Appendix F:
Geology and Soils Geotechnical Supporting Information

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F.1 - Geotechnical Report for 1750 Oak Park Boulevard

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1750 OAK PARK BLOULAVARD
PLEASANT HILL, CALIFORNIA

GEOTECHNICAL EXPLORATION

SUBMITTED TO
Mr. Scott Stringer
Bates Stringer Oak Park, LLC
875 Orange Blossom Way
Danville, California 94562

PREPARED BY
ENGEO Incorporated

September 4, 2018

PROJECT NO.
7843.001.001

ENGEO
Expect Excellence

Project No.
7843.001.001

September 4, 2018

Mr. Scott Stringer
Bates Stringer Oak Park, LLC
875 Orange Blossom Way
Danville, CA 94562

Subject: 1750 Oak Park Boulevard
Pleasant Hill, California

GEOTECHNICAL EXPLORATION

Dear Mr. Stringer:

We prepared this geotechnical exploration report for the proposed residential development as outlined in our agreement dated April 12, 2018. We characterized the subsurface conditions at the site to provide the enclosed geotechnical recommendations for design.

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to review the project plans and specifications and provide geotechnical observation and testing services during construction. Please let us know when working drawings are nearing completion, and we will be glad to discuss these additional services with you.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

Spencer Waganaar, EIT

Bahareh Heidarzadeh, Ph.D

REGISTERED PROFESSIONAL ENGINEER
MACY M.S. TONG
No. 2300
GEOTECHNICAL
STATE OF CALIFORNIA

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

We prepared this geotechnical exploration report for design and construction of a residential development in Pleasant Hill, California. We prepared this report as outlined in our agreement dated April 12, 2018. Bates Stringer Oak Park, LLC authorized ENGEO to conduct the following scope of services:

- Reviewing available literature, geologic maps, previous geotechnical exploration report pertinent to the site.
- Performing subsurface field exploration.
- Conducting soil laboratory testing.
- Analyzing the geotechnical field and laboratory test data.
- Providing geotechnical recommendations for grading, foundation design, and construction of the residential development.

This report was prepared for the exclusive use of Bates Stringer for design of this project. In the event that any changes are made in the character, design or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to evaluate whether modifications are recommended. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 PROJECT LOCATION

The property is located at 1750 Oak Park Boulevard and comprises approximately 5 acres of land, which is currently occupied by the Pleasant Hill Library and is located northwest of the intersection of Monticello Avenue and Oak Park Boulevard on the Vicinity Map, Figure 1. The site is bounded by athletic fields to the north, a vacant lot to the east, Oak Park Boulevard to the south, and the Contra Costa County's Office of Education to the west. The library building is located at the northern half of the subject site, and the parking lot is situated at the southern half of the property.

A conceptual grading plan for the site was prepared by BKF Engineers, dated June 22, 2018. According to the plan, the site slightly slopes from north to south. Site elevations range from approximately 85 feet Mean Sea Level (MSL) in the northwest area of the site to 73 feet MSL in the southeast corner of the site.

1.3 PROJECT DESCRIPTION

Based on our review of the provided conceptual site plan (Figure 2), the following site improvements are proposed:

1. The development of the site will consist of construction of 34 single-family residential lots. We anticipate residential structures will be 1 to 2 stories high and be wood-framed construction.
2. Fills up to about 3 feet thick are planned throughout the property with potential small cuts, up to about one foot deep, in the northwestern portion of the property.
3. Paved streets and drive lanes will be constructed throughout the neighborhood.
4. Utilities, bio-retention areas, and other infrastructure improvements will be installed at the site.

2.0 FINDINGS

2.1 FIELD EXPLORATIONS

Our field explorations included drilling six borings and advancing seven Cone Penetration Test (CPT) soundings at various locations on the site. We performed our field explorations in May and June 2018. Our explorations are located using approximate distances from structures in the field (Figure 2), and should be considered accurate only to the degree implied by the method used.

Logs of exploratory borings and CPTs are presented in Appendices A and C, respectively.

2.1.1 Borings

Soil boring drilling was conducted on May 9 and May 24, 2018. The approximate locations of the six soil borings (1-B1, 1-B2 and 1-B4 through 1-B7) are shown on the Site Plan, Figure 2. We retained a track-mounted drill rig and crew to advance the borings using 4-inch-diameter mud rotary method. The borings were advanced to depths ranging from 31½ to 41½ feet below existing grade. We permitted and backfilled the borings in accordance with the requirements of Contra Costa County Environmental Health Division.

ENGEO engineers observed the drilling and logged the subsurface conditions at each location. We obtained bulk soil samples from drill cuttings and retrieved samples at various intervals in the borings using standard penetration tests, 2½-inch O.D. split-spoon sampler (SPT), and Modified California Sampler. The standard penetration resistance blow counts were obtained by dropping a 140-pound automatic-trip hammer through a 30-inch free fall. The 2½-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration. In addition, 2.5-inch I.D. samples were obtained using a Modified California Sampler driven into the soil with the 140-pound hammer previously described. The blows per foot recorded on the boring logs represent the accumulated number of blows to drive the last 1 foot of penetration; the blow counts have not been converted using any correction factors.

We used the field logs to develop the report logs in Appendix A. The logs depict subsurface conditions at the exploration locations for the date of exploration; however, subsurface conditions may vary with time.

2.1.2 Cone Penetration Tests

We retained a CPT rig to push seven cone penetration tests (CPTs) to a maximum depth of about 50 feet below ground. The CPT has a 20-ton compression-type cone with a 15-square-centimeter (cm^2) base area, an apex angle of 60 degrees, and a friction sleeve with a surface area of 225 cm^2. The cone, connected with a series of rods, is pushed into the ground at a constant rate. Cone readings are taken at approximately 5-cm intervals with a penetration rate of 2 cm per second in accordance with ASTM D-5778. Measurements include the tip resistance to penetration of the cone (Qc), the resistance of the surface sleeve (Fs), and pore pressure (U) (Robertson and Campanella, 1988). CPT logs are presented in Appendix C.

2.2 SITE BACKGROUND

Review of historical aerial photographs found the site remained undeveloped up until the late 1940s, after which the current library was constructed. Additionally, historic aerial photography circa 1939 shows the current channelized creek to the east of the site had previously multiple meandering channels which traversed through the southern portion of the site with entry points along the east and exit points along the south and west perimeters of the property. An historical aerial photograph from around 1946 shows the original creek channels were filled in and diverted to a more direct route. By the late 1950s, the natural creek alignment and its meandering footprint appears to have been abandoned entirely and filled in as a product of the channelization of the waterway to the east of the property. The approximate locations of the former meandering creek channels are shown on Figure 2.

2.3 GEOLOGY AND SEISMICITY

2.3.1 Regional Geology

The site is located within the Coast Ranges geomorphic province of California. The Coast Ranges geomorphic province is characterized by a system of northwest-trending, fault-bounded mountain ranges and intervening alluvial valleys. Bedrock in the Coast Ranges consists of igneous, metamorphic and sedimentary rocks that range in age from Jurassic to Pleistocene. The present topography and geology of the Coast Ranges are the result of deformation and deposition along the tectonic boundary between the North American plate and the Pacific plate. Plate boundary fault movements are largely concentrated along the well-known fault zones, which in the area include the San Andreas, Hayward, and Calaveras faults, as well as other lesser-order faults.

2.3.2 Geology

More specifically, the site is located within the west portion of Ygnacio Valley. Ygnacio Valley represents an area of low relief, between Mount Diablo within the Diablo Range to the east and the Briones Hills within the East Bay Hills to the west. Both Dibblee (2005, Figure 3) and Witter (2006) map the geology at the site as alluvial fan deposits and further interprets the deposits as Holocene aged. The alluvial deposits are commonly unconsolidated, heterogeneous, poorly to moderately sorted, irregularly interbedded clays and silts containing discontinuous lenses of sand, silty clay, and gravel. According to Witter (2006), the alluvial deposits underlying the site are considered of moderate liquefaction susceptibility. Our relevant experience in the area indicates that the alluvium may consist of moderately to highly expansive clay to sandy clay. Bedrock exposed in the Briones Hill directly west of the site generally comprises units of the Monterey Formation and Martinez Group.

2.3.3 Seismicity

The Bay Area contains numerous active earthquake faults. An active fault is defined by the California Geological Survey as one that has had surface displacement within the last 11,000 years (SP42 CGS, 2007). Because of the presence of nearby active faults, the Bay Area Region is considered seismically active. Numerous small earthquakes occur every year in the San Francisco Bay Region, and larger earthquakes have been recorded and can be expected to occur in the future. Figure 4 shows the approximate locations of these faults and significant historic earthquakes recorded within the San Francisco Bay Region.

The site is not located within a designated Alquist-Priolo Earthquake Fault Zone and no known surface expression of active faulting is believed to exist within the site. Fault rupture through the site, therefore, is not anticipated.

The site does lie within a seismically active region. According to 2008 USGS National Seismic Hazard Maps, the nearest active fault is the Green Valley Connected fault, which is mapped approximately six miles southwest of the site. This fault is considered capable of a moment magnitude earthquake of 6.8. Other active faults in the region are summarized in the table below and Figure 4, including the Mount Diablo Thrust fault approximately eleven miles away, capable of a moment magnitude of 6.7 and the Calaveras fault approximately fourteen miles away, capable of a moment magnitude of 7.0.

TABLE 2.3.3-1: Active Faults Capable of Producing Significant Ground Shaking at the Site

FAULT NAME	DISTANCE FROM SITE (MILES)	DIRECTION FROM SITE	MAXIMUM MOMENT MAGNITUDE
Concord	2.8	Northeast	6.8
Mount Diablo Thrust	4.3	East	6.7
Calaveras	8.7	South	7.0
Greenville Connected	13.3	Southeast	7.0
Hayward-Rogers Creek	17.4	West	7.3

The third version of Uniform California Earthquake Forecast (UCERF3) developed by the Working Group on California Earthquake Probabilities (Field et al., 2013) provides updated estimates of the 30-year probability of various magnitudes earthquakes in the San Francisco Bays Area. The results of the study are summarized in the following table:

TABLE 2.3.3-2: 30-Year Probability of Earthquake in the Bay Area

EARTHQUAKE MAGNITUDE	30-YEAR PROBABILITY OF ONE OR MORE EVENTS
5 or Greater	100%
6 or Greater	98%
7 or Greater	51%
8 or Greater	4%

In the event of an earthquake, the Modified Mercalli Intensity Shaking Severity Level in this area in eight, which is considered to be very strong shaking.

California Seismic Hazard Zones map by California Geologic Survey does not evaluate this area for liquefaction and landslides. However, according to Witter (2006), the alluvial deposits underlying the site are considered of moderate liquefaction susceptibility. The evaluation of liquefaction and landslide hazards are provided later in this report.

2.4 SUBSURFACE CONDITIONS

We encountered an existing fill layer beneath the paving in all of the six borings. The existing fill is approximately 2½ to 5½ feet thick and consists of clay, sandy silt and clayey sand.

Native soils found in the site generally consist of interbedded layers of clay, silt, silty sand, and clayey sand of alluvial deposits. The upper layer of native clayey deposit found in Borings 1-B1 and 1-B2 in the southern end of the site are soft in consistency and saturated. The softer clay is about 12 to 13 feet thick. The softer soil was underlain by sandy clay, clayey sand, and silty clay. The medium dense sandy deposits are found at a depth of approximately 12 feet or lower below ground surface in the southern locations. Clayey sand and silty sand of medium dense are found at a depth of 4 feet or lower below ground surface in the northern portion of the site.

Consult the Site Plan and exploration logs for specific subsurface conditions at each location. We include our exploration boring logs in Appendix A. The logs contain the soil type, color, consistency, and visual classification in general accordance with the Unified Soil Classification System. The logs graphically depict the subsurface conditions encountered at the time of the exploration.

2.5 GROUNDWATER CONDITIONS

The static groundwater level estimated in the CPT soundings is listed in the table below:

TABLE 2.5-1: Groundwater Observations

EXPLORATION LOCATION	APPROX. DEPTH TO GROUNDWATER (FEET)	APPROX. GROUNDWATER ELEVATION (FEET)
1-CPT1	5.0	69.0
1-CPT2	6.7	69.3
1-CPT3	6.0	71.0
1-CPT4	6.8	72.6
1-CPT5	7.0	72.8
1-CPT6	9.0	69.6
1-CPT7	16.5	64.0

Groundwater was not able to measure due to the drilling method used in test borings. As required, the test borings and CPT probes were backfilled under the observation of inspectors from Contra Costa County Environmental Health Division with approved material.

Fluctuations in the level of groundwater may occur due to variations in rainfall, irrigation practice, and other factors not evident at the time measurements were made. Future irrigation may cause an overall rise in groundwater levels.

2.6 LABORATORY TESTING

We performed laboratory tests on selected soil samples collected from the borings to evaluate their engineering properties. For this project, we performed moisture content, dry density, unconfined compressive strength, plasticity index, gradation, consolidation, soil corrosion potential, and sulfate testing. Moisture contents and dry densities are presented on the boring logs in Appendix A; and other laboratory test data is included in Appendix B.

3.0 DISCUSSION AND CONCLUSIONS

From a geotechnical engineering viewpoint, in our opinion, the site is suitable for the proposed residential development, provided that the geotechnical recommendations in this report are properly incorporated into the design plans and specifications and during construction.

The primary geotechnical concerns that could affect development on the site are seismic hazard, liquefaction of granular material and cyclic softening of clay-like material, existing fill, shallow groundwater table, soil compressibility, and expansive soil. We provide our discussion of these geotechnical concerns and summarize our conclusions below.

3.1 SEISMIC HAZARDS

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, and ground lurching. The following sections present a discussion of these hazards as they apply to the site. Based on topographic and lithologic data, the risk of regional subsidence or uplift, landslides, tsunamis, flooding, or seiches is considered low to negligible at the site. We discuss soil liquefaction and lateral spreading in the later sections.

3.1.1 Ground Rupture

Since there are no known active faults crossing the property and the site is not located within an Earthquake Fault Special Study Zone, it is our opinion that ground rupture is unlikely at the subject property.

3.1.2 Ground Lurching

Ground lurching is a result of the rolling motion imparted to the ground surface during energy released by an earthquake. Such rolling motion can cause ground cracks to form in weaker soils. The potential for the formation of these cracks is considered greater at contacts between deep alluvium and bedrock. Such an occurrence is possible at the site as in other locations in the Bay Area region, but based on the site location, it is our opinion that the offset is expected to be minor. We provide recommendations for foundation and pavement design in this report that are intended to reduce the potential for adverse impacts from lurch cracking.

3.1.3 Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, structures should be designed using sound engineering judgment and the 2016 California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code-prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

3.1.4 2016 California Building Code (CBC) Seismic Design Parameters

The 2016 CBC utilizes design criteria set forth in the 2010 ASCE 7 Standard. Based on the subsurface conditions encountered, we characterized the site as Site Class D in accordance with the 2016 CBC. We provide the 2016 CBC seismic design parameters in Table 3.1.4-1 below, which include design spectral response acceleration parameters based on the mapped

Risk-Targeted Maximum Considered Earthquake (MCE_R) spectral response acceleration parameters.

TABLE 3.1.4-1: 2016 CBC Seismic Design Parameters, Latitude: 37.9337 Longitude: -122.0692

PARAMETER	VALUE
Site Class	D
Mapped MCE_R Spectral Response Acceleration at Short Periods, S_S (g)	1.672
Mapped MCE_R Spectral Response Acceleration at 1-second Period, S_1 (g)	0.604
Site Coefficient, F_A	1.00
Site Coefficient, F_V	1.50
MCE_R Spectral Response Acceleration at Short Periods, S_{MS} (g)	1.672
MCE_R Spectral Response Acceleration at 1-second Period, S_{M1} (g)	0.902
Design Spectral Response Acceleration at Short Periods, S_{DS} (g)	1.114
Design Spectral Response Acceleration at 1-second Period, S_{D1} (g)	0.601
Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration, PGA (g)	0.635
Site Coefficient, F_{PGA}	1.00
MCE_G Peak Ground Acceleration adjusted for Site Class effects, PGA_M (g)	0.635

3.1.5 Liquefaction

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands below the groundwater table. Empirical evidence indicate that low plasticity silt and clay are also potentially liquefiable, though this phenomenon is commonly referred to as cyclic softening. For the purpose of this report, we will refer to cyclic softening as liquefaction. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressure to develop.

As previously discussed, the subsurface soils consist of mostly clay and silty clay, with interbedded layers of silty sand, sandy silt, and poorly graded sand. We used visual classification, in-situ dilatancy test, and index testing results from the boring soil samples in conjunction with the Bray and Sancio (2006) screening criteria to determine which of the samples of fine-grained soils from the borings may be liquefiable. We also used these data to establish a relationship between soil that is potentially liquefiable and in the CPTs by comparing them to adjacent “matched-pair” borings. To perform this comparison, we compared the calculated Soil Behavior Type Index (I_C) to soil zones that were potentially liquefiable in the adjacent borings. This comparison allows us to calibrate the results of CPT testing at this site with soil behavior recovered from our borings. The following matched pairs of borings and CPTs were used to perform these calibrations:

Match Pairs
Match Pair 1: 1-B4 and 1-CPT4
Match Pair 2: 1-B6 and 1-CPT5 and 1-CPT6

Two soil samples, were plotted well outside the limits of susceptibility to liquefaction according to the Bray and Sancio procedure, and had a soil behavior index (I_c) of 2.48 to 2.64, as shown in Table 3.1.5-1. Based on this screening, we established an I_c cutoff value of 2.48, which represents the I_c value that index and fines content testing indicates that soil with a higher I_c value is a clay.

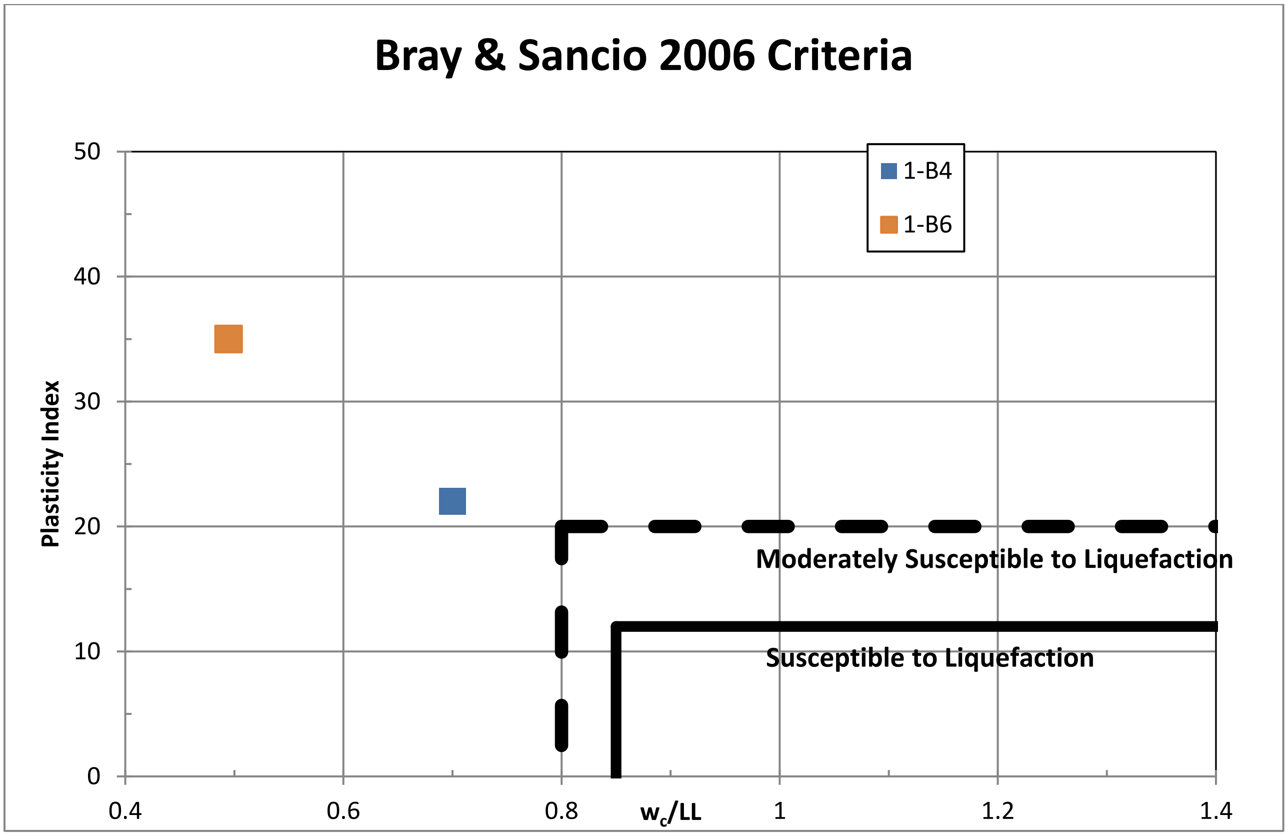
TABLE 3.1.5-1: "Clay-like" Soil Samples

BORING	SAMPLE DEPTH (FEET)	I_C
1-B4	10	2.48
1-B6	27	2.64

Chart 3.1.5-1 shows the Bray and Sancio screening results for soil where the adjacent CPT indicates the I_C value is over 2.48; soil that plots outside the "Moderately Susceptible to Liquefaction" zone is unlikely to be liquefiable.

The Bray and Sancio (2006) screening indicates that liquefaction will not occur in clay-like soil with I_C above 2.48 at this site. Therefore, we established and I_C cut-off of 2.48 based on site-specific data and significant lab testing.

CHART 3.1.5-1: Bray and Sancio (2006) Screening of I_C > 2.5 Soils



We evaluated the data from CPTs for triggering of liquefaction using the calibrated I_C values to represent transitions in soil type and behavior. In performing our analysis, we assumed a design groundwater level of 5 feet below existing grade and used the mapped maximum considered earthquake (MCE) geometric mean peak ground acceleration (PGA_M) of 0.64g based on the 2016 California Building Code. We assumed a moment magnitude of 6.8 for our analyses to represent the highest level of ground shaking on the controlling faults. As discussed earlier, we also used am I_C of cut-off of 2.48 based on our site-specific data.

We utilized the software package, CLiq Version 2.2.1.4 by Geologismiki Geotechnical Software, to evaluate liquefaction susceptibility from the CPT data. We performed our analyses using the method outlined by Boulanger and Idriss (2014).

Furthermore, in locations where there was a match pair, we evaluated the susceptibility to liquefaction of coarse-grained layers using Standard Penetration (SPT) blow counts and converted Modified California sampler blow counts as outlined by Idriss and Boulanger (2008).

Based off the analysis, we negated non-liquefiable layers from the Cliq analysis above, as well as estimated settlement at boring locations where there was no accompanying CPT (1-B5 and 1-B7). The results of our analyses are presented in Appendix D, and final estimated liquefaction-induced settlements are summarized below:

TABLE 3.1.3-2: Summary of Liquefaction-Induced Settlement Calculations

EXPLORATION LOCATION	TOTAL SETTLEMENT (INCHES)
1-CPT1	0.2
1-CPT2	1.0
1-CPT3	0.9
1-CPT4	2.2
1-CPT5	1.1
1-CPT6	0.9
1-CPT7	2.4
1-B5	0.6
1-B7	1.4

The estimated liquefaction-induced settlement is estimated to be a maximum value of about 2.5 inches across the site. To address liquefaction-induced settlement, we recommend that improvements at the site include:

- Incorporating a total settlement of 2.5 inches and a differential settlement of 1.25 inch over a horizontal distance of 40 feet due to liquefaction settlement in the foundation and superstructure designs.
- Providing flexible connections for building utilities that allow for 1.25 inch of vertical movement without breaking.
- Utilities on the project should be designed either with flexible materials or with flexible joints that allow the utility line to move at least 1.25 inch over a distance of 40 feet without breaking.

3.1.6 Liquefaction-induced Surface Disruption and Lateral Spreading

One of the results of liquefaction is surface disruption. Surface disruption could consist of sand boils and ground fissures. We anticipate minor sand boils and ground fissures in the new development area. However, the foundation should be designed to accommodate settlements as described in the foundation recommendation section.

Lateral spreading involves lateral ground movements caused by seismic shaking. These lateral ground movements are often associated with a wakening or failure of an embankment or soil mass overlying a layer of liquefied or weak soil. The effects of lateral spreading are often amplified by sloping ground and a "free-face". A free-face can include a near-vertical cut often found near river or creek banks. Based on our observations in the field, proximity from the subject site to the channel and topographic data of the site, there is no significant sliding ground condition near the site. Therefore, we anticipate the potential of lateral spread to be negligible.

3.1.7 Flooding

Flood Insurance Map by FEMA (Figure 5) indicates that the southern portion of the site within Zone X. The Civil Engineer should review the pertinent information relating to flood levels for the subject site based on final pad elevations and provide appropriate design measures for development of the project, if necessary. Based on the proposed grade as shown on the Concept Grading Analysis plan by BKF Engineers, the building pads at a final elevation ranging from 76.5 and 83 feet, which is above the mapped flood elevation.

3.2 EXISTING FILL

As discussed in early section, a layer of fill was found at the site and is approximately 2½ to 5½ feet thick. The thicker section of the fill is located in the southern portion of the site (Borings 1-B1, 1-B2, and 1-B4), and could be related to the filling of the old channels and/or construction of the library. A summary of fill at each boring is presented below:

TABLE 3.2-1: Approximate Thickness of Existing Fill

EXPLORATION LOCATION	UNDOCUMENTED FILL THICKNESS (Feet)
1-B1	5½
1-B2	5½
1-B4	4
1-B5	4
1-B6	2½
1-B7	3

Since the compaction conditions of this fill is unknown, it is our opinion that this undocumented fill should be removed and can be recompacted as engineered fill.

3.3 GROUNDWATER CONSIDERATIONS

Shallow groundwater condition at this site is summarized in the previous section. Groundwater table was found at a depth of 5 feet at the southern end of the site to 16.5 feet at the northern end of the site. Existing fill removal and any deep utility trench excavation may encountered groundwater. Shallow groundwater condition should be considered during site grading, and excavation of the utility trenches, and foundation construction. The project contractor should evaluate the site conditions and selected properly designed dewatering, shoring systems, and other as necessary during site grading and construction.

3.4 COMPRESSIBLE SOIL

As discussed in the early section, we encountered soft saturated clayey deposits ranging from approximately 4 feet to 13 feet thick in the southern portion of the site.

Our laboratory consolidation test results and CPT data indicate that this material consists of compressible, slightly over-consolidated clay, which will compress when subjected to increased loads potentially resulting in settlement at the ground surface. Settlement at the site could be generated from: (1) consolidation of the clay deposits where additional fills will be placed, (2) compression of the fills due to their own weights, and (3) compression of soils beneath foundation system due to building load. The amount of settlement is a factor of proposed loads, thickness of the clay deposit, and previous loads experienced by the clay deposits.

Our settlement analyses indicate that the total settlement due to consolidation of clayey deposits when subjected to additional loads (fill thickness of 3 feet and assumed building loads of 600 psf) is estimated to be approximately 1 to 1½ inches.

To reduce post-construction consolidation settlement, the southern portion of the site can be preloaded using surcharge fill. The evaluation of surcharge fill program, if desire, can be conducted during review of the final grading plans, based on final fill thickness and actual building load.

3.5 EXPANSIVE SOIL

Expansive high plasticity clay was found near the surface in the southern portion of the site, and expansive silty and lean clay was encountered near the surface in the northern area of the site. Our laboratory test results indicate that both these clayey soils exhibit moderate to very high shrink/swell potential (with a Plasticity Index ranging from 24 and 38).

Expansive soils change in volume with changes in moisture. They can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Building damage due to volume changes associated with expansive soils can be reduced by: (1) using a rigid mat foundation that is designed to resist the settlement and heave of expansive soil, (2) deepening the foundations to below the zone of moisture fluctuation, i.e. by using deep footings or drilled piers, and/or (3) using footings at normal shallow depths but bottomed on a layer of select fill having a low expansion potential.

Post-tensioned mat foundations are the preferred foundation system for the residential structures. Design criteria for the post-tensioned mats are presented in Foundation Recommendations section.

Successful performance of structures on expansive soils requires special attention during construction. It is imperative that exposed soils be kept moist prior to placement of concrete for foundation construction. It can be difficult to remoisturize clayey soils without excavation, moisture conditioning, and recompaction.

We have also provided specific grading recommendations for compaction of clay soil at the site. The purpose of these recommendations is to reduce the swell potential of the clay by compacting the soil at a high moisture content and controlling the amount of compaction. Compaction recommendations are presented in Earthwork Recommendations section of this report.

3.6 SOIL CORROSION POTENTIAL

As part of this study, we obtained near-surface representative soil samples and submitted to a qualified analytical laboratory (CERCO) for determination of redox, pH, resistivity, sulfate, and chloride. The results are included in Appendix B and summarized in the table below.

TABLE 3.6-1: Corrosivity Test Results

SAMPLE LOCATION	DEPTH	PH	RESISTIVITY (OHMS-CM)	CHLORIDE (MG/KG)	SULFATE (MG/KG)
Combined 1-B5/1-B2	Surface	8.16	430	43	330

*ASTM D4327

A brief corrosivity evaluation of the tested soil sample by CERCO is included and presented in Appendix B. If desired to investigate this further, we recommend a corrosion consultant be retained to evaluate the soil material for specific corrosion recommendations for underground utilities for the project.

We also collected a near-surface soil sample from Borings 1-B2 and 1-B5 and submitted to an outside laboratory, CERCO Analytical, for corrosion and sulfate ion concentration determination. The test results are included in Appendix B.

The 2016 CBC references the 2014 American Concrete Institute Manual, ACI 318-14, Section 19.3.1 for concrete durability requirements. ACI Table 19.3.1.1 provides the following exposure categories and classes, and Table 19.3.2.1 provides requirements for concrete in contact with soil based upon the exposure class.

TABLE 3.6-2: ACI Table 19.3.1.1: Exposure Categories and Classes

CATEGORY	SEVERITY	CLASS	CONDITION	
F Freezing and thawing	Not Applicable	F0	Concrete not exposed to freezing-and-thawing cycles	
	Moderate	F1	Concrete exposed to freezing-and-thawing cycles and occasional exposure to moisture	
	Severe	F2	Concrete exposed to freezing-and-thawing cycles and in continuous contact with moisture	
	Very Severe	F3	Concrete exposed to freezing-and-thawing cycles and in continuous contact with moisture and exposed to deicing chemicals	
			WATER- SOLUBLE SULFATE IN SOIL % BY WEIGHT*	**DISSOLVED SULFATE IN WATER MG/KG (PPM)****
S Sulfate	Not applicable	S0	$SO_4 < 0.10$	$SO_4 < 150$
	Moderate	S1	$0.10 \le SO_4 < 0.20$	$150 \le SO_4 \le 1,500$ seawater
	Severe	S2	$0.20 \le SO_4 \le 2.00$	$1,500 \le SO_4 \le 10,000$
	Very severe	S3	$SO_4 > 2.00$	$SO_4 > 10,000$
			CONDITION	
P Requiring low permeability	Not applicable	P0	In contact with water where low permeability is not required.	
	Required	P1	In contact with water where low permeability is required.	
C Corrosion protection of reinforcement	Not applicable	C0	Concrete dry or protected from moisture	
	Moderate	C1	Concrete exposed to moisture but not to external sources of chlorides	
	Severe	C2	Concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources	

* Percent sulfate by mass in soil determined by ASTM C1580
** Concentration of dissolved sulfates in water in ppm determined by ASTM D516 or ASTM D4130

The test results of the sample indicate sulfate content is 0.033% by weight (330 mg/kg). In accordance with the criteria presented in the above table, the soil is categorized as Not Applicable, and is within the S0 sulfate exposure class.

Considering a ‘Not Applicable’ sulfate exposure, there is no requirement for cement type or water-cement ratio; however, a minimum concrete compressive strength of 2,500 pounds per square inch (psi) is specified by the building code. For this sulfate range, we recommend Type II cement and a concrete mix design for foundations that incorporates a maximum water cement ration of 0.50 and a minimum compressive strength of 3,000 psi. It should be noted, however, that the structural engineering design requirements for concrete may result in more stringent concrete specifications.

4.0 CONSTRUCTION MONITORING

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to:

1. Review the final grading and foundation plans and specifications prior to construction to evaluate whether our recommendations have been implemented, and to provide additional or modified recommendations, as needed. This also allows us to check if any changes have occurred in the nature, design or location of the proposed improvements and provides the opportunity to prepare a written response with updated recommendations.

2. Perform construction monitoring to check the validity of the assumptions we made to prepare this report. Earthwork operations should be performed under the observation of our representative to check that the site is properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fills has been performed in accordance with our recommendations and the project specifications. Sufficient notification to us prior to earthwork is important.

If we are not retained to perform the services described above, then we are not responsible for any party’s interpretation of our report (and subsequent addenda, letters, and verbal discussions.

5.0 EARTHWORK RECOMMENDATIONS

All grading and site development plans should be coordinated with the Geotechnical Engineer so that appropriate geotechnical guidance can be incorporated into project design. The Geotechnical Engineer should review the final grading plans for the project site before submittal to the appropriate authority.

ENGEO should be notified at least 48 hours prior to grading in order to coordinate our schedule with the grading contractor. Grading operations should meet the requirements of the Supplemental Recommendations in Appendix E.

5.1 GENERAL SITE CLEARING/DEMOLITION

After demolition of the existing library structure, paving, and associated improvements, the development portion of the site should be cleared of all obstructions, including existing foundations, and debris. As shown on the civil plan, storm drain system existed within the parking areas. Any existing underground utilities within the proposed development area should be identified and removed entirely including pipes and their backfill. Depressions resulting from the removal of underground obstructions extending below the proposed finish grades should be cleared and backfilled with suitable material compacted to the recommendations presented in Fill Compaction section.

Areas containing surface vegetation or organic laden topsoil within the areas to be improved should be stripped to an appropriate depth to remove these materials. Tree roots should be removed to a depth of at least 3 feet below finished grade in cut areas and 3 feet below original grade in fill areas. The amount of actual stripping and tree root removal should be determined in the field by the Geotechnical Engineer at the time of construction. Subject to approval by the Landscape Architect, strippings and organically contaminated soils can be used in landscape areas. Otherwise, such soils should be removed from the project site. Any topsoil that will be retained for future use in landscape areas should be stockpiled in areas where it will not interfere with grading operations.

Stripping and demolition below design grades should be cleaned to a firm undisturbed soil surface determined by the Geotechnical Engineer. This surface should then be cleaned, scarified, moisture conditioned, and backfilled with suitable material compacted to the recommendations presented in Fill Compaction section. No loose or uncontrolled backfilling of depressions resulting from demolition and stripping should be permitted.

5.2 EXISTING FILL REMOVAL

As discussed in the previous section, fill materials were encountered at the site and range from 2½ to 5½ feet thick. The exploration logs in Appendix A display fill thickness at specific locations. Since the compaction data of these fills are unknown, fill removal should be anticipated. The extent and quality of existing fills should be evaluated at the time of site grading activities.

Remove all existing fill to competent native soil, as evaluated by ENGEO and replaced with engineered fill. The removed fill can be used as compacted fill to raise the grade throughout the site given recommendations in Fill Compaction section are implemented.

5.3 ACCEPTABLE FILL

With the exception of organically contaminated soil containing more than 2 percent organics, the site soils are suitable for use as engineered fill. The Geotechnical Engineer should be informed when imported materials are planned for the site. Imported fill materials should conform to Supplemental Recommendations in Appendix E. Allow ENGEO to sample and test proposed imported fill materials at least 5 days prior to delivery to the site.

5.4 FILL COMPACTION

5.4.1 General Grading

During fill placement, scarify the surface at least 12 inches, moisture condition, and compact in accordance with the recommendations presented below. Fills should be placed in thin lifts, with the lift thickness not to exceed 10 inches or the depth of penetration of the compaction equipment used, whichever is less.

The following compaction control requirements should be applied to general fill areas with a Plasticity Index (PI) of greater than 12:

Test Procedures:	ASTM D-1557.
Required Moisture Content:	Not less than 5 percentage points above optimum moisture content for upper 5 feet of finished grade. Not less than 4 percentage points above optimum moisture content below 5 feet of finished grade.
Minimum Relative Compaction:	Between 87 to 92 percent for upper 5 feet of finished grade. Not less than 90 percent below 5 feet of finished grade.

The following compaction control requirements should be applied to non- to low-expansive select fill with a Plasticity Index (PI) of less than 12:

Test Procedures:	ASTM D-1557.
Required Moisture Content:	Not less than 2 percentage points above optimum moisture content.
Minimum Relative Compaction:	Not less than 90 percent.

Relative compaction refers to the in-place dry density of soil expressed as a percentage of the maximum dry density of the same material.

5.4.2 Underground Utility Backfill

The contractor is responsible for conducting trenching and shoring in accordance with CALOSHA requirements. Project consultants involved in utility design should specify pipe bedding materials.

Where utility trenches cross perimeter building foundations, backfill with native clay soil for pipe bedding and backfill for a distance of 2 feet on the exterior side of the foundation. This will help prevent the normally granular bedding materials from acting as a conduit for water to enter beneath the building. As an alternative, a sand cement slurry (minimum 28-day compressive strength of 500 psi) may be used in place of native clay soil in both side of the foundation.

Jetting of backfill is not an acceptable means of compaction. We may allow thicker loose lift thicknesses based on acceptable density test results, where increased effort is applied to rocky fill or for the first lift of fill over pipe bedding.

5.5 SLOPES

Final slope can be constructed with a gradient of 2:1 (horizontal:vertical) and up to 6 feet high. The contractor is responsible to construct temporary construction slopes in accordance with CALOSHA requirements.

5.6 SITE DRAINAGE

5.6.1 Surface Drainage

The project Civil Engineer is responsible for designing surface drainage improvements. Finish grades should be sloped away from buildings and pavements to the maximum extent practical to reduce the potentially damaging effects of expansive soil. The latest California Building Code specifies minimum slopes of 5 percent at least 10 feet away from foundation. Where lot lines or surface improvements restrict meeting this slope requirement, we recommend that specific drainage requirements be developed. As a minimum, we recommend the following:

1. Discharge roof downspouts into closed conduits and direct away from foundation to appropriate drainage devices.

2. Consider the use of rear lot surface drainage collection systems to reduce overland surface drainage from back to front of lot.

3. Do not allow water to pond near foundation, pavements, or exterior flatwork.

5.6.2 Subsurface Drainage

Based on our site exploration and current grading concepts for the site, we do not anticipate that subdrainage systems will be necessary. We recommend that we review the site grading plans to further evaluate the need for subdrainage systems as well as observe the earthwork operations during site grading.

5.7 STORMWATER INFILTRATION

Due to the density of the near surface site soils and fines content (percentage passing the No. 200 sieve) generally exceeding 50 percent, the near-surface site soils are expected to have a low to moderate permeability value for stormwater infiltration in grassy swales or permeable pavers, unless subdrains are installed. In addition, the groundwater encountered at the site is at shallow depth that makes stormwater infiltration very difficult. Therefore, Best Management Practices should assume that limited stormwater infiltration will occur at the site.

5.8 STORMWATER BIORETENTION AREAS

Based on the conceptual grading plan provided, several bioretention areas are planned along the periphery of the development. As designs finalize, we recommend that, when practical, bioretention areas be planned a minimum of 5 feet away from structural site improvements, such as buildings, streets, retaining walls, and sidewalks/driveways. When this is not practical, bioretention areas located within 5 feet of structural site improvements can either:

1. Be constructed with structural side walls capable of withstanding the loads from the adjacent improvements, or

2. Incorporate filter material compacted to between 85 and 90 percent relative compaction (ASTM D1557, latest edition) and a waterproofing system designed to reduce the potential for moisture transmission into the subgrade soil beneath the adjacent improvement.

In addition, one of the following options should be followed:

1. We recommend that bioretention design incorporate a waterproofing system lining the bioswale excavation and a subdrain, or other storm drain system, to collect and convey water to an approved outlet. The waterproofing system should cover the bioretention area excavation in such a manner as to reduce the potential for moisture transmission beneath the adjacent improvements.

2. Alternatively, and with some risk of movement of adjacent improvements, if infiltration is desired, we recommend the perimeter of the bioretention areas be lined with an HDPE tree root barrier that extends at least 1 foot below the bottom of the bioretention areas/infiltration trenches.

Site improvements located adjacent to bioretention areas that are underlain by base rock, sand, or other imported granular materials, should be designed with a deepened edge that extends to the bottom of the imported material underlying the improvement.

Where adjacent site improvements include building greater than three stories, streets steeper than 3 percent, or design elements subject to lateral loads (such as from impact or traffic patterns), additional design considerations may be recommended. If the surface of the bioretention area is depressed, the slope gradient should follow the slope guidelines described in earlier section(s) of this document. In addition, although not recommended, if trees are to be planted within bioretention areas, HDPE Tree Boxes that extend below the bottom of the bioretention system should be installed to reduce potential impact to subdrain systems that may be part of the bioretention area design. For this condition, the waterproofing system should be connected to the HPDE Tree Box with a waterproof seal.

Given the nature of bioretention systems and possible proximity to improvements, we recommend ENGEO be retained to review final design plans and provide testing and observation services during the installation of linings, compaction of the filter material, and connection of designed drains.

It should be noted that the contractor is responsible for conducting all excavation and shoring in a manner that does not cause damage to adjacent improvements during construction and future maintenance of the bioretention areas. As with any excavation adjacent to improvements, the contractor should reduce the exposure time such that the improvements are not detrimentally impacted.

5.9 LANDSCAPING CONSIDERATION

As the near-surface soils are moderately to highly expansive, we recommend greatly restricting the amount of surface water infiltration near structures, pavements, flatwork, and slabs-on-grade. This may be accomplished by:

- Selecting landscaping that requires little or no watering, especially within 3 feet of structures, slabs-on-grade, or pavements.
- Using low precipitation sprinkler heads.
- Regulating the amount of water distributed to lawn or planter areas by installing timers on the sprinkler system.

- Providing surface grades to drain rainfall or landscape watering to appropriate collection systems and away from structures, slabs-on-grade, or pavements.
- Preventing water from draining toward or ponding near building foundations, slabs-on-grade, or pavements.
- Avoiding open planting areas within 3 feet of the building perimeter.

We recommend that these items be incorporated into the landscaping plans.

6.0 FOUNDATION RECOMMENDATIONS

We developed the following foundation recommendations using data obtained from our field exploration, laboratory test results, and engineering analysis.

6.1 POST-TENSIONED MATS

The proposed single-family structures can be supported on post-tensioned mat foundations. We recommend that the post-tensioned mats be at least 10 inches thick.

Design post-tensioned mats for an average allowable bearing pressure of 1,000 pounds per square foot (psf) for dead-plus-live loads, with maximum localized bearing pressures of 1,500 psf at column or wall loads. Allowable bearing pressures can be increased by one-third for all loads, including wind or seismic. Design post-tensioned mats using the criteria presented in Table 6.1-1 below.

TABLE 6.1-1: Post-Tensioned Mat Design Criteria

Condition	Center Lift	Edge Lift
Edge Moisture Variation Distance, e_m (feet)	8.0	4.1
Differential Soil Movement, y_m (inches)	1.2	1.9

The above design criteria are based on the procedure presented by the Post-Tensioning Institute "Design of Post-Tensioned Slabs-on-Ground" Third Edition, including appropriate addenda (2004).

6.1.1 Settlement

Provided our report recommendations are followed and given the proposed construction (Section 1.3), we estimate total and differential foundation settlements to be less than approximately 2.5 and 1.25 inches over 40 feet, respectively. These values consider the liquefaction-induced settlement and the consolidation settlement due to the loads from additional fill and buildings as discussed in the Liquefaction and Compressible Soil sections.

7.0 SLABS-ON-GRADE

7.1 INTERIOR CONCRETE FLOOR SLABS

7.1.1 Slab Moisture Vapor Reduction

When building is constructed with concrete slab-on-grade, water vapor from beneath the slab will migrate through the slab and into the building. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. When water vapor migrating through the slab would be undesirable, we recommend the following to reduce, but not stop, water vapor transmission upward through the concrete mat.

1. Construct a moisture retarder system directly beneath the mat that consists of the following:
   a. Vapor retarder membrane sealed at all seams and pipe penetrations and connected to all footings. Vapor retarders shall conform to Class A vapor retarder in accordance with ASTM E1745, latest edition, “Standard Specification for Plastic Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs”.

2. Use a concrete water-cement ratio for slabs-on-grade of no more than 0.50.

3. Provide inspection and testing during concrete placement to check that the proper concrete and water cement ratio are used.

4. Moist cure slabs for a minimum of 3 days or use other equivalent curing specified by the structural engineer.

The subgrade material under mat foundations should be uniform. The pad subgrade should be moisture conditioned to a moisture content of at least 5 percentage points above optimum. The subgrade should not be allowed to dry prior to concrete placement.

7.2 EXTERIOR FLATWORK

Secondary slabs-on-grade should be constructed structurally independent of the foundation system. This allows slab movement to occur with a minimum of foundation distress. Where secondary slab-on-grade construction is anticipated, care must be exercised in attaining a near-saturation condition of the subgrade soil before concrete placement.

Exterior flatwork includes items such as concrete sidewalks, steps, and outdoor courtyards exposed to foot traffic only. Provide a minimum concrete flatwork thickness of 4 inches over 4 inches of aggregate base. Construct control and construction joints in accordance with current Portland Cement Association Guidelines.

Secondary slabs-on-grade should be designed specifically for their intended use and loading requirements. Cracking of conventional slabs should be expected as a result of concrete shrinkage and the expansive soils at the site. Slabs-on-grade should be reinforced for control of cracking, and frequent control joints should be provided to control the cracking. Such reinforcement should be designed by the Structural Engineer. In our experience, welded wire mesh may not be sufficient to control slab cracking. As a minimum, secondary slabs-on-grade should be reinforced with No. 4 bars spaced 16 inches on center each way.

8.0 RETAINING WALLS

8.1 LATERAL SOIL PRESSURES

Unrestrained, drained retaining walls can be designed to resist an active pressure of 50 pounds per cubic foot (pcf) for a level backfill. Walls restrained from movement at the top, such as basement walls, should be designed to resist an at-rest pressure of 80 pcf for level backfill. Retaining walls greater than 6 feet in height should be included seismic consideration. For seismic consideration, dynamic increment of 20 pcf should be added to the lateral pressure for both restrained and unrestrained walls. Passive pressures acting on foundations may be assumed as 250 pounds per cubic foot (pcf) provided that the area in front of the retaining wall is level for a distance of at least 10 feet or three times the depth of foundation, whichever is greater. The upper one foot of soil should be ignored in passive resistance calculations.

The friction factor for sliding resistance may be assumed as 0.30. It is recommended that retaining wall footings be at least 12 inches wide and founded a minimum of 24 inches below the lowest adjacent finished grade. The footings may be designed using an allowable bearing pressure of 2,000 pounds per square foot (psf) in engineered fill. Appropriate safety factors against overturning and sliding should be incorporated into the design calculations.

In addition, design retaining walls to resist an additional uniform pressure equivalent to one-half of any surcharge loads applied at the top of the wall.

The above lateral earth pressures assume sufficient drainage behind the walls to prevent any build-up of hydrostatic pressures from surface water infiltration. If adequate drainage is not provided and if the groundwater level is located behind the wall, we recommend that an additional equivalent fluid pressure of 40 pcf be added to the values recommended above for both restrained and unrestrained walls. Damp-proofing of the walls should be included in areas where wall moisture would be problematic.

Construct a drainage system, as recommended below, to reduce hydrostatic forces behind the retaining wall.

8.2 RETAINING WALL DRAINAGE

Construct either graded rock drains or geosynthetic drainage composites behind the retaining walls to reduce hydrostatic lateral forces. For rock drain construction, we recommend two types of rock drain alternatives:

1. A minimum 12-inch-thick layer of Class 2 permeable material (Caltrans Specification 68-2.02F) placed directly behind the wall, or

2. A minimum 12-inch-thick layer of washed, crushed rock with 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Envelop rock in a minimum 6-ounce, nonwoven geotextile filter fabric.

For both types of rock drains:

1. Place the rock drain directly behind the walls of the structure.

2. Extend rock drains from the wall base to within 12 inches of the top of the wall.

3. Place a minimum of 4-inch-diameter perforated pipe (glued joints and end caps) at the base of the wall, inside the rock drain and fabric, with perforations placed down.

4. Place pipe at a gradient at least 1 percent to direct water away from the wall by gravity to a drainage facility.

5. Place onsite compacted clayey soil in the upper 12 inches of the top of the wall.

ENGEO should review and approve geosynthetic composite drainage systems prior to use.

8.3 BACKFILL

Backfill behind retaining walls should be placed and compacted in accordance with Fill Compaction section. Use light compaction equipment within 5 feet of the wall face. If heavy compaction equipment is used, the walls should be temporarily braced to avoid excessive wall movement.

9.0 PRELIMINARY PAVEMENT DESIGN

9.1 FLEXIBLE PAVEMENTS

Based on the site soil conditions, a Resistance-value (R-value) of 5 was estimated for the near-surface clayey soil. Using estimated Traffic Indices for various pavement loading requirements, we developed the following preliminary pavement sections using Topic 633 of the Caltrans Highway Design Manual, presented in Table 9.1-1 below.

TABLE 9.1-1: Recommended Hot Mix Asphalt Concrete Pavement Sections

TRAFFIC INDEX	SECTION	
	HOT MIX ASPHALT CONCRETE (INCHES)	CLASS 2 AGGREGATE BASE (INCHES)
5	3	10
5.5	3	12
6	3½	13

The civil engineer should determine the appropriate Traffic Indices for the streets and drives of the subdivision. These sections are for estimating purposes only. Actual sections to be used should be based on the results of R-value tests performed on samples of actual subgrade materials recovered at the time of grading.

Pavement materials and construction should comply with the specifications and requirements of the Standard Specifications by Caltrans, City of Pleasant Hill, and the following minimum requirements.

- All pavement subgrades should be scarified to a minimum depth of 12 inches below finished subgrade elevation, moisture conditioned to 3 percentage points above optimum, and compacted to at least 90 percent relative compaction and in accordance with City requirement. Subgrade soil should be in a stable, non-pumping condition at the time aggregate base materials are placed and compacted.

- Adequate provisions must be made such that the subgrades soil and aggregate base materials are not allowed to become saturated.

- Asphalt paving materials should meet current Caltrans specifications for hot mix asphalt.

- All concrete curbs separating pavement and irrigated landscaped areas should extend into the subgrade and below the bottom of adjacent aggregate baserock materials.

9.2 SUBGRADE AND AGGREGATE BASE COMPACTION

Compact finish subgrade and aggregate base in accordance with recommendations stated in previous sections. Aggregate base should meet the requirements for Class 2 aggregate base in accordance with Section 26-1.02B of the latest Caltrans Standard Specifications.

9.3 CUT-OFF CURBS

Saturated pavement subgrade or aggregate base can cause premature failure or increased maintenance of asphalt concrete pavements. This condition often occurs where landscape areas directly abut and drain toward pavements. If desired to install pavement cutoff barriers, they should be considered where pavement areas lie downslope of any landscape areas that are to be sprinklered or irrigated, and should extend to a depth of at least 4 inches below the base rock layer. Cutoff barriers may consist of deepened concrete curbs or deep-root moisture barriers.

If reduced pavement life and greater than normal pavement maintenance are acceptable to the owner, then the cutoff barrier may be eliminated.

10.0 GROUND HEAT EXCHANGE

Based on our findings and review of the proposed development, we consider the site to be *highly* suitable for using a Ground Heat-Exchange (GHX) system to achieve energy savings and to potentially eliminate the need for outdoor air conditioner units, if desired. For the thermal properties of the soil and groundwater conditions at the site, a closed-loop GHX system would likely be well suited and could be implemented on select buildings, or integrated into a project-wide system.

As project planning progresses into architectural design, we can meet with you, your architect, and your MEP designer to further assess and develop GHX energy saving opportunities and efficiencies.

11.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical recommendations for design and construction of the improvements discussed in Section 1.3 for the new townhome development project located in Pleasant Hill, California. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the owner to transmit the information and recommendations of this report to the appropriate organizations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers. The conclusions and recommendations contained in this report are solely professional opinions and are valid for a period of no more than 2 years from the date of report issuance.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in building on or with earth materials. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of report preparation. We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data is representative of the actual subsurface conditions across the site. Considering possible underground variability of soil, rock, stockpiled material, and groundwater, additional costs may be required to complete the project. We recommend that the owner establish a contingency fund to cover such costs. If unexpected conditions are encountered, notify ENGEO immediately to review these conditions and provide additional and/or modified recommendations, as necessary.

Our services did not include excavation sloping or shoring, soil volume change factors, flood potential, or a geohazard exploration. In addition, our geotechnical exploration did not include work to determine the existence of possible hazardous materials. If any hazardous materials are encountered during construction, notify the proper regulatory officials immediately.

This document must not be subject to unauthorized reuse, that is, reusing without written authorization of ENGEO. Such authorization is essential because it requires ENGEO to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to ENGEO's documents. Therefore, ENGEO must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If ENGEO's scope of services does not include on-site construction observation, or if other persons or entities are retained to provide such services, ENGEO cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

We determined the lines designating the interface between layers on the exploration logs using visual observations. The transition between the materials may be abrupt or gradual. The exploration logs contain information concerning samples recovered, indications of the presence of various materials such as clay, sand, silt, rock, existing fill, etc., and observations of groundwater encountered. The field logs also contain our interpretation of the subsurface conditions between sample locations. Therefore, the logs contain both factual and interpretative information. Our recommendations are based on the contents of the final logs, which represent our interpretation of the field logs.

SELECTED REFERENCES

Bray, J. D., & Sancio, R. B. (2006). Assessment of the liquefaction susceptibility of fine-grained soils. *Journal of geotechnical and geoenvironmental engineering, 132(9), 1165-1177.*

Bryant, W. and Hart, E., 2007, Special Publication 42, "Fault-Rupture Hazard Zones in California", Interim Revision 2007, California Department of Conservation.

California Building Code, 2016.

California Geologic Survey, 2008, Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

Dibblee, T.W., Jr., 2005, Preliminary Geologic Map of the Richmond Quadrangle, Contra Costa & Alameda Counties, California, U.S. Geological Survey Open-File Report OF-80-1100.

Division of Mines and Geology, 1997, Special Publication 117, Guidelines for Evaluation and Mitigating Seismic Hazards in California, Adopted March 13.

Field, E. H., Arrowsmith, R. J., Biasi, G. P., Bird, P., Dawson, T. E., Felzer, K. R., & Michael, A. J., 2014, Uniform California earthquake rupture forecast, version 3 (UCERF3) The time-independent model. *Bulletin of the Seismological Society of America, 104(3)*, 1122-1180.

FEMA Flood Insurance Map, 2009, (https://msc.fema.gov/portal)

Helley, E.J., and Graymer, R.W., 1997, Quaternary geology of Alameda County and parts of Contra Costa, Santa Clara, San Mateo, San Francisco, Stanislaus, and San Joaquin Counties, California: U.S. Geological Survey, Open-File Report OF-97-97, scale 1:100,000.

Idriss I.I. and Boulanger R.W.; Soil Liquefaction During Earthquakes, 2008, Earthquake Engineering Research Institute.

Idriss, I. M., & Boulanger, R. W., 2014, CPT and SPT based liquefaction triggering procedures. *Centre for Geotechnical Modelling.*

Priestley, M. J. N., Kowalsky, M. J., Ranzo, G., & Benzoni, G., 1996, October, Preliminary development of direct displacement-based design for multi-degree of freedom systems. *In Proceedings of 65th Annual SEAOC Convention, Maui, Hawaii, USA, SEAOC.*

Robertson, P. K., & Campanella, R. G., 1988, *Guidelines for geotechnical design using CPT and CPTU data*. Civil Engineering Department, University of British Columbia.

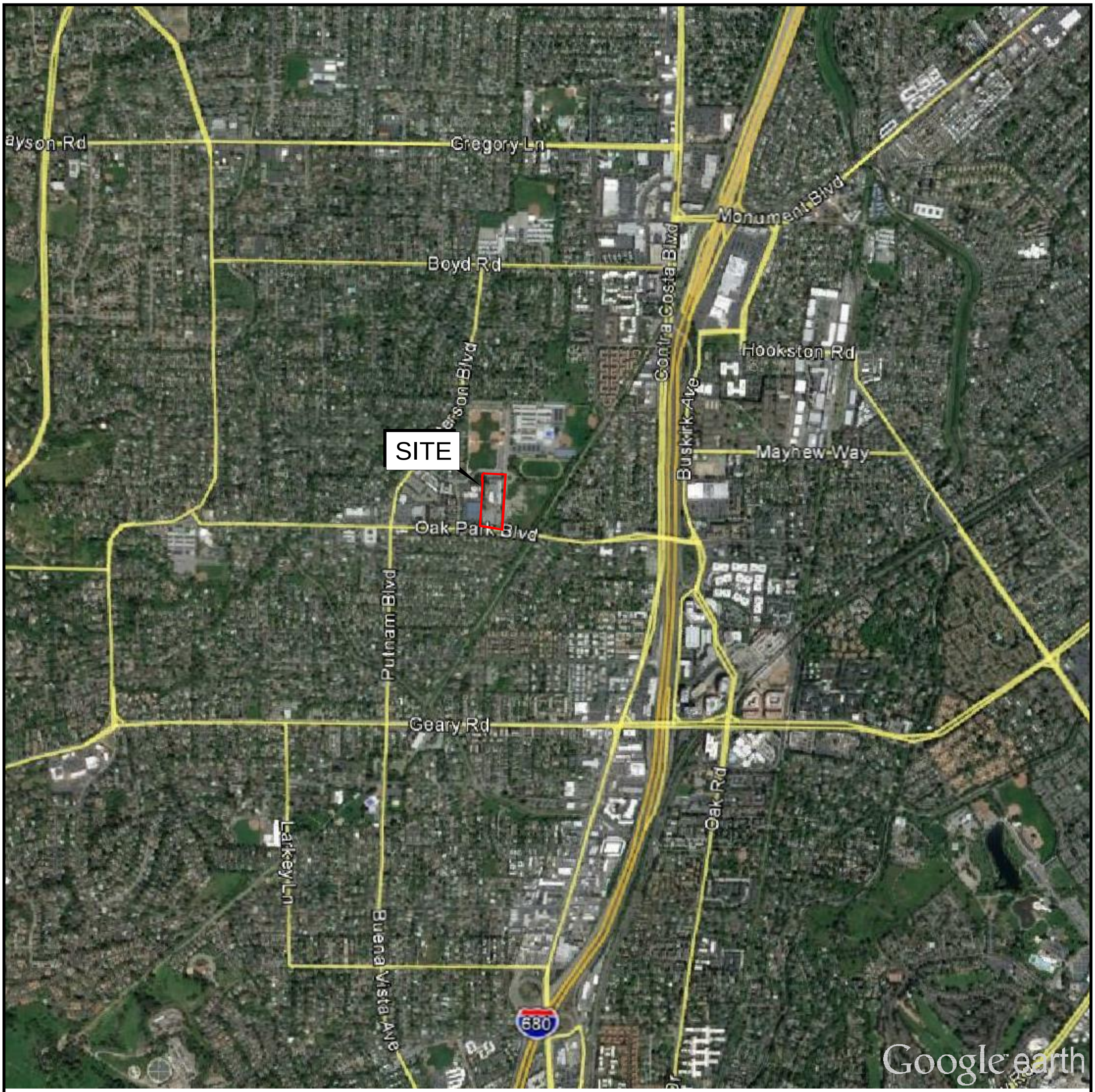
SEAOC, 1996, Recommended Lateral Force Requirements and Tentative Commentary. Structural Engineers Association of California.

Teledyne, Inc. and UC Berkeley; Whittier College. 1939 Aerial Photograph. Flight C-5750, Frame 3965.

U.S. Geological Survey. 1946 Aerial Photograph. Flight GS_CP, Frame 4-29.

Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S, K., and Gans, K.D., 2006, Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay region, California: U.S. Geological Survey, Open-File Report OF-2006-1037, scale 1:200,000.

FIGURES



BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICES

ENGEO Expect Excellence	VICINITY MAP 1750 OAK PARK BOULEVARD PLEASANT HILL, CALIFORNIA	PROJECT NO.: 7843.001.001 SCALE: AS SHOWN DRAWN BY: JF / CHECKED BY: BH	FIGURE NO. 1

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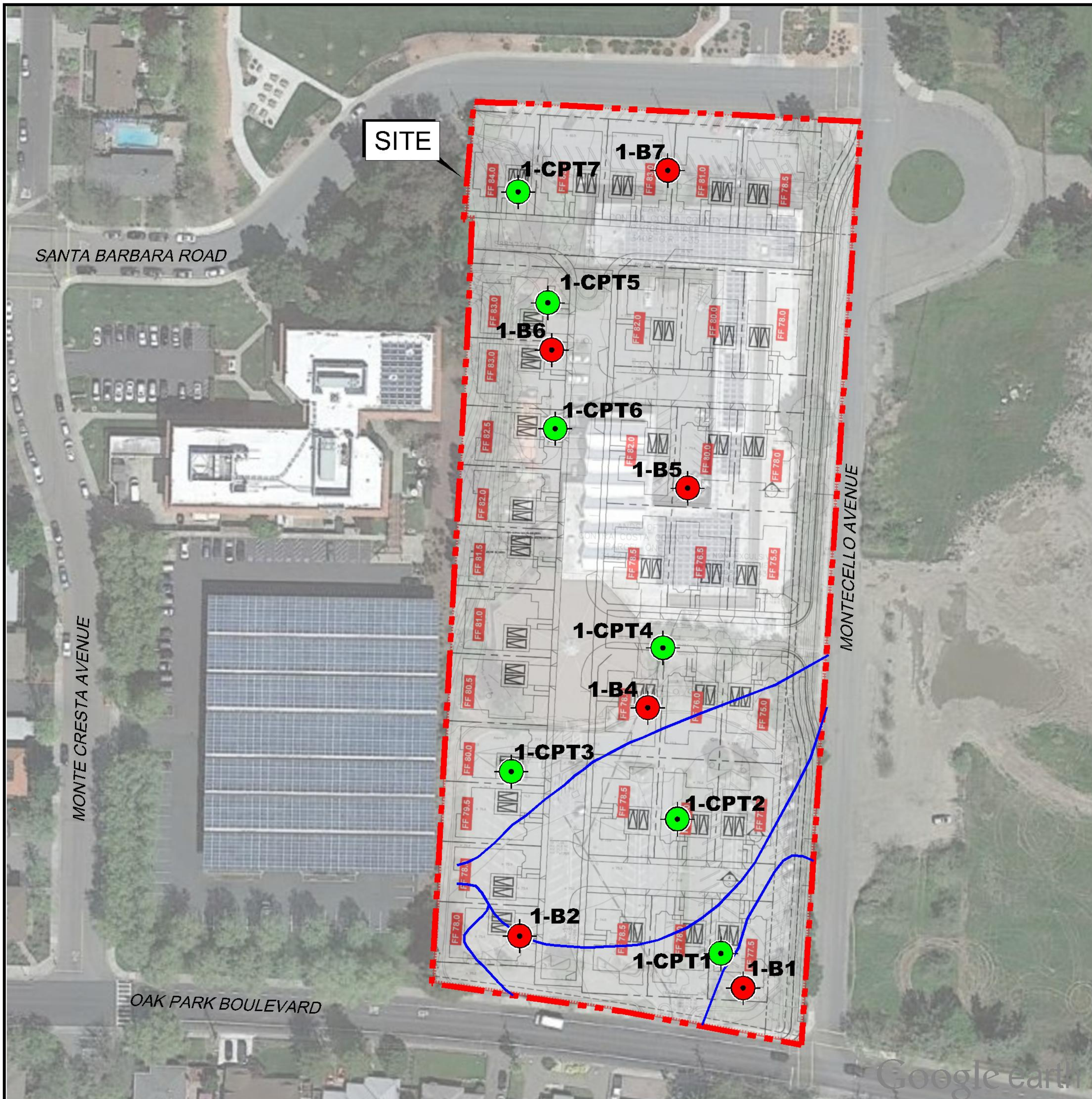
ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

ALL LOCATIONS ARE APPROXIMATE

1-B8 BORING (ENGEO, 2018)

1-CPT7 CONE PENETRATION TEST (ENGEO, 2018)

APPROXIMATE PATHS OF HISTORIC CHANNELS

BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICES AND BKF

ENGEO — Expect Excellence

SITE PLAN
1750 OAK PARK BOULEVARD
PLEASANT HILL, CALIFORNIA

PROJECT NO.: 7843.001.001		FIGURE NO. 2
SCALE: AS SHOWN		
DRAWN BY: JF	CHECKED BY: BH	

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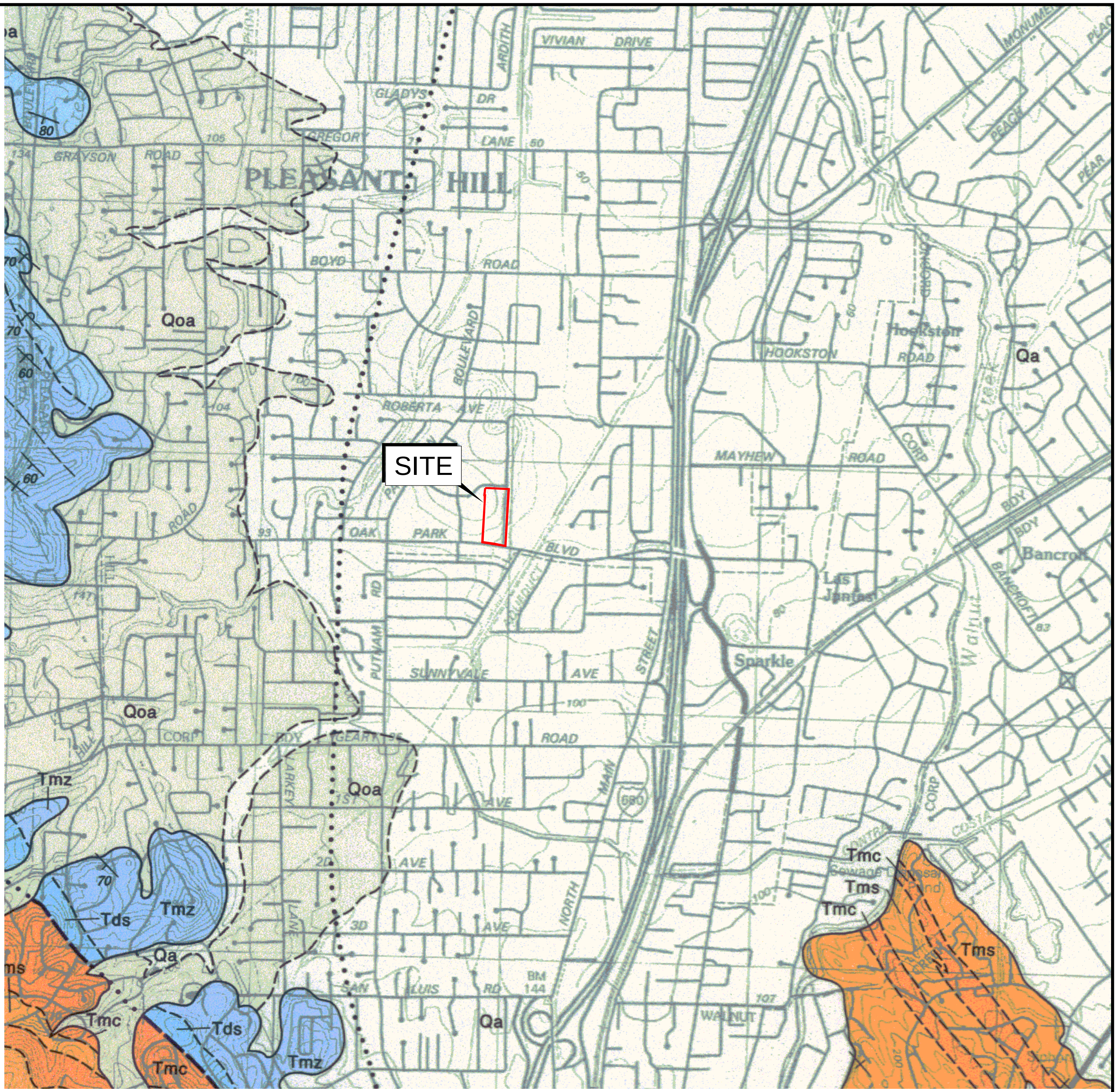
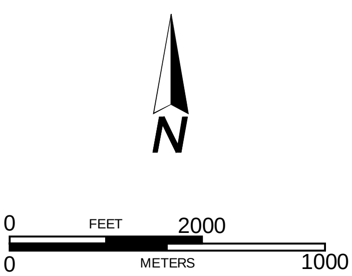
ORIGINAL FIGURE PRINTED IN COLOR





EXPLANATION

(geologic contact line)	GEOLOGIC CONTACT-DASHED WHERE GRADATIONAL OR APPROXIMATELY LOCATED
(fault line)	FAULT-DASHED WHERE INFERRED, DOTTED WHERE CONCEALED

Qa	ALLUVIUM
Qoa	ALLUVIUM
Tms	SANDSTONE
Tmc	CLAY SHALE
Tds	SANDSTONE
Tmz	CLAY SHALE

BASE MAP SOURCE: DIBBLEE, 2005

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REGIONAL GEOLOGIC MAP

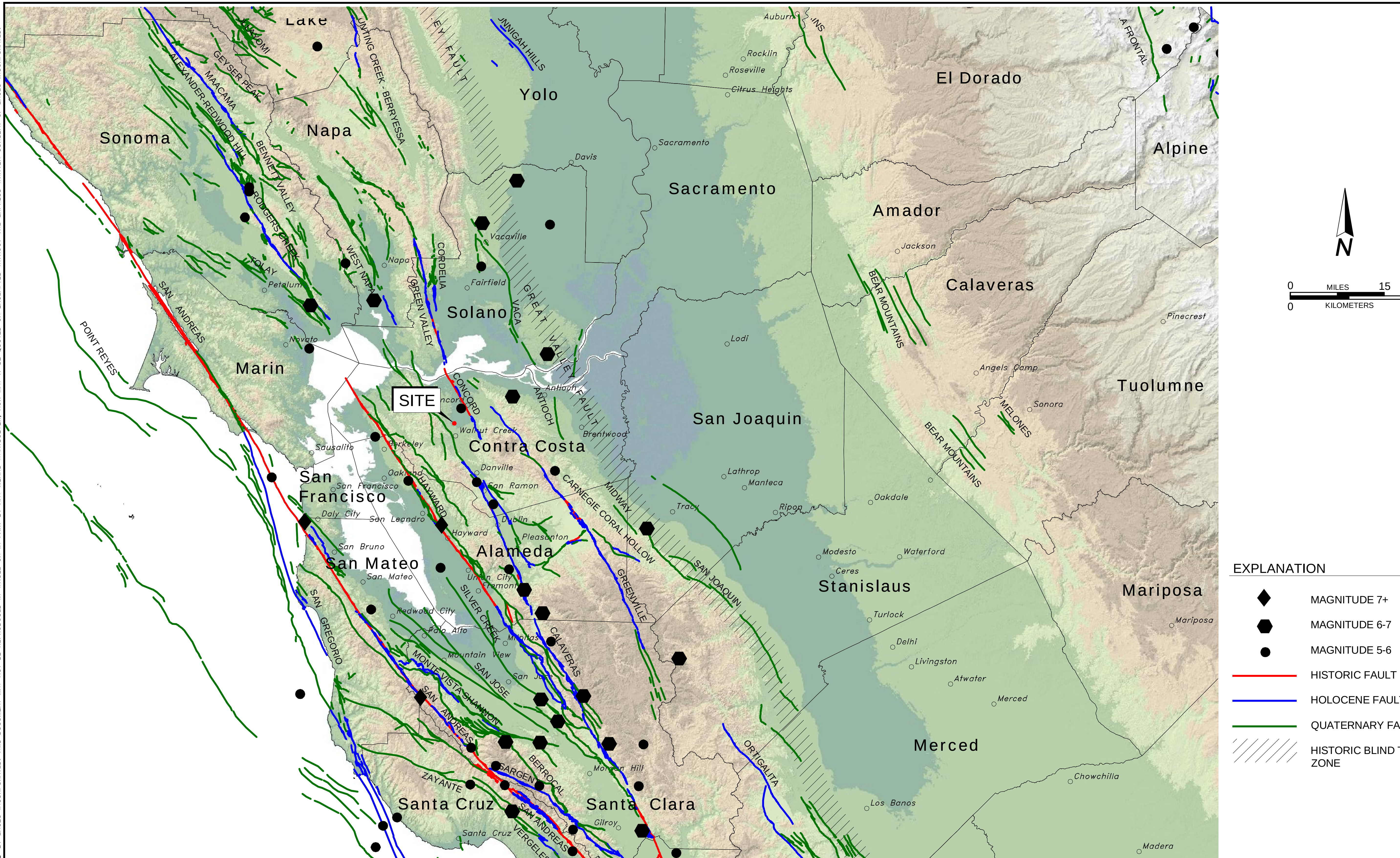
1750 OAK PARK BOULEVARD

PLEASANT HILL, CALIFORNIA

PROJECT NO.: 7843.001.001	FIGURE NO. 3
SCALE: AS SHOWN	
DRAWN BY: JF	CHECKED BY: BH

G:\Drafting\DRAFTING2_Dwg\7843\001\GEX-0818\07843001000-GEX-3-REOGEO-0818.dwg Plot Date: 8-31-18 jfaylor

ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

- MAGNITUDE 7+
- MAGNITUDE 6-7
- MAGNITUDE 5-6
- HISTORIC FAULT
- HOLOCENE FAULT
- QUATERNARY FAULT
- HISTORIC BLIND THRUST FAULT ZONE

BASE MAP SOURCE:
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATASET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, NOVEMBER, 2010
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800–2000)

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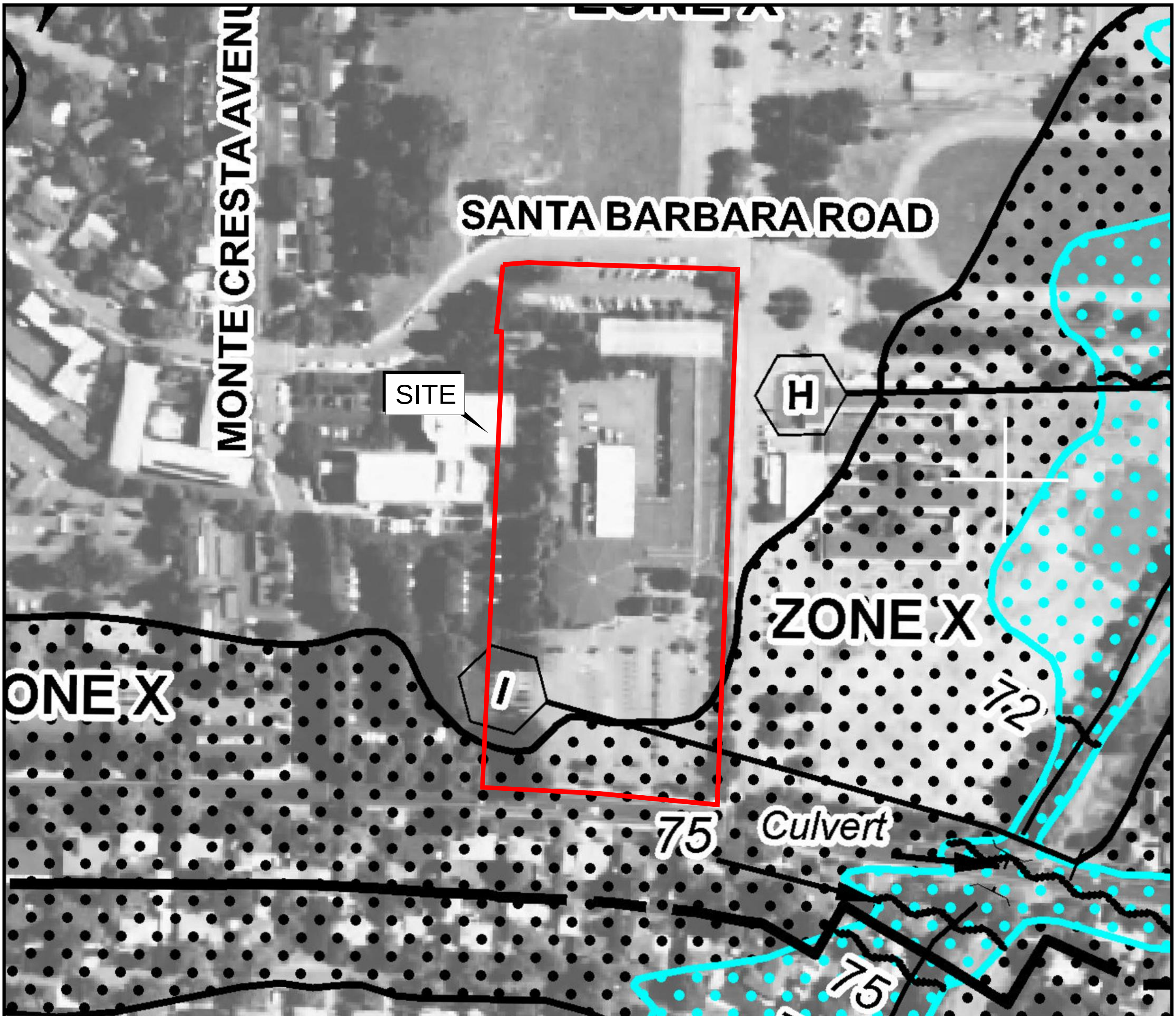
REGIONAL FAULTING AND SEISMICITY
1750 OAK PARK BOULEVARD
PLEASANT HILL, CALIFORNIA

PROJECT NO.: 7843.001.001	FIGURE NO. 4
SCALE: AS SHOWN	
DRAWN BY: JF	CHECKED BY: BH

ORIGINAL FIGURE PRINTED IN COLOR

G:\Drafting\DRAFTING2_Dwg\7843\001\001-GEX-0818\07843001000-GEX-4-FAULT_SEISMICITY-0818.dwg Plot Date: 8-14-18 jfaylor



EXPLANATION

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR *indicates that the former flood control system is being restored to provide* protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - - 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American *Datum of 1983 (NAD 83), Western Hemisphere*
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 10N
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone III (FIPSZONE 0403), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

N

0 FEET 200

0 METERS 100

BASE MAP SOURCE: CONTRA COSTA COUNTY, 2009

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FEMA FLOOD INSURANCE MAP

1750 OAK PARK BOULEVARD

PLEASANT HILL, CALIFORNIA

PROJECT NO.: 7843.001.001	FIGURE NO. 5
SCALE: AS SHOWN	
DRAWN BY: JF	CHECKED BY: BH

APPENDIX A

BORING LOG KEY
EXPLORATION LOGS

KEY TO BORING LOGS

MAJOR TYPES			DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW - Well graded gravels or gravel-sand mixtures
			GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES	GM - Silty gravels, gravel-sand and silt mixtures
			GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES	SW - Well graded sands, or gravelly sand mixtures
			SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES	SM - Silty sand, sand-silt mixtures
			SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS		ML - Inorganic silt with low to medium plasticity
			CL - Inorganic clay with low to medium plasticity
			OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %		MH - Elastic silt with high plasticity
			CH - Fat clay with high plasticity
			OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS		PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with >30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAINE SIZES

	U.S. STANDARD SERIES SIEVE SIZE				CLEAR SQUARE SIEVE OPENINGS		
	200	40	10	4	3/4 "	3"	12"
SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Dames and Moore Piston
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

LINE TYPES

________	Solid - Layer Break
– – – – – –	Dashed - Gradational or approximate layer break

GROUND-WATER SYMBOLS

- ▽ Groundwater level during drilling
- ▼ Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

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LOG OF BORING 1-B1

ENGEO
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LATITUDE: 37.933773 | LONGITUDE: -122.068366

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 36.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 74 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet scale: 5, 10, 15, 20, 25. Elevation in Feet scale: 70, 65, 60, 55, 50.

DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
PAVEMENT (ASPHALT)										
AGGREGATE BASE (AB), base rock, gravel and sand. [FILL]										
FAT CLAY (CH), dark grayish green mottled with dark gray, very stiff, moist, very high plasticity, fine- to coarse-grained sand, fine gravel, no dilatancy, medium toughness. [FILL]	20	55	15	40	81	23.7	100.1		3.5*	PP
Mottled with pale olive, becomes stiff.	12								1.5*	PP
FAT CLAY (CH), dark grayish green mottled with dark gray, very stiff, moist, very high plasticity, fine- to coarse-grained sand, fine gravel, medium toughness, [NATIVE]										
	50 psi							860		LVS
Dark grayish green, saturated, coarse-grained sand, fine gravel, trace wood and organics. Consolidation test @ 12.75 feet						38.4	82.8			
	6					40.7	80.8	633		UU
Soft, organics, active weathering or granular modules.										
FAT CLAY (CH), dark grayish green, medium stiff, saturated, active weathering or granular modules.										
	12									
Pale olive, increasing fine sand content. (~5%)										

LOG OF BORING 1-B1

ENGEO Expect Excellence

LATITUDE: 37.933773 LONGITUDE: -122.068366

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 36.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 74 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	45		GRAVELLY CLAYEY SAND (SC), pale olive to light olive brown, medium dense, moist, high plasticity, some clay content, subangular to angular sand, some fine to medium gravel.			17	51	16	35	38					
30	40		LEAN CLAY (CL), light yellowish brown mottled with grayish gray, stiff, moist, no dilatancy, medium toughness, medium to high plasticity, 5-8% fine to medium grained sand, active weathering. calcite veins.			12								1.75*	PP
35			SILTY CLAY (CL/ML), light yellowish brown to pale olive, stiff to very stiff, moist, fine- to coarse-grained sand, slow dilatancy, low toughness, low to medium plasticity, weathered granule nodules.			22								1.75* 2.0*	PP PP

End of boring at 36.5 feet, groundwater was not measured due to method of drilling

LOG - GEOTECHNICAL_SU+QU W/ ELEV 7834.001.001 GINT.GPJ ENGEO INC.GDT 8/31/18

ENGEO
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LOG OF BORING 1-B2

LATITUDE: 37.933896 LONGITUDE: -122.069085

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 41.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 75 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			PAVEMENT (ASPHALT) 3"												
			AGGREGATE BASE (AB), [FILL]												
			FAT CLAY (CH), dark gray, stiff to very stiff, moist, high plasticity, fine- to coarse-grained sand, fine gravel, medium toughness, trace organics. [FILL]			16					24.8			1.5* 1.75* 2.0*	PP PP PP
5	70					18								1.5* 1.5*	PP PP
			FAT CLAY (CH), dark gray, medium stiff to stiff, moist, high plasticity, fine- to coarse-grained sand, fine gravel, medium toughness, trace organics, calcium carbonate veins. [NATIVE]												
10	65		Soft, saturated			150 psi					56.5	67.6	880		UU
15	60		Grayish green, medium stiff, gravel, no organics, weathered gravel.			8								0.75*	PP
20	55		SANDY LEAN CLAY (CL), dark brown, very stiff, saturated, fine- to coarse-grained sand, some fines, trace fine to medium rounded gravel.			28	41	15	26	65	19.1				
25	50														

LOG OF BORING 1-B2

ENGEO Expect Excellence

LATITUDE: 37.933896 LONGITUDE: -122.069085

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 41.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 75 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			LEAN CLAY (CL), pale olive, moist, stiff to very stiff, low to medium plasticity, weathered granular nodules, <5% fine- to medium-grained sand.			12								2.5*	PP
30	45		color changes to yellowish brown mottled with grayish green			26	39	20	19		25.8			3.5* 2.5*	PP PP
35	40		becomes mottled with strong brown			28								3.0* 1.5*	PP PP
			becomes softer												
40	35		color changes to pale olive			22									
			End of boring at 41.5 feet, groundwater was not measured due to method of drilling												

LOG - GEOTECHNICAL_SU+QU W/ ELEV 7834.001.001 GINT.GPJ ENGEO INC.GDT 8/31/18

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LOG OF BORING 1-B4

LATITUDE: 37.934354 LONGITUDE: -122.068683

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 34.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 79 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			PAVEMENT (ASPHALT)												
			AGGREGATE BASE (AB), yellowish brown, sandy clay with gravel (CL/GC), 40-50% sand, 20% gravel. [FILL]												
			FAT CLAY WITH SAND (CH), greenish gray, very stiff, slightly moist, medium to high plasticity, 5-10% fine- to medium-grained sand. [FILL]			10					22	102	1880		UC
5	75					16								2.0*	PP
			FAT CLAY (CH), dark gray, stiff, slightly moist, high plasticity, trace fine sand and gravel, trace organics, fissured with white veins (calcium carbonate). [NATIVE]											2.25*	PP
10	70		LEAN CLAY WITH SAND (CL), light yellowish brown to pale olive, very stiff, moist, slow dilatancy, low to medium plasticity, some fine- to coarse-grained sand, trace gravels, weathered gravels, trace organics.			19	41	19	22		28.7	94.4		2.5*	PP
15	65		SANDY LEAN CLAY WITH GRAVEL (CL), pale olive brown, stiff, moist, low to medium plasticity, 25-30% fine to medium gravel (lense of gravel at 15.25'), active weathering of gravels, 10-20% fine- to coarse-grained sand.			22									
20	60		LEAN CLAY WITH SAND AND GRAVEL (CL), pale olive brown to yellowish brown, very stiff to hard, moist, medium plasticity, 10-15% fine- to coarse-grained sand, 5-10% fin to medium weathered gravels.			26					26.6			4.5*	PP
25	55														

LOG OF BORING 1-B4

ENGEO Expect Excellence

LATITUDE: 37.934354 LONGITUDE: -122.068683

Geotechnical Exploration 1750 Oak Park Blvd. Pleasant Hill, CA 07843.001.001	DATE DRILLED: 6/9/2018 HOLE DEPTH: 34.5 ft. HOLE DIAMETER: 4.0 in. SURF ELEV (wgs85): 79 ft.	LOGGED / REVIEWED BY: S. Waganaar / DRILLING CONTRACTOR: Britton Exploration DRILLING METHOD: Mud Rotary HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	50		LEAN CLAY WITH SAND (CL), yellowish brown, very stiff, moist, medium plasticity, some fine- to coarse-grained sand, trace gravels.			19								2.25* 2.5* 2.25*	PP PP PP
30	45		FAT CLAY (CH), pale olive, very stiff, moist, high plasticity			21	51	31	20		31.2			2.0* 2.25*	PP PP
						20								2.5* 2.25*	PP PP
			End of boring at 34.5 feet, groundwater was not measured due to method of drilling												

LOG OF BORING 1-B5

LATITUDE: 37.934872 LONGITUDE: -122.06856

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/24/2018
HOLE DEPTH: 31.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 79 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			PAVEMENT (ASPHALT)												
			BASEROCK [FILL]												
			LEAN CLAY (CL), pale olive, stiff to very stiff, slightly moist, low plasticity, trace fine- to coarse-grained sand. [FILL]											3.0*	PP
						22	43	16	27	75					
	75														
5			LEAN CLAY (CL), pale olive, stiff to very stiff, slightly moist, low plasticity, trace fine- to coarse-grained sand. [NATIVE]			21								2.75*	PP
			seams of white cementation, material becomes more plastic												
			becomes more sandy												
	70														
10			SILTY SAND (SM), pale olive yellow, medium dense, moist to wet, low plasticity, fine-grained sand, some fines content.			21				20	23.9				
						23									
	65														
15			Grades to coarser sand.												
			Trace gravels.			22									
	60		LEAN CLAY (CL), grayish green, very stiff, wet, medium plasticity, <5% fine- to coarse-grained sand and gravel, maximum gravel size of 1.25".												
20						24					31.1			3.0*	PP
														2.75*	PP
	55														
25														3.0*	PP

LOG OF BORING 1-B5

ENGEO
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LATITUDE: 37.934872 LONGITUDE: -122.06856

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/24/2018
HOLE DEPTH: 31.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 79 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	50		SILTY CLAY (CL/ML), grayish green, stiff to very stiff, moist, low plasticity, slow dilatancy, trace fine- to coarse-grained sand and gravel, active weathering of gravel, trace organics.			27								2.0*	PP
30			SILT WITH SAND (ML), grayish green, medium dense, saturated, rapid dilatancy, low to no plasticity, 10-20% fine sand.			32					25.7				
			End of boring at 31.5 feet, groundwater was not measured due to method of drilling												

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LOG OF BORING 1-B6

LATITUDE: 37.935171 LONGITUDE: -122.06901

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 39.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 79 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			PAVEMENT (ASPHALT) 3"												
			BASEROCK [FILL]												
			SANDY SILT (ML), light olive brown to olive, stiff, slightly moist, low to no plasticity, 10-20% fine-grained sand. [FILL]			21					24.9	98		2.0*	PP
5	75		CLAYEY SAND (SM), light olive brown to olive, medium dense, moist, fine- to medium-grained sand, 5-10% fines content, trace coarse sand and fine gravel, lenses of low fines sand. [NATIVE] Becomes sandier, grades to fine- to medium-grained sand.			22									
	70		SILTY SAND (CL), light olive brown, medium dense, moist, medium plasticity, some fines.												
10			lense of clayey sand			28				27	19.2			3.0*	PP
														3.25*	PP
15	65		CLAYEY SAND (SC), pale olive, medium dense, very moist, fine-grained sand, 10-20% fines content, trace fine gravels.			51									
	60		POORLY GRADED SAND WITH CLAY AND GRAVEL (SP), yellowish brown to pale olive, very dense, wet, fine- to coarse-grained sand, 5-10% fines, 5-10% fine to medium gravel.			45									
20			CLAYEY SAND (SC), pale olive, medium dense, wet, fine- to medium-grained sand, some fines content, lenses of poorly graded gravel.			33				18	20.1				
25	55														

LOG OF BORING 1-B6

ENGEO Expect Excellence

LATITUDE: 37.935171 LONGITUDE: -122.06901

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/9/2018
HOLE DEPTH: 39.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 79 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			LEAN CLAY (CH), grayish green, very stiff, moist, high plasticity, trace fine sand and fine to medium gravel, cemented seams.			21	57	22	35		29.2			3.0* 2.75*	PP PP
	50														
30			Becomes softer.												
			becoming more silty			30								1.75* 1.5* 3.0*	PP PP PP
	45														
35															
			becoming more plastic			27								2.75* 2.75*	PP PP
	40		Trace organics. Lense of silty material.			30									
			End of boring at 39.5 feet, groundwater was not measured due to method of drilling												

LOG OF BORING 1-B7

ENGEO
Expect Excellence

LATITUDE: 37.935569 LONGITUDE: -122.068638

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/24/2018
HOLE DEPTH: 34.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 80 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		PAVEMENT (ASPHALT) 3"										
		BASEROCK (AB), [FILL]										
		CLAYEY SAND (SC), pale olive mottled with yellowish red, dense, slightly moist, fine- to coarse-grained sand, trace roots, oxidized seams. [FILL]	27	44	20	24						
5	75	CLAYEY SAND (SC), pale olive, medium dense, slightly moist, low plasticity, fine- to medium-grained sand, some fines. [NATIVE]	23				48	24.5				
		Becomes more plastic and moist. CLAYEY SAND (SC), olive, loose to medium dense, moist, fine- to medium-grained sand, 10-15% fines, clay is low-medium plasticity.	19	35	14	21						
10	70											
		LEAN CLAY (CL), grayish green, stiff to very stiff, moist, fine- to coarse-grained sand, low to medium plasticity, trace rounded fine gravel.	24								2.0* 2.0*	PP PP
15	65											
		Becomes softer and sand content increases. increasing sand content	37					31.9			1.75*	PP
		trace fine sand										
20	60											
		ELASTIC SILT (ML), grayish green, stiff to very stiff, moist, trace fine grained sand.	26								1.5* 2.0*	PP PP
25	55											

ENGEO
Expect Excellence

LOG OF BORING 1-B7

LATITUDE: 37.935569 LONGITUDE: -122.068638

Geotechnical Exploration
1750 Oak Park Blvd.
Pleasant Hill, CA
07843.001.001

DATE DRILLED: 6/24/2018
HOLE DEPTH: 34.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs85): 80 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

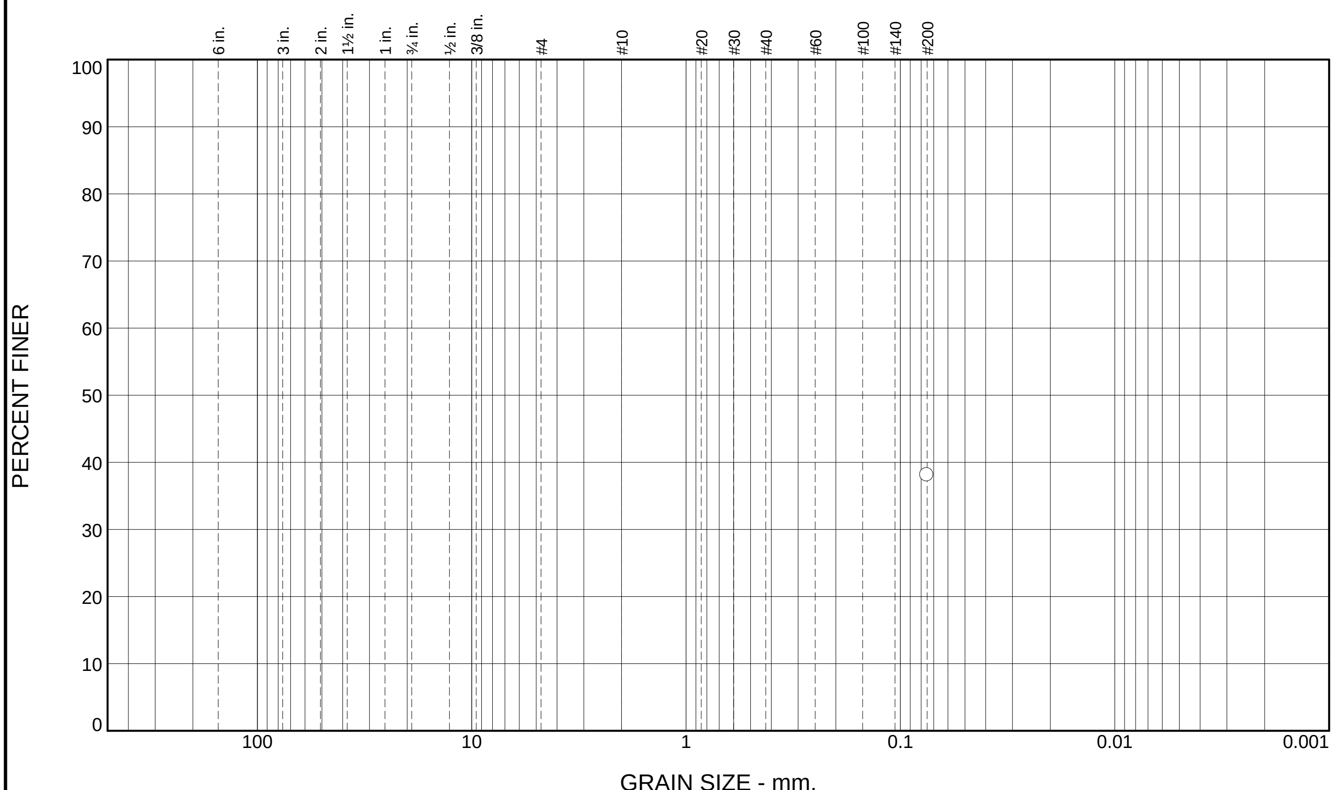
Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			Slow dilatancy			17	41	25	16		30.7			1.25*	PP
														1.5*	PP
30	50		5-15% fine- to coarse-grained sand.			29								3.0*	PP
														3.5*	PP
						24					30.4			3.5*	PP
														3.5*	PP
			End of boring at 34.5 feet, groundwater was not measured due to method of drilling												

APPENDIX B

LABORATORY TEST DATA

Particle Size Distribution Report
Liquid and Plastic Limits Test Report
Incremental Consolidation
Unconfined Compression Test
Laboratory Vane Shear
Unconsolidated Undrained Triaxial
Soil Corrosivity

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						38.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	38.1		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Sample size: 181.6g; Soak time: 16hrs

Sample Number: 1-B01 @ 25 **Depth:** 25.0 feet

Date: 08/10/18

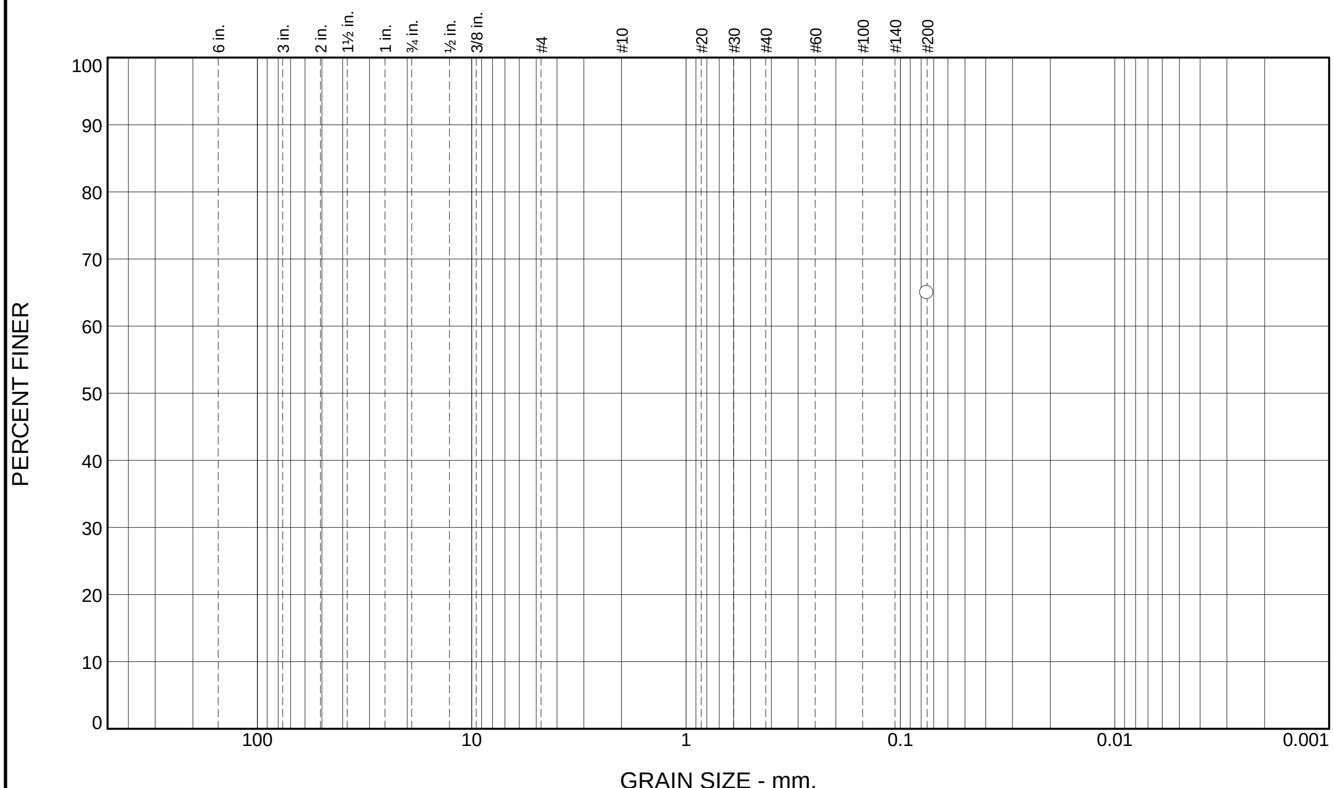
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						64.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	64.9		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

GS: ASTM D1140, Method B
Sample size: 347.2g; Soak time: 16hrs
PI: ASTM D4318, Wet method

Sample Number: 1-B02 @ 21 **Depth:** 21.0 feet

Date: 08/10/18

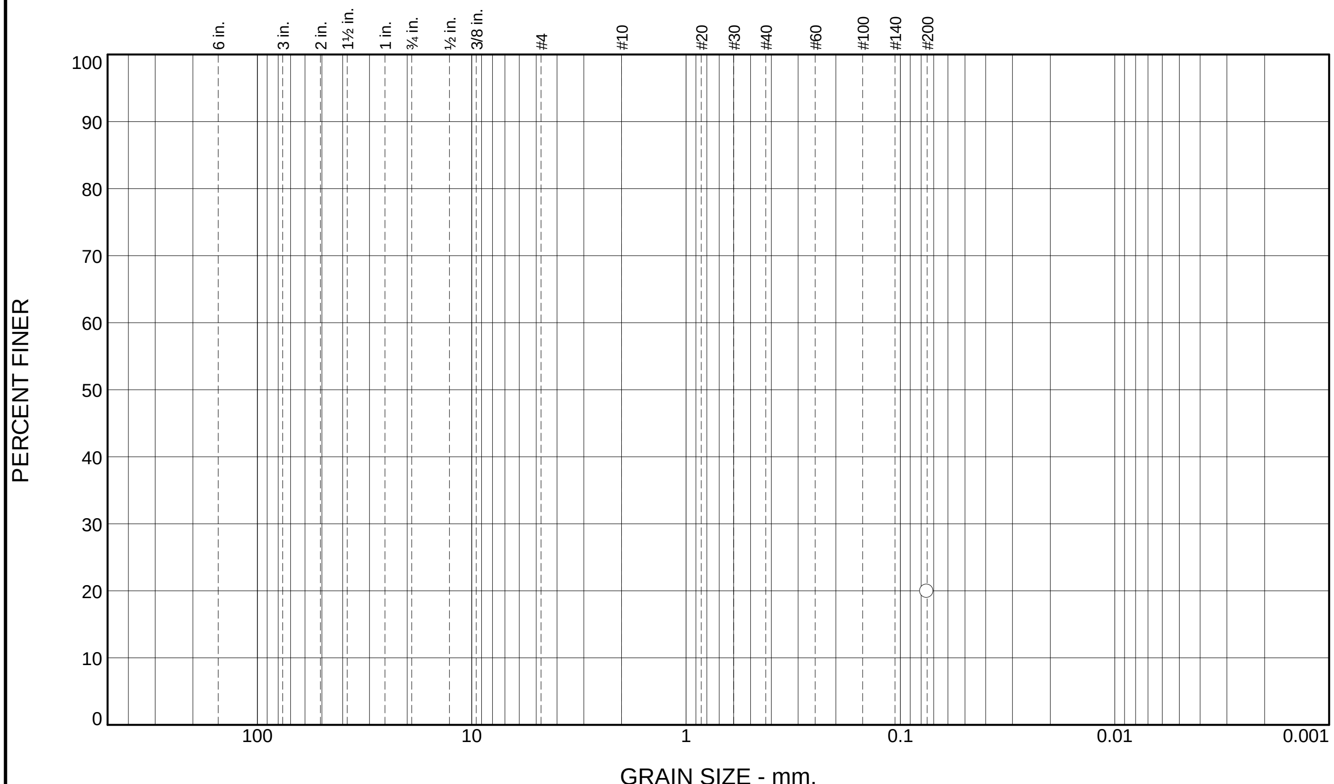
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						19.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	19.9		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Sample size: 470.4g; Soak time: 16hrs

Sample Number: 1-B05 @ 10 **Depth:** 10.0 feet

Date: 08/13/18

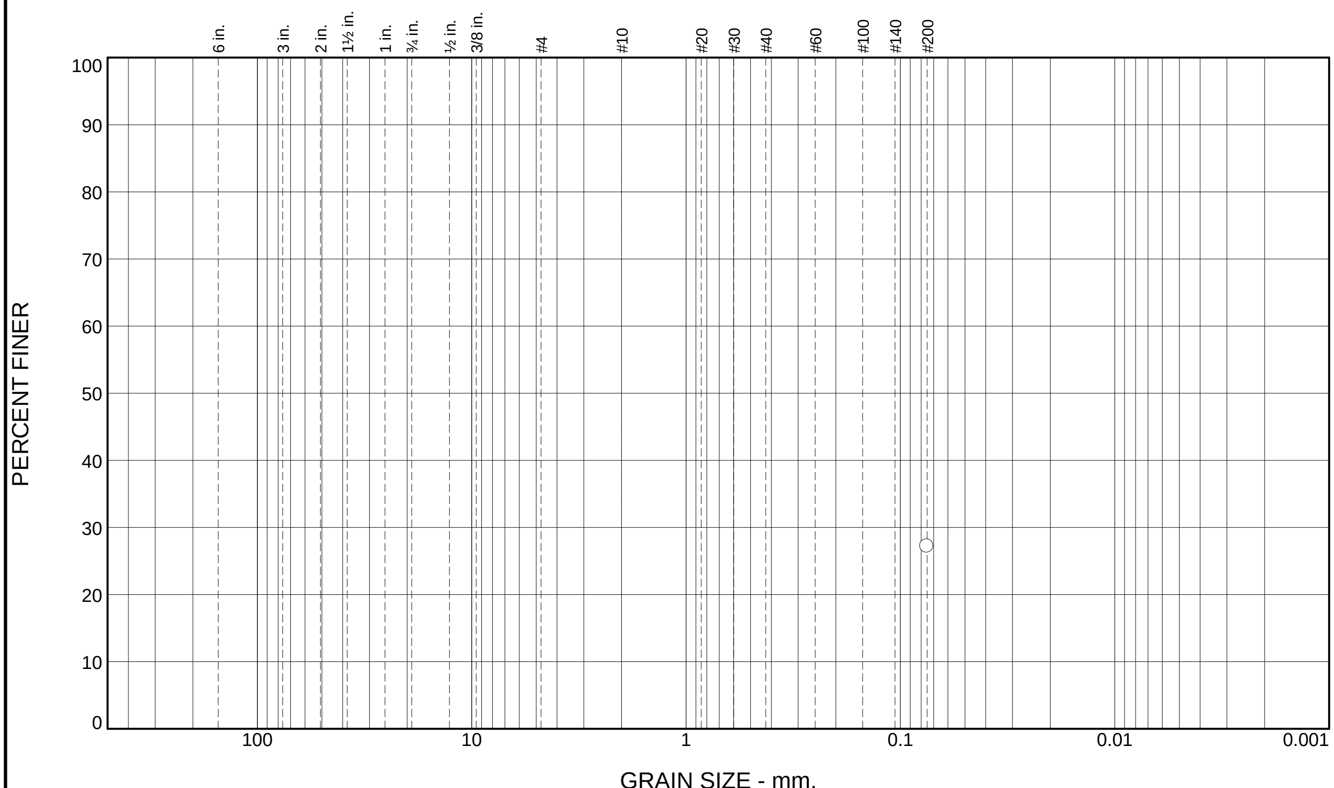
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						27.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	27.2		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Sample size: 541.2g; Soak time: 16hrs

Sample Number: 1-B06 @ 10 **Depth:** 10.0 feet

Date: 08/13/18

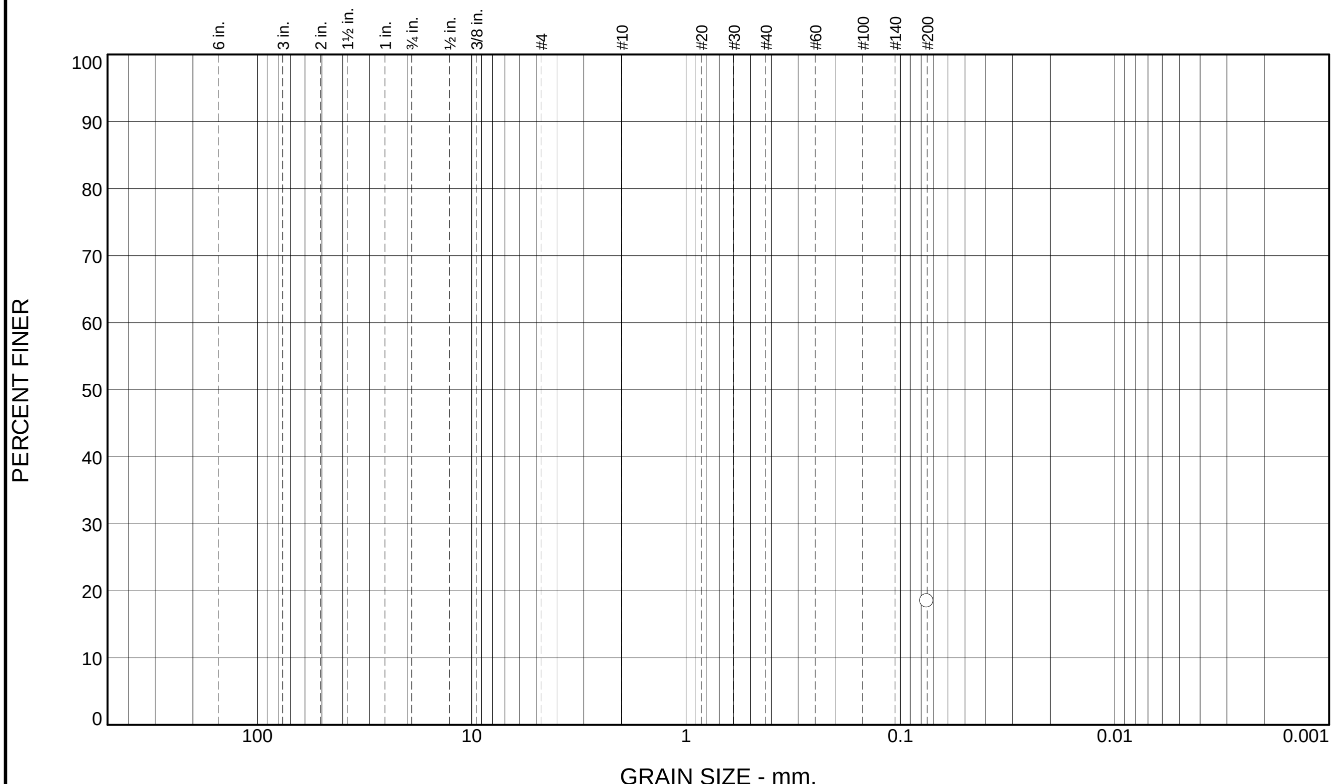
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						18.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	18.4		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Sample size: 678.0g; Soak time: 16hrs

Sample Number: 1-B06 @ 23 **Depth:** 23.0 feet

Date: 08/13/18

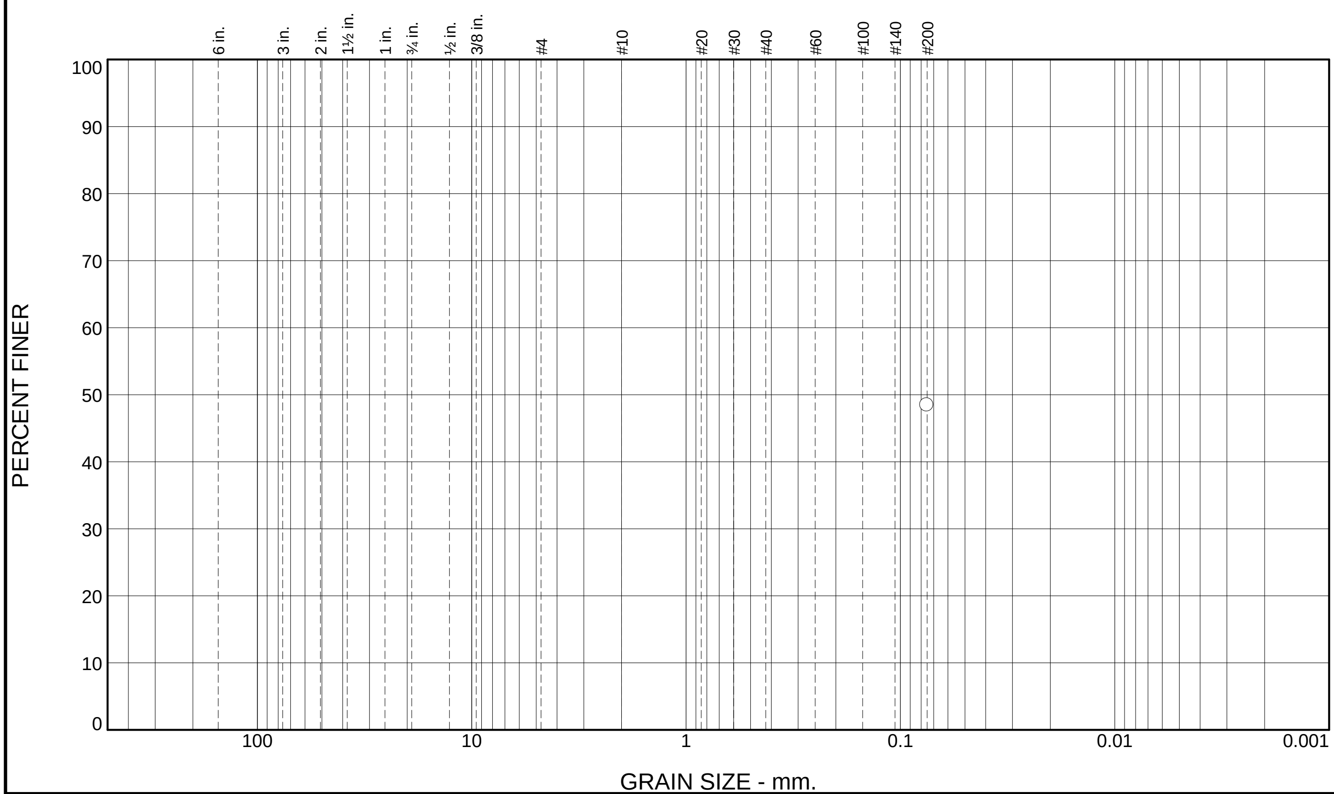
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						48.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	48.4		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140, Method B
Sample size: 457.1g; Soak time: 16hrs

Sample Number: 1-B07 @ 5 **Depth:** 5.0 feet

Date: 08/13/18

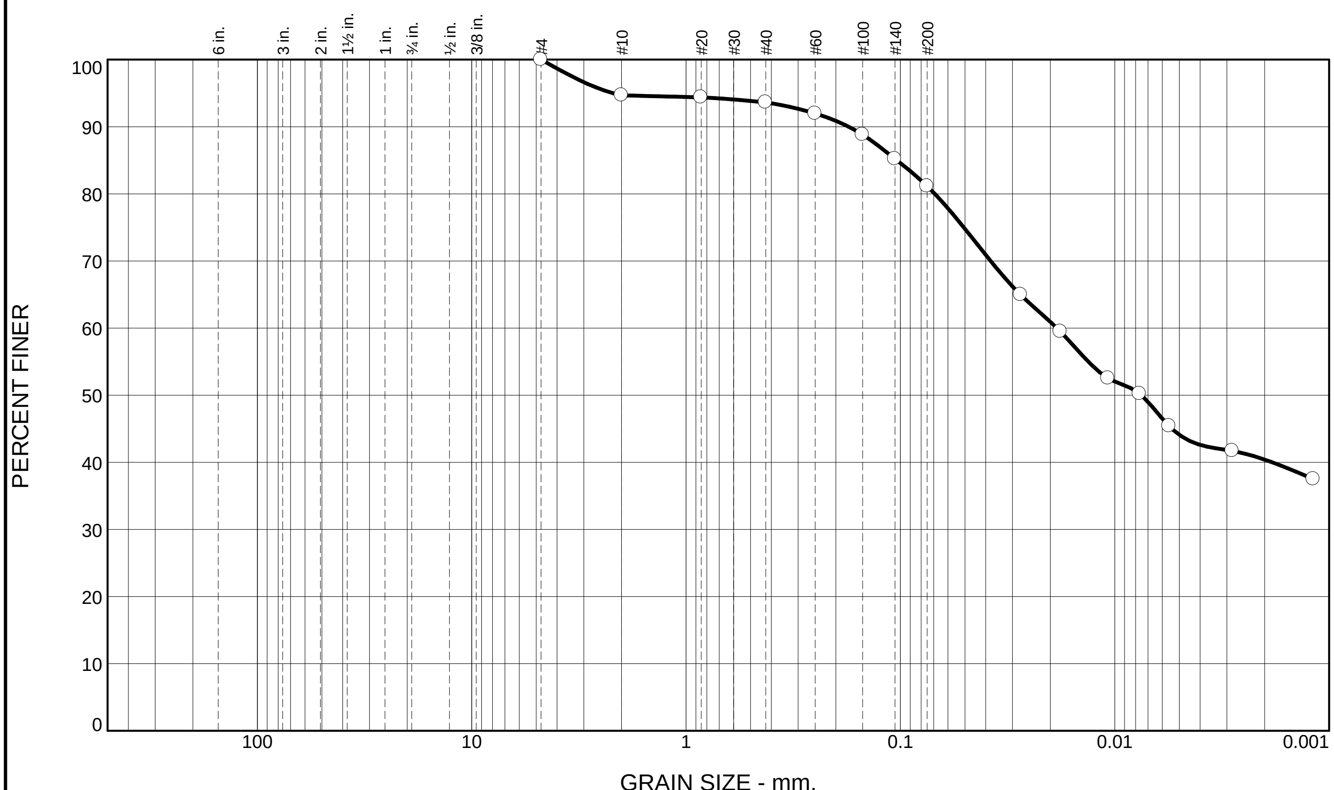
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: M. Bromfield **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	5.3	1.1	12.4	40.8	40.4

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	94.7		
#20	94.4		
#40	93.6		
#60	92.0		
#100	88.8		
#140	85.2		
#200	81.2		
0.0275 mm.	64.9		
0.0179 mm.	59.5		
0.0107 mm.	52.5		
0.0077 mm.	50.2		
0.0056 mm.	45.4		
0.0028 mm.	41.7		
0.0012 mm.	37.5		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= 15 LL= 53 PI= 38

Coefficients

D_{90}= 0.1740 D_{85}= 0.1040 D_{60}= 0.0186
D_{50}= 0.0075 D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CH AASHTO= A-7-6(31)

Remarks

GS: ASTM D422
Silt/clay division of 0.002mm used
PI: ASTM D4318, Wet method

Sample Number: 1-B01 @ 3 **Depth:** 3.0 feet

Date: 08/13/18

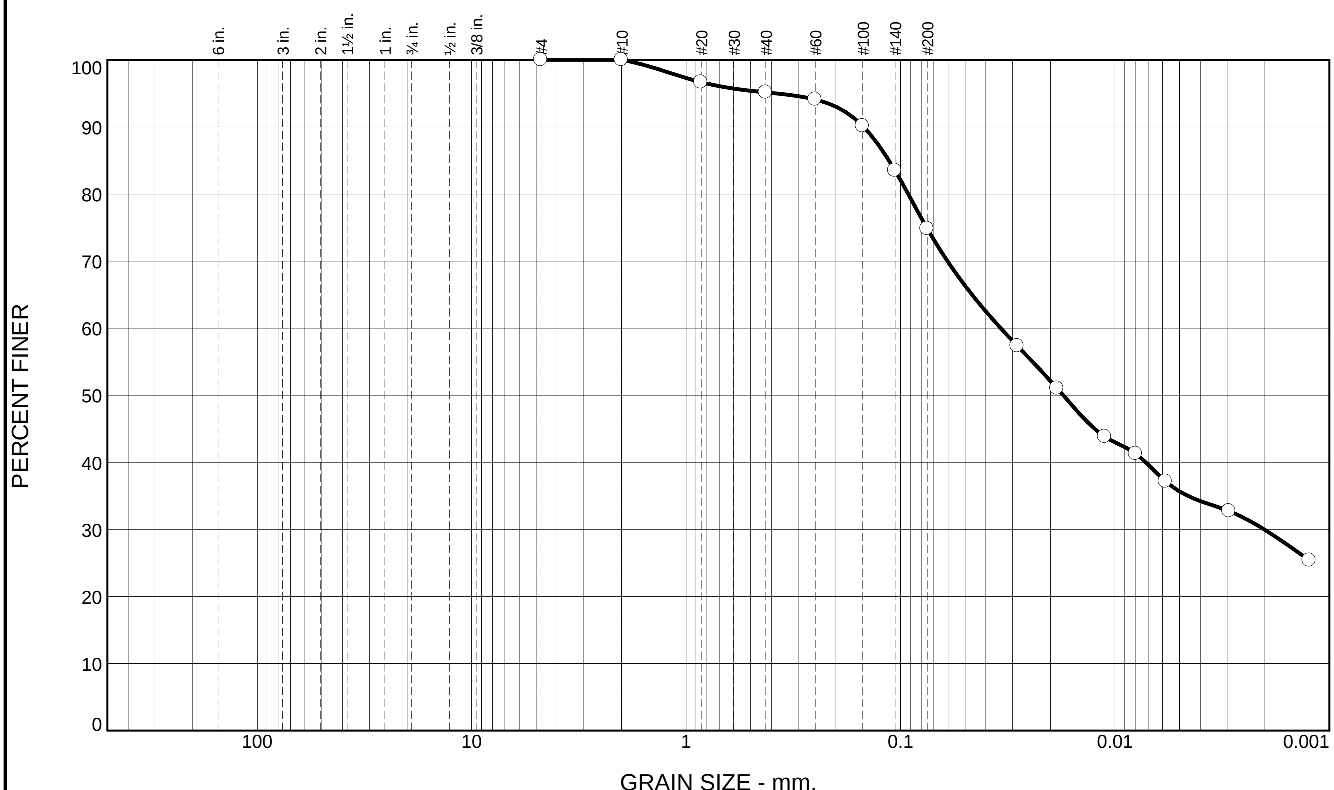
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: A. Chandler **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	4.9	20.3	44.9	29.9

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	96.7		
#40	95.1		
#60	94.1		
#100	90.1		
#140	83.5		
#200	74.8		
0.0285 mm.	57.3		
0.0186 mm.	51.0		
0.0111 mm.	43.8		
0.0080 mm.	41.3		
0.0058 mm.	37.1		
0.0029 mm.	32.7		
0.0012 mm.	25.4		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= 16 LL= 43 PI= 27

Coefficients

D_{90}= 0.1485 D_{85}= 0.1133 D_{60}= 0.0341
D_{50}= 0.0174 D_{30}= 0.0020 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(19)

Remarks

GS: ASTM D422
Silt/clay division of 0.002mm used
PI: ASTM D4318, Wet method

Sample Number: 1-B05 @ 2.5 **Depth:** 2.5 feet

Date: 08/13/18

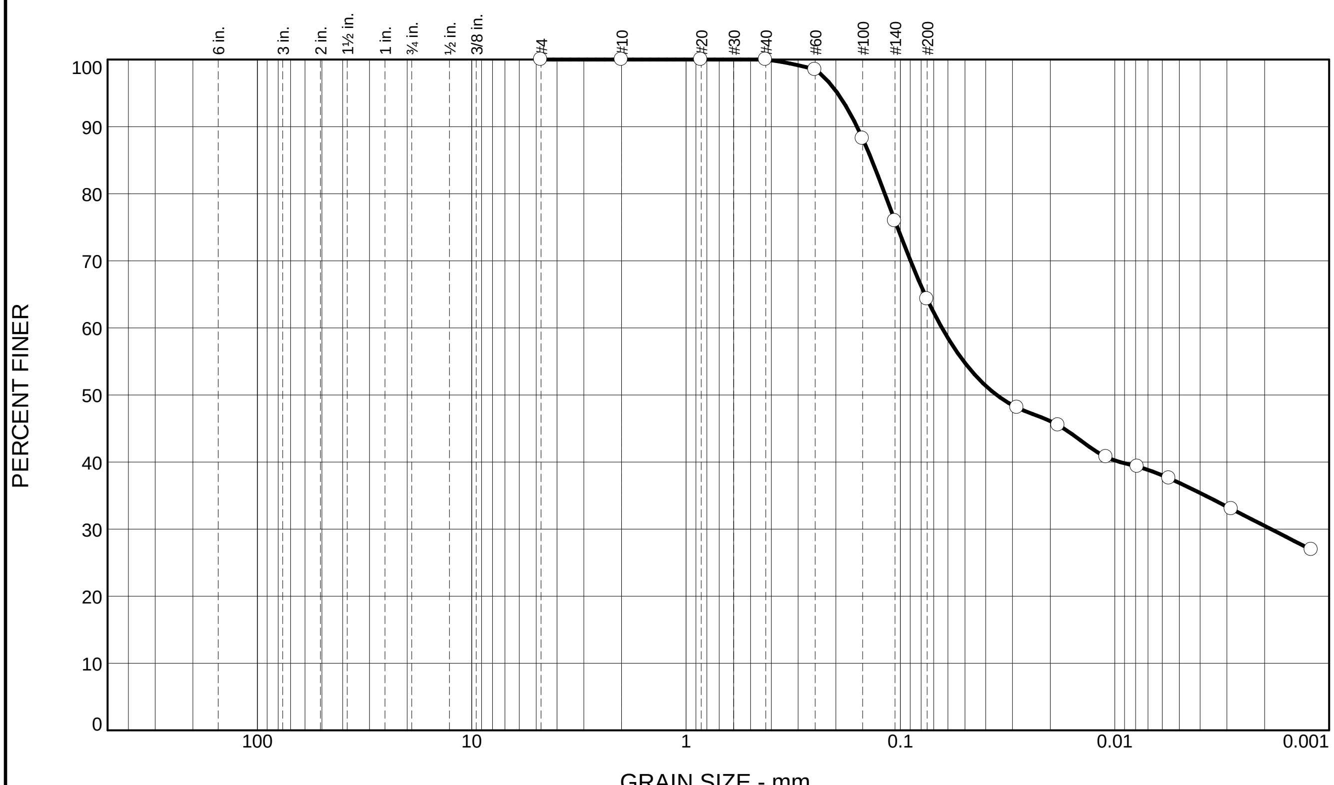
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: A. Chandler **Checked By:** G. Criste

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.0	35.7	33.8	30.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	100.0		
#20	100.0		
#40	100.0		
#60	98.5		
#100	88.2		
#140	75.9		
#200	64.3		
0.0285 mm.	48.1		
0.0184 mm.	45.5		
0.0110 mm.	40.7		
0.0078 mm.	39.3		
0.0056 mm.	37.6		
0.0029 mm.	33.0		
0.0012 mm.	26.9		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= 20 LL= 44 PI= 24

Coefficients

D_{90}= 0.1593 D_{85}= 0.1360 D_{60}= 0.0640
D_{50}= 0.0356 D_{30}= 0.0019 D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= CL AASHTO= A-7-6(13)

Remarks

GS: ASTM D422
Silt/clay division of 0.002mm used
PI: ASTM D4318, Wet method

Sample Number: 1-B07 @ 3 **Depth:** 3.0 feet

Date: 08/14/18

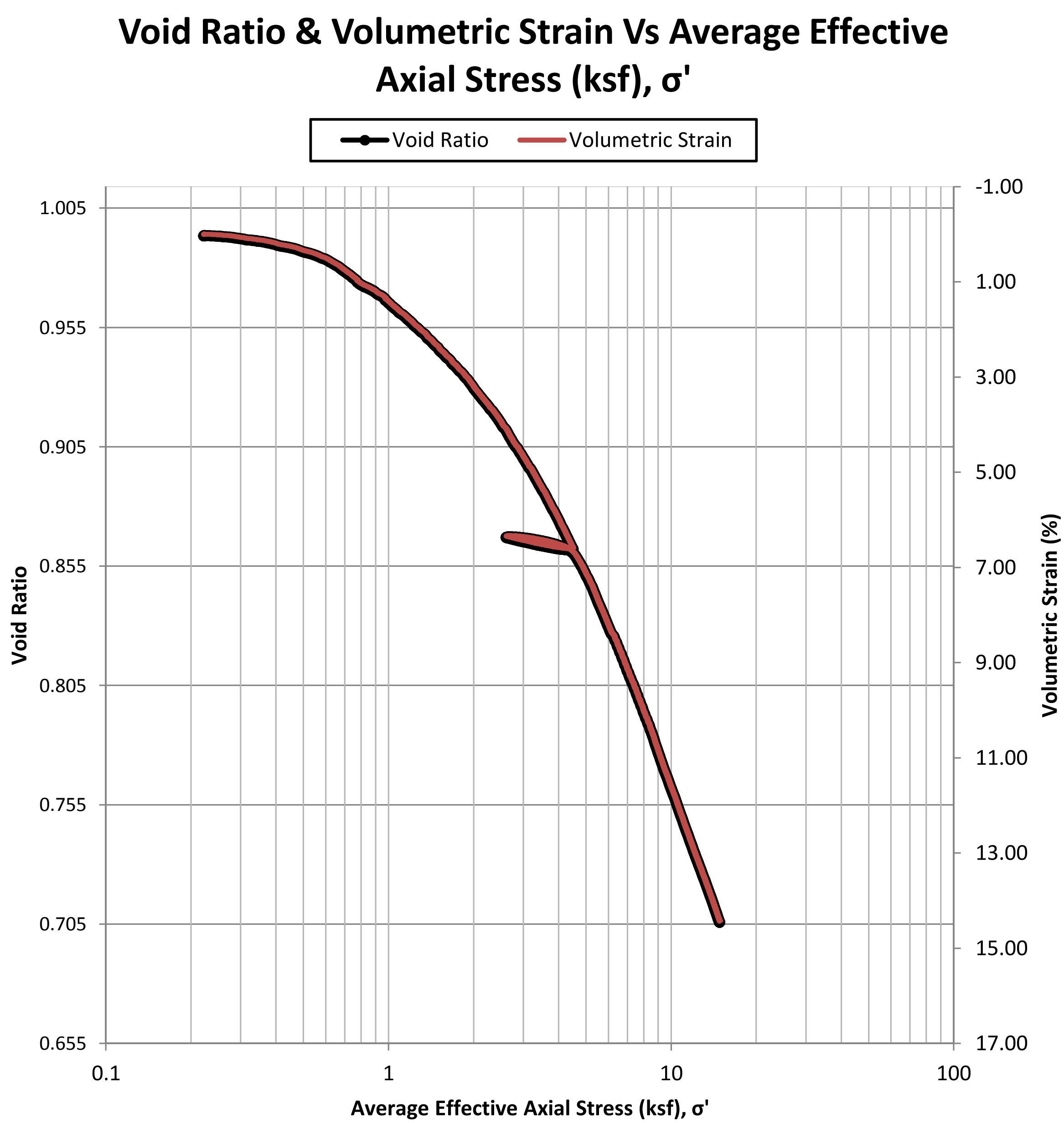
ENGEO INCORPORATED

Client: Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

Project No: 7843.001.001

Tested By: A. Chandler **Checked By:** G. Criste

Constant Rate of Strain Consolidation
ASTM D4186



ASTM D2974 - Method A (OD mass)		
	Initial	Final
Moisture (%):	38.42%	29.39%
Dry Density (pcf):	82.81	96.78
Saturation (%):	102.44%	100.00%
Void Ratio:	0.9934	0.7057

Test Date: 8/8/2018

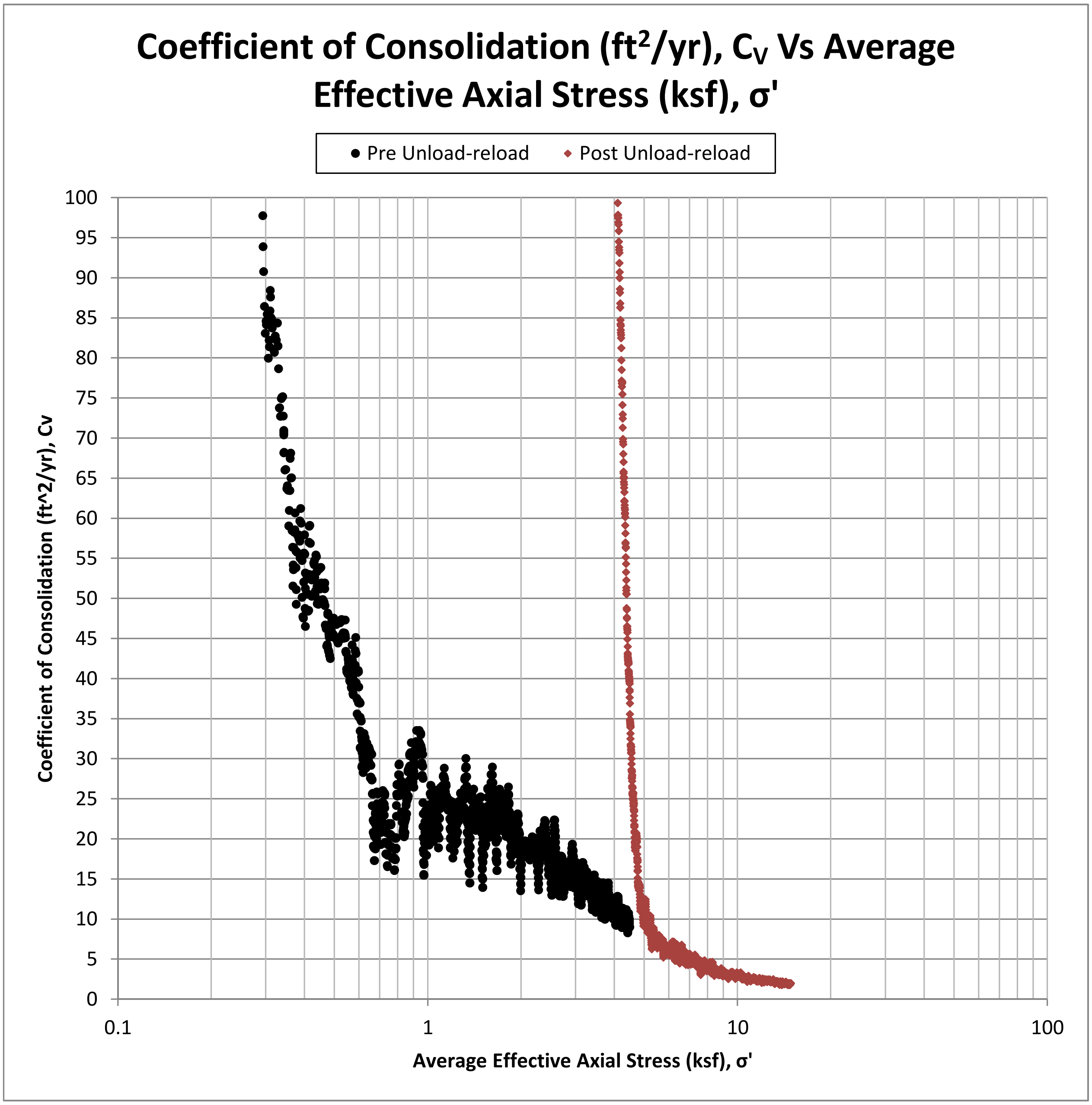
ASTM D4318 - Wet Method	
Liquid Limit:	
Plastic Limit:	
ASTM D854 - Measured	
Specific Gravity:	2.649
Soil Description:	See exploration logs

Project Number:	7843.001.001	**Depth:**	12.75-13 ft
Sample Number:	1-B1 @ 10-13	**Boring #:**	1-B1
Project Name:	South Pleasant Hill Properties		
Client:	Bates Stringer Oak Park, LLC		
Location:	Pleasant Hill, California		
Tested By:	D. Seibold	**Reviewed By:**	K. Gerhart

ENGEO — Expect Excellence —

Remarks:

Constant Rate of Strain Consolidation
ASTM D4186



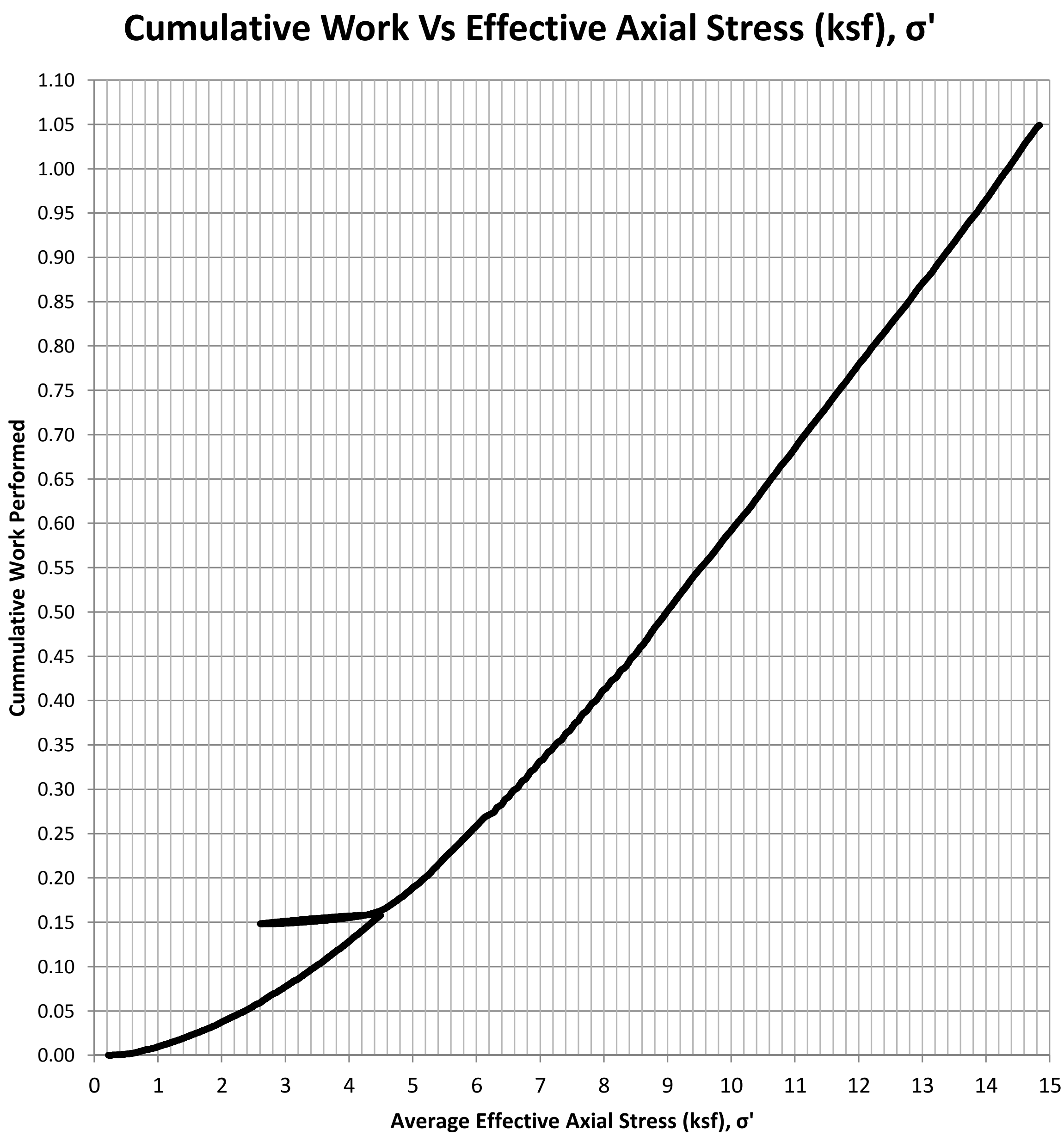
ASTM D2974 - 2974 Method A (OD mass)			Test Date: 8/8/2018	
	Initial	Final	ASTM D4318 - Wet Method	
Moisture (%):	38.42%	29.39%	Liquid Limit:	
Dry Density (pcf):	82.81	96.78	Plastic Limit:	
Saturation (%):	102.44%	100.00%	ASTM D854 - Measured	
Void Ratio:	0.9934	0.7057	Specific Gravity:	2.649
			Soil Description:	See exploration logs

Project Number:	7843.001.001	**Depth:**	12.75-13 ft
Sample Number:	1-B1 @ 10-13	**Boring #:**	1-B1
Project Name:	South Pleasant Hill Properties		
Client:	Bates Stringer Oak Park, LLC		
Location:	Pleasant Hill, California		
Tested By:	D. Seibold	**Reviewed By:**	K. Gerhart

ENGEO Expect Excellence

Remarks:

Constant Rate of Strain Consolidation
ASTM D4186



ASTM D2974 - Method A (OD mass)		
	Initial	Final
Moisture (%):	38.42%	29.39%
Dry Density (pcf):	82.81	96.78
Saturation (%):	102.44%	100.00%
Void Ratio:	0.9934	0.7057

Test Date: 8/8/2018

ASTM D4318 - Wet Method	
Liquid Limit:	
Plastic Limit:	
ASTM D854 - Measured	
Specific Gravity:	2.649
Soil Description:	See exploration logs

Project Number:	7843.001.001
Sample Number:	1-B1 @ 10-13
Project Name:	South Pleasant Hill Properties
Client:	Bates Stringer Oak Park, LLC
Location:	Pleasant Hill, California
Tested By:	D. Seibold

Depth: 12.75-13 ft
Boring #: 1-B1

ENGEO — Expect Excellence

Reviewed By: K. Gerhart

Remarks:

LABORATORY MINIATURE VANE SHEAR

ASTM D4648

APPARATUS USED: Wykeham Farrance, Model 27-WF1730/4

Sample #	Sample ID	Remold? (Y/N)	Test depth (ft)	Spring number	Shear strength (psf)
1	1-B01 @ 10	N	11.5	4	859

Testing remarks:

PROJECT NAME: 1750 Oak Park Boulevard
PROJECT NUMBER: 7843.001.001
CLIENT: Bates Stringer Oak Park, LLC
PHASE NUMBER: 002

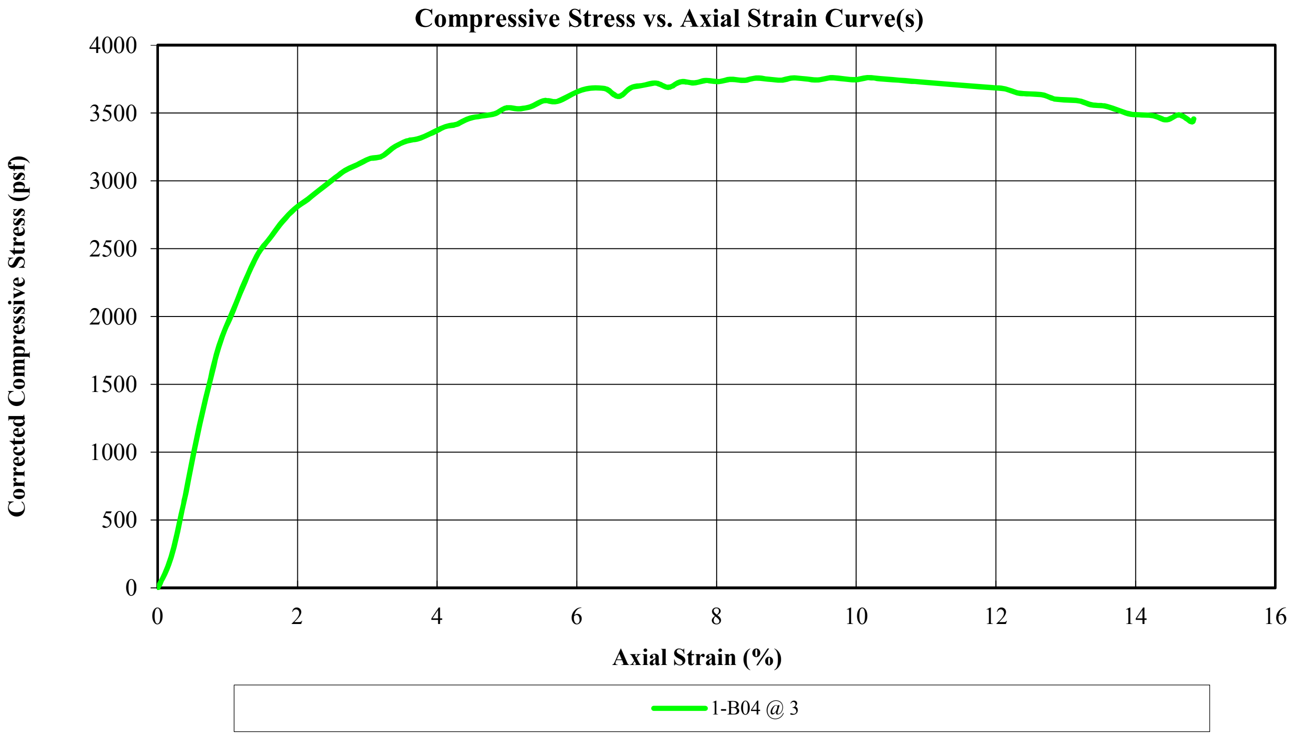
DATE: 08/10/18

ENGEO
Expect Excellence

Tested by: M. Quasem

Reviewed by: G. Criste

UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



BEFORE TEST	SPECIMEN 1-B04 @ 3
Moisture Content (%)	22.0
Dry Density (pcf)	102.4
Saturation (%)	94.8
Void Ratio	0.62
Diameter (in)	2.426
Height (in)	5.76
Height-To-Diameter Ratio	2.38
TEST DATA	
Unconfined Compressive Strength (psf)	3761
Undrained Shear Strength (psf)	1880
Strain Rate (in./min.)	0.05
Specific Gravity	2.650
Strain at Failure (%)	10.16
Liquid Limit	-
Plastic Limit	-
Test Remarks	

SPECIMEN	DESCRIPTION
1-B04 @ 3	See exploration logs

PROJECT NAME: 1750 Oak Park Boulevard
PROJECT NO: 7843.001.001
CLIENT: Bates Stringer Oak Park, LLC
LOCATION: Pleasant Hill, CA
PHASE NO: 002

Test Date: 08/09/18
Tested By: M. Bromfield
Reviewed By: M. Quasem

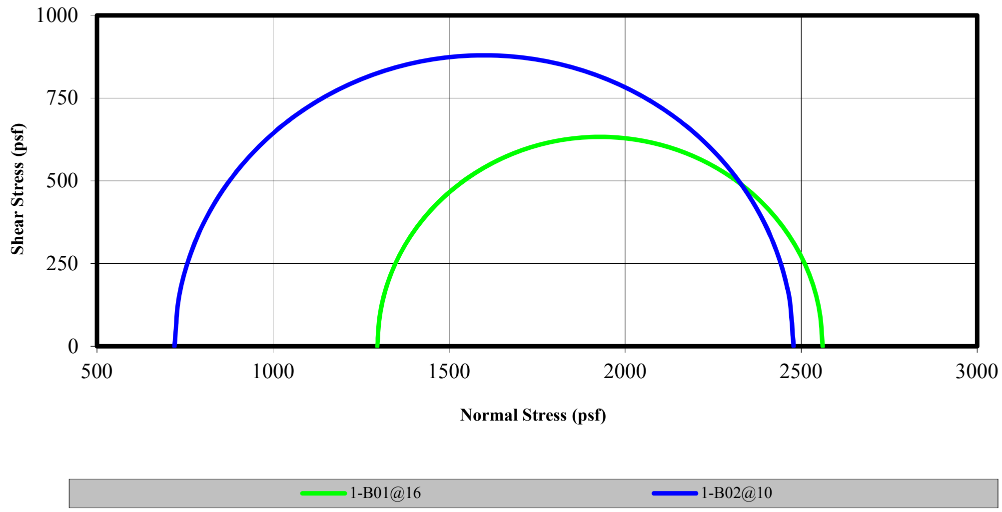
ENGEO
Expect Excellence

ENGEO

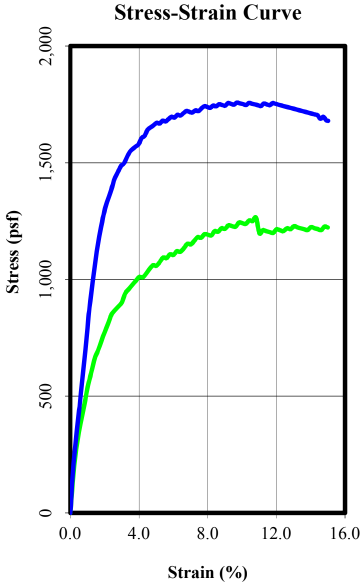
Unconsolidated Undrained Triaxial Test (ASTM D2850)

Tested By: M. Quasem   Date: 08/13/18   Checked By: G. Criste   Date: 08/13/18

Mohr Circles



Stress-Strain Curve



Before Test	Specimen 1-B01@16	1-B02@10		
Water Content (%)	40.65	56.48		
Dry Density (pcf)	80.79	67.55		
Saturation (%)	100.00	100.00		
Void Ratio	1.09	1.53		
Diameter (in)	2.382	2.834		
Height (in)	5.028	5.800		
Liquid Limit	-	-		
Plastic Limit	-	-		
Specific Gravity (Assumed)	2.700	2.740		
Height-to-Diameter Ratio	2.111	2.047		
After Test	**1-B01@16**	**1-B02@10**		
Water Content (%)	40.65	56.48		
Saturation (%)	100.00	100.00		
Strain Rate (in/min)	0.05	0.05		
Peak Deviator Stress (psf)	1265.1	1758.2		
Axial Strain @ Failure (%)	10.819	9.707		
	Cell Pressure			
Cell (psf)	1296.0	720.0		
Back (psf)	n/a	n/a		
	Principle Stresses at Failure			
σ1 (psf)	2561.1	2478.2		
σ3 (psf)	1296.0	720.0		

Mohr-Coulomb Parameters with a Non-zero Friction Angle (Ø≠0)			Cohesion at Failure with a Zero Friction Angle (Ø=0)			
Cohesion, c (psf)	0.0		632.5	879.1		
Friction Angle Ø	0.00		n/a	n/a		

Project Information			
Project Name:	1750 Oak Park Boulevard		
Project Number:	7843.001.001	Job Number:	7843.001.001
Location:	Pleasant Hill, CA	Boring Number:	Multiple
Client:	Bates Stringer Oak Park, LLC	Sample Number:	Multiple
Description:	See exploration logs		

Lab Address: 3420 Fostoria Way, Suite E, Danville, CA 94526. Phone No. (925) 355-9047.

California State Certified Laboratory No. 2153

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

Client: ENGEO Incorporated
Client's Project No.: 07843.001.001
Client's Project Name: 1750 Oak Park Blvd.
Date Sampled: 9-Jun-18
Date Received: 15-Aug-18
Matrix: Soil
Authorization: Signed Chain of Custody

Date of Report: 31-Aug-2018

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1808135-001	1-B5/1-B2	310	8.16	-	430	-	43	330

	Redox	pH	Conductivity	Resistivity	Sulfide	Chloride	Sulfate
Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:	-	-	10	-	50	15	15
	30-Aug-2018	30-Aug-2018	-	29-Aug-2018	-	30-Aug-2018	30-Aug-2018

* Results Reported on "As Received" Basis

Cheryl McMillen
Laboratory Director

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

California State Certified Laboratory No. 2153

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

31 August, 2018

Job No. 1808135
Cust. No. 10169

Mr. Spencer Wagnaar
ENGEO Inc.
2010 Crow Canyon Place, Suite 250
San Ramon, CA 94583

Subject: Project No.: 07843.001.001
Project Name: 1750 Oak Park Blvd.
Corrosivity Analysis – ASTM Test Methods

Dear Mr. Wagnaar:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on August 15, 2018. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

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

The chloride ion concentration is 43 mg/kg and is determined to be insufficient to attack steel embedded in a concrete mortar coating.

The sulfate ion concentration is 330 mg/kg and is determined to be sufficient to potentially be detrimental to reinforced concrete structures and cement mortar-coated steel at these locations. Therefore, concrete that comes into contact with this soil should use sulfate resistant cement such as Type II, with a maximum water-to-cement ratio of 0.55.

The pH of the soil is 8.16, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potential is 310-mV and is indicative of potentially "slightly corrosive" soils resulting from anaerobic soil conditions.

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

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

Very truly yours,
CERCO ANALYTICAL, INC.

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

JDH/jdl
Enclosure

CU#10169 CA1808135

CHAIN OF CUSTODY RECORD

PROJECT NUMBER: 07843.001.001	PROJECT NAME: 1750 Oak Park Blvd.
SAMPLED BY: (SIGNATURE/PRINT)	Spencer Wagnaar
PROJECT MANAGER: Kelsey Gerhart	
ROUTING: E-MAIL	swaganaar@engeo.com, kgerhart@engeo.com

	SAMPLE NUMBER	DATE	TIME	MATRIX	NUMBER OF CONTAINERS	CONTAINER SIZE	PRESERVATIVE	Redox, pH, sulfate, resistivity (100% sat.) chloride	REMARKS REQUIRED DETECTION LIMITS
001A 001B	1-B5/1-B2	06/09/18	9:00 AM	soil	2	Liner	none	X	Composite Sample with brief evaluation

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
[signature]	8/15 10:40am	[signature]			
RELINQUISHED BY: (SIGNATURE) [signature]	8-15-18 1535	RECEIVED FOR LABORATORY BY: (SIGNATURE) [signature]	DATE/TIME		

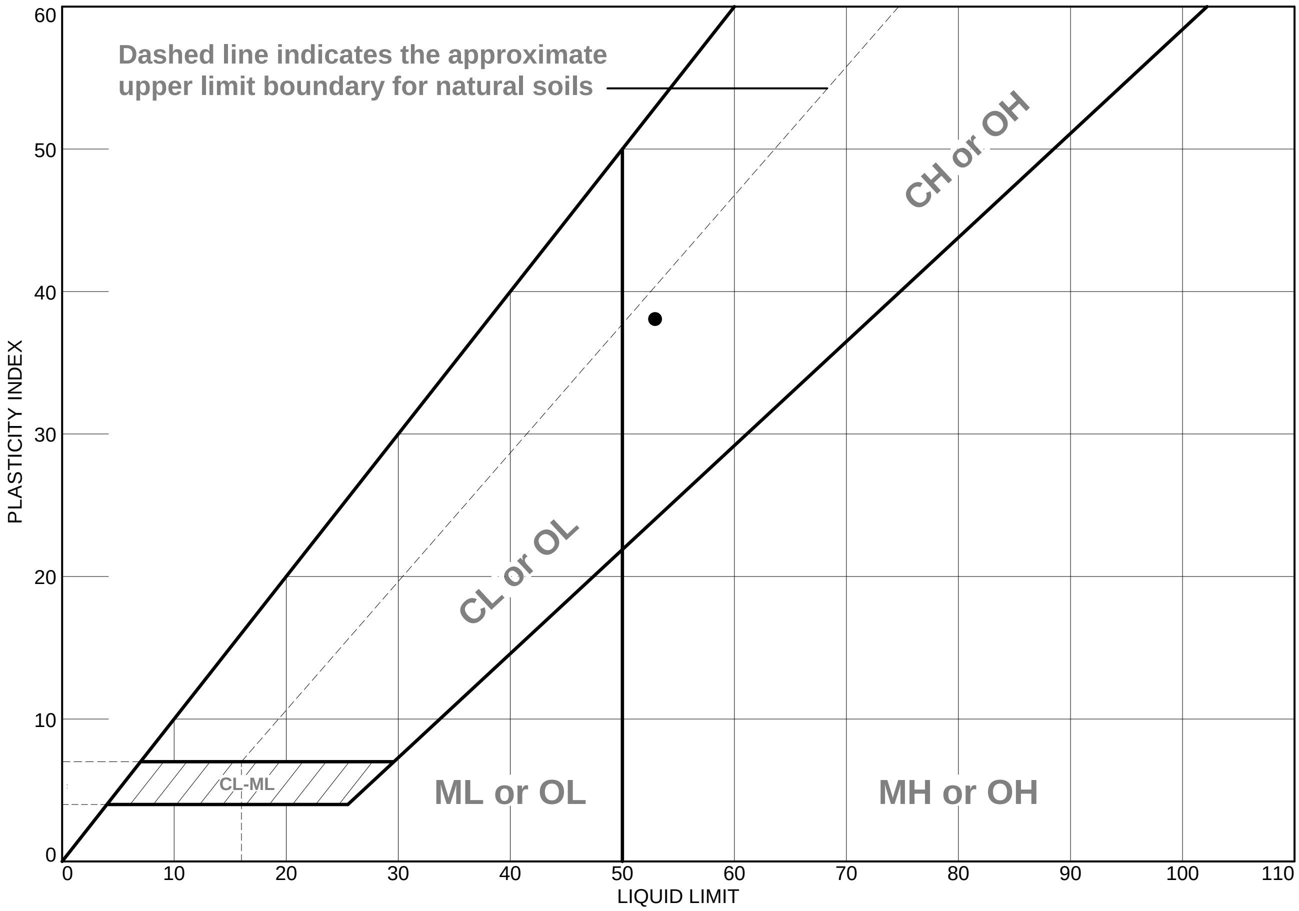
REMARKS: Standard 10 day turn-around time

ENGEO INCORPORATED

2010 CROW CANYON PLACE, SUITE 250
SAN RAMON, CALIFORNIA 94583
(925) 837-2973 FAX (888) 279-2698
WWW.ENGEO.COM

DISTRIBUTION: ORIGINAL ACCOMPANIES SHIPMENT; COPY TO PROJECT FIELD FILES

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	53	15	38	93.6	81.2	CH

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 3.0 feet **Sample Number:** 1-B01 @ 3

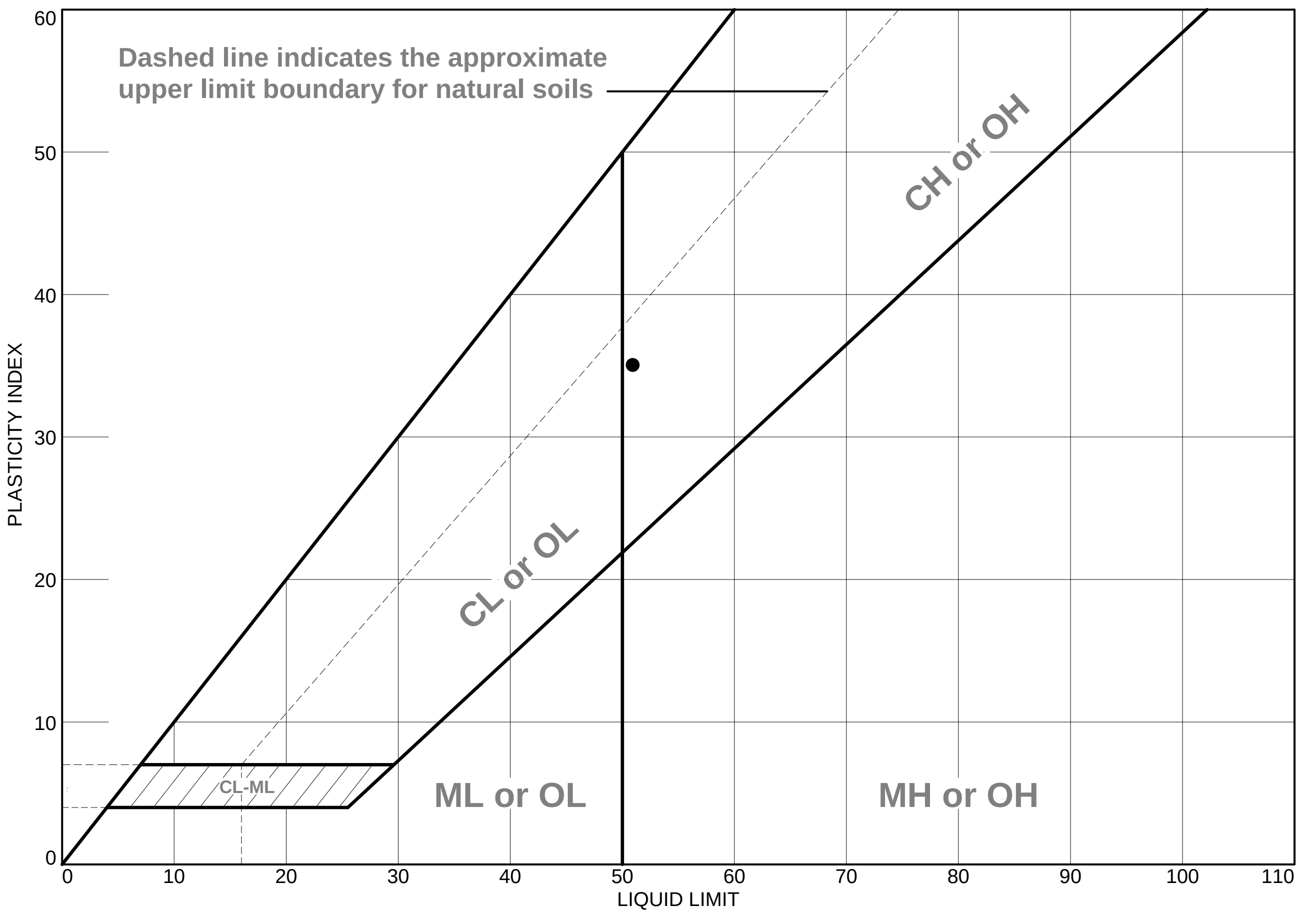
ENGEO INCORPORATED

Remarks:

●PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487

Tested By: M. Quasem **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	51	16	35			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

● **Depth:** 26.0 feet **Sample Number:** 1-B01 @ 26

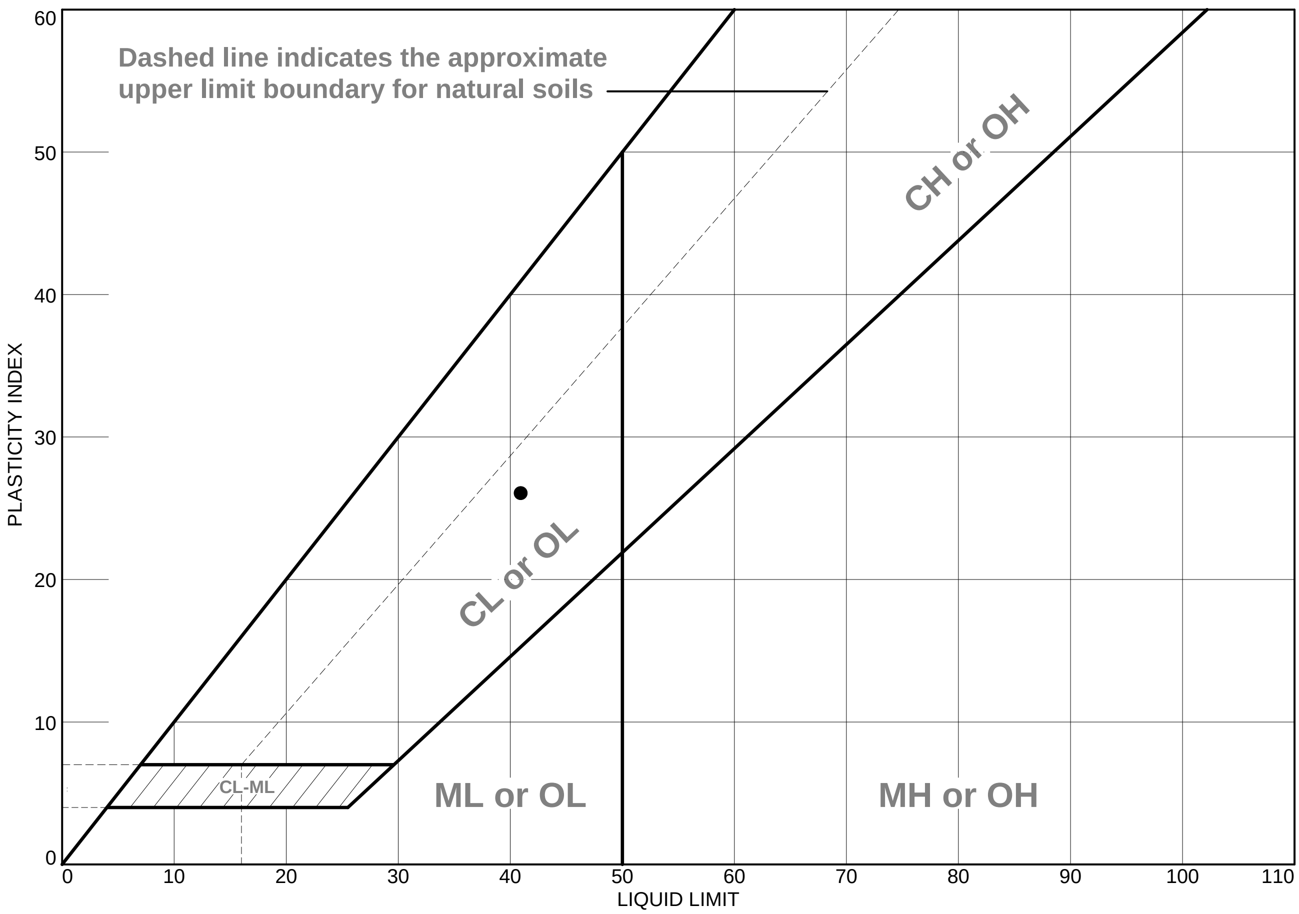
Remarks:

● ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	41	15	26		64.9	

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

● **Depth:** 21.0 feet **Sample Number:** 1-B02 @ 21

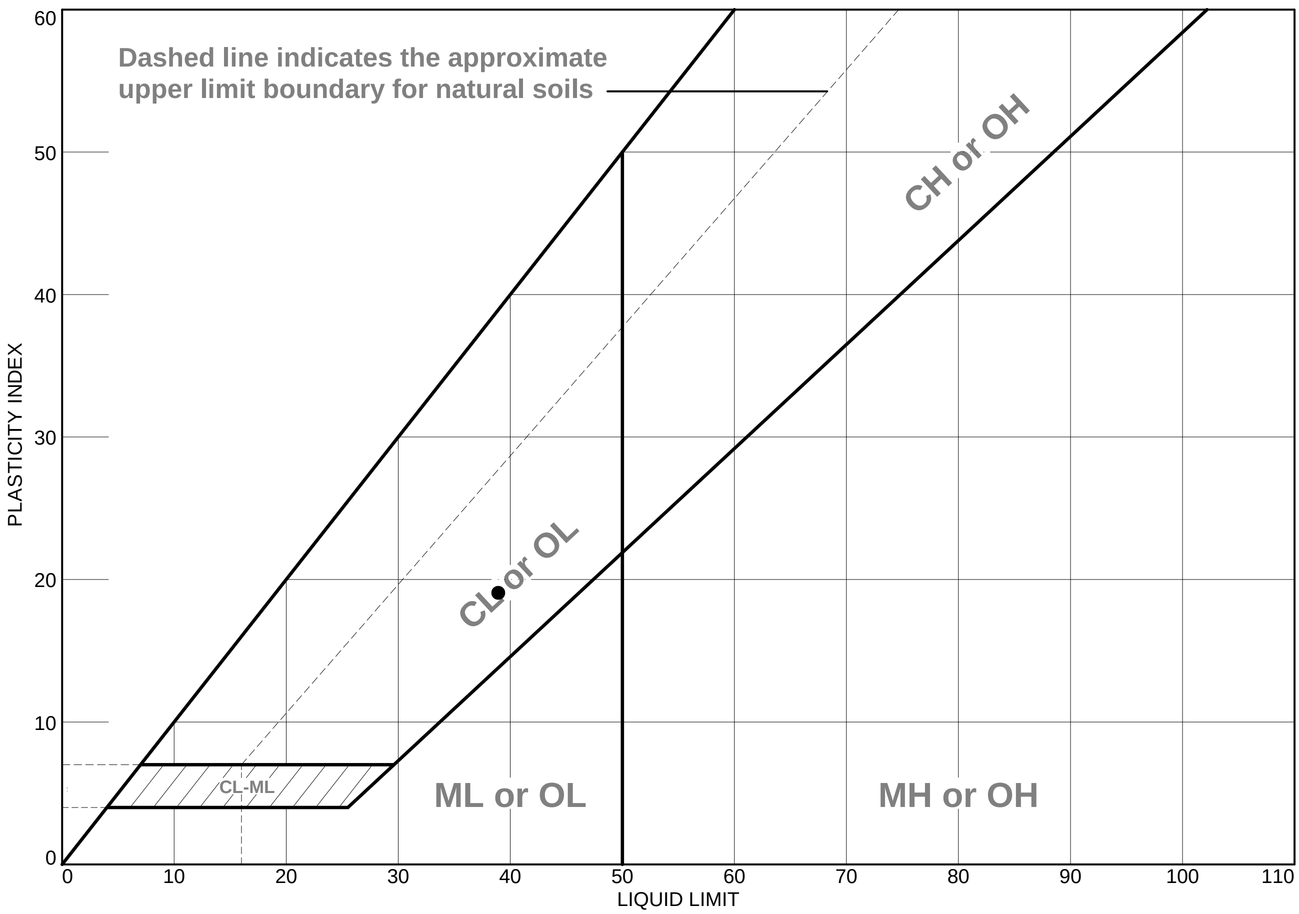
Remarks:

● PI: ASTM D4318, Wet method
GS: ASTM D1140

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	39	20	19			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 31.0 feet **Sample Number:** 1-B02 @ 31

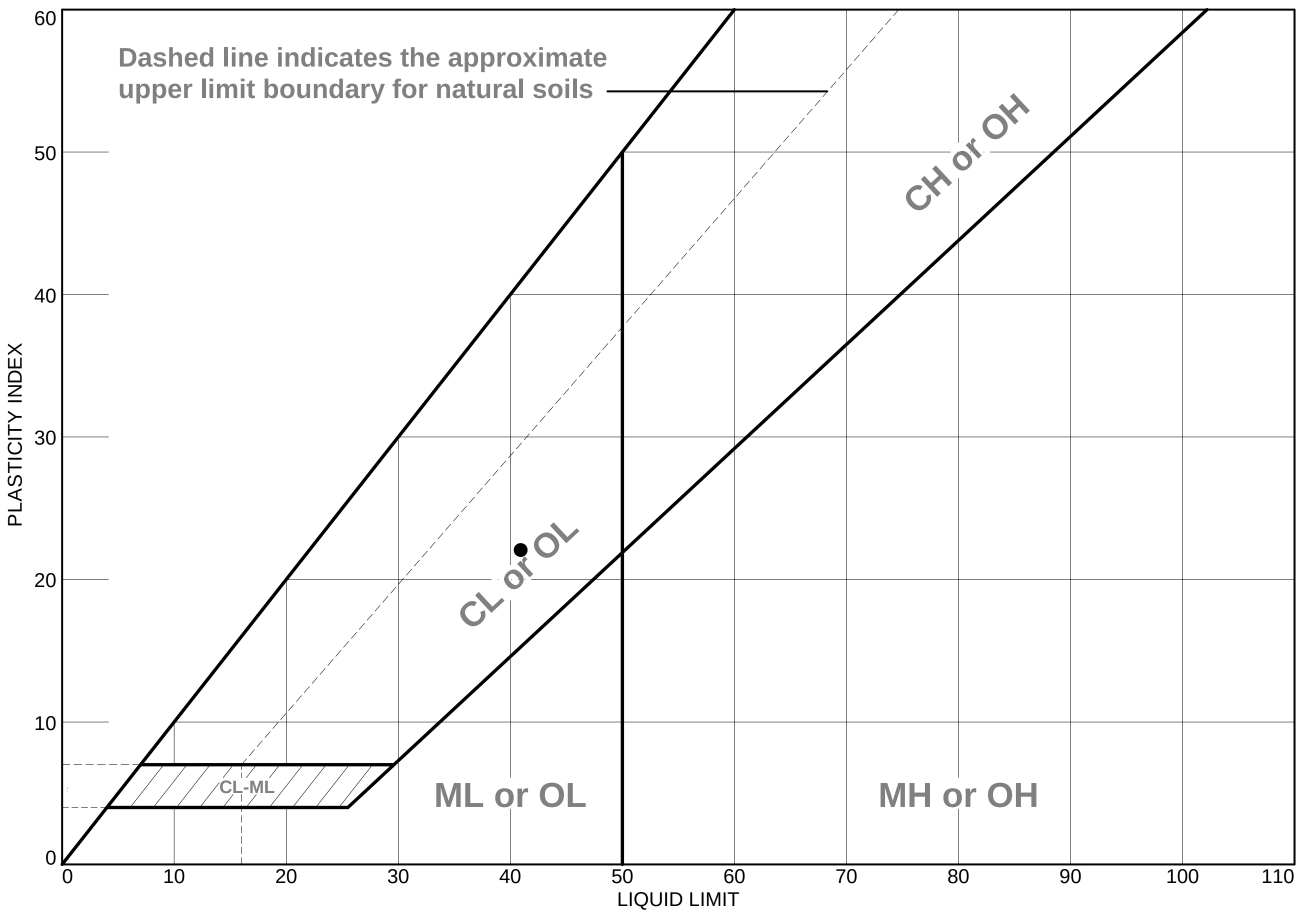
Remarks:

●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	41	19	22			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 10.0 feet **Sample Number:** 1-B04 @ 10

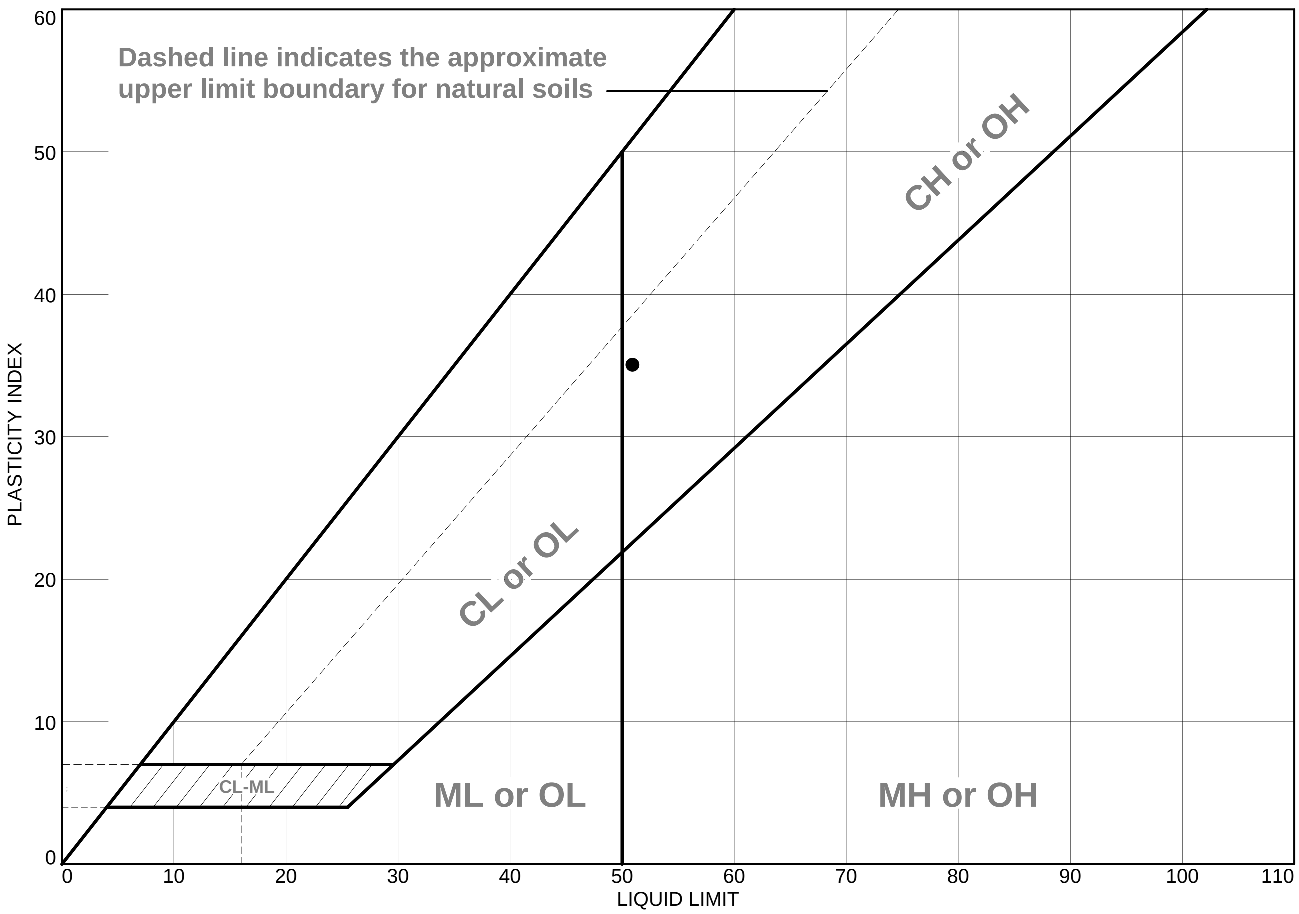
Remarks:

●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	51	16	35			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 31.0 feet **Sample Number:** 1-B04 @ 31

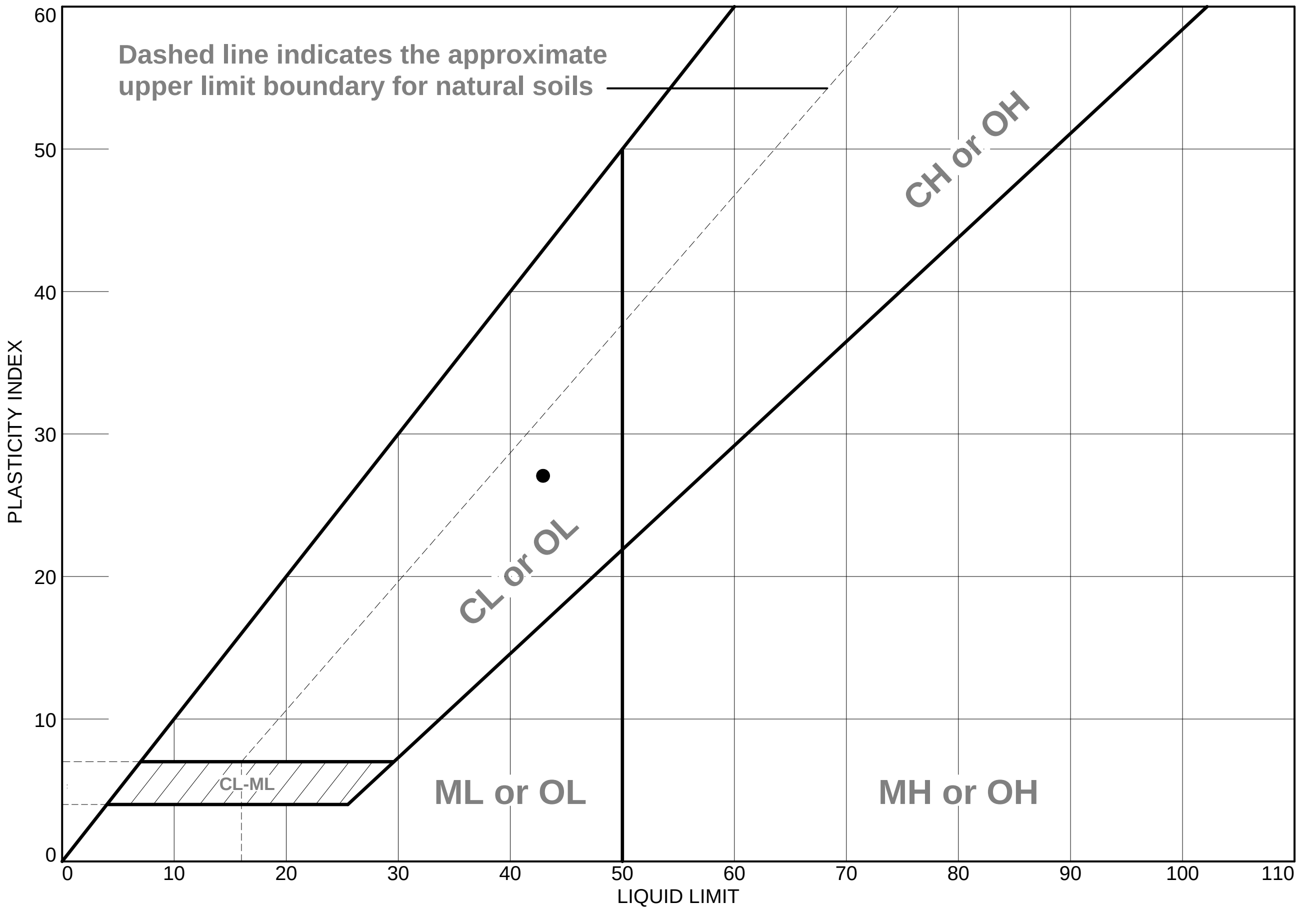
Remarks:

●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	43	16	27	95.1	74.8	CL

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

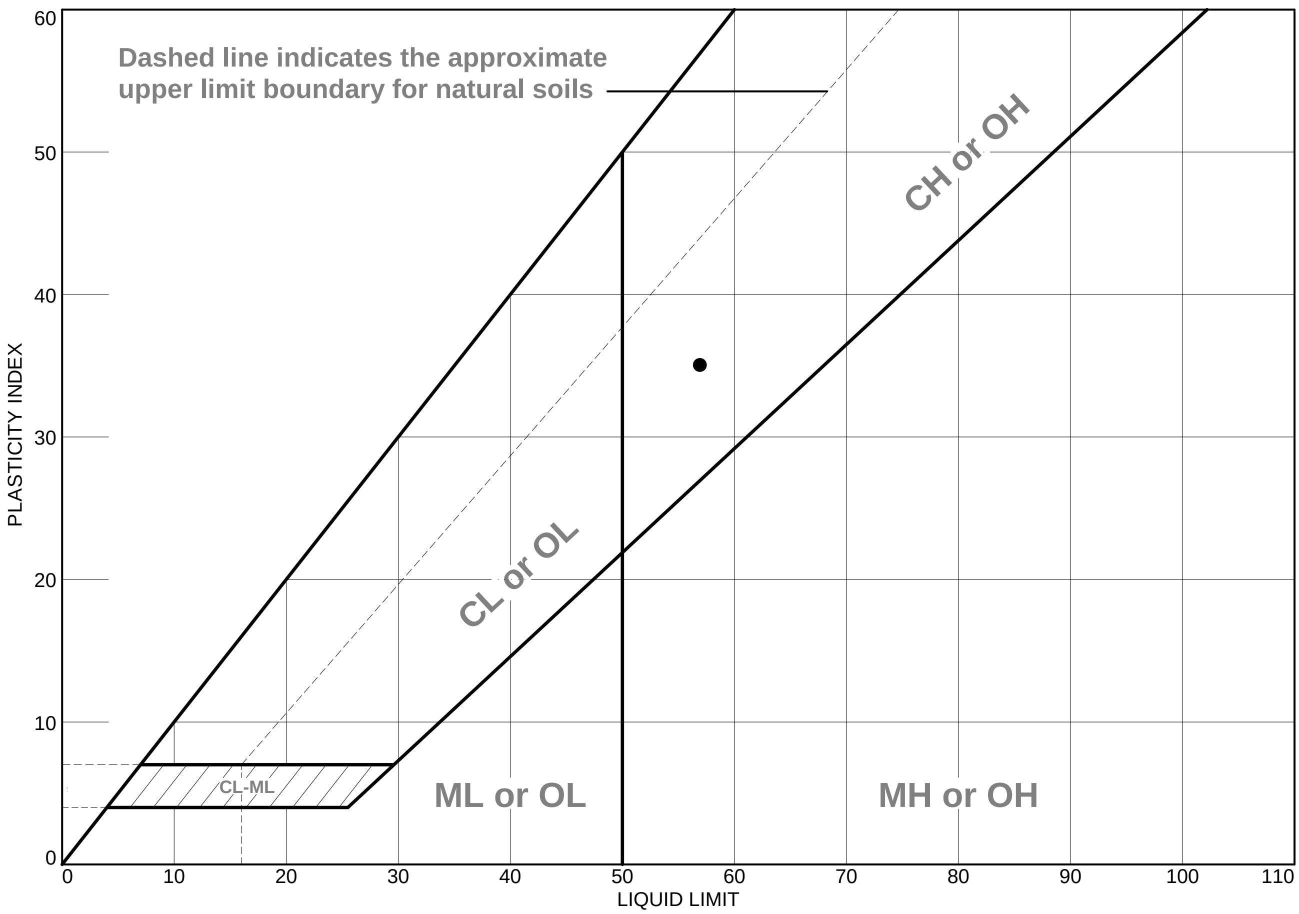
●**Depth:** 2.5 feet **Sample Number:** 1-B05 @ 2.5

Remarks:
●PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487

ENGEO INCORPORATED

Tested By: W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	57	22	35			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 28.0 feet **Sample Number:** 1-B06 @ 28

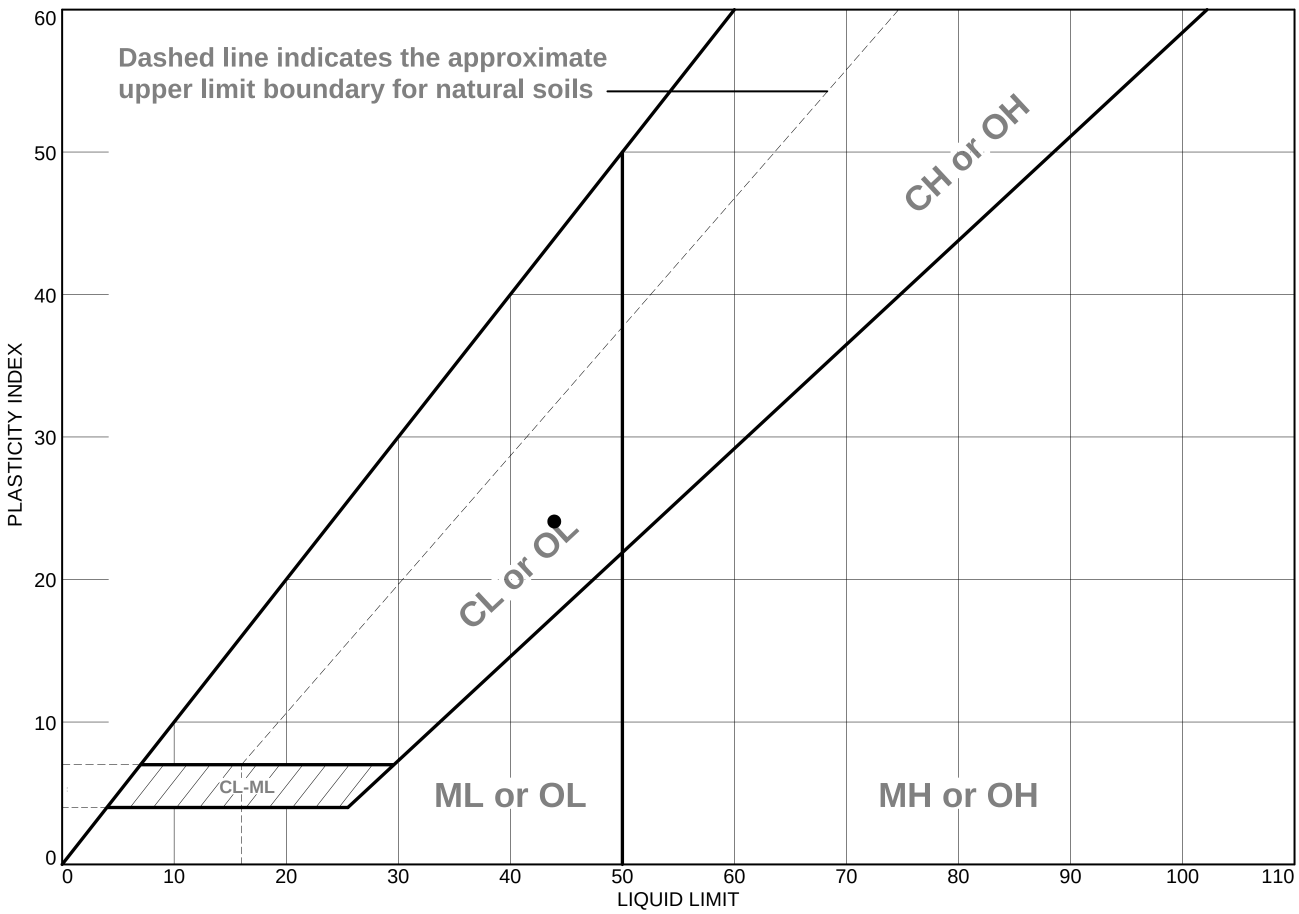
Remarks:

●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: M. Quasem **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	44	20	24	100.0	64.3	CL

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

● **Depth:** 3.0 feet **Sample Number:** 1-B07 @ 3

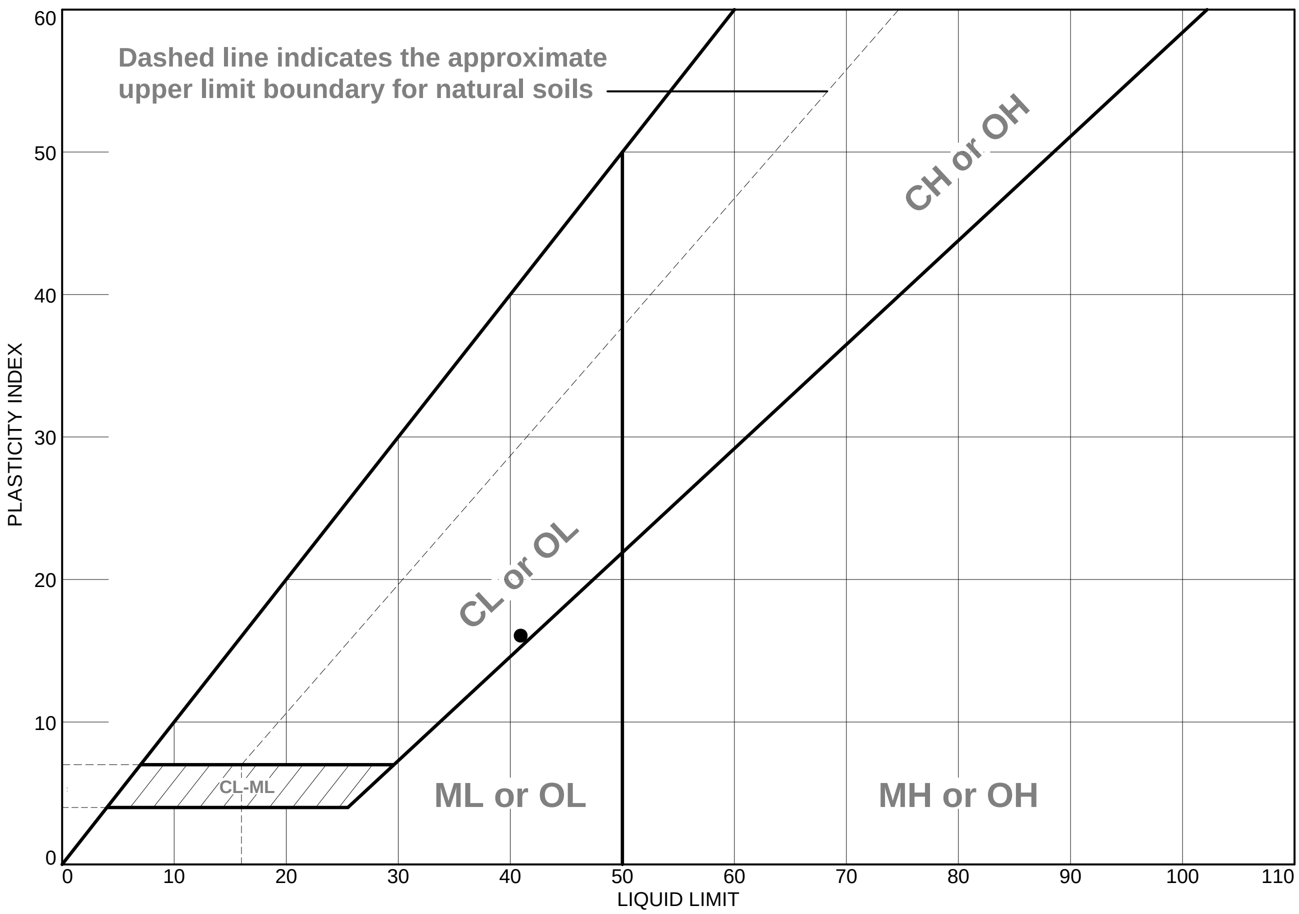
ENGEO INCORPORATED

Remarks:

● PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487

Tested By: M. Quasem **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	41	25	16			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 26.0 feet **Sample Number:** 1-B07 @ 26

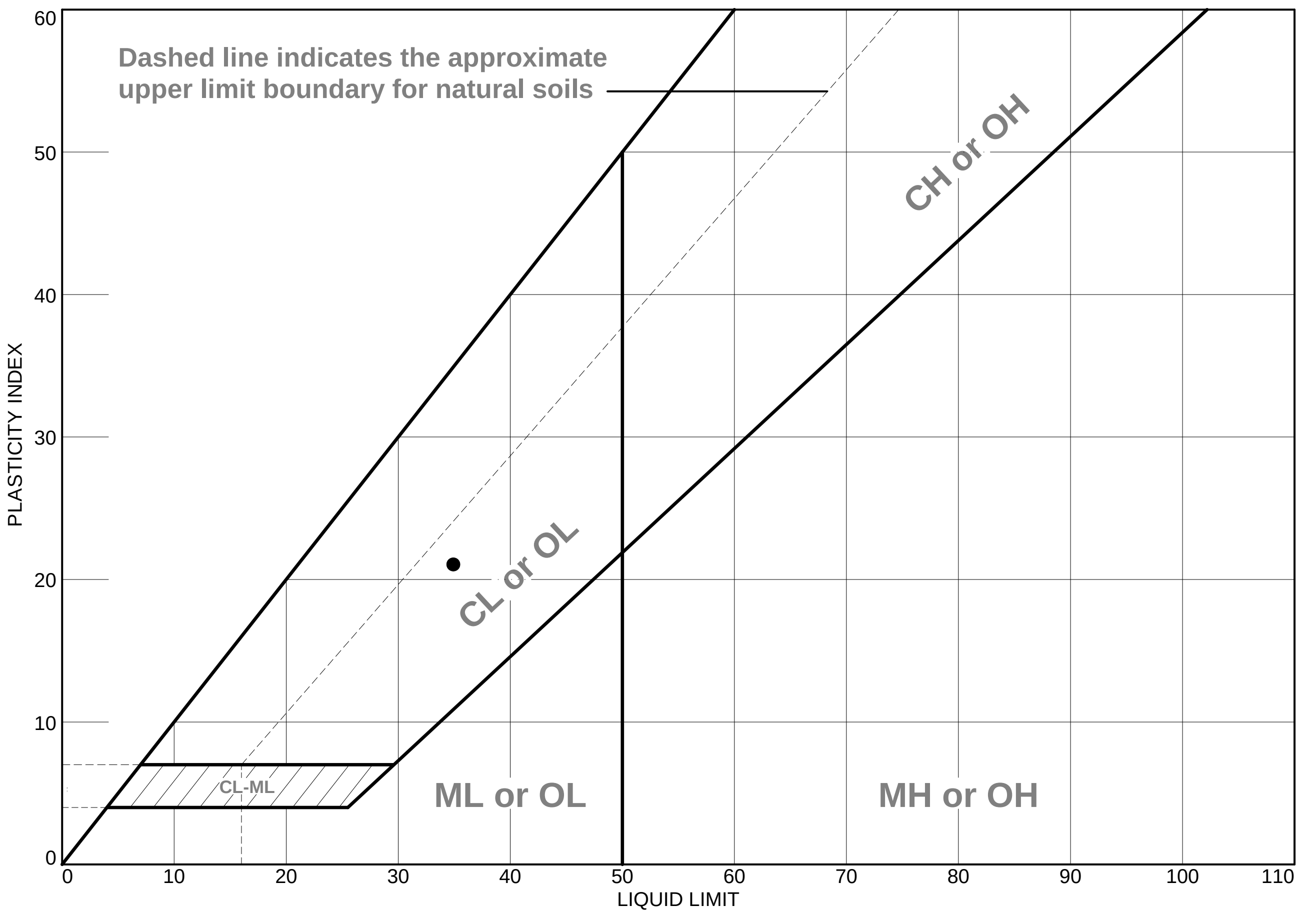
Remarks:

●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: M. Quasem **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	35	14	21			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC
Project: 1750 Oak Park Boulevard

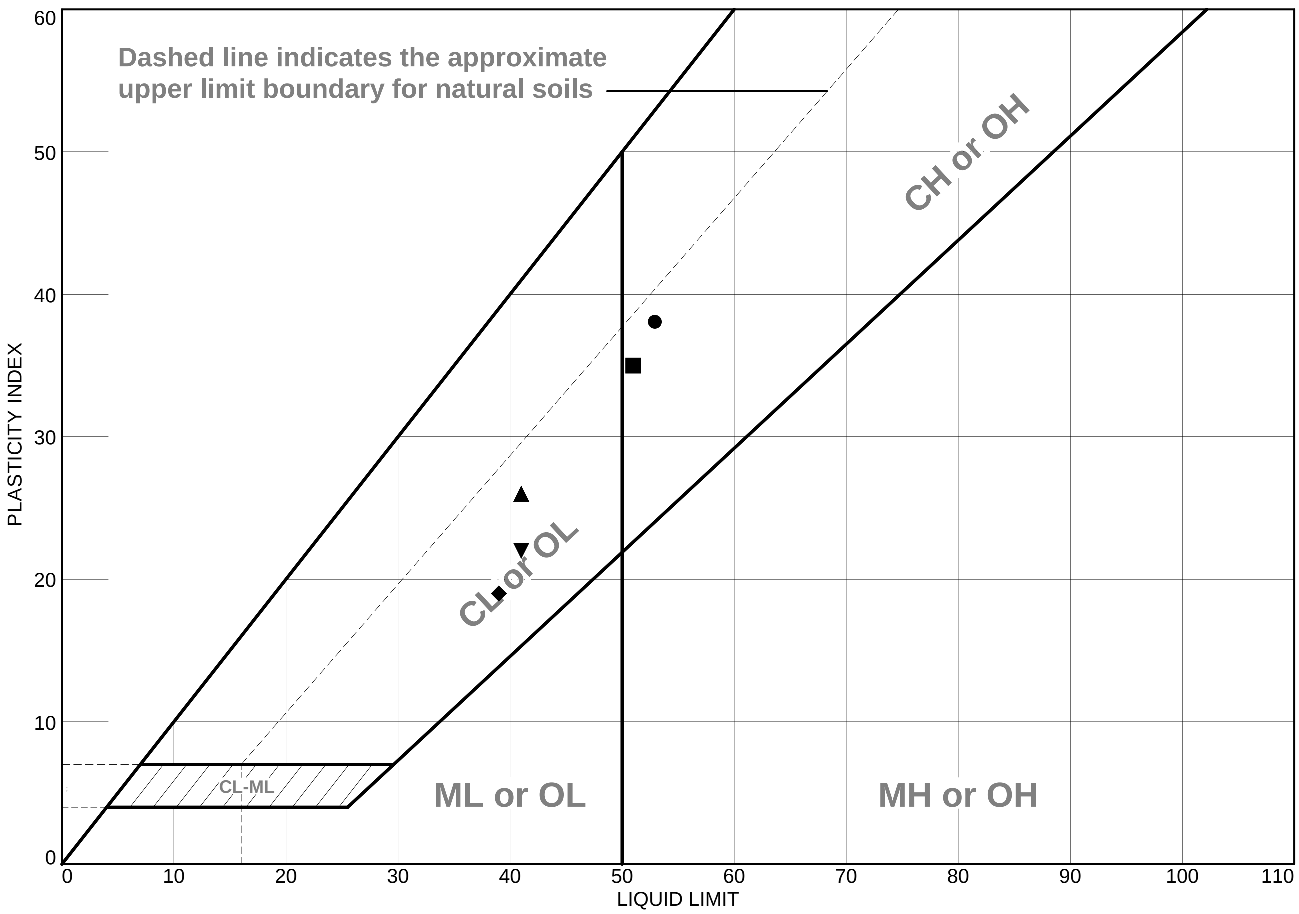
●**Depth:** 8.0 feet **Sample Number:** 1-B07 @ 8

Remarks:
●ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: M. Quasem **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	53	15	38	93.6	81.2	CH
■	See exploration logs	51	16	35			
▲	See exploration logs	41	15	26		64.9	
◆	See exploration logs	39	20	19			
▼	See exploration logs	41	19	22			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

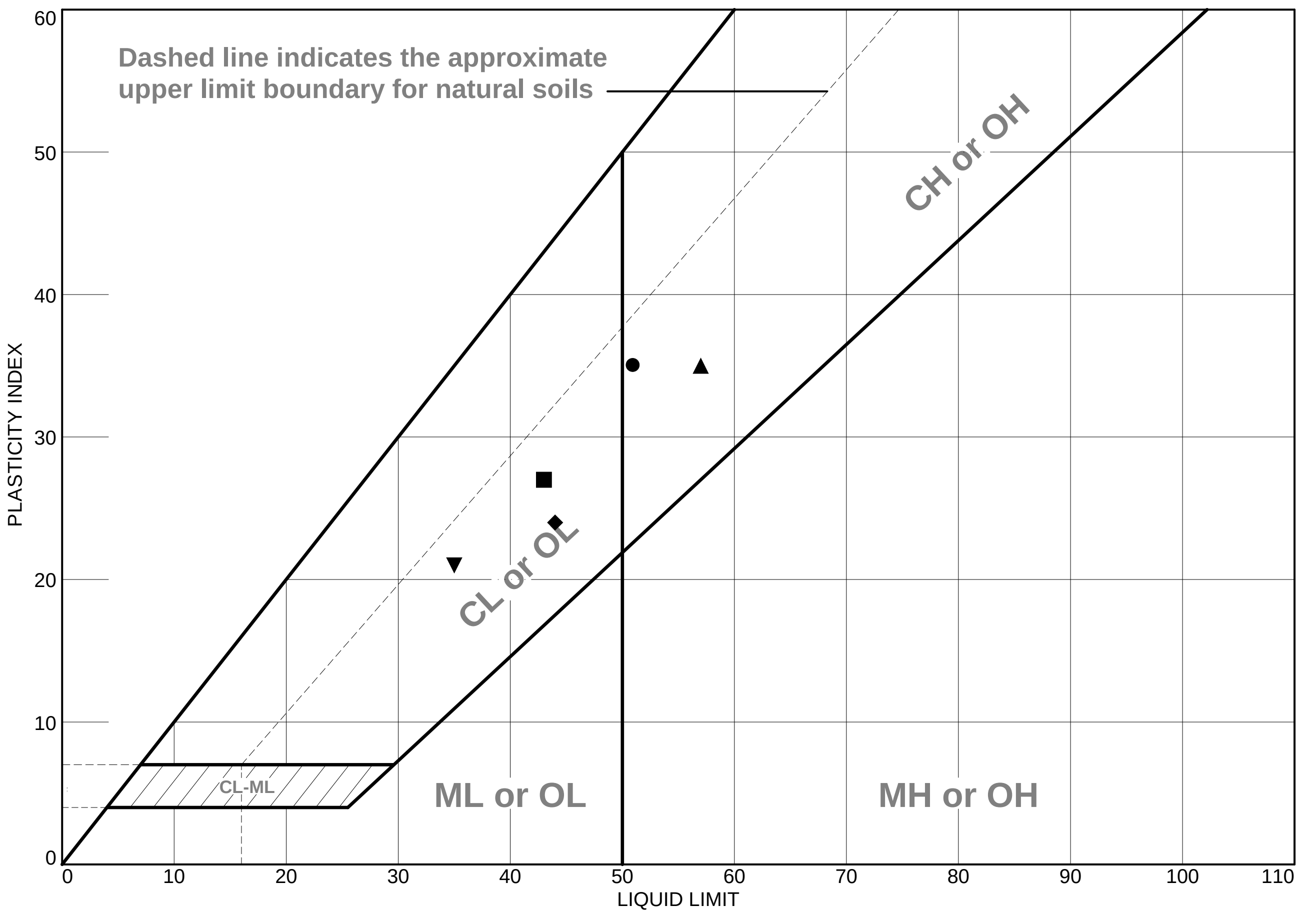
●**Depth:** 3.0 feet **Sample Number:** 1-B01 @ 3
■**Depth:** 26.0 feet **Sample Number:** 1-B01 @ 26
▲**Depth:** 21.0 feet **Sample Number:** 1-B02 @ 21
◆**Depth:** 31.0 feet **Sample Number:** 1-B02 @ 31
▼**Depth:** 10.0 feet **Sample Number:** 1-B04 @ 10

ENGEO INCORPORATED

Remarks:
●PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487
■ASTM D4318, Wet method
▲PI: ASTM D4318, Wet method
GS: ASTM D1140
◆ASTM D4318, Wet method
▼ASTM D4318, Wet method

Tested By: ○ M. Quasem □ W. Miller △ W. Miller ◇ W. Miller ▽ W. Miller **Checked By:** G. Criste

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	51	16	35			
■	See exploration logs	43	16	27	95.1	74.8	CL
▲	See exploration logs	57	22	35			
◆	See exploration logs	44	20	24	100.0	64.3	CL
▼	See exploration logs	35	14	21			

Project No. 7843.001.001 **Client:** Bates Stringer Oak Park, LLC

Project: 1750 Oak Park Boulevard

●**Depth:** 31.0 feet **Sample Number:** 1-B04 @ 31
■**Depth:** 2.5 feet **Sample Number:** 1-B05 @ 2.5
▲**Depth:** 28.0 feet **Sample Number:** 1-B06 @ 28
◆**Depth:** 3.0 feet **Sample Number:** 1-B07 @ 3
▼**Depth:** 8.0 feet **Sample Number:** 1-B07 @ 8

ENGEO INCORPORATED

Remarks:
●ASTM D4318, Wet method
■PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487
▲ASTM D4318, Wet method
◆PI: ASTM D4318, Wet method
GS: ASTM D422
USCS: ASTM D2487
▼ASTM D4318, Wet method

Tested By: ○ W. Miller □ W. Miller △ M. Quasem ◇ M. Quasem ▽ M. Quasem **Checked By:** G. Criste

APPENDIX C

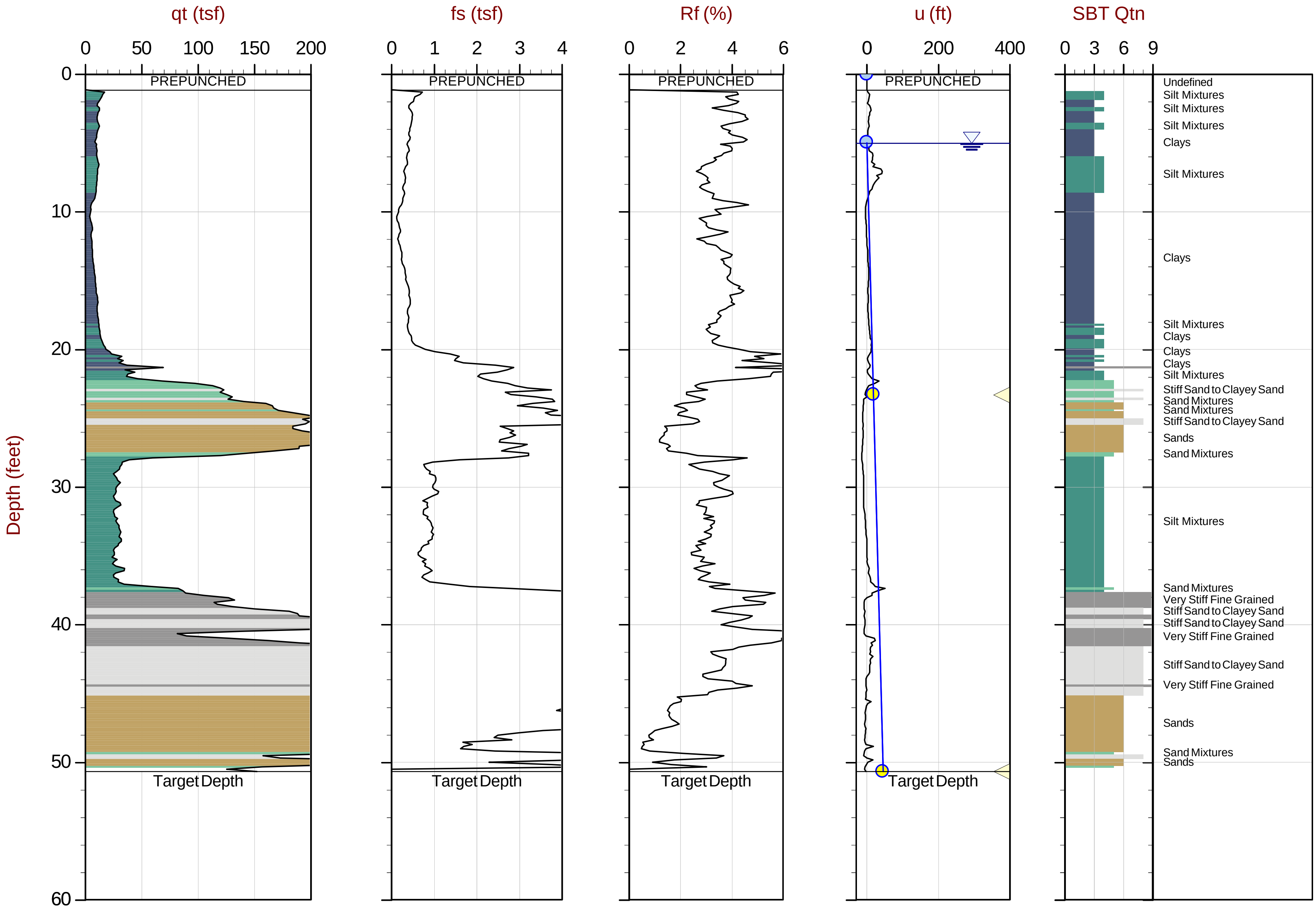
CPT DATA

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 08:17
Site: 1750 Oak Park Blvd.

Sounding: 1-CPT01
Cone: 448:T1500F15U500



Max Depth: 15.450 m / 50.69 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56083_CP01.COR
Unit Wt: SBTQtn (PKR2009)

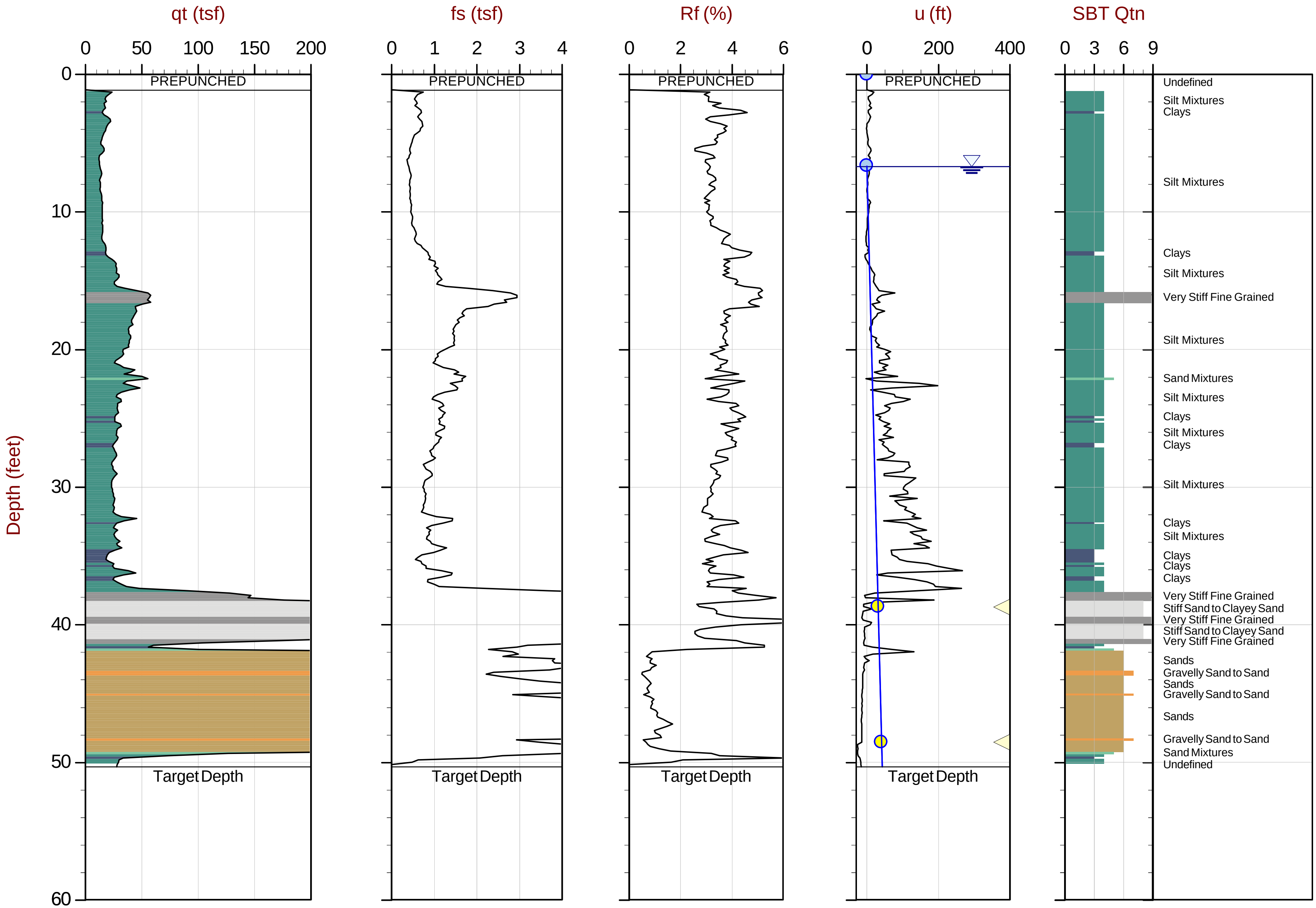
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198884m E: 581860m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 11:55
Site: 1750 Oak Park Blvd.
Sounding: 1-CPT02
Cone: 448:T1500F15U500



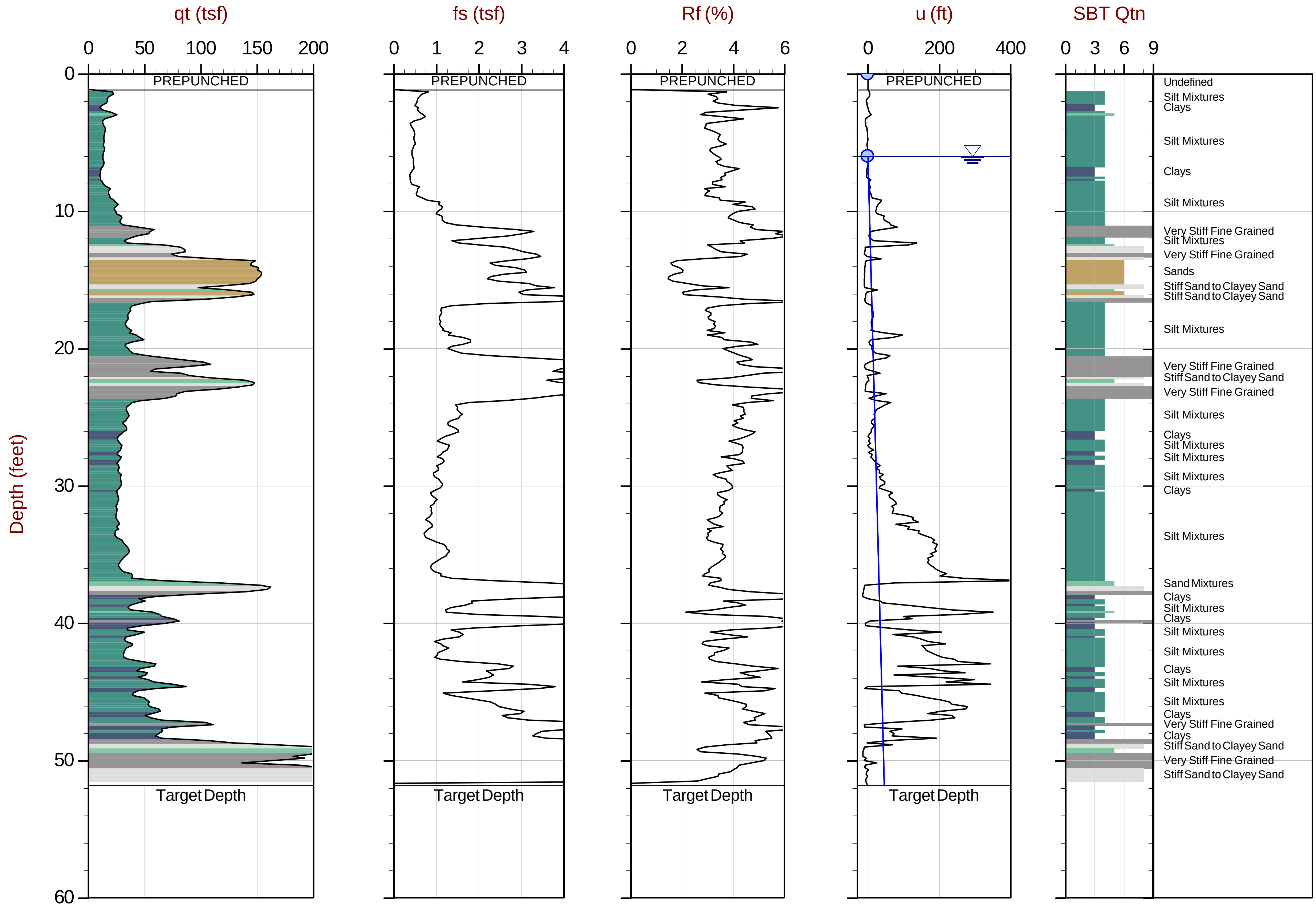
Max Depth: 15.350 m / 50.36 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
File: 18-56083_CP02.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198919m E: 581848m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 11:22
Site: 1750 Oak Park Blvd.
Sounding: 1-CPT03
Cone: 448:T1500F15U500



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56083_CP03.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198922m E: 581805m
Page No: 1 of 1

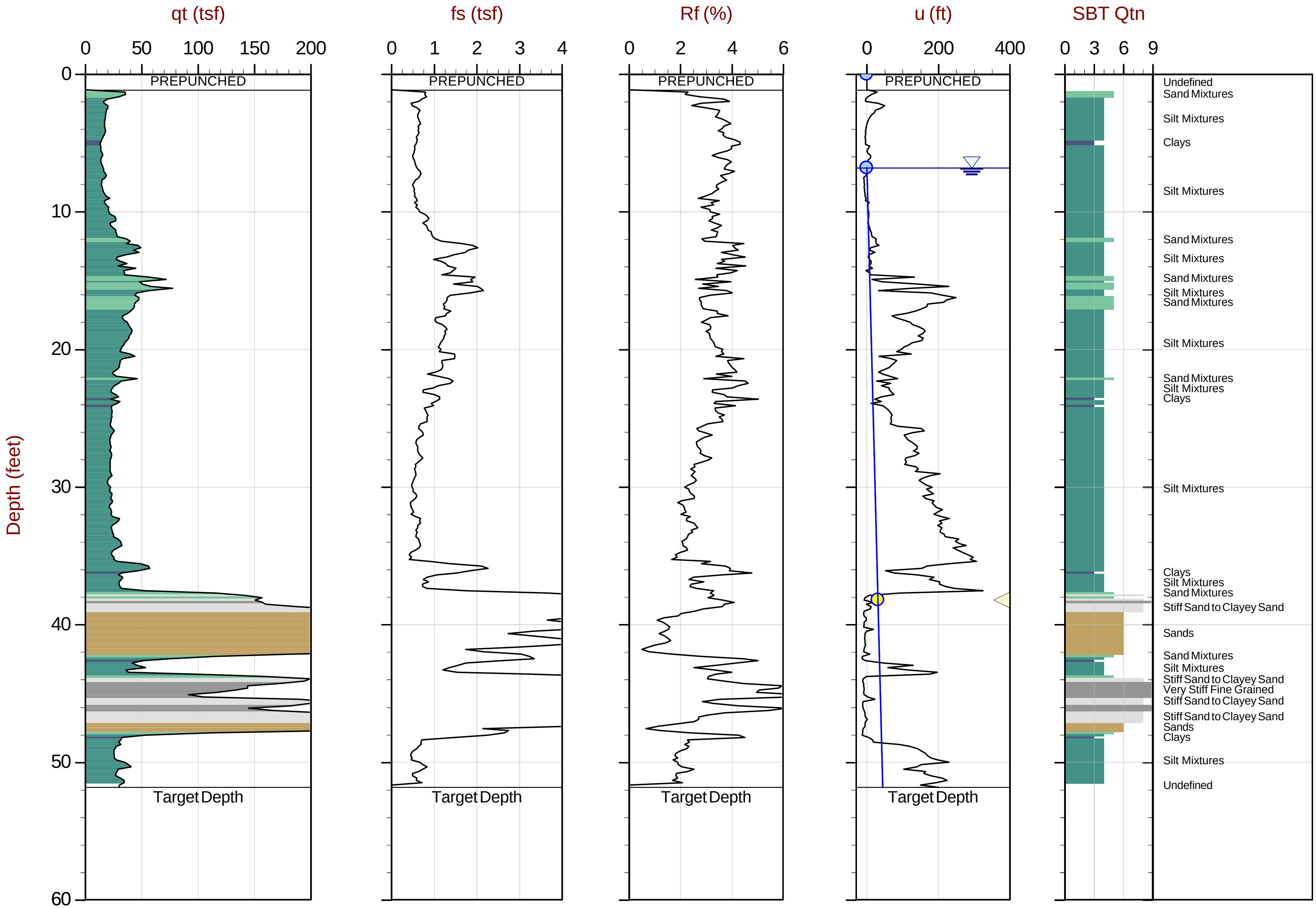
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 10:17
Site: 1750 Oak Park Blvd.

Sounding: 1-CPT04
Cone: 448:T1500F15U500



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56083_SP04.COR
Unit Wt: SBTQtn (PKR2009)

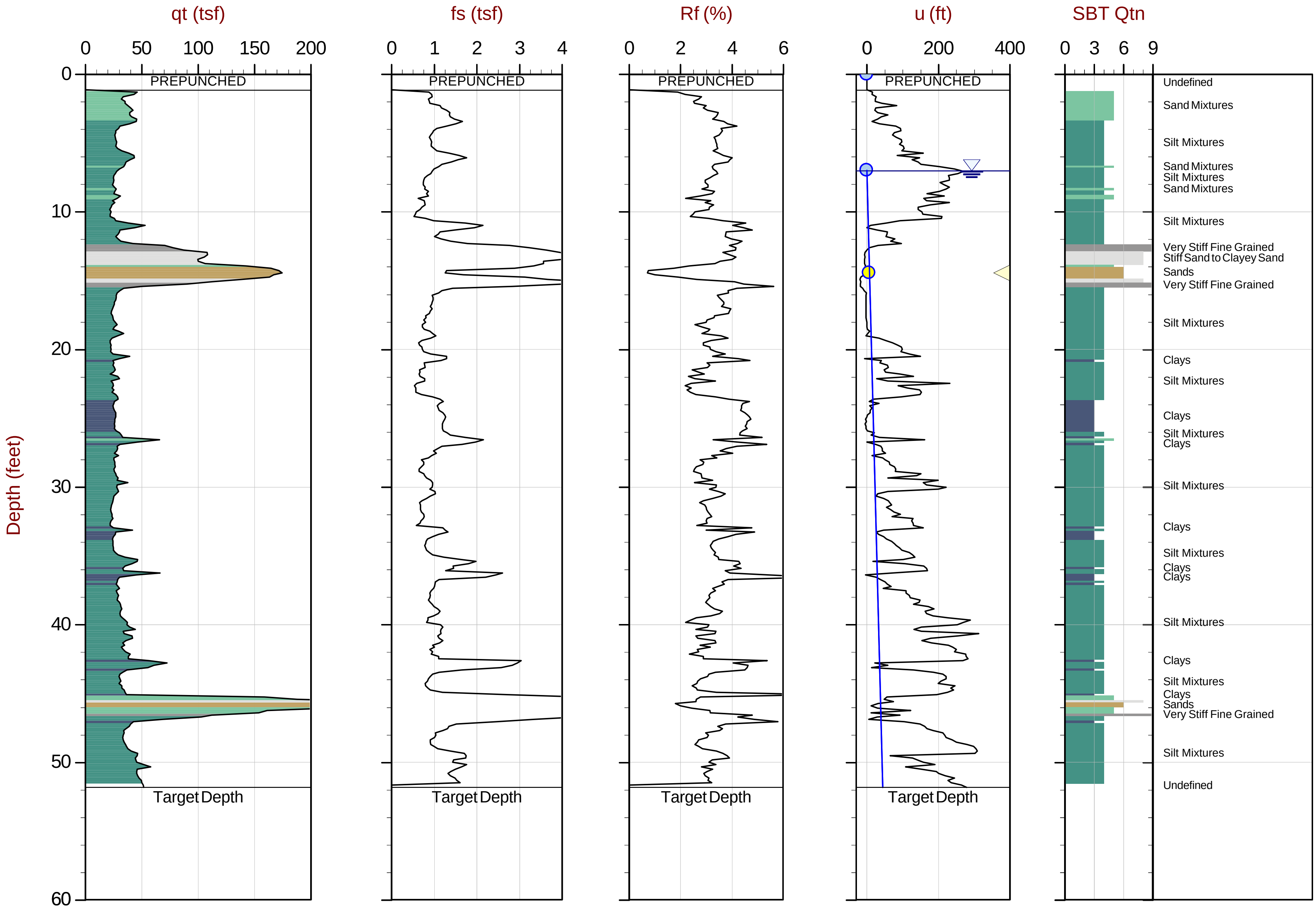
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198935m E: 581834m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 13:29
Site: 1750 Oak Park Blvd.
Sounding: 1-CPT05
Cone: 448:T1500F15U500



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56083_CP05.COR
Unit Wt: SBTQtn (PKR2009)

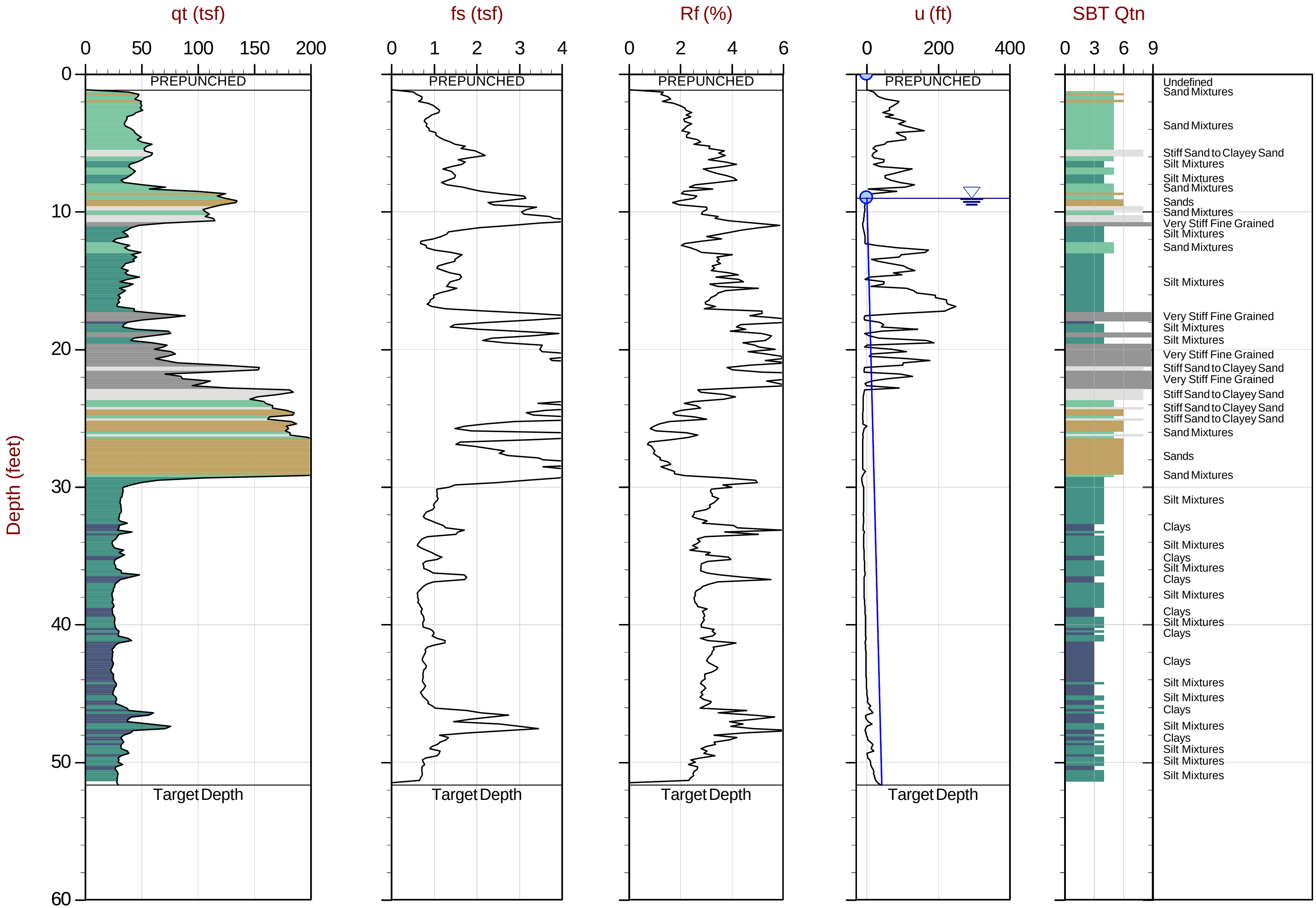
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4199032m E: 581811m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 12:50
Site: 1750 Oak Park Blvd.
Sounding: 1-CPT06
Cone: 448:T1500F15U500



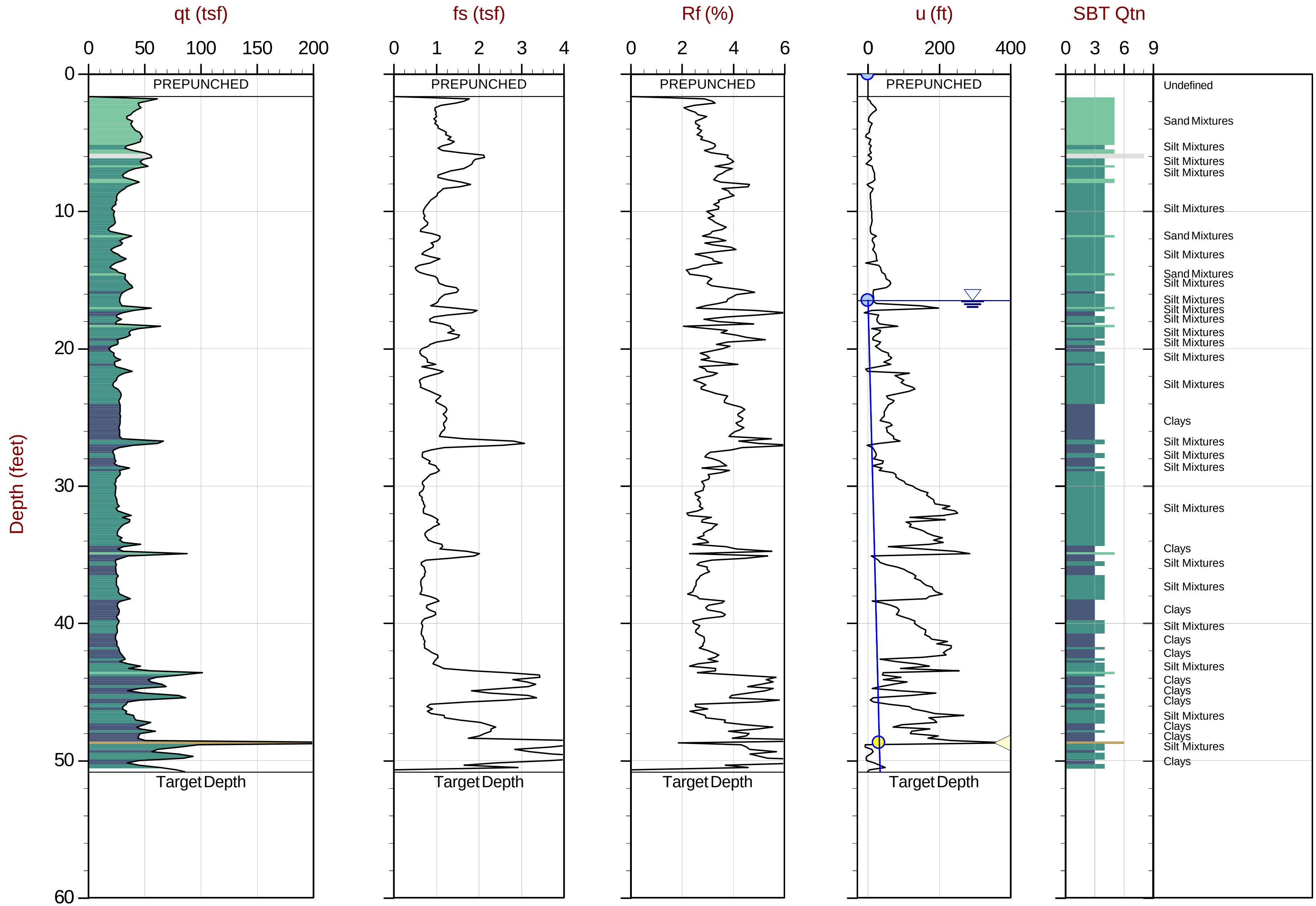
Max Depth: 15.750 m / 51.67 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
File: 18-56083_CP06.COR
Unit Wt: SBTQtn (PKR2009)
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4199008m E: 581816m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56083
Date: 2018-05-29 14:17
Site: 1750 Oak Park Blvd.
Sounding: 1-CPT07
Cone: 448:T1500F15U500



Max Depth: 15.500 m / 50.85 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56083_CP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4199076m E: 581806m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

APPENDIX D

LIQUEFACTION ANALYSIS

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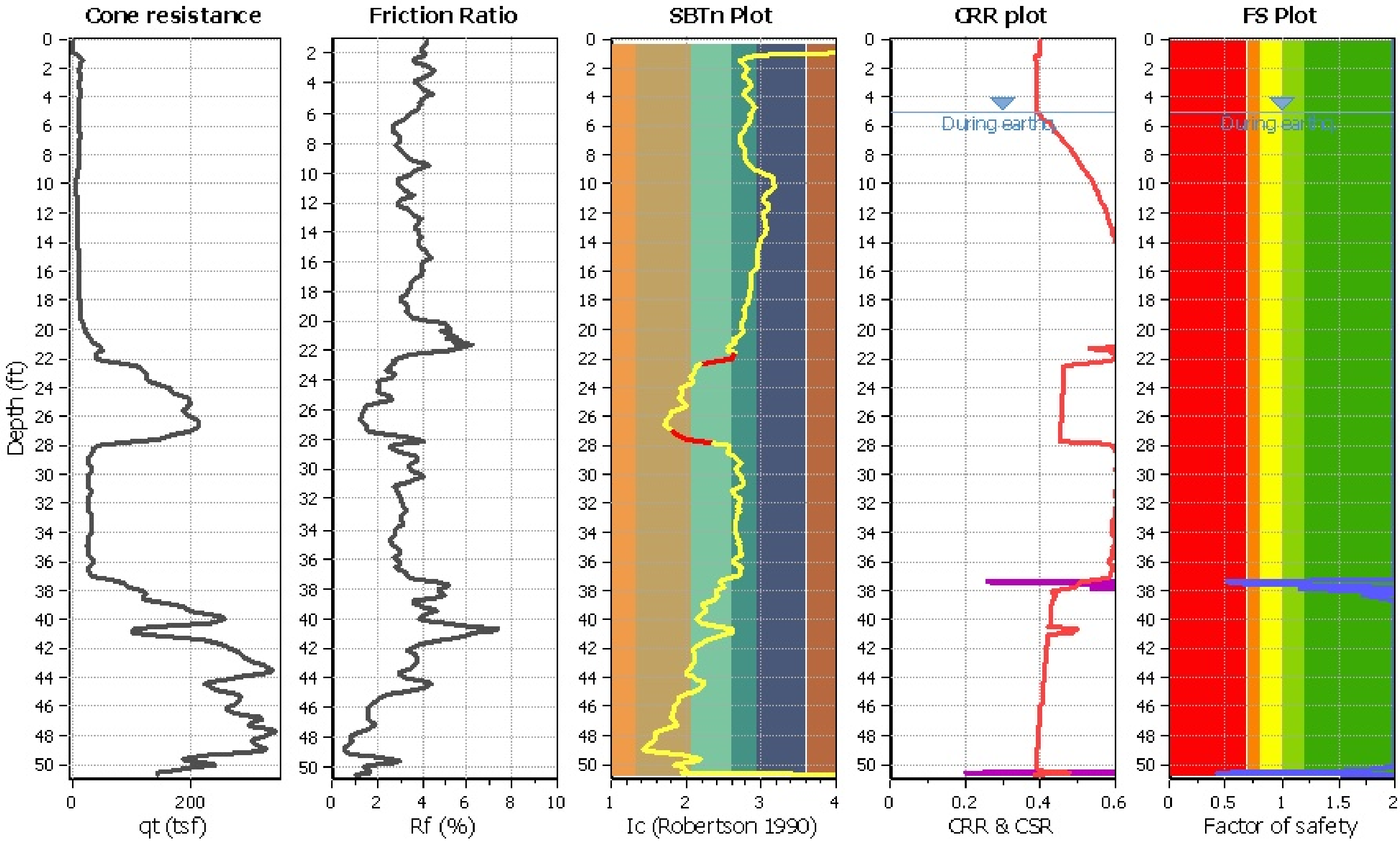
LIQUEFACTION ANALYSIS REPORT

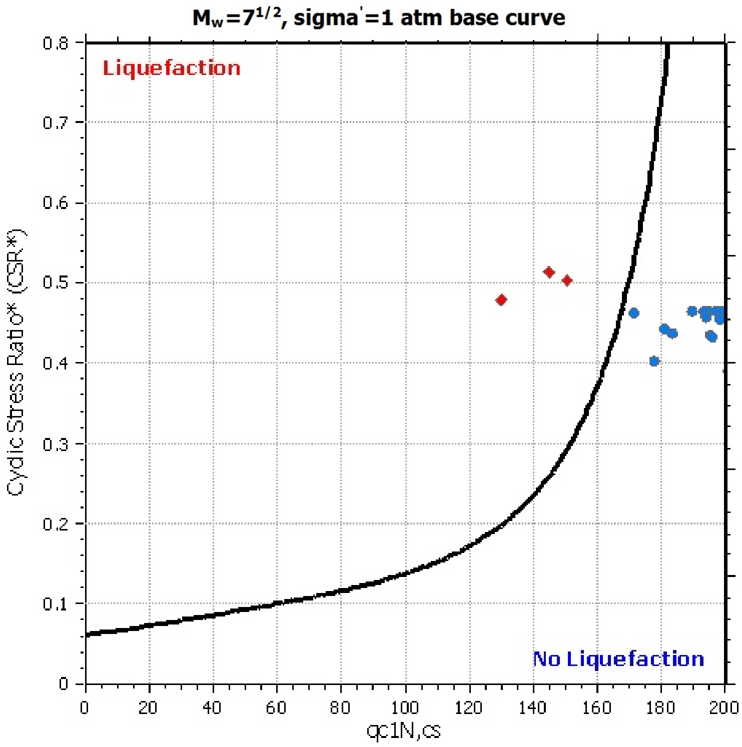
Project title : 1750 Oak Park Blvd. **Location :**

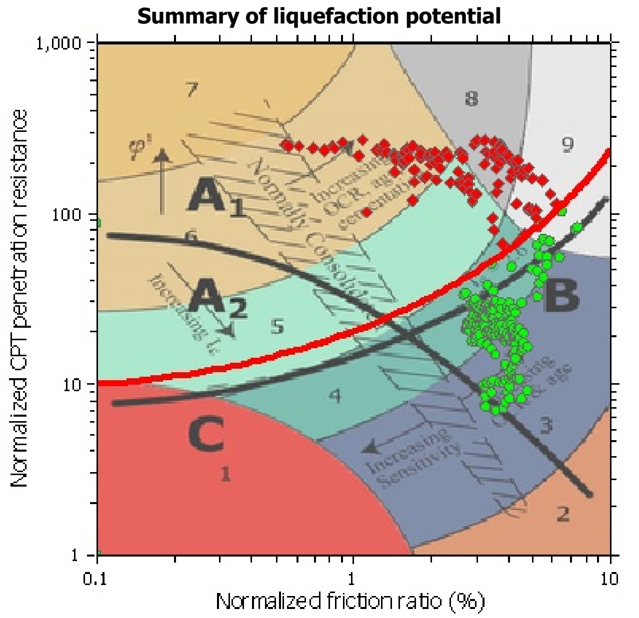
CPT file : 1-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

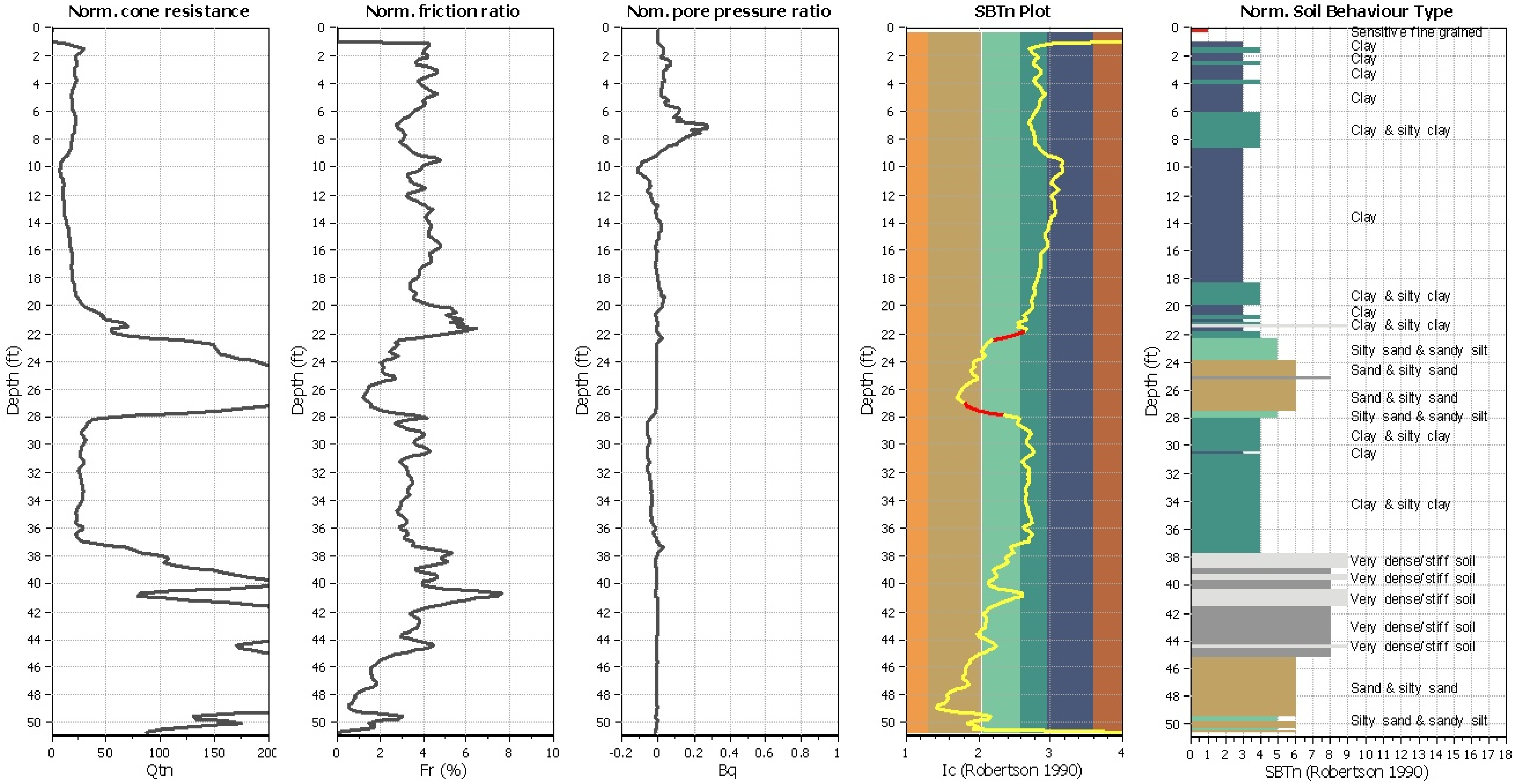






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



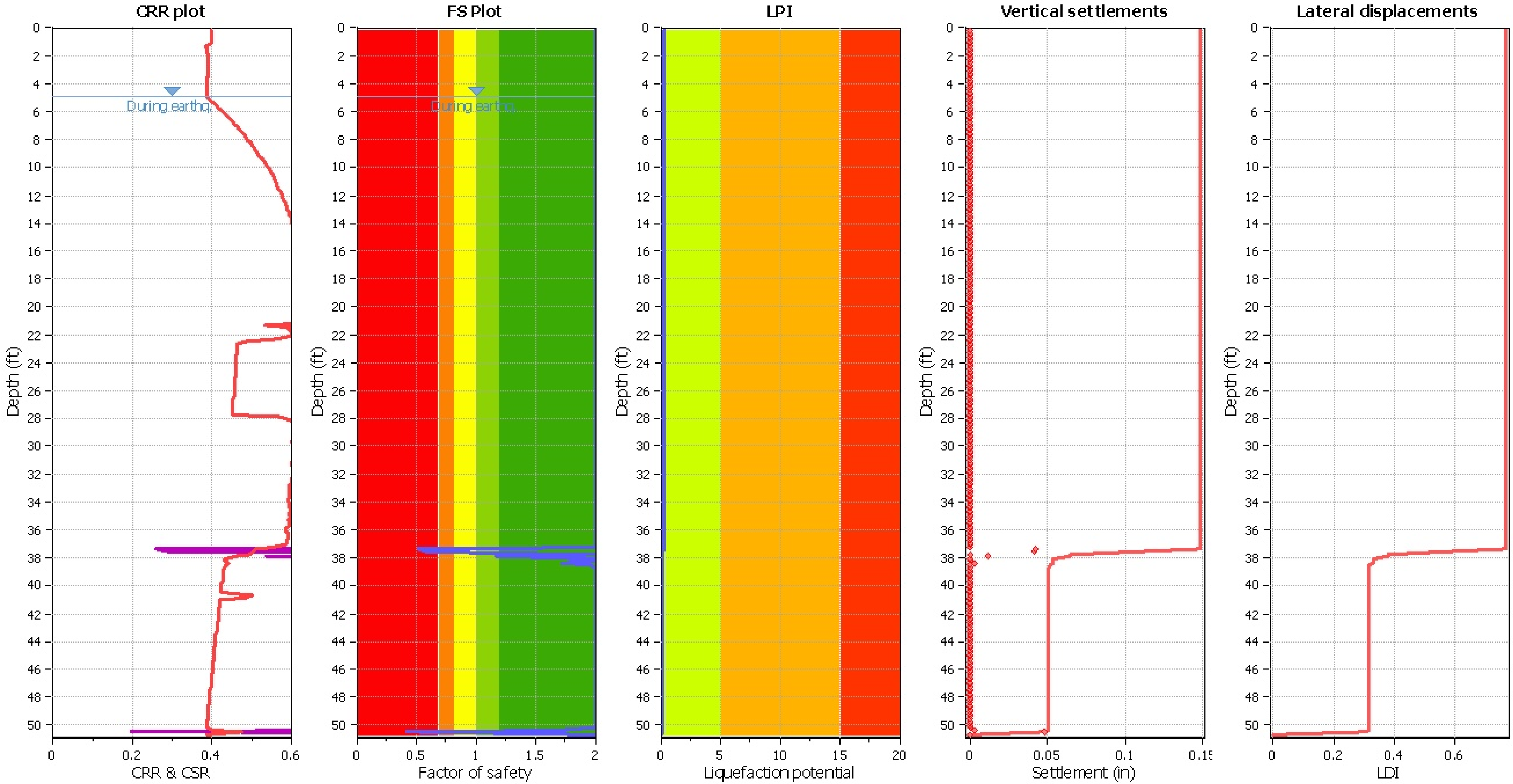
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

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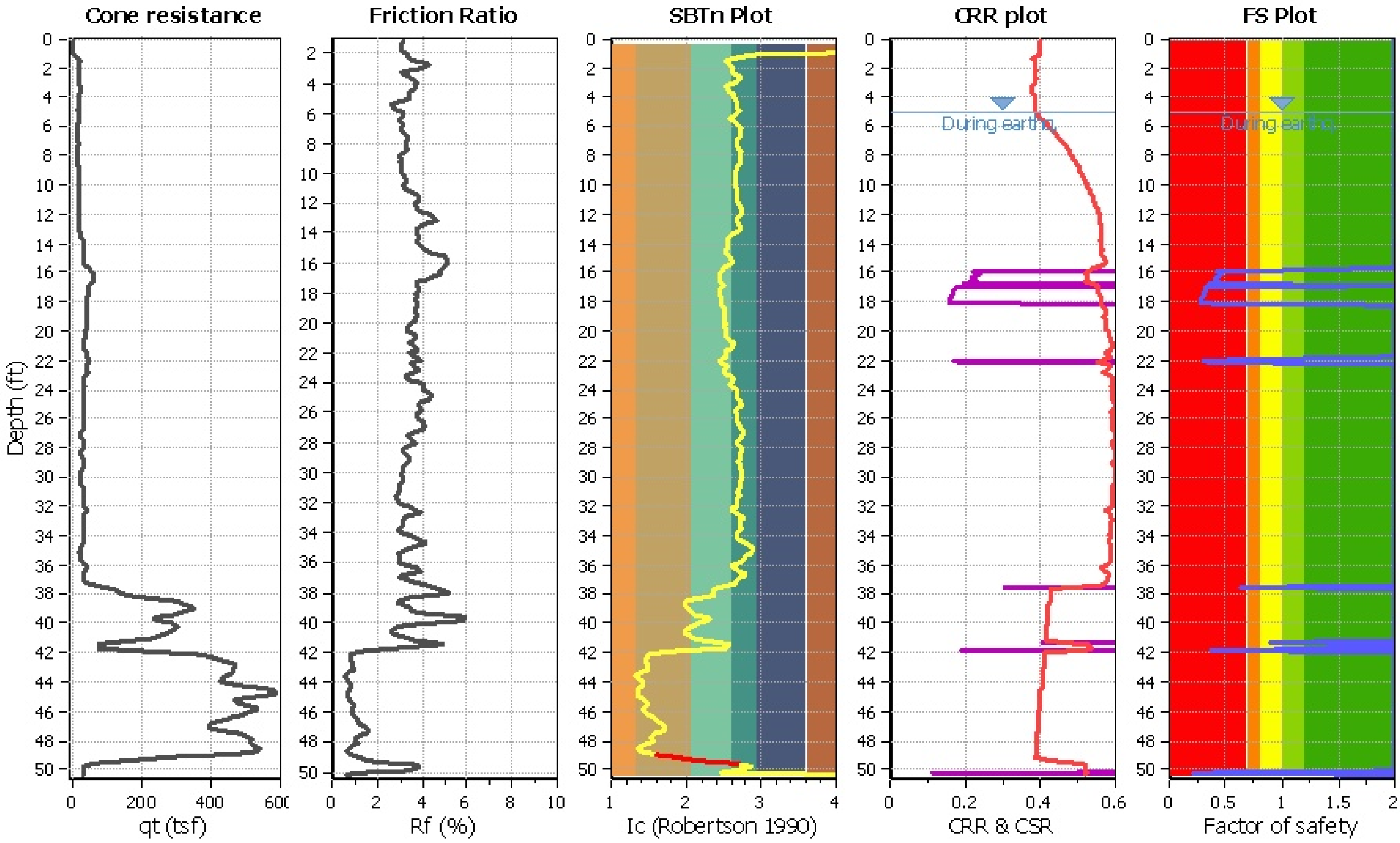
LIQUEFACTION ANALYSIS REPORT

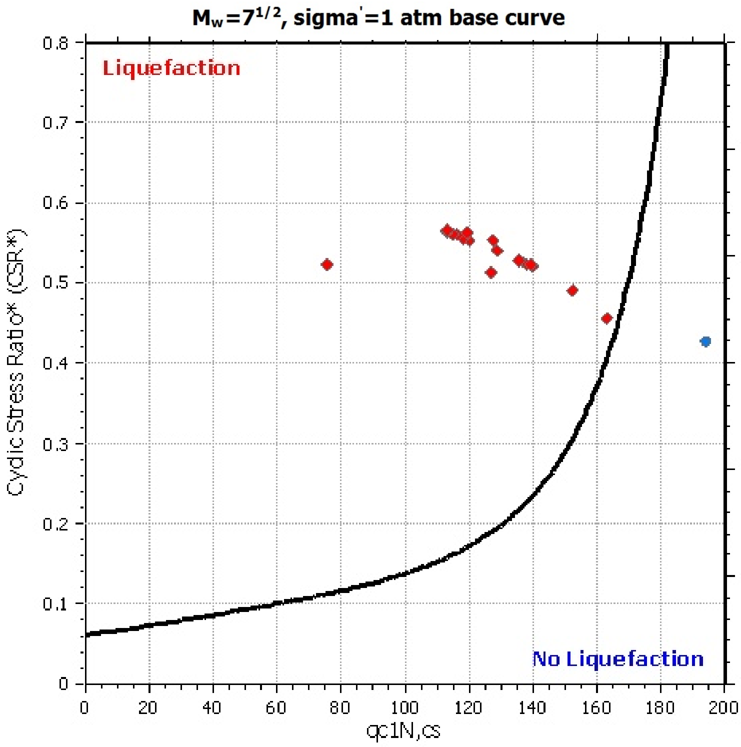
Project title : 1750 Oak Park Blvd. **Location :**

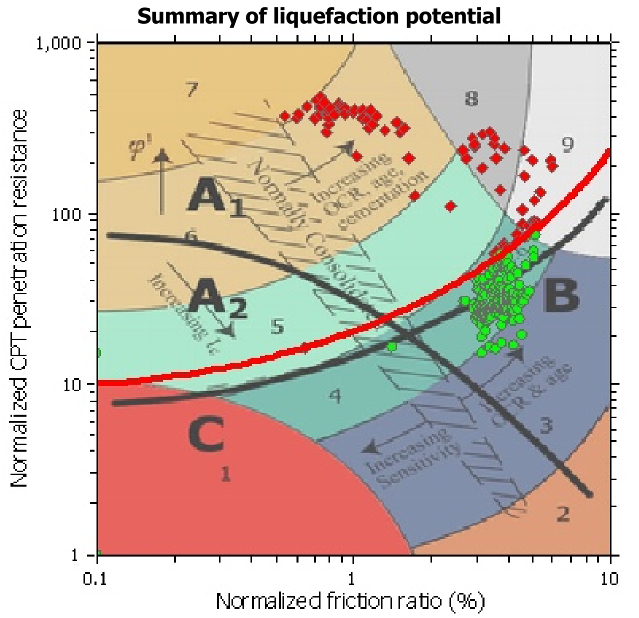
CPT file : 1-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

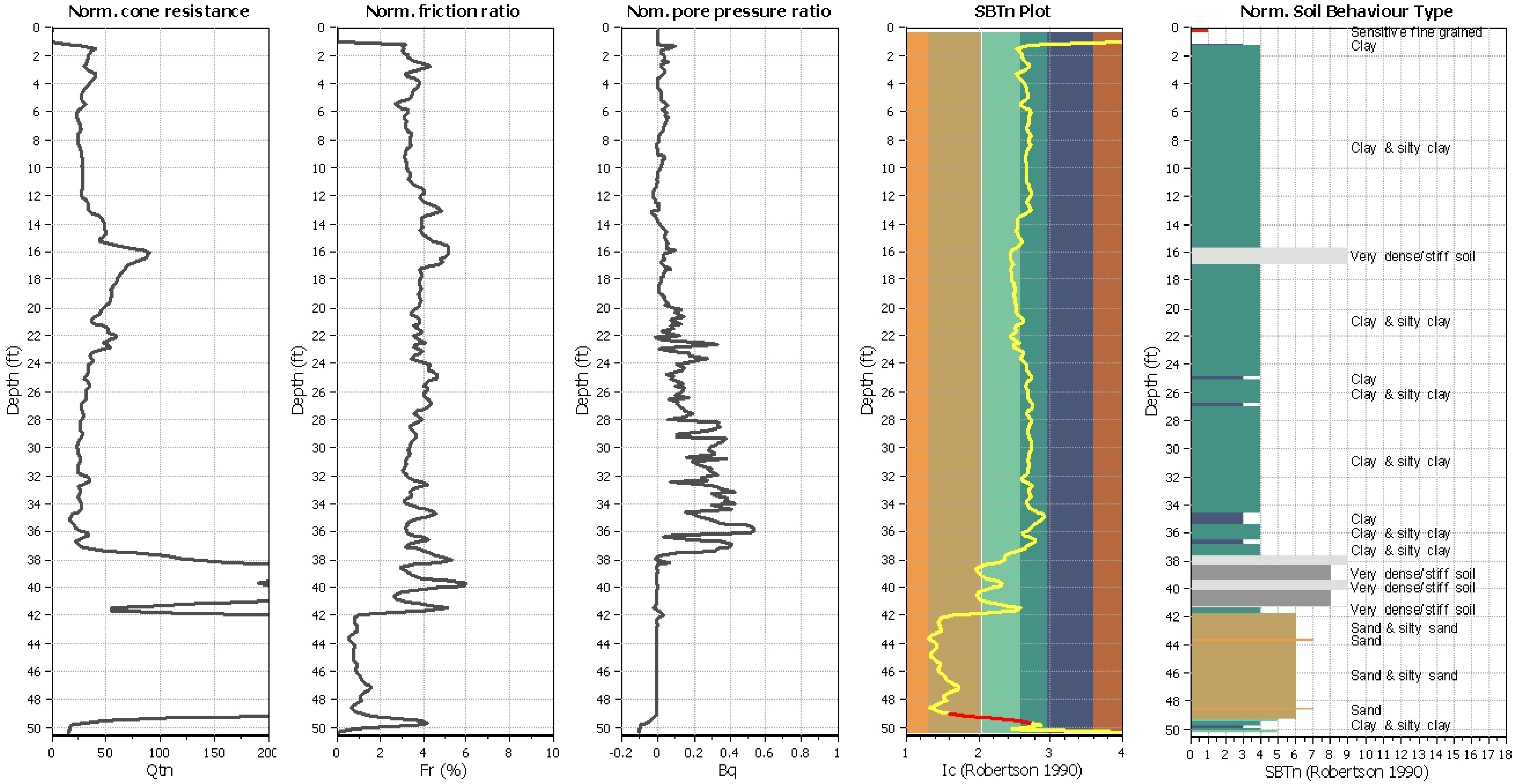






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



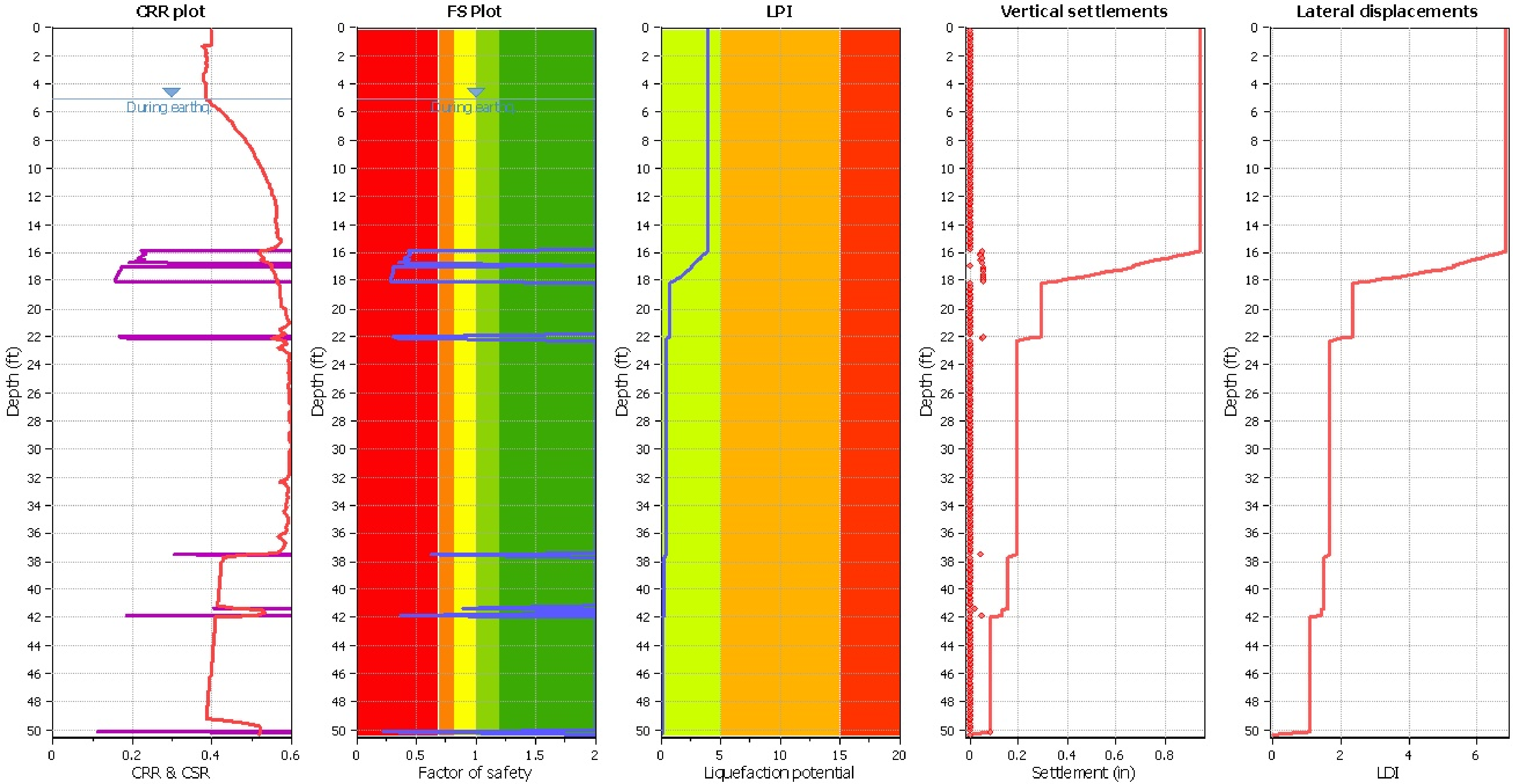
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

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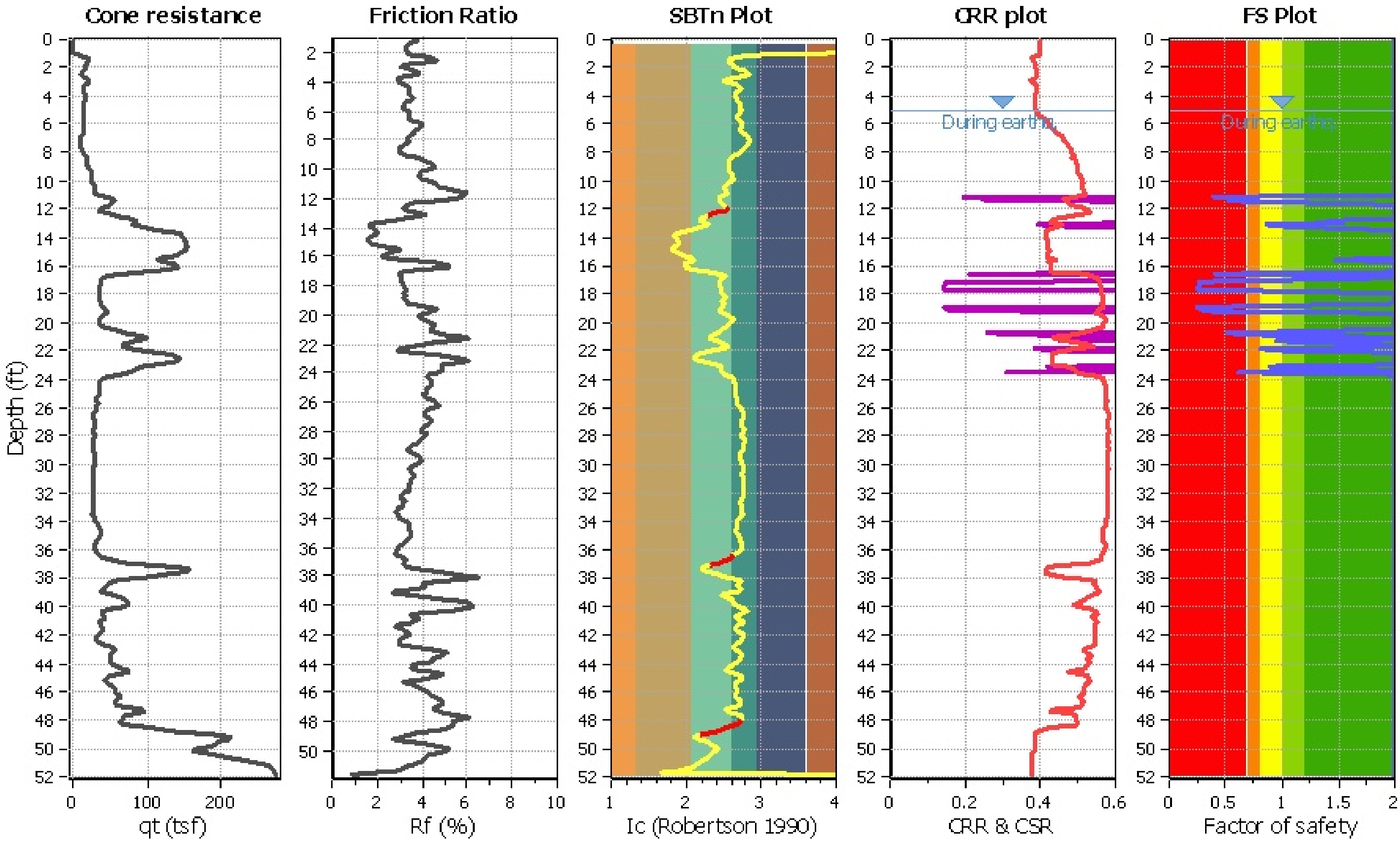
LIQUEFACTION ANALYSIS REPORT

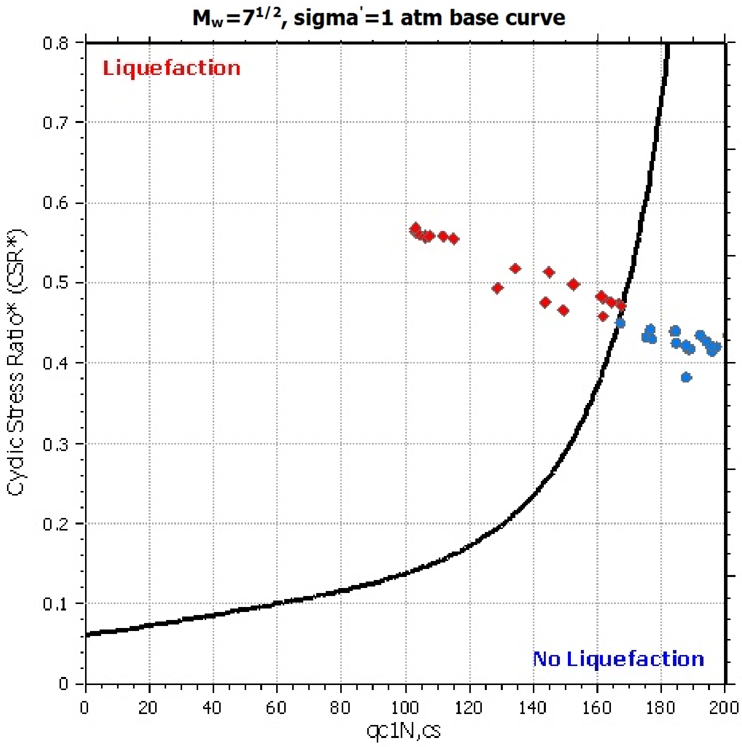
Project title : 1750 Oak Park Blvd. **Location :**

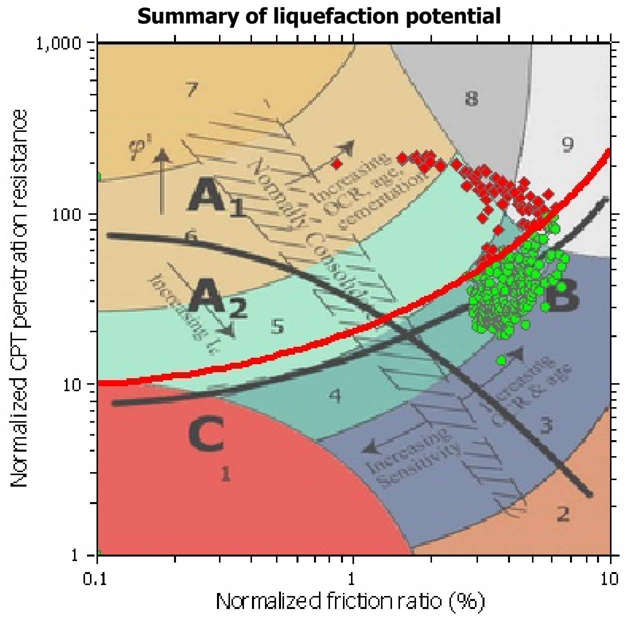
CPT file : 1-CPT3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

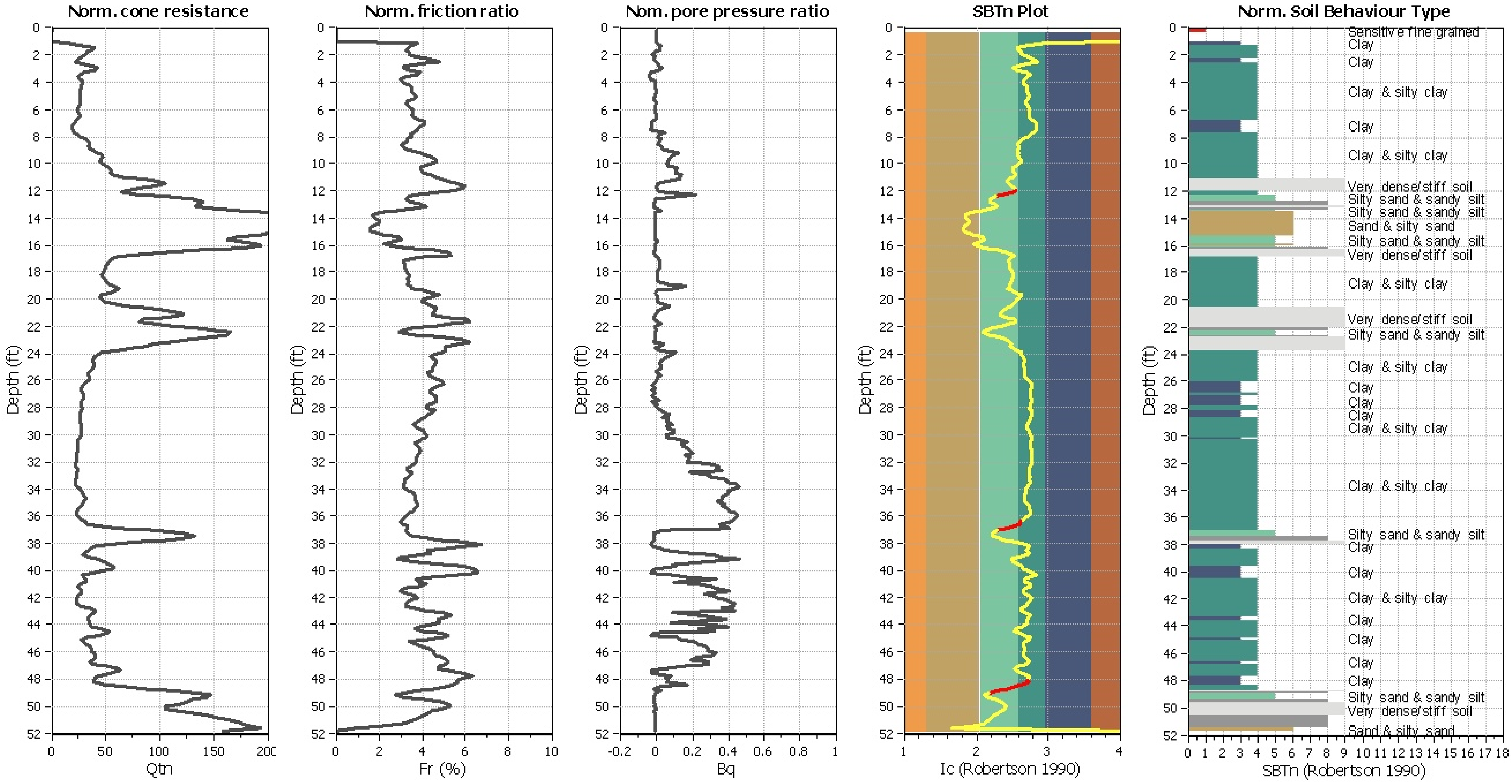






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



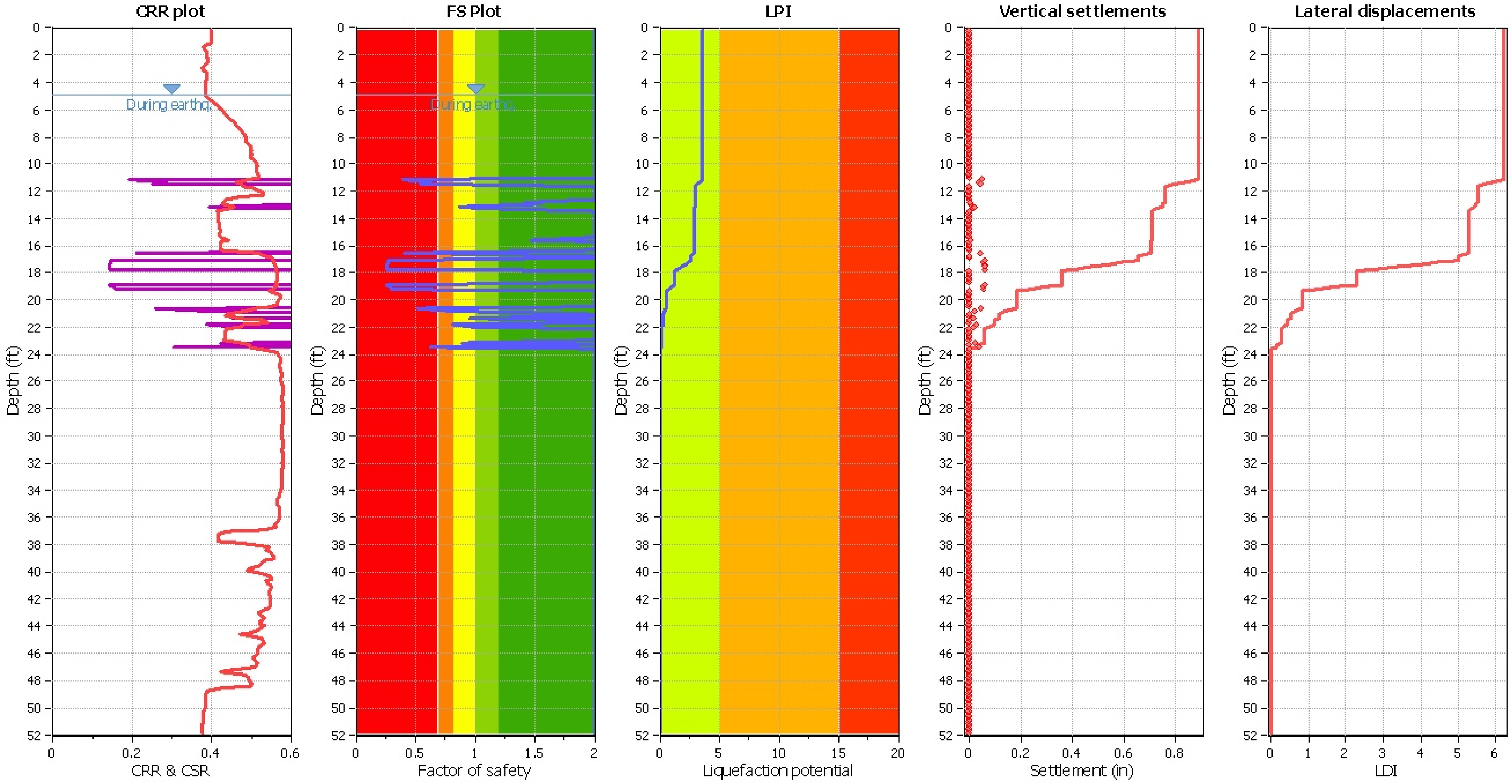
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

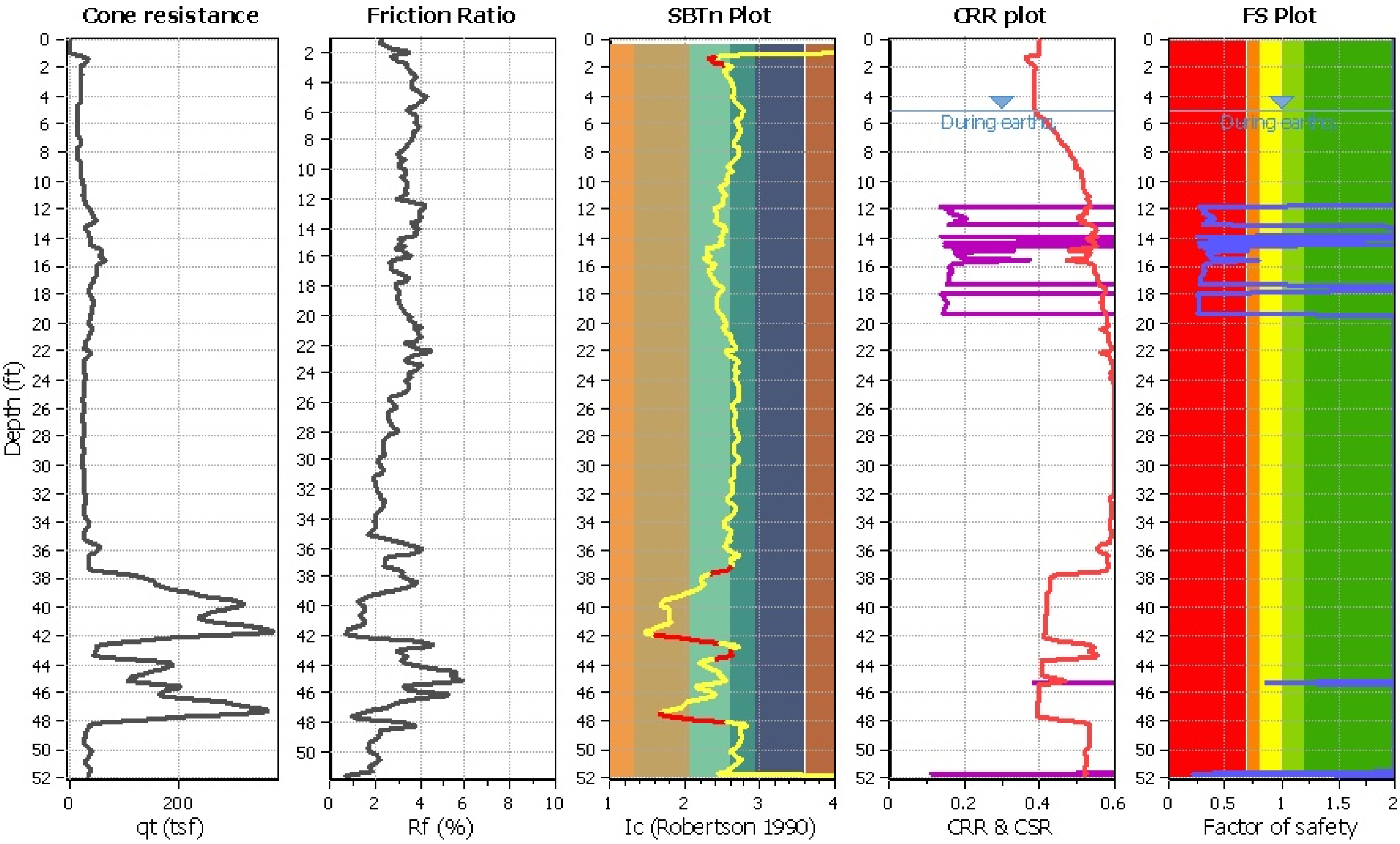
LIQUEFACTION ANALYSIS REPORT

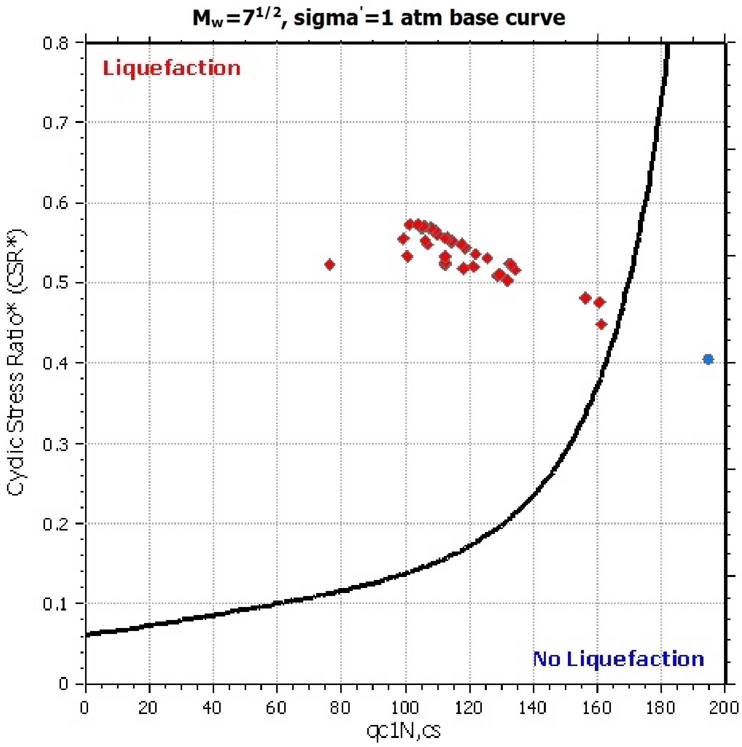
Project title : 1750 Oak Park Blvd. **Location :**

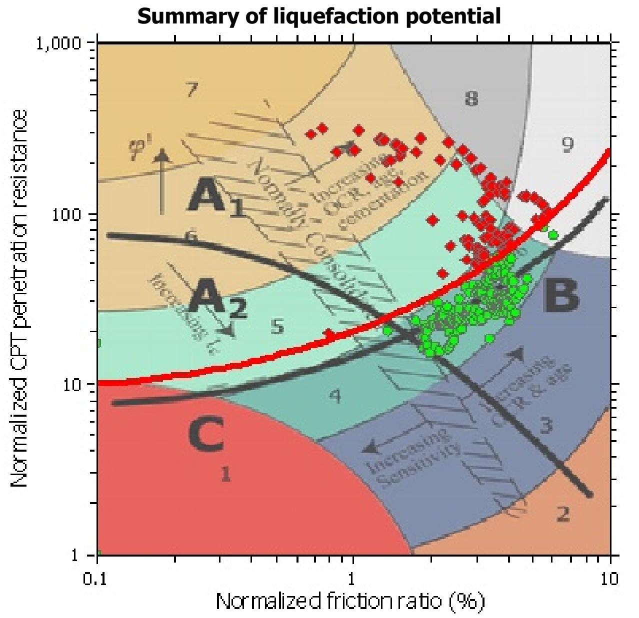
CPT file : 1-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

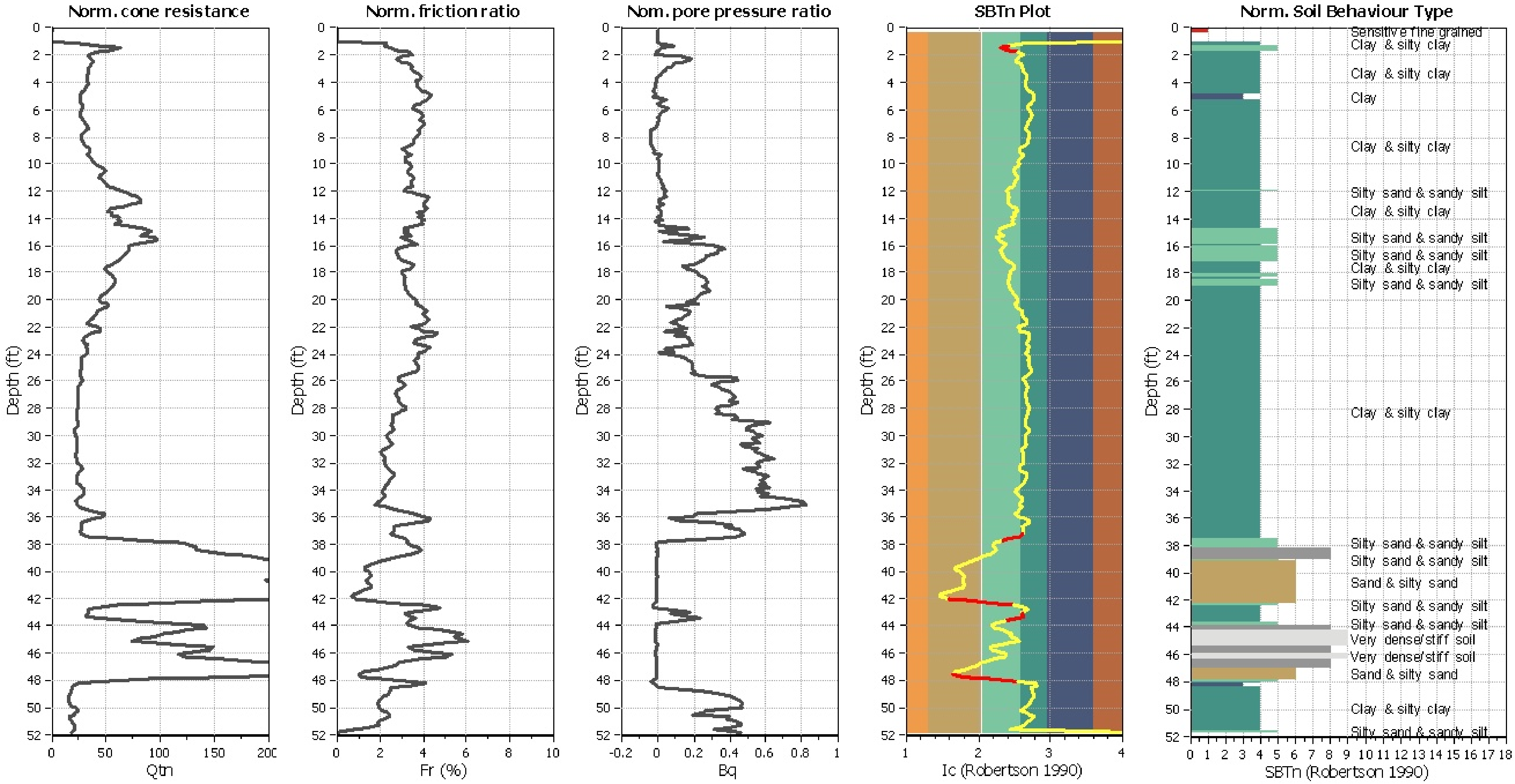






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



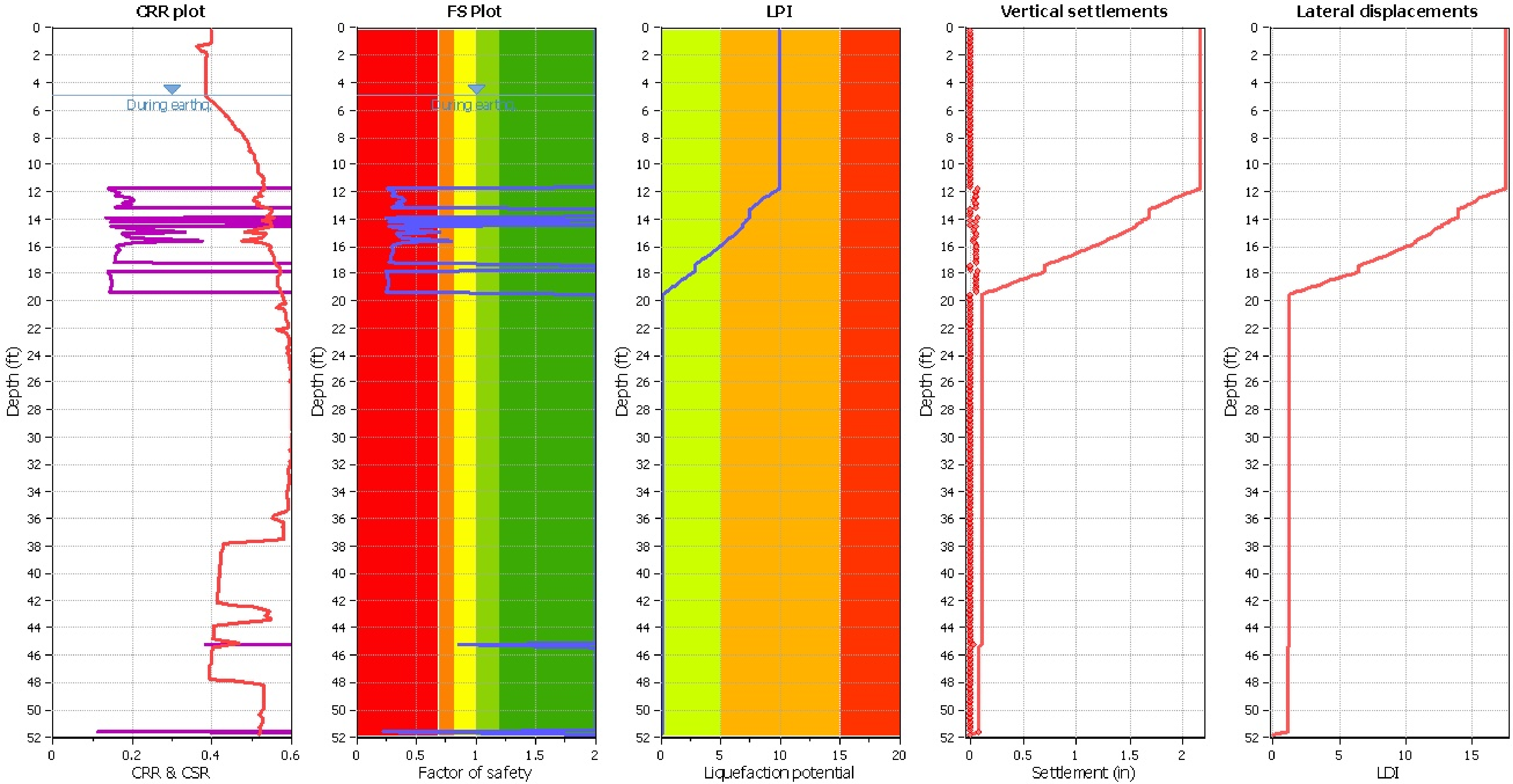
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

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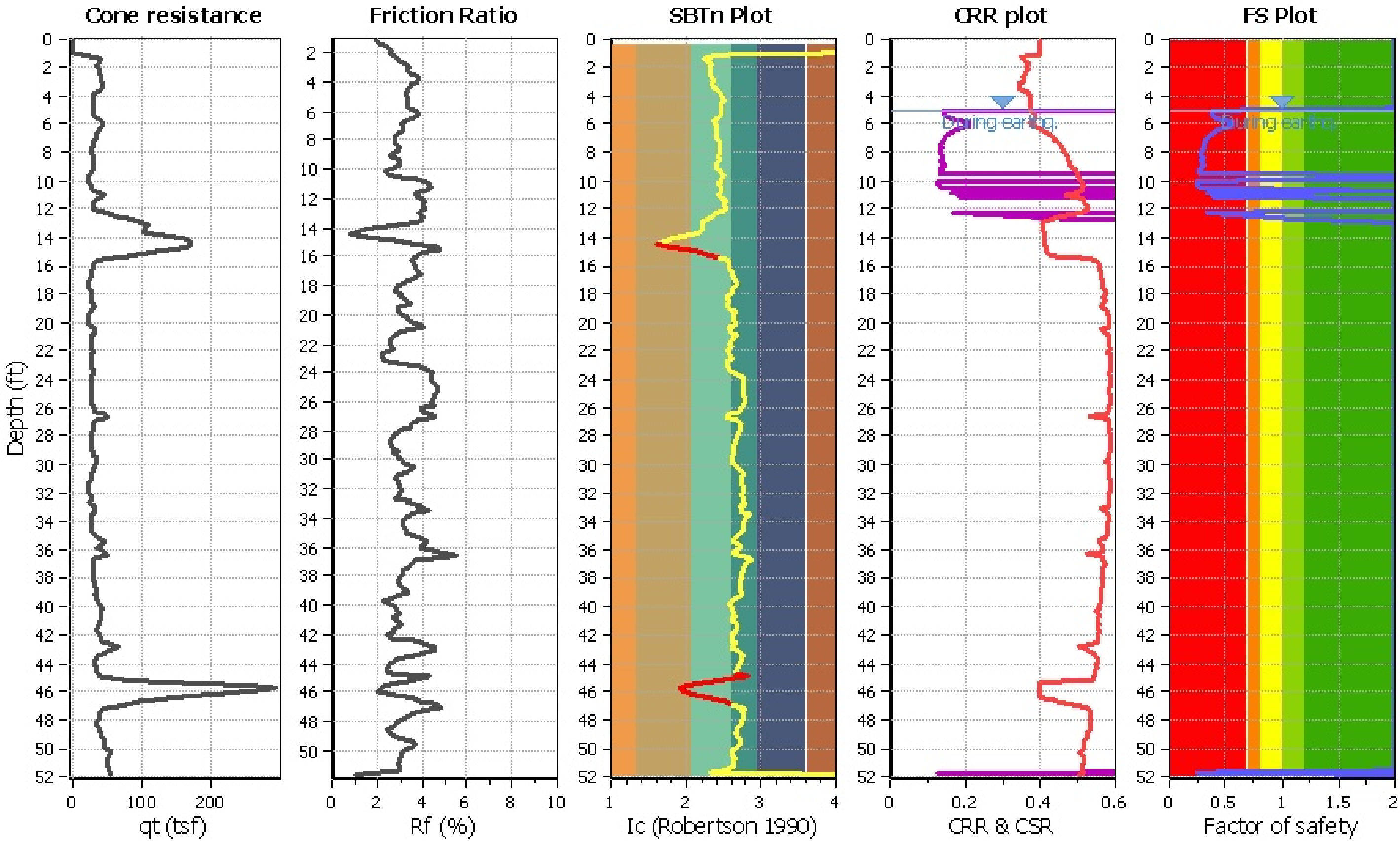
LIQUEFACTION ANALYSIS REPORT

Project title : 1750 Oak Park Blvd. **Location :**

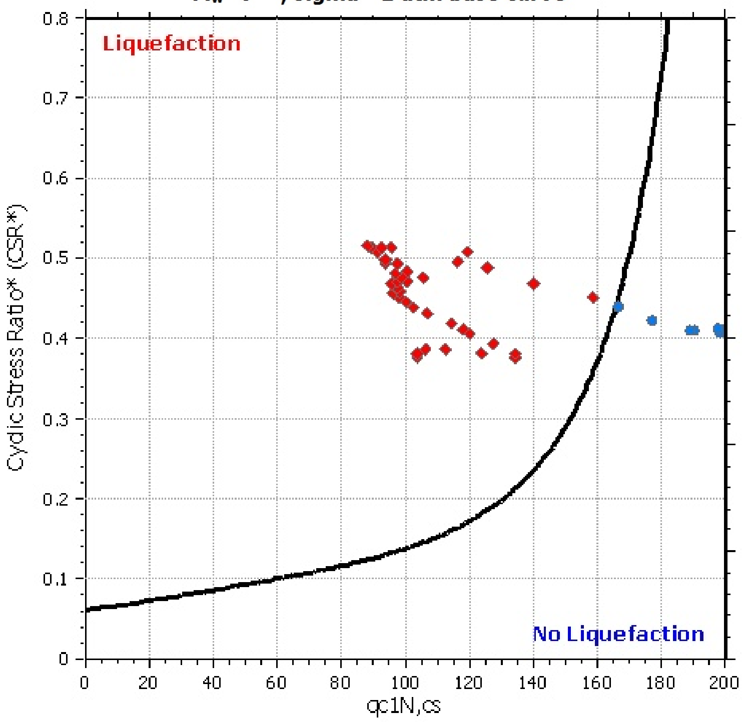
CPT file : 1-CPT5

Input parameters and analysis data

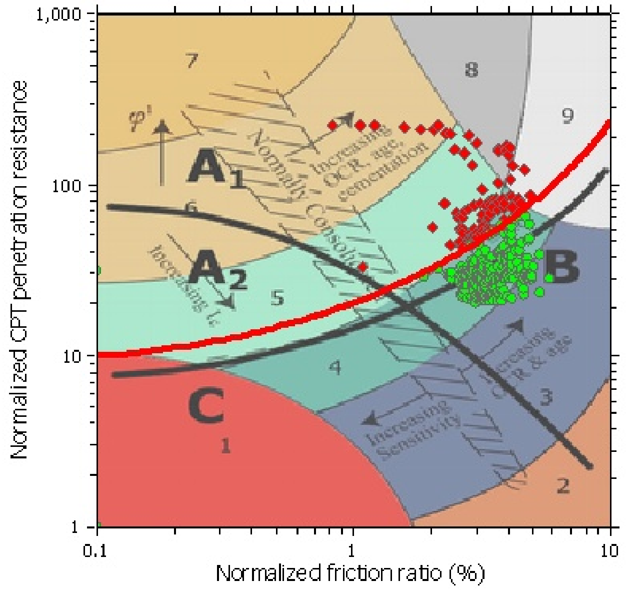
Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		



$M_w=7^{1/2}$, sigma'=1 atm base curve

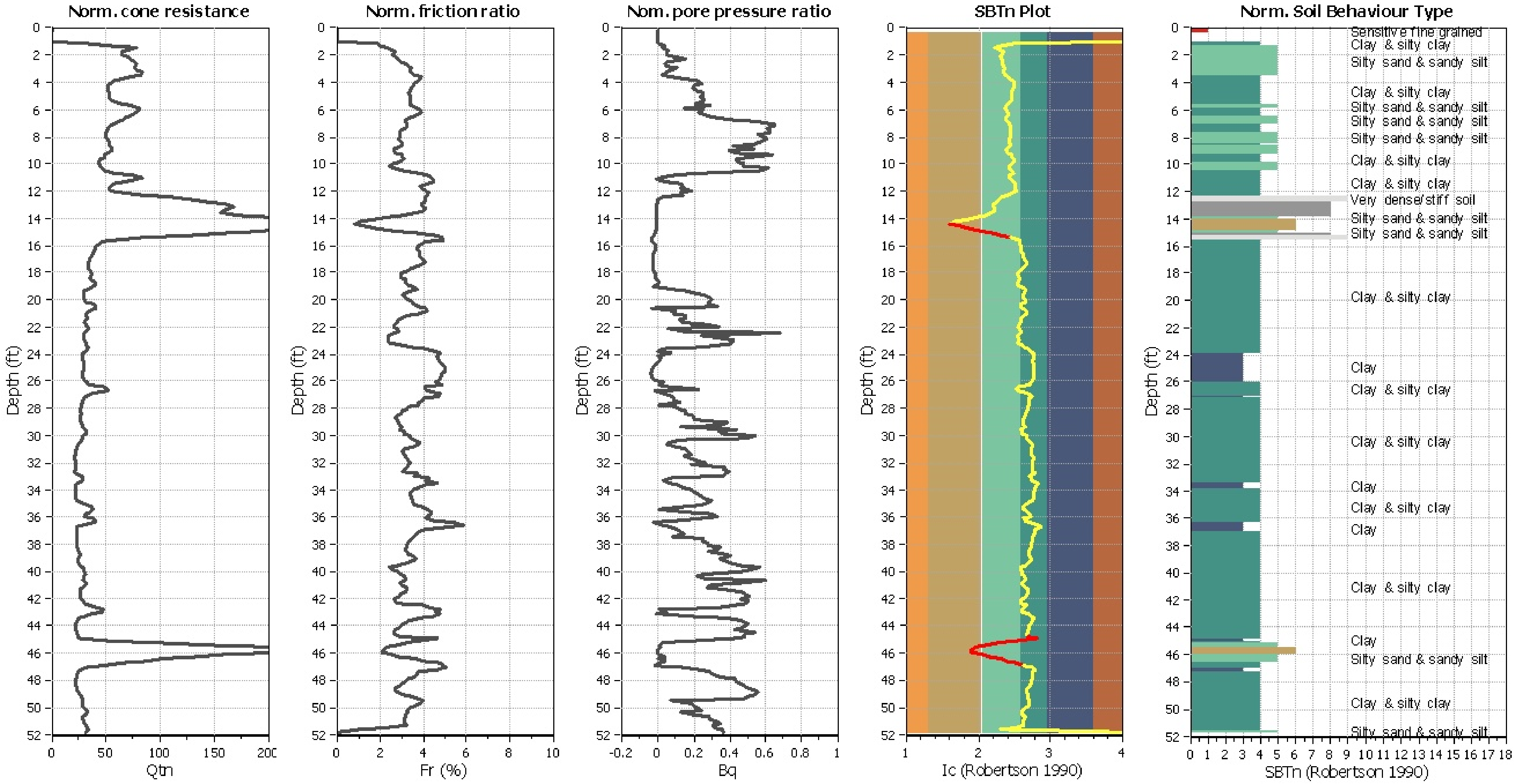


Summary of liquefaction potential



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 (normaliz



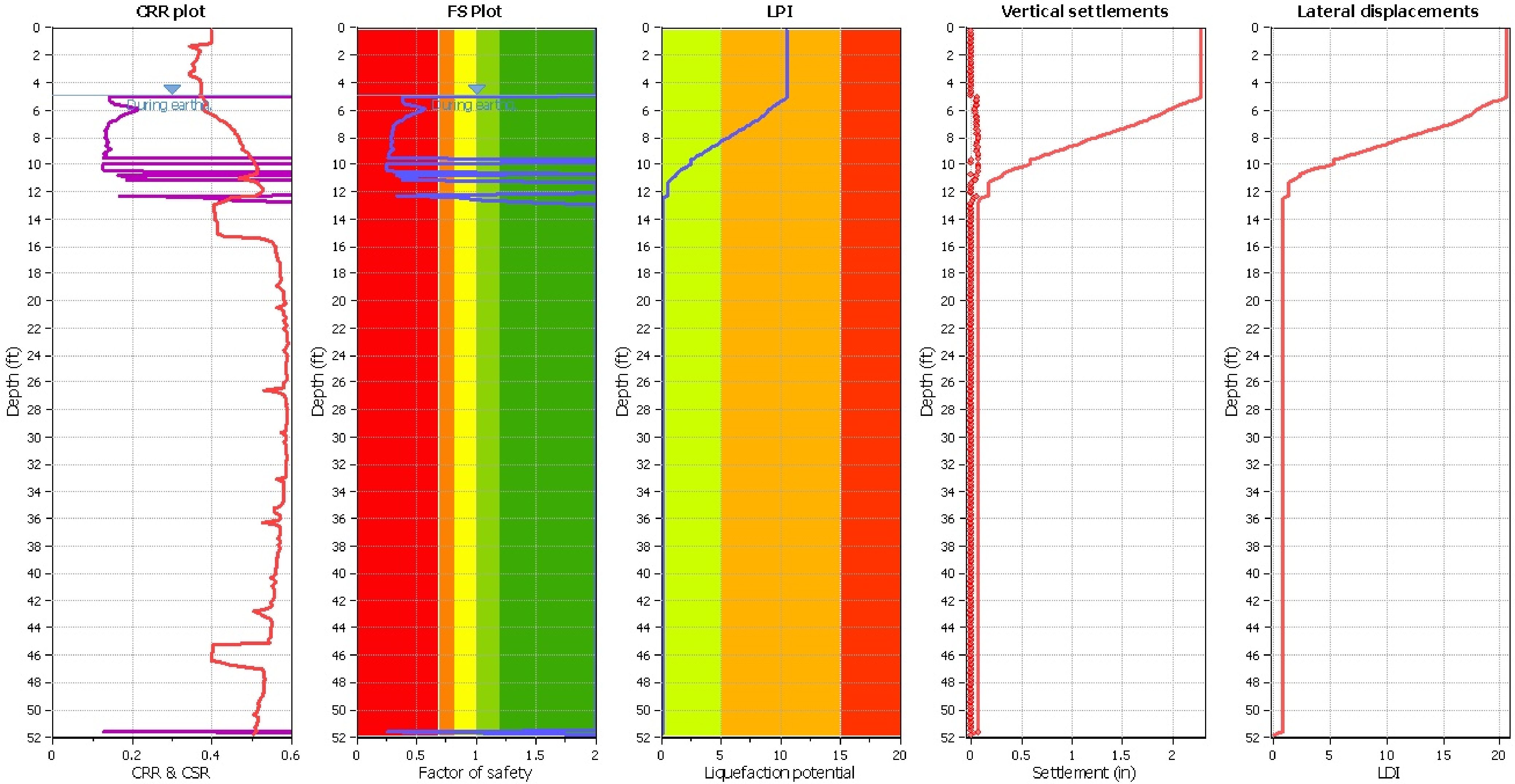
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

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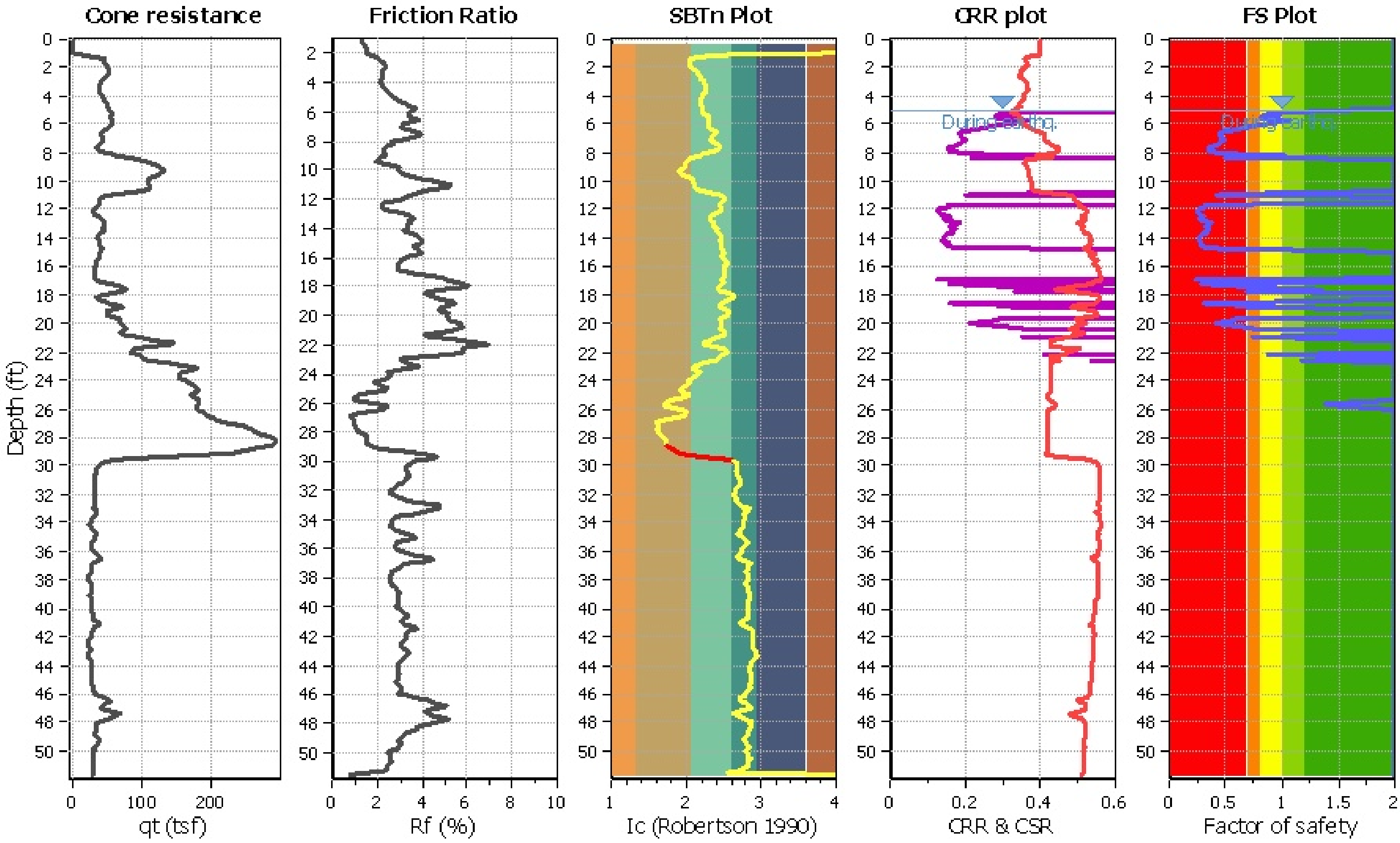
LIQUEFACTION ANALYSIS REPORT

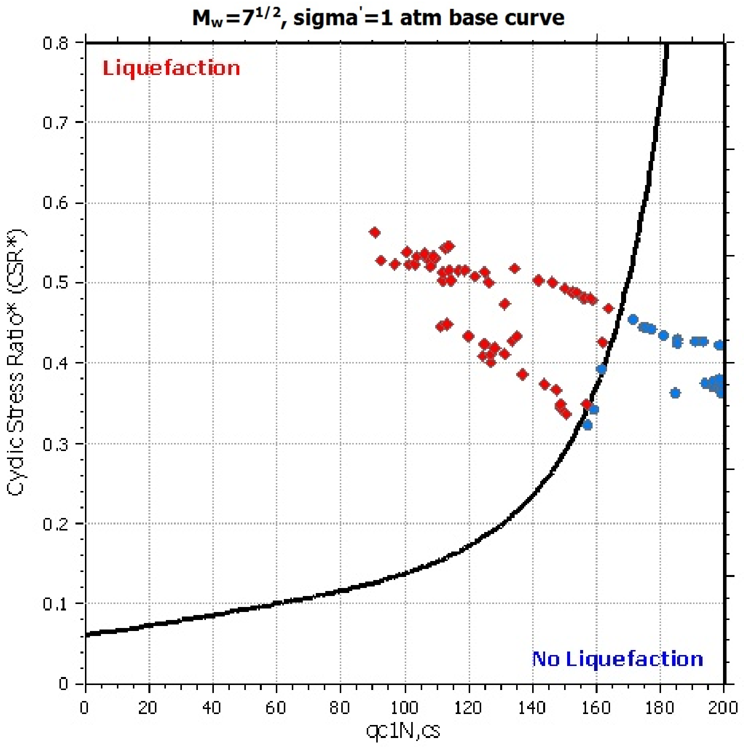
Project title : 1750 Oak Park Blvd. **Location :**

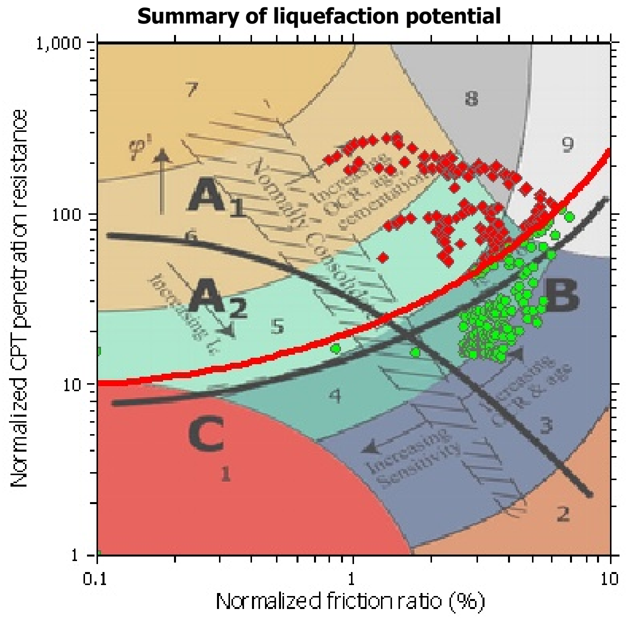
CPT file : 1-CPT6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

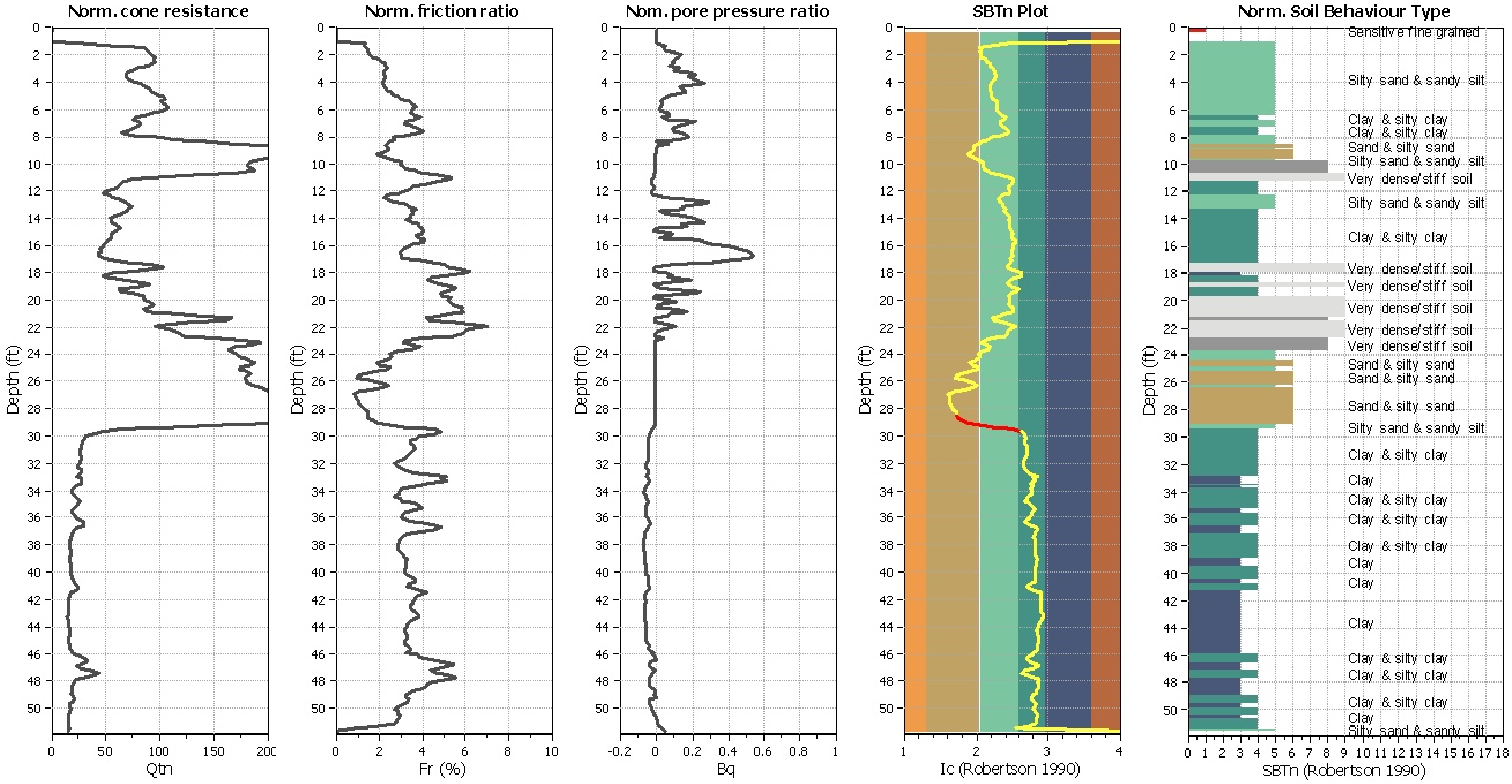






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



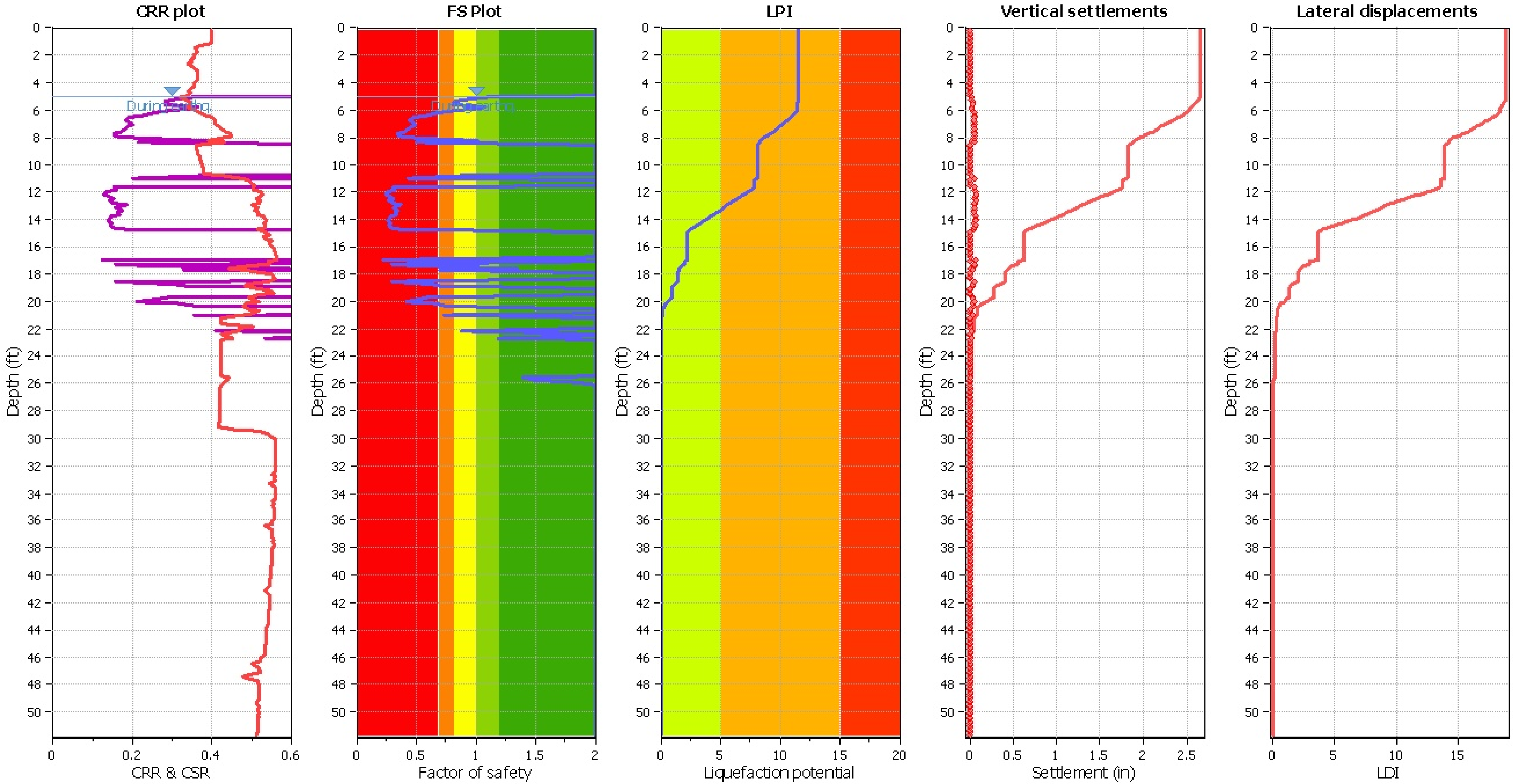
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

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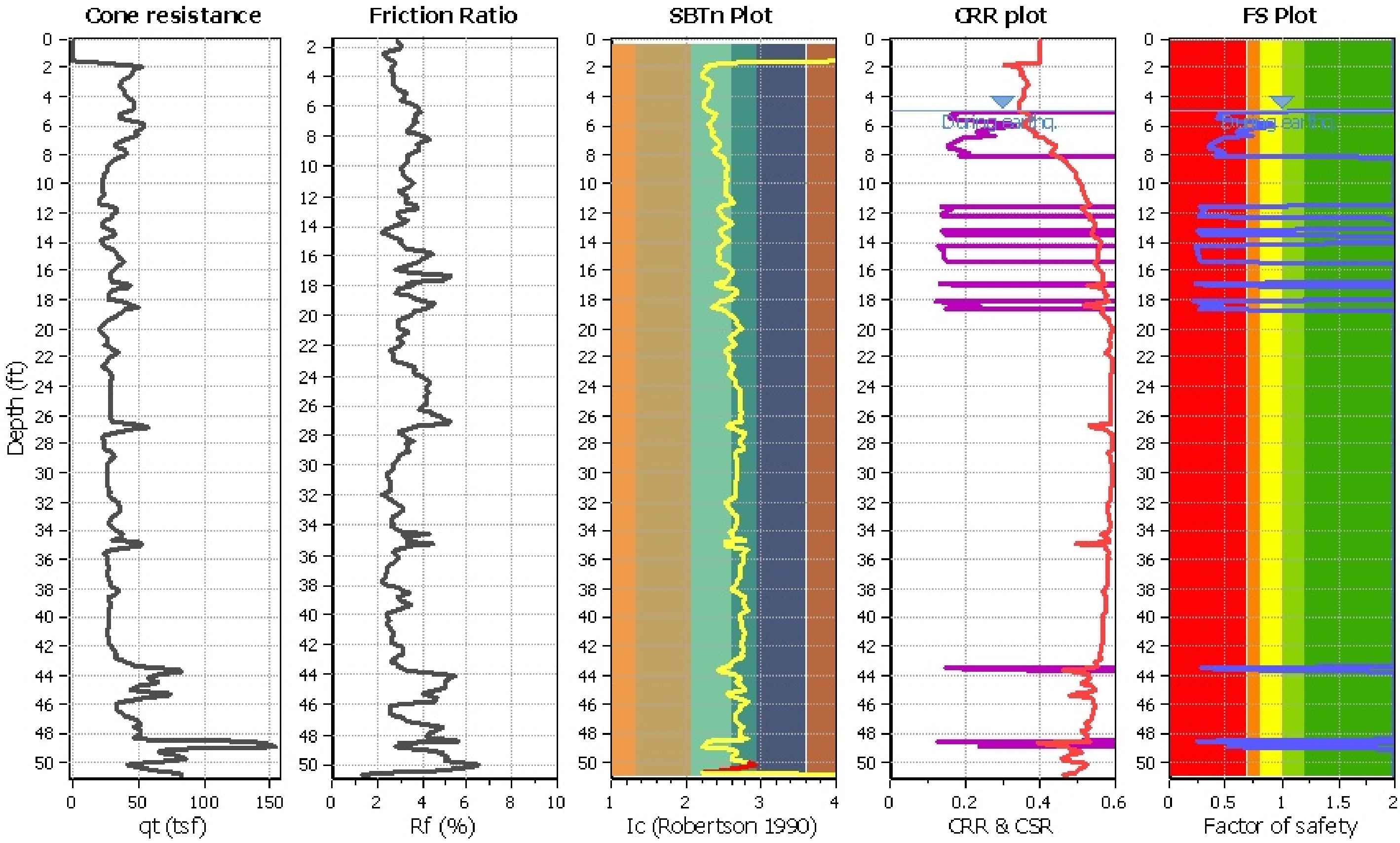
LIQUEFACTION ANALYSIS REPORT

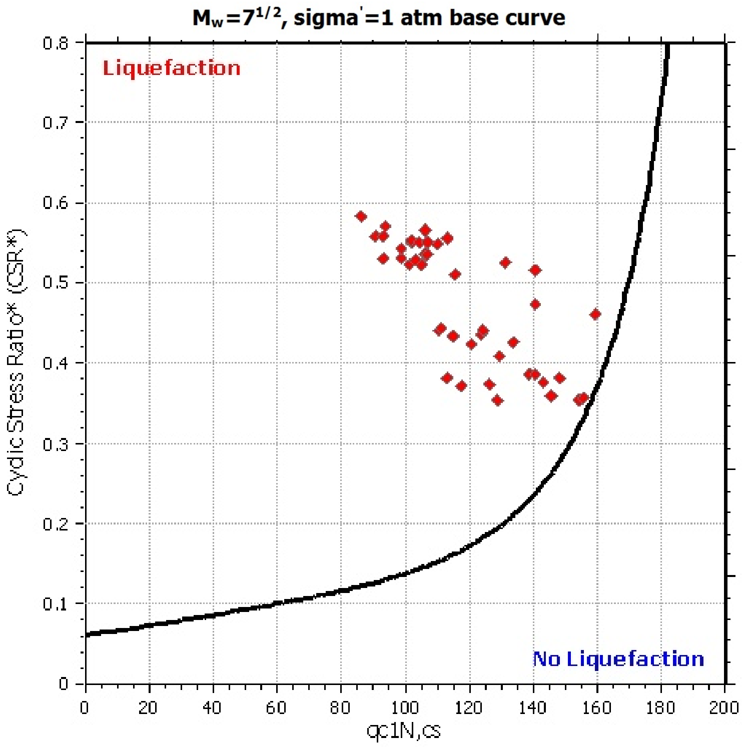
Project title : 1750 Oak Park Blvd. **Location :**

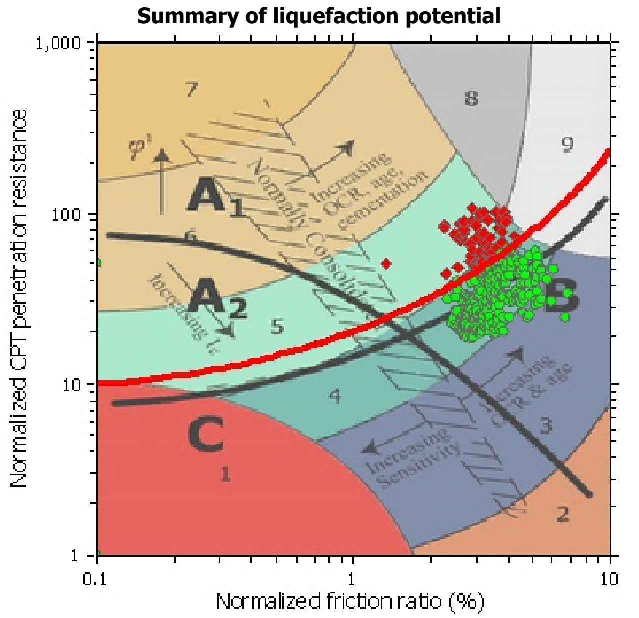
CPT file : 1-CPT7

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	5.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.00 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:	6.50	Ic cut-off value:	2.48	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

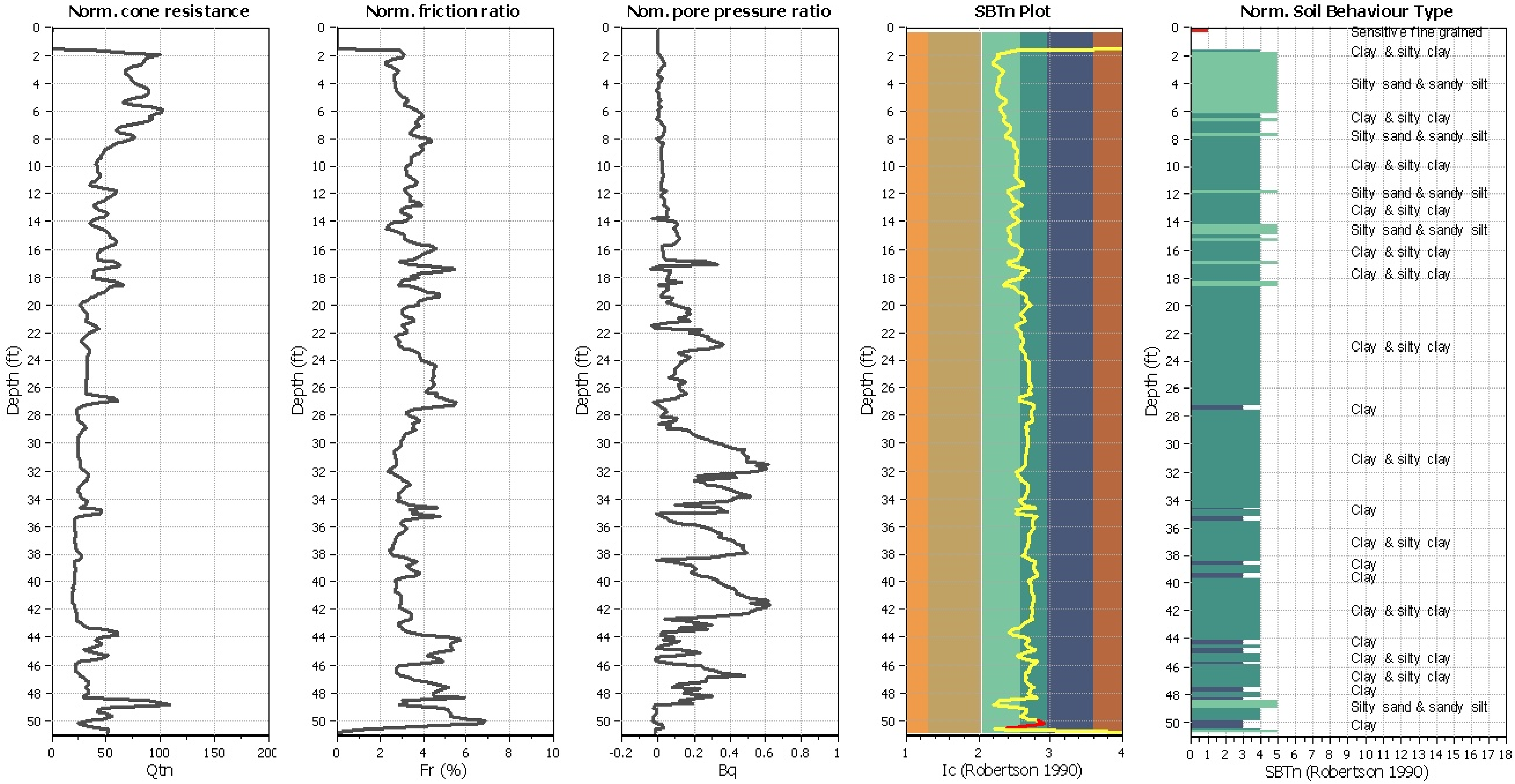






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normaliz



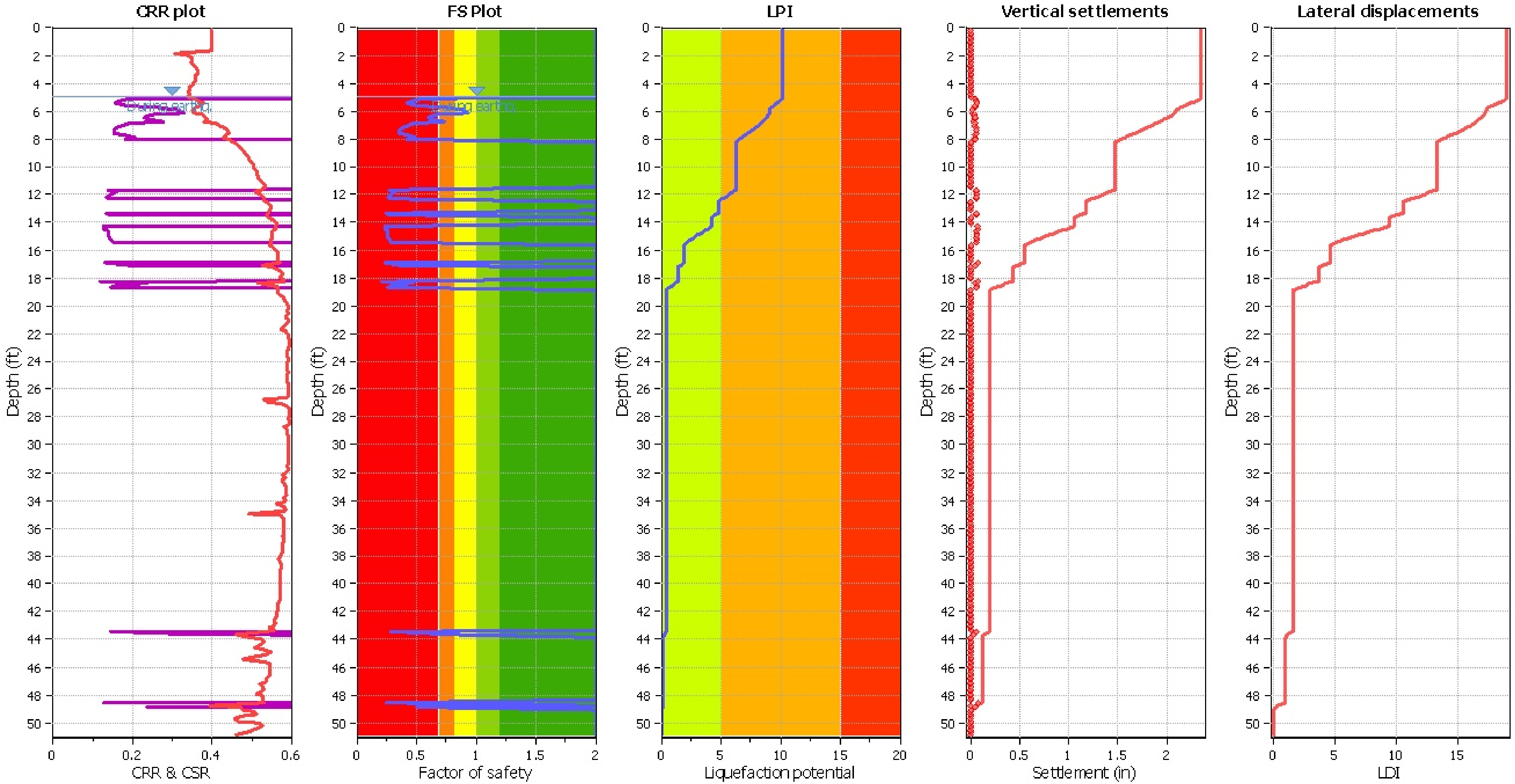
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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 plot



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.48	K_σ applied:	Yes
Earthquake magnitude M_w:	6.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	5.00 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

APPENDIX E

SUPPLEMENTAL RECOMMENDATIONS

SUPPLEMENTAL RECOMMENDATIONS

Prepared by
ENGEO Incorporated

Expect Excellence

TABLE OF CONTENTS

GENERAL INFORMATION

PREFACE

These supplemental recommendations are intended as a guide for earthwork and are in addition to any previous earthwork recommendations made by the Geotechnical Engineer. If there is a conflict between these supplemental recommendations and any previous recommendations, it should be immediately brought to the attention of ENGEO. Testing standards identified in this document shall be the most current revision (unless stated otherwise).

DEFINITIONS

BACKFILL	Soil, rock or soil-rock material used to fill excavations and trenches.
DRAWINGS	Documents approved for construction which describe the work.
THE GEOTECHNICAL ENGINEER	The project geotechnical engineering consulting firm, its employees, or its designated representatives.
ENGINEERED FILL	Fill upon which the Geotechnical Engineer has made sufficient observations and tests to confirm that the fill has been placed and compacted in accordance with geotechnical engineering recommendations.
FILL	Soil, rock, or soil-rock materials placed to raise the grades of the site or to backfill excavations.
IMPORTED MATERIAL	Soil and/or rock material which is brought to the site from offsite areas.
ONSITE MATERIAL	Soil and/or rock material which is obtained from the site.
OPTIMUM MOISTURE	Water content, percentage by dry weight, corresponding to the maximum dry density as determined by ASTM D-1557.
RELATIVE COMPACTION	The ratio, expressed as a percentage, of the in-place dry density of the fill or backfill material as compacted in the field to the maximum dry density of the same material as determined by ASTM D-1557.
SELECT MATERIAL	Onsite and/or imported material which is approved by the Geotechnical Engineer as a specific-purpose fill.

PART I - EARTHWORK

1.0 GENERAL

1.1 WORK COVERED

Supplemental recommendations for performing earthwork and grading. Activities include:

- ✓ Site Preparation and Demolition
- ✓ Excavation
- ✓ Grading
- ✓ Backfill of Excavations and Trenches
- ✓ Engineered Fill Placement, Moisture Conditioning, and Compaction

1.2 CODES AND STANDARDS

The contractor should perform their work complying with applicable occupational safety and health standards, rules, regulations, and orders. The Occupational Safety and Health Standards (OSHA) Board is the only agency authorized in the State to adopt and enforce occupational safety and health standards (Labor Code § 142 et seq.). The owner, their representative and contractor are responsible for site safety; ENGEO representatives are not responsible for site safety.

Excavating, trenching, filling, backfilling, shoring and grading work should meet the minimum requirements of the applicable Building Code, and the standards and ordinances of state and local governing authorities.

1.3 TESTING AND OBSERVATION

Site preparation, cutting and shaping, excavating, filling, and backfilling should be carried out under the testing and observation of ENGEO. ENGEO shall be retained to perform appropriate field and laboratory tests to check compliance with the recommendations. Any fill or backfill that does not meet the supplemental recommendations shall be removed and/or reworked, until the supplemental recommendations are satisfied.

Tests for compaction shall be made in accordance with test procedures outlined in ASTM D-1557, as applicable, unless other testing methods are deemed appropriate by ENGEO. These and other tests shall be performed in accordance with accepted testing procedures, subject to the engineering discretion of ENGEO.

2.0 MATERIALS

2.1 STANDARD

Materials, tools, equipment, facilities, and services as required for performing the required excavating, trenching, filling and backfilling should be furnished by the Contractor.

2.2 ENGINEERED FILL AND BACKFILL

Material to be used for engineered fill and backfill should be free from organic matter and other deleterious substances, and of such quality that it will compact thoroughly without excessive voids when watered and rolled.

Unless specified elsewhere by ENGEO, engineered fill and backfill shall be free of significant organics, or any other unsatisfactory material. In addition, engineered fill and backfill shall comply with the grading requirements shown in the following table:

TABLE 2.2-1: Engineered Fill and Backfill Requirements

US STANDARD SIEVE	PERCENTAGE PASSING
3"	100
No. 4	35–100
No. 30	20–100

Earth materials to be used as engineered fill and backfill shall be cleared of debris, rubble and deleterious matter. Rocks and aggregate exceeding the maximum allowable size shall be removed from the site. Rocks of maximum dimension in excess of two-thirds of the lift thickness shall be removed from any fill material to the satisfaction of ENGEO.

ENGEO shall be immediately notified if potential hazardous materials or suspect soils exhibiting staining or odor are encountered. Work activities shall be discontinued within the area of potentially hazardous materials. ENGEO shall be notified at least 72 hours prior to the start of filling and backfilling operations. Materials to be used for filling and backfilling shall be submitted to ENGEO no less than 10 days prior to intended delivery to the site. Unless specified elsewhere by ENGEO, where conditions require the importation of low expansive fill material, the material shall be an inert, low to non-expansive soil, or soil-rock material, free of organic matter and meeting the following requirements:

TABLE 2.2-2: Imported Fill Material Requirements

	SIEVE SIZE	PERCENT PASSING
GRADATION (ASTM D-421)	2-inch	100
	#200	15 - 70
PLASTICITY (ASTM D-4318)	Plasticity Index < 12	
ORGANIC CONTENT (ASTM D-2974)	Less than 2 percent	

A sample of the proposed import material should be submitted to ENGEO no less than 10 days prior to intended delivery to the site.

2.3 SUBDRAINS

A subdrain system is an underground network of piping used to remove water from areas that collect or retain surface water or subsurface water. Subsurface water is collected by allowing water into the pipe through perforations. Subdrain systems may drain and discharge to an appropriate outlet such as storm drain, natural swales or drainage, etc.. Details for subdrain systems may vary depending on many items, including but not limited to site conditions, soil types, subdrain spacing, depth of the pipe and pervious medium, as well as pipe diameter.

2.4 PIPE

Subdrain pipe shall conform with these supplemental recommendations unless specified elsewhere by ENGEO. Perforated pipe for various depths shall be manufactured in accordance with the following requirements:

TABLE 2.4-1: Perforated Pipe Requirements

PIPE TYPE	STANDARD	TYPICAL SIZES (INCHES)	PIPE STIFFNESS (PSI)
PIPE STIFFNESS ABOVE 200 PSI (BELOW 50 FEET OF FINISHED GRADE)			
ABS SDR 15.3		4 to 6	450
PVC Schedule 80	ASTM D1785	3 to 10	530
PIPE STIFFNESS BETWEEN 100 PSI AND 150 PSI (BETWEEN 15 AND 50 FEET OF FINISHED GRADE)			
ABS SDR 23.5	ASTM D2751	4 to 6	150
PVC SDR 23.5	ASTM D3034	4 to 6	153
PVC Schedule 40	ASTM D1785	3 to 10	135
ABS Schedule 40/DWV	ASTM D1527 & D2661	3 to 10	
PIPE STIFFNESS BETWEEN 45 PSI AND 50 PSI* (BETWEEN 0 TO 15 FEET OF FINISHED GRADE)			
PVC A-2000	ASTM F949	4 to 10	50
PVC SDR 35	ASTM D3034	4 to 8	46
ABS SDR 35	ASTM D2751	4 to 8	45
Corrugated PE	AASHTO M294 Type S	4 to 10	45

***Pipe with a stiffness less than 45 psi should not be used.**

Other pipes not listed in the table above shall be submitted for review by the Geotechnical Engineer not less 72 hours before proposed use.

2.5 OUTLETS AND RISERS

Subdrain outlets and risers must be fabricated from the same material as the subdrain pipe. Outlet and riser pipe and fittings must not be perforated. Covers must be fitted and bolted into the riser pipe or elbow. Covers must seat uniformly and not be subject to rocking.

2.6 PERMEABLE MATERIAL

Permeable material shall generally conform to Caltrans Standard Specification unless specified otherwise by ENGEO. Class 2 permeable material shall comply with the gradation requirements shown in the following table.

TABLE 2.6-1: Class 2 Permeable Material Grading Requirements

SIEVE SIZES	PERCENTAGE PASSING
1"	100
3/4"	90 to 100
3/8"	40 to 100
No. 4	25 to 40
No. 8	18 to 33
No. 30	5 to 15
No. 50	0 to 7
No. 200	0 to 3

2.7 FILTER FABRIC

Filter fabric shall meet the following Minimum Average Roll Values unless specified elsewhere by ENGEO.

Grab Strength (ASTM D-4632) .... 180 lbs
Mass per Unit Area (ASTM D-4751) .... 6 oz/yd^2
Apparent Opening Size (ASTM D-4751) ....70-100 U.S. Std. Sieve
Flow Rate (ASTM D-4491).. 80 $gal/min/ft^2$
Puncture Strength (ASTM D-4833) .... 80 lbs

Areas to receive filter fabric must comply with the compaction and elevation tolerance specified for the material involved. Handle and place filter fabric under the manufacturer's instructions. Align and place filter fabric without wrinkles.

Overlap adjacent roll ends of filter fabric in accordance with manufacturer's recommendations. The preceding roll must overlap the following roll in the direction that the permeable material is being spread. Completely replace torn or punctured sections damaged during placement or repair by placing a piece of filter fabric that is large enough to cover the damaged area and comply with the overlap specified. Cover filter fabric with the thickness of overlying material shown within 72 hours of placing the fabric.

2.8 GEOCOMPOSITE DRAINAGE

Geocomposite drainage is a prefabricated material that includes filter fabric and plastic pipe. Filter fabric must be Class A. The drain shall be of composite construction consisting of a supporting structure or drainage core material surrounded by a geotextile. The geotextile shall encapsulate the drainage core and prevent random soil intrusion into the drainage structure. The drainage core material shall consist of a three-dimensional polymeric material with a structure that permits flow along the core laterally. The core structure shall also be constructed to permit flow regardless of the water inlet surface. The drainage core shall provide support to the geotextile.

A geotextile flap shall be provided along drainage core edges. This flap shall be of sufficient width for sealing the geotextile to the adjacent drainage structure edge to prevent soil intrusion into the structure during and after installation. The geotextile shall cover the full length of the core. The geocomposite core shall be furnished with an approved method of constructing and connecting with outlet pipes. If the fabric on the geocomposite drain is torn or punctured, replace the damaged section completely. The specific drainage composite material and supplier shall be preapproved by ENGEO.

The Contractor shall submit a manufacturer's certification that the geocomposite meets the design properties and respective index criteria measured in full accordance with applicable test methods. The manufacturer's certification shall include a submittal package of documented test results that confirm the design values. In case of dispute over validity of design values, the Contractor will supply design property test data from a laboratory approved by ENGEO, to support the certified values submitted.

Geocomposite material suppliers shall provide a qualified and experienced representative onsite to assist the Contractor and ENGEO at the start of construction with directions on the use of drainage composite. If there is more than one application on a project, this criterion will apply to construction of the initial application only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining applications. The soil surface against which the geocomposite is to be placed shall be free of debris and inordinate irregularities that will prevent intimate contact between the soil surface and the drain.

Edge seams shall be formed by utilizing the flap of the geotextile extending from the geocomposite's edge and lapping over the top of the fabric of the adjacent course. The fabric flap shall be securely fastened to the adjacent fabric by means of plastic tape or non-water-soluble construction adhesive, as recommended by the supplier. To prevent soil intrusion, exposed edges of the geocomposite drainage core edge must be covered.

Approved backfill shall be placed immediately over the geocomposite drain. Backfill operations should be performed to not damage the geotextile surface of the drain. Also during operations, avoid excessive settlement of the backfill material. The geocomposite drain, once installed, shall not be exposed for more than 7 days prior to backfilling.

PART II - GEOGRID SOIL REINFORCEMENT

Geogrid soil reinforcement (geogrid) shall be submitted to ENGEO and should be approved before use. The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction to ultraviolet degradation and to chemical and biological degradation encountered in the soil being reinforced. The geogrids shall have an Allowable Tensile Strength (T_a) and Pullout Resistance, for the soil type(s) as specified on design plans.

The contractor shall submit a manufacturer's certification that the geogrids supplied meet plans and project specifications. The contractor shall check the geogrid upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geogrid will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geogrid damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geogrid material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project, for a minimum of three days, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). Geogrid reinforcement may be joined with mechanical connections or overlaps as recommended and approved by the manufacturer. Joints shall not be placed within 6 feet of the slope face, within 4 feet below top of slope, nor horizontally or vertically adjacent to another joint.

The geogrid reinforcement shall be installed in accordance with the manufacturer's recommendations. The geogrid reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed. The geogrid reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the manufacturer's approval. Only one joint per length of geogrid shall be allowed. This joint shall be made for the full width of the strip by using a similar material with similar strength. Joints in geogrid reinforcement shall be pulled and held taut during fill placement.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geogrid reinforcement shall be overlapped or mechanically connected where exposed in a wrap around face system, as applicable.

The Contractor may place only that amount of geogrid reinforcement required for immediately pending work to prevent undue damage. After a layer of geogrid reinforcement has been placed, the next succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geogrid reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geogrid reinforcement and soil. Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geogrid reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geogrid reinforcement in position until the subsequent soil layer can be placed.

Under no circumstances shall a track-type vehicle be allowed on the geogrid reinforcement before at least 6 inches of soil have been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geogrid reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided. During construction, the surface of the fill should be kept approximately horizontal. Geogrid reinforcement shall be placed directly on the compacted horizontal fill surface. Geogrid reinforcements are to be placed as shown on plans, and oriented correctly.

PART III - GEOTEXTILE SOIL REINFORCEMENT

The specific geotextile material and supplier shall be preapproved by ENGEO. The contractor shall submit a manufacturer's certification that the geotextiles supplied meet the respective index criteria set when geotextile was approved by ENGEO, measured in full accordance with specified test methods and standards.

The contractor shall check the geotextile upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geotextile shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geotextile will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geotextile damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geotextile material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project to assist the Contractor and ENGEO personnel at the start of construction. The geotextile reinforcement shall be installed in accordance with the manufacturer's recommendations. The geotextile reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed, secured with staples, pins, or small piles of backfill, placed without wrinkles, and aligned with the primary strength direction perpendicular to slope contours. Cover geotextile reinforcement with backfill within the same work shift. Place at least 6 inches of backfill on the geotextile reinforcement before operating or driving equipment or vehicles over it, except those used under the conditions specified below for spreading backfill.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geotextile reinforcement shall be overlapped or mechanically connected where exposed in a wraparound face system, as applicable.

The contractor may place only that amount of geotextile reinforcement required for immediately pending work to prevent undue damage. After a layer of geotextile reinforcement has been placed, the succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geotextile reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geotextile reinforcement and soil.

Geotextile reinforcement shall be placed to lay flat and be pulled tight prior to backfilling. After a layer of geotextile reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geotextile reinforcement in position until the subsequent soil layer can be placed. Under no circumstances shall a track-type vehicle be allowed on the geotextile reinforcement before at least six inches of soil has been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geotextile reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geotextile reinforcement as slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

During construction, the surface of the fill should be kept approximately horizontal. Geotextile reinforcement shall be placed directly on the compacted horizontal fill surface. Geotextile reinforcements are to be placed within three inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by ENGEO.

Replace or repair any geotextile reinforcement damaged during construction. Grade and compact backfill to ensure the reinforcement remains taut. Geotextile soil reinforcement must be tested to the required design values using the following ASTM test methods.

TABLE III-1: Geotextile Soil Reinforcements

PROPERTY	TEST
Elongation at break, percent	ASTM D 4632
Grab breaking load, lb, 1-inch grip (min) in each direction	ASTM D 4632
Wide width tensile strength at 5 percent strain, lb/ft (min)	ASTM D 4595
Wide width tensile strength at ultimate strength, lb/ft (min)	ASTM D 4595
Tear strength, lb (min)	ASTM D 4533
Puncture strength, lb (min)	ASTM D 6241
Permittivity, sec^{-1} (min)	ASTM D 4491
Apparent opening size, inches (max)	ASTM D 4751
Ultraviolet resistance, percent (min) retained grab break load, 500 hours	ASTM D 4355

PART IV - EROSION CONTROL MAT

Work shall consist of furnishing and placing a synthetic erosion control mat and/or degradable erosion control blanket for slope face protection and lining of runoff channels. The specific erosion control material and supplier shall be pre-approved by ENGEO.

The Contractor shall submit a manufacturer's certification that the erosion mat/blanket supplied meets the criteria specified when the material was approved by ENGEO. The manufacturer's certification shall include a submittal package of documented test results that confirm the property values. Jute mesh shall consist of processed natural jute yarns woven into a matrix, and netting shall consist of coconut fiber woven into a matrix. Erosion control blankets shall be made of processed natural fibers that are mechanically, structurally, or chemically bound together to form a continuous matrix that is surrounded by two natural nets.

The Contractor shall check the erosion control material upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140°F, mud, dirt, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be removed by cutting out a section of the mat. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the Contractor at no additional cost to the Owner.

Erosion control material suppliers shall provide a qualified and experienced representative onsite, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). The erosion control material shall be placed and anchored on a smooth graded, firm surface approved by the Engineer. Anchoring terminal ends of the erosion control material shall be accomplished through use of key trenches. The material in the trenches shall be anchored to the soil on maximum 1½ foot centers. Topsoil, if required by construction drawings, placed over final grade prior to installation of the erosion control material shall be limited to a depth not exceeding 3 inches.

Erosion control material shall be anchored, overlapped, and otherwise constructed to ensure performance until vegetation is well established. Anchors shall be as designated on the construction drawings, with a minimum of 12-inch length, and shall be spaced as designated on the construction drawings, with a maximum spacing of 4 feet.

ENGEO
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F.2 - Geotechnical Report for 1700 Oak Park Boulevard

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PLEASANT HILL LIBRARY AND PARK
PLEASANT HILL, CALIFORNIA

GEOTECHNICAL EXPLORATION

SUBMITTED TO
Ms. June Catalano
City Manager
City of Pleasant Hill
100 Gregory Lane
Pleasant Hill, CA 94523

PREPARED BY
ENGEO Incorporated

July 2, 2018
Revised September 24, 2018

PROJECT NO.
15031.000.000

ENGEO
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ENGEO
Expect Excellence

GEOTECHNICAL
ENVIRONMENTAL
WATER RESOURCES
CONSTRUCTION SERVICES

Project No.
15031.000.000

July 2, 2018
Revised September 21, 2018

Ms. June Catalano
City Manager
City of Pleasant Hill
100 Gregory Lane
Pleasant Hill, CA 94523

Subject: Pleasant Hill Library and Park
Oak Park Boulevard
Pleasant Hill, California

GEOTECHNICAL EXPLORATION

Dear Ms. Catalano:

We prepared this geotechnical exploration report for the proposed library and park as outlined in our agreement dated May 25, 2018. We characterized the subsurface conditions at the site to provide the enclosed geotechnical recommendations for design.

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to review the project plans and specifications and provide geotechnical observation and testing services during construction. Please let us know when working drawings are nearing completion, and we will be glad to discuss these additional services with you.

If you have any questions or comments regarding this report, please call and we will be glad to discuss them with you.

Sincerely,

ENGEO Incorporated

Bahareh Heidarzadeh, PhD
bh/mt/bvv

Macy Tong, GE

REGISTERED PROFESSIONAL ENGINEER
MACY M.S. TONG
No. 2300
GEOTECHNICAL
STATE OF CALIFORNIA

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1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

We prepared this geotechnical exploration report for design and construction of the Pleasant Hill New Library and Park in Pleasant Hill, California. We prepared this report as outlined in our agreement dated May 25, 2018. City of Pleasant Hill authorized ENGEO to conduct the following scope of services:

- Reviewing available literature, geologic maps, previous geotechnical exploration report pertinent to the site.
- Performing subsurface field exploration.
- Conducting soil laboratory testing.
- Analyzing the geotechnical field and laboratory test data.
- Providing geotechnical recommendations for grading, foundation design, and construction of the New Library and Park.

For our use, we received a site plan for the library prepared by Bohlin Cywinski Jackson (BCJ), dated May 30, 2018, and the Concept Grading Analysis plan for the entire site prepared by Sherwood Design Engineer, date March 21, 2018.

We performed previous subsurface explorations at the site as referenced in our reports titled Preliminary Geotechnical Exploration for 1700 Oak Park Blvd, dated June 29, 2007 (ENGEO, 2007a) and Supplemental Liquefaction Assessment for 1700 Oak Park Blvd, dated July 19, 2007 (ENGEO, 2007b). We also performed geotechnical explorations at this site in February and March of 2018 under a separate contract.

This report was prepared for the exclusive use of City of Pleasant Hill and its consultants for design of this project. In the event that any changes are made in the character, design or layout of the development, we must be contacted to review the conclusions and recommendations contained in this report to evaluate whether modifications are recommended. This document may not be reproduced in whole or in part by any means whatsoever, nor may it be quoted or excerpted without our express written consent.

1.2 PROJECT LOCATION

The site location is displayed on Figure 1, the Vicinity Map. The property comprises approximately 10 acres of currently unoccupied land located northeast of the intersection of Monticello Avenue and Oak Park Boulevard (Property) on the Site Plan, Figure 2. Figure 2 also shows site boundaries, proposed building and portion of the park area, and our exploratory locations. The Property is bounded by a school to the north, a creek and an East Bay Municipal Utility District (EBMUD) trail to the east, Oak Park Boulevard to the south, and Monticello Avenue to the west. Review of historical aerial photographs found the northern portion of the Property had been occupied by Oak Park Elementary School from as early as the late 1950s through at least 2005 (EDR LIGHTBOX[1]).

[1] Historic Aerial Photographs

1.3 PROJECT DESCRIPTION

Based on our discussion with Swinerton Management and Consulting and review of the information provided on the site plan by Bohlin Cywinski Jackson (BCJ) and the Concept Grading Analysis plan by Sherwood Design Engineer, we understand that the following site improvements are proposed:

1. Cuts and fills up to 1.5 feet thick in the Park and fills up to 5 feet thick in the New Library building footprint.
2. The New Library will be located at the southern portion of the subject site and is proposed to be a one- to two-story building with a gross area of about 25,000 square feet. A rough typical column load of 140 kips (dead load) and 165 kips (dead load plus live load) is being considered for the preliminary design according to the Structural Engineer, Rutherford and Chekene.
3. Recreation Park area and associated developments will be constructed at the northern portion of the site.
4. Paved streets, parking, and drive lanes will be constructed between the library and the park area.
5. Utilities and other infrastructure improvements will be installed at the site.

Our recommendations provided in this report covers the items listed above, specifically the New Library and Park area.

2.0 FINDINGS

2.1 PREVIOUS FIELD EXPLORATION

We explored the site in 2007 by performing five borings (ENGEO, 2007a) and advancing five Cone Penetration Test soundings (ENGEO, 2007b). These CPTs and borings were roughly located by placing from existing features and the locations should be considered accurate only to the degree implied by the method used (Figure 2). Logs of exploratory borings and CPTs and related test results are presented in Appendices A through C.

2.2 FIELD EXPLORATION

Our field exploration included drilling six borings, and advancing eight Cone Penetration Test (CPT) soundings at various locations on the site. We performed our field exploration between February 2018 and May 2018. The location of our explorations are recorded using handheld GPS in the field (Figure 2); they should be considered accurate only to the degree implied by the method used.

Logs of all exploratory borings and CPTs are presented in Appendices A and C, respectively.

2.2.1 Borings

We observed drilling of six borings at the locations shown on the Site Plan, Figure 2. ENGEO engineers observed the drilling and logged the subsurface conditions at each location. We retained a truck-mounted Mobile B53 drill rig and crew to advance the borings using 4-inch-diameter mud rotary methods. The borings were advanced to depths ranging from 30 to 50 feet below existing grade. We permitted and backfilled the borings in accordance with the requirements of Contra Costa County Environmental Health Division.

We obtained bulk soil samples from drill cuttings and retrieved samples at various intervals in the borings using standard penetration tests, 2½-inch O.D. split-spoon sampler, and Modified California Sampler.

The standard penetration resistance blow counts were obtained by dropping a 140-pound automatic-trip hammer through a 30-inch free fall. The 2½-inch O.D. split-spoon sampler was driven 18 inches and the number of blows was recorded for each 6 inches of penetration. In addition, 2.5-inch I.D. samples were obtained using a Modified California Sampler driven into the soil with the 140-pound hammer previously described. Unless otherwise indicated, the blows per foot recorded on the boring logs represent the accumulated number of blows to drive the last 1 foot of penetration; the blow counts have not been converted using any correction factors. When sampler driving was difficult, penetration was recorded only as inches penetrated for 50 hammer blows.

We used the field logs to develop the report logs in Appendix A. The logs depict subsurface conditions at the exploration locations for the date of exploration; however, subsurface conditions may vary with time.

2.2.2 Cone Penetration Tests

We retained a CPT rig to push the cone penetrometer to a maximum depth of about 50 feet below ground. The CPT has a 20-ton compression-type cone with a 15-square-centimeter (cm^2) base area, an apex angle of 60 degrees, and a friction sleeve with a surface area of 225 cm^2. The cone, connected with a series of rods, is pushed into the ground at a constant rate. Cone readings are taken at approximately 5-cm intervals with a penetration rate of 2 cm per second in accordance with ASTM D-5778. Measurements include the tip resistance to penetration of the cone (Qc), the resistance of the surface sleeve (Fs), and pore pressure (U) (Robertson and Campanella, 1988). CPT logs are presented in Appendix C.

2.3 SITE BACKGROUND

Review of historical aerial photographs found the southern portion of the Property has remained undeveloped, with the exception of minor pedestrian pathways and a small aggregate-base-topped parking area near the northwest corner of the southern half of the Property. Historic aerial photography circa 1939 shows the current channelized creek to the east of the Property had previously traversed through the central portion of the Property with entry and exit points along the northeast and southwest perimeters of the Property. An historical aerial photograph from around 1946 shows the original creek alignment had been filled in and diverted to a more direct route. By the late 1950s, the natural creek alignment appears to have been abandoned entirely and filled in as a product of the channelization of the waterway to the east of the Property. The approximate location of the former drain channel is shown on Figure 2.

Review of historical aerial photographs found the northern portion of the Property had been occupied by Oak Park Elementary School from as early as the late 1950s through at least 2005.

2.4 GEOLOGY AND SEISMICITY

2.4.1 Regional Geology

The site is located within the Coast Ranges geomorphic province of California. The Coast Ranges geomorphic province is characterized by a system of northwest-trending, fault-bounded mountain ranges and intervening alluvial valleys. Bedrock in the Coast Ranges consists of igneous, metamorphic and sedimentary rocks that range in age from Jurassic to Pleistocene. The present topography and geology of the Coast Ranges are the result of deformation and deposition along the tectonic boundary between the North American plate and the Pacific plate. Plate boundary fault movements are largely concentrated along the well-known fault zones, which in the area include the San Andreas, Hayward, and Calaveras faults, as well as other lesser-order faults.

2.4.2 Geology

More specifically, the site is located within the west portion of Ygnacio Valley. Ygnacio Valley represents an area of low relief, between Mount Diablo within the Diablo Range to the east and the Briones Hills within the East Bay Hills to the west. Both Witter (2006) and Helley (1997) map the geology at the site as alluvial fan deposits; however Witter interprets the deposits as Holocene and Helley interprets them as Pleistocene. The alluvial deposits are commonly unconsolidated, heterogeneous, poorly to moderately sorted, irregularly interbedded clays and silts containing discontinuous lenses of sand, silty clay, and gravel. According to Witter (2006), the alluvial deposits underlying the site are considered of moderate liquefaction susceptibility. Our relevant experience in the area indicates that the alluvium may consist of moderately to highly expansive clay to sandy clay. Bedrock exposed in the Briones Hill directly west of the site generally comprises units of the Monterey Formation and Martinez Group.

2.4.3 Seismicity

The Bay Area contains numerous active earthquake faults. An active fault is defined by the California Geological Survey as one that has had surface displacement within the last 11,000 years (SP42 CGS, 2007). Because of the presence of nearby active faults, the Bay Area Region is considered seismically active. Numerous small earthquakes occur every year in the San Francisco Bay Region, and larger earthquakes have been recorded and can be expected to occur in the future. Figure 4 shows the approximate locations of these faults and significant historic earthquakes recorded within the San Francisco Bay Region.

The site is not located within a designated Alquist-Priolo Earthquake Fault Zone and no known surface expression of active faulting is believed to exist within the site. Fault rupture through the site, therefore, is not anticipated.

The site does lie within a seismically active region. According to 2008 USGS National Seismic Hazard Maps, the nearest active fault is the Green Valley Connected fault, which is mapped approximately six miles southwest of the site. This fault is considered capable of a moment magnitude earthquake of 6.8. Other active faults in the region are summarized in the table below, including the Mount Diablo Thrust fault approximately eleven miles away, capable of a moment magnitude of 6.7 and the Calaveras fault approximately fourteen miles away, capable of a moment magnitude of 7.03.

TABLE 2.4.3-1: Active Faults Capable of Producing Significant Ground Shaking at the Site

FAULT NAME	DISTANCE FROM SITE (MILES)	DIRECTION FROM SITE	MAXIMUM MOMENT MAGNITUDE
Green Valley Connected	5.7	Southwest	6.8
Mount Diablo Thrust	10.6	North	6.7
Calaveras	14.1	North	7.03
Hayward-Rogers Creek	17.3	Northeast	7.3
Greenville Connected	21.3	West	7.0

The third version of Uniform California Earthquake Forecast (UCERF3) developed by the Working Group on California Earthquake Probabilities (Field et al., 2013) provides updated estimates of the 30-year probability of various magnitudes earthquakes in the San Francisco Bays Area. The results of the study are summarized in the following table:

TABLE 2.4.3-2: 30-Year Probability of Earthquake in the Bay Area

EARTHQUAKE MAGNITUDE	30-YEAR PROBABILITY OF ONE OR MORE EVENTS
5 or Greater	100%
6 or Greater	98%
7 or Greater	51%
8 or Greater	4%

In the event of an earthquake, the Modified Mercalli Intensity Shaking Severity Level in this area in eight, which is considered to be very strong shaking.

The state of California Seismic Hazard Zones map by California Geologic Survey does not evaluate this area for liquefaction and landslides. However, according to Witter (2006) the alluvial deposits underlying the site are considered of moderate liquefaction susceptibility. The evaluation of liquefaction and landslide hazards are provided later in this report.

2.5 SURFACE CONDITIONS

According to published topographic maps, the Property is relatively level at an elevation of approximately 71 feet above Mean Sea level (MSL); however, the property appears to be gently sloping to the north. In the park area, the property appears to be gently sloping to the east towards the creek. In the area of the future library building footprint (south of the Property), the elevation is ranging from approximately 72½ feet MSL to 76 feet MSL in the southwest corner of the building footprint.

The Property has medium to tall grasses with some trees and thick foliage along the perimeter of the site. A walking path and creek are present along the eastern boundary of the site as shown on the Site Plan, Figure 2.

2.6 SUBSURFACE CONDITIONS

2.6.1 Park Area

Alluvial deposits were found in Borings 1-B1, 1-B2, 1-B3, 2-B1, and 2-B2 and the granular materials appear to be discontinuous layers at different elevations across the site.

In general, the near surface soils encountered in our borings appeared to be native material with one exception. We encountered undocumented fill in Boring 1-B1 (ENGEO, 2007a) to a depth of approximately 5.5 feet below ground surface (bgs) and consisted of dark brown, very stiff, silty clay.

The native material encountered were mostly composed of medium stiff to very stiff clayey deposits with interbedded medium dense to dense silty sand deposits. A 5-foot layer of loose silty sand deposit was encountered in Boring 1-B1 at the depth of about 14½ feet below ground.

Laboratory test results show a Plasticity Index (PI) of 33 and 31 for near-surface clayey materials tested in Borings 1-B3 and 2-B1, respectively. This is an indication that these deposits have highly plasticity and are considered moderately to highly expansive when subject to fluctuation in moisture content. Additionally, we conducted silty to clayey sands, with low plasticity in deeper elevations in Borings 1-B1 and 1-B2, which have PIs ranging from 3 to 5.

2.6.2 New Library and Parking Area

We encountered an undocumented fill layer near the surface in Borings 2-B4, 2-B5, and 2-B6 with a thickness of ranging from about 9½ to 12 feet. The undocumented fill may be related to the filling of the old channel, previously traversed through the central portion of the Property with entry and exit points along the northeast and southwest perimeters of the Property. The undocumented fill is variable and consists of clayey sand with gravel, sandy lean clay, lean clay, silt with sand, gravely silt, and silty clay with low shear strength.

Similar to the Park area, alluvial deposits were found in Borings 1-B4, 1-B5, 2-B3, 2-B4, 2-B5, and 2-B6.The granular materials appear to be discontinuous layers at different elevations in Boring 2-B6. The presence of granular materials is thicker in Borings 2-B4 and 2-B5 at starting depths between 21 feet and 30 feet and beyond, respectively. The sandy materials are mostly dense in consistency with the exception of a 2-foot-thick loose clayey sand layer in Boring 2-B5 at the depth of 30 feet below grade. The clayey deposits encountered in Borings 2-B2, 2-B5, and 2-B6 are stiff to very stiff in consistency.

Consult the Site Plan and exploration logs for specific subsurface conditions at each location. We include our exploration logs in Appendix A. The logs contain the soil type, color, consistency, and visual classification in general accordance with the Unified Soil Classification System. The logs graphically depict the subsurface conditions encountered at the time of the exploration.

2.7 GROUNDWATER CONDITIONS

We observed static groundwater in several of our subsurface explorations. We summarize our observations in the table below:

TABLE 2.7-1: Groundwater Observations

EXPLORATION LOCATION	APPROX. DEPTH TO GROUNDWATER (FEET)	APPROX. GROUNDWATER ELEVATION (FEET)
1-B1	17	53
1-B2	13	57
1-B3	14	56
1-B4	16	54

EXPLORATION LOCATION	APPROX. DEPTH TO GROUNDWATER (FEET)	APPROX. GROUNDWATER ELEVATION (FEET)
2-B1	19	50
2-B2	12	60
2-B3	9	62
2-B4	3	69
2-B5	8	65
2-CPT1	7.2	61.8
2-CPT2	5.8	64.2
2-CPT4	4.7	66.3
2-CPT7	2.1	69.9
2-CPT9	6.0	65

The relatively shallow groundwater depth encountered in Boring 2-B4 and 2-CPT7 could be due to proximity to the former creek channel going through the Property, as shown in Figure 2. Several pipe easements are within the project site and the demolition of the utilities related to the former school building at the northern portion of the site are unknown. It is possible the high groundwater is related to leakage of utility lines.

As required, the test borings and CPT probes were backfilled under the observation of inspectors from Contra Costa County Environmental Health Division with approved material. Because of the county grouting requirements, boreholes may not been left open a sufficient amount of time to allow water levels to stabilize.

Fluctuations in the level of groundwater may occur due to variations in rainfall, irrigation practice, and other factors not evident at the time measurements were made. Future irrigation may cause an overall rise in groundwater levels.

2.8 LABORATORY TESTING

We performed laboratory tests on selected soil samples to evaluate their engineering properties. For this project, we performed moisture content, dry density, unconfined compressive strength, plasticity index, #200 wash, consolidation, soil corrosion potential, and sulfate testing. Moisture contents dry densities are recorded on the boring logs in Appendix A; other laboratory test data is included in Appendix B.

3.0 DISCUSSION AND CONCLUSIONS

From a geotechnical engineering viewpoint, in our opinion, the site is suitable for the proposed development, provided the geotechnical recommendations in this report are properly incorporated into the design plans and specifications.

The primary geotechnical concerns that could affect development on the site are seismic hazard, existing fill, shallow groundwater table, liquefaction of granular material and cyclic softening of clay-like material, and expansive soil. We summarize our conclusions below.

3.1 SEISMIC HAZARDS

Potential seismic hazards resulting from a nearby moderate to major earthquake can generally be classified as primary and secondary. The primary effect is ground rupture, also called surface faulting. The common secondary seismic hazards include ground shaking, and ground lurching. The following sections present a discussion of these hazards as they apply to the site. Based on topographic and lithologic data, the risk of regional subsidence or uplift, landslides, tsunamis, flooding, or seiches is considered low to negligible at the site. We discuss soil liquefaction and lateral spreading in Sections 3.1.3 and 3.1.4, respectively.

3.1.1 Ground Rupture

Since there are no known active faults crossing the property and the site is not located within an Earthquake Fault Special Study Zone, it is our opinion that ground rupture is unlikely at the subject property.

3.1.2 Ground Shaking

An earthquake of moderate to high magnitude generated within the San Francisco Bay region could cause considerable ground shaking at the site, similar to that which has occurred in the past. To mitigate the shaking effects, structures should be designed using sound engineering judgment and the 2016 California Building Code (CBC) requirements, as a minimum. Seismic design provisions of current building codes generally prescribe minimum lateral forces, applied statically to the structure, combined with the gravity forces of dead-and-live loads. The code-prescribed lateral forces are generally considered to be substantially smaller than the comparable forces that would be associated with a major earthquake. Therefore, structures should be able to: (1) resist minor earthquakes without damage, (2) resist moderate earthquakes without structural damage but with some nonstructural damage, and (3) resist major earthquakes without collapse but with some structural as well as nonstructural damage. Conformance to the current building code recommendations does not constitute any kind of guarantee that significant structural damage would not occur in the event of a maximum magnitude earthquake; however, it is reasonable to expect that a well-designed and well-constructed structure will not collapse or cause loss of life in a major earthquake (SEAOC, 1996).

3.1.3 Liquefaction

Soil liquefaction results from loss of strength during cyclic loading, such as imposed by earthquakes. Soils most susceptible to liquefaction are clean, loose, saturated, uniformly graded, fine-grained sands below the groundwater table. Empirical evidence indicate that low plasticity silt and clay are also potentially liquefiable, though this phenomenon is commonly referred to as cyclic softening. For the purpose of this report, we will refer to cyclic softening as liquefaction. When seismic ground shaking occurs, the soil is subjected to cyclic shear stresses that can cause excess hydrostatic pressure to develop.

As previously discussed, the subsurface soils consist of mostly clay and silty clay, with interbedded layers of silty sand, sandy silt, and poorly graded sand. We used visual classification, in-situ dilatancy test, and index testing results from the boring samples in conjunction with the Bray and Sancio (2006) screening criteria to determine which of the samples of fine-grained soil from the borings may be liquefiable. We also used these data to establish a relationship between soil that is potentially liquefiable and in the CPTs by comparing them to adjacent “matched-pair” borings. To perform this comparison, we compared the calculated Soil Behavior Type Index (I_C)

to soil zones that were potentially liquefiable in the adjacent borings. This comparison allows us to calibrate the results of CPT testing at this site with soil behavior recovered from our borings. From this method, we established that soil with I_C greater than 2.5 is most likely clay and has low susceptibility to liquefaction. The following matched pairs of borings and CPTs were used to perform these calibrations:

Park Area

Match Pair 1: 2-B1 and 2-CPT1
Match Pair 2: 1-B2 and 2-CPT2

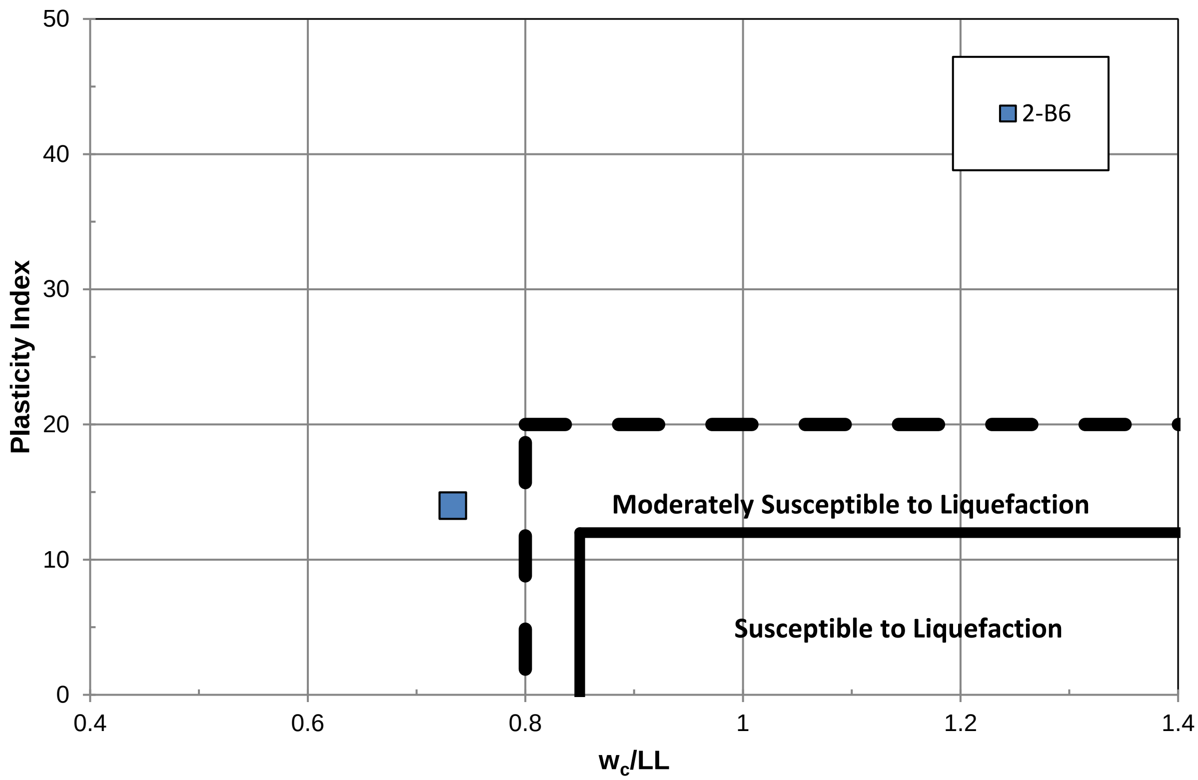
New Library and Parking Area

Match Pair 1: 2-B4 and 2-CPT7
Match Pair 2: 2-B6 and 2-CPT6

Chart 3.1.3-1 shows the Bray and Sancio screening results for soil where the adjacent CPT indicates the I_C value is over 2.5; soil that plots outside the "Moderately Susceptible to Liquefaction" zone is unlikely to be liquefiable:

The Bray and Sancio (2006) screening indicates that liquefaction will not occur in clay-like soil with I_C above 2.5 at this site. Therefore, we established and I_C cut-off of 2.5 based on site-specific data and significant lab testing.

CHART 3.1.3-1: Bray and Sancio (2006) Screening of I_C > 2.5 Soils



We evaluated the data from CPTs for triggering of liquefaction using I_C values to represent transitions in soil type and behavior. In performing our analysis, we assumed a design groundwater level of 6 feet below existing grade (except for 2-CPT7 where a groundwater level of 2 feet below existing grade was considered) and used the mapped maximum considered earthquake (MCE) geometric mean peak ground acceleration (PGA_M) of 0.64g, as listed in Table 3.5-1 based on the 2016 California Building Code. We assumed a moment magnitude of 7.3 for our analyses to represent the highest level of ground shaking on the controlling faults. As discussed earlier, we also used am I_C of cut-off of 2.5 based on our site-specific data.

We utilized the software package, CLiq Version 2.2.1.4 by Geologismiki Geotechnical Software, to evaluate liquefaction susceptibility from the CPT data. We performed our analyses using the method outlined by Boulanger and Idriss (2014).

The results of our analyses are presented in Appendix D, and liquefaction-induced settlements are summarized below:

TABLE 3.1.3-1: Summary of Liquefaction-Induced Settlement Calculations

AREA	CPT DESIGNATION	SETTLEMENT (INCHES)	
		SAND BEHAVIOR	SAND AND CLAY-LIKE BEHAVIOR
Park	1-CPT4	0.3	0.3
Park	1-CPT5	0.3	0.3
Park	2-CPT1	0.9	1.7
Park	2-CPT2	4.0	4.5
Park	2-CPT4	2.5	2.8
Park	2-CPT5	9.0	9.0
Library	1-CPT2	0.3	0.3
Library	2-CPT6	0.8	0.8
Parking	1-CPT1	0.7	0.8
Parking	1-CPT3	0.2	0.2
Parking	2-CPT7	1.2	1.8
Parking	2-CPT8	0.6	0.6
Parking	2-CPT9	1.1	2.5

Park Area and Parking Area

The estimated liquefaction-induced settlement in the Park area is up to 9 inches with an average value of 5 inches. The settlement is up to 2 inches in the parking area. However, inhabitable structures and park facilities are typically not mitigated for liquefaction-induced effects. Maintenance of the park and parking areas during and after seismic events due to liquefaction-induced settlements should be expected in the future. Flexible connection of utilities at face of building and as-required throughout the parking and park areas should be provided.

New Library Area

The liquefaction-induced settlement for the library area is estimated to be about 1 inch. To address liquefaction-induced settlement, we recommend that improvements at the site include:

- Incorporating a total settlement of 1 inch and a differential settlement of 0.5 inch over a horizontal distance of 50 feet due to liquefaction settlement in the foundation and superstructure designs.

- Providing flexible connections for building utilities that allow for 0.5 inch of vertical movement without breaking.

- Utilities on the project should be designed either with flexible materials or with flexible joints that allow the utility line to move at least 0.5 inch over a distance of 50 feet without breaking.

3.1.4 Liquefaction-induced Surface Disruption and Lateral Spreading

One of the results of liquefaction is surface disruption. Surface disruption could consist of sand boils and ground fissures. We anticipate minor sand boils and ground fissures in the New Library area. However, the foundation should be designed to accommodate settlements as described in Section 6.1.5.

We expect sand boils and ground fissures in the Park and Parking areas. Maintenance of the park and parking areas during and after seismic events due to liquefaction-induced settlements should be expected in the future.

Lateral spreading involves lateral ground movements caused by seismic shaking. These lateral ground movements are often associated with a wakening or failure of an embankment or soil mass overlying a layer of liquefied or weak soil. The effects of lateral spreading are often amplified by sloping ground and a “free-face”. A free-face can include a near-vertical cut often found near river or creek banks. Based on our observations in the field and topographic data of the site, there is no significant sliding ground condition near the channelized creek on the east side of the Property. The material that are susceptible to liquefaction are encountered below the bottom of the channelized creek. Moreover, the material in this part of the site are mostly clayey and not susceptible to liquefaction. Therefore, we anticipate the potential of lateral spread to be negligible.

3.1.5 Ground Lurching

Ground lurching is a result of the rolling motion imparted to the ground surface during energy released by an earthquake. Such rolling motion can cause ground cracks to form in weaker soils. The potential for the formation of these cracks is considered greater at contacts between deep alluvium and bedrock. Such an occurrence is possible at the site as in other locations in the Bay Area region, but based on the site location, it is our opinion that the offset is expected to be minor. We provide recommendations for foundation and pavement design in this report that are intended to reduce the potential for adverse impacts from lurch cracking.

3.1.6 Flooding

Flood Insurance Map by FEMA (Figure 5) indicates that the Property has two mapped flood zones within its boundaries. Zone AE with flood elevation of 70 to 72 feet is mapped on the eastern portion of the site along the existing creek, and a Zone X is mapped west of Zone AE covering the majority of the site. The Civil Engineer should review the pertinent information relating to flood levels for the subject site based on final pad elevations and provide appropriate design measures for development of the project, if necessary. Based on the proposed grade as shown on the

Concept Grading Analysis plan by Sherwood Design Engineer, the library building pad will be raised to an elevation of 76 feet and is above the mapped flood elevation.

3.2 EXISTING FILL

Our borings indicate that portions of the site are underlain by undocumented fill. The undocumented fill locations with approximate fill thickness are shown in Table 3.2-1.

TABLE 3.2-1: Thickness of Undocumented Fill

AREA	BORING DESIGNATION	FILL THICKNESS (FEET)
Park	1-B1	5½
Parking	2-B4	12
Library	2-B5	9½
Library	2-B6	10

Undocumented fills can undergo excessive vertical settlement, especially under new fill or building loads. Unconfined compressive laboratory test results indicated the existing fill material has shear strength of about 1,000 pounds per square foot (psf) or lower. In addition, we anticipate that some filling related to the demolition of the school building may exist at northwest portion of the site. Without proper documentation of existing fill placed on the site, we recommend complete removal and recompaction of the existing fills. The extent and quality of existing fills should be evaluated at the time of site grading activities. We present our fill removal recommendations in Section 5.1.

3.3 EXPANSIVE SOIL

We observed potentially expansive sandy lean clay and silty clay near the surface of the site. Our laboratory test results indicate that these soils exhibit moderate to high shrink/swell potential (with a Plasticity Index ranging from 31 and 33).

It is our understanding from the Concept Grading Analysis plan by Sherwood Design Engineer that the soil material in the Park and Parking areas will be used to raise the site in the New Library building area. Expansive soils change in volume with changes in moisture. They can shrink or swell and cause heaving and cracking of slabs-on-grade, pavements, and structures founded on shallow foundations. Building damage due to volume changes associated with expansive soils can be reduced by: (1) using a rigid mat foundation that is designed to resist the settlement and heave of expansive soil, (2) deepening the foundations to below the zone of moisture fluctuation, i.e. by using deep footings or drilled piers, and/or (3) using footings at normal shallow depths but bottomed on a layer of select fill having a low expansion potential.

Successful performance of structures on expansive soils requires special attention during construction. It is imperative that exposed soils be kept moist prior to placement of concrete for foundation construction. It can be difficult to remoisturize clayey soils without excavation, moisture conditioning, and recompaction.

To reduce the potential for damage to the planned building, we recommend that the upper 18 inches of the building pad be underlain by non-expansive fill. In lieu of importing non-expansive fill, it may be cost effective to lime treat the upper 18 inches of the building pad to reduce the expansion potential of the onsite soil. The special treatment area should include the building footprint and an area extending 5 feet out from the building perimeters or to adjacent curb where walkways are planned. We recommend that other structural elements, such as pavements and flatwork be designed for moderately to highly expansive soil conditions.

We have also provided specific grading recommendations for compaction of clay soil at the site. The purpose of these recommendations is to reduce the swell potential of the clay by compacting the soil at a high moisture content and controlling the amount of compaction. Expansive soil mitigation recommendations are presented in Section 4.1 of this report.

For estimation purposes of the earthwork volume calculation for site grading, we recommend using a rough shrinkage factor of 5 to 10 percent.

3.4 SOIL CORROSION POTENTIAL

As part of this study, we obtained near-surface representative soil samples and submitted to a qualified analytical laboratory (CERCO) for determination of redox, pH, resistivity, sulfate, and chloride. The results are included in Appendix B and summarized in the table below.

TABLE 3.4-1: Corrosivity Test Results

SAMPLE LOCATION	DEPTH	PH	RESISTIVITY (OHMS-CM)	CHLORIDE (MG/KG)	SULFATE (MG/KG)
Combined 2-B5/2-B6	Surface	8.12	780	N.D.	N.D.

*ASTM D4327

A brief corrosivity evaluation of the tested soil sample by CERCO is included and presented in Appendix B. If desired to investigate this further, we recommend a corrosion consultant be retained to evaluate the soil material for specific corrosion recommendations for underground utilities for the project.

We also collected near-surface soil sample from Boring 2-B1 in the park area and submitted to our laboratory for sulfate ion concentration determination. The sulfate test results are included in Appendix B.

The 2016 CBC references the 2014 American Concrete Institute Manual, ACI 318-14, Section 19.3.1 for concrete durability requirements. ACI Table 19.3.1.1 provides the following exposure categories and classes, and Table 19.3.2.1 provides requirements for concrete in contact with soil based upon the exposure class.

TABLE 3.4-2: ACI Table 19.3.1.1: Exposure Categories and Classes

CATEGORY	SEVERITY	CLASS	CONDITION
F Freezing and thawing	Not Applicable	F0	Concrete not exposed to freezing-and-thawing cycles
	Moderate	F1	Concrete exposed to freezing-and-thawing cycles and occasional exposure to moisture
	Severe	F2	Concrete exposed to freezing-and-thawing cycles and in continuous contact with moisture
	Very Severe	F3	Concrete exposed to freezing-and-thawing cycles and in continuous contact with moisture and exposed to deicing chemicals

CATEGORY	SEVERITY	CLASS	CONDITION	
			WATER- SOLUBLE SULFATE IN SOIL % BY WEIGHT*	DISSOLVED SULFATE IN WATER MG/KG (PPM)**
S Sulfate	Not applicable	S0	$SO_4 < 0.10$	$SO_4 < 150$
	Moderate	S1	$0.10 \leq SO_4 < 0.20$	$150 \leq SO_4 \leq 1{,}500$ seawater
	Severe	S2	$0.20 \leq SO_4 \leq 2.00$	$1{,}500 \leq SO_4 \leq 10{,}000$
	Very severe	S3	$SO_4 > 2.00$	$SO_4 > 10{,}000$
			CONDITION	
P Requiring low permeability	Not applicable	P0	In contact with water where low permeability is not required.	
	Required	P1	In contact with water where low permeability is required.	
C Corrosion protection of reinforcement	Not applicable	C0	Concrete dry or protected from moisture	
	Moderate	C1	Concrete exposed to moisture but not to external sources of chlorides	
	Severe	C2	Concrete exposed to moisture and an external source of chlorides from deicing chemicals, salt, brackish water, seawater, or spray from these sources	

* Percent sulfate by mass in soil determined by ASTM C1580
**Concentration of dissolved sulfates in water in ppm determined by ASTM D516 or ASTM D4130

The test results of the samples indicate sulfate content is not detected. In accordance with the criteria presented in the above table, the soil is categorized as Not Applicable, and is within the S0 sulfate exposure class. Cement type, water-cement ratio, and concrete strength, are not specified for these ranges.

Considering a 'Not Applicable' sulfate exposure, there is no requirement for cement type or water-cement ratio; however, a minimum concrete compressive strength of 2,500 pounds per square inch (psi) is specified by the building code. For this sulfate range, we recommend Type II cement and a concrete mix design for foundations and building slabs-on-grade that incorporates a maximum water-cement ratio of 0.50. It should be noted, however, that the structural engineering design requirements for concrete may result in more stringent concrete specifications.

3.5 2016 CBC SEISMIC DESIGN PARAMETERS

The 2016 CBC utilizes design criteria set forth in the 2010 ASCE 7 Standard. Based on the subsurface conditions encountered, we characterized the site as Site Class D in accordance with the 2016 CBC. We provide the 2016 CBC seismic design parameters in Table 3.5-1 below, which include design spectral response acceleration parameters based on the mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) spectral response acceleration parameters.

TABLE 3.5-1: 2016 CBC Seismic Design Parameters, Latitude: 37.93465 Longitude: -122.06733

PARAMETER	VALUE
Site Class	D
Mapped MCE_R Spectral Response Acceleration at Short Periods, S_S (g)	1.696
Mapped MCE_R Spectral Response Acceleration at 1-second Period, S_1 (g)	0.604
Site Coefficient, F_A	1.00
Site Coefficient, F_V	1.50
MCE_R Spectral Response Acceleration at Short Periods, S_{MS} (g)	1.696

PARAMETER	VALUE
MCE_R Spectral Response Acceleration at 1-second Period, S_{M1} (g)	0.907
Design Spectral Response Acceleration at Short Periods, S_{DS} (g)	1.131
Design Spectral Response Acceleration at 1-second Period, S_{D1} (g)	0.604
Mapped MCE Geometric Mean (MCE_G) Peak Ground Acceleration, PGA (g)	0.644
Site Coefficient, F_{PGA}	1.00
MCE_G Peak Ground Acceleration adjusted for Site Class effects, PGA_M (g)	0.644

3.6 CONSOLIDATION SETTLEMENT OF CLAY DEPOSITS

Settlement at the site could be generated from: (1) consolidation of the alluvial deposits where additional fills will be placed, (2) compression of the fills due to their own weights, and (3) compression of soils beneath foundation system due to building load. Our consolidation settlement evaluation was conducted for the building area only.

As discussed in Section 2.5, the project site is underlain by several clayey deposit layers. Medium stiff clay was encountered in Borings 2-B5 and 2-B6 at a depth of approximately 10 feet below the ground surface. Groundwater was found at a depth of 8 feet below grade in Boring 2-B5 during drilling. The medium stiff clay is approximately 15 feet thick. We performed consolidation test on the medium-stiff clayey soil sample collected in Boring 2-B5 in our laboratory and performed evaluation of the potential settlement due to loads from additional fill based on the laboratory test results. Our analyses were based on a fill thickness of 5 feet. We will further refine the consolidation-induced settlement once the building loads are finalized by the structural engineer.

Our consolidation test results indicate that the clayey deposit is over-consolidated and our settlement analyses indicate that the total settlement due to consolidation of clayey deposits when subjected to additional loads is estimated to ½ inch.

3.7 SLOPE STABILITY AND CREEK SETBACK

We recommend planning the new library at a location outside a minimum 3:1 (horizontal:vertical) line projection from the toe of the channelized creek bank to the ground surface at the top of bank. The purpose of the setback is to address potential for instability and erosion of the creek banks. According to the site plan provided, the proposed library building will be set back more than 60 feet from creek bank. It is our opinion the proposed building setback distance is adequate for the site.

It is anticipated that surficial failures may adversely impact the area within the recommended setback zone. Maintenance and/or repair within this area may be necessary over the long term.

3.8 GROUNDWATER CONSIDERATIONS

Shallow groundwater condition at this site is summarized in Table 2.7-1. Groundwater table was found at a depth of ranging from 2 to 19 feet below grade depending on locations. Existing fill removal and any deep utility trench excavation may encountered groundwater. Shallow groundwater condition should be considered during design of utilities, site grading, and excavation of the utility trenches and foundation. The project contractor should evaluate the site conditions and selected properly designed dewatering, shoring systems, and other as necessary during site grading and construction.

4.0 CONSTRUCTION MONITORING

Our experience and that of our profession clearly indicate that the risk of costly design, construction, and maintenance problems can be significantly lowered by retaining the design geotechnical engineering firm to:

1. Review the final grading and foundation plans and specifications prior to construction to evaluate whether our recommendations have been implemented, and to provide additional or modified recommendations, as needed. This also allows us to check if any changes have occurred in the nature, design or location of the proposed improvements and provides the opportunity to prepare a written response with updated recommendations.

2. Perform construction monitoring to check the validity of the assumptions we made to prepare this report. Earthwork operations should be performed under the observation of our representative to check that the site is properly prepared, the selected fill materials are satisfactory, and that placement and compaction of the fills has been performed in accordance with our recommendations and the project specifications. Sufficient notification to us prior to earthwork is important.

If we are not retained to perform the services described above, then we are not responsible for any party's interpretation of our report (and subsequent addenda, letters, and verbal discussions).

5.0 EARTHWORK RECOMMENDATIONS

All the earthwork, including relative compaction and optimum moisture content of soil and aggregate base, should conform to Supplemental Recommendations in Appendix E.

5.1 GENERAL SITE CLEARING

Areas to be developed should be cleared of surface and subsurface deleterious materials, including buried utility and irrigation lines, debris, and designated trees, shrubs, and associated roots. Following clearing, strip the site to remove surface organic materials. Strip organics from the ground surface to a depth of at least 2 to 3 inches below the surface. Remove tree roots to a depth of at least 3 feet below existing grade. The Geotechnical Engineer's representative should determine the actual depths of stripping and tree root removal during grading. Remove strippings from the site or, if considered suitable by the landscape architect and owner, use them in landscape fill.

Clean and backfill excavations extending below the planned finished site grades with suitable material compacted to the recommendations presented in Section 5.9. Retain ENGEO to observe and test backfilling.

5.2 EXISTING FILL REMOVAL

As discussed in the previous section, fill materials were encountered at the site and range from 5½ feet to 12 feet thick. Table 3.2-1 and the exploration logs in Appendix A display fill depths at specific locations. Since the compaction data of these fills are unknown, fill removal should be anticipated. The extent and quality of existing fills should be evaluated at the time of site grading activities.

Remove all existing fill to competent native soil, as evaluated by ENGEO and replaced with engineered fill. The removed fill can be used as compacted fill to raise the grade in the New Library area given recommendations in Section 5.3 are implemented.

5.3 EXPANSIVE SOIL MITIGATION

Due to the variable expansive soil conditions, we recommend constructing the upper 18 inches of the building pad with non-expansive fill. As an alternative to importing non-expansive fill for the building pad, it may be cost effective to lime treat the upper 18 inches of subgrade soils. The special treatment for the building include the building footprint and to 5 feet laterally beyond or to adjacent curb where walkways are planned.

5.4 DIFFERENTIAL FILL THICKNESS

Due to the existing fills within the building pad, different fill thickness may exist within the building footprint. Differential building movements may result from conditions where building pad have significant differentials in fill thickness. We recommend that the differential fill thickness across the building footprint be no greater than 10 feet. Local subexcavation of soil material and replacement with compacted fill may be needed to achieve this recommendation.

5.5 OVER-OPTIMUM SOIL MOISTURE CONDITIONS

The contractor should anticipate encountering excessively over-optimum (wet) soil moisture conditions during winter or spring grading, or during or following periods of rain. Wet soil can make proper compaction difficult or impossible. Wet soil conditions can be mitigated by:

1. Frequent spreading and mixing during warm dry weather.
2. Mixing with drier materials.
3. Mixing with a lime, lime-flyash, or cement product; or
4. Stabilizing with aggregate, geotextile stabilization fabric, or both.

Options 3 and 4 should be evaluated by ENGEO prior to implementation.

5.6 ACCEPTABLE FILL

With the exception of organically contaminated soil containing more than 2 percent organics, the site soils are suitable for use as engineered fill. The Geotechnical Engineer should be informed when imported materials are planned for the site. Imported fill materials should conform to Supplemental Recommendations in Appendix E. Allow ENGEO to sample and test proposed imported fill materials at least 5 days prior to delivery to the site.

5.7 FILL COMPACTION

5.7.1 General Grading

The following compaction control requirements should be generally applied to the existing subgrade and fills.

1. Scarify to a depth of at least 8 inches.

2. Moisture condition soil to at least 4 percentage point above the optimum moisture content; **and**

3. Compact the subgrade to at least 90 percent relative compaction.

After the subgrade soil has been compacted, place and compact acceptable fill as follows:

1. Spread fill in loose lifts that do not exceed 8 inches.

2. Moisture condition lifts to at least 4 percentage point above the optimum moisture content; **and**

3. Compact fill to a minimum of 90 percent relative compaction.

Compact aggregate base in pavement areas to 95 percent relative compaction and at least 2 percentage point above the optimum moisture content.

5.7.2 Special Building Pad Treatment

As recommended in the previous section, the upper 18 inches of the building pad subgrade soils should consist of non-expansive soil material. As an alternative to importation of select fill, the upper 18 inches of building pad subgrade soils can be lime treated. The special treatment area should include the building footprint and an area extending 5 feet out from the building perimeters or to adjacent curb where walkways are planned.

5.7.2.1 Non-Expansive Selected Fill

The non-expansive selected fill should be compacted to a relative compaction of at least 95 percent and a moisture content of at least 2 percentage points above the optimum.

5.7.2.2 Lime-Treated Subgrade Soils

The lime mix should consist of 3 to 5 percent lime. However, if the site soils are mixed with vegetation stripping, the percentage of lime may be increased to 4 to 6 percent depending on the percentage of the organic content of the soil mixture. The lime mix should be approved by ENGEO. Prior to lime treating the subgrade soils, testing should be preform to determine the actual percentage of lime required.

1. The soil should be moisture conditioned to at least 3 percentage points above the optimum moisture content before mixing. The mixing should be performed in accordance with the current version of Caltrans Standard Specifications with the following exceptions:

2. Following mixing, the treated soils should be allowed to fully hydrate at least 24 hours prior to compaction.

3. Following hydration, the treated soil should be compacted according to ASTM D-1557 to not less than 95 percent relative compaction at a moisture content at least 3 percentage points above the optimum to a non-yielding surface.

5.7.3 Underground Utility Backfill

The contractor is responsible for conducting trenching and shoring in accordance with CALOSHA requirements. Project consultants involved in utility design should specify pipe bedding materials.

For utility trench within building pad, the upper 18 inches of the trench backfill should consist of non-expansive material.

Place and compact granular trench backfill as follows:

1. Trench backfill should have a maximum particle size of 6 inches.

2. Moisture condition trench backfill to or slightly above the optimum moisture content. Moisture condition backfill outside the trench.

3. Place fill in loose lifts not exceeding 12 inches;
and

4. Compact fill to a minimum of 90 percent relative compaction (ASTM D1557).

For perimeter foundations with slab-on-grade floors, where utility trenches cross perimeter building foundations, backfill with native clay soil for pipe bedding and backfill for a distance of 2 feet on the exterior side of the foundation. This will help prevent the normally granular bedding materials from acting as a conduit for water to enter beneath the building. As an alternative, a sand cement slurry (minimum 28-day compressive strength of 500 psi) may be used in place of native clay soil in both side of the foundation.

Jetting of backfill is not an acceptable means of compaction. We may allow thicker loose lift thicknesses based on acceptable density test results, where increased effort is applied to rocky fill, or for the first lift of fill over pipe bedding.

5.7.4 Landscape Fill

Process, place and compact fill in accordance with section 5.7 Landscape fill can be compacted to at least 85 percent relative compaction (ASTM D1557), if desired.

5.8 SLOPES

Construct final slope gradients to 2:1 (horizontal:vertical) and up to 6 feet high. The contractor is responsible to construct temporary construction slopes in accordance with CALOSHA requirements.

5.9 SITE DRAINAGE

5.9.1 Surface Drainage

The project civil engineer is responsible for designing surface drainage improvements. With regard to geotechnical engineering issues, we recommend that finish grades be sloped away from building and pavements to the maximum extent practical to reduce the potentially damaging effects of expansive soil. The latest California Building Code Section 1804.4 specifies minimum slopes of 5 percent at least 10 feet away from foundation. Where lot lines or surface improvements restrict meeting this slope requirement, we recommend that specific drainage requirements be developed. As a minimum, we recommend the following:

1. Discharge roof downspouts into closed conduits and direct away from foundation to appropriate drainage devices.

2. Consider the use of rear lot surface drainage collection systems to reduce overland surface drainage from back to front of lot.

3. Do not allow water to pond near foundation, pavements, or exterior flatwork.

5.9.2 Subsurface Drainage

Based on our site exploration and current grading concepts for the site, we do not anticipate that subdrainage systems will be recommended. We recommend that we review the site grading plans to further evaluate the need for subdrainage systems as well as observe the earthwork operations during site grading.

5.10 STORMWATER INFILTRATION

Due to the density of the site soils and fines content (percentage passing the No. 200 sieve) generally exceeding 30 percent, the near-surface site soils are expected to have a low to moderate permeability value for stormwater infiltration in grassy swales or permeable pavers, unless subdrains are installed. In addition, the groundwater encountered at the site is at shallow depth that makes stormwater infiltration very difficult. Therefore, Best Management Practices should assume that limited stormwater infiltration will occur at the site.

5.11 STORMWATER BIORETENTION AREAS

If bioretention areas are implemented, we recommend that, when practical, they be planned a minimum of 5 feet away from structural site improvements, such as buildings, streets, retaining walls, and sidewalks/driveways. When this is not practical, bioretention areas located within 5 feet of structural site improvements can either:

1. Be constructed with structural side walls capable of withstanding the loads from the adjacent improvements, or

2. Incorporate filter material compacted to between 85 and 90 percent relative compaction (ASTM D1557, latest edition) and a waterproofing system designed to reduce the potential for moisture transmission into the subgrade soil beneath the adjacent improvement.

In addition, one of the following options should be followed.

1. We recommend that bioretention design incorporate a waterproofing system lining the bioswale excavation and a subdrain, or other storm drain system, to collect and convey water to an approved outlet. The waterproofing system should cover the bioretention area excavation in such a manner as to reduce the potential for moisture transmission beneath the adjacent improvements.

2. Alternatively, and with some risk of movement of adjacent improvements, if infiltration is desired, we recommend the perimeter of the bioretention areas be lined with an HDPE tree root barrier that extends at least 1 foot below the bottom of the bioretention areas/infiltration trenches.

Site improvements located adjacent to bioretention areas that are underlain by base rock, sand, or other imported granular materials, should be designed with a deepened edge that extends to the bottom of the imported material underlying the improvement.

Where adjacent site improvements include building greater than three stories, streets steeper than 3 percent, or design elements subject to lateral loads (such as from impact or traffic patterns), additional design considerations may be recommended. If the surface of the bioretention area is depressed, the slope gradient should follow the slope guidelines described in earlier section(s) of this document. In addition, although not recommended, if trees are to be planted within bioretention areas, HDPE Tree Boxes that extend below the bottom of the bioretention system should be installed to reduce potential impact to subdrain systems that may be part of the bioretention area design. For this condition, the waterproofing system should be connected to the HPDE Tree Box with a waterproof seal.

Given the nature of bioretention systems and possible proximity to improvements, we recommend ENGEO be retained to review design plans and provide testing and observation services during the installation of linings, compaction of the filter material, and connection of designed drains.

It should be noted that the contractor is responsible for conducting all excavation and shoring in a manner that does not cause damage to adjacent improvements during construction and future maintenance of the bioretention areas. As with any excavation adjacent to improvements, the contractor should reduce the exposure time such that the improvements are not detrimentally impacted.

5.12 LANDSCAPING CONSIDERATION

As the near-surface soils are moderately to highly expansive, we recommend greatly restricting the amount of surface water infiltration near structures, pavements, flatwork, and slabs-on-grade. This may be accomplished by:

- Selecting landscaping that requires little or no watering, especially within 3 feet of structures, slabs-on-grade, or pavements.
- Using low precipitation sprinkler heads.
- Regulating the amount of water distributed to lawn or planter areas by installing timers on the sprinkler system.
- Providing surface grades to drain rainfall or landscape watering to appropriate collection systems and away from structures, slabs-on-grade, or pavements.
- Preventing water from draining toward or ponding near building foundations, slabs-on-grade, or pavements.
- Avoiding open planting areas within 3 feet of the building perimeter.

We recommend that these items be incorporated into the landscaping plans.

6.0 FOUNDATION RECOMMENDATIONS

We developed foundation recommendations using data obtained from our field exploration, laboratory test results, and engineering analysis.

6.1 CONVENTIONAL FOOTINGS WITH SLAB-ON-GRADE

Provided that the subgrade soils are treated as described above, the proposed New Library Building can be supported on continuous or isolated spread footing system.

6.1.1 Footing Dimensions and Allowable Bearing Capacity

Provide minimum footing dimensions as follows in the Table 6.1.1-1 below.

TABLE 6.1.1-1: Minimum Footing Dimensions

FOOTING TYPE	*MINIMUM DEPTH (INCHES)	MINIMUM WIDTH (INCHES)
Continuous	36	18
Isolated	36	18

* below lowest adjacent pad grade

Minimum footing depths shown above are taken from lowest adjacent pad grade. Design foundations recommended above for a maximum allowable bearing pressure of 2,000 pounds per square foot (psf) for dead load only, 2,500 psf for dead-plus-live loads, and $3,250 psf for including short-term seismic load.

The maximum allowable bearing pressure is a net value; the weight of the footing may be neglected for design purposes. Footings located adjacent to utility trenches should have their bearing surfaces below an imaginary 1:1 (horizontal:vertical) plane projected upward from the bottom edge of the trench to the footing.

We recommend using an allowable soil bearing pressure of 3,500 psf in the design of thrust blocks for restraint of water pressure systems such as fire lines.

6.1.2 Waterstop

If a two-pour system is used for footings and slab, the cold joint between the exterior footing and slab-on-grade should be located at least 4 inches above adjacent finish exterior grade. If this is not done, then we recommend the addition of a waterstop between the two pours to reduce moisture penetration through the cold joint and migration under the slab. Use of a monolithic pour would eliminate the need for the waterstop.

6.1.3 Reinforcement

The structural engineer should design footing reinforcement to support the intended structural loads without excessive settlement. Reinforce continuous footings with top and bottom steel to provide structural continuity and to permit spanning of local irregularities.

6.1.4 Foundation Lateral Resistance

Lateral loads may be resisted by friction along the base and by passive pressure along the sides of foundations. The passive pressure is based on an equivalent fluid pressure in pounds per cubic foot (pcf). We recommend the following allowable values for design:

- Passive Lateral Pressure: 300 pcf
- Coefficient of Friction: 0.30

The above allowable values include a factor of safety of 1.5. Increase the above values by one-third for the short-term effects of wind or seismic loading.

Passive lateral pressure should not be used for footings on or above slopes.

Resistance to short duration (earthquake-induced) lateral loads may be provided by frictional resistance between the foundation concrete and the bearing soils and by passive earth pressure acting against the side of the foundation. A coefficient of friction of 0.30 can be used between concrete and the subgrade. A uniform pressure of 1,000 psf can be used to evaluate the passive resistance that can be developed on the foundation elements for transient loads. For static loads, passive resistance should be evaluated using a triangular pressure distribution modeled as an equivalent fluid pressure of 250 pounds per cubic foot. The upper 1 foot of soil should be excluded from passive pressure computations unless it is confined by pavement or a concrete slab. A combination of both friction and passive pressure may be used if one of the values is reduced by 50 percent.

6.1.5 Settlement

Provided our report recommendations are followed and given the proposed construction (Section 1.3), we estimate total and differential foundation settlements to be less than approximately 1.5 and 0.75 inches, respectively. These values consider the liquefaction-induced settlement and the consolidation settlement due to the loads from additional fill and the building as discussed in Sections 3.1.3 and 3.6, respectively.

6.2 DRILLED PIER FOUNDATION

Provided that the existing fill was removed and recompacted, drilled pier foundation can be used to support flag poles, mast lighting, and fences and can be designed using the following criteria:

Minimum Pier Diameter:	12 inches.
Minimum Pier Depth:	10 feet.
Allowable Skin Friction Value:	500 pounds per square foot (psf); however, the upper 3 feet should be ignored in the load computation. This value can be increased by 30 percent to include seismic or wind loads.
Passive Earth Pressure:	250 pounds per cubic foot (pcf) acting on two times the pier diameter.

In order to reduce potential future pier settlements, all loose soil should be removed from the bottom of pier holes prior to placing concrete. Pier drilling operations and concrete placement should be coordinated so that pier holes are left open a minimum amount of time. Pier holes should not be allowed to desiccate significantly before placement of concrete and certainly not to the point of showing shrinkage cracks.

Depressions at the top of the piers resulting from drilling operations or from any other cause should be backfilled to prevent ponding. Concrete collars occurring at the top of the piers as a result of excessive concrete placement should be removed.

7.0 SLABS-ON-GRADE

7.1 INTERIOR CONCRETE FLOOR SLABS

7.1.1 Minimum Design Section

Provided the fill removal and building pad special treatment are implemented, we recommend the following minimum design for the slab-on-grade floor:

1. Provide a minimum concrete thickness of 6 inches.

2. Place minimum steel reinforcing of No. 4 rebar spaced on 16 inches on center each way within the middle third of the slab to help control the width of shrinkage cracking that inherently occurs as concrete cures.

The structural engineer should provide final design thickness and additional reinforcement, as necessary, for the intended structural loads.

7.1.2 Slab Moisture Vapor Reduction

When building is constructed with concrete slab-on-grade, water vapor from beneath the slab will migrate through the slab and into the building. This water vapor can be reduced but not stopped. Vapor transmission can negatively affect floor coverings and lead to increased moisture within a building. When water vapor migrating through the slab would be undesirable, we recommend the following to reduce, but not stop, water vapor transmission upward through the slab-on-grade.

1. Construct a moisture retarder system directly beneath the slab on-grade that consists of the following:
   a. Vapor retarder membrane sealed at all seams and pipe penetrations and connected to all footings. Vapor retarders shall conform to Class A vapor retarder in accordance with ASTM E 1745, latest edition, “Standard Specification for Plastic Water Vapor Retarders used in Contact with Soil or Granular Fill under Concrete Slabs”. The vapor retarder should be **underlain by**

   b. 6 inches of clean crushed rock. Crushed rock should have 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 Sieve.

2. Use a concrete water-cement ratio for slabs-on-grade of no more than 0.50.

3. Provide inspection and testing during concrete placement to check that the proper concrete and water cement ratio are used.

4. Moist cure slabs for a minimum of 3 days or use other equivalent curing specified by the structural engineer.

7.1.3 Subgrade Modulus for Structural Slab Design

Provided the site earthwork is conducted in accordance with the recommendations of this report, a subgrade modulus of 115 psi/in can be used for deal plus live loads and 150 psi/in for including seismic load for structural slab design.

7.2 EXTERIOR FLATWORK

Secondary slabs-on-grade should be constructed structurally independent of the foundation system. This allows slab movement to occur with a minimum of foundation distress. Where secondary slab-on-grade construction is anticipated, care must be exercised in attaining a near-saturation condition of the subgrade soil before concrete placement.

Exterior flatwork includes items such as concrete sidewalks, steps, and outdoor courtyards exposed to foot traffic only. Provide a minimum concrete flatwork thickness of 4 inches over 4 inches of aggregate base. Construct control and construction joints in accordance with current Portland Cement Association Guidelines.

Secondary slabs-on-grade should be designed specifically for their intended use and loading requirements. Cracking of conventional slabs should be expected as a result of concrete shrinkage and the expansive soils at the site. Slabs-on-grade should be reinforced for control of cracking, and frequent control joints should be provided to control the cracking. Such reinforcement should be designed by the Structural Engineer. In our experience, welded wire mesh may not be sufficient to control slab cracking. As a minimum, secondary slabs-on-grade should be reinforced with No. 4 bars spaced 16 inches on center each way.

7.3 TRENCH BACKFILL

Backfill and compact all trenches below building slabs-on-grade and to 5 feet laterally beyond any edge in accordance with Section 5.9.2.

8.0 RETAINING WALLS

8.1 LATERAL SOIL PRESSURES

Unrestrained retaining walls can be designed to resist an active pressure of 50 pounds per cubic foot (pcf) for a level backfill. Walls restrained from movement at the top should be designed to resist an at-rest pressure of 80 pcf for level backfill. Retaining walls greater than 6 feet in height should be included seismic consideration. For seismic consideration, dynamic increment of 20 pcf should be added to the lateral pressure for both restrained and unrestrained walls.

In addition, design retaining walls to resist an additional uniform pressure equivalent to one-half of any surcharge loads applied at the top of the wall.

The above lateral earth pressures assume sufficient drainage behind the walls to prevent any build-up of hydrostatic pressures from surface water infiltration. If adequate drainage is not provided and if the groundwater level is located behind the wall, we recommend that an additional equivalent fluid pressure of 40 pcf be added to the values recommended above for both restrained and unrestrained walls. Damp-proofing of the walls should be included in areas where wall moisture would be problematic.

Construct a drainage system, as recommended below, to reduce hydrostatic forces behind the retaining wall.

8.2 RETAINING WALL DRAINAGE

Construct either graded rock drains or geosynthetic drainage composites behind the retaining walls to reduce hydrostatic lateral forces. For rock drain construction, we recommend two types of rock drain alternatives:

1. A minimum 12-inch-thick layer of Class 2 permeable material (Caltrans Specification 68-2.02F) placed directly behind the wall, or

2. A minimum 12-inch-thick layer of washed, crushed rock with 100 percent passing the ¾-inch sieve and less than 5 percent passing the No. 4 sieve. Envelop rock in a minimum 6-ounce, nonwoven geotextile filter fabric.

For both types of rock drains:

1. Place the rock drain directly behind the walls of the structure.

2. Extend rock drains from the wall base to within 12 inches of the top of the wall.

3. Place a minimum of 4-inch-diameter perforated pipe (glued joints and end caps) at the base of the wall, inside the rock drain and fabric, with perforations placed down.

4. Place pipe at a gradient at least 1 percent to direct water away from the wall by gravity to a drainage facility.

5. Place onsite compacted clayey soil in the upper 12 inches of the top of the wall.

ENGEO should review and approve geosynthetic composite drainage systems prior to use.

8.3 BACKFILL

Backfill behind retaining walls should be placed and compacted in accordance with Section 5.7. Use light compaction equipment within 5 feet of the wall face. If heavy compaction equipment is used, the walls should be temporarily braced to avoid excessive wall movement.

8.4 FOUNDATIONS

Retaining walls may be supported on continuous footings designed in accordance with recommendations presented in Section 6.1.1.

9.0 PAVEMENT DESIGN

9.1 FLEXIBLE PAVEMENTS

An R-value of 5 was estimated for the near surface clayey soil. Using estimated Traffic Indices for various pavement loading requirements, we developed the following recommended pavement sections using Topic 633 of the Caltrans Highway Design Manual (including the factor of safety for the hot mix asphalt), presented in Table 9.1-1 below.

TABLE 9.1-1: Recommended Asphalt Concrete Pavement Sections

TRAFFIC INDEX	SECTION	
	HOT MIX ASPHALT CONCRETE (INCHES)	CLASS 2 AGGREGATE BASE (INCHES)
4.5	2½	10
5	3	10
5.5	3	12
6	3½	13

The civil engineer should determine the appropriate traffic indices based on the estimated traffic loads and frequencies.

Pavement materials and construction should comply with the specifications and requirements of the Standard Specifications by Caltrans, and the following minimum requirements.

- All pavement subgrades should be scarified to a minimum depth of 12 inches below finished subgrade elevation. Subgrade soil should be in a stable, non-pumping condition at the time aggregate base materials are placed and compacted.
- Adequate provisions must be made such that the subgrades soil and aggregate base materials are not allowed to become saturated.
- Asphalt paving materials should meet current Caltrans specifications for hot mix asphalt.
- All concrete curbs separating pavement and irrigated landscaped areas should extend into the subgrade and below the bottom of adjacent aggregate baserock materials.

9.2 SUBGRADE AND AGGREGATE BASE COMPACTION

Compact finish subgrade and aggregate base in accordance with Section 5.7. Aggregate Base (AB) should meet the requirements for Class 2 AB in accordance with Section 26-1.02B of the latest Caltrans Standard Specifications.

9.3 CUT-OFF CURBS

Saturated pavement subgrade or aggregate base can cause premature failure or increased maintenance of asphalt concrete pavements. This condition often occurs where landscape areas directly abut and drain toward pavements. If desired to install pavement cutoff barriers, they should be considered where pavement areas lie downslope of any landscape areas that are to be sprinklered or irrigated, and should extend to a depth of at least 4 inches below the base rock layer. Cutoff barriers may consist of deepened concrete curbs or deep-root moisture barriers.

If reduced pavement life and greater than normal pavement maintenance are acceptable to the owner, then the cutoff barrier may be eliminated.

11.0 GROUND HEAT EXCHANGE

Based on our findings and review of the proposed development, we consider the site to be *highly* suitable for using a Ground Heat-Exchange (GHX) system to achieve energy savings and to potentially eliminate the need for outdoor air conditioner units, if desired. For the thermal properties of the soil and groundwater conditions at the site, a closed-loop GHX system would likely be well suited and could be implemented on select buildings, or integrated into a project-wide system.

As project planning progresses into architectural design, we can meet with you, your architect, and your MEP designer to further assess and develop GHX energy saving opportunities and efficiencies.

12.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

This report presents geotechnical recommendations for design and construction of the improvements discussed in Section 1.3 for the New Pleasant Hill Library and Park project. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the owner to transmit the information and recommendations of this report to the appropriate organizations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers. The conclusions and recommendations contained in this report are solely professional opinions and are valid for a period of no more than 2 years from the date of report issuance.

We strived to perform our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty is expressed or implied. There are risks of earth movement and property damages inherent in building on or with earth materials. We are unable to eliminate all risks or provide insurance; therefore, we are unable to guarantee or warrant the results of our services.

This report is based upon field and other conditions discovered at the time of report preparation. We developed this report with limited subsurface exploration data. We assumed that our subsurface exploration data is representative of the actual subsurface conditions across the site. Considering possible underground variability of soil, rock, stockpiled material, and groundwater, additional costs may be required to complete the project. We recommend that the owner establish a contingency fund to cover such costs. If unexpected conditions are encountered, notify ENGEO immediately to review these conditions and provide additional and/or modified recommendations, as necessary.

Our services did not include excavation sloping or shoring, soil volume change factors, flood potential, or a geohazard exploration. In addition, our geotechnical exploration did not include work to determine the existence of possible hazardous materials. If any hazardous materials are encountered during construction, notify the proper regulatory officials immediately.

This document must not be subject to unauthorized reuse, that is, reusing without written authorization of ENGEO. Such authorization is essential because it requires ENGEO to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

Actual field or other conditions will necessitate clarifications, adjustments, modifications or other changes to ENGEO's documents. Therefore, ENGEO must be engaged to prepare the necessary clarifications, adjustments, modifications or other changes before construction activities commence or further activity proceeds. If ENGEO's scope of services does not include on-site construction observation, or if other persons or entities are retained to provide such services, ENGEO cannot be held responsible for any or all claims arising from or resulting from the performance of such services by other persons or entities, and from any or all claims arising from or resulting from clarifications, adjustments, modifications, discrepancies or other changes necessary to reflect changed field or other conditions.

We determined the lines designating the interface between layers on the exploration logs using visual observations. The transition between the materials may be abrupt or gradual. The exploration logs contain information concerning samples recovered, indications of the presence of various materials such as clay, sand, silt, rock, existing fill, etc., and observations of groundwater encountered. The field logs also contain our interpretation of the subsurface conditions between sample locations. Therefore, the logs contain both factual and interpretative information. Our recommendations are based on the contents of the final logs, which represent our interpretation of the field logs.

SELECTED REFERENCES

Bray, J. D., & Sancio, R. B. (2006). Assessment of the liquefaction susceptibility of fine-grained soils. *Journal of geotechnical and geoenvironmental engineering, 132(9), 1165-1177.*

Bryant, W. and Hart, E., 2007, Special Publication 42, “Fault-Rupture Hazard Zones in California”, Interim Revision 2007, California Department of Conservation.

California Building Code, 2016.

California Geologic Survey, 2008, Special Publication 117A, Guidelines for Evaluating and Mitigating Seismic Hazards in California.

Division of Mines and Geology, 1997, Special Publication 117, Guidelines for Evaluation and Mitigating Seismic Hazards in California, Adopted March 13.

ENGEO, 2007a, Preliminary Geotechnical Exploration, 1700 Oak Park Boulevard, Pleasant Hill, California, June 29; Project No. 7843.100.101.

ENGEO, 2007b, Supplemental Liquefaction Assessment, 1700 Oak Park Boulevard, Pleasant Hill, California, July 19; Project No. 7843.100.101.

Field, E. H., Arrowsmith, R. J., Biasi, G. P., Bird, P., Dawson, T. E., Felzer, K. R., & Michael, A. J. (2014), Uniform California earthquake rupture forecast, version 3 (UCERF3) The time-independent model. *Bulletin of the Seismological Society of America, 104(3)*, 1122-1180.

FEMA Flood Insurance Map (2009), (https://msc.fema.gov/portal)

Helley, E.J., and Graymer, R.W., 1997, Quaternary geology of Alameda County and parts of Contra Costa, Santa Clara, San Mateo, San Francisco, Stanislaus, and San Joaquin Counties, California: U.S. Geological Survey, Open-File Report OF-97-97, scale 1:100,000.

Idriss, I. M., & Boulanger, R. W. (2014). CPT and SPT based liquefaction triggering procedures. *Centre for Geotechnical Modelling.*

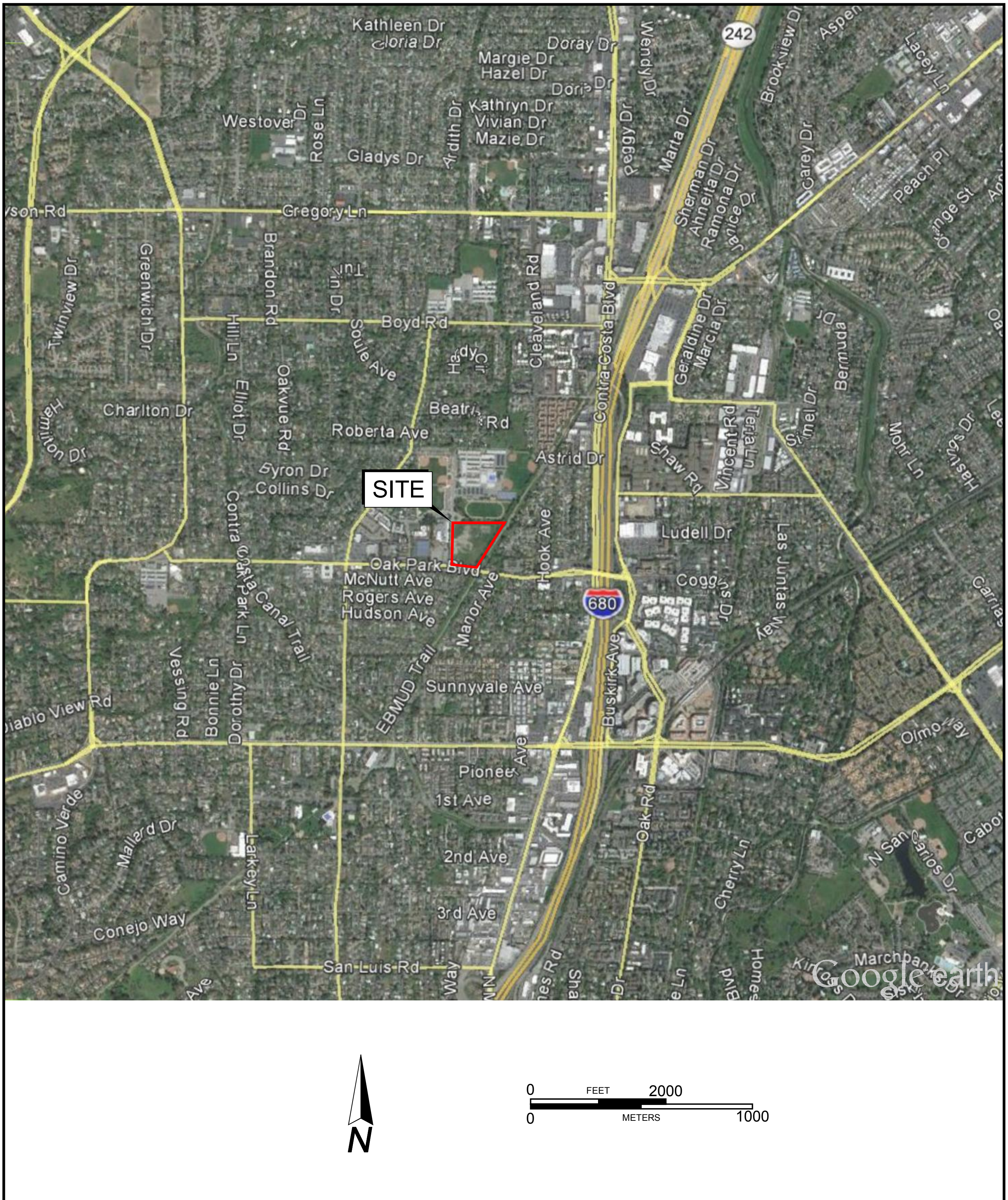
Priestley, M. J. N., Kowalsky, M. J., Ranzo, G., & Benzoni, G. (1996, October), Preliminary development of direct displacement-based design for multi-degree of freedom systems. *In Proceedings of 65th Annual SEAOC Convention, Maui, Hawaii, USA, SEAOC.*

Robertson, P. K., & Campanella, R. G. (1988), *Guidelines for geotechnical design using CPT and CPTU data*. Civil Engineering Department, University of British Columbia.

SEAOC, (1996), Recommended Lateral Force Requirements and Tentative Commentary. Structural Engineers Association of California.

Witter, R.C., Knudsen, K.L., Sowers, J.M., Wentworth, C.M., Koehler, R.D., Randolph, C.E., Brooks, S, K., and Gans, K.D., 2006, Maps of Quaternary deposits and liquefaction susceptibility in the central San Francisco Bay region, California: U.S. Geological Survey, Open-File Report OF-2006-1037, scale 1:200,000.

FIGURES



BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE

ENGEO Expect Excellence	VICINITY MAP PLEASANT HILL LIBRARY AND PARK PLEASANT HILL, CALIFORNIA	PROJECT NO.: 15031.000.000 SCALE: AS SHOWN DRAWN BY: SRP CHECKED BY: MT	FIGURE NO. 1

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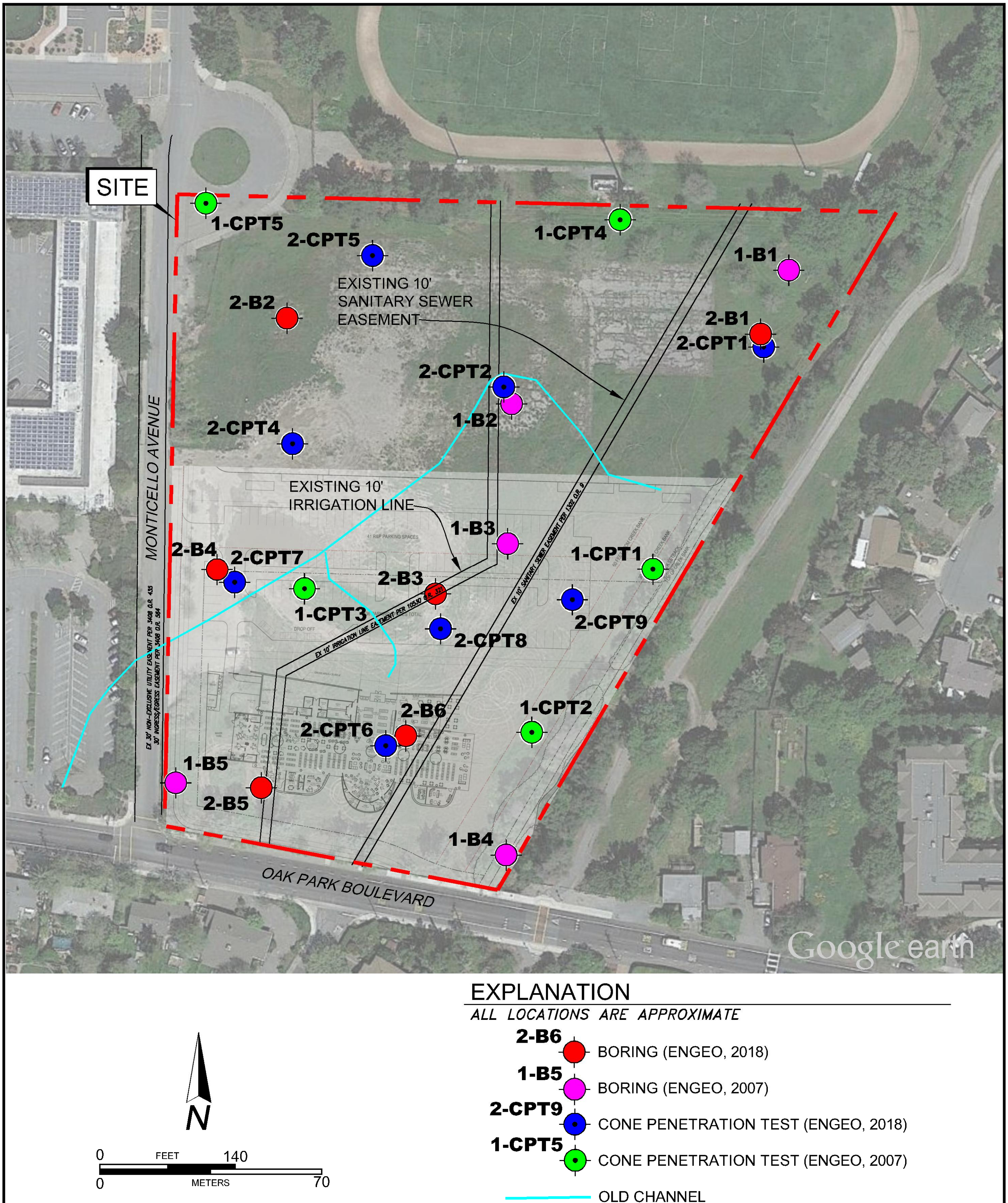
ORIGINAL FIGURE PRINTED IN COLOR



BASE MAP SOURCE: GOOGLE EARTH MAPPING SERVICE, BOHLIN CYWINSKI JACKSON, MAY 30, 2018

ENGEO Expect Excellence	SITE PLAN PLEASANT HILL LIBRARY AND PARK PLEASANT HILL, CALIFORNIA	PROJECT NO.: 15031.000.000 SCALE: AS SHOWN DRAWN BY: SRP / CHECKED BY: MT	FIGURE NO. 2

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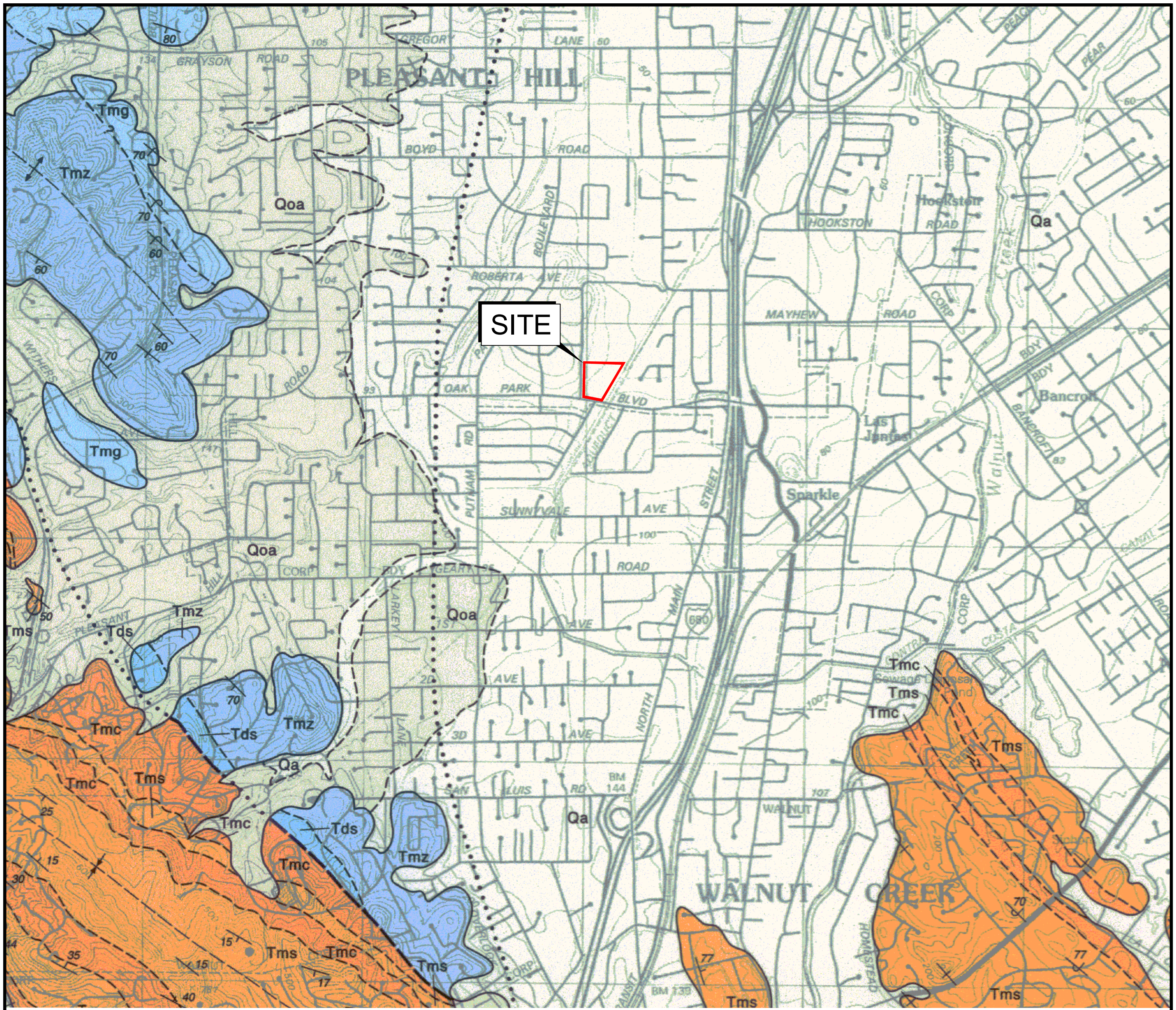
ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

BEDROCK CONTACT-DASHED WHERE GRADATIONAL OR APPROXIMATELY LOCATED

FAULT-DASHED WHERE INFERRED, DOTTED WHERE CONCEALED, QUERIED WHERE EXISTENCE IS DOUBTFUL

STRIKE AND DIP OF STRATA

INCLINED VERTICAL OVERTURNED

Qa	ALLUVIAL GRAVEL
Qoa	OLDER ALLUVIAM
Tms	MONTEREY SANDSTONE
Tmc	MONTEREY CLAY SHALE
Tds	DOMENGENE SANDSTONE
Tmg	MEGANOS FORMATION
Tmz	MARTINEZ FORMATION

N

0 FEET 3000
0 METERS 1500

BASE MAP SOURCE: DIBBLEE, 2006

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REGIONAL GEOLOGIC MAP
PLEASANT HILL LIBRARY AND PARK
PLEASANT HILL, CALIFORNIA

PROJECT NO.: 15031.000.000	FIGURE NO. 3
SCALE: AS SHOWN	
DRAWN BY: SRP	CHECKED BY: MT

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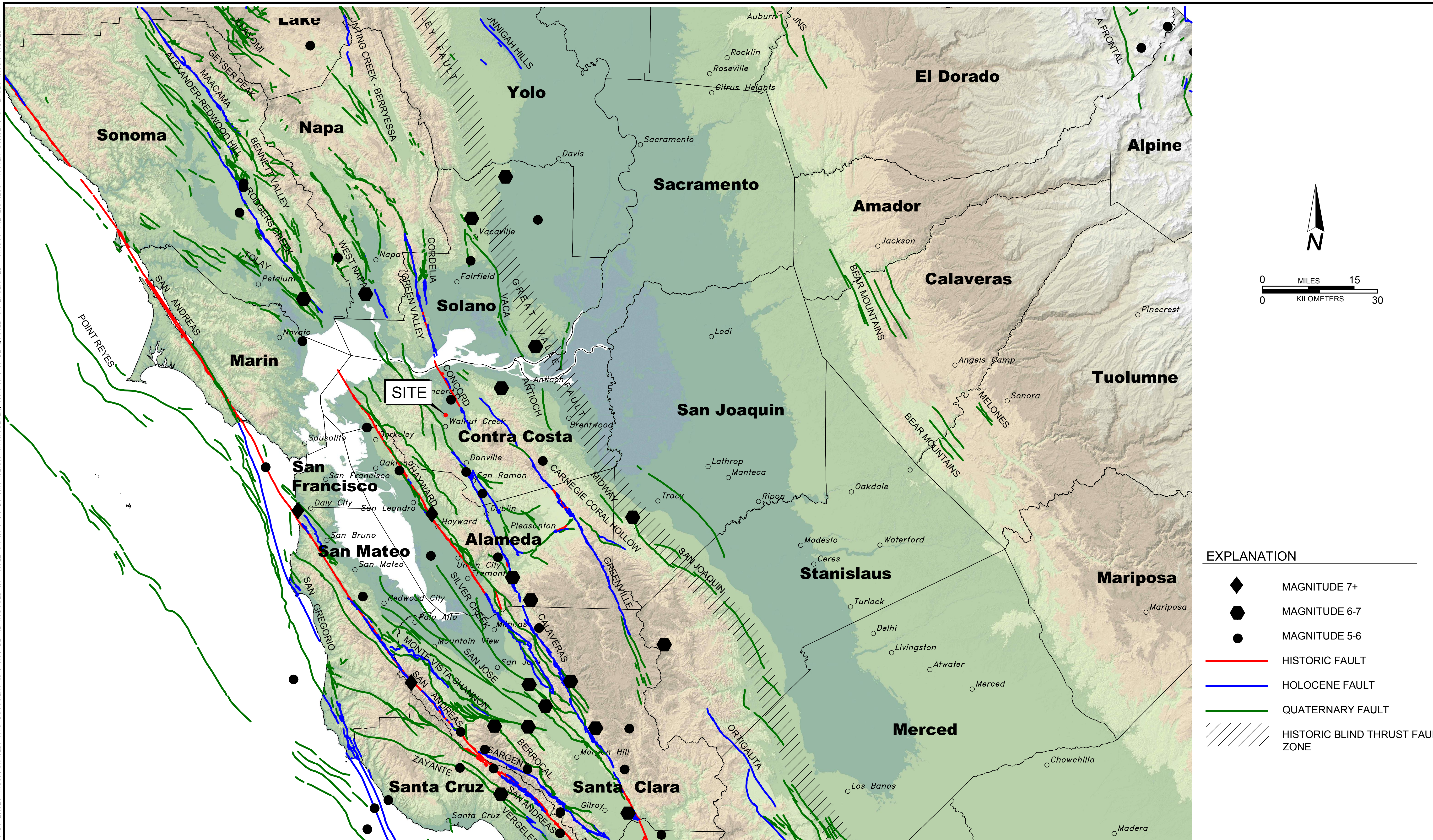
ORIGINAL FIGURE PRINTED IN COLOR



BASE MAP SOURCE:
COLOR HILLSHADE IMAGE BASED ON THE NATIONAL ELEVATION DATASET (NED) AT 30 METER RESOLUTION
U.S.G.S. QUATERNARY FAULT DATABASE, NOVEMBER, 2010
U.S.G.S. HISTORIC EARTHQUAKE DATABASE (1800–2000)

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REGIONAL FAULTING AND SEISMICITY
PLEASANT HILL LIBRARY AND PARK
PLEASANT HILL, CALIFORNIA

PROJECT NO.: 15031.000.000	FIGURE NO. 4
SCALE: AS SHOWN	
DRAWN BY: SRP	CHECKED BY: MT

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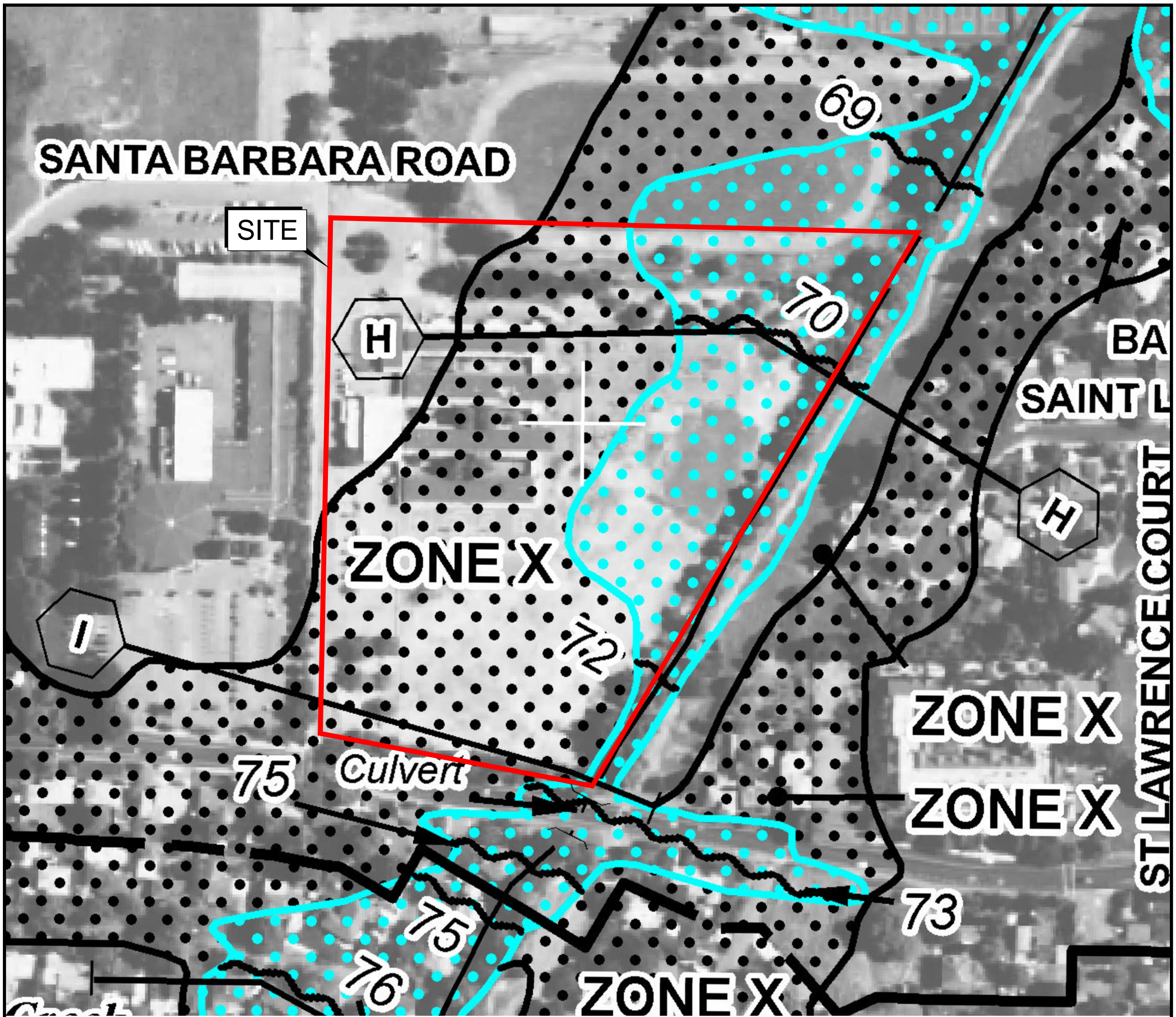
ORIGINAL FIGURE PRINTED IN COLOR



EXPLANATION

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	*Area to be protected from 1% annual chance flood by a Federal flood* protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

~~ *513* ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
2476000mN	1000-meter Universal Transverse Mercator grid values, zone 10N
600000 FT	5000-foot grid ticks: California State Plane coordinate system, zone III (FIPSZONE 0403), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

N

0 FEET 200

0 METERS 100

BASE MAP SOURCE: FEMA, 2009

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FEMA FLOOD INSURANCE MAP
PLEASANT HILL LIBRARY AND PARK
PLEASANT HILL, CALIFORNIA

PROJECT NO.: 15031.000.000	FIGURE NO. 5
SCALE: AS SHOWN	
DRAWN BY: SRP	CHECKED BY: MT

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ORIGINAL FIGURE PRINTED IN COLOR

APPENDIX A

BORING LOG KEY
EXPLORATION LOGS

KEY TO BORING LOGS

MAJOR TYPES				DESCRIPTION
COARSE-GRAINED SOILS MORE THAN HALF OF MAT'L LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LESS THAN 5% FINES		GW - Well graded gravels or gravel-sand mixtures
				GP - Poorly graded gravels or gravel-sand mixtures
		GRAVELS WITH OVER 12 % FINES		GM - Silty gravels, gravel-sand and silt mixtures
				GC - Clayey gravels, gravel-sand and clay mixtures
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LESS THAN 5% FINES		SW - Well graded sands, or gravelly sand mixtures
				SP - Poorly graded sands or gravelly sand mixtures
		SANDS WITH OVER 12 % FINES		SM - Silty sand, sand-silt mixtures
				SC - Clayey sand, sand-clay mixtures
FINE-GRAINED SOILS MORE THAN HALF OF MAT'L SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50 % OR LESS			ML - Inorganic silt with low to medium plasticity
				CL - Inorganic clay with low to medium plasticity
				OL - Low plasticity organic silts and clays
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50 %			MH - Elastic silt with high plasticity
				CH - Fat clay with high plasticity
				OH - Highly plastic organic silts and clays
	HIGHLY ORGANIC SOILS			PT - Peat and other highly organic soils

For fine-grained soils with 15 to 29% retained on the #200 sieve, the words "with sand" or "with gravel" (whichever is predominant) are added to the group name.

For fine-grained soil with >30% retained on the #200 sieve, the words "sandy" or "gravelly" (whichever is predominant) are added to the group name.

GRAIN SIZES

U.S. STANDARD SERIES SIEVE SIZE: 200 — 40 — 10 — 4 | CLEAR SQUARE SIEVE OPENINGS: 3/4 " — 3" — 12"

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

RELATIVE DENSITY

SANDS AND GRAVELS	BLOWS/FOOT (S.P.T.)
VERY LOOSE	0-4
LOOSE	4-10
MEDIUM DENSE	10-30
DENSE	30-50
VERY DENSE	OVER 50

CONSISTENCY

SILTS AND CLAYS	STRENGTH*
VERY SOFT	0-1/4
SOFT	1/4-1/2
MEDIUM STIFF	1/2-1
STIFF	1-2
VERY STIFF	2-4
HARD	OVER 4

MOISTURE CONDITION

DRY	Dusty, dry to touch
MOIST	Damp but no visible water
WET	Visible freewater

SAMPLER SYMBOLS

- Modified California (3" O.D.) sampler
- California (2.5" O.D.) sampler
- S.P.T. - Split spoon sampler
- Shelby Tube
- Dames and Moore Piston
- Continuous Core
- Bag Samples
- Grab Samples
- NR No Recovery

LINE TYPES

- Solid - Layer Break
- Dashed - Gradational or approximate layer break

GROUND-WATER SYMBOLS

- Groundwater level during drilling
- Stabilized groundwater level

(S.P.T.) Number of blows of 140 lb. hammer falling 30" to drive a 2-inch O.D. (1-3/8 inch I.D.) sampler

* Unconfined compressive strength in tons/sq. ft., asterisk on log means determined by pocket penetrometer

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LOG OF BORING 2-B1

LATITUDE: 37.935072 LONGITUDE: -122.065987

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 29¼ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 69 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		SANDY LEAN CLAY (CL), dark brown, medium stiff, moist, medium to high plasticity, 15-20% fine to medium grained sand, trace rootlets										
			14	48	17	31		17.2	108.5		3.0*	PP
	65											
5												
		color change to pale olive, mottled with iron and carbonate staining.	7									
		color change to olive brown.	11					23.9	102.3			
	60										1.5*	PP
10												
			15								0.75* 1.5*	PP PP
	55											
15			21									
		stiffer, color change to dark brown, 20-25% fine to medium grained sand.										
		SILTY SAND (SM), olive brown, loose, wet, sand is subrounded, 10-15% fines content.										
	50											
20			11									
		SILTY SAND (SM), grayish green, dense to very dense, wet, sand is subrounded, 10-15% fines content.										
	45											
25			50/4"									

LOG OF BORING 2-B1

ENGEO Expect Excellence

LATITUDE: 37.935072 LONGITUDE: -122.065987

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 29¼ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 69 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY SAND (SM), grayish green, dense to very dense, wet, sand is subrounded, 10-15% fines content.												
	40		Light yellowish brown, some iron staining, possible boulder			50/4"									
			Borehole terminated at 29 1/3 feet below ground surface. Ground water encountered at 19 feet below ground surface.												

LOG - GEOTECHNICAL_SU+QU W/ ELEV PLEASANT HILL NEW LIBRARY_GINT.GPJ ENGEO INC.GDT 6/28/18

LOG OF BORING 2-B2

ENGEO
Expect Excellence

LATITUDE: 37.935102 LONGITUDE: -122.067684

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 33 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		SANDY LEAN CLAY (CL), pale olive, very stiff, moist, medium to high plasticity, some fine to medium grained sand, trace carbonate nodules.											
	70												
				21									
												4.5*	PP
5													
				25								3.5*	PP
												2.0*	PP
		increasing sand content.											
	65												
				19									
10													
				19					26	97.37			
		SILTY SAND (SM), pale olive, medium dense, wet, some low plasticity fines.											
			▽										
	60			15									
15													
		dense to medium dense, grades to fine to medium grained sand, wet.		43									
	55			28									
20		medium dense											
				20									
	50												
25													

LOG OF BORING 2-B2

LATITUDE: 37.935102 LONGITUDE: -122.067684

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 33 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY SAND (SM), pale olive, medium dense, wet, some low plasticity fines. Very loose to loose			3									
	45		decreasing fines content			8									
30			SANDY ELASTIC SILT (ML), grayish green, medium stiff, moist, low plasticity, 15-20% fine to medium grained sand, lenses or sandy clay, trace coarse grained sand.			8									
	40					32									
			Borehole terminated at 33 feet below ground surface. Ground water encountered at 12 feet below ground surface.												

LOG OF BORING 2-B2 (redrill)

ENGEO
Expect Excellence

LATITUDE: 37.9351 | LONGITUDE: -122.0677

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SANDY LEAN CLAY (CL), light brown, medium stiff, moist, medium plasticity, some fine grained sand pockets, some iron and manganese staining, trace gravels.												
	70														
5															
	65														
						45								2.25*	PP
			LEAN CLAY (CL), pale olive, stiff to very stiff, moist, medium plasticity											1.5*	PP
10															
						9									
	60		SILTY SAND (SM), pale olive, medium dense, wet to saturated, 15-20% fines content.												
						27									
15															
	55														
			grades to medium to coarse sand, 5-10% fines content.			23									
20															
	50														
			heavily iron stained, grades to fine grained sand.			28									
25															

ENGEO
Expect Excellence

LOG OF BORING 2-B2 (redrill)

LATITUDE: 37.9351 LONGITUDE: -122.0677

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 31½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY SAND (SM), pale olive, medium dense, wet to saturated, 15-20% fines content.												
	45														
						36									
30			color changes to pale olive.												
						23									
			Borehole terminated at 33 feet below ground surface. Ground water encountered at 12 feet below ground surface.												

ENGEO
Expect Excellence

LOG OF BORING 2-B3

LATITUDE: 37.934316 LONGITUDE: -122.067133

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 29½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 71 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	70	SANDY LEAN CLAY (CL), pale olive, very stiff, moist, low plasticity, medium to high plasticity, 20-30% fine grained sand.											
				15								2.75* 2.25*	PP PP
5	65	high sand content, approx. 30-40%		15					13.1	120.4		2.5*	PP
		LEAN CLAY WITH SAND (CL), olive brown, very stiff, moist, medium plasticity, some Mn staining, 10-15% sand content.											
		SILTY SAND (SM), olive brown, medium dense, moist to wet, 15-20% fines content.	▽	11									
10	60	SANDY SILT (ML), olive brown, soft, moist, low plasticity, some fine grained sand.		12								0.5*	PP
		SANDY LEAN CLAY (CL), pale olive, stiff, moist, low plasticity, some fine grained sand.		9								2.5*	PP
15	55	SILTY SAND (SM), pale olive, medium dense, moist, 15-20% fines content		15									
20	50	SANDY LEAN CLAY (CL), pale olive, medium stiff to stiff, wet to saturated, low plasticity, some fine and coarse grained sand.		8									
25				19									

LOG OF BORING 2-B3

ENGEO Expect Excellence

LATITUDE: 37.934316 LONGITUDE: -122.067133

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 2/7/2018
HOLE DEPTH: Approx. 29½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 71 ft.

LOGGED / REVIEWED BY: L. Gordon /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	45		SANDY SILT (ML), pale olive, very stiff, moist, low plasticity, some fine grained sand, carbonate veins, iron staining.											2.5*	PP
			SANDY LEAN CLAY (CL), pale olive mottled with yellowish brown, stiff, moist, low plasticity, medium to high plasticity, fine to coarse sand lenses.			14									

Borehole terminated at 29 1/2 feet below ground surface.
Ground water encountered at 9 feet below ground surface.

LOG OF BORING 2-B4

ENGEO
Expect Excellence

LATITUDE: 37.934263 LONGITUDE: -122.067946

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 41½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Water Level	Blow Count/Foot	Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
0	72	Asphalt											
		CLAYEY SAND WITH GRAVEL (SC), light gray mottled with brown, loose, slightly moist, 15-20% fines content with pockets of clay, clay is medium plasticity, 5% gravel. [FILL]											
	70	SANDY LEAN CLAY (CL), olive brown, medium stiff, very moist, medium plasticity, 30-40% fine sand. [FILL]	∇	13									
5	65	SILT WITH SAND (ML), pale olive brown to olive brown, medium stiff, moist, low plasticity, 5% fine grained sand. [FILL]		10								1.0* 1.25*	PP
10		becomes more sandy											
		GRAVELLY ELASTIC SILT (ML), olive brown, stiff to very stiff, moist, low plasticity, [FILL]		25									
	60	SILTY SAND (SM), olive brown, medium dense to dense, moist, 20-30% fines content, silt is low plasticity. [NATIVE]											
15	55	SANDY ELASTIC SILT (ML), olive brown, stiff to very stiff, moist, medium to high plasticity, 20-30% fine grained sand, becomes more clayey.		15				30					
		LEAN CLAY (CL), pale olive mottled with strong brown, medium stiff, moist, low plasticity, 5% fine grained sand, active weathering.											
20	50	POORLY GRADED SAND WITH CLAY AND GRAVEL (SP), brown, dense, saturated, sand is angular to subangular, 5-8% fines content, <5% fine gravel.		21									
25													

LOG OF BORING 2-B4

ENGEO Expect Excellence

LATITUDE: 37.934263 LONGITUDE: -122.067946

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 41½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
	45		POORLY GRADED SAND WITH CLAY AND GRAVEL (SP), brown, dense, saturated, sand is angular to subangular, 5-8% fines content, <5% fine gravel.			43									
30	40		POORLY GRADED SAND WITH GRAVEL (SP), brown grayish brown, dense, saturated, sand is angular to subangular, 5-10% fine to medium gravel.			32									
35	35														
40						32									
			Borehole terminated at 41 1/2 feet below ground surface. Ground water encountered at 3 feet below ground surface.												

LOG OF BORING 2-B5

ENGEO
Expect Excellence

LATITUDE: 37.933781 LONGITUDE: -122.067747

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 73 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Water Level	Blow Count/Foot	Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		LEAN CLAY (CL), dark brown to black, stiff, slightly moist, medium plasticity, fragments of brick and asphalt, trace organics and roots. [FILL]											
	70			18									
		Color changes to pale olive brown, increasing sand content											
5				14					35.4	83.9	853	1.0* 1.5*	UU PP PP
		CLAYEY SAND (SC), pale olive to olive brown, medium dense, moist, 10-20% fines content, clay is medium plasticitiy. [FILL]											
	65		∇										
10		LEAN CLAY (CL), dark brown to dark gray, medium stiff, moist, medium plasticity, <5% fine grained sand. [NATIVE]											
				12								1.0* 1.25*	PP
	60												
15		Trace organics and brown fibrous wood											
				12					25.8	98.6	2018*	2.5* 2.0*	UU PP
	55												
20													
				12								1.5* 1.25*	PP
	50												
25													

ENGEO
Expect Excellence

LOG OF BORING 2-B5

LATITUDE: 37.933781 LONGITUDE: -122.067747

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 73 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Water Level	Blow Count/Foot	Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		SANDY LEAN CLAY (CL), olive to pale olive, medium stiff, moist, medium plasticity, 10-15% fine grained sand, trace organics.		15								1.0*	PP
		GRAVELLY LEAN CLAY WITH SAND (CL), pale olive, medium stiff, moist, medium plasticity, active weathering, trace organics.											
	45	SANDY LEAN CLAY (CL), olive to pale olive, medium stiff, moist, medium plasticity, 10-15% fine grained sand, trace organics.											
30		CLAYEY SAND (SC), pale olive, loose, saturated, 5-10% fines content, fines are low plasticity		12									
	40	POORLY GRADED SAND WITH CLAY AND GRAVEL (SP-SC), grayish brown mottled with strong brown, dense, saturated, sand grains are subangular, 5-10% fines content, 5-10% fine to medium gravel.		32									
35	35	SILTY SAND (SM), olive to yellowish brown, dense, saturated, 25-30% fines content, fines are low plasticity.		47									
40	30	POORLY GRADED SAND WITH CLAY AND GRAVEL (SP), brown to grayish brown, dense, saturated, sand grains are subangular, 5-8% fines content, 5-10% fine to medium gravel.		41									
		increasing fines content											
45	25	CLAYEY SAND WITH GRAVEL (SC), olive brown mottled with strong brown, dense, saturated, sand grains are angular to subangular, 30-40% clay content, clay is low to medium plasticity, 5-7% fine to medium gravel, active weathering.		47									
50													

ENGEO
Expect Excellence

LOG OF BORING 2-B5

LATITUDE: 37.933781 LONGITUDE: -122.067747

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 73 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SANDY ELASTIC SILT (ML), olive brown, hard, saturated, low plasticity, 30-40% fine grained sand, trace coarse sand.			37									
			Borehole terminated at 51 1/2 feet below ground surface. Ground water encountered at 8 feet below ground surface.												

LOG - GEOTECHNICAL_SU+QU W/ ELEV PLEASANT HILL NEW LIBRARY_GINT.GPJ ENGEO INC.GDT 6/28/18

ENGEO
Expect Excellence

LOG OF BORING 2-B6

LATITUDE: 37.933888 LONGITUDE: -122.067168

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY CLAY (CL/ML), dark brown to black, stiff, moist, low to medium plasticity, trace organics. [FILL]												
	70														
						22								4.5* 3.5*	PP PP
			LEAN CLAY (CL), olive mottled with dark brown, stiff, moist, medium plasticity, trace fine to coarse sand. [FILL]												
5															
			becomes softer.												
	65					10					28.9	93.5	1058	1.0 0.5*	UU TV
			SILTY CLAY (CL/ML), olive to pale olive, medium stiff, moist, low plasticity, slow dilatancy, trace fine sand, gritty. [FILL]												
10			SANDY CLAY (CL), grayish brown, stiff, moist, medium plasticity, 10-15% fine to coarse sand. [NATIVE]												
						15					24.5	104.6		1.5* 1.75*	PP
	60														
15			LEAN CLAY (CL), gray, stiff, moist, medium plasticity, trace fine sand, no dilatancy, medium toughness.												
						13								1.5*	PP
	55														
20															
						10								1.5*	PP
	50														
25															

ENGEO
Expect Excellence

LOG OF BORING 2-B6

LATITUDE: 37.933888 LONGITUDE: -122.067168

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	DESCRIPTION	Blow Count/Foot	Atterberg Limits: Liquid Limit	Plastic Limit	Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
		SANDY CLAY (CL), bluish gray, very stiff, moist, low plasticity, trace organics and fiberous wood.										
	45		21					21.7	111		3.5*	PP
		LEAN CLAY WITH SAND (CL), bluish gray, stiff, moist, low to medium plasticity, 5-10% fine to coarse sand, 5% fine gravel, trace fiberous organics.										
30												
		SILT (ML), olive yellow, very stiff, moist, low to medium plasticity, slow dilatancy.										
	40		21	39	25	14		28.6	96.8		2.75*	PP
35		color changes to pale yellow.										
			22								2.75*	PP
	35											
40		LEAN CLAY (CL/ML), bluish gray, very stiff, moist, medium plasticity, tlow dilatancy, race fine to coarse grained angular sand.										
			25								2.75* 1.75*	PP
	30											
45												
			26					34.7	88.3		2.25*	PP
	25											
50												

ENGEO
Expect Excellence

LOG OF BORING 2-B6

LATITUDE: 37.933888 LONGITUDE: -122.067168

Geotechnical Exploration
Pleasant Hill New Library
Pleasant Hill, California
15031.000.000

DATE DRILLED: 5/16/2018
HOLE DEPTH: Approx. 51½ ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (wgs84): Approx. 72 ft.

LOGGED / REVIEWED BY: S. Waganaar /
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Mud Rotary
HAMMER TYPE: 140 lb. Auto Trip

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY CLAY (CL/ML), greenish gray, very stiff, moist, low plasticity to non plastic, rapid dilatancy.			33								3.5*	PP
			Borehole terminated at 51 1/2 feet below ground surface. No groundwater encountered.												

LOG - GEOTECHNICAL_SU+QU W/ ELEV PLEASANT HILL NEW LIBRARY_GINT.GPJ ENGEO INC.GDT 6/28/18

Expect Excellence

LOG OF BORING 1B-1

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 34 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY CLAY (CL), dark brown, very stiff, dry, medium plasticity, some roots, (Fill)			28					11.5	92.6			
			few fine gravels, very hard			32									
			slightly mottled, dark brown with yellowish brown.												
			SAND (SM), gray, medium dense, dry, trace rootlets, some clay in the sample but a very distinct contact between the sand and clay (Fill)			22				64					
5	65		mottled clay and sand			18									
			SILTY CLAY (CL), dark brown, medium stiff to stiff, dry to moist, low plasticity, with sand			12									
			SILTY CLAY (CL), dark yellowish brown mottled with yellowish brown, stiff, moist, medium plasticity, trace carbonates, and rootlets			14					24.7	98.4			
10	60														
			CLAY (CL), dark brown, stiff, moist, high plasticity, trace silt, and fine-grained sand			16					25.1	99.5			
15	55														
					∇										
20	50					31									

LOG OF BORING 1B-1

ENGEO
Expect Excellence

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 34 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILT WITH CLAY (ML), dark olive brown, very stiff, wet, medium plasticity, some carbonate veinlets, trace fine-grained sand												
25	45		SAND WITH SILT (SM), pale olive mottled with olive brown, loose, wet, trace subangular gravel, some gray carbonate veins			13	23	20	3	28	20.2	107.1			
30	40		SILTY SAND (SM), dark reddish yellow, very dense, wet			50/4"									
						50/0"									
			Bottom of boring at approximately 34 feet. Groundwater encountered at approximately 17 feet.												

LOG - GEOTECHNICAL_SU+QU W/ ELEV GINT LOGS.GPJ ENGEO INC.GDT 6/28/18

LOG OF BORING 1B-2

ENGEO Expect Excellence

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 26.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			1-inch Asphalt Concrete over 5-inches Aggregate Base												
			CLAY (CL), very dark brown, medium stiff, dry to moist, high plasticity, some silt, and subangular gravel			10									
			some oxidation of roots and rootlets			16									
5	65		as above, slightly mottled very dark brown with yellowish brown			18					15.6				
10	60		SILTY SAND (SM), dark yellowish brown to olive brown, medium dense, wet		∇	21				54					
15	55		as above			23				42					
20	50														

LOG OF BORING 1B-2

ENGEO Expect Excellence

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 26.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			as above			10	27	22	5	46	23.5				
25	45		SILTY CLAY (CL), olive brown to dark yellowish brown, stiff, wet, low plasticity, some Iron Oxide deposits			18									
			Bottom of boring at approximately 26 1/2 feet. Groundwater encountered at approximately 13 feet.												

ENGEO
Expect Excellence

LOG OF BORING 1B-3

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 16.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY CLAY (CL), dark brown, stiff, dry, medium plasticity, trace roots, and fine gravel, zone of mottling with Calcium Carbonate from approximately 1.75 to 2.25			22	48	15	33		12.9	97.4			
5	65		SILTY CLAY (CL), dark brown mottled with olive brown, some Calicuim Carboante deposits, silty lithic fragmetns at top of sample			18					24.3	99.4		1.8	
10	60		SILTY CLAY (CL), very dark brown, stiff, dry to moist, high plasticity, some organics, and silt, trace subrounded coarse-grained sand		∇	14									
15	55		CLAYEY SILT (ML), dark yellowish brown to olive brown, very stiff, moist, low plasticity, trace fine-grained sand			28									
			Bottom of boring at approximately 16 1/2 feet. Groundwater encountered at approximately 14 feet.												

LOG - GEOTECHNICAL_SU+QU W/ ELEV GINT LOGS.GPJ ENGEO INC.GDT 6/28/18

LOG OF BORING 1B-4

ENGEO
Expect Excellence

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 26.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			CLAY (CL), dark brownish black, very stiff, dry to moist, medium plasticity, bottom of sample mottled with gray Calcium Carbonate veins.			24					25.2	94.7			
5	65		SILTY CLAY (CL), dark brown mottled with dark yellowish brown, stiff, dry to moist, low plasticity, some Calcium Carbonate nodules			17									
10	60		CLAY (CL), very dark brown mottled with dark olive, stiff, moist, high plasticity			16									
15	55		as above, some Calcium Carbonate nodules and veins, trace organic matter		∇	15				81					
20	50														

ENGEO
Expect Excellence

LOG OF BORING 1B-4

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 26.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
						19									
			SILTY CLAY (CL), dark olive gray, stiff, wet, high plasticity, some Calcium Carbonate nodules and fine veins												
25	45		CLAY (CL), very dark green mottled with dark gray, stiff, wet, high plasticity, trace carbonates			14				98	24.8	84.7			
			Bottom of boring at approximately 26.5 feet. Groundwater encountered at approximately 16 feet.												

ENGEO
Expect Excellence

LOG OF BORING 1B-5

LATITUDE: LONGITUDE:

Geotechnical Exploration
1700 Oak Park Boulevard
Pleasant HIll, California
7843.1.001.01

DATE DRILLED: 6/22/2007
HOLE DEPTH: 16.5 ft.
HOLE DIAMETER: 4.0 in.
SURF ELEV (MSL): Approx. 70 ft.

LOGGED / REVIEWED BY: J. Botelho / RB
DRILLING CONTRACTOR: Britton Exploration
DRILLING METHOD: Solid Flight Auger
HAMMER TYPE: 140 lb. Rope and Cathead

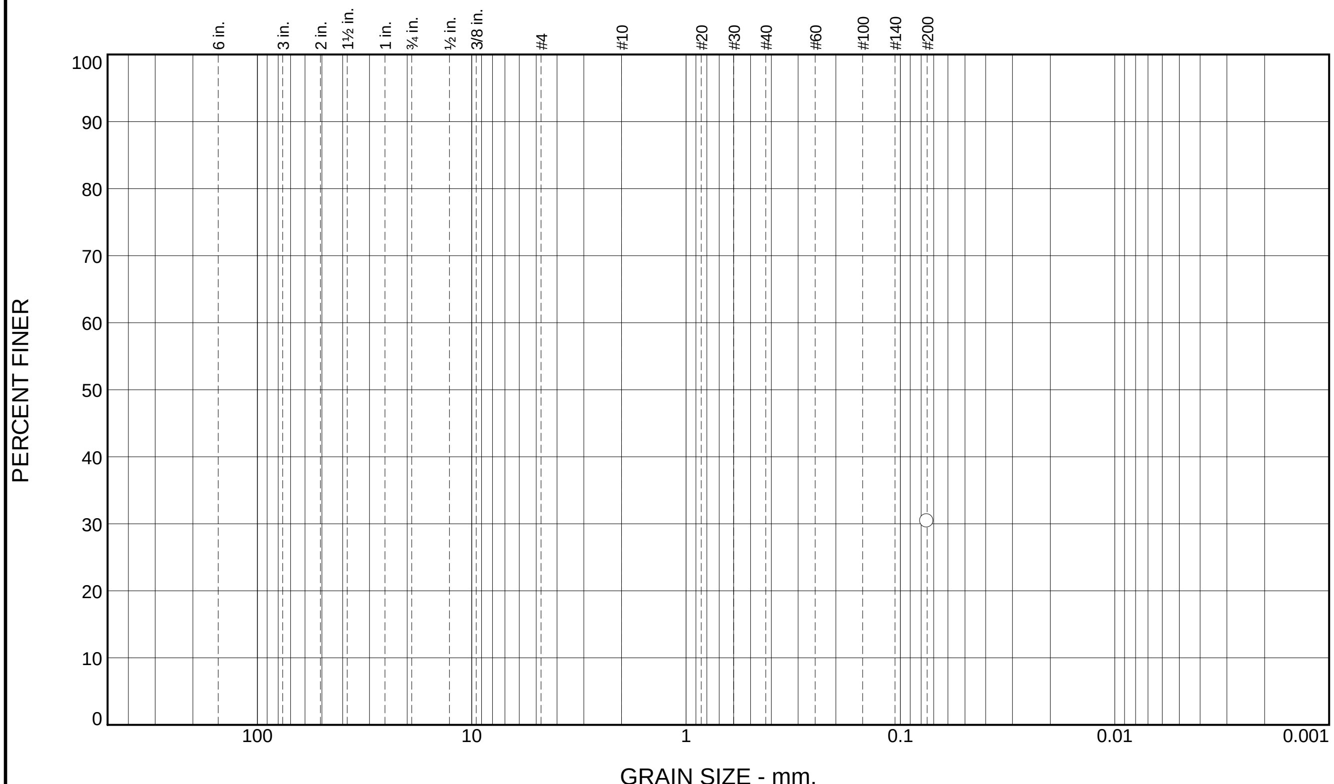
Depth in Feet	Elevation in Feet	Sample Type	DESCRIPTION	Log Symbol	Water Level	Blow Count/Foot	Atterberg Limits: Liquid Limit	Atterberg Limits: Plastic Limit	Atterberg Limits: Plasticity Index	Fines Content (% passing #200 sieve)	Moisture Content (% dry weight)	Dry Unit Weight (pcf)	Shear Strength (psf) *field approximation	Unconfined Strength (tsf) *field approximation	Strength Test Type
			SILTY CLAY (CL), very dark brownish black, stiff, dry, medium plasticity, some carbonates, trace rootlets			21					28.2	90.2			
5	65														
			Some carbonates SILTY CLAY (CL), olive brown to pale olive, stiff, dry, low plasticity			17									
10	60														
			CLAY (CL), dark grayish black mottled with very dark olive gray, stiff, moist, high plasticity, some rootlets, large Calcium Carbonate nodules in shoe			14				90					
15	55														
			as above, not mottled, lighter seam through very dark grayish black, some small Calcium Carbonate nodules			17									
			Bottom of boring at approximately 16.5 feet. No groundwater encountered.												

APPENDIX B

LABORATORY TEST DATA

Particle Size Distribution Report
Liquid and Plastic Limits Test Report
Incremental Consolidation
Unconfined Compression Test
Sulfate Test
Analytical Results of Soil Corrosion
Previous Laboratory Test Data

Particle Size Distribution Report



% +75mm	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						30.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	30.4		

* (no specification provided)

Soil Description

See exploration logs

Atterberg Limits

PL= LL= PI=

Coefficients

D_{90}= D_{85}= D_{60}=
D_{50}= D_{30}= D_{15}=
D_{10}= C_u= C_c=

Classification

USCS= AASHTO=

Remarks

ASTM D1140

Sample Number: 2-B4 @ 15

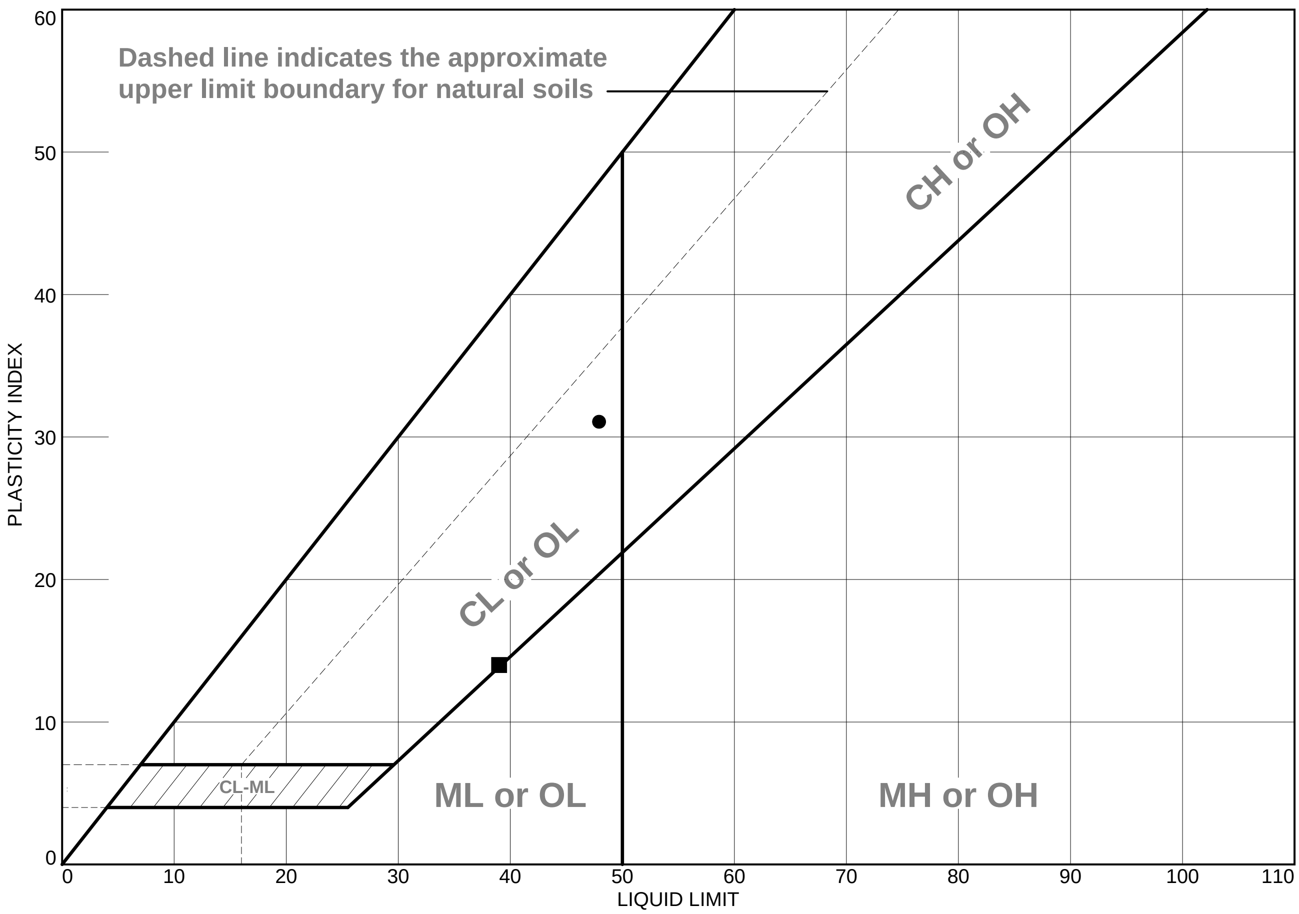
Date: 6/5/18

ENGEO INCORPORATED

Client: City of Pleasant Hill
Project: Pleasant Hill Geotechnical and Environmental Services for New Library Project
Project No: 15031.000.000

Tested By: M. Quasem **Checked By:** M. Bromfield

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	See exploration logs	48	17	31			
■	See exploration logs	39	25	14			

Project No. 15031.000.000 **Client:** City of Pleasant Hill

Project: Pleasant Hill Geotechnical and Environmental Services for New Library Project

●**Sample Number:** 2-B1 @ 2.5

■**Sample Number:** 2-B6 @ 31.5

Remarks:

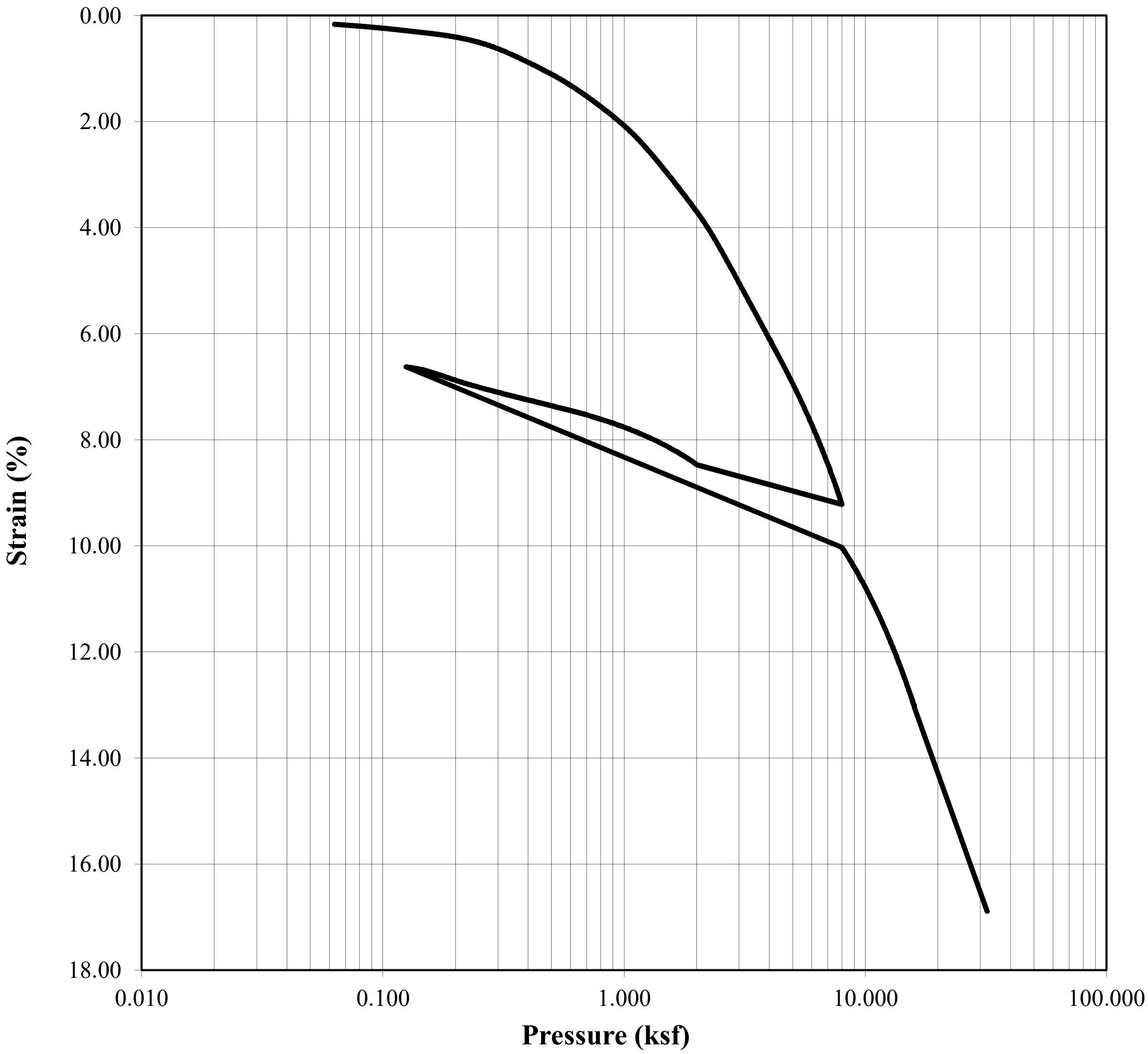
●ASTM D4318, Wet method

■ASTM D4318, Wet method

ENGEO INCORPORATED

Tested By: M. Bromfield **Checked By:** M. Quasem

Incremental Consolidation
ASTM D2435 - Method B

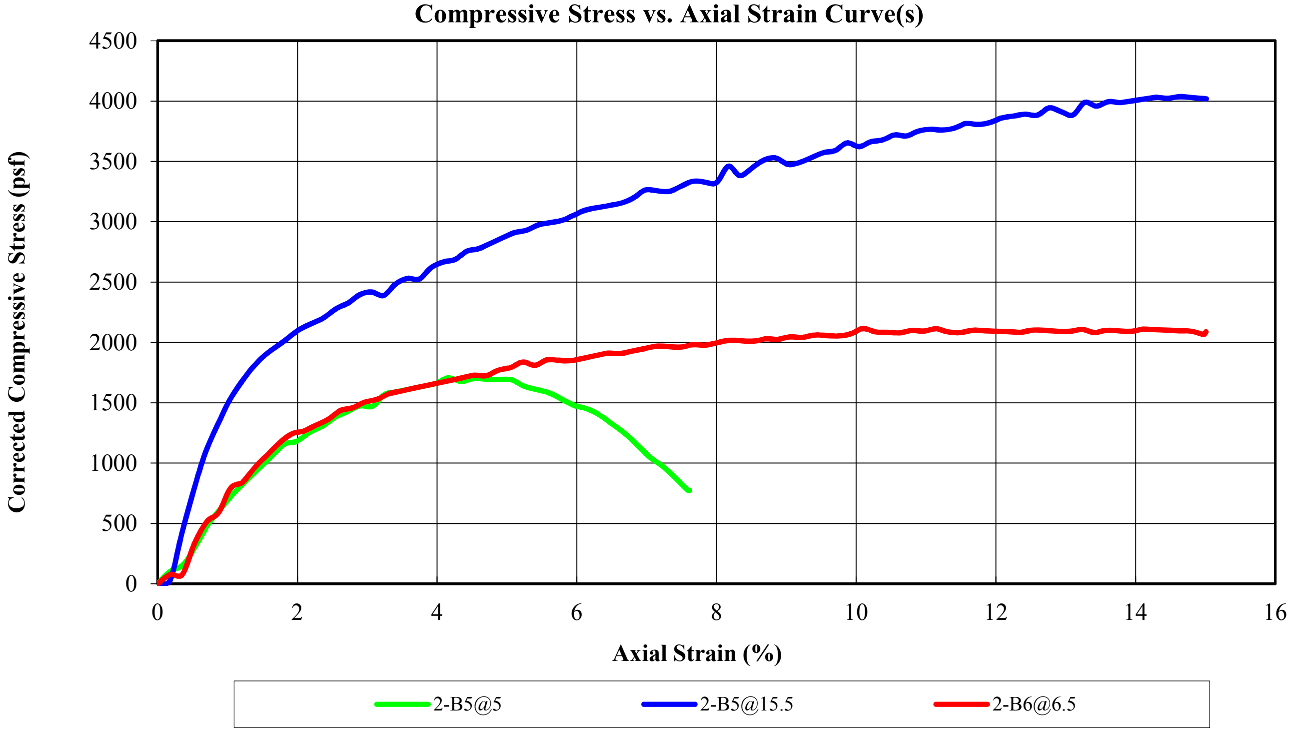


	Before	After	ASTM D4318 - Wet Method		Test Date: 06/04/18
Moisture (%):	26.19	15.01	**Liquid Limit:**	n/a	
Dry Density (pcf):	97.37	118.52	**Plastic Limit:**	n/a	
Saturation (%):	99.02	100.00	ASTM D854 - Measured		
Void Ratio:	0.7041	0.4163	**Specific Gravity:**	2.655	
Sample Description:	See exploration logs		**Remarks:**		

Project Number: 15031.000.000 **Depth:** 10.5-11.5 feet
Sample Number: 2-B5@10.5-11.5 **Boring #:** 2-B5
Project Name: Pleasant Hill Geotechnical and Environmental Services for New Library Project
Client: City of Pleasant Hill
Location: Pleasant Hill, California
Tested By: G. Criste **Checked By:** K. Lecce

ENGEO
Expect Excellence

UNCONFINED COMPRESSION TEST REPORT
(ASTM D2166)



	SPECIMEN		
BEFORE TEST	**2-B5@5**	**2-B5@15.5**	**2-B6@6.5**
Moisture Content (%)	35.4	25.8	28.9
Dry Density (pcf)	83.9	98.6	93.5
Saturation (%)	96.5	100.0	99.4
Void Ratio	0.97	0.68	0.77
Diameter (in)	2.403	2.412	2.418
Height (in)	5.58	5.93	5.79
Height-To-Diameter Ratio	2.32	2.46	2.40
TEST DATA			
Unconfined Compressive Strength (psf)	1706	4037	2115
Undrained Shear Strength (psf)	853	2018	1058
Strain Rate (in./min.)	0.05	0.05	0.05
Specific Gravity (Assumed)	2.650	2.650	2.650
Strain at Failure (%)	4.16	14.63	10.10
Liquid Limit	-	-	-
Plastic Limit	-	-	-
Test Remarks			

SPECIMEN	DESCRIPTION
2-B5@5	See exploration logs
2-B5@15.5	See exploration logs
2-B6@6.5	See exploration logs

ENGEO
Expect Excellence

PROJECT NAME: Pleasant Hill Geotechnical and Environmental Services for New Library Project
PROJECT NO: 15031.000.000
CLIENT: City of Pleasant Hill
LOCATION: Pleasant Hill, CA
PHASE NO: 001

Tested By: M. Bromfield
Reviewed By: M. Quasem
Test Date: 06/04/18

WATER SOLUBLE SULFATES IN SOILS

ASTM C1580

Sample number	Sample Location / ID	Matrix	Water Soluble Sulfate % by mass
1	2-B1 @ 2.5	soil	ND

Remarks: Results are reported to the nearest 100mg/kg. Anything less than 50mg/kg will be reported as 'ND' for Not-Detectable.

PROJECT NAME: Pleasant Hill Geotechnical and Environmental Services for New Library Project
PROJECT NUMBER: 15031.000.000
CLIENT: City of Pleasant Hill
PHASE NUMBER: 001
DATE: 6/4/2018

ENGEO — Expect Excellence

Tested by: M. Quasem
Reviewed by: M. Bromfield

Lab Address: 3420 Fostoria Way Suite E, San Ramon, CA 94583. Phone No. (925) 355-9047

California State Certified Laboratory No. 2153

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

18 June, 2018

Job No. 1806040
Cust. No. 10169

Ms. Kelsey Gerhart
ENGEO Inc.
2010 Crow Canyon Place, Suite 250
San Ramon, CA 94583

Subject: Project No.: 15031.000.000
Project Name: Pleasant Hill Library and Park
Corrosivity Analysis – ASTM Test Methods

Dear Ms. Gerhart:

Pursuant to your request, CERCO Analytical has analyzed the soil sample submitted on June 06, 2018. Based on the analytical results, this brief corrosivity evaluation is enclosed for your consideration.

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

The chloride ion concentration reflects none detected with a reporting limit of 15 mg/kg.

The sulfate ion concentration reflects none detected with a reporting limit of 15 mg/kg.

The pH of the soil is 8.12, which does not present corrosion problems for buried iron, steel, mortar-coated steel and reinforced concrete structures.

The redox potential is 340-mV, which is indicative of potentially "slightly corrosive" soils resulting from anaerobic soil conditions.

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

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

Very truly yours,
CERCO ANALYTICAL, INC.

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

JDH/jdl
Enclosure

California State Certified Laboratory No. 2153

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

Client:	ENGEO Incorporated
Client's Project No.:	15031.000.000
Client's Project Name:	Pleasant Hill Library and Park
Date Sampled:	16-May-18
Date Received:	6-Jun-18
Matrix:	Soil
Authorization:	Signed Chain of Custody

Date of Report: 18-Jun-2018

Job/Sample No.	Sample I.D.	Redox (mV)	pH	Conductivity (umhos/cm)	Resistivity (100% Saturation) (ohms-cm)	Sulfide (mg/kg)*	Chloride (mg/kg)*	Sulfate (mg/kg)*
1806040-001	2-B5/2-B6	340	8.12	-	780	-	N.D.	N.D.

	Redox	pH	Conductivity	Resistivity	Sulfide	Chloride	Sulfate
Method:	ASTM D1498	ASTM D4972	ASTM D1125M	ASTM G57	ASTM D4658M	ASTM D4327	ASTM D4327
Reporting Limit:	-	-	10	-	50	15	15
	14-Jun-2018	14-Jun-2018	-	14-Jun-2018	-	15-Jun-2018	15-Jun-2018

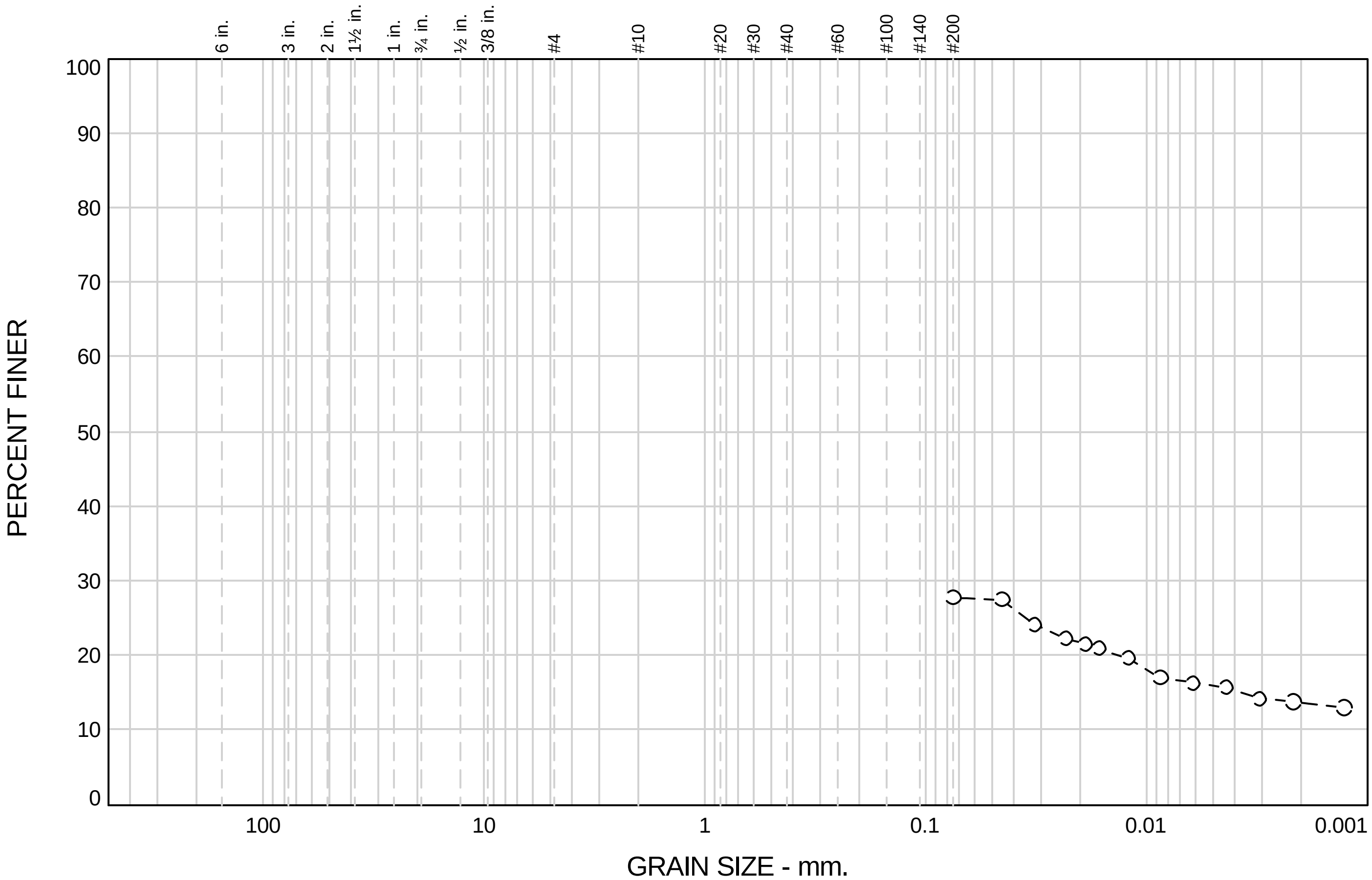
* Results Reported on "As Received" Basis

N.D. - None Detected

Cheryl McMillen
Laboratory Director

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

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						14.2	13.6

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	27.8		

* (no specification provided)

Material Description

Mottled olive brown and olive gray silty SAND

Atterberg Limits

PL= 20 LL= 23 PI= 3

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= 0.0037 D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

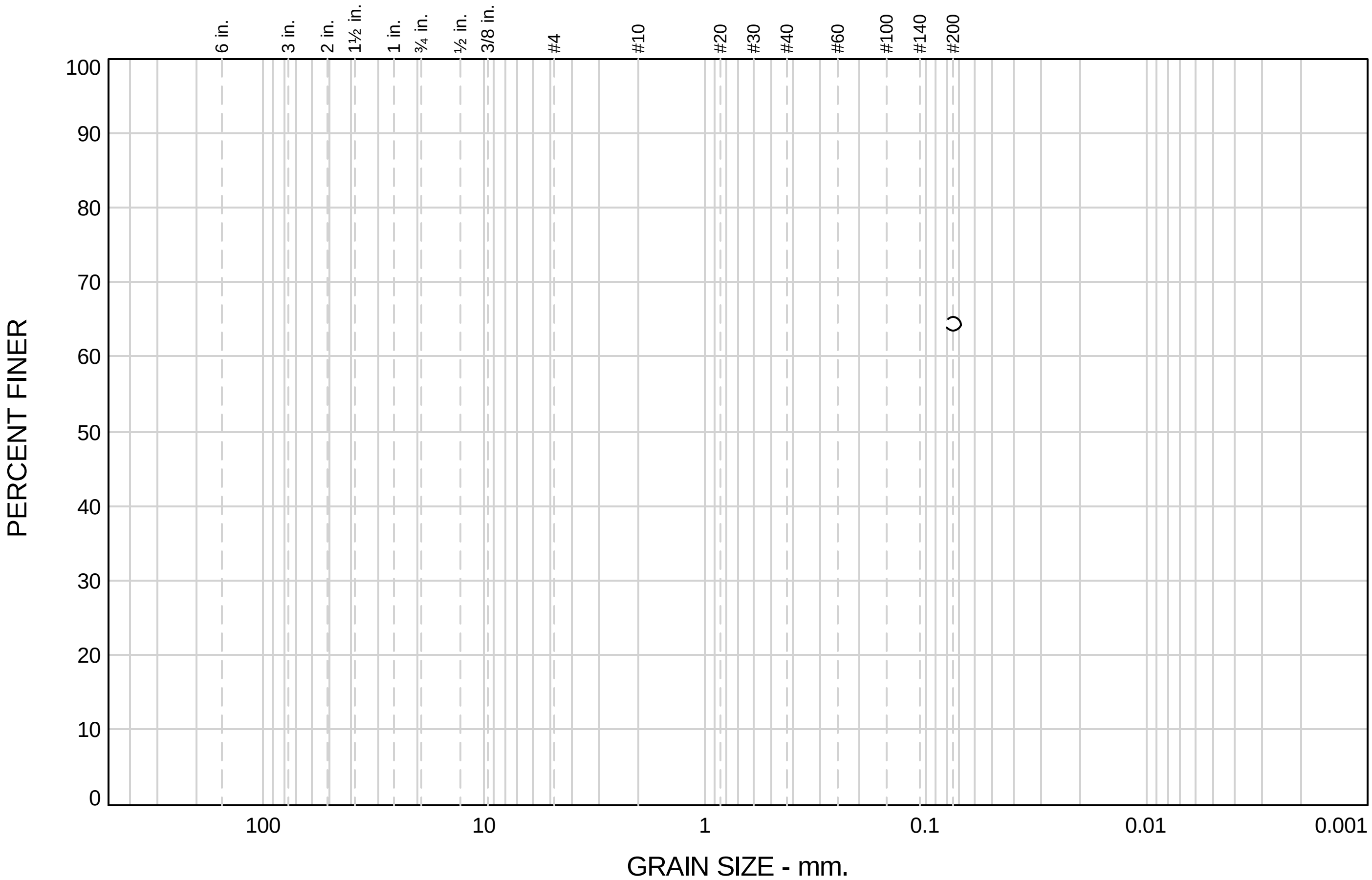
Remarks

Sample Number: B1 @ 25' **Date:** 6/28/07

ENGEO INCORPORATED — GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS, MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						64.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	64.4		

* (no specification provided)

Material Description

Dark grayish brown sandy silty CLAY.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

Remarks

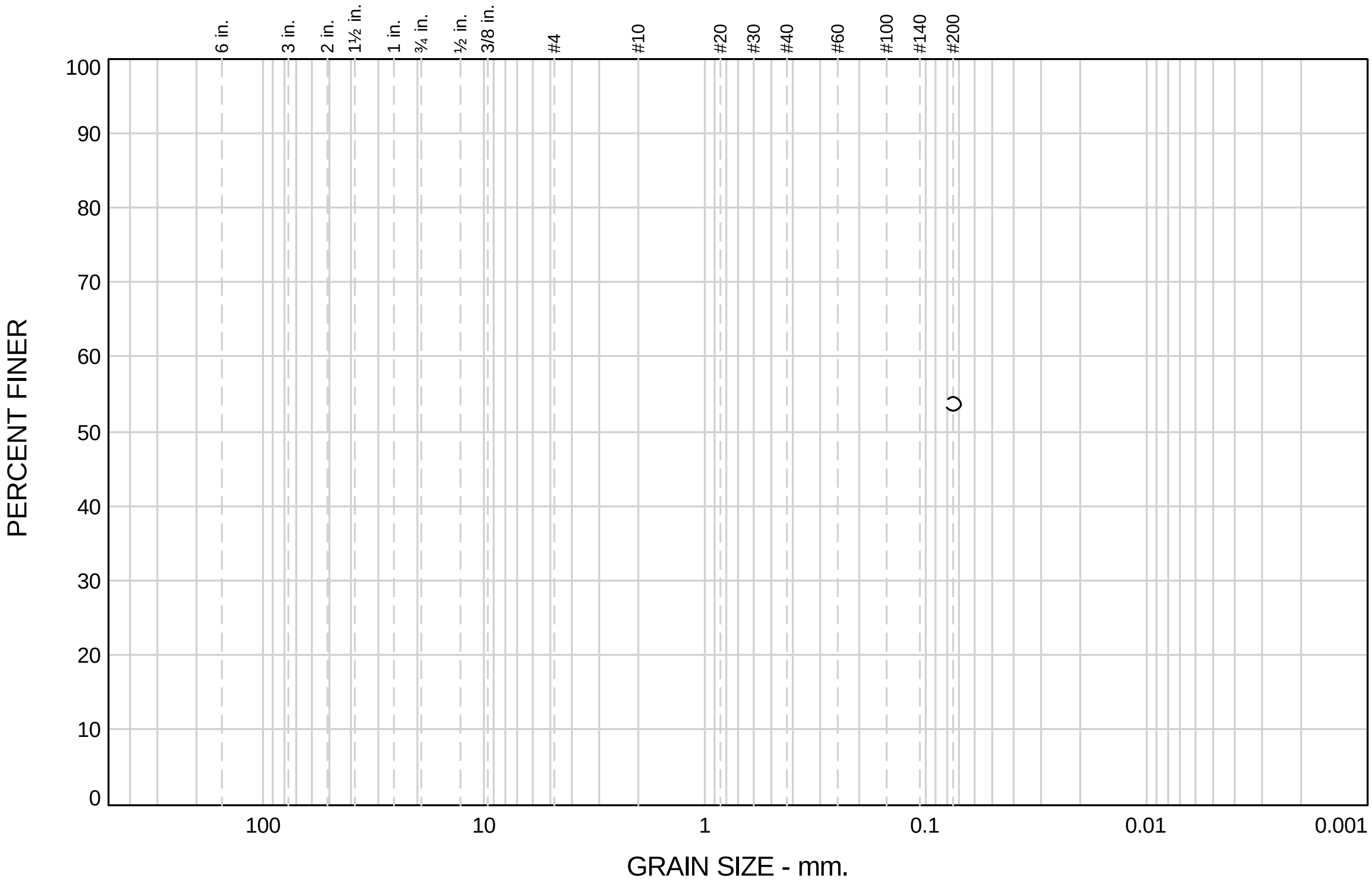
Sample Number: B1 @ 4'

Date: 6/28/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01
Plate

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						53.7	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	53.7		

* (no specification provided)

Material Description

Olive brown sandy CLAY to clayey SAND.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC-SM AASHTO=

Remarks

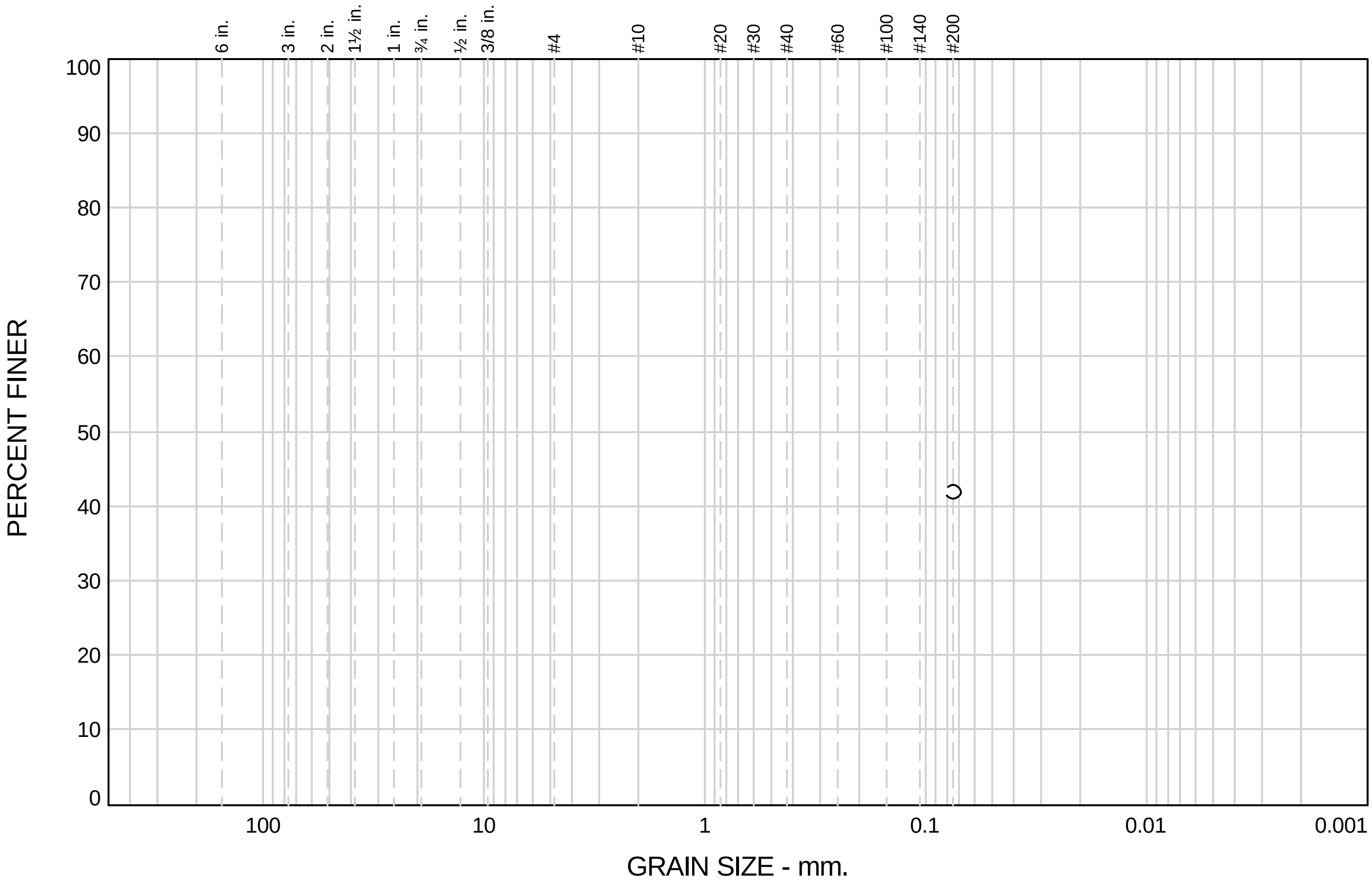
Sample Number: B2 @ 11'

Date: 6/28/07

ENGEO INCORPORATED — GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS, MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01
Plate

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						41.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	41.9		

* (no specification provided)

Material Description

Olive brown clayey SAND.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO=

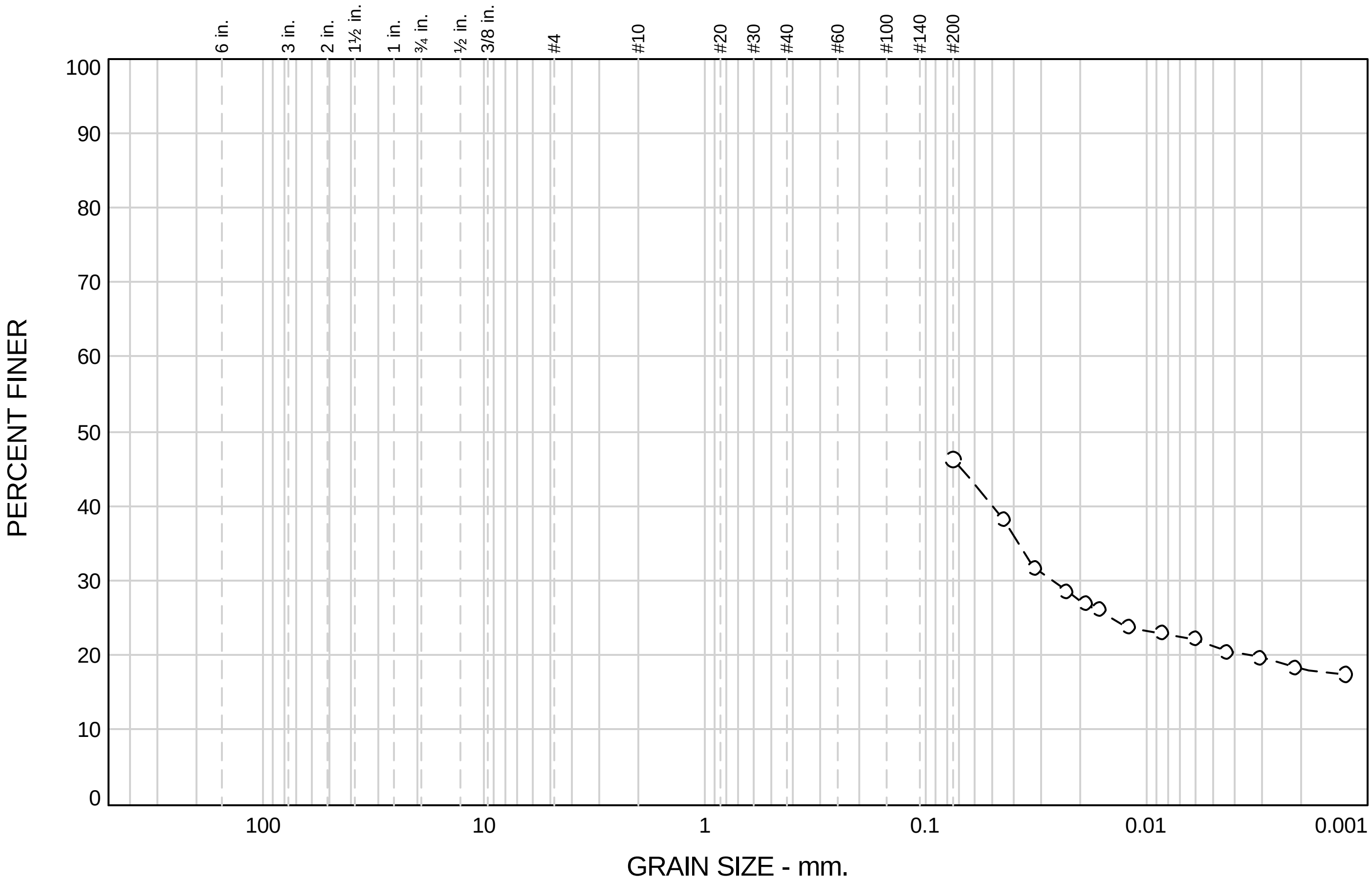
Remarks

Sample Number: B2 @ 16' **Date:** 6/28/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						28.0	18.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	46.2		

* (no specification provided)

Material Description

Olive brown silty SAND

Atterberg Limits

PL= 22 LL= 27 PI= 5

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= 0.0267 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= SM AASHTO=

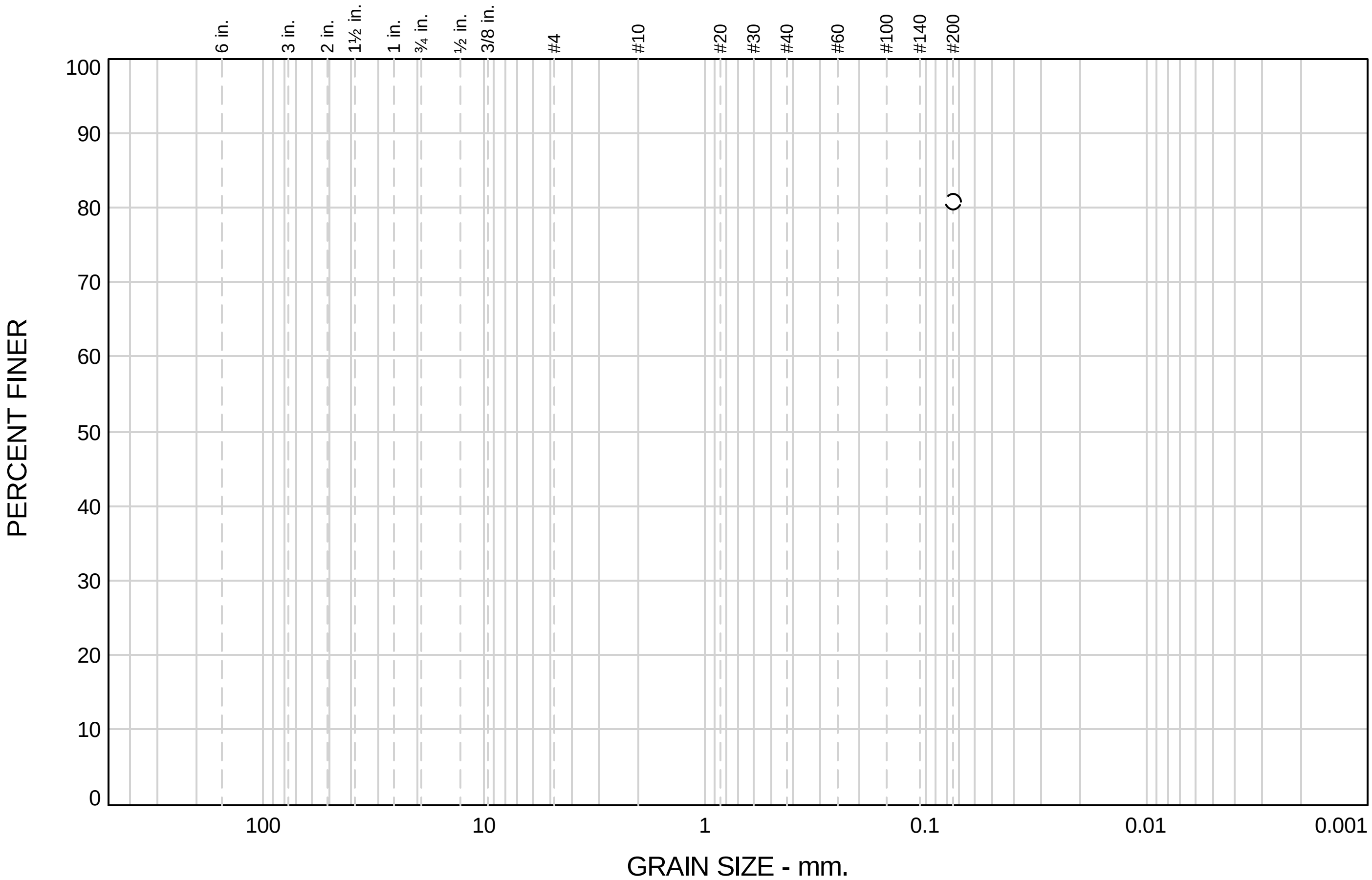
Remarks

Sample Number: B2 @ 20' **Date:** 6/28/07

ENGEO INCORPORATED GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						80.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	80.8		

* (no specification provided)

Material Description

Very dark grayish brown silty CLAY with sand.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO=

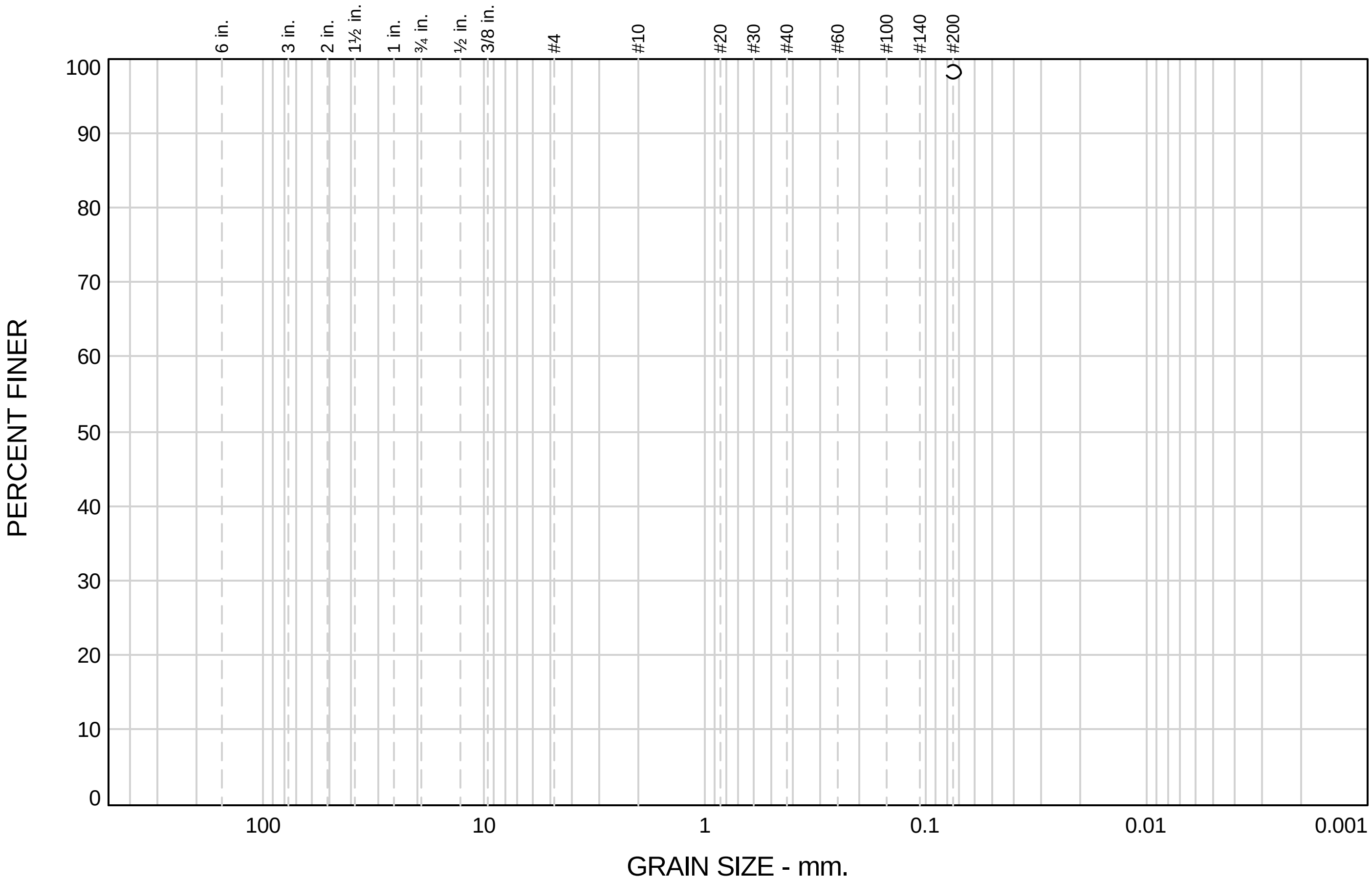
Remarks

Sample Number: B4 @ 16' **Date:** 6/28/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						98.2	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	98.2		

* (no specification provided)

Material Description

Very dark gray CLAY.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

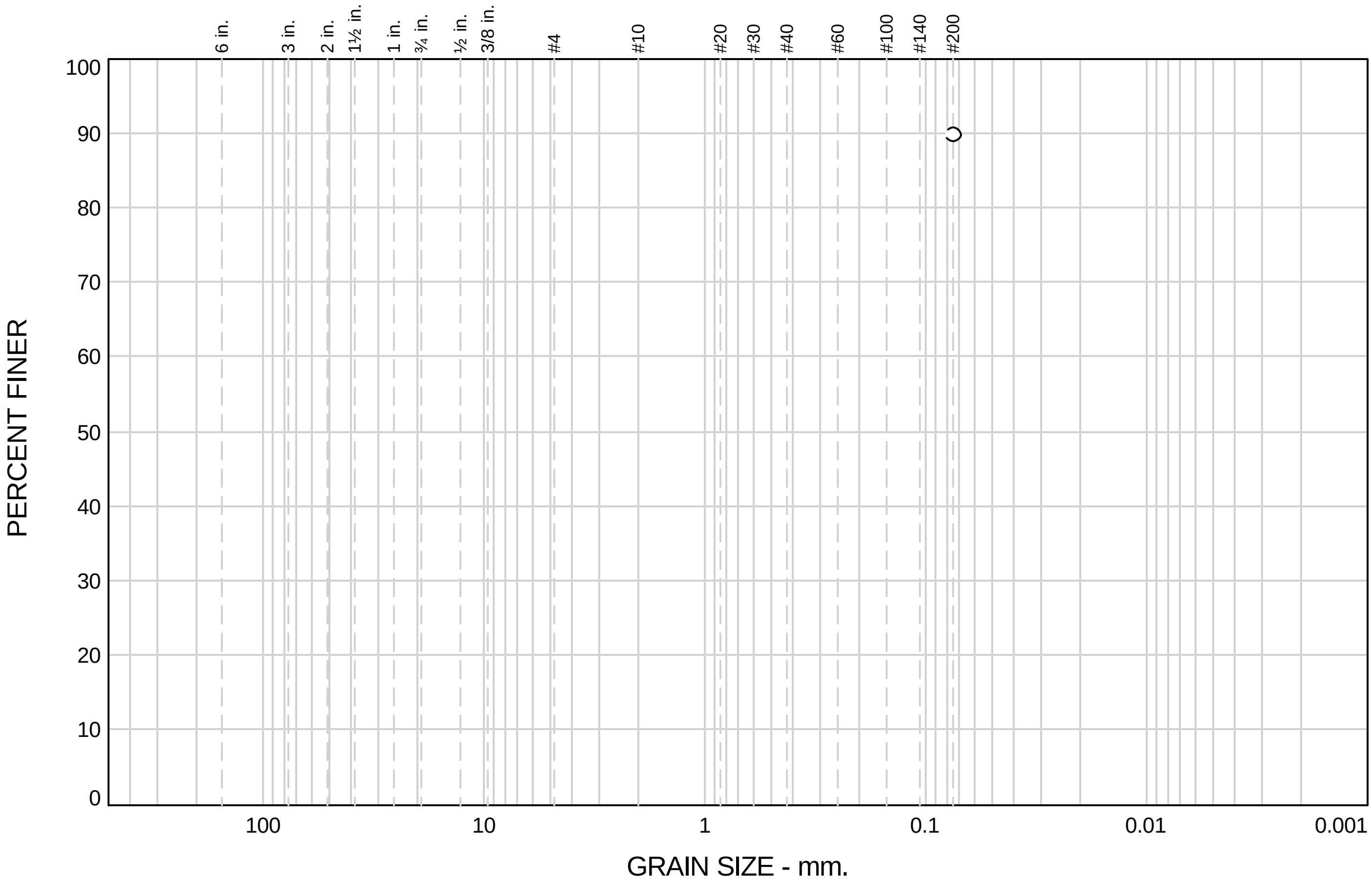
Remarks

Sample Number: B4 @ 26' **Date:** 6/28/07

ENGEO INCORPORATED — GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS — MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						89.9	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	89.9		

* (no specification provided)

Material Description

Very dark gray silty CLAY. Trace sand.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CH AASHTO=

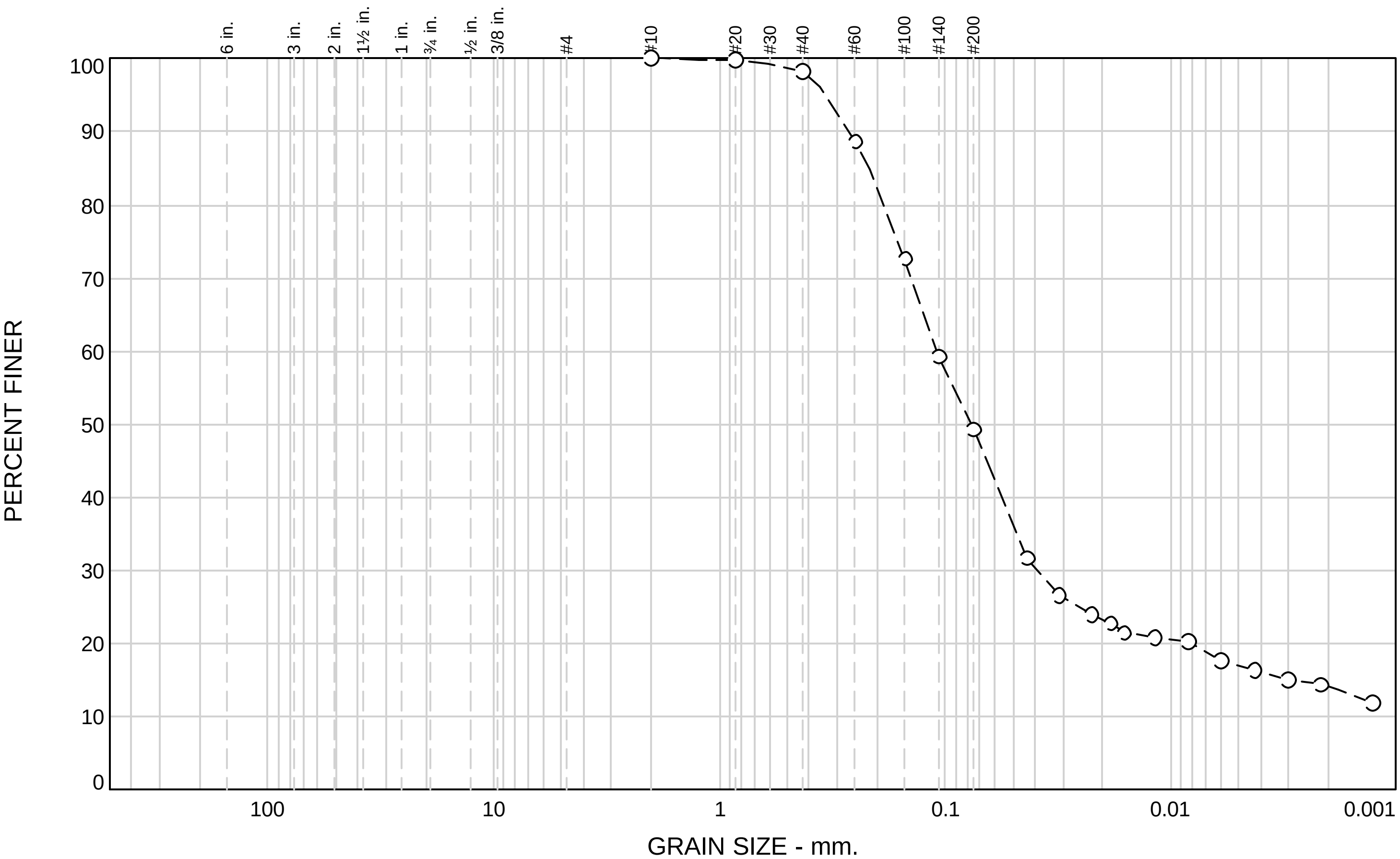
Remarks

Sample Number: B5 @ 11' **Date:** 6/28/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01 **Plate**

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.8	48.9	35.1	14.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#20	99.9		
#40	98.2		
#60	88.7		
#100	72.6		
#140	59.3		
#200	49.3		

* (no specification provided)

Material Description

Olive gray clayey SAND.

Atterberg Limits

PL= 17 LL= 25 PI= 8

Coefficients

D_{85}= 0.2178 D_{60}= 0.1083 D_{50}= 0.0767
D_{30}= 0.0398 D_{15}= 0.0029 D_{10}=
C_u= C_c=

Classification

USCS= SC AASHTO= A-4(1)

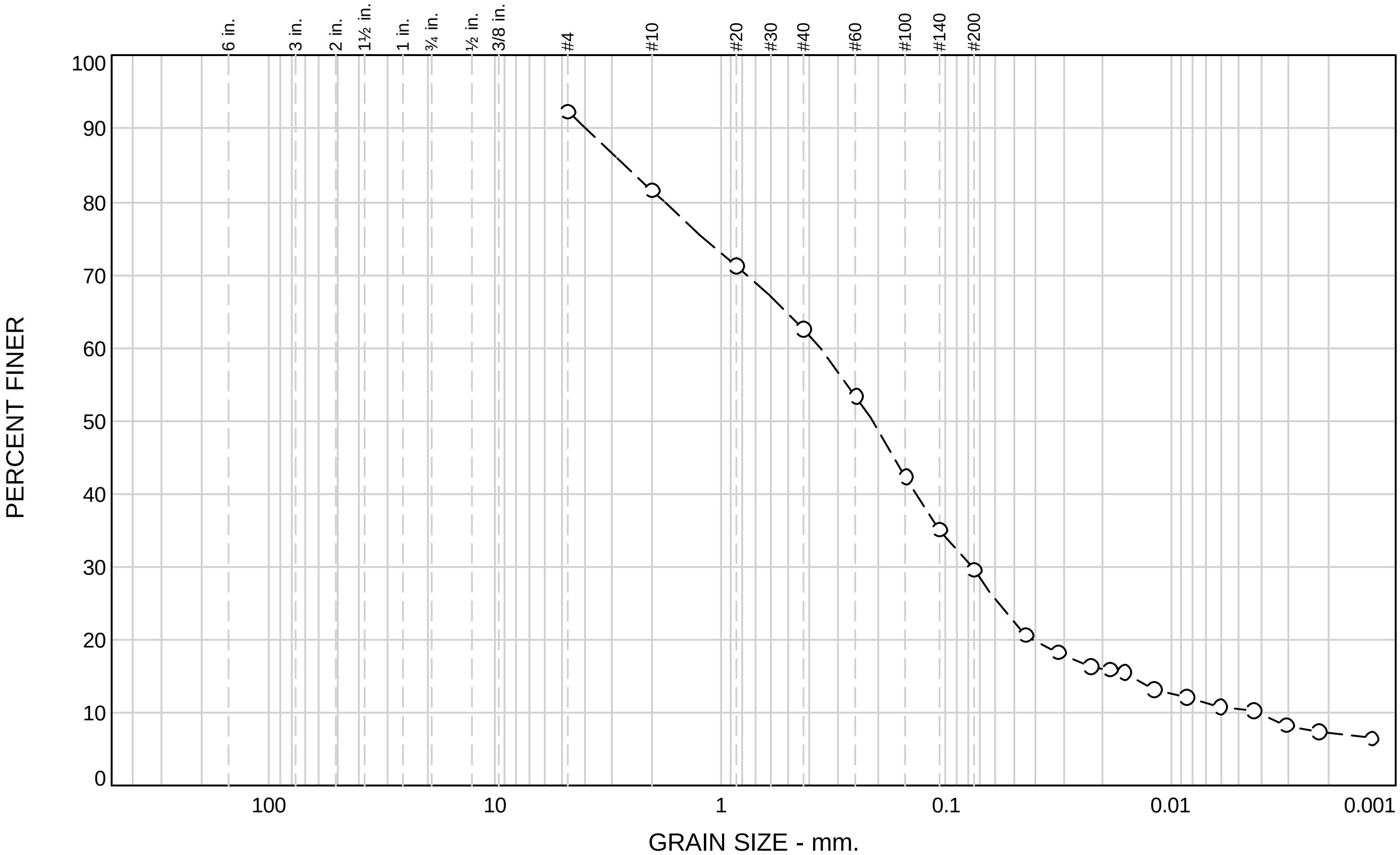
Remarks

Sample Number: CPT-1 @ 22.5-26.5' **Date:** 7/14/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
			10.8	19.1	32.9	22.4	7.2

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	92.4		
#10	81.6		
#20	71.2		
#40	62.5		
#60	53.4		
#100	42.4		
#140	35.1		
#200	29.6		

* (no specification provided)

Material Description

Dark gray silty SAND. Trace clay.

Atterberg Limits

PL= 19 LL= 21 PI= 2

Coefficients

D_{85}= 2.6355 D_{60}= 0.3615 D_{50}= 0.2121
D_{30}= 0.0767 D_{15}= 0.0150 D_{10}= 0.0041
C_u= 89.08 C_c= 4.01

Classification

USCS= SM AASHTO= A-2-4(0)

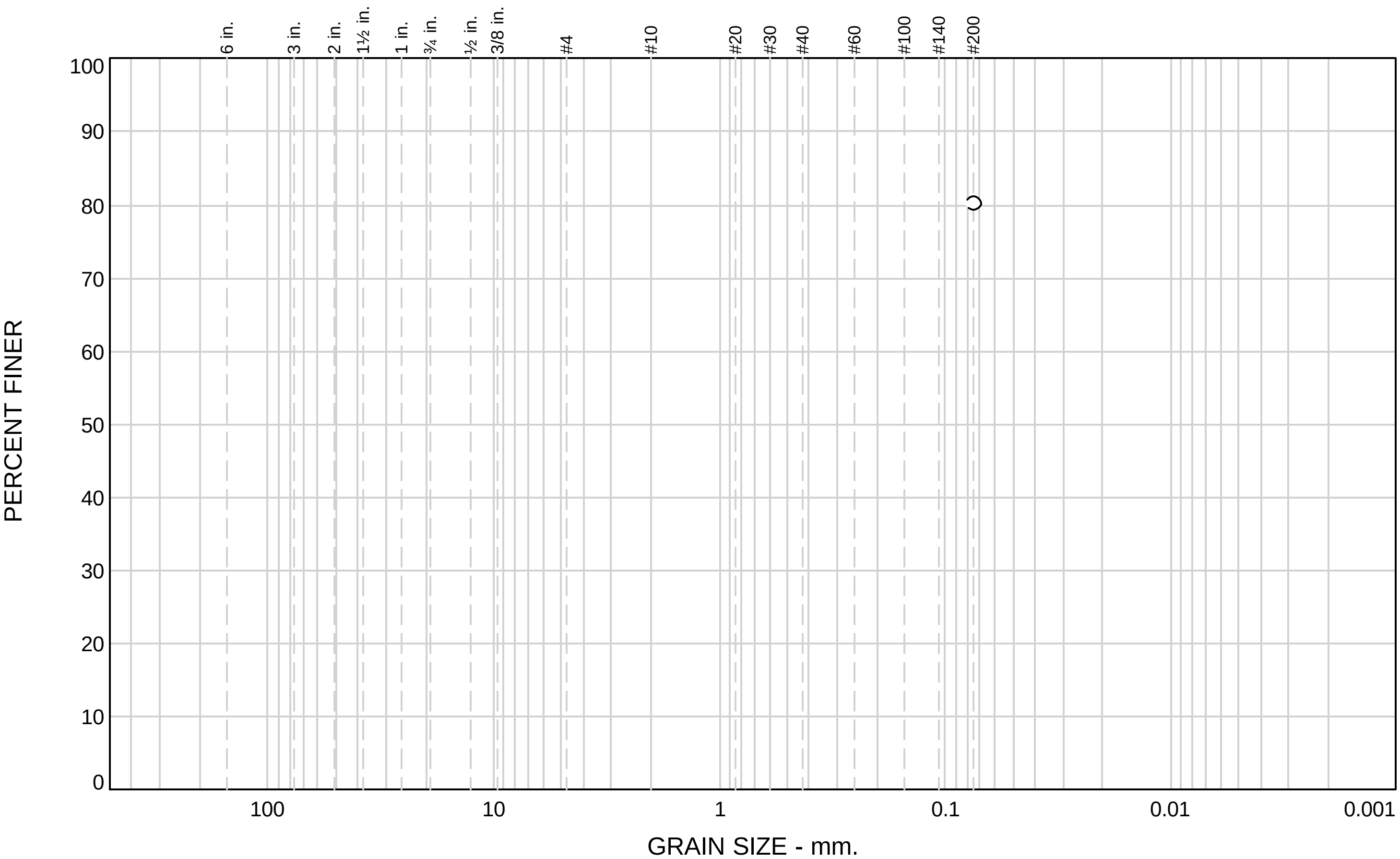
Remarks

Sample Number: CPT-5 @ 18-22' **Date:** 7/14/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						80.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	80.3		

* (no specification provided)

Material Description

Mix of very dark grayish and dark grayish brown sandy SILT

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

Sample Number: CPT-2 @ 7-11'

Date: 7/14/07

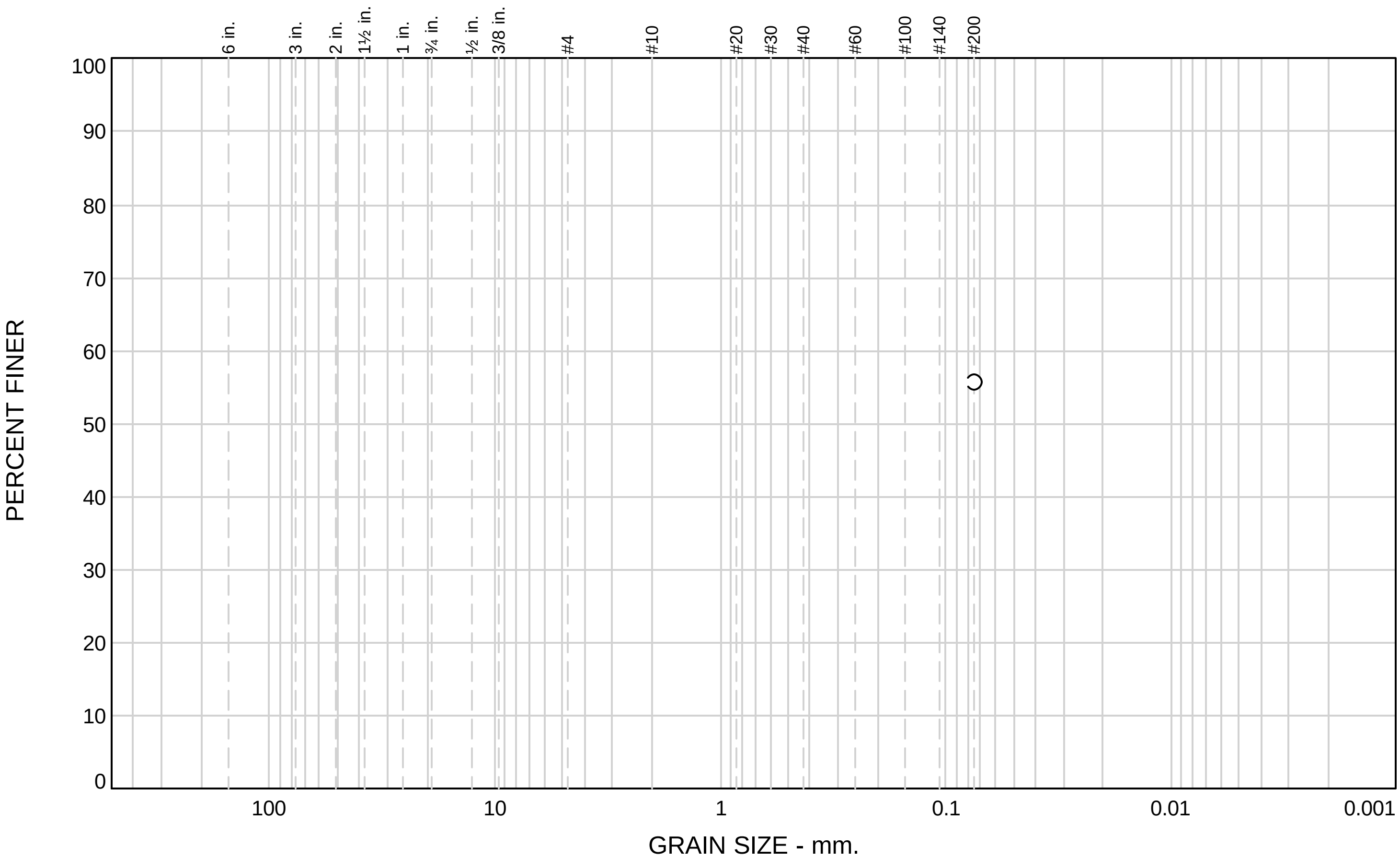
ENGEO INCORPORATED — GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS — MATERIALS TESTING

Client:

Project: 1700 Oak Park Blvd

Project No: 7843.1.001.01

Particle Size Distribution Report



% Cobbles	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
						55.8	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#200	55.8		

* (no specification provided)

Material Description

Grayish brown sandy SILT. Trace gravel.

Atterberg Limits

PL= LL= PI=

Coefficients

D_{85}= D_{60}= D_{50}=
D_{30}= D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= AASHTO=

Remarks

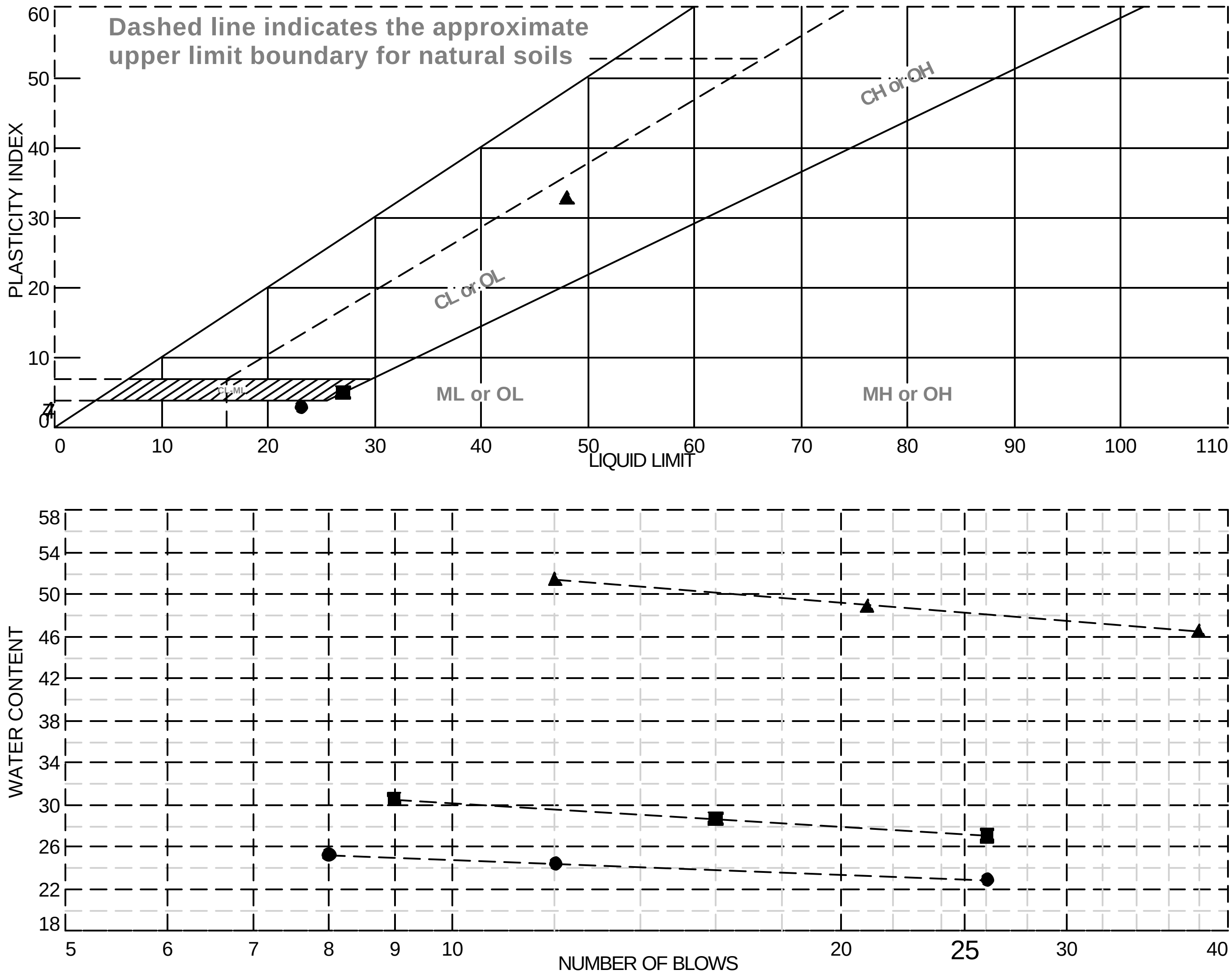
Sample Number: CPT-3 @ 12-16'

Date: 7/14/07

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Client:
Project: 1700 Oak Park Blvd
Project No: 7843.1.001.01

LIQUID AND PLASTIC LIMITS TEST REPORT



	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Mottled olive brown and olive gray silty SAND	23	20	3		27.8	SM
■	Olive brown silty SAND	27	22	5		46.2	SM
▲	Very dark grayish brown silty CLAY to CLAY	48	15	33			CL-CH

Project No. 7843.1.001.01 **Client:**

Remarks:

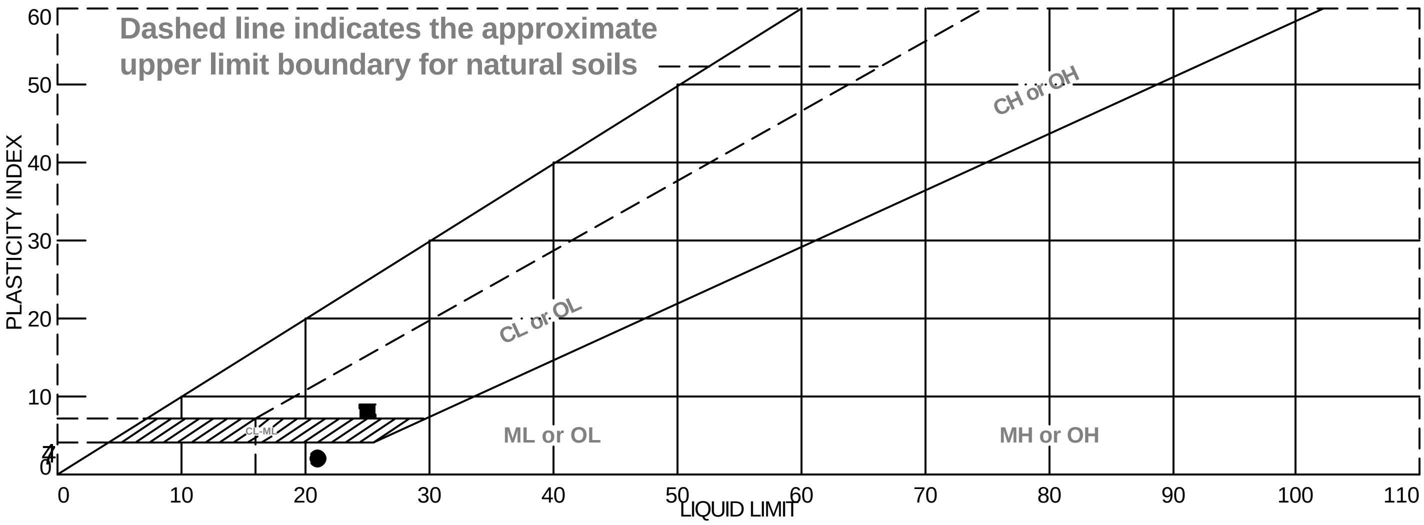
Project: 1700 Oak Park Blvd

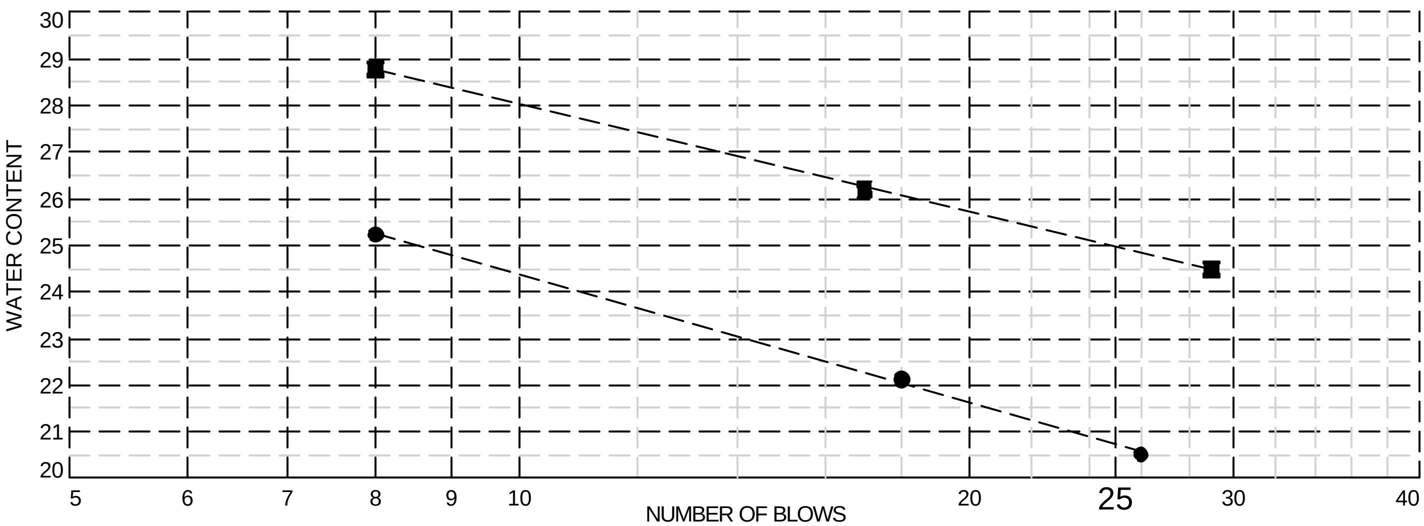
● **Sample Number:** B1 @ 25'
■ **Sample Number:** B2 @ 20'
▲ **Sample Number:** B3 @ 2'

ENGEO INCORPORATED — GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS MATERIALS TESTING

Plate

LIQUID AND PLASTIC LIMITS TEST REPORT





	MATERIAL DESCRIPTION	LL	PL	PI	%<#40	%<#200	USCS
●	Dark gray silty SAND. Trace clay.	21	19	2	62.5	29.6	SM
■	Olive gray clayey SAND.	25	17	8	98.2	49.3	SC

Project No. 7843.1.001.01 **Client:**

Project: 1700 Oak Park Blvd

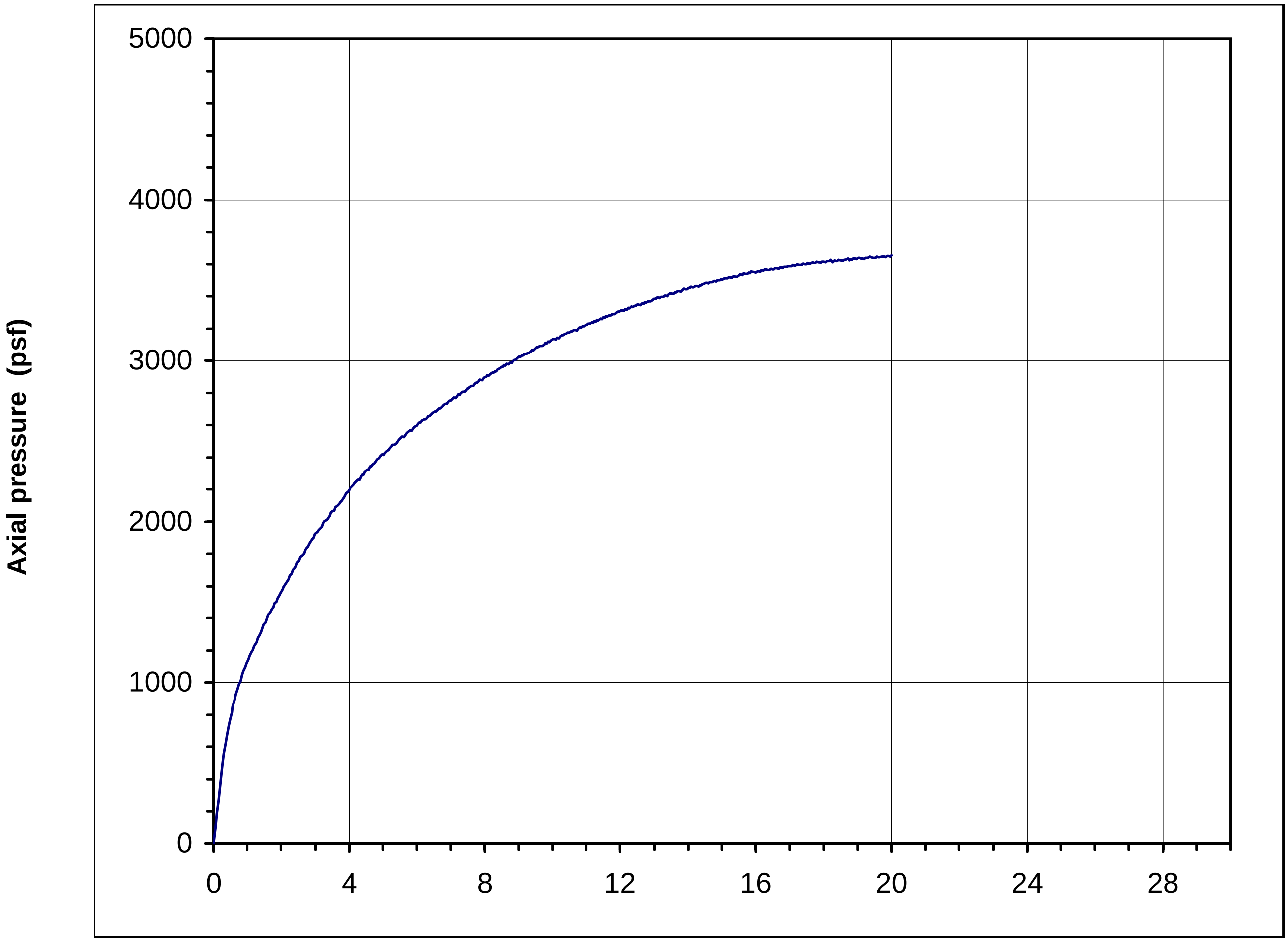
● **Sample Number:** CPT-5 @ 18-22'

■ **Sample Number:** CPT-1 @ 22.5-26.5'

Remarks:

ENGEO INCORPORATED
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS
MATERIALS TESTING

Unconfined Compression Test
ASTM Test Method D2166



Unconfined Compressive Strength: **3650 psf** **1.8 tsf**

Sample Description: **Dark grayish brown silty CLAY**

Initial Diameter:	**2.420**	**in.**	**Sample Number:**	**B3@6**	
Initial Height:	**4.90**	**in.**	**Dry Unit Weight:**	**99.4**	**pcf**
Strain Rate:	**1.322**	**%/min**	**Moisture Content:**	**24.3**	**%**
Total Strain:	**20.01**	**%**	**Depth of Sample:**	**6.0**	**ft.**

***EN* GEO** INCORPORATED	**1700 OAK PARK BOULEVARD** **Pleasant Hill, California**	**Job No.:** 7843.1.001.01 **Sample Number:** B3@6 **Date:** 6/26/2007	**Figure No.**

SULFATE TEST RESULTS

CALTRANS Test Method 417

Project Name: 1700 Oak Park Blvd.   Project Number: 7843.1.001.01

Tested By: RC   Date: June 27, 2007

Measurements less than 15 mg/kg are reported as Not Detectable (ND)

Sample Number	Sample Location	Matrix	Water Soluble Sulfate (SO_4) in Soil	
			mg/kg	% by Weight
1	B1@1	Soil	143	0.014
2	B5@2	Soil	1761	0.176

APPENDIX C

CPT DATA

PRESENTATION OF SITE INVESTIGATION RESULTS

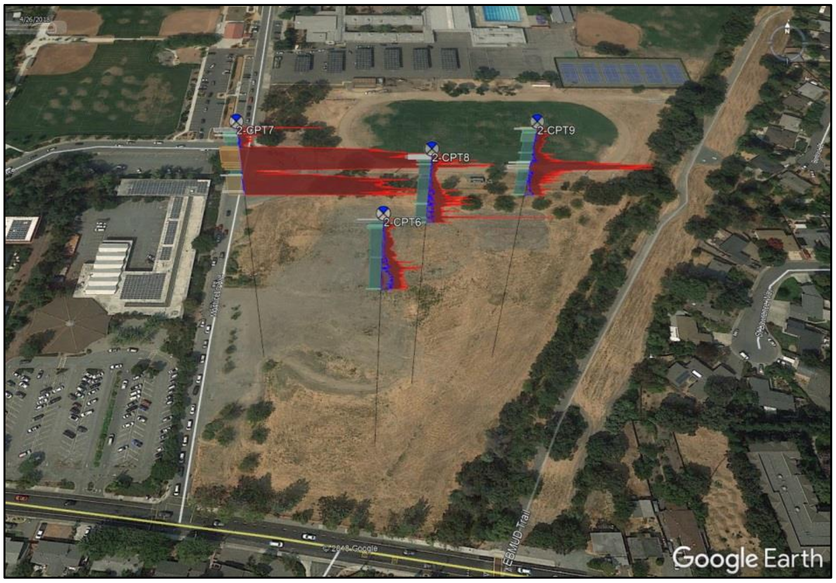
Pleasant Hill Library

Prepared for:

ENGEO Inc.

CPT Inc. Job No: 18-56056

Project Start Date: 27-Apr-2018
Project End Date: 27-Apr-2018
Report Date: 30-Apr-2018



Prepared by:

California Push Technologies Inc.
820 Aladdin Avenue
San Leandro, CA 94577

Tel: (510) 357-3677

Email: cpt@cptinc.com
www.cptinc.com

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

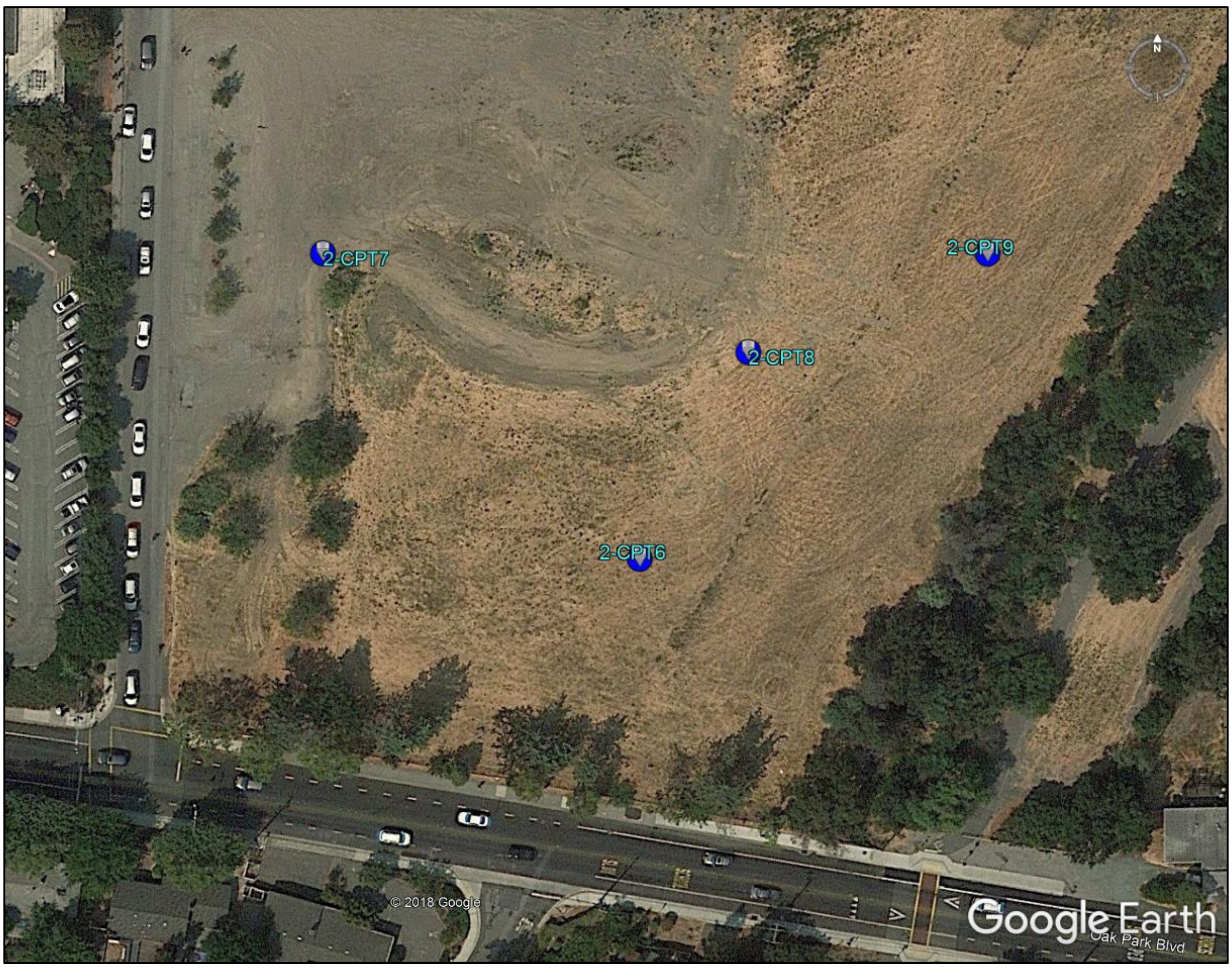
Introduction

The enclosed report presents the results of the site investigation program conducted by CPT Inc. for ENGEO Inc. at Pleasant Hill, CA. The program consisted of four cone penetration tests (CPT).

Project Information

Project	
Client	ENGEO Inc.
Project	Pleasant Hill Library
CPT Inc. project number	18-56056

A map from Google earth including the CPT test locations is presented below.



Rig Description	Deployment System	Test Type
CPT truck rig (C17)	30 ton rig cylinder	CPT

Coordinates		
Test Type	Collection Method	EPSG Reference
CPT	Consumer Grade GPS	32610

Cone Penetration Test (CPT)	
Depth reference	Depths are referenced to the existing ground surface at the time of each test.
Depth recording interval	5.0 cm
Tip and sleeve data offset	0.1 meter This has been accounted for in the CPT data files.
Additional plots	Standard-expanded range, Advanced plots with Ic, Su(Nkt), Phi and $N_1(60)_{Ic}$ as well as SBT scatter plots are provided in the data release folder.

Cone Penetrometers Used for this Project						
Cone Description	Cone Number	Cross Sectional Area (cm^2)	Sleeve Area (cm^2)	Tip Capacity (bar)	Sleeve Capacity (bar)	Pore Pressure Capacity (psi)
448:T1500F15U500	448	15	225	1500	15	500
Cone AD448 was used for all the CPT soundings.						

CPT Calculated Parameters	
Additional information	The Normalized Soil Behavior Type Chart based on Q_{tn} (SBT Qtn) (Robertson, 2009) was used to classify the soil for this project. A detailed set of calculated CPT parameters have been generated and are provided in Excel format files in the release folder. The CPT parameter calculations are based on values of corrected tip resistance (q_t) sleeve friction (f_s), and pore pressure (u_2). Hydrostatic conditions were assumed for the calculated parameters. Effective stresses are calculated based on unit weights that have been assigned to the individual soil behavior type zones and the assumed equilibrium pore pressure profile. Soils were classified as either drained or undrained based on the Q_{tn} Normalized Soil Behavior Type Chart (Robertson, 2009). Calculations for both drained and undrained parameters were included for materials that classified as sand mixtures (zone 5).

Limitations

This report has been prepared for the exclusive use of ENGEO Inc. (Client) for the project titled "Pleasant Hill Library". The report's contents may not be relied upon by any other party without the express written permission of CPT Inc. CPT Inc. has provided site investigation services, prepared the factual data reporting, and provided geotechnical parameter calculations consistent with current best practices. No other warranty, expressed or implied, is made.

The information presented in the report document and the accompanying data set pertain to the specific project, site conditions and objectives described to CPT Inc. by the Client. In order to properly understand the factual data, assumptions and calculations, reference must be made to the documents provided and their accompanying data sets, in their entirety.

The cone penetration tests (CPTu) are conducted using an integrated electronic piezocone penetrometer and data acquisition system manufactured by Adara Systems Ltd. of Richmond, British Columbia, Canada.

CPT Inc.'s piezocone penetrometers are compression type designs in which the tip and friction sleeve load cells are independent and have separate load capacities. The piezocones use strain gauged load cells for tip and sleeve friction and a strain gauged diaphragm type transducer for recording pore pressure. The piezocones also have a platinum resistive temperature device (RTD) for monitoring the temperature of the sensors, an accelerometer type dual axis inclinometer and a geophone sensor for recording seismic signals. All signals are amplified down hole within the cone body and the analog signals are sent to the surface through a shielded cable.

The penetrometers are manufactured with various tip, friction and pore pressure capacities in both 10 cm^2 and 15 cm^2 tip base area configurations in order to maximize signal resolution for various soil conditions. The specific piezocone used for each test is described in the CPT summary table presented in the first appendix. The 15 cm^2 penetrometers do not require friction reducers as they have a diameter larger than the deployment rods. The 10 cm^2 piezocones use a friction reducer consisting of a rod adapter extension behind the main cone body with an enlarged cross sectional area (typically 44 mm diameter over a length of 32 mm with tapered leading and trailing edges) located at a distance of 585 mm above the cone tip.

The penetrometers are designed with equal end area friction sleeves, a net end area ratio of 0.8 and cone tips with a 60 degree apex angle.

All piezocones can record pore pressure at various locations. Unless otherwise noted, the pore pressure filter is located directly behind the cone tip in the "u_2" position (ASTM Type 2). The filter is 6 mm thick, made of porous plastic (polyethylene) having an average pore size of 125 microns (90-160 microns). The function of the filter is to allow rapid movements of extremely small volumes of water needed to activate the pressure transducer while preventing soil ingress or blockage.

The piezocone penetrometers are manufactured with dimensions, tolerances and sensor characteristics that are in general accordance with the current ASTM D5778 standard. Our calibration criteria also meet or exceed those of the current ASTM D5778 standard. An illustration of the piezocone penetrometer is presented in Figure CPTu.

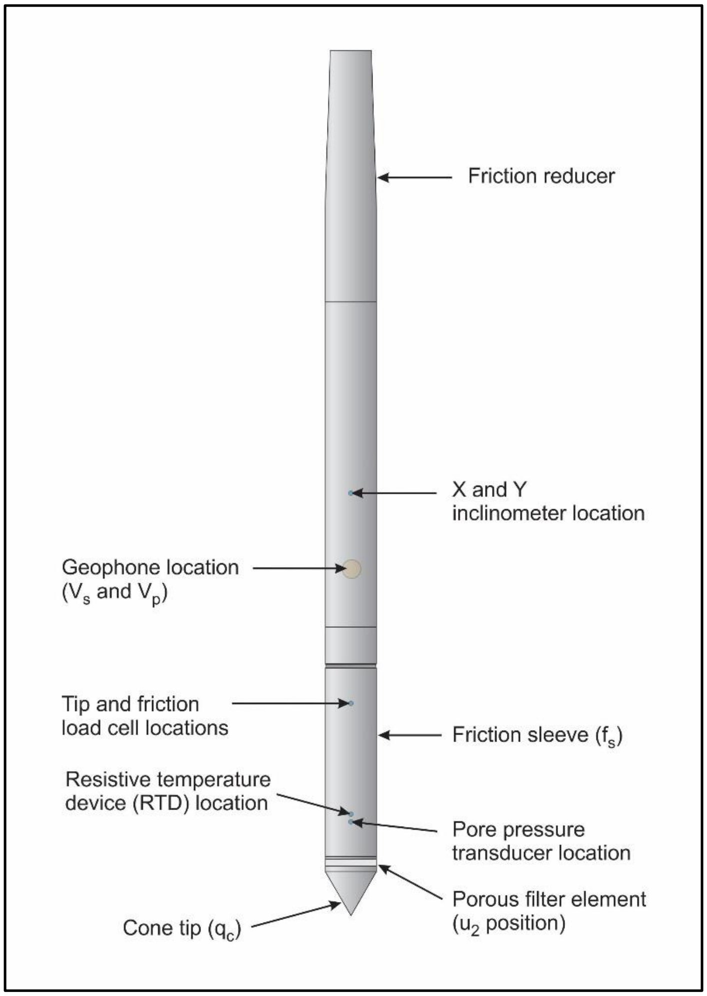


Figure CPTu. Piezocone Penetrometer (15 cm^2)

The data acquisition systems consist of a Windows based computer and a signal conditioner and power supply interface box with a 16 bit (or greater) analog to digital (A/D) converter. The data is recorded at fixed depth increments using a depth wheel attached to the push cylinders or by using a spring loaded rubber depth wheel that is held against the cone rods. The typical recording intervals are either 2.5 cm or 5.0 cm depending on project requirements; custom recording intervals are possible. The system displays the CPTu data in real time and records the following parameters to a storage media during penetration:

- Depth
- Uncorrected tip resistance (q_c)
- Sleeve friction (f_s)
- Dynamic pore pressure (u)
- Additional sensors such as resistivity, passive gamma, ultra violet induced fluorescence, if applicable

All testing is performed in accordance to CPT Inc.'s CPT operating procedures which are in general accordance with the current ASTM D5778 standard.

Prior to the start of a CPTu sounding a suitable cone is selected, the cone and data acquisition system are powered on, the pore pressure system is saturated with either glycerin or silicone oil and the baseline readings are recorded with the cone hanging freely in a vertical position.

The CPTu is conducted at a steady rate of 2 cm/s, within acceptable tolerances. Typically one meter length rods with an outer diameter of 1.5 inches are added to advance the cone to the sounding termination depth. After cone retraction final baselines are recorded.

Additional information pertaining to CPT Inc.'s cone penetration testing procedures:

- Each filter is saturated in silicone oil or glycerin under vacuum pressure prior to use
- Recorded baselines are checked with an independent multi-meter
- Baseline readings are compared to previous readings
- Soundings are terminated at the client's target depth or at a depth where an obstruction is encountered, excessive rod flex occurs, excessive inclination occurs, equipment damage is likely to take place, or a dangerous working environment arises
- Differences between initial and final baselines are calculated to ensure zero load offsets have not occurred and to ensure compliance with ASTM standards

The interpretation of the piezocone data and associated calculated parameters for this report are based on the corrected tip resistance (q_t), sleeve friction (f_s) and pore water pressure (u). The interpretation of soil type is based on the correlations developed by Robertson (1990) and Robertson (2009). It should be noted that it is not always possible to accurately identify a soil type based on these parameters. In these situations, experience, judgment and an assessment of other parameters may be used to infer soil behavior type.

The recorded tip resistance (q_c) is the total force acting on the piezocone tip divided by its base area. The tip resistance is corrected for pore pressure effects and termed corrected tip resistance (q_t) according to the following expression presented in Robertson et al, 1986:

$$q_t = q_c + (1\text{-}a) \bullet u_2$$

where: q_t is the corrected tip resistance
q_c is the recorded tip resistance
u_2 is the recorded dynamic pore pressure behind the tip (u_2 position)
a is the Net Area Ratio for the piezocone (0.8 for CPT Inc. probes)

The sleeve friction (f_s) is the frictional force on the sleeve divided by its surface area. As all CPT Inc. piezocones have equal end area friction sleeves, pore pressure corrections to the sleeve data are not required.

The dynamic pore pressure (u) is a measure of the pore pressures generated during cone penetration. To record equilibrium pore pressure, the penetration must be stopped to allow the dynamic pore pressures to stabilize. The rate at which this occurs is predominantly a function of the permeability of the soil and the diameter of the cone.

The friction ratio (Rf) is a calculated parameter. It is defined as the ratio of sleeve friction to the tip resistance expressed as a percentage. Generally, saturated cohesive soils have low tip resistance, high friction ratios and generate large excess pore water pressures. Cohesionless soils have higher tip resistances, lower friction ratios and do not generate significant excess pore water pressure.

A summary of the CPTu soundings along with test details and individual plots are provided in the appendices. A set of files with calculated geotechnical parameters were generated for each sounding based on published correlations and are provided in Excel format in the data release folder. Information regarding the methods used is also included in the data release folder.

For additional information on CPTu interpretations and calculated geotechnical parameters, refer to Robertson et al. (1986), Lunne et al. (1997), Robertson (2009), Mayne (2013, 2014) and Mayne and Peuchen (2012).

The cone penetration test is halted at specific depths to carry out pore pressure dissipation (PPD) tests, shown in Figure PPD-1. For each dissipation test the cone and rods are decoupled from the rig and the data acquisition system measures and records the variation of the pore pressure (u) with time (t).

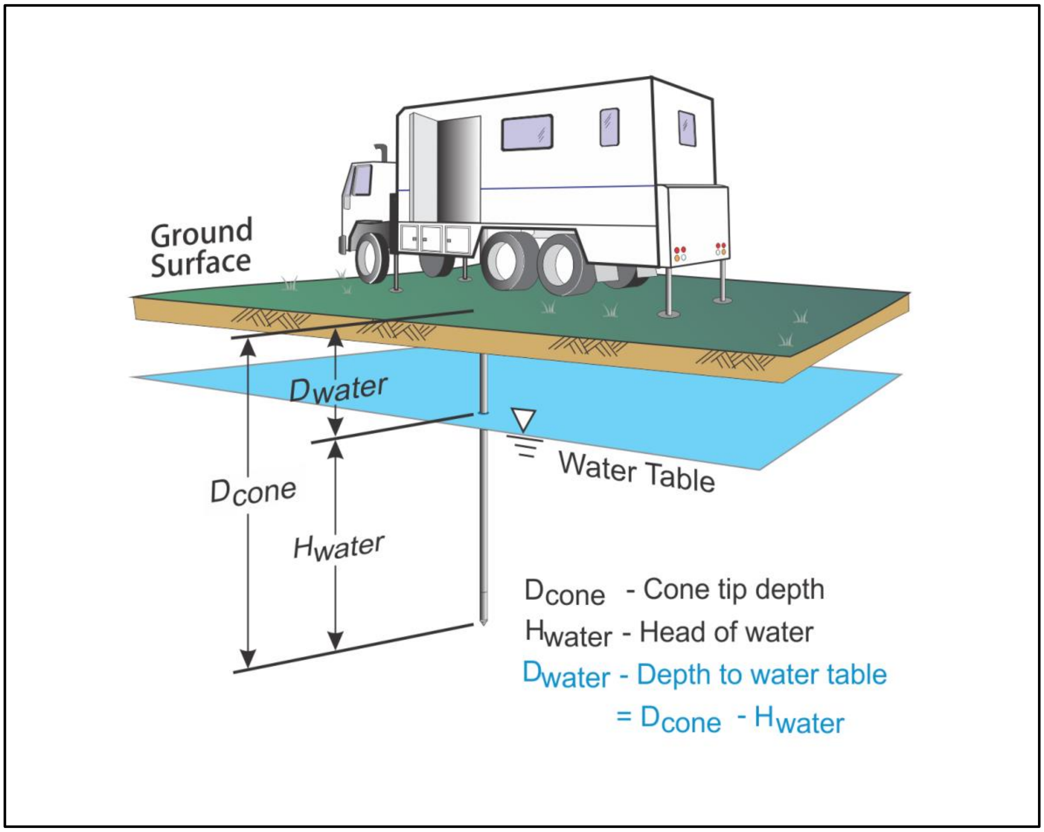


Figure PPD-1. Pore pressure dissipation test setup

Pore pressure dissipation data can be interpreted to provide estimates of ground water conditions, permeability, consolidation characteristics and soil behavior.

The typical shapes of dissipation curves shown in Figure PPD-2 are very useful in assessing soil type, drainage, in situ pore pressure and soil properties. A flat curve that stabilizes quickly is typical of a freely draining sand. Undrained soils such as clays will typically show positive excess pore pressure and have long dissipation times. Dilative soils will often exhibit dynamic pore pressures below equilibrium that then rise over time. Overconsolidated fine-grained soils will often exhibit an initial dilatory response where there is an initial rise in pore pressure before reaching a peak and dissipating.

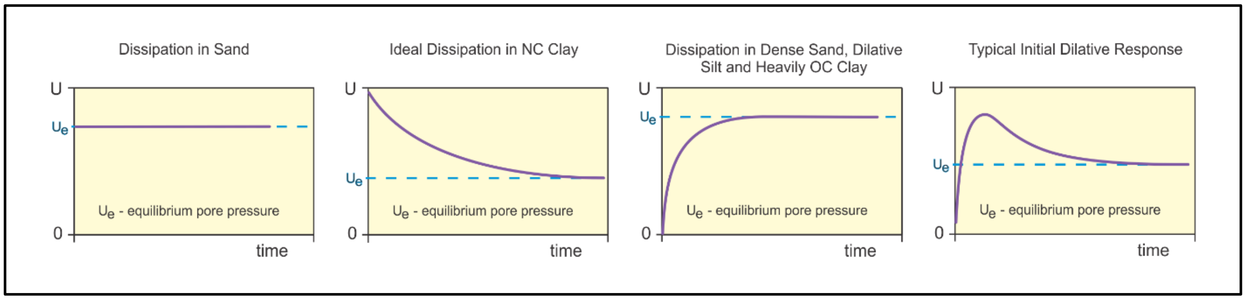


Figure PPD-2. Pore pressure dissipation curve examples

In order to interpret the equilibrium pore pressure (u_{eq}) and the apparent phreatic surface, the pore pressure should be monitored until such time as there is no variation in pore pressure with time as shown for each curve of Figure PPD-2.

In fine grained deposits the point at which 100% of the excess pore pressure has dissipated is known as t_{100}. In some cases this can take an excessive amount of time and it may be impractical to take the dissipation to t_{100}. A theoretical analysis of pore pressure dissipations by Teh and Houlsby (1991) showed that a single curve relating degree of dissipation versus theoretical time factor (T*) may be used to calculate the coefficient of consolidation (c_h) at various degrees of dissipation resulting in the expression for c_h shown below.

$$c_h = \frac{T^* \cdot a^2 \cdot \sqrt{I_r}}{t}$$

Where:

- T* is the dimensionless time factor (Table Time Factor)
- a is the radius of the cone
- I_r is the rigidity index
- t is the time at the degree of consolidation

Table Time Factor. T* versus degree of dissipation (Teh and Houlsby, 1991)

Degree of Dissipation (%)	20	30	40	50	60	70	80
T* (u_2)	0.038	0.078	0.142	0.245	0.439	0.804	1.60

The coefficient of consolidation is typically analyzed using the time (t_{50}) corresponding to a degree of dissipation of 50% (u_{50}). In order to determine t_{50}, dissipation tests must be taken to a pressure less than u_{50}. The u_{50} value is half way between the initial maximum pore pressure and the equilibrium pore pressure value, known as u_{100}. To estimate u_{50}, both the initial maximum pore pressure and u_{100} must be known or estimated. Other degrees of dissipations may be considered, particularly for extremely long dissipations.

At any specific degree of dissipation the equilibrium pore pressure (u at t_{100}) must be estimated at the depth of interest. The equilibrium value may be determined from one or more sources such as measuring the value directly (u_{100}), estimating it from other dissipations in the same profile, estimating the phreatic surface and assuming hydrostatic conditions, from nearby soundings, from client provided information, from site observations and/or past experience, or from other site instrumentation.

For calculations of c_h (Teh and Houlsby, 1991), t_{50} values are estimated from the corresponding pore pressure dissipation curve and a rigidity index (I_r) is assumed. For curves having an initial dilatory response in which an initial rise in pore pressure occurs before reaching a peak, the relative time from the peak value is used in determining t_{50}. In cases where the time to peak is excessive, t_{50} values are not calculated.

Due to possible inherent uncertainties in estimating I_r, the equilibrium pore pressure and the effect of an initial dilatory response on calculating t_{50}, other methods should be applied to confirm the results for c_h.

Additional published methods for estimating the coefficient of consolidation from a piezocone test are described in Burns and Mayne (1998, 2002), Jones and Van Zyl (1981), Robertson et al. (1992) and Sully et al. (1999).

A summary of the pore pressure dissipation tests and dissipation plots are presented in the relevant appendix.

ASTM D5778-12, 2012, "Standard Test Method for Performing Electronic Friction Cone and Piezocone Penetration Testing of Soils", ASTM, West Conshohocken, US.

Burns, S.E. and Mayne, P.W., 1998, “Monotonic and dilatory pore pressure decay during piezocone tests”, Canadian Geotechnical Journal 26 (4): 1063-1073.

Burns, S.E. and Mayne, P.W., 2002, “Analytical cavity expansion-critical state model cone dissipation in fine-grained soils”, Soils & Foundations, Vol. 42(2): 131-137.

Jones, G.A. and Van Zyl, D.J.A., 1981, “The piezometer probe: a useful investigation tool”, Proceedings, 10th International Conference on Soil Mechanics and Foundation Engineering, Vol. 3, Stockholm: 489-495.

Lunne, T., Robertson, P.K. and Powell, J. J. M., 1997, “Cone Penetration Testing in Geotechnical Practice”, Blackie Academic and Professional.

Mayne, P.W., 2013, “Evaluating yield stress of soils from laboratory consolidation and in-situ cone penetration tests”, Sound Geotechnical Research to Practice (Holtz Volume) GSP 230, ASCE, Reston/VA: 406-420.

Mayne, P.W., 2014, “Interpretation of geotechnical parameters from seismic piezocone tests”, CPT’14 Keynote Address, Las Vegas, NV, May 2014.

Mayne, P.W. and Peuchen, J., 2012, “Unit weight trends with cone resistance in soft to firm clays”, Geotechnical and Geophysical Site Characterization *4,* Vol. 1 (Proc. ISC-4, Pernambuco), CRC Press, London: 903-910.

Robertson, P.K., 1990, “Soil Classification Using the Cone Penetration Test”, Canadian Geotechnical Journal, Volume 27: 151-158.

Robertson, P.K., 2009, “Interpretation of cone penetration tests – a unified approach”, Canadian Geotechnical Journal, Volume 46: 1337-1355.

Robertson, P.K., Campanella, R.G., Gillespie, D. and Greig, J., 1986, “Use of Piezometer Cone Data”, Proceedings of InSitu 86, ASCE Specialty Conference, Blacksburg, Virginia.

Robertson, P.K., Sully, J.P., Woeller, D.J., Lunne, T., Powell, J.J.M. and Gillespie, D.G., 1992, “Estimating coefficient of consolidation from piezocone tests”, Canadian Geotechnical Journal, 29(4): 551-557.

Sully, J.P., Robertson, P.K., Campanella, R.G. and Woeller, D.J., 1999, “An approach to evaluation of field CPTU dissipation data in overconsolidated fine-grained soils”, Canadian Geotechnical Journal, 36(2): 369-381.

Teh, C.I., and Houlsby, G.T., 1991, “An analytical study of the cone penetration test in clay”, Geotechnique, 41(1): 17-34.

The appendices listed below are included in the report:

- Cone Penetration Test Summary and Standard Plots
- Cone Penetration Test Standard Plots – Expanded Range
- Advanced Cone Penetration Test Plots with Ic, Su(Nkt) , Phi and N1(60)Ic
- Soil Behaviour Type (SBT) Scatter Plots
- Pore Pressure Dissipation Summary and Pore Pressure Dissipation Plots

Cone Penetration Test Summary and Standard Cone Penetration Test Plots

CPT CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Job No: 18-56056
Client: ENGEO Inc.
Project: Pleasant Hill Library
Start Date: 27-Apr-2018
End Date: 27-Apr-2018

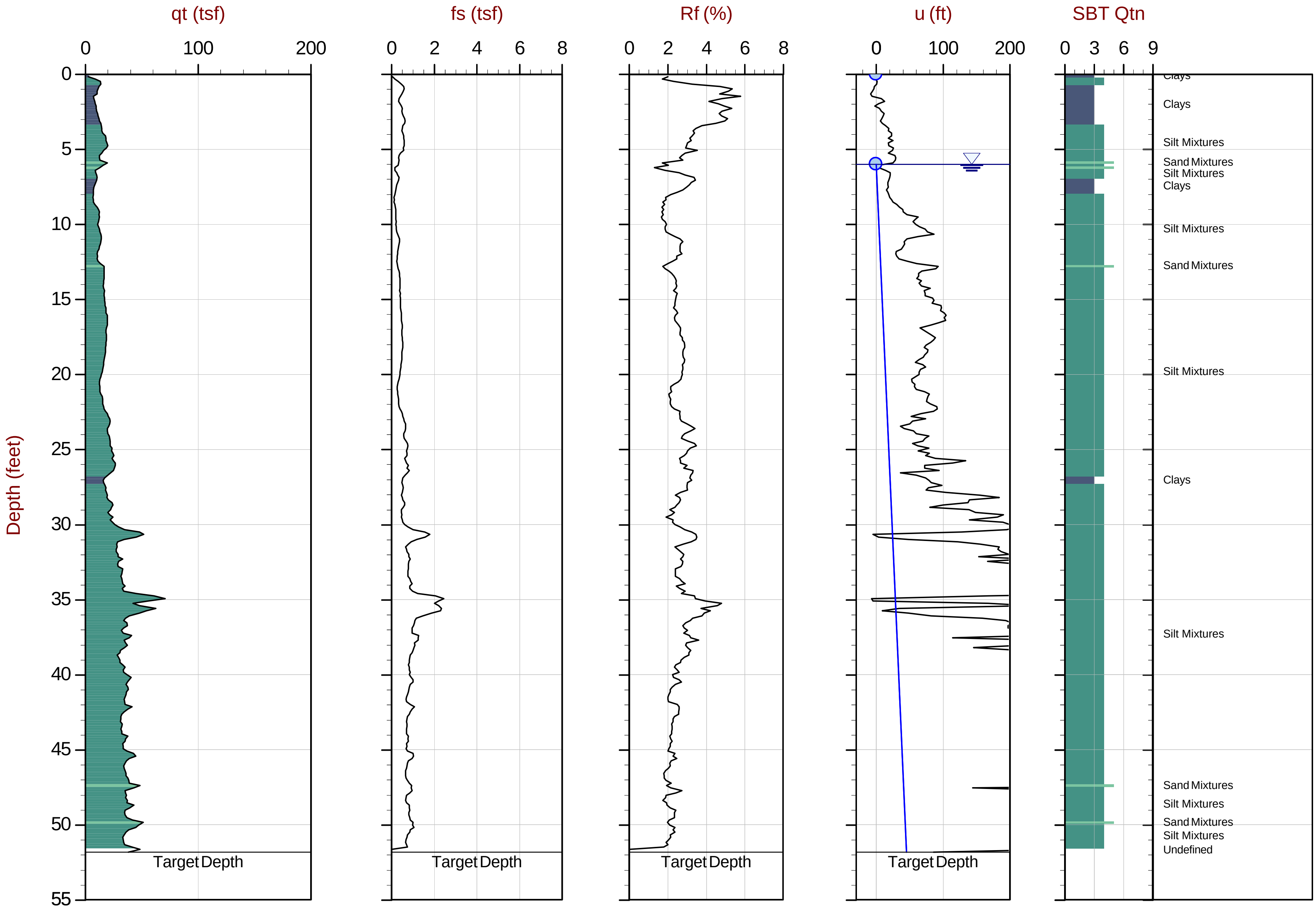
CONE PENETRATION TEST SUMMARY

Sounding ID	File Name	Date	Cone	Assumed Phreatic Surface[1] (ft)	Final Depth (ft)	Northing[2] (m)	Easting (m)	Refer to Notation Number
2-CPT6	18-56056_CP06	27-Apr-2018	448:T1500F15U500	6.0	51.84	4198890	581967	3
2-CPT7	18-56056_CP07	27-Apr-2018	448:T1500F15U500	1.1	50.52	4198938	581916	
2-CPT8	18-56056_CP08	27-Apr-2018	448:T1500F15U500	6.0	50.52	4198923	581984	3
2-CPT9	18-56056_CP09	27-Apr-2018	448:T1500F15U500	6.0	50.52	4198939	582022	

1. The assumed phreatic surface was based on pore pressure dissipation tests unless otherwise noted. Hydrostatic conditions were assumed for the calculated parameters.
2. The coordinates were acquired using consumer grade GPS equipment, datum: WGS 1984 / UTM Zone 10 North.
3. The assumed phreatic surface was based on the dynamic pore pressure response.

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.	Job No: 18-56056	Sounding: 2-CPT6
	Date: 2018-04-27 10:24	Cone: 448:T1500F15U500
	Site: Pleasant Hill Library	



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP06.COR
Unit Wt: SBTQtn (PKR2009)

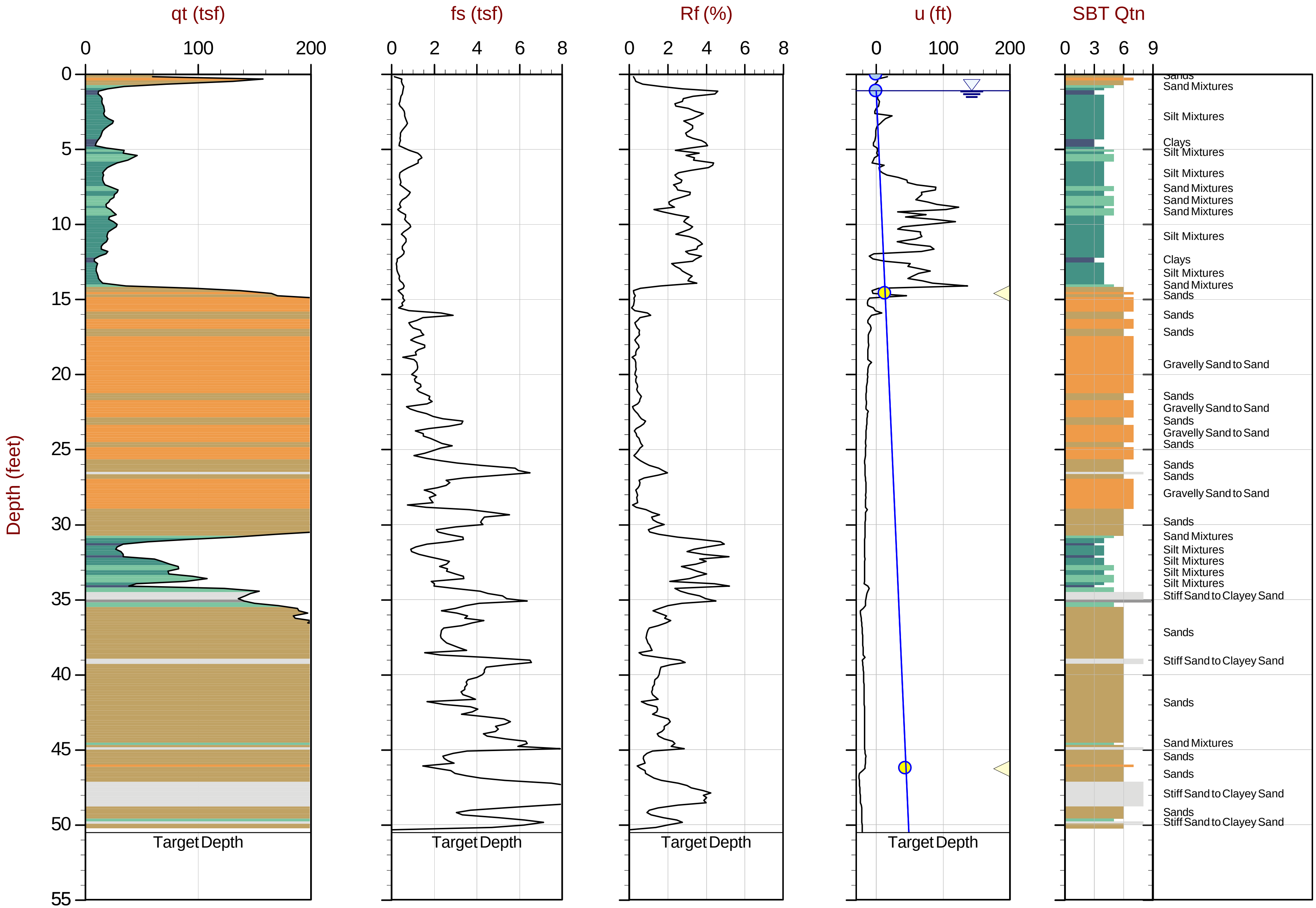
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198890m E: 581967m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 08:26
Site: Pleasant Hill Library
Sounding: 2-CPT7
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

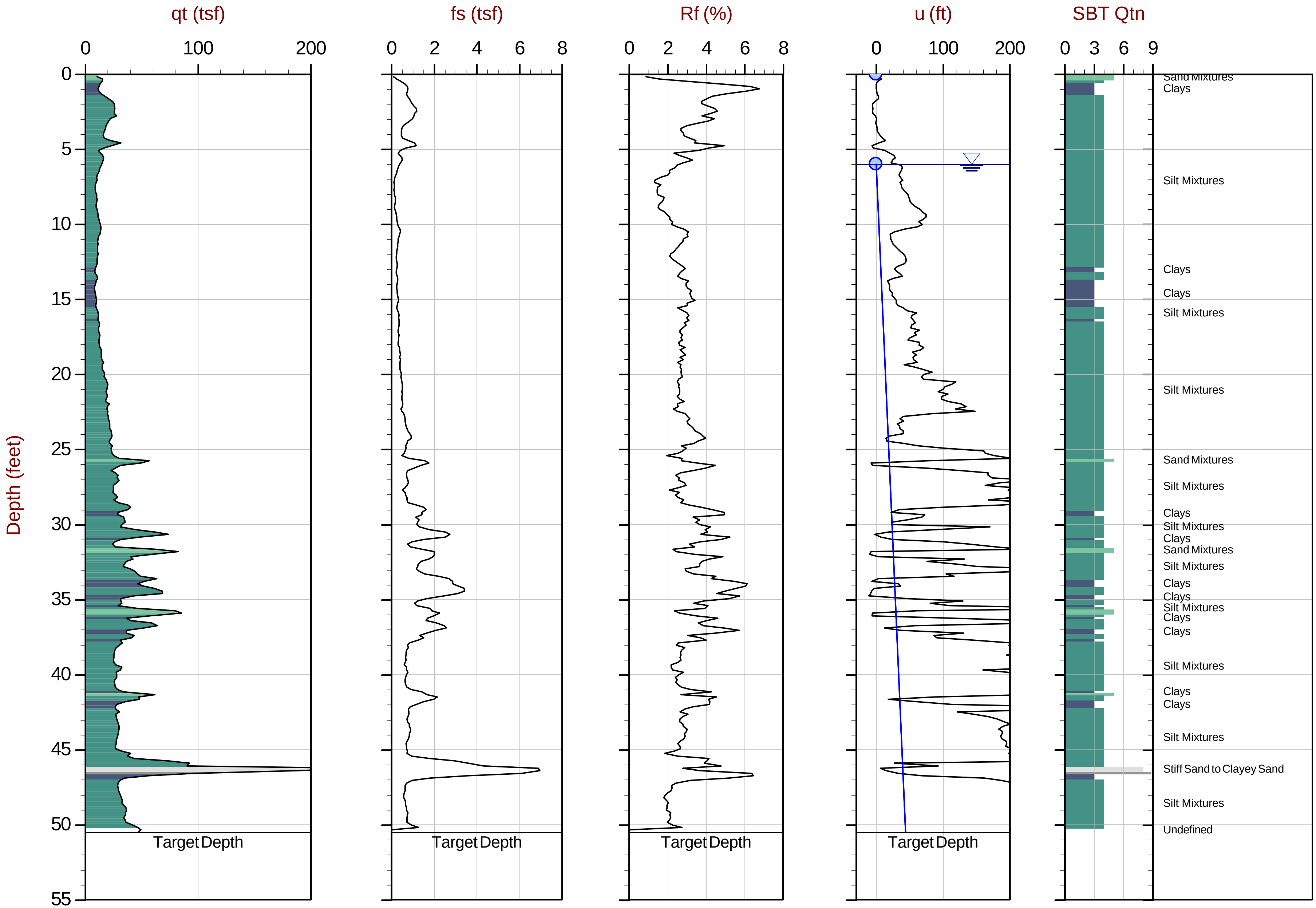
File: 18-56056_CP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198938m E: 581916m
Page No: 1 of 1

Overplot Item: Assumed Ueq, Ueq, Dissipation, equilibrium achieved, Dissipation, equilibrium not achieved, Hydrostatic Line

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 12:30
Site: Pleasant Hill Library
Sounding: 2-CPT8
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

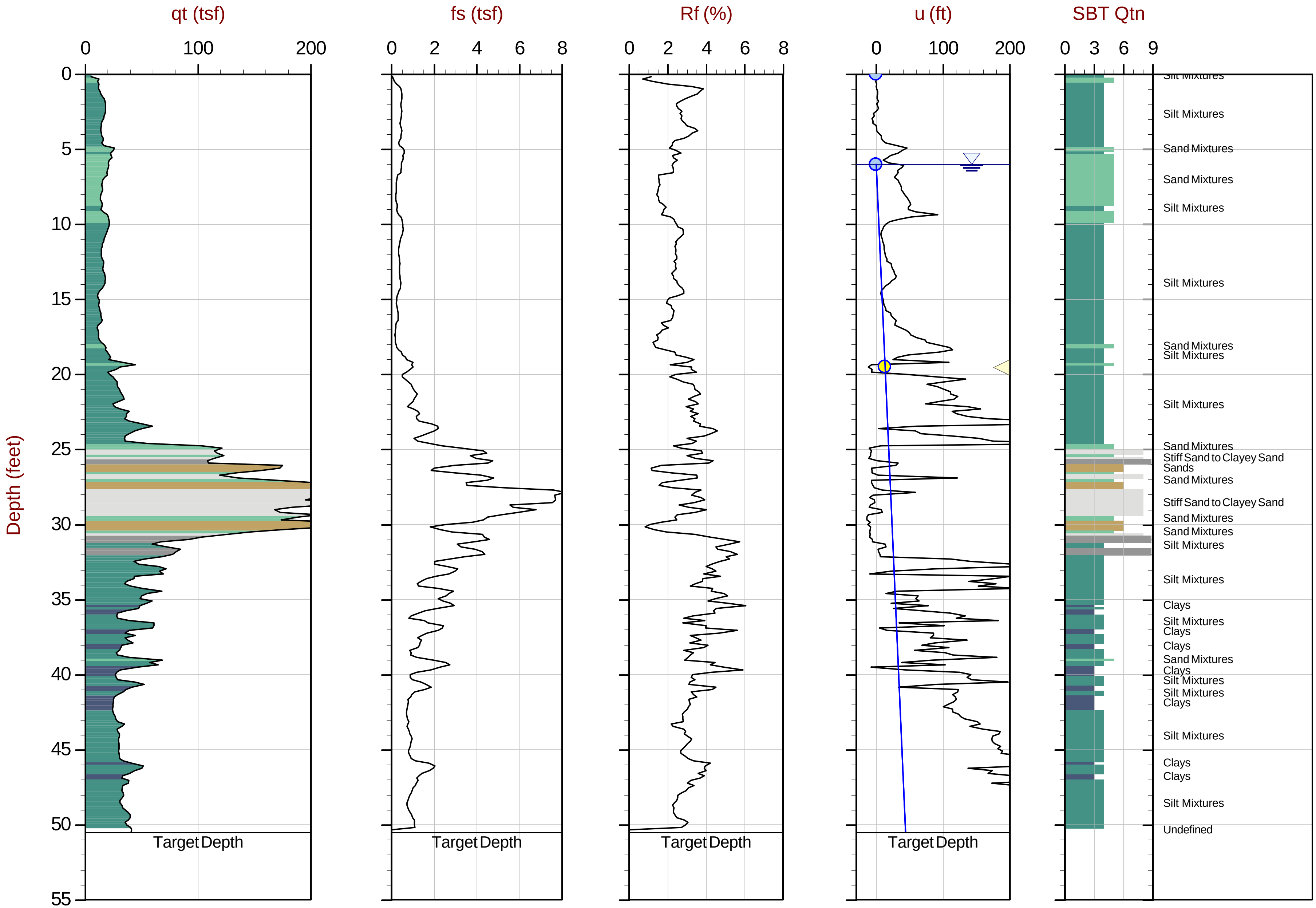
File: 18-56056_CP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198923m E: 581984m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.	Job No: 18-56056	Sounding: 2-CPT9
	Date: 2018-04-27 11:24	Cone: 448:T1500F15U500
	Site: Pleasant Hill Library	



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP09.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198939m E: 582022m
Page No: 1 of 1

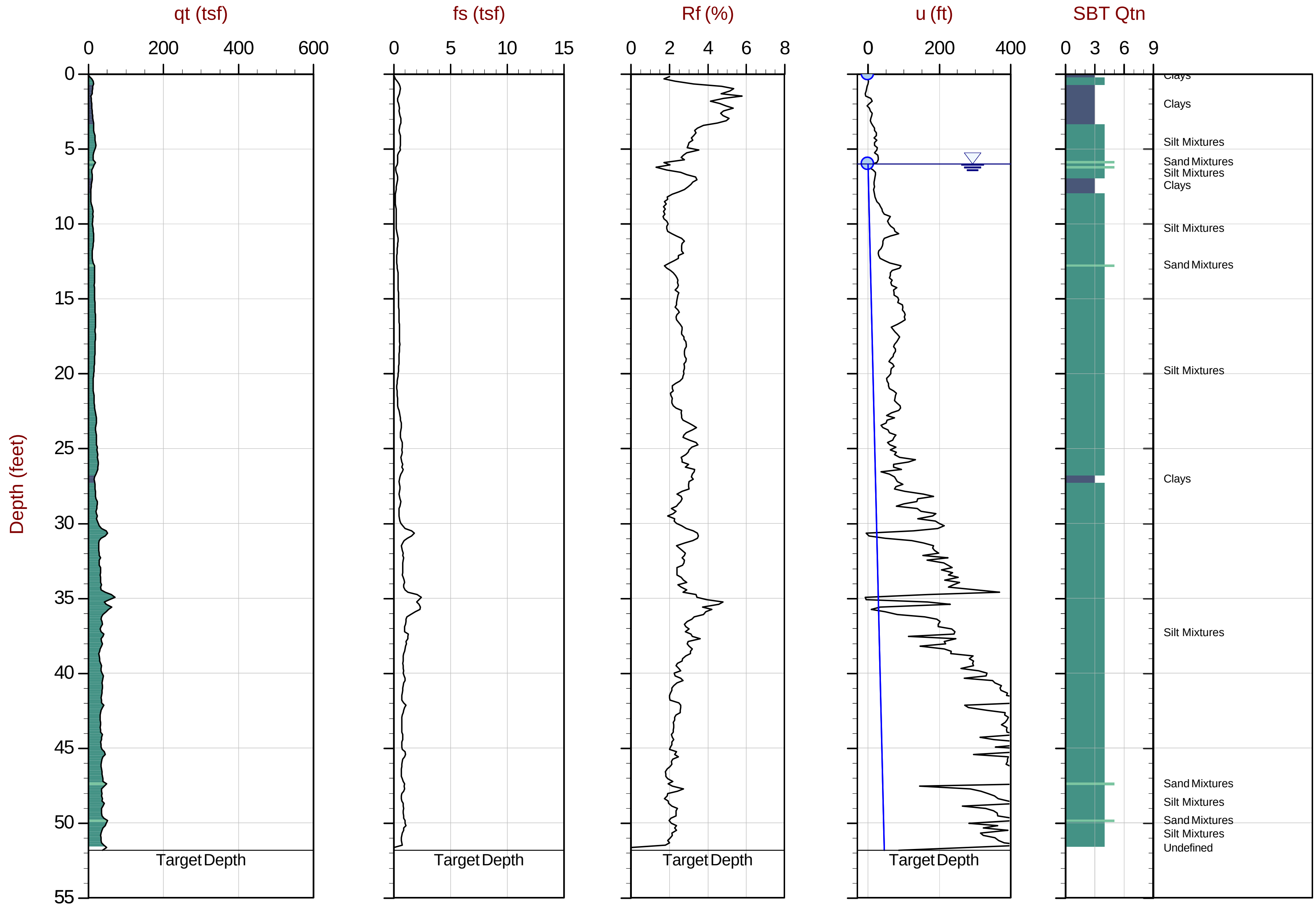
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

Cone Penetration Test Standard Plots – Expanded Range

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.	Job No: 18-56056	Sounding: 2-CPT6
	Date: 2018-04-27 10:24	Cone: 448:T1500F15U500
	Site: Pleasant Hill Library	



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP06.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198890m E: 581967m
Page No: 1 of 1

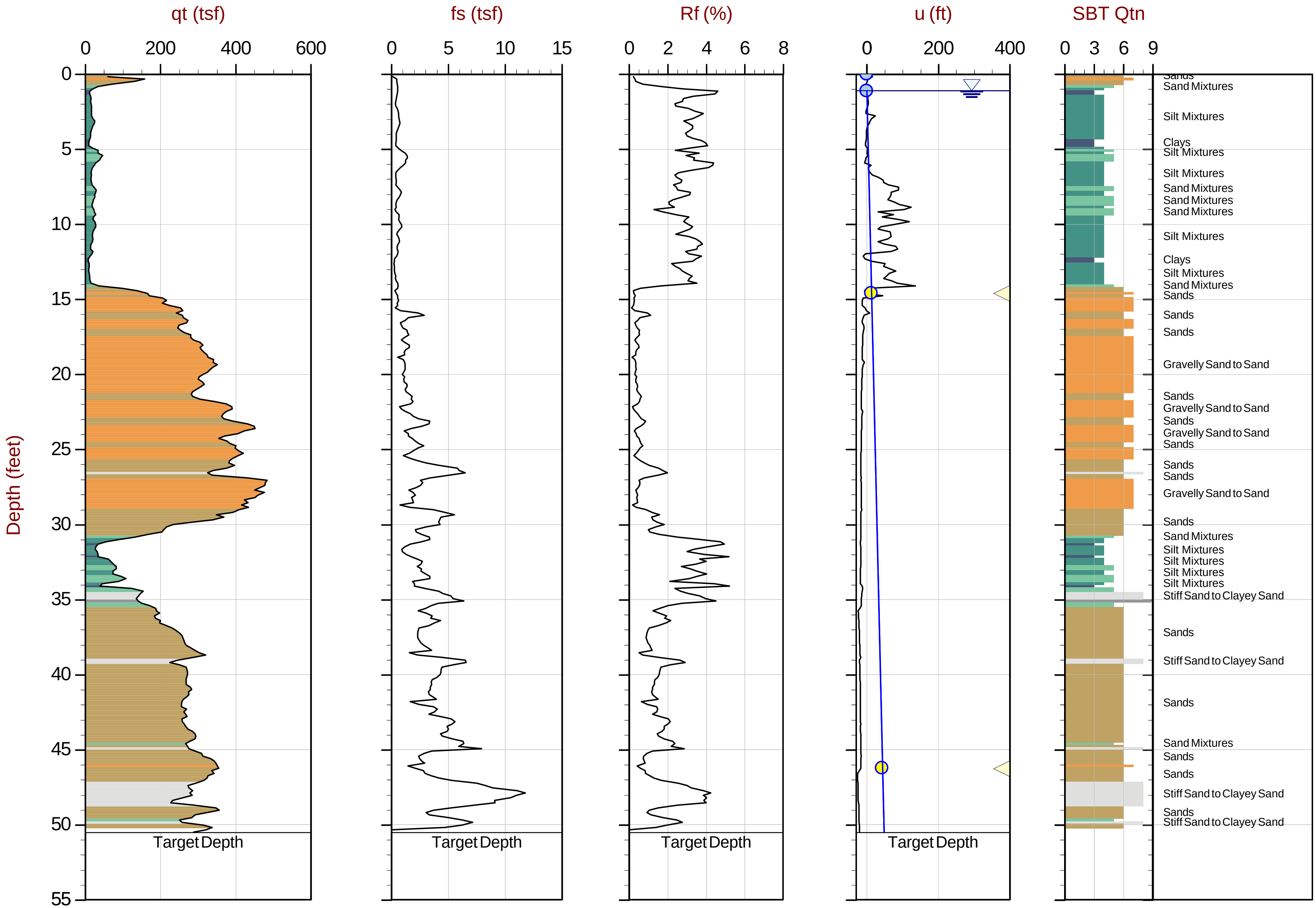
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 08:26
Site: Pleasant Hill Library

Sounding: 2-CPT7
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

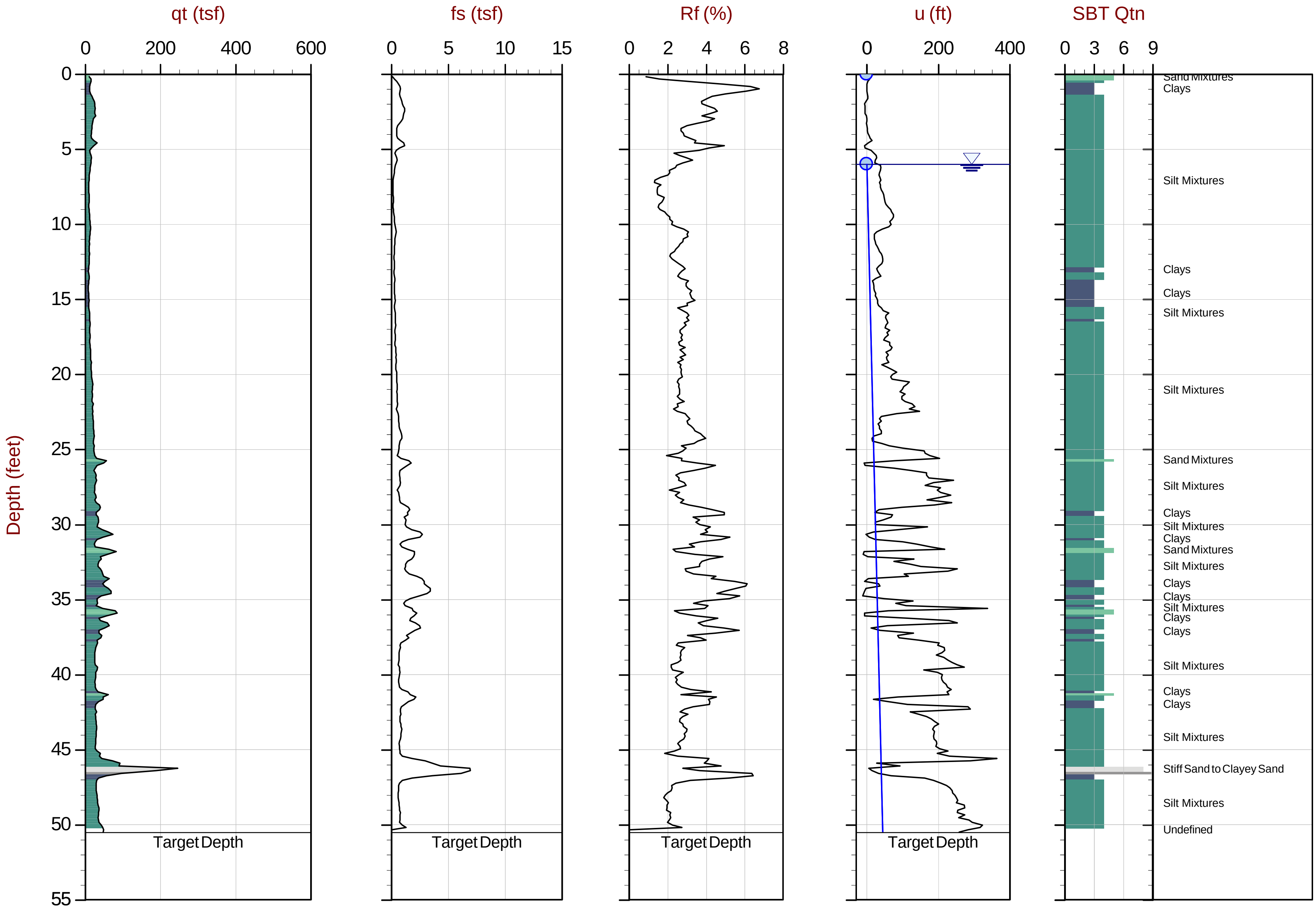
File: 18-56056_CP07.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198938m E: 581916m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 12:30
Site: Pleasant Hill Library
Sounding: 2-CPT8
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP08.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198923m E: 581984m
Page No: 1 of 1

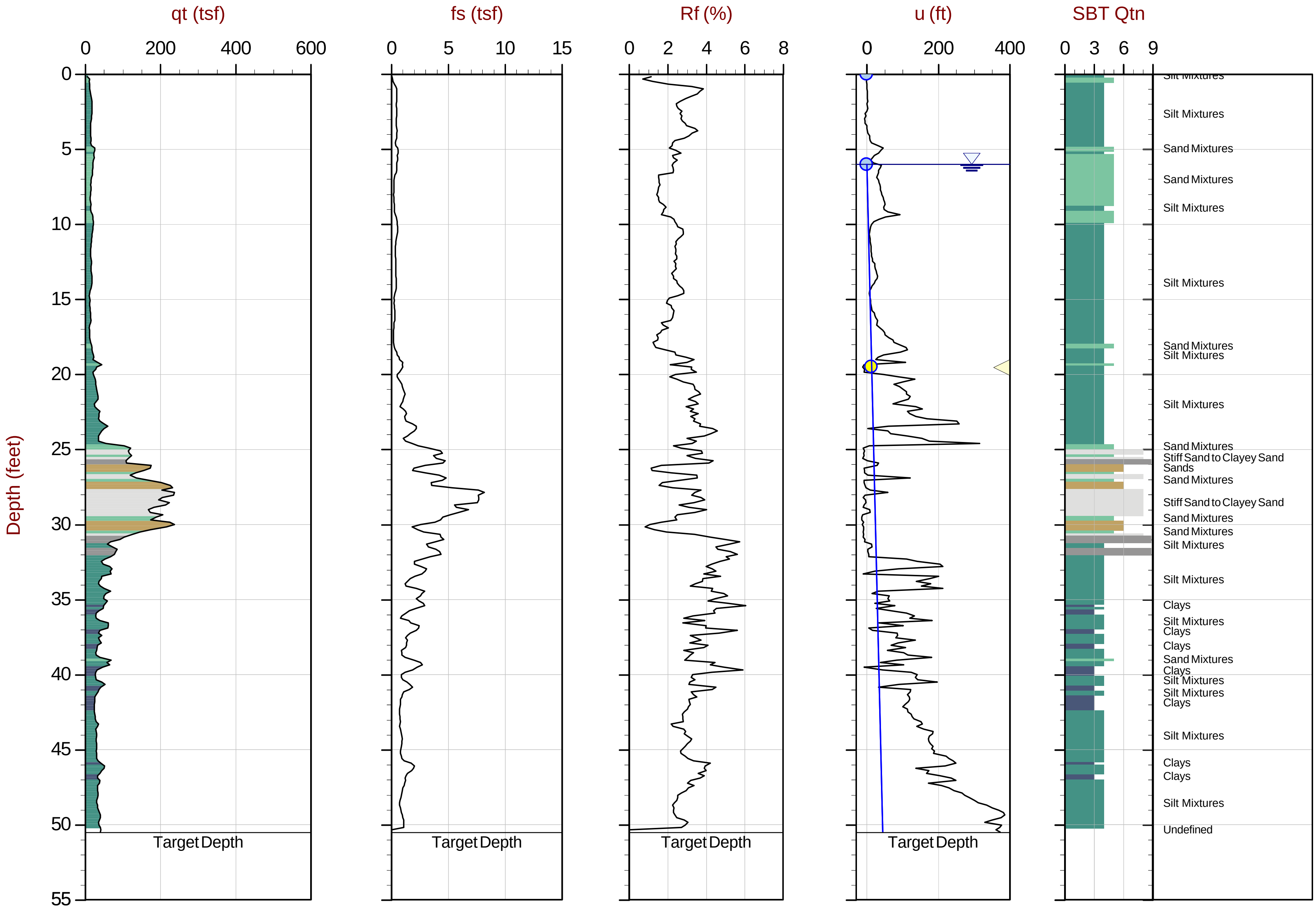
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 11:24
Site: Pleasant Hill Library

Sounding: 2-CPT9
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP09.COR
Unit Wt: SBTQtn (PKR2009)

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198939m E: 582022m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

Advanced Cone Penetration Test Plots

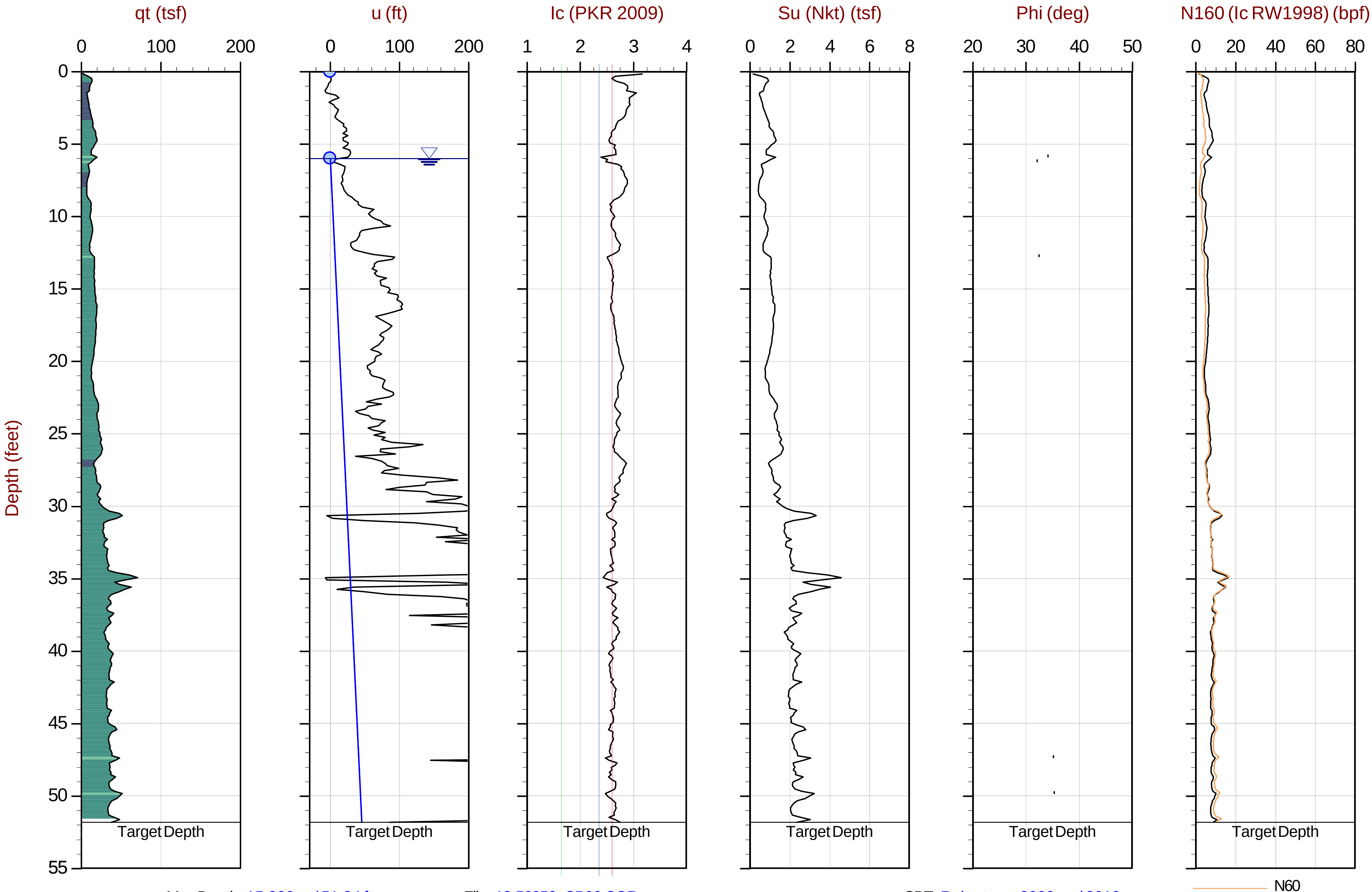
with I_c, $Su(N_{kt})$, Phi and $N1(60)I_c$

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 10:24
Site: Pleasant Hill Library

Sounding: 2-CPT6
Cone: 448:T1500F15U500



Max Depth: 15.800 m / 51.84 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP06.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0

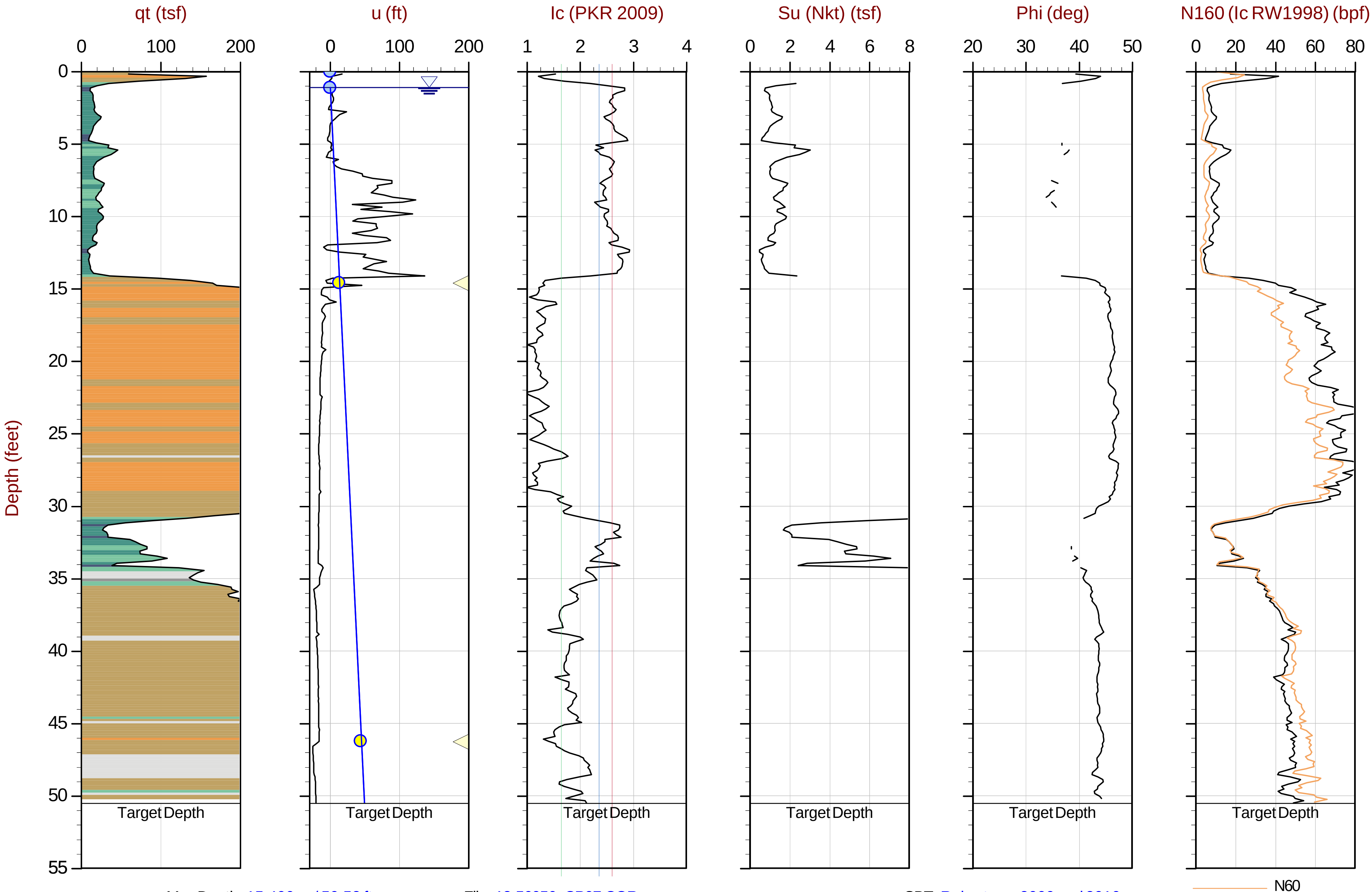
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198890m E: 581967m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 08:26
Site: Pleasant Hill Library
Sounding: 2-CPT7
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

File: 18-56056_CP07.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198938m E: 581916m
Page No: 1 of 1

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 12:30
Site: Pleasant Hill Library
Sounding: 2-CPT8
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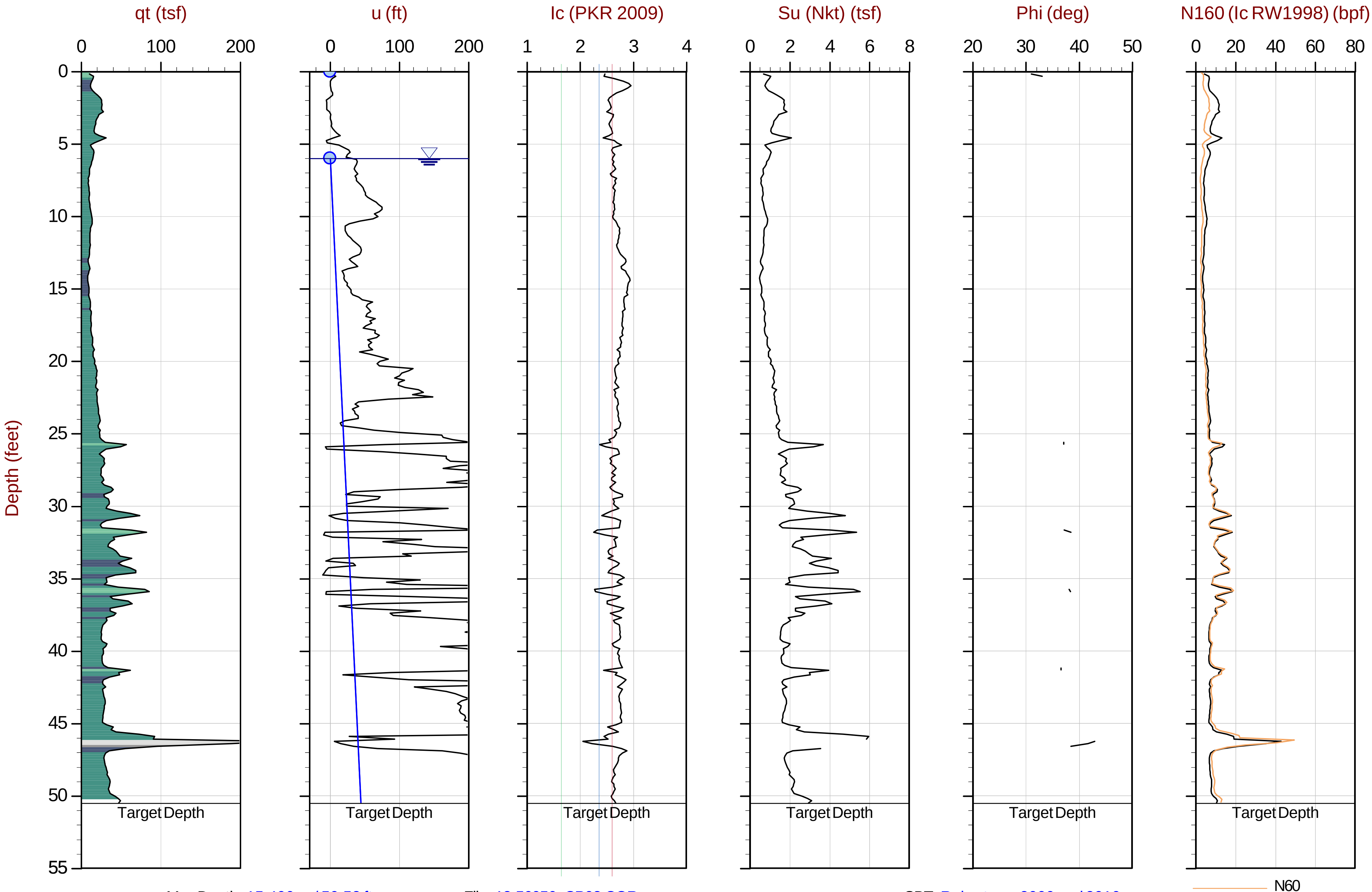

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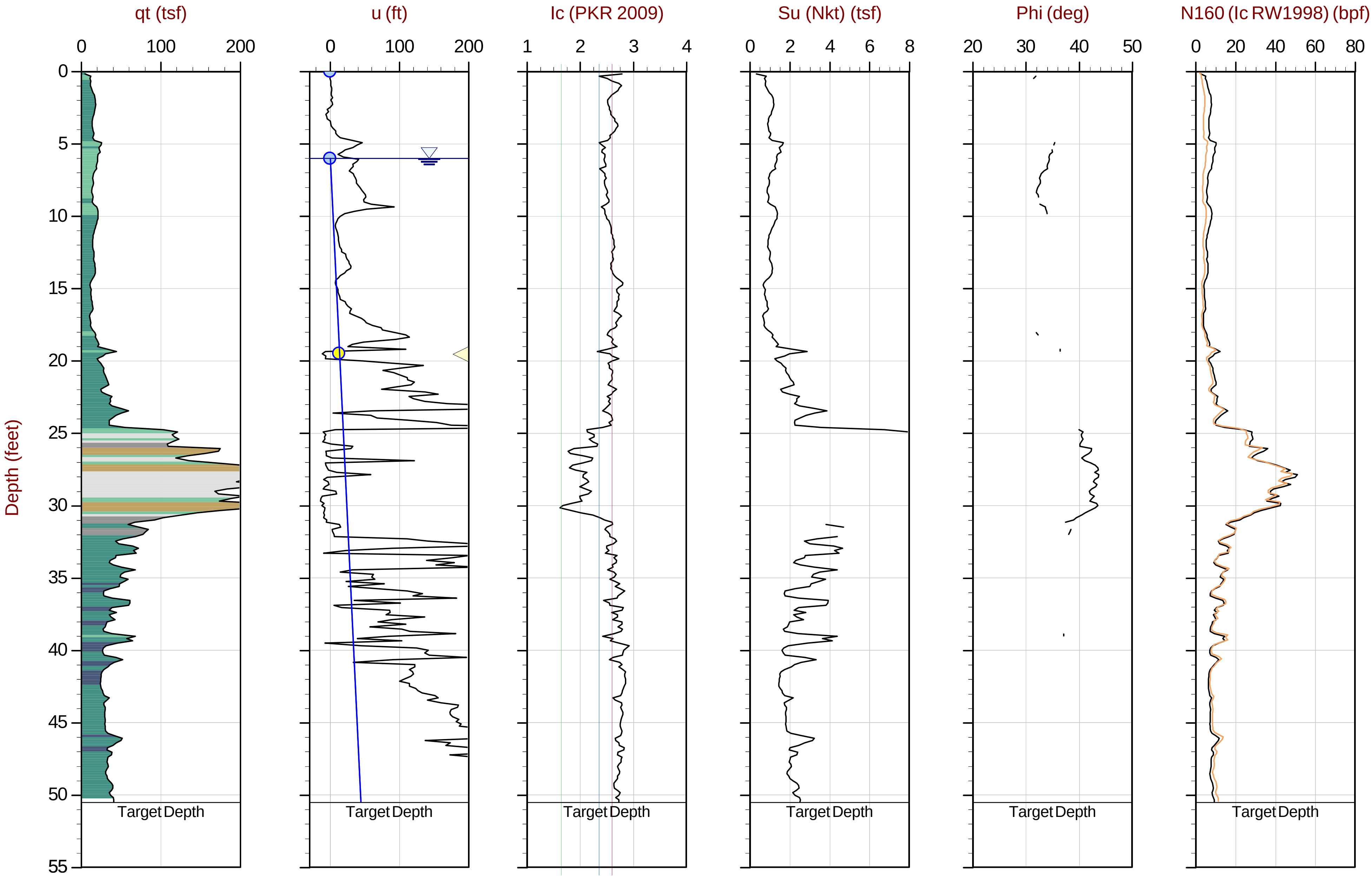
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point
File: 18-56056_CP08.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0
SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198923m E: 581984m
Page No: 1 of 1
Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 11:24
Site: Pleasant Hill Library

Sounding: 2-CPT9
Cone: 448:T1500F15U500



Max Depth: 15.400 m / 50.52 ft
Depth Inc: 0.050 m / 0.164 ft
Avg Int: Every Point

File: 18-56056_CP09.COR
Unit Wt: SBTQtn (PKR2009)
Su Nkt: 15.0

SBT: Robertson, 2009 and 2010
Coords: UTM Zone 10 N: 4198939m E: 582022m
Page No: 1 of 1

Overplot Item: Assumed Ueq; Ueq; Dissipation, equilibrium achieved; Dissipation, equilibrium not achieved; Hydrostatic Line

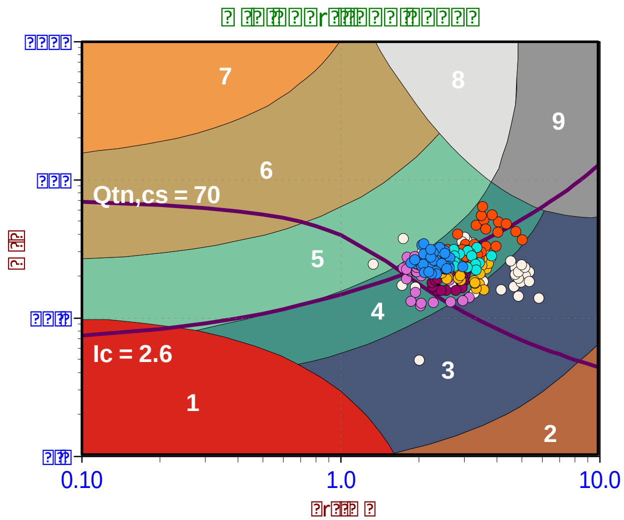
Soil Behavior Type (SBT) Scatter Plots

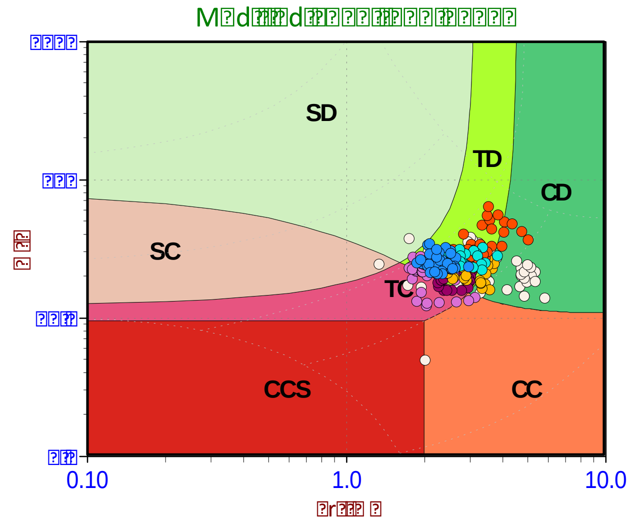
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

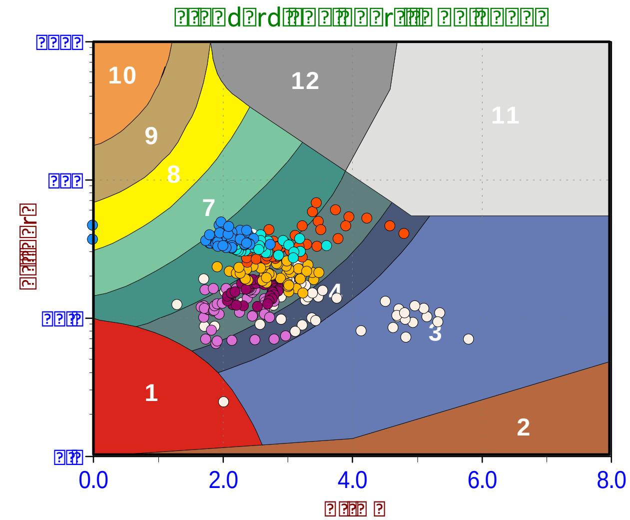
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 10:24
Site: Pleasant Hill Library
Sounding: 2-CPT6
Cone: 448:T1500F15U500







Depth Ranges

- >0.0 to 7.5 ft
- >7.5 to 15.0 ft
- >15.0 to 22.5 ft
- >22.5 to 30.0 ft
- >30.0 to 37.5 ft
- >37.5 to 45.0 ft
- >45.0 to 52.5 ft
- >52.5 to 60.0 ft
- >60.0 to 67.5 ft
- >67.5 to 75.0 ft
- >75.0 ft

Legend

- Sensitive, Fined Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

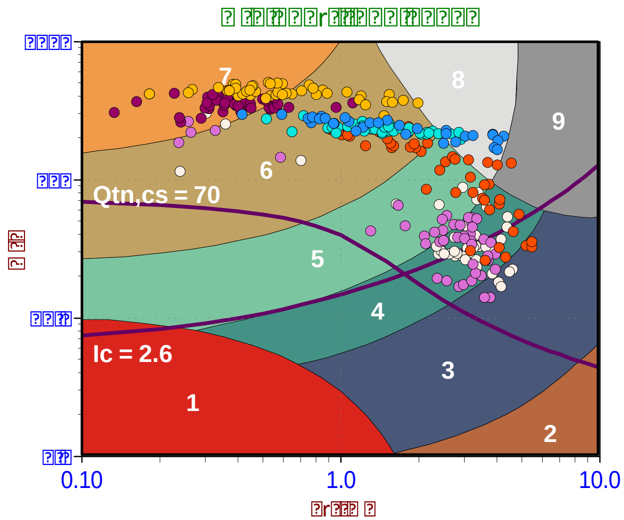
Legend

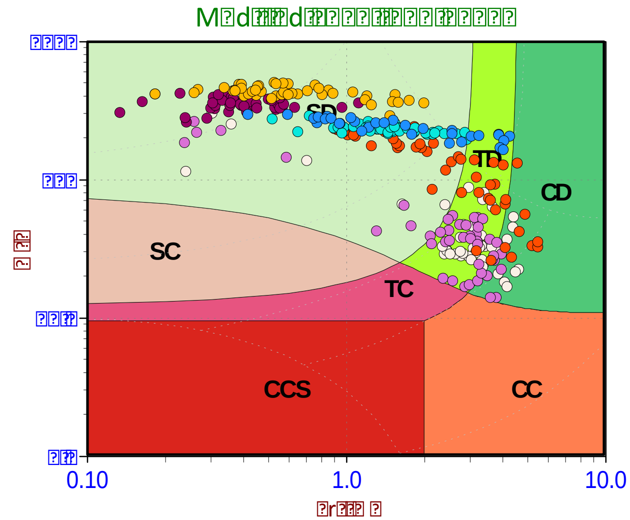
- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

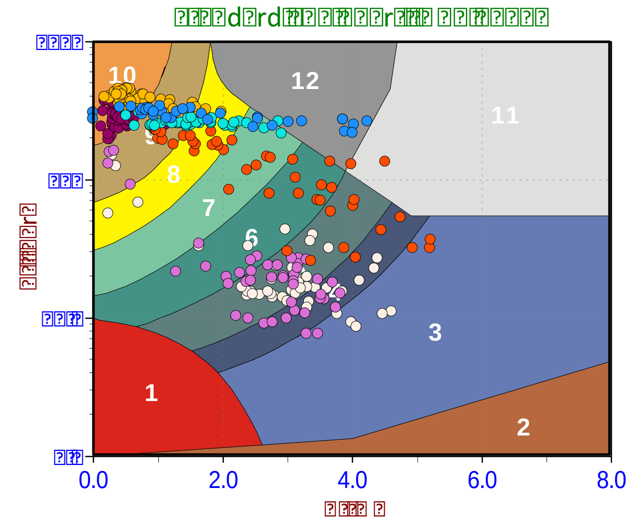
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 08:26
Site: Pleasant Hill Library
Sounding: 2-CPT7
Cone: 448:T1500F15U500







Depth Ranges

- >0.0 to 7.5 ft
- >7.5 to 15.0 ft
- >15.0 to 22.5 ft
- >22.5 to 30.0 ft
- >30.0 to 37.5 ft
- >37.5 to 45.0 ft
- >45.0 to 52.5 ft
- >52.5 to 60.0 ft
- >60.0 to 67.5 ft
- >67.5 to 75.0 ft
- >75.0 ft

Legend

- Sensitive, Fined Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

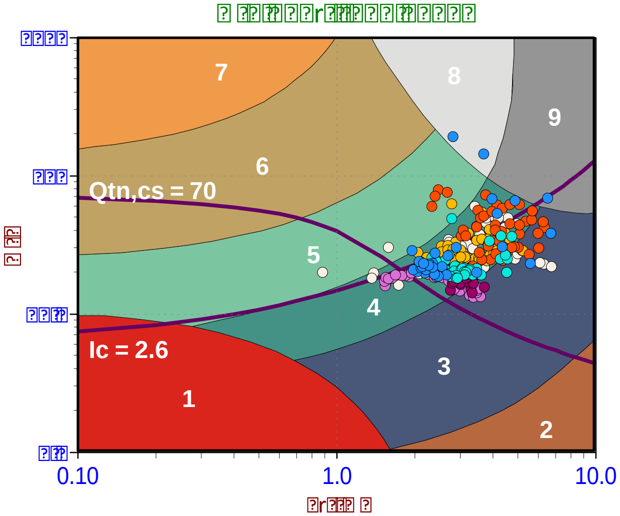
- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

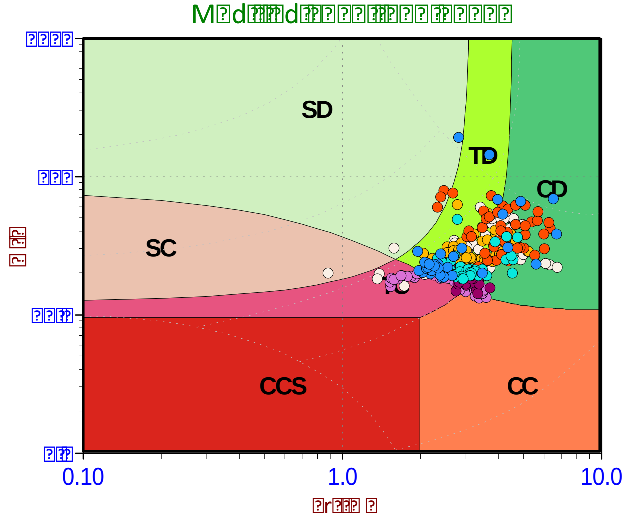
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

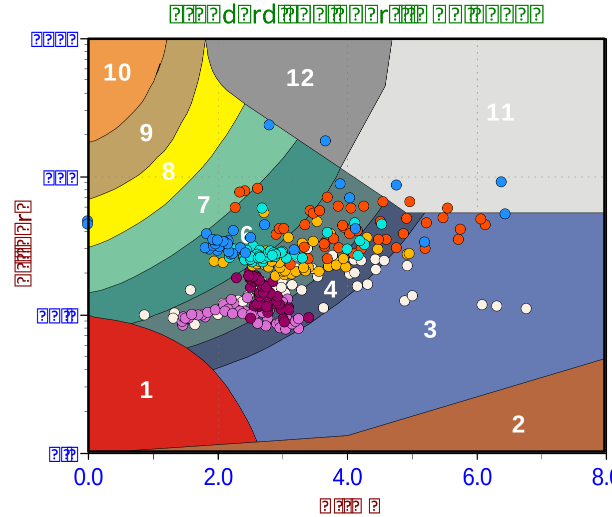
ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 12:30
Site: Pleasant Hill Library

Sounding: 2-CPT8
Cone: 448:T1500F15U500







Depth Ranges

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- >52.5 to 60.0 ft
- >60.0 to 67.5 ft
- >67.5 to 75.0 ft
- >75.0 ft

Legend

- Sensitive, Fined Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend

- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend

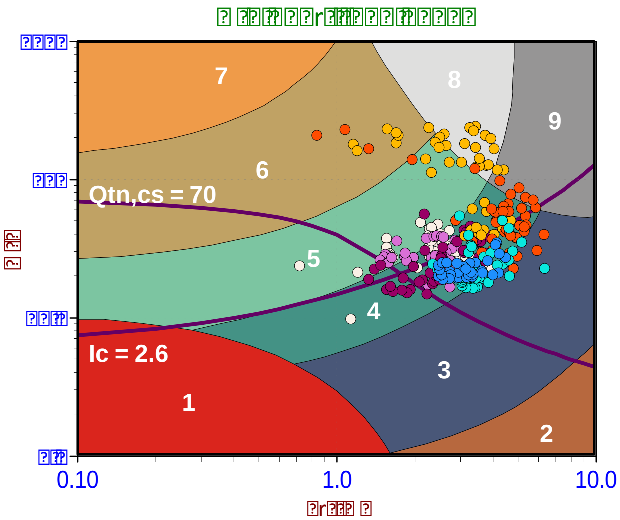
- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

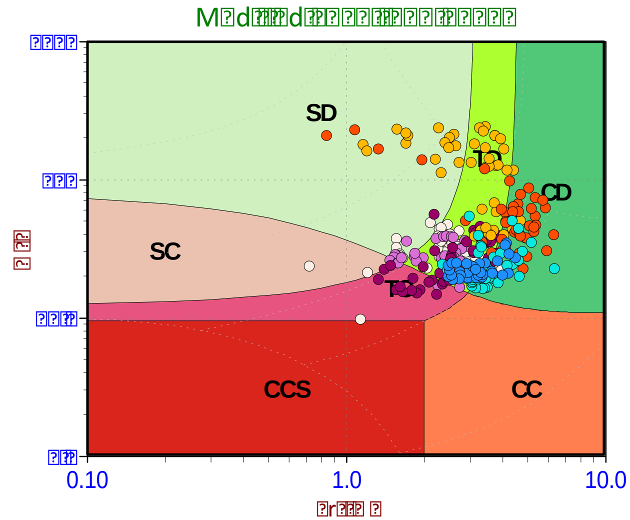
CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

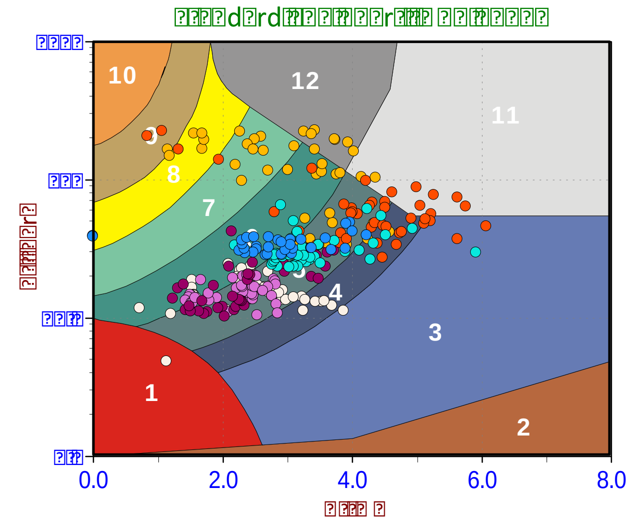
ENGEO Inc.

Job No: 18-56056
Date: 2018-04-27 11:24
Site: Pleasant Hill Library

Sounding: 2-CPT9
Cone: 448:T1500F15U500







Depth Ranges
- >0.0 to 7.5 ft
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- >15.0 to 22.5 ft
- >22.5 to 30.0 ft
- >30.0 to 37.5 ft
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- >45.0 to 52.5 ft
- >52.5 to 60.0 ft
- >60.0 to 67.5 ft
- >67.5 to 75.0 ft
- >75.0 ft

Legend
- Sensitive, Fined Grained
- Organic Soils
- Clays
- Silt Mixtures
- Sand Mixtures
- Sands
- Gravelly Sand to Sand
- Stiff Sand to Clayey Sand
- Very Stiff Fine Grained

Legend
- CCS (Cont. sensitive clay like)
- CC (Cont. clay like)
- TC (Cont. transitional)
- SC (Cont. sand like)
- CD (Dil. clay like)
- TD (Dil. transitional)
- SD (Dil. sand like)

Legend
- Sensitive Fines
- Organic Soil
- Clay
- Silty Clay
- Clayey Silt
- Silt
- Sandy Silt
- Silty Sand/Sand
- Sand
- Gravelly Sand
- Stiff Fine Grained
- Cemented Sand

Pore Pressure Dissipation Summary and
Pore Pressure Dissipation Plots

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

Job No: 18-56056
Client: ENGEO Inc.
Project: Pleasant Hill Library
Start Date: 27-Apr-2018
End Date: 27-Apr-2018

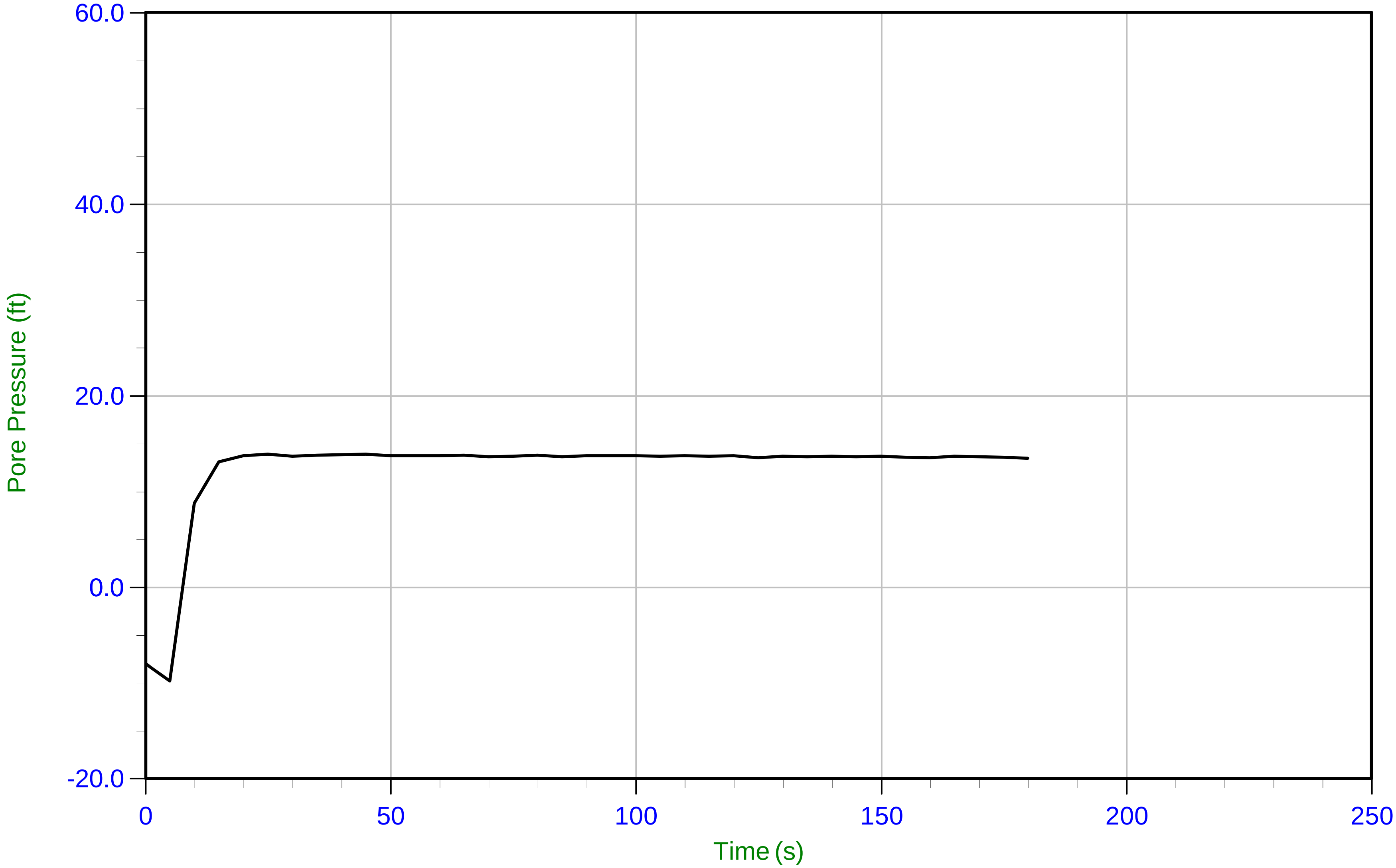
CPTu PORE PRESSURE DISSIPATION SUMMARY

Sounding ID	File Name	Cone Area (cm^2)	Duration (s)	Test Depth (ft)	Estimated Equilibrium Pore Pressure U_{eq} (ft)	Calculated Phreatic Surface (ft)
2-CPT7	18-56056_CP07	15	180	14.60	13.5	1.1
2-CPT7	18-56056_CP07	15	360	46.26	44.1	2.1
2-CPT9	18-56056_CP09	15	300	19.52	13.5	6.0

ENGEO Inc.

Job No: 18-56056
Date: 04/27/2018 08:26
Site: Pleasant Hill Library

Sounding: 2-CPT7
Cone: 448:T1500F15U500 Area=15 cm²



Trace Summary:

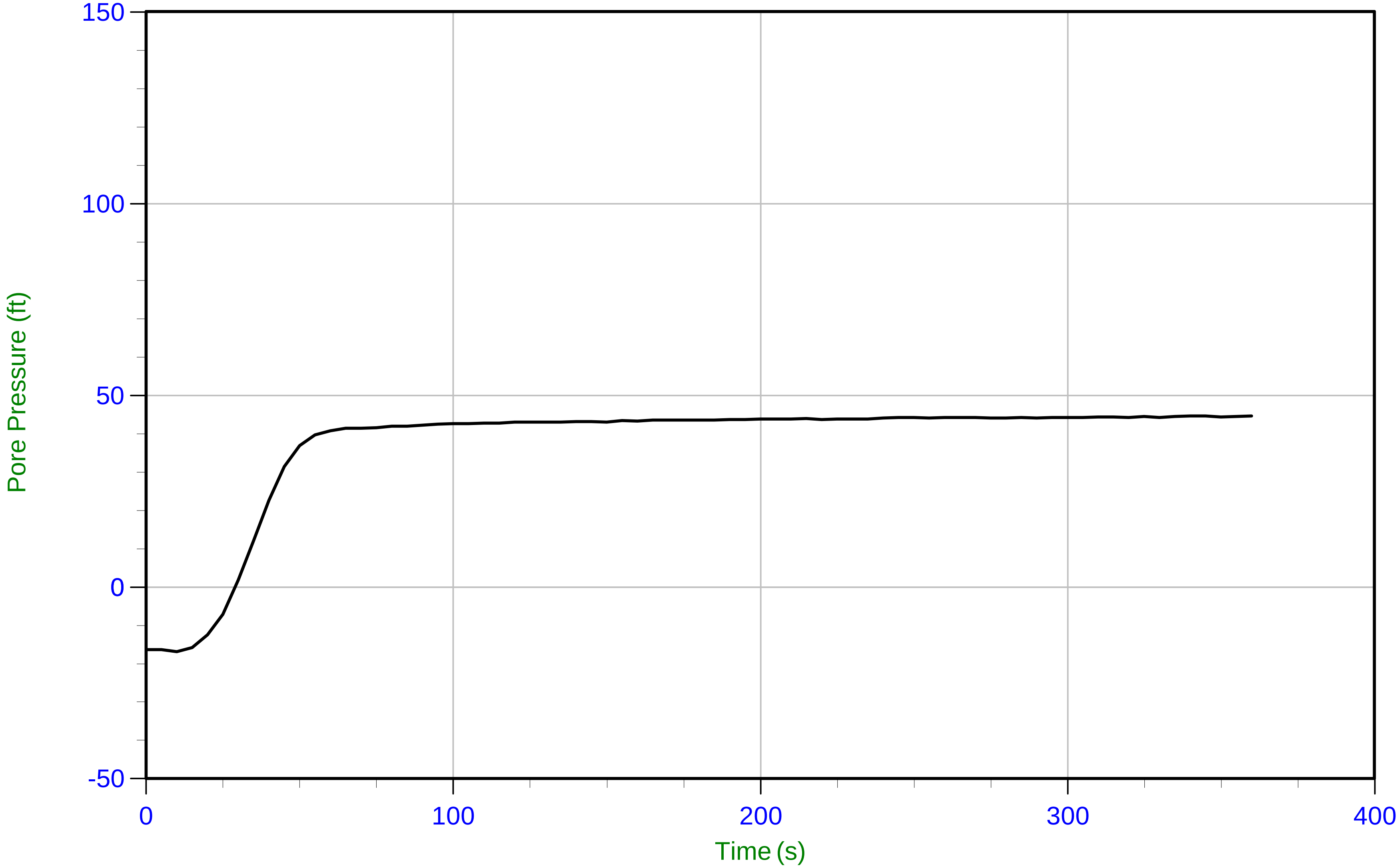
Filename: 18-56056_CP07.PPF
Depth: 4.450 m / 14.600 ft
Duration: 180.0 s

U Min: -9.8 ft
U Max: 13.9 ft

WT: 0.343 m / 1.125 ft
Ueq: 13.5 ft

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.	Job No: 18-56056 Date: 04/27/2018 08:26 Site: Pleasant Hill Library	Sounding: 2-CPT7 Cone: 448:T1500F15U500 Area=15 cm²



Trace Summary:

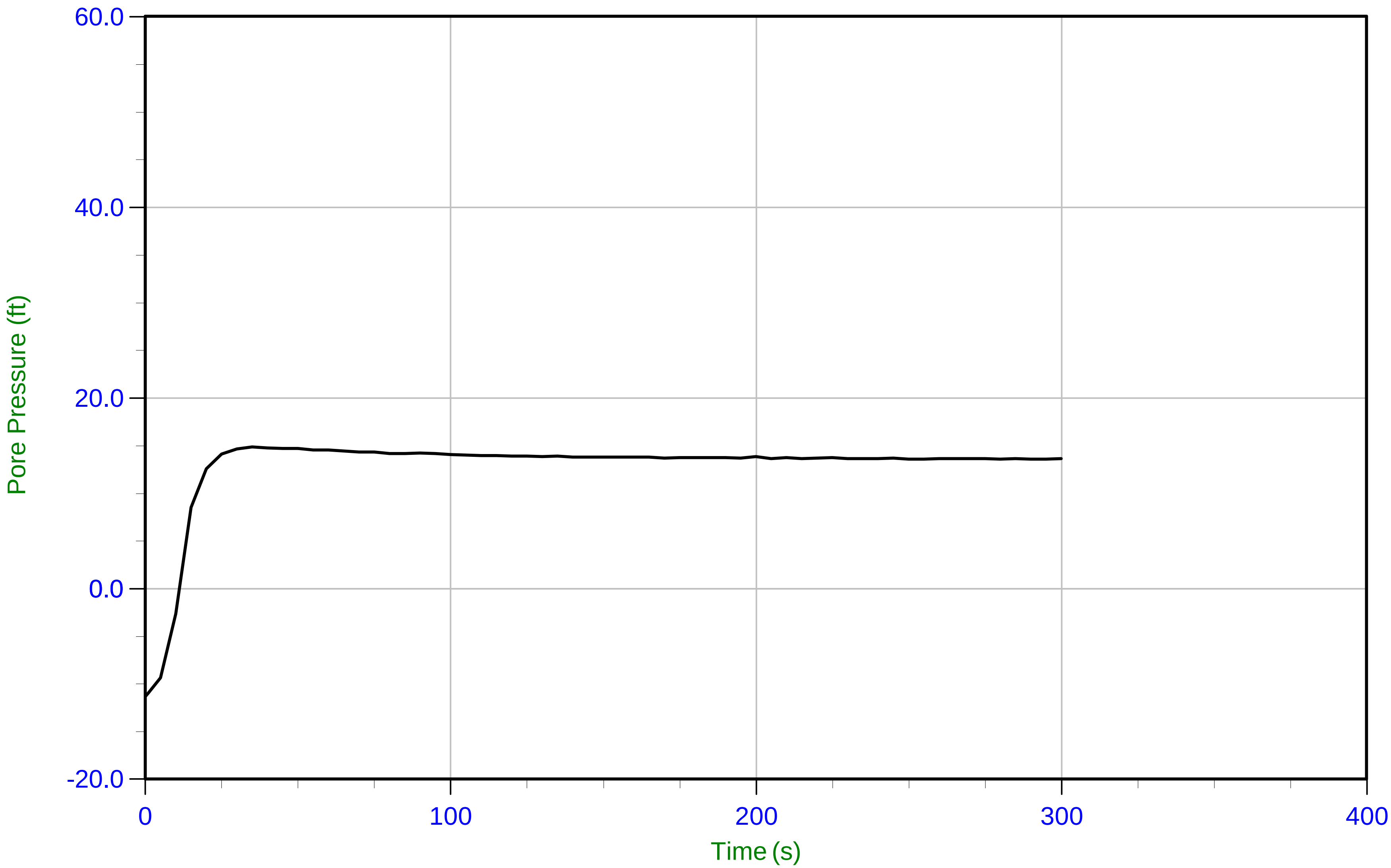
Filename: 18-56056_CP07.PPF
Depth: 14.100 m / 46.259 ft
Duration: 360.0 s

U Min: -16.8 ft
U Max: 44.6 ft

WT: 0.645 m / 2.116 ft
Ueq: 44.1 ft

CALIFORNIA PUSH TECHNOLOGIES INCORPORATED

ENGEO Inc.	Job No: 18-56056 Date: 04/27/2018 11:24 Site: Pleasant Hill Library	Sounding: 2-CPT9 Cone: 448:T1500F15U500 Area=15 cm²



Trace Summary:

Filename: 18-56056_CP09.PPF	U Min: -11.3 ft	WT: 1.843 m / 6.047 ft
Depth: 5.950 m / 19.521 ft	U Max: 14.8 ft	Ueq: 13.5 ft
Duration: 300.0 s		

APPENDIX D

LIQUEFACTION ANALYSIS

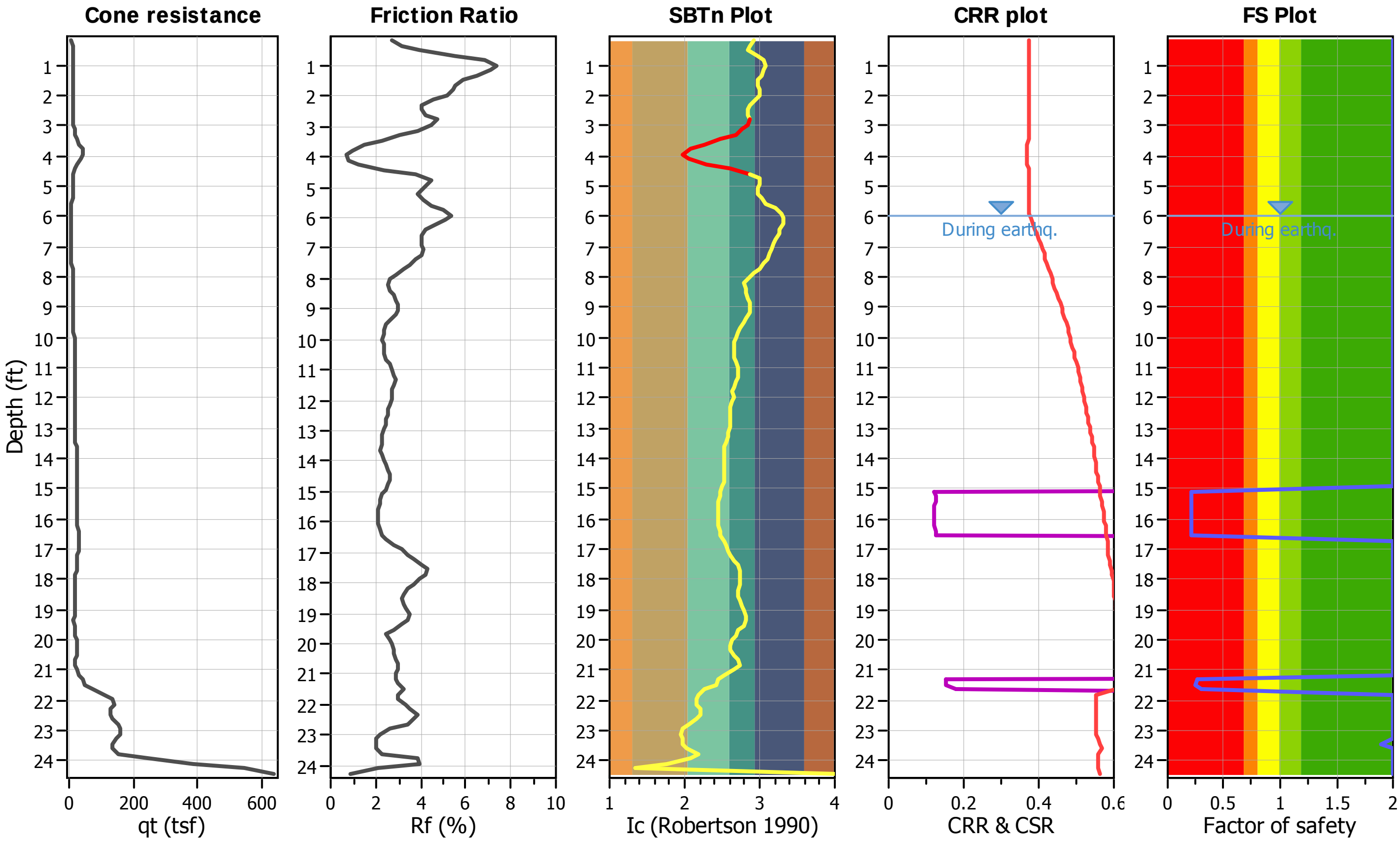
LIQUEFACTION ANALYSIS REPORT

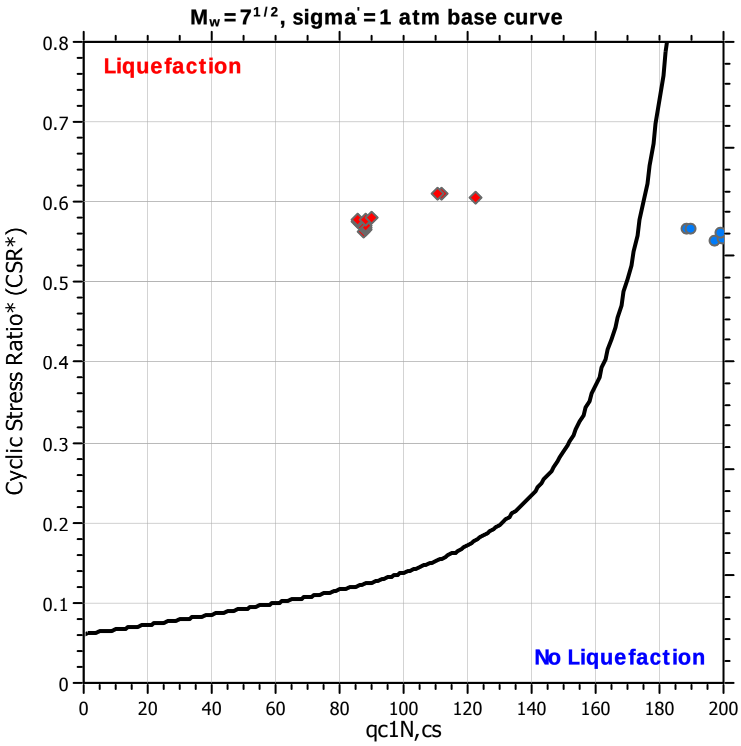
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

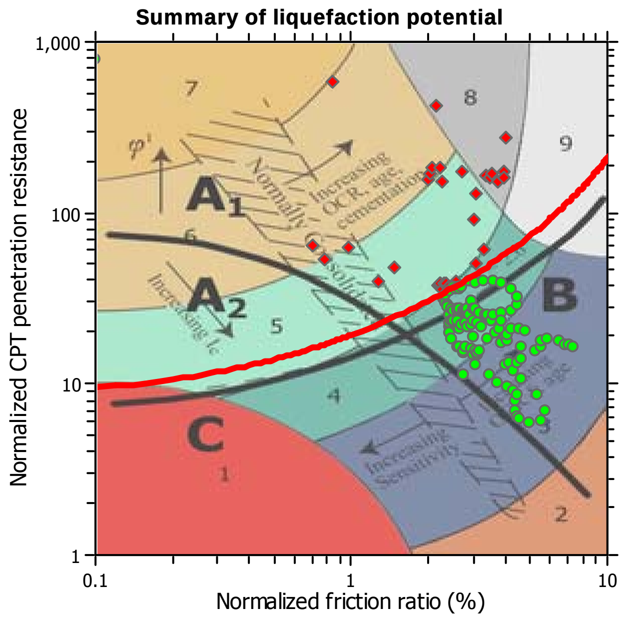
CPT file : 2-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

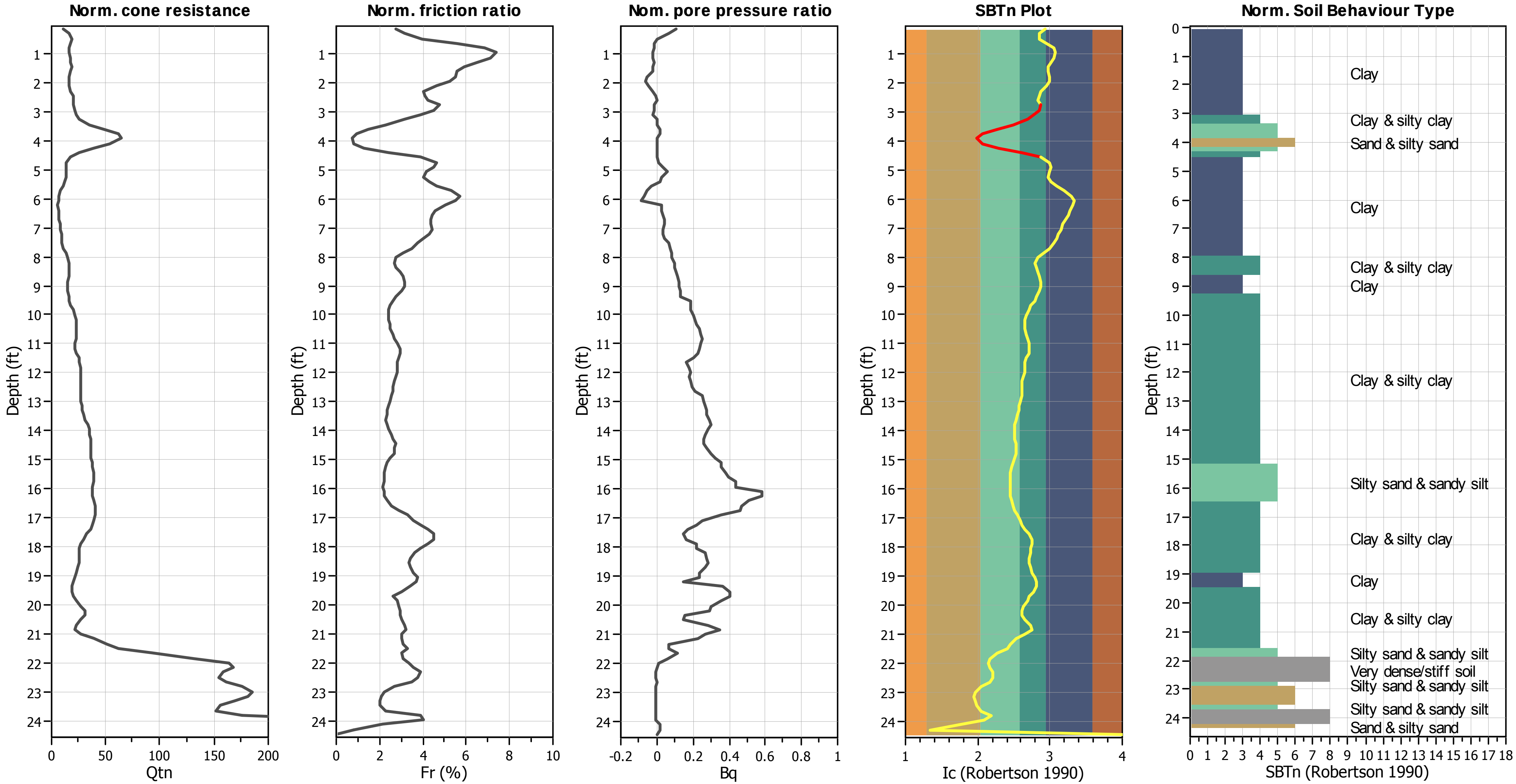






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



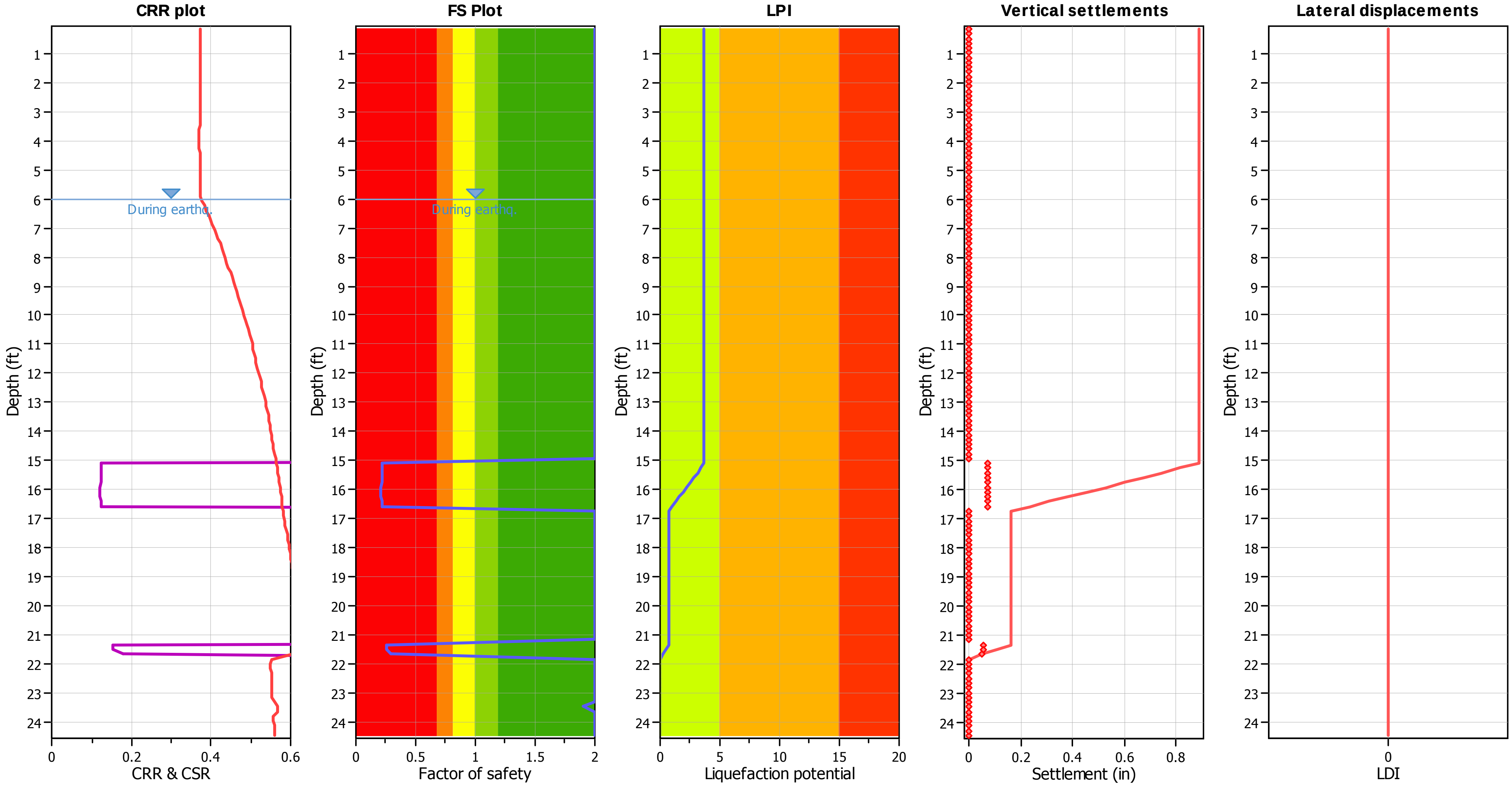
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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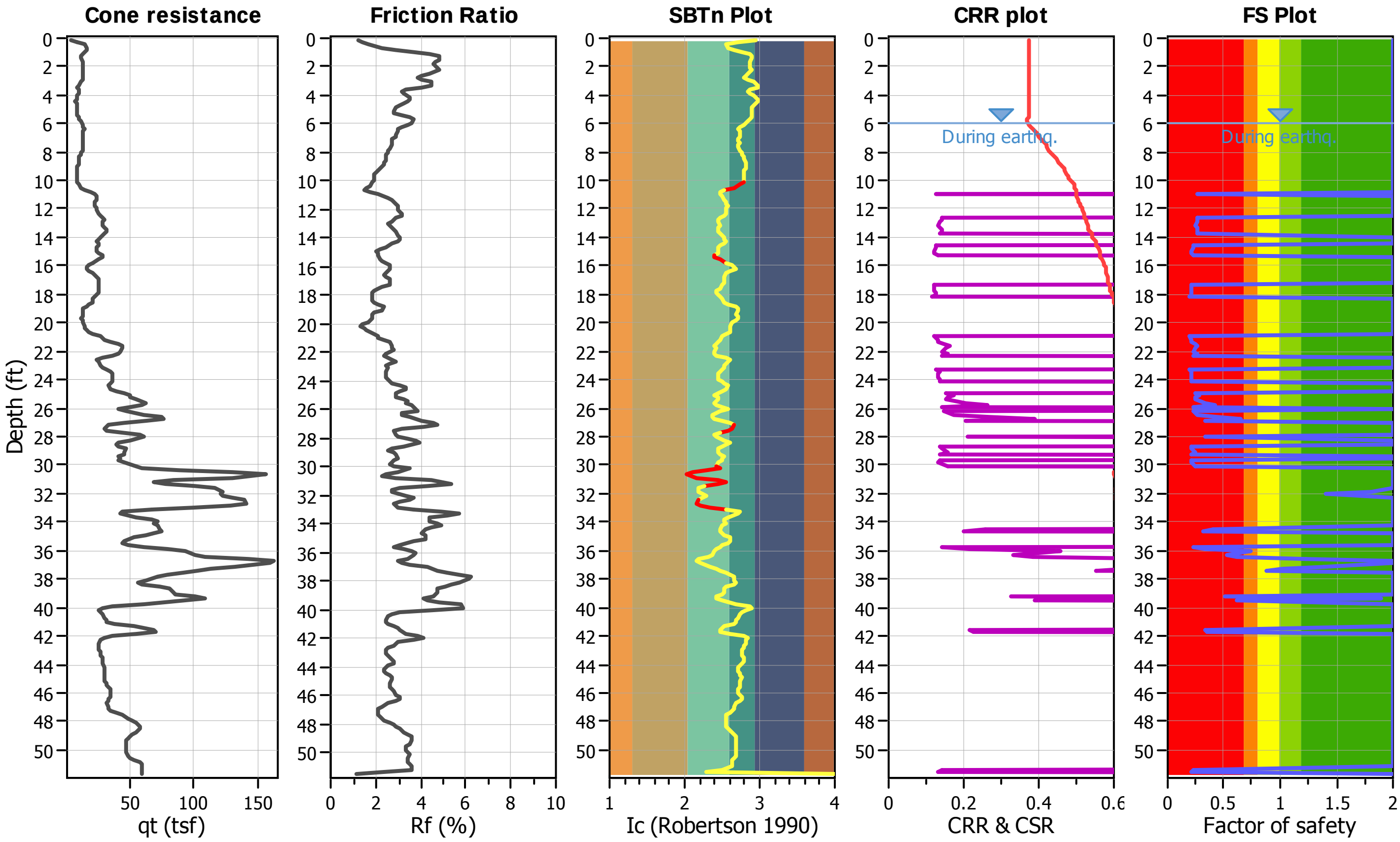
LIQUEFACTION ANALYSIS REPORT

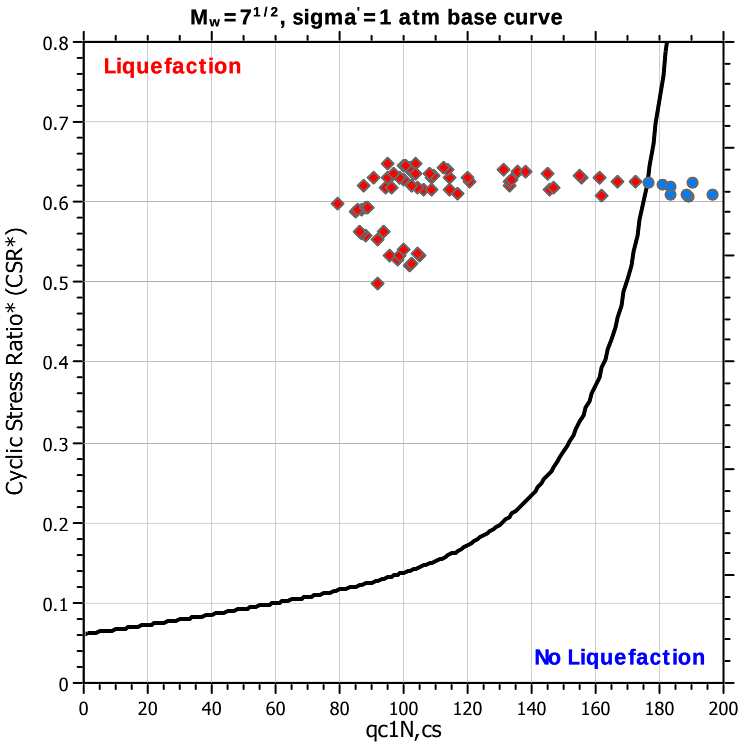
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

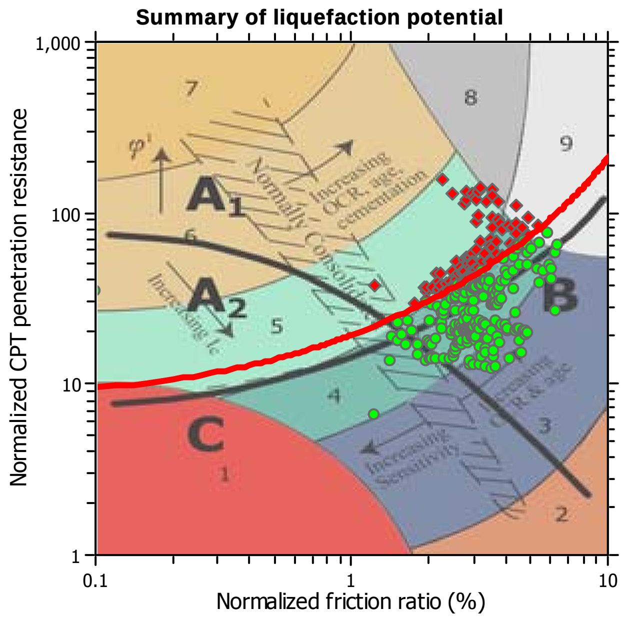
CPT file : 2-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

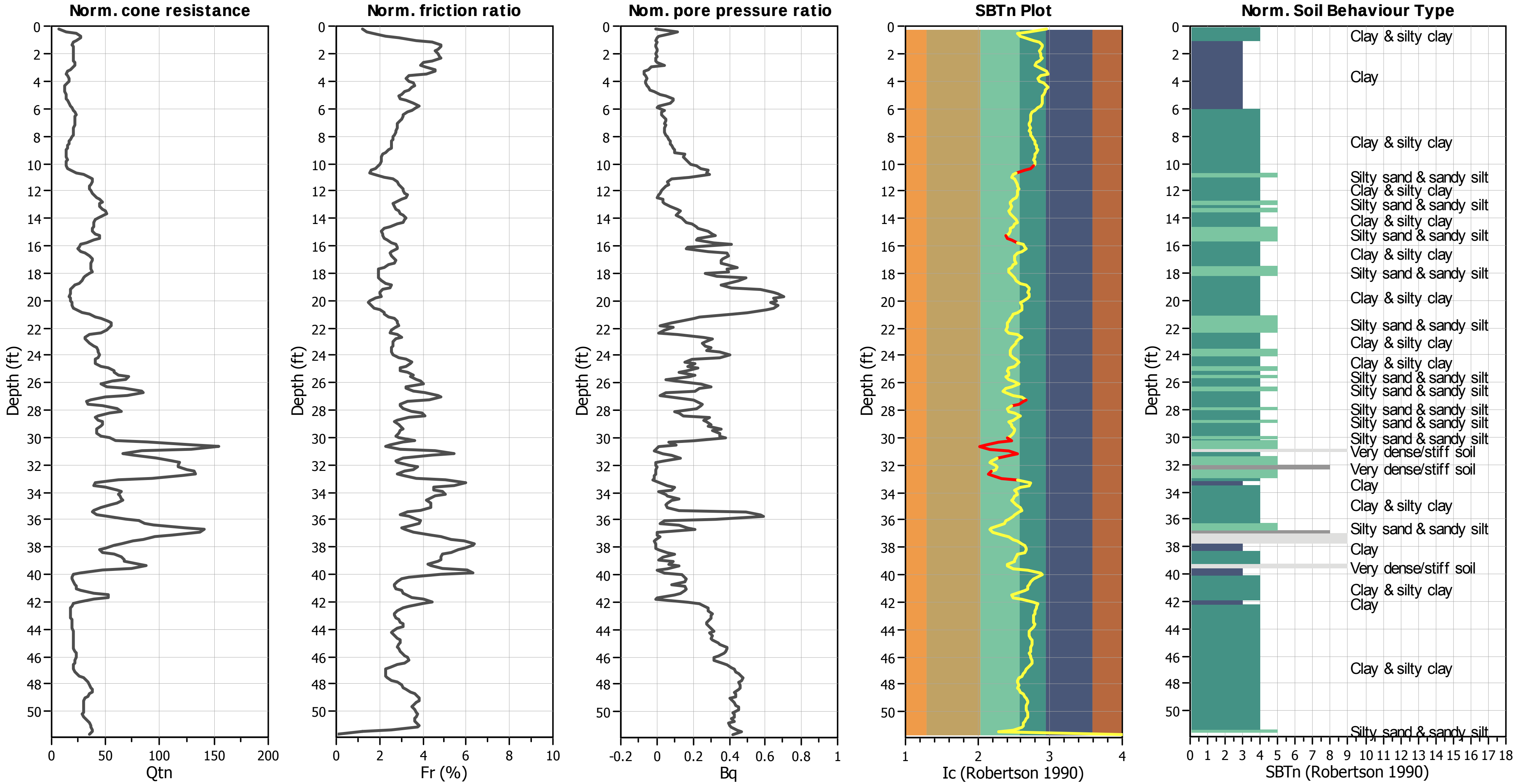






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



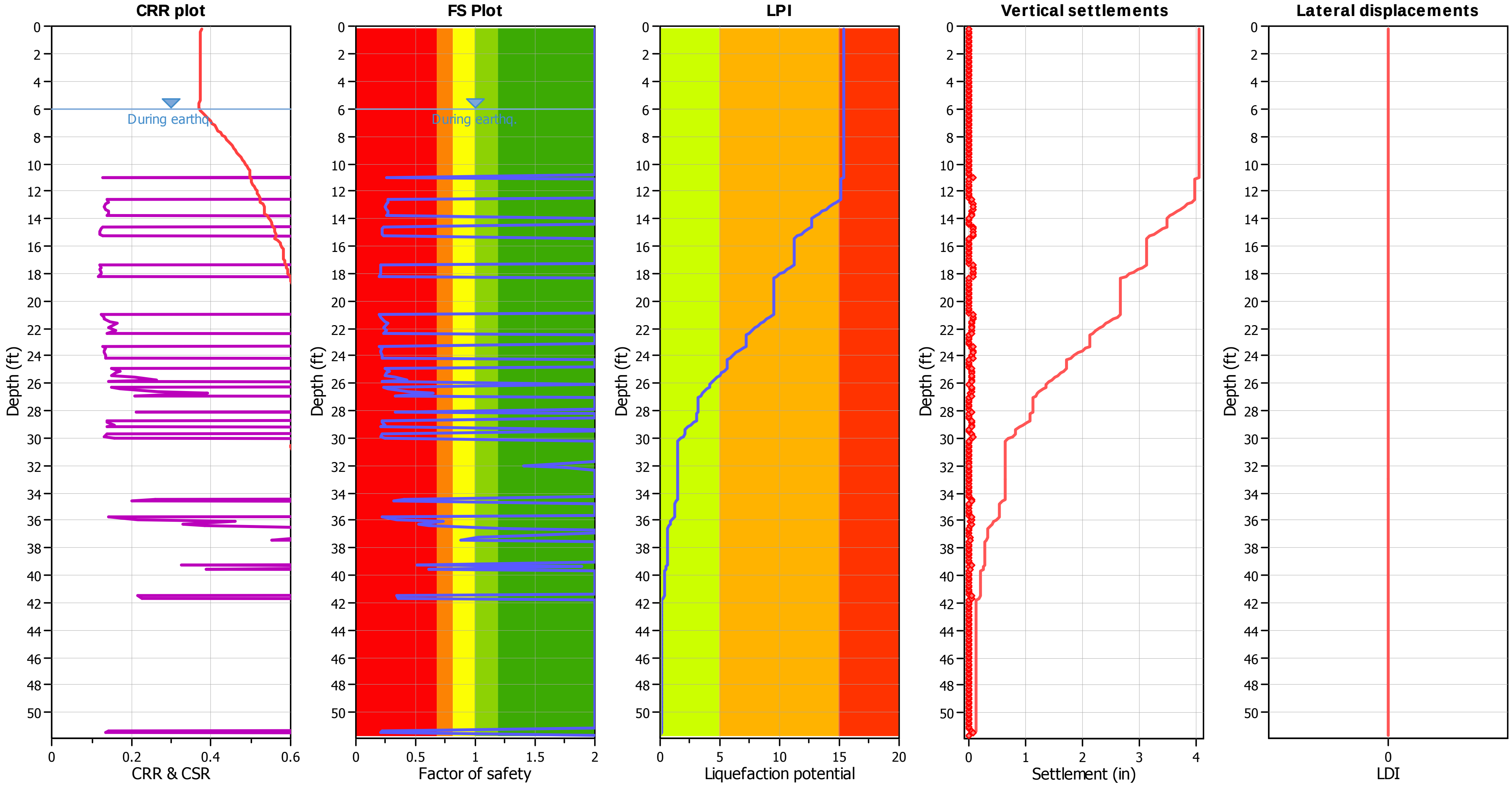
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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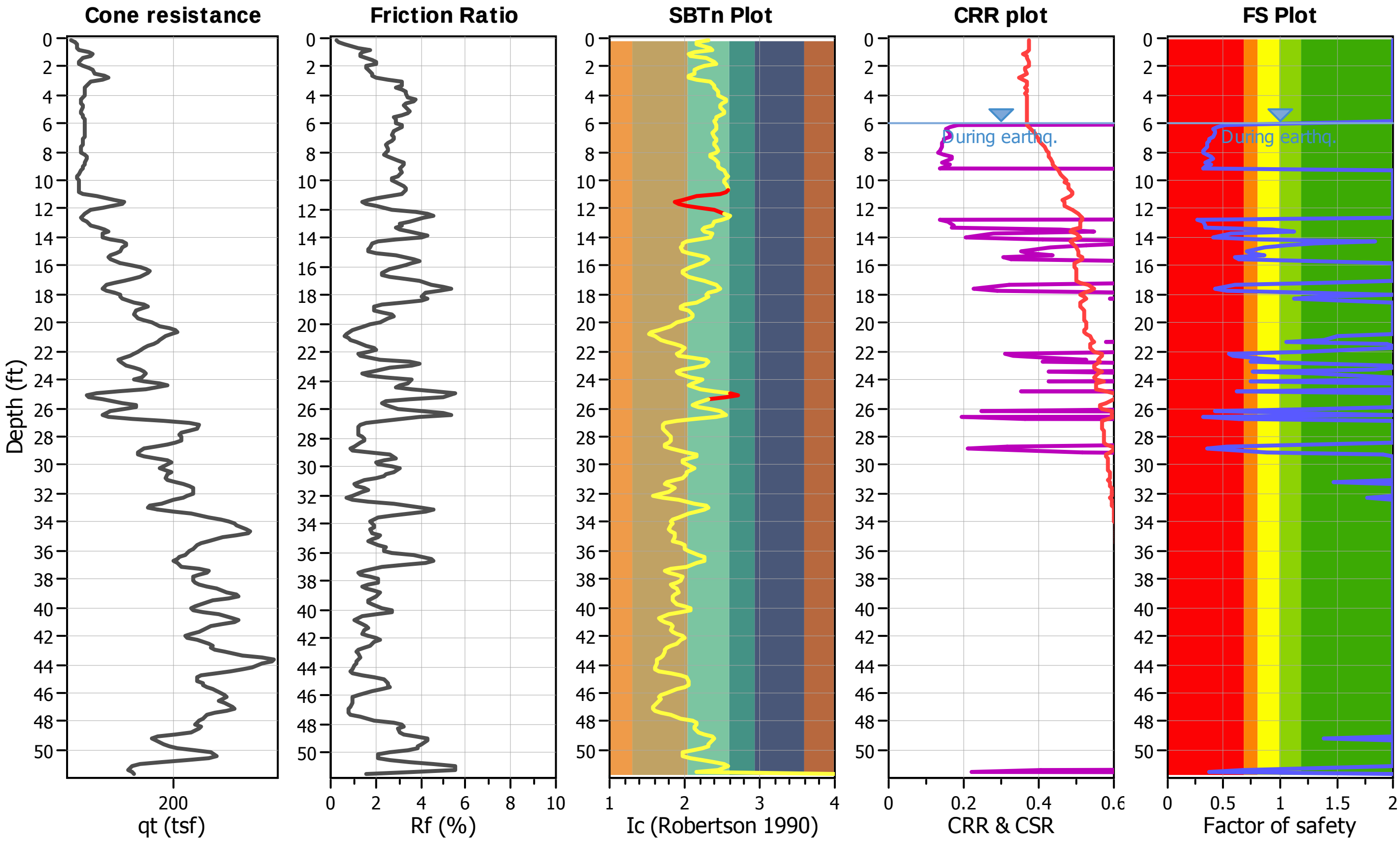
LIQUEFACTION ANALYSIS REPORT

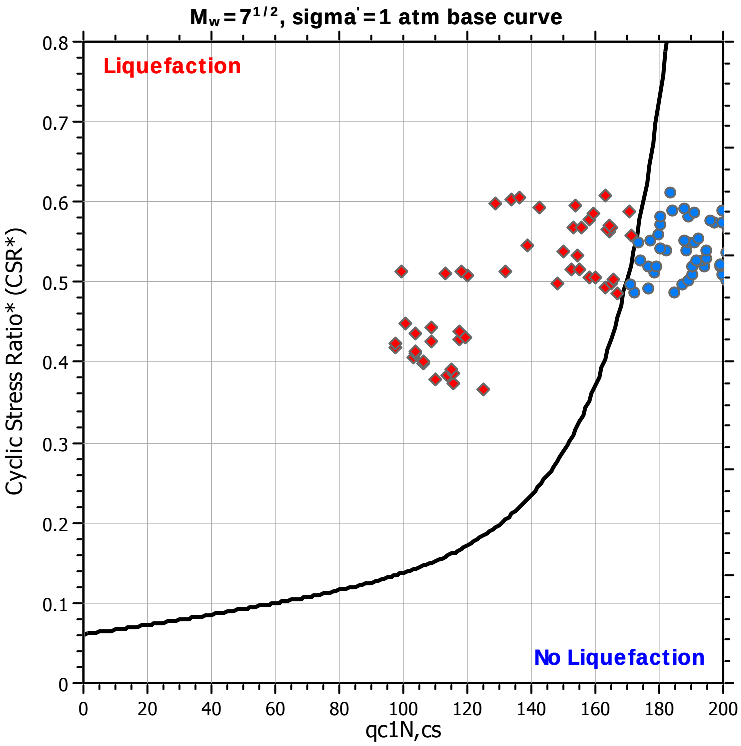
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

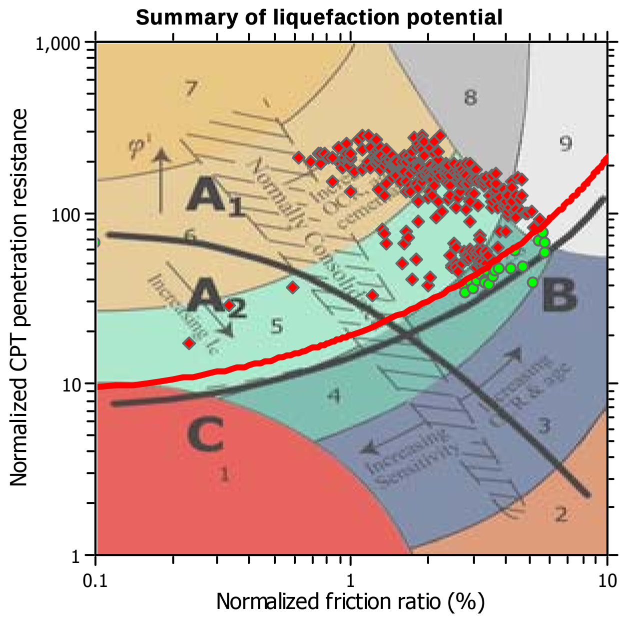
CPT file : 2-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

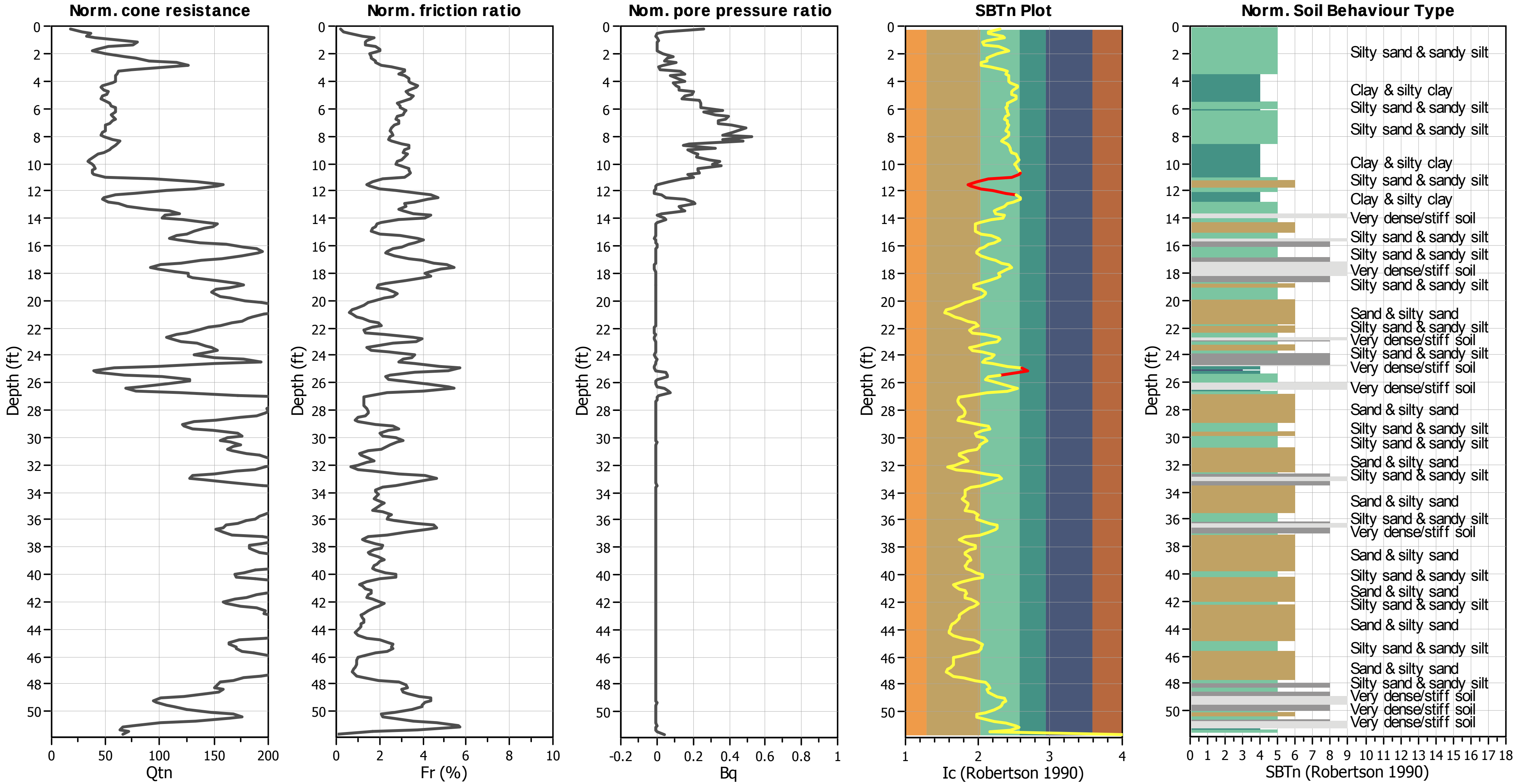






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



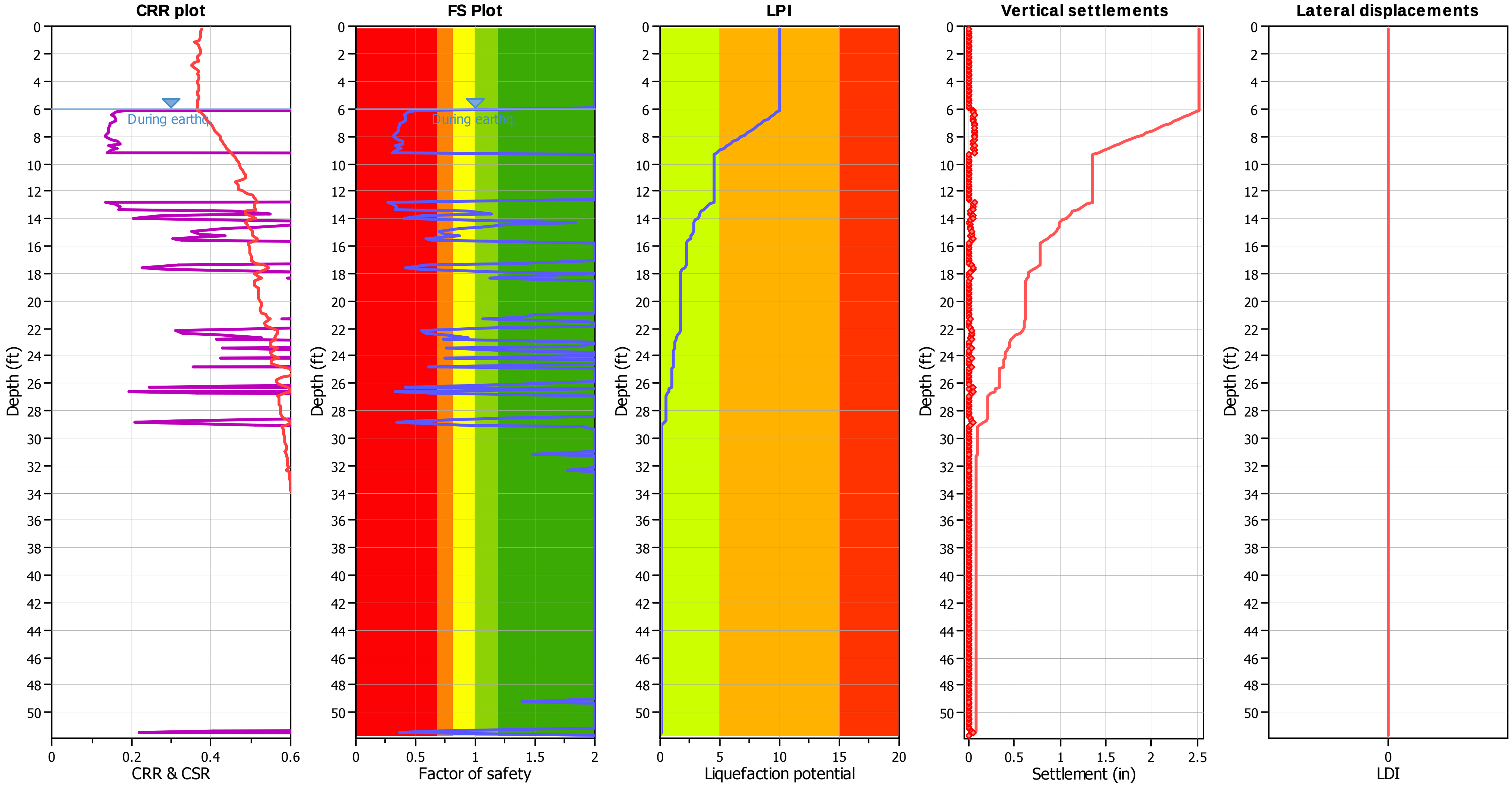
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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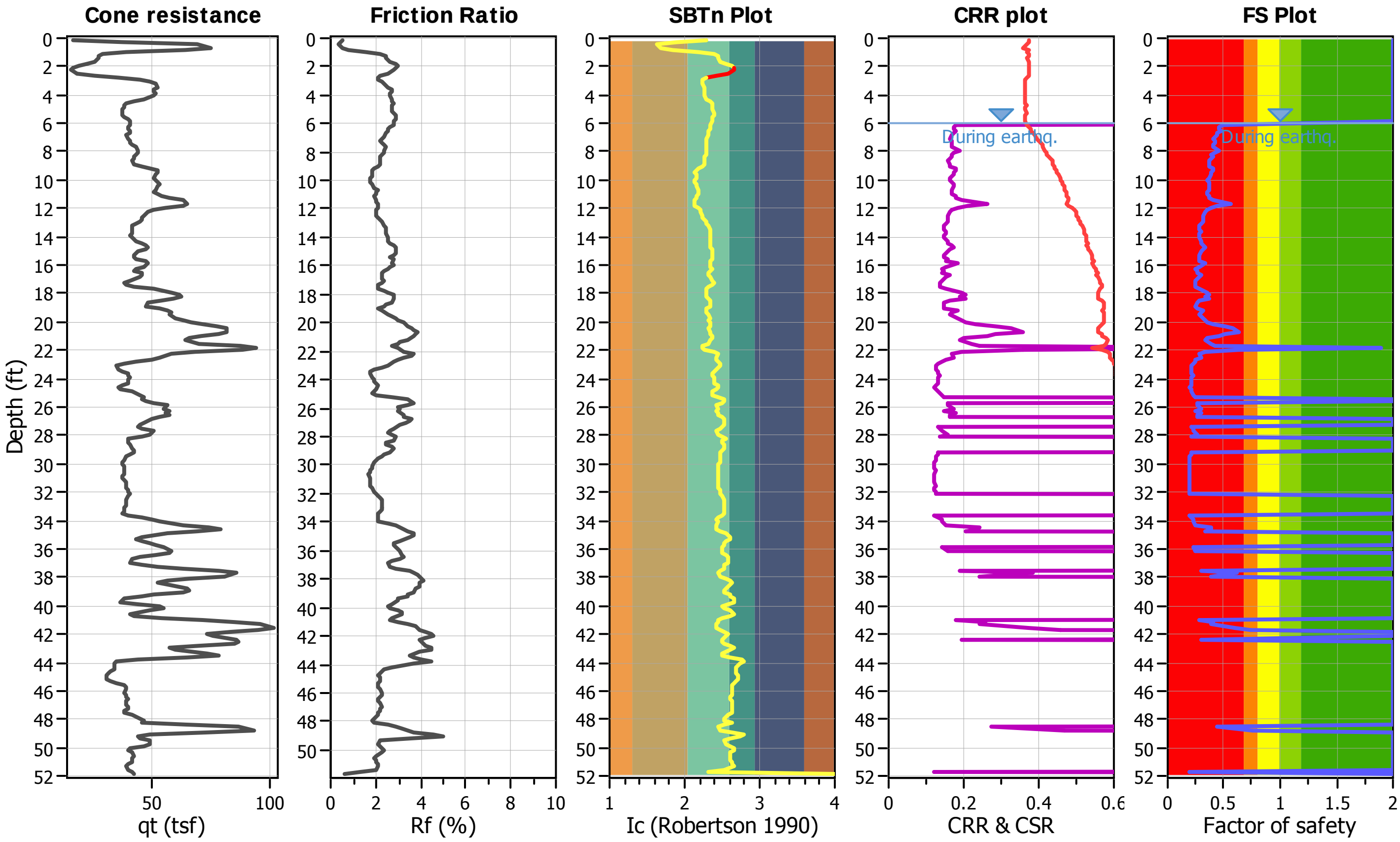
LIQUEFACTION ANALYSIS REPORT

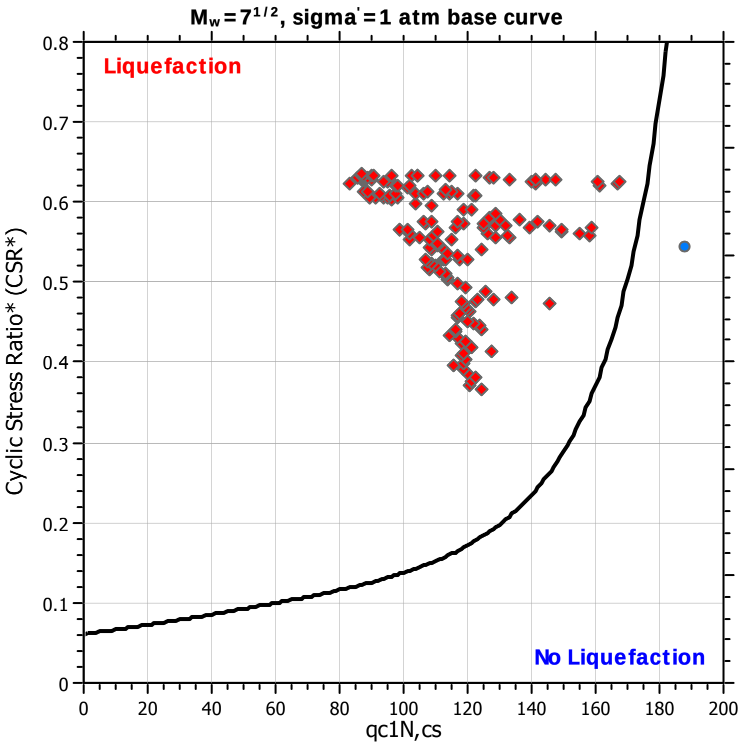
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

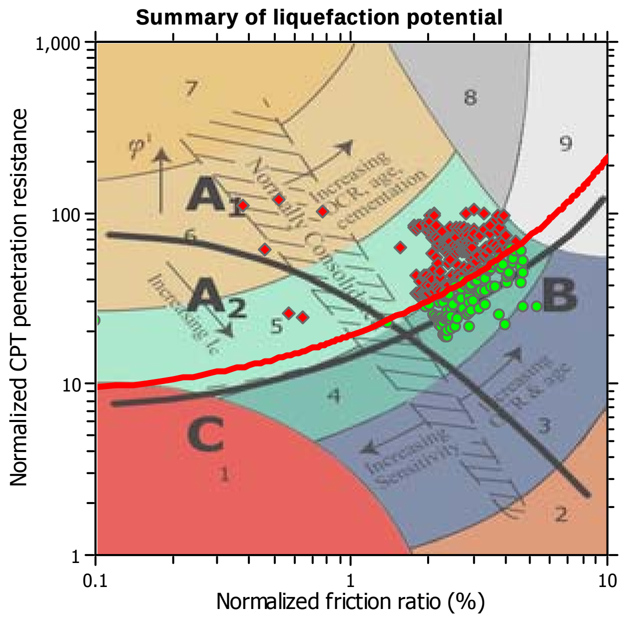
CPT file : 2-CPT5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior	
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 ft	Fill height:	N/A	applied:	Sands only
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method







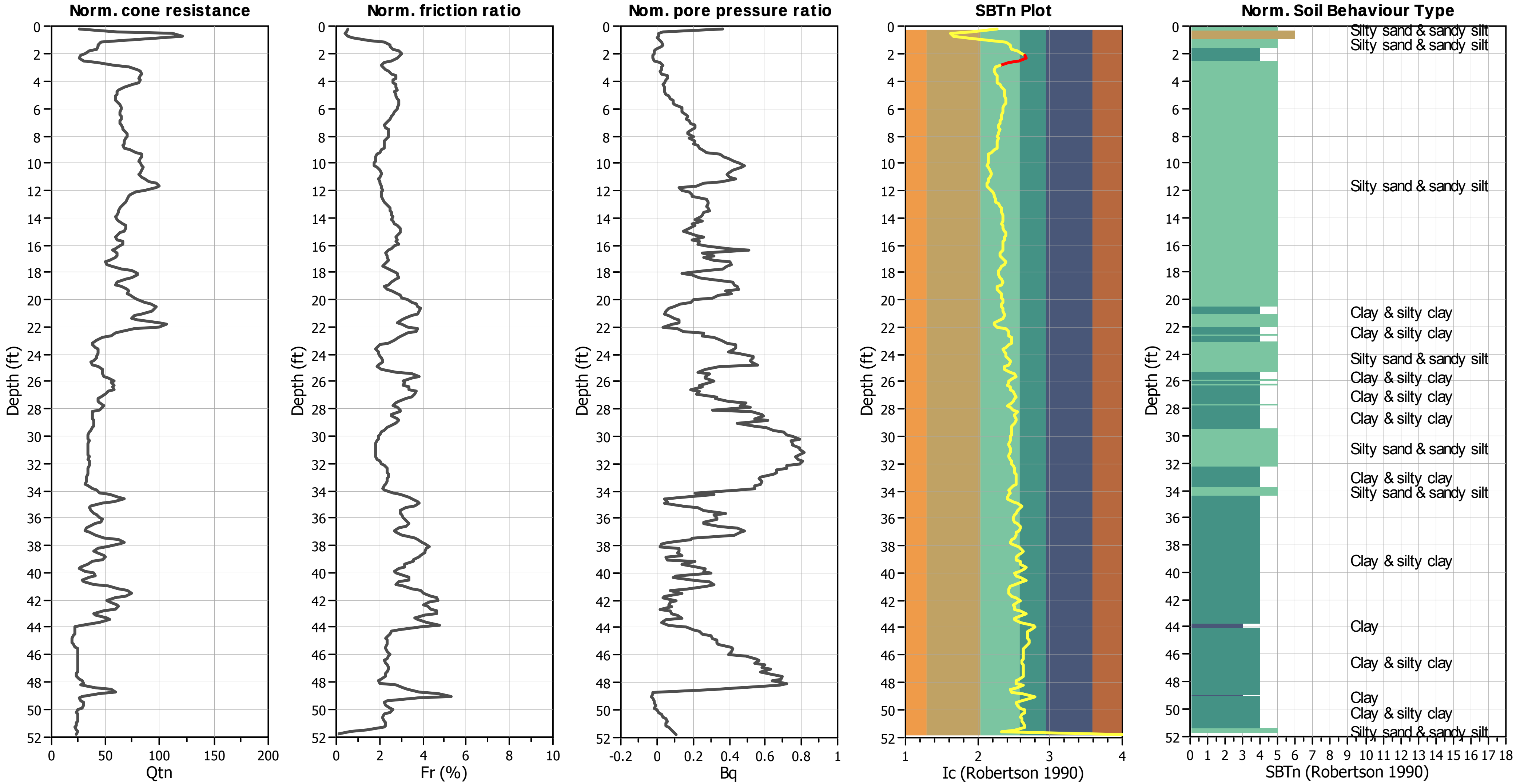
Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading

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 (normalized)



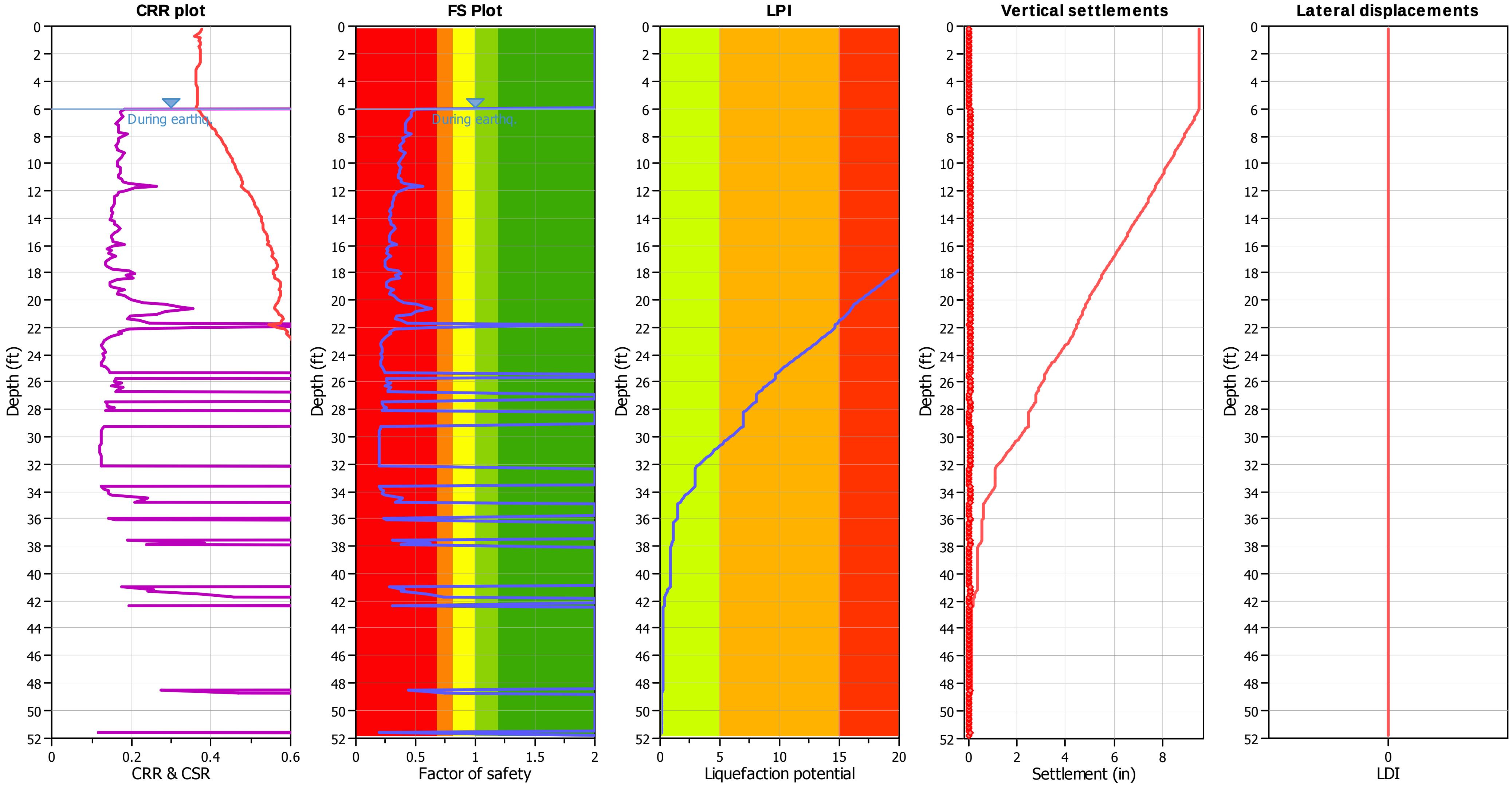
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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ENGEO Expect Excellence

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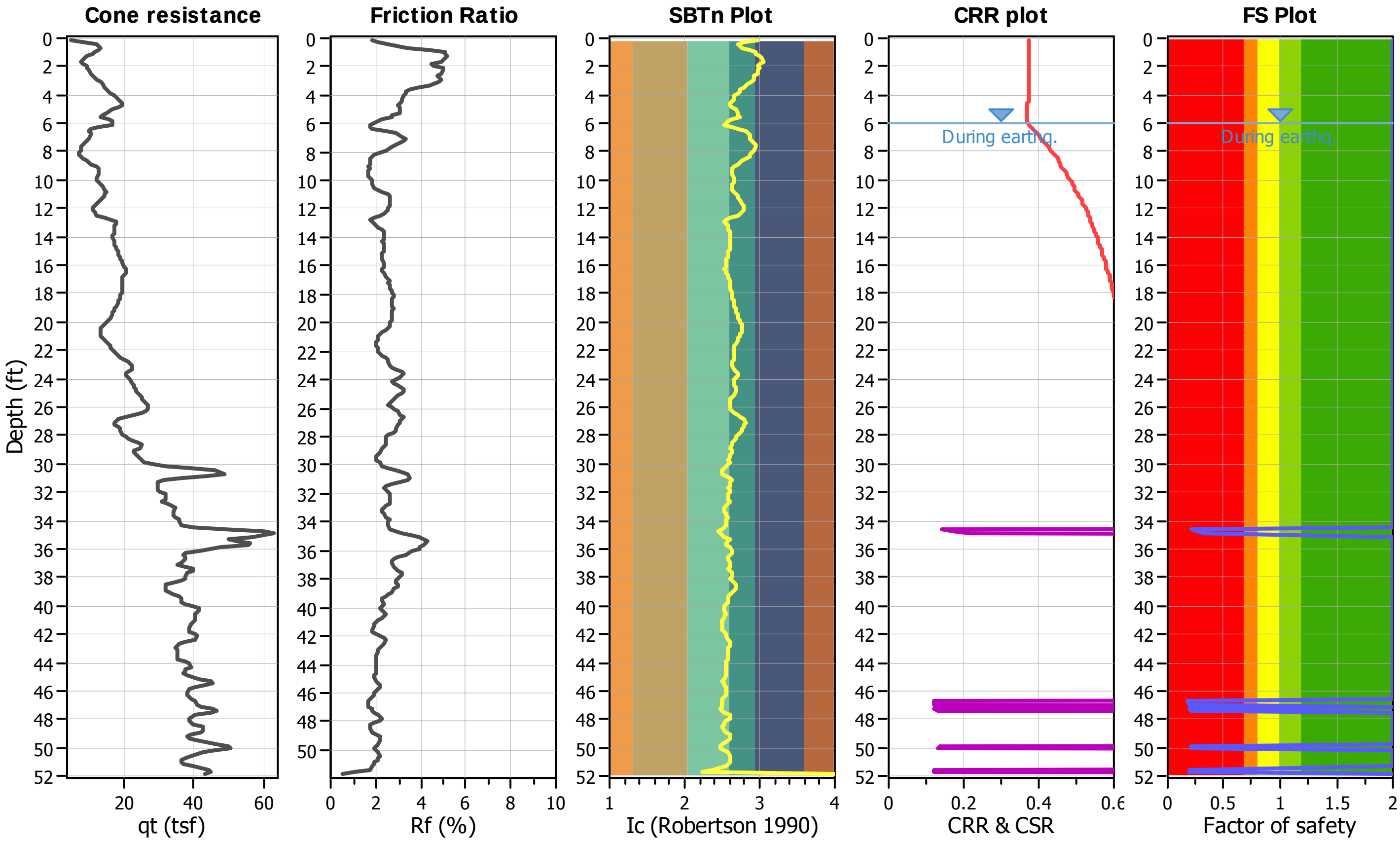
LIQUEFACTION ANALYSIS REPORT

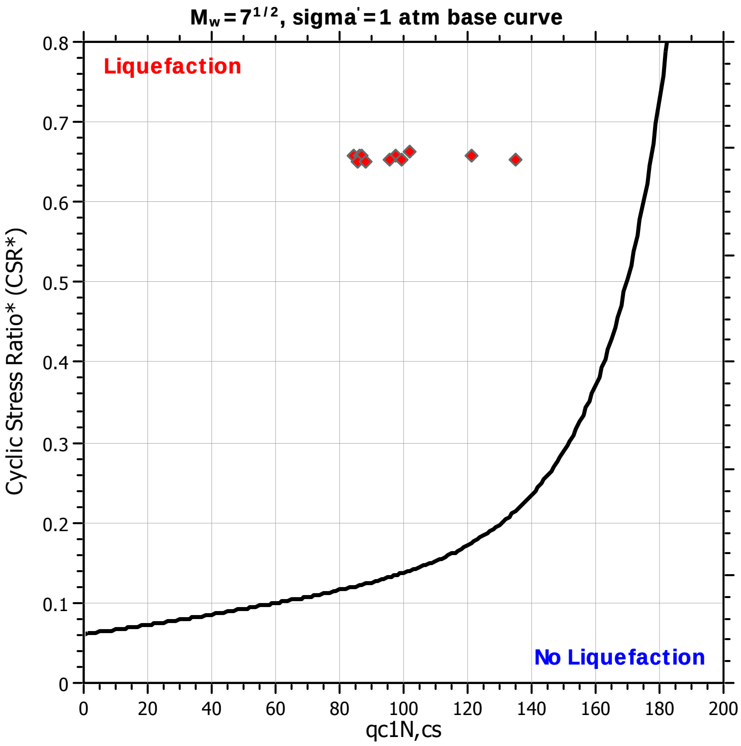
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

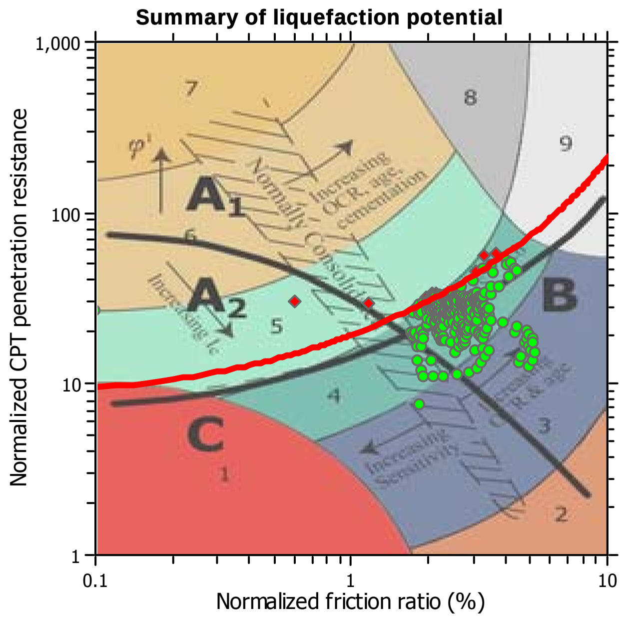
CPT file : 2-CPT6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

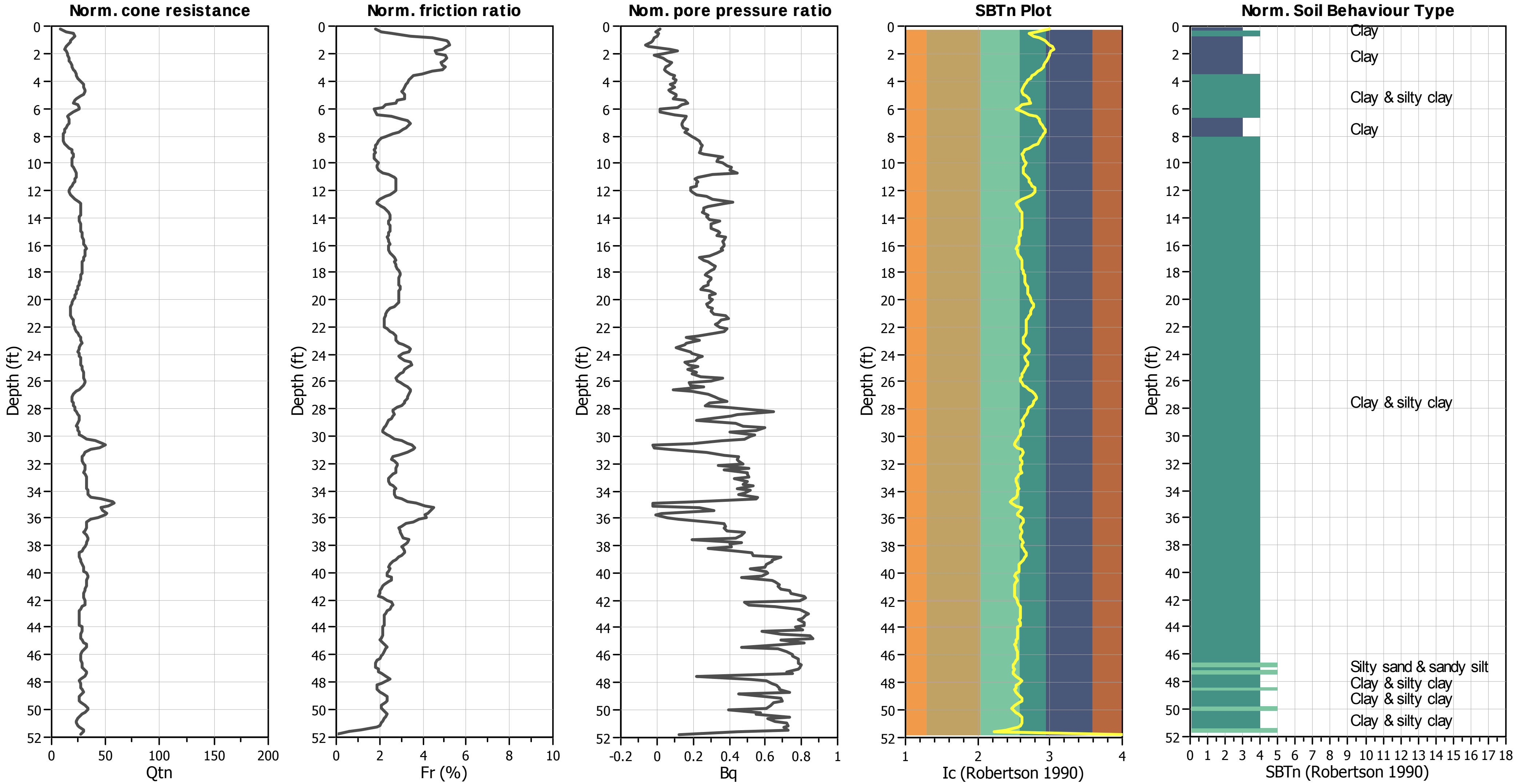






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



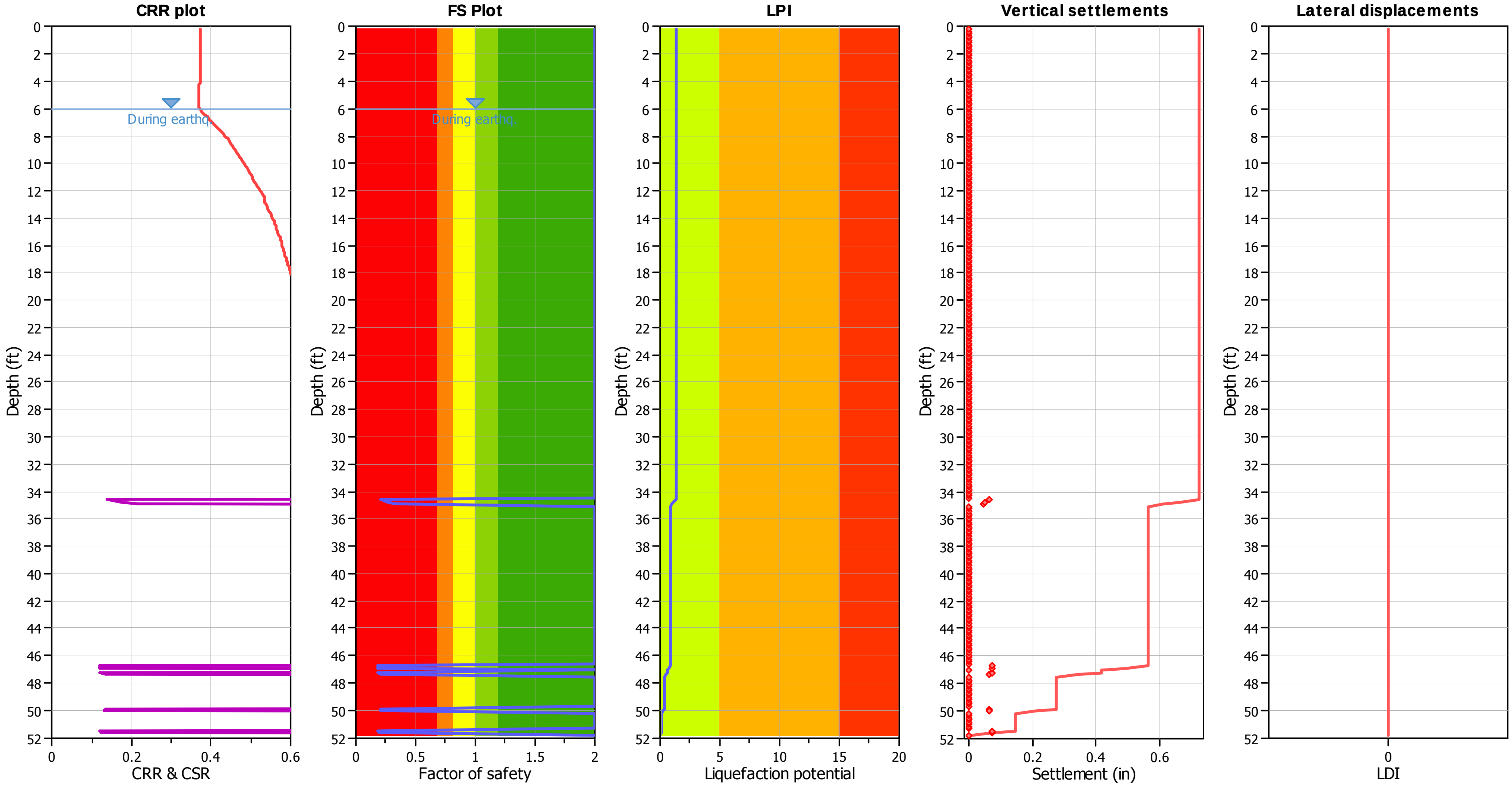
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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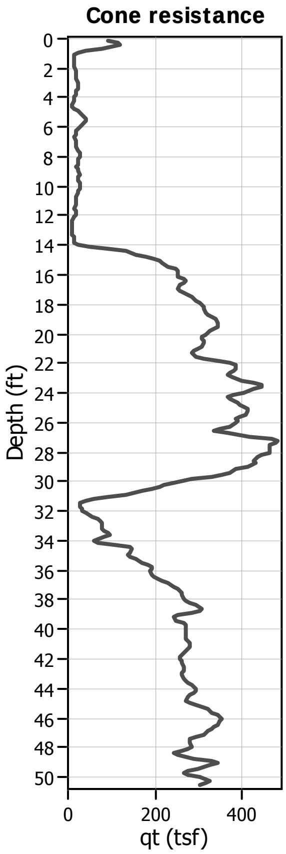
LIQUEFACTION ANALYSIS REPORT

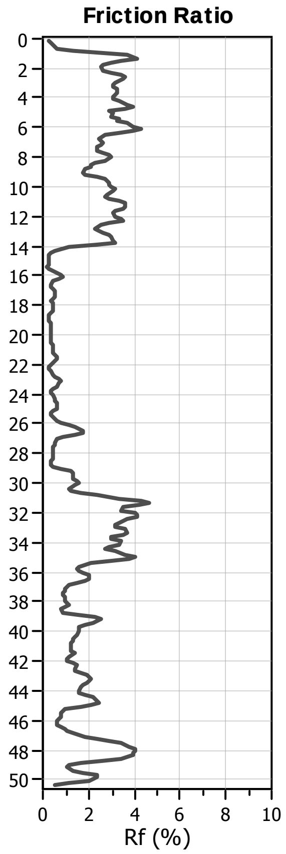
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

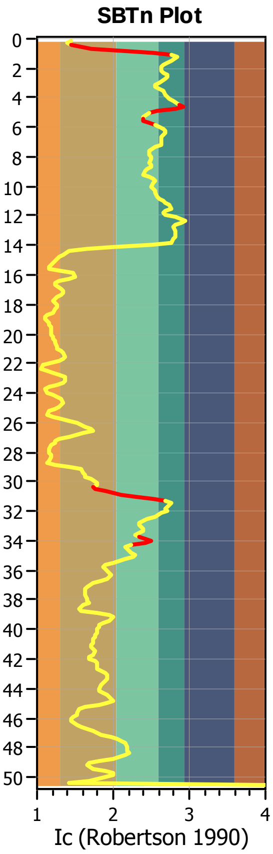
CPT file : 2-CPT7

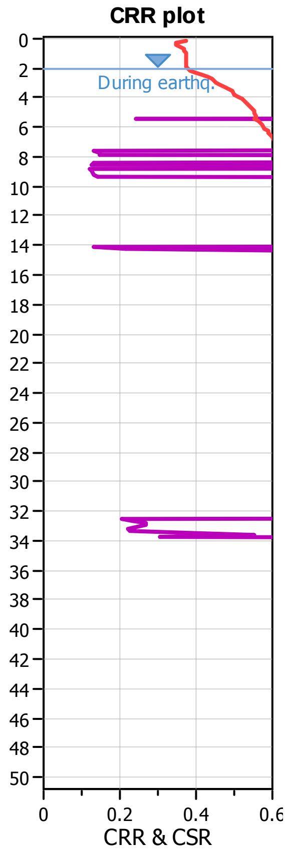
Input parameters and analysis data

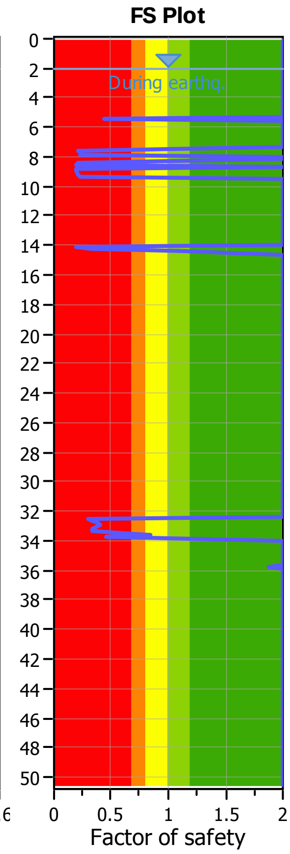
Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 ft	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

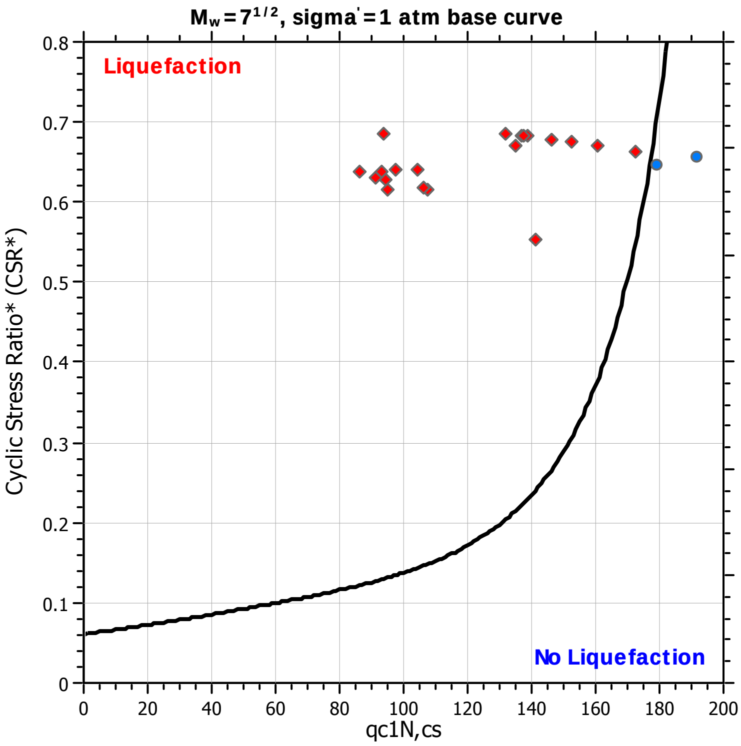


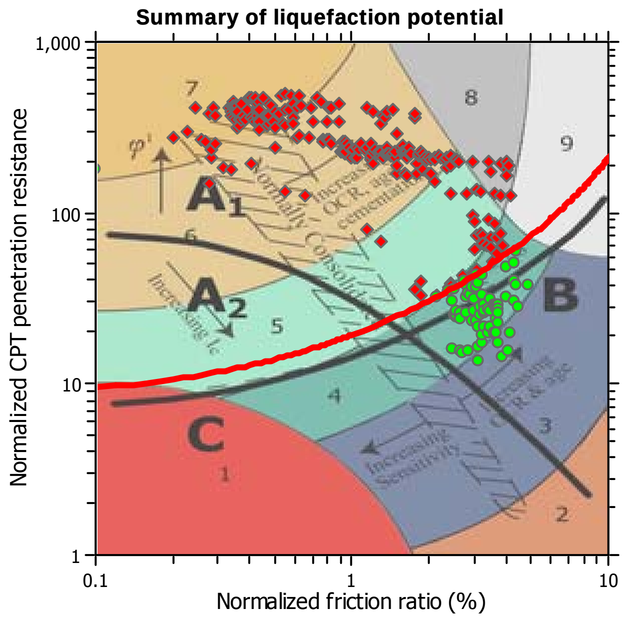






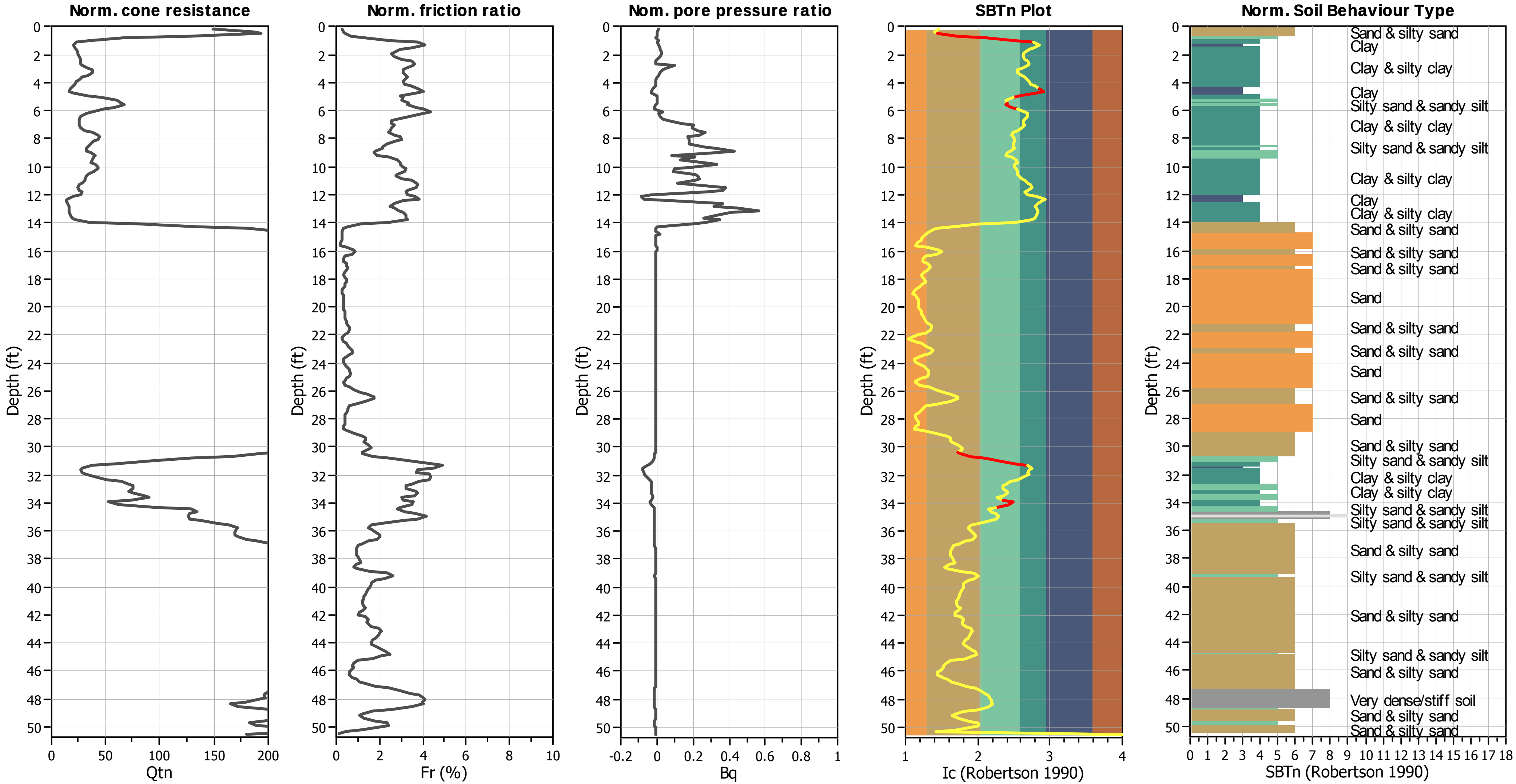






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



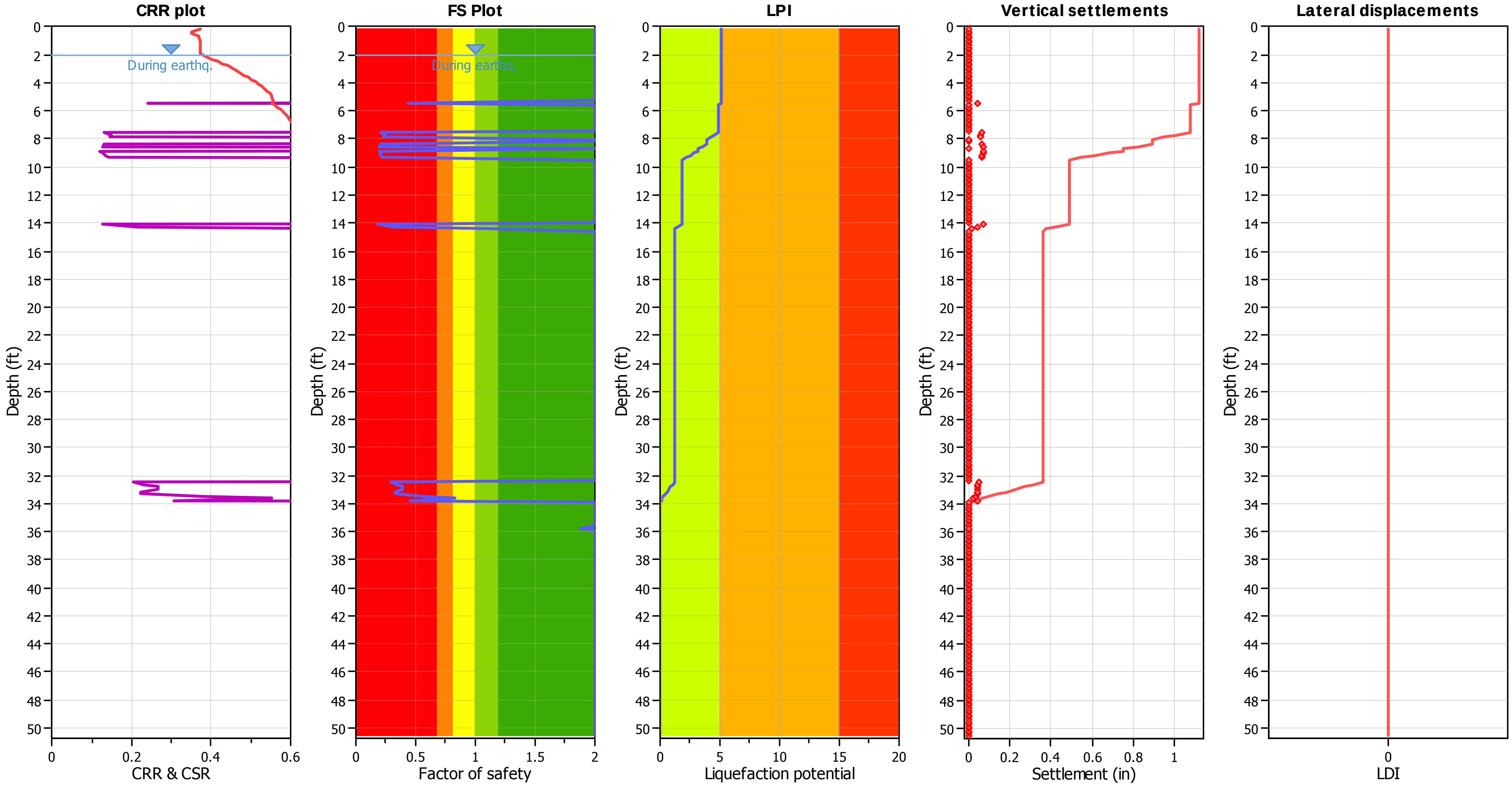
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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

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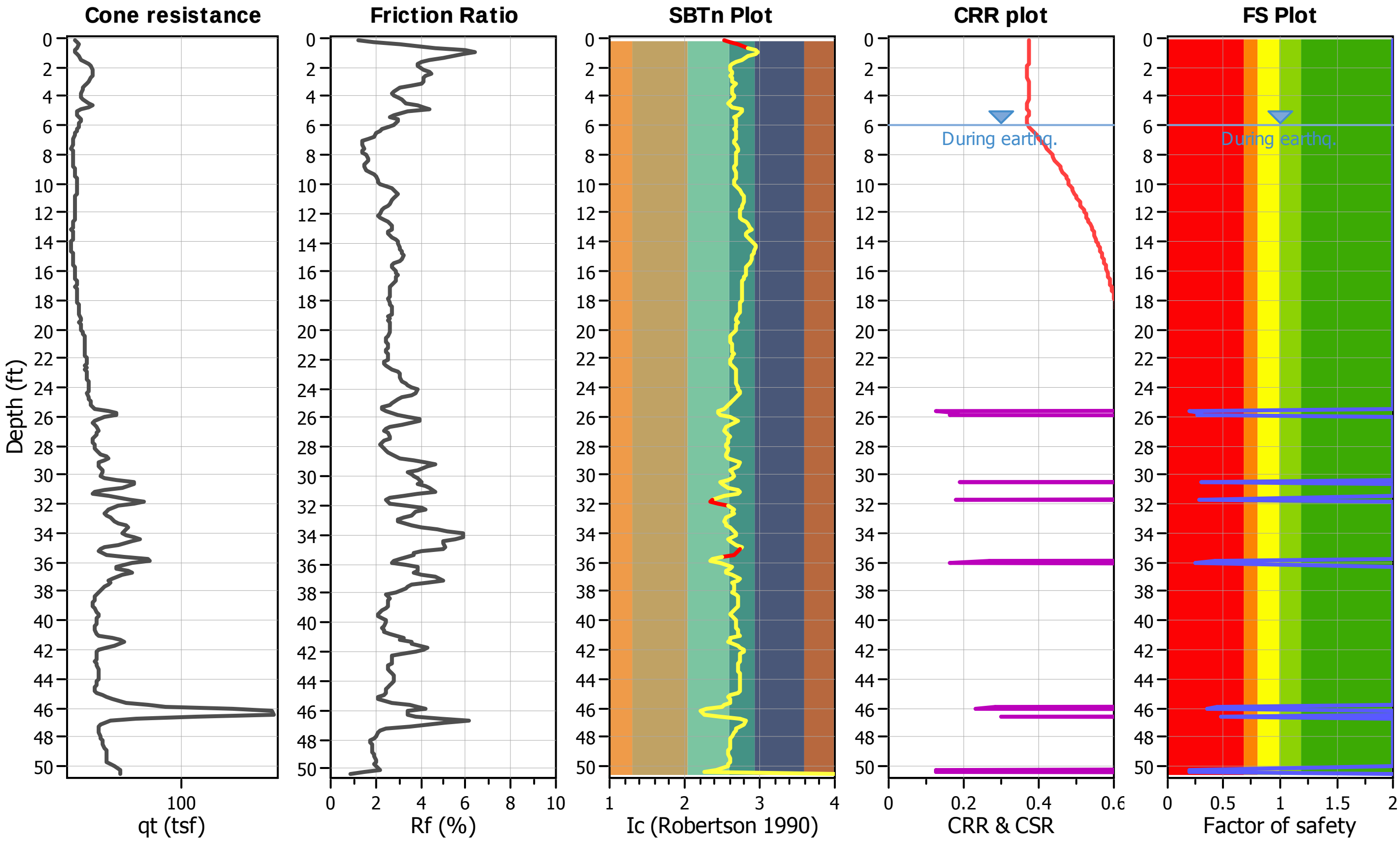
LIQUEFACTION ANALYSIS REPORT

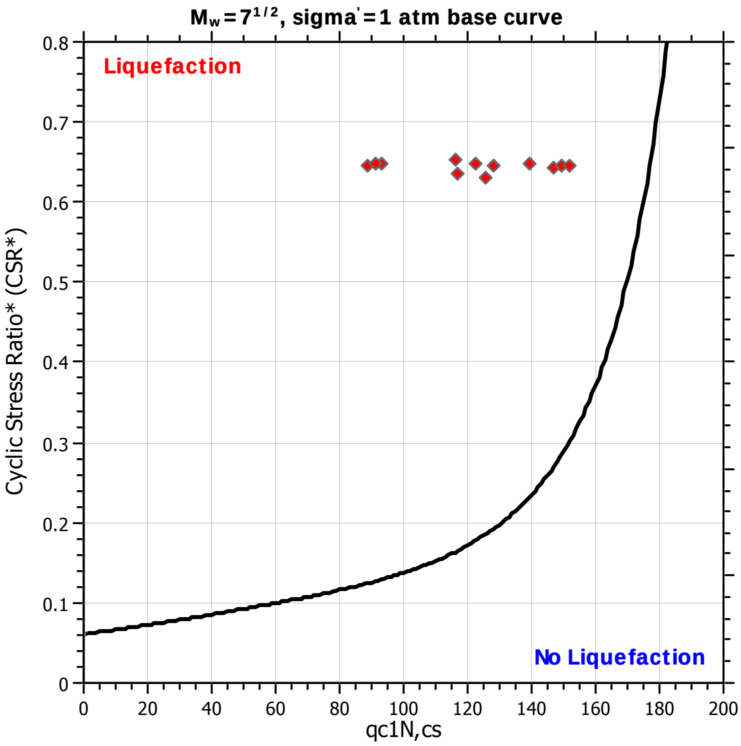
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

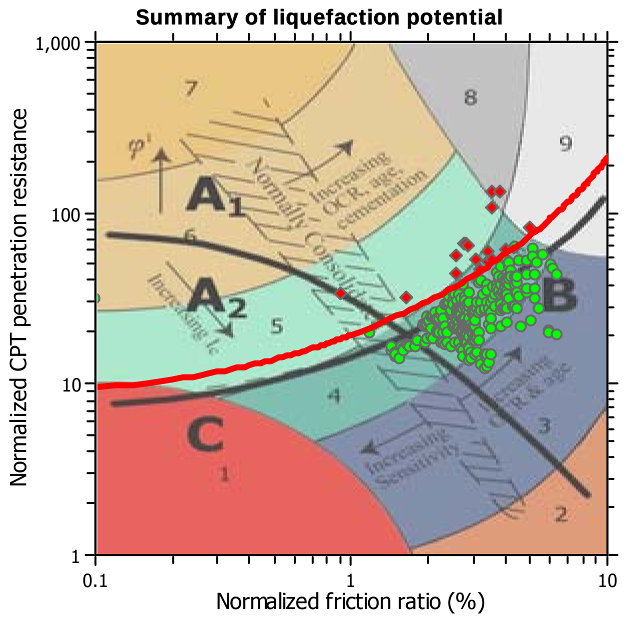
CPT file : 2-CPT8

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

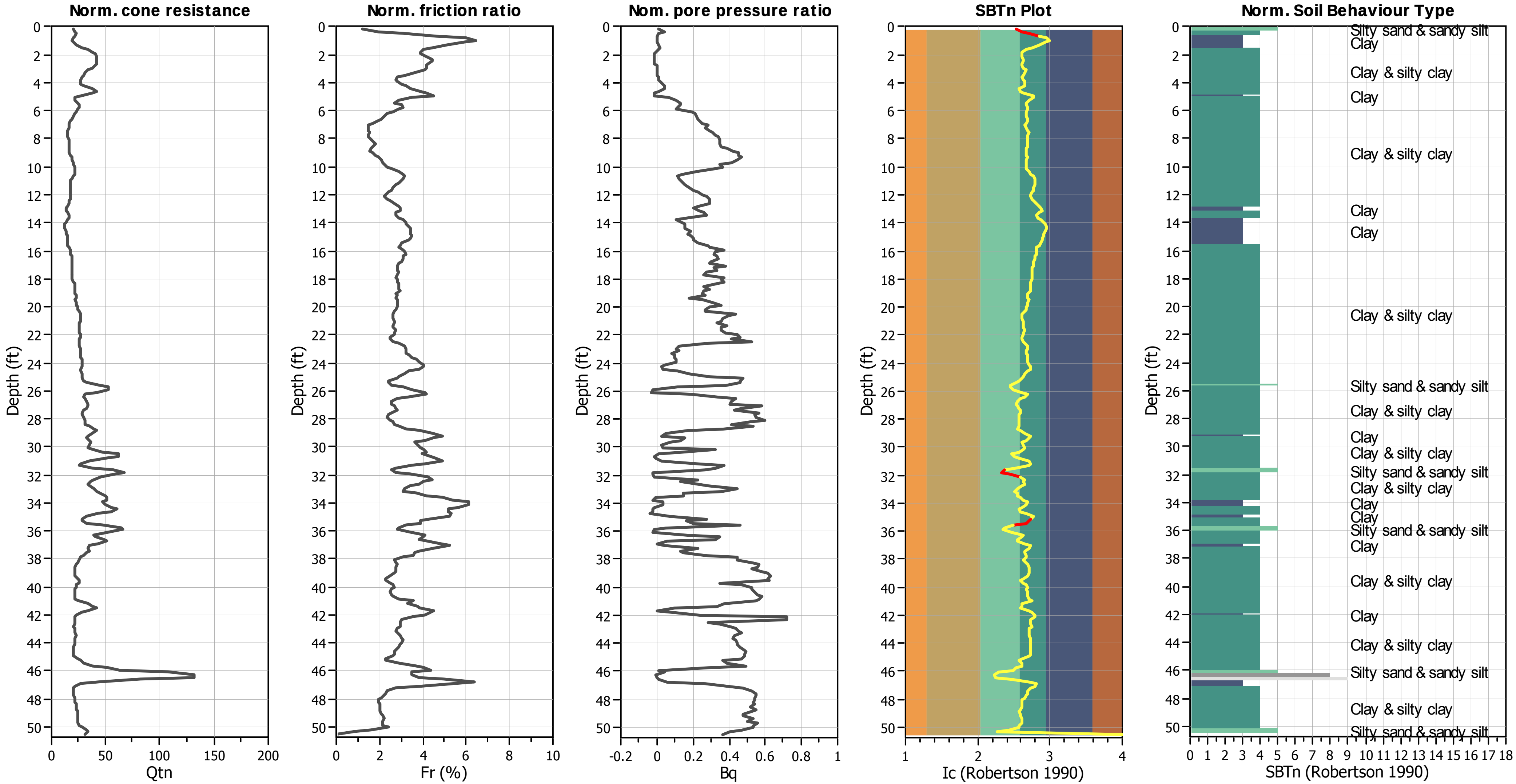






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



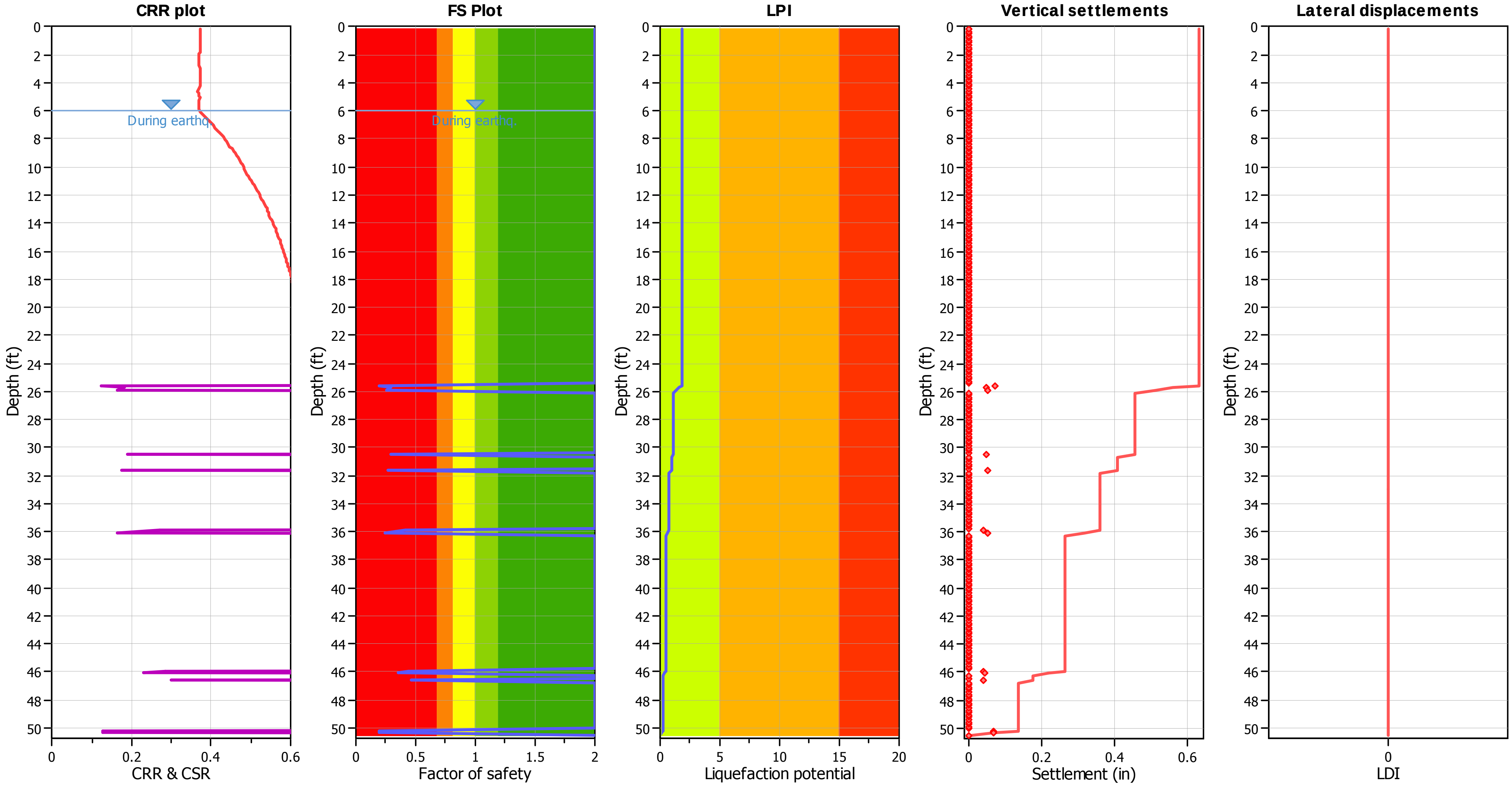
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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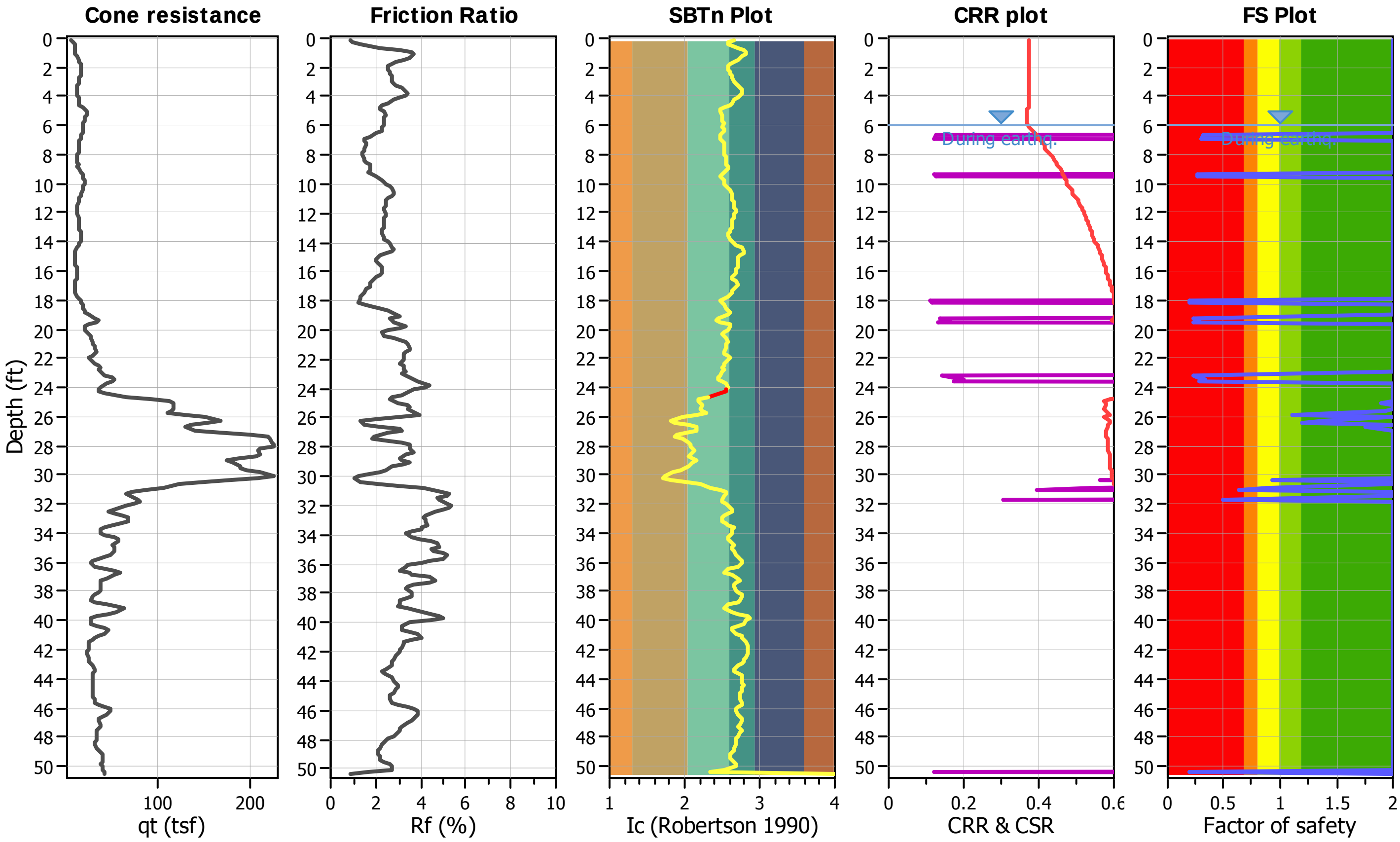
LIQUEFACTION ANALYSIS REPORT

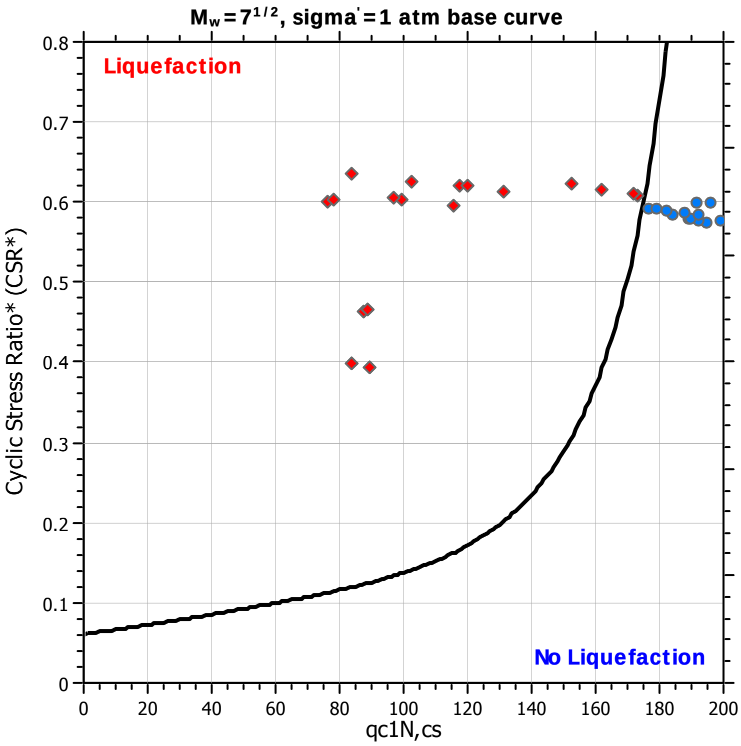
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

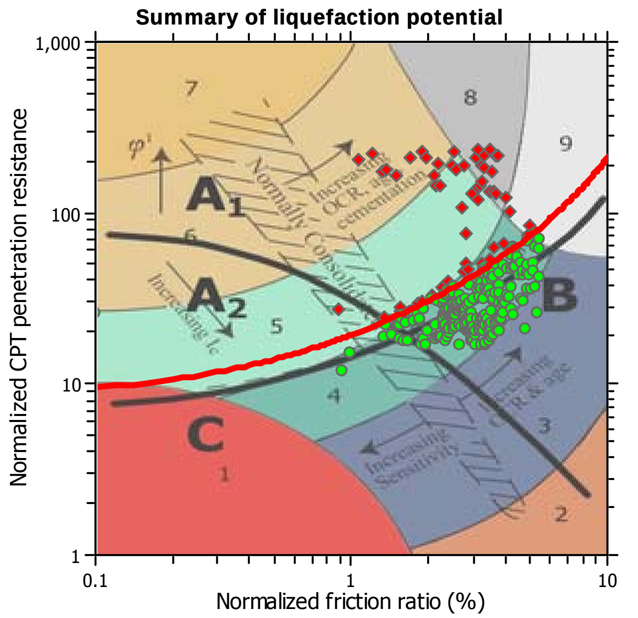
CPT file : 2-CPT9

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

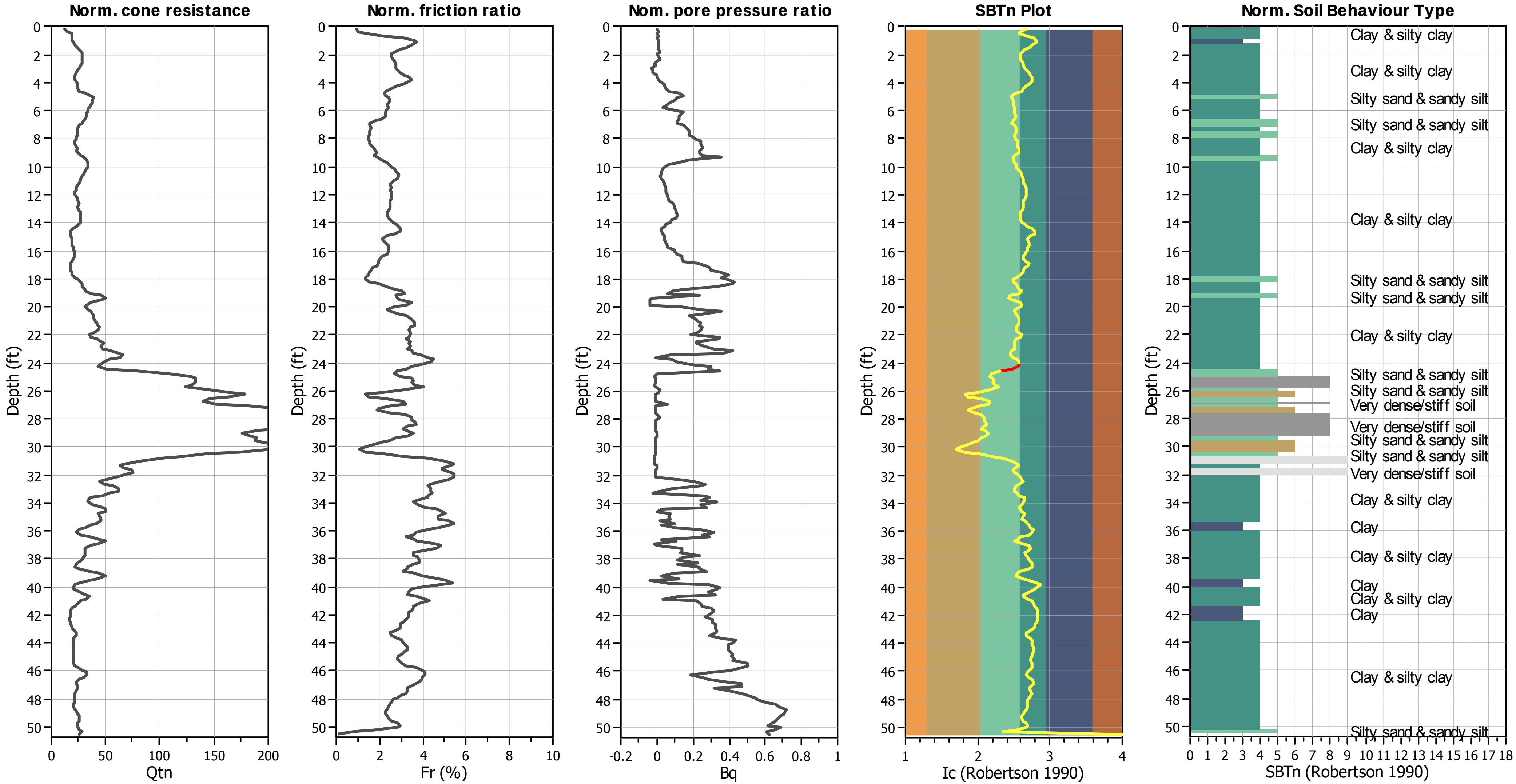






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



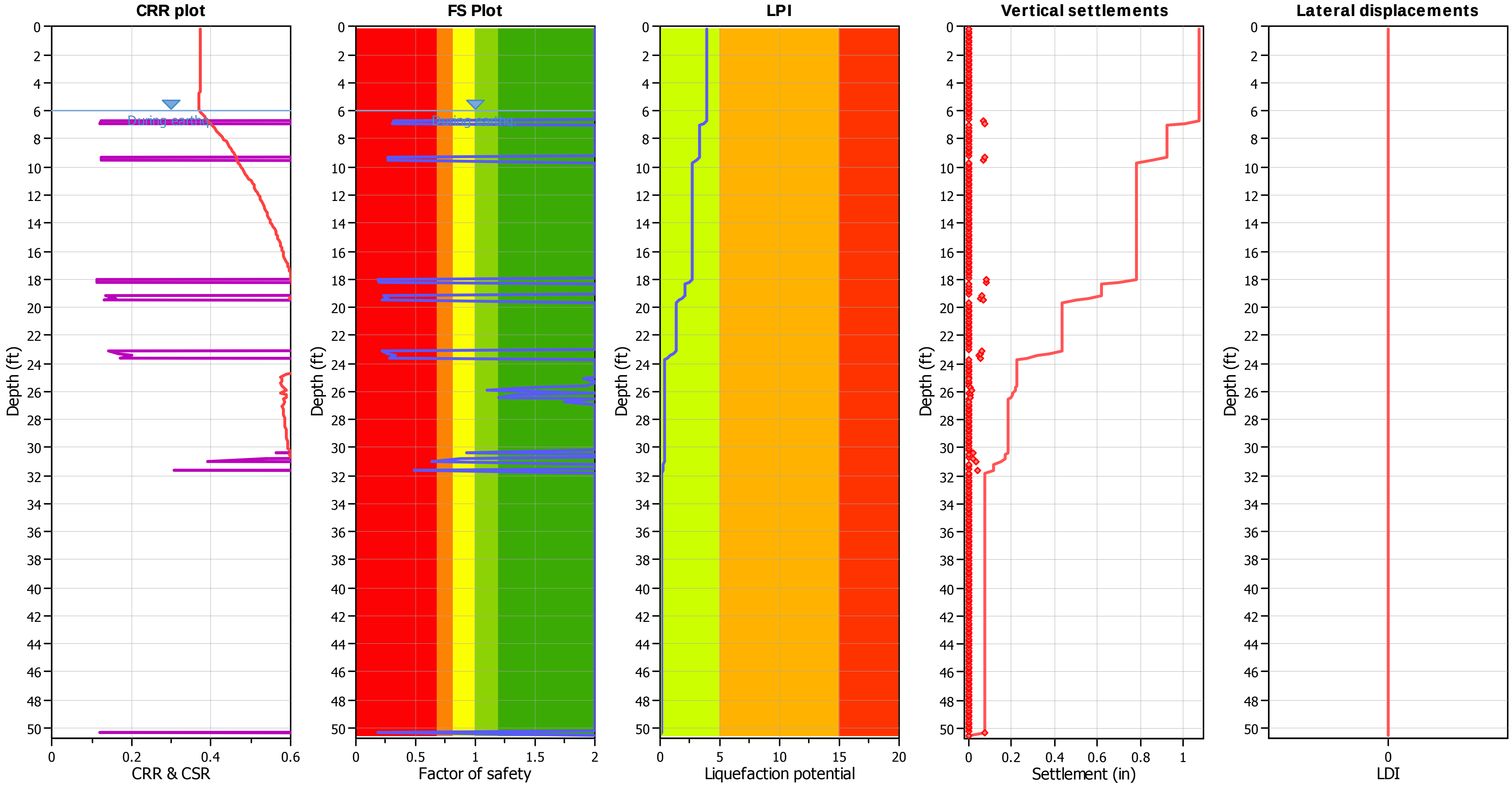
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

LIQUEFACTION ANALYSIS REPORT

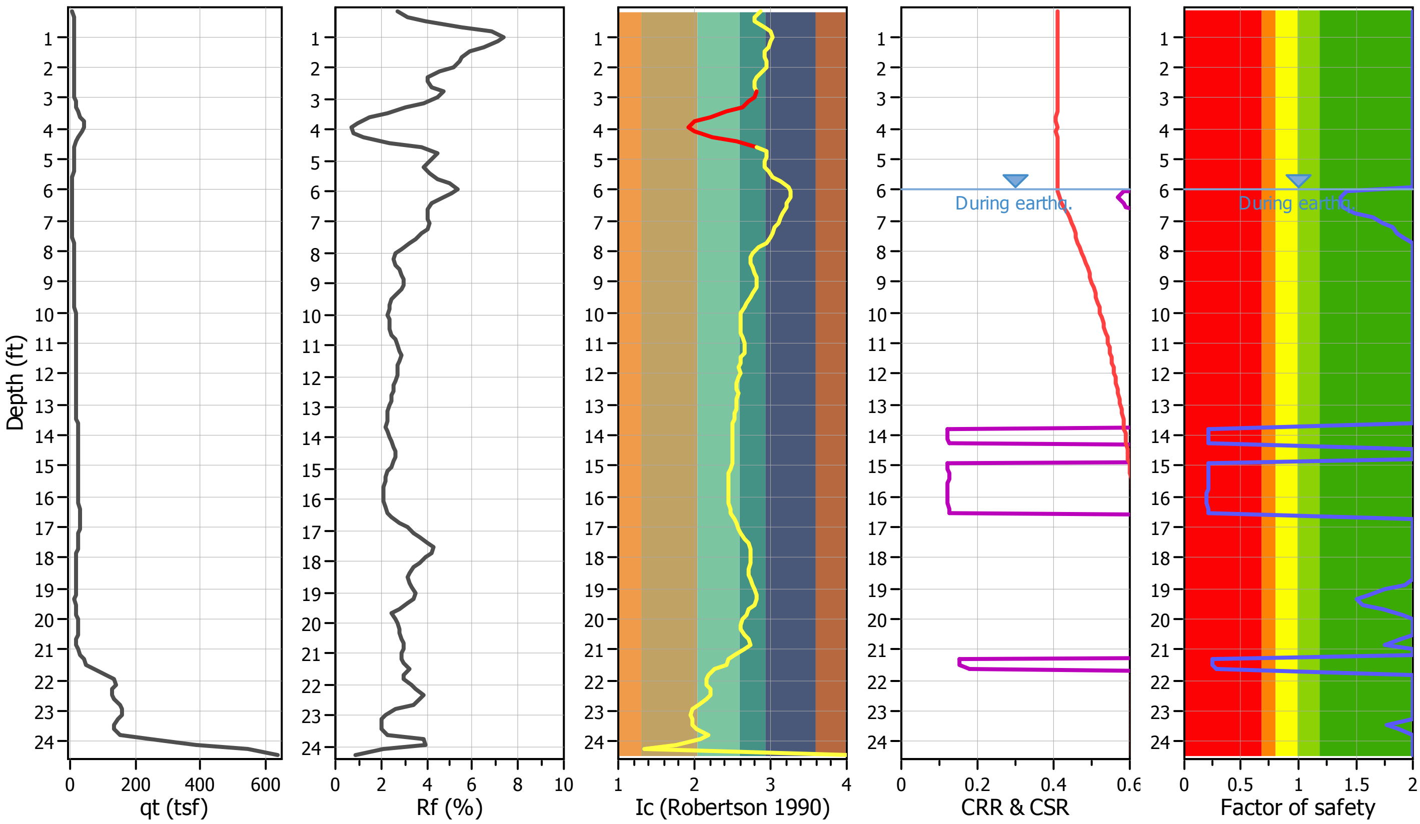
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

CPT file : 2-CPT1

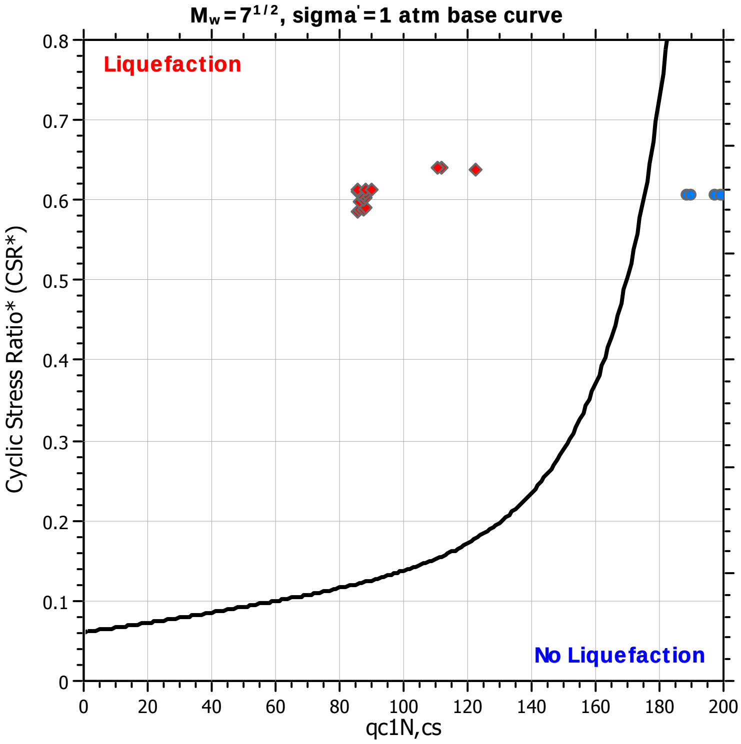
Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

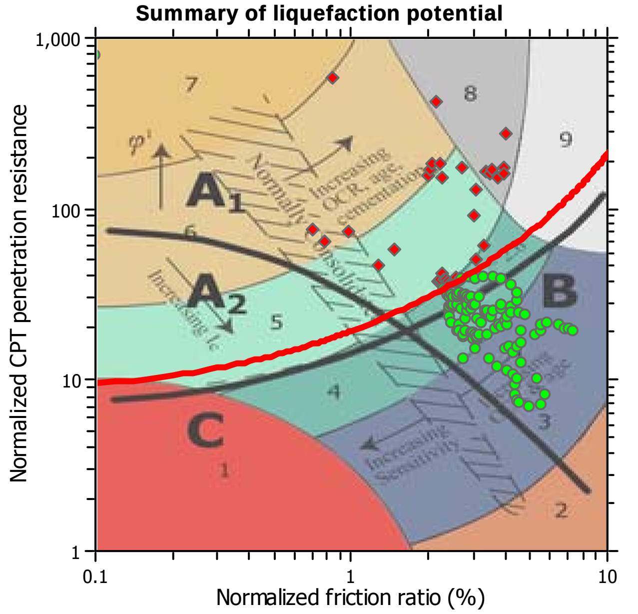
Cone resistance **Friction Ratio** **SBTn Plot** **CRR plot** **FS Plot**



$M_w=7^{1/2}$, sigma'=1 atm base curve

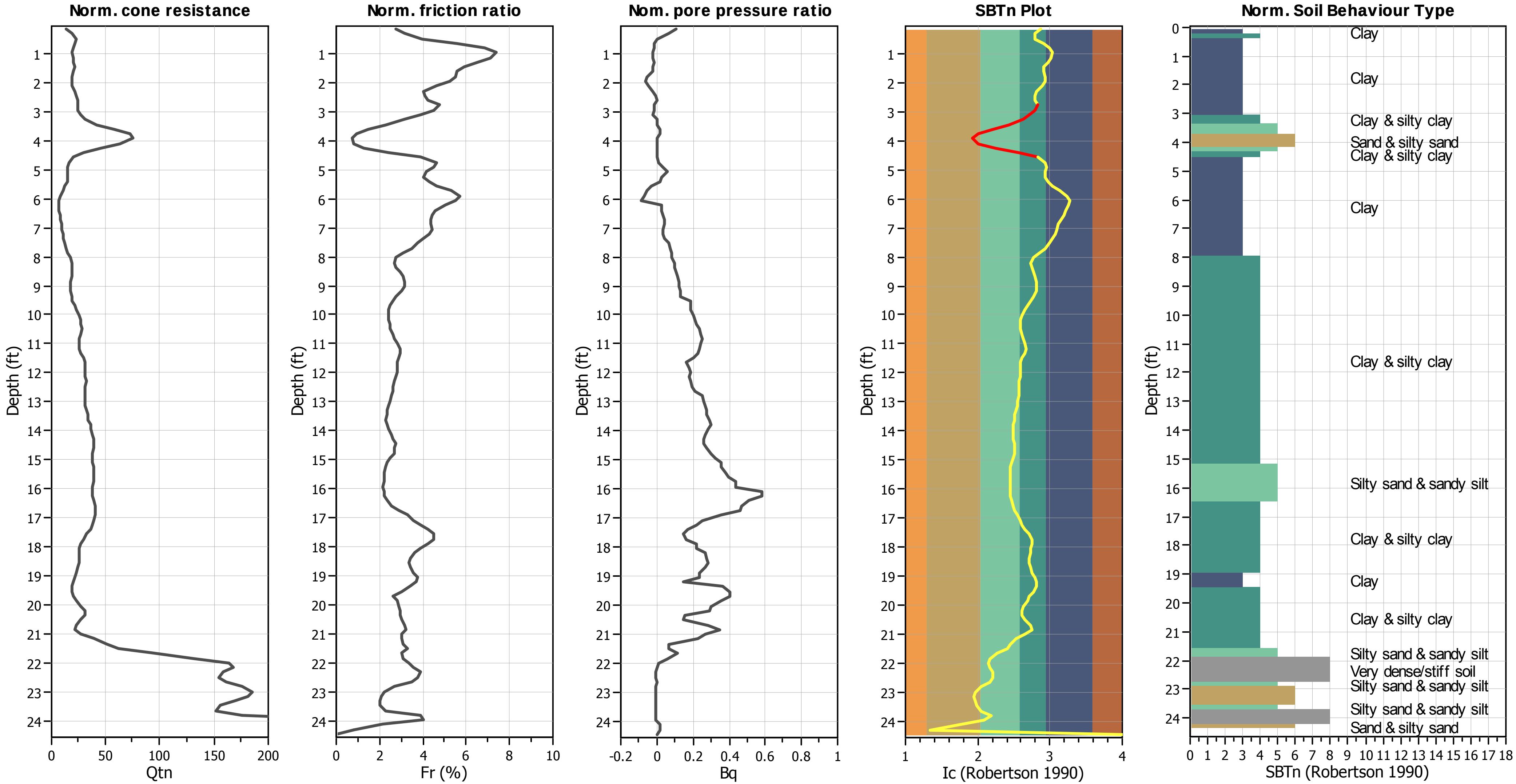


Summary of liquefaction potential



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 (normalized)



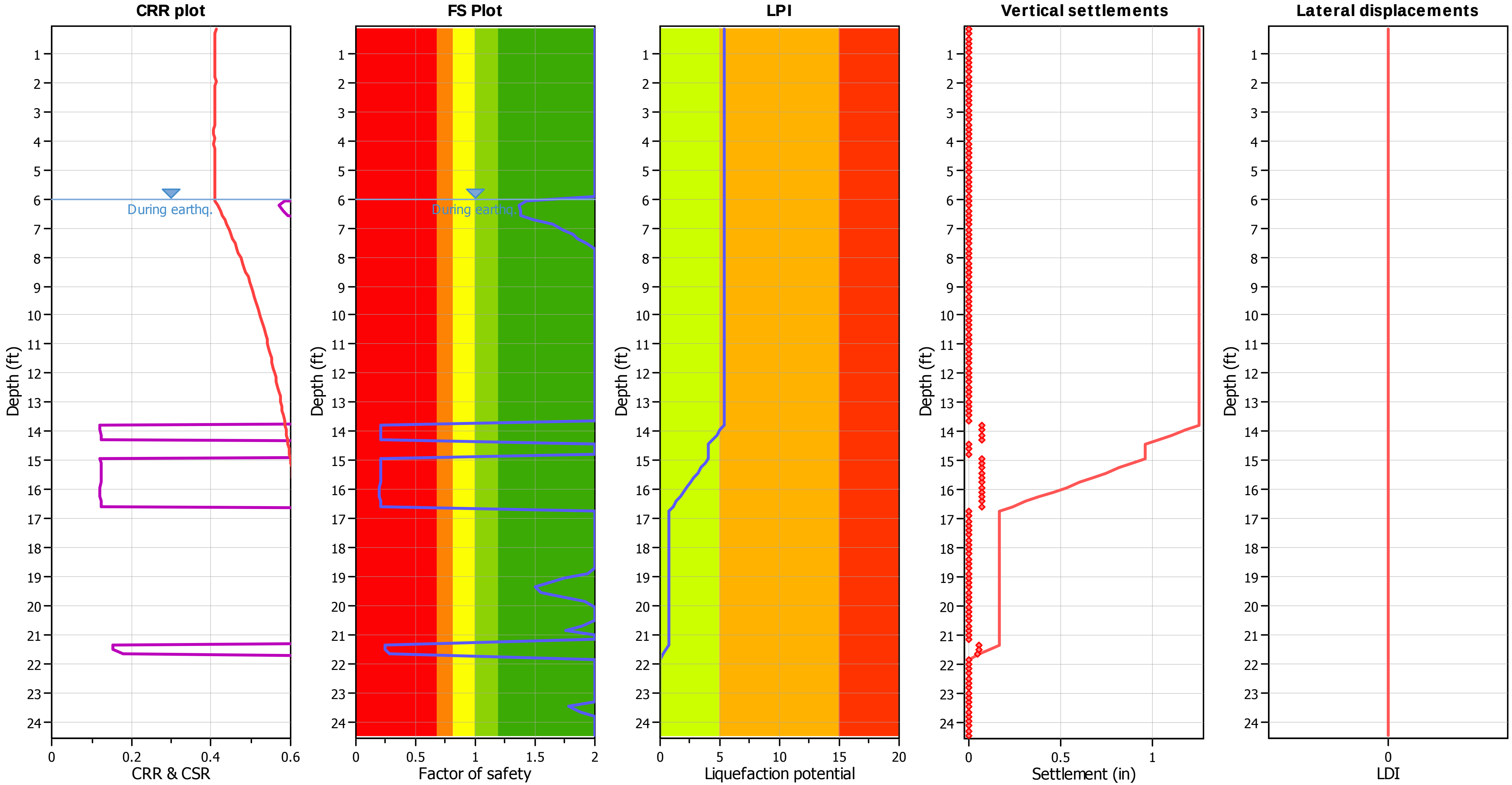
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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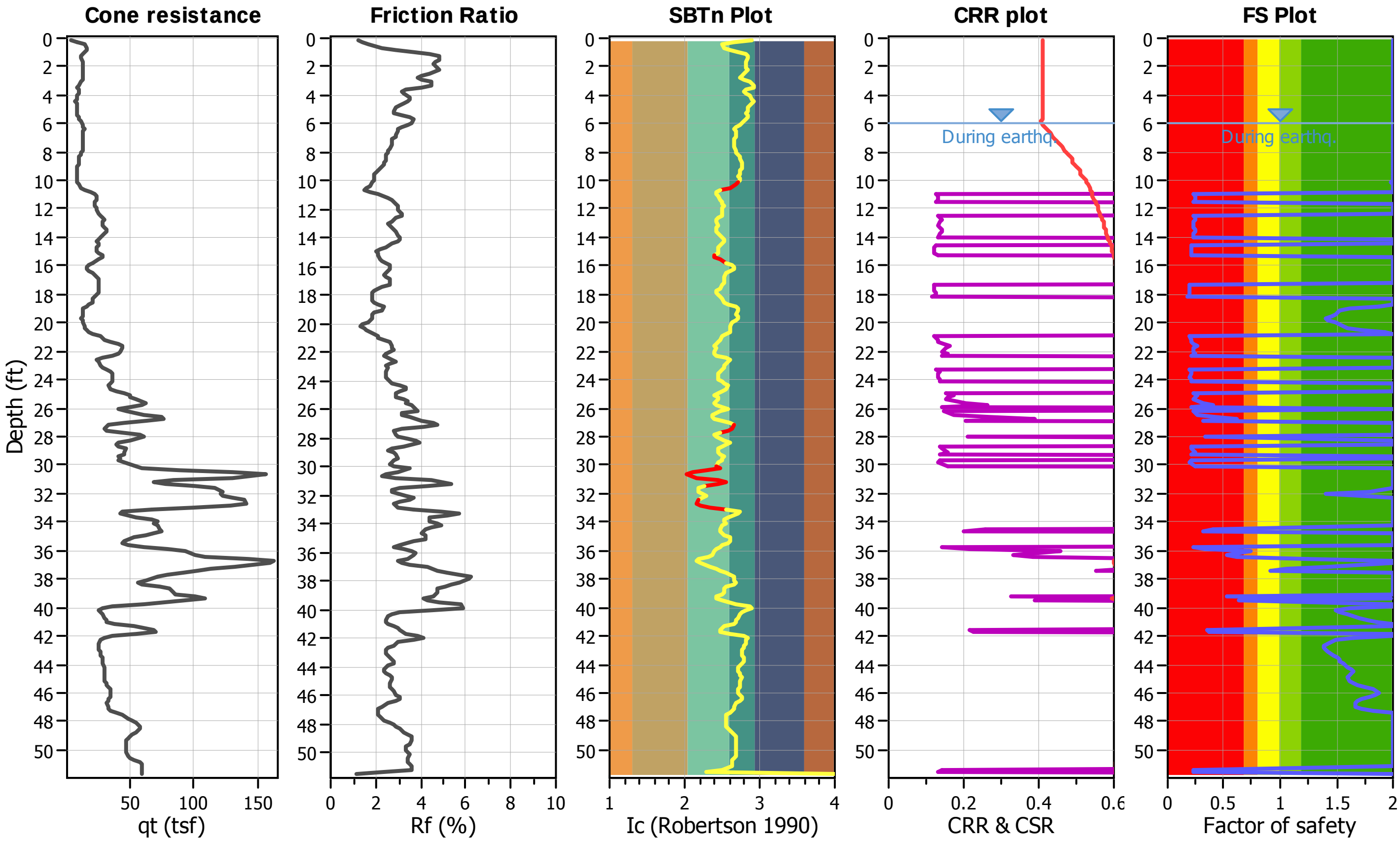
LIQUEFACTION ANALYSIS REPORT

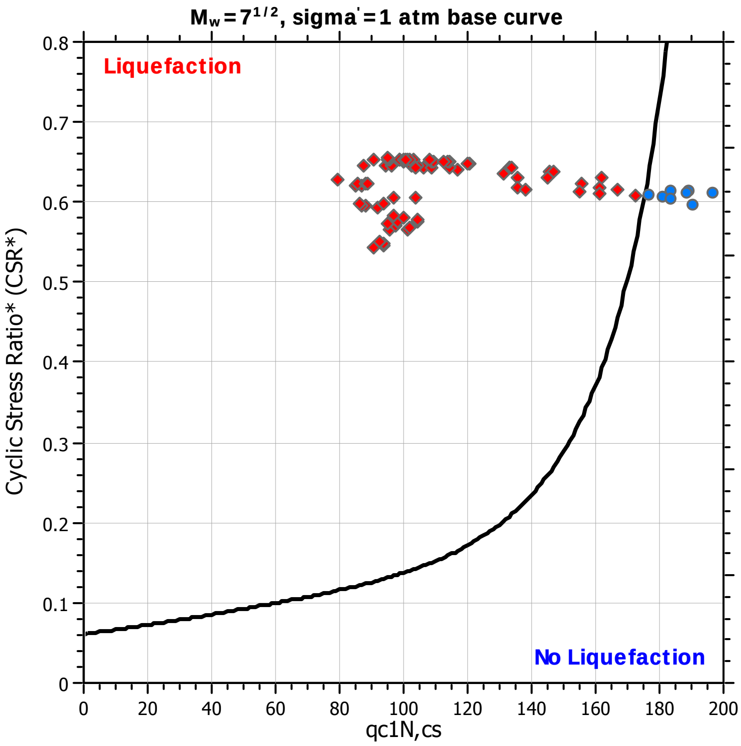
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

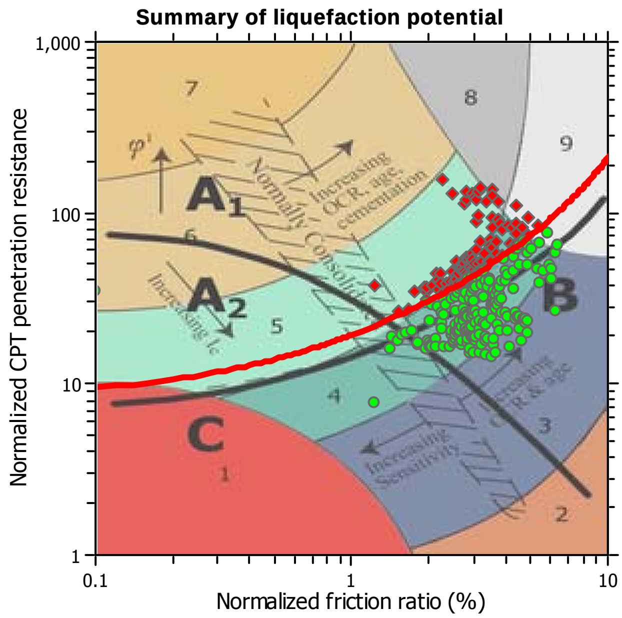
CPT file : 2-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

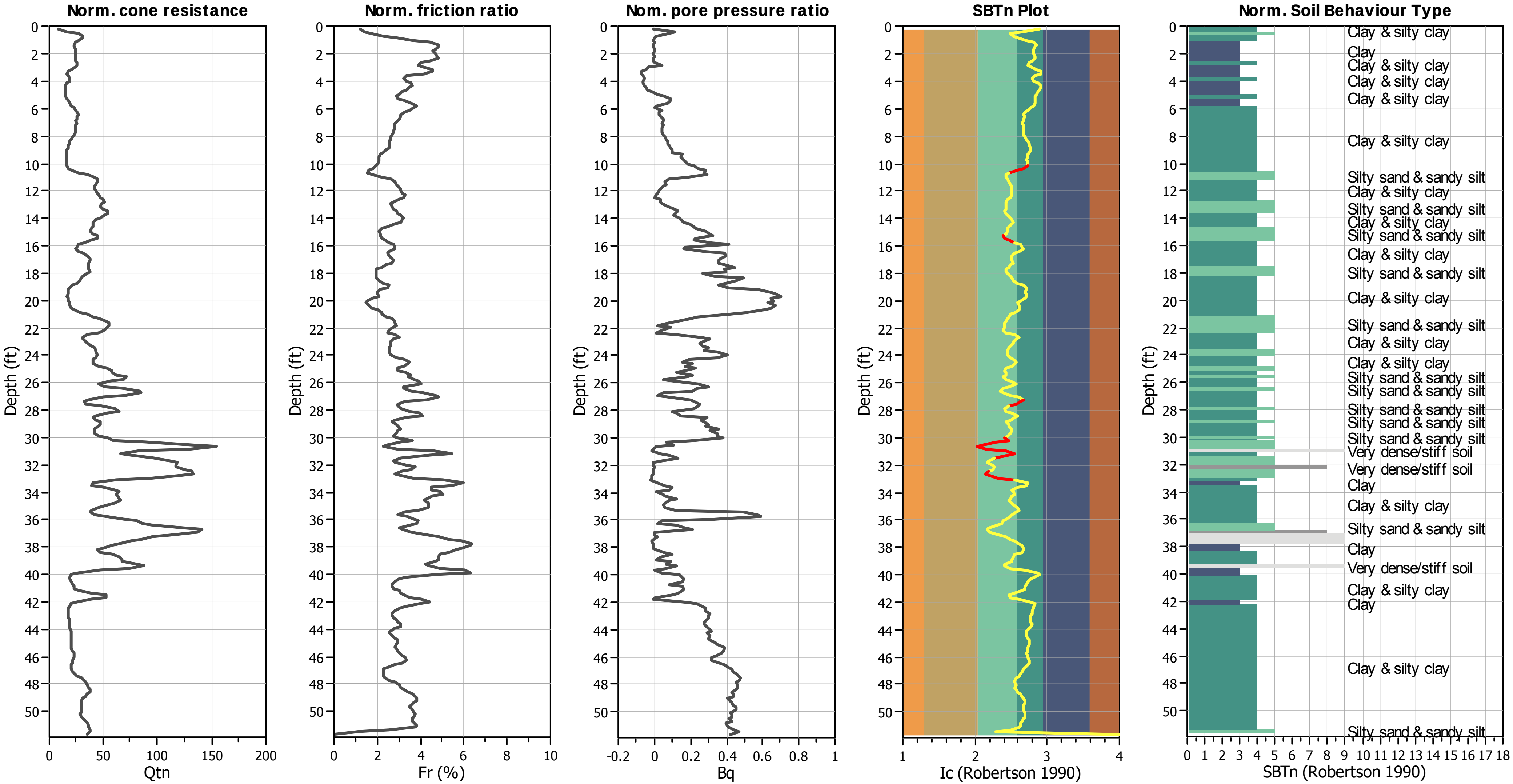






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



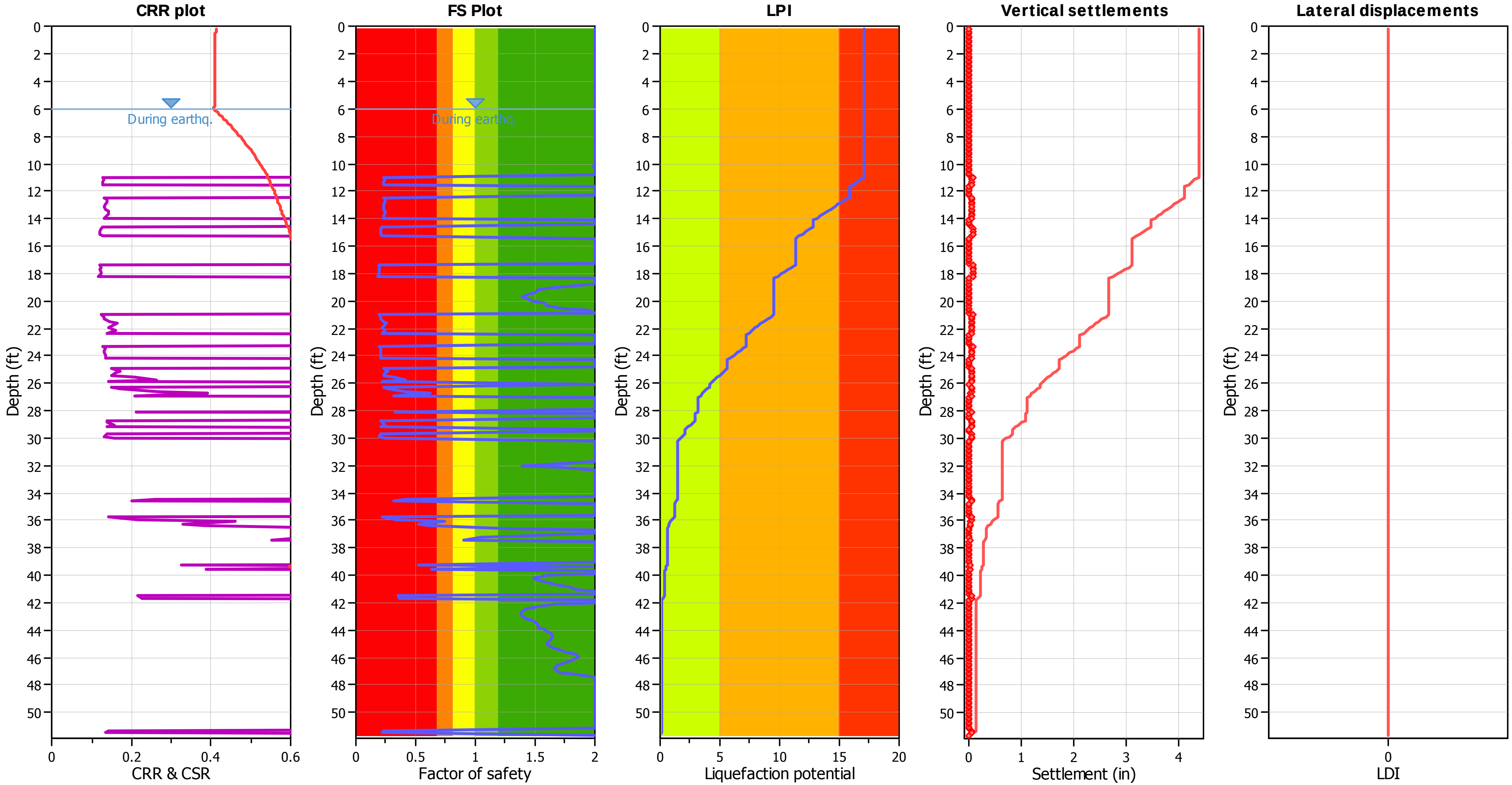
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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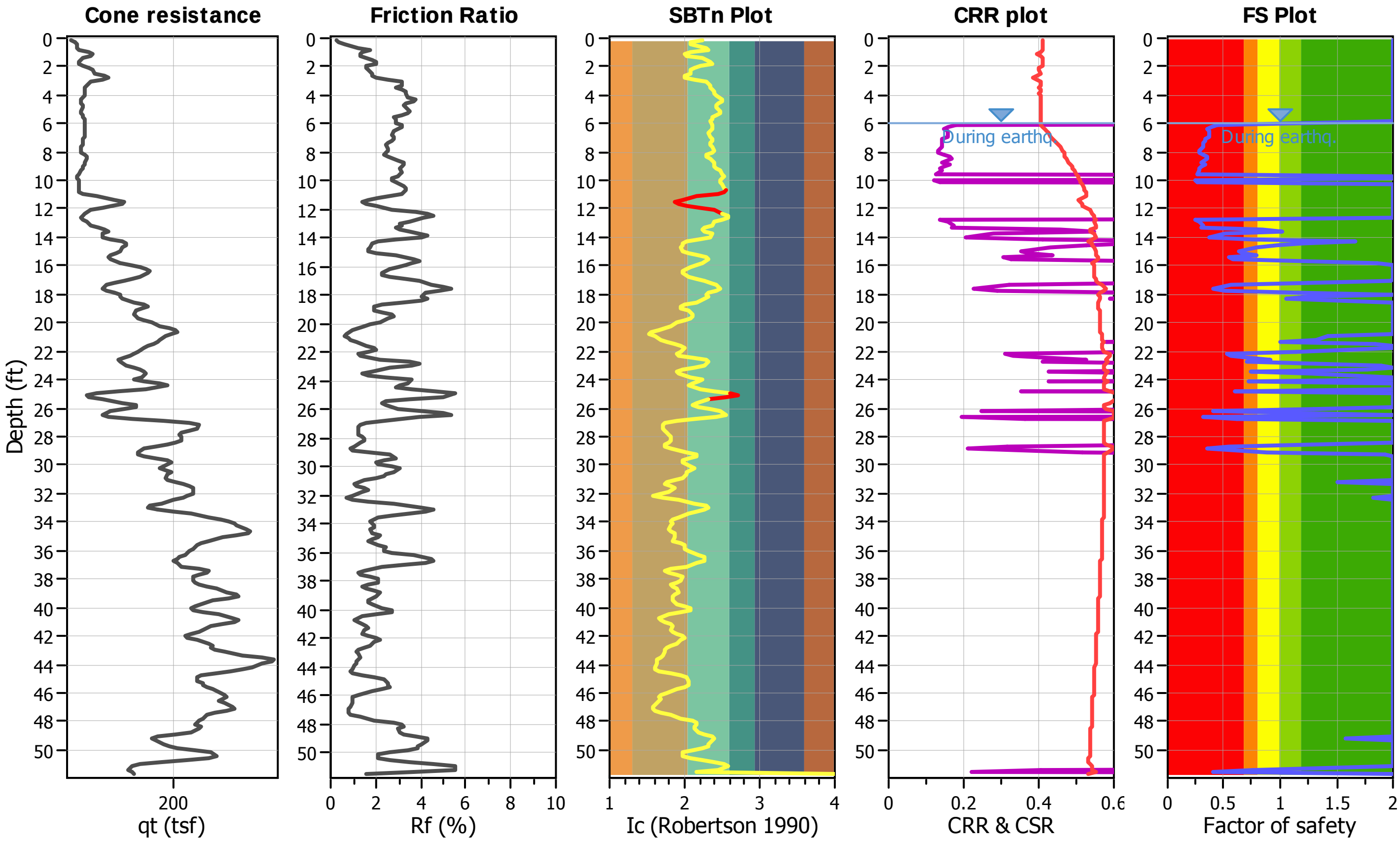
LIQUEFACTION ANALYSIS REPORT

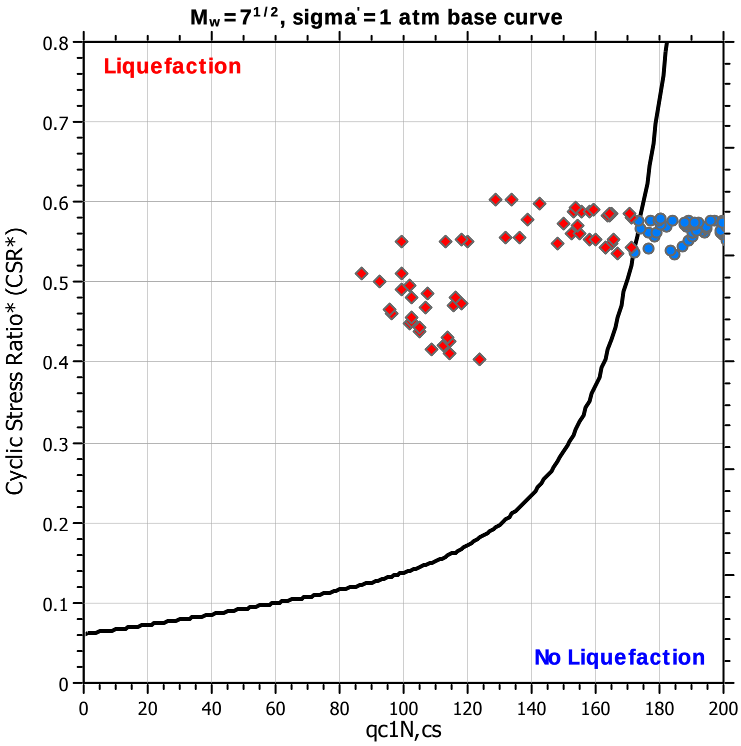
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

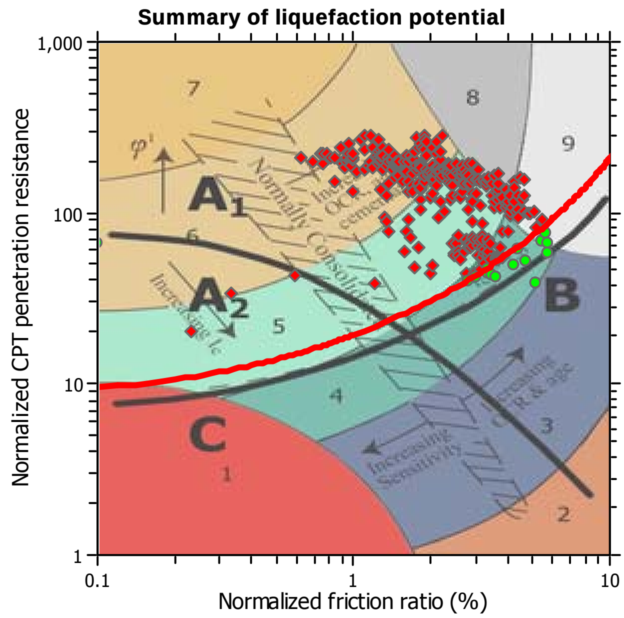
CPT file : 2-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

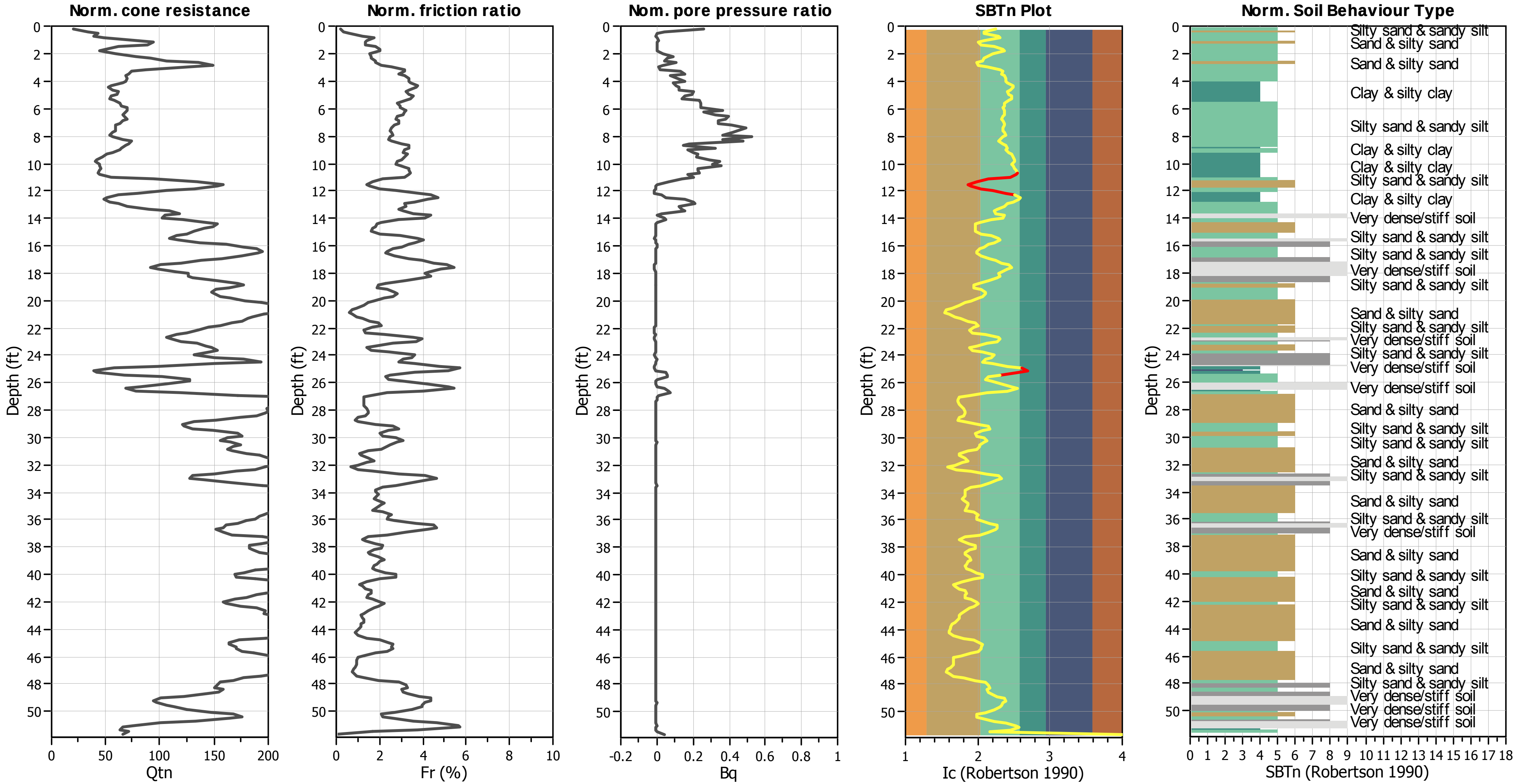






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



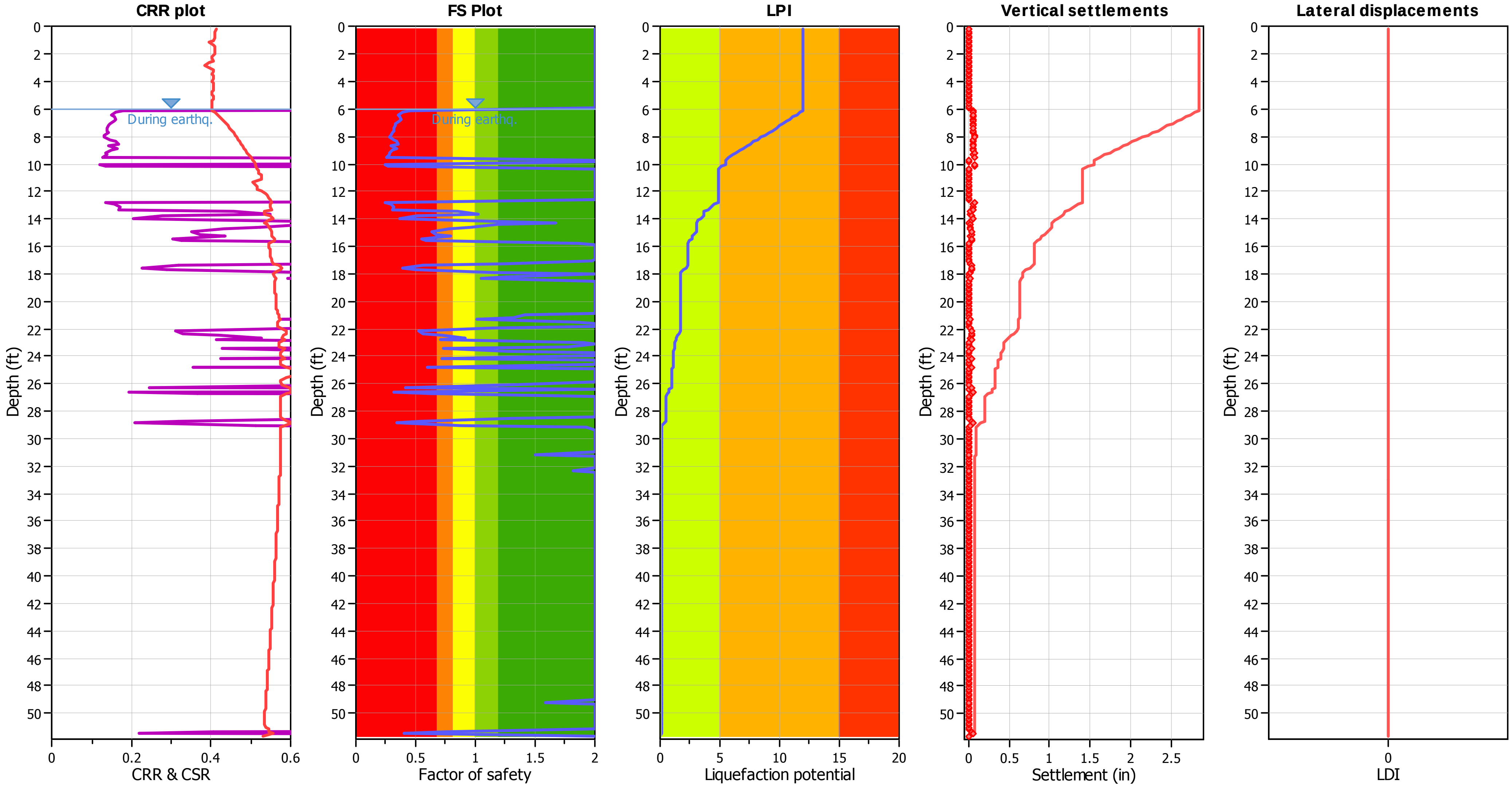
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

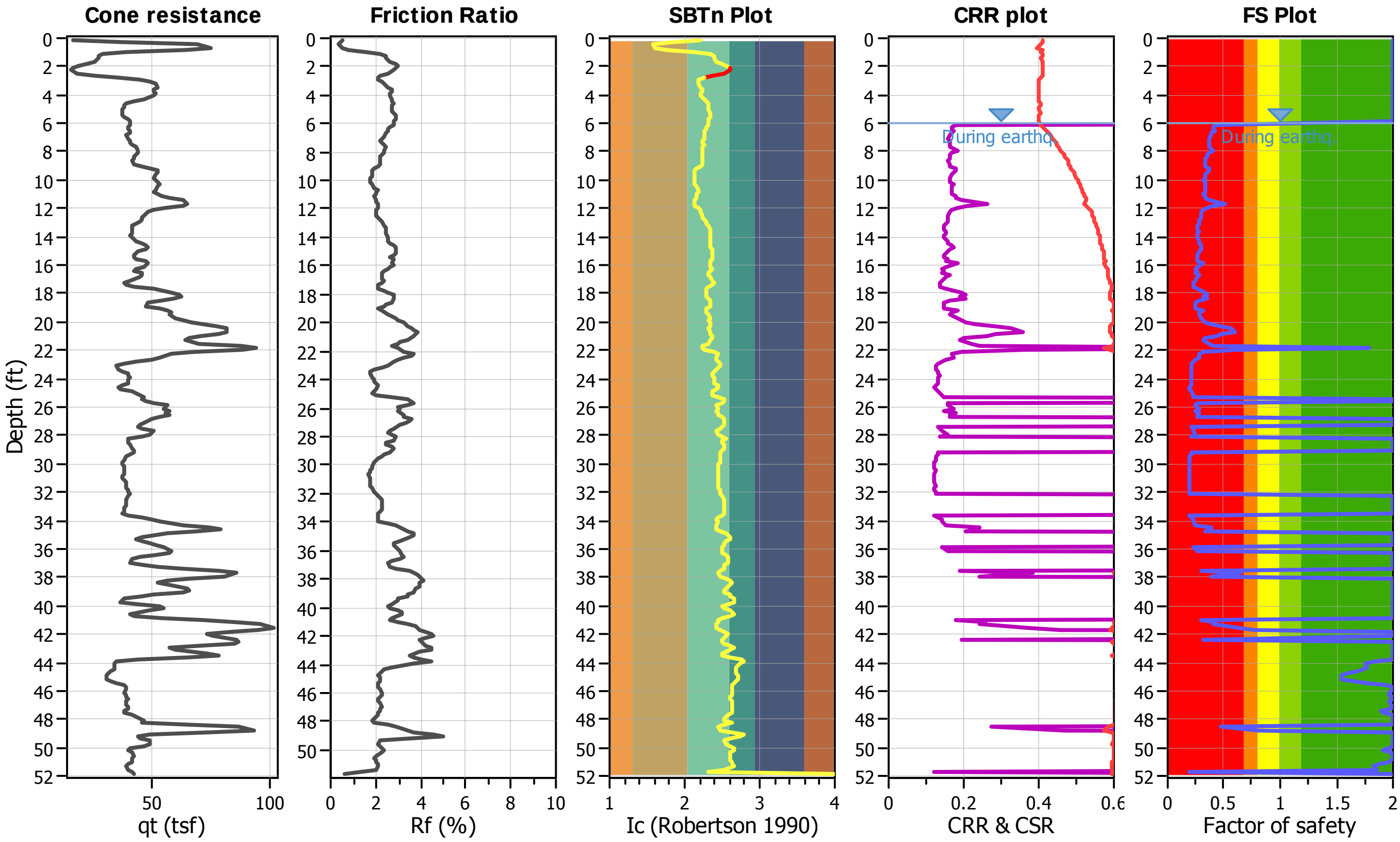
LIQUEFACTION ANALYSIS REPORT

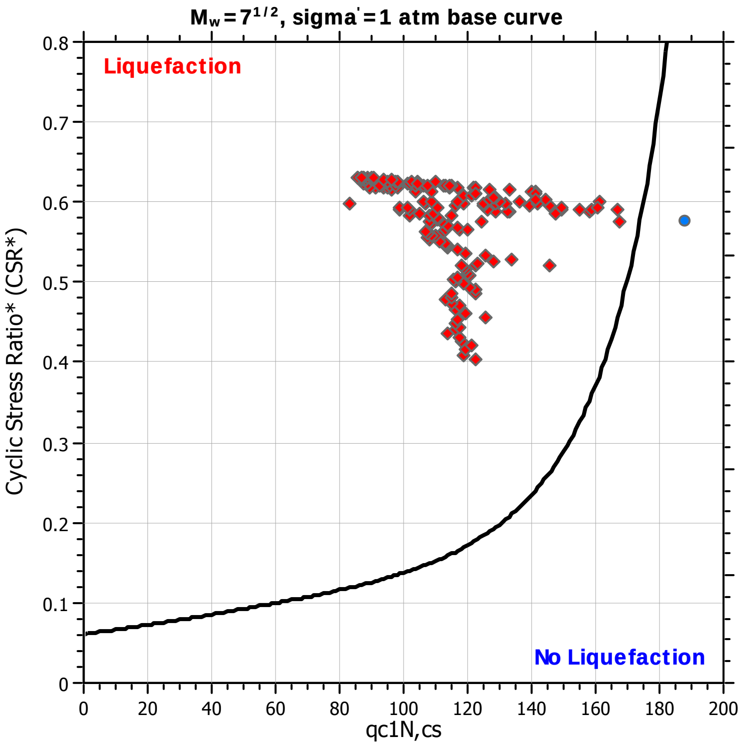
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

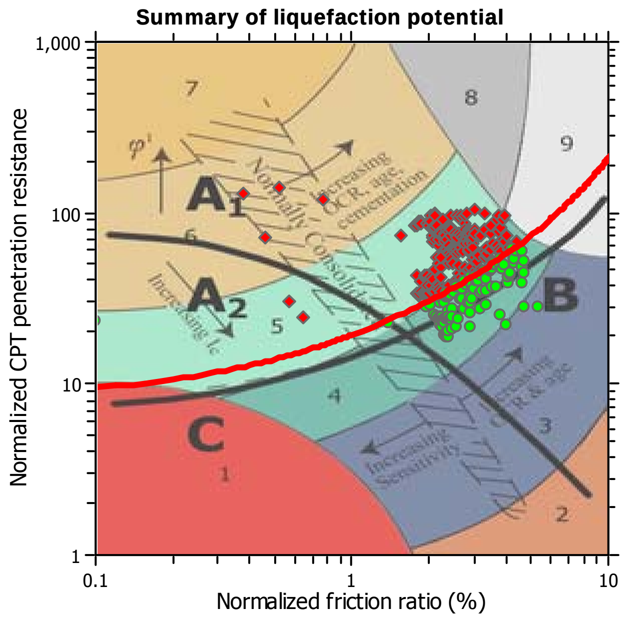
CPT file : 2-CPT5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

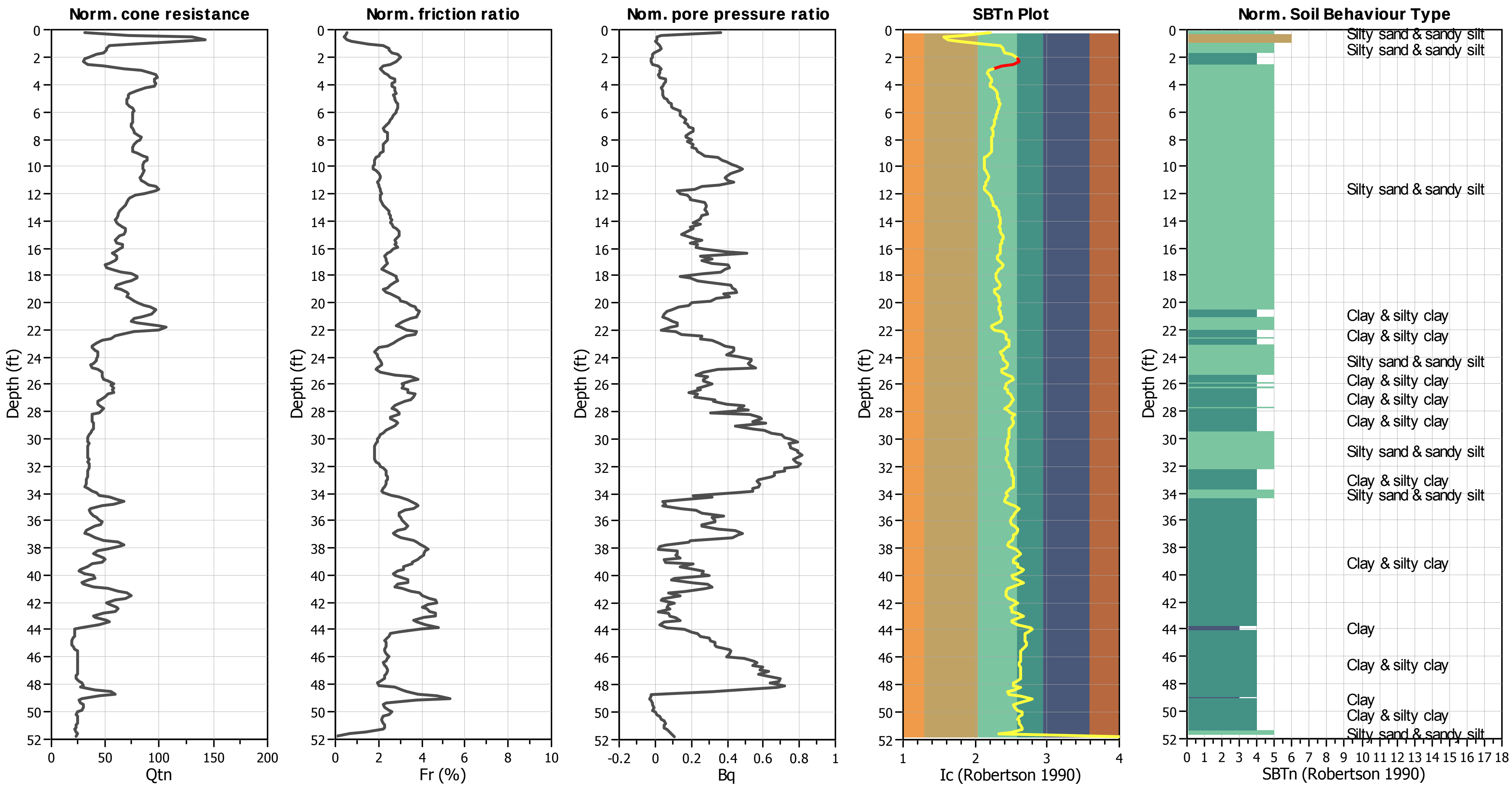






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



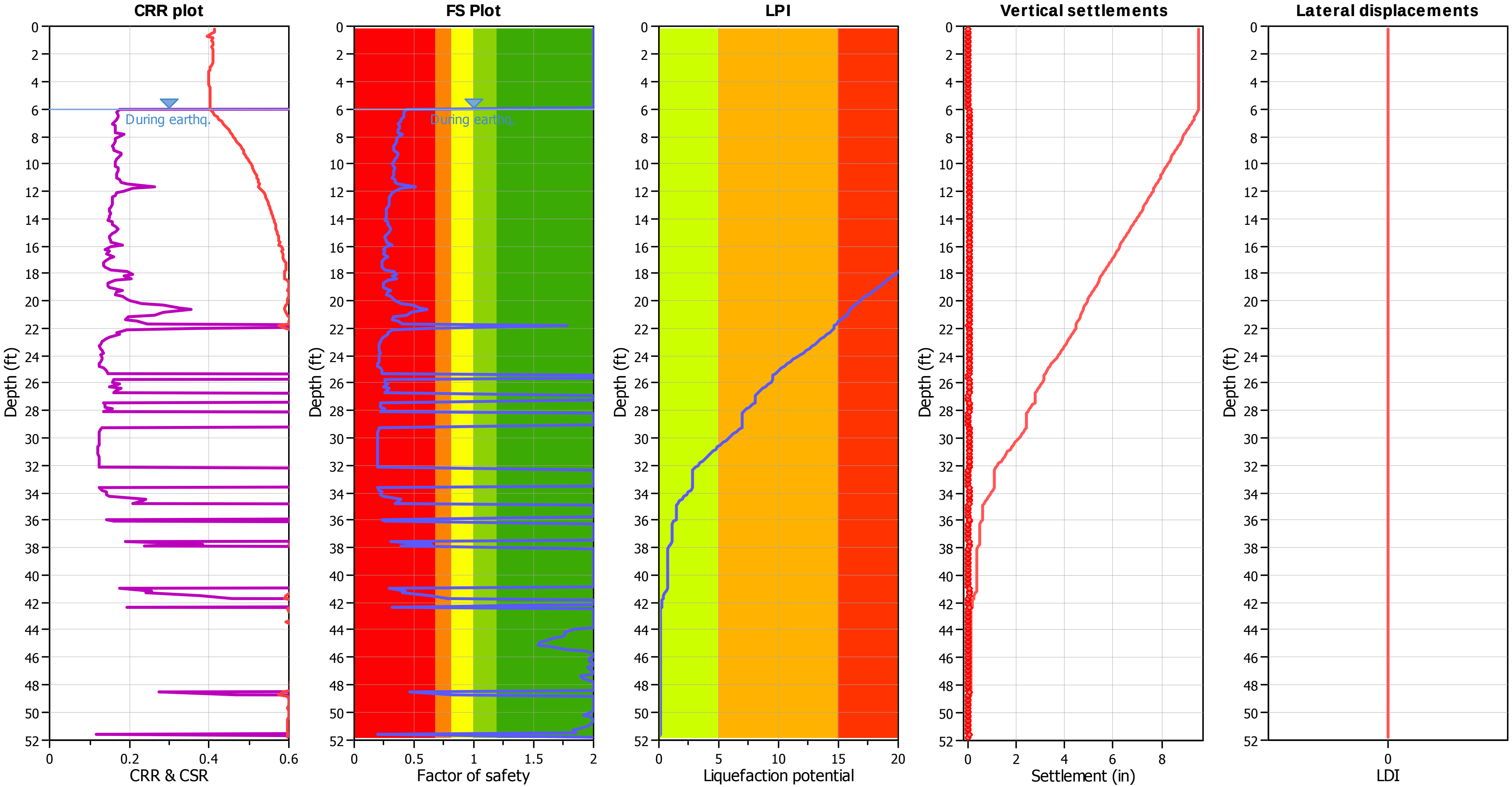
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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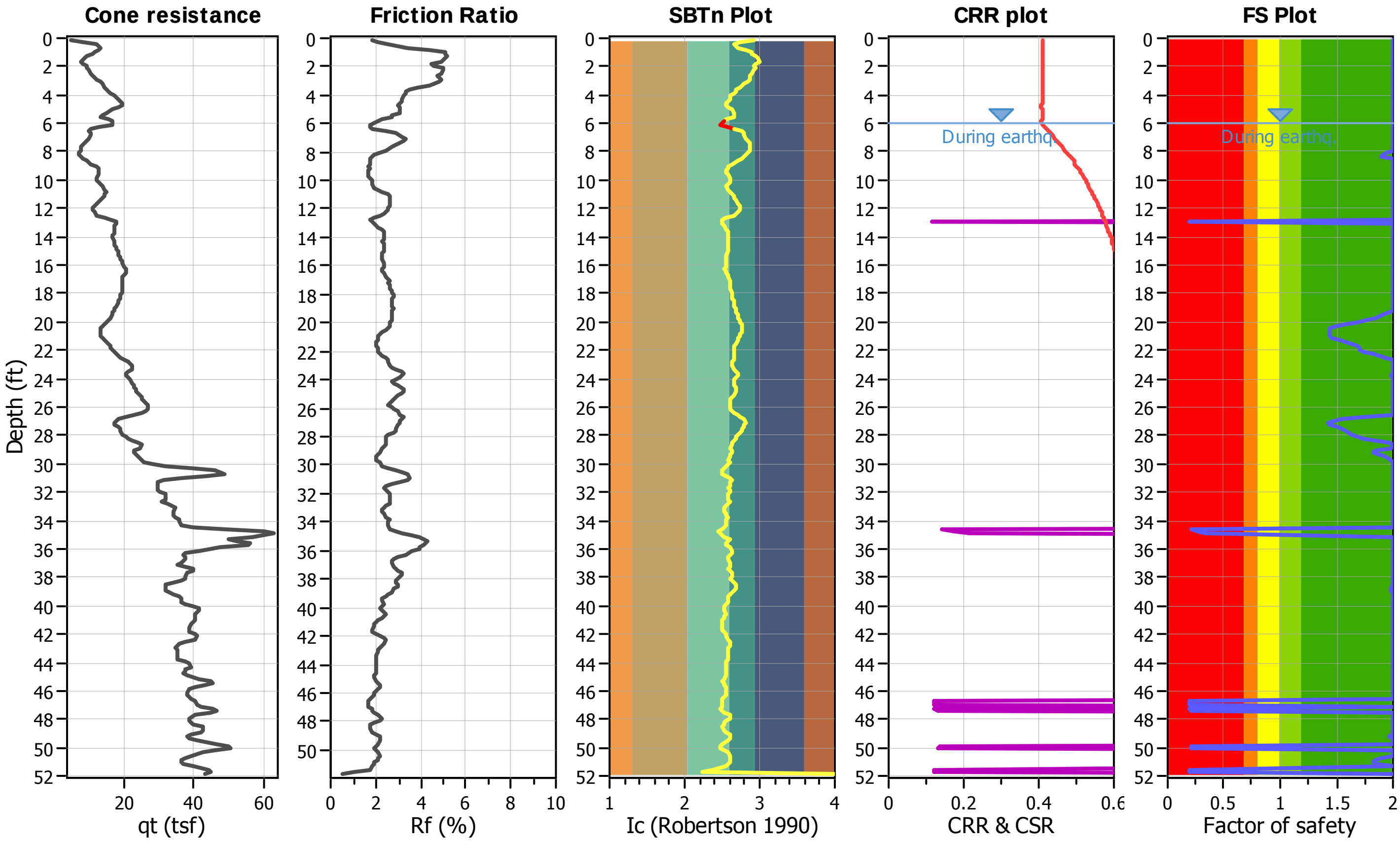
LIQUEFACTION ANALYSIS REPORT

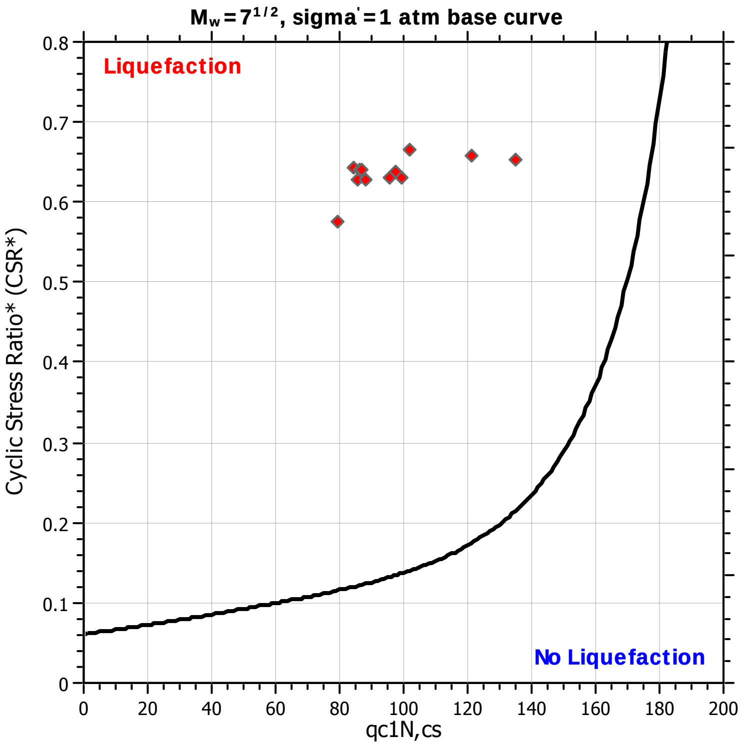
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

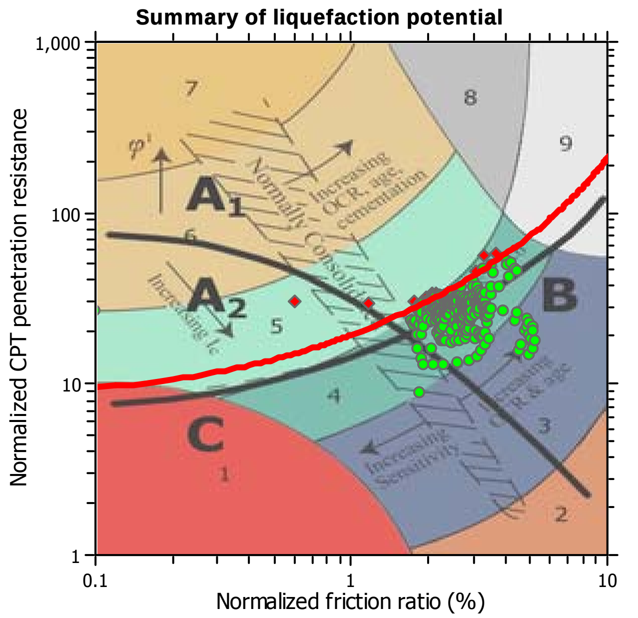
CPT file : 2-CPT6

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

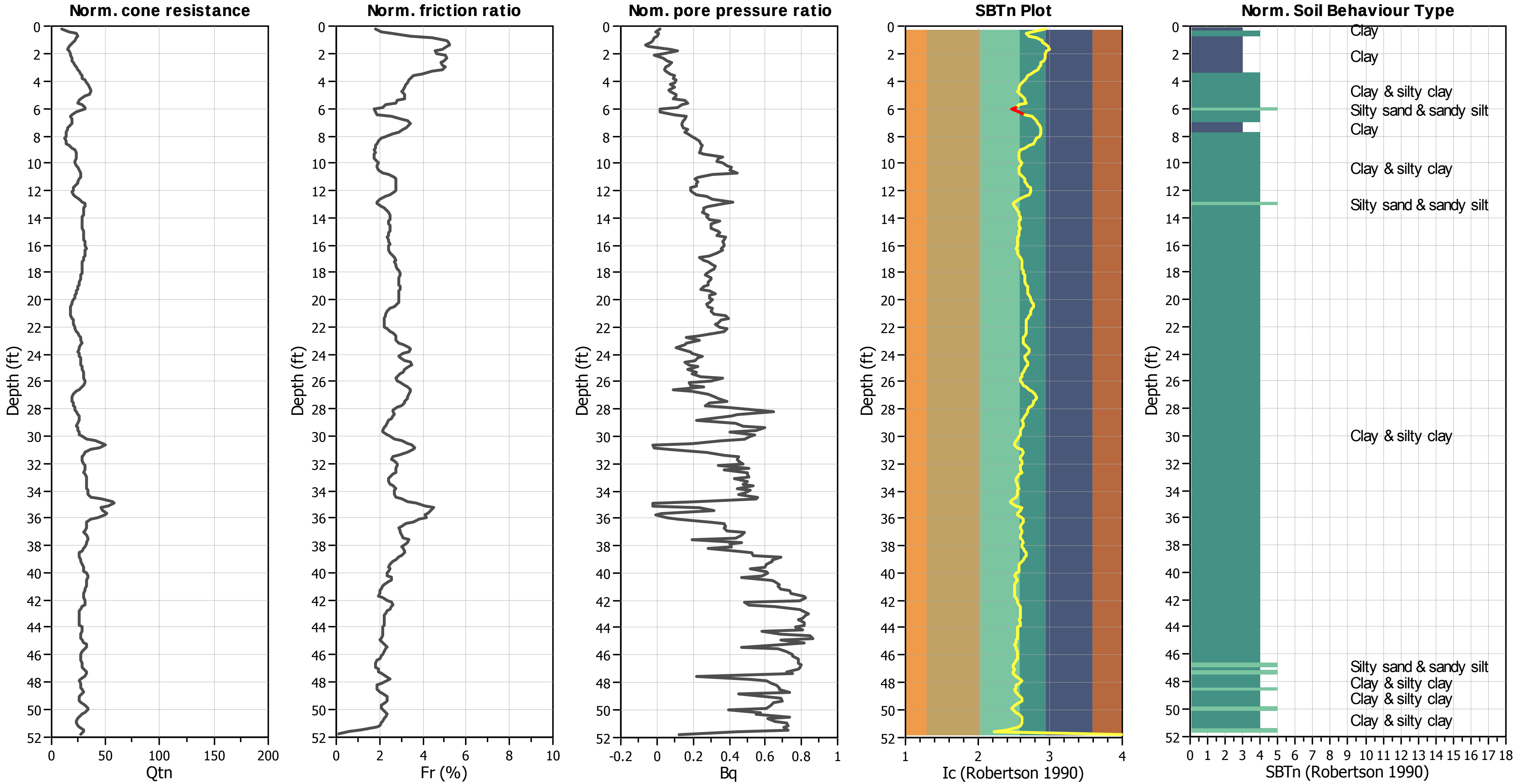






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



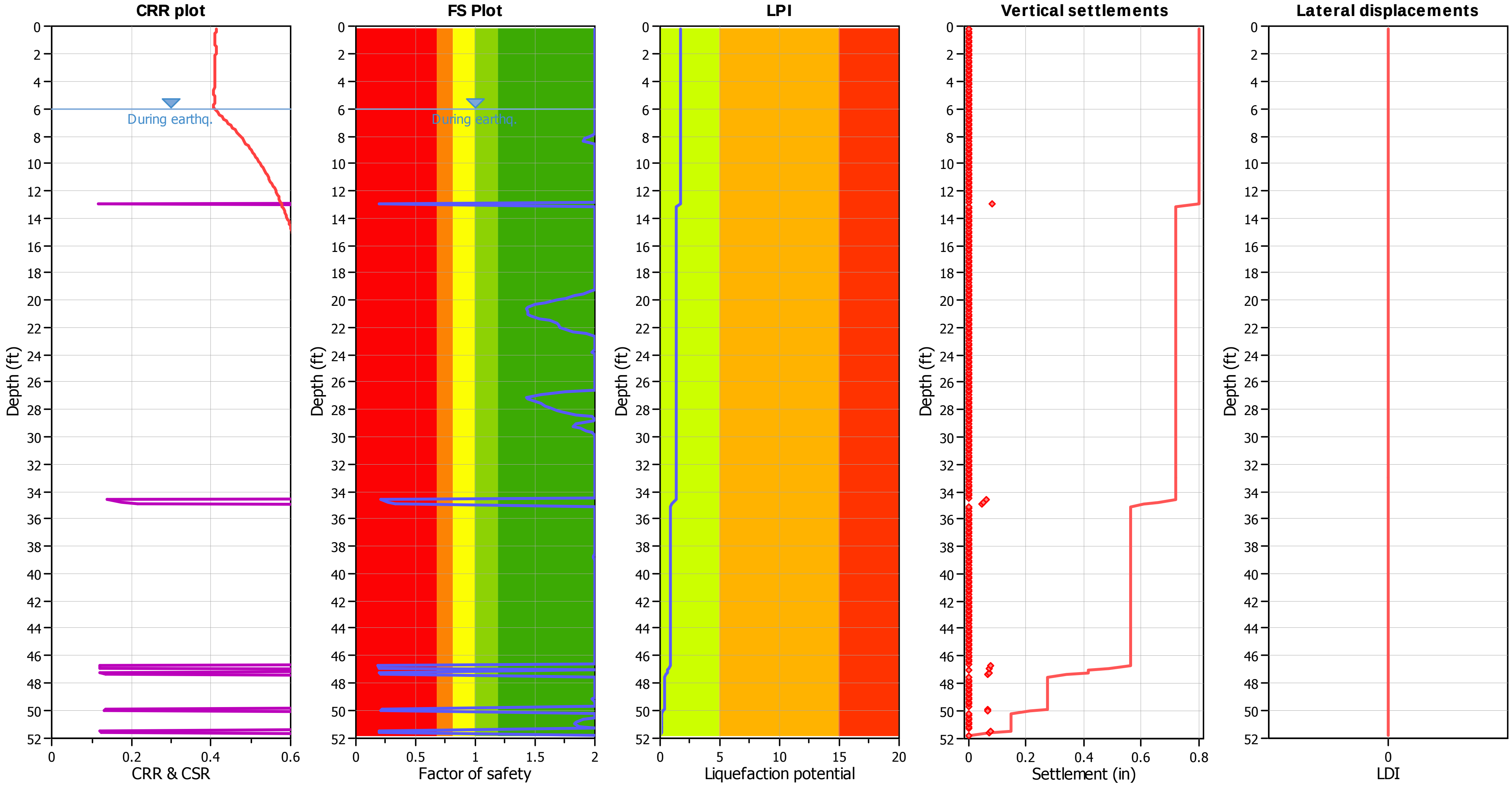
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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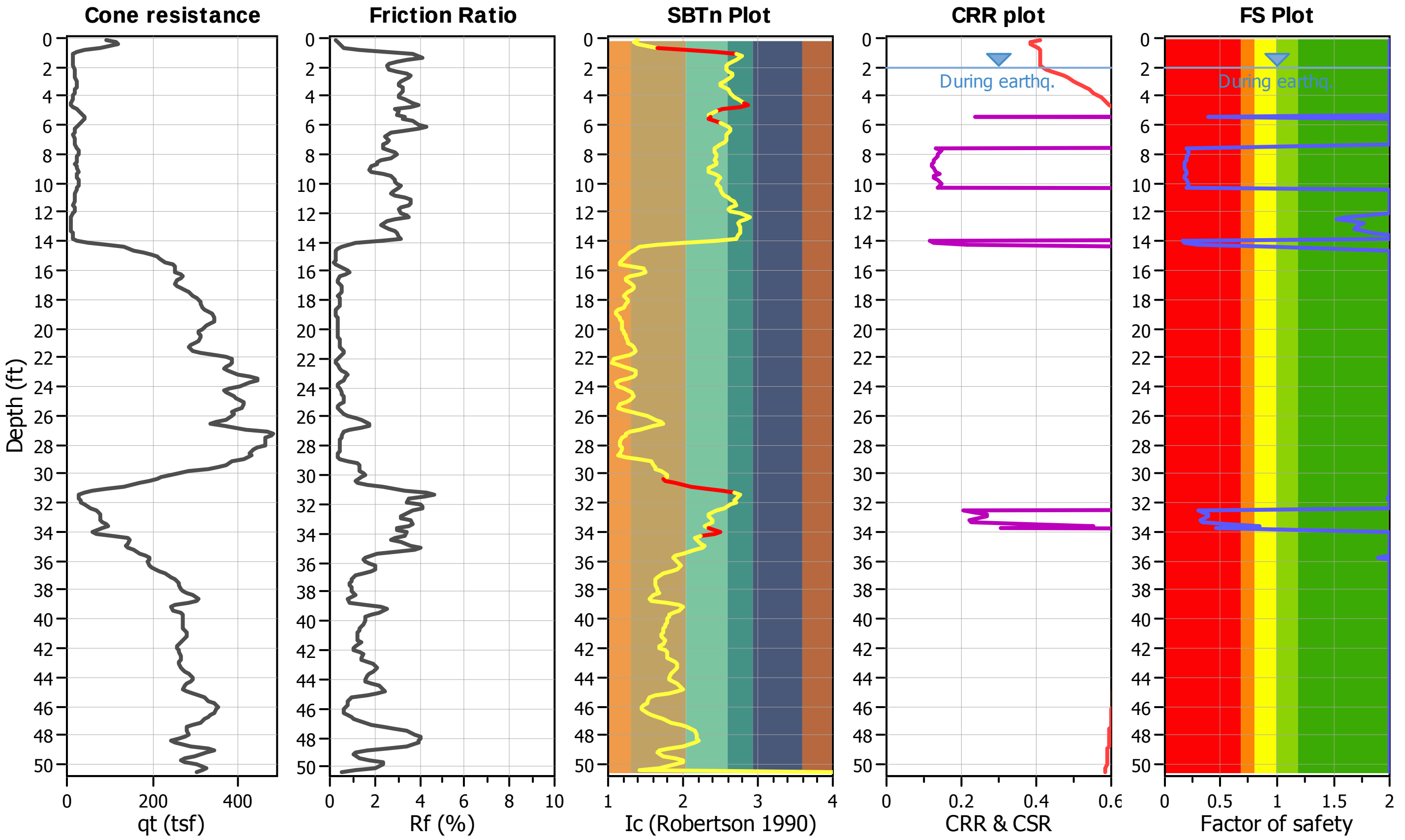
LIQUEFACTION ANALYSIS REPORT

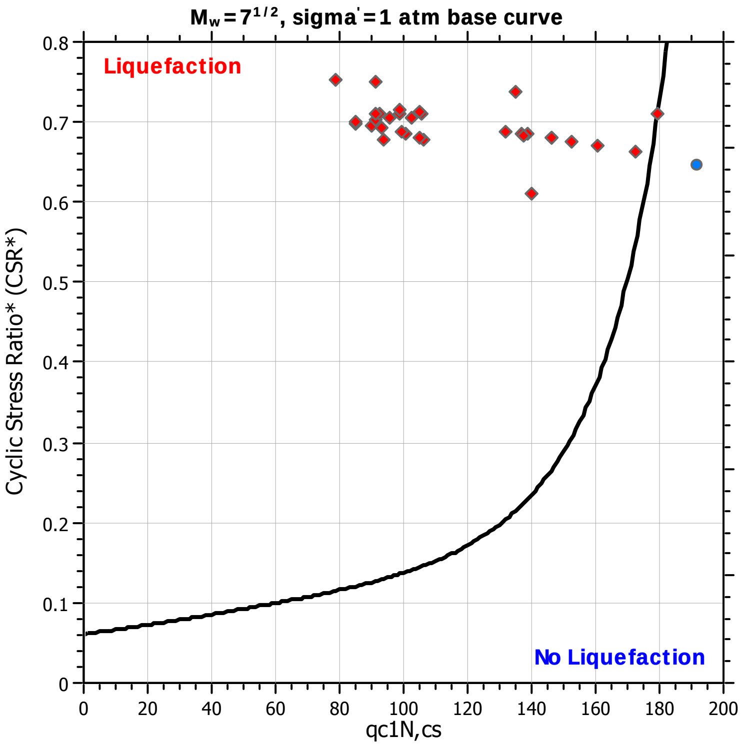
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

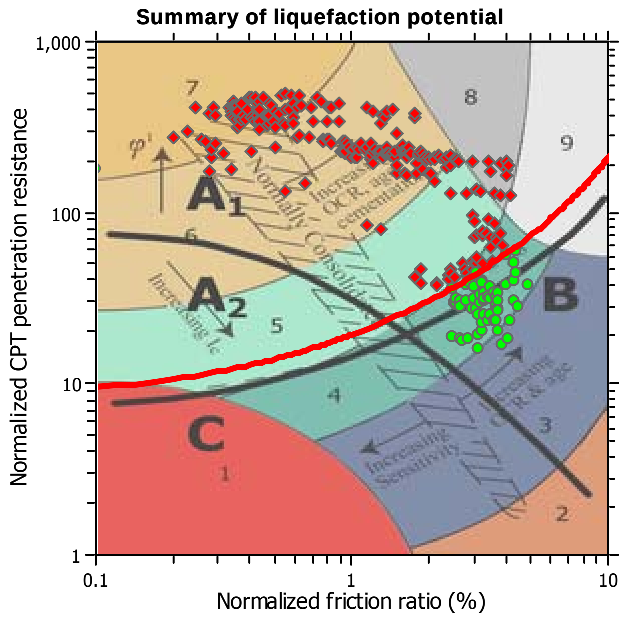
CPT file : 2-CPT7

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

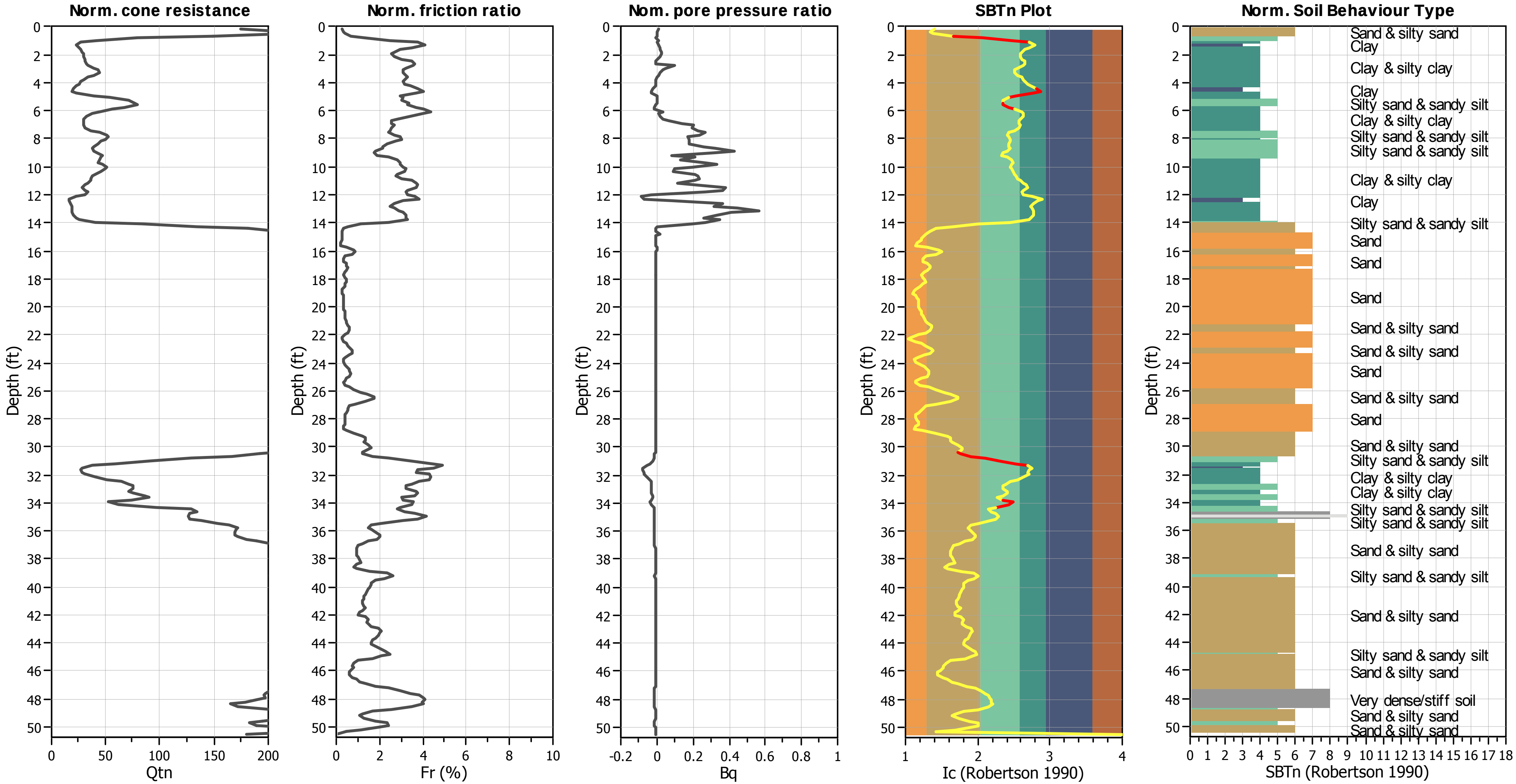






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



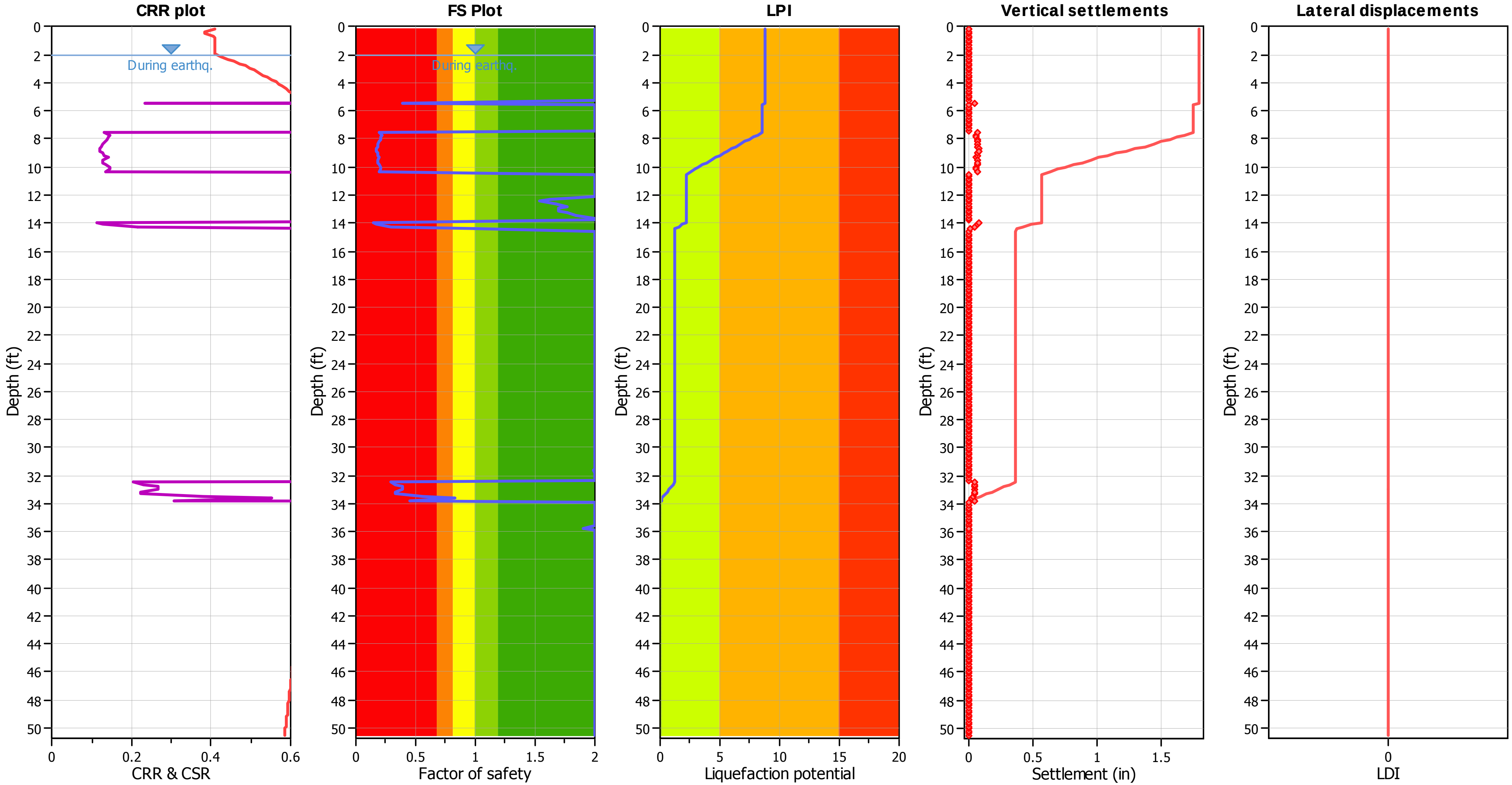
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.00 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

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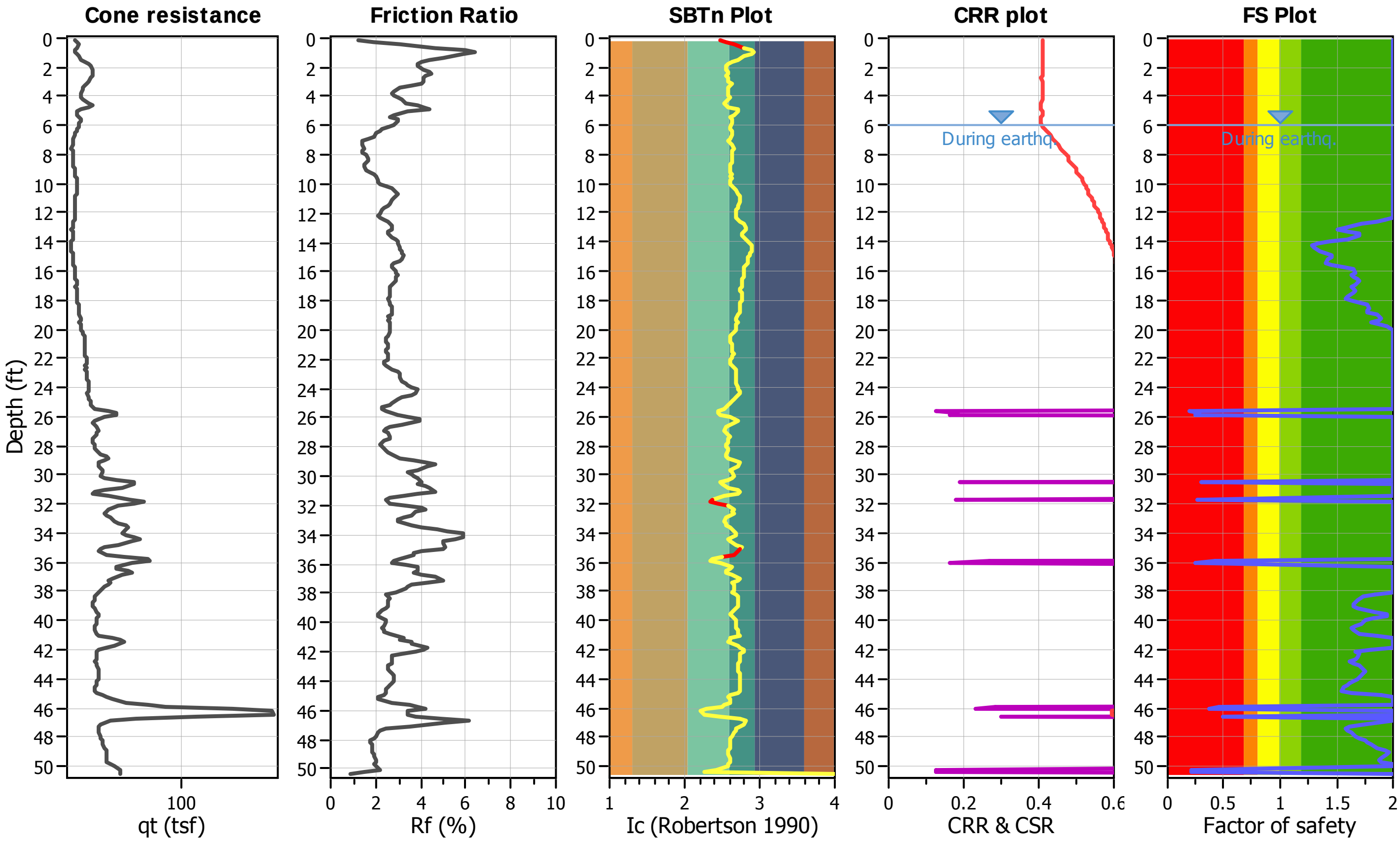
LIQUEFACTION ANALYSIS REPORT

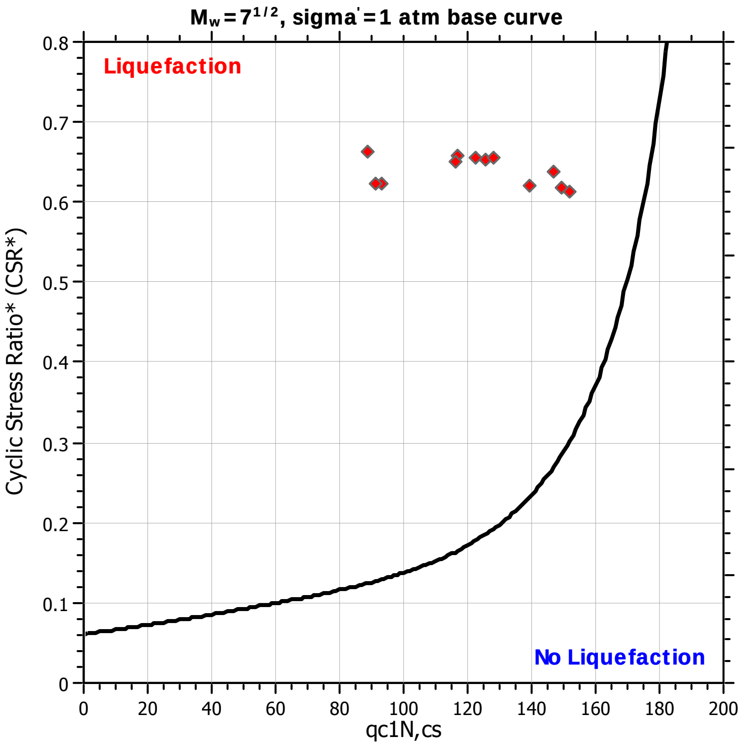
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

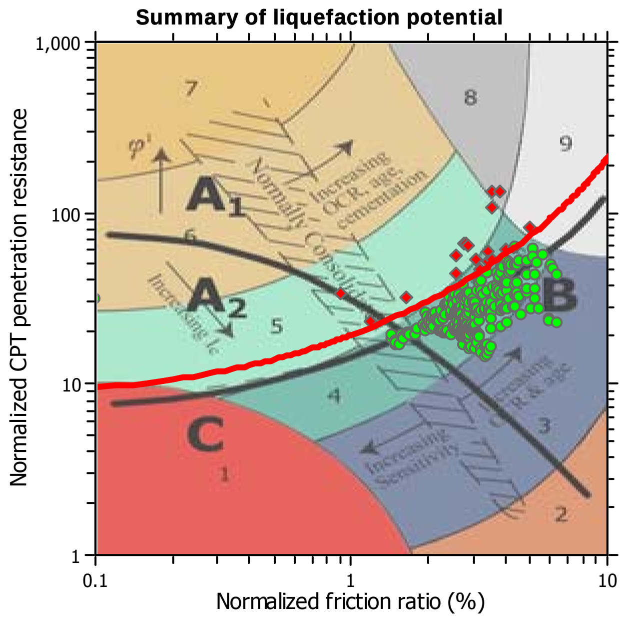
CPT file : 2-CPT8

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	Limit depth:	N/A
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method

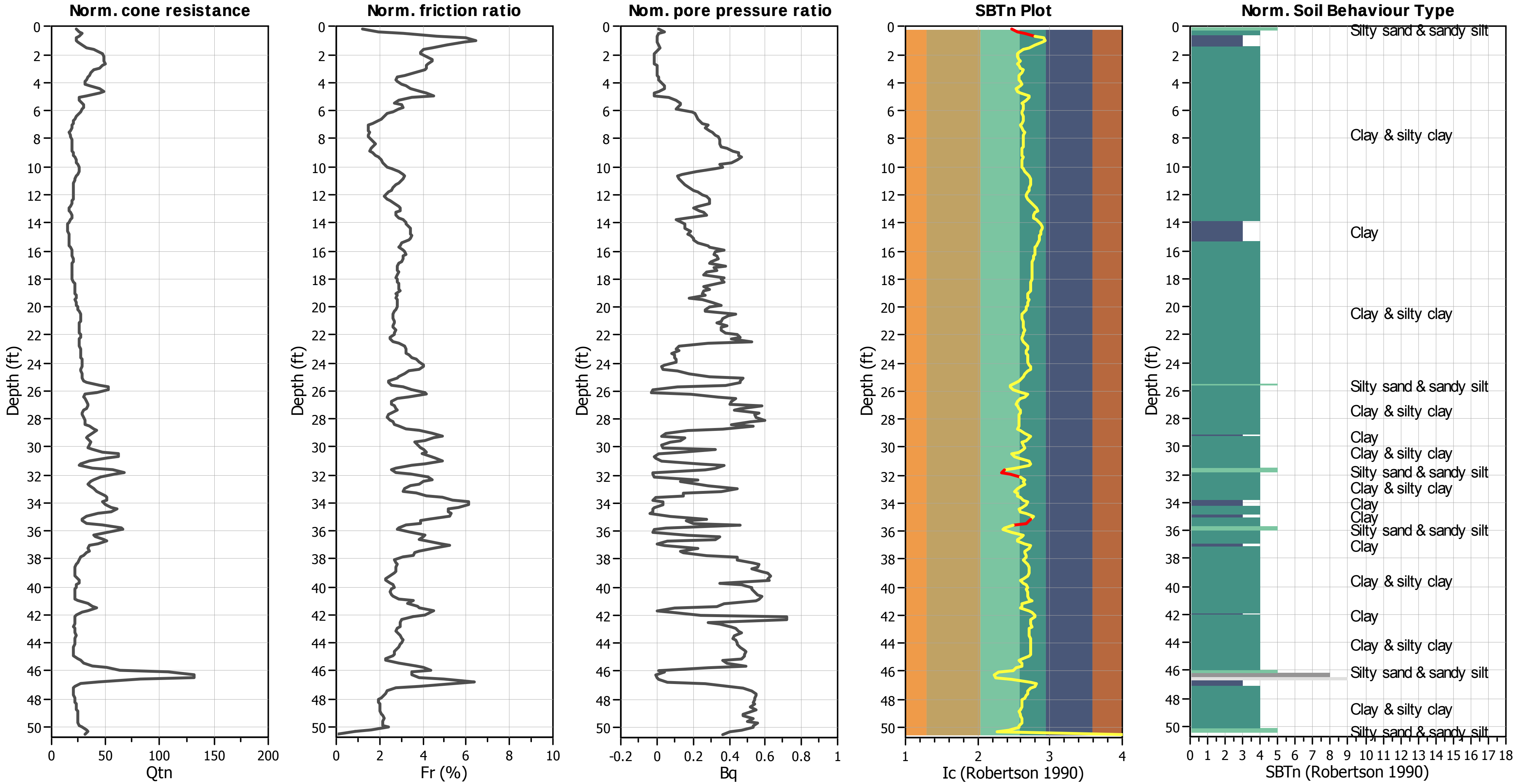






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



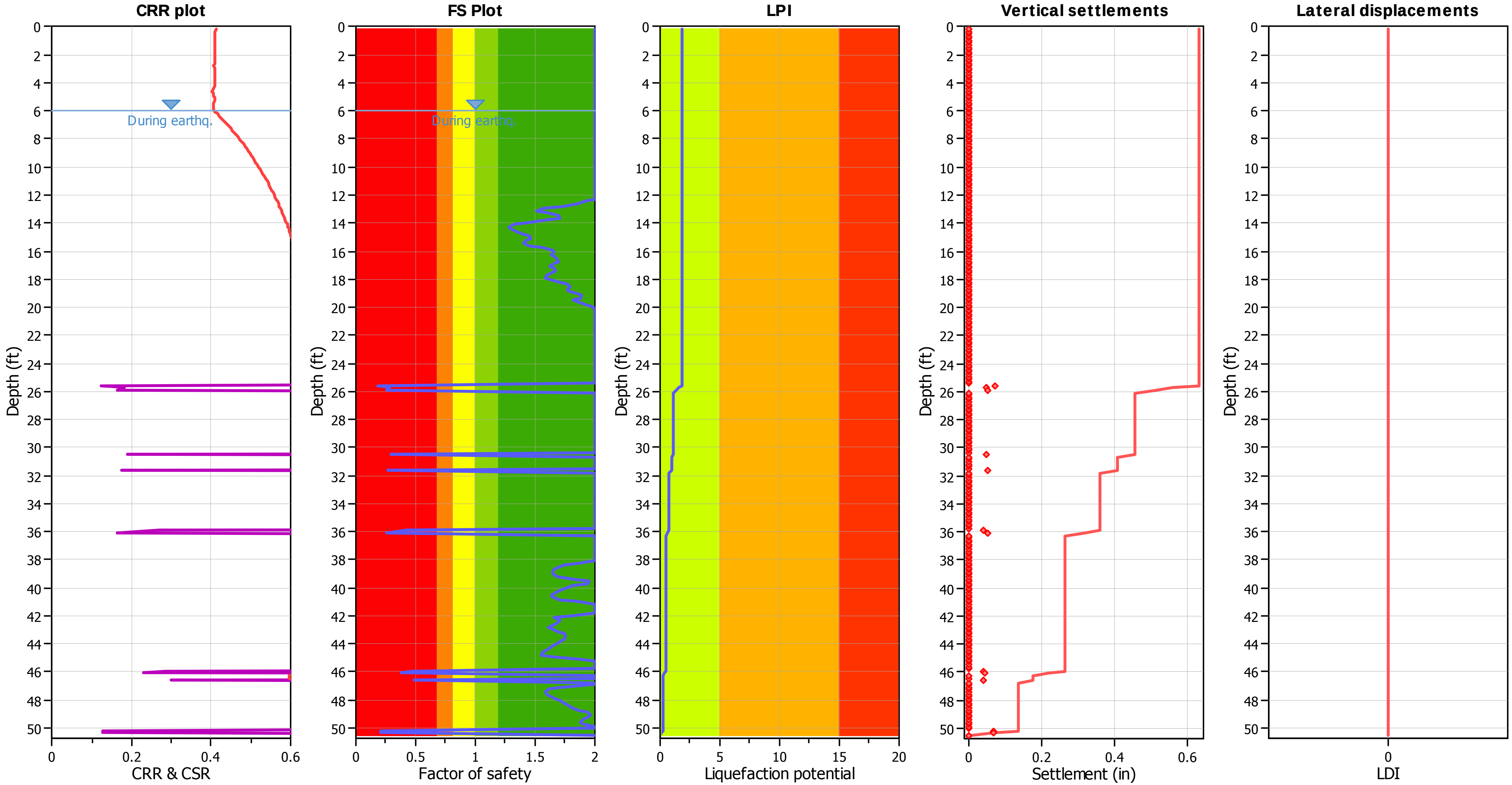
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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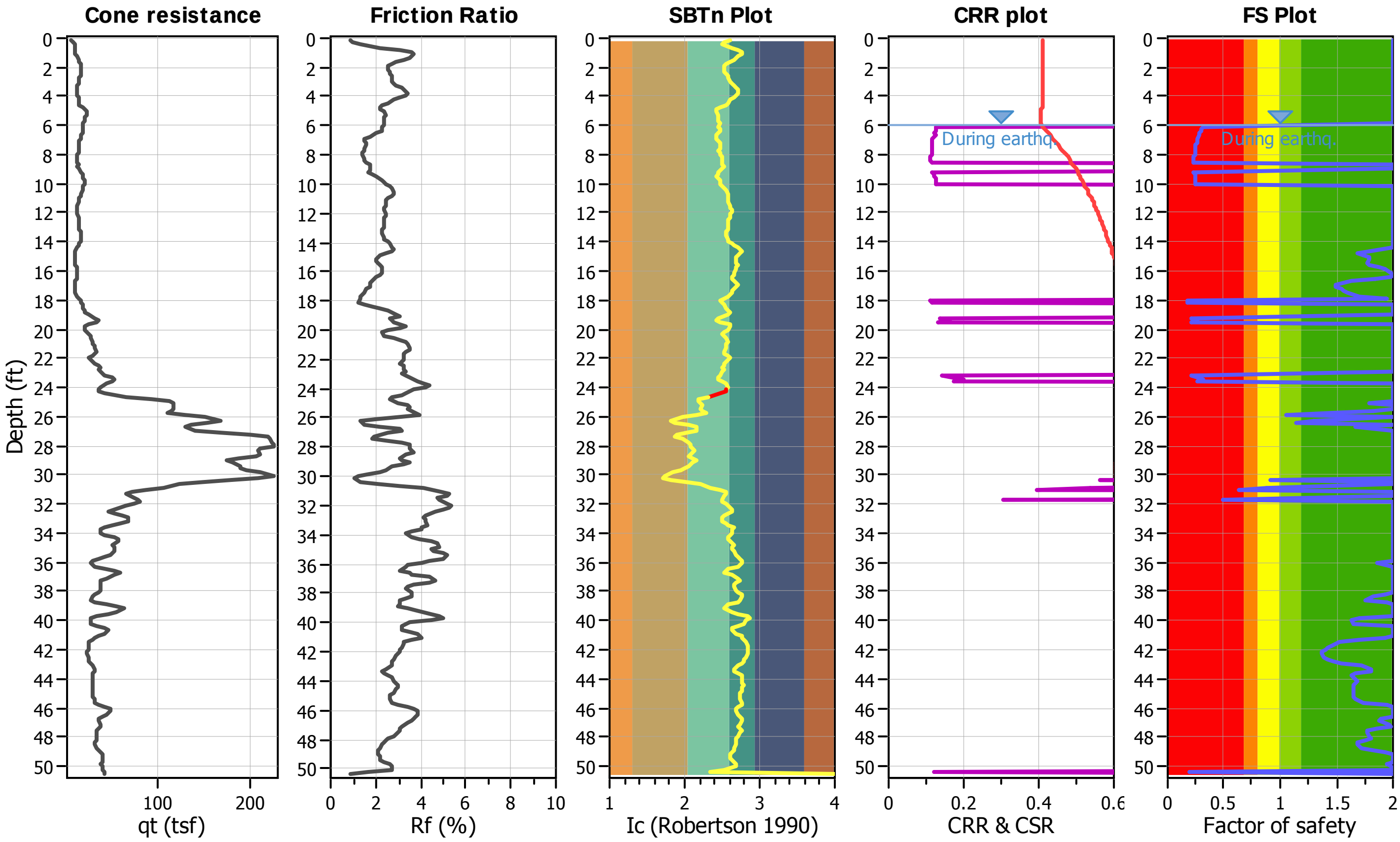
LIQUEFACTION ANALYSIS REPORT

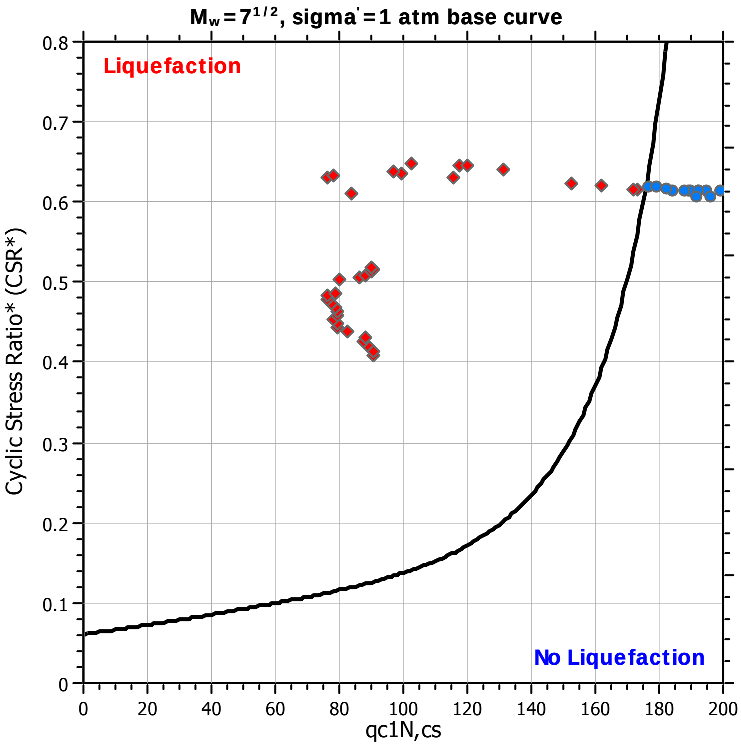
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

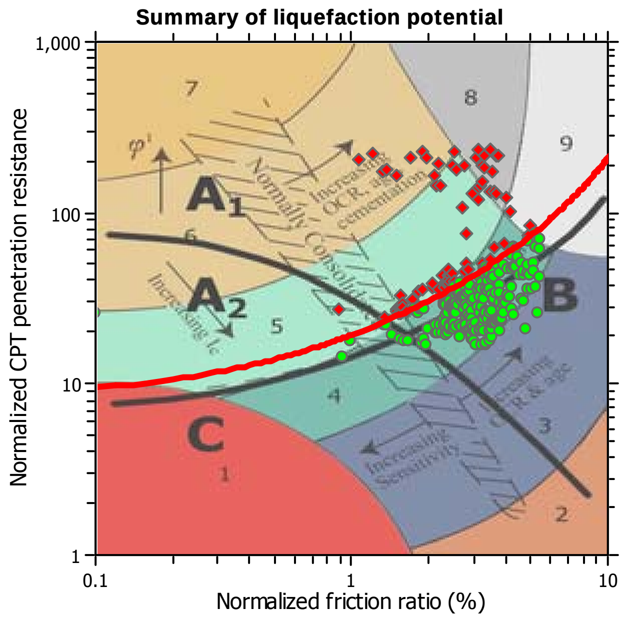
CPT file : 2-CPT9

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.30	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

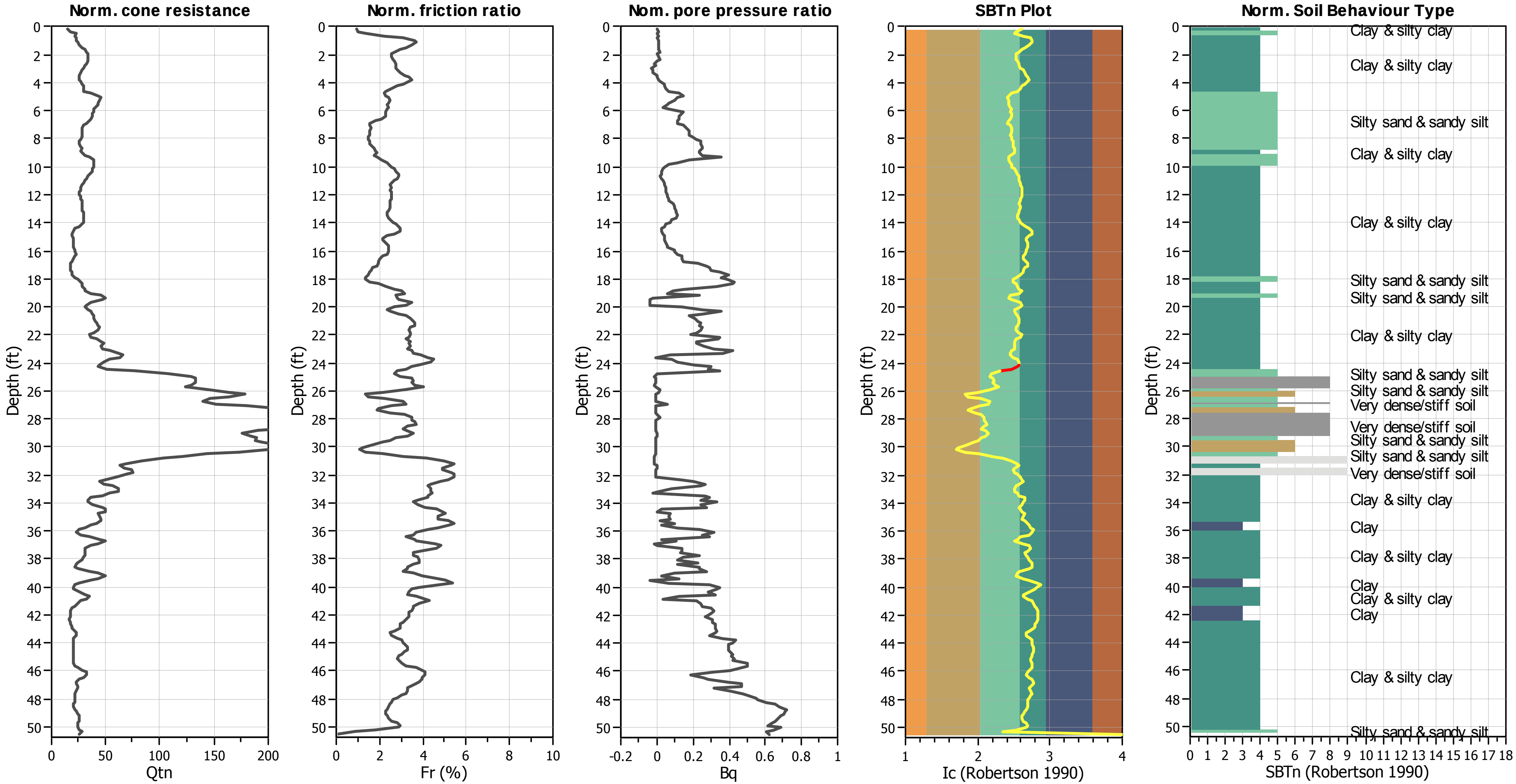






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



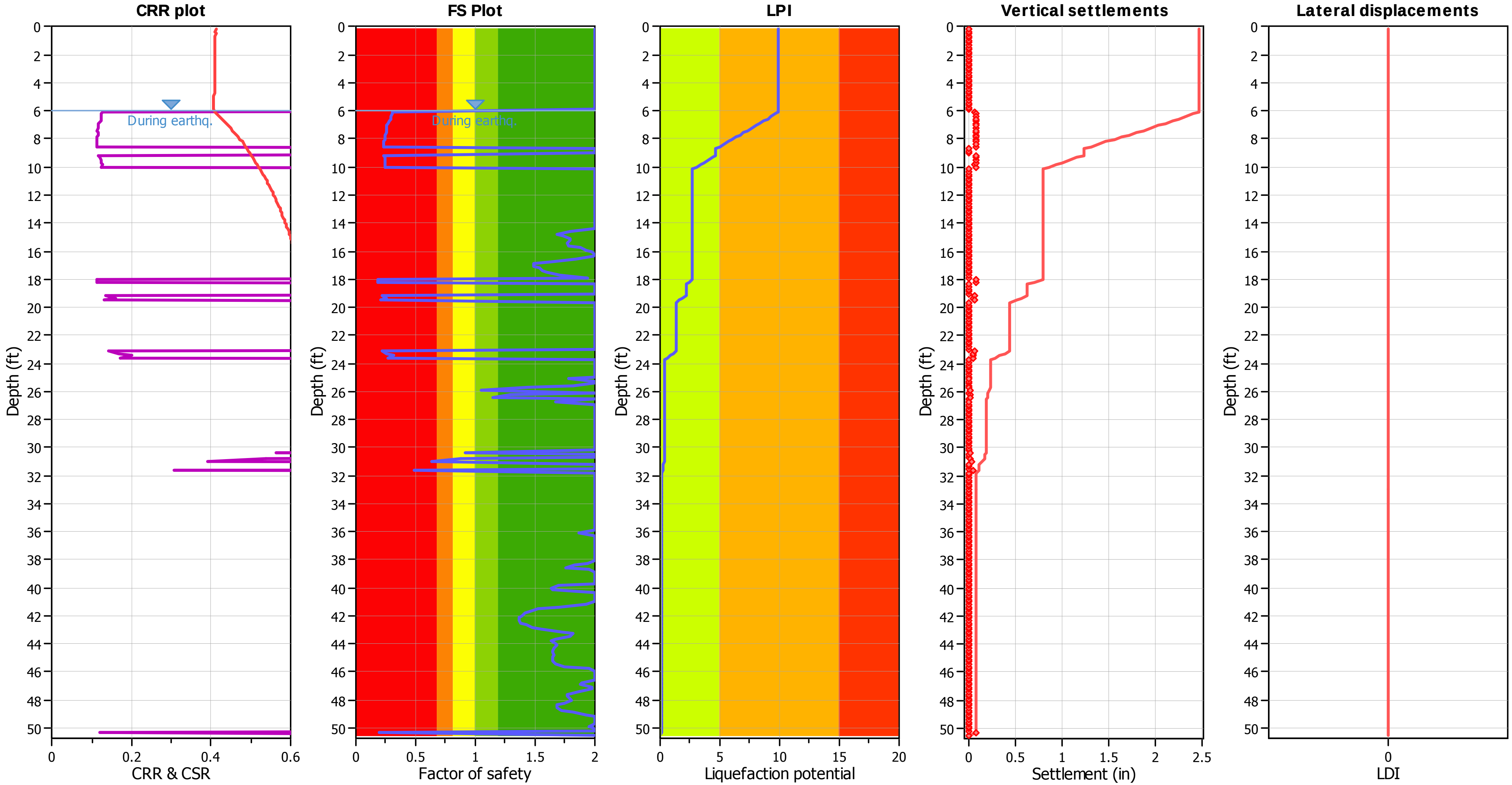
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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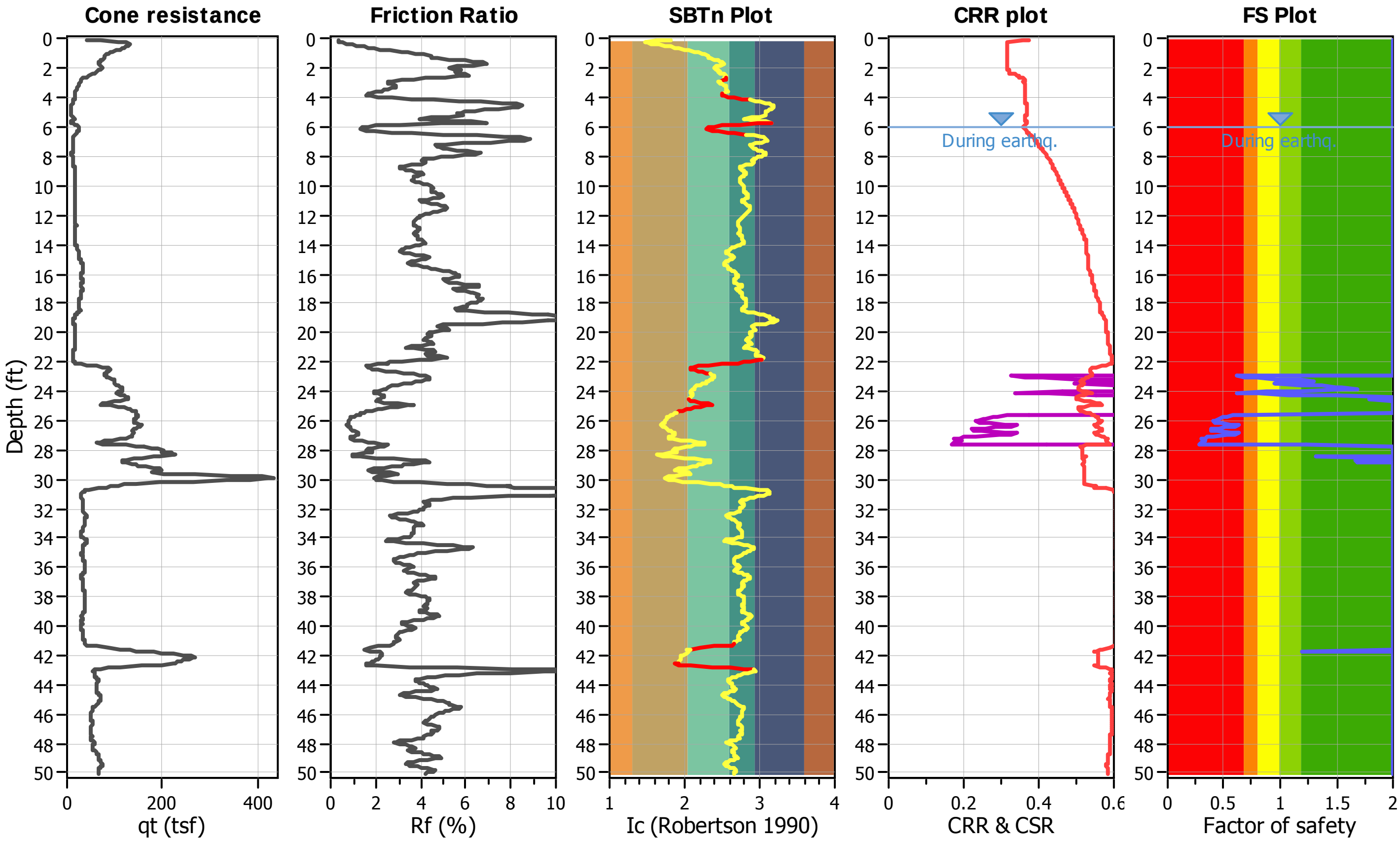
LIQUEFACTION ANALYSIS REPORT

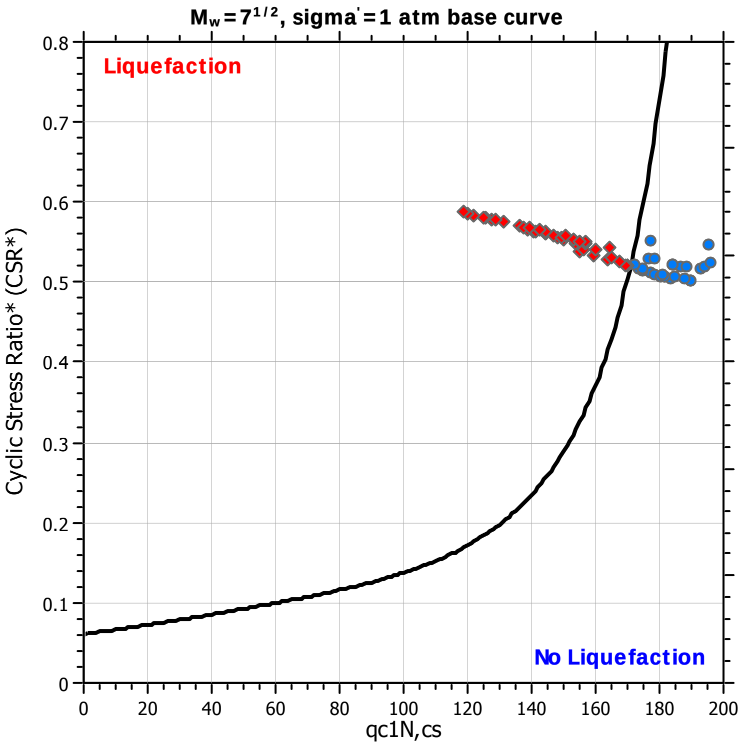
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

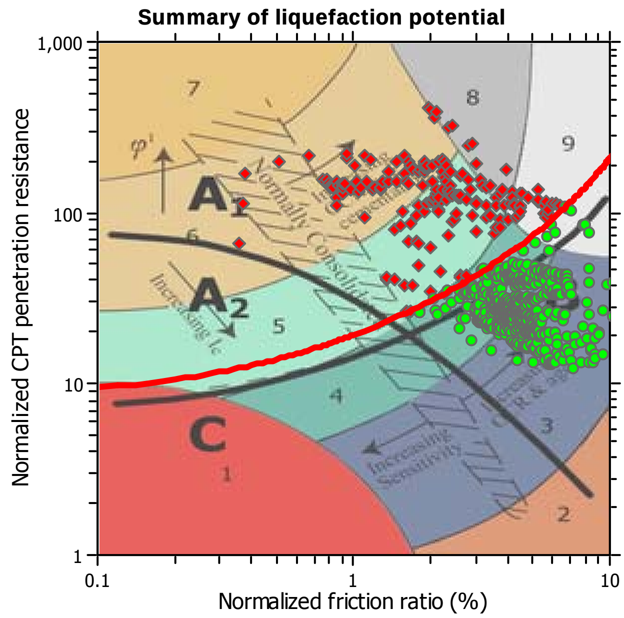
CPT file : 1-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

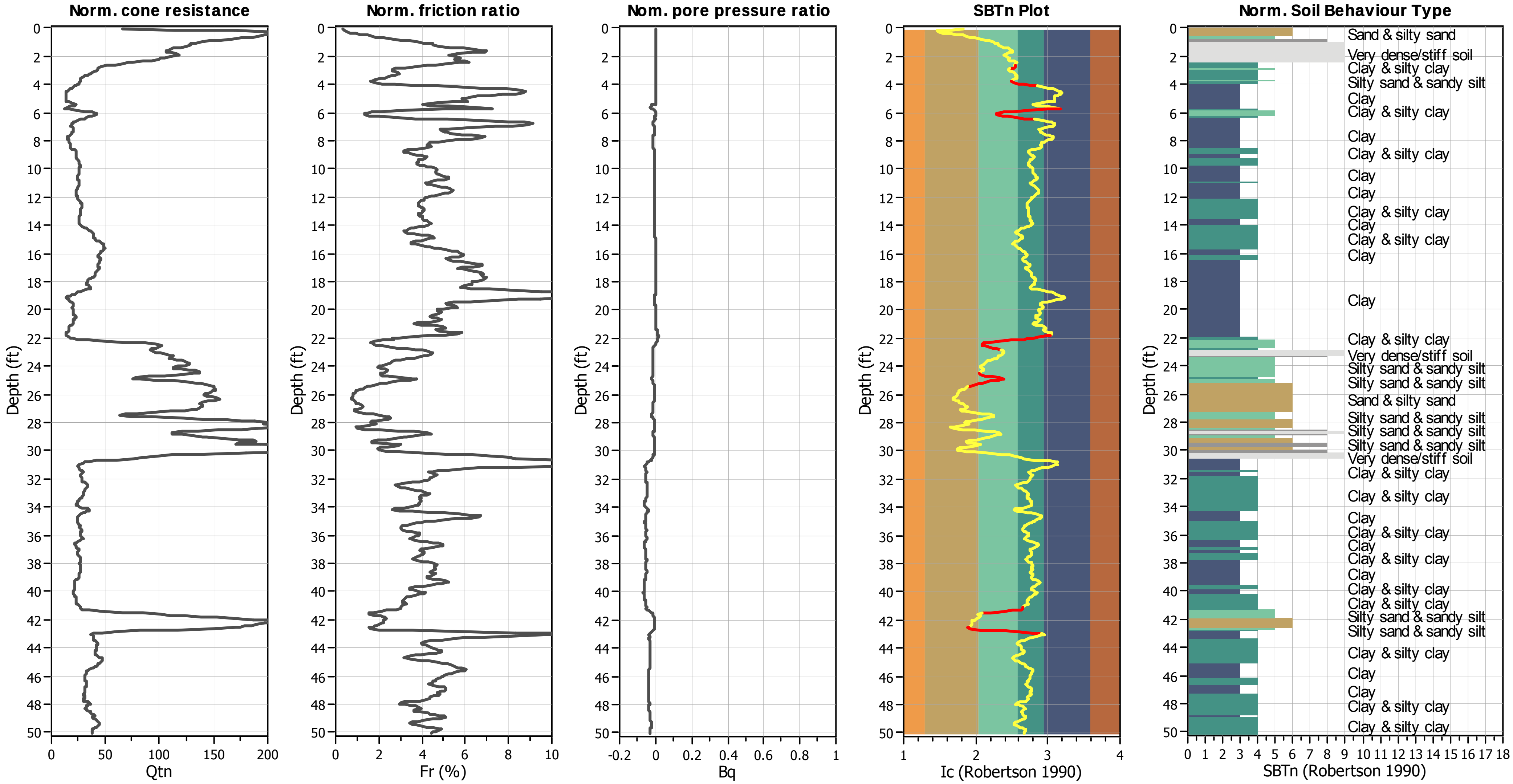






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



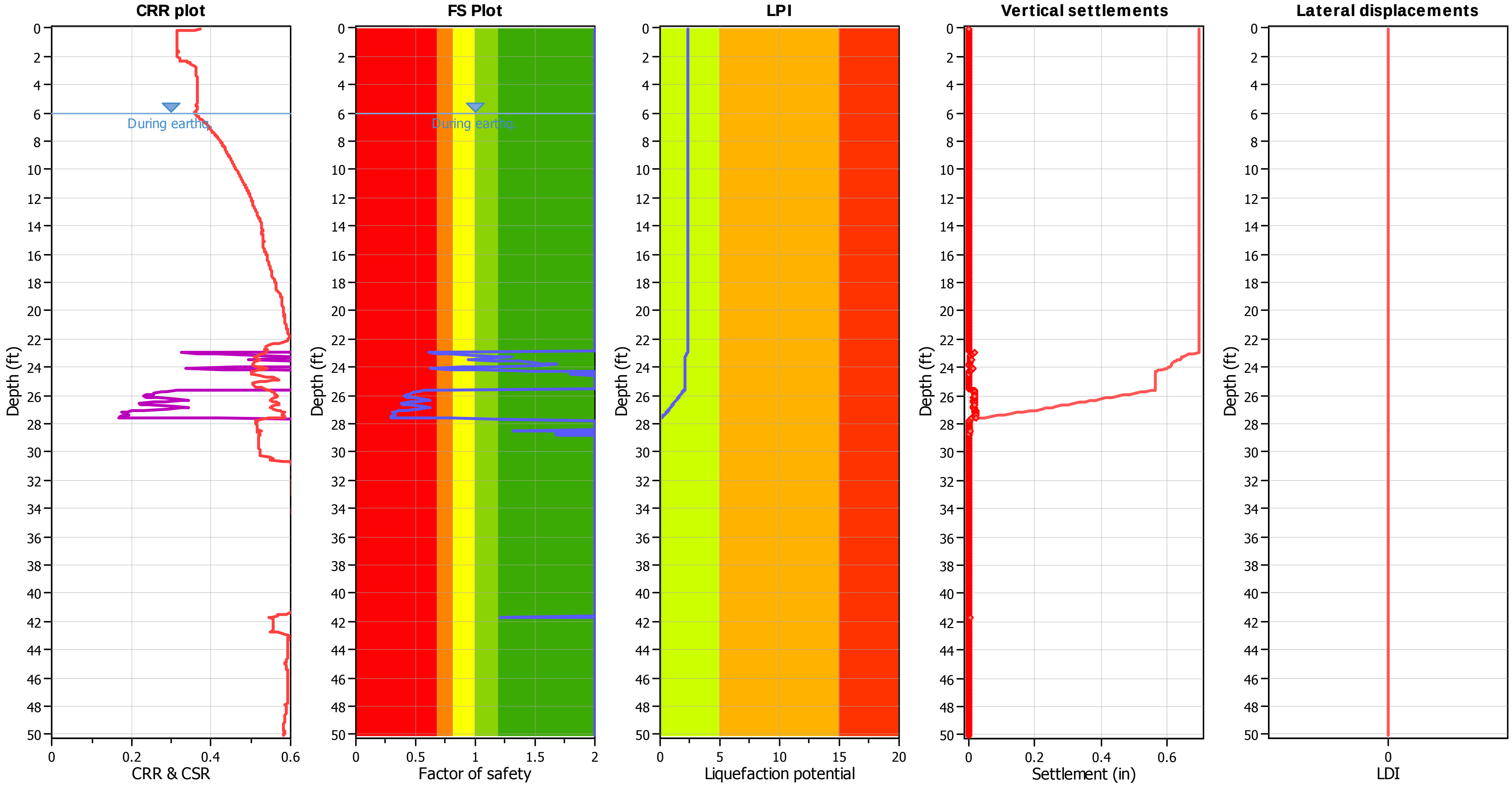
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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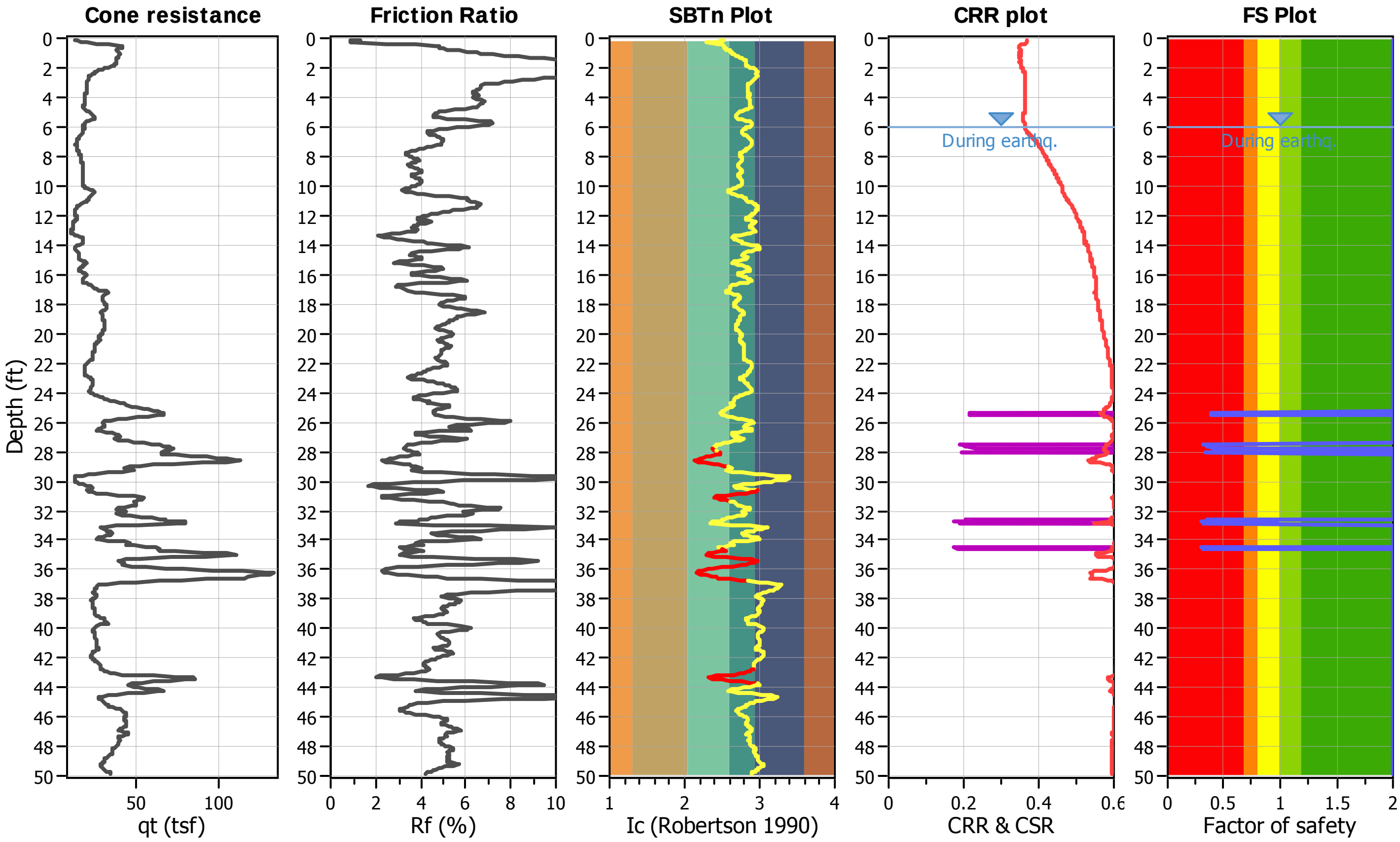
LIQUEFACTION ANALYSIS REPORT

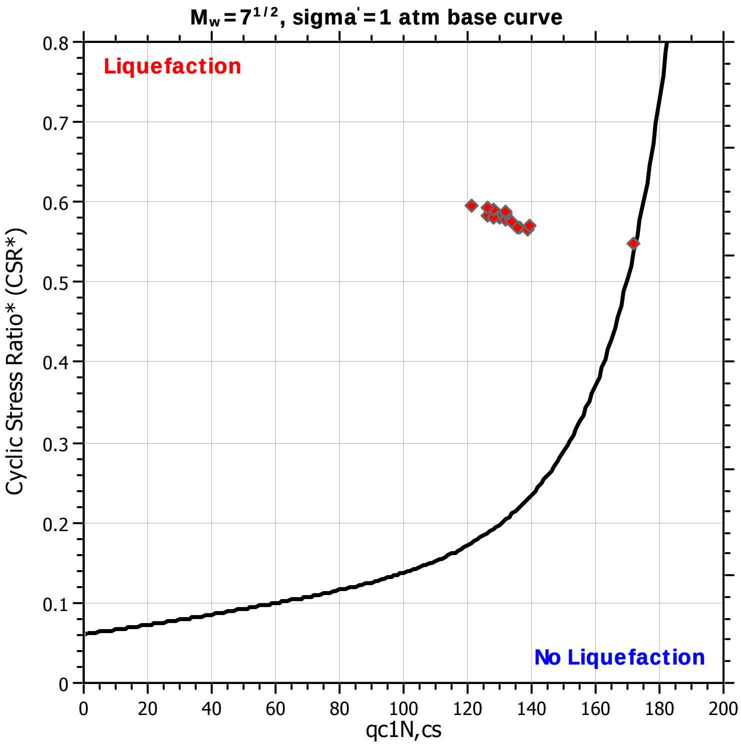
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

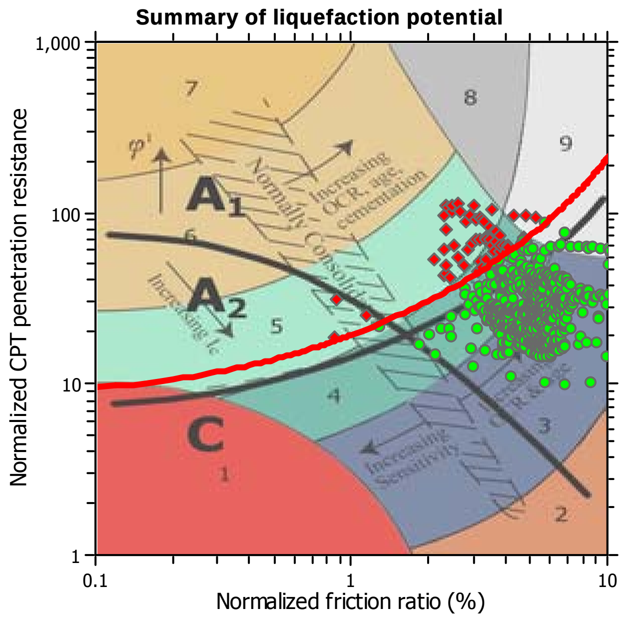
CPT file : 1-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

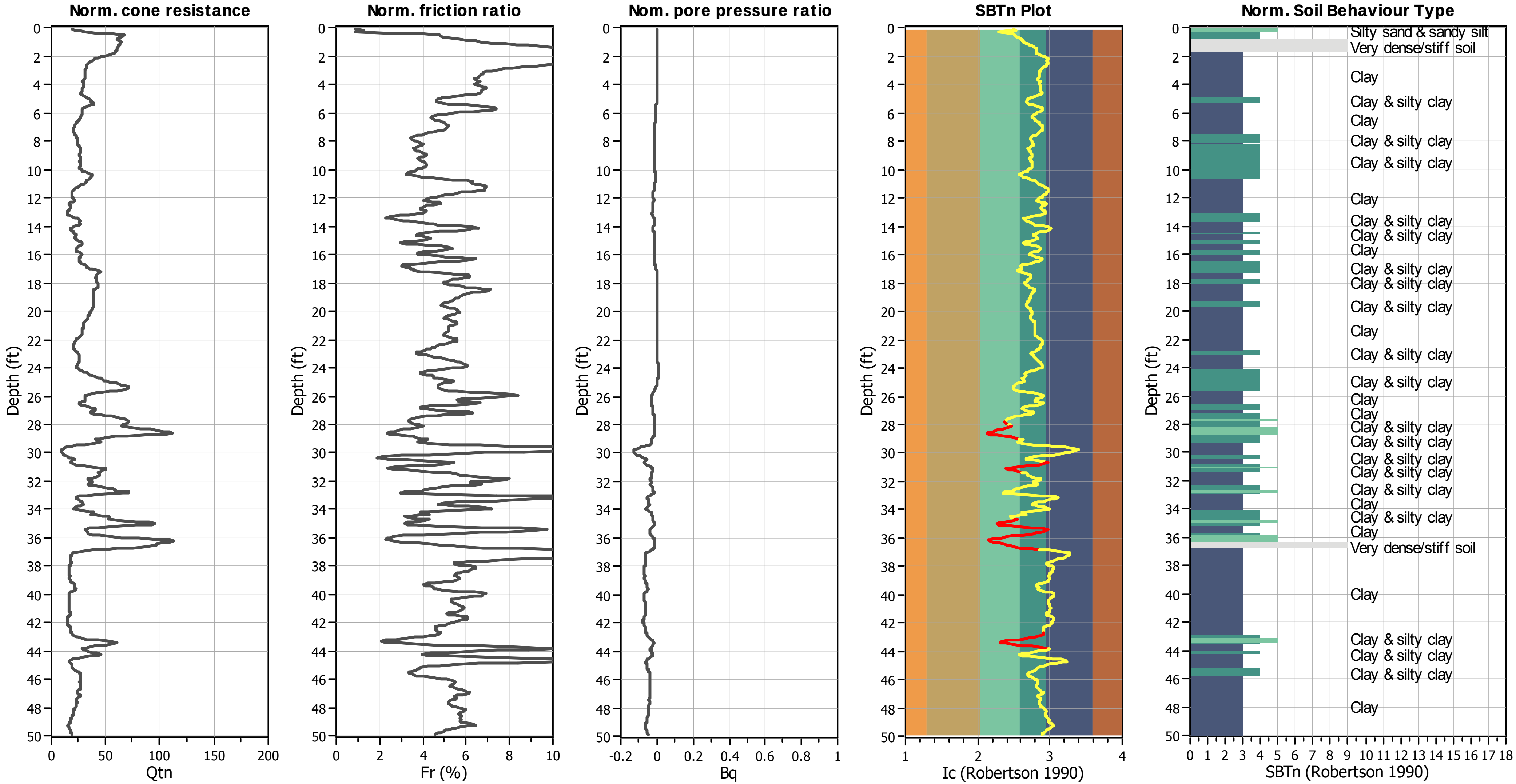






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



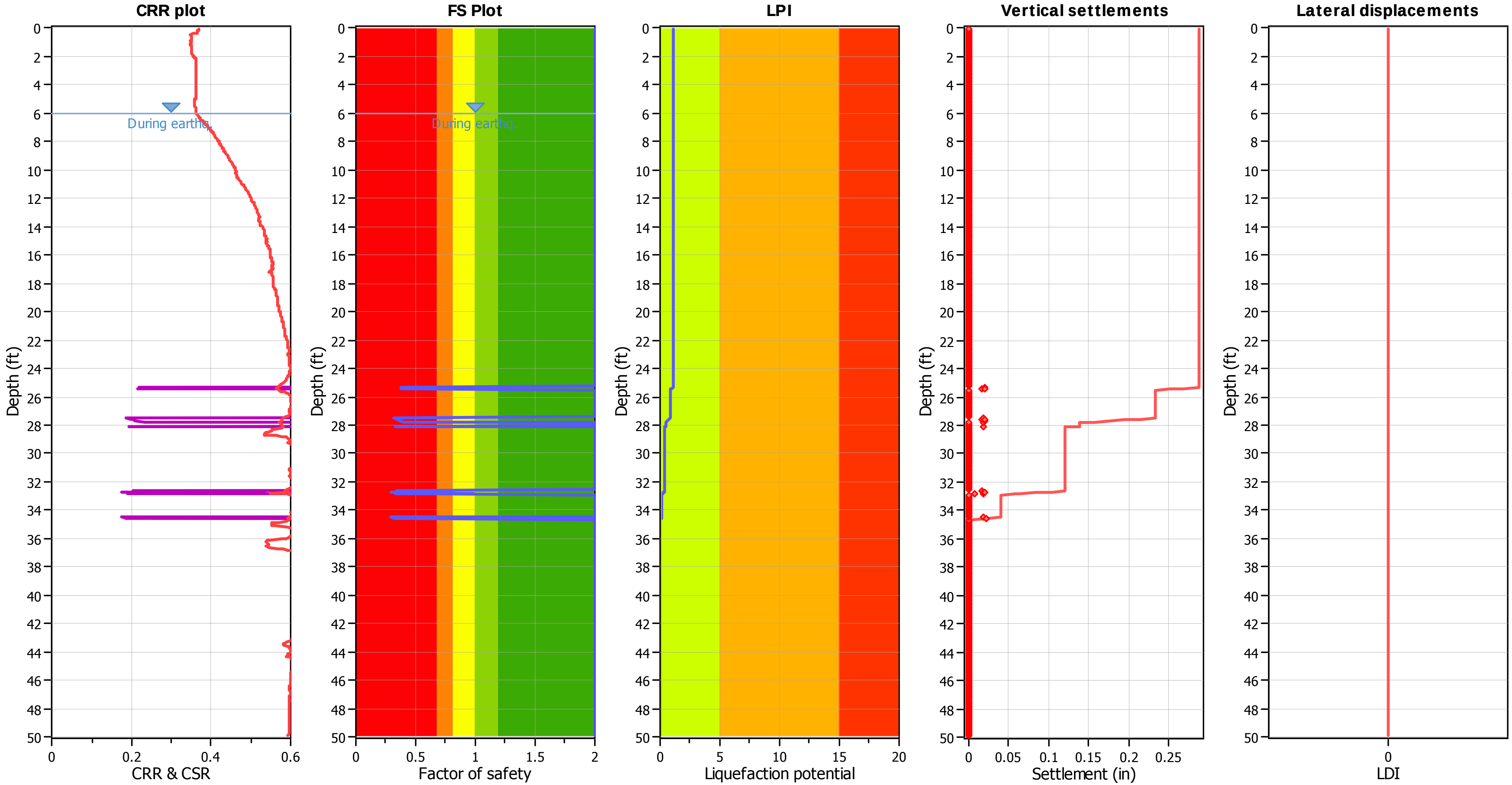
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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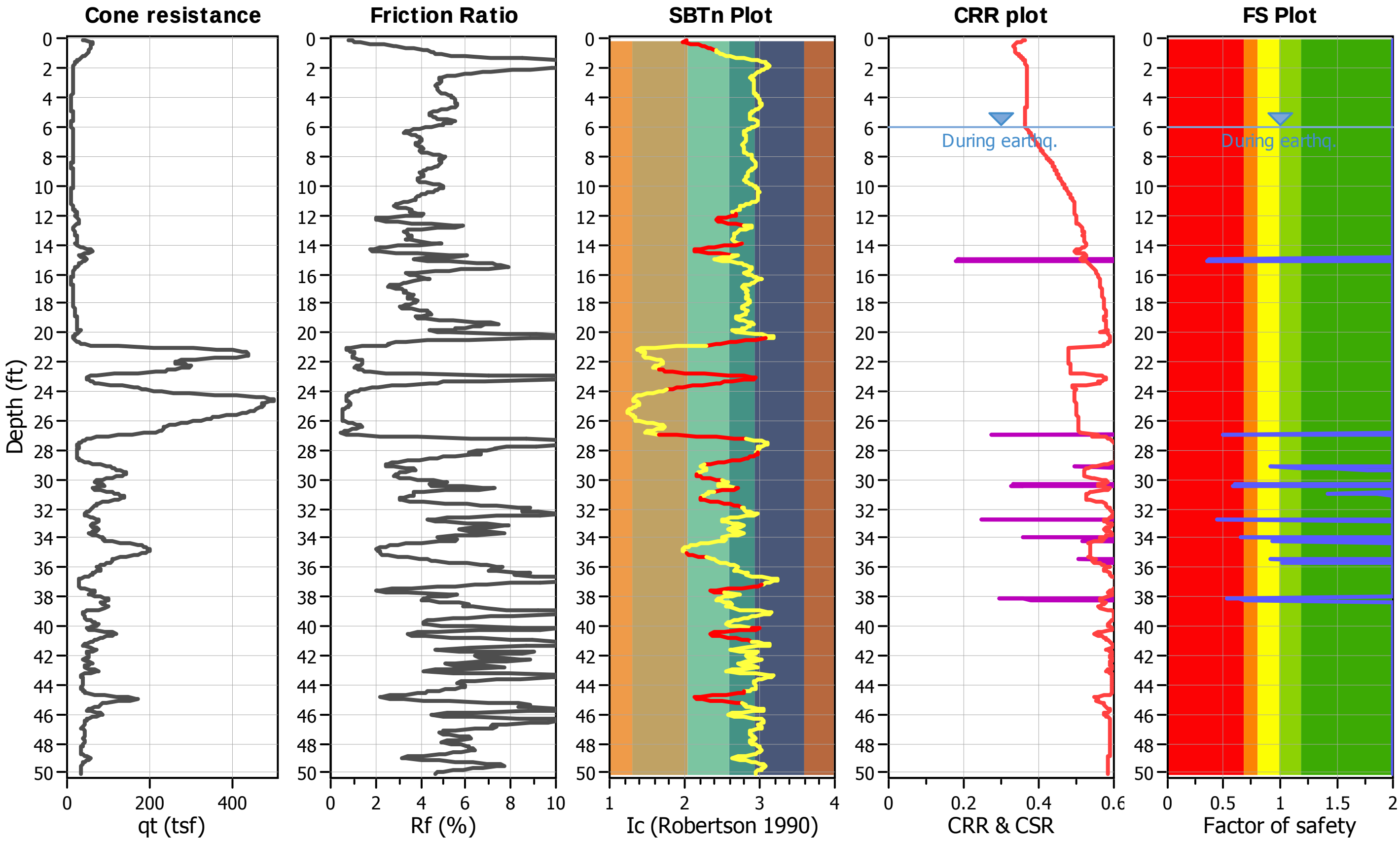
LIQUEFACTION ANALYSIS REPORT

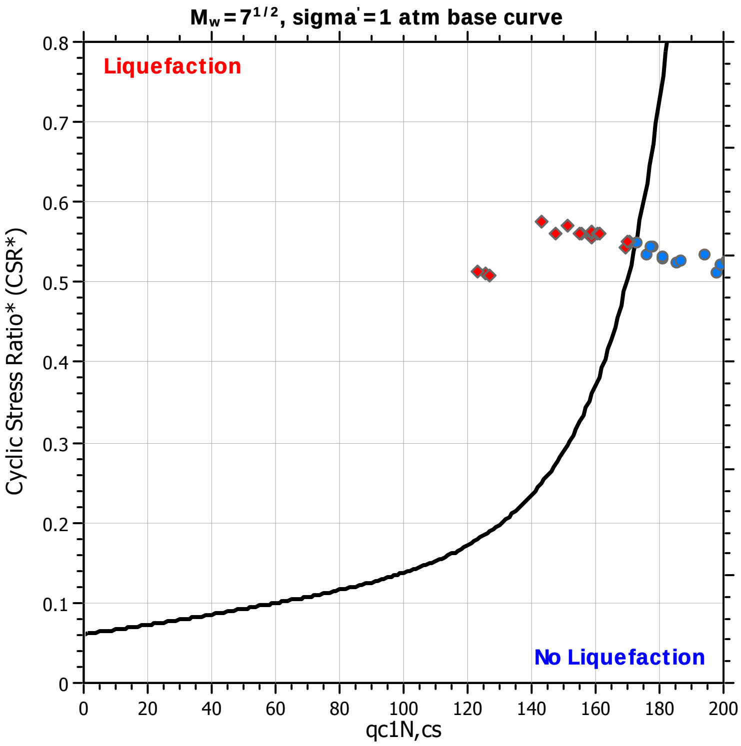
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

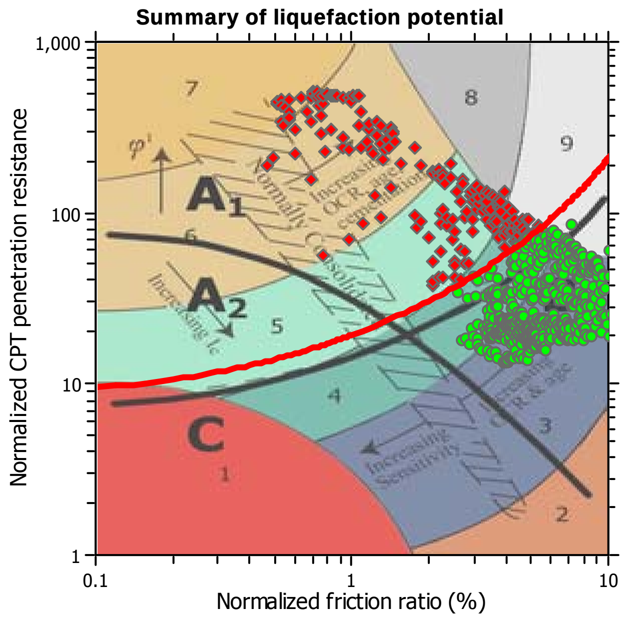
CPT file : 1-CPT3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

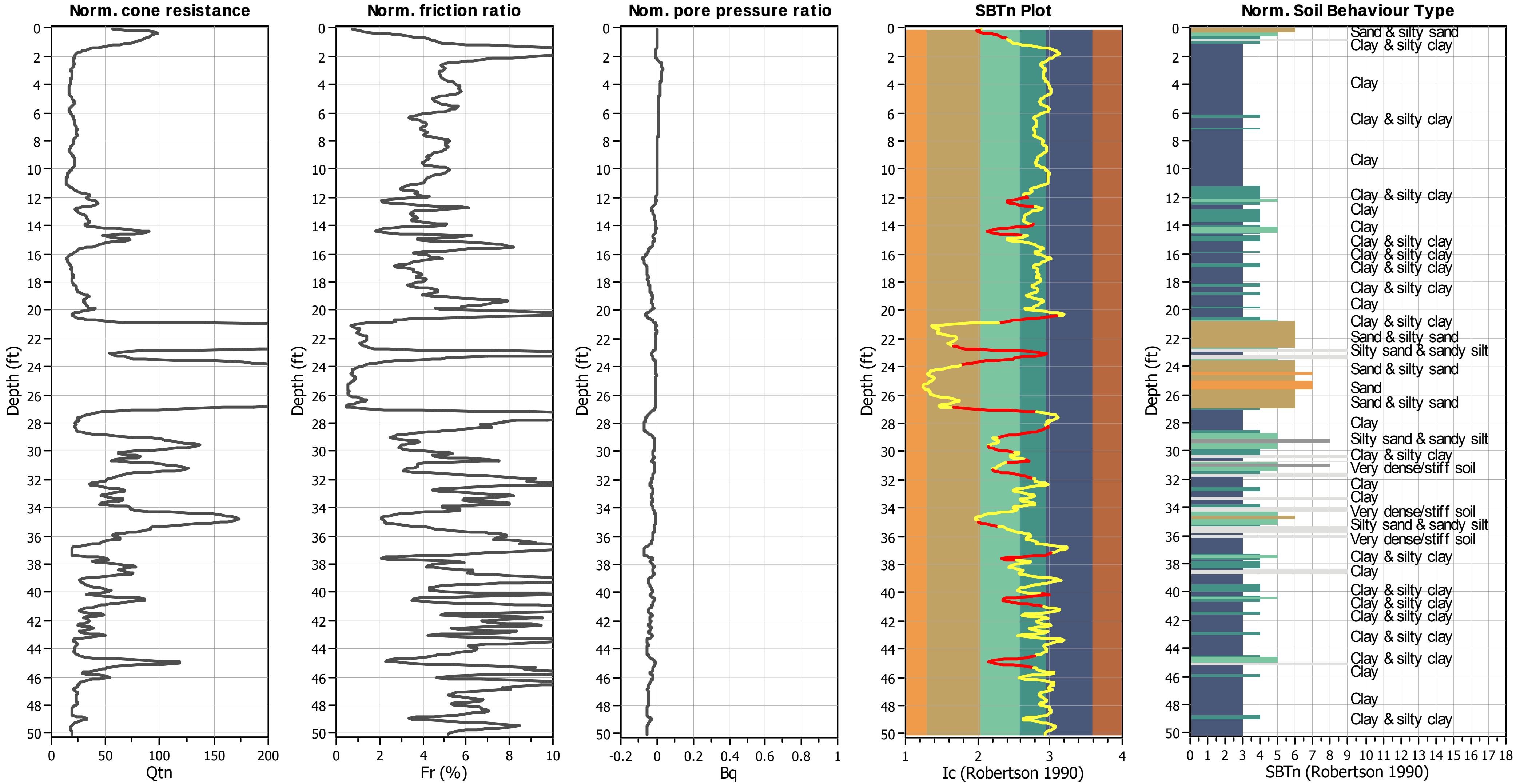






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



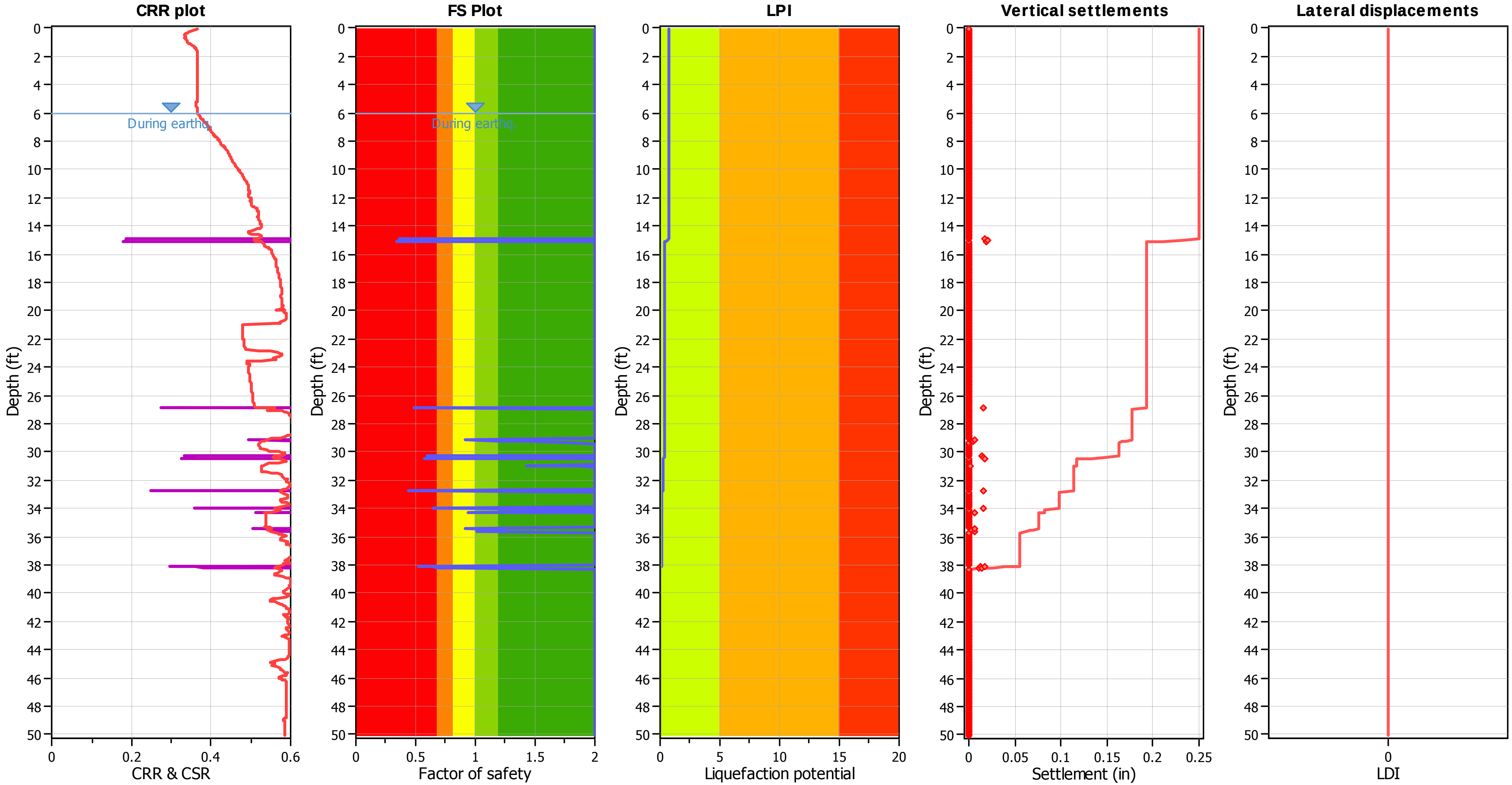
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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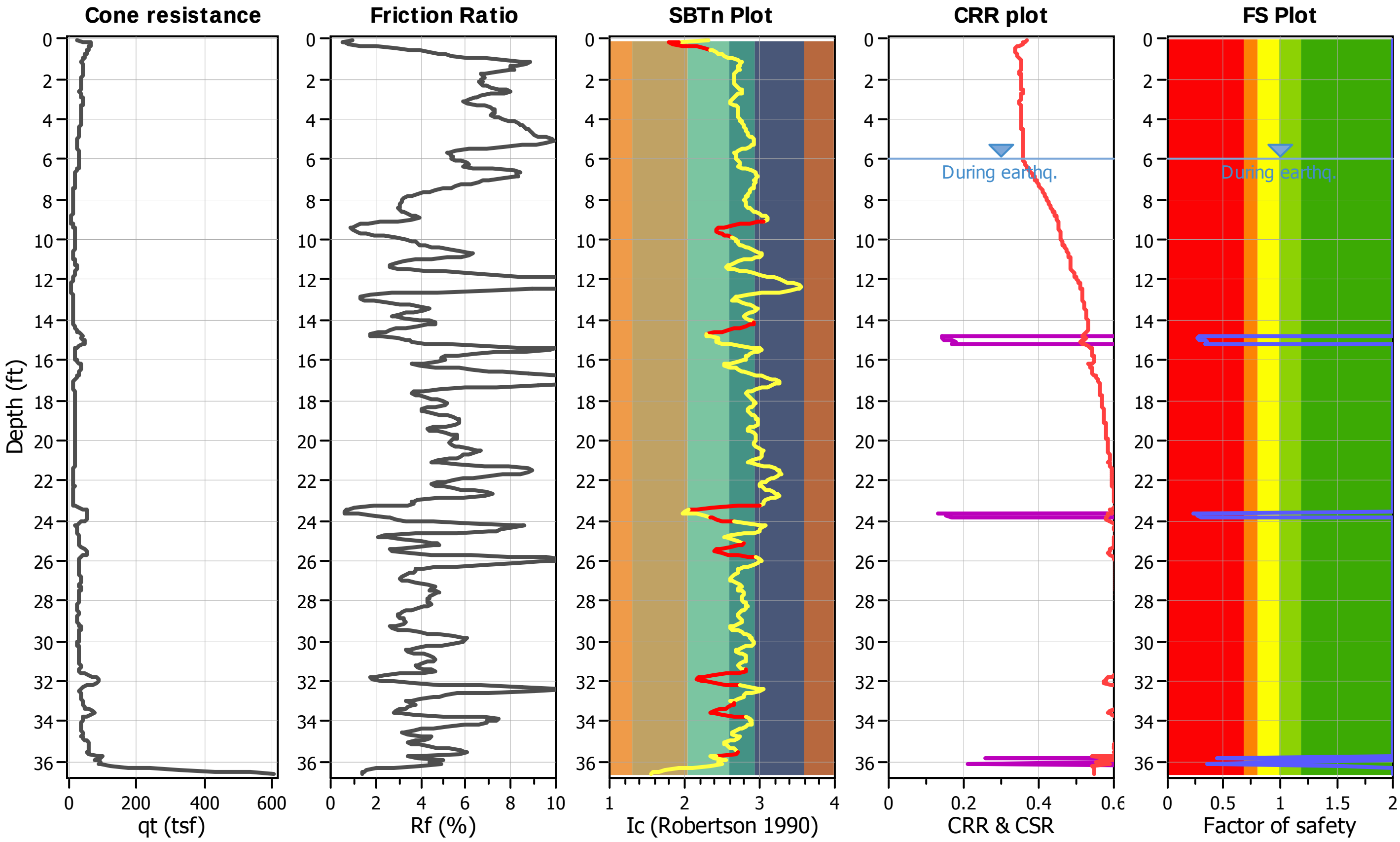
LIQUEFACTION ANALYSIS REPORT

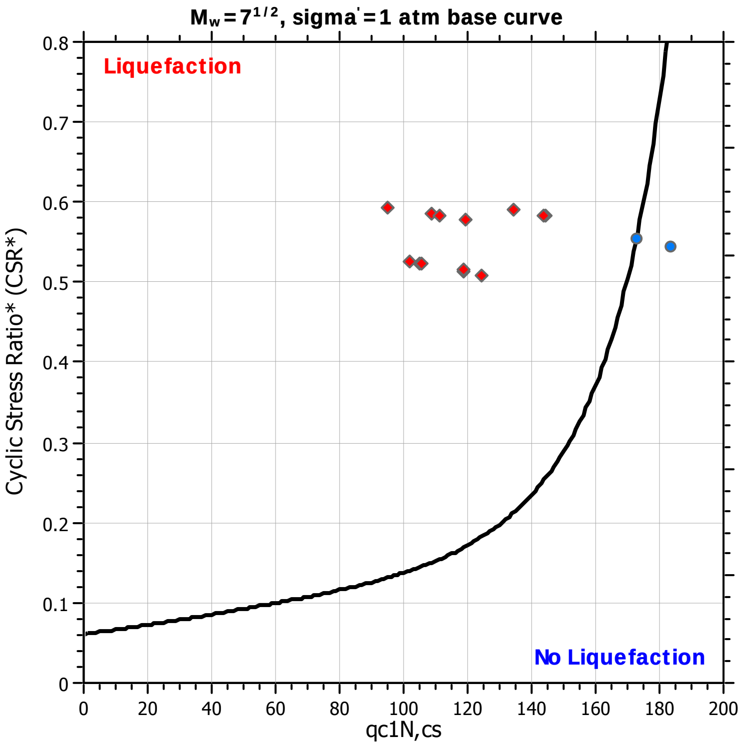
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

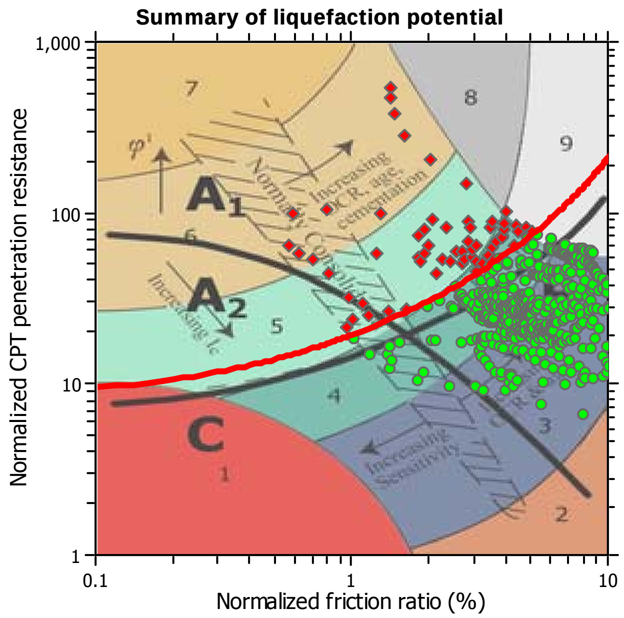
CPT file : 1-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

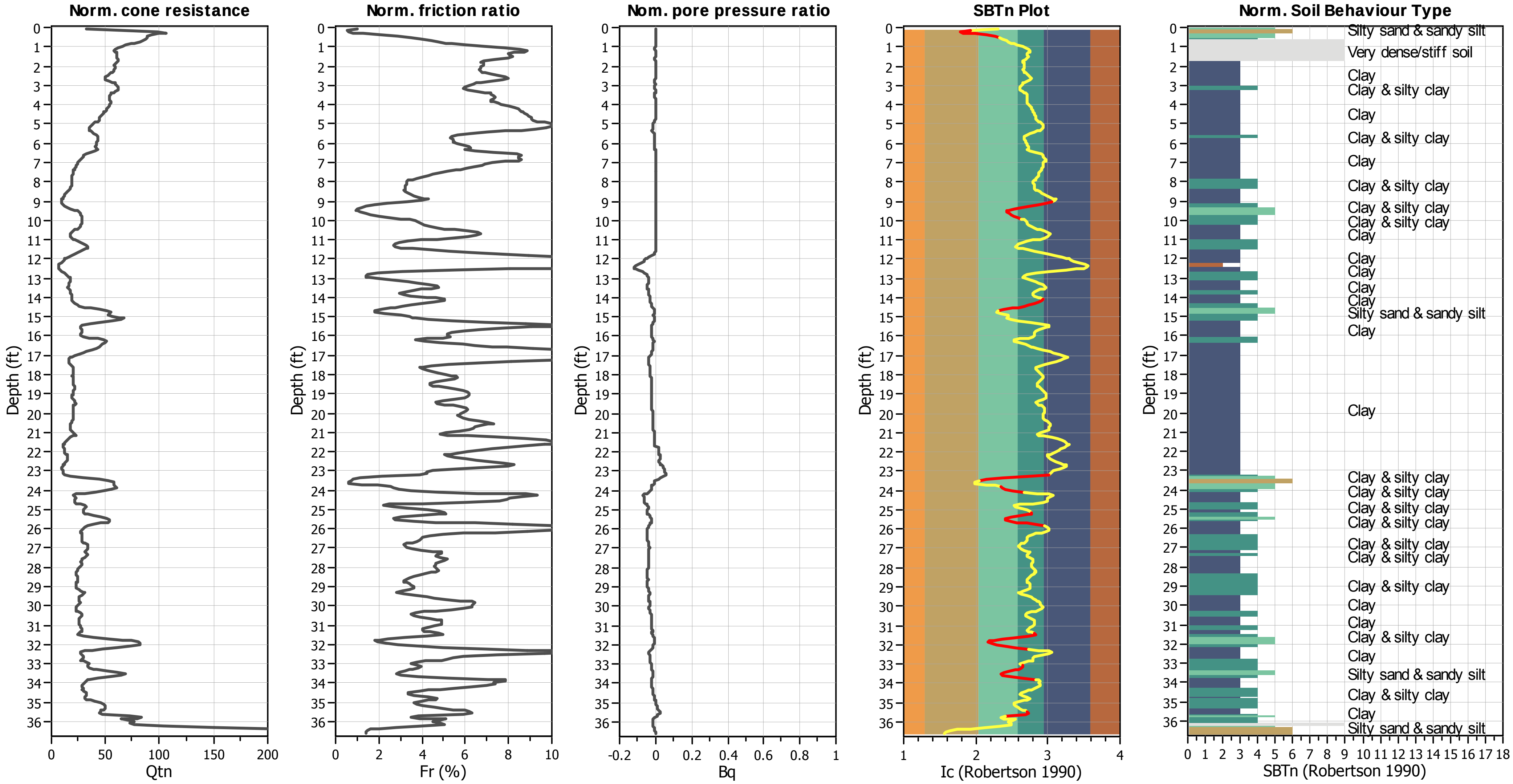






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



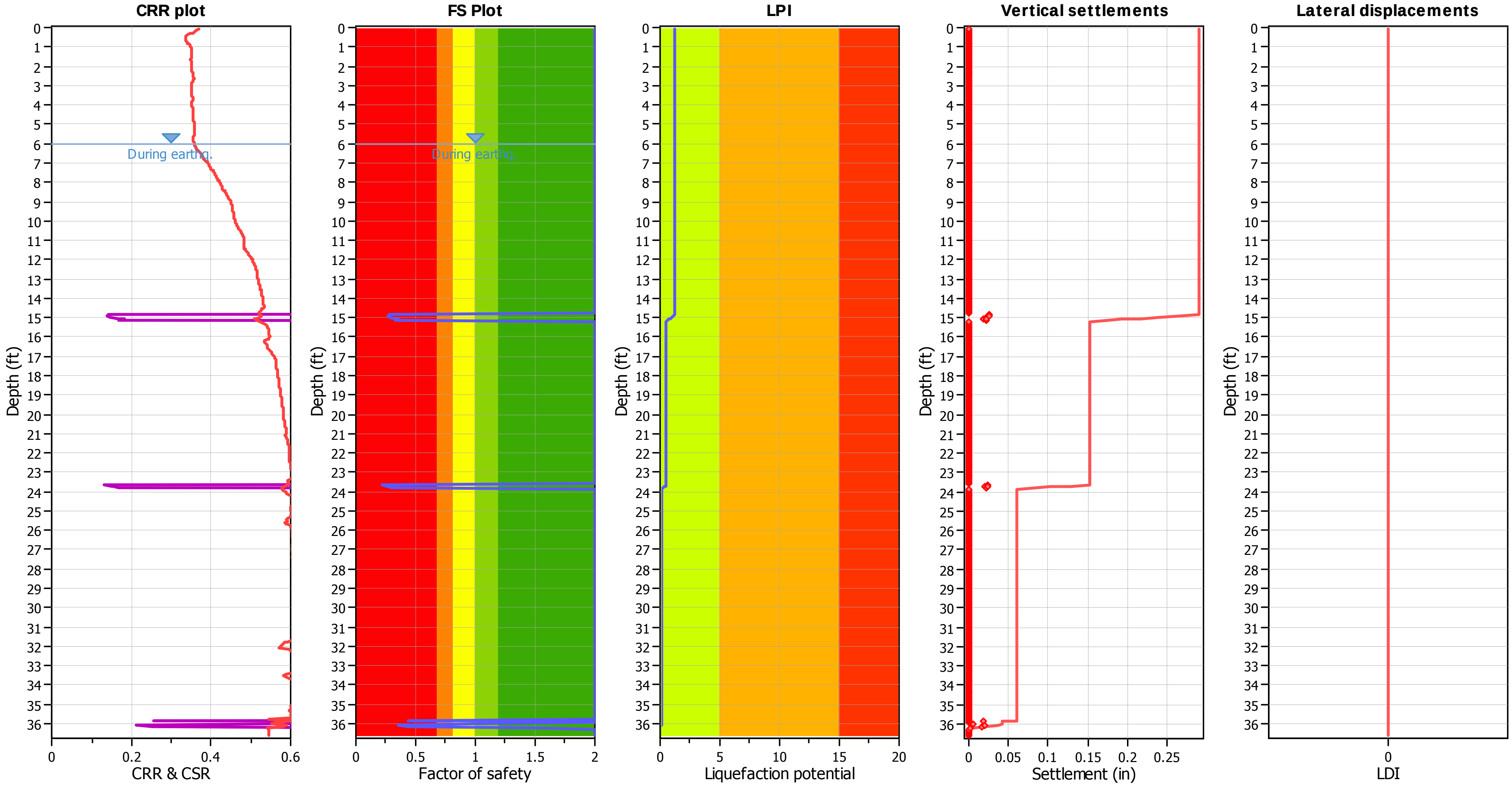
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

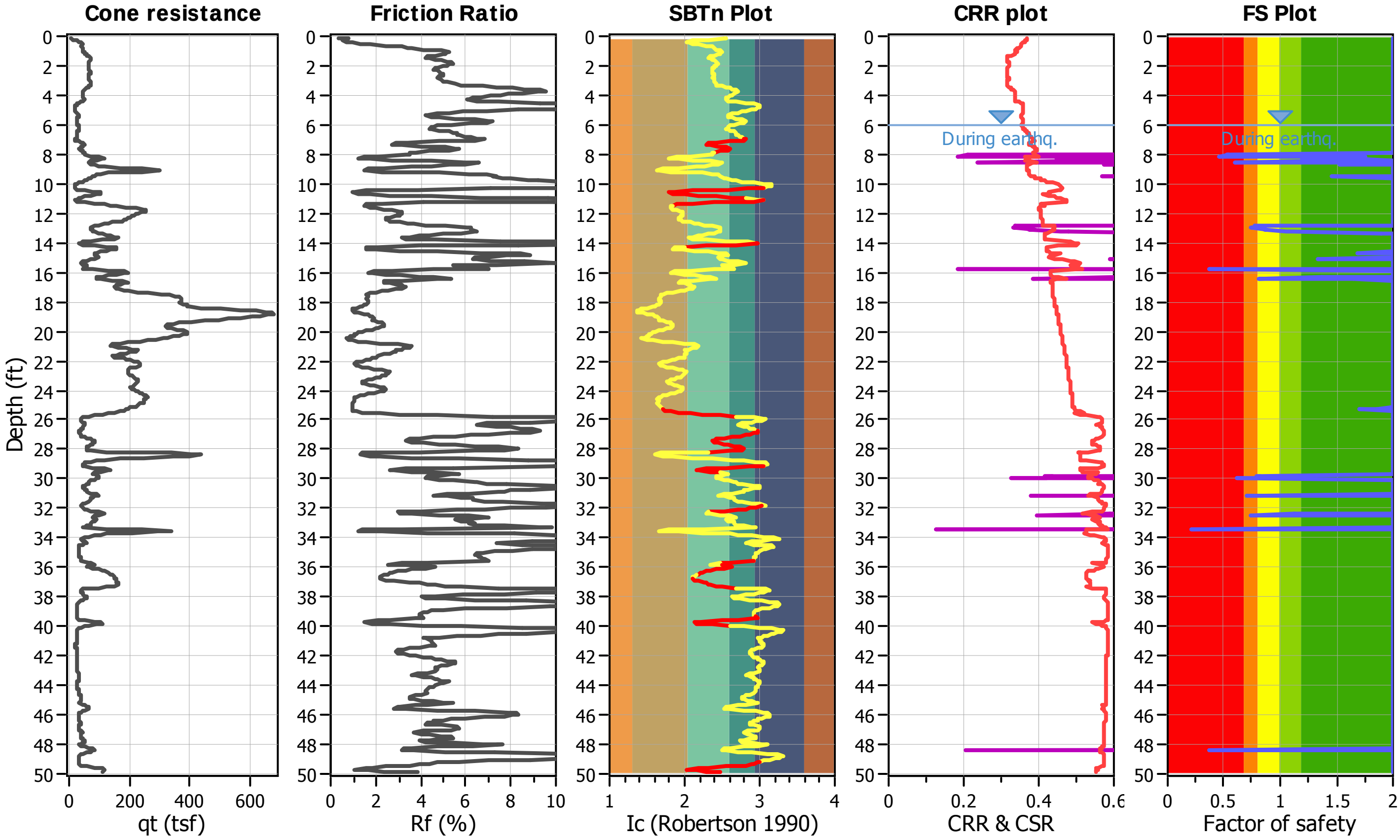
LIQUEFACTION ANALYSIS REPORT

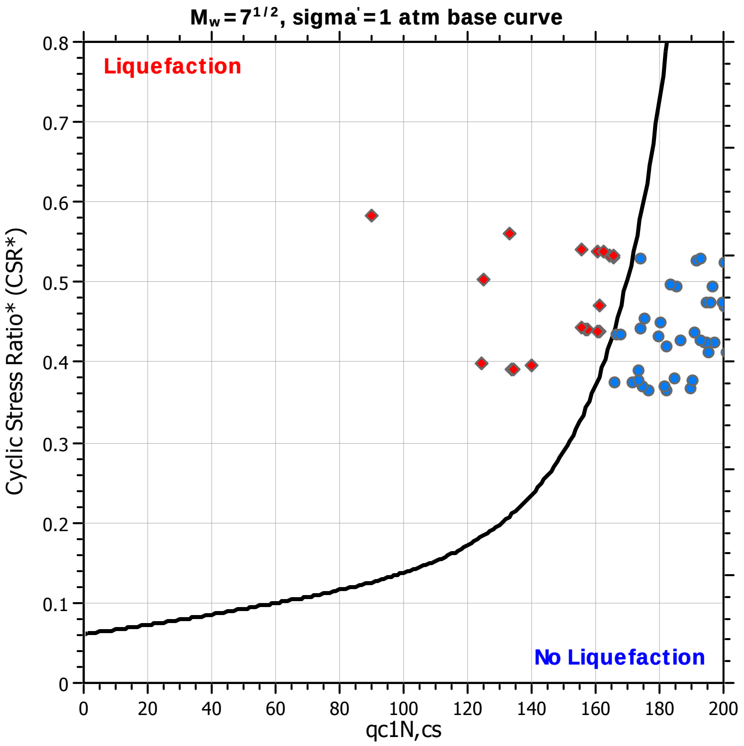
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

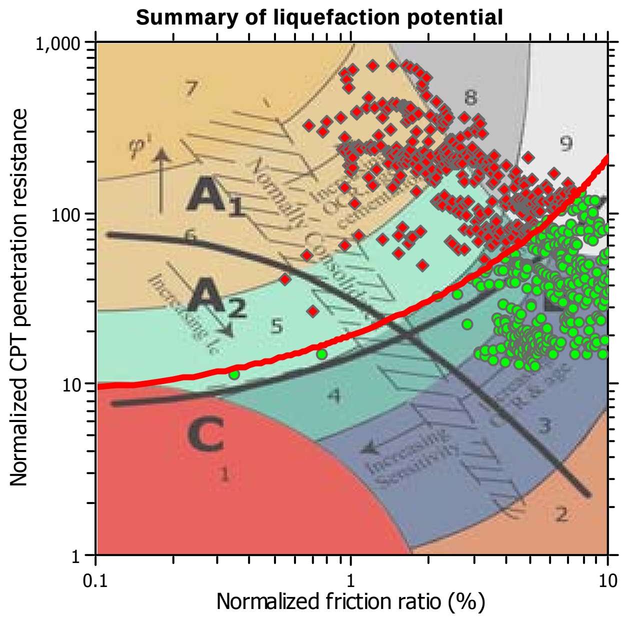
CPT file : 1-CPT5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

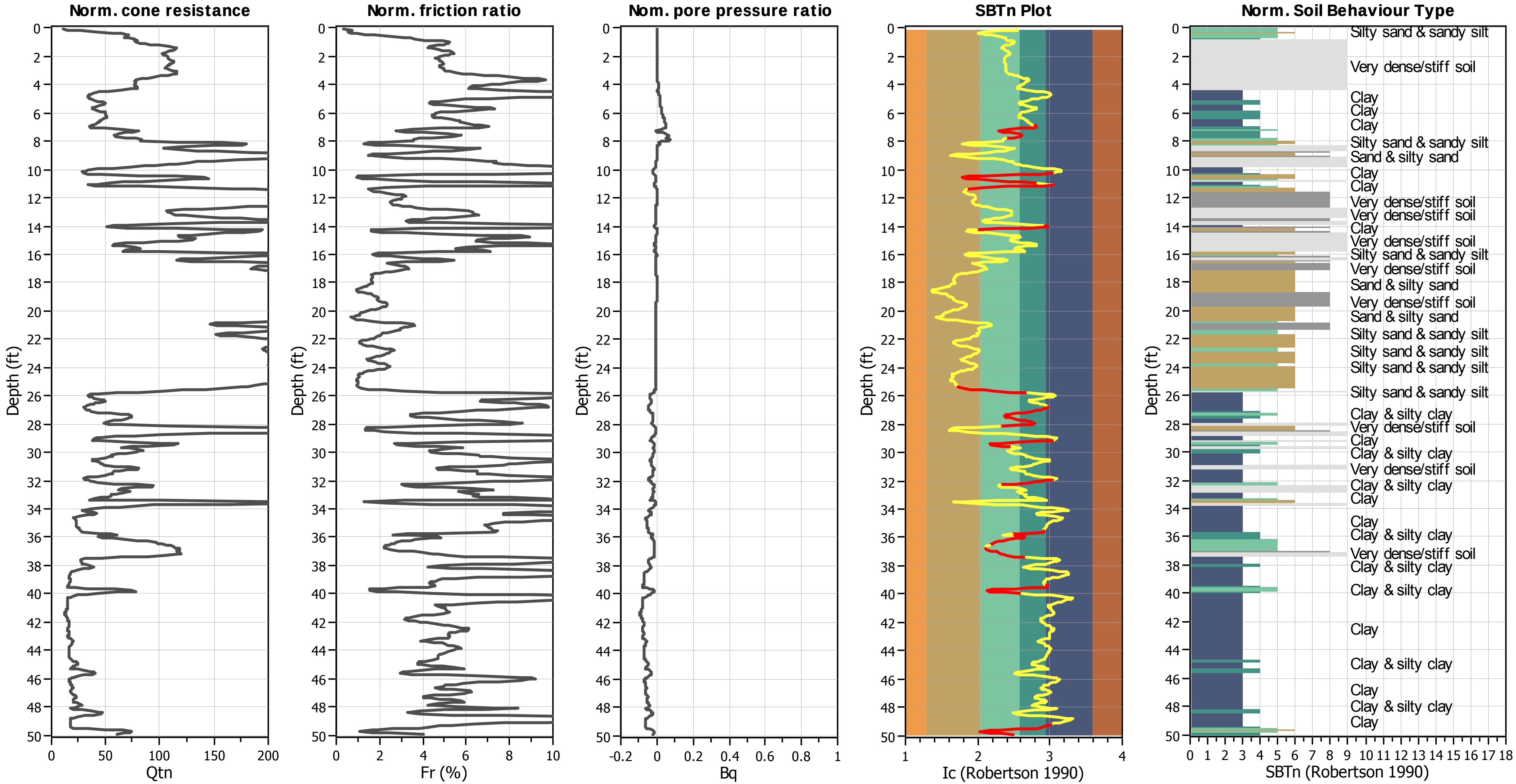






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



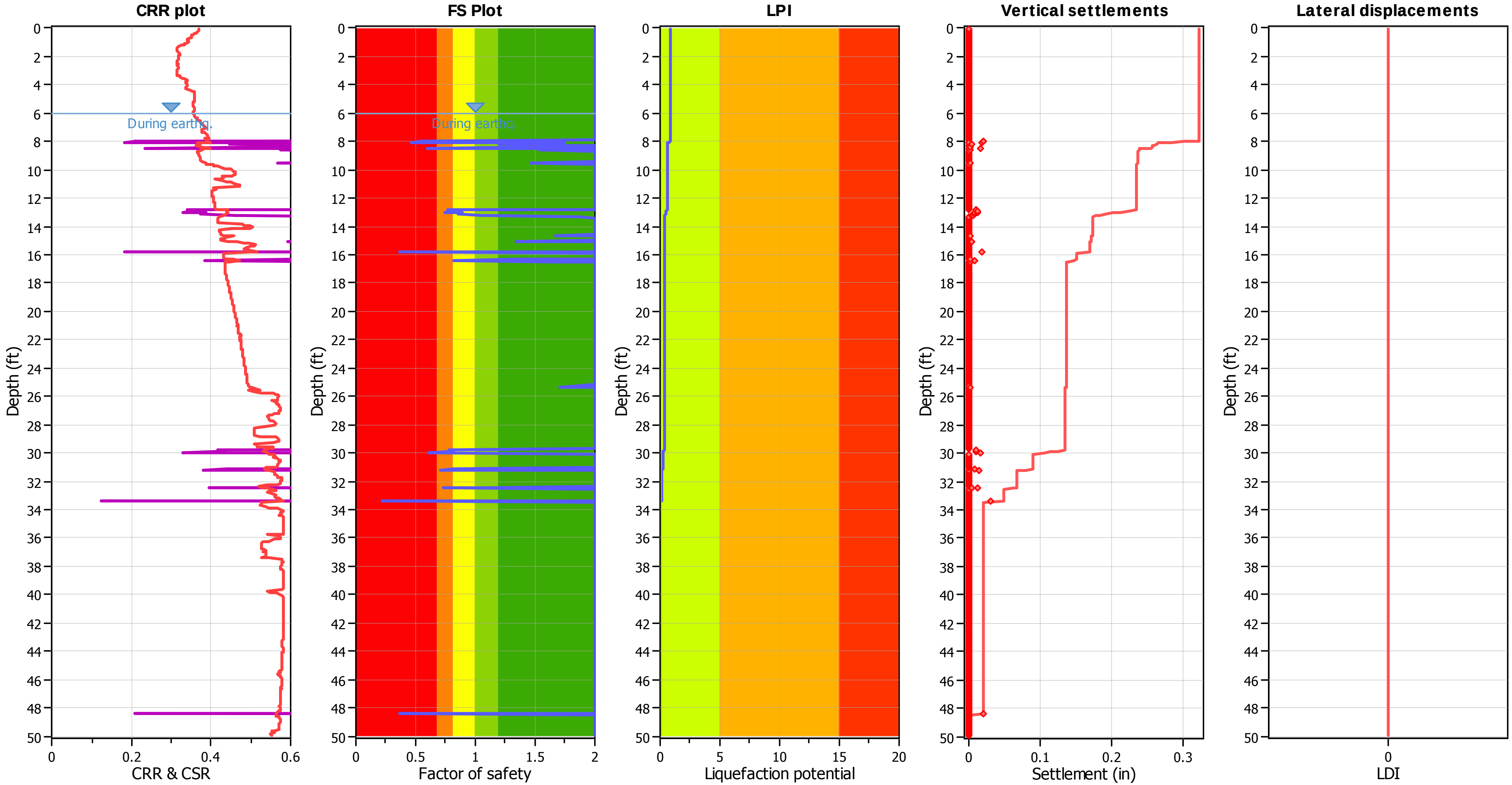
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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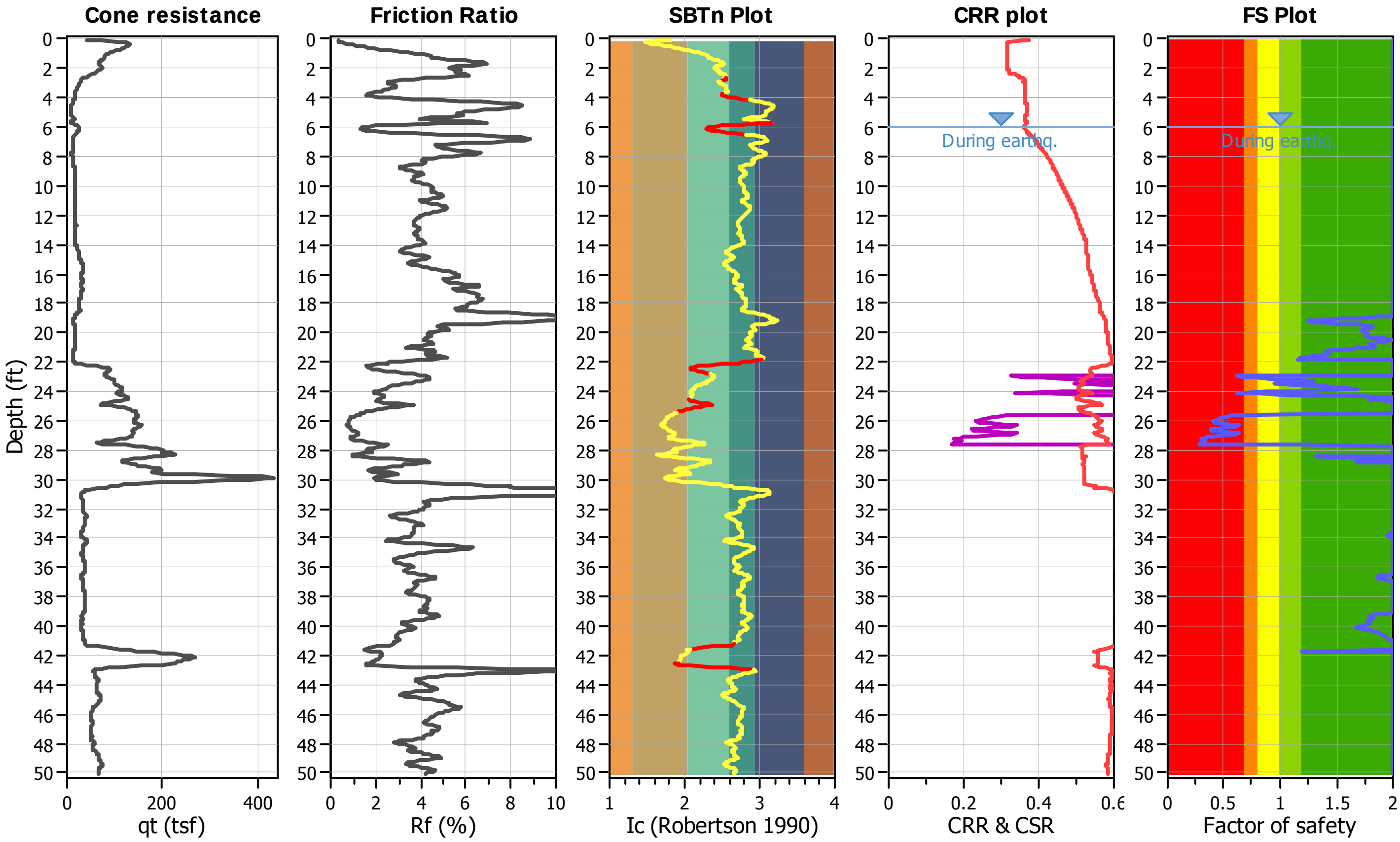
LIQUEFACTION ANALYSIS REPORT

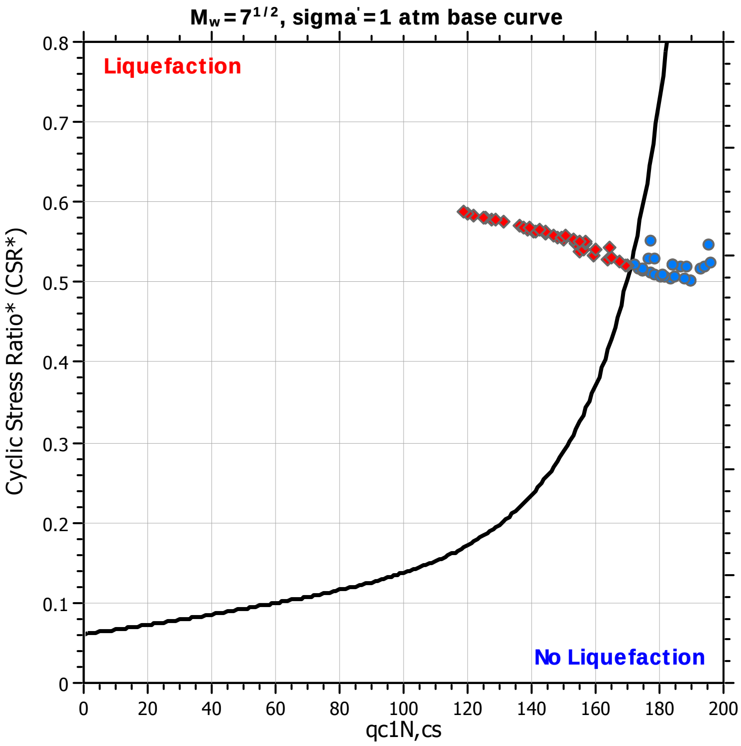
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

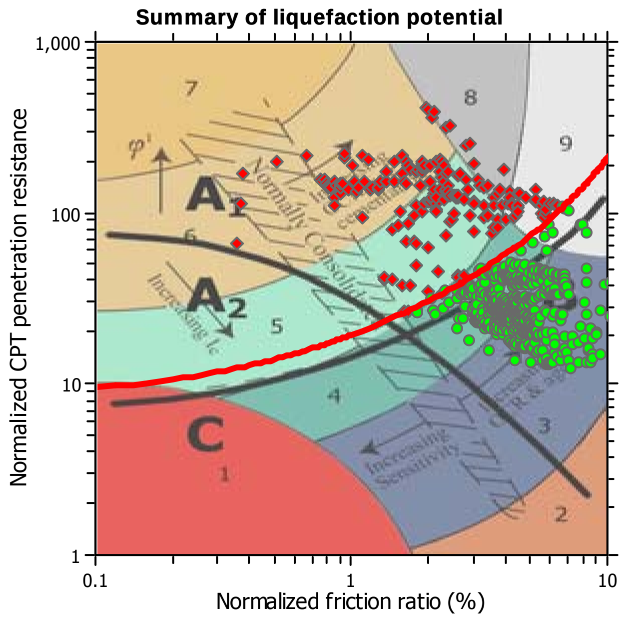
CPT file : 1-CPT1

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

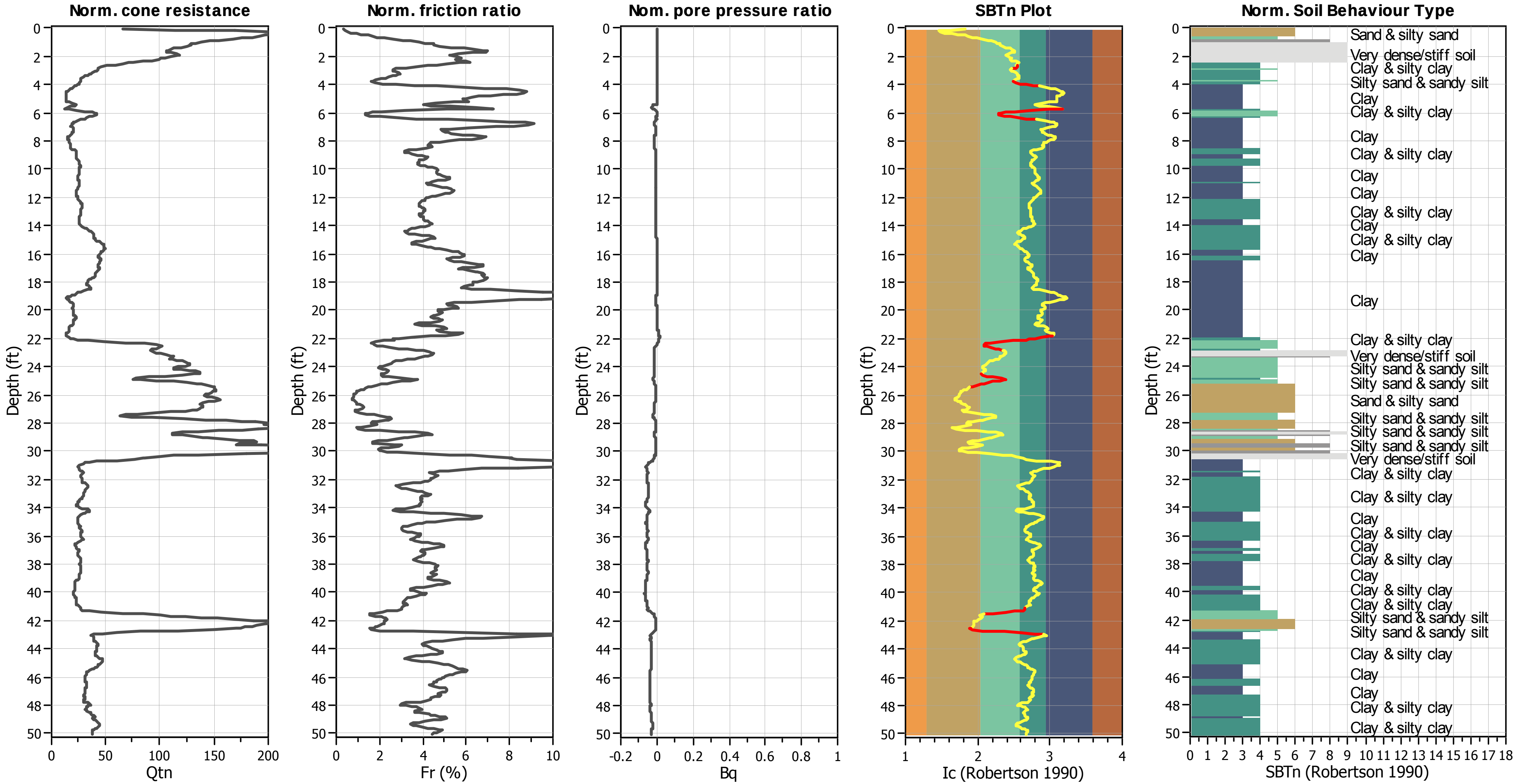






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



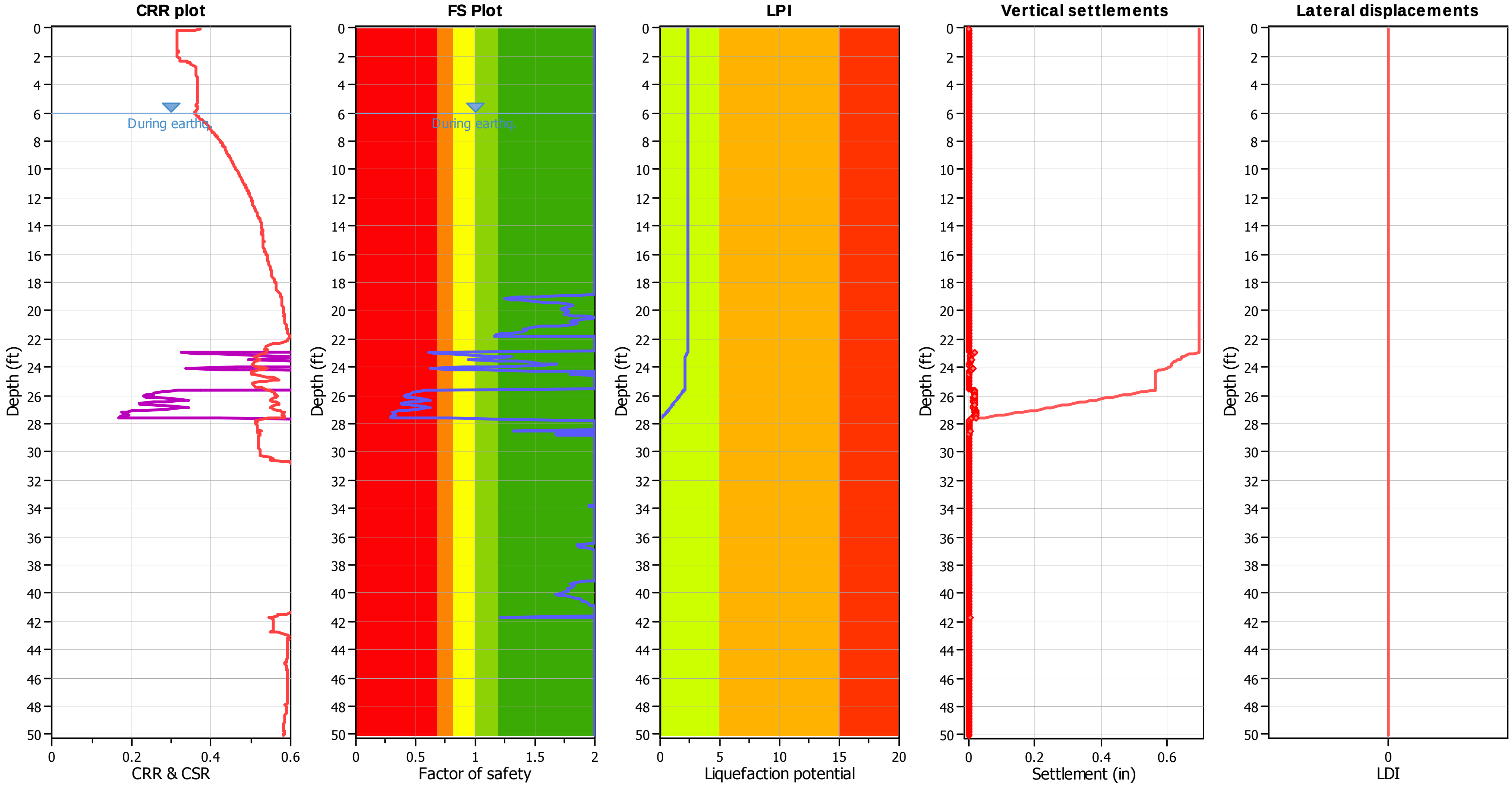
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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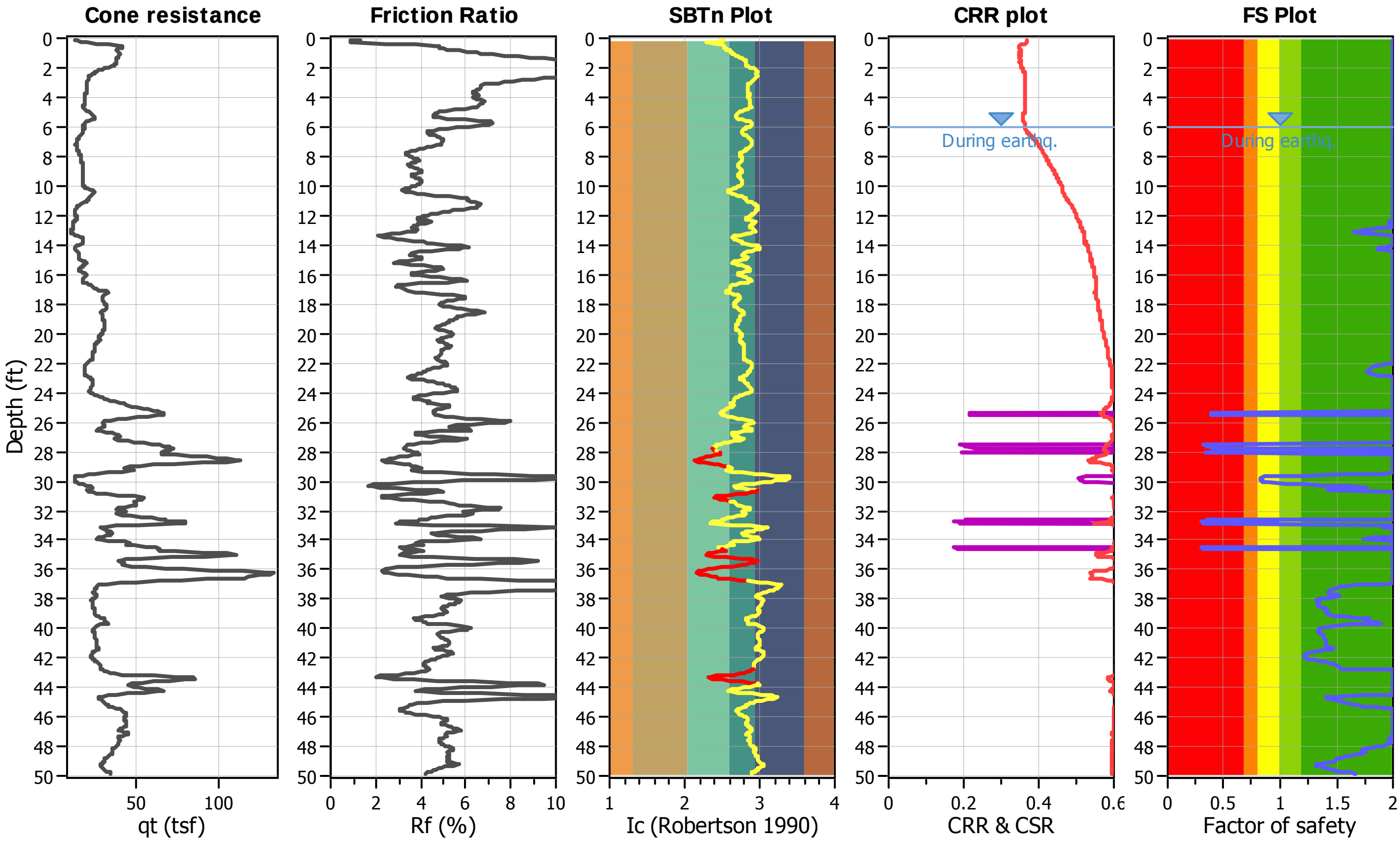
LIQUEFACTION ANALYSIS REPORT

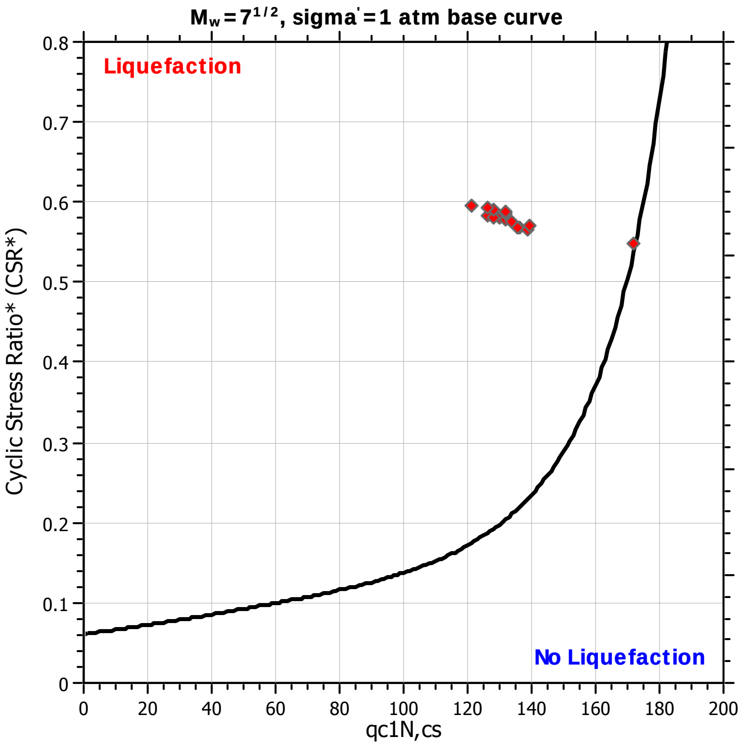
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

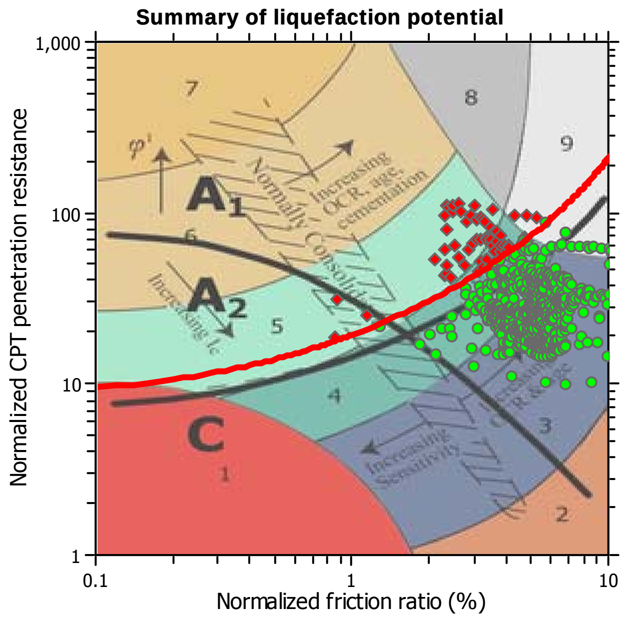
CPT file : 1-CPT2

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

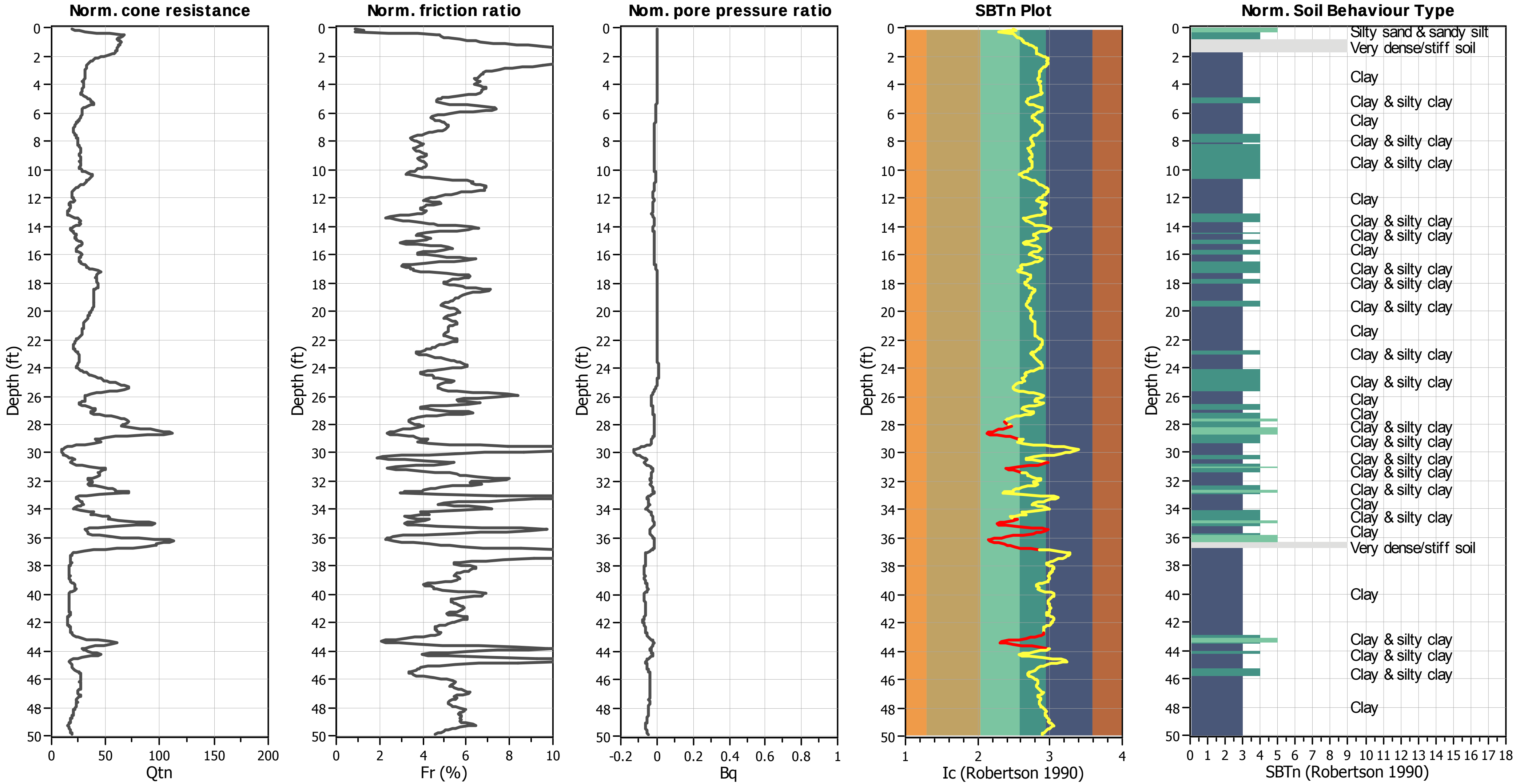






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



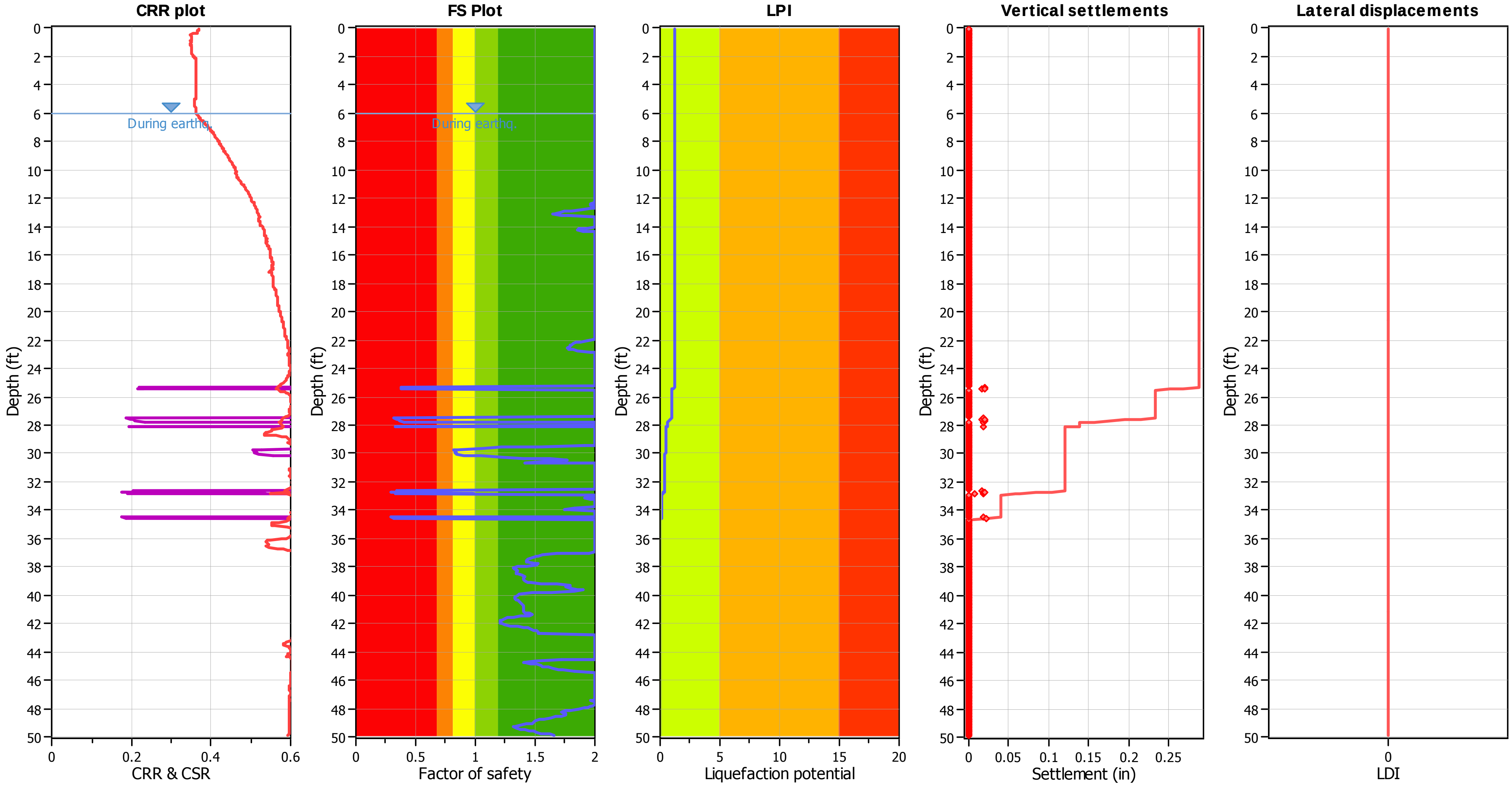
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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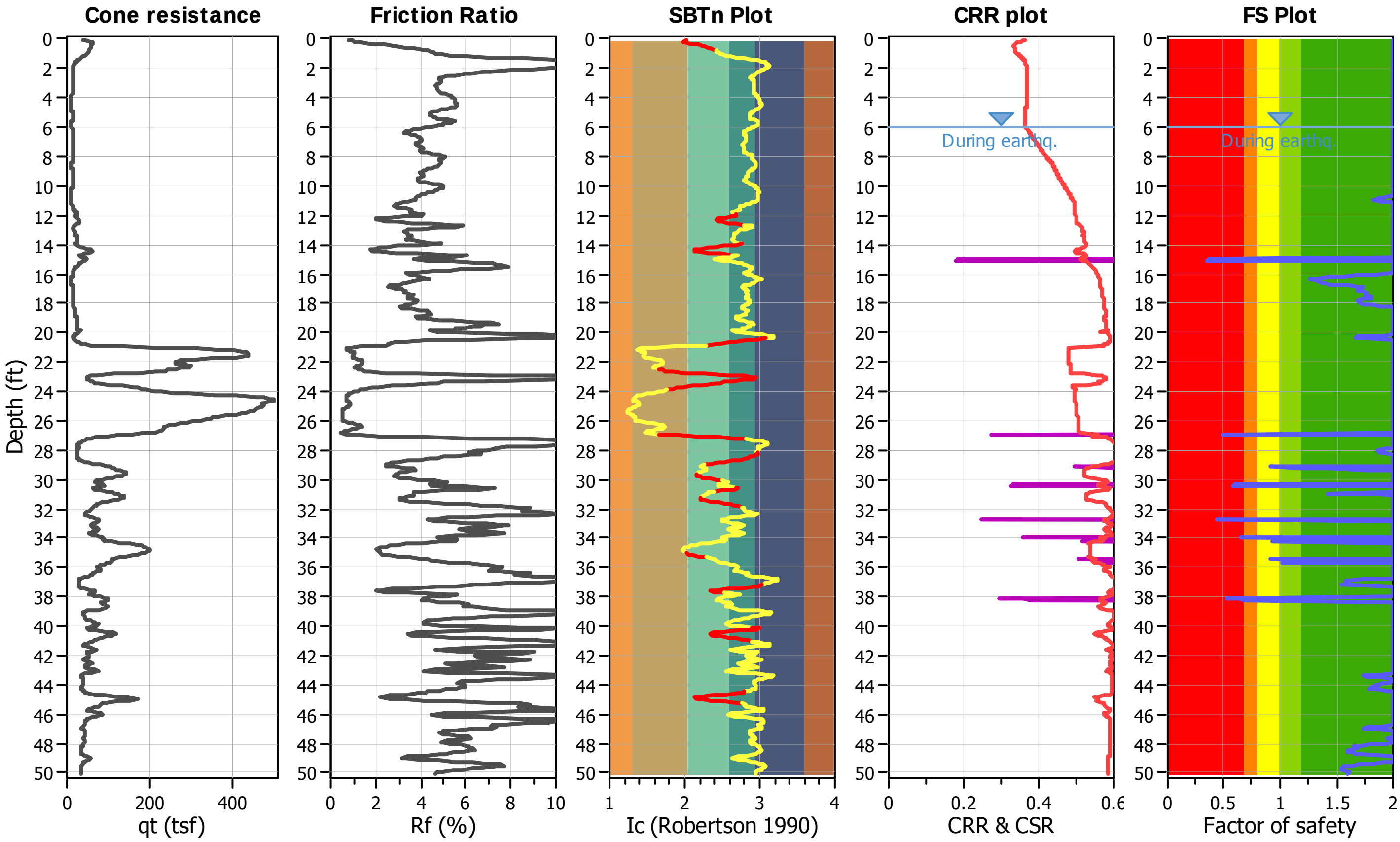
LIQUEFACTION ANALYSIS REPORT

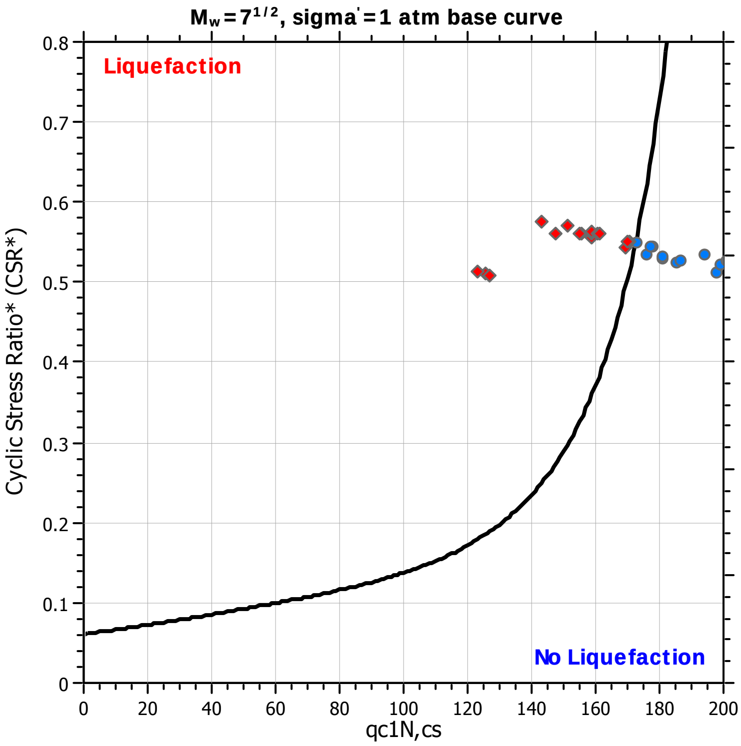
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

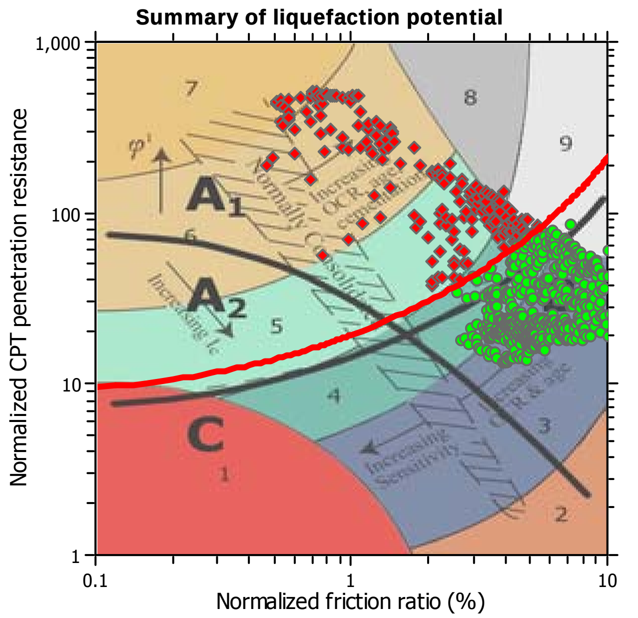
CPT file : 1-CPT3

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

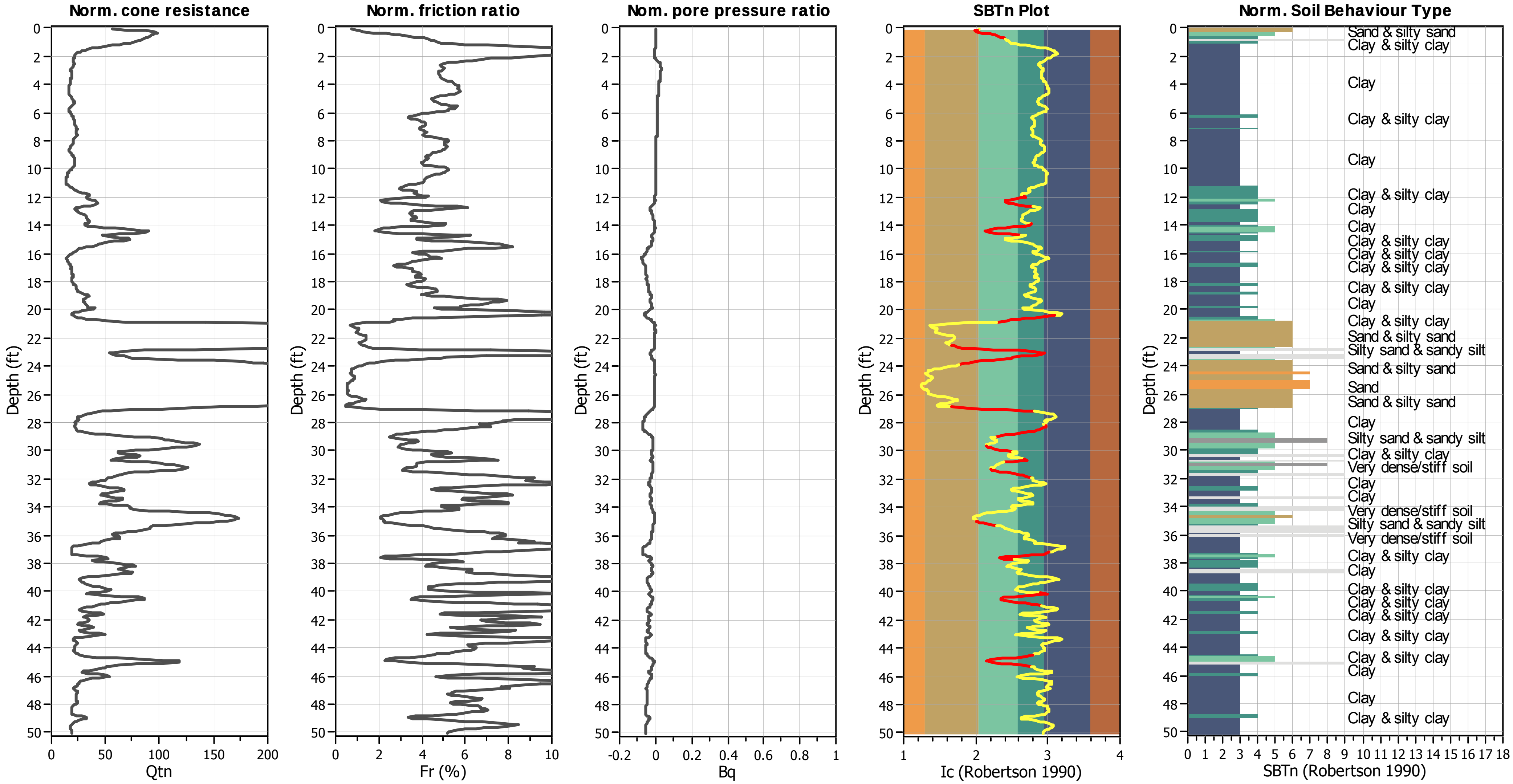






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



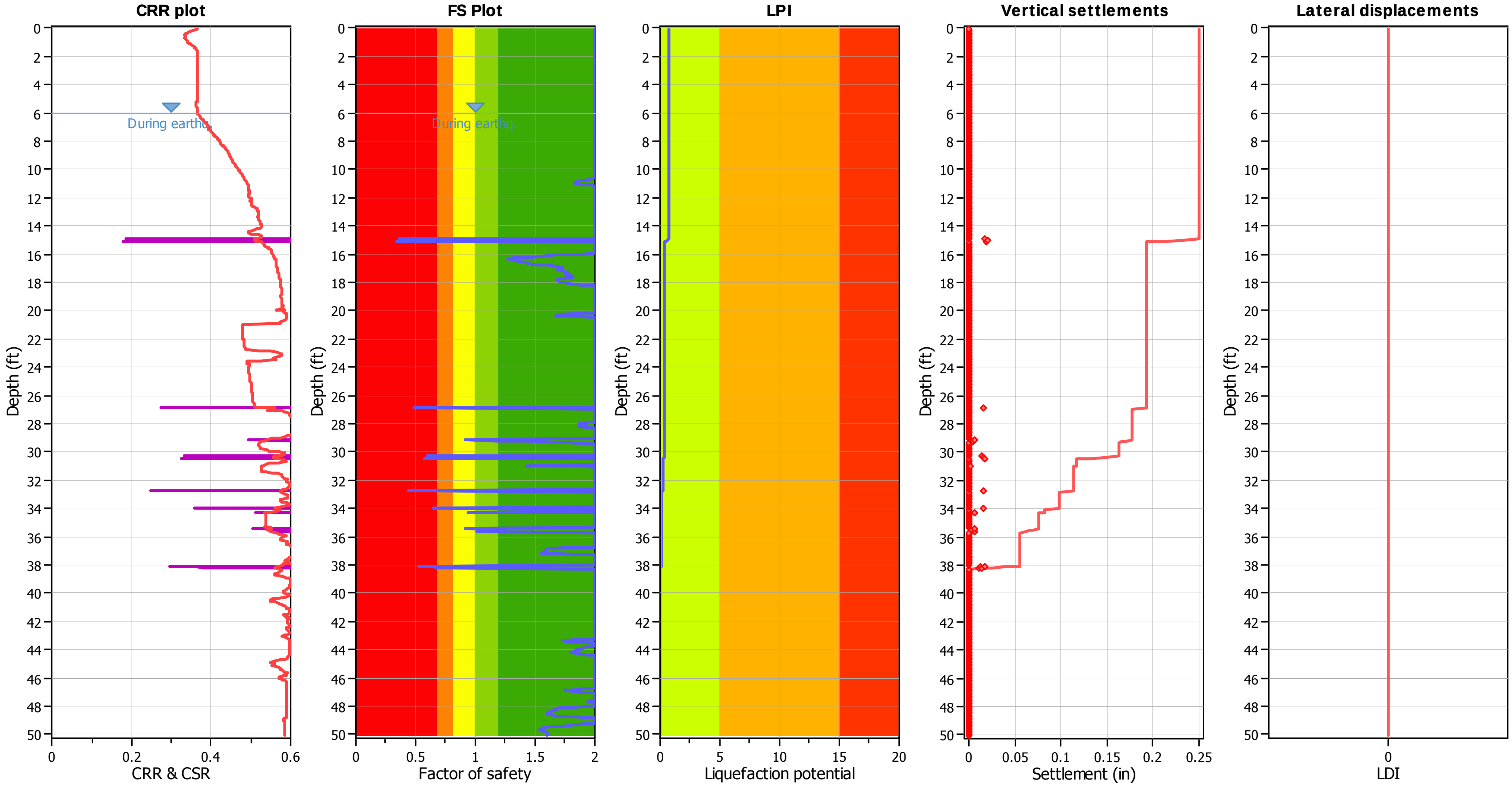
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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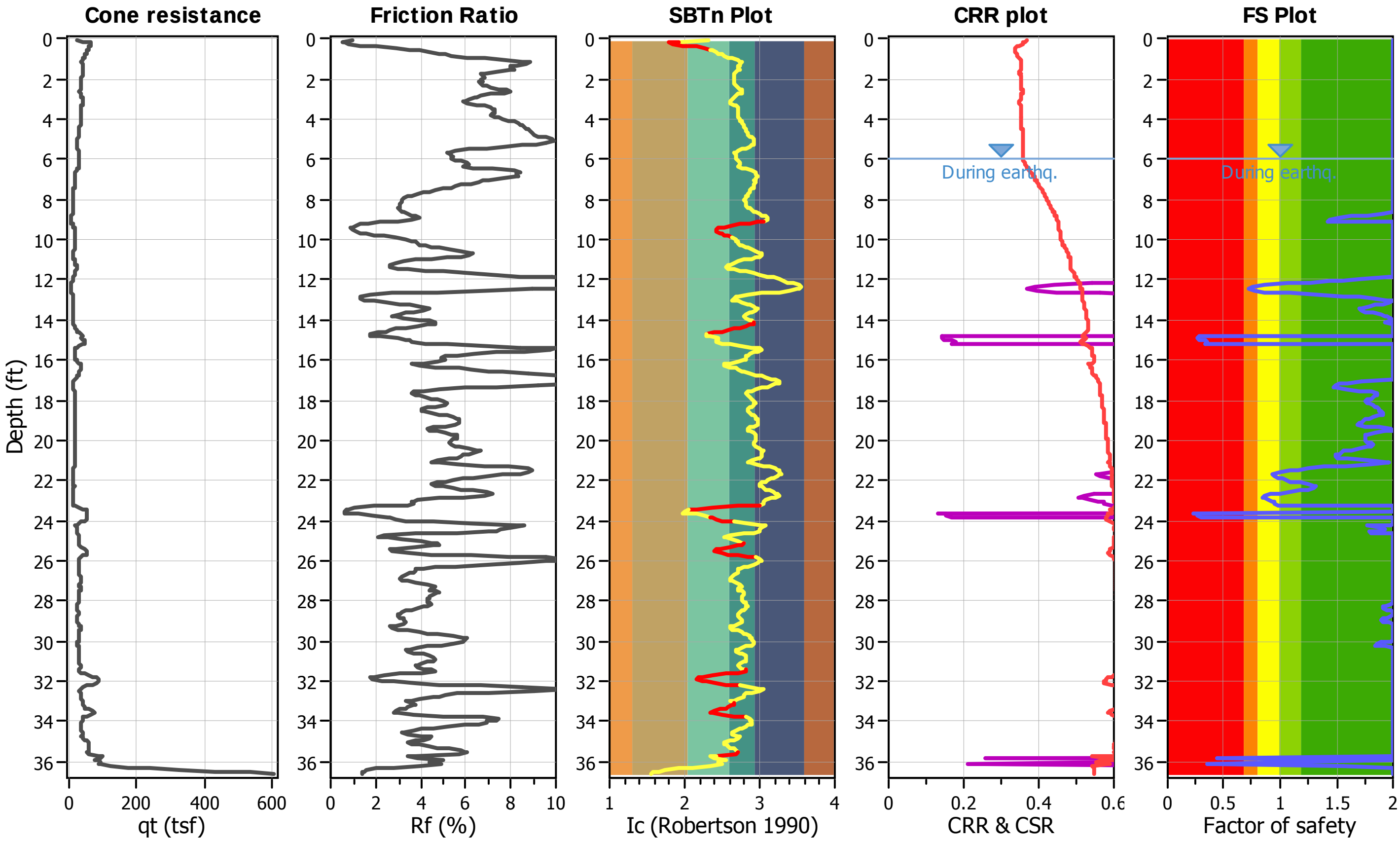
LIQUEFACTION ANALYSIS REPORT

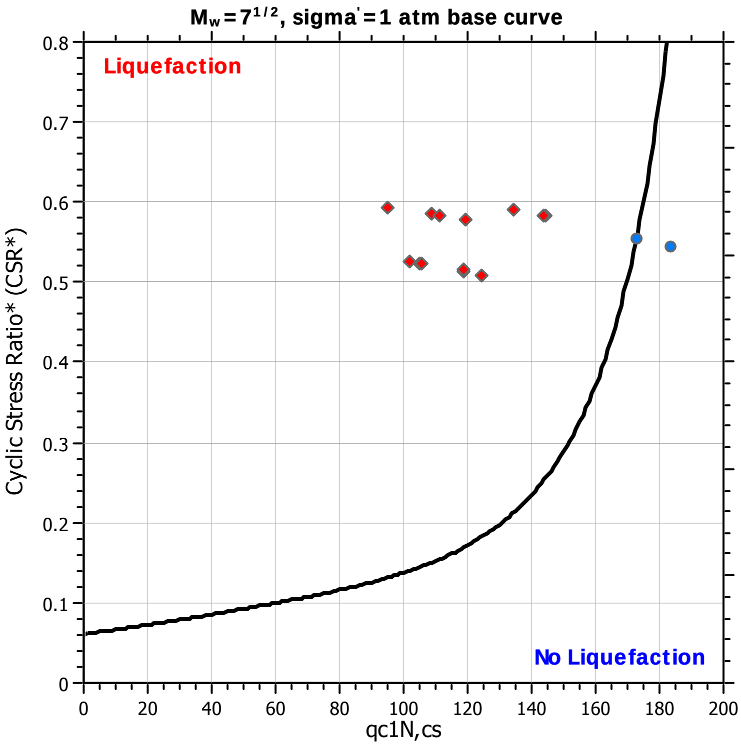
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

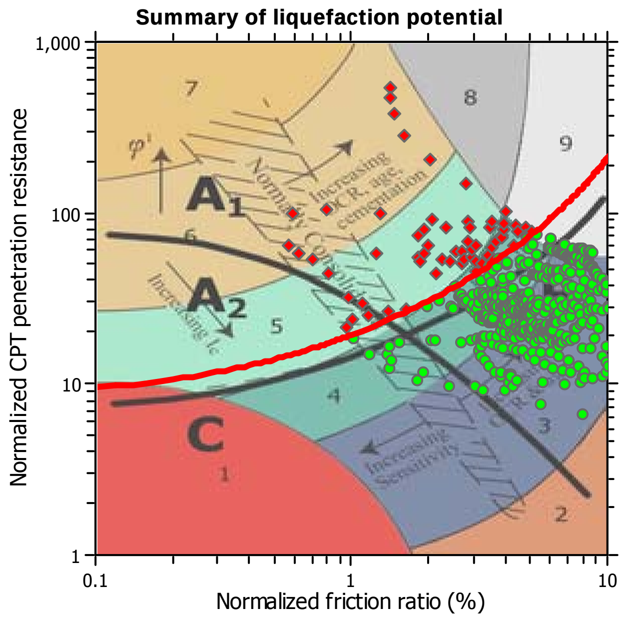
CPT file : 1-CPT4

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

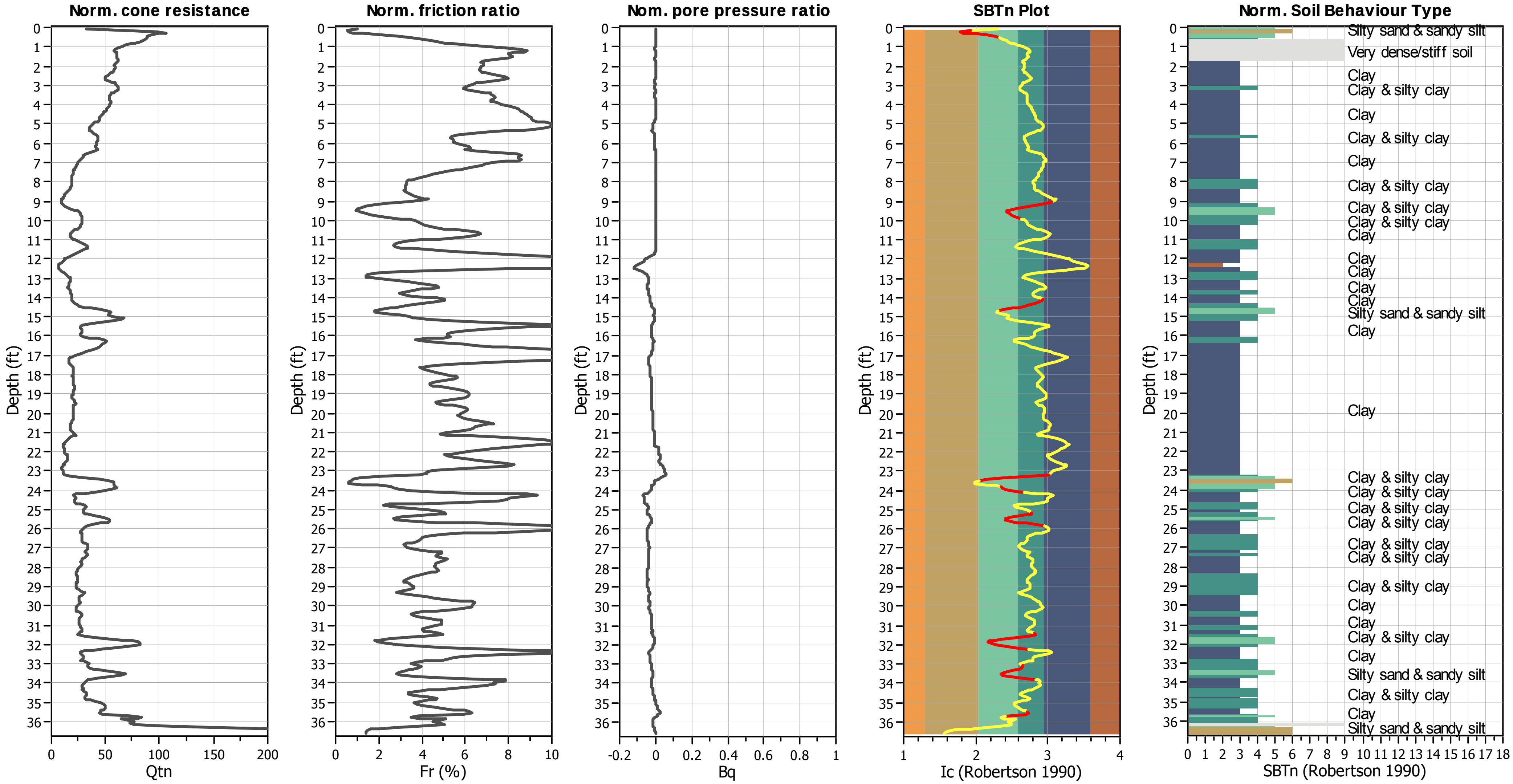






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots (normalized)



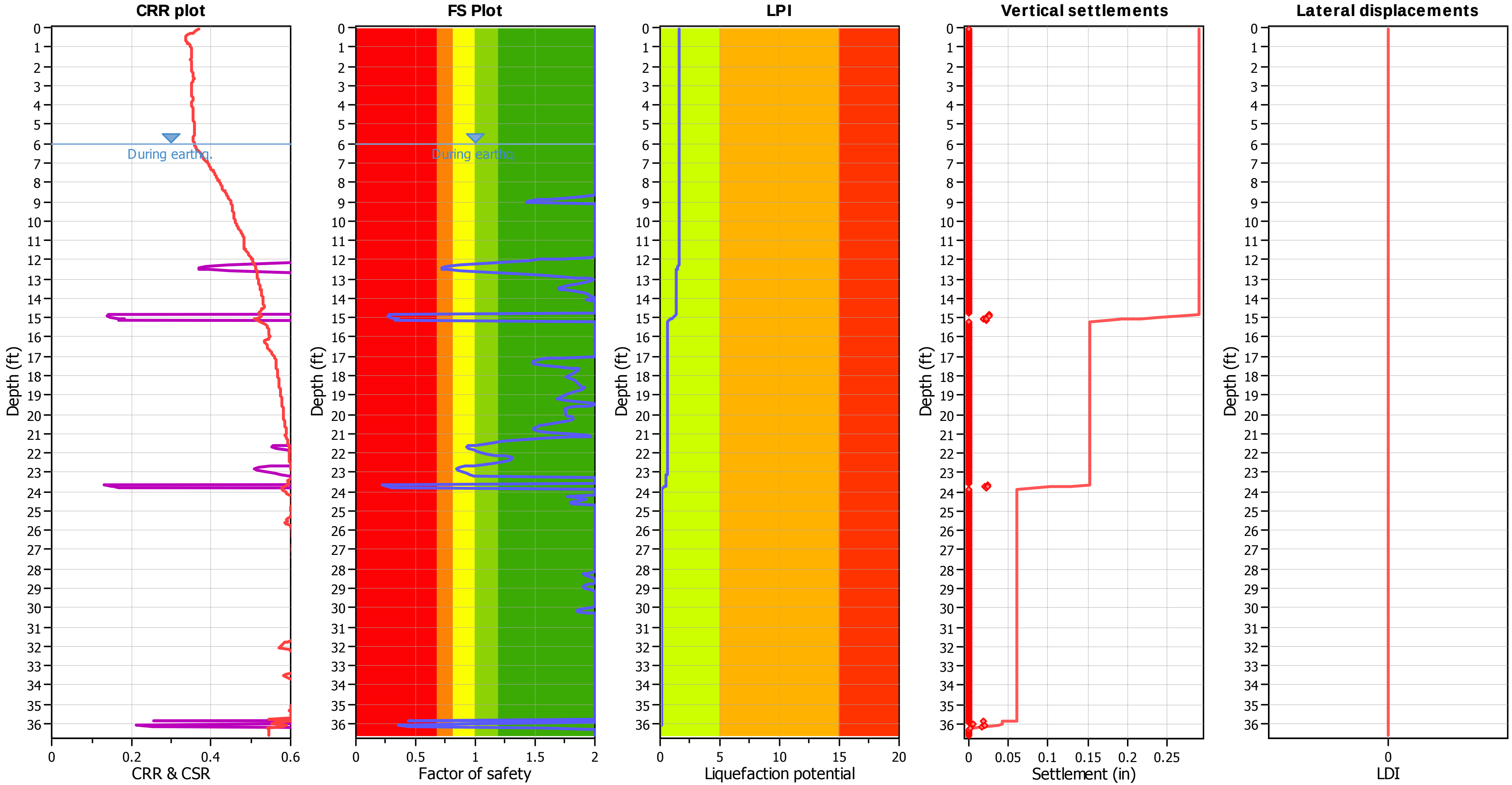
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

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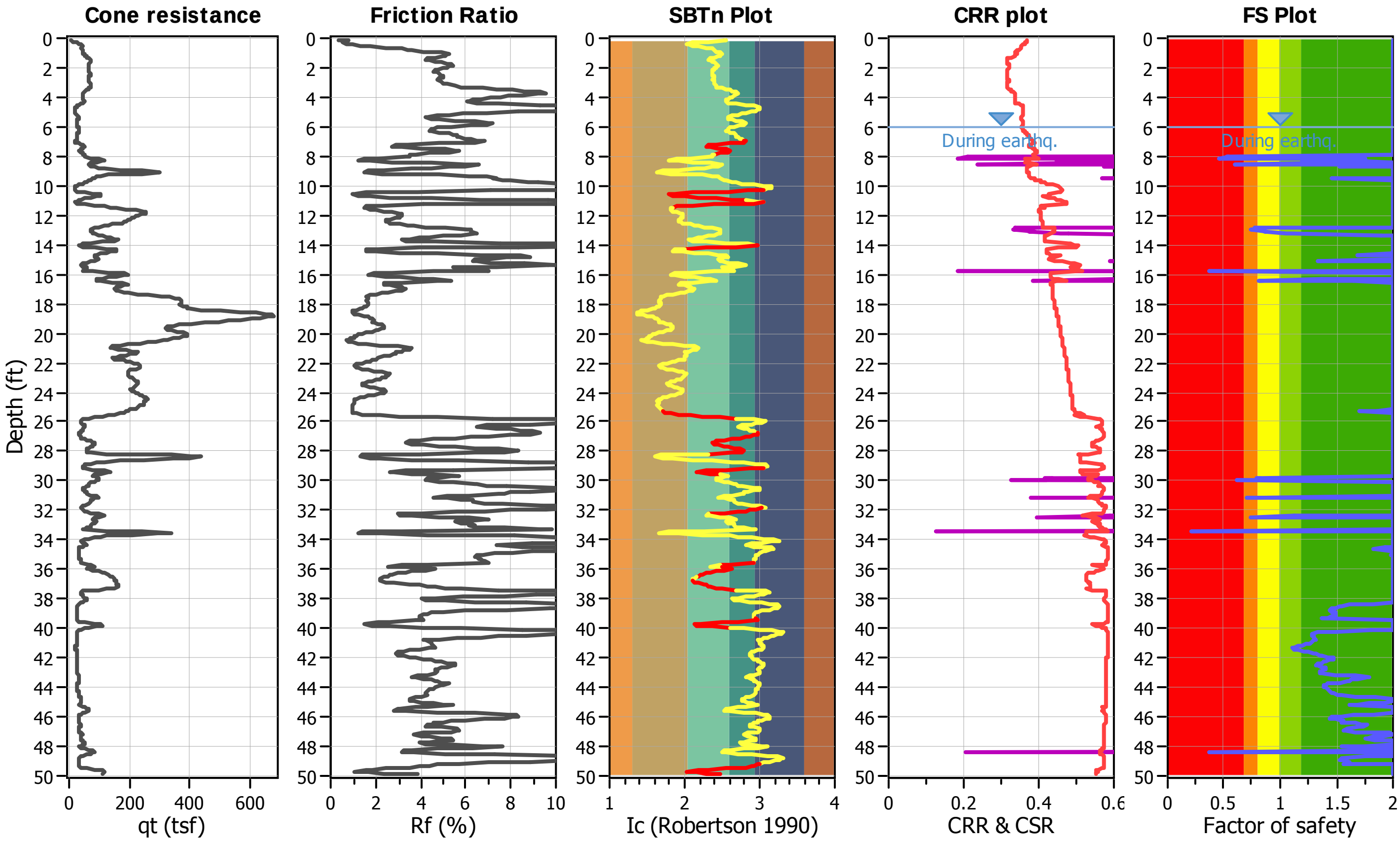
LIQUEFACTION ANALYSIS REPORT

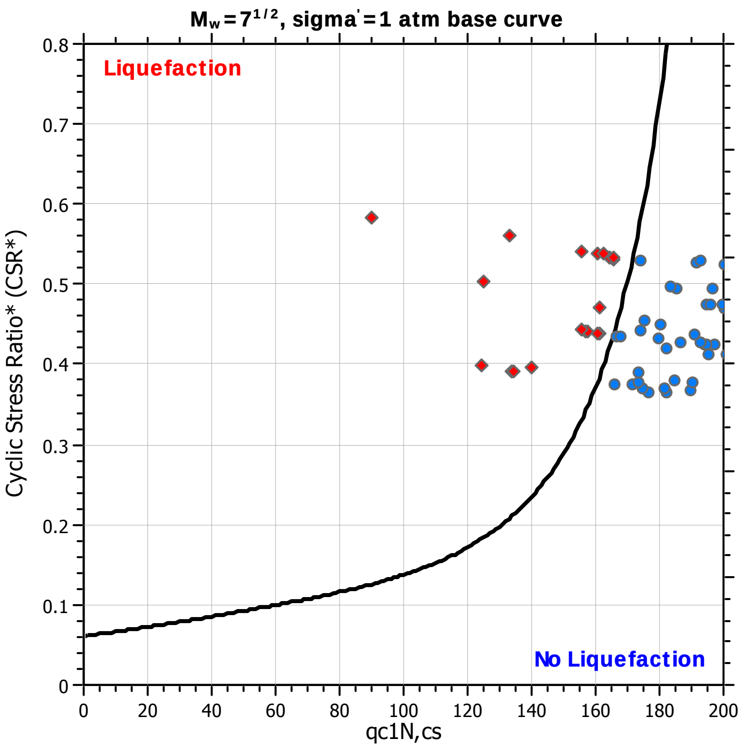
Project title : Pleasant Hill Library **Location : Pleasant Hill, CA**

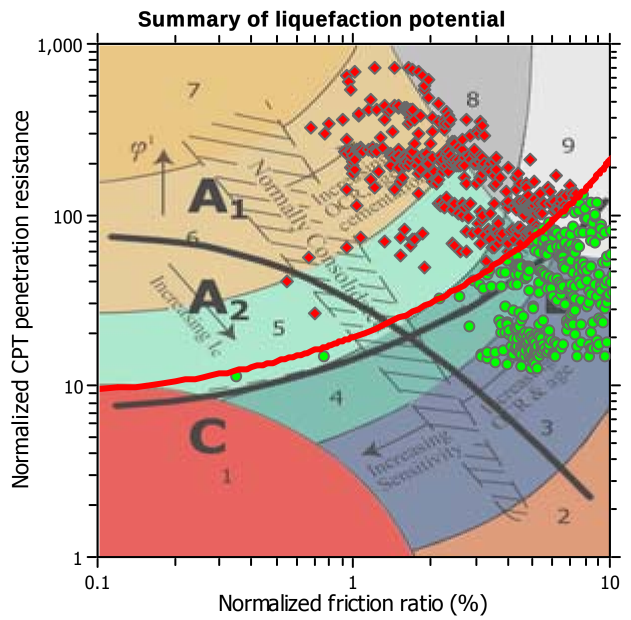
CPT file : 1-CPT5

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	6.00 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.00 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:	7.03	Ic cut-off value:	2.50	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.64	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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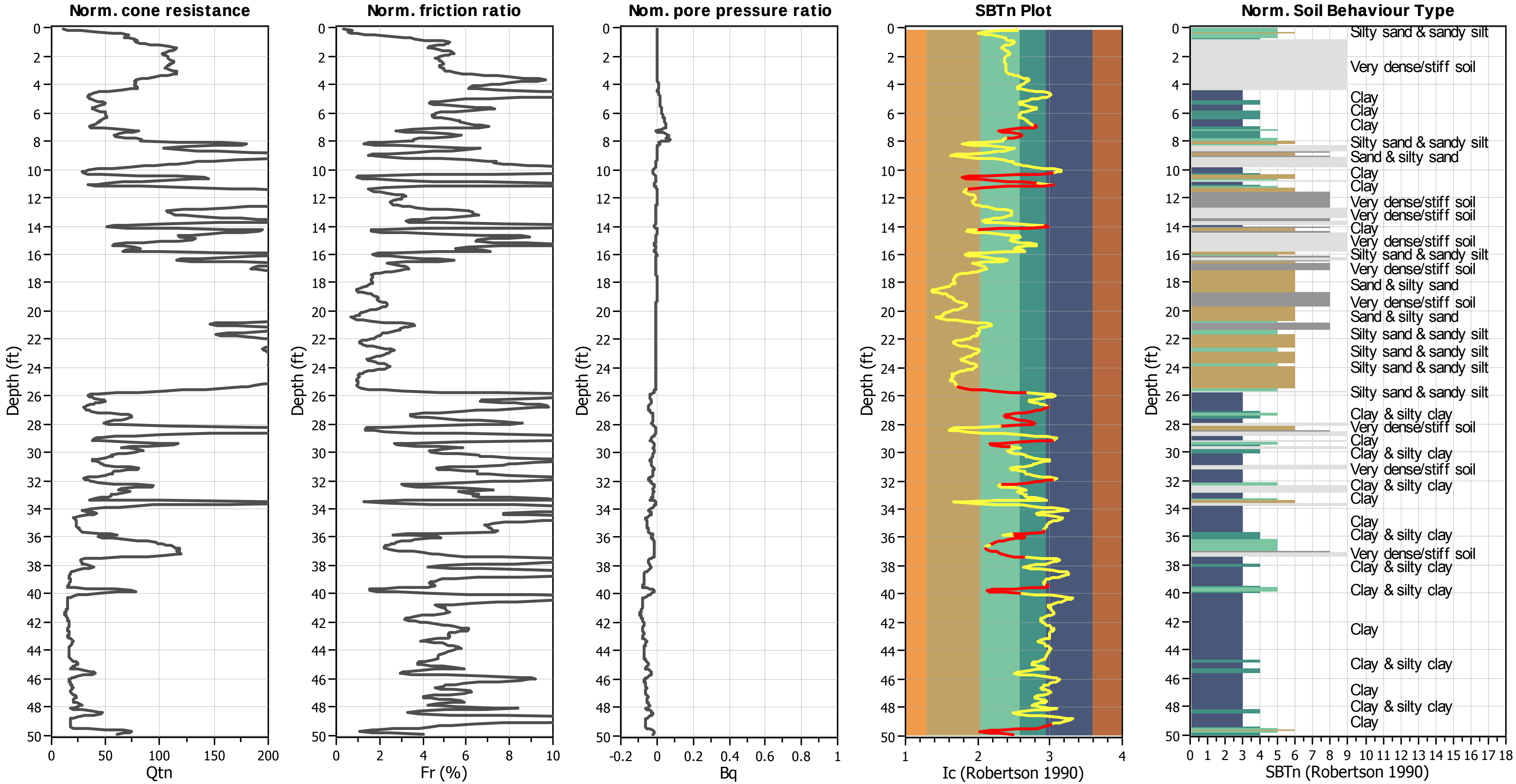
CPT basic interpretation plots (normalized)



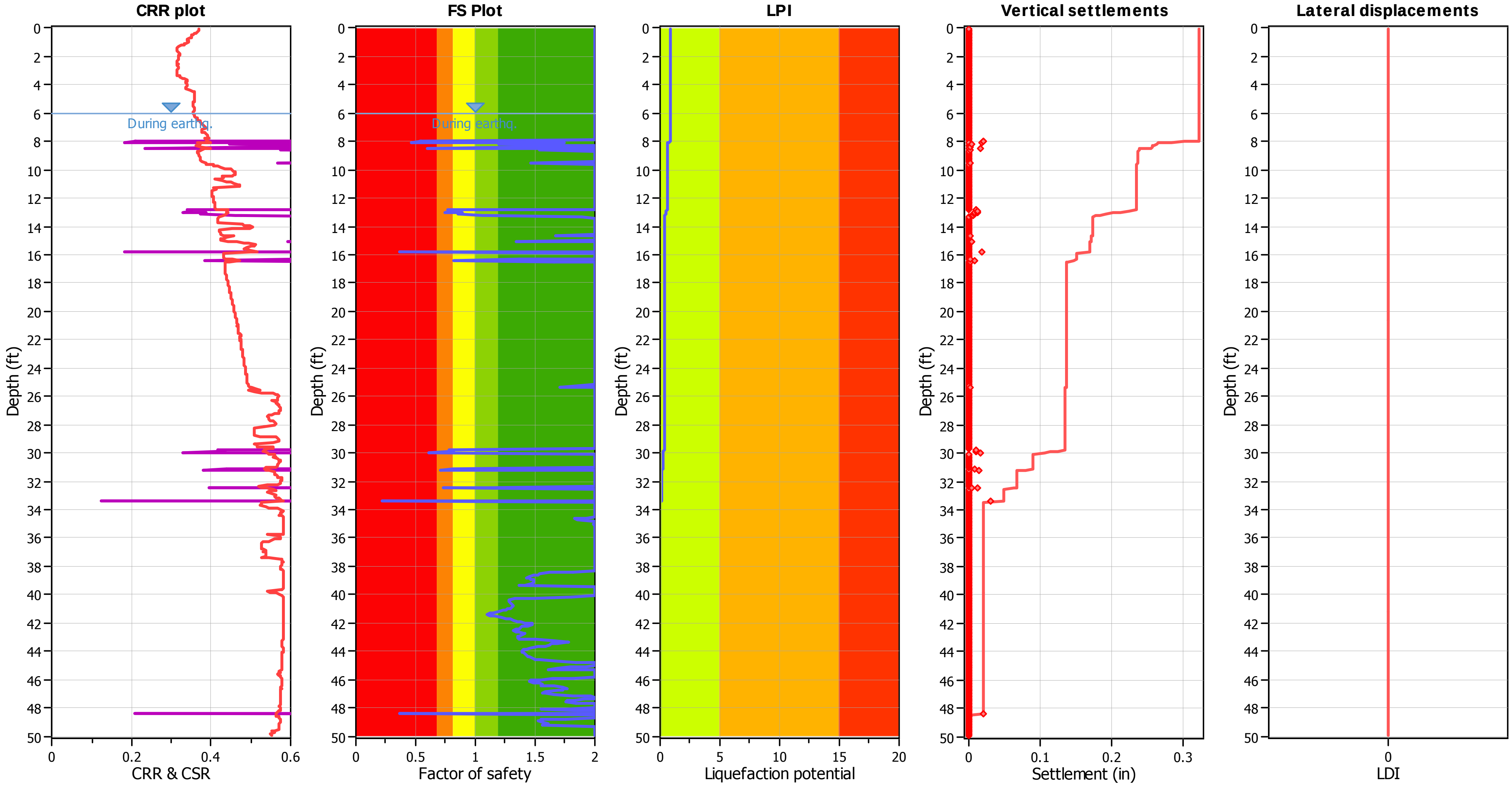
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.00 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.50	K_σ applied:	Yes
Earthquake magnitude M_w:	7.03	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.64	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	6.00 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

APPENDIX E

SUPPLEMENTAL RECOMMENDATIONS

SUPPLEMENTAL RECOMMENDATIONS

Prepared by
ENGEO Incorporated

ENGEO
Expect Excellence

TABLE OF CONTENTS

GENERAL INFORMATION

PREFACE

These supplemental recommendations are intended as a guide for earthwork and are in addition to any previous earthwork recommendations made by the Geotechnical Engineer. If there is a conflict between these supplemental recommendations and any previous recommendations, it should be immediately brought to the attention of ENGEO. Testing standards identified in this document shall be the most current revision (unless stated otherwise).

DEFINITIONS

BACKFILL	Soil, rock or soil-rock material used to fill excavations and trenches.
DRAWINGS	Documents approved for construction which describe the work.
THE GEOTECHNICAL ENGINEER	The project geotechnical engineering consulting firm, its employees, or its designated representatives.
ENGINEERED FILL	Fill upon which the Geotechnical Engineer has made sufficient observations and tests to confirm that the fill has been placed and compacted in accordance with geotechnical engineering recommendations.
FILL	Soil, rock, or soil-rock materials placed to raise the grades of the site or to backfill excavations.
IMPORTED MATERIAL	Soil and/or rock material which is brought to the site from offsite areas.
ONSITE MATERIAL	Soil and/or rock material which is obtained from the site.
OPTIMUM MOISTURE	Water content, percentage by dry weight, corresponding to the maximum dry density as determined by ASTM D-1557.
RELATIVE COMPACTION	The ratio, expressed as a percentage, of the in-place dry density of the fill or backfill material as compacted in the field to the maximum dry density of the same material as determined by ASTM D-1557.
SELECT MATERIAL	Onsite and/or imported material which is approved by the Geotechnical Engineer as a specific-purpose fill.

PART I - EARTHWORK

1.0 GENERAL

1.1 WORK COVERED

Supplemental recommendations for performing earthwork and grading. Activities include:

- ✓ Site Preparation and Demolition
- ✓ Excavation
- ✓ Grading
- ✓ Backfill of Excavations and Trenches
- ✓ Engineered Fill Placement, Moisture Conditioning, and Compaction

1.2 CODES AND STANDARDS

The contractor should perform their work complying with applicable occupational safety and health standards, rules, regulations, and orders. The Occupational Safety and Health Standards (OSHA) Board is the only agency authorized in the State to adopt and enforce occupational safety and health standards (Labor Code § 142 et seq.). The owner, their representative and contractor are responsible for site safety; ENGEO representatives are not responsible for site safety.

Excavating, trenching, filling, backfilling, shoring and grading work should meet the minimum requirements of the applicable Building Code, and the standards and ordinances of state and local governing authorities.

1.3 TESTING AND OBSERVATION

Site preparation, cutting and shaping, excavating, filling, and backfilling should be carried out under the testing and observation of ENGEO. ENGEO shall be retained to perform appropriate field and laboratory tests to check compliance with the recommendations. Any fill or backfill that does not meet the supplemental recommendations shall be removed and/or reworked, until the supplemental recommendations are satisfied.

Tests for compaction shall be made in accordance with test procedures outlined in ASTM D-1557, as applicable, unless other testing methods are deemed appropriate by ENGEO. These and other tests shall be performed in accordance with accepted testing procedures, subject to the engineering discretion of ENGEO.

2.0 MATERIALS

2.1 STANDARD

Materials, tools, equipment, facilities, and services as required for performing the required excavating, trenching, filling and backfilling should be furnished by the Contractor.

2.2 ENGINEERED FILL AND BACKFILL

Material to be used for engineered fill and backfill should be free from organic matter and other deleterious substances, and of such quality that it will compact thoroughly without excessive voids when watered and rolled.

Unless specified elsewhere by ENGEO, engineered fill and backfill shall be free of significant organics, or any other unsatisfactory material. In addition, engineered fill and backfill shall comply with the grading requirements shown in the following table:

TABLE 2.2-1: Engineered Fill and Backfill Requirements

US STANDARD SIEVE	PERCENTAGE PASSING
3"	100
No. 4	35–100
No. 30	20–100

Earth materials to be used as engineered fill and backfill shall be cleared of debris, rubble and deleterious matter. Rocks and aggregate exceeding the maximum allowable size shall be removed from the site. Rocks of maximum dimension in excess of two-thirds of the lift thickness shall be removed from any fill material to the satisfaction of ENGEO.

ENGEO shall be immediately notified if potential hazardous materials or suspect soils exhibiting staining or odor are encountered. Work activities shall be discontinued within the area of potentially hazardous materials. ENGEO shall be notified at least 72 hours prior to the start of filling and backfilling operations. Materials to be used for filling and backfilling shall be submitted to ENGEO no less than 10 days prior to intended delivery to the site. Unless specified elsewhere by ENGEO, where conditions require the importation of low expansive fill material, the material shall be an inert, low to non-expansive soil, or soil-rock material, free of organic matter and meeting the following requirements:

TABLE 2.2-2: Imported Fill Material Requirements

<table>
<tr><th rowspan="3">GRADATION (ASTM D-421)</th><th>SIEVE SIZE</th><th>PERCENT PASSING</th></tr>
<tr><td>2-inch</td><td>100</td></tr>
<tr><td>#200</td><td>15 - 70</td></tr>
<tr><th>PLASTICITY (ASTM D-4318)</th><td colspan="2">Plasticity Index < 12</td></tr>
<tr><th>ORGANIC CONTENT (ASTM D-2974)</th><td colspan="2">Less than 2 percent</td></tr>
</table>

A sample of the proposed import material should be submitted to ENGEO no less than 10 days prior to intended delivery to the site.

2.3 SUBDRAINS

A subdrain system is an underground network of piping used to remove water from areas that collect or retain surface water or subsurface water. Subsurface water is collected by allowing water into the pipe through perforations. Subdrain systems may drain and discharge to an appropriate outlet such as storm drain, natural swales or drainage, etc.. Details for subdrain systems may vary depending on many items, including but not limited to site conditions, soil types, subdrain spacing, depth of the pipe and pervious medium, as well as pipe diameter.

2.4 PIPE

Subdrain pipe shall conform with these supplemental recommendations unless specified elsewhere by ENGEO. Perforated pipe for various depths shall be manufactured in accordance with the following requirements:

TABLE 2.4-1: Perforated Pipe Requirements

PIPE TYPE	STANDARD	TYPICAL SIZES (INCHES)	PIPE STIFFNESS (PSI)
PIPE STIFFNESS ABOVE 200 PSI (BELOW 50 FEET OF FINISHED GRADE)			
ABS SDR 15.3		4 to 6	450
PVC Schedule 80	ASTM D1785	3 to 10	530
PIPE STIFFNESS BETWEEN 100 PSI AND 150 PSI (BETWEEN 15 AND 50 FEET OF FINISHED GRADE)			
ABS SDR 23.5	ASTM D2751	4 to 6	150
PVC SDR 23.5	ASTM D3034	4 to 6	153
PVC Schedule 40	ASTM D1785	3 to 10	135
ABS Schedule 40/DWV	ASTM D1527 & D2661	3 to 10	
PIPE STIFFNESS BETWEEN 45 PSI AND 50 PSI* (BETWEEN 0 TO 15 FEET OF FINISHED GRADE)			
PVC A-2000	ASTM F949	4 to 10	50
PVC SDR 35	ASTM D3034	4 to 8	46
ABS SDR 35	ASTM D2751	4 to 8	45
Corrugated PE	AASHTO M294 Type S	4 to 10	45

***Pipe with a stiffness less than 45 psi should not be used.**

Other pipes not listed in the table above shall be submitted for review by the Geotechnical Engineer not less 72 hours before proposed use.

2.5 OUTLETS AND RISERS

Subdrain outlets and risers must be fabricated from the same material as the subdrain pipe. Outlet and riser pipe and fittings must not be perforated. Covers must be fitted and bolted into the riser pipe or elbow. Covers must seat uniformly and not be subject to rocking.

2.6 PERMEABLE MATERIAL

Permeable material shall generally conform to Caltrans Standard Specification unless specified otherwise by ENGEO. Class 2 permeable material shall comply with the gradation requirements shown in the following table.

TABLE 2.6-1: Class 2 Permeable Material Grading Requirements

SIEVE SIZES	PERCENTAGE PASSING
1"	100
3/4"	90 to 100
3/8"	40 to 100
No. 4	25 to 40
No. 8	18 to 33
No. 30	5 to 15
No. 50	0 to 7
No. 200	0 to 3

2.7 FILTER FABRIC

Filter fabric shall meet the following Minimum Average Roll Values unless specified elsewhere by ENGEO.

Grab Strength (ASTM D-4632) .... 180 lbs
Mass per Unit Area (ASTM D-4751) ....6 oz/yd^2
Apparent Opening Size (ASTM D-4751) ....70-100 U.S. Std. Sieve
Flow Rate (ASTM D-4491).. 80 gal/min/ft^2
Puncture Strength (ASTM D-4833) .... 80 lbs

Areas to receive filter fabric must comply with the compaction and elevation tolerance specified for the material involved. Handle and place filter fabric under the manufacturer's instructions. Align and place filter fabric without wrinkles.

Overlap adjacent roll ends of filter fabric in accordance with manufacturer's recommendations. The preceding roll must overlap the following roll in the direction that the permeable material is being spread. Completely replace torn or punctured sections damaged during placement or repair by placing a piece of filter fabric that is large enough to cover the damaged area and comply with the overlap specified. Cover filter fabric with the thickness of overlying material shown within 72 hours of placing the fabric.

2.8 GEOCOMPOSITE DRAINAGE

Geocomposite drainage is a prefabricated material that includes filter fabric and plastic pipe. Filter fabric must be Class A. The drain shall be of composite construction consisting of a supporting structure or drainage core material surrounded by a geotextile. The geotextile shall encapsulate the drainage core and prevent random soil intrusion into the drainage structure. The drainage core material shall consist of a three-dimensional polymeric material with a structure that permits flow along the core laterally. The core structure shall also be constructed to permit flow regardless of the water inlet surface. The drainage core shall provide support to the geotextile.

A geotextile flap shall be provided along drainage core edges. This flap shall be of sufficient width for sealing the geotextile to the adjacent drainage structure edge to prevent soil intrusion into the structure during and after installation. The geotextile shall cover the full length of the core. The geocomposite core shall be furnished with an approved method of constructing and connecting with outlet pipes. If the fabric on the geocomposite drain is torn or punctured, replace the damaged section completely. The specific drainage composite material and supplier shall be preapproved by ENGEO.

The Contractor shall submit a manufacturer's certification that the geocomposite meets the design properties and respective index criteria measured in full accordance with applicable test methods. The manufacturer's certification shall include a submittal package of documented test results that confirm the design values. In case of dispute over validity of design values, the Contractor will supply design property test data from a laboratory approved by ENGEO, to support the certified values submitted.

Geocomposite material suppliers shall provide a qualified and experienced representative onsite to assist the Contractor and ENGEO at the start of construction with directions on the use of drainage composite. If there is more than one application on a project, this criterion will apply to construction of the initial application only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining applications. The soil surface against which the geocomposite is to be placed shall be free of debris and inordinate irregularities that will prevent intimate contact between the soil surface and the drain.

Edge seams shall be formed by utilizing the flap of the geotextile extending from the geocomposite's edge and lapping over the top of the fabric of the adjacent course. The fabric flap shall be securely fastened to the adjacent fabric by means of plastic tape or non-water-soluble construction adhesive, as recommended by the supplier. To prevent soil intrusion, exposed edges of the geocomposite drainage core edge must be covered.

Approved backfill shall be placed immediately over the geocomposite drain. Backfill operations should be performed to not damage the geotextile surface of the drain. Also during operations, avoid excessive settlement of the backfill material. The geocomposite drain, once installed, shall not be exposed for more than 7 days prior to backfilling.

PART II - GEOGRID SOIL REINFORCEMENT

Geogrid soil reinforcement (geogrid) shall be submitted to ENGEO and should be approved before use. The geogrid shall be a regular network of integrally connected polymer tensile elements with aperture geometry sufficient to permit significant mechanical interlock with the surrounding soil or rock. The geogrid structure shall be dimensionally stable and able to retain its geometry under construction stresses and shall have high resistance to damage during construction to ultraviolet degradation and to chemical and biological degradation encountered in the soil being reinforced. The geogrids shall have an Allowable Tensile Strength (T_a) and Pullout Resistance, for the soil type(s) as specified on design plans.

The contractor shall submit a manufacturer's certification that the geogrids supplied meet plans and project specifications. The contractor shall check the geogrid upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geogrid shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geogrid will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geogrid damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geogrid material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project, for a minimum of three days, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall also be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). Geogrid reinforcement may be joined with mechanical connections or overlaps as recommended and approved by the manufacturer. Joints shall not be placed within 6 feet of the slope face, within 4 feet below top of slope, nor horizontally or vertically adjacent to another joint.

The geogrid reinforcement shall be installed in accordance with the manufacturer's recommendations. The geogrid reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed. The geogrid reinforcement shall be placed in continuous longitudinal strips in the direction of main reinforcement. However, if the Contractor is unable to complete a required length with a single continuous length of geogrid, a joint may be made with the manufacturer's approval. Only one joint per length of geogrid shall be allowed. This joint shall be made for the full width of the strip by using a similar material with similar strength. Joints in geogrid reinforcement shall be pulled and held taut during fill placement.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geogrid reinforcement shall be overlapped or mechanically connected where exposed in a wrap around face system, as applicable.

The Contractor may place only that amount of geogrid reinforcement required for immediately pending work to prevent undue damage. After a layer of geogrid reinforcement has been placed, the next succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geogrid reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geogrid reinforcement and soil. Geogrid reinforcement shall be placed to lay flat and pulled tight prior to backfilling. After a layer of geogrid reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geogrid reinforcement in position until the subsequent soil layer can be placed.

Under no circumstances shall a track-type vehicle be allowed on the geogrid reinforcement before at least 6 inches of soil have been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geogrid reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geosynthetic reinforcement at slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided. During construction, the surface of the fill should be kept approximately horizontal. Geogrid reinforcement shall be placed directly on the compacted horizontal fill surface. Geogrid reinforcements are to be placed as shown on plans, and oriented correctly.

PART III - GEOTEXTILE SOIL REINFORCEMENT

The specific geotextile material and supplier shall be preapproved by ENGEO. The contractor shall submit a manufacturer's certification that the geotextiles supplied meet the respective index criteria set when geotextile was approved by ENGEO, measured in full accordance with specified test methods and standards.

The contractor shall check the geotextile upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the geotextile shall be protected from temperatures greater than 140°F, mud, dirt, dust, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the geotextile will be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be repaired by placing a patch over the damaged area. Any geotextile damaged during storage or installation shall be replaced by the Contractor at no additional cost to the owner.

Geotextile material suppliers shall provide a qualified and experienced representative onsite at the initiation of the project to assist the Contractor and ENGEO personnel at the start of construction. The geotextile reinforcement shall be installed in accordance with the manufacturer's recommendations. The geotextile reinforcement shall be placed within the layers of the compacted soil as shown on the plans or as directed, secured with staples, pins, or small piles of backfill, placed without wrinkles, and aligned with the primary strength direction perpendicular to slope contours. Cover geotextile reinforcement with backfill within the same work shift. Place at least 6 inches of backfill on the geotextile reinforcement before operating or driving equipment or vehicles over it, except those used under the conditions specified below for spreading backfill.

Adjacent strips, in the case of 100 percent coverage in plan view, need not be overlapped. The minimum horizontal coverage is 50 percent, with horizontal spacing between reinforcement no greater than 40 inches. Horizontal coverage of less than 100 percent shall not be allowed unless specifically detailed in the construction drawings. Adjacent rolls of geotextile reinforcement shall be overlapped or mechanically connected where exposed in a wraparound face system, as applicable.

The contractor may place only that amount of geotextile reinforcement required for immediately pending work to prevent undue damage. After a layer of geotextile reinforcement has been placed, the succeeding layer of soil shall be placed and compacted as appropriate. After the specified soil layer has been placed, the next geotextile reinforcement layer shall be installed. The process shall be repeated for each subsequent layer of geotextile reinforcement and soil.

Geotextile reinforcement shall be placed to lay flat and be pulled tight prior to backfilling. After a layer of geotextile reinforcement has been placed, suitable means, such as pins or small piles of soil, shall be used to hold the geotextile reinforcement in position until the subsequent soil layer can be placed. Under no circumstances shall a track-type vehicle be allowed on the geotextile reinforcement before at least six inches of soil has been placed. Turning of tracked vehicles should be kept to a minimum to prevent tracks from displacing the fill and the geotextile reinforcement. If approved by the Manufacturer, rubber-tired equipment may pass over the geotextile reinforcement as slow speeds, less than 10 mph. Sudden braking and sharp turning shall be avoided.

During construction, the surface of the fill should be kept approximately horizontal. Geotextile reinforcement shall be placed directly on the compacted horizontal fill surface. Geotextile reinforcements are to be placed within three inches of the design elevations and extend the length as shown on the elevation view unless otherwise directed by ENGEO.

Replace or repair any geotextile reinforcement damaged during construction. Grade and compact backfill to ensure the reinforcement remains taut. Geotextile soil reinforcement must be tested to the required design values using the following ASTM test methods.

TABLE III-1: Geotextile Soil Reinforcements

PROPERTY	TEST
Elongation at break, percent	ASTM D 4632
Grab breaking load, lb, 1-inch grip (min) in each direction	ASTM D 4632
Wide width tensile strength at 5 percent strain, lb/ft (min)	ASTM D 4595
Wide width tensile strength at ultimate strength, lb/ft (min)	ASTM D 4595
Tear strength, lb (min)	ASTM D 4533
Puncture strength, lb (min)	ASTM D 6241
Permittivity, sec^{-1} (min)	ASTM D 4491
Apparent opening size, inches (max)	ASTM D 4751
Ultraviolet resistance, percent (min) retained grab break load, 500 hours	ASTM D 4355

PART IV - EROSION CONTROL MAT

Work shall consist of furnishing and placing a synthetic erosion control mat and/or degradable erosion control blanket for slope face protection and lining of runoff channels. The specific erosion control material and supplier shall be pre-approved by ENGEO.

The Contractor shall submit a manufacturer's certification that the erosion mat/blanket supplied meets the criteria specified when the material was approved by ENGEO. The manufacturer's certification shall include a submittal package of documented test results that confirm the property values. Jute mesh shall consist of processed natural jute yarns woven into a matrix, and netting shall consist of coconut fiber woven into a matrix. Erosion control blankets shall be made of processed natural fibers that are mechanically, structurally, or chemically bound together to form a continuous matrix that is surrounded by two natural nets.

The Contractor shall check the erosion control material upon delivery to ensure that the proper material has been received. During periods of shipment and storage, the erosion mat shall be protected from temperatures greater than 140°F, mud, dirt, and debris. Manufacturer's recommendations in regard to protection from direct sunlight must also be followed. At the time of installation, the erosion mat/blanket shall be rejected if it has defects, tears, punctures, flaws, deterioration, or damage incurred during manufacture, transportation, or storage. If approved by ENGEO, torn or punctured sections may be removed by cutting out a section of the mat. The remaining ends should be overlapped and secured with ground anchors. Any erosion mat/blanket damaged during storage or installation shall be replaced by the Contractor at no additional cost to the Owner.

Erosion control material suppliers shall provide a qualified and experienced representative onsite, to assist the Contractor and ENGEO personnel at the start of construction. If there is more than one slope on a project, this criterion will apply to construction of the initial slope only. The representative shall be available on an as-needed basis, as requested by ENGEO, during construction of the remaining slope(s). The erosion control material shall be placed and anchored on a smooth graded, firm surface approved by the Engineer. Anchoring terminal ends of the erosion control material shall be accomplished through use of key trenches. The material in the trenches shall be anchored to the soil on maximum 1½ foot centers. Topsoil, if required by construction drawings, placed over final grade prior to installation of the erosion control material shall be limited to a depth not exceeding 3 inches.

Erosion control material shall be anchored, overlapped, and otherwise constructed to ensure performance until vegetation is well established. Anchors shall be as designated on the construction drawings, with a minimum of 12-inch length, and shall be spaced as designated on the construction drawings, with a maximum spacing of 4 feet.

ENGEO

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F.3 - Paleontological Resources Paleo Report

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Kenneth L. Finger, Ph.D.
Consulting Paleontologist

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May 14, 2018

Dana DePietro
FirstCarbon Solutions
1350 Treat Boulevard, Suite 380
Walnut Creek, CA 94597

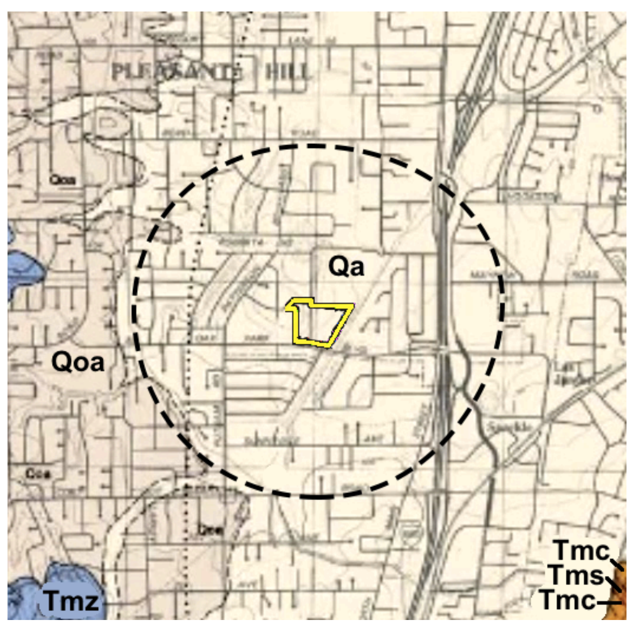
Re: Paleontological Records Search: Oak Park Project (4282.0009), Pleasant Hill, Contra Costa County, California

Dear Dr. DePietro:

As per your request, I have performed a records search on the University of California Museum of Paleontology (UCMP) database for the Oak Park Project in Pleasant Hill. This site is located on the north side of Oak Park Boulevard and east side of Monticello Avenue. Its PRS (public Land Survey location is in the Sect. 15, T1N, R2S, Walnut Creek quadrangle (1980 USGS 7.5-series topographic map). Google Earth imagery shows that this terrain to be flat, barren, and disturbed.

Geologic Units

According to the part of the geologic map by Dibblee and Minch (2005) shown here, the entire Oak Park project site (yellow outline at center) and all of the surrounding half-mile search area (dashed black outline) are located on Holocene alluvium (Qa). Pleistocene alluvium (Qoa) extends from the west to just within the search area. Farther to the west and southwest are the Martinez Formation (Tmz), while the Monterey Group (Tms, Tmc) is indicated at the southeast corner of this map. While the Holocene deposits are too young to be fossiliferous, all of the other geologic units shown in this area are potentially fossiliferous. Pleistocene alluvium likely extends farther eastward in the subsurface and exists at some depth below the surface of the site.



Key to mapped units

Qa Younger alluivium (Holocene)
Qoa Older alluvium (Pleistocene)
Tms Sobrante Sandstone, Monterey Group (mid to lower Miocene)
Tmc Claremont Shale, Monterey Group (mid to lower Mio-

cene)
Tmz Martinez Fm (early Eocene to Paleogene

Paleontological Records Search

The paleontological record search for the Oak Park project was performed on the UCMP database. Because the three Tertiary units are mapped about a mile from the project site, their subsurface extensions would most likely be well below project-related excavations, but Pleistocene alluvium may be shallow enough to be impacted; hence, the records search focused on Pleistocene vertebrate localities in Contra Costa County. It revealed 63 localities, including V6006 (Pleasant Hill High School), which is adjacent to the project site and yielded *Megalonyx* (ground sloth). The composite Pleistocene assemblage from the County comprises 9928 specimens, nearly all of which are assigned to the late Pleistocene Rancholabrean NALMS (North American Land Mammal Stage). The 95 species identified are on the attached list.

Remarks and Recommendations

The Oaks Park Project site is mapped solely as Holocene alluvium, which is too young to be fossiliferous; however, it likely overlies Pleistocene alluvium, which has a high paleontological sensitivity. In addition, it is in an area that has produced a large number of Pleistocene localities and specimens. Project-related excavations of previously undisturbed deposits could therefore impact significant paleontological resources. A paleontological walkover of the survey is not recommended because the entire surface of the site has been disturbed. Due to the large number of Pleistocene vertebrate localities in Contra Costa County, including one adjacent to the project site, I recommend paleontological monitoring of excavations into previously undisturbed Pleistocene alluvium. Should any vertebrate remains (i.e., bones, teeth, or unusually abundant and well-preserved invertebrates or plants) be encountered, the construction crew should not attempt to remove the remains; instead, their activities should be diverted away from the discovery until a paleontological monitor or a professional paleontologist assesses the find and, if deemed appropriate, salvages it in a timely manner. Any recovered fossil should be deposited in an appropriate repository, such as the UCMP, where it will be properly curated and made accessible for future studies.

Sincerely

Ken Finger

Reference Cited

Dibblee, T.W., Jr., and Minch, J.A., 2005. Geologic map of the Walnut Creek quadrangle, Contra Costa County, California. Dibblee Foundation Map DF-149, scale 1:24,000.

UCMP Vertebrates from Contra Costa County

Class Amphibia
- Order Anura
  - *Pseudoacris* (chorus frog)
- Order Caudata or Urodela
  - *Ambystoma* (mole salamander)
  - *Aneides lugubris* (arboreal salamander)
  - *Taricha* (newt)

Class Reptilia
- Order Sauria
  - *Elgaria* (alligator lizards)
  - *Gerrhonotus coeruleus* (northern alligator lizard)
  - *Scleoporus* (spiny lizards)
  - *Uta* (sideblotched lizard)
- Order Serpentes
  - *Crotalus* (rattlesnake)
- Order Testudines
  - *Clemmys marmorata* (western pond turtle)

Class Chondrichthyes (cartilaginous fish)
- Order Myliobatiformes
  - *Myliobatus* (bat ray)

Class Osteichthyes (bony fish)
- Order Cypriniformes
  - *Orthodon* (Sacramento blackfish)
- Order Gasterosteiformes
  - *Gasterosteus aculeatus* (three-spined stickleback)

Class Aves (birds)
- Order Anseriformes
  - *Anas acuta* (pintail duck)
  - *Melanitta* (scoter)
- Order Ciconiformes
  - ardeidid (heron)
- Order Culidae
  - *Geococcyx* (roadrunner)
- Order Galliformes
  - *Callipepia* (quail)
  - *Centrocercus* (sage grouse)
- Order Passeriformes
  - *Euphagus* (New World blackbirds)
  - *Turdus* (true thrushes)
- Order Piciformes
  - picidid (woodpecker)
- Order Podicipedformes
  - *Aechmophorus occidentalis* (western grebe)
- Order Strigiformes
  - *Asio flammeus* (short-eared owl)

Class Mammalia (mammals)
- Order Insectivora
  - *Scapanus latimanus* (broad-footed mole)
  - *Sorex ornatus* (ornate shrew)
- Order Xenartha
  - *Glossotherium harlani* (Harlan's ground sloth)
  - *Megalonyx jeffersoni* (Jefferson's flat-footed ground sloth)
- Order Lagomorpha
  - *Sylvilagus bachmani* (cottontail rabbit)
  - *Lepus* (jackrabbit)
- Order Rodentia
  - *Dipodomys* (kangaroo rat)
  - *Microtus californicus* (California meadow vole)
  - *Neotoma fuscipes* (dusky-footed wood rat)
  - *Perognathus* (pocket mouse)
  - *Peromyscus boylii* (brush mouse)
  - *Peromyscus californicus* (California deer mouse)
  - *Peromyscus maniculatus* (white-footed mouse)
  - *Peromyscus truei* (pinyon mouse)
  - *Reithrodontomys raviventris* (salt marsh harvest mouse)
  - *Sciurus* (squirrel)
  - *Tamias* (chipmunk)
  - *Otospermophilus beecheyi* (California ground squirrel)
  - *Thomomys bottae* (Botta's pocket gopher)
- Order Chiroptera
  - *Antrozous pallidus* (pallid bat)
  - *Eptesicus fuscus* (big brown bat)
  - *Lasiurus* (hairy-tailed bat)
- Order Carnivora
  - *Cynodesmus thooides* (extinct canid)
  - *Enhydra lutris* (sea otter)
  - *Procyon lotor* (racoon)
  - *Taxidea* (badger)
  - *Ursus americanus* (American black bear)
- Order Proboscidea
  - *Mammut americanum* (American mastodon)
  - *Mammuthus columbi* (Columbian mammoth)
- Order Perissodactyla
  - *Equus pacificus* (Pacific horse)
  - *Pliohippus interpolatus* (Pliocene horse)
  - *Tapirus merriami* (tapir)
- Order Artiodactyla
  - *Antilocapra pacifica* (Pacific pronghorn)
  - *Bison bison antiquus* (ancient bison)
  - *Bison latifrons* (long-horned bison)
  - *Camelops hesternus* (yesterday's camel)
  - *Capromeryx minor* (diminutive pronghorn)
  - *Cervus* (elk)
  - *Odocoileus* (mule deer)
  - *Sphenophalos* (pronghorn)

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