boundary

X	Y
352.757	410
399.925	410
404.799	410

Material Boundary

X	Y
339.567	410
352.757	410

Material Boundary

X	Y
359.024	411.961
365.63	413.472

Material Boundary

X	Y
418.352	418.779
425.355	423.194
433.632	429.648
441.629	437.364
454.813	448.473

Material Boundary

X	Y
100	398.753
339.367	400
377.393	401.088
378.357	401.088
385.616	404.088
399.925	410
410.07	414.192
418.352	418.779

Material Boundary

X	Y
364.868	250
377.393	401.088

Material Boundary

X	Y
366.764	414.192
410.07	414.192

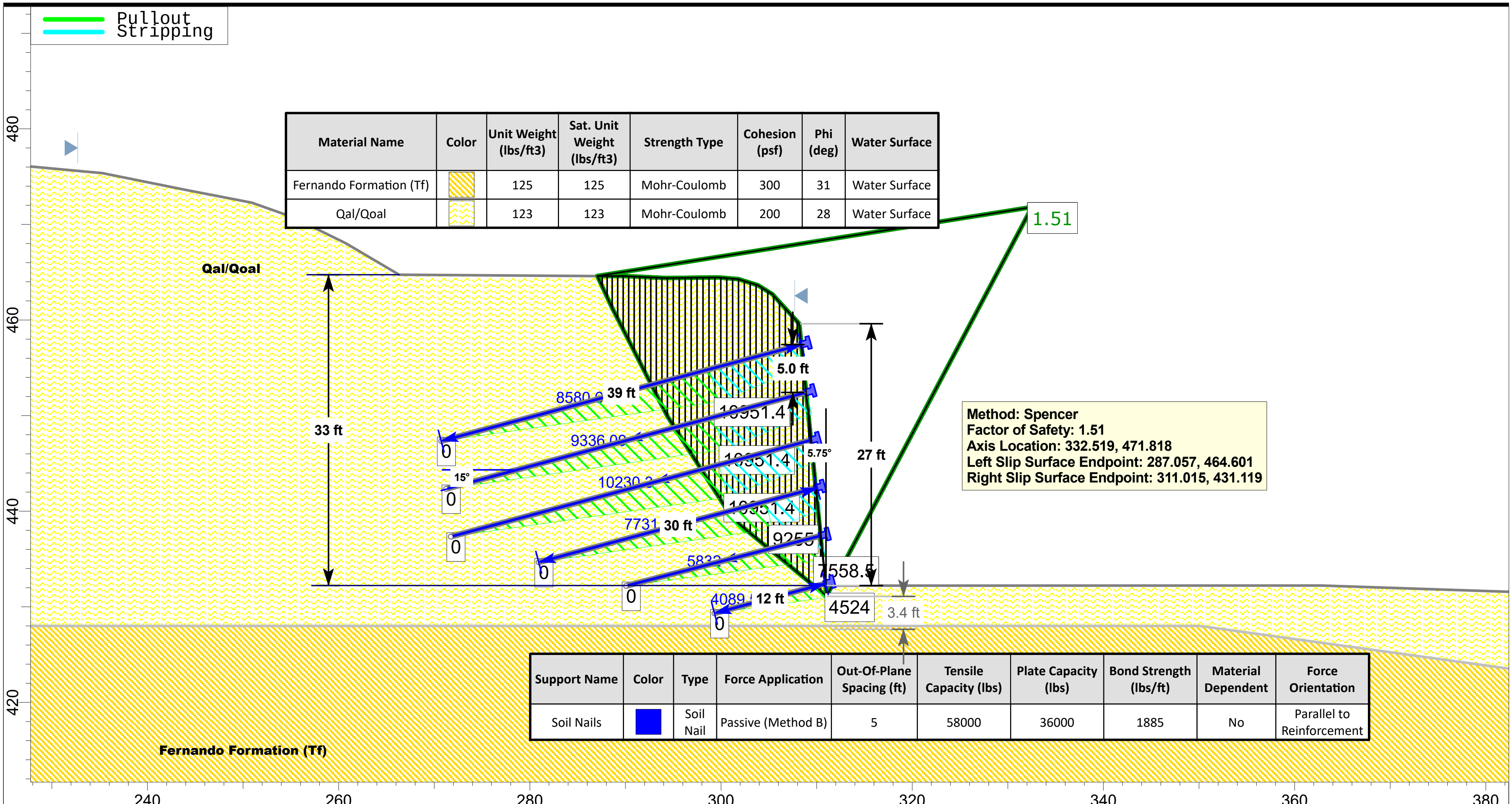
Material Boundary

X	Y
328.849	403.421
385.616	404.088
385.679	404.088

Section 47+00 - Retaining Wall 12A - Soil Nail Wall

Soil Nail Load Demand Analysis - Dia 6 in. - Sh 5 Sv 5

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 47+00_10-1_Demand_RW-12A\Sec 47+00_10-1_SN_Demand_D6_p36 B8 q2200_path______p9 ts.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fernando Formation (Tf)		125	125	Mohr-Coulomb	300	31	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	200	28	Water Surface

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nails		Soil Nail	Passive (Method B)	5	58000	36000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

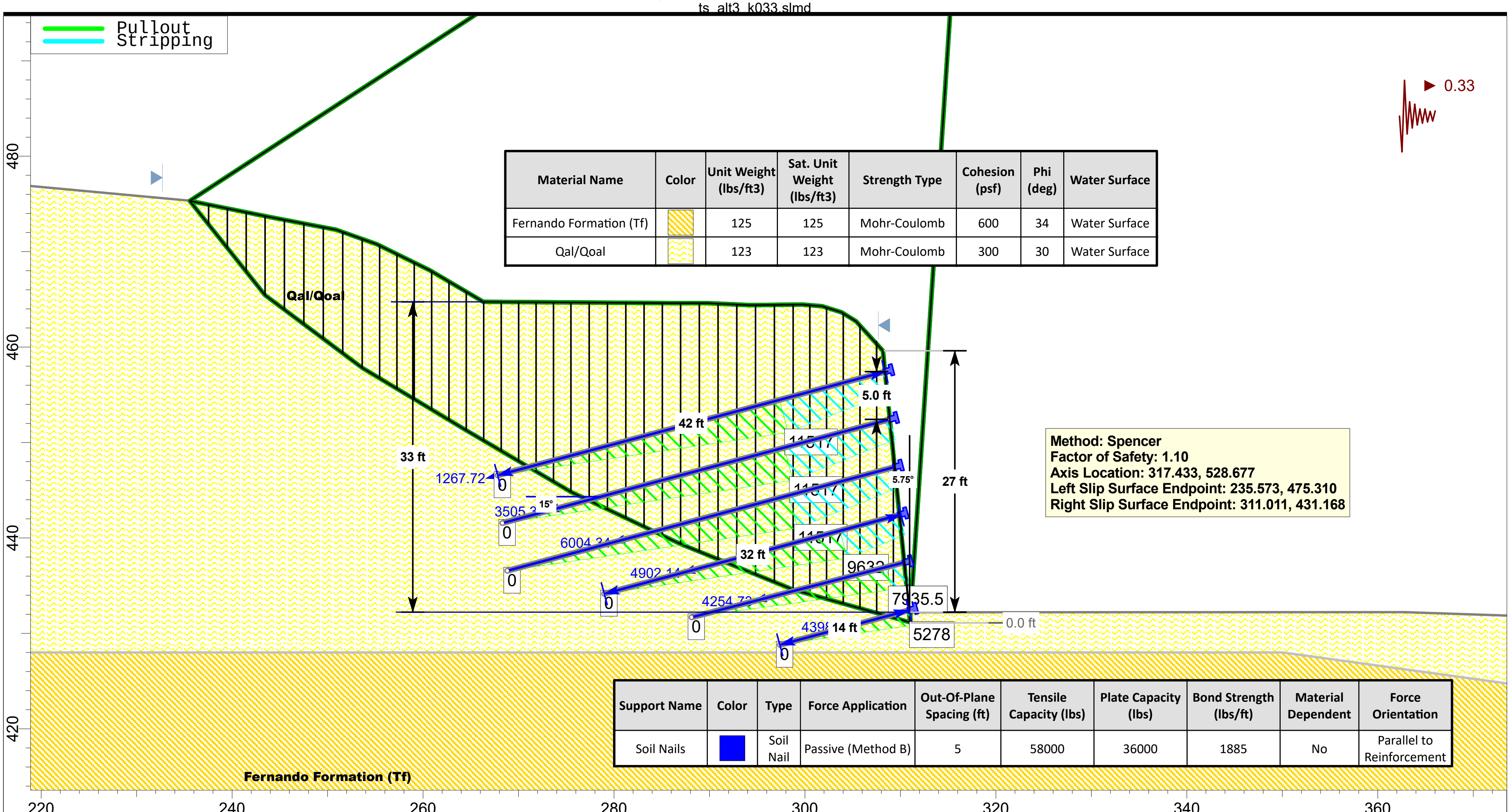
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**				
Analyzed By: JEH	Units: feet	Scale: 1:180	Project No.: **11588.001**	File Name: Master Scenario
Date: June 3, 2019	Condition: **Static**			

Section 47+00 - Retaining Wall 12A - Soil Nail Wall

Soil Nail Load Demand Analysis - Dia 6 in. - Sh 5 Sv 5

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 47+00_10-1_Demand_RW-12A\Sec 47+00_10-1_SN_Demand_D6_p36 B8 q2200_path______p9 ts_alt3_k033.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Fernando Formation (Tf)		125	125	Mohr-Coulomb	600	34	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30	Water Surface

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nails		Soil Nail	Passive (Method B)	5	58000	36000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project:
Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California

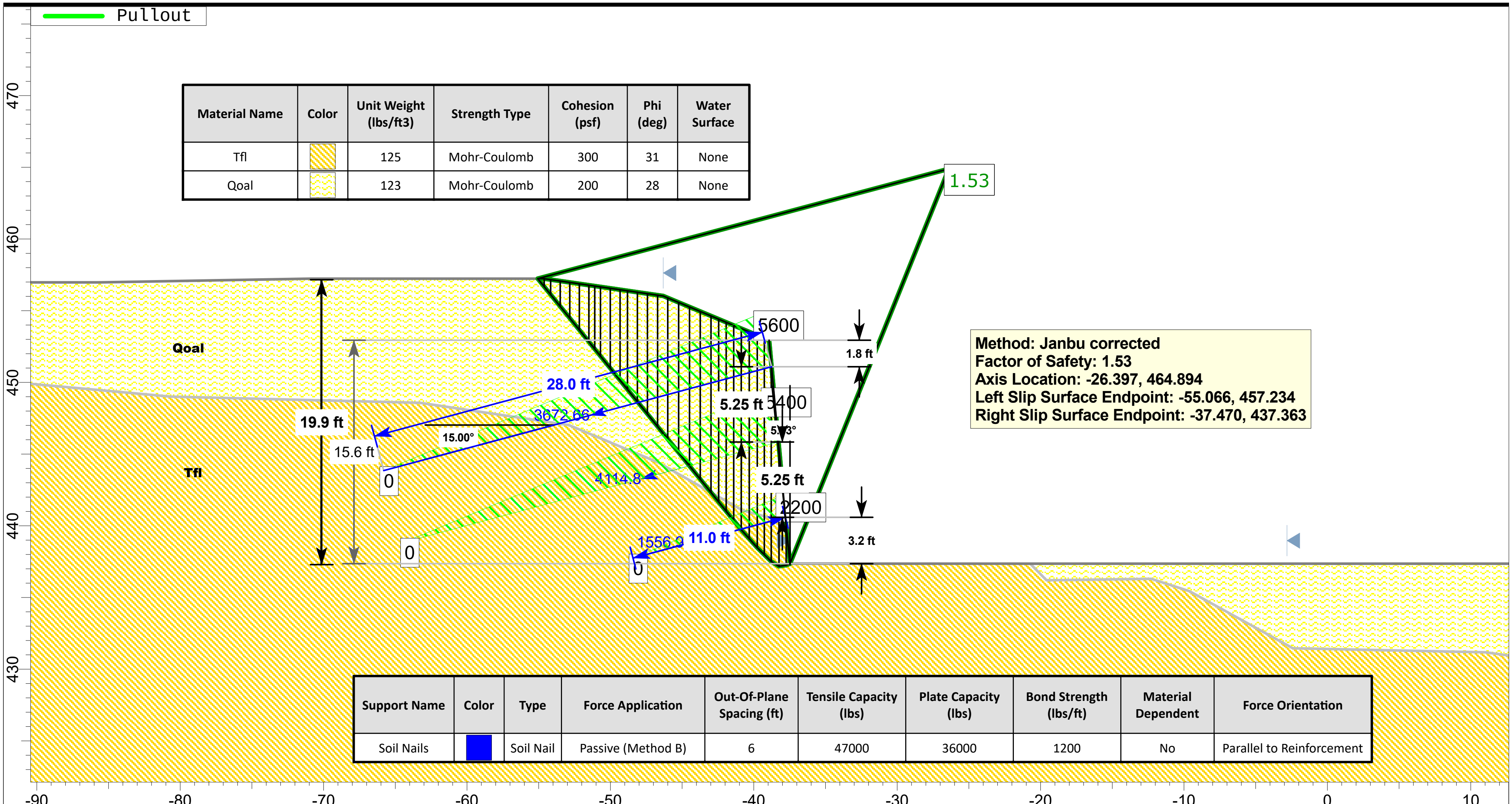
Analyzed By:	Units:	Scale:	Project No.:	File Name:
JEH	feet	1:180	**11588.001**	Master Scenario

Date:	Condition:
June 3, 2019	**PseudoStatic**

Section 53+50 - Retaining Wall 12C - Soil Nail Wall

Soil Nail Load Demand - Dia 4 in. - Sv 5.25 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 53+50-!0-1_Demand_RW-12C\Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Tfl		125	Mohr-Coulomb	300	31	None
Qoal		123	Mohr-Coulomb	200	28	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nails		Soil Nail	Passive (Method B)	6	47000	36000	1200	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**

Analyzed By: JEH | *Units:* feet | *Scale:* 1:120 | *Project No.:* **11588.001** | *Analysis Scenario:* D4 B8 f60 p36 q1200 path SrfAlt_p1

Date: May 31, 2019 | *Condition:* **Static**

Slide Analysis Information

Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var

Project Summary

File Name:	Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var.slmd
Slide Modeler Version:	8.022
Project Title:	Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California
Analysis:	Section 53+50 - Retaining Wall 12C - Soil Nail Wall
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 31, 2019

Comments

Static

11588.001

Soil Nail Load Demand - Dia 4 in. - Sv 5.25 feet Sh 6 feet

10V:1H Wall Batter

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Sec 53+50_10-1_SN_Demand_var	Master Scenario	Janbu Corrected: 1.526570 Spencer: 1.495420	00h:00m:34.849s
	D4 B8 f60 p36 q1200 cco SrfAlt_c1	Janbu Corrected: 1.528120 Spencer: 1.480180	00h:00m:21.264s
	D4 B8 f60 p36 q1200 path SrfAlt_p1	Janbu Corrected: 1.531660 Spencer: 1.469470	00h:00m:19.682s
	D4 B8 f60 p36 q1200 blk SrfAlt_b3	Janbu Corrected: 1.529120 Spencer: 1.491040	00h:00m:10.212s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios	
Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios	
Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios	
Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Sec 53+50_10-1_SN_Demand_var - Master Scenario	
Search Method:	Cuckoo Search
Initial # of Surface Vertices:	8
Maximum Iterations:	500
Number of Nests:	50
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Convex Surfaces Only:	Enabled

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1	
Search Method:	Cuckoo Search
Initial # of Surface Vertices:	8
Maximum Iterations:	500
Number of Nests:	50
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Convex Surfaces Only:	Enabled

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1	
Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3	
Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Left Projection Angle (Start Angle) [°]:	95
Left Projection Angle (End Angle) [°]:	135
Right Projection Angle (Start Angle) [°]:	5
Right Projection Angle (End Angle) [°]:	45
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios	
Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Property	Tfl	Qoal	Qal
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123	120
Cohesion [psf]	300	200	100
Friction Angle [°]	31	28	25
Water Surface	Assigned per scenario	Assigned per scenario	Assigned per scenario
Ru Value	0	0	0

Materials In Use

Material	Master Scenario	D4 B8 f60 p36 q1200 cco SrfAlt_c1	D4 B8 f60 p36 q1200 path SrfAlt_p1	D4 B8 f60 p36 q1200 blk SrfAlt_b3
Tfl	✓	✓	✓	✓
Qoal	✓	✓	✓	✓
Qal	✓	✓	✓	✓

Support

Soil Nails

Support Type: Soil Nail
Force Application: Passive
Force Orientation: Parallel to Reinforcement
Out-of-Plane Spacing: 6 ft
Tensile Capacity: 47000 lb
Plate Capacity: 36000 lb
Bond Strength: 1200 lb/ft

Global Minimums

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

FS	1.526570
Axis Location:	-26.373, 464.846
Left Slip Surface Endpoint:	-55.018, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	19687 lb
Driving Horizontal Force:	12896.2 lb
Passive Horizontal Support Force:	9178.37 lb
Maximum Single Support Force:	4139.07 lb
Total Support Force:	9502.15 lb
Total Slice Area:	140.654 ft2
Surface Horizontal Width:	17.5477 ft
Surface Average Height:	8.01552 ft

Method: spencer

FS	1.495420
Axis Location:	-26.246, 464.592
Left Slip Surface Endpoint:	-54.764, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Moment:	548965 lb-ft
Driving Moment:	367097 lb-ft
Resisting Horizontal Force:	19300.6 lb
Driving Horizontal Force:	12906.4 lb
Passive Support Moment:	132261 lb-ft
Passive Horizontal Support Force:	9212.85 lb
Maximum Single Support Force:	4156.83 lb
Total Support Force:	9537.85 lb
Total Slice Area:	139.379 ft2
Surface Horizontal Width:	17.2937 ft
Surface Average Height:	8.05953 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

FS	1.528120
Axis Location:	-26.306, 464.712
Left Slip Surface Endpoint:	-54.884, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	19617.8 lb
Driving Horizontal Force:	12837.9 lb
Passive Horizontal Support Force:	9209.62 lb
Maximum Single Support Force:	4159.44 lb
Total Support Force:	9534.5 lb
Total Slice Area:	139.556 ft2
Surface Horizontal Width:	17.4138 ft
Surface Average Height:	8.01412 ft

Method: spencer

FS	1.480180
Axis Location:	-25.615, 462.752
Left Slip Surface Endpoint:	-53.039, 457.002
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Moment:	500821 lb-ft
Driving Moment:	338721 lb-ft
Resisting Horizontal Force:	18473.1 lb
Driving Horizontal Force:	12494 lb
Passive Support Moment:	113775 lb-ft
Passive Horizontal Support Force:	9225.37 lb
Maximum Single Support Force:	4139.36 lb
Total Support Force:	9550.81 lb
Total Slice Area:	130.823 ft2
Surface Horizontal Width:	15.5692 ft
Surface Average Height:	8.40266 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

FS	1.531660
Axis Location:	-26.397, 464.894
Left Slip Surface Endpoint:	-55.066, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	20077.8 lb
Driving Horizontal Force:	13108.6 lb
Passive Horizontal Support Force:	9025.98 lb
Maximum Single Support Force:	4114.79 lb
Total Support Force:	9344.38 lb
Total Slice Area:	146.254 ft2
Surface Horizontal Width:	17.5956 ft
Surface Average Height:	8.31198 ft

Method: spencer

FS	1.469470
Axis Location:	-25.412, 469.079
Left Slip Surface Endpoint:	-56.173, 457.234
Right Slip Surface Endpoint:	-34.393, 437.363
Resisting Moment:	840836 lb-ft
Driving Moment:	572202 lb-ft
Resisting Horizontal Force:	22760.6 lb
Driving Horizontal Force:	15489 lb
Passive Support Moment:	147804 lb-ft
Passive Horizontal Support Force:	8047.9 lb
Maximum Single Support Force:	3765.78 lb
Total Support Force:	8331.8 lb
Total Slice Area:	190.063 ft2
Surface Horizontal Width:	21.78 ft
Surface Average Height:	8.72649 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

FS	1.529120
Axis Location:	-26.516, 465.132
Left Slip Surface Endpoint:	-55.304, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	19859.5 lb
Driving Horizontal Force:	12987.5 lb
Passive Horizontal Support Force:	9160.52 lb
Maximum Single Support Force:	4150.88 lb
Total Support Force:	9483.67 lb
Total Slice Area:	142.73 ft2
Surface Horizontal Width:	17.8338 ft
Surface Average Height:	8.00331 ft

Method: spencer

FS	1.491040
Axis Location:	-25.790, 468.652
Left Slip Surface Endpoint:	-56.338, 457.234
Right Slip Surface Endpoint:	-34.985, 437.363
Resisting Moment:	810928 lb-ft
Driving Moment:	543866 lb-ft
Resisting Horizontal Force:	22620.6 lb
Driving Horizontal Force:	15171 lb
Passive Support Moment:	147931 lb-ft
Passive Horizontal Support Force:	8144.35 lb
Maximum Single Support Force:	3801.58 lb
Total Support Force:	8431.65 lb
Total Slice Area:	187.468 ft2
Surface Horizontal Width:	21.3533 ft
Surface Average Height:	8.77933 ft

Global Minimum Coordinates

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

X	Y
-55.0177	457.234
-54.4437	456.599
-53.8699	455.944
-53.0573	454.988
-52.2447	454.004
-51.4322	453.077
-50.626	452.128
-49.7979	451.125
-48.9699	450.094
-48.1772	449.078
-47.3844	448.035
-46.5917	447.02
-45.799	446.021
-45.0063	445.021
-44.2136	444.021
-43.6054	443.343
-42.9971	442.717
-42.389	442.069
-41.7824	441.402
-41.1759	440.714
-40.564	439.999
-40.0019	439.322
-39.3903	438.564
-38.7786	437.855
-38.2276	437.339
-37.47	437.363

Method: spencer

X	Y
-54.7637	457.234
-54.0103	456.126
-53.1145	454.833
-51.9452	453.53
-50.7743	452.201
-49.6034	450.841
-48.7448	449.814
-47.9687	448.859
-47.1928	447.877
-46.8115	447.46
-46.4528	447.055
-46.1859	446.744
-45.8955	446.396
-45.686	446.138
-45.4765	445.872
-45.267	445.599
-45.0574	445.319
-44.7371	444.879
-44.2092	444.136
-43.5581	443.453
-42.7946	442.626
-41.9332	441.663
-41.0721	440.669
-39.7443	439.092
-38.4146	437.814
-37.47	437.363

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

X	Y
-54.8838	457.234
-54.3064	456.557
-53.7289	455.876
-52.9363	454.912
-52.1437	453.922
-51.3583	452.993
-50.573	452.068
-49.7478	451.073
-48.9226	450.087
-48.3951	449.437
-47.8677	448.77
-47.3402	448.084
-46.8127	447.381
-46.1244	446.529
-45.4362	445.702
-44.748	444.85
-44.0597	443.975
-43.5699	443.451
-43.0802	442.91
-42.2932	442.013
-41.5061	441.108
-40.6978	440.154
-39.8894	439.172
-39.0765	438.249
-38.2637	437.354
-37.47	437.363

Method: spencer

X	Y
-53.0392	457.002
-52.7312	456.585
-52.4231	456.156
-52.115	455.717
-51.8069	455.267
-51.2111	454.376
-50.5617	453.382
-49.7874	452.17
-49.0131	450.931
-48.5183	450.122
-48.0527	449.345
-47.4461	448.311
-46.8409	447.492
-46.161	446.623
-45.4811	445.732
-44.8109	444.83
-44.1407	443.904
-43.4705	443.225
-42.7979	442.538
-42.2309	441.939
-41.6639	441.321
-40.8789	440.437
-40.0939	439.526
-39.2691	438.63
-38.4444	437.828
-37.47	437.363

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

X	Y
-55.0656	457.234
-54.1676	456.126
-53.501	455.304
-52.8337	454.481
-52.166	453.658
-51.4979	452.834
-50.6864	451.833
-50.0047	450.992
-49.3252	450.154
-48.8041	449.511
-48.1109	448.656
-47.4176	447.801
-46.708	446.926
-45.9983	446.05
-45.239	445.114
-44.4794	444.177
-43.729	443.251
-42.9781	442.325
-41.9194	441.019
-40.873	439.729
-39.7546	438.473
-38.7771	437.51
-38.2419	437.177
-37.7357	437.257
-37.47	437.363

Method: spencer

X	Y
-56.1734	457.234
-54.9509	455.65
-54.1252	454.548
-53.2586	453.368
-52.6657	452.558
-52.1354	451.84
-51.2308	450.616
-50.3589	449.436
-49.4402	448.187
-48.3898	446.763
-47.254	445.227
-46.1183	443.66
-44.9826	442.174
-43.8467	440.751
-42.6285	439.183
-41.4104	437.84
-40.7019	437.12
-39.9946	436.377
-38.934	435.253
-37.7998	434.736
-36.6643	435.632
-35.5288	436.508
-34.3934	437.363

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

X	Y
-55.3038	457.234
-54.9617	456.814
-54.5744	456.393
-53.7692	455.489
-52.9656	454.559
-52.1825	453.64
-51.4065	452.792
-50.7331	452.033
-50.0597	451.25
-49.1813	450.198
-48.2998	449.112
-47.2828	447.823
-46.3106	446.653
-45.3384	445.477
-44.3663	444.298
-43.6296	443.403
-42.8928	442.592
-42.2504	441.871
-41.5465	441.058
-40.846	440.224
-40.1719	439.414
-39.5173	438.686
-38.8626	437.95
-38.2078	437.319
-37.47	437.363

Method: spencer

X	Y
-56.338	457.234
-55.697	456.41
-55.0562	455.563
-54.3229	454.569
-53.5896	453.555
-52.9762	452.708
-52.2803	451.745
-51.6401	450.852
-50.9387	449.87
-50.066	448.65
-49.1917	447.416
-48.3129	446.431
-47.4341	445.451
-46.5554	444.44
-45.6768	443.398
-44.798	442.418
-43.941	441.482
-43.0417	440.47
-42.0685	439.341
-41.0953	438.179
-40.2768	437.173
-39.4913	436.18
-38.9173	435.434
-38.3432	434.693
-36.6642	435.825
-34.9847	437.363

Valid/Invalid Surfaces

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

Number of Valid Surfaces: 13530
Number of Invalid Surfaces: 36589

Error Codes:

Error Code -108 reported for 5 surfaces
Error Code -109 reported for 4 surfaces
Error Code -111 reported for 27 surfaces
Error Code -112 reported for 42 surfaces
Error Code -114 reported for 122 surfaces
Error Code -120 reported for 94 surfaces
Error Code -121 reported for 11215 surfaces
Error Code -124 reported for 21 surfaces
Error Code -1000 reported for 25059 surfaces

Method: spencer

Number of Valid Surfaces: 10739
Number of Invalid Surfaces: 39380

Error Codes:

Error Code -108 reported for 87 surfaces
Error Code -109 reported for 4 surfaces
Error Code -111 reported for 2384 surfaces
Error Code -112 reported for 49 surfaces
Error Code -114 reported for 122 surfaces
Error Code -120 reported for 53 surfaces
Error Code -121 reported for 11215 surfaces
Error Code -124 reported for 21 surfaces
Error Code -1000 reported for 25445 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

Number of Valid Surfaces: 12287
Number of Invalid Surfaces: 37831

Error Codes:

Error Code -109 reported for 2 surfaces
Error Code -111 reported for 27 surfaces
Error Code -112 reported for 61 surfaces
Error Code -114 reported for 137 surfaces
Error Code -120 reported for 1177 surfaces
Error Code -121 reported for 12078 surfaces
Error Code -124 reported for 43 surfaces
Error Code -1000 reported for 24306 surfaces

Method: spencer

Number of Valid Surfaces: 9357
Number of Invalid Surfaces: 40761

Error Codes:

Error Code -108 reported for 50 surfaces
Error Code -109 reported for 2 surfaces
Error Code -111 reported for 3592 surfaces
Error Code -112 reported for 49 surfaces
Error Code -114 reported for 137 surfaces
Error Code -120 reported for 185 surfaces
Error Code -121 reported for 12078 surfaces
Error Code -124 reported for 43 surfaces
Error Code -1000 reported for 24625 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

Number of Valid Surfaces: 4706
Number of Invalid Surfaces: 332

Error Codes:

Error Code -108 reported for 6 surfaces
Error Code -111 reported for 82 surfaces
Error Code -120 reported for 36 surfaces
Error Code -121 reported for 96 surfaces
Error Code -124 reported for 97 surfaces
Error Code -1000 reported for 15 surfaces

Method: spencer

Number of Valid Surfaces: 3742
Number of Invalid Surfaces: 1296

Error Codes:

Error Code -108 reported for 51 surfaces
Error Code -111 reported for 1028 surfaces
Error Code -112 reported for 1 surface
Error Code -120 reported for 2 surfaces
Error Code -121 reported for 96 surfaces
Error Code -124 reported for 97 surfaces
Error Code -1000 reported for 21 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

Number of Valid Surfaces: 4982
Number of Invalid Surfaces: 38

Error Codes:

Error Code -111 reported for 25 surfaces
Error Code -124 reported for 3 surfaces
Error Code -1000 reported for 10 surfaces

Method: spencer

Number of Valid Surfaces: 3285
Number of Invalid Surfaces: 1735

Error Codes:

Error Code -108 reported for 31 surfaces
Error Code -111 reported for 1689 surfaces
Error Code -120 reported for 4 surfaces
Error Code -124 reported for 3 surfaces
Error Code -1000 reported for 8 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-109 = Soiltype for slice base not located. This error should occur very rarely, if at all. It may occur if a very low number of slices is combined with certain soil geometries, such that the midpoint of a slice base is actually outside the soil region,even though the slip surface is wholly within the soil region.
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.
-120 = Tensile effective normal stress on the base of a slice exceeds the tensile strength of the material. The stress state on the base of the surface violates the strength criterion.
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Sec 53+50_10-1_SN_Demand_var - Master Scenario

- Global Minimum Query (janbu corrected) - Safety Factor: 1.52657

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.573984	22.0758	-47.8934	Qoal	200	28	103.893	158.599	-77.8633	0	-77.8633	37.0903	37.0903
2	0.573859	63.0051	-48.7775	Qoal	200	28	120.698	184.254	-29.6135	0	-29.6135	108.15	108.15
3	0.4063	69.3707	-49.6315	Qoal	200	28	134.654	205.559	10.455	0	10.455	168.85	168.85
4	0.4063	90.315	-49.6315	Qoal	200	28	147.347	224.935	46.8956	0	46.8956	220.22	220.22
5	0.812547	244.862	-50.4566	Qoal	200	28	165.375	252.457	98.6569	0	98.6569	298.964	298.964
6	0.406255	154.189	-48.7744	Qoal	200	28	187.704	286.544	162.765	0	162.765	376.984	376.984
7	0.406255	174.418	-48.7744	Qoal	200	28	200.072	305.424	198.273	0	198.273	426.607	426.607
8	0.806191	407.418	-49.6285	Qoal	200	28	217.053	331.346	247.026	0	247.026	502.319	502.319
9	0.414061	241.667	-50.4537	Qoal	200	28	234.291	357.662	296.519	0	296.519	580.27	580.27
10	0.414061	264.153	-50.4537	Qoal	200	28	247.547	377.898	334.579	0	334.579	634.383	634.383
11	0.827958	597.108	-51.2511	Qoal	200	28	265.572	405.415	386.328	0	386.328	717.238	717.238
12	0.396378	319.065	-52.0217	Qoal	200	28	283.422	432.663	437.576	0	437.576	800.623	800.623
13	0.396378	341.021	-52.0217	Qoal	200	28	296.714	452.954	475.739	0	475.739	855.812	855.812
14	0.792741	749.244	-52.7667	Qoal	200	28	505.753	772.068	1075.9	0	1075.9	1741.41	1741.41
15	0.792728	838.391	-52.0169	Qoal	200	28	344.068	525.244	611.695	0	611.695	1052.35	1052.35
16	0.792716	920.931	-51.5509	Qoal	200	28	370.973	566.317	688.943	0	688.943	1156.17	1156.17
17	0.792706	987.366	-51.6134	Qoal	200	28	390.924	596.773	746.222	0	746.222	1239.68	1239.68
18	0.792696	1052.57	-51.5992	Qoal	200	28	626.798	956.851	1423.43	0	1423.43	2214.23	2214.23
19	0.608195	848.423	-48.0915	Qoal	200	28	442.946	676.188	895.579	0	895.579	1389.1	1389.1
20	0.608252	878.253	-45.8404	Qoal	200	28	465.113	710.028	959.224	0	959.224	1438.19	1438.19
21	0.608158	906.734	-46.7947	Qoal	200	28	472.869	721.867	981.489	0	981.489	1484.95	1484.95
22	0.148094	225.301	-47.7163	Qoal	200	28	476.302	727.108	991.347	0	991.347	1515.1	1515.1
23	0.458495	709.293	-47.7163	Tfl	300	31	560.111	855.048	923.756	0	923.756	1539.66	1539.66
24	0.606494	966.463	-48.6065	Tfl	300	31	567.357	866.11	942.165	0	942.165	1585.85	1585.85
25	0.611887	1009.15	-49.4663	Tfl	300	31	576.937	880.734	966.504	0	966.504	1641.21	1641.21
26	0.562084	958.745	-50.297	Tfl	300	31	720.257	1099.52	1330.64	0	1330.64	2198.1	2198.1
27	0.61163	1079.45	-51.0997	Tfl	300	31	596.662	910.847	1016.62	0	1016.62	1756.06	1756.06
28	0.611693	1101.8	-49.2022	Tfl	300	31	619.574	945.823	1074.83	0	1074.83	1792.67	1792.67
29	0.551047	729.085	-43.114	Tfl	300	31	522.463	797.577	828.106	0	828.106	1317.26	1317.26
30	0.757566	365.579	1.81571	Tfl	300	31	391.402	597.502	495.126	0	495.126	482.718	482.718

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- Global Minimum Query (

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]
1	0.577409	23.045	-49.5343	Qoal	200
2	0.577409	65.8714	-49.7252	Qoal	200
3	0.792645	160.926	-50.5471	Qoal	200
4	0.792645	244.989	-51.3414	Qoal	200
5	0.785334	324.423	-49.7941	Qoal	200
6	0.785334	402.976	-49.6609	Qoal	200
7	0.825177	508.979	-50.3131	Qoal	200
8	0.412588	287.692	-50.0953	Qoal	200
9	0.412588	309.697	-50.0953	Qoal	200
10	0.527484	428.588	-50.9047	Qoal	200
11	0.527484	466.349	-51.687	Qoal	200
12	0.527481	505.303	-52.4431	Qoal	200
13	0.527481	545.401	-53.1113	Qoal	200
14	0.688255	769.407	-51.0704	Qoal	200
15	0.688255	820.34	-50.2427	Qoal	200
16	0.688236	867.005	-51.0472	Qoal	200
17	0.688236	915.726	-51.8246	Qoal	200
18	0.489771	678.967	-46.9266	Qoal	200
19	0.489771	698.703	-47.8437	Qoal	200
20	0.787027	1166.51	-48.7295	Qoal	200
21	0.132432	201.7	-49.0053	Qoal	200
22	0.654596	1020.44	-49.0053	Tfl	300
23	0.404177	649.883	-49.7106	Tfl	300
24	0.404177	665.384	-49.7106	Tfl	300
25	0.808353	1378.92	-50.533	Tfl	300
26	0.812881	1449.19	-48.643	Tfl	300
27	0.40644	703.644	-47.741	Tfl	300
28	0.40644	518.969	-47.741	Tfl	300
29	0.396827	303.855	0.620252	Tfl	300
30	0.396827	97.3501	0.620252	Tfl	300

- Global Minimum Query (spencer) - Safety Factor: 1.49542

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.753426	47.8023	-55.7818	Qoal	200	28	137.649	205.843	10.9885	0	10.9885	213.394	213.394
2	0.89576	176.104	-55.288	Qoal	200	28	153.925	230.183	56.7658	0	56.7658	278.962	278.962
3	0.584641	177.154	-48.1036	Qoal	200	28	180.686	270.202	132.031	0	132.031	333.435	333.435
4	0.584641	217.929	-48.1036	Qoal	200	28	192.041	287.183	163.966	0	163.966	378.027	378.027
5	0.585464	259.521	-48.6134	Qoal	200	28	202.146	302.293	192.386	0	192.386	421.784	421.784
6	0.585464	301.26	-48.6134	Qoal	200	28	213.575	319.384	224.528	0	224.528	466.896	466.896
7	0.585443	343.541	-49.2646	Qoal	200	28	222.931	333.375	250.842	0	250.842	509.699	509.699
8	0.585443	386.387	-49.2646	Qoal	200	28	234.424	350.563	283.167	0	283.167	555.37	555.37
9	0.858612	645.758	-50.1021	Qoal	200	28	245.304	366.833	313.767	0	313.767	607.17	607.17
10	0.776103	667.022	-50.9113	Qoal	200	28	257.738	385.427	348.737	0	348.737	666.012	666.012
11	0.775915	748.597	-51.6933	Qoal	200	28	874.972	1308.45	2084.7	0	2084.7	3192.34	3192.34
12	0.381283	396.74	-47.5609	Qoal	200	28	303.806	454.318	478.304	0	478.304	810.559	810.559
13	0.35872	389.028	-48.4563	Qoal	200	28	305.857	457.385	484.071	0	484.071	829.249	829.249
14	0.266853	299.385	-49.3213	Qoal	200	28	306.618	458.523	486.211	0	486.211	842.956	842.956
15	0.290381	333.742	-50.1569	Qoal	200	28	305.632	457.048	483.437	0	483.437	849.707	849.707
16	0.209528	245.935	-50.9642	Qoal	200	28	304.053	454.687	478.997	0	478.997	853.992	853.992
17	0.209528	250.431	-51.7445	Qoal	200	28	301.904	451.474	472.953	0	472.953	855.842	855.842
18	0.209519	255.105	-52.4987	Qoal	200	28	299.751	448.254	466.896	0	466.896	857.521	857.521
19	0.209517	259.974	-53.2279	Qoal	200	28	297.565	444.985	460.748	0	460.748	858.916	858.916
20	0.320301	407.26	-53.9331	Qoal	200	28	296.171	442.9	456.828	0	456.828	863.472	863.472
21	0.527972	698.209	-54.6152	Qoal	200	28	1246.19	1863.58	3128.74	0	3128.74	4883.29	4883.29
22	0.651041	898.314	-46.3582	Qoal	200	28	368.573	551.171	660.458	0	660.458	1046.93	1046.93
23	0.763544	1096.67	-47.2948	Qoal	200	28	371.276	555.213	668.058	0	668.058	1070.33	1070.33
24	0.735433	1102.56	-48.1993	Qoal	200	28	374.687	560.315	677.654	0	677.654	1096.71	1096.71
25	0.125898	193.426	-48.1993	Tfl	300	31	479.507	717.064	694.112	0	694.112	1230.4	1230.4
26	0.861151	1361.73	-49.073	Tfl	300	31	479.57	717.159	694.27	0	694.27	1247.37	1247.37
27	1.32785	2237	-49.917	Tfl	300	31	670.55	1002.75	1169.58	0	1169.58	1966.36	1966.36
28	0.664819	1177.67	-43.8559	Tfl	300	31	568.224	849.733	914.91	0	914.91	1460.88	1460.88
29	0.664819	1037.83	-43.8559	Tfl	300	31	524.602	784.501	806.345	0	806.345	1310.4	1310.4
30	0.944612	545.095	-25.519	Tfl	300	31	418.393	625.674	542.012	0	542.012	741.746	741.746

- Global Minimum Qu

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]
1	0.308078	7.06786	-53.5858	Qoal	200
2	0.308078	21.4074	-54.2793	Qoal	200
3	0.308088	36.156	-54.9501	Qoal	200
4	0.308088	51.3119	-55.5993	Qoal	200
5	0.595792	143.563	-56.2277	Qoal	200
6	0.64939	224.545	-56.8362	Qoal	200
7	0.774321	362.963	-57.4255	Qoal	200
8	0.38716	221.084	-57.9964	Qoal	200
9	0.38716	247.915	-57.9964	Qoal	200
10	0.494796	356.422	-58.5497	Qoal	200
11	0.465556	376.8	-59.086	Qoal	200
12	0.606579	552.727	-59.6061	Qoal	200
13	0.60521	613.929	-53.5416	Qoal	200
14	0.679943	752.149	-51.9481	Qoal	200
15	0.679943	806.673	-52.6655	Qoal	200
16	0.670177	845.736	-53.3892	Qoal	200
17	0.670177	897.954	-54.0891	Qoal	200
18	0.670213	941.046	-45.3907	Qoal	200
19	0.67263	977.727	-45.5981	Qoal	200
20	0.566952	850.862	-46.5607	Qoal	200
21	0.073284	111.834	-47.4904	Qoal	200
22	0.493668	765.063	-47.4904	Tfl	300
23	0.78503	1260	-48.3882	Tfl	300
24	0.392515	650.738	-49.2555	Tfl	300
25	0.392515	665.082	-49.2555	Tfl	300
26	0.824768	1441.06	-47.3617	Tfl	300
27	0.412384	737.411	-44.1744	Tfl	300
28	0.412384	604.942	-44.1744	Tfl	300
29	0.487177	439.965	-25.5346	Tfl	300
30	0.487177	140.691	-25.5346	Tfl	300

Interslice Data

Sec 53+50_10-1_SN_Demand_var - Master Scenario

- Global Minimum Query (janbu corrected) - Safety Factor: 1.52657

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-55.0177	457.234	0	0	0
2	-54.4437	456.599	-109.794	0	0
3	-53.8699	455.944	-199.28	0	0
4	-53.4636	455.466	-249.645	0	0
5	-53.0573	454.988	-287.813	0	0
6	-52.2447	454.004	-326.694	0	0
7	-51.8385	453.54	-328.394	0	0
8	-51.4322	453.077	-318.715	0	0
9	-50.626	452.128	-261.55	0	0
10	-50.212	451.627	-211.022	0	0
11	-49.7979	451.125	-146.963	0	0
12	-48.9699	450.094	29.0914	0	0
13	-48.5736	449.586	137.584	0	0
14	-48.1772	449.078	260.121	0	0
15	-47.3844	448.035	-1402.59	0	0
16	-46.5917	447.02	-1057.57	0	0
17	-45.799	446.021	-667.311	0	0
18	-45.0063	445.021	-234.204	0	0
19	-44.2136	444.021	-1963.62	0	0
20	-43.6054	443.343	-1629.35	0	0
21	-42.9971	442.717	-1314.81	0	0
22	-42.389	442.069	-970.299	0	0
23	-42.2409	441.906	-880.239	0	0
24	-41.7824	441.402	-674.381	0	0
25	-41.1759	440.714	-374.287	0	0
26	-40.564	439.999	-39.9082	0	0
27	-40.0019	439.322	-603.411	0	0
28	-39.3903	438.564	-202.108	0	0
29	-38.7786	437.855	176.127	0	0
30	-38.2276	437.339	312.026	0	0
31	-37.47	437.363	0	0	0

- Global Minimum Query (spencer) - Safety Factor: 1.49542

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-54.7637	457.234	0	0	0
2	-54.0103	456.126	-91.2412	-88.141	44.0099
3	-53.1145	454.833	-155.33	-150.052	44.0098
4	-52.5299	454.181	-174.627	-168.694	44.01
5	-51.9452	453.53	-179.732	-173.625	44.0099
6	-51.3597	452.865	-169.927	-164.154	44.01
7	-50.7743	452.201	-145.44	-140.498	44.0098
8	-50.1888	451.521	-105.065	-101.495	44.0098
9	-49.6034	450.841	-49.4251	-47.7457	44.0099
10	-48.7448	449.814	62.7761	60.6431	44.0099
11	-47.9687	448.859	196.486	189.81	44.0099
12	-47.1928	447.877	-838.349	-809.864	44.0099
13	-46.8115	447.46	-754.412	-728.779	44.0099
14	-46.4528	447.055	-667.85	-645.157	44.0098
15	-46.1859	446.744	-598.483	-578.147	44.0098
16	-45.8955	446.396	-518.749	-501.123	44.0099
17	-45.686	446.138	-458.496	-442.917	44.0099
18	-45.4765	445.872	-395.896	-382.444	44.0099
19	-45.267	445.599	-331.042	-319.793	44.0098
20	-45.0574	445.319	-264.039	-255.067	44.0098
21	-44.7371	444.879	-157.733	-152.373	44.0098
22	-44.2092	444.136	-1173.08	-1133.22	44.0099
23	-43.5581	443.453	-961.491	-928.821	44.0099
24	-42.7946	442.626	-691.495	-667.999	44.0099
25	-42.0591	441.803	-408.891	-394.997	44.0098
26	-41.9332	441.663	-371.354	-358.736	44.0099
27	-41.0721	440.669	-93.6248	-90.4436	44.0099
28	-39.7443	439.092	-206.302	-199.293	44.01
29	-39.0794	438.453	1.4297	1.38112	44.0098
30	-38.4146	437.814	168.73	162.997	44.0099
31	-37.47	437.363	0	0	0

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- Global Minimum Query (janbu corrected) - Safety Factor: 1.52812

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-54.8838	457.234	0	0	0
2	-54.3064	456.557	-115.091	0	0
3	-53.7289	455.876	-205.772	0	0
4	-52.9363	454.912	-290.494	0	0
5	-52.1437	453.922	-324.431	0	0
6	-51.3583	452.993	-310.192	0	0
7	-50.573	452.068	-250.392	0	0
8	-49.7478	451.073	-133.576	0	0
9	-49.3352	450.58	-56.1208	0	0
10	-48.9226	450.087	34.404	0	0
11	-48.3951	449.437	174.684	0	0
12	-47.8677	448.77	343.783	0	0
13	-47.3402	448.084	-1424.77	0	0
14	-46.8127	447.381	-1192.65	0	0
15	-46.1244	446.529	-878.525	0	0
16	-45.4362	445.702	-544.995	0	0
17	-44.748	444.85	-170.992	0	0
18	-44.0597	443.975	-1960.31	0	0
19	-43.5699	443.451	-1707.29	0	0
20	-43.0802	442.91	-1432.28	0	0
21	-42.2932	442.013	-947.497	0	0
22	-42.1607	441.861	-861.837	0	0
23	-41.5061	441.108	-541.993	0	0
24	-41.1019	440.631	-326.758	0	0
25	-40.6978	440.154	-103.274	0	0
26	-39.8894	439.172	-508.747	0	0
27	-39.0765	438.249	-26.4461	0	0
28	-38.6701	437.802	193.419	0	0
29	-38.2637	437.354	323.001	0	0
30	-37.8668	437.359	119.182	0	0
31	-37.47	437.363	0	0	0

- Global Minimum Query (spencer) - Safety Factor: 1.48018

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-53.0392	457.002	0	0	0
2	-52.7312	456.585	-42.9498	-47.5248	47.8948
3	-52.4231	456.156	-80.8892	-89.5056	47.8948
4	-52.115	455.717	-113.514	-125.606	47.8949
5	-51.8069	455.267	-140.52	-155.489	47.8949
6	-51.2111	454.376	-175.51	-194.205	47.8948
7	-50.5617	453.382	-186.305	-206.15	47.8948
8	-49.7874	452.17	-160.015	-177.06	47.8948
9	-49.4002	451.551	-130.26	-144.136	47.8949
10	-49.0131	450.931	-89.218	-98.7215	47.8948
11	-48.5183	450.122	-19.7121	-21.8118	47.8948
12	-48.0527	449.345	63.6828	70.4664	47.8948
13	-47.4461	448.311	-789.506	-873.604	47.8948
14	-46.8409	447.492	-643.241	-711.76	47.8948
15	-46.161	446.623	-462.112	-511.336	47.8948
16	-45.4811	445.732	-257.135	-284.525	47.8948
17	-44.8109	444.83	-32.208	-35.6388	47.8948
18	-44.1407	443.904	-1042.51	-1153.56	47.8948
19	-43.4705	443.225	-835.78	-924.808	47.8948
20	-42.7979	442.538	-616.217	-681.857	47.8948
21	-42.2309	441.939	-416.098	-460.421	47.8948
22	-42.1576	441.859	-388.81	-430.226	47.8948
23	-41.6639	441.321	-250.523	-277.209	47.8948
24	-40.8789	440.437	-8.53808	-9.44756	47.8948
25	-40.4864	439.981	123.246	136.374	47.8948
26	-40.0939	439.526	-336.583	-372.436	47.8948
27	-39.2691	438.63	-56.3406	-62.3421	47.8948
28	-38.8567	438.229	69.449	76.8468	47.8948
29	-38.4444	437.828	158.178	175.027	47.8948
30	-37.9572	437.596	87.4648	96.7816	47.8948
31	-37.47	437.363	0	0	0

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- Global Minimum Query (janbu corrected) - Safety Factor: 1.53166

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-55.0656	457.234	0	0	0
2	-54.6166	456.68	-95.3873	0	0
3	-54.1676	456.126	-173.239	0	0
4	-53.501	455.304	-258.304	0	0
5	-52.8337	454.481	-306.925	0	0
6	-52.166	453.658	-318.988	0	0
7	-51.4979	452.834	-294.427	0	0
8	-51.0922	452.333	-261.626	0	0
9	-50.6864	451.833	-215.309	0	0
10	-50.0047	450.992	-107.056	0	0
11	-49.3252	450.154	38.7925	0	0
12	-48.8041	449.511	176.317	0	0
13	-48.1109	448.656	393.826	0	0
14	-47.4176	447.801	-1318.67	0	0
15	-46.708	446.926	-1014.79	0	0
16	-45.9983	446.05	-670.519	0	0
17	-45.239	445.114	-266.173	0	0
18	-44.4794	444.177	-2032.78	0	0
19	-43.729	443.251	-1563.31	0	0
20	-42.9781	442.325	-1058.91	0	0
21	-42.4488	441.672	-781.185	0	0
22	-41.9194	441.019	-487.548	0	0
23	-41.3962	440.374	-181.669	0	0
24	-40.873	439.729	-709.635	0	0
25	-40.3138	439.101	-393.961	0	0
26	-39.7546	438.473	-64.4827	0	0
27	-39.2659	437.991	177.057	0	0
28	-38.7771	437.51	419.582	0	0
29	-38.2419	437.177	431.105	0	0
30	-37.7357	437.257	115.776	0	0
31	-37.47	437.363	0	0	0

- Global Minimum Query (spencer) - Safety Factor: 1.46947

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-56.1734	457.234	0	0	0
2	-55.5622	456.442	-141.815	14.1815	-5.71059
3	-54.9509	455.65	-243.201	24.3201	-5.71059
4	-54.1252	454.548	-318.206	31.8206	-5.71059
5	-53.2586	453.368	-319.721	31.9721	-5.71059
6	-52.6657	452.558	-274.06	27.406	-5.71059
7	-52.1354	451.84	-201.877	20.1877	-5.71059
8	-51.2308	450.616	-10.0931	1.00931	-5.71059
9	-50.3589	449.436	256.838	-25.6838	-5.71059
10	-49.4402	448.187	-1328.2	132.82	-5.71059
11	-48.3898	446.763	-795.612	79.5612	-5.71059
12	-47.8219	445.995	-459.71	45.971	-5.71059
13	-47.254	445.227	-89.6688	8.96688	-5.71059
14	-46.6657	444.415	339.598	-33.9598	-5.71059
15	-46.1183	443.66	-1547.42	154.742	-5.71059
16	-44.9826	442.174	-868.672	86.8672	-5.71059
17	-43.8467	440.751	-146.933	14.6933	-5.71059
18	-42.6285	439.183	50.8243	-5.08243	-5.71059
19	-42.0195	438.512	437.052	-43.7052	-5.71059
20	-41.4104	437.84	839.175	-83.9175	-5.71059
21	-40.7019	437.12	1262.81	-126.281	-5.71059
22	-39.9946	436.377	1729.33	-172.933	-5.71059
23	-39.4643	435.815	2096.96	-209.696	-5.71059
24	-38.934	435.253	2475.37	-247.537	-5.71059
25	-38.3669	434.994	2398.4	-239.84	-5.71059
26	-37.7998	434.736	2304.97	-230.497	-5.71059
27	-37.232	435.184	1711.82	-171.182	-5.71059
28	-36.6643	435.632	1267.03	-126.703	-5.71059
29	-35.5288	436.508	536.975	-53.6975	-5.71059
30	-34.9611	436.935	246.663	-24.6663	-5.71059
31	-34.3934	437.363	0	0	0

Se

Entity Information

Group: Sec 53+50_10-1_SN_Demand_var

Shared Entities

Type	Coordinates	
	X	Y
	-380	496
	-380	300
	400	300
	400	456
	392.411	452.002
	387.055	450.395
	384.377	449.502
	370.075	442.973
	367.953	442.004
	356.706	440.041
	343.317	439.148
	317.967	437.72
	289.939	436.113
	246.202	433.435
	207.284	432.007
	194.787	429.329
	184.969	427.544
	171.401	426.116
	165.867	423.438
	162.901	421.735
	156.227	417.904
	148.55	416.119
	139.088	416.119
	127.485	417.725
	119.273	418.797
	110.882	419.154
	99.814	421.474
External Boundary	92.5946	421.65
	85.175	421.831
	59.289	436.113
	53.041	437.363
	40.544	437.541
	35.484	437.363
	-20.7234	437.363
	-37.47	437.363
	-37.7655	440.265
	-38.928	452.94
	-46.312	456.028
	-54.64	457.234
	-62.445	457.234
	-70.931	457.234
	-85.598	456.979
	-102.378	456.979
	-151.758	460.002
	-165.195	466.049
	-173.929	467.729
	-186.358	470.416
	-196.1	475.119
	-200.96	475.886
	-208.865	477.134
	-230.699	479.822
	-260.932	481.501
	-287.134	484.189
	-322.741	489.227
	-342.225	492.251
Material Boundary		

X	Y
-20.7234	437.363
-19.579	436.205
-12.274	436.3
-9.618	435.446
-2.407	431.461
11.065	431.177
14.48	430.702
17.042	429.753
22.326	427.685
27.108	424.953
32.487	424.184
34.878	424.867
40.001	425.721
44.612	424.697
48.113	424.184
52.639	424.697
56.396	424.099
58.359	423.16
61.775	421.452
62.885	419.403
64.593	417.012
68.179	415.56
75.01	412.316
79.108	411.12
82.865	410.437
87.732	409.327
91.062	408.729
92.77	407.961
96.015	405.399
97.979	403.521
101.138	399.593
103.614	395.58
107.969	395.495
110.787	395.58
119.411	396.946
125.832	398.739
130.596	398.739
134.439	397.663
140.125	397.049
143.507	396.357
153.113	396.818
169.942	400.584
172.939	400.737
184.082	404.733
185.85	405.502
188.386	405.809
193.381	405.502
199.606	404.81
207.521	404.964
220.431	410.651
223.966	412.111
227.809	412.956
233.342	412.726
245.714	412.572
249.633	412.572
256.166	414.109
261.468	414.109
268.999	412.418
275.07	412.572
282.678	414.262
292.284	417.874
295.819	418.489
304.887	418.489
310.113	417.413
314.416	416.722
316.491	415.723
329.017	415.723
332.86	415.723
335.165	417.567
338.7	422.331
341.543	425.713
344.079	428.095
348.229	428.864
357.374	429.709
360.064	430.554
361.601	433.398
362.907	437.086

	X	Y
	365.597	439.238
	368.671	440.544
	370.075	442.973
Material Boundary	X	Y
	92.5946	421.65
	94.206	418.168
	96.231	413.396
	99.412	410.36
	107.799	408.914
	117.776	407.178
	127.32	406.166
	134.839	404.865
	139.901	404.865
	143.226	403.274
	148.577	402.985
	152.77	405.154
	157.397	409.637
	161.591	412.673
	163.037	417.879
	162.901	421.735
Material Boundary	X	Y
	-200.96	475.886
	-194.176	462.016
	-186.242	458.269
	-168.61	453.421
	-158.251	452.319
	-148.774	451.878
	-137.093	449.674
	-119.902	449.894
	-100.948	449.674
	-92.793	450.115
	-80.671	449.013
	-63.26	448.572
	-52.901	447.029
	-46.664	444.414
	-40.78	441.078
	-37.7655	440.265

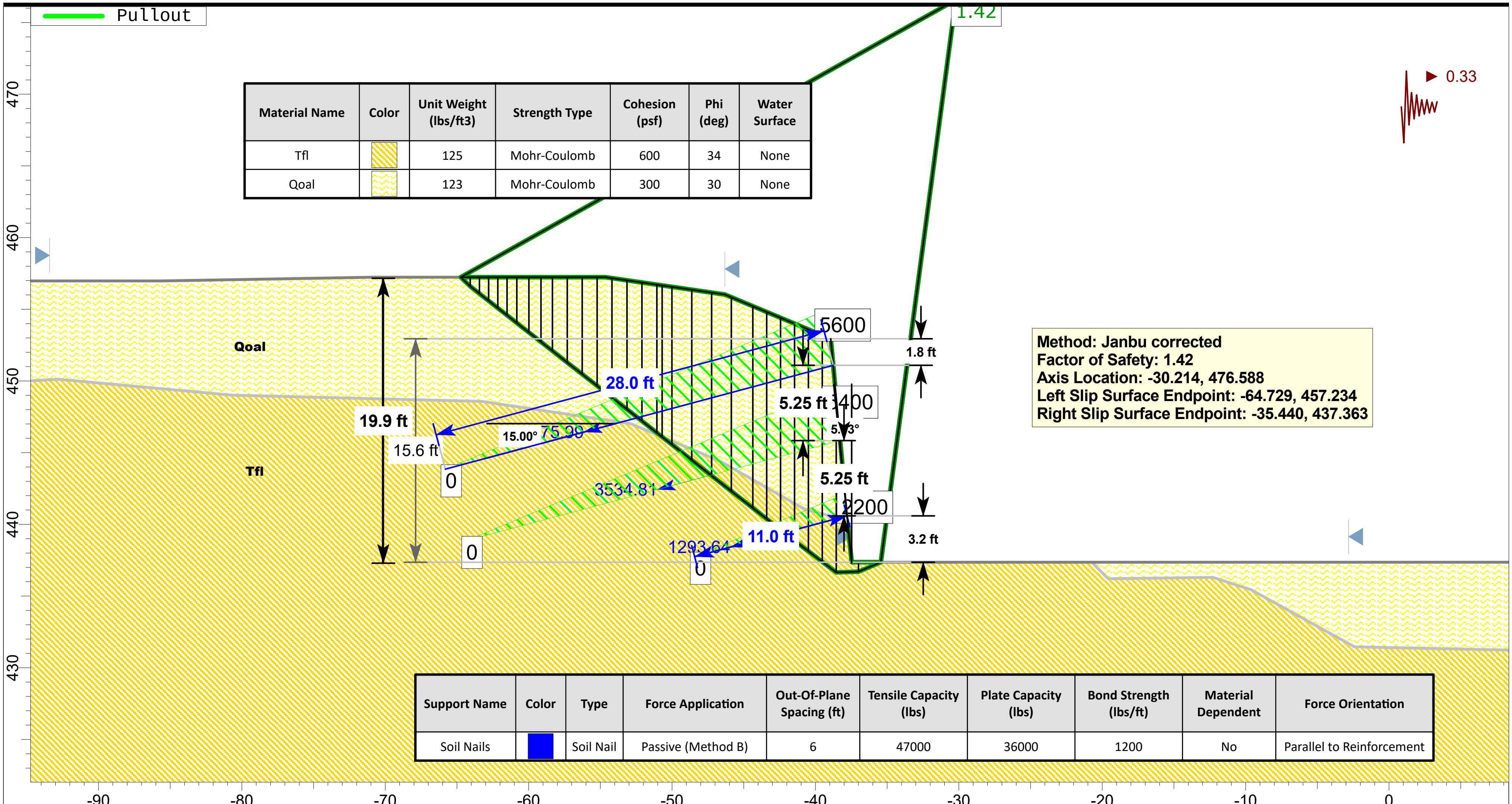
Scenario-based Entities

Type	Coordinates (X, Y)	Master Scenario	D4 B8 f60 p36 q1200 cco SrfAlt_c1	D4 B8 f60 p36 q1200 path SrfAlt_p1	D4 B8 f60 p36 q1200 blk SrfAlt_b3
Block Search Window	-66.543, 449.554 -48.008, 449.603 -53.891, 455.945 -70.694, 455.945	✗	✗	✗	✓
Block Search Window	-61.566, 439.199 -43.425, 439.85 -45.459, 447.74 -66.021, 447.874	✗	✗	✗	✓
Block Search Window	-38.862, 438.708 -59.44, 438.59 -55.941, 431.295 -35.6, 431.355	✗	✗	✗	✓

Section 53+50 - Retaining Wall 12C - Soil Nail Wall

Soil Nail Load Demand - Dia 4 in. - Sv 5.25 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11588 On-Call OCPW Geo\001 Brea Canyon Rd Widening\Analyses\Slope Stability\Sec 53+50-!0-1_Demand_RW-12C\Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var_k033.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Tfl		125	Mohr-Coulomb	600	34	None
Qoal		123	Mohr-Coulomb	300	30	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nails		Soil Nail	Passive (Method B)	6	47000	36000	1200	No	Parallel to Reinforcement

SLIDEINTERPRET 8.022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:120	*Project No.:* **11588.001**
Date: May 31, 2019	*Condition:* **PseudoStatic**		*Analysis Scenario:* D4 B8 f60 p36 q1200 path SrfAlt_p1

Slide Analysis Information

Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var_k033

Project Summary

File Name:	Sec 53+50_10-1_SN_Demand_D4 B8 f60k p36 q1200_var_k033.slmd
Slide Modeler Version:	8.022
Project Title:	Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange, California
Analysis:	Section 53+50 - Retaining Wall 12C - Soil Nail Wall
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 31, 2019

Comments

PseudoStatic

11588.001

Soil Nail Load Demand - Dia 4 in. - Sv 5.25 feet Sh 6 feet

10V:1H Wall Batter

Currently Open Scenarios

Group Name	Scenario Name	Global Minimum	Compute Time
Sec 53+50_10-1_SN_Demand_var	Master Scenario	Janbu Corrected: 1.319770 Spencer: 1.520710	00h:00m:46.228s
	D4 B8 f60 p36 q1200 cco SrfAlt_c1	Janbu Corrected: 1.316650 Spencer: 1.525840	00h:00m:36.806s
	D4 B8 f60 p36 q1200 path SrfAlt_p1	Janbu Corrected: 1.417900 Spencer: 1.562870	00h:00m:21.421s
	D4 B8 f60 p36 q1200 blk SrfAlt_b3	Janbu Corrected: 1.323990 Spencer: 1.843780	00h:00m:02.452s

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

All Open Scenarios	
Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	30
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Check tensile effective normal stresses in the first:	95%
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

All Open Scenarios	
Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

All Open Scenarios	
Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Search Method:	Simulated Annealing Search
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Convex Surfaces Only:	Enabled

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Search Method:	Cuckoo Search
Initial # of Surface Vertices:	8
Maximum Iterations:	500
Number of Nests:	50
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Convex Surfaces Only:	Enabled

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [°]:	Auto Defined
Lower Angle [°]:	Auto Defined

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Surface Type:	Non-Circular Block Search
Number of Surfaces:	5000
Multiple Groups:	Disabled
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Disabled
Left Projection Angle (Start Angle) [°]:	95
Left Projection Angle (End Angle) [°]:	135
Right Projection Angle (Start Angle) [°]:	5
Right Projection Angle (End Angle) [°]:	45
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined

Seismic Loading

All Open Scenarios	
Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.33

Materials

Property	Tfl	Qoal	Qal
Color			
Strength Type	Mohr-Coulomb	Mohr-Coulomb	Mohr-Coulomb
Unit Weight [lbs/ft3]	125	123	120
Cohesion [psf]	600	300	100
Friction Angle [°]	34	30	25
Water Surface	Assigned per scenario	Assigned per scenario	Assigned per scenario
Ru Value	0	0	0

Materials In Use

Material	Master Scenario	D4 B8 f60 p36 q1200 cco SrfAlt_c1	D4 B8 f60 p36 q1200 path SrfAlt_p1	D4 B8 f60 p36 q1200 blk SrfAlt_b3
Tfl	✓	✓	✓	✓
Qoal	✓	✓	✓	✓
Qal	✓	✓	✓	✓

Support

Soil Nails

Support Type: Soil Nail
Force Application: Passive
Force Orientation: Parallel to Reinforcement
Out-of-Plane Spacing: 6 ft
Tensile Capacity: 47000 lb
Plate Capacity: 36000 lb
Bond Strength: 1200 lb/ft

Global Minimums

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

FS	1.319770
Axis Location:	-28.769, 469.639
Left Slip Surface Endpoint:	-59.811, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	25246.1 lb
Driving Horizontal Force:	19134 lb
Passive Horizontal Support Force:	8624.08 lb
Maximum Single Support Force:	3999.04 lb
Total Support Force:	8928.3 lb
Total Slice Area:	182.857 ft2
Surface Horizontal Width:	22.3406 ft
Surface Average Height:	8.18497 ft

Method: spencer

FS	1.520710
Axis Location:	-36.598, 485.099
Left Slip Surface Endpoint:	-75.306, 457.158
Right Slip Surface Endpoint:	-37.470, 437.367
Resisting Moment:	2.32807e+06 lb-ft
Driving Moment:	1.53091e+06 lb-ft
Resisting Horizontal Force:	47790.3 lb
Driving Horizontal Force:	31426.4 lb
Passive Support Moment:	201525 lb-ft
Passive Horizontal Support Force:	5282.98 lb
Maximum Single Support Force:	2732.8 lb
Total Support Force:	5469.35 lb
Total Slice Area:	387.561 ft2
Surface Horizontal Width:	37.836 ft
Surface Average Height:	10.2432 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

FS	1.316650
Axis Location:	-28.893, 469.887
Left Slip Surface Endpoint:	-60.059, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	25588.5 lb
Driving Horizontal Force:	19434.5 lb
Passive Horizontal Support Force:	8544.81 lb
Maximum Single Support Force:	3974.52 lb
Total Support Force:	8846.24 lb
Total Slice Area:	187.245 ft2
Surface Horizontal Width:	22.5886 ft
Surface Average Height:	8.28934 ft

Method: spencer

FS	1.525840
Axis Location:	-35.475, 482.954
Left Slip Surface Endpoint:	-73.145, 457.196
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Moment:	2.08044e+06 lb-ft
Driving Moment:	1.36347e+06 lb-ft
Resisting Horizontal Force:	44569.8 lb
Driving Horizontal Force:	29209.9 lb
Passive Support Moment:	204062 lb-ft
Passive Horizontal Support Force:	5731.21 lb
Maximum Single Support Force:	2909.39 lb
Total Support Force:	5933.39 lb
Total Slice Area:	355.406 ft2
Surface Horizontal Width:	35.6751 ft
Surface Average Height:	9.96231 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

FS	1.417900
Axis Location:	-30.214, 476.588
Left Slip Surface Endpoint:	-64.729, 457.234
Right Slip Surface Endpoint:	-35.440, 437.363
Resisting Horizontal Force:	34400.5 lb
Driving Horizontal Force:	24261.5 lb
Passive Horizontal Support Force:	7345.32 lb
Maximum Single Support Force:	3534.81 lb
Total Support Force:	7604.43 lb
Total Slice Area:	251.689 ft2
Surface Horizontal Width:	29.2892 ft
Surface Average Height:	8.59322 ft

Method: spencer

FS	1.562870
Axis Location:	-37.313, 486.476
Left Slip Surface Endpoint:	-76.697, 457.134
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Moment:	2.4225e+06 lb-ft
Driving Moment:	1.55003e+06 lb-ft
Resisting Horizontal Force:	48694.6 lb
Driving Horizontal Force:	31157.2 lb
Passive Support Moment:	206092 lb-ft
Passive Horizontal Support Force:	5205.5 lb
Maximum Single Support Force:	2688.59 lb
Total Support Force:	5389.13 lb
Total Slice Area:	394.413 ft2
Surface Horizontal Width:	39.2272 ft
Surface Average Height:	10.0546 ft

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

FS	1.323990
Axis Location:	-28.830, 469.760
Left Slip Surface Endpoint:	-59.931, 457.234
Right Slip Surface Endpoint:	-37.470, 437.363
Resisting Horizontal Force:	25155.4 lb
Driving Horizontal Force:	18999.6 lb
Passive Horizontal Support Force:	8691.01 lb
Maximum Single Support Force:	4010.28 lb
Total Support Force:	8997.6 lb
Total Slice Area:	181.137 ft2
Surface Horizontal Width:	22.4611 ft
Surface Average Height:	8.06446 ft

Method: spencer

FS	1.843780
Axis Location:	-28.513, 476.293
Left Slip Surface Endpoint:	-62.882, 457.234
Right Slip Surface Endpoint:	-33.887, 437.363
Resisting Moment:	1.27246e+06 lb-ft
Driving Moment:	690135 lb-ft
Resisting Horizontal Force:	34127.7 lb
Driving Horizontal Force:	18509.6 lb
Passive Support Moment:	234624 lb-ft
Passive Horizontal Support Force:	8856.96 lb
Maximum Single Support Force:	4056.47 lb
Total Support Force:	9169.4 lb
Total Slice Area:	226.693 ft2
Surface Horizontal Width:	28.9948 ft
Surface Average Height:	7.81842 ft

Global Minimum Coordinates

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

X	Y
-59.8106	457.234
-58.9891	456.422
-58.1676	455.605
-57.3463	454.806
-56.5251	454.011
-55.8358	453.407
-55.1439	452.819
-54.3737	452.193
-53.604	451.541
-52.3522	450.436
-51.1002	449.287
-49.8479	448.095
-48.5952	447.093
-47.3413	446.053
-46.0896	444.973
-44.2209	443.294
-42.412	441.607
-40.6032	439.912
-40.1017	439.442
-39.6001	438.971
-39.3458	438.732
-39.0921	438.494
-38.828	438.246
-38.5169	437.953
-38.2173	437.685
-37.47	437.363

Method: spencer

X	Y
-75.3065	457.158
-69.3824	452.875
-67.2572	451.564
-57.8178	446.184
-50.7982	442.189
-47.9236	440.845
-41.7006	438.416
-37.4704	437.367

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

X	Y
-60.0586	457.234
-59.1672	456.31
-58.5072	455.69
-57.8471	455.046
-57.1548	454.348
-56.4624	453.697
-55.5241	452.915
-54.5889	452.114
-53.5385	451.21
-52.2794	450.106
-51.0203	448.959
-49.7612	447.767
-48.8415	447.016
-47.9217	446.268
-47.002	445.516
-46.0822	444.762
-45.1625	444.002
-44.2427	443.21
-43.5097	442.554
-42.7768	441.872
-41.9563	441.08
-41.1355	440.314
-40.3951	439.629
-39.6548	438.944
-38.114	437.514
-37.47	437.363

Method: spencer

X	Y
-73.1451	457.196
-69.8965	454.886
-64.2128	451.09
-58.2396	447.41
-53.7489	444.654
-49.3617	442.066
-41.1122	438.237
-37.47	437.363

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

X	Y
-64.7293	457.234
-64.073	456.598
-63.4305	456.094
-62.7881	455.59
-62.1456	455.086
-61.5031	454.582
-60.8182	454.045
-59.9789	453.387
-59.1398	452.729
-58.3395	452.101
-57.3013	451.287
-56.263	450.473
-55.2248	449.659
-54.1866	448.845
-53.1415	448.025
-52.0964	447.205
-51.0512	446.386
-50.0061	445.566
-48.6218	444.48
-47.2374	443.395
-45.8651	442.319
-44.3675	441.144
-41.4577	438.862
-38.5486	436.655
-36.9942	436.698
-35.4401	437.363

Method: spencer

X	Y
-76.6972	457.134
-75.1861	456.01
-74.462	455.501
-73.7833	454.999
-72.0158	453.632
-70.2569	452.865
-68.8483	452.249
-66.9288	451.405
-65.0128	450.496
-63.4613	449.706
-61.9122	448.863
-60.2942	447.926
-58.6783	446.933
-57.3005	446.039
-55.9245	445.146
-54.4856	444.262
-53.0309	443.365
-51.5784	442.465
-50.0791	441.534
-48.3089	440.868
-46.5385	440.183
-44.7475	439.427
-42.9521	438.614
-40.4821	437.948
-38.0094	437.448
-37.47	437.363

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

X	Y
-59.9311	457.234
-59.079	456.464
-58.2269	455.704
-57.3748	454.94
-56.4557	454.102
-55.5366	453.256
-54.6175	452.385
-53.6984	451.563
-52.8213	450.826
-51.9442	450.088
-51.0671	449.347
-50.1901	448.605
-49.3124	447.833
-48.4348	447.088
-47.5571	446.322
-46.7026	445.59
-45.8481	444.836
-44.9936	444.052
-44.0121	443.149
-43.0305	442.294
-41.9724	441.335
-40.9142	440.34
-39.6229	439.086
-38.8612	438.378
-38.288	437.844
-37.47	437.363

Method: spencer

X	Y
-62.8818	457.234
-59.3514	447.694
-50.2955	451.995
-38.6119	435.328
-33.887	437.363

Valid/Invalid Surfaces

Sec 53+50_10-1_SN_Demand_var - Master Scenario

Method: janbu corrected

Number of Valid Surfaces: 17539
Number of Invalid Surfaces: 11394

Error Codes:

Error Code -120 reported for 1 surface
Error Code -1000 reported for 11393 surfaces

Method: spencer

Number of Valid Surfaces: 11392
Number of Invalid Surfaces: 17541

Error Codes:

Error Code -111 reported for 3 surfaces
Error Code -1000 reported for 17538 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

Method: janbu corrected

Number of Valid Surfaces: 10338
Number of Invalid Surfaces: 39781

Error Codes:

Error Code -111 reported for 30 surfaces
Error Code -112 reported for 53 surfaces
Error Code -114 reported for 160 surfaces
Error Code -120 reported for 2477 surfaces
Error Code -121 reported for 11549 surfaces
Error Code -124 reported for 27 surfaces
Error Code -1000 reported for 25485 surfaces

Method: spencer

Number of Valid Surfaces: 8631
Number of Invalid Surfaces: 41488

Error Codes:

Error Code -108 reported for 119 surfaces
Error Code -111 reported for 6029 surfaces
Error Code -112 reported for 108 surfaces
Error Code -114 reported for 160 surfaces
Error Code -120 reported for 575 surfaces
Error Code -121 reported for 11549 surfaces
Error Code -124 reported for 27 surfaces
Error Code -1000 reported for 22921 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

Method: janbu corrected

Number of Valid Surfaces: 3644
Number of Invalid Surfaces: 1379

Error Codes:

Error Code -108 reported for 2 surfaces
Error Code -111 reported for 45 surfaces
Error Code -120 reported for 1126 surfaces
Error Code -121 reported for 96 surfaces
Error Code -124 reported for 97 surfaces
Error Code -1000 reported for 13 surfaces

Method: spencer

Number of Valid Surfaces: 543
Number of Invalid Surfaces: 4480

Error Codes:

Error Code -108 reported for 60 surfaces
Error Code -111 reported for 4206 surfaces
Error Code -120 reported for 12 surfaces
Error Code -121 reported for 96 surfaces
Error Code -124 reported for 97 surfaces
Error Code -1000 reported for 9 surfaces

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 blk SrfAlt_b3

Method: janbu corrected

Number of Valid Surfaces: 3450
Number of Invalid Surfaces: 1558

Error Codes:

Error Code -108 reported for 5 surfaces
Error Code -111 reported for 892 surfaces
Error Code -112 reported for 190 surfaces
Error Code -120 reported for 429 surfaces
Error Code -124 reported for 42 surfaces

Method: spencer

Number of Valid Surfaces: 406
Number of Invalid Surfaces: 4602

Error Codes:

Error Code -108 reported for 29 surfaces
Error Code -111 reported for 4294 surfaces
Error Code -112 reported for 224 surfaces
Error Code -120 reported for 7 surfaces
Error Code -124 reported for 42 surfaces
Error Code -1000 reported for 6 surfaces

Error Codes

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculation of extremely high safety factors if the driving force is very small (0.1 is an arbitrary number).
-111 = safety factor equation did not converge
-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calculation. This screens out some slip surfaces which may not be valid in the context of the analysis, in particular, deep seated slip surfaces with many high negative base angle slices in the passive zone.
-114 = Surface with Reverse Curvature.
-120 = Tensile effective normal stress on the base of a slice exceeds the tensile strength of the material. The stress state on the base of the surface violates the strength criterion.
-121 = Concave failure surface, only convex surfaces have been defined as being allowed.
-124 = A slice has a width less than the minimum acceptable value.
-1000 = No valid slip surface is generated

Slice Data

Sec 53+50_10-1_SN_Demand_var - Master Scenario

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.31977**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.821504	41.0434	-44.6801	Qoal	300	30	173.796	229.371	-122.333	0	-122.333	49.533	49.533
2	0.821488	123.345	-44.8318	Qoal	300	30	204.039	269.284	-53.2016	0	-53.2016	149.642	149.642
3	0.821287	204.896	-44.1939	Qoal	300	30	235.877	311.303	19.5782	0	19.5782	248.91	248.91
4	0.821285	285.416	-44.093	Qoal	300	30	266.226	351.357	88.9529	0	88.9529	346.881	346.881
5	0.689233	298.859	-41.2337	Qoal	300	30	301.218	397.539	168.943	0	168.943	432.952	432.952
6	0.691938	350.761	-40.3587	Qoal	300	30	327.147	431.759	228.213	0	228.213	506.232	506.232
7	0.770191	447.294	-39.0962	Qoal	300	30	354.901	468.388	291.657	0	291.657	580.039	580.039
8	0.76967	499.196	-40.2809	Qoal	300	30	372.57	491.707	332.047	0	332.047	647.796	647.796
9	1.25181	924.621	-41.4255	Qoal	300	30	396.858	523.761	387.565	0	387.565	737.756	737.756
10	1.25201	1070.34	-42.5311	Qoal	300	30	428.794	565.91	460.57	0	460.57	853.916	853.916
11	0.626174	592.031	-43.5989	Qoal	300	30	452.114	596.686	513.875	0	513.875	944.4	944.4
12	0.626174	630.972	-43.5989	Qoal	300	30	790.922	1043.84	1288.36	0	1288.36	2041.51	2041.51
13	1.25269	1364.45	-38.6524	Qoal	300	30	521.047	687.662	671.448	0	671.448	1088.17	1088.17
14	0.626952	731.062	-39.6591	Qoal	300	30	540.802	713.734	716.608	0	716.608	1164.94	1164.94
15	0.626952	764.141	-39.6591	Qoal	300	30	557.729	736.074	755.301	0	755.301	1217.66	1217.66
16	1.25168	1626.99	-40.8034	Qoal	300	30	577.36	761.982	800.175	0	800.175	1298.6	1298.6
17	0.934365	1285.61	-41.9302	Qoal	300	30	594.891	785.119	840.25	0	840.25	1374.58	1374.58
18	0.934365	1337.15	-41.9302	Qoal	300	30	876.278	1156.49	1483.47	0	1483.47	2270.55	2270.55
19	0.724719	1073.75	-43.0186	Qoal	300	30	621.238	819.891	900.478	0	900.478	1480.17	1480.17
20	1.08415	1668.83	-43.0186	Tfl	600	34	839.818	1108.37	753.688	0	753.688	1537.34	1537.34
21	0.904388	1449.91	-43.1296	Tfl	600	34	860.832	1136.1	794.801	0	794.801	1601.19	1601.19
22	0.904388	1502.7	-43.1296	Tfl	600	34	880.987	1162.7	834.24	0	834.24	1659.51	1659.51
23	0.501502	856.158	-43.1574	Tfl	600	34	1117.11	1474.33	1296.25	0	1296.25	2343.73	2343.73
24	0.501652	872.841	-43.1845	Tfl	600	34	907.486	1197.67	886.086	0	886.086	1737.81	1737.81
25	0.254296	448.741	-43.1979	Tfl	600	34	915.872	1208.74	902.496	0	902.496	1762.49	1762.49
26	0.253695	451.896	-43.211	Tfl	600	34	921.468	1216.13	913.445	0	913.445	1779.1	1779.1
27	0.26402	468.319	-43.2246	Tfl	600	34	918.756	1212.55	908.136	0	908.136	1771.65	1771.65
28	0.311124	462.804	-43.2403	Tfl	600	34	819.851	1082.01	714.617	0	714.617	1485.6	1485.6
29	0.29961	333.438	-41.8786	Tfl	600	34	701.271	925.516	482.597	0	482.597	1111.34	1111.34
30	0.747305	339.407	-23.2863	Tfl	600	34	562.67	742.595	211.405	0	211.405	453.571	453.571

Sec 53+50_10-1_SN_Demand_

- **Global Minimum Query (**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]
1	0.891389	50.6766	-46.0419	Qoal	300
2	0.66008	100.223	-43.2085	Qoal	300
3	0.66007	151.497	-44.2531	Qoal	300
4	0.692337	216.034	-45.2619	Qoal	300
5	0.692386	273.508	-43.2213	Qoal	300
6	0.938319	453.31	-39.7939	Qoal	300
7	0.935145	542.81	-40.6058	Qoal	300
8	1.05041	709.149	-40.717	Qoal	300
9	0.629534	471.955	-41.2349	Qoal	300
10	0.629534	507.623	-41.2349	Qoal	300
11	0.629565	544.169	-42.347	Qoal	300
12	0.629565	581.543	-42.347	Qoal	300
13	0.62956	619.763	-43.4211	Qoal	300
14	0.62956	658.838	-43.4211	Qoal	300
15	0.919725	1025.97	-39.2224	Qoal	300
16	0.919724	1095.71	-39.1451	Qoal	300
17	0.91973	1165.5	-39.2508	Qoal	300
18	0.919778	1234.8	-39.3664	Qoal	300
19	0.919767	1284.92	-39.5489	Qoal	300
20	0.919757	1329.13	-40.7183	Qoal	300
21	0.514091	763.535	-41.8481	Qoal	300
22	0.218885	329.817	-41.8481	Tfl	600
23	0.732976	1126.34	-42.9392	Tfl	600
24	0.820432	1302.82	-43.9931	Tfl	600
25	0.820857	1348.02	-43.022	Tfl	600
26	0.740352	1252.6	-42.7615	Tfl	600
27	0.740351	1287.47	-42.7953	Tfl	600
28	0.770378	1375.64	-42.8637	Tfl	600
29	0.770378	988.842	-42.8637	Tfl	600
30	0.644004	255.431	-13.1714	Tfl	600

- **Global Minimum Query (spencer) - Safety Factor: 1.52071**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]	Base Friction Angle [degrees]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.1848	63.9197	-35.8675	Qoal	300	30	453.677	689.911	675.345	0	675.345	1003.36	1003.36
2	1.1848	191.759	-35.8675	Qoal	300	30	398.438	605.908	529.848	0	529.848	817.924	817.924
3	1.1848	319.598	-35.8675	Qoal	300	30	343.198	521.905	384.35	0	384.35	632.488	632.488
4	1.1848	447.296	-35.8675	Qoal	300	30	288.02	437.995	239.014	0	239.014	447.257	447.257
5	1.1848	572.855	-35.8675	Qoal	300	30	233.766	355.491	96.1127	0	96.1127	265.129	265.129
6	1.06261	612.593	-31.67	Qoal	300	30	255.442	388.454	153.206	0	153.206	310.786	310.786
7	1.06261	698.27	-31.67	Qoal	300	30	236.414	359.517	103.087	0	103.087	248.929	248.929
8	1.13845	839.429	-29.6805	Qoal	300	30	251.614	382.632	143.122	0	143.122	286.527	286.527
9	1.13845	930.286	-29.6805	Qoal	300	30	238.545	362.758	108.699	0	108.699	244.655	244.655
10	1.13845	1021.14	-29.6805	Qoal	300	30	225.476	342.884	74.2767	0	74.2767	202.784	202.784
11	1.13845	1112	-29.6805	Qoal	300	30	212.407	323.01	39.8541	0	39.8541	160.913	160.913
12	1.13845	1202.86	-29.6805	Qoal	300	30	199.338	303.136	5.43137	0	5.43137	119.042	119.042
13	1.24908	1424.94	-29.6805	Tfl	600	34	632.72	962.184	536.96	0	536.96	897.571	897.571
14	1.24908	1535.62	-29.6805	Tfl	600	34	622.207	946.197	513.259	0	513.259	867.878	867.878
15	1.24908	1646.31	-29.6805	Tfl	600	34	611.695	930.211	489.558	0	489.558	838.186	838.186
16	1.40391	1982.39	-29.6416	Tfl	600	34	1487.16	2261.54	2463.34	0	2463.34	3309.59	3309.59
17	1.40391	2122	-29.6416	Tfl	600	34	589.631	896.657	439.813	0	439.813	775.336	775.336
18	1.40391	2252.09	-29.6416	Tfl	600	34	578.671	879.991	415.104	0	415.104	744.391	744.391
19	1.40391	2357.68	-29.6416	Tfl	600	34	569.776	866.464	395.049	0	395.049	719.274	719.274
20	1.40391	2461.25	-29.6416	Tfl	600	34	1983.42	3016.21	3582.17	0	3582.17	4710.82	4710.82
21	1.43729	2613.85	-25.0722	Tfl	600	34	654.799	995.759	586.736	0	586.736	893.08	893.08
22	1.43729	2696.13	-25.0722	Tfl	600	34	647.68	984.934	570.687	0	570.687	873.7	873.7
23	1.24459	2393.62	-21.3201	Tfl	600	34	759.021	1154.25	821.713	0	821.713	1117.95	1117.95
24	1.24459	2427.13	-21.3201	Tfl	600	34	754.523	1147.41	811.571	0	811.571	1106.05	1106.05
25	1.24459	2423.53	-21.3201	Tfl	600	34	755.007	1148.15	812.664	0	812.664	1107.33	1107.33
26	1.24459	2417.66	-21.3201	Tfl	600	34	1835.59	2791.4	3248.88	0	3248.88	3965.29	3965.29
27	1.24459	2411.8	-21.3201	Tfl	600	34	756.581	1150.54	816.212	0	816.212	1111.5	1111.5
28	1.41007	2707.76	-13.9231	Tfl	600	34	1481.99	2253.68	2451.68	0	2451.68	2819.07	2819.07
29	1.41007	2664.31	-13.9231	Tfl	600	34	1487.02	2261.32	2463	0	2463	2831.64	2831.64
30	1.41007	1260.5	-13.9231	Tfl	600	34	1673.3	2544.6	2882.99	0	2882.99	3297.81	3297.81

- **Global Minimum Qu**

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [degrees]	Base Material	Base Cohesion [psf]
1	1.08287	52.5324	-35.4153	Qoal	300
2	1.08287	157.597	-35.4153	Qoal	300
3	1.08287	261.517	-35.4153	Qoal	300
4	1.42091	493.375	-33.7384	Qoal	300
5	1.42091	659.234	-33.7384	Qoal	300
6	1.42091	825.093	-33.7384	Qoal	300
7	1.42091	990.952	-33.7384	Qoal	300
8	1.27172	1022.39	-31.6313	Qoal	300
9	1.27172	1144.92	-31.6313	Qoal	300
10	1.27172	1267.45	-31.6313	Qoal	300
11	1.27172	1389.98	-31.6313	Qoal	300
12	0.886296	1041.53	-31.6313	Tfl	600
13	1.12268	1405.64	-31.5365	Tfl	600
14	1.12268	1501.95	-31.5365	Tfl	600
15	1.12268	1598.26	-31.5365	Tfl	600
16	1.12268	1687.5	-31.5365	Tfl	600
17	1.09681	1718.6	-30.5399	Tfl	600
18	1.09681	1785.07	-30.5399	Tfl	600
19	1.09681	1851.35	-30.5399	Tfl	600
20	1.09681	1917.64	-30.5399	Tfl	600
21	1.1785	2123.42	-24.8994	Tfl	600
22	1.1785	2178.1	-24.8994	Tfl	600
23	1.1785	2228.71	-24.8994	Tfl	600
24	1.1785	2244.36	-24.8994	Tfl	600
25	1.1785	2251.93	-24.8994	Tfl	600
26	1.1785	2259.49	-24.8994	Tfl	600
27	1.1785	2267.06	-24.8994	Tfl	600
28	1.21407	2322.97	-13.492	Tfl	600
29	1.21407	2252.16	-13.492	Tfl	600
30	1.21407	930.726	-13.492	Tfl	600

Interslice Data

Sec 53+50_10-1_SN_Demand_var - Master Scenario

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.31977**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-59.8106	457.234	0	0	0
2	-58.9891	456.422	-228.967	0	0
3	-58.1676	455.605	-399.745	0	0
4	-57.3463	454.806	-510.702	0	0
5	-56.5251	454.011	-564.929	0	0
6	-55.8358	453.407	-572.377	0	0
7	-55.1439	452.819	-549.36	0	0
8	-54.3737	452.193	-493.248	0	0
9	-53.604	451.541	-399.395	0	0
10	-52.3522	450.436	-164.192	0	0
11	-51.1002	449.287	179.794	0	0
12	-50.474	448.691	397.767	0	0
13	-49.8479	448.095	-1547.53	0	0
14	-48.5952	447.093	-1078.88	0	0
15	-47.9682	446.573	-805.075	0	0
16	-47.3413	446.053	-510.882	0	0
17	-46.0896	444.973	166.185	0	0
18	-45.1552	444.134	738.383	0	0
19	-44.2209	443.294	-1336.16	0	0
20	-43.4961	442.618	-824.218	0	0
21	-42.412	441.607	-423.803	0	0
22	-41.5076	440.759	-52.4542	0	0
23	-40.6032	439.912	351.449	0	0
24	-40.1017	439.442	-516.744	0	0
25	-39.6001	438.971	-267.891	0	0
26	-39.3458	438.732	-137.791	0	0
27	-39.0921	438.494	-5.32118	0	0
28	-38.828	438.246	131.398	0	0
29	-38.5169	437.953	237.492	0	0
30	-38.2173	437.685	266.532	0	0
31	-37.47	437.363	0	0	0

- **Global Minimum Query (spencer) - Safety Factor: 1.52071**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-75.3065	457.158	0	0	0
2	-74.1217	456.301	63.7402	264.44	76.448
3	-72.9369	455.445	110.278	457.51	76.448
4	-71.7521	454.588	139.612	579.21	76.448
5	-70.5673	453.731	151.763	629.62	76.448
6	-69.3824	452.875	147.017	609.933	76.448
7	-68.3198	452.219	178.996	742.603	76.448
8	-67.2572	451.564	226.552	939.899	76.448
9	-66.1188	450.915	310.854	1289.64	76.448
10	-64.9803	450.266	417.636	1732.65	76.448
11	-63.8419	449.617	546.899	2268.93	76.448
12	-62.7034	448.968	698.643	2898.47	76.448
13	-61.565	448.32	872.867	3621.27	76.448
14	-60.3159	447.608	937.453	3889.22	76.448
15	-59.0668	446.896	1034.78	4293.02	76.4481
16	-57.8178	446.184	1164.86	4832.67	76.448
17	-56.4138	445.385	624.527	2590.98	76.448
18	-55.0099	444.586	850.885	3530.08	76.448
19	-53.606	443.787	1115.77	4629.01	76.448
20	-52.2021	442.988	1411.93	5857.69	76.448
21	-50.7982	442.189	574.009	2381.4	76.448
22	-49.3609	441.517	892.857	3704.21	76.448
23	-47.9236	440.845	1238.27	5137.21	76.448
24	-46.679	440.359	1485.52	6163	76.448
25	-45.4344	439.873	1744.49	7237.39	76.448
26	-44.1898	439.387	2002.2	8306.56	76.448
27	-42.9452	438.902	1443.36	5988.1	76.448
28	-41.7006	438.416	1696.97	7040.26	76.448
29	-40.2906	438.066	1364.22	5659.75	76.448
30	-38.8805	437.717	1014.02	4206.89	76.4481
31	-37.4704	437.367	0	0	0

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 cco SrfAlt_c1

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.31665**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-60.0586	457.234	0	0	0
2	-59.1672	456.31	-252.905	0	0
3	-58.5072	455.69	-385.386	0	0
4	-57.8471	455.046	-484.594	0	0
5	-57.1548	454.348	-549.357	0	0
6	-56.4624	453.697	-573.245	0	0
7	-55.5241	452.915	-559.137	0	0
8	-54.5889	452.114	-484.801	0	0
9	-53.5385	451.21	-337.536	0	0
10	-52.909	450.658	-216.727	0	0
11	-52.2794	450.106	-72.9091	0	0
12	-51.6499	449.532	101.76	0	0
13	-51.0203	448.959	301.341	0	0
14	-50.3907	448.363	534.865	0	0
15	-49.7612	447.767	-1376.64	0	0
16	-48.8415	447.016	-1011.74	0	0
17	-47.9217	446.268	-605.731	0	0
18	-47.002	445.516	-155.671	0	0
19	-46.0822	444.762	338.581	0	0
20	-45.1625	444.002	866.898	0	0
21	-44.2427	443.21	-1245.77	0	0
22	-43.7286	442.75	-896.129	0	0
23	-43.5097	442.554	-824.58	0	0
24	-42.7768	441.872	-558.444	0	0
25	-41.9563	441.08	-219.719	0	0
26	-41.1355	440.314	132.6	0	0
27	-40.3951	439.629	-632.909	0	0
28	-39.6548	438.944	-274.642	0	0
29	-38.8844	438.229	121.188	0	0
30	-38.114	437.514	280.92	0	0
31	-37.47	437.363	0	0	0

- **Global Minimum Query (spencer) - Safety Factor: 1.52584**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-73.1451	457.196	0	0	0
2	-72.0622	456.426	22.9167	90.8335	75.8401
3	-70.9793	455.656	43.0146	170.494	75.8401
4	-69.8965	454.886	60.3244	239.104	75.8401
5	-68.4756	453.937	56.658	224.571	75.8401
6	-67.0546	452.988	77.0939	305.572	75.8401
7	-65.6337	452.039	121.632	482.105	75.8401
8	-64.2128	451.09	190.273	754.171	75.8401
9	-62.9411	450.306	313.511	1242.64	75.8401
10	-61.6694	449.523	467.104	1851.43	75.8401
11	-60.3977	448.74	651.051	2580.52	75.8401
12	-59.1259	447.956	865.351	3429.93	75.8401
13	-58.2396	447.41	934.978	3705.91	75.8401
14	-57.117	446.721	1048.3	4155.09	75.8402
15	-55.9943	446.032	437.343	1733.47	75.8402
16	-54.8716	445.343	608	2409.89	75.8401
17	-53.7489	444.654	805.219	3191.59	75.8401
18	-52.6521	444.007	1014.49	4021.06	75.8401
19	-51.5553	443.36	1243.91	4930.39	75.8401
20	-50.4585	442.713	1493.42	5919.35	75.8401
21	-49.3617	442.066	553.067	2192.15	75.8401
22	-48.1832	441.519	808.973	3206.47	75.8401
23	-47.0047	440.972	1082.62	4291.11	75.8401
24	-45.8262	440.425	1372.69	5440.84	75.8401
25	-44.6477	439.878	1667.84	6610.7	75.8401
26	-43.4692	439.331	1965.44	7790.29	75.8401
27	-42.2907	438.784	1623.51	6434.99	75.8401
28	-41.1122	438.237	1926.02	7634.04	75.8401
29	-39.8981	437.946	1534.55	6082.39	75.8401
30	-38.6841	437.654	1111.22	4404.49	75.8402
31	-37.47	437.363	0	0	0

Sec 53+50_10-1_SN_Demand_var - D4 B8 f60 p36 q1200 path SrfAlt_p1

- **Global Minimum Query (janbu corrected) - Safety Factor: 1.4179**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-64.7293	457.234	0	0	0
2	-64.073	456.598	-178.721	0	0
3	-63.4305	456.094	-306.43	0	0
4	-62.7881	455.59	-410.068	0	0
5	-62.1456	455.086	-489.634	0	0
6	-61.5031	454.582	-545.13	0	0
7	-60.8182	454.045	-577.784	0	0
8	-59.9789	453.387	-580.496	0	0
9	-59.1398	452.729	-542.139	0	0
10	-58.3395	452.101	-467.308	0	0
11	-57.3013	451.287	-314.565	0	0
12	-56.263	450.473	-98.9603	0	0
13	-55.2248	449.659	179.505	0	0
14	-54.1866	448.845	519.724	0	0
15	-53.1415	448.025	915.815	0	0
16	-52.0964	447.205	-440.507	0	0
17	-51.0512	446.386	59.4521	0	0
18	-50.6892	446.102	244.741	0	0
19	-50.0061	445.566	388.889	0	0
20	-48.6218	444.48	742.664	0	0
21	-47.2374	443.395	-1159.76	0	0
22	-45.8651	442.319	-647.663	0	0
23	-44.3675	441.144	-27.2565	0	0
24	-43.3976	440.384	404.083	0	0
25	-42.4276	439.623	858.626	0	0
26	-41.4577	438.862	480.462	0	0
27	-40.488	438.126	957.733	0	0
28	-39.5183	437.391	1456.14	0	0
29	-38.5486	436.655	1926.94	0	0
30	-36.9942	436.698	1067.92	0	0
31	-35.4401	437.363	0	0	0

- **Query 1 (janbu corrected) - Safety Factor: 1.49866**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	N/A	N/A

- **Global Minimum Query (spencer) - Safety Factor: 1.56287**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-76.6972	457.134	0	0	0
2	-75.1861	456.01	-145.701	-467.004	72.6726
3	-74.462	455.501	-194.464	-623.302	72.6726
4	-73.7833	454.999	-224.766	-720.426	72.6726
5	-72.0158	453.632	-235.506	-754.852	72.6726
6	-70.2569	452.865	-246.134	-788.916	72.6726
7	-68.8483	452.249	-214.33	-686.978	72.6726
8	-66.9288	451.405	-113.742	-364.569	72.6726
9	-65.9708	450.95	-30.1245	-96.556	72.6726
10	-65.0128	450.496	70.9502	227.412	72.6726
11	-63.4613	449.706	284.255	911.101	72.6726
12	-61.9122	448.863	556.607	1784.05	72.6726
13	-60.7696	448.201	797.056	2554.75	72.6726
14	-60.2942	447.926	829.941	2660.15	72.6726
15	-58.6783	446.933	1000.73	3207.56	72.6725
16	-57.3005	446.039	546.159	1750.57	72.6726
17	-55.9245	445.146	805.804	2582.79	72.6726
18	-54.4856	444.262	1116.4	3578.32	72.6726
19	-53.0309	443.365	1476.3	4731.9	72.6727
20	-51.5784	442.465	1876.86	6015.76	72.6726
21	-50.0791	441.534	1254.98	4022.5	72.6726
22	-48.3089	440.868	1578.33	5058.91	72.6726
23	-46.5385	440.183	1954.72	6265.32	72.6726
24	-44.7475	439.427	2416.57	7745.65	72.6726
25	-43.8498	439.02	2670.08	8558.21	72.6726
26	-42.9521	438.614	2366.1	7583.9	72.6726
27	-41.7171	438.281	2353.27	7542.78	72.6726
28	-40.4821	437.948	2330.51	7469.81	72.6726
29	-39.2458	437.698	1796.58	5758.45	72.6726
30	-38.0094	437.448	1047.64	3357.92	72.6726
31	-37.47	437.363	0	0	0

- **Query 1 (spencer) - Safety Factor: 1.56287**

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [degrees]
1	-76.6972	457.134	0	0	0
2	-75.1861	456.01	-145.701	-467.004	72.6726
3	-74.462	455.501	-194.464	-623.302	72.6726
4	-73.7833	454.999	-224.766	-720.426	72.6726
5	-72.0158	453.632	-235.506	-754.852	72.6726
6	-70.2569	452.865	-246.134	-788.916	72.6726
7	-68.8483	452.249	-214.33	-686.978	72.6726
8	-66.9288	451.405	-113.742	-364.569	72.6726
9	-65.9708	450.95	-30.1245	-96.556	72.6726
10	-65.0128	450.496	70.9502	227.412	72.6726
11	-63.4613	449.706	284.255	911.101	72.6726
12	-61.9122	448.863	556.607	1784.05	72.6726
13	-60.7696	448.201	797.056	2554.75	72.6726
14	-60.2942	447.926	829.941	2660.15	72.6726
15	-58.6783	446.933	1000.73	3207.56	72.6725
16	-57.3005	446.039	546.159	1750.57	72.6726
17	-55.9245	445.146	805.804	2582.79	72.6726
18	-54.4856	444.262	1116.4	3578.32	72.6726
19	-53.0309	443.365	1476.3	4731.9	72.6727
20	-51.5784	442.465	1876.86	6015.76	72.6726
21	-50.0791	441.534	1254.98	4022.5	72.6726
22	-48.3089	440.868	1578.33	5058.91	72.6726
23	-46.5385	440.183	1954.72	6265.32	72.6726
24	-44.7475	439.427	2416.57	7745.65	72.6726
25	-43.8498	439.02	2670.08	8558.21	72.6726
26	-42.9521	438.614	2366.1	7583.9	72.6726
27	-41.7171	438.281	2353.27	7542.78	72.6726
28	-40.4821	437.948	2330.51	7469.81	72.6726
29	-39.2458	437.698	1796.58	5758.45	72.6726
30	-38.0094	437.448	1047.64	3357.92	72.6726
31	-37.47	437.363	0	0	0

Entity Information

Group: Sec 53+50_10-1_SN_Demand_var

Shared Entities

Type	Coordinates	
	X	Y
	-380	496
	-380	300
	400	300
	400	456
	392.411	452.002
	387.055	450.395
	384.377	449.502
	370.075	442.973
	367.953	442.004
	356.706	440.041
	343.317	439.148
	317.967	437.72
	289.939	436.113
	246.202	433.435
	207.284	432.007
	194.787	429.329
	184.969	427.544
	171.401	426.116
	165.867	423.438
	162.901	421.735
	156.227	417.904
	148.55	416.119
	139.088	416.119
	127.485	417.725
	119.273	418.797
	110.882	419.154
	99.814	421.474
External Boundary	92.5946	421.65
	85.175	421.831
	59.289	436.113
	53.041	437.363
	40.544	437.541
	35.484	437.363
	-20.7234	437.363
	-37.47	437.363
	-37.7655	440.265
	-38.928	452.94
	-46.312	456.028
	-54.64	457.234
	-62.445	457.234
	-70.931	457.234
	-85.598	456.979
	-102.378	456.979
	-151.758	460.002
	-165.195	466.049
	-173.929	467.729
	-186.358	470.416
	-196.1	475.119
	-200.96	475.886
	-208.865	477.134
	-230.699	479.822
	-260.932	481.501
	-287.134	484.189
	-322.741	489.227
	-342.225	492.251
Material Boundary		

X	Y
-20.7234	437.363
-19.579	436.205
-12.274	436.3
-9.618	435.446
-2.407	431.461
11.065	431.177
14.48	430.702
17.042	429.753
22.326	427.685
27.108	424.953
32.487	424.184
34.878	424.867
40.001	425.721
44.612	424.697
48.113	424.184
52.639	424.697
56.396	424.099
58.359	423.16
61.775	421.452
62.885	419.403
64.593	417.012
68.179	415.56
75.01	412.316
79.108	411.12
82.865	410.437
87.732	409.327
91.062	408.729
92.77	407.961
96.015	405.399
97.979	403.521
101.138	399.593
103.614	395.58
107.969	395.495
110.787	395.58
119.411	396.946
125.832	398.739
130.596	398.739
134.439	397.663
140.125	397.049
143.507	396.357
153.113	396.818
169.942	400.584
172.939	400.737
184.082	404.733
185.85	405.502
188.386	405.809
193.381	405.502
199.606	404.81
207.521	404.964
220.431	410.651
223.966	412.111
227.809	412.956
233.342	412.726
245.714	412.572
249.633	412.572
256.166	414.109
261.468	414.109
268.999	412.418
275.07	412.572
282.678	414.262
292.284	417.874
295.819	418.489
304.887	418.489
310.113	417.413
314.416	416.722
316.491	415.723
329.017	415.723
332.86	415.723
335.165	417.567
338.7	422.331
341.543	425.713
344.079	428.095
348.229	428.864
357.374	429.709
360.064	430.554
361.601	433.398
362.907	437.086

Type	Coordinates	
	365.597	439.238
	368.671	440.544
	370.075	442.973

Type	X	Y
Material Boundary	92.5946	421.65
	94.206	418.168
	96.231	413.396
	99.412	410.36
	107.799	408.914
	117.776	407.178
	127.32	406.166
	134.839	404.865
	139.901	404.865
	143.226	403.274
	148.577	402.985
	152.77	405.154
	157.397	409.637
	161.591	412.673
	163.037	417.879
	162.901	421.735

Type	X	Y
Material Boundary	-200.96	475.886
	-194.176	462.016
	-186.242	458.269
	-168.61	453.421
	-158.251	452.319
	-148.774	451.878
	-137.093	449.674
	-119.902	449.894
	-100.948	449.674
	-92.793	450.115
	-80.671	449.013
	-63.26	448.572
	-52.901	447.029
	-46.664	444.414
	-40.78	441.078
	-37.7655	440.265

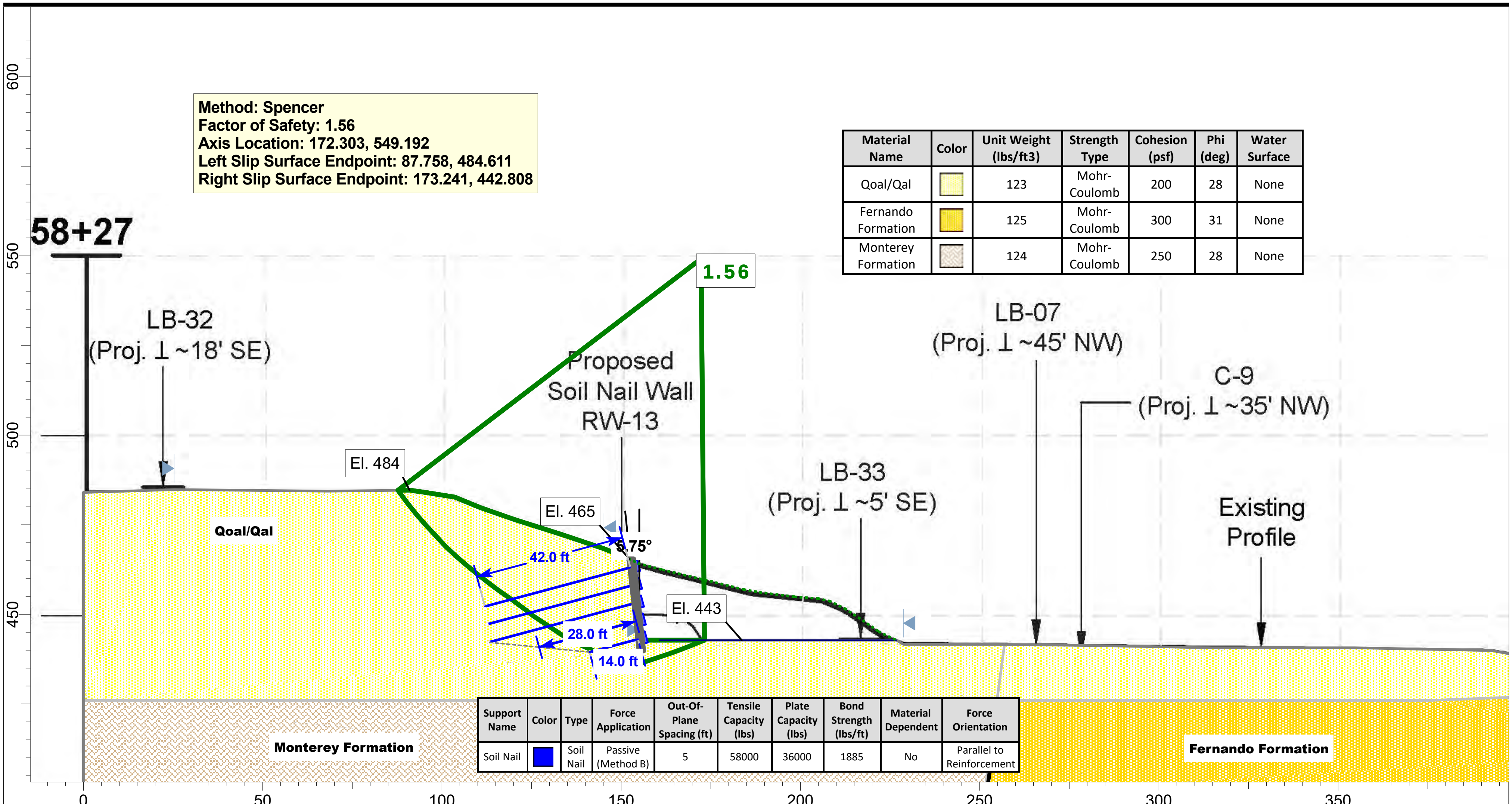
Scenario-based Entities

Type	Coordinates	Master Scenario	D4 B8 f60 p36 q1200 cco SrfAlt_c1	D4 B8 f60 p36 q1200 path SrfAlt_p1	D4 B8 f60 p36 q1200 blk SrfAlt_b3
Block Search Window	X Y -66.543 449.554 -48.008 449.603 -53.891 455.945 -70.694 455.945	✗	✗	✗	✓
Block Search Window	X Y -61.566 439.199 -43.425 439.85 -45.459 447.74 -66.021 447.874	✗	✗	✗	✓
Block Search Window	X Y -38.862 438.708 -59.44 438.59 -55.941 431.295 -35.6 431.355	✗	✗	✗	✓

Section 58+27 - Retaining Wall 13 - Soil Nail Wall

Soil Nail Load Demand - Dia. 6 inches - Sv 5 feet Sh 5 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 58+27_RW 13\Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qoal/Qal		123	Mohr-Coulomb	200	28	None
Fernando Formation		125	Mohr-Coulomb	300	31	None
Monterey Formation		124	Mohr-Coulomb	250	28	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	5	58000	36000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA			
Analyzed By: JEH	Units: feet	Scale: 1:480	Project No.: 11588.001
Date: May 12, 2021	Condition: **Static**		File Name: Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:06.14s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 12, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Qoal/Qal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	None
Ru Value	0
Fernando Formation	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	300
Friction Angle [deg]	31
Water Surface	None
Ru Value	0
Monterey Formation	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	250
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	5
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	1.450180
Axis Location:	171.639, 543.420
Left Slip Surface Endpoint:	89.961, 484.638
Right Slip Surface Endpoint:	169.658, 442.808
Resisting Horizontal Force:	115720 lb
Driving Horizontal Force:	79797.4 lb
Passive Horizontal Support Force:	13938.2 lb
Maximum Single Support Force:	5634.53 lb
Total Support Force:	14429.9 lb
Total Slice Area:	1478.72 ft2
Surface Horizontal Width:	79.6974 ft
Surface Average Height:	18.5542 ft

Method: spencer

FS	1.559990
Axis Location:	172.303, 549.192
Left Slip Surface Endpoint:	87.758, 484.611
Right Slip Surface Endpoint:	173.241, 442.808
Resisting Moment:	1.40541e+07 lb-ft
Driving Moment:	9.0091e+06 lb-ft
Resisting Horizontal Force:	115239 lb
Driving Horizontal Force:	73871.9 lb
Passive Support Moment:	1.53242e+06 lb-ft
Passive Horizontal Support Force:	17158.2 lb
Maximum Single Support Force:	6525.87 lb
Total Support Force:	17763.4 lb
Total Slice Area:	1462.61 ft2
Surface Horizontal Width:	85.4823 ft
Surface Average Height:	17.1101 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
89.9609	484.638
91.9662	482.455
93.9715	480.272
96.3392	477.695
98.7432	475.078
101.148	472.461
103.652	469.735
105.878	467.312
108.104	464.889
110.994	461.743
112.531	460.07
115.271	457.089
118.249	453.929
121.302	451.237
124.354	448.644
126.732	446.713
129.11	444.782
132.625	442.678
136.022	441.03
139.431	439.377
142.858	437.715
146.481	435.958
148.887	434.791
151.294	433.624
153.701	432.61
156.092	434.068
158.481	435.525
160.445	436.722
162.408	437.919
164.221	439.024
166.033	440.129
167.846	441.234
169.658	442.808

Method: spencer

X	Y
87.7582	484.611
90.3274	481.102
92.8974	477.869
95.4683	474.948
98.2611	471.944
101.054	468.939
103.872	466.313
106.827	463.724
109.719	461.383
112.62	459.097
114.849	457.408
117.023	455.848
119.232	454.299
121.439	452.674
123.505	451.124
125.57	449.507
129.792	446.695
134.015	443.9
136.312	442.47
138.611	441.469
141.018	440.426
143.425	439.384
146	438.508
148.575	437.631
151.103	436.718
153.671	435.959
156.252	436.636
158.834	437.485
161.513	438.363
164.192	439.269
168.863	441.038
173.241	442.808

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 5						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
153.101, 458.085	42	31.3716	10.6284	31.3716	10.6284	4006.91
152.562, 463.085	42	35.4895	6.51051	35.4895	6.51051	2454.46
153.641, 453.085	42	27.0543	14.9457	27.0543	14.9457	5634.53
154.721, 443.085	14	Not Effective	Not Effective	Not Effective	Not Effective	0
154.181, 448.085	28	21.809	6.19098	21.809	6.19098	2334

Method: spencer

Number of Supports: 5						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
153.101, 458.085	42	29.6852	12.3148	29.6852	12.3148	4642.66
152.562, 463.085	42	34.3567	7.64327	34.3567	7.64327	2881.51
153.641, 453.085	42	24.69	17.31	24.69	17.31	6525.87
154.721, 443.085	14	12.69	1.30999	12.69	1.30999	493.866
154.181, 448.085	28	19.4601	8.53987	19.4601	8.53987	3219.53

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4862
Number of Invalid Surfaces:	155
Error Codes	
Error Code -105 reported for 30 surfaces	
Error Code -108 reported for 3 surfaces	
Error Code -111 reported for 36 surfaces	
Error Code -121 reported for 78 surfaces	
Error Code -1000 reported for 8 surfaces	

Method: spencer

Number of Valid Surfaces:	4423
Number of Invalid Surfaces:	594
Error Codes	
Error Code -105 reported for 30 surfaces	
Error Code -108 reported for 30 surfaces	
Error Code -111 reported for 449 surfaces	
Error Code -121 reported for 78 surfaces	
Error Code -1000 reported for 7 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eẍtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.45018

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.00528	262.957	-47.4258	Qoal/Qal	200	28	130.325	188.995	-20.6966	0	-20.6966	121.16	121.16
2	2.00527	737.883	-47.4258	Qoal/Qal	200	28	191.172	277.234	145.256	0	145.256	353.342	353.342
3	1.18386	653.445	-47.4258	Qoal/Qal	200	28	238.441	345.783	274.179	0	274.179	533.717	533.717
4	1.18386	814.917	-47.4258	Qoal/Qal	200	28	273.483	396.6	369.75	0	369.75	667.43	667.43
5	2.40398	2148.63	-47.4258	Qoal/Qal	200	28	326.258	473.133	513.688	0	513.688	868.812	868.812
6	1.20225	1322.68	-47.4258	Qoal/Qal	200	28	379.283	550.028	658.305	0	658.305	1071.14	1071.14
7	1.20225	1488.13	-47.4258	Qoal/Qal	200	28	414.637	601.299	754.735	0	754.735	1206.06	1206.06
8	1.2523	1726.01	-47.4258	Qoal/Qal	200	28	450.729	653.638	853.168	0	853.168	1343.78	1343.78
9	1.2523	1905.45	-47.4258	Qoal/Qal	200	28	487.541	707.022	953.571	0	953.571	1484.25	1484.25
10	2.2261	3748.32	-47.4258	Qoal/Qal	200	28	529.225	767.472	1067.26	0	1067.26	1643.31	1643.31
11	2.2261	4160.7	-47.4258	Qoal/Qal	200	28	576.818	836.49	1197.06	0	1197.06	1824.92	1824.92
12	1.44499	2921.49	-47.4258	Qoal/Qal	200	28	616.061	893.399	1304.1	0	1304.1	1974.66	1974.66
13	1.44499	3095.54	-47.4258	Qoal/Qal	200	28	647.007	938.276	1388.5	0	1388.5	2092.75	2092.75
14	1.53687	3495.39	-47.4258	Qoal/Qal	200	28	680.944	987.492	1481.06	0	1481.06	2222.25	2222.25
15	1.36962	3296.36	-47.4258	Qoal/Qal	200	28	714.962	1036.82	1573.84	0	1573.84	2352.05	2352.05
16	1.36962	3467.28	-47.4258	Qoal/Qal	200	28	747.021	1083.32	1661.27	0	1661.27	2474.39	2474.39
17	1.48897	3959.59	-46.6996	Qoal/Qal	200	28	785.737	1139.46	1766.87	0	1766.87	2600.66	2600.66
18	1.48897	4154.14	-46.6996	Qoal/Qal	200	28	819.559	1188.51	1859.11	0	1859.11	2728.79	2728.79
19	1.5266	4435.35	-41.396	Qoal/Qal	200	28	977.603	1417.7	2290.17	0	2290.17	3151.92	3151.92
20	1.5266	4589.95	-41.396	Qoal/Qal	200	28	921.527	1336.38	2137.22	0	2137.22	2949.54	2949.54
21	1.52622	4745.17	-40.3507	Qoal/Qal	200	28	1096.26	1589.77	2613.77	0	2613.77	3545.14	3545.14
22	1.52622	4897.62	-40.3507	Qoal/Qal	200	28	985.822	1429.62	2312.57	0	2312.57	3150.11	3150.11
23	1.18907	3918.08	-39.0731	Qoal/Qal	200	28	1020.82	1480.37	2408.02	0	2408.02	3236.83	3236.83
24	1.18907	4004.06	-39.0731	Qoal/Qal	200	28	1040.93	1509.53	2462.86	0	2462.86	3307.99	3307.99
25	1.18907	4090.05	-39.0731	Qoal/Qal	200	28	1312.72	1903.68	3204.15	0	3204.15	4269.95	4269.95
26	1.18907	4176.03	-39.0731	Qoal/Qal	200	28	1081.13	1567.84	2572.53	0	2572.53	3450.31	3450.31
27	1.75729	6288.57	-30.9112	Qoal/Qal	200	28	1174.12	1702.68	2826.13	0	2826.13	3529.14	3529.14
28	1.75729	6395.4	-30.9112	Qoal/Qal	200	28	1192.17	1728.86	2875.36	0	2875.36	3589.18	3589.18
29	1.69875	6263.1	-25.8722	Qoal/Qal	200	28	1332.37	1932.18	3257.75	0	3257.75	3903.92	3903.92
30	1.69875	6316.95	-25.8722	Qoal/Qal	200	28	1261.29	1829.1	3063.89	0	3063.89	3675.59	3675.59
31	1.7042	6390.24	-25.8722	Qoal/Qal	200	28	1270.88	1843	3090.03	0	3090.03	3706.38	3706.38
32	1.7042	6443.35	-25.8722	Qoal/Qal	200	28	1280.48	1856.92	3116.21	0	3116.21	3737.21	3737.21
33	1.71368	6532.73	-25.8722	Qoal/Qal	200	28	1290.1	1870.88	3142.46	0	3142.46	3768.13	3768.13
34	1.71368	6586.43	-25.8722	Qoal/Qal	200	28	1299.75	1884.87	3168.79	0	3168.79	3799.14	3799.14
35	1.8116	7021.19	-25.8722	Qoal/Qal	200	28	1309.68	1899.27	3195.87	0	3195.87	3831.03	3831.03
36	1.8116	7074.88	-25.8722	Qoal/Qal	200	28	1318.81	1912.51	3220.76	0	3220.76	3860.35	3860.35
37	2.406	9449.98	-25.8722	Qoal/Qal	200	28	1325.69	1922.49	3239.54	0	3239.54	3882.46	3882.46
38	2.4067	9512.21	-25.8722	Qoal/Qal	200	28	1333.31	1933.54	3260.31	0	3260.31	3906.93	3906.93
39	1.20335	4752.8	-22.8382	Qoal/Qal	200	28	1361.11	1973.85	3336.12	0	3336.12	3909.35	3909.35
40	1.20335	3736.11	-22.8382	Qoal/Qal	200	28	1095.26	1588.33	2611.06	0	2611.06	3072.33	3072.33
41	1.19547	2061.49	31.3699	Qoal/Qal	200	28	1012.4	1468.16	2385.06	0	2385.06	1767.82	1767.82
42	1.19547	1211.06	31.3699	Qoal/Qal	200	28	669.538	970.951	1449.95	0	1449.95	1041.74	1041.74
43	1.19476	1230.88	31.3699	Qoal/Qal	200	28	677.819	982.96	1472.53	0	1472.53	1059.28	1059.28
44	1.19476	1123.83	31.3699	Qoal/Qal	200	28	634.637	920.338	1354.76	0	1354.76	967.828	967.828
45	1.96358	1614.46	31.3699	Qoal/Qal	200	28	577.561	837.568	1199.09	0	1199.09	846.962	846.962
46	1.9632	1325.1	31.3699	Qoal/Qal	200	28	506.598	734.659	1005.55	0	1005.55	696.682	696.682
47	1.81258	966.822	31.3699	Qoal/Qal	200	28	438.365	635.708	819.446	0	819.446	552.183	552.183
48	1.81258	720.443	31.3699	Qoal/Qal	200	28	372.853	540.704	640.771	0	640.771	413.449	413.449
49	1.81256	474.06	31.3699	Qoal/Qal	200	28	307.342	445.701	462.096	0	462.096	274.715	274.715
50	1.81256	175.437	40.9672	Qoal/Qal	200	28	263.024	381.432	341.225	0	341.225	112.846	112.846

Global Minimum Query (spencer) - Safety Factor: 1.55999

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.28458	139.815	-53.7897	Qoal/Qal	200	28	126.647	197.569	-4.57278	0	-4.57278	168.404	168.404
2	1.28458	419.444	-53.7897	Qoal/Qal	200	28	165.192	257.697	108.513	0	108.513	334.133	334.133
3	1.28499	684.761	-51.5209	Qoal/Qal	200	28	207.687	323.989	233.189	0	233.189	494.482	494.482
4	1.28499	914.365	-51.5209	Qoal/Qal	200	28	240.786	375.624	330.302	0	330.302	633.238	633.238
5	1.28546	1127.41	-48.649	Qoal/Qal	200	28	282.395	440.533	452.377	0	452.377	773.243	773.243
6	1.28546	1327.79	-48.649	Qoal/Qal	200	28	312.863	488.063	541.767	0	541.767	897.252	897.252
7	2.79287	3543.06	-47.0832	Qoal/Qal	200	28	367.015	572.539	700.645	0	700.645	1095.37	1095.37
8	1.39635	2101.6	-47.0944	Qoal/Qal	200	28	414.472	646.572	839.879	0	839.879	1285.82	1285.82
9	1.39635	2321.77	-47.0944	Qoal/Qal	200	28	446.157	696	932.84	0	932.84	1412.87	1412.87
10	1.40908	2548.54	-42.9848	Qoal/Qal	200	28	504.367	786.807	1103.62	0	1103.62	1573.7	1573.7
11	1.40908	2736.32	-42.9848	Qoal/Qal	200	28	533.066	831.578	1187.82	0	1187.82	1684.65	1684.65
12	1.4777	3019.13	-41.2185	Qoal/Qal	200	28	568.711	887.183	1292.41	0	1292.41	1790.6	1790.6
13	1.4777	3143.78	-41.2185	Qoal/Qal	200	28	587.399	916.337	1347.23	0	1347.23	1861.8	1861.8
14	1.44598	3188.4	-38.988	Qoal/Qal	200	28	623.371	972.453	1452.77	0	1452.77	1957.36	1957.36
15	1.44598	3290.63	-38.988	Qoal/Qal	200	28	639.589	997.753	1500.35	0	1500.35	2018.06	2018.06
16	2.90051	6912.12	-38.2394	Qoal/Qal	200	28	671.013	1046.77	1592.55	0	1592.55	2121.33	2121.33
17	2.22925	5609.79	-37.1501	Qoal/Qal	200	28	712.392	1111.32	1713.95	0	1713.95	2253.71	2253.71
18	2.17431	5701.31	-35.6678	Qoal/Qal	200	28	752.135	1173.32	1830.55	0	1830.55	2370.38	2370.38
19	2.20821	6005.56	-35.0509	Qoal/Qal	200	28	782.056	1220	1918.35	0	1918.35	2466.99	2466.99
20	2.20771	6228.71	-36.348	Qoal/Qal	200	28	931.038	1452.41	2355.44	0	2355.44	3040.55	3040.55
21	2.06561	6056.41	-36.8766	Qoal/Qal	200	28	813.441	1268.96	2010.42	0	2010.42	2620.64	2620.64
22	2.06514	6290.72	-38.0707	Qoal/Qal	200	28	1058.67	1651.52	2729.91	0	2729.91	3559.14	3559.14
23	2.1111	6651.13	-33.6657	Qoal/Qal	200	28	903.512	1409.47	2274.67	0	2274.67	2876.46	2876.46
24	2.1111	6842.2	-33.6657	Qoal/Qal	200	28	925.98	1444.52	2340.61	0	2340.61	2957.36	2957.36
25	2.11116	7032.3	-33.4957	Qoal/Qal	200	28	1291.63	2014.93	3413.39	0	3413.39	4268.17	4268.17
26	2.11116	7220.84	-33.4957	Qoal/Qal	200	28	972.699	1517.4	2477.67	0	2477.67	3121.38	3121.38
27	2.29766	8052.31	-31.8997	Qoal/Qal	200	28	1173.26	1830.28	3066.12	0	3066.12	3796.4	3796.4
28	2.29879	8181.54	-23.5454	Qoal/Qal	200	28	1147.14	1789.53	2989.48	0	2989.48	3489.35	3489.35
29	2.4069	8634.62	-23.4159	Qoal/Qal	200	28	1157.19	1805.21	3018.97	0	3018.97	3520.11	3520.11
30	1.20345	4343.16	-23.4159	Qoal/Qal	200	28	1163.35	1814.82	3037.04	0	3037.04	3540.85	3540.85
31	1.20345	4360.4	-23.4159	Qoal/Qal	200	28	1219.63	1902.61	3202.13	0	3202.13	3730.32	3730.32
32	1.28762	4675.01	-18.7933	Qoal/Qal	200	28	1241.56	1936.82	3266.48	0	3266.48	3688.98	3688.98
33	1.28762	4673.41	-18.7933	Qoal/Qal	200	28	1241.18	1936.23	3265.37	0	3265.37	3687.74	3687.74
34	2.57525	9311.54	-18.7956	Qoal/Qal	200	28	1236.96	1929.64	3252.99	0	3252.99	3673.97	3673.97
35	1.2639	4553.81	-19.851	Qoal/Qal	200	28	1216.32	1897.44	3192.42	0	3192.42	3631.54	3631.54
36	1.2639	4545.87	-19.851	Qoal/Qal	200	28	1214.42	1894.49	3186.87	0	3186.87	3625.32	3625.32
37	1.28369	4598.72	-16.4725	Qoal/Qal	200	28	1264.39	1972.44	3333.49	0	3333.49	3707.35	3707.35
38	1.28369	3569.83	-16.4725	Qoal/Qal	200	28	1011.57	1578.04	2591.71	0	2591.71	2890.82	2890.82
39	2.58169	2591.97	14.6888	Qoal/Qal	200	28	711.025	1109.19	1709.94	0	1709.94	1523.56	1523.56
40	1.29099	946.356	18.1998	Qoal/Qal	200	28	611.014	953.175	1416.51	0	1416.51	1215.63	1215.63
41	1.29099	878.956	18.1998	Qoal/Qal	200	28	580.742	905.951	1327.7	0	1327.7	1136.76	1136.76
42	1.33956	840.88	18.1489	Qoal/Qal	200	28	549.318	856.931	1235.51	0	1235.51	1055.44	1055.44
43	1.33956	768.531	18.1489	Qoal/Qal	200	28	518.042	808.141	1143.75	0	1143.75	973.937	973.937
44	1.33952	695.009	18.6883	Qoal/Qal	200	28	492.147	767.744	1067.77	0	1067.77	901.303	901.303
45	1.33952	620.357	18.6883	Qoal/Qal	200	28	459.416	716.684	971.739	0	971.739	816.34	816.34
46	1.55675	621.132	20.7446	Qoal/Qal	200	28	442.083	689.645	920.888	0	920.888	753.445	753.445
47	1.55675	508.228	20.7446	Qoal/Qal	200	28	397.007	619.327	788.64	0	788.64	638.27	638.27
48	1.55675	395.325	20.7446	Qoal/Qal	200	28	351.931	549.009	656.392	0	656.392	523.095	523.095
49	2.18893	357.364	22.011	Qoal/Qal	200	28	304.047	474.311	515.904	0	515.904	392.992	392.992
50	2.18893	119.121	22.011	Qoal/Qal	200	28	233.837	364.783	309.913	0	309.913	215.384	215.384

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.45018

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	89.9609	484.638	0	0	0
2	91.9662	482.455	-324.887	0	0
3	93.9715	480.272	-418.141	0	0
4	95.1553	478.984	-366.961	0	0
5	96.3392	477.695	-237.028	0	0
6	98.7432	475.078	267.669	0	0
7	99.9454	473.77	641.093	0	0
8	101.148	472.461	1095.21	0	0
9	102.4	471.098	1654.03	0	0
10	103.652	469.735	2300.37	0	0
11	105.878	467.312	3625.47	0	0
12	108.104	464.889	5151.69	0	0
13	109.549	463.316	6250.03	0	0
14	110.994	461.743	7433.26	0	0
15	112.531	460.07	8790.74	0	0
16	113.901	458.579	10088.9	0	0
17	115.271	457.089	11470.5	0	0
18	116.76	455.509	13010	0	0
19	118.249	453.929	14641.4	0	0
20	119.775	452.583	14376.1	0	0
21	121.302	451.237	15746.5	0	0
22	122.828	449.941	14488.3	0	0
23	124.354	448.644	15876.6	0	0
24	125.543	447.678	16902.1	0	0
25	126.732	446.713	17955	0	0
26	127.921	445.748	15360.8	0	0
27	129.11	444.782	16468.4	0	0
28	130.868	443.73	17233.7	0	0
29	132.625	442.678	18016.8	0	0
30	134.324	441.854	16614.3	0	0
31	136.022	441.03	16845.3	0	0
32	137.727	440.204	17081.1	0	0
33	139.431	439.377	17321	0	0
34	141.145	438.546	17566.4	0	0
35	142.858	437.715	17816	0	0
36	144.67	436.836	18084.4	0	0
37	146.481	435.958	18357	0	0
38	148.887	434.791	18723.2	0	0
39	151.294	433.624	19094.1	0	0
40	152.497	433.117	19031.8	0	0
41	153.701	432.61	18944.4	0	0
42	154.896	433.339	15910.7	0	0
43	156.092	434.068	13997.2	0	0
44	157.287	434.796	12057.8	0	0
45	158.481	435.525	10259.4	0	0
46	160.445	436.722	7610.07	0	0
47	162.408	437.919	5342.03	0	0
48	164.221	439.024	3586.03	0	0
49	166.033	440.129	2154.57	0	0
50	167.846	441.234	1047.68	0	0
51	169.658	442.808	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.55999

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	87.7582	484.611	0	0	0
2	89.0428	482.857	-170.713	-76.512	24.1415
3	90.3274	481.102	-192.531	-86.2905	24.1415
4	91.6124	479.486	-82.4185	-36.9393	24.1415
5	92.8974	477.869	142.159	63.7143	24.1415
6	94.1828	476.408	439.883	197.152	24.1415
7	95.4683	474.948	829.005	371.553	24.1415
8	98.2611	471.944	1908.52	855.38	24.1415
9	99.6575	470.442	2591.56	1161.52	24.1416
10	101.054	468.939	3370.03	1510.42	24.1415
11	102.463	467.626	4108.71	1841.49	24.1415
12	103.872	466.313	4917.53	2203.99	24.1415
13	105.35	465.018	5750.12	2577.15	24.1415
14	106.827	463.724	6626.07	2969.75	24.1415
15	108.273	462.553	7425.06	3327.84	24.1415
16	109.719	461.383	8256.28	3700.39	24.1415
17	112.62	459.097	9950.1	4459.55	24.1415
18	114.849	457.408	11256.9	5045.25	24.1415
19	117.023	455.848	12478.2	5592.62	24.1415
20	119.232	454.299	13723	6150.53	24.1415
21	121.439	452.674	13709.9	6144.67	24.1415
22	123.505	451.124	15145	6787.84	24.1415
23	125.57	449.507	14499.8	6498.69	24.1415
24	127.681	448.101	15790.8	7077.31	24.1415
25	129.792	446.695	17127.1	7676.23	24.1415
26	131.903	445.298	15128.5	6780.44	24.1414
27	134.015	443.9	16536.5	7411.53	24.1415
28	136.312	442.47	16232.3	7275.16	24.1415
29	138.611	441.469	16589.8	7435.4	24.1415
30	141.018	440.426	16951.4	7597.45	24.1415
31	142.221	439.905	17134.2	7679.38	24.1415
32	143.425	439.384	17029.5	7632.46	24.1415
33	144.713	438.946	16862.1	7557.44	24.1415
34	146	438.508	16694.7	7482.43	24.1415
35	148.575	437.631	16360.4	7332.57	24.1415
36	149.839	437.175	16279.8	7296.45	24.1415
37	151.103	436.718	16199	7260.26	24.1415
38	152.387	436.339	15841.2	7099.91	24.1416
39	153.671	435.959	15526.4	6958.82	24.1416
40	156.252	436.636	12533.6	5617.44	24.1415
41	157.543	437.061	11143.5	4994.43	24.1416
42	158.834	437.485	9830.25	4405.83	24.1415
43	160.174	437.924	8551.89	3832.88	24.1415
44	161.513	438.363	7355.72	3296.77	24.1415
45	162.853	438.816	6212.67	2784.46	24.1415
46	164.192	439.269	5156.98	2311.31	24.1415
47	165.749	439.859	3925.78	1759.5	24.1415
48	167.306	440.449	2842.72	1274.08	24.1415
49	168.863	441.038	1907.82	855.069	24.1415
50	171.052	441.923	785.77	352.175	24.1415
51	173.241	442.808	0	0	0

Entity Information

External Boundary

X	Y
0	484
0.0158504	426
0.023	399.838
251.329	399.918
511.422	400
550	400
550	420
550	428
511.422	428.018
503.491	425.168
497.914	423.681
482.052	417.856
462.843	417.98
455.408	420.211
450.575	422.937
441.776	428.514
437.935	430.001
431.986	430.869
425.418	432.108
415.628	434.091
405.095	437.313
398.031	438.924
392.826	439.915
354.533	440.659
314.753	440.659
283.524	441.278
256.947	441.601
252.915	441.65
228.75	441.65
226.735	442.808
198.388	442.808
160.743	442.808
155.29	442.808
155.29	439.795
155.077	439.786
152.306	465.451
145.225	468.294
133.596	472.205
120.374	476.403
110.72	479.76
103.585	482.699
95.61	483.958
91.008	484.65
68.117	484.378
25.304	484.797

Material Boundary

X	Y
0.0158504	426
254.844	426
375.896	426

Material Boundary

X	Y
375.896	426
402.523	427.04
430.506	424.708
441.698	419.111
459.187	412.582
482.739	412.349
502.793	417.013
516.085	419.811
550	420

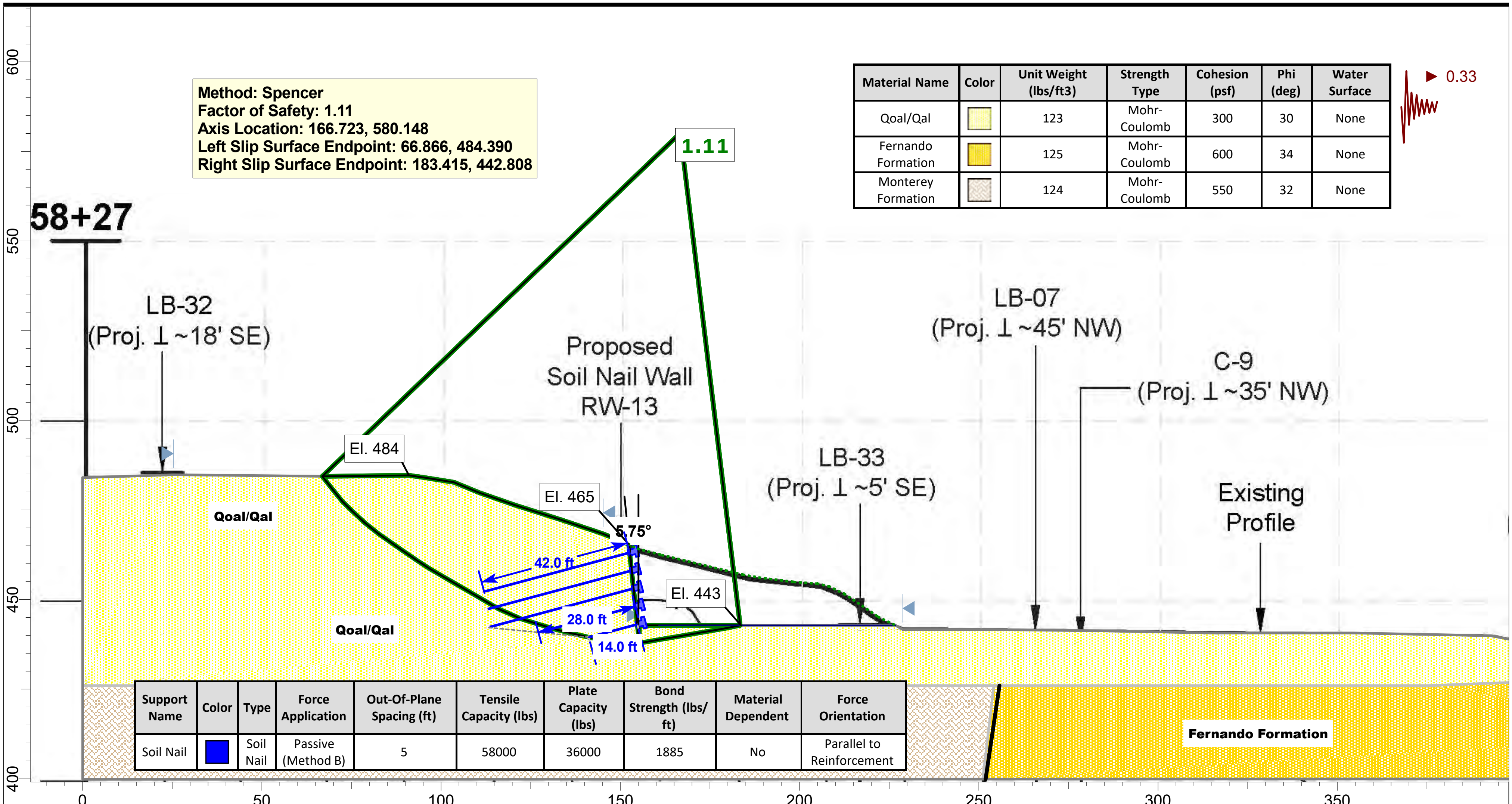
Material Boundary

X	Y
251.329	399.918
254.844	426
256.947	441.601

Section 58+27 - Retaining Wall 13 - Soil Nail Wall

Soil Nail Load Demand - Dia. 6 inches - Sv 5 feet Sh 5 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 58+27_RW-13_Demand\Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2_k033.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qoal/Qal		123	Mohr-Coulomb	300	30	None
Fernando Formation		125	Mohr-Coulomb	600	34	None
Monterey Formation		124	Mohr-Coulomb	550	32	None

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	5	58000	36000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA**			
Analyzed By: JEH	Units: feet	Scale: 1:480	Project No.: **11588.001**
Date: May 31, 2019	Condition: **PseudoStatic**		File Name: Sec 58+27_10-1_SN_D8 B75 p3600 q1200_path SrfAlt_p2_k033.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, County of Orange CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:05.761s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 31, 2019

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.33

Materials

Qoal/Qal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	None
Ru Value	0
Fernando Formation	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	125
Cohesion [psf]	600
Friction Angle [deg]	34
Water Surface	None
Ru Value	0
Monterey Formation	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	550
Friction Angle [deg]	32
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	5
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	0.964429
Axis Location:	163.994, 553.581
Left Slip Surface Endpoint:	77.348, 484.488
Right Slip Surface Endpoint:	167.281, 442.808
Resisting Horizontal Force:	143280 lb
Driving Horizontal Force:	148565 lb
Passive Horizontal Support Force:	5787.96 lb
Maximum Single Support Force:	3692.41 lb
Total Support Force:	5992.14 lb
Total Slice Area:	1900.98 ft2
Surface Horizontal Width:	89.9327 ft
Surface Average Height:	21.1378 ft

Method: spencer

FS	1.108830
Axis Location:	166.723, 580.148
Left Slip Surface Endpoint:	66.866, 484.390
Right Slip Surface Endpoint:	183.415, 442.808
Resisting Moment:	2.60891e+07 lb-ft
Driving Moment:	2.35284e+07 lb-ft
Resisting Horizontal Force:	171396 lb
Driving Horizontal Force:	154573 lb
Passive Support Moment:	736511 lb-ft
Passive Horizontal Support Force:	5938.11 lb
Maximum Single Support Force:	3552.48 lb
Total Support Force:	6147.58 lb
Total Slice Area:	2194.62 ft2
Surface Horizontal Width:	116.549 ft
Surface Average Height:	18.8301 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
77.3482	484.488
79.2314	482.318
81.114	480.315
84.4594	476.938
86.1323	475.249
88.1355	473.227
90.1387	471.205
91.9277	469.399
93.7164	467.593
95.5089	465.949
99.3022	462.471
102.189	459.823
105.076	457.176
108.714	453.84
112.371	450.486
116.027	448.068
119.683	446.203
123.339	444.338
127.529	442.401
131.718	440.606
135.403	439.581
139.089	438.604
142.926	437.644
146.785	436.756
150.468	436.062
154.124	435.711
157.157	437.347
160.963	439.4
164.769	441.453
167.281	442.808

Method: spencer

X	Y
66.8664	484.39
69.8795	480.552
72.4307	477.42
74.9814	474.86
78.7671	471.375
82.5518	468.346
85.7532	466.107
88.885	463.917
93.5329	460.744
96.7652	458.63
100.44	456.489
106.027	453.233
111.071	450.294
116.114	447.355
119.214	445.973
122.313	444.591
128.511	442.702
131.682	441.738
134.853	440.939
138.189	440.172
141.525	439.406
144.939	438.871
148.308	438.351
154.198	437.73
157.585	438.254
161.534	438.93
165.348	439.582
169.05	440.215
172.642	440.83
176.233	441.444
179.824	442.058
183.415	442.808

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 5						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
153.101, 458.085	42	38.4746	3.52543	38.4746	3.52543	1329.09
152.562, 463.085	42	Not Effective	Not Effective	Not Effective	Not Effective	0
153.641, 453.085	42	32.2058	9.7942	32.2058	9.7942	3692.41
154.721, 443.085	14	Not Effective	Not Effective	Not Effective	Not Effective	0
154.181, 448.085	28	25.4254	2.57464	25.4254	2.57464	970.639

Method: spencer

Number of Supports: 5						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
153.101, 458.085	42	39.2887	2.71125	39.2887	2.71125	1022.14
152.562, 463.085	42	Not Effective	Not Effective	Not Effective	Not Effective	0
153.641, 453.085	42	32.577	9.42303	32.577	9.42303	3552.48
154.721, 443.085	14	13.9592	0.0407905	13.9592	0.0407905	15.378
154.181, 448.085	28	23.8685	4.1315	23.8685	4.1315	1557.58

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4898
Number of Invalid Surfaces:	116
Error Codes	
Error Code -105 reported for 30 surfaces	
Error Code -111 reported for 2 surfaces	
Error Code -121 reported for 78 surfaces	
Error Code -1000 reported for 6 surfaces	

Method: spencer

Number of Valid Surfaces:	2787
Number of Invalid Surfaces:	2227
Error Codes	
Error Code -105 reported for 30 surfaces	
Error Code -108 reported for 18 surfaces	
Error Code -111 reported for 2095 surfaces	
Error Code -121 reported for 78 surfaces	
Error Code -1000 reported for 6 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eaxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.964429

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.88311	253.922	-49.0512	Qoal/Qal	300	30	225.81	217.778	-142.413	0	-142.413	117.822	117.822
2	1.88261	742.142	-46.7665	Qoal/Qal	300	30	325.941	314.347	24.8494	0	24.8494	371.535	371.535
3	1.67274	1043.47	-45.2706	Qoal/Qal	300	30	416.402	401.59	175.96	0	175.96	596.313	596.313
4	1.67274	1394.98	-45.2706	Qoal/Qal	300	30	492.931	475.397	303.796	0	303.796	801.405	801.405
5	1.67283	1746.6	-45.2706	Qoal/Qal	300	30	569.461	549.205	431.635	0	431.635	1006.5	1006.5
6	2.0032	2554.09	-45.2706	Qoal/Qal	300	30	653.551	630.304	572.104	0	572.104	1231.86	1231.86
7	2.0032	3058.22	-45.2706	Qoal/Qal	300	30	745.198	718.691	725.194	0	725.194	1477.46	1477.46
8	1.78903	3148.97	-45.2706	Qoal/Qal	300	30	830.229	800.697	867.232	0	867.232	1705.34	1705.34
9	1.78868	3494	-45.2706	Qoal/Qal	300	30	900.603	868.568	984.789	0	984.789	1893.94	1893.94
10	1.79258	3822.54	-42.5221	Qoal/Qal	300	30	1001.73	966.099	1153.72	0	1153.72	2072.35	2072.35
11	1.89664	4372.87	-42.5221	Qoal/Qal	300	30	1067.14	1029.18	1262.98	0	1262.98	2241.59	2241.59
12	1.89664	4708.78	-42.5221	Qoal/Qal	300	30	1134.04	1093.7	1374.72	0	1374.72	2414.68	2414.68
13	1.44345	3808.75	-42.5221	Qoal/Qal	300	30	1192.94	1150.51	1473.12	0	1473.12	2567.09	2567.09
14	1.44345	4003.31	-42.5221	Qoal/Qal	300	30	1243.85	1199.61	1558.16	0	1558.16	2698.83	2698.83
15	1.44354	4198.09	-42.5221	Qoal/Qal	300	30	1294.76	1248.7	1643.2	0	1643.2	2830.54	2830.54
16	1.44354	4358	-42.5221	Qoal/Qal	300	30	1336.6	1289.05	1713.09	0	1713.09	2938.81	2938.81
17	1.8187	5674.91	-42.5221	Qoal/Qal	300	30	1374.88	1325.97	1777.04	0	1777.04	3037.85	3037.85
18	1.8187	5880.42	-42.5221	Qoal/Qal	300	30	1417.55	1367.13	1848.33	0	1848.33	3148.29	3148.29
19	1.82861	6119.67	-42.5221	Qoal/Qal	300	30	1460.36	1408.41	1919.82	0	1919.82	3259.03	3259.03
20	1.82861	6338.18	-42.5221	Qoal/Qal	300	30	1505.49	1451.94	1995.22	0	1995.22	3375.82	3375.82
21	1.82825	6518.32	-33.4813	Qoal/Qal	300	30	1719.9	1658.72	2353.37	0	2353.37	3490.94	3490.94
22	1.82825	6647.29	-33.4813	Qoal/Qal	300	30	1837.11	1771.76	2549.17	0	2549.17	3764.26	3764.26
23	1.82802	6744.31	-27.0256	Qoal/Qal	300	30	1901.19	1833.56	2656.2	0	2656.2	3625.97	3625.97
24	1.82802	6811.04	-27.0256	Qoal/Qal	300	30	1917.67	1849.46	2683.75	0	2683.75	3661.93	3661.93
25	1.82806	6880.31	-27.0256	Qoal/Qal	300	30	1934.76	1865.94	2712.28	0	2712.28	3699.18	3699.18
26	1.82806	6958.59	-27.0256	Qoal/Qal	300	30	2214.96	2136.17	3180.34	0	3180.34	4310.17	4310.17
27	1.3965	5363.45	-24.8102	Qoal/Qal	300	30	2015.88	1944.17	2847.78	0	2847.78	3779.68	3779.68
28	1.3965	5398.17	-24.8102	Qoal/Qal	300	30	2027.38	1955.26	2866.99	0	2866.99	3804.21	3804.21
29	1.3965	5432.9	-24.8102	Qoal/Qal	300	30	2038.87	1966.35	2886.2	0	2886.2	3828.73	3828.73
30	2.09448	8204.32	-23.1965	Qoal/Qal	300	30	2148.2	2071.79	3068.83	0	3068.83	3989.4	3989.4
31	2.09448	8264.23	-23.1965	Qoal/Qal	300	30	2099.36	2024.68	2987.24	0	2987.24	3886.87	3886.87
32	1.84248	7288.01	-15.5431	Qoal/Qal	300	30	2275.4	2194.46	3281.29	0	3281.29	3914.16	3914.16
33	1.84248	7267.79	-15.5431	Qoal/Qal	300	30	2269.82	2189.08	3271.97	0	3271.97	3903.29	3903.29
34	1.84284	7242.22	-14.853	Qoal/Qal	300	30	2278.33	2197.29	3286.2	0	3286.2	3890.41	3890.41
35	1.84284	7212.51	-14.853	Qoal/Qal	300	30	2270.08	2189.33	3272.41	0	3272.41	3874.43	3874.43
36	1.91864	7474.2	-14.0404	Qoal/Qal	300	30	2279.55	2198.46	3288.23	0	3288.23	3858.29	3858.29
37	1.91864	7435.15	-14.0404	Qoal/Qal	300	30	2269.04	2188.33	3270.67	0	3270.67	3838.11	3838.11
38	1.92956	7433.54	-12.9655	Qoal/Qal	300	30	2282.19	2201.01	3292.65	0	3292.65	3818.09	3818.09
39	1.92956	7375.21	-12.9655	Qoal/Qal	300	30	2266.42	2185.8	3266.3	0	3266.3	3788.11	3788.11
40	1.84165	6957.82	-10.6582	Qoal/Qal	300	30	2297.05	2215.34	3317.48	0	3317.48	3749.77	3749.77
41	1.84165	6868.86	-10.6582	Qoal/Qal	300	30	2271.23	2190.44	3274.35	0	3274.35	3701.79	3701.79
42	1.82766	6709.84	-5.48789	Qoal/Qal	300	30	2363.99	2279.9	3429.29	0	3429.29	3656.41	3656.41
43	1.82766	4784.25	-5.48789	Qoal/Qal	300	30	1769.69	1706.74	2436.54	0	2436.54	2606.56	2606.56
44	1.51674	1331.77	28.3413	Qoal/Qal	300	30	1275.49	1230.12	1611.01	0	1611.01	923.046	923.046
45	1.51674	1095.04	28.3413	Qoal/Qal	300	30	1133.05	1092.74	1373.08	0	1373.08	761.936	761.936
46	1.90298	1158.01	28.3413	Qoal/Qal	300	30	1029.53	992.906	1200.15	0	1200.15	644.847	644.847
47	1.90298	917.764	28.3413	Qoal/Qal	300	30	914.314	881.791	1007.69	0	1007.69	514.533	514.533
48	1.90288	677.487	28.3413	Qoal/Qal	300	30	799.104	770.679	815.237	0	815.237	384.22	384.22
49	1.90288	437.261	28.3413	Qoal/Qal	300	30	683.896	659.569	622.794	0	622.794	253.917	253.917
50	2.5122	209.351	28.3413	Qoal/Qal	300	30	550.243	530.67	399.533	0	399.533	102.745	102.745

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
28	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
29	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
31	N/A	N/A	N/A	Qoal/Qal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.10883

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.0131	710.01	-51.8707	Qoal/Qal	300	30	279.329	309.728	16.8491	0	16.8491	372.715	372.715
2	2.55117	1703.36	-50.8301	Qoal/Qal	300	30	359.961	399.135	171.707	0	171.707	613.536	613.536
3	2.5507	2605.37	-45.1057	Qoal/Qal	300	30	463.171	513.578	369.93	0	369.93	834.813	834.813
4	3.78575	5291.87	-42.6313	Qoal/Qal	300	30	563.528	624.857	562.669	0	562.669	1081.43	1081.43
5	1.89234	3234.88	-38.6722	Qoal/Qal	300	30	676.179	749.768	779.021	0	779.021	1320.2	1320.2
6	1.89234	3592.64	-38.6722	Qoal/Qal	300	30	721.414	799.926	865.897	0	865.897	1443.28	1443.28
7	3.20144	6828.87	-34.9639	Qoal/Qal	300	30	830.819	921.237	1076.02	0	1076.02	1656.98	1656.98
8	3.13178	7547.74	-34.9639	Qoal/Qal	300	30	902.818	1001.07	1214.29	0	1214.29	1845.6	1845.6
9	2.32394	6149.45	-34.3258	Qoal/Qal	300	30	975.644	1081.82	1354.16	0	1354.16	2020.34	2020.34
10	2.32394	6548.12	-34.3258	Qoal/Qal	300	30	1020.87	1131.97	1441.02	0	1441.02	2138.08	2138.08
11	3.23233	9676.58	-33.18	Qoal/Qal	300	30	1090.59	1209.28	1574.92	0	1574.92	2288.04	2288.04
12	1.83736	5770.98	-30.23	Qoal/Qal	300	30	1195.9	1326.05	1777.17	0	1777.17	2474.04	2474.04
13	1.83736	5947.39	-30.23	Qoal/Qal	300	30	1223.61	1356.78	1830.41	0	1830.41	2543.43	2543.43
14	2.7935	9380.36	-30.23	Qoal/Qal	300	30	1258.55	1395.52	1897.49	0	1897.49	2630.87	2630.87
15	2.7935	9694.98	-30.23	Qoal/Qal	300	30	1291.06	1431.57	1959.93	0	1959.93	2712.26	2712.26
16	2.52191	8894.95	-30.23	Qoal/Qal	300	30	1307.38	1449.66	1991.28	0	1991.28	2753.1	2753.1
17	2.52191	9029.05	-30.23	Qoal/Qal	300	30	1322.73	1466.68	2020.76	0	2020.76	2791.53	2791.53
18	2.52184	9194	-30.23	Qoal/Qal	300	30	1341.64	1487.65	2057.08	0	2057.08	2838.87	2838.87
19	2.52184	9377.81	-30.23	Qoal/Qal	300	30	1502.76	1666.3	2366.51	0	2366.51	3242.19	3242.19
20	3.0994	11696.5	-24.0292	Qoal/Qal	300	30	1560.44	1730.26	2477.29	0	2477.29	3172.99	3172.99
21	3.0995	11819.8	-24.0292	Qoal/Qal	300	30	2028.82	2249.62	3376.83	0	3376.83	4281.36	4281.36
22	3.09867	11882.4	-16.9551	Qoal/Qal	300	30	1838.64	2038.74	3011.59	0	3011.59	3572.15	3572.15
23	3.09867	11867.5	-16.9551	Qoal/Qal	300	30	1836.76	2036.65	3007.97	0	3007.97	3567.95	3567.95
24	3.17097	12128.4	-16.9029	Qoal/Qal	300	30	2067.77	2292.8	3451.63	0	3451.63	4079.98	4079.98
25	3.17097	12077.7	-14.1496	Qoal/Qal	300	30	1950.23	2162.47	3225.91	0	3225.91	3717.57	3717.57
26	1.66821	6310.52	-12.9401	Qoal/Qal	300	30	1995.98	2213.2	3313.75	0	3313.75	3772.36	3772.36
27	1.66821	6274.05	-12.9401	Qoal/Qal	300	30	1986.48	2202.67	3295.53	0	3295.53	3751.95	3751.95
28	1.66821	6237.58	-12.9401	Qoal/Qal	300	30	1976.99	2192.15	3277.3	0	3277.3	3731.55	3731.55
29	1.66821	6201.11	-12.9401	Qoal/Qal	300	30	1972.3	2186.94	3268.28	0	3268.28	3721.45	3721.45
30	3.41348	12522.6	-8.90257	Qoal/Qal	300	30	2154.44	2388.91	3618.1	0	3618.1	3955.57	3955.57
31	1.68438	6076.16	-8.76715	Qoal/Qal	300	30	2132.37	2364.44	3575.71	0	3575.71	3904.57	3904.57
32	1.68438	5990.22	-8.76715	Qoal/Qal	300	30	2107.55	2336.91	3528.03	0	3528.03	3853.06	3853.06
33	2.94536	10241.3	-6.0198	Qoal/Qal	300	30	2230.45	2473.19	3764.07	0	3764.07	3999.28	3999.28
34	2.94536	7974.08	-6.0198	Qoal/Qal	300	30	1824.25	2022.78	2983.94	0	2983.94	3176.31	3176.31
35	1.69348	1064.26	8.79154	Qoal/Qal	300	30	1193.07	1322.91	1771.73	0	1771.73	1587.22	1587.22
36	1.69348	975.851	8.79154	Qoal/Qal	300	30	1142.87	1267.24	1675.32	0	1675.32	1498.57	1498.57
37	1.97456	1064.99	9.70714	Qoal/Qal	300	30	1159.14	1285.29	1706.57	0	1706.57	1508.29	1508.29
38	1.97456	982.96	9.70714	Qoal/Qal	300	30	1117	1238.57	1625.65	0	1625.65	1434.57	1434.57
39	1.90698	871.448	9.70714	Qoal/Qal	300	30	1075.59	1192.64	1546.11	0	1546.11	1362.12	1362.12
40	1.90698	794.933	9.70714	Qoal/Qal	300	30	1034.89	1147.52	1467.95	0	1467.95	1290.92	1290.92
41	1.85092	698.39	9.70714	Qoal/Qal	300	30	994.798	1103.06	1390.94	0	1390.94	1220.77	1220.77
42	1.85092	626.307	9.70714	Qoal/Qal	300	30	955.3	1059.26	1315.09	0	1315.09	1151.67	1151.67
43	1.7957	538.733	9.70714	Qoal/Qal	300	30	916.39	1016.12	1240.36	0	1240.36	1083.6	1083.6
44	1.7957	470.887	9.70714	Qoal/Qal	300	30	878.071	973.631	1166.76	0	1166.76	1016.56	1016.56
45	1.79568	403.036	9.70714	Qoal/Qal	300	30	839.751	931.141	1093.17	0	1093.17	949.521	949.521
46	1.79568	335.192	9.70714	Qoal/Qal	300	30	801.431	888.651	1019.58	0	1019.58	882.482	882.482
47	1.79547	267.319	9.70714	Qoal/Qal	300	30	763.114	846.164	945.985	0	945.985	815.446	815.446
48	1.79547	199.49	9.70714	Qoal/Qal	300	30	724.799	803.679	872.4	0	872.4	748.415	748.415
49	1.79546	124.181	11.7933	Qoal/Qal	300	30	757.103	839.498	934.44	0	934.44	776.365	776.365
50	1.79546	41.3938	11.7933	Qoal/Qal	300	30	703.71	780.295	831.893	0	831.893	684.966	684.966

Query 1 (spencer) - Safety Factor: 1.10883

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.0131	710.01	-51.8707	Qoal/Qal	300	30	279.329	309.728	16.8491	0	16.8491	372.715	372.715
2	2.55117	1703.36	-50.8301	Qoal/Qal	300	30	359.961	399.135	171.707	0	171.707	613.536	613.536
3	2.5507	2605.37	-45.1057	Qoal/Qal	300	30	463.171	513.578	369.93	0	369.93	834.813	834.813
4	3.78575	5291.87	-42.6313	Qoal/Qal	300	30	563.528	624.857	562.669	0	562.669	1081.43	1081.43
5	1.89234	3234.88	-38.6722	Qoal/Qal	300	30	676.179	749.768	779.021	0	779.021	1320.2	1320.2
6	1.89234	3592.64	-38.6722	Qoal/Qal	300	30	721.414	799.926	865.897	0	865.897	1443.28	1443.28
7	3.20144	6828.87	-34.9639	Qoal/Qal	300	30	830.819	921.237	1076.02	0	1076.02	1656.98	1656.98
8	3.13178	7547.74	-34.9639	Qoal/Qal	300	30	902.818	1001.07	1214.29	0	1214.29	1845.6	1845.6
9	2.32394	6149.45	-34.3258	Qoal/Qal	300	30	975.644	1081.82	1354.16	0	1354.16	2020.34	2020.34
10	2.32394	6548.12	-34.3258	Qoal/Qal	300	30	1020.87	1131.97	1441.02	0	1441.02	2138.08	2138.08
11	3.23233	9676.58	-33.18	Qoal/Qal	300	30	1090.59	1209.28	1574.92	0	1574.92	2288.04	2288.04
12	1.83736	5770.98	-30.23	Qoal/Qal	300	30	1195.9	1326.05	1777.17	0	1777.17	2474.04	2474.04
13	1.83736	5947.39	-30.23	Qoal/Qal	300	30	1223.61	1356.78	1830.41	0	1830.41	2543.43	2543.43
14	2.7935	9380.36	-30.23	Qoal/Qal	300	30	1258.55	1395.52	1897.49	0	1897.49	2630.87	2630.87
15	2.7935	9694.98	-30.23	Qoal/Qal	300	30	1291.06	1431.57	1959.93	0	1959.93	2712.26	2712.26
16	2.52191	8894.95	-30.23	Qoal/Qal	300	30	1307.38	1449.66	1991.28	0	1991.28	2753.1	2753.1
17	2.52191	9029.05	-30.23	Qoal/Qal	300	30	1322.73	1466.68	2020.76	0	2020.76	2791.53	2791.53
18	2.52184	9194	-30.23	Qoal/Qal	300	30	1341.64	1487.65	2057.08	0	2057.08	2838.87	2838.87
19	2.52184	9377.81	-30.23	Qoal/Qal	300	30	1502.76	1666.3	2366.51	0	2366.51	3242.19	3242.19
20	3.0994	11696.5	-24.0292	Qoal/Qal	300	30	1560.44	1730.26	2477.29	0	2477.29	3172.99	3172.99
21	3.0995	11819.8	-24.0292	Qoal/Qal	300	30	2028.82	2249.62	3376.83	0	3376.83	4281.36	4281.36
22	3.09867	11882.4	-16.9551	Qoal/Qal	300	30	1838.64	2038.74	3011.59	0	3011.59	3572.15	3572.15
23	3.09867	11867.5	-16.9551	Qoal/Qal	300	30	1836.76	2036.65	3007.97	0	3007.97	3567.95	3567.95
24	3.17097	12128.4	-16.9029	Qoal/Qal	300	30	2067.77	2292.8	3451.63	0	3451.63	4079.98	4079.98
25	3.17097	12077.7	-14.1496	Qoal/Qal	300	30	1950.23	2162.47	3225.91	0	3225.91	3717.57	3717.57
26	1.66821	6310.52	-12.9401	Qoal/Qal	300	30	1995.98	2213.2	3313.75	0	3313.75	3772.36	3772.36
27	1.66821	6274.05	-12.9401	Qoal/Qal	300	30	1986.48	2202.67	3295.53	0	3295.53	3751.95	3751.95
28	1.66821	6237.58	-12.9401	Qoal/Qal	300	30	1976.99	2192.15	3277.3	0	3277.3	3731.55	3731.55
29	1.66821	6201.11	-12.9401	Qoal/Qal	300	30	1972.3	2186.94	3268.28	0	3268.28	3721.45	3721.45
30	3.41348	12522.6	-8.90257	Qoal/Qal	300	30	2154.44	2388.91	3618.1	0	3618.1	3955.57	3955.57
31	1.68438	6076.16	-8.76715	Qoal/Qal	300	30	2132.37	2364.44	3575.71	0	3575.71	3904.57	3904.57
32	1.68438	5990.22	-8.76715	Qoal/Qal	300	30	2107.55	2336.91	3528.03	0	3528.03	3853.06	3853.06
33	2.94536	10241.3	-6.0198	Qoal/Qal	300	30	2230.45	2473.19	3764.07	0	3764.07	3999.28	3999.28
34	2.94536	7974.08	-6.0198	Qoal/Qal	300	30	1824.25	2022.78	2983.94	0	2983.94	3176.31	3176.31
35	1.69348	1064.26	8.79154	Qoal/Qal	300	30	1193.07	1322.91	1771.73	0	1771.73	1587.22	1587.22
36	1.69348	975.851	8.79154	Qoal/Qal	300	30	1142.87	1267.24	1675.32	0	1675.32	1498.57	1498.57
37	1.97456	1064.99	9.70714	Qoal/Qal	300	30	1159.14	1285.29	1706.57	0	1706.57	1508.29	1508.29
38	1.97456	982.96	9.70714	Qoal/Qal	300	30	1117	1238.57	1625.65	0	1625.65	1434.57	1434.57
39	1.90698	871.448	9.70714	Qoal/Qal	300	30	1075.59	1192.64	1546.11	0	1546.11	1362.12	1362.12
40	1.90698	794.933	9.70714	Qoal/Qal	300	30	1034.89	1147.52	1467.95	0	1467.95	1290.92	1290.92
41	1.85092	698.39	9.70714	Qoal/Qal	300	30	994.798	1103.06	1390.94	0	1390.94	1220.77	1220.77
42	1.85092	626.307	9.70714	Qoal/Qal	300	30	955.3	1059.26	1315.09	0	1315.09	1151.67	1151.67
43	1.7957	538.733	9.70714	Qoal/Qal	300	30	916.39	1016.12	1240.36	0	1240.36	1083.6	1083.6
44	1.7957	470.887	9.70714	Qoal/Qal	300	30	878.071	973.631	1166.76	0	1166.76	1016.56	1016.56
45	1.79568	403.036	9.70714	Qoal/Qal	300	30	839.751	931.141	1093.17	0	1093.17	949.521	949.521
46	1.79568	335.192	9.70714	Qoal/Qal	300	30	801.431	888.651	1019.58	0	1019.58	882.482	882.482
47	1.79547	267.319	9.70714	Qoal/Qal	300	30	763.114	846.164	945.985	0	945.985	815.446	815.446
48	1.79547	199.49	9.70714	Qoal/Qal	300	30	724.799	803.679	872.4	0	872.4	748.415	748.415
49	1.79546	124.181	11.7933	Qoal/Qal	300	30	757.103	839.498	934.44	0	934.44	776.365	776.365
50	1.79546	41.3938	11.7933	Qoal/Qal	300	30	703.71	780.295	831.893	0	831.893	684.966	684.966

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 0.964429

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	77.3482	484.488	0	0	0
2	79.2314	482.318	-678.303	0	0
3	81.114	480.315	-1037.39	0	0
4	82.7867	478.626	-1138.01	0	0
5	84.4594	476.938	-1043.14	0	0
6	86.1323	475.249	-752.775	0	0
7	88.1355	473.227	-147.833	0	0
8	90.1387	471.205	737.457	0	0
9	91.9277	469.399	1760.39	0	0
10	93.7164	467.593	2975.35	0	0
11	95.5089	465.949	4220.22	0	0
12	97.4056	464.21	5703.6	0	0
13	99.3022	462.471	7357.02	0	0
14	100.746	461.147	8729.31	0	0
15	102.189	459.823	10200.1	0	0
16	103.633	458.499	11769.4	0	0
17	105.076	457.176	13419.7	0	0
18	106.895	455.508	15592.2	0	0
19	108.714	453.84	17868.7	0	0
20	110.542	452.163	20262.4	0	0
21	112.371	450.486	22766.8	0	0
22	114.199	449.277	24413.6	0	0
23	116.027	448.068	24693.2	0	0
24	117.855	447.135	25692.9	0	0
25	119.683	446.203	26708.1	0	0
26	121.511	445.27	27739.6	0	0
27	123.339	444.338	24747.6	0	0
28	124.736	443.692	25356.7	0	0
29	126.132	443.047	25972.6	0	0
30	127.529	442.401	26595.2	0	0
31	129.623	441.504	26227.6	0	0
32	131.718	440.606	26951.4	0	0
33	133.56	440.094	26571.4	0	0
34	135.403	439.581	26190.9	0	0
35	137.246	439.092	25713.6	0	0
36	139.089	438.604	25236.1	0	0
37	141.007	438.124	24620.6	0	0
38	142.926	437.644	24005.3	0	0
39	144.855	437.2	23229.5	0	0
40	146.785	436.756	22455.2	0	0
41	148.627	436.409	21394	0	0
42	150.468	436.062	20339.2	0	0
43	152.296	435.887	18552.5	0	0
44	154.124	435.711	17113.2	0	0
45	155.64	436.529	14173.6	0	0
46	157.157	437.347	11580.7	0	0
47	159.06	438.374	8643.69	0	0
48	160.963	439.4	6058.53	0	0
49	162.866	440.427	3825.31	0	0
50	164.769	441.453	1943.91	0	0
51	167.281	442.808	0	0	0

Query 1 (janbu corrected) - Safety Factor: -1000

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	N/A	N/A	N/A	N/A	N/A
2	N/A	N/A	N/A	N/A	N/A
3	N/A	N/A	N/A	N/A	N/A
4	N/A	N/A	N/A	N/A	N/A
5	N/A	N/A	N/A	N/A	N/A
6	N/A	N/A	N/A	N/A	N/A
7	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A
11	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A
15	N/A	N/A	N/A	N/A	N/A
16	N/A	N/A	N/A	N/A	N/A
17	N/A	N/A	N/A	N/A	N/A
18	N/A	N/A	N/A	N/A	N/A
19	N/A	N/A	N/A	N/A	N/A
20	N/A	N/A	N/A	N/A	N/A
21	N/A	N/A	N/A	N/A	N/A
22	N/A	N/A	N/A	N/A	N/A
23	N/A	N/A	N/A	N/A	N/A
24	N/A	N/A	N/A	N/A	N/A
25	N/A	N/A	N/A	N/A	N/A
26	N/A	N/A	N/A	N/A	N/A
27	N/A	N/A	N/A	N/A	N/A
28	N/A	N/A	N/A	N/A	N/A
29	N/A	N/A	N/A	N/A	N/A
30	N/A	N/A	N/A	N/A	N/A
31	N/A	N/A	N/A	N/A	N/A
32	N/A	N/A	N/A	N/A	N/A

Global Minimum Query (spencer) - Safety Factor: 1.10883

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	66.8664	484.39	0	0	0
2	69.8795	480.552	-542.666	-413.024	37.2748
3	72.4307	477.42	-361.197	-274.908	37.2749
4	74.9814	474.86	264.225	201.102	37.2748
5	78.7671	471.375	1838.06	1398.95	37.2748
6	80.6594	469.86	2805.86	2135.55	37.2749
7	82.5518	468.346	3937.71	2997	37.2748
8	85.7532	466.107	5940.24	4521.13	37.2748
9	88.885	463.917	8262.81	6288.84	37.2748
10	91.2089	462.33	10173.6	7743.13	37.2748
11	93.5329	460.744	12248.6	9322.47	37.2749
12	96.7652	458.63	15245.5	11603.3	37.2746
13	98.6026	457.559	16855.3	12828.6	37.2748
14	100.44	456.489	18529.5	14102.8	37.2748
15	103.233	454.861	21198	16133.8	37.2748
16	106.027	453.233	23981.1	18252.1	37.2749
17	108.549	451.764	26545.7	20204	37.2749
18	111.071	450.294	29159	22193	37.2749
19	113.593	448.825	31832.6	24227.8	37.2748
20	116.114	447.355	33724.7	25667.9	37.2748
21	119.214	445.973	36171.3	27530.1	37.2749
22	122.313	444.591	35355.2	26908.9	37.2748
23	125.412	443.647	36424.1	27722.5	37.2749
24	128.511	442.702	37490.6	28534.1	37.2748
25	131.682	441.738	36905.2	28088.6	37.2748
26	134.853	440.939	37285.5	28378.1	37.2749
27	136.521	440.556	37308.5	28395.5	37.2748
28	138.189	440.172	37328.2	28410.6	37.2749
29	139.857	439.789	37344.7	28423.1	37.2748
30	141.525	439.406	37340.2	28419.7	37.2748
31	144.939	438.871	36053.1	27440.1	37.2748
32	146.623	438.611	35395.3	26939.5	37.2749
33	148.308	438.351	34738.7	26439.7	37.2748
34	151.253	438.041	32717.9	24901.7	37.2749
35	154.198	437.73	30903.1	23520.4	37.2748
36	155.892	437.992	28769.8	21896.8	37.2749
37	157.585	438.254	26717.6	20334.8	37.2748
38	159.56	438.592	24203.9	18421.6	37.2748
39	161.534	438.93	21773.5	16571.9	37.2749
40	163.441	439.256	19505.6	14845.8	37.2749
41	165.348	439.582	17315.6	13178.9	37.2748
42	167.199	439.899	15264.3	11617.7	37.2749
43	169.05	440.215	13286.5	10112.3	37.2746
44	170.846	440.522	11437.7	8705.23	37.2748
45	172.642	440.83	9657.89	7350.64	37.2748
46	174.437	441.137	7947.17	6048.61	37.2748
47	176.233	441.444	6305.48	4799.11	37.2748
48	178.029	441.751	4733	3602.29	37.2748
49	179.824	442.058	3229.53	2458	37.2748
50	181.619	442.433	1560.86	1187.97	37.2748
51	183.415	442.808	0	0	0

Query 1 (spencer) - Safety Factor: 1.10883

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	66.8664	484.39	0	0	0
2	69.8795	480.552	-542.666	-413.024	37.2748
3	72.4307	477.42	-361.197	-274.908	37.2749
4	74.9814	474.86	264.225	201.102	37.2748
5	78.7671	471.375	1838.06	1398.95	37.2748
6	80.6594	469.86	2805.86	2135.55	37.2749
7	82.5518	468.346	3937.71	2997	37.2748
8	85.7532	466.107	5940.24	4521.13	37.2748
9	88.885	463.917	8262.81	6288.84	37.2748
10	91.2089	462.33	10173.6	7743.13	37.2748
11	93.5329	460.744	12248.6	9322.47	37.2749
12	96.7652	458.63	15245.5	11603.3	37.2746
13	98.6026	457.559	16855.3	12828.6	37.2748
14	100.44	456.489	18529.5	14102.8	37.2748
15	103.233	454.861	21198	16133.8	37.2748
16	106.027	453.233	23981.1	18252.1	37.2749
17	108.549	451.764	26545.7	20204	37.2749
18	111.071	450.294	29159	22193	37.2749
19	113.593	448.825	31832.6	24227.8	37.2748
20	116.114	447.355	33724.7	25667.9	37.2748
21	119.214	445.973	36171.3	27530.1	37.2749
22	122.313	444.591	35355.2	26908.9	37.2748
23	125.412	443.647	36424.1	27722.5	37.2749
24	128.511	442.702	37490.6	28534.1	37.2748
25	131.682	441.738	36905.2	28088.6	37.2748
26	134.853	440.939	37285.5	28378.1	37.2749
27	136.521	440.556	37308.5	28395.5	37.2748
28	138.189	440.172	37328.2	28410.6	37.2749
29	139.857	439.789	37344.7	28423.1	37.2748
30	141.525	439.406	37340.2	28419.7	37.2748
31	144.939	438.871	36053.1	27440.1	37.2748
32	146.623	438.611	35395.3	26939.5	37.2749
33	148.308	438.351	34738.7	26439.7	37.2748
34	151.253	438.041	32717.9	24901.7	37.2749
35	154.198	437.73	30903.1	23520.4	37.2748
36	155.892	437.992	28769.8	21896.8	37.2749
37	157.585	438.254	26717.6	20334.8	37.2748
38	159.56	438.592	24203.9	18421.6	37.2748
39	161.534	438.93	21773.5	16571.9	37.2749
40	163.441	439.256	19505.6	14845.8	37.2749
41	165.348	439.582	17315.6	13178.9	37.2748
42	167.199	439.899	15264.3	11617.7	37.2749
43	169.05	440.215	13286.5	10112.3	37.2746
44	170.846	440.522	11437.7	8705.23	37.2748
45	172.642	440.83	9657.89	7350.64	37.2748
46	174.437	441.137	7947.17	6048.61	37.2748
47	176.233	441.444	6305.48	4799.11	37.2748
48	178.029	441.751	4733	3602.29	37.2748
49	179.824	442.058	3229.53	2458	37.2748
50	181.619	442.433	1560.86	1187.97	37.2748
51	183.415	442.808	0	0	0

Entity Information

External Boundary

X	Y
0	484
0.0158504	426
0.023	399.838
251.097	399.918
511.422	400
550	400
550	420
550	428
511.422	428.018
503.491	425.168
497.914	423.681
482.052	417.856
462.843	417.98
455.408	420.211
450.575	422.937
441.776	428.514
437.935	430.001
431.986	430.869
425.418	432.108
415.628	434.091
405.095	437.313
398.031	438.924
392.826	439.915
354.533	440.659
314.753	440.659
283.524	441.278
252.915	441.65
228.75	441.65
226.735	442.808
198.388	442.808
160.743	442.808
155.29	442.808
155.29	439.795
155.077	439.786
152.306	465.451
145.225	468.294
133.596	472.205
120.374	476.403
110.72	479.76
103.585	482.699
95.61	483.958
91.008	484.65
68.117	484.378
25.304	484.797

Material Boundary

X	Y
0.0158504	426
254.193	426
375.896	426

Material Boundary

X	Y
375.896	426
402.523	427.04
430.506	424.708
441.698	419.111
459.187	412.582
482.739	412.349
502.793	417.013
516.085	419.811
550	420

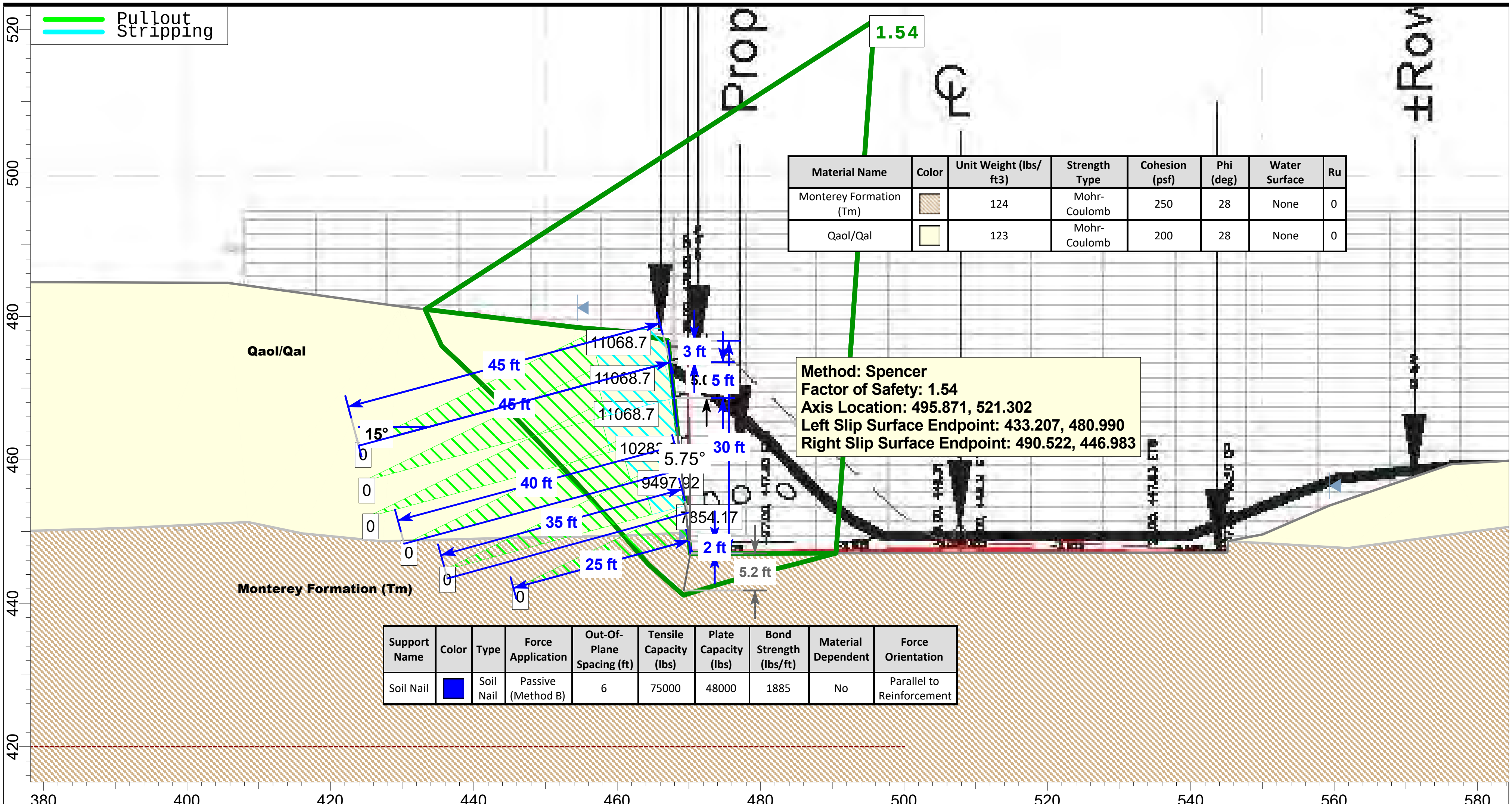
Material Boundary

X	Y
251.097	399.918
254.193	426

Section 62+00 Retaining Wall 14 - Soil Nail Wall

Soil Nail Load Demand - Dia. 6 inches - Sv 5 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 62+00_RW-14_Demand\Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Monterey Formation (Tm)		124	Mohr-Coulomb	250	28	None	0
Qaol/Qal		123	Mohr-Coulomb	200	28	None	0

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	6	75000	48000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA**				
Analyzed By: JEH	Units: feet	Scale: 1:240	Project No.: **11585.005**	File Name: Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1.slim
Date: June 2, 2021	Condition: **Static**			

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA

Project Summary

Slide Modeler Version:	9.012
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	June 2, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	40
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Monterey Formation (Tm)	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	250
Friction Angle [deg]	28
Water Surface	None
Ru Value	0
Qaol/Qal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	6
Tensile Capacity [lb]	75000
Plate Capacity [lb]	48000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	1.530740
Axis Location:	488.678, 526.842
Left Slip Surface Endpoint:	422.144, 482.442
Right Slip Surface Endpoint:	484.277, 446.974
Resisting Horizontal Force:	111323 lb
Driving Horizontal Force:	72725 lb
Passive Horizontal Support Force:	28323 lb
Maximum Single Support Force:	6091.39 lb
Total Support Force:	29322.1 lb
Total Slice Area:	1146.6 ft2
Surface Horizontal Width:	62.1338 ft
Surface Average Height:	18.4537 ft

Method: spencer

FS	1.538580
Axis Location:	495.871, 521.302
Left Slip Surface Endpoint:	433.207, 480.990
Right Slip Surface Endpoint:	490.522, 446.983
Resisting Moment:	7.41903e+06 lb-ft
Driving Moment:	4.822e+06 lb-ft
Resisting Horizontal Force:	94053.1 lb
Driving Horizontal Force:	61129.7 lb
Passive Support Moment:	2.27987e+06 lb-ft
Passive Horizontal Support Force:	43344.6 lb
Maximum Single Support Force:	8819.3 lb
Total Support Force:	44873.7 lb
Total Slice Area:	723.575 ft2
Surface Horizontal Width:	57.3151 ft
Surface Average Height:	12.6245 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
422.144	482.442
424.202	479.977
426.259	477.546
428.242	475.202
430.225	472.859
432.208	470.515
434.192	468.17
436.666	465.246
438.033	463.645
439.4	462.044
441.676	459.378
443.859	456.821
446.198	454.081
447.588	452.453
448.804	451.243
450.021	450.032
451.321	448.744
455.219	445.818
457.855	443.95
460.918	441.778
463.089	440.239
465.259	438.702
467.436	437.158
469.567	436.544
472.802	438.763
474.925	440.22
476.439	441.259
479.055	443.146
481.666	445.03
484.277	446.974

Method: spencer

X	Y
433.207	480.99
435.518	475.887
437.828	473.755
440.381	471.311
442.967	468.77
446.736	464.937
450.509	460.968
454.985	456.104
459.461	451.083
464.364	445.413
469.259	441.124
474.583	442.776
479.902	444.242
485.212	445.559
490.522	446.983

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 6

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
468.453, 463.619	45	25.6109	19.3891	25.6109	19.3891	6091.39
467.409, 473.619	45	31.9239	13.0761	31.9239	13.0761	4108.06
470.021, 448.619	25	14.0897	10.9103	14.0897	10.9103	3427.64
468.974, 458.619	40	22.4541	17.5459	22.4541	17.5459	5512.34
469.496, 453.619	35	18.8204	16.1796	18.8204	16.1796	5083.08
467.931, 468.619	45	28.7678	16.2322	28.7678	16.2322	5099.62

Method: spencer

Number of Supports: 6

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
468.453, 463.619	45	16.928	28.072	16.928	28.072	8819.3
467.409, 473.619	45	23.9344	21.0656	23.9344	21.0656	6618.12
470.021, 448.619	25	7.08583	17.9142	7.08583	17.9142	5628.04
468.974, 458.619	40	13.5641	26.4359	13.5641	26.4359	8305.29
469.496, 453.619	35	10.278	24.722	10.278	24.722	7766.84
467.931, 468.619	45	20.3759	24.6241	20.3759	24.6241	7736.09

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4879
Number of Invalid Surfaces:	137

Error Codes

Error Code -105 reported for 9 surfaces
Error Code -108 reported for 3 surfaces
Error Code -111 reported for 35 surfaces
Error Code -112 reported for 5 surfaces
Error Code -121 reported for 80 surfaces
Error Code -1000 reported for 5 surfaces

Method: spencer

Number of Valid Surfaces:	4278
Number of Invalid Surfaces:	738

Error Codes

Error Code -105 reported for 9 surfaces
Error Code -108 reported for 28 surfaces
Error Code -111 reported for 607 surfaces
Error Code -112 reported for 5 surfaces
Error Code -121 reported for 80 surfaces
Error Code -1000 reported for 9 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.53074

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.05819	276.462	-50.1365	Qaol/Qal	200	28	122.384	187.339	-23.8123	0	-23.8123	122.747	122.747
2	2.05702	824.674	-49.7639	Qaol/Qal	200	28	187.058	286.337	162.375	0	162.375	383.446	383.446
3	1.98363	1310.61	-49.7639	Qaol/Qal	200	28	249.599	382.071	342.427	0	342.427	637.41	637.41
4	1.9824	1815.45	-49.7639	Qaol/Qal	200	28	311.003	476.065	519.202	0	519.202	886.755	886.755
5	1.9834	2327.62	-49.7639	Qaol/Qal	200	28	373.054	571.048	697.84	0	697.84	1138.73	1138.73
6	1.98373	2842.19	-49.7639	Qaol/Qal	200	28	435.45	666.561	877.474	0	877.474	1392.1	1392.1
7	1.23699	2032.59	-49.7639	Qaol/Qal	200	28	486.107	744.104	1023.31	0	1023.31	1597.81	1597.81
8	1.23699	2232.54	-49.7639	Qaol/Qal	200	28	670.869	1026.93	1555.22	0	1555.22	2348.07	2348.07
9	1.36705	2698.66	-49.5118	Qaol/Qal	200	28	567.31	868.404	1257.08	0	1257.08	1921.6	1921.6
10	1.36705	2940.46	-49.5118	Qaol/Qal	200	28	610.005	933.759	1380	0	1380	2094.52	2094.52
11	1.13788	2631.93	-49.5118	Qaol/Qal	200	28	846.479	1295.74	2060.79	0	2060.79	3052.3	3052.3
12	1.13788	2799.46	-49.5118	Qaol/Qal	200	28	684.658	1048.03	1594.92	0	1594.92	2396.89	2396.89
13	1.0915	2842.75	-49.5118	Qaol/Qal	200	28	719.472	1101.32	1695.14	0	1695.14	2537.89	2537.89
14	1.0915	2996.89	-49.5118	Qaol/Qal	200	28	999.321	1529.7	2500.81	0	2500.81	3671.35	3671.35
15	1.16983	3383.12	-49.5118	Qaol/Qal	200	28	788.873	1207.56	1894.94	0	1894.94	2818.98	2818.98
16	1.16983	3560.18	-49.5118	Qaol/Qal	200	28	825.411	1263.49	2000.13	0	2000.13	2966.96	2966.96
17	1.38925	4457.94	-49.5118	Qaol/Qal	200	28	1040.1	1592.13	2618.21	0	2618.21	3836.52	3836.52
18	1.21663	4093.08	-44.859	Qaol/Qal	200	28	946.32	1448.57	2348.22	0	2348.22	3289.89	3289.89
19	1.2167	4252.74	-44.859	Qaol/Qal	200	28	979.474	1499.32	2443.66	0	2443.66	3418.32	3418.32
20	0.808506	2913.98	-44.7344	Qaol/Qal	200	28	1008.2	1543.29	2526.37	0	2526.37	3525.26	3525.26
21	0.491669	1806.43	-44.7344	Monterey Formation (Tm)	250	28	1527.47	2338.16	3927.27	0	3927.27	5440.64	5440.64
22	1.94891	7361.2	-36.8954	Monterey Formation (Tm)	250	28	1151.36	1762.44	2844.49	0	2844.49	3708.81	3708.81
23	1.94891	7660.47	-36.8954	Monterey Formation (Tm)	250	28	1192.99	1826.16	2964.33	0	2964.33	3859.9	3859.9
24	2.63559	10839.9	-35.3291	Monterey Formation (Tm)	250	28	1322.92	2025.05	3338.39	0	3338.39	4276.08	4276.08
25	1.53189	6549.59	-35.3291	Monterey Formation (Tm)	250	28	1302.44	1993.69	3279.41	0	3279.41	4202.58	4202.58
26	1.53189	6730.46	-35.3291	Monterey Formation (Tm)	250	28	1334.84	2043.29	3372.7	0	3372.7	4318.83	4318.83
27	2.17089	9801.66	-35.3291	Monterey Formation (Tm)	250	28	1368.18	2094.33	3468.67	0	3468.67	4438.44	4438.44
28	2.16926	10091.2	-35.3291	Monterey Formation (Tm)	250	28	1405.74	2151.83	3576.83	0	3576.83	4573.22	4573.22
29	2.17734	10360.7	-35.3291	Monterey Formation (Tm)	250	28	1434.97	2196.57	3660.96	0	3660.96	4678.07	4678.07
30	2.13106	6921.41	-16.0751	Monterey Formation (Tm)	250	28	1165.6	1784.23	2885.46	0	2885.46	3221.35	3221.35
31	1.61737	2209.24	34.4502	Monterey Formation (Tm)	250	28	858.513	1314.16	2001.41	0	2001.41	1412.46	1412.46
32	1.61737	1754.1	34.4502	Monterey Formation (Tm)	250	28	726.941	1112.76	1622.61	0	1622.61	1123.92	1123.92
33	2.12291	1965.42	34.4502	Monterey Formation (Tm)	250	28	652.726	999.154	1408.95	0	1408.95	961.183	961.183
34	1.51462	1168.46	34.4502	Monterey Formation (Tm)	250	28	580.551	888.672	1201.17	0	1201.17	802.906	802.906

35	1.30795	848.581	35.8141	Monterey Formation (Tm)	250	28	532.763	815.521	1063.59	0	1063.59	679.149	679.149
36	1.30795	695.836	35.8141	Monterey Formation (Tm)	250	28	477.16	730.408	903.52	0	903.52	559.203	559.203
37	1.30558	542.243	35.8141	Monterey Formation (Tm)	250	28	421.609	645.373	743.592	0	743.592	439.361	439.361
38	1.30558	390.052	35.8141	Monterey Formation (Tm)	250	28	366.107	560.415	583.807	0	583.807	319.625	319.625
39	1.30555	235.463	36.6589	Monterey Formation (Tm)	250	28	313.382	479.707	432.015	0	432.015	198.777	198.777
40	1.30555	78.4876	36.6589	Monterey Formation (Tm)	250	28	255.461	391.044	265.266	0	265.266	75.1359	75.1359

Global Minimum Query (spencer) - Safety Factor: 1.53858

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.15541	171.488	-65.6362	Qaol/Qal	200	28	102.819	158.196	-78.6228	0	-78.6228	148.422	148.422
2	1.15541	514.463	-65.6362	Qaol/Qal	200	28	161.003	247.716	89.7404	0	89.7404	445.267	445.267
3	1.15545	751.935	-42.6992	Qaol/Qal	200	28	269.081	414.002	402.479	0	402.479	650.772	650.772
4	1.15545	883.849	-42.6992	Qaol/Qal	200	28	298.995	460.028	489.042	0	489.042	764.939	764.939
5	1.27611	1132.94	-43.7612	Qaol/Qal	200	28	328.187	504.942	573.513	0	573.513	887.806	887.806
6	1.27611	1300.83	-43.7612	Qaol/Qal	200	28	362.35	557.504	672.369	0	672.369	1019.38	1019.38
7	1.29316	1492.04	-44.4927	Qaol/Qal	200	28	394.712	607.296	766.014	0	766.014	1153.8	1153.8
8	1.29316	1669.56	-44.4927	Qaol/Qal	200	28	430.126	661.784	868.489	0	868.489	1291.07	1291.07
9	1.2564	1795.45	-45.4812	Qaol/Qal	200	28	461.617	710.235	959.615	0	959.615	1429.05	1429.05
10	1.2564	1969.71	-45.4812	Qaol/Qal	200	28	723.674	1113.43	1717.92	0	1717.92	2453.85	2453.85
11	1.2564	2143.97	-45.4812	Qaol/Qal	200	28	532.551	819.373	1164.87	0	1164.87	1706.44	1706.44
12	1.25756	2323.85	-46.4479	Qaol/Qal	200	28	563.692	867.285	1254.98	0	1254.98	1847.91	1847.91
13	1.25756	2505.22	-46.4479	Qaol/Qal	200	28	862.529	1327.07	2119.71	0	2119.71	3026.97	3026.97
14	1.25756	2686.59	-46.4479	Qaol/Qal	200	28	636.801	979.77	1466.53	0	1466.53	2136.36	2136.36
15	1.49197	3427.41	-47.3814	Qaol/Qal	200	28	671.631	1033.36	1567.32	0	1567.32	2297.24	2297.24
16	1.49197	3692.27	-47.3814	Qaol/Qal	200	28	966.047	1486.34	2419.25	0	2419.25	3469.13	3469.13
17	1.49197	3957.82	-47.3814	Qaol/Qal	200	28	760.945	1170.77	1825.76	0	1825.76	2652.74	2652.74
18	1.49197	4235.98	-48.283	Qaol/Qal	200	28	1033.97	1590.84	2615.8	0	2615.8	3775.6	3775.6
19	1.49197	4521.13	-48.283	Qaol/Qal	200	28	848.36	1305.27	2078.7	0	2078.7	3030.31	3030.31
20	1.49197	4806.28	-48.283	Qaol/Qal	200	28	895.956	1378.5	2216.43	0	2216.43	3221.43	3221.43
21	1.43593	4897.36	-49.1538	Qaol/Qal	200	28	1159.58	1784.11	2979.27	0	2979.27	4320.48	4320.48
22	1.7335	6244.02	-49.1538	Monterey Formation (Tm)	250	28	1005.4	1546.89	2439.1	0	2439.1	3601.97	3601.97
23	1.7335	6600.44	-49.1538	Monterey Formation (Tm)	250	28	1191.01	1832.46	2976.18	0	2976.18	4353.73	4353.73
24	1.63167	6492.05	-41.2205	Monterey Formation (Tm)	250	28	1180.19	1815.81	2944.85	0	2944.85	3978.77	3978.77
25	1.63167	6552.58	-41.2205	Monterey Formation (Tm)	250	28	1190.03	1830.95	2973.33	0	2973.33	4015.87	4015.87
26	1.63167	4403.01	-41.2205	Monterey Formation (Tm)	250	28	840.554	1293.26	1962.09	0	1962.09	2698.47	2698.47
27	1.33118	1445	17.2378	Monterey Formation (Tm)	250	28	602.192	926.52	1272.35	0	1272.35	1085.5	1085.5
28	1.33118	859.979	17.2378	Monterey Formation (Tm)	250	28	432.074	664.78	780.091	0	780.091	646.03	646.03
29	1.33118	792.141	17.2378	Monterey Formation (Tm)	250	28	412.348	634.43	723.009	0	723.009	595.068	595.068
30	1.33118	724.304	17.2378	Monterey Formation (Tm)	250	28	392.622	604.08	665.927	0	665.927	544.106	544.106

31	1.77272	865.976	15.4103	Monterey Formation (Tm)	250	28	366.188	563.409	589.44	0	589.44	488.504	488.504
32	1.77272	759.169	15.4103	Monterey Formation (Tm)	250	28	343.174	528.001	522.844	0	522.844	428.251	428.251
33	1.77272	652.363	15.4103	Monterey Formation (Tm)	250	28	320.16	492.592	456.25	0	456.25	368.001	368.001
34	1.77006	550.183	13.9297	Monterey Formation (Tm)	250	28	295.208	454.201	384.046	0	384.046	310.827	310.827
35	1.77006	454.425	13.9297	Monterey Formation (Tm)	250	28	274.759	422.739	324.875	0	324.875	256.728	256.728
36	1.77006	358.667	13.9297	Monterey Formation (Tm)	250	28	254.311	391.278	265.705	0	265.705	202.63	202.63
37	1.32755	203.955	15.0134	Monterey Formation (Tm)	250	28	237.603	365.571	217.358	0	217.358	153.633	153.633
38	1.32755	145.682	15.0134	Monterey Formation (Tm)	250	28	220.884	339.848	168.979	0	168.979	109.737	109.737
39	1.32755	87.4091	15.0134	Monterey Formation (Tm)	250	28	204.165	314.124	120.6	0	120.6	65.8426	65.8426
40	1.32755	29.1364	15.0134	Monterey Formation (Tm)	250	28	187.446	288.4	72.2206	0	72.2206	21.9475	21.9475

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.53074

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	422.144	482.442	0	0	0
2	424.202	479.977	-330.477	0	0
3	426.259	477.546	-350.907	0	0
4	428.242	475.202	-82.3707	0	0
5	430.225	472.859	468.819	0	0
6	432.208	470.515	1306.23	0	0
7	434.192	468.17	2431.36	0	0
8	435.429	466.708	3278.55	0	0
9	436.666	465.246	1859.72	0	0
10	438.033	463.645	3035.86	0	0
11	439.4	462.044	4345.84	0	0
12	440.538	460.711	2581.16	0	0
13	441.676	459.378	3866.35	0	0
14	442.767	458.1	5186.28	0	0
15	443.859	456.821	3059.3	0	0
16	445.029	455.451	4660.14	0	0
17	446.198	454.081	6358.99	0	0
18	447.588	452.453	5307.34	0	0
19	448.804	451.243	6907.97	0	0
20	450.021	450.032	8580.72	0	0
21	450.83	449.231	9724.93	0	0
22	451.321	448.744	7366.83	0	0
23	453.27	447.281	9107.28	0	0
24	455.219	445.818	10935.5	0	0
25	457.855	443.95	11076.2	0	0
26	459.386	442.864	12484.2	0	0
27	460.918	441.778	13940	0	0
28	463.089	440.239	16072.6	0	0
29	465.259	438.702	18281.9	0	0
30	467.436	437.158	20560.7	0	0
31	469.567	436.544	19652.5	0	0
32	471.184	437.654	15933.7	0	0
33	472.802	438.763	12864.7	0	0
34	474.925	440.22	9317.71	0	0
35	476.439	441.259	7120.89	0	0
36	477.747	442.202	5365.19	0	0
37	479.055	443.146	3839.04	0	0
38	480.361	444.088	2544.58	0	0
39	481.666	445.03	1478.84	0	0
40	482.972	446.002	617.611	0	0
41	484.277	446.974	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.53858

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	433.207	480.99	0	0	0
2	434.362	478.439	-319.393	0	0
3	435.518	475.887	-276.457	0	0
4	436.673	474.821	-158.247	0	0
5	437.828	473.755	17.6889	0	0
6	439.105	472.533	299.769	0	0
7	440.381	471.311	659.062	0	0
8	441.674	470.04	1121.83	0	0
9	442.967	468.77	1668.99	0	0
10	444.223	467.492	2315.09	0	0
11	445.48	466.214	-554.055	0	0
12	446.736	464.937	265.184	0	0
13	447.994	463.614	1216.37	0	0
14	449.251	462.291	-1921.15	0	0
15	450.509	460.968	-782.067	0	0
16	452.001	459.347	757.207	0	0
17	453.493	457.725	-2298.2	0	0
18	454.985	456.104	-473.125	0	0
19	456.477	454.43	-2852.2	0	0
20	457.969	452.757	-639.11	0	0
21	459.461	451.083	1733.46	0	0
22	460.897	449.423	140.414	0	0
23	462.63	447.418	3287.96	0	0
24	464.364	445.413	3657.31	0	0
25	465.995	443.983	5941.17	0	0
26	467.627	442.554	8249.68	0	0
27	469.259	441.124	9682.88	0	0
28	470.59	441.537	8355.73	0	0
29	471.921	441.95	7458.36	0	0
30	473.252	442.363	6610.83	0	0
31	474.583	442.776	5813.13	0	0
32	476.356	443.265	4875.96	0	0
33	478.129	443.754	4012.13	0	0
34	479.902	444.242	3221.64	0	0
35	481.672	444.681	2530.5	0	0
36	483.442	445.12	1901.53	0	0
37	485.212	445.559	1334.74	0	0
38	486.539	445.915	941.917	0	0
39	487.867	446.271	588.518	0	0
40	489.194	446.627	274.54	0	0
41	490.522	446.983	0	0	0

Entity Information

External Boundary

X	Y
99.418	509.098
99.5183	464.436
100	250
1006.8	250
1006.8	436.615
931.466	435.737
916.364	431.522
904.071	429.415
893.886	426.079
869.653	426.254
865.789	428.361
859.819	433.278
851.214	435.912
835.41	437.493
812.581	437.669
728.626	439.118
696.251	440.155
665.719	442.574
657.193	444.648
647.4	449.142
640.372	452.713
624.192	457.126
617.559	458.935
608.227	459.741
600.392	460.778
589.678	460.202
576.313	459.396
559.376	453.635
550.044	449.602
545.205	448.681
545.089	447.068
470.2	446.952
469.887	449.871
467.096	476.618
460.368	477.978
454.448	478.453
429.849	481.391
405.617	484.695
361.181	484.849
234.963	487.336
225.014	491.689
211.335	500.393

Material Boundary

X	Y
99.5183	464.436
191.348	460.645
211.42	460.645
225.012	462.226
232.282	461.436
252.195	456.378
266.419	452.901
287.913	452.743
309.724	453.059
323.315	454.008
337.697	454.324
347.496	452.427
358.401	449.898
366.146	449.74
392.065	450.531
408.501	451.321
416.088	449.74
427.309	448.634
444.378	449.108
460.972	449.424
469.887	449.871

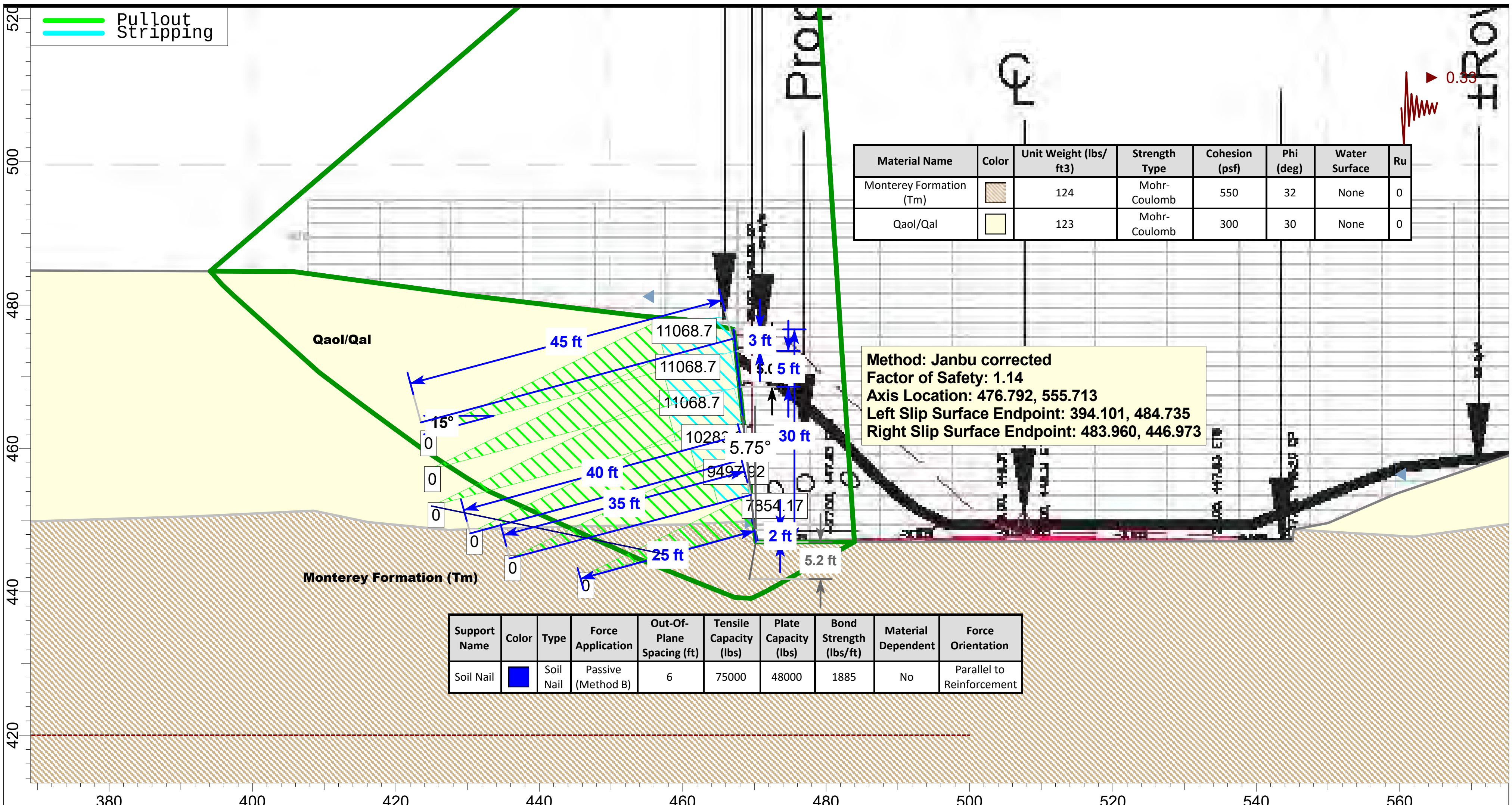
Material Boundary

X	Y
545.205	448.681
561.963	447.686
580.928	450.215
597.207	452.269
613.96	454.956
618.859	455.114
624.192	457.126

Section 62+00 Retaining Wall 14 - Soil Nail Wall

Soil Nail Load Demand - Dia. 6 inches - Sv 5 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 62+00_RW-14_Demand\Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1_k033.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Monterey Formation (Tm)		124	Mohr-Coulomb	550	32	None	0
Qaol/Qal		123	Mohr-Coulomb	300	30	None	0

Method: Janbu corrected
Factor of Safety: 1.14
Axis Location: 476.792, 555.713
Left Slip Surface Endpoint: 394.101, 484.735
Right Slip Surface Endpoint: 483.960, 446.973

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	6	75000	48000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA**			
Analyzed By: JEH	Units: feet	Scale: 1:240	Project No.: **11585.005**
Date: June 2, 2021	Condition: **PseudoStatic**		File Name: Sec 62+00_10-1_SN_D6 B8 75k p36_Path_SrfAlt_b1_k033.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:03.631s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	June 2, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Left to Right

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	40
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.33

Materials

Monterey Formation (Tm)	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	550
Friction Angle [deg]	32
Water Surface	None
Ru Value	0
Qaol/Qal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	6
Tensile Capacity [lb]	75000
Plate Capacity [lb]	48000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	1.139180
Axis Location:	476.792, 555.713
Left Slip Surface Endpoint:	394.101, 484.735
Right Slip Surface Endpoint:	483.960, 446.973
Resisting Horizontal Force:	166080 lb
Driving Horizontal Force:	145788 lb
Passive Horizontal Support Force:	12608.9 lb
Maximum Single Support Force:	3725.73 lb
Total Support Force:	13053.7 lb
Total Slice Area:	1829.69 ft2
Surface Horizontal Width:	89.859 ft
Surface Average Height:	20.3618 ft

Method: spencer

FS	1.324920
Axis Location:	477.324, 582.051
Left Slip Surface Endpoint:	381.458, 484.779
Right Slip Surface Endpoint:	497.622, 446.994
Resisting Moment:	2.87895e+07 lb-ft
Driving Moment:	2.17292e+07 lb-ft
Resisting Horizontal Force:	198624 lb
Driving Horizontal Force:	149914 lb
Passive Support Moment:	1.52723e+06 lb-ft
Passive Horizontal Support Force:	12287.9 lb
Maximum Single Support Force:	3902.25 lb
Total Support Force:	12721.4 lb
Total Slice Area:	2138.62 ft2
Surface Horizontal Width:	116.165 ft
Surface Average Height:	18.4102 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
394.101	484.735
395.774	482.85
397.441	481.284
401.045	478.042
404.644	474.803
406.941	472.737
409.238	470.67
411.529	468.928
413.391	467.526
415.36	466.046
417.304	464.607
419.249	463.167
420.757	462.07
423.3	460.23
426.51	458.082
429.718	456.013
432.924	454.052
436.314	452.521
439.704	450.99
443.093	449.459
446.301	448.01
449.648	446.499
453.203	444.893
456.752	443.415
460.299	442.005
462.63	441.079
464.961	440.153
467.292	439.227
469.565	439.097
471.659	440.093
473.535	441.142
475.411	442.192
477.691	443.467
479.921	444.714
481.199	445.429
482.478	446.144
483.96	446.973

Method: spencer

X	Y
381.458	484.779
384.942	480.083
387.638	477.274
390.333	475.019
393.523	472.784
396.713	470.55
399.879	468.695
403.046	466.84
407.12	464.793
411.195	462.746
415.247	461.061
419.3	459.376
422.551	458.025
425.2	456.923
428.42	455.585
431.64	454.246
435.003	452.848
438.366	451.45
441.205	450.269
444.044	449.177
446.897	448.079
449.751	446.981
452.604	445.883
455.457	444.848
458.959	443.897
462.461	442.946
465.963	441.994
469.461	441.422
473.019	442.098
476.58	442.775
480.162	443.456
483.744	444.137
487.214	444.797
490.683	445.456
494.153	446.181
497.622	446.994

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 6						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
468.453, 463.619	45	36.8375	8.16246	36.8375	8.16246	2564.37
467.409, 473.619	45	Not Effective	Not Effective	Not Effective	Not Effective	0
470.021, 448.619	25	16.2311	8.76887	16.2311	8.76887	2754.89
468.974, 458.619	40	29.9955	10.0045	29.9955	10.0045	3143.09
469.496, 453.619	35	23.1409	11.8591	23.1409	11.8591	3725.73
467.931, 468.619	45	42.2449	2.75515	42.2449	2.75515	865.575

Method: spencer

Number of Supports: 6

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
468.453, 463.619	45	37.3677	7.63226	37.3677	7.63226	2397.8
467.409, 473.619	45	Not Effective	Not Effective	Not Effective	Not Effective	0
470.021, 448.619	25	14.8253	10.1747	14.8253	10.1747	3196.54
468.974, 458.619	40	30.125	9.87504	30.125	9.87504	3102.41
469.496, 453.619	35	22.579	12.421	22.579	12.421	3902.25
467.931, 468.619	45	44.6105	0.389485	44.6105	0.389485	122.363

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4900

Number of Invalid Surfaces: 115

Error Codes

Error Code -105 reported for 9 surfaces

Error Code -111 reported for 18 surfaces

Error Code -112 reported for 4 surfaces

Error Code -121 reported for 80 surfaces

Error Code -1000 reported for 4 surfaces

Method: spencer

Number of Valid Surfaces: 1724

Number of Invalid Surfaces: 3291

Error Codes

Error Code -105 reported for 9 surfaces

Error Code -108 reported for 40 surfaces

Error Code -111 reported for 3149 surfaces

Error Code -112 reported for 4 surfaces

Error Code -121 reported for 80 surfaces

Error Code -1000 reported for 9 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-105 = More than two surface / slope intersections with no valid slip surface.

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eaxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.13918

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.67275	193.313	-48.4131	Qaol/Qal	300	30	200.751	228.691	-123.511	0	-123.511	102.704	102.704
2	1.66663	545.095	-43.2103	Qaol/Qal	300	30	285.468	325.2	43.6473	0	43.6473	311.817	311.817
3	1.80215	941.31	-41.9772	Qaol/Qal	300	30	356.347	405.943	183.498	0	183.498	504.097	504.097

4	1.80215	1299.33	-41.9772	Qaol/Qal	300	30	424.289	483.341	317.556	0	317.556	699.281	699.281
5	3.59942	3666.76	-41.9772	Qaol/Qal	300	30	526.11	599.334	518.461	0	518.461	991.794	991.794
6	2.29696	3072.09	-41.9772	Qaol/Qal	300	30	635.124	723.521	733.559	0	733.559	1304.97	1304.97
7	2.29715	3575.5	-41.9772	Qaol/Qal	300	30	710.035	808.858	881.37	0	881.37	1520.18	1520.18
8	2.29031	4013.25	-37.258	Qaol/Qal	300	30	818.107	931.971	1094.61	0	1094.61	1716.89	1716.89
9	1.86269	3559.19	-36.9566	Qaol/Qal	300	30	877.946	1000.14	1212.68	0	1212.68	1873.22	1873.22
10	1.96815	4046.33	-36.9566	Qaol/Qal	300	30	930.374	1059.86	1316.12	0	1316.12	2016.1	2016.1
11	1.94406	4282.11	-36.5098	Qaol/Qal	300	30	987.97	1125.48	1429.77	0	1429.77	2161.09	2161.09
12	1.94505	4565.24	-36.5098	Qaol/Qal	300	30	1040.39	1185.19	1533.19	0	1533.19	2303.32	2303.32
13	1.50881	3733.01	-36.0138	Qaol/Qal	300	30	1092.07	1244.06	1635.17	0	1635.17	2429	2429
14	2.5424	6663.13	-35.8985	Qaol/Qal	300	30	1146.93	1306.56	1743.4	0	1743.4	2573.6	2573.6
15	3.20979	9044.6	-33.7851	Qaol/Qal	300	30	1245.2	1418.51	1937.32	0	1937.32	2770.44	2770.44
16	3.20822	9699.59	-32.8257	Qaol/Qal	300	30	1358.91	1548.04	2161.67	0	2161.67	3038.29	3038.29
17	3.20646	10326.5	-31.4512	Qaol/Qal	300	30	1501.1	1710.02	2442.23	0	2442.23	3360.35	3360.35
18	3.38964	11480.1	-24.3055	Qaol/Qal	300	30	1594.19	1816.07	2625.9	0	2625.9	3345.89	3345.89
19	3.38983	11950.3	-24.3055	Qaol/Qal	300	30	1650.71	1880.46	2737.43	0	2737.43	3482.94	3482.94
20	3.38939	12418.2	-24.3055	Qaol/Qal	300	30	1798.1	2048.36	3028.24	0	3028.24	3840.32	3840.32
21	0.806428	3023.75	-24.3055	Qaol/Qal	300	30	1742.21	1984.69	2917.98	0	2917.98	3704.82	3704.82
22	2.40156	9163.55	-24.3055	Monterey Formation (Tm)	550	32	2041.34	2325.45	2841.31	0	2841.31	3763.25	3763.25
23	3.34644	13166.4	-24.3055	Monterey Formation (Tm)	550	32	2209.19	2516.66	3147.3	0	3147.3	4145.04	4145.04
24	1.77768	7182.42	-24.3055	Monterey Formation (Tm)	550	32	2139	2436.71	3019.37	0	3019.37	3985.42	3985.42
25	1.77768	7313.04	-24.3055	Monterey Formation (Tm)	550	32	2170.95	2473.1	3077.59	0	3077.59	4058.07	4058.07
26	3.5485	14973.9	-22.6162	Monterey Formation (Tm)	550	32	2335.64	2660.72	3377.87	0	3377.87	4350.88	4350.88
27	1.77394	7677.38	-21.67	Monterey Formation (Tm)	550	32	2321.91	2645.07	3352.82	0	3352.82	4275.41	4275.41
28	1.77394	7801.44	-21.67	Monterey Formation (Tm)	550	32	2353.09	2680.59	3409.65	0	3409.65	4344.63	4344.63
29	2.33019	10397.9	-21.67	Monterey Formation (Tm)	550	32	2381.82	2713.32	3462.04	0	3462.04	4408.44	4408.44
30	2.33154	10536.9	-21.67	Monterey Formation (Tm)	550	32	2407.24	2742.28	3508.38	0	3508.38	4464.88	4464.88
31	2.33072	10643.9	-21.67	Monterey Formation (Tm)	550	32	2428.43	2766.42	3547.01	0	3547.01	4511.93	4511.93
32	2.27271	6926.32	-3.25961	Monterey Formation (Tm)	550	32	2085.63	2375.91	2922.07	0	2922.07	3040.85	3040.85
33	2.09431	2145.56	25.4329	Monterey Formation (Tm)	550	32	1442.39	1643.14	1749.38	0	1749.38	1063.47	1063.47
34	1.87589	1474.29	29.2186	Monterey Formation (Tm)	550	32	1352.39	1540.62	1585.33	0	1585.33	828.923	828.923
35	1.87599	1230.96	29.2186	Monterey Formation (Tm)	550	32	1247.08	1420.65	1393.33	0	1393.33	695.829	695.829
36	2.27984	1168.32	29.2186	Monterey Formation (Tm)	550	32	1130.43	1287.76	1180.66	0	1180.66	548.405	548.405
37	2.23005	795.014	29.2186	Monterey Formation (Tm)	550	32	1003.83	1143.55	949.877	0	949.877	388.425	388.425
38	1.27869	300.702	29.2186	Monterey Formation (Tm)	550	32	905.344	1031.35	770.32	0	770.32	263.954	263.954
39	1.27871	187.621	29.2186	Monterey Formation (Tm)	550	32	833.558	949.573	639.45	0	639.45	173.235	173.235

40	1.48214	75.9651	29.2186	Monterey Formation (Tm)	550	32	756.061	861.29	498.168	0	498.168	75.2977	75.2977

Global Minimum Query (spencer) - Safety Factor: 1.32492

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	3.48463	1003.67	-53.4198	Qaol/Qal	300	30	241.554	320.04	34.7102	0	34.7102	360.198	360.198
2	2.69559	2016.94	-46.1807	Qaol/Qal	300	30	340.946	451.726	262.798	0	262.798	618.093	618.093
3	2.69559	2853.45	-39.9221	Qaol/Qal	300	30	431.861	572.181	471.431	0	471.431	832.806	832.806
4	3.18976	4253.33	-35.0084	Qaol/Qal	300	30	523.464	693.548	681.644	0	681.644	1048.29	1048.29
5	3.18976	5125.56	-35.0083	Qaol/Qal	300	30	584.063	773.837	820.71	0	820.71	1229.8	1229.8
6	3.16638	5880.02	-30.3645	Qaol/Qal	300	30	688.01	911.558	1059.25	0	1059.25	1462.33	1462.33
7	3.16638	6598.23	-30.3643	Qaol/Qal	300	30	743.173	984.645	1185.84	0	1185.84	1621.23	1621.23
8	4.0745	9443.66	-26.6763	Qaol/Qal	300	30	850.344	1126.64	1431.78	0	1431.78	1859.02	1859.02
9	2.03725	5029.17	-26.676	Qaol/Qal	300	30	889.838	1178.96	1522.41	0	1522.41	1969.48	1969.48
10	2.03725	5216.05	-26.676	Qaol/Qal	300	30	913.849	1210.78	1577.51	0	1577.51	2036.65	2036.65
11	2.02625	5351.35	-22.5745	Qaol/Qal	300	30	1003.34	1329.34	1782.88	0	1782.88	2200	2200
12	2.02625	5492.44	-22.5745	Qaol/Qal	300	30	1023.13	1355.57	1828.31	0	1828.31	2253.66	2253.66
13	2.02625	5633.54	-22.5745	Qaol/Qal	300	30	1042.93	1381.8	1873.74	0	1873.74	2307.32	2307.32
14	2.02625	5774.63	-22.5745	Qaol/Qal	300	30	1062.73	1408.03	1919.17	0	1919.17	2360.99	2360.99
15	3.25142	9561.13	-22.5745	Qaol/Qal	300	30	1088.51	1442.19	1978.33	0	1978.33	2430.87	2430.87
16	2.64904	8058.34	-22.5745	Qaol/Qal	300	30	1129.81	1496.91	2073.11	0	2073.11	2542.81	2542.81
17	3.21979	10119.2	-22.5745	Qaol/Qal	300	30	1146.01	1518.37	2110.27	0	2110.27	2586.71	2586.71
18	3.21979	10478.8	-22.5745	Qaol/Qal	300	30	1177.76	1560.44	2183.14	0	2183.14	2672.78	2672.78
19	3.36331	11347.2	-22.5745	Qaol/Qal	300	30	1404.19	1860.44	2702.76	0	2702.76	3286.53	3286.53
20	3.36334	11759.5	-22.5745	Qaol/Qal	300	30	1246.53	1651.55	2340.95	0	2340.95	2859.18	2859.18
21	2.83889	10246.7	-22.5745	Qaol/Qal	300	30	1573.76	2085.1	3091.88	0	3091.88	3746.15	3746.15
22	2.83887	10525.1	-21.0492	Qaol/Qal	300	30	1343.45	1779.96	2563.36	0	2563.36	3080.39	3080.39
23	0.18915	710.617	-21.0492	Qaol/Qal	300	30	1357.94	1799.16	2596.63	0	2596.63	3119.23	3119.23
24	2.66413	10134.4	-21.0492	Monterey Formation (Tm)	550	32	1695.14	2245.92	2714.04	0	2714.04	3366.42	3366.42
25	2.85329	11114.1	-21.0492	Monterey Formation (Tm)	550	32	2141.23	2836.96	3659.91	0	3659.91	4483.96	4483.96
26	2.85329	11383.2	-21.0492	Monterey Formation (Tm)	550	32	1754.66	2324.78	2840.24	0	2840.24	3515.52	3515.52
27	2.85329	11643.4	-19.9278	Monterey Formation (Tm)	550	32	1821.35	2413.14	2981.65	0	2981.65	3641.97	3641.97
28	3.5021	14602.5	-15.1962	Monterey Formation (Tm)	550	32	2343.82	3105.37	4089.46	0	4089.46	4726.09	4726.09
29	3.5021	14862	-15.1962	Monterey Formation (Tm)	550	32	2054.38	2721.89	3475.76	0	3475.76	4033.78	4033.78
30	3.50203	14985.3	-15.1962	Monterey Formation (Tm)	550	32	2067.26	2738.96	3503.08	0	3503.08	4064.59	4064.59
31	3.49741	11765.9	-9.29535	Monterey Formation (Tm)	550	32	1957.11	2593.02	3269.52	0	3269.52	3589.85	3589.85
32	3.55841	2609.76	10.7634	Monterey Formation (Tm)	550	32	1440	1907.89	2173.07	0	2173.07	1899.33	1899.33
33	3.5603	1996.51	10.7634	Monterey Formation (Tm)	550	32	1296.36	1717.57	1868.5	0	1868.5	1622.07	1622.07
34	3.58238	1709.78	10.7634	Monterey Formation (Tm)	550	32	1226.88	1625.52	1721.19	0	1721.19	1487.96	1487.96
35	1.79119	742.37	10.7634	Monterey Formation (Tm)	550	32	1174.61	1556.27	1610.36	0	1610.36	1387.07	1387.07
36	1.79119	667.358	10.7634	Monterey Formation (Tm)	550	32	1139.77	1510.1	1536.48	0	1536.48	1319.81	1319.81

37	3.46953	1079.3	10.7634	Monterey Formation (Tm)	550	32	1088.6	1442.3	1427.98	0	1427.98	1221.04	1221.04
38	3.46953	797.861	10.7634	Monterey Formation (Tm)	550	32	1021.1	1352.88	1284.87	0	1284.87	1090.76	1090.76
39	3.46951	502.415	11.7974	Monterey Formation (Tm)	550	32	988.519	1309.71	1215.79	0	1215.79	1009.32	1009.32
40	3.46951	173.846	13.1966	Monterey Formation (Tm)	550	32	958.236	1269.59	1151.58	0	1151.58	926.887	926.887

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.13918

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	394.101	484.735	0	0	0
2	395.774	482.85	-523.913	0	0
3	397.441	481.284	-778.518	0	0
4	399.243	479.663	-849.073	0	0
5	401.045	478.042	-713.529	0	0
6	404.644	474.803	174.091	0	0
7	406.941	472.737	1162.01	0	0
8	409.238	470.67	2439.66	0	0
9	411.529	468.928	3690.68	0	0
10	413.391	467.526	4836.37	0	0
11	415.36	466.046	6185.3	0	0
12	417.304	464.607	7626.02	0	0
13	419.249	463.167	9201.34	0	0
14	420.757	462.07	10485.2	0	0
15	423.3	460.23	12810.7	0	0
16	426.51	458.082	15731.8	0	0
17	429.718	456.013	18023.2	0	0
18	432.924	454.052	18835.7	0	0
19	436.314	452.521	20933.1	0	0
20	439.704	450.99	23153.8	0	0
21	443.093	449.459	22629.7	0	0
22	443.9	449.095	23205.5	0	0
23	446.301	448.01	24130.1	0	0
24	449.648	446.499	22079.7	0	0
25	451.425	445.696	22855.4	0	0
26	453.203	444.893	23660.9	0	0
27	456.752	443.415	22367.7	0	0
28	458.525	442.71	22911.4	0	0
29	460.299	442.005	23477.6	0	0
30	462.63	441.079	24248.7	0	0
31	464.961	440.153	25044.4	0	0
32	467.292	439.227	25859.9	0	0
33	469.565	439.097	23514.3	0	0
34	471.659	440.093	19287.5	0	0
35	473.535	441.142	15429.5	0	0
36	475.411	442.192	11901.2	0	0
37	477.691	443.467	8057.56	0	0
38	479.921	444.714	4769.26	0	0
39	481.199	445.429	3094.1	0	0
40	482.478	446.144	1572.2	0	0
41	483.96	446.973	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.32492

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	381.458	484.779	0	0	0
2	384.942	480.083	-347.542	-251.512	35.8928
3	387.638	477.274	137.199	99.2892	35.8928
4	390.333	475.019	978.087	707.829	35.8928
5	393.523	472.784	2234.88	1617.35	35.8927
6	396.713	470.55	3896.89	2820.13	35.8928
7	399.879	468.695	5623.75	4069.84	35.8928
8	403.046	466.84	7647.78	5534.6	35.8928
9	407.12	464.793	10230.5	7403.68	35.8928
10	409.157	463.769	11635.6	8420.51	35.8927
11	411.195	462.746	13109.8	9487.38	35.8927
12	413.221	461.903	14344.6	10381	35.8928
13	415.247	461.061	15624.1	11307	35.8929
14	417.273	460.219	16948.3	12265.3	35.8928
15	419.3	459.376	18317.3	13256	35.8928
16	422.551	458.025	20607.4	14913.3	35.8928
17	425.2	456.923	22467.6	16259.5	35.8928
18	428.42	455.585	24941.8	18050.1	35.8928
19	431.64	454.246	27530	19923.1	35.8928
20	435.003	452.848	28582.9	20685	35.8927
21	438.366	451.45	31544.3	22828.2	35.8928
22	441.205	450.269	31845.3	23046	35.8927
23	444.044	449.177	34305.2	24826.2	35.8927
24	444.233	449.104	34471.9	24946.8	35.8927
25	446.897	448.079	36082.8	26112.7	35.8928
26	449.751	446.981	34814.8	25195	35.8928
27	452.604	445.883	36683.5	26547.4	35.8928
28	455.457	444.848	38413.3	27799.2	35.8928
29	458.959	443.897	36583.5	26475	35.8928
30	462.461	442.946	37599.5	27210.3	35.8928
31	465.963	441.994	38637.2	27961.2	35.8927
32	469.461	441.422	37546.6	27172	35.8928
33	473.019	442.098	31813.7	23023.2	35.8928
34	476.58	442.775	26592.5	19244.7	35.8928
35	480.162	443.456	21589.4	15624	35.8928
36	481.953	443.797	19182.1	13881.8	35.8927
37	483.744	444.137	16837.6	12185.2	35.8929
38	487.214	444.797	12475	9028.01	35.8928
39	490.683	445.456	8348.12	6041.43	35.8928
40	494.153	446.181	4203.2	3041.8	35.8928
41	497.622	446.994	0	0	0

Entity Information

External Boundary

X	Y
99.418	509.098
99.5183	464.436
100	250
1006.8	250
1006.8	436.615
931.466	435.737
916.364	431.522
904.071	429.415
893.886	426.079
869.653	426.254
865.789	428.361
859.819	433.278
851.214	435.912
835.41	437.493
812.581	437.669
728.626	439.118
696.251	440.155
665.719	442.574
657.193	444.648
647.4	449.142
640.372	452.713
624.192	457.126
617.559	458.935
608.227	459.741
600.392	460.778
589.678	460.202
576.313	459.396
559.376	453.635
550.044	449.602
545.205	448.681
545.089	447.068
470.2	446.952
469.887	449.871
467.096	476.618
460.368	477.978
454.448	478.453
429.849	481.391
405.617	484.695
361.181	484.849
234.963	487.336
225.014	491.689
211.335	500.393

Material Boundary

X	Y
99.5183	464.436
191.348	460.645
211.42	460.645
225.012	462.226
232.282	461.436
252.195	456.378
266.419	452.901
287.913	452.743
309.724	453.059
323.315	454.008
337.697	454.324
347.496	452.427
358.401	449.898
366.146	449.74
392.065	450.531
408.501	451.321
416.088	449.74
427.309	448.634
444.378	449.108
460.972	449.424
469.887	449.871

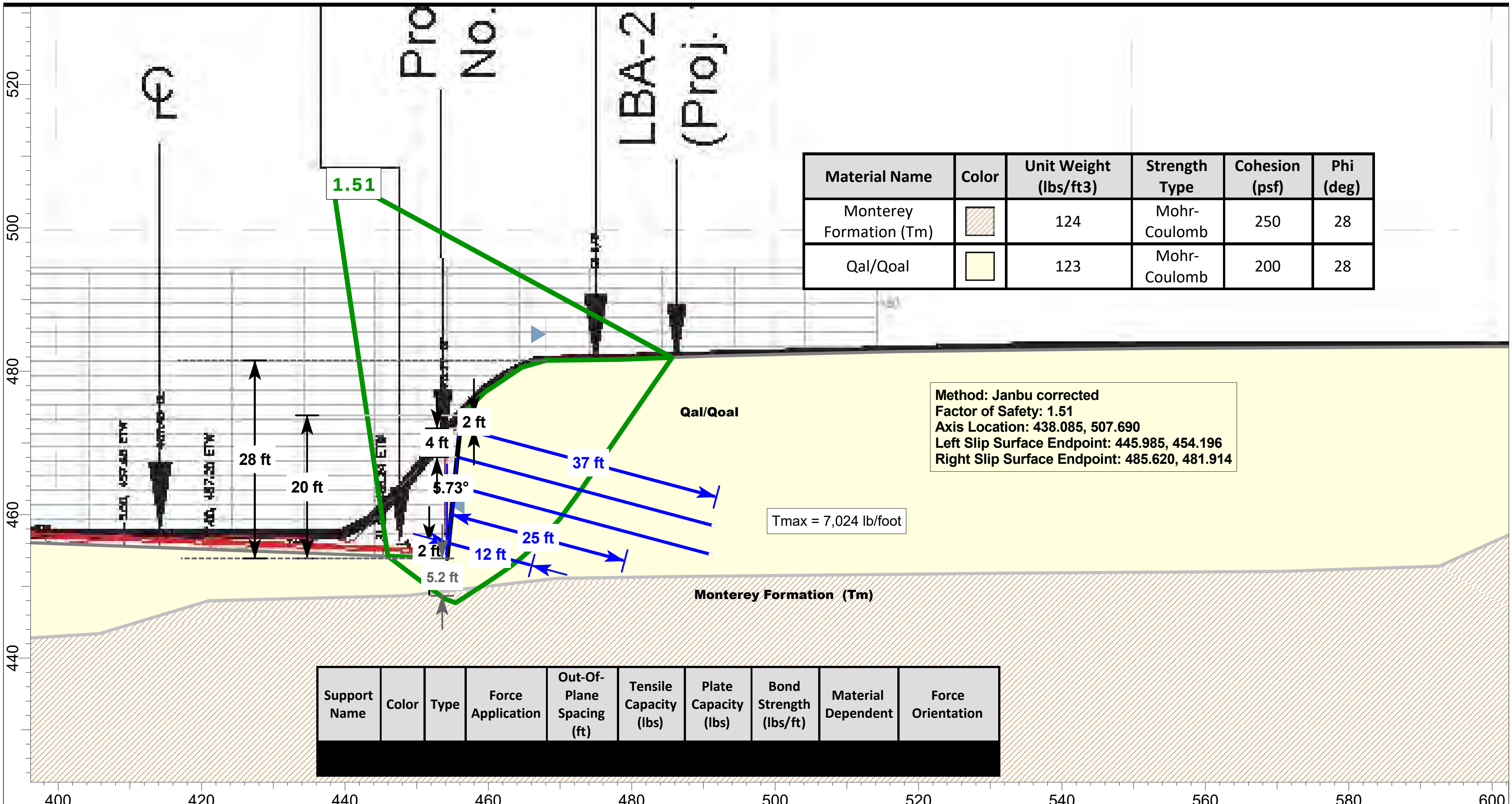
Material Boundary

X	Y
545.205	448.681
561.963	447.686
580.928	450.215
597.207	452.269
613.96	454.956
618.859	455.114
624.192	457.126

Section 66+50 - Retaining Wall 15 - Soil Nail System

Soil Nail Load Demand - Dia. 6 inches - Sv 4 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 66+50_RW-15_Demand\Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Monterey Formation (Tm)		124	Mohr-Coulomb	250	28
Qal/Qoal		123	Mohr-Coulomb	200	28

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA**			
Analyzed By: JEH	Units: feet	Scale: 1:240	Project No.: **11585.005**
Date: May 12, 2021	Condition: **Static**		File Name: Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:19.546s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 12, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No

Materials

Monterey Formation (Tm)	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	250
Friction Angle [deg]	28
Water Surface	None
Ru Value	0
Qal/Qoal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	200
Friction Angle [deg]	28
Water Surface	None
Ru Value	0
Engineered Fill	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	30
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	6
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	1.511380
Axis Location:	438.085, 507.690
Left Slip Surface Endpoint:	445.985, 454.196
Right Slip Surface Endpoint:	485.620, 481.914
Resisting Horizontal Force:	64309.3 lb
Driving Horizontal Force:	42550 lb
Passive Horizontal Support Force:	21743.2 lb
Maximum Single Support Force:	6707.03 lb
Total Support Force:	22510.3 lb
Total Slice Area:	583.922 ft2
Surface Horizontal Width:	39.6351 ft
Surface Average Height:	14.7324 ft

Method: spencer

FS	1.407770
Axis Location:	436.432, 498.573
Left Slip Surface Endpoint:	448.669, 454.095
Right Slip Surface Endpoint:	479.357, 481.676
Resisting Moment:	2.66706e+06 lb-ft
Driving Moment:	1.89453e+06 lb-ft
Resisting Horizontal Force:	54546.1 lb
Driving Horizontal Force:	38746.4 lb
Passive Support Moment:	768860 lb-ft
Passive Horizontal Support Force:	27789.4 lb
Maximum Single Support Force:	8037.41 lb
Total Support Force:	28769.7 lb
Total Slice Area:	420.205 ft2
Surface Horizontal Width:	30.6878 ft
Surface Average Height:	13.6929 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
445.985	454.196
447.613	452.954
449.09	451.85
450.319	450.932
451.547	450.014
452.578	449.244
453.842	448.3
455.439	447.69
456.976	448.669
458.529	449.686
460.082	450.712
461.719	451.805
463.17	452.833
464.621	453.971
466.076	455.294
467.514	456.609
468.747	458.019
469.996	459.46
471.252	461.171
472.508	462.882
473.543	464.384
474.547	465.841
475.501	467.226
476.455	468.61
477.569	470.227
478.82	472.043
480.138	473.957
481.187	475.479
482.043	476.721
483.235	478.451
484.428	480.183
485.62	481.914

Method: spencer

X	Y
448.669	454.095
449.713	452.995
450.634	452.025
451.815	450.781
452.995	449.538
454.435	448.021
455.618	447.958
456.794	449.251
457.853	450.414
458.911	451.578
459.872	452.637
460.773	453.682
461.49	454.641
462.411	455.874
463.332	457.106
464.275	458.368
465.227	459.641
466.135	460.856
466.952	462.033
467.769	463.258
468.586	464.483
469.403	465.707
470.221	466.933
471.087	468.232
471.767	469.251
472.447	470.271
473.67	472.103
474.352	473.179
475.039	474.347
475.741	475.538
476.447	476.736
477.084	477.818
477.768	478.979
478.563	480.327
479.357	481.676

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 5						
			Soil Nail			
Support Type: Soil Nail						
Start (x, y)	**Length (ft)**	**L Inside SS (ft)**	**L Outside SS (ft)**	**Li (ft)**	**Lo (ft)**	**Force (lb)**
454.455, 456.029	12	9.86921	2.13079	9.86921	2.13079	669.423
455.66, 468.029	37	17.8235	19.1765	17.8235	19.1765	6024.6
455.258, 464.029	37	15.6514	21.3486	15.6514	21.3486	6707.03
456.062, 472.029	37	19.8809	17.1191	19.8809	17.1191	5378.24
454.857, 460.029	25	13.1243	11.8757	13.1243	11.8757	3730.96

Method: spencer

Number of Supports: 5

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
454.455, 456.029	12	6.96247	5.03753	6.96247	5.03753	1582.63
455.66, 468.029	37	13.4303	23.5697	13.4303	23.5697	7404.81
455.258, 464.029	37	11.4167	25.5833	11.4167	25.5833	8037.41
456.062, 472.029	37	15.4213	21.5787	15.4213	21.5787	6779.32
454.857, 460.029	25	9.19464	15.8054	9.19464	15.8054	4965.52

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces: 4898
Number of Invalid Surfaces: 124

Error Codes

Error Code -108 reported for 8 surfaces
Error Code -111 reported for 38 surfaces
Error Code -121 reported for 67 surfaces
Error Code -1000 reported for 11 surfaces

Method: spencer

Number of Valid Surfaces: 3945
Number of Invalid Surfaces: 1077

Error Codes

Error Code -108 reported for 47 surfaces
Error Code -111 reported for 952 surfaces
Error Code -112 reported for 2 surfaces
Error Code -121 reported for 67 surfaces
Error Code -1000 reported for 9 surfaces

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eąxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-112 = The coefficient M-Alpha = cos(alpha)(1+tan(alpha)tan(phi)/F) < 0.2 for the final iteration of the safety factor calcula. on. This screens out some slip surfaces which may not be valid in the context of the analysis, in parcu lar, deep seated slip surfaces with many high negav e base angle slices in the passive zone.

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.51138

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	1.6272	118.201	-37.3643	Qal/Qoal	200	28	222.192	335.817	255.434	0	255.434	85.7747	85.7747
2	0.738817	131.149	-36.7622	Qal/Qoal	200	28	271.723	410.676	396.223	0	396.223	193.228	193.228
3	0.738817	178.776	-36.7622	Qal/Qoal	200	28	303.36	458.492	486.151	0	486.151	259.521	259.521
4	0.61425	184.893	-36.7622	Qal/Qoal	200	28	332.33	502.277	568.5	0	568.5	320.227	320.227
5	0.61425	217.814	-36.7622	Qal/Qoal	200	28	358.633	542.031	643.266	0	643.266	375.343	375.343
6	0.61425	250.734	-36.7622	Qal/Qoal	200	28	384.936	581.785	718.033	0	718.033	430.459	430.459
7	0.61425	283.655	-36.7622	Qal/Qoal	200	28	411.239	621.539	792.799	0	792.799	485.576	485.576
8	1.03076	549.971	-36.7622	Qal/Qoal	200	28	446.46	674.771	892.912	0	892.912	559.376	559.376
9	0.0900348	52.441	-36.7622	Qal/Qoal	200	28	470.457	711.04	961.122	0	961.122	609.659	609.659
10	0.586797	359.257	-36.7622	Monterey Formation (Tm)	250	28	531.224	802.881	1039.82	0	1039.82	642.958	642.958
11	0.586797	389.597	-36.7622	Monterey Formation (Tm)	250	28	556.6	841.234	1111.95	0	1111.95	696.13	696.13
12	0.798741	663.186	-20.9135	Monterey Formation (Tm)	250	28	535.002	808.592	1050.56	0	1050.56	846.117	846.117
13	0.798741	1377.49	-20.9135	Monterey Formation (Tm)	250	28	902.903	1364.63	2096.31	0	2096.31	1751.28	1751.28
14	0.768383	2054.02	32.4942	Monterey Formation (Tm)	250	28	890.789	1346.32	2061.88	0	2061.88	2629.25	2629.25
15	0.768383	2434.58	32.4942	Monterey Formation (Tm)	250	28	1031.14	1558.45	2460.84	0	2460.84	3117.61	3117.61
16	1.55281	4994.9	33.2394	Monterey Formation (Tm)	250	28	1038.96	1570.27	2483.06	0	2483.06	3163.96	3163.96
17	0.301675	981.55	33.4419	Monterey Formation (Tm)	250	28	1047.78	1583.59	2508.11	0	2508.11	3200.09	3200.09
18	1.25147	4103.94	33.4419	Qal/Qoal	200	28	1028.53	1554.5	2547.45	0	2547.45	3226.72	3226.72
19	0.818792	2692.01	33.7336	Qal/Qoal	200	28	1028.63	1554.65	2547.73	0	2547.73	3234.61	3234.61
20	0.818792	2692.89	33.7336	Qal/Qoal	200	28	1028.93	1555.1	2548.58	0	2548.58	3235.66	3235.66
21	0.725274	2384.75	35.3022	Qal/Qoal	200	28	1016.31	1536.03	2512.71	0	2512.71	3232.35	3232.35
22	0.725274	2382.83	35.3022	Qal/Qoal	200	28	1015.58	1534.92	2510.63	0	2510.63	3229.75	3229.75
23	0.725556	2379.36	38.1222	Qal/Qoal	200	28	991.193	1498.07	2441.32	0	2441.32	3219.14	3219.14
24	0.725556	2372.47	38.1222	Qal/Qoal	200	28	1034.78	1563.95	2565.21	0	2565.21	3377.23	3377.23
25	0.727565	2356.31	42.2811	Qal/Qoal	200	28	945.725	1429.35	2312.07	0	2312.07	3172.05	3172.05
26	0.727565	2316.06	42.2811	Qal/Qoal	200	28	931.255	1407.48	2270.94	0	2270.94	3117.75	3117.75
27	0.718742	2248.28	42.442	Qal/Qoal	200	28	915.475	1383.63	2226.09	0	2226.09	3063.27	3063.27
28	0.718742	2208.67	42.442	Qal/Qoal	200	28	901.077	1361.87	2185.16	0	2185.16	3009.17	3009.17
29	1.23364	3668.12	48.8159	Qal/Qoal	200	28	959.17	1449.67	2350.29	0	2350.29	3446.56	3446.56
30	0.624273	1777.52	49.0854	Qal/Qoal	200	28	788.978	1192.45	1866.52	0	1866.52	2776.87	2776.87
31	0.624273	1722.78	49.0854	Qal/Qoal	200	28	767.516	1160.01	1805.52	0	1805.52	2691.1	2691.1
32	1.25638	3281.01	53.7152	Qal/Qoal	200	28	921.707	1393.05	2243.8	0	2243.8	3499.25	3499.25
33	0.628095	1541.97	53.7152	Qal/Qoal	200	28	656.873	992.785	1491.01	0	1491.01	2385.74	2385.74
34	0.628095	1476.46	53.7152	Qal/Qoal	200	28	632.671	956.206	1422.21	0	1422.21	2283.97	2283.97
35	1.03466	2283.42	55.4357	Qal/Qoal	200	28	830.023	1254.48	1983.19	0	1983.19	3187.98	3187.98
36	1.00411	2034.74	55.4357	Qal/Qoal	200	28	545.245	824.073	1173.71	0	1173.71	1965.15	1965.15
37	0.954007	1767.82	55.4357	Qal/Qoal	200	28	741.956	1121.38	1732.86	0	1732.86	2809.82	2809.82
38	0.953783	1606.3	55.4357	Qal/Qoal	200	28	467.567	706.671	952.91	0	952.91	1631.59	1631.59
39	1.11384	1671.94	55.4357	Qal/Qoal	200	28	426.021	643.88	834.817	0	834.817	1453.19	1453.19
40	0.625565	842.675	55.4357	Qal/Qoal	200	28	391.07	591.056	735.47	0	735.47	1303.11	1303.11
41	0.625565	773.673	55.4357	Qal/Qoal	200	28	366.038	553.223	664.315	0	664.315	1195.63	1195.63
42	0.659055	741.43	55.4357	Qal/Qoal	200	28	340.673	514.886	592.215	0	592.215	1086.71	1086.71
43	0.659055	665.918	55.4357	Qal/Qoal	200	28	314.671	475.587	518.304	0	518.304	975.053	975.053
44	1.04904	904.204	55.4357	Qal/Qoal	200	28	280.975	424.66	422.523	0	422.523	830.363	830.363
45	0.855545	595.785	55.4357	Qal/Qoal	200	28	243.403	367.874	315.726	0	315.726	669.029	669.029
46	0.596081	339.884	55.4357	Qal/Qoal	200	28	214.767	324.594	234.326	0	234.326	546.063	546.063
47	0.596081	278.113	55.4357	Qal/Qoal	200	28	191.249	289.049	167.477	0	167.477	445.077	445.077
48	0.596426	216.449	55.4357	Qal/Qoal	200	28	167.724	253.494	100.608	0	100.608	344.062	344.062
49	0.596426	154.606	55.4357	Qal/Qoal	200	28	144.192	217.929	33.72	0	33.72	243.017	243.017
50	1.19284	123.683	55.4357	Qal/Qoal	200	28	108.895	164.582	-66.612	0	-66.612	91.451	91.451

Global Minimum Query (spencer) - Safety Factor: 1.40777

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.522077	17.0251	-46.4883	Qal/Qoal	200	28	227.524	320.302	226.255	0	226.255	-13.4079	-13.4079
2	0.522077	51.0752	-46.4883	Qal/Qoal	200	28	260.656	366.943	313.973	0	313.973	39.412	39.412
3	0.460602	73.3331	-46.4883	Qal/Qoal	200	28	291.836	410.838	396.527	0	396.527	89.1221	89.1221
4	0.460602	99.8366	-46.4883	Qal/Qoal	200	28	321.066	451.987	473.918	0	473.918	135.724	135.724
5	0.590241	166.679	-46.4883	Qal/Qoal	200	28	354.409	498.926	562.199	0	562.199	188.883	188.883
6	0.590241	210.201	-46.4883	Qal/Qoal	200	28	391.866	551.657	661.37	0	661.37	248.599	248.599
7	1.18048	550.967	-46.4883	Qal/Qoal	200	28	448.05	630.752	810.125	0	810.125	338.172	338.172
8	0.276746	154.356	-46.4883	Qal/Qoal	200	28	494.289	695.845	932.548	0	932.548	411.889	411.889
9	0.581505	355.707	-46.4883	Monterey Formation (Tm)	250	28	574.433	808.67	1050.7	0	1050.7	445.626	445.626
10	0.581505	421.727	-46.4883	Monterey Formation (Tm)	250	28	632.107	889.861	1203.41	0	1203.41	537.579	537.579
11	1.1826	1998.46	-3.07097	Monterey Formation (Tm)	250	28	798.938	1124.72	1645.11	0	1645.11	1602.25	1602.25
12	0.588422	1611.49	47.6965	Monterey Formation (Tm)	250	28	887.555	1249.47	1879.73	0	1879.73	2855.02	2855.02
13	0.588422	1820.87	47.6965	Monterey Formation (Tm)	250	28	987.569	1390.27	2144.54	0	2144.54	3229.73	3229.73
14	0.406872	1256.56	47.6965	Monterey Formation (Tm)	250	28	985.843	1387.84	2139.96	0	2139.96	3223.25	3223.25
15	0.651362	2006.67	47.6965	Qal/Qoal	200	28	960.136	1351.65	2165.95	0	2165.95	3220.99	3220.99
16	0.529098	1625.61	47.7279	Qal/Qoal	200	28	957.55	1348.01	2159.09	0	2159.09	3212.46	3212.46
17	0.529098	1621.65	47.7279	Qal/Qoal	200	28	955.44	1345.04	2153.51	0	2153.51	3204.56	3204.56
18	0.480405	1468.95	47.7779	Qal/Qoal	200	28	953.018	1341.63	2147.1	0	2147.1	3197.31	3197.31
19	0.480405	1462.88	47.7779	Qal/Qoal	200	28	949.466	1336.63	2137.7	0	2137.7	3184	3184
20	0.450882	1361.49	49.2248	Qal/Qoal	200	28	930.607	1310.08	2087.76	0	2087.76	3166.83	3166.83
21	0.450882	1349.46	49.2248	Qal/Qoal	200	28	923.205	1299.66	2068.15	0	2068.15	3138.63	3138.63
22	0.716466	2113.95	53.2265	Qal/Qoal	200	28	946.142	1331.95	2128.89	0	2128.89	3394.85	3394.85
23	0.460617	1337.07	53.2265	Qal/Qoal	200	28	864.701	1217.3	1913.27	0	1913.27	3070.25	3070.25
24	0.460617	1319.86	53.2265	Qal/Qoal	200	28	854.692	1203.21	1886.77	0	1886.77	3030.36	3030.36
25	0.921235	2588.08	53.2265	Qal/Qoal	200	28	839.686	1182.09	1847.04	0	1847.04	2970.55	2970.55
26	0.47155	1298.11	53.2265	Qal/Qoal	200	28	1151.85	1621.54	2673.52	0	2673.52	4214.71	4214.71
27	0.47155	1280.07	53.2265	Qal/Qoal	200	28	814.313	1146.37	1779.85	0	1779.85	2869.41	2869.41
28	0.475644	1272.65	53.2265	Qal/Qoal	200	28	803.876	1131.67	1752.22	0	1752.22	2827.82	2827.82
29	0.475644	1246.78	53.2265	Qal/Qoal	200	28	789.315	1111.17	1713.67	0	1713.67	2769.79	2769.79
30	0.453891	1162.59	53.2265	Qal/Qoal	200	28	773.287	1088.61	1671.23	0	1671.23	2705.9	2705.9
31	0.453891	1136.06	53.2265	Qal/Qoal	200	28	757.634	1066.57	1629.78	0	1629.78	2643.51	2643.51
32	0.8171	1974.05	55.2406	Qal/Qoal	200	28	1018.3	1433.53	2319.94	0	2319.94	3787.3	3787.3
33	0.8171	1877.23	56.2918	Qal/Qoal	200	28	679.378	956.408	1422.6	0	1422.6	2440.97	2440.97
34	0.817098	1772.54	56.2918	Qal/Qoal	200	28	646.131	909.604	1334.57	0	1334.57	2303.1	2303.1
35	0.817098	1651.51	56.2918	Qal/Qoal	200	28	880.669	1239.78	1955.54	0	1955.54	3275.64	3275.64
36	0.817783	1530.62	56.2918	Qal/Qoal	200	28	568.888	800.863	1130.06	0	1130.06	1982.8	1982.8
37	0.433132	761.127	56.2918	Qal/Qoal	200	28	539.197	759.066	1051.45	0	1051.45	1859.69	1859.69
38	0.433132	726.811	56.2918	Qal/Qoal	200	28	990.105	1393.84	2245.29	0	2245.29	3729.43	3729.43
39	0.680225	1072.18	56.2918	Qal/Qoal	200	28	492.213	692.922	927.053	0	927.053	1664.87	1664.87
40	0.680225	987.543	56.2918	Qal/Qoal	200	28	459.922	647.465	841.56	0	841.56	1530.97	1530.97
41	0.611167	815.102	56.2918	Qal/Qoal	200	28	429.272	604.316	760.408	0	760.408	1403.87	1403.87
42	0.611167	746.779	56.2918	Qal/Qoal	200	28	400.26	563.474	683.596	0	683.596	1283.57	1283.57
43	0.681826	750.237	57.6321	Qal/Qoal	200	28	362.487	510.298	583.586	0	583.586	1155.48	1155.48
44	0.687764	662.573	59.499	Qal/Qoal	200	28	319.109	449.232	468.738	0	468.738	1010.46	1010.46
45	0.701704	574.922	59.499	Qal/Qoal	200	28	283.097	398.535	373.39	0	373.39	853.974	853.974
46	0.705861	475.324	59.499	Qal/Qoal	200	28	246.616	347.178	276.801	0	276.801	695.455	695.455
47	0.637127	340.331	59.499	Qal/Qoal	200	28	211.808	298.177	184.643	0	184.643	544.207	544.207
48	0.684233	271.761	59.499	Qal/Qoal	200	28	177.56	249.964	93.9692	0	93.9692	395.395	395.395
49	0.794204	193.755	59.499	Qal/Qoal	200	28	139.257	196.041	-7.44486	0	-7.44486	228.957	228.957
50	0.794205	64.375	59.499	Qal/Qoal	200	28	98.5276	138.704	-115.281	0	-115.281	51.9794	51.9794

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.51138

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	445.985	454.196	0	0	0
2	447.613	452.954	706.916	0	0
3	448.351	452.402	1141.9	0	0
4	449.09	451.85	1651.71	0	0
5	449.704	451.391	2132.53	0	0
6	450.319	450.932	2665.06	0	0
7	450.933	450.473	3249.31	0	0
8	451.547	450.014	3885.27	0	0
9	452.578	449.244	5068.68	0	0
10	452.668	449.177	5178.97	0	0
11	453.255	448.739	5970.65	0	0
12	453.842	448.3	6810	0	0
13	454.64	447.995	7591.07	0	0
14	455.439	447.69	9007.94	0	0
15	456.207	448.179	8736.3	0	0
16	456.976	448.669	8385.61	0	0
17	458.529	449.686	7596.91	0	0
18	458.83	449.885	7437.77	0	0
19	460.082	450.712	6719.11	0	0
20	460.901	451.259	6233.55	0	0
21	461.719	451.805	5747.79	0	0
22	462.445	452.319	5251.52	0	0
23	463.17	452.833	4755.75	0	0
24	463.895	453.402	4140.6	0	0
25	464.621	453.971	3949.92	0	0
26	465.349	454.633	3161.62	0	0
27	466.076	455.294	2389.18	0	0
28	466.795	455.952	1634.97	0	0
29	467.514	456.609	896.518	0	0
30	468.747	458.019	1426.63	0	0
31	469.372	458.739	612.834	0	0
32	469.996	459.46	-171.459	0	0
33	471.252	461.171	1854.71	0	0
34	471.88	462.026	1023.63	0	0
35	472.508	462.882	235.029	0	0
36	473.543	464.384	2330.32	0	0
37	474.547	465.841	1209.53	0	0
38	475.501	467.226	3275.93	0	0
39	476.455	468.61	2437.17	0	0
40	477.569	470.227	1598.73	0	0
41	478.194	471.135	1194.49	0	0
42	478.82	472.043	837.991	0	0
43	479.479	473	513.365	0	0
44	480.138	473.957	240.982	0	0
45	481.187	475.479	-84.82	0	0
46	482.043	476.721	-252.536	0	0
47	482.639	477.586	-317.351	0	0
48	483.235	478.451	-339.431	0	0
49	483.831	479.317	-318.75	0	0
50	484.428	480.183	-255.284	0	0
51	485.62	481.914	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.40777

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	448.669	454.095	0	0	0
2	449.191	453.545	243.209	-24.0247	-5.6415
3	449.713	452.995	551.954	-54.5233	-5.64151
4	450.174	452.51	878.759	-86.8058	-5.6415
5	450.634	452.025	1256.57	-124.127	-5.64151
6	451.225	451.403	1815.3	-179.319	-5.64149
7	451.815	450.781	2457.78	-242.786	-5.64153
8	452.995	449.538	3994.06	-394.542	-5.6415
9	453.272	449.246	4402.7	-434.909	-5.64151
10	453.854	448.634	5380.32	-531.48	-5.6415
11	454.435	448.021	6485.01	-640.604	-5.6415
12	455.618	447.958	7534.21	-744.246	-5.6415
13	456.206	448.604	6841.05	-675.774	-5.6415
14	456.794	449.251	6035.52	-596.203	-5.64151
15	457.201	449.698	5479.87	-541.315	-5.64152
16	457.853	450.414	4554.99	-449.953	-5.64151
17	458.382	450.996	3804.95	-375.862	-5.64151
18	458.911	451.578	3057.04	-301.981	-5.6415
19	459.391	452.107	2378.2	-234.924	-5.6415
20	459.872	452.637	1702.62	-168.189	-5.64152
21	460.323	453.16	1030.71	-101.816	-5.64151
22	460.773	453.682	365.719	-36.1265	-5.6415
23	461.49	454.641	88.6457	-8.75663	-5.64151
24	461.951	455.257	-692.23	68.3801	-5.64151
25	462.411	455.874	-1461.39	144.359	-5.64149
26	463.332	457.106	-2964.54	292.844	-5.64151
27	463.804	457.737	-701.201	69.2663	-5.64151
28	464.275	458.368	-1440.2	142.266	-5.6415
29	464.751	459.005	-2172.99	214.653	-5.64151
30	465.227	459.641	-2888.17	285.3	-5.64151
31	465.681	460.248	-3552.14	350.889	-5.64151
32	466.135	460.856	-4198.05	414.693	-5.64151
33	466.952	462.033	-582.819	57.5722	-5.64151
34	467.769	463.258	-1770.11	174.856	-5.64152
35	468.586	464.483	-2876.75	284.172	-5.64151
36	469.403	465.707	528.387	-52.1953	-5.64151
37	470.221	466.933	-391.653	38.6884	-5.64151
38	470.654	467.583	-840.768	83.053	-5.64151
39	471.087	468.232	2781.85	-274.798	-5.64152
40	471.767	469.251	2171.41	-214.497	-5.64151
41	472.447	470.271	1626.17	-160.637	-5.64151
42	473.059	471.187	1191.9	-117.739	-5.64152
43	473.67	472.103	810.27	-80.0403	-5.6415
44	474.352	473.179	429.649	-42.4418	-5.64152
45	475.039	474.347	101.848	-10.0607	-5.64146
46	475.741	475.538	-144.289	14.2532	-5.64151
47	476.447	476.736	-301.895	29.8219	-5.64151
48	477.084	477.818	-366.654	36.219	-5.64152
49	477.768	478.979	-354.312	34.9998	-5.64151
50	478.563	480.327	-233.677	23.0831	-5.64149
51	479.357	481.676	0	0	0

Entity Information

External Boundary

X	Y
100	538
100	476.486
100	436.383
100	250
925	250
925	447
896.946	448.928
892.466	449.419
879.762	453.224
868.163	457.397
857.3	459.913
843.737	462.368
834.163	464.762
817.225	468.444
804.337	470.96
774.142	474.458
749.777	477.097
700.742	478.939
634.645	483.603
551.977	483.173
517.18	482.744
491.281	482.13
478.393	481.639
468.021	481.516
464.646	480.534
459.49	477.036
456.243	473.838
454.24	453.885
376.434	456.818
374.897	471.343
365.958	477.463
357.945	482.577
353.578	484.035
341.382	484.642
323.39	485.425
312.829	489.727
300.331	492.945
262.714	516.66
254.536	519.522
241.452	526.474
221.007	541.602
202.199	541.602
147.817	539.967

Material Boundary

X	Y
100	476.486
159.043	476.269
210.76	479.094
283.555	482.136
314.194	482.354
323.39	485.425

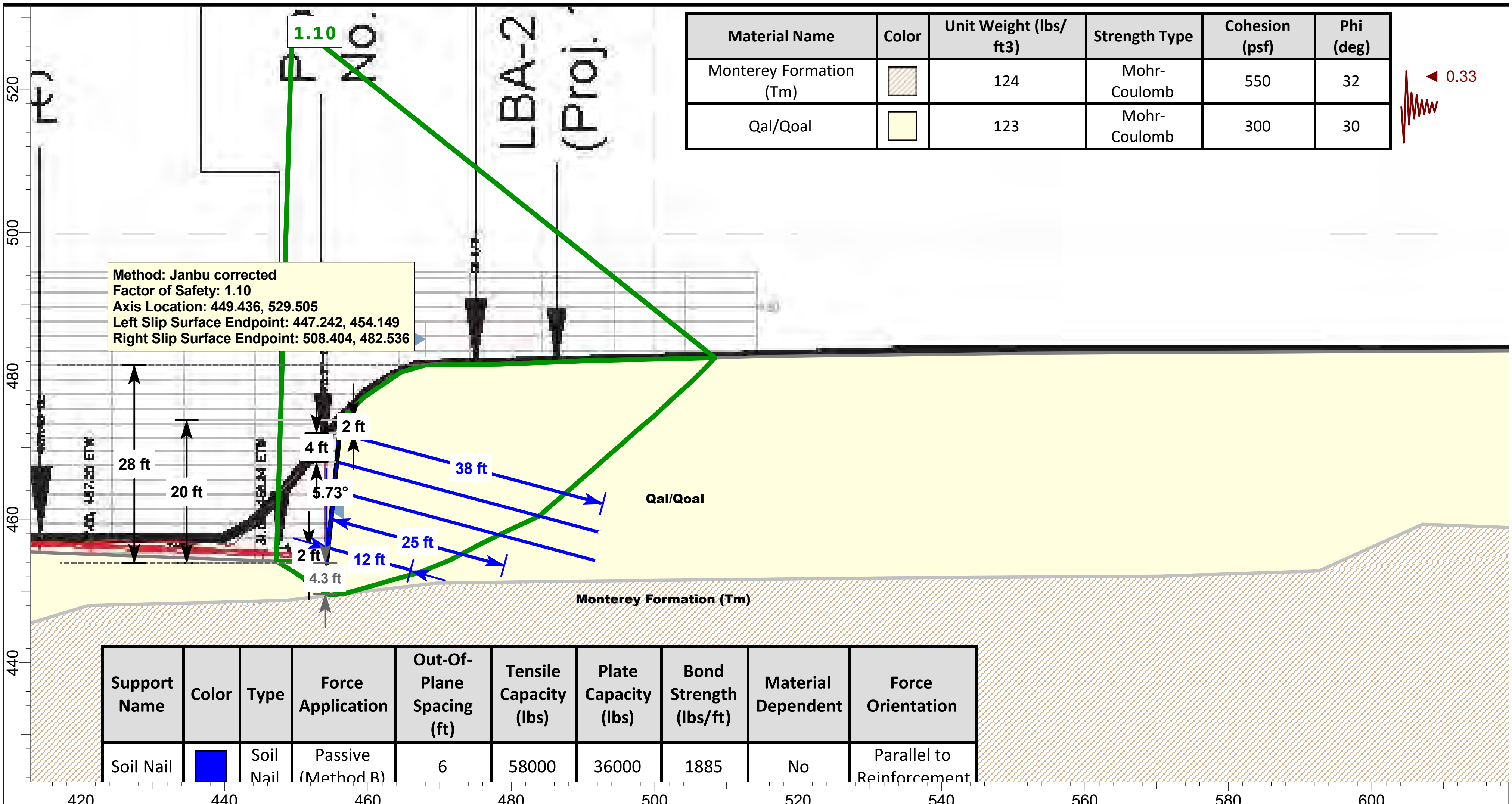
Material Boundary

X	Y
100	436.383
136.058	437.59
164.548	438.073
189.417	438.073
216.458	438.073
236.981	440.729
258.711	440.246
299.997	439.763
323.417	441.453
354.081	442.177
382.329	441.936
405.749	443.385
420.96	447.972
448.485	448.696
469.49	451.111
486.633	451.352
532.989	451.835
570.413	452.077
592.626	452.801
607.112	459.32
626.428	458.596
642.604	456.664
666.024	459.32
694.273	459.561
719.866	457.388
735.077	457.63
745.218	462.7
753.427	464.39
765.74	465.597
772.742	470.909
774.142	474.458

Section 66+50 - Retaining Wall 15 - Soil Nail System

Soil Nail Load Demand - Dia. 6 inches - Sv 4 feet Sh 6 feet

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Section 66+50_RW-15_Demand\Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1_k033 x.slim



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Monterey Formation (Tm)		124	Mohr-Coulomb	550	32
Qal/Qoal		123	Mohr-Coulomb	300	30

Support Name	Color	Type	Force Application	Out-Of-Plane Spacing (ft)	Tensile Capacity (lbs)	Plate Capacity (lbs)	Bond Strength (lbs/ft)	Material Dependent	Force Orientation
Soil Nail		Soil Nail	Passive (Method B)	6	58000	36000	1885	No	Parallel to Reinforcement

SLIDEINTERPRET 9.012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA**			
Analyzed By: JEH	Units: feet	Scale: 1:240	Project No.: **11585.005**
Date: May 12, 2021	Condition: **PseudoStatic**		File Name: Sec 66+50_10-1_SN_D6 B8 75k p36_Path_SrfAlt_a1_k033 x.slim

Slide Analysis Information

Proposed Widening of Brea Boulevard, Orange County Public Works, Orange County, CA

Project Summary

Slide Modeler Version:	9.012
Compute Time:	00h:00m:12.22s
Author:	JEH
Company:	Leighton Consulting, Inc.
Date Created:	May 12, 2021

General Settings

Units of Measurement:	Imperial Units
Time Units:	days
Permeability Units:	feet/second
Data Output:	Standard
Failure Direction:	Right to Left

Analysis Options

Slices Type:	Vertical
Analysis Methods Used	
	Janbu corrected
	Spencer
Number of slices:	50
Tolerance:	0.005
Maximum number of iterations:	75
Check malpha < 0.2:	Yes
Create Interslice boundaries at intersections with water tables and piezos:	Yes
Initial trial value of FS:	1
Steffensen Iteration:	Yes

Groundwater Analysis

Groundwater Method:	Water Surfaces
Pore Fluid Unit Weight [lbs/ft3]:	62.4
Use negative pore pressure cutoff:	Yes
Maximum negative pore pressure [psf]:	0
Advanced Groundwater Method:	None

Random Numbers

Pseudo-random Seed:	10116
Random Number Generation Method:	Park and Miller v.3

Surface Options

Surface Type:	Non-Circular Path Search
Number of Surfaces:	5000
Pseudo-Random Surfaces:	Enabled
Convex Surfaces Only:	Enabled
Segment Length:	Auto Defined
Minimum Elevation:	Not Defined
Minimum Depth:	Not Defined
Minimum Area:	Not Defined
Minimum Weight:	Not Defined
Upper Angle [deg]:	Auto Defined
Lower Angle [deg]:	Auto Defined

Seismic Loading

Advanced seismic analysis:	No
Staged pseudostatic analysis:	No
Seismic Load Coefficient (Horizontal):	0.33

Materials

Monterey Formation (Tm)	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	124
Cohesion [psf]	550
Friction Angle [deg]	32
Water Surface	None
Ru Value	0
Qal/Qoal	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	123
Cohesion [psf]	300
Friction Angle [deg]	30
Water Surface	None
Ru Value	0
Engineered Fill	
Color	
Strength Type	Mohr-Coulomb
Unit Weight [lbs/ft3]	120
Cohesion [psf]	200
Friction Angle [deg]	30
Water Surface	None
Ru Value	0

Support

Soil Nail	
Color	
Support Type	Soil Nail
Force Application	Passive
Force Orientation	Parallel to Reinforcement
Out-of-Plane Spacing [ft]	6
Tensile Capacity [lb]	58000
Plate Capacity [lb]	36000
Bond Strength [lb/ft]	1885
Material Dependent	No

Global Minimums

Method: janbu corrected

FS	1.099710
Axis Location:	449.436, 529.505
Left Slip Surface Endpoint:	447.242, 454.149
Right Slip Surface Endpoint:	508.404, 482.536
Resisting Horizontal Force:	90826.4 lb
Driving Horizontal Force:	82591.5 lb
Passive Horizontal Support Force:	10471.8 lb
Maximum Single Support Force:	4435.17 lb
Total Support Force:	10841.2 lb
Total Slice Area:	1030.85 ft2
Surface Horizontal Width:	61.1622 ft
Surface Average Height:	16.8544 ft

Method: spencer

FS	1.273870
Axis Location:	450.241, 559.482
Left Slip Surface Endpoint:	433.017, 454.685
Right Slip Surface Endpoint:	523.744, 482.825
Resisting Moment:	1.36283e+07 lb-ft
Driving Moment:	1.06984e+07 lb-ft
Resisting Horizontal Force:	119825 lb
Driving Horizontal Force:	94064.1 lb
Passive Support Moment:	517282 lb-ft
Passive Horizontal Support Force:	5504.83 lb
Maximum Single Support Force:	3138.79 lb
Total Support Force:	5699.02 lb
Total Slice Area:	1407.16 ft2
Surface Horizontal Width:	90.7274 ft
Surface Average Height:	15.5097 ft

Global Minimum Coordinates

Method: janbu corrected

X	Y
447.242	454.149
449.103	453.042
450.964	451.844
452.825	450.593
454.686	449.435
456.744	449.651
458.801	450.215
460.9	450.829
462.999	451.444
465.109	452.026
467.219	452.609
469.403	453.493
471.463	454.32
473.477	455.385
475.609	456.508
477.742	457.559
479.874	458.61
481.869	459.526
483.866	460.443
485.86	462.205
487.986	464.01
489.821	465.637
491.449	467.053
493.564	468.906
495.678	470.763
497.087	472.016
498.495	473.222
499.888	474.367
501.281	475.702
503.598	477.84
505.2	479.263
506.802	480.851
508.404	482.536

Method: spencer

X	Y
433.017	454.685
435.283	454.187
437.55	453.722
439.827	453.255
443.77	452.446
447.713	451.637
450.674	451.029
453.27	450.549
455.822	450.486
459.24	450.934
462.658	451.445
466.355	452.204
468.859	452.814
471.362	453.423
473.864	454.116
476.367	454.81
478.659	455.501
480.951	456.193
485.03	457.95
488.964	459.699
492.898	461.448
496.019	462.836
499.04	464.271
502.354	465.994
505.667	467.718
509.757	469.846
512.093	471.149
514.009	472.378
515.924	473.612
518.469	475.696
520.855	477.92
522.626	480.52
523.744	482.825

Global Minimum Support Data

Method: janbu corrected

Number of Supports: 5

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
454.455, 456.029	12	Not Effective	Not Effective	Not Effective	Not Effective	0
454.857, 460.029	25	18.8279	6.17213	18.8279	6.17213	1939.08
455.66, 468.029	38	29.2268	8.77321	29.2268	8.77321	2756.25
455.258, 464.029	38	23.8827	14.1173	23.8827	14.1173	4435.17
456.062, 472.029	38	32.5548	5.44524	32.5548	5.44524	1710.71

Method: spencer

Number of Supports: 5

Soil Nail

Support Type: Soil Nail

Start (x, y)	Length (ft)	L Inside SS (ft)	L Outside SS (ft)	Li (ft)	Lo (ft)	Force (lb)
454.455, 456.029	12	Not Effective	Not Effective	Not Effective	Not Effective	0
454.857, 460.029	25	21.2349	3.76507	21.2349	3.76507	1182.86
455.66, 468.029	38	33.6158	4.38421	33.6158	4.38421	1377.37
455.258, 464.029	38	28.0092	9.99085	28.0092	9.99085	3138.79
456.062, 472.029	38	Not Effective	Not Effective	Not Effective	Not Effective	0

Valid and Invalid Surfaces

Method: janbu corrected

Number of Valid Surfaces:	4932
Number of Invalid Surfaces:	86
Error Codes	
Error Code -108 reported for 2 surfaces	
Error Code -111 reported for 6 surfaces	
Error Code -121 reported for 67 surfaces	
Error Code -1000 reported for 11 surfaces	

Method: spencer

Number of Valid Surfaces:	1061
Number of Invalid Surfaces:	3957
Error Codes	
Error Code -108 reported for 37 surfaces	
Error Code -111 reported for 3848 surfaces	
Error Code -121 reported for 67 surfaces	
Error Code -1000 reported for 5 surfaces	

Error Code Descriptions

The following errors were encountered during the computation:

-108 = Total driving moment or total driving force < 0.1. This is to limit the calculaon of eaxtremely high safety factors if the driving force is very small (0.1 is an arbitrary number).

-111 = Safety factor equation did not converge

-121 = Concave failure surface, only convex surfaces have been defined as being allowed.

-1000 = No valid slip surface is generated

Slice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.09971

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	0.930418	29.6567	-30.7417	Qal/Qoal	300	30	432.556	475.686	304.297	0	304.297	47.0375	47.0375
2	0.930418	88.97	-30.7417	Qal/Qoal	300	30	482.556	530.672	399.536	0	399.536	112.539	112.539
3	0.93046	150.918	-32.7844	Qal/Qoal	300	30	557.619	613.219	542.51	0	542.51	183.365	183.365
4	0.93046	215.489	-32.7844	Qal/Qoal	300	30	614.375	675.634	650.617	0	650.617	254.917	254.917
5	0.930627	281.593	-33.8929	Qal/Qoal	300	30	688.975	757.673	792.712	0	792.712	329.865	329.865
6	0.930627	349.141	-33.8929	Qal/Qoal	300	30	749.797	824.559	908.559	0	908.559	404.852	404.852
7	0.930618	414.046	-31.892	Qal/Qoal	300	30	774.21	851.406	955.062	0	955.062	473.308	473.308
8	0.930618	598.836	-31.892	Qal/Qoal	300	30	933.596	1026.68	1258.65	0	1258.65	677.721	677.721
9	1.02873	1767.06	6.00079	Qal/Qoal	300	30	1109.75	1220.4	1594.18	0	1594.18	1710.84	1710.84
10	1.02873	2911.59	6.00079	Qal/Qoal	300	30	1661.59	1827.27	2645.31	0	2645.31	2819.98	2819.98
11	1.02846	3168.28	15.3144	Qal/Qoal	300	30	1640.4	1803.96	2604.93	0	2604.93	3054.14	3054.14
12	1.02846	3260.8	15.3144	Qal/Qoal	300	30	1681.38	1849.03	2683	0	2683	3143.43	3143.43
13	1.04953	3419.24	16.3247	Qal/Qoal	300	30	1705.49	1875.54	2728.92	0	2728.92	3228.44	3228.44
14	1.04953	3480.43	16.3247	Qal/Qoal	300	30	1731.81	1904.49	2779.06	0	2779.06	3286.29	3286.29
15	1.04953	3532.66	16.3272	Qal/Qoal	300	30	1754.24	1929.16	2821.78	0	2821.78	3335.66	3335.66
16	1.04953	3584.89	16.3272	Qal/Qoal	300	30	1776.7	1953.86	2864.57	0	2864.57	3385.03	3385.03
17	1.05514	3657.88	15.421	Qal/Qoal	300	30	1814.57	1995.5	2936.69	0	2936.69	3437.22	3437.22
18	1.05514	3707.9	15.421	Qal/Qoal	300	30	1836.15	2019.23	2977.8	0	2977.8	3484.28	3484.28
19	2.11028	7438.65	15.4344	Qal/Qoal	300	30	1840.85	2024.4	2986.75	0	2986.75	3495	3495
20	2.18349	7634.73	22.0414	Qal/Qoal	300	30	1721.12	1892.73	2758.68	0	2758.68	3455.5	3455.5
21	2.06046	7004.48	21.8731	Qal/Qoal	300	30	1682.11	1849.83	2684.39	0	2684.39	3359.68	3359.68
22	1.00666	3340.2	27.8837	Qal/Qoal	300	30	1556.85	1712.08	2445.79	0	2445.79	3269.53	3269.53
23	1.00666	3275.73	27.8837	Qal/Qoal	300	30	1725.62	1897.68	2767.26	0	2767.26	3680.29	3680.29
24	1.06614	3399.15	27.7646	Qal/Qoal	300	30	1505.91	1656.06	2348.77	0	2348.77	3141.55	3141.55
25	1.06614	3327.2	27.7646	Qal/Qoal	300	30	1478.5	1625.92	2296.56	0	2296.56	3074.92	3074.92
26	1.06626	3257.96	26.2364	Qal/Qoal	300	30	1473.28	1620.18	2286.62	0	2286.62	3012.72	3012.72
27	1.06626	3190.7	26.2364	Qal/Qoal	300	30	1447.28	1591.59	2237.1	0	2237.1	2950.4	2950.4
28	2.13251	6183.16	26.2367	Qal/Qoal	300	30	1622.56	1784.35	2570.98	0	2570.98	3370.67	3370.67
29	0.997354	2806.22	24.6755	Qal/Qoal	300	30	1393.94	1532.93	2135.5	0	2135.5	2775.92	2775.92
30	0.997354	2754.67	24.6755	Qal/Qoal	300	30	1372.33	1509.16	2094.33	0	2094.33	2724.82	2724.82
31	0.998669	2706.7	24.6402	Qal/Qoal	300	30	1351.17	1485.89	2054.02	0	2054.02	2673.78	2673.78
32	0.998669	2655.1	24.6402	Qal/Qoal	300	30	1329.55	1462.12	2012.85	0	2012.85	2622.7	2622.7
33	0.997094	2573.45	41.4719	Qal/Qoal	300	30	1334	1467.01	2021.32	0	2021.32	3200.37	3200.37
34	0.997094	2470.02	41.4719	Qal/Qoal	300	30	1054.96	1160.15	1489.83	0	1489.83	2422.26	2422.26
35	2.12581	4930.49	40.329	Qal/Qoal	300	30	1084.1	1192.2	1545.34	0	1545.34	2465.67	2465.67
36	0.917387	1986.56	41.5722	Qal/Qoal	300	30	944.115	1038.25	1278.69	0	1278.69	2116.09	2116.09
37	0.917387	1898.69	41.5722	Qal/Qoal	300	30	910.435	1001.22	1214.54	0	1214.54	2022.08	2022.08
38	1.62817	3156.25	41.0017	Qal/Qoal	300	30	870.036	956.787	1137.59	0	1137.59	1893.95	1893.95
39	2.11452	3687.95	41.2349	Qal/Qoal	300	30	799.076	878.752	1002.43	0	1002.43	1702.82	1702.82
40	1.05728	1668.03	41.282	Qal/Qoal	300	30	739.92	813.697	889.749	0	889.749	1539.37	1539.37
41	1.05728	1550.58	41.282	Qal/Qoal	300	30	700.727	770.596	815.098	0	815.098	1430.31	1430.31
42	1.40845	1881.67	41.6701	Qal/Qoal	300	30	651.716	716.699	721.744	0	721.744	1301.79	1301.79
43	1.40853	1674.54	40.5605	Qal/Qoal	300	30	607.756	668.355	638.01	0	638.01	1158.19	1158.19
44	1.39311	1460.47	39.4249	Qal/Qoal	300	30	564.964	621.297	556.504	0	556.504	1020.98	1020.98
45	1.39319	1253.72	43.7732	Qal/Qoal	300	30	486.251	534.735	406.573	0	406.573	872.435	872.435
46	1.15839	875.466	42.7116	Qal/Qoal	300	30	442.483	486.603	323.206	0	323.206	731.683	731.683
47	1.15839	727.013	42.7116	Qal/Qoal	300	30	398.02	437.707	238.516	0	238.516	605.948	605.948
48	1.60207	766.35	41.6124	Qal/Qoal	300	30	350.737	385.709	148.453	0	148.453	459.987	459.987
49	1.60207	477.212	44.7391	Qal/Qoal	300	30	276.73	304.323	7.48777	0	7.48777	281.709	281.709
50	1.60207	162.269	46.4438	Qal/Qoal	300	30	205.702	226.213	-127.804	0	-127.804	88.5353	88.5353

Global Minimum Query (spencer) - Safety Factor: 1.27387

Slice Number	Width [ft]	Weight [lbs]	Angle of Slice Base [deg]	Base Material	Base Cohesion [psf]	Base Friction Angle [deg]	Shear Stress [psf]	Shear Strength [psf]	Base Normal Stress [psf]	Pore Pressure [psf]	Effective Normal Stress [psf]	Base Vertical Stress [psf]	Effective Vertical Stress [psf]
1	2.26608	57.4942	-12.3937	Qal/Qoal	300	30	599.447	763.618	803.012	0	803.012	671.284	671.284
2	2.26728	168.001	-11.5956	Qal/Qoal	300	30	620.811	790.832	850.147	0	850.147	722.762	722.762
3	2.27658	275.248	-11.5956	Qal/Qoal	300	30	664.228	846.14	945.943	0	945.943	809.65	809.65
4	1.97158	324.648	-11.5956	Qal/Qoal	300	30	704.819	897.848	1035.5	0	1035.5	890.88	890.88
5	1.97158	404.73	-11.5956	Qal/Qoal	300	30	742.496	945.844	1118.64	0	1118.64	966.283	966.283
6	1.97157	484.81	-11.5956	Qal/Qoal	300	30	780.173	993.839	1201.76	0	1201.76	1041.68	1041.68
7	1.97157	564.891	-11.5956	Qal/Qoal	300	30	817.85	1041.84	1284.89	0	1284.89	1117.08	1117.08
8	1.48057	476.859	-11.5956	Qal/Qoal	300	30	850.836	1083.85	1357.67	0	1357.67	1183.09	1183.09
9	1.48057	522.02	-11.5956	Qal/Qoal	300	30	879.13	1119.9	1420.11	0	1420.11	1239.72	1239.72
10	1.29786	492.623	-10.4646	Qal/Qoal	300	30	851.647	1084.89	1359.47	0	1359.47	1202.17	1202.17
11	1.29786	523.08	-10.4646	Qal/Qoal	300	30	871.893	1110.68	1404.13	0	1404.13	1243.09	1243.09
12	1.27597	585.456	-1.42702	Qal/Qoal	300	30	649.405	827.258	913.238	0	913.238	897.061	897.061
13	1.27597	2006.31	-1.42702	Qal/Qoal	300	30	1271.12	1619.24	2284.98	0	2284.98	2253.31	2253.31
14	1.70935	4877.89	7.46025	Qal/Qoal	300	30	1517.04	1932.51	2827.59	0	2827.59	3026.24	3026.24
15	1.70935	5282.89	7.46025	Qal/Qoal	300	30	1615.46	2057.88	3044.73	0	3044.73	3256.27	3256.27
16	1.70875	5544.34	8.50402	Qal/Qoal	300	30	1634.25	2081.82	3086.2	0	3086.2	3330.56	3330.56
17	1.70875	5735.47	8.50402	Qal/Qoal	300	30	1679.33	2139.25	3185.67	0	3185.67	3436.77	3436.77
18	1.84874	6407.54	11.6076	Qal/Qoal	300	30	1594.95	2031.76	2999.5	0	2999.5	3327.12	3327.12
19	1.84874	6536.76	11.6076	Qal/Qoal	300	30	1620.82	2064.71	3056.57	0	3056.57	3389.5	3389.5
20	2.50328	8882.3	13.6843	Qal/Qoal	300	30	1547.71	1971.58	2895.26	0	2895.26	3272.1	3272.1
21	2.50328	8751.38	13.6843	Qal/Qoal	300	30	1529.38	1948.23	2854.81	0	2854.81	3227.19	3227.19
22	2.50227	8556.48	15.4856	Qal/Qoal	300	30	1442.55	1837.62	2663.24	0	2663.24	3062.9	3062.9
23	2.50227	8352.24	15.4856	Qal/Qoal	300	30	1599.64	2037.73	3009.84	0	3009.84	3453.02	3453.02
24	2.29199	7463.29	16.7893	Qal/Qoal	300	30	1348.8	1718.2	2456.4	0	2456.4	2863.35	2863.35
25	2.29199	7286.33	16.7893	Qal/Qoal	300	30	1323.76	1686.3	2401.14	0	2401.14	2800.54	2800.54
26	2.03992	6308.69	23.3068	Qal/Qoal	300	30	1632.1	2079.08	3081.45	0	3081.45	3784.57	3784.57
27	2.03992	6107.68	23.3068	Qal/Qoal	300	30	1105.95	1408.84	1920.57	0	1920.57	2397.02	2397.02
28	1.96691	5695.47	23.9705	Qal/Qoal	300	30	1064.71	1356.3	1829.57	0	1829.57	2302.95	2302.95
29	1.96691	5502.02	23.9705	Qal/Qoal	300	30	1261.33	1606.77	2263.38	0	2263.38	2824.19	2824.19
30	1.96691	5308.58	23.9705	Qal/Qoal	300	30	1010.79	1287.62	1710.6	0	1710.6	2160.01	2160.01
31	1.96691	5112.83	23.9705	Qal/Qoal	300	30	983.509	1252.86	1650.41	0	1650.41	2087.69	2087.69
32	1.56061	3914.25	23.9705	Qal/Qoal	300	30	958.495	1221	1595.22	0	1595.22	2021.37	2021.37
33	1.56061	3788.16	23.9705	Qal/Qoal	300	30	936.348	1192.79	1546.35	0	1546.35	1962.66	1962.66
34	1.5105	3542.21	25.4032	Qal/Qoal	300	30	889.597	1133.23	1443.2	0	1443.2	1865.67	1865.67
35	1.5105	3415.58	25.4032	Qal/Qoal	300	30	867.349	1104.89	1394.11	0	1394.11	1806.02	1806.02
36	1.65679	3593.13	27.4809	Qal/Qoal	300	30	811.533	1033.79	1270.96	0	1270.96	1693.07	1693.07
37	1.65679	3425.52	27.4809	Qal/Qoal	300	30	785.9	1001.13	1214.4	0	1214.4	1623.18	1623.18
38	1.65679	3257.88	27.4865	Qal/Qoal	300	30	760.191	968.384	1157.68	0	1157.68	1553.18	1553.18
39	1.65679	3090.23	27.4865	Qal/Qoal	300	30	734.555	935.728	1101.11	0	1101.11	1483.28	1483.28
40	1.36314	2416.8	27.4865	Qal/Qoal	300	30	711.192	905.966	1049.57	0	1049.57	1419.58	1419.58
41	1.36314	2303.31	27.4865	Qal/Qoal	300	30	690.1	879.098	1003.03	0	1003.03	1362.06	1362.06
42	1.36314	2189.82	27.4865	Qal/Qoal	300	30	669.009	852.23	956.49	0	956.49	1304.55	1304.55
43	2.33648	3476.84	29.1575	Qal/Qoal	300	30	621.355	791.525	851.346	0	851.346	1198.01	1198.01
44	1.91547	2563.93	32.6761	Qal/Qoal	300	30	552.64	703.992	699.733	0	699.733	1054.2	1054.2
45	1.9154	2284.43	32.7968	Qal/Qoal	300	30	518.711	660.77	624.874	0	624.874	959.12	959.12
46	1.27237	1345.3	39.3176	Qal/Qoal	300	30	443.084	564.431	458.008	0	458.008	820.895	820.895
47	1.27237	1185.77	39.3176	Qal/Qoal	300	30	418.638	533.291	404.072	0	404.072	746.938	746.938
48	2.3861	1751.15	42.9758	Qal/Qoal	300	30	361.875	460.982	278.829	0	278.829	615.997	615.997
49	1.77126	780.037	55.7418	Qal/Qoal	300	30	266.172	339.069	67.6696	0	67.6696	458.476	458.476
50	1.11787	157.502	64.1252	Qal/Qoal	300	30	209.854	267.327	-56.5909	0	-56.5909	376.071	376.071

Interslice Data

Global Minimum Query (janbu corrected) - Safety Factor: 1.09971

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	447.242	454.149	0	0	0
2	448.173	453.595	584.777	0	0
3	449.103	453.042	1251.95	0	0
4	450.033	452.443	2076.68	0	0
5	450.964	451.844	3000.82	0	0
6	451.895	451.218	4082.46	0	0
7	452.825	450.593	5274.17	0	0
8	453.756	450.014	6453.55	0	0
9	454.686	449.435	7904.83	0	0
10	455.715	449.543	8358.23	0	0
11	456.744	449.651	8921.43	0	0
12	457.772	449.933	8928.77	0	0
13	458.801	450.215	8928.24	0	0
14	459.85	450.522	8856.49	0	0
15	460.9	450.829	8778.4	0	0
16	461.949	451.137	8694.72	0	0
17	462.999	451.444	8605.62	0	0
18	464.054	451.735	8571.27	0	0
19	465.109	452.026	8532.56	0	0
20	467.219	452.609	8451.32	0	0
21	469.403	453.493	7472.65	0	0
22	471.463	454.32	6610.91	0	0
23	472.47	454.853	5865.53	0	0
24	473.477	455.385	6953.67	0	0
25	474.543	455.947	6213.8	0	0
26	475.609	456.508	5496.02	0	0
27	476.675	457.033	4882.74	0	0
28	477.742	457.559	4288.34	0	0
29	479.874	458.61	7335.05	0	0
30	480.871	459.068	6902.67	0	0
31	481.869	459.526	6483.35	0	0
32	482.867	459.984	6078.14	0	0
33	483.866	460.443	5685.96	0	0
34	484.863	461.324	7027.52	0	0
35	485.86	462.205	6013.34	0	0
36	487.986	464.01	5629.06	0	0
37	488.903	464.823	4850.19	0	0
38	489.821	465.637	4119.81	0	0
39	491.449	467.053	2968.13	0	0
40	493.564	468.906	1682.46	0	0
41	494.621	469.834	1134.51	0	0
42	495.678	470.763	650.73	0	0
43	497.087	472.016	97.0379	0	0
44	498.495	473.222	-318.228	0	0
45	499.888	474.367	-604.114	0	0
46	501.281	475.702	-843.156	0	0
47	502.44	476.771	-934.905	0	0
48	503.598	477.84	-941.642	0	0
49	505.2	479.263	-810.76	0	0
50	506.802	480.851	-510.654	0	0
51	508.404	482.536	0	0	0

Global Minimum Query (spencer) - Safety Factor: 1.27387

Slice Number	X coordinate [ft]	Y coordinate - Bottom [ft]	Interslice Normal Force [lbs]	Interslice Shear Force [lbs]	Interslice Force Angle [deg]
1	433.017	454.685	0	0	0
2	435.283	454.187	1739.31	1463.7	40.082
3	437.55	453.722	3486.95	2934.41	40.082
4	439.827	453.255	5350.18	4502.39	40.0819
5	441.798	452.85	7051.58	5934.19	40.082
6	443.77	452.446	8834.46	7434.56	40.082
7	445.741	452.041	10698.8	9003.5	40.0821
8	447.713	451.637	12644.7	10641	40.0819
9	449.194	451.333	14159.5	11915.8	40.082
10	450.674	451.029	15720.3	13229.3	40.082
11	451.972	450.789	16988.9	14296.9	40.0821
12	453.27	450.549	18284.5	15387.2	40.0821
13	454.546	450.518	18949	15946.3	40.0819
14	455.822	450.486	19981.5	16815.2	40.0819
15	457.531	450.71	20332	17110.2	40.082
16	459.24	450.934	20668.5	17393.4	40.082
17	460.949	451.189	20843	17540.2	40.0819
18	462.658	451.445	21005.9	17677.3	40.0819
19	464.507	451.824	20701.1	17420.8	40.0819
20	466.355	452.204	20379.7	17150.4	40.0821
21	468.859	452.814	19558.2	16459.1	40.0821
22	471.362	453.423	18758.8	15786.3	40.082
23	473.864	454.116	17698.5	14894	40.082
24	476.367	454.81	17755.3	14941.8	40.082
25	478.659	455.501	16685.2	14041.3	40.082
26	480.951	456.193	15654.4	13173.8	40.0819
27	482.99	457.071	16573.9	13947.6	40.082
28	485.03	457.95	15126.6	12729.6	40.0819
29	486.997	458.825	13741.3	11563.9	40.0821
30	488.964	459.699	13471.6	11336.9	40.082
31	490.931	460.574	12212	10276.9	40.082
32	492.898	461.448	11016	9270.4	40.0819
33	494.459	462.142	10113.3	8510.72	40.0819
34	496.019	462.836	9251.49	7785.51	40.082
35	497.53	463.553	8391.05	7061.41	40.082
36	499.04	464.271	7573.99	6373.82	40.082
37	500.697	465.133	6637.54	5585.76	40.082
38	502.354	465.994	5762.67	4849.53	40.082
39	504.011	466.856	4949.18	4164.93	40.0819
40	505.667	467.718	4197.29	3532.19	40.082
41	507.031	468.427	3624.86	3050.47	40.082
42	508.394	469.137	3094.14	2603.84	40.0819
43	509.757	469.846	2605.12	2192.32	40.082
44	512.093	471.149	1799.79	1514.6	40.082
45	514.009	472.378	1152.59	969.955	40.0821
46	515.924	473.612	621.039	522.63	40.082
47	517.197	474.654	263.584	221.817	40.082
48	518.469	475.696	-16.125	-13.5698	40.0819
49	520.855	477.92	-350.417	-294.89	40.082
50	522.626	480.52	-312.348	-262.854	40.082
51	523.744	482.825	0	0	0

Entity Information

External Boundary

X	Y
100	538
100	476.486
100	436.383
100	250
925	250
925	447
896.946	448.928
892.466	449.419
879.762	453.224
868.163	457.397
857.3	459.913
843.737	462.368
834.163	464.762
817.225	468.444
804.337	470.96
774.142	474.458
749.777	477.097
700.742	478.939
634.645	483.603
551.977	483.173
517.18	482.744
491.281	482.13
478.393	481.639
468.021	481.516
464.646	480.534
459.49	477.036
456.243	473.838
454.24	453.885
376.434	456.818
374.897	471.343
365.958	477.463
357.945	482.577
353.578	484.035
341.382	484.642
323.39	485.425
312.829	489.727
300.331	492.945
262.714	516.66
254.536	519.522
241.452	526.474
221.007	541.602
202.199	541.602
147.817	539.967

Material Boundary

X	Y
100	476.486
159.043	476.269
210.76	479.094
283.555	482.136
314.194	482.354
323.39	485.425

Material Boundary

X	Y
100	436.383
136.058	437.59
164.548	438.073
189.417	438.073
216.458	438.073
236.981	440.729
258.711	440.246
299.997	439.763
323.417	441.453
354.081	442.177
382.329	441.936
405.749	443.385
420.96	447.972
448.485	448.696
469.49	451.111
486.633	451.352
532.989	451.835
570.413	452.077
592.626	452.801
607.112	459.32
626.428	458.596
642.604	456.664
666.024	459.32
694.273	459.561
719.866	457.388
735.077	457.63
745.218	462.7
753.427	464.39
765.74	465.597
772.742	470.909
774.142	474.458

APPENDIX E

General Earthwork and Grading Guideline Specifications

APPENDIX E

LEIGHTON CONSULTING, INC.
EARTHWORK AND GRADING GUIDE SPECIFICATIONS

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E-1.0 GENERAL

E-1.1 Intent

These Earthwork and Grading Guide Specifications are for grading and earthwork shown on the current, approved grading plan(s) and/or indicated in the Leighton Consulting, Inc. geotechnical report(s). These Guide Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the project-specific recommendations in the geotechnical report shall supersede these Guide Specifications. Leighton Consulting, Inc. shall provide geotechnical observation and testing during earthwork and grading. Based on these observations and tests, Leighton Consulting, Inc. may provide new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

E-1.2 Role of Leighton Consulting, Inc.

Prior to commencement of earthwork and grading, Leighton Consulting, Inc. shall meet with the earthwork contractor to review the earthwork contractor's work plan, to schedule sufficient personnel to perform the appropriate level of observation, mapping and compaction testing. During earthwork and grading, Leighton Consulting, Inc. shall observe, map, and document subsurface exposures to verify geotechnical design assumptions. If observed conditions are found to be significantly different than the interpreted assumptions during the design phase, Leighton Consulting, Inc. shall inform the owner, recommend appropriate changes in design to accommodate these observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include (1) natural ground after clearing to receiving fill but before fill is placed, (2) bottoms of all "remedial removal" areas, (3) all key bottoms, and (4) benches made on sloping ground to receive fill.

Leighton Consulting, Inc. shall observe moisture-conditioning and processing of the subgrade and fill materials, and perform relative compaction testing of fill to determine the attained relative compaction. Leighton Consulting, Inc. shall provide *Daily Field Reports* to the owner and the Contractor on a routine and frequent basis.

E-1.3 The Earthwork Contractor

The earthwork contractor (Contractor) shall be qualified, experienced and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Guide

Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing grading and backfilling in accordance with the current, approved plans and specifications.

The Contractor shall inform the owner and Leighton Consulting, Inc. of changes in work schedules at least one working day in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that Leighton Consulting, Inc. is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish earthwork and grading in accordance with the applicable grading codes and agency ordinances, these Guide Specifications, and recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of Leighton Consulting, Inc., unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, adverse weather, etc., are resulting in a quality of work less than required in these specifications, Leighton Consulting, Inc. shall reject the work and may recommend to the owner that earthwork and grading be stopped until unsatisfactory condition(s) are rectified.

E-2.0 PREPARATION OF AREAS TO BE FILLED

E-2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies and Leighton Consulting, Inc.. Care should be taken not to encroach upon or otherwise damage native and/or historic trees designated by the Owner or appropriate agencies to remain. Pavements, flatwork or other construction should not extend under the “drip line” of designated trees to remain.

Leighton Consulting, Inc. shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 3 percent of organic materials (by dry weight: ASTM D 2974). Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area. As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

E-2.2 Processing

Existing ground that has been declared satisfactory for support of fill, by Leighton Consulting, Inc., shall be scarified to a minimum depth of 6 inches (15 cm). Existing ground that is not satisfactory shall be over-excavated as specified in the following Section E-2.3. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

E-2.3 Overexcavation

In addition to removals and over-excavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be over-excavated to competent ground as evaluated by Leighton Consulting, Inc. during grading. All undocumented fill soils under proposed structure footprints should be excavated

E-2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), (>20 percent grade) the ground shall be stepped or benched. The lowest bench or key shall be a minimum of 15 feet (4.5 m) wide and at least 2 feet (0.6 m) deep, into competent material as evaluated by Leighton Consulting, Inc.. Other benches shall be excavated a minimum height of 4 feet (1.2 m) into competent material or as otherwise recommended by Leighton Consulting, Inc.. Fill placed on ground sloping flatter than 5:1 (horizontal to vertical units), (<20 percent grade) shall also be benched or otherwise over-excavated to provide a flat subgrade for the fill.

E-2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by Leighton Consulting, Inc. as suitable to receive fill. The Contractor shall obtain a written acceptance (*Daily Field Report*) from Leighton Consulting, Inc. prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys and benches.

E-3.0 FILL MATERIAL

E-3.1 Fill Quality

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by Leighton Consulting, Inc. prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to Leighton Consulting, Inc. or mixed with other soils to achieve satisfactory fill material.

E-3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 6 inches (15 cm), shall not be buried or placed in fill unless location, materials and placement methods are specifically accepted by Leighton Consulting, Inc.. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 feet (3 m) measured vertically from finish grade, or within 2 feet (0.61 m) of future utilities or underground construction.

E-3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section E-3.1, and be free of hazardous materials ("contaminants") and rock larger than 3-inches (8 cm) in largest dimension. All import soils shall have an Expansion Index (EI) of 20 or less and a sulfate content no greater than (≤) 500 parts-per-million (ppm). A representative sample of a potential import source shall be given to Leighton Consulting, Inc. at least four full working days before importing begins, so that suitability of this import material can be determined and appropriate tests performed.

E-4.0 FILL PLACEMENT AND COMPACTION

E-4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill, as described in Section E-2.0, above, in near-horizontal layers not exceeding 8 inches (20 cm) in loose thickness. Leighton Consulting, Inc. may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers, and only if the building officials with the appropriate jurisdiction approve. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

E-4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM) Test Method D 1557.

E-4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, each layer shall be uniformly compacted to not-less-than (≥) 90 percent of the maximum dry density as determined by ASTM Test Method D 1557. In some cases, structural fill may be specified (see project-specific geotechnical report) to be uniformly compacted to at-least (≥) 95 percent of the ASTM D 1557 modified Proctor laboratory maximum dry density. For fills thicker than (>) 15 feet (4.5 m), the portion of fill deeper than 15 feet below proposed finish grade shall be compacted to 95 percent of the ASTM D 1557 laboratory maximum density. Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

E-4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by back rolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet (1 to 1.2 m) in fill elevation, or by other methods producing satisfactory results acceptable to Leighton Consulting, Inc.. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of the ASTM D 1557 laboratory maximum density.

E-4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by Leighton Consulting, Inc.. Location and frequency of tests shall be at our field representative(s) discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

E-4.6 Compaction Test Locations

Leighton Consulting, Inc. shall document the approximate elevation and horizontal coordinates of each density test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that Leighton

Consulting, Inc. can determine the test locations with sufficient accuracy. Adequate grade stakes shall be provided.

E-5.0 EXCAVATION

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by Leighton Consulting, Inc. during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by Leighton Consulting, Inc. based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, then observed and reviewed by Leighton Consulting, Inc. prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by Leighton Consulting, Inc..

E-6.0 TRENCH BACKFILLS

E-6.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations. Work should be performed in accordance with Article 6 of the *California Construction Safety Orders*, 2009 Edition or more current (see also: http://www.dir.ca.gov/title8/sb4a6.html).

E-6.2 Bedding and Backfill

All utility trench bedding and backfill shall be performed in accordance with applicable provisions of the 2018 Edition of the *Standard Specifications for Public Works Construction* (Green Book). Bedding material shall have a Sand Equivalent greater than 30 (SE>30). Bedding shall be placed to 1-foot (0.3 m) over the top of the conduit, and densified by jetting in areas of granular soils, if allowed by the permitting agency. Otherwise, the pipe-bedding zone should be backfilled with Controlled Low Strength Material (CLSM) consisting of at least one sack of Portland cement per cubic-yard of sand, and conforming to Section 201-6 of the 2018 Edition of the *Standard Specifications for Public Works Construction* (Green Book). Backfill over the bedding zone shall be placed and densified mechanically to a minimum of 90 percent of relative compaction (ASTM D 1557) from 1 foot (0.3 m) above the top of the conduit to the surface. Backfill above the pipe zone shall **not** be jetted. Jetting of the bedding around the conduits shall be observed by Leighton Consulting, Inc. and backfill above the pipe zone (bedding) shall be observed and tested by Leighton Consulting, Inc..

E-6.3 <u>Lift Thickness</u>

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to Leighton Consulting, Inc. that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method, and only if the building officials with the appropriate jurisdiction approve.

GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Plate-1

Leighton

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Plate-2

Leighton

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

LB-27
Qalo (0-40')
Tfu (40-51')
T.D. 51.0'
G.W.@31'
LB-4
Afu (0-11')
Qalo (11-20')
Tfu (20-70.5')
T.D. 70.5'
No G.W.
CWE P-4
Afu (0-6.5')
Qalo (6.5-30')
Tfu (30-51')
T.D. 51.0'
G.W.@38.5'
LB-30
Afu (0-1')
Qalo (1-25')
Tfu (25-51')
T.D. 51.0'
No G.W.
LB-15
Afu (0-1')
Qalo (1'-33')
Tfu (33' - 40'11")
T.D. 40' 11"
SEEPAGE @ 40' 10"
LB-5
AC (0-15")
Qalo (15"-5')
Tfu (5'-26.5')
T.D. 26.5'
No G.W.
LB-31
Afu (0-3')
Qalo (3-20')
Tfu (20-61')
T.D. 61.0'
No G.W.
LB-16
Afu (0-1')
Qalo (1'-5')
Tmy (5'-31.5')
T.D. 31.5'
No G.W.
LB-26
Afu (0-5')
Qalo (5-40')
T.D. 40.0'
No G.W.
C-4
T.D. 34'
G.W.@29'
SC-3
T.D. 65'
No G.W.
RW-8 (SOLDIER PILE)
RW-9 (SOIL NAIL)
RW-10 (SOLDIER PILE)
RW-11 (SOLDIER PILE)
RW-12A (SOIL NAIL)
RW-12B (SOIL NAIL)
RW-12C (SOIL NAIL)
BRIDGE 3 (55C-0123)
39+50
40+00
40+50
42+50
45+50
47+00
50+00
53+50
39+50'
40+50'
42+50'
45+50'
47+00'
50+00'
53+50'
FOUND 2" BRASS DISK STAMPED "U.O. CO. STEARNS NO. 5 ELEV. 462.93' L.S. 1696" PER (R6 & R12), FLUSH IN CONCRETE MONUMENT
APN 304-151-59
APN 300-012-35
2013000023005 O.R.
M.M. 898/19-35
MONUMENT NOTES
FOUND O.C.S. HORIZONTAL CONTROL STATION PER O.C.S. HORIZONTAL CONTROL DATA SHEET ON FILE IN THE ORANGE COUNTY SURVEYOR'S OFFICE, BOUNDARY-GEODETIC UNIT
FOUND MONUMENT AS NOTED
SEARCHED, FOUND NOTHING
REFERENCES
R1 - PARCEL MAP 87-241, P.M.B. 285/18-21
R2 - TRACT NO. 9111, M.M. 374/24-26
R3 - P.M.B. 68/18
R4 - 214/212 O.R. AND 216/177 O.R.
R5 - TRACT NO 9473, M.M. 391/26-28
R6 - TRACT NO. 16976, M.M. 898/19-35
R7 - RECORD OF SURVEY 2009-1153, R.S.B. 243/3-14
R8 - 10370/229 O.R.
SEE PLATE 1 FOR LEGEND
N
0 50 100
SCALE FEET
GEOTECHNICAL EXPLORATION PLAN
Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California
Plate-3
Proj: 11585.005
Eng/Geol: JEH/JLH
Scale: 1"=50'
Date: April 2021
Leighton
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GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

Plate-4

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GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Plate-5

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

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GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Plate-6

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

Leighton

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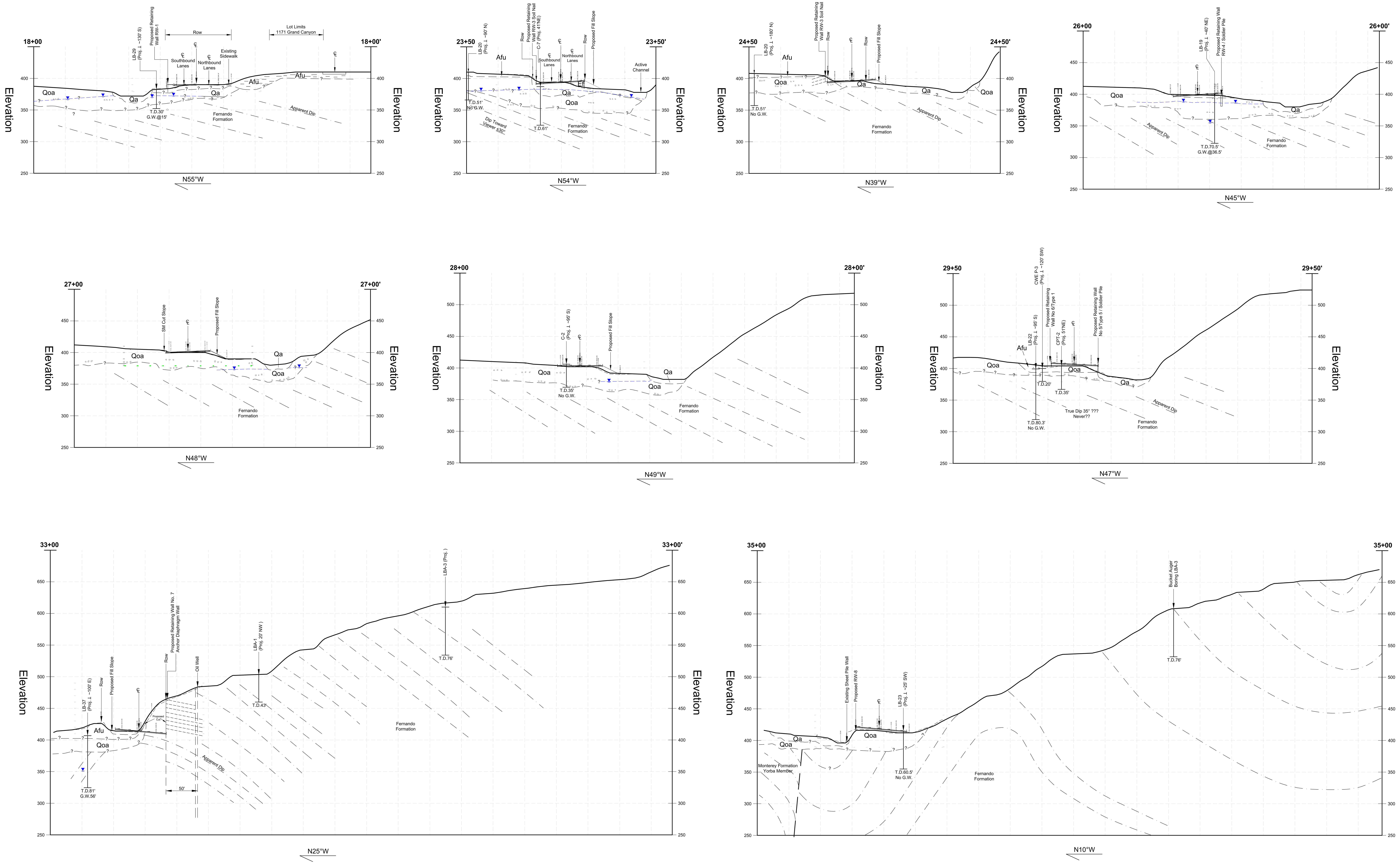
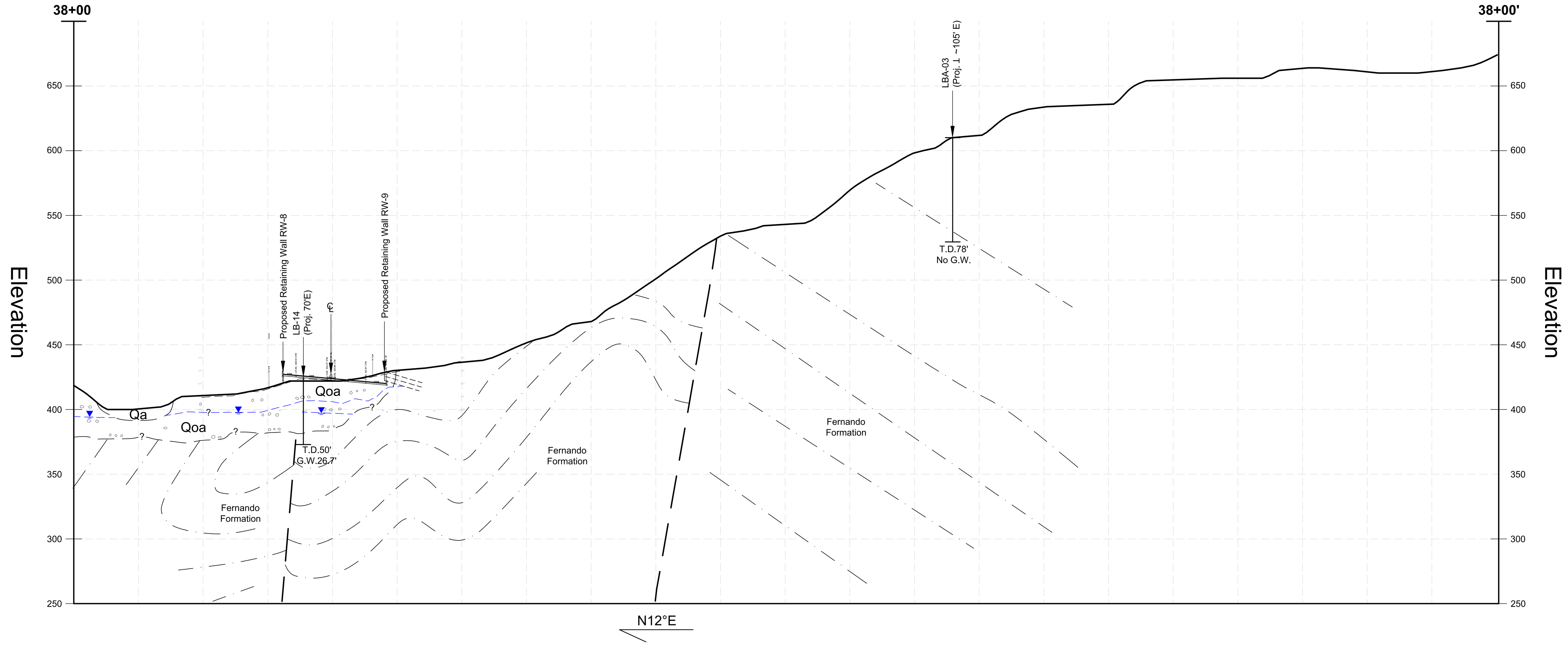
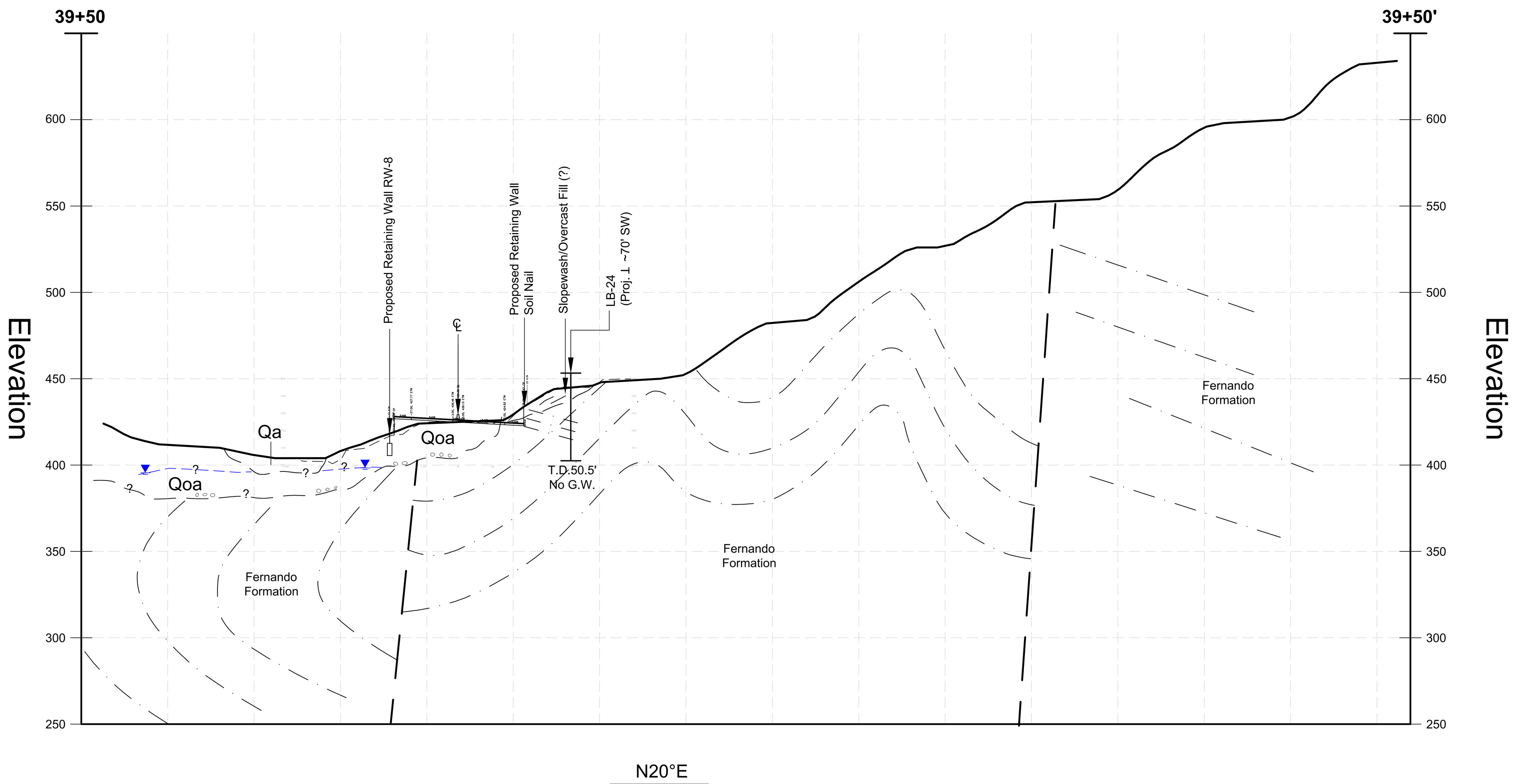
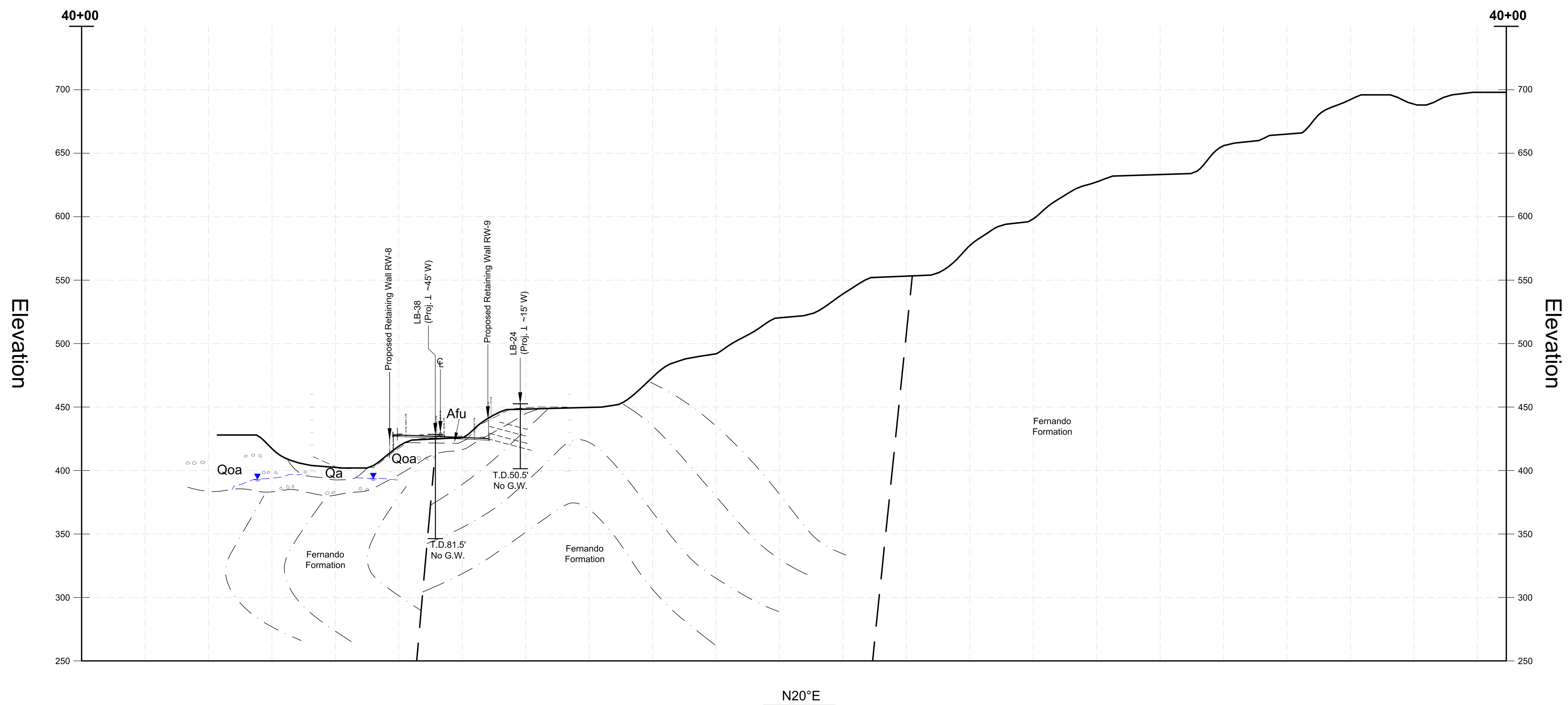


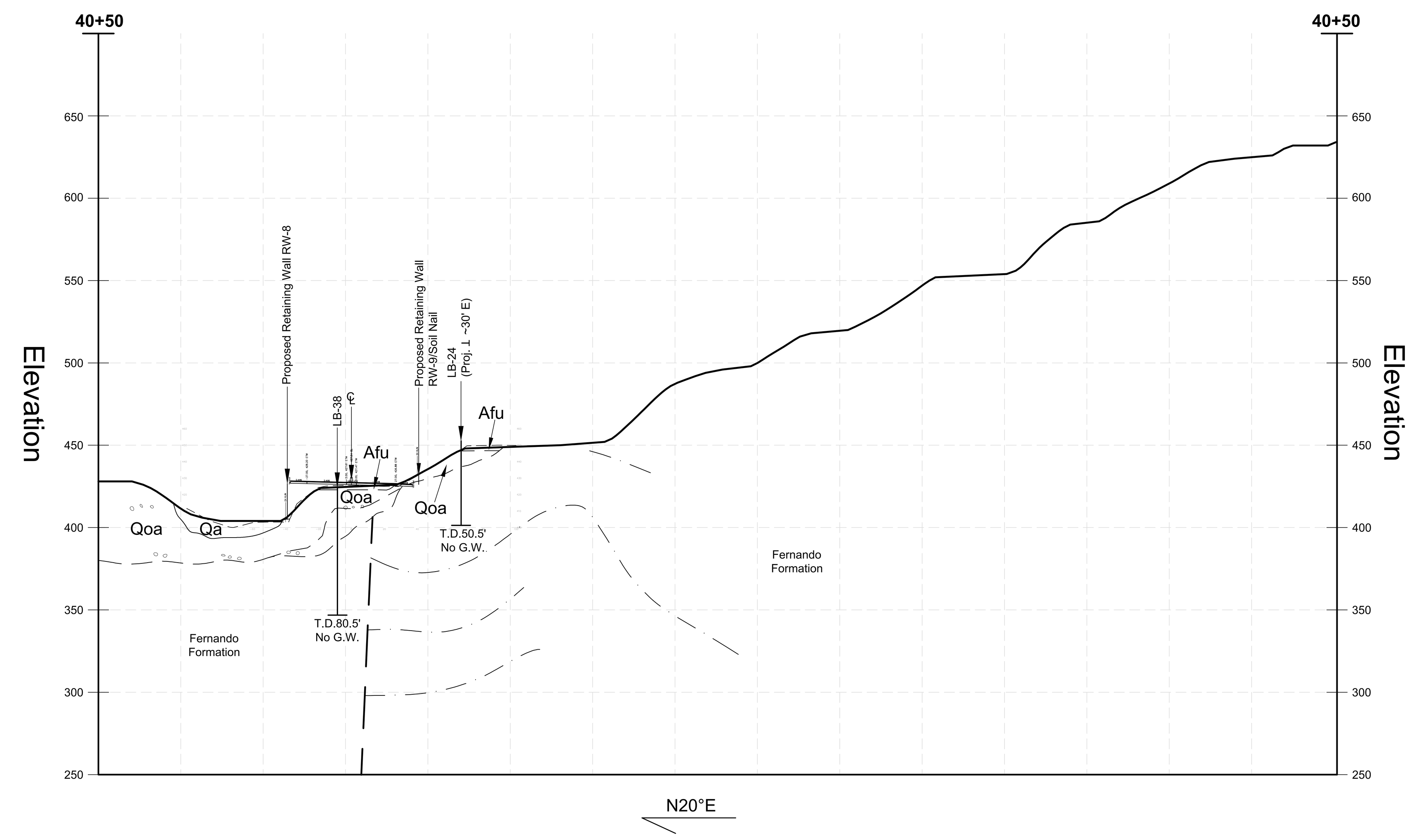
GEOLOGIC CROSS-SECTIONS Proposed Brea Boulevard Widening Canyon Country Road (Brea) to Orange County Line Sta. 8+00 to Sta. 101+00 Orange County, California	Plate 7
Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: December 2020

Leighton









GEOLOGIC CROSS-SECTIONS Proposed Brea Boulevard Widening Canyon Country Road (Brea) to Orange County Line Sta. 8+00 to Sta. 101+00 Orange County, California	Plate 8
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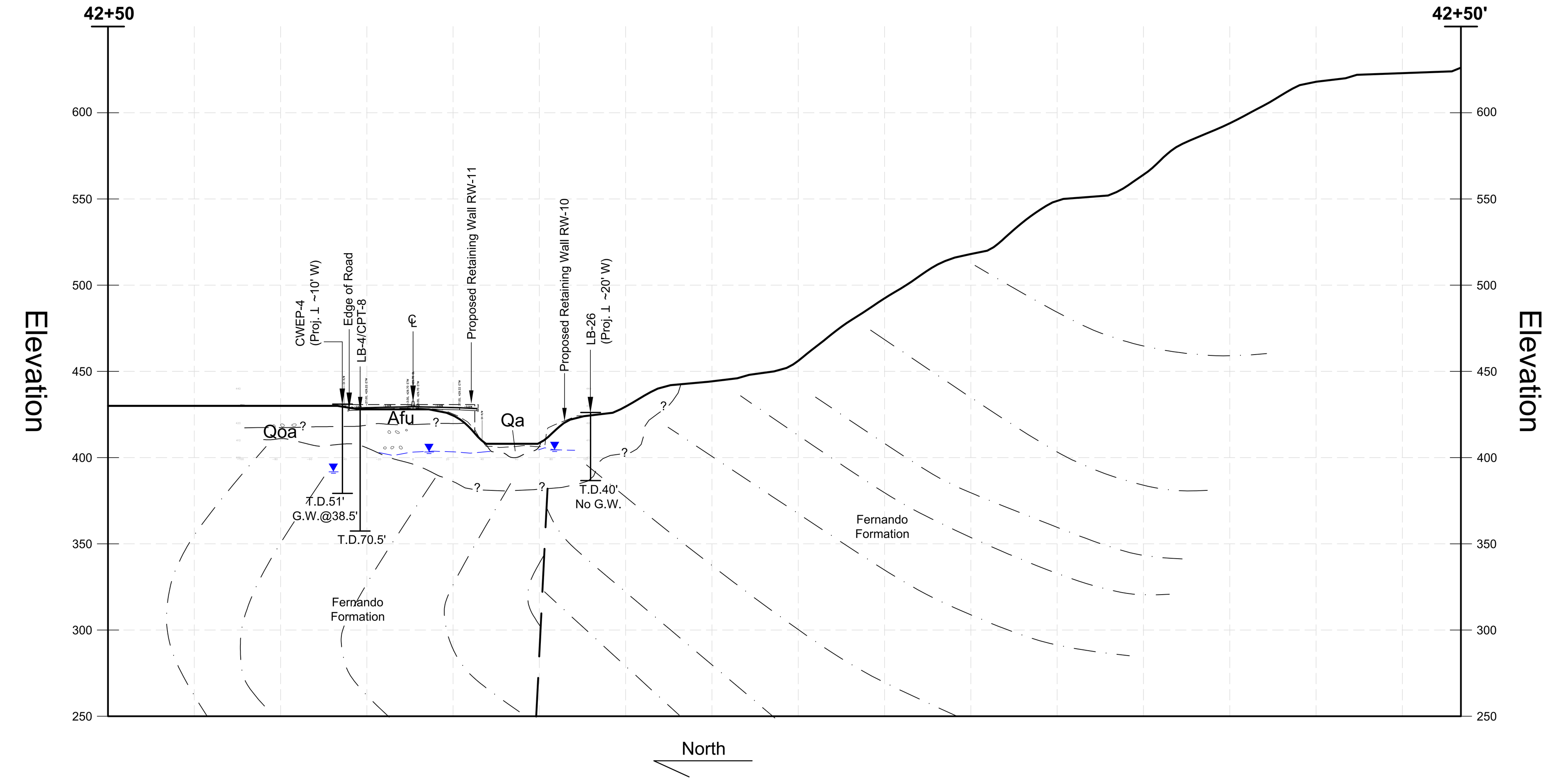

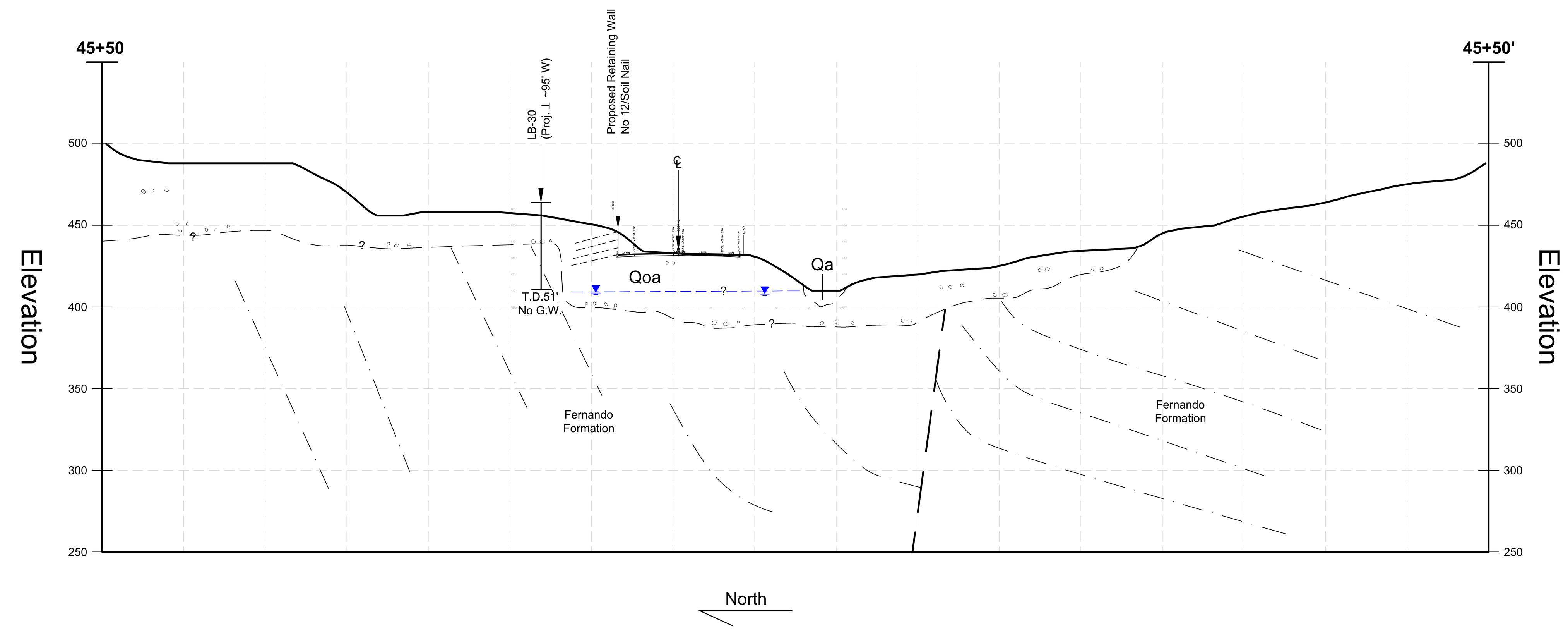

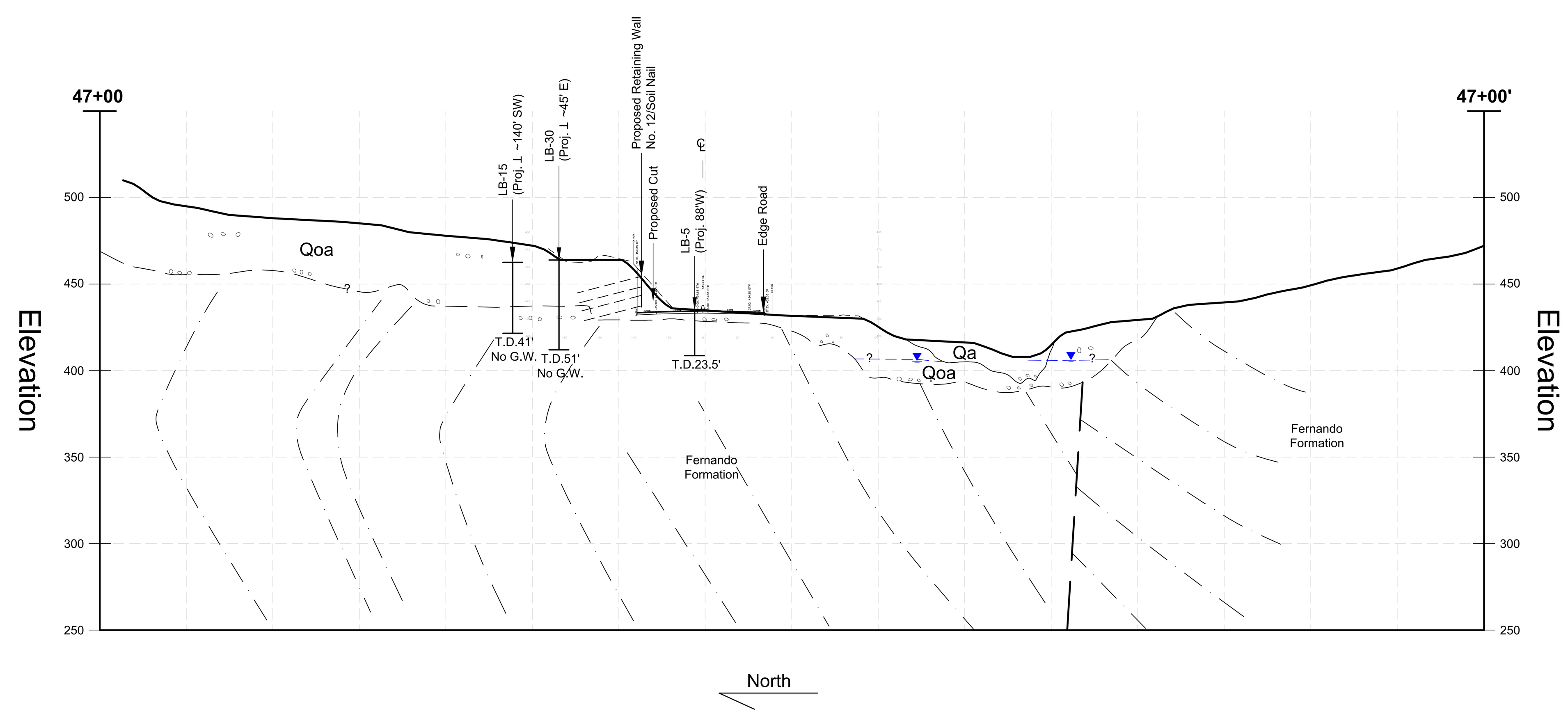

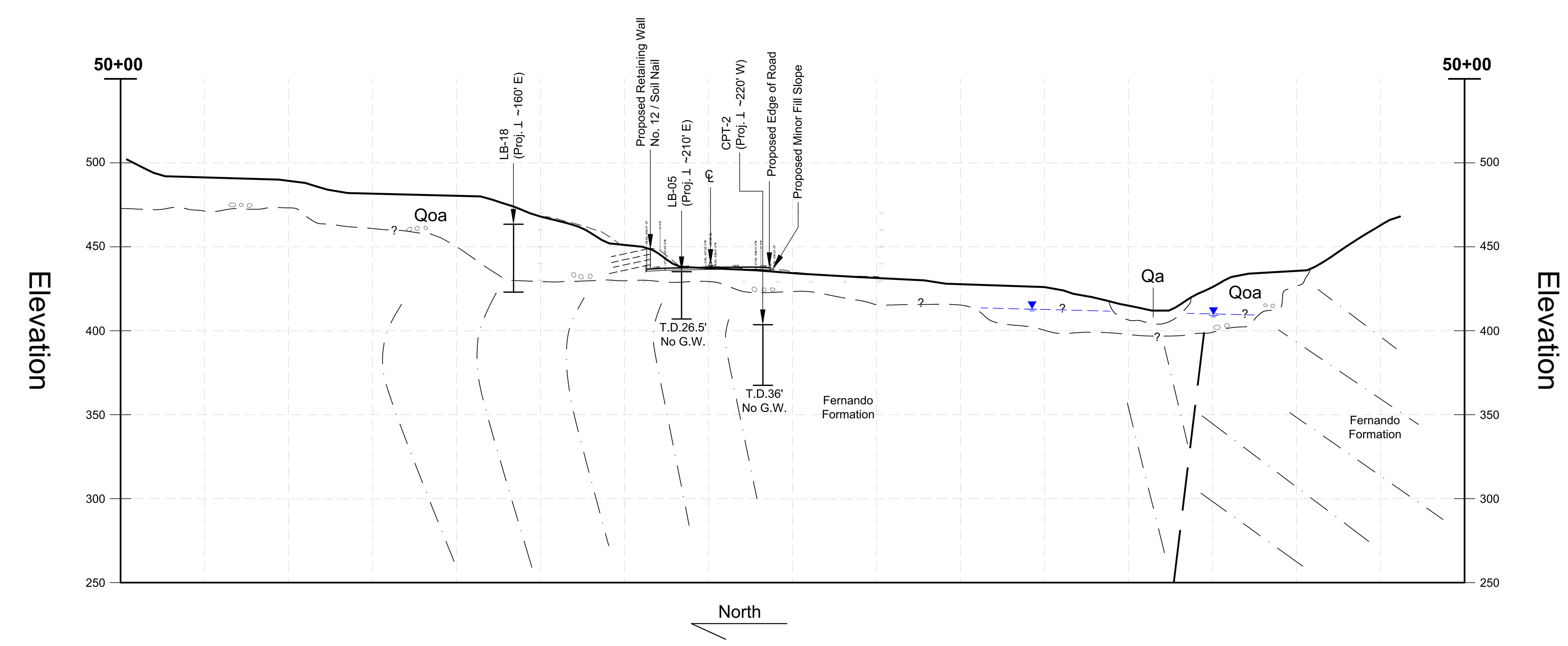

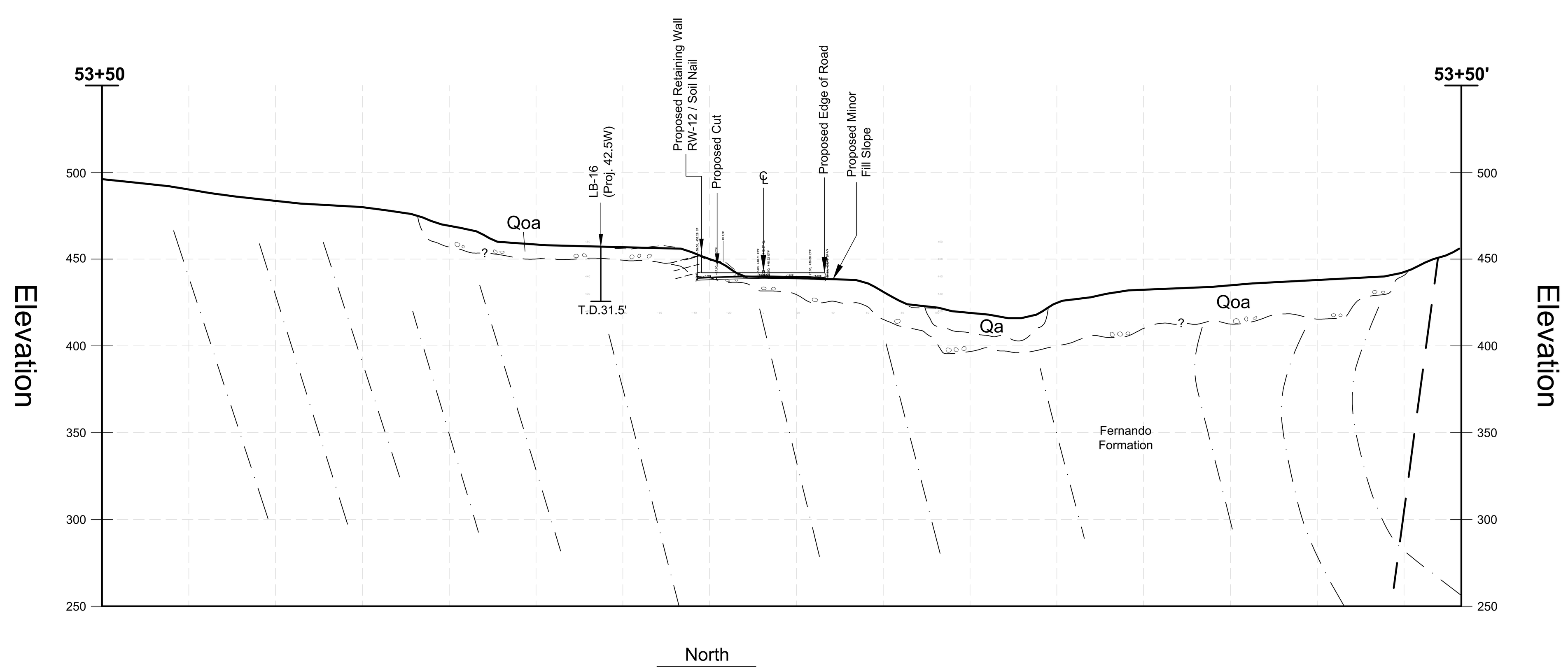

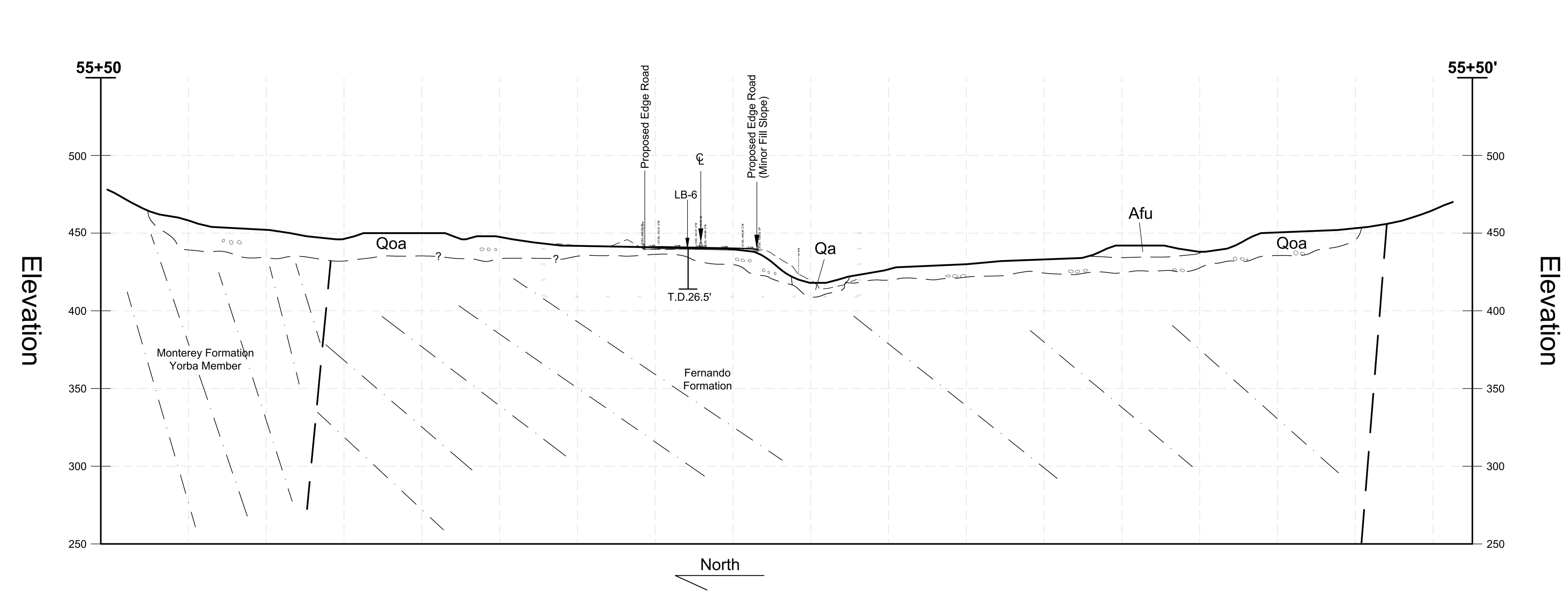

GEOLOGIC CROSS-SECTIONS Proposed Brea Boulevard Widening Canyon Country Road (Brea) to Orange County Line Sta. 8+00 to Sta. 101+00 Orange County, California	Plate 9
Proj: 11585.005 | Eng/Geol: JEH/JLH	Leighton
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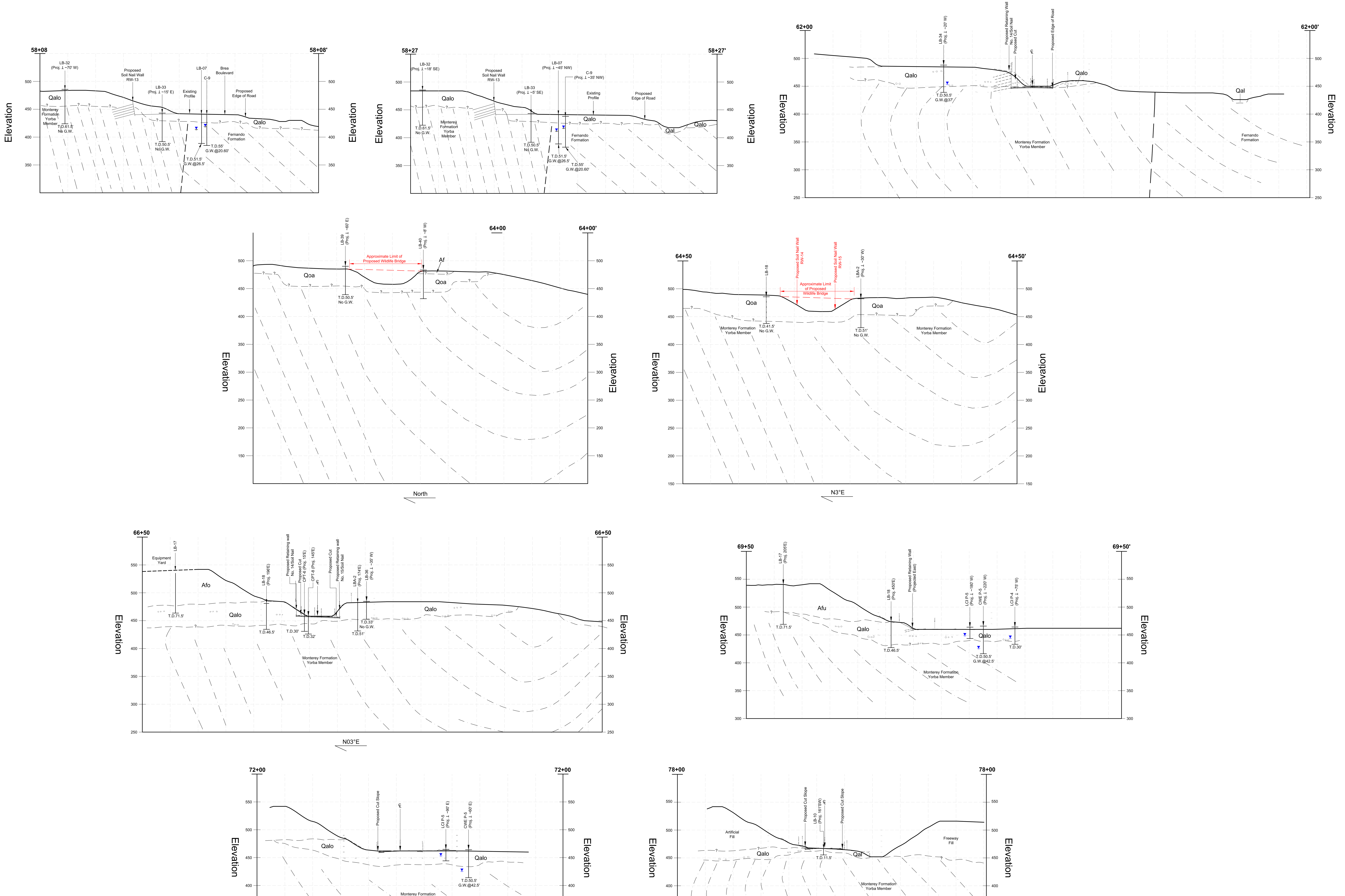

GEOLOGIC CROSS-SECTIONS Proposed Brea Boulevard Widening Canyon Country Road (Brea) to Orange County Line Sta. 8+00 to Sta. 101+00 Orange County, California		Plate 10
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FOUNDATION REPORT, PROPOSED BRIDGE STRUCTURES

FOUNDATION REPORT
PROPOSED BRIDGE STRUCTURES
BREA BOULEVARD CORRIDOR IMPROVEMENTS
COUNTY OF ORANGE, CALIFORNIA

Prepared for:

COUNTY OF ORANGE – OC PUBLIC WORKS

601 N. Ross Street
Santa Ana, California

Project No. 11585.005

January 28, 2022

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

January 28, 2022

Project No. 11585.005

County of Orange, OC Public Works
601 N. Ross Street
Santa Ana, California 92703-5000

Attention: Mr. Austin Morgan, P.E.

Subject: Foundation Report
Proposed Bridge Structures
Brea Boulevard Corridor Improvements
County of Orange, California

In accordance with your request and authorization, Leighton Consulting, Inc. performed a geotechnical exploration for the proposed "Brea Boulevard Corridor Improvements" project, which essentially consists of widening Brea Boulevard in the northern region of the County of Orange, north of the City of Brea.

The purpose of our study was to evaluate the subsurface soil and groundwater conditions at the site and to provide geotechnical recommendations for the design and construction of new bridge structures to replace the existing bridges; design of new earth retaining wall systems; and reconstruction and rehabilitation of roadway pavement.

This report presents the results of our exploration and recommendations for the proposed bridge structures to assist the project structural engineer in the design of the foundations and associated earth-retaining systems. Recommendations for the proposed earth retaining structures separate from the bridges and pavement associated with the roadway were presented in a separate report to assist the project structural engineer and civil engineer in design of that scope of the project.

The design concept currently planned for use consists of two types of structures. At Bridge 1 and Bridge 3, the abutments will consist of widely spaced drilled shaft foundations (i.e. Cast in Drilled Hole or CIDH pile foundations) with a continuous wall structure along the channel. At Bridge 2, the abutment walls will consist of a secant pile system in which the walls include both the CIDH piles that provide structural support and intermediate shorter length drilled shafts filling the open span between foundation shafts to create a continuous wall structure. At all bridges, the bridge deck will be supported by seat-type abutments that, in turn, are supported by the CIDH pile foundations. Sub-horizontal earth anchors (tieback anchors) are planned to be installed in the abutment walls to assist in developing sufficient lateral load resistance due to the height of the abutment walls that will result in the event the channel scour occurs to the forecasted depths.

We appreciate the opportunity to provide our services for this project. We trust that the information contained herein will be sufficient. If you have any questions or comments, please contact us at your convenience. The undersigned can be reached at the phone extensions and email addresses listed below.

Respectfully submitted,

LEIGHTON CONSULTING INC.

John E. Haertle, PE, GE 2352
Principal Engineer
Ext. 4268, jhaertle@leightongroup.com

Djan Chandra, PE, GE 2376
Senior Principal Engineer
Ext. 4267, dchandra@leightongroup.com

JEH/JLH/DJC/lr

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1.0 INTRODUCTION

1.1 Project Overview

The County of Orange (County) plans to increase traffic capacity along a portion of Brea Boulevard from Sta. 5+00 south of Canyondale Drive in the City of Brea to Sta. 85+00 north of Tonner Canyon Road in unincorporated Orange County for a total length of approximately 8,200 feet (1.52 miles). This segment of Brea Boulevard currently includes one traffic lane in each direction and gently rises in elevation progressing northerly/easterly toward the corporate boundary with Los Angeles County. Increase in traffic capacity will consist of adding one lane in each direction. Upon completion, this segment of Brea Boulevard will have two lanes in each direction with a raised median and paved shoulders. The portion of Brea Boulevard planned for widening is shown on Figure 1, *Site Location Map*.

To accommodate the widening and realignment of the roadway, a number of earth retaining systems will be constructed to support the necessary cuts into ascending slopes. The heights of these walls typically range from less than 10 to 30 feet with a maximum height of approximately 55 feet to support the cut planned along the inner radius of the prominent curve of the roadway (approximate Sta. 31+50 to Sta. 34+50) as the alignment transitions from northerly to easterly and crosses Bridge 2. In areas of the proposed widening, fill will be required to raise grade that will be accommodated either by new slopes or retaining wall structures. A number of utility crossings and culverts will also be reconstructed to preserve their function. Design of retaining structures is addressed in a separate report (Leighton Consulting, 2021).

The bridges proposed for construction will replace the three existing bridges that span Brea Creek within the region planned for widening. The existing bridges are referenced as follows:

Table 1 – Existing Bridge Structure Data

Bridge Identification		Approximate Location		Deck Elevation (feet)	Creek Bottom Elevation(1) (feet)
Existing	New	Latitude	Longitude		
55C-0121	55C-0729	33.9378°	-117.8917°	393	373
55C-0122	55C-0730	33.9400°	-117.8906°	408	384
55C-0123	55C-0731	33.9411°	-117.8875°	424	402
Note: (1) Creek bottom elevation assumed to be equal to Thalweg Elevation per Hydrologic Study Report (Avila, 2021)					

Available structural data regarding the existing bridges was limited. No data was available through review of online sources for Bridge No. 55C-0121. Information collected for Bridge No. 55C-0122 included a General Plan and Foundation Plan for seismic retrofit planned in 1997. Similar information was obtained for Bridge No. 55C-0123 as well as a report prepared by Lim & Nascimento Engineering Corp. (Contract No. 59Y021, April 11, 1997) that provided structural data and evaluation in advance of proposed retrofit activities.

1.2 Proposed Bridges

The proposed road widening includes the construction of new bridges to replace the three existing bridges referenced above. Details regarding the proposed bridges are presented below from review of the project plans prepared for each bridge structure (October, 2021) and discussion with the project structural engineer regarding current design concept. The General Plan and Foundation Plan for each bridge structure are included in Appendix A.

Table 2 – Proposed Bridge Structures

Bridge ID		Begin Bridge			End Bridge		
Existing Name	Project Name	Project Station	Finish Grade Elevation(1)	Abutment Bottom Elevation(2)	Project Station	Finish Grade Elevation(1)	Abutment Bottom Elevation(2)
55C-0121	1	22+34.69	392.92	363	23+08.29	394.52	363
55C-0122	2	30+26.47	408.84	N/A(3)	31+01.84	410.43	N/A(3)
55C-0123	3	40+93.80	428.54	391	42+01.80	429.65	392

(1) Elevation in feet as indicated on Foundation Plan
(2) Elevation in feet as indicated on Abutment Layout plans
(3) Abutments at Bridge 2 consist of secant pile walls and do not include separate abutment structures supported by foundations.

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The structural spans for the proposed bridges consist of a reinforced concrete slab supported by precast, prestressed concrete I-girders. The girders are supported by seat-type abutments, which, in turn, are supported by drilled shafts extending continuously from the bottom of the abutment to the design tip elevations. The distances between the top of the deck slab and bottom of the girders range from 3’9” at Bridge 1, 4 feet at Bridge 2, and 5’6” at Bridge 3 with the slab being 1 foot thick above the girders.

A number of wingwalls and retaining walls are planned at several of the abutments. The retaining walls are referenced as “channel walls” in project plans and are typically located along the creek channel extending continuously from the end of the approach abutment structures. The following tables present data regarding the wing walls and channel walls.

Table 3 – Proposed Wing Walls

Bridge No.	Abutment No.	Direction	Footing Data		Wall Data	
			Center Line Station	Bottom Elev.	Bearing	Length
1	1	Left	22+75.63	383.5	N41°10'34"E	35'09"
		Right	22+23.25	387.25	N39°28'45"E	43'11"
	2	Right	23+68.16	388.25	-	51'04½"
2	2	Right	30+94.12	398	N04°29’12”W	34'09⅜"

Table 4 – Proposed Channel Walls

Bridge No.	Abutment No.	Direction	Top of Wall Elevations (feet)		Wall Data		
			Begin	End	Center Line Station	Bearing	Length
1	2	Left	392	391	22+76.72	N75°31'19"E	42'06"
2	1	Left	404.5	397.75	30+63.13	N60°50'42"W	20'
	2	Right	396	396	30+56.23	N19°25'44"W	40'
	2	Left	408	407	31+36.23	N02°42'31"E	80'
3	2	Left	421	419	41+22.83	N41°18'09"W	80'

The bridge structures will each be supported by drilled shaft foundations. The drilled shafts will extend continuously from the bottoms of the abutments to the design tip elevations. Initial design concepts included the drilled shafts at an on-center spacing of approximately 2 to 2½ diameters. A top-down wall was originally planned to be constructed to serve as the channel wall below the bridge decks. However, based on the scour potential identified by the hydrology study conducted for the project (Avila, 2021), construction of a channel wall in this manner to provide scour protection was not anticipated to be feasible. An alternate design concept was considered in which the originally proposed abutment walls (i.e. constructed in a top-down manner) would be replaced by the use of secant piles positioned between the load bearing drilled shafts that provide support of the bridge decks. The use of the secant pile system was selected for Bridge 2 whereas the original design concept was ultimately selected for Bridges 1 and 3.

The project may ultimately include an additional bridge. The purpose of this bridge will be to allow wildlife to cross the Brea Boulevard corridor. This wildlife crossing may be located in the vicinity of Sta. 64+00. The actual location and design details have yet to be established.

1.3 Design Standards

Design specifications for the proposed bridges include the American Association of State Highway and Transportation Officials (AASHTO) *Load and Resistance Factor Design (LRFD) Bridge Design Specifications* 8th edition with California Amendments (AASHTO-CA BDS-8). In addition, design of the structures is also subject to the Caltrans *Seismic Design Criteria* Version 2.0 (2019) with Errata dated July 10, 2020.

1.4 Purpose and Scope

This Foundation Report has been prepared for use in the design and construction of replacement bridge structures associated with the proposed widening of Brea Boulevard. Details regarding the proposed bridges have been based upon the project plan set developed at the 100% design submittal and updated as final design progressed. The latest General Plan and Foundation Plan sheets for the respective bridges are included in Appendix A.

Recommendations presented in this report were based upon understanding of the project structures; subsurface exploration consisting of borings and CPT soundings; geologic mapping; and evaluation of the collected data. Scour depths for use in design have been determined by others (Avila, 2021) for the proposed bridge structures, but no scour analysis has been performed for the wall structures located along the creek channel that extend beyond the abutment structures.

In terms of discrete tasks, our scope for service included the following:

- ***Literature Review***: In preparation of this report, we performed a review of relevant geotechnical and geological literature available in the public domain and in our in-house library. A list of references used in preparation of this report is presented in Section 5.0.

- ***Subsurface Exploration:*** Our field exploration was performed in phases that included three large-diameter borings advanced by a truck-mounted drilling rig using a bucket-auger apparatus. These borings were performed in the private property (Bridge Energy parcel) along the south side of Brea Boulevard and were intended to explore the geologic conditions in which proposed wall cuts will be performed.

  Exploration also included small-diameter boreholes drilled by a truck-mounted drilling rig using hollow-stem augers. These borings were primarily located along the existing roadway at accessible locations and off the roadway in the private property to better assess conditions in the various wall areas. These borings were intended to provide subsurface data that would be used in the design of foundations for bridge structures and retaining walls, expose the existing pavement section (i.e. thickness of asphalt concrete and base course), and explore the subsurface conditions below the pavement of the existing roadway.

  Additional field exploration was conducted to supplement available data and provide further exploration of various retaining wall and the channel wall areas proposed in association with the proposed bridge structures. The recent exploration consisted solely of test borings and included test boring Nos. 19 through 40 conducted during the period of September to October of 2020.

  Field sampling and testing performed during drilling included drive sampling using a split-barrel sampler. In addition, bulk samples of the auger cuttings were collected at various depths below grade. Drive samples were collected from the borings using a Modified California ring-lined split-barrel sampler with sampling conducted in accordance with ASTM D3550. Other samples were collected by the Standard Penetration Test (SPT) performed within the borings in accordance with ASTM D1586. The ring and SPT samplers were driven for a total penetration of 18 inches using a 140-pound automatic hammer falling freely for 30 inches for the hollow-stem auger borings; sampling of the large diameter borings was performed using the weight of the drill rig Kelly bar as the drive weight. The number of blows per 6 inches of penetration was recorded on the boring logs included in Appendix B, *Field Exploration* unless practical refusal was encountered (i.e. greater than 50 blows) for an individual 6-inch test interval.

The borings were logged in the field by a California Certified Engineering Geologist and a geotechnical engineer from our staff. Each collected soil sample was reviewed and described in general accordance with the Unified Soil Classification System. The samples were sealed and packaged for transportation to our Irvine laboratory.

Upon completion of drilling activities, the boreholes that encountered groundwater or were extended to depths greater than 30 feet were backfilled with either a cement-bentonite grout or bentonite pellets in conjunction with collecting and placing all cuttings and drilling spoils in 55-gallon drums for temporary storage prior to final disposal at an appropriate waste collection facility. The large diameter bucket-auger borings and the small diameter, shallow hollow-stem auger test borings were backfilled with soil cuttings. The ground surface was patched with cold asphalt concrete (AC) to match existing site conditions.

The field exploration was supplemented by advancing a total of ten (10) Cone Penetrometer Test (CPT) soundings as part of the initial phase of exploration. The CPT soundings were performed in accordance with ASTM D 5778 and D 3441.

The approximate locations of the test borings and CPT soundings relevant to the bridge structures are shown on Plates 1 through 3, *Exploration Location Map*, included at the end of the report. The logs of the field exploration are included in Appendix B. The relevant test borings and CPT soundings along with their respective depths of exploration in proximity to the proposed bridges are summarized in the following table.

Table 5 – Field Exploration at Bridge Locations

Bridge No.		Boring No. and Depth Explored	CPT No. and Depth
55C-0121	1	LB-02; 61' LB-20; 51' CWE P-2; 51'	SC-1; 29' C-7; 33'
55C-0122	2	LB-03; 70.5' LB-22; 80.5' LB-37; 81' CWE P-3; 20'	C-2; 36'
55C-0123	3	LB-04; 70.5' LB-25; 80' LB-27; 51' LB-38; 81.5' CWE P-4; 51'	SC-3; 65' C-8; 31'

Based upon the subsurface conditions encountered during exploration and the observations collected by field mapping, a number of geotechnical cross-sections were developed for the project area. The locations of the sections were intended to be representative of the proposed walls and slopes. The locations of the cross-sections are shown on Plates 1 through 3 and the individual sections were presented in the retaining wall and pavement report (Leighton Consulting, 2021).

- ***Laboratory Testing:*** Geotechnical laboratory testing was performed on select soil samples collected during our field exploration to determine the relevant engineering properties of the encountered subsurface soils. The results of laboratory testing are presented in Appendix C, *Laboratory Test Results.*

- ***Geotechnical Design and Analyses*:** Geotechnical engineering analyses were conducted using data obtained from the subsurface exploration to evaluate geotechnical conditions and develop recommendations for design of the bridge foundations and associated channel walls. Results of the analyses are presented in Appendix D, *Engineering Analyses*.

- ***Report Preparation*:** Relevant geotechnical data were compiled in this report along with our findings and recommendations for the proposed bridge structures.

2.0 GEOTECHNICAL AND GEOLOGIC OVERVIEW

2.1 Sources of Information

Geotechnical data relevant to the proposed alignment and existing bridges were not available for use in preparation of this report. A structural assessment report (Lim & Nascimento, 1997) was prepared for Bridge No. 55C-0123 (Bridge 3) in conjunction with seismic retrofit of the bridge structure. The geotechnical data included a cursory discussion of subsurface conditions but specific test boring or laboratory test data were not included.

Supplemental geotechnical data in the general vicinity of the proposed project was obtained in conjunction with the geotechnical report prepared by Caltrans (2001) for the Climbing Lane Widening project for State Route 57. A portion of that project area includes the Tonner Canyon Road Undercrossing, which is located in the geologic formation through which Brea Boulevard passes.

2.2 Existing Laboratory Data

Evaluation and analyses presented in this report did not rely upon laboratory test data prepared by others and no such data is known to exist for the subject region of Brea Boulevard. Data presented in the Caltrans report (2001) was reviewed to supplement the data generated as part of the exploration conducted by our firm.

2.3 Site Topography

The portion of Brea Boulevard that is planned for widening is located on the USGS Topographic Maps for the La Habra and Yorba Linda Quadrangles. The existing roadway traverses the bottom of a distinct linear and relatively narrow west-northwest trending valley (Brea Canyon). The ephemeral, antecedent Brea Creek channel meanders from east to west through the canyon bottom, crossing beneath the alignment at the three bridge locations that are the subject of this report. The lower portions of the valley floor are manifest in stair-stepped topography exhibiting a series of flat-lying benches (terrace surfaces) bracketed by intermediate slopes ascending away from the modern creek channel. The terraces represent the remnants of former alluvial plains in the valley, now abandoned due to more recent stream entrenchment. It is common for the morphology and elevation of the terrace surfaces to mirror each other on opposite sides of the canyon/creek. The roadway variably spans both older and younger age alluvial terraces through the valley. The existing roadway gradient descends from approximate elevation (El.) 512 feet above mean sea level at Station 107+87.94 on the east to El. 390 feet at Station 7+00.00 on the west, a total fall of around 122 feet in vertical elevation.

The bounding walls of Brea Canyon ascend south and north from alluvial terrace areas and manifest in moderate to steep hummocky topographic relief. Several unimproved access roads transect hillside areas, providing access to abandoned and active oil wells on leveled cut/fill pads. Hilltop elevations south and east of the roadway reach elevations of approximately 770 feet. Canyon terrain on the north rises at least 450 feet higher than the south, achieving elevations of approximately 1,228 feet.

2.4 Regional Geologic Setting

From a regional perspective, the roadway lies within the Peninsular Ranges Geomorphic Province of Southern California. This province has a regional expanse of approximately 900 miles that extends from the Santa Monica Mountains on the northwest to the tip of Baja California to the southeast (Yerkes, et al., 1965). The province is composed of a northwest-trending series of mountain ridges and alternating sediment-filled valleys, bounded by fault zones. The faults tend to truncate, merge with, or terminate at the Transverse Ranges province to the northwest. The San Jacinto, Whittier-Elsinore, Palos Verdes, and Newport-Inglewood fault zones are most prominent within the province. Bedrock is generally composed of intrusive pre-cretaceous age igneous rocks ranging in composition from gabbro to granodiorite and Tonalite. These basement rocks are overlain by a sequence of uplifted, faulted and folded Cenozoic age sedimentary marine and non-marine formations.

Brea Canyon lies immediately northeast of the abrupt regional geographic boundary between the elevated Puente Hills block on the northwest and broad flat-lying alluvial plain of the Los Angeles Basin (LA Basin) on the southeast.

2.5 Local Geologic Setting

The Puente Hills are an uplifted block of smoothly eroded hills underlain by Miocene to Pliocene age bedrock. This striking linear southwest margin on the hills are coincident with and formed by the Whittier Fault Zone (WFZ). The origins of the canyon and its orientation parallel to the WFZ relate directly to the tectonic history of the region. Lateral movement along the faults has deflected the north-south axis of Brea Creek a distance of approximately 4,000 to 5,000 feet to the west-northwest (Yerkes, 1972). This offset has also resulted in the juxtaposition of completely different rock formations on opposite sides of Brea Canyon.

As further discussed below, tectonics have played an important role in development of the existing topography and morphology of the project area. Brea Canyon is defined as a fault-valley; a valley subjected to and formed by past, currently inactive fault activity. Although some evidence of faulted older alluvium deposits is reportedly documented in Brea Canyon, no evidence exists for offset of any Holocene age alluvium (Yerkes, 1972). Presently active faults are mapped as transecting the hills a short distance north of Brea Canyon, within the boundaries of the Alquist-Priolo Earthquake Fault Hazard Map for the Whittier Fault Zone, published by the California Geological Survey.

2.6 <u>Faulting and Seismicity</u>

The tectonic regime of southern California and the site area was very different from the regime active today. Major changes relate to a transition of the North American tectonic plate boundary from subduction to a translational style of motion. This change resulted in formation of the San Andreas Fault system. Since middle- to late-Miocene time over the past 16 million years, the site area was subjected to first extensional and then compressional forces (Bjorklund, 2003). The north-south oriented compressional forces were active between 14 and 8 million years ago, and produced large depositional grabens and local volcanism. The Proto-Whittier Fault initially developed as a normal fault under this regime. Over the past 8 million years, the San Andreas and related faults matured, and the overall motion became compressional.

The former normal Whittier Fault transitioned into a reverse fault, accommodating uplift of the Puente Hills Block. Movement along the Whittier Fault has occurred since early Pliocene time, but mostly during the late Pleistocene (Yerkes, 1972). Reverse offset resulted in the emplacement of older bedrock of Miocene age north of the fault, over the top of younger Mio-Pliocene age bedrock units south of the fault zone. In accommodating some of the uplift and smaller amounts of right-lateral strike slip, two subsidiary parallel reverse faults formed southwest of the Proto-Whittier Fault, including the Tonner and Menchego Faults, respectively. The period of reverse thrusting also resulted in formation of significant folds (anticlines and synclines), which became entrapments for the oil now extracted from the Brea-

Olinda Oil Field. The present day Whittier, Tonner and Menchego Faults all have a similar strike of 65 to 70 degrees (northwest). The approximate trace of these faults is depicted on Figure 2, *Regional Geology Map*.

Review of the USGS Seismic Source Parameters database has identified the presence of several faults of significance in the vicinity of the proposed roadway improvement area. The identified faults are summarized as follows using the location of Bridge 2 as the point of reference for distance measurements:

Table 6 – Geologic Faults

Fault Name	Distance (km)	Style of Faulting	Slip Rate (mm/year)	Range of M_{max}	
				Ellsworth	Hanks-Baukin
Elsinore (Whittier)	0.11	Strike Slip	2.5	7.0	6.8
Puente Hills (Coyote Hills)	5.12	Thrust	0.7	6.90	6.60
Chino	16.4	Strike Slip	1.0	6.70	6.40
Sierra Madre (connected)	22.35	Reverse	2.0	7.30	7.20
Elysian Park	24.09	Reverse	1.3	6.70	6.50
Cucamonga	25.37	Thrust	5.0	6.70	6.50
San Joaquin Hills	27.38	Thrust	0.5	7.28	7.19
Newport Inglewood	28.12	Strike Slip	1.3	7.50	7.50
Elsinore	30.33	Strike Slip	5	7.28	7.19
Palos Verdes	39.92	Strike Slip	3	7.30	7.20
San Andreas	51.48	Strike Slip	29	7.91	8.02

The faults presented in the table above do not comprise an exhaustive, inclusive listing of all identified faults or rupture scenarios but are considered to be representative of the seismic regime. Recommendations for seismic design are presented in Section 3.1 based upon the Caltrans *Seismic Design Criteria*.

2.7 Seismic Hazards

2.7.1 Fault Rupture

To protect structures from ground surface rupture hazards along a fault, the California Geological Survey (CGS), under the State-mandated Alquist-

Priolo Act of 1972, has delineated “Earthquake Fault Zones” or "Alquist-Priolo Special Studies Zones" along active or potentially active faults. Based on the available data, the bridge locations are not located within the abovementioned earthquake fault zones.

2.7.2 Liquefaction

Phenomenon and Consequences – Liquefaction is the phenomenon of the reduction in strength and stiffness of certain soil types that exist below the groundwater table when subjected to strong ground shaking such as typically associated with seismic activity. Soils most susceptible to liquefaction are saturated granular deposits that exhibit loose to medium dense relative density. The phenomenon occurs due to the generation of excess pore pressures in the soils resulting from the tendency for these loose granular deposits to densify during strong ground shaking. The pressure of the water contained in the soil void space (pores) increases as the densification or consolidation process is impeded due to the presence of the pore water and the temporary inability of the water to drain. Consequently, the pore pressures within the saturated soils increase above hydrostatic pressure. Liquefaction occurs when this excess pore pressure (i.e. magnitude above hydrostatic) approaches the magnitude of the in-situ lithostatic stress and, therefore, the difference between the in-situ stress and excess pore pressure approaches zero.

In general, liquefaction hazards are the most severe in the upper 50 feet below ground surface for structures supported at-grade on shallow foundations. Depending upon the depth below ground surface and the extent of the susceptible deposits, the effects of liquefaction at sites with level grade may consist of the following:

- Settlement of the ground surface as pore pressure equilibrium is reestablished in the soils after ground shaking;
- Ground failure in which large, intact blocks of the non-liquefied soils above the water table (the non-liquefied crust) develop fissures. These blocks tend to oscillate during ground shaking, thereby resulting in the potential for differential horizontal displacements (i.e. ground oscillation); and
- Loss of bearing strength and failure of foundations.

Liquefaction will also affect deep foundations in that the soils susceptible to liquefaction temporarily lose their capability to provide foundation support (both vertical and lateral load resistance); and impart downdrag and the associated drag load on deep foundations as the liquefied deposits consolidate to reestablish equilibrium. In effect, the drag load increases load demand on the foundations.

Triggering Analysis – Evaluation of the potential for liquefaction to occur was performed using a combination of the test boring and CPT data generated from field exploration. Liquefaction triggering was evaluated using the methods by Youd et al. (2001) as programmed in the *LiqSVs* software package (test borings) and the *CLiq* software package (CPT soundings), both produced by Geologismiki (2007, 2006). Evaluation of seismic-induced settlement was performed using the method described in Zhang (2002) as programmed in the software. Analysis was performed using a groundwater table typically in the range of 20 to 25 feet below ground surface at the various boring and CPT locations; shallower depths were used where the results of field exploration indicated the presence of groundwater above a depth of 20 feet. The following input parameters were utilized in our evaluation:

- Peak ground acceleration of 0.65g for a 975-year average return period (MCE event); and

- Mean moment magnitude of 6.72 and distance of 8.9 km determined by deaggregation of the seismic hazards using USGS online deaggregation program (Unified Hazard Tool).

Summary of Results – Results of the analysis generally indicated the potential for liquefaction triggering was low in the vicinity of Bridge 2 and east of retaining wall RW-11 and, therefore, not a significant design consideration for these regions of the proposed roadway expansion.

The potential for liquefaction to be triggered was identified in proximity to the following structures planned for the proposed project:

- Bridge No. 1 – Abutments 1 and 2
- Bridge No. 3 – Abutments 1 and 2
- Bridge No. 3 – Channel Wall Abutment 2 Left

The following table summarizes the strata at the respective test boring and CPT soundings in which liquefaction susceptibility was identified for the design earthquake scenario.

Table 7 – Strata Susceptible to Liquefaction

Bridge No.		Exploration I.D.	Depth Interval (feet)
55C-0121 or 55C-0729	1	LB-2 SC-1 C-7	17 – 20 19.0 – 21.2 21.1 – 23.1
55C-0122 or 55C-0730	2	LB-3 LB-22 LB-37 CWE P-3 C-2	No Liquefaction; Shallow Bedrock
55C-0123 or 55C-0731	3	LB-4 LB-25 LB-27 LB-38 CWE P-4 SC-3 C-8	25 – 30 No Liquefaction 25 – 37 18 – 23 26 – 31 23.1 – 24.4 24.9 – 25.4 26.9 – 28.2 21.3 – 22.8 24.9 – 25.4 26.9 – 28.2

For the proposed bridge structures, the occurrence of liquefaction is most likely to be manifested by the following: settlement of soils from the ground surface to the bottom of the lowest liquefiable stratum; some reduction in lateral load capacity of the soils in which liquefaction occurs; drag load imparted to the foundations due to the induced settlement; and lateral load imposed upon foundations to resist lateral translation of the soils toward the creek channel (i.e. lateral spreading).

The results of the liquefaction triggering analysis conducted on the CPT soundings provides greater specificity in evaluating the effect of liquefaction and potential consequences due to the refinement in subsurface stratigraphy provided by the continuous record of lithology recorded during advancement of the CPT probe. Review of the strata data presented in the previous table indicates the potentially liquefiable strata are typically thin with thicknesses not greater than approximately 2 feet at the CPT soundings. The measured thicknesses suggest the strata are not likely to be continuous over large distances. However, considering the proximity of these explorations relative to the proposed bridge structures, the identification of liquefaction was considered to be applicable to a sufficient extent (approximately 100 feet) behind the bridge abutments to consider the effect of liquefaction and the consequences previously summarized (i.e. settlement, strength reduction, lateral displacement). The associated effects of settlement and strength loss are addressed in the relevant sections of this report that address foundation design. The effect of lateral displacement is subsequently described.

2.7.3 <u>Lateral Spreading</u>

Lateral spreading consists of the lateral movement of earth materials due to ground shaking and the triggering of liquefaction at some depth below ground surface. Once liquefaction is triggered, the liquefied soils provide a weak layer for the lateral displacement of the overlying relatively intact, non-liquefied soil deposits, with each pulsation of ground motion in which the ground acceleration exceeds some threshold value (yield acceleration or ky). Lateral spreading typically requires that the liquefiable zone be continuous; the overlying intact, non-liquefied mass unconstrained laterally; and the non-liquefied mass is free to move along gently sloping ground toward an unconfined area. Due to the general absence of potentially liquefiable soils in the vicinity of Bridge 2, the potential for lateral spreading is considered low and not a significant design consideration for this bridge. However, the identification of liquefiable soils at Bridge 1 and Bridge 3 indicate the potential effect should be evaluated and addressed in design.

Evaluation of the load demand associated with lateral spreading was performed by limit equilibrium (i.e. slope stability) analysis. The results of the analyses indicated the additional load demand on the abutment structures typically ranged from 20 to 40 kips per lineal foot (klf) of abutment wall. The load demand imposed upon Abutment 2 channel wall for Bridge 3 was calculated to be approximately 76 klf. Design of the bridge structures should provide sufficient resistance to the lateral load demand associated with liquefaction-induced lateral spread.

The potential load demand imposed upon the bridge abutment walls was reviewed with the project structural engineer and the client. Agreement was reached that, as an alternative, ground improvement technologies will be implemented to mitigate the potential adverse effects of liquefaction and allow design to be completed without special consideration relative to lateral spreading. Recommendations for ground improvement is discussed in Section 3.2 of this report.

2.7.4 Seiches and Tsunami

Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the absence of enclosed bodies of water near the site and the inland location of the site, seiches and tsunami risks at the site are considered negligible.

2.8 Subsurface Soil and Geologic Units

Based on our review of available literature and the findings of our subsurface exploration and field mapping, we find the roadway alignment is largely underlain at the surface by deposits of Pleistocene to Holocene age alluvium (see Figure 2, *Geologic Map)*. The alluvium predominantly consists of weak to moderately consolidated sands and gravels. In and around the existing bridge abutments are localized deposits of undocumented artificial fill of variable thicknesses. The alluvium and fill are underlain by Tertiary age marine and non-marine (terrestrial) bedrock formations. North of the active Whittier Fault Zone, the bedrock consists of the Soquel Sandstone and Siltstone Yorba Shale, which are each members of the Monterey Formation. South of the active Whittier Fault Zone, within Brea Canyon, are sandstone and claystone facies assigned to the Pliocene age Fernando Formation. Geologic formational names follow that of Dibblee (2001a and 2001b). For the purposes of this report, we have grouped the facies of the Fernando Formation into a single “undifferentiated” unit.

The general stratigraphic relationships of encountered subsurface units are noted in our borings included in Appendix B. A general description of each unit is described below, based on our field and laboratory interpretations.

2.8.1 Artificial Fill Undocumented

Map Symbol: **Afu**; Recent Age - Consists of light brown silty sands with gravel and poorly graded sands, silt and gravel. Mantles site surface locally, mainly limited to abutment areas on opposite sides of existing bridges. The thickness of fill varies and may exist locally in other unexplored areas along the right-of-way (ROW).

2.8.2 Quaternary Alluvium

Map Symbol: **Qa**; Holocene Age - Consists of alternating layers of clayey sand and gravel that are loose to medium dense, very stiff and moist. Exposed at surface along drainages or underlies fill within the northern and southern portions of the alignment. Basal contact depths in our borings were up to approximately 12 feet below existing grade.

2.8.3 Quaternary Older Alluvium

Map Symbol: **Qoa**; Pleistocene Age - Consists of alternating lenses of brown to reddish brown and light yellow brown silty sand to sand with gravel and cobbles, and olive green clayey sand that is very stiff and locally wet. Exposed at surface or underlies deposits of Quaternary Alluvium within the central portion of the alignment. Basal contact depths in borings were up to approximately 28 feet below existing grade.

2.8.4 Fernando Formation Undifferentiated

Map Symbol: **Tf**; Sandstone/Siltstone/Claystone Facies; Pliocene to Early Pleistocene Age - Consists of thin alternating beds of light to dark grey, yellow brown and olive brown siltstone, claystone and sandstone that is soft to dense, contains local concretionary beds, is internally sheared, petroliferous, oxidized in near surface, and harder and unoxidized at depth. Limited in occurrence to areas on lower north and south sides of Brea Canyon. Significantly folded with locally steep and overturned bedding. Observed in borings to maximum depth of drilling where encountered.

2.8.5 Yorba Shale Member Monterey Formation

Map Symbol: **Tmy**; Middle Miocene Age - Consists of thin alternating beds of very dense siltstone and sandstone with local gravel, blue-grey to blue-green and dark-gray to olive-grey in color, exhibiting locally steep to overturned bedding. Limited in occurrence to areas on lower north and south sides of Brea Canyon. Observed in borings to maximum depth of drilling where encountered.

Map Symbol: **Tmss**; Soquel Sandstone Member Monterey Formation; Middle Miocene Age - Consists of massive reddish-brown sandstone that is intensely weathered, conglomeratic and oxidized. It is limited in occurrence to northern alignment areas, generally north of active Whittier Fault Zone. Observed in borings to maximum depth of drilling where encountered.

2.9 Groundwater

Groundwater was typically encountered in the deeper test borings at depths approximately coincident with the elevation of the creek channel. Groundwater levels encountered during subsurface exploration are summarized in Table 8.

Table 8 – Summary of Groundwater Levels

Bridge No.	Boring No.	Boring Depth (feet)	Current Surface Elevation[1] (feet)	Groundwater	
				Depth (feet)	Approximate Elevation (feet)
1	LB-02	61	393	17	376
	LB-20	51	414	-	-
	CWE P-2	51	388	18	370
2	LB-03	70.5	408	-	-
	LB-22	805	400	-	-
	LB-37	81	405	56	349
	CWE P-3	20	401	-	-
3	LB-04	70.5	430	25	405
	LB-25	80	422	-	-
	LB-27	51	426	31	395
	LB-38	81.5	428	-	-
	CWE P-4	51	431	38.5	392.5

(1) Estimated from available topographic data on Plates 1 - 3, *Geotechnical Exploration Plan*

Based on the available groundwater level information, the depth to groundwater used in analysis ranged from 20 to 25 feet depending upon location; shallower depths were used where groundwater was either encountered during or inferred from field exploration.

2.10 Idealized Subsurface Profiles

Based on the subsurface soil conditions encountered during field exploration and the findings of field geologic mapping, idealized subsurface profiles at each bridge location are presented in Tables D-1 to D-6 included in Appendix D. These tables

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also include relevant geotechnical engineering parameters for use in foundation design. The parameters include total unit weight, effective friction angle, undrained shear strength and modulus of subgrade reaction.

2.11 As-Built Foundation Data

The limited information available for Bridge 55C-0123 (Bridge 3) indicates the existing structure is supported by 16-inch square butt, 10-inch square tip, driven precast concrete pile foundations (Lin & Nascimento, 1997). The as-built lengths of the piles and corresponding tip elevations were not provided.

2.12 Scour Potential

The potential for scour to occur has been evaluated and presented in a hydrology report (Avila, 2021). The results of that assessment are summarized in the following table with the data obtained from the referenced hydrology report.

Table 9 – Scour Elevations at Bridges

Bridge Identification		Elevations (feet)			
Existing	**Proposed**	**Thalweg**	**Degradation**	**Contraction**	**Abutment**
1 – 55C0121	55C-0729	373	372	370	364
2 – 55C0122	55C-0730	384	383	379	368
3 – 55C0123	55C-0731	402	401	400	393

2.13 Corrosion Potential

For structural elements, Caltrans considers a site corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site:

- Chloride concentration is 500 parts per million or greater
- Sulfate concentration is 1,500 parts per million or greater
- pH is 5.5 or less

Testing to measure the concentrations of soluble sulfate and chloride is required when the minimum resistivity is 1,100 ohm-cm or less. Corrosion test results from this exploration are summarized in Table 7. Based on the test results, the soils are considered corrosive per Caltrans guidelines and the minimum resistivity exhibited by the tested samples.

Table 10 – Corrosivity Test Results

Boring No.	Depth (feet)	Approximate Station	Resistivity (Ohm-cm)	Chloride (ppm)	Sulfate (ppm)	pH
LB-03	0 to 5	31+50	320	375	1,443	6.82
LB-07	0 to 5	58+00	570	128	315	7.23
LB-14	5 to 10	37+00	715	54	1,374	7.05
LB-14	15 to 20	37+00	1,100	129	88	7.47
LB-14	25 to 30	37+00	1,099	71	293	7.81
LB-16	0 to 5	53+50	1,586	85	114	7.55
LB-18	15 to 20	64+50	3,260	34	74	7.67
LB-19	25 to 35	26+00	1,700	40	198	8.08
LB-26	10 to 20	43+50	509	220	955	7.57
LB-32	30 to 40	59+20	448	320	3,634	6.34
LB-34	20 to 30	62+00	2,000	40	132	8.23

The measured sulfate concentrations indicate special mix designs will be necessary for concrete that is in contact with the soils at the project site. Based upon guidelines provided by the American Concrete Institute (ACI 318-14), the exposure category of "S1" appears to be appropriate for the project site. However, the sample collected from a depth range of approximately 30 to 40 feet at Test Boring LB-32 (approximate El. 454 to El. 444) yielded a sulfate concentration (3,634 ppm) that results in an exposure category of "S2" for concrete in contact with these materials.

The measured concentrations of chloride were less than the Caltrans threshold of 500 ppm above which corrosion protection measures should be implemented with respect to chloride exposure.

The results of resistivity testing indicate the tested soils exhibit corrosive potential for metallic materials in contact with the soils. The appropriate provisions in design and construction should, therefore, be undertaken to reduce the potential for material degradation through corrosion processes. Of particular concern will be providing the appropriate corrosion protection for the tendons for the earth anchors planned for use at abutment and channel walls.

2.14 Seismic Shear Wave Velocity (Vs_{30})

Shear wave velocity measurements were conducted at three of the CPT sounding locations. Testing/measurements were conducted at approximate 5-foot intervals. The results of testing indicated average shear wave velocities in soil material to be approximately 600 feet per second (fps). Shear wave velocities measured in the bedrock were typically in excess of 1,000 fps. Based upon the results of exploration and testing, the shear wave velocity used in seismic profile analyses was 310 meters per second (approximately 1,010 fps).

3.0 GEOTECHNICAL RECOMMENDATIONS

The findings from our field exploration and laboratory testing program have been used to conduct geotechnical engineering analyses relevant for design of the bridge structures for the proposed road widening project. Project information has been based upon the current General Plan and Foundation Plan sheets for the respective bridges included in Appendix A. Geotechnical recommendations for design and construction are provided in the following sections.

3.1 Response Spectra

Caltrans design ARS curves were developed for each of the proposed bridge locations following Caltrans *Seismic Design Criteria* (2019) using Caltrans ARS Online, V.3.0.2. The Caltrans seismic hazard corresponds to the USGS 2014 fault model considering a 975-year average ground motion return period (5 percent chance of exceedance in 50 years). The subsurface profile was modeled by a V_{s30} value of 310 meters/second. The response spectra curves for the site are provided on Figures 3a through 3c for Bridge Nos, 1, 2 and 3, respectively. The digitized values of the design ARS curves are also tabulated in these figures.

The results of the seismic analysis conducted in accordance with Caltrans procedures indicated a peak ground acceleration of 0.65g and a mean magnitude of 6.72. The mean site-to-source distance that corresponds to a spectral period of 1 second was 13.9 km.

3.2 In-Situ Ground Improvement

As discussed in Section 2.7.3 of this report, use of in-situ ground improvement has been reviewed and accepted by the client to mitigate the effect of liquefaction-induced lateral spread, which will reduce load demand on the abutments and channel walls and allow design to be based upon stable soil conditions. Ground improvement is recommended to be implemented prior to bridge construction.

Ground improvement technologies that may prove feasible for the proposed project consist of rammed aggregate piers, deep mixing method/deep soil mixing (soil-cement columns) or drilled displacement columns (DDC). Each technology is proprietary and is, therefore, designed and implemented by contractors that specialize in the respective methods.

The general concept used in design of such systems consists of developing a weighted average shear strength in the zone of liquefaction such that the results of conventional slope stability analysis achieve a minimum calculated factor of safety (Appendix D-4). The manner in which this is performed is to determine the Area Replacement Ratio (Ar) defined as the cumulative area of the improvement elements relative to the total area to be improved such that the weighted average shear strength (Su,avg) of the improvement area can be achieved in the field. The replacement ratio (Ar) defines the size (diameter) of the reinforcing elements and the on-center spacing to be used in the field to achieve desired cumulative area of the improvement elements. In the event of cementitious elements (soil-cement columns, drilled displacement columns), the shear strength ($c_{\text{improved soil}}$) is one-half of the unconfined compressive strength (*f'c*). Slope stability analyses referenced in this report have been based upon this concept. Alternate analyses will be required with the use of rammed aggregate piers due to the frictional nature of the shear strength of these elements and the mechanism of strength mobilization.

Equation (a) can be used to determine the Area Replacement Ratio (Ar) and Equation (b) can be used to determine the shear strength of the reinforcing element ($c_{\text{improved soil}}$) based on the appropriate combinations of replacement ratio and the average shear strength of the improvement zone:

Ar = Improved Area / Total Area (a)

Su,avg (psf) = (Ar)($c_{\text{improved soil}}$) + (1 - Ar)(Sr) (b)

Sr (psf) = liquefied residual strength of the layer susceptible to liquefaction.

The use of equation (b) will allow determination of the minimum shear strength of each reinforcing element in the zone of improvement ($c_{\text{improved soil}}$).

The following table summarizes the shear strength of the improved soil for various extents of the improvement zone behind each abutment.

Table 11 – Ground Improvement Design Parameters

Bridge No.	Abutment No.	Liquefied Residual Strength (Sr) (psf)	Length of Improvement Zone (feet)	Average Shear Strength (Su,avg) (psf)
1	1	400	50 75	1,050 850
	2	400	50 75	1,375 1,050
3	1	375	50 70	1,250 1,000
	2	1,100	50 70	1,350 1,250
	Channel Wall	700	70	2,600

Other combinations of improved shear strength and length of improvement zone are possible but will require the appropriate slope stability analysis. The design of the ground improvement system will require adequate embedment to develop the intended shear resistance.

The use of ground improvement at the project site may potentially mitigate the effects of scour if performed along the creek channel, pending construction space and access. If performed and the potential of erosion is mitigated, the recommendations presented in the following sections of this report will require review and revision as warranted. Revisions to the recommendations will affect foundation design and the structural plans for the bridge foundations.

3.3 <u>Foundation Type</u>

The proposed bridge abutments will be supported by a deep foundation system consisting of drilled shafts (i.e. Cast-in-Drilled-Hole or CIDH piles). At Bridge 1 and Bridge 3, these CIDH piles will be relatively widely spaced to reduce interactive effects. A continuous wall will be constructed along the channel side of the CIDH piles to serve as channel walls. These walls will be constructed in a top-down manner and consist of shotcrete concrete with an aesthetic facing.

At Bridge 2, the CIDH piles will be closely spaced with secant piles constructed between these closely spaced primary piles thereby developing a secant pile system. The layout of the piles to support each abutment are shown in the Foundation Plans included in Appendix A.

3.4 Foundation Recommendations

3.4.1 Axial Capacity

Drilled shaft foundations develop axial resistance by a combination of skin friction acting along the side of the piles and end bearing at the pile tip. The use of end bearing in design requires careful control/verification during construction to ensure the borehole bottom is properly cleaned and the borehole bottom is competent to provide the estimated tip capacity. Based upon the potential for variances in the actual end-bearing conditions, pile design recommendations have been solely based upon shaft resistance.

Axial capacity was calculated using the SHAFT computer software package (Ensoft, 2018). The software computes capacity based on the AASHTO methodology, using effective stress to evaluate skin friction of cohesionless soils and total stress methods to evaluate skin friction resistance in cohesive soils. The results of analyses presented in this report are nominal (Resistance Factor φ_s = 1.0) and are appropriate for use under the Extreme Limit State per AASHTO. A reduction factor of 0.7 should be applied to the nominal capacities for the Strength Limit State. Tensile resistance should be based upon a reduction factor of 0.7 applied to the nominal shaft resistance in compression with the appropriate resistance factor applied for the particular LRFD limit state.

The proposed abutments will each be supported by a single row of piles that will line the creek channel. In accordance with AASHTO design specifications, reduction in axial capacity is not required for the following conditions: adjacent shafts where the center-to-center spacing is 2.5 pile diameters or greater; the pile cap is in intimate contact with the ground consisting of medium dense or denser soil; and no scour is anticipated below the pile cap. Pile caps will not be part of the proposed foundation systems as previously discussed in which the drilled shafts will extend continuously from pile tip to the bottom of the seat-type abutments. For the proposed bridges, scour potential has been evaluated (Avila, 2021) and was presented in Section 2.12 of this report. The scour depths identified by the hydrology study should be appropriately addressed in design.

Analysis of the axial compressive capacity has been performed for the sizes of CIDH piles that have been selected by the structural engineer for support of the bridges: 4-foot diameter shafts at Bridges 1 and 3, and 3-foot diameter at Bridge 2. The results of the analyses are presented in Appendix D-5. Table 5 of the Appendix D-5 indicates the recommended tip elevations for the Extreme and Strength limit states. Based upon the recommended embedment depths, the drilled shafts will be supported within the bedrock that underlies the project site. The strength and compressibility characteristics of the bedrock is expected to result in settlements under the Service limit state to be within the structural tolerance of 1 inch.

3.4.2 Lateral Load Capacity

The resistance of foundations to lateral loading conditions includes the lateral capacity of the piles plus available passive resistance on the embedded pile caps. The current design of the abutments do not include pile caps but rather CIDH foundations extended in height to the bottoms of the seat-type abutments. As a result, lateral load resistance will be developed solely by the lengths of the piles embedded below the identified scour depths at the respective abutments.

Lateral capacity of the CIDH piles is understood to be evaluated by the project structural engineer using the computer program LPILE (Ensoft, 2016) which employs a non-linear model (p-y method) to evaluate response to lateral load and calculating the distribution of shear load, bending moment and displacement along the length of the pile. The idealized profiles indicated in Tables D-1 through D-6 are recommended for use by the structural engineer in lateral load analysis.

Groups of closely spaced piles have reduced lateral capacity due to group interaction and the shadowing effect of rows of piles behind the lead row. The group capacity reduction is a function of the number of piles in the group and the center-to-center spacing. As discussed, the current pile configuration is a single row of piles. Use of an on-center pile spacing the equivalent of at least four pile diameters (4D) will allow no reduction and a p-multiplier of 1.0. The use of other pile spacing will require adjustment to the p-multiplier to account for group effect.

3.5 Retaining Wall Recommendations

For the proposed bridges, earth-retaining systems consist of abutment walls and, in some instances, channel walls that extend beyond the ends of the abutment wall systems. Wing walls are planned at Bridge 1. In general, earth-retaining systems should be designed in accordance with applicable requirements set forth in Article 11 of the AASHTO LRFD BDS with California Amendments.

The abutment walls are planned to be constructed in a top-down manner with wall installation performed in construction lifts, as the necessary cuts are performed at the abutment locations. Due to the type of construction, these abutment walls will generally retain on-site material exposed in the cuts. .

3.5.1 Wing Wall Backfill Material

Wing walls should be backfilled with cohesionless structure backfill meeting the Sand Equivalent and grading requirements of Section 19-3.02B of Caltrans *Standard Specifications*. As such, backfill behind wing walls is assumed to exhibit a minimum angle of internal friction of 34 degrees and in-place compacted unit weight of 120 pcf.

3.5.2 Soil Compaction

The compaction of the wing wall backfill shall meet a minimum of 90 percent of the Modified Proctor Test in accordance with ASTM D1557 standard specifications. Care shall be taken not to damage the walls during compaction using light compactor or hand-held tamper.

3.5.3 Lateral Earth Pressures

Active earth pressures may be used for walls than can yield ¼ inch per 10 feet of wall height; restrained walls that cannot move this much should be designed for at-rest pressures. The following table presents recommendations for design of the abutment walls and channel walls based on equivalent fluid pressures with a level grade behind the retaining structures.

Table 12 – Abutment Wall Design Parameters

Design Parameter	Retained Material		
	Onsite[1] Total Unit Weight	**Onsite[1] Buoyant**	**Bedrock**
Soil Unit Weight (pcf)	125	63	68
Angle of Internal Friction (ø)	32°	32°	34°
Equivalent Fluid Pressure (Level Surface Behind Wall):			
Active (pcf)	38	19	19
At-Rest (pcf)	59	30	30
Seismic Increment [2] (k_h = 0.22)	19	9	10
(k_h = 0.33)	32	16	16

[1] Very low to non-expansive soil.

[2] Total load demand on wall due to seismic shaking is sum of the Static earth pressure and the Seismic Increment; both pressures applied as equivalent fluid, i.e. linearly increasing with depth below top of wall. The k_h value of 0.33 recommended for use in design of anchor-supported walls

Design of the retaining walls should include the surcharges associated with surface loads adjacent to the walls or located within a distance equal to the wall height. Traffic surcharges may be modeled as a uniform lateral pressure of intensity 125 psf in accordance with AASHTO 3.11.6.4.

3.6 Earth Anchors

The design of the proposed abutment walls and channel walls will include sub-horizontal earth anchors (tieback anchors) to supplement the lateral load resistance of the wall system. The recommendations subsequently presented for design have been based upon the use of ground improvement techniques to mitigate the effects of liquefaction-induced lateral spreading, thereby allowing design to be based solely upon the earth pressures generated by the retained material and no additional load demand to restrain/stabilize the bridge approaches.

3.6.1 Anchor Bond Stress

The pullout capacity of the earth anchors embedded into the cuts required to construct abutments and channel walls will contribute to the total resistance to lateral load imposed upon the wall system. The installation of the anchors is expected to be within the geologic unit identified as older alluvial soils (Qoa). Based upon the type of material into which the anchors of these soldier pile walls will be embedded, the anchor pullout resistance is recommended to be calculated using a unit resistance of 1,500 psf (nominal) with grout placement under gravity or 3,000 psf (nominal) using pressure grout methods.

The unbonded zones of the anchors for is recommended to extend a distance behind the proposed wall to ensure all bonded lengths are behind a hypothetical failure plane rising up at an inclination of 60 degrees beginning at the bottom of the retaining wall.

The actual length of the unbonded zone should be determined based upon a parallel offset located at a distance equal to the greater of 5 feet or 20 percent of the wall height behind the hypothetical failure plane described above.

3.6.2 Anchor Installation

Anchor installation is recommended to be performed at shallow angle, typically in the range to 10 to 20 degrees to reduce axial compressive load demand on the CIDH piles and to ensure the entirety of the bonded lengths of the anchors will be above groundwater, which was typically encountered at depths of 20 to 25 feet below current grade. Test boring exploration of the anchor zones immediately prior to construction may be beneficial to evaluate groundwater conditions that may exist at the time.

The soils in which anchors will be installed include zones of granular soils that may be prone to caving. Anchor installation should, therefore, be performed as soon as practical to reduce the potential for caving to occur. Provisions to allow clearing boreholes of sloughed material (i.e. hole-cleaning tools) should be available on site. In no instance should anchors be forced into a borehole with difficulty or be partially inserted into a borehole.

Conventional anchors should be filled with concrete placed by pumping from the tip outward (toward the wall), and the concrete should extend from the tip of the anchor to the offset plane behind the active wedge. To minimize chances of caving, we suggest that the portion of the anchor shaft within the active wedge be backfilled with sand before testing the anchor.

This portion of the shaft should be filled tightly and flush with the face of the excavation. The sand backfill may contain a small amount of cement to allow the sand to be placed by pumping.

3.6.3 Anchor Testing

The installation of the anchors and the testing of the completed anchors should be observed by the geotechnical engineer. Testing of the anchors is recommended to be performed in substantial compliance with Caltrans specifications (Section 46-2.01D(2)(b)).

In accordance with Caltrans guidelines, performance testing is required of three (3) anchors per wall zone and 5% of the total production anchors; all remaining production anchors are subjected to proof tests. The loading schedules and load durations for the two types of tests should follow the Caltrans specifications.

After a satisfactory test, each production anchor should be stressed to a specific load (i.e. lock off load) against the structure element. For the production anchors located in the abutment wall structures, the lock off load is recommended to be 67% of the factored design load (FDL). Production anchors located in the channel walls are recommended to be stressed to 55% of the FDL.

3.6.4 Wall Drainage

The pressures in Section 3.5.3 include the equivalent fluid pressure under drained conditions as well as undrained conditions (i.e. buoyant) in which hydrostatic pressures have been assumed to develop behind the respective retaining structure. The use of the drained equivalent fluid pressure assumes that retaining structures are equipped with a drainage system to prevent the accumulation of hydrostatic pressures.

The abutment walls at Bridge 1 and Bridge 3 are planned to be constructed in a top-down manner after installation of the CIDH piles that will support the bridge structures. Drainage systems behind the top-down wall systems will require installation of a geosynthetic specially designed and manufactured for this purpose (i.e. drainboard) placed against the earth materials exposed by cutting. The drainboards should be placed at regular intervals across the widths of the walls, and in each section the drainboard should continuously extend vertically to an appropriate drainage facility such as pre-fabricated drain pipe outletting to a central collection facility. In the case of secant pile walls, design should either be based upon undrained conditions (i.e. buoyant equivalent earth pressures plus hydrostatic pressure) or a permanent subsurface system drainage system be included in design and construction. In consideration of the nature of this type of structure, installation of a drainage system will need to be performed after construction or somehow incorporated in the construction of the CIDH piles. One possible method of drainage may be the installation of weep holes in the non-reinforced piles (referenced as "primary" piles in the project plans).

In the case of wing walls and the anticipation that these walls will be backfilled after construction of the retaining wall structure, a permanent subsurface drain such as the drain indicated in Caltrans Standard Plan BO-3 (or equivalent) is recommended.

3.7 Drilled Shaft Construction

The construction of the drilled shafts is recommended to be performed in accordance with Section 49-3.02 of the Caltrans *Standard Specifications* (2018).

3.7.1 Permanent Casing

In accordance with Section 49-3.02C(7) of the *Standard Specifications*, a permanent casing should be used for construction in situations where a construction joint is utilized. In general, casings may be installed by impact hammer, vibratory hammer, oscillators, rotators, or by placing in a drilled hole. We recommend that the casing consist of corrugated steel. This casing should be installed in an oversized drilled hole and grouted in place in accordance with Caltrans *Standard Specifications* Section 49-3.02C(6).

Grouting the annulus is equivalent to pouring a CIDH and, therefore, no reduction in skin friction or increase in pile length would be necessary with this type of permanent casing installation. The use of other methods/types of permanent casing at the construction joint will require review of the axial capacity calculations and may result in the need for slightly deeper tip elevations.

3.7.2 <u>Acceptance Criteria</u>

The as-built quality of the completed drilled shafts is recommended to be evaluated by conducing non-destructive testing such as Gamma-Gamma logging per Caltrans Test Method 233. Anomalies detected by gamma-gamma logging will need to be evaluated and/or repaired prior to acceptance of the pile(s). In this event, a mitigation plan will be required as described in Section 49-3.02A(3)(g) of the Caltrans *Standard Specifications* (2018).

3.7.3 <u>Installation Methods</u>

Drilling operations for installation of the CIDH piles will encounter interbedded layers of non-cohesive sand and silty sands that could present borehole stability problems if dry construction techniques are used without temporary casing. In addition, groundwater is anticipated to be encountered at depths of 20 to 25 feet below current roadway grade, which could also result in borehole stability problems and adversely affect construction. As a result, drilling operations may include either the use of drilling slurry (i.e. wet construction) to maintain borehole stability or the use of temporary casing to prevent caving. The use of a temporary casing may be hindered and infeasible where a construction joint is intended for construction of drilled shafts due to the requirement for a permanent casing to be used across the joint.

In general, casings may be installed by impact hammer, vibratory hammer, oscillators, rotators, or by placing in a drilled hole. Casing installed in an oversized drilled hole and grouted in place is expected to result in no reduction in skin friction, as described above in regard to permanent casing.

Pile installation by wet construction should use an appropriate slurry as a drilling fluid. To maintain hole sidewall and bottom stability and mitigate potential anomalies it is essential that positive head be maintained above the groundwater table at all times during drilling operations and concrete placement. Concrete placement should be performed using a tremie and the bottom of the tremie be kept at least 10 feet below the rising surface of the fresh concrete.

As an alternate to the use of drilling fluids, piles may be constructed using a temporary full-depth oscillator casing to maintain a stable hole.

Experience indicates that use of oscillator casing minimizes the potential for anomalies and can allow cleaning of the bottom for inclusion of end bearing in design. The oscillation of the cutting teeth on the bottom of the casing leaves a rough surface texture on the drilled shaft during withdrawal. The condition of the borehole walls after removal of the oscillator casing is, therefore, considered to have no significant effect on side resistance.

3.8 Additional Geotechnical Services

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited subsurface explorations, limited laboratory testing and information available at the time the report is prepared. Additional geotechnical exploration and analysis may be required based on final foundation and improvement plans. Leighton Consulting should review the site and grading plans when available and comment further on the geotechnical aspects of the project. Geotechnical observation and testing should be conducted during excavation and all phases of grading and construction operations. The conclusions and recommendations should be reviewed and verified by Leighton Consulting during earthwork and foundation construction and revised accordingly if geotechnical conditions encountered vary from our preliminary findings and interpretations.

Geotechnical observation and testing should be provided during the following activities:

- Grading and excavation of the site;
- During overexcavation and removal of unsuitable soil;
- Subgrade preparation;
- Compaction of all fill materials;
- Utility trench backfilling and compaction;
- During ground improvement installation, if used;
- Drilled shaft construction;
- During installation and testing of ground anchors;
- Pavement subgrade and base preparation;
- Placement of asphalt concrete and/or concrete; and
- When conditions are encountered on site that are not consistent with the conditions described in this report.

4.0 LIMITATIONS

Leighton Consulting's professional services were performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, express or implied, is made as to the conclusions and professional opinions included in this report.

As in many projects, conditions revealed in excavations may be at variance with preliminary findings. If this occurs, the geotechnical consultant should evaluate the changed conditions and additional recommendations be obtained, as warranted.

The identification and testing of hazardous, toxic or contaminated materials were outside the scope of Leighton Consulting's work. Should such materials be encountered at any time, or their existence be suspected, and all measures stipulated in local, County, State and Federal regulations, as applicable, should be implemented.

This report is issued with the understanding that it is the responsibility of the owner, or of his representative, to ensure that the information and recommendations contained herein are brought to the attention of the necessary design consultants for the project and incorporated into the plans; and that the necessary steps are taken to see that the contractors carry out such recommendations in the field.

The findings of this report are considered valid as of the report's date. However, changes in the condition of a property can occur with the passage of time, whether due to natural processes or the work of man on the subject or adjacent properties. In addition, changes in standards of practice may occur from legislation or the broadening of knowledge. Accordingly, the findings of this report may at some future time be invalidated wholly or partially by changes outside Leighton Consulting's control.

The conclusions and recommendations in this report are based in part upon data that were obtained from a necessarily limited number of observations, site visits, excavations, samples and tests. Such data are strictly applicable only with respect to the specific locations explored, and therefore may not completely define all subsurface conditions throughout the site. The nature of many sites is that differing geotechnical or geological conditions can occur within small distances and under varying climatic conditions. Furthermore, changes in subsurface conditions can and do occur over time. Therefore, the findings, conclusions and recommendations presented in this report can be relied upon only if Leighton has the opportunity to observe the subsurface conditions during grading and construction of the project, in order to verify that our preliminary findings are representative of the site.

This report is intended only for the use of County of Orange and its representatives, and only as related expressly to the subject project. This report is not intended for any Third Party and should not be used for other projects. No responsibility is assumed for any Third Party that utilizes this report.

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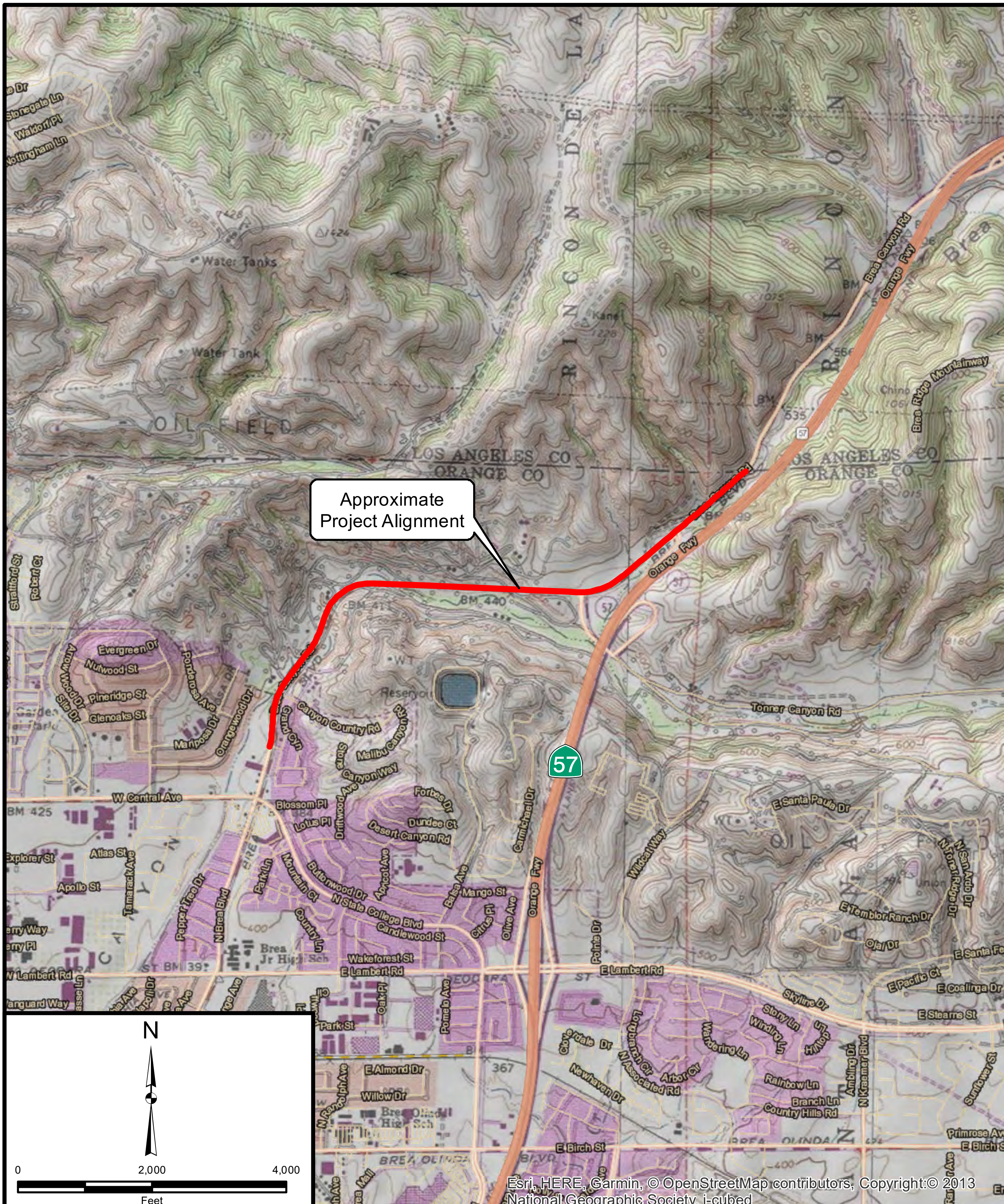


Project: 11588.001	Eng/Geol: JEH/JLH
Scale: 1 " = 2,000 '	Date: January 2019

Base Map: ESRI ArcGIS Online 2019

Author: Leighton Geomatics (mmurphy)

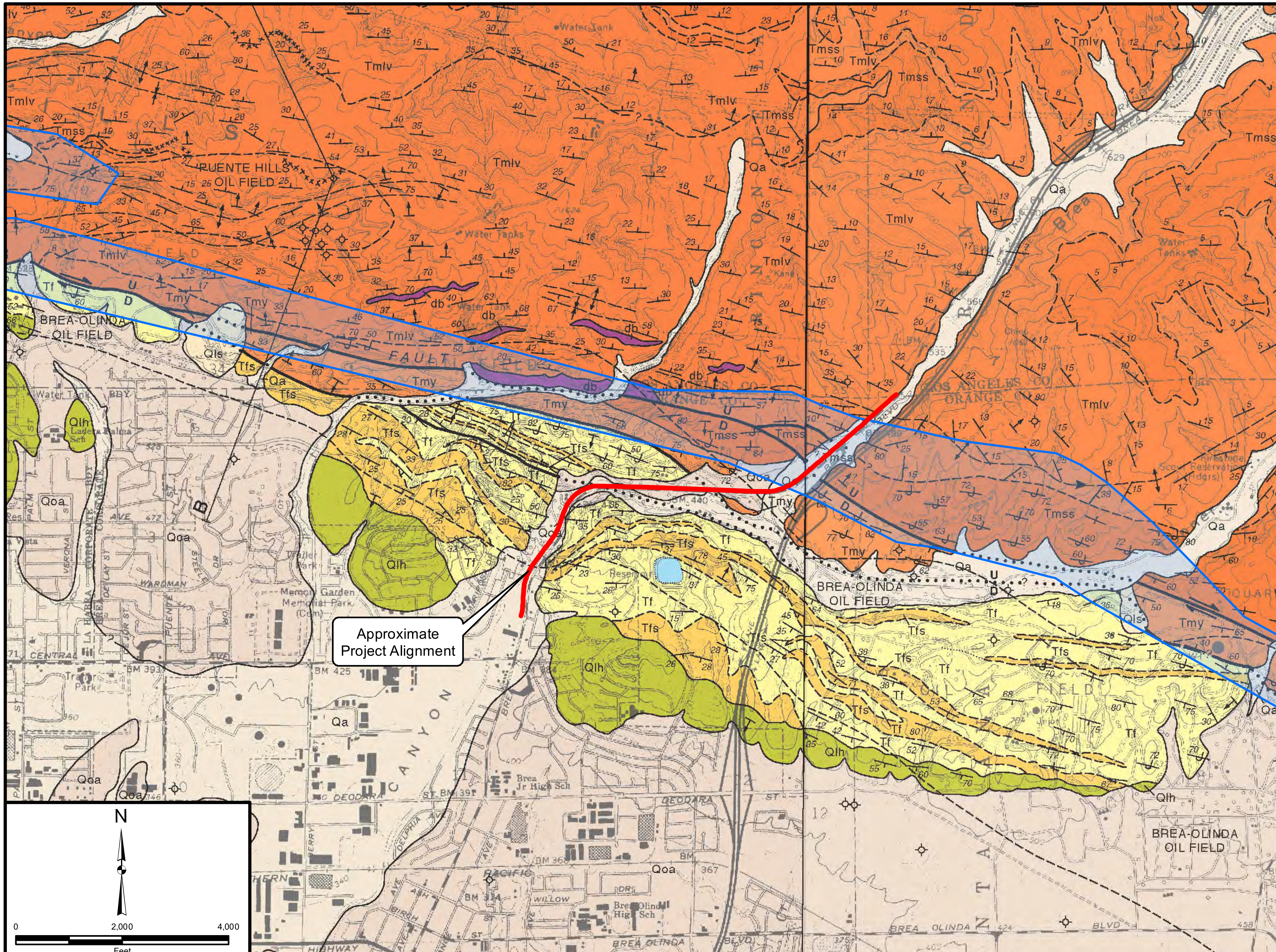
SITE LOCATION MAP

Brea Boulevard Widening
Orange County, California

Figure 1

Leighton

Map Saved as V:\Drafting\11588\001\Maps\11588-001_F01_SLM_2019-01-30.mxd on 1/30/2019 8:32:39 AM



Legend

Symbol	Description
	AP Fault Zone
af	Artificial fill, some recent areas may not be shown
Qa	Alluvial gravel, sand, and silt of valleys and floodplains
Qls	Landslide debris
Qoa	Elevated, dissected remnants of alluvial sand and gravel
Qlh	Tan to light gray sandstone and pebble conglomerate, vaguely bedded, includes abundant siliceous shale pebbles south of Puente Hills
Tfs	Sandstone facies: light gray, weathers light brown, fine to coarse-grained, bedded, locally fossiliferous; includes pebble conglomerate; locally includes minor gray siltstone
Tf	Siltstone to claystone facies: siltstone to claystone facies; gray, vaguely bedded, commonly finely sandy, micaceous, locally includes thin layers of sandstone
Tmy	Yorba Shale Member: thin-bedded, white-weathering, platy siliceous, to light gray, semi-siliceous to silty, locally with thin layers of fine-grained sandstone; locally includes few thin layers of hard, yellowish-gray dolomite
Tmss	Soquel Sandstone Member and facies: mostly bedded sandstone, light gray, weathering fan, mostly medium-grained, arkosic, locally ranging to coarse pebbly, with minor biotite; inclues minor silty clay shale
Tmlv	La Vida Shale Member: thin-bedded, cream-white weathering, platy, siliceous to semi-siliceous shale, with some thin layers of gray siltstone, also some layers of hard, yellow-gray dolomite, and thin layers of sandstone
db	Diabase: black, fine-grained, massive; forms one or more sills within lower Tmlv

GEOLOGIC SYMBOLS

not all symbols shown on each map

FORMATION CONTACT dashed where inferred or indefinite dotted where concealed

MEMBER CONTACT between units of a formation; Prominent bed

CONTACT BETWEEN SURFICIAL SEDIMENTS located only approximately in places

FAULT: Dashed where indefinite or inferred, dotted where concealed, queried where existence is doubtful. Parallel arrows indicate inferred relative lateral movement. Relative vertical movement is shown by U/D (U=upthrown side, D=downthrown side). Short arrow indicates dip of fault plane. Sawtooth are on upper plate of low angle thrust fault.

FOLDS: overturned; ANTICLINE; SYNCLINE; arrow on axial trace of fold indicates direction of plunge; dotted where concealed by surficial sediments

Strike and dip of sedimentary rocks: inclined; inclined (approximate); overturned; horizontal; vertical

Strike and dip of metamorphic or igneous rock foliation or flow banding or compositional layers: inclined; inclined (approximate); vertical; overturned

OTHER SYMBOLS: Direction of landslide movement; outline of water bodies shown on map; water well; oil well; springs

Project: 11588.001	Eng/Geol: JEH/JLH
Scale: 1 " = 2,000 '	Date: April 2019

Base Maps: Geologic Map of the Whittier & La Habra Quadrangles by Thomas W. Dibblee, Jr., 2001 and Yorba Linda & Prado Dam Quadrangles by Thomas W. Dibblee, Jr., 2001.
Author: Leighton Geomatics (mmurphy)

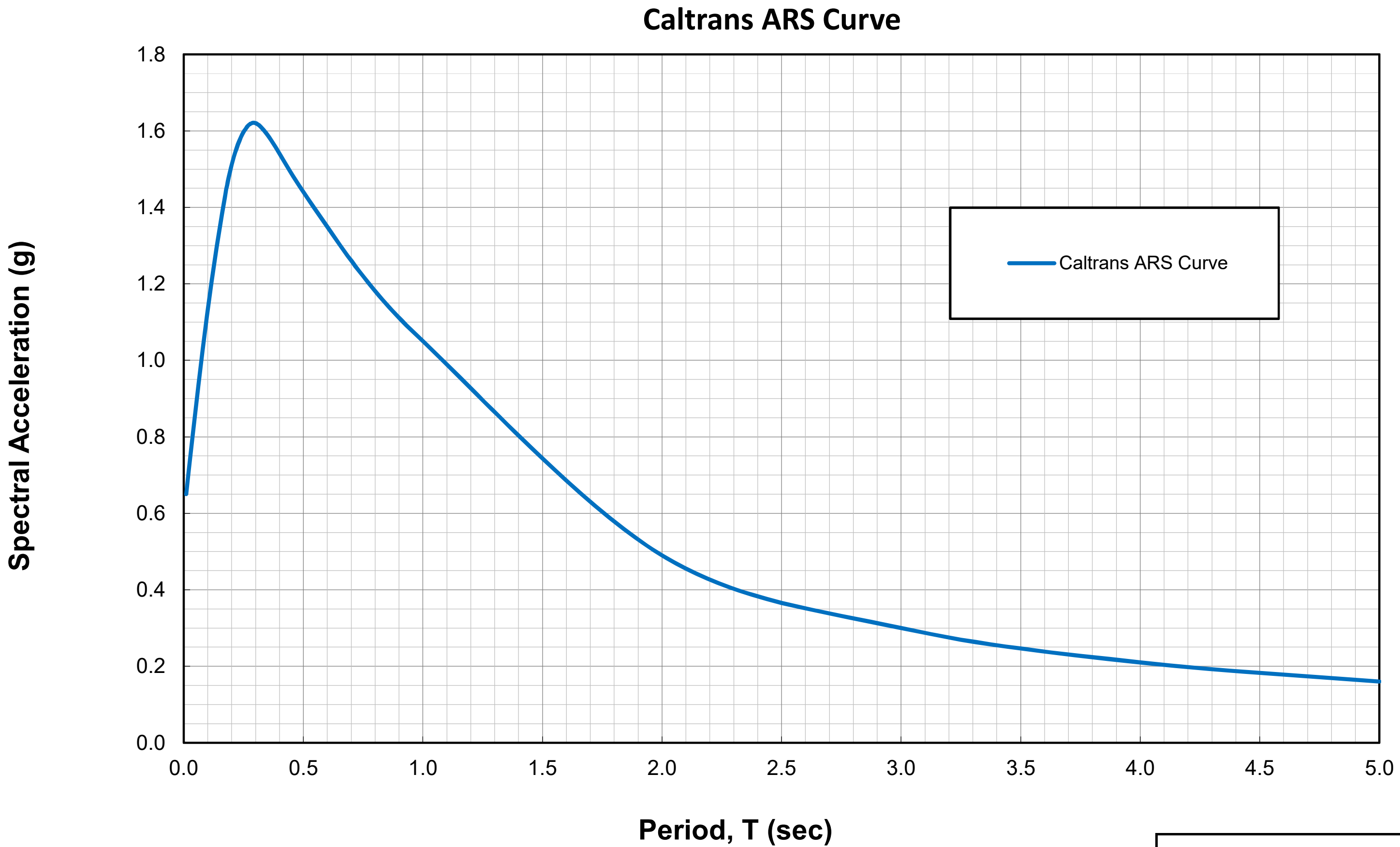
REGIONAL GEOLOGY MAP

Brea Boulevard Widening
Orange County, California

Figure 2

Leighton

Map Saved as V:\Drafting\11588\001\Maps\11588-001_F02_RGM_2019-01-29.mxd on 4/18/2019 12:19:57 PM



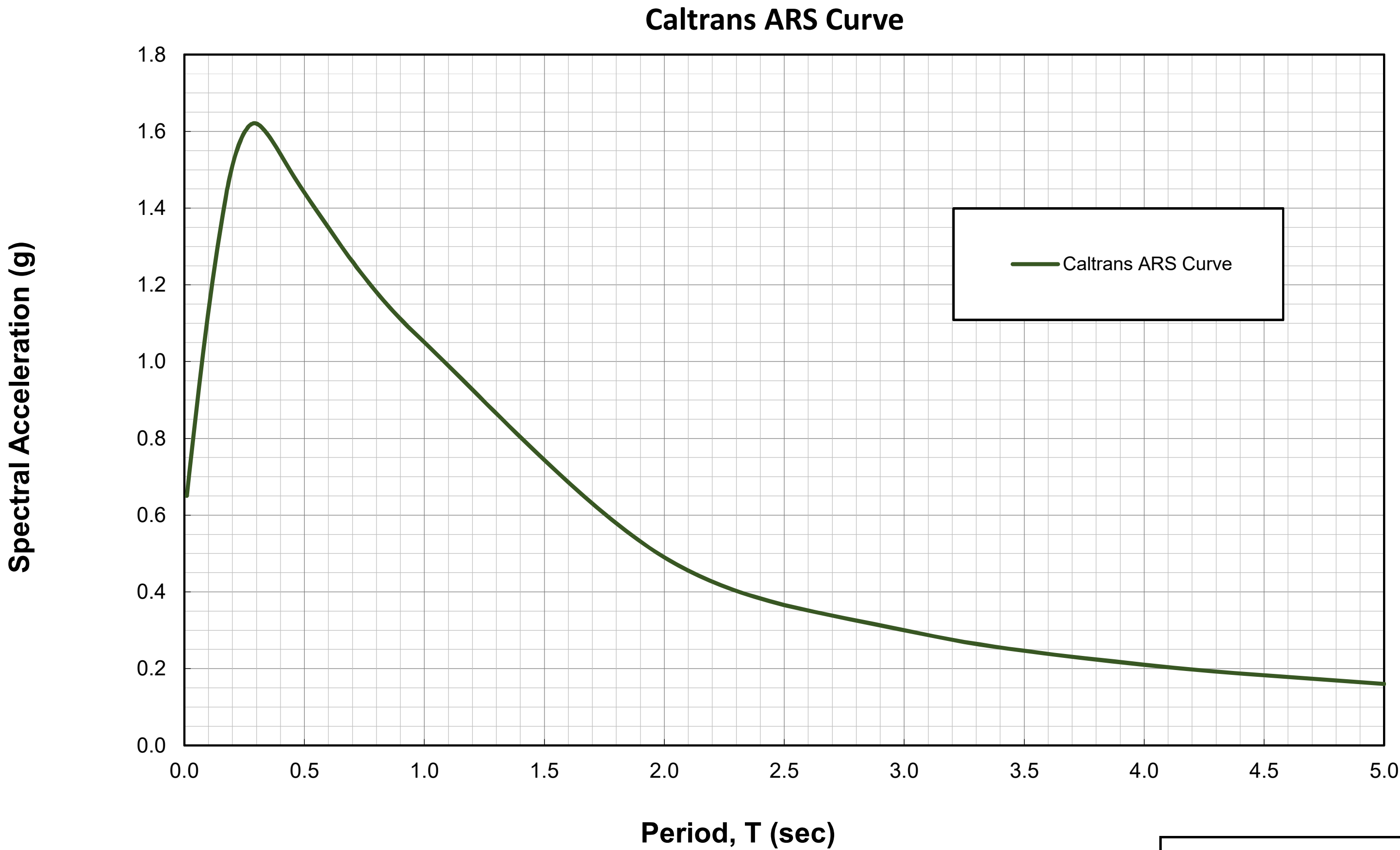
Caltrans ARS Design Envelope	
Period (sec)	Spectral Acceleration (g)
0.01	0.65
0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9378; Longitude: -117.8917
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 1
Orange County, California

Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3a



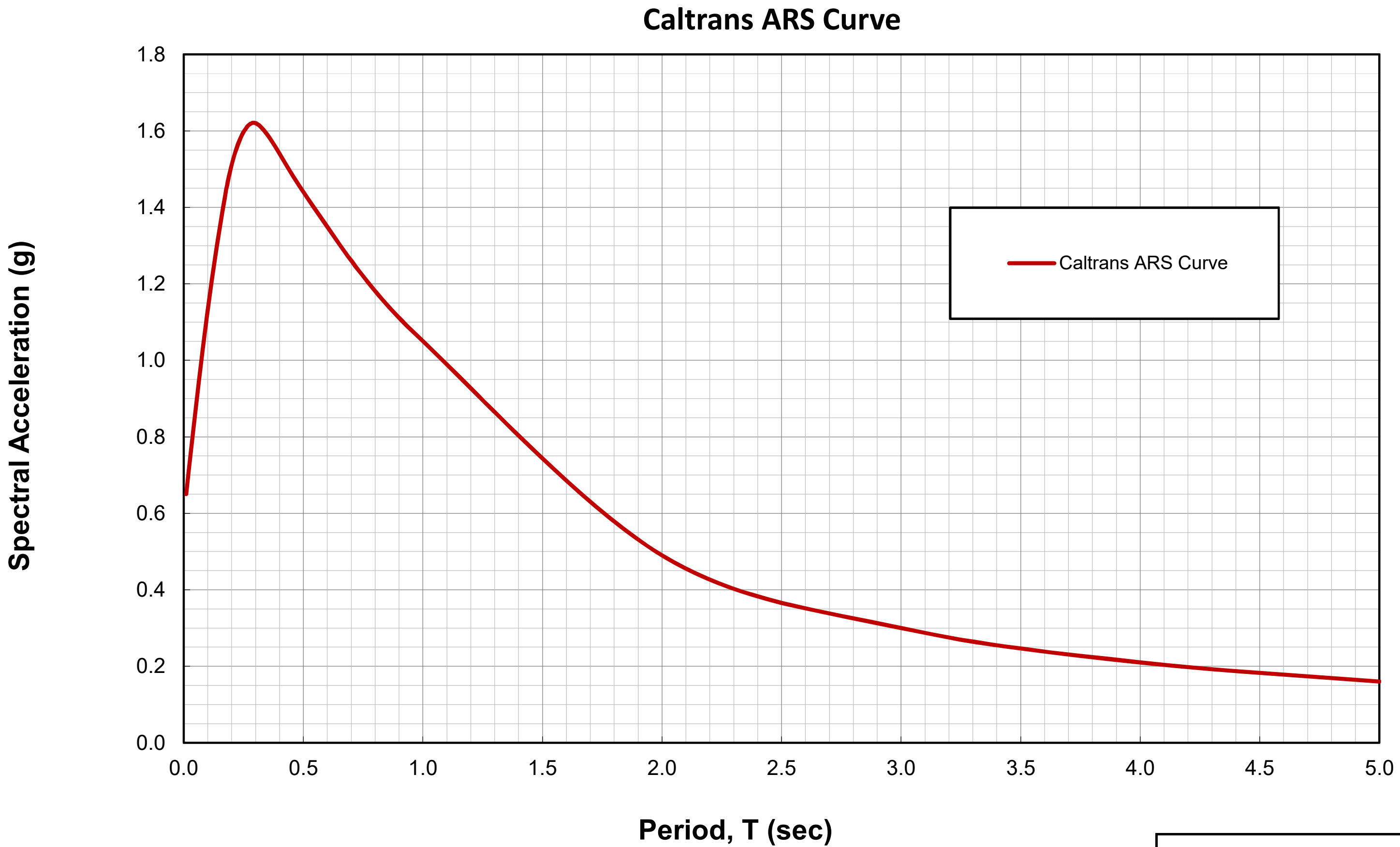
Caltrans ARS Design Envelope	
Period (sec)	**Spectral Acceleration (g)**
0.01	0.65
0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9400; Longitude: -117.8906
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 2
Orange County, California

Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3b



Caltrans ARS Design Envelope

Period (sec)	Spectral Acceleration (g)
0.01	0.65
0.10	1.13
0.20	1.51
0.30	1.62
0.50	1.44
0.75	1.22
1.00	1.05
2.00	0.49
3.00	0.30
4.00	0.21
5.00	0.16

Site Coordinates: Latitude: 33.9411; Longitude: -117.8875
Shear Wave Velocity - Vs_{30} (meters/sec) = 310
Program Used: Caltrans ARS Online Version 3.0.2

CALTRANS ARS CURVE
Brea Boulevard Corridor Improvements - Bridge 3
Orange County, California

Project Name: Brea Boulevard
Project No.: 11585.005
Designed/Checked by: JEH
Date: May 2021

Figure 3c

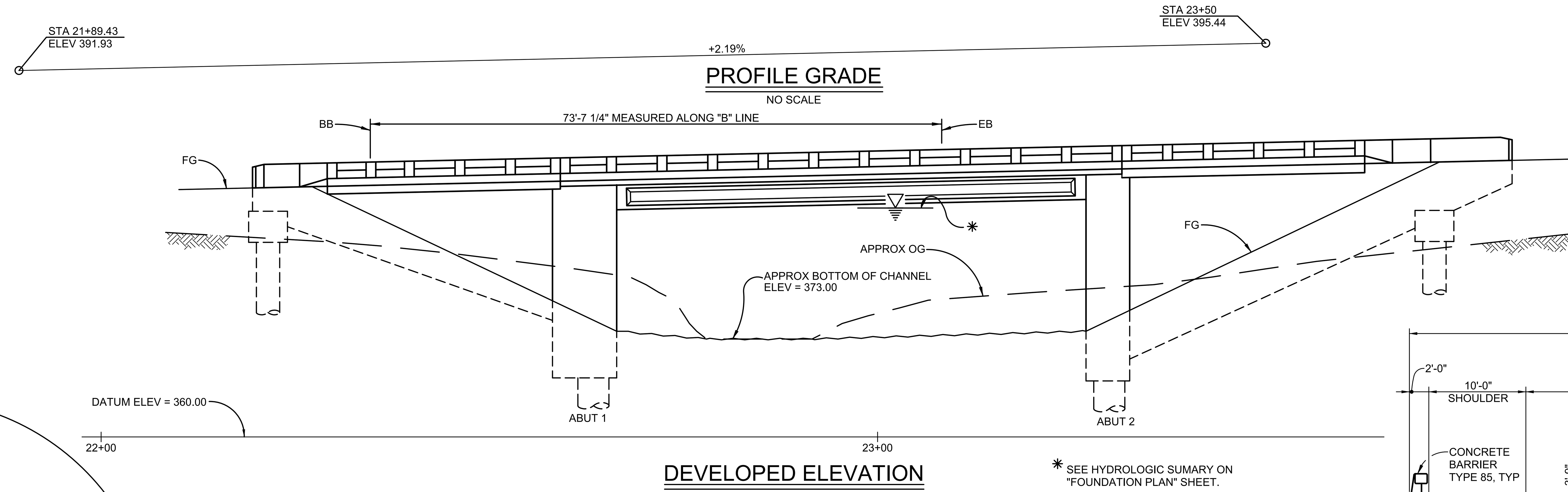
APPENDIX A

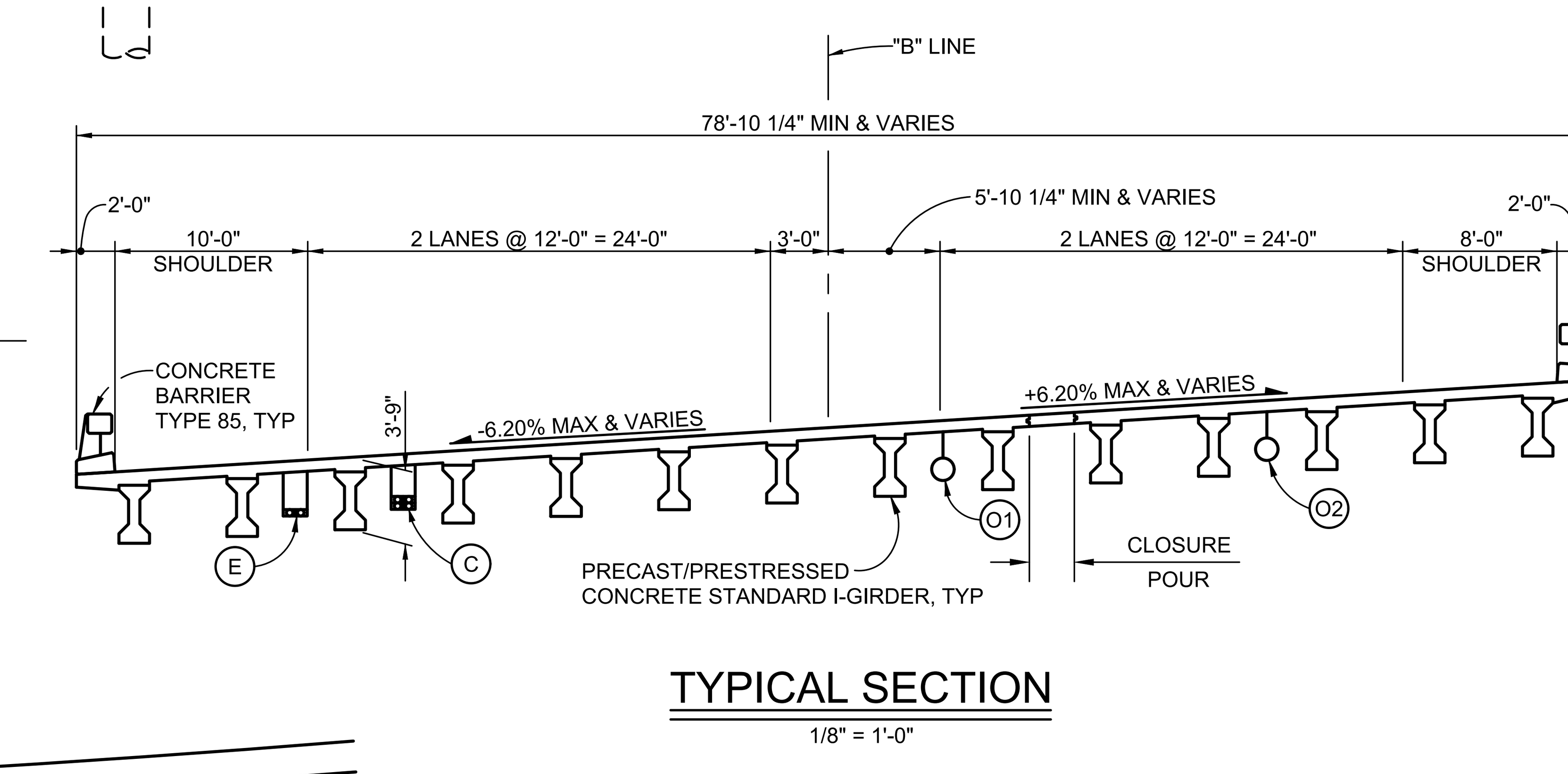
General Plans

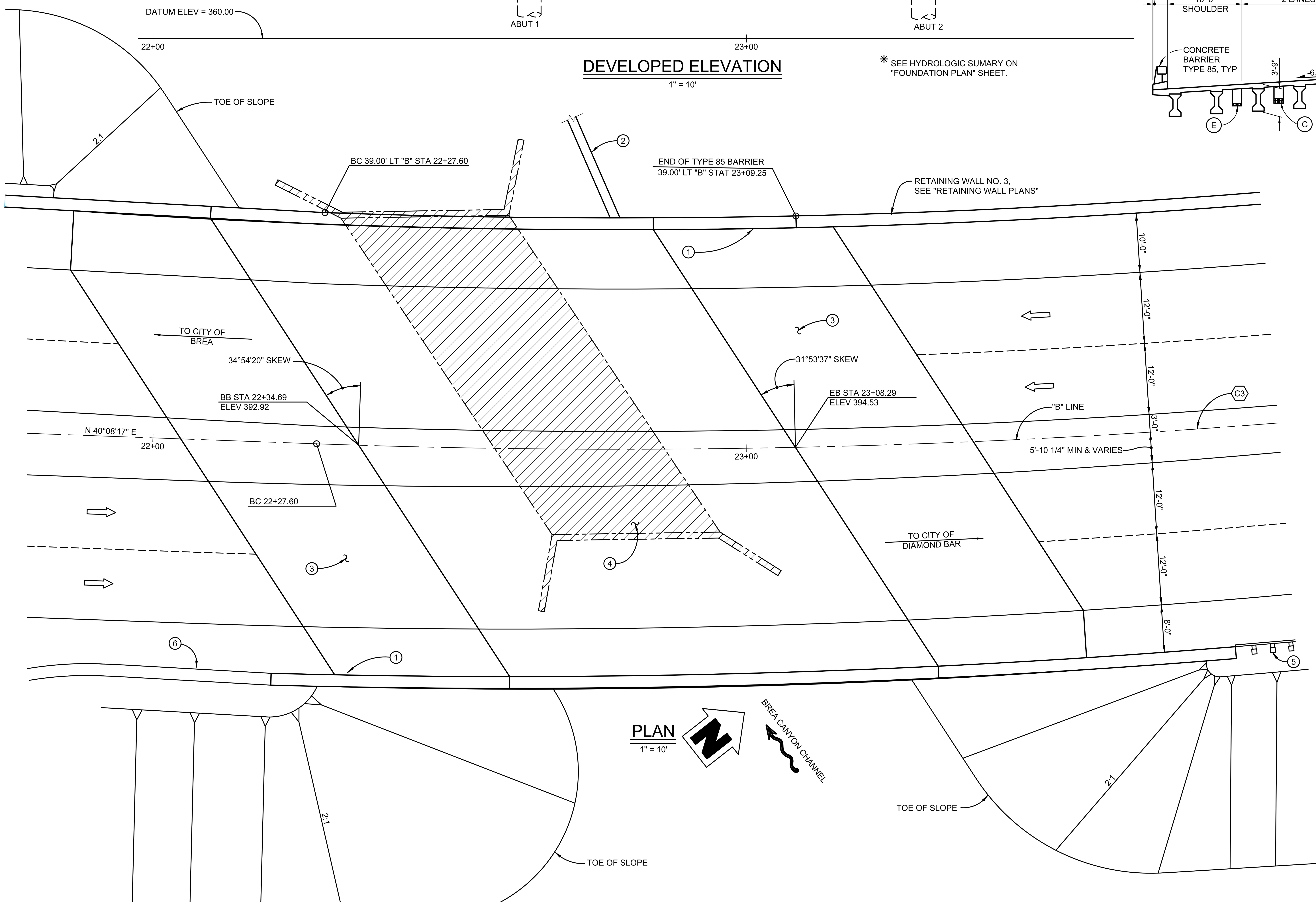
and

Foundation Plans

Leighton







UTILITIES

- (C) 4 - 4"Ø AT&T AND CHARTER COMMUNICATIONS LINES
- (E) 2 - 4"Ø SCE ELECTRICAL LINES
- (O1) 8"Ø OIL LINE
- (O2) 6"Ø OIL LINE

NOTES:

1. PAINT "BRIDGE NO. 55C0729"
2. TOP DOWN CONSTRUCTION CHANNEL WALL
3. STRUCTURE APPROACH SLAB TYPE N(30)
4. REMOVE EXISTING 55C021 BRIDGE IN STAGES
5. MIDWEST GUARD RAIL
6. CONCRETE BARRIER TYPE 60M

LEGEND:

- INDICATES EXISTING STRUCTURE TO BE REMOVED
- INDICATES DIRECTION OF FLOW
- INDICATES DIRECTION OF TRAFFIC

ALIGNMENT CURVE DATA

CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C3	1400.00'	19°38'58"	242.44'	480.13'

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
DATE

REGISTERED PROFESSIONAL ENGINEER MICHAEL A THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA

DESIGNED BY: JL
DRAWN BY: AR
CHECKED BY: JW
DRAWING NO.:
FILE NAME: S-01 GENERAL PLAN.dwg
PLOT DATE: 10/17/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks

PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS

BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0729
GENERAL PLAN

SHEET
S-01
175 OF 278

FOUNDATION PLAN

1" = 10'

SCOUR DATA TABLE

SUPPORT No.	LONG TERM (DEGRADATION AND CONTRACTION SCOUR ELEVATION (ft)	SHORT TERM (LOCAL) SCOUR DEPTH (ft)
ABUT 1	369	9
ABUT 2	369	9

HYDROLOGIC SUMMARY FOR BRIDGE NO. 55C0729

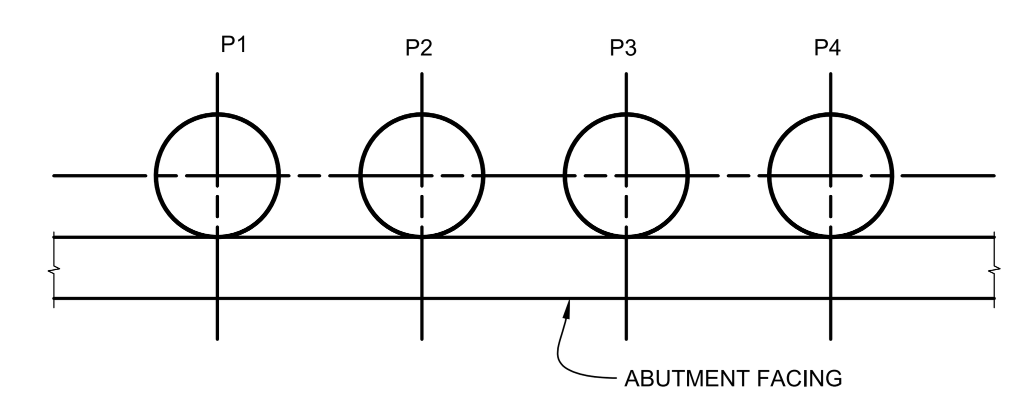
DRAINAGE AREA: 18.4 MI^2

FREQUENCY	DESIGN FLOOD	BASE FLOOD	FLOOD OF RECORD (1941)
	50-YEAR	100-YEAR	< 50-YEAR
DISCHARGE	7,180 cfs	8,030 cfs	3,000 cfs
WATER SURFACE ELEVATION AT BRIDGE	390.4 ft	391.5 ft	385.2 ft

FLOODPLAIN DATA ARE BASED UPON INFORMATION AVAILABLE WHEN THE PLANS WERE PREPARED AND ARE SHOWN TO MEET FEDERAL REQUIREMENTS. THE ACCURACY OF SAID INFORMATION IS NOT WARRANTED BY BIGGS CARDOSA ASSOCIATES AND INTERESTED OR AFFECTED PARTIES SHOULD MAKE THEIR OWN INVESTIGATION.

PILE INSTALLATION PROCEDURE
1. DAY 1: P1, P3
2. DAY 2: P2, P4

DRILLING OF THE DAY 2 PILES MUST NOT BEGIN UNTIL THE CONCRETE FROM THE DAY 1 PILES HAS SET UP FOR AT LEAST 24 HOURS AFTER PLACEMENT.



UTILITY TABLE

UTILITY	DESCRIPTION	OWNER	DISPOSITION
1	6" OIL	CHEVRON	TO BE RELOCATED (BY OWNER)
2	8" OIL	CRIMSON	TO BE RELOCATED (BY OWNER)
3	10" SEWER	COOPER & BRAIN	TO BE REMOVED
4	CABLE	AT & T	TO BE RELOCATED (BY OWNER)
5	ELECTRICAL	SCE	TO BE RELOCATED (BY OWNER)
6	CABLE	CHARTER	TO BE RELOCATED (BY OWNER)
7	8" SEWER	UNKNOWN	TO BE REMOVED
8	WATER	UNKNOWN	TO BE RELOCATED

LEGEND:
- INDICATES CIDH PILE
- INDICATES BOTTOM OF FOOTING ELEVATION

NOTES:
1. LOCATION OF UTILITIES ARE APPROXIMATE. SEE UTILITY PLANS FOR MORE INFORMATION.
2. PROTECT-IN-PLACE ALL UTILITIES THAT WILL BE PLACED PRIOR TO BRIDGE CONSTRUCTION.
3. AT THIS LOCATION, LIQUEFACTION HAS BEEN DETERMINED AS POSSIBLE DURING A SEISMIC EVENT. SOIL IMPROVEMENTS MUST BE MADE TO MITIGATE THE RISK POSED BY LIQUEFACTION PRIOR TO CONSTRUCTION OF PILE FOUNDATIONS. REFER TO FOUNDATION REPORT FOR LIMITS OF IMPACTED AREA AND RECOMMENDATIONS FOR SOIL IMPROVEMENTS.

PILE DATA TABLE

LOCATION	PILE TYPE	NOMINAL RESISTANCE (kips)		DESIGN TIP EL (ft)	SPECIFIED TIP EL (ft)
		COMPRESSION	TENSION		
ABUT 1	48" DIA CIDH	570	0	337.5(a); 340.0(d)	337.5
ABUT 2	48" DIA CIDH	615	0	336.5(a); 342.0(d)	336.5
ABUT 2 WEST CHANNEL WALL	36" DIA CIDH	80	0	338.0(a); 353.0(d)	338.0
ABUT 1 WINGWALL	36" DIA CIDH	100	0	348.5(a); 357.0(d)	348.5
ABUT 2 EAST PILE CAP	36" DIA CIDH	160	0	350.25(a); 358.0(d)	350.0

PILE DATA TABLE NOTES:
1. DESIGN TIP ELEVATIONS FOR ABUTMENTS AND BENTS ARE CONTROLLED BY: (a) COMPRESSION, (b) TENSION, (c) SETTLEMENT, (d) LATERAL LOAD.
2. THE CIDH SPECIFIED TIP ELEVATION SHALL NOT BE RAISED

100% SUBMITTAL NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

DATE

REGISTERED PROFESSIONAL ENGINEER MICHAEL A. THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA

DESIGNED BY: JL | CHECKED BY: JW | DRAWN BY: AR | DRAWING NO.: | FILE NAME: S-05 FOUNDATION PLAN.dwg | PLOT DATE: 10/17/2021 | SCALE: AS SHOWN

County of Orange
OC PublicWorks

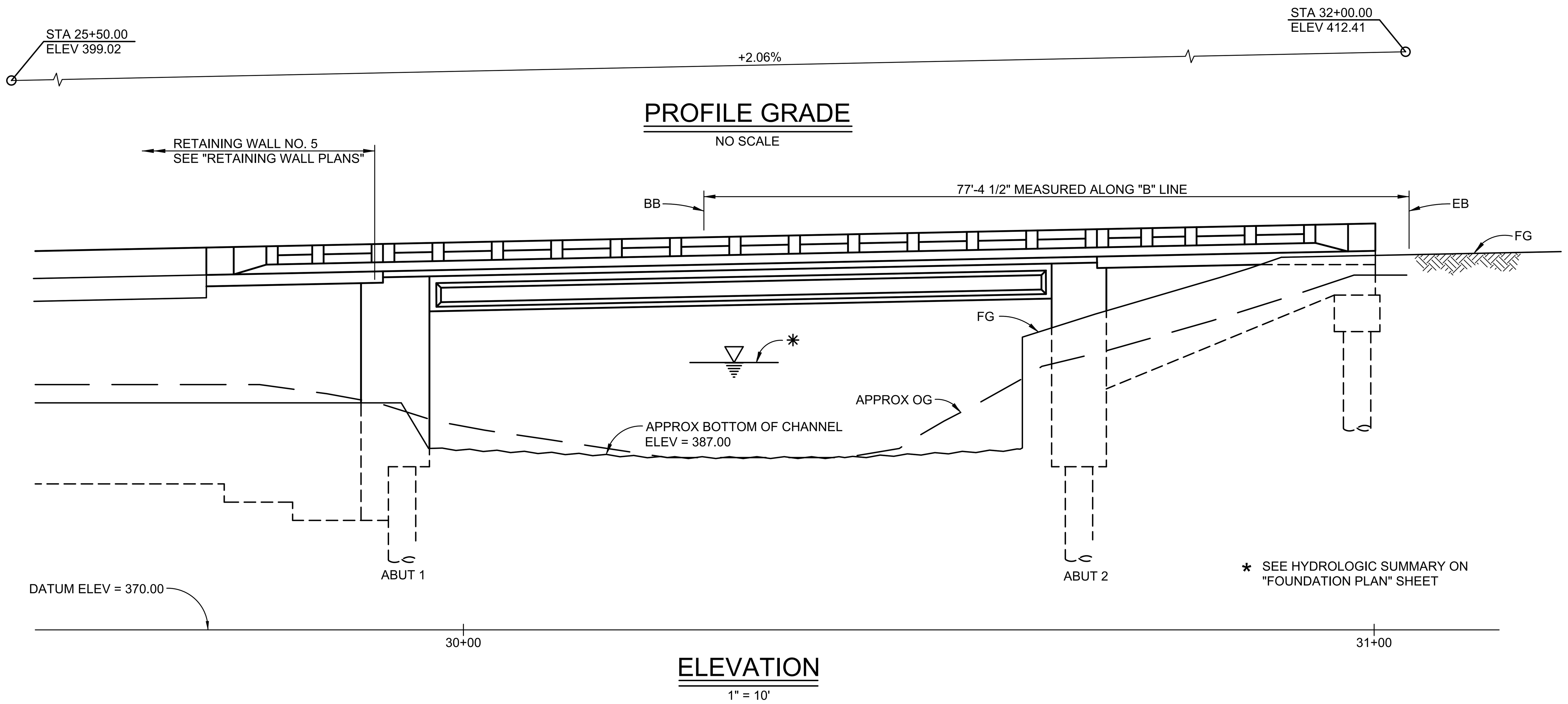
PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS

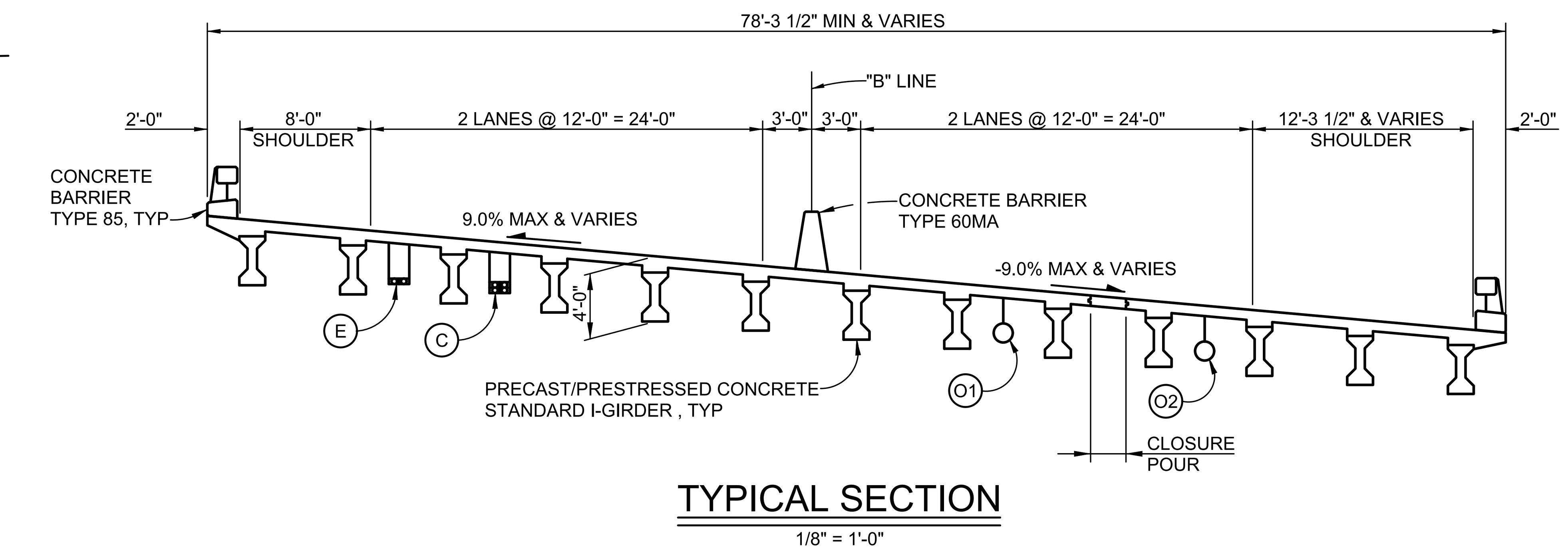
BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0729

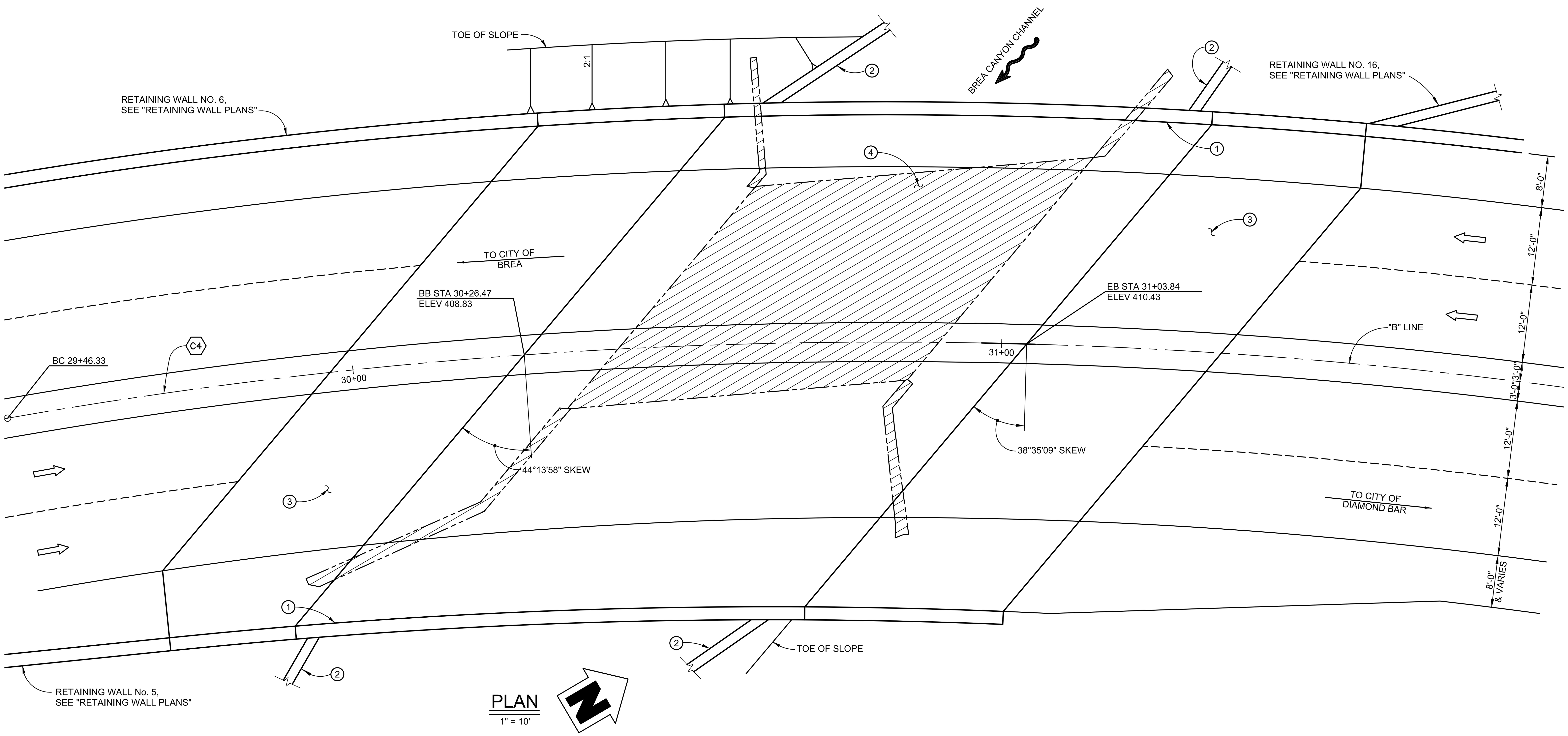
FOUNDATION PLAN

SHEET

S-05







UTILITIES

- (C) 4 - 4"Ø AT&T AND CHARTER COMMUNICATION LINES
- (E) 2 - 4"Ø SCE ELECTRICAL LINES
- (O1) 8"Ø OIL LINE (CRIMSON PIPELINE)
- (O2) 6"Ø OIL LINE (CHEVRON PIPELINE)

NOTES:

1. PAINT "BRIDGE NO. 55C0730"
2. CHANNEL WALL
3. STRUCTURE APPROACH TYPE N(30)
4. REMOVE EXISTING 55C022 BRIDGE IN STAGES

LEGEND:

- INDICATES EXISTING STRUCTURE TO BE REMOVED
- INDICATES DIRECTION OF TRAFFIC
- INDICATES DIRECTION OF FLOW

ALIGNMENT CURVE TABLE

CURVE #	RADIUS	DELTA	TANGENT	LENGTH
C4	785.00'	71°55'33"	569.56'	985.44'

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER MICHAEL A THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA

DATE

DESIGNED BY: JL
CHECKED BY: JW
DRAWN BY: AR
DRAWING NO.:
FILE NAME: S-28 GENERALPLAN.dwg
PLOT DATE: 10/17/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks

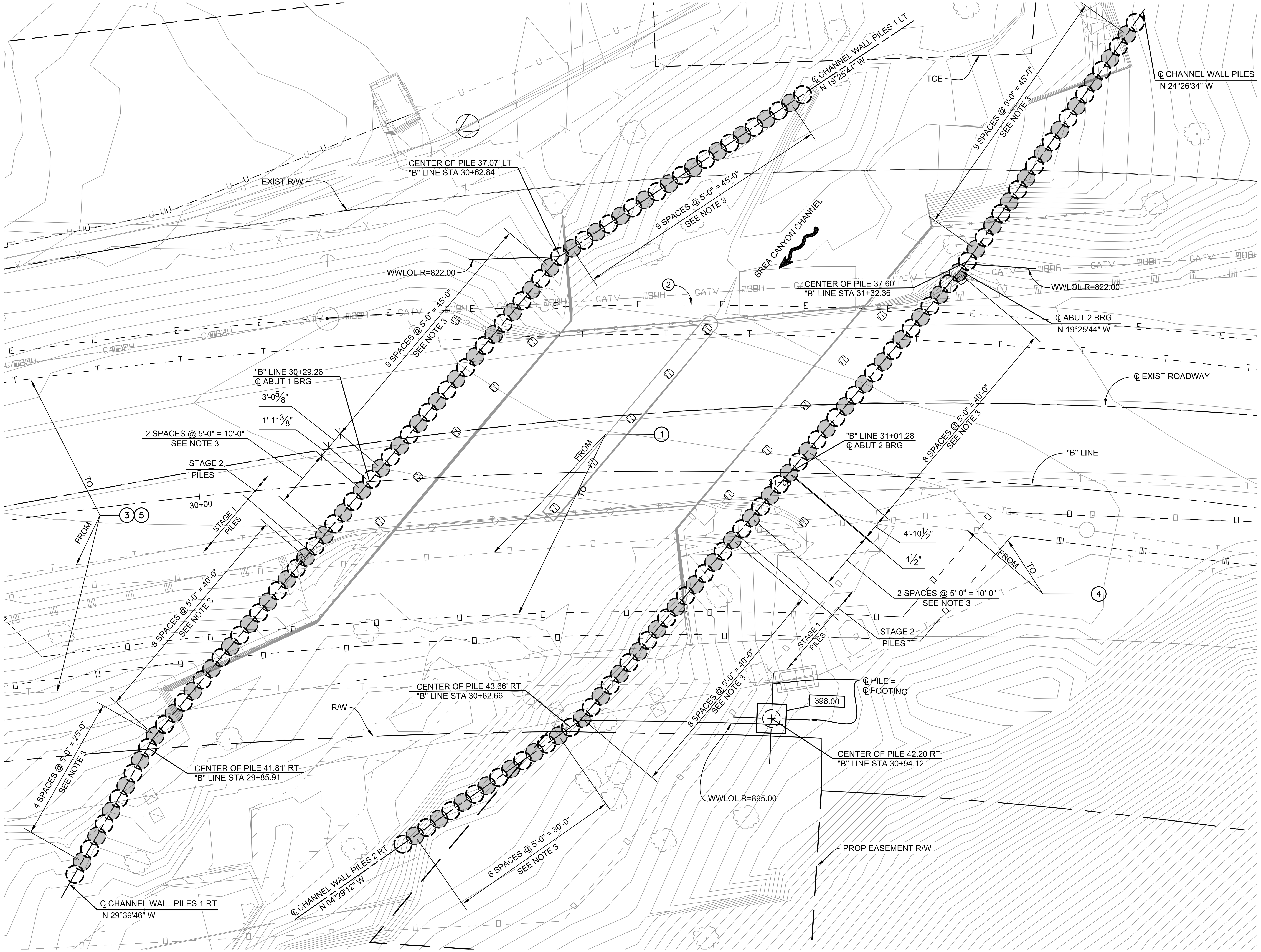
PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS

BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0730

GENERAL PLAN

SHEET

S-28



SCOUR DATA TABLE		
SUPPORT No.	LONG TERM (DEGRADATION & CONTRACTION SCOUR ELEVATION) (ft)	SHORT TERM (LOCAL) SCOUR DEPTH (ft)
ABUT 1	369.00	9
ABUT 2	369.00	9

HYDROLOGIC SUMMARY FOR BRIDGE NO. 55C0730			
DRAINAGE AREA: 18.4 MI^2			
FREQUENCY	DESIGN FLOOD	BASE FLOOD	FLOOD OF RECORD (1941)
	50-YEAR	100-YEAR	< 50-YEAR
DISCHARGE	7,180 cfs	8,030 cfs	3,000 cfs
WATER SURFACE ELEVATION AT BRIDGE	398.1 ft	398.7 ft	394.1 ft

FLOODPLAIN DATA ARE BASED UPON INFORMATION AVAILABLE WHEN THE PLANS WERE PREPARED AND ARE SHOWN TO MEET FEDERAL REQUIREMENTS. THE ACCURACY OF SAID INFORMATION IS NOT WARRANTED BY BIGGS CARDOSA ASSOCIATES AND INTERESTED OR AFFECTED PARTIES SHOULD MAKE THEIR OWN INVESTIGATION.

NOTES:
1. LOCATION OF UTILITIES ARE APPROXIMATE. SEE UTILITY PLANS FOR MORE INFORMATION.
2. PROTECT-IN-PLACE ALL UTILITIES THAT WILL BE PLACED PRIOR TO BRIDGE CONSTRUCTION.
3. ALL DIMENSIONS REPRESENT SPACING BETWEEN ℄ OF PRIMARY PILES
4. FOR CUTOFF ELEVATIONS, SEE "GROUND ANCHOR LAYOUT" SHEET.

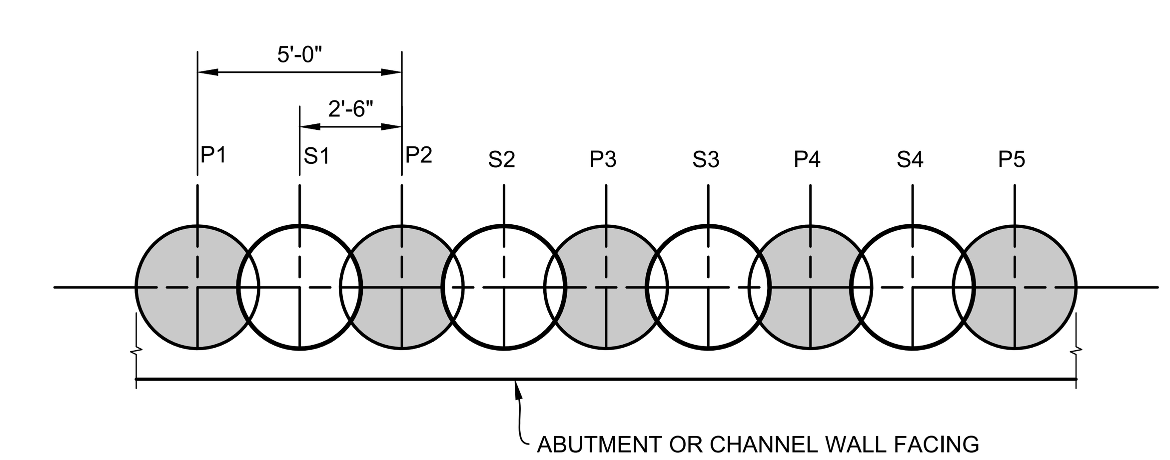
PILE DATA TABLE

LOCATION	PILE TYPE	NOMINAL RESISTANCE (kips) COMPRESSION	NOMINAL RESISTANCE (kips) TENSION	DESIGN TIP EL (ft)	SPECIFIED TIP ELEV (ft)
ALL	36" DIA CIDH (PRIMARY)	-	-	-	365
ABUT 1	36" DIA CIDH (SECONDARY)	385	0	355(a); 347(d)	347
ABUT 2	36" DIA CIDH (SECONDARY)	370	0	356(a); 348(d)	348
CHANNEL WALL 1 LT	36" DIA CIDH (SECONDARY)	70	0	363(a); 351(d)	351
CHANNEL WALL 1 RT	36" DIA CIDH (SECONDARY)	70	0	363(a); 351(d)	351
CHANNEL WALL 2 LT	36" DIA CIDH (SECONDARY)	70	0	361(a); 351(d)	351
CHANNEL WALL 2 RT	36" DIA CIDH (SECONDARY)	70	0	366(a); 351(d)	351
WINGWALL	36" DIA CIDH	80	0	372(a); 373(d)	370

PILE DATA TABLE NOTES:
1. DESIGN TIP ELEVATIONS FOR ABUTMENTS AND BENTS ARE CONTROLLED BY: (a) COMPRESSION, (b) TENSION, (c) SETTLEMENT, (d) LATERAL LOAD.
2. THE CIDH SPECIFIED TIP ELEVATION SHALL NOT BE RAISED

PILE INSTALLATION PROCEDURE
1. DAY 1: P1, P3, P5
2. DAY 2: P2, P4
3. DAY 3: S1, S3
4. DAY 4: S2, S4

S = SECONDARY (REINFORCED) PILES
P = PRIMARY (UNREINFORCED) PILES



UTILITY TABLE

UTILITY	DESCRIPTION	OWNER	DISPOSITION
1	6" OIL	CHEVRON	PROTECT IN PLACE
2	ELEC OH	SOUTHERN CALIFORNIA EDISON	RELOCATE (BY OWNER)
3	TELEPHONE	AT & T	RELOCATE (BY OWNER)
4	8" OIL	CRIMSON	RELOCATE (BY OWNER)
5	TELEPHONE	CHARTER	RELOCATE (BY OWNER)

FOUNDATION PLAN
1" = 10'

LEGEND:
- INDICATES PRIMARY PILE
- INDICATES SECONDARY PILE
- INDICATES EXISTING PILE FOR REMOVAL OR DEMOLISH TO 2' BELOW THALWEG ELEVATION
- INDICATES BOTTOM OF FOOTING ELEVATION

100% SUBMITTAL NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:
REGISTERED PROFESSIONAL ENGINEER MICHAEL A THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA
DATE

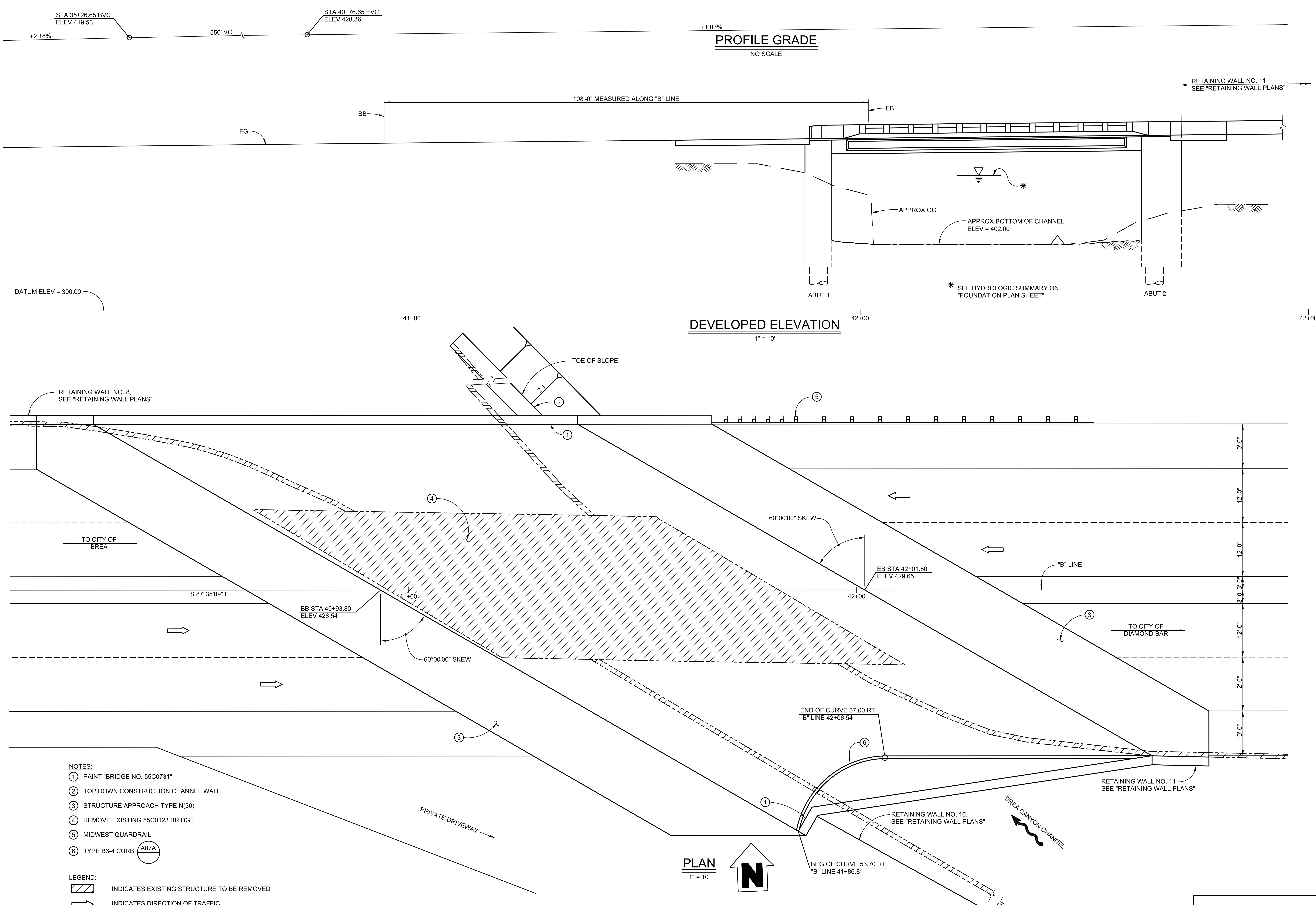
DESIGNED BY: JL
CHECKED BY: JW
DRAWN BY: AR
DRAWING NO.:
FILE NAME: S-32 FOUNDATION PLAN.dwg
PLOT DATE: 10/17/2021
SCALE: AS SHOWN

County of Orange
OC PublicWorks
PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS

BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0730

FOUNDATION PLAN

SHEET
S-32
206 OF 278



NOTES:

1. PAINT "BRIDGE NO. 55C0731"
2. TOP DOWN CONSTRUCTION CHANNEL WALL
3. STRUCTURE APPROACH TYPE N(30)
4. REMOVE EXISTING 55C0123 BRIDGE
5. MIDWEST GUARDRAIL
6. TYPE B3-4 CURB (A87A)

LEGEND:

- INDICATES EXISTING STRUCTURE TO BE REMOVED
- INDICATES DIRECTION OF TRAFFIC
- INDICATES DIRECTION OF FLOW

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER MICHAEL A THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA

DATE

DESIGNED BY: JL
CHECKED BY: JW
DRAWN BY: AR
DRAWING NO.:
FILE NAME: S-55 GENERAL PLAN NO1.dwg
PLOT DATE: 10/17/2021
SCALE: AS SHOWN

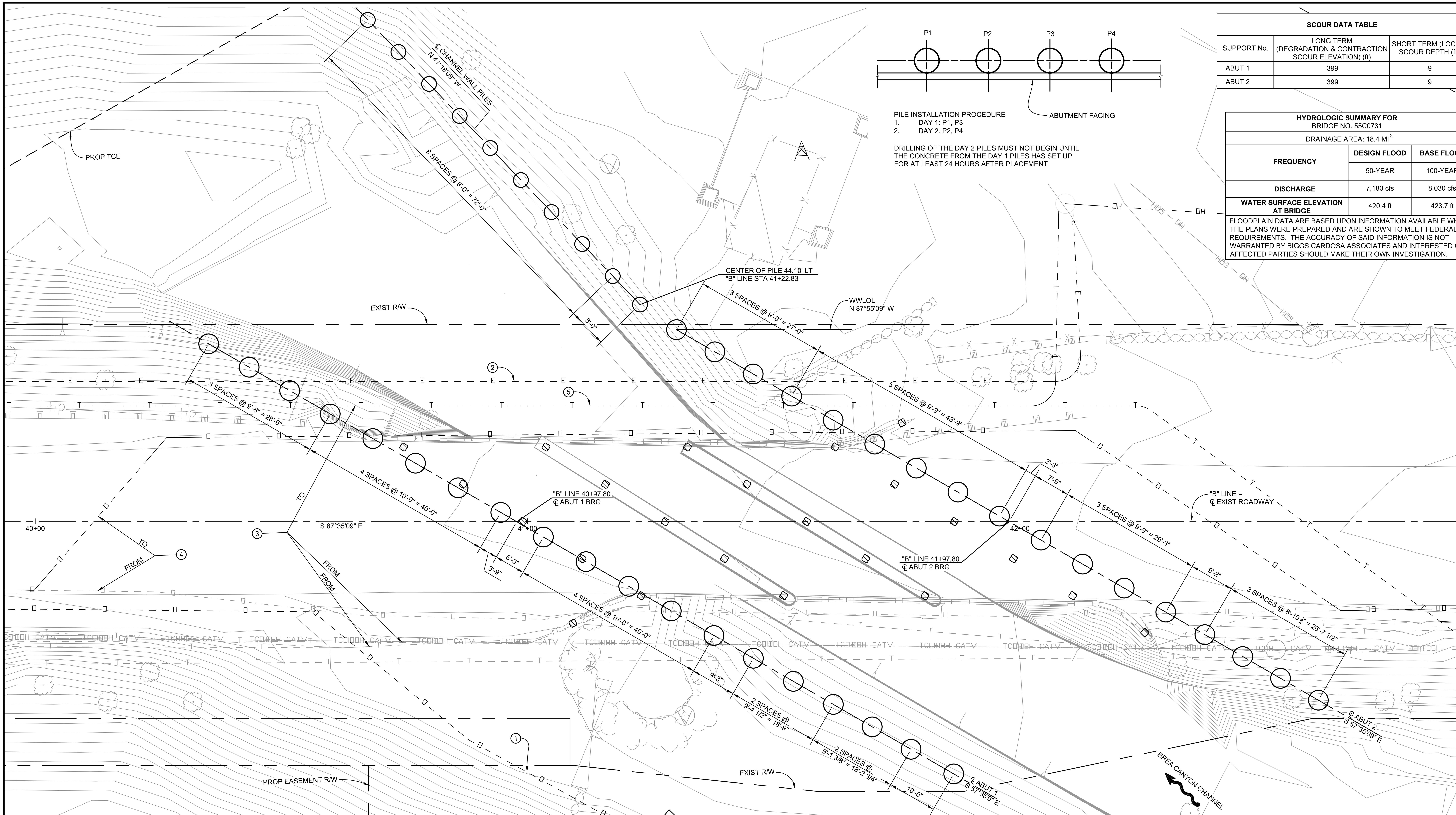
County of Orange
OC PublicWorks

PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS
500 S. Main Street, Suite 1200
Orange, California 92868
714-550-4665

BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0731

GENERAL PLAN No. 1

SHEET
S-55



PILE INSTALLATION PROCEDURE
1. DAY 1: P1, P3
2. DAY 2: P2, P4

DRILLING OF THE DAY 2 PILES MUST NOT BEGIN UNTIL THE CONCRETE FROM THE DAY 1 PILES HAS SET UP FOR AT LEAST 24 HOURS AFTER PLACEMENT.

SCOUR DATA TABLE

SUPPORT No.	LONG TERM (DEGRADATION & CONTRACTION SCOUR ELEVATION) (ft)	SHORT TERM (LOCAL) SCOUR DEPTH (ft)
ABUT 1	399	9
ABUT 2	399	9

HYDROLOGIC SUMMARY FOR
BRIDGE NO. 55C0731

DRAINAGE AREA: 18.4 MI^2

FREQUENCY	DESIGN FLOOD	BASE FLOOD
	50-YEAR	100-YEAR
DISCHARGE	7,180 cfs	8,030 cfs
WATER SURFACE ELEVATION AT BRIDGE	420.4 ft	423.7 ft

FLOODPLAIN DATA ARE BASED UPON INFORMATION AVAILABLE WHEN THE PLANS WERE PREPARED AND ARE SHOWN TO MEET FEDERAL REQUIREMENTS. THE ACCURACY OF SAID INFORMATION IS NOT WARRANTED BY BIGGS CARDOSA ASSOCIATES AND INTERESTED OR AFFECTED PARTIES SHOULD MAKE THEIR OWN INVESTIGATION.

FOUNDATION PLAN

1" = 10'

UTILITY TABLE

UTILITY	DESCRIPTION	OWNER	DISPOSITION
1	6" OIL	CHEVRON	PROTECT IN PLACE
2	ELEC OH	SOUTHERN CALIFORNIA EDISON	RELOCATE (BY OWNER)
3	TELEPHONE	AT & T	RELOCATE (BY OWNER)
4	8" OIL	CRIMSON	RELOCATE (BY OWNER)
5	TELEPHONE	CHARTER	RELOCATE (BY OWNER)

LEGEND:
- ○ INDICATES PILE
- ◇ INDICATES EXISTING PILE TO BE REMOVED

NOTES:
1. LOCATION OF UTILITIES ARE APPROXIMATE. SEE UTILITY PLANS FOR MORE INFORMATION.
2. PROTECT-IN-PLACE ALL UTILITIES THAT WILL BE PLACED PRIOR TO BRIDGE CONSTRUCTION.
3. AT THIS LOCATION, LIQUEFACTION HAS BEEN DETERMINED AS POSSIBLE DURING A SEISMIC EVENT. SOIL IMPROVEMENTS MUST BE MADE TO MITIGATE THE RISK POSED BY LIQUEFACTION PRIOR TO CONSTRUCTION OF PILE FOUNDATIONS. REFER TO FOUNDATION REPORT FOR LIMITS OF IMPACTED AREA AND RECOMMENDATIONS FOR SOIL IMPROVEMENTS.

PILE DATA TABLE

LOCATION	PILE TYPE	NOMINAL RESISTANCE (kips)		DESIGN TIP EL (ft)	SPECIFIED TIP EL (ft)
		COMPRESSION	TENSION		
ABUT 1	48" DIA CIDH	660	0	365.5(a); 372.0(d)	365.5
ABUT 2	48" DIA CIDH	620	0	375.5(a); 372.0(d)	372.0
CHANNEL WALL	36" DIA CIDH	80	0	380.0(a); 373.0(d)	373.0

PILE DATA TABLE NOTES:
1. DESIGN TIP ELEVATIONS FOR ABUTMENTS AND BENTS ARE CONTROLLED BY: (a) COMPRESSION, (b) TENSION, (c) SETTLEMENT, (d) LATERAL LOAD.
2. THE CIDH SPECIFIED TIP ELEVATION SHALL NOT BE RAISED

100% SUBMITTAL
NOT FOR CONSTRUCTION

COUNTY OF ORANGE CALIFORNIA

MARK	DESCRIPTION	DATE	APPR

PREPARED UNDER THE RESPONSIBLE CHARGE OF:

REGISTERED PROFESSIONAL ENGINEER MICHAEL A THOMAS No. S4676 Exp. 9/30/22 STRUCTURAL STATE OF CALIFORNIA

DATE

DESIGNED BY: JL	
DRAWN BY: AR	CHECKED BY: JW
DRAWING NO.:	
FILE NAME: S-60 FOUNDATION PLAN.dwg	
PLOT DATE: 10/17/2021	SCALE: AS SHOWN

County of Orange
OC PublicWorks

PREPARED BY:
BIGGS CARDOSA ASSOCIATES INC
STRUCTURAL ENGINEERS
500 S. Main Street, Suite 1200
Orange, California 92868
714-550-4665

BREA BLVD/BREA CANYON ROAD WIDENING
OCPW BRIDGE NO.55C0731

FOUNDATION PLAN

SHEET

S-60

APPENDIX B

Field Exploration

Leighton

APPENDIX B.1

Test Boring Logs

Hollow Stem Auger Borings

Geotechnical Exploration

GEOTECHNICAL BORING LOG LB-02

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
390	0			B-1				SP-SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Poorly-graded SAND with Silt and Gravel, light brown, moist, mostly fine to medium sand, little fine to coarse gravel, few fines, nonplastic	
									QUATERNARY OLDER ALLUVIUM (Qoa):	
385	5			R-2	4 6 8				@ 5': Medium dense	
				R-3	3 4 8	91	8	SM	@ 8': Silty SAND with Gravel, medium dense, brown, moist, mostly fine to coarse sand, little fine gravel, little fines, nonplastic	
380	10									
				R-4	5 6 7	106	9	ML	@ 11': Sandy SILT with Gravel, hard, brown, moist, mostly fines, some fine sand, little fine subrounded gravel, trace organics (roots), low plasticity, PP=4.0 tsf, (FILL)	
				R-5	3 4 9			CL	@ 14': Sandy lean CLAY with Gravel, very stiff, brown, moist, mostly fines, some fine to medium sand, little gravel, medium plasticity	AL, UC
375	15									
				R-6	3 5 7	107	21	SM	@ 17': Silty SAND with Gravel, medium dense, brown, wet, mostly fine to coarse sand, little fines, little fine gravel, nonplastic	
370	20			R-7	3 7 22			CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 20': Sandy lean CLAYSTONE, very stiff, brownish gray, very moist, mostly fines, some fine sand, few fine gravel, medium plasticity, oxide staining	UC
365	25			R-8	9 9 9			SAND-STONE	@ 25': No recovery	
				R-9	9 18 41	112	18		@ 27': Poorly-graded SANDSTONE with Silt, very dense, olive gray, wet, mostly fine sand, few fines, nonplastic	
360	30									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-02

Project No.	11588.001	**Date Drilled**	7-17-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
360	30			S-10	3 10 26			SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 30': Well-graded SANDSTONE with Gravel, dense, gray, wet, mostly fine to coarse sand, little fine gravel, trace fines, nonplastic	
355	35			R-11	15 50/3"	105	22	SILT-STONE	@ 35': SILTSTONE, decomposed, dark olive gray, (SILT, hard, moist to wet, mostly fines, few fine sand, low plasticity, PP>4.5 tsf)	
350	40			S-12	9 27 46				@ 40': CLAYSTONE, decomposed, dark olive gray, (Lean CLAY with Sand, hard, moist to wet, mostly fines, little fine sand, medium plasticity, petroleum odor, PP>4.5 tsf)	
345	45			S-13	8 21 36				@ 45': Gray, (petroleum staining, PP>4.5 tsf)	
340	50			S-14	11 22 37				@ 50': (PP>4.5 tsf)	
335	55			S-15	12 28 50				@ 55': (PP>4.5 tsf)	
330	60									

SAMPLE TYPES:
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Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	390'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
330	60			S-16	47 50			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 60': (PP>4.5 tsf)	
									TOTAL DEPTH OF BORING: 61 FEET. **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH GRANULAR BENTONITE.**	
325	65									
320	70									
315	75									
310	80									
305	85									
300	90									

SAMPLE TYPES:
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GEOTECHNICAL BORING LOG LB-03

Project No.	11588.001	**Date Drilled**	7-18-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Silty SAND with Gravel, light brown, moist, mostly fine to coarse sand, little fine to coarse gravel, little fines, nonplastic	CR
405									**QUATERNARY OLDER ALLUVIUM (Qoa):**	
	5			R-2	11 14 20			SC	@ 5': Clayey SAND with Gravel, dense, brown, moist, mostly fine to coarse sand, little fine gravel, little fines, medium plasticity	
400				R-3	13 11 12					
	10			R-4	8 10 9		16	CLAY-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu):** @ 10': CLAYSTONE with Sand, olive brown, moist, mostly fines, little fine sand, medium plasticity, oxide staining	
395				R-5	8 9 10				@ 12.5': No recovery	
	15			R-7	6 18 31	105	20		@ 15': CLAYSTONE, hard, dark olive gray, moist, mostly fines, trace fine sand, medium plasticity	
390										
	20			R-8	20 50/3"	112	15	SILT-STONE	@ 20': SILTSTONE, decomposed, light gray with brown, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
385										
	25			R-9	14 27 38	110	14		@ 25': (PP>4.5 tsf)	
380										
	30									

SAMPLE TYPES:
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- C CORE SAMPLE
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- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

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Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	30			R-10	14 50	108	16	SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @ 30': (PP>4.5 tsf)	
375										
	35			S-11	12 23 31			CLAY-STONE	@ 20': CLAYSTONE, decomposed, light olive gray, (Silty CLAY, hard, moist, mostly fines, few fine sand, low plasticity, tar staining, PP>4.5 tsf)	
370										
	40			S-12	10 22 28				@ 40': (PP>4.5 tsf)	
365										
	45			S-13	14 28 50			SILT-STONE	@ 45': SILTSTONE, decomposed, light olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
360										
	50			S-14	15 33 47				@ 50': (PP>4.5 tsf)	
355										
	55			S-15	15 35 50/5"				@ 55': No tar	
350										
	60									

SAMPLE TYPES:
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Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	408'
Location		**Sampled By**	BNS

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Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			S-16	12 32 50/1"			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfsu), continued:** @ 60': (PP>4.5 tsf)	
345										
	65			R-17	20 50/4"			CLAY-STONE	@ 65': CLAYSTONE, decomposed, olive gray with brown, (Silty CLAY with Sand, moist, mostly fines, little fine SAND, petroleum odor and staining, low to medium plasticity)	
340										
	70			R-18	50 REF	105	10		@ 70': (Sandy lean CLAY, hard, dark brownish gray, moist, mostly fines, some fine sand, medium plasticity, strong petroleum odor)	
335									**TOTAL DEPTH OF BORING: 70.5 FEET.** **GROUNDWATER NOT ENCOUNTERED DURING DRILLING** **BACKFILLED WITH GRANULAR BENTONITE**	
	75									
330										
	80									
325										
	85									
320										
	90									

SAMPLE TYPES:
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GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
430	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu):** Surface: Unpaved / Dirt @ 0.1': Silty SAND with Gravel, light brown, moist, mostly fine to coarse sand, some fine gravel (subangular to subrounded), little fines, nonplastic, (FILL)	
									QUATERNARY ALLUVIUM (Qa):	
425	5			R-2	5 6 6	87	7		@ 5': Medium dense	
				R-3	3 3 5		8		@ 8': Loose	
420	10									
				R-4	6 7 6	102	17	CL	**QUATERNARY OLDER ALLUVIUM (Qoa):** @ 11': Sandy lean CLAY with Gravel, very stiff, brown, moist, mostly fines, some fine to medium sand, some fine to coarse gravel, medium plasticity, oxide staining, PP=3.25 tsf	
				R-5	3 5 9				@ 14': Hard, PP=4.0 tsf	UC
415	15									
				R-6	3 7 10	109	18		@ 17': Sandy lean CLAY, very stiff, brown, moist, mostly fines, some fine sand, few fine gravel, medium plasticity, PP=3.0 tsf	
410	20			R-7	7 14 15			SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs):** @ 20': Silty SANDSTONE, medium dense, reddish brown, moist, mostly fine to coarse, little fines, trace fine gravel , nonplastic	DS
405	25			R-8	7 17 26	109	19		@ 25': Poorly-graded SANDSTONE with Silt, gray with brown, wet, mostly fine to medium sand, few fines, nonplastic	
400	30									

SAMPLE TYPES:
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- RV R VALUE
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- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

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Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
400	30			R-9	5 22 45	118	14	SAND-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 30': Well-graded SANDSTONE with Gravel, very dense, gray, wet, mostly fine to coarse sand, some fine gravel, nonplastic	
395	35			S-10	9 16 23			SILT-STONE	@ 20': SILTSTONE, decomposed, dark olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, PP>4.5 tsf)	
390	40			R-11	21 50/4"				@ 40': (PP>4.5 tsf)	Tx
385	45			S-12	13 32 50				@ 45': SILTSTONE, decomposed, light olive gray, (SILT, hard, moist, mostly fines, trace fine sand, low plasticity, tar staining, PP>4.5 tsf)	
380	50			R-13	26 50/3"	110	18		@ 50': (PP>4.5 tsf)	
375	55			S-14	14 29 49				@ 55': No tar	
370	60									

SAMPLE TYPES:
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- RV R VALUE
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GEOTECHNICAL BORING LOG LB-04

Project No.	11588.001	**Date Drilled**	7-16-18
Project	Brea Boulevard Corridor Improvements	**Logged By**	BNS
Drilling Co.	Martini Drilling Corp.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	430'
Location		**Sampled By**	BNS

SOIL DESCRIPTION

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Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
370	60			R-15	33 50/4"			SILT-STONE	**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs), continued:** @ 60': (PP>4.5 tsf)	Tx
365	65			S-16	13 26 42			CLAY-STONE	@ 65': CLAYSTONE, decomposed, olive gray with brown, (Silty CLAY with Sand, hard, moist, mostly fines, little fine SAND, petroleum odor and staining, low to medium plasticity, PP>4.5 tsf)	
360	70			R-17	34 50/4"				@ 70': (Sandy lean CLAY, hard, dark brownish gray, moist, mostly fines, some fine sand, medium plasticity, strong petroleum odor, PP>4.5 tsf)	
									TOTAL DEPTH OF BORING: 70.5 FEET. **GROUNDWATER NOT ENCOUNTERED DURING DRILLING.** **BACKFILLED WITH GRANULAR BENTONITE.**	
355	75									
350	80									
345	85									
340	90									

SAMPLE TYPES:
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- SE SAND EQUIVALENT
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- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-20

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
414	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown, moist, fine sand, low plasticity silt, fine subangular gravel	
410										
	5			R-1	20 25 29	93	4		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, dense, light brown to light yellowish brown, moist, fine sand, low plasticity silt	
				R-2	12 20 27					
405										
	10			R-3	7 9 11	104	8		@10.0': SILTY SAND, medium dense, light yellowish brown, moist, fine sand, non plastic silt	
400										
	15			R-4	7 9 10	99	7	ML	@15.0': SANDY SILT, medium dense, oliveish white, moist, non plastic silt, fine sand, carbonate nodule, manganese oxide staining	DS
395										
	20			B-2 R-5	8 14 14	108	6	SM	@20.0': SILTY SAND, medium dense, light brown, moist, fine to medium sand, low plasticity silt, trace fine subangular gravel, manganese oxide staining	
390										
	25			S-6	6 9 11			SP-SM	@25.0': Poorly graded SAND with SILT, medium dense, light reddish brown, moist, fine sand, non plastic silt	
385										
	30			R-7	16 44 50/3"	109	17		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SANDY SILTSTONE, massive, fine grained, light oliveish gray to mottled orangeish gray, moderately weathered, hard, manganese oxide staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380										
	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-20

Project No.	11585.005	**Date Drilled**	10-1-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	414'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35			S-8	13 34 50/5"					
375	40			R-9	21 50/3"	109	19		PP > 4.5 tsf	
370	45			S-10	12 30 50/1"				@45': SANDY SILTSTONE, very thickly bedded, fine grained, brownish olive, slightly weathered to moderately weathered, hard, (SANDY SILT (ML), hard, low plasticity)	
365	50			R-11	17 50/3"	108	19		@50': SANDY SILTSTONE, fine grained, oliveish gray, slightly weathered, hard, manganese oxide staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf **Boring terminated at 51 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings**.	
360	55									
355	60									
350	65									
345	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
400	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown, moist, fine sand, low plasticity silt, fine subrounded gravel	
395	5			R-1	25 47 50/5"	111	17		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @5': SILTY SANDSTONE, very thickly bedded, fine grained, mottled orangeish olive to grayish olive, moderately weathered to intensely weathered, medium hard, moist, manganese oxide staining, moderate cementation, (SILTY SAND (SM), very dense)	
				R-2	28 50/4"					
390	10			R-3	24 40 50/5"	103	21		@10': CLAYSTONE, very thickly bedded, very fine grained, mottled orangeish olive to grayish olive, moderately weathered, hard, moist, manganese oxide staining, (Lean CLAY (CL), hard, low plasticity)	SA AL
				T-4A T-4B	23 42 50				PP > 4.5 tsf PP > 4.5 tsf	
385	15									
				R-5	42 50/3"	109	18		@18.5': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray, slightly weathered to moderately weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380	20									
				S-6	18 29 44				@23.5': SILTSTONE, very thickly bedded, very fine grained, oliveish gray, fresh to slightly weathered, hard, moist, (SILT (ML), hard, low plasticity)	SA AL
375	25									
				T-7	46 50/2"				PP > 4.5 tsf	
370	30			R-8	41 50/3"	111	17		@30': SANDY SILTSTONE, massive, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	CU
				S-9	50/5"					
365	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
365	35									
360	40									
				T-10	41 50/2"				PP > 4.5 tsf	
355	45									
				S-11	23 39 50/5"					
350	50			R-12	37 50/3"	109	19		@50': SANDY SILTSTONE, massive, very fine grained, dark oliveish gray to oliveish gray, fresh, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	UU
345	55			S-13	25 44 50/4"					
340	60			R-14	31 50/4"	107	21		PP > 4.5 tsf	
335	65			S-15	26 46 50/5"					
330	70									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-22

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	400'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
330	70			R-16	50/4"				@70': SANDY SILTSTONE, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
325	75			S-17	21 37 50/5"					
320	80			R-18	50/4"	109	19		PP > 4.5 tsf	
									Boring terminated at 80.5 ft. **Groundwater not encountered.** **Backfilled with auger cuttings.**	
315	85									
310	90									
305	95									
300	100									
295	105									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
420	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark brown, moist, fine sand, non plastic silt	
415	5			R-1	14 35 50	124	8		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, very dense, mottled reddish olive, moist, fine sand, low plasticity silt, strong cementation, iron oxide staining	
				R-2	13 30 27				@7.5': SILTY SAND, very dense, oliveish brown, moist, fine sand, non plastic silt, manganese oxide staining	
410	10			R-3	9 21 17	108	10		@10.0': SILTY SAND, dense, reddish brown to orangeish brown, moist, fine to medium sand, low plasticity silt, manganese oxide staining	
				T-4A T-4B	15 20 17	89	12	CH	@12.5': Fat CLAY, hard, blackish olive, moist, medium plasticity clay, hydrocarbon odor, hydrocarbon staining PP > 4.5 tsf	
405	15			T-5A	8 13 30	100	12			DS
				T-5B		94	12	SW-SM CH	@16.0': Well-graded SAND with SILT, dense, blackish olive, moist, fine to medium sand, non plastic silt, hydrocarbon odor, hydrocarbon staining @16.5': Fat CLAY, very stiff to hard, blackish olive, moist, medium plasticity clay, hydrocarbon odor, hydrocarbon staining	SA AL
				R-6	15 17 23				@18.5': very stiff PP = 3.5 tsf	
400	20			T-7A T-7B	9 22 40			ML	@21.0': SILT, hard, oliveish gray, moist, low plasticity silt	
				S-8	6 10 11				@23.5': SILT with SAND, very stiff, oliveish gray, moist, low plasticity silt, fine sand	
395	25									
390	30			R-9	20 50/5"	120	8		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @28.5': SILTY SANDSTONE, very thickly bedded, fine grained, oliveish gray, slightly weathered to moderately weathered, hard, moist, (SILTY SAND (SM), very dense)	
	35			S-10	11 15				@33.5': SANDY SILTSTONE, very thickly bedded, very fine grained, dark oliveish gray, slightly weathered, hard, moist,	

SAMPLE TYPES:

B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

TYPE OF TESTS:

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	35				18				(SILT with SAND (ML), hard, low plasticity)	
385										
				T-11A T-11B	17 50/6"				@38.5': SILTY SANDSTONE, very thickly bedded, fine grained, dark brownish gray, slightly weathered, hard, moist, (SILTY SAND (SM), very dense)	
	40									
380										
				R-12	26 50/5"	112	11		@43.5': SANDY SILTSTONE, massive, fine grained, dark oliveish gray to brownish gray, fresh to slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
	45									
375										
				S-13	17 31 43					
	50									
370										
				S-14	12 13 27					
	55									
365										
				R-15	50/6"	113	12		@58.5': strong hydrocarbon odor and oil staining	
	60									
360										
				S-16	18 28 40					
	65									
355										
				R-17	50/6"	113	13			
	70									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-25

Project No.	11585.005	**Date Drilled**	9-16-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	422'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	70									
350										
				S-18	27 50/6"					
	75									
345										
				R-19	50/6"					
	80								**Boring terminated at 80 ft.** **Groundwater not encountered.** **Backfilled with cement bentonite grout.**	
340										
	85									
335										
	90									
330										
	95									
325										
	100									
320										
	105									

SAMPLE TYPES:
B BULK SAMPLE
C CORE SAMPLE
G GRAB SAMPLE
R RING SAMPLE
S SPLIT SPOON SAMPLE
T TUBE SAMPLE

TYPE OF TESTS:
-200 % FINES PASSING
AL ATTERBERG LIMITS
CN CONSOLIDATION
CO COLLAPSE
CR CORROSION
CU UNDRAINED TRIAXIAL
DS DIRECT SHEAR
EI EXPANSION INDEX
H HYDROMETER
MD MAXIMUM DENSITY
PP POCKET PENETROMETER
RV R VALUE
SA SIEVE ANALYSIS
SE SAND EQUIVALENT
SG SPECIFIC GRAVITY
UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-27

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	426'
Location		**Sampled By**	SG

SOIL DESCRIPTION: This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
425	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, light brown, moist, fine sand, non plastic silt, fine subrounded gravel	
									QUATERNARY OLDER ALLUVIUM (Qoa) @2.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, weak cementation	
420	5			R-1	5 8 8				@5.0': SILTY SAND, medium dense, brown to whiteish brown, moist, fine to medium sand, non plastic silt, manganese oxide staining	
				R-2	5 9 10				@7.5': SILTY SAND, medium dense, brown to mottled reddish brown, moist, fine to medium sand, non plastic silt, carbonate nodule, manganese oxide staining	
415	10			R-3	7 13 15					
410	15			R-4	9 10 11				@15.0': SILTY SAND with GRAVEL, medium dense, light gray to oliveish gray, moist, fine sand, low plasticity silt, fine angular elongated gravel, possible decomposed shale	
405	20			R-5	9 10 17	113	17	CL	@20.0': SANDY lean CLAY, stiff to very stiff, light reddish brown to brown, moist, low plasticity clay, fine sand PP = 2.25 tsf	SA AL CU
400	25			S-6	3 9 9			ML	@25.0': SILT with SAND, very stiff, brown, moist, low plasticity silt, fine sand	
395	30			R-7	9 13 13			SM	@30.0': SILTY SAND, very stiff, grayish brown, wet, fine sand, non plastic silt	
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG LB-27

Project No.	11585.005	**Date Drilled**	9-24-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	426'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
390	35			S-8	5 8 15					
385	40			R-9	50/4"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @40': SANDY SILTSTONE, massive, very fine grained, blueish gray, fresh to slightly weathered, hard, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380	45			S-10	20 34 50					
375	50			R-11	23 50/5"	114	17		PP > 4.5 tsf	UU
									Boring terminated at 51 ft. **Groundwater encountered at 31 feet during drilling..** Backfill Details 51'- 25': grout 25'- 0': cutting	
370	55									
365	60									
360	65									
	70									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
405	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, dark black to reddish brown, moist, fine sand, low plasticity silt	
400	5			R-1	9 26 33	108	7		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, dense, light brown to brown, moist, fine sand, low plasticity silt, carbonate nodule, moderate cementation	
				R-2	12 16 20				@7.5': SILTY SAND, medium dense, dark reddish brown, moist, fine sand, low plasticity silt, carbonate nodule, iron oxide staining	
395	10			R-3	10 17 24	99	24	ML	@10.0': SANDY SILT, very stiff, whiteish olive, moist, low plasticity silt, fine sand, manganese oxide staining PP = 4 tsf	
				T-4A T-4B	6 16 32				PP = 4 tsf	
390	15									
				R-5	15 19 21	99	25		@18.5': SILT, hard, grayish olive, moist, low plasticity silt, manganese oxide staining PP = 4.5 tsf	
385	20									
				S-6A S-6B	6 13 19					
380	25								@24.5': SANDY SILT, hard, blackish olive, moist, low plasticity silt, fine sand, hydrocarbon odor, hydrocarbon staining	
				T-7A T-7B	16 50/6"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @26': SILTY SANDSTONE, very thickly bedded, fine grained, blackish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, (SILTY SAND (SM), very dense)	
375	30			R-8	20 50/6"	109	18		@30': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	UU
370	35									

SAMPLE TYPES:

B	BULK SAMPLE
C	CORE SAMPLE
G	GRAB SAMPLE
R	RING SAMPLE
S	SPLIT SPOON SAMPLE
T	TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
370	35		S-9	11 16 22				@35': SANDY SILTSTONE, very thickly bedded, very fine grained, blackish olive to grayish olive, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
365	40		R-10	36 50/5"	119	11		PP > 4.5 tsf	
			T-11A T-11B	25 50/5"	103	18			UU
360	45		S-12	14 22 30				@45': SANDY SILTSTONE, very thickly bedded, very fine grained, grayish olive, fresh, hard, moist, hydrocarbon staining, (SILT with SAND (ML), hard, low plasticity)	
355	50		R-13	50/6"	114	14		@50': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
350	55		S-14	14 21 30					
345	60		R-15	50/5"	119	9		@60': SANDY SILTSTONE, very thickly bedded, very fine grained, dark olive to grayish olive, fresh, hard, wet, (SANDY SILT (ML), hard, low plasticity)	
340	65		S-16	17 27 31				@65': SILTY SANDSTONE, very thickly bedded, fine grained, dark olive to grayish olive, fresh, hard, wet, (SILTY SAND (SM), very dense)	
335	70								

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG LB-37

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	405'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
335	70			R-17	30 50/4"				@70': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, wet, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
330	75			S-18	12 21 30				@75': SANDY SILTSTONE, very thickly bedded, very fine grained, dark grayish olive, fresh, hard, wet, hydrocarbon staining, bituminous vein, (SILT with SAND (ML), hard, low plasticity)	
325	80			R-19	10 50/6"				**Boring terminated at 81 ft.** **Groundwater encountered at 56 feet during drilling.**. Backfill Details 81'- 50': cement bentonite grout 50'- 0': auger cuttings	
320	85									
315	90									
310	95									
305	100									
300	105									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

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GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							Surface: Asphalt Concrete, 4 in.	
								Aggregate Base, 10 in.	
			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @1.2': SILTY SAND with GRAVEL, yellowish brown, moist, fine sand, low plasticity silt, fine subrounded gravel	
425									
	5		R-1	15 26 50/5"	117	9		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, very dense, light yellowish brown, moist, fine sand, non plastic silt, moderate cementation, manganese oxide staining	
420			R-2	21 32 40				@7.5': SILTY SAND with GRAVEL, very dense, brown to mottled blackish brown, moist, fine to medium sand, non plastic silt, fine subrounded gravel, moderate cementation, manganese oxide staining	
	10		B-2 R-3	12 18 24	119	10		@10.0': SILTY SAND, dense, brown, moist, fine to medium sand, low plasticity silt	
415			T-4A T-4B	4 7 10			ML	@12.5': SILT with SAND, very stiff, blackish gray to oliveish gray, moist, low plasticity silt, fine sand, hydrocarbon odor, hydrocarbon staining	
	15		T-5						
410			R-6	4 9 9	102	21		PP = 2.5 tsf	DS
	20		B-3						
405			S-7	4 13 22			CL	@23.5': Lean CLAY with SAND, hard, brownish olive, moist, low plasticity clay, fine sand	
	25								
			T-8					**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @26': SANDY SILTSTONE, very thickly bedded, very fine grained, blackish gray, slightly weathered, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
400			T-9A T-9B	34 50/3"					
	30		R-10	35 50/2"				@30': SANDY SILTSTONE, very thickly bedded, very fine grained, oliveish gray to blueish gray, slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), very stiff, low plasticity) PP = 3.75 tsf	
395									
	35								

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

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GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			S-11	15 31 33				@35': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity)	
390										
	40			R-12	32 50/4"	115	14		PP = 4.5 tsf	
385				T-13	18 50/5"	110	13		@42': SANDY SILTSTONE, very thickly bedded, very fine grained, blueish gray to brownish gray, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	CU
	45									
380										
	50			R-14	30 50/4"	115	16		PP > 4.5 tsf	UU
375										
	55			S-15	19 26 42				@55': SANDY SILTSTONE, very thickly bedded, very fine grained, olive to grayish olive, fresh to slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity)	
370										
	60			R-16	50/6"	109	15		@60': SANDY SILTSTONE, massive, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
365										
	65			S-17	14 26 37					
360										
	70									

SAMPLE TYPES:

B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

(TYPE OF TESTS: columns 3–8)

GEOTECHNICAL BORING LOG LB-38

Project No.	11585.005	**Date Drilled**	9-28-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	428'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	70			R-18	40 50/2"	116	14		PP > 4.5 tsf	
355										
	75			S-19	19 31 44					
350										
	80			R-20	11 30 50/5"				@80': SANDY SILTSTONE, very fine grained, brownish olive to blackish olive, fresh to slightly weathered, hard, moist, petroleum flowing on sample surface, (SANDY SILT (ML), hard, low plasticity)	
345									**Boring terminated at 81.5 ft.** **Groundwater not encountered.** **Backfilled with auger cuttings; paved with cold-patch asphalt concrete**.	
	85									
340										
	90									
335										
	95									
330										
	100									
325										
	105									

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
- DS DIRECT SHEAR
- EI EXPANSION INDEX
- H HYDROMETER
- MD MAXIMUM DENSITY
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

APPENDIX B.2

Test Boring Logs

Hollow Stem Auger Borings

Percolation Testing

GEOTECHNICAL BORING LOG CWE P-2

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	388'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, grayish brown, moist, fine sand, non plastic silt	
385										
	5			R-1	3 5 7	105	6		**QUATERNARY OLDER ALLUVIUM (Qoa)** @5.0': SILTY SAND, medium dense, dark brown to grayish brown, moist, fine sand, low plasticity silt, trace gypsum gravel	
380				R-2	5 6 10	106	9		@7.5': SILTY SAND, medium dense, light brown, moist, fine sand, low plasticity silt	-200
	10			R-3	4 8 10	108	9		@10.0': SILTY SAND, medium dense, mottled whiteish brown to dark grayish brown, moist, fine sand, low plasticity silt	CO
375										
	15			R-4	5 11 14			CL	@15.0': Lean CLAY with SAND, very stiff, yellow to yellowish brown, moist, low plasticity clay, fine sand PP = 3 tsf	
370 ▽										
	20			R-5	4 11 17			ML	@20.0': SILT with SAND, very stiff, yellowish olive to grayish olive, wet, low plasticity silt, fine sand PP = 3 tsf	
365										
	25			S-6	6 7 7					
360										
	30			R-7	44 50/6"				**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SILTY SANDSTONE, very thickly bedded, fine to medium grained, yellowish olive to grayish olive, slightly weathered to moderately weathered, hard, (SILTY SAND (SM), very dense)	
355										
	35									

SAMPLE TYPES:
B BULK SAMPLE
C CORE SAMPLE
G GRAB SAMPLE
R RING SAMPLE
S SPLIT SPOON SAMPLE
T TUBE SAMPLE

TYPE OF TESTS:
-200 % FINES PASSING
AL ATTERBERG LIMITS
CN CONSOLIDATION
CO COLLAPSE
CR CORROSION
CU UNDRAINED TRIAXIAL
DS DIRECT SHEAR
EI EXPANSION INDEX
H HYDROMETER
MD MAXIMUM DENSITY
PP POCKET PENETROMETER
RV R VALUE
SA SIEVE ANALYSIS
SE SAND EQUIVALENT
SG SPECIFIC GRAVITY
UC UNCONFINED COMPRESSIVE STRENGTH

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG CWE P-2

Project No.	11585.005	**Date Drilled**	9-29-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	388'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	35			S-8	10 22 37				@35': SANDY SILTSTONE, massive, fine grained, blueish gray, fresh, hard, (SANDY SILT (ML), hard, low plasticity)	
350										
	40			R-9	30 50/3"				PP = 4 tsf	
345										
	45			S-10	14 40 50/5"					
340										
	50			R-11	34 50/4"				@50': SANDY SILTSTONE, fine grained, dark blueish brown to dark blueish gray, fresh, hard, hydrocarbon staining, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
335									**Boring terminated at 51 ft.** **Groundwater encountered at 18 feet during drilling.** **Boring converted into a percolation test well, test performed on 09/30/2020; test well was then removed.**. Backfill Details 51'- 15': cement bentonite grout 15'- 0': auger cuttings	
	55									
330										
	60									
325										
	65									
320										
	70									

SAMPLE TYPES:

B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

(TYPE OF TESTS: columns 3–8)

* * * This log is a part of a report by Leighton and should not be used as a stand-alone document. * * *

GEOTECHNICAL BORING LOG CWE P-3

Project No.	11585.005	**Date Drilled**	9-30-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	401'
Location		**Sampled By**	SG

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
400	0							SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND with GRAVEL, brown to light brown, moist, fine sand, low plasticity silt, fine subangular gravel	
395	5			R-1	22 50/6"	109	18		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @5': SILTY SANDSTONE, very thickly bedded, fine grained, mottled orangeish olive to grayish olive, moderately weathered, hard, moist, manganese oxide staining, (SILTY SAND (SM), very dense) @8': Rig chattering	
390	10			B-1 R-2	25 50/6"	106	20		@10': SANDY SILTSTONE, very thickly bedded, very fine grained, mottled orangeish olive to grayish olive, slightly weathered, hard, moist, manganese oxide staining, (SILT with SAND (ML), hard, low plasticity) PP > 4.5 tsf	-200
385	15			R-3	32 50/4"	106	21		PP > 4.5 tsf	-200
				R-4	50/3"				@18.5': SANDY SILTSTONE, very fine grained, blueish gray to oliveish gray, fresh, hard, moist, (SANDY SILT (ML), hard, low plasticity) PP > 4.5 tsf	
380	20								**Boring terminated at 20 ft.** **Groundwater not encountered.** **Boring converted into a percolation test well, test performed on 10/01/2020; test well was then removed..** Backfill Details 20'- 3': Monterey Sand #3 3'- 0': Bentonite Chip	
375	25									
370	30									
	35									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

GEOTECHNICAL BORING LOG CWE P-4

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	431'
Location		**Sampled By**	SG

SOIL DESCRIPTION

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
430	0			B-1				SM	**ARTIFICIAL FILL, UNDOCUMENTED (Afu)** @0.0': SILTY SAND, light brown, moist, fine sand, non plastic silt, weak cementation	
425	5			R-1	11 15 18					
				R-2	4 8 9				**QUATERNARY OLDER ALLUVIUM (Qoa)** @6.5': SILTY SAND, medium dense, brown to mottled whiteish brown, moist, fine sand, low plasticity silt, carbonate nodule, manganese oxide staining	
420	10			R-3	7 12 13	113	15			
415	15			R-4	6 9 13			ML	@15.0': SILT with SAND, very stiff, brown to light reddish brown, moist, low plasticity silt, fine sand, manganese oxide staining PP = 3.75 tsf	-200
410	20			R-5	15 21 21	119	12		@20': hard PP > 4.5 tsf	
405	25			S-6	4 6 10			SM	@25.0': SILTY SAND, very stiff, grayish olive, moist, fine sand, low plasticity silt	-200
400	30			R-7	11 50/5"	110	23		**FERNANDO FORMATION, UNDIFFERENTIATED (Tf/Tfs)** @30': SILTY SANDSTONE, very thickly bedded, fine grained, grayish olive, slightly weathered to moderately weathered, hard, moist, hydrocarbon staining, with shell, (SILTY SAND (SM), very dense)	
	35									

SAMPLE TYPES:
- B BULK SAMPLE
- C CORE SAMPLE
- G GRAB SAMPLE
- R RING SAMPLE
- S SPLIT SPOON SAMPLE
- T TUBE SAMPLE

TYPE OF TESTS:

-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
CR	CORROSION	PP	POCKET PENETROMETER		
CU	UNDRAINED TRIAXIAL	RV	R VALUE		

*** This log is a part of a report by Leighton and should not be used as a stand-alone document. ***

GEOTECHNICAL BORING LOG CWE P-4

Project No.	11585.005	**Date Drilled**	9-23-20
Project	Brea Boulevard Corridor Improvements	**Logged By**	SG
Drilling Co.	2R Drilling, Inc.	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger; Hammer: Automatic, 140 lb, 30 in drop	**Ground Elevation**	431'
Location		**Sampled By**	SG

This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	35			S-8	50/5"				@35': SANDY SILTSTONE, massive, fine grained, grayish olive, slightly weathered, hard, moist, hydrocarbon staining, (SANDY SILT (ML), very stiff to hard, low plasticity)	
395										
390	40			R-9	50/3"				PP = 3.75 tsf	
385	45			S-10	18 29 38					
380	50			R-11	30 50/4"				PP > 4.5 tsf	
									Boring terminated at 51 ft. **Groundwater encountered at 38.5 feet at end of drilling.** **Boring converted into a percolation test well, test performed on 09/24/2020; test well was then removed..** Backfill Details 51'- 30': cement bentonite grout 30'- 0': auger cuttings	
375	55									
370	60									
365	65									
	70									

SAMPLE TYPES:		TYPE OF TESTS:					
B	BULK SAMPLE	-200	% FINES PASSING	DS	DIRECT SHEAR	SA	SIEVE ANALYSIS
C	CORE SAMPLE	AL	ATTERBERG LIMITS	EI	EXPANSION INDEX	SE	SAND EQUIVALENT
G	GRAB SAMPLE	CN	CONSOLIDATION	H	HYDROMETER	SG	SPECIFIC GRAVITY
R	RING SAMPLE	CO	COLLAPSE	MD	MAXIMUM DENSITY	UC	UNCONFINED COMPRESSIVE STRENGTH
S	SPLIT SPOON SAMPLE	CR	CORROSION	PP	POCKET PENETROMETER		
T	TUBE SAMPLE	CU	UNDRAINED TRIAXIAL	RV	R VALUE		

APPENDIX B.4

Cone Penetration Test Soundings

SUMMARY

OF

CONE PENETRATION TEST DATA

Project:

Tonner Canyon Road & SR-57
Brea, CA
August 6-7, 2018

Prepared for:

Mr. John Haertle
Leighton Consulting
17781 Cowan
Irvine, CA 92614-6009
Office (800) 253-4567 / Fax (949) 250-1114

Prepared by:

KTE

KEHOE TESTING & ENGINEERING

5415 Industrial Drive
Huntington Beach, CA 92649-1518
Office (714) 901-7270 / Fax (714) 901-7289
www.kehoetesting.com

TABLE OF CONTENTS

SUMMARY

OF

CONE PENETRATION TEST DATA

1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the project located at Tonner Canyon Road & SR-57 in Brea, California. The work was performed by Kehoe Testing & Engineering (KTE) on August 6-7, 2018. The scope of work was performed as directed by Leighton Consulting personnel.

2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at nine locations to determine the soil lithology. Groundwater measurements and hole collapse depths provided in **TABLE 2.1** are for information only. The readings indicate the apparent depth to which the hole is open and the apparent water level (if encountered) in the CPT probe hole at the time of measurement upon completion of the CPT. KTE does not warranty the accuracy of the measurements and the reported water levels may not represent the true or stabilized groundwater levels.

LOCATION	DEPTH OF CPT (ft)	COMMENTS/NOTES:
C-2	36	Refusal, hole open to 10.3 ft (dry)
C-4	34	Groundwater @ 29.0 ft
C-5	30	Hole open to 27.0 ft (dry)
C-7	33	Refusal, groundwater @ 15.0 ft
C-8	31	Refusal, hole open to 10.0 ft (dry)
C-9	55	Hole open to 18.0 ft (dry)
SC-1	29	Refusal, hole open to 12.0 ft (dry)
SC-3	65	Refusal, hole open to 3.2 ft (dry)
SC-6	6	Refusal, hole open to 4.5 ft (dry)

TABLE 2.1 - Summary of CPT Soundings

3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by **KTE** using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm^2 cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
- Pore Pressure Dissipation (at selected depths)

At locations SC-1, SC-3 & SC-6 shear wave measurements were obtained at various depths. The shear wave is generated using an air-actuated hammer, which is located inside the front jack of the CPT rig. The cone has a triaxial geophone, which recorded the shear wave signal generated by the air hammer.

The above parameters were recorded and viewed in real time using a laptop computer. Data is stored at the KTE office for up to 2 years for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring base line readings ensures that the cone electronics are operating properly.

4. CONE PENETRATION TEST DATA & INTERPRETATION

The Cone Penetration Test data is presented in graphical form in the attached Appendix. These plots were generated using the CPeT-IT program. Penetration depths are referenced to ground surface. The soil classification on the CPT plots is derived from the attached CPT Classification Chart (Robertson) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance (qc), sleeve friction (fs), and penetration pore pressure (u). The friction ratio (Rf), which is sleeve friction divided by cone resistance, is a calculated parameter that is used along with cone resistance to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

Tables of basic CPT output from the interpretation program CPeT-IT are provided for CPT data averaged over one foot intervals in the Appendix. We recommend a geotechnical engineer review the assumed input parameters and the calculated output from the CPeT-IT program. A summary of the equations used for the tabulated parameters is provided in the Appendix.

It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. In these situations, experience, judgement and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

KEHOE TESTING & ENGINEERING

Richard W. Koester, Jr.
General Manager

08/13/18-hh-9616

APPENDIX

Kehoe Testing and Engineering
714-901-7270
rich@kehoetesting.com
www.kehoetesting.com

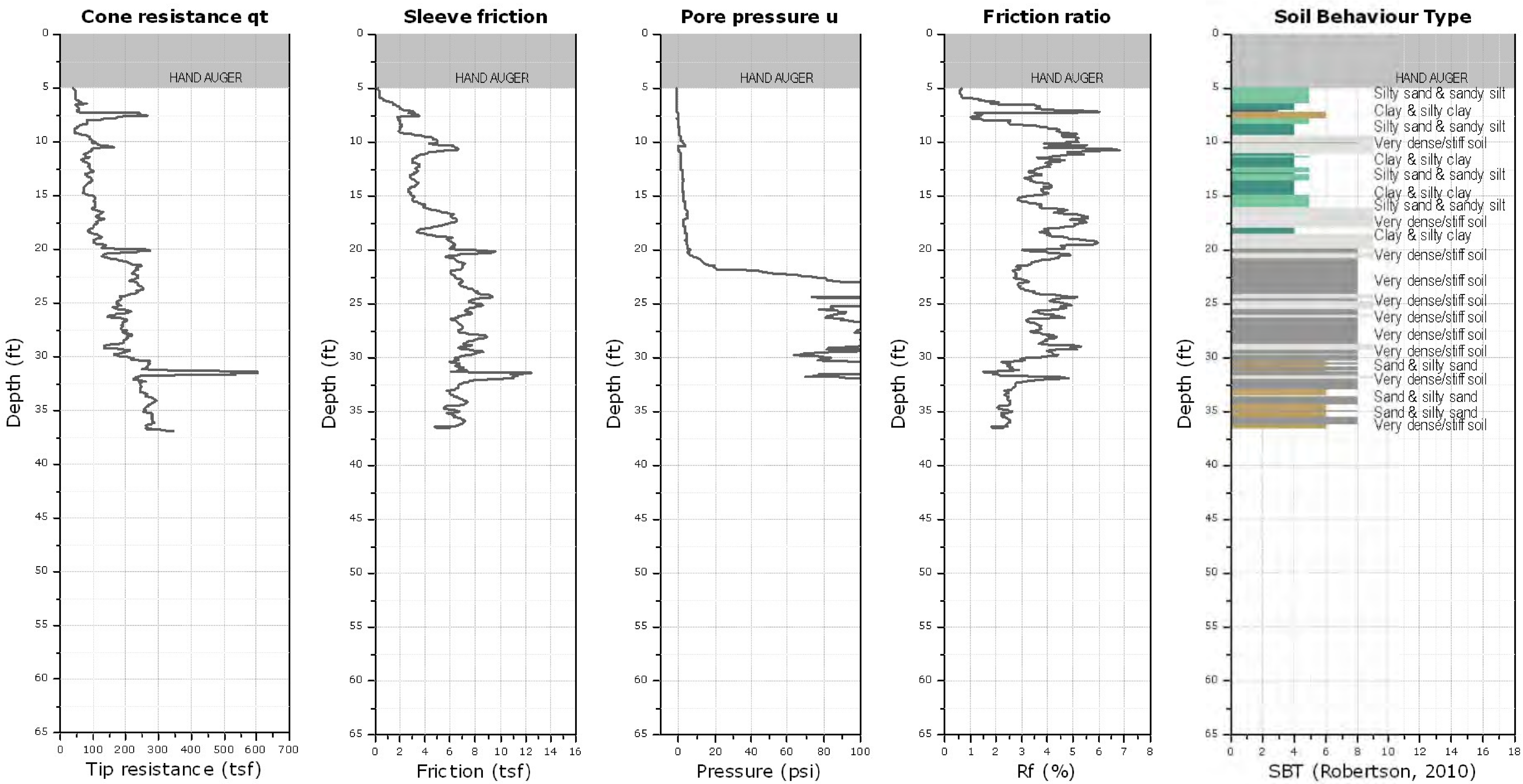
C-2

Project: **Leighton Consulting**

Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 36.95 ft, Date: 8/6/2018

Cone Type: Vertek



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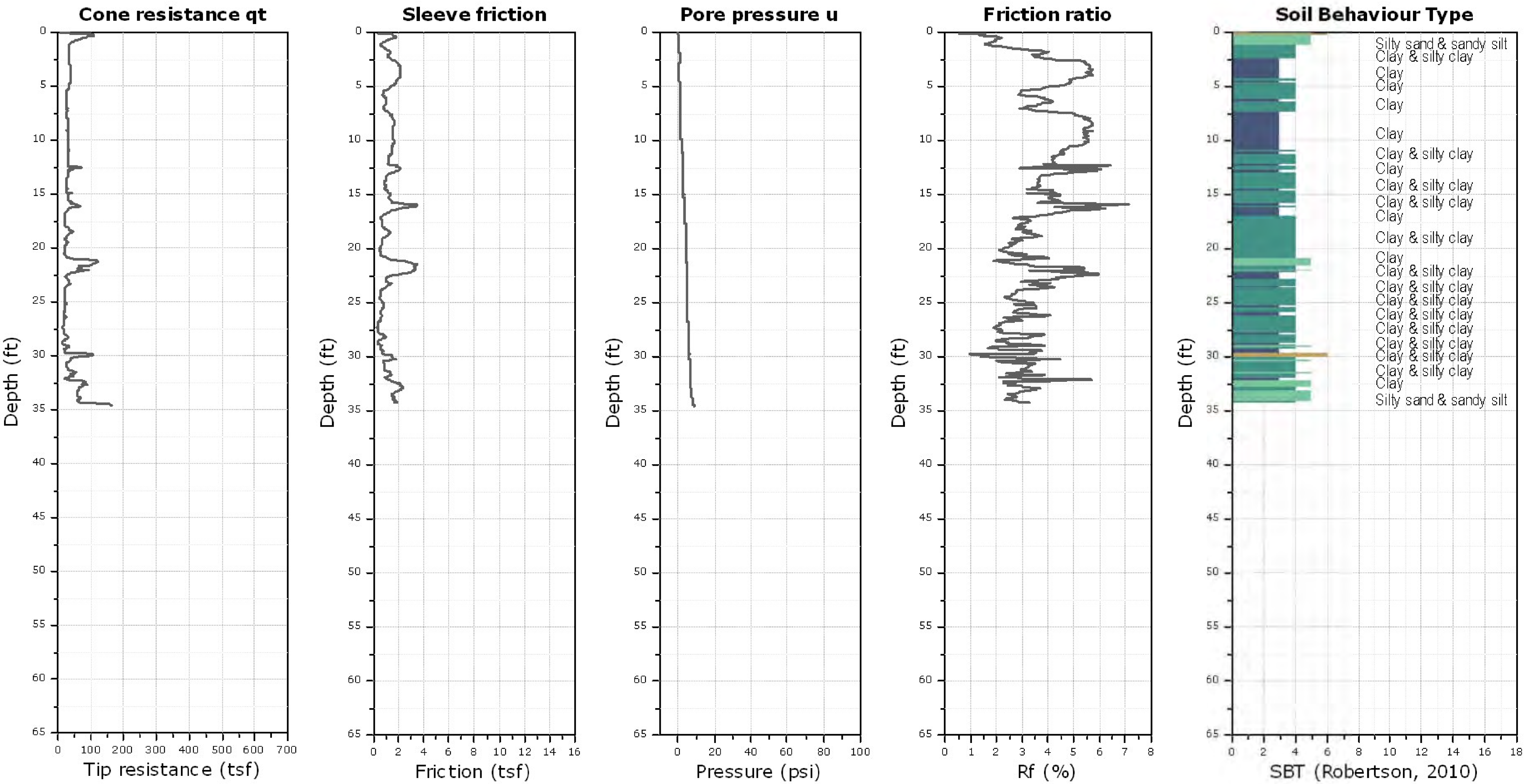
C-4

Project: Leighton Consulting
Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 34.67 ft, Date: 8/7/2018
Cone Type: Vertek



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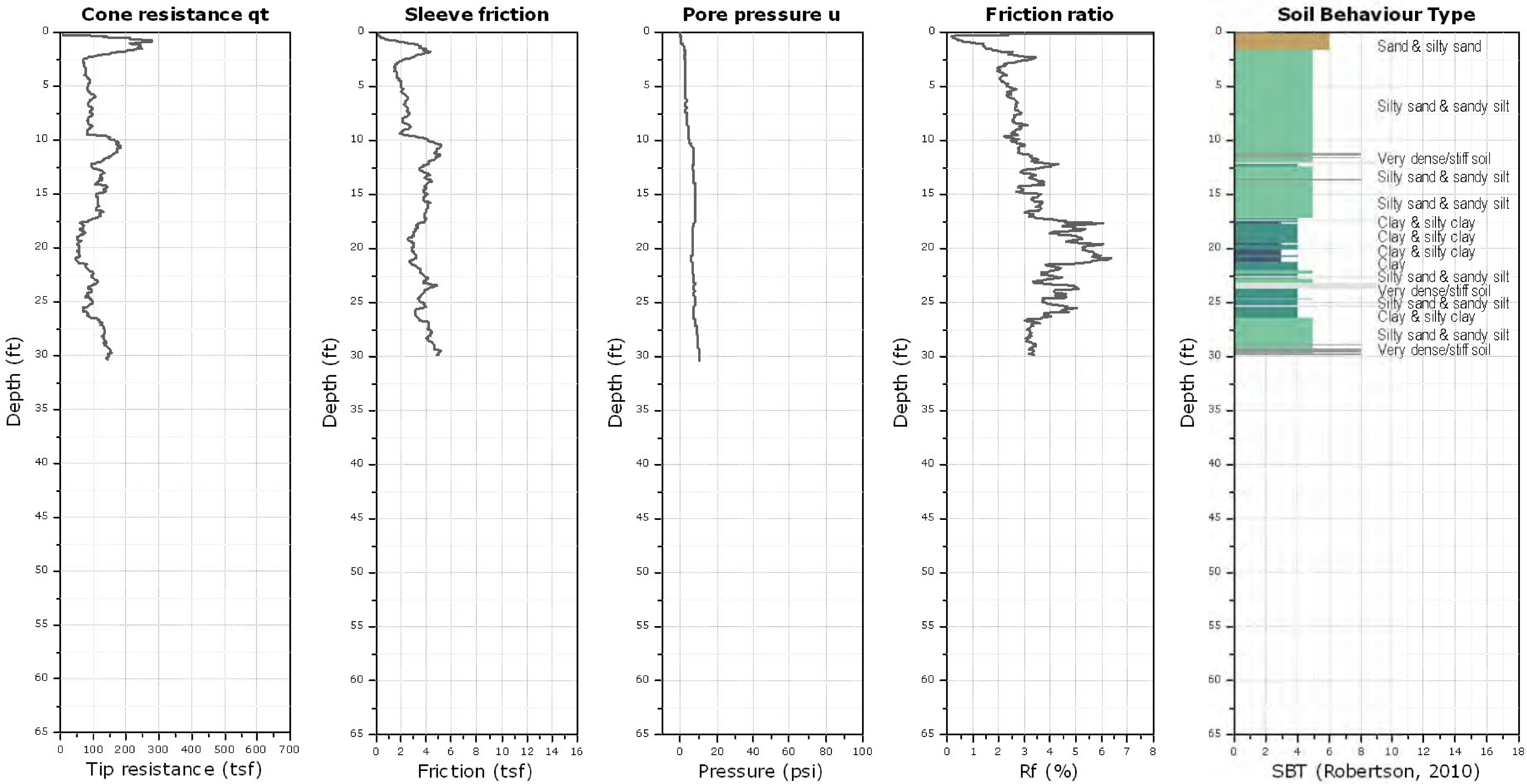
C-5

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 30.33 ft, Date: 8/7/2018
Cone Type: Vertek



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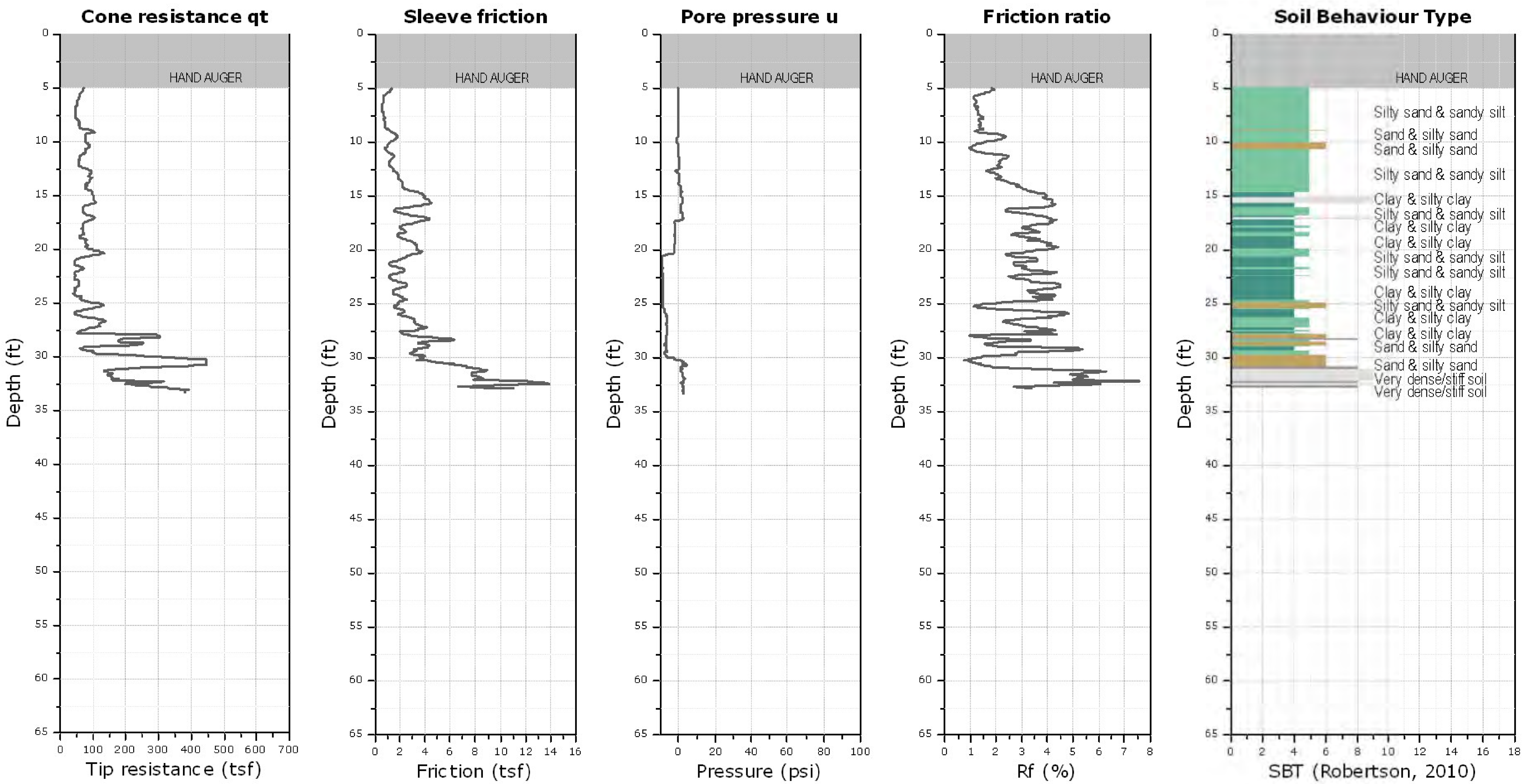
C-7

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 33.28 ft, Date: 8/6/2018
Cone Type: Vertek



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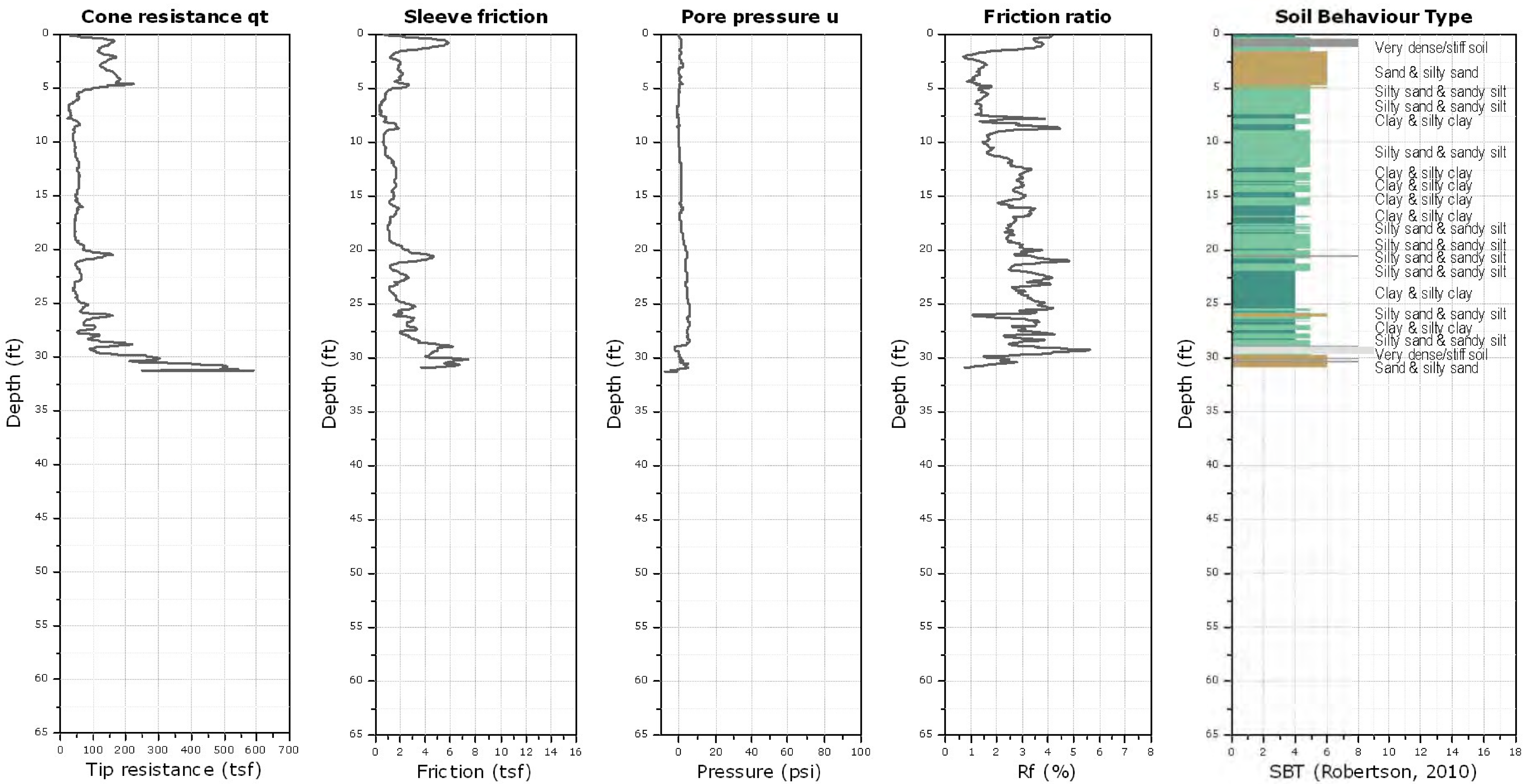
C-8

Project: Leighton Consulting

Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 31.31 ft, Date: 8/7/2018

Cone Type: Vertek



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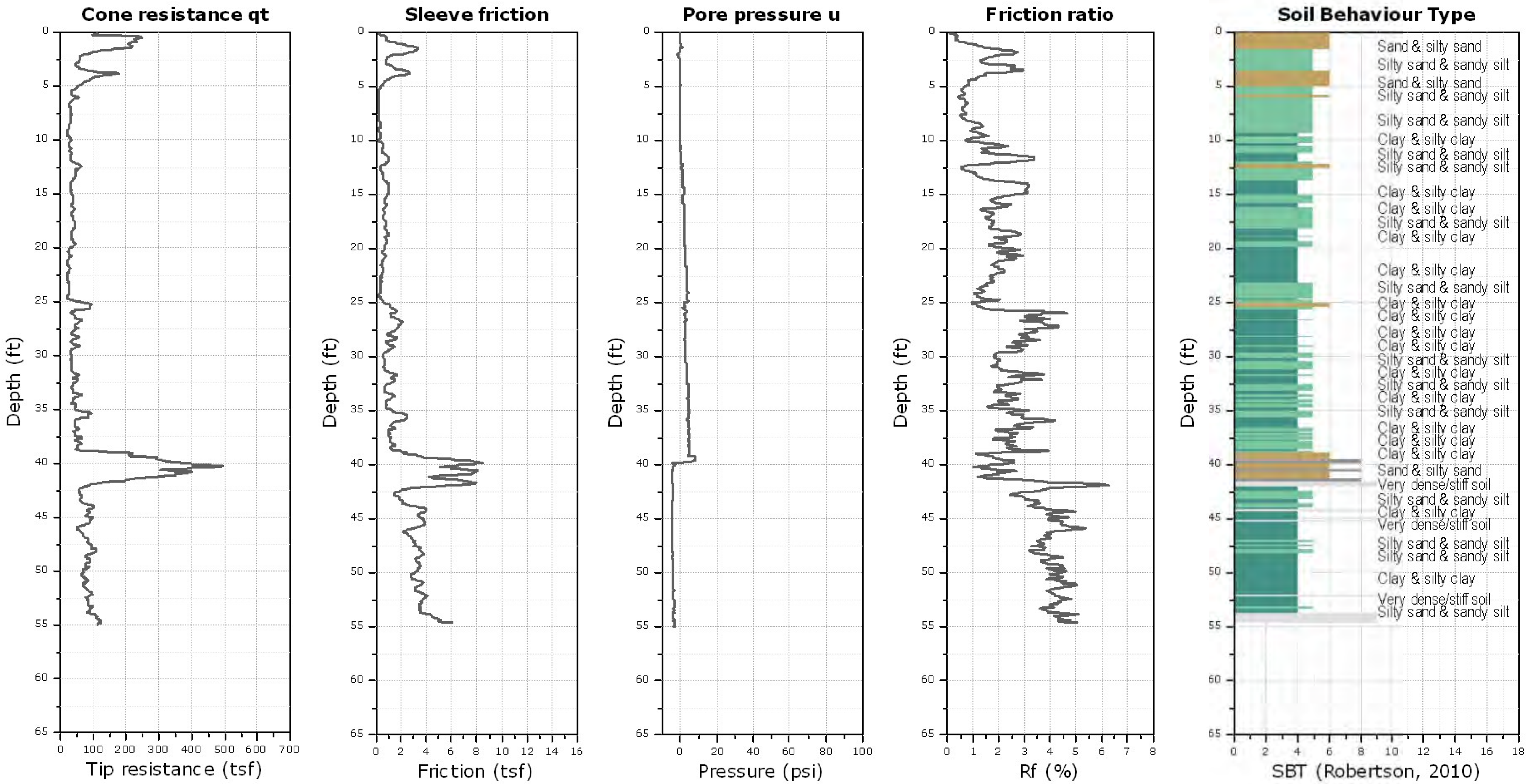
C-9

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 55.06 ft, Date: 8/7/2018
Cone Type: Vertek



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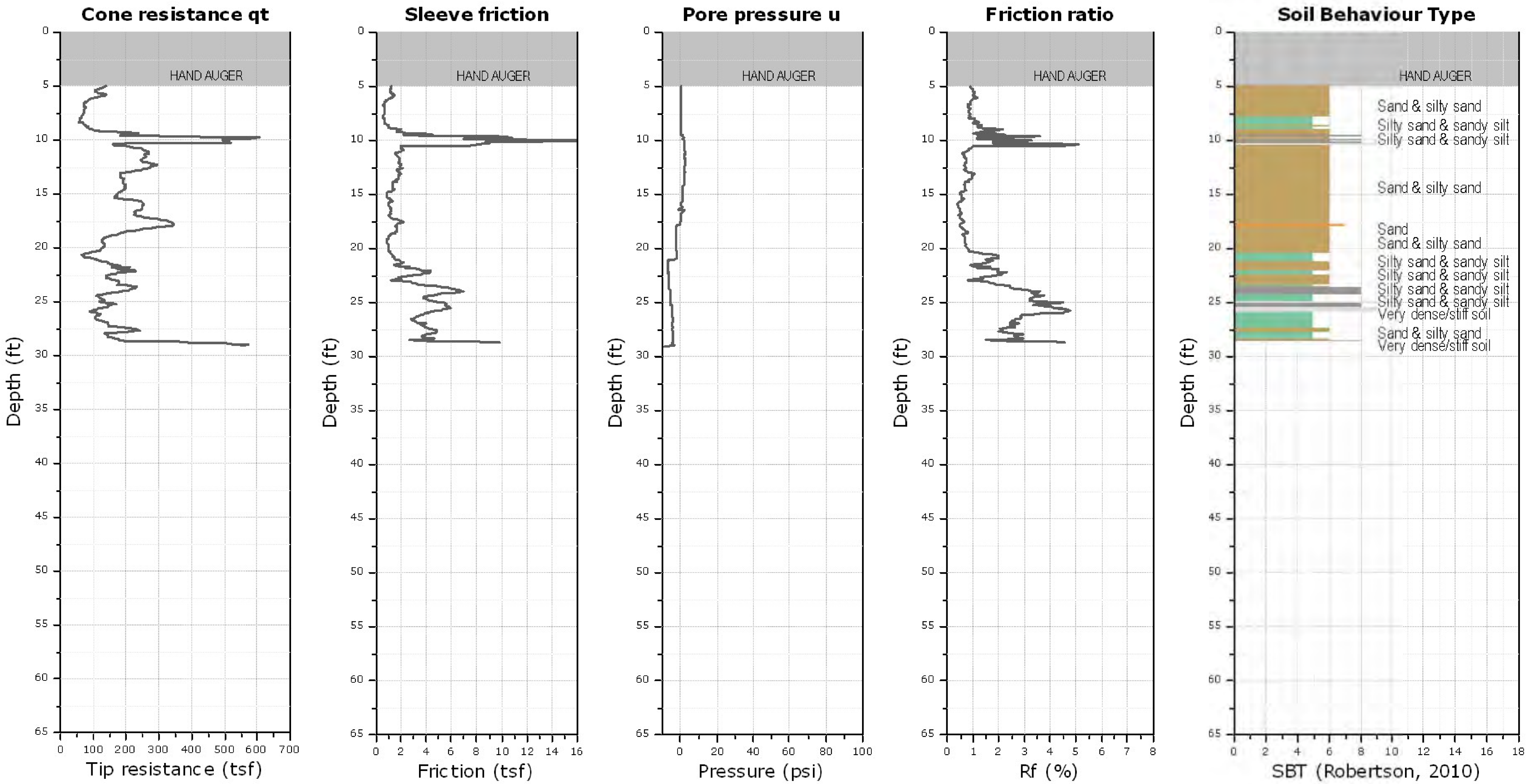
SC-1

Project: **Leighton Consulting**

Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 29.07 ft, Date: 8/6/2018

Cone Type: Vertek



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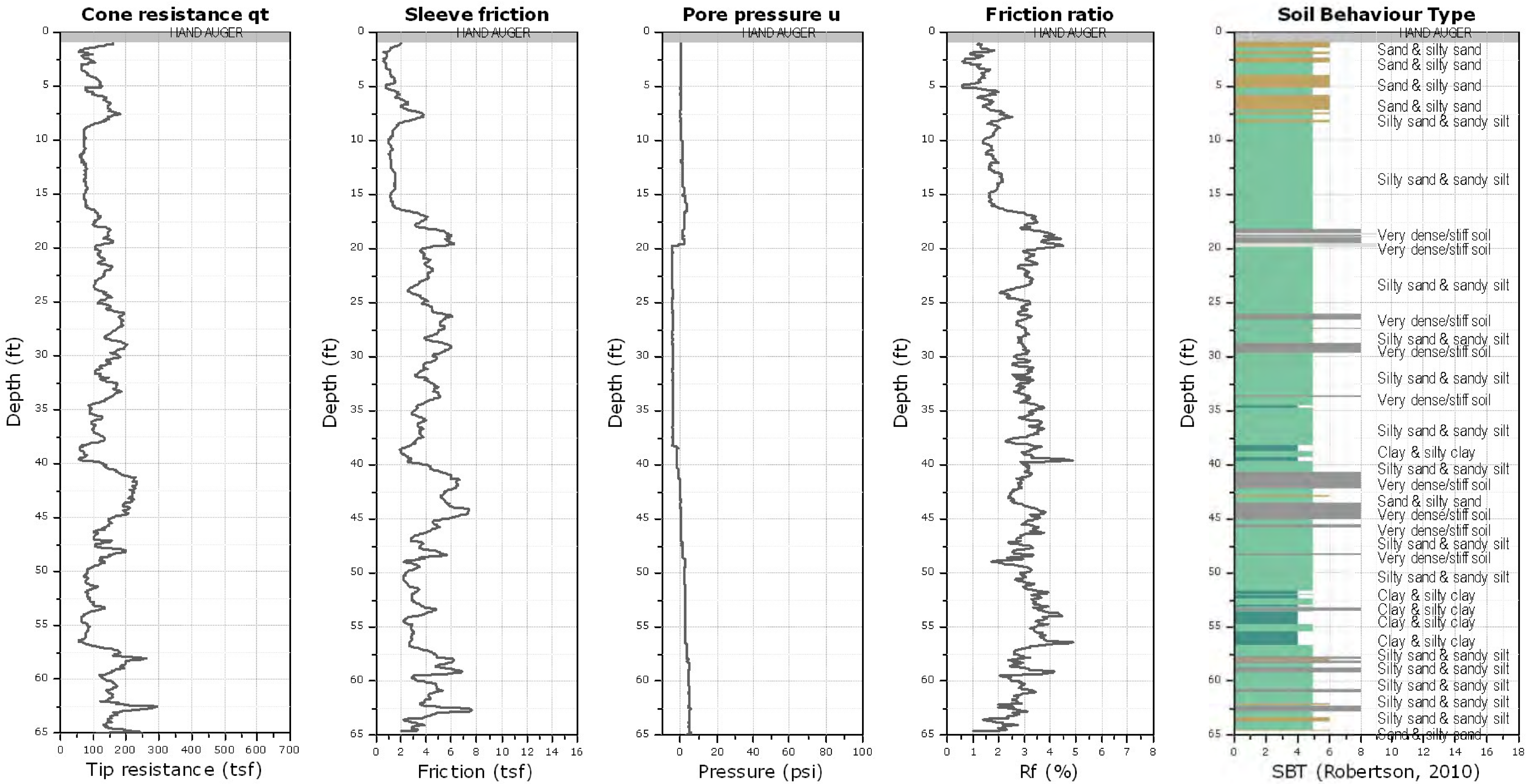
SC-3

Project: **Leighton Consulting**
Location: **Tonner Canyon Road & SR-57 Brea, CA**

Total depth: 65.06 ft, Date: 8/7/2018
Cone Type: Vertek



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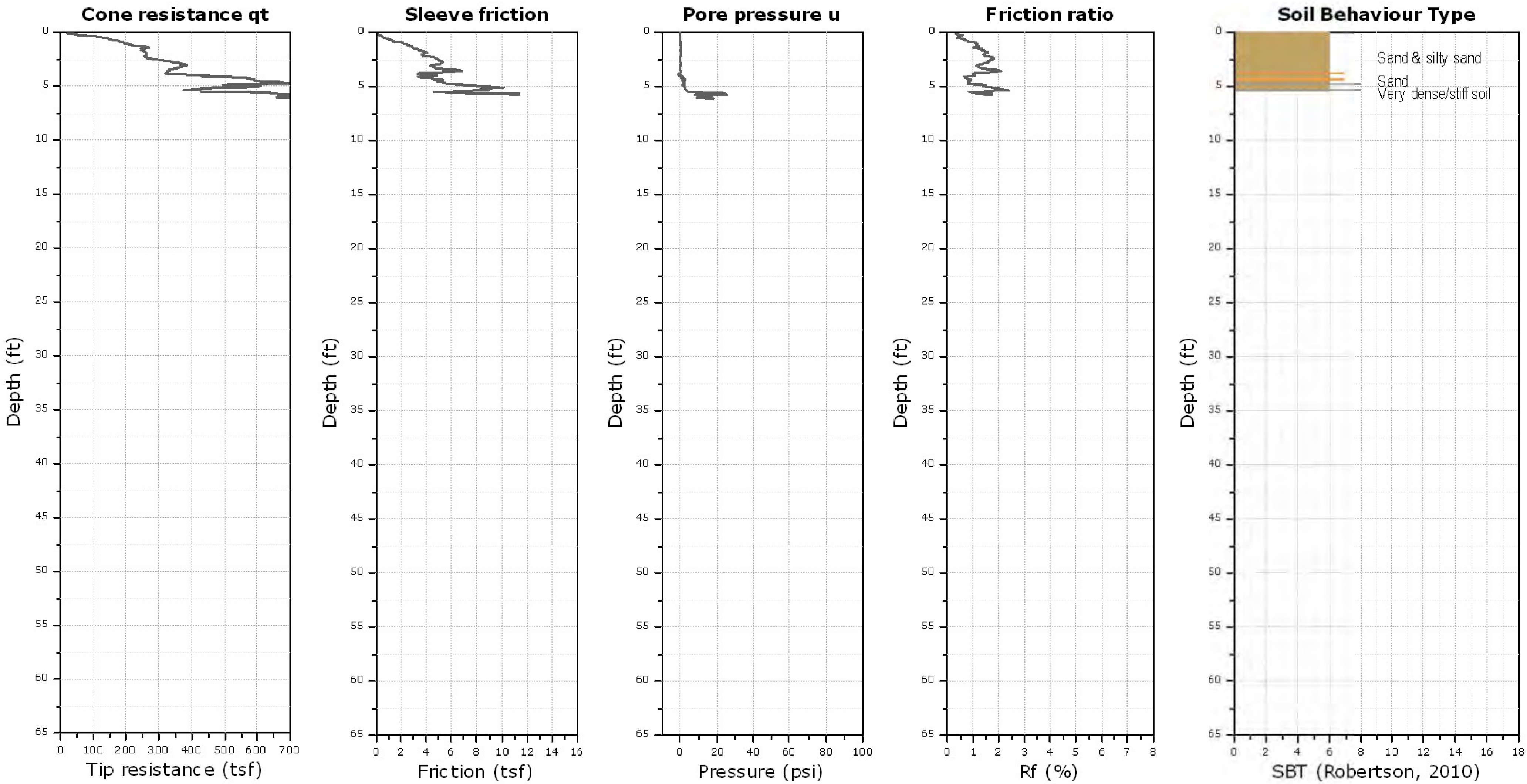
SC-6

Project: Leighton Consulting
Location: Tonner Canyon Road & SR-57 Brea, CA

Total depth: 6.17 ft, Date: 8/7/2018
Cone Type: Vertek



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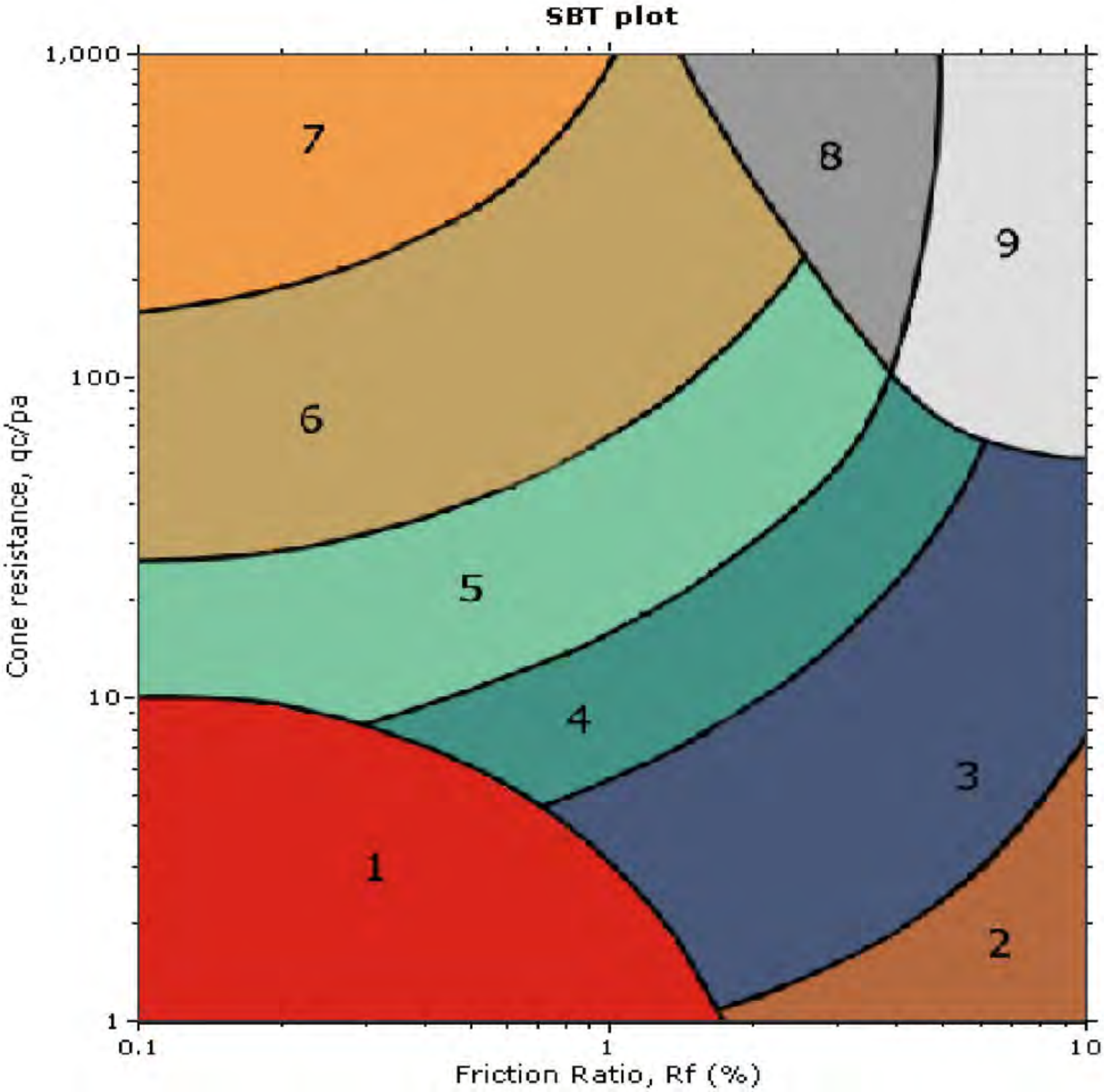


SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to clayey sand
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

C-2 In situ data Basic output data

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	91.73	0.73	0.1	-1.56	91.74	0.8	6	1.9	119.1	0.06	0	0.06	1538.5	0.8	0	6	0.42	3.39	1.5	293.75	0.12	99.62	7
2	45.13	0.45	-0.2	-1.58	45.12	1	5	2.21	113.81	0.12	0	0.12	386.21	1	0	6	0.54	3.3	1.8	140.22	-0.12	71.35	7
3	34.19	0.43	-0.3	-1.5	34.18	1.25	5	2.36	112.71	0.17	0	0.17	196.89	1.25	0	6	0.61	3.04	1.98	97.84	-0.12	56	7
4	34.84	0.5	-0.4	-1.8	34.83	1.44	5	2.39	113.94	0.23	0	0.23	150.62	1.45	0	5	0.65	2.68	2.06	87.66	-0.12	49.65	7
5	38.29	0.25	-0.7	-1.94	38.28	0.64	5	2.17	108.98	0.28	0	0.28	133.65	0.65	0	6	0.58	2.15	1.89	77.31	-0.18	72.67	7
6	46.58	0.82	-0.93	-1.97	46.57	1.76	5	2.34	118.26	0.34	0	0.34	134.6	1.77	0	5	0.67	2.12	2.1	92.46	-0.2	43.79	7
7	54.01	1.83	-1.09	-2.4	54	3.39	4	2.48	124.5	0.41	0	0.41	132.09	3.41	0	5	0.74	2.03	2.28	102.73	-0.19	26.8	5
8	83.85	1.96	-0.07	-3.43	83.85	2.34	5	2.23	126.07	0.47	0	0.47	177.94	2.35	0	5	0.66	1.72	2.08	135.34	-0.01	37.48	7
9	43.83	2.94	0.4	-3.38	43.83	6.7	3	2.76	127.46	0.53	0	0.53	81.33	6.79	0	9	0.87	1.81	2.6	74.23	0.05	14.68	3
10	99.02	5.37	2.24	-3.35	99.05	5.42	9	2.46	133.86	0.6	0	0.6	164.27	5.45	0	9	0.78	1.55	2.35	144.57	0.27	18.02	3
11	81.43	5.32	1.53	-3.32	81.46	6.54	9	2.58	133.32	0.67	0	0.67	121.3	6.59	0	9	0.83	1.47	2.48	112.04	0.17	15.1	3
12	81.17	3.14	1.49	-3.15	81.19	3.87	4	2.4	129.45	0.73	0	0.73	110.1	3.9	0	4	0.77	1.33	2.33	101.21	0.15	23.92	5
13	78.79	3.35	1.89	-2.92	78.81	4.25	4	2.44	129.85	0.8	0	0.8	98.06	4.29	0	9	0.8	1.26	2.39	92.54	0.17	21.95	3
14	78.4	3.09	2.09	-2.78	78.43	3.94	4	2.42	129.25	0.86	0	0.86	90.17	3.99	0	4	0.8	1.18	2.38	86.47	0.17	23.26	5
15	92.08	2.94	2.98	-2.61	92.12	3.2	5	2.31	129.29	0.92	0	0.92	98.6	3.23	0	5	0.76	1.11	2.28	95.51	0.23	27.88	5
16	104.01	4.39	3.95	-2.46	104.07	4.22	9	2.36	132.51	0.99	0	0.99	103.99	4.26	0	9	0.79	1.05	2.36	102.6	0.29	22.2	5
17	112.18	5.98	5.16	-2.37	112.26	5.33	9	2.42	134.96	1.06	0	1.06	105.03	5.38	0	9	0.83	1	2.43	105.04	0.35	18.12	3
18	99.84	5.18	3.38	-2.21	99.89	5.19	9	2.45	133.63	1.13	0	1.13	87.76	5.25	0	9	0.84	0.95	2.47	88.61	0.22	18.43	3
19	118.71	5.1	4.27	-2.05	118.77	4.3	9	2.33	133.93	1.19	0	1.19	98.61	4.34	0	9	0.81	0.91	2.37	100.9	0.26	21.84	3
20	236.73	6.06	6.55	-1.98	236.83	2.56	5	1.98	136.88	1.26	0	1.26	186.83	2.57	0	5	0.68	0.89	2.01	197.78	0.37	35.88	7
21	175.66	6.1	12.61	-2.11	175.85	3.47	8	2.16	136.2	1.33	0	1.33	131.31	3.5	0.01	8	0.75	0.84	2.21	138.89	0.68	26.79	5
22	228.01	6.79	44.96	-1.73	228.66	2.97	8	2.04	137.37	1.4	0	1.4	162.59	2.99	0.01	8	0.71	0.82	2.09	176.12	2.32	31.22	5
23	217.96	6.93	121.87	-1.57	219.72	3.15	8	2.07	137.37	1.47	0	1.47	148.85	3.18	0.04	8	0.73	0.79	2.13	162.43	5.98	29.44	5
24	231.53	7.64	239.28	-1.13	234.97	3.25	8	2.06	137.37	1.53	0	1.53	152.08	3.27	0.07	8	0.74	0.76	2.14	167.74	11.22	28.72	5
25	176.18	7.4	119	-0.91	177.9	4.16	8	2.22	137.37	1.6	0	1.6	109.93	4.2	0.05	9	0.81	0.72	2.31	119.14	5.34	22.66	5
26	189.79	6.95	85.58	-0.83	191.02	3.64	8	2.15	137.35	1.67	0	1.67	113.22	3.67	0.03	8	0.79	0.7	2.25	124.78	3.68	25.54	5
27	187.73	6.63	108.09	-0.75	189.29	3.5	8	2.14	136.99	1.74	0	1.74	107.73	3.53	0.04	8	0.79	0.67	2.25	119.61	4.47	26.3	5
28	214.95	6.95	103.31	-0.41	216.44	3.21	8	2.08	137.37	1.81	0	1.81	118.61	3.24	0.03	5	0.77	0.66	2.19	134.2	4.11	28.58	5
29	134.63	7.39	94.46	-0.02	135.99	5.44	9	2.38	136.98	1.88	0	1.88	71.41	5.51	0.05	9	0.9	0.6	2.53	75.57	3.62	17.59	3
30	199.08	7.37	83.7	0.28	200.29	3.68	8	2.15	137.37	1.95	0	1.95	101.88	3.71	0.03	8	0.81	0.61	2.28	114.35	3.1	25.13	5
31	260.11	8.36	288.97	1.09	264.28	3.16	8	2.03	137.37	2.02	0	2.02	130.12	3.19	0.08	8	0.77	0.61	2.15	151.34	10.32	29.2	5
32	231.77	9.71	109.49	0.65	233.35	4.16	8	2.16	137.37	2.08	0	2.08	110.96	4.2	0.03	9	0.82	0.57	2.3	125	3.78	22.69	5
33	240.96	6.59	240.31	-0.07	244.42	2.69	8	1.99	137.37	2.15	0	2.15	112.54	2.72	0.07	5	0.76	0.58	2.13	133.04	8.04	33.14	7
34	285.59	6.17	545.39	-0.39	293.45	2.1	6	1.85	137.37	2.22	0	2.22	131.1	2.12	0.13	5	0.72	0.59	1.99	161.95	17.68	41.64	7
35	256.55	5.96	327.91	-0.39	261.27	2.28	6	1.91	137	2.29	0	2.29	113.09	2.3	0.09	5	0.75	0.56	2.07	137.57	10.31	38.15	7
36	276.13	0	647.02	-0.23	285.45	0	0	0	87.42	2.33	0	2.33	121.31	0	0.16	0	1	0.45	0	121.31	19.96	187.59	0

	C-4	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	γ (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	38.41	1.21	0.69	0.53	38.42	3.14	4	2.57	120.61	0.06	0	0.06	635.7	3.14	0	8	0.64	6.18	2.05	223.93	0.83	30.25	5
2	32.84	1.33	1.09	0.4	32.86	4.04	4	2.69	120.93	0.12	0	0.12	270.88	4.05	0	8	0.71	4.69	2.25	145.2	0.65	23.58	5
3	35.72	1.86	0.99	0.38	35.74	5.22	3	2.74	123.63	0.18	0	0.18	194.82	5.24	0	9	0.76	3.81	2.37	127.91	0.39	18.62	3
4	37.71	1.99	0.99	0.4	37.72	5.27	3	2.73	124.23	0.24	0	0.24	153.19	5.3	0	9	0.78	3.13	2.41	110.88	0.29	18.38	3
5	34.18	1.4	1.19	0.45	34.2	4.1	4	2.68	121.43	0.31	0	0.31	110.96	4.13	0	4	0.78	2.63	2.4	84.22	0.28	22.54	5
6	24.84	0.81	1.19	0.42	24.85	3.24	4	2.72	116.61	0.36	0	0.36	67.33	3.29	0	4	0.8	2.35	2.45	54.49	0.24	25.86	5
7	27.14	1.11	1.32	0.42	27.16	4.07	4	2.76	119.14	0.42	0	0.42	63.16	4.14	0	4	0.83	2.14	2.53	54.18	0.22	21.82	3
8	28.79	1.46	1.39	0.38	28.81	5.07	3	2.8	121.31	0.48	0	0.48	58.54	5.15	0	4	0.87	1.97	2.61	52.7	0.21	18.35	3
9	27.64	1.59	1.69	0.4	27.66	5.74	3	2.85	121.83	0.54	0	0.54	49.78	5.85	0	3	0.9	1.82	2.68	46.53	0.22	16.51	3
10	28.67	1.52	1.79	0.38	28.69	5.28	3	2.81	121.58	0.61	0	0.61	46.37	5.39	0	4	0.9	1.65	2.67	43.81	0.21	17.56	3
11	31.62	1.37	2.48	0.35	31.66	4.32	4	2.72	121.07	0.67	0	0.67	46.52	4.42	0.01	4	0.88	1.5	2.61	43.94	0.27	20.42	3
12	28.86	1.55	2.58	0.34	28.9	5.35	3	2.82	121.74	0.73	0	0.73	38.74	5.49	0.01	3	0.92	1.41	2.73	37.64	0.26	17.22	3
13	30.22	1.71	2.88	0.45	30.26	5.66	3	2.82	122.6	0.79	0	0.79	37.39	5.81	0.01	3	0.94	1.32	2.75	36.68	0.26	16.49	3
14	25.49	1.01	3.18	0.55	25.54	3.95	4	2.77	118.31	0.85	0	0.85	29.13	4.09	0.01	4	0.93	1.23	2.72	28.66	0.27	20.66	3
15	30.75	1.21	3.33	0.49	30.79	3.94	4	2.71	120.13	0.91	0	0.91	32.93	4.06	0.01	4	0.91	1.15	2.68	32.5	0.26	21.03	3
16	53.24	1.33	3.53	0.47	53.29	2.5	5	2.4	122.15	0.97	0	0.97	54.01	2.55	0	5	0.8	1.07	2.39	53.09	0.26	30.74	5
17	19.31	0.95	3.87	0.63	19.36	4.88	3	2.92	117.16	1.03	0	1.03	17.85	5.15	0.02	3	1	1.03	2.94	17.85	0.27	17.19	3
18	22.59	0.85	4.07	0.63	22.65	3.76	3	2.79	116.79	1.09	0	1.09	19.87	3.95	0.01	3	0.98	0.98	2.83	19.88	0.27	20.11	3
19	25.37	1.03	4.27	0.65	25.43	4.04	3	2.77	118.43	1.14	0	1.14	21.22	4.23	0.01	3	0.98	0.93	2.83	21.25	0.27	19.55	3
20	21.96	0.63	4.37	0.65	22.02	2.85	4	2.73	114.49	1.2	0	1.2	17.32	3.02	0.02	4	0.98	0.88	2.8	17.38	0.26	22.35	5
21	41.27	1.61	4.64	0.61	41.33	3.9	4	2.61	122.92	1.26	0	1.26	31.71	4.02	0.01	4	0.93	0.85	2.68	32.1	0.26	21.15	3
22	62.38	2.57	5.16	0.59	62.46	4.12	4	2.5	127.35	1.33	0	1.33	46.06	4.21	0.01	4	0.89	0.82	2.57	47.18	0.28	21.29	3
23	31.71	1.02	5.36	0.63	31.79	3.19	4	2.63	118.89	1.39	0	1.39	21.93	3.34	0.01	4	0.96	0.77	2.75	22.15	0.28	22.33	5
24	20.44	0.78	5.36	0.73	20.51	3.79	3	2.83	115.88	1.44	0	1.44	13.2	4.08	0.02	3	1	0.73	2.98	13.2	0.27	18.73	3
25	21.06	0.55	5.36	0.77	21.13	2.58	4	2.72	113.36	1.5	0	1.5	13.08	2.78	0.02	3	1	0.7	2.88	13.08	0.26	21.69	2
26	17.6	0.6	5.46	0.75	17.68	3.39	3	2.85	113.61	1.56	0	1.56	10.35	3.72	0.02	3	1	0.68	3.04	10.35	0.25	18.76	2
27	15.35	0.44	5.56	0.76	15.43	2.88	3	2.85	111.07	1.61	0	1.61	8.56	3.21	0.03	3	1	0.66	3.07	8.56	0.25	19.04	2
28	20.11	0.35	5.66	0.77	20.19	1.71	4	2.63	109.9	1.67	0	1.67	11.1	1.87	0.02	4	1	0.63	2.85	11.1	0.24	23.26	4
29	18.05	0.48	5.76	0.79	18.13	2.67	4	2.78	112.11	1.72	0	1.72	9.51	2.95	0.03	3	1	0.61	3.01	9.51	0.24	19.89	2
30	103.71	0.78	6.06	0.67	103.8	0.75	6	1.84	119.86	1.78	0	1.78	57.17	0.77	0	6	0.69	0.7	1.98	67.28	0.24	63.6	7
31	26.85	1.12	6.55	0.59	26.94	4.16	4	2.76	119.22	1.84	0	1.84	13.61	4.47	0.02	3	1	0.57	2.99	13.61	0.26	18.05	3
32	32.73	1.69	6.65	0.61	32.82	5.14	3	2.76	122.7	1.91	0	1.91	16.22	5.46	0.02	3	1	0.56	2.99	16.22	0.25	16.53	3
33	62.66	1.88	7.31	0.65	62.77	3	5	2.4	125.09	1.97	0	1.97	30.9	3.1	0.01	4	0.94	0.56	2.6	32.16	0.27	24.84	5
34	66.19	0	7.94	0.51	66.31	0	0	0	87.42	2.01	0	2.01	31.96	0	0.01	0	1	0.53	0	31.96	0.28	59.94	0

	C-5	In situ data											Basic output data										
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	221.62	1.92	0.91	0.69	221.63	0.87	6	1.63	128.3	0.06	0	0.06	3451.6	0.87	0	6	0.37	2.82	1.35	590.04	1.02	103.2	7
2	154.44	3.22	2.58	0.95	154.48	2.08	5	2.02	131.2	0.13	0	0.13	1188.8	2.08	0	8	0.52	2.99	1.75	436.64	1.43	45.58	7
3	71.17	1.84	2.72	0.93	71.21	2.58	5	2.31	125.2	0.19	0	0.19	369.38	2.58	0	5	0.63	2.91	2.01	195.4	1.02	35.72	7
4	76.41	1.73	2.78	0.87	76.45	2.26	5	2.25	124.92	0.25	0	0.25	299.08	2.26	0	5	0.62	2.42	2	174.53	0.79	39.67	7
5	84.49	2.06	2.88	0.87	84.53	2.43	5	2.24	126.46	0.32	0	0.32	264.78	2.44	0	5	0.64	2.15	2.03	171.2	0.65	37.1	7
6	103.55	2.22	3.18	0.69	103.59	2.14	5	2.14	127.5	0.38	0	0.38	270.3	2.15	0	6	0.62	1.88	1.97	182.94	0.6	41.64	7
7	93.98	2.37	3.28	0.45	94.02	2.52	5	2.22	127.75	0.45	0	0.45	209.93	2.53	0	5	0.66	1.77	2.07	156.16	0.53	35.69	7
8	83.53	2.63	3.68	0.22	83.59	3.15	5	2.33	128.23	0.51	0	0.51	162.99	3.17	0	5	0.71	1.68	2.19	131.62	0.52	29.09	5
9	84.98	2.77	4.07	0.08	85.04	3.25	5	2.33	128.63	0.57	0	0.57	147.14	3.27	0	5	0.72	1.55	2.21	124.05	0.51	28.16	5
10	157.72	3.7	4.93	-0.03	157.79	2.34	5	2.05	132.27	0.64	0	0.64	245.46	2.35	0	6	0.63	1.37	1.97	203.9	0.55	38.9	7
11	171.55	4.94	7.55	-0.59	171.66	2.88	5	2.1	134.59	0.71	0	0.71	241.6	2.89	0	8	0.66	1.3	2.03	210.58	0.77	32.52	7
12	124	4.25	7.65	-0.99	124.11	3.42	5	2.25	132.7	0.77	0	0.77	159.36	3.45	0	8	0.72	1.25	2.19	146.04	0.71	27.23	5
13	132.45	3.75	7.36	-1.13	132.55	2.83	5	2.16	131.95	0.84	0	0.84	156.85	2.85	0	5	0.7	1.18	2.12	146.3	0.63	32.11	7
14	110.84	4.22	7.85	-0.87	110.96	3.8	5	2.31	132.37	0.91	0	0.91	121.47	3.83	0.01	8	0.76	1.13	2.28	117.08	0.62	24.5	5
15	111.4	3.85	8.05	-0.89	111.52	3.45	5	2.28	131.72	0.97	0	0.97	113.74	3.48	0.01	5	0.76	1.07	2.26	111.43	0.6	26.5	5
16	112.81	3.94	8.09	-1.07	112.93	3.49	5	2.28	131.91	1.04	0	1.04	107.8	3.52	0.01	5	0.77	1.01	2.28	107.32	0.56	26.22	5
17	122.04	3.79	8.42	-1.29	122.16	3.1	5	2.22	131.82	1.1	0	1.1	109.67	3.13	0.01	5	0.75	0.97	2.23	110.83	0.55	29.01	5
18	65.86	3.33	7.13	-1.55	65.96	5.05	4	2.55	129.37	1.17	0	1.17	55.46	5.14	0.01	4	0.89	0.92	2.59	56.06	0.44	18.46	3
19	53.18	2.99	6.91	-1.65	53.28	5.62	4	2.65	128.08	1.23	0	1.23	42.23	5.75	0.01	3	0.94	0.87	2.7	42.63	0.4	16.69	3
20	54.97	3.06	6.46	-1.49	55.06	5.55	4	2.63	128.31	1.3	0	1.3	41.46	5.69	0.01	3	0.94	0.83	2.7	41.96	0.36	16.84	3
21	47.79	3.17	6.26	-1.56	47.88	6.61	3	2.73	128.22	1.36	0	1.36	34.18	6.81	0.01	3	0.99	0.78	2.82	34.28	0.33	14.6	3
22	85.46	3.43	6.76	-1.62	85.55	4.01	4	2.4	130.23	1.43	0	1.43	59	4.08	0.01	4	0.86	0.77	2.49	61.43	0.34	22.29	5
23	108.92	4.1	7.58	-1.77	109.03	3.76	5	2.31	132.13	1.49	0	1.49	72.09	3.81	0.01	4	0.84	0.75	2.4	76.28	0.37	23.9	5
24	92.69	3.92	7.91	-1.7	92.81	4.23	4	2.4	131.41	1.56	0	1.56	58.58	4.3	0.01	4	0.88	0.71	2.5	61.43	0.37	21.38	3
25	97.07	3.25	7.94	-1.3	97.19	3.34	5	2.3	130.13	1.62	0	1.62	58.89	3.4	0.01	4	0.85	0.7	2.42	62.81	0.35	25.7	5
26	81.66	3.31	7.45	-0.94	81.77	4.05	4	2.42	129.85	1.69	0	1.69	47.45	4.13	0.01	4	0.9	0.66	2.55	49.66	0.32	21.68	3
27	125.39	3.78	8.25	-1.21	125.51	3.01	5	2.2	131.86	1.75	0	1.75	70.57	3.05	0	5	0.82	0.66	2.33	77.31	0.34	28.55	5
28	132.18	4.36	9.4	-1.54	132.32	3.3	5	2.21	133.05	1.82	0	1.82	71.7	3.34	0.01	5	0.83	0.64	2.35	78.54	0.37	26.62	5
29	135.22	4.58	9.94	-1.64	135.37	3.38	5	2.22	133.46	1.89	0	1.89	70.75	3.43	0.01	5	0.84	0.62	2.36	77.63	0.38	26.07	5
30	146.36	0	10.64	-1.85	146.51	0	0	0	87.42	1.93	0	1.93	74.89	0	0.01	0	1	0.55	0	74.89	0.4	121.28	0

	C-7	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	73.76	0.8	0	0.28	73.76	1.09	5	2.06	119.22	0.06	0	0.06	1235.6	1.09	0	6	0.47	3.89	1.63	270.89	0	77.01	7
2	54.05	0.67	-0.05	0.23	54.05	1.24	5	2.2	117.15	0.12	0	0.12	456.04	1.24	0	6	0.55	3.31	1.81	168.89	-0.03	63.9	7
3	58.05	0.7	0.1	0.22	58.05	1.21	5	2.17	117.64	0.18	0	0.18	327.11	1.21	0	6	0.56	2.72	1.84	148.83	0.04	63.55	7
4	79.7	1.06	0	0.22	79.7	1.33	5	2.08	121.44	0.24	0	0.24	334.31	1.33	0	6	0.56	2.3	1.82	172.44	0	60.9	7
5	71.86	1.27	-0.1	0.14	71.85	1.77	5	2.2	122.52	0.3	0	0.3	239.32	1.77	0	6	0.61	2.17	1.96	146.47	-0.02	47.43	7
6	54.08	0.65	-0.2	0.2	54.07	1.21	5	2.19	116.95	0.36	0	0.36	150.26	1.21	0	6	0.62	1.95	1.97	99.02	-0.04	57.34	7
7	46.48	0.61	-0.37	0.18	46.48	1.32	5	2.27	116.14	0.42	0	0.42	110.83	1.33	0	5	0.66	1.84	2.06	80.31	-0.06	51	7
8	52.75	0.7	-0.42	0.18	52.74	1.32	5	2.22	117.38	0.47	0	0.47	110.24	1.33	0	5	0.65	1.69	2.05	83.47	-0.06	51.53	7
9	103.31	1.1	-0.2	0.22	103.31	1.06	6	1.94	122.35	0.54	0	0.54	191.97	1.07	0	6	0.57	1.47	1.81	142.84	-0.03	68.64	7
10	77.73	1.38	-0.7	0.2	77.72	1.78	5	2.18	123.34	0.6	0	0.6	129.17	1.79	0	5	0.66	1.46	2.06	106.56	-0.09	44.65	7
11	74.17	0.98	0.03	0.24	74.17	1.32	5	2.11	120.68	0.66	0	0.66	111.81	1.33	0	6	0.65	1.36	2.01	94.51	0	53.45	7
12	54.22	1.33	0.7	0.2	54.23	2.45	5	2.38	122.16	0.72	0	0.72	74.47	2.48	0	5	0.76	1.34	2.3	67.87	0.07	32.69	7
13	88.46	1.71	0.3	0.16	88.47	1.93	5	2.16	125.2	0.78	0	0.78	112.27	1.95	0	5	0.69	1.23	2.1	102.1	0.03	41.68	7
14	79.77	2.59	0.66	0.18	79.78	3.24	5	2.35	127.99	0.85	0	0.85	93.41	3.28	0	5	0.77	1.19	2.31	88.69	0.06	27.35	5
15	99.69	3.75	1.69	0.18	99.72	3.76	5	2.34	131.26	0.91	0	0.91	108.49	3.8	0	5	0.77	1.12	2.31	104.87	0.13	24.53	5
16	73.94	3.76	1.29	0.16	73.96	5.08	4	2.52	130.54	0.98	0	0.98	74.78	5.15	0	9	0.85	1.07	2.51	73.89	0.1	18.63	3
17	101.63	2.41	2.45	0.16	101.66	2.37	5	2.18	128.07	1.04	0	1.04	96.74	2.4	0	5	0.73	1.01	2.18	96.3	0.17	35.33	7
18	65.49	2.18	-1.89	0.12	65.47	3.34	4	2.42	126.27	1.1	0	1.1	58.35	3.39	0	4	0.83	0.97	2.44	58.76	-0.12	25.53	5
19	69.25	2.34	-1.97	0.14	69.22	3.38	4	2.41	126.91	1.17	0	1.17	58.34	3.44	0	4	0.84	0.92	2.44	59.28	-0.12	25.31	5
20	91.19	3	-2.22	0.12	91.16	3.29	5	2.32	129.39	1.23	0	1.23	73.04	3.33	0	5	0.81	0.88	2.36	75.19	-0.13	26.57	5
21	49.15	2.22	-9.15	0.14	49.02	4.53	4	2.6	125.69	1.29	0	1.29	36.87	4.66	-0.01	4	0.93	0.83	2.68	37.39	-0.51	19.41	3
22	52.87	1.58	-8.95	0.08	52.74	3	4	2.45	123.38	1.36	0	1.36	37.89	3.08	-0.01	4	0.88	0.8	2.54	39.02	-0.48	25.78	5
23	55.92	1.37	-8.45	0.13	55.8	2.46	5	2.38	122.47	1.42	0	1.42	38.38	2.52	-0.01	4	0.86	0.78	2.47	39.99	-0.43	29.26	5
24	42.31	1.92	-8.35	0.12	42.19	4.55	4	2.65	124.25	1.48	0	1.48	27.52	4.71	-0.01	3	0.98	0.72	2.77	27.74	-0.41	18.8	3
25	117.37	2.33	-8.21	0.12	117.25	1.99	5	2.08	128.16	1.54	0	1.54	74.98	2.01	-0.01	5	0.75	0.75	2.18	82.32	-0.38	39.16	7
26	42.89	2.59	-6.78	0.1	42.79	6.05	3	2.73	126.47	1.61	0	1.61	25.63	6.29	-0.01	3	1	0.66	2.88	25.63	-0.3	15.42	3
27	120.05	2.75	-6.57	0.13	119.96	2.3	5	2.12	129.44	1.67	0	1.67	70.78	2.33	0	5	0.78	0.7	2.24	78.22	-0.28	34.99	7
28	296.97	2.53	-7.06	-0.5	296.87	0.85	6	1.54	131.05	1.74	0	1.74	169.94	0.86	0	6	0.55	0.76	1.62	212.29	-0.29	88.1	7
29	152.74	3.01	-7.05	-1.22	152.64	1.97	5	2	130.69	1.8	0	1.8	83.7	2	0	5	0.75	0.67	2.13	95.83	-0.28	40.5	7
30	277.23	3.92	-5.82	-1.28	277.15	1.42	6	1.73	134.08	1.87	0	1.87	147.28	1.43	0	6	0.64	0.7	1.83	181.12	-0.22	58.24	7
31	259.66	6.76	1.54	-2.66	259.68	2.6	8	1.96	137.37	1.94	0	1.94	133	2.62	0	5	0.73	0.64	2.08	156.33	0.06	34.66	7
32	158.52	7.88	3.25	-2.99	158.57	4.97	9	2.31	137.37	2.01	0	2.01	78.02	5.03	0	9	0.88	0.57	2.47	83.98	0.12	19.07	3
33	365.39	0	2.6	-3.78	365.43	0	0	0	87.42	2.05	0	2.05	177.24	0	0	0	1	0.52	0	177.24	0.09	267.49	0

	C-8	In situ data										Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	145.22	4.32	1.31	-0.1	145.23	2.98	5	2.16	133.21	0.07	0	0.07	2178.1	2.98	0	8	0.55	4.53	1.82	621.64	1.41	32.87	7
2	168.73	1.86	0.79	-0.3	168.74	1.1	6	1.79	127.4	0.13	0	0.13	1293.1	1.1	0	6	0.44	2.51	1.53	400.72	0.44	80.26	7
3	124.31	2.08	1.79	-0.28	124.34	1.67	6	2.01	127.47	0.19	0	0.19	640.04	1.67	0	6	0.53	2.46	1.76	288.71	0.66	53.96	7
4	174.11	2.38	1.05	-0.3	174.12	1.37	6	1.85	129.28	0.26	0	0.26	672.22	1.37	0	6	0.49	2	1.66	328.86	0.29	65.17	7
5	110.59	1.97	0.59	-0.14	110.6	1.78	5	2.07	126.79	0.32	0	0.32	342.39	1.79	0	6	0.58	1.99	1.87	207.01	0.13	49.37	7
6	53.35	0.64	0	-0.06	53.35	1.2	5	2.19	116.81	0.38	0	0.38	139.2	1.21	0	6	0.62	1.89	1.98	94.63	0	56.64	7
7	26.79	0.5	-0.6	-0.12	26.78	1.86	4	2.55	113.26	0.44	0	0.44	60.26	1.89	0	5	0.76	1.95	2.33	48.62	-0.1	36.2	7
8	45.09	1.13	0.07	-0.67	45.09	2.51	5	2.45	120.54	0.5	0	0.5	89.67	2.54	0	5	0.74	1.75	2.28	73.83	0.01	32.56	7
9	41.09	1.42	0.08	-0.75	41.09	3.46	4	2.58	121.98	0.56	0	0.56	72.6	3.51	0	4	0.8	1.67	2.43	63.91	0.01	25.13	5
10	40.28	0.7	0.1	-0.77	40.28	1.73	5	2.39	116.74	0.62	0	0.62	64.31	1.76	0	5	0.74	1.49	2.26	55.91	0.01	39.12	7
11	44.8	0.99	0.5	-0.83	44.81	2.22	5	2.42	119.58	0.68	0	0.68	65.23	2.25	0	5	0.76	1.41	2.32	58.71	0.05	33.97	7
12	55.21	1.44	1.09	-0.87	55.22	2.61	5	2.4	122.81	0.74	0	0.74	73.83	2.64	0	5	0.77	1.32	2.32	67.92	0.11	31.21	5
13	56.45	1.62	1.19	-0.91	56.46	2.87	5	2.42	123.72	0.8	0	0.8	69.61	2.91	0	5	0.79	1.25	2.36	65.58	0.11	28.98	5
14	55.28	1.49	1.49	-0.95	55.3	2.69	5	2.41	123.05	0.86	0	0.86	63.21	2.74	0	5	0.79	1.18	2.37	60.56	0.12	29.94	5
15	48.17	1.28	1.61	-0.98	48.2	2.65	5	2.45	121.6	0.92	0	0.92	51.27	2.71	0	5	0.82	1.12	2.42	49.99	0.13	29.22	5
16	63.04	1.27	1.69	-1.03	63.07	2.01	5	2.28	122.19	0.98	0	0.98	63.14	2.04	0	5	0.76	1.06	2.27	62.04	0.12	36.65	7
17	46.31	1.43	0.8	-1.16	46.32	3.09	4	2.5	122.32	1.04	0	1.04	43.35	3.16	0	4	0.86	1.01	2.51	43.27	0.06	25.78	5
18	41.14	1.06	1.39	-1.26	41.16	2.59	4	2.49	119.87	1.1	0	1.1	36.28	2.66	0	4	0.86	0.96	2.52	36.49	0.09	27.85	5
19	46.51	1.42	2.46	-1.26	46.55	3.05	4	2.5	122.29	1.17	0	1.17	38.94	3.13	0	4	0.87	0.92	2.54	39.42	0.15	25.55	5
20	69.21	2.97	3.88	-1.3	69.26	4.29	4	2.48	128.65	1.23	0	1.23	55.32	4.37	0	4	0.87	0.88	2.53	56.39	0.23	21	3
21	69.4	3.41	3.29	-1.32	69.44	4.91	4	2.53	129.68	1.29	0	1.29	52.64	5.01	0	4	0.9	0.83	2.59	53.73	0.18	18.8	3
22	57.45	1.68	4.02	-1.59	57.51	2.92	5	2.42	124.02	1.36	0	1.36	41.39	2.99	0.01	4	0.87	0.81	2.5	42.78	0.21	26.69	5
23	46.63	1.97	3.98	-1.68	46.69	4.23	4	2.6	124.7	1.42	0	1.42	31.91	4.36	0.01	4	0.95	0.76	2.7	32.41	0.2	20.06	3
24	46.48	1.28	4.67	-1.71	46.54	2.75	4	2.47	121.52	1.48	0	1.48	30.45	2.84	0.01	4	0.91	0.74	2.59	31.43	0.23	26.01	5
25	68.76	1.73	5.54	-1.7	68.84	2.52	5	2.32	124.7	1.54	0	1.54	43.64	2.58	0.01	5	0.85	0.73	2.43	46.17	0.26	29.73	5
26	107.73	2.14	6.24	-1.78	107.82	1.99	5	2.11	127.35	1.61	0	1.61	66.14	2.02	0	5	0.77	0.73	2.22	72.8	0.28	38.15	7
27	75.96	2.46	5.96	-1.8	76.05	3.23	5	2.37	127.5	1.67	0	1.67	44.55	3.3	0.01	4	0.88	0.67	2.5	47.01	0.26	25.3	5
28	116.99	2.75	4.77	-1.84	117.06	2.35	5	2.14	129.36	1.73	0	1.73	66.5	2.38	0	5	0.79	0.68	2.26	73.63	0.2	34.09	7
29	163.01	4.22	-2.62	-1.84	162.97	2.59	5	2.08	133.32	1.8	0	1.8	89.5	2.62	0	5	0.77	0.66	2.2	101	-0.1	33.19	7
30	266.55	5.17	0.87	-2.2	266.56	1.94	6	1.85	136.01	1.87	0	1.87	141.63	1.95	0	6	0.68	0.68	1.96	169.59	0.03	44.73	7
31	499.17	0	1.94	-2.48	499.2	0	0	0	87.42	1.91	0	1.91	260.01	0	0	0	1	0.55	0	260.01	0.07	385.73	0

	C-9	In situ data											Basic output data										
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	212.33	1.72	0.1	0.95	212.34	0.81	6	1.62	127.38	0.06	0	0.06	3330.8	0.81	0	6	0.36	2.79	1.34	559.32	0.11	108.99	7
2	80.86	2.35	-1.24	0.54	80.84	2.91	5	2.31	127.33	0.13	0	0.13	633.36	2.92	0	8	0.61	3.62	1.97	276.51	-0.7	32.71	7
3	45.07	1.38	-0.1	0.52	45.07	3.05	4	2.51	121.98	0.19	0	0.19	238.42	3.07	0	5	0.68	3.25	2.16	138.07	-0.04	30.01	5
4	140.36	1.89	-0.1	0.61	140.36	1.35	6	1.91	127.06	0.25	0	0.25	556.35	1.35	0	6	0.51	2.08	1.7	274.99	-0.03	64.69	7
5	54.05	0.49	0.2	0.55	54.06	0.91	5	2.12	114.88	0.31	0	0.31	173.77	0.92	0	6	0.58	2.04	1.87	103.53	0.05	68.92	7
6	52.76	0.22	0	0.53	52.76	0.41	6	1.96	108.88	0.36	0	0.36	144.03	0.42	0	6	0.53	1.76	1.74	87.38	0	91.53	7
7	28.91	0.19	-0.3	0.58	28.9	0.65	5	2.28	106.31	0.42	0	0.42	68.32	0.66	0	6	0.65	1.84	2.06	49.44	-0.05	57.92	7
8	29.3	0.24	-0.21	0.59	29.3	0.81	5	2.32	108.08	0.47	0	0.47	61.22	0.83	0	5	0.68	1.74	2.12	47.3	-0.03	52.54	7
9	23.26	0.36	0.1	0.57	23.26	1.55	4	2.55	110.55	0.53	0	0.53	43.21	1.58	0	5	0.78	1.72	2.37	37.03	0.01	36.55	7
10	33.64	0.44	0.17	0.58	33.64	1.29	5	2.38	112.84	0.58	0	0.58	56.75	1.32	0	5	0.73	1.54	2.23	48.25	0.02	43.62	7
11	27.57	0.73	0.1	0.55	27.57	2.65	4	2.63	116.13	0.64	0	0.64	42.02	2.71	0	4	0.83	1.52	2.51	38.68	0.01	27.84	5
12	36.65	0.76	0.89	0.53	36.66	2.08	5	2.47	117.16	0.7	0	0.7	51.42	2.12	0	5	0.79	1.38	2.37	47.07	0.09	33.59	7
13	44.88	0.43	1.19	0.51	44.89	0.95	5	2.2	113.42	0.76	0	0.76	58.39	0.97	0	5	0.7	1.26	2.12	52.7	0.11	51.76	7
14	31.11	0.76	1.49	0.47	31.13	2.43	4	2.57	116.7	0.81	0	0.81	37.23	2.5	0	4	0.84	1.25	2.51	35.75	0.13	28.72	5
15	34.04	0.86	1.99	0.47	34.07	2.53	4	2.55	117.86	0.87	0	0.87	38.02	2.59	0	4	0.85	1.18	2.51	36.92	0.16	28.3	5
16	35.17	0.66	1.89	0.49	35.2	1.87	5	2.45	115.99	0.93	0	0.93	36.8	1.93	0	5	0.82	1.11	2.43	35.97	0.15	33.01	7
17	35.16	0.67	2.37	0.47	35.2	1.9	5	2.46	116.11	0.99	0	0.99	34.57	1.96	0	5	0.83	1.06	2.46	34.19	0.17	32.25	7
18	42.47	0.82	2.29	0.45	42.5	1.93	5	2.4	118.04	1.05	0	1.05	39.55	1.98	0	5	0.82	1.01	2.41	39.48	0.16	33.42	7
19	34.9	0.87	2.38	0.43	34.93	2.49	4	2.53	118	1.11	0	1.11	30.55	2.57	0.01	4	0.88	0.96	2.57	30.71	0.16	27.31	5
20	29.83	0.73	2.68	0.45	29.87	2.44	4	2.58	116.32	1.17	0	1.17	24.63	2.54	0.01	4	0.91	0.92	2.64	24.85	0.17	26.18	5
21	23.91	0.61	2.96	0.53	23.95	2.56	4	2.67	114.52	1.22	0	1.22	18.59	2.7	0.01	4	0.96	0.87	2.75	18.71	0.17	23.82	5
22	27.58	0.41	3.28	0.61	27.63	1.48	5	2.48	111.88	1.28	0	1.28	20.6	1.55	0.01	4	0.89	0.84	2.57	21.04	0.18	30.25	4
23	21.7	0.36	3.58	0.63	21.75	1.66	4	2.59	110.38	1.33	0	1.33	15.31	1.76	0.01	4	0.95	0.8	2.71	15.5	0.19	26.2	4
24	24.63	0.32	4.02	0.61	24.69	1.31	5	2.49	109.91	1.39	0	1.39	16.78	1.39	0.01	4	0.91	0.78	2.62	17.18	0.21	28.95	4
25	56.74	0.73	2.59	0.59	56.78	1.29	5	2.19	117.92	1.45	0	1.45	38.22	1.32	0	5	0.79	0.78	2.29	40.79	0.13	40.97	7
26	29.84	1.56	2.29	-0.04	29.87	5.23	3	2.8	121.89	1.51	0	1.51	18.8	5.5	0.01	3	1	0.7	2.94	18.8	0.11	16.6	3
27	51.66	1.67	2.78	-0.18	51.7	3.24	4	2.48	123.74	1.57	0	1.57	31.92	3.34	0	4	0.92	0.69	2.62	32.92	0.13	23.86	5
28	33.73	1.18	2.94	-0.22	33.77	3.5	4	2.64	120.15	1.63	0	1.63	19.71	3.67	0.01	3	1	0.65	2.81	19.72	0.13	20.86	3
29	41.4	0.74	2.87	-0.25	41.44	1.78	5	2.39	117.22	1.69	0	1.69	23.53	1.86	0.01	4	0.9	0.65	2.56	24.6	0.12	29.89	5
30	31.93	0.64	3.18	-0.3	31.98	2	4	2.5	115.52	1.75	0	1.75	17.3	2.11	0.01	4	0.96	0.62	2.71	17.61	0.13	25.75	4
31	32.88	0.97	3.28	-0.36	32.93	2.96	4	2.6	118.68	1.81	0	1.81	17.23	3.13	0.01	4	1	0.59	2.82	17.23	0.13	21.97	3
32	42.38	1.36	3.48	-0.43	42.43	3.2	4	2.54	121.73	1.87	0	1.87	21.72	3.35	0.01	4	0.99	0.57	2.75	21.88	0.13	22.26	5
33	33.75	1.07	4.07	-0.53	33.81	3.17	4	2.61	119.44	1.93	0	1.93	16.54	3.36	0.01	3	1	0.55	2.85	16.54	0.15	21.13	3
34	38.94	1.2	4.27	-0.59	39	3.08	4	2.56	120.63	1.99	0	1.99	18.62	3.25	0.01	4	1	0.53	2.8	18.62	0.15	21.94	3
35	42.5	1.36	4.74	-0.65	42.57	3.2	4	2.54	121.76	2.05	0	2.05	19.78	3.36	0.01	4	1	0.52	2.79	19.78	0.17	21.82	3
36	44.7	2.13	4.07	-0.62	44.76	4.75	4	2.64	125.14	2.11	0	2.11	20.2	4.98	0.01	3	1	0.5	2.89	20.2	0.14	17.7	3
37	42.48	1.37	4.75	-0.63	42.55	3.22	4	2.54	121.81	2.17	0	2.17	18.59	3.4	0.01	4	1	0.49	2.81	18.59	0.16	21.48	3
38	49.66	1.23	5.26	-0.71	49.74	2.47	5	2.42	121.39	2.23	0	2.23	21.28	2.59	0.01	4	0.98	0.48	2.69	21.6	0.17	25.1	5
39	200.62	3.56	4.88	-0.72	200.69	1.77	6	1.89	132.57	2.3	0	2.3	86.31	1.79	0	5	0.75	0.56	2.07	105.1	0.15	44.53	7
40	387	7.66	-2.47	-0.58	386.96	1.98	6	1.77	137.37	2.37	0	2.37	162.46	1.99	0	6	0.69	0.57	1.91	208.85	-0.08	45.01	7
41	367.23	7.98	-4.67	-0.21	367.16	2.17	8	1.81	137.37	2.44	0	2.44	149.72	2.19	0	6	0.71	0.55	1.96	190.21	-0.14	41.2	7
42	88.68	5.56	-4.17	0.22	88.62	6.28	9	2.54	133.85	2.5	0	2.5	34.41	6.46	0	3	1	0.42	2.8	34.41	-0.12	15.2	3
43	61.81	1.75	-4.07	0.47	61.75	2.84	5	2.39	124.52	2.57	0	2.57	23.07	2.96	0	4	1	0.41	2.7	23.07	-0.11	23.91	5
44	102.71	2.59	-4.67	0.57	102.65	2.53	5	2.2	128.62	2.63	0	2.63	38.04	2.59	0	4	0.92	0.43	2.47	41	-0.13	28.92	5
45	91.82	3.42	-4.95	0.45	91.75	3.73	4	2.36	130.37	2.69	0	2.69	33.05	3.84	0	4	0.99	0.4	2.65	33.4	-0.13	21.89	3
46	51.55	3.32	-4.99	0.75	51.48	6.45	3	2.7	128.75	2.76	0	2.76	17.66	6.82	-0.01	3	1	0.38	3.03	17.66	-0.13	14.52	3
47	83.73	2.97	-4.67	0.81	83.66	3.55	5	2.37	129.11	2.82	0	2.82	28.63	3.67	0	4	1	0.37	2.69	28.63	-0.12	22.06	5
48	111.03	3.41	-4.42	0.71	110.97	3.07	5	2.24	130.82	2.89	0	2.89	37.41	3.15	0	4	0.96	0.38	2.55	39.05	-0.11	25.39	5
49	87.28	3.27	-4.17	1.23	87.22	3.75	4	2.37	129.93	2.95	0	2.95	28.53	3.88	0	4	1	0.36	2.71	28.53	-0.1	21.31	3
50	69.55	3.23	-4.27	1.3	69.49	4.65	4	2.51	129.29	3.02	0	3.02	22.02	4.87	0	3	1	0.35	2.86	22.02	-0.1	18.08	3
51	80.28	2.99	-4.02	1.38	80.22	3.73	4	2.4	129.07	3.08	0	3.08	25.02	3.88	0	4	1	0.34	2.75	25.02	-0.09	20.96	3
52	92.44	3.23	-3.59	1.32	92.39	3.5	5	2.33	129.98	3.15	0	3.15	28.35	3.62	0	4	1	0.34	2.69	28.35	-0.08	22.21	5
53	85.3	3.57	-3.38	1.78	85.25	4.19	4	2.42	130.52	3.21	0	3.21	25.53	4.36	0	3	1	0.33	2.78	25.53	-0.08	19.61	3
54	103.92	4.4	-3.58	1.79	103.87	4.23	9	2.37	132.52	3.28	0	3.28	30.67	4.37	0	4	1	0.32	2.72	30.67	-0.08	19.93	3
55	112.24	0	-3.48	1.86	112.19	0	0	0	87.42	3.32	0	3.32	32.76	0	0	0	1	0.32	0	32.76	-0.08	61.08	0

	SC-1	In situ data											Basic output data											
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	133.24	0.95	0.09	-0.8	133.24	0.71	6	1.74	121.88	0.06	0	0.06	2184.1	0.71	0	6	0.38	2.99	1.4	375.93	0.11	114.5	7
2	87.59	0.8	0.38	-0.92	87.6	0.91	6	1.95	119.63	0.12	0	0.12	723.95	0.92	0	6	0.47	2.8	1.62	231.4	0.22	85.64	7
3	111.74	0.77	0.3	-0.84	111.74	0.69	6	1.79	119.91	0.18	0	0.18	617.61	0.69	0	6	0.44	2.19	1.53	230.68	0.12	105.33	7
4	114.66	0.93	0.4	-1.46	114.66	0.82	6	1.83	121.42	0.24	0	0.24	474.04	0.82	0	6	0.47	2.01	1.6	217.28	0.12	91.84	7
5	147.21	1.16	0.7	-1.93	147.22	0.79	6	1.73	123.6	0.3	0	0.3	484.53	0.79	0	6	0.46	1.77	1.55	245.62	0.17	96.97	7
6	110.24	1.08	0.76	-2.09	110.25	0.98	6	1.89	122.37	0.36	0	0.36	301.51	0.98	0	6	0.52	1.74	1.71	180.66	0.15	77.13	7
7	75.12	0.63	0.45	-2.2	75.13	0.84	6	1.98	117.53	0.42	0	0.42	176.5	0.85	0	6	0.56	1.67	1.81	117.79	0.08	75.27	7
8	60.61	0.74	0.7	-2.27	60.62	1.21	5	2.15	118.11	0.48	0	0.48	124.73	1.22	0	6	0.63	1.64	1.99	93.29	0.1	56.12	7
9	92.09	3.8	0.99	-2.39	92.1	4.12	4	2.39	131.15	0.55	0	0.55	167.14	4.15	0	8	0.74	1.63	2.26	140.69	0.13	23.05	5
10	498.49	6.46	1.99	-1.11	498.52	1.3	6	1.55	137.37	0.62	0	0.62	807.64	1.3	0	6	0.45	1.28	1.5	600.44	0.23	71.92	7
11	262.06	1.94	2.63	-1.36	262.1	0.74	6	1.53	128.8	0.68	0	0.68	383.91	0.74	0	6	0.44	1.22	1.47	300.47	0.28	105.83	7
12	247.58	1.84	2.68	-1.39	247.62	0.74	6	1.55	128.25	0.75	0	0.75	331.33	0.74	0	6	0.46	1.17	1.5	273.94	0.26	103.65	7
13	206.94	1.77	2.17	-1.46	206.97	0.86	6	1.65	127.55	0.81	0	0.81	254.93	0.86	0	6	0.5	1.14	1.61	222.96	0.19	88.96	7
14	189.52	1.52	1.97	-1.53	189.54	0.8	6	1.66	126.19	0.87	0	0.87	216.4	0.8	0	6	0.51	1.1	1.63	196.87	0.16	90.6	7
15	172.51	1.31	1.59	-1.42	172.53	0.76	6	1.67	124.91	0.93	0	0.93	183.66	0.77	0	6	0.52	1.07	1.65	173.11	0.12	90.41	7
16	251.38	1.23	0.6	-1.52	251.38	0.49	6	1.42	125.37	1	0	1	251.12	0.49	0	6	0.44	1.03	1.42	242.87	0.04	133.28	7
17	227.97	1.46	0.5	-1.56	227.97	0.64	6	1.53	126.37	1.06	0	1.06	214.01	0.64	0	6	0.48	1	1.54	214.24	0.03	107.79	7
18	328.65	1.8	-2.44	-1.58	328.62	0.55	6	1.37	128.77	1.12	0	1.12	291.23	0.55	0	6	0.43	0.97	1.38	301.54	-0.16	132.41	7
19	138.38	1.24	-2.67	-1.6	138.34	0.9	6	1.79	123.96	1.19	0	1.19	115.59	0.91	0	6	0.6	0.93	1.82	121.02	-0.16	72.93	7
20	127.66	1.11	-2.26	-1.6	127.62	0.87	6	1.81	122.97	1.25	0	1.25	101.26	0.88	0	6	0.61	0.9	1.85	107.92	-0.13	71.4	7
21	99.03	1.84	-2.93	-1.69	98.99	1.86	5	2.11	126.01	1.31	0	1.31	74.5	1.88	0	5	0.74	0.85	2.17	78.79	-0.16	40.68	7
22	191.27	2.46	-6.84	-1.91	191.17	1.29	6	1.8	129.75	1.38	0	1.38	137.93	1.3	0	6	0.62	0.85	1.85	152.38	-0.36	60.72	7
23	166.47	3.26	-6.56	-2.5	166.38	1.96	6	1.98	131.48	1.44	0	1.44	114.41	1.98	0	5	0.7	0.81	2.04	125.66	-0.33	42.59	7
24	199.3	5.02	-5.76	-2.78	199.22	2.52	5	2.01	135.07	1.51	0	1.51	131	2.54	0	5	0.72	0.78	2.09	144.9	-0.27	35.39	7
25	120.12	4.3	-5.44	-3.03	120.04	3.58	5	2.27	132.7	1.58	0	1.58	75.19	3.63	0	4	0.83	0.72	2.37	80.54	-0.25	25.01	5
26	94.6	4.46	-4.74	-3.09	94.53	4.72	9	2.43	132.39	1.64	0	1.64	56.58	4.8	0	4	0.9	0.67	2.55	59.14	-0.21	19.54	3
27	143.62	3.58	-4.37	-3.08	143.56	2.5	5	2.1	131.81	1.71	0	1.71	83.06	2.53	0	5	0.77	0.69	2.21	92.58	-0.18	33.76	7
28	137.17	6.15	-4.04	-3.02	137.12	4.49	9	2.31	135.65	1.78	0	1.78	76.23	4.55	0	9	0.86	0.64	2.44	81.8	-0.16	20.78	3
29	563.9	0	-3.85	-3.12	563.85	0	0	0	87.42	1.82	0	1.82	308.95	0	0	0	1	0.58	0	308.95	-0.15	455.65	0

SC-3 **In situ data** **Basic output data**

Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	164.79	1.87	0.6	2.07	164.8	1.14	6	1.81	127.4	0.06	0	0.06	2584.5	1.14	0	6	0.42	3.26	1.49	508.1	0.67	79.98	7
2	84.59	0.92	0.88	2	84.6	1.08	6	2.01	120.55	0.12	0	0.12	681	1.09	0	6	0.5	2.89	1.67	230.85	0.51	75.07	7
3	63.71	0.76	0.31	2.41	63.71	1.2	5	2.13	118.5	0.18	0	0.18	346.86	1.2	0	6	0.55	2.63	1.82	158.13	0.12	64.66	7
4	85.39	1.23	0.58	2.39	85.4	1.44	5	2.08	122.71	0.24	0	0.24	348.23	1.44	0	6	0.56	2.27	1.83	182.9	0.17	57.76	7
5	124.33	1.55	0.91	2.45	124.34	1.25	6	1.92	125.33	0.31	0	0.31	403.7	1.25	0	6	0.52	1.91	1.73	223.59	0.21	66.83	7
6	135.16	1.94	0.31	2.19	135.17	1.43	6	1.94	127.17	0.37	0	0.37	363.45	1.44	0	6	0.54	1.77	1.77	225.07	0.06	59.69	7
7	143.36	2.95	0.85	2.09	143.38	2.06	5	2.04	130.38	0.44	0	0.44	327.77	2.06	0	6	0.59	1.69	1.89	228.36	0.14	44.03	7
8	147.93	3.05	0.35	2.21	147.93	2.06	5	2.03	130.69	0.5	0	0.5	294.11	2.07	0	6	0.6	1.57	1.91	218.15	0.05	43.81	7
9	73.33	1.54	0.89	2.23	73.34	2.1	5	2.24	123.97	0.56	0	0.56	129.2	2.11	0	5	0.68	1.54	2.12	105.77	0.11	39.46	7
10	70.85	1.26	0.89	2.17	70.87	1.78	5	2.21	122.42	0.62	0	0.62	112.47	1.79	0	5	0.68	1.43	2.1	94.93	0.1	43.71	7
11	71.12	1.19	1.39	2.15	71.14	1.68	5	2.19	122.05	0.69	0	0.69	102.75	1.69	0	5	0.68	1.34	2.1	89.51	0.15	44.89	7
12	63.37	1.15	0.89	1.99	63.38	1.81	5	2.25	121.46	0.75	0	0.75	83.91	1.83	0	5	0.71	1.28	2.17	75.93	0.09	41.14	7
13	74.26	1.37	1.29	1.93	74.28	1.85	5	2.2	123.17	0.81	0	0.81	90.96	1.87	0	5	0.71	1.21	2.15	84.03	0.12	41.46	7
14	74.54	1.52	1.69	1.82	74.57	2.03	5	2.23	123.91	0.87	0	0.87	84.73	2.06	0	5	0.73	1.15	2.19	80.3	0.14	38.41	7
15	71.48	1.36	1.39	1.74	71.5	1.91	5	2.22	123.03	0.93	0	0.93	75.77	1.93	0	5	0.73	1.1	2.2	73.23	0.11	39.37	7
16	76.87	1.9	3.34	1.62	76.92	2.48	5	2.28	125.66	0.99	0	0.99	76.37	2.51	0	5	0.76	1.05	2.27	75.25	0.24	32.94	7
17	113.9	3.22	2.29	1.68	113.94	2.83	5	2.21	130.47	1.06	0	1.06	106.54	2.86	0	5	0.74	1	2.21	106.57	0.16	31.14	5
18	101.73	4.33	1.99	1.6	101.76	4.25	9	2.37	132.35	1.13	0	1.13	89.41	4.3	0	9	0.81	0.95	2.39	90.44	0.13	21.89	3
19	135.88	5.85	1.69	1.66	135.91	4.3	9	2.3	135.26	1.19	0	1.19	112.9	4.34	0	9	0.79	0.91	2.33	115.73	0.1	21.97	3
20	104.11	5.12	-4.48	1.74	104.05	4.92	9	2.42	133.63	1.26	0	1.26	81.57	4.98	0	9	0.85	0.86	2.46	83.77	-0.26	19.25	3
21	132.46	3.92	-4.37	1.78	132.4	2.96	5	2.18	132.26	1.33	0	1.33	98.83	2.99	0	5	0.76	0.84	2.23	104.26	-0.24	29.94	5
22	150.65	4.07	-4.57	2.01	150.59	2.71	5	2.11	132.86	1.39	0	1.39	107.13	2.73	0	5	0.74	0.81	2.17	114.91	-0.24	32.55	7
23	111.53	3.61	-4.57	2.52	111.47	3.24	5	2.26	131.25	1.46	0	1.46	75.44	3.28	0	5	0.81	0.77	2.34	80.18	-0.23	27.06	5
24	119.93	3.07	-4.27	2.81	119.87	2.56	5	2.16	130.24	1.52	0	1.52	77.69	2.6	0	5	0.78	0.75	2.25	84.2	-0.2	32.65	7
25	117.39	3.95	-4.43	3.02	117.32	3.37	5	2.25	132.03	1.59	0	1.59	72.82	3.41	0	5	0.82	0.72	2.36	78.23	-0.2	26.17	5
26	178.07	4.75	-4.31	3.26	178.01	2.67	5	2.06	134.4	1.66	0	1.66	106.45	2.69	0	5	0.75	0.71	2.16	119	-0.19	33.03	7
27	187.39	5.24	-4.08	3.34	187.33	2.8	5	2.07	135.24	1.72	0	1.72	107.64	2.82	0	5	0.76	0.69	2.17	121.1	-0.17	31.82	5
28	148.54	4.96	-4.4	3.08	148.48	3.34	8	2.19	134.27	1.79	0	1.79	81.89	3.38	0	5	0.82	0.65	2.31	90.18	-0.18	26.71	5
29	199.83	4.98	-4.27	2.49	199.77	2.49	5	2.01	135.02	1.86	0	1.86	106.47	2.52	0	5	0.75	0.66	2.13	122.63	-0.17	35.03	7
30	176.76	4.66	-4.18	2.17	176.7	2.63	5	2.06	134.23	1.93	0	1.93	90.75	2.66	0	5	0.78	0.63	2.2	103.67	-0.16	32.84	7
31	116.8	3.61	-4.27	1.96	116.74	3.1	5	2.23	131.36	1.99	0	1.99	57.61	3.15	0	5	0.86	0.58	2.4	63.03	-0.15	27.2	5
32	129.67	3.69	-4.18	1.68	129.61	2.84	5	2.17	131.77	2.06	0	2.06	61.99	2.89	0	5	0.84	0.57	2.34	68.96	-0.15	29.32	5
33	166.23	4.85	-3.8	1.48	166.18	2.92	5	2.11	134.38	2.12	0	2.12	77.22	2.96	0	5	0.82	0.57	2.28	87.63	-0.13	29.67	5
34	139.06	4.43	-3.97	1.3	139.01	3.19	5	2.19	133.28	2.19	0	2.19	62.44	3.24	0	5	0.86	0.53	2.38	69.17	-0.13	26.93	5
35	90.28	3.31	-4.26	1.3	90.22	3.67	5	2.36	130.09	2.26	0	2.26	38.98	3.76	0	4	0.94	0.49	2.59	40.74	-0.14	22.73	5
36	106.69	3.62	-4.27	1.24	106.63	3.39	5	2.28	131.15	2.32	0	2.32	44.92	3.47	0	4	0.92	0.49	2.51	47.96	-0.13	24.52	5
37	101.13	3.63	-4.27	1.29	101.07	3.59	5	2.32	131.04	2.39	0	2.39	41.33	3.67	0	4	0.94	0.47	2.56	43.47	-0.13	23.28	5
38	114.56	2.82	-4.18	1.45	114.5	2.46	5	2.16	129.5	2.45	0	2.45	45.69	2.52	0	5	0.88	0.48	2.4	50.57	-0.12	30.71	5
39	73.75	2.15	-1.49	1.09	73.73	2.92	5	2.34	126.44	2.52	0	2.52	28.31	3.02	0	4	0.97	0.43	2.63	29.02	-0.04	24.76	5
40	127.67	3.48	-1.47	1.3	127.65	2.72	5	2.16	131.3	2.58	0	2.58	48.45	2.78	0	5	0.89	0.45	2.41	53.45	-0.04	29.03	5
41	184.32	5.58	-0.99	2.55	184.3	3.03	8	2.1	135.66	2.65	0	2.65	68.57	3.07	0	5	0.86	0.45	2.33	77.89	-0.03	28.43	5
42	228.43	6	0.08	4.03	228.43	2.63	5	1.99	136.72	2.72	0	2.72	83.06	2.66	0	5	0.82	0.46	2.21	98.35	0	32.69	7
43	218.46	5.53	0	5.01	218.46	2.53	5	1.99	136	2.79	0	2.79	77.44	2.56	0	5	0.83	0.45	2.22	91.5	0	33.34	7
44	194.52	6.07	0.23	5.74	194.52	3.12	8	2.1	136.41	2.85	0	2.85	67.17	3.17	0	5	0.88	0.42	2.34	75.83	0.01	27.66	5
45	160.74	5.99	0.3	5.73	160.75	3.73	8	2.21	135.84	2.92	0	2.92	54.02	3.79	0	4	0.93	0.39	2.48	57.76	0.01	23.43	5
46	133.33	4.23	0.42	5.73	133.33	3.17	5	2.2	132.85	2.99	0	2.99	43.62	3.25	0	4	0.95	0.37	2.5	46.19	0.01	25.55	5
47	102.68	3.19	0.99	5.89	102.69	3.11	5	2.27	130.14	3.05	0	3.05	32.64	3.2	0	4	0.99	0.35	2.6	33.1	0.02	24.48	5
48	190.22	3.55	1.09	6.1	190.23	1.87	6	1.92	132.43	3.12	0	3.12	59.99	1.9	0	5	0.84	0.4	2.2	71.53	0.03	39.61	7
49	120.77	3.49	3.11	5.81	120.82	2.89	5	2.2	131.2	3.18	0	3.18	36.94	2.97	0	4	0.97	0.34	2.53	38.32	0.07	26.29	5
50	80.98	2.73	2.41	4.93	81.02	3.37	5	2.36	128.43	3.25	0	3.25	23.94	3.51	0	4	1	0.33	2.74	23.94	0.05	22.03	3
51	76.52	2.57	2.48	4.63	76.56	3.36	5	2.38	127.85	3.31	0	3.31	22.11	3.51	0	4	1	0.32	2.76	22.11	0.05	21.74	3
52	81.87	3.19	3.08	4.46	81.92	3.9	4	2.4	129.59	3.38	0	3.38	23.25	4.06	0	3	1	0.31	2.79	23.25	0.07	20.22	3
53	99.71	3.43	2.78	4.56	99.75	3.44	5	2.31	130.59	3.44	0	3.44	27.97	3.56	0	4	1	0.31	2.69	27.97	0.06	22.4	5
54	73.74	3.53	2.68	4.3	73.78	4.79	4	2.5	130.08	3.51	0	3.51	20.03	5.03	0	3	1	0.3	2.9	20.03	0.06	17.59	3
55	81.27	2.57	2.88	3.83	81.31	3.16	5	2.34	127.98	3.57	0	3.57	21.76	3.3	0	4	1	0.3	2.75	21.76	0.06	22.39	5
56	76.72	2.82	3.08	3.79	76.77	3.67	4	2.4	128.51	3.64	0	3.64	20.11	3.85	0	3	1	0.29	2.82	20.11	0.06	20.43	3
57	110.89	3.45	3.51	3.94	110.94	3.11	5	2.24	130.9	3.7	0	3.7	28.97	3.22	0	4	1	0.29	2.65	28.97	0.07	23.89	5
58	236.67	4.83	4.33	4.24	236.73	2.04	6	1.9	135.21	3.77	0	3.77	61.81	2.07	0	5	0.88	0.33	2.23	72.29	0.08	37.44	7
59	194.64	4.09	4.67	4.46	194.71	2.1	6	1.96	133.52	3.84	0	3.84	49.76	2.14	0	5	0.92	0.31	2.32	55.46	0.09	34.66	7
60	133.35	3.63	4.47	4.09	133.41	2.72	5	2.15	131.72	3.9	0	3.9	33.19	2.8	0	4	1	0.27	2.56	33.19	0.08	26.5	5
61	145.66	4.65	4.77	4.54	145.73	3.19	5	2.18	133.75	3.97	0	3.97	35.72	3.28	0	4	1	0.27	2.59	35.72	0.09	24.43	5
62	131.62	5.38	4.87	4.44	131.69	4.08	9	2.29	134.57	4.04	0	4.04	31.63	4.21	0	4	1	0.26	2.7	31.63	0.09	20.48	3
63	185.34	5.65	5.27	4.22	185.41	3.05	8	2.1	135.77	4.1	0	4.1	44.18	3.12	0	4	1	0.26	2.5	44.32	0.09	26.1	5
64	145.15	2.09	4.87	4.07	145.22	1.44	6	1.92	127.89	4.17	0	4.17	33.84	1.48	0	5	0.95	0.27	2.36	36.31	0.08	37.39	7
65	127.14	0	3.27	2.63	127.19	0	0	0	87.42	4.21	0	4.21	29.2	0	0	0	1	0.25	0	29.2	0.06	56	0

	SC-6	In situ data									Basic output data														
Depth (ft)	qc (tsf)	fs (tsf)	u (psi)	Other	qt (tsf)	Rf(%)	SBT	Ic SBT	y (pcf)	ó,v (tsf)	u0 (tsf)	ó',vo (tsf)	Qt1	Fr (%)	Bq	SBTn	n	Cn	Ic	Qtn	U2	I(B)	Mod. SBTn
1	193.43	1.88	0	1.62	193.43	0.97	6	1.71	127.8	0.06	0	0.06	3024.1	0.97	0	6	0.39	3	1.41	548.84	0	92.78	7
2	262.29	4.02	0.53	0.92	262.3	1.53	6	1.77	134.13	0.13	0	0.13	2000.5	1.54	0	6	0.45	2.55	1.56	631.79	0.29	61.72	7
3	380.86	5.66	0.4	0.64	380.86	1.49	6	1.67	137.37	0.2	0	0.2	1907.6	1.49	0	6	0.44	2.07	1.52	744.76	0.14	64.11	7
4	448.75	6.05	0.52	0.49	448.76	1.35	6	1.59	137.37	0.27	0	0.27	1671.7	1.35	0	6	0.42	1.79	1.47	758.1	0.14	70.29	7
5	589.66	7.41	2.4	0.5	589.69	1.26	6	1.5	137.37	0.34	0	0.34	1748.8	1.26	0	6	0.41	1.59	1.42	886.73	0.51	75.68	7
6	683.78	0	9.36	0	683.91	0	0	0	87.42	0.38	0	0.38	1795.2	0	0	7	1	2.78	0	>1,000	1.77	2578.91	0

Tonner Canyon Rd & SR-57
Brea, CA

CPT Shear Wave Measurements

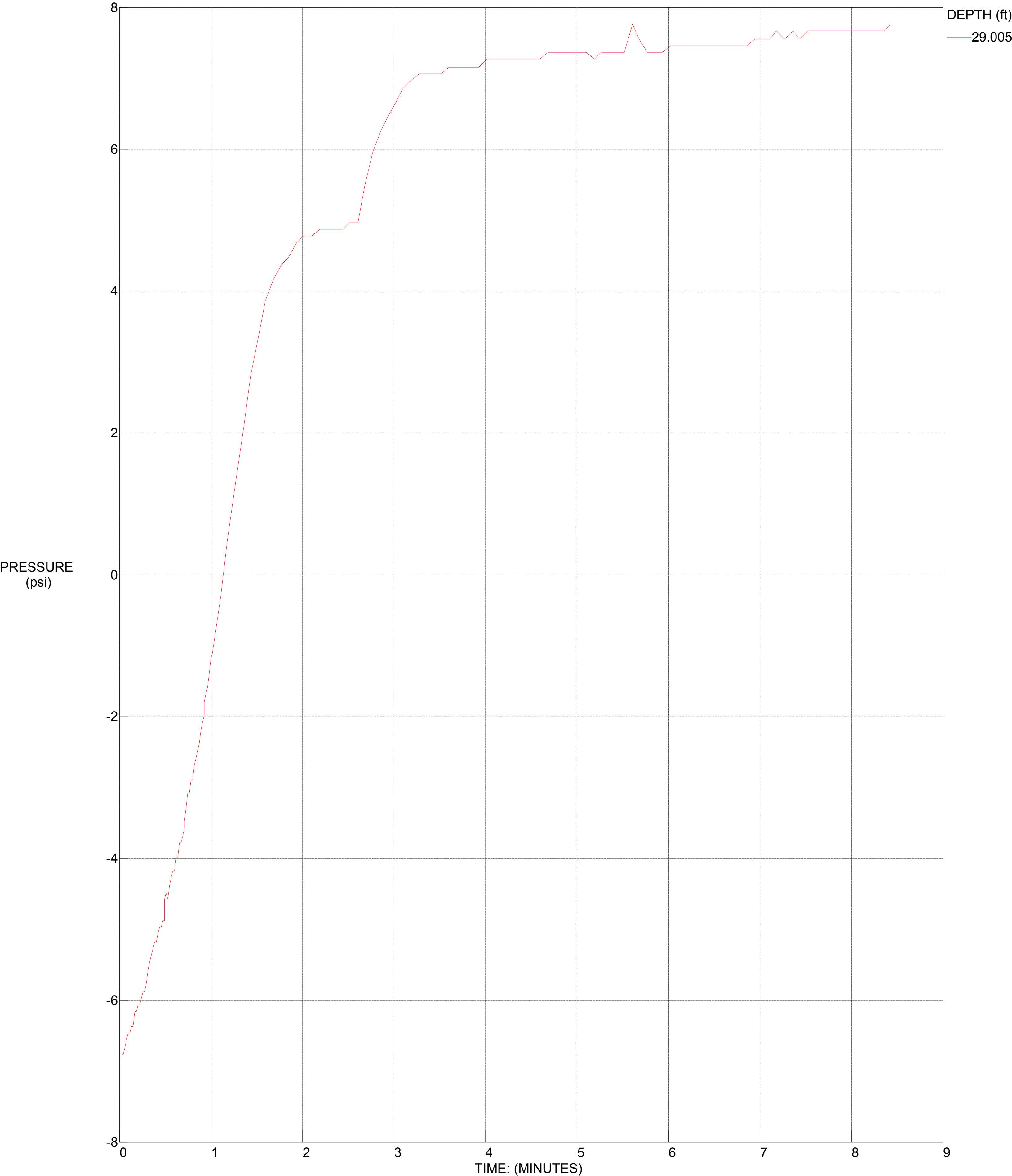
	Tip Depth (ft)	Geophone Depth (ft)	Travel Distance (ft)	S-Wave Arrival (msec)	S-Wave Velocity from Surface (ft/sec)	Interval S-Wave Velocity (ft/sec)
SC-1						
	5.09	4.09	6.46	11.12	580.91	
	10.07	9.07	10.36	17.64	587.12	597.72
	16.08	15.08	15.89	24.52	647.93	803.84
	20.05	19.05	19.70	29.16	675.42	820.68
	25.07	24.07	24.58	35.24	697.61	804.04
	29.04	28.04	28.48	38.94	731.44	1053.64
SC-3						
	5.09	4.09	6.46	10.80	598.12	
	10.07	9.07	10.36	17.02	608.51	626.55
	15.12	14.12	14.98	26.54	564.40	485.53
	20.08	19.08	19.72	32.20	612.55	838.36
	25.07	24.07	24.58	37.04	663.71	1004.04
	30.09	29.09	29.52	41.20	716.42	1185.75
	35.07	34.07	34.43	45.16	762.51	1242.01
	40.09	39.09	39.41	49.88	790.07	1053.72
	45.05	44.05	44.33	54.68	810.77	1025.91
	50.13	49.13	49.38	58.49	844.31	1325.70
	54.99	53.99	54.22	62.40	868.93	1237.15
	60.04	59.04	59.25	67.44	878.58	1102.52
	65.03	64.03	64.22	70.86	906.36	1454.26
SC-6	5.02	4.02	6.42	5.24	1224.36	

Shear Wave Source Offset = 5 ft

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

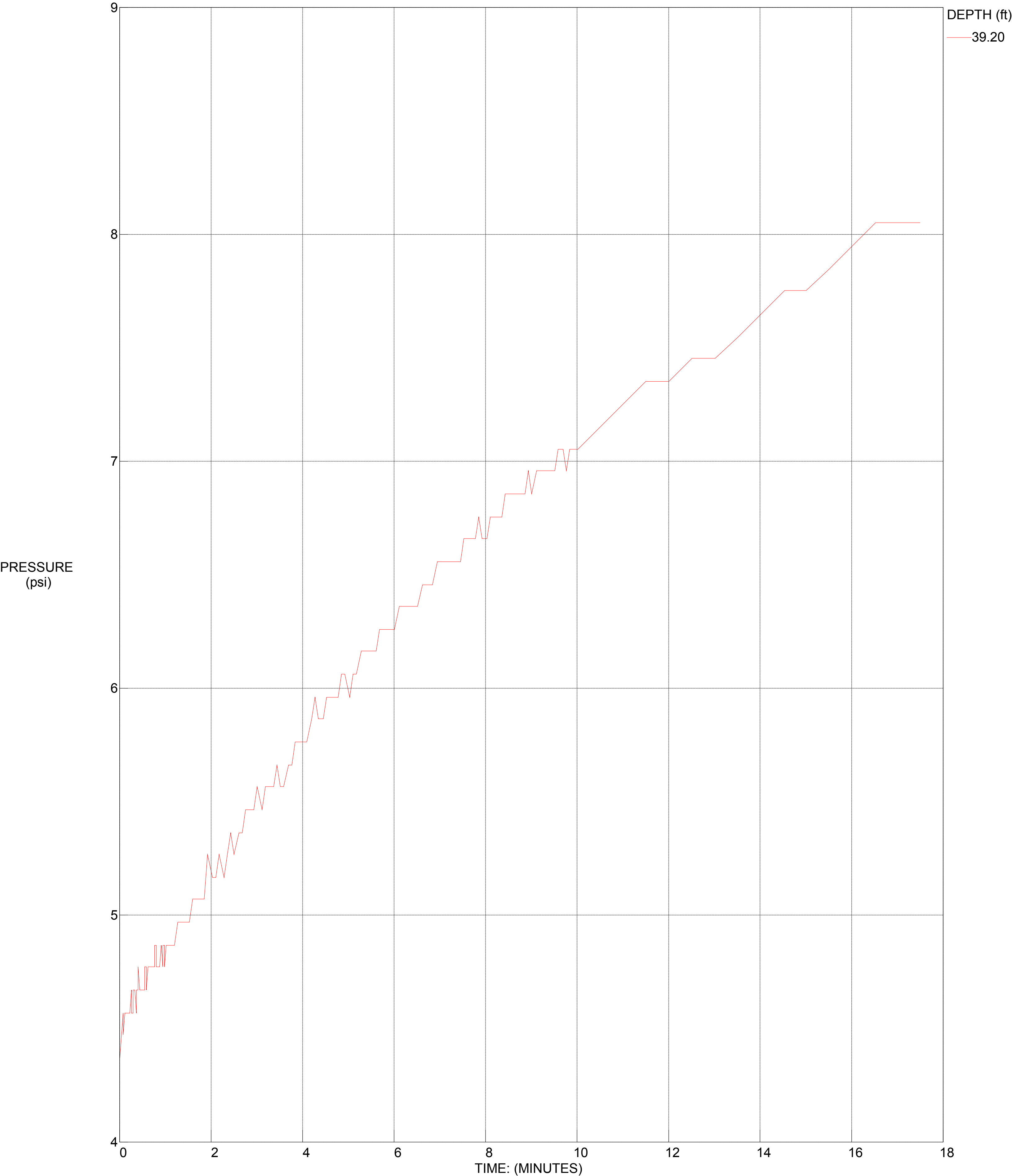
DISSIPATION

TEST ID: C-7
LOCATION: Brea
TEST DATE: Mon 06/Aug/2018
CLIENT: Leighton Consulting



DISSIPATION

TEST ID: C-9
LOCATION: Brea
TEST DATE: Tue 07/Aug/2018
CLIENT: Leighton Consulting



Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236\right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$$I_c < 3.27 \text{ and } I_c > 1.00 \text{ then } k = 10^{0.952-3.04 \cdot I_c}$$

$$I_c \leq 4.00 \text{ and } I_c > 3.27 \text{ then } k = 10^{-4.52-1.37 \cdot I_c}$$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a}\right) \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268-0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Peak drained friction angle, φ (°) ::

$$\varphi = 17.60 + 11 \cdot \log(Q_{tn})$$

(applicable only to SBT_n: 5, 6, 7 and 8)

:: 1-D constrained modulus, M (MPa) ::

$$\text{If } I_c > 2.20$$
$$a = 14 \text{ for } Q_{tn} > 14$$
$$a = Q_{tn} \text{ for } Q_{tn} \leq 14$$
$$M_{CPT} = a \cdot (q_t - \sigma_v)$$

$$\text{If } I_c \leq 2.20$$
$$M_{CPT} = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho}\right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$$N_{kt} = 10.50 + 7 \cdot \log(F_r) \text{ or user defined}$$

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$$S_{u(rem)} = f_s$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 + 7 \cdot \log(F_r))}\right]^{1.25} \text{ or user defined}$$

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Effective Stress Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

(applicable for $0.10 < B_q < 1.00$)

References

- Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012
- Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

APPENDIX C

Laboratory Testing

Leighton

APPENDIX C.1

Index Properties

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	09/06/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/12/18
Boring No.:	LB-2	Checked By:	J. Ward		
Sample No.:	R-5	Depth (ft.)	14.0		
Soil Identification:	Olive brown lean clay (CL)				

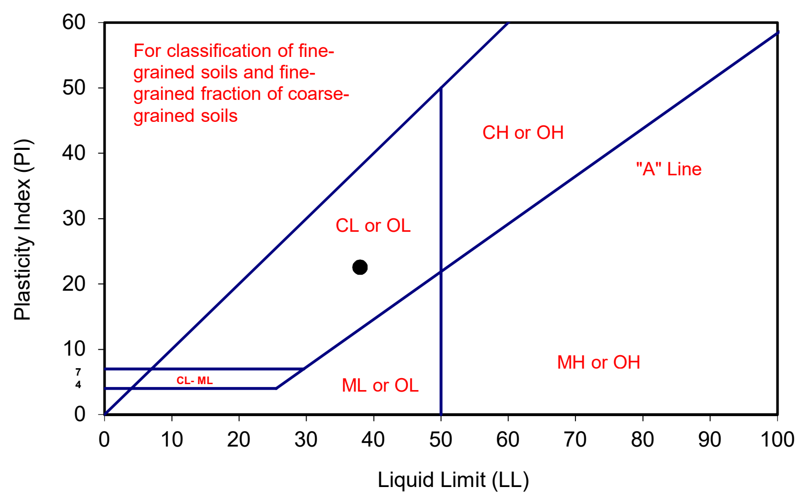
TEST NO.	PLASTIC LIMIT 1	PLASTIC LIMIT 2	LIQUID LIMIT 1	LIQUID LIMIT 2	LIQUID LIMIT 3	LIQUID LIMIT 4
Number of Blows [N]			31	22	18	
Wet Wt. of Soil + Cont. (g)	18.55	18.26	26.92	25.49	26.71	
Dry Wt. of Soil + Cont. (g)	17.60	17.32	23.38	22.15	22.90	
Wt. of Container (g)	11.46	11.21	13.63	13.55	13.55	
Moisture Content (%) [Wn]	15.47	15.38	36.31	38.84	40.75	

Liquid Limit	**38**
Plastic Limit	**15**
Plasticity Index	**23**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 13.14

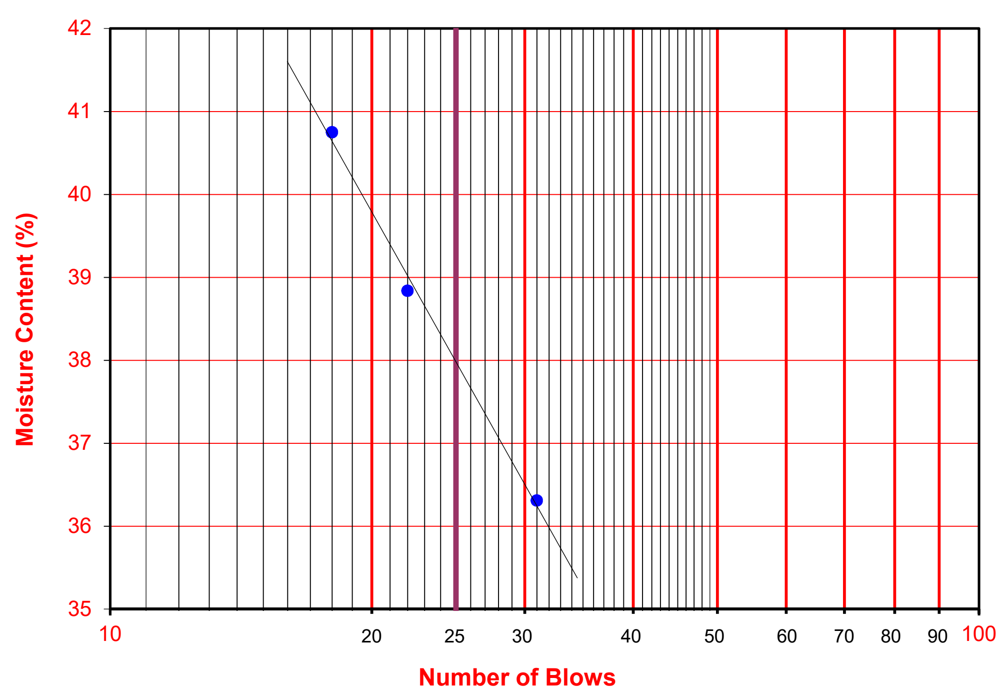
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	08/02/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/04/18
Boring No.:	LB-9	Checked By:	J. Ward		
Sample No.:	B-1	Depth (ft.)	0.0		
Soil Identification:	Brown lean clay (CL)				

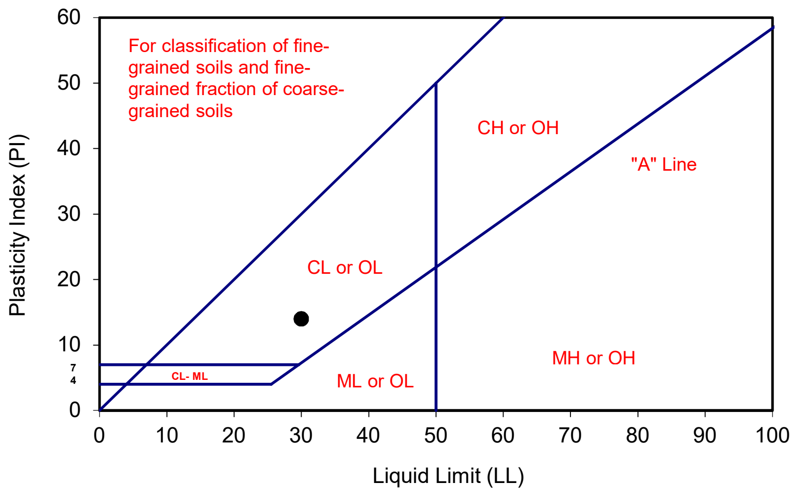
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	24	18	
Wet Wt. of Soil + Cont. (g)	18.39	18.66	27.07	28.01	28.25	
Dry Wt. of Soil + Cont. (g)	17.40	17.61	23.99	24.70	24.83	
Wt. of Container (g)	11.21	11.05	13.55	13.77	13.74	
Moisture Content (%) [Wn]	15.99	16.01	29.50	30.28	30.84	

Liquid Limit	**30**
Plastic Limit	**16**
Plasticity Index	**14**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 7.3

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



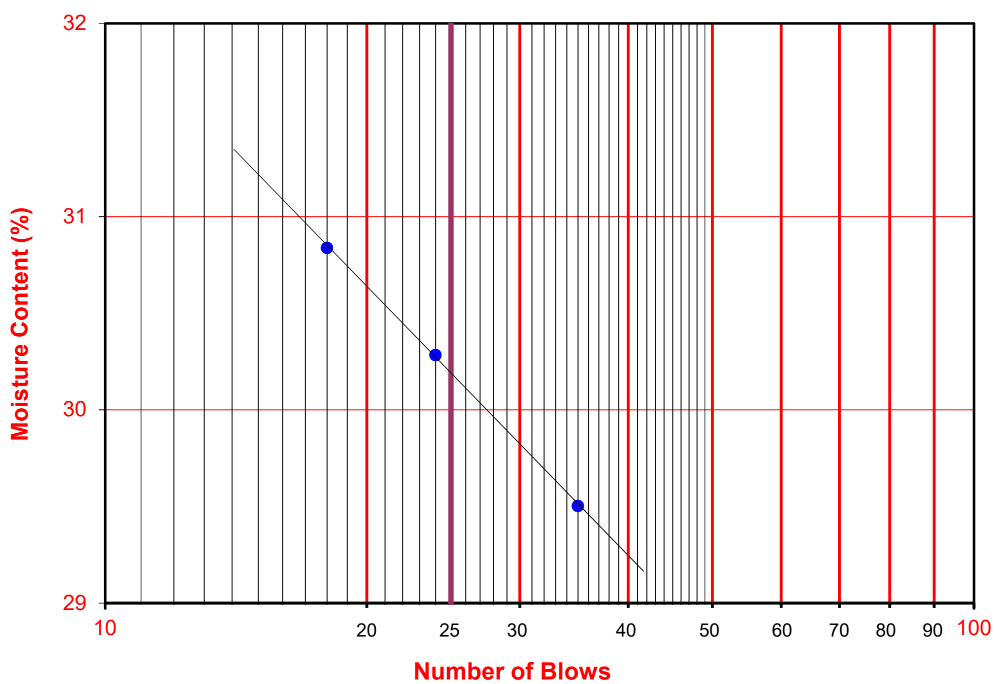
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

X Dry Preparation
Multipoint - Dry

X Procedure A
Multipoint Test

☐ Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	R. Manning	Date:	08/02/18
Project No. :	11588.001	Input By:	G. Bathala	Date:	09/04/18
Boring No.:	LB-12	Checked By:	J. Ward		
Sample No.:	B-1	Depth (ft.)	1.25		
Soil Identification:	Light grayish brown clayey sand (SC)				

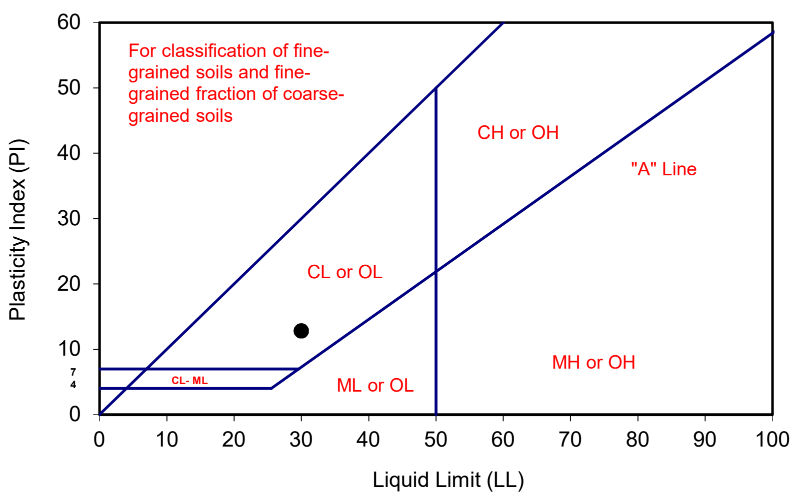
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	25	18	
Wet Wt. of Soil + Cont. (g)	18.38	18.56	26.60	26.81	29.21	
Dry Wt. of Soil + Cont. (g)	17.31	17.52	23.65	23.80	25.59	
Wt. of Container (g)	11.09	11.46	13.58	13.74	13.61	
Moisture Content (%) [Wn]	17.20	17.16	29.29	29.92	30.22	

Liquid Limit	**30**
Plastic Limit	**17**
Plasticity Index	**13**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 7.3

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



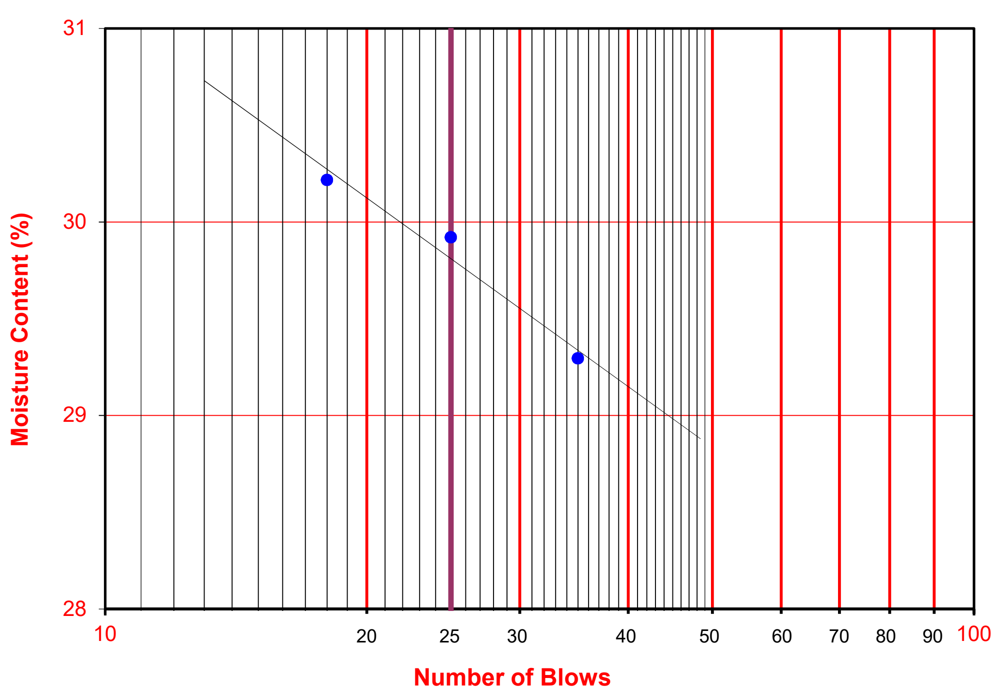
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

☒ Dry Preparation
Multipoint - Dry

☒ Procedure A
Multipoint Test

☐ Procedure B
One-point Test



Leighton

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Corridor Improvements	Tested By: R. Manning	Date: 08/22/18
Project No. :	11588.001	Input By: G. Bathala	Date: 08/29/18
Boring No.:	LBA-1	Checked By: J. Ward	
Sample No.:	G-1	Depth (ft.) 7.6-9.5	

Soil Identification: Light olive brown fat clay (CH), mica noted

Note: Material was not screened through sieve #40

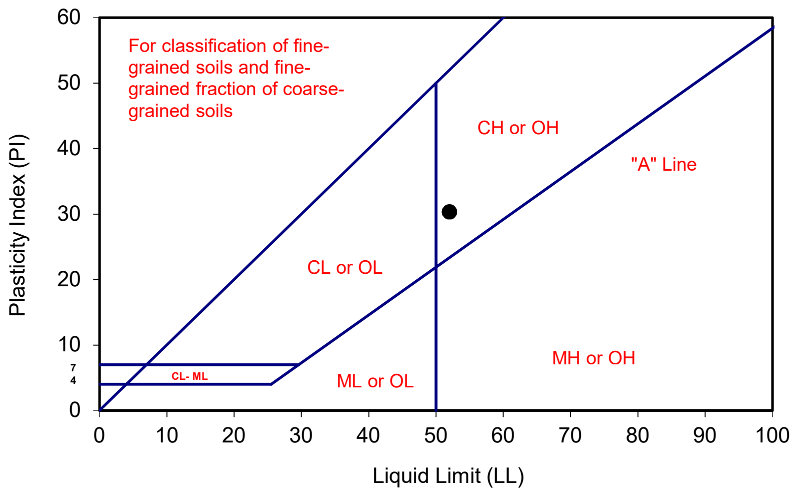
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	22	18	45
Wet Wt. of Soil + Cont. (g)	18.08	17.52	29.80	29.24	26.76	26.53
Dry Wt. of Soil + Cont. (g)	16.85	16.38	24.67	23.79	22.03	22.09
Wt. of Container (g)	11.23	11.06	13.48	13.70	13.75	11.21
Moisture Content (%) [Wn]	21.89	21.43	45.84	54.01	57.13	40.81

Liquid Limit	**52**
Plastic Limit	**22**
Plasticity Index	**30**
Classification	**CH**

PI at "A" - Line = 0.73(LL-20) 23.36

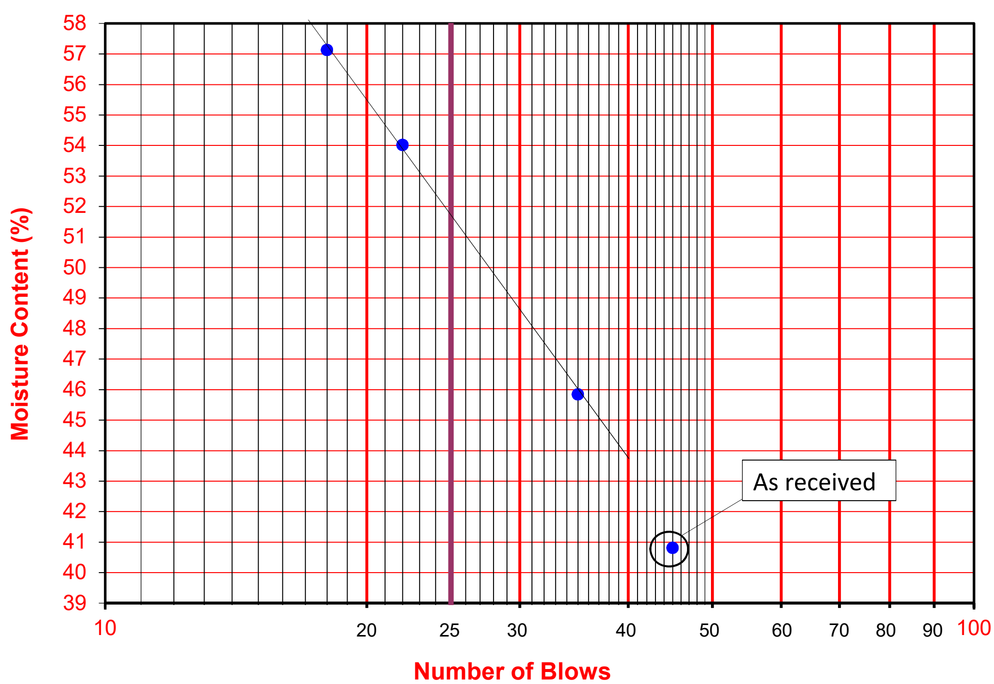
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation — Multipoint - Wet
- [X] Dry Preparation — Multipoint - Dry
- [X] Procedure A — Multipoint Test
- [ ] Procedure B — One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen
Date:	10/26/20		
Project No. :	11585.005	Input By:	G. Bathala
Date:	11/07/20		
Boring No.:	LB-19	Checked By:	A. Santos
Sample No.:	S-7	Depth (ft.)	25.0
Soil Identification:	Yellowish brown clayey sand (SC)		

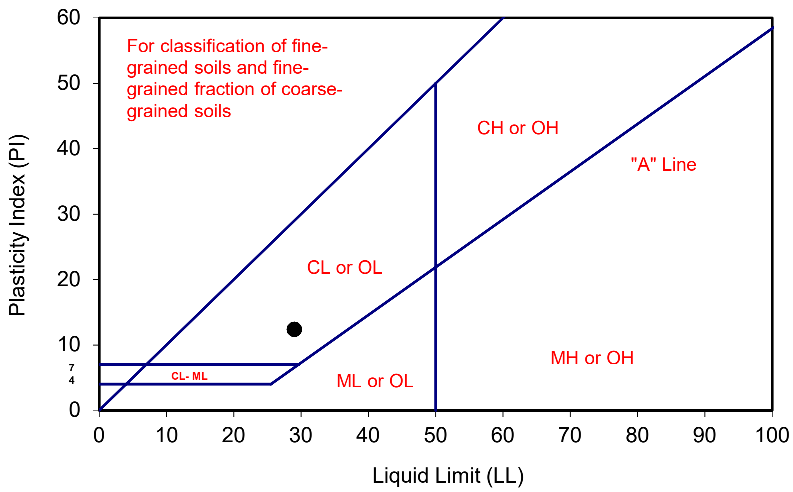
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			32	26	19	
Wet Wt. of Soil + Cont. (g)	9.63	9.71	21.38	20.66	21.85	
Dry Wt. of Soil + Cont. (g)	8.39	8.49	16.90	16.23	16.99	
Wt. of Container (g)	1.02	1.06	1.02	1.04	0.98	
Moisture Content (%) [Wn]	16.82	16.42	28.21	29.16	30.36	

Liquid Limit	**29**
Plastic Limit	**17**
Plasticity Index	**12**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 6.57

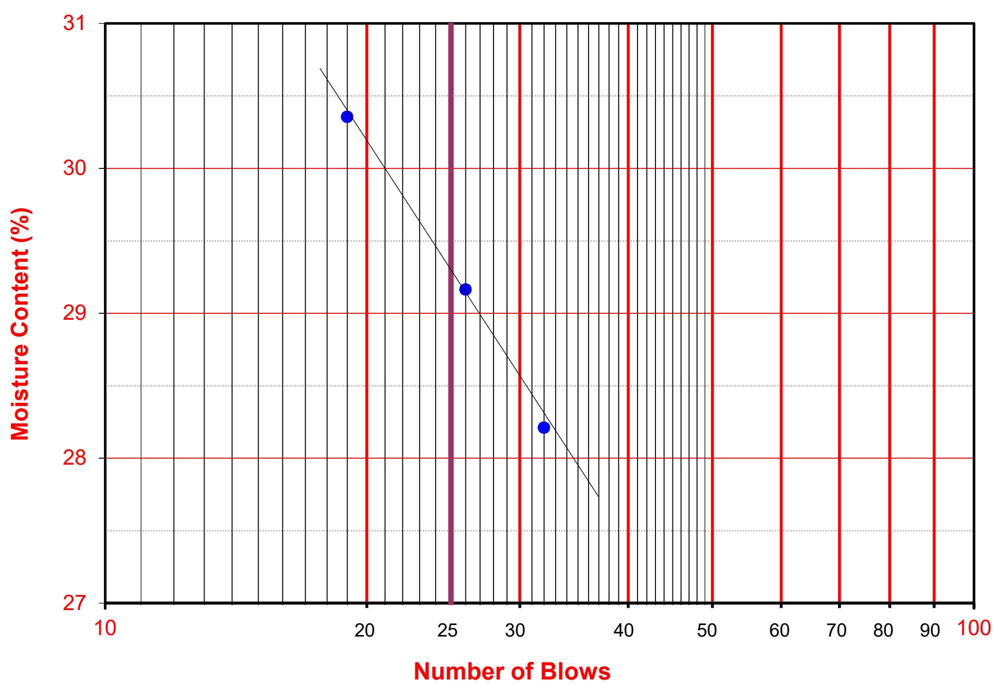
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
Multipoint - Wet
- [X] Dry Preparation
Multipoint - Dry
- [X] Procedure A
Multipoint Test
- [ ] Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-22	Checked By:	A. Santos		
Sample No.:	R-3	Depth (ft.)	10.0		
Soil Identification:	Light brown lean clay (CL)				

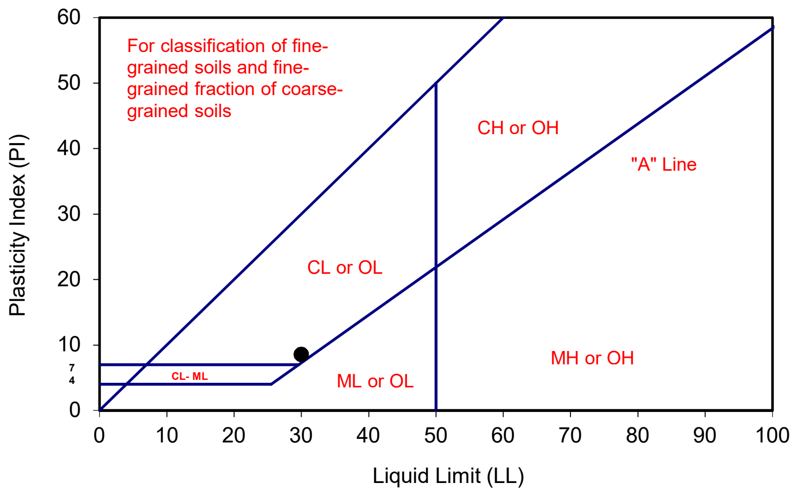
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			29	22	16	
Wet Wt. of Soil + Cont. (g)	9.21	9.27	20.51	21.20	20.30	
Dry Wt. of Soil + Cont. (g)	7.76	7.83	16.05	16.44	15.61	
Wt. of Container (g)	1.01	1.09	1.11	1.03	1.08	
Moisture Content (%) [Wn]	21.48	21.36	29.85	30.89	32.28	

Liquid Limit	**30**
Plastic Limit	**21**
Plasticity Index	**9**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 7.3

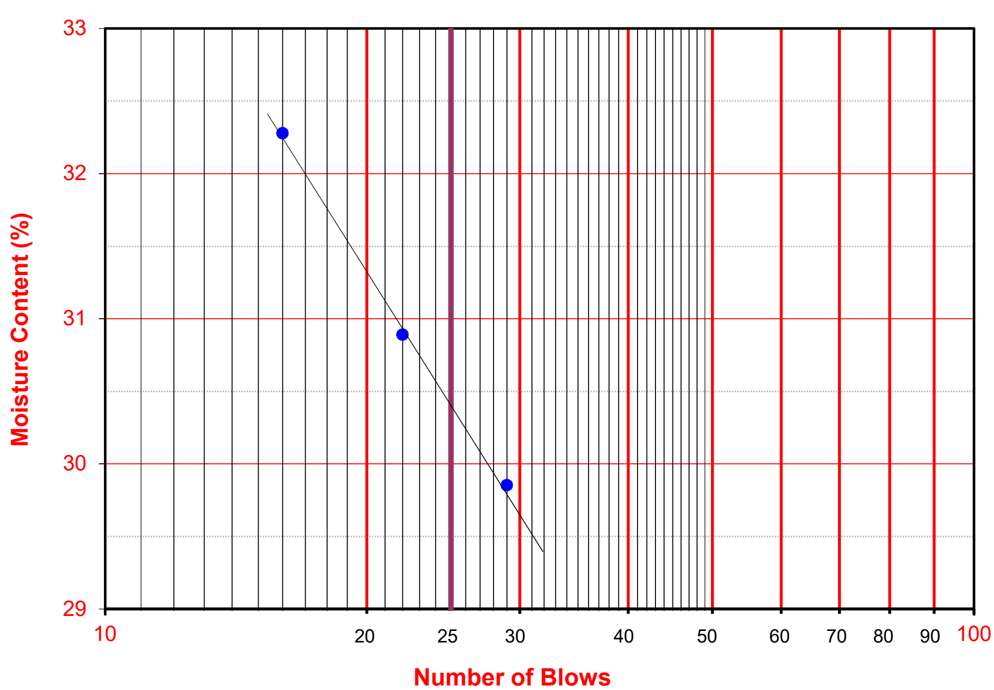
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-22	Checked By:	A. Santos		
Sample No.:	S-6	Depth (ft.)	23.5		
Soil Identification:	Gray silt (ML)				

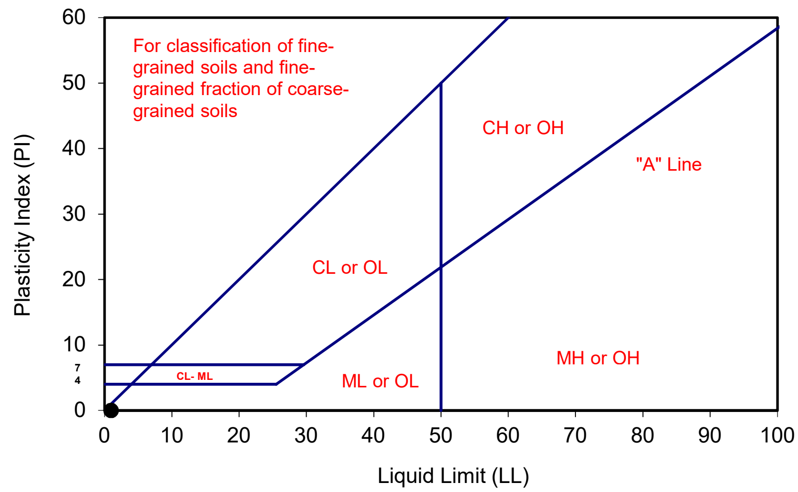
TEST NO.	PLASTIC LIMIT 1	PLASTIC LIMIT 2	LIQUID LIMIT 1	LIQUID LIMIT 2	LIQUID LIMIT 3	LIQUID LIMIT 4
Number of Blows [N]			10			
Wet Wt. of Soil + Cont. (g)	**Cannot be rolled:**		21.62	**Cannot get more than 10 blows:**		
Dry Wt. of Soil + Cont. (g)	**NonPlastic**		17.52	**NonPlastic**		
Wt. of Container (g)			1.01			
Moisture Content (%) [Wn]			24.83			

Liquid Limit	**NP**
Plastic Limit	**NP**
Plasticity Index	**NP**
Classification	**NP**

PI at "A" - Line = 0.73(LL-20) =

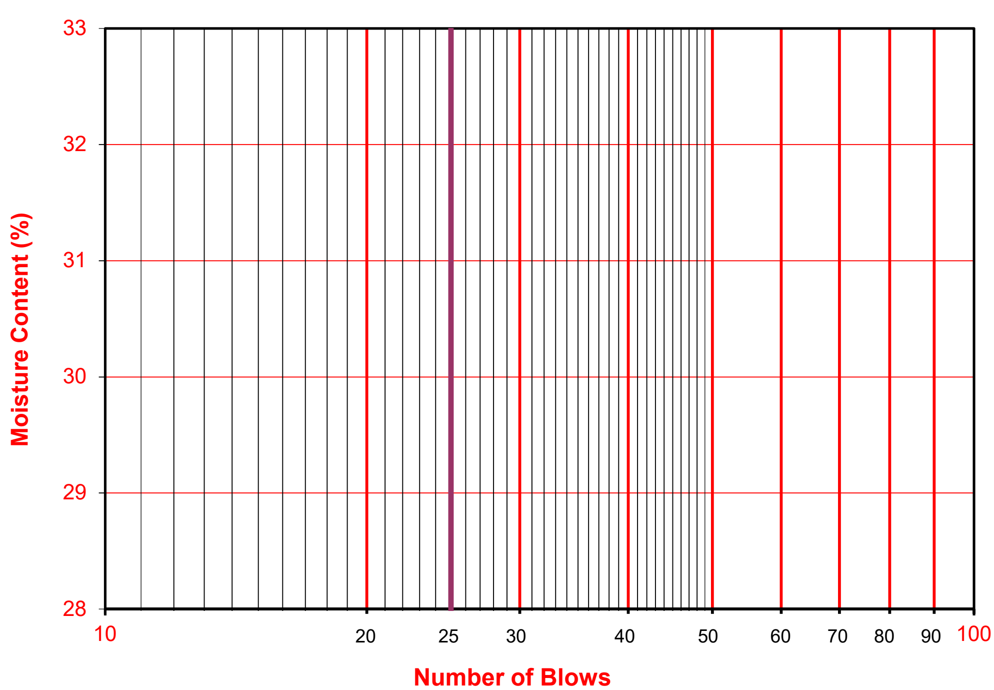
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

☐	Wet Preparation Multipoint - Wet
X	Dry Preparation Multipoint - Dry
X	Procedure A Multipoint Test
☐	Procedure B One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-25	Checked By:	A. Santos		
Sample No.:	T-5B	Depth (ft.)	16.0		
Soil Identification:	Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons				

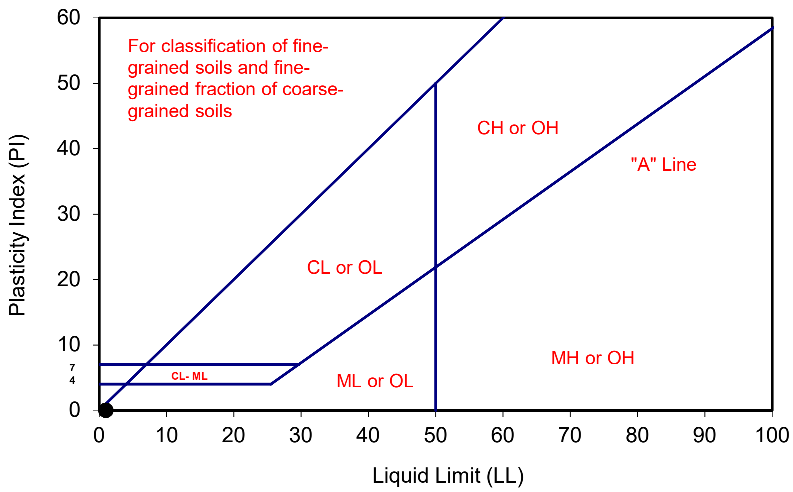
TEST NO.	PLASTIC LIMIT 1	PLASTIC LIMIT 2	LIQUID LIMIT 1	LIQUID LIMIT 2	LIQUID LIMIT 3	LIQUID LIMIT 4
Number of Blows [N]			7			
Wet Wt. of Soil + Cont. (g)	**Cannot be rolled:**		18.28	**Cannot get more than 7 blows:**		
Dry Wt. of Soil + Cont. (g)	**NonPlastic**		15.01	**NonPlastic**		
Wt. of Container (g)			1.00			
Moisture Content (%) [Wn]			23.34			

Liquid Limit	**NP**
Plastic Limit	**NP**
Plasticity Index	**NP**
Classification	**NP**

PI at "A" - Line = 0.73(LL-20) =

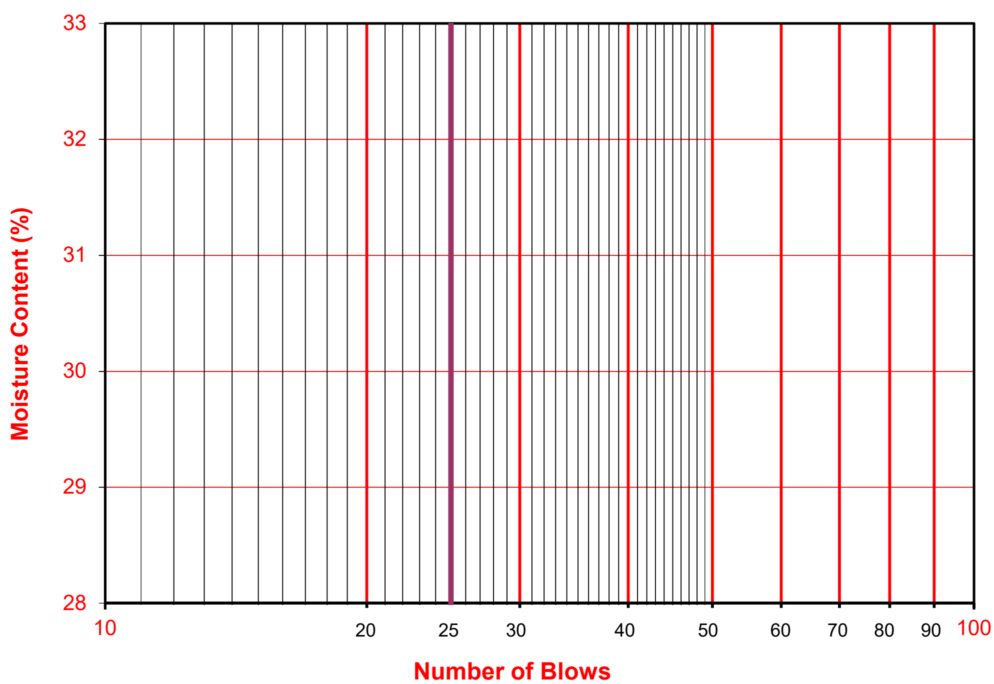
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation Multipoint - Wet
- [X] Dry Preparation Multipoint - Dry
- [X] Procedure A Multipoint Test
- [ ] Procedure B One-point Test



Leighton

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	A. Santos	Date:	11/07/20
Boring No.:	LB-27	Checked By:	A. Santos		
Sample No.:	R-5	Depth (ft.)	20.0		
Soil Identification:	Brown sandy lean clay s(CL)				

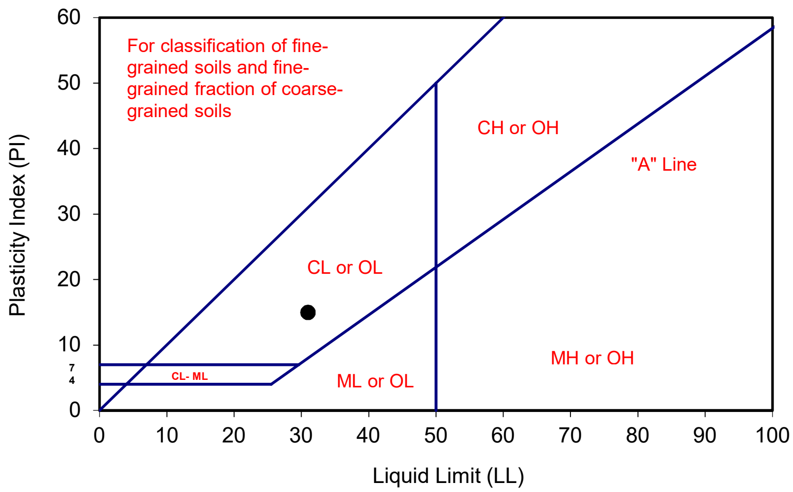
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			30	24	18	
Wet Wt. of Soil + Cont. (g)	10.07	10.08	20.91	22.08	20.16	
Dry Wt. of Soil + Cont. (g)	8.83	8.84	16.31	17.12	15.52	
Wt. of Container (g)	1.09	1.10	1.01	1.05	1.04	
Moisture Content (%) [Wn]	16.02	16.02	30.07	30.86	32.04	

Liquid Limit	**31**
Plastic Limit	**16**
Plasticity Index	**15**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 8.03

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



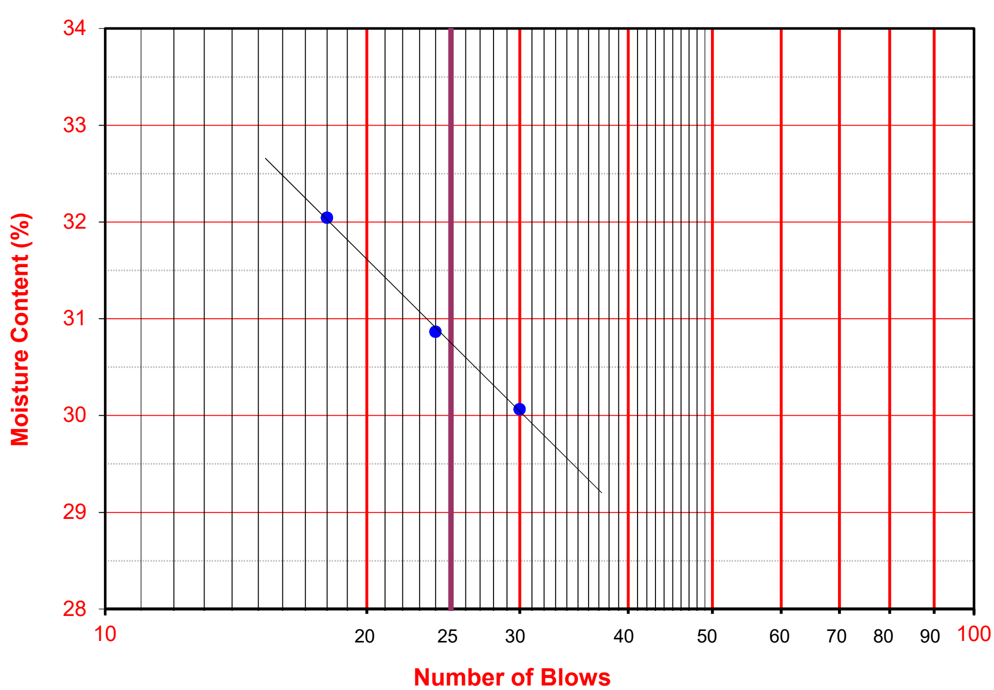
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

X Dry Preparation
Multipoint - Dry

X Procedure A
Multipoint Test

☐ Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/04/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/07/20
Boring No.:	LB-31	Checked By:	A. Santos		
Sample No.:	R-2	Depth (ft.)	10.0		
Soil Identification:	Dark brown lean clay with sand (CL)s				

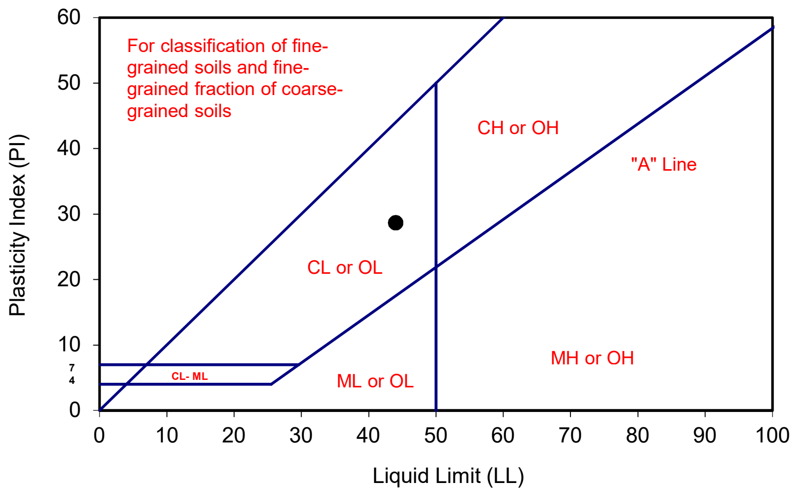
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	26	19	
Wet Wt. of Soil + Cont. (g)	9.22	9.34	19.69	20.41	19.24	
Dry Wt. of Soil + Cont. (g)	8.14	8.23	14.06	14.46	13.57	
Wt. of Container (g)	1.05	1.04	1.06	1.02	0.98	
Moisture Content (%) [Wn]	15.23	15.44	43.31	44.27	45.04	

Liquid Limit	**44**
Plastic Limit	**15**
Plasticity Index	**29**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 17.52

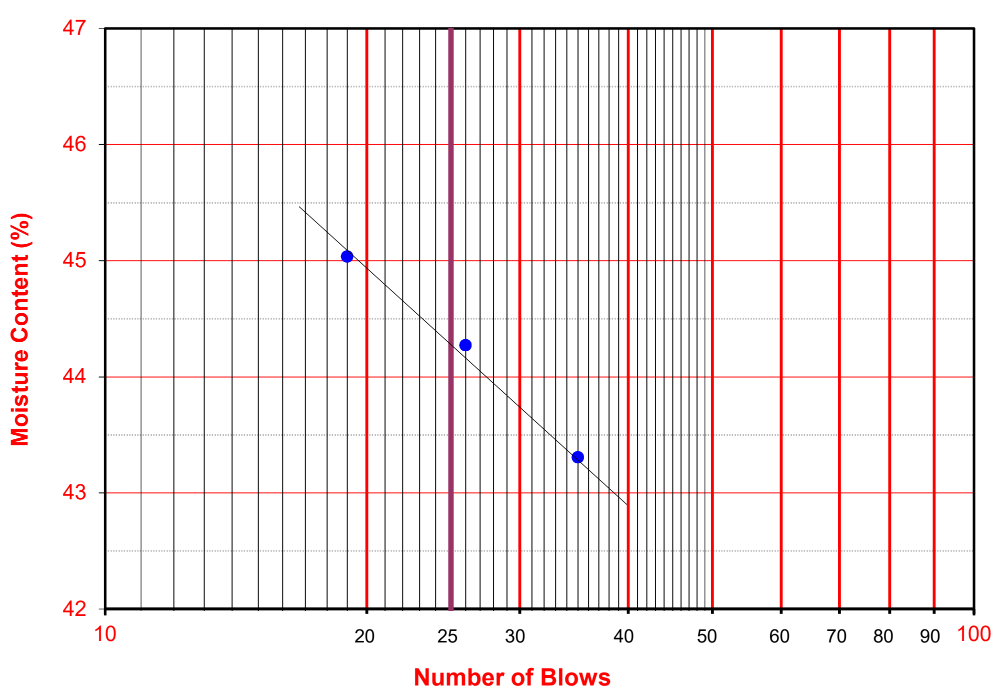
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [x] Dry Preparation
  Multipoint - Dry
- [x] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	10/26/20
Project No. :	11585.005	Input By:	G. Bathala	Date:	11/02/20
Boring No.:	LB-39	Checked By:	A. Santos		
Sample No.:	S-6	Depth (ft.)	25.0		
Soil Identification:	Yellowish brown clayey sand (SC)				

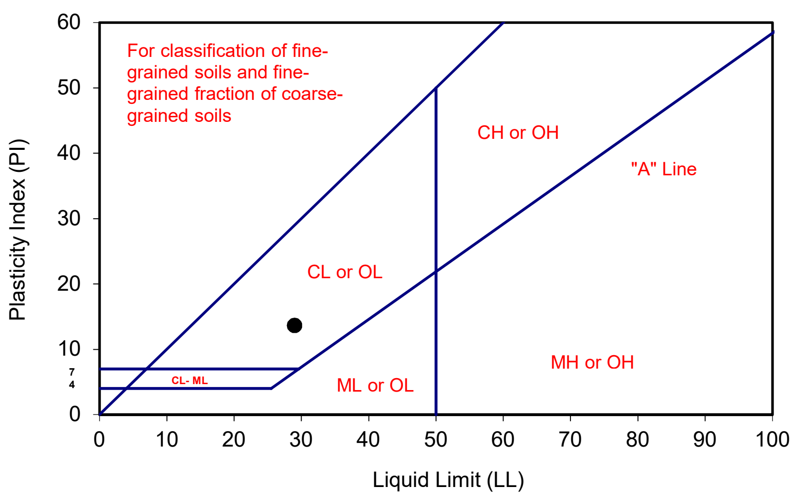
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			29	23	16	
Wet Wt. of Soil + Cont. (g)	9.69	9.81	20.50	20.83	21.57	
Dry Wt. of Soil + Cont. (g)	8.56	8.64	16.26	16.38	16.81	
Wt. of Container (g)	1.17	1.07	1.10	1.01	1.05	
Moisture Content (%) [Wn]	15.29	15.46	27.97	28.95	30.20	

Liquid Limit	**29**
Plastic Limit	**15**
Plasticity Index	**14**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) 6.57

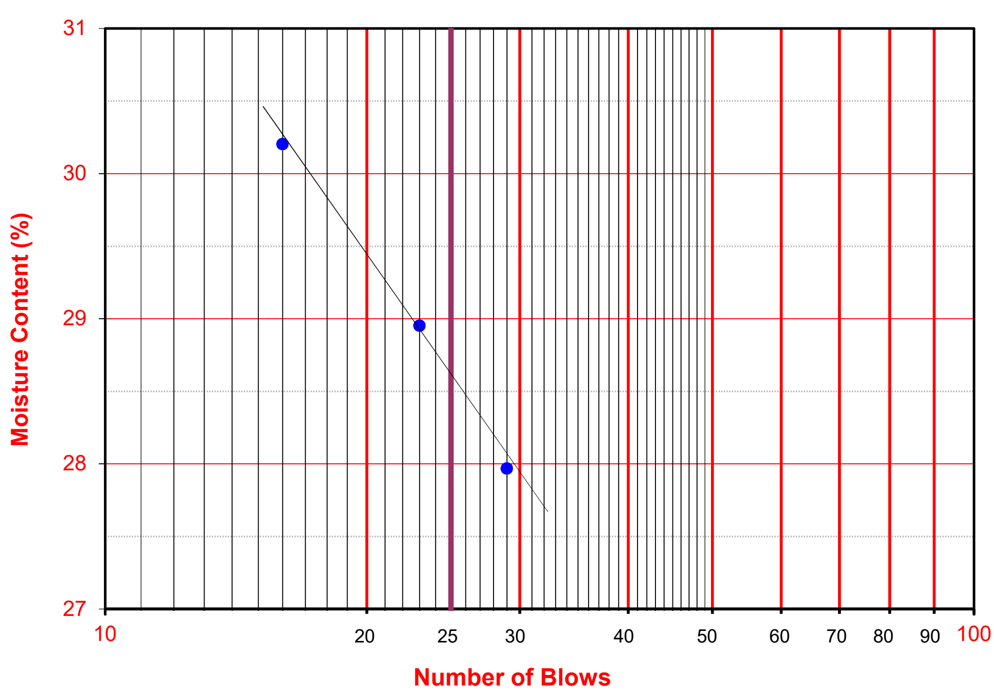
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Leighton

EXPANSION INDEX of SOILS

ASTM D 4829

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Felter	Date:	09/06/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Location:	LB-5	Depth (ft.):	1.25		
Sample No.:	B-1				
Soil Identification:	Gray clayey sand (SC)				

Dry Wt. of Soil + Cont.	(g)	1000.00
Wt. of Container No.	(g)	0.00
Dry Wt. of Soil	(g)	1000.00
Weight Soil Retained on #4 Sieve		0.00
Percent Passing # 4		100.00

MOLDED SPECIMEN		Before Test	After Test
Specimen Diameter	(in.)	4.01	4.01
Specimen Height	(in.)	1.0000	1.0285
Wt. Comp. Soil + Mold	(g)	542.30	416.68
Wt. of Mold	(g)	163.60	0.00
Specific Gravity (Assumed)		2.70	2.70
Container No.		O	O
Wet Wt. of Soil + Cont.	(g)	759.30	580.28
Dry Wt. of Soil + Cont.	(g)	678.00	501.76
Wt. of Container	(g)	0.00	163.60
Moisture Content	(%)	11.99	23.22
Wet Density	(pcf)	114.2	122.2
Dry Density	(pcf)	102.0	99.2
Void Ratio		0.653	0.700
Total Porosity		0.395	0.412
Pore Volume	(cc)	81.8	87.6
Degree of Saturation (%) [S_{meas}]		**49.6**	89.6

SPECIMEN INUNDATION in distilled water for the period of 24 h or expansion rate < 0.0002 in./h

Date	Time	Pressure (psi)	Elapsed Time (min.)	Dial Readings (in.)
09/06/18	11:36	1.0	0	0.2535
09/06/18	11:46	1.0	10	0.2535
Add Distilled Water to the Specimen				
09/06/18	12:01	1.0	15	0.2660
09/07/18	6:40	1.0	1134	0.2820
09/07/18	7:52	1.0	1206	0.2820

Expansion Index (EI_{meas}) = ((Final Rdg - Initial Rdg) / Initial Thick.) x 1000	**29**

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS
ASTM D 6913

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Felter	Date:	08/02/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-1	Depth (feet):	1.25		
Sample No.:	B-1				
Soil Identification:	Brown clayey sand (SC)				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	SP-04	9545	Wt. of Air-Dry Soil + Cont.(g)	0.0	0.0
Wt. Air-Dried Soil + Cont.(g)	5330.5	718.9	Wt. of Dry Soil + Cont. (g)	0.0	0.0
Wt. of Container (g)	788.1	106.9	Wt. of Container No.______(g)	1.0	1.0
Dry Wt. of Soil (g)	4542.4	612.0	Moisture Content (%)	0.0	0.0

Passing #4 Material After Wet Sieve		
	Container No.	9545
	Wt. of Dry Soil + Container (g)	454.9
	Wt. of Container (g)	106.9
	Dry Wt. of Soil Retained on # 200 Sieve (g)	348.0

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
1 1/2"	37.5			
1"	25.0			
3/4"	19.0	0.0		100.0
1/2"	12.5	21.3		99.5
3/8"	9.5	40.3		99.1
#4	4.75	107.0		97.6
#8	2.36		10.7	95.9
#16	1.18		25.5	93.5
#30	0.600		49.1	89.8
#50	0.300		103.1	81.2
#100	0.150		228.6	61.1
#200	0.075		345.3	42.5
PAN				

GRAVEL: **2 %**

SAND: **55 %**

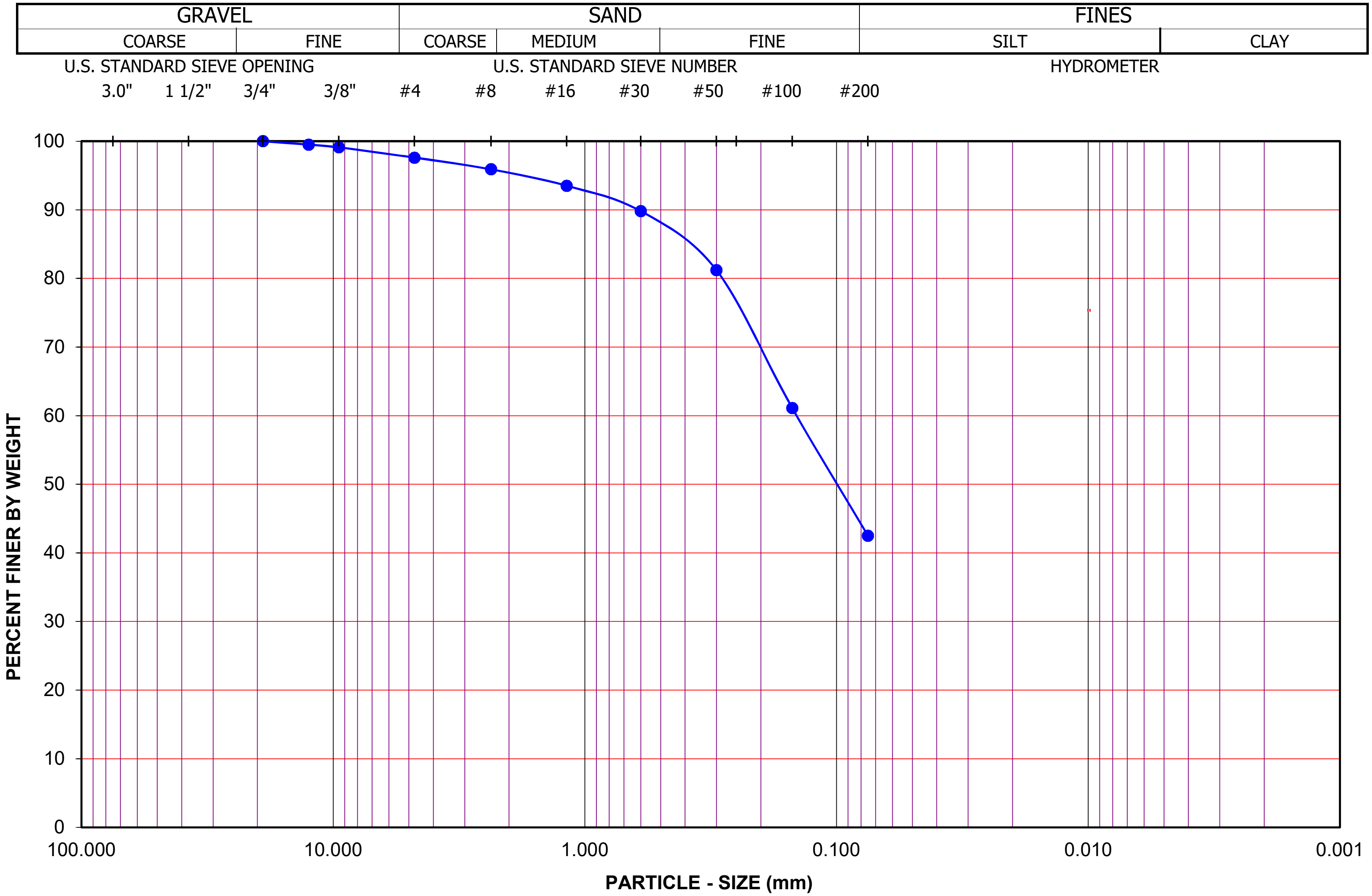
FINES: **43 %**

GROUP SYMBOL: **SC**

Cu = D60/D10 = ______

Cc = $(D30)^2/(D60*D10)$ = ______

Remarks:



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LB-1 Sample No.: B-1

Depth (feet): 1.3 Soil Type : SC

Soil Identification: Brown clayey sand (SC)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 2 : 55 : 43

Sep-18

SA LB-1, B-1 @ 1.25

PARTICLE-SIZE DISTRIBUTION (GRADATION) of SOILS USING SIEVE ANALYSIS
ASTM D 6913

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Felter	Date:	08/02/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-11	Depth (feet):	3.0		
Sample No.:	B-1				
Soil Identification:	Brown clayey sand (SC)				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	AB-10	901	Wt. of Air-Dry Soil + Cont.(g)	0.0	0.0
Wt. Air-Dried Soil + Cont.(g)	2847.8	700.3	Wt. of Dry Soil + Cont. (g)	0.0	0.0
Wt. of Container (g)	223.3	108.0	Wt. of Container No.______(g)	1.0	1.0
Dry Wt. of Soil (g)	2624.5	592.3	Moisture Content (%)	0.0	0.0

Passing #4 Material After Wet Sieve		
	Container No.	901
	Wt. of Dry Soil + Container (g)	390.3
	Wt. of Container (g)	108.0
	Dry Wt. of Soil Retained on # 200 Sieve (g)	282.3

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
1 1/2"	37.5			
1"	25.0			
3/4"	19.0	0.0		100.0
1/2"	12.5	53.3		98.0
3/8"	9.5	116.8		95.5
#4	4.75	260.6		90.1
#8	2.36		35.4	84.7
#16	1.18		76.0	78.5
#30	0.600		114.2	72.7
#50	0.300		156.4	66.3
#100	0.150		210.9	58.0
#200	0.075		279.1	47.6
PAN				

GRAVEL: **10 %**

SAND: **42 %**

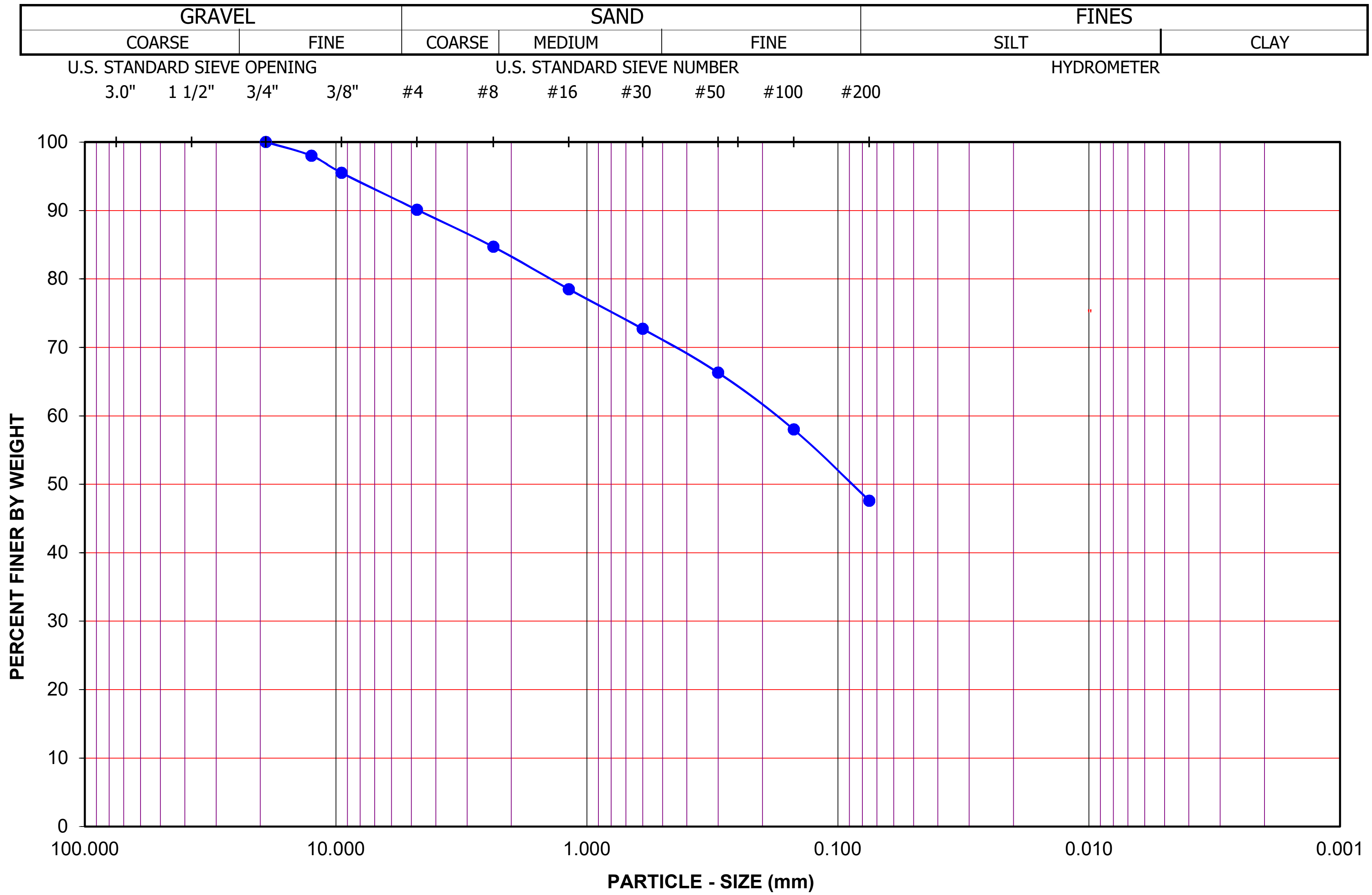
FINES: **48 %**

GROUP SYMBOL: **SC**

$Cu = D60/D10 =$ ______

$Cc = (D30)^2/(D60*D10) =$ ______

Remarks: ______



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LB-11 | Sample No.: B-1

Depth (feet): 3.0 | Soil Type : SC

Soil Identification: Brown clayey sand (SC)

Leighton

PARTICLE - SIZE DISTRIBUTION
ASTM D 6913

GR:SA:FI : (%) 10 : 42 : 48

Sep-18

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Corridor Improvements — Tested By: G. Berdy — Date: 08/26/18

Project No.: 11588.001 — Data Input By: J. Ward — Date: 08/28/18

Boring No.: LBA-1

Sample No.: G-1 — Depth (feet): 7.6-9.5

Soil Identification: Light olive brown fat clay (CH), mica noted

		Soil Type
% Gravel	**0**	**CH**
% Sand	**8**	
% Fines	**92**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	84.42	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	84.05	78.90
Wt.of Air-Dry Soil + Cont. (g)	95.55	Wt. of Container No.___ (g)	1.00	74.56	74.92
Wt. of Container	39.21	Moisture Content (%)	0.00	3.90	
Dry Wt. of Soil (g)	56.34	Wt. of Dry Soil (g)			3.98

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.08	99.9
Pan		

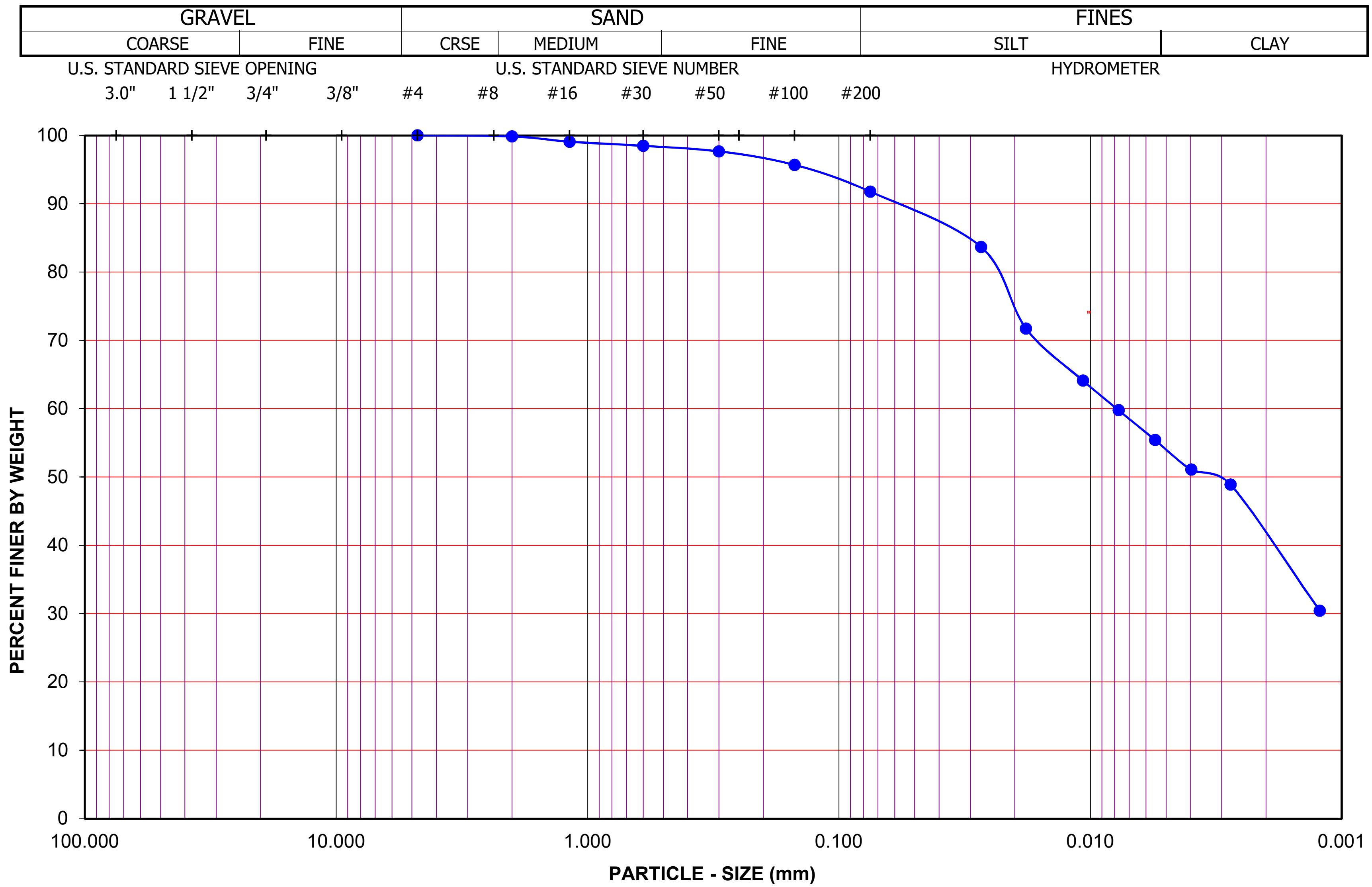
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.9
No. 16	0.35	99.2	99.1
No. 30	0.63	98.6	98.5
No. 50	1.00	97.8	97.7
No. 100	1.90	95.8	95.7
No. 200	3.69	91.9	91.8
Pan			

Hydrometer — Wt. of Air-Dry Soil (g) 47.35 — Wt. of Dry Soil (g) 45.57

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
27-Aug-06	7:38	0		7.5			
	7:40	2	23.9	7.5	46.0	83.7	0.0272
	7:43	5	23.9	7.5	40.5	71.7	0.0180
	7:53	15	23.9	7.5	37.0	64.1	0.0107
	8:08	30	23.9	7.5	35.0	59.8	0.0077
	8:38	60	23.8	7.5	33.0	55.4	0.0055
	9:38	120	23.7	7.5	31.0	51.1	0.0040
	11:48	250	23.7	7.5	30.0	48.9	0.0028
28-Aug-06	7:38	1440	23.0	7.5	21.5	30.4	0.0012



Project Name: Brea Boulevard Corridor Improvements

Project No.: 11588.001

Boring No.: LBA-1 Sample No.: G-1

Depth (feet): 7.6-9.5 Soil Type : CH

Soil Identification: Light olive brown fat clay (CH), mica noted

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 8 : 92

Aug-18

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Brea Boulevard Additional Borings — Tested By: Y. Nguyen — Date: 10/26/20

Project No.: 11585.005 — Checked By: A. Santos — Date: 11/30/20

Boring No.: LB-19

Sample No.: S-7 — Depth (feet): 25.0

Soil Identification: Yellowish brown clayey sand (SC)

		Soil Type
% Gravel	**0**	**SC**
% Sand	**57**	
% Fines	**43**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	68.08	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	68.05	117.56
Wt.of Air-Dry Soil + Cont. (g)	733.10	Wt. of Container No.___ (g)	1.00	52.93	88.03
Wt. of Container	106.40	Moisture Content (%)	0.00	0.20	
Dry Wt. of Soil (g)	626.70	Wt. of Dry Soil (g)			29.53

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	1.51	99.8
No. 10	4.93	99.2
Pan		

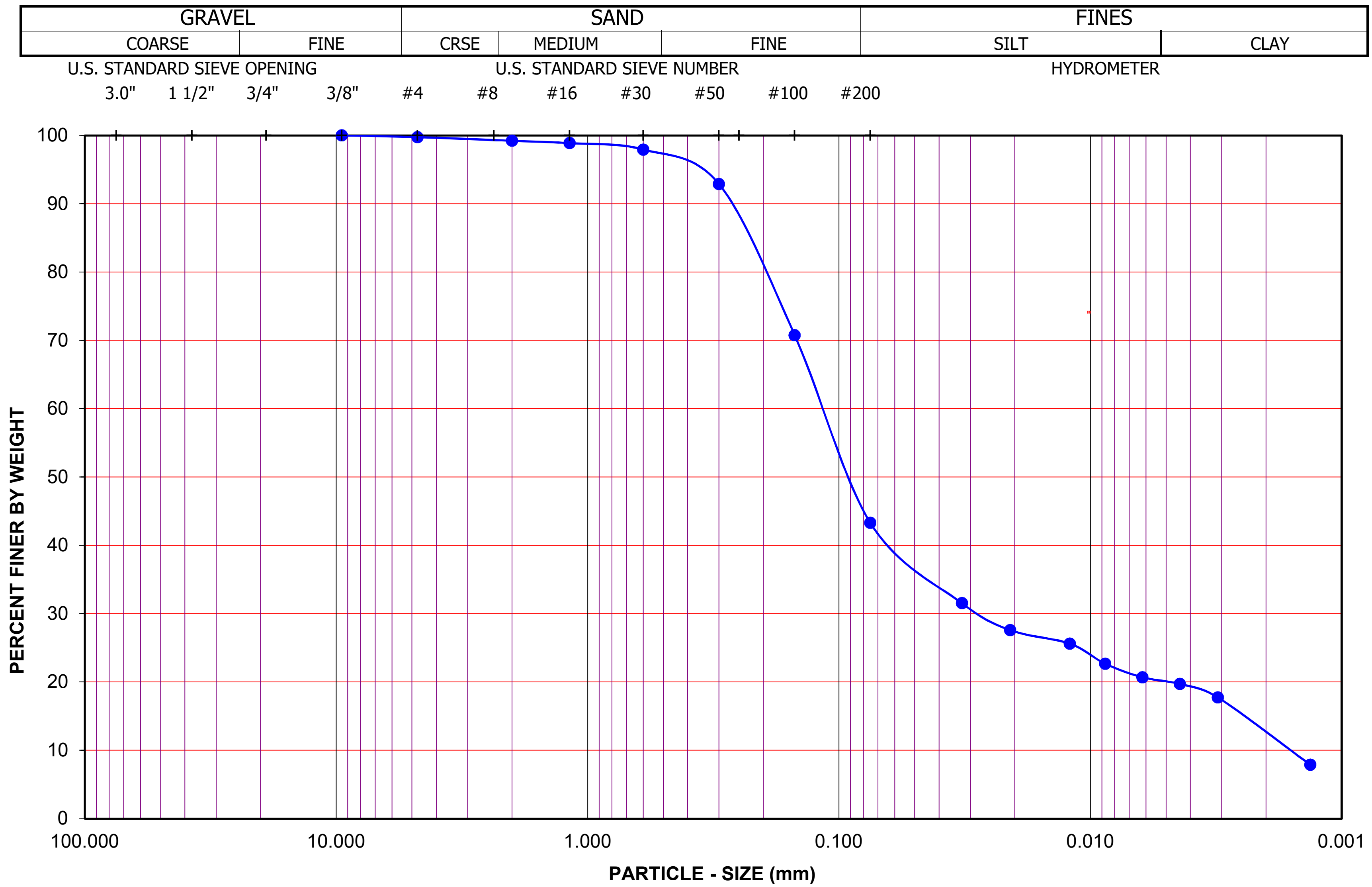
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.2
No. 16	0.17	99.7	98.9
No. 30	0.64	98.7	97.9
No. 50	3.19	93.6	92.9
No. 100	14.32	71.3	70.8
No. 200	28.15	43.6	43.3
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.04 Wt. of Dry Soil (g) 49.94

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:28	0		7.0			
	9:30	2	23.3	7.0	23.0	31.5	0.0324
	9:33	5	23.2	7.0	21.0	27.6	0.0208
	9:43	15	23.1	7.0	20.0	25.6	0.0121
	9:58	30	22.9	7.0	18.5	22.7	0.0087
	10:28	60	22.7	7.0	17.5	20.7	0.0062
	11:28	120	22.6	7.0	17.0	19.7	0.0044
	13:38	250	21.8	7.0	16.0	17.7	0.0031
29-Oct-20	9:28	1440	21.6	7.0	11.0	7.9	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-19 Sample No.: S-7

Depth (feet): 25.0 Soil Type : SC

Soil Identification: Yellowish brown clayey sand (SC)

GR:SA:FI : (%) 0 : 57 : 43

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings
Tested By: Y. Nguyen
Date: 10/27/20

Project No.: 11585.005
Checked By: A. Santos
Date: 11/30/20

Boring No.: LB-22

Sample No.: R-3
Depth (feet): 10.0

Soil Identification: Light brown lean clay (CL)

		Soil Type
% Gravel	**0**	**CL**
% Sand	**9**	
% Fines	**91**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.20	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.17	100.46
Wt.of Air-Dry Soil + Cont. (g)	814.60	Wt. of Container No.___ (g)	1.00	56.67	88.26
Wt. of Container	251.34	Moisture Content (%)	0.00	0.19	
Dry Wt. of Soil (g)	563.26	Wt. of Dry Soil (g)			12.20

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

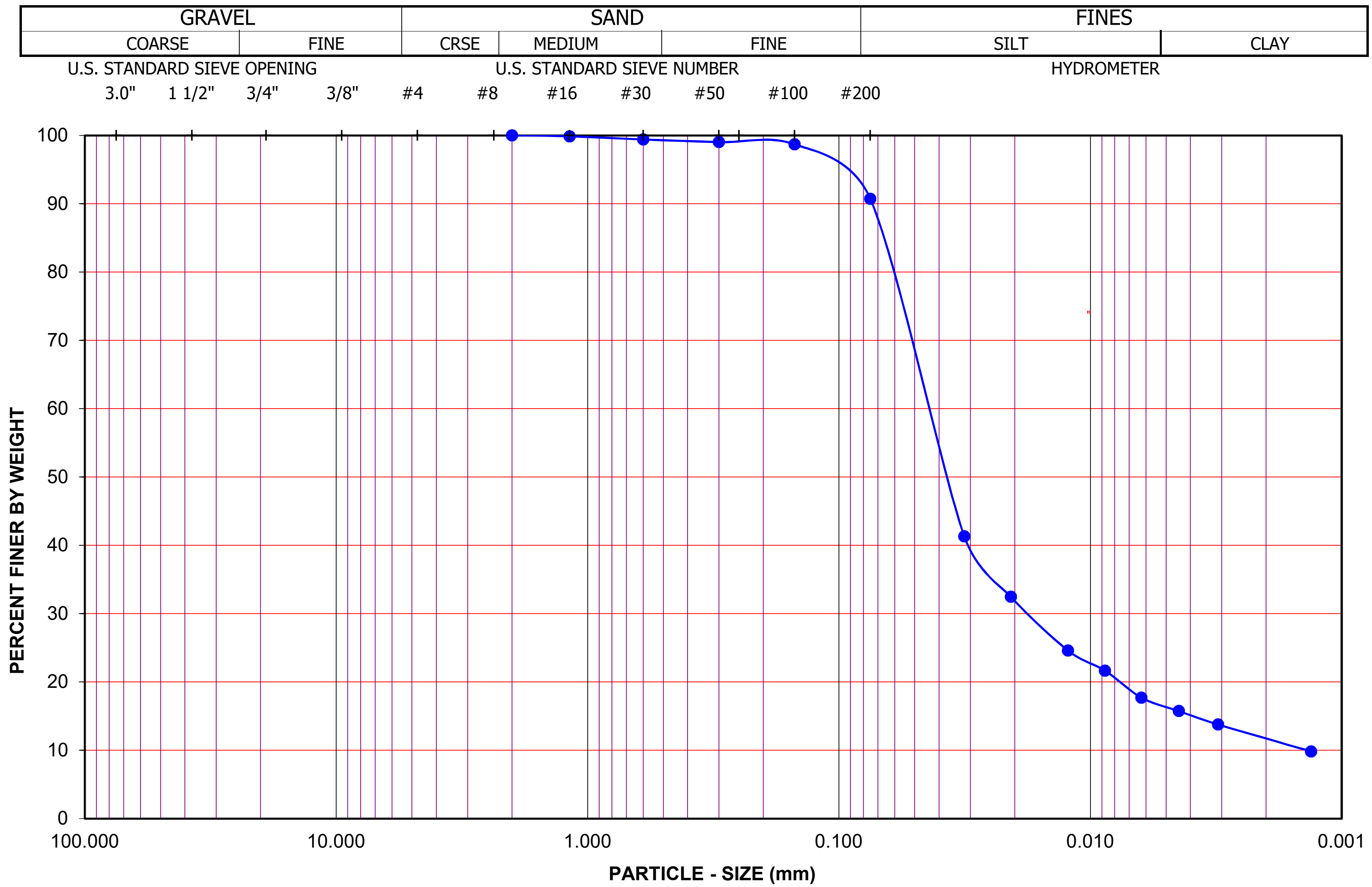
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.06	99.9	99.9
No. 30	0.30	99.4	99.4
No. 50	0.49	99.0	99.0
No. 100	0.66	98.7	98.7
No. 200	4.68	90.7	90.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.49 Wt. of Dry Soil (g) 50.39

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:20	0		7.0			
	9:22	2	22.8	7.0	28.0	41.3	0.0317
	9:25	5	22.8	7.0	23.5	32.5	0.0207
	9:35	15	22.7	7.0	19.5	24.6	0.0123
	9:50	30	22.6	7.0	18.0	21.7	0.0087
	10:20	60	22.5	7.0	16.0	17.7	0.0063
	11:20	120	22.6	7.0	15.0	15.7	0.0045
	13:30	250	22.1	7.0	14.0	13.8	0.0031
29-Oct-20	9:20	1440	21.6	7.0	12.0	9.8	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-22   Sample No.: R-3

Depth (feet): 10.0   Soil Type : CL

Soil Identification: Light brown lean clay (CL)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 9 : 91

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings — Tested By: Y. Nguyen — Date: 10/26/20

Project No.: 11585.005 — Checked By: A. Santos — Date: 11/30/20

Boring No.: LB-22

Sample No.: S-6 — Depth (feet): 23.5

Soil Identification: Gray silt (ML)

		Soil Type
% Gravel	0	ML
% Sand	14	
% Fines	86	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.76	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.72	85.10
Wt.of Air-Dry Soil + Cont. (g)	805.50	Wt. of Container No.___ (g)	1.00	57.34	74.77
Wt. of Container	108.10	Moisture Content (%)	0.00	0.26	
Dry Wt. of Soil (g)	697.40	Wt. of Dry Soil (g)			10.33

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.00	100.0
Pan		

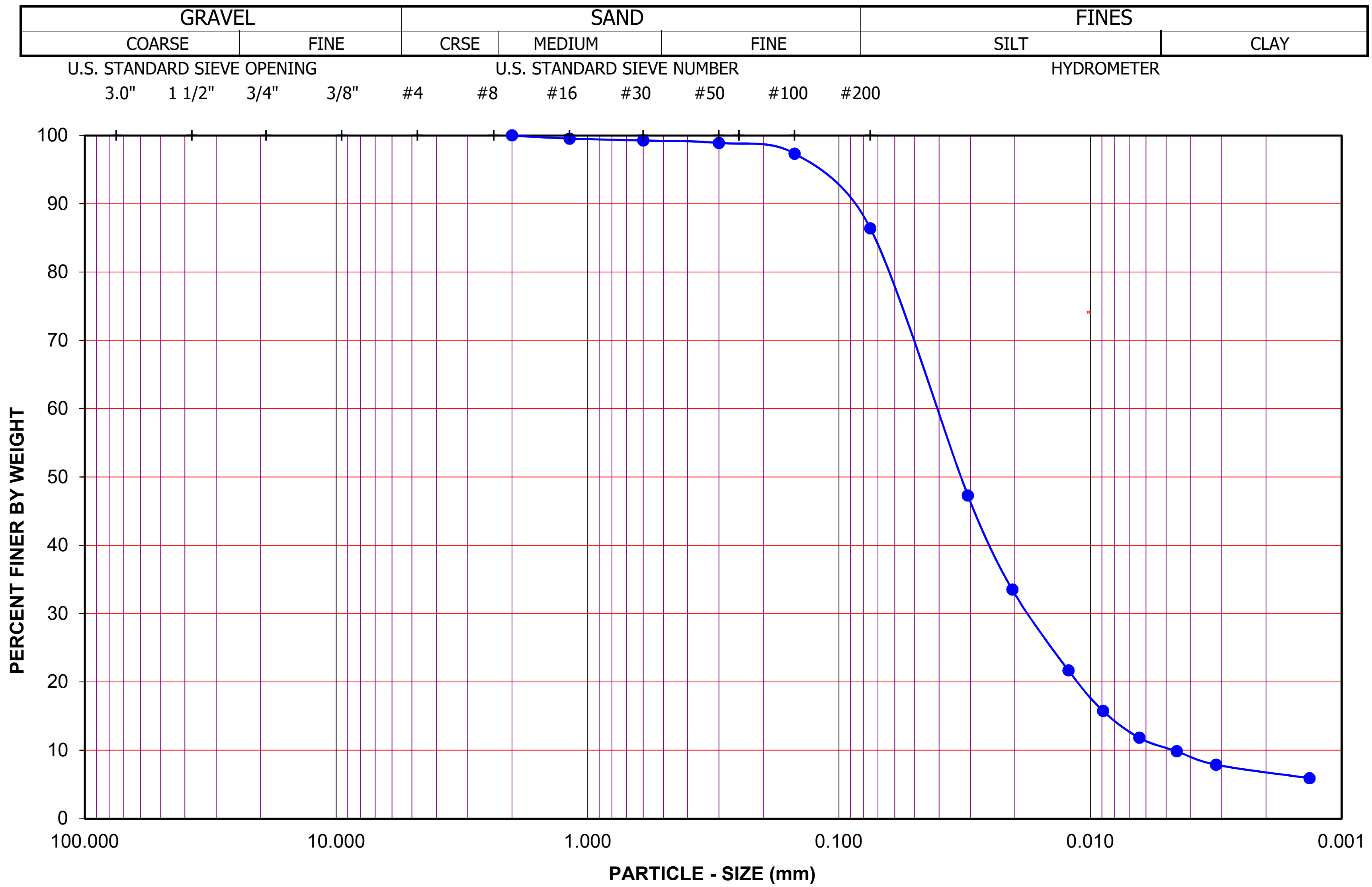
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.23	99.5	99.5
No. 30	0.37	99.3	99.3
No. 50	0.55	98.9	98.9
No. 100	1.34	97.3	97.3
No. 200	6.84	86.4	86.4
Pan			

Hydrometer — Wt. of Air-Dry Soil (g): 50.46 — Wt. of Dry Soil (g): 50.33

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:24	0		7.0			
	9:26	2	23.0	7.0	31.0	47.3	0.0307
	9:29	5	23.1	7.0	24.0	33.5	0.0204
	9:39	15	23.0	7.0	18.0	21.7	0.0122
	9:54	30	22.8	7.0	15.0	15.8	0.0089
	10:24	60	22.6	7.0	13.0	11.8	0.0064
	11:24	120	22.6	7.0	12.0	9.9	0.0045
	13:34	250	22.0	7.0	11.0	7.9	0.0032
29-Oct-20	9:24	1440	21.5	7.0	10.0	5.9	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-22 Sample No.: S-6

Depth (feet): 23.5 Soil Type : ML

Soil Identification: Gray silt (ML)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 14 : 86

Nov-20

Leighton

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Project Name: Brea Boulevard Additional Borings   Tested By: Y. Nguyen   Date: 10/28/20

Project No.: 11585.005   Checked By: A. Santos   Date: 11/30/20

Boring No.: LB-25

Sample No.: T-5B   Depth (feet): 16.0

Soil Identification: Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons

% Gravel	2	Soil Type
% Sand	92	(SW-SM)
% Fines	6	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	72.68	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	72.51	117.69
Wt.of Air-Dry Soil + Cont. (g)	643.39	Wt. of Container No.___ (g)	1.00	56.95	76.23
Wt. of Container	107.29	Moisture Content (%)	0.00	1.09	
Dry Wt. of Soil (g)	536.10	Wt. of Dry Soil (g)			41.46

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	12.69	97.6
No. 10	363.99	32.1
Pan		

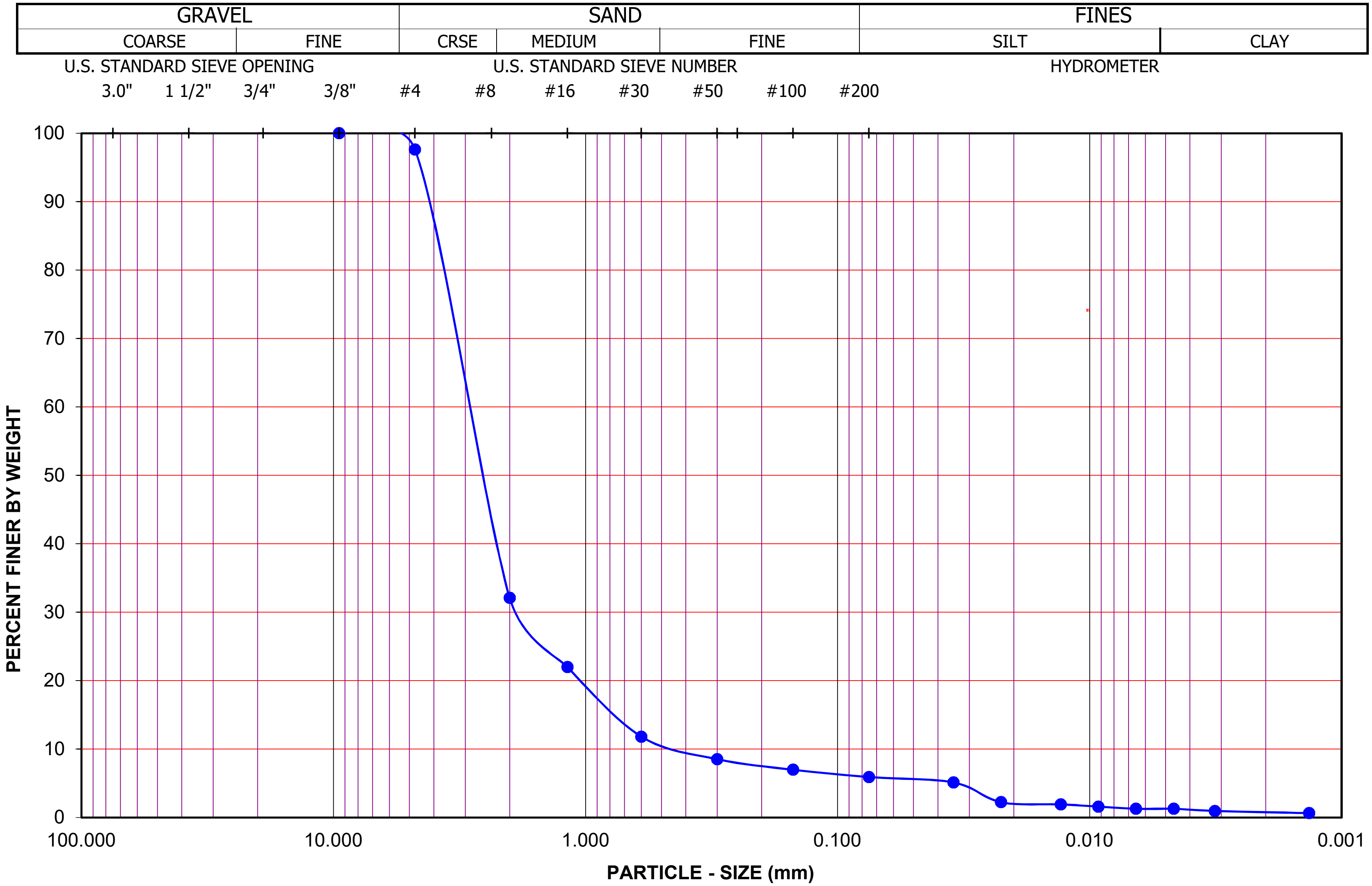
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	32.1
No. 16	15.68	68.5	22.0
No. 30	31.43	36.8	11.8
No. 50	36.53	26.6	8.5
No. 100	38.92	21.7	7.0
No. 200	40.56	18.5	5.9
Pan			

Hydrometer   Wt. of Air-Dry Soil (g) 50.28   Wt. of Dry Soil (g) 49.74

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Oct-20	6:38	0		8.5			
	6:40	2	21.7	8.5	16.5	5.1	0.0346
	6:43	5	21.7	8.5	12.0	2.2	0.0225
	6:53	15	21.7	8.5	11.5	1.9	0.0130
	7:08	30	21.6	8.5	11.0	1.6	0.0092
	7:38	60	21.4	8.5	10.5	1.3	0.0066
	8:38	120	21.4	8.5	10.5	1.3	0.0046
	10:48	250	22.0	8.5	10.0	1.0	0.0032
31-Oct-20	6:38	1440	21.2	8.5	9.5	0.6	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-25 Sample No.: T-5B

Depth (feet): 16.0 Soil Type : (SW-SM)

Soil Identification: Dark olive gray well-graded sand with silt (SW-SM), noted hydrocarbons

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 2 : 92 : 6

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	Y. Nguyen	Date:	11/19/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	11/30/20
Boring No.:	LB-27				
Sample No.:	R-5	Depth (feet):	20.0		
Soil Identification:	Brown sandy lean clay s(CL)				

% Gravel	**0**	**Soil Type**
% Sand	**30**	**s(CL)**
% Fines	**70**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	78.46	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	78.19	103.11
Wt.of Air-Dry Soil + Cont. (g)	525.44	Wt. of Container No.___ (g)	1.00	61.40	87.44
Wt. of Container	74.08	Moisture Content (%)	0.00	1.61	
Dry Wt. of Soil (g)	451.36	Wt. of Dry Soil (g)			15.67

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.00	100.0
No. 10	0.20	100.0
Pan		

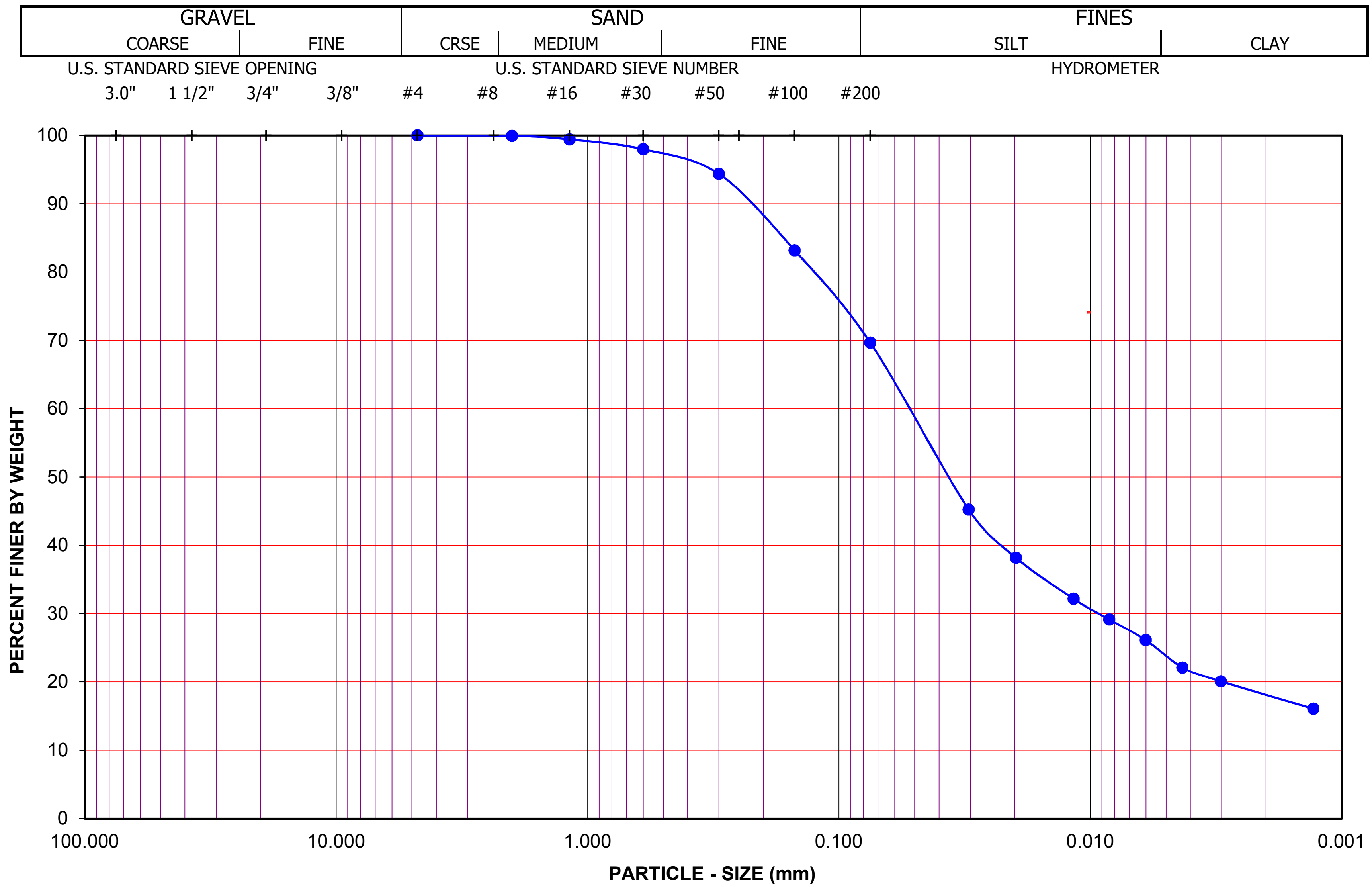
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	100.0
No. 16	0.26	99.5	99.4
No. 30	0.97	98.0	98.0
No. 50	2.76	94.4	94.4
No. 100	8.28	83.2	83.2
No. 200	14.95	69.7	69.7
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.12 Wt. of Dry Soil (g) 49.33

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
23-Nov-20	9:00	0		8.0			
	9:02	2	24.0	8.0	30.5	45.2	0.0305
	9:05	5	24.0	8.0	27.0	38.2	0.0198
	9:15	15	24.0	8.0	24.0	32.2	0.0117
	9:30	30	23.8	8.0	22.5	29.1	0.0084
	10:00	60	23.5	8.0	21.0	26.1	0.0060
	11:00	120	23.0	8.0	19.0	22.1	0.0043
	13:10	250	22.9	8.0	18.0	20.1	0.0030
24-Nov-20	9:00	1440	21.6	8.0	16.0	16.1	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-27 Sample No.: R-5

Depth (feet): 20.0 Soil Type : s(CL)

Soil Identification: Brown sandy lean clay s(CL)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 30 : 70

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings | Tested By: YN/GEB | Date: 10/28/20

Project No.: 11585.005 | Checked By: A. Santos | Date: 11/30/20

Boring No.: LB-31

Sample No.: R-2 | Depth (feet): 10.0

Soil Identification: Dark brown lean clay with sand (CL)s

		Soil Type
% Gravel	4	(CL)s
% Sand	25	
% Fines	71	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	83.99	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	83.83	90.56
Wt.of Air-Dry Soil + Cont. (g)	711.10	Wt. of Container No.___ (g)	1.00	68.11	77.60
Wt. of Container	140.30	Moisture Content (%)	0.00	1.02	
Dry Wt. of Soil (g)	570.80	Wt. of Dry Soil (g)			12.96

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	5.98	99.0
No. 4	20.17	96.5
No. 10	35.29	93.8
Pan		

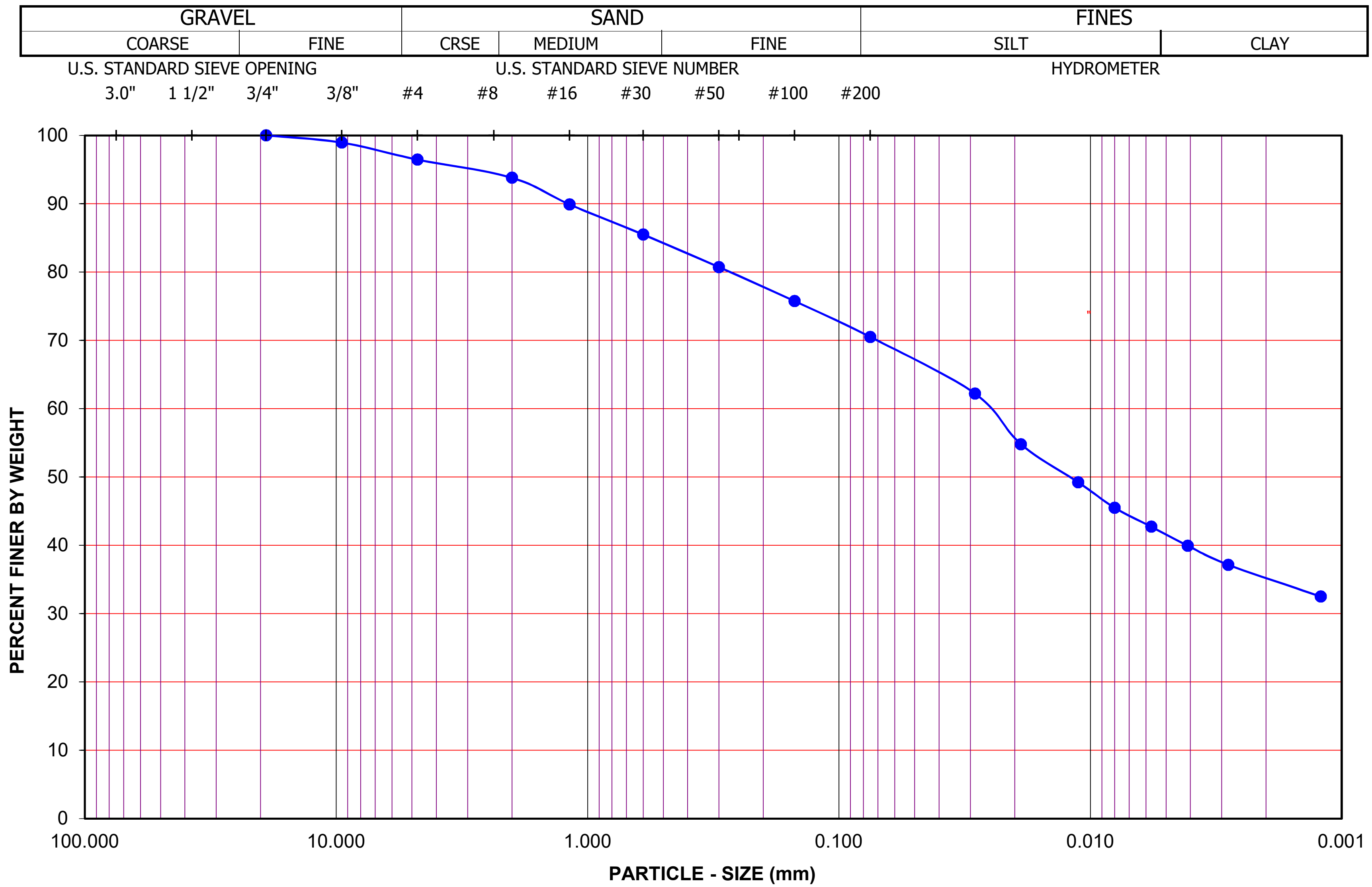
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	93.8
No. 16	2.09	95.8	89.9
No. 30	4.45	91.1	85.5
No. 50	6.99	86.0	80.7
No. 100	9.65	80.7	75.7
No. 200	12.45	75.1	70.5
Pan			

Hydrometer Wt. of Air-Dry Soil (g) 50.61 Wt. of Dry Soil (g) 50.10

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
30-Oct-20	6:42	0		8.5			
	6:44	2	21.6	8.5	42.0	62.2	0.0288
	6:47	5	21.6	8.5	38.0	54.8	0.0189
	6:57	15	21.6	8.5	35.0	49.2	0.0112
	7:12	30	21.5	8.5	33.0	45.5	0.0080
	7:42	60	21.4	8.5	31.5	42.7	0.0057
	8:42	120	21.4	8.5	30.0	39.9	0.0041
	10:52	250	22.0	8.5	28.5	37.2	0.0028
31-Oct-20	6:42	1440	21.3	8.5	26.0	32.5	0.0012



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-31 Sample No.: R-2

Depth (feet): 10.0 Soil Type : (CL)s

Soil Identification: Dark brown lean clay with sand (CL)s

GR:SA:FI : (%) 4 : 25 : 71

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

Nov-20

PARTICLE-SIZE ANALYSIS OF SOILS

ASTM D 422

Leighton

Project Name: Brea Boulevard Additional Borings — Tested By: Y. Nguyen — Date: 10/26/20

Project No.: 11585.005 — Checked By: A. Santos — Date: 11/30/20

Boring No.: LB-39

Sample No.: S-6 — Depth (feet): 25.0

Soil Identification: Yellowish brown clayey sand (SC)

		Soil Type
% Gravel	**0**	**SC**
% Sand	**58**	
% Fines	**42**	

			Moisture Content of Total Air-Dry Soil	Moisture Content of Air-Dry Soil Passing #10	After Hydrometer & Wet Sieve ret. in #200 Sieve
Specific Gravity (Assumed)	2.70	Wt.of Air-Dry Soil + Cont.(g)	0.00	84.75	
Correction for Specific Gravity	0.99	Dry Wt. of Soil + Cont. (g)	0.00	84.71	118.10
Wt.of Air-Dry Soil + Cont. (g)	746.30	Wt. of Container No.___ (g)	1.00	69.47	87.44
Wt. of Container	107.30	Moisture Content (%)	0.00	0.26	
Dry Wt. of Soil (g)	639.00	Wt. of Dry Soil (g)			30.66

Coarse Sieve

U.S. Sieve	Cumulative Wt. Of Dry Soil Retained (g)	% Passing
3"	0.00	100.0
1½"	0.00	100.0
3/4"	0.00	100.0
3/8"	0.00	100.0
No. 4	0.33	99.9
No. 10	0.77	99.9
Pan		

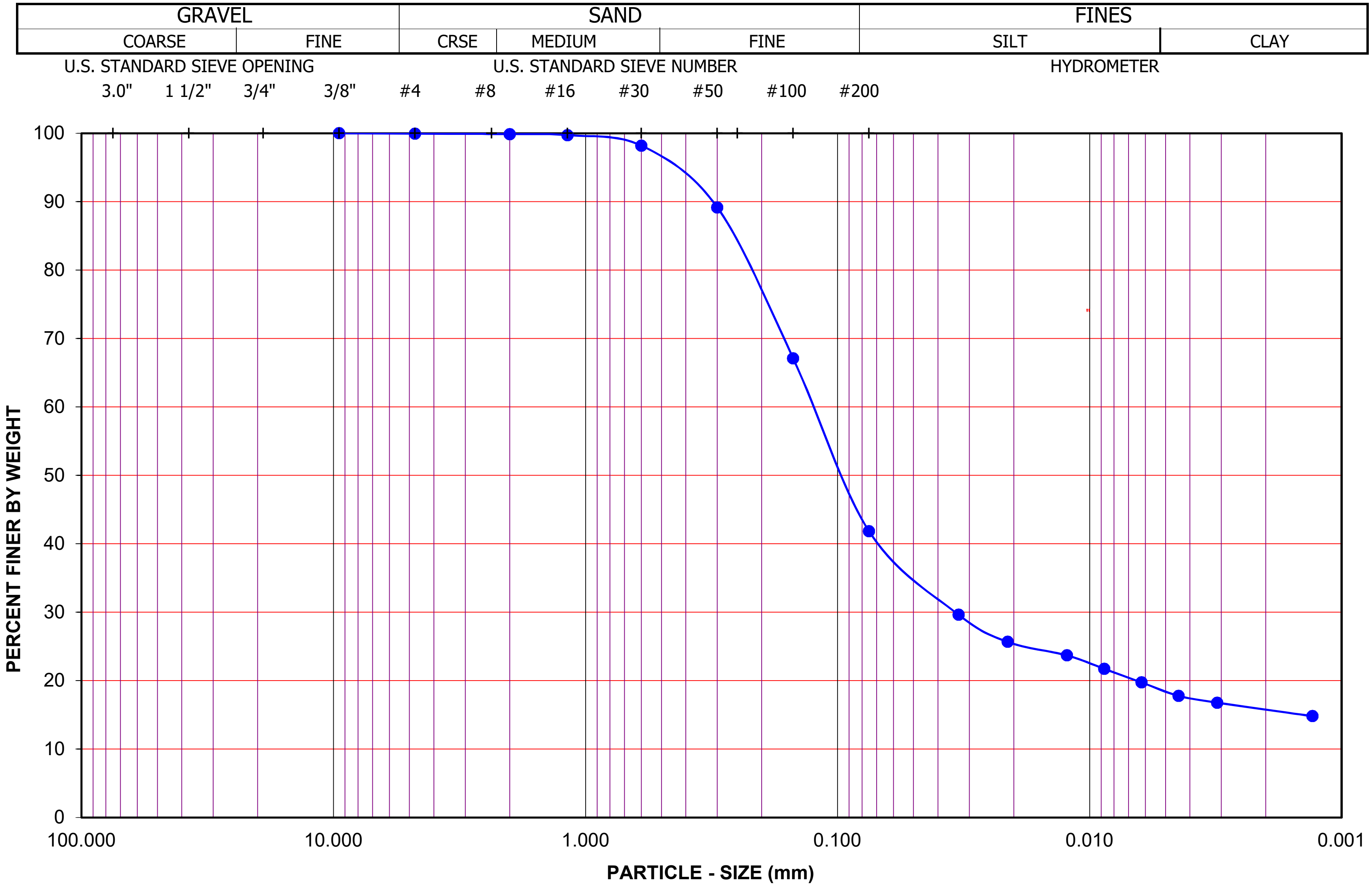
Sieve after Hydrometer & Wet Sieve

U.S. Sieve Size	Cumulative Wt. Of Dry Soil Retained (g)	% Passing	% Total Sample
No. 10	0.00	100.0	99.9
No. 16	0.08	99.8	99.7
No. 30	0.85	98.3	98.2
No. 50	5.38	89.3	89.2
No. 100	16.46	67.2	67.1
No. 200	29.16	41.9	41.8
Pan			

Hydrometer — Wt. of Air-Dry Soil (g): 50.30 — Wt. of Dry Soil (g): 50.17

Deflocculant 125 cc of 4% Solution

Date	Time	Elapsed Time (min)	Water Temperature (°C)	Composite Correction 152H	Actual Hydrometer Readings	% Total Sample (%)	Soil Particle Diameter (mm)
28-Oct-20	9:32	0		7.0			
	9:34	2	22.5	7.0	22.0	29.6	0.0331
	9:37	5	22.4	7.0	20.0	25.7	0.0212
	9:47	15	22.4	7.0	19.0	23.7	0.0123
	10:02	30	22.3	7.0	18.0	21.7	0.0087
	10:32	60	22.2	7.0	17.0	19.7	0.0062
	11:32	120	22.4	7.0	16.0	17.8	0.0044
	13:42	250	21.8	7.0	15.5	16.8	0.0031
29-Oct-20	9:32	1440	21.5	7.0	14.5	14.8	0.0013



Project Name: Brea Boulevard Additional Borings

Project No.: 11585.005

Boring No.: LB-39 Sample No.: S-6

Depth (feet): 25.0 Soil Type : SC

Soil Identification: Yellowish brown clayey sand (SC)

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 422

GR:SA:FI : (%) 0 : 58 : 42

Nov-20

APPENDIX C.2

Compressibility

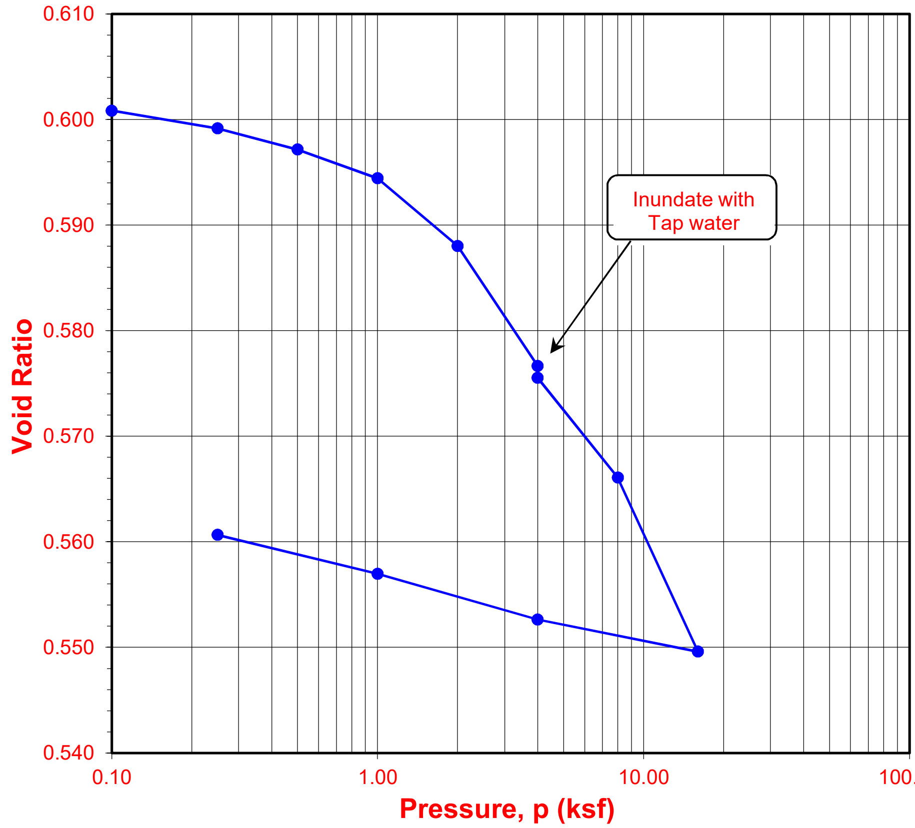
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	G. Bathala	Date:	08/01/18
Project No.:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-7	Depth (ft.):	20.0		
Sample No.:	R-7	Sample Type:	Ring		
Soil Identification:	Olive brown silty sand (SM)				

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	184.72
Weight of Ring (g)	44.55
Height after consol. (in.)	0.9748
Before Test	
Wt.Wet Sample+Cont. (g)	201.24
Wt.of Dry Sample+Cont. (g)	188.33
Weight of Container (g)	67.93
Initial Moisture Content (%)	10.7
Initial Dry Density (pcf)	105.3
Initial Saturation (%)	48
Initial Vertical Reading (in.)	0.3362
After Test	
Wt.of Wet Sample+Cont. (g)	229.82
Wt. of Dry Sample+Cont. (g)	207.33
Weight of Container (g)	39.58
Final Moisture Content (%)	18.25
Final Dry Density (pcf)	105.1
Final Saturation (%)	82
Final Vertical Reading (in.)	0.3080
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

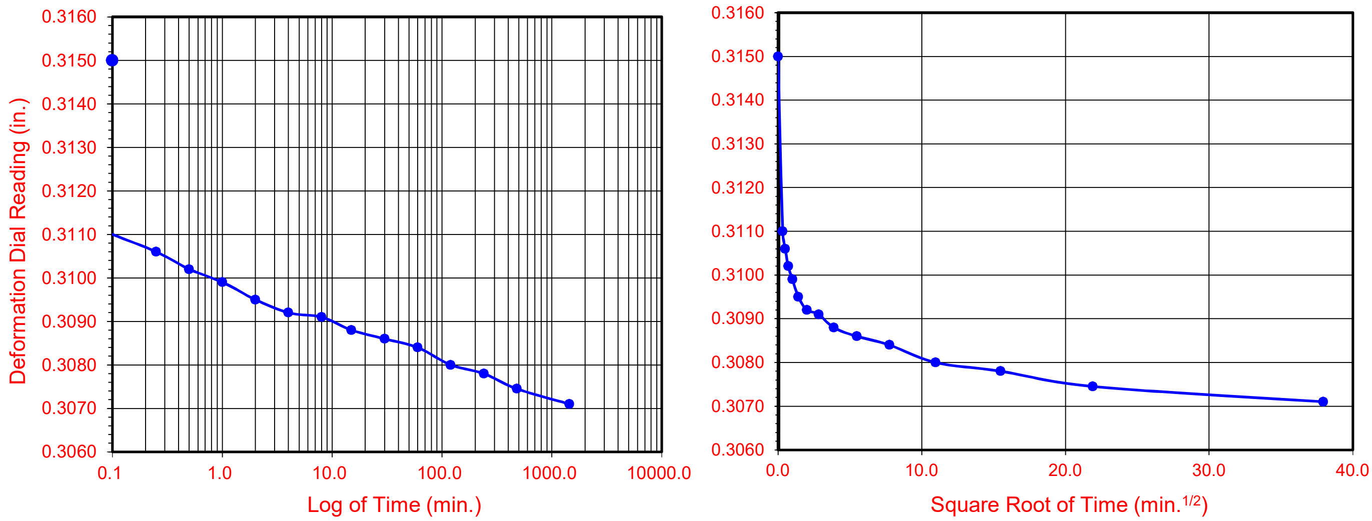


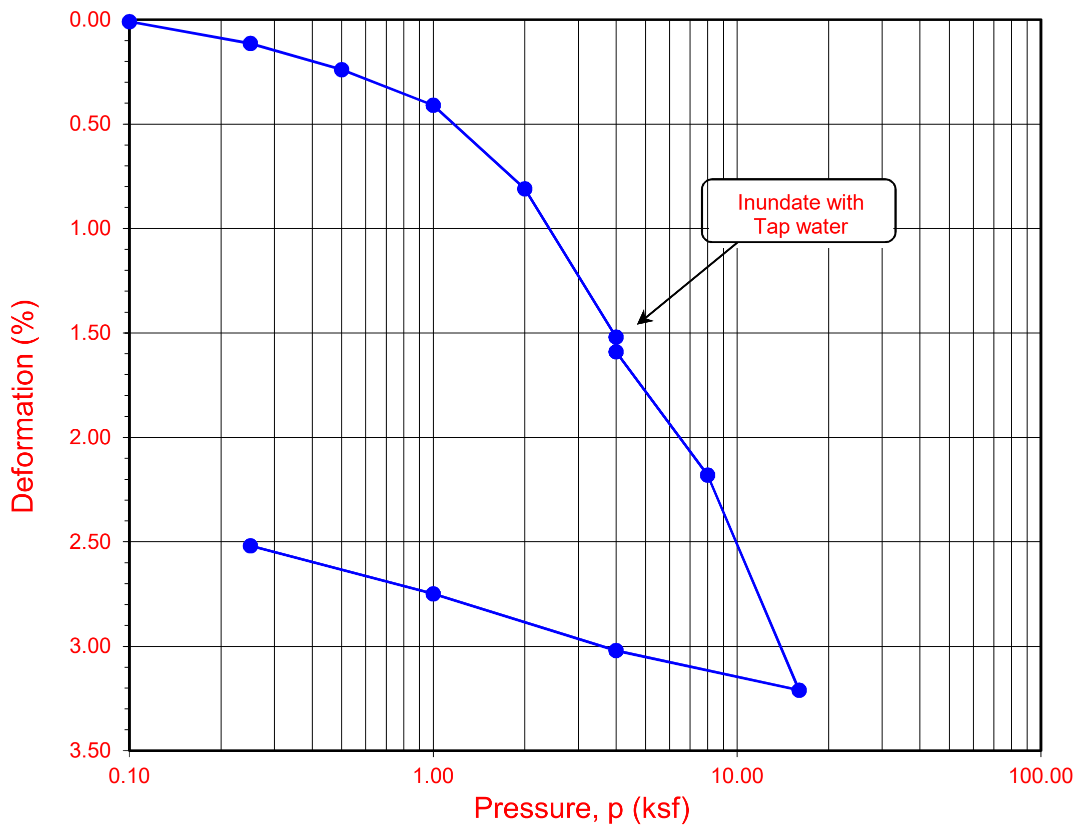
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3361	0.9999	0.00	0.01	0.601	0.01
0.25	0.3348	0.9986	0.03	0.14	0.599	0.11
0.50	0.3326	0.9964	0.12	0.36	0.597	0.24
1.00	0.3297	0.9935	0.24	0.65	0.594	0.41
2.00	0.3244	0.9882	0.37	1.18	0.588	0.81
4.00	0.3157	0.9795	0.53	2.05	0.577	1.52
4.00	0.3150	0.9788	0.53	2.12	0.576	1.59
8.00	0.3071	0.9709	0.73	2.91	0.566	2.18
16.00	0.2949	0.9587	0.92	4.13	0.550	3.21
4.00	0.2991	0.9629	0.69	3.71	0.553	3.02
1.00	0.3040	0.9678	0.47	3.22	0.557	2.75
0.25	0.3080	0.9718	0.30	2.82	0.561	2.52

Time Readings @ 8.0 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
8/6/18	7:55:00	0.0	0.0	0.3150
8/6/18	7:55:06	0.1	0.3	0.3110
8/6/18	7:55:15	0.2	0.5	0.3106
8/6/18	7:55:30	0.5	0.7	0.3102
8/6/18	7:56:00	1.0	1.0	0.3099
8/6/18	7:57:00	2.0	1.4	0.3095
8/6/18	7:59:00	4.0	2.0	0.3092
8/6/18	8:03:00	8.0	2.8	0.3091
8/6/18	8:10:00	15.0	3.9	0.3088
8/6/18	8:25:00	30.0	5.5	0.3086
8/6/18	8:55:00	60.0	7.7	0.3084
8/6/18	9:55:00	120.0	11.0	0.3080
8/6/18	11:55:00	240.0	15.5	0.3078
8/6/18	15:55:00	480.0	21.9	0.3075
8/7/18	7:55:00	1440.0	37.9	0.3071

Time Readings @ 8.0 ksf





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-7	**R-7**	**20.0**	**10.7**	**18.3**	**105.3**	**105.1**	**0.601**	**0.561**	**48**	**82**

Soil Identification: Olive brown silty sand (SM)

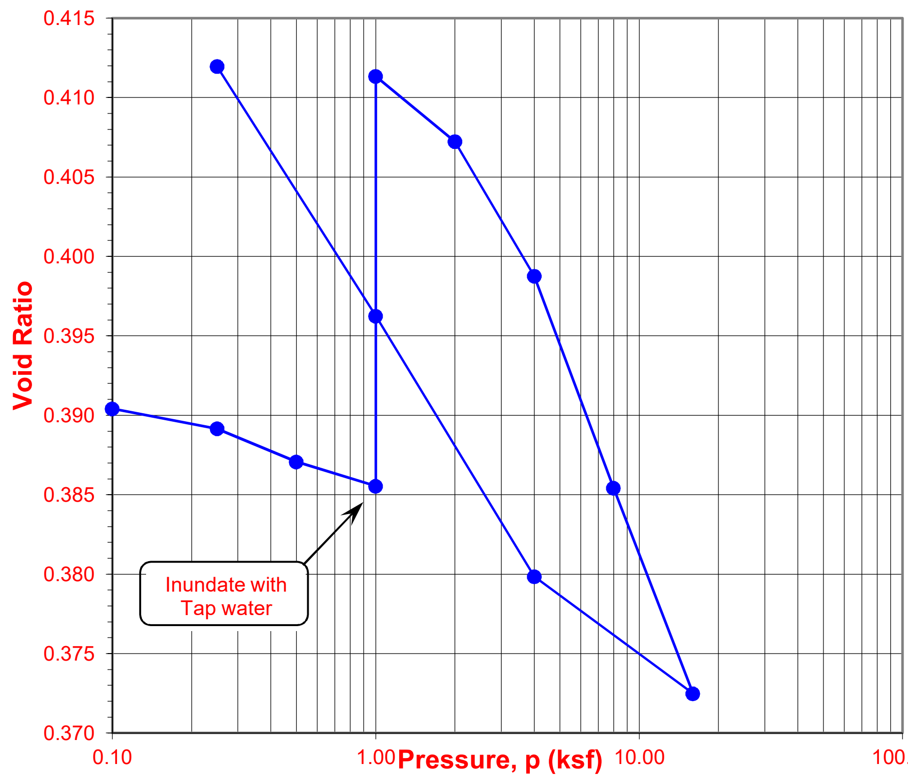
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By: ACS/GB	Date: 01/31/19
Project No.:	11588.001	Checked By: J. Ward	Date: 02/14/19
Boring No.:	LB-14	Depth (ft.): 6-6.5	
Sample No.:	R-1	Sample Type:	Ring
Soil Identification:	Dark yellowish brown sandy lean clay s(CL)		

Sample Diameter (in.):	2.415
Sample Thickness (in.):	1.000
Weight of Sample + ring (g):	203.30
Weight of Ring (g):	42.28
Height after consol. (in.):	1.0155
Before Test	
Wt. of Wet Sample+Cont. (g):	221.30
Wt. of Dry Sample+Cont. (g):	204.12
Weight of Container (g):	39.90
Initial Moisture Content (%)	10.5
Initial Dry Density (pcf)	121.2
Initial Saturation (%):	72
Initial Vertical Reading (in.)	0.2325
After Test	
Wt. of Wet Sample+Cont. (g):	285.43
Wt. of Dry Sample+Cont. (g):	263.74
Weight of Container (g):	75.86
Final Moisture Content (%)	14.90
Final Dry Density (pcf):	119.2
Final Saturation (%):	97
Final Vertical Reading (in.)	0.2178
Specific Gravity (assumed):	2.70
Water Density (pcf):	62.43

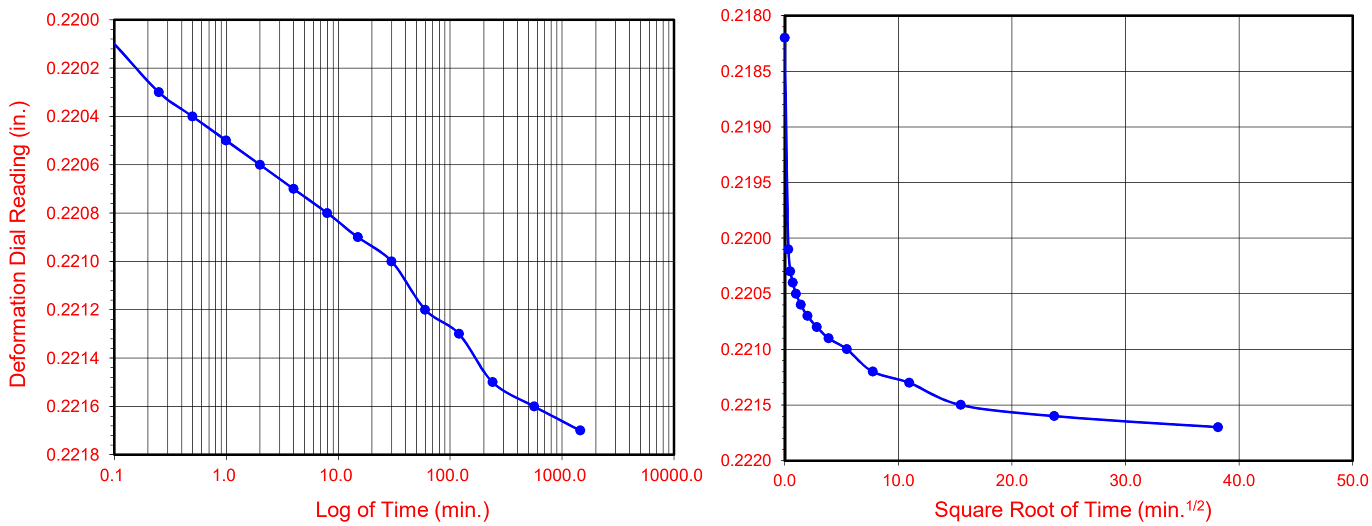


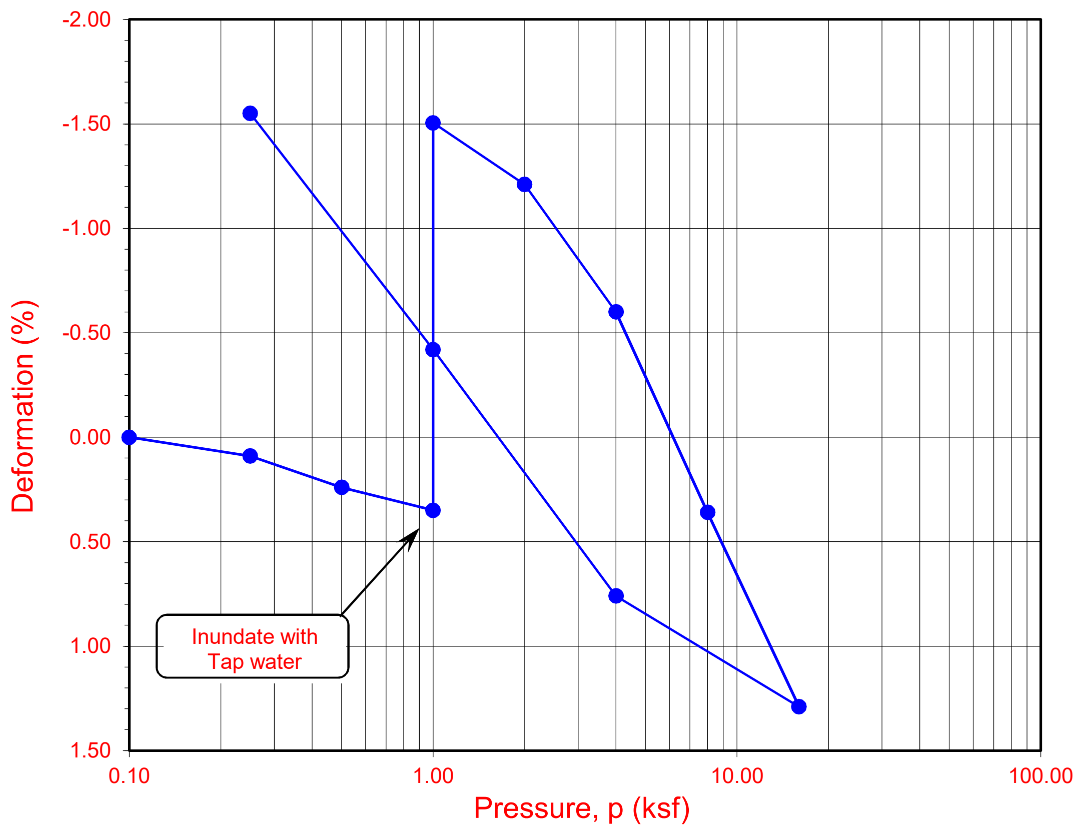
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2325	1.0000	0.00	0.00	0.390	0.00
0.25	0.2335	0.9990	0.01	0.10	0.389	0.09
0.50	0.2354	0.9971	0.05	0.29	0.387	0.24
1.00	0.2368	0.9957	0.08	0.43	0.386	0.35
1.00	0.2183	1.0143	0.08	-1.43	0.411	-1.51
2.00	0.2217	1.0108	0.13	-1.08	0.407	-1.21
4.00	0.2286	1.0039	0.21	-0.39	0.399	-0.60
8.00	0.2394	0.9931	0.33	0.69	0.385	0.36
16.00	0.2506	0.9819	0.52	1.81	0.372	1.29
4.00	0.2426	0.9899	0.25	1.01	0.380	0.76
1.00	0.2297	1.0028	0.14	-0.28	0.396	-0.42
0.25	0.2178	1.0147	0.08	-1.47	0.412	-1.55

Time Readings @ 2.0 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
2/4/19	8:47:00	0.0	0.0	0.2182
2/4/19	8:47:06	0.1	0.3	0.2201
2/4/19	8:47:15	0.2	0.5	0.2203
2/4/19	8:47:30	0.5	0.7	0.2204
2/4/19	8:48:00	1.0	1.0	0.2205
2/4/19	8:49:00	2.0	1.4	0.2206
2/4/19	8:51:00	4.0	2.0	0.2207
2/4/19	8:55:00	8.0	2.8	0.2208
2/4/19	9:02:00	15.0	3.9	0.2209
2/4/19	9:17:00	30.0	5.5	0.2210
2/4/19	9:47:00	60.0	7.7	0.2212
2/4/19	10:47:00	120.0	11.0	0.2213
2/4/19	12:47:00	240.0	15.5	0.2215
2/4/19	18:10:00	563.0	23.7	0.2216
2/5/19	9:02:00	1455.0	38.1	0.2217

Time Readings @ 2.0 ksf





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-14	**R-1**	**6-6.5**	**10.5**	**14.9**	**121.2**	**119.2**	**0.390**	**0.412**	**72**	**97**

Soil Identification: Dark yellowish brown sandy lean clay s(CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19

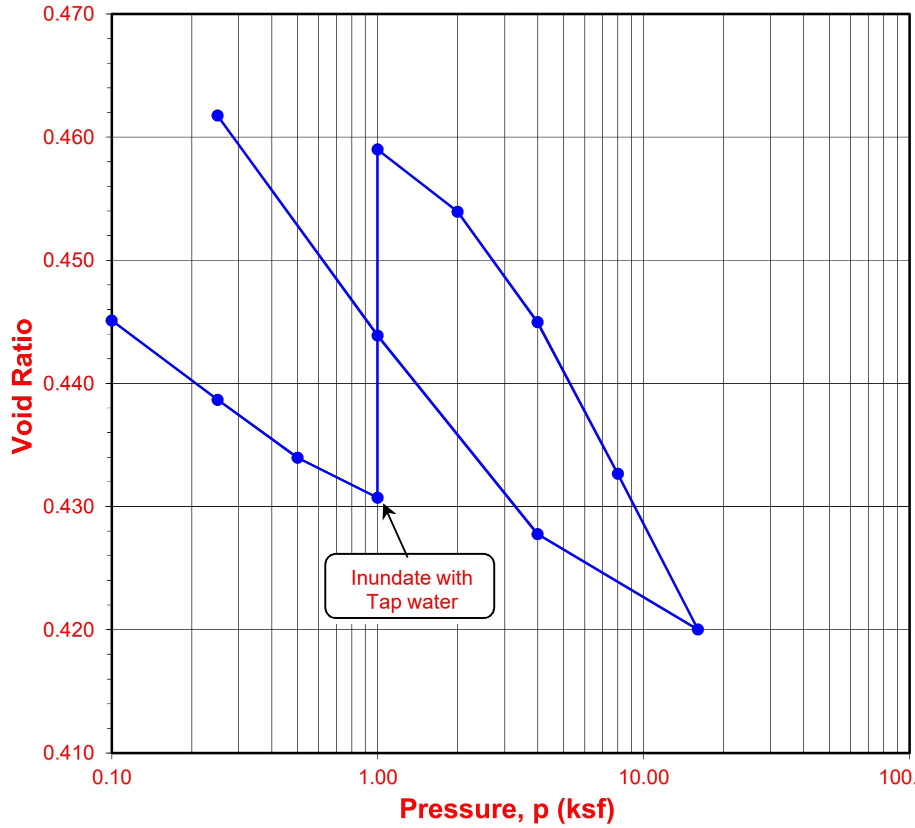
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By: G. Bathala	Date: 10/24/20
Project No.:	11585.005	Checked By: A. Santos	Date: 12/02/20
Boring No.:	LB-28	Depth (ft.): 5.0	
Sample No.:	R-1	Sample Type: Ring	
Soil Identification:	Olive brown lean clay (CL)		

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	195.62
Weight of Ring (g)	37.98
Height after consol. (in.)	1.0109
Before Test	
Wt.Wet Sample+Cont. (g)	183.31
Wt.of Dry Sample+Cont. (g)	169.33
Weight of Container (g)	57.18
Initial Moisture Content (%)	12.5
Initial Dry Density (pcf)	116.6
Initial Saturation (%)	75
Initial Vertical Reading (in.)	0.2718
After Test	
Wt.of Wet Sample+Cont. (g)	255.83
Wt. of Dry Sample+Cont. (g)	233.78
Weight of Container (g)	53.69
Final Moisture Content (%)	15.52
Final Dry Density (pcf)	116.9
Final Saturation (%)	95
Final Vertical Reading (in.)	0.2790
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

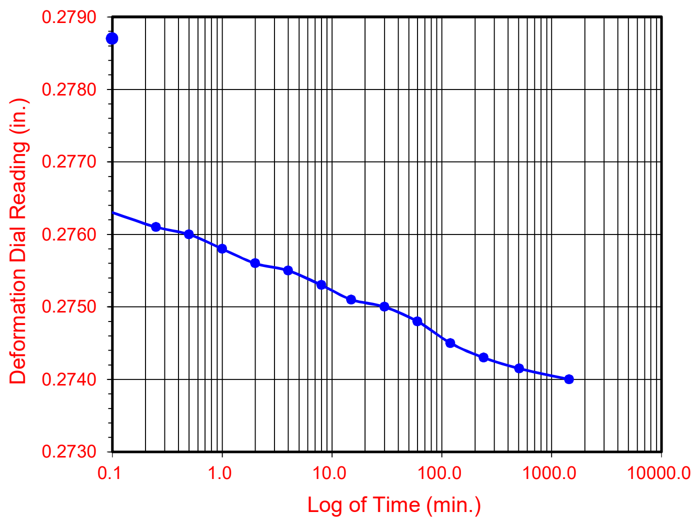


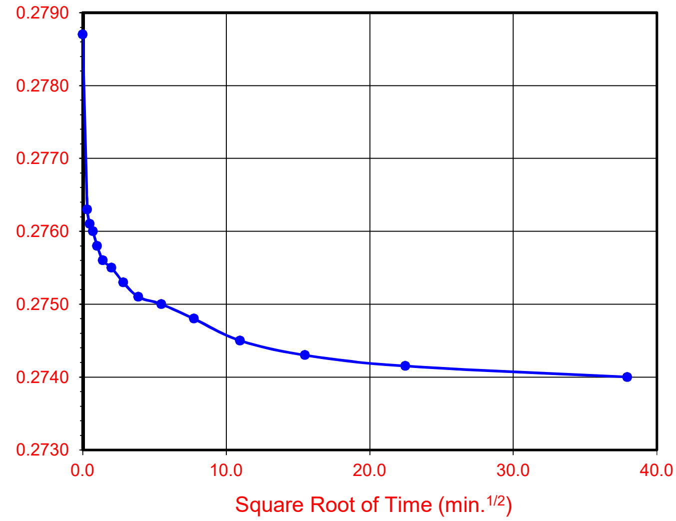
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2712	0.9994	0.00	0.06	0.445	0.06
0.25	0.2661	0.9943	0.07	0.57	0.439	0.50
0.50	0.2622	0.9904	0.13	0.96	0.434	0.83
1.00	0.2592	0.9874	0.21	1.27	0.431	1.06
1.00	0.2787	1.0069	0.21	-0.69	0.459	-0.90
2.00	0.2740	1.0022	0.33	-0.22	0.454	-0.55
4.00	0.2665	0.9947	0.46	0.53	0.445	0.07
8.00	0.2562	0.9844	0.64	1.56	0.433	0.92
16.00	0.2453	0.9735	0.86	2.66	0.420	1.80
4.00	0.2524	0.9806	0.68	1.94	0.428	1.26
1.00	0.2654	0.9936	0.50	0.65	0.444	0.15
0.25	0.2790	1.0072	0.37	-0.72	0.462	-1.09

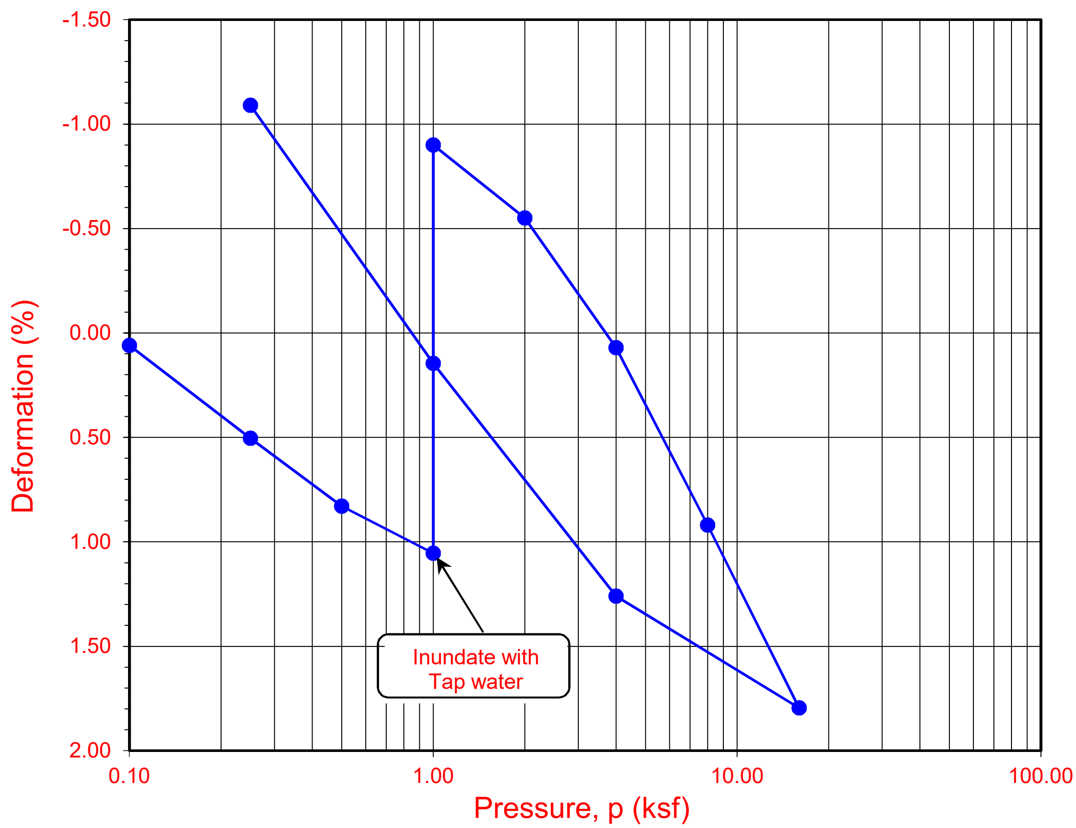
Time Readings @ 2 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:30:00	0.0	0.0	0.2787
10/26/20	8:30:06	0.1	0.3	0.2763
10/26/20	8:30:15	0.2	0.5	0.2761
10/26/20	8:30:30	0.5	0.7	0.2760
10/26/20	8:31:00	1.0	1.0	0.2758
10/26/20	8:32:00	2.0	1.4	0.2756
10/26/20	8:34:00	4.0	2.0	0.2755
10/26/20	8:38:00	8.0	2.8	0.2753
10/26/20	8:45:00	15.0	3.9	0.2751
10/26/20	9:00:00	30.0	5.5	0.2750
10/26/20	9:30:00	60.0	7.7	0.2748
10/26/20	10:30:00	120.0	11.0	0.2745
10/26/20	12:30:00	240.0	15.5	0.2743
10/26/20	16:55:00	505.0	22.5	0.2742
10/27/20	8:30:00	1440.0	37.9	0.2740

Time Readings @ 2 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-28	**R-1**	**5.0**	**12.5**	**15.5**	**116.6**	**116.9**	**0.446**	**0.462**	**75**	**95**

Soil Identification: Olive brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

Leighton

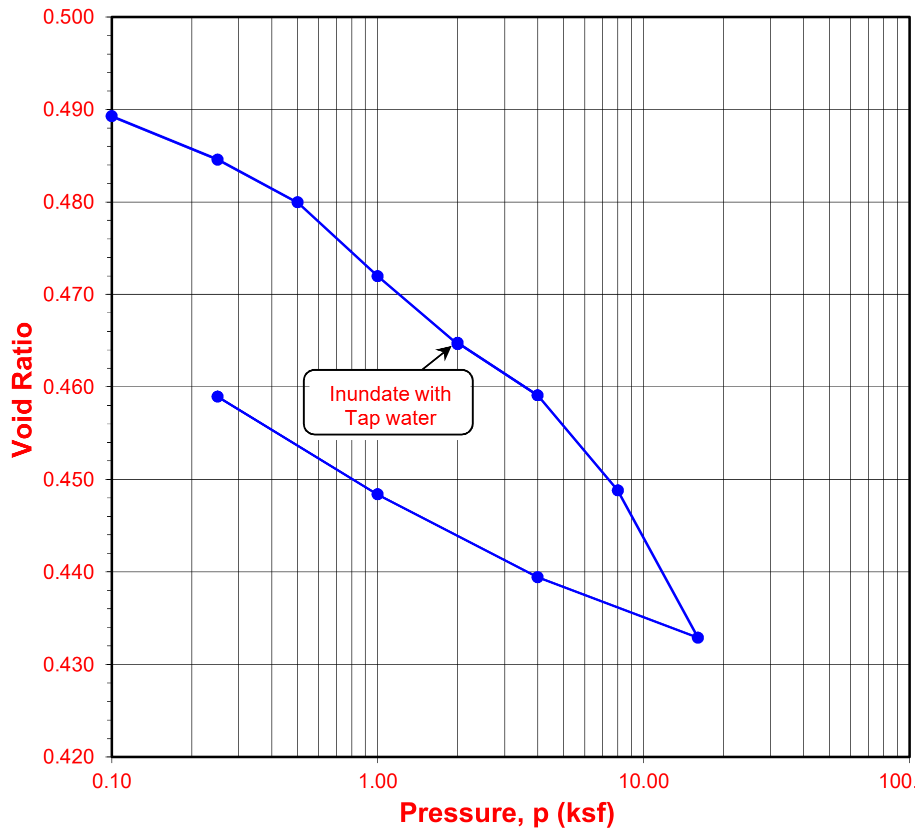
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Project Name: Brea Boulevard Additional Borings
Project No.: 11585.005
Boring No.: LB-29
Sample No.: R-1
Soil Identification: Yellowish brown lean clay (CL)

Tested By: G. Bathala Date: 10/23/20
Checked By: A. Santos Date: 12/02/20
Depth (ft.): 5.0
Sample Type: Ring

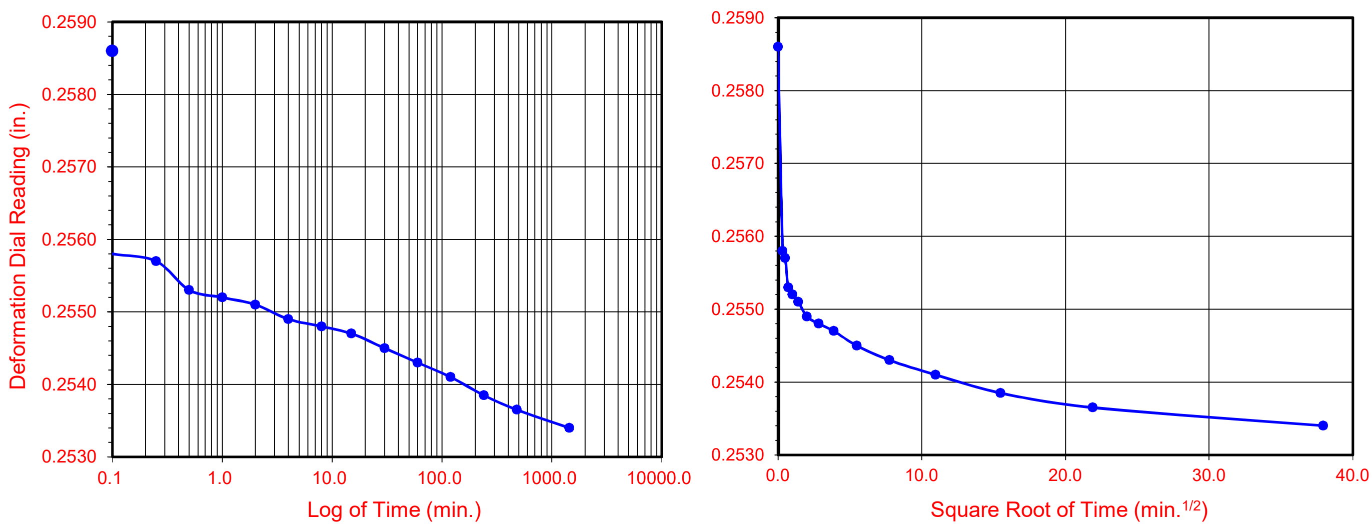
Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	196.25
Weight of Ring (g)	37.87
Height after consol. (in.)	0.9796
Before Test	
Wt.Wet Sample+Cont. (g)	215.56
Wt.of Dry Sample+Cont. (g)	195.55
Weight of Container (g)	73.40
Initial Moisture Content (%)	16.4
Initial Dry Density (pcf)	113.2
Initial Saturation (%)	90
Initial Vertical Reading (in.)	0.2782
After Test	
Wt.of Wet Sample+Cont. (g)	262.24
Wt. of Dry Sample+Cont. (g)	242.58
Weight of Container (g)	64.91
Final Moisture Content (%)	14.06
Final Dry Density (pcf)	118.7
Final Saturation (%)	90
Final Vertical Reading (in.)	0.2543
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

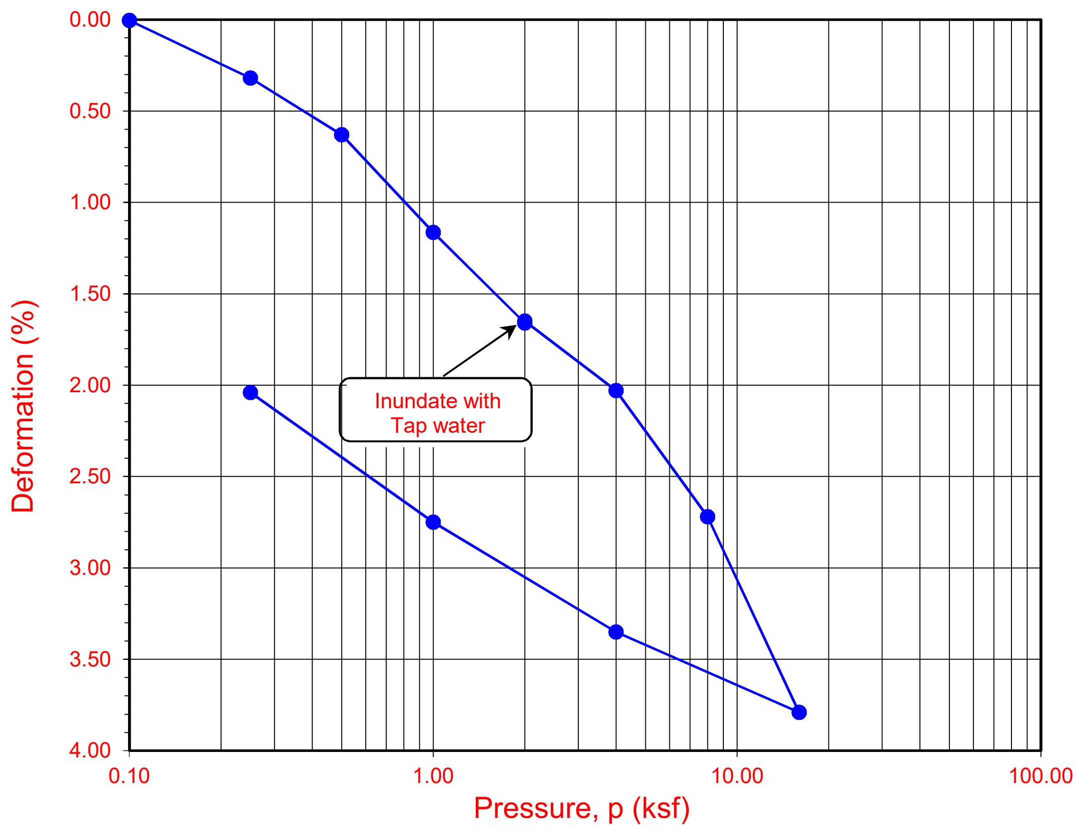


Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2782	1.0000	0.00	0.00	0.489	0.00
0.25	0.2745	0.9963	0.05	0.37	0.485	0.32
0.50	0.2708	0.9926	0.11	0.74	0.480	0.63
1.00	0.2646	0.9864	0.20	1.36	0.472	1.16
2.00	0.2585	0.9803	0.31	1.97	0.465	1.66
2.00	0.2586	0.9804	0.31	1.96	0.465	1.65
4.00	0.2534	0.9752	0.45	2.48	0.459	2.03
8.00	0.2449	0.9667	0.61	3.33	0.449	2.72
16.00	0.2322	0.9540	0.81	4.60	0.433	3.79
4.00	0.2380	0.9598	0.67	4.02	0.439	3.35
1.00	0.2458	0.9676	0.49	3.24	0.448	2.75
0.25	0.2543	0.9761	0.35	2.39	0.459	2.04

Time Readings @ 4 ksf				
Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:20:00	0.0	0.0	0.2586
10/26/20	8:20:06	0.1	0.3	0.2558
10/26/20	8:20:15	0.2	0.5	0.2557
10/26/20	8:20:30	0.5	0.7	0.2553
10/26/20	8:21:00	1.0	1.0	0.2552
10/26/20	8:22:00	2.0	1.4	0.2551
10/26/20	8:24:00	4.0	2.0	0.2549
10/26/20	8:28:00	8.0	2.8	0.2548
10/26/20	8:35:00	15.0	3.9	0.2547
10/26/20	8:50:00	30.0	5.5	0.2545
10/26/20	9:20:00	60.0	7.7	0.2543
10/26/20	10:20:00	120.0	11.0	0.2541
10/26/20	12:20:00	240.0	15.5	0.2539
10/26/20	16:20:00	480.0	21.9	0.2537
10/27/20	8:20:00	1440.0	37.9	0.2534

Time Readings @ 4 ksf





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-29	**R-1**	**5.0**	**16.4**	**14.1**	**113.2**	**118.7**	**0.489**	**0.459**	**90**	**90**

Soil Identification: Yellowish brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

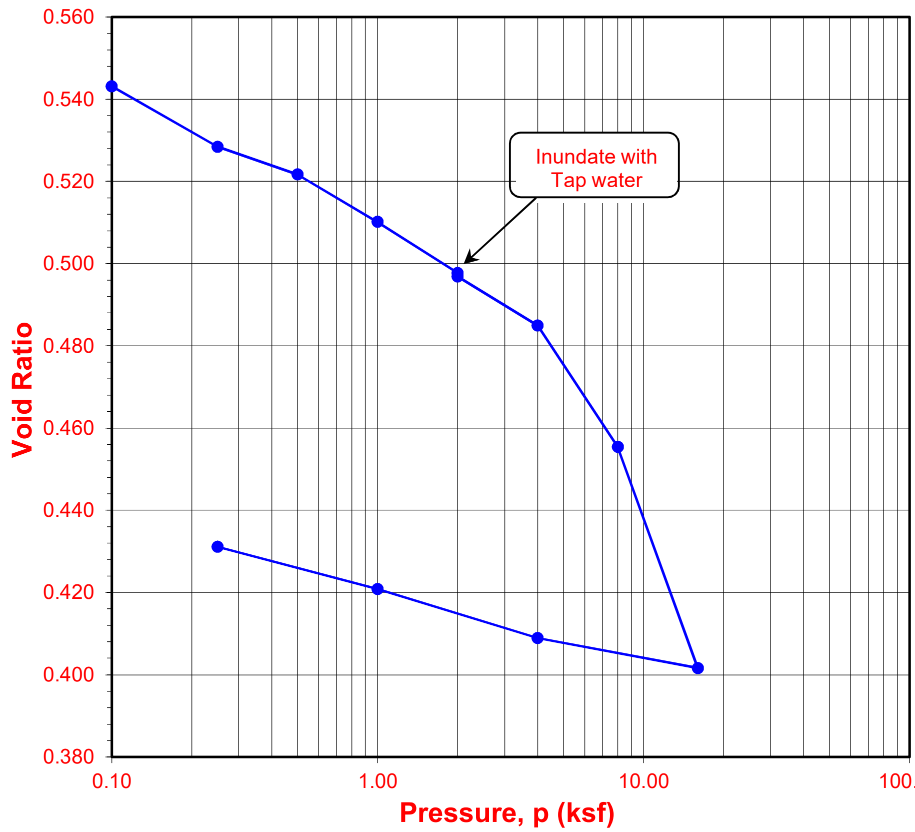
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	10/23/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-29	Depth (ft.):	12.5		
Sample No.:	R-4A	Sample Type:	Ring		
Soil Identification:	Grayish brown lean clay (CL)				

Sample Diameter (in.)	2.415
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	203.42
Weight of Ring (g)	45.89
Height after consol. (in.)	0.9256
Before Test	
Wt.Wet Sample+Cont. (g)	179.05
Wt.of Dry Sample+Cont. (g)	158.92
Weight of Container (g)	59.15
Initial Moisture Content (%)	20.2
Initial Dry Density (pcf)	109.0
Initial Saturation (%)	100
Initial Vertical Reading (in.)	0.3278
After Test	
Wt.of Wet Sample+Cont. (g)	237.66
Wt. of Dry Sample+Cont. (g)	215.16
Weight of Container (g)	38.57
Final Moisture Content (%)	17.21
Final Dry Density (pcf)	117.4
Final Saturation (%)	107
Final Vertical Reading (in.)	0.2501
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

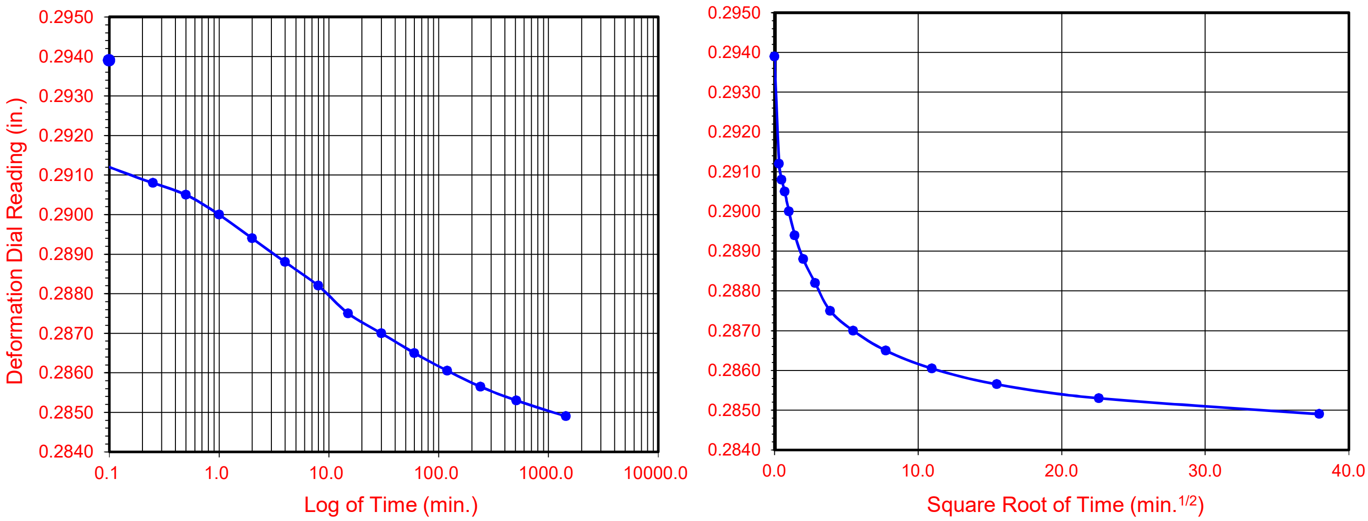


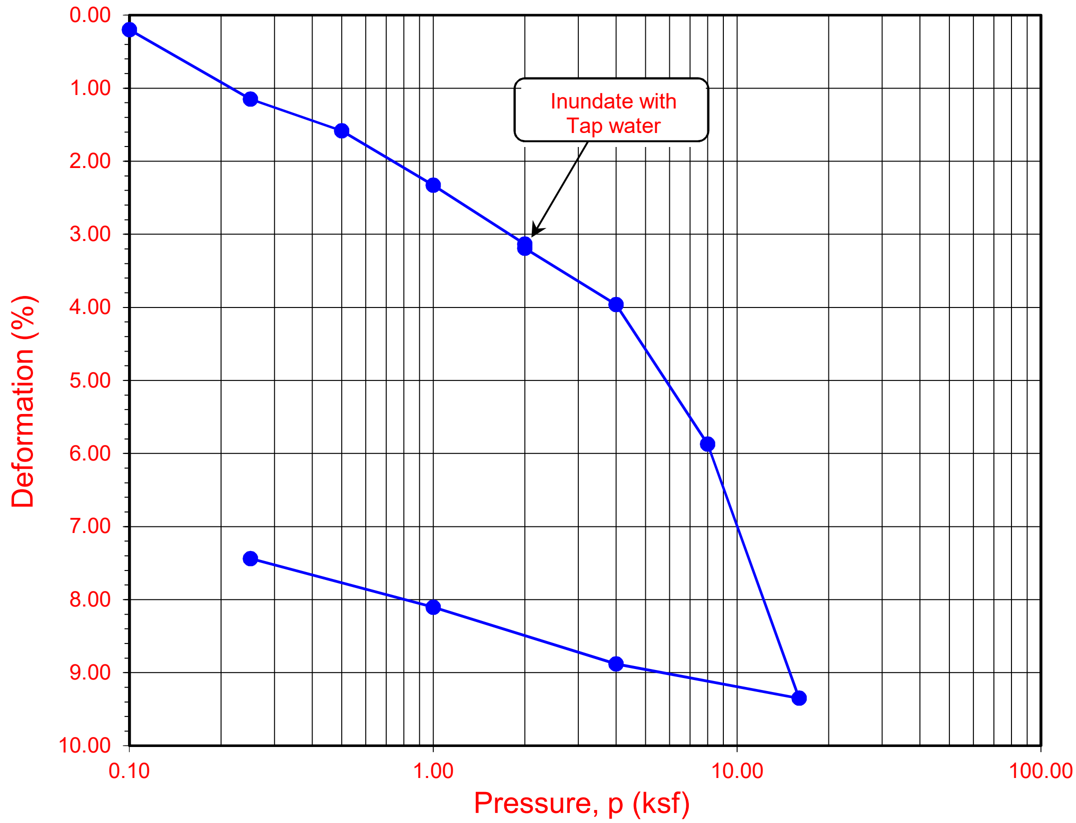
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.3258	0.9980	0.00	0.20	0.543	0.20
0.25	0.3160	0.9882	0.03	1.18	0.528	1.15
0.50	0.3114	0.9836	0.06	1.65	0.522	1.59
1.00	0.3034	0.9756	0.11	2.44	0.510	2.33
2.00	0.2945	0.9667	0.20	3.34	0.498	3.14
2.00	0.2939	0.9661	0.20	3.39	0.497	3.19
4.00	0.2849	0.9571	0.33	4.29	0.485	3.96
8.00	0.2643	0.9365	0.48	6.35	0.455	5.87
16.00	0.2276	0.8998	0.67	10.02	0.402	9.35
4.00	0.2340	0.9062	0.50	9.38	0.409	8.88
1.00	0.2429	0.9151	0.39	8.50	0.421	8.11
0.25	0.2501	0.9223	0.33	7.77	0.431	7.44

Time Readings @ 4 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
10/26/20	8:25:00	0.0	0.0	0.2939
10/26/20	8:25:06	0.1	0.3	0.2912
10/26/20	8:25:15	0.2	0.5	0.2908
10/26/20	8:25:30	0.5	0.7	0.2905
10/26/20	8:26:00	1.0	1.0	0.2900
10/26/20	8:27:00	2.0	1.4	0.2894
10/26/20	8:29:00	4.0	2.0	0.2888
10/26/20	8:33:00	8.0	2.8	0.2882
10/26/20	8:40:00	15.0	3.9	0.2875
10/26/20	8:55:00	30.0	5.5	0.2870
10/26/20	9:25:00	60.0	7.7	0.2865
10/26/20	10:25:00	120.0	11.0	0.2861
10/26/20	12:25:00	240.0	15.5	0.2857
10/26/20	16:55:00	510.0	22.6	0.2853
10/27/20	8:25:00	1440.0	37.9	0.2849

Time Readings @ 4 ksf





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
LB-29	**R-4A**	**12.5**	**20.2**	**17.2**	**109.0**	**117.4**	**0.546**	**0.431**	**100**	**107**

Soil Identification: Grayish brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 11585.005

Brea Boulevard Additional Borings

12-20

ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	CWE P-1	Sample Type:	Ring		
Sample No.:	R-4	Depth (ft.)	12.5		
Sample Description:	Light olive brown silty sand (SM)				

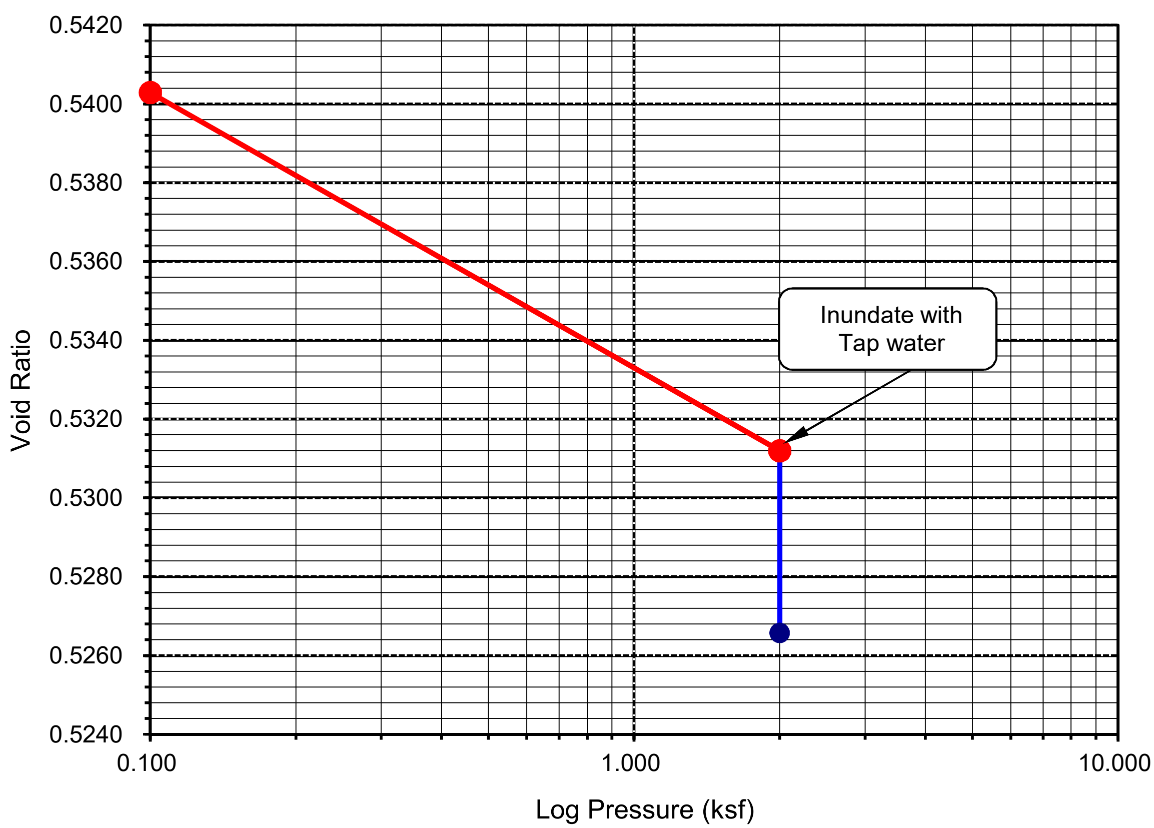
Initial Dry Density (pcf):	109.4
Initial Moisture (%):	3.85
Initial Length (in.):	1.0000
Initial Dial Reading:	0.3326
Diameter(in):	2.415

Final Dry Density (pcf):	110.4
Final Moisture (%) :	17.1
Initial Void Ratio:	0.5407
Specific Gravity(assumed):	2.70
Initial Saturation (%)	19.2

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.3323	0.9997	0.00	-0.03	0.5403	-0.03
2.000	0.3244	0.9918	0.20	-0.82	0.5312	-0.62
H2O	0.3214	0.9888	0.20	-1.12	0.5266	-0.92

Percent Swell (+) / Settlement (-) After Inundation = -0.30

Void Ratio - Log Pressure Curve



ONE-DIMENSIONAL SWELL OR SETTLEMENT POTENTIAL OF COHESIVE SOILS
ASTM D 4546

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	G. Bathala	Date:	11/02/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	CWE P-2	Sample Type:	Ring		
Sample No.:	R-3	Depth (ft.)	10.0		
Sample Description:	Olive brown silty, clayey sand (SC-SM)				

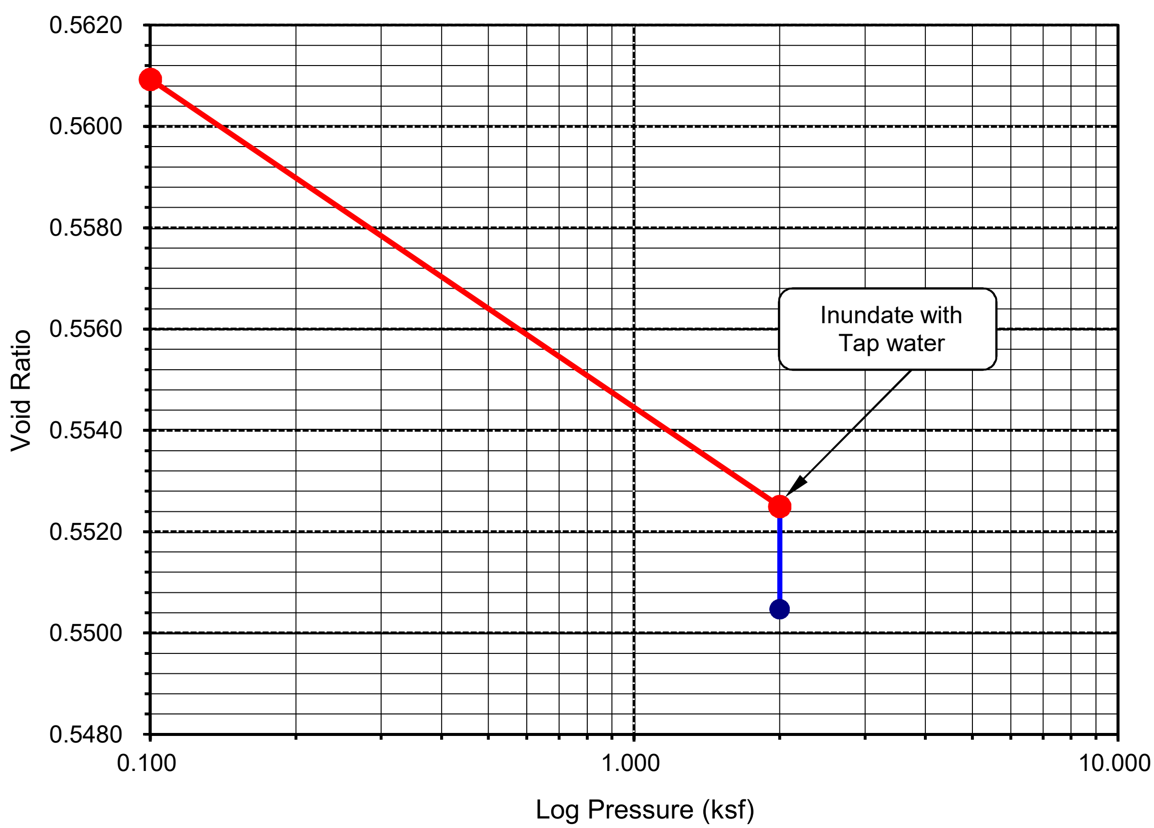
Initial Dry Density (pcf):	108.0
Initial Moisture (%):	9.40
Initial Length (in.):	1.0000
Initial Dial Reading:	0.2369
Diameter(in):	2.415

Final Dry Density (pcf):	108.7
Final Moisture (%) :	17.3
Initial Void Ratio:	0.5614
Specific Gravity(assumed):	2.70
Initial Saturation (%)	45.2

Pressure (p) (ksf)	Final Reading (in)	Apparent Thickness (in)	Load Compliance (%)	Swell (+) Settlement (-) % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.100	0.2366	0.9997	0.00	-0.03	0.5609	-0.03
2.000	0.2279	0.9910	0.33	-0.90	0.5525	-0.57
H2O	0.2266	0.9897	0.33	-1.03	0.5505	-0.70

Percent Swell (+) / Settlement (-) After Inundation = -0.13

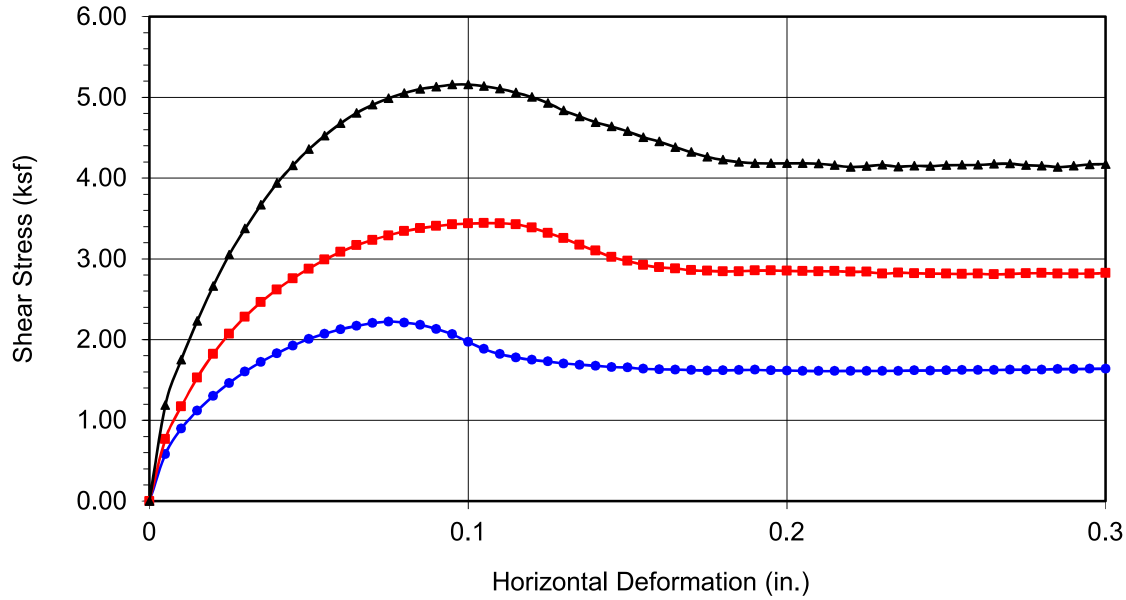
Void Ratio - Log Pressure Curve

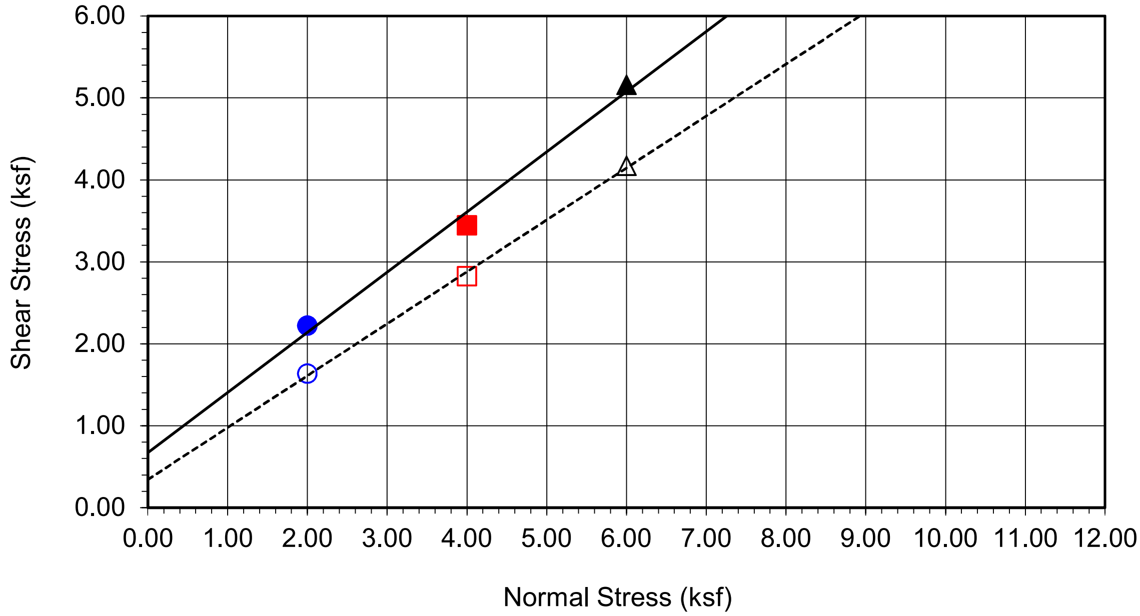


APPENDIX C.3

Shear Strength:

Direct Shear Tests





Boring No.	**LB-4**
Sample No.	**R-7**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Yellowish brown clayey sand (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	672	36
Ultimate	344	32

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.223	■ 3.442	▲ 5.159
Shear Stress @ End of Test (ksf)	○ 1.638	□ 2.823	△ 4.172
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.97	14.97	14.97
Dry Density (pcf)	112.4	113.8	114.4
Saturation (%)	80.9	84.1	85.3
Soil Height Before Shearing (in.)	0.9838	0.9684	0.9709
Final Moisture Content (%)	16.4	16.0	15.0

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

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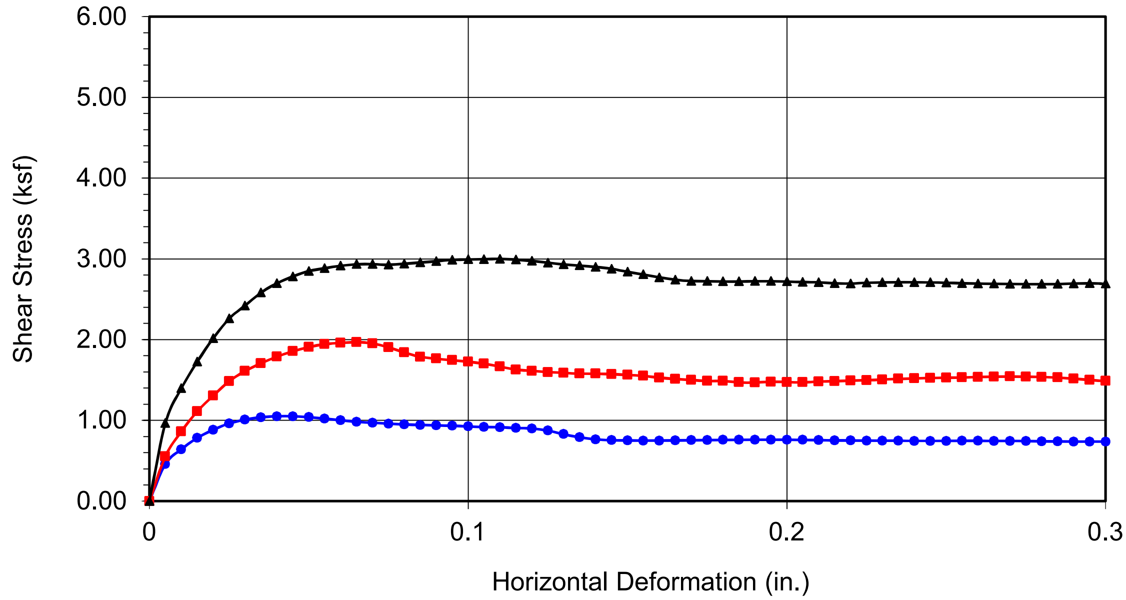

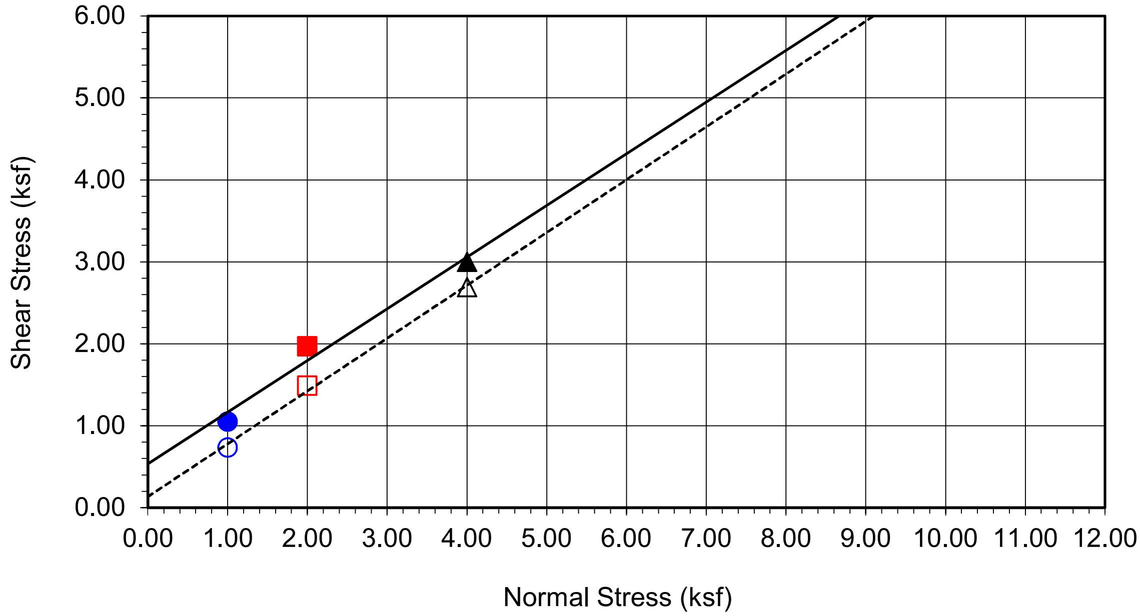

Boring No.	**LB-5**
Sample No.	**R-2**
Depth (ft)	**5**
Sample Type:	Ring

Soil Identification:
Dark brown silty clay (CL-ML)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	535	32
Ultimate	134	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.050	■ 1.968	▲ 2.999
Shear Stress @ End of Test (ksf)	○ 0.736	□ 1.487	△ 2.691
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.86	20.86	20.86
Dry Density (pcf)	103.1	104.1	104.1
Saturation (%)	88.6	90.9	91.0
Soil Height Before Shearing (in.)	0.9920	0.9803	0.9768
Final Moisture Content (%)	21.6	20.9	21.2

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DIRECT SHEAR TEST RESULTS
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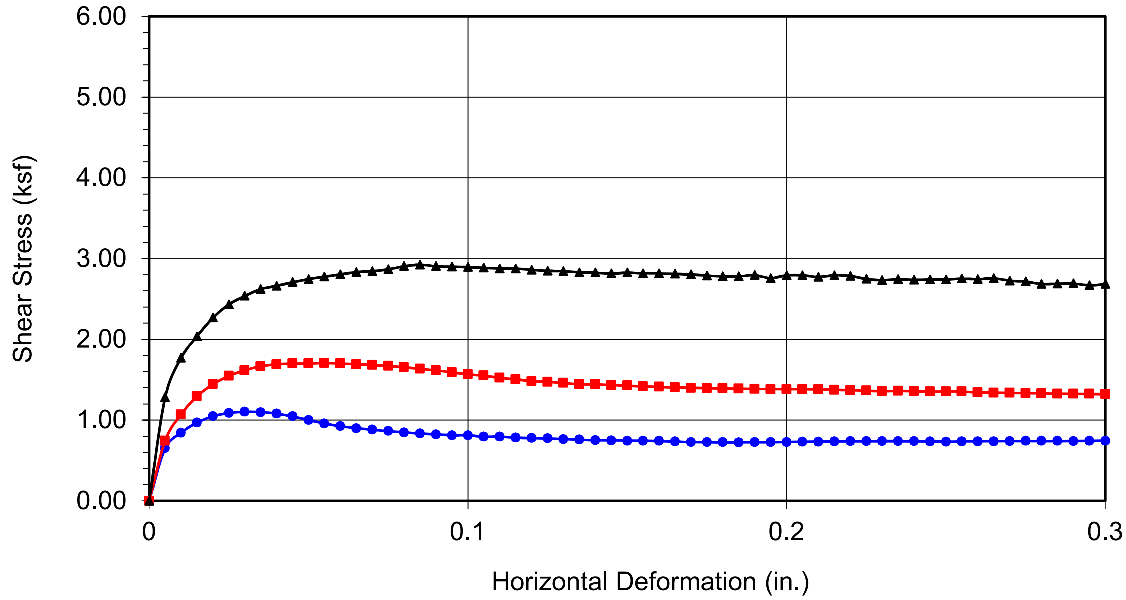

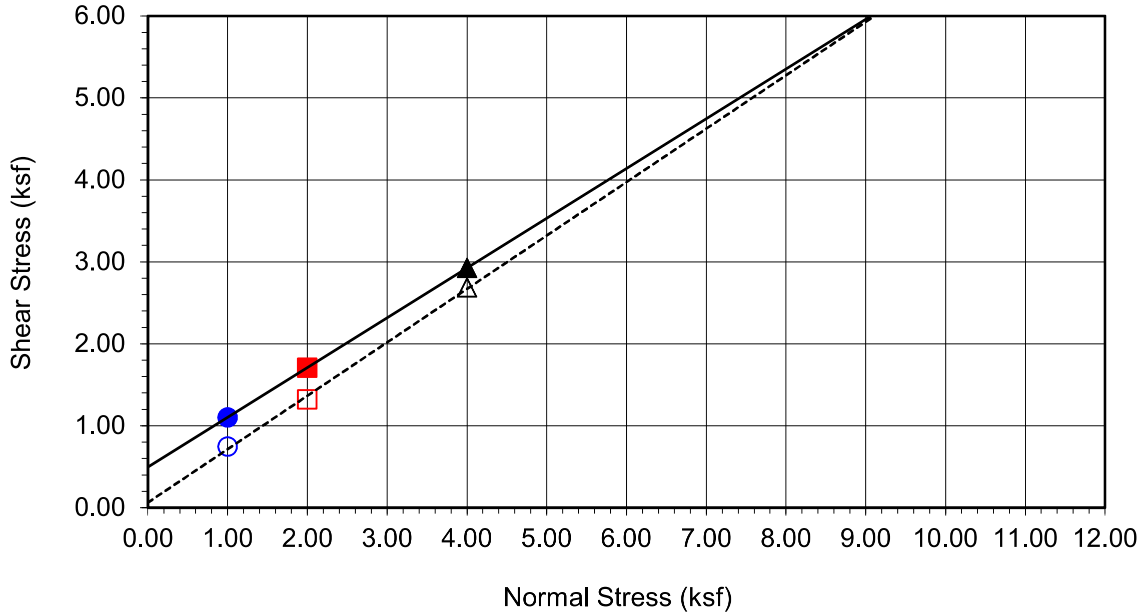

Boring No.	**LB-6**
Sample No.	**R-4**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:
Yellowish brown silty clay with gravel (CL-ML)g

Strength Parameters

	C (psf)	ϕ (°)
Peak	495	31
Ultimate	62	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.103	■ 1.707	▲ 2.924
Shear Stress @ End of Test (ksf)	○ 0.745	□ 1.320	△ 2.685
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.73	13.73	13.73
Dry Density (pcf)	111.8	111.8	114.0
Saturation (%)	72.9	73.1	77.4
Soil Height Before Shearing (in.)	1.0018	0.9851	0.9752
Final Moisture Content (%)	17.3	16.7	17.2

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

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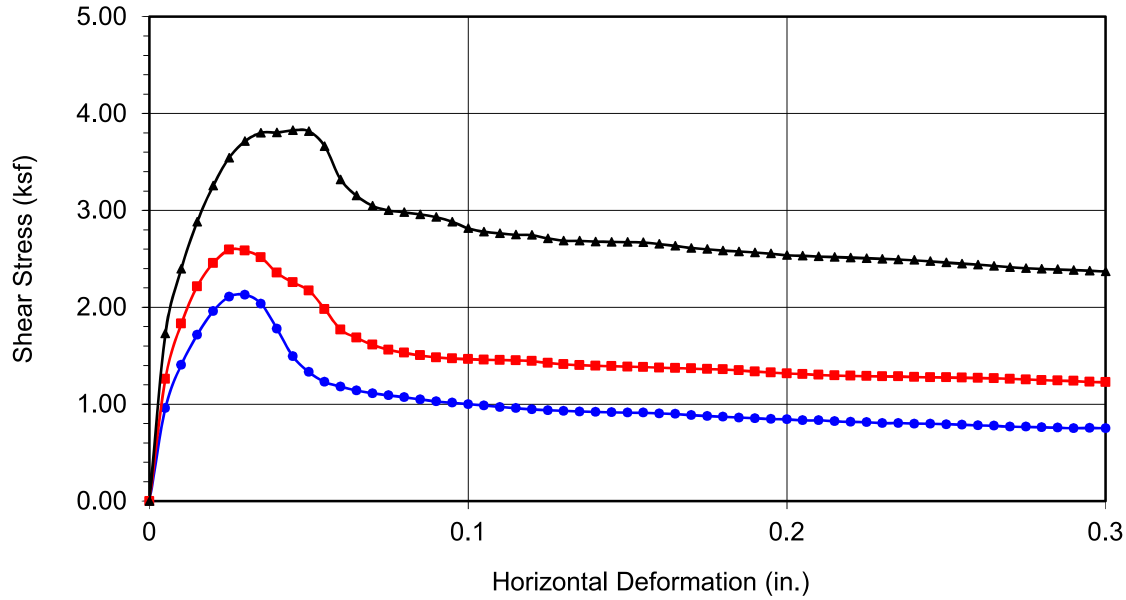
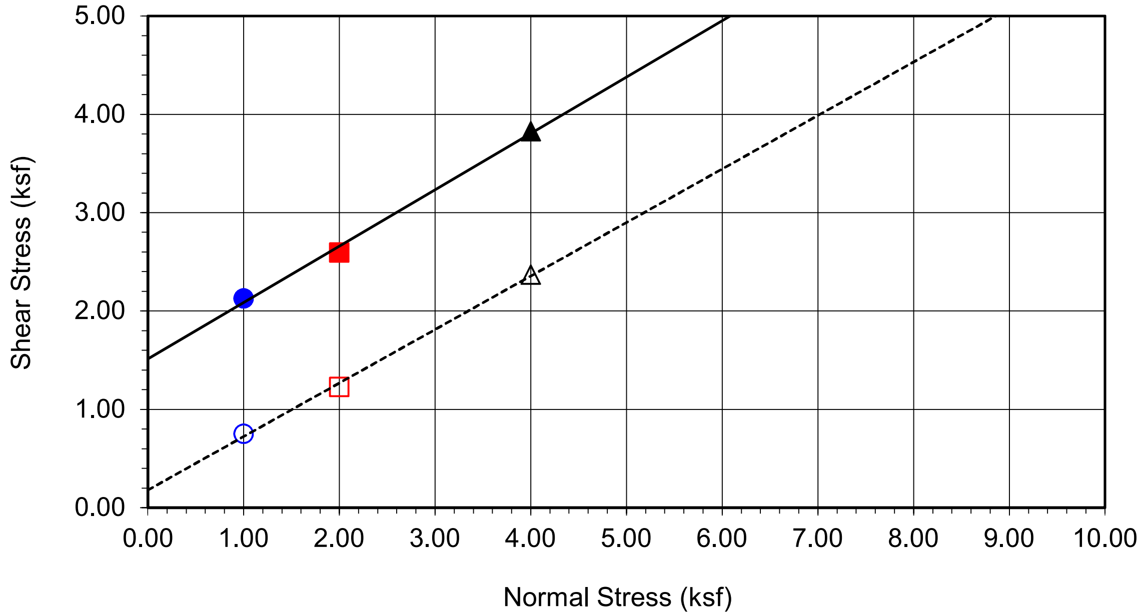
DS LB-6, R-4 @ 10





Boring No.	**LBA-1**
Sample No.	**R-2**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:
Olive gray silty clay'stone' (CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1512	30
Ultimate	179	29

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.128	■ 2.594	▲ 3.826
Shear Stress @ End of Test (ksf)	○ 0.751	□ 1.226	△ 2.370
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.57	16.57	16.57
Dry Density (pcf)	110.4	111.2	111.3
Saturation (%)	85.0	86.6	87.0
Soil Height Before Shearing (in.)	1.0041	1.0002	0.9941
Final Moisture Content (%)	21.7	21.2	21.2

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

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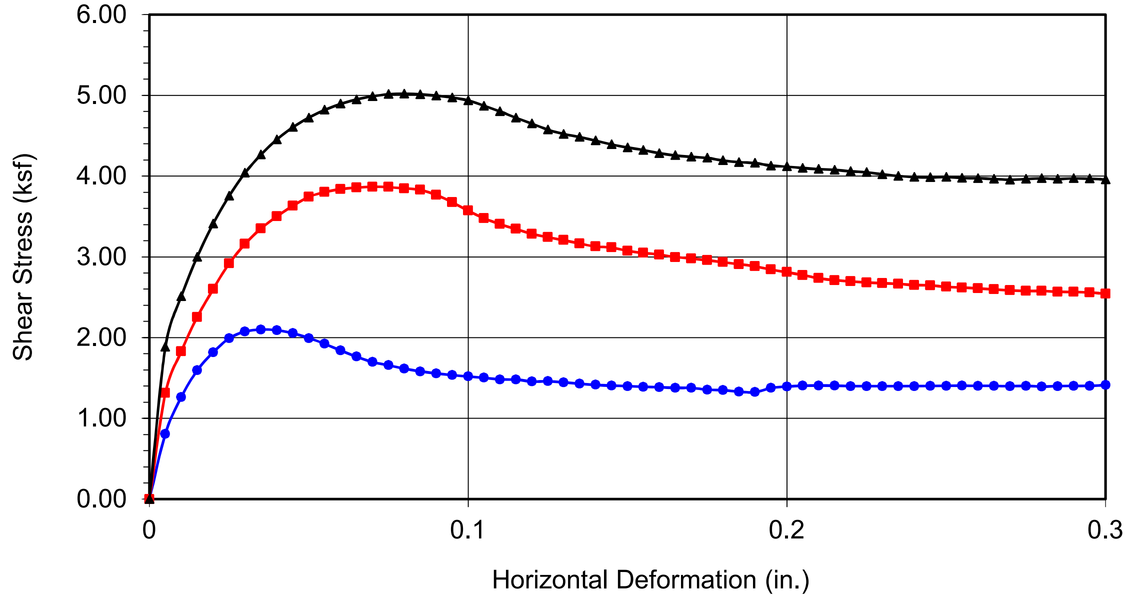

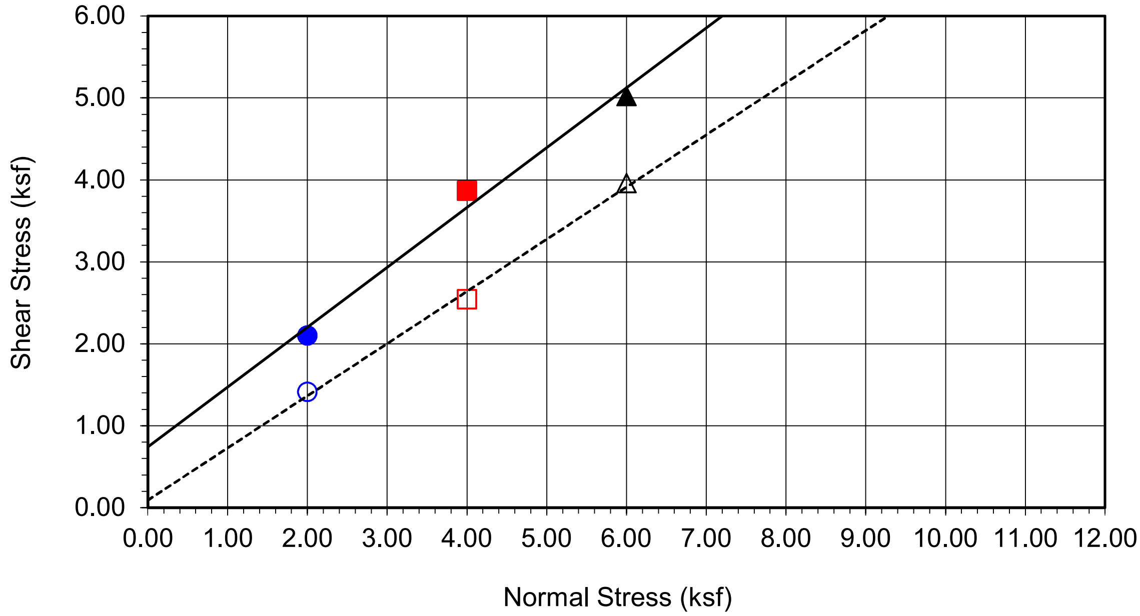

Boring No.	**LBA-2**
Sample No.	**R-4**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Light olive brown sandy silty clay'stone' s(CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	742	36
Ultimate	92	32

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.100	■ 3.867	▲ 5.021
Shear Stress @ End of Test (ksf)	○ 1.412	□ 2.543	△ 3.958
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.23	14.23	14.23
Dry Density (pcf)	104.4	105.4	106.9
Saturation (%)	62.4	64.0	66.7
Soil Height Before Shearing (in.)	0.9943	0.9879	0.9831
Final Moisture Content (%)	20.4	21.7	19.4

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

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Brea Boulevard Corridor Improvements

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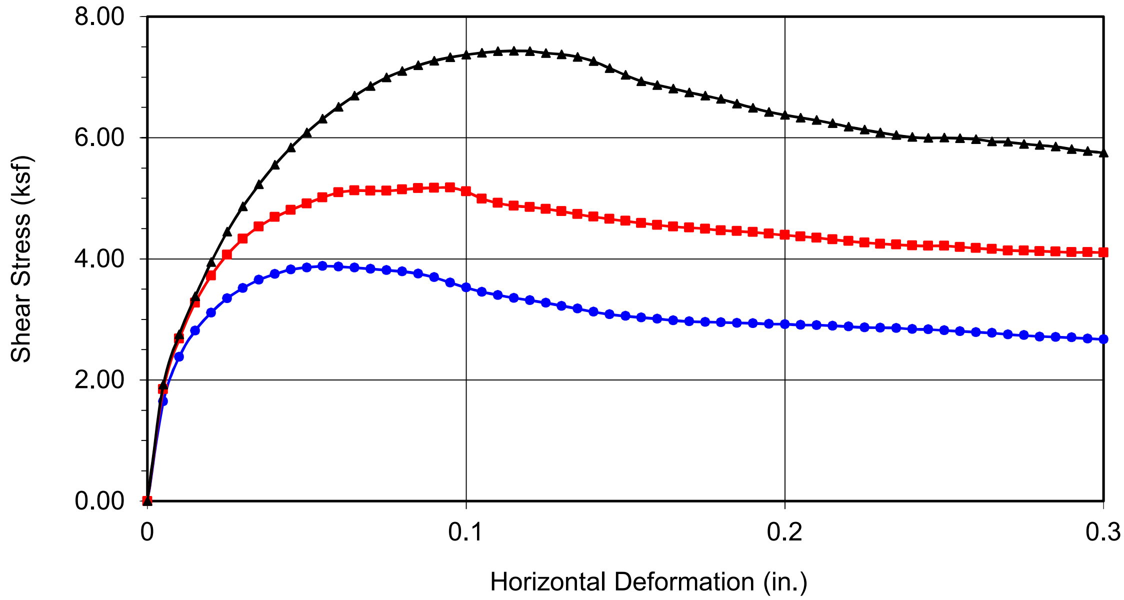

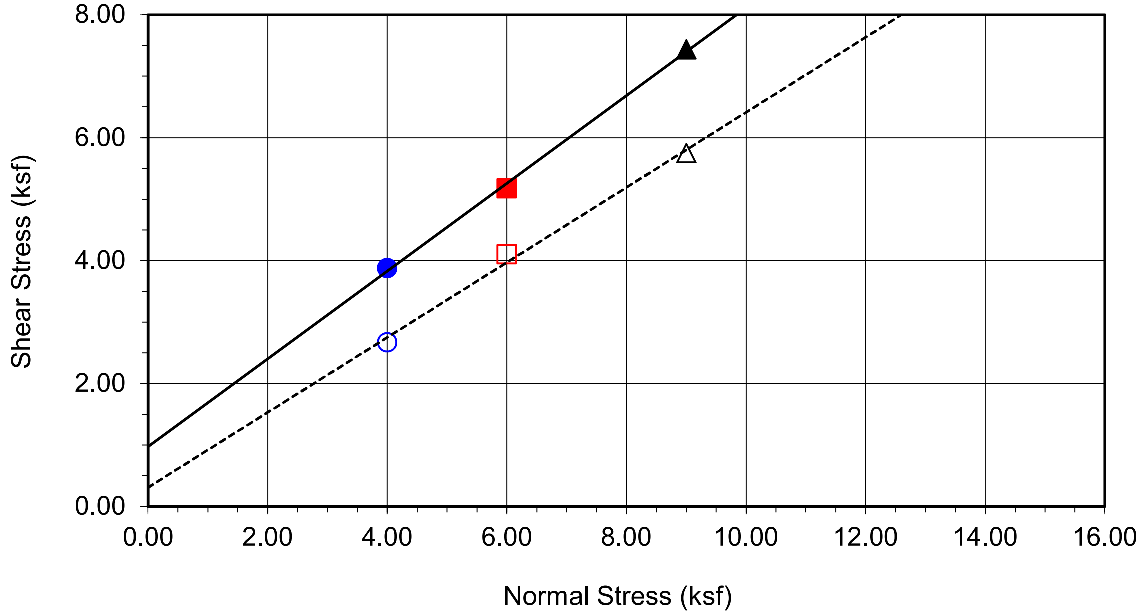

Boring No.	**LBA-2**
Sample No.	**R-8**
Depth (ft)	**40**
Sample Type:	Ring

Soil Identification:
Dark olive gray silty clay'stone'
(CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	974	36
Ultimate	310	31

Normal Stress (kip/ft²)	4.000	6.000	9.000
Peak Shear Stress (kip/ft²)	● 3.879	■ 5.175	▲ 7.432
Shear Stress @ End of Test (ksf)	○ 2.672	□ 4.103	△ 5.750
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	32.19	32.19	32.19
Dry Density (pcf)	85.8	86.9	88.1
Saturation (%)	90.0	92.5	95.1
Soil Height Before Shearing (in.)	0.9905	0.9841	0.9822
Final Moisture Content (%)	35.8	31.6	31.5

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

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Brea Boulevard Corridor Improvements

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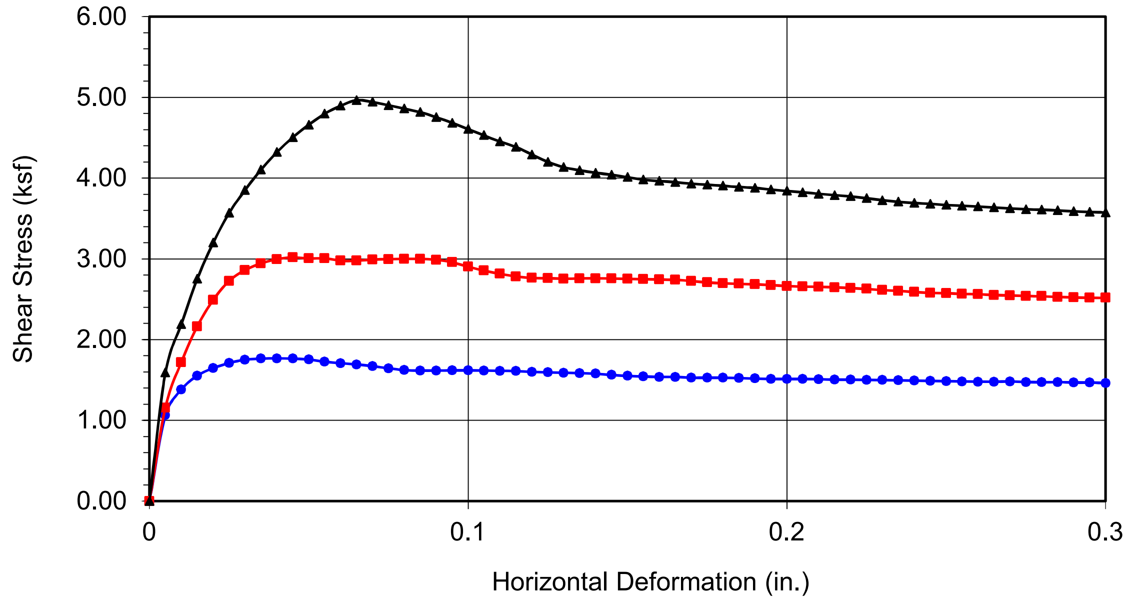

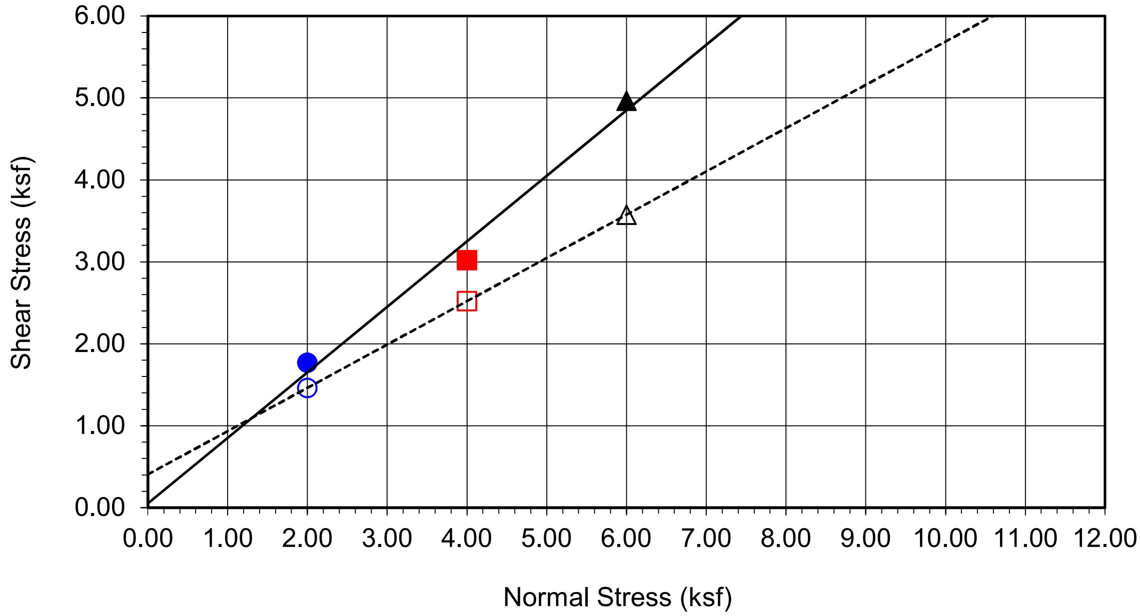

Boring No.	**LBA-3**
Sample No.	**R-4**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Light olive brown silt'stone' (ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	53	39
Ultimate	406	28

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.767	■ 3.018	▲ 4.964
Shear Stress @ End of Test (ksf)	○ 1.462	□ 2.518	△ 3.574
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.64	13.64	13.64
Dry Density (pcf)	95.4	101.7	104.4
Saturation (%)	48.0	56.0	60.0
Soil Height Before Shearing (in.)	0.9988	0.9932	0.9913
Final Moisture Content (%)	25.1	23.6	22.5

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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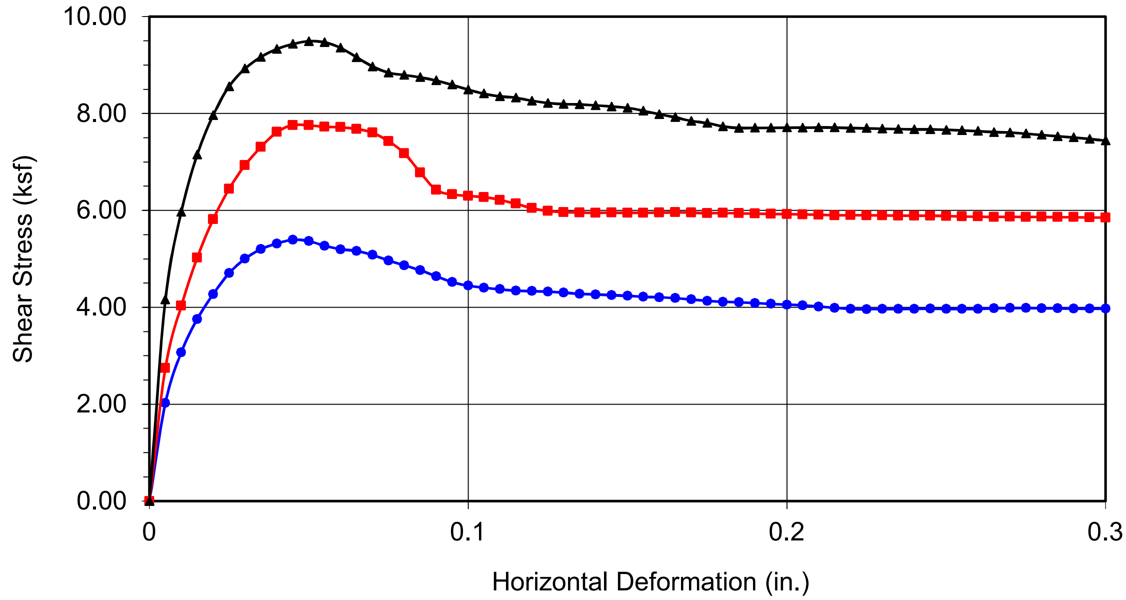

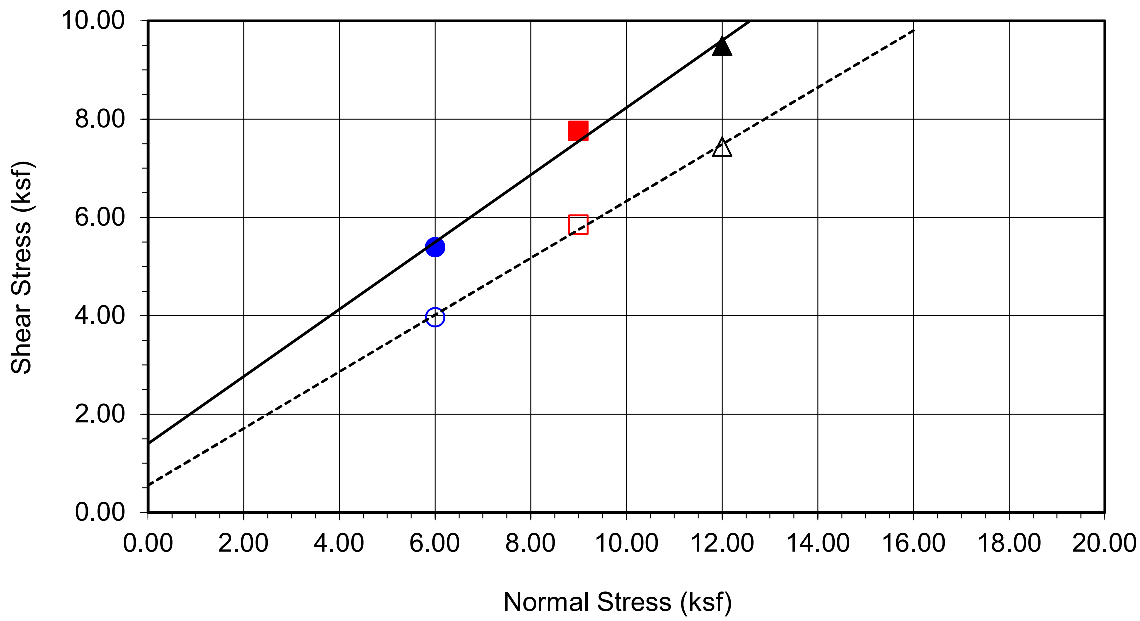

Boring No.	**LBA-3**
Sample No.	**R-12**
Depth (ft)	**60**
Sample Type:	Ring
Soil Identification: Dark olive brown silt'stone' (ML)	

Strength Parameters

	C (psf)	ϕ (°)
Peak	1399	34
Ultimate	553	30

Normal Stress (kip/ft²)	6.000	9.000	12.000
Peak Shear Stress (kip/ft²)	● 5.392	■ 7.759	▲ 9.491
Shear Stress @ End of Test (ksf)	○ 3.971	□ 5.851	△ 7.438
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.93	14.93	14.93
Dry Density (pcf)	107.0	109.0	109.6
Saturation (%)	70.1	73.8	75.0
Soil Height Before Shearing (in.)	0.9887	0.9844	0.9796
Final Moisture Content (%)	19.9	19.4	19.0

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DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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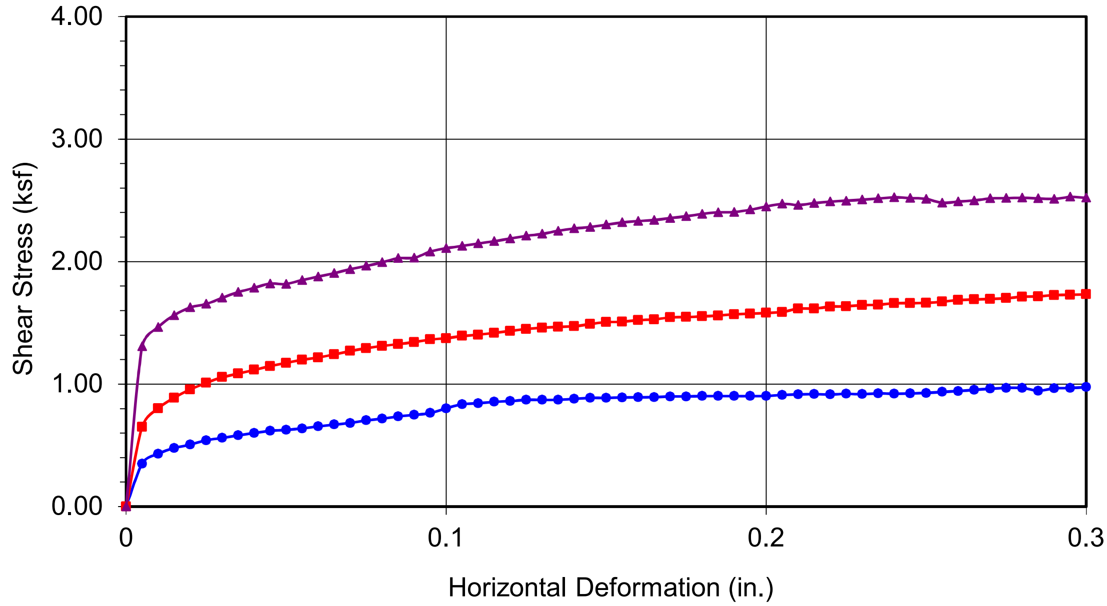

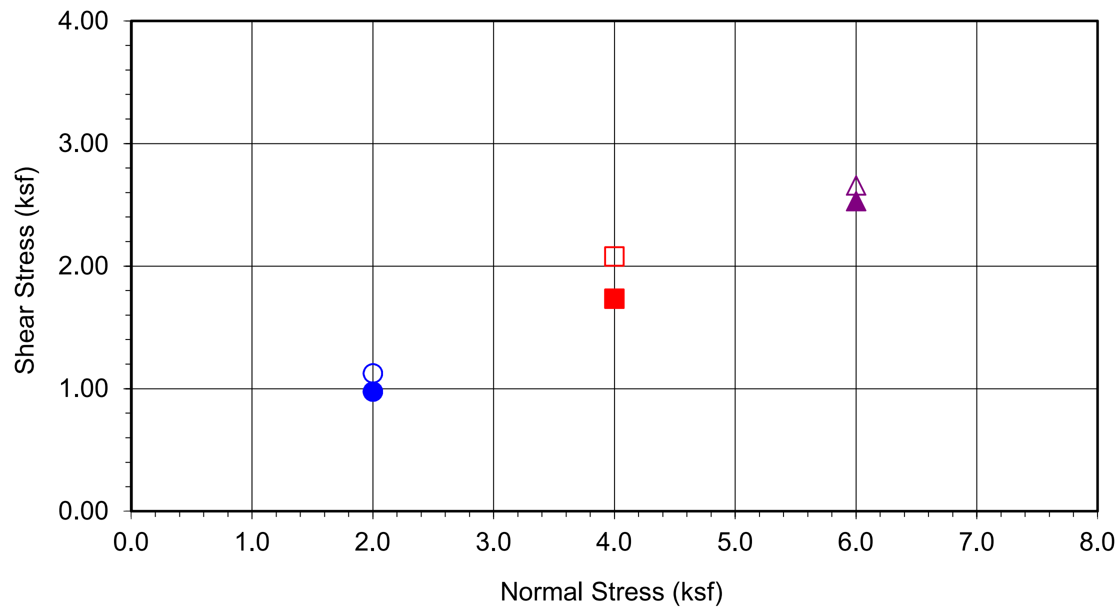

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 0.975	■ 1.732	▲ 2.528
Shear Stress @ End of Pass 9 (ksf)	○ 1.125	□ 2.078	△ 2.656
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	45.53	45.53	45.53
Dry Density (pcf)	73.9	74.4	74.5
Saturation (%)	95.9	97.0	97.3
Soil Height Before Shearing (in.)	0.8561	0.8092	0.7792
Final Moisture Content (%)	31.6	28.5	26.7

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

Leighton

Boring No.:	LBA-1
Sample No.:	G-1
Depth (ft)	7.6-9.5
Sample Type:	Remold
Soil Description:	Light olive brown fat clay (CH)

Project No.: 11588.001

Brea Boulevard Corridor Improvements

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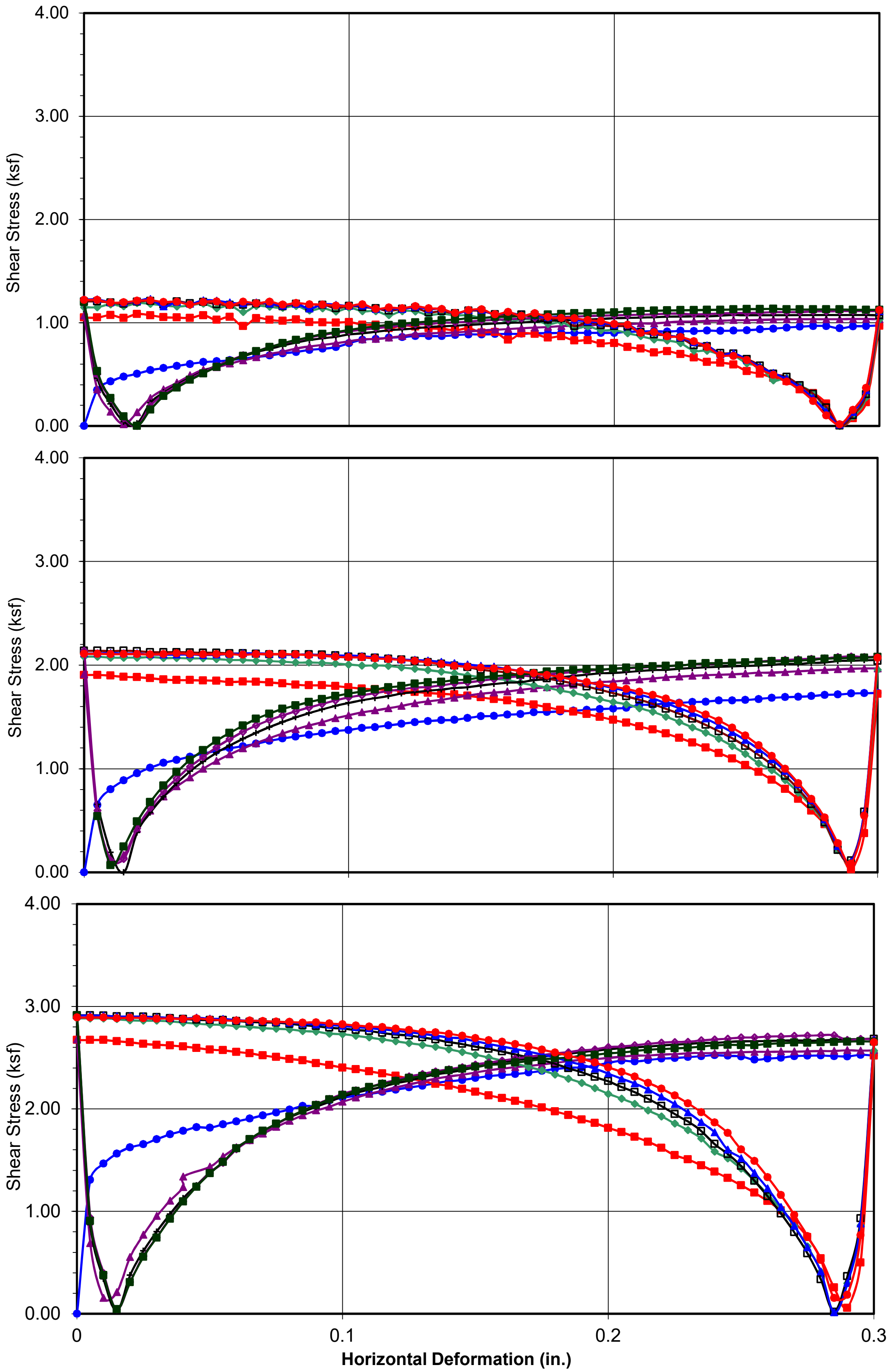


Normal Stress (ksf) 2.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	0.975
2	1.050
3	1.034
4	1.151
5	1.072
6	1.207
7	1.113
8	1.226
9	1.125
10	1.220

Normal Stress (ksf) 4.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	1.732
2	1.905
3	1.968
4	2.081
5	2.050
6	2.138
7	2.084
8	2.113
9	2.078
10	2.109

Normal Stress (ksf) 6.00	
Shear Stress @ End of Pass (ksf)	
Pass No.	Shear Stress (ksf)
1	2.521
2	2.672
3	2.572
4	2.883
5	2.685
6	2.914
7	2.678
8	2.911
9	2.656
10	2.892

Pass 1-10 0.0017"/min

DIRECT SHEAR TEST RESULTS

Consolidated Drained - ASTM D 3080

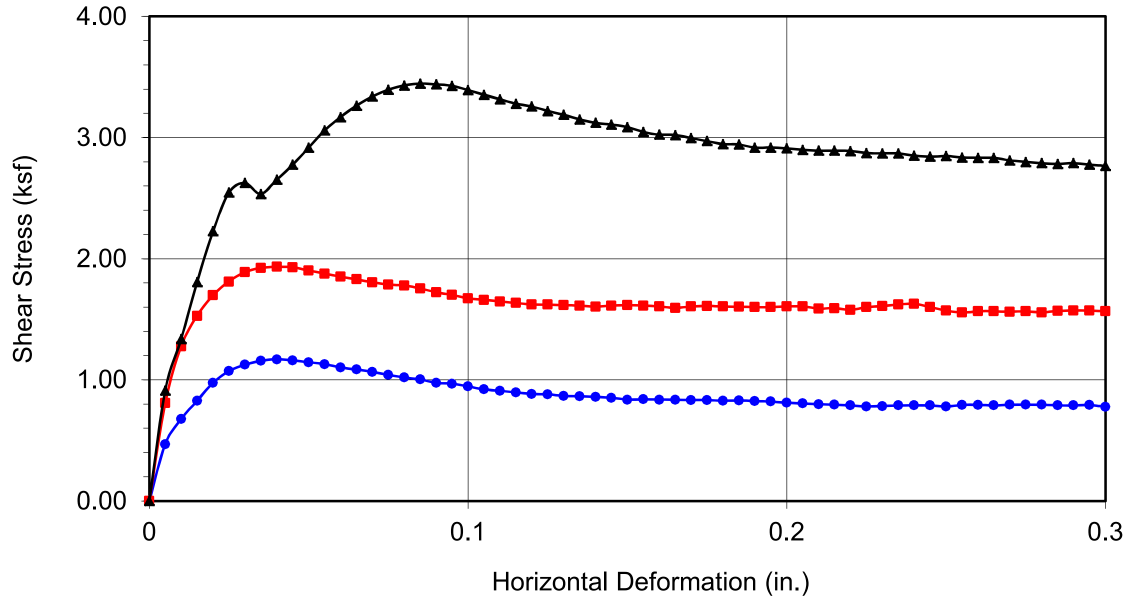
Leighton

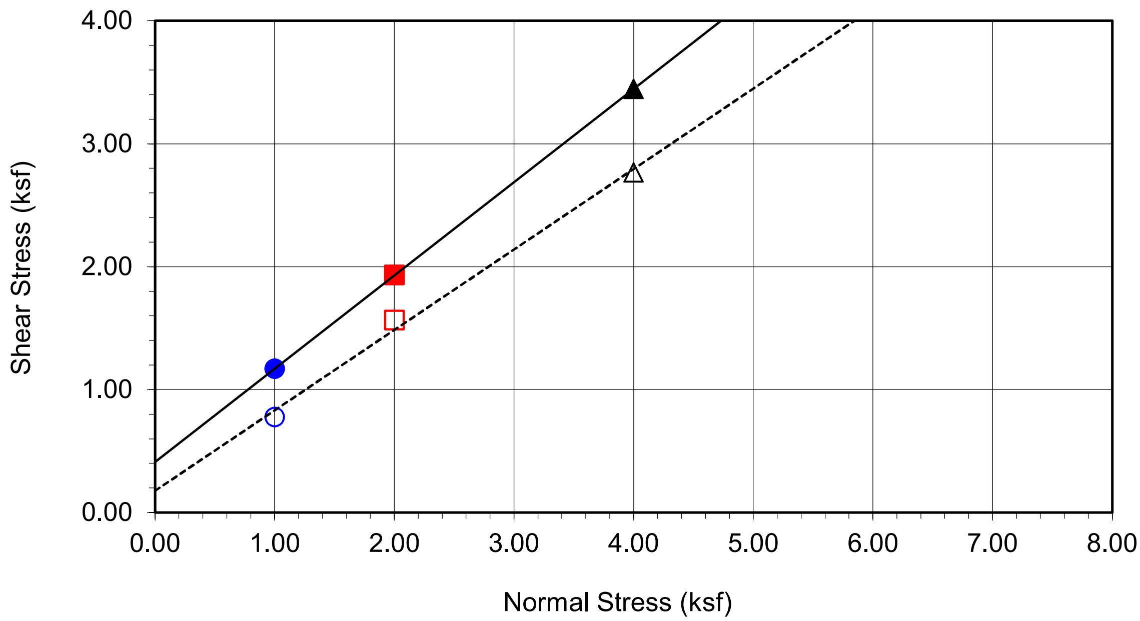
Boring No.:	LBA-1
Sample No.:	G-1
Depth (ft)	7.6-9.5
Soil Type:	Remold
Soil Description:	Light olive brown fat clay (CH)

Project No.: 11588.001

Brea Boulevard Corridor Improvements

09-18





Boring No.	**LB-14**
Sample No.	**B-1**
Depth (ft)	**2-5**
Sample Type: 90% Remold	
Soil Identification: Olive brown silty sand with gravel (SM)g	

Strength Parameters

	C (psf)	ϕ (°)
Peak	413	37
Ultimate	177	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.169	■ 1.933	▲ 3.446
Shear Stress @ End of Test (ksf)	○ 0.777	□ 1.566	△ 2.767
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	7.26	7.26	7.26
Dry Density (pcf)	125.7	125.7	125.7
Saturation (%)	57.5	57.5	57.5
Soil Height Before Shearing (in.)	0.9892	0.9790	0.9820
Final Moisture Content (%)	12.9	12.2	11.8

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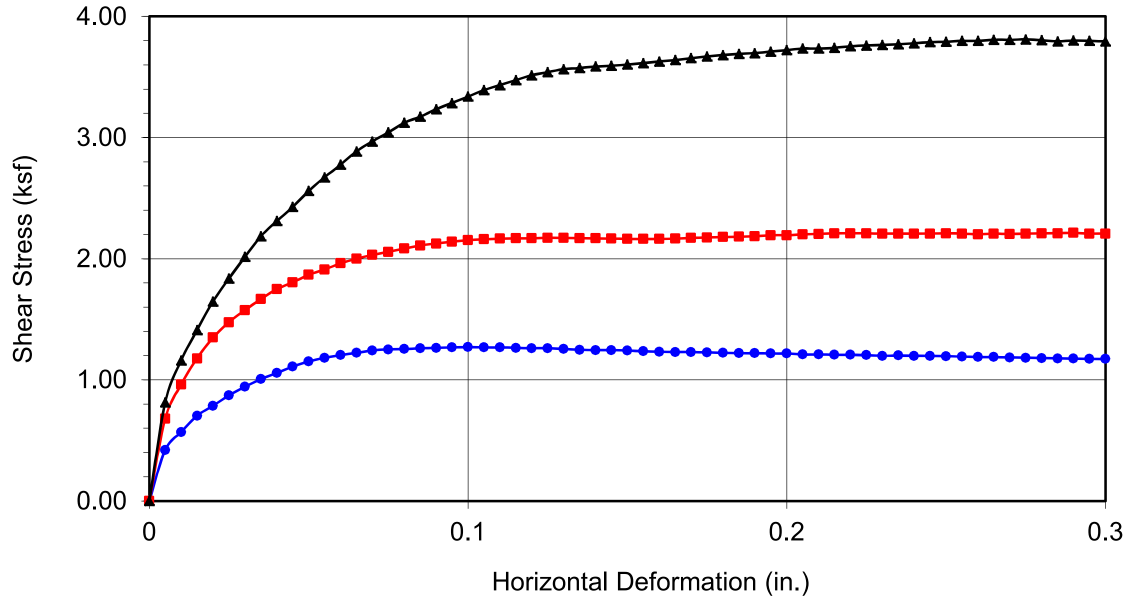
DIRECT SHEAR TEST RESULTS

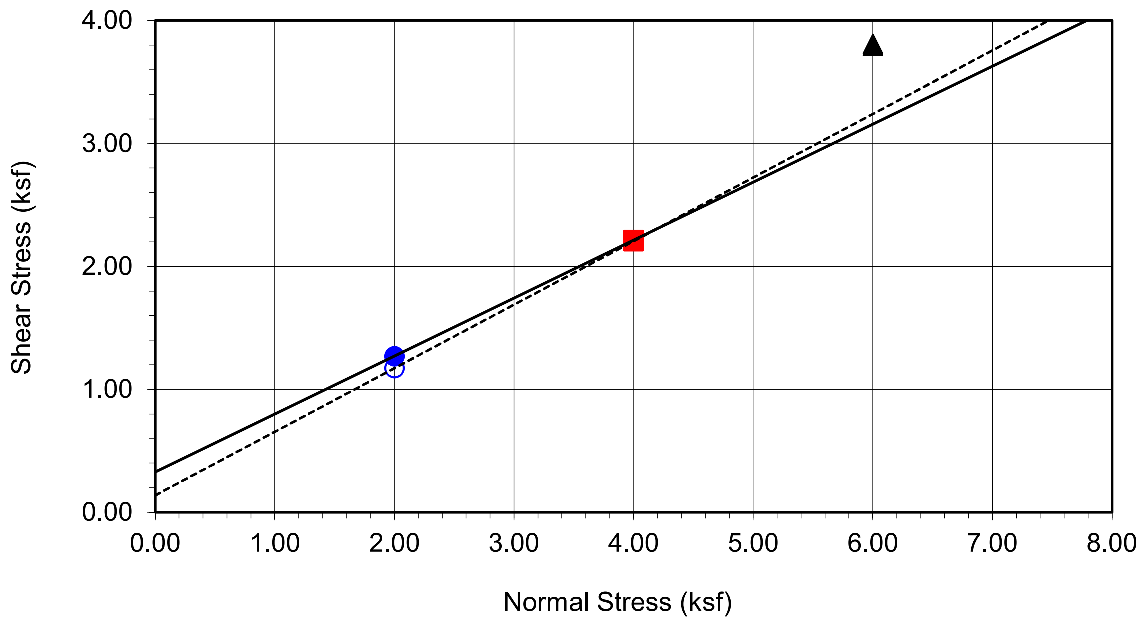
Consolidated Undrained

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

02-19





Boring No.	**LB-14**
Sample No.	**R-6**
Depth (ft)	**31-31.5**
Sample Type:	Ring

Soil Identification:
Brownish gray sandy lean clay s(CL)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	327	25
Ultimate	139	27

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.270	■ 2.213	▲ 3.810
Shear Stress @ End of Test (ksf)	○ 1.173	□ 2.207	△ 3.795
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	24.66	24.66	24.66
Dry Density (pcf)	95.4	96.2	97.7
Saturation (%)	86.7	88.6	91.7
Soil Height Before Shearing (in.)	0.9593	0.9488	0.9296
Final Moisture Content (%)	32.1	28.8	24.3

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DIRECT SHEAR TEST RESULTS
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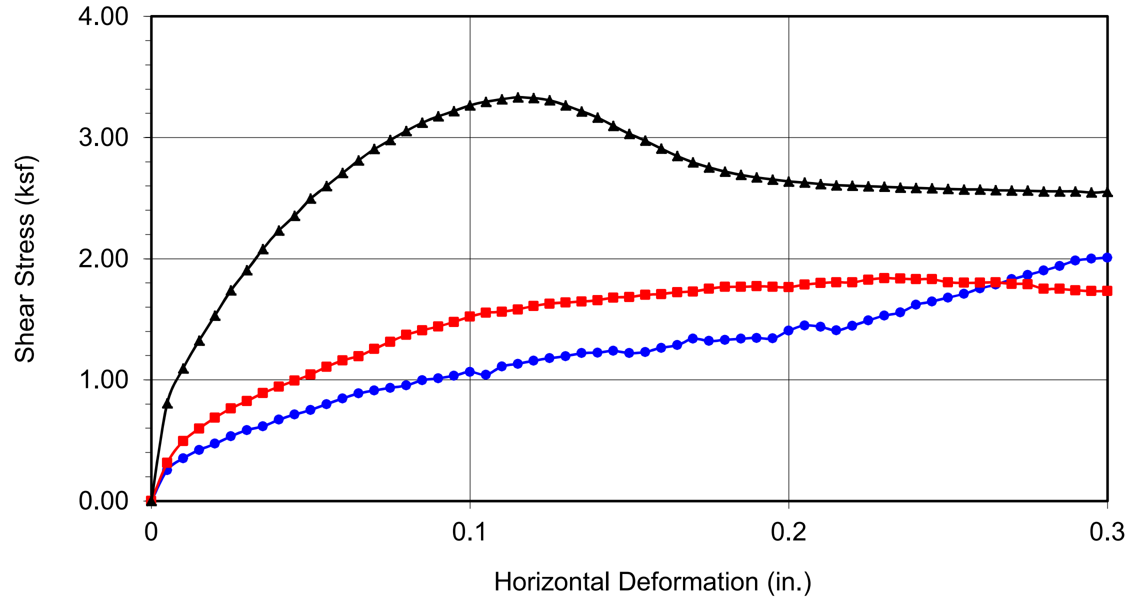
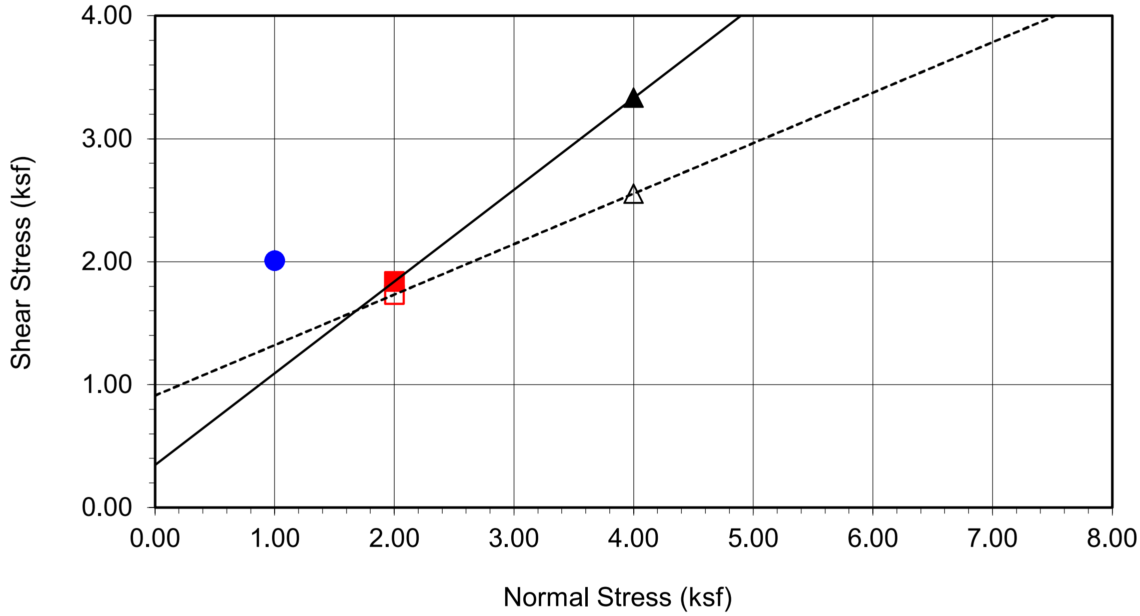
Brea Boulevard Corridor
Improvements - Supplemental

01-19





Boring No.	**LB-15**
Sample No.	**R-1**
Depth (ft)	**10.5-11**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty sand (SM), siltstone noted

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	346	37
Ultimate	911	22

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.009	■ 1.839	▲ 3.332
Shear Stress @ End of Test (ksf)	○ 2.009	□ 1.732	△ 2.553
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	4.10	4.10	4.10
Dry Density (pcf)	99.7	103.1	110.8
Saturation (%)	16.0	17.4	21.2
Soil Height Before Shearing (in.)	0.9635	0.9303	0.9665
Final Moisture Content (%)	20.9	17.5	19.5

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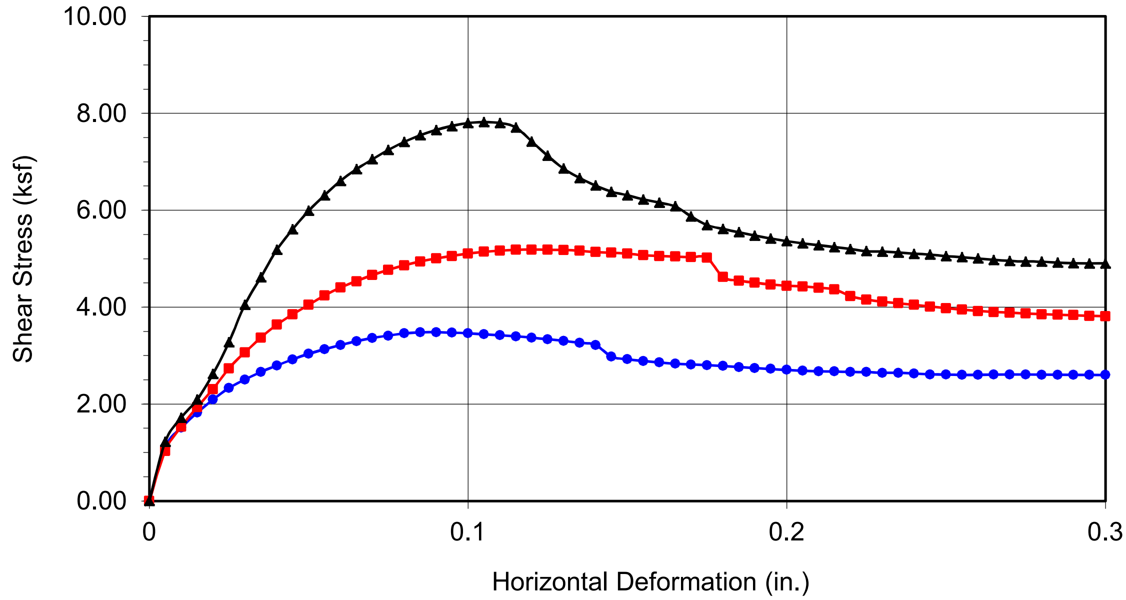

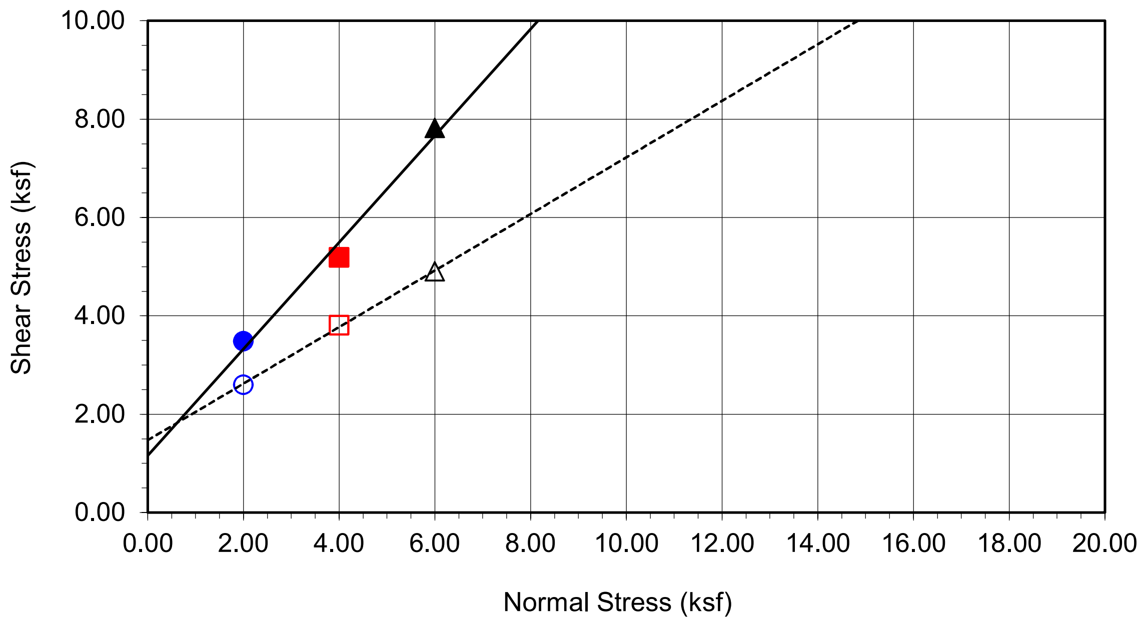

Boring No.	**LB-15**
Sample No.	**R-2**
Depth (ft)	**21-21.5**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty sand (SM), siltstone noted

Strength Parameters

	C (psf)	ϕ (°)
Peak	1160	47
Ultimate	1469	30

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 3.483	■ 5.187	▲ 7.819
Shear Stress @ End of Test (ksf)	○ 2.600	□ 3.810	△ 4.901
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.97	9.97	9.97
Dry Density (pcf)	114.2	115.0	118.5
Saturation (%)	56.5	57.9	63.7
Soil Height Before Shearing (in.)	1.0015	0.9713	0.9930
Final Moisture Content (%)	19.0	18.5	16.9

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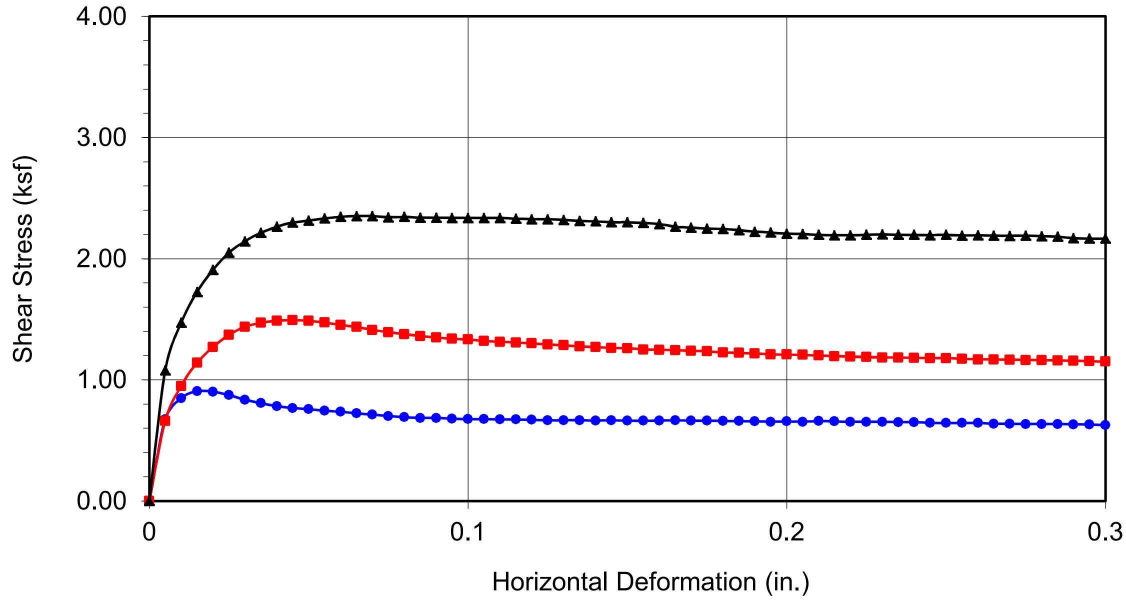

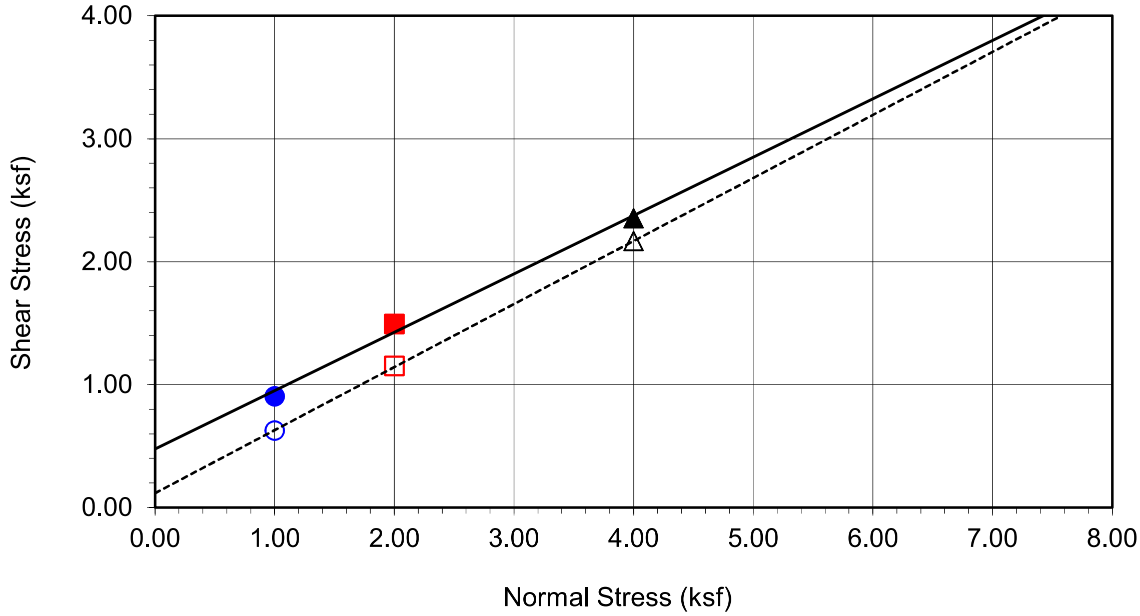

Boring No.	**LB-16**
Sample No.	**R-1**
Depth (ft)	**6-6.5**
Sample Type:	Ring

Soil Identification:
Brown lean clay (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	476	25
Ultimate	119	27

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.905	■ 1.493	▲ 2.352
Shear Stress @ End of Test (ksf)	○ 0.626	□ 1.151	△ 2.166
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.26	11.26	11.26
Dry Density (pcf)	109.2	111.8	112.4
Saturation (%)	55.9	59.9	60.8
Soil Height Before Shearing (in.)	1.0153	0.9991	0.9909
Final Moisture Content (%)	21.1	19.9	19.0

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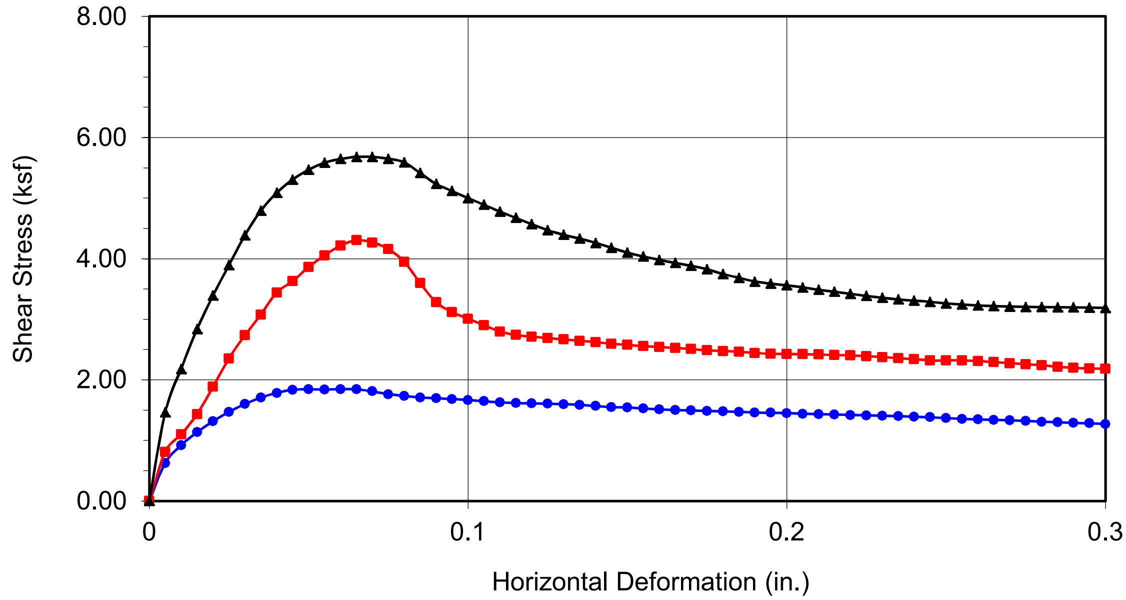

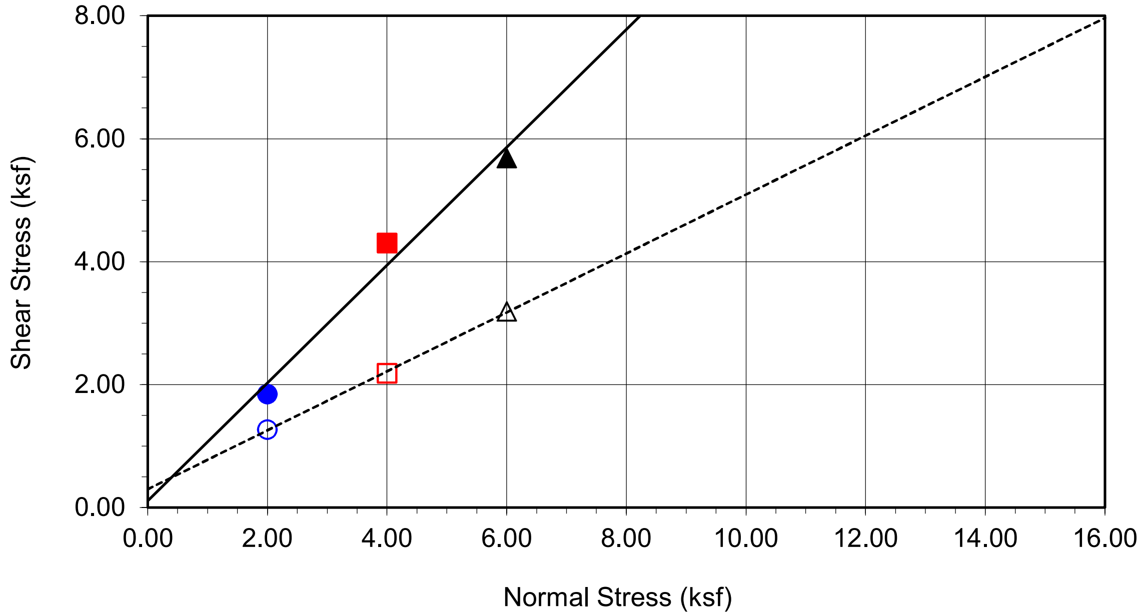

Boring No.	**LB-16**
Sample No.	**R-2**
Depth (ft)	**16-16.5**
Sample Type:	Ring

Soil Identification:
Brownish yellow silty clay (CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	107	44
Ultimate	295	26

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.845	■ 4.304	▲ 5.681
Shear Stress @ End of Test (ksf)	○ 1.270	□ 2.182	△ 3.188
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	19.58	19.58	19.58
Dry Density (pcf)	101.1	105.0	107.0
Saturation (%)	79.1	87.4	91.9
Soil Height Before Shearing (in.)	0.9902	0.9821	0.9857
Final Moisture Content (%)	31.9	25.0	23.2

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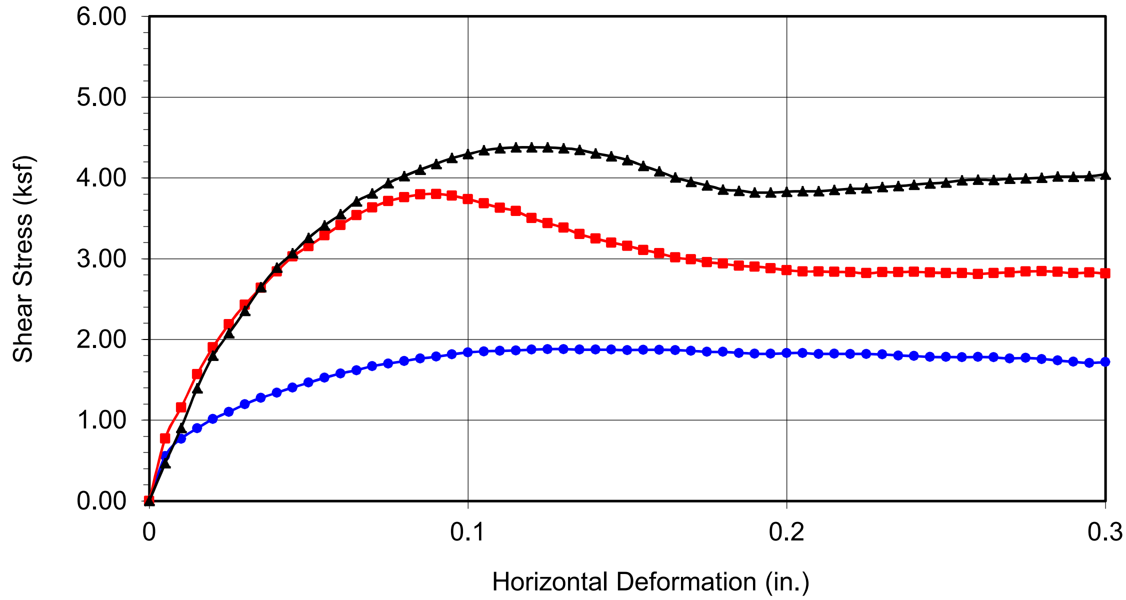

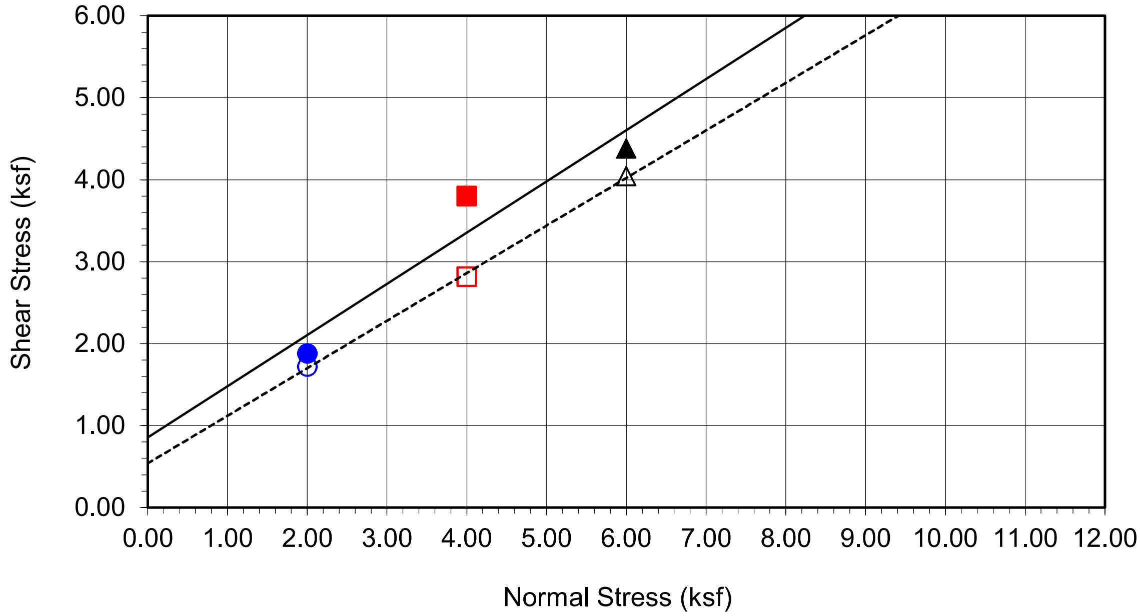

Boring No.	**LB-18**
Sample No.	**R-2**
Depth (ft)	**16-16.5**
Sample Type:	Ring

Soil Identification:
Yellowish brown clayey sand (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	854	32
Ultimate	537	30

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.880	■ 3.801	▲ 4.379
Shear Stress @ End of Test (ksf)	○ 1.720	□ 2.817	△ 4.043
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	3.83	3.83	3.83
Dry Density (pcf)	106.2	107.9	110.4
Saturation (%)	17.6	18.4	19.6
Soil Height Before Shearing (in.)	0.9640	0.9736	0.9729
Final Moisture Content (%)	17.8	17.8	16.2

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DIRECT SHEAR TEST RESULTS

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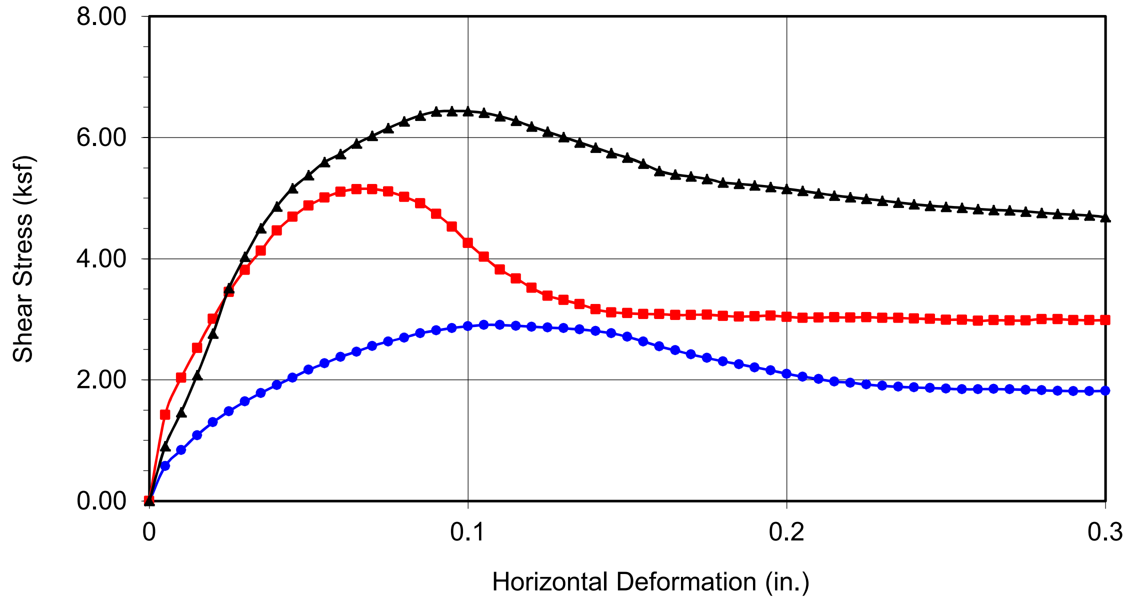

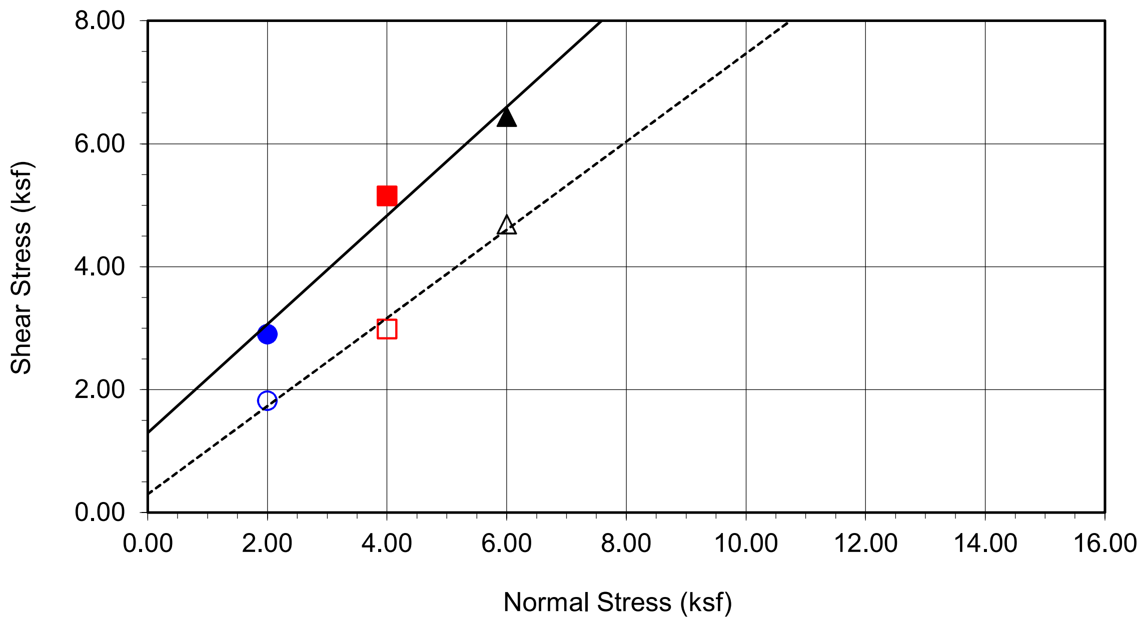

Boring No.	**LB-18**
Sample No.	**R-3**
Depth (ft)	**26-26.5**
Sample Type:	Ring

Soil Identification:
Brownish gray clayey sand (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1298	41
Ultimate	298	36

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 2.905	■ 5.149	▲ 6.438
Shear Stress @ End of Test (ksf)	○ 1.820	□ 2.987	△ 4.687
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.33	10.33	10.33
Dry Density (pcf)	112.5	117.8	118.7
Saturation (%)	55.9	64.8	66.4
Soil Height Before Shearing (in.)	0.9805	0.9780	0.9863
Final Moisture Content (%)	17.0	14.2	15.4

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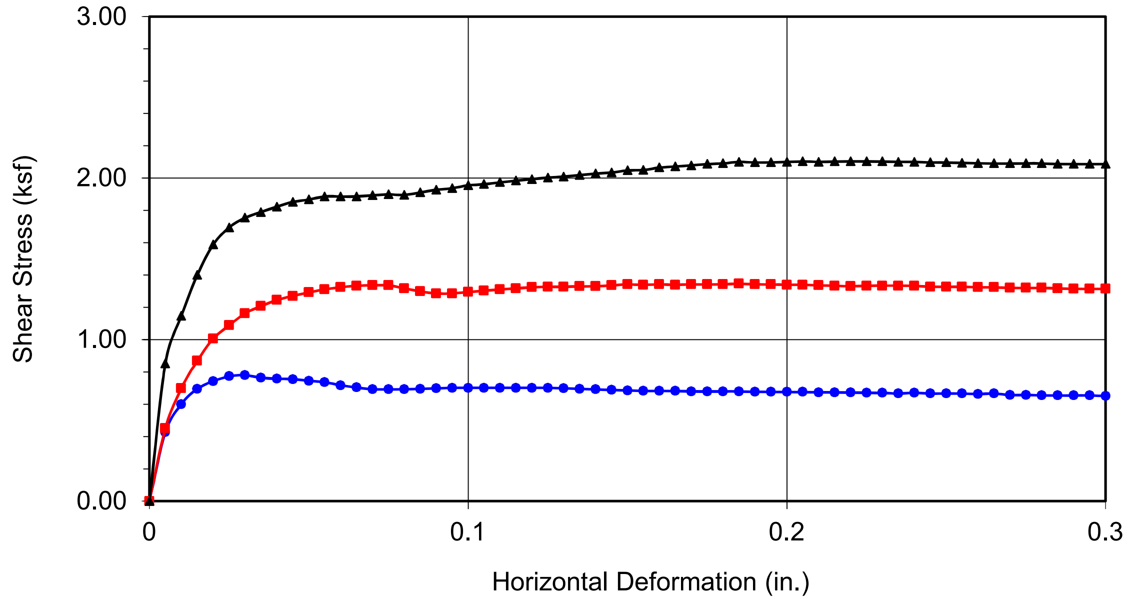

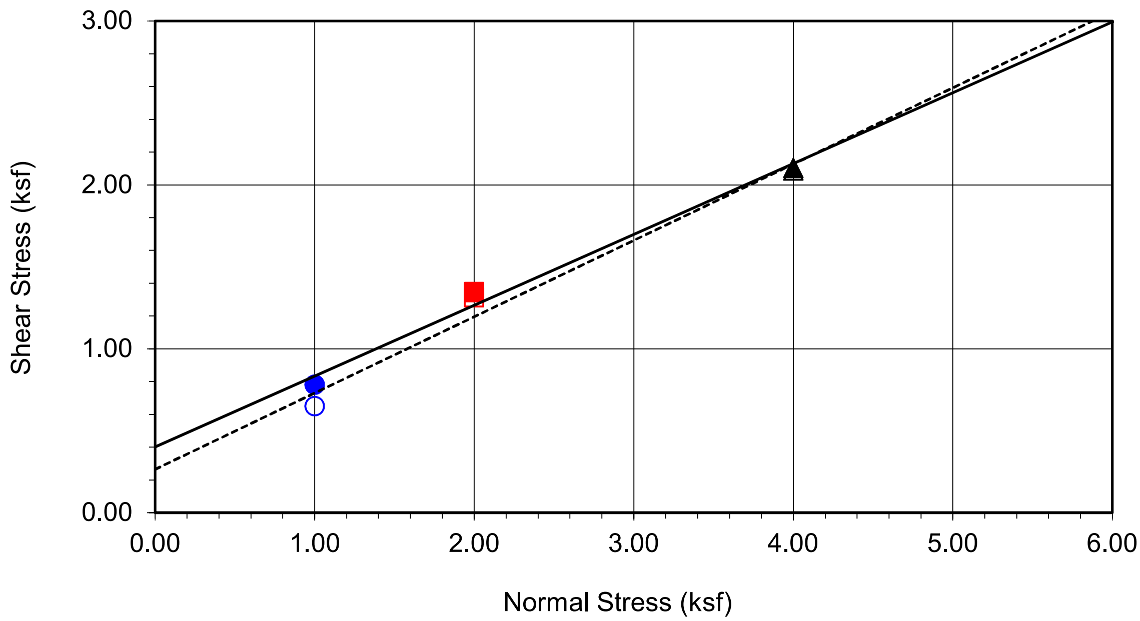

Boring No.	**LB-20**
Sample No.	**R-4**
Depth (ft)	**15**
Sample Type:	Ring

Soil Identification:
Light olive brown silt with sand (ML)s

Strength Parameters

	C (psf)	ϕ (°)
Peak	402	23
Ultimate	265	25

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.780	■ 1.346	▲ 2.103
Shear Stress @ End of Test (ksf)	○ 0.651	□ 1.314	△ 2.087
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	6.76	6.76	6.76
Dry Density (pcf)	96.6	96.8	102.4
Saturation (%)	24.5	24.6	28.2
Soil Height Before Shearing (in.)	0.9975	0.9924	0.9878
Final Moisture Content (%)	25.8	23.3	23.3

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DIRECT SHEAR TEST RESULTS
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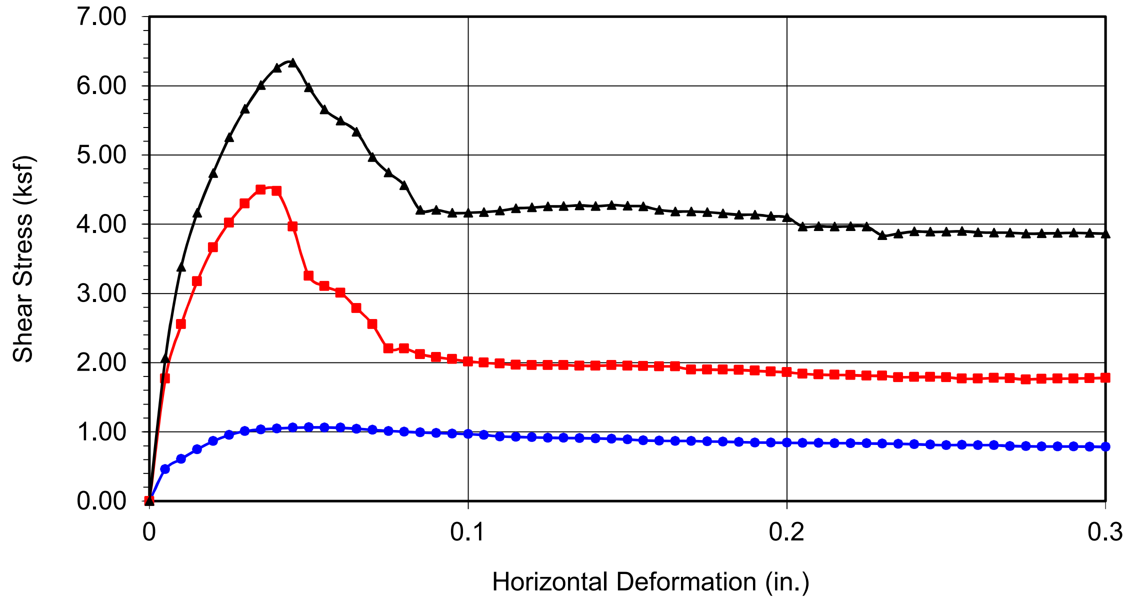

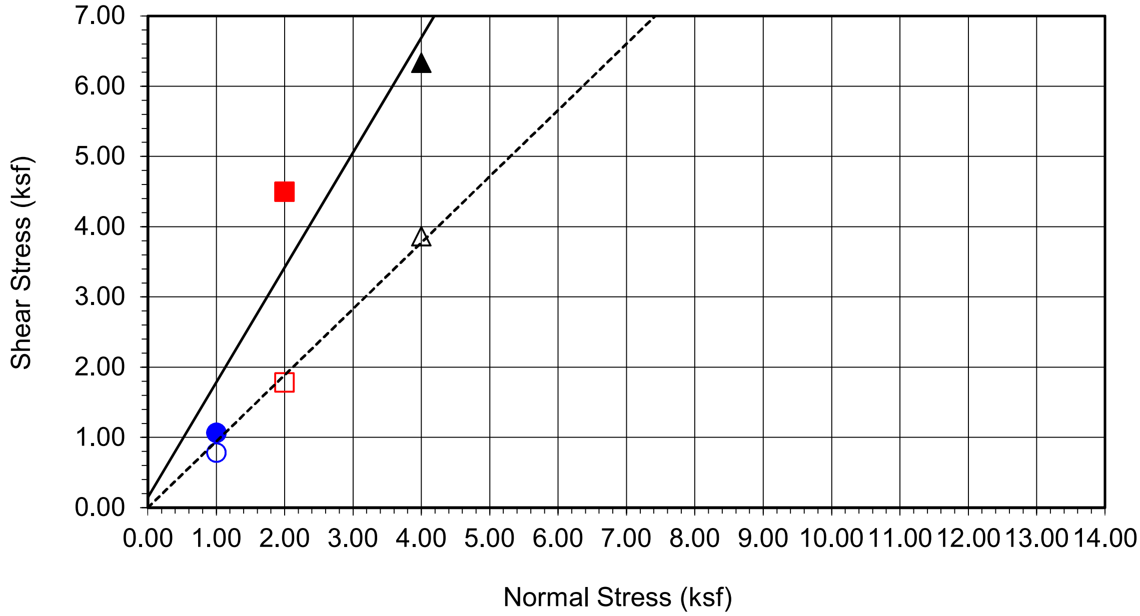

Boring No.	**LB-24**
Sample No.	**R-4**
Depth (ft)	**15**
Sample Type:	Tube

Soil Identification:
Olive gray silt stone (ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	148	59
Ultimate	0	43

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.066	■ 4.496	▲ 6.332
Shear Stress @ End of Test (ksf)	○ 0.783	□ 1.779	△ 3.864
Deformation Rate (in./min.)	0.0025	0.0025	0.0025
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	11.51	11.51	11.51
Dry Density (pcf)	108.2	116.7	119.6
Saturation (%)	55.8	70.0	75.9
Soil Height Before Shearing (in.)	0.9965	0.9951	0.9900
Final Moisture Content (%)	18.9	16.5	15.7

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DIRECT SHEAR TEST RESULTS
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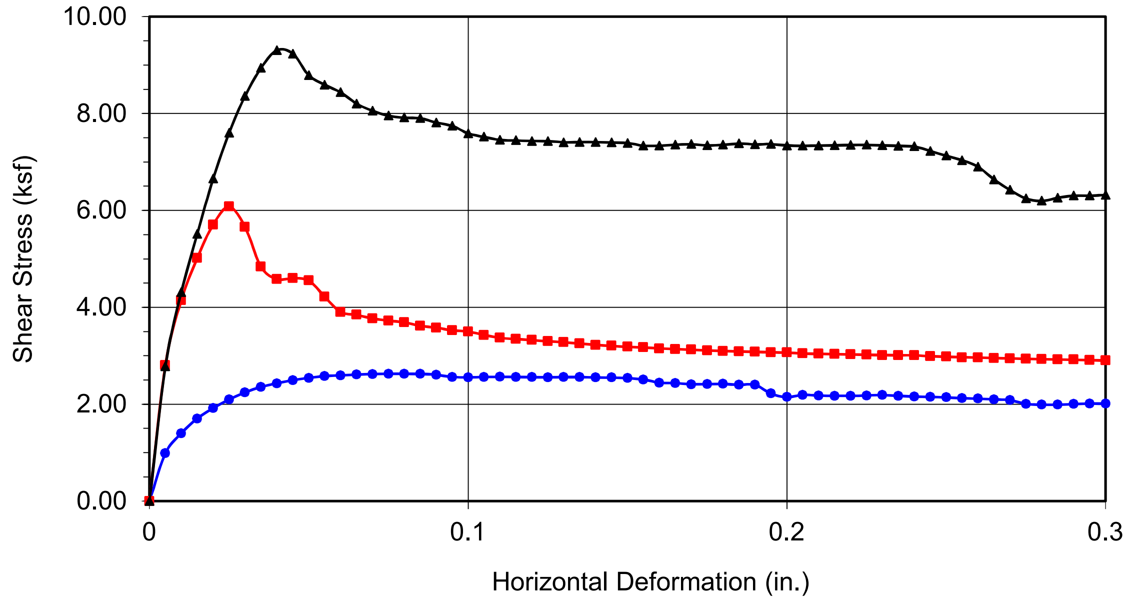

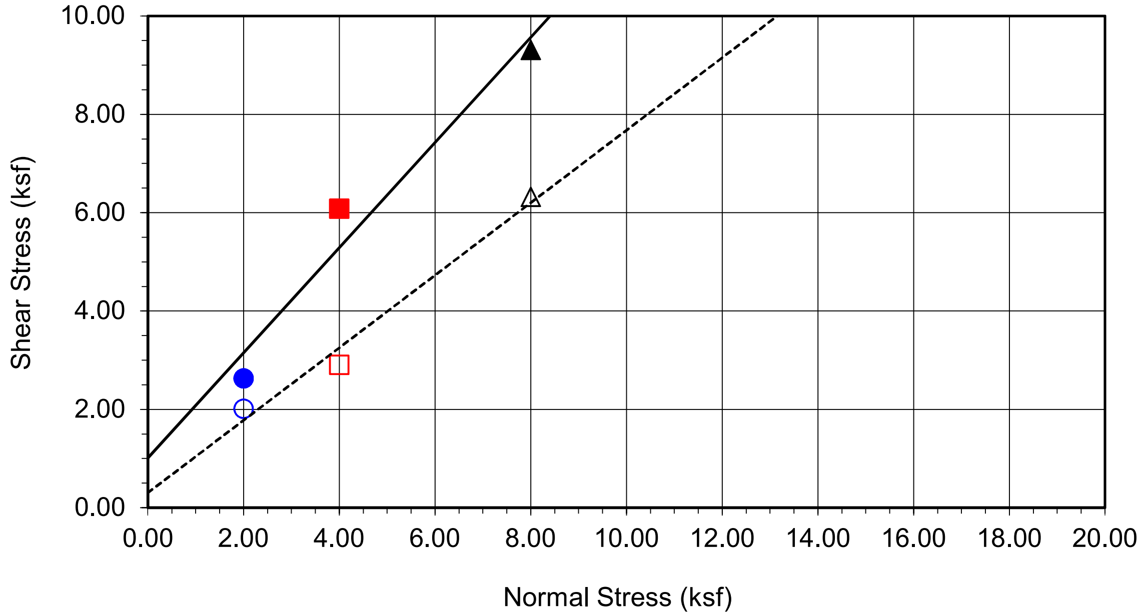

Boring No.	**LB-24**
Sample No.	**R-7**
Depth (ft)	**30**
Sample Type:	Tube

Soil Identification:
Olive gray silty clay stone (CL-ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1014	47
Ultimate	304	36

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.628	■ 6.077	▲ 9.306
Shear Stress @ End of Test (ksf)	○ 2.012	□ 2.902	△ 6.319
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.93	12.93	12.93
Dry Density (pcf)	113.3	119.0	119.5
Saturation (%)	71.7	83.8	85.0
Soil Height Before Shearing (in.)	0.9895	0.9906	0.9842
Final Moisture Content (%)	18.7	14.2	14.3

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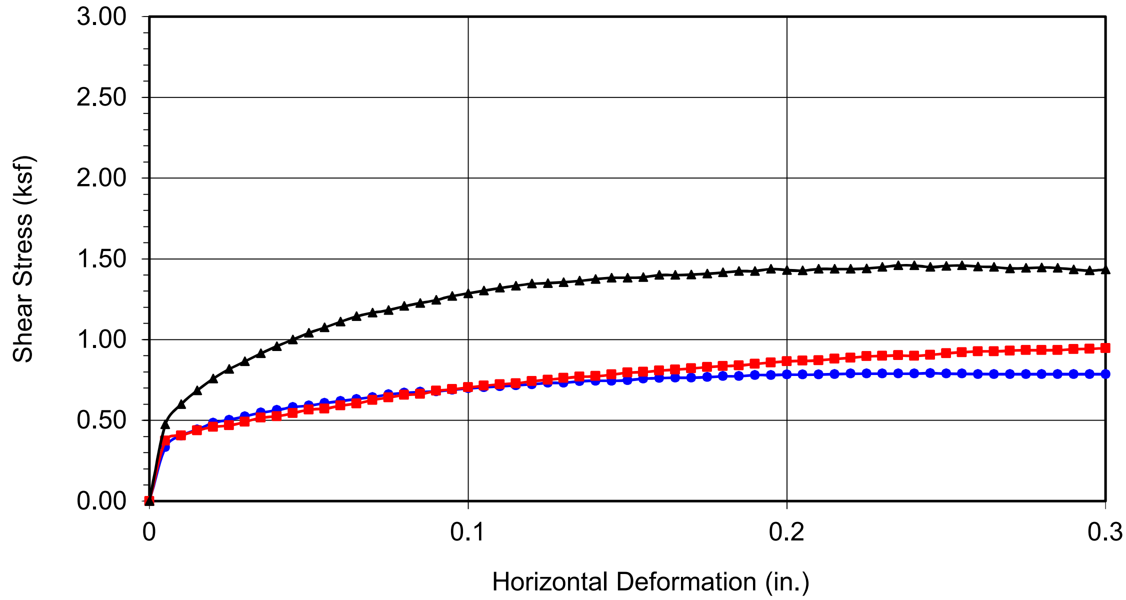
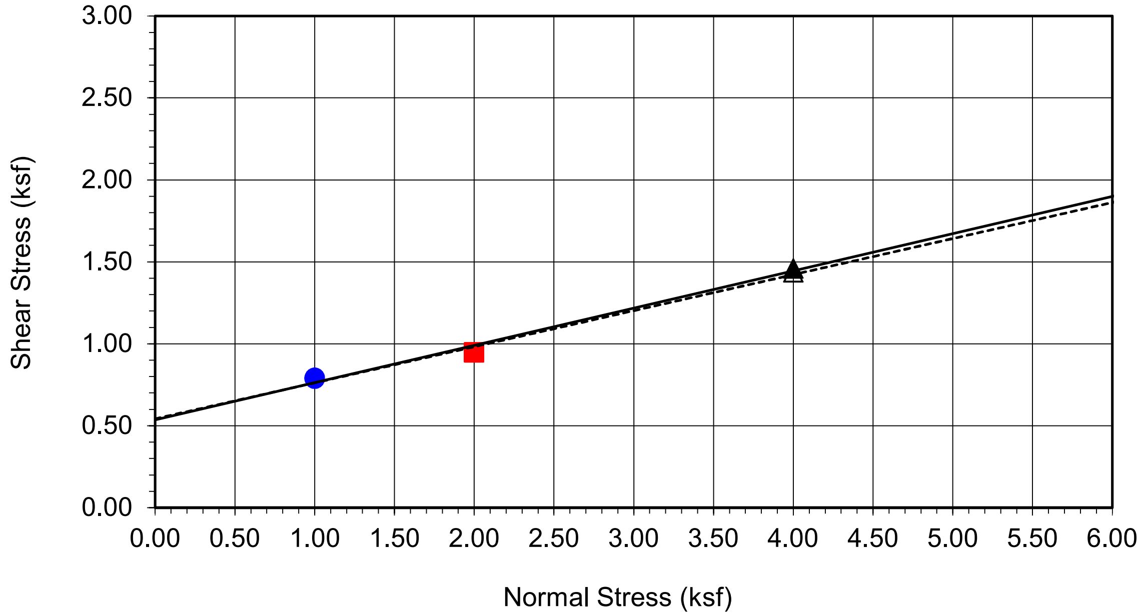




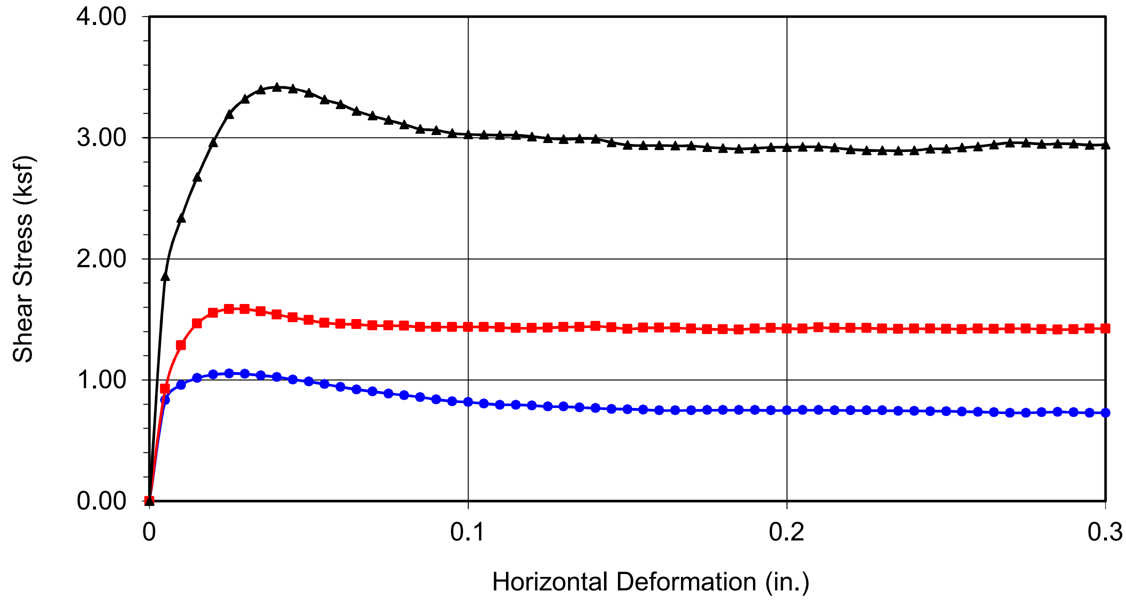
Boring No.	**LB-25**
Sample No.	**T-5A**
Depth (ft)	**15**
Sample Type:	Tube

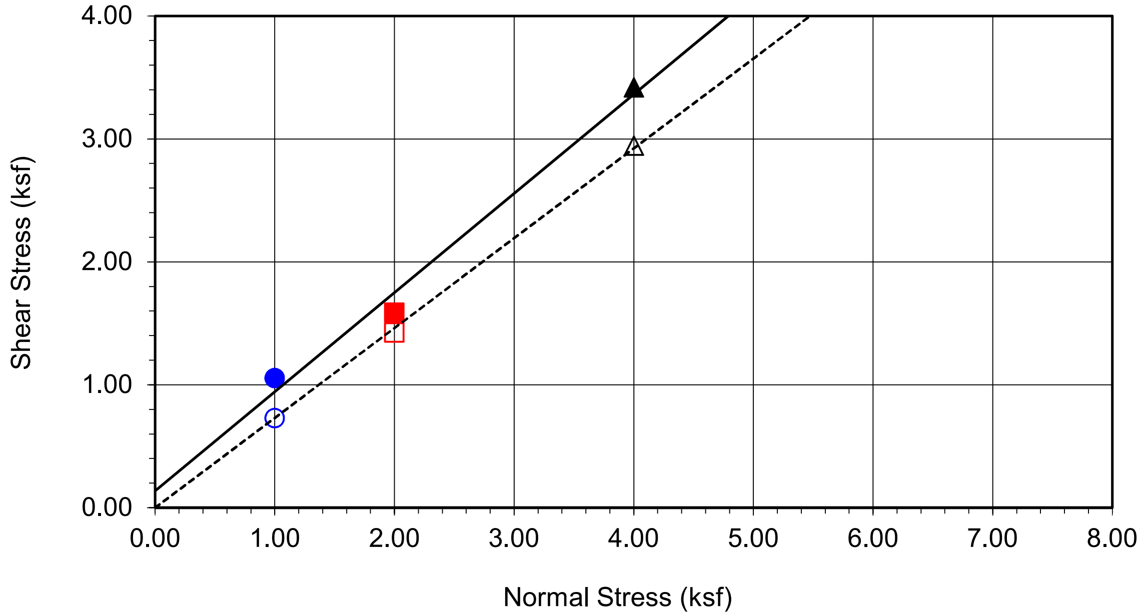
Soil Identification:
Very dark gray fat clay (CH), noted hydrocarbon smell

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	536	13
Ultimate	542	12

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.792	■ 0.946	▲ 1.459
Shear Stress @ End of Test (ksf)	○ 0.786	□ 0.946	△ 1.434
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	12.14	12.14	12.14
Dry Density (pcf)	98.0	100.4	102.1
Saturation (%)	45.5	48.3	50.4
Soil Height Before Shearing (in.)	0.9677	0.9558	0.9312
Final Moisture Content (%)	12.1	11.8	11.5





Boring No.	**LB-29**
Sample No.	**B-1**
Depth (ft)	**2-5**
Sample Type:	90% Remold

Soil Identification:
Olive brown silty sand (SM)

Strength Parameters

	C (psf)	ϕ (°)
Peak	137	39
Ultimate	0	36

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.053	■ 1.584	▲ 3.417
Shear Stress @ End of Test (ksf)	○ 0.729	□ 1.424	△ 2.943
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.48	9.48	9.48
Dry Density (pcf)	112.7	112.9	114.2
Saturation (%)	51.6	52.0	53.8
Soil Height Before Shearing (in.)	0.9915	0.9887	0.9848
Final Moisture Content (%)	15.4	15.2	13.8

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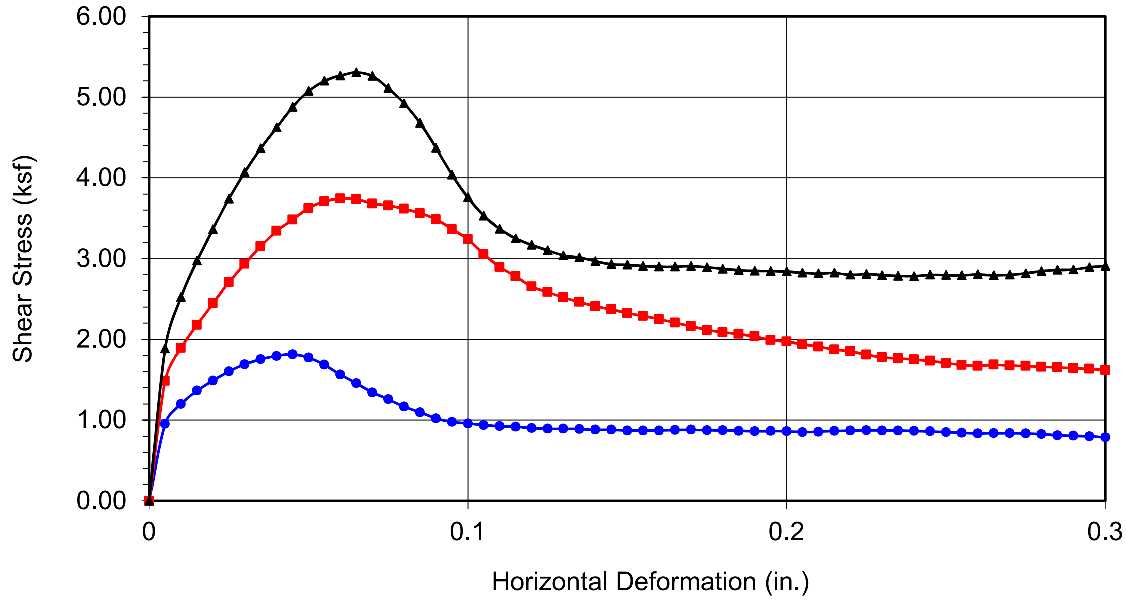

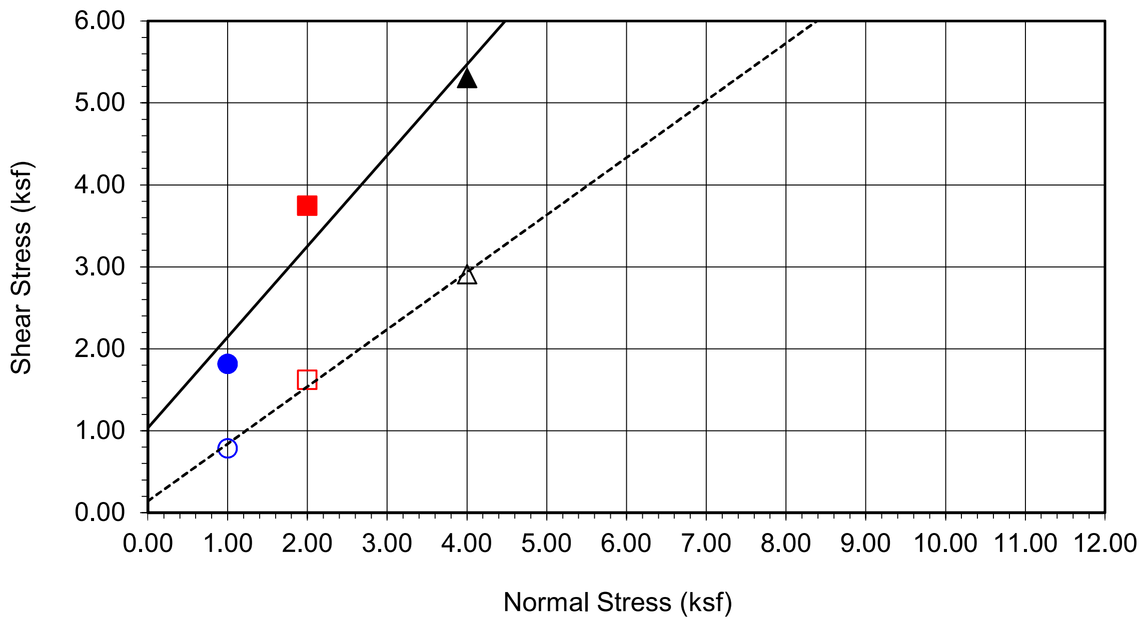

Boring No.	**LB-29**
Sample No.	**R-2**
Depth (ft)	**7.5**
Sample Type:	Ring

Soil Identification:
Dark yellowish brown clayey sand stone (SC)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1034	48
Ultimate	142	35

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.814	■ 3.744	▲ 5.304
Shear Stress @ End of Test (ksf)	○ 0.786	□ 1.619	△ 2.908
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	10.21	10.21	10.21
Dry Density (pcf)	122.7	123.5	125.3
Saturation (%)	73.7	75.6	79.9
Soil Height Before Shearing (in.)	0.9929	0.9910	0.9898
Final Moisture Content (%)	13.3	12.8	11.8

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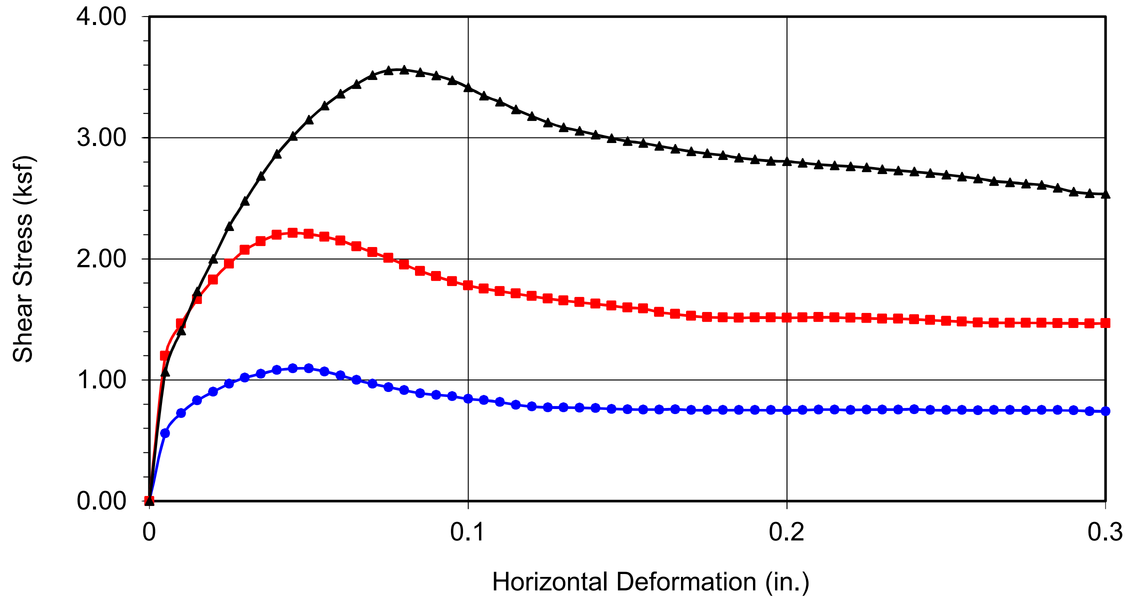

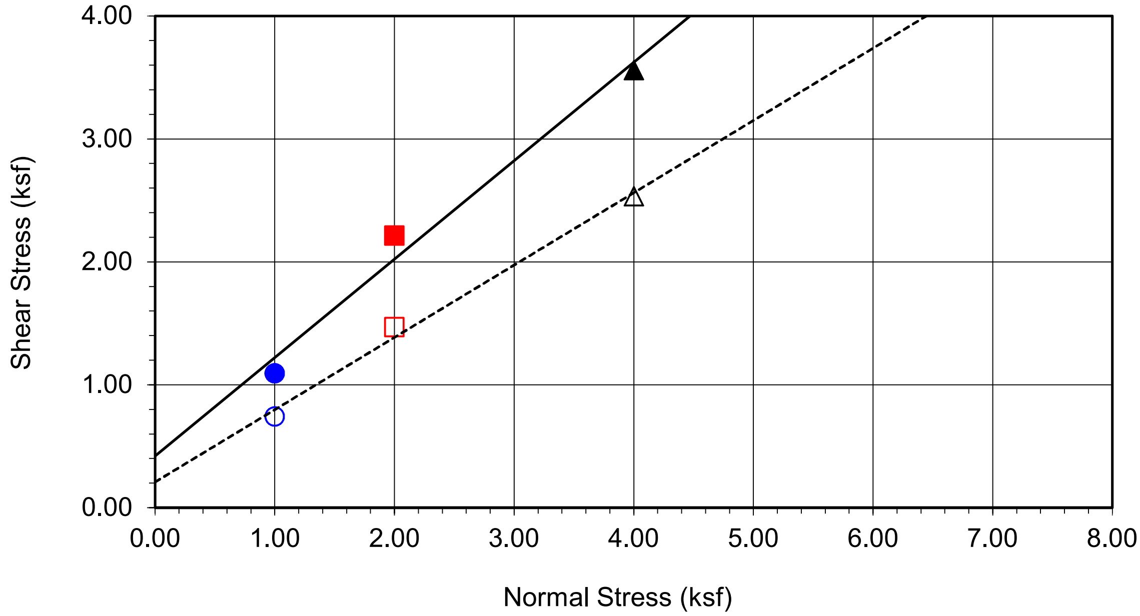

Boring No.	**LB-30**
Sample No.	**R-3**
Depth (ft)	**10**
Sample Type:	Ring

Soil Identification:
Yellowish brown sandy silt
s(ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	421	39
Ultimate	209	30

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.094	■ 2.213	▲ 3.559
Shear Stress @ End of Test (ksf)	○ 0.742	□ 1.468	△ 2.534
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	9.46	9.46	9.46
Dry Density (pcf)	107.4	108.5	110.2
Saturation (%)	44.9	46.2	48.3
Soil Height Before Shearing (in.)	0.9952	0.9875	0.9855
Final Moisture Content (%)	20.1	20.4	21.5

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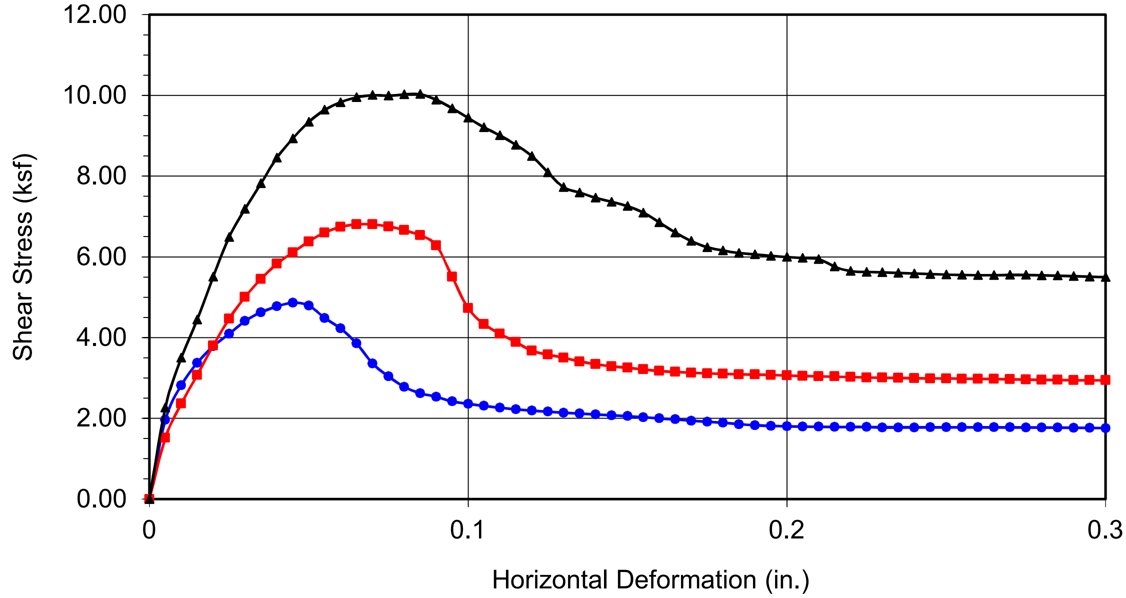
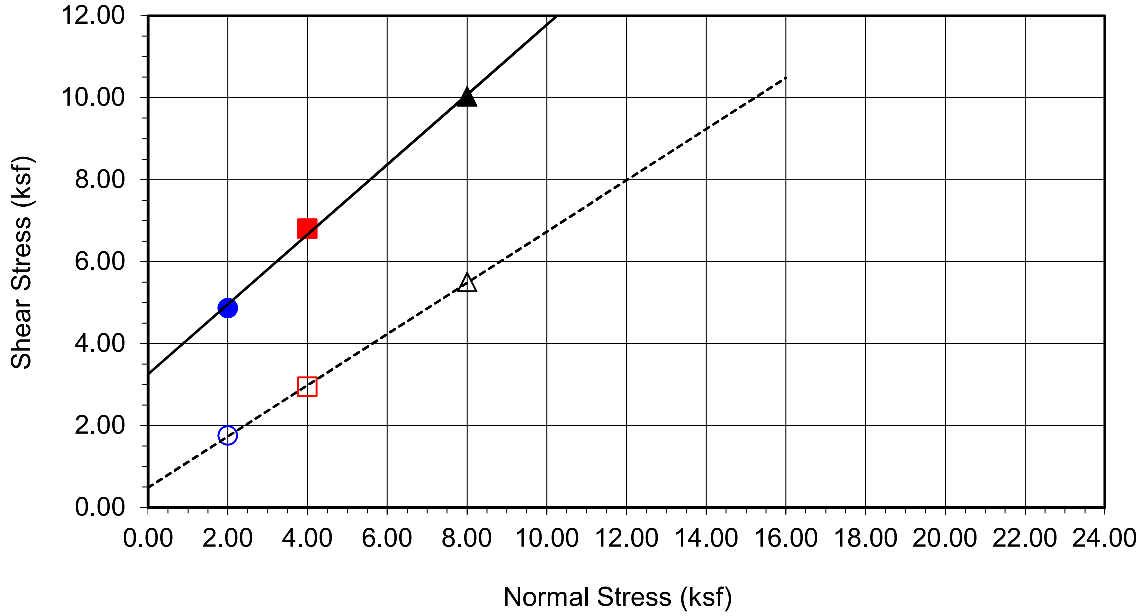




Boring No.	**LB-30**
Sample No.	**R-7**
Depth (ft)	**30**
Sample Type:	Ring

Soil Identification:
Olive gray silt stone (ML)

Strength Parameters

	C (psf)	ϕ (°)
Peak	3250	40
Ultimate	481	32

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 4.863	■ 6.803	▲10.029
Shear Stress @ End of Test (ksf)	○ 1.757	□ 2.943	△ 5.495
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	18.05	18.05	18.05
Dry Density (pcf)	112.9	113.5	113.6
Saturation (%)	98.8	100.4	100.8
Soil Height Before Shearing (in.)	0.9983	0.9921	0.9835
Final Moisture Content (%)	21.3	20.8	20.2

Leighton

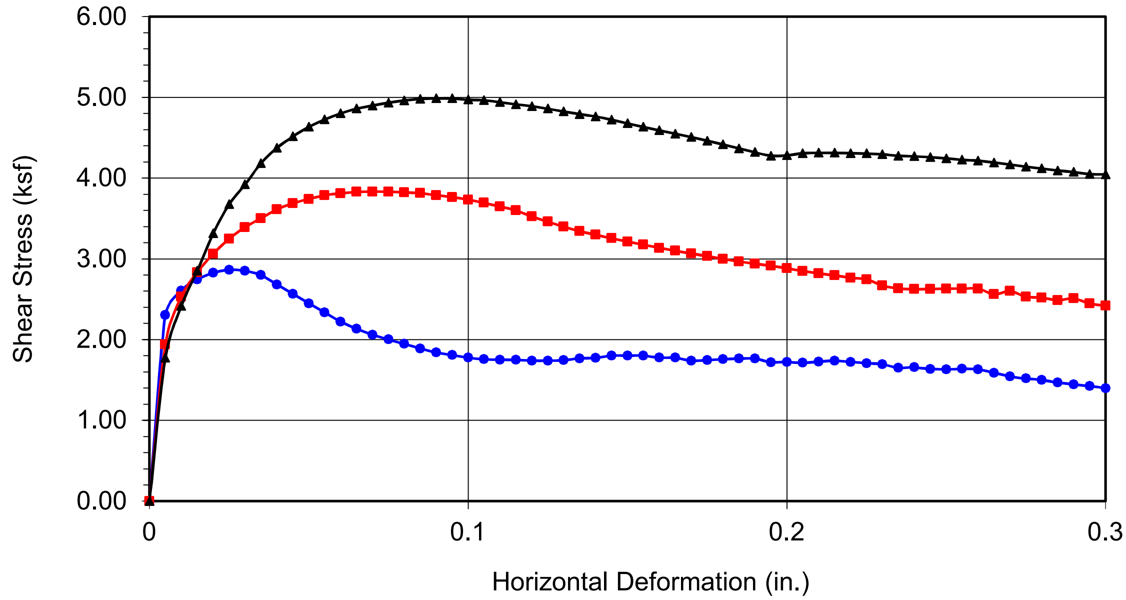
DIRECT SHEAR TEST RESULTS

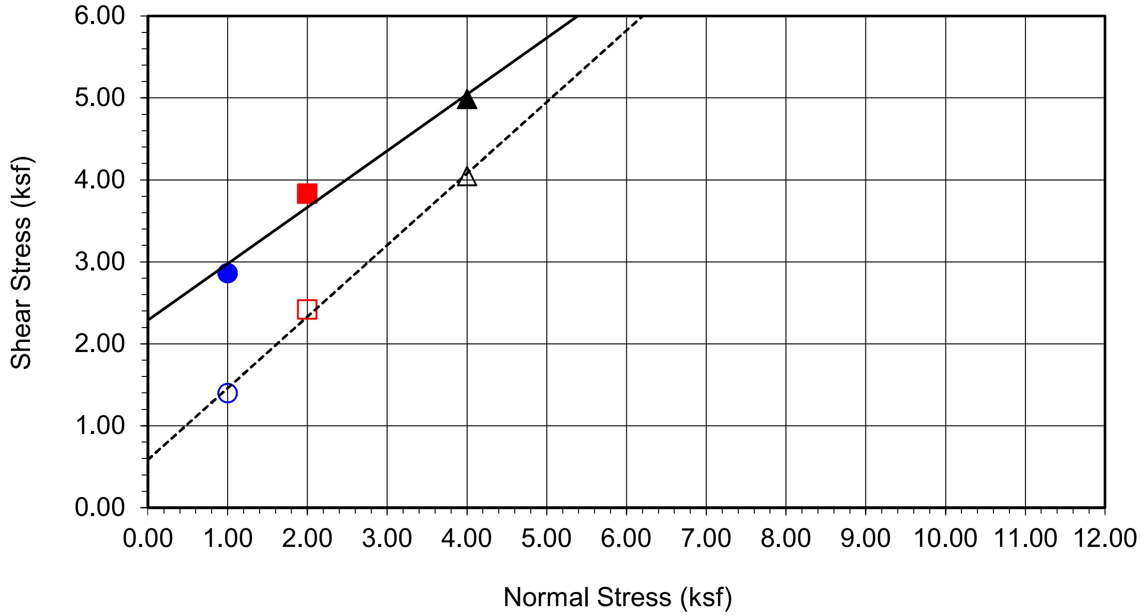
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

11-20





Boring No.	**LB-31**
Sample No.	**R-2**
Depth (ft)	**10**
Sample Type:	Tube

Soil Identification:
Dark brown lean clay with sand (CL)s

Strength Parameters

	C (psf)	ϕ (°)
Peak	2287	35
Ultimate	585	41

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 2.864	■ 3.832	▲ 4.986
Shear Stress @ End of Test (ksf)	○ 1.399	□ 2.418	△ 4.046
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	13.07	13.07	13.07
Dry Density (pcf)	117.9	118.1	118.5
Saturation (%)	82.1	82.6	83.5
Soil Height Before Shearing (in.)	1.0161	1.0143	1.0046
Final Moisture Content (%)	17.8	18.2	17.4

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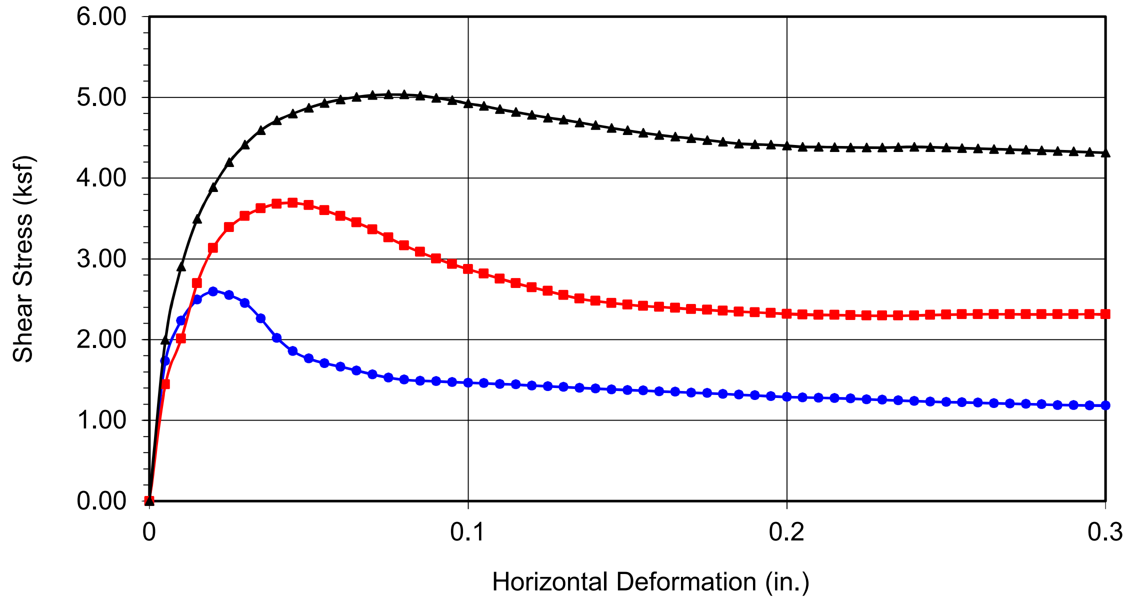
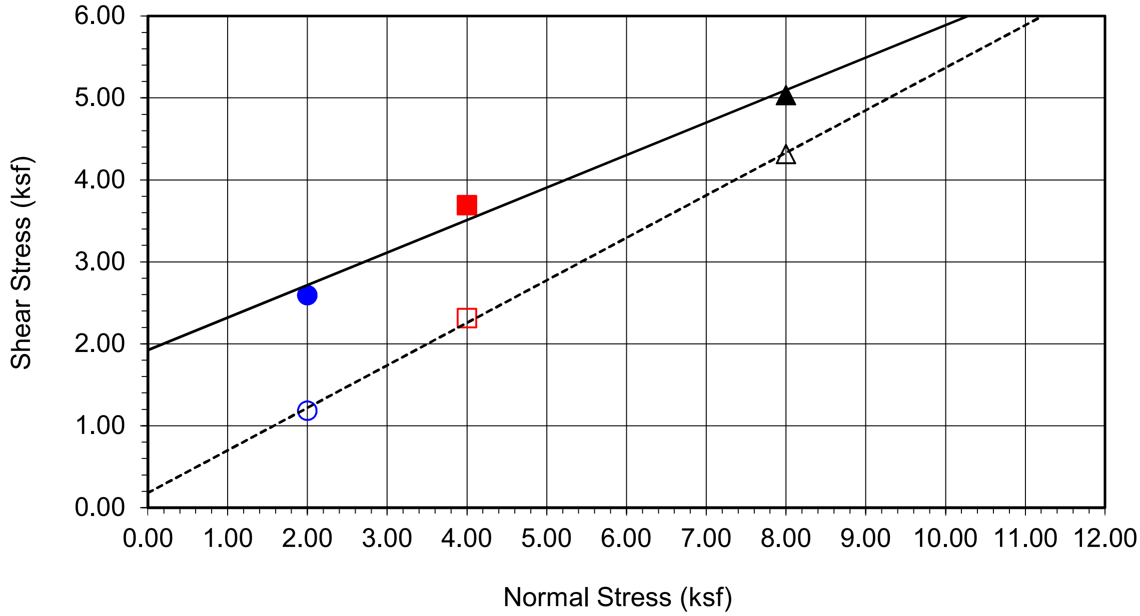
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-31**
Sample No.	**R-6**
Depth (ft)	**30**
Sample Type:	Ring

Soil Identification:
Dark olive brown lean clay stone (CL)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	1923	22
Ultimate	181	27

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.594	■ 3.691	▲ 5.033
Shear Stress @ End of Test (ksf)	○ 1.182	□ 2.311	△ 4.313
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	29.22	29.22	29.22
Dry Density (pcf)	91.0	91.8	92.0
Saturation (%)	92.6	94.4	94.8
Soil Height Before Shearing (in.)	1.0001	0.9954	0.9835
Final Moisture Content (%)	33.8	33.4	32.9

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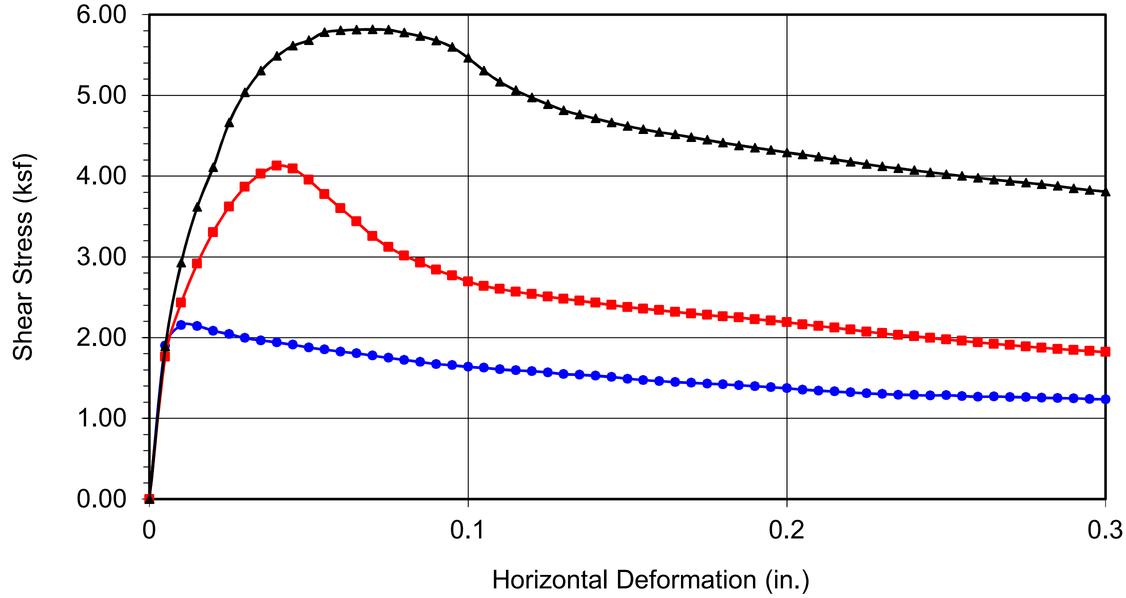
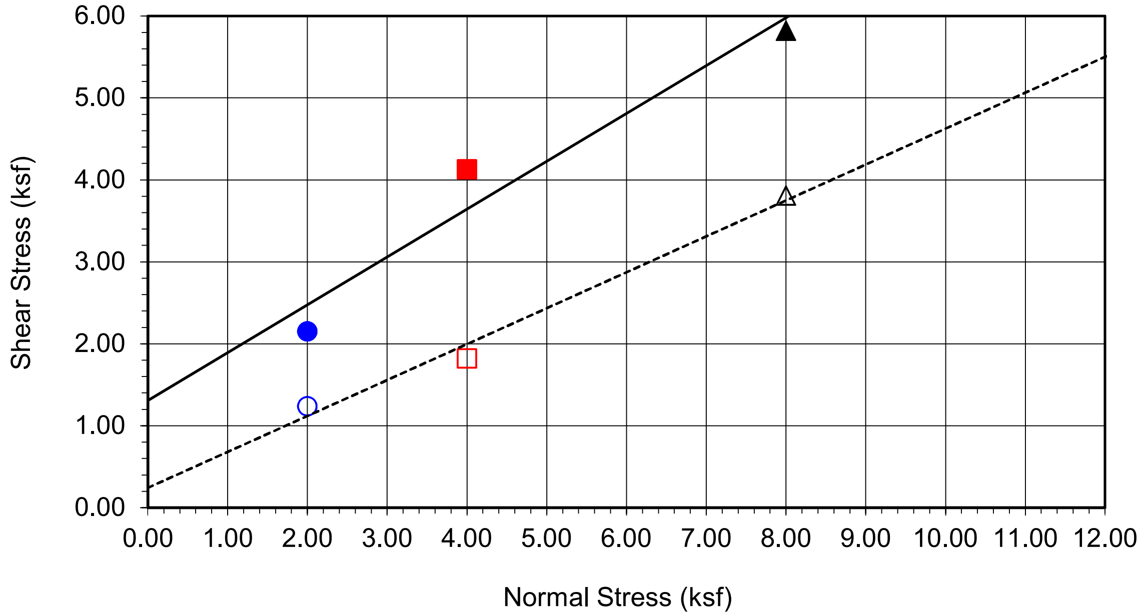
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-32**
Sample No.	**R-6**
Depth (ft)	**30**
Sample Type:	Ring

Soil Identification:
Olive gray lean clay stone (CL)

Strength Parameters

	C (psf)	ϕ (°)
Peak	1309	30
Ultimate	243	24

Normal Stress (kip/ft²)	2.000	4.000	8.000
Peak Shear Stress (kip/ft²)	● 2.153	■ 4.128	▲ 5.816
Shear Stress @ End of Test (ksf)	○ 1.236	□ 1.820	△ 3.807
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	31.75	31.75	31.75
Dry Density (pcf)	77.7	85.0	86.2
Saturation (%)	73.3	87.2	89.7
Soil Height Before Shearing (in.)	1.0000	0.9896	0.9851
Final Moisture Content (%)	45.8	38.9	38.0

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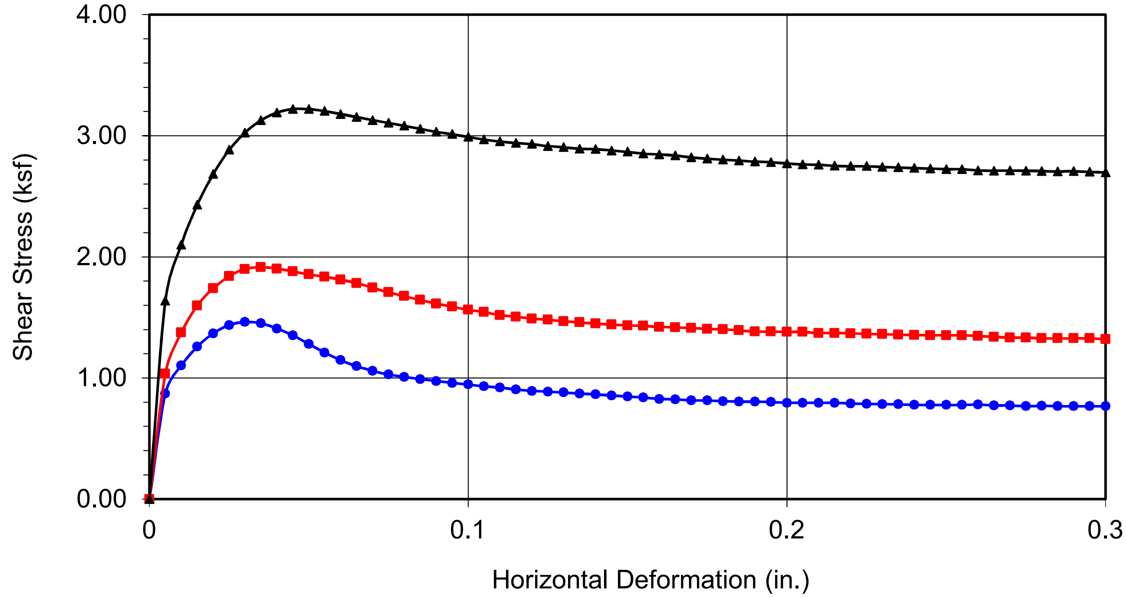
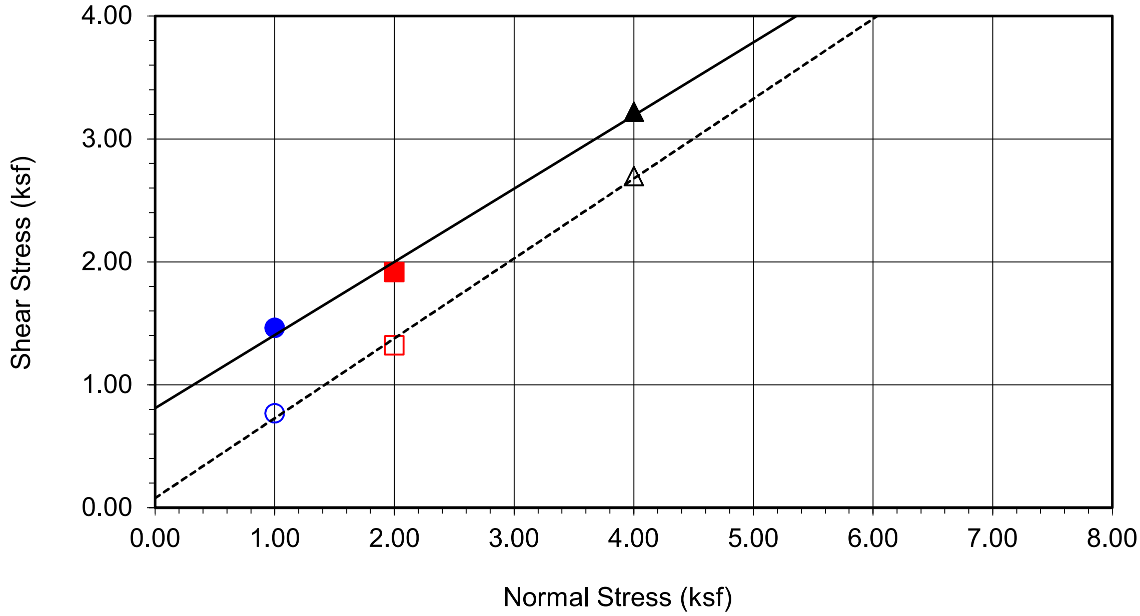
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-33**
Sample No.	**R-4**
Depth (ft)	**12.5**
Sample Type:	Ring

Soil Identification:
Olive brown lean clay (CL)

Strength Parameters

	C (psf)	ϕ (^{o})
Peak	810	31
Ultimate	78	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 1.462	■ 1.915	▲ 3.219
Shear Stress @ End of Test (ksf)	○ 0.767	□ 1.320	△ 2.697
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	16.20	16.20	16.20
Dry Density (pcf)	111.9	112.2	112.8
Saturation (%)	86.4	87.0	88.5
Soil Height Before Shearing (in.)	0.9998	0.9877	0.9837
Final Moisture Content (%)	18.8	19.2	18.6

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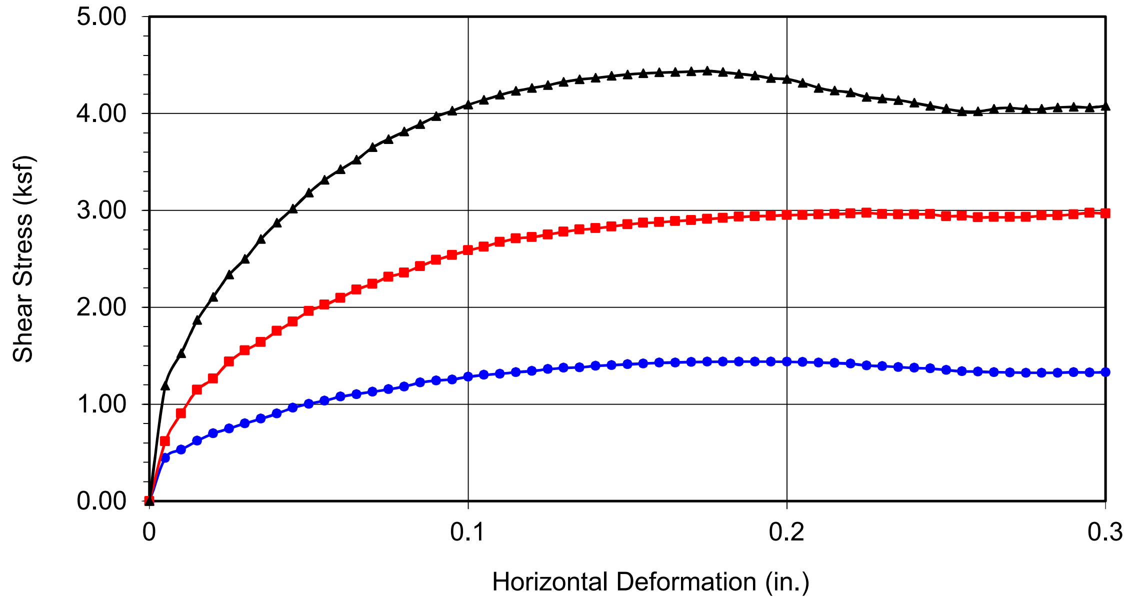
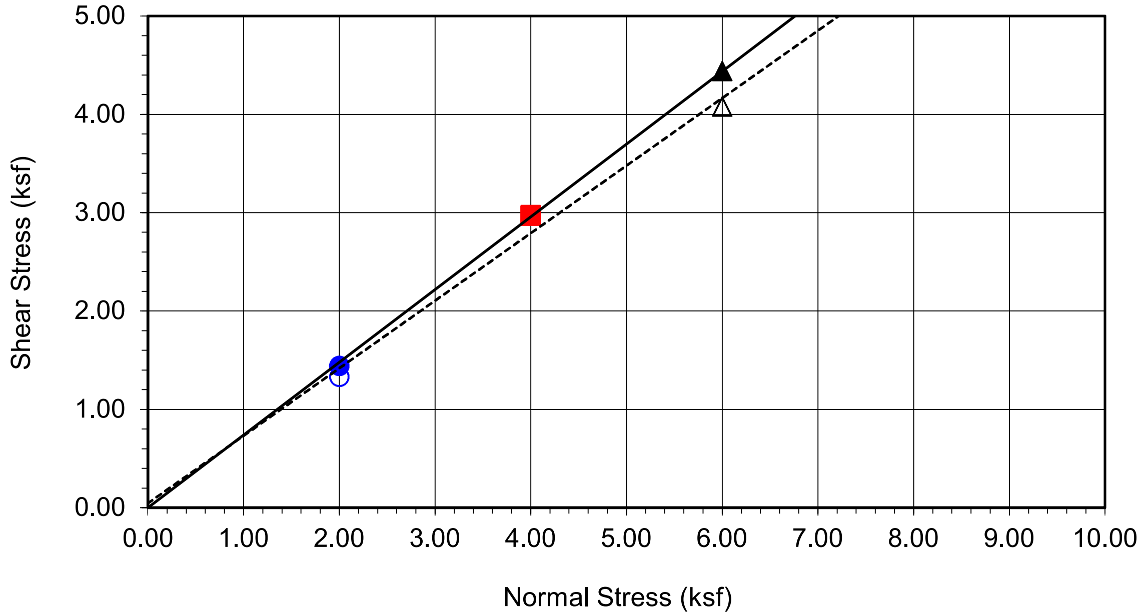
DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-34**
Sample No.	**R-5**
Depth (ft)	**20**
Sample Type:	Ring

Soil Identification:
Olive yellow silty sand (SM)

Strength Parameters

	C (psf)	ϕ (°)
Peak	0	36
Ultimate	45	34

Normal Stress (kip/ft²)	2.000	4.000	6.000
Peak Shear Stress (kip/ft²)	● 1.440	■ 2.974	▲ 4.439
Shear Stress @ End of Test (ksf)	○ 1.330	□ 2.968	△ 4.077
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	5.87	5.87	5.87
Dry Density (pcf)	93.6	93.7	99.3
Saturation (%)	19.8	19.9	22.7
Soil Height Before Shearing (in.)	0.9432	0.9545	0.9477
Final Moisture Content (%)	20.6	19.8	18.7

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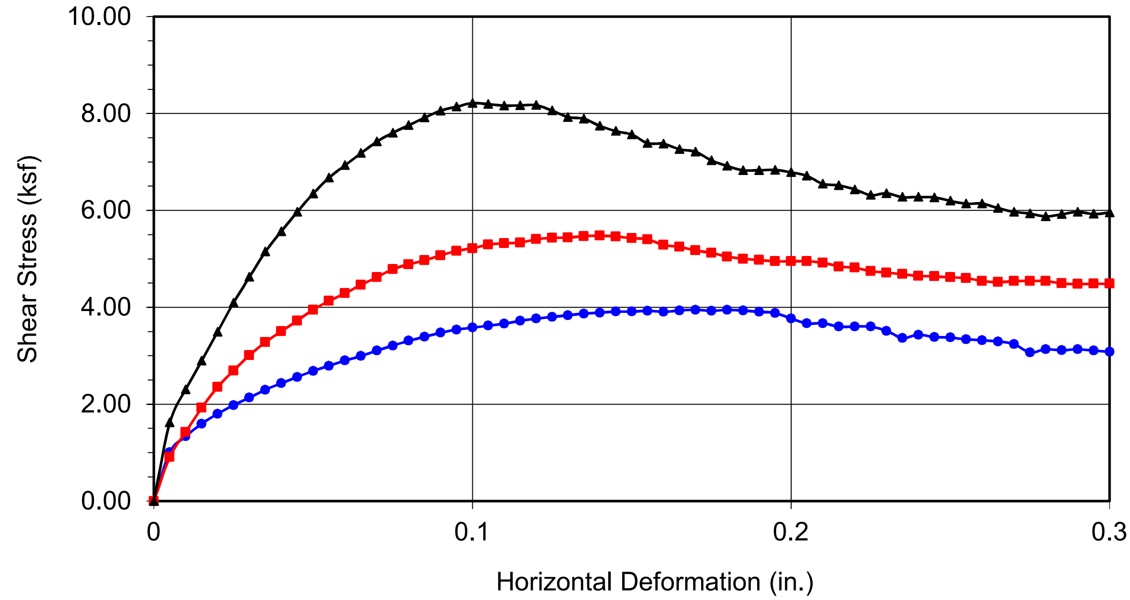
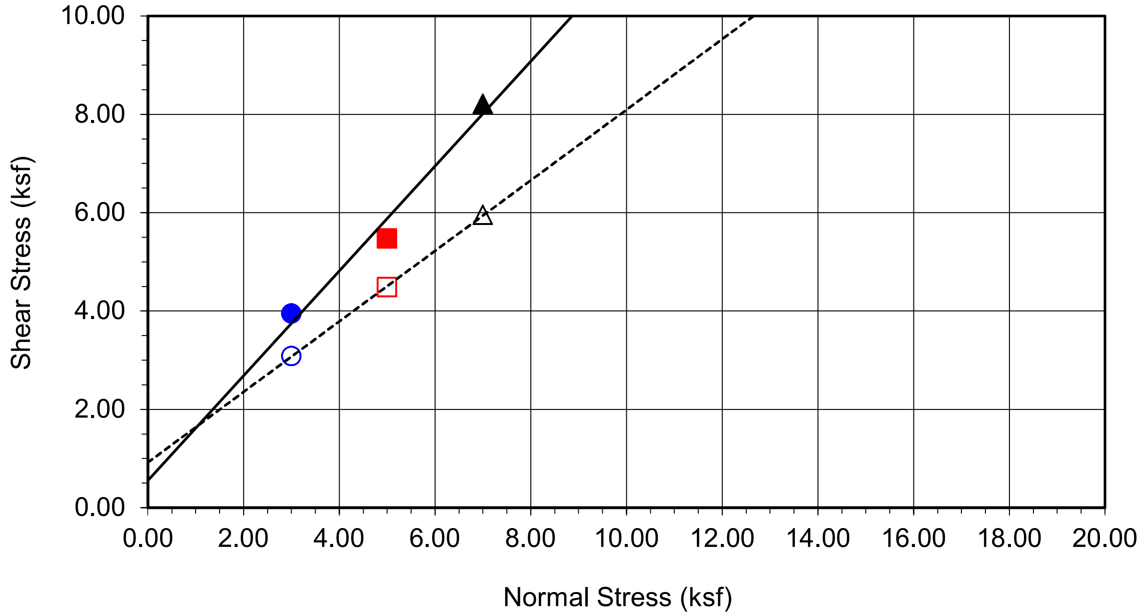
DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005

Brea Boulevard Additional Borings

10-20





Boring No.	**LB-34**
Sample No.	**R-9**
Depth (ft)	**40**
Sample Type:	Ring

Soil Identification:
Greenish gray silty, clayey sand with gravel (SC-SM)g

Strength Parameters

	C (psf)	ϕ (°)
Peak	550	47
Ultimate	920	36

Normal Stress (kip/ft²)	3.000	5.000	7.000
Peak Shear Stress (kip/ft²)	● 3.949	■ 5.476	▲ 8.212
Shear Stress @ End of Test (ksf)	○ 3.084	□ 4.486	△ 5.954
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	14.48	14.48	14.48
Dry Density (pcf)	113.3	116.8	118.1
Saturation (%)	80.2	88.1	91.6
Soil Height Before Shearing (in.)	0.9787	0.9716	0.9762
Final Moisture Content (%)	17.2	15.1	15.1

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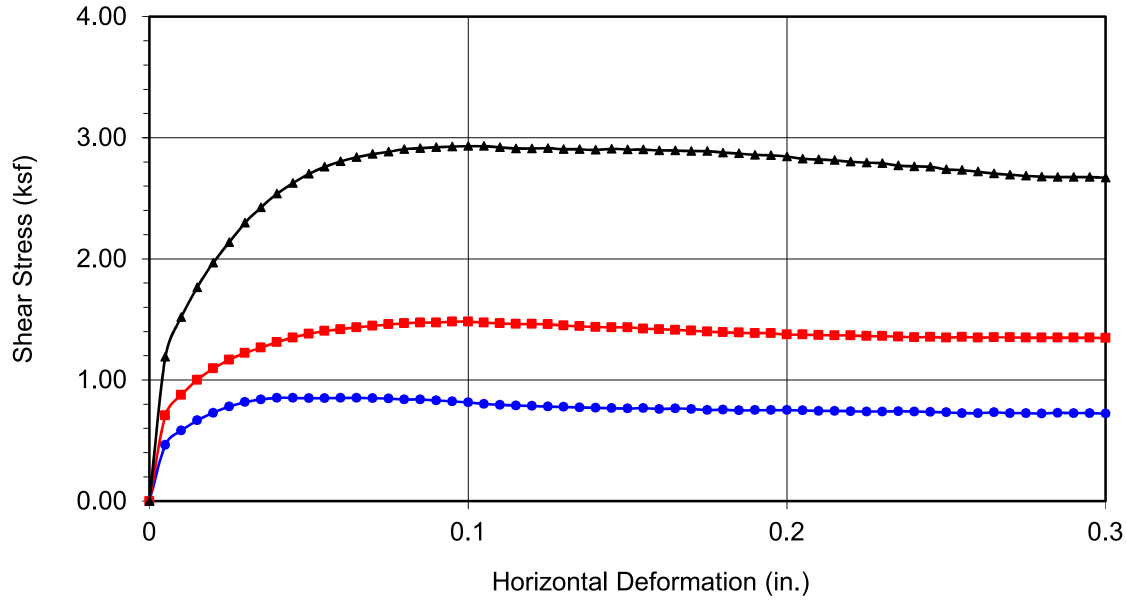
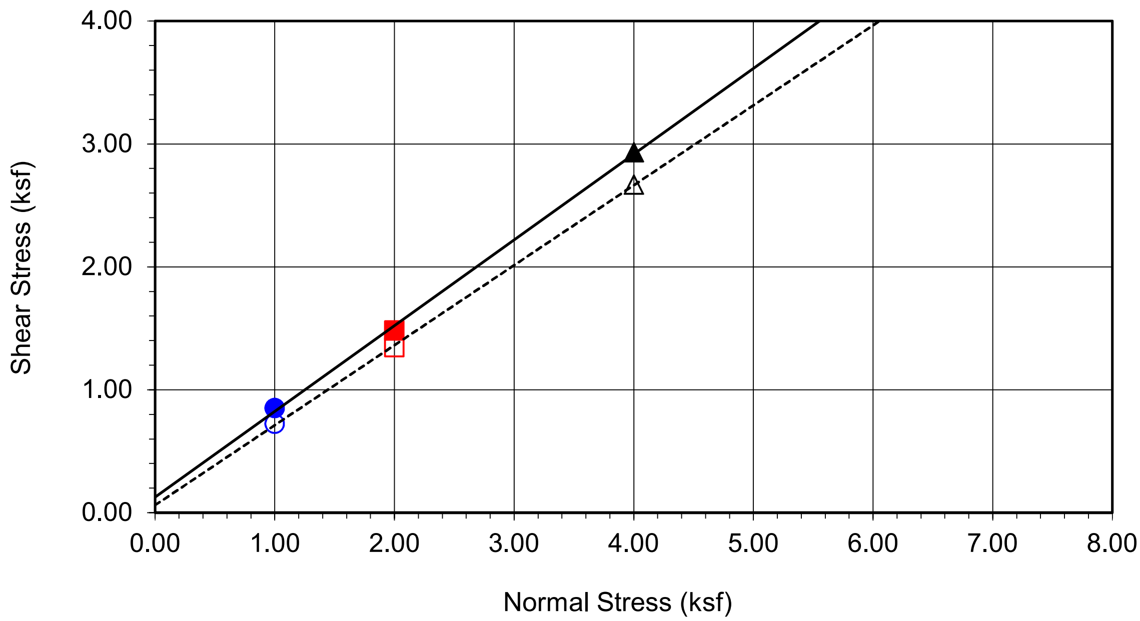
DIRECT SHEAR TEST RESULTS
Consolidated Undrained

Project No.: 11585.005
Brea Boulevard Additional Borings
11-20





Boring No.	**LB-38**
Sample No.	**R-6**
Depth (ft)	**18.5**
Sample Type:	Ring

Soil Identification:
Dark olive gray silt (ML), noted hydrocarbon smell

Strength Parameters

	C (psf)	ϕ (°)
Peak	128	35
Ultimate	62	33

Normal Stress (kip/ft²)	1.000	2.000	4.000
Peak Shear Stress (kip/ft²)	● 0.852	■ 1.481	▲ 2.930
Shear Stress @ End of Test (ksf)	○ 0.723	□ 1.346	△ 2.669
Deformation Rate (in./min.)	0.0017	0.0017	0.0017
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	20.88	20.88	20.88
Dry Density (pcf)	99.3	102.5	105.0
Saturation (%)	80.9	87.4	93.2
Soil Height Before Shearing (in.)	0.9861	0.9850	0.9763
Final Moisture Content (%)	22.9	20.2	16.7

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DIRECT SHEAR TEST RESULTS
Consolidated Drained - ASTM D 3080

Project No.: 11585.005

Brea Boulevard Additional Borings

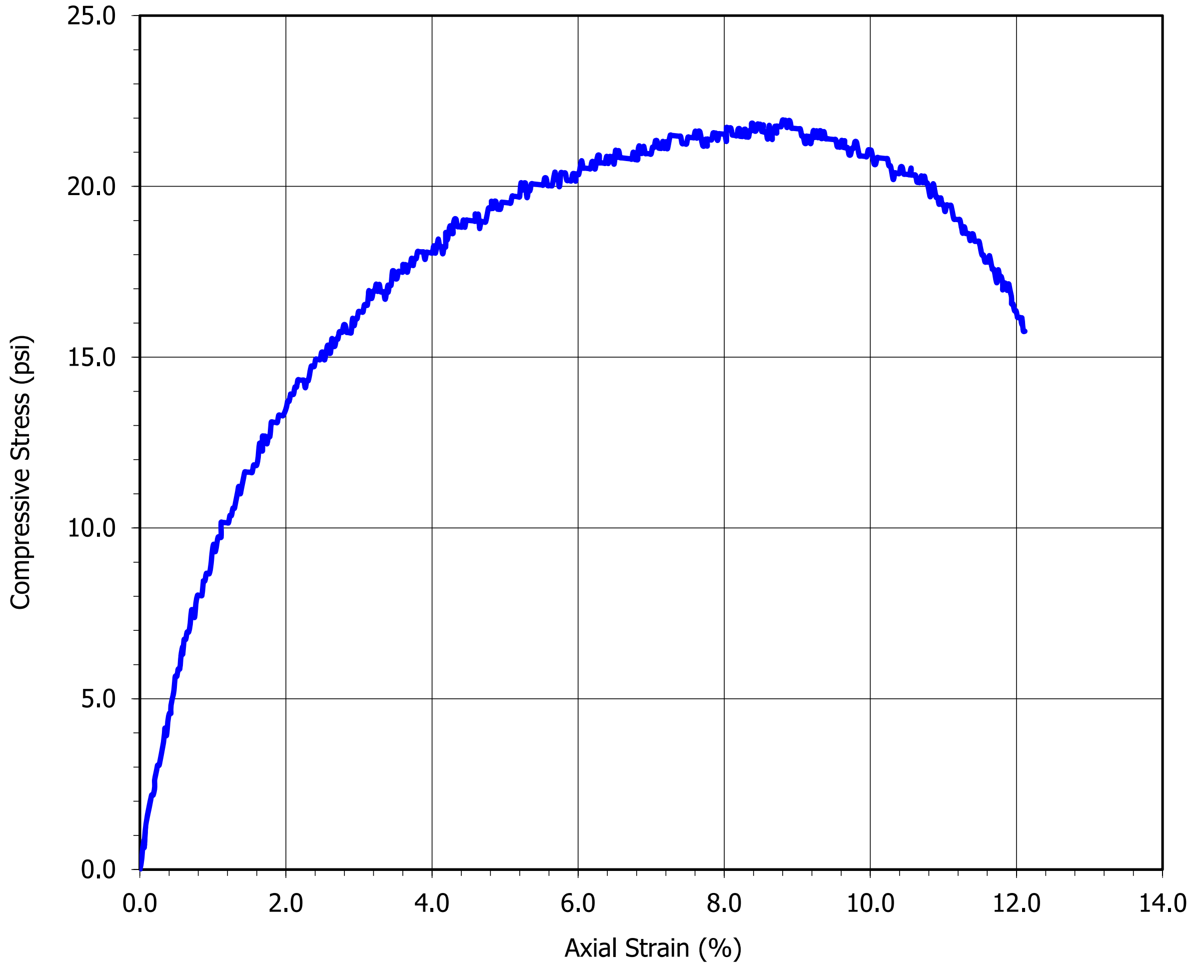
10-20

DS LB-38, R-6 @ 18.5

APPENDIX C.4

Shear Strength:

Uniaxial Compression



Boring No.:	LB-2
Sample No.:	R-5
Depth (ft):	14.0
Soil Type:	Ring
Sample Description:	Olive brown lean clay (CL)

Sample Diameter (in.)	2.413
Sample Height (in.)	4.944
Initial Moisture Content (%)	19.26
Dry Density (pcf)	105.7
Specific Gravity (assumed)	2.70
Saturation (%)	87.6
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.05

At Failure

Compressive Strength (psi)	**21.94**
Axial Strain (%)	8.80

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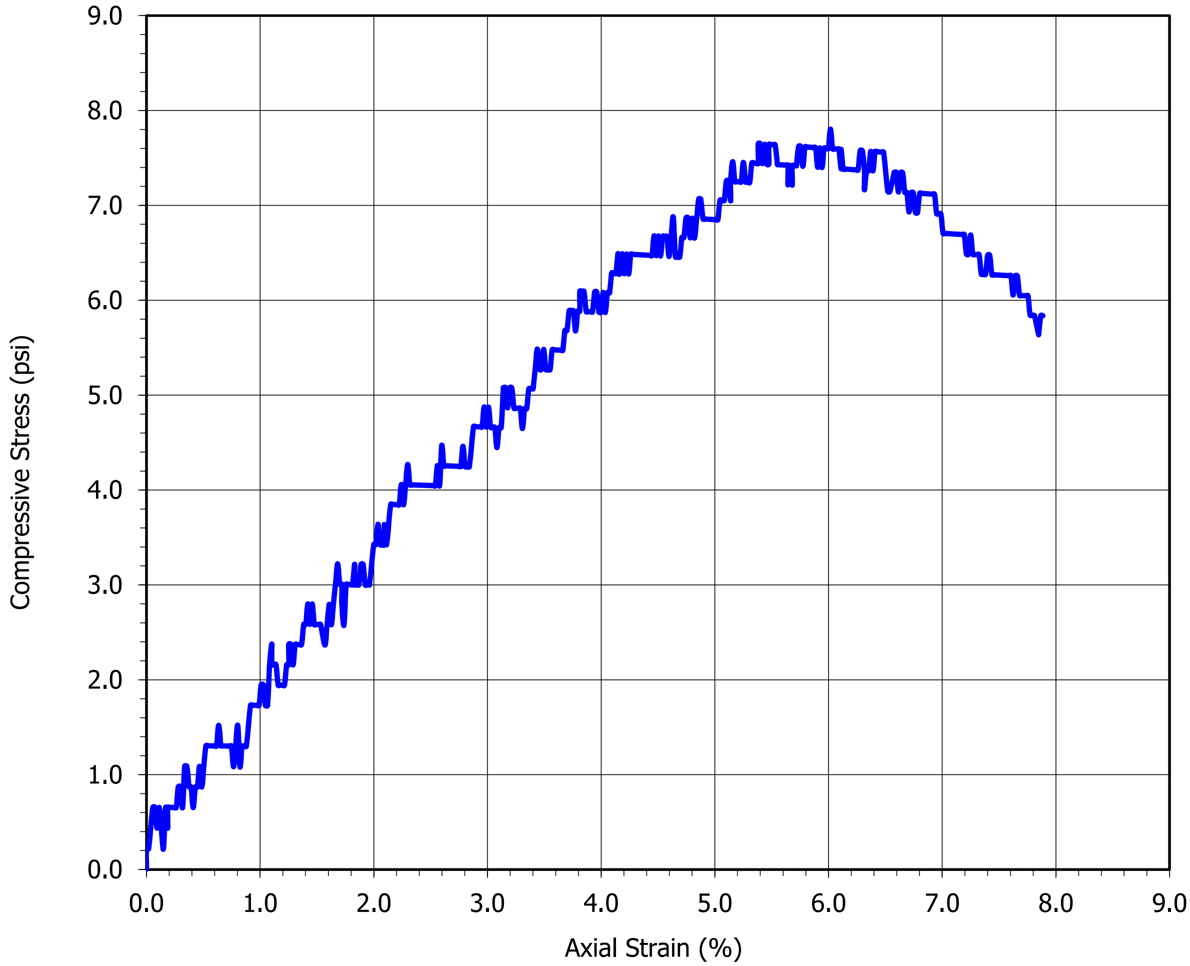
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-2
Sample No.:	R-7
Depth (ft):	20.0
Soil Type:	Ring
Sample Description:	Olive silty sand (SM)

Sample Diameter (in.)	2.414
Sample Height (in.)	5.352
Initial Moisture Content (%)	20.55
Dry Density (pcf)	107.2
Specific Gravity (assumed)	2.70
Saturation (%)	97.1
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.22

At Failure

Compressive Strength (psi)	**7.80**
Axial Strain (%)	6.02

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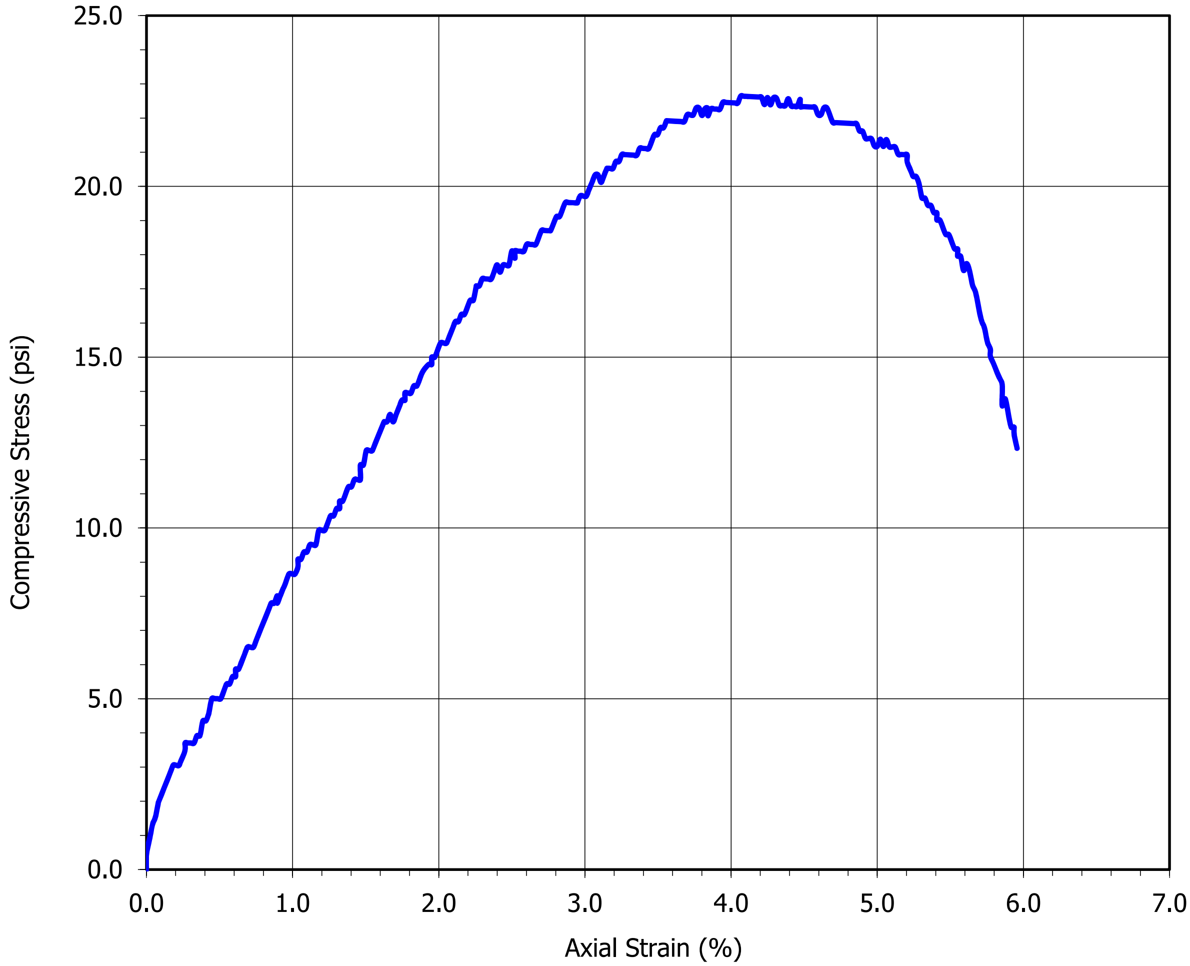
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-4
Sample No.:	R-5
Depth (ft):	14.0
Soil Type:	Ring
Sample Description:	Olive brown clayey sand (SC)

Sample Diameter (in.)	2.414
Sample Height (in.)	4.919
Initial Moisture Content (%)	17.80
Dry Density (pcf)	109.0
Specific Gravity (assumed)	2.70
Saturation (%)	88.1
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.04

At Failure

Compressive Strength (psi)	**22.64**
Axial Strain (%)	4.07

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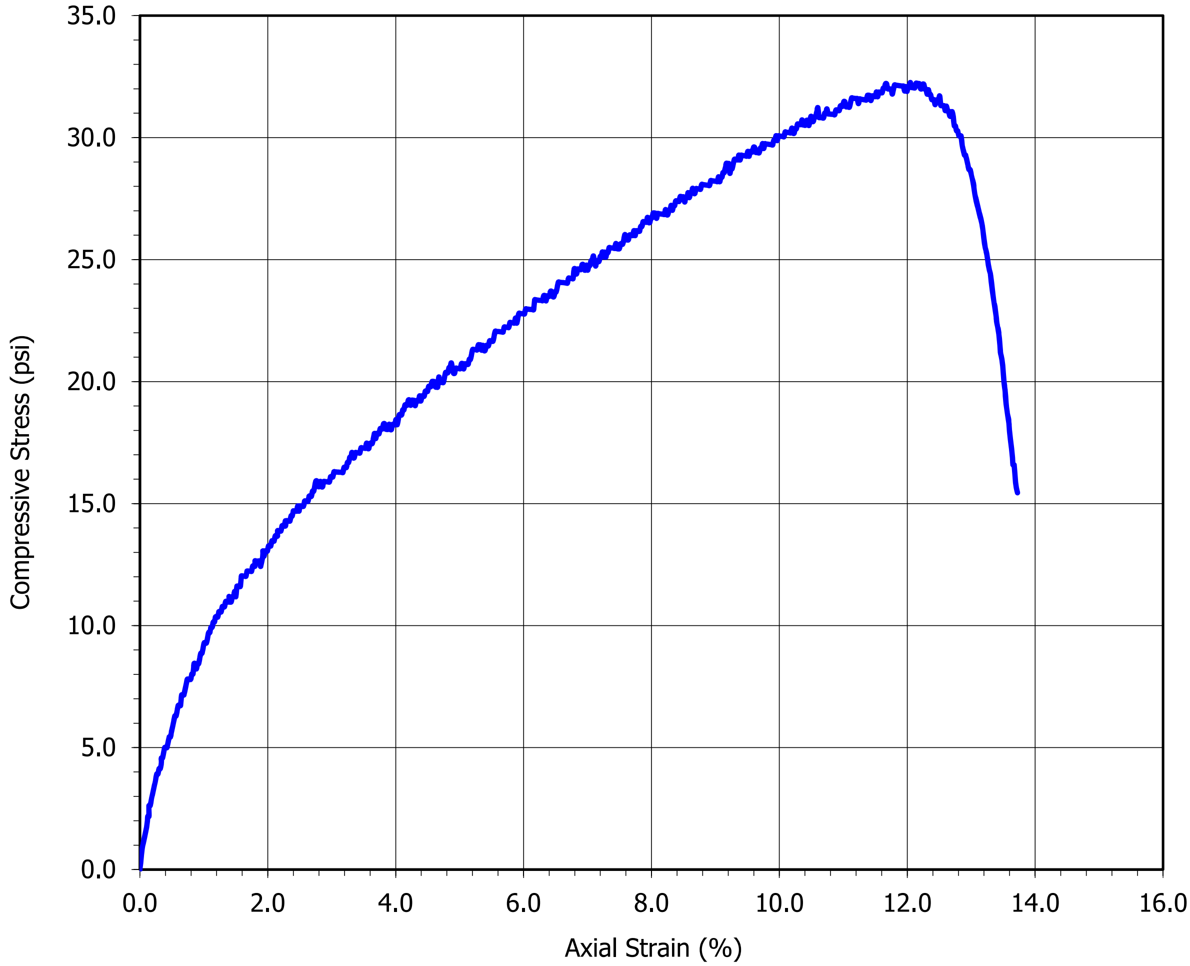
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11588.001**

Brea Boulevard Corridor Improvements

09/05/18



Boring No.:	LB-26
Sample No.:	R-4
Depth (ft):	18.5
Soil Type:	Ring
Sample Description:	Dark olive lean clay (CL)

Sample Diameter (in.)	2.415
Sample Height (in.)	5.669
Initial Moisture Content (%)	20.92
Dry Density (pcf)	103.4
Specific Gravity (assumed)	2.70
Saturation (%)	89.8
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.35

At Failure

Compressive Strength (psi)	**32.26**
Axial Strain (%)	12.05

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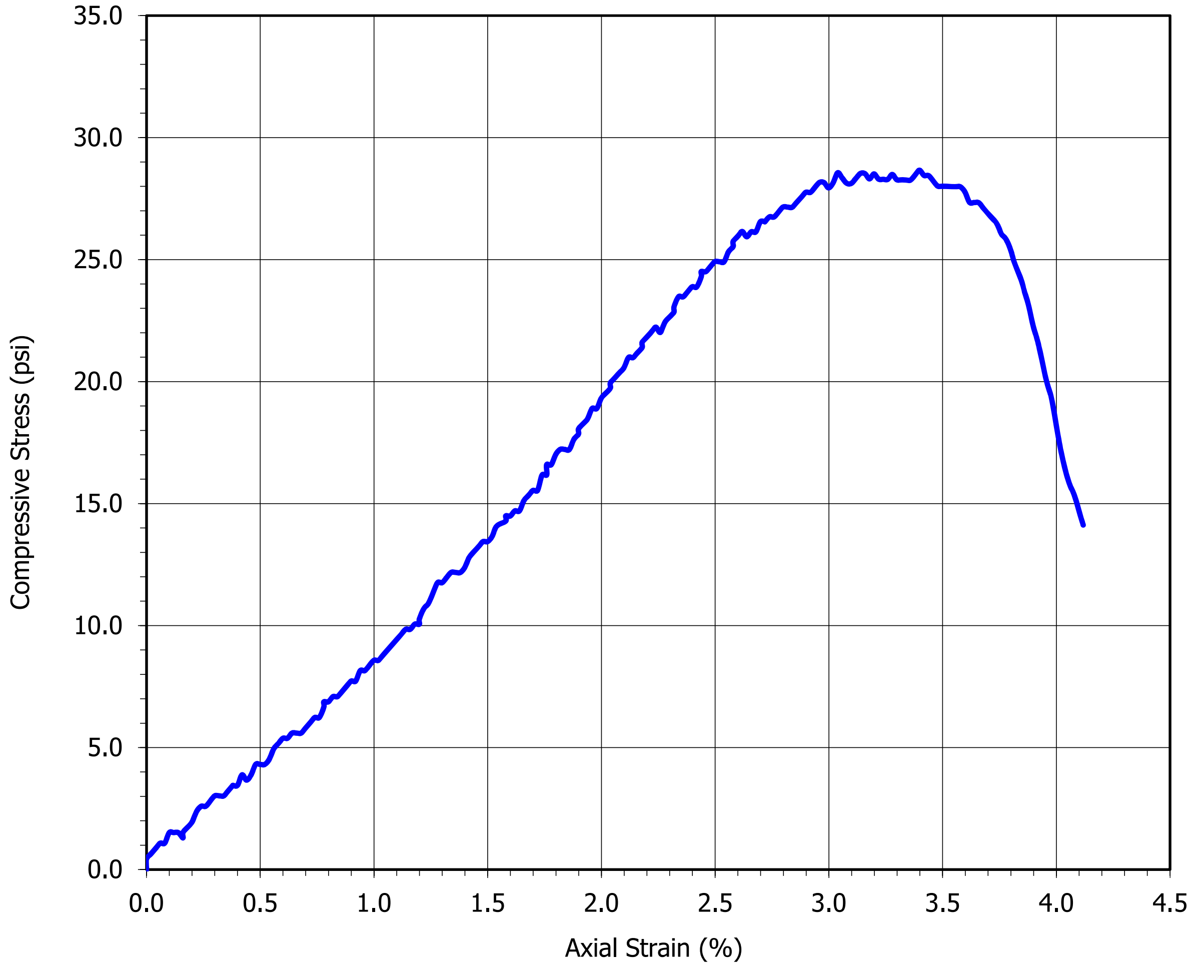
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20



Boring No.:	LB-39
Sample No.:	R-7
Depth (ft):	30
Soil Type:	Ring
Sample Description:	Light olive (SP-SM) & ML

Sample Diameter (in.)	2.425
Sample Height (in.)	5.002
Initial Moisture Content (%)	16.19
Dry Density (pcf)	108.8
Specific Gravity (assumed)	2.70
Saturation (%)	79.6
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.06

At Failure

Compressive Strength (psi)	**28.66**
Axial Strain (%)	3.40

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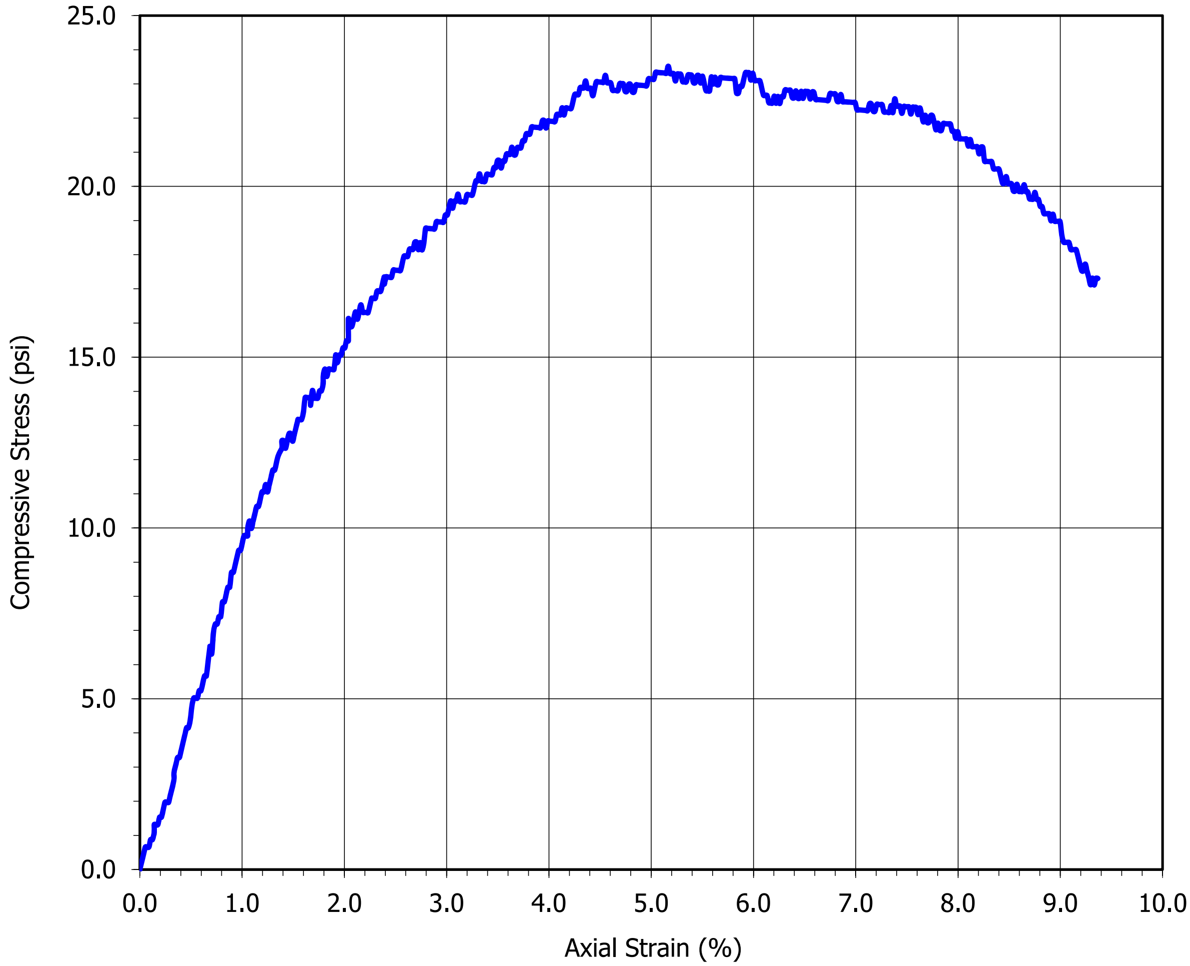
Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20



Boring No.:	LB-40
Sample No.:	R-7
Depth (ft):	30
Soil Type:	Ring
Sample Description:	Dark olive gray silt (ML)

Sample Diameter (in.)	2.409
Sample Height (in.)	5.690
Initial Moisture Content (%)	33.47
Dry Density (pcf)	85.9
Specific Gravity (assumed)	2.70
Saturation (%)	94.0
Rate of Deformation (in/min)	0.0500
Height / Diameter Ratio	2.36

At Failure

Compressive Strength (psi)	**23.52**
Axial Strain (%)	5.17

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Unconfined Compressive Strength of Cohesive Soil
ASTM D 2166

Project No.: **11585.005**

Brea Boulevard Corridor Improvements

10/30/20

APPENDIX C.5

Shear Strength:

Triaxial Compression

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CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4	Sample Type:	Ring		
Sample No.:	R-11				
Depth (ft.):	40.0				
Soil Description	Dark olive silt'stone' (ML)				

Diameter (in)	2.402	2.400	2.401	Avg. =	2.401
Height (in)	5.102	5.103	5.103	Avg. =	5.103

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.528	4.522	4.468	
Moisture Content (%)	18.09			21.80
Wt. Wet Sample + Cont. (g)	179.60			858.30
Wt. Dry Sample + Cont. (g)	159.00			718.00
Wt. Container (g)	45.10			74.40
Density and Saturation				
Wt. Wet Sample + Cont. (g)	763.20			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	125.8			132.6
Dry Density (pcf)	106.6			108.9
Void Ratio	0.581			0.547
% Saturation	84.1			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

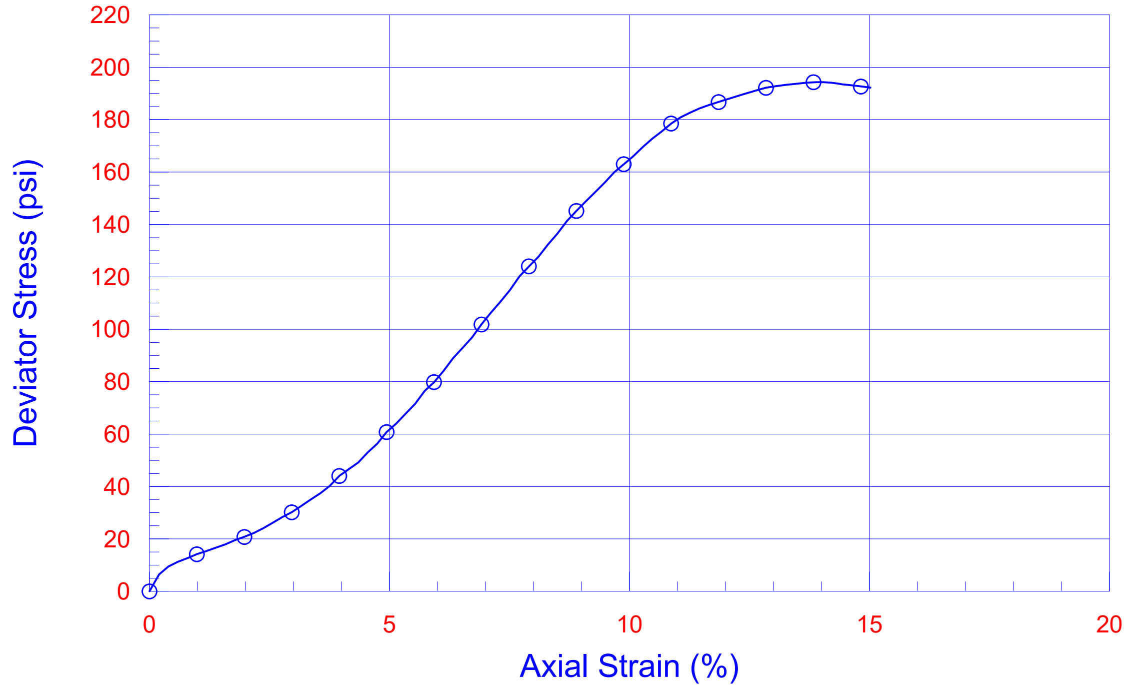
		Burette Area (sq. in.)=	0.397
		Initial Burette Ht.(cm)=	26.0
		Final Burette Ht.(cm)=	9.8
		Volume of water during saturation (cc):	41.5
B Value (%) =	95	Change in Height (in)=	0.003

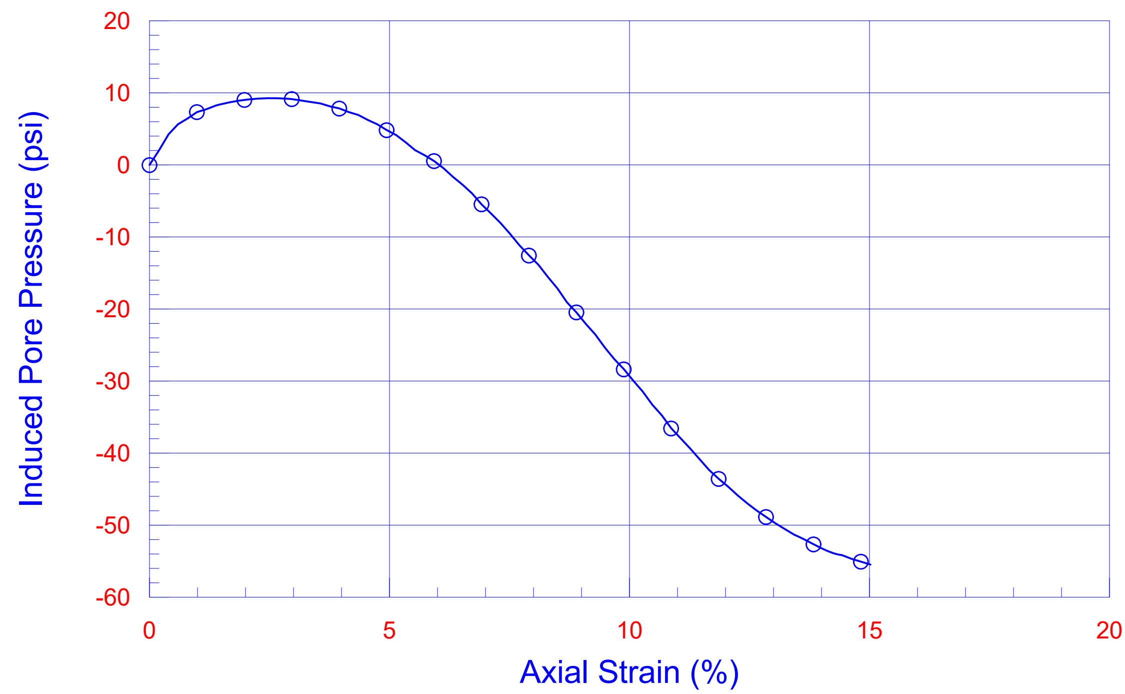
Consolidation

Cell Pressure (psi) =	96.35	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	81.35	Initial Burette Ht.(cm)=	3.8
Eff. Consol. Stress (psi) =	15.00	Final Burette Ht.(cm)=	6.7
Change in Height (in) =	0.0390	Final Height (in)=	5.061

Shear

		At Failure	
Rate of Deformation (in/min)=	0.0052	Deviator Stress (psi) =	194.3
Time to 50% primary Consolidation =	4.50 min	Eff. Minor Principal stress (psi) =	68.3
Failure Criterion:		Eff. Major Principal stress (psi) =	262.6
Maximum deviator stress, to 15% axial strain		Axial Strain (%) =	14.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-11	40.0	15.0	194.3
□					
△					

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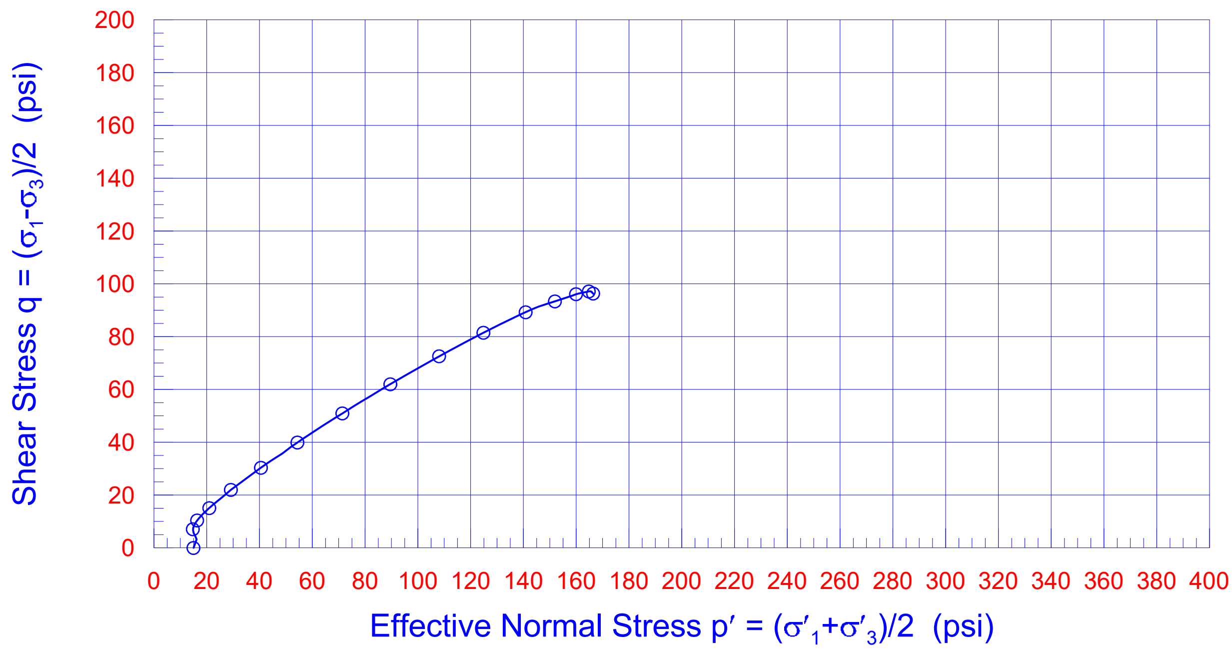
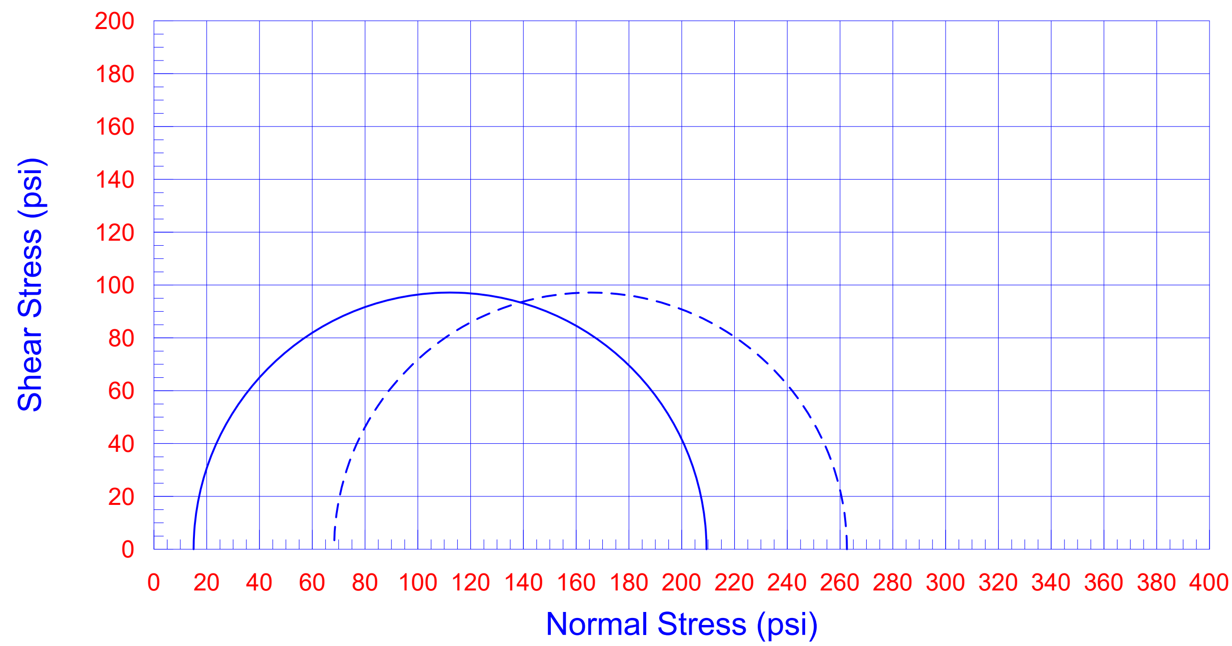
Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test ASTM D 4767

09-18





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-11	40.0	15.0	194.3
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

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Project No.: 11588.001
Brea Boulevard
Corridor Improvements

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

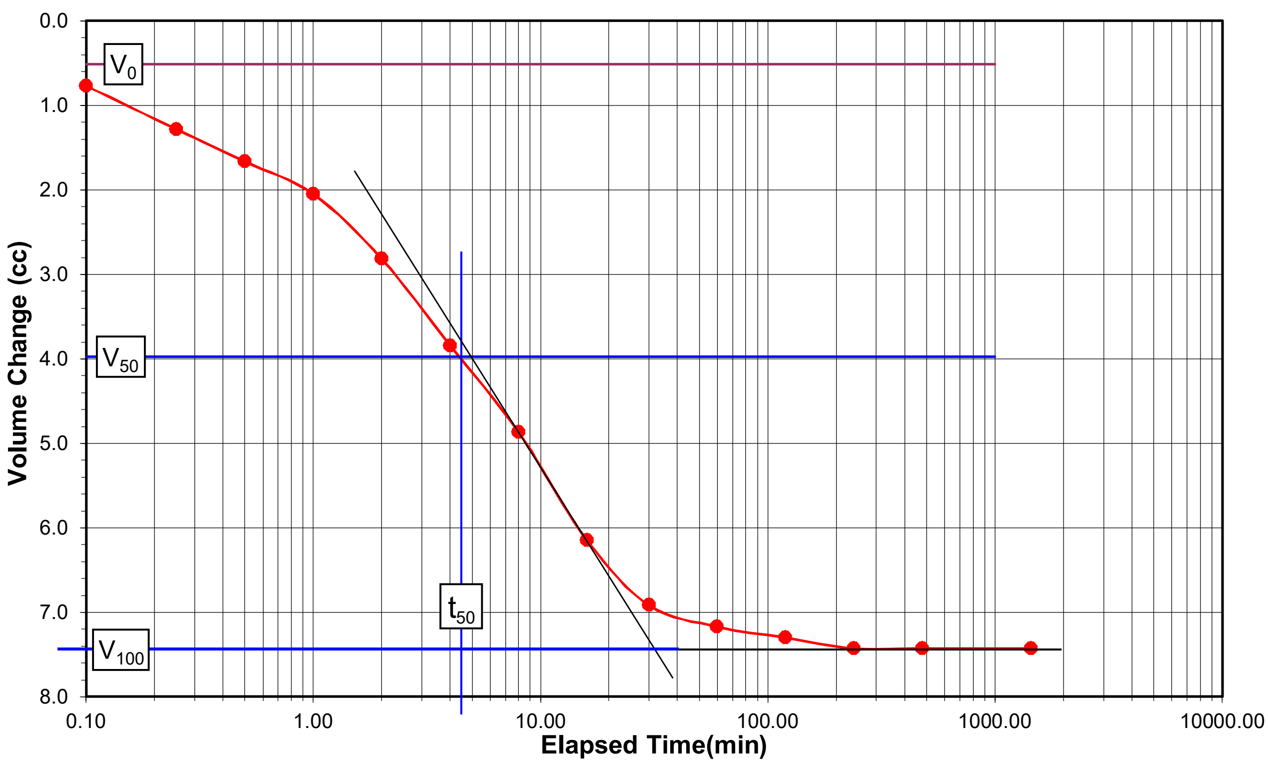
09-18

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	40.0
Boring No.:	LB-4	Eff. Stress (psi):	15.00
Sample No.:	R-11	Burette Area:	0.397 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/28/18	9:20:00			Initial Burette	3.80	
08/28/18	9:20:06	0.10	0.32		4.10	0.8
08/28/18	9:20:15	0.25	0.50		4.30	1.3
08/28/18	9:20:30	0.50	0.71		4.45	1.7
08/28/18	9:21:00	1.00	1.00		4.60	2.0
08/28/18	9:22:00	2.00	1.41		4.90	2.8
08/28/18	9:24:00	4.00	2.00		5.30	3.8
08/28/18	9:28:00	8.00	2.83		5.70	4.9
08/28/18	9:36:00	16.00	4.00		6.20	6.1
08/28/18	9:50:00	30.00	5.48		6.50	6.9
08/28/18	10:20:00	60.00	7.75		6.60	7.2
08/28/18	11:20:00	120.00	10.95		6.65	7.3
08/28/18	13:20:00	240.00	15.49		6.70	7.4
08/28/18	17:20:00	480.00	21.91		6.70	7.4
08/29/18	9:20:00	1440.00	37.95		6.70	7.4



V_0	(cc)	0.51
V_{100}	(cc)	7.43
V_{50}	(cc)	3.97
t_{50}	(min)	4.50
Height After Consolidation (in)		5.061
Strain Rate	(in/min)	**0.0045**
Duration of Test*	(hr)	2.8

*Based on a total strain of 15%

Height (ft)		5.102
		5.103
		5.103
Average		5.103
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2880	0.2930
Final Rdg. (in)	0.2910	0.3320

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4				
Sample No.:	R-11				
Depth (ft.):	40.0				
Sample Type:	Ring				

15.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4	Sample Type:	Ring		
Sample No.:	R-15				
Depth (ft.):	60.0				
Soil Description	Dark olive silt (ML)				

Diameter (in)	2.423	2.423	2.423	Avg. =	2.423
Height (in)	5.480	5.481	5.482	Avg. =	5.481

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.611	4.601	4.516	
Moisture Content (%)	16.82			22.13
Wt. Wet Sample + Cont. (g)	110.00			924.60
Wt. Dry Sample + Cont. (g)	104.50			770.80
Wt. Container (g)	71.80			75.80
Density and Saturation				
Wt. Wet Sample + Cont. (g)	822.50			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	124.0			134.6
Dry Density (pcf)	106.1			110.2
Void Ratio	0.588			0.529
% Saturation	77.3			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

Burette Area (sq. in.)=	0.358
Initial Burette Ht.(cm)=	25.0
Final Burette Ht.(cm)=	3.5
Volume of water during saturation (cc):	49.7
Change in Height (in)=	0.006

B Value (%) = 95

Consolidation

Cell Pressure (psi) =	111.37	Burette Area (sq. in.)=	0.3580
Back Pressure(psi) =	81.37	Initial Burette Ht.(cm)=	3.9
Eff. Consol. Stress (psi) =	30.00	Final Burette Ht.(cm)=	9.95
Change in Height (in) =	0.0860	Final Height (in)=	5.389

Shear

Rate of Deformation (in/min)= 0.0052

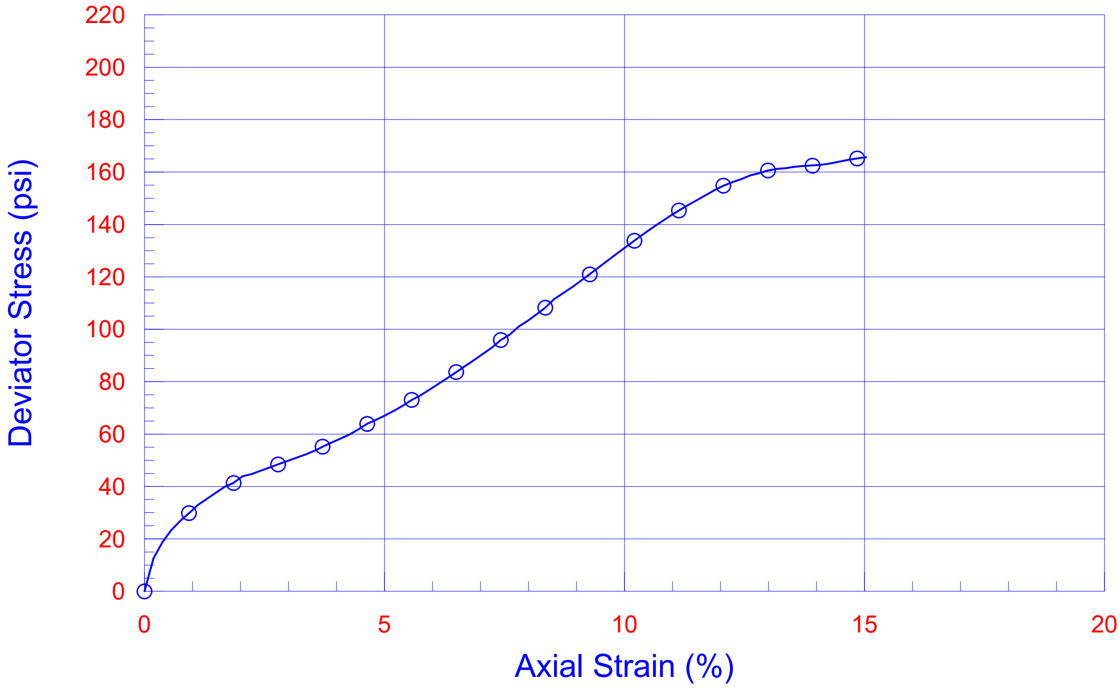
Time to 50% primary Consolidation = 2.00 min

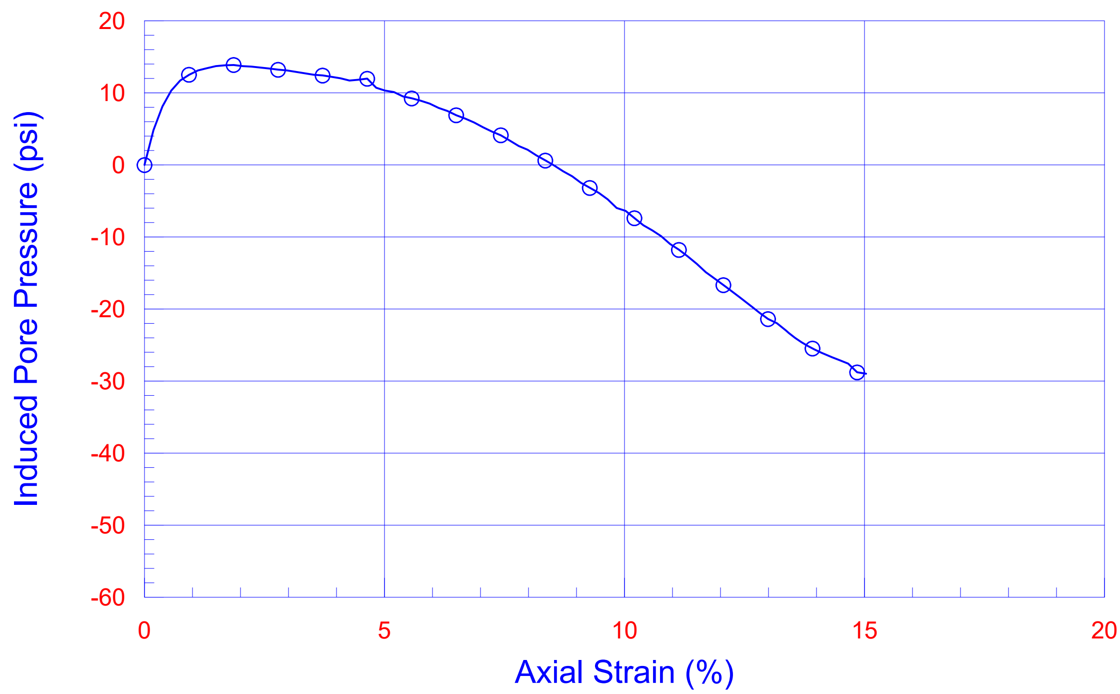
Failure Criterion:

Maximum deviator stress, to 15% axial strain

At Failure

Deviator Stress (psi) =	165.7
Eff. Minor Principal stress (psi) =	59.0
Eff. Major Principal stress (psi) =	224.7
Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-15	60.0	30.0	165.7
□					
△					

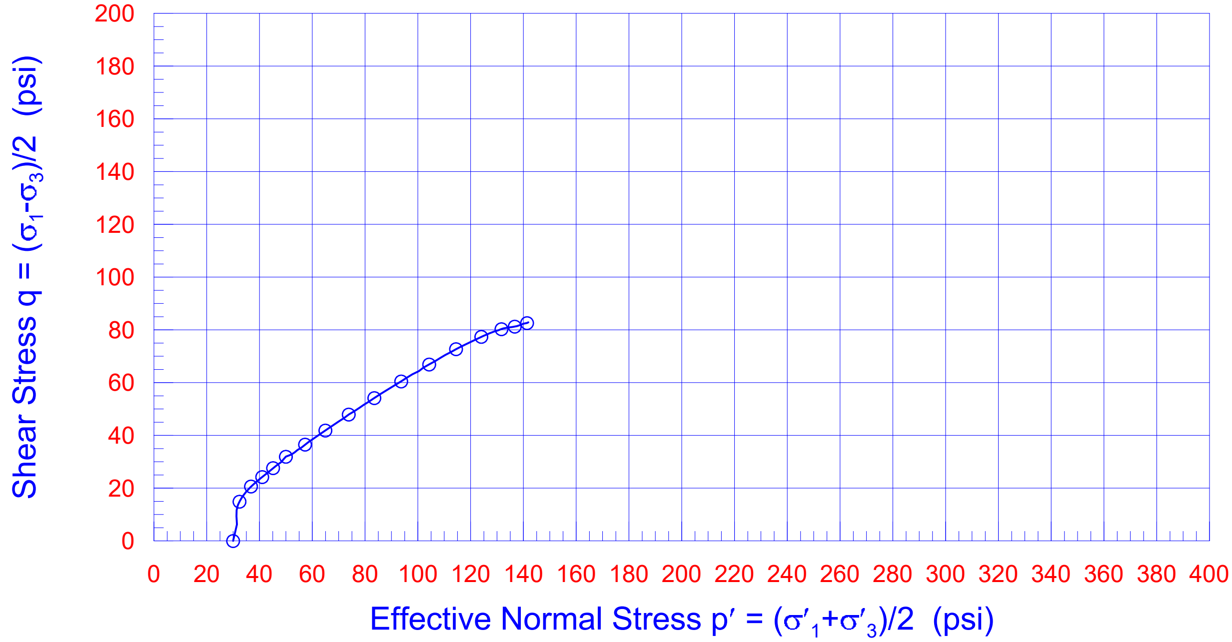
Leighton

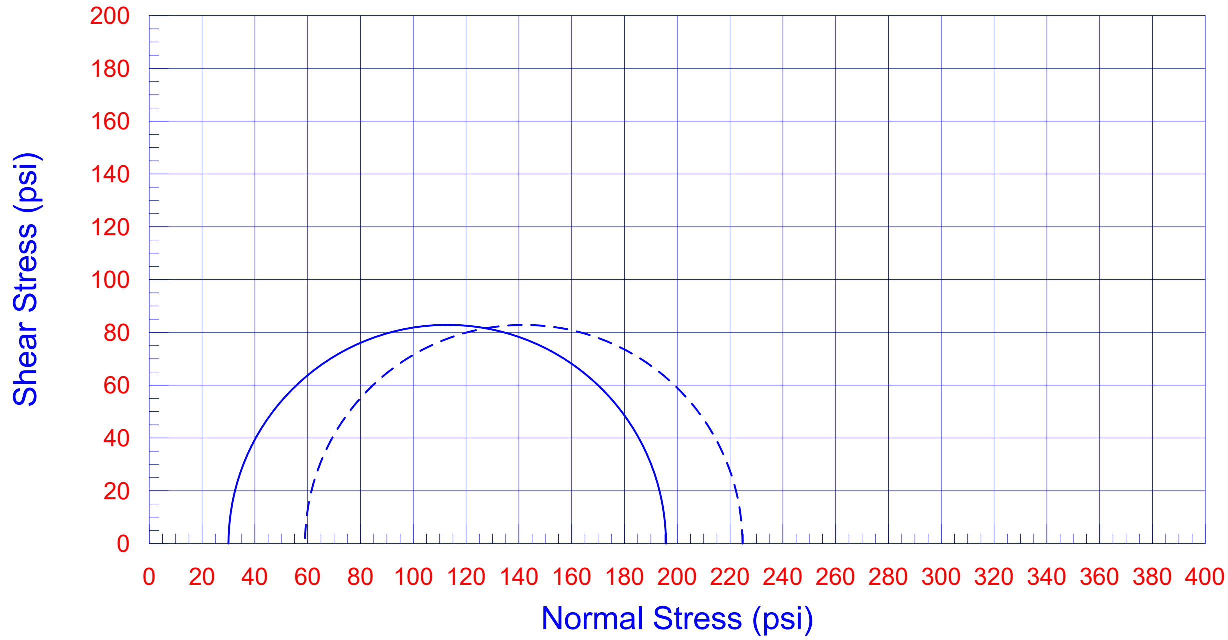
Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test ASTM D 4767

09-18





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-4	R-15	60.0	30.0	165.7
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001
Brea Boulevard
Corridor Improvements

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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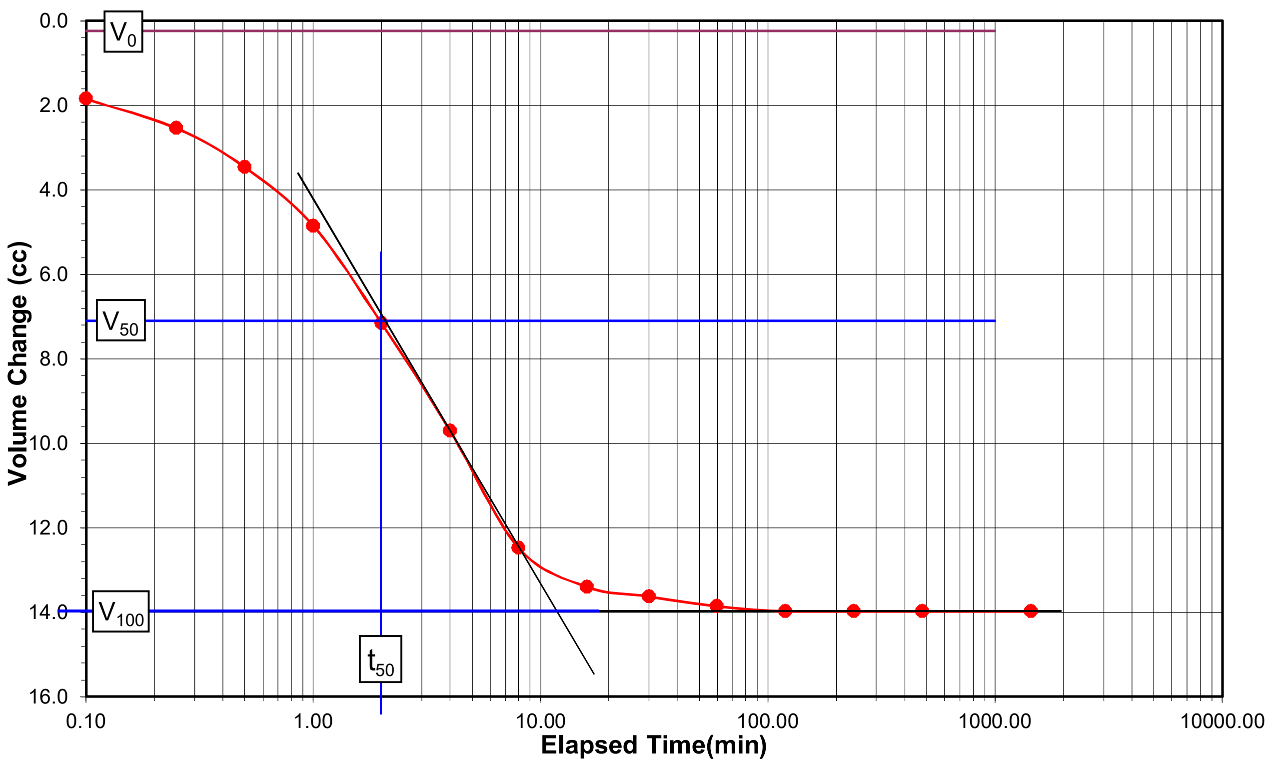
CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	60.0
Boring No.:	LB-4	Eff. Stress (psi):	30.00
Sample No.:	R-15	Burette Area:	0.358 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/28/18	9:40:00			Initial Burette	3.90	
08/28/18	9:40:06	0.10	0.32		4.70	1.8
08/28/18	9:40:15	0.25	0.50		5.00	2.5
08/28/18	9:40:30	0.50	0.71		5.40	3.5
08/28/18	9:41:00	1.00	1.00		6.00	4.9
08/28/18	9:42:00	2.00	1.41		7.00	7.2
08/28/18	9:44:00	4.00	2.00		8.10	9.7
08/28/18	9:48:00	8.00	2.83		9.30	12.5
08/28/18	9:56:00	16.00	4.00		9.70	13.4
08/28/18	10:10:00	30.00	5.48		9.80	13.6
08/28/18	10:40:00	60.00	7.75		9.90	13.9
08/28/18	11:40:00	120.00	10.95		9.95	14.0
08/28/18	13:40:00	240.00	15.49		9.95	14.0
08/28/18	17:40:00	480.00	21.91		9.95	14.0
08/29/18	9:40:00	1440.00	37.95		9.95	14.0



V_0	(cc)	0.23
V_{100}	(cc)	13.97
V_{50}	(cc)	7.10
t_{50}	(min)	2.00
Height After Consolidation (in)		5.389
Strain Rate	(in/min)	**0.0108**
Duration of Test*	(hr)	1.3

*Based on a total strain of 15%

Height (ft)		5.480
		5.481
		5.482
Average		5.481
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1620	0.1220
Final Rdg. (in)	0.1680	0.2080

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/20/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/14/18
Boring No.:	LB-4				
Sample No.:	R-15				
Depth (ft.):	60.0				
Sample Type:	Ring				

30.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/21/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/15/18
Boring No.:	LB-7	Sample Type:	Ring		
Sample No.:	R-9				
Depth (ft.):	30.0				
Soil Description	Brown lean clay (CL)				

Diameter (in)	2.421	2.420	2.420	Avg. =	2.420
Height (in)	5.501	5.501	5.502	Avg. =	5.501

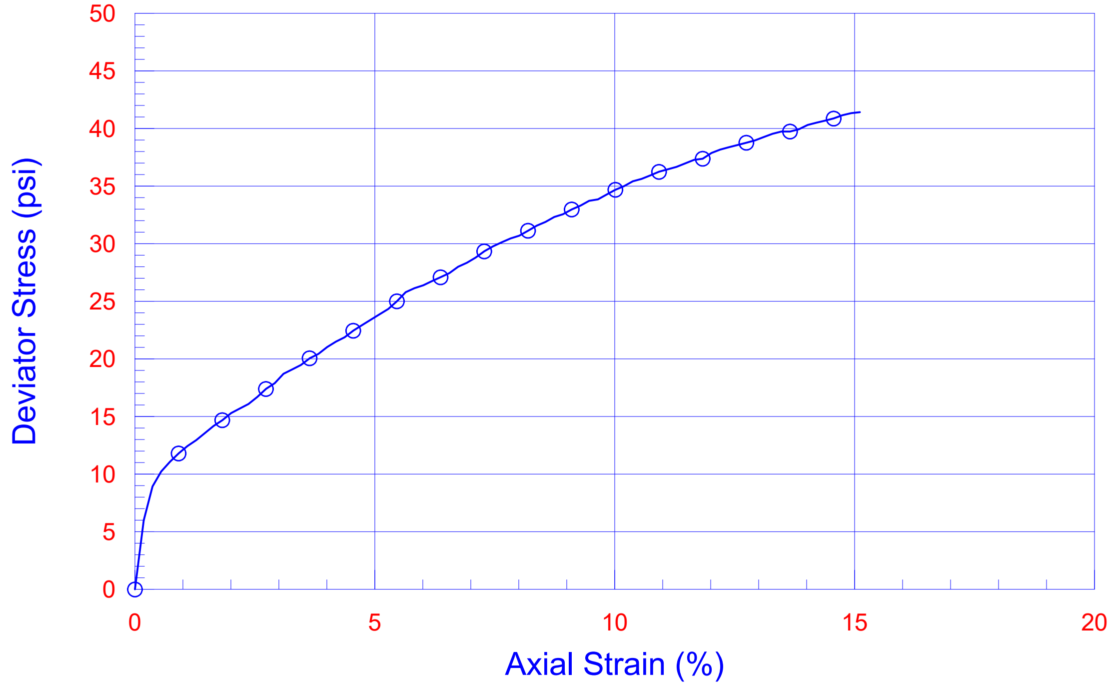
	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.601	4.599	4.528	
Moisture Content (%)	21.69			20.63
Wt. Wet Sample + Cont. (g)	89.30			915.60
Wt. Dry Sample + Cont. (g)	83.40			771.90
Wt. Container (g)	56.20			75.20
Density and Saturation				
Wt. Wet Sample + Cont. (g)	848.40			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	127.7			128.8
Dry Density (pcf)	104.9			106.8
Void Ratio	0.606			0.578
% Saturation	96.7			96.3

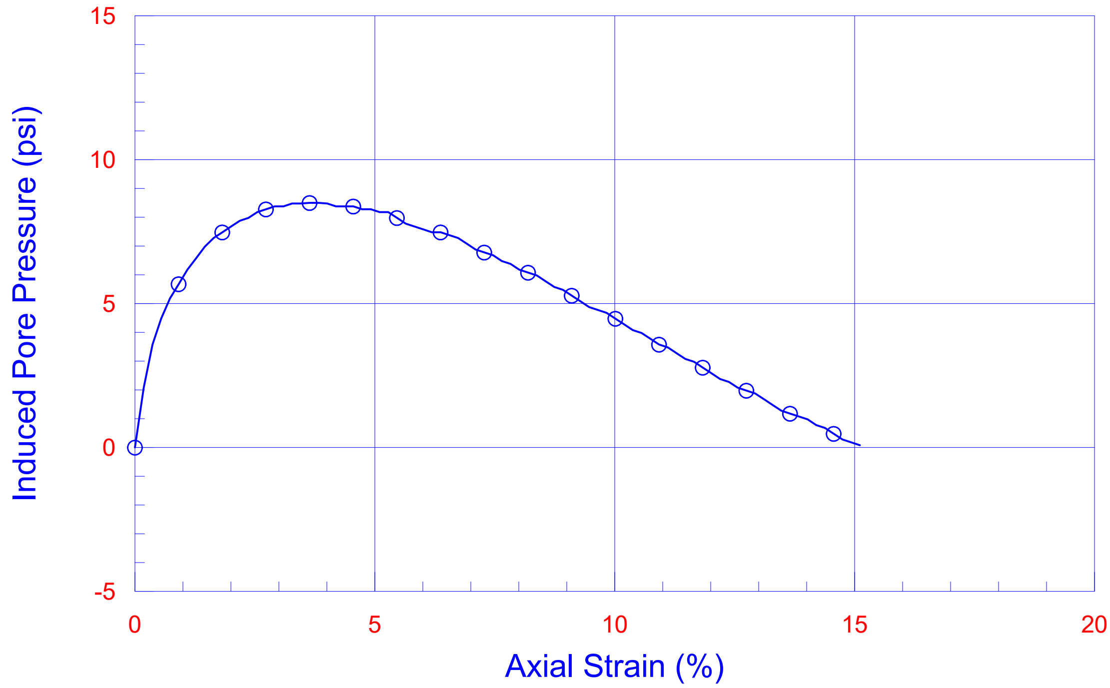
Specific Gravity (assumed) = 2.70

Back Pressure Saturation			
		Burette Area (sq. in.)=	0.357
		Initial Burette Ht.(cm)=	25.5
		Final Burette Ht.(cm)=	23.5
		Volume of water during saturation (cc):	4.6
B Value (%) =	96	Change in Height (in)=	0.001

Consolidation			
Cell Pressure (psi) =	84.12	Burette Area (sq. in.)=	0.3570
Back Pressure(psi) =	71.12	Initial Burette Ht.(cm)=	4.8
Eff. Consol. Stress (psi) =	13.00	Final Burette Ht.(cm)=	7.8
Change in Height (in) =	0.0070	Final Height (in)=	5.493

Shear		At Failure	
Rate of Deformation (in/min)=	0.0052	Deviator Stress (psi) =	41.4
Time to 50% primary Consolidation =	40.00 min	Eff. Minor Principal stress (psi) =	12.9
Failure Criterion:		Eff. Major Principal stress (psi) =	54.3
Maximum deviator stress, to 15% axial strain		Axial Strain (%) =	15.1





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-7	R-9	30.0	13.0	41.4
□					
△					

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

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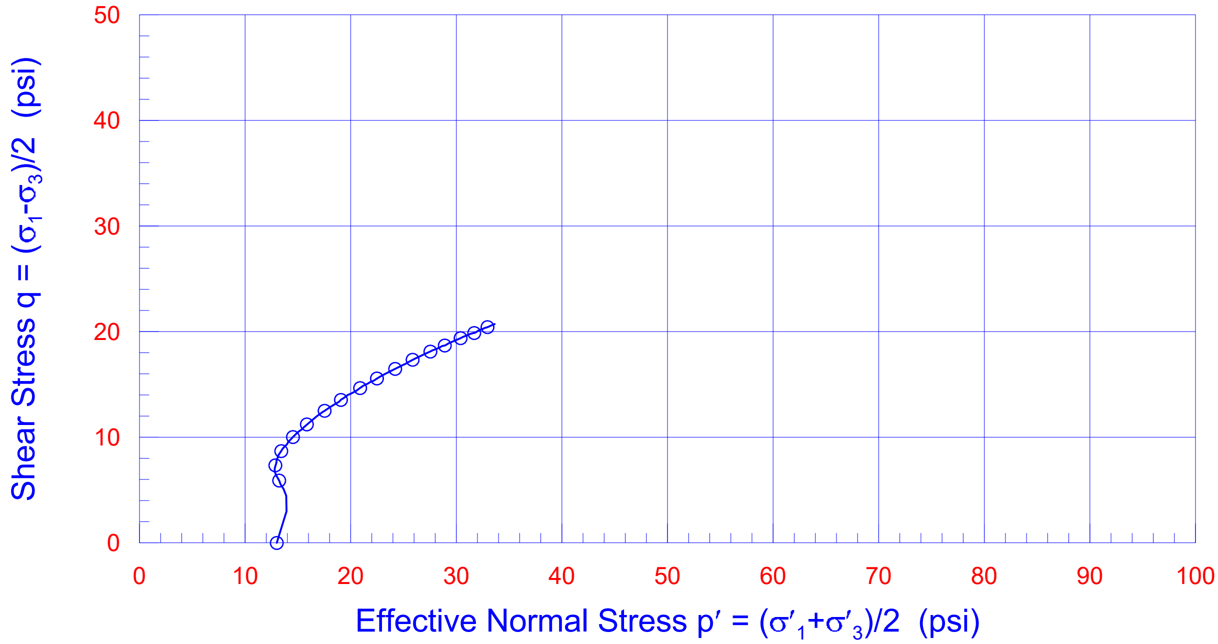
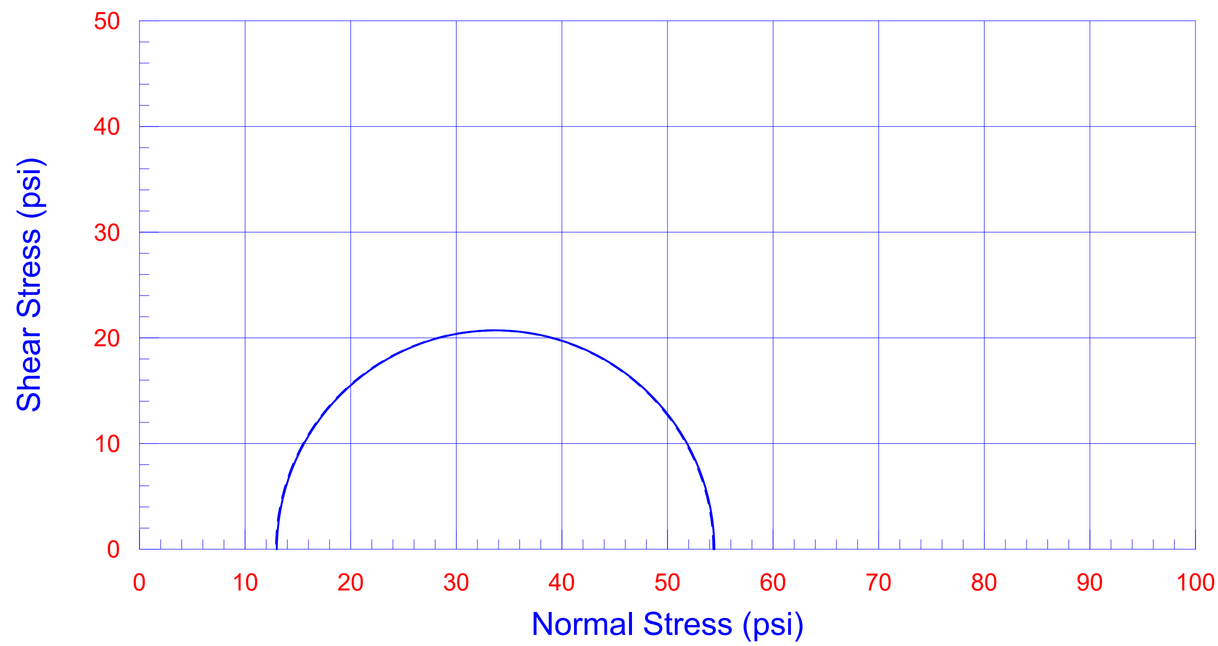




	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-7	R-9	30.0	13.0	41.4
□					
△					

——— Mohr Circle based on Total Stress
– – – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard
Corridor Improvements

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

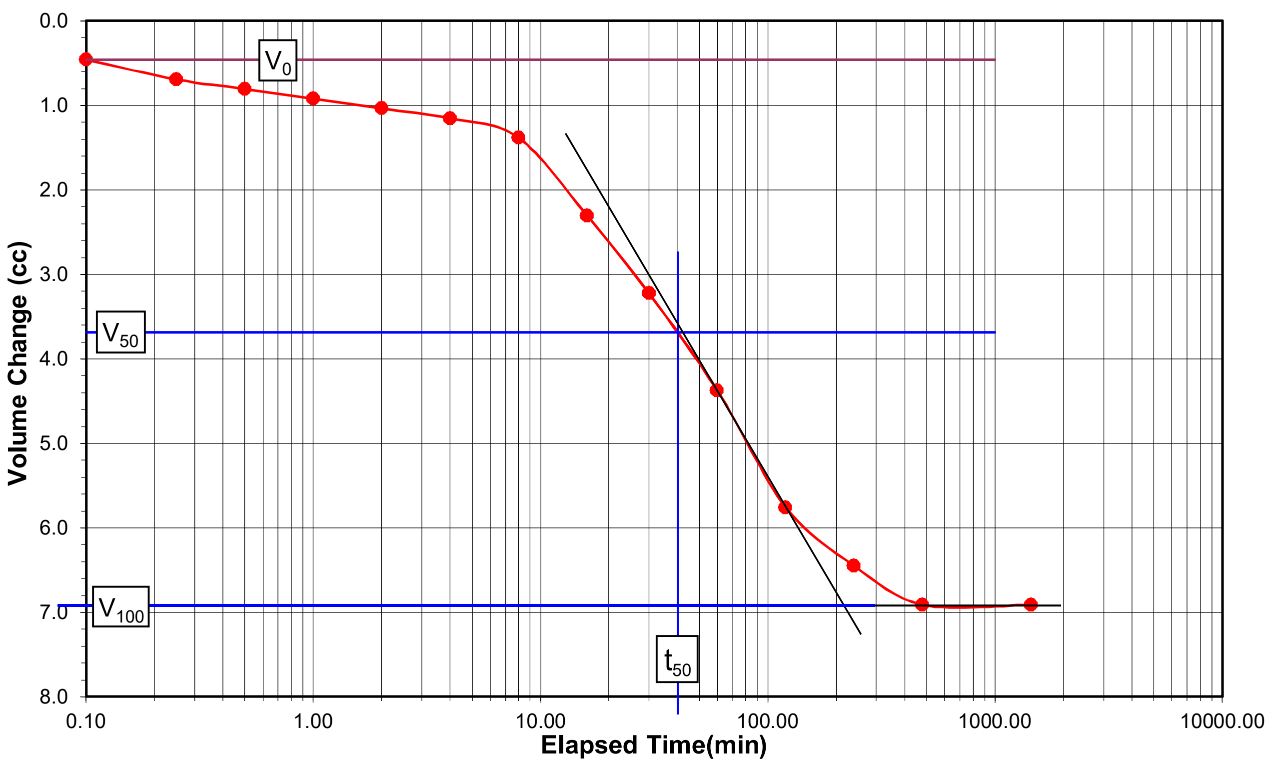
09-18

Leighton

CU TRIAXIAL TEST CONSOLIDATION CURVE

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	30.0
Boring No.:	LB-7	Eff. Stress (psi):	13.00
Sample No.:	R-9	Burette Area:	0.357 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
08/27/18	8:00:00			Initial Burette	4.80	
08/27/18	8:00:06	0.10	0.32		5.00	0.5
08/27/18	8:00:15	0.25	0.50		5.10	0.7
08/27/18	8:00:30	0.50	0.71		5.15	0.8
08/27/18	8:01:00	1.00	1.00		5.20	0.9
08/27/18	8:02:00	2.00	1.41		5.25	1.0
08/27/18	8:04:00	4.00	2.00		5.30	1.2
08/27/18	8:08:00	8.00	2.83		5.40	1.4
08/27/18	8:16:00	16.00	4.00		5.80	2.3
08/27/18	8:30:00	30.00	5.48		6.20	3.2
08/27/18	9:00:00	60.00	7.75		6.70	4.4
08/27/18	10:00:00	120.00	10.95		7.30	5.8
08/27/18	12:00:00	240.00	15.49		7.60	6.4
08/27/18	16:00:00	480.00	21.91		7.80	6.9
08/28/18	8:00:00	1440.00	37.95		7.80	6.9



V_0	(cc)	0.46
V_{100}	(cc)	6.91
V_{50}	(cc)	3.69
t_{50}	(min)	40.00
Height After Consolidation (in)		5.493
Strain Rate	(in/min)	**0.0005**
Duration of Test*	(hr)	25.0

*Based on a total strain of 15%

Height (ft)		5.501
		5.501
		5.502
Average		5.501
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2260	0.2290
Final Rdg. (in)	0.2270	0.2360

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	08/21/18
Project No:	11588.001	Checked By:	J. Ward	Date:	09/15/18
Boring No.:	LB-7				
Sample No.:	R-9				
Depth (ft.):	30.0				
Sample Type:	Ring				

13.0 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	02/05/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-14	Sample Type:	Ring		
Sample No.:	R-10				
Depth (ft.):	51-51.5				
Soil Description	Olive gray sandy siltstone s(ML)				

Diameter (in)	2.423	2.423	2.423	Avg. =	2.423
Height (in)	5.041	5.040	5.040	Avg. =	5.040

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.611	4.627	4.561	
Moisture Content (%)	18.38			19.01
Wt. Wet Sample + Cont. (g)	242.60			928.70
Wt. Dry Sample + Cont. (g)	216.80			797.60
Wt. Container (g)	76.40			108.10
Density and Saturation				
Wt. Wet Sample + Cont. (g)	812.10			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	133.1			135.8
Dry Density (pcf)	112.5			114.1
Void Ratio	0.498			0.477
% Saturation	99.6			100.0

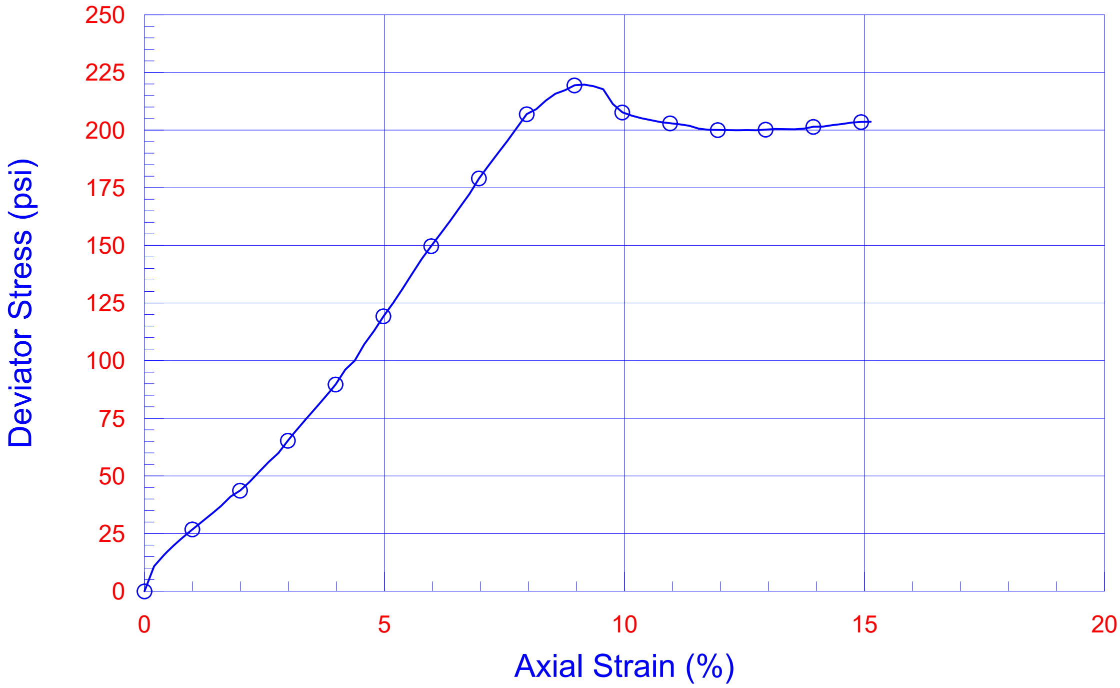
Specific Gravity (assumed) = 2.70

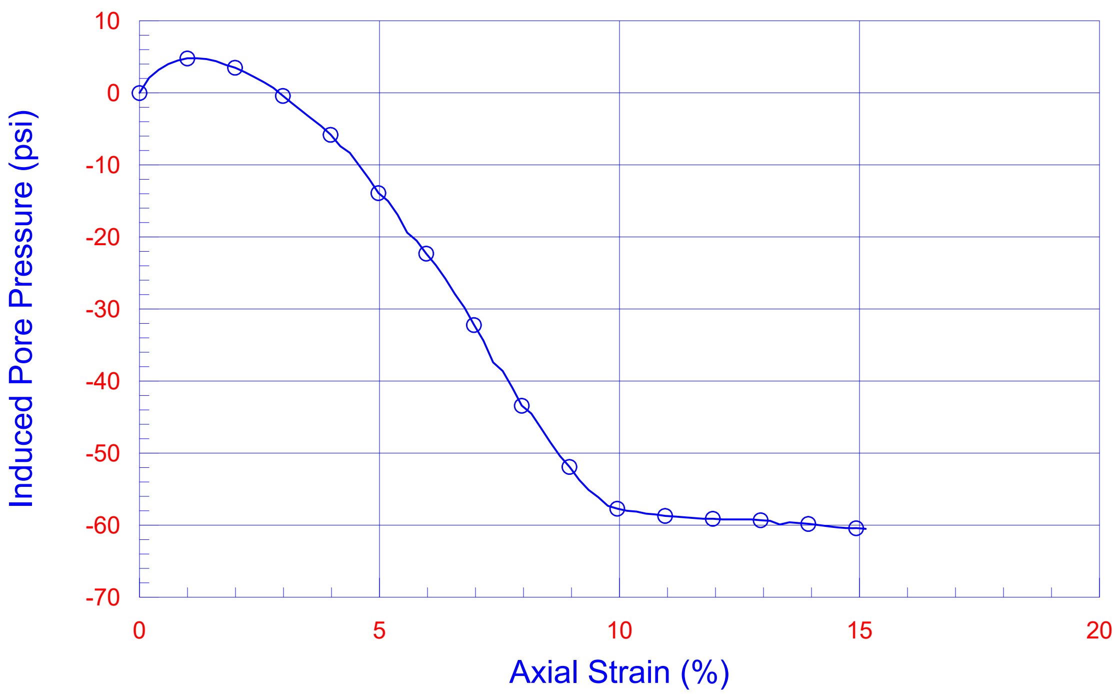
Back Pressure Saturation		Burette Area (sq. in.)=	0.361
		Initial Burette Ht.(cm)=	24.0
		Final Burette Ht.(cm)=	15.7
		Volume of water during saturation (cc):	19.3
B Value (%) =	95	Change in Height (in)=	-0.009

Consolidation

Cell Pressure (psi) =	105.40	Burette Area (sq. in.)=	0.3610
Back Pressure(psi) =	90.40	Initial Burette Ht.(cm)=	4.5
Eff. Consol. Stress (psi) =	15.00	Final Burette Ht.(cm)=	7.7
Change in Height (in) =	0.0260	Final Height (in)=	5.023

Shear		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	219.8
Time to 50% primary Consolidation =	6.20 min	Eff. Minor Principal stress (psi) =	68.7
Failure Criterion:		Eff. Major Principal stress (psi) =	288.5
Maximum deviator stress to 15% axial strain		Axial Strain (%) =	9.2





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-14	R-10	51-51.5	15.0	219.8
□					
△					

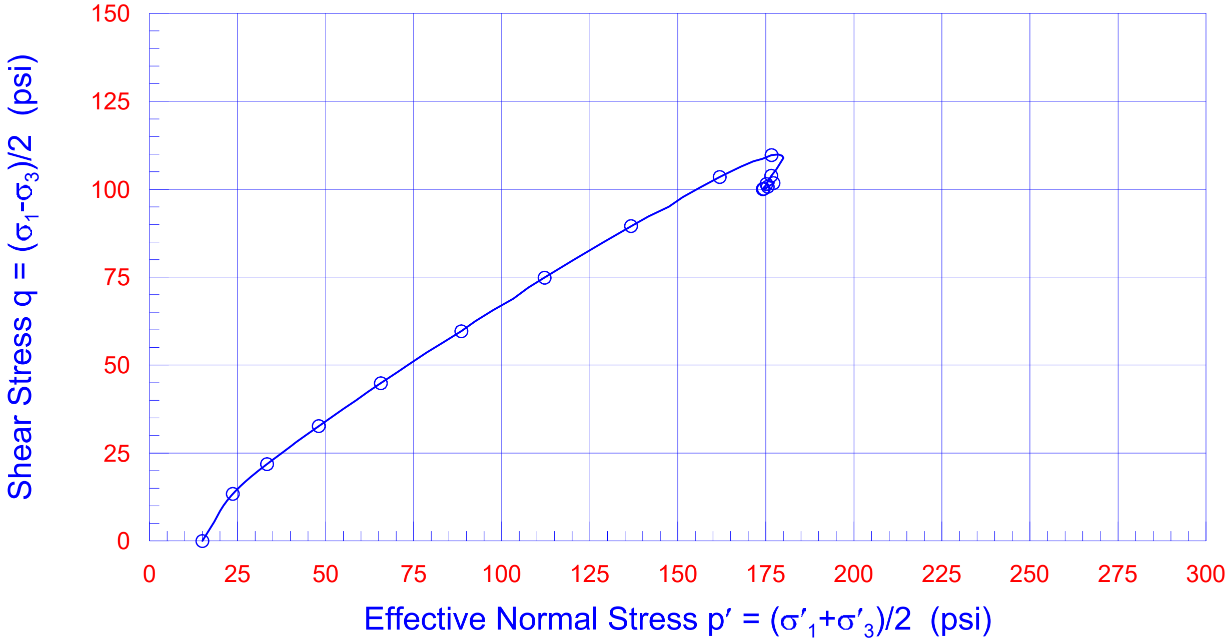
Leighton

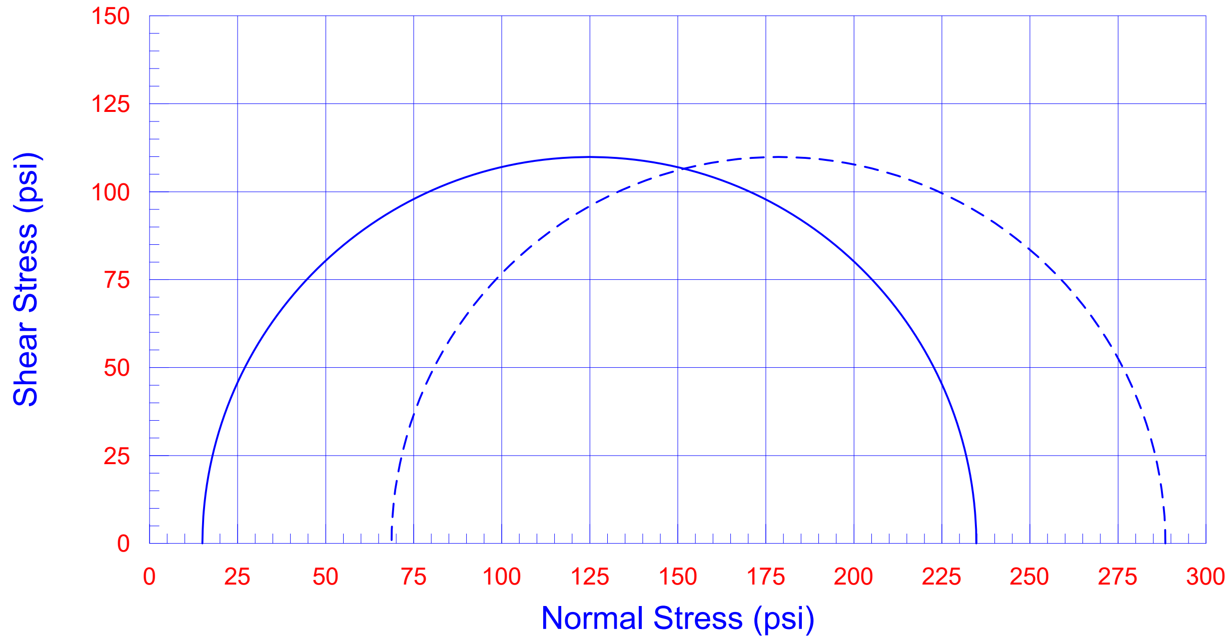
Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

02/19





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-14	R-10	51-51.5	15.0	219.8
□					
△					

——— Mohr Circle based on Total Stress

– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

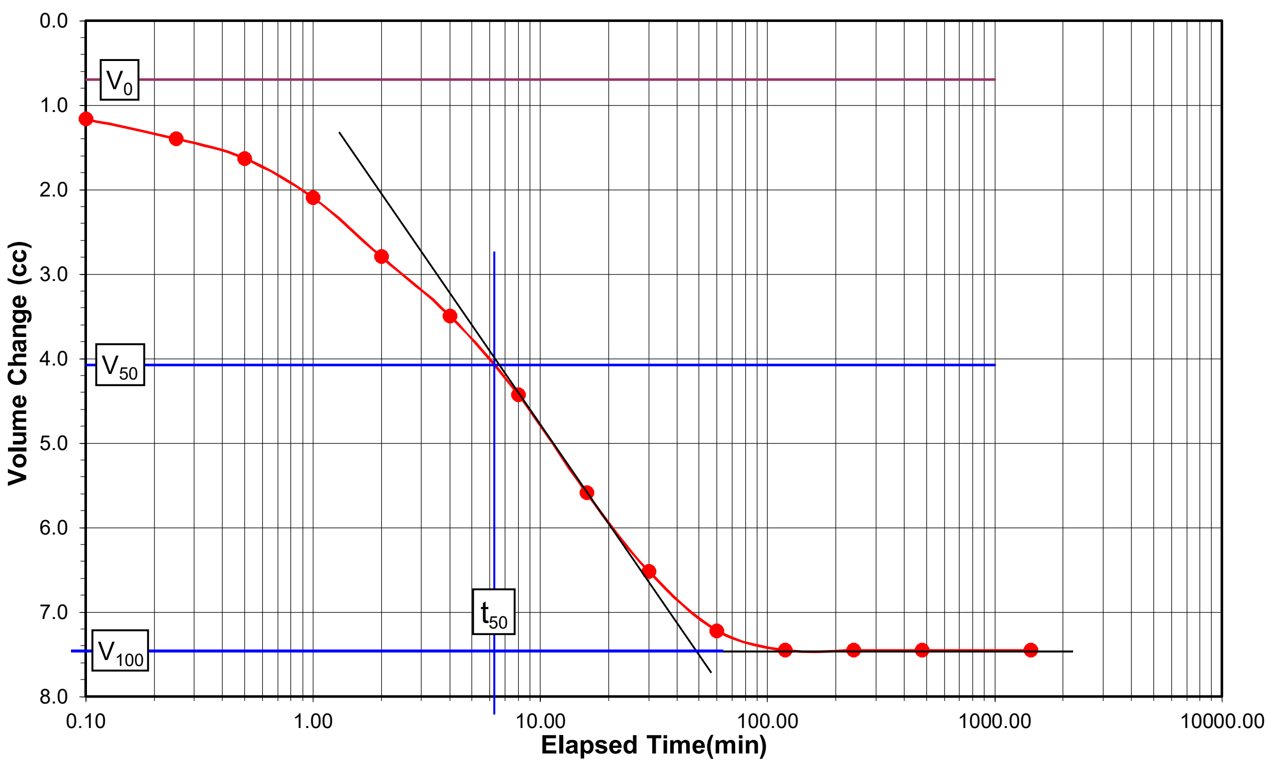
02-19

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	51-51.5
Boring No.:	LB-14	Eff. Stress (psi):	15.00
Sample No.:	R-10	Burette Area:	0.361 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
02/11/19	9:09:00			Initial Burette	4.50	
02/11/19	9:09:06	0.10	0.32		5.00	1.2
02/11/19	9:09:15	0.25	0.50		5.10	1.4
02/11/19	9:09:30	0.50	0.71		5.20	1.6
02/11/19	9:10:00	1.00	1.00		5.40	2.1
02/11/19	9:11:00	2.00	1.41		5.70	2.8
02/11/19	9:13:00	4.00	2.00		6.00	3.5
02/11/19	9:17:00	8.00	2.83		6.40	4.4
02/11/19	9:25:00	16.00	4.00		6.90	5.6
02/11/19	9:39:00	30.00	5.48		7.30	6.5
02/11/19	10:09:00	60.00	7.75		7.60	7.2
02/11/19	11:09:00	120.00	10.95		7.70	7.5
02/11/19	13:09:00	240.00	15.49		7.70	7.5
02/11/19	17:09:00	480.00	21.91		7.70	7.5
02/12/19	9:09:00	1440.00	37.95		7.70	7.5



V_0	(cc)	0.70
V_{100}	(cc)	7.45
V_{50}	(cc)	4.07
t_{50}	(min)	6.20
Height After Consolidation (in)		5.023
Strain Rate	(in/min)	**0.0032**
Duration of Test*	(hr)	3.9

*Based on a total strain of 15%

Height (ft)		5.041
		5.040
		5.040
Average		5.040
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1630	0.1520
Final Rdg. (in)	0.1540	0.1780

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	02/05/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-14				
Sample No.:	R-10				
Depth (ft.):	51-51.5				
Sample Type:	Ring				

15 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/03/20
Boring No.:	LB-22	Sample Type:	Ring		
Sample No.:	R-8				
Depth (ft.):	30.0				
Soil Description	Gray silt (ML)				

Diameter (in)	2.425	2.425	2.425	Avg. =	2.425
Height (in)	5.516	5.515	5.515	Avg. =	5.515

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.619	4.627	4.556	
Moisture Content (%)	16.67			20.56
Wt. Wet Sample + Cont. (g)	112.20			943.40
Wt. Dry Sample + Cont. (g)	105.90			795.40
Wt. Container (g)	68.10			75.70
Density and Saturation				
Wt. Wet Sample + Cont. (g)	862.30			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	129.0			136.1
Dry Density (pcf)	110.5			112.9
Void Ratio	0.524			0.493
% Saturation	85.8			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

Burette Area (sq. in.)=	0.397
Initial Burette Ht.(cm)=	23.5
Final Burette Ht.(cm)=	20.3
Volume of water during saturation (cc):	8.2
Change in Height (in)=	-0.005

B Value (%) = 98

Consolidation

Cell Pressure (psi) =	115.76	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	90.76	Initial Burette Ht.(cm)=	5.3
Eff. Consol. Stress (psi) =	25.00	Final Burette Ht.(cm)=	9.1
Change in Height (in) =	0.0440	Final Height (in)=	5.476

Shear

Rate of Deformation (in/min)= 0.0024

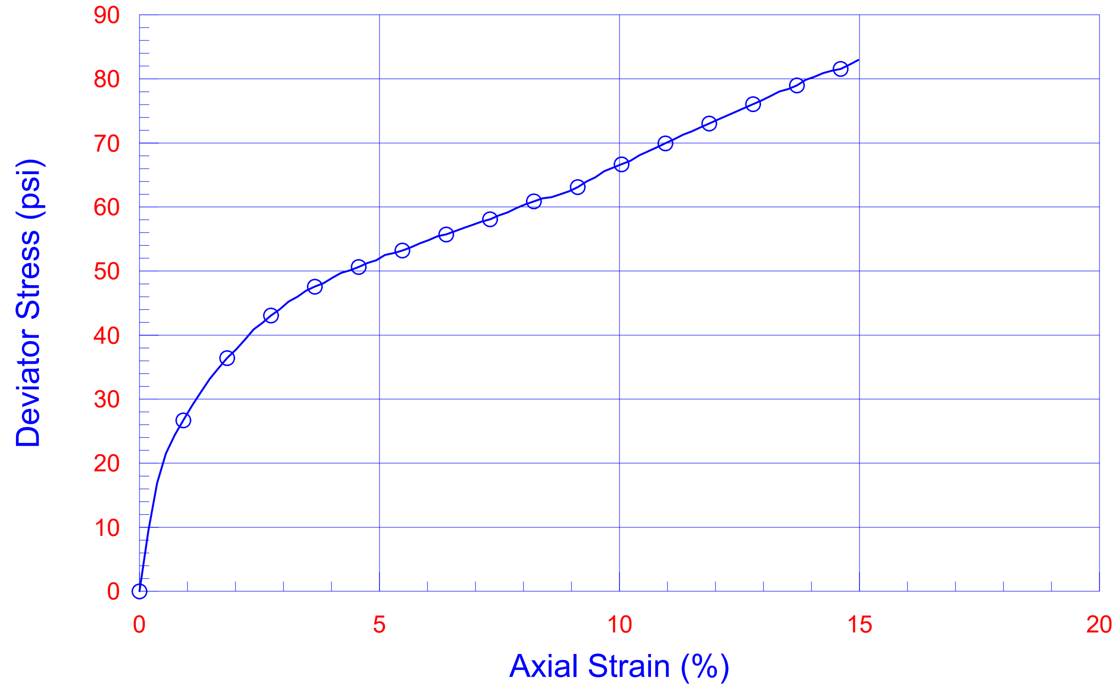
Time to 50% primary Consolidation = 7.2 min

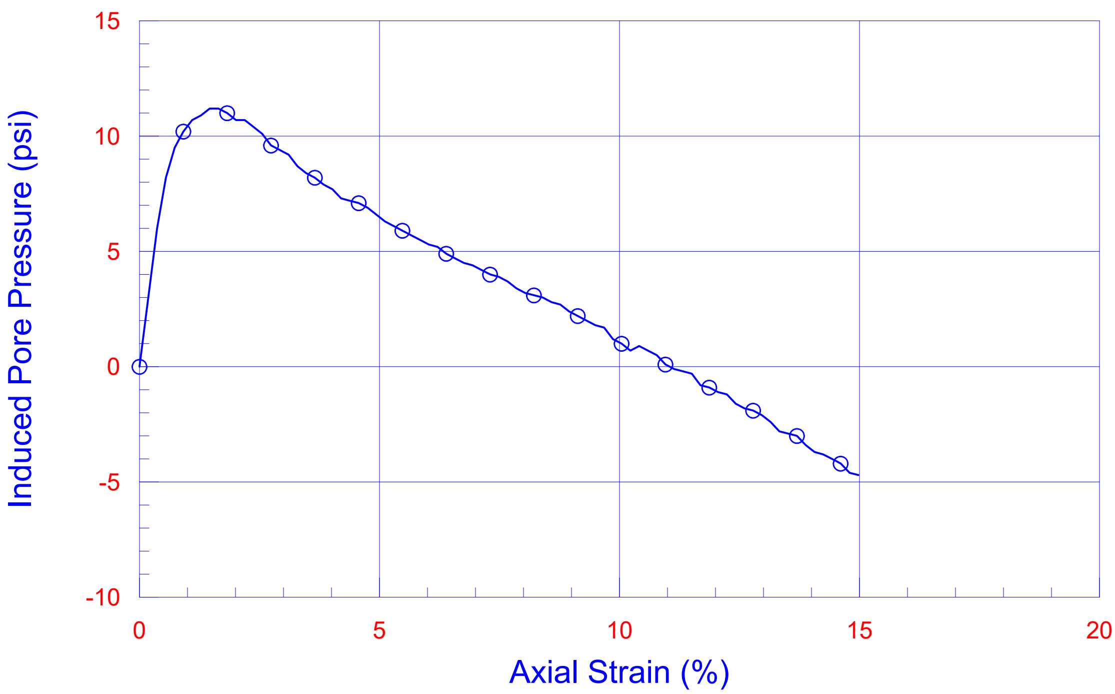
Failure Criterion:

Maximum deviator stress up to axail strain = 15%

At Failure

Deviator Stress (psi) =	83.0
Eff. Minor Principal stress (psi) =	29.7
Eff. Major Principal stress (psi) =	112.7
Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-22	R-8	30.0	25.0	83.0
□					
△					

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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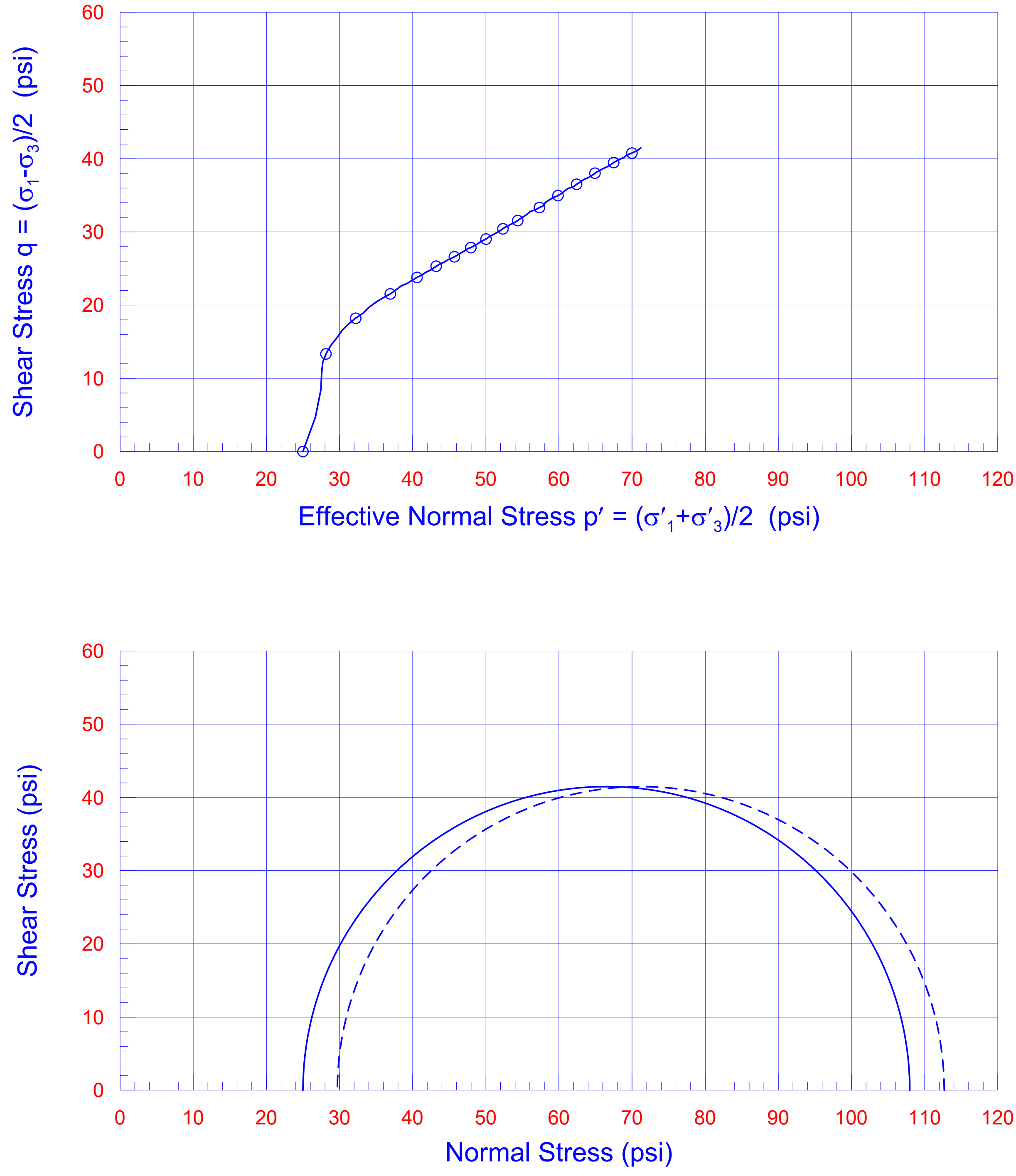

Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○ LB-22	R-8	30.0	25.0	83.0
□				
△				

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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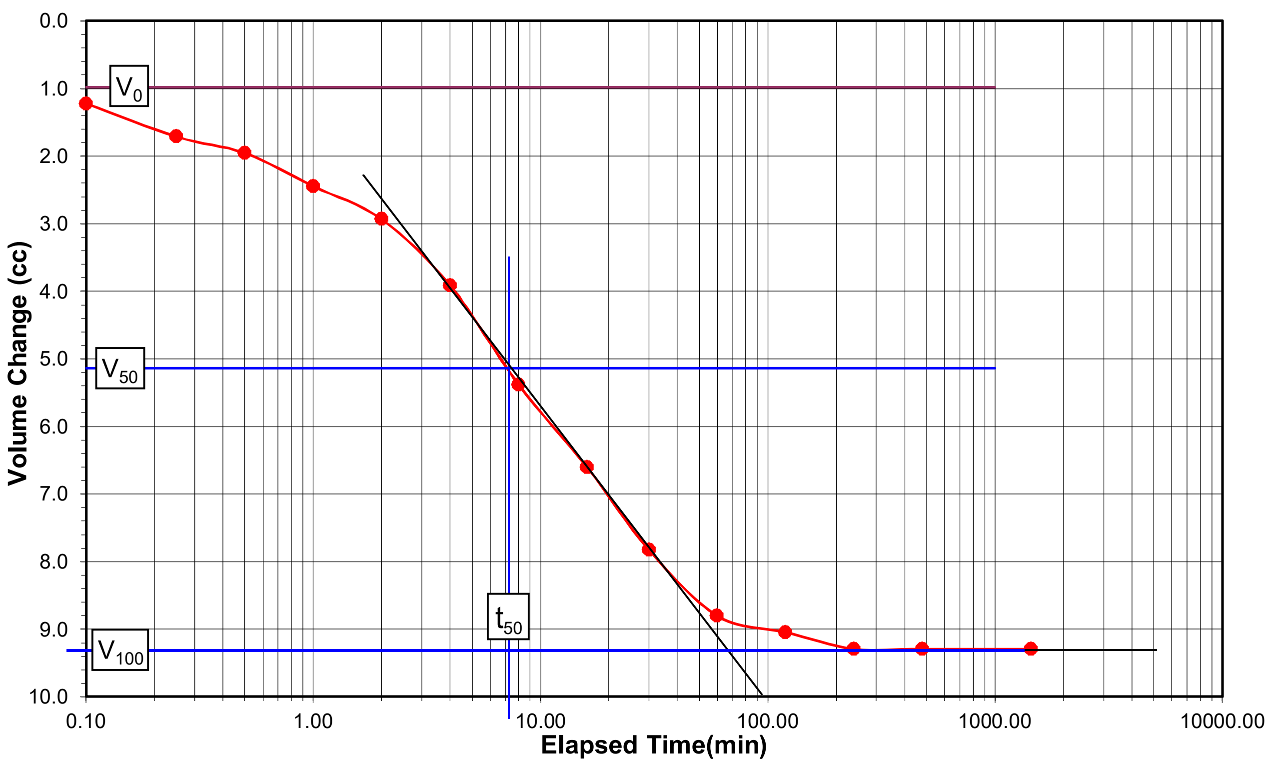
CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	30.0
Boring No.:	LB-22	Eff. Stress (psi):	25.00
Sample No.:	R-8	Burette Area:	0.379 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/13/20	8:48:00			Initial Burette	5.30	
11/13/20	8:48:06	0.10	0.32		5.80	1.22
11/13/20	8:48:15	0.25	0.50		6.00	1.71
11/13/20	8:48:30	0.50	0.71		6.10	1.96
11/13/20	8:49:00	1.00	1.00		6.30	2.45
11/13/20	8:50:00	2.00	1.41		6.50	2.93
11/13/20	8:52:00	4.00	2.00		6.90	3.91
11/13/20	8:56:00	8.00	2.83		7.50	5.38
11/13/20	9:04:00	16.00	4.00		8.00	6.60
11/13/20	9:18:00	30.00	5.48		8.50	7.82
11/13/20	9:48:00	60.00	7.75		8.90	8.80
11/13/20	10:48:00	120.00	10.95		9.00	9.05
11/13/20	12:48:00	240.00	15.49		9.10	9.29
11/13/20	16:46:00	478.00	21.86		9.10	9.29
11/14/20	8:48:00	1440.00	37.95		9.10	9.29



V_0	(cc)	0.98
V_{100}	(cc)	9.29
V_{50}	(cc)	5.13
t_{50}	(min)	7.20
Height After Consolidation (in)		5.476
Strain Rate	(in/min)	**0.0030**
Duration of Test*	(hr)	4.5

*Based on a total strain of 15%

Height (ft)		5.516
		5.515
		5.515
Average		5.515
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.3200	0.3140
Final Rdg. (in)	0.3150	0.3580

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-22				
Sample No.:	R-8				
Depth (ft.):	30.0				
Sample Type:	Ring				

16 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/03/20
Boring No.:	LB-27	Sample Type:	Ring		
Sample No.:	R-5				
Depth (ft.):	20				
Soil Description	Brown lean clay (CL)				

Diameter (in)	2.415	2.415	2.415	Avg. =	2.415
Height (in)	5.243	5.244	5.244	Avg. =	5.244

	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.581	4.574	3.982	
Moisture Content (%)	17.11			17.48
Wt. Wet Sample + Cont. (g)	158.00			905.50
Wt. Dry Sample + Cont. (g)	143.20			781.90
Wt. Container (g)	56.70			74.70
Density and Saturation				
Wt. Wet Sample + Cont. (g)	837.40			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	132.8			154.6
Dry Density (pcf)	113.4			131.6
Void Ratio	0.486			0.280
% Saturation	95.1			100.0

Specific Gravity (assumed) = 2.70

Back Pressure Saturation

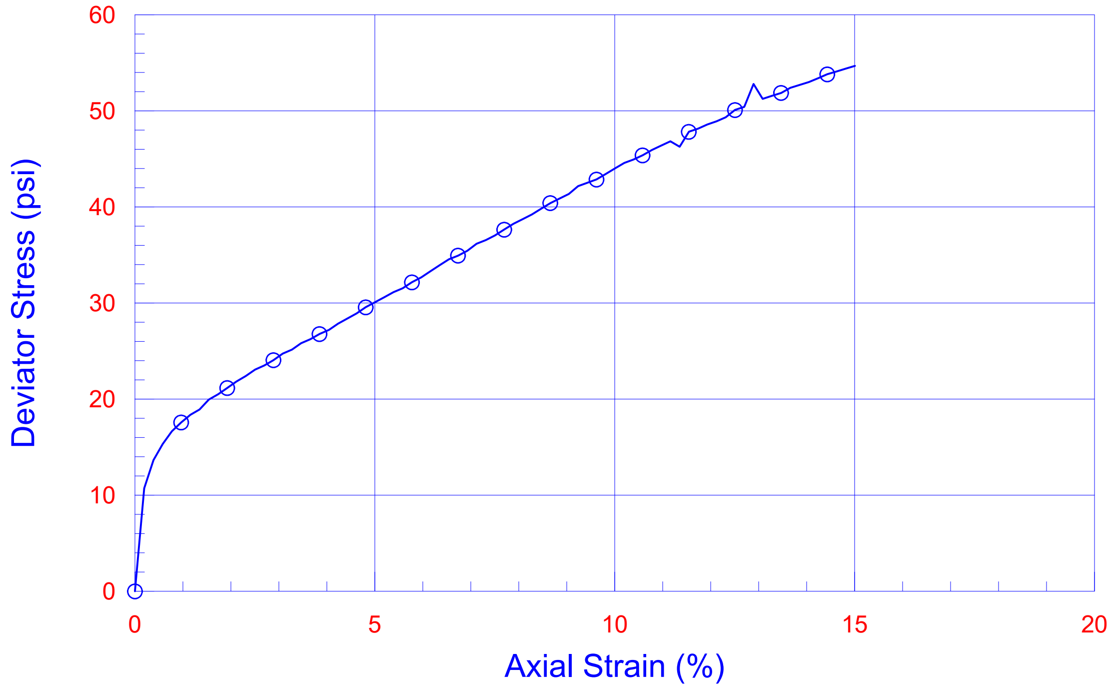
		Burette Area (sq. in.)=	0.408
		Initial Burette Ht.(cm)=	24.0
		Final Burette Ht.(cm)=	22.8
		Volume of water during saturation (cc):	3.2
B Value (%) =	95	Change in Height (in)=	0.004

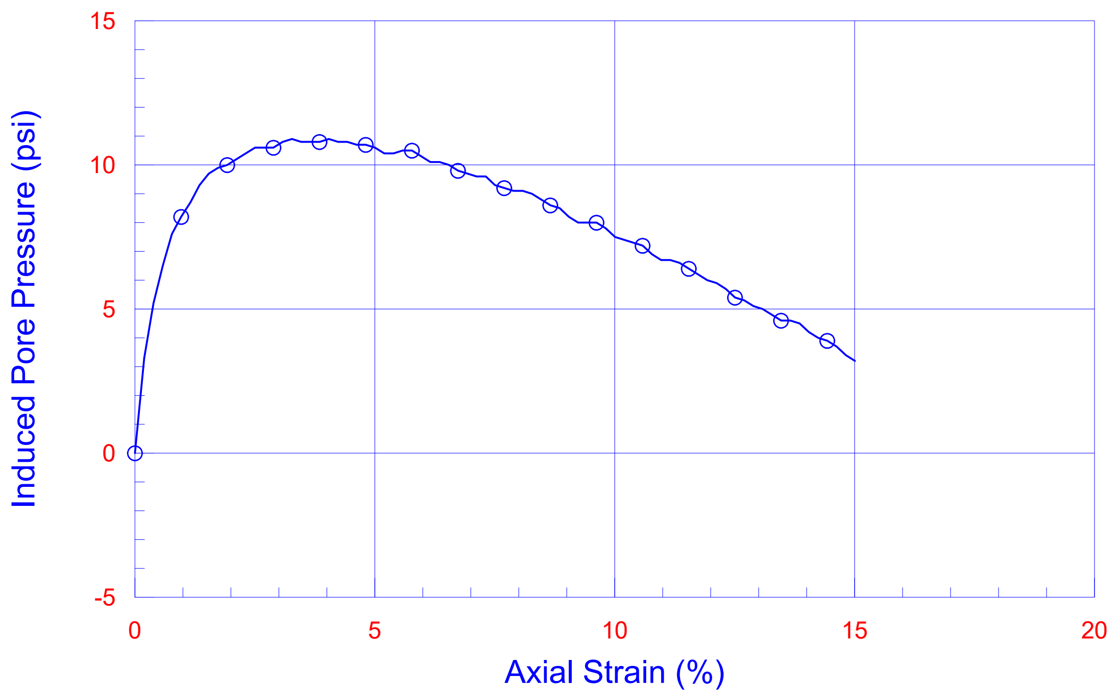
Consolidation

Cell Pressure (psi) =	108.66	Burette Area (sq. in.)=	0.0380
Back Pressure(psi) =	90.66	Initial Burette Ht.(cm)=	1.5
Eff. Consol. Stress (psi) =	18.00	Final Burette Ht.(cm)=	220.0
Change in Height (in) =	0.0420	Final Height (in)=	5.198

Shear

		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	54.7
Time to 50% primary Consolidation =	130 min	Eff. Minor Principal stress (psi) =	14.8
Failure Criterion:		Eff. Major Principal stress (psi) =	69.5
Maximum deviator stress up to axail strain = 15%		Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-27	R-5	20	18.0	54.7
□					
△					

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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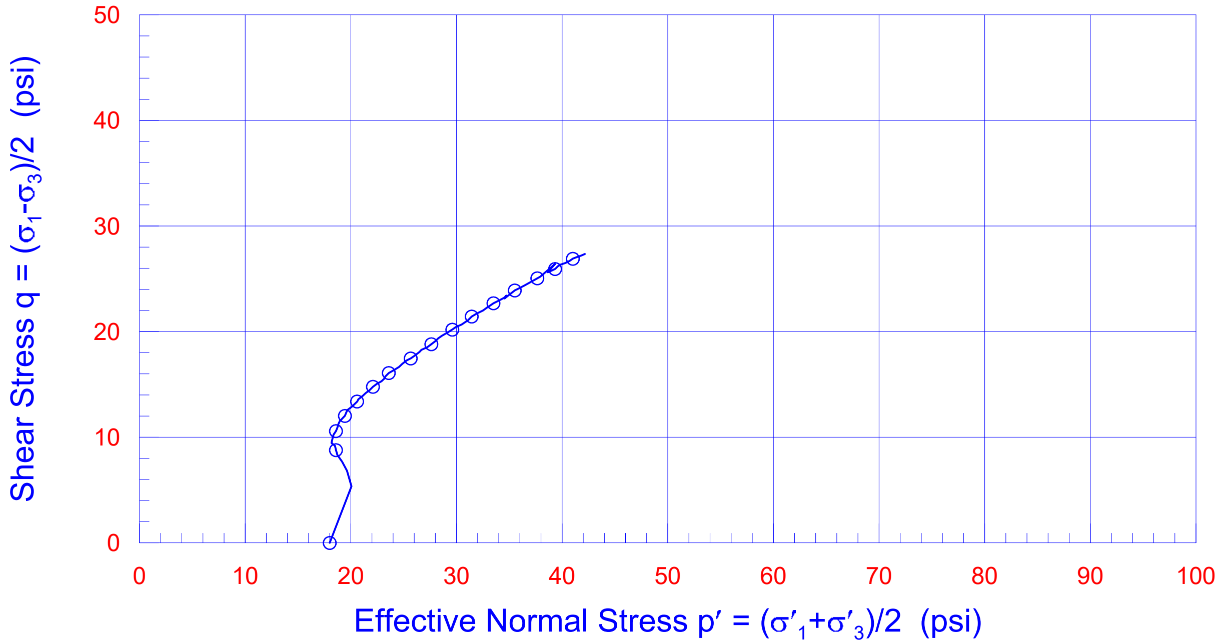

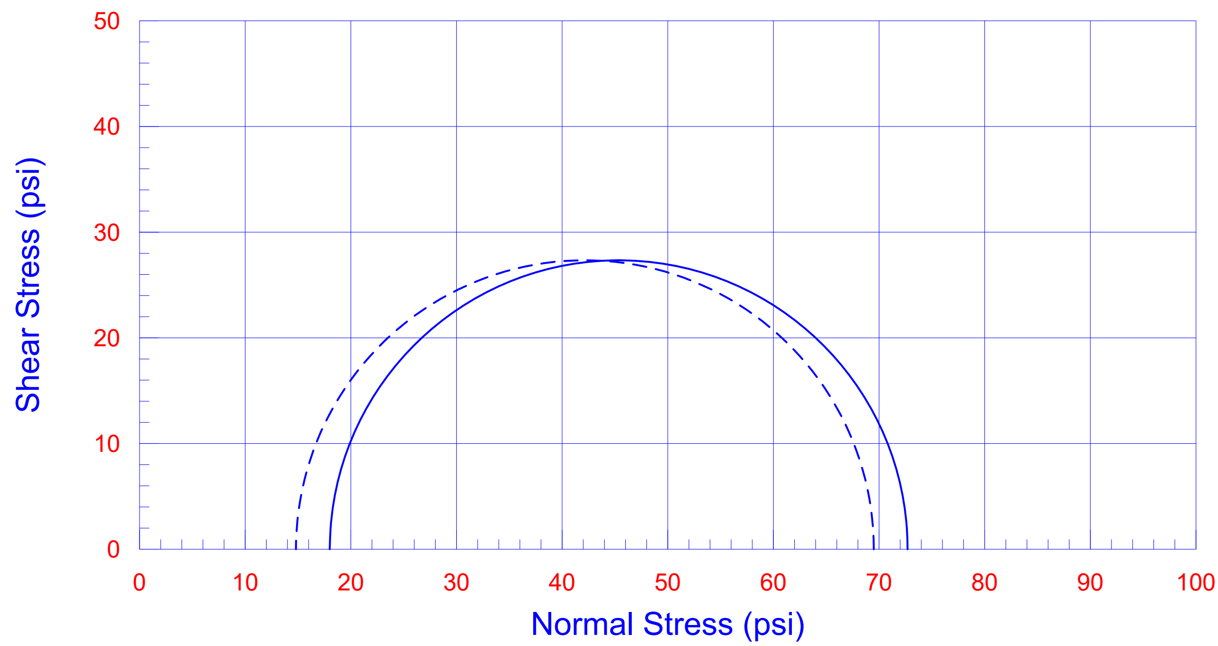

	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-27	R-5	20	18.0	54.7
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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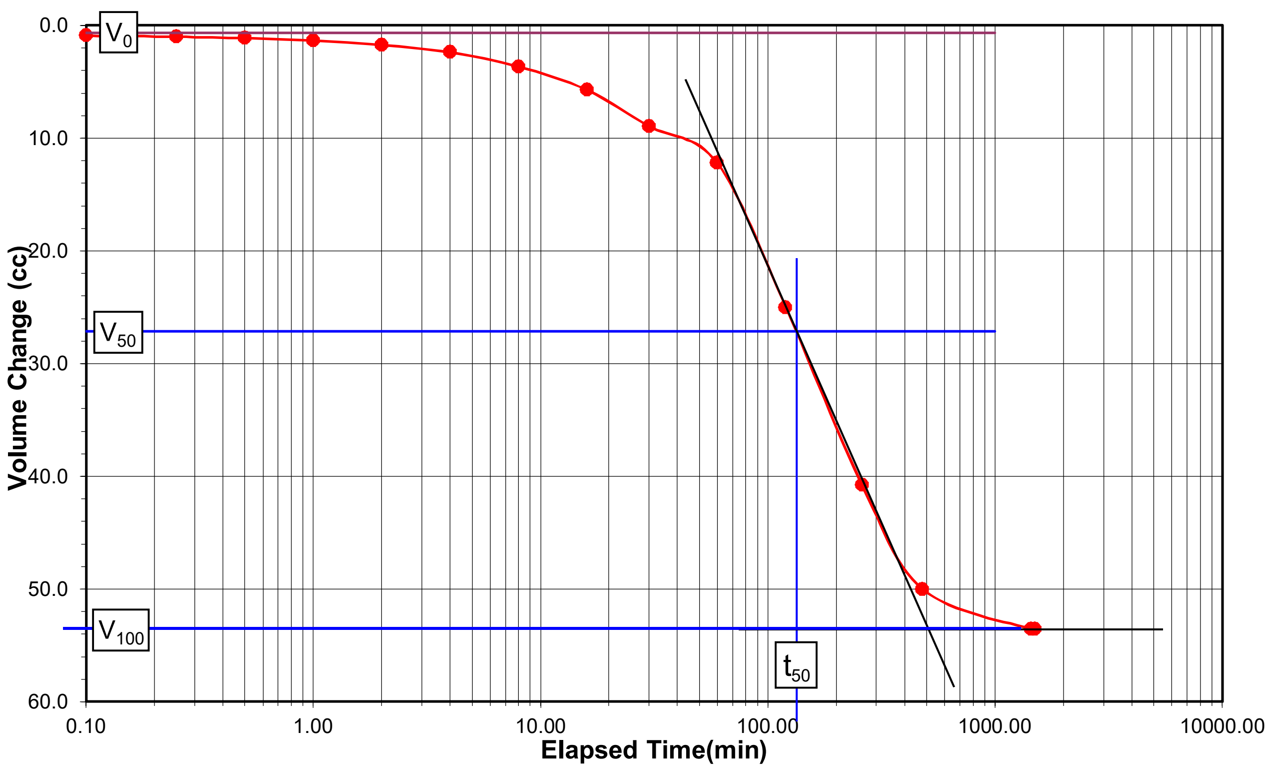
CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	20.0
Boring No.:	LB-27	Eff. Stress (psi):	18.00
Sample No.:	R-5	Burette Area:	0.038 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/12/20	8:36:00			Initial Burette	1.50	
11/12/20	8:36:06	0.10	0.32		5.20	0.91
11/12/20	8:36:15	0.25	0.50		5.60	1.01
11/12/20	8:36:30	0.50	0.71		6.10	1.13
11/12/20	8:37:00	1.00	1.00		7.00	1.35
11/12/20	8:38:00	2.00	1.41		8.50	1.72
11/12/20	8:40:00	4.00	2.00		11.20	2.38
11/12/20	8:44:00	8.00	2.83		16.40	3.65
11/12/20	8:52:00	16.00	4.00		24.80	5.71
11/12/20	9:06:00	30.00	5.48		38.00	8.95
11/12/20	9:36:00	60.00	7.75		51.30	12.21
11/12/20	10:36:00	120.00	10.95		103.50	25.01
11/12/20	12:56:00	260.00	16.12		167.90	40.79
11/12/20	16:36:00	480.00	21.91		205.50	50.01
11/13/20	8:36:00	1440.00	37.95		220.00	53.57
11/13/20	9:36:00	1500.00	38.73		220.00	53.57



V_0	(cc)	0.66
V_{100}	(cc)	53.57
V_{50}	(cc)	27.12
t_{50}	(min)	130.00
Height After Consolidation (in)		5.198
Strain Rate	(in/min)	**0.0002**
Duration of Test*	(hr)	81.3

*Based on a total strain of 15%

Height (ft)		5.244
		5.244
		5.243
Average		5.244
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.1980	0.1980
Final Rdg. (in)	0.2020	0.2400

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-27				
Sample No.:	R-5				
Depth (ft.):	20.0				
Sample Type:	Ring				

18 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/10/20
Project No:	11585.005	Checked By:	J. Ward	Date:	11/03/20
Boring No.:	LB-38	Sample Type:	Tube		
Sample No.:	T13A				
Depth (ft.):	42.0				
Soil Description	Gray silt (ML)				

Diameter (in)	2.409	2.409	2.408	Avg. =	2.409
Height (in)	4.535	4.533	4.536	Avg. =	4.535

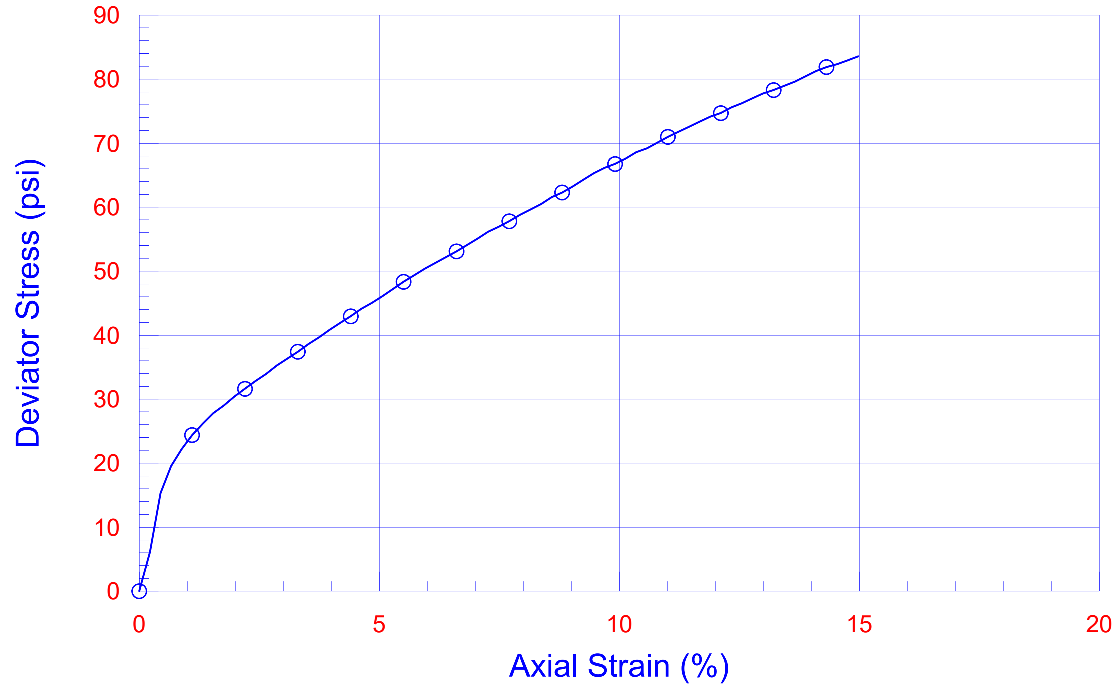
	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.557	4.565	4.522	
Moisture Content (%)	12.55			16.09
Wt. Wet Sample + Cont. (g)	674.20			771.20
Wt. Dry Sample + Cont. (g)	599.00			674.70
Wt. Container (g)	0.00			74.80
Density and Saturation				
Wt. Wet Sample + Cont. (g)	855.80			Calculated from initial dry weight and final moisture content
Wt. Container (g)	181.60			
Wet Density (pcf)	124.3			129.0
Dry Density (pcf)	110.4			111.2
Void Ratio	0.526			0.516
% Saturation	64.5			84.2

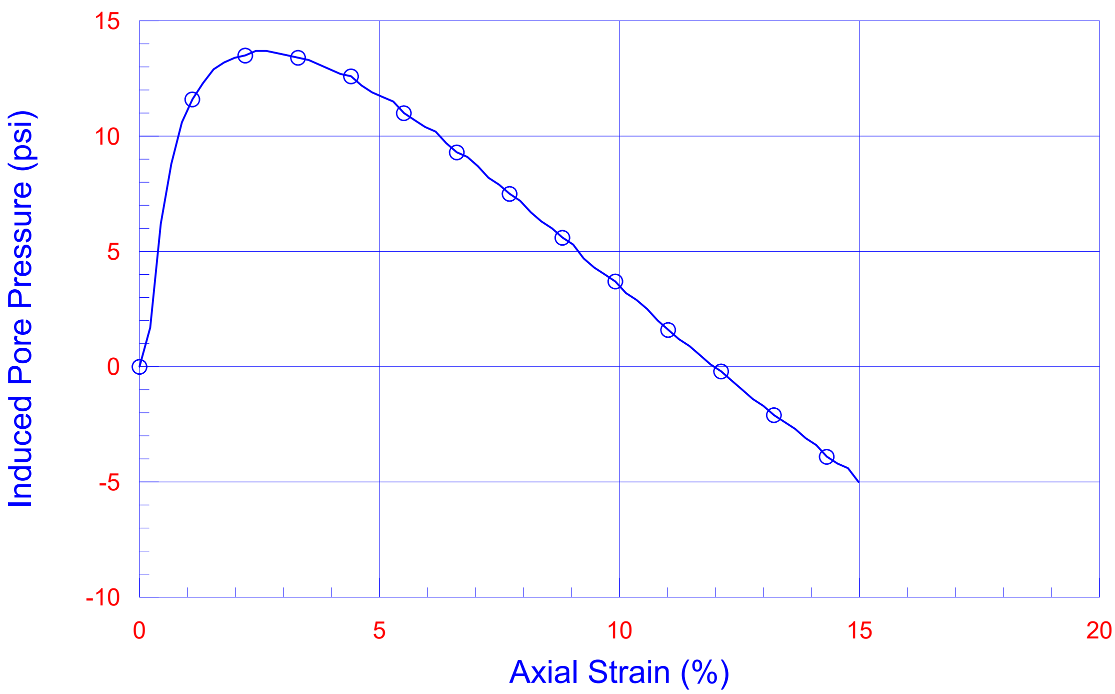
Specific Gravity (assumed) = 2.70

Back Pressure Saturation			
		Burette Area (sq. in.)=	0.397
		Initial Burette Ht.(cm)=	24.3
		Final Burette Ht.(cm)=	14.0
		Volume of water during saturation (cc):	26.4
B Value (%) =	97	Change in Height (in)=	-0.004

Consolidation			
Cell Pressure (psi) =	116.70	Burette Area (sq. in.)=	0.3970
Back Pressure(psi) =	91.70	Initial Burette Ht.(cm)=	4.9
Eff. Consol. Stress (psi) =	25.00	Final Burette Ht.(cm)=	6.1
Change in Height (in) =	-0.0010	Final Height (in)=	4.540

Shear		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	83.6
Time to 50% primary Consolidation =	2.8 min	Eff. Minor Principal stress (psi) =	30.0
Failure Criterion:		Eff. Major Principal stress (psi) =	113.6
Maximum deviator stress up to axial strain = 15%		Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-38	T13A	42.0	25.0	83.6
□					
△					

Leighton

Project No.: 11585.005
Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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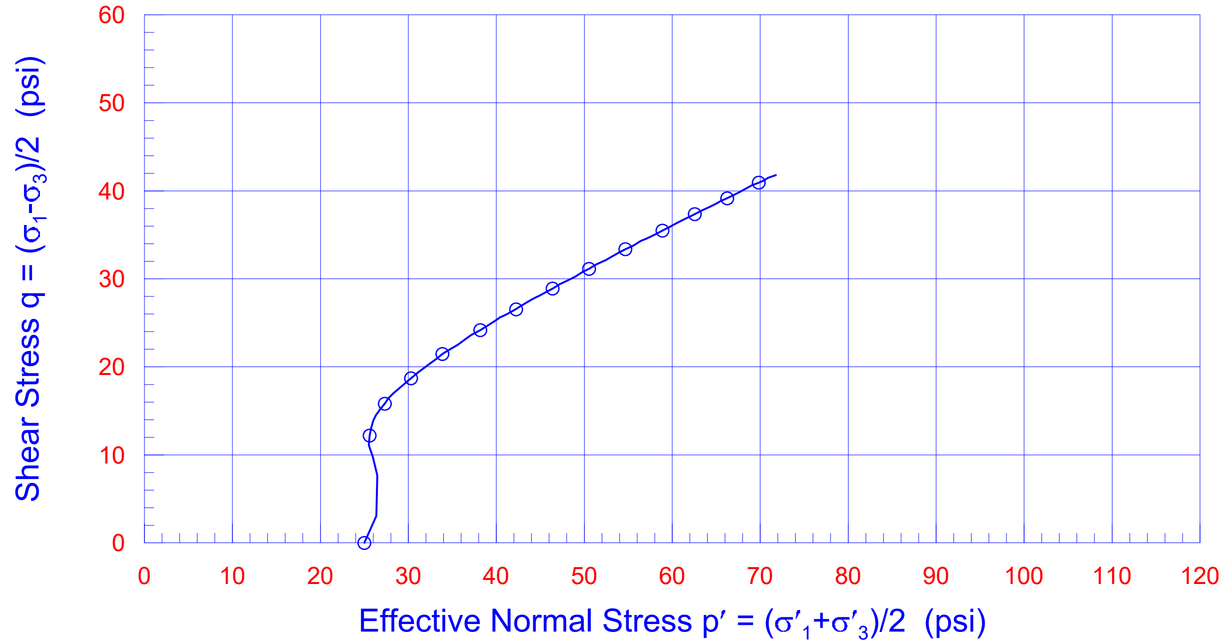

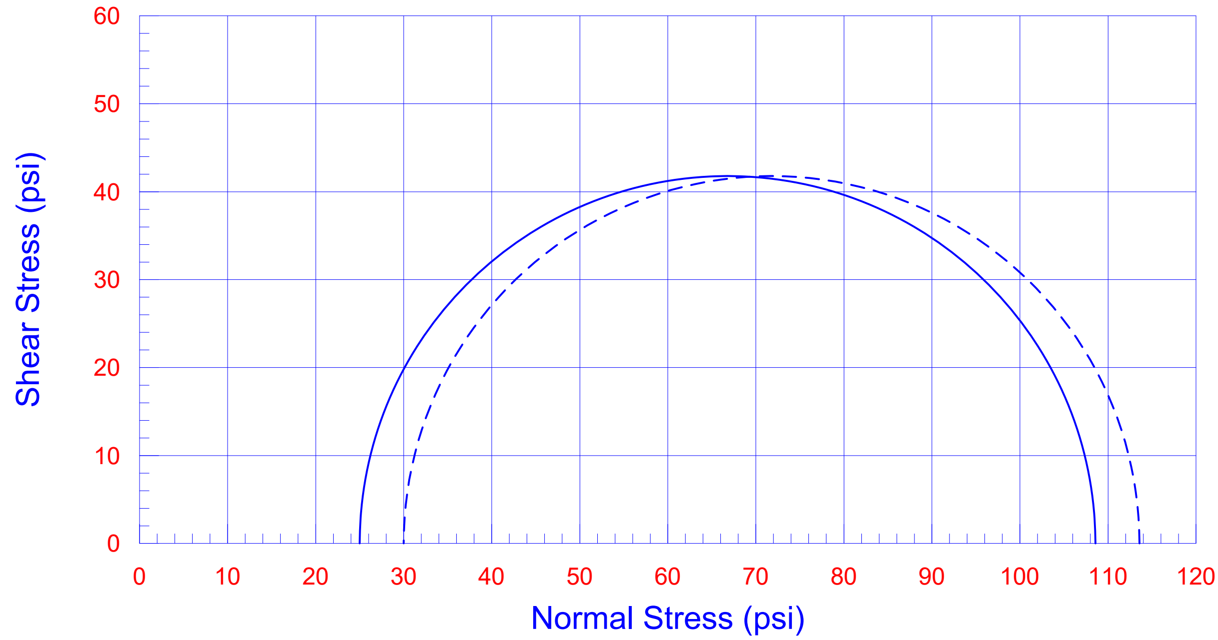

	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-38	T13A	42.0	25.0	83.6
□					
△					

——— Mohr Circle based on Total Stress

– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11585.005

Brea Boulevard
Additional Borings

Consolidated Undrained
Triaxial Compression Test
ASTM D 4767

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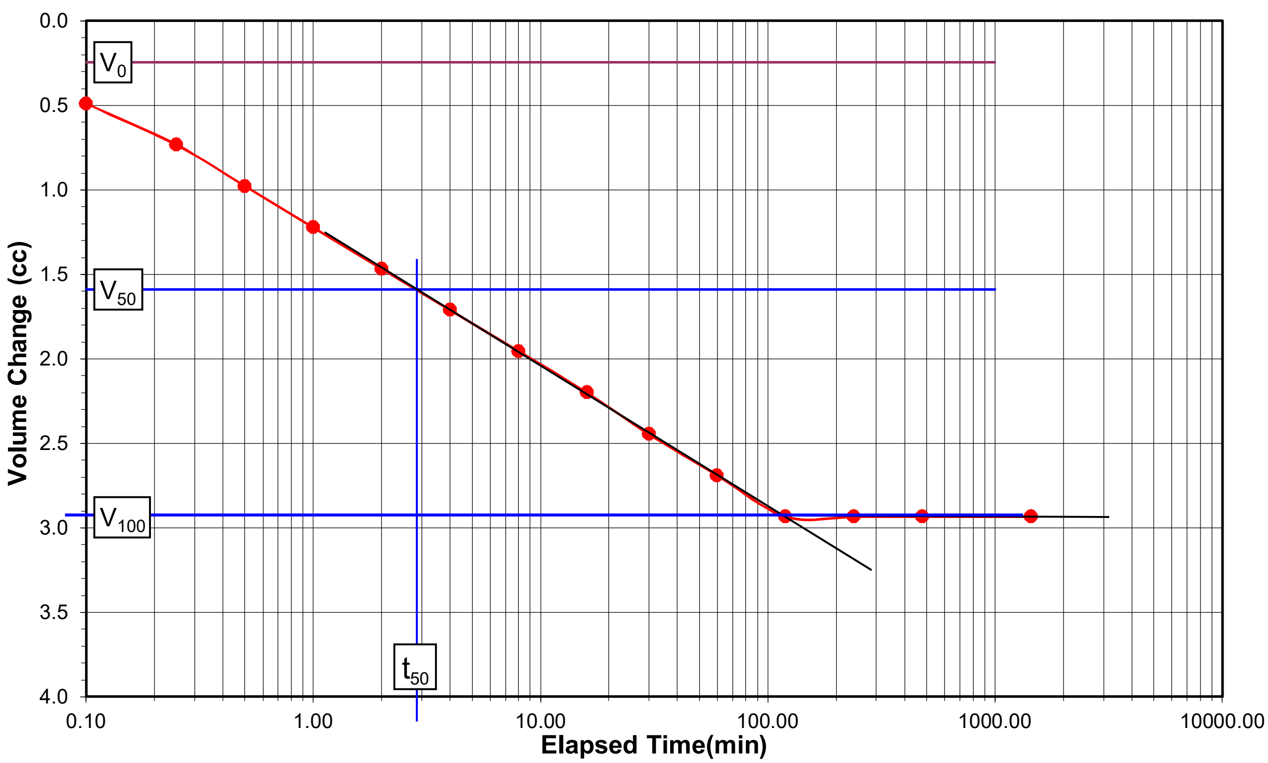
CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos
Project No.:	11585.005	Depth (ft.) :	42.0
Boring No.:	LB-38	Eff. Stress (psi):	25.00
Sample No.:	T13A	Burette Area:	0.379 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
11/20/20	10:47:00			Initial Burette	4.90	
11/20/20	10:47:06	0.10	0.32		5.10	0.49
11/20/20	10:47:15	0.25	0.50		5.20	0.73
11/20/20	10:47:30	0.50	0.71		5.30	0.98
11/20/20	10:48:00	1.00	1.00		5.40	1.22
11/20/20	10:49:00	2.00	1.41		5.50	1.47
11/20/20	10:51:00	4.00	2.00		5.60	1.71
11/20/20	10:55:00	8.00	2.83		5.70	1.96
11/20/20	11:03:00	16.00	4.00		5.80	2.20
11/20/20	11:17:00	30.00	5.48		5.90	2.45
11/20/20	11:47:00	60.00	7.75		6.00	2.69
11/20/20	12:47:00	120.00	10.95		6.10	2.93
11/20/20	14:47:00	240.00	15.49		6.10	2.93
11/20/20	18:47:00	480.00	21.91		6.10	2.93
11/21/20	10:47:00	1440.00	37.95		6.10	2.93



V_0	(cc)	0.24
V_{100}	(cc)	2.93
V_{50}	(cc)	1.59
t_{50}	(min)	2.80
Height After Consolidation (in)		4.540
Strain Rate	(in/min)	**0.0065**
Duration of Test*	(hr)	1.8

*Based on a total strain of 15%

Height (ft)		4.535
		4.533
		4.536
Average		4.535
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.2610	0.2540
Final Rdg. (in)	0.2570	0.2530

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Additional Borings	Tested By:	A. Santos	Date:	11/14/20
Project No:	11585.005	Checked By:	J. Ward	Date:	12/04/20
Boring No.:	LB-33				
Sample No.:	T13A				
Depth (ft.):	42.0				
Sample Type:	Ring				

25 psi

CONSOLIDATED UNDRAINED TRIAXIAL TEST

ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	01/31/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-16	Sample Type:	Ring		
Sample No.:	R-3				
Depth (ft.):	26-26.5				
Soil Description	Olive gray siltstone (ML)				

Diameter (in)	2.424	2.424	2.424	Avg. =	2.424
Height (in)	5.412	5.413	5.413	Avg. =	5.413

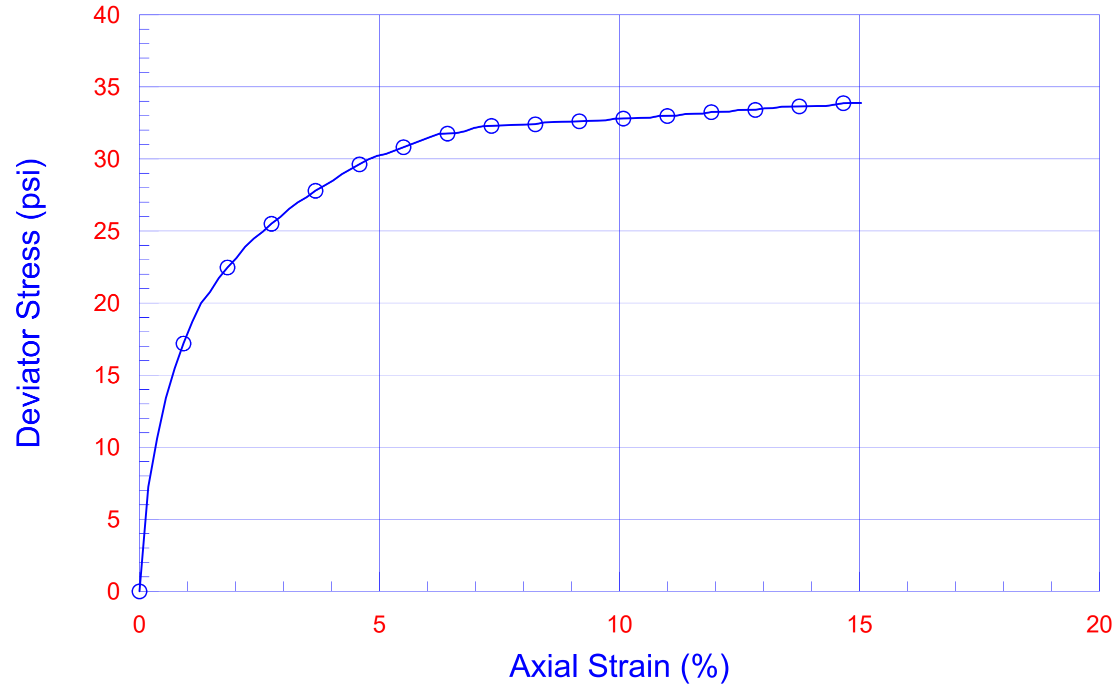
	Before Saturation	Pre-Consol.	Post Consol.	Post Test
Area (in²)	4.615	4.729	4.661	
Moisture Content (%)	18.65			27.39
Wt. Wet Sample + Cont. (g)	162.60			933.20
Wt. Dry Sample + Cont. (g)	145.20			748.50
Wt. Container (g)	51.90			74.25
Density and Saturation				
Wt. Wet Sample + Cont. (g)	832.90			Calculated from initial dry weight and final moisture content
Wt. Container (g)	0.00			
Wet Density (pcf)	127.0			134.0
Dry Density (pcf)	107.1			105.2
Void Ratio	0.574			0.602
% Saturation	87.8			100.0

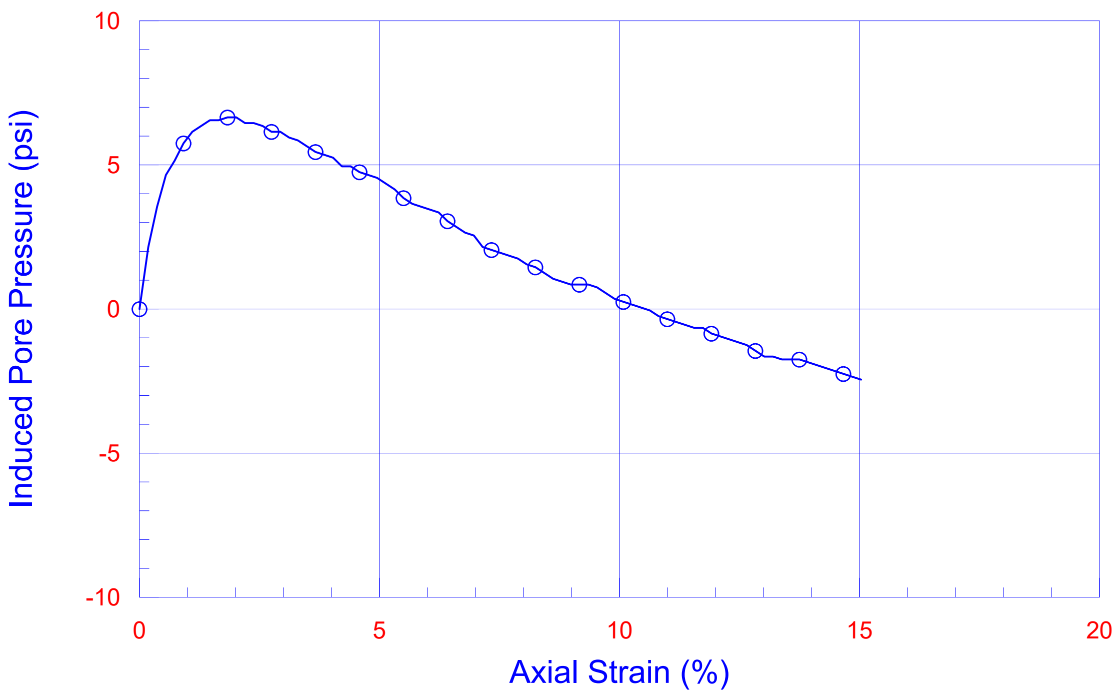
Specific Gravity (assumed) = 2.70

Back Pressure Saturation		Burette Area (sq. in.)=	0.358
		Initial Burette Ht.(cm)=	24.0
		Final Burette Ht.(cm)=	7.0
		Volume of water during saturation (cc):	39.3
B Value (%) =	95	Change in Height (in)=	-0.068

Consolidation			
Cell Pressure (psi) =	102.45	Burette Area (sq. in.)=	0.3580
Back Pressure(psi) =	90.45	Initial Burette Ht.(cm)=	6.6
Eff. Consol. Stress (psi) =	12.00	Final Burette Ht.(cm)=	10.1
Change in Height (in) =	0.0250	Final Height (in)=	5.456

Shear		At Failure	
Rate of Deformation (in/min)=	0.0024	Deviator Stress (psi) =	33.9
Time to 50% primary Consolidation =	71.00 min	Eff. Minor Principal stress (psi) =	14.5
Failure Criterion:		Eff. Major Principal stress (psi) =	48.3
Maximum deviator stress to 15% axial strain		Axial Strain (%) =	15.0





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-16	R-3	26-26.5	12.0	33.9
□					
△					

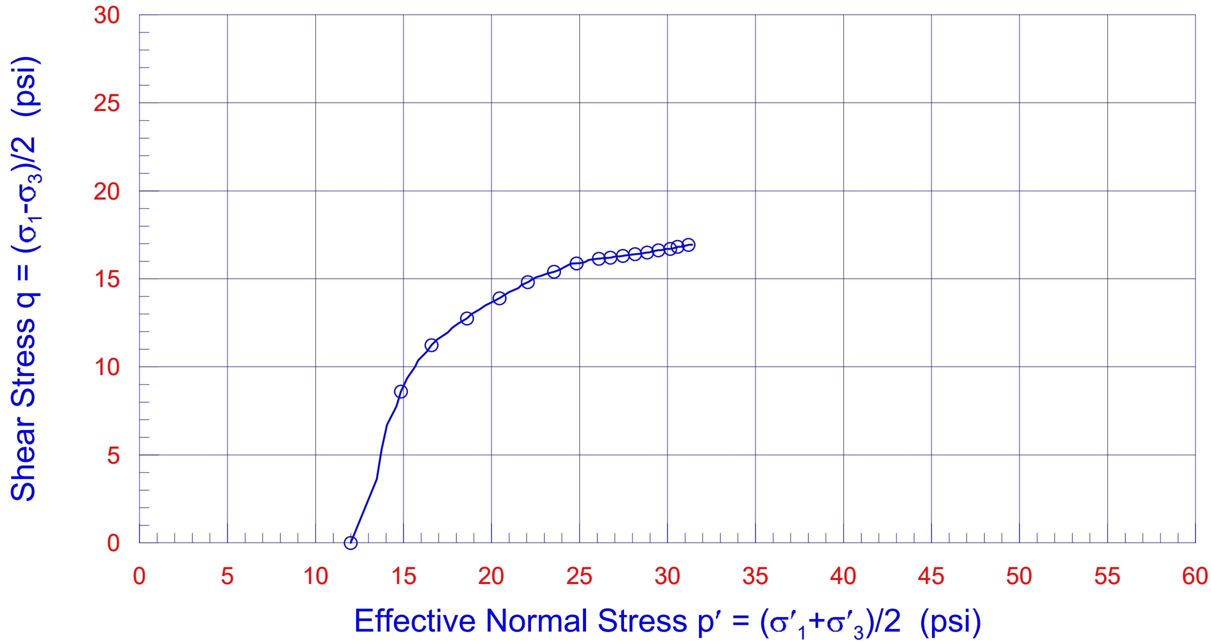
Leighton

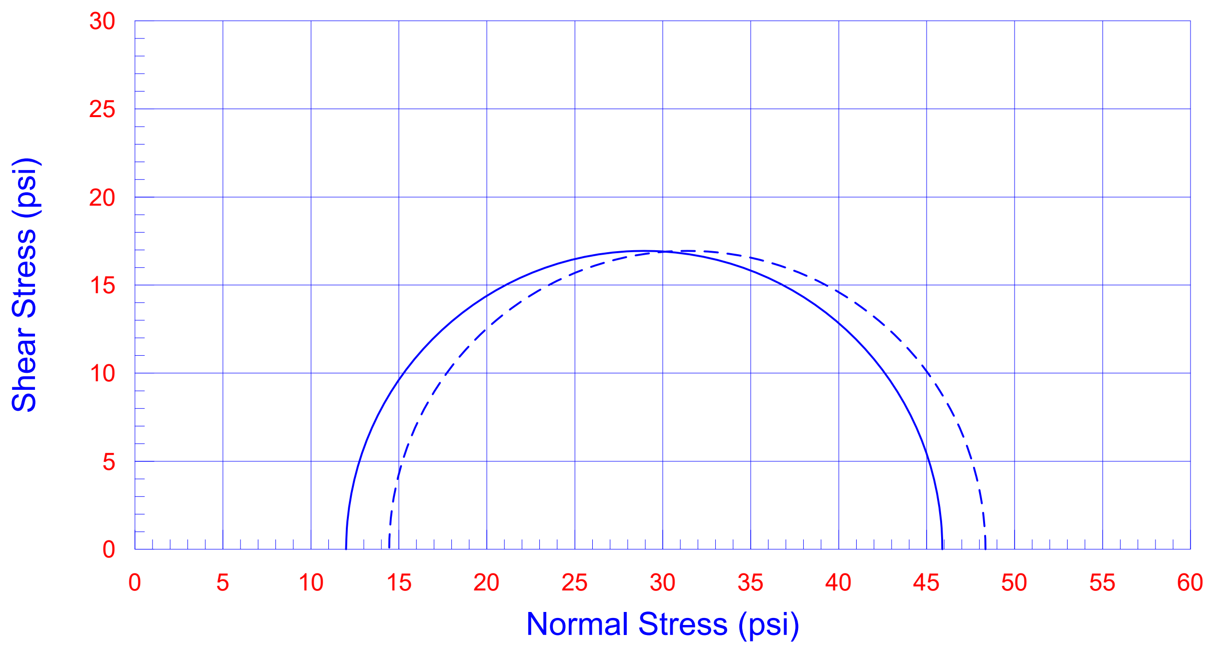
Project No.: 11588.001

Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

02/19





	Boring No.	Sample No.	Depth (ft.)	Eff. Conf. Pressure (psi)	Max. Dev. Stress (psi)
○	LB-16	R-3	26-26.5	12.0	33.9
□					
△					

——— Mohr Circle based on Total Stress
– – – – Mohr Circle based on Effective Stress

Leighton

Project No.: 11588.001
Brea Boulevard Corridor Improvements - Supplemental

Consolidated Undrained Triaxial Compression Test
ASTM D 4767

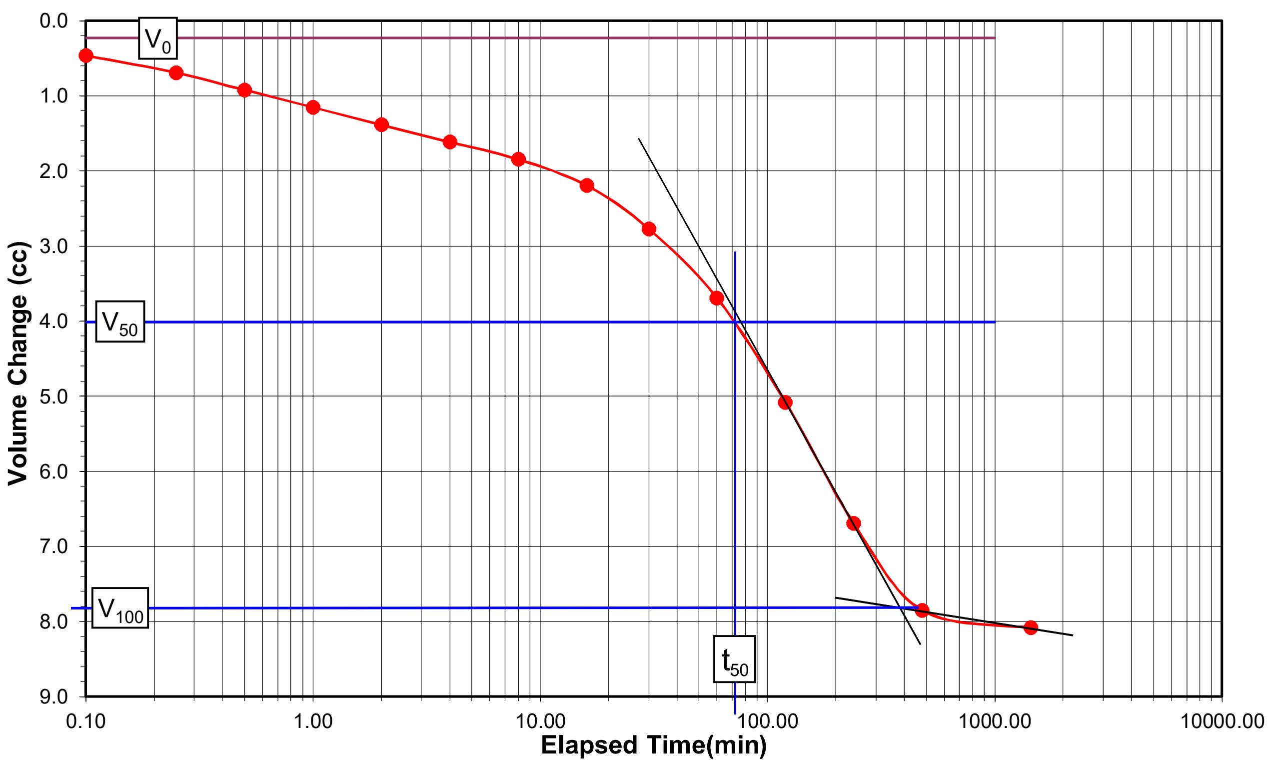
02-19

CU TRIAXIAL TEST CONSOLIDATION CURVE

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos
Project No.:	11588.001	Depth (ft.) :	26-26.5
Boring No.:	LB-16	Eff. Stress (psi):	12.00
Sample No.:	R-3	Burette Area:	0.358 in²

Date	Time	Elapsed Time (min)	Square Root Time (min½)	Dial Rdgs (in.)	Burette Rdgs (cm.)	Volume Change (cc)
02/06/19	9:22:00			Initial Burette	6.60	
02/06/19	9:22:06	0.10	0.32		6.80	0.5
02/06/19	9:22:15	0.25	0.50		6.90	0.7
02/06/19	9:22:30	0.50	0.71		7.00	0.9
02/06/19	9:23:00	1.00	1.00		7.10	1.2
02/06/19	9:24:00	2.00	1.41		7.20	1.4
02/06/19	9:26:00	4.00	2.00		7.30	1.6
02/06/19	9:30:00	8.00	2.83		7.40	1.8
02/06/19	9:38:00	16.00	4.00		7.55	2.2
02/06/19	9:52:00	30.00	5.48		7.80	2.8
02/06/19	10:22:00	60.00	7.75		8.20	3.7
02/06/19	11:22:00	120.00	10.95		8.80	5.1
02/06/19	13:22:00	240.00	15.49		9.50	6.7
02/06/19	17:22:00	480.00	21.91		10.00	7.9
02/07/19	9:22:00	1440.00	37.95		10.10	8.1



V_0	(cc)	0.23
V_{100}	(cc)	7.80
V_{50}	(cc)	4.02
t_{50}	(min)	71.00
Height After Consolidation (in)		5.456
Strain Rate	(in/min)	**0.0003**
Duration of Test*	(hr)	44.4

*Based on a total strain of 15%

Height (ft)		5.412
		5.413
		5.413
Average		5.413
Dial Readings	Saturation	Consolidation
Initial Rdg. (in)	0.3100	0.2410
Final Rdg. (in)	0.2420	0.2660

CONSOLIDATED UNDRAINED TRIAXIAL TEST
ASTM D 4767

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	A. Santos	Date:	01/31/19
Project No:	11588.001	Checked By:	J. Ward	Date:	02/15/19
Boring No.:	LB-16				
Sample No.:	R-3				
Depth (ft.):	26-26.5				
Sample Type:	Ring				

12 psi

Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos
Date:	11/12/20		
Project No:	11585.005	Checked by:	J. Ward
Date:	12/02/20		
Boring No.:	LB-22	Sample Type:	Ring
Sample No.:	R-12	Depth(ft):	50.0
Sample Description:	Gray silt (ML)		

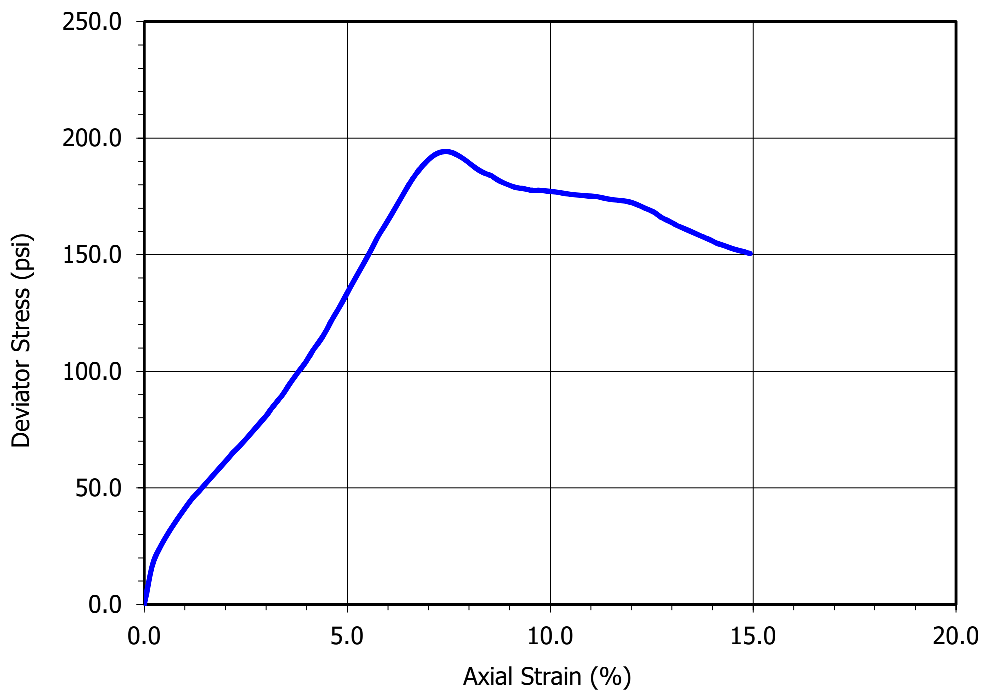
Diameter (in)	1	2.425
	2	2.425
	3	2.425
	Average	2.425
Height (in)	1	5.026
	2	5.025
	3	5.027
	Average	5.026
Weight of Sample + Tube / Rings (g)		790.8
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		877.6
Weight of Dry Sample + Container (g)		749.3
Weight of Container (g)		88.3
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	19.41
Dry Density (pcf)	108.7
Void Ratio	0.550
% Saturation	95.3

At Failure*	
Deviator stress (psi)	**194.17**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**236.17**
Axial strain (%)	**7.36**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

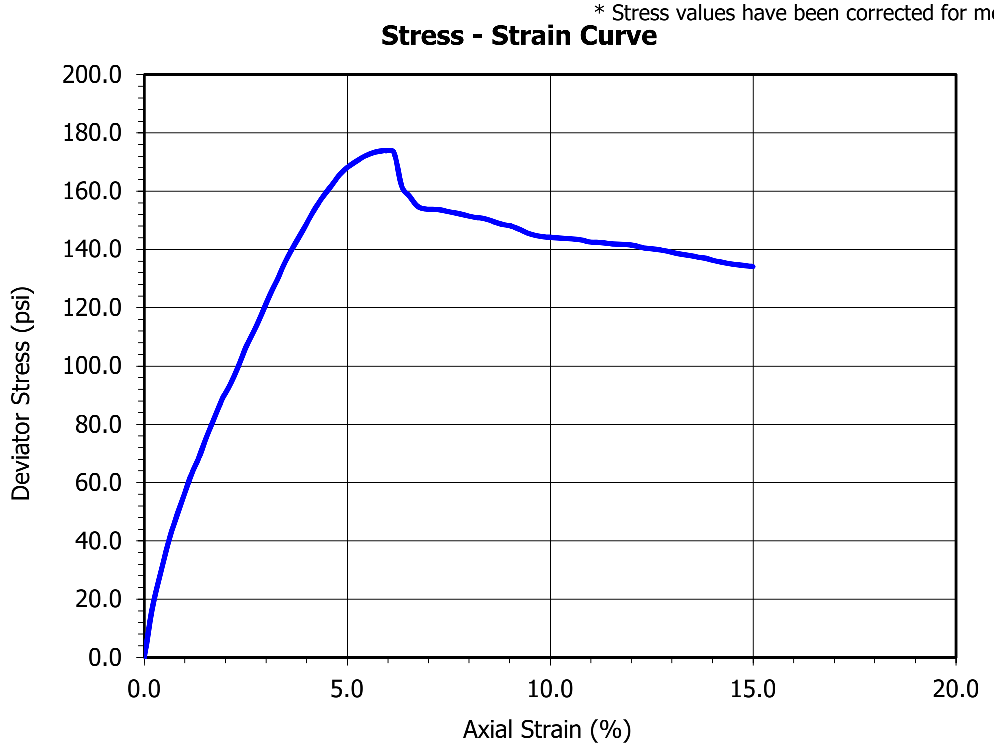
Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/11/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-27	Sample Type:	Ring		
Sample No.:	R-11	Depth(ft):	50.0		
Sample Description:	Gray silt (ML)				

Diameter (in)	1	2.425
	2	2.425
	3	2.425
	Average	2.425
Height (in)	1	5.202
	2	5.202
	3	5.205
	Average	5.203
Weight of Sample + Tube / Rings (g)		841.3
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		915.5
Weight of Dry Sample + Container (g)		794.7
Weight of Container (g)		75.0
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	16.78
Dry Density (pcf)	114.2
Void Ratio	0.475
% Saturation	95.3

At Failure*	
Deviator stress (psi)	**173.88**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**215.88**
Axial strain (%)	**5.96**

* Stress values have been corrected for membrane effects



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/12/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-37	Sample Type:	Ring		
Sample No.:	R-8	Depth(ft):	30.0		
Sample Description:	Gray silt (ML)				

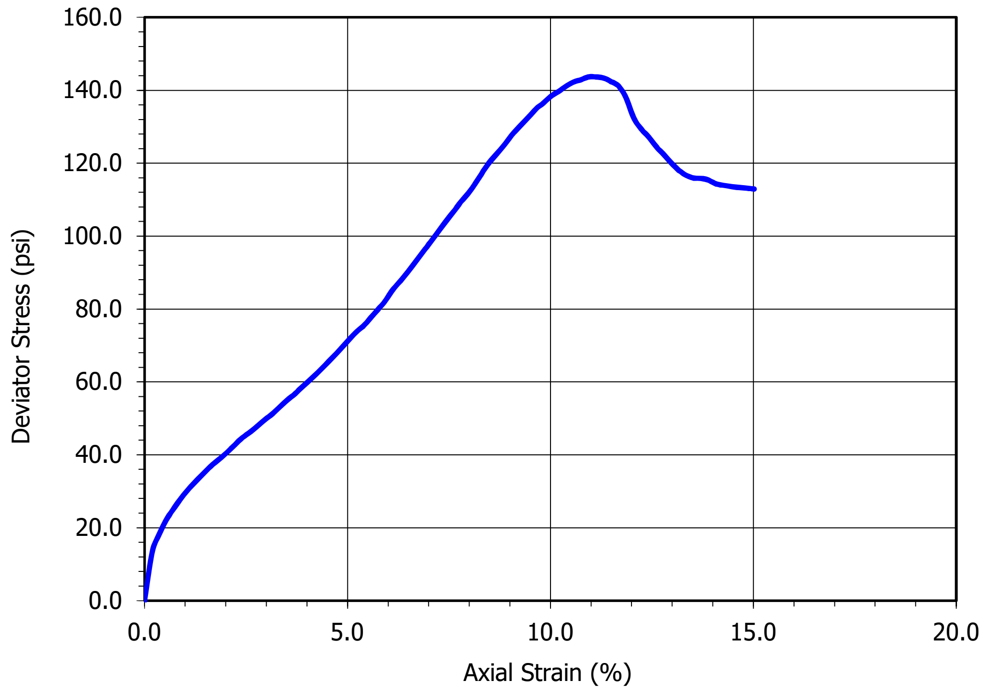
Diameter (in)	1	2.423
	2	2.423
	3	2.423
	Average	2.423
Height (in)	1	5.392
	2	5.393
	3	5.393
	Average	5.393
Weight of Sample + Tube / Rings (g)		842.2
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		915.7
Weight of Dry Sample + Container (g)		786.1
Weight of Container (g)		74.1
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		25.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	18.20
Dry Density (pcf)	109.2
Void Ratio	0.543
% Saturation	90.4

At Failure*	
Deviator stress (psi)	**143.67**
Minor principal total stress (psi)	**25.00**
Major principal total stress (psi)	**168.67**
Axial strain (%)	**10.94**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos	Date:	11/12/20
Project No:	11585.005	Checked by:	J. Ward	Date:	12/02/20
Boring No.:	LB-37	Sample Type:	Tube		
Sample No.:	T-11B	Depth(ft):	43.0		
Sample Description:	Dark gray silt (ML)				

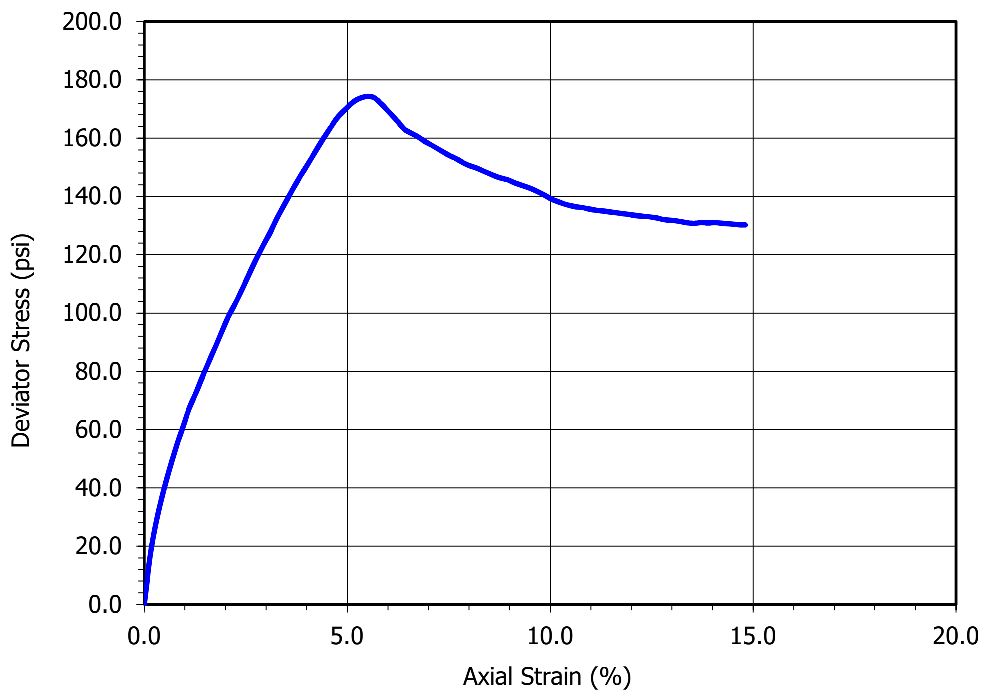
Diameter (in)	1	2.416
	2	2.416
	3	2.416
	Average	2.416
Height (in)	1	5.472
	2	5.470
	3	5.470
	Average	5.471
Weight of Sample + Tube / Rings (g)		797.5
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		873.2
Weight of Dry Sample + Container (g)		751.2
Weight of Container (g)		78.5
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		35.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	18.14
Dry Density (pcf)	102.5
Void Ratio	0.643
% Saturation	76.1

At Failure*	
Deviator stress (psi)	**174.32**
Minor principal total stress (psi)	**35.00**
Major principal total stress (psi)	**209.32**
Axial strain (%)	**5.48**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated, Undrained Compressive Strength of Cohesive Soils in Triaxial Compression

AASHTO T 296

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested by:	A. Santos
Date:	11/12/20		
Project No:	11585.005	Checked by:	J. Ward
Date:	12/02/20		
Boring No.:	LB-38	Sample Type:	Ring
Sample No.:	R-14	Depth(ft):	43.0
Sample Description:	Gray silt (ML)		

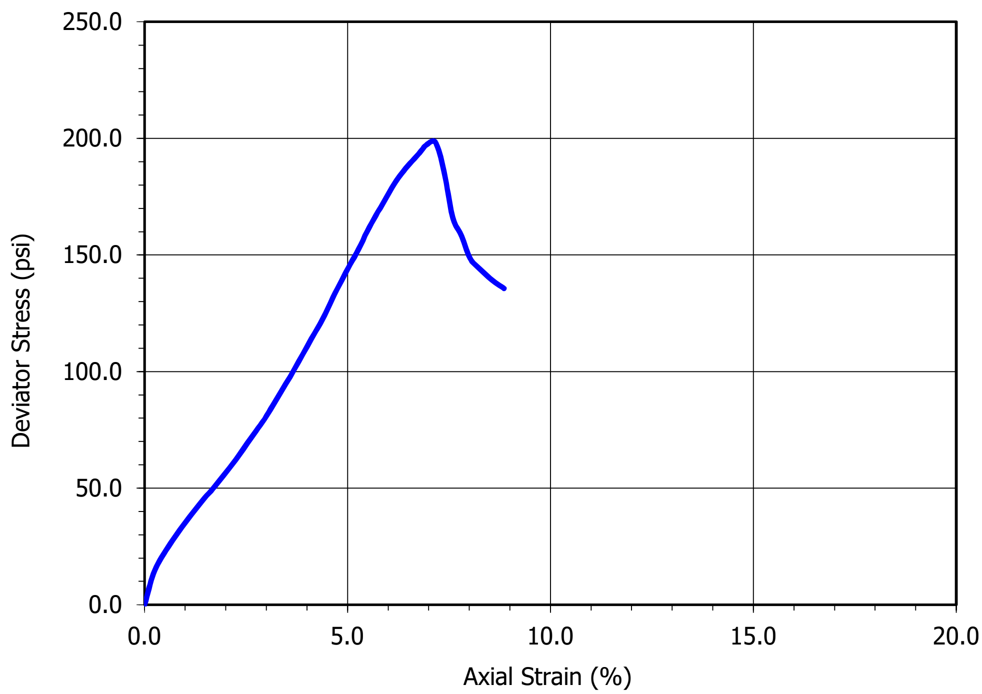
Diameter (in)	1	2.423
	2	2.423
	3	2.423
	Average	2.423
Height (in)	1	4.740
	2	4.741
	3	4.744
	Average	4.742
Weight of Sample + Tube / Rings (g)		764.8
Weight of Tube / Rings (g)		0.0
Weight of Wet Sample + Container (g)		852.0
Weight of Dry Sample + Container (g)		744.4
Weight of Container (g)		87.9
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		42.0
Rate of Deformation (in/min)		0.040

Sample Properties	
Moisture Content (%)	16.39
Dry Density (pcf)	114.5
Void Ratio	0.472
% Saturation	93.8

At Failure*	
Deviator stress (psi)	**198.23**
Minor principal total stress (psi)	**42.00**
Major principal total stress (psi)	**240.23**
Axial strain (%)	**7.17**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



APPENDIX C.6

Pavement Support and Earthwork

MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Dansby	Date:	09/11/18
Project No.:	11588.001	Input By:	J. Ward	Date:	09/14/18
Boring No.:	LBA-1	Depth (ft.):	10-15		
Sample No.:	B-1				
Soil Identification:	Light olive brown silty clay (CL-ML)				

Preparation Method: [X] Moist [ ] Dry — [X] Mechanical Ram [ ] Manual Ram

Mold Volume (ft³) 0.03330 — *Ram Weight = 10 lb.; Drop = 18 in.*

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3658	3732	3796	3787		
Weight of Mold (g)	1848	1848	1848	1848		
Net Weight of Soil (g)	1810	1884	1948	1939		
Wet Weight of Soil + Cont. (g)	678.0	701.7	456.4	447.7		
Dry Weight of Soil + Cont. (g)	639.0	650.6	399.5	383.9		
Weight of Container (g)	228.5	230.1	39.2	39.1		
Moisture Content (%)	9.50	12.15	15.79	18.50		
Wet Density (pcf)	119.8	124.7	129.0	128.4		
Dry Density (pcf)	109.4	111.2	111.4	108.3		

Maximum Dry Density (pcf) 112.0 **Optimum Moisture Content (%)** 14.5

PROCEDURE USED

[X] **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

[ ] **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

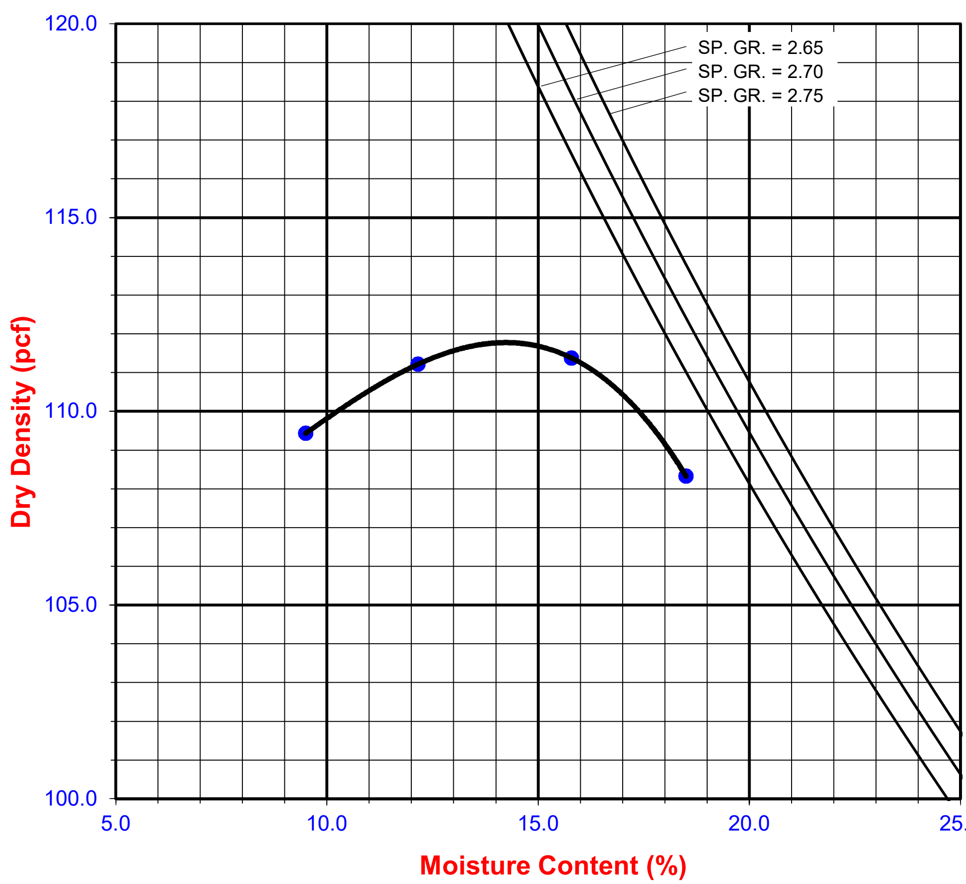
[ ] **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By:	S. Dansby	Date:	09/12/18
Project No.:	11588.001	Input By:	J. Ward	Date:	09/14/18
Boring No.:	LBA-2	Depth (ft.):	10-15		
Sample No.:	B-2				
Soil Identification:	Light brown silty, clayey sand (SC-SM)				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

Preparation Method:	X	Moist
		Dry
Compaction Method	X	Mechanical Ram
		Manual Ram

Scalp Fraction (%)	
#3/4	
#3/8	6.8
#4	

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) 0.03330

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3800	3882	3951	3877		
Weight of Mold (g)	1848	1848	1848	1848		
Net Weight of Soil (g)	1952	2034	2103	2029		
Wet Weight of Soil + Cont. (g)	437.2	468.5	471.7	526.6		
Dry Weight of Soil + Cont. (g)	418.9	439.0	432.7	473.1		
Weight of Container (g)	40.0	38.9	38.8	39.1		
Moisture Content (%)	4.83	7.37	9.90	12.33		
Wet Density (pcf)	129.2	134.7	139.2	134.3		
Dry Density (pcf)	123.3	125.4	126.7	119.6		

Maximum Dry Density (pcf) 127.0 **Optimum Moisture Content (%)** 9.5

Corrected Dry Density (pcf) 129.0 **Corrected Moisture Content (%)** 9.0

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☒ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

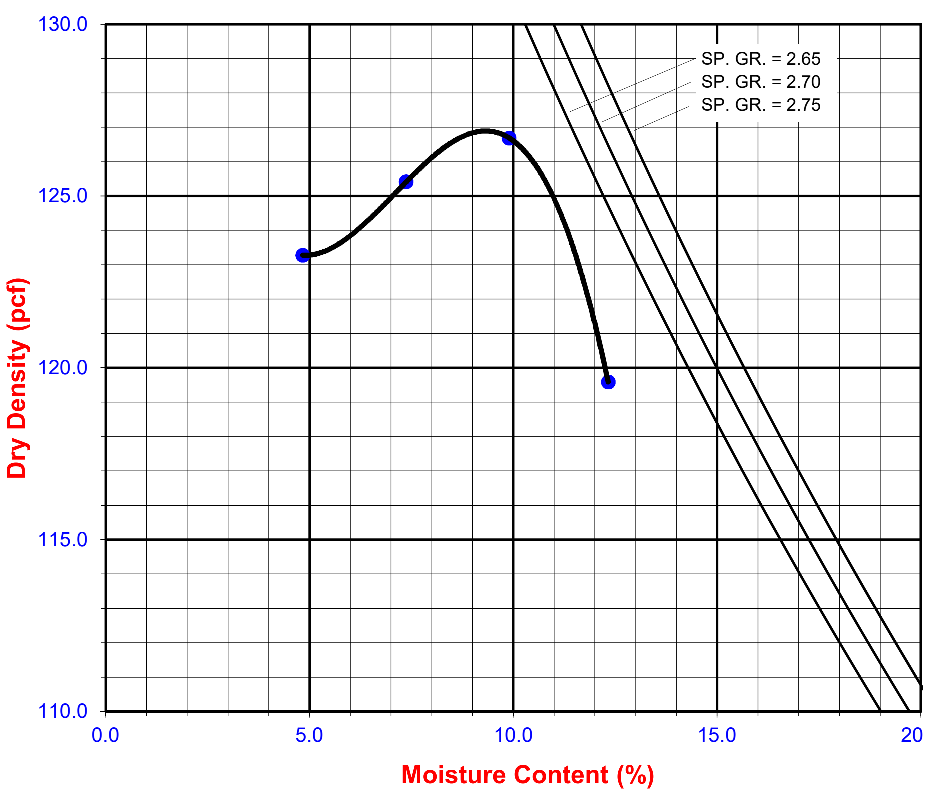
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST

ASTM D 1557

Leighton

Project Name:	Brea Boulevard Corridor Improvements - Supplemental	Tested By:	S. Dansby	Date:	01/30/19
Project No.:	11588.001	Input By:	J. Ward	Date:	02/01/19
Boring No.:	LB-14	Depth (ft.):	2-5		
Sample No.:	B-1				
Soil Identification:	Olive brown silty sand with gravel (SM)g				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)	
Preparation Method:	X	Moist	#3/4	
		Dry	#3/8	5.1
Compaction Method	X	Mechanical Ram	#4	
		Manual Ram		

Rammer Weight (lb.) = 10.0

Height of Drop (in.) = 18.0

Mold Volume (ft³) 0.03320

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3927	4054	4014			
Weight of Mold (g)	1830	1830	1830			
Net Weight of Soil (g)	2097	2224	2184			
Wet Weight of Soil + Cont. (g)	588.5	461.6	493.0			
Dry Weight of Soil + Cont. (g)	569.9	438.1	457.0			
Weight of Container (g)	39.3	39.2	39.3			
Moisture Content (%)	3.51	5.89	8.62			
Wet Density (pcf)	139.2	147.7	145.0			
Dry Density (pcf)	134.5	139.5	133.5			

Maximum Dry Density (pcf) 139.5 **Optimum Moisture Content (%)** 5.9

Corrected Dry Density (pcf) 140.7 **Corrected Moisture Content (%)** 5.7

☐ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☒ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

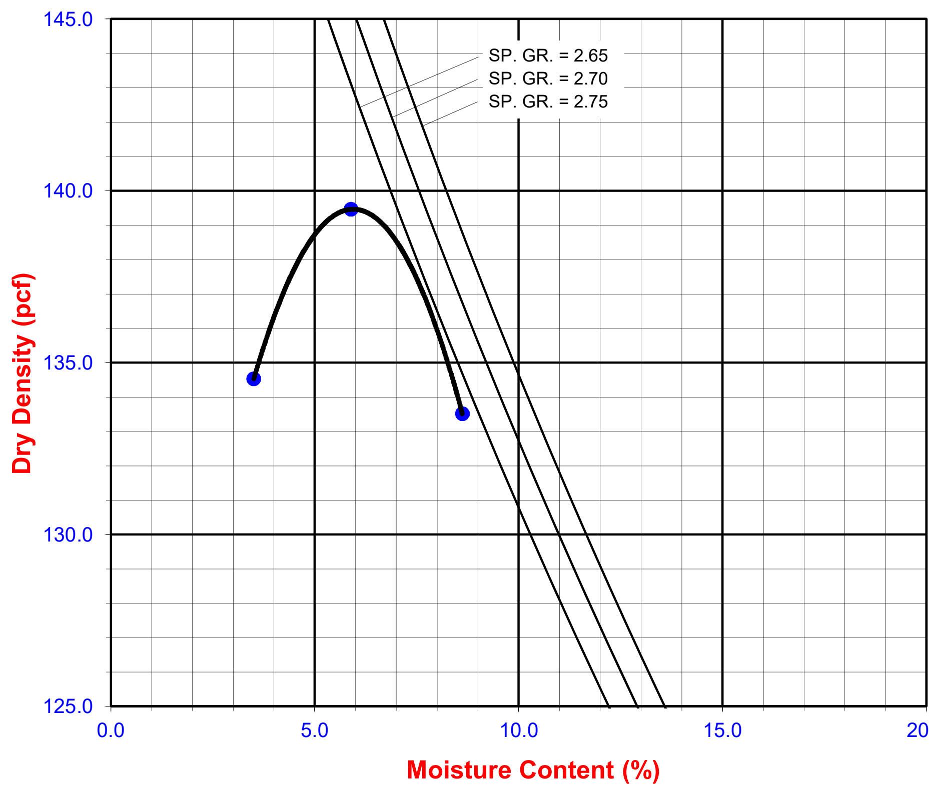
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



MODIFIED PROCTOR COMPACTION TEST
ASTM D 1557

Leighton

Project Name:	Brea Boulevard Additonal Borings	Tested By:	J. Gonzalez	Date:	10/26/20
Project No.:	11585.005	Checked By:	A. Santos	Date:	10/28/20
Boring No.:	LB-29	Depth (ft.):	2-5		
Sample No.:	B-1				
Soil Identification:	Olive brown silty sand (SM)				

Note: Corrected dry density calculation assumes specific gravity of 2.70 and moisture content of 1.0% for oversize particles

			Scalp Fraction (%)		
Preparation Method:	X	Moist	#3/4		Rammer Weight (lb.) = 10.0
		Dry	#3/8		Height of Drop (in.) = 18.0
Compaction Method	X	Mechanical Ram	#4	15.2	Mold Volume (ft³) 0.03330
		Manual Ram			

TEST NO.	1	2	3	4	5	6
Wt. Compacted Soil + Mold (g)	3835	3926	3889			
Weight of Mold (g)	1868	1868	1868			
Net Weight of Soil (g)	1967	2058	2021			
Wet Weight of Soil + Cont. (g)	331.2	311.0	293.7			
Dry Weight of Soil + Cont. (g)	311.0	286.6	264.9			
Weight of Container (g)	39.2	38.6	39.9			
Moisture Content (%)	7.43	9.84	12.80			
Wet Density (pcf)	130.2	136.2	133.8			
Dry Density (pcf)	121.2	124.0	118.6			

Maximum Dry Density (pcf)	**124.1**	**Optimum Moisture Content (%)**	**9.8**
Corrected Dry Density (pcf)	**129.3**	**Corrected Moisture Content (%)**	**8.5**

☒ **Procedure A**
Soil Passing No. 4 (4.75 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
May be used if +#4 is 20% or less

☐ **Procedure B**
Soil Passing 3/8 in. (9.5 mm) Sieve
Mold : 4 in. (101.6 mm) diameter
Layers : 5 (Five)
Blows per layer : 25 (twenty-five)
Use if +#4 is >20% and +3/8 in. is 20% or less

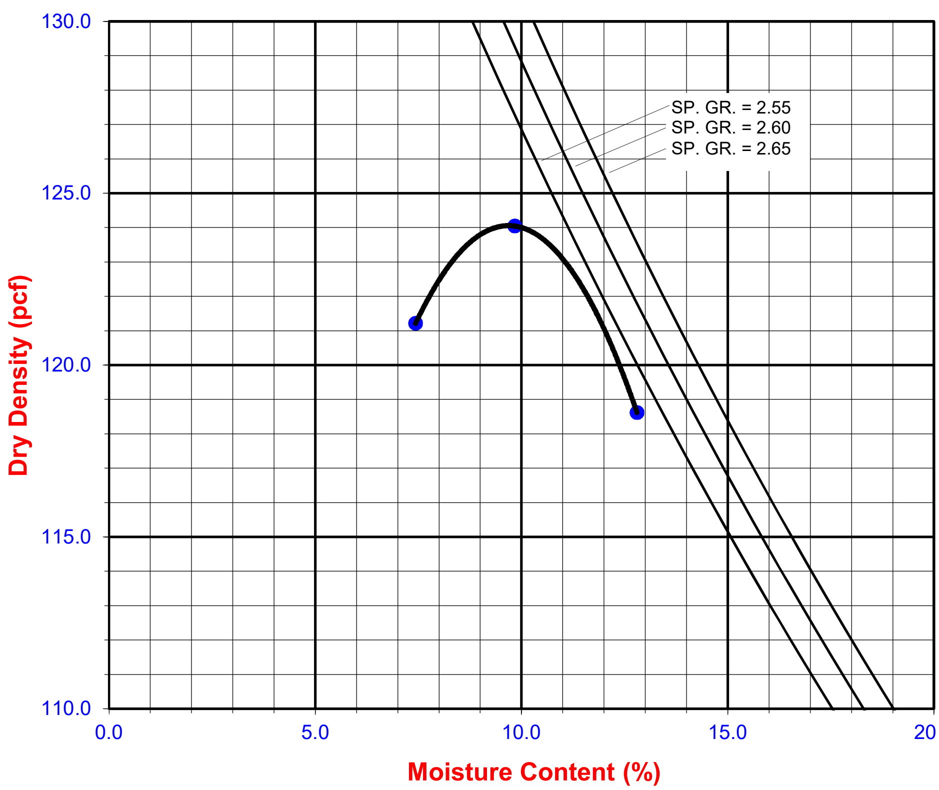
☐ **Procedure C**
Soil Passing 3/4 in. (19.0 mm) Sieve
Mold : 6 in. (152.4 mm) diameter
Layers : 5 (Five)
Blows per layer : 56 (fifty-six)
Use if +3/8 in. is >20% and +¾ in. is <30%

Particle-Size Distribution:

GR:SA:FI

Atterberg Limits:

LL,PL,PI



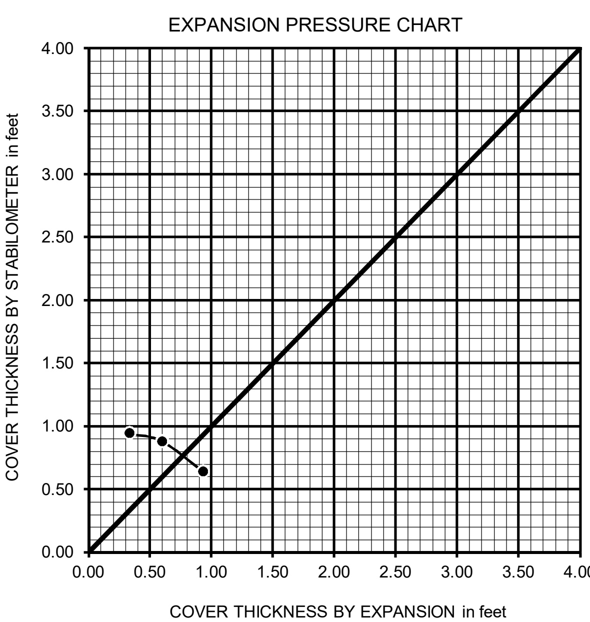
R-VALUE TEST RESULTS

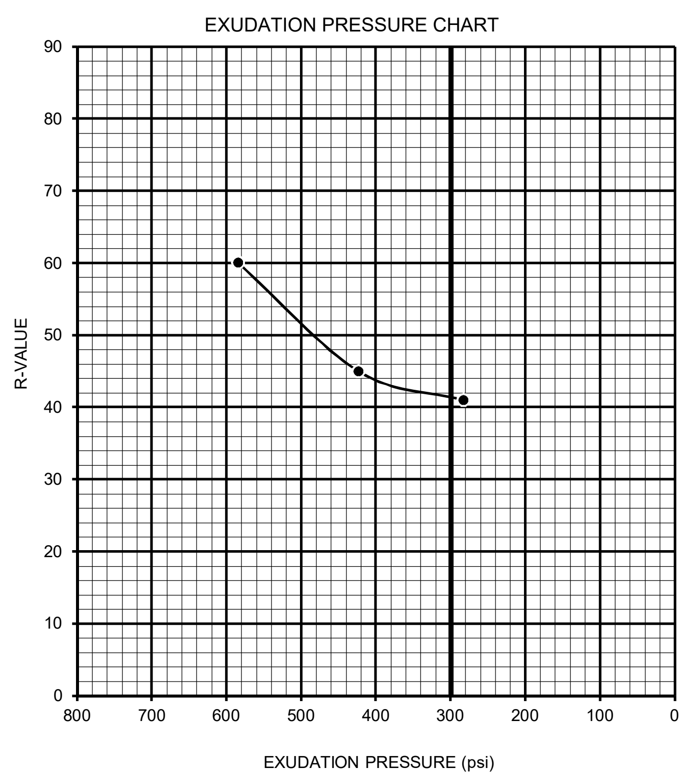
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-1	DEPTH (FT.):	1.25
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	12.9	13.8	14.3
HEIGHT OF SAMPLE, Inches	2.45	2.45	2.47
DRY DENSITY, pcf	116.6	115.0	114.4
COMPACTOR PRESSURE, psi	250	150	50
EXUDATION PRESSURE, psi	584	423	282
EXPANSION, Inches x 10exp-4	28	18	10
STABILITY Ph 2,000 lbs (160 psi)	46	64	70
TURNS DISPLACEMENT	4.07	4.53	4.70
R-VALUE UNCORRECTED	60	45	41
R-VALUE CORRECTED	60	45	41

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.64	0.88	0.94
EXPANSION PRESSURE THICKNESS, ft.	0.93	0.60	0.33





R-VALUE BY EXPANSION:	51
R-VALUE BY EXUDATION:	41
EQUILIBRIUM R-VALUE:	41

Leighton

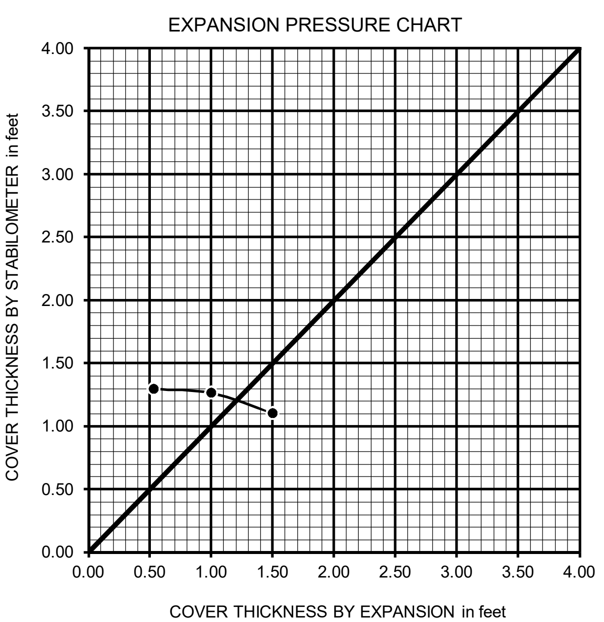
R-VALUE TEST RESULTS

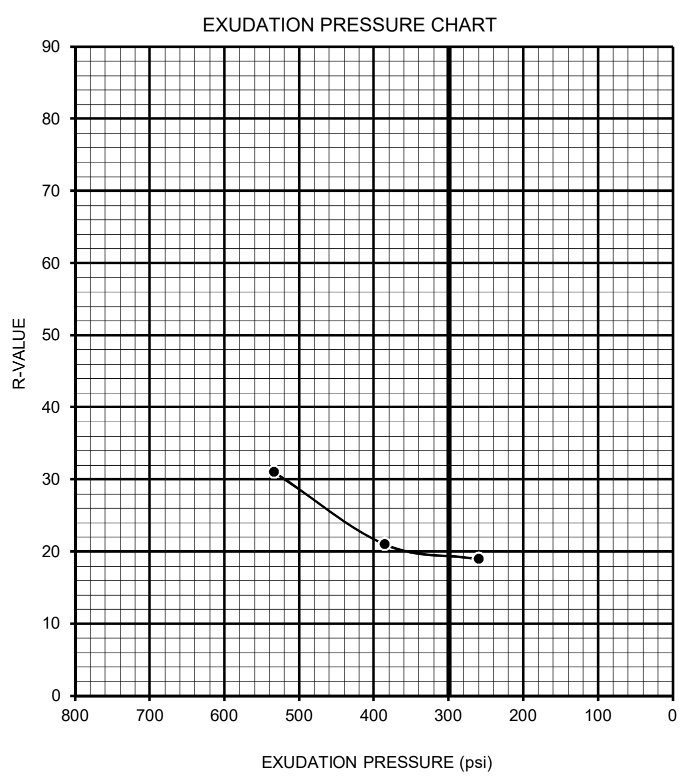
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-9	DEPTH (FT.):	
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown lean clay (CL)	DATE COMPLETED:	8/8/2018

TEST SPECIMEN	**a**	**b**	**c**
MOISTURE AT COMPACTION %	20.0	21.0	21.5
HEIGHT OF SAMPLE, Inches	2.46	2.55	2.51
DRY DENSITY, pcf	108.1	106.8	104.8
COMPACTOR PRESSURE, psi	200	150	100
EXUDATION PRESSURE, psi	533	386	259
EXPANSION, Inches x 10exp-4	45	30	16
STABILITY Ph 2,000 lbs (160 psi)	98	112	118
TURNS DISPLACEMENT	3.58	3.94	3.80
R-VALUE UNCORRECTED	31	21	19
R-VALUE CORRECTED	31	21	19

DESIGN CALCULATION DATA	**a**	**b**	**c**
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	1.10	1.26	1.30
EXPANSION PRESSURE THICKNESS, ft.	1.50	1.00	0.53





R-VALUE BY EXPANSION:	25
R-VALUE BY EXUDATION:	19
EQUILIBRIUM R-VALUE:	19

Leighton

R-VALUE TEST RESULTS

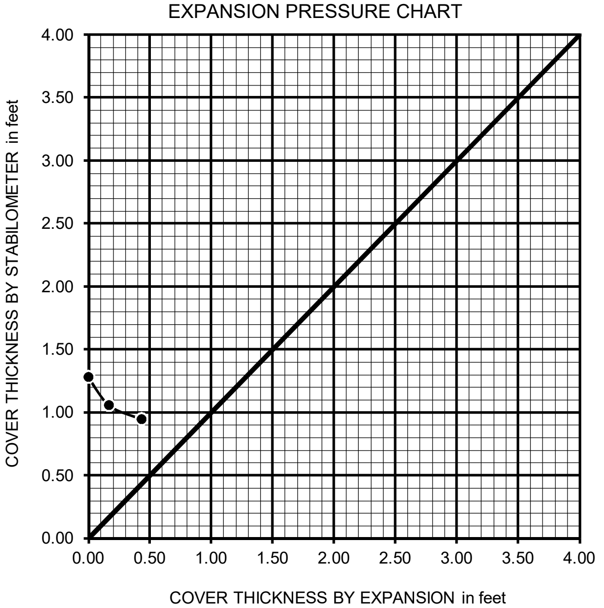
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-11	DEPTH (FT.):	3.0
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

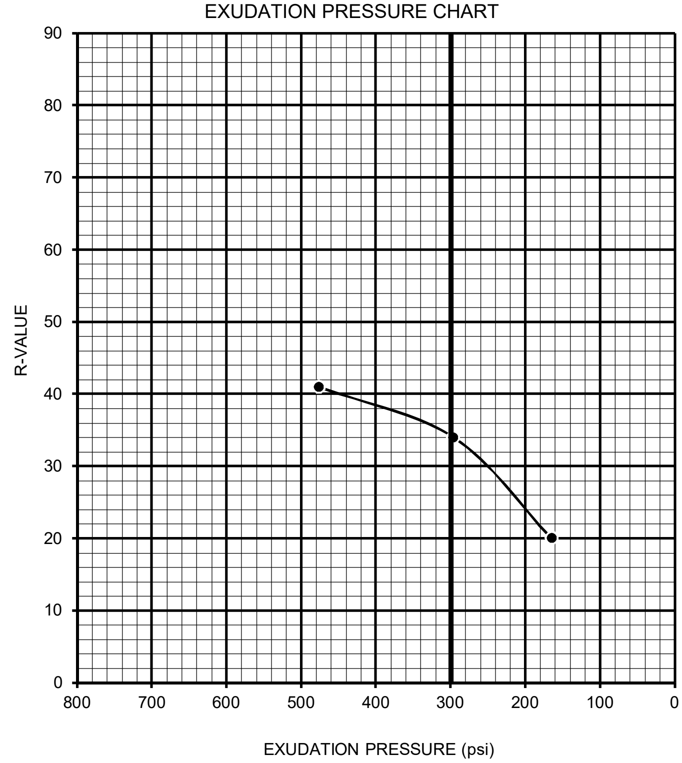
TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	17.0	17.4	18.4
HEIGHT OF SAMPLE, Inches	2.51	2.58	2.65
DRY DENSITY, pcf	109.4	107.4	106.2
COMPACTOR PRESSURE, psi	150	100	50
EXUDATION PRESSURE, psi	476	296	165
EXPANSION, Inches x 10exp-4	13	5	0
STABILITY Ph 2,000 lbs (160 psi)	72	91	119
TURNS DISPLACEMENT	4.31	3.99	3.88
R-VALUE UNCORRECTED	41	32	18
R-VALUE CORRECTED	41	34	20

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.94	1.06	1.28
EXPANSION PRESSURE THICKNESS, ft.	0.43	0.17	0.00

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	49
R-VALUE BY EXUDATION:	34
EQUILIBRIUM R-VALUE:	34

Leighton

R-VALUE TEST RESULTS

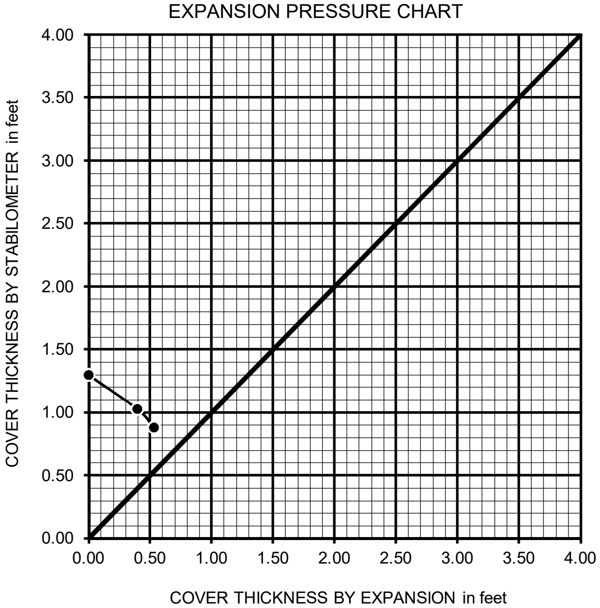
DOT CA Test 301

PROJECT NAME:	Brea Boulevard Corridor Improvements	PROJECT NUMBER:	11588.001
BORING NUMBER:	LB-12	DEPTH (FT.):	1.3
SAMPLE NUMBER:	B-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Light grayish brown clayey sand (SC)	DATE COMPLETED:	8/8/2018

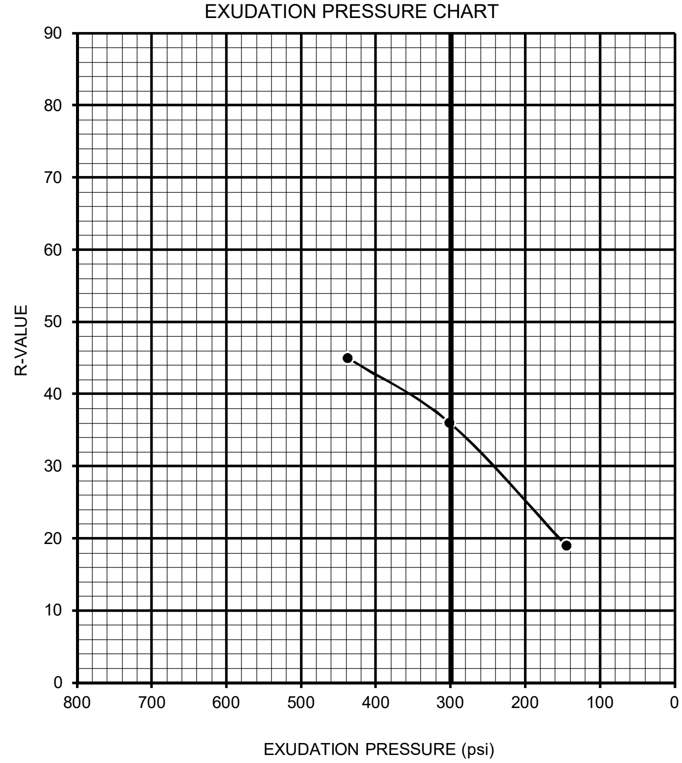
TEST SPECIMEN	**a**	**b**	**c**
MOISTURE AT COMPACTION %	11.5	12.0	12.9
HEIGHT OF SAMPLE, Inches	2.44	2.54	2.50
DRY DENSITY, pcf	117.5	114.0	115.1
COMPACTOR PRESSURE, psi	150	100	50
EXUDATION PRESSURE, psi	438	301	145
EXPANSION, Inches x 10exp-4	16	12	0
STABILITY Ph 2,000 lbs (160 psi)	67	85	118
TURNS DISPLACEMENT	4.11	3.98	3.87
R-VALUE UNCORRECTED	46	36	19
R-VALUE CORRECTED	45	36	19

DESIGN CALCULATION DATA	**a**	**b**	**c**
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.88	1.02	1.30
EXPANSION PRESSURE THICKNESS, ft.	0.53	0.40	0.00

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	56
R-VALUE BY EXUDATION:	36
EQUILIBRIUM R-VALUE:	36

APPENDIX C.7

Corrosivity

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name: Brea Boulevard Corridor Improvements | Tested By : G. Berdy | Date: 07/30/18

Project No. : 11588.001 | Data Input By: J. Ward | Date: 09/12/18

Boring No.	LB-3	LB-7		
Sample No.	B-1	B-1		
Sample Depth (ft)	0.0	0.0		
Soil Identification:	Olive brown SC-SM	Dark brown SC		
Wet Weight of Soil + Container (g)	212.56	211.74		
Dry Weight of Soil + Container (g)	206.10	203.08		
Weight of Container (g)	39.33	60.22		
Moisture Content (%)	3.87	6.06		
Weight of Soaked Soil (g)	100.24	100.80		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	2	91		
Crucible No.	5, 7 & 24	24		
Furnace Temperature (°C)	860	860		
Time In / Time Out	9:00/9:45	8:15/9:00		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	56.1147	17.0939		
Wt. of Crucible (g)	56.0810	17.0867		
Wt. of Residue (g) (A)	0.0337	0.0072		
PPM of Sulfate (A) x 41150	1386.76	296.28		
PPM of Sulfate, Dry Weight Basis	**1443**	**315**		

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	5	15		
ml of AgNO3 Soln. Used in Titration (C)	0.8	0.8		
PPM of Chloride (C -0.2) * 100 * 30 / B	360	120		
PPM of Chloride, Dry Wt. Basis	**375**	**128**		

pH TEST, DOT California Test 643

pH Value	**6.82**	**7.23**		
Temperature °C	22.8	22.7		

SOIL RESISTIVITY TEST
DOT CA TEST 643

Leighton

Project Name:	Brea Boulevard Corridor Improvements	Tested By :	G. Berdy	Date:	09/11/18
Project No. :	11588.001	Data Input By:	J. Ward	Date:	09/12/18
Boring No.:	LB-3	Depth (ft.) :	0.0		
Sample No. :	B-1				
Soil Identification:*	Olive brown SC-SM				

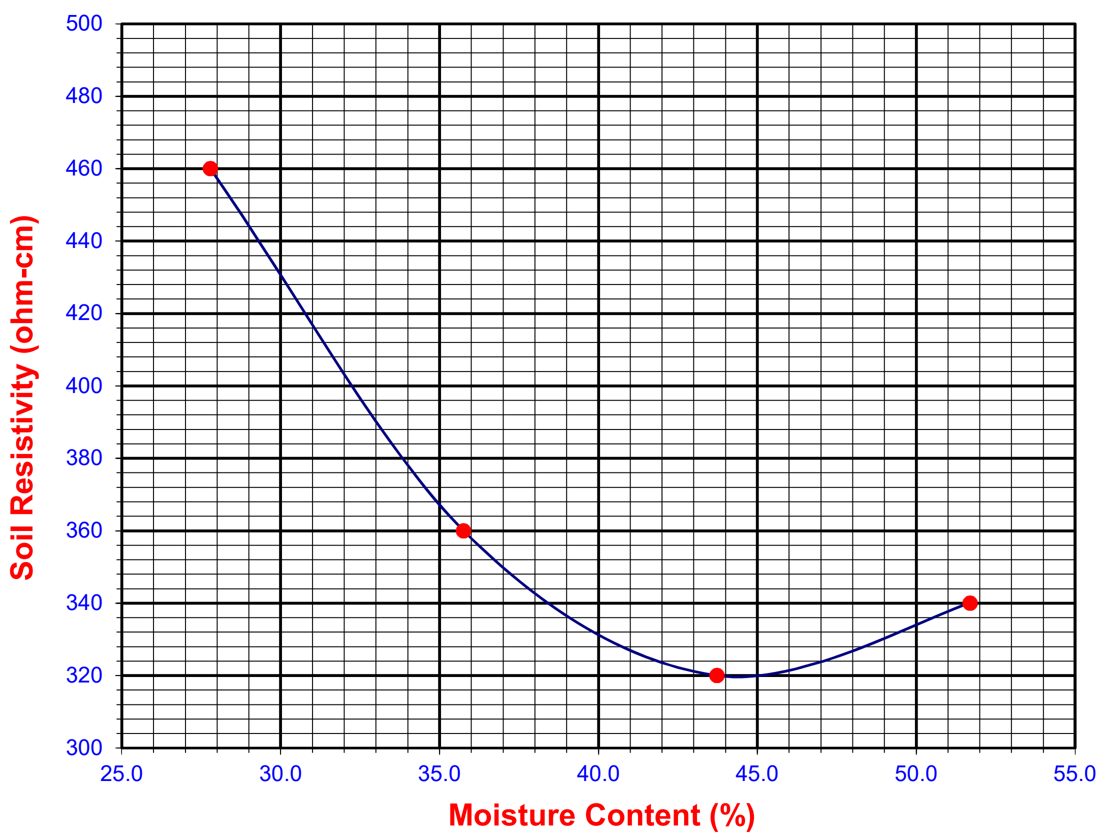
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	27.79	460	460
2	40	35.76	360	360
3	50	43.73	320	320
4	60	51.70	340	340
5				

Moisture Content (%) (MCi)	3.87
Wet Wt. of Soil + Cont. (g)	212.56
Dry Wt. of Soil + Cont. (g)	206.10
Wt. of Container (g)	39.33
Container No.	
Initial Soil Wt. (g) (Wt)	130.31
Box Constant	1.000

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
320	**44.4**	**1443**	**375**	**6.82**	**22.8**



SOIL RESISTIVITY TEST

DOT CA TEST 643

Project Name:	Brea Boulevard Corridor Improvements	Tested By :	G. Berdy	Date:	08/01/18
Project No. :	11588.001	Data Input By:	J. Ward	Date:	09/12/18
Boring No.:	LB-7	Depth (ft.) :	0.0		
Sample No. :	B-1				

Soil Identification:* Dark brown SC

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	30.52	610	610
2	40	38.68	580	580
3	50	46.83	570	570
4	60	54.98	580	580
5				

Moisture Content (%) (MCi)	6.06
Wet Wt. of Soil + Cont. (g)	211.74
Dry Wt. of Soil + Cont. (g)	203.08
Wt. of Container (g)	60.22
Container No.	
Initial Soil Wt. (g) (Wt)	130.08
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
570	**46.8**	**315**	**128**	**7.23**	**22.7**

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Leighton

Project Name: Brea Boulevard Additional Borings — Tested By : G. Berdy — Date: 10/27/20

Project No. : 11585.005 — Checked By: A. Santos — Date: 12/02/20

Boring No.	LB-19	LB-26	LB-32	LB-34
Sample No.	B-2	B-2	B-3	B-2
Sample Depth (ft)	25-35	10-20	30-40	20-30
Soil Identification:	Olive brown (SC)	Dark brown (CL)	Dark brown (ML)	Yellowish brown SM
Wet Weight of Soil + Container (g)	0.00	0.00	0.00	0.00
Dry Weight of Soil + Container (g)	0.00	0.00	0.00	0.00
Weight of Container (g)	1.00	1.00	1.00	1.00
Moisture Content (%)	0.00	0.00	0.00	0.00
Weight of Soaked Soil (g)	100.10	100.33	100.39	100.39

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	16	94	200A	306
Crucible No.	4	9	14/17	11
Furnace Temperature (°C)	860	860	860	860
Time In / Time Out	7:15/8:00	7:15/8:00	7:15/8:00	7:15/8:00
Duration of Combustion (min)	45	45	45	45
Wt. of Crucible + Residue (g)	21.0709	21.2313	43.9918	18.0327
Wt. of Crucible (g)	21.0661	21.2081	43.9035	18.0295
Wt. of Residue (g) (A)	0.0048	0.0232	0.0883	0.0032
PPM of Sulfate (A) x 41150	197.52	954.68	3633.54	131.68
PPM of Sulfate, Dry Weight Basis	**198**	**955**	**3634**	**132**

CHLORIDE CONTENT, DOT California Test 422

ml of Extract For Titration (B)	30	30	15	15
ml of AgNO3 Soln. Used in Titration (C)	0.6	2.4	1.8	0.4
PPM of Chloride (C -0.2) * 100 * 30 / B	40	220	320	40
PPM of Chloride, Dry Wt. Basis	**40**	**220**	**320**	**40**

pH TEST, DOT California Test 643

pH Value	**8.08**	**7.57**	**6.34**	**8.23**
Temperature °C	19.8	19.8	19.8	19.6

SOIL RESISTIVITY TEST

DOT CA TEST 643

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-19	Depth (ft.) :	25-35
Sample No. :	B-2		

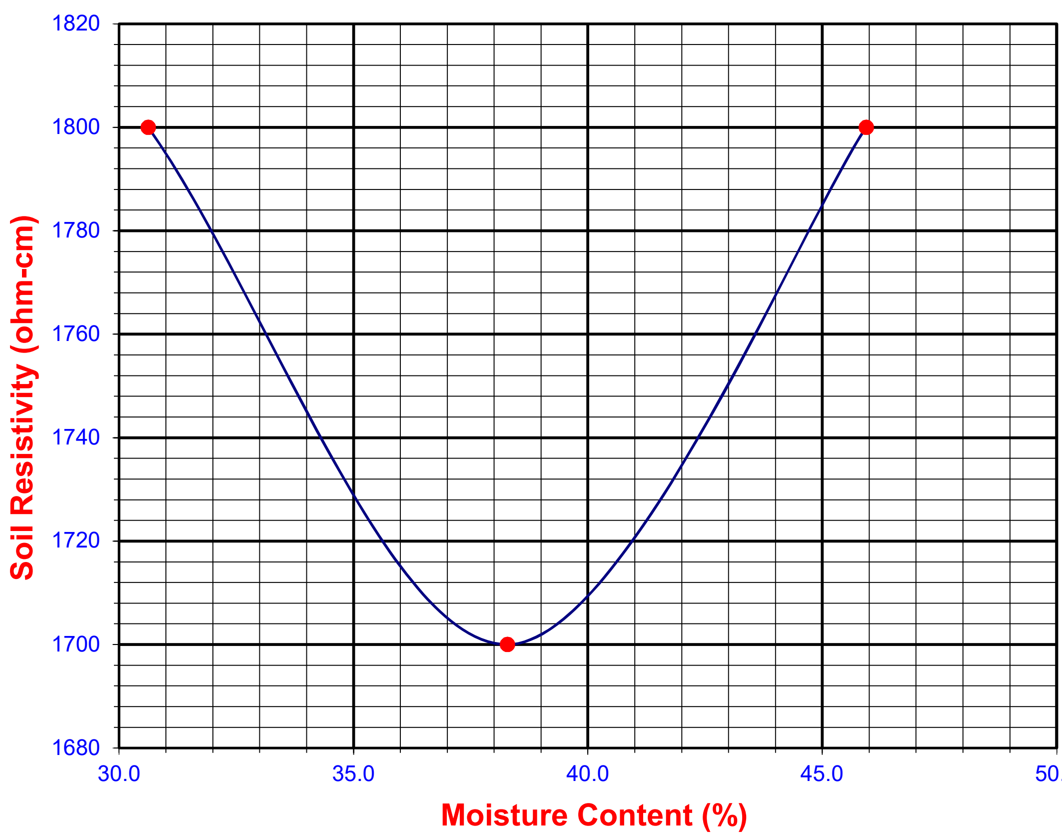
Soil Identification:* Olive brown (SC)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	40	30.63	1800	1800
2	50	38.28	1700	1700
3	60	45.94	1800	1800
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.61
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
1700	**38.3**	**198**	**40**	**8.08**	**19.8**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez	Date:	10/30/20
Project No. :	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-26	Depth (ft.) :	10-20		
Sample No. :	B-2				

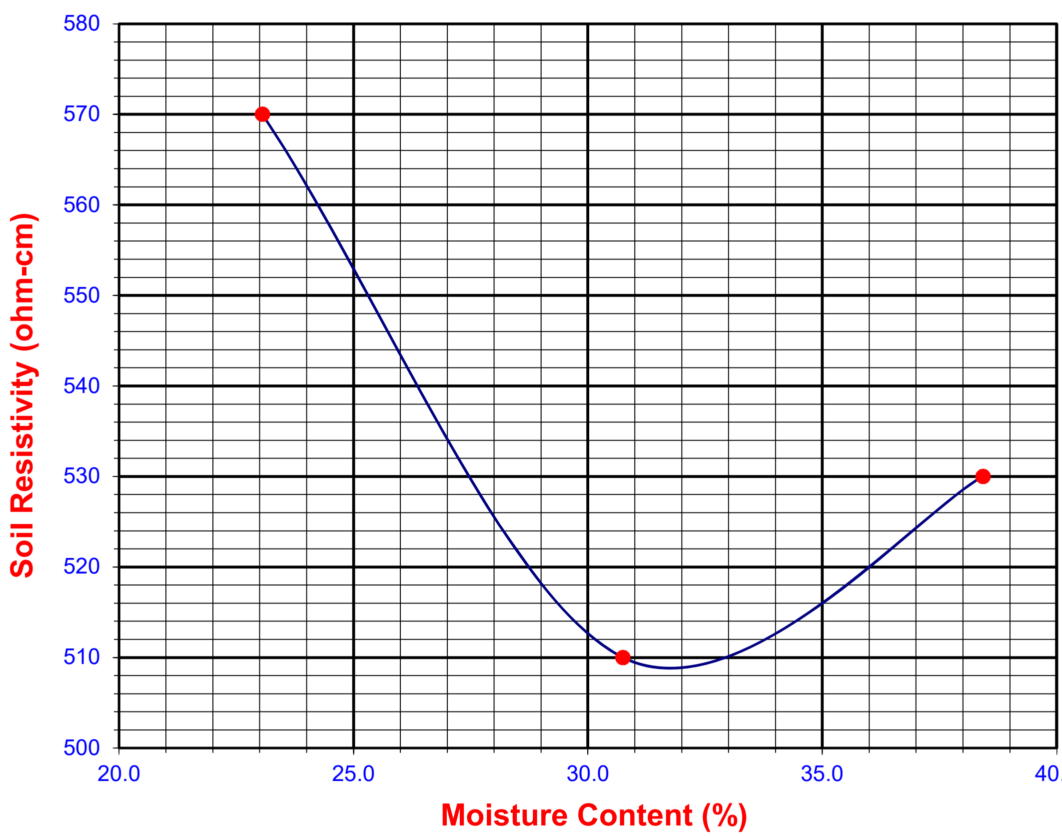
Soil Identification:* Dark brown (CL)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	30	23.06	570	570
2	40	30.75	510	510
3	50	38.43	530	530
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.10
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
509	**31.8**	**955**	**220**	**7.57**	**19.8**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Leighton

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez Date: 10/30/20
Project No. :	11585.005	Checked By:	A. Santos Date: 12/02/20
Boring No.:	LB-32	Depth (ft.) :	30-40
Sample No. :	B-3		

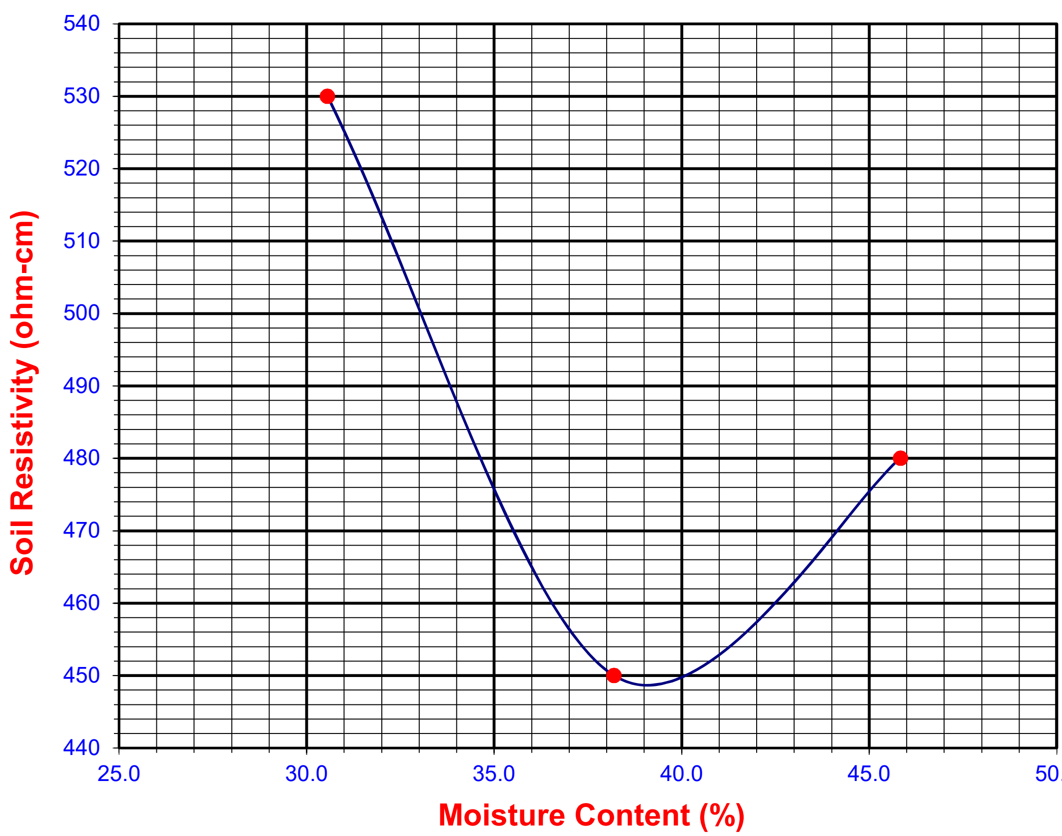
Soil Identification:* Dark brown (ML)

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	40	30.56	530	530
2	50	38.20	450	450
3	60	45.84	480	480
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.90
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
448	**39.2**	**3634**	**320**	**6.34**	**19.8**



SOIL RESISTIVITY TEST
DOT CA TEST 643

Project Name:	Brea Boulevard Additional Borings	Tested By :	J. Gonzalez	Date:	10/30/20
Project No. :	11585.005	Checked By:	A. Santos	Date:	12/02/20
Boring No.:	LB-34	Depth (ft.) :	20-30		
Sample No. :	B-2				

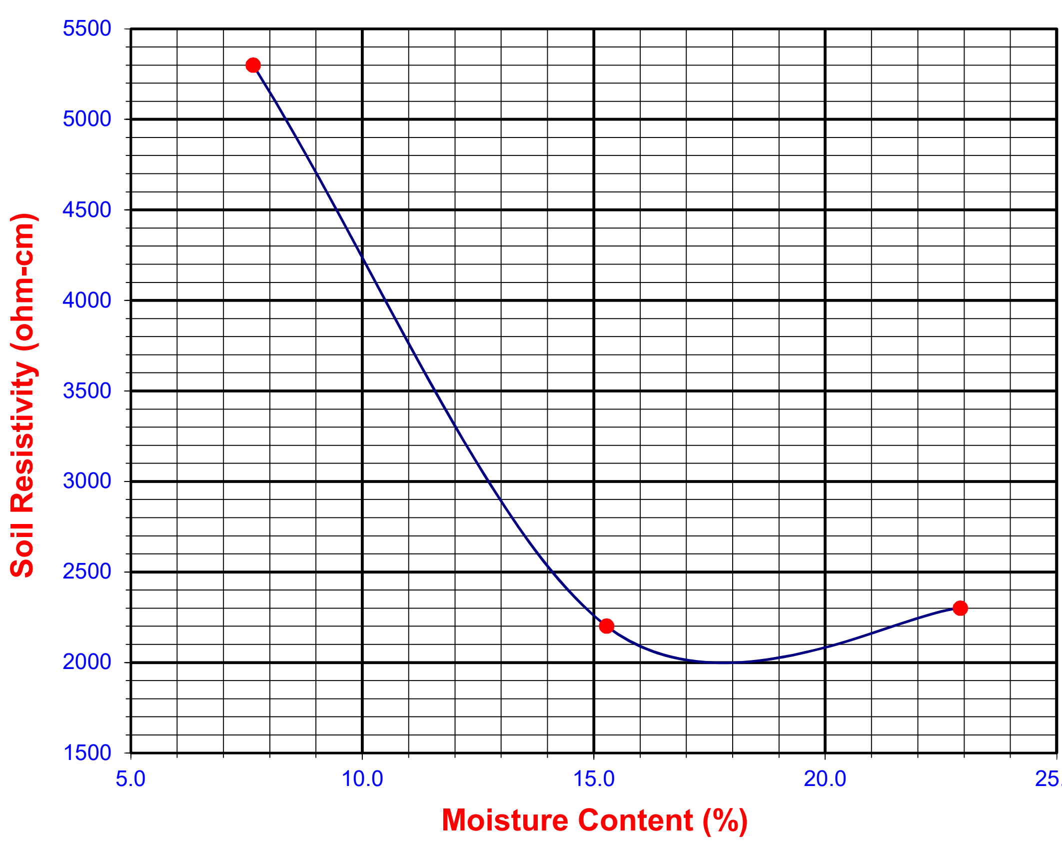
Soil Identification:* Yellowish brown SM

*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	10	7.64	5300	5300
2	20	15.28	2200	2200
3	30	22.92	2300	2300
4				
5				

Moisture Content (%) (MCi)	0.00
Wet Wt. of Soil + Cont. (g)	0.00
Dry Wt. of Soil + Cont. (g)	0.00
Wt. of Container (g)	1.00
Container No.	
Initial Soil Wt. (g) (Wt)	130.90
Box Constant	1.000
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 643	
2000	**18.0**	**132**	**40**	**8.23**	**19.6**



APPENDIX D

Engineering Analyses

Leighton

TABLE D-1 - BRIDGE NO. 1 AND RETAINING WALL – ABUTMENT 2 LEFT

Idealized Soil Profile and Geotechnical Design Parameters
Lateral Load Analysis and Design of Pile Foundations

Approximate Design Depth Range	Soil Type	N	N60	Total (In-Situ) Unit Weight (γ)	Angle of Internal Friction (ø)	Cohesion (c')	Static Undrained Shear Strength	Liquefied or Softened Shear Strength	P-Multiplier (m_p)	Modulus of Horizontal Subgrade Reaction (k)	ε_{50}
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+390) to 15	SM ML	8	10	110	32	50	---	Non-Liquefiable	1.0	60	---
15 to 20[(1)]	CL	----	----	130	---	---	1,500	Non-Liquefiable	1.0	----	0.012
20 to 25	SP SM	10	12	125	32	200	---	350	0.1	40	---
25 to 35	SP SP-SM	30	38	130	36	0	---	Non-Liquefiable	1.0	90	---
35 to 45	Bedrock 1	---	---	127	---	---	6,000	Non-Liquefiable	---	---	0.03
45 to 61	Bedrock 2	---	---	130	---	---	9,000	Non-Liquefiable	---	---	0.045

Notes: (1) Soil Profile and geotechnical engineering parameters based upon Test Boring No. LB-2, LB-19, LB-20, SCPT-1 and CPT-7

Blue line represents design groundwater table. Red line represents bedrock contact.

Proposed Brea Boulevard Corridor Improvements
Brea Boulevard
City of Brea and County of Orange, California
Project No. 11585.005
August 2021

TABLE D-2 - BRIDGE NO. 2 AND CHANNEL WALL 2 RIGHT

IDEALIZED SOIL PROFILE AND GEOTECHNICAL DESIGN PARAMETERS
LATERAL LOAD ANALYSIS AND DESIGN OF PILE FOUNDATIONS

Approximate Design Depth Range	Soil Type	N	N60	Total (In-Situ) Unit Weight (γ)	Angle of Internal Friction (ø)	Cohesion (c')	Static Undrained Shear Strength	Liquefied or Softened Shear Strength	P-Multiplier (m_p)	Modulus of Horizontal Subgrade Reaction (k)	ε_{50}
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+410) to 10	SC SM	20	25	120	34	0	---	Non-Liquefiable	1.0	110	---
10 to 15	CL	----	----	125	---	---	4,000	Non-Liquefiable	1.0	---	0.05
15 to 20	CL	----	----	125	---	---	5,000	Non-Liquefiable	1.0	---	0.05
20 to 45	Bedrock 1	---	---	127	---	---	6,000	Non-Liquefiable	---	---	0.03
45 to 60	Bedrock 2	---	---	130	---	---	9,000	Non-Liquefiable	---	---	0.045

Notes: (1) Soil Profile and geotechnical engineering parameters based upon Test Boring No. LB-3, LB-22 and CPT-2

Blue line represents design groundwater table. Red line represents bedrock contact.

TABLE D-3 - CHANNEL WALL 2 LEFT AT BRIDGE NO. 2

Idealized Soil Profile and Geotechnical Design Parameters
Lateral Load Analysis and Design of Pile Foundations

Approximate Design Depth Range	Soil Type	N	N60	Total (In-Situ) Unit Weight (γ)	Angle of Internal Friction (ø)	Cohesion (c')	Static Undrained Shear Strength	Liquefied or Softened Shear Strength	P-Multiplier (m_p)	Modulus of Horizontal Subgrade Reaction (k)	ε_{50}
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+405) to 10	SC SM	20	25	120	34	0	---	Non-Liquefiable	1.0	110	---
10 to 15	ML	28	34	125	36	0	---	Non-Liquefiable	1.0	140	---
15 to 20	ML	28	34	125	36	0	---	Non-Liquefiable	1.0	140	---
20 to 25	ML	28	34	125	36	0	---	Non-Liquefiable	1.0	90	---
25 to 45	Bedrock 1	---	---	127	---	---	6,000	Non-Liquefiable	---	---	0.03
45 to 60	Bedrock 2	---	---	130	---	---	9,000	Non-Liquefiable	---	---	0.045

Notes: (1) Soil Profile and geotechnical engineering parameters based upon Test Boring No. LB-37

Blue line represents design groundwater table. Red line represents bedrock contact.

TABLE D-4 – BRIDGE NO. 3 – ABUTMENT 1

IDEALIZED SOIL PROFILE AND GEOTECHNICAL DESIGN PARAMETERS
LATERAL LOAD ANALYSIS AND DESIGN OF PILE FOUNDATIONS

Approximate Design Depth Range	Soil Type	N	N60	Total (In-Situ) Unit Weight (γ)	Angle of Internal Friction (ϕ)	Cohesion (c')	Static Undrained Shear Strength	Liquefied or Softened Shear Strength	P-Multiplier (m_p)	Modulus of Horizontal Subgrade Reaction (k)	ε_{50}
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+430) to 12	SM	25	31	125	32	50	---	Non-Liquefiable	1.0	90	---
12 to 17	ML	10	12	120	28	200	---	Non-Liquefiable	1.0	60	---
17 to 22	SM	11	15	120	30	---	---	375	0.1	60	---
22 to 26	CL	20	25	125	---	---	2,500	Non-Liquefiable	1.0	---	0.04
26 to 40	Bedrock	50+	50+	125	---	---	6,000	Non-Liquefiable	---	---	0.03
40 to 80	Bedrock	50+	50+	130	---	---	9,000	Non-Liquefiable	---	---	0.045

Notes: (1) Profile based on LB-38, LB-25, CPT SC-03

Blue line represents design groundwater table. Red line represents bedrock contact.

TABLE D-5 – BRIDGE NO. 3 – ABUTMENT 2

Idealized Soil Profile and Geotechnical Design Parameters Lateral Load Analysis and Design of Pile Foundations											
Approximate Design Depth Range	**Soil Type**	**N**	**N60**	**Total (In-Situ) Unit Weight (γ)**	**Angle of Internal Friction (ø)**	**Cohesion (c')**	**Static Undrained Shear Strength**	**Liquefied or Softened Shear Strength**	**P-Multiplier (m_p)**	**Modulus of Horizontal Subgrade Reaction (k)**	**ε_{50}**
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+430) to 11	SM	7	9	110	32	50	---	Non-Liquefiable	1.0	60	---
11 to 20	CL	---	---	120	---	---	2,500	Non-Liquefiable	1.0	---	0.04
20 to 25	SM	17	21	125	32	0	---	Non-Liquefiable	1.0	90	---
25 to 30	SP SM	26	32	130	34	0	---	1,100	0.1		---
30 to 35	SP SW	29	36	130	36	0	---	Non-Liquefiable	0.1		---
30 to 45	Bedrock	50+	50+	125	---	---	6,000	Non-Liquefiable	---	---	0.03
45 to 80	Bedrock	50+	50+	130	---	---	9,000	Non-Liquefiable	---	---	0.045
Notes:	(1)	Profile based on LB-04, CPT C-08, LB CWE P-4 Blue line represents design groundwater table. Red line represents bedrock contact.									

TABLE D-6 – BRIDGE NO. 3 – CHANNEL WALL – ABUTMENT 2 LEFT

IDEALIZED SOIL PROFILE AND GEOTECHNICAL DESIGN PARAMETERS
LATERAL LOAD ANALYSIS AND DESIGN OF PILE FOUNDATIONS

Approximate Design Depth Range	Soil Type	N	N60	Total (In-Situ) Unit Weight (γ)	Angle of Internal Friction (ϕ)	Cohesion (c')	Static Undrained Shear Strength	Liquefied or Softened Shear Strength	P-Multiplier (m_p)	Modulus of Horizontal Subgrade Reaction (k)	ε_{50}
(feet)			ER 1.25	(pcf)	(degrees)	(psf)	(psf)	(psf)		(lbs./in^3)	
O.G. (+430) to 20	SM	16	20	115	32	50	---	Non-Liquefiable	1.0	80	---
20 to 25	CL	---	---	120	---	---	2,500	Non-Liquefiable	1.0	---	0.04
25 to 30	ML	18	23	125	28	200	---	700	0.1	60	---
30 to 35	SM	16	20	130	32	0	---	550	0.1	60	---
35 to 40	SM	23	29	130	34	0	---	1,100	0.1	60	---
40 to 55	Bedrock	50+	50+	125	---	---	6,000	Non-Liquefiable	---	---	0.03
55 to 80	Bedrock	50+	50+	130	---	---	9,000	Non-Liquefiable	---	---	0.045

Notes: (1) Profile based on LB-27

Blue line represents design groundwater table. Red line represents bedrock contact.

APPENDIX D.1

CALTRANS ARS Analysis

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9381 **Longitude:** -117.8917 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1.01	1	0.66	0.65
0.10	1.1	1.13	1.04	1.01	1	1.15	1.13
0.20	1.39	1.5	1.01	1.01	1	1.4	1.51
0.30	1.38	1.6	1.01	1.01	1	1.4	1.62
0.50	1.21	1.42	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.77	0.86	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.4	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.12	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.15	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.9

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.9 Update

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9399 **Longitude:** -117.8906 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1	1	0.67	0.65
0.10	1.11	1.13	1.04	1	1	1.15	1.13
0.20	1.39	1.5	1.01	1	1	1.4	1.51
0.30	1.39	1.61	1.01	1.01	1	1.4	1.62
0.50	1.21	1.43	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.77	0.87	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.4	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.12	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.14	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.8

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.8 Update

ARS Online V3.0.2

Using the tool: Specify latitude and longitude in decimal degrees in the input boxes below. Alternatively, **Google Maps** can be used to find the site location. Specify the time-averaged shear-wave velocity in the upper 30m (Vs30) in the input box. After submitting the data, the USGS 2014 hazard data for a 975-year return period will be reported along with adjustment factors required by Caltrans Seismic Design Criteria (SDC) V2.0.

Latitude: 33.9410 **Longitude:** -117.8875 **Vs30 (m/s):** 310 Submit

Caltrans Design Spectrum (5% damping)

Period(s)	Sa_{2008}(g)	Sa_{2014}(g)	$Basin_{2008}$	$Basin_{2014}$	Near Fault Amp	Design Sa_{2008}(g)	Design Sa_{2014}(g)
PGA	0.64	0.65	1.04	1	1	0.67	0.65
0.10	1.11	1.13	1.04	1	1	1.16	1.13
0.20	1.4	1.5	1.01	1	1	1.41	1.51
0.30	1.39	1.61	1.01	1.01	1	1.4	1.62
0.50	1.21	1.43	1.01	1.01	1	1.22	1.44
0.75	0.98	1.1	1.01	1.01	1.1	1.09	1.22
1.0	0.78	0.87	1.01	1.01	1.2	0.94	1.05
2.0	0.38	0.41	1.04	1.01	1.2	0.47	0.49
3.0	0.23	0.25	1.08	1.01	1.2	0.3	0.3
4.0	0.16	0.17	1.11	1.01	1.2	0.22	0.21
5.0	0.13	0.13	1.14	1.01	1.2	0.18	0.16

Copy table

Deaggregation (based on 2014 hazard)

mean magnitude (for PGA)	6.69
mean site-source distance (km, for Sa at 1s)	13.8

Option: recalculate Near Fault amplification with user specified distance

Site-source distance (km): 13.8 Update

APPENDIX D.2

Liquefaction Analysis

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

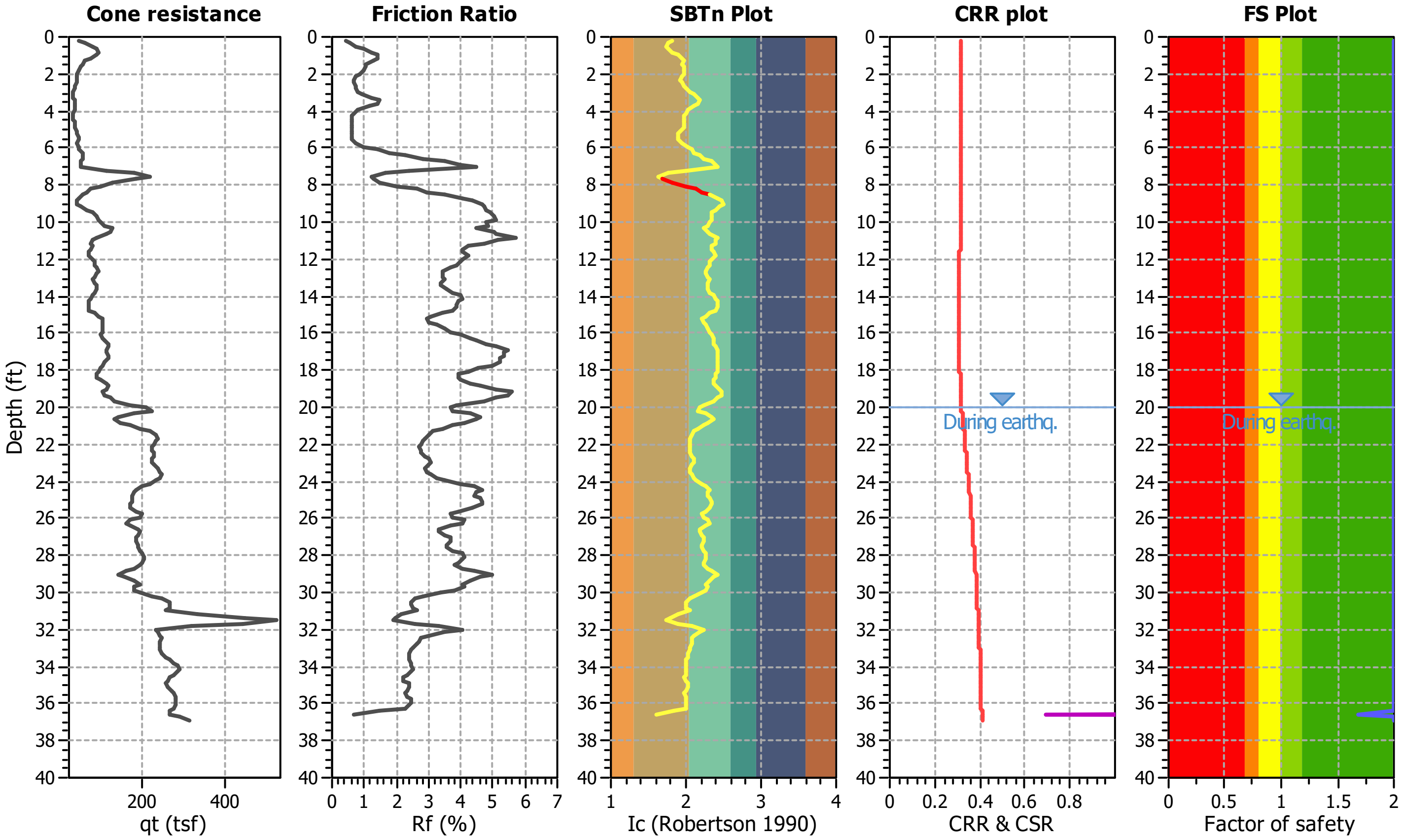
LIQUEFACTION ANALYSIS REPORT

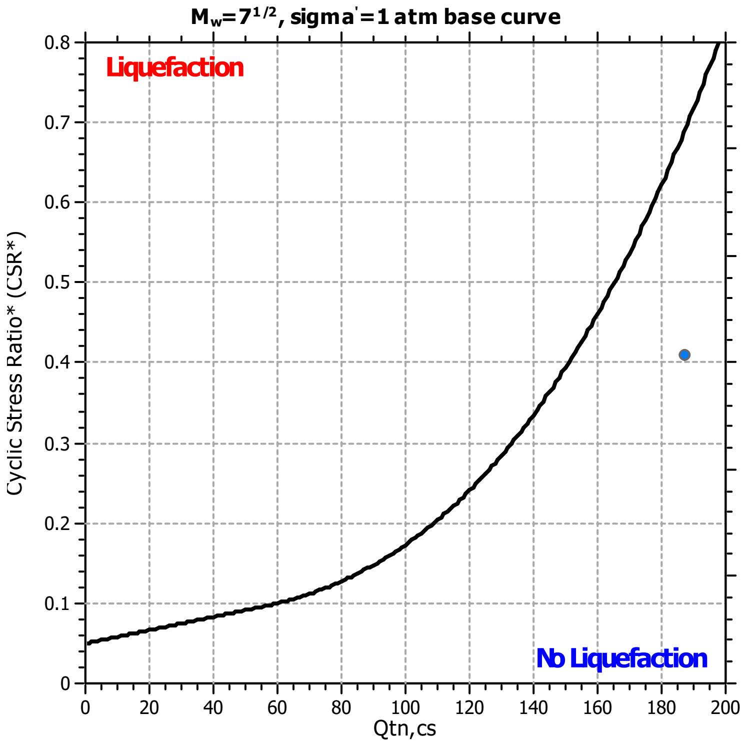
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

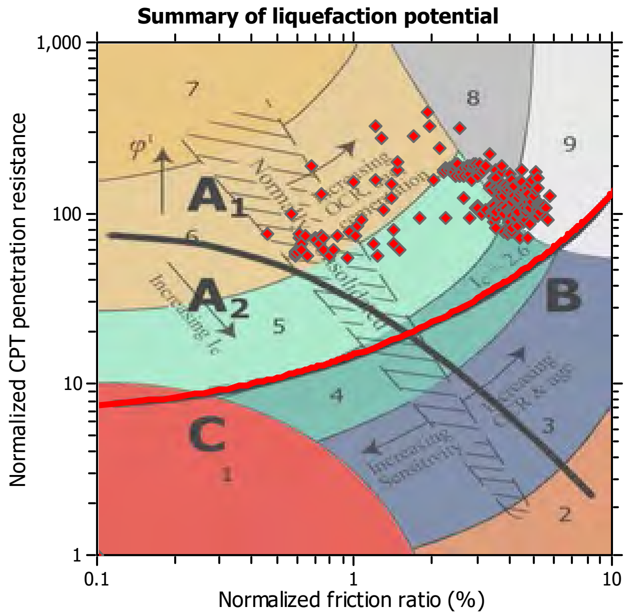
CPT file : C-2

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

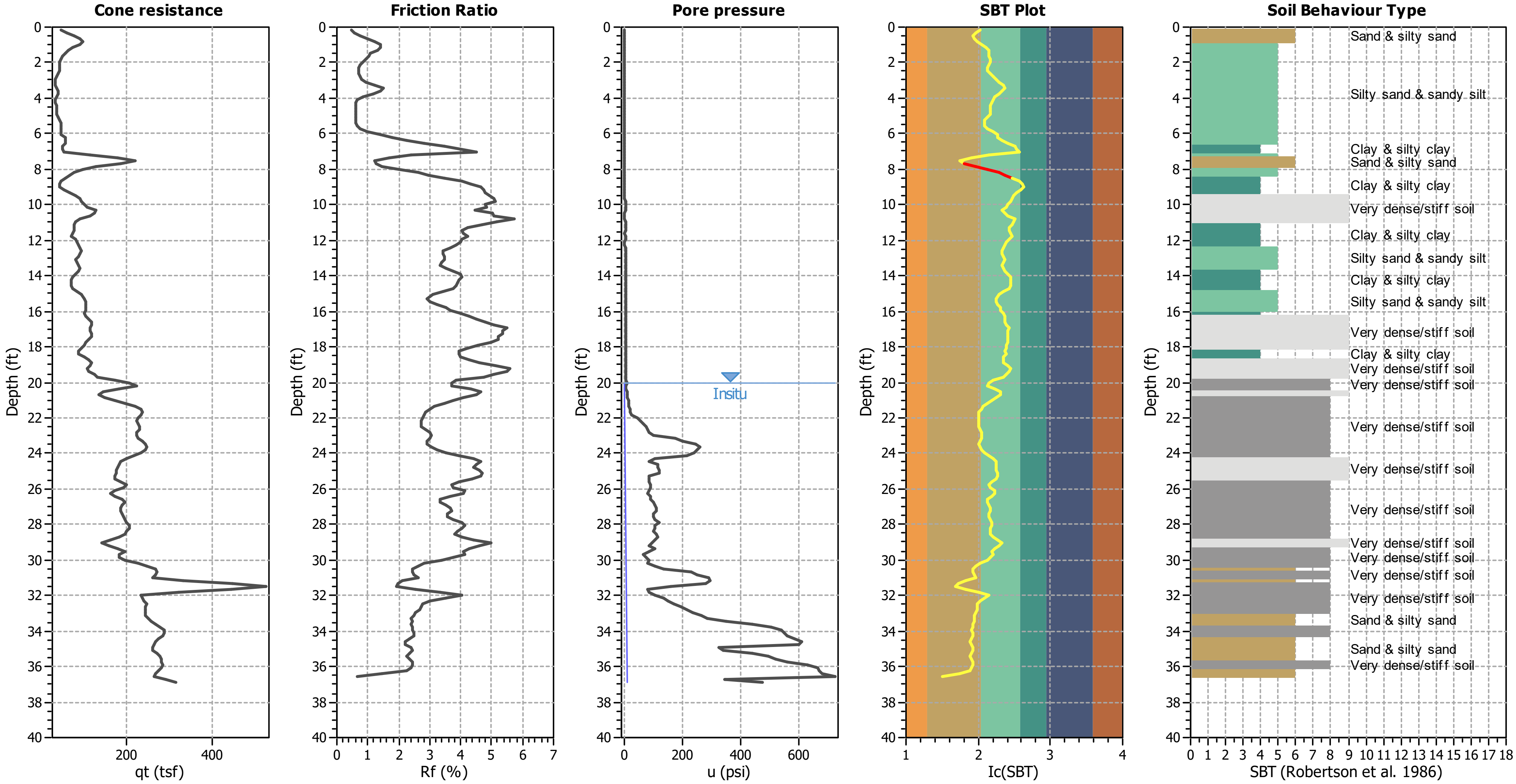






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



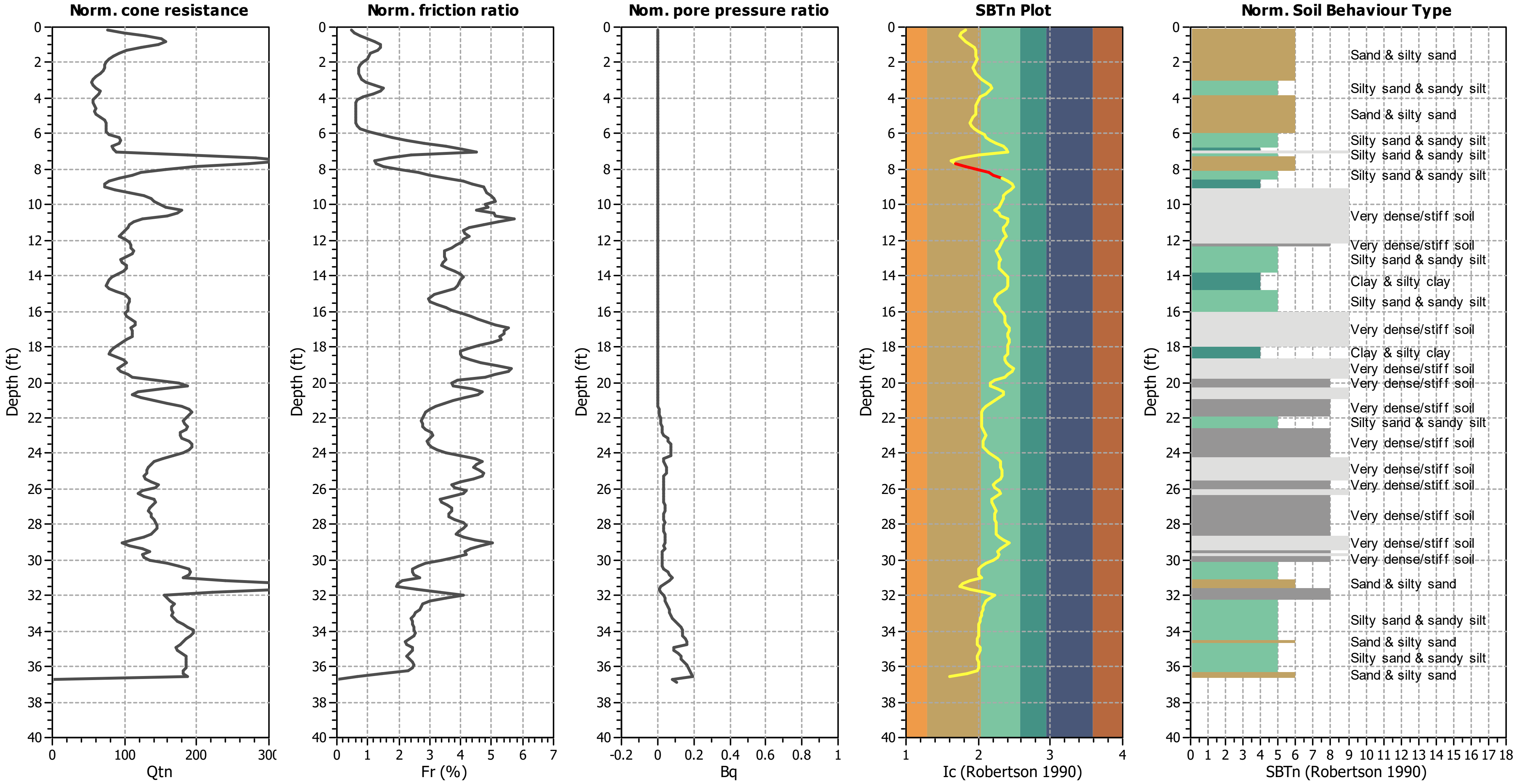
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



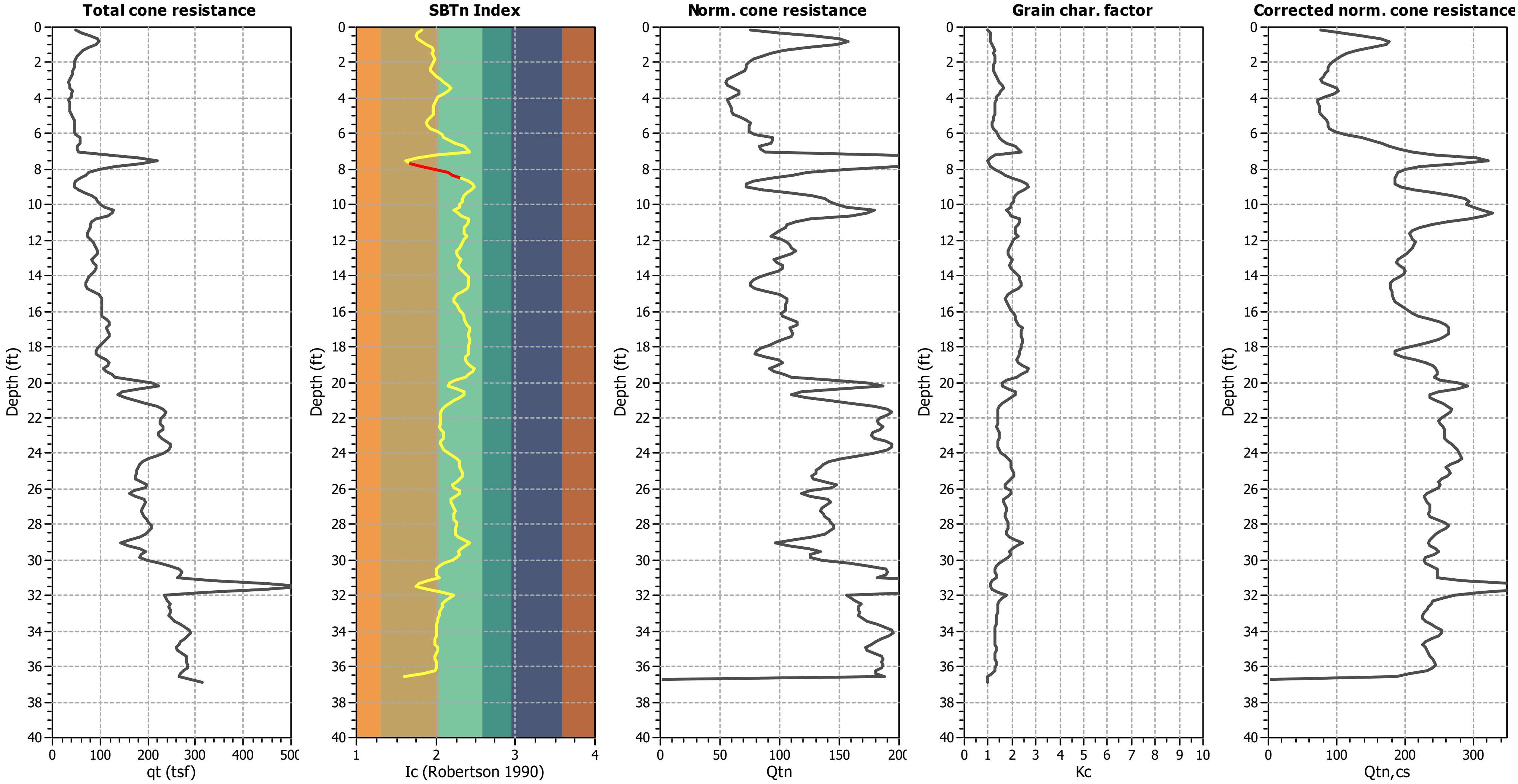
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

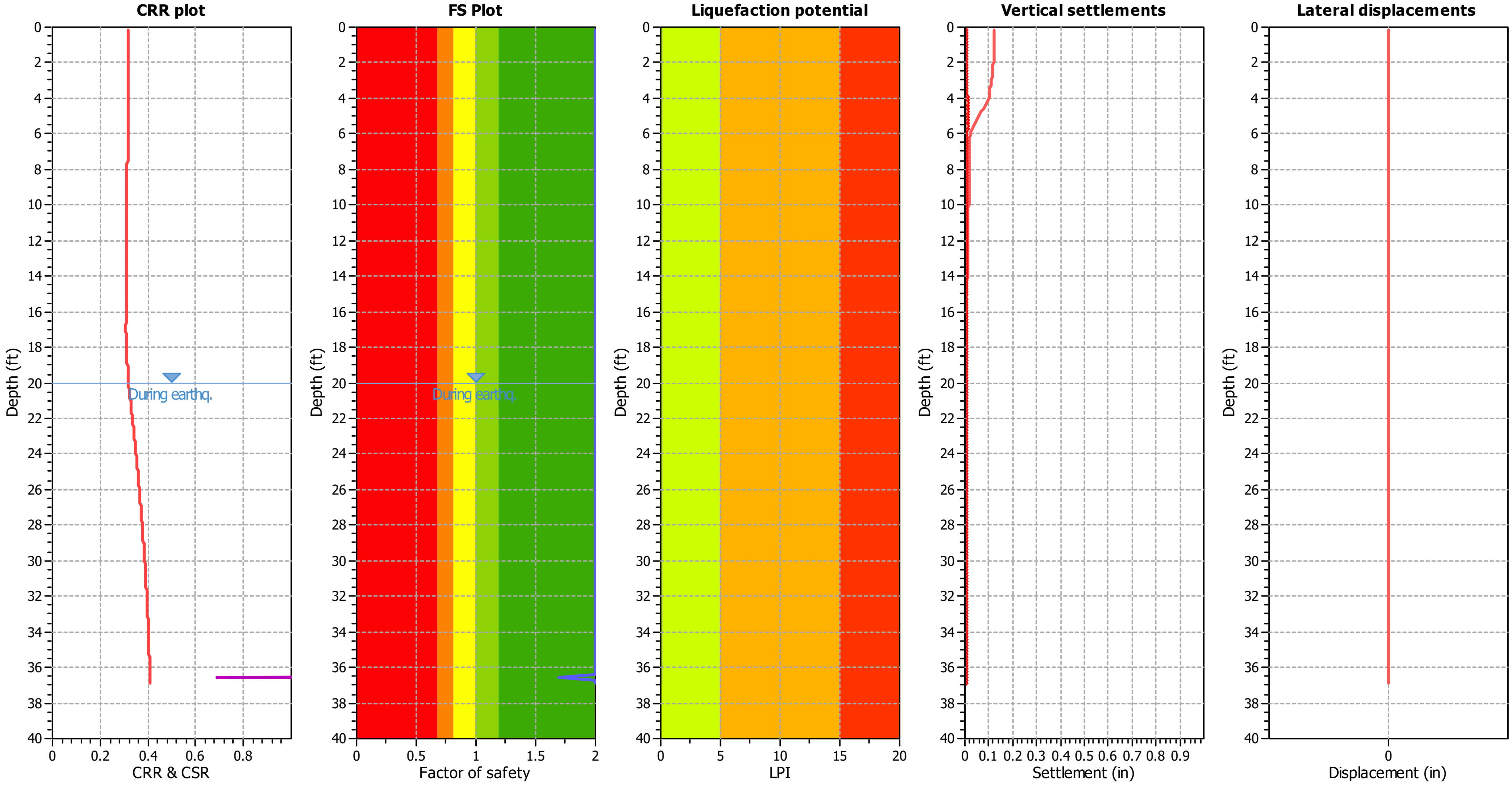
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	20.00 ft	Fill height:	N/A	Limit depth:	N/A

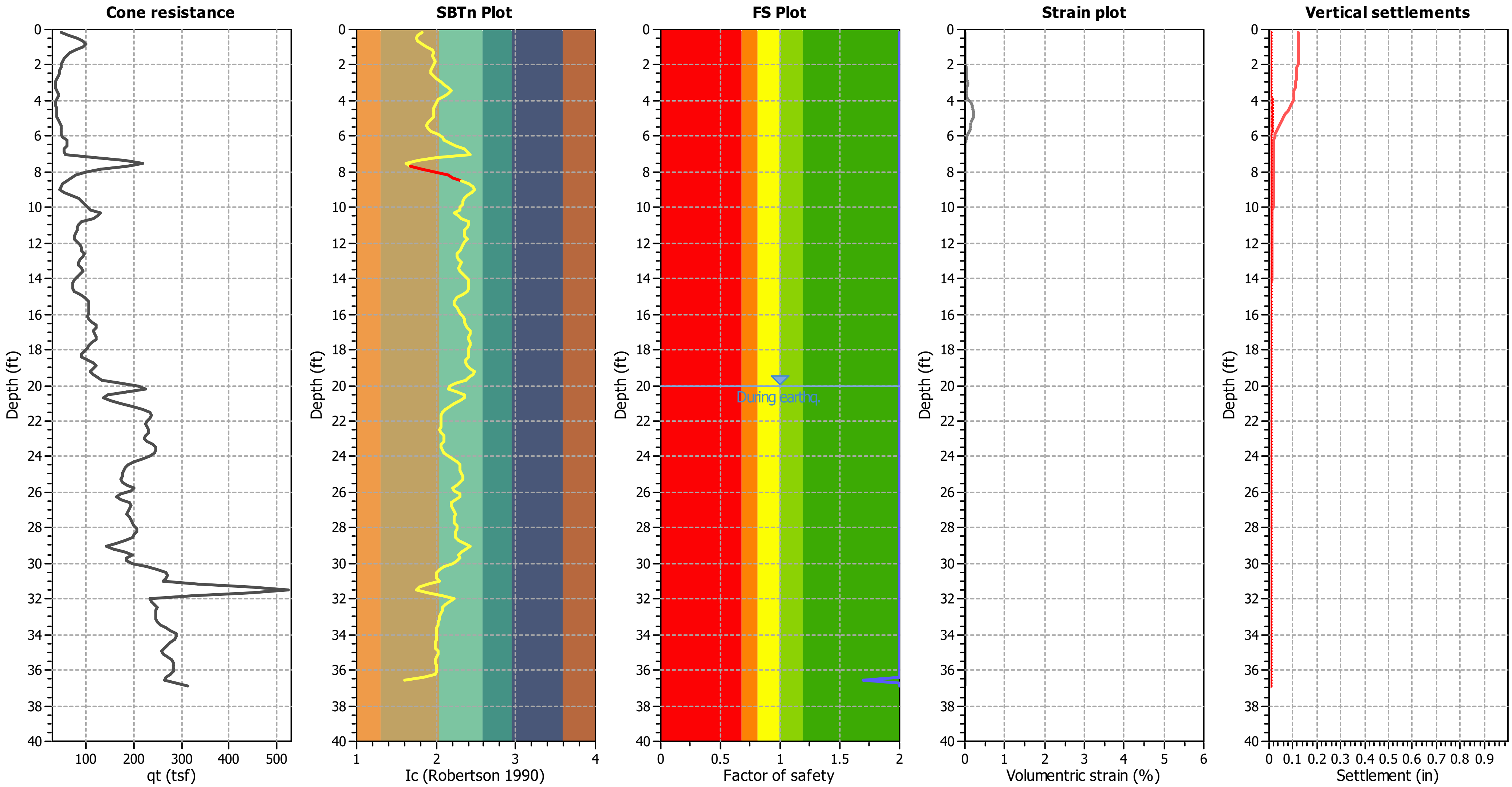
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

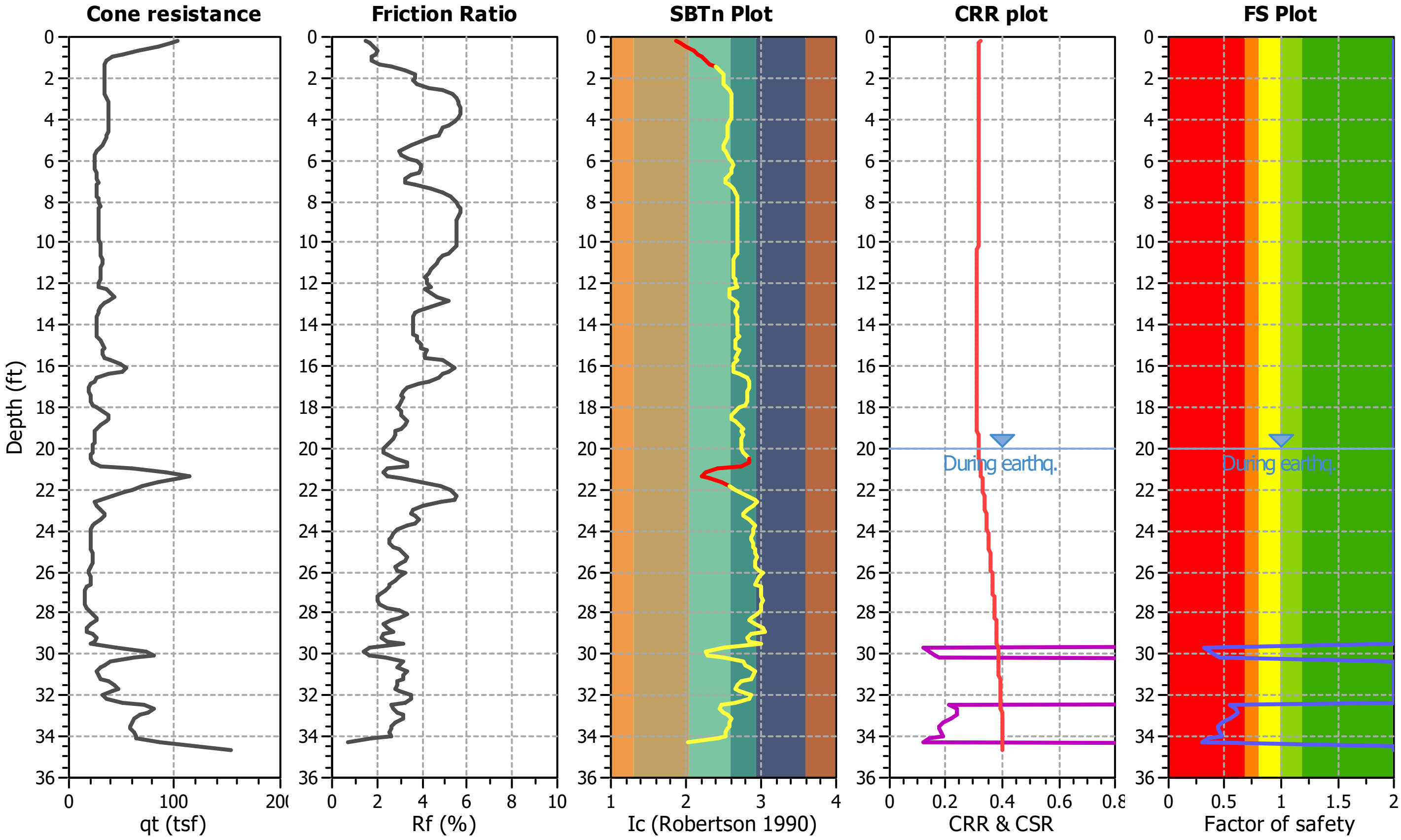
LIQUEFACTION ANALYSIS REPORT

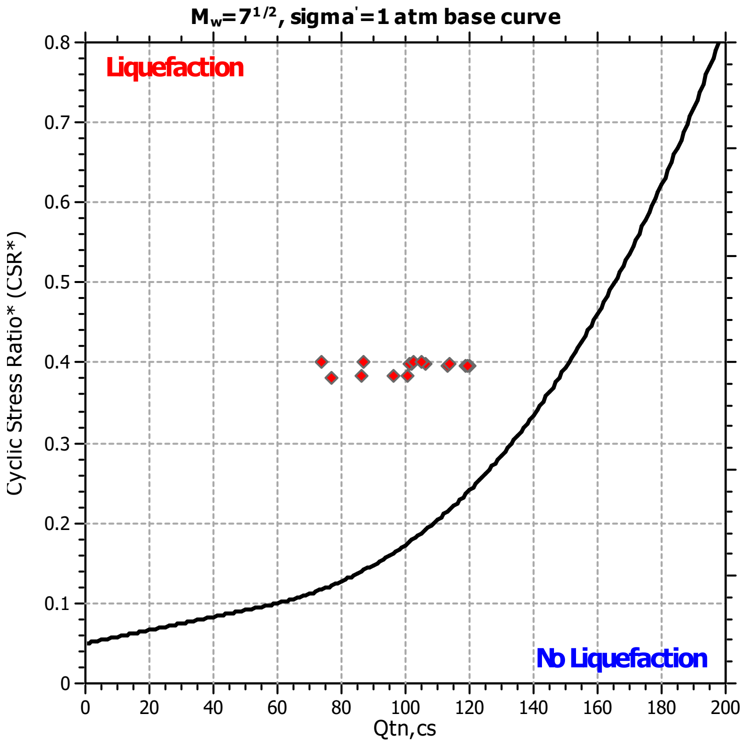
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

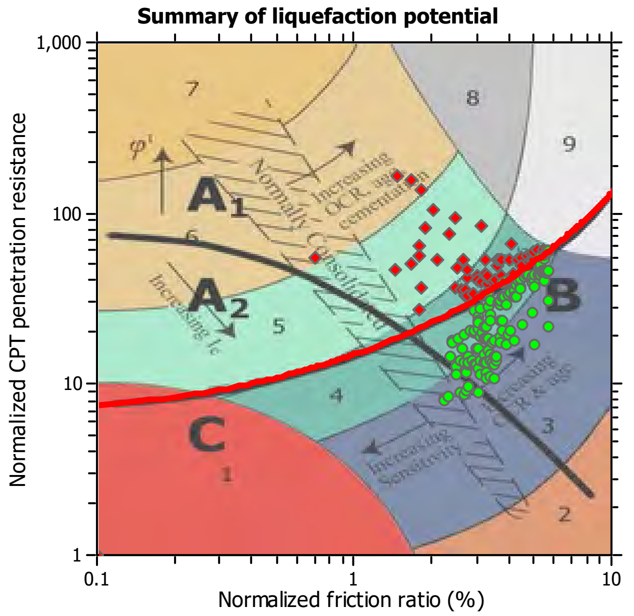
CPT file : C-4

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	29.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

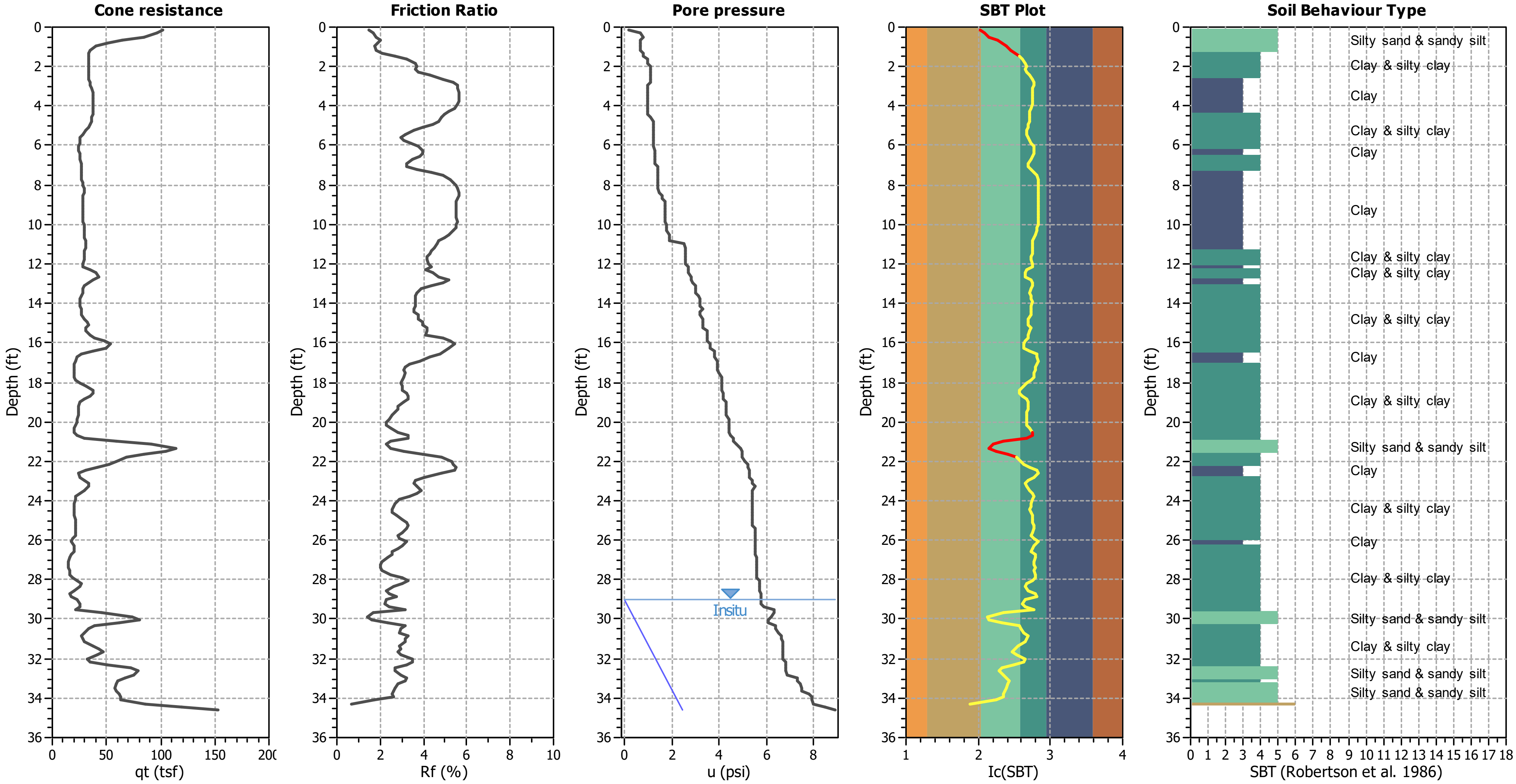






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



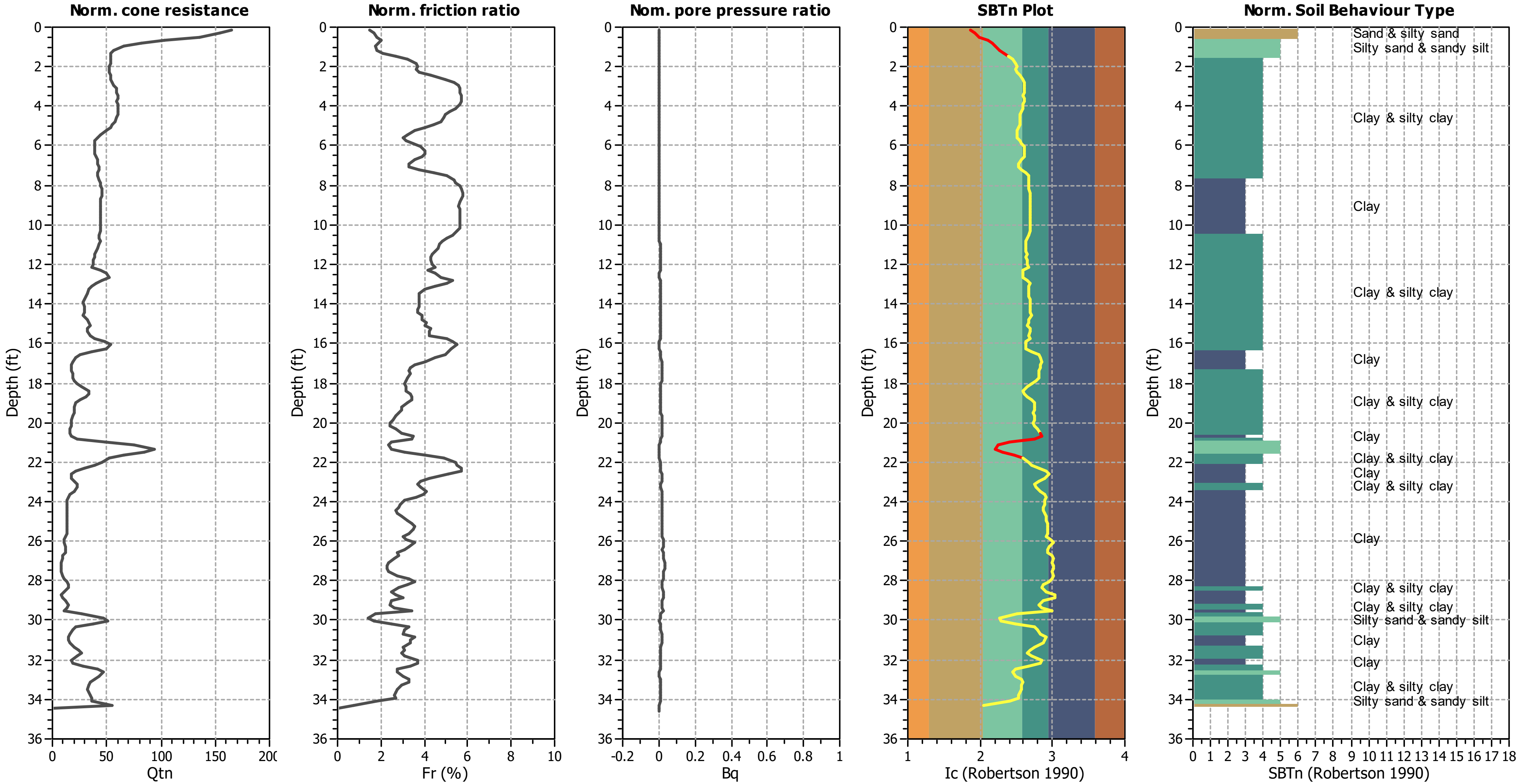
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



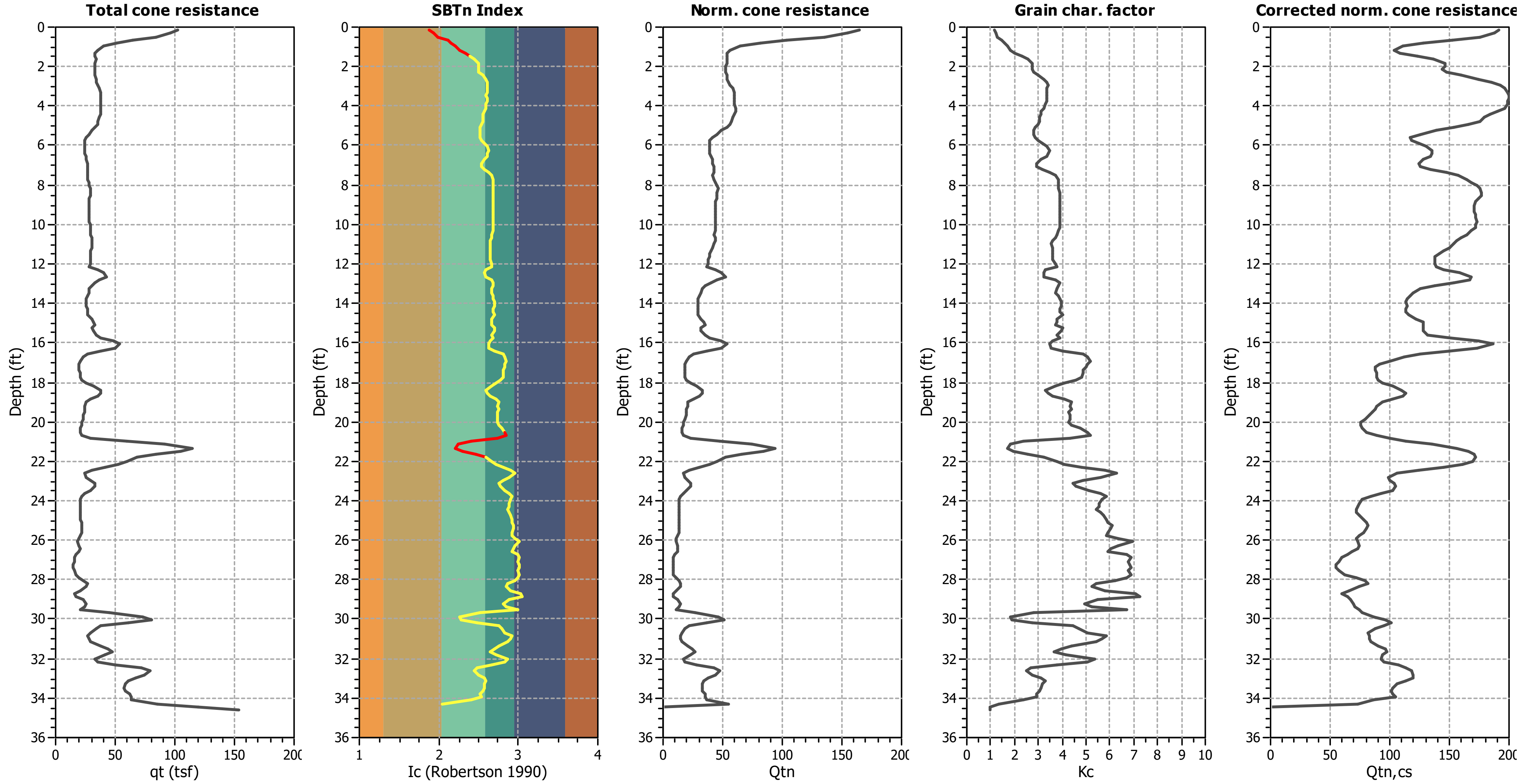
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

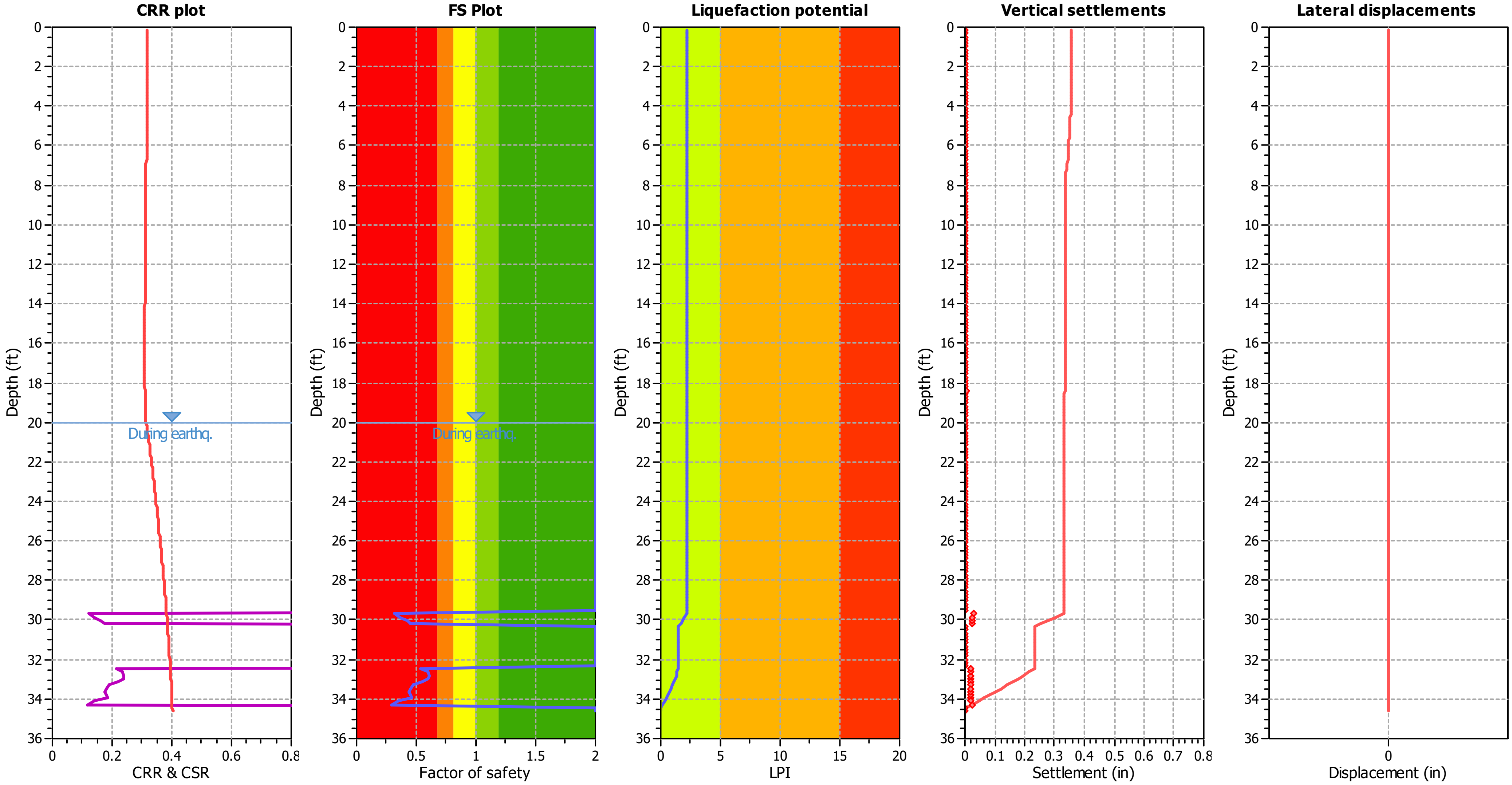
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

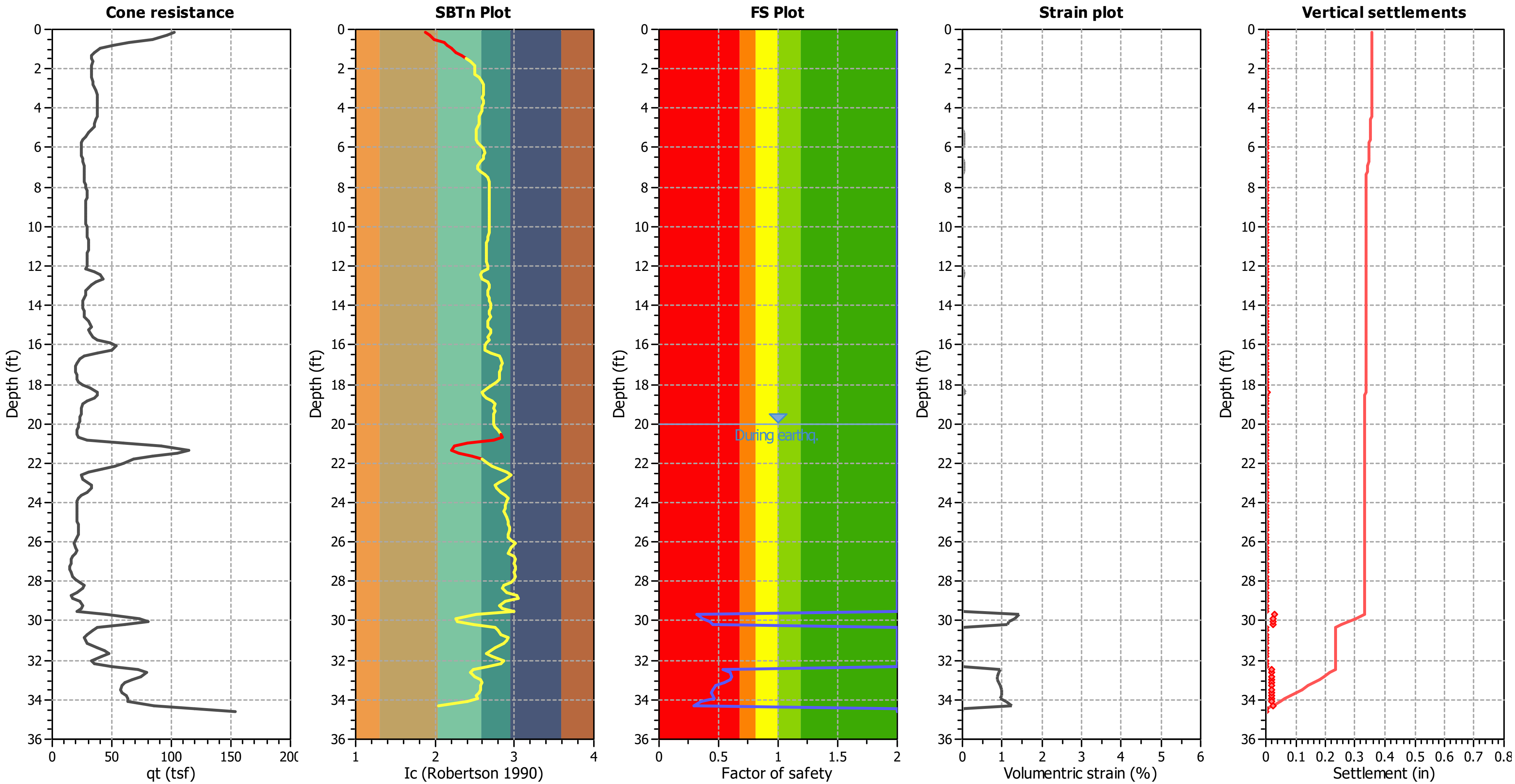
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

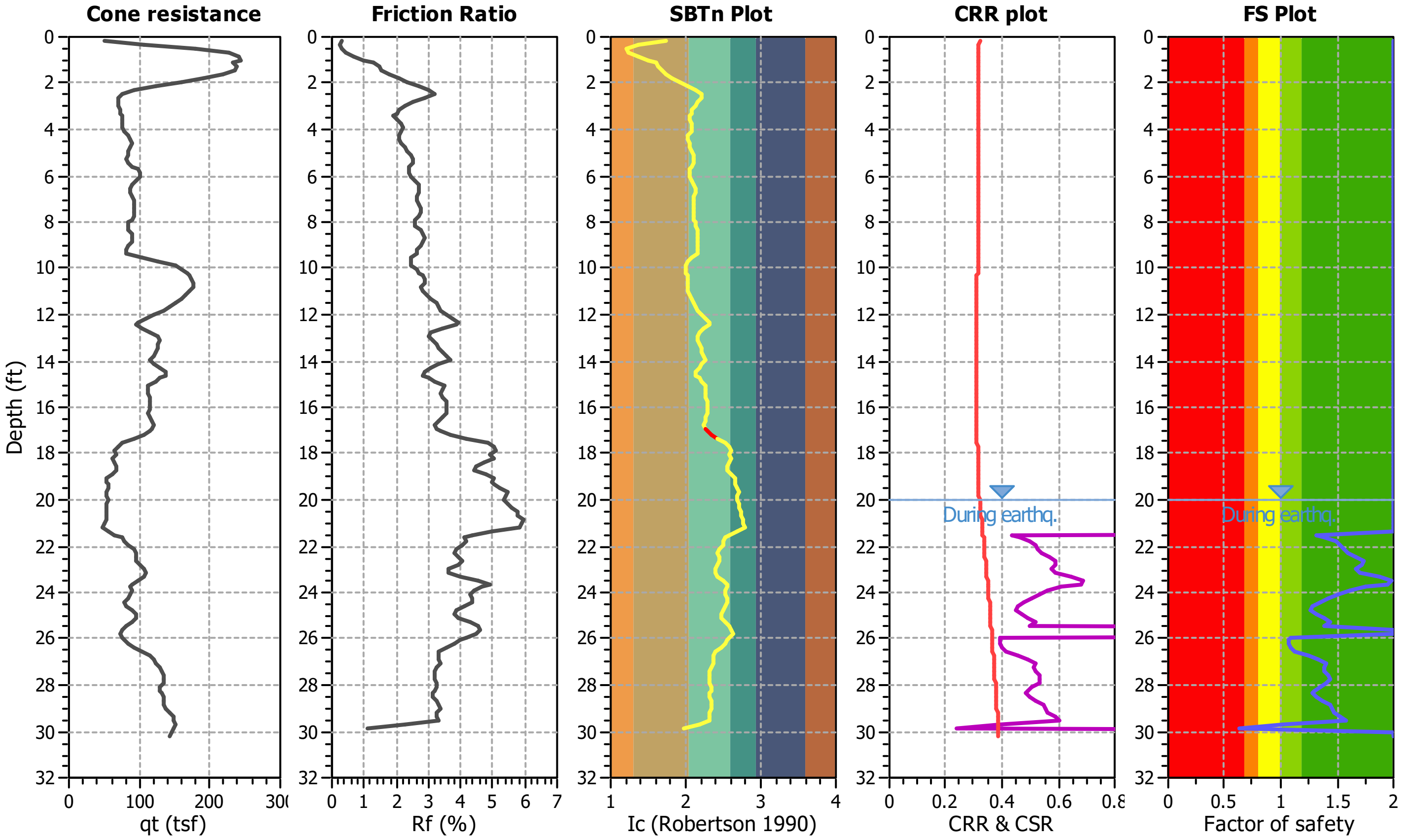
LIQUEFACTION ANALYSIS REPORT

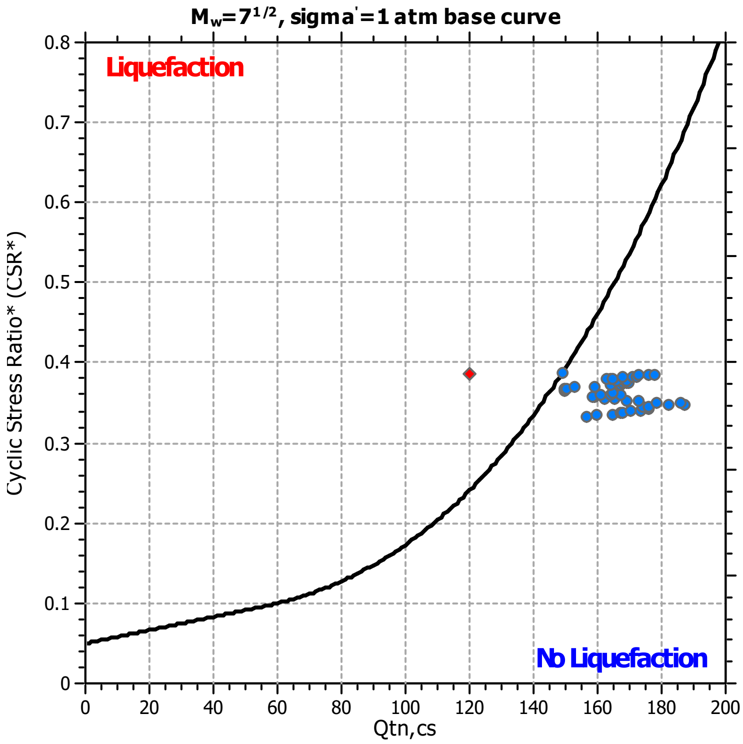
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

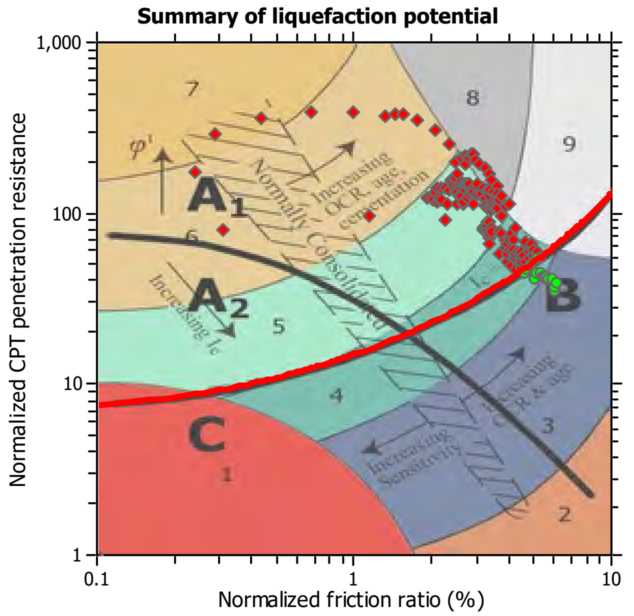
CPT file : C-5

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	29.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

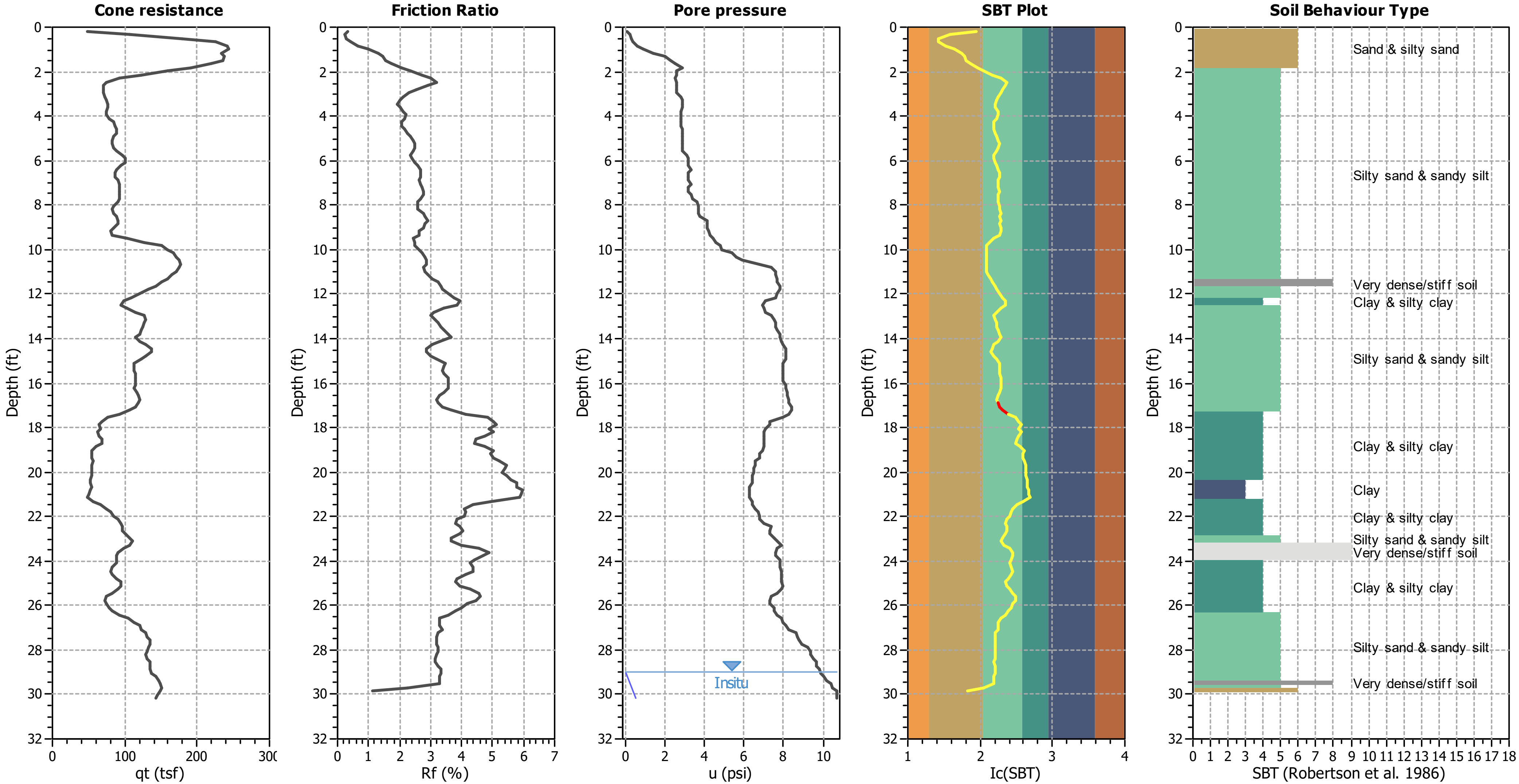






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



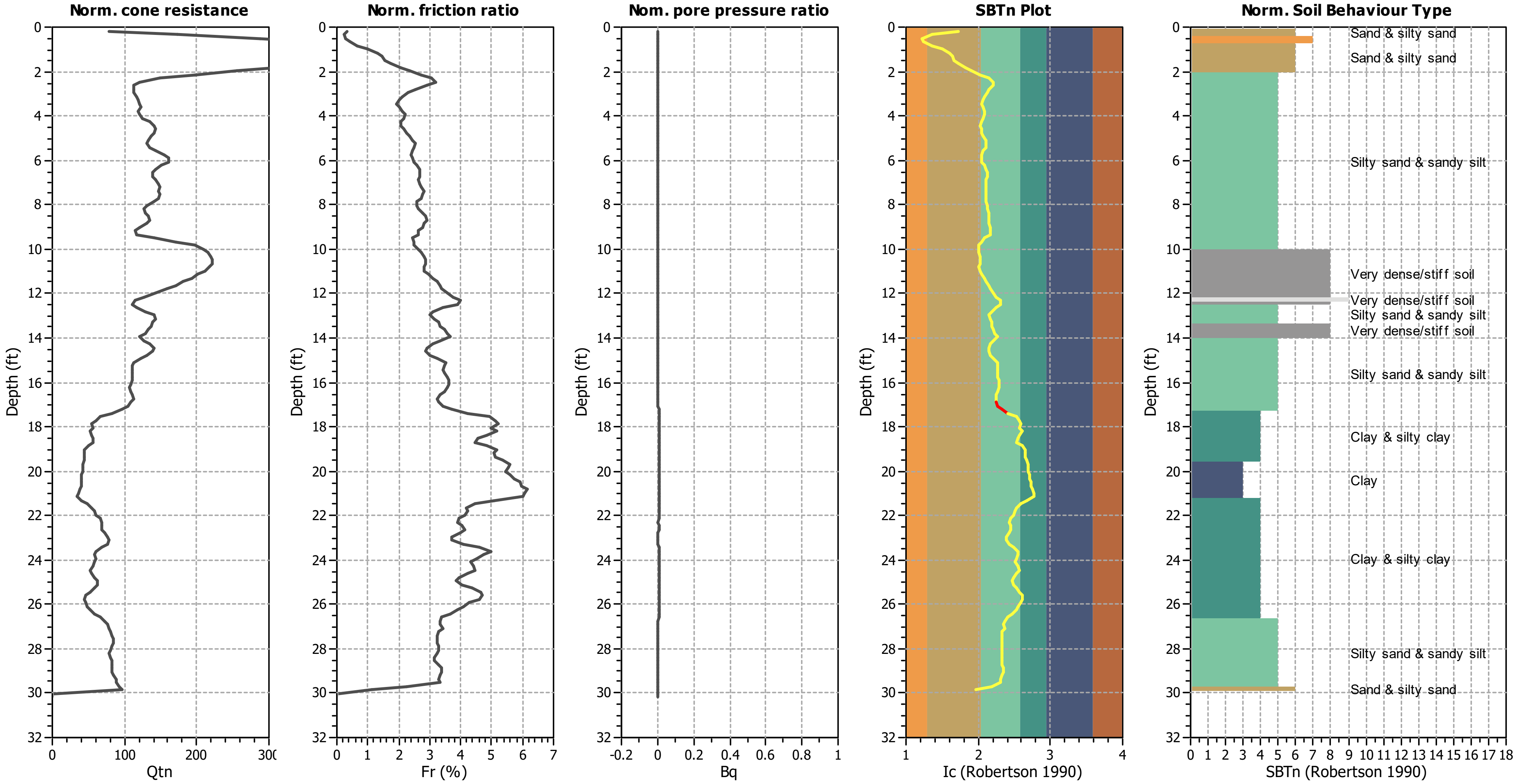
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



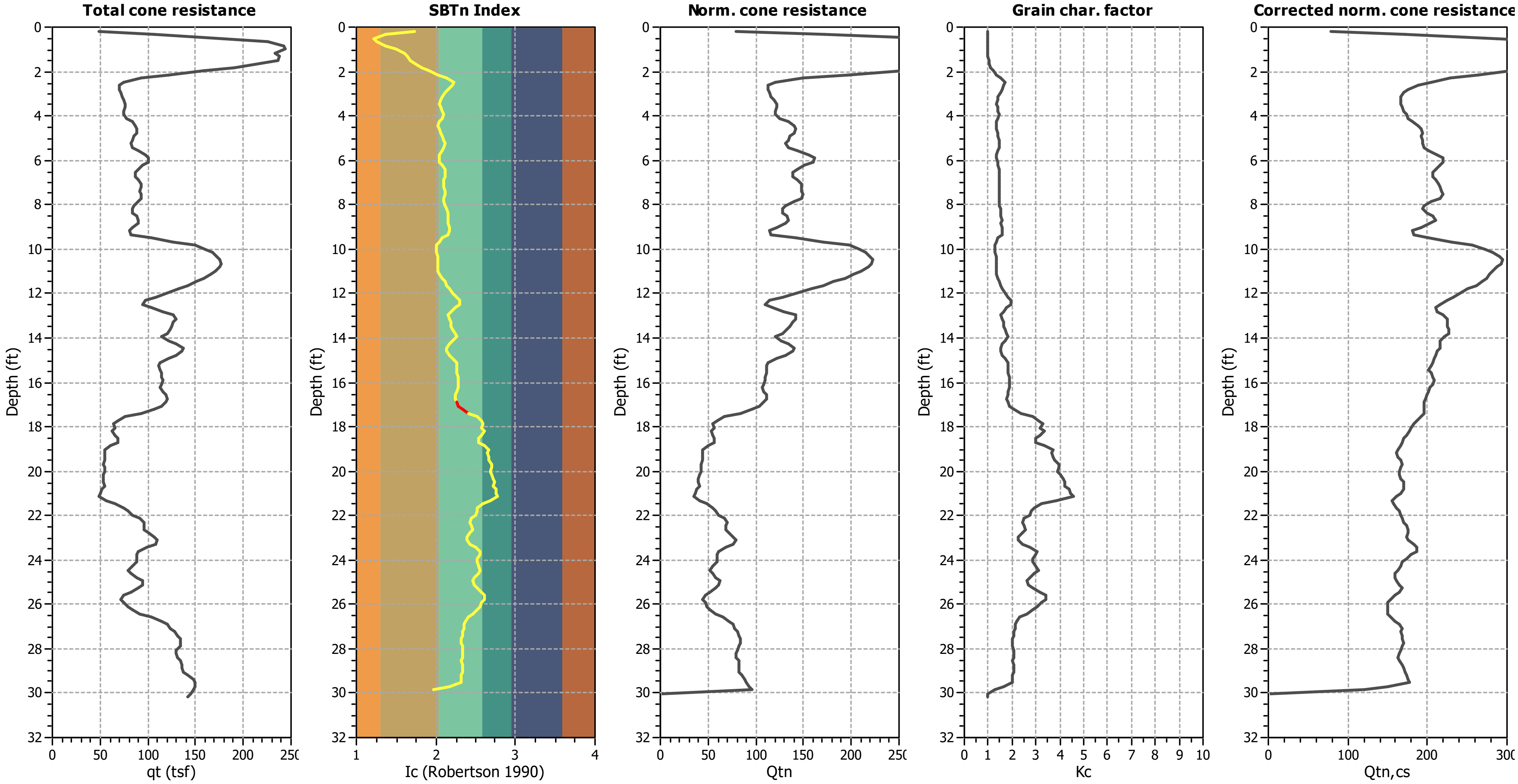
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

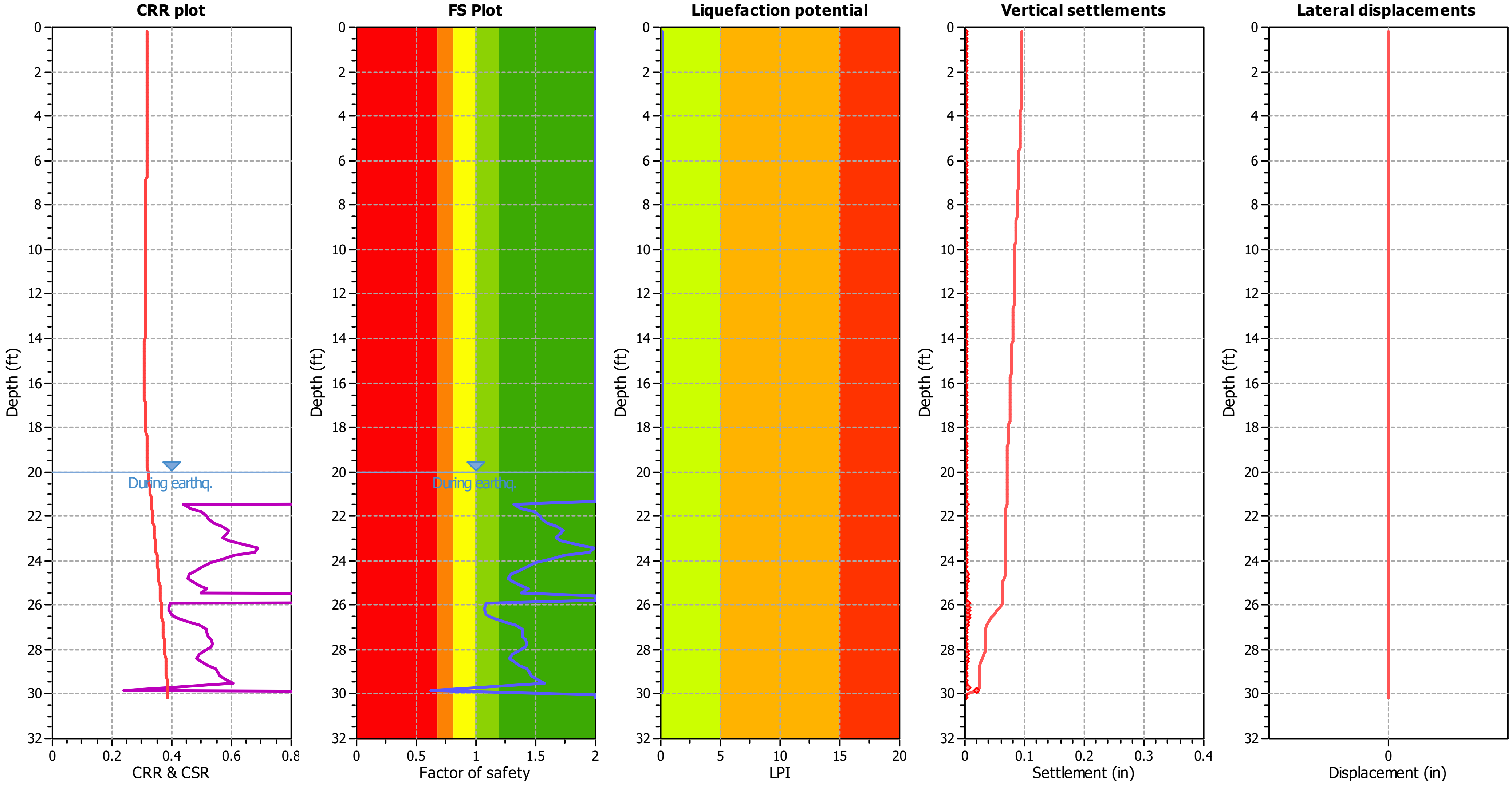
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	29.00 ft	Fill height:	N/A	Limit depth:	N/A

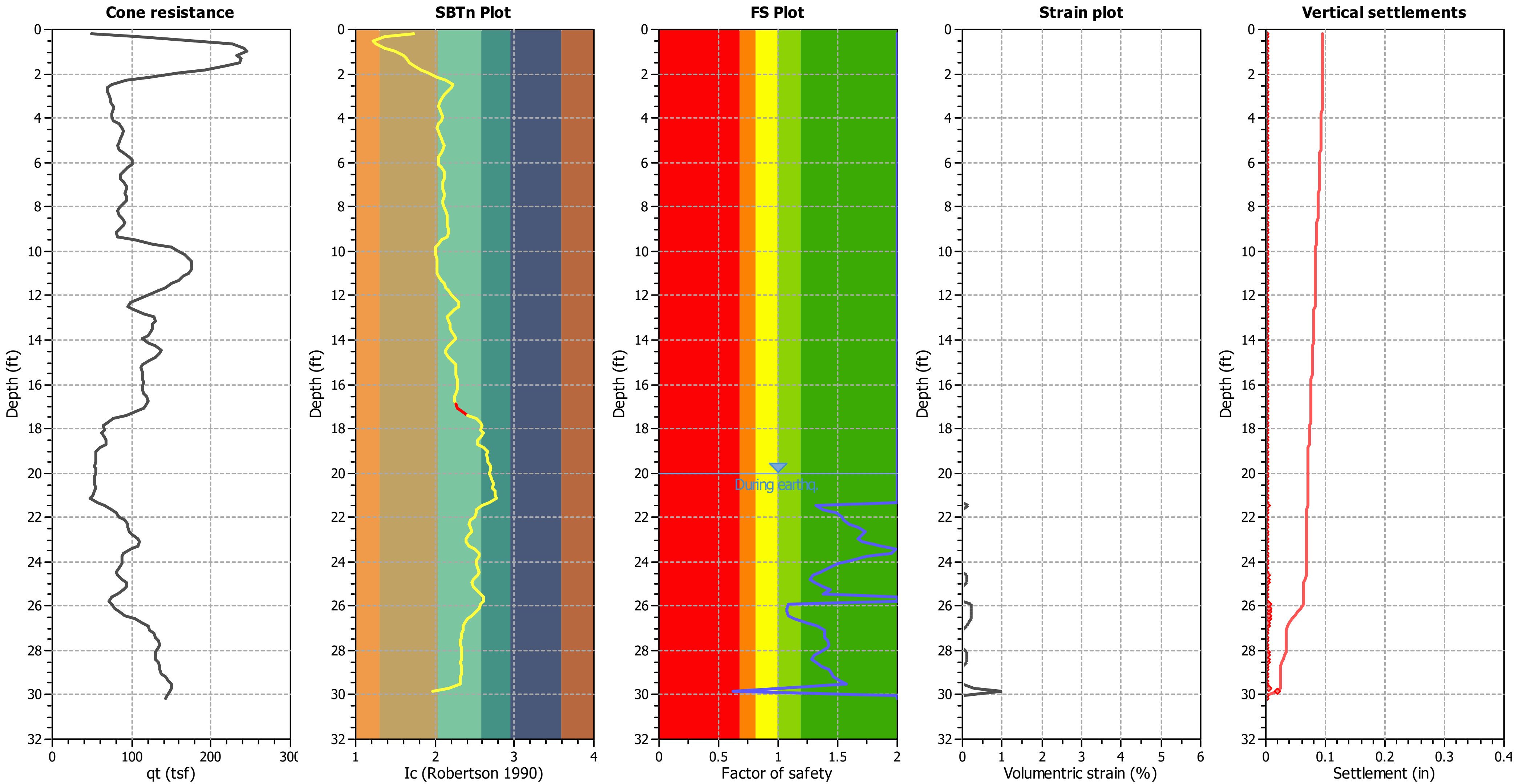
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

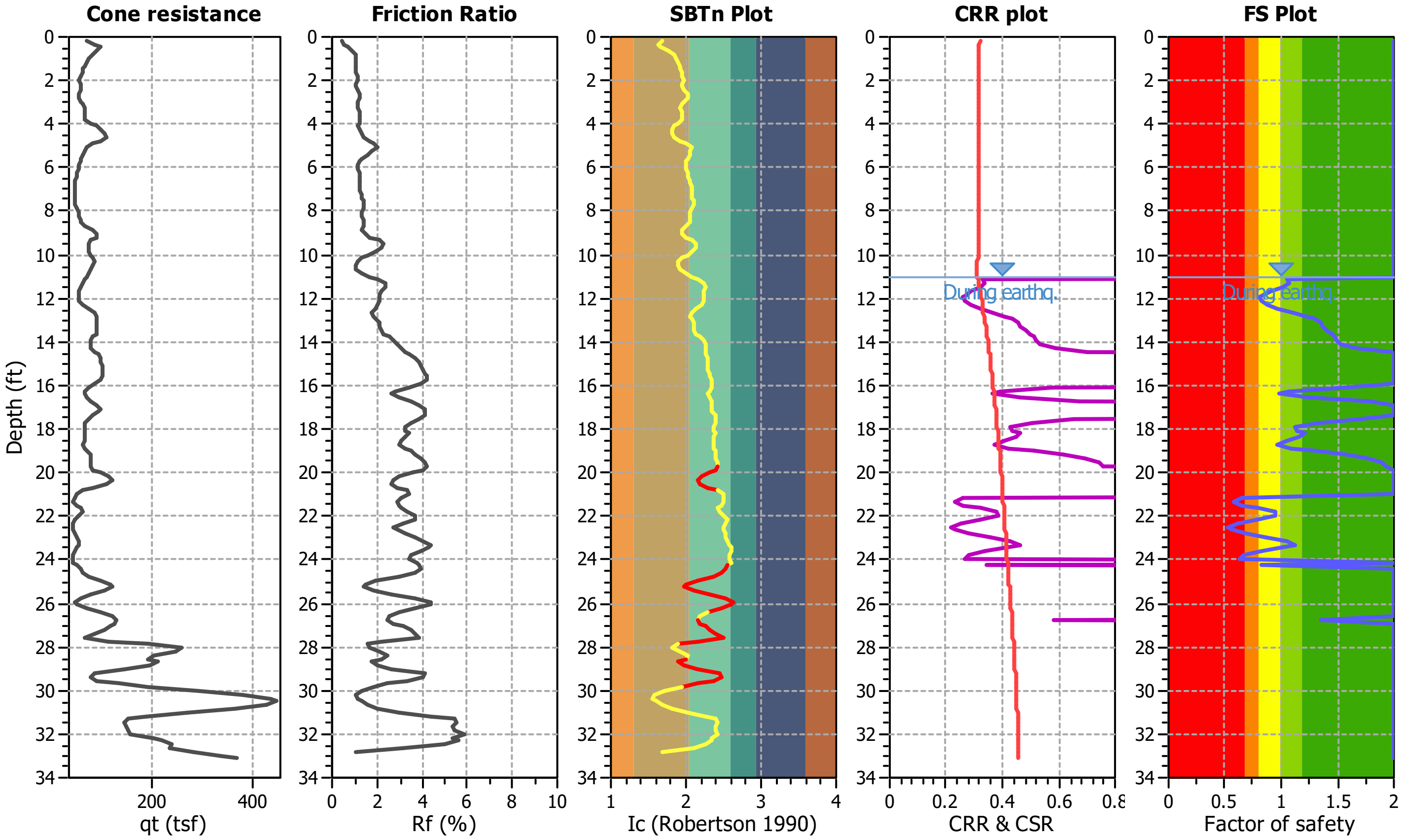
LIQUEFACTION ANALYSIS REPORT

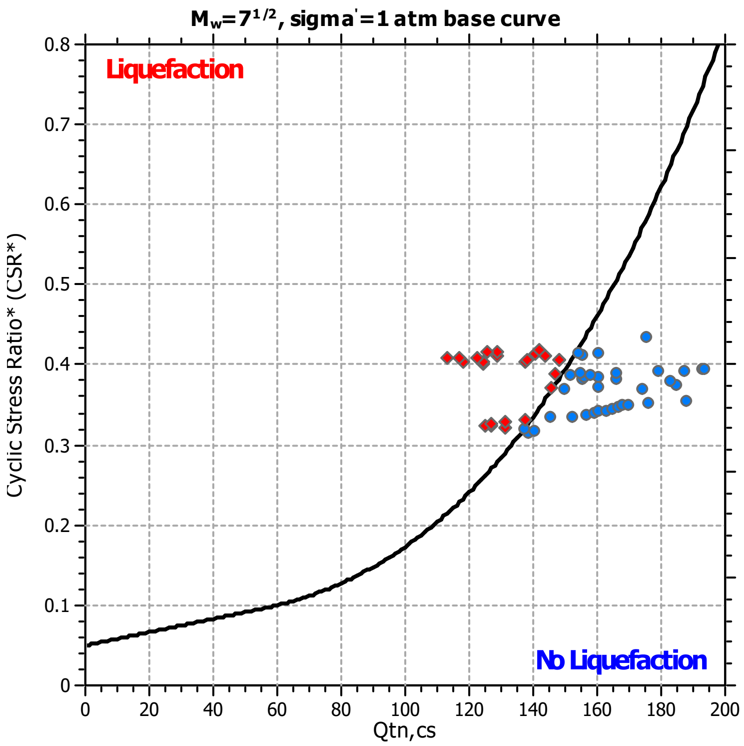
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

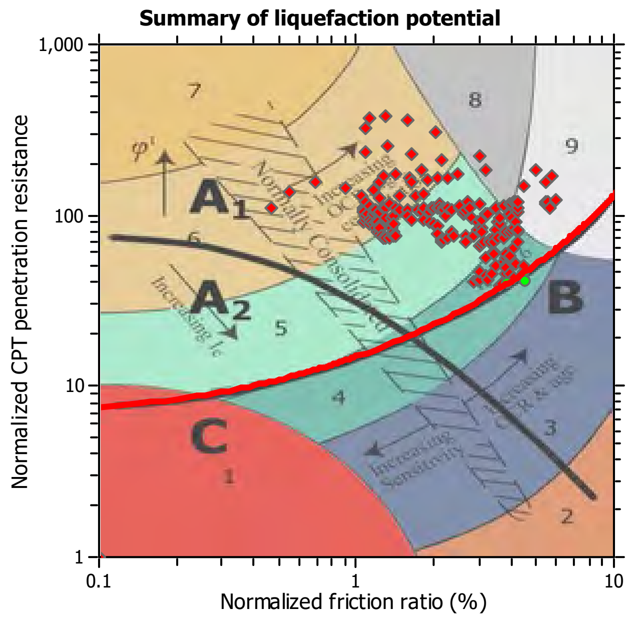
CPT file : C-7

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	11.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	11.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

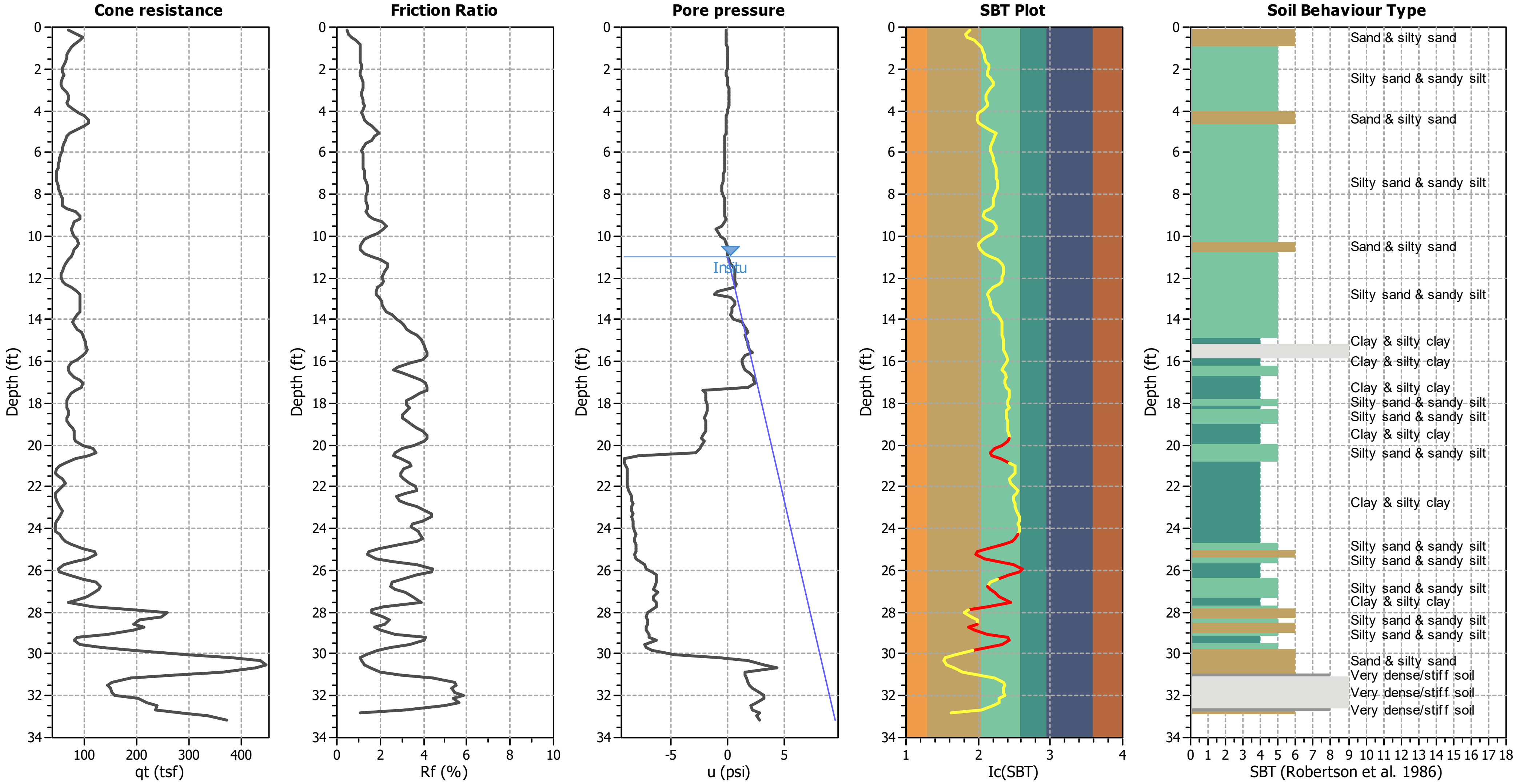






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



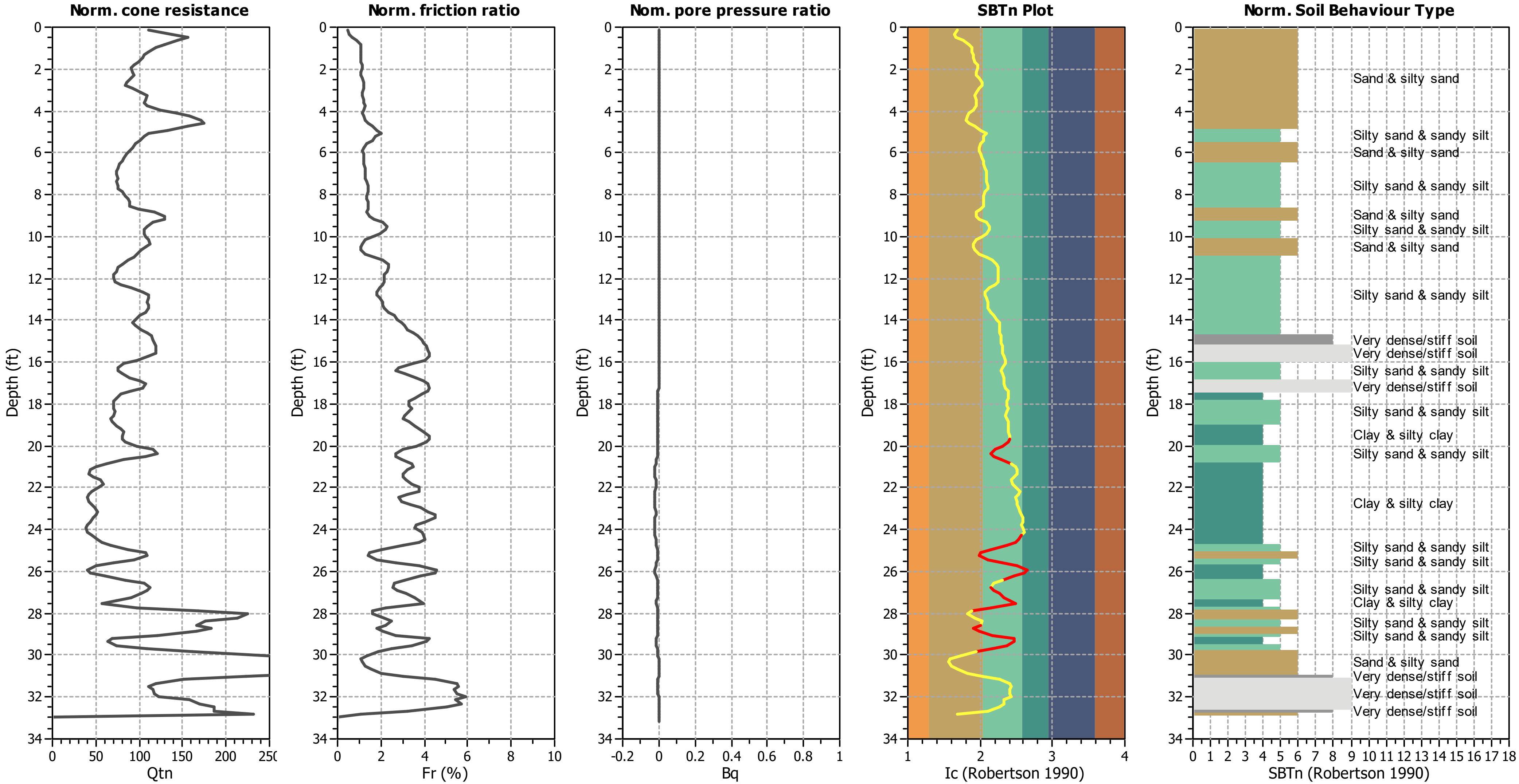
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
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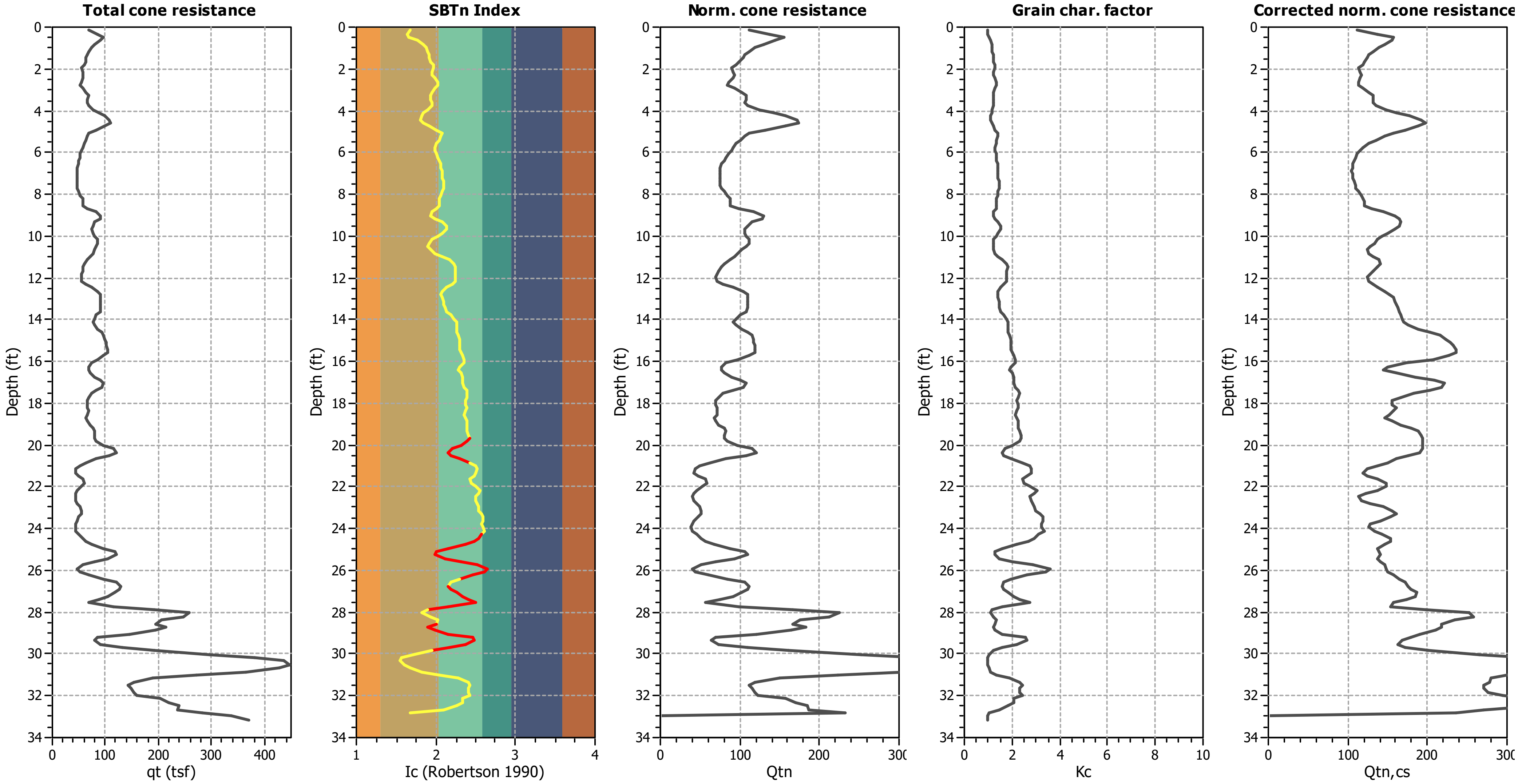
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

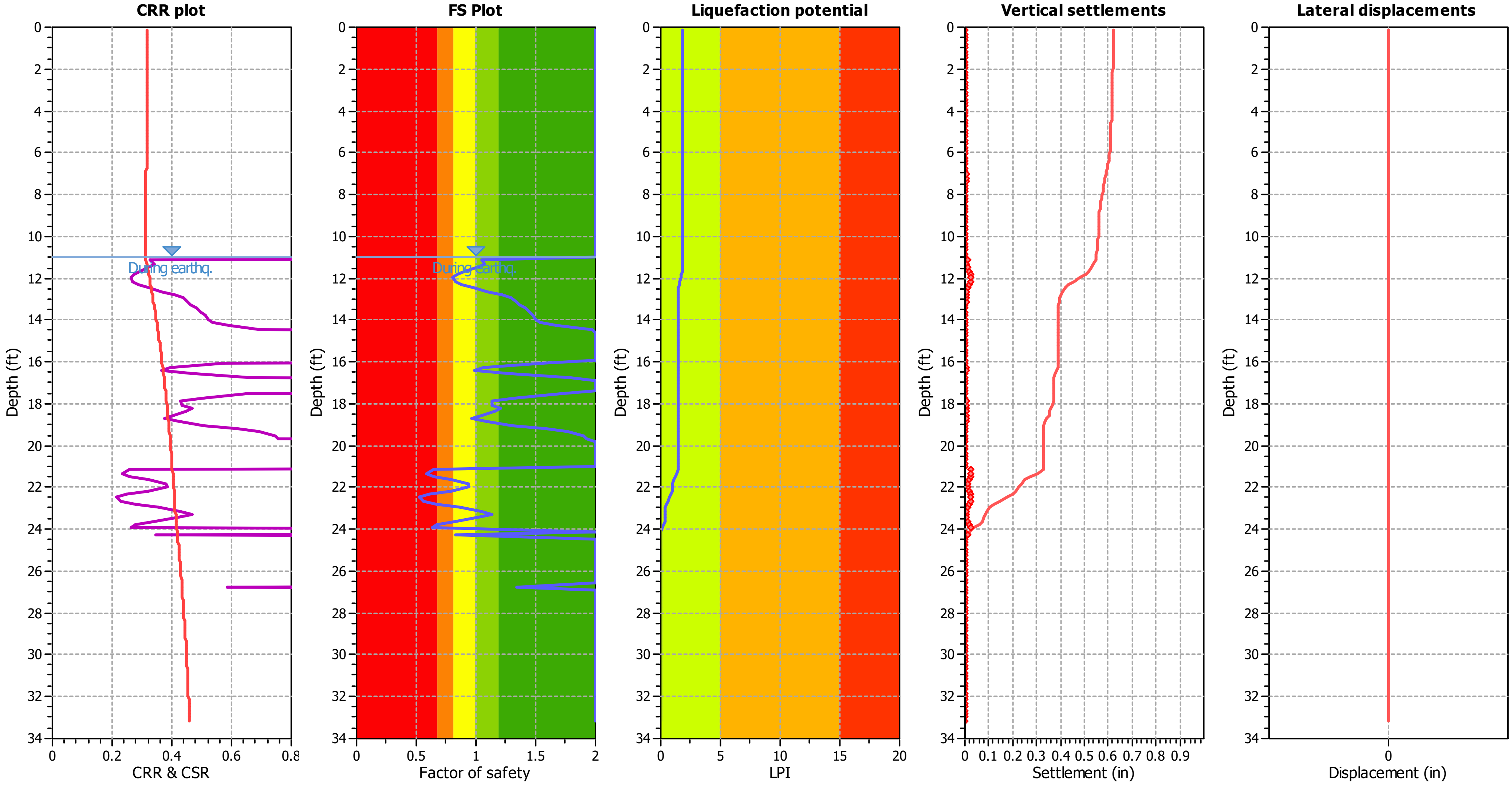
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



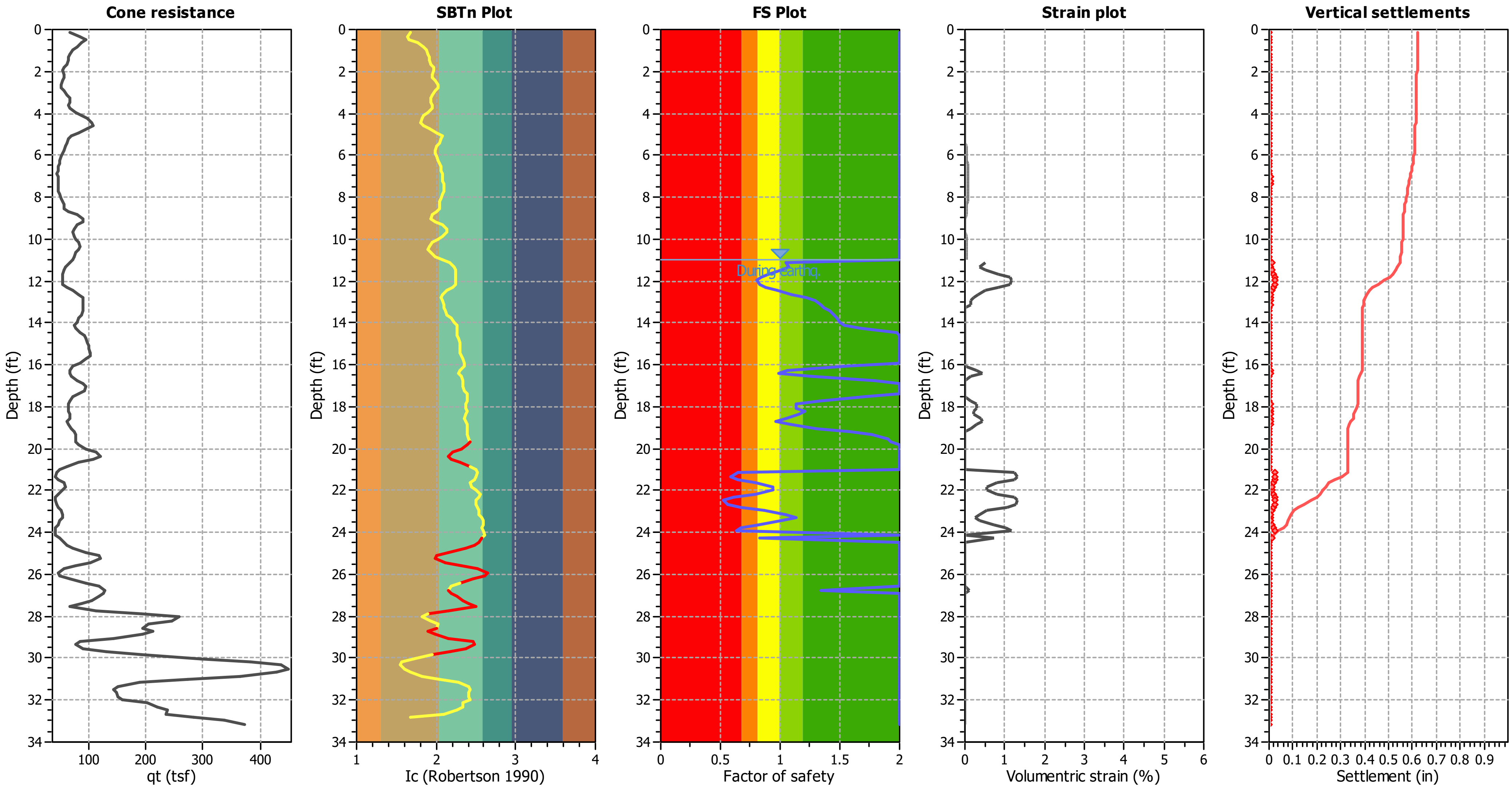
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	11.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	11.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

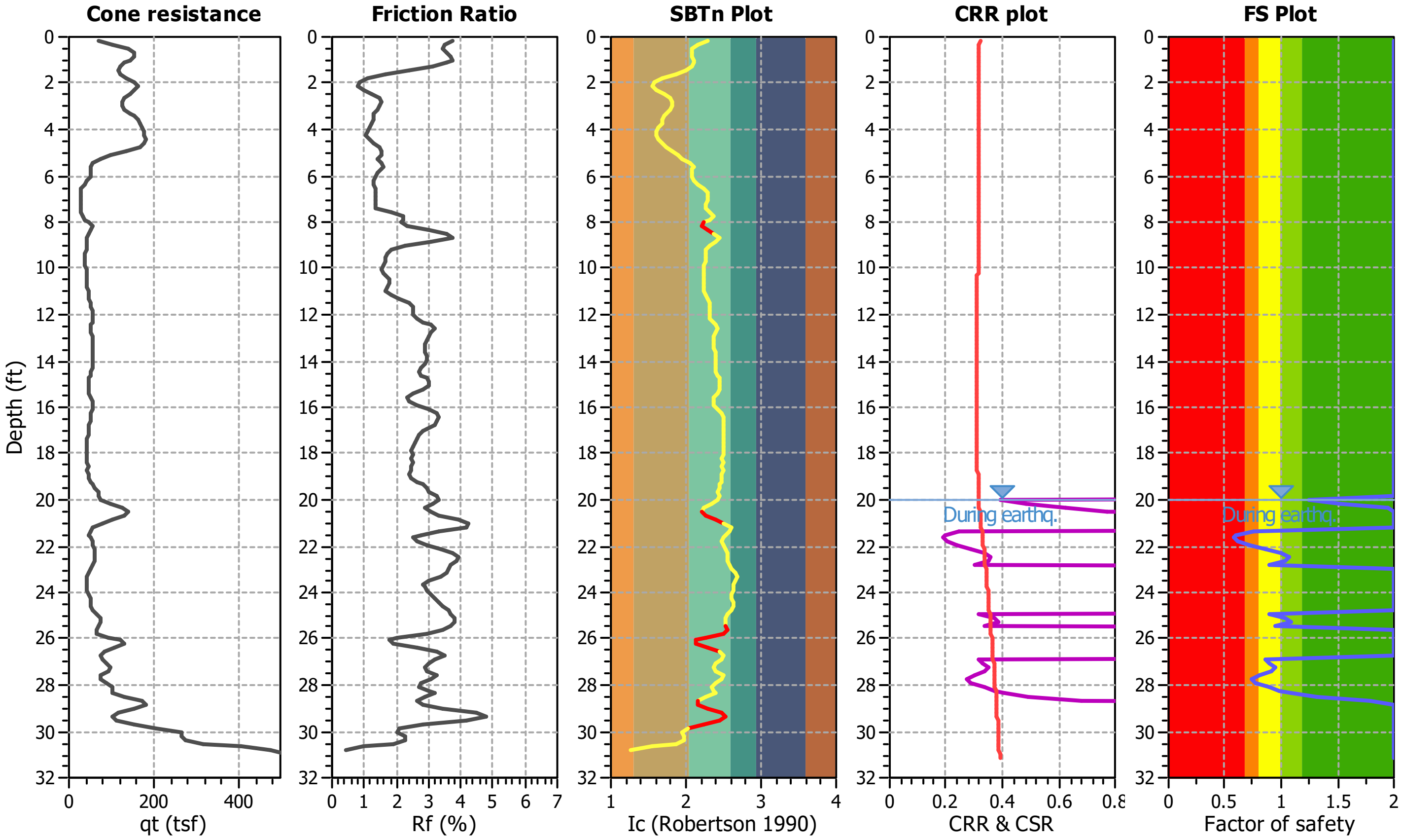
LIQUEFACTION ANALYSIS REPORT

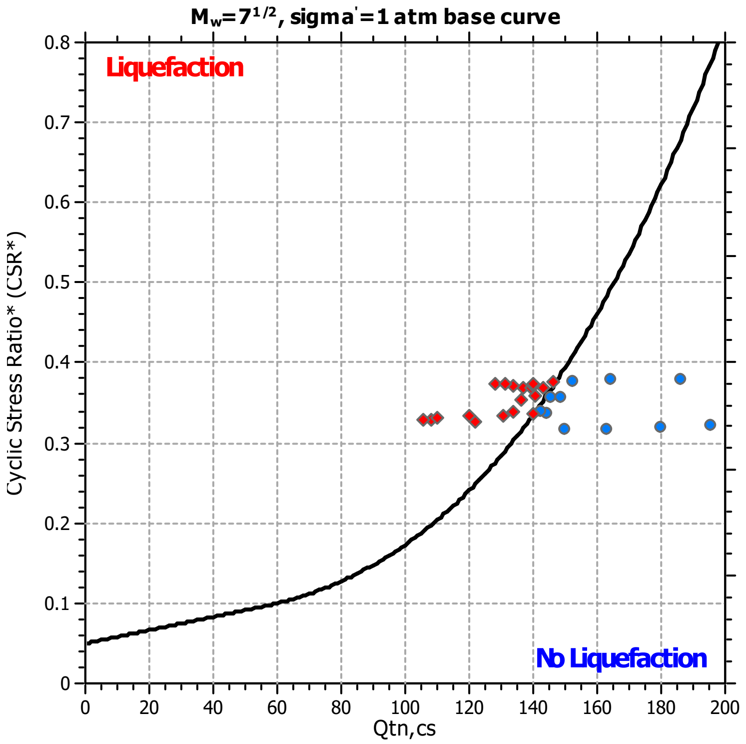
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

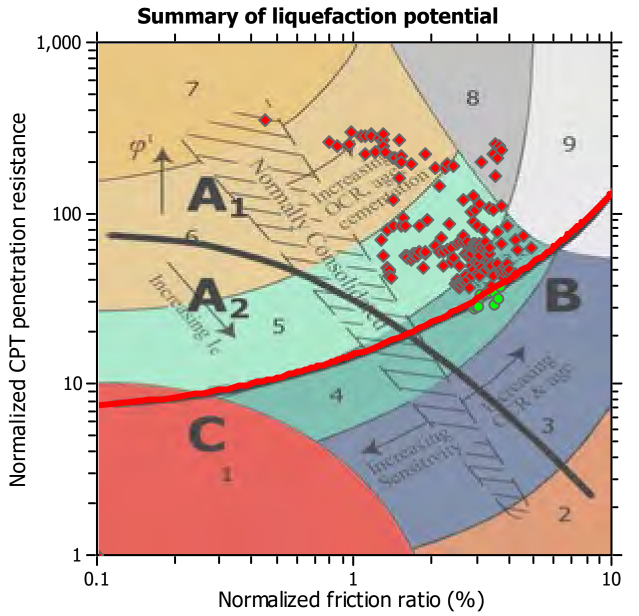
CPT file : C-8

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	25.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
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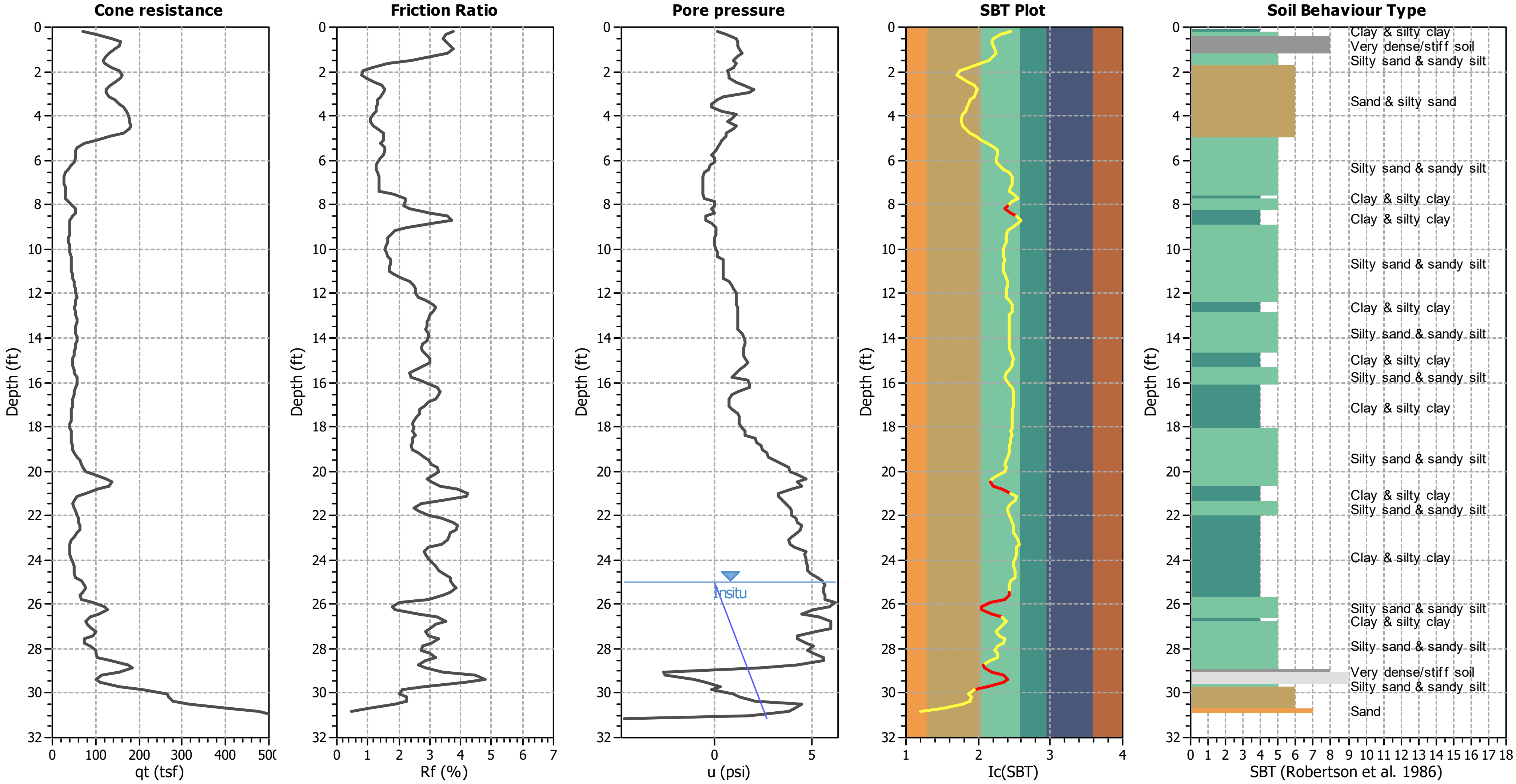
CPT basic interpretation plots



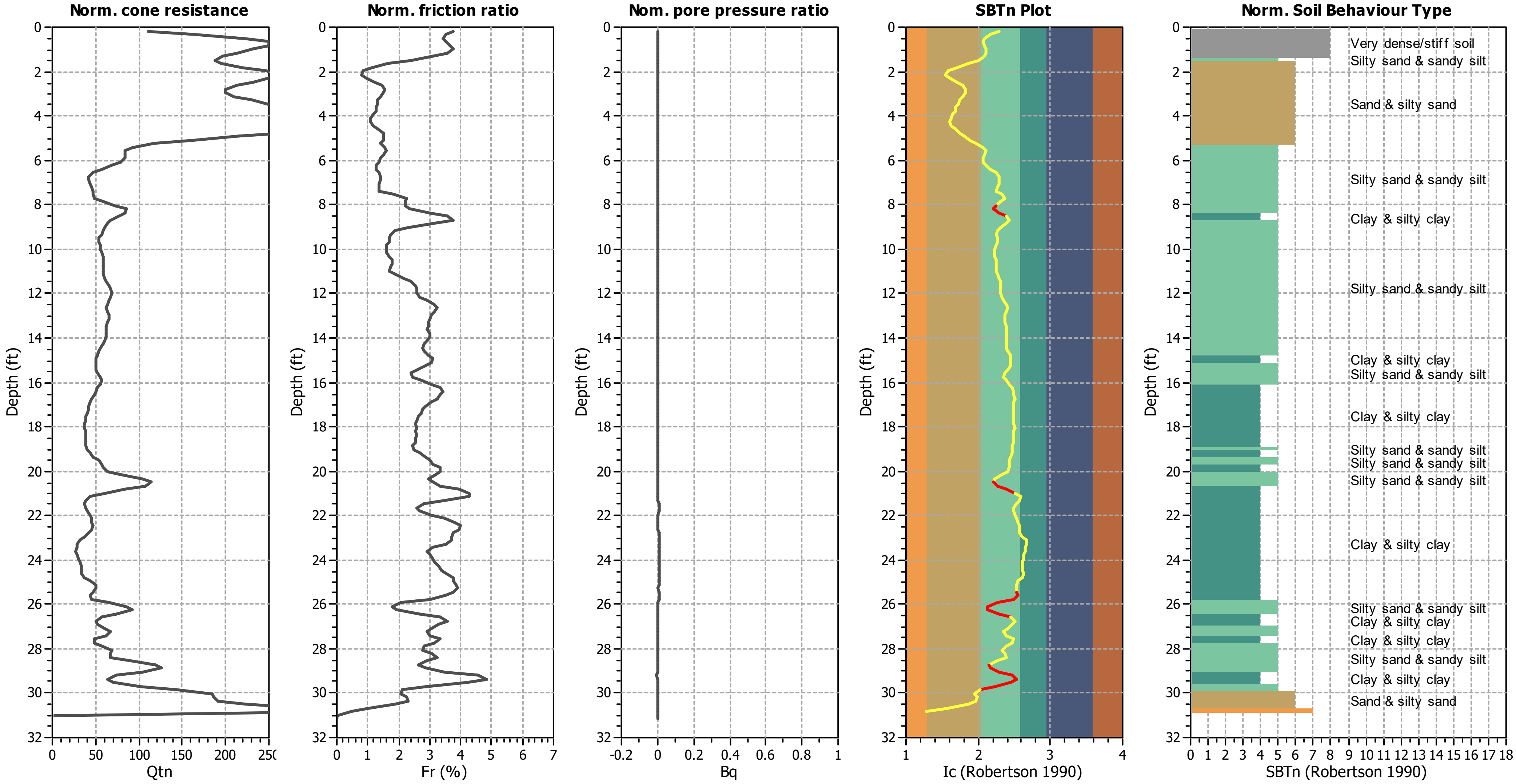
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A		
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes		
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only		
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No		
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A		

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 1. Sensitive fine grained
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- 6. Clean sand to silty sand
- 7. Gravely sand to sand
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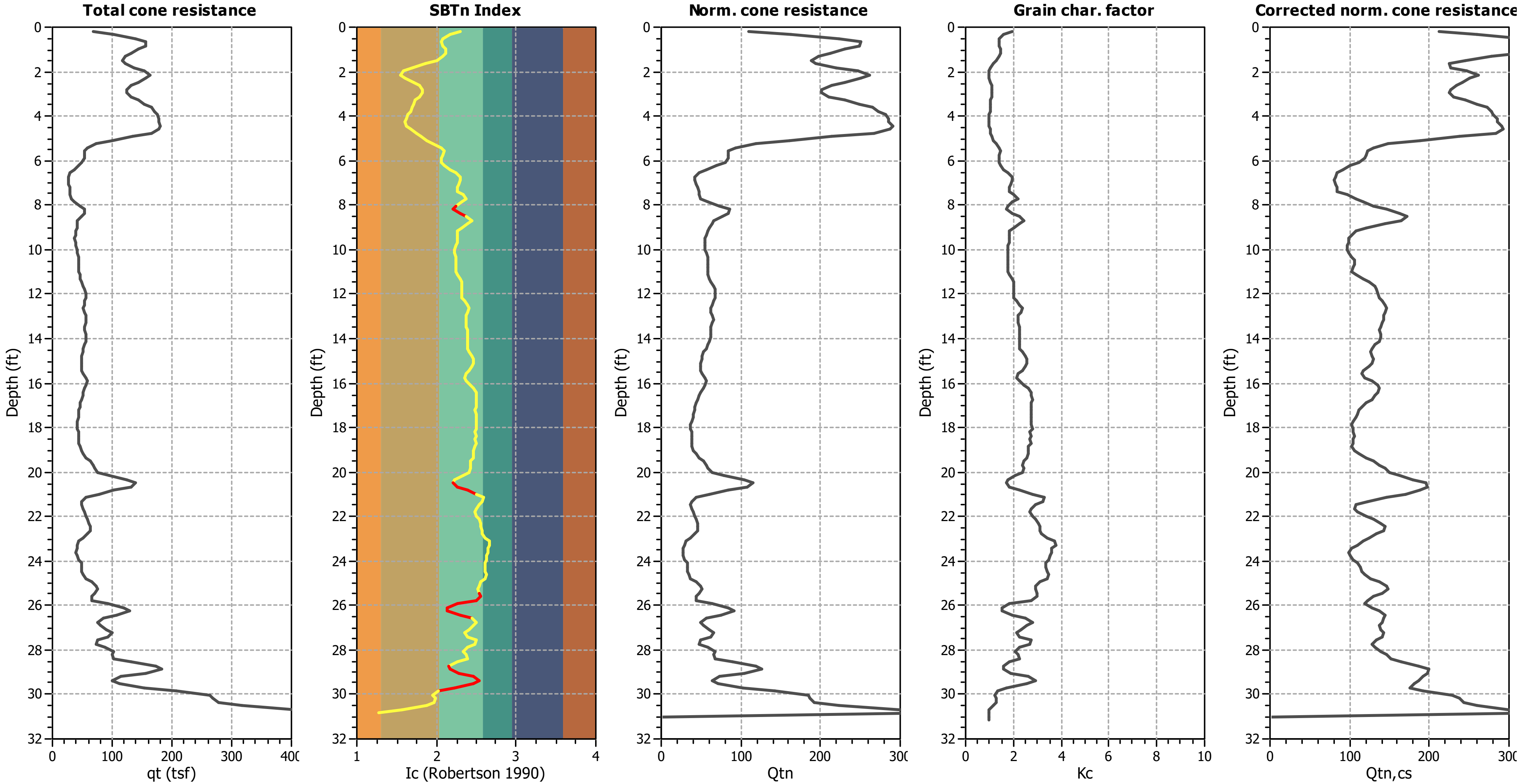
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
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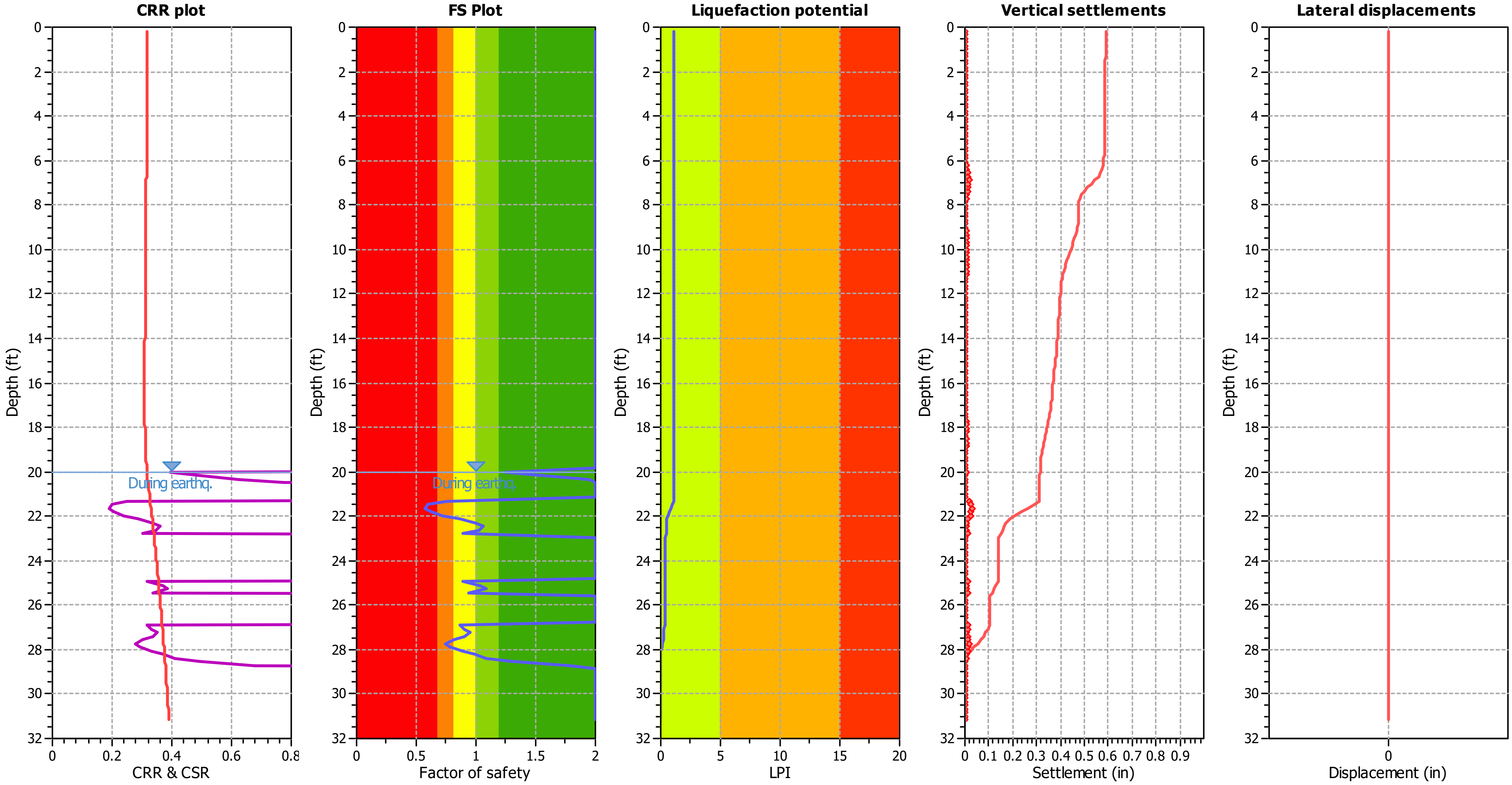
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



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Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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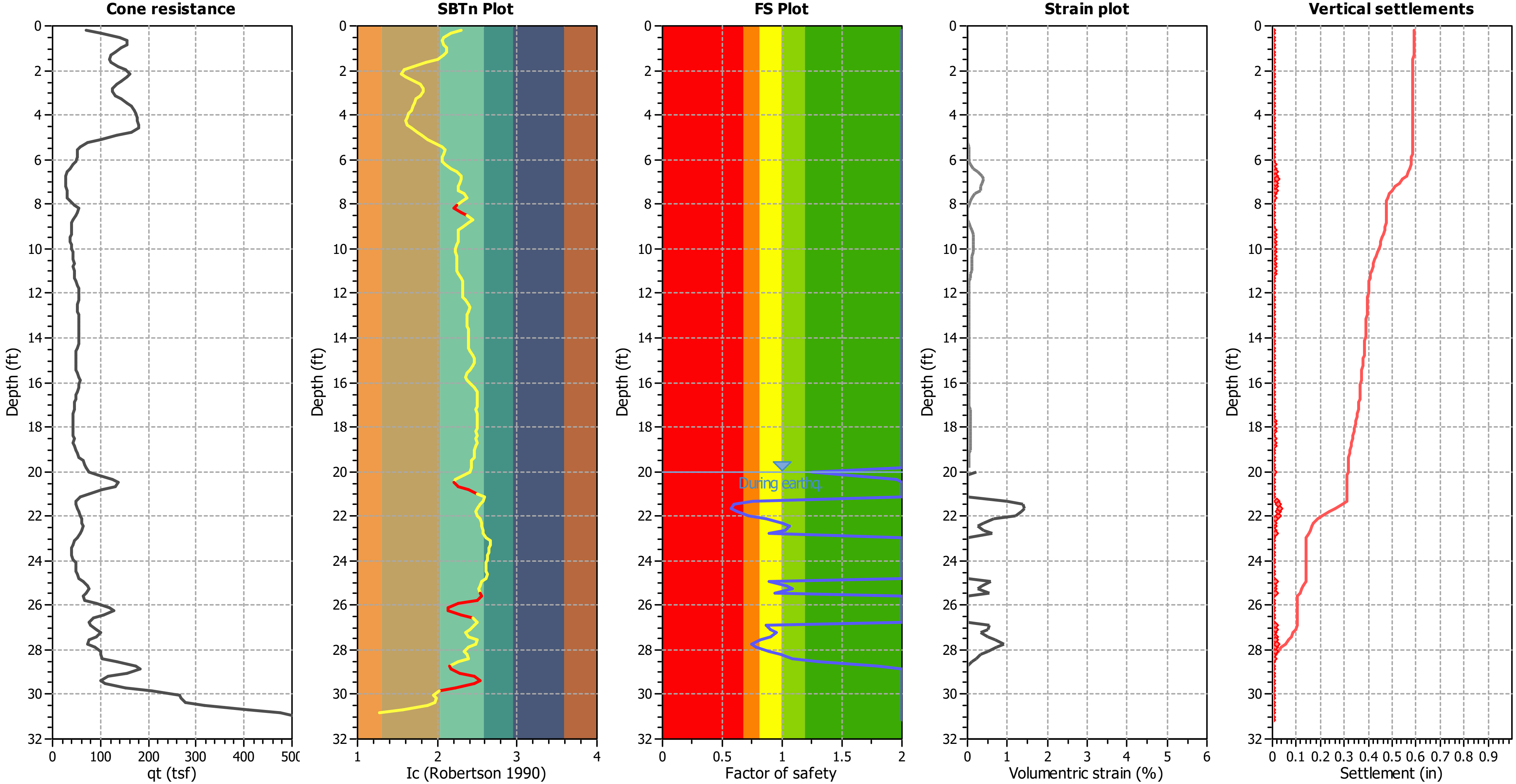
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

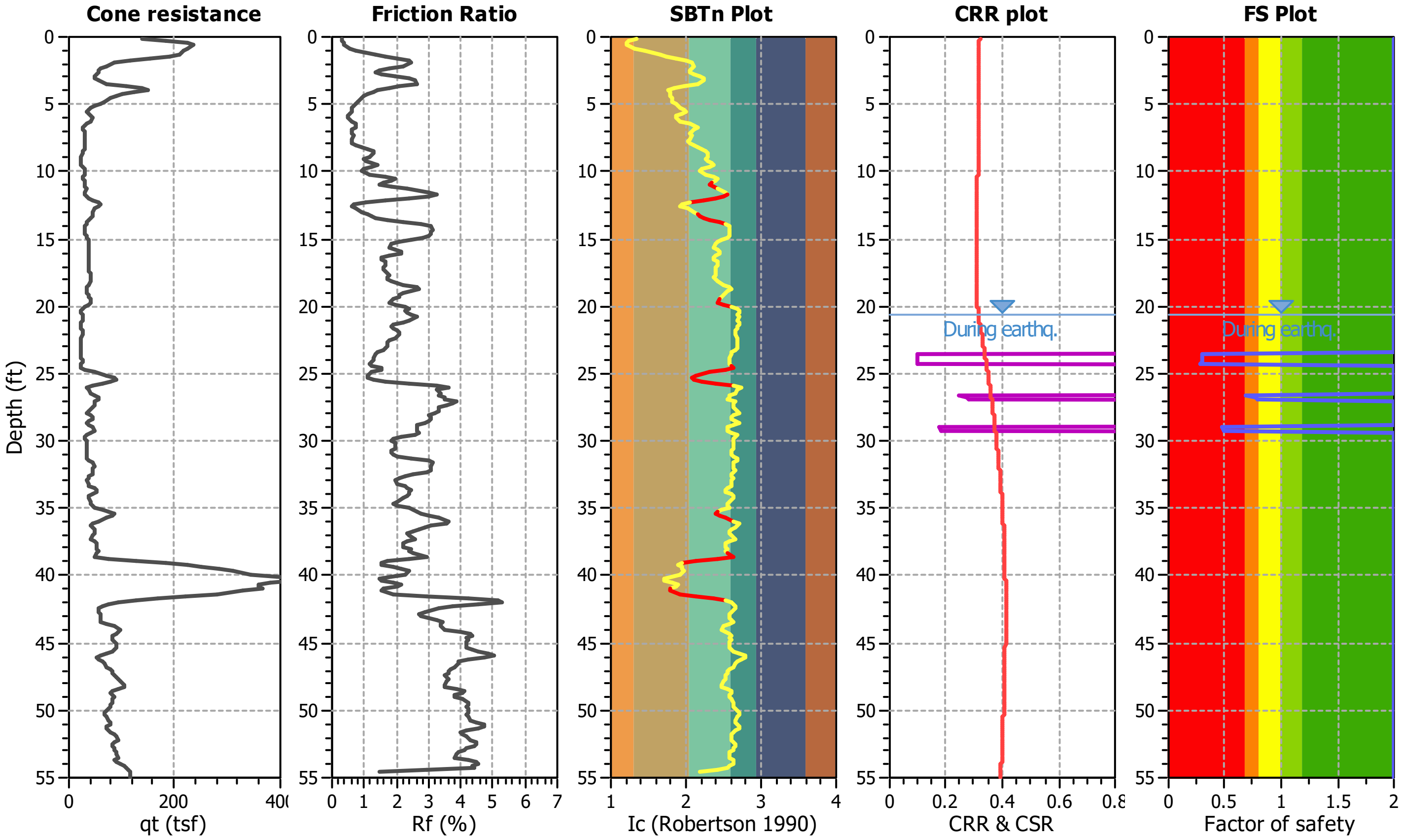
LIQUEFACTION ANALYSIS REPORT

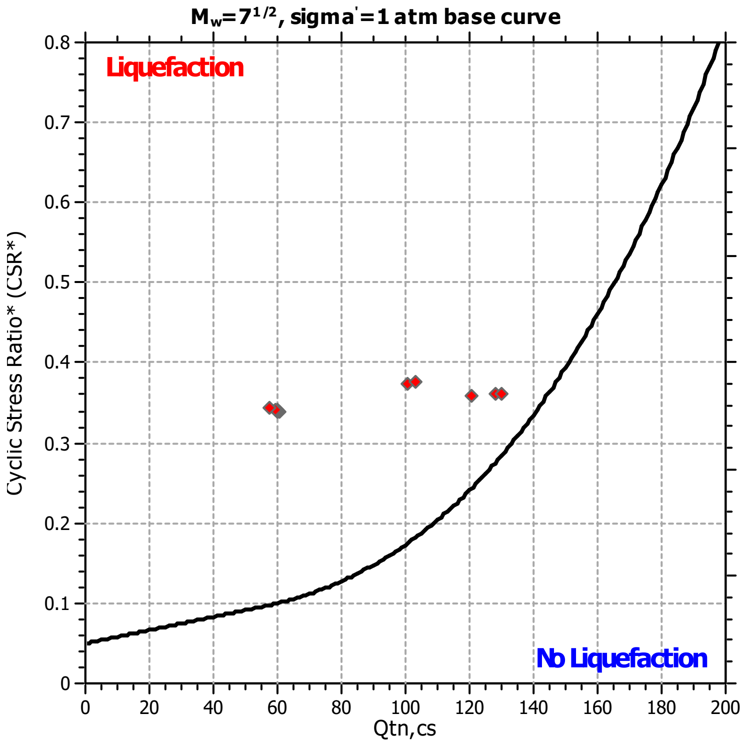
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

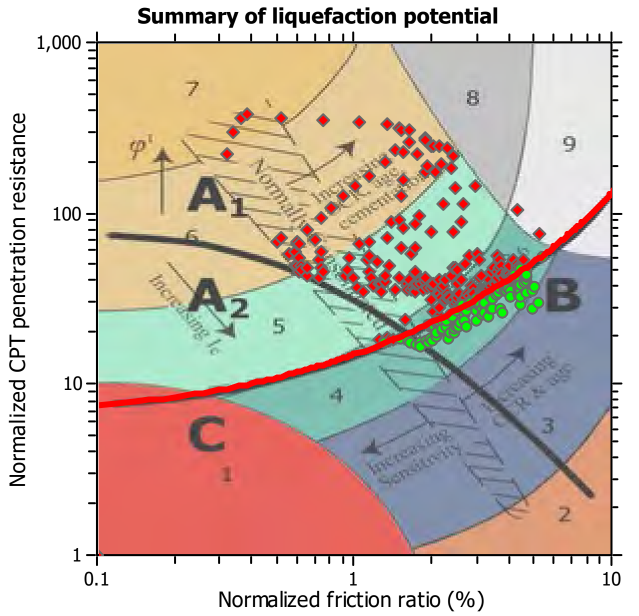
CPT file : C-9

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	20.60 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.60 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	30.00 ft
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

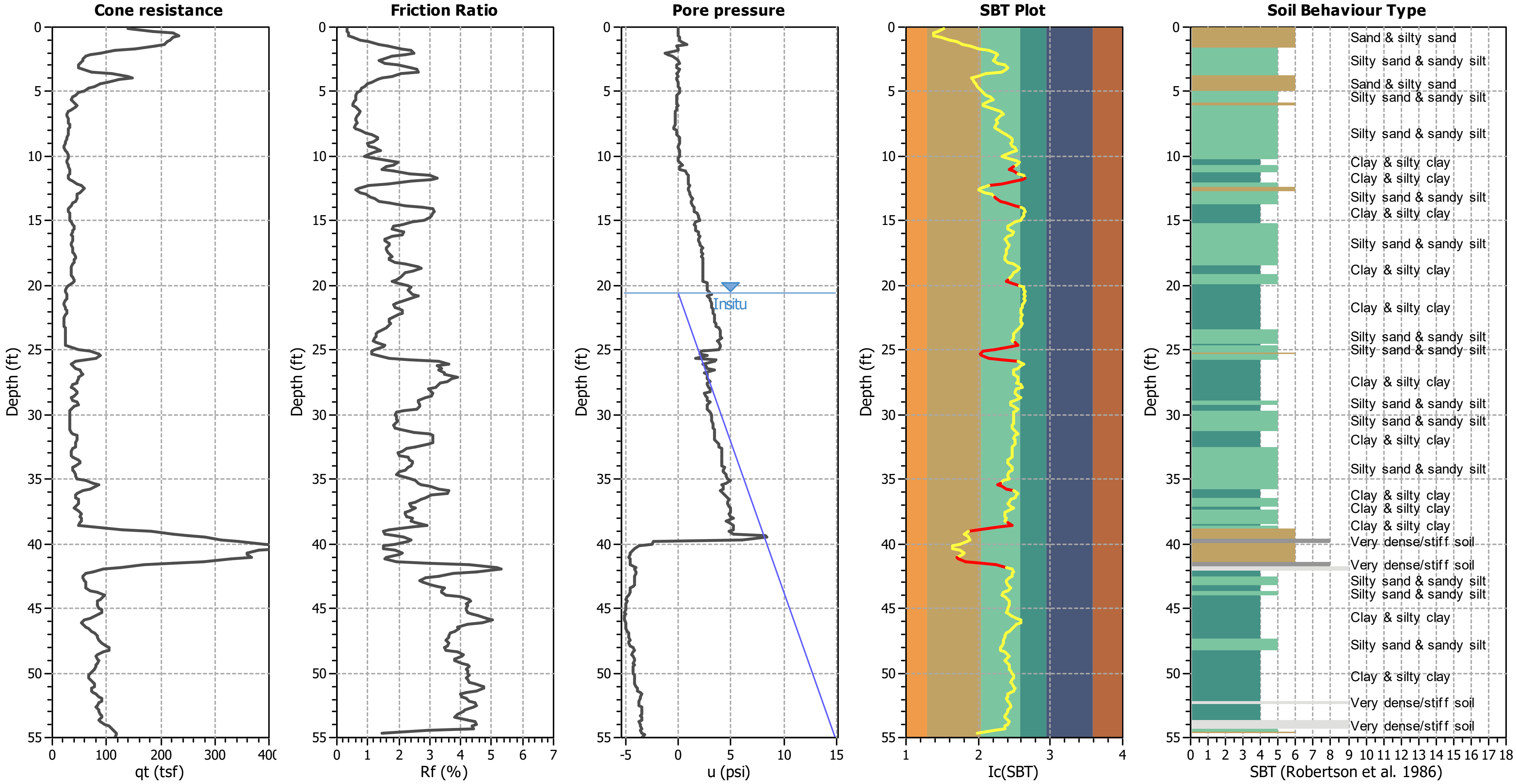






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



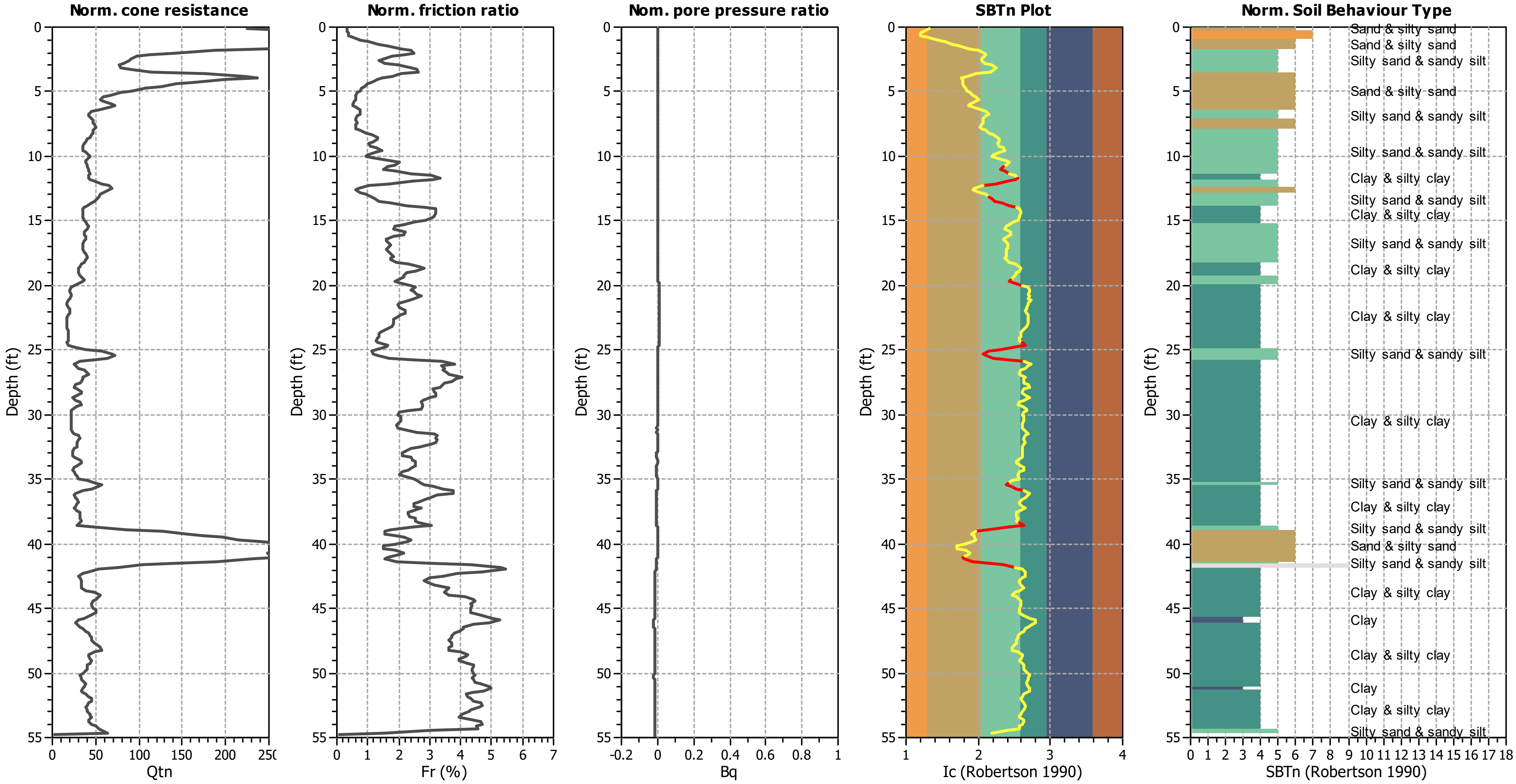
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A		
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes		
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only		
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes		
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft		

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



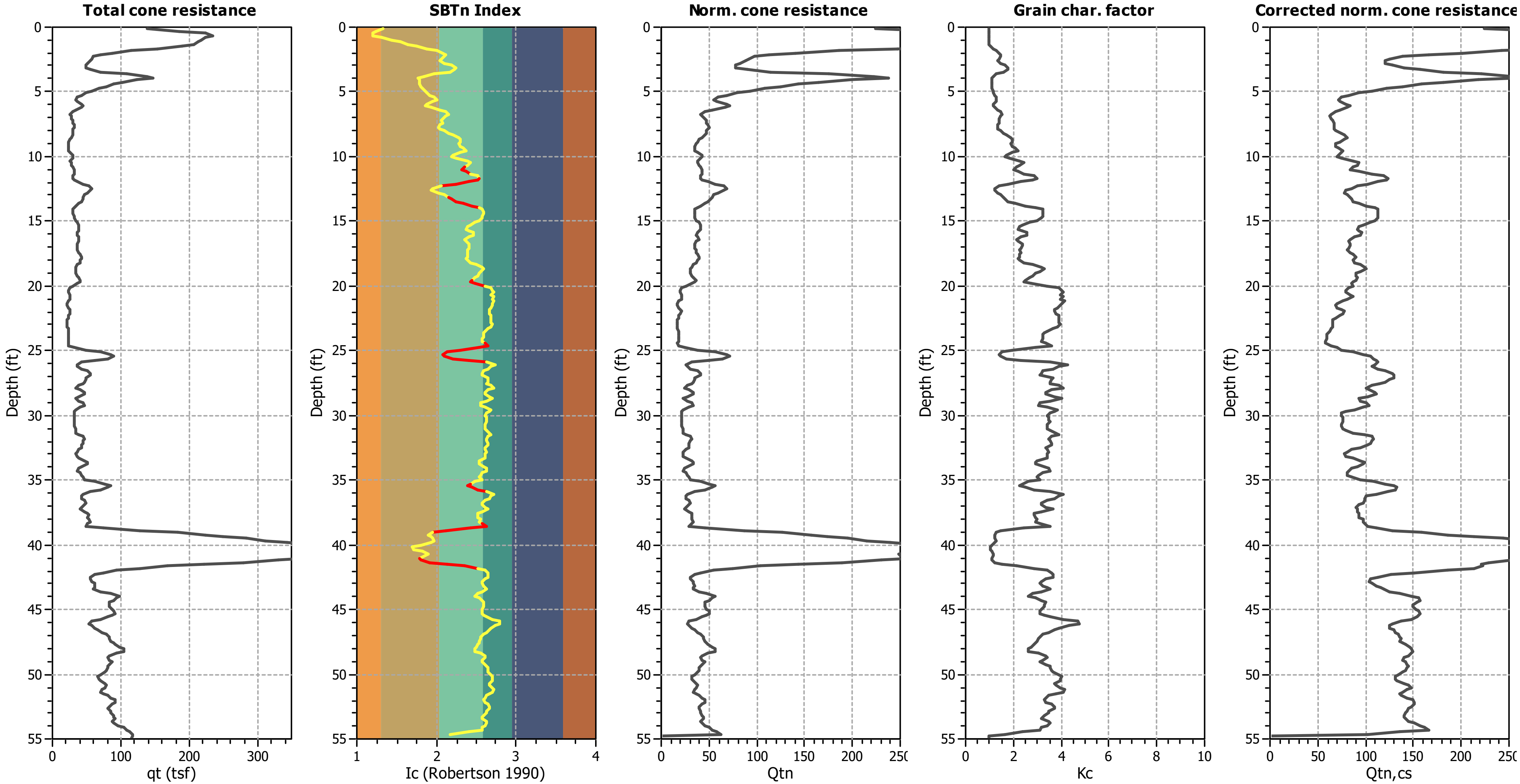
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

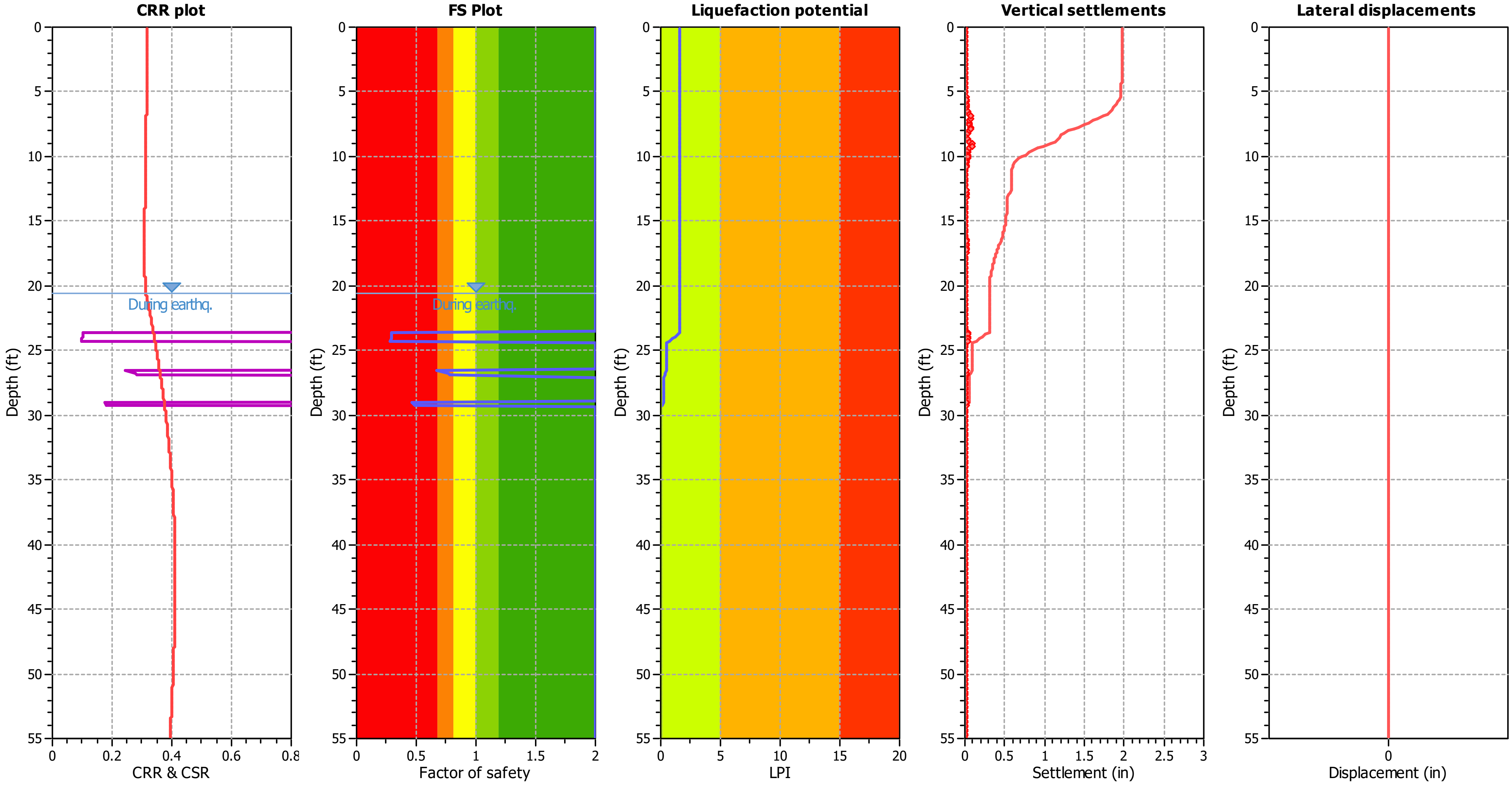
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.60 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	20.60 ft	Fill height:	N/A	Limit depth:	30.00 ft

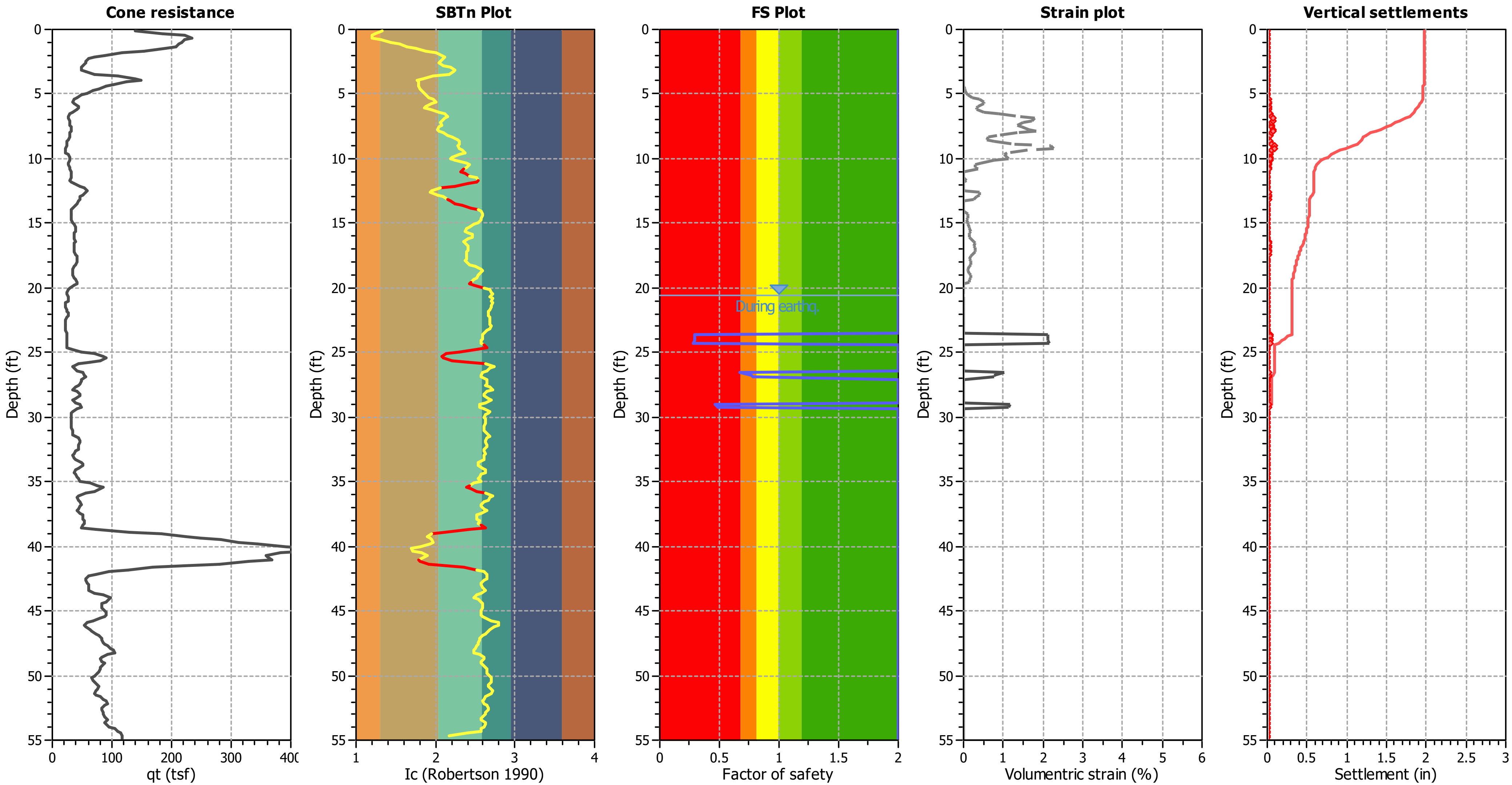
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

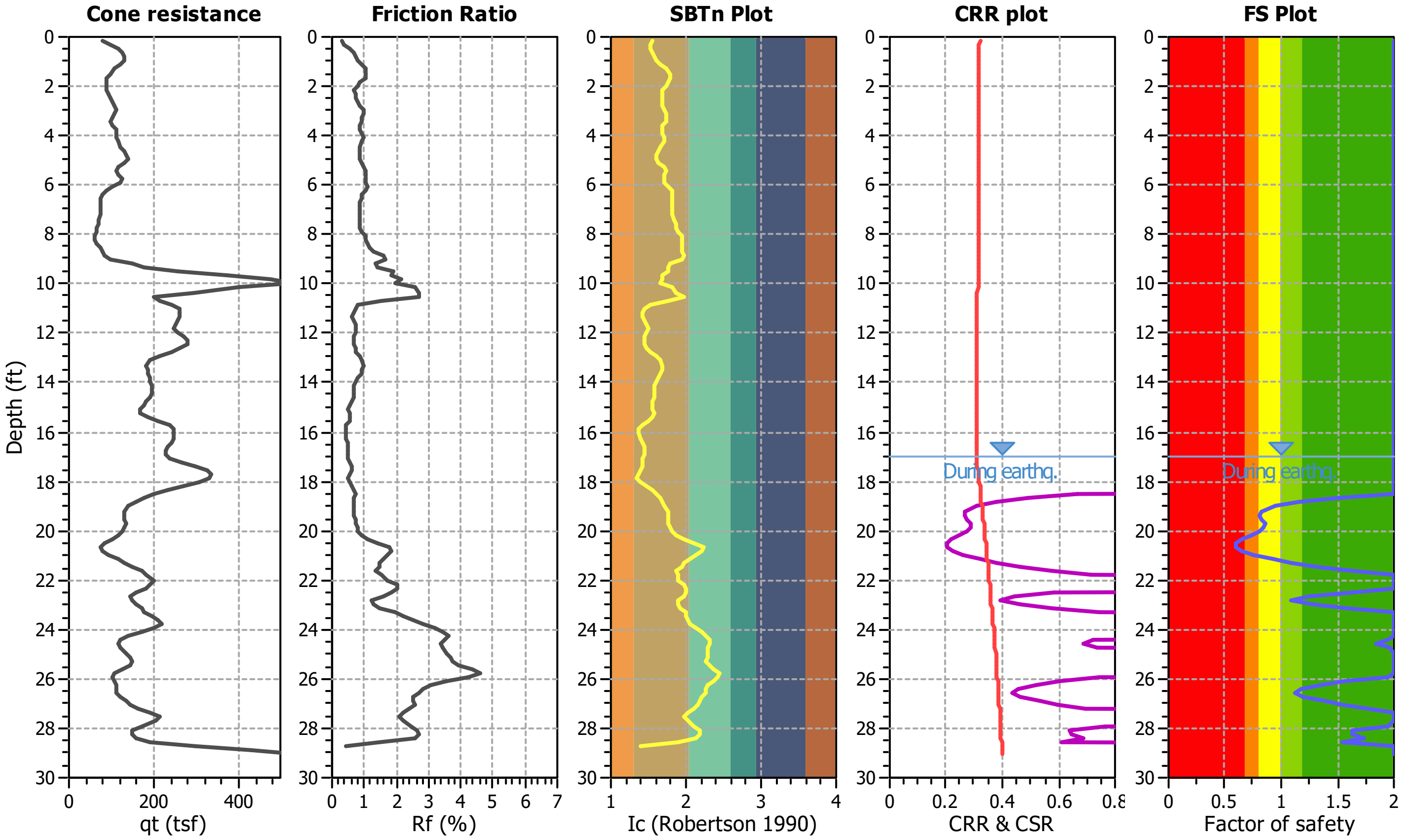
LIQUEFACTION ANALYSIS REPORT

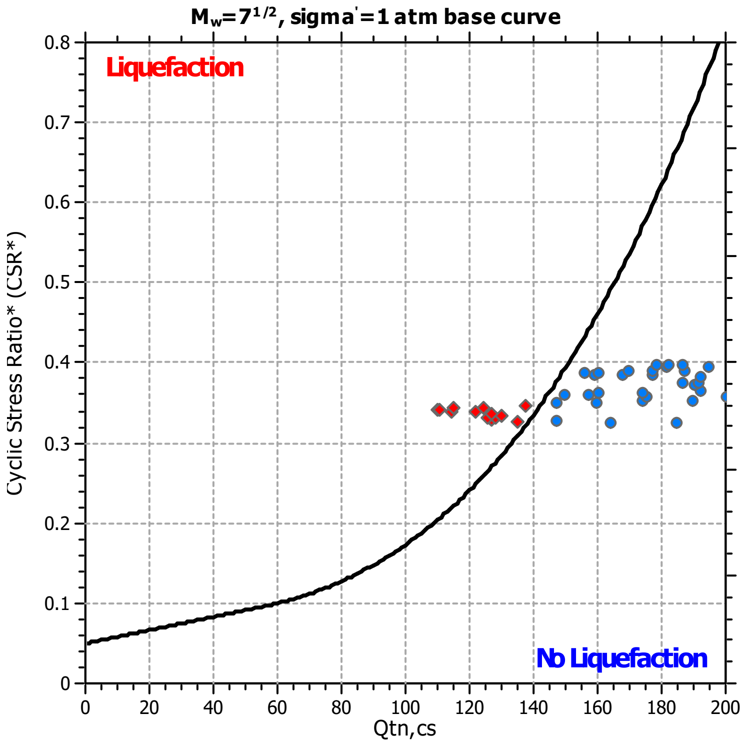
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

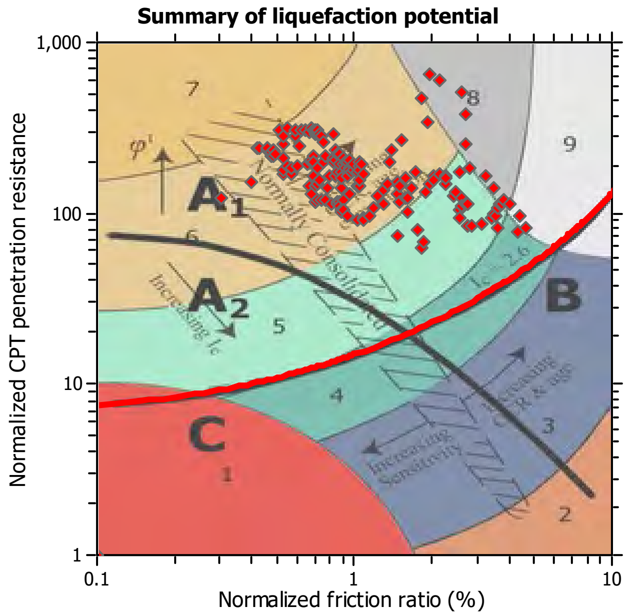
CPT file : SC-1

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	17.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	17.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

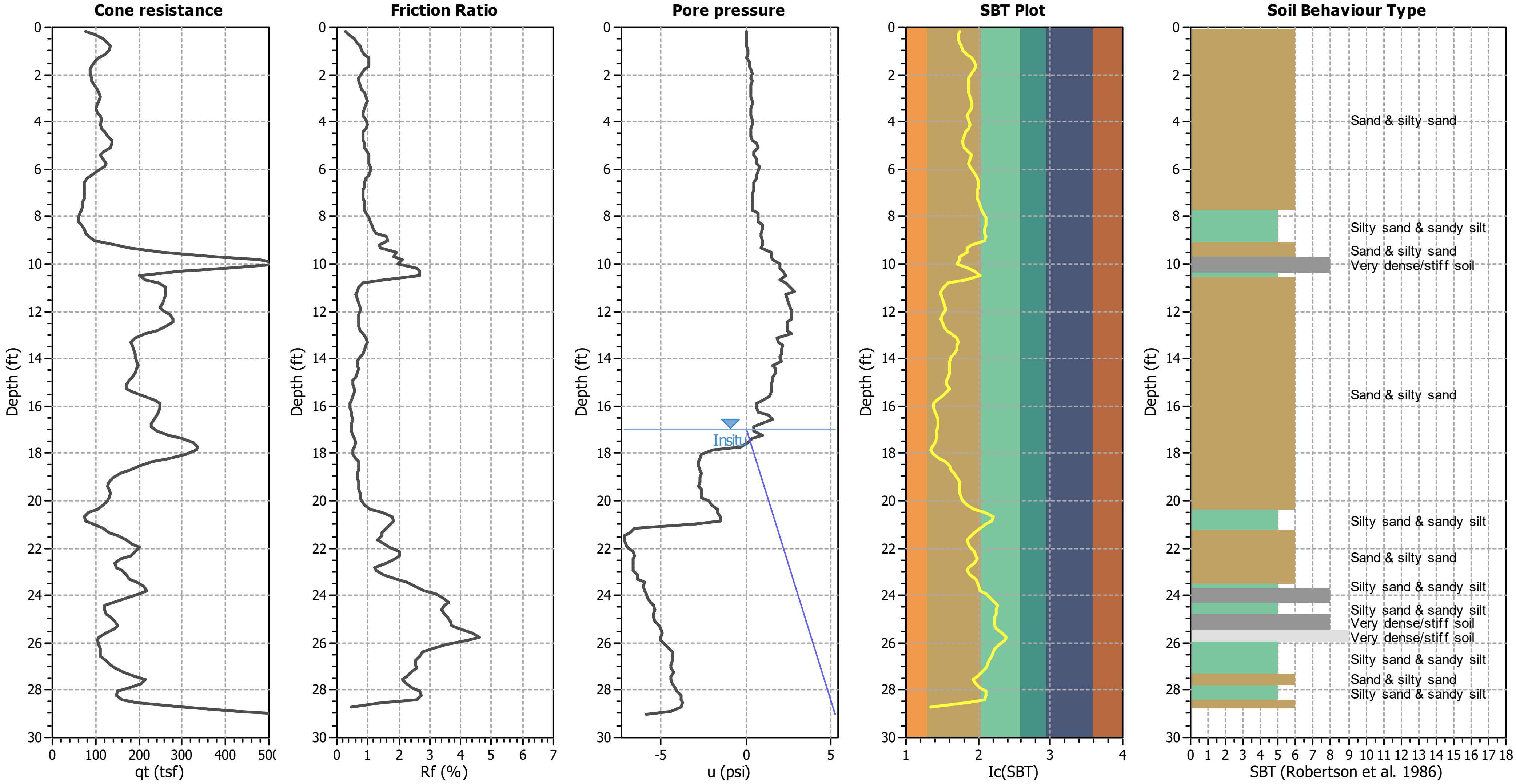






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



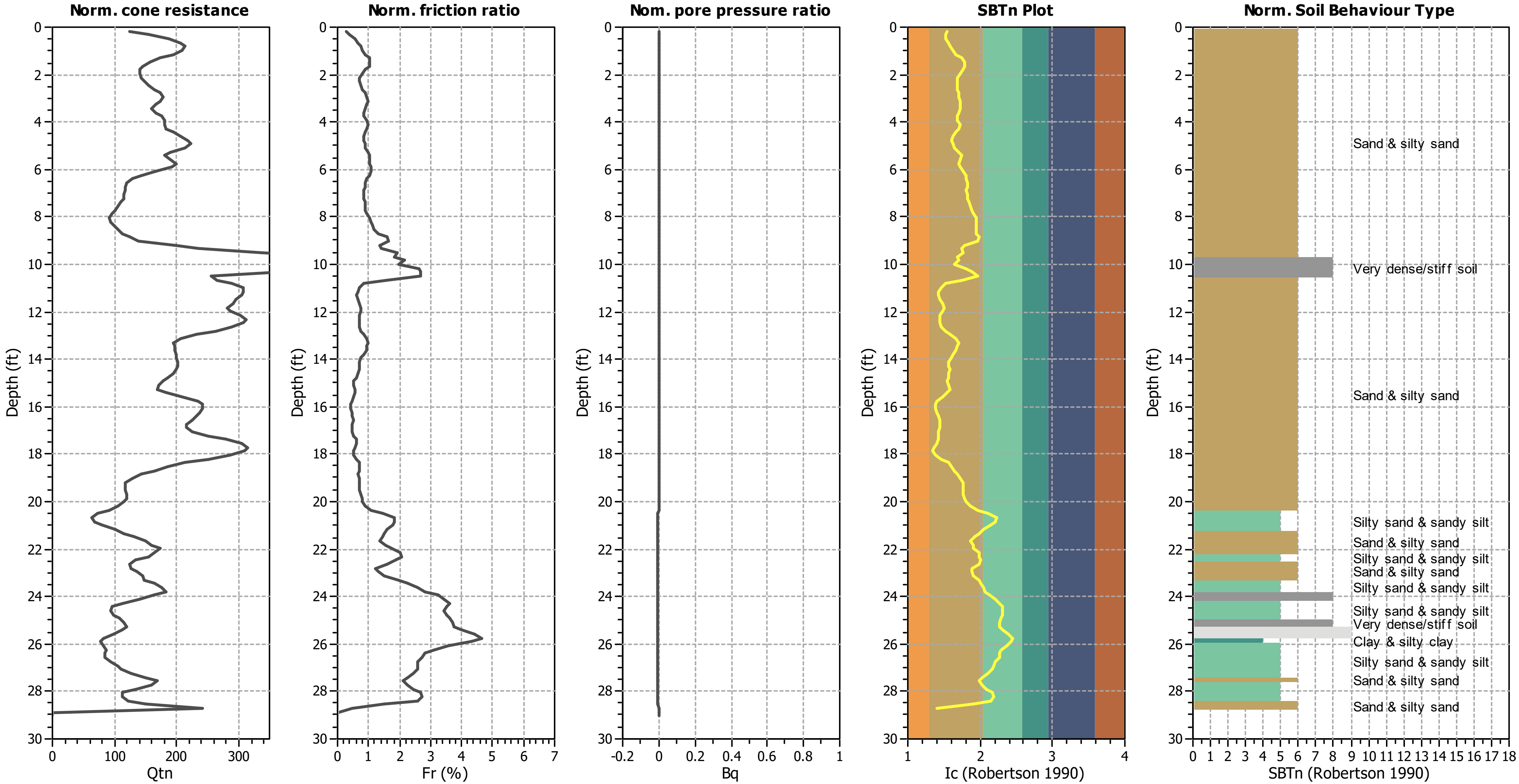
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



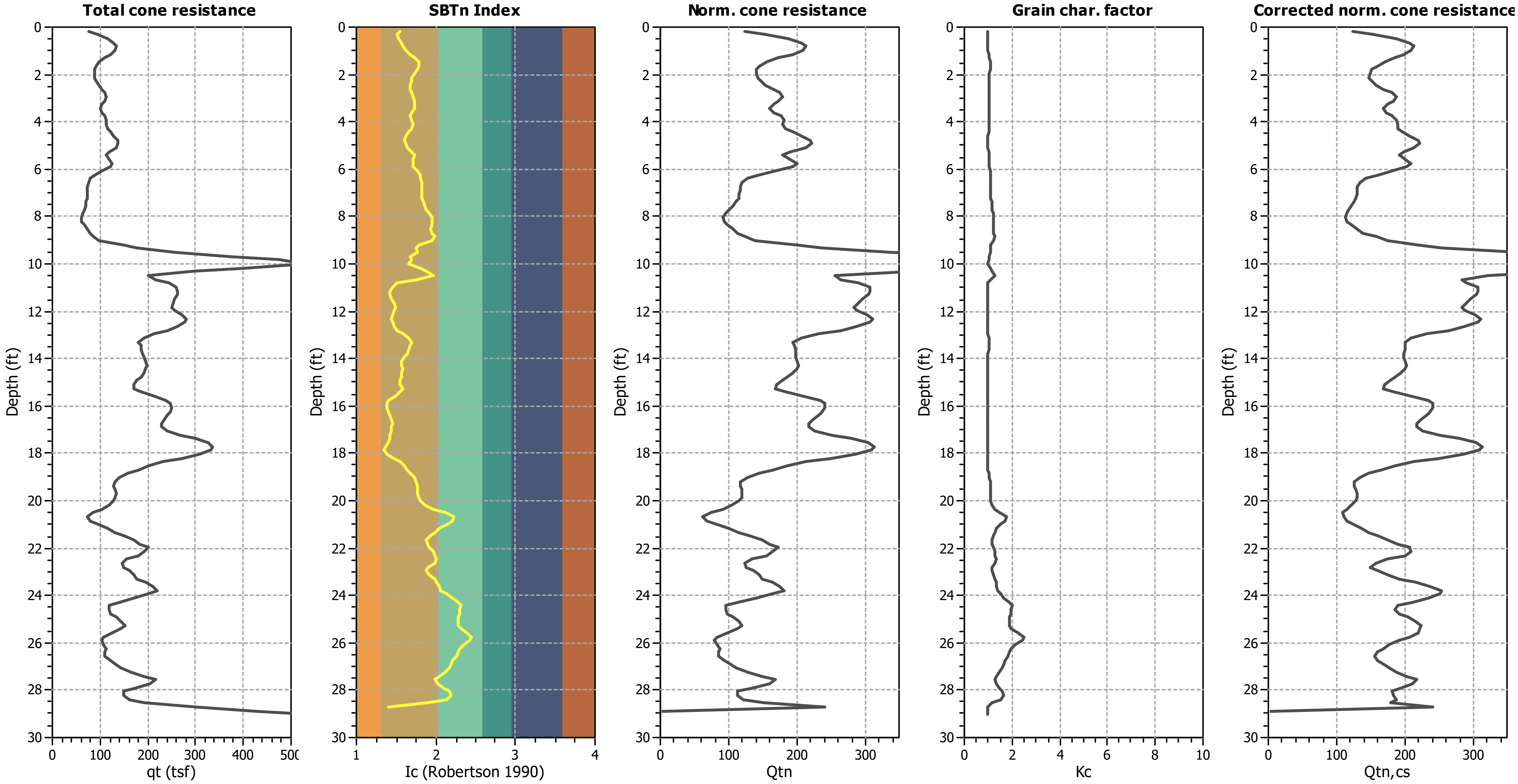
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

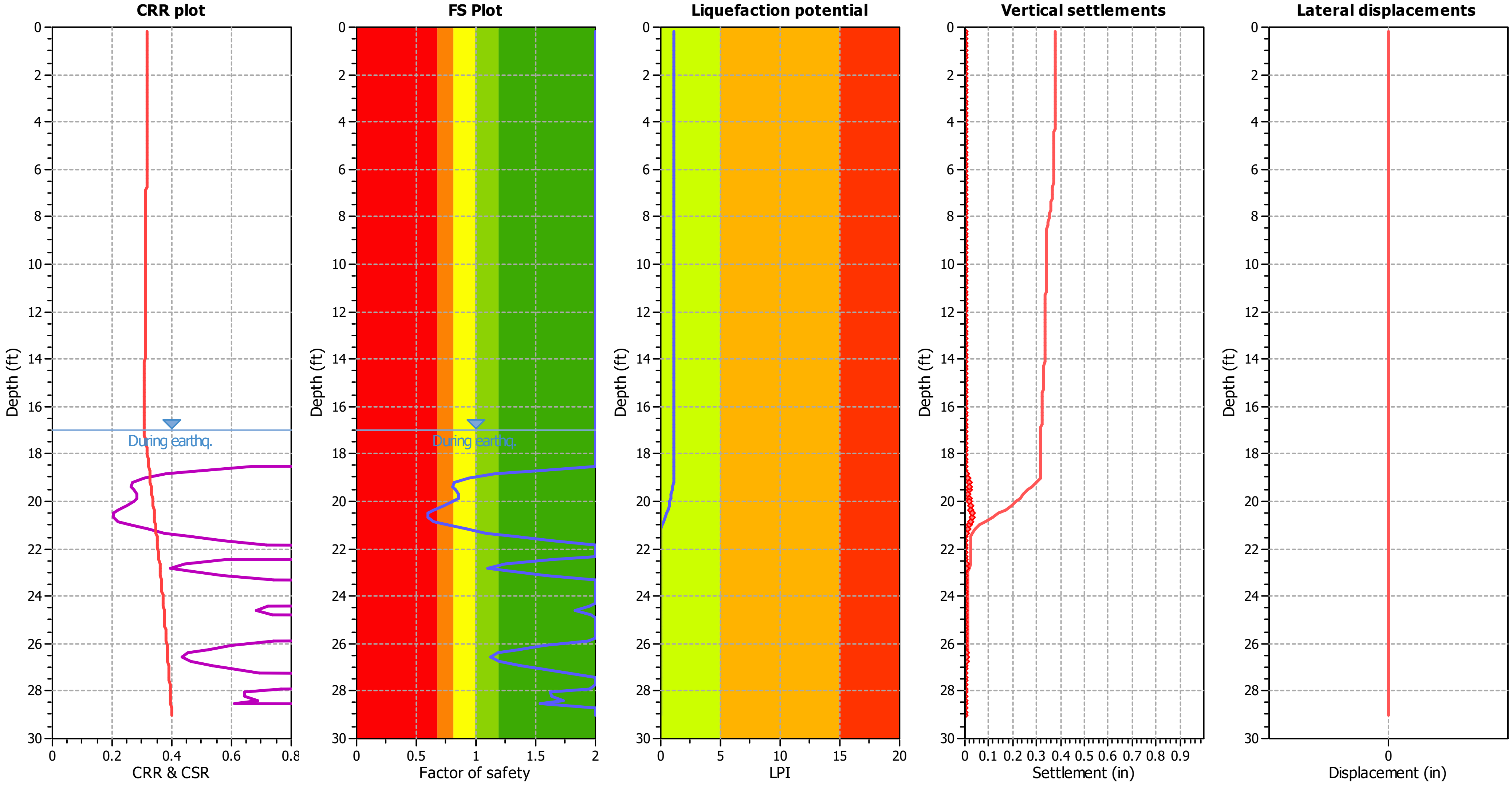
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	17.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	17.00 ft	Fill height:	N/A	Limit depth:	N/A

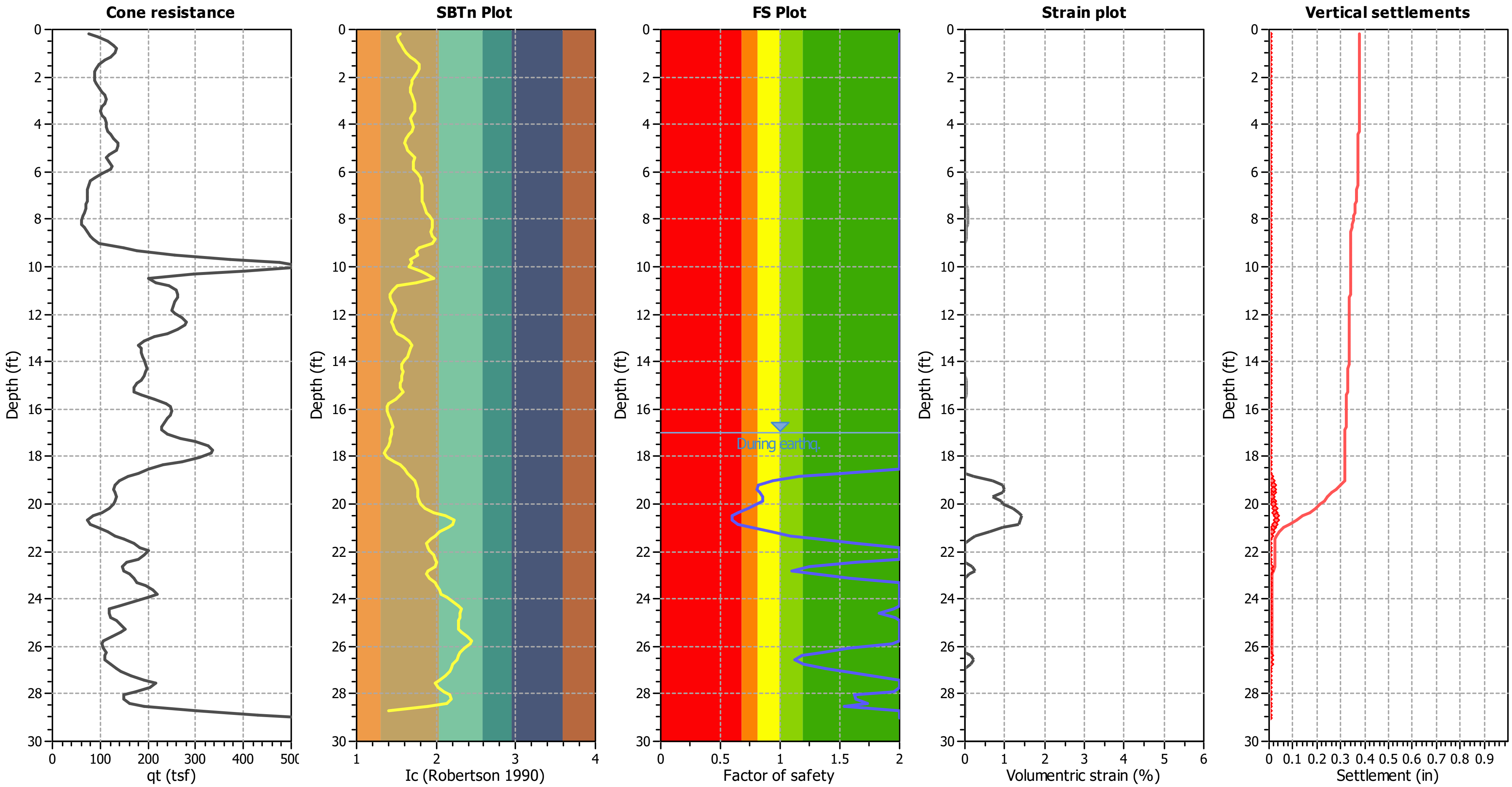
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

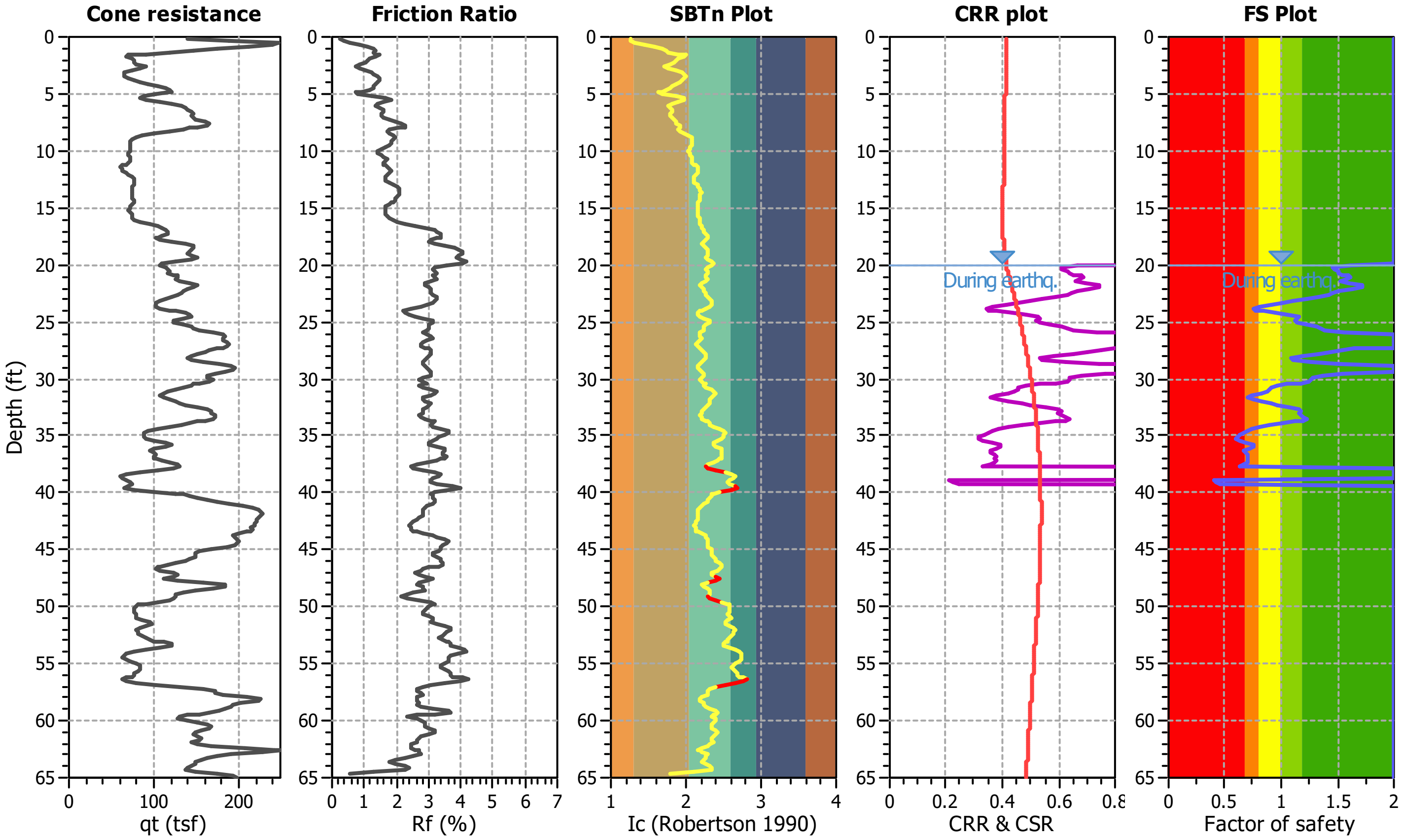
LIQUEFACTION ANALYSIS REPORT

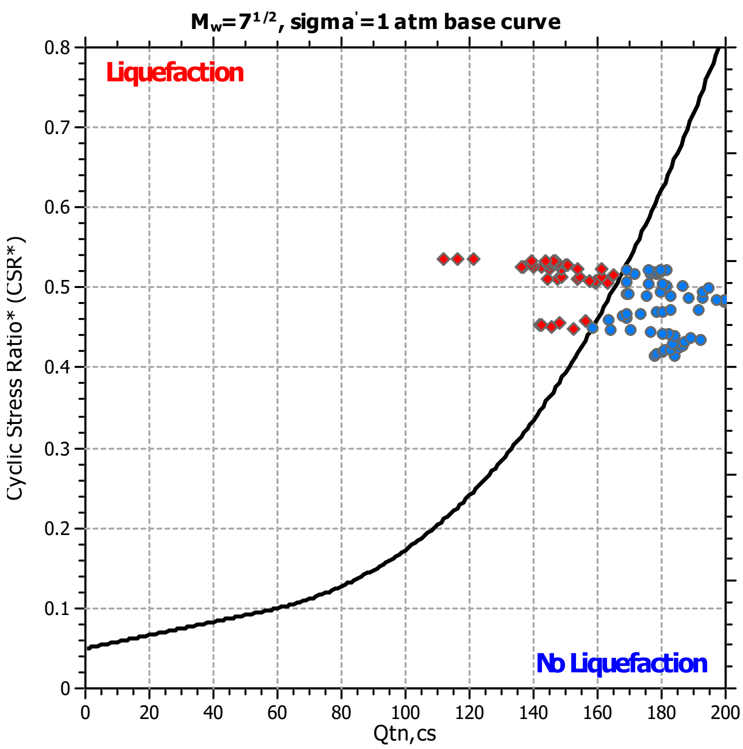
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

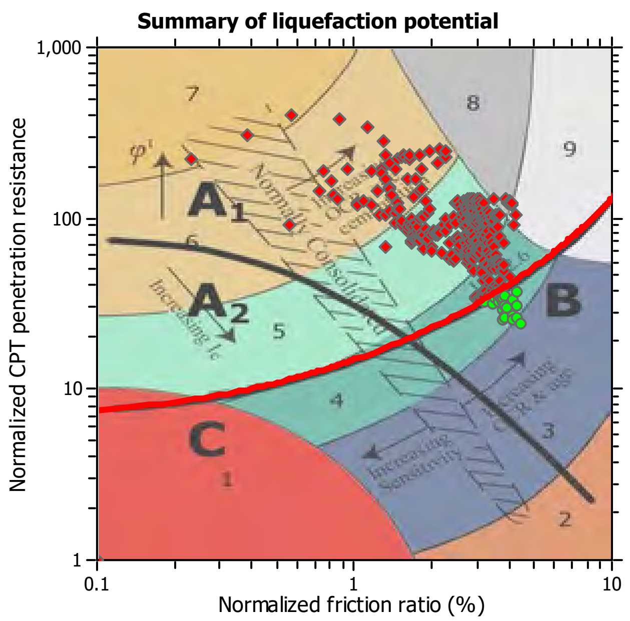
CPT file : SC-3

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	25.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	20.00 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	40.00 ft
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

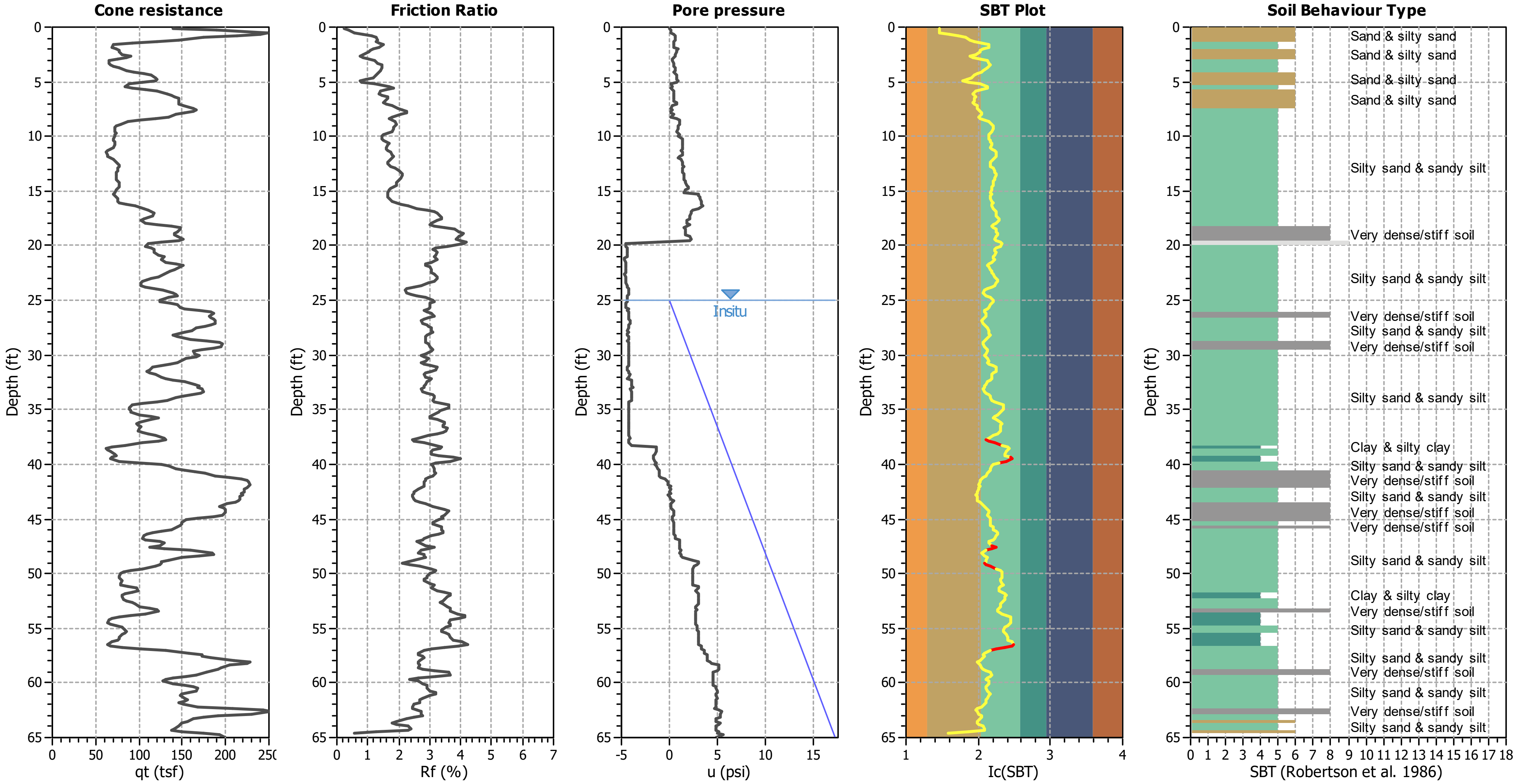






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



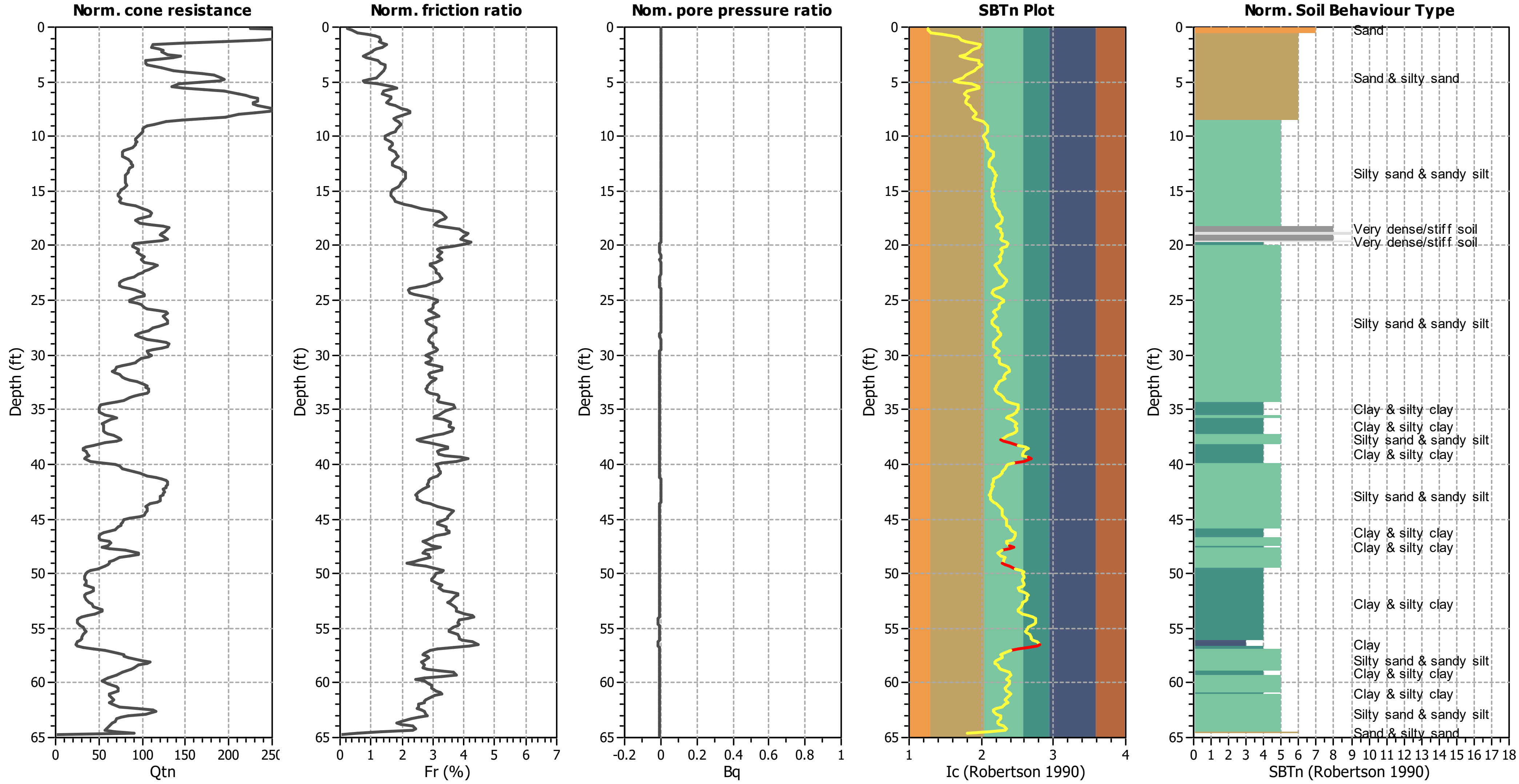
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A		
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes		
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only		
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes		
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft		

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



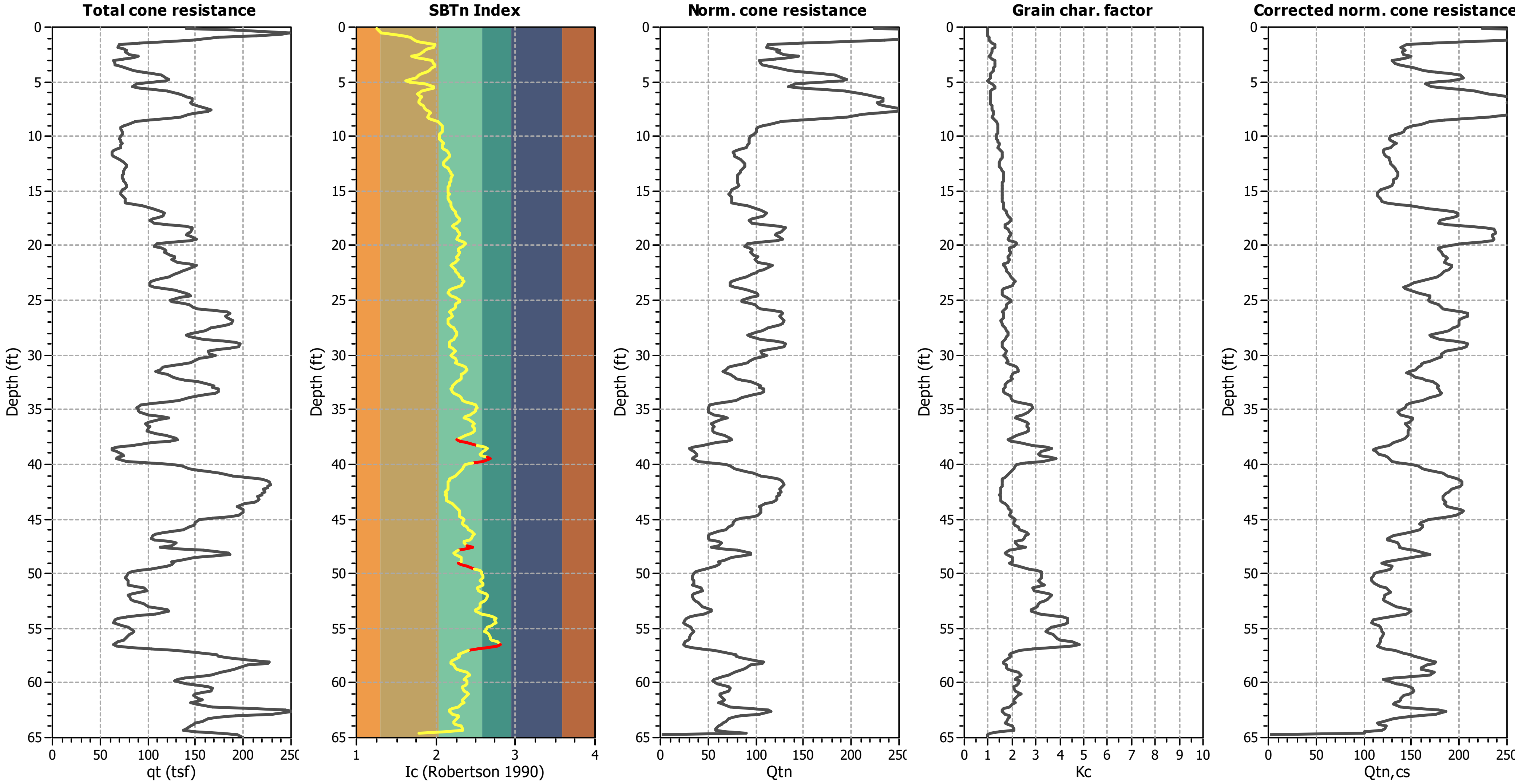
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

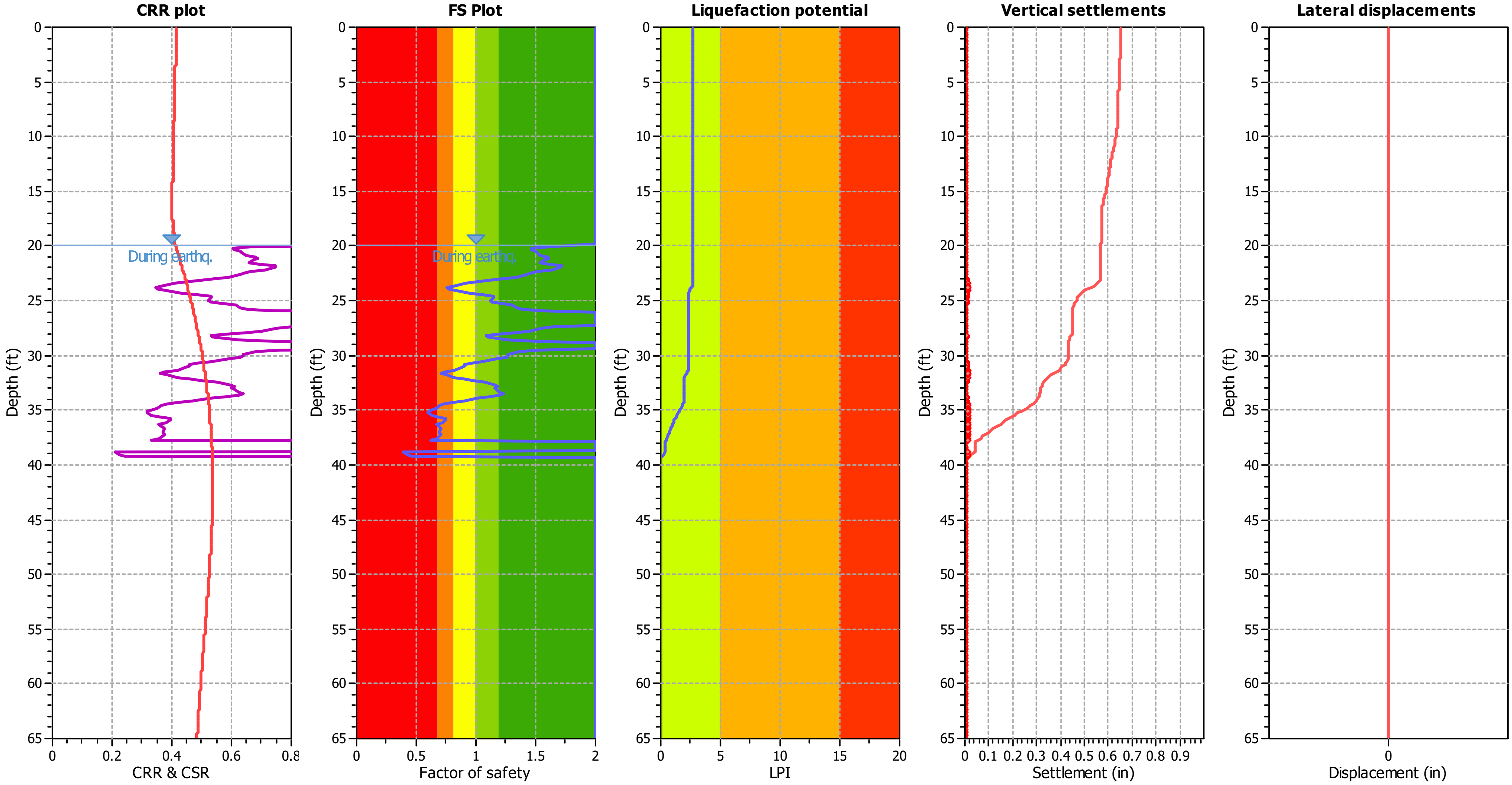
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	20.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	25.00 ft	Fill height:	N/A	Limit depth:	40.00 ft

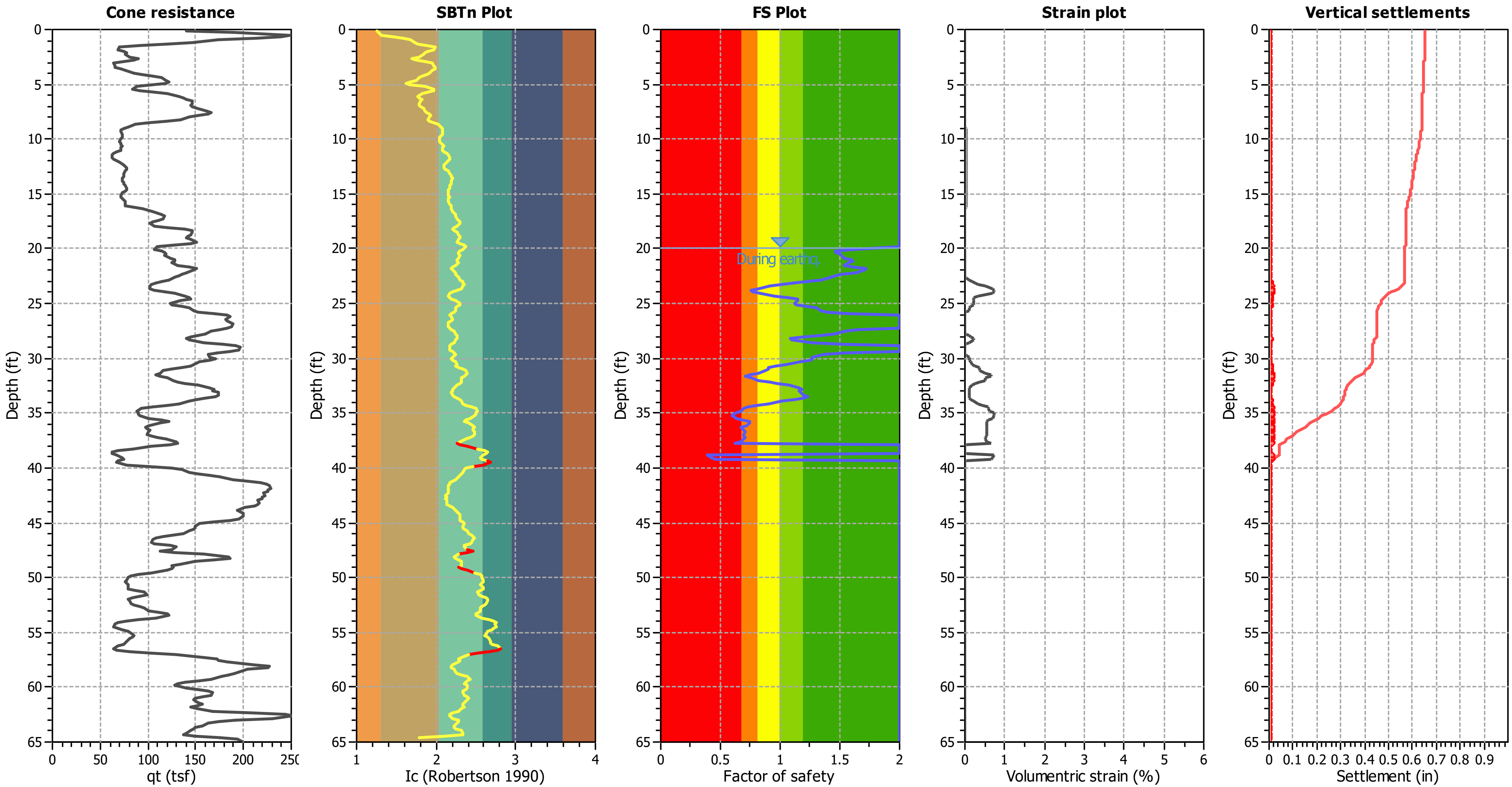
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

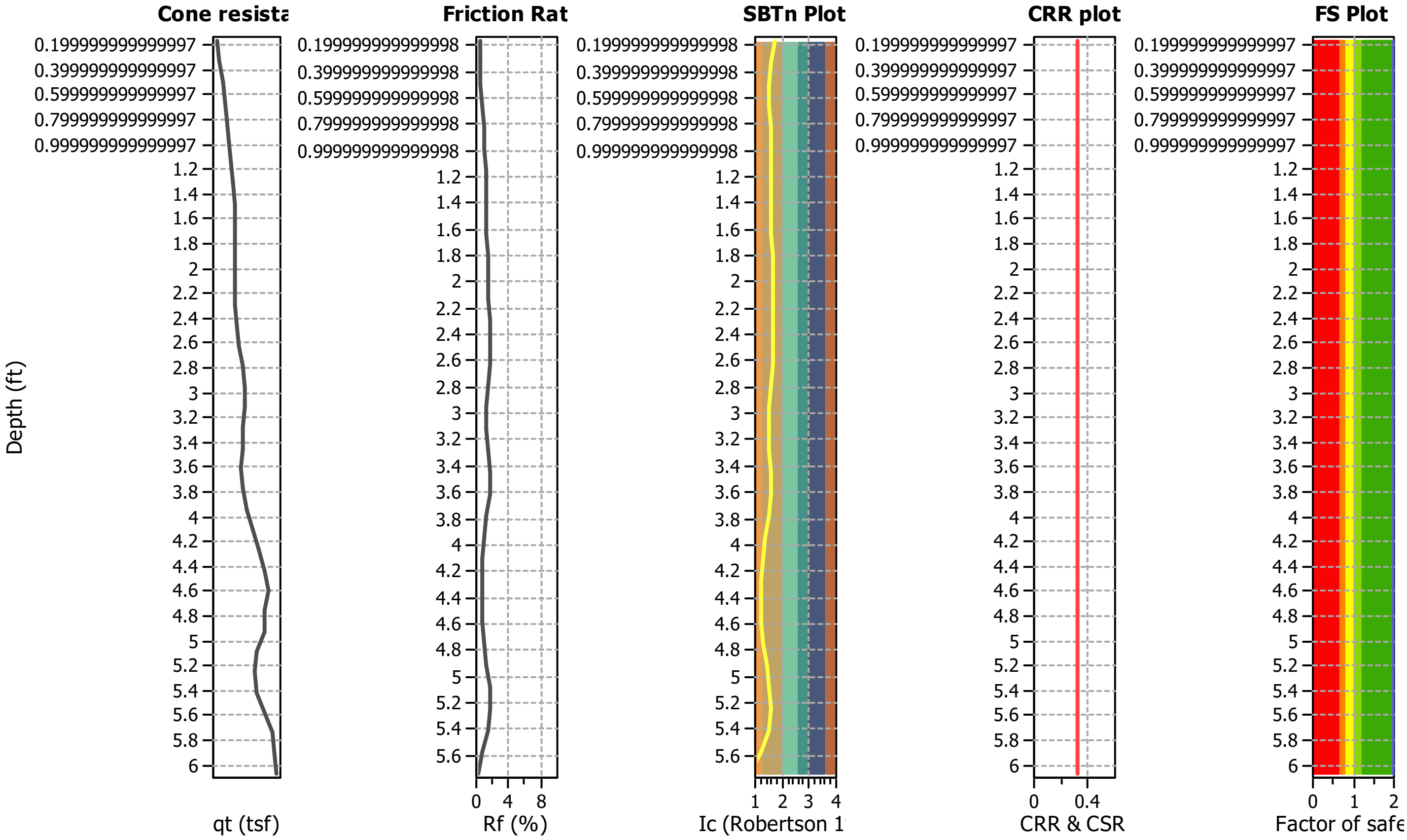
LIQUEFACTION ANALYSIS REPORT

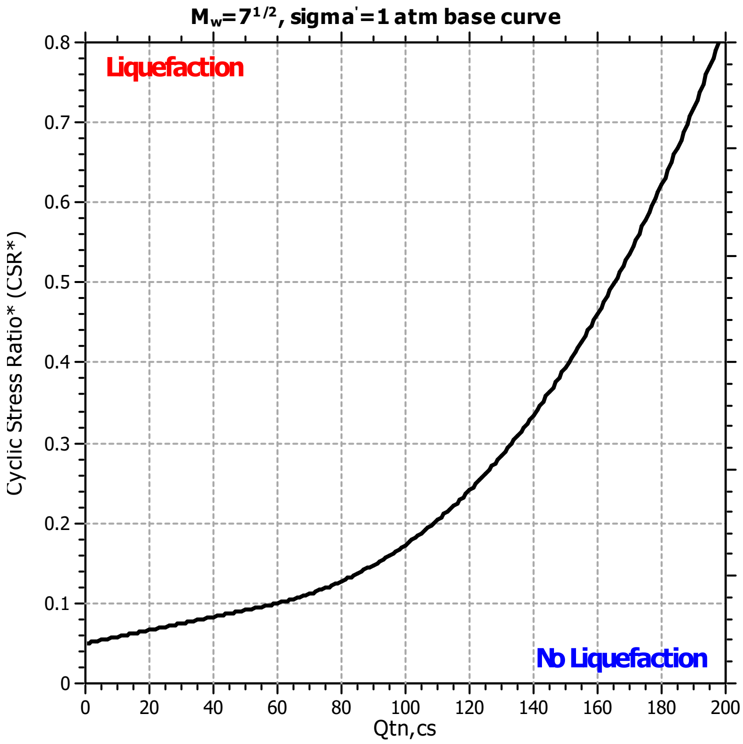
Project title : Brea Boulevard Corridor Improvements Project **Location : Orange County, California**

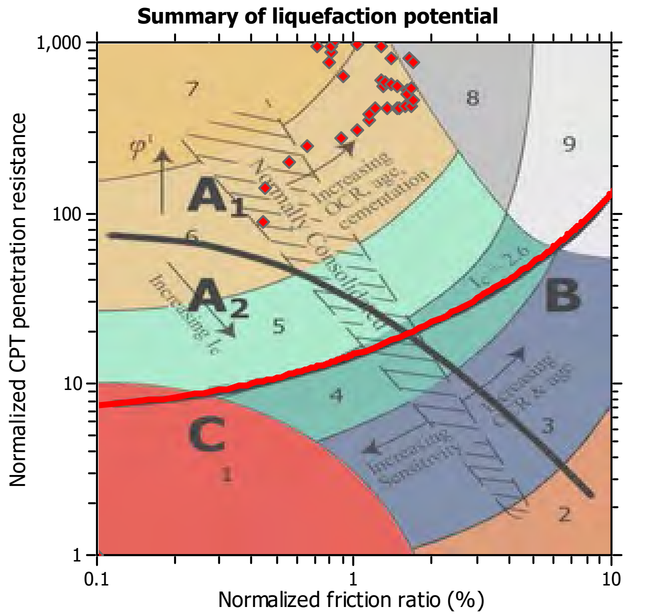
CPT file : SC-6

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	45.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	45.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.72	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.65	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

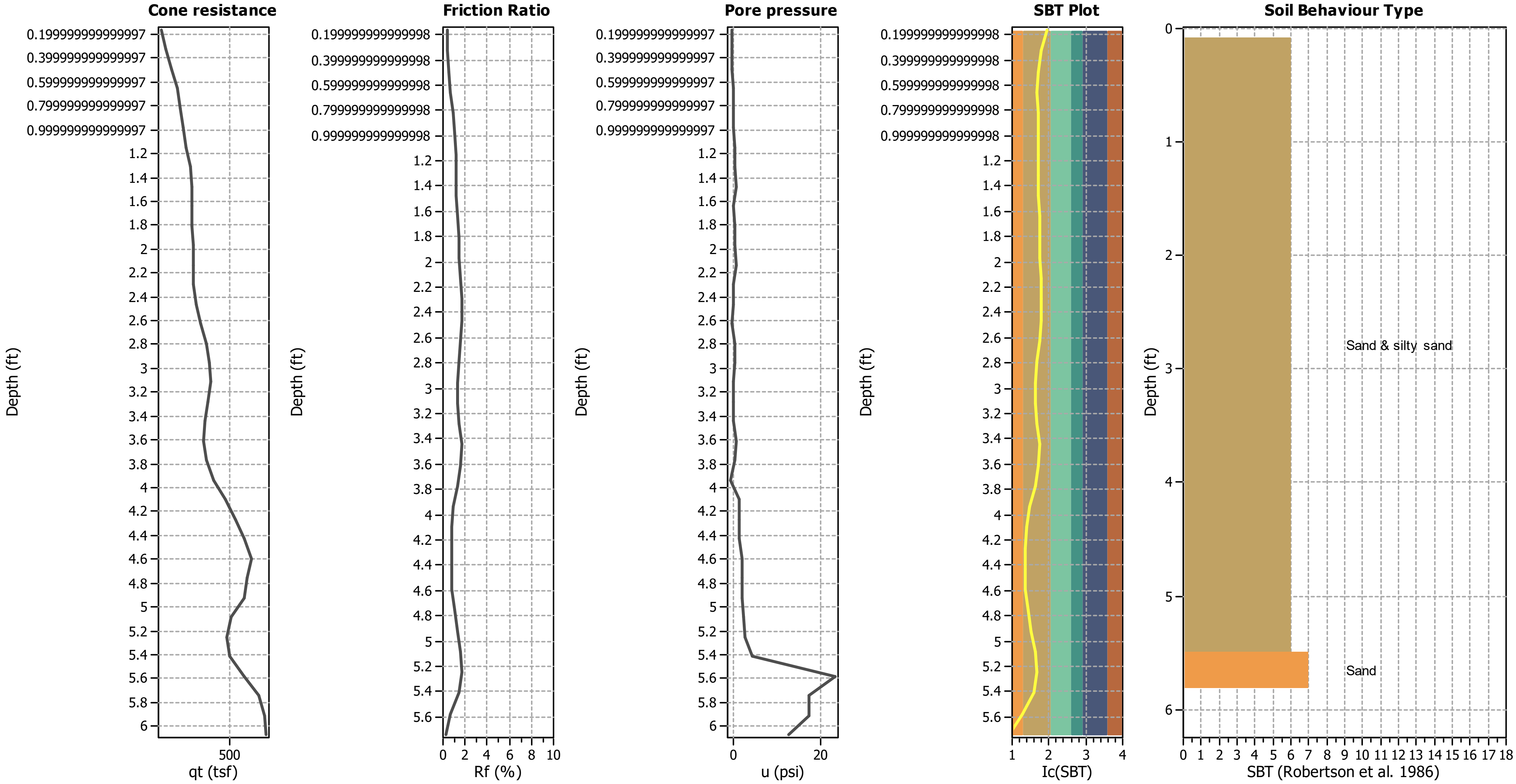






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



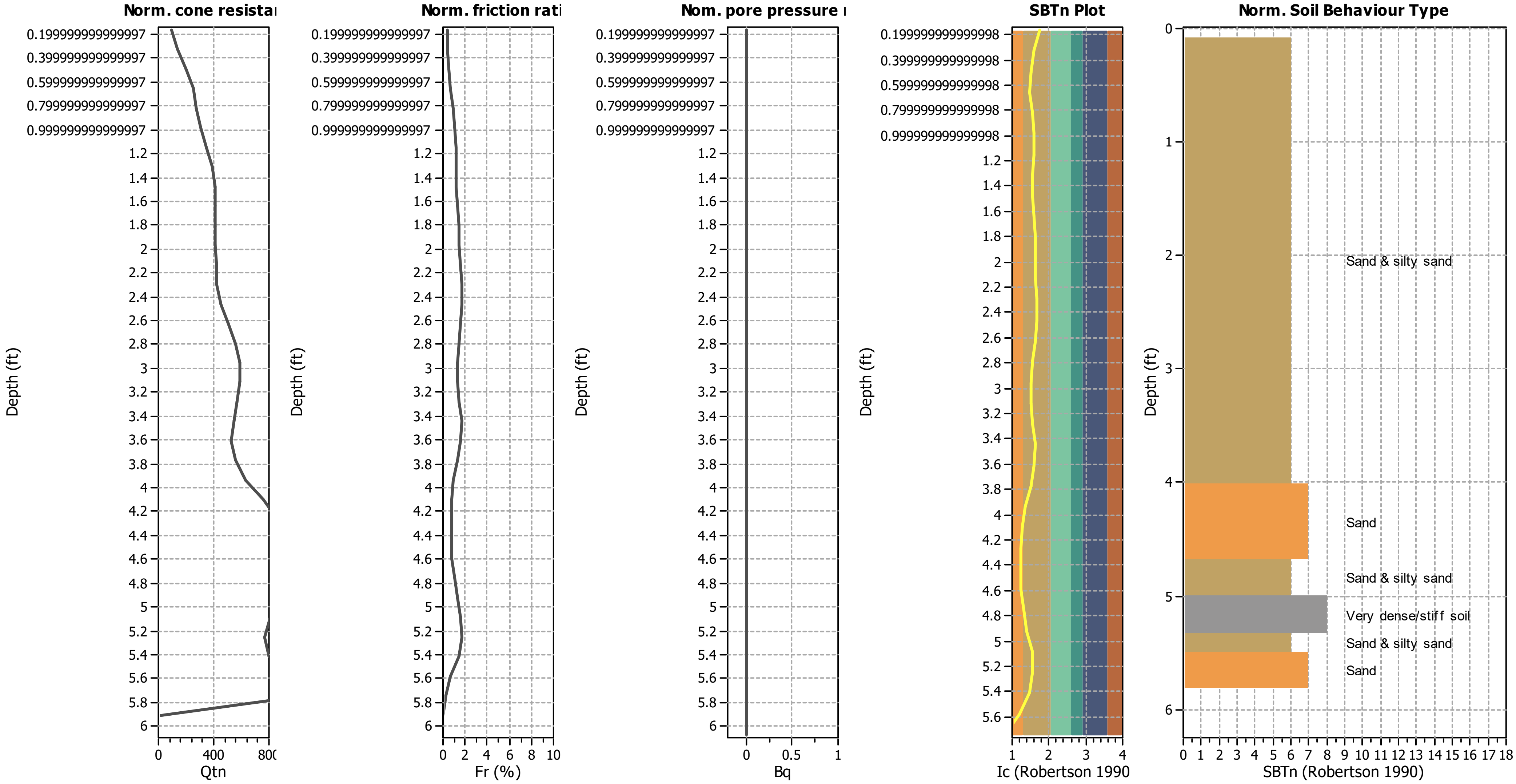
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



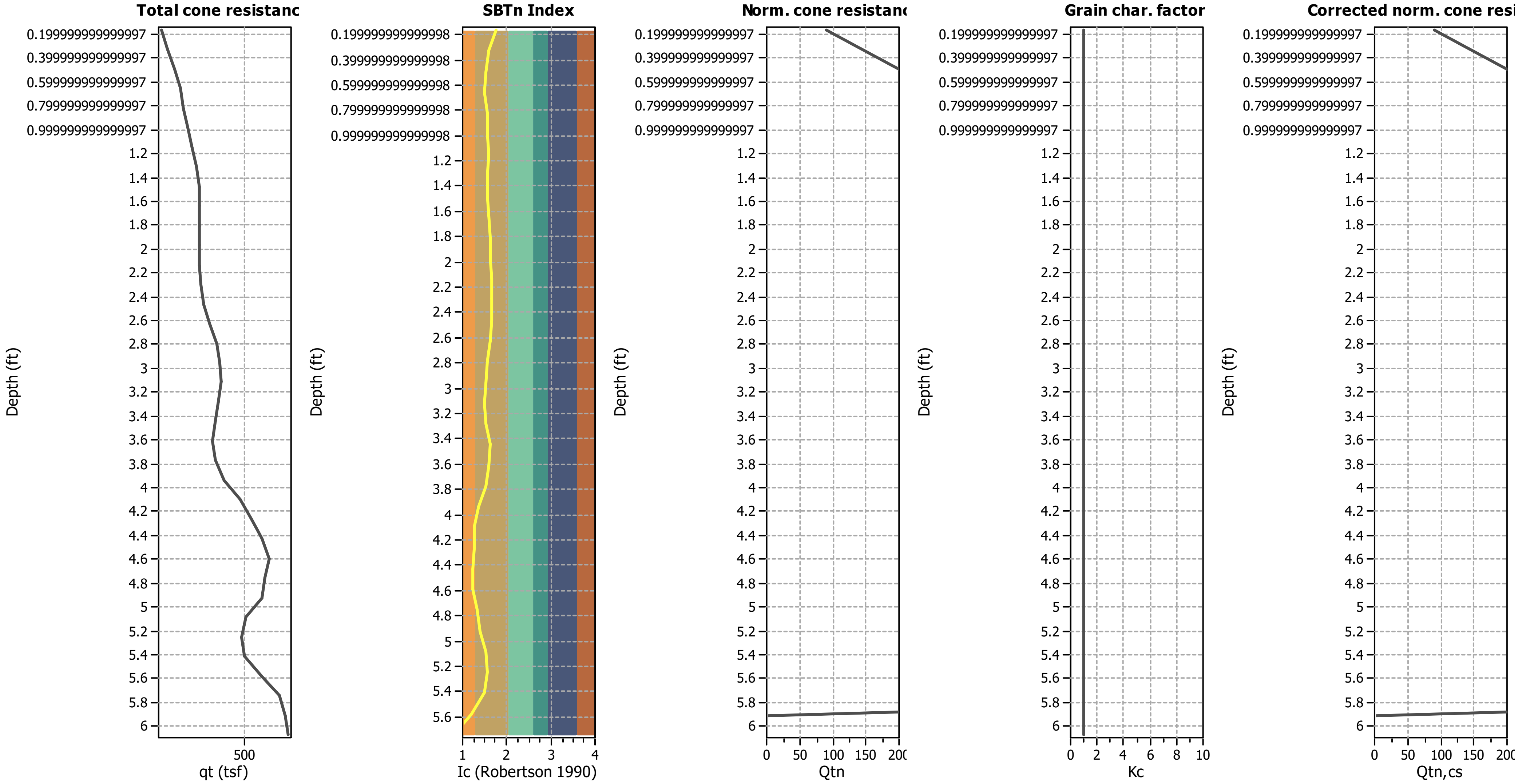
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

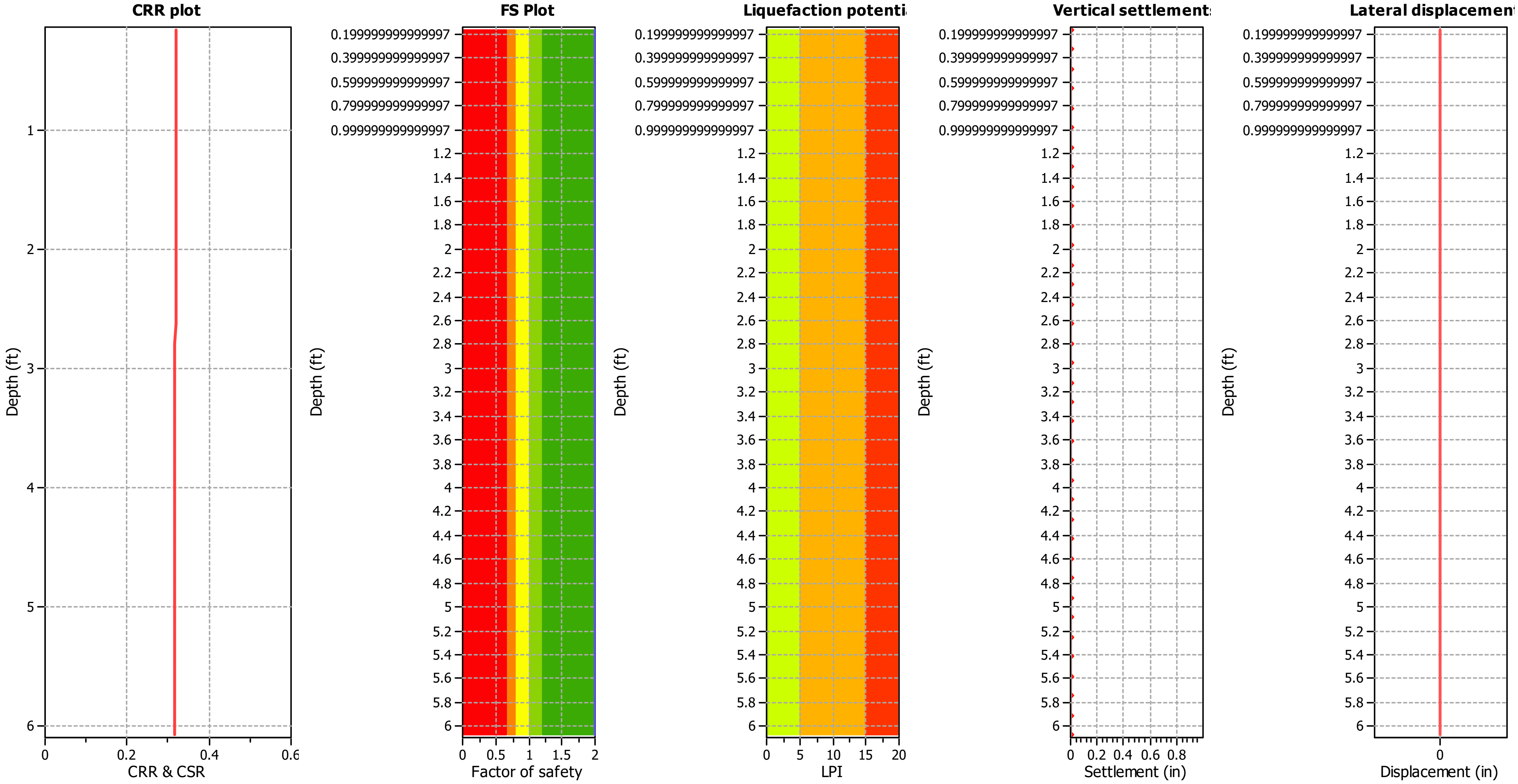
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	45.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.72	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.65	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	45.00 ft	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

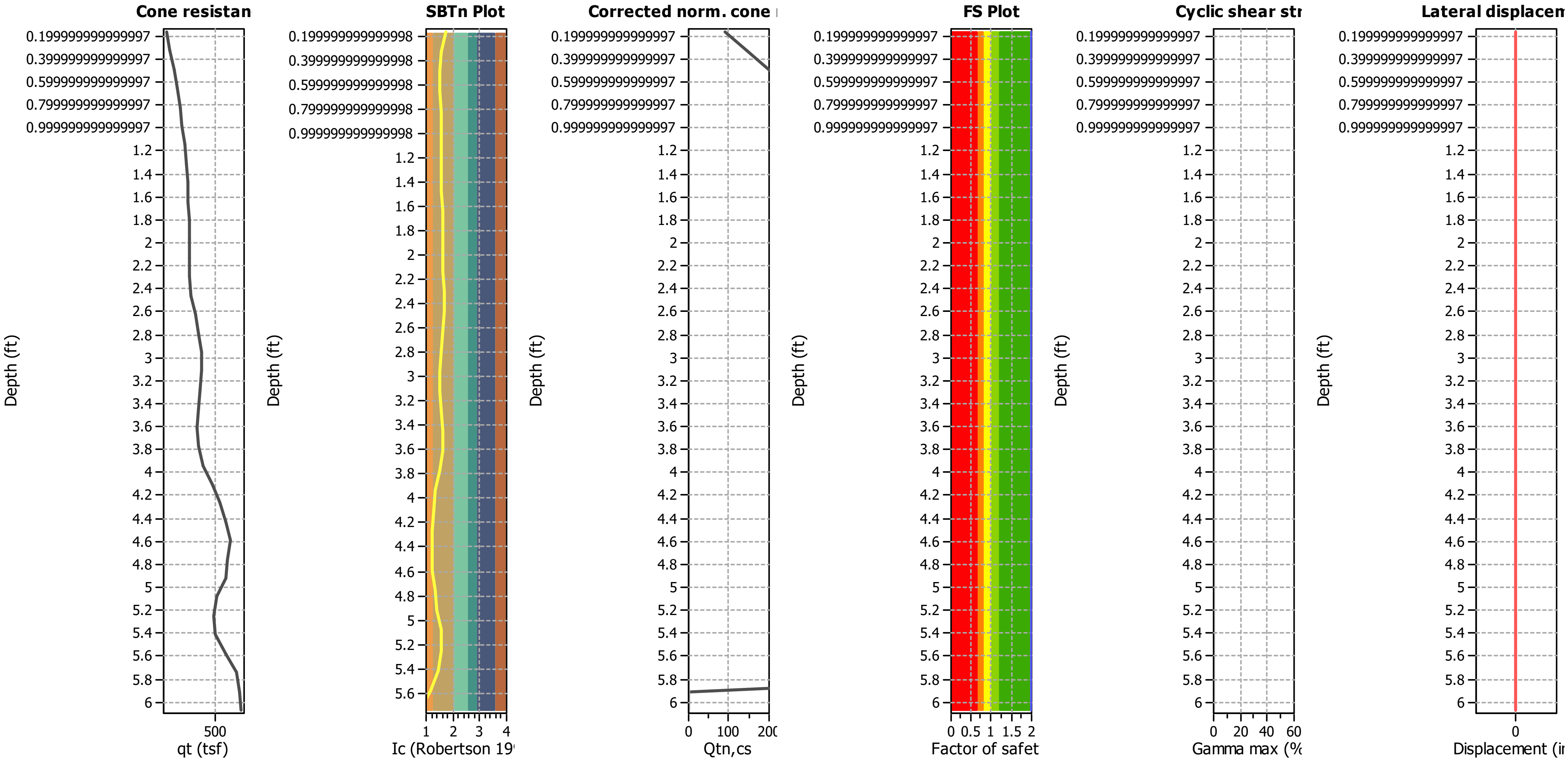
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Estimation of post-earthquake lateral Displacements

Geometric parameters: Gently sloping ground without free face (Slope 1.00 %)

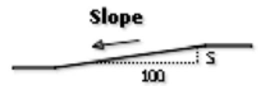


Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
$Q_{tn,cs}$: Equivalent clean sand normalized CPT total cone resistance

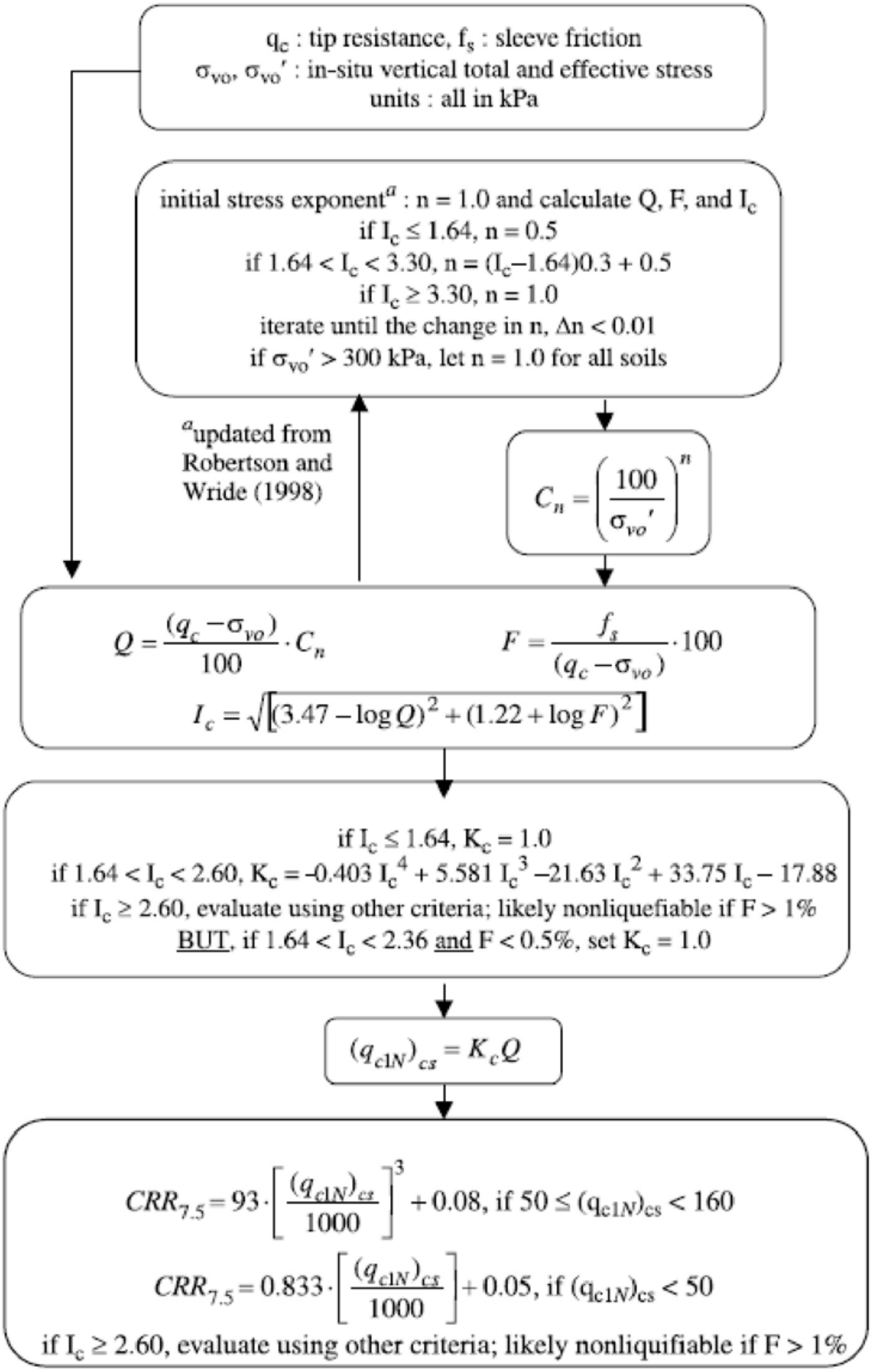
F.S.: Factor of safety
γ_{max}: Maximum cyclic shear strain
LDI: Lateral displacement index

Surface condition



Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

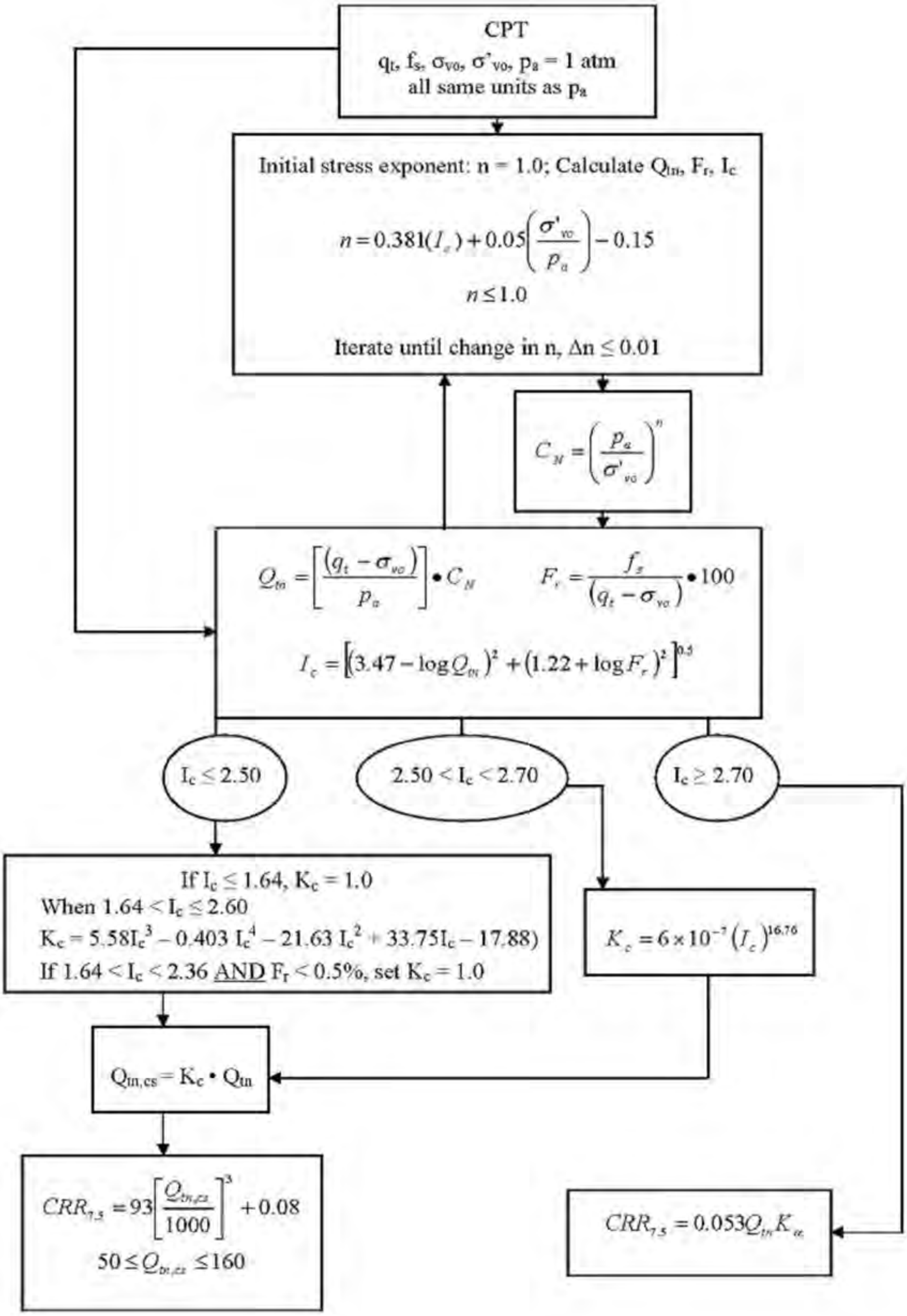
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

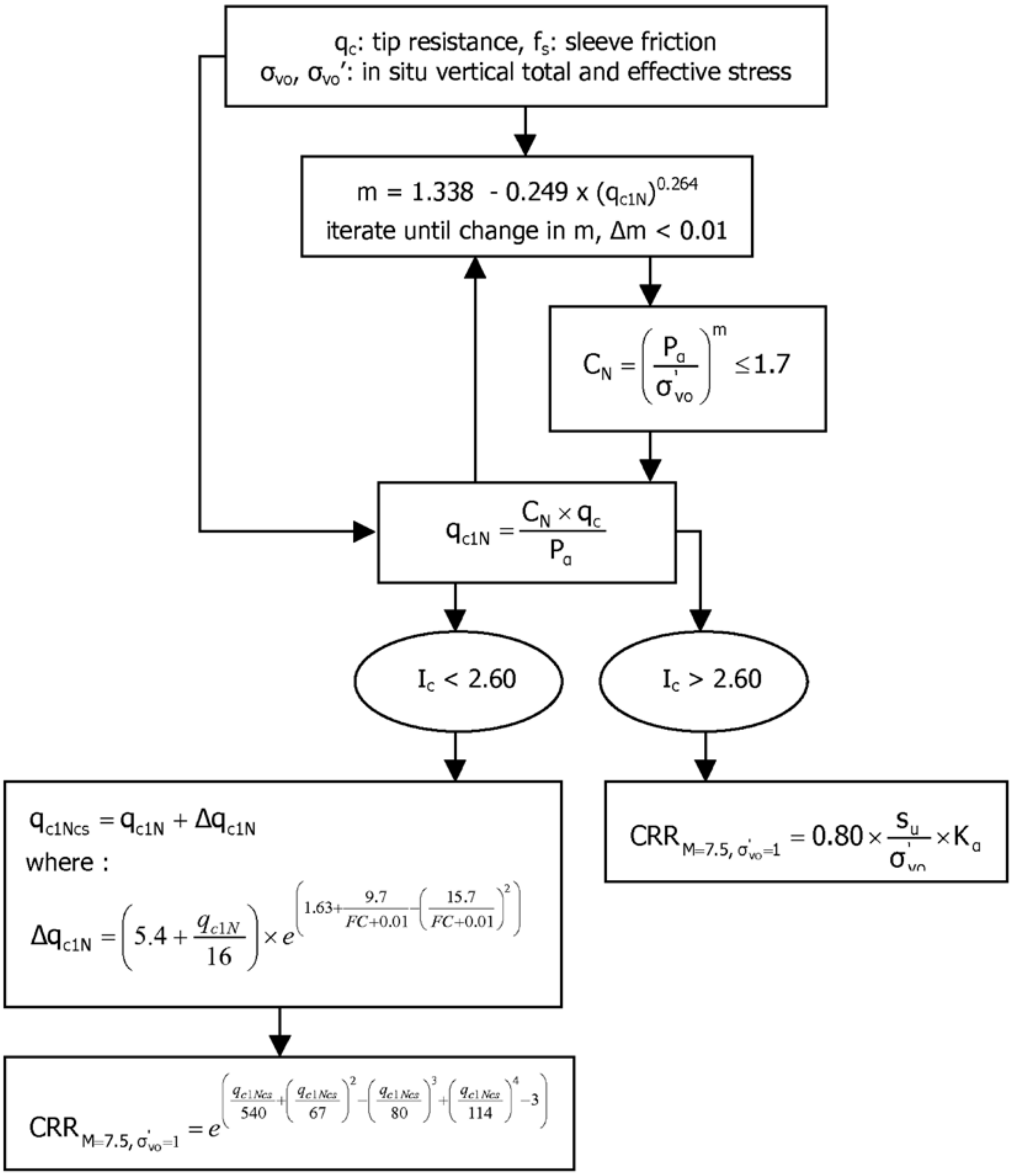
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

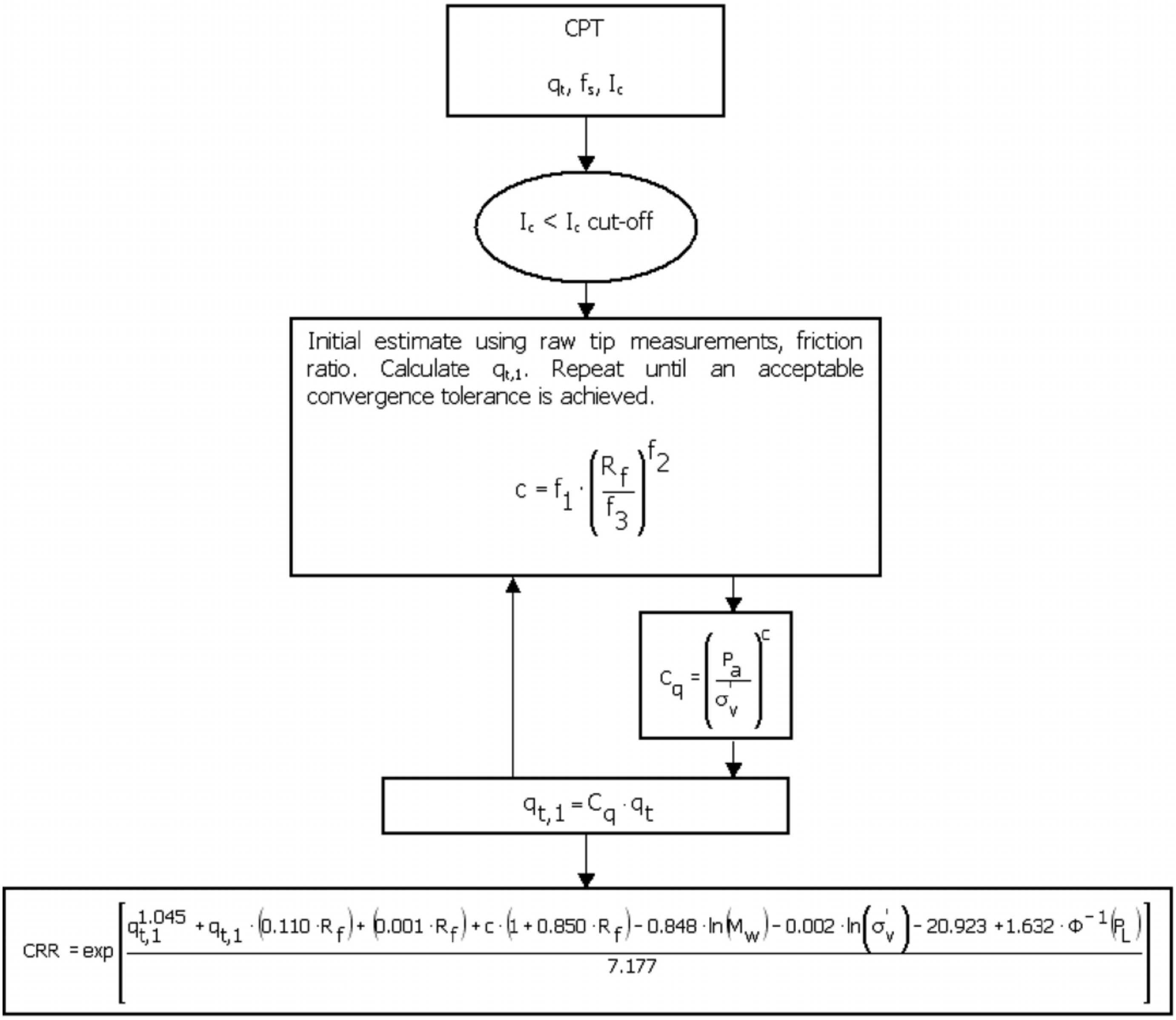


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65\frac{\sigma_v}{\sigma'_v}\frac{a_{max}}{g}r_d\frac{1}{MSF}\frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z)+\beta(z)\cdot M\right]$$

$$\alpha(z) = -1.012-1.126\sin\left(\frac{z}{11.73}+5.133\right)$$

$$\beta(z) = 0.106+0.118\sin\left(\frac{z}{11.28}+5.142\right)$$

$$K_\sigma = 1-C_\sigma\ln\left(\frac{\sigma'_v}{P_a}\right)\le 1.1$$

$$C_\sigma = \frac{1}{37.3-8.27\left(q_{c1Ncs}\right)^{0.264}}\le 0.3$$

$$MSF = 1+\left(MSF_{max}-1\right)\left(8.64\exp\left(\frac{-M}{4}\right)-1.325\right)$$

$$MSF_{max} = 1.09+\left(\frac{q_{c1Ncs}}{180}\right)^3\le 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113}+\left(\frac{q_{c1Ncs}}{1000}\right)^2-\left(\frac{q_{c1Ncs}}{140}\right)^3+\left(\frac{q_{c1Ncs}}{137}\right)^4-2.80\right)$$

$$q_{c1Ncs} = q_{c1N}+\Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9+\frac{q_{c1N}}{14.6}\right)\exp\left(1.63-\frac{9.7}{FC+2}-\left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_{Nq}\frac{q_c}{P_a}$$

$$C_{Nq} = \left(\frac{P_a}{\sigma'_v}\right)^m\le 1.7$$

$$m = 1.338-0.249\left(q_{c1Ncs}\right)^{0.264}\quad with\quad 0.264\le m\le 0.782$$

$$FC = 80\left(I_C+C_{FC}\right)-137\quad with\quad 0\%\le FC\le 100\%$$

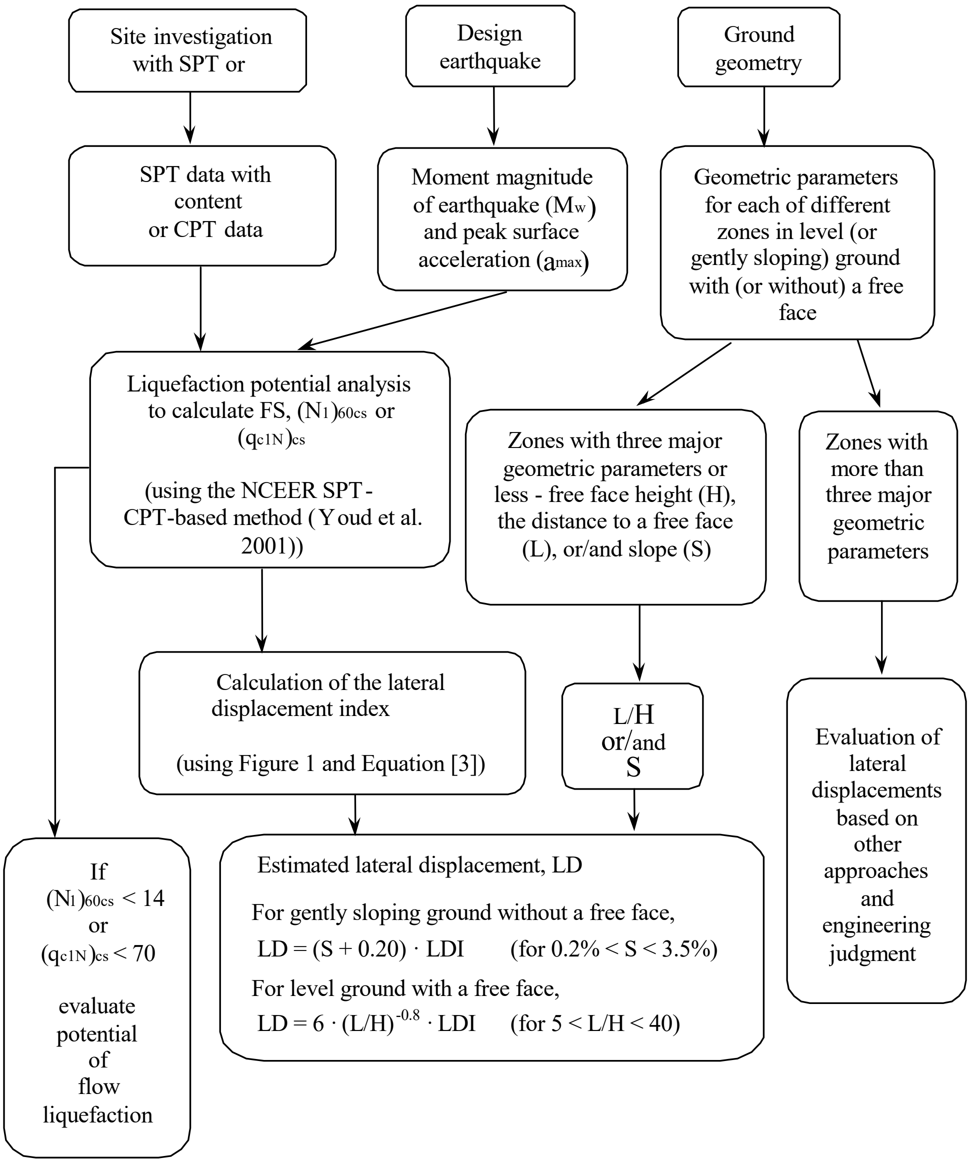
$$I_c = \left[\left(3.47-\log(Q)\right)^2+\left(1.22+\log(F)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c-\sigma_{vo}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vo}}\right)^n \text{ with } 0.5\le n\le 1.0 \text{ per Robertson \& Wride (1998)}$$

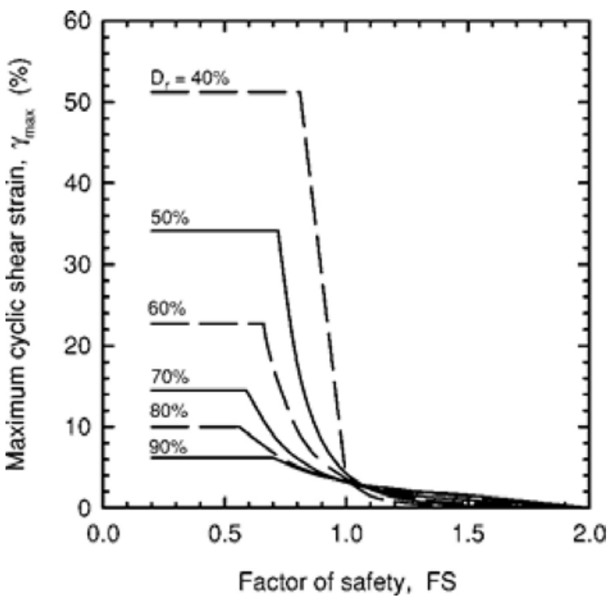
$$F = \left(\frac{f_s}{q_c-\sigma_{vo}}\right)\cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] **Figure 1**

$$LDI = \int_0^{Z_{max}} \gamma_{max} \, dz$$

[1] **Equation [3]**

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{a_{max}}{g} \cdot \sigma_{v0} \cdot \tau_{a}$$

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

Estimate shear strain amplitude, γ (based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0} \text{ (Note } \tau_{av} \text{ and } G_0 \text{ same units)}$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

Seismic settlement, s

$$s = 2 \cdot \int_{0}^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

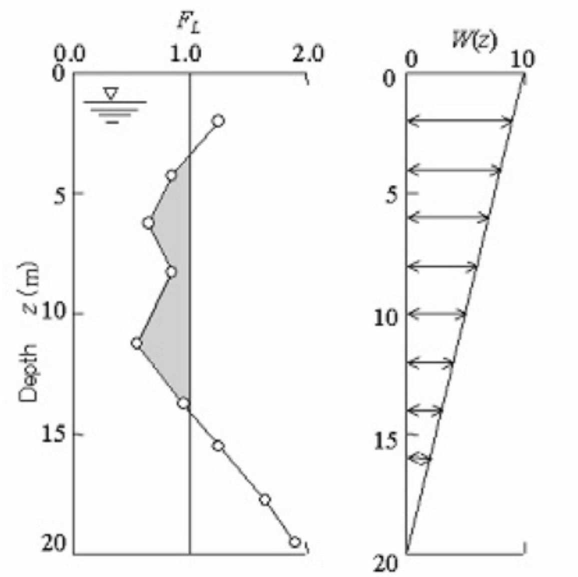
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\textbf{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$Ln(Ds) = c1 + c2 * LBS + 0.58 * Ln\left(Tanh\left(\frac{HL}{6}\right)\right) + 4.59 * Ln(Q) - 0.42 * Ln(Q)^2 - 0.02 * B + 0.84 * Ln(CAVdp) + 0.41 * Ln(Sa1) + \varepsilon$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for LBS ≤ 16, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0, W is a foundation-weighting factor wherein W = 0.0 for z less than Df, which is the embedment depth of the foundation, and W = 1.0 otherwise. The shear strain parameter (ε_shear) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

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Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

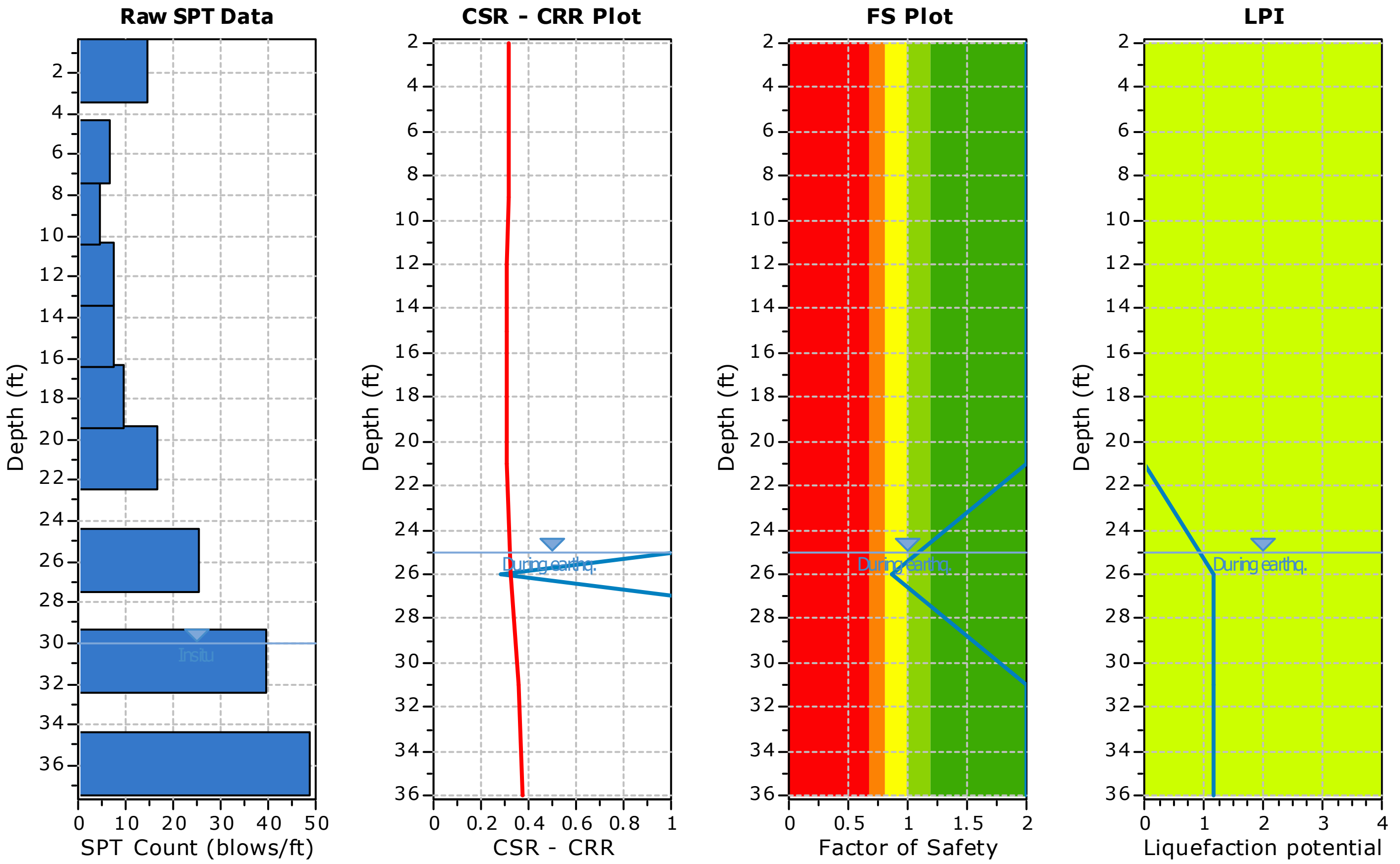
SPT BASED LIQUEFACTION ANALYSIS REPORT

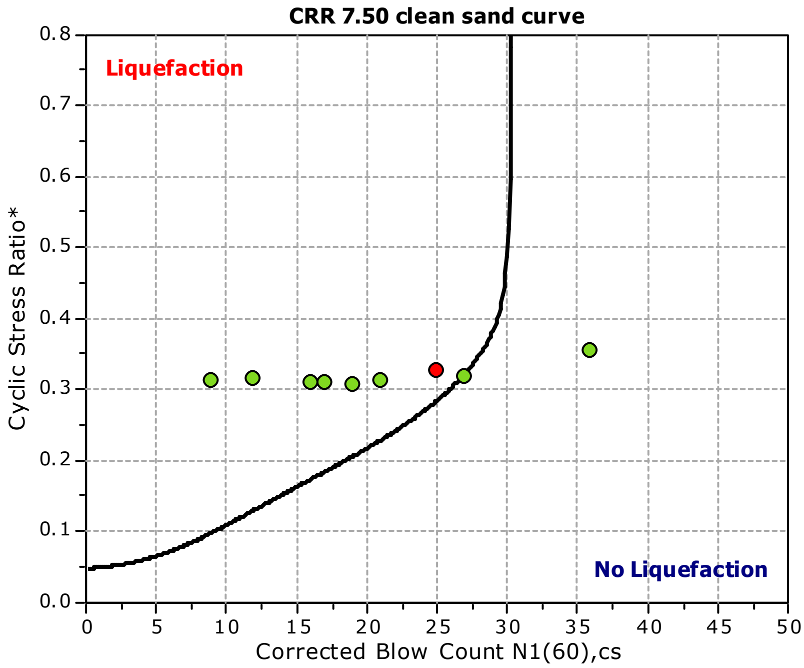
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-04**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	25.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





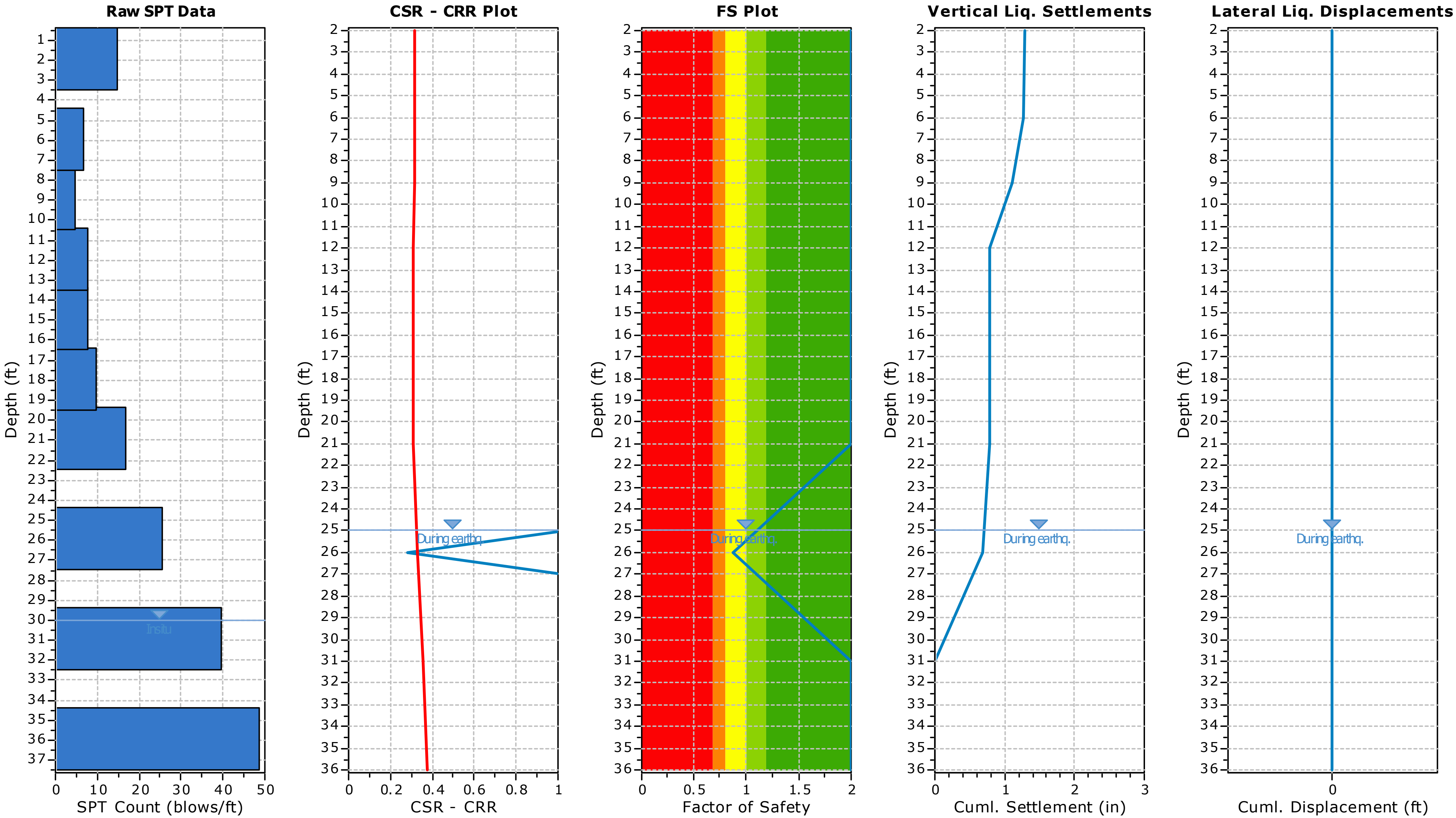
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	7	15.00	93.00	3.00	Yes
9.00	5	15.00	95.00	3.00	Yes
12.00	8	80.00	119.00	3.00	No
15.00	8	80.00	120.00	3.00	No
18.00	10	70.00	129.00	3.00	No
21.00	17	15.00	125.00	5.00	Yes
26.00	26	5.00	130.00	5.00	Yes
31.00	40	5.00	135.00	5.00	Yes
36.00	49	80.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	7	93.00	0.31	0.00	0.31	1.48	1.20	1.00	0.75	1.00	9	15.00	2.50	1.05	12	4.000
9.00	5	95.00	0.45	0.00	0.45	1.35	1.20	1.00	0.75	1.00	6	15.00	2.50	1.05	9	4.000
12.00	8	119.00	0.63	0.00	0.63	1.23	1.20	1.00	0.85	1.00	10	80.00	5.00	1.20	17	4.000
15.00	8	120.00	0.81	0.00	0.81	1.12	1.20	1.00	0.85	1.00	9	80.00	5.00	1.20	16	4.000
18.00	10	129.00	1.00	0.00	1.00	1.03	1.20	1.00	0.95	1.00	12	70.00	5.00	1.20	19	4.000
21.00	17	125.00	1.19	0.00	1.19	0.95	1.20	1.00	0.95	1.00	18	15.00	2.50	1.05	21	4.000
26.00	26	130.00	1.51	0.00	1.51	0.84	1.20	1.00	0.95	1.00	25	5.00	0.00	1.00	25	0.285
31.00	40	135.00	1.85	0.03	1.82	0.75	1.20	1.00	1.00	1.00	36	5.00	0.00	1.00	36	4.000
36.00	49	130.00	2.18	0.19	1.99	0.71	1.20	1.00	1.00	1.00	42	80.00	5.00	1.20	55	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	93.00	0.31	0.00	0.31	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR*	FS	
9.00	95.00	0.45	0.00	0.45	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
12.00	119.00	0.63	0.00	0.63	0.97	1.00	0.412	1.32	0.311	1.00	0.311	2.000	●
15.00	120.00	0.81	0.00	0.81	0.97	1.00	0.409	1.32	0.309	1.00	0.309	2.000	●
18.00	129.00	1.00	0.00	1.00	0.96	1.00	0.406	1.32	0.307	1.00	0.307	2.000	●
21.00	125.00	1.19	0.00	1.19	0.95	1.00	0.403	1.32	0.304	0.98	0.312	2.000	●
26.00	130.00	1.51	0.03	1.48	0.94	1.00	0.405	1.32	0.306	0.93	0.327	0.872	●
31.00	135.00	1.85	0.19	1.66	0.92	1.00	0.430	1.32	0.325	0.91	0.356	2.000	●
36.00	130.00	2.18	0.34	1.83	0.88	1.00	0.443	1.32	0.335	0.90	0.374	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
12.00	2.000	0.00	8.17	3.00	0.00
15.00	2.000	0.00	7.71	3.00	0.00
18.00	2.000	0.00	7.26	3.00	0.00
21.00	2.000	0.00	6.80	3.00	0.00
26.00	0.872	0.13	6.04	5.00	1.18
31.00	2.000	0.00	5.28	5.00	0.00
36.00	2.000	0.00	4.51	5.00	0.00

Overall potential I_L : 1.18

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	9	0.13	0.21	463.38	0.14	13024.08	0.00	0.00	8.77	0.21	3.00	0.150
9.00	6	0.19	0.30	509.69	0.14	10354.34	0.00	0.01	8.77	0.47	3.00	0.338
12.00	10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
15.00	9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
18.00	12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
21.00	18	0.48	0.80	1100.25	0.17	5771.52	0.00	0.00	8.77	0.09	5.00	0.102

Cumulative settlemetns: 0.620

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
26.00	0.00	5.00	1.13	5.00	0.676
31.00	0.00	5.00	0.00	5.00	0.000
36.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.676

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	9	42.00	0.00	3.00	0.000	0.00
9.00	6	34.29	0.00	3.00	0.000	0.00
12.00	10	44.27	0.00	3.00	0.000	0.00
15.00	9	42.00	0.00	3.00	0.000	0.00
18.00	12	48.50	0.00	3.00	0.000	0.00
21.00	18	59.40	0.00	5.00	0.000	0.00
26.00	25	70.00	4.76	5.00	0.000	0.00
31.00	36	84.00	0.00	5.00	0.000	0.00
36.00	42	90.73	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

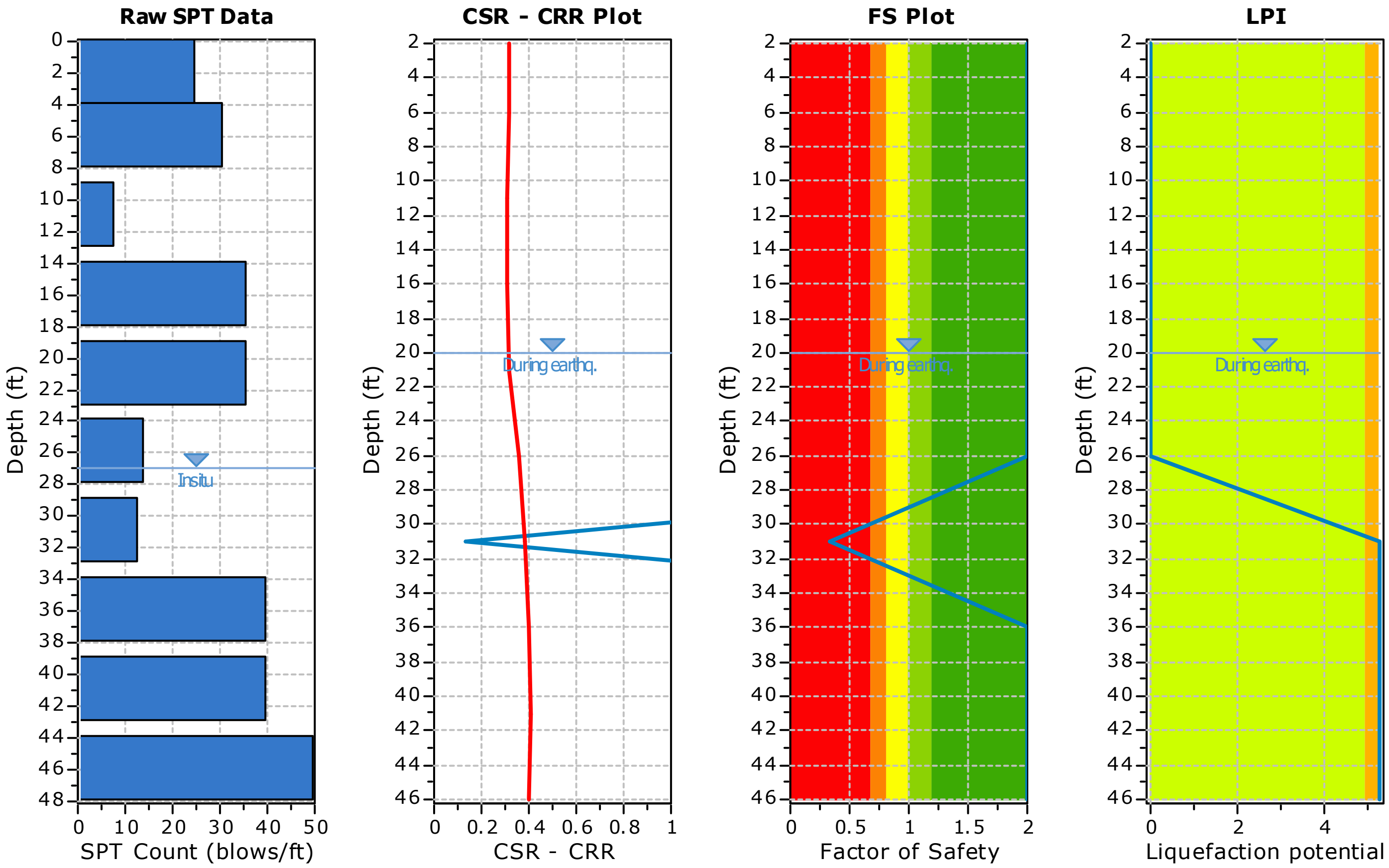
SPT BASED LIQUEFACTION ANALYSIS REPORT

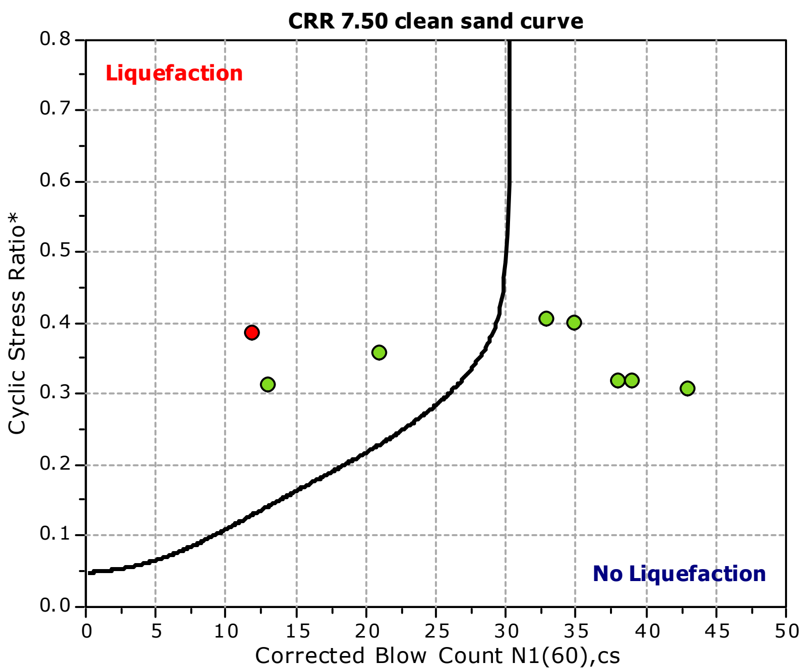
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-14**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	27.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

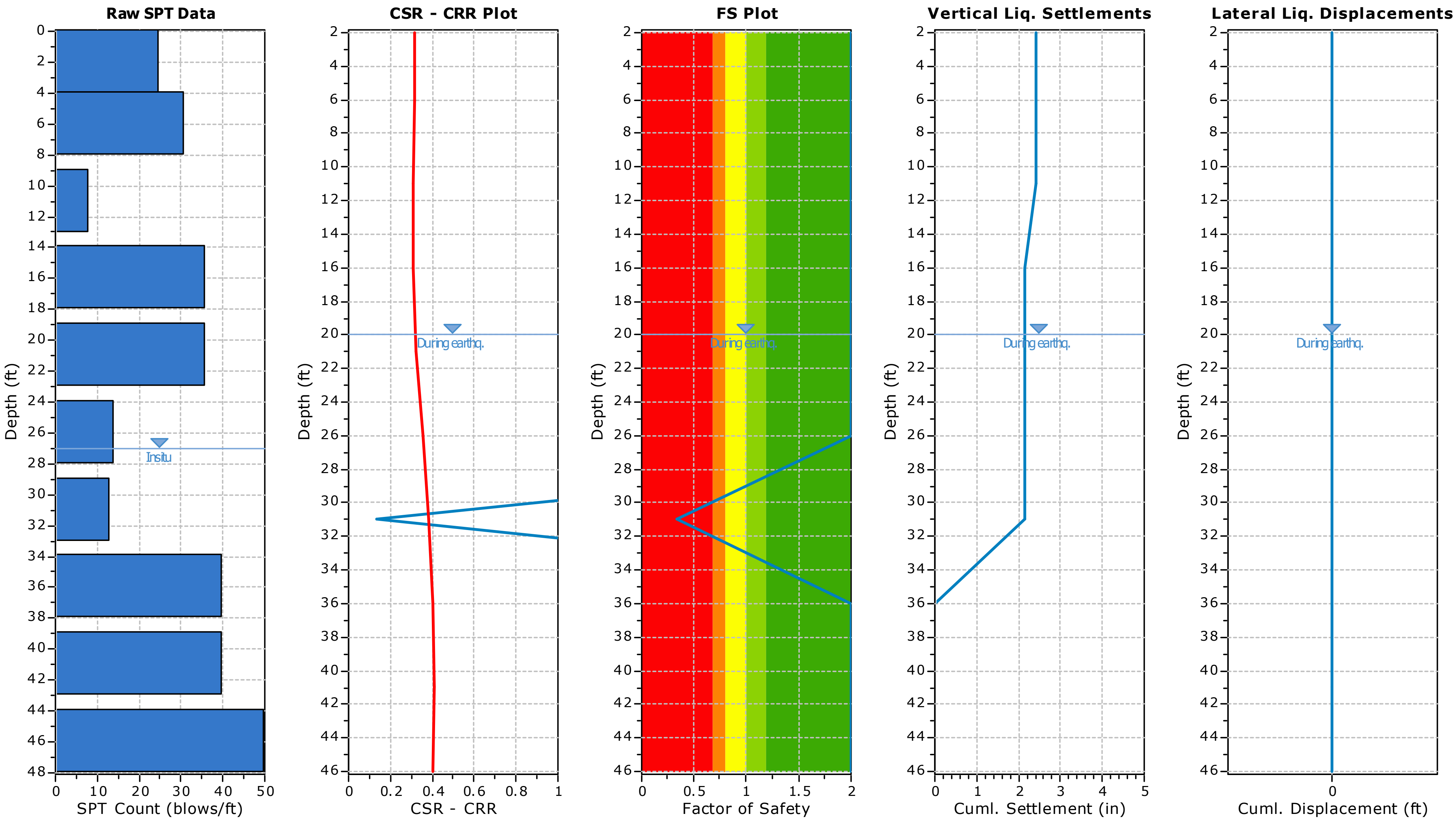




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	5.00	125.00	5.00	No
6.00	31	35.00	134.00	5.00	Yes
11.00	8	15.00	100.00	5.00	Yes
16.00	36	15.00	111.00	5.00	Yes
21.00	36	5.00	114.00	5.00	Yes
26.00	14	80.00	127.00	5.00	No
31.00	13	5.00	120.00	5.00	Yes
36.00	40	5.00	135.00	5.00	Yes
41.00	40	5.00	137.00	4.00	Yes
46.00	50	75.00	130.00	6.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	5.00	0.00	1.00	38	4.000
6.00	31	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	39	35.00	5.00	1.20	52	4.000
11.00	8	100.00	0.64	0.00	0.64	1.22	1.20	1.00	0.85	1.00	10	15.00	2.50	1.05	13	4.000
16.00	36	111.00	0.92	0.00	0.92	1.06	1.20	1.00	0.85	1.00	39	15.00	2.50	1.05	43	4.000
21.00	36	114.00	1.21	0.00	1.21	0.94	1.20	1.00	0.95	1.00	39	5.00	0.00	1.00	39	4.000
26.00	14	127.00	1.52	0.00	1.52	0.83	1.20	1.00	0.95	1.00	13	80.00	5.00	1.20	21	4.000
31.00	13	120.00	1.82	0.12	1.70	0.78	1.20	1.00	1.00	1.00	12	5.00	0.00	1.00	12	0.131
36.00	40	135.00	2.16	0.28	1.88	0.74	1.20	1.00	1.00	1.00	35	5.00	0.00	1.00	35	4.000
41.00	40	137.00	2.50	0.44	2.07	0.70	1.20	1.00	1.00	1.00	33	5.00	0.00	1.00	33	4.000
46.00	50	130.00	2.83	0.59	2.24	0.66	1.20	1.00	1.00	1.00	40	75.00	5.00	1.20	53	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
11.00	100.00	0.64	0.00	0.64	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
16.00	111.00	0.92	0.00	0.92	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
21.00	114.00	1.21	0.03	1.17	0.95	1.00	0.414	1.32	0.313	0.98	0.319	2.000	●
26.00	127.00	1.52	0.19	1.34	0.94	1.00	0.452	1.32	0.341	0.95	0.358	2.000	●
31.00	120.00	1.82	0.34	1.48	0.92	1.00	0.476	1.32	0.360	0.94	0.385	0.341	●
36.00	135.00	2.16	0.50	1.66	0.88	1.00	0.485	1.32	0.367	0.91	0.401	2.000	●
41.00	137.00	2.50	0.66	1.85	0.84	1.00	0.482	1.32	0.364	0.89	0.407	2.000	●
46.00	130.00	2.83	0.81	2.02	0.79	1.00	0.470	1.32	0.355	0.88	0.404	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
11.00	2.000	0.00	8.32	5.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	2.000	0.00	6.04	5.00	0.00
31.00	0.341	0.66	5.28	5.00	5.30
36.00	2.000	0.00	4.51	5.00	0.00
41.00	2.000	0.00	3.75	5.00	0.00
46.00	2.000	0.00	2.99	5.00	0.00

Overall potential I_L : 5.30

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000
6.00	39	0.16	0.26	856.14	0.14	11208.42	0.00	0.00	8.77	0.01	5.00	0.011
11.00	10	0.27	0.43	689.87	0.15	8341.68	0.00	0.00	8.77	0.21	5.00	0.248
16.00	39	0.38	0.62	1229.83	0.16	6726.14	0.00	0.00	8.77	0.02	5.00	0.022

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.282

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	0.00	5.00	0.000
31.00	0.00	5.00	3.55	5.00	2.131
36.00	0.00	5.00	0.00	5.00	0.000
41.00	0.00	5.00	0.00	4.00	0.000
46.00	0.00	5.00	0.00	6.00	0.000

Cumulative settlements: 2.131

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	39	87.43	0.00	5.00	0.000	0.00
11.00	10	44.27	0.00	5.00	0.000	0.00
16.00	39	87.43	0.00	5.00	0.000	0.00
21.00	39	87.43	0.00	5.00	0.000	0.00
26.00	13	50.48	0.00	5.00	0.000	0.00
31.00	12	48.50	34.10	5.00	0.000	0.00
36.00	35	82.83	0.00	5.00	0.000	0.00
41.00	33	80.42	0.00	4.00	0.000	0.00
46.00	40	88.54	0.00	6.00	0.000	0.00

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

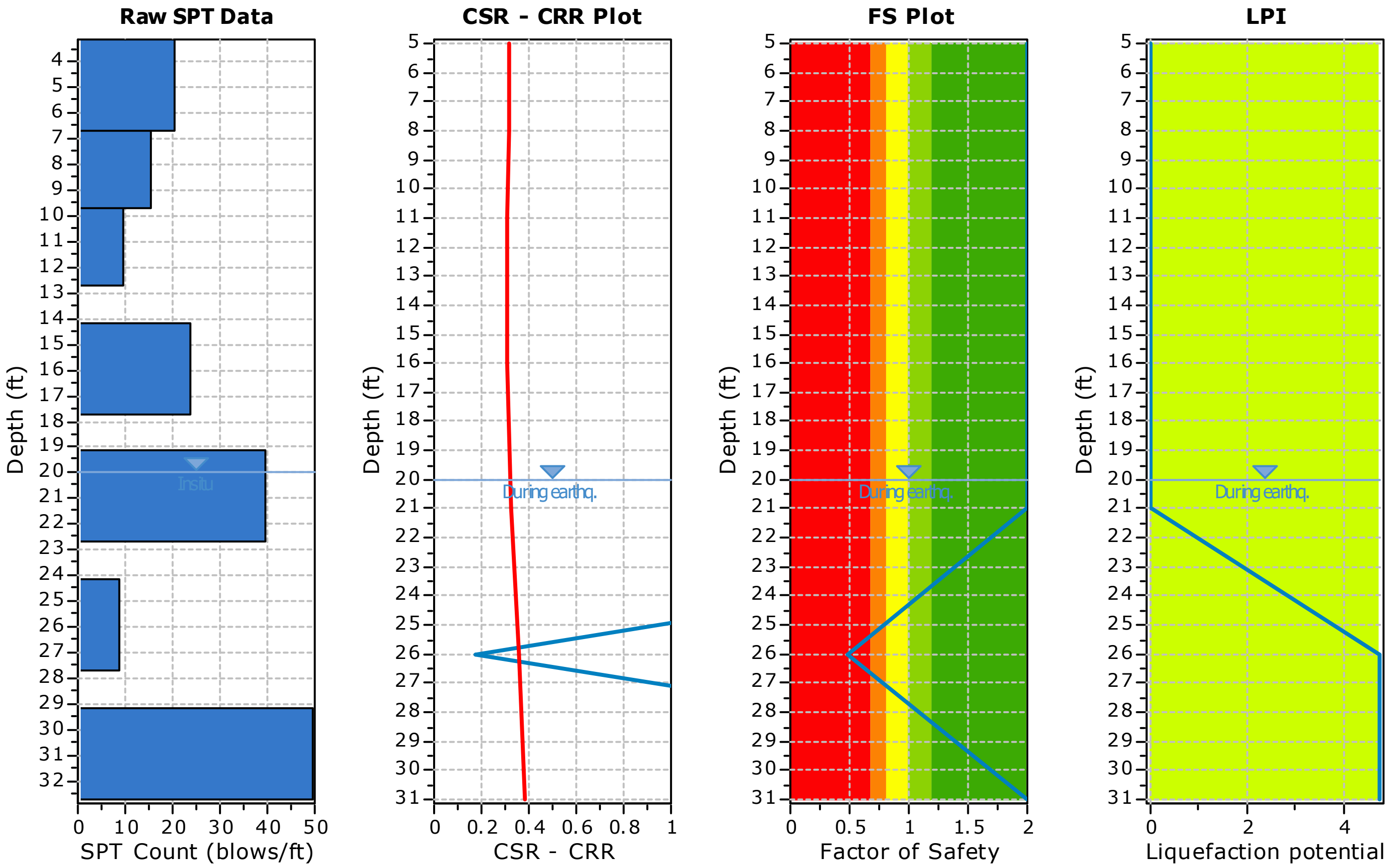
SPT BASED LIQUEFACTION ANALYSIS REPORT

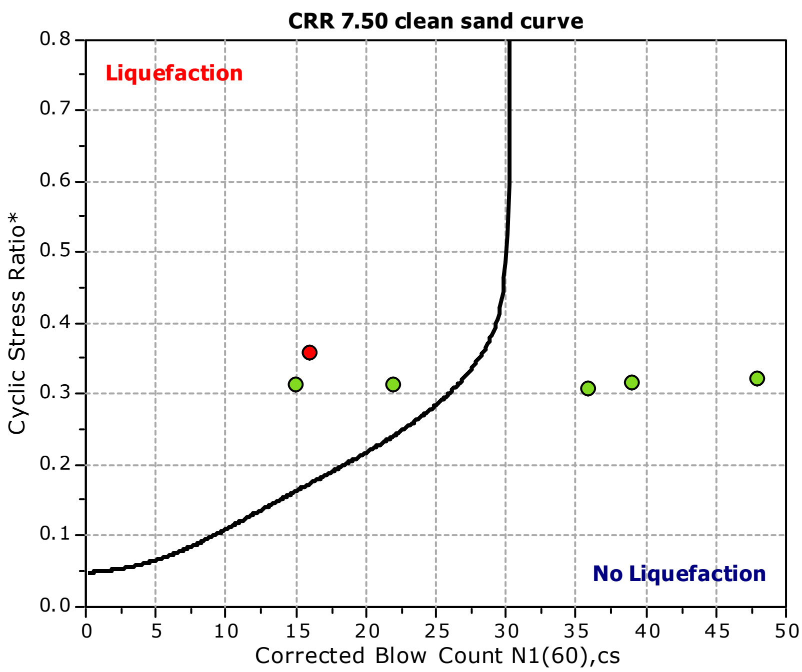
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-19**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





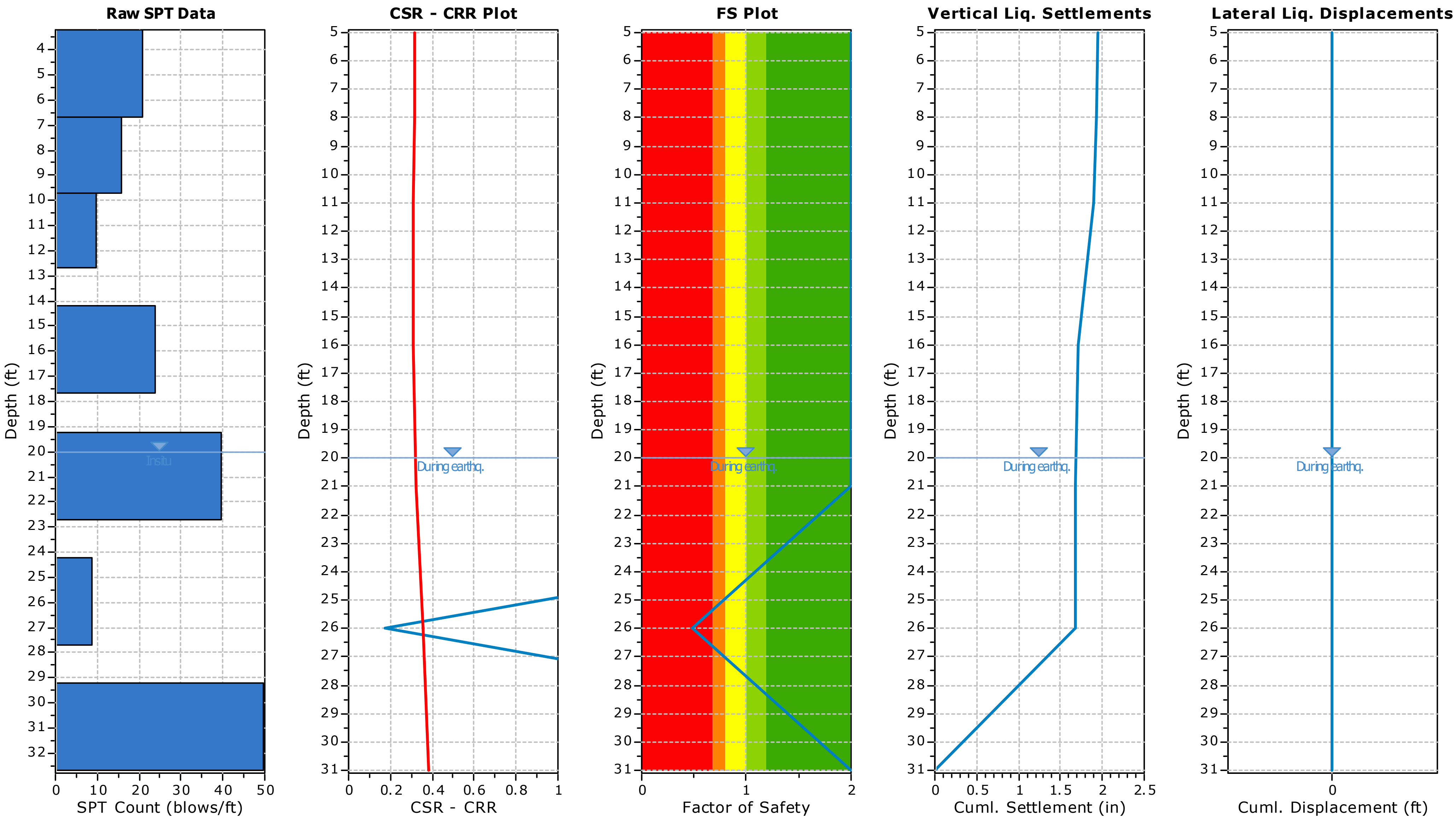
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
5.00	21	35.00	118.00	5.00	Yes
8.00	16	15.00	118.00	3.00	Yes
11.00	10	15.00	109.00	5.00	Yes
16.00	24	35.00	110.00	5.00	Yes
21.00	40	15.00	138.00	5.00	Yes
26.00	9	35.00	120.00	5.00	Yes
31.00	50	65.00	130.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
5.00	21	118.00	0.30	0.00	0.30	1.49	1.20	1.00	0.75	1.00	28	35.00	5.00	1.20	39	4.000
8.00	16	118.00	0.47	0.00	0.47	1.34	1.20	1.00	0.75	1.00	19	15.00	2.50	1.05	22	4.000
11.00	10	109.00	0.64	0.00	0.64	1.22	1.20	1.00	0.85	1.00	12	15.00	2.50	1.05	15	4.000
16.00	24	110.00	0.91	0.00	0.91	1.07	1.20	1.00	0.85	1.00	26	35.00	5.00	1.20	36	4.000
21.00	40	138.00	1.26	0.03	1.22	0.93	1.20	1.00	0.95	1.00	43	15.00	2.50	1.05	48	4.000
26.00	9	120.00	1.56	0.19	1.37	0.88	1.20	1.00	0.95	1.00	9	35.00	5.00	1.20	16	0.174
31.00	50	130.00	1.88	0.34	1.54	0.83	1.20	1.00	1.00	1.00	50	65.00	5.00	1.20	65	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
5.00	118.00	0.30	0.00	0.30	0.99	1.00	0.418	1.32	0.316	1.00	0.316	2.000
8.00	118.00	0.47	0.00	0.47	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000
11.00	109.00	0.64	0.00	0.64	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000
16.00	110.00	0.91	0.00	0.91	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000
21.00	138.00	1.26	0.03	1.22	0.95	1.00	0.413	1.32	0.312	0.97	0.321	2.000
26.00	120.00	1.56	0.19	1.37	0.94	1.00	0.451	1.32	0.340	0.95	0.358	0.486
31.00	130.00	1.88	0.34	1.54	0.92	1.00	0.473	1.32	0.357	0.93	0.385	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio (adjusted for improvement)
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
5.00	2.000	0.00	9.24	3.00	0.00
8.00	2.000	0.00	8.78	3.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.486	0.51	6.04	5.00	4.73
31.00	2.000	0.00	5.28	5.00	0.00

Overall potential I_L : 4.73

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
5.00	28	0.12	0.20	673.92	0.14	13313.33	0.00	0.00	8.77	0.01	5.00	0.017
8.00	19	0.20	0.32	704.35	0.14	10041.87	0.00	0.00	8.77	0.06	3.00	0.041
11.00	12	0.26	0.43	719.34	0.15	8400.61	0.00	0.00	8.77	0.15	5.00	0.177
16.00	26	0.37	0.61	1152.80	0.16	6770.36	0.00	0.00	8.77	0.03	5.00	0.031

Cumulative settlemetns: 0.266

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	2.81	5.00	1.684
31.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.684

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
5.00	28	74.08	0.00	5.00	0.000	0.00
8.00	19	61.02	0.00	3.00	0.000	0.00
11.00	12	48.50	0.00	5.00	0.000	0.00
16.00	26	71.39	0.00	5.00	0.000	0.00
21.00	43	100.00	0.00	5.00	0.000	0.00
26.00	9	42.00	51.20	5.00	0.000	0.00
31.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

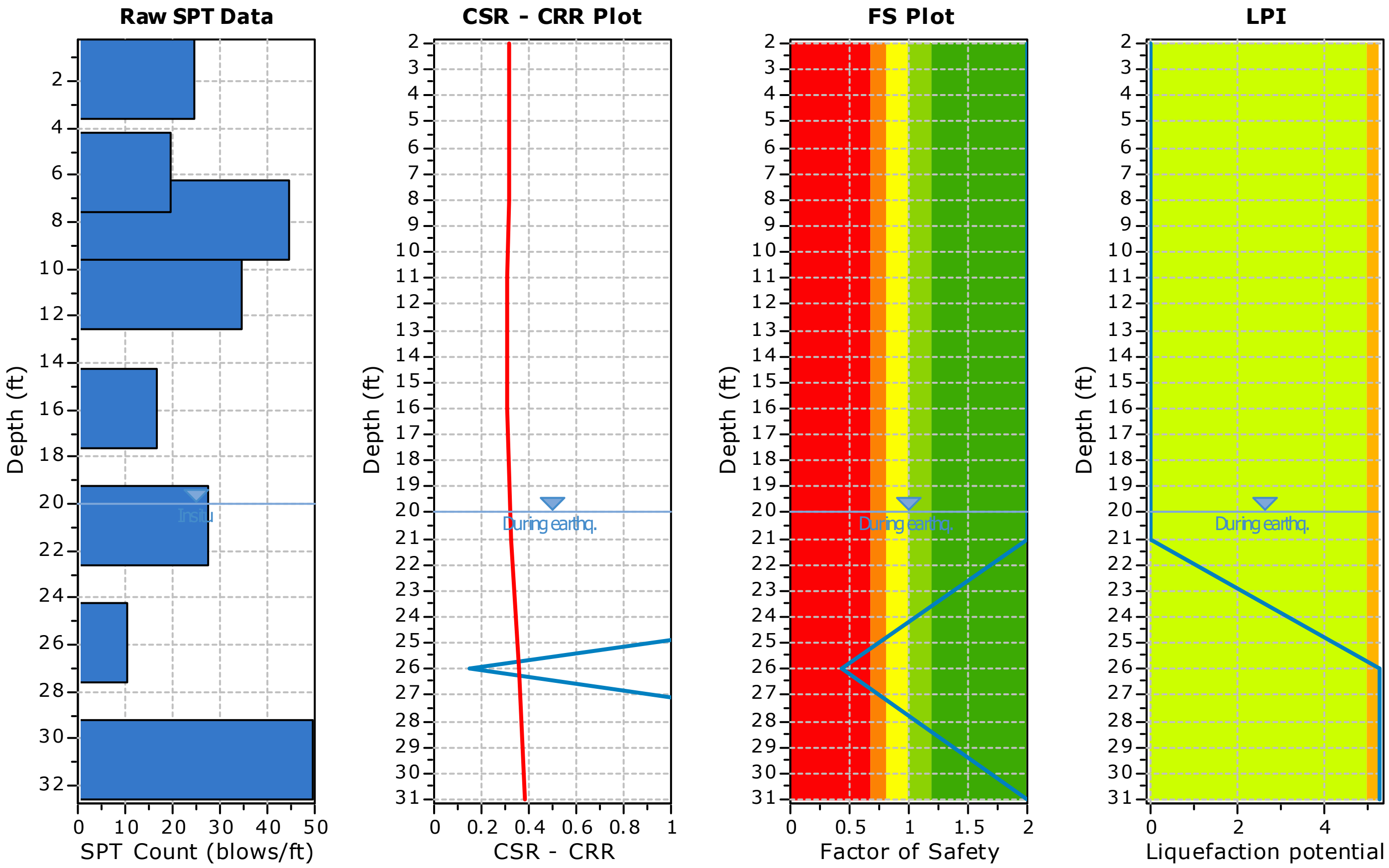
SPT BASED LIQUEFACTION ANALYSIS REPORT

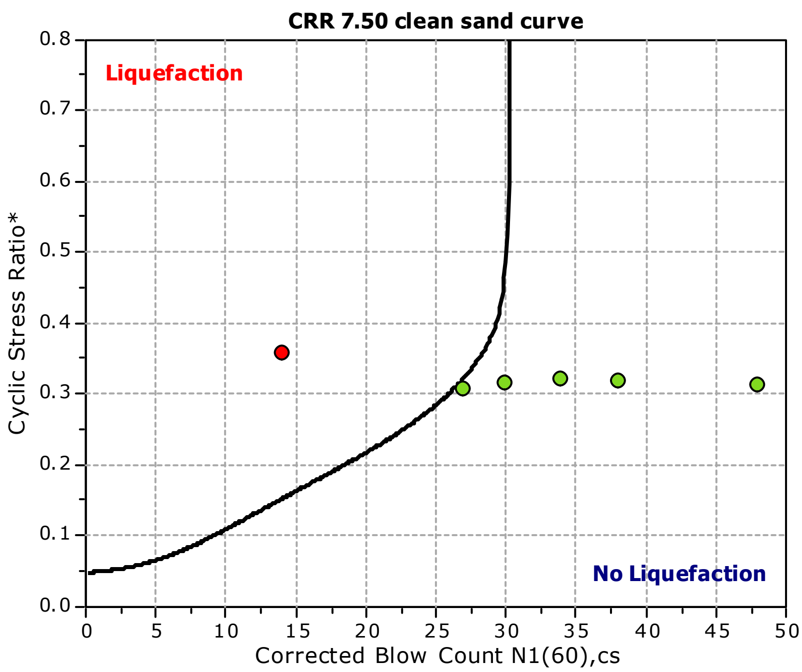
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-23**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





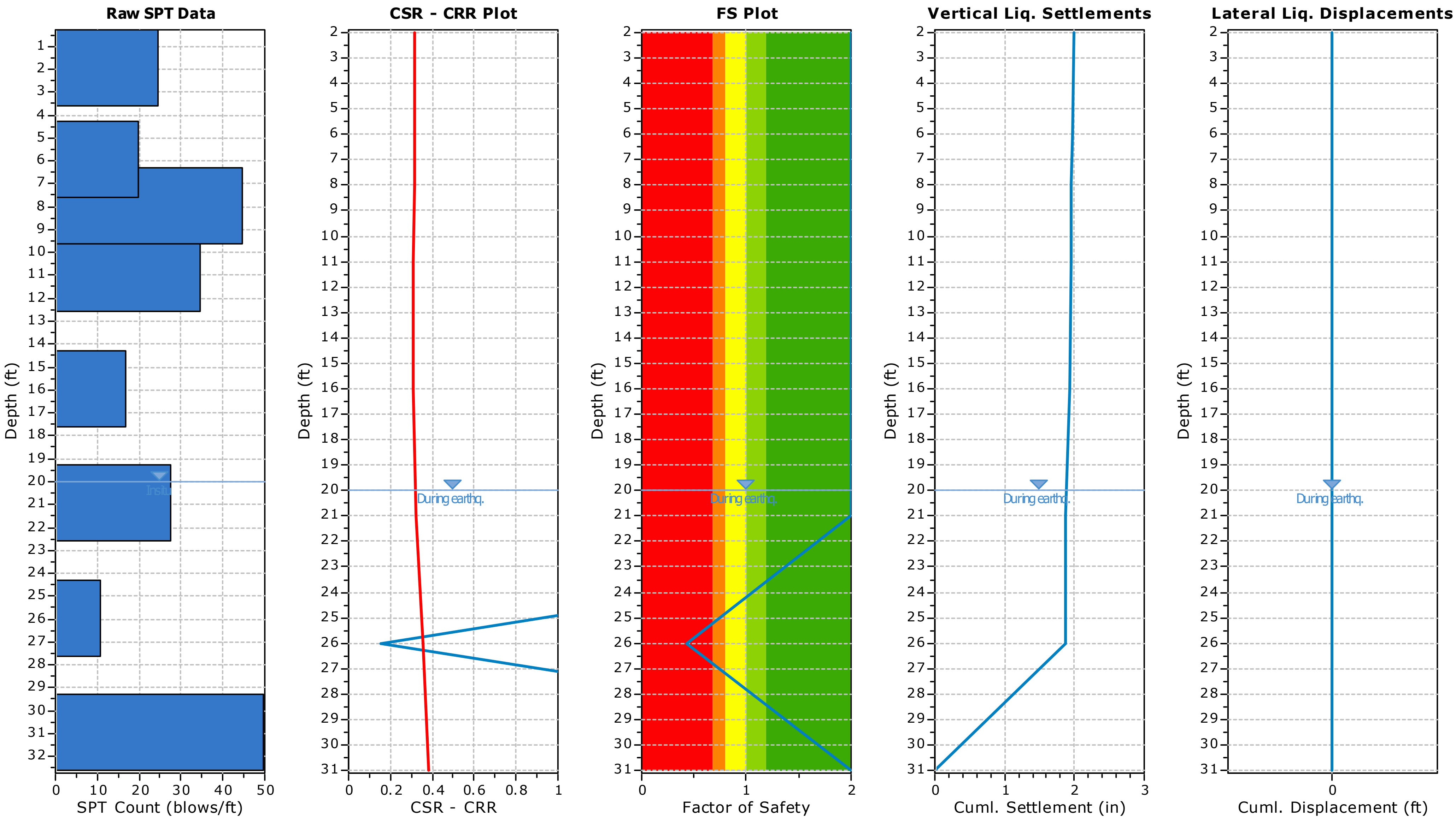
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	5.00	125.00	5.00	Yes
6.00	20	15.00	109.00	2.00	Yes
8.00	45	15.00	125.00	3.00	Yes
11.00	35	15.00	130.00	5.00	Yes
16.00	17	65.00	125.00	5.00	Yes
21.00	28	15.00	110.00	5.00	Yes
26.00	11	15.00	120.00	5.00	Yes
31.00	50	85.00	135.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	5.00	0.00	1.00	38	4.000
6.00	20	109.00	0.34	0.00	0.34	1.44	1.20	1.00	0.75	1.00	26	15.00	2.50	1.05	30	4.000
8.00	45	125.00	0.47	0.00	0.47	1.34	1.20	1.00	0.75	1.00	54	15.00	2.50	1.05	59	4.000
11.00	35	130.00	0.66	0.00	0.66	1.20	1.20	1.00	0.85	1.00	43	15.00	2.50	1.05	48	4.000
16.00	17	125.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	18	65.00	5.00	1.20	27	4.000
21.00	28	110.00	1.25	0.03	1.22	0.94	1.20	1.00	0.95	1.00	30	15.00	2.50	1.05	34	4.000
26.00	11	120.00	1.55	0.19	1.36	0.88	1.20	1.00	0.95	1.00	11	15.00	2.50	1.05	14	0.153
31.00	50	135.00	1.89	0.34	1.54	0.83	1.20	1.00	1.00	1.00	50	85.00	5.00	1.20	65	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	109.00	0.34	0.00	0.34	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000
8.00	125.00	0.47	0.00	0.47	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000
11.00	130.00	0.66	0.00	0.66	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000
16.00	125.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000
21.00	110.00	1.25	0.03	1.22	0.95	1.00	0.413	1.32	0.312	0.97	0.321	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
26.00	120.00	1.55	0.19	1.36	0.94	1.00	0.451	1.32	0.340	0.95	0.358	0.426	●
31.00	135.00	1.89	0.34	1.54	0.92	1.00	0.473	1.32	0.357	0.93	0.385	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.426	0.57	6.04	5.00	5.28
31.00	2.000	0.00	5.28	5.00	0.00

Overall potential I_L : 5.28

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.05	0.08	434.91	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.014
6.00	26	0.14	0.23	665.83	0.14	12161.96	0.00	0.00	8.77	0.03	2.00	0.013
8.00	54	0.19	0.31	974.43	0.14	10093.28	0.00	0.00	8.77	0.01	3.00	0.006
11.00	43	0.27	0.44	1082.72	0.15	8189.77	0.00	0.00	8.77	0.01	5.00	0.016
16.00	18	0.40	0.65	1084.13	0.16	6495.96	0.00	0.00	8.77	0.05	5.00	0.057

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.105

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
21.00	0.00	5.00	0.00	5.00	0.000
26.00	0.00	5.00	3.13	5.00	1.878
31.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.878

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	26	71.39	0.00	2.00	0.000	0.00
8.00	54	100.00	0.00	3.00	0.000	0.00
11.00	43	100.00	0.00	5.00	0.000	0.00
16.00	18	59.40	0.00	5.00	0.000	0.00
21.00	30	76.68	0.00	5.00	0.000	0.00
26.00	11	46.43	34.10	5.00	0.000	0.00
31.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

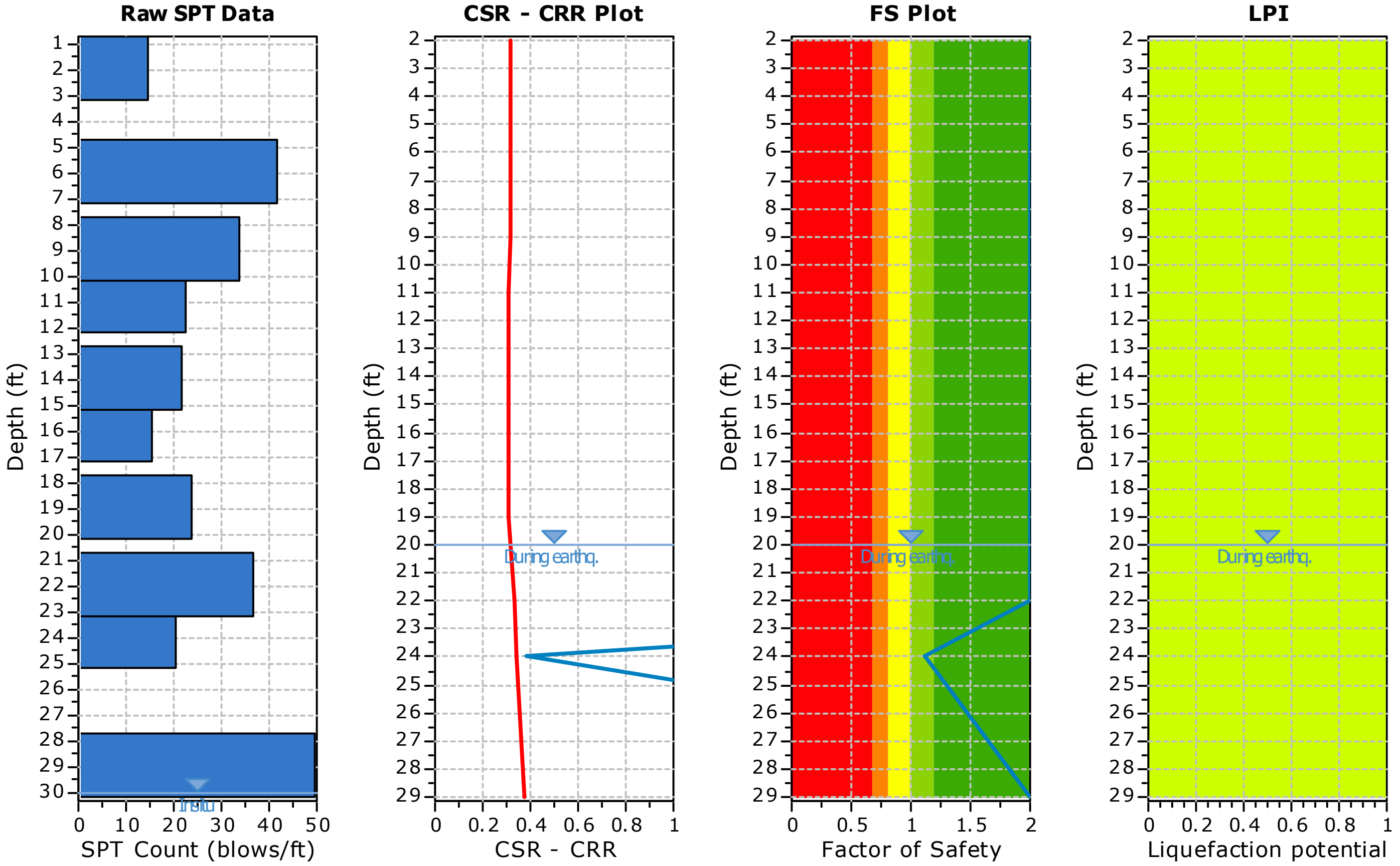
SPT BASED LIQUEFACTION ANALYSIS REPORT

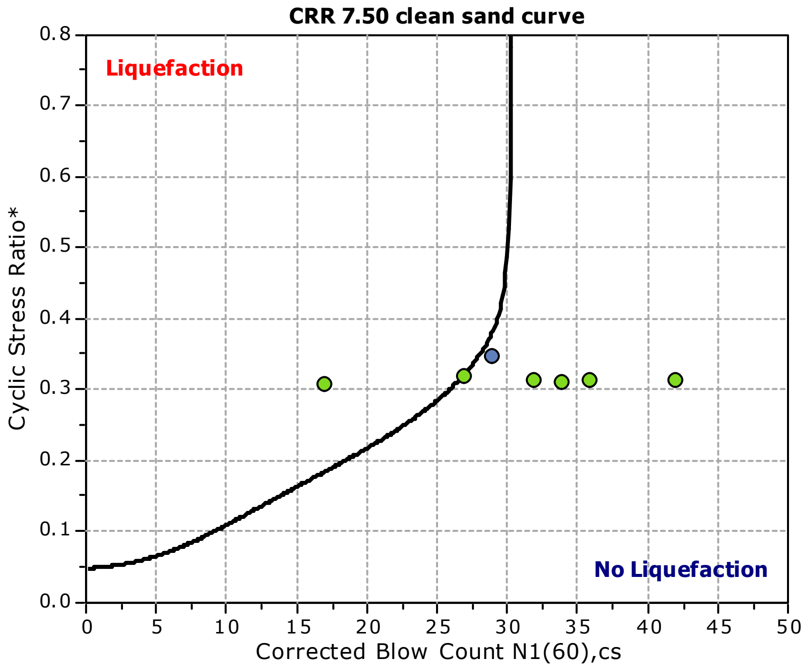
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-25**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

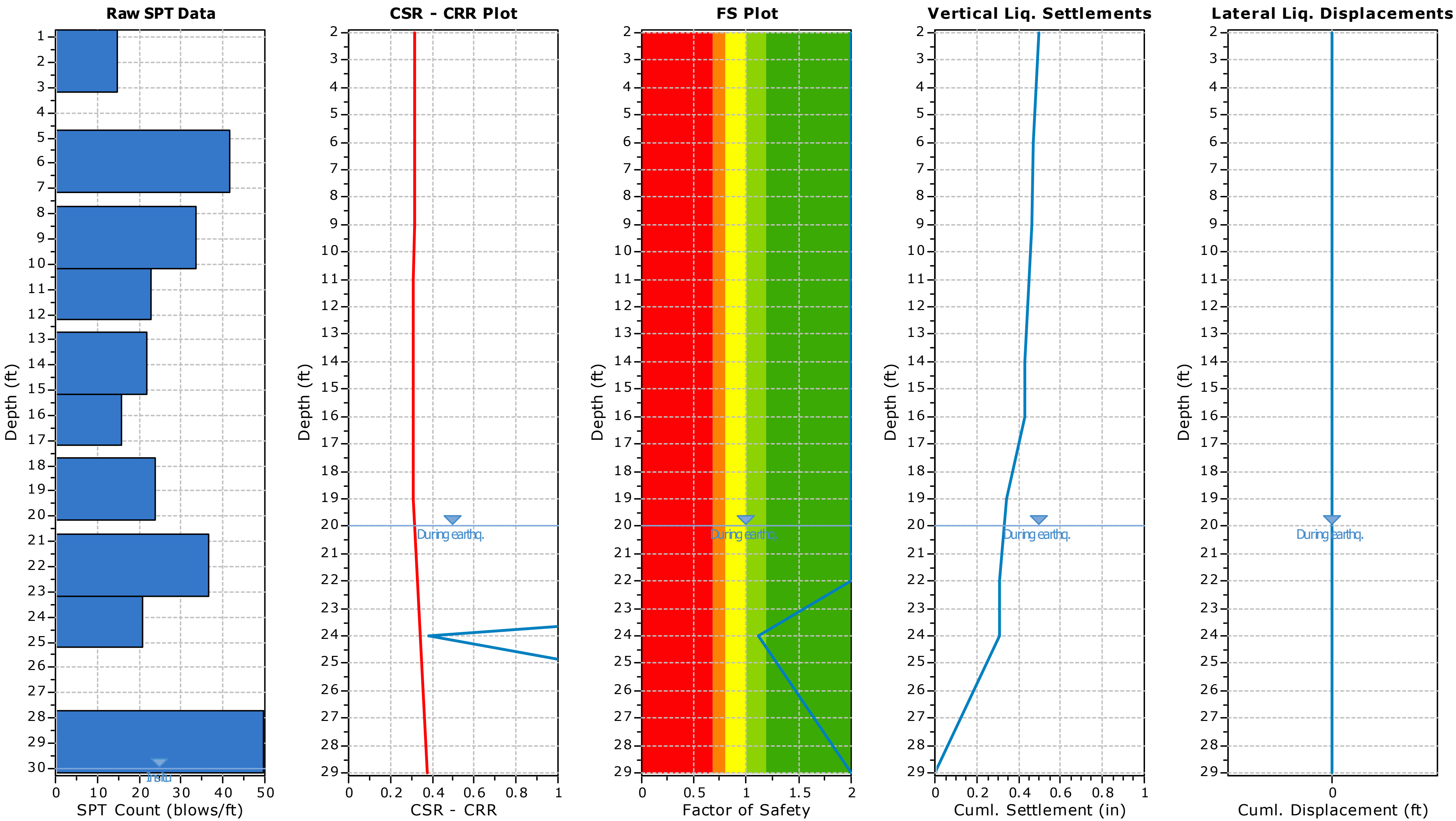




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	42	15.00	134.00	3.00	Yes
9.00	34	15.00	130.00	3.00	Yes
11.00	23	15.00	119.00	3.00	Yes
14.00	22	85.00	112.00	3.00	No
16.00	16	6.00	105.00	3.00	Yes
19.00	24	80.00	120.00	4.00	Yes
22.00	37	70.00	125.00	3.00	Yes
24.00	21	60.00	120.00	6.00	Yes
29.00	50	50.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	42	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	53	15.00	2.50	1.05	58	4.000
9.00	34	130.00	0.58	0.00	0.58	1.26	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
11.00	23	119.00	0.70	0.00	0.70	1.18	1.20	1.00	0.85	1.00	28	15.00	2.50	1.05	32	4.000
14.00	22	112.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	24	85.00	5.00	1.20	34	4.000
16.00	16	105.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	17	6.00	0.03	1.00	17	4.000
19.00	24	120.00	1.16	0.00	1.16	0.96	1.20	1.00	0.95	1.00	26	80.00	5.00	1.20	36	4.000
22.00	37	125.00	1.34	0.00	1.34	0.89	1.20	1.00	0.95	1.00	38	70.00	5.00	1.20	51	4.000
24.00	21	120.00	1.46	0.00	1.46	0.85	1.20	1.00	0.95	1.00	20	60.00	5.00	1.20	29	0.384
29.00	50	130.00	1.79	0.00	1.79	0.76	1.20	1.00	0.95	1.00	43	50.00	5.00	1.20	57	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
9.00	130.00	0.58	0.00	0.58	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
11.00	119.00	0.70	0.00	0.70	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
14.00	112.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000	●
16.00	105.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
19.00	120.00	1.16	0.00	1.16	0.96	1.00	0.405	1.32	0.306	0.98	0.312	2.000	●
22.00	125.00	1.34	0.06	1.28	0.95	1.00	0.422	1.32	0.318	0.96	0.331	2.000	●
24.00	120.00	1.46	0.12	1.34	0.95	1.00	0.437	1.32	0.330	0.95	0.346	1.110	●
29.00	130.00	1.79	0.28	1.51	0.93	1.00	0.464	1.32	0.350	0.93	0.376	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
11.00	2.000	0.00	8.32	2.00	0.00
14.00	2.000	0.00	7.87	3.00	0.00
16.00	2.000	0.00	7.56	2.00	0.00
19.00	2.000	0.00	7.10	3.00	0.00
22.00	2.000	0.00	6.65	3.00	0.00
24.00	1.110	0.00	6.34	2.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	53	0.16	0.26	882.21	0.14	11294.86	0.00	0.00	8.77	0.01	3.00	0.005
9.00	38	0.24	0.39	971.10	0.15	8846.65	0.00	0.00	8.77	0.02	3.00	0.012
11.00	28	0.29	0.47	973.26	0.15	7913.67	0.00	0.00	8.77	0.03	3.00	0.022
14.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
16.00	17	0.40	0.65	928.96	0.16	6497.96	0.00	0.00	8.77	0.13	3.00	0.092
19.00	26	0.47	0.77	1298.38	0.17	5869.90	0.00	0.00	8.77	0.03	4.00	0.028

Cumulative settlemetns: 0.187

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
22.00	0.00	5.00	0.00	3.00	0.000
24.00	0.00	5.00	0.43	6.00	0.312
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.312

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	53	100.00	0.00	3.00	0.000	0.00
9.00	38	86.30	0.00	3.00	0.000	0.00
11.00	28	74.08	0.00	3.00	0.000	0.00
14.00	24	68.59	0.00	3.00	0.000	0.00
16.00	17	57.72	0.00	3.00	0.000	0.00
19.00	26	71.39	0.00	4.00	0.000	0.00
22.00	38	86.30	0.00	3.00	0.000	0.00
24.00	20	62.61	2.26	6.00	0.000	0.00
29.00	43	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

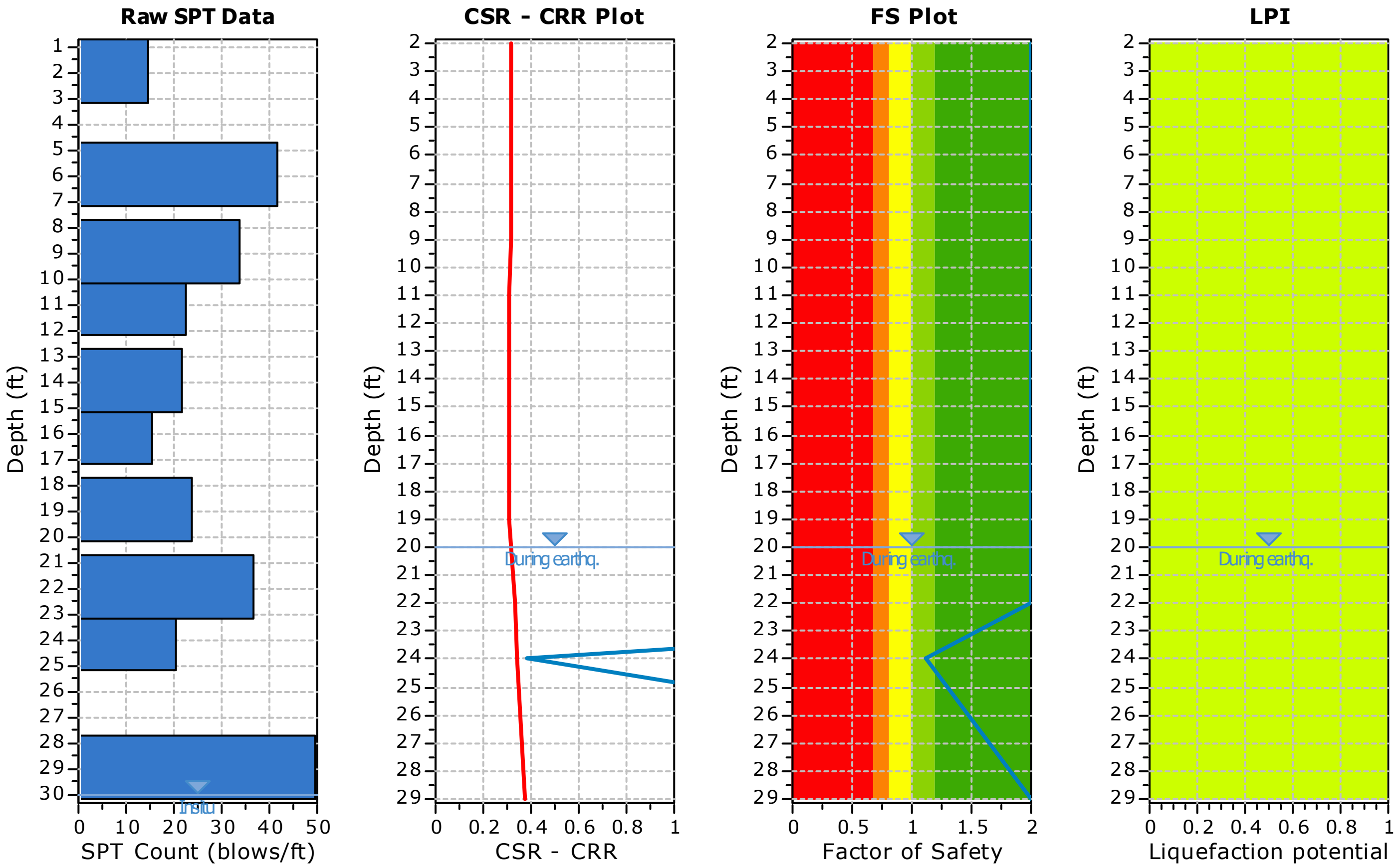
SPT BASED LIQUEFACTION ANALYSIS REPORT

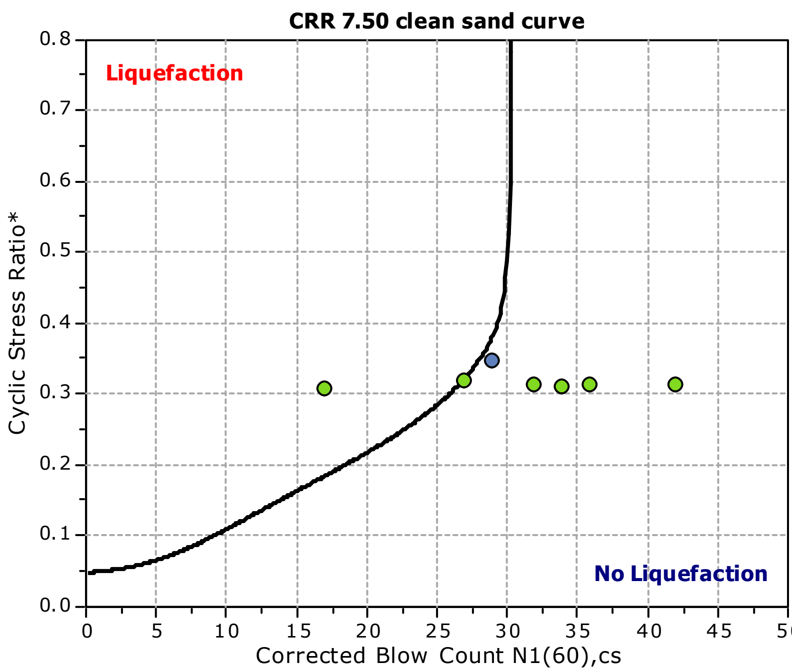
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-25**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	30.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		





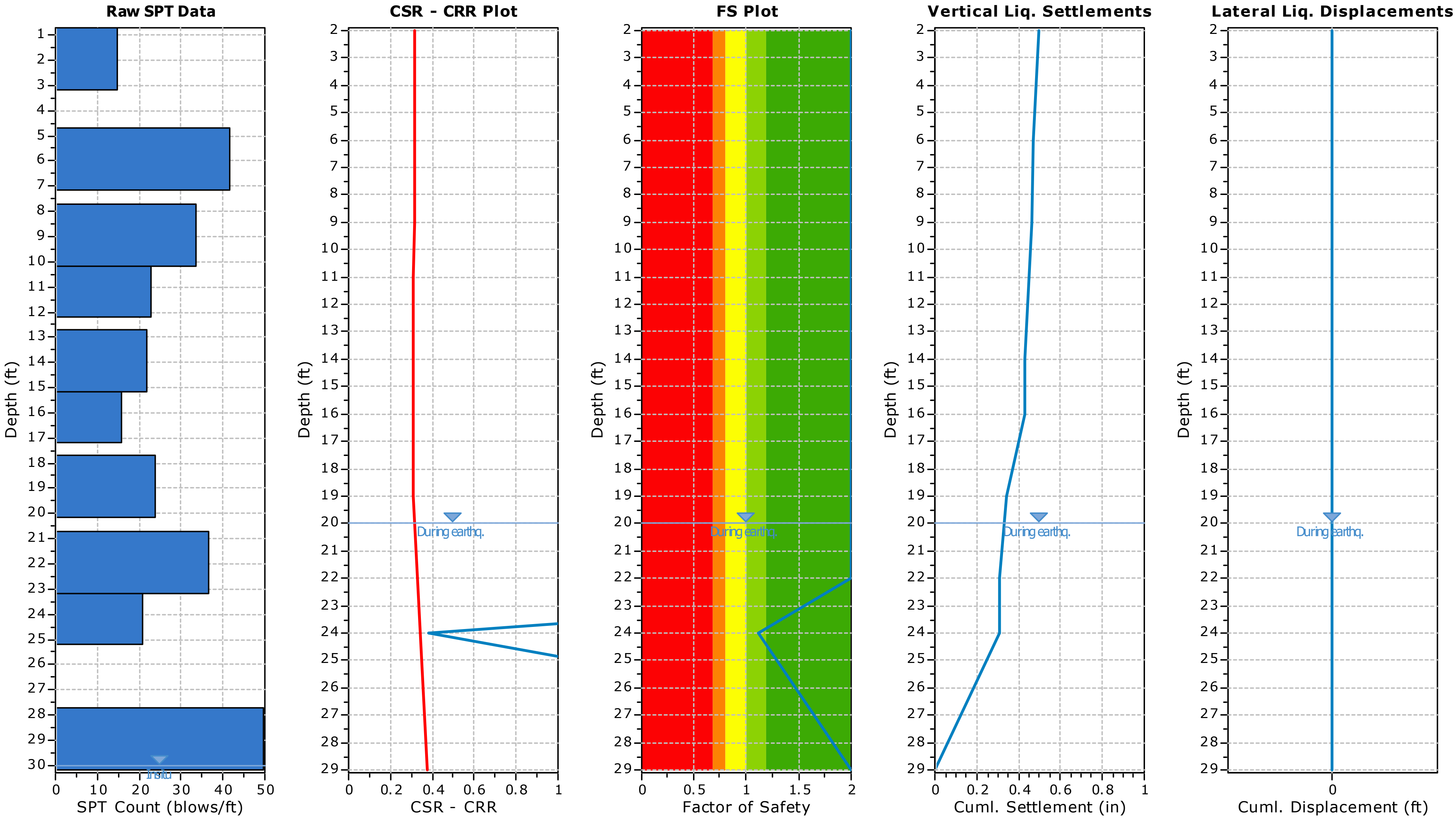
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	42	15.00	134.00	3.00	Yes
9.00	34	15.00	130.00	3.00	Yes
11.00	23	15.00	119.00	3.00	Yes
14.00	22	85.00	112.00	3.00	No
16.00	16	6.00	105.00	3.00	Yes
19.00	24	80.00	120.00	4.00	Yes
22.00	37	70.00	125.00	3.00	Yes
24.00	21	60.00	120.00	6.00	Yes
29.00	50	50.00	130.00	5.00	No

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	42	134.00	0.39	0.00	0.39	1.40	1.20	1.00	0.75	1.00	53	15.00	2.50	1.05	58	4.000
9.00	34	130.00	0.58	0.00	0.58	1.26	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
11.00	23	119.00	0.70	0.00	0.70	1.18	1.20	1.00	0.85	1.00	28	15.00	2.50	1.05	32	4.000
14.00	22	112.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	24	85.00	5.00	1.20	34	4.000
16.00	16	105.00	0.98	0.00	0.98	1.04	1.20	1.00	0.85	1.00	17	6.00	0.03	1.00	17	4.000
19.00	24	120.00	1.16	0.00	1.16	0.96	1.20	1.00	0.95	1.00	26	80.00	5.00	1.20	36	4.000
22.00	37	125.00	1.34	0.00	1.34	0.89	1.20	1.00	0.95	1.00	38	70.00	5.00	1.20	51	4.000
24.00	21	120.00	1.46	0.00	1.46	0.85	1.20	1.00	0.95	1.00	20	60.00	5.00	1.20	29	0.384
29.00	50	130.00	1.79	0.00	1.79	0.76	1.20	1.00	0.95	1.00	43	50.00	5.00	1.20	57	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	134.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
9.00	130.00	0.58	0.00	0.58	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000	●
11.00	119.00	0.70	0.00	0.70	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
14.00	112.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000	●
16.00	105.00	0.98	0.00	0.98	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
19.00	120.00	1.16	0.00	1.16	0.96	1.00	0.405	1.32	0.306	0.98	0.312	2.000	●
22.00	125.00	1.34	0.06	1.28	0.95	1.00	0.422	1.32	0.318	0.96	0.331	2.000	●
24.00	120.00	1.46	0.12	1.34	0.95	1.00	0.437	1.32	0.330	0.95	0.346	1.110	●
29.00	130.00	1.79	0.28	1.51	0.93	1.00	0.464	1.32	0.350	0.93	0.376	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
11.00	2.000	0.00	8.32	2.00	0.00
14.00	2.000	0.00	7.87	3.00	0.00
16.00	2.000	0.00	7.56	2.00	0.00
19.00	2.000	0.00	7.10	3.00	0.00
22.00	2.000	0.00	6.65	3.00	0.00
24.00	1.110	0.00	6.34	2.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	53	0.16	0.26	882.21	0.14	11294.86	0.00	0.00	8.77	0.01	3.00	0.005
9.00	38	0.24	0.39	971.10	0.15	8846.65	0.00	0.00	8.77	0.02	3.00	0.012
11.00	28	0.29	0.47	973.26	0.15	7913.67	0.00	0.00	8.77	0.03	3.00	0.022
14.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
16.00	17	0.40	0.65	928.96	0.16	6497.96	0.00	0.00	8.77	0.13	3.00	0.092
19.00	26	0.47	0.77	1298.38	0.17	5869.90	0.00	0.00	8.77	0.03	4.00	0.028

Cumulative settlemetns: 0.187

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
22.00	0.00	5.00	0.00	3.00	0.000
24.00	0.00	5.00	0.43	6.00	0.312
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.312

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	53	100.00	0.00	3.00	0.000	0.00
9.00	38	86.30	0.00	3.00	0.000	0.00
11.00	28	74.08	0.00	3.00	0.000	0.00
14.00	24	68.59	0.00	3.00	0.000	0.00
16.00	17	57.72	0.00	3.00	0.000	0.00
19.00	26	71.39	0.00	4.00	0.000	0.00
22.00	38	86.30	0.00	3.00	0.000	0.00
24.00	20	62.61	2.26	6.00	0.000	0.00
29.00	43	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

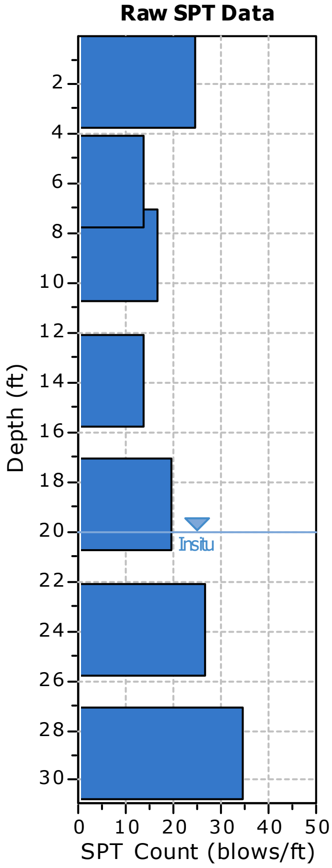
SPT BASED LIQUEFACTION ANALYSIS REPORT

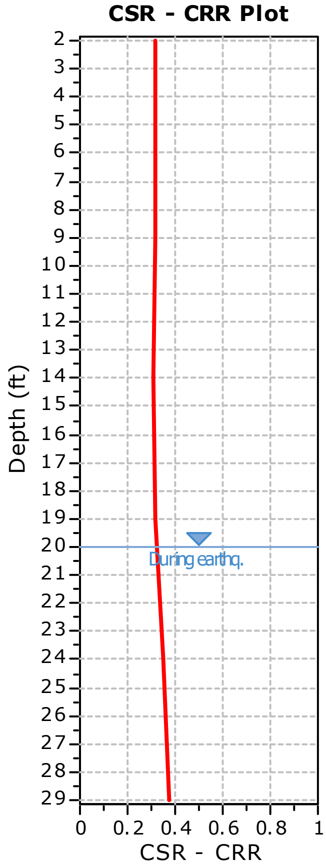
Project title : Brea Boulevard Corridor Improvements — **SPT Name: LB-26**

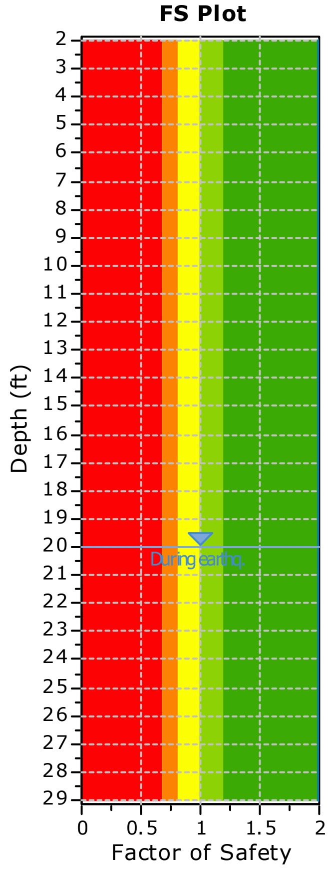
Location : Orange County, California

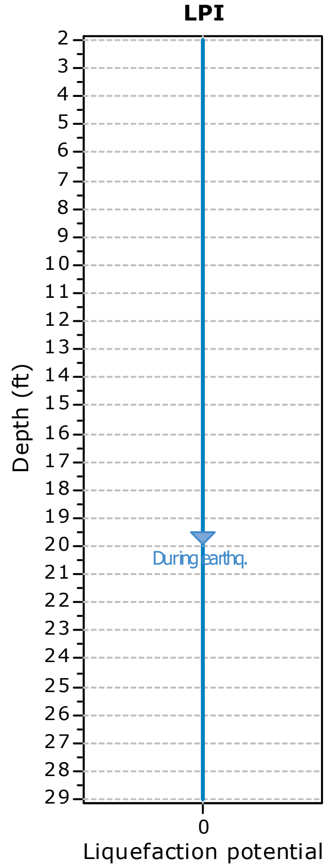
:: Input parameters and analysis properties ::

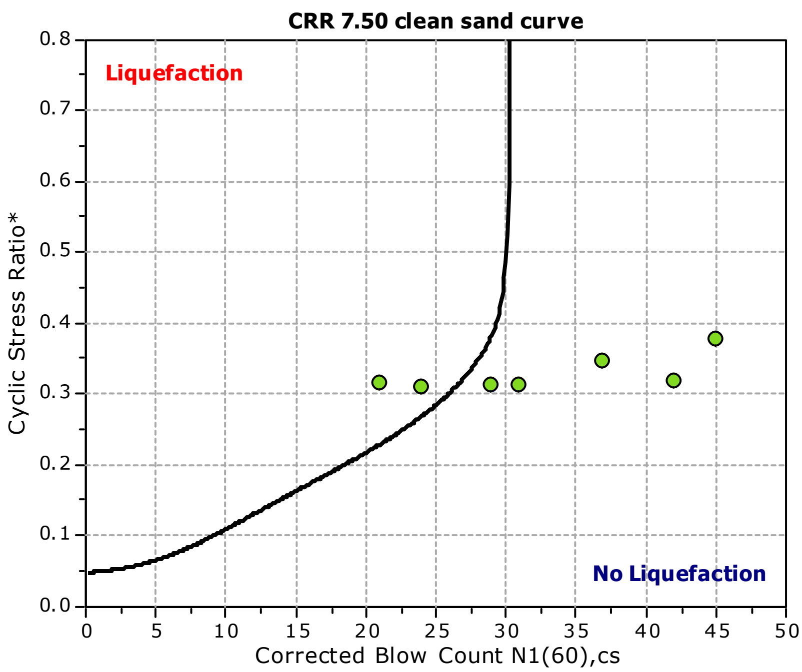
Analysis method:	NCEER 1998	G.W.T. (in-situ):	20.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	20.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		







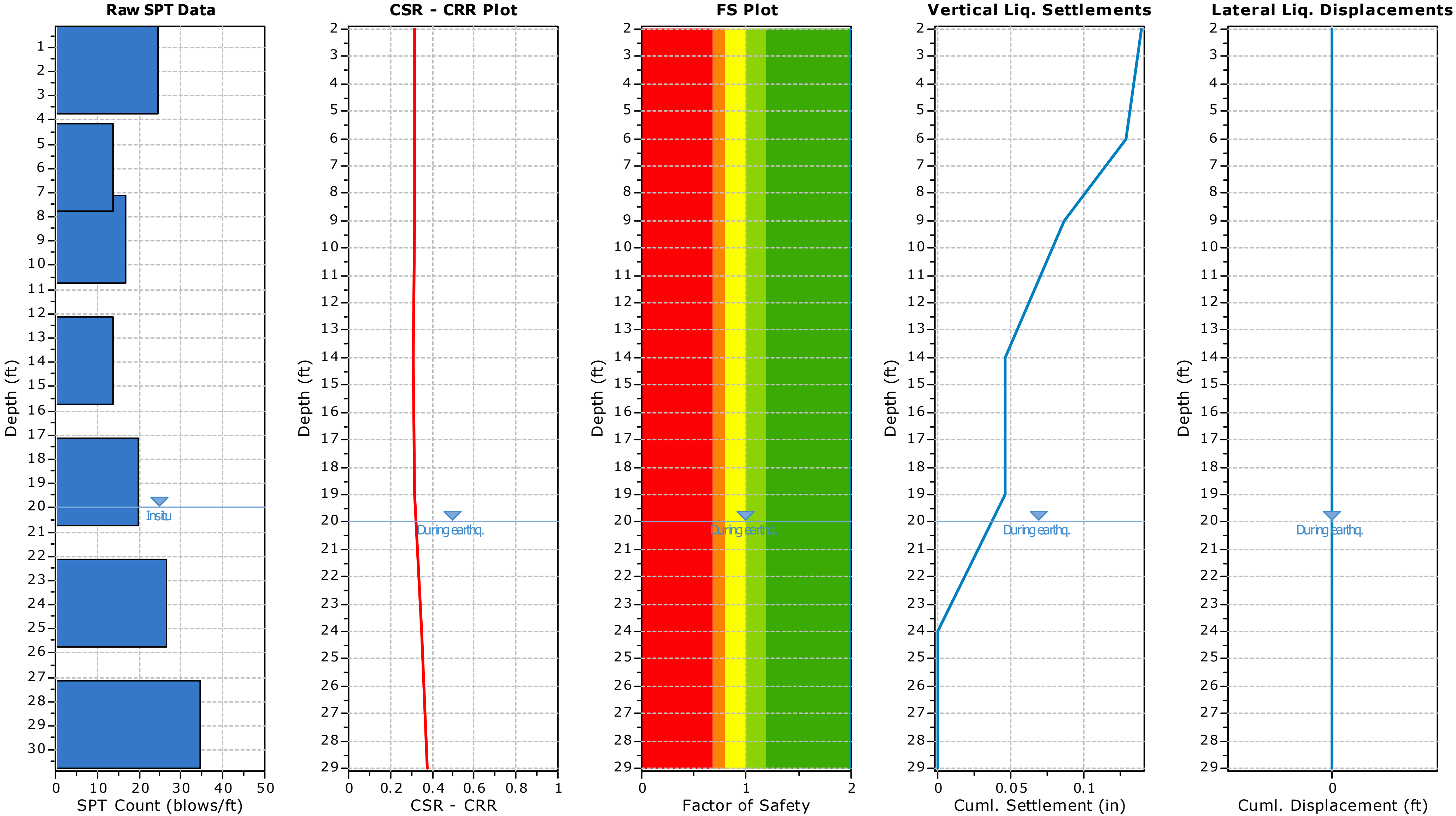




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	25	15.00	125.00	5.00	Yes
6.00	14	15.00	120.00	3.00	Yes
9.00	17	60.00	125.00	5.00	Yes
14.00	14	75.00	125.00	5.00	No
19.00	20	60.00	125.00	5.00	Yes
24.00	27	60.00	125.00	5.00	Yes
29.00	35	35.00	125.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	25	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	38	15.00	2.50	1.05	42	4.000
6.00	14	120.00	0.37	0.00	0.37	1.42	1.20	1.00	0.75	1.00	18	15.00	2.50	1.05	21	4.000
9.00	17	125.00	0.55	0.00	0.55	1.28	1.20	1.00	0.75	1.00	20	60.00	5.00	1.20	29	4.000
14.00	14	125.00	0.87	0.00	0.87	1.09	1.20	1.00	0.85	1.00	16	75.00	5.00	1.20	24	4.000
19.00	20	125.00	1.18	0.00	1.18	0.95	1.20	1.00	0.95	1.00	22	60.00	5.00	1.20	31	4.000
24.00	27	125.00	1.49	0.12	1.37	0.88	1.20	1.00	0.95	1.00	27	60.00	5.00	1.20	37	4.000
29.00	35	125.00	1.80	0.28	1.52	0.83	1.20	1.00	0.95	1.00	33	35.00	5.00	1.20	45	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	120.00	0.37	0.00	0.37	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000
9.00	125.00	0.55	0.00	0.55	0.98	1.00	0.415	1.32	0.313	1.00	0.313	2.000
14.00	125.00	0.87	0.00	0.87	0.97	1.00	0.410	1.32	0.310	1.00	0.310	2.000
19.00	125.00	1.18	0.00	1.18	0.96	1.00	0.405	1.32	0.306	0.98	0.313	2.000
24.00	125.00	1.49	0.12	1.37	0.95	1.00	0.436	1.32	0.329	0.95	0.346	2.000
29.00	125.00	1.80	0.28	1.52	0.93	1.00	0.463	1.32	0.350	0.93	0.376	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS

Abbreviations

$\sigma_{v,eq}$: Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$: Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$: Effective overburden pressure, during earthquake (tsf)
r_d : Nonlinear shear mass factor
α: Improvement factor due to stone columns
CSR : Cyclic Stress Ratio (adjusted for improvement)
MSF : Magnitude Scaling Factor
$CSR_{eq,M=7.5}$: CSR adjusted for M=7.5
K_{sigma}: Effective overburden stress factor
CSR^*: CSR fully adjusted (user FS applied)***
FS: Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
9.00	2.000	0.00	8.63	3.00	0.00
14.00	2.000	0.00	7.87	5.00	0.00
19.00	2.000	0.00	7.10	5.00	0.00
24.00	2.000	0.00	6.34	5.00	0.00
29.00	2.000	0.00	5.58	5.00	0.00

Overall potential I_L : 0.00

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	38	0.05	0.08	449.66	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.011
6.00	18	0.15	0.24	609.86	0.14	11716.67	0.00	0.00	8.77	0.06	3.00	0.042
9.00	20	0.23	0.37	835.56	0.15	9136.52	0.00	0.00	8.77	0.03	5.00	0.040
14.00	16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000
19.00	22	0.48	0.79	1247.23	0.17	5802.34	0.00	0.00	8.77	0.04	5.00	0.047

Cumulative settlemetns: 0.140

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
24.00	0.00	5.00	0.00	5.00	0.000
29.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 0.000

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	38	86.30	0.00	5.00	0.000	0.00
6.00	18	59.40	0.00	3.00	0.000	0.00
9.00	20	62.61	0.00	5.00	0.000	0.00
14.00	16	56.00	0.00	5.00	0.000	0.00
19.00	22	65.67	0.00	5.00	0.000	0.00
24.00	27	72.75	0.00	5.00	0.000	0.00
29.00	33	80.42	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

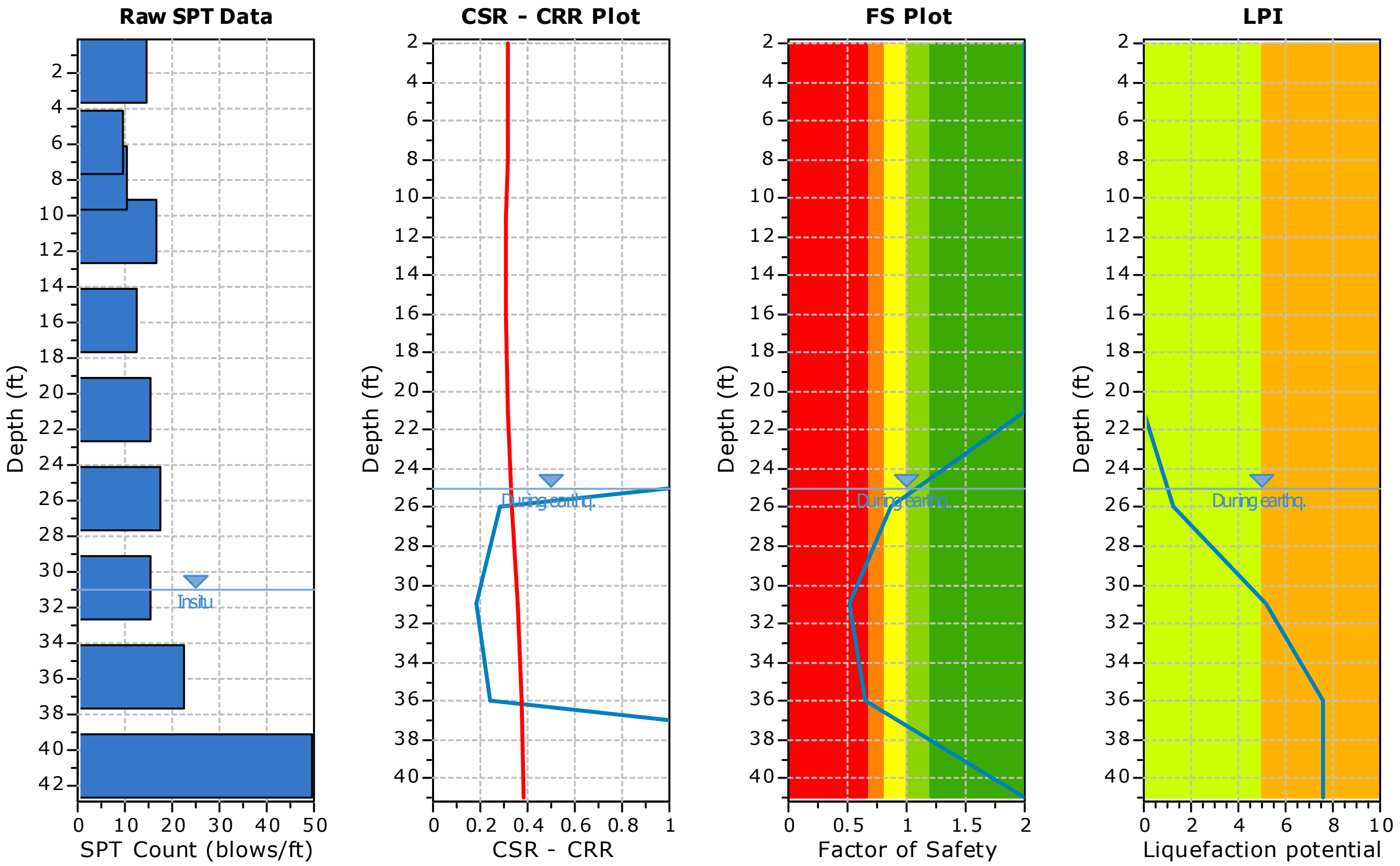
SPT BASED LIQUEFACTION ANALYSIS REPORT

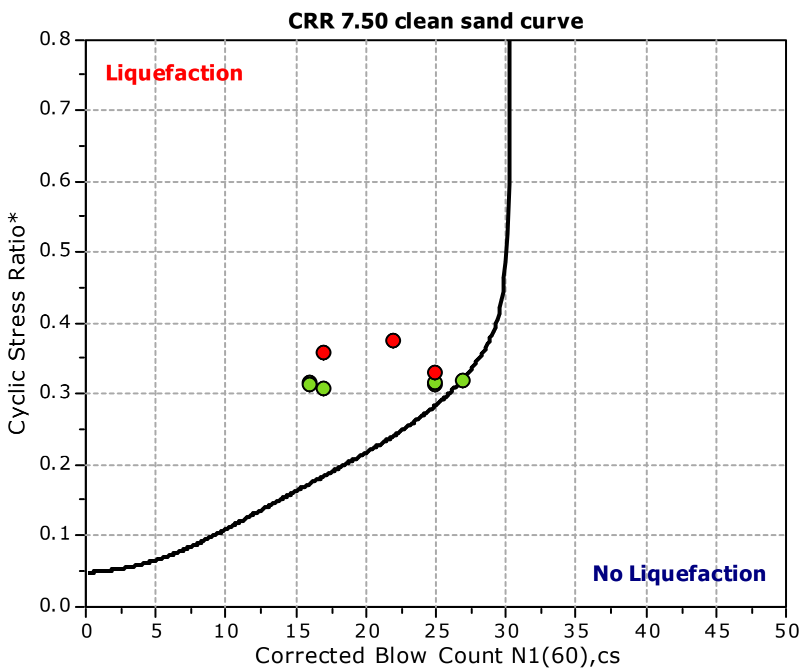
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-27**

Location : Orange County, California

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	31.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	25.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

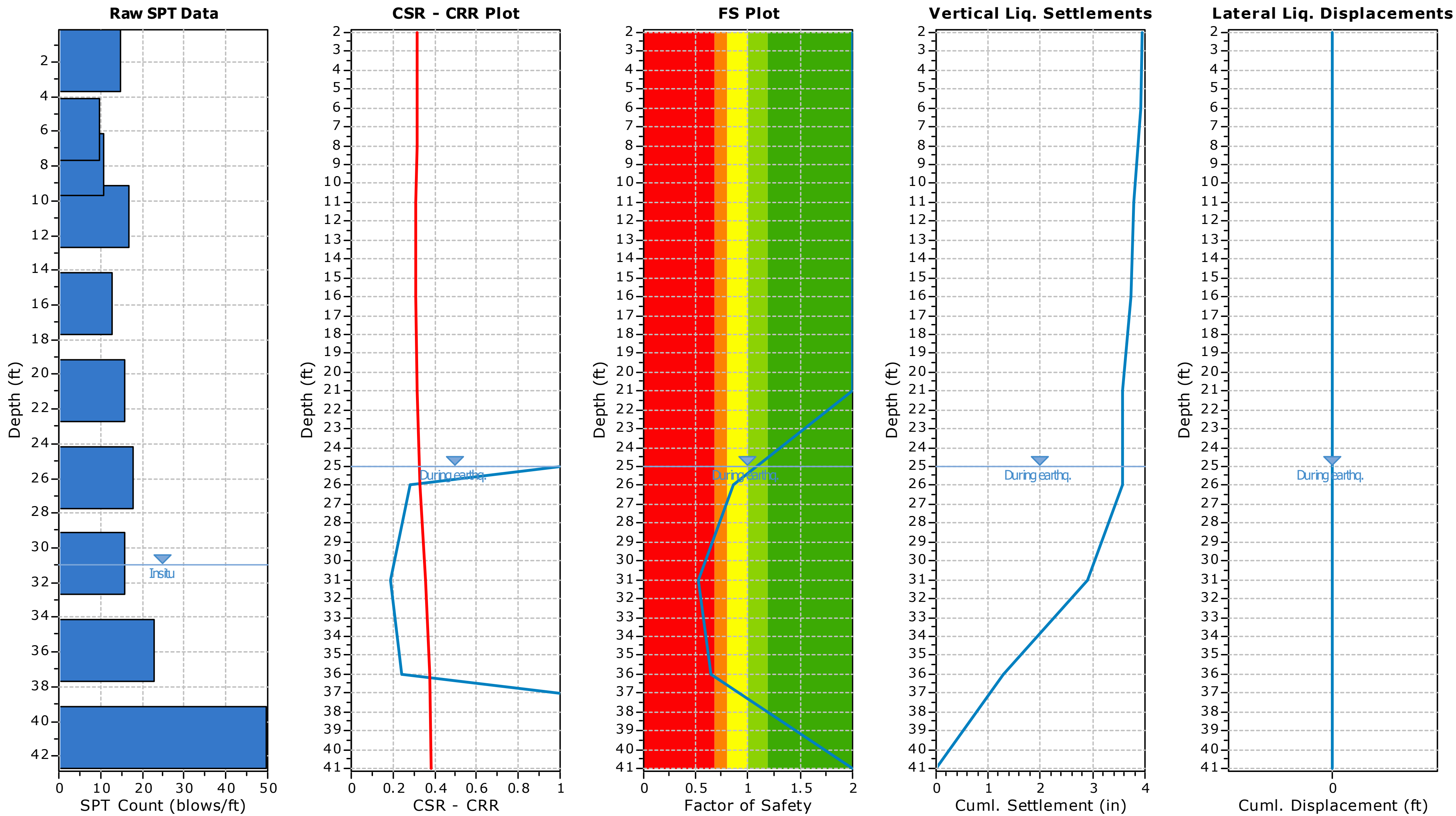




F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	15.00	120.00	5.00	Yes
6.00	10	15.00	120.00	2.00	Yes
8.00	11	15.00	120.00	3.00	Yes
11.00	17	15.00	120.00	5.00	Yes
16.00	13	15.00	120.00	5.00	Yes
21.00	16	70.00	132.00	5.00	No
26.00	18	70.00	125.00	5.00	Yes
31.00	16	15.00	125.00	5.00	Yes
36.00	23	15.00	125.00	5.00	Yes
41.00	50	30.00	130.00	5.00	No

Abbreviations

Depth:	Depth at which test was performed (ft)
SPT Field Value:	Number of blows per foot
Fines Content:	Fines content at test depth (%)
Unit Weight:	Unit weight at test depth (pcf)
Infl. Thickness:	Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy:	User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	15.00	2.50	1.05	27	4.000
6.00	10	120.00	0.36	0.00	0.36	1.43	1.20	1.00	0.75	1.00	13	15.00	2.50	1.05	16	4.000
8.00	11	120.00	0.48	0.00	0.48	1.33	1.20	1.00	0.75	1.00	13	15.00	2.50	1.05	16	4.000
11.00	17	120.00	0.66	0.00	0.66	1.21	1.20	1.00	0.85	1.00	21	15.00	2.50	1.05	25	4.000
16.00	13	120.00	0.96	0.00	0.96	1.04	1.20	1.00	0.85	1.00	14	15.00	2.50	1.05	17	4.000
21.00	16	132.00	1.29	0.00	1.29	0.91	1.20	1.00	0.95	1.00	17	70.00	5.00	1.20	25	4.000
26.00	18	125.00	1.60	0.00	1.60	0.81	1.20	1.00	0.95	1.00	17	70.00	5.00	1.20	25	0.285
31.00	16	125.00	1.92	0.00	1.92	0.73	1.20	1.00	1.00	1.00	14	15.00	2.50	1.05	17	0.185
36.00	23	125.00	2.23	0.16	2.07	0.70	1.20	1.00	1.00	1.00	19	15.00	2.50	1.05	22	0.242
41.00	50	130.00	2.55	0.31	2.24	0.66	1.20	1.00	1.00	1.00	40	30.00	4.71	1.15	51	4.000

Abbreviations

σ_v:	Total stress during SPT test (tsf)
u_o:	Water pore pressure during SPT test (tsf)
σ'_{vo}:	Effective overburden pressure during SPT test (tsf)
C_N:	Overburden corretion factor
C_E:	Energy correction factor
C_B:	Borehole diameter correction factor
C_R:	Rod length correction factor
C_S:	Liner correction factor
$N_{1(60)}$:	Corrected N_{SPT} to a 60% energy ratio
α, β:	Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$:	Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$:	Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000	●
6.00	120.00	0.36	0.00	0.36	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000	●

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
8.00	120.00	0.48	0.00	0.48	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000	●
11.00	120.00	0.66	0.00	0.66	0.98	1.00	0.413	1.32	0.312	1.00	0.312	2.000	●
16.00	120.00	0.96	0.00	0.96	0.97	1.00	0.408	1.32	0.308	1.00	0.308	2.000	●
21.00	132.00	1.29	0.00	1.29	0.95	1.00	0.403	1.32	0.304	0.96	0.317	2.000	●
26.00	125.00	1.60	0.03	1.57	0.94	1.00	0.404	1.32	0.305	0.92	0.330	0.863	●
31.00	125.00	1.92	0.19	1.73	0.92	1.00	0.429	1.32	0.324	0.91	0.357	0.517	●
36.00	125.00	2.23	0.34	1.88	0.88	1.00	0.441	1.32	0.333	0.89	0.374	0.646	●
41.00	130.00	2.55	0.50	2.05	0.84	1.00	0.442	1.32	0.334	0.88	0.381	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction
*** User FS:	1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	2.000	0.00	8.32	3.00	0.00
16.00	2.000	0.00	7.56	5.00	0.00
21.00	2.000	0.00	6.80	5.00	0.00
26.00	0.863	0.14	6.04	5.00	1.26
31.00	0.517	0.48	5.28	5.00	3.88
36.00	0.646	0.35	4.51	5.00	2.43
41.00	2.000	0.00	3.75	5.00	0.00

Overall potential I_L : 7.58

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	380.24	0.13	22838.69	0.00	0.00	8.77	0.02	5.00	0.029
6.00	13	0.15	0.24	553.18	0.14	11814.04	0.00	0.00	8.77	0.11	2.00	0.052
8.00	13	0.20	0.32	638.76	0.14	9941.12	0.00	0.00	8.77	0.12	3.00	0.084
11.00	21	0.27	0.44	869.15	0.15	8212.09	0.00	0.00	8.77	0.05	5.00	0.058
16.00	14	0.39	0.64	921.79	0.16	6558.69	0.00	0.00	8.77	0.13	5.00	0.152

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
21.00	17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.00	0.000

Cumulative settlemetns: 0.375

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
26.00	0.00	5.00	1.13	5.00	0.676
31.00	0.00	5.00	2.67	5.00	1.602
36.00	0.00	5.00	2.16	5.00	1.297
41.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 3.575

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
6.00	13	50.48	0.00	2.00	0.000	0.00
8.00	13	50.48	0.00	3.00	0.000	0.00
11.00	21	64.16	0.00	5.00	0.000	0.00
16.00	14	52.38	0.00	5.00	0.000	0.00
21.00	17	57.72	0.00	5.00	0.000	0.00
26.00	17	57.72	6.88	5.00	0.000	0.00
31.00	14	52.38	34.10	5.00	0.000	0.00
36.00	19	61.02	22.70	5.00	0.000	0.00
41.00	40	88.54	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

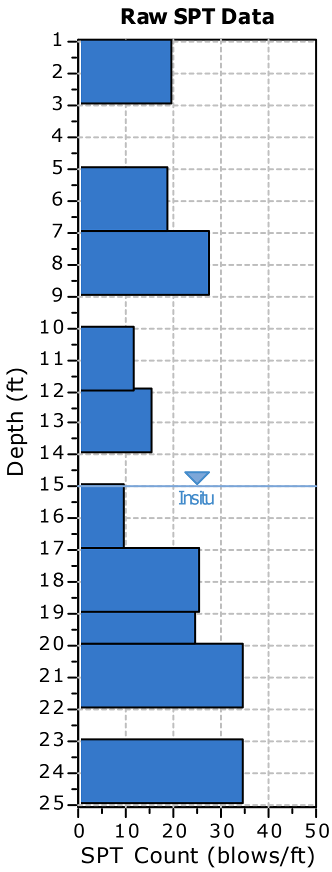
SPT BASED LIQUEFACTION ANALYSIS REPORT

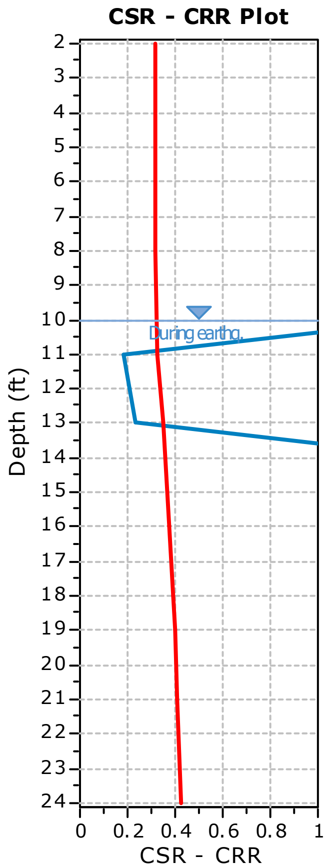
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-29**

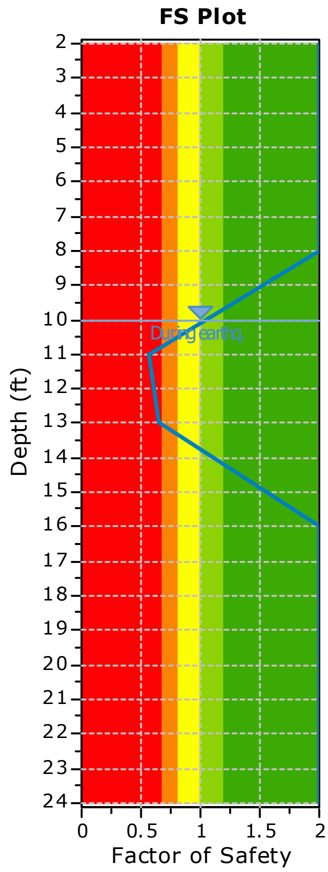
Location : Orange County, California

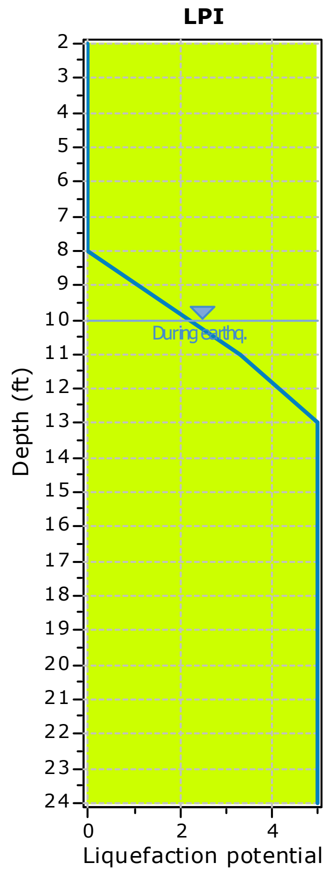
:: Input parameters and analysis properties ::

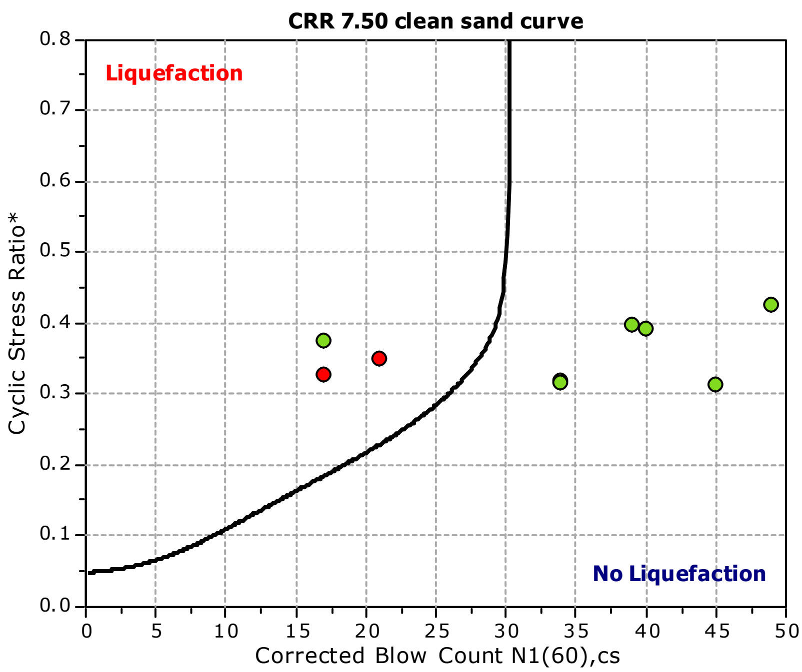
Analysis method:	NCEER 1998	G.W.T. (in-situ):	15.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	10.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		











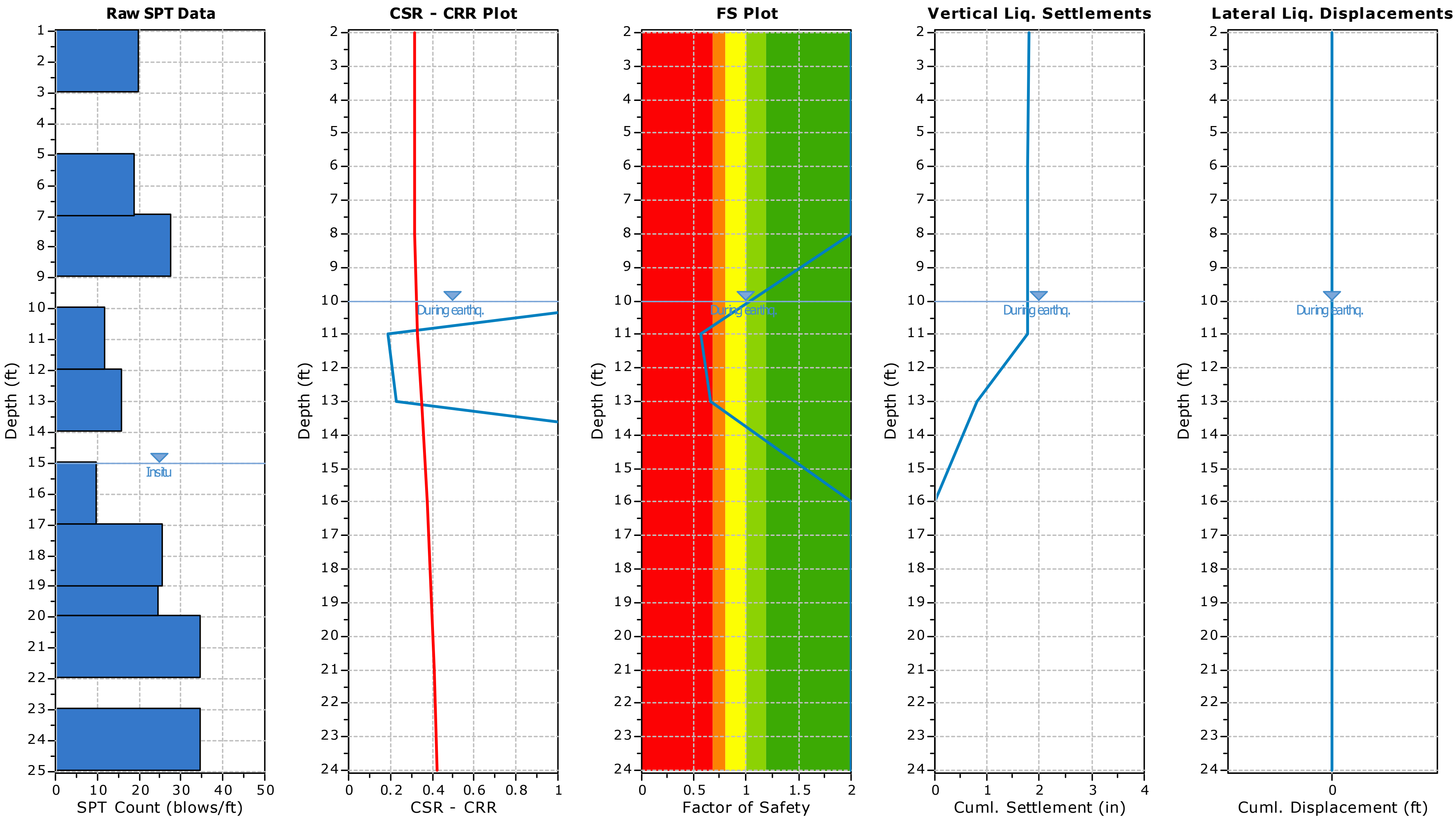
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	20	15.00	125.00	5.00	Yes
6.00	19	75.00	131.00	3.00	No
8.00	28	35.00	136.00	3.00	Yes
11.00	12	15.00	135.00	3.00	Yes
13.00	16	15.00	131.00	3.00	Yes
16.00	10	65.00	125.00	3.00	No
18.00	26	65.00	125.00	2.00	No
19.00	25	65.00	125.00	2.00	No
21.00	35	65.00	125.00	5.00	No
24.00	35	35.00	125.00	5.00	Yes

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	20	125.00	0.13	0.00	0.13	1.67	1.20	1.00	0.75	1.00	30	15.00	2.50	1.05	34	4.000
6.00	19	131.00	0.39	0.00	0.39	1.41	1.20	1.00	0.75	1.00	24	75.00	5.00	1.20	34	4.000
8.00	28	136.00	0.52	0.00	0.52	1.30	1.20	1.00	0.75	1.00	33	35.00	5.00	1.20	45	4.000
11.00	12	135.00	0.73	0.00	0.73	1.17	1.20	1.00	0.85	1.00	14	15.00	2.50	1.05	17	0.185
13.00	16	131.00	0.86	0.00	0.86	1.09	1.20	1.00	0.85	1.00	18	15.00	2.50	1.05	21	0.229
16.00	10	125.00	1.04	0.03	1.01	1.02	1.20	1.00	0.85	1.00	10	65.00	5.00	1.20	17	4.000
18.00	26	125.00	1.17	0.09	1.08	0.99	1.20	1.00	0.95	1.00	29	65.00	5.00	1.20	40	4.000
19.00	25	125.00	1.23	0.12	1.11	0.98	1.20	1.00	0.95	1.00	28	65.00	5.00	1.20	39	4.000
21.00	35	125.00	1.36	0.19	1.17	0.95	1.20	1.00	0.95	1.00	38	65.00	5.00	1.20	51	4.000
24.00	35	125.00	1.54	0.28	1.26	0.92	1.20	1.00	0.95	1.00	37	35.00	5.00	1.20	49	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	125.00	0.13	0.00	0.13	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
6.00	131.00	0.39	0.00	0.39	0.99	1.00	0.417	1.32	0.315	1.00	0.315	2.000

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
8.00	136.00	0.52	0.00	0.52	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000	●
11.00	135.00	0.73	0.03	0.69	0.98	1.00	0.431	1.32	0.326	1.00	0.326	0.567	●
13.00	131.00	0.86	0.09	0.76	0.97	1.00	0.461	1.32	0.348	1.00	0.348	0.658	●
16.00	125.00	1.04	0.19	0.86	0.97	1.00	0.498	1.32	0.376	1.00	0.376	2.000	●
18.00	125.00	1.17	0.25	0.92	0.96	1.00	0.517	1.32	0.390	1.00	0.390	2.000	●
19.00	125.00	1.23	0.28	0.95	0.96	1.00	0.525	1.32	0.397	1.00	0.397	2.000	●
21.00	125.00	1.36	0.34	1.01	0.95	1.00	0.540	1.32	0.408	1.00	0.408	2.000	●
24.00	125.00	1.54	0.44	1.11	0.95	1.00	0.557	1.32	0.421	0.99	0.424	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	4.00	0.00
6.00	2.000	0.00	9.09	4.00	0.00
8.00	2.000	0.00	8.78	2.00	0.00
11.00	0.567	0.43	8.32	3.00	3.29
13.00	0.658	0.34	8.02	2.00	1.67
16.00	2.000	0.00	7.56	3.00	0.00
18.00	2.000	0.00	7.26	2.00	0.00
19.00	2.000	0.00	7.10	1.00	0.00
21.00	2.000	0.00	6.80	2.00	0.00
24.00	2.000	0.00	6.34	3.00	0.00

Overall potential I_L : 4.96

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	30	0.05	0.08	419.08	0.13	22286.09	0.00	0.00	8.77	0.01	5.00	0.017
6.00	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.00	0.000
8.00	33	0.22	0.35	941.17	0.14	9442.33	0.00	0.00	8.77	0.01	3.00	0.010

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.027

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
11.00	0.00	5.00	2.67	3.00	0.961
13.00	0.00	5.00	2.25	3.00	0.808
16.00	0.00	5.00	0.00	3.00	0.000
18.00	0.00	5.00	0.00	2.00	0.000
19.00	0.00	5.00	0.00	2.00	0.000
21.00	0.00	5.00	0.00	5.00	0.000
24.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.769

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	30	76.68	0.00	5.00	0.000	0.00
6.00	24	68.59	0.00	3.00	0.000	0.00
8.00	33	80.42	0.00	3.00	0.000	0.00
11.00	14	52.38	34.10	3.00	0.000	0.00
13.00	18	59.40	22.70	3.00	0.000	0.00
16.00	10	44.27	0.00	3.00	0.000	0.00
18.00	29	75.39	0.00	2.00	0.000	0.00
19.00	28	74.08	0.00	2.00	0.000	0.00
21.00	38	86.30	0.00	5.00	0.000	0.00
24.00	37	85.16	0.00	5.00	0.000	0.00

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

Leighton Consulting, Inc.
Irvine, California

Project No. 11585.005

SPT BASED LIQUEFACTION ANALYSIS REPORT

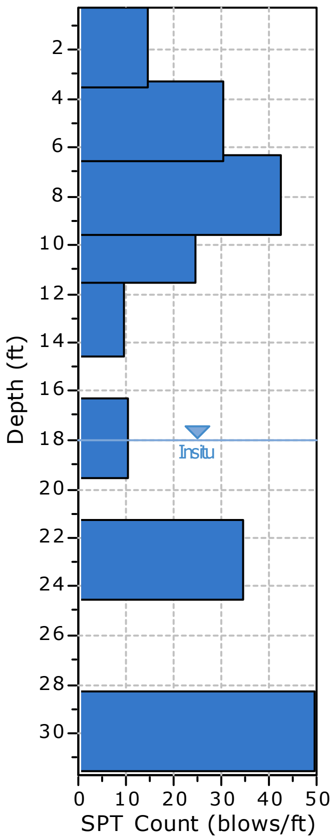
Project title : Brea Boulevard Corridor Improvements **SPT Name: LB-38**

Location : Orange County, California

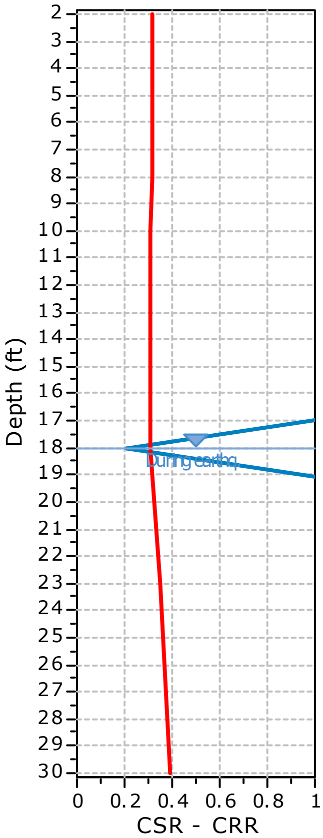
:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	18.00 ft
Fines correction method:	NCEER 1998	G.W.T. (earthq.):	18.00 ft
Sampling method:	Standard Sampler	Earthquake magnitude M_w:	6.72
Borehole diameter:	65mm to 115mm	Peak ground acceleration:	0.65 g
Rod length:	3.30 ft	Eq. external load:	0.00 tsf
Hammer energy ratio:	1.20		

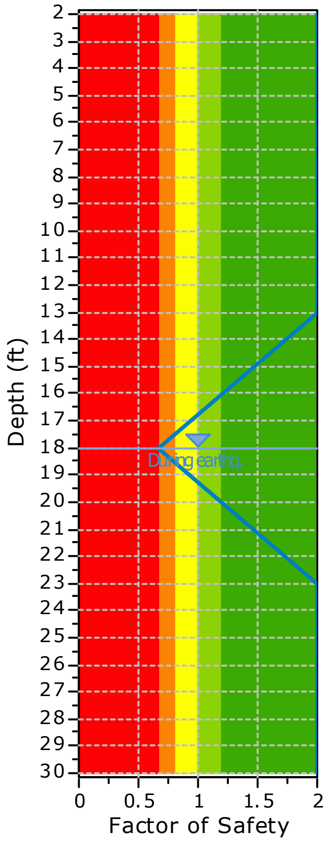
Raw SPT Data



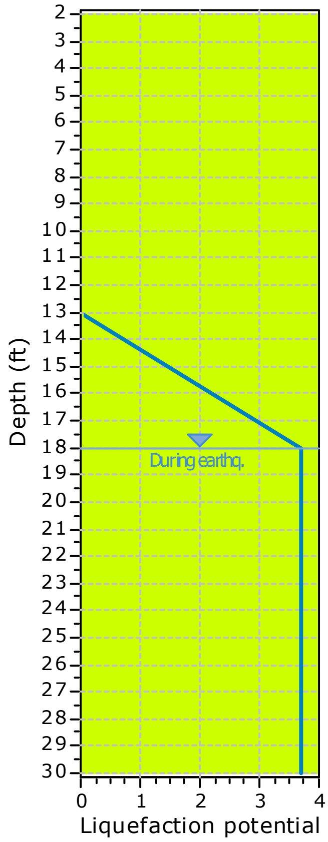
CSR - CRR Plot



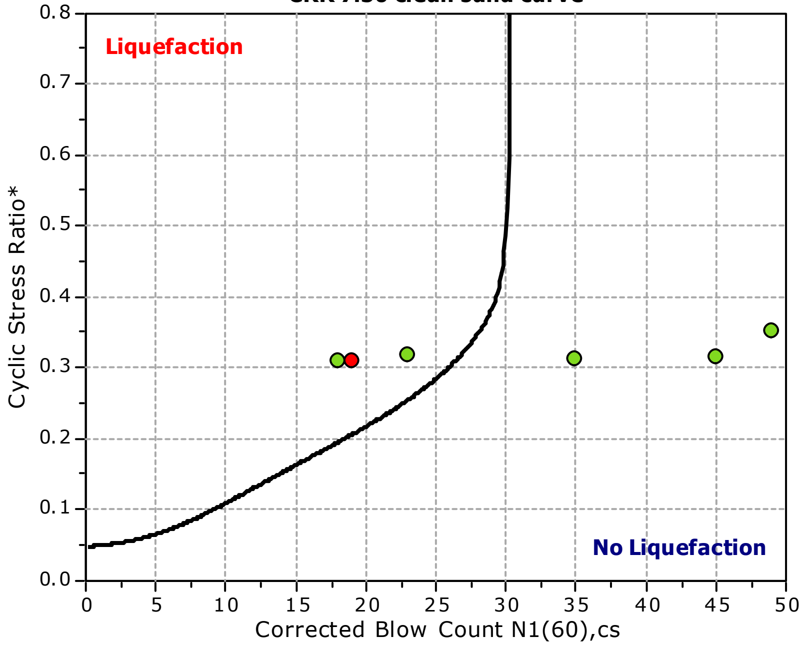
FS Plot



LPI



CRR 7.50 clean sand curve



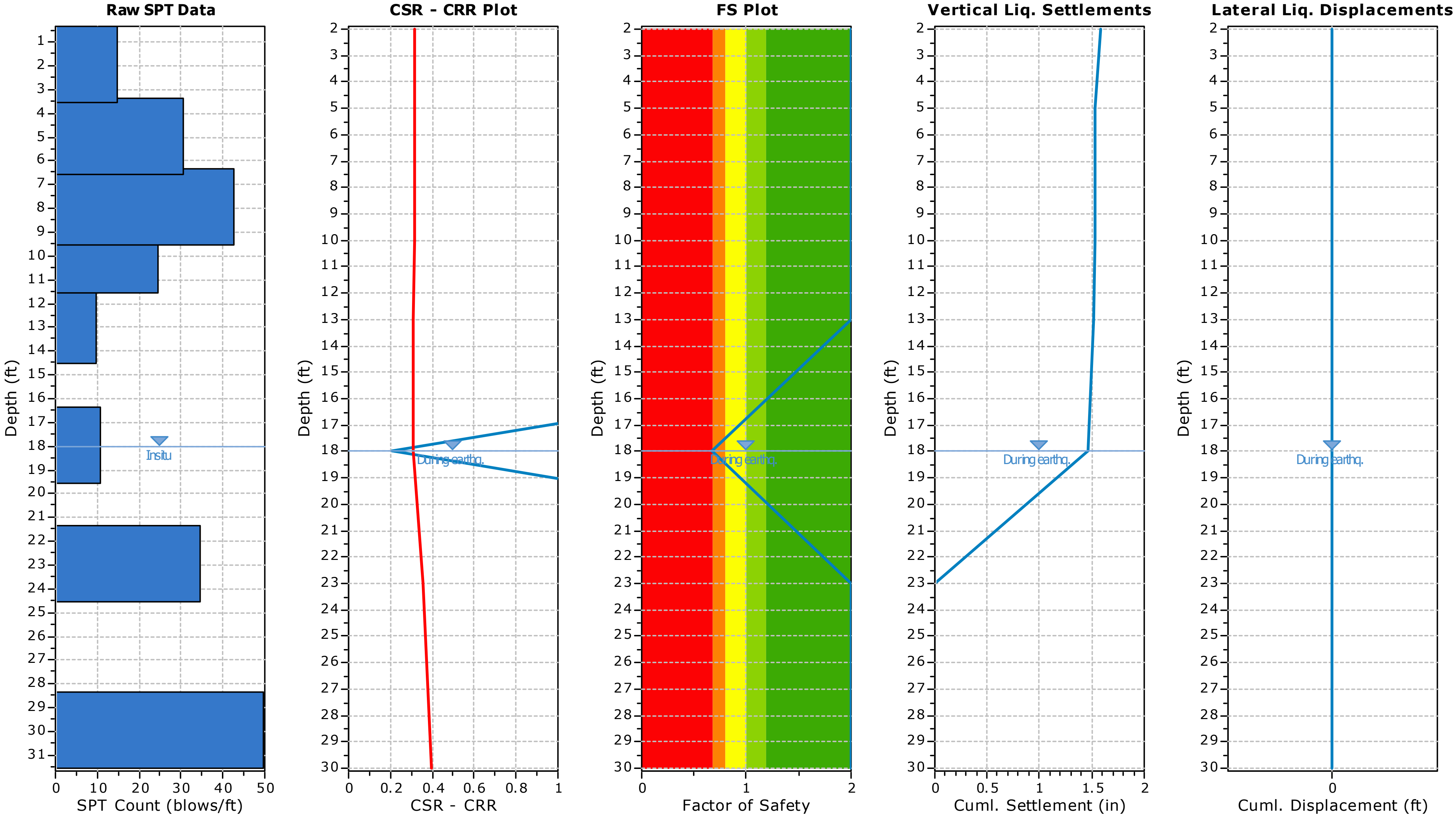
F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

:: Overall Liquefaction Assessment Analysis Plots ::



:: Field input data ::

Test Depth (ft)	SPT Field Value (blows)	Fines Content (%)	Unit Weight (pcf)	Infl. Thickness (ft)	Can Liquefy
2.00	15	5.00	120.00	5.00	Yes
5.00	31	15.00	127.00	3.00	Yes
8.00	43	15.00	125.00	2.00	Yes
10.00	25	15.00	131.00	2.00	Yes
13.00	10	60.00	120.00	2.00	Yes
18.00	11	60.00	123.00	5.00	Yes
23.00	35	70.00	125.00	3.00	No
30.00	50	60.00	130.00	5.00	No

Abbreviations

Depth: Depth at which test was performed (ft)
SPT Field Value: Number of blows per foot
Fines Content: Fines content at test depth (%)
Unit Weight: Unit weight at test depth (pcf)
Infl. Thickness: Thickness of the soil layer to be considered in settlements analysis (ft)
Can Liquefy: User defined switch for excluding/including test depth from the analysis procedure

:: Cyclic Resistance Ratio (CRR) calculation data ::

Depth (ft)	SPT Field Value	Unit Weight (pcf)	σ_v (tsf)	u_o (tsf)	σ'_{vo} (tsf)	C_N	C_E	C_B	C_R	C_S	$(N_1)_{60}$	Fines Content (%)	α	β	$(N_1)_{60cs}$	$CRR_{7.5}$
2.00	15	120.00	0.12	0.00	0.12	1.68	1.20	1.00	0.75	1.00	23	5.00	0.00	1.00	23	4.000
5.00	31	127.00	0.31	0.00	0.31	1.47	1.20	1.00	0.75	1.00	41	15.00	2.50	1.05	45	4.000
8.00	43	125.00	0.50	0.00	0.50	1.32	1.20	1.00	0.75	1.00	51	15.00	2.50	1.05	56	4.000
10.00	25	131.00	0.63	0.00	0.63	1.23	1.20	1.00	0.85	1.00	31	15.00	2.50	1.05	35	4.000
13.00	10	120.00	0.81	0.00	0.81	1.12	1.20	1.00	0.85	1.00	11	60.00	5.00	1.20	18	4.000
18.00	11	123.00	1.12	0.00	1.12	0.98	1.20	1.00	0.95	1.00	12	60.00	5.00	1.20	19	0.206
23.00	35	125.00	1.43	0.16	1.27	0.92	1.20	1.00	0.95	1.00	37	70.00	5.00	1.20	49	4.000
30.00	50	130.00	1.88	0.37	1.51	0.84	1.20	1.00	1.00	1.00	50	60.00	5.00	1.20	65	4.000

Abbreviations

σ_v: Total stress during SPT test (tsf)
u_o: Water pore pressure during SPT test (tsf)
σ'_{vo}: Effective overburden pressure during SPT test (tsf)
C_N: Overburden corretion factor
C_E: Energy correction factor
C_B: Borehole diameter correction factor
C_R: Rod length correction factor
C_S: Liner correction factor
$N_{1(60)}$: Corrected N_{SPT} to a 60% energy ratio
α, β: Clean sand equivalent clean sand formula coefficients
$N_{1(60)cs}$: Corected $N_{1(60)}$ value for fines content
$CRR_{7.5}$: Cydic resistance ratio for M=7.5

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS
2.00	120.00	0.12	0.00	0.12	1.00	1.00	0.421	1.32	0.318	1.00	0.318	2.000
5.00	127.00	0.31	0.00	0.31	0.99	1.00	0.418	1.32	0.316	1.00	0.316	2.000
8.00	125.00	0.50	0.00	0.50	0.98	1.00	0.416	1.32	0.314	1.00	0.314	2.000
10.00	131.00	0.63	0.00	0.63	0.98	1.00	0.414	1.32	0.312	1.00	0.312	2.000
13.00	120.00	0.81	0.00	0.81	0.97	1.00	0.411	1.32	0.310	1.00	0.310	2.000
18.00	123.00	1.12	0.00	1.12	0.96	1.00	0.406	1.32	0.307	0.99	0.310	0.665

:: Cyclic Stress Ratio calculation (CSR fully adjusted and normalized) ::

Depth (ft)	Unit Weight (pcf)	$\sigma_{v,eq}$ (tsf)	$u_{o,eq}$ (tsf)	$\sigma'_{vo,eq}$ (tsf)	r_d	α	CSR	MSF	$CSR_{eq,M=7.5}$	K_{sigma}	CSR^*	FS	
23.00	125.00	1.43	0.16	1.27	0.95	1.00	0.450	1.32	0.340	0.96	0.353	2.000	●
30.00	130.00	1.88	0.37	1.51	0.92	1.00	0.485	1.32	0.367	0.93	0.394	2.000	●

Abbreviations

$\sigma_{v,eq}$:	Total overburden pressure at test point, during earthquake (tsf)
$u_{o,eq}$:	Water pressure at test point, during earthquake (tsf)
$\sigma'_{vo,eq}$:	Effective overburden pressure, during earthquake (tsf)
r_d :	Nonlinear shear mass factor
α:	Improvement factor due to stone columns
CSR :	Cyclic Stress Ratio (adjusted for improvement)
MSF :	Magnitude Scaling Factor
$CSR_{eq,M=7.5}$:	CSR adjusted for M=7.5
K_{sigma}:	Effective overburden stress factor
CSR^*:	CSR fully adjusted (user FS applied)***
FS:	Calculated factor of safety against soil liquefaction

*** User FS: 1.00

:: Liquefaction potential according to Iwasaki ::

Depth (ft)	FS	F	wz	Thickness (ft)	I_L
2.00	2.000	0.00	9.70	3.00	0.00
5.00	2.000	0.00	9.24	3.00	0.00
8.00	2.000	0.00	8.78	3.00	0.00
10.00	2.000	0.00	8.48	2.00	0.00
13.00	2.000	0.00	8.02	3.00	0.00
18.00	0.665	0.33	7.26	5.00	3.70
23.00	2.000	0.00	6.49	5.00	0.00
30.00	2.000	0.00	5.43	7.00	0.00

Overall potential I_L : 3.70

I_L = 0.00 - No liquefaction
I_L between 0.00 and 5 - Liquefaction not probable
I_L between 5 and 15 - Liquefaction probable
I_L > 15 - Liquefaction certain

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)
2.00	23	0.05	0.08	360.45	0.13	22838.69	0.00	0.00	8.77	0.03	5.00	0.041
5.00	41	0.13	0.21	725.18	0.14	12910.50	0.00	0.00	8.77	0.01	3.00	0.008
8.00	51	0.21	0.33	987.85	0.14	9723.94	0.00	0.00	8.77	0.01	2.00	0.004
10.00	31	0.26	0.42	949.20	0.15	8452.59	0.00	0.00	8.77	0.02	2.00	0.012
13.00	11	0.33	0.54	862.47	0.16	7267.93	0.00	0.00	8.77	0.11	2.00	0.051

:: Vertical settlements estimation for dry sands ::

Depth (ft)	$(N_1)_{60}$	τ_{av}	p	G_{max} (tsf)	α	b	γ	ε_{15}	N_c	ε_{Nc} (%)	Δh (ft)	ΔS (in)

Cumulative settlemetns: 0.116

Abbreviations

τ_{av}: Average cyclic shear stress
p: Average stress
G_{max}: Maximum shear modulus (tsf)
α, b: Shear strain formula variables
γ: Average shear strain
ε_{15}: Volumetric strain after 15 cycles
N_c: Number of cycles
ε_{Nc}: Volumetric strain for number of cycles N_c (%)
Δh: Thickness of soil layer (in)
ΔS: Settlement of soil layer (in)

:: Vertical settlements estimation for saturated sands ::

Depth (ft)	D_{50} (in)	q_c/N	e_v (%)	Δh (ft)	s (in)
18.00	0.00	5.00	2.44	5.00	1.462
23.00	0.00	5.00	0.00	3.00	0.000
30.00	0.00	5.00	0.00	5.00	0.000

Cumulative settlements: 1.462

Abbreviations

D_{50}: Median grain size (in)
q_c/N: Ratio of cone resistance to SPT
e_v: Post liquefaction volumetric strain (%)
Δh: Thickness of soil layer to be considered (ft)
s: Estimated settlement (in)

:: Lateral displacements estimation for saturated sands ::

Depth (ft)	$(N_1)_{60}$	D_r (%)	γ_{max} (%)	d_z (ft)	LDI	LD (ft)
2.00	23	67.14	0.00	5.00	0.000	0.00
5.00	41	89.64	0.00	3.00	0.000	0.00
8.00	51	100.00	0.00	2.00	0.000	0.00
10.00	31	77.95	0.00	2.00	0.000	0.00
13.00	11	46.43	0.00	2.00	0.000	0.00
18.00	12	48.50	34.10	5.00	0.000	0.00
23.00	37	85.16	0.00	3.00	0.000	0.00
30.00	50	100.00	0.00	5.00	0.000	0.00

Cumulative lateral displacements: 0.00

Abbreviations

D_r: Relative density (%)
γ_{max}: Maximum amplitude of cyclic shear strain (%)
d_z: Soil layer thickness (ft)
LDI: Lateral displacement index (ft)
LD: Actual estimated displacement (ft)

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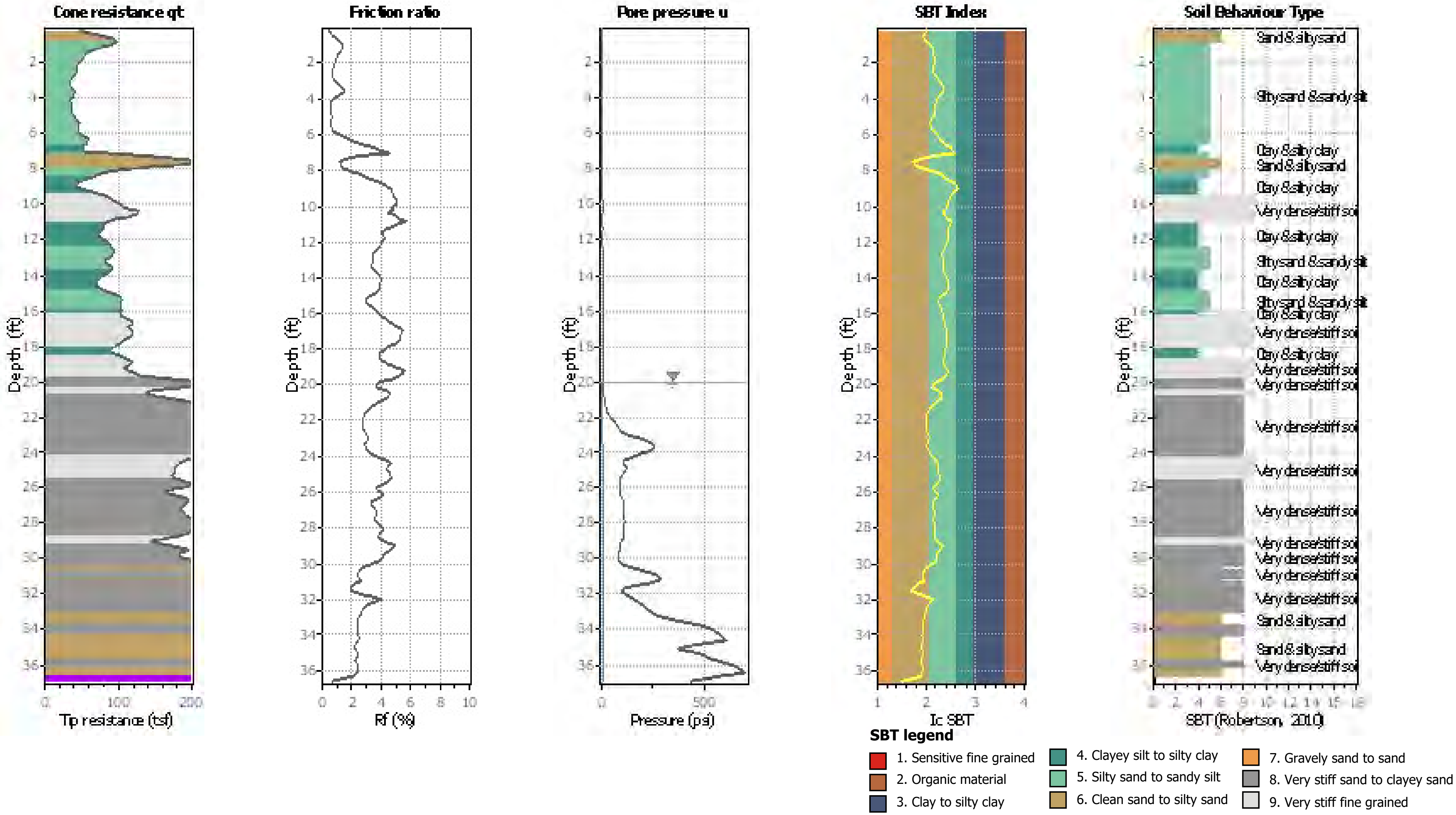
APPENDIX D.3

CPT Interpretations and Property Correlations

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

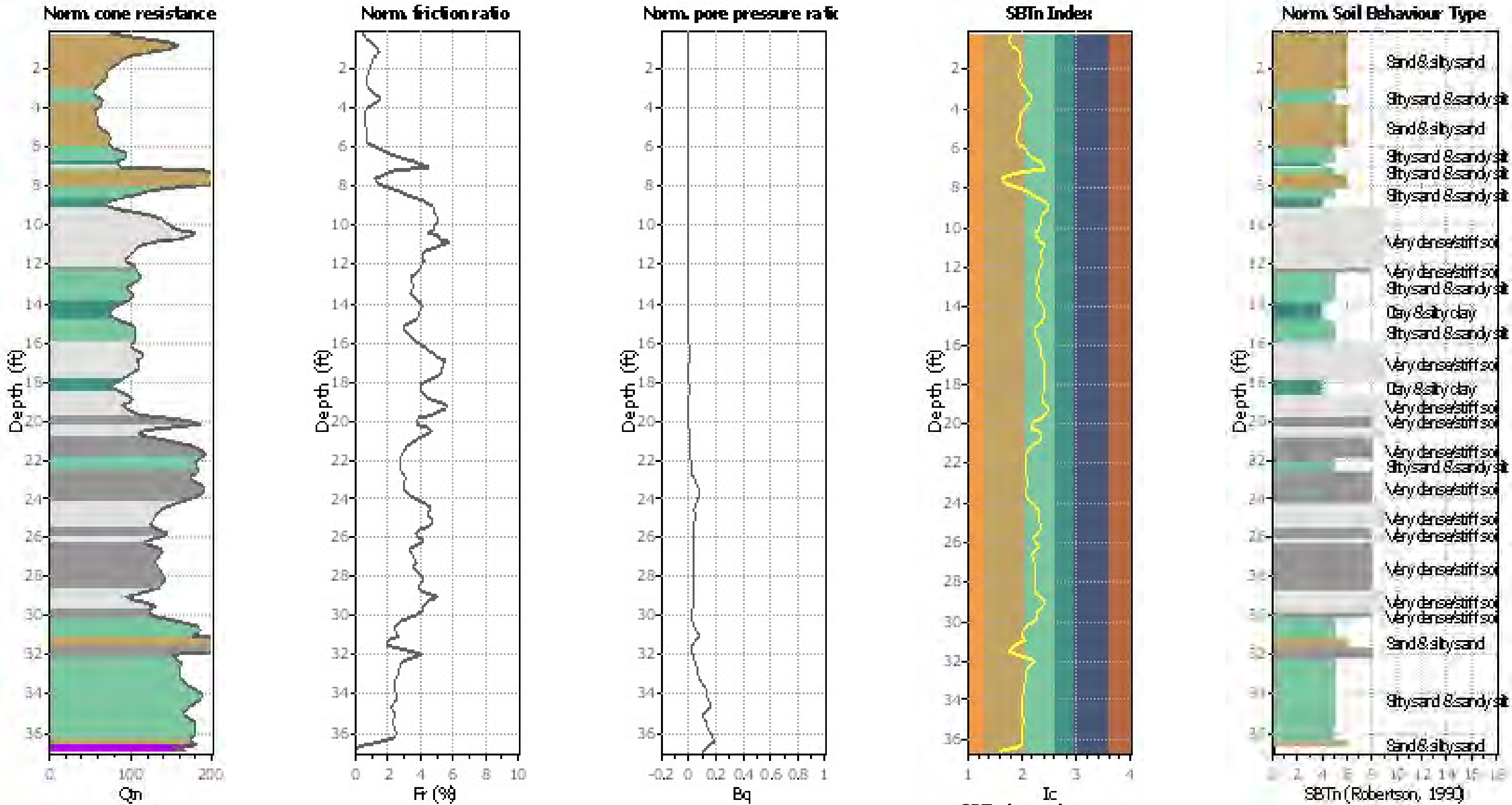
Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



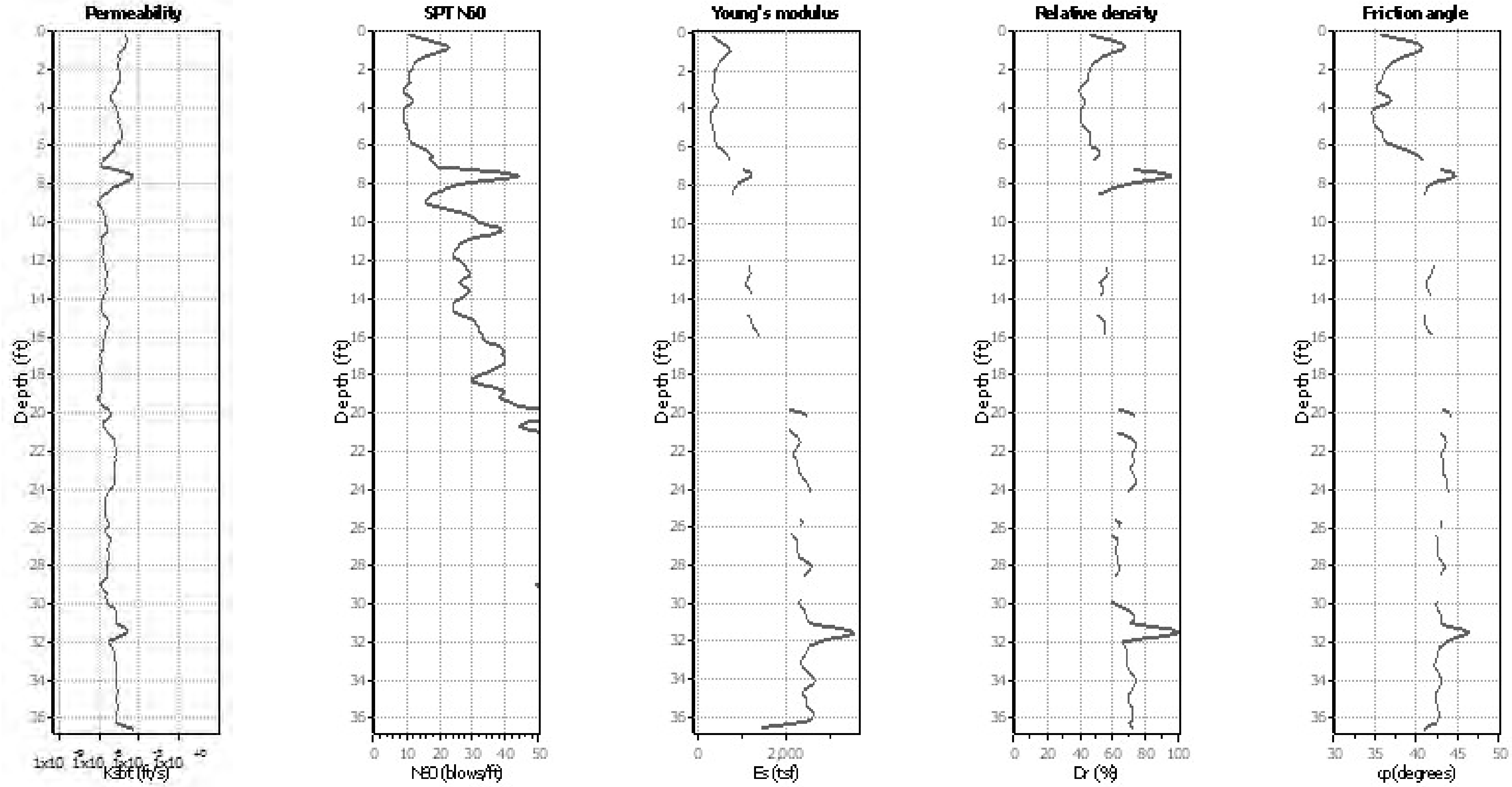
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

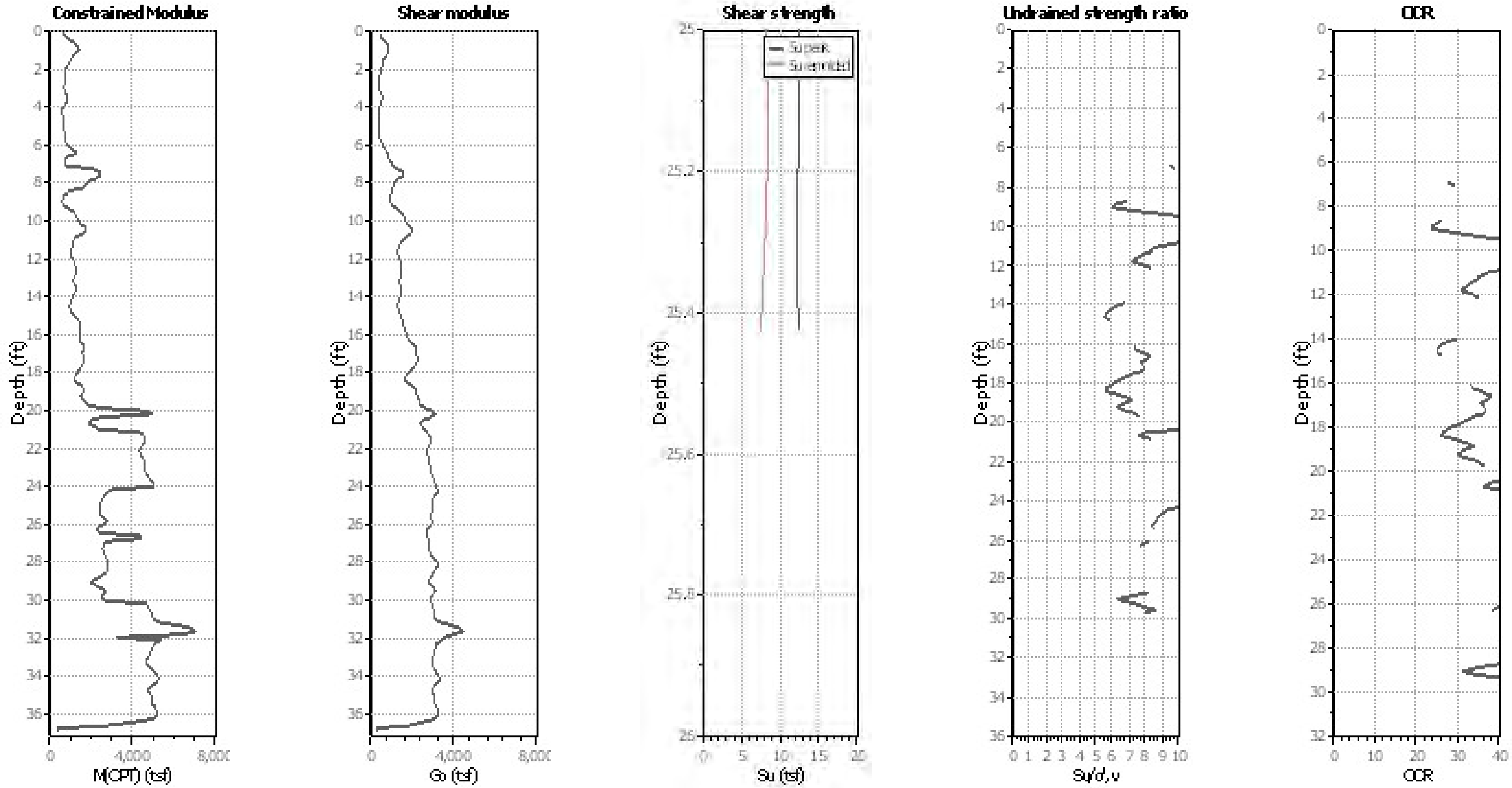


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

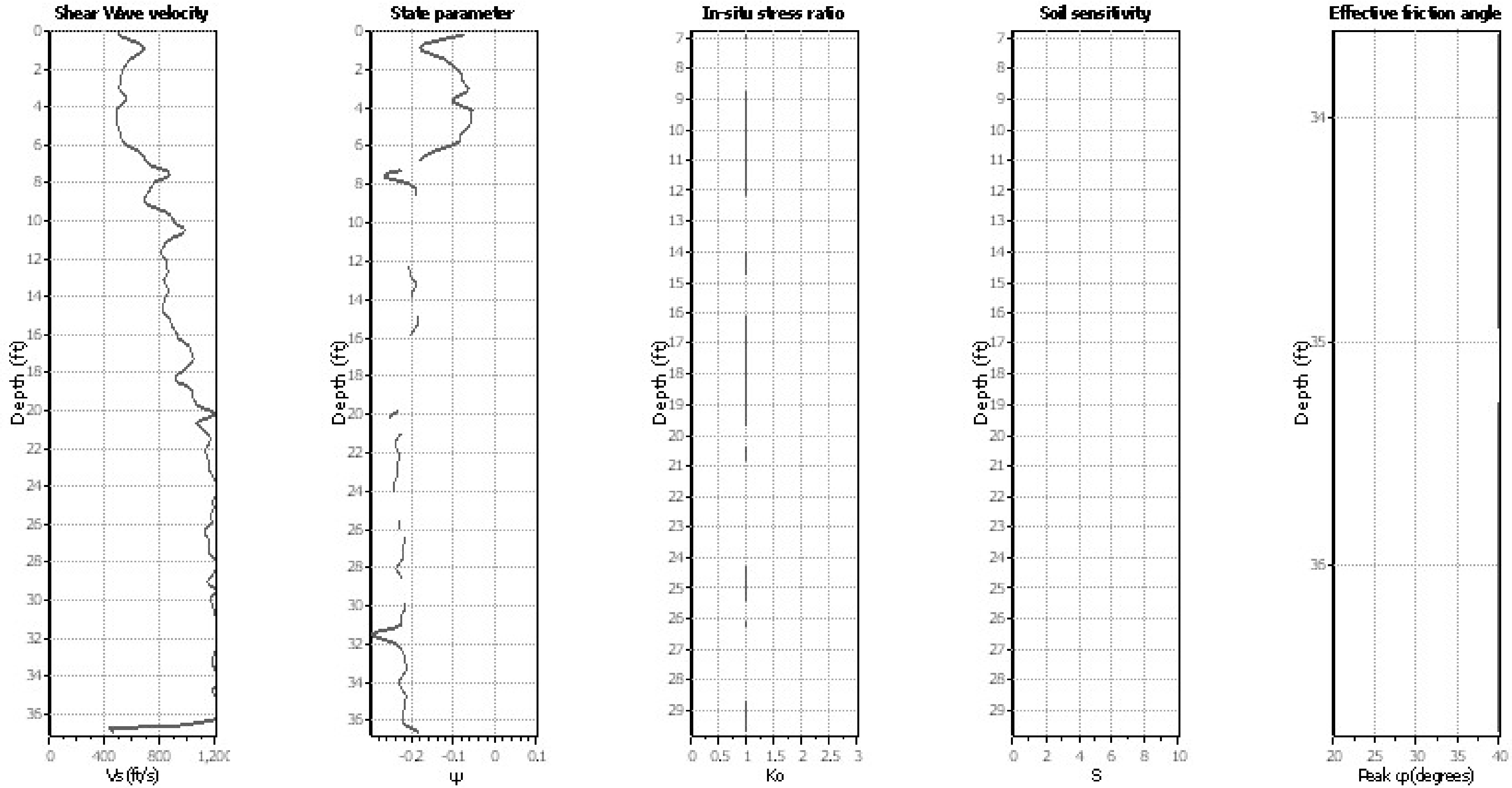
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-2
Total depth: 36.91 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

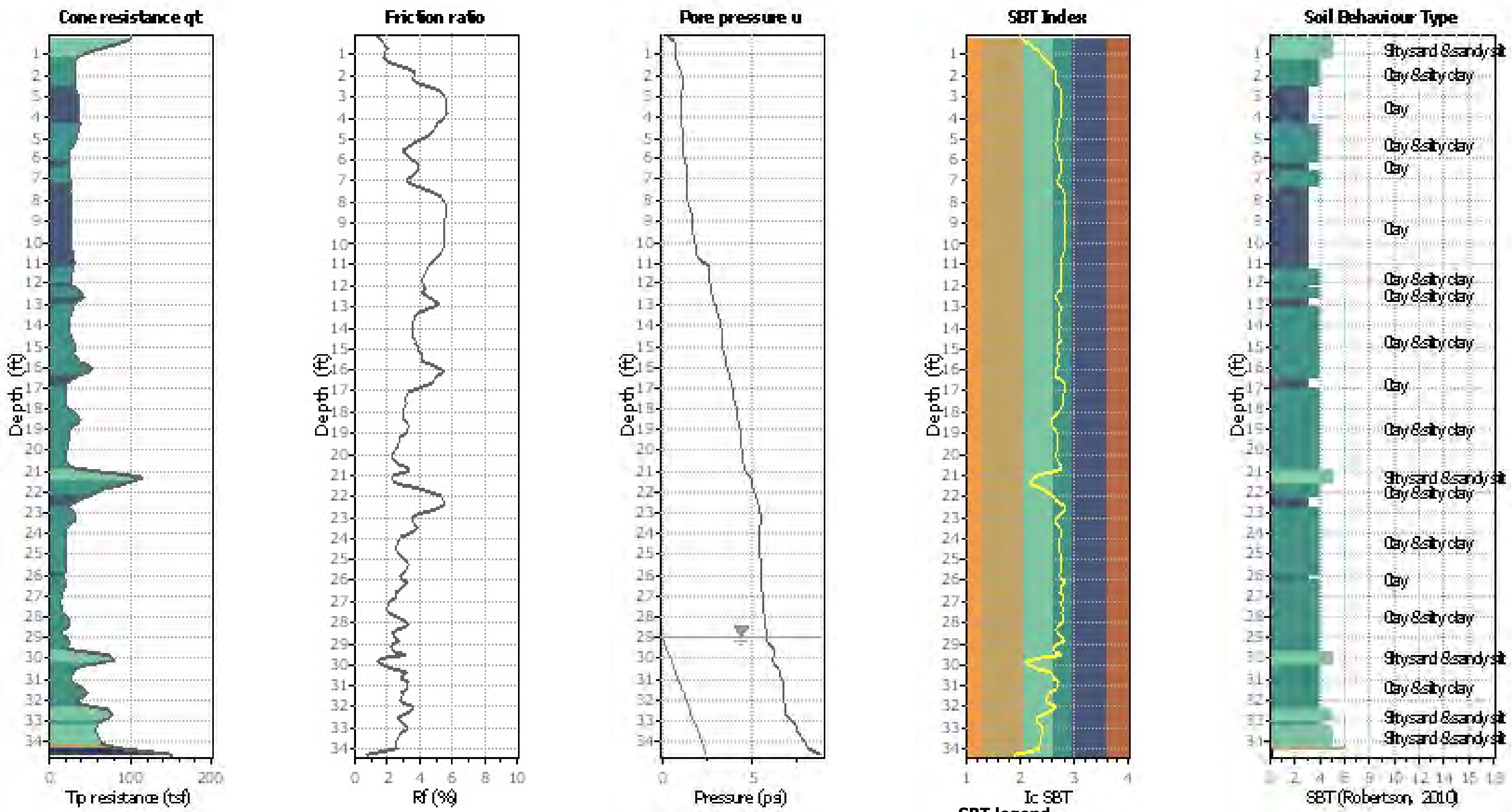
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



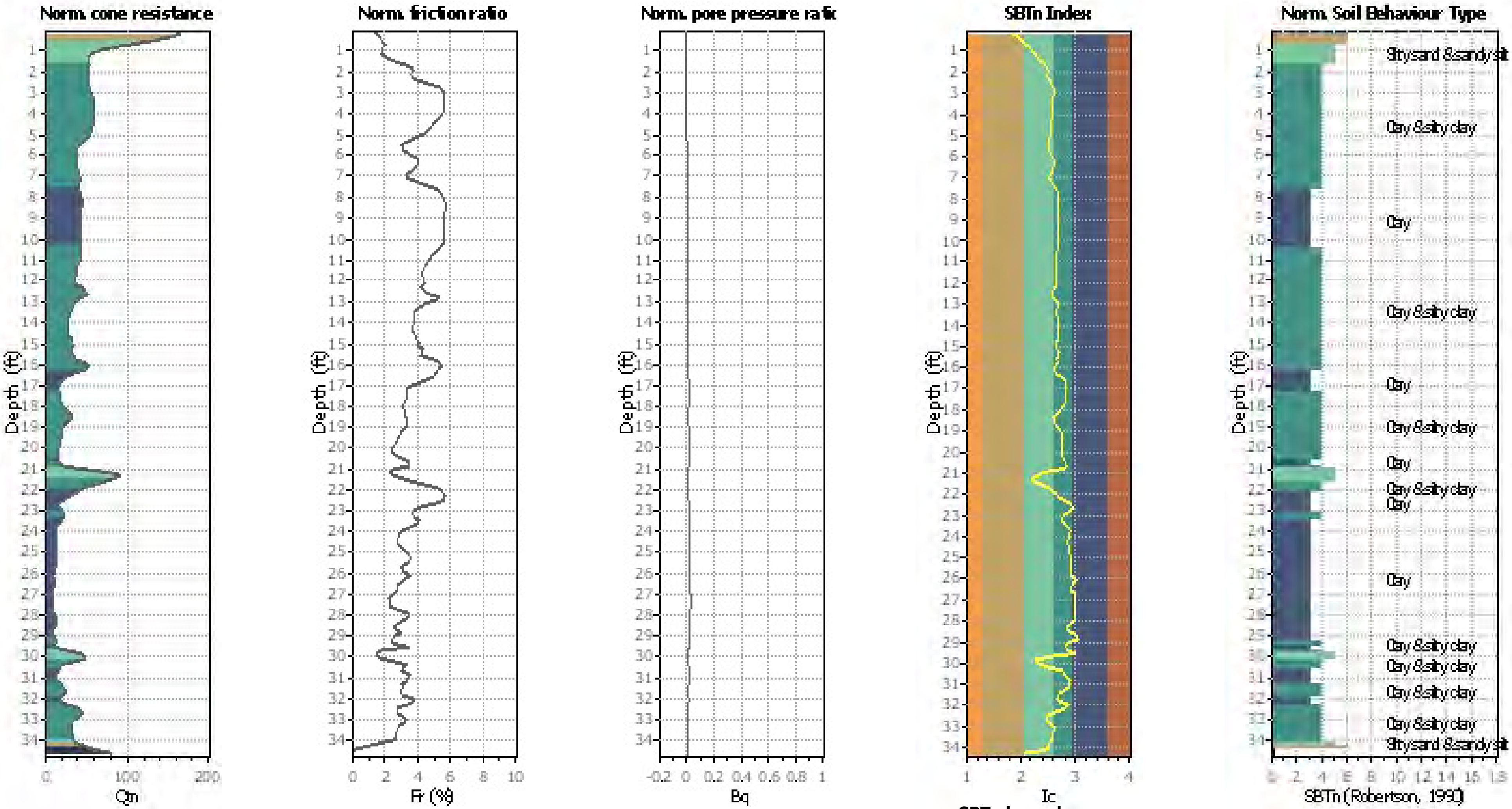
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



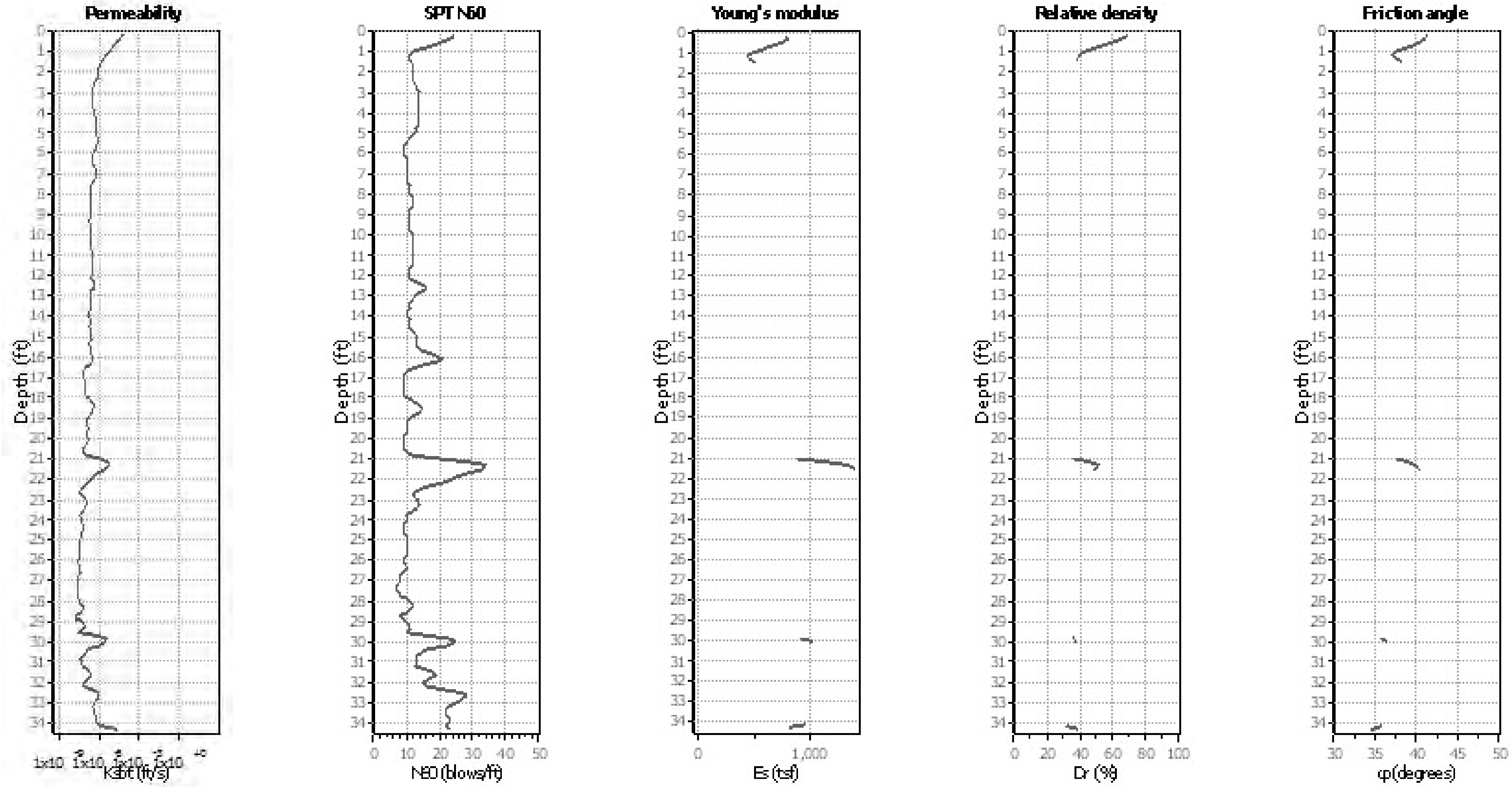
SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

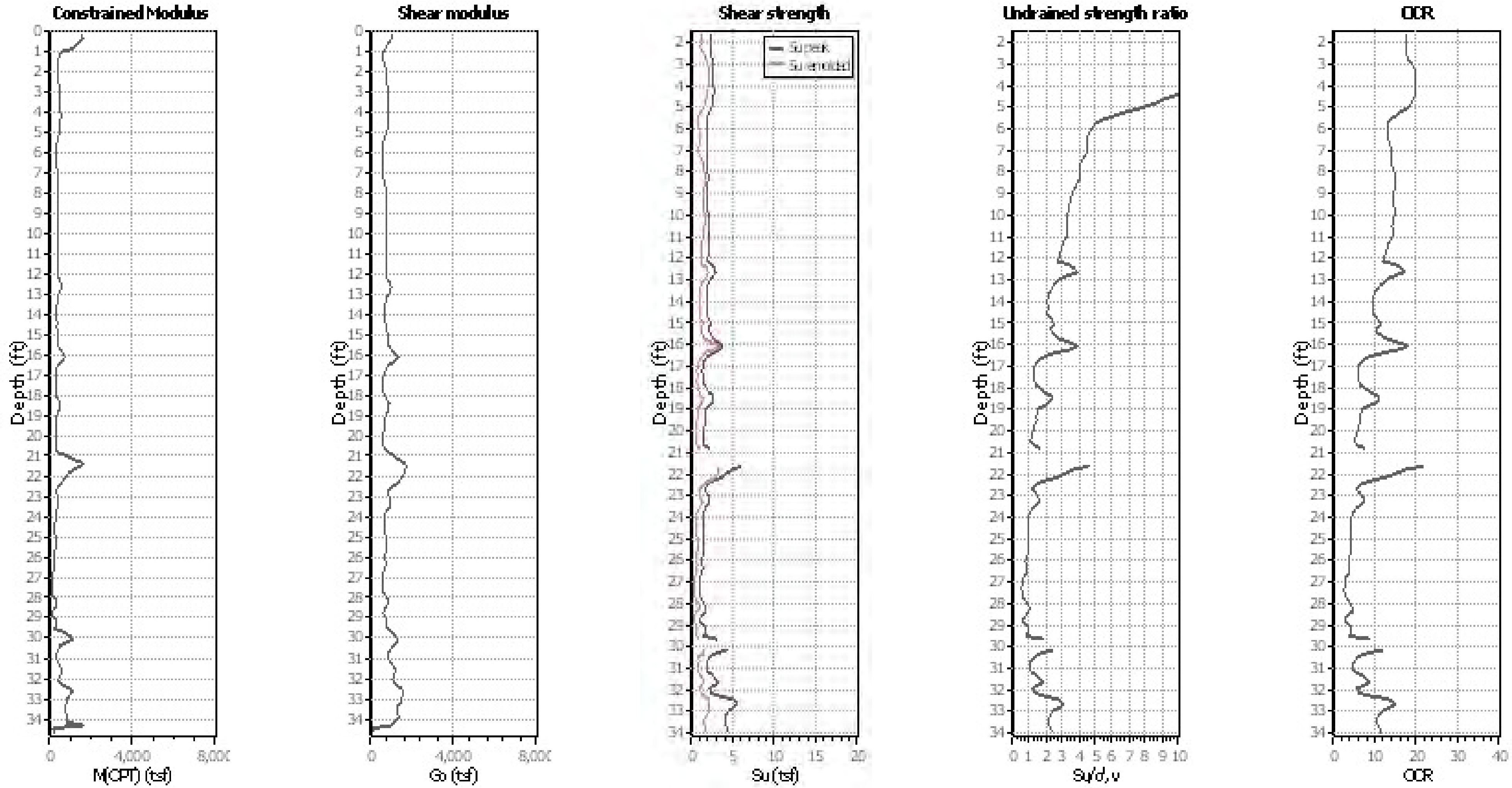


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



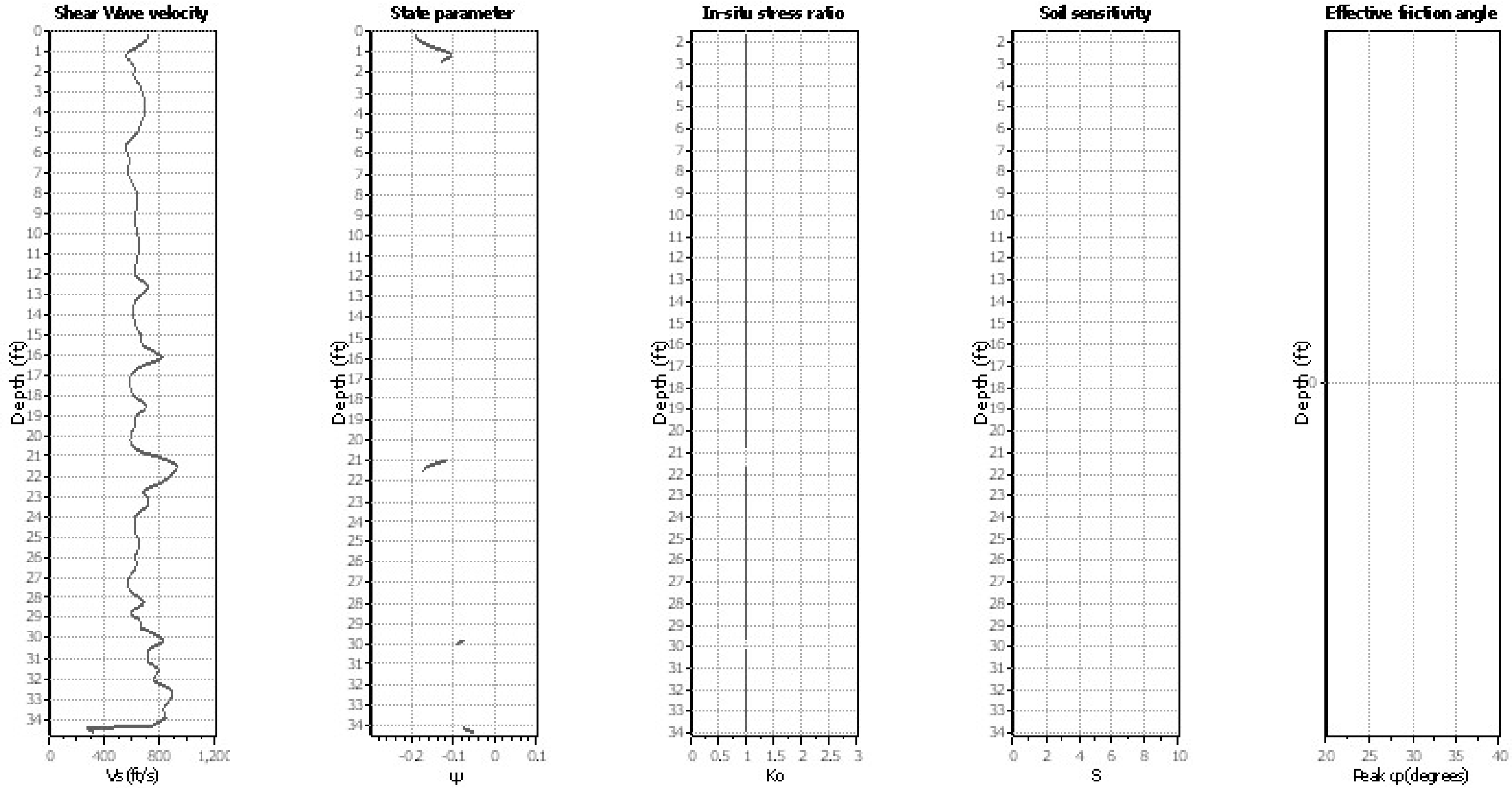
Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-4
Total depth: 34.61 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00
User defined estimation data

Leighton Consulting, Inc.
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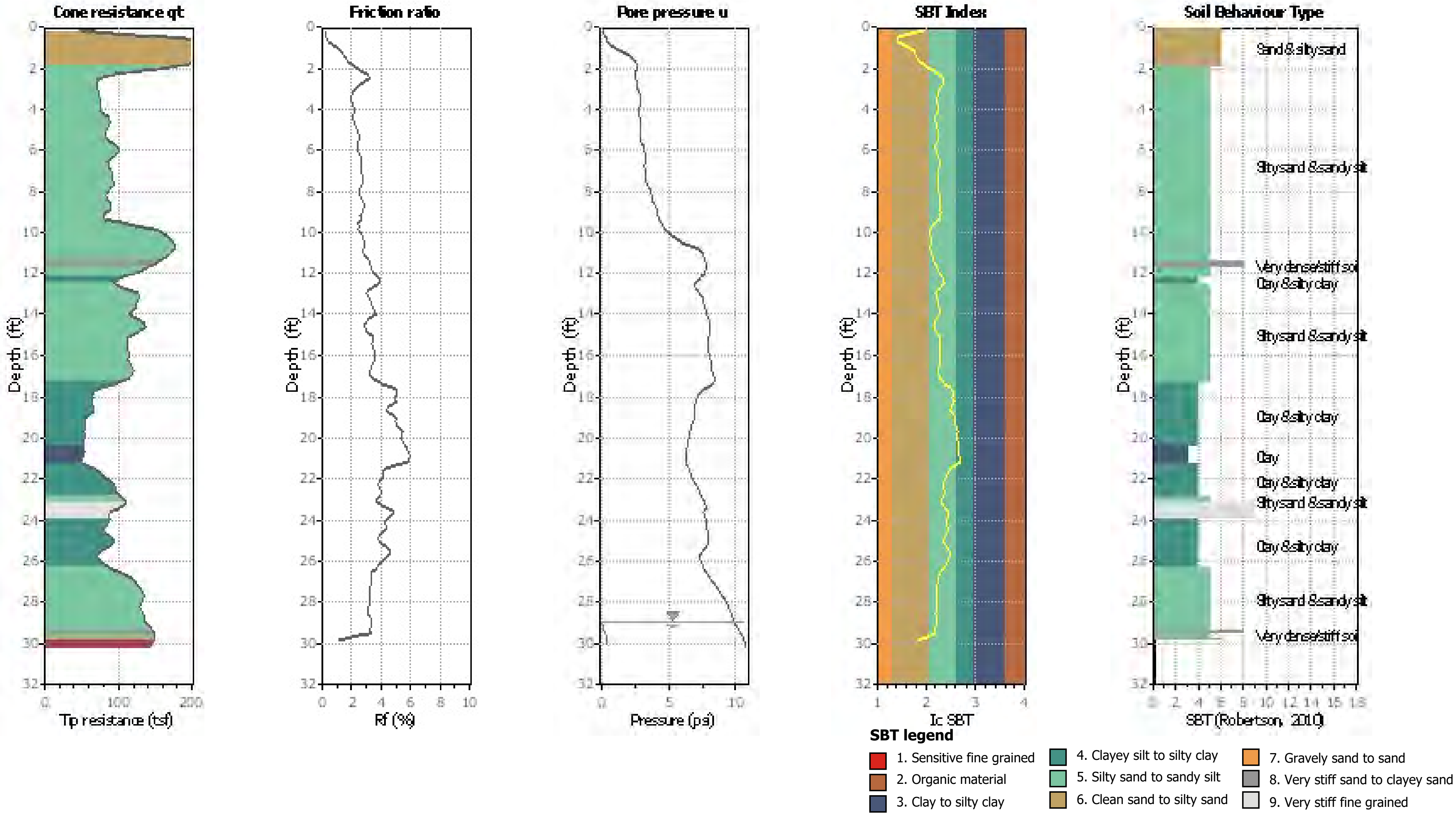
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

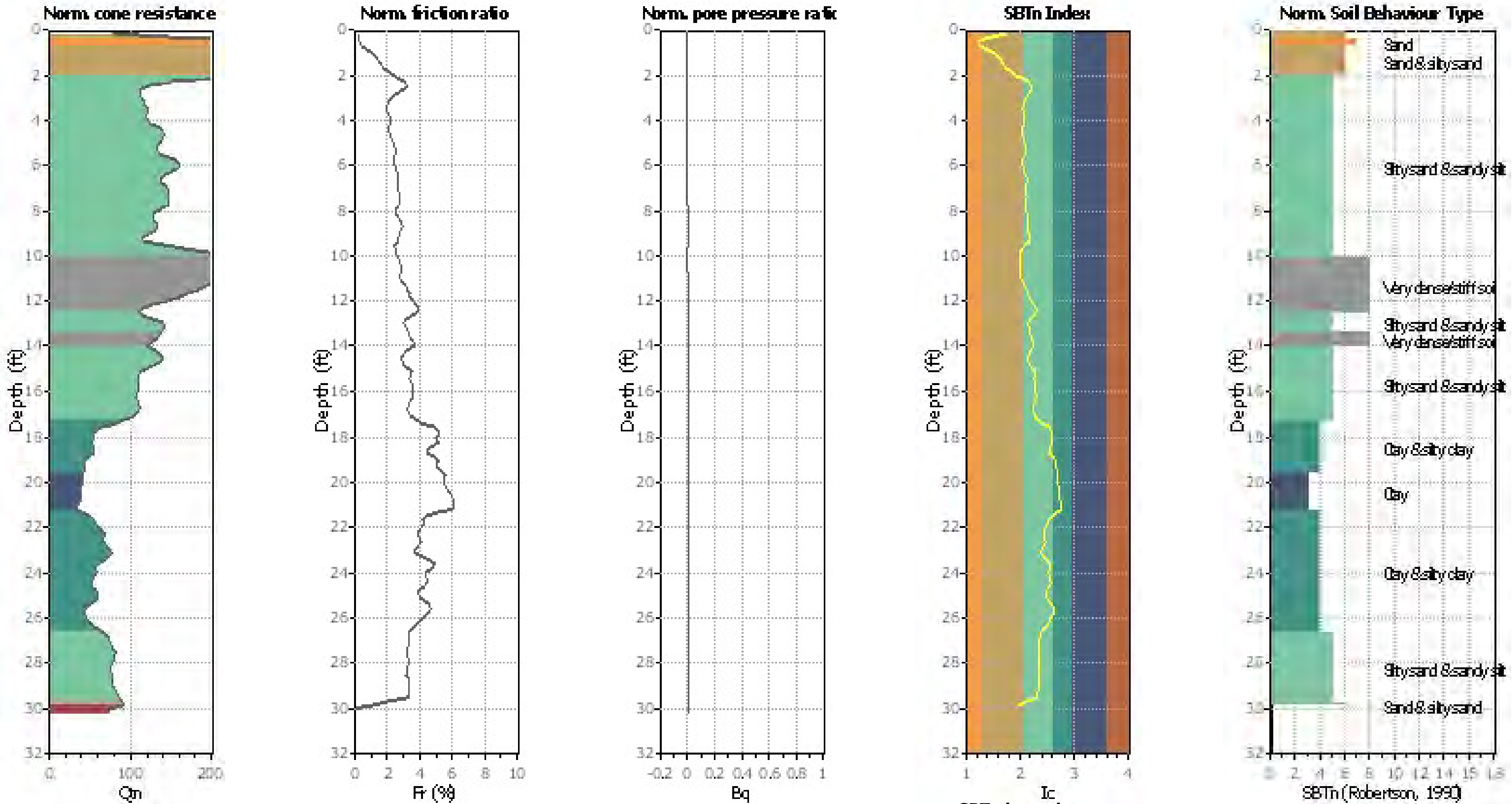
CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



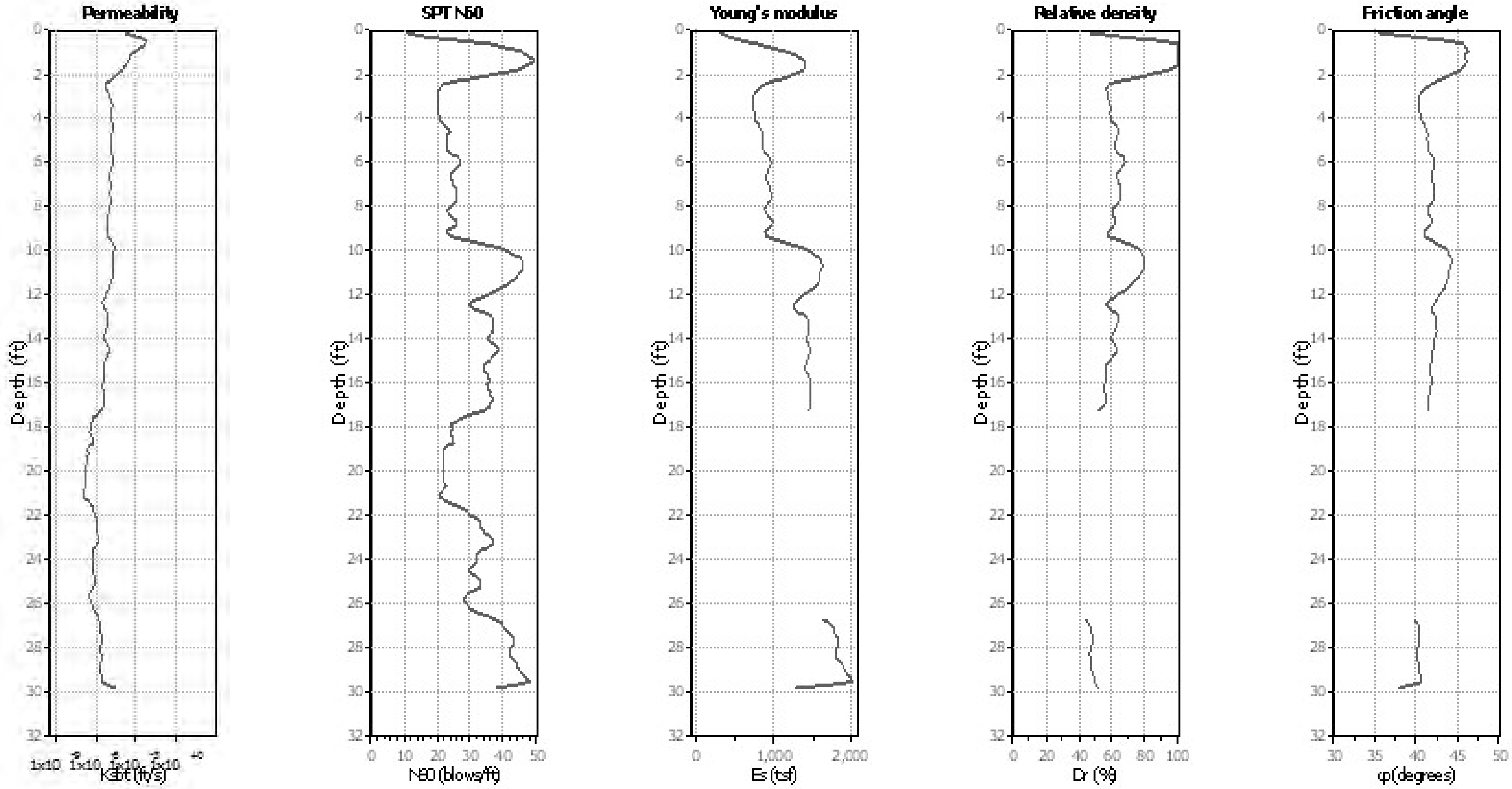
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

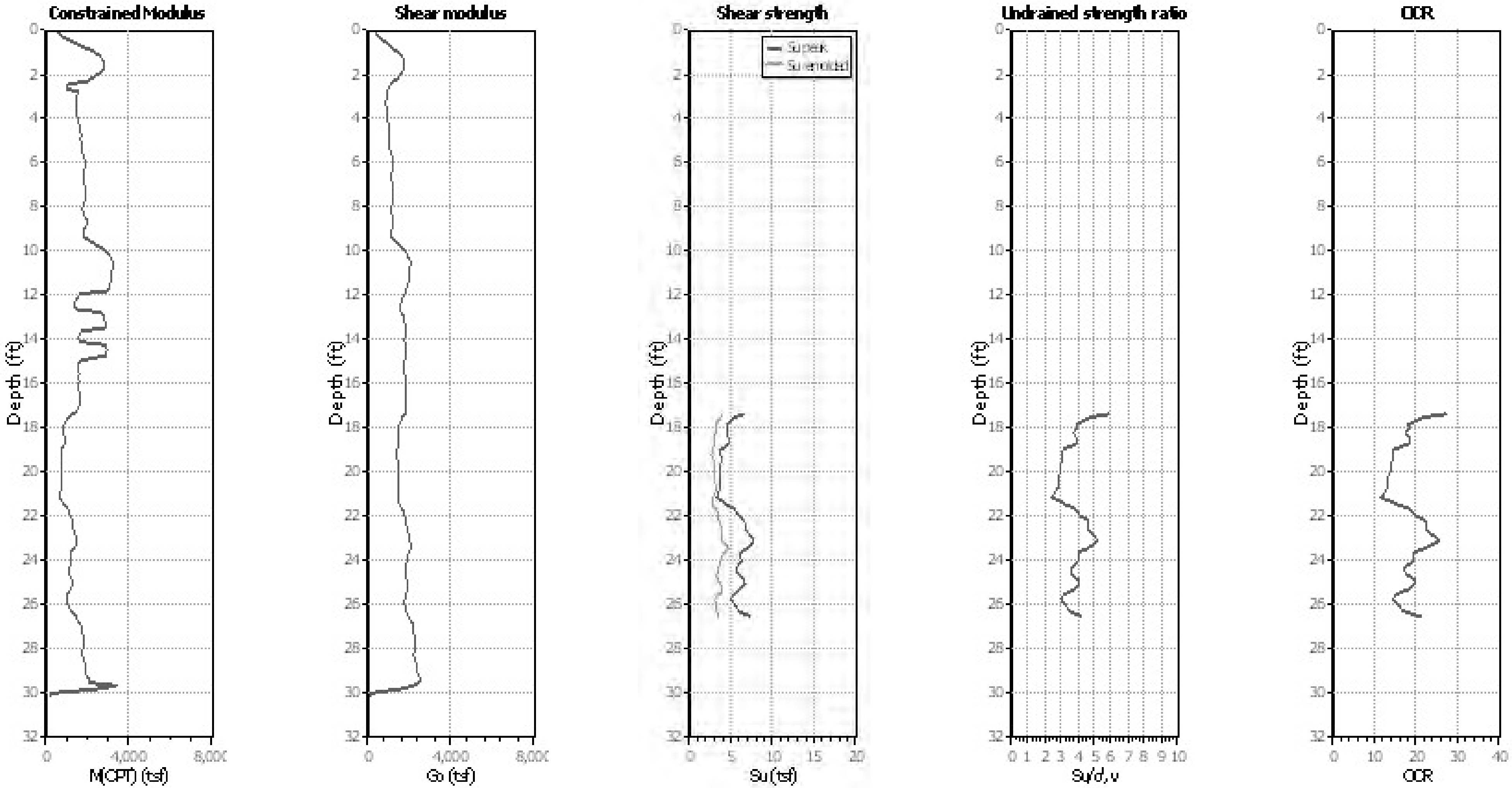


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

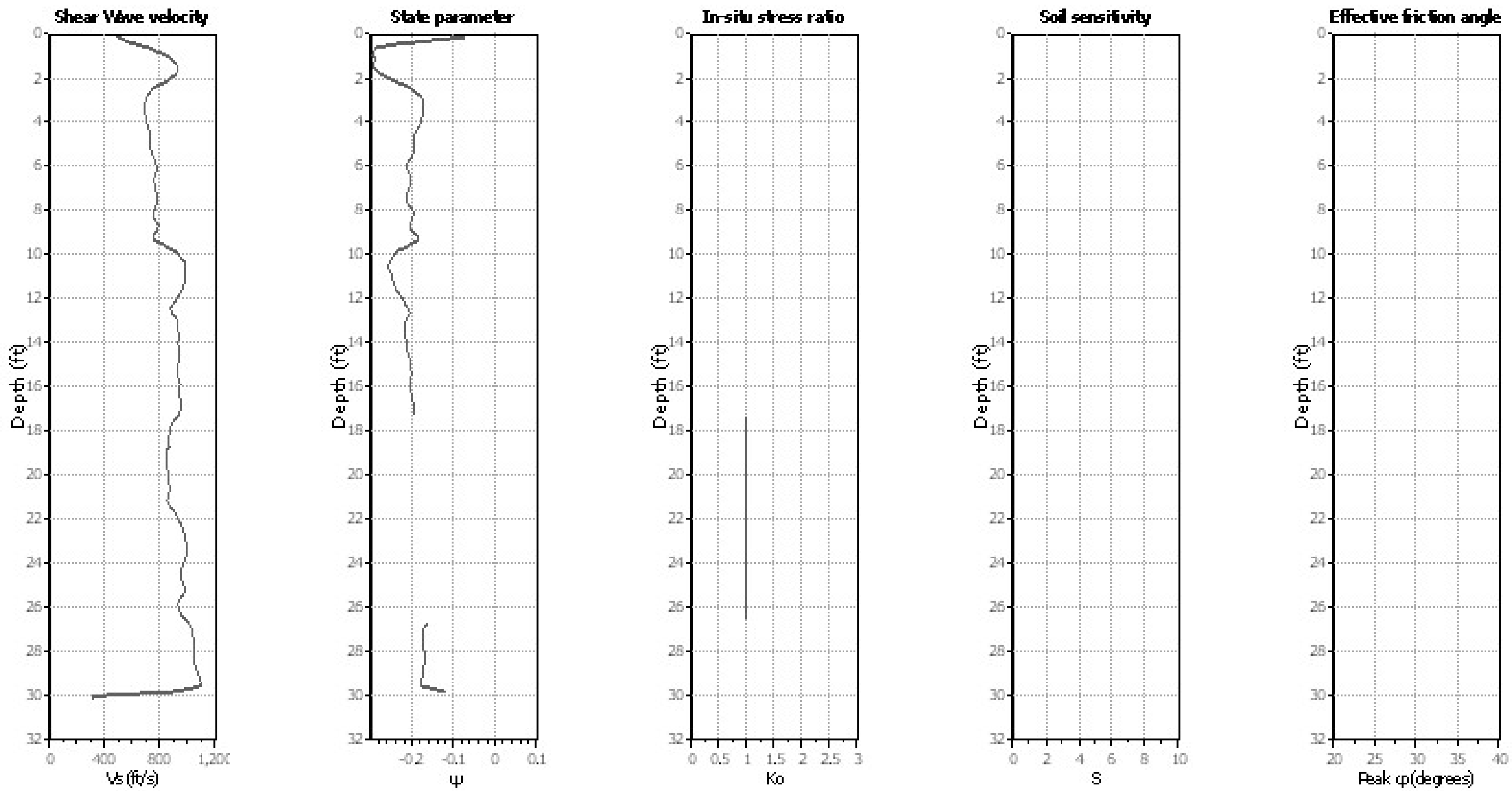


Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-5
Total depth: 30.18 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



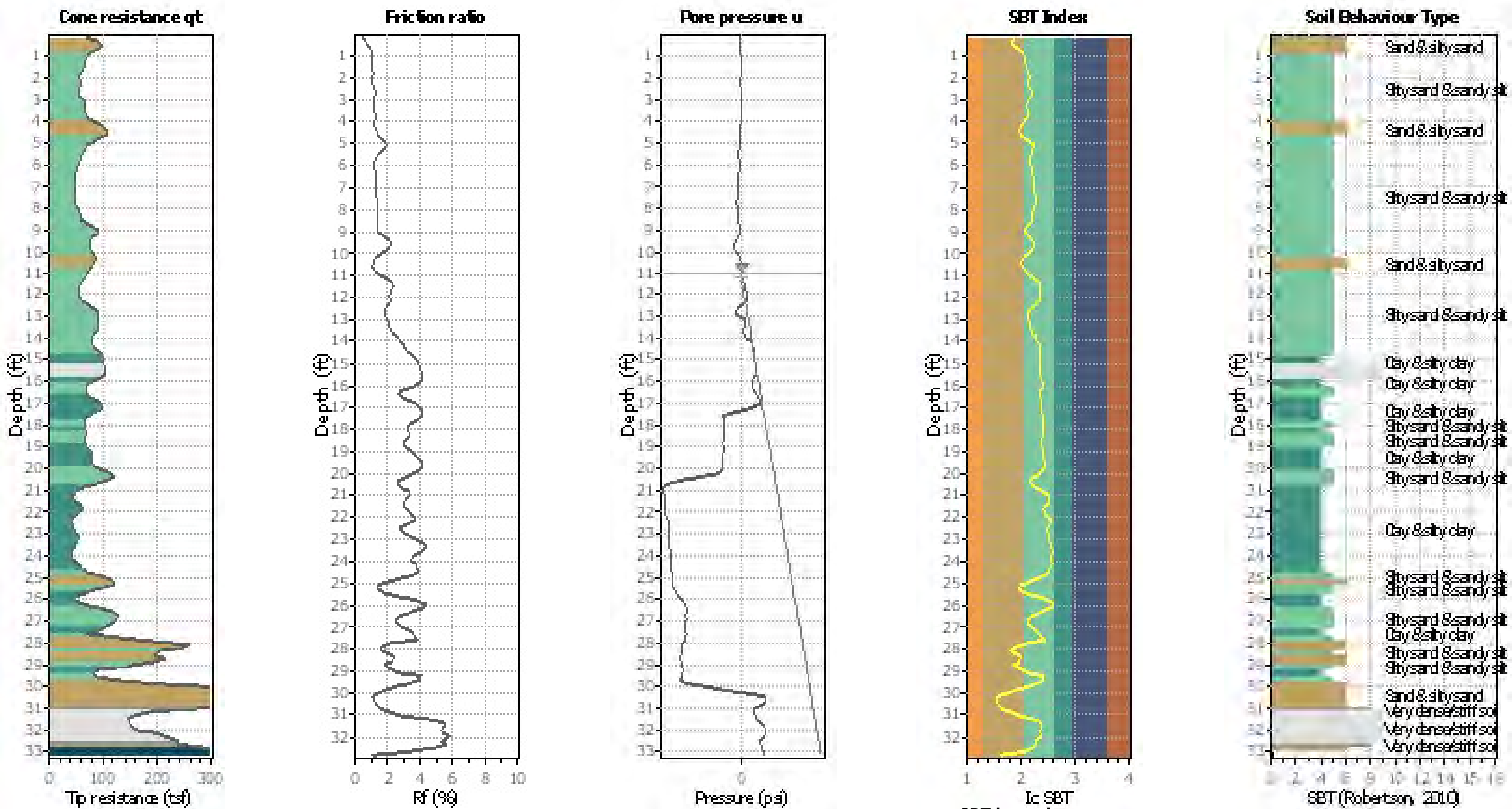
Calculation parameters

Soil Sensitivity factor, N_S: 350.00
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



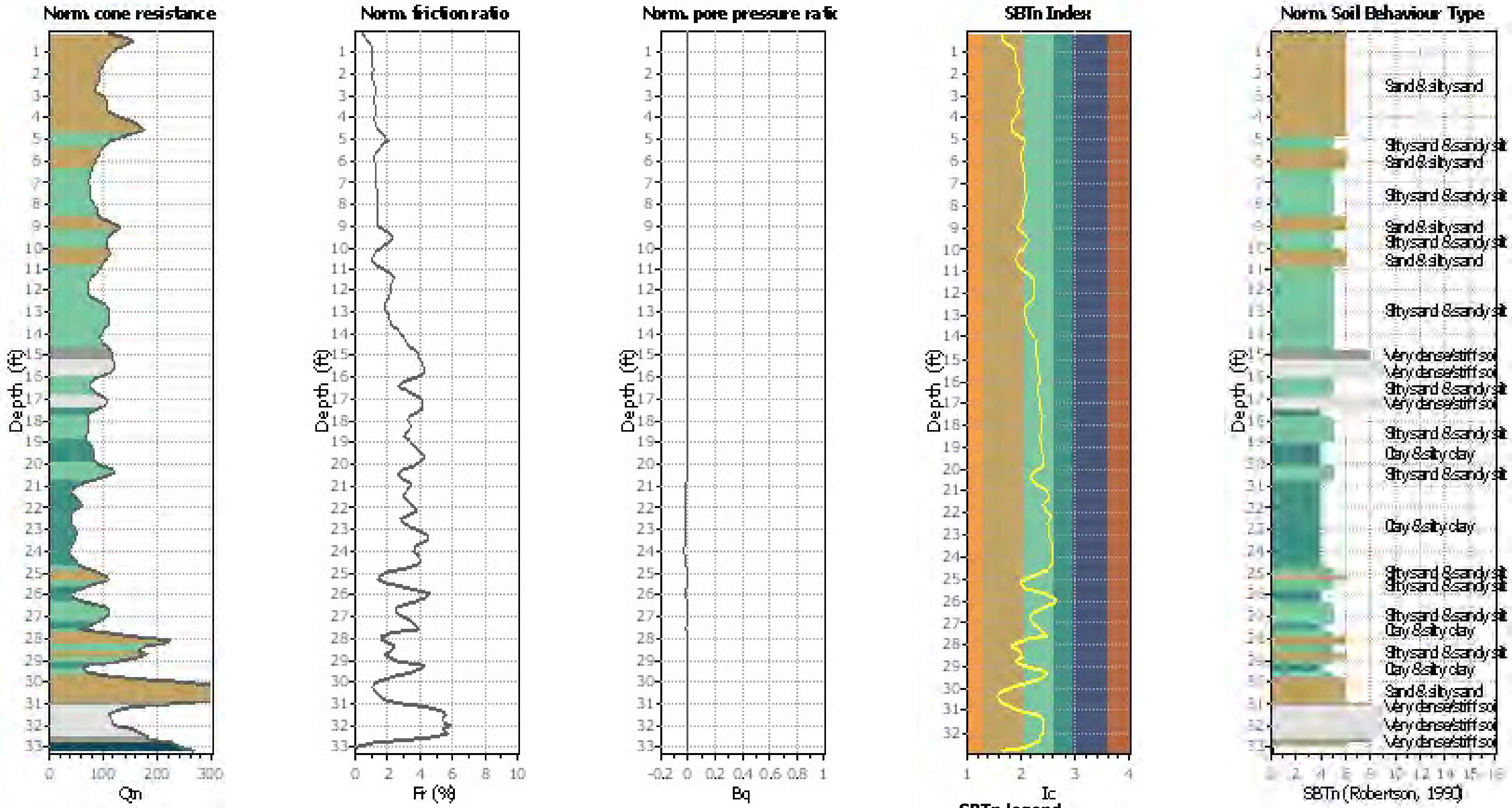
SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



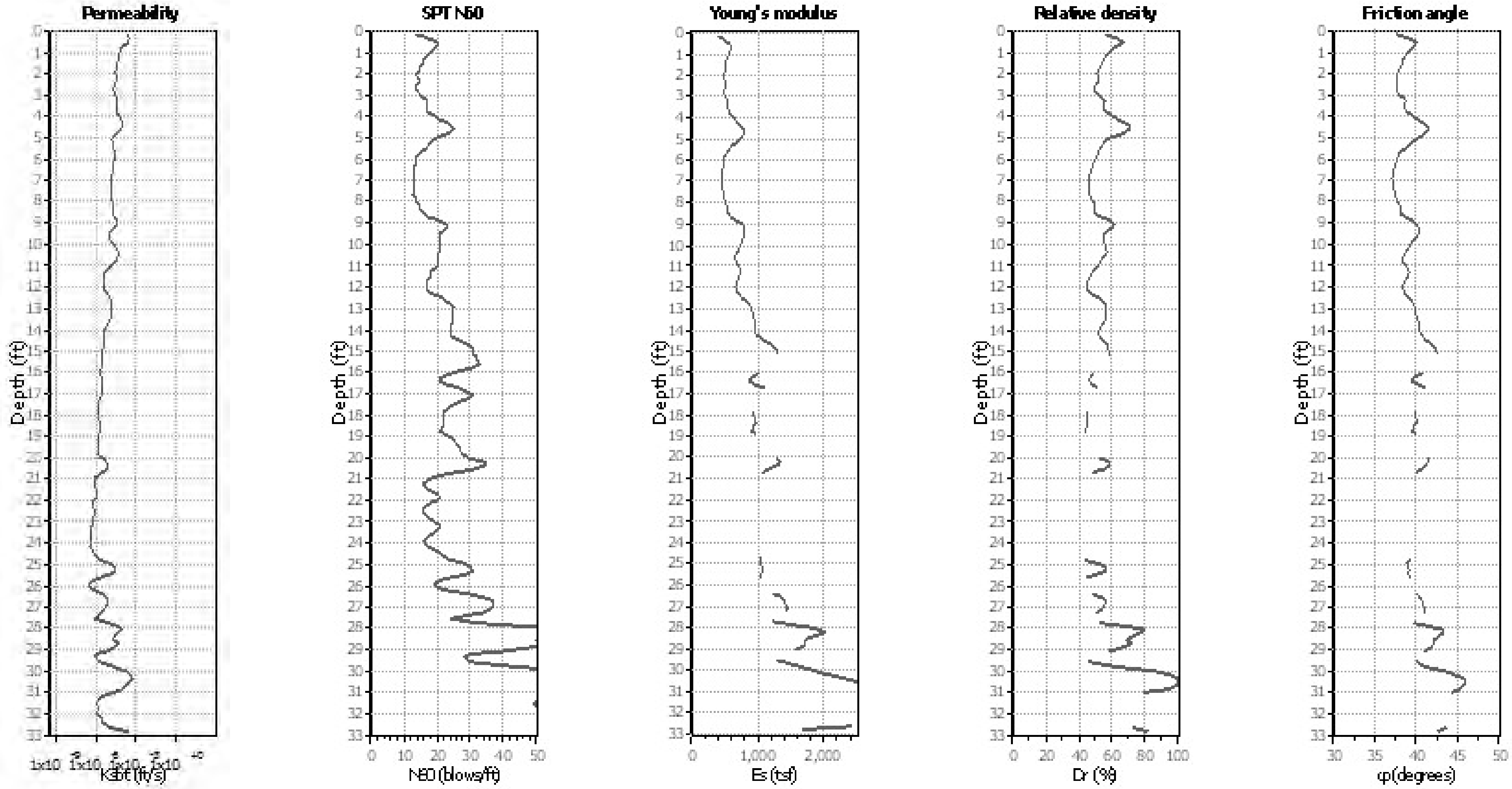
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

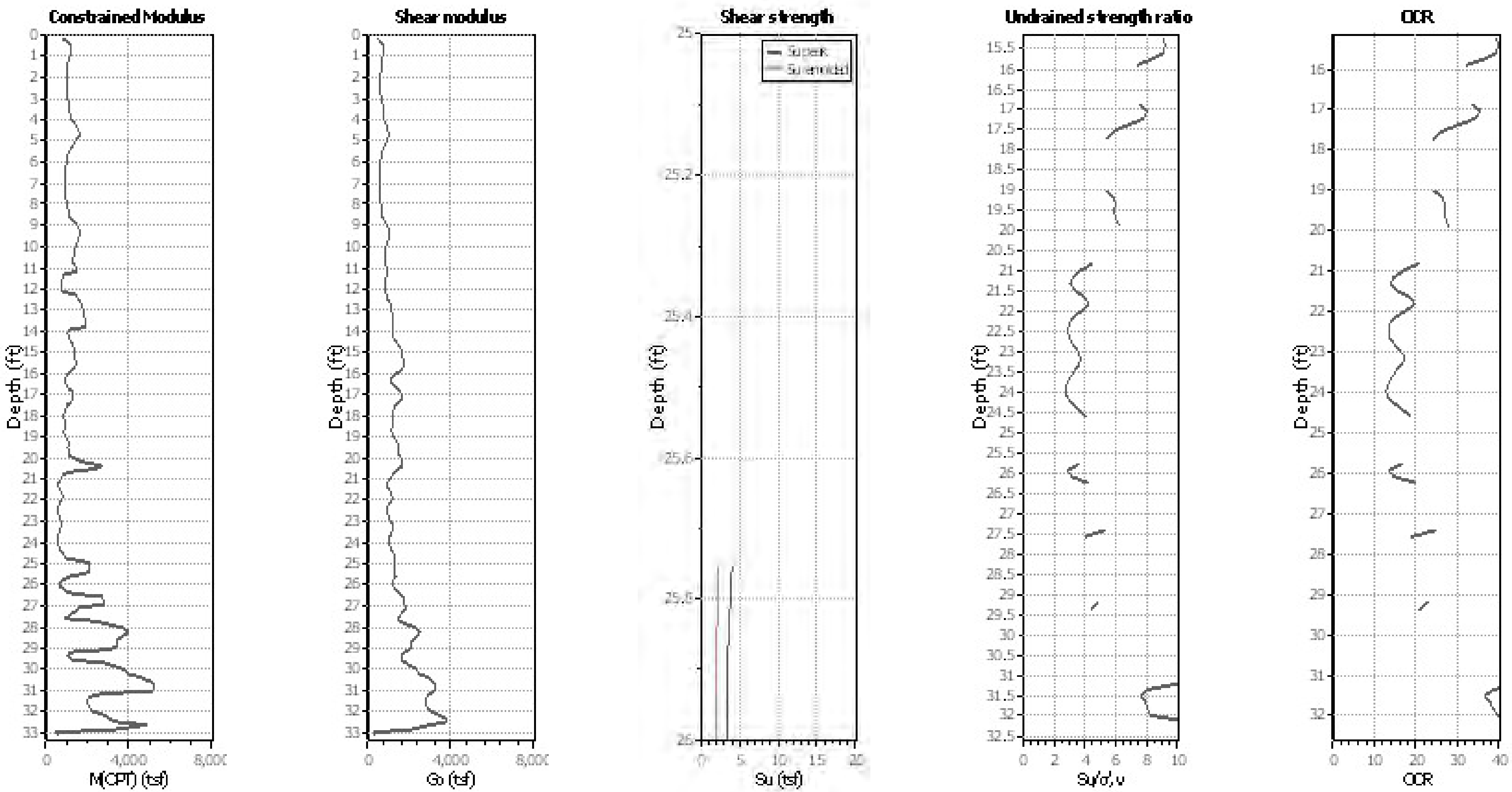


Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

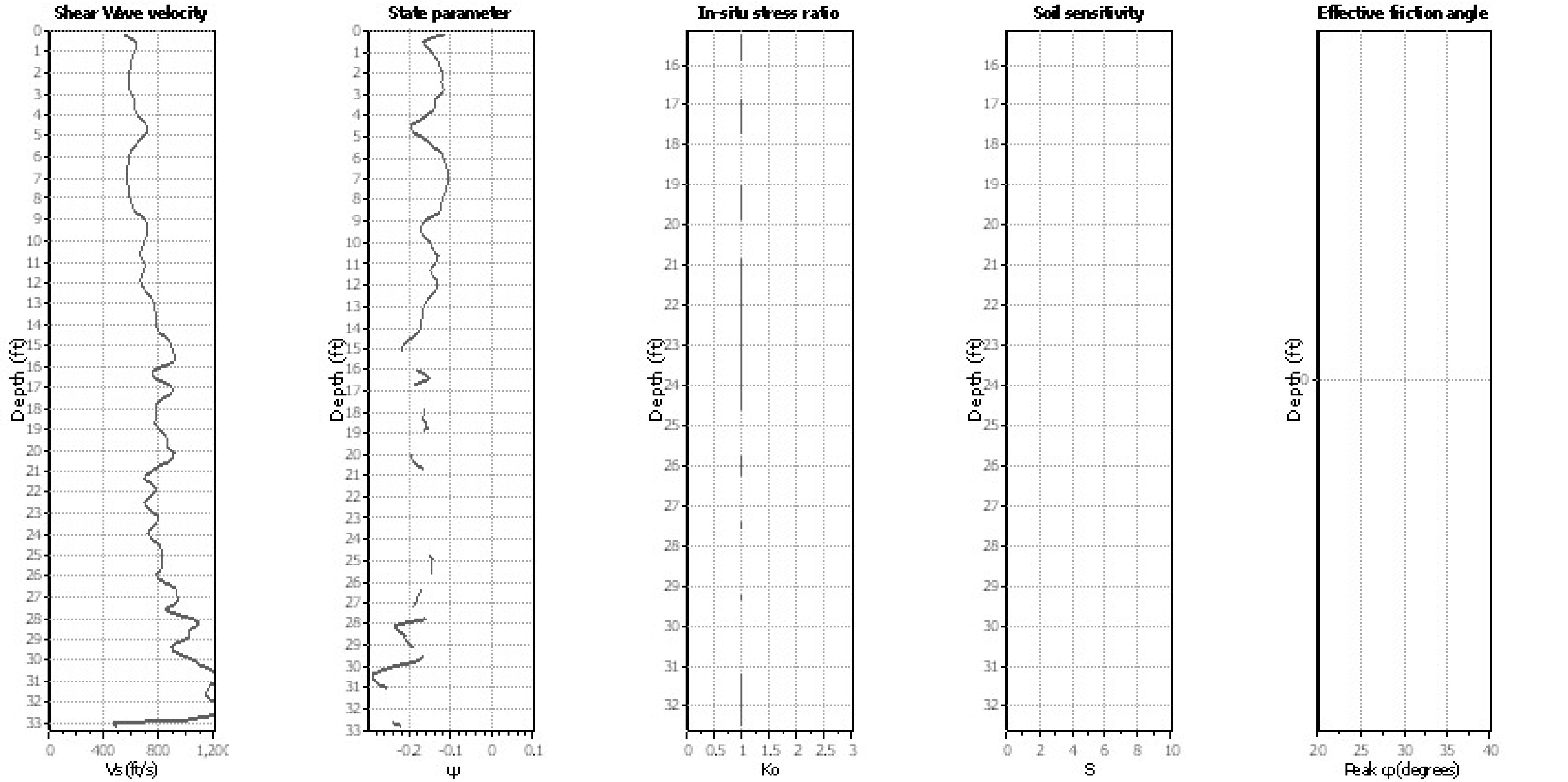


Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-7
Total depth: 33.14 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

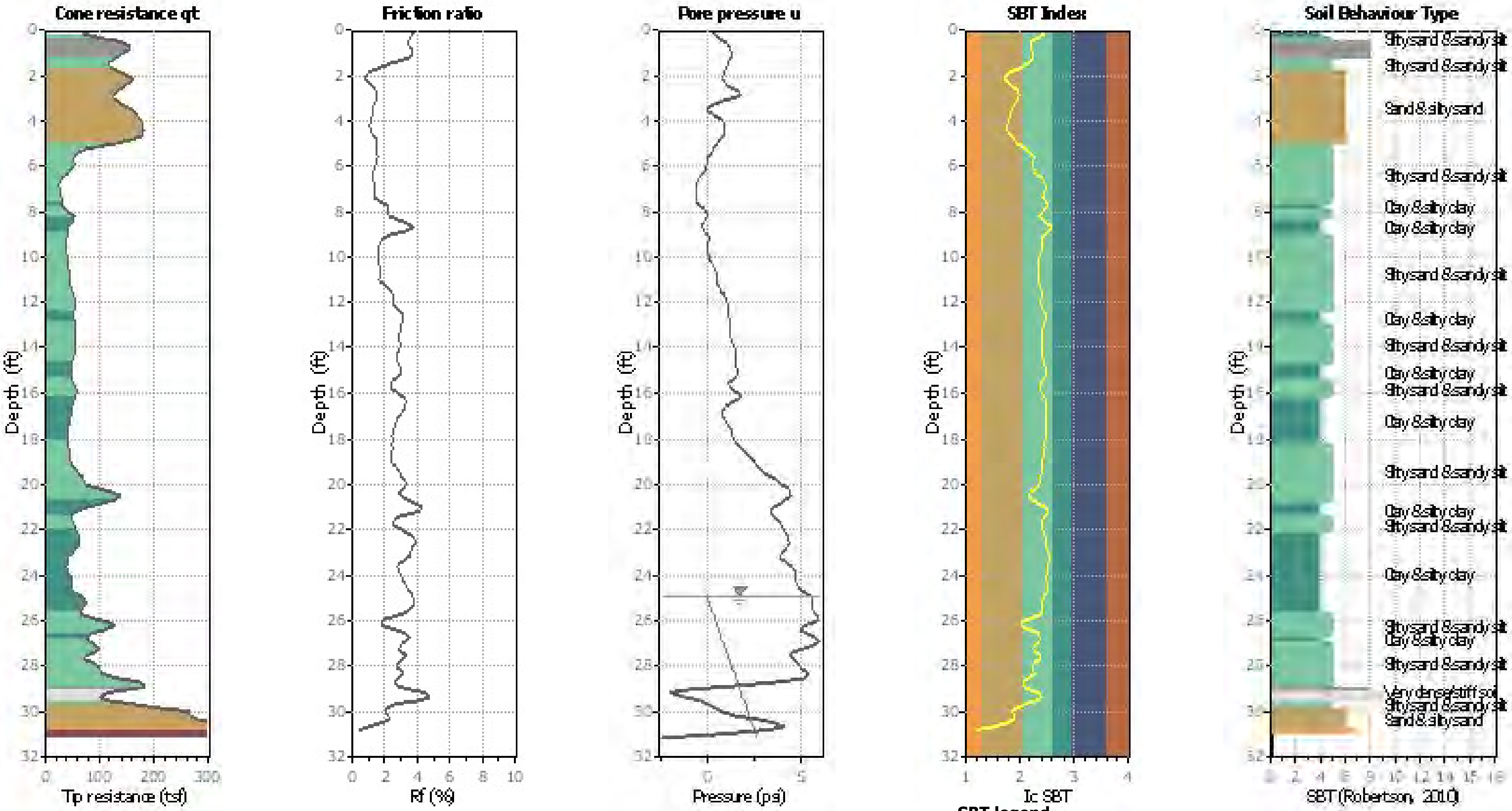
Soil Sensitivity factor, N_S: 350.00

User defined estimation data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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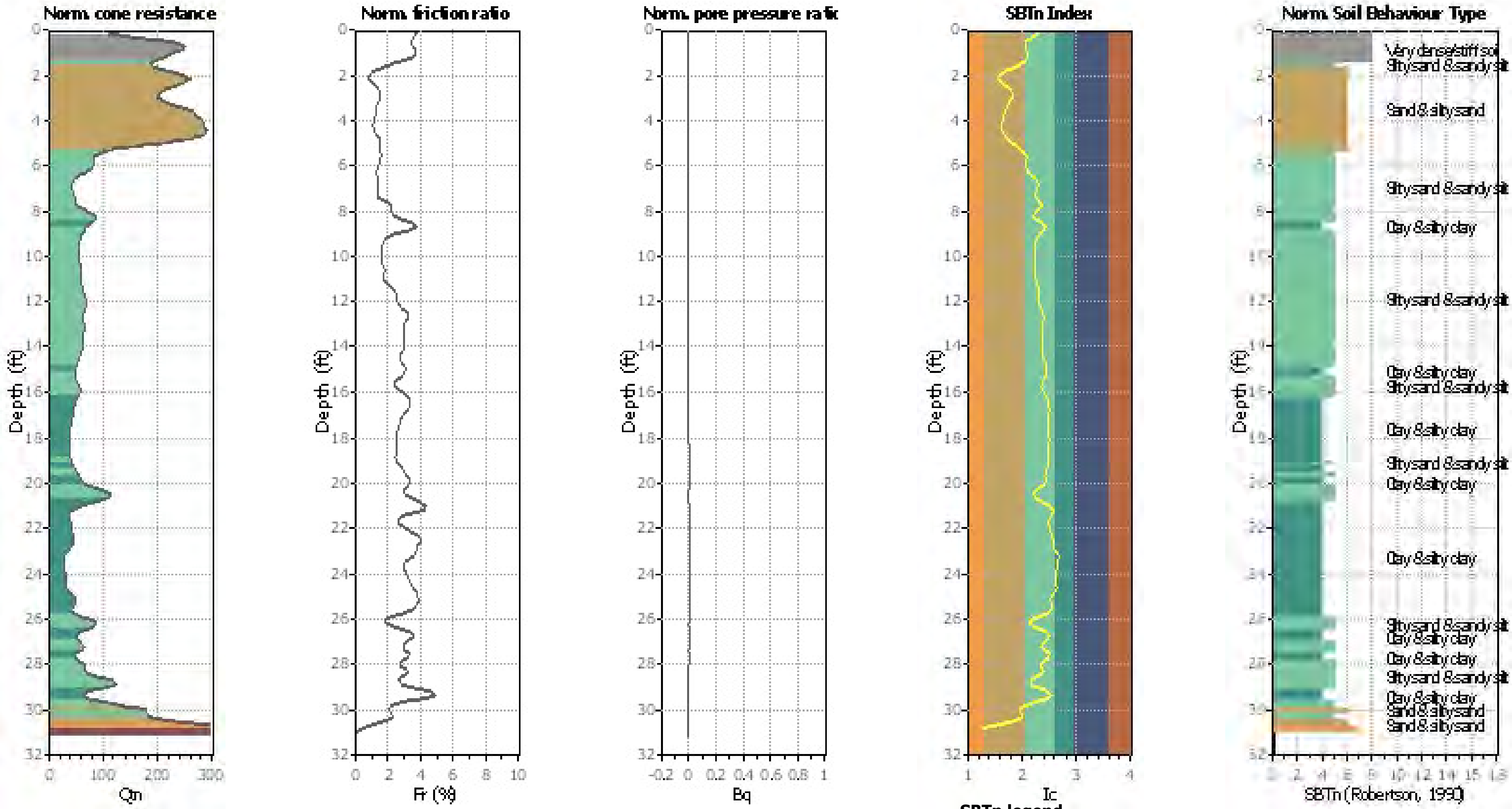
CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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CPT: C-8
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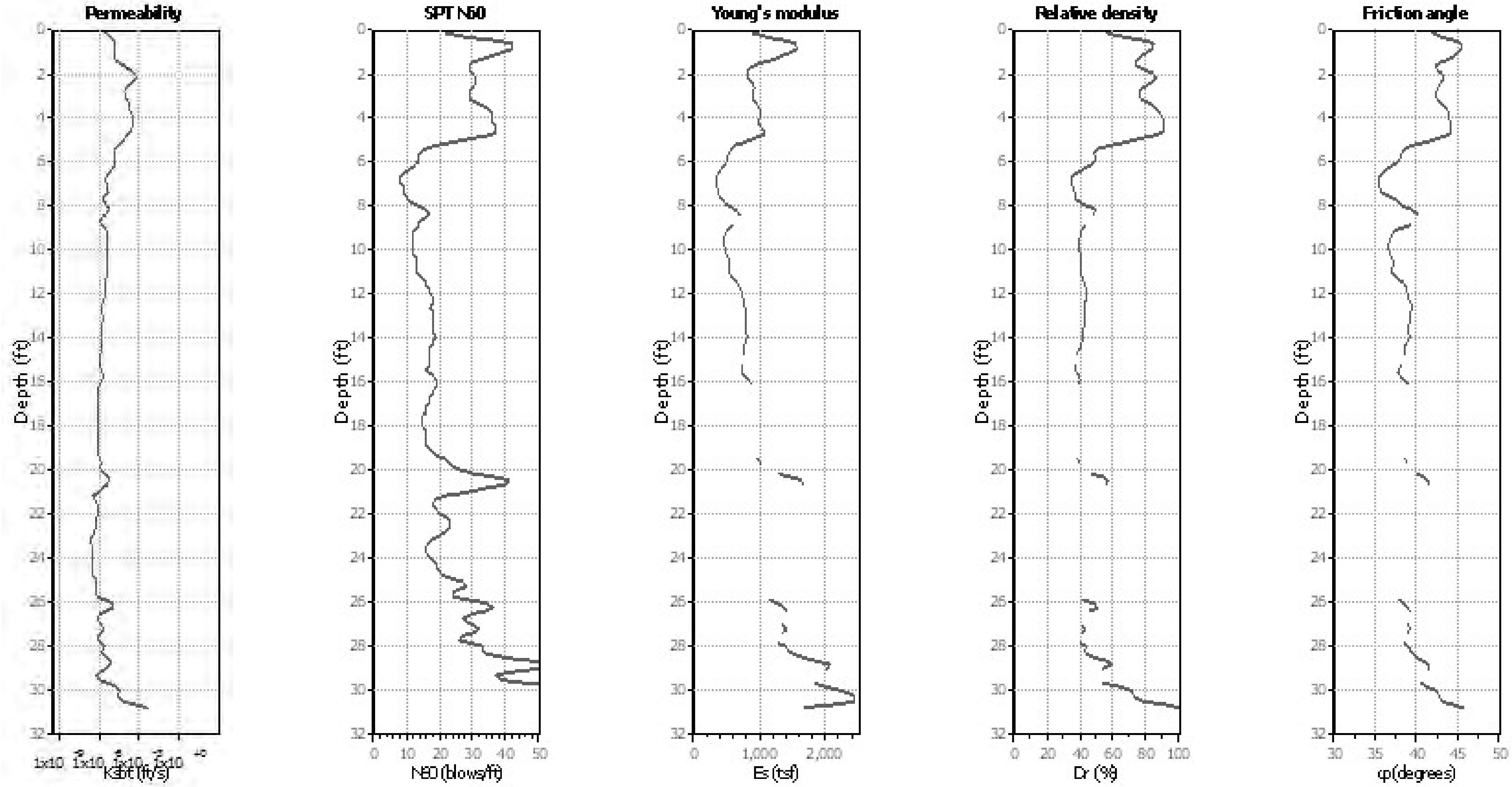
Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

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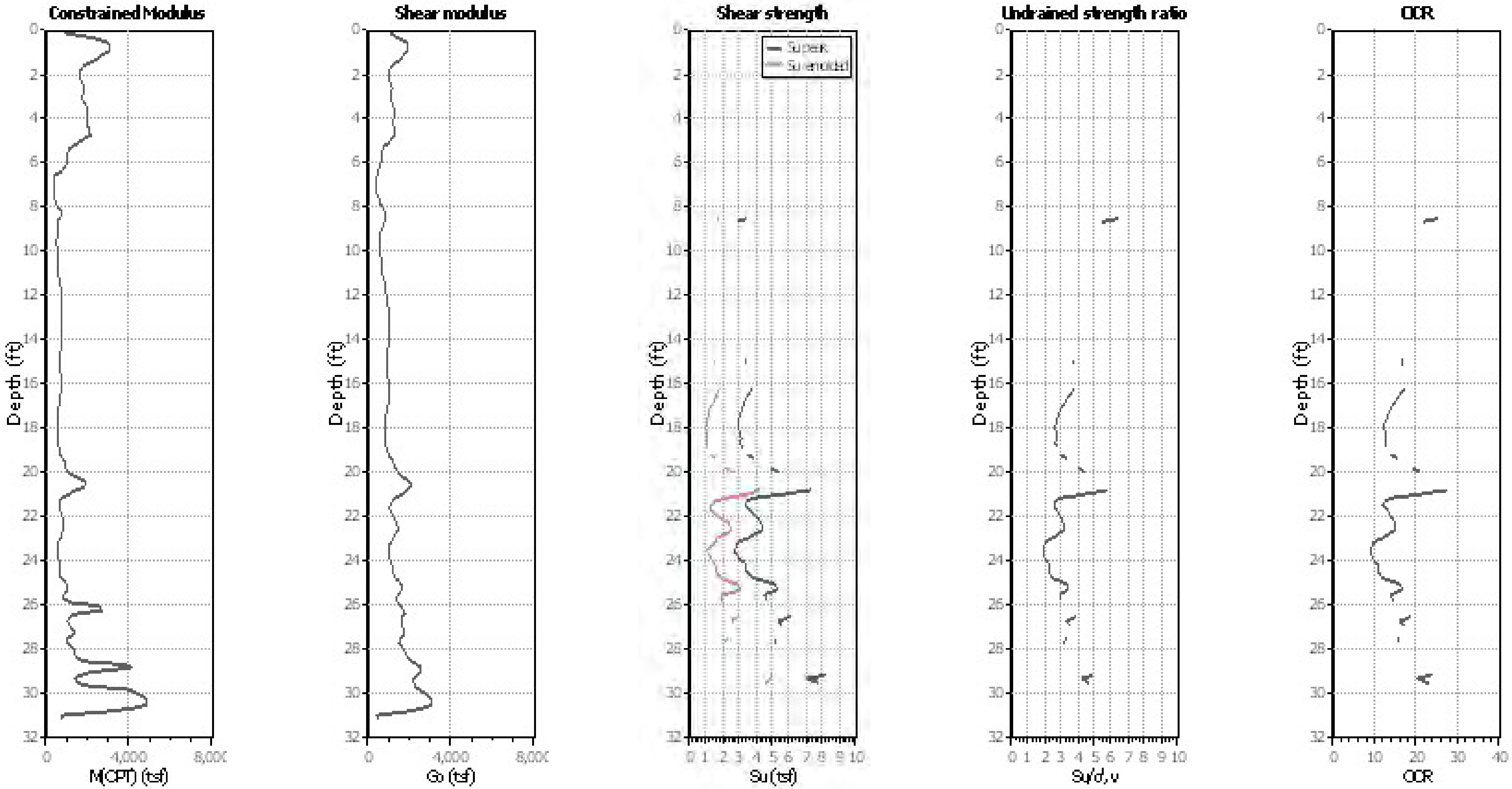
CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

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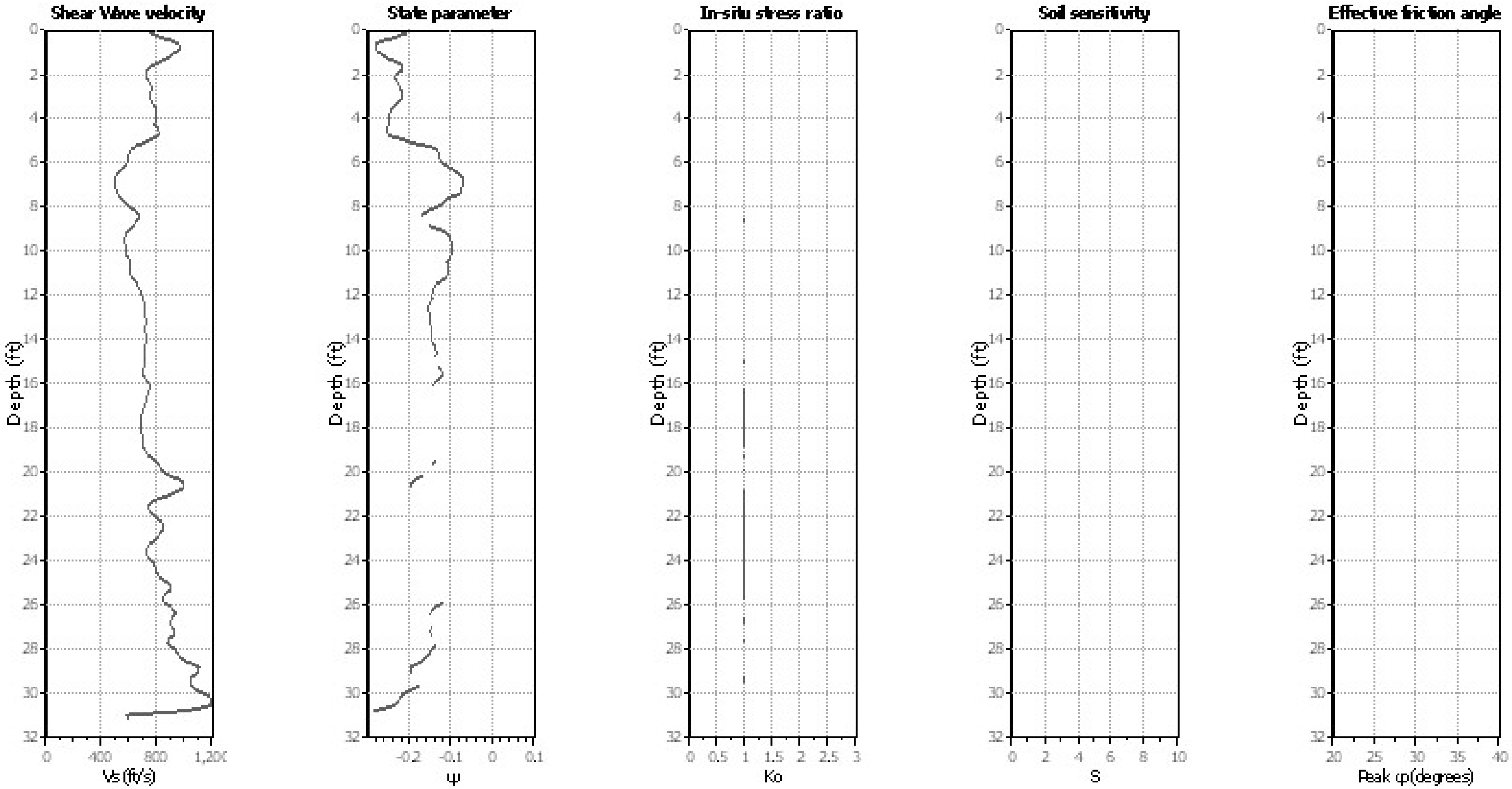
CPT: C-8
Total depth: 31.17 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

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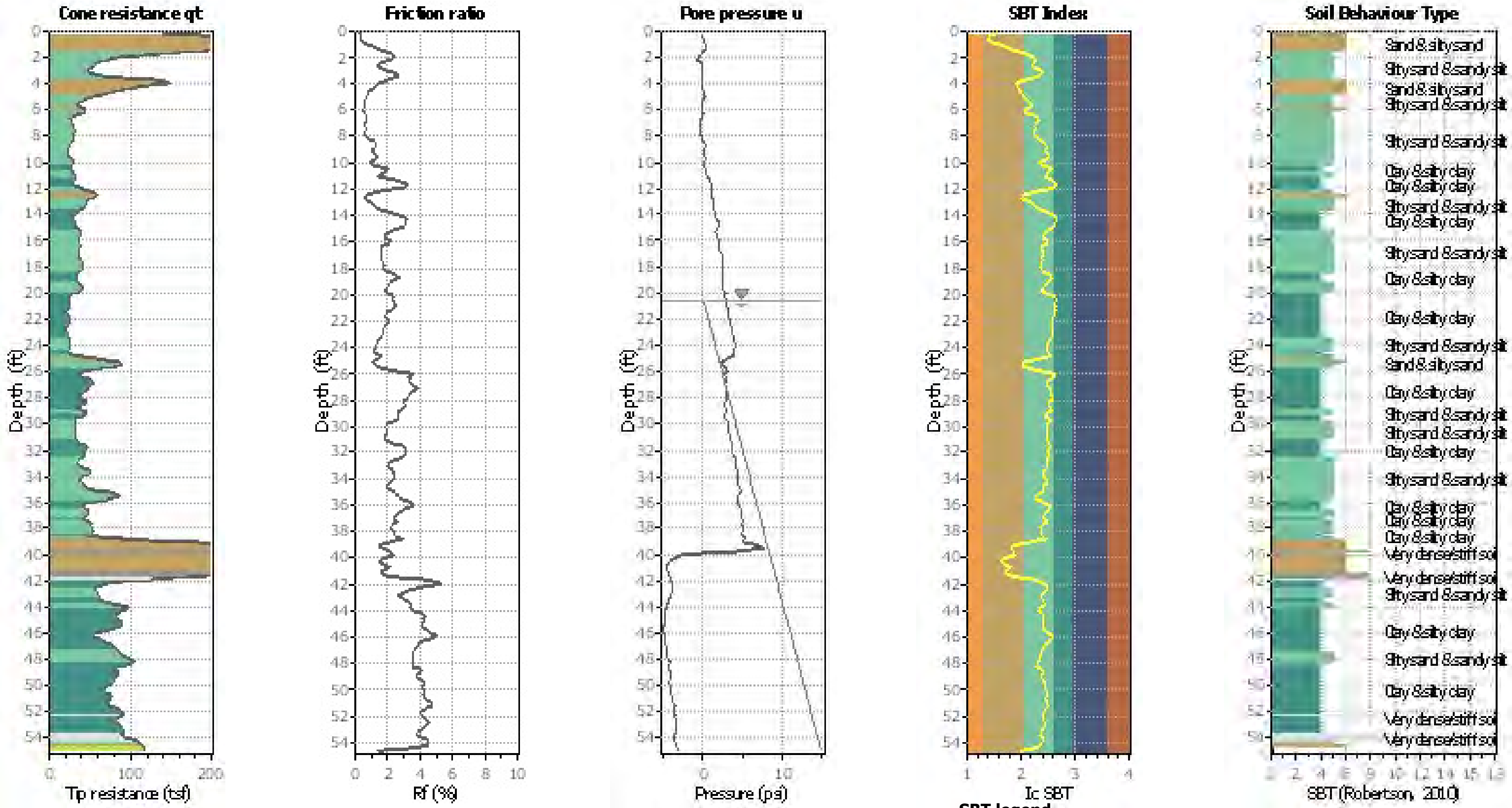
CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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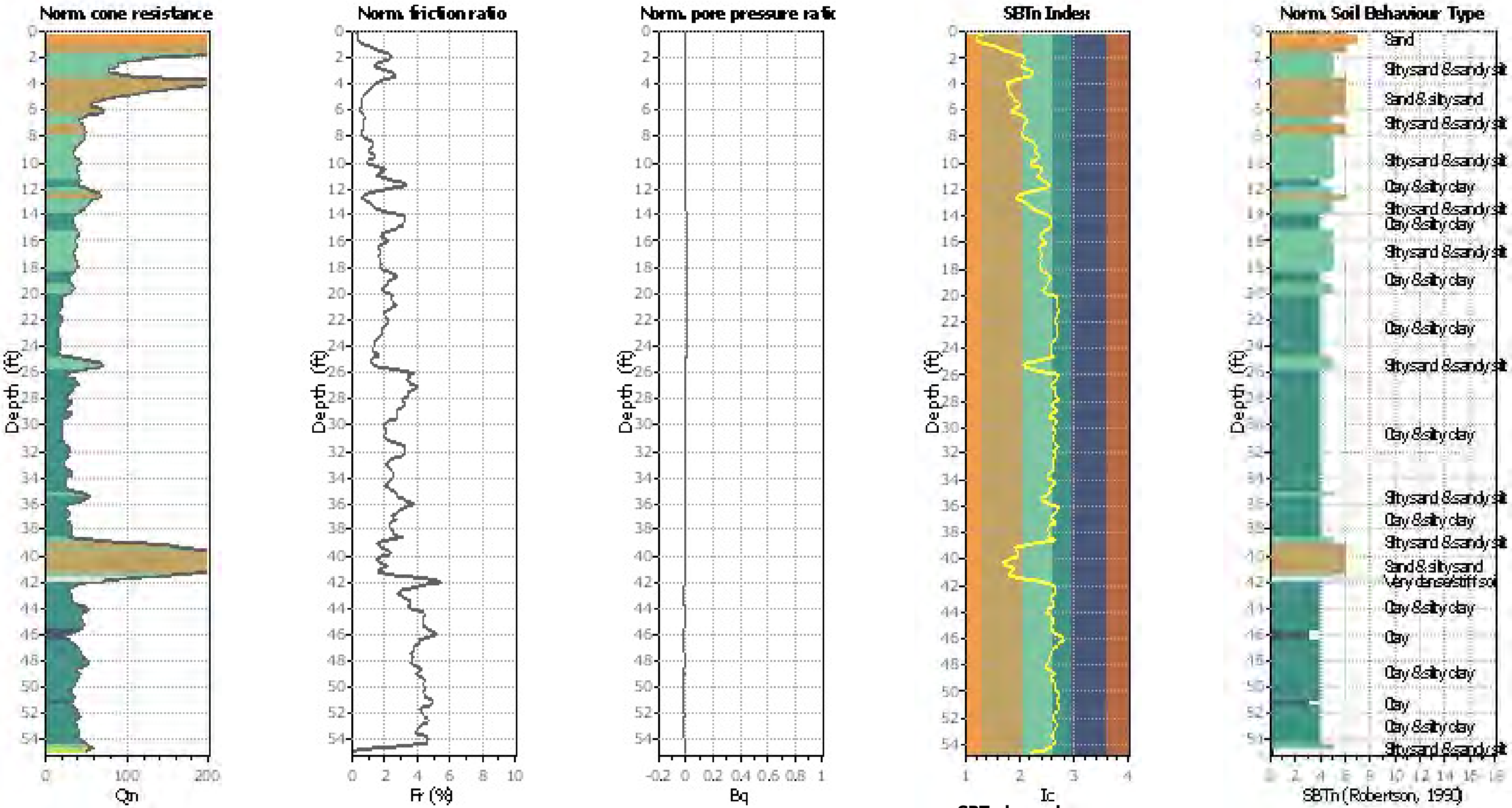
CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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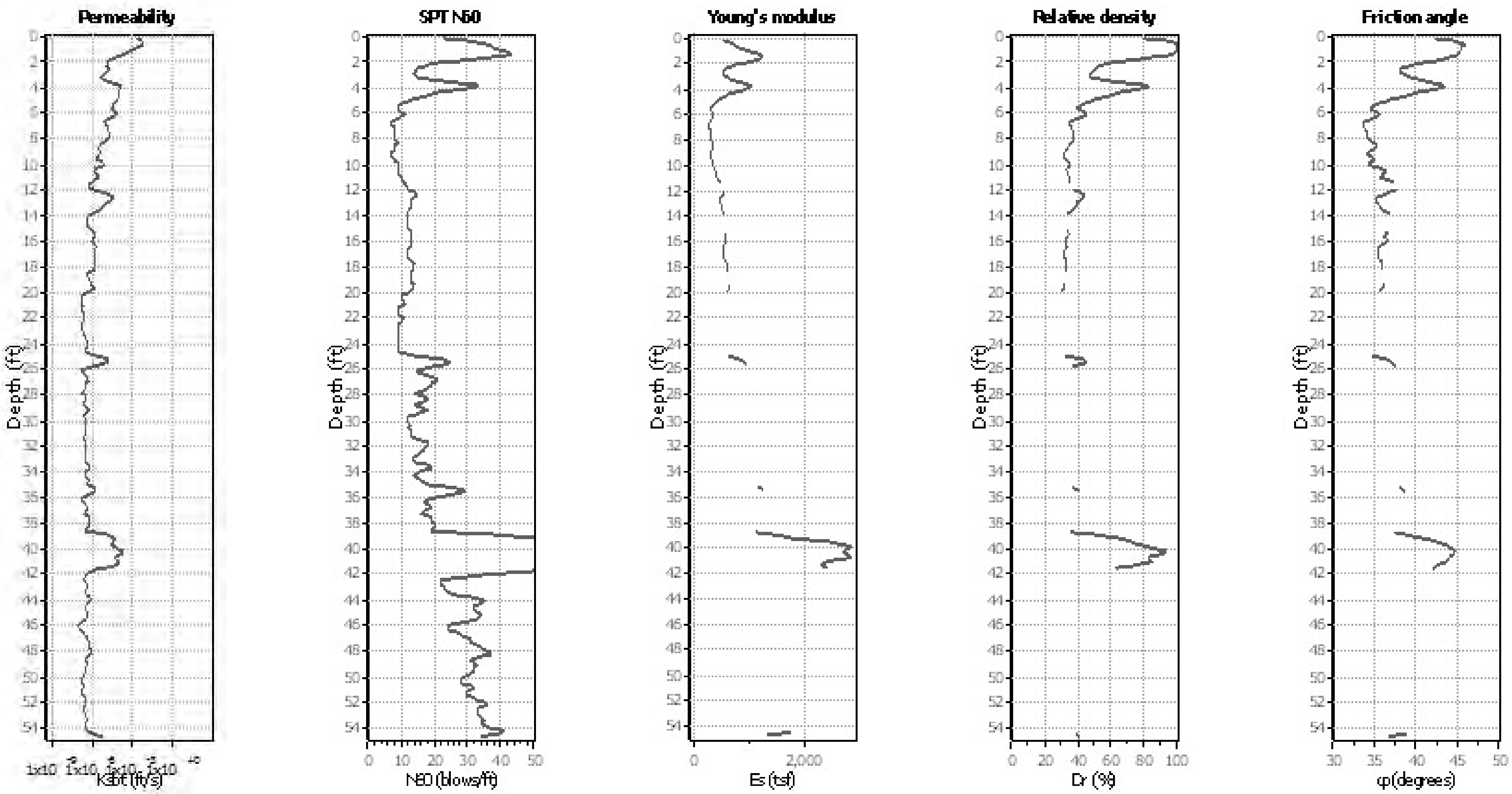
CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Proposed Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

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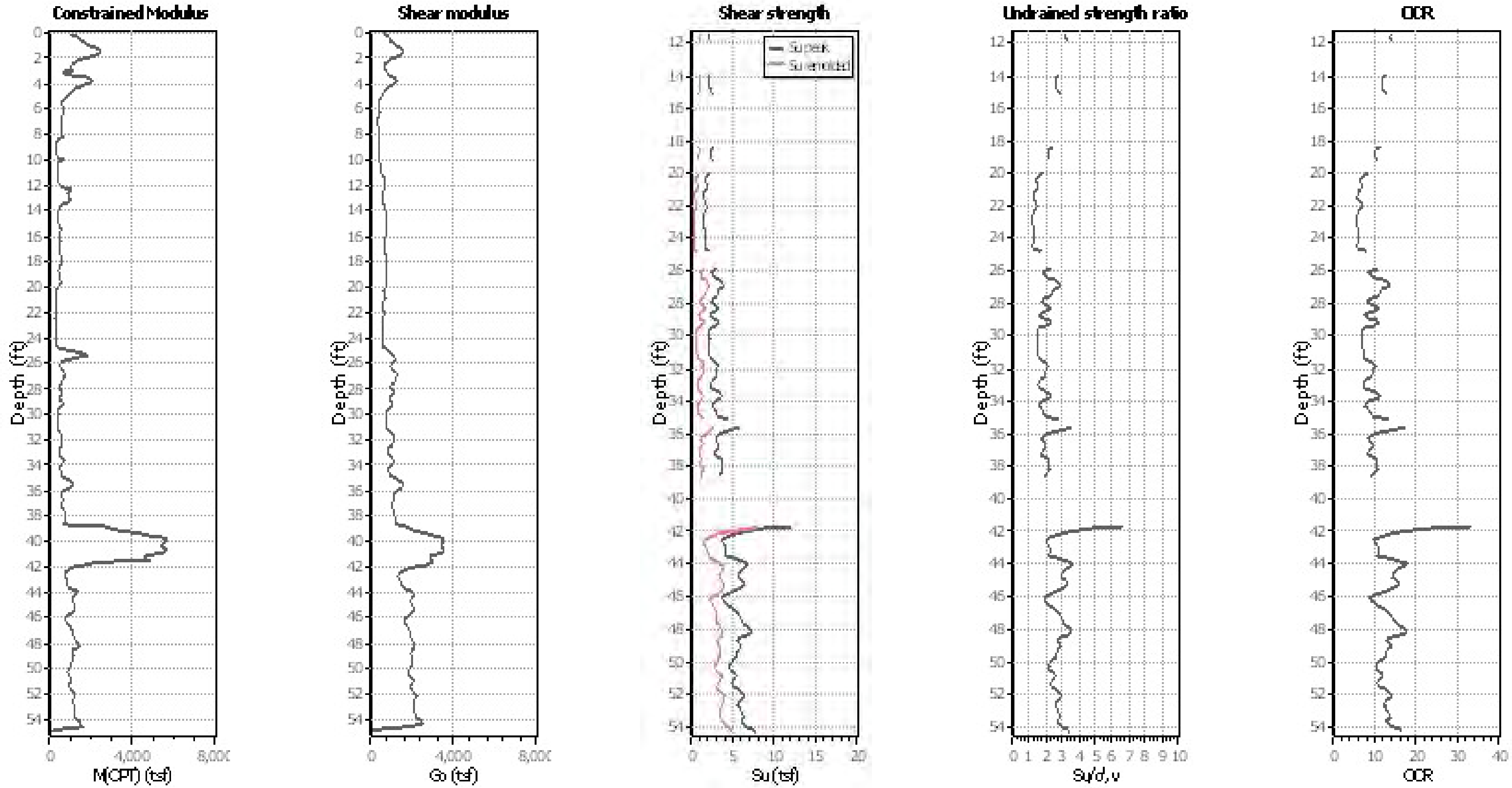
CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
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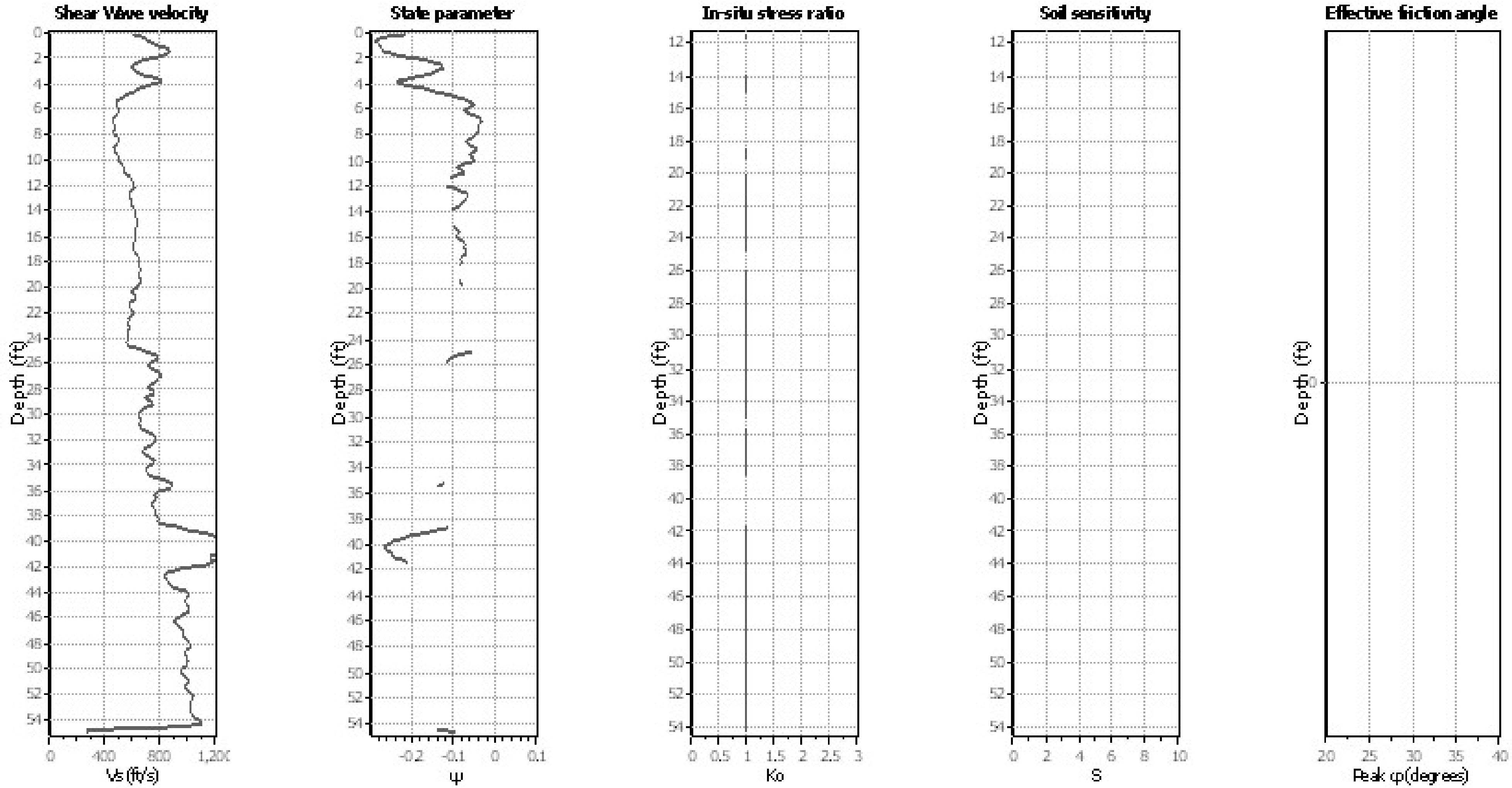
CPT: C-9
Total depth: 54.95 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

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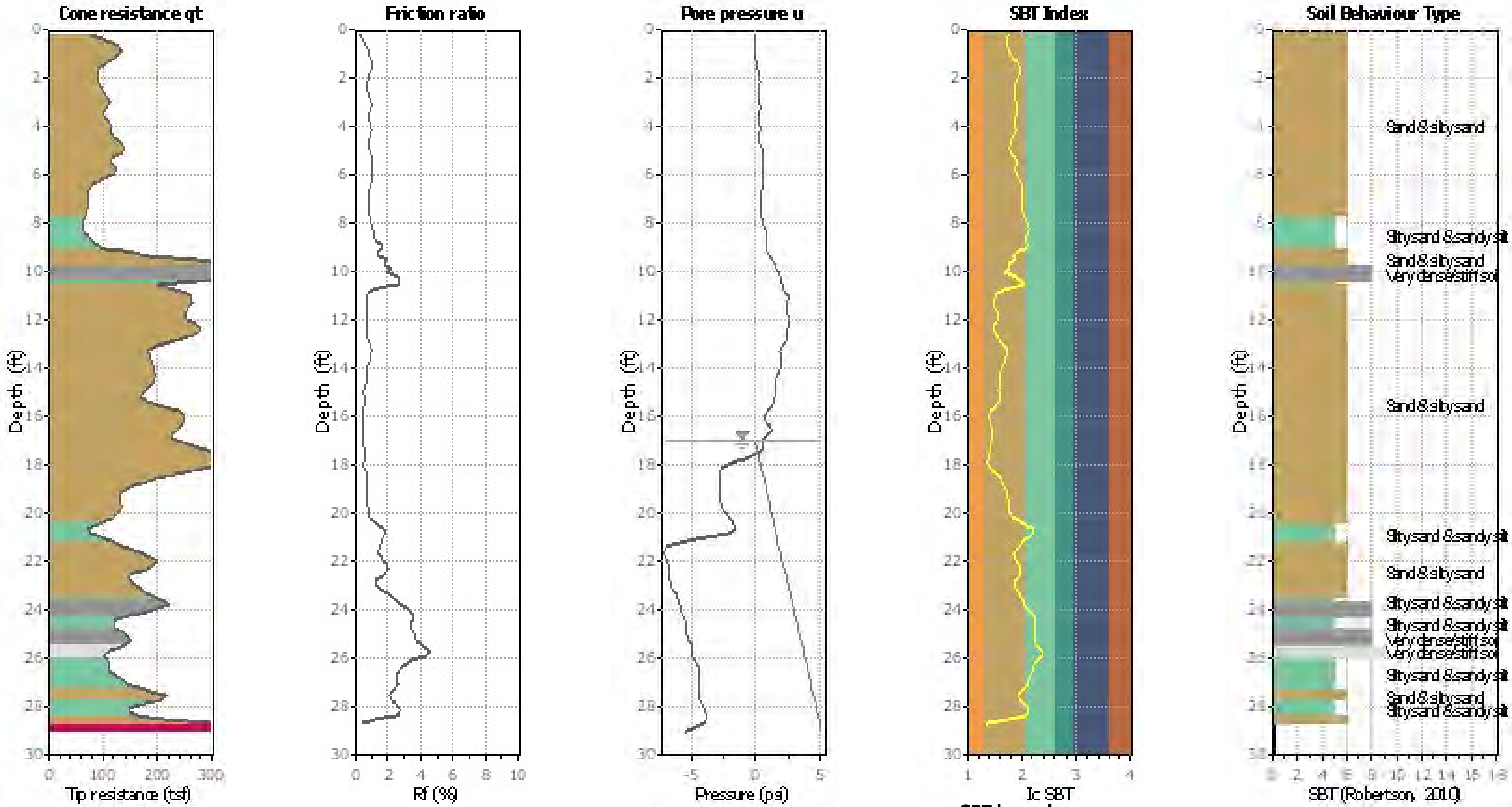
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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Engineering Consultants, Irvine California
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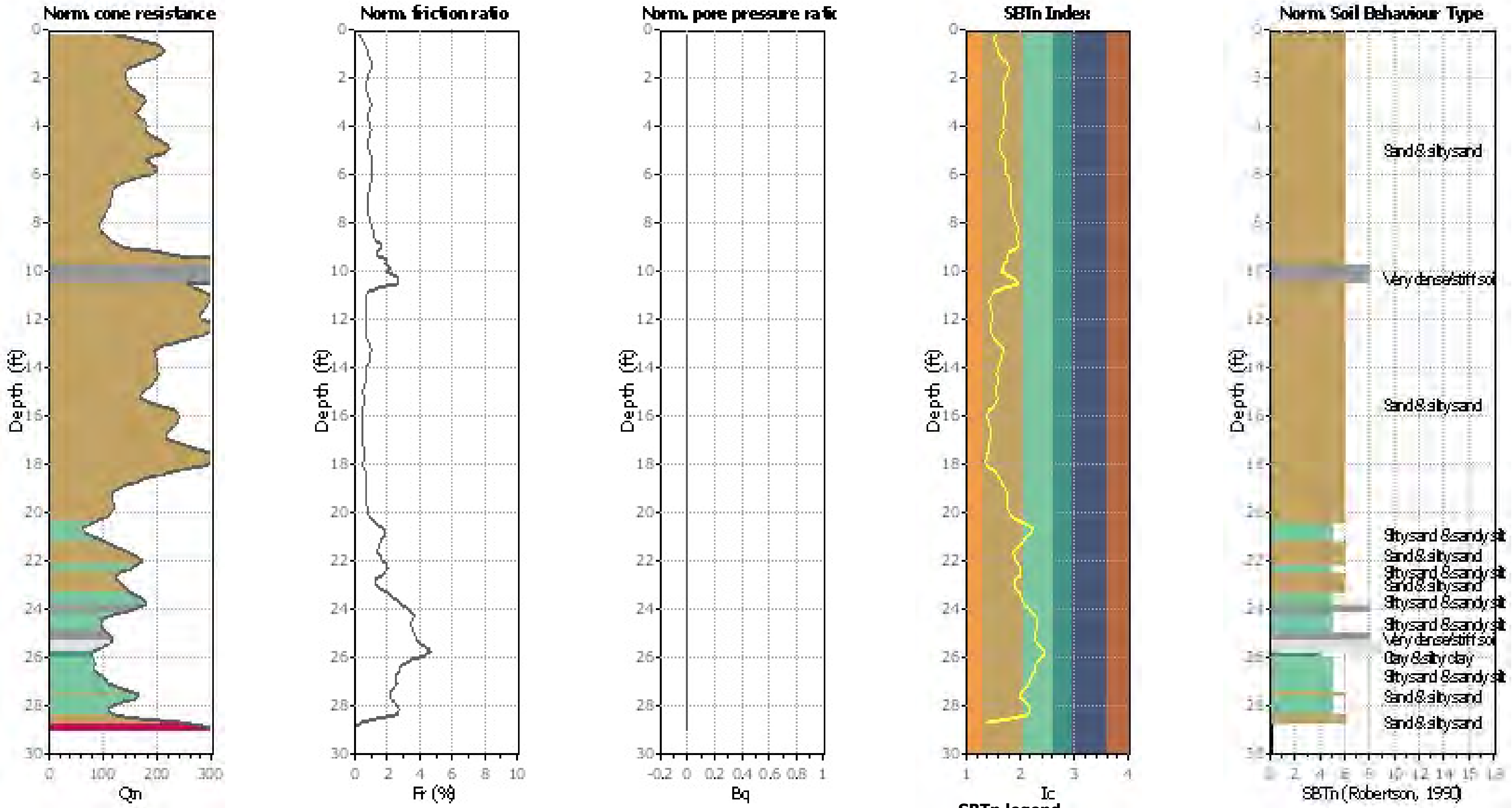
CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

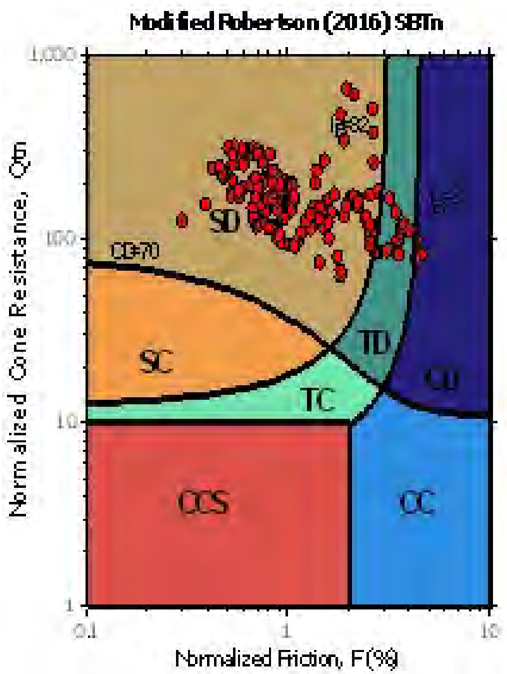
Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

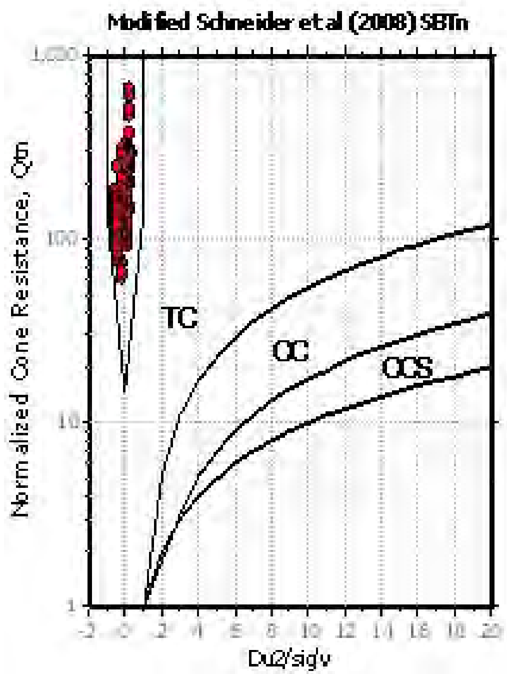


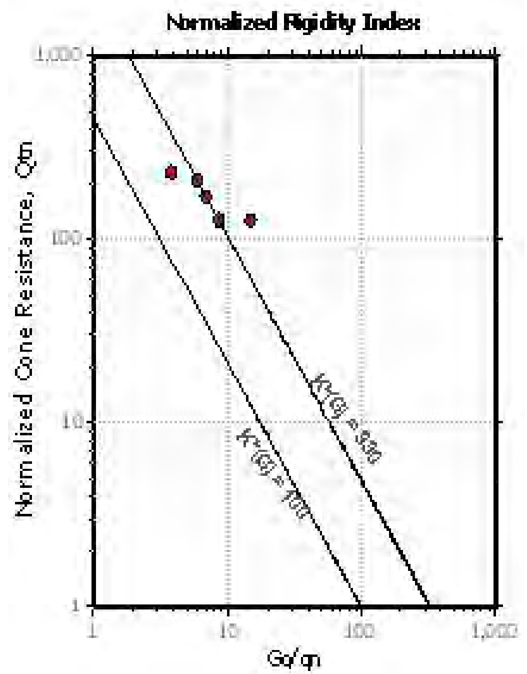
SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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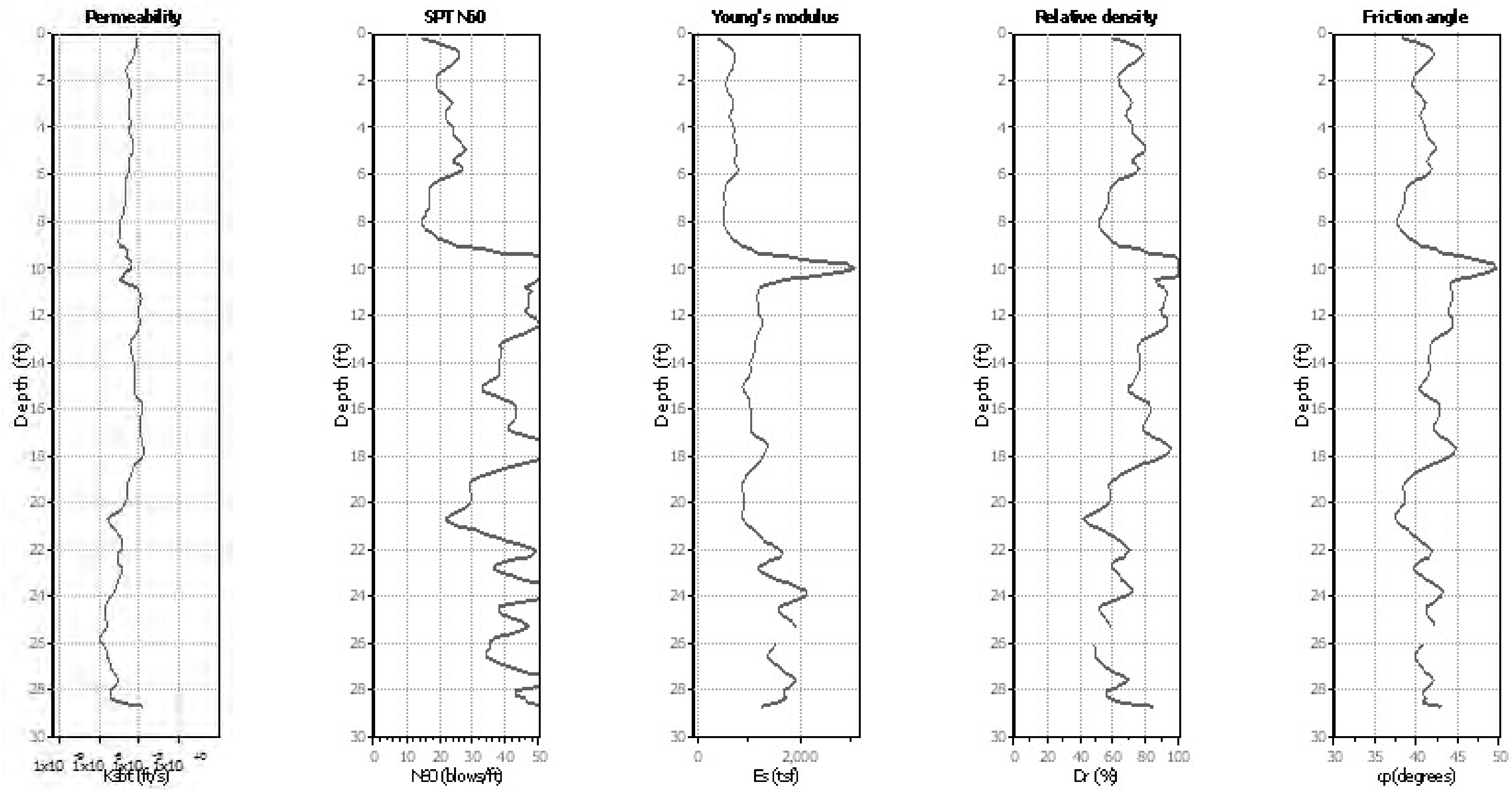
CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

Leighton Consulting, Inc.
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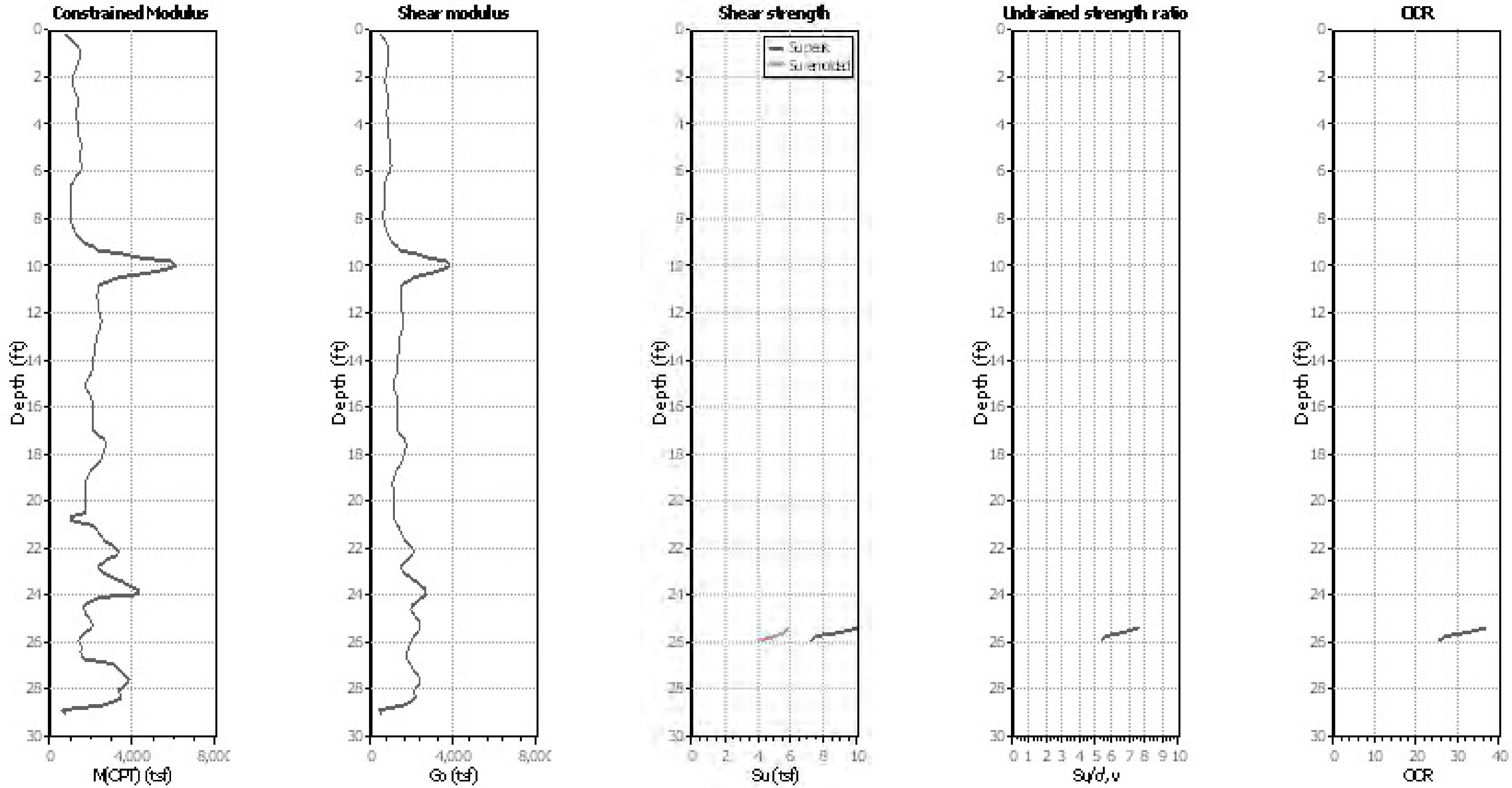
Engineering Consultants, Irvine California
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Proposed Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
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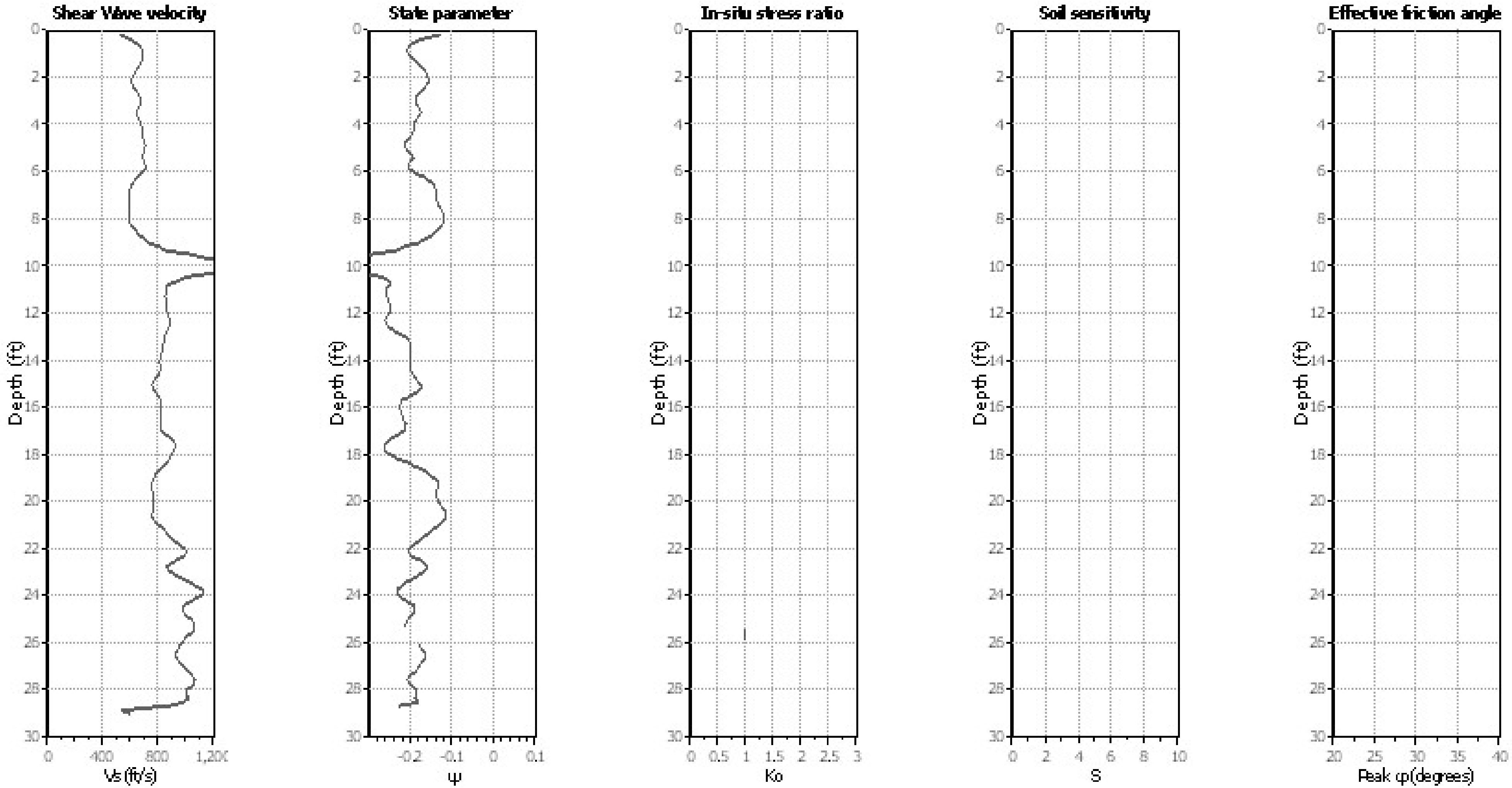
11588.001 Brea Boulevard Corridor Improvements

CPT: SC-1
Total depth: 29.04 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

Leighton Consulting, Inc.
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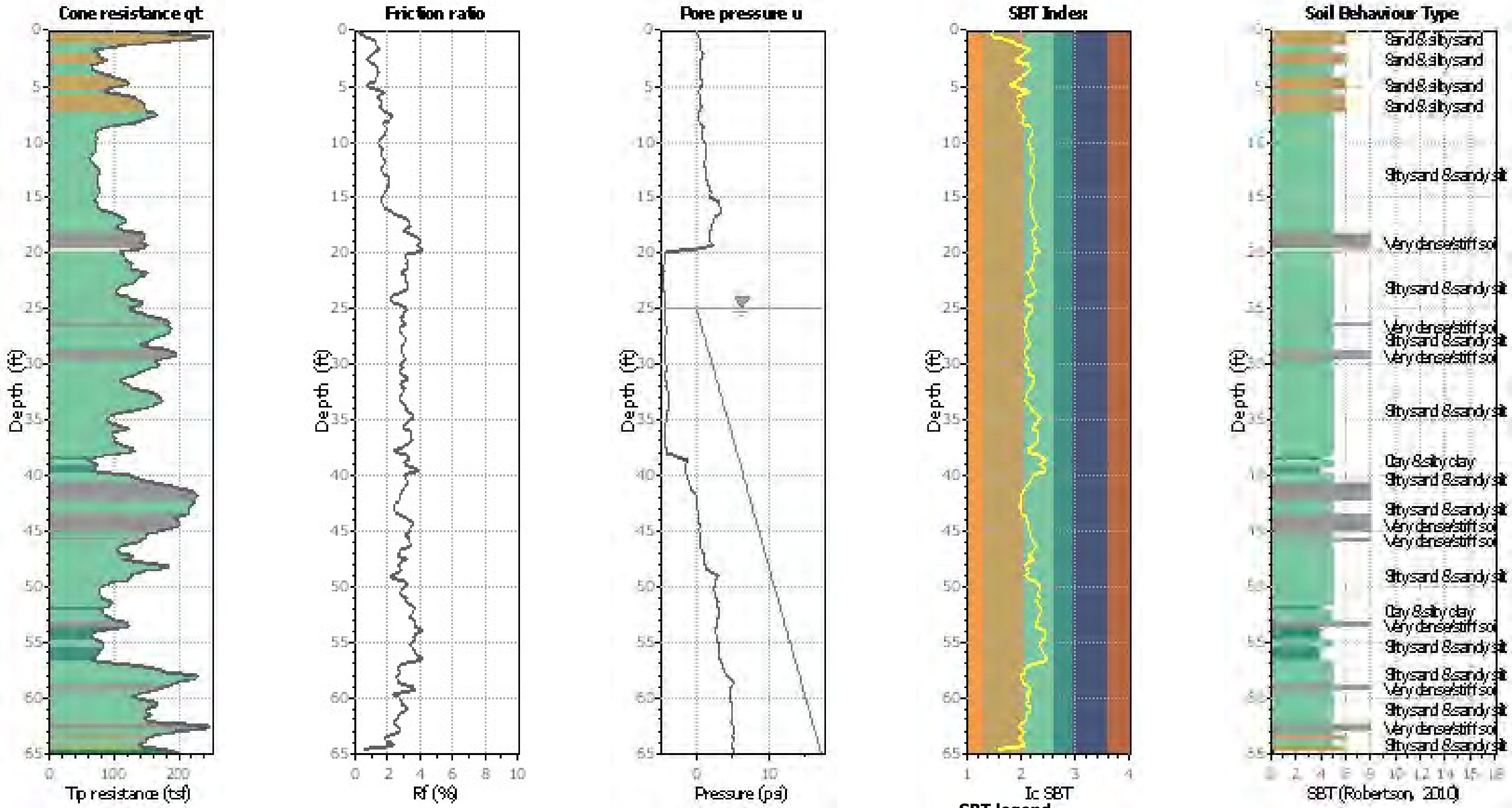
CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Proposed Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



SBT legend
1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty clay
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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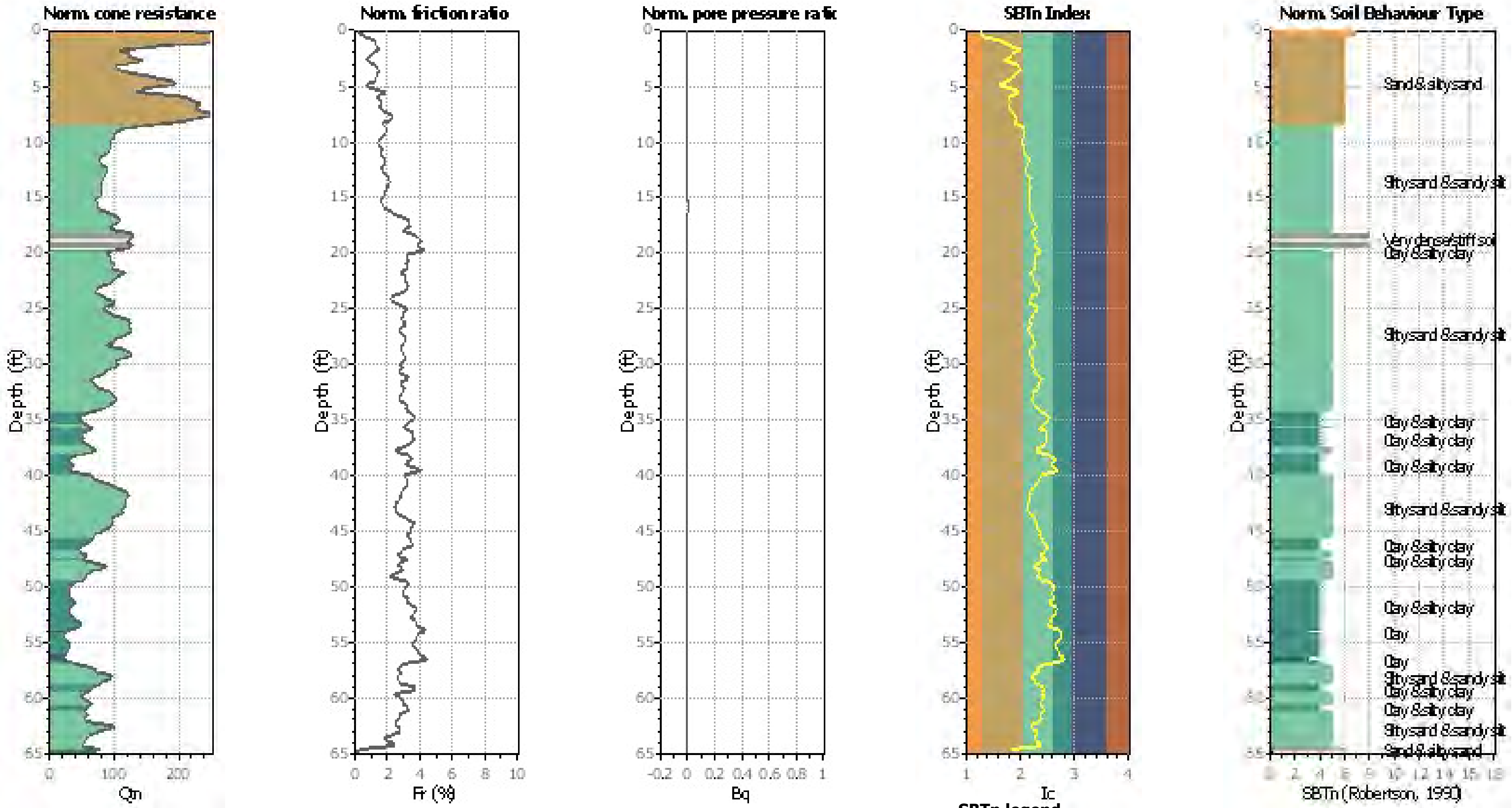
CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

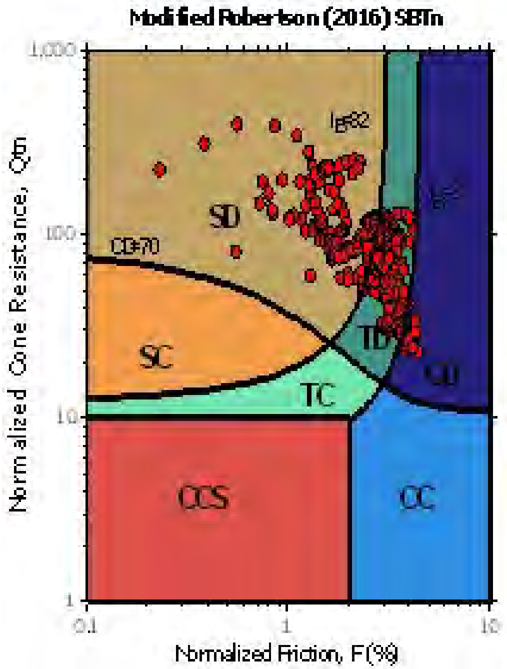
Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**

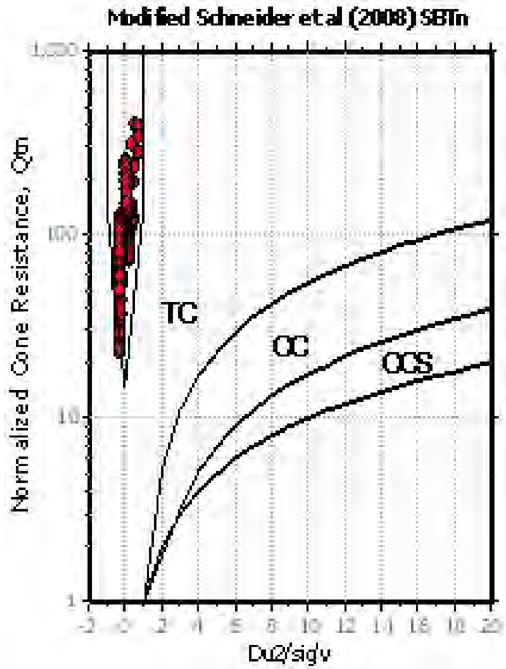


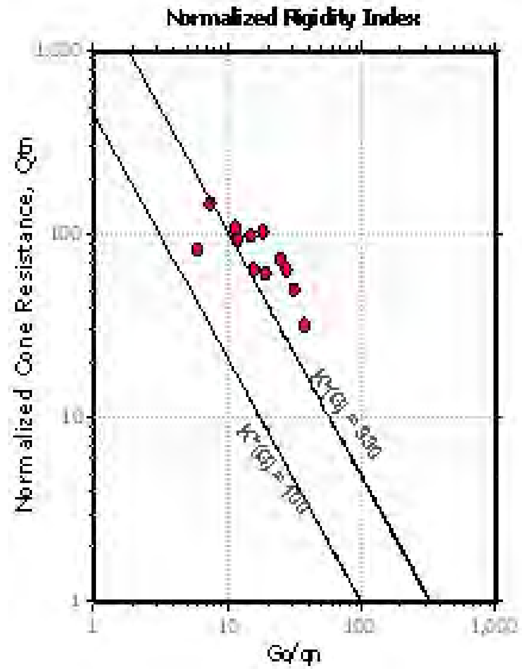
SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty clay
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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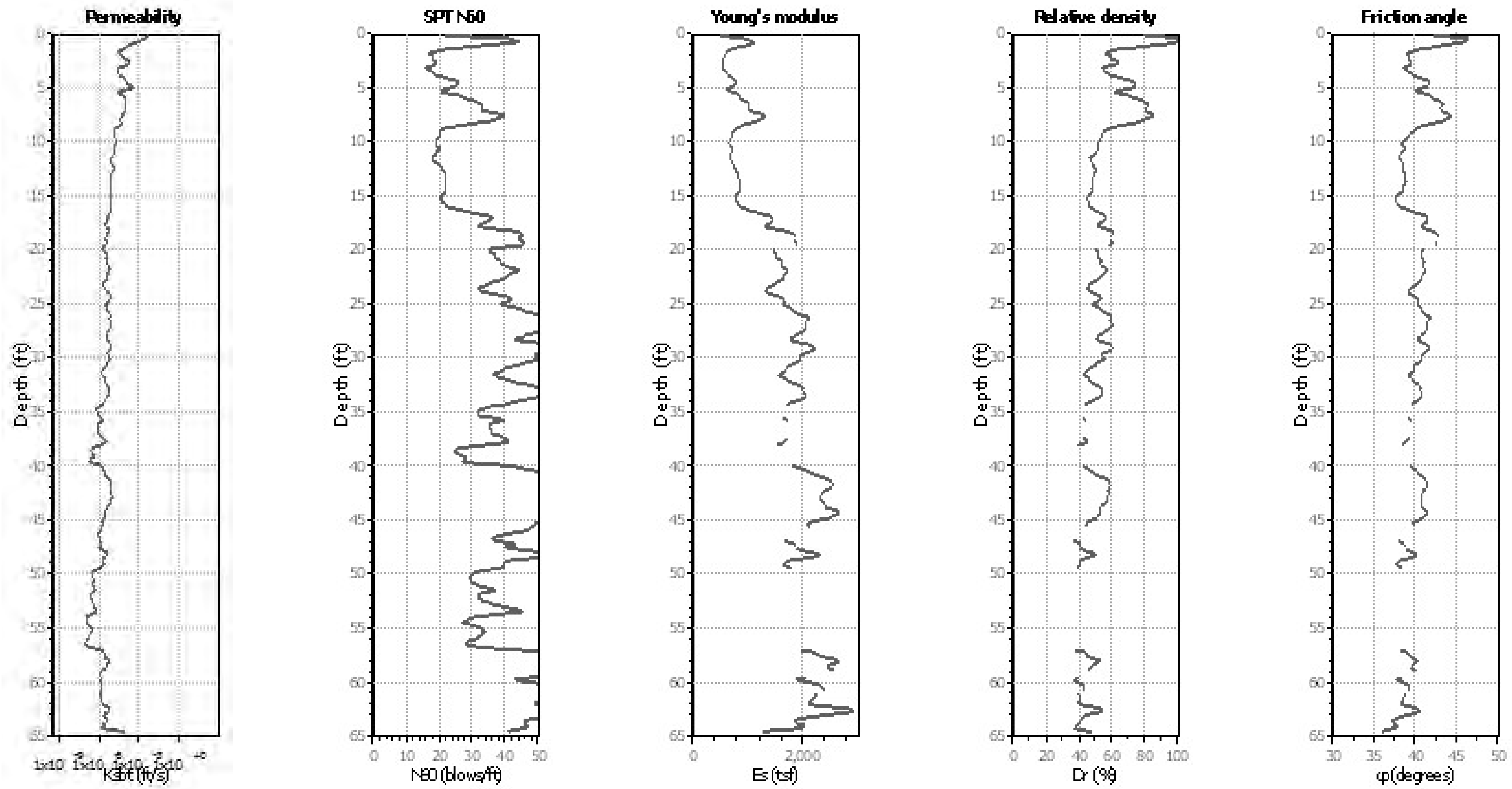
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
User defined estimation data

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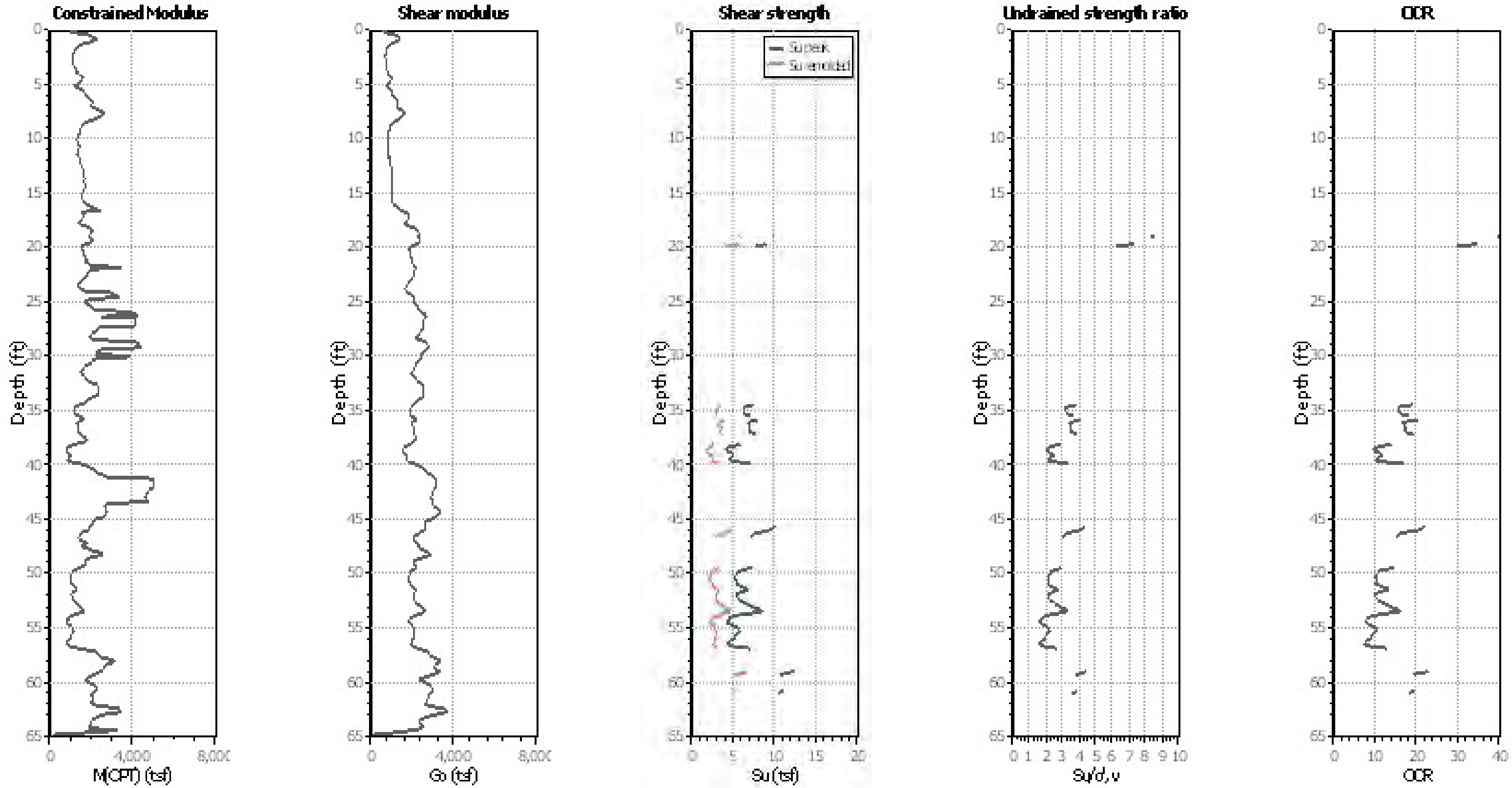
CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: Proposed Brea Boulevard Corridor Improvements
Location: Brea, Orange County, California



Calculation parameters
Constrained modulus: Based on variable alpha using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable alpha using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14
OCR factor for clays, N_{kt}: 0.33
User defined estimation data
Flat Dilatometer Test data

Leighton Consulting, Inc.
Geotechnical, Materials, Environmental
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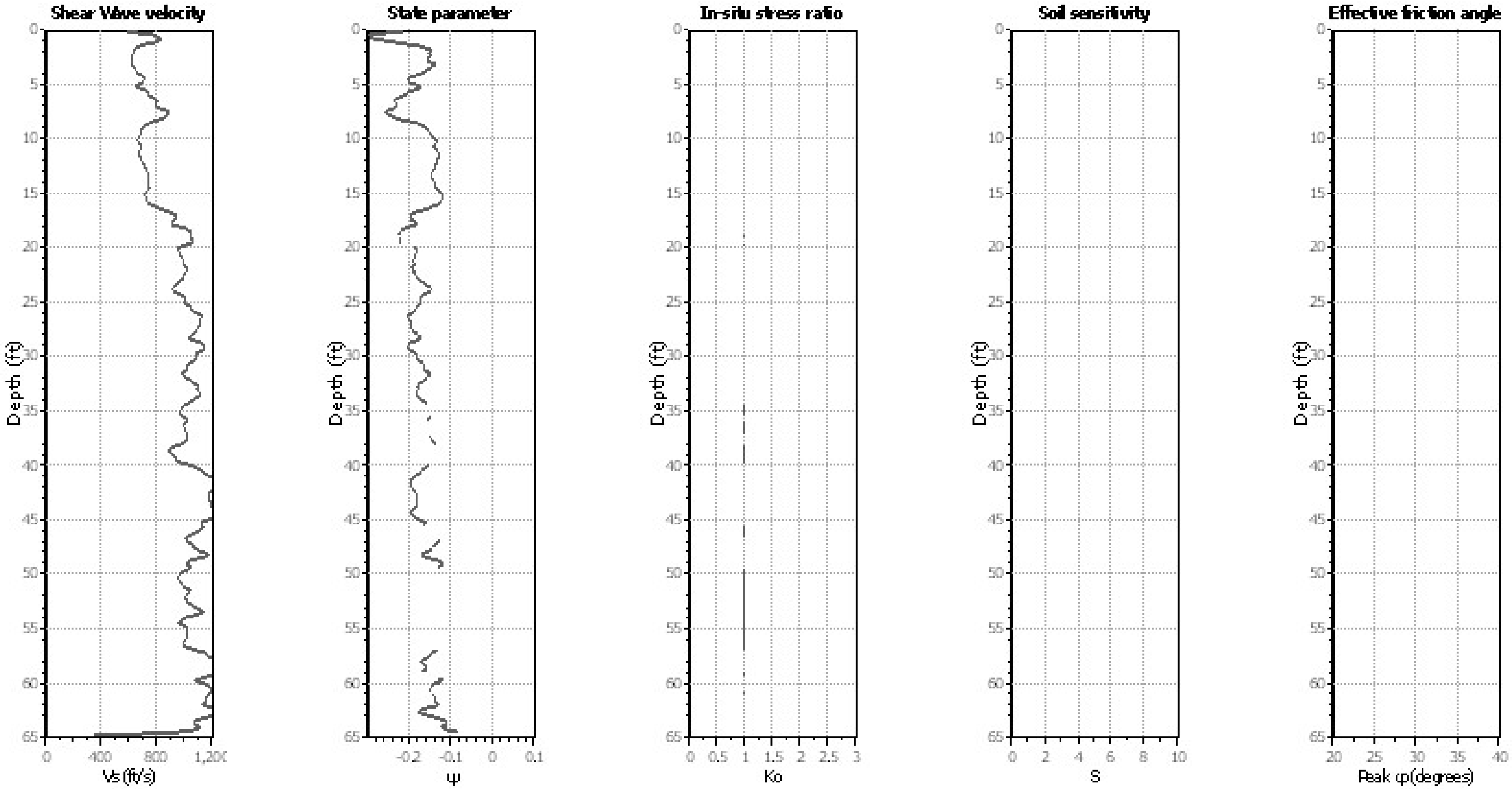
CPT: SC-3
Total depth: 64.96 ft, Date: 8/6/2018
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Vertek
Cone Operator: Kehoe Testing and Engineering, Inc.

Project: **Proposed Brea Boulevard Corridor Improvements**
Location: **Brea, Orange County, California**



Calculation parameters

Soil Sensitivity factor, N_S: 350.00

User defined estimation data

APPENDIX D.4

Slope Stability Analysis

Appendix D - Slope Stability Analysis

Slope stability analyses were performed to evaluate the effect of liquefaction and lateral spreading on the abutment walls for Bridge 1 and Bridge 3. Slope stability analyses were conducted using the computer program *SLIDE2 v9.0212* (Rocscience, 2020). *SLIDE* performs stability calculations using two-dimensional (2D) limit equilibrium techniques based on vertical slice equilibrium. Algorithms programmed into the software include techniques for optimization of non-circular failure surfaces identified by search routines to refine location and shape of the critical surfaces and increase the potential that the surface of minimum factor-of-safety is identified.

Geologic Model: The models used for slope stability analysis programmed into *SLIDE* were developed based upon the subsurface conditions encountered at the test boring and Cone Penetrometer Test (CPT) soundings performed in the vicinity of each bridge. The stratigraphy depicted in each cross-section represents the interpretation of the subsurface conditions to develop an idealized profile at each bridge.

The stability analyses that follow provide color-coded cross-sections along with a summary table for each analysis that summarizes the relevant engineering properties and program input such as the limits and constraints of the search for the critical surface (i.e., surface with lowest calculated factor-of-safety) for the various analysis scenarios. Additional details of the analyses are presented in the text files that follow each graphical output.

Material Strength Parameters: Strength parameters of the materials encountered during field exploration were determined by direct shear testing and triaxial compression testing on representative relatively undisturbed samples. Peak shear strengths were used in modeling transient loading conditions (i.e., pseudostatic analysis) while the ultimate (end-of-shearing) strength parameters were used for long-term, static conditions. The strength along bedding planes was modeled using the results of residual/reshear direct shear testing on a sample of the bedding plane material remolded at a moisture content approximately 85% of Liquid Limit. The equivalent shear strength of the soils susceptible to liquefaction were determined based upon correlations between the corrected SPT N-value ($N_{1\,60}$) or corrected CPT tip resistance ($qc1_{Ncs\text{-}Sr}$) The results of laboratory tests are presented in Appendix B. The following table summarizes the values used in analysis.

Table D-1 Summary of Shear Strength Parameters Used in Slope Stability Analysis

Material Description	Static		PseudoStatic[1]	
	c' (psf)	ø'	c' (psf)	ø'
Tf – Fernando Formation				
(Cross-Bedding)	300	31°	600	34°
(Along Bedding)	200	15°	200	15°
Tm – Monterey Formation				
(Cross-Bedding)	250	28°	550	32°
(Along Bedding)	200	15°	200	15°
Qalo/Qal – Alluvium & Older Alluvial Soil	200	28°	300	30°
Qalo/Qal LQ – Soils susceptible to liquefaction	Varies[2]		Varies[2]	
Afc - Structural Fill (compacted/engineered)	100	32°	100	32°

Notes:

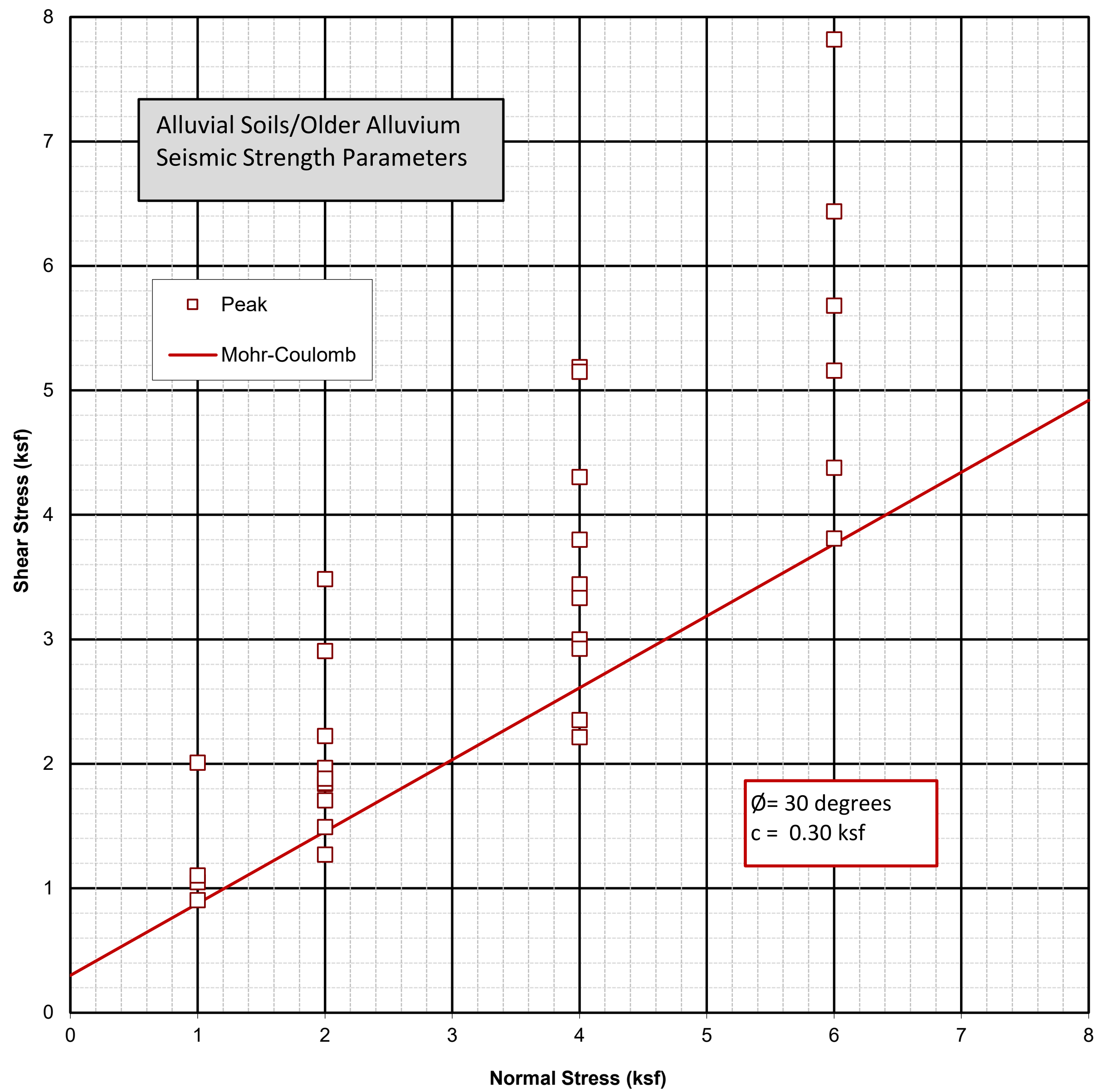
1) PseudoStatic analysis conducted based on k_h = 0.22 for global stability.
2) The equivalent shear strength used for post-liquefaction analysis of lateral spread was derived from correlation of corrected SPT N-value (Kramer and Wang, 2015) and/or corrected CPT tip resistance (Idriss and Boulanger, 2008).

Anisotropic shear strength models were typically used for the bedrock material to capture the variance in shear strength across along and across bedding planes. The range of bedding attitudes considered in each model is described in the graphical output of the analyses (e.g., see "Anisotropic Function" inserts in the graphics). The nomenclature of the Anisotropic Function identifies the materials designation, conveys the range of bedding dip angle (e.g., Tf_40 to 45 out) and relative direction, either into slope ("In") or out-of-slope ("Out") relative to the inclination of the slope being analyzed.

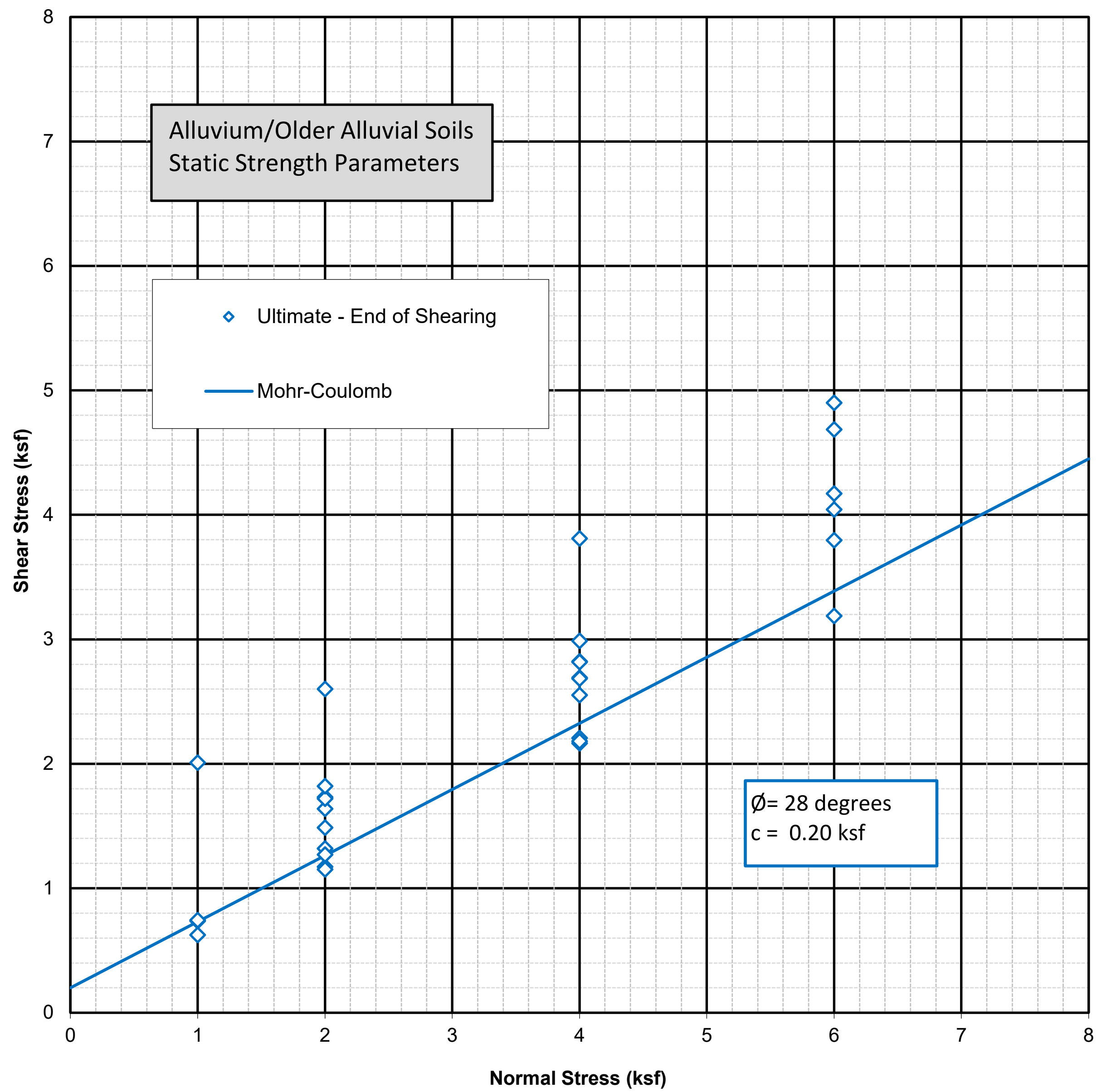
Stability Analysis Methodology: _Slope stability analyses were performed to calculate the factor of safety for static and pseudostatic conditions (k_h 0.22). Analysis criteria were a minimum factor of safety of 1.5 for static conditions and 1.1 for pseudostatic. The critical surfaces were located by invoking circular and non-circular search routines programmed in the software. Non-circular surface searches were performed in the bedrock material that exhibited adverse bedding orientations. Circular searches were performed in isotropic (soil) material or anisotropic (bedrock) material in which the bedding attitudes were favorable with respect to the probable direction of movement.

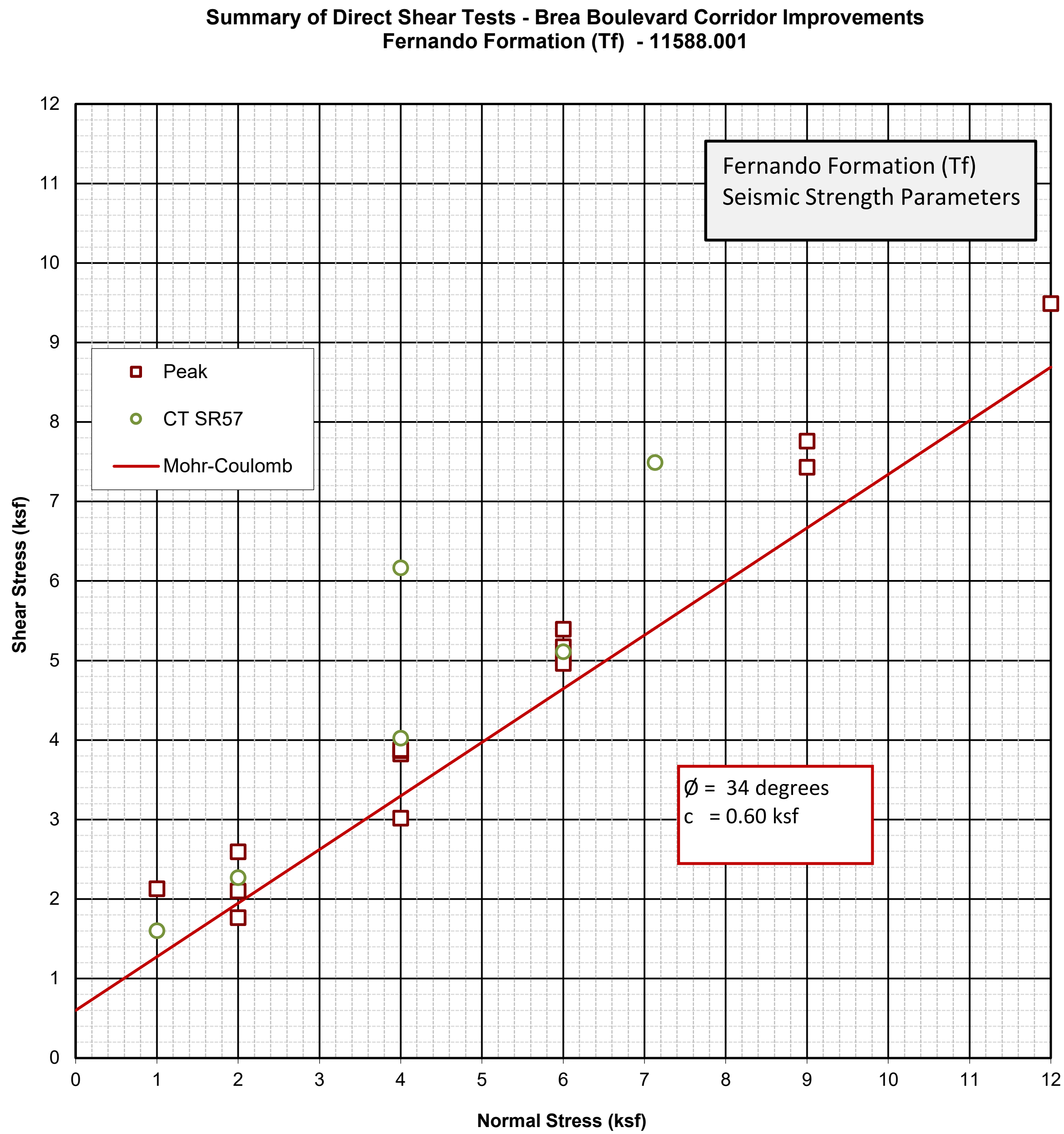
The analyses typically consisted of generating several thousand trial surfaces based upon specific search parameters input to the program. The factor-of-safety for each surface was calculated using Janbu's method and Spencer's method of General Limit Equilibrium (GLE) for non-circular surfaces; Bishops's method and Spencer's method were used for circular surfaces.

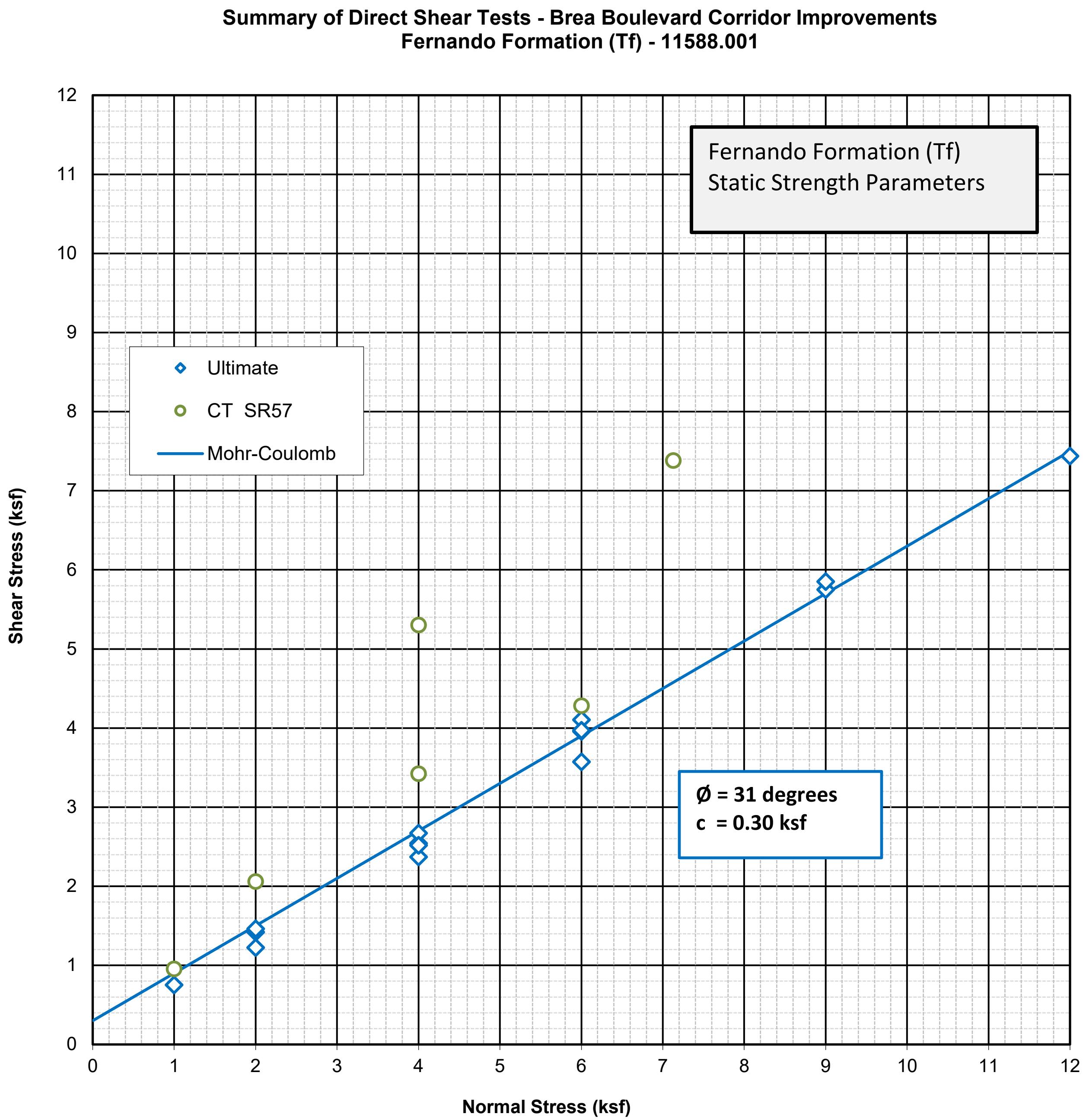
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
All Soils - 11588.001



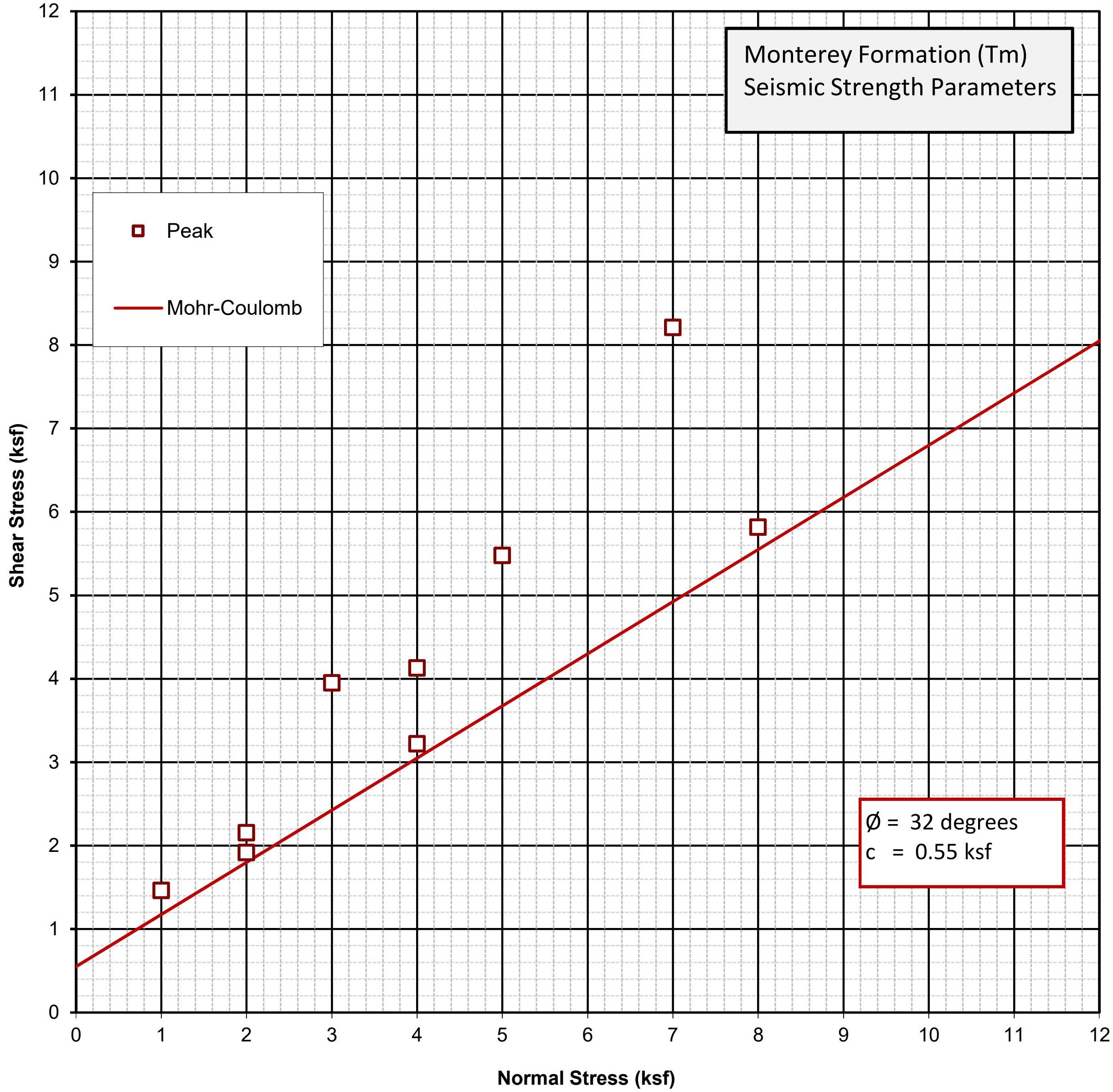
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
All Soils - 11588.001



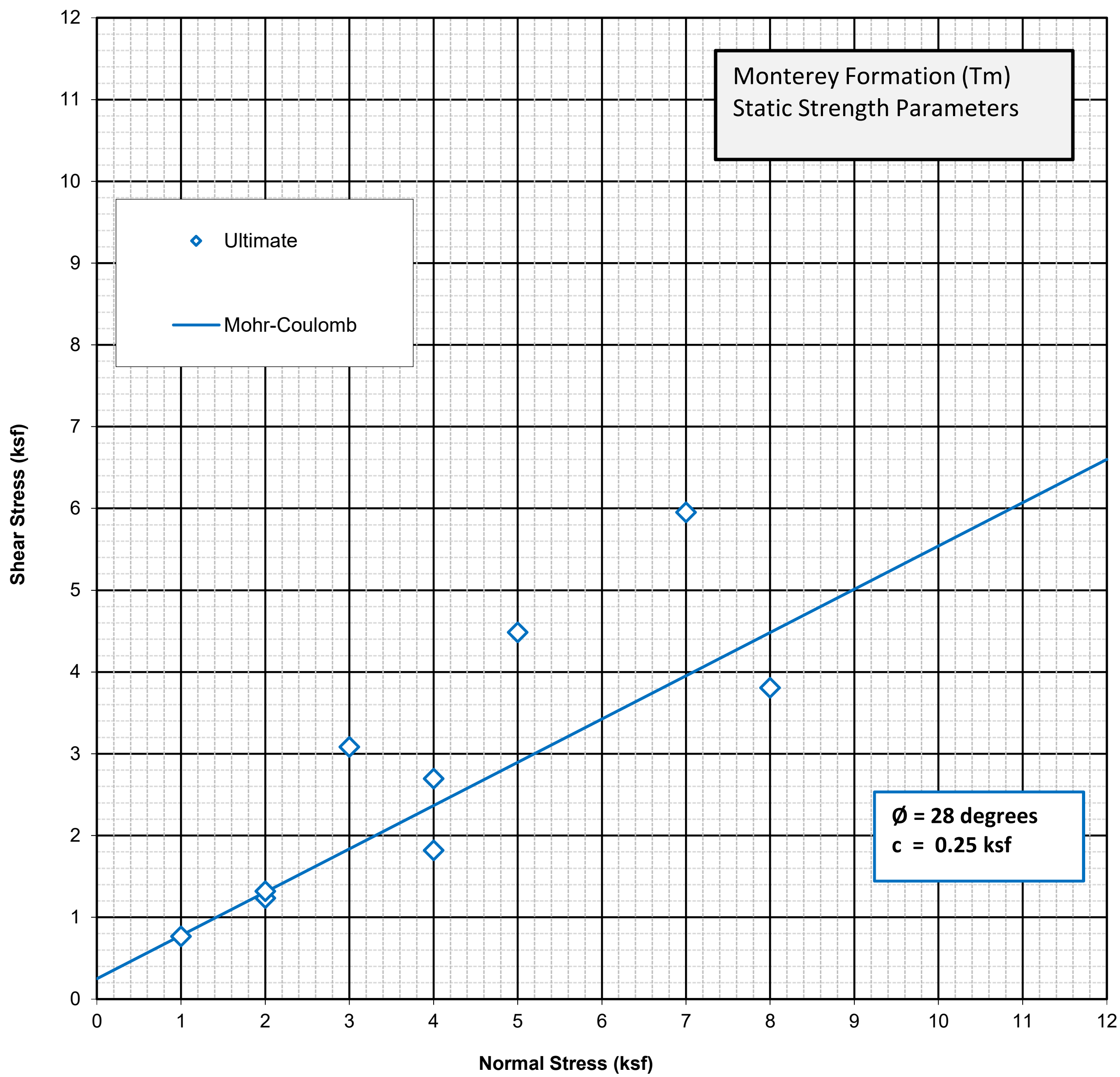

Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Fernando Formation (Tf) - 11588.001
Fernando Formation (Tf)
Seismic Strength Parameters
Peak
CT SR57
Mohr-Coulomb
Ø = 34 degrees
c = 0.60 ksf
Shear Stress (ksf)
Normal Stress (ksf)
0
1
2
3
4
5
6
7
8
9
10
11
12


Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Fernando Formation (Tf) - 11588.001
Fernando Formation (Tf)
Static Strength Parameters
Ultimate
CT SR57
Mohr-Coulomb
Ø = 31 degrees
c = 0.30 ksf
Shear Stress (ksf)
Normal Stress (ksf)
0
1
2
3
4
5
6
7
8
9
10
11
12

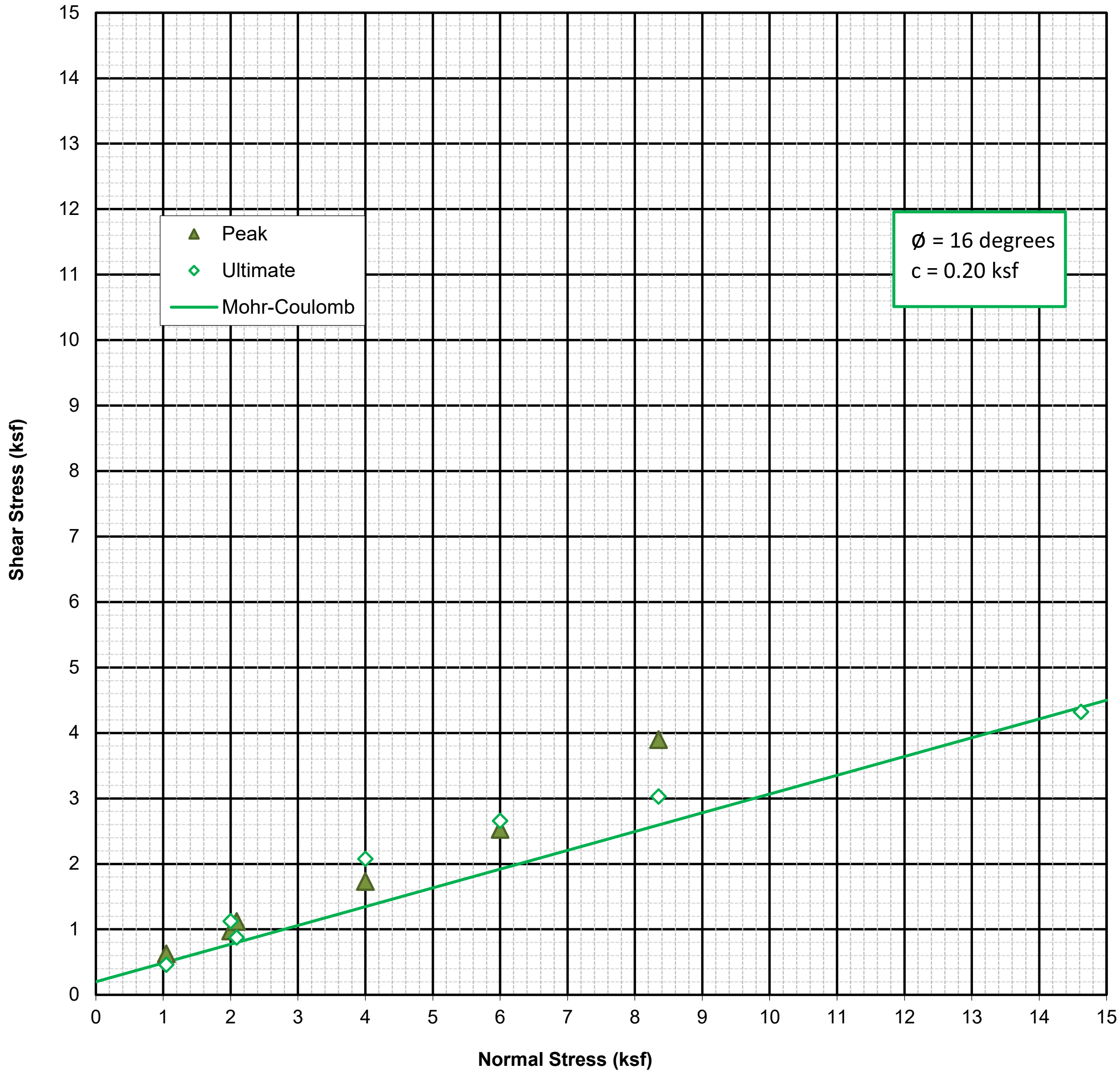
Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Monterey Formation (Tm) - 11585.005



Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Monterey Formation (Tm) - 11585.005



Summary of Direct Shear Tests - Brea Boulevard Corridor Improvements
Residual/Reshear- 11588.001



Bridge 1 - Abutment 1 - Post-Scour - Liquefaction - Ground Improvement

Liquefied Residual Strength and Inertial Loading

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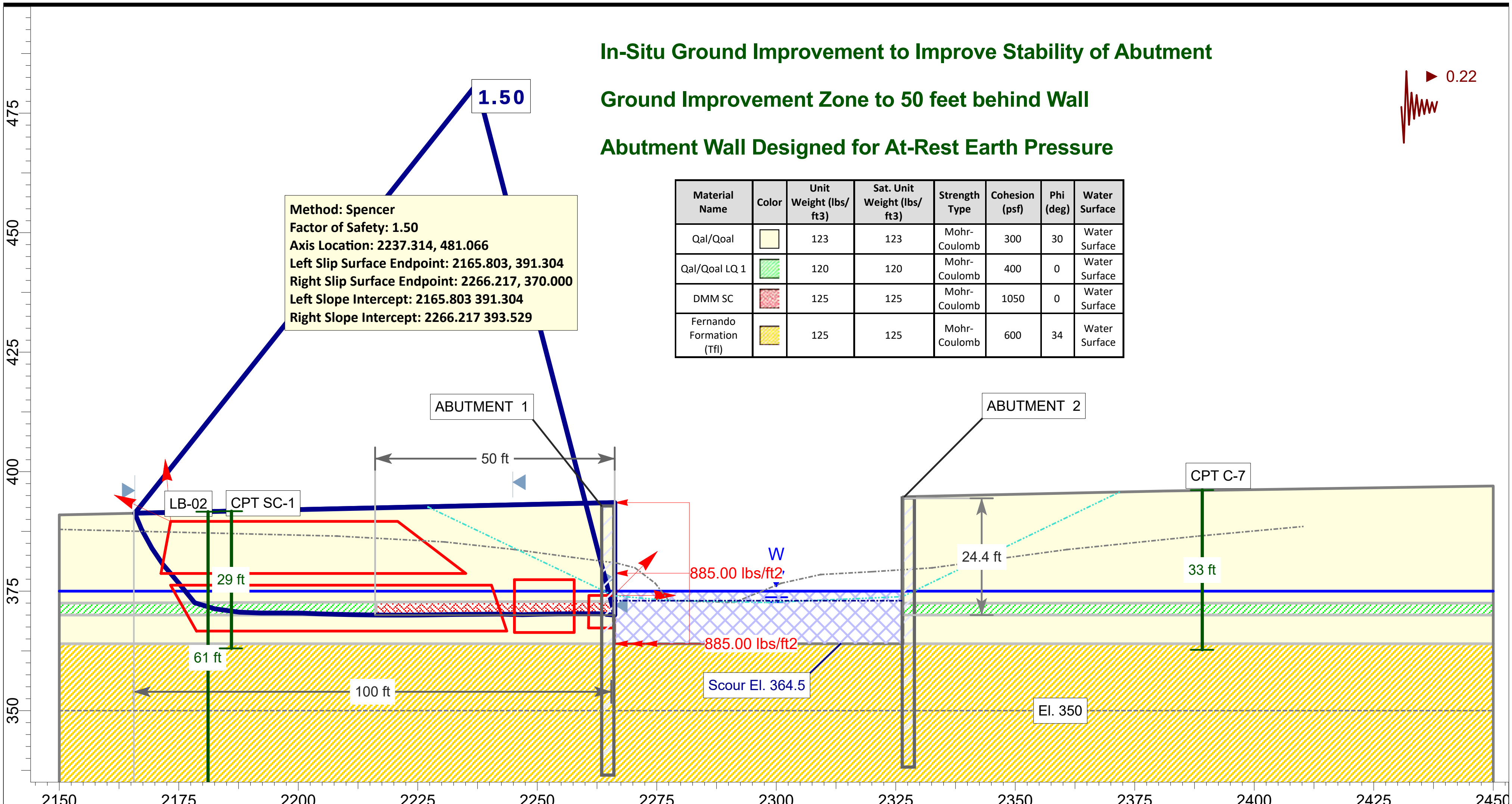


Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30	Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	400	0	Water Surface
DMM SC		125	125	Mohr-Coulomb	1050	0	Water Surface
Fernando Formation (Tfl)		125	125	Mohr-Coulomb	600	34	Water Surface

SLIDEINTERPRET 9.012

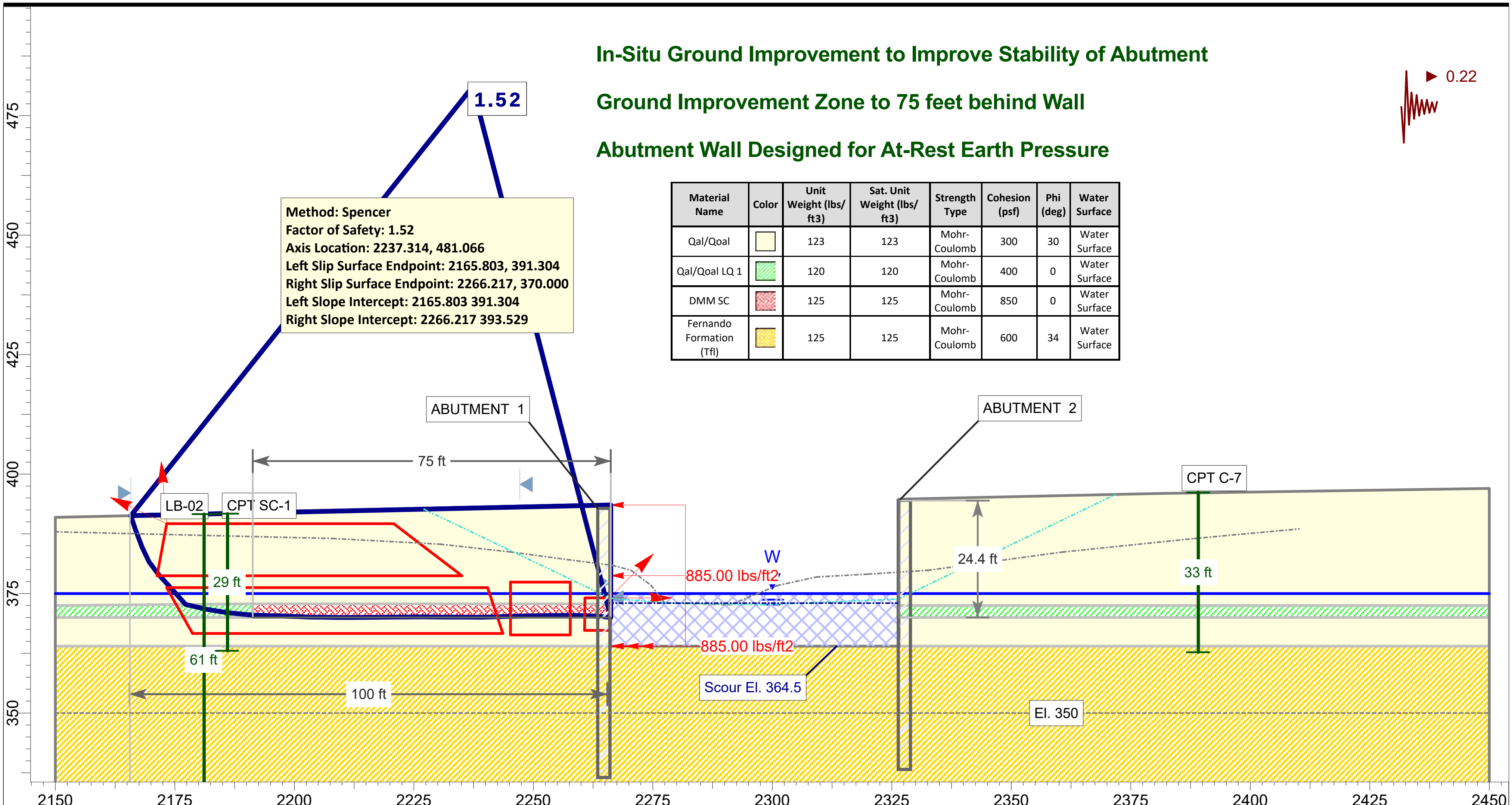
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: **11585.005**
Date: September 30, 2021	Condition: **Liquefaction**		File Name: 11585_Bridge 1 LB 02 CPT SC-1 C-7_A01_EFP Ko_Blk SrfA_LQ Scour_x2a.slim

Bridge 1 - Abutment 1 - Post-Scour - Liquefaction - Ground Improvement

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 1 - Ground Imp. EFP Ko\11585_Bridge 1 LB 02 CPT SC-1 C-7_A01_EFP Ko_Blk SrfA_LQ Scour_x3a.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30	Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	400	0	Water Surface
DMM SC		125	125	Mohr-Coulomb	850	0	Water Surface
Fernando Formation (Tfl)		125	125	Mohr-Coulomb	600	34	Water Surface

SLIDEINTERPRET 9.012

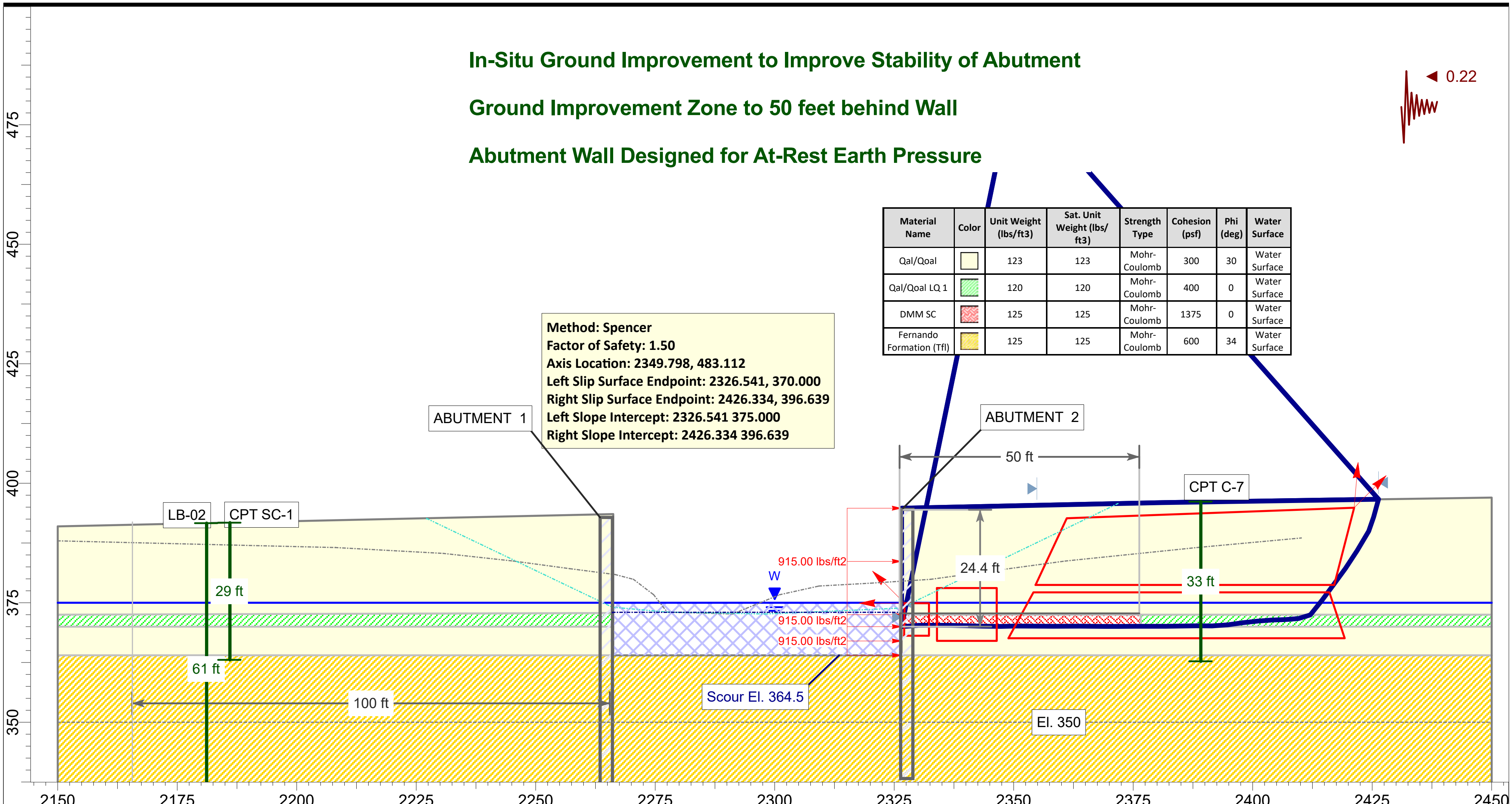
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: 11585.005
Date: September 30, 2021	Condition: Liquefaction		File Name: 11585_Bridge 1 LB 02 CPT SC-1 C-7_A01_EFP Ko_Blk SrfA_LQ Scour_x3a.slim

Bridge 1 - Abutment 1 - Post-Scour - Liquefaction - Ground Improvement

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 1 - Ground Imp. EFP Ko\11585_Bridge 1 LB 02 CPT SC-1 C-7_A02_EFP Ko_Blk SrfA_LQ Scour_y2a.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30	Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	400	0	Water Surface
DMM SC		125	125	Mohr-Coulomb	1375	0	Water Surface
Fernando Formation (Tfl)		125	125	Mohr-Coulomb	600	34	Water Surface

SLIDEINTERPRET 9.012

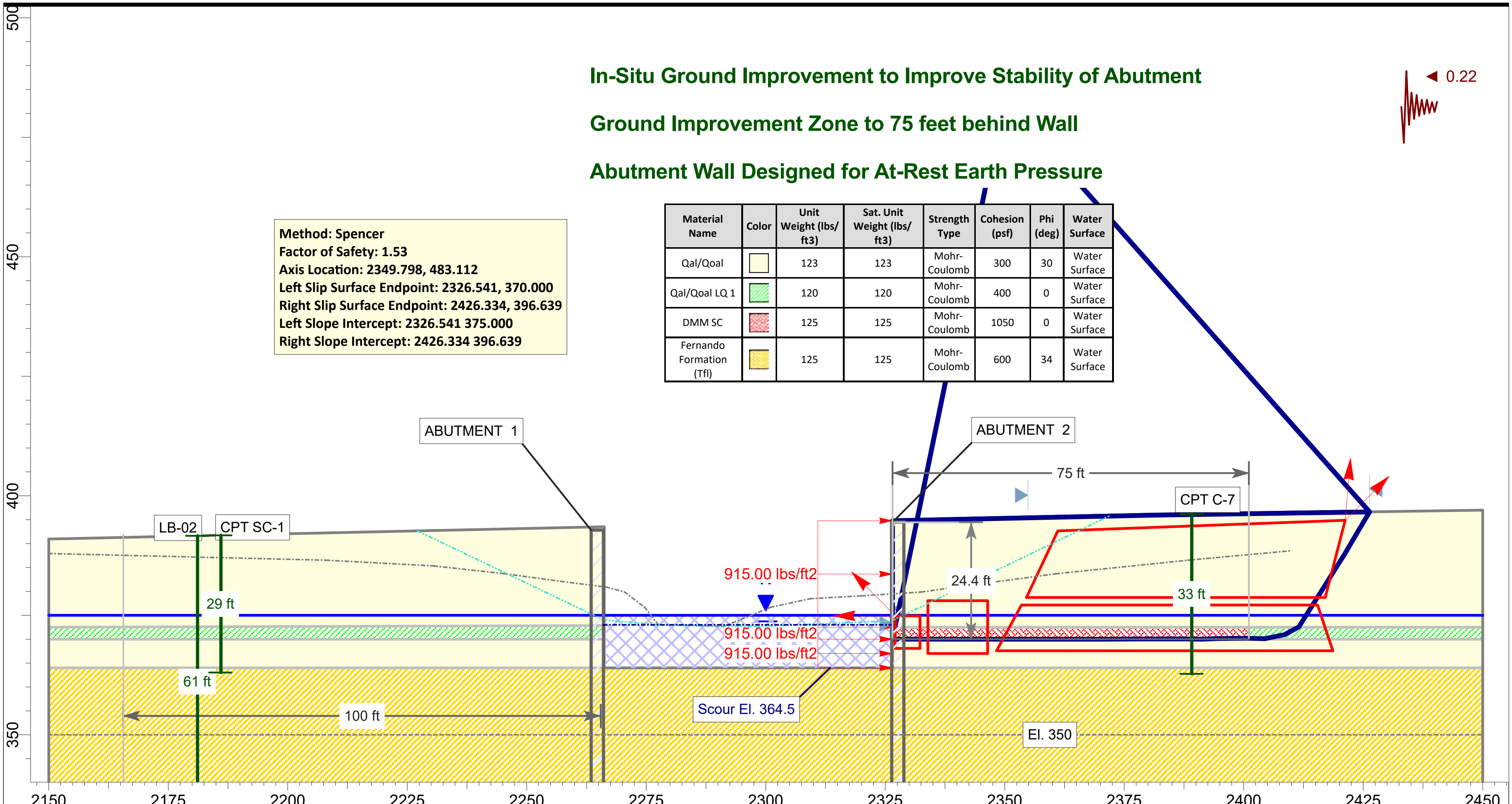
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**
Date: September 30, 2021	*Condition:* **Liquefaction**		*File Name:* 11585_Bridge 1 LB 02 CPT SC-1 C-7_A02_EFP Ko_Blk SrfA_LQ Scour_y2a.slim

Bridge 1 - Abutment 1 - Post-Scour - Liquefaction - Ground Improvement

Liquefied Residual Strength and Inertial Loading

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 1 - Ground Imp. EFP Ko\11585_Bridge 1 LB 02 CPT SC-1 C-7_A02_EFP Ko_Blk SrfA_LQ Scour_y3a.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30	Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	400	0	Water Surface
DMM SC		125	125	Mohr-Coulomb	1050	0	Water Surface
Fernando Formation (Tfl)		125	125	Mohr-Coulomb	600	34	Water Surface

SLIDEINTERPRET 9.012

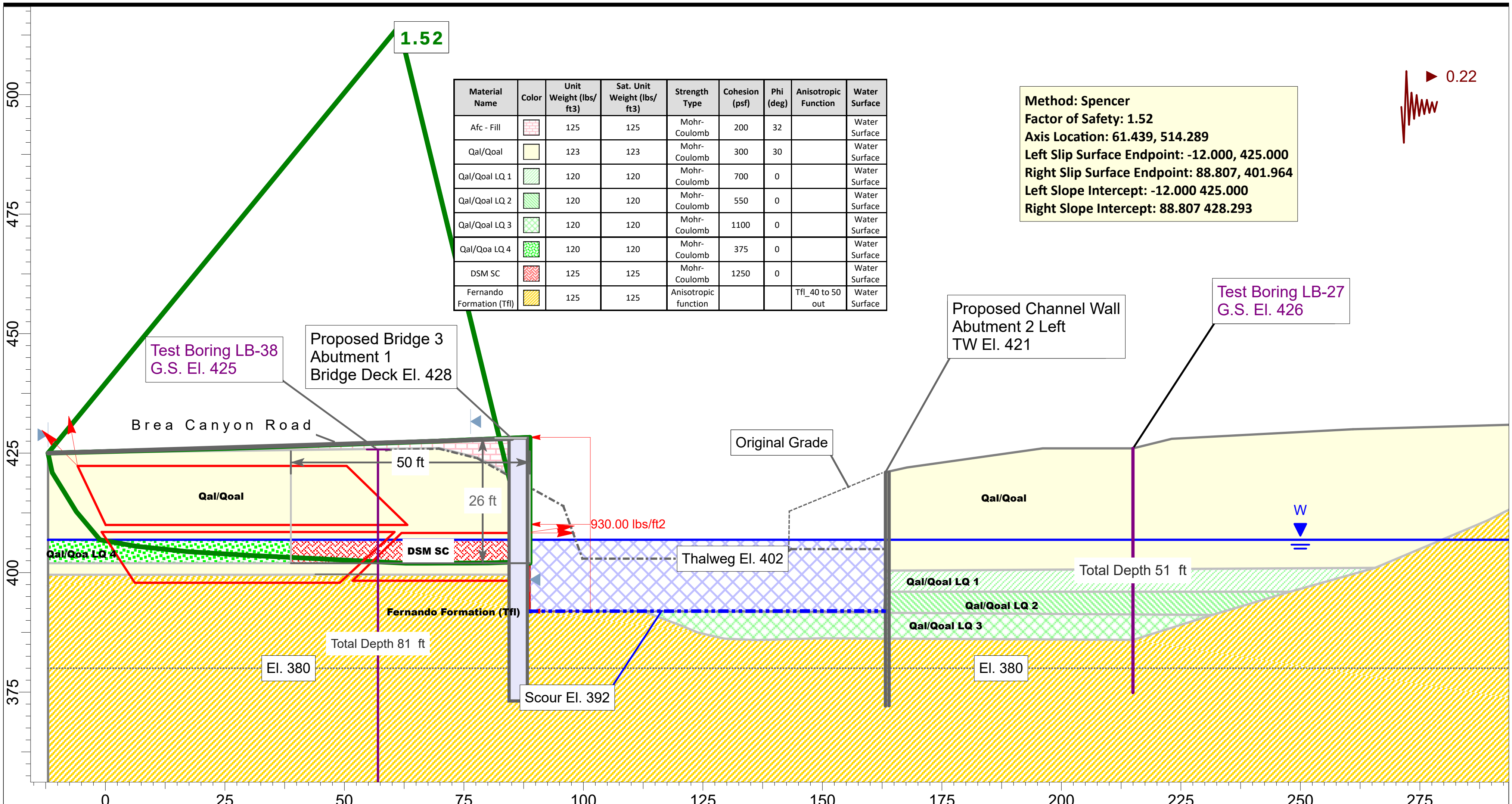
Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: **11585.005**
Date: September 30, 2021	Condition: **Liquefaction**		File Name: 11585_Bridge 1 LB 02 CPT SC-1 C-7_A02_EFP Ko_Blk SrfA_LQ Scour_y3a.slim

Bridge 3 - Abutment 1 - Section LB-38 to LB-27 - Channel Scour

At-rest Lateral Earth Pressure at Abutment Wall

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_LB-38 LB-27\Br3_Sec B38-B27_A01_Blk SrfA_G I DSM_sc1a.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	700	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	550	0		Water Surface
Qal/Qoal LQ 3		120	120	Mohr-Coulomb	1100	0		Water Surface
Qal/Qoa LQ 4		120	120	Mohr-Coulomb	375	0		Water Surface
DSM SC		125	125	Mohr-Coulomb	1250	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 out	Water Surface

Method: Spencer
Factor of Safety: 1.52
Axis Location: 61.439, 514.289
Left Slip Surface Endpoint: -12.000, 425.000
Right Slip Surface Endpoint: 88.807, 401.964
Left Slope Intercept: -12.000 425.000
Right Slope Intercept: 88.807 428.293

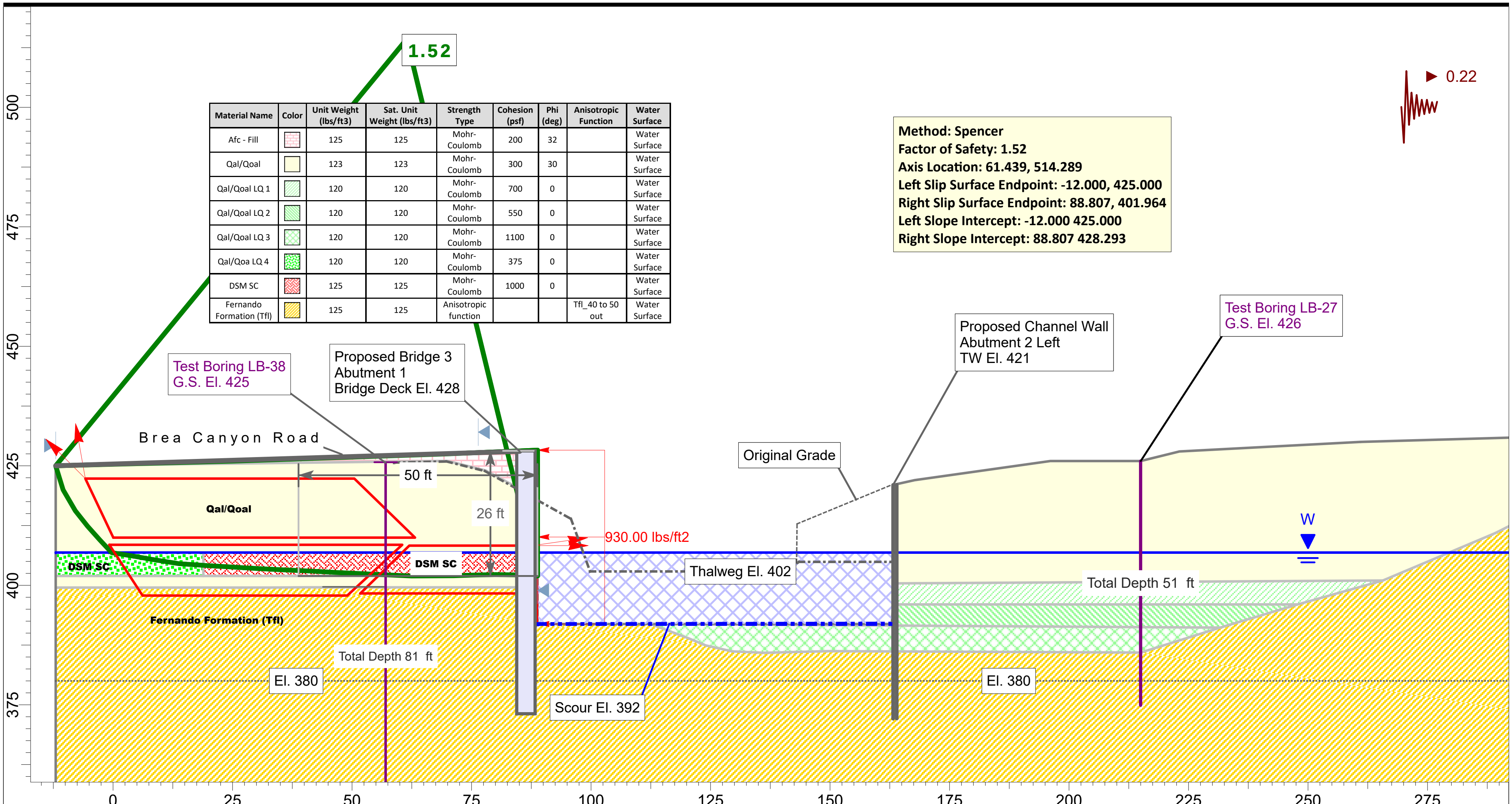
SLIDEINTERPRET 9.012

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**
Date: September 24, 2021	*Condition:* **Liquefaction**		*File Name:* Br3_Sec B38-B27_A01_Blk SrfA_G I DSM_sc1a.slim

Bridge 3 - Abutment 1 - Section LB-38 to LB-27 - Channel Scour

At-rest Lateral Earth Pressure at Abutment Wall

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_LB-38 LB-27\Br3_Sec B38-B27_A01_Blk SrfA_G I DSM_sc2a.slim



Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	700	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	550	0		Water Surface
Qal/Qoal LQ 3		120	120	Mohr-Coulomb	1100	0		Water Surface
Qal/Qoa LQ 4		120	120	Mohr-Coulomb	375	0		Water Surface
DSM SC		125	125	Mohr-Coulomb	1000	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 out	Water Surface

Method: Spencer
Factor of Safety: 1.52
Axis Location: 61.439, 514.289
Left Slip Surface Endpoint: -12.000, 425.000
Right Slip Surface Endpoint: 88.807, 401.964
Left Slope Intercept: -12.000 425.000
Right Slope Intercept: 88.807 428.293

SLIDEINTERPRET 9.012

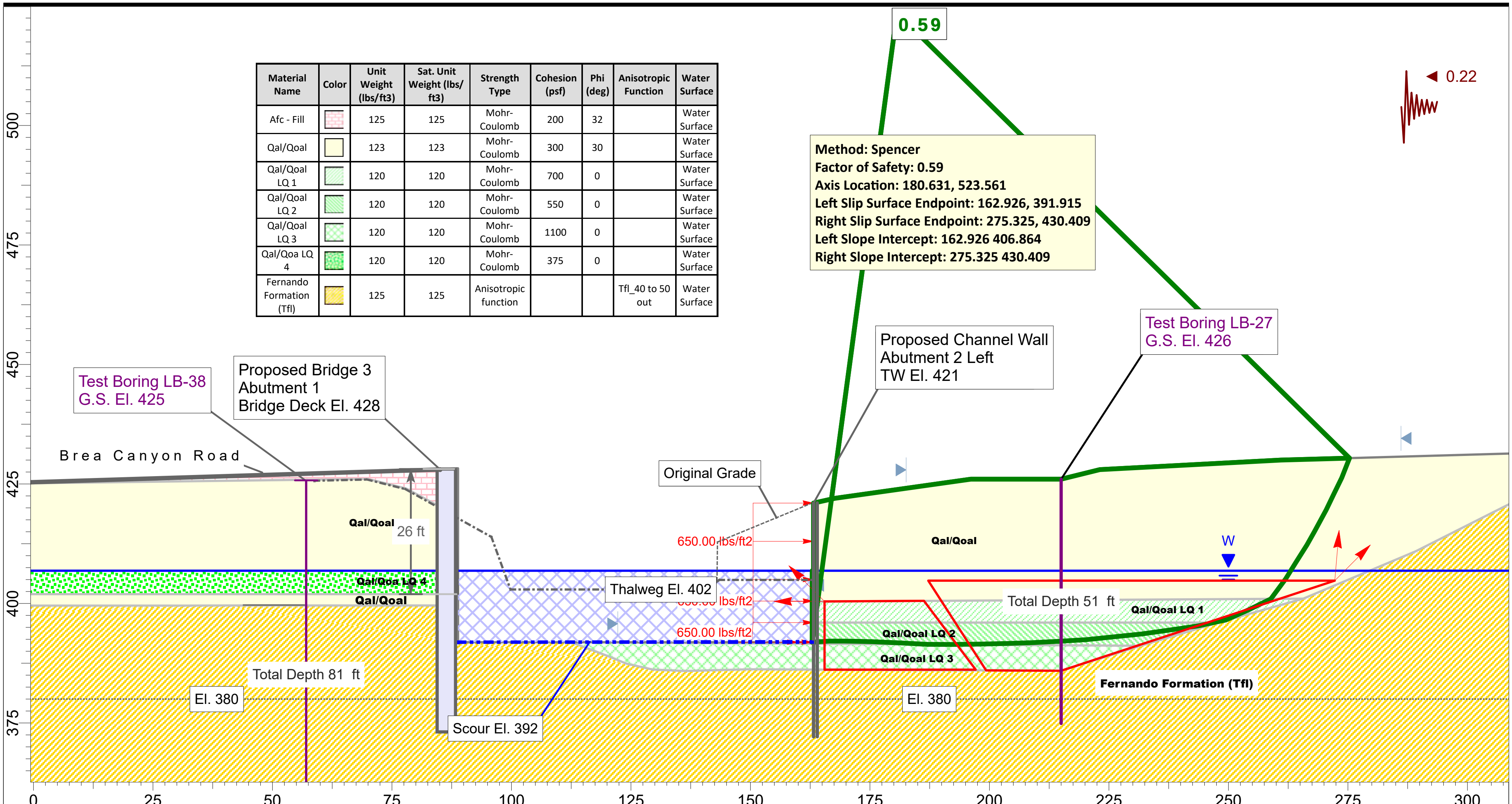
Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	*Units:* feet	*Scale:* 1:360	*Project No.:* **11585.005**
Date: September 24, 2021	*Condition:* **Liquefaction**		*File Name:* Br3_Sec B38-B27_A01_Blk SrfA_G I DSM_sc2a.slim

Bridge 3 - Channel Wall Abutment 2 Left - Section LB-38 to LB-27 - Channel Scour

Active Earth Pressure External Load

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_LB-38 LB-27\Br3_Sec B38-B27_CA A2L_Blk SrfA_LQ_G I a_m2.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	700	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	550	0		Water Surface
Qal/Qoal LQ 3		120	120	Mohr-Coulomb	1100	0		Water Surface
Qal/Qoa LQ 4		120	120	Mohr-Coulomb	375	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 out	Water Surface



SLIDEINTERPRET 9.012

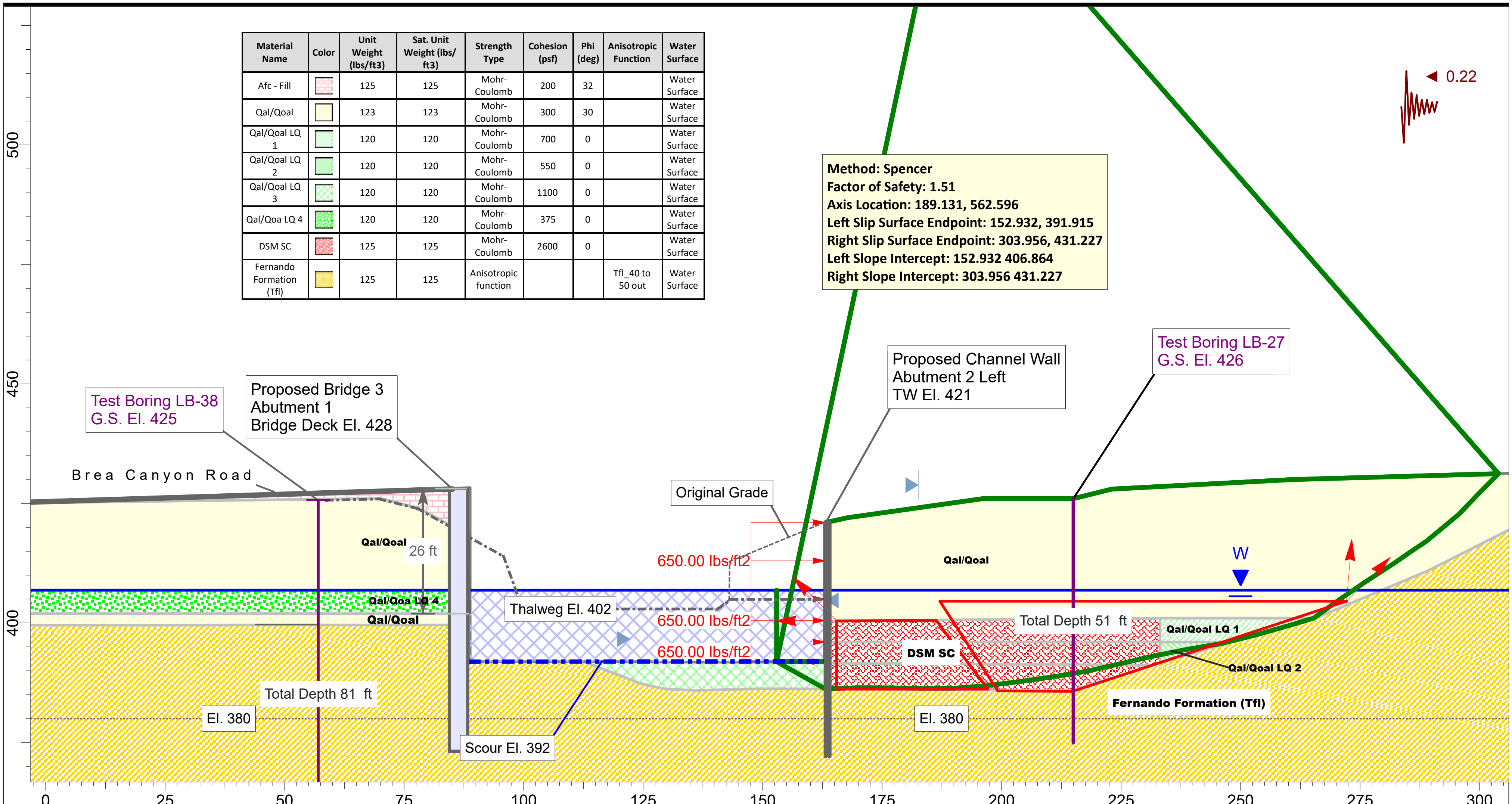
Project: Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA				
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: 11585.005	File Name: Br3_Sec B38-B27_CA A2L_Blk SrfA_LQ_G I a_m2.slim
Date: September 24, 2021	Condition: Liquefaction			

Bridge 3 - Channel Wall Abutment 2 Left - Section LB-38 to LB-27 - Channel Scour

Active Earth Pressure External Load

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_LB-38 LB-27\Br3_Sec B38-B27_CA A2L_Blk SrfA_LQ_G I DSM_m2b.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	700	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	550	0		Water Surface
Qal/Qoal LQ 3		120	120	Mohr-Coulomb	1100	0		Water Surface
Qal/Qoa LQ 4		120	120	Mohr-Coulomb	375	0		Water Surface
DSM SC		125	125	Mohr-Coulomb	2600	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 out	Water Surface



SLIDEINTERPRET 9.012

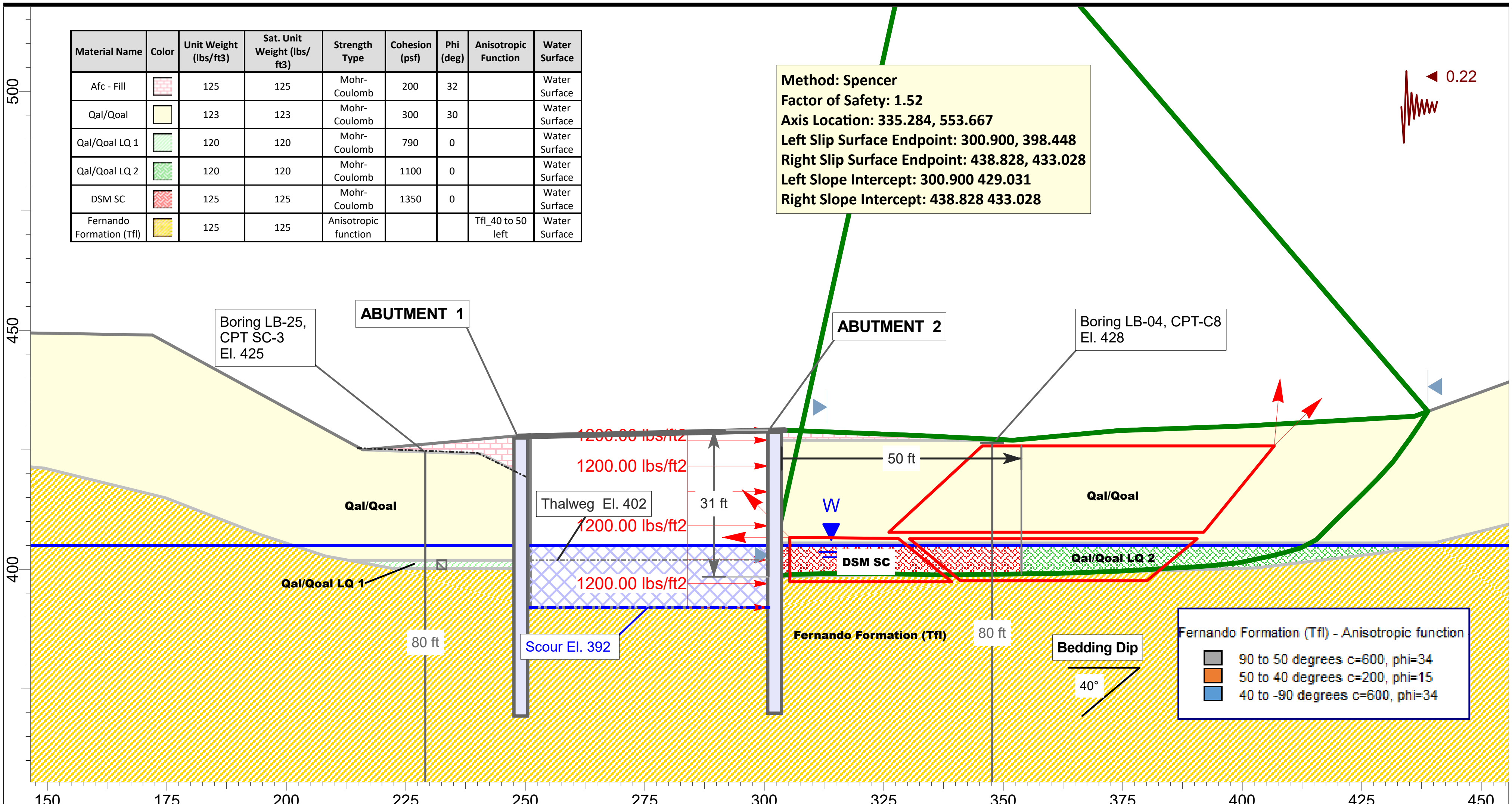
Project: Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: 11585.005
Date: September 24, 2021	Condition: **Liquefaction**		File Name: Br3_Sec B38-B27_CA A2L_Blk SrfA_LQ_G I DSM_m2b.slim

Bridge 3 - Abutment 2 - Section CPT SC-03 to CPT C-08 - Channel Scour

At-Rest Earth Pressure on Abutment Wall

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_SC-03 C-08 LB-04\Br3_C3B4C8_Abut 2_Scour_Blk SrfA_G I DSM_sc1.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	790	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	1100	0		Water Surface
DSM SC		125	125	Mohr-Coulomb	1350	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 left	Water Surface



SLIDEINTERPRET 9.012

Project: Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: 11585.005
Date: September 10, 2021	Condition: Liquefaction		File Name: Br3_C3B4C8_Abut 2_Scour_Blk SrfA_G I DSM_sc1.slim

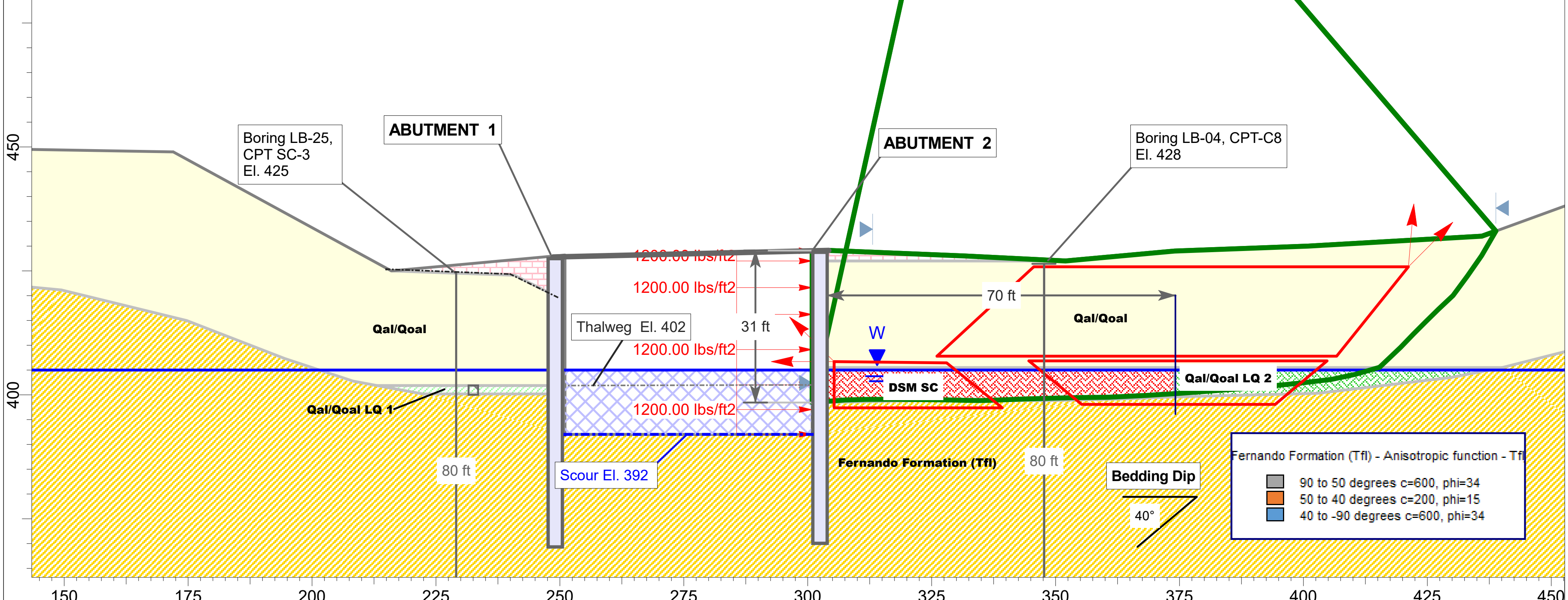
Bridge 3 - Abutment 2 - Section CPT SC-03 to CPT C-08 - Channel Scour

At-Rest Earth Pressure on Abutment Wall

P:\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005 Brea Canyon\Analyses\S L I D E\Bridge 3_SC-03 C-08 LB-04\Br3_C3B4C8_Abut 2_Scour_Blk SrfA_G I DSM_sc2.slim

Material Name	Color	Unit Weight (lbs/ft3)	Sat. Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Anisotropic Function	Water Surface
Afc - Fill		125	125	Mohr-Coulomb	200	32		Water Surface
Qal/Qoal		123	123	Mohr-Coulomb	300	30		Water Surface
Qal/Qoal LQ 1		120	120	Mohr-Coulomb	790	0		Water Surface
Qal/Qoal LQ 2		120	120	Mohr-Coulomb	1100	0		Water Surface
DSM SC		125	125	Mohr-Coulomb	1250	0		Water Surface
Fernando Formation (Tfl)		125	125	Anisotropic function			Tfl_40 to 50 left	Water Surface

Method: Spencer
Factor of Safety: 1.50
Axis Location: 335.284, 553.667
Left Slip Surface Endpoint: 300.900, 398.448
Right Slip Surface Endpoint: 438.828, 433.028
Left Slope Intercept: 300.900 429.031
Right Slope Intercept: 438.828 433.028



SLIDEINTERPRET 9.012

Project: **Proposed Brea Boulevard Widening, County of Orange Public Works, Orange County CA**			
Analyzed By: JEH	Units: feet	Scale: 1:360	Project No.: **11585.005**
Date: September 10, 2021	Condition: **Liquefaction**		File Name: Br3_C3B4C8_Abut 2_Scour_Blk SrfA_G I DSM_sc2.slim

APPENDIX D.5

Drilled Shaft (CIDH) Axial Capacity

Appendix D – Drilled Shaft Axial Capacity Analysis

Axial capacity of the drilled shaft foundations was evaluated using the computer software SHAFT (Ensoft, 2018). Design methodology programmed in the software conforms to the procedure described by the FHWA (2018) as incorporated in AASHTO Bridge Specifications for LRFD design. Design was performed for the drilled shaft diameters provided by the structural engineer. Analysis was performed to determine the minimum tip embedment depth (maximum elevation) based on the load demands presented by the structural engineer as summarized in their table (attached).

The proposed bridge structures span the existing Brea Creek. As such, the potential for scour to occur at the abutments has been performed as discussed in the hydrology report for the project (Avila, 2021). The scour depths stated in the referenced repot were used to determine the appropriate scour depths for use in analysis under the LRFD limit states. Table 1 summarizes the scour depths and elevations for each bridge structure. Table 2 presents the corresponding scour depths and elevations for each LRFD limit state.

Analysis considered the proposed center-to-center (CTC) spacing provided for each abutment as indicated in the project plans (BCA, 2021). Table 3 summarizes the load adjustment factors to be applied to the load demands provided by the structural engineer to account for pile spacing where less than the equivalent to three (3) diameters on-center. The geotechnical load demand used in analysis to determine minimum pile lengths is presented in Table 4.

Table 5 presents a summary of the minimum pile lengths and maximum tip elevations for the drilled shaft foundations at each bridge for the Extreme and Strength limit states. The pile lengths (L_{MIN}) and tip elevations indicated in Table 5 correspond to the top of pile (D = 0 feet) in the analysis model. This depth was referenced to scour elevation for each limit state.

The SHAFT analysis output is included in this appendix following the summary tables described above.

Brea Blvd/Brea Canyon Road Widening - Pile Loads

Date: 9/30/2021

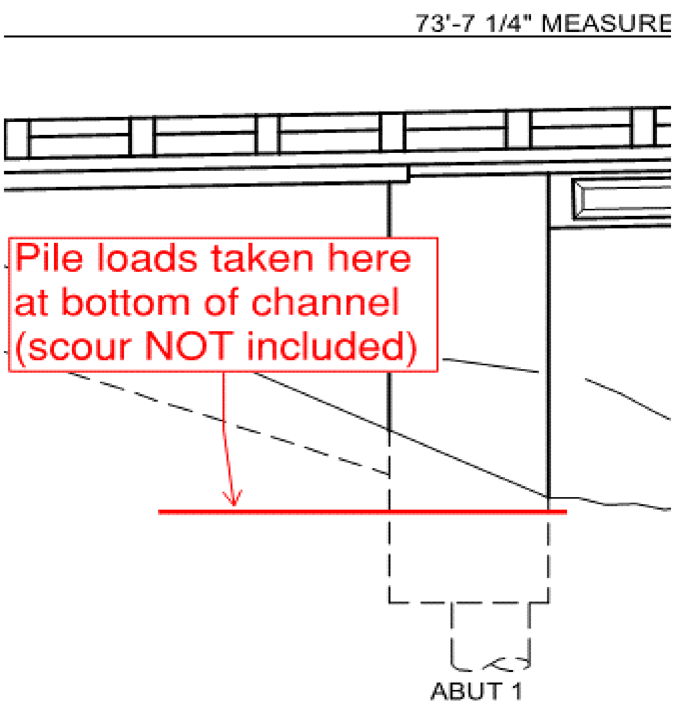
Foundation Factored Design Loads - BRIDGE 1 (55C-0729)											
Support No. (Bridge 1)	Pile Type	Pile Cutoff Elev. (ft)	Service-I Limit State		Strength/Construction Limit State				Extreme Limit State		
			Total Load per Support	Permanent Loads Per support	Compression		Tension		Compression		Tension
					Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Max Per Pile
Abut 1	48" CIDH	383.0 to 387.6	2600 kip	1900 kip	3500 kip	400 kip	N/A	N/A	1900 kip	380 kip	30 kip
Abut 2	48" CIDH	383.8 to 389.4	2600 kip	1900 kip	3400 kip	430 kip	N/A	N/A	1900 kip	410 kip	50 kip

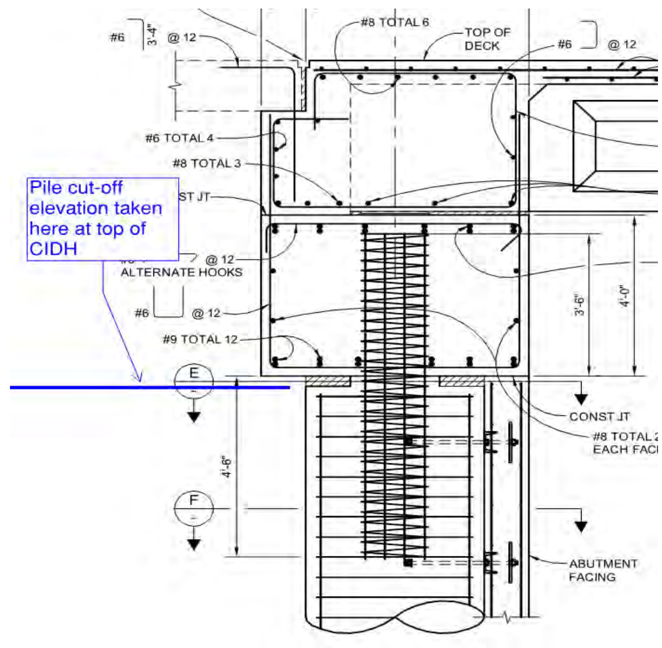
Foundation Factored Design Loads - BRIDGE 2 (55C-0730)											
Support No. (Bridge 2)	Pile Type	Pile Cutoff Elev. (ft)	Service-I Limit State		Strength/Construction Limit State				Extreme Limit State		
			Total Load per Support	Permanent Loads Per support	Compression		Tension		Compression		Tension
					Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Max Per Pile
Abut 1	36" CIDH	397.5 to 404.9	2900 kip	2200 kip	3900 kip	270 kip	N/A	N/A	2200 kip	200 kip	0 kip
Abut 2	36" CIDH	397.9 to 406.3	2800 kip	2100 kip	3700 kip	260 kip	N/A	N/A	2100 kip	200 kip	0 kip

Foundation Factored Design Loads - BRIDGE 3 (55C-0731)											
Support No. (Bridge 3)	Pile Type	Pile Cutoff Elev. (ft)	Service-I Limit State		Strength/Construction Limit State				Extreme Limit State		
			Total Load per Support	Permanent Loads Per support	Compression		Tension		Compression		Tension
					Per Support	Max Per Pile	Per Support	Max Per Pile	Per Support	Max Per Pile	Max Per Pile
Abut 1	48" CIDH	418.8 to 419.3	4800 kip	4000 kip	6300 kip	460 kip	N/A	N/A	4000 kip	310 kip	0 kip
Abut 2	48" CIDH	420.0 to 419.8	4400 kip	3600 kip	5900 kip	430 kip	N/A	N/A	3600 kip	350 kip	0 kip

See next page for further information

Note: Pile loads are taken at lower channel grade, NOT accounting for scour. Pile cut-off elevation is the physical top of pile.





TYPICAL ABUTMENT SECTION

1/2" = 1'-0"

Table 1 – Summary of Scour Depths and Elevations at Bridges

Bridge No.	Abutment No.	Original Grade	Bridge Deck Elevation	Thalweg Elevation	Degradation		Contraction		Abutment		Short Term
					Depth	Elevation	Depth	Elevation	Depth	Elevation	
1	1	390	392.92	373	1	372	3	370	9	364	9
	2		394.53	373	1	372	3	370	9	364	9
2	1	410	408.83	384	1	383	5	379	16	368	16
	2		410.43	384	1	383	5	379	16	368	16
3	1	430	428.54	402	1	401	2	400	9	393	9
	2		429.85	402	1	401	2	400	9	393	9

Table 2 – LRFD Scour Depths and Elevations at Bridges

Bridge No.	Abutment No.	Extreme = 100% (D + C)		Strength = (D + C) + 50%(ST)		Service = D + C	
		Depth	Elevation	Depth	Elevation	Depth	Elevation
1	1	4	369	8.5	364.5	4	369
	2	4	369	8.5	364.5	4	369
2	1	6	378	14	370	6	378
	2	6	378	14	370	6	378
3	1	3	399	7.5	394.5	3	399
	2	3	399	7.5	394.5	3	399

Table 3 – Load Adjustment Factor (η) due to Pile Spacing

Bridge No.	Abutment No.	C - T - C SPACING (feet)	SHAFT DIAMETER (feet)	C - T - C RATIO	η
1	1	9	4	2.250	0.925
	2	9.5	4	2.375	0.938
	CWA2L	8.5	3	2.833	0.983
2	1	5	3	1.667	0.867
	2	5	3	1.667	0.867
3	1	10	4	2.500	0.950
		9.5	4	2.375	0.938
		9.375	4	2.344	0.934
		9.115	4	2.279	0.928
	2	9.75	4	2.438	0.944
		9	4	2.250	0.925
		8.875	4	2.219	0.922
		8.75	4	2.188	0.919

Table 4 - Geotechnical Load Demand for Axial Capacity Analysis

Bridge No.	Structure	Structural Demand Extreme (kips)	Structural Demand Strength (kips)	Minimum Spacing (CTC)	η	Adjusted Load Demand - CTC Extreme (kips)	Adjusted Load Demand - CTC Strength (kips)	Adjusted Load Demand - CTC Extreme (tons)	Adjusted Load Demand - CTC Strength (tons)	Geotechnical Demand: Liquefaction Zone El. Top	Liquefaction Zone El. Bottom	Dragload[(1)] (tons)	Extreme (tons)	Extreme (kips)	Strength (tons)	Strength (kips)
1	Abutment 1	380	400	9	0.925	411	432	205	216	369	365	6	211	423	216	432
	Abutment 2	410	430	9.5	0.938	437	458	219	229	369	365	6	225	449	229.5	459
2	Abutment 1	200	270	5	0.867	231	311	115	156	---	---	---	115.5	231	156	312
	Abutment 2	200	260	5	0.867	231	300	115	150	---	---	---	115.5	231	150	300
3	Abutment 1	310	460	9.1	0.928	334	496	167	248	413	408	---	167	334	248	496
	Abutment 2	350	430	8.75	0.919	381	468	190	234	405	400	---	190.5	381	234	468

(1) Dragload includes Load Factor of 1.25

Table 5 - Minimum Pile Lengths

Bridge No.	Structure	Pile Cutoff Elevation	EXTREME Top of Pile (D = 0)	EXTREME L_{MIN} (feet)	EXTREME Tip Elevation	STRENGTH Top of Pile (D = 0)	STRENGTH L_{MIN} (feet)	STRENGTH Tip Elevation
1	Abutment 1	383	369	25	344	364.5	26	338.5
	Abutment 2	383	369	26	343	364.5	27	337.5
2	Abutment 1	397.5	378	11	367	370	15	355
	Abutment 2	397.5	378	11	367	370	15	355
3	Abutment 1	418.8	399	11	388	394.5	29	365.5
	Abutment 2	420	399	13	386	394.5	19	375.5

D = 0 equates to 1) Top of Pile in SHAFT Analysis; 2) Scour Elevation corresponding to Limit State

L_{MIN} = Length derived from SHAFT analysis based on Geotechnical Demand

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

                      SHAFT for Windows, Version 2017.8.10

                       Serial Number :  158517381

                    VERTICALLY LOADED DRILLED SHAFT ANALYSIS
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                           All Rights Reserved

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


     Path to file locations      : \\Ds-irv\project\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry
SI\005  Brea Canyon\Analyses\SHAFT\Revised Bridge 1_11-15-21\
     Name of input data file     : B1_Dia 4_CIDH_EXT_fsqb limit_a.sf8d
     Name of output file         : B1_Dia 4_CIDH_EXT_fsqb limit_a.sf8o
     Name of plot output file    : B1_Dia 4_CIDH_EXT_fsqb limit_a.sf8p
     Name of runtime file        : B1_Dia 4_CIDH_EXT_fsqb limit_a.sf8r


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

               Date:  November 17, 2021     Time:  09:22:49

11585.005 - Brea Boulevard Widening - Bridge 1 - 48" CIDH


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    4
     ------------------


     WATER TABLE DEPTH =      -3.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                  = 0.550E+00  (*)
       END BEARING COEFFICIENT-Nc                       = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.350E+03
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                       = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.150E+04
       DEPTH, FT                                        = 0.000E+00


       AT THE BOTTOM

       STRENGTH REDUCTION FACTOR-ALPHA                  = 0.550E+00  (*)
       END BEARING COEFFICIENT-Nc                       = 0.720E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.350E+03
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                       = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.150E+04
       DEPTH, FT                                        = 0.400E+01


       LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.100E+01
       LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.100E+01


     LAYER NO  2----SAND

       AT THE TOP

       SIDE FRICTION PROCEDURE, BETA METHOD
       SKIN FRICTION COEFFICIENT- BETA                  = 0.120E+01  (*)
```

B1_Dia 4_CIDH_STR_fsqb limit_a.sf8o

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

                  SHAFT for Windows, Version 2017.8.10

                   Serial Number :  158517381

                VERTICALLY LOADED DRILLED SHAFT ANALYSIS
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                       All Rights Reserved

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


     Path to file locations      : \\Ds-irv\project\INFOCUS PROJECTS\11501-12000\11585 On-Call OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Revised Bridge 1_11-15-21\
     Name of input data file     : B1_Dia 4_CIDH_STR_fsqb limit_a.sf8d
     Name of output file         : B1_Dia 4_CIDH_STR_fsqb limit_a.sf8o
     Name of plot output file    : B1_Dia 4_CIDH_STR_fsqb limit_a.sf8p
     Name of runtime file        : B1_Dia 4_CIDH_STR_fsqb limit_a.sf8r


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

          Date:  November 15, 2021     Time:  11:50:30

11585.005 - Brea Boulevard Widening - Bridge 1 - 48" CIDH


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    3
     ------------------


     WATER TABLE DEPTH =      -9.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----SAND

       AT THE TOP

       SIDE FRICTION PROCEDURE, BETA METHOD
       SKIN FRICTION COEFFICIENT- BETA                 = 0.120E+01  (*)
       INTERNAL FRICTION ANGLE, DEG.                   = 0.360E+02
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST   = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                      = 0.130E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT        = 0.400E+04
       DEPTH, FT                                       = 0.000E+00

       AT THE BOTTOM

       SIDE FRICTION PROCEDURE, BETA METHOD
       SKIN FRICTION COEFFICIENT- BETA                 = 0.107E+01  (*)
       INTERNAL FRICTION ANGLE, DEG.                   = 0.360E+02
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST   = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                      = 0.130E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT        = 0.400E+04
       DEPTH, FT                                       = 0.100E+02

       LRFD RESISTANCE FACTOR (SIDE FRICTION)          = 0.700E+00
       LRFD RESISTANCE FACTOR (TIP RESISTANCE)         = 0.500E+00


     LAYER NO  2----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                 = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                      = 0.900E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT              = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST   = 0.000E+00
```

```
  SOIL UNIT WEIGHT, LB/CU FT                          = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
  DEPTH, FT                                           = 0.100E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                     = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                          = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                  = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                          = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
  DEPTH, FT                                           = 0.200E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  3----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                     = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                          = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                  = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                          = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
  DEPTH, FT                                           = 0.200E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                     = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                          = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                  = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                          = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
  DEPTH, FT                                           = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)              = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)             = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.



(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

- CASE ANALYZED : 1
  VARIATION LENGTH : 1
  VARIATION DIAMETER : 1

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	0.25	32.51	32.77	0.18	16.26	16.44
2.0	0.93	1.02	37.54	38.56	0.71	18.77	19.48
3.0	1.40	2.29	81.40	83.70	1.61	40.70	42.31
4.0	1.86	4.08	128.83	132.90	2.85	64.41	67.27
5.0	2.33	6.37	179.73	186.09	4.46	89.86	94.32
6.0	2.79	9.10	234.02	243.12	6.37	117.01	123.38
7.0	3.26	12.26	274.36	286.62	8.58	137.18	145.76
8.0	3.72	15.82	301.00	316.82	11.07	150.50	161.57
9.0	4.19	19.77	314.20	333.97	13.84	157.10	170.94
10.0	4.65	24.10	314.20	338.30	16.87	157.10	173.97
11.0	5.12	39.18	314.20	353.38	27.43	157.10	184.53
12.0	5.59	54.27	314.20	368.47	37.99	157.10	195.09
13.0	6.05	69.35	342.48	411.83	48.54	171.24	219.78
14.0	6.52	84.43	373.90	458.33	59.10	186.95	246.05
15.0	6.98	99.51	408.46	507.97	69.66	204.23	273.89
16.0	7.45	114.59	446.16	560.76	80.21	223.08	303.30
17.0	7.91	129.67	474.44	604.12	90.77	237.22	327.99
18.0	8.38	144.76	493.29	638.05	101.33	246.65	347.98
19.0	8.84	159.84	502.72	662.56	111.89	251.36	363.25
20.0	9.31	174.92	502.72	677.64	122.44	251.36	373.80
21.0	9.78	197.54	502.72	700.26	138.28	251.36	389.64
22.0	10.24	220.16	502.72	722.88	154.11	251.36	405.47
23.0	10.71	242.79	502.72	745.51	169.95	251.36	421.31
24.0	11.17	265.41	502.72	768.13	185.79	251.36	437.15
25.0	11.64	288.03	502.72	790.75	201.62	251.36	452.98
26.0	12.10	310.65	502.72	813.37	217.46	251.36	468.82
27.0	12.57	333.28	502.72	836.00	233.29	251.36	484.65
28.0	13.03	355.90	502.72	858.62	249.13	251.36	500.49
29.0	13.50	378.52	502.72	881.24	264.96	251.36	516.32
30.0	13.96	401.14	502.72	903.86	280.80	251.36	532.16
31.0	14.43	423.77	502.72	926.49	296.64	251.36	548.00
32.0	14.90	446.39	502.72	949.11	312.47	251.36	563.83
33.0	15.36	469.01	502.72	971.73	328.31	251.36	579.67
34.0	15.83	491.63	502.72	994.35	344.14	251.36	595.50
35.0	16.29	514.25	502.72	1016.97	359.98	251.36	611.34
36.0	16.76	536.88	502.72	1039.60	375.81	251.36	627.17
37.0	17.22	559.50	502.72	1062.22	391.65	251.36	643.01
38.0	17.69	582.12	502.72	1084.84	407.49	251.36	658.85
39.0	18.15	604.74	502.72	1107.46	423.32	251.36	674.68

40.0	18.62	627.37	502.72	1130.09	439.16	251.36	690.52
41.0	19.08	649.99	502.72	1152.71	454.99	251.36	706.35
42.0	19.55	672.61	502.72	1175.33	470.83	251.36	722.19
43.0	20.02	695.23	502.72	1197.95	486.66	251.36	738.02
44.0	20.48	717.86	502.72	1220.58	502.50	251.36	753.86
45.0	20.95	740.48	502.72	1243.20	518.34	251.36	769.70
46.0	21.41	763.10	502.72	1265.82	534.17	251.36	785.53
47.0	21.88	785.72	502.72	1288.44	550.01	251.36	801.37
48.0	22.34	808.35	502.72	1311.07	565.84	251.36	817.20
49.0	22.81	830.97	502.72	1333.69	581.68	251.36	833.04
50.0	23.27	853.59	502.72	1356.31	597.51	251.36	848.87

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1216E+00	0.2360E-04	0.8274E-02	0.1000E-04
0.6081E+00	0.1180E-03	0.4137E-01	0.5000E-04
0.1216E+01	0.2360E-03	0.8274E-01	0.1000E-03
0.6134E+02	0.1185E-01	0.4137E+01	0.5000E-02
0.9202E+02	0.1777E-01	0.6205E+01	0.7500E-02
0.1227E+03	0.2370E-01	0.8274E+01	0.1000E-01
0.3066E+03	0.5924E-01	0.2068E+02	0.2500E-01
0.5264E+03	0.1112E+00	0.4137E+02	0.5000E-01
0.6498E+03	0.1515E+00	0.6205E+02	0.7500E-01
0.7608E+03	0.1907E+00	0.8274E+02	0.1000E+00
0.9934E+03	0.3771E+00	0.2020E+03	0.2500E+00
0.1072E+04	0.6424E+00	0.2874E+03	0.5000E+00
0.1094E+04	0.7724E+00	0.3240E+03	0.6250E+00
0.1141E+04	0.1360E+01	0.4349E+03	0.1200E+01
0.1194E+04	0.2570E+01	0.4876E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1946E+00	0.3117E-04	0.1236E-01	0.1000E-04
0.9728E+00	0.1559E-03	0.6179E-01	0.5000E-04
0.1946E+01	0.3117E-03	0.1236E+00	0.1000E-03
0.9851E+02	0.1570E-01	0.6179E+01	0.5000E-02
0.1478E+03	0.2354E-01	0.9269E+01	0.7500E-02
0.1970E+03	0.3139E-01	0.1236E+02	0.1000E-01
0.4840E+03	0.7810E-01	0.3090E+02	0.2500E-01
0.7496E+03	0.1378E+00	0.6179E+02	0.5000E-01
0.8530E+03	0.1773E+00	0.9269E+02	0.7500E-01
0.9227E+03	0.2132E+00	0.1236E+03	0.1000E+00
0.1156E+04	0.4027E+00	0.3000E+03	0.2500E+00
0.1226E+04	0.6666E+00	0.3816E+03	0.5000E+00
0.1236E+04	0.7948E+00	0.4104E+03	0.6250E+00
0.1259E+04	0.1377E+01	0.4826E+03	0.1200E+01
0.1277E+04	0.2580E+01	0.5002E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.6238E-01	0.1715E-04	0.4189E-02	0.1000E-04
0.3119E+00	0.8573E-04	0.2095E-01	0.5000E-04
0.6238E+00	0.1715E-03	0.4189E-01	0.1000E-03
0.3134E+02	0.8586E-02	0.2095E+01	0.5000E-02
0.4701E+02	0.1288E-01	0.3142E+01	0.7500E-02
0.6269E+02	0.1717E-01	0.4189E+01	0.1000E-01
0.1567E+03	0.4293E-01	0.1047E+02	0.2500E-01
0.3027E+03	0.8496E-01	0.2095E+02	0.5000E-01
0.4254E+03	0.1243E+00	0.3142E+02	0.7500E-01
0.5337E+03	0.1624E+00	0.4189E+02	0.1000E+00
0.8277E+03	0.3513E+00	0.1041E+03	0.2500E+00
0.9188E+03	0.6182E+00	0.1931E+03	0.5000E+00
0.9379E+03	0.7485E+00	0.2376E+03	0.6250E+00
0.1023E+04	0.1343E+01	0.3871E+03	0.1200E+01
0.1108E+04	0.2559E+01	0.4726E+03	0.2400E+01

```
  INTERNAL FRICTION ANGLE, DEG.                        = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.400E+04
  DEPTH, FT                                            = 0.400E+01

  AT THE BOTTOM

  SIDE FRICTION PROCEDURE, BETA METHOD
  SKIN FRICTION COEFFICIENT- BETA                      = 0.995E+00  (*)
  INTERNAL FRICTION ANGLE, DEG.                        = 0.360E+02
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.400E+04
  DEPTH, FT                                            = 0.140E+02

  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


LAYER NO  3----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.140E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.240E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  4----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.240E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01
```

..........WARNING..........
THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
GEOMATERIAL IS RECOMMENDED.

(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS

INPUT DRILLED SHAFT INFORMATION

```
 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	1.21	32.09	33.30	1.21	32.09	33.30
2.0	0.93	2.42	37.33	39.75	2.42	37.33	39.75
3.0	1.40	3.63	42.57	46.20	3.63	42.57	46.20
4.0	1.86	4.84	47.60	52.44	4.84	47.60	52.44
5.0	2.33	6.94	52.62	59.57	6.94	52.62	59.57
6.0	2.79	9.49	57.65	67.14	9.49	57.65	67.14
7.0	3.26	12.47	98.50	110.96	12.47	98.50	110.96
8.0	3.72	15.85	142.57	158.42	15.85	142.57	158.42
9.0	4.19	19.63	189.78	209.41	19.63	189.78	209.41
10.0	4.65	23.80	240.05	263.85	23.80	240.05	263.85
11.0	5.12	28.32	277.38	305.70	28.32	277.38	305.70

12.0	5.59	33.20	302.01	335.21	33.20	302.01	335.21
13.0	6.05	38.43	314.20	352.63	38.43	314.20	352.63
14.0	6.52	43.98	314.20	358.18	43.98	314.20	358.18
15.0	6.98	59.06	314.20	373.26	59.06	314.20	373.26
16.0	7.45	74.14	314.20	388.34	74.14	314.20	388.34
17.0	7.91	89.22	342.48	431.70	89.22	342.48	431.70
18.0	8.38	104.30	373.90	478.20	104.30	373.90	478.20
19.0	8.84	119.38	408.46	527.84	119.38	408.46	527.84
20.0	9.31	134.46	446.16	580.63	134.46	446.16	580.63
21.0	9.78	149.55	474.44	623.99	149.55	474.44	623.99
22.0	10.24	164.63	493.29	657.92	164.63	493.29	657.92
23.0	10.71	179.71	502.72	682.43	179.71	502.72	682.43
24.0	11.17	194.79	502.72	697.51	194.79	502.72	697.51
25.0	11.64	217.41	502.72	720.13	217.41	502.72	720.13
26.0	12.10	240.04	502.72	742.76	240.04	502.72	742.76
27.0	12.57	262.66	502.72	765.38	262.66	502.72	765.38
28.0	13.03	285.28	502.72	788.00	285.28	502.72	788.00
29.0	13.50	307.90	502.72	810.62	307.90	502.72	810.62
30.0	13.96	330.53	502.72	833.25	330.53	502.72	833.25
31.0	14.43	353.15	502.72	855.87	353.15	502.72	855.87
32.0	14.90	375.77	502.72	878.49	375.77	502.72	878.49
33.0	15.36	398.39	502.72	901.11	398.39	502.72	901.11
34.0	15.83	421.02	502.72	923.74	421.02	502.72	923.74
35.0	16.29	443.64	502.72	946.36	443.64	502.72	946.36
36.0	16.76	466.26	502.72	968.98	466.26	502.72	968.98
37.0	17.22	488.88	502.72	991.60	488.88	502.72	991.60
38.0	17.69	511.50	502.72	1014.22	511.50	502.72	1014.22
39.0	18.15	534.13	502.72	1036.85	534.13	502.72	1036.85
40.0	18.62	556.75	502.72	1059.47	556.75	502.72	1059.47
41.0	19.08	579.37	502.72	1082.09	579.37	502.72	1082.09
42.0	19.55	601.99	502.72	1104.71	601.99	502.72	1104.71
43.0	20.02	624.62	502.72	1127.34	624.62	502.72	1127.34
44.0	20.48	647.24	502.72	1149.96	647.24	502.72	1149.96
45.0	20.95	669.86	502.72	1172.58	669.86	502.72	1172.58
46.0	21.41	692.48	502.72	1195.20	692.48	502.72	1195.20
47.0	21.88	715.11	502.72	1217.83	715.11	502.72	1217.83
48.0	22.34	737.73	502.72	1240.45	737.73	502.72	1240.45
49.0	22.81	760.35	502.72	1263.07	760.35	502.72	1263.07
50.0	23.27	782.97	502.72	1285.69	782.97	502.72	1285.69

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1083E+00	0.2280E-04	0.8274E-02	0.1000E-04
0.5413E+00	0.1140E-03	0.4137E-01	0.5000E-04
0.1083E+01	0.2280E-03	0.8274E-01	0.1000E-03
0.5456E+02	0.1144E-01	0.4137E+01	0.5000E-02
0.8185E+02	0.1717E-01	0.6205E+01	0.7500E-02
0.1091E+03	0.2289E-01	0.8274E+01	0.1000E-01
0.2726E+03	0.5722E-01	0.2068E+02	0.2500E-01
0.4778E+03	0.1083E+00	0.4137E+02	0.5000E-01
0.5917E+03	0.1479E+00	0.6205E+02	0.7500E-01
0.6956E+03	0.1867E+00	0.8274E+02	0.1000E+00
0.9260E+03	0.3729E+00	0.2020E+03	0.2500E+00
0.1008E+04	0.6384E+00	0.2874E+03	0.5000E+00
0.1031E+04	0.7685E+00	0.3240E+03	0.6250E+00
0.1084E+04	0.1357E+01	0.4349E+03	0.1200E+01
0.1137E+04	0.2566E+01	0.4876E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1709E+00	0.2977E-04	0.1236E-01	0.1000E-04
0.8546E+00	0.1489E-03	0.6179E-01	0.5000E-04
0.1709E+01	0.2977E-03	0.1236E+00	0.1000E-03
0.8645E+02	0.1498E-01	0.6179E+01	0.5000E-02
0.1297E+03	0.2247E-01	0.9269E+01	0.7500E-02
0.1729E+03	0.2996E-01	0.1236E+02	0.1000E-01
0.4285E+03	0.7478E-01	0.3090E+02	0.2500E-01
0.6833E+03	0.1338E+00	0.6179E+02	0.5000E-01
0.7842E+03	0.1731E+00	0.9269E+02	0.7500E-01

0.8528E+03	0.2088E+00	0.1236E+03	0.1000E+00
0.1084E+04	0.3982E+00	0.3000E+03	0.2500E+00
0.1156E+04	0.6622E+00	0.3816E+03	0.5000E+00
0.1168E+04	0.7906E+00	0.4104E+03	0.6250E+00
0.1196E+04	0.1373E+01	0.4826E+03	0.1200E+01
0.1213E+04	0.2576E+01	0.5002E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.5631E-01	0.1678E-04	0.4189E-02	0.1000E-04
0.2816E+00	0.8389E-04	0.2095E-01	0.5000E-04
0.5631E+00	0.1678E-03	0.4189E-01	0.1000E-03
0.2828E+02	0.8401E-02	0.2095E+01	0.5000E-02
0.4242E+02	0.1260E-01	0.3142E+01	0.7500E-02
0.5657E+02	0.1680E-01	0.4189E+01	0.1000E-01
0.1414E+03	0.4201E-01	0.1047E+02	0.2500E-01
0.2741E+03	0.8322E-01	0.2095E+02	0.5000E-01
0.3858E+03	0.1219E+00	0.3142E+02	0.7500E-01
0.4850E+03	0.1594E+00	0.4189E+02	0.1000E+00
0.7654E+03	0.3474E+00	0.1041E+03	0.2500E+00
0.8597E+03	0.6145E+00	0.1931E+03	0.5000E+00
0.8817E+03	0.7450E+00	0.2376E+03	0.6250E+00
0.9723E+03	0.1340E+01	0.3871E+03	0.1200E+01
0.1057E+04	0.2556E+01	0.4726E+03	0.2400E+01

==

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

==

```
     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
2\
     Name of input data file     : EXT_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH_fsqb_a.sf8d
     Name of output file         : EXT_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH_fsqb_a.sf8o
     Name of plot output file    : EXT_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH_fsqb_a.sf8p
     Name of runtime file        : EXT_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH_fsqb_a.sf8r
```

Time and Date of Analysis

Date: October 03, 2021   Time: 12:25:23

11585.005 - Brea Boulevard Widening - Bridge 2 & Channel Wall 2 Right -

```
PROPOSED DEPTH =      50.0 FT
----------------

NUMBER OF LAYERS =    2
------------------

WATER TABLE DEPTH =      -6.0 FT.
-------------------


SOIL INFORMATION
---------------

LAYER NO  1----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                     = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                          = 0.600E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                  = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                          = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
  DEPTH, FT                                           = 0.000E+00
```

```
  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                    = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                         = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.550E+04
  DEPTH, FT                                          = 0.130E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                    = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                         = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.550E+04
  DEPTH, FT                                          = 0.130E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                    = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                         = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                         = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.550E+04
  DEPTH, FT                                          = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)             = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)            = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


INPUT DRILLED SHAFT INFORMATION
```

```
 MINIMUM SHAFT DIAMETER    =    3.000  FT.
 MAXIMUM SHAFT DIAMETER    =    3.000  FT.
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    3.000  FT.
 DIAMETER OF BASE          =    3.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   10.180  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.26	11.31	172.24	183.55	11.31	172.24	183.55
2.0	0.52	22.62	179.82	202.44	22.62	179.82	202.44
3.0	0.79	33.93	185.48	219.41	33.93	185.48	219.41
4.0	1.05	45.24	188.95	234.19	45.24	188.95	234.19
5.0	1.31	56.56	190.49	247.05	56.56	190.49	247.05
6.0	1.57	67.87	190.88	258.74	67.87	190.88	258.74

7.0	1.83	79.18	190.88	270.05	79.18	190.88	270.05
8.0	2.09	90.49	210.37	300.86	90.49	210.37	300.86
9.0	2.36	101.80	232.65	334.45	101.80	232.65	334.45
10.0	2.62	113.11	257.72	370.83	113.11	257.72	370.83
11.0	2.88	124.42	274.43	398.85	124.42	274.43	398.85
12.0	3.14	135.73	282.78	418.51	135.73	282.78	418.51
13.0	3.40	147.05	282.78	429.83	147.05	282.78	429.83
14.0	3.67	164.01	282.78	446.79	164.01	282.78	446.79
15.0	3.93	180.98	282.78	463.76	180.98	282.78	463.76
16.0	4.19	197.95	282.78	480.73	197.95	282.78	480.73
17.0	4.45	214.91	282.78	497.69	214.91	282.78	497.69
18.0	4.71	231.88	282.78	514.66	231.88	282.78	514.66
19.0	4.97	248.85	282.78	531.63	248.85	282.78	531.63
20.0	5.24	265.81	282.78	548.59	265.81	282.78	548.59
21.0	5.50	282.78	282.78	565.56	282.78	282.78	565.56
22.0	5.76	299.75	282.78	582.53	299.75	282.78	582.53
23.0	6.02	316.71	282.78	599.49	316.71	282.78	599.49
24.0	6.28	333.68	282.78	616.46	333.68	282.78	616.46
25.0	6.55	350.65	282.78	633.43	350.65	282.78	633.43
26.0	6.81	367.61	282.78	650.39	367.61	282.78	650.39
27.0	7.07	384.58	282.78	667.36	384.58	282.78	667.36
28.0	7.33	401.55	282.78	684.33	401.55	282.78	684.33
29.0	7.59	418.51	282.78	701.29	418.51	282.78	701.29
30.0	7.85	435.48	282.78	718.26	435.48	282.78	718.26
31.0	8.12	452.45	282.78	735.23	452.45	282.78	735.23
32.0	8.38	469.41	282.78	752.19	469.41	282.78	752.19
33.0	8.64	486.38	282.78	769.16	486.38	282.78	769.16
34.0	8.90	503.35	282.78	786.13	503.35	282.78	786.13
35.0	9.16	520.32	282.78	803.10	520.32	282.78	803.10
36.0	9.43	537.28	282.78	820.06	537.28	282.78	820.06
37.0	9.69	554.25	282.78	837.03	554.25	282.78	837.03
38.0	9.95	571.22	282.78	854.00	571.22	282.78	854.00
39.0	10.21	588.18	282.78	870.96	588.18	282.78	870.96
40.0	10.47	605.15	282.78	887.93	605.15	282.78	887.93
41.0	10.74	622.12	282.78	904.90	622.12	282.78	904.90
42.0	11.00	639.08	282.78	921.86	639.08	282.78	921.86
43.0	11.26	656.05	282.78	938.83	656.05	282.78	938.83
44.0	11.52	673.02	282.78	955.80	673.02	282.78	955.80
45.0	11.78	689.98	282.78	972.76	689.98	282.78	972.76
46.0	12.04	706.95	282.78	989.73	706.95	282.78	989.73
47.0	12.31	723.92	282.78	1006.70	723.92	282.78	1006.70
48.0	12.57	740.88	282.78	1023.66	740.88	282.78	1023.66
49.0	12.83	757.85	282.78	1040.63	757.85	282.78	1040.63
50.0	13.09	774.82	282.78	1057.60	774.82	282.78	1057.60

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1969E+00	0.3887E-04	0.6205E-02	0.1000E-04
0.9843E+00	0.1944E-03	0.3103E-01	0.5000E-04
0.1969E+01	0.3887E-03	0.6205E-01	0.1000E-03
0.1003E+03	0.1963E-01	0.3103E+01	0.5000E-02
0.1504E+03	0.2945E-01	0.4654E+01	0.7500E-02
0.2003E+03	0.3926E-01	0.6205E+01	0.1000E-01
0.4218E+03	0.9297E-01	0.1551E+02	0.2500E-01

0.5970E+03	0.1526E+00	0.3103E+02	0.5000E-01
0.6974E+03	0.2008E+00	0.4654E+02	0.7500E-01
0.7586E+03	0.2421E+00	0.6205E+02	0.1000E+00
0.8559E+03	0.4213E+00	0.1298E+03	0.2500E+00
0.8768E+03	0.6846E+00	0.1891E+03	0.5000E+00
0.8626E+03	0.8101E+00	0.2090E+03	0.6250E+00
0.8844E+03	0.1093E+01	0.2446E+03	0.9000E+00
0.9141E+03	0.2003E+01	0.2743E+03	0.1800E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.3545E+00	0.5797E-04	0.9269E-02	0.1000E-04
0.1773E+01	0.2898E-03	0.4634E-01	0.5000E-04
0.3554E+01	0.5798E-03	0.9269E-01	0.1000E-03
0.1820E+03	0.2947E-01	0.4634E+01	0.5000E-02
0.2702E+03	0.4417E-01	0.6952E+01	0.7500E-02
0.3442E+03	0.5842E-01	0.9269E+01	0.1000E-01
0.6123E+03	0.1266E+00	0.2317E+02	0.2500E-01
0.7498E+03	0.1853E+00	0.4634E+02	0.5000E-01
0.8123E+03	0.2271E+00	0.6952E+02	0.7500E-01
0.8518E+03	0.2632E+00	0.9269E+02	0.1000E+00
0.9619E+03	0.4483E+00	0.1844E+03	0.2500E+00
0.9723E+03	0.7086E+00	0.2363E+03	0.5000E+00
0.9625E+03	0.8335E+00	0.2499E+03	0.6250E+00
0.9764E+03	0.1114E+01	0.2715E+03	0.9000E+00
0.9863E+03	0.2017E+01	0.2814E+03	0.1800E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.8908E-01	0.2424E-04	0.3142E-02	0.1000E-04
0.4454E+00	0.1212E-03	0.1571E-01	0.5000E-04
0.8908E+00	0.2424E-03	0.3142E-01	0.1000E-03
0.4500E+02	0.1217E-01	0.1571E+01	0.5000E-02
0.6751E+02	0.1826E-01	0.2356E+01	0.7500E-02
0.9002E+02	0.2435E-01	0.3142E+01	0.1000E-01
0.2203E+03	0.6064E-01	0.7855E+01	0.2500E-01
0.3923E+03	0.1152E+00	0.1571E+02	0.5000E-01
0.5167E+03	0.1642E+00	0.2357E+02	0.7500E-01
0.5998E+03	0.2068E+00	0.3142E+02	0.1000E+00
0.7503E+03	0.3943E+00	0.7525E+02	0.2500E+00
0.7609E+03	0.6569E+00	0.1420E+03	0.5000E+00
0.7547E+03	0.7846E+00	0.1681E+03	0.6250E+00
0.7924E+03	0.1073E+01	0.2177E+03	0.9000E+00
0.8405E+03	0.1989E+01	0.2658E+03	0.1800E+01

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

                 SHAFT for Windows, Version 2017.8.10

                  Serial Number :  158517381

               VERTICALLY LOADED DRILLED SHAFT ANALYSIS
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     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
2\
     Name of input data file     : STR_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH.sf8d
     Name of output file         : STR_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH.sf8o
     Name of plot output file    : STR_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH.sf8p
     Name of runtime file        : STR_Bridge No 2 and Channel Wall 2 Right_3-foot
CIDH.sf8r


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

               Date:  October 03, 2021     Time:  12:28:55

     11585.005 - Brea Boulevard Widening - Bridge 2 & Channel Wall 2 Right -


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =     -14.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                     = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                          = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT                  = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST       = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                          = 0.127E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT            = 0.550E+04
       DEPTH, FT                                           = 0.000E+00
```

```
  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                  = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                       = 0.800E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.550E+04
  DEPTH, FT                                        = 0.500E+01


  LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                  = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                       = 0.800E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.550E+04
  DEPTH, FT                                        = 0.500E+01


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                  = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                       = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT               = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST    = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                       = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT         = 0.550E+04
  DEPTH, FT                                        = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)           = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)          = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


INPUT DRILLED SHAFT INFORMATION
```

MINIMUM SHAFT DIAMETER = 3.000 FT.
MAXIMUM SHAFT DIAMETER = 3.000 FT.
RATIO BASE/SHAFT DIAMETER = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 0.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
ELASTIC MODULUS, Ec = 0.360E+07 LB/SQ IN

COMPUTATION RESULTS

- CASE ANALYZED : 1
  VARIATION LENGTH : 1
  VARIATION DIAMETER : 1

DRILLED SHAFT INFORMATION

DIAMETER OF STEM = 3.000 FT.
DIAMETER OF BASE = 3.000 FT.
END OF STEM TO BASE = 0.000 FT.
ANGLE OF BELL = 0.000 DEG.
IGNORED TOP PORTION = 0.000 FT.
IGNORED BOTTOM PORTION = 0.000 FT.
AREA OF ONE PERCENT STEEL = 10.180 SQ.IN.
ELASTIC MODULUS, Ec = 0.360E+07 LB/SQ IN
VOLUME OF UNDERREAM = 0.000 CU.YDS.
SHAFT LENGTH = 50.000 FT.

PREDICTED RESULTS

QS = ULTIMATE SIDE RESISTANCE;
QB = ULTIMATE BASE RESISTANCE;
WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.26	11.31	213.63	224.94	7.92	106.81	114.73
2.0	0.52	22.62	246.23	268.86	15.84	123.12	138.95
3.0	0.79	33.93	268.90	302.83	23.75	134.45	158.20
4.0	1.05	45.24	280.85	326.10	31.67	140.43	172.10
5.0	1.31	56.56	282.52	339.08	39.59	141.26	180.85
6.0	1.57	73.52	282.78	356.30	51.47	141.39	192.86

7.0	1.83	90.49	282.78	373.27	63.34	141.39	204.73
8.0	2.09	107.46	282.78	390.24	75.22	141.39	216.61
9.0	2.36	124.42	282.78	407.20	87.10	141.39	228.49
10.0	2.62	141.39	282.78	424.17	98.97	141.39	240.36
11.0	2.88	158.36	282.78	441.14	110.85	141.39	252.24
12.0	3.14	175.32	282.78	458.10	122.73	141.39	264.12
13.0	3.40	192.29	282.78	475.07	134.60	141.39	275.99
14.0	3.67	209.26	282.78	492.04	146.48	141.39	287.87
15.0	3.93	226.22	282.78	509.00	158.36	141.39	299.75
16.0	4.19	243.19	282.78	525.97	170.23	141.39	311.62
17.0	4.45	260.16	282.78	542.94	182.11	141.39	323.50
18.0	4.71	277.12	282.78	559.90	193.99	141.39	335.38
19.0	4.97	294.09	282.78	576.87	205.86	141.39	347.25
20.0	5.24	311.06	282.78	593.84	217.74	141.39	359.13
21.0	5.50	328.02	282.78	610.80	229.62	141.39	371.01
22.0	5.76	344.99	282.78	627.77	241.49	141.39	382.88
23.0	6.02	361.96	282.78	644.74	253.37	141.39	394.76
24.0	6.28	378.93	282.78	661.71	265.25	141.39	406.64
25.0	6.55	395.89	282.78	678.67	277.12	141.39	418.51
26.0	6.81	412.86	282.78	695.64	289.00	141.39	430.39
27.0	7.07	429.83	282.78	712.61	300.88	141.39	442.27
28.0	7.33	446.79	282.78	729.57	312.75	141.39	454.14
29.0	7.59	463.76	282.78	746.54	324.63	141.39	466.02
30.0	7.85	480.73	282.78	763.51	336.51	141.39	477.90
31.0	8.12	497.69	282.78	780.47	348.38	141.39	489.77
32.0	8.38	514.66	282.78	797.44	360.26	141.39	501.65
33.0	8.64	531.63	282.78	814.41	372.14	141.39	513.53
34.0	8.90	548.59	282.78	831.37	384.02	141.39	525.41
35.0	9.16	565.56	282.78	848.34	395.89	141.39	537.28
36.0	9.43	582.53	282.78	865.31	407.77	141.39	549.16
37.0	9.69	599.49	282.78	882.27	419.65	141.39	561.04
38.0	9.95	616.46	282.78	899.24	431.52	141.39	572.91
39.0	10.21	633.43	282.78	916.21	443.40	141.39	584.79
40.0	10.47	650.39	282.78	933.17	455.28	141.39	596.67
41.0	10.74	667.36	282.78	950.14	467.15	141.39	608.54
42.0	11.00	684.33	282.78	967.11	479.03	141.39	620.42
43.0	11.26	701.29	282.78	984.07	490.91	141.39	632.30
44.0	11.52	718.26	282.78	1001.04	502.78	141.39	644.17
45.0	11.78	735.23	282.78	1018.01	514.66	141.39	656.05
46.0	12.04	752.19	282.78	1034.97	526.54	141.39	667.93
47.0	12.31	769.16	282.78	1051.94	538.41	141.39	679.80
48.0	12.57	786.13	282.78	1068.91	550.29	141.39	691.68
49.0	12.83	803.10	282.78	1085.88	562.17	141.39	703.56
50.0	13.09	820.06	282.78	1102.84	574.04	141.39	715.43

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2154E+00	0.3997E-04	0.6205E-02	0.1000E-04
0.1077E+01	0.1999E-03	0.3103E-01	0.5000E-04
0.2154E+01	0.3997E-03	0.6205E-01	0.1000E-03
0.1098E+03	0.2020E-01	0.3103E+01	0.5000E-02
0.1647E+03	0.3030E-01	0.4654E+01	0.7500E-02
0.2191E+03	0.4039E-01	0.6205E+01	0.1000E-01
0.4542E+03	0.9494E-01	0.1551E+02	0.2500E-01

0.6379E+03	0.1551E+00	0.3103E+02	0.5000E-01
0.7390E+03	0.2034E+00	0.4654E+02	0.7500E-01
0.8009E+03	0.2447E+00	0.6205E+02	0.1000E+00
0.8983E+03	0.4239E+00	0.1298E+03	0.2500E+00
0.9162E+03	0.6870E+00	0.1891E+03	0.5000E+00
0.9004E+03	0.8124E+00	0.2090E+03	0.6250E+00
0.9222E+03	0.1096E+01	0.2446E+03	0.9000E+00
0.9519E+03	0.2005E+01	0.2743E+03	0.1800E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.3924E+00	0.6019E-04	0.9269E-02	0.1000E-04
0.1962E+01	0.3009E-03	0.4634E-01	0.5000E-04
0.3943E+01	0.6024E-03	0.9269E-01	0.1000E-03
0.2018E+03	0.3062E-01	0.4634E+01	0.5000E-02
0.2989E+03	0.4589E-01	0.6952E+01	0.7500E-02
0.3788E+03	0.6053E-01	0.9269E+01	0.1000E-01
0.6552E+03	0.1293E+00	0.2317E+02	0.2500E-01
0.7946E+03	0.1881E+00	0.4634E+02	0.5000E-01
0.8580E+03	0.2299E+00	0.6952E+02	0.7500E-01
0.8979E+03	0.2661E+00	0.9269E+02	0.1000E+00
0.1007E+04	0.4511E+00	0.1844E+03	0.2500E+00
0.1015E+04	0.7112E+00	0.2363E+03	0.5000E+00
0.1004E+04	0.8361E+00	0.2499E+03	0.6250E+00
0.1018E+04	0.1116E+01	0.2715E+03	0.9000E+00
0.1028E+04	0.2019E+01	0.2814E+03	0.1800E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.9619E-01	0.2467E-04	0.3142E-02	0.1000E-04
0.4810E+00	0.1234E-03	0.1571E-01	0.5000E-04
0.9619E+00	0.2467E-03	0.3142E-01	0.1000E-03
0.4863E+02	0.1239E-01	0.1571E+01	0.5000E-02
0.7294E+02	0.1859E-01	0.2356E+01	0.7500E-02
0.9726E+02	0.2479E-01	0.3142E+01	0.1000E-01
0.2373E+03	0.6167E-01	0.7855E+01	0.2500E-01
0.4209E+03	0.1169E+00	0.1571E+02	0.5000E-01
0.5510E+03	0.1663E+00	0.2357E+02	0.7500E-01
0.6372E+03	0.2091E+00	0.3142E+02	0.1000E+00
0.7897E+03	0.3967E+00	0.7525E+02	0.2500E+00
0.7965E+03	0.6592E+00	0.1420E+03	0.5000E+00
0.7887E+03	0.7867E+00	0.1681E+03	0.6250E+00
0.8263E+03	0.1075E+01	0.2177E+03	0.9000E+00
0.8744E+03	0.1991E+01	0.2658E+03	0.1800E+01

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

                    SHAFT for Windows, Version 2017.8.10

                     Serial Number :  158517381

                  VERTICALLY LOADED DRILLED SHAFT ANALYSIS
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==========================================================================


     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
3\
     Name of input data file     : EXT_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8d
     Name of output file         : EXT_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8o
     Name of plot output file    : EXT_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8p
     Name of runtime file        : EXT_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8r


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

               Date:  October 03, 2021     Time:  12:49:45

     11585.005 - Brea Boulevard Widening - Bridge 3 Abutment 1 - 48" CIDH


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =      -3.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                           = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                           = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
       DEPTH, FT                                            = 0.000E+00


       AT THE BOTTOM
```

```
  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.870E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.900E+01


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.870E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.900E+01


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
```

```
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	15.08	299.37	314.45	15.08	299.37	314.45
2.0	0.93	30.16	335.19	365.35	30.16	335.19	365.35
3.0	1.40	45.24	372.03	417.28	45.24	372.03	417.28
4.0	1.86	60.33	409.72	470.04	60.33	409.72	470.04
5.0	2.33	75.41	448.05	523.46	75.41	448.05	523.46
6.0	2.79	90.49	475.95	566.44	90.49	475.95	566.44
7.0	3.26	105.57	493.99	599.56	105.57	493.99	599.56
8.0	3.72	120.65	502.72	623.37	120.65	502.72	623.37
9.0	4.19	135.73	502.72	638.45	135.73	502.72	638.45
10.0	4.65	158.36	502.72	661.08	158.36	502.72	661.08

11.0	5.12	180.98	502.72	683.70	180.98	502.72	683.70
12.0	5.59	203.60	502.72	706.32	203.60	502.72	706.32
13.0	6.05	226.22	502.72	728.94	226.22	502.72	728.94
14.0	6.52	248.85	502.72	751.57	248.85	502.72	751.57
15.0	6.98	271.47	502.72	774.19	271.47	502.72	774.19
16.0	7.45	294.09	502.72	796.81	294.09	502.72	796.81
17.0	7.91	316.71	502.72	819.43	316.71	502.72	819.43
18.0	8.38	339.34	502.72	842.06	339.34	502.72	842.06
19.0	8.84	361.96	502.72	864.68	361.96	502.72	864.68
20.0	9.31	384.58	502.72	887.30	384.58	502.72	887.30
21.0	9.78	407.20	502.72	909.92	407.20	502.72	909.92
22.0	10.24	429.83	502.72	932.55	429.83	502.72	932.55
23.0	10.71	452.45	502.72	955.17	452.45	502.72	955.17
24.0	11.17	475.07	502.72	977.79	475.07	502.72	977.79
25.0	11.64	497.69	502.72	1000.41	497.69	502.72	1000.41
26.0	12.10	520.32	502.72	1023.04	520.32	502.72	1023.04
27.0	12.57	542.94	502.72	1045.66	542.94	502.72	1045.66
28.0	13.03	565.56	502.72	1068.28	565.56	502.72	1068.28
29.0	13.50	588.18	502.72	1090.90	588.18	502.72	1090.90
30.0	13.96	610.80	502.72	1113.52	610.80	502.72	1113.52
31.0	14.43	633.43	502.72	1136.15	633.43	502.72	1136.15
32.0	14.90	656.05	502.72	1158.77	656.05	502.72	1158.77
33.0	15.36	678.67	502.72	1181.39	678.67	502.72	1181.39
34.0	15.83	701.29	502.72	1204.01	701.29	502.72	1204.01
35.0	16.29	723.92	502.72	1226.64	723.92	502.72	1226.64
36.0	16.76	746.54	502.72	1249.26	746.54	502.72	1249.26
37.0	17.22	769.16	502.72	1271.88	769.16	502.72	1271.88
38.0	17.69	791.78	502.72	1294.50	791.78	502.72	1294.50
39.0	18.15	814.41	502.72	1317.13	814.41	502.72	1317.13
40.0	18.62	837.03	502.72	1339.75	837.03	502.72	1339.75
41.0	19.08	859.65	502.72	1362.37	859.65	502.72	1362.37
42.0	19.55	882.27	502.72	1384.99	882.27	502.72	1384.99
43.0	20.02	904.90	502.72	1407.62	904.90	502.72	1407.62
44.0	20.48	927.52	502.72	1430.24	927.52	502.72	1430.24
45.0	20.95	950.14	502.72	1452.86	950.14	502.72	1452.86
46.0	21.41	972.76	502.72	1475.48	972.76	502.72	1475.48
47.0	21.88	995.39	502.72	1498.11	995.39	502.72	1498.11
48.0	22.34	1018.01	502.72	1520.73	1018.01	502.72	1520.73
49.0	22.81	1040.63	502.72	1543.35	1040.63	502.72	1543.35
50.0	23.27	1063.25	502.72	1565.97	1063.25	502.72	1565.97

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1679E+00	0.2501E-04	0.8274E-02	0.1000E-04
0.8395E+00	0.1250E-03	0.4137E-01	0.5000E-04
0.1679E+01	0.2501E-03	0.8274E-01	0.1000E-03
0.8486E+02	0.1256E-01	0.4137E+01	0.5000E-02
0.1273E+03	0.1885E-01	0.6205E+01	0.7500E-02
0.1697E+03	0.2513E-01	0.8274E+01	0.1000E-01
0.4178E+03	0.6273E-01	0.2068E+02	0.2500E-01
0.6803E+03	0.1161E+00	0.4137E+02	0.5000E-01
0.8327E+03	0.1574E+00	0.6205E+02	0.7500E-01
0.9541E+03	0.1971E+00	0.8274E+02	0.1000E+00
0.1193E+04	0.3838E+00	0.2020E+03	0.2500E+00

0.1264E+04	0.6488E+00	0.2874E+03	0.5000E+00
0.1283E+04	0.7787E+00	0.3240E+03	0.6250E+00
0.1313E+04	0.1366E+01	0.4349E+03	0.1200E+01
0.1366E+04	0.2576E+01	0.4876E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2807E+00	0.3373E-04	0.1236E-01	0.1000E-04
0.1403E+01	0.1686E-03	0.6179E-01	0.5000E-04
0.2807E+01	0.3373E-03	0.1236E+00	0.1000E-03
0.1426E+03	0.1700E-01	0.6179E+01	0.5000E-02
0.2138E+03	0.2550E-01	0.9269E+01	0.7500E-02
0.2851E+03	0.3400E-01	0.1236E+02	0.1000E-01
0.6578E+03	0.8368E-01	0.3090E+02	0.2500E-01
0.9492E+03	0.1444E+00	0.6179E+02	0.5000E-01
0.1058E+04	0.1841E+00	0.9269E+02	0.7500E-01
0.1131E+04	0.2201E+00	0.1236E+03	0.1000E+00
0.1371E+04	0.4099E+00	0.3000E+03	0.2500E+00
0.1433E+04	0.6735E+00	0.3816E+03	0.5000E+00
0.1437E+04	0.8016E+00	0.4104E+03	0.6250E+00
0.1450E+04	0.1384E+01	0.4826E+03	0.1200E+01
0.1468E+04	0.2587E+01	0.5002E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.8224E-01	0.1777E-04	0.4189E-02	0.1000E-04
0.4112E+00	0.8884E-04	0.2095E-01	0.5000E-04
0.8224E+00	0.1777E-03	0.4189E-01	0.1000E-03
0.4136E+02	0.8900E-02	0.2095E+01	0.5000E-02
0.6205E+02	0.1335E-01	0.3142E+01	0.7500E-02
0.8274E+02	0.1780E-01	0.4189E+01	0.1000E-01
0.2069E+03	0.4451E-01	0.1047E+02	0.2500E-01
0.3944E+03	0.8786E-01	0.2095E+02	0.5000E-01
0.5504E+03	0.1283E+00	0.3142E+02	0.7500E-01
0.6834E+03	0.1672E+00	0.4189E+02	0.1000E+00
0.1012E+04	0.3574E+00	0.1041E+03	0.2500E+00
0.1094E+04	0.6241E+00	0.1931E+03	0.5000E+00
0.1106E+04	0.7542E+00	0.2376E+03	0.6250E+00
0.1176E+04	0.1348E+01	0.3871E+03	0.1200E+01
0.1261E+04	0.2564E+01	0.4726E+03	0.2400E+01

STR_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8o

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

                  SHAFT for Windows, Version 2017.8.10

                   Serial Number :  158517381

                 VERTICALLY LOADED DRILLED SHAFT ANALYSIS
                  (c) Copyright ENSOFT, Inc., 1987-2017
                        All Rights Reserved

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


     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
3\
     Name of input data file     : STR_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8d
     Name of output file         : STR_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8o
     Name of plot output file    : STR_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8p
     Name of runtime file        : STR_Bridge 3 Abutment 1_4-foot CIDH_fsqb_a.sf8r


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

               Date:  October 03, 2021     Time:  12:53:52

     11585.005 - Brea Boulevard Widening - Bridge 3 Abutment 1 - 48" CIDH


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =      -7.5 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                           = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                           = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.200E+04
       DEPTH, FT                                            = 0.000E+00


       AT THE BOTTOM
```

```
  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.735E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.200E+04
  DEPTH, FT                                            = 0.450E+01


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.735E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.200E+04
  DEPTH, FT                                            = 0.450E+01


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.200E+04
  DEPTH, FT                                            = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


INPUT DRILLED SHAFT INFORMATION
-------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
```

```
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	12.57	346.50	359.07	8.80	173.25	182.05
2.0	0.93	25.14	362.34	387.47	17.60	181.17	198.76
3.0	1.40	37.70	372.33	410.03	26.39	186.16	212.56
4.0	1.86	50.27	377.04	427.31	35.19	188.52	223.71
5.0	2.33	62.84	377.04	439.88	43.99	188.52	232.51
6.0	2.79	75.41	377.04	452.45	52.79	188.52	241.31
7.0	3.26	87.98	377.04	465.02	61.58	188.52	250.10
8.0	3.72	100.54	377.04	477.58	70.38	188.52	258.90
9.0	4.19	113.11	377.04	490.15	79.18	188.52	267.70
10.0	4.65	125.68	377.04	502.72	87.98	188.52	276.50

11.0	5.12	138.25	377.04	515.29	96.77	188.52	285.29
12.0	5.59	150.82	377.04	527.86	105.57	188.52	294.09
13.0	6.05	163.38	377.04	540.42	114.37	188.52	302.89
14.0	6.52	175.95	377.04	552.99	123.17	188.52	311.69
15.0	6.98	188.52	377.04	565.56	131.96	188.52	320.48
16.0	7.45	201.09	377.04	578.13	140.76	188.52	329.28
17.0	7.91	213.66	377.04	590.70	149.56	188.52	338.08
18.0	8.38	226.22	377.04	603.26	158.36	188.52	346.88
19.0	8.84	238.79	377.04	615.83	167.15	188.52	355.67
20.0	9.31	251.36	377.04	628.40	175.95	188.52	364.47
21.0	9.78	263.93	377.04	640.97	184.75	188.52	373.27
22.0	10.24	276.50	377.04	653.54	193.55	188.52	382.07
23.0	10.71	289.06	377.04	666.10	202.34	188.52	390.86
24.0	11.17	301.63	377.04	678.67	211.14	188.52	399.66
25.0	11.64	314.20	377.04	691.24	219.94	188.52	408.46
26.0	12.10	326.77	377.04	703.81	228.74	188.52	417.26
27.0	12.57	339.34	377.04	716.38	237.54	188.52	426.06
28.0	13.03	351.90	377.04	728.94	246.33	188.52	434.85
29.0	13.50	364.47	377.04	741.51	255.13	188.52	443.65
30.0	13.96	377.04	377.04	754.08	263.93	188.52	452.45
31.0	14.43	389.61	377.04	766.65	272.73	188.52	461.25
32.0	14.90	402.18	377.04	779.22	281.52	188.52	470.04
33.0	15.36	414.74	377.04	791.78	290.32	188.52	478.84
34.0	15.83	427.31	377.04	804.35	299.12	188.52	487.64
35.0	16.29	439.88	377.04	816.92	307.92	188.52	496.44
36.0	16.76	452.45	377.04	829.49	316.71	188.52	505.23
37.0	17.22	465.02	377.04	842.06	325.51	188.52	514.03
38.0	17.69	477.58	377.04	854.62	334.31	188.52	522.83
39.0	18.15	490.15	377.04	867.19	343.11	188.52	531.63
40.0	18.62	502.72	377.04	879.76	351.90	188.52	540.42
41.0	19.08	515.29	377.04	892.33	360.70	188.52	549.22
42.0	19.55	527.86	377.04	904.90	369.50	188.52	558.02
43.0	20.02	540.42	377.04	917.46	378.30	188.52	566.82
44.0	20.48	552.99	377.04	930.03	387.09	188.52	575.61
45.0	20.95	565.56	377.04	942.60	395.89	188.52	584.41
46.0	21.41	578.13	377.04	955.17	404.69	188.52	593.21
47.0	21.88	590.70	377.04	967.74	413.49	188.52	602.01
48.0	22.34	603.26	377.04	980.30	422.29	188.52	610.81
49.0	22.81	615.83	377.04	992.87	431.08	188.52	619.60
50.0	23.27	628.40	377.04	1005.44	439.88	188.52	628.40

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.8994E-01	0.1816E-04	0.6205E-02	0.1000E-04
0.4497E+00	0.9080E-04	0.3103E-01	0.5000E-04
0.8994E+00	0.1816E-03	0.6205E-01	0.1000E-03
0.4526E+02	0.9097E-02	0.3103E+01	0.5000E-02
0.6790E+02	0.1365E-01	0.4654E+01	0.7500E-02
0.9053E+02	0.1820E-01	0.6205E+01	0.1000E-01
0.2263E+03	0.4549E-01	0.1551E+02	0.2500E-01
0.3891E+03	0.8751E-01	0.3103E+02	0.5000E-01
0.4808E+03	0.1222E+00	0.4654E+02	0.7500E-01
0.5646E+03	0.1563E+00	0.6205E+02	0.1000E+00
0.7362E+03	0.3321E+00	0.1515E+03	0.2500E+00

0.7947E+03	0.5937E+00	0.2155E+03	0.5000E+00
0.8113E+03	0.7227E+00	0.2430E+03	0.6250E+00
0.8455E+03	0.1308E+01	0.3261E+03	0.1200E+01
0.8851E+03	0.2516E+01	0.3657E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1437E+00	0.2251E-04	0.9269E-02	0.1000E-04
0.7183E+00	0.1125E-03	0.4634E-01	0.5000E-04
0.1437E+01	0.2251E-03	0.9269E-01	0.1000E-03
0.7251E+02	0.1129E-01	0.4634E+01	0.5000E-02
0.1088E+03	0.1694E-01	0.6952E+01	0.7500E-02
0.1450E+03	0.2259E-01	0.9269E+01	0.1000E-01
0.3590E+03	0.5644E-01	0.2317E+02	0.2500E-01
0.5548E+03	0.1040E+00	0.4634E+02	0.5000E-01
0.6312E+03	0.1388E+00	0.6952E+02	0.7500E-01
0.6833E+03	0.1714E+00	0.9269E+02	0.1000E+00
0.8580E+03	0.3502E+00	0.2250E+03	0.2500E+00
0.9100E+03	0.6109E+00	0.2862E+03	0.5000E+00
0.9175E+03	0.7386E+00	0.3078E+03	0.6250E+00
0.9342E+03	0.1320E+01	0.3620E+03	0.1200E+01
0.9474E+03	0.2522E+01	0.3752E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.4614E-01	0.1434E-04	0.3142E-02	0.1000E-04
0.2307E+00	0.7171E-04	0.1571E-01	0.5000E-04
0.4614E+00	0.1434E-03	0.3142E-01	0.1000E-03
0.2315E+02	0.7175E-02	0.1571E+01	0.5000E-02
0.3473E+02	0.1076E-01	0.2357E+01	0.7500E-02
0.4630E+02	0.1435E-01	0.3142E+01	0.1000E-01
0.1158E+03	0.3588E-01	0.7855E+01	0.2500E-01
0.2239E+03	0.7132E-01	0.1571E+02	0.5000E-01
0.3150E+03	0.1052E+00	0.2357E+02	0.7500E-01
0.3952E+03	0.1383E+00	0.3142E+02	0.1000E+00
0.6127E+03	0.3138E+00	0.7808E+02	0.2500E+00
0.6796E+03	0.5766E+00	0.1448E+03	0.5000E+00
0.6938E+03	0.7060E+00	0.1782E+03	0.6250E+00
0.7568E+03	0.1297E+01	0.2903E+03	0.1200E+01
0.8209E+03	0.2509E+01	0.3544E+03	0.2400E+01

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

                 SHAFT for Windows, Version 2017.8.10

                  Serial Number :  158517381

               VERTICALLY LOADED DRILLED SHAFT ANALYSIS
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                      All Rights Reserved

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


     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
3\
     Name of input data file     : EXT_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8d
     Name of output file         : EXT_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8o
     Name of plot output file    : EXT_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8p
     Name of runtime file        : EXT_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8r


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

               Date:  October 03, 2021     Time:  15:16:30

     11585.005 - Brea Boulevard Widening - Bridge 3 Abutment 1 - 48" CIDH


     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =      -3.0 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                    = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                         = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT                 = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST      = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                         = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT           = 0.550E+04
       DEPTH, FT                                          = 0.000E+00


       AT THE BOTTOM
```

```
  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.140E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.140E+02


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                      = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                           = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                   = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST        = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                           = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT             = 0.550E+04
  DEPTH, FT                                            = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)               = 0.100E+01
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)              = 0.100E+01


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.



(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS



INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
```

```
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	15.08	299.37	314.45	15.08	299.37	314.45
2.0	0.93	30.16	310.68	340.84	30.16	310.68	340.84
3.0	1.40	45.24	320.30	365.54	45.24	320.30	365.54
4.0	1.86	60.33	328.02	388.35	60.33	328.02	388.35
5.0	2.33	75.41	333.68	409.09	75.41	333.68	409.09
6.0	2.79	90.49	337.07	427.56	90.49	337.07	427.56
7.0	3.26	105.57	363.28	468.85	105.57	363.28	468.85
8.0	3.72	120.65	391.07	511.73	120.65	391.07	511.73
9.0	4.19	135.73	421.03	556.76	135.73	421.03	556.76
10.0	4.65	150.82	453.70	604.52	150.82	453.70	604.52

11.0	5.12	165.90	478.21	644.11	165.90	478.21	644.11
12.0	5.59	180.98	494.55	675.53	180.98	494.55	675.53
13.0	6.05	196.06	502.72	698.78	196.06	502.72	698.78
14.0	6.52	211.14	502.72	713.86	211.14	502.72	713.86
15.0	6.98	233.76	502.72	736.48	233.76	502.72	736.48
16.0	7.45	256.39	502.72	759.11	256.39	502.72	759.11
17.0	7.91	279.01	502.72	781.73	279.01	502.72	781.73
18.0	8.38	301.63	502.72	804.35	301.63	502.72	804.35
19.0	8.84	324.25	502.72	826.97	324.25	502.72	826.97
20.0	9.31	346.88	502.72	849.60	346.88	502.72	849.60
21.0	9.78	369.50	502.72	872.22	369.50	502.72	872.22
22.0	10.24	392.12	502.72	894.84	392.12	502.72	894.84
23.0	10.71	414.74	502.72	917.46	414.74	502.72	917.46
24.0	11.17	437.37	502.72	940.09	437.37	502.72	940.09
25.0	11.64	459.99	502.72	962.71	459.99	502.72	962.71
26.0	12.10	482.61	502.72	985.33	482.61	502.72	985.33
27.0	12.57	505.23	502.72	1007.95	505.23	502.72	1007.95
28.0	13.03	527.86	502.72	1030.58	527.86	502.72	1030.58
29.0	13.50	550.48	502.72	1053.20	550.48	502.72	1053.20
30.0	13.96	573.10	502.72	1075.82	573.10	502.72	1075.82
31.0	14.43	595.72	502.72	1098.44	595.72	502.72	1098.44
32.0	14.90	618.35	502.72	1121.07	618.35	502.72	1121.07
33.0	15.36	640.97	502.72	1143.69	640.97	502.72	1143.69
34.0	15.83	663.59	502.72	1166.31	663.59	502.72	1166.31
35.0	16.29	686.21	502.72	1188.93	686.21	502.72	1188.93
36.0	16.76	708.84	502.72	1211.56	708.84	502.72	1211.56
37.0	17.22	731.46	502.72	1234.18	731.46	502.72	1234.18
38.0	17.69	754.08	502.72	1256.80	754.08	502.72	1256.80
39.0	18.15	776.70	502.72	1279.42	776.70	502.72	1279.42
40.0	18.62	799.32	502.72	1302.04	799.32	502.72	1302.04
41.0	19.08	821.95	502.72	1324.67	821.95	502.72	1324.67
42.0	19.55	844.57	502.72	1347.29	844.57	502.72	1347.29
43.0	20.02	867.19	502.72	1369.91	867.19	502.72	1369.91
44.0	20.48	889.81	502.72	1392.53	889.81	502.72	1392.53
45.0	20.95	912.44	502.72	1415.16	912.44	502.72	1415.16
46.0	21.41	935.06	502.72	1437.78	935.06	502.72	1437.78
47.0	21.88	957.68	502.72	1460.40	957.68	502.72	1460.40
48.0	22.34	980.30	502.72	1483.02	980.30	502.72	1483.02
49.0	22.81	1002.93	502.72	1505.65	1002.93	502.72	1505.65
50.0	23.27	1025.55	502.72	1528.27	1025.55	502.72	1528.27

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1603E+00	0.2468E-04	0.8274E-02	0.1000E-04
0.8016E+00	0.1234E-03	0.4137E-01	0.5000E-04
0.1603E+01	0.2468E-03	0.8274E-01	0.1000E-03
0.8100E+02	0.1240E-01	0.4137E+01	0.5000E-02
0.1215E+03	0.1860E-01	0.6205E+01	0.7500E-02
0.1620E+03	0.2480E-01	0.8274E+01	0.1000E-01
0.3990E+03	0.6191E-01	0.2068E+02	0.2500E-01
0.6539E+03	0.1150E+00	0.4137E+02	0.5000E-01
0.8013E+03	0.1560E+00	0.6205E+02	0.7500E-01
0.9200E+03	0.1956E+00	0.8274E+02	0.1000E+00
0.1157E+04	0.3822E+00	0.2020E+03	0.2500E+00

0.1229E+04	0.6473E+00	0.2874E+03	0.5000E+00
0.1248E+04	0.7772E+00	0.3240E+03	0.6250E+00
0.1282E+04	0.1365E+01	0.4349E+03	0.1200E+01
0.1334E+04	0.2574E+01	0.4876E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2668E+00	0.3314E-04	0.1236E-01	0.1000E-04
0.1334E+01	0.1657E-03	0.6179E-01	0.5000E-04
0.2668E+01	0.3314E-03	0.1236E+00	0.1000E-03
0.1354E+03	0.1670E-01	0.6179E+01	0.5000E-02
0.2032E+03	0.2505E-01	0.9269E+01	0.7500E-02
0.2709E+03	0.3340E-01	0.1236E+02	0.1000E-01
0.6281E+03	0.8238E-01	0.3090E+02	0.2500E-01
0.9140E+03	0.1428E+00	0.6179E+02	0.5000E-01
0.1022E+04	0.1825E+00	0.9269E+02	0.7500E-01
0.1094E+04	0.2184E+00	0.1236E+03	0.1000E+00
0.1332E+04	0.4082E+00	0.3000E+03	0.2500E+00
0.1396E+04	0.6719E+00	0.3816E+03	0.5000E+00
0.1401E+04	0.8000E+00	0.4104E+03	0.6250E+00
0.1416E+04	0.1382E+01	0.4826E+03	0.1200E+01
0.1433E+04	0.2585E+01	0.5002E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.7889E-01	0.1762E-04	0.4189E-02	0.1000E-04
0.3944E+00	0.8812E-04	0.2095E-01	0.5000E-04
0.7889E+00	0.1762E-03	0.4189E-01	0.1000E-03
0.3967E+02	0.8827E-02	0.2095E+01	0.5000E-02
0.5952E+02	0.1324E-01	0.3142E+01	0.7500E-02
0.7936E+02	0.1766E-01	0.4189E+01	0.1000E-01
0.1984E+03	0.4414E-01	0.1047E+02	0.2500E-01
0.3788E+03	0.8719E-01	0.2095E+02	0.5000E-01
0.5290E+03	0.1274E+00	0.3142E+02	0.7500E-01
0.6574E+03	0.1661E+00	0.4189E+02	0.1000E+00
0.9794E+03	0.3560E+00	0.1041E+03	0.2500E+00
0.1062E+04	0.6227E+00	0.1931E+03	0.5000E+00
0.1075E+04	0.7528E+00	0.2376E+03	0.6250E+00
0.1148E+04	0.1347E+01	0.3871E+03	0.1200E+01
0.1233E+04	0.2563E+01	0.4726E+03	0.2400E+01

STR_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8o

===

SHAFT for Windows, Version 2017.8.10

Serial Number : 158517381

VERTICALLY LOADED DRILLED SHAFT ANALYSIS

===

```
     Path to file locations      : P:\INFOCUS PROJECTS\11501-12000\11585 On-Call
OCPW Masonry SI\005  Brea Canyon\Analyses\SHAFT\Bridge Foundations_10-01-21\Bridge
3\
     Name of input data file     : STR_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8d
     Name of output file         : STR_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8o
     Name of plot output file    : STR_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8p
     Name of runtime file        : STR_Bridge 3 Abutment 2_4-foot CIDH_fsqb_b.sf8r
```

Time and Date of Analysis

Date: October 03, 2021   Time: 15:13:58

11585.005 - Brea Boulevard Widening - Bridge 3 Abutment 1 - 48" CIDH

```
     PROPOSED DEPTH =      50.0 FT
     ----------------


     NUMBER OF LAYERS =    2
     ------------------


     WATER TABLE DEPTH =      -7.5 FT.
     -------------------




     SOIL INFORMATION
     ---------------

     LAYER NO  1----CLAY

       AT THE TOP

       STRENGTH REDUCTION FACTOR-ALPHA                   = 0.400E+00  (*)
       END BEARING COEFFICIENT-Nc                        = 0.600E+01  (*)
       UNDRAINED SHEAR STRENGTH, LB/SQ FT                = 0.600E+04
       BLOWS PER FOOT FROM STANDARD PENETRATION TEST     = 0.000E+00
       SOIL UNIT WEIGHT, LB/CU FT                        = 0.125E+03
       MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT          = 0.550E+04
       DEPTH, FT                                         = 0.000E+00


       AT THE BOTTOM
```

```
  STRENGTH REDUCTION FACTOR-ALPHA                        = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                             = 0.885E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                     = 0.600E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST          = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                             = 0.127E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT               = 0.550E+04
  DEPTH, FT                                              = 0.950E+01


  LRFD RESISTANCE FACTOR (SIDE FRICTION)                 = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)                = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


LAYER NO  2----CLAY

  AT THE TOP

  STRENGTH REDUCTION FACTOR-ALPHA                        = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                             = 0.885E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                     = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST          = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                             = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT               = 0.550E+04
  DEPTH, FT                                              = 0.950E+01


  AT THE BOTTOM

  STRENGTH REDUCTION FACTOR-ALPHA                        = 0.400E+00  (*)
  END BEARING COEFFICIENT-Nc                             = 0.900E+01  (*)
  UNDRAINED SHEAR STRENGTH, LB/SQ FT                     = 0.900E+04
  BLOWS PER FOOT FROM STANDARD PENETRATION TEST          = 0.000E+00
  SOIL UNIT WEIGHT, LB/CU FT                             = 0.130E+03
  MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT               = 0.550E+04
  DEPTH, FT                                              = 0.600E+02


  LRFD RESISTANCE FACTOR (SIDE FRICTION)                 = 0.700E+00
  LRFD RESISTANCE FACTOR (TIP RESISTANCE)                = 0.500E+00


  ..........WARNING..........
  THE SHEAR STRENGTH OF THIS MATERIAL MAY BE TOO HIGH
  FOR USING CLAY CRITERIA. DESIGN AS INTERMEDIATE
  GEOMATERIAL IS RECOMMENDED.


(*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS


INPUT DRILLED SHAFT INFORMATION
------------------------------

 MINIMUM SHAFT DIAMETER    =    4.000  FT.
 MAXIMUM SHAFT DIAMETER    =    4.000  FT.
```

```
 RATIO BASE/SHAFT DIAMETER =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
```

COMPUTATION RESULTS

```
- CASE ANALYZED      :     1
  VARIATION LENGTH   :     1
  VARIATION DIAMETER :     1
```

DRILLED SHAFT INFORMATION

```
 DIAMETER OF STEM          =    4.000  FT.
 DIAMETER OF BASE          =    4.000  FT.
 END OF STEM TO BASE       =    0.000  FT.
 ANGLE OF BELL             =    0.000  DEG.
 IGNORED TOP PORTION       =    0.000  FT.
 IGNORED BOTTOM PORTION    =    0.000  FT.
 AREA OF ONE PERCENT STEEL =   18.098  SQ.IN.
 ELASTIC MODULUS, Ec       = 0.360E+07 LB/SQ IN
 VOLUME OF UNDERREAM       =    0.000  CU.YDS.
 SHAFT LENGTH              =   50.000  FT.
```

PREDICTED RESULTS

```
QS      = ULTIMATE SIDE RESISTANCE;
QB      = ULTIMATE BASE RESISTANCE;
WT      = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);
QU      = TOTAL ULTIMATE RESISTANCE;
LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE SIDE RESISTANCE;
LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR
          TO THE ULTIMATE BASE RESISTANCE
LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.
```

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
1.0	0.47	15.08	299.37	314.45	10.56	149.68	160.24
2.0	0.93	30.16	310.68	340.84	21.11	155.34	176.45
3.0	1.40	45.24	344.80	390.05	31.67	172.40	204.07
4.0	1.86	60.33	379.76	440.09	42.23	189.88	232.11
5.0	2.33	75.41	415.37	490.78	52.79	207.69	260.47
6.0	2.79	90.49	451.44	541.93	63.34	225.72	289.06
7.0	3.26	105.57	477.65	583.22	73.90	238.82	312.72
8.0	3.72	120.65	494.55	615.20	84.46	247.28	331.73
9.0	4.19	135.73	502.72	638.45	95.01	251.36	346.37
10.0	4.65	150.82	502.72	653.54	105.57	251.36	356.93

11.0	5.12	173.44	502.72	676.16	121.41	251.36	372.77
12.0	5.59	196.06	502.72	698.78	137.24	251.36	388.60
13.0	6.05	218.68	502.72	721.40	153.08	251.36	404.44
14.0	6.52	241.31	502.72	744.03	168.91	251.36	420.27
15.0	6.98	263.93	502.72	766.65	184.75	251.36	436.11
16.0	7.45	286.55	502.72	789.27	200.59	251.36	451.95
17.0	7.91	309.17	502.72	811.89	216.42	251.36	467.78
18.0	8.38	331.80	502.72	834.52	232.26	251.36	483.62
19.0	8.84	354.42	502.72	857.14	248.09	251.36	499.45
20.0	9.31	377.04	502.72	879.76	263.93	251.36	515.29
21.0	9.78	399.66	502.72	902.38	279.76	251.36	531.12
22.0	10.24	422.28	502.72	925.00	295.60	251.36	546.96
23.0	10.71	444.91	502.72	947.63	311.44	251.36	562.80
24.0	11.17	467.53	502.72	970.25	327.27	251.36	578.63
25.0	11.64	490.15	502.72	992.87	343.11	251.36	594.47
26.0	12.10	512.77	502.72	1015.49	358.94	251.36	610.30
27.0	12.57	535.40	502.72	1038.12	374.78	251.36	626.14
28.0	13.03	558.02	502.72	1060.74	390.61	251.36	641.97
29.0	13.50	580.64	502.72	1083.36	406.45	251.36	657.81
30.0	13.96	603.26	502.72	1105.98	422.28	251.36	673.64
31.0	14.43	625.89	502.72	1128.61	438.12	251.36	689.48
32.0	14.90	648.51	502.72	1151.23	453.96	251.36	705.32
33.0	15.36	671.13	502.72	1173.85	469.79	251.36	721.15
34.0	15.83	693.75	502.72	1196.47	485.63	251.36	736.99
35.0	16.29	716.38	502.72	1219.10	501.46	251.36	752.82
36.0	16.76	739.00	502.72	1241.72	517.30	251.36	768.66
37.0	17.22	761.62	502.72	1264.34	533.13	251.36	784.49
38.0	17.69	784.24	502.72	1286.96	548.97	251.36	800.33
39.0	18.15	806.87	502.72	1309.59	564.81	251.36	816.17
40.0	18.62	829.49	502.72	1332.21	580.64	251.36	832.00
41.0	19.08	852.11	502.72	1354.83	596.48	251.36	847.84
42.0	19.55	874.73	502.72	1377.45	612.31	251.36	863.67
43.0	20.02	897.35	502.72	1400.07	628.15	251.36	879.51
44.0	20.48	919.98	502.72	1422.70	643.98	251.36	895.34
45.0	20.95	942.60	502.72	1445.32	659.82	251.36	911.18
46.0	21.41	965.22	502.72	1467.94	675.66	251.36	927.02
47.0	21.88	987.84	502.72	1490.56	691.49	251.36	942.85
48.0	22.34	1010.47	502.72	1513.19	707.33	251.36	958.69
49.0	22.81	1033.09	502.72	1535.81	723.16	251.36	974.52
50.0	23.27	1055.71	502.72	1558.43	739.00	251.36	990.36

AXIAL LOAD VS SETTLEMENT CURVES

RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1663E+00	0.2495E-04	0.8274E-02	0.1000E-04
0.8316E+00	0.1248E-03	0.4137E-01	0.5000E-04
0.1663E+01	0.2495E-03	0.8274E-01	0.1000E-03
0.8405E+02	0.1253E-01	0.4137E+01	0.5000E-02
0.1261E+03	0.1880E-01	0.6205E+01	0.7500E-02
0.1681E+03	0.2507E-01	0.8274E+01	0.1000E-01
0.4139E+03	0.6258E-01	0.2068E+02	0.2500E-01
0.6749E+03	0.1159E+00	0.4137E+02	0.5000E-01
0.8263E+03	0.1571E+00	0.6205E+02	0.7500E-01
0.9473E+03	0.1969E+00	0.8274E+02	0.1000E+00
0.1186E+04	0.3835E+00	0.2020E+03	0.2500E+00

0.1257E+04	0.6486E+00	0.2874E+03	0.5000E+00
0.1276E+04	0.7785E+00	0.3240E+03	0.6250E+00
0.1307E+04	0.1366E+01	0.4349E+03	0.1200E+01
0.1360E+04	0.2576E+01	0.4876E+03	0.2400E+01

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2778E+00	0.3362E-04	0.1236E-01	0.1000E-04
0.1389E+01	0.1681E-03	0.6179E-01	0.5000E-04
0.2778E+01	0.3362E-03	0.1236E+00	0.1000E-03
0.1411E+03	0.1695E-01	0.6179E+01	0.5000E-02
0.2116E+03	0.2542E-01	0.9269E+01	0.7500E-02
0.2821E+03	0.3389E-01	0.1236E+02	0.1000E-01
0.6518E+03	0.8346E-01	0.3090E+02	0.2500E-01
0.9422E+03	0.1441E+00	0.6179E+02	0.5000E-01
0.1051E+04	0.1839E+00	0.9269E+02	0.7500E-01
0.1124E+04	0.2198E+00	0.1236E+03	0.1000E+00
0.1363E+04	0.4096E+00	0.3000E+03	0.2500E+00
0.1426E+04	0.6733E+00	0.3816E+03	0.5000E+00
0.1430E+04	0.8013E+00	0.4104E+03	0.6250E+00
0.1443E+04	0.1383E+01	0.4826E+03	0.1200E+01
0.1461E+04	0.2587E+01	0.5002E+03	0.2400E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.8155E-01	0.1774E-04	0.4189E-02	0.1000E-04
0.4077E+00	0.8872E-04	0.2095E-01	0.5000E-04
0.8155E+00	0.1774E-03	0.4189E-01	0.1000E-03
0.4102E+02	0.8888E-02	0.2095E+01	0.5000E-02
0.6153E+02	0.1333E-01	0.3142E+01	0.7500E-02
0.8205E+02	0.1778E-01	0.4189E+01	0.1000E-01
0.2051E+03	0.4444E-01	0.1047E+02	0.2500E-01
0.3912E+03	0.8775E-01	0.2095E+02	0.5000E-01
0.5460E+03	0.1282E+00	0.3142E+02	0.7500E-01
0.6781E+03	0.1670E+00	0.4189E+02	0.1000E+00
0.1006E+04	0.3572E+00	0.1041E+03	0.2500E+00
0.1088E+04	0.6239E+00	0.1931E+03	0.5000E+00
0.1099E+04	0.7539E+00	0.2376E+03	0.6250E+00
0.1170E+04	0.1348E+01	0.3871E+03	0.1200E+01
0.1256E+04	0.2564E+01	0.4726E+03	0.2400E+01


PROPOSED INFILTRATION BASIN
CWE P-1
Afu (0-6')
Qal (6-33.5')
Tfu (33.5-50')
T.D. 50.0'
G.W.@19.5'
(5-10') IR=4.52 in/hr
LCI P-1
Afu (0-6.5')
Qal (6.5-30')
T.D. 30'
No G.W.
(5-10') IR=0.83 in/hr
LB-28
Afu (0-5')
Qal (5-16.5')
T.D. 16.5'
G.W.@14.5'
RW-1
(MECHANICALLY STABILIZED EARTH-MSE))
RW-2
(CALTRANS TYPE 1)
LB-29
AC/AB (0-4.5')
Afu (0.4-5')
Qal (5-24')
Tfu (24-30')
T.D. 30'
G.W.@15'
LCI P-2
Afu (0-6')
Qal (6-23.5')
Tfu (23.5-24')
T.D. 24'
G.W.@11.5'
(5-10') IR=0.15 in/hr
LB-20
Afu (0-5')
Qalo (5-30')
Tfu (30-50.75')
T.D. 50.8'
No G.W.
LB-1
AC/Base (0-15")
Qal (15"-10')
Tfu (10'-11.5')
T.D. 11.5'
No G.W.
SC-1
T.D. 29'
No G.W.
LB-2
Afu (0-3')
Qalo (3'-20')
Tfu (20'-61')
T.D. 61'
No G.W.
CWE P-2
Afu (0-5')
Qalo (5-30')
Tfu (30-51')
T.D. 51.0'
G.W.@18'
(5-10') IR=1.36 in/hr
C-7
T.D. 33'
G.W.@16'
RW-3
(SOIL NAIL)
BRIDGE 1
(55C-0121)
N. BREA BOULEVARD
CANYON COUNTRY ROAD
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
18+00
18+00'
23+50
23+50'
24+50
24+50'
LEGEND
PROPOSED TEST BORING AND PERCOLATION TEST LOCATIONS
JANUARY 27, 2020
LB-36
Qalo (0-30')
Tmy (30-33')
T.D. 33.0'
No G.W.
APPROXIMATE LOCATION OF HOLLOW-STEM AUGER BORING SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.) AND DEPTH TO EARTH UNITS
LCI P-5
Afu (0-8')
Qalo (8-20')
T.D. 20.0'
G.W.@15.5'
(3-5') IR=0.22 in/hr
APPROXIMATE LOCATION OF PRIOR PERCOLATION TEST BY LEIGHTON CONSULTING, INC., SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.) AND INFILTRATION RATE IN INCHES PER HOUR (in/hr)
CWE P-5
Qalo (0-30')
Tmy (30-50.5')
T.D. 50.5'
G.W.@42.5'
(10-30') IR=0.22 in/hr
APPROXIMATE LOCATION OF PERCOLATION TEST BORING PER (CWE), SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.) AND INFILTRATION RATE IN INCHES PER HOUR (in/hr)
LB-36
AC/BASE/AC (0-28.5")
Afu (28.5"-5')
Qalo (5'-44')
Tfu (44'-51.5')
T.D. 51.5'
G.W. @ 26' 8"
APPROXIMATE LOCATION OF HOLLOW-STEM AUGER BORING SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.) AND DEPTH TO EARTH UNITS
LBA-3
Tfu (0-78')
T.D. 78'
No G.W.
APPROXIMATE LOCATION OF BUCKET AUGER BORING SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.) AND DEPTH TO EARTH UNITS
SC-6
T.D. 6'
No G.W.
APPROXIMATE LOCATION OF SEISMIC CPT SHOWING TOTAL DEPTH (T.D.), DEPTH TO GROUNDWATER (G.W.)
C-9
T.D. 55'
No G.W.
APPROXIMATE LOCATION OF CONE PENETROMETER TEST (CPT) SHOWING TOTAL DEPTH (T.D.) AND DEPTH TO GROUNDWATER (G.W.)
SL-1
APPROXIMATE LOCATION OF SEISMIC LINE (SOUTHWEST GEOSCIENCE, INC., 9/18)
78+00
78+00'
GEOLOGIC CROSS-SECTION
BEDDING ATTITUDE
VERTICAL FAULT ATTITUDE
GEOTECHNICAL EXPLORATION PLAN
Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California
Plate-1
Proj: 11585.005
Eng/Geol: JEH/JLH
Scale: 1"=50'
Date: April 2021
Leighton
0
50
100
SCALE
FEET

GEOTECHNICAL EXPLORATION PLAN

Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California

Plate-2

Leighton

Proj: 11585.005	Eng/Geol: JEH/JLH
Scale: 1"=50'	Date: April 2021

V:\DRAFTING\11585\005\CAD\2021-02-02\11585-005_P01-06_GM_2021-04-19.DWG (04-19-21 2:23:40PM) Plotted by: btran

39+50
40+00
40+50
42+50
45+50
47+00
50+00
53+50
39+50'
40+50'
42+50'
45+50'
47+00'
50+00'
53+50'
38+00
39+00
41+00
42+00
43+00
44+00
45+00
46+00
47+00
48+00
49+00
50+00
51+00
52+00
53+00
54+00
LB-27
Qalo (0-40')
Tfu (40-51')
T.D. 51.0'
G.W.@31'
LB-4
Afu (0-11')
Qalo (11-20')
Tfu (20-70.5')
T.D. 70.5'
No G.W.
CWE P-4
Afu (0-6.5')
Qalo (6.5-30')
Tfu (30-51')
T.D. 51.0'
G.W.@38.5'
(10-30') IR=2.72 in/hr
C-8
LB-38
LB-25
SC-3
T.D. 65'
No G.W.
LB-24
Afu (0-5')
Qalo (5-7.5')
Tfu (7.5-50')
LB-26
Afu (0-5')
Qalo (5-40')
T.D. 40.0'
No G.W.
LB-30
Afu (0-1')
Qalo (1-25')
Tfu (25-51')
T.D. 51.0'
No G.W.
LB-15
Afu (0-1')
Qalo (1'-33')
Tfu (33' - 40'11")
T.D. 40' 11"
SEEPAGE @ 40' 10"
LB-5
AC (0-15")
Qalo (15"-5')
Tfu (5'-26.5')
T.D. 26.5'
No G.W.
LB-31
Afu (0-3')
Qalo (3-20')
Tfu (20-61')
T.D. 61.0'
No G.W.
LB-16
Afu (0-1')
Qalo (1'-5')
Tmy (5'-31.5')
T.D. 31.5'
No G.W.
C-4
T.D. 34'
G.W.@29'
RW-8 (SOLDIER PILE)
BRIDGE 3 (55C-0123)
RW-9 (SOIL NAIL)
RW-10 (SOLDIER PILE)
RW-11 (SOLDIER PILE)
RW-12A (SOIL NAIL)
RW-12B (SOIL NAIL)
RW-12C (SOIL NAIL)
FOUND 2" BRASS DISK STAMPED "U.O. CO. STEARNS NO. 5 ELEV. 462.93' L.S. 1..." PER (R6 & R12), FLUSH IN CONCRETE MONUMENT
FOUND 3" I.P. WITH 4" IRON CAP STAMPED "UNION OIL OF CALIFORNIA BM EL" PER (R6), UP 0.4' ACCEPTED AS "U.O. CO. 15" PER (R12)
FOUND SEVERELY DISTURBED
BREA BOULEVARD
APN 304-012-35
2013000023005 O.R.
CITY
M.M. 898/19-35
MONUMENT NOTES
FOUND O.C.S. HORIZONTAL CONTROL STATION PER O.C.S. HORIZONTAL CONTROL DATA SHEET ON FILE IN THE ORANGE COUNTY SURVEYOR'S OFFICE, BOUNDARY-GEODETIC UNIT
FOUND MONUMENT AS NOTED
SEARCHED, FOUND NOTHING
REFERENCES
R1 PARCEL MAP 87-241, P.M.B. 285/18-21
R2 TRACT NO. 9111, M.M. 374/24-26
R3 P.M.B. 68/18
R4 214/212 O.R. AND 216/177 O.R.
R5 TRACT NO. 9473, M.M. 391/26-28
R6 TRACT NO. 16976, M.M. 898/19-35
R7 RECORD OF SURVEY 2009-1153, R.S.B. 243/3-14
R8 10370/229 O.R.
SEE PLATE 1 FOR LEGEND
N
0 50 100
SCALE FEET
GEOTECHNICAL EXPLORATION PLAN
Proposed Brea Boulevard Corridor Improvement Project
Canyon Country Road (Brea) to Orange County Line
Sta. 8+00 to Sta. 101+00
Orange County, California
Plate-3
Proj: 11585.005
Eng/Geol: JEH/JLH
Scale: 1"=50'
Date: April 2021
Leighton