Appendix E

Geotechnical Engineering and Geologic Hazards Study for the Cole Campus Central Administrative Center

Consolidated Engineering Laboratories, as revised September 25, 2020

CONSOLIDATED ENGINEERING
LABORATORIES
— AN ATLAS COMPANY —

September 25, 2020

Oakland Unified School District
Department of Facilities Planning and Management
955 High Street
Oakland, California 94601

Attention: Mr. Tadashi Nakadegawa, Acting Executive Director

Subject: ***Response to CGS Review Comments***
Cole Campus – Central Administrative Center
1011 Union Street, Oakland, California 94607
CEL Project No. 84-04726-B

References:
1) *"Geotechnical Engineering and Geologic Hazards Study, Cole Campus – Central Administrative Center,"* CEL Project No. 84-04726-PWA, dated May 22, 2020.
2) *"Engineering Geology and Seismology Review for Central Administrative Center at Cole Campus – New Buildings, CGS Application No. 01-CGS4511,"* dated September 10, 2020.

Dear Mr. Nakadegawa,

Consolidated Engineering Laboratories (CEL) has prepared this response letter to address review comments issued by the California Geological Survey (CGS) to the Oakland Unified School District (District) regarding the proposed new Central Administrative Center at Cole Campus in Oakland. CEL previously prepared and submitted the referenced geotechnical report for this project (Reference 1).

Following their review of our report, CGS (Reference 2) requested CEL revise our site-specific ground motion analysis to include the possibility of rupture of all the segments of the Hayward Fault, and provide updated site-specific ground motion parameters, design response spectrum, and PGA_M. Based on the resulting analysis results, CGS also requested CEL to revise the liquefaction analyses, as needed.

As recommended by CGS, we revised our May 22, 2020 geotechnical engineering and geologic hazards study report, which is attached. As presented in our revised report, Section *6.2.2 Deterministic (MCE_R) Ground Motions*, our site-specific ground motion analysis was revised to include all segments of the Hayward Fault: HN+HN+HS. The results of the analysis are presented in Section 6.2 of our revised report.

Using the resultant PGA_M from our revised site-specific ground motion analysis, we have updated our liquefaction analysis and the results are presented in the table below, as well as in our revised report. Our revised analysis shows that the calculated total seismically-induced settlements have increased slightly (< 0.1 inch); however, it remains our judgment that the calculated values of potential liquefaction settlement would not result in significant surface manifestation of such liquefaction settlement, and that significant post-seismic reduction in the bearing capacities of the existing overlying soils would not occur. In our opinion, the proposed project site is still suitable for a shallow foundation system as recommended in our report.

Seismic Settlement Analysis Results

CPT No.	Calculated Liquefaction Settlement (inches)	Calculated Dynamic Compaction Settlement (inches)	Calculated Total Seismic Settlement (inches)
CPT-1	0.34	0.08	0.42
CPT-2	0.62	0.10	0.72
CPT-3	0.66	0.02	0.68
CPT-4	0.53	0.04	0.57

Closing

We trust that this letter provides the requested information at this time. If you have any questions regarding the contents of this letter, please contact Mr. Dare via email (cdare@ce-labs.com). We greatly appreciate the opportunity to be of service to the District and to be involved in the design of this project.

Sincerely,
CONSOLIDATED ENGINEERING LABORATORIES

Alex Lim, PE, QSP
Project Engineer

Corey T. Dare, PE, GE
Principal Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER COREY T. DARE No. 2013 Exp. 6-30-2022 GEOTECHNICAL STATE OF CALIFORNIA

Attachments: Geotechnical Engineering and Geologic Hazards Study, revised September 25, 2020.
Letter from California Geological Survey to Oakland Unified School District, dated September 10, 2020.

Distribution: PDF to Mr. Colland Jang, OUSD; colland.jang@ousd.org
PDF to Ms. Kenya Chatman, OUSD; kenya.chatman@ousd.org

AL/CTD:pmf

CONSOLIDATED ENGINEERING LABORATORIES
AN ATLAS COMPANY

Geotechnical Engineering and Geologic Hazards Study

COLE CAMPUS - CENTRAL ADMINISTRATIVE CENTER

Oakland, California

PREPARED FOR:

Oakland Unified School District
955 High Street
Oakland, CA 94601

PREPARED BY:

Consolidated Engineering Laboratories
534 23rd Avenue
Oakland, CA 94606

CEL Project No. 84-04726-PWA
Revised September 25, 2020

CONSOLIDATED ENGINEERING
LABORATORIES
AN ATLAS COMPANY

May 22, 2020
Revised September 25, 2020

Oakland Unified School District
Department of Facilities Planning and Management
955 High Street
Oakland, California 94601

Attention: Mr. Tadashi Nakadegawa, Acting Executive Director

Subject: **Geotechnical Engineering and Geologic Hazards Study**
Cole Campus – Central Administrative Center
1011 Union Street, Oakland, California 94607
CEL Project No. 84-04726-PWA

Dear Mr. Nakadegawa:

Consolidated Engineering Laboratories has completed a Geotechnical Engineering and Geologic Hazards Study for the proposed new Central Administrative Center project to be located at Cole Campus in Oakland, California. This report has been prepared in accordance with the requirements set forth in California Geological Survey Note 48. Transmitted herewith are the results of our findings, conclusions, and recommendations for foundations, interior and exterior concrete slabs, site preparation, grading, drainage, utility trench backfilling, and pavements. In general, the proposed improvements at the site are considered to be geotechnically feasible provided the recommendations of this report are implemented in the design and construction of the project.

Should you or members of the design team have questions or need additional information, please contact any of the undersigned at (925) 314-7100, or by e-mail at cdare@ce-labs.com. We greatly appreciate the opportunity to be of service to the Oakland Unified School District and to be involved in the design of this project.

Sincerely,
CONSOLIDATED ENGINEERING LABORATORIES

Alex Lim, P.E., Q.S.P.
Project Engineer

Corey T. Dare, P.E., G.E.
Principal Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER COREY T. DARE No. 2013 Exp. 6-30-20 GEOTECHNICAL STATE OF CALIFORNIA

REGISTERED GEOLOGIST JOEL E. BALDWIN, II No. EG 1132 CERTIFIED ENGINEERING GEOLOGIST STATE OF CALIFORNIA (Renewal date 02/28/2021)

Joel E. Baldwin II, P.G., C.E.G., C.Hg.
Principal Engineering Geologist

Distribution: PDF to Mr. Colland Jang, OUSD; colland.jang@ousd.org
PDF to Ms. Kenya Chatman, OUSD; kenya.chatman@ousd.org

AK/AL/JEB/CTD:pmf

CONSOLIDATED ENGINEERING LABORATORIES — AN ATLAS COMPANY

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CONSOLIDATED ENGINEERING LABORATORIES
AN ATLAS COMPANY

GEOTECHNICAL ENGINEERING AND GEOLOGIC HAZARDS STUDY

Project: **Cole Campus – Central Administrative Center**
Oakland, California

Client: **Oakland Unified School District**
Oakland, California

1.0 INTRODUCTION

1.1 Purpose and Scope

The purposes of this study were to evaluate the subsurface conditions at the site and prepare geotechnical and geological recommendations for the proposed improvements. This study provides recommendations for foundations, interior and exterior concrete slabs, site preparation, grading, drainage, and utility trench backfilling. This study was performed in accordance with the scope of work outlined in our proposal dated September 11, 2019 and our Contract Amendment request dated February 19, 2020, which included additional services to cover revisions to the originally proposed project.

The scope of this study included the review of pertinent published and unpublished documents related to the site, the drilling of five subsurface borings, four Cone Penetration Tests (CPT), laboratory testing of selected samples retrieved from the borings, engineering analysis of the accumulated data, and preparation of this report. The conclusions and recommendations presented in this report are based on the data acquired and analyzed during this study, and on prudent engineering judgment and experience. This study did not include an assessment of potentially toxic or hazardous materials that may be present on or beneath the site.

1.2 Site Description

Cole Campus is located at 1011 Union Street in Oakland, California, as shown on Plate 1, *Site Vicinity Map*. The project site is located at approximately 37.8082° north latitude and 122.2897° west longitude.

The school site is bounded by 10th Street on the south, Poplar Street on the west, Wade Johnson Park on the north, and Union Street on the south. The proposed Main Building is to be located adjacent to Poplar Street, adjacent to the north side of an existing one-story, former school building. A Multi-Purpose Room (MPR) building is also proposed in the northeast corner of the site.

The property is essentially level, with site elevations ranging between about +15 and +17, based on a revised survey plan prepared by Martin M. Ron Associates dated November 22, 2019 (Oakland City Datum). The school site is occupied by a U-shaped, two-story former school building on the southern portion of the property, the aforementioned one-story former school building adjacent to the northwest corner of the two-story building, a relocatable building on the northeast corner of the site and paved parking and play yard areas on the east and north sides of the property. We understand the southern Main Building is currently used as offices for the OUSD Police Department.

1.3 Proposed Development

Based on our understanding, the project will primarily consist of construction of a new 2-story, 54,000 square-foot office building on the northwest corner of the campus and a single-story, 4,000 square foot MPR building as well as redevelopment of the rest of the property. The project area is currently partially occupied by an existing Main Building, a smaller Cafeteria Building, a relocatable building, a playground, and a parking lot. Project construction will consist of four distinct phases: Demolition of the existing Cafeteria Building, construction of the New Main and MPR Buildings, demolition of the existing Main Building, and site redevelopment consisting of a new parking lot, and other site amenities. Construction of the new buildings will require the removal of current existing AC pavement. The approximate locations of the proposed new office and MPR buildings are shown on Plate 2a, *Site Plan*. A detailed schematic drawing of the proposed development is shown on Plate 2b, *Development Plan*.

1.4 Validity of Report

This report is valid for three years after publication. If construction begins after this time period, CEL should be contacted to confirm that the site conditions have not changed significantly. If the proposed development differs considerably from that described above, CEL should be notified to determine if additional recommendations are required. Additionally, if CEL is not involved during the geotechnical aspects of construction, this report may become wholly or in part invalid; CEL's geotechnical personnel should be retained to verify that the subsurface conditions anticipated when preparing this report are similar to the subsurface conditions revealed during construction. CEL's involvement should include grading and foundation plan review, grading observation and testing, foundation excavation observation, testing of subgrade and baserock preparation in new hardscape and pavement areas, asphalt concrete pavement placement, and utility trench backfill testing.

2.0 PROCEDURES AND RESULTS

2.1 Literature Review

Pertinent geologic and geotechnical literature pertaining to the site area were reviewed. These included various publications and maps issued by the United States Geological Survey (USGS), California Geological Survey (CGS), United States Department of Agriculture (USDA), Federal Emergency Management Agency (FEMA), water agencies, and other government agencies, as listed in the *References* section.

2.2 Field Exploration

In order to characterize the subsurface conditions beneath the proposed improvement areas, a field exploration program was conducted at the site on November 9, 2019 and May 2, 2020 under the supervision of a California-certified geotechnical engineer. The borings were sited to satisfy CGS Note 48 requirements and to facilitate development of soil cross section profiles across the area of the subject project. Our field exploration program consisted of performing a combination of drilled test borings and Cone Penetration Tests (CPT). A total of five test borings were drilled and four CPTs were advanced at the locations shown on Plates 2a and 2b. The borings supplement two borings previously drilled at the site by CEL's geotechnical affiliate, Geosphere Consultants, Inc., in 2015.

2.2.1 Test Borings

The new borings, designated B-1 through B-4, and B-5, were drilled using a truck-mounted B-53R and B-61 drill rig equipped with eight-inch hollow stem augers, respectively. Following the completion of drilling, the boreholes were backfilled using a cement grout in accordance with Alameda County Public Works Agency (ACPWA) drilling permit requirements.

A CEL representative visually classified the materials encountered in the borings according to the Unified Soil Classification System as the borings were advanced. Relatively undisturbed soil samples were recovered at selected intervals using a three-inch outside diameter Modified California split spoon sampler containing six-inch long brass liners, and a two-inch outside diameter Standard Penetration Test (SPT) sampler. The samplers were driven by means of a 140-pound wireline hammer with an approximate 30-inch fall using a manually operated lever-drop mechanism. Resistance to penetration was recorded as the number of hammer blows required to drive the sampler the final foot of an 18-inch drive. All of the field blow counts recorded using Modified California (MC) split spoon sampler were converted in the final logs to equivalent SPT blow counts using appropriate modification factors suggested by Burmister (1948), i.e., a factor of 0.65 with inner diameter of 2.5 inches. Therefore, all blow counts shown on the final boring logs are either directly measured (SPT sampler) or equivalent SPT (MC sampler) blow counts.

The boring logs with descriptions of the various materials encountered in each boring, a key to the boring symbols, and select laboratory test results are included in Appendix A, which also includes previous Geosphere boring logs. Ground surface elevations indicated on the soil boring logs were estimated to the nearest foot using a survey produced by Martin M. Ron Associates.

2.2.2 Cone Penetration Tests (CPTs)

Four CPTs, designated CPT-1 through CPT-4, were conducted on November 9, 2019 to practical refusal depths of 26 to 29 feet. The CPTs were conducted by Middle Earth Geo Testing, Inc. (MEGT) of Orange, California using a truck-mounted, 25-ton cone apparatus. The instrumented cone assembly used for this project included a cone tip with a 60-degree apex, diameter of 44.45 millimeters (mm), and a projected cross sectional area of 15 square centimeters (cm^2), a sleeve segment with a surface area of 225 cm^2, and a pore pressure transducer near the base (shoulder) of the cone tip.

Prior to the start of the test, the truck was jacked up and leveled on four pads to provide a stable reaction for the cone thrust. During the test, the instrumented cone was hydraulically pushed into the ground at a rate of about 20 millimeters per second (about four feet per minute), and continuous readings of cone tip resistance, sleeve friction, and pore pressure were digitally recorded. As the cone advanced, additional cone rods were added. The PC-based data acquisition hardware received electric signals from strain gauges mounted in the cone assembly, and generated graphical logs including cone resistance, friction resistance, friction ratio, and pore pressure ratio versus depth. Pore pressure dissipation tests and shear wave velocity measurements were also performed on select CPTs.

CPT data was subsequently processed based on generally accepted soil behavior type correlations (e.g., Robertson et al., 1986) to interpret soil classification and other properties such as SPT N-value and undrained shear strength were also estimated through correlations. CPT test summaries and plots for all of the CPTs are also presented in Appendix A.

2.3 Laboratory Testing

Laboratory tests were performed on select samples to determine some of the physical and engineering properties of the subsurface soils. The results of the laboratory testing are either presented on the boring logs, and/or are included in Appendix B. The following soil tests were performed for this study:

Dry Density and Moisture Content (ASTM D2216 and ASTM 2937) – In-situ dry density and/or moisture tests were conducted on select samples to measure the in-place dry density and moisture content of the subsurface materials. These properties provide information for evaluating the physical characteristics of the subsurface soils. Test results are shown on the boring logs.

Atterberg Limits (ASTM D4318 and CT204) – An Atterberg Limits test was performed on one sample of cohesive soils encountered at the site. Liquid Limit, Plastic Limit, and Plasticity Index are useful in the classification and characterization of the engineering properties of soil, and help to evaluate the expansive characteristics of the soil and determine the USCS soil classification. Test results are presented in Appendix B, and on the boring logs.

Particle Size Analysis (Wet and Dry Sieve) (ASTM D422, D1140, and CT202) - Sieve analysis testing was conducted on select samples to measure the soil particle size distribution and the total percentage of fines (i.e., percent passing the USCS No. 200 sieve). This information is useful for characterizing the soil type according to USCS, and to assist in the evaluation of liquefaction susceptibility of granular soils or soils of relatively low cohesion. Test results are presented in Appendix B.

Direct Shear (modified ASTM D3080) - Direct shear testing was performed on two samples of onsite soil materials to measure the angle of internal friction and cohesion of the tested material. This data can be utilized in developing allowable bearing capacities, retaining wall design parameters, and strength characteristics of the materials. Direct shear specimens were wetted to near saturation and consolidated under 1,000, 3,000 and 5,000 psf normal loads prior to and during testing. Test results are presented in Appendix B.

R-Value Test (ASTM D2844 and CT301) – One R-value test was conducted on a bulk sample of near-surface material collected from cuttings generated from Boring B-1 to provide data on prospective pavement subgrade materials for use in new pavement section design. Test results are presented in Section 6.8 and in Appendix B.

Soil Corrosivity, Redox (ASTM D1498), pH (ASTM D4972), Resistivity (ASTM G57), Chloride (ASTM D4327), and Sulfate (ASTM D4327) - Soil corrosivity testing was performed to determine the effects of constituents in the soil on buried steel and concrete. Water-soluble sulfate testing is required by the CBC and IBC. Test results are presented in Appendix B and discussed in Section 4.3.

3.0 GEOLOGIC AND SEISMIC OVERVIEW

3.1 Geologic Setting

The site is located in the central portion of the Coast Ranges geomorphic province of California. The Coast Ranges extend from the Transverse Ranges in southern California to the Oregon border and are comprised of a northwest-trending series of mountain ranges and intervening valleys that reflect the overall structural grain of the province. The ranges consist of a variably thick veneer of Cenozoic volcanic and sedimentary deposits overlying Mesozoic sedimentary, metamorphic, and basic igneous Franciscan Assemblage and marine sedimentary rocks of the Great Valley Sequence. The sedimentary rocks of the Coast Ranges are flanked on the east by sedimentary rocks of the Great Valley geomorphic province (Page, 1966).

More specifically, the project site is located in the flatlands west of the base of the Oakland Hills, which is proximal to the San Francisco Bay structural depression to the west. According to Radbruch (1957), the site is underlain by Pleistocene-epoch Merritt sand, consisting of beach or near-shore deposits of slightly clayey, silty sand, the approximate extent of which is shown on Plate 3, *Regional Geologic Map*. Geologic maps by Graymer (2000, 2006), show the site to be underlain by Quaternary-age Beach and dune sand deposits. Bedrock underlying the Oakland-San Leandro area and exposed in the hills to the east primarily consists of gabbro and basalt of the Jurassic Coast Range Ophiolite, Late Jurassic-Early Cretaceous Franciscan rocks, Jurassic silicic volcanics (keratophyre; e.g., Leona Rhyolite) and Late Jurassic-Early Cretaceous Knoxville Formation, as described in Graymer (2000) and CGS (2003). According to the USDA Natural Resources Conservation Service, Web Soil Survey, the site soil is classified as Urban Land - Baywood Eolian deposits generally described as loamy sand.

3.2 Geologic Evolution of the Northern Coast Ranges

The subject site is located within the tectonically active and geologically complex northern Coast Ranges, which have been shaped by continuous deformation resulting from tectonic plate convergence (subduction) beginning in the Jurassic period (about 145 million years ago). Eastward thrusting of the oceanic plate beneath the continental plate resulted in the accretion of materials onto the continental plate. These accreted materials now largely comprise the Coast Ranges. The dominant tectonic structures formed during this time include generally east-dipping thrust and reverse faults.

Beginning in the Cenozoic time period (about 25 to 30 million years ago), the tectonics along the California coast changed to a transpressional regime and right-lateral strike-slip displacements as well as thrusting were superimposed on the earlier structures resulting in the formation of northwest-trending, near-vertical faults comprising the San Andreas Fault System. The northern Coast Ranges were segmented into a series of tectonic blocks separated by major faults including the San Andreas, Hayward, and Calaveras. The project site is situated between the active Hayward and San Andreas faults, but no known active faults with Holocene movement (i.e., last 11,000 years) lie within the limits of the site. The site is not mapped within an Alquist-Priolo Earthquake Fault Zone.

3.3 Regional Faulting and Tectonics

Regional transpression has caused uplift and folding of the bedrock units within the Coast Ranges. This structural deformation occurred during periods of tectonic activity that began in the Miocene and continues today. The site is located in a seismically active region that has experienced periodic, large magnitude earthquakes during historic times. This seismic activity appears to be largely controlled by displacement between the Pacific and North American crustal plates, separated by the San Andreas Fault zone located approximately 14.5 miles southwest of the site. This plate displacement produced regional strain that is concentrated along major faults of the San Andreas Fault System including the San Andreas, Hayward, and Calaveras faults in this area.

The site is located in a seismically active region dominated by major faults of the San Andreas Fault System. Major active faults include the aforementioned San Andreas Fault; the Hayward Fault, located approximately 4 miles northeast of the site; the Calaveras Fault, located on the order of 14 miles northeast of the site; the Concord-Green Valley Fault, located on the order of 18 miles northeast of the site and the San Gregorio Fault, estimated to be on the order of 23 miles southwest of the site. The site location relative to active and potentially active faults in the San Francisco Bay Area is shown on Plate 4, *Regional Fault Map*. A discussion of the four nearest active faults to the site follows.

3.3.1 Hayward Fault

The Hayward Fault trends northwesterly approximately 88 km from the Milpitas area to San Pablo Bay. The Hayward Fault has been divided into two main segments, the Northern and Southern segments. The Rodgers Creek Fault, considered as a possible extension of the Hayward Fault, extends northward from beneath San Pablo Bay up to near Healdsburg, where it is aligned with the Healdsburg Fault zone (Watt, et al., 2016). The site is located approximately 4.2 miles southwest of the northern segment of the Hayward Fault. The slip rate on this segment of the Hayward Fault is estimated to be about 9 mm/year and has been assigned a moment magnitude

(M_{max}) of 6.4 (CGS, 2003). UCERF3, the earthquake forecast model developed by the Working Group on California Earthquake Probabilities (USGS, 2015) has estimated that there is a 14.3 percent probability of at least one magnitude 6.7 or greater earthquake before 2044 along the Hayward Fault.

3.3.2 San Andreas Fault

The northwest-trending San Andreas Fault runs along the western coast of California extending on the order of 625 miles from the north near Point Arena to the Salton Sea area in southern California (Jennings, 1994). The fault zone has been divided into 11 segments. The site is located about 14½ miles to the northeast of the Peninsula segment. The slip rate on the Peninsula segment of the San Andreas Fault is estimated to be about 17 mm/year and has been assigned a moment magnitude (M_{max}) of 7.1 (CGS, 2003). UCERF3 has estimated that there is a 6.4 percent probability of at least one magnitude 6.7 or greater earthquake before 2044 along the Northern San Andreas Fault.

3.3.3 Calaveras Fault

The Calaveras Fault trends northwesterly about 123 km in length from near Hollister to the San Ramon/Dublin area. The Calaveras Fault has been divided into three segments, the Northern, Central, and Southern segments. The site is located approximately 14 miles southwest of the northern segment of the Calaveras Fault. The slip rate on the north segment of the Calaveras Fault is estimated to be about 6 mm/year and has been assigned a moment magnitude (M_{max}) of 6.8 (CGS, 2003). UCRF3 has estimated that there is a 7.4 percent probability of at least one magnitude 6.7 or greater earthquake before 2044 along the Calaveras Fault.

3.3.4 Concord - Green Valley Fault

The north to northwest trending Concord Fault extends from the approximate central Walnut Creek and Concord border, northward into the Green Valley Fault. The Green Valley Fault extends northward from Suisun Bay up to just west of Lake Curry, northeast of Napa. The site is located on the order of 18 miles southwest of the Concord Fault. The slip rate of the Concord Fault is estimated to be about 4 mm/year and has been assigned a moment magnitude (M_{max}) of 6.2 (CGS, 2002). UCERF3 estimated that there is a three percent probability of at least one magnitude 6.7 or greater earthquake before 2044 occurring on the Concord Fault, and seven percent probability of at least one magnitude 6.7 or greater earthquake before 2044 occurring on the Green Valley Fault.

3.4 Historic Seismicity

As discussed above, the San Francisco Bay Area is subject to a high level of seismic activity. Within the period of 1800 to 2000 there were an estimated 20 earthquakes exceeding a Richter magnitude of 6.0 within a 100-mile radius of the site, seven exceeding 6.5, four exceeding 7.0 and one exceeding 7.5. There have been six major Bay Area earthquakes since 1800. Those were in 1836 and 1868 on the Hayward-Rodgers Creek Fault, in 1861 on the Calaveras Fault, and in 1838, 1906, and 1989 on the San Andreas Fault.

Of the major earthquakes known to have affected the site, the 1868 Hayward earthquake caused the most damage with at least 30 deaths in the region and with extensive building collapse in Hayward and San Leandro, including the Alameda County Courthouse in San Leandro. The 1906 San Francisco earthquake and the 1989 Loma Prieta earthquake also caused property and extensive structural damage in the vicinity. The project site is located approximately ½ mile southeast of the portion of the Cypress structure which collapsed in the 1989 earthquake. However, the collapsed portion of the structure was underlain by soft Bay Mud as opposed to Merritt Sand underlying the project site.

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4.0 SUBSURFACE CONDITIONS

4.1 Subsurface Soil Conditions

During our subsurface exploration program, we investigated the subsurface soils and evaluated soil conditions to a maximum depth of 50 feet in the four borings and 29 feet in the four CPTs performed for this study. From our collected data, we conclude that where explored, the area of the proposed new construction is underlain by Merritt sands, consisting of dark brown sand to silty sand layers with frequent lenses of medium dense to very dense, clayey to silty sand to a depth of about 27 feet, below which primarily clean, fine sand was encountered to a depth of about 50 feet. The consistency of the sand layers was found to be loose in the upper three to five feet, becoming denser immediately after. The CPTs encountered what appeared to be primarily fine grained sands to refusal depths of 27 to 29 feet.

Borings B-1 and B-2 were drilled at the proposed Main Building site in an existing paved area that was found to consist of about one inch of asphalt concrete overlying four to six inches of aggregate baserock. Below the pavement section, Boring B-1 encountered fill consisting of loose, fine sand mixed with brick and concrete fragments. Borings B-3 and B-4 were drilled in a landscape area at a previously considered future Server Building site encountering similar subsurface soil conditions as the Main Building site. Boring B-5 was drilled near the northeast entrance of the site in the area of the proposed MPR Building. Previous explorations conducted by Geosphere in 2015 encountered similar materials.

Atterberg Limit tests performed on one sample at a depth of about 15 feet in the area of the proposed MPR Building resulted in measured Liquid Limits (LL) of 17 and corresponding Plasticity Index (PI) of 5, indicative of low plasticity and low expansion potential which suggest that the sample may be susceptible to liquefaction.

Our interpretation of the general subsurface geologic conditions below the Office Building site is presented in Plate 5a, *Cross Sections A-A’ and B-B’* and Plate 5b, *Cross Section C-C’*. Additional details of materials encountered in the exploratory borings, including laboratory test results are included in the boring logs in Appendix A, and laboratory test summaries are presented in Appendix B. Also, details of CPT test results including soil behavior type (SBT) are presented in Appendix A.

4.2 Groundwater

Free groundwater was encountered during drilling at Borings B-1 through B-4 at a depth of approximately 19 feet and were measured after drilling completion at a depth of approximately 18 feet. Groundwater was encountered at Boring B-5 at a depth of 17 feet during drilling and 14 feet after completion of drilling. Pore-pressure dissipation tests performed in the CPTs estimated that free groundwater may be at depths ranging from 13 to 15 feet. A historic high groundwater depth is estimated to be about 12 feet deep based on historic high groundwater table contours presented in Plate 1.2 of the Seismic Hazard Zone Report 081 for the Oakland West Quadrangle (CGS, 2003). The borings and CPTs were backfilled with a neat cement grout in accordance with Alameda County Public Works Agency requirements shortly after drilling. We note that the borings may not have been left open for a sufficient period of time to establish equilibrium groundwater conditions. Groundwater levels can vary in response to time of year, variations in seasonal rainfall, well pumping, irrigation, and alterations to site drainage. A detailed investigation of local groundwater conditions was not performed and is beyond the scope of this study.

4.3 Corrosion Testing

A sample collected from the upper five feet of the soil profile at Boring B-2 was tested to measure sulfate content, chloride content, redox potential, pH, resistivity, and presence of sulfides. Test results are included in Appendix B and are summarized on Table 1.

Table 1: Summary of Corrosion Test Results

Soil Description	Sample Depth (feet)	Sulfate (mg/kg)	Chloride (mg/kg)	Redox (mV)	Resistivity (ohm-cm)	Sulfide	pH
Very Dark Brown Silty SAND (SM)	0-5	47	2	501	23,762	Negative	6.0

Water-soluble sulfate can affect the concrete mix design for concrete in contact with the ground, such as shallow foundations, piles, piers, and concrete slabs. Section 4.3 in American Concrete Institute (ACI) 318, as referenced by the CBC, provides the following evaluation criteria:

Table 2: Sulfate Evaluation Criteria

Sulfate Exposure	Water-Soluble Sulfate in Soil, Percentage by Weight or (mg/kg)	Sulfate in Water, ppm	Cement Type	Max. Water Cementitious Ratio by Weight	Min. Unconfined Compressive Strength, psi
Negligible	0.00-0.10 (0-1,000)	0-150	NA	NA	NA
Moderate	0.10-0.20 (1,000-2,000)	150-1,500	II, IP (MS), IS (MS)	0.50	4,000
Severe	0.20-2.00 (2,000-20,000)	1,500-10,000	V	0.45	4,500
Very Severe	Over 2.00 (20,000)	Over 10,000	V plus pozzolan	0.45	4,500

The water-soluble sulfate content was measured to be about 47 mg/kg (ppm) or 0.0047% by dry weight in the soil sample, suggesting the site soil should have negligible impact on buried concrete structures at the site. However, it should be pointed out that the water-soluble sulfate concentrations can vary due to the addition of fertilizer, irrigation, and other possible development activities.

Table 4.4.1 in ACI 318 suggests use of mitigation measures to protect reinforcing steel from corrosion where chloride ion contents are above 0.06% by dry weight. The chloride content was measured to be 2 mg/kg (ppm) or 0.0002% by dry weight in the soil sample. Therefore, the test result for chloride content does not suggest a corrosion hazard for mortar-coated steel and reinforced concrete structures due to high concentration of chloride.

In addition to sulfate and chloride contents described above, pH, oxidation reduction potential (Redox), and resistivity values were measured in the soil sample. For cast and ductile iron pipes, an evaluation was based on the 10-Point scaling method developed by the Cast Iron Pipe Research Association (CIPRA) and as detailed in Appendix A of the American Water Works Association (AWWA) publication C-105, and shown on Table 3.

Table 3: Soil Test Evaluation Criteria (AWWA C-105)

Soil Characteristics	Points		Soil Characteristics	Points
Resistivity, ohm-cm, based on single probe or water-saturated soil box.			**Redox Potential, mV**	
<700	10		>+100	0
700-1,000	8		+50 to +100	3.5
1,000-1,200	5		0 to 50	4
1,200-1,500	2		Negative	5
1,500-2,000	1		**Sulfides**	
>2,000	0		Positive	3.5
PH			Trace	2
0-2	5		Negative	0
2-4	3		**Moisture**	
4-6.5	0		Poor drainage, continuously wet	2
6.5-7.5	0		Fair drainage, generally moist	1
7.5-8.5	0		Good drainage, generally dry	0
>8.5	5			

Assuming fair site drainage, the tested soil sample had a total score of 1 point, indicating a non-corrosive rating. When total points on the AWWA corrosivity scale are at least 10, the soil is classified as corrosive to cast and ductile iron pipe, and use of cathodic corrosion protection is often recommended.

These results are preliminary, and provide information only on the specific soil sampled and tested. Other soil at the site may be more or less corrosive. Providing a complete assessment of the corrosion potential of the site soils are not within our scope of work. For specific long-term corrosion control design recommendations, we recommend that a California-registered professional corrosion engineer evaluate the corrosion potential of the soil environment on buried concrete structures, steel pipe coated with cement-mortar, and ferrous metals.

5.0 GEOLOGIC HAZARDS

5.1 Seismic Induced Hazards

Seismic hazards resulting from the effects of an earthquake generally include ground shaking, liquefaction, lateral spreading, dynamic settlement, fault ground rupture and fault creep, seismically-induced landsliding, and tsunamis and seiches. The site is not necessarily impacted by all of these potential seismic hazards. Nonetheless, potential seismic hazards are discussed and evaluated in the following sections in relation to the planned construction.

5.1.1 Ground Shaking

The site may experience strong to severe ground shaking from a major earthquake originating from the major Bay Area faults, particularly the nearby Hayward Fault (approximately 4 miles from the site), Calaveras Fault (14 miles from the site), or San Andreas Fault (14½ miles from the site). Moderate shaking may also be generated at the site by the Concord-Green Valley Fault (approximately 18 miles from the site).

5.1.2 Liquefaction

Research and historical data indicate that soil liquefaction generally occurs in saturated, loose granular soil (primarily fine to medium-grained, clean, poorly-graded sand deposits) during or after strong seismic ground shaking and is typified by a loss of shear strength in the affected soil layer, thereby causing the soil to flow as a liquid. Typically, liquefaction potential increases with increased duration and magnitude of cyclic loading. However, because of the higher intergranular pressure of the soil at greater depths, the potential for liquefaction is generally limited to the upper 40 feet of the soil. Potential hazards associated with soil liquefaction below or near a structure include loss of foundation support, lateral spreading, sand boils, and areal and differential settlement. No specific liquefaction related ground failures other than isolated ground settlement in old tidal marsh areas in the vicinity of Lake Merritt and the Oakland Estuary were reported as a result of the 1906, 1868, or 1989 earthquakes (Youd and Hoose, 1978; Plafker and Galloway, 1989).

The site has been mapped as within a Seismic Hazard Zone for liquefaction based on the State of California, Official Map of the Oakland West Quadrangle released on February 14, 2003. The site location relative to these zones is shown on Plate 6, *Seismic Hazard Zones Map*. The soils encountered in the subsurface investigation below the water table included layers of dense to very dense sand that may be susceptible to liquefaction in response to strong ground shaking.

To analyze for liquefaction settlement, we utilized the CLiq v 2.2.1.11 software, developed by Geologismiki, Geotechnical Software. Calculation of soil resistance against liquefaction is performed according to the Robertson (NCEER R&W 1998, 2009) procedure and as recommended on CGS Special Publication 117 A (2008). The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). This methodology compares a critical Cyclic Shear Stress (CSR) against the field Cyclic Resistance Ratio (CRR). When the CSR exceeds the CRR, the factor-of-safety falls below 1.0 and liquefaction can occur.

All CPTs were identified as susceptible to potential seismic settlement through liquefaction. Borings were not used for liquefaction analysis since sampling (and SPT blow counts) were not continuous and as such, were considered to be less accurate for liquefaction evaluation. For analysis purposes, ASCE 7-16 specifies the use of Peak Ground Acceleration PGA_M for use in liquefaction analyses or a PGA value generated from a site-specific seismic response analysis. A PGA_M value of 0.7g, generated from a site-specific seismic response analysis was used in our calculation. We also used a Mean Magnitude of 6.9 based on the return period of 10 percent in 50 years in the Unified Hazard Tool Deaggregation Report. Based on historic high groundwater table contours presented in Plate 1.2 of the Seismic Hazard Zone report 081 for the Oakland West Quadrangle (CGS, 2003), a historic high groundwater depth of 12 feet was assumed for the analysis. Per SP117A (2008) guidelines, we also assumed a Factor-of-Safety (FS) of 1.3 below which would initiate liquefaction.

The following table presents a summary of our analysis results. A summary report of the analyses is presented in Appendix C of this report.

Table 4: Seismic Settlement Analysis Results

CPT No.	Calculated Liquefaction Settlement (inches)	Calculated Dynamic Compaction Settlement (inches)	Calculated Total Seismic Settlement (inches)
CPT-1	0.34	0.08	0.42
CPT-2	0.62	0.10	0.72
CPT-3	0.66	0.02	0.68
CPT-4	0.53	0.04	0.57

Based on the analysis results, in our opinion, it is reasonable to assume that seismically-induced settlements at the project site due to the design earthquake may potentially range between on the order of ⅓ to ¾ inch with differential settlements across the site generally considered to be ½ to ⅔ the maximum estimated total seismic settlement value. These settlements were calculated to occur in discontinuous layers primarily between depth intervals of 15 to 18 feet. Assuming a 1-meter-thick liquefiable zone overlain by 5 meters of non-liquefiable materials, per Youd and Garris (1995), it is our opinion that the calculated values of potential liquefaction settlement would not result in significant surface manifestation of such liquefaction settlement, and that significant post-seismic reduction in the bearing capacities of the existing overlying soils would not occur.

5.1.3 Lateral Spreading

Lateral spreading involves both vertical and lateral ground movement, with some vertical component, as a result of liquefaction. In addition to liquefaction, a free face or slope is necessary in most cases for lateral spreading to occur. Lateral spreading can occur on relatively flat sites with slopes less than two percent under certain circumstances, and manifest itself at the ground surface in the form of cracking and settlement. Lateral spreading can occur in areas located within close proximity to an open face which are supported by underlying liquefiable soil under or close to the open face. Under a lateral spreading condition, soils which liquefy lose strength and the slope moves towards the open face. Any structures or improvements located within close proximity to the slope can also move and possibly be destabilized.

No significant free slope faces are present within the general vicinity of the project site. In addition, no significant continuous liquefiable subsurface layers underlying the site were identified in our exploration. Therefore, it is our opinion that the potential for the occurrence of lateral spreading effects (i.e., surface cracking, settlement) significant enough to structurally impact the new buildings is very low to nil.

5.1.4 Dynamic Compaction (Settlement)

Dynamic compaction is a phenomenon where loose, sandy soil located above the water table densified from vibratory loading, typically from seismic shaking or vibratory equipment. The site is generally underlain by layers of medium dense to very dense silty to clayey sand. Based on our evaluation of the composition, measured density and strength of the soils encountered above the historic high ground-water table depth in the borings, and CLiq calculation results, potential dynamic settlements for the design seismic event are anticipated to be less than 0.1 inch.

5.1.5 Fault Ground Rupture and Fault Creep

A Regional Fault Map is shown on Plate 4. The State of California adopted the Alquist-Priolo (A-P) Earthquake Fault Zone Act of 1972 (Chapter 7.5, Division 2, Sections 2621 – 2630, California Public Resources Code), which regulates development near active faults for the purpose of preventing surface fault rupture hazards to structures for human occupancy. In accordance with the Alquist-Priolo (A-P) Act, the California Geological Survey established boundary zones or A-P “Earthquake Fault Zones” surrounding faults or fault segments judged to be sufficiently active, well-defined and mapped for some distance. These zones generally extend at least 500 feet on each side of a mapped or inferred trace of an active fault. Structures for human occupancy within designated Earthquake Fault Zone boundaries are not permitted unless surface fault rupture and fault creep hazards are adequately addressed in a site-specific evaluation of the development site.

The site is not currently within a designated Earthquake Fault Zone as defined by the State (Hart and Bryant, 1997), as shown on Plate 6. The closest Earthquake Fault Zone is that of the Hayward Fault, which is located about four miles east of the site (not shown on Plate 6). Since the site is not within an Earthquake Fault Zone and no faults are known to be present that are within or toward the project site, the potential for fault ground rupture and surface manifestations from fault creep is judged to be very low to nil.

5.1.6 Tsunamis and Seiches

Tsunamis are long-period sea waves generated by seafloor movements from submarine earthquakes or volcanic eruptions that rapidly displace large volumes of water. Coastal communities along the Pacific Ocean are particularly susceptible to such phenomena. In accordance with CEMA et al. (2009), the edge of the potential tsunami inundation area in closest proximity to the project site is near the intersection of Mandela Parkway and 15th Street, located about ¼ mile northwest of the site. Therefore, the site is not expected to be susceptible to tsunami inundation.

Earthquake-induced waves generated within enclosed bodies of water are called seiches. The nearest significant enclosed body of water is Lake Merritt, located about 1.4 aerial miles east of the site and is separated by urban developed land of downtown Oakland. The City of Oakland Safety Element (2004, Amended 2012) does not identify a seiche from Lake Merritt as a potential seismic hazard for Oakland. Due to these factors, the site is not considered to be susceptible to seiches.

5.2 Other Hazards

Potential geologic hazards other than those caused by a seismic event generally include ground failure and subsidence, consolidation settlement, landslides under static loading conditions, expansive and collapsible soils, flooding, naturally occurring asbestos (NOA) and soil erosion. These are discussed and evaluated in the following sections.

5.2.1 Ground Cracking and Subsidence

Withdrawal of groundwater and other fluids (i.e. petroleum and the extraction of natural gas) from beneath the surface has been linked to large-scale land subsidence and associated cracking on the ground surface. Other causes for ground cracking and subsidence include the oxidation and resultant compaction of peat beds, the decline of groundwater levels and consequent compaction of aquifers, hydrocompaction and subsequent settlement of alluvial deposits above the water table from irrigation, or a combination of any of these causes. However, subsidence generally impacts a region, and should not produce excessive differential settlement in a single location, such as the subject site. Local and regional locations prone to subsidence generally subside equally over time.

5.2.2 Settlement Due to Consolidation

Consolidation is the densification of soil into a more dense arrangement from additional loading, such as new fills or foundations. Consolidation of clayey soils is usually a long-term process, whereby the water is squeezed out of the soil matrix with time. Sandy soils consolidate relatively rapidly with an introduction of a load. Consolidation of soft and loose soil layers and lenses can cause settlement of the ground surface or buildings. Based on visual observation in the field, and laboratory testing, the subsurface soils are primarily granular, so are not considered to be susceptible to long-term consolidation settlement. However, the uppermost four feet underlying the site consists of loose sands which may be susceptible to immediate compression settlement due to imposed footing loads, as well as minor settlement due to earthquake shaking as discussed in Sections 5.1.2 and 5.1.4. Immediate compression settlements of these near surface loose sandy soils can be controlled by limiting the magnitude of building loads, or minimized by either deepening the building foundations to bear on denser underlying soils or by reworking loose soils under footings as compacted, engineered fill.

5.2.3 Landsliding

Landslides can occur under a variety of loading conditions, including both static and seismic, but involve sloping ground. As shown on Plate 6, the site is not within a zone of seismically-induced landslide investigation. The site and immediate vicinity are relatively flat, covered by urban development, and does not exhibit landslide features as determined by our site reconnaissance and literature review. Therefore, the site is not considered susceptible to landsliding.

5.2.4 Expansive and Collapsible Soils

The subsurface deposits encountered during the drilling program generally consisted of moist to wet, medium dense to very dense clayey to silty sand. Collapsible soils are fine sandy and silty soils that have been laid down by the action of flowing water, usually in alluvial fan deposits. Terrace deposits and fluvial deposits can also contain collapsible soil deposits. The soil particles are usually bound together with a mineral precipitate. The loose structure is maintained in the soil until a load is imposed on the soil and water is introduced. The water breaks down the inter-particle bonds and the newly imposed loading densifies the soil.

The potential for collapsible soils underlying the site is considered to be low provided that our recommendations are followed. Visual observation of selective samples of the near-surface soils indicated the soils to be of low plasticity, and the near-surface soils are considered to be generally of very low expansion potential. In addition, the soil did not show visual evidence of collapse potential.

5.2.5 Flooding

The site does not appear to be subject to significant flooding, as indicated in the Safety Element of the City of Oakland General Plan (adopted 2004, amended 2012). As shown on Plate 7, *Flood Hazard Map*, FEMA (2009), the project site is mapped as within the portion of Zone X outside the 0.2 percent annual chance floodplain.

The City of Oakland Safety Element also shows the site as not located within a potential dam failure inundation zone. The nearest source of potential flooding inundation of the site due to dam failure is Upper and Lower Edwards Reservoirs in Piedmont, located on the order of 3⅓ aerial miles northeast of the site. The theoretical dam failure inundation zone for these reservoirs is along the narrow creek channel of Glen Echo Creek, which discharges into Lake Merritt at Grand Avenue, about 1½ miles northeast of the site. Therefore, based on our reviewed data, we conclude that the hazard of significant flooding of the site due to dam failure to be essentially nil.

An in-depth engineering evaluation of the flooding potential of the site is beyond the scope of this study or our expertise, and a flood specialist should be contacted if a more in-depth flooding analysis is desired.

5.2.6 Soil Erosion

Present construction techniques and agency requirements have provisions to limit soil erosion and resultant siltation during construction. These measures will reduce the potential for soil erosion at the site during the various construction phases. Long-term erosion at the site will be reduced by landscaping and hardscape areas, such as parking lots and walkways, designed with appropriate surface drainage facilities.

5.2.7 Naturally Occurring Asbestos (NOA)

No sources of NOA have been mapped in the vicinity of the site and therefore the potential for NOA to impact the site is very low.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are based upon the analysis of the information gathered during the course of this study and our understanding of the proposed improvements.

6.1 Conclusions

The site is considered geologically and geotechnically suitable for the proposed improvements provided the recommendations of this report are incorporated into the design and implemented during construction. The predominant geotechnical and geological issues that need to be addressed at this site are summarized below.

Seismic Ground Shaking – The site is located within a seismically active region. As a minimum, the building design should consider the effects of seismic activity in accordance with the latest edition of the California Building Code (CBC).

Loose Surficial/Artificial Soil – A surficial loose layer up to four feet in thickness was encountered in all of our borings and CPTs, and in at least one boring was identified as undocumented fill. In order to provide uniform bearing support and to limit abrupt differential settlements beneath the structures, we recommend the new buildings be supported on a reworked engineered fill layer. Detailed recommendations for remedial earthwork and foundation design as part of our mitigation recommendations are contained in the earthwork and foundations sections of this report.

Seismic Settlements – The site is mapped as being located in a zone of potential liquefaction settlement. Based on the subsurface soil encountered and its characteristics, and the results of our liquefaction analysis, liquefaction settlement of soils below historic high groundwater table may occur at the site in response to the design seismic event. Liquefaction settlement was calculated in all four CPT's as occurring within discrete granular layers between depths of about 15 and 18 feet, with calculated total site settlements of ⅓ to ¾ inches resulting from the design earthquake event. Dynamic compaction of soils above historic high groundwater table was also calculated to occur in the CPTs but was not found to be significant (i.e., 0.1 inch or less). Potential differential settlements across the structure may be considered to be on the order of ½ to ⅔ of the aforementioned total seismic settlement range. These settlements are considered to be relatively minor and occurring at sufficient depth as to not result in a significant degree of surface manifestation of liquefaction, due to the thickness of non-liquefiable capping soil at the site, including our recommended construction of an engineered fill layer supporting the structure. As such, significant strength loss of the near-surface soils of an extent to induce foundation failure is not expected to result from the design seismic event. In addition, we have provided conservative allowable bearing capacity values to also account for potential loss of bearing capacity.

Other potential geotechnical considerations, including those that should not significantly impact the project are explained below.

Groundwater – Relatively shallow groundwater was encountered at a depth of about 13 feet or greater during our field investigation. Therefore, with the exception of unanticipated shallow seepage, groundwater should not be problematic with placement of the anticipated shallow conventional foundations and associated over-excavations and all except for relatively deep utility trenches, if any.

Utility Connections – As a general suggestion, where utility damage during a design seismic event may be an issue, the design engineer should consider using utility connections at building perimeters designed for minimum of one inch of potential movement in any direction where the utility enters the buildings. This flexibility would help accommodate potential differential movement during a seismic event.

Winter Construction – If grading occurs in the winter rainy season, appropriate erosion control measures will be required, and weatherproofing of the building pads, foundation excavations, and/or pavement areas should be considered. Winter rains may also impact foundation excavations and underground utilities.

6.2 Seismic Design Parameters

The proposed structures should be designed in accordance with local design practice to resist the lateral forces generated by ground shaking associated with a major earthquake occurring within the greater San Francisco Bay region. Based on the measured shear wave velocity at the site on all CPT's, subsurface conditions encountered in our borings, our evaluation of the geology of the site and extrapolating the site condition in mapped Pleistocene-epoch Merritt sand to 100 feet, we have estimated average shear wave velocity, V_{s30} of 300 meter/second and classifies the site as Site Class "D". In accordance with ASCE 7-16, Section 11.4.8, a ground motion hazard analysis is required for structures on Site Class "D" with S_1 greater than or equal to 0.2 (unless Exceptions are taken). Since the project site is mapped as S_1 equal to 0.6, a site specific ground motion analysis in accordance with CBC 2019 and ASCE 7-16, Section 21.2.1.2, was performed for the site, as requested by the Structural Engineer.

6.2.1 Probabilistic (MCE_R) Ground Motions

A Probabilistic Seismic Hazard Analysis was performed for a 2,475-year return period ground motion corresponding to a 2% probability that the ground motion will be exceeded over a 50-year period. The analysis was performed using the 2014 USGS Unified Hazard Tool, Dynamic Ed., which includes the attenuation relationships of Abrahamson et al. (2014) NGA West 2, Boore et al. (2014) NGA West 2, Campbell-Bozorgnia (2014) NGA West 2, and Chiou-Youngs (2014) NGA West 2. The Method 2 analysis was carried out using the USGS Risk-Targeted Ground Motion Calculator. The resultant spectral accelerations were then scaled up by maximum direction scale factors presented in Section 21.2. The results are presented in Appendix D, *Site Specific Ground Motion Analysis*.

6.2.2 Deterministic (MCE_R) Ground Motions

A site specific deterministic analysis (ASCE 7-16, Section 21.2.2), was performed for all known influential seismic sources in the region as shown on USGS Deaggregation website, using the USGS Response Spectra Application. The attenuation relationships of Abrahamson et al. (2014) NGA West 2, Boore-et al (2014) NGA West 2, Campbell-Bozorgnia (2014) NGA West 2, and Chiou-Youngs (2014) NGA West 2 were utilized. The highest acceleration for each period, comparing the different faults, was used and compared to the deterministic lower limit as shown in Figure 21.2.1 (ASCE 7-16). Based on our analysis, the design earthquake occurring on the Hayward: HN+HS+HE at a rupture distance of 7.5 km from the project site, was found to govern the site. The results are presented in Appendix D.

6.2.3 Site-Specific MCE_R

The site specific Risk Targeted Maximum Considered Earthquake ground motion was then determined per ASCE 7-16, Section 21.2.3 by taking the lower of the spectral accelerations taken from the probabilistic and deterministic analysis performed per ASCE 7-16, Sections 21.2.1 and 21.2.2. The results are presented in Appendix D.

6.2.4 Design Response Spectrum

The design response spectral acceleration was calculated per ASCE 7-16, Section 21.3 and compared to the design response spectrum from ASCE 7-16, Section 11.4.6 to verify that the values from the site specific analysis meet the requirement of not less than 80 percent of the accelerations obtained from Section 11.4.6. If the values were less than the 80 percent requirement, they were then raised to the 80 percent value to obtain the final Design Response Spectrum S_a (g). The results are presented in Appendix D.

The adjusted maximum spectral response accelerations and designed spectral response acceleration values were determined from the site specific analysis as per ASCE 7-16, Section 21.4 and were confirmed that the values are not less than 80 percent of the values obtained from, ASCE 7-16, Section 11.4.3 and 11.4.4.

6.2.5 Design Acceleration Parameters

The design acceleration parameters were calculated per ASCE 7-16, Section 21.4 and the values were compared to verify that the values meet the requirement of not less than 80 percent of the values determined in accordance with Section 11.4.3 and 11.4.4.

6.2.6 Peak Ground Acceleration (PGA)

Peak Ground Acceleration (PGA) was determined per ASCE 7-16, Section 21.5 by taking the lower of the PGA determined by the probabilistic ground motions, and deterministic ground motions, not less than 80 percent of PGA_M determined from ASCE 7-16, equation 11.8 -1. The results are presented in Appendix D.

6.2.7 Conclusions

For design of the site structures in accordance with the seismic provisions of the CBC 2019 and American Society of Civil Engineers (ASCE) 7-16, the following design seismic ground motion values are recommended. The results are presented in Appendix D. The structural engineer should refer to ASCE Section 21.4 for permitted usage.

Table 5: Seismic Design Parameters Based on 2019 CBC (ASCE 7-16)	
Site Class	D
Mapped Spectral Response Accelerations	
Short Period, S_S	1.592 g
1-second Period, S_1	0.6 g
Adjusted Maximum Spectral Response Accelerations	
Short Period, S_{MS}	1.778 g
1-second Period, S_{M1}	1.650 g
Design Spectral Response Accelerations	
Short Period, S_{DS}	1.185 g
1-second Period, S_{D1}	1.100 g
Site-Specific Peak Ground Acceleration (PGA)	0.700 g

6.3 Site Grading and Site Preparation

6.3.1 General Grading, Demolition, Preparation and Site Drainage

Site grading should be performed in accordance with these recommendations. A pre-construction conference should be held at the jobsite with representatives from the owner, general contractor, grading contractor, and CEL prior to starting the clearing and demolition operations at the site.

Following demolition of the existing site pavements in the proposed project area, as well as clearing and grubbing of landscape areas, site grading is generally anticipated to consist of overexcavation and construction of the engineered fill supporting layer for the new building pads, as well as minor cuts and fills required to establish new site grades as required. In existing landscape areas within proposed new construction, organic topsoils should be completely removed and may be re-used as landscape topsoil, but should not be used as structural fill.

On-site soils having an organic content of less than three percent by weight and meeting the size requirements for import fill can be reused as structural, non-expansive (i.e., select) backfill as approved by the Geotechnical Engineer. Onsite soils containing construction debris such as brick or concrete should not be reused unless oversize material is removed prior to use. Tree roots exceeding one inch in diameter shall be removed if encountered in any excavated soils proposed for re-use.

Imported select soil should be non-expansive, having a Plasticity Index of 12 or less, an R-Value greater than 40, and contain sufficient fines so the soil can bind together. Import general fill soil for mass grading should be at least of comparable quality as the existing onsite soils, and in any case shall be approved by the Geotechnical Engineer prior to use on the project. Imported materials should be free of environmental contaminants, organic materials and debris, and should not contain rocks or lumps greater than six inches in maximum size, and at least 95 percent smaller than three inches in maximum size. In general, recycled baserock material containing recycled asphalt concrete should not be used in building pad areas. All import fill materials should be approved by the Geotechnical Engineer prior to use on site.

Excavations resulting from the removal of abandoned underground utilities, or deleterious materials should be cleaned down to firm soil, processed as necessary, and backfilled with engineered fill in accordance with the grading sections of this report. The Geotechnical Engineer's representative should verify the adequacy of site clearing operations during construction, prior to placement of engineered fill.

Existing underground utilities where encountered will need to be properly abandoned and/or entirely removed if impacting any proposed building, pavement or flatwork areas. In general, utility pipelines less than four inches in diameter to be abandoned may be left in place provided they will not be in close proximity to new foundation elements or interfere with new utilities. Such pipes should be plugged at the ends with concrete or sand-cement slurry. Larger utility pipelines or pipelines that underlie new foundations should be removed and replaced with engineered fill, or left in place and completely grouted with flowable sand-cement slurry or other approved Controlled Density Fill (CDF; also known as Controlled Low Strength Material, or CLSM).

Engineered fill should be placed in maximum eight-inch thick, pre-compacted lifts. The fill should be moisture conditioned and thoroughly mixed during placement to provide uniformity in each layer, and subsequently compacted per the requirements listed in Table 6.

Final grading should be designed to provide drainage away from structures and the top of slopes. Soil areas within 10 feet of proposed structures should slope at a minimum of 5% away from the buildings. Adjacent concrete hardscape should slope a minimum 2% away from the buildings. Roof leaders and downspouts should not discharge into landscape areas adjacent to buildings, and should discharge onto paved surfaces sloping away from the structures or into a closed pipe system channeled away from the structure to an approved collector or outfall.

6.3.2 Project Compaction Recommendations

The following table provides the recommended compaction requirements for this project. Not all soils, aggregates and scenarios listed below may be applicable for this project. Specific grading recommendations are discussed individually within applicable sections of this report.

Table 6: Project Compaction Requirements

Description	Min. Percent Relative Compaction (per ASTM D1557)	Min. Percent Above Optimum Moisture Content
Fill Areas, Engineered Fill, Onsite Soil/Select Fill	90	2
Building Pads, Onsite Soil – scarified subgrade or used as Fill	95	2
Building Pads, Baserock or Select Engineered Fill	95	2
Concrete Flatwork, Subgrade Soil	90	2
Concrete Flatwork, Baserock	90	2
Underground Utility Backfill (upper 3', below existing vehicular AC pavement sections)	95	2
Underground Utility Backfill (all other applications)	90	2

Description	Min. Percent Relative Compaction (per ASTM D1557)	Min. Percent Above Optimum Moisture Content
AC Pavement – Class 2 Aggregate Base Section (Vehicular/Traffic areas)	95	2
AC Pavement – Baserock in Non-Traffic (e.g., Playground) Areas	90	2
AC Pavement – Non-Expansive Subgrades in Vehicular/Traffic Areas (upper 8 inches)	95	2
AC Pavement –Non-Expansive Subgrades in Non-Traffic Areas	90	2

6.3.3 Building Pad Grading

To reduce potential abrupt differential settlement of the near surface soils as well as to provide uniform bearing support, the buildings should be supported by a layer of reworked, engineered fill. The fill layer should extend to at least four feet below existing ground surface, and be constructed by a combination of over-excavating the pad below the existing grade, scarifying the over-excavation subgrade to a depth of at least eight inches, and compacting the exposed surface to the project compaction requirements, and backfilling with compacted, engineered fill to the new building pad subgrades. Therefore, the scarified fill thickness can be considered to be a part of the required minimum four-foot engineered fill thickness. The engineered fill layer should extend at least five feet horizontally beyond the perimeter of the building footprints or as feasible if limited by nearby structures.

Engineered fill should be placed and compacted to final pad subgrade in accordance with the recommendations presented in Sections 6.3.1, 6.3.2 and Table 6. Due to the granular nature of the near-surface materials, excavating the edges of the over-excavations may require that slopes be cut back, as near-vertical slopes may not stand beyond the short-term.

6.3.4 Grading Flatwork/Pavement Areas

Areas to receive concrete hardscape or pavements should be scarified to a minimum depth of eight inches below existing grade or final subgrade whichever is lower. Scarified areas should be moisture conditioned and compacted. Where required, engineered fill should be placed and compacted to reach design subgrade elevation.

Rubber-tired heavy equipment, such as a full water truck, should be used to proof load exposed subgrade areas where pumping is suspected. Proof loading will determine if the subgrade soil is capable of supporting construction equipment without excessive pumping or rutting.

6.3.5 Site Winterization and Unstable Subgrade Conditions

If grading occurs in the winter rainy season, unstable and unworkable subgrade conditions may be present and compaction of onsite soils may not be feasible. These conditions may be remedied using soil admixtures, such as lime and cement. A four percent mixture of equal parts of lime and cement based on a dry soil unit weight of 105 pcf is recommended for planning purposes. Treatment should vary between 12 to 18 inches, depending on the anticipated construction equipment loads and extent of observed instability. More detailed and final recommendations can be provided during construction. Stabilizing subgrade in small, isolated areas can be accomplished with the approval of the Geotechnical Engineer by over-excavating one foot, placing Tensar TriAx TX140 or equivalent geogrid on the soil, and then placing 12 inches of Class 2 baserock on the geogrid. The upper six inches of the baserock should be compacted to at least 90 percent (building pads) or 95 percent (pavement subgrades) relative compaction.

6.4 Utility Trench Construction

6.4.1 Trench Backfilling

Utility trenches may be backfilled with onsite soil above the utility bedding and shading materials. If rocks or concrete larger than four inches in maximum size are encountered, they should be removed from the fill material prior to placement in the utility trenches. Utility bedding and shading compaction requirements should be in conformance with the requirements of the local agencies having jurisdiction and as recommended by the pipe manufacturers. Jetting of trench backfill is not recommended. Compaction recommendations are presented in Section 6.3.2, *Project Compaction Recommendations*.

Pea gravel, rod mill, or other similar self-compacting material should not be utilized for trench backfill since this material will transmit the shallow groundwater to other locations within the site and potentially beneath the building. Additionally, fines may migrate into the voids in the pea gravel or rod mill, which could cause settlement of the ground surface above the trench.

If rain is expected and the trench will remain open, the bottom of the trench may be lined with one to two inches of gravel. This would provide a working surface in the trench bottom. The trench bottom may have to be sloped to a low point to pump the water out of the trench.

6.4.2 Utility Penetrations at Building Perimeter

Flexible connections at building perimeters should be considered for utility lines going through perimeter foundations. This would provide flexibility during a seismic event. This could be provided by special flexible connections, pipe sleeving with appropriate waterproofing, or other methods.

6.4.3 Pipe Bedding and Shading

Pipe bedding material is placed in the utility trench bottom to provide a uniform surface, a cushion, and protection for the utility pipe. Shading material is placed around the utility pipe after installation and testing to protect the pipe. Bedding and shading material and placement are typically specified by the pipe manufacturer, agency, or project designer. Agency and pipe manufacturer recommendations may supersede our suggestions. These suggestions are intended as guidelines and our opinions based on our experience to provide the most cost-effective method for protecting the utility pipe and surrounding structures. Other geotechnical engineers, agency personnel, contractors, and civil engineers may have different opinions regarding this matter.

Bedding and Shading Material - The bedding and shading material should be the same material to simplify construction. The material should be clean, uniformly graded, fine to medium grained sand. It is suggested that bedding and shading material contain less than three percent fines with 100 percent passing the No. 8 sieve. Coarse sand, angular gravel or baserock should be avoided since this type of shading material may bridge when backfilling around the pipe, possibly creating voids, and may be too stiff as bedding material. Open graded gravel should be avoided for shading since this material contains voids, and the surrounding soil could wash into the voids, potentially causing future ground settlement. However, open graded gravel may be required for bedding material when water is entering the trench. This would provide a stable working surface and a drainage path to a sump pit in the trench for water in the trench. The maximum size for bedding material should be limited to about ¾ inch.

Bedding Material Placement - The thickness of the bedding material should be minimized to reduce the amount of trench excavation, soil export, and imported bedding material. Two to three inches for pipes less than eight-inches in diameter and about four to six inches for larger pipes are suggested. Bedding for very large diameter pipes are typically controlled by the pipe manufacturer. Compaction is not required for thin layers of bedding material. The pipe needs to be able to set into the bedding, and walking on a thin layer of bedding material should sufficiently compact the sand. Rounded gravel may be unstable during construction, but once the pipe and shading material is in place, the rounded gravel will be confined and stable.

Shading Material Placement – Jetting is not recommended since the type of shading material is unknown when preparing the geotechnical report and agencies typically do not permit jetting. If the sand contains fines or if the sand is well graded, jetting will not work. Additionally, if too much water is used during jetting, this could create a wet and unstable condition. The shading material should be able to flow around and under the utility pipe during placement. Some compactive effort along the sides of the pipe should be made by the contractor to consolidate the shading material around the pipe. A minimum thickness of about six-inches of shading material should be placed over the pipe to protect the pipe from compaction of the soil above the shading material. The contractor should provide some compactive effort to densify the shading material above the pipe. Relative compaction testing is not usually performed on the shading material. However, the contractor is ultimately responsible for the integrity of the utility pipe.

6.5 Temporary Excavation Slopes and Shoring

Where temporary excavation slopes are required, the Contractor should incorporate all appropriate requirements of OSHA/ Cal OSHA into the design of any temporary construction slopes used during construction. Excavation safety regulations are provided in the OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, Subpart P, and apply to excavations greater than five feet in depth.

The Contractor, or his specialty subcontractor, should design temporary construction slopes to conform to the OSHA regulations and should determine actual temporary slope inclinations based on the subsurface conditions exposed at the time of construction. For pre-construction planning purposes, the subsurface materials in the areas of the site where excavation may take place may be assumed to consist of a silty sand mix categorized as OSHA Type C with temporary slope inclination of no steeper than 1.5:1 (horizontal to vertical). This maximum slope ratio is assumed to be uniform from top to toe of the slope. The type of slope material and actual temporary construction slopes should be confirmed or adjusted during construction by a person who is trained as a "competent person" as designated by OSHA and directly responsible to the grading contractor.

If temporary slopes are left open for extended periods of time, exposure to weather and rain could have detrimental effects such as sloughing and erosion on surficial soils exposed in the excavations. We recommend that all vehicles and other surcharge loads be kept at least 10 feet away from the top of temporary slopes, and that such temporary slopes are protected from excessive drying or saturation during construction. In addition, adequate provisions should be made to prevent water from ponding on top of the slope and from flowing over the slope face. Desiccation or excessive moisture in the excavation could reduce stability and require shoring or laying back side slopes.

6.6 Building Foundations

6.6.1 Shallow Foundations

The proposed buildings can be supported on conventional continuous perimeter and interior spread footings bearing on the recommended engineered fill layer. Footings should have a minimum width of 18 inches and should be founded a minimum of 24 inches below lowest adjacent finished grade (i.e., pad subgrade for interior continuous footings, exterior compacted surface grade for exterior footings, not including loose landscape or topsoil material).

Footings located adjacent to other footings or utility trenches should bear below an imaginary 1.5:1 (horizontal to vertical) plane projected upward from the bottom edge of the adjacent footings or utility trenches. Footing reinforcement should be determined by the project Structural Engineer.

Footings should be designed for the following allowable bearing pressures, assuming design Factors-of-Safety of 3.0, 2.0 and 1.5 for dead loads, dead plus live loads and total loads, respectively, from the calculated ultimate bearing pressure.

Table 7: Allowable Bearing Pressures for Spread Footings

Load Condition	Allowable Net Bearing Pressure (psf)
Dead Load	3,000
Dead plus Live Loads	4,500
Total Loads (including wind or seismic)	6,000

If site preparation and foundation observation services are conducted as outlined in the Geotechnical Study report, static vertical settlement is expected to be on the order of ½ inch or less for footings bearing within the materials described in the report and designed to the aforementioned allowable bearing pressures. Differential settlement across the structure is not expected to exceed about ½ this value. In addition to the aforementioned static settlements, potential post-construction seismic total and differential settlements resulting from a design earthquake as discussed in Sections 5.1.2 and 6.1 should be considered when designing the building foundations. To evaluate immediate (distortion) settlement of footing foundations using an elastic spring constant, a modulus of subgrade reaction value, k_{v1}, of 230 pounds per cubic inch may be assumed for footings bearing directly on onsite subsurface granular soils that have been improved through dynamic compaction, or for footings bearing on soil improvement columns. The k_{v1} value applies for a 1-foot by 1-foot area and should be adjusted for footing width to obtain the k_v value as follows:

$$K_v = K_{v1} \times (B+1/2B)^2$$

where B = width of the footing in feet.

CEL personnel should be retained to observe and confirm that footing excavations prior to formwork and reinforcing steel placement bear in engineered fill soils suitable for the recommended maximum design bearing pressure.

Footing excavations should have firm bottoms and be free from excessive slough prior to concrete or reinforcing steel placement. Care should also be taken to prevent excessive wetting or drying of the bearing materials during construction. Extremely wet or dry or any loose or disturbed material in the bottom of the footing excavations should be removed prior to placing concrete. If construction occurs during the winter months, a thin layer of concrete (sometimes referred to as a rat slab) could be placed at the bottom of the footing excavations. This will protect the bearing soil and facilitate removal of water and slough if rainwater fills the excavations.

6.6.2 Lateral Resistance

Shallow foundations can resist lateral loads with a combination of bottom friction and passive resistance, and for mat foundations, bottom friction only. An allowable coefficient of friction of 0.40 between the base of the foundation elements and underlying material is recommended. In addition, an allowable passive resistance equal to an equivalent fluid weighing 350 pounds per cubic foot (pcf) acting against the foundation may be used for lateral load resistance against the sides of footings perpendicular to the direction of loading where the footing is poured neat against engineered fill material. The top foot of passive resistance at foundations not adjacent to pavement or hardscape should be neglected. The friction between the bottom of a slab-on-grade floor and the underlying soil should not be utilized to resist lateral forces.

6.6.3 Foundations for Equipment Pads and Minor Structures

Foundations for equipment pads and other minor structures may be designed using the recommendations presented in Sections 6.6.1 and 6.6.2 provided that supporting subgrade is prepared in accordance with Section 6.3.3. However, if the foundation for a minor structure will not bear on the engineered fill layer, it should be designed using a reduced allowable dead plus live bearing capacity of 1,500 psf, a modulus of subgrade reaction value of k_{v1}, of 75 pci, a coefficient of friction of 0.35, and a passive pressure of 250 pcf.

6.7 Concrete Slabs-on-Grade

6.7.1 Interior Floor Slabs

Surficial onsite materials appeared low to non-plastic; therefore, a non-expansive fill layer is not required for the proposed building. Slab reinforcing as well as slab construction joints should be designed by the structural engineer or slab designer to satisfy the anticipated use and loading of the slab. Slab-on-grade subgrade surfaces should be proof-rolled to provide a smooth, unyielding surface for slab support.

If desired and where potential near-surface water seepage from irrigation or surface water sources may be a concern, slab-on-grade concrete floors with moisture sensitive floor coverings can be underlain by a moisture retarder system constructed between the slab and subgrade. Such a system could consist of four inches of free-draining gravel, such as ¾-inch, clean, crushed, uniformly graded gravel with less than three percent passing No. 200 sieve, or equivalent, overlain by a relatively impermeable vapor retarder placed between the subgrade soil and the slab. The vapor retarder should be at least 10-mil thick and should conform to the requirements for ASTM E 1745 Class C Underslab Vapor Retarders (e.g., Griffolyn Type 65, Griffolyn Vapor Guard, Moistop Ultra C, or equivalent). If additional protection is desired by the owner, a higher quality vapor barrier conforming to the requirements of ASTM E 1745 Class A, with a water vapor transmission rate less than or equal to 0.006 gr/ft^2/hr (i.e., 0.012 perms) per ASTM E 96 (e.g., 15-mil thick "Stego Wrap Class A"), or to Class B (Griffolyn Type 85, Moistop Ultra B, or equivalent) may be used in place of a Class C retarder.

The vapor retarder or barrier should be placed directly under the slab. A sand layer is not required over the vapor retarder from a geotechnical standpoint. If sand on top of the vapor retarder is required by the design structural engineer, we suggest the thickness be minimized to less than one inch. If construction occurs in the winter months, water may pond within the sand layer since the vapor retarder may prevent the vertical percolation of rainwater.

ASTM E1643 should be utilized as a guideline for the installation of the vapor retarder. During construction, all penetrations (e.g., pipes and conduits,) overlap seams, and punctures should be completely sealed using a waterproof tape or mastic applied in accordance with the vapor retarder manufacturer's specifications. The vapor retarder or barrier should extend to the perimeter cutoff beam or footing.

6.7.2 Exterior Concrete Flatwork

Exterior concrete flatwork with pedestrian traffic should be at least four-inches thick and placed on subgrade compacted to the applicable requirements in Table 6. If desired, an underlying baserock layer can be used at the option of the designing engineer.

6.8 Pavements

Recommendations for the design of flexible asphalt concrete pavement sections were developed in accordance with the procedures outlined in the latest edition of the Caltrans Highway Design Manual. The Caltrans design method uses Traffic Indices (TI) to represent anticipated wheel loads and frequency of usage for a given design life. A design life of 20 years is typically used in California. Factors such as surface and subsurface drainage have an effect on the overall life of a pavement section.

An R-value of 79 was obtained from a laboratory test on a sample of typical existing near-surface onsite materials. To account for potential local variation in the clay and silt content of the near-surface soils, an R-value of 45 was used for determining the design sections. Based on assumed Traffic Index values of 4.5, 5.0, 6.0 and 7.0, the following resulting structural asphalt concrete (AC)/ aggregate base (AB) pavement sections were developed based on the provided TI values.

Table 8: Recommended Pavement Design Alternatives

Traffic Index	Asphalt Concrete (in.)	Class 2 AB (in.)	Total Section (in.)
4.5	2.0	6.0*	8.0
5.0	2.5	6.0*	8.5
6.0	3.5	6.0*	9.5
7.0	4.0	6.0	10.0

* Minimum recommended AB thickness

Asphalt concrete pavement should be designed and constructed per Caltrans standards. The asphalt pavement should be placed in minimum 1½-inch thick compacted lifts and maximum 3-inch thick lifts.

Minimizing subgrade saturation is an important factor in maintaining subgrade strength. Water allowed to pond on or adjacent to pavements could saturate the subgrade and cause premature pavement deterioration. The pavement should be sloped to provide rapid surface drainage, and positive surface drainage should be maintained away from the edge of the paved areas. Design alternatives which could reduce the risk of subgrade saturation and improve long-term pavement performance include crowning the pavement subgrades to drain toward the edges, rather than to the center of the pavement areas; and installing surface drains next to any areas where surface water could pond, should be considered. Properly designed and constructed subsurface drainage will reduce the time subgrade soils are saturated and can also improve subgrade strength and performance.

Periodic maintenance extends the service life of the pavement and should include crack sealing, surface sealing and patching of any deteriorated areas. Also, thicker pavement sections could be used to reduce the required maintenance and extend the service life of the pavement. The owner/user should consider placing signs at entryways to deter heavy duty trucks from light duty pavement areas, or by extending concrete curbs to a depth of three inches below the pavement subgrade.

6.9 Stormwater Infiltration Design Considerations

In order to meet the requirements of Provision C.3 of the Bay Area Municipal Regional Stormwater Permit (MRP), post-construction stormwater controls would be required as part of the project, post-construction stormwater controls may be required as part of the project. Stormwater infiltration treatment systems utilizing measures such as biofiltration swales or planters, or pervious pavements or pavers should be designed considering the typical infiltration rates characteristic of the onsite surficial soils. The near-surface soils at the site were found to typically consist of sand with silt and clayey sand with little clay soils, and would likely be categorized as Hydrologic Soil Group “B” soils (USDA, 2007). In such a case where the infiltration rates may be too low to accommodate infiltration of collected stormwater into the underlying soils, the use of a subdrainage layer consisting of an appropriate permeable material will be required.

In general, biofiltration swales or basins should not be placed directly adjacent to building perimeters in order to minimize impact on the long-term performance of foundations. If such features must be constructed adjacent to foundations, the filter material should not be located within the footing zone of influence, considered to be the zone below an imaginary 1.5:1 (horizontal to vertical) plane projected downward from the bottom edge of the adjacent building footing. In addition, the bottom of the bioswale or biofiltration area should include a perforated subdrain pipe to carry collected infiltration water away from the foundations.

Biofiltration swales should generally be placed a minimum of five feet away from pavements or exterior flatwork in order to reduce potential impacts on these features such as settlement or lateral movement. Where concrete curbs are located adjacent to bioswale or other filtration features, the loose biofiltration material should not be located within a zone below an imaginary 1:1 (horizontal to vertical) plane projected downward from the bottom edge of the adjacent curb. Curbs adjacent to deeper biofiltration features may also be designed as retaining walls with the bottom of the wall deriving passive resistance from soils below the adjacent biofiltration medium. Retaining walls may be designed assuming an ultimate lateral active pressure of 30 pcf EFP.

6.10 Plan Review

We recommend that CEL be provided the opportunity to review the final project plans prior to construction. The purpose of this review is to assess the general compliance of the plans with the recommendations provided in this report and confirm the incorporation of these recommendations into the project plans and specifications.

6.11 Observation and Testing During Construction

We recommend that CEL be retained to provide observation and testing services during site preparation, mass grading, underground utility construction, foundation excavation, and to observe final site drainage. This is to observe compliance with the design concepts, specifications and recommendations, and to allow for possible changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

7.0 LIMITATIONS AND UNIFORMITY OF CONDITIONS

The recommendations of this report are based upon the soil and conditions encountered in the borings. If variations or undesirable conditions are encountered during construction, CEL should be contacted so that supplemental recommendations may be provided.

This report is issued with the understanding that it is the responsibility of the owner or his representatives to see that the information and recommendations contained herein are called to the attention of the other members of the design team and incorporated into the plans and specifications, and that the necessary steps are taken to see that the recommendations are implemented during construction.

The findings and recommendations presented in this report are valid as of the present time for the development as currently proposed. However, changes in the conditions of the property or adjacent properties may occur with the passage of time, whether by natural processes or the acts of other persons. In addition, changes in applicable or appropriate standards may occur through legislation or the broadening of knowledge. Accordingly, the findings and recommendations presented in this report may be invalidated, wholly or in part, by changes outside our control. Therefore, this report is subject to review by CEL after a period of three (3) years has elapsed from the date of issuance of this report. In addition, if the currently proposed design scheme as noted in this report is altered CEL should be provided the opportunity to review the changed design and provide supplemental recommendations as needed.

Recommendations are presented in this report which specifically request that CEL be provided the opportunity to review the project plans prior to construction and that we be retained to provide observation and testing services during construction. The validity of the recommendations of this report assumes that CEL will be retained to provide these services.

This report was prepared upon your request for our services, and in accordance with currently accepted geotechnical engineering practice. No warranty based on the contents of this report is intended, and none shall be inferred from the statements or opinions expressed herein.

The scope of our services for this report did not include an environmental assessment or investigation for the presence or absence of wetlands or hazardous or toxic materials in the soil, surface water, groundwater or air, on, below or around this site. Any statements within this report or on the attached Plates, logs or records regarding odors noted or other items or conditions observed are for the information of our client only.

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Publications may have been used as general reference and not specifically cited in the report text.

PLATES

Plate 1 – Site Vicinity Map
Plate 2a – Site Plan
Plate 2b – Development Plan
Plate 3 – Regional Geologic Map
Plate 4 – Regional Fault Map
Plate 5a –Cross-Sections A-A' and B-B'
Plate 5b –Cross-Section C-C'
Plate 6 – Seismic Hazard Zones Map
Plate 7 – Flood Hazard Map

N

SCALE

2000 0 2000 4000

Feet

USGS Topographic Map, Oakland West, CA Quadrangle 2015.

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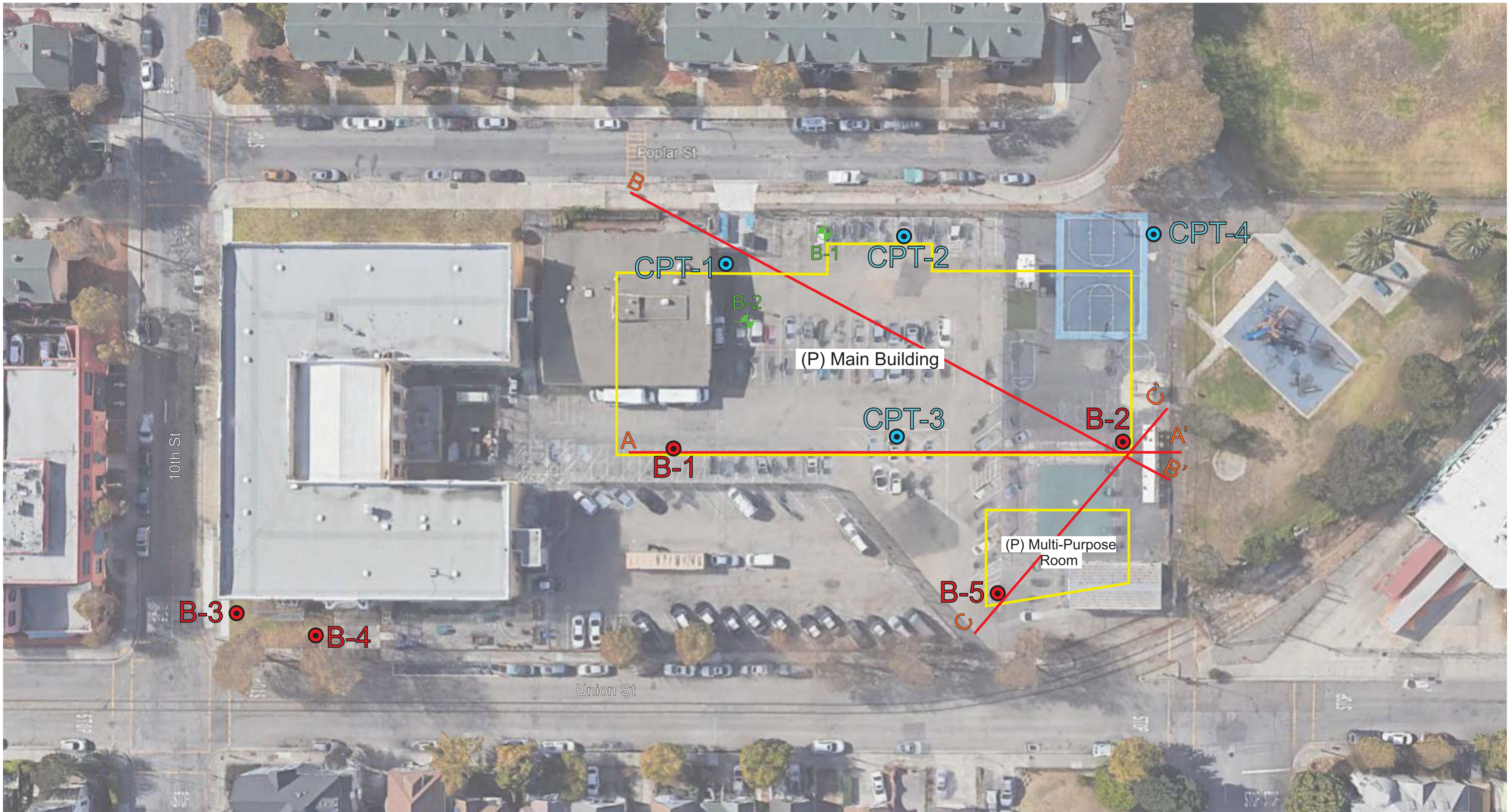
Site Vicinity Map		
Central Administrative Center Cole Campus 1011 Union Street, Oakland, California 94607		
84-04726-PWA	May 2020	Plate 1



B-1 - Approximate Boring Location (Geosphere 2015)
B1 - Approximate Boring Location (This Study)
CPT1 - Approximate CPT Location
- Geologic Cross Section

100 feet
Scale

Base map: Google Earth (2019)

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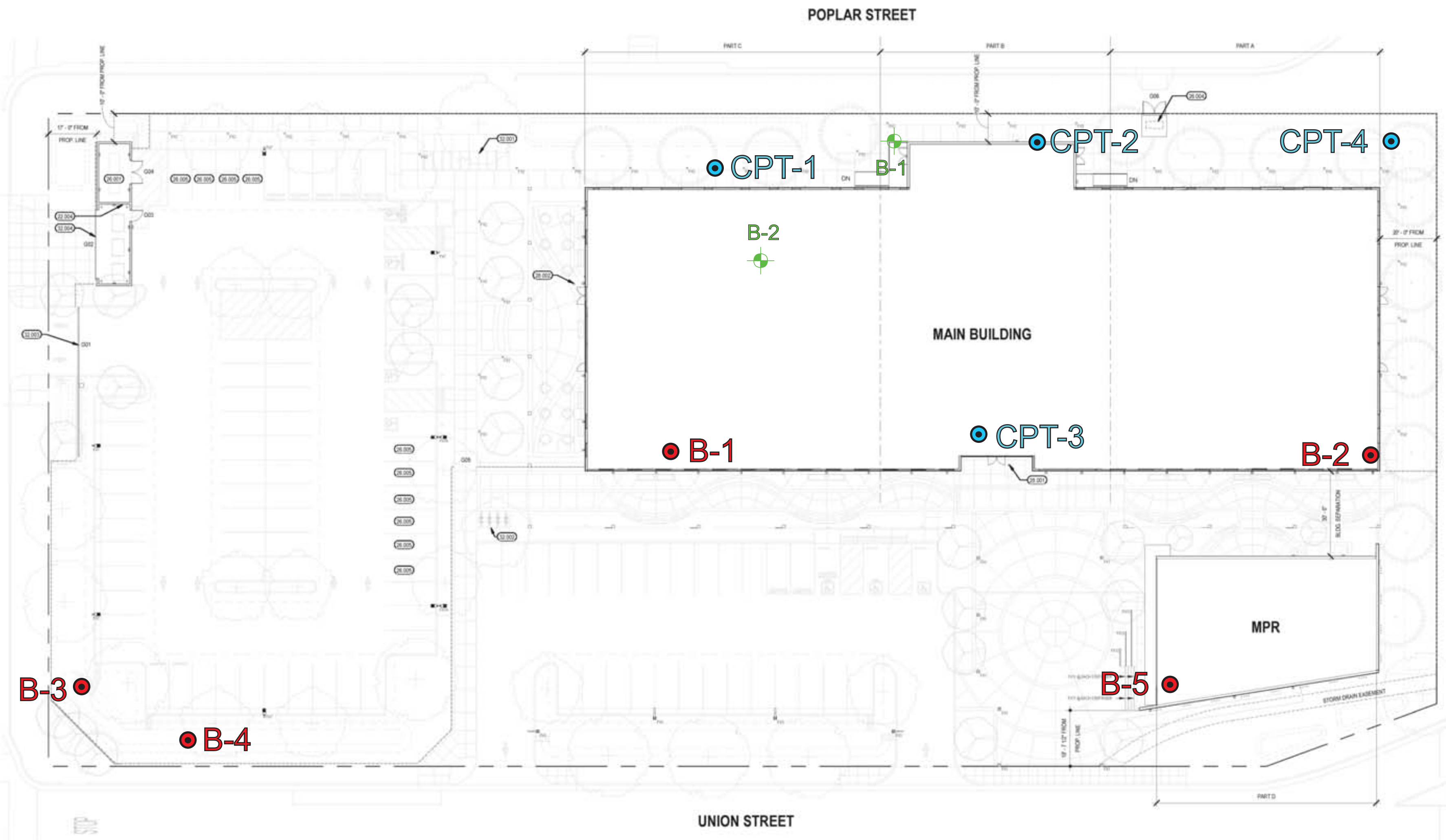
Site Plan		
Central Administrative Center Cole Campus 1011 Union Street, Oakland, California 94607		
84-04726-PWA	May 2020	Plate 2a



- Approximate Boring Location (Geosphere 2015)

B1 - Approximate Boring Location (This Study)

CPT1 - Approximate CPT Location

70 feet

Scale

Base map: Shah Kawasaki Architects (2020)

Development Plan		
Central Administrative Center Cole Campus 1011 Union Street, Oakland, California 94607		
84-04726-PWA	May 2020	Plate 2b

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Qtc - Temescal formation

Qm - Merritt sand

Qaf - Artificial fill

N

SCALE

2000 0 2000 4000

Feet

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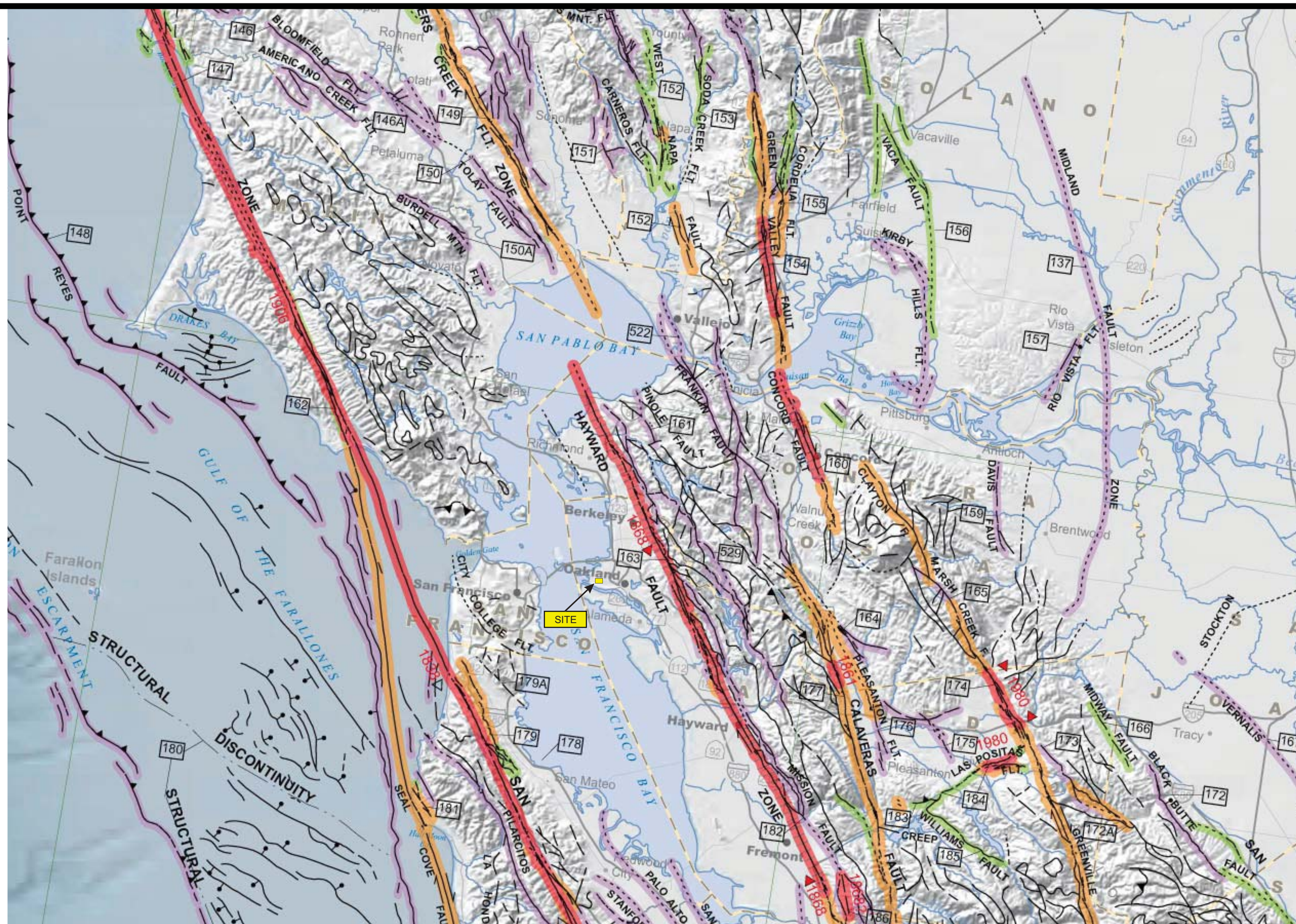
Regional Geologic Map

Central Administrative Center
Cole Campus
1011 Union Street, Oakland, California 94607

84-04726-PWA	May 2020	Plate 3

DESCRIPTION	
ON LAND	OFFSHORE
Displacement during historic time (e.g. San Andreas fault 1906). Includes areas of known fault creep.	
Displacement during Holocene time.	Fault offsets seafloor sediments or strata of Holocene age.
Faults showing evidence of displacement during late Quaternary time.	Faults cuts strata of Late Pleistocene age.
Undivided Quaternary faults - most faults in this category show evidence of displacement during the last 1,600,000 years; possible exceptions are faults which displace rocks of undifferentiated Plio-Pleistocene age.	Fault cuts strata of Quaternary age.
Faults without recognized Quaternary displacement or showing evidence of no displacement during Quaternary time. Not necessarily inactive.	Fault cuts strata of Pliocene or older age.

Geologic Time Scale			Years Before Present (Approx.)	Fault Symbol	Recency of Movement
Quaternary	Late Quaternary	Historic	200		
		Holocene	11,700		
		Pleistocene	700,000		
	Early Quaternary		1,600,000		
Pre-Quaternary			4.5 billion (Age of Earth)		



20 miles
Scale

Base map: Google Earth Pro (2018)

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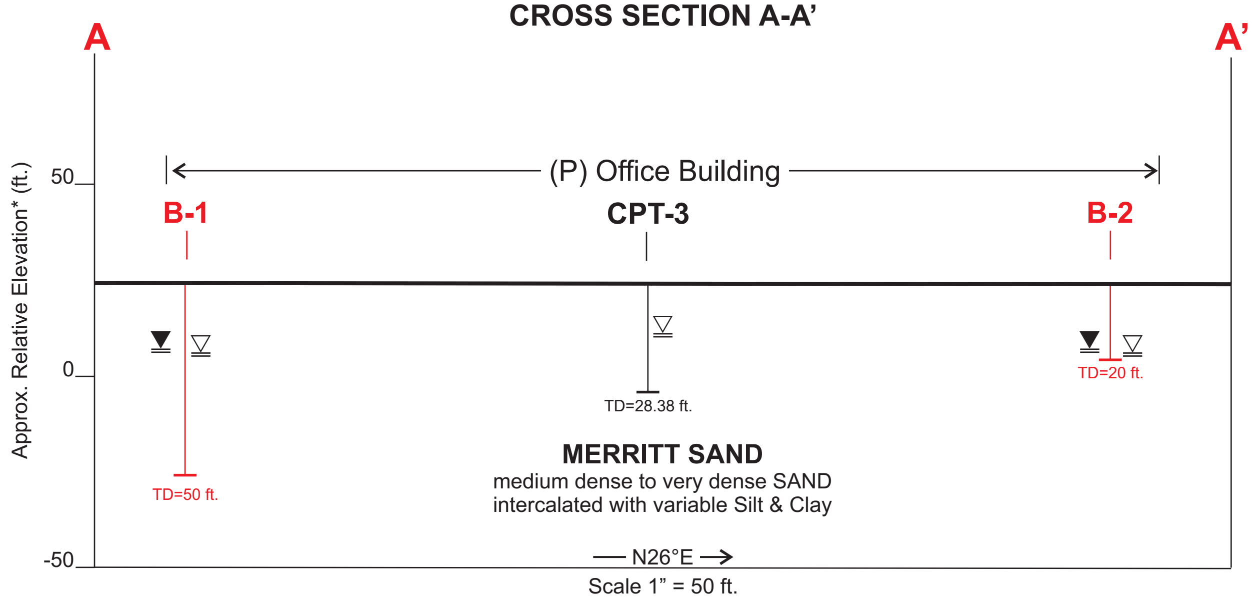
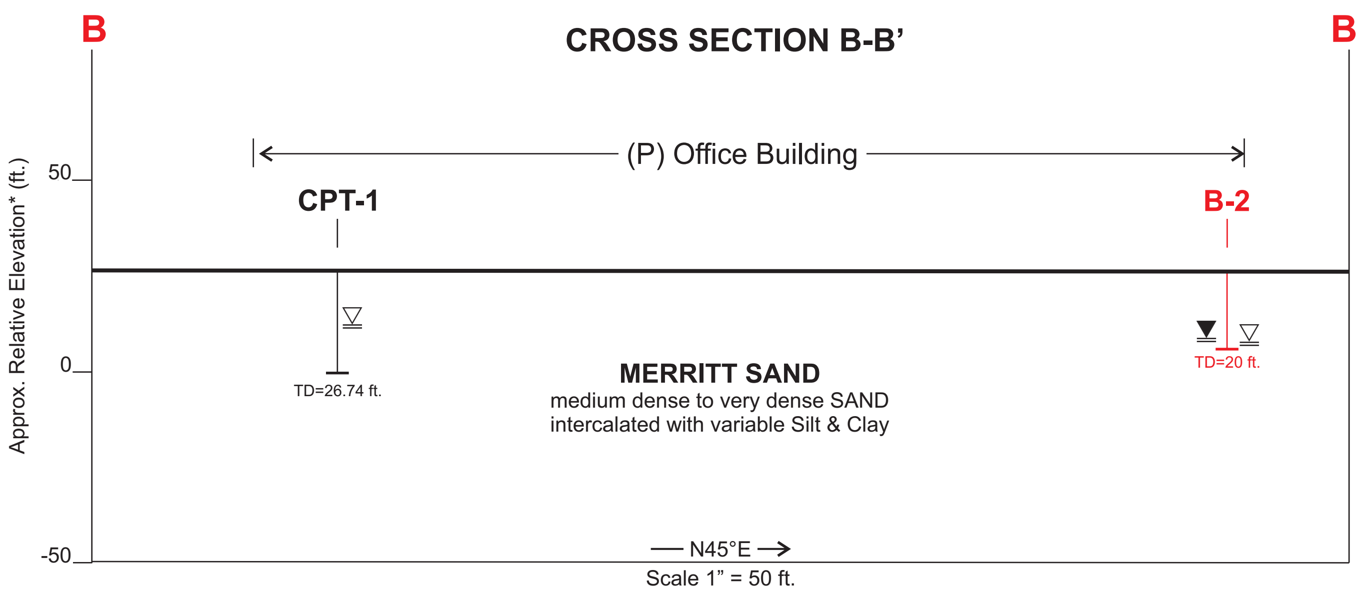
Regional Fault Map		
Central Administrative Center Cole Campus 1011 Union Street, Oakland, California 94607		
84-04726-PWA	May 2020	Plate 4

CROSS SECTION A-A’



CROSS SECTION B-B’



EXPLANATION

▽ Water first encountered during drilling

▼ Water level post drilling

B-2 — TD=20 ft. — Approx. location and total depth drilled (this study)

*elevation from Google Earth Pro

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— AN ATLAS COMPANY —

Job No.: 84-04726-PWA

Approved: AL

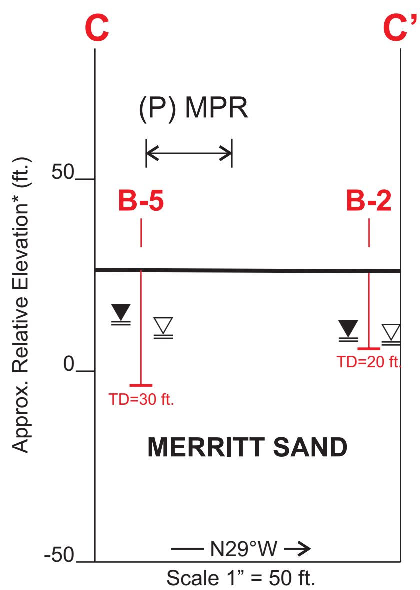
Date: May 2019

CROSS SECTIONS A-A’ & B-B’

Central Administrative Center
Cole Campus
1011 Union Street, Oakland, California

Plate 5a

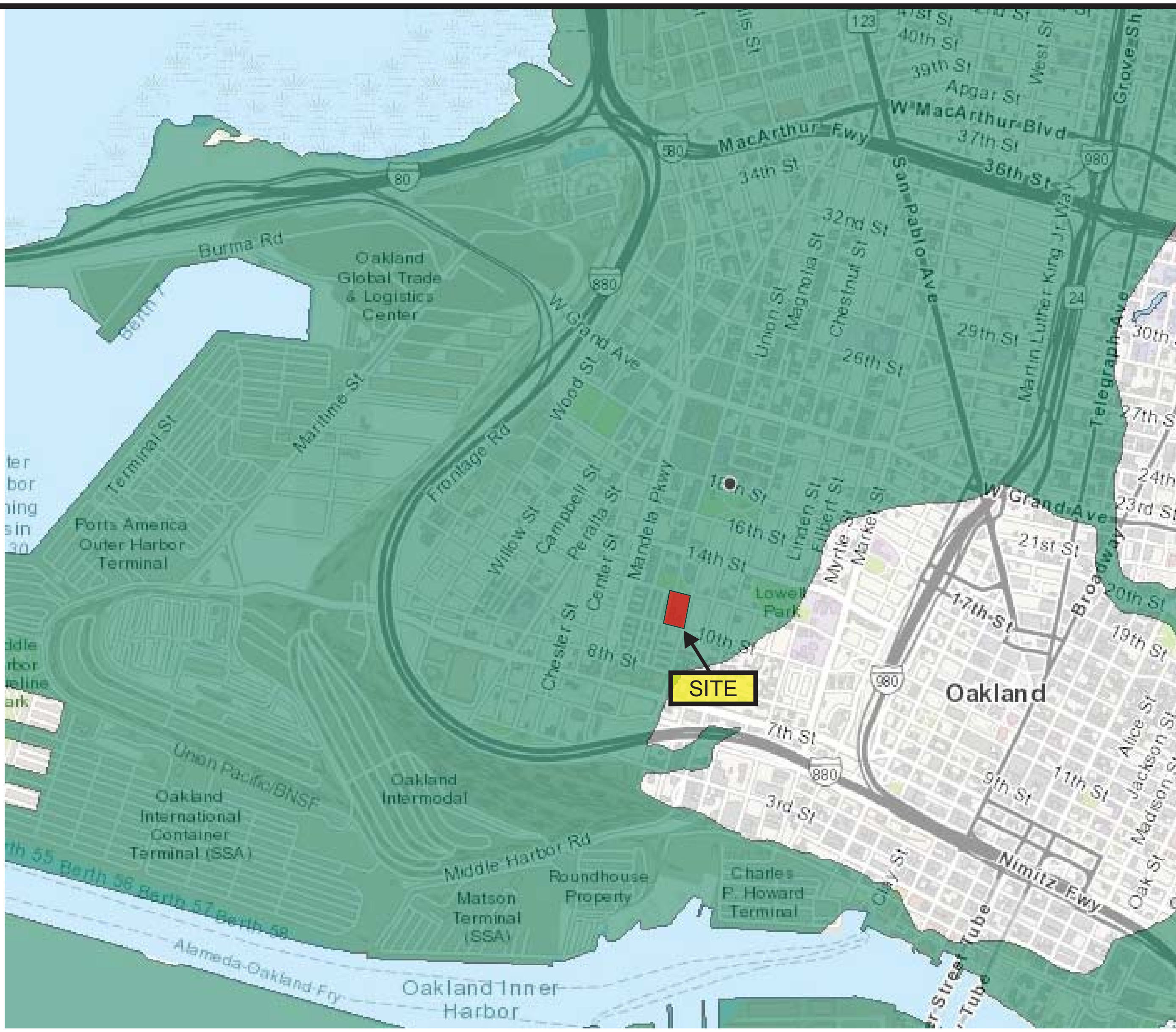
CROSS SECTION C-C’



EXPLANATION

*elevation from Martin M. Ron Associates (2015)

ATLAS CONSOLIDATED ENGINEERING LABORATORIES — AN ATLAS COMPANY —	**Job No.:** 84-04726-PWA **Approved:** AL **Date:** May 2020	**CROSS SECTIONS C-C’** Central Administrative Center Cole Campus 1011 Union Street, Oakland, California	**Plate** 5b



MAP EXPLANATION

ALQUIST-PRIOLO EARTHQUAKE FAULT ZONES

Earthquake Fault Zones
Zone boundaries are delineated by straight-line segments; the boundaries define the zone encompassing active faults that constitute a potential hazard to structures from surface faulting or fault creep such that avoidance as described in Public Resources Code Section 2621.5(a) would be required.

Active Fault Traces
1906 C ? ?
Faults considered to have been active during Holocene time and to have potential for surface rupture: Solid Line in Black or Red where Accurately Located; Long Dash in Black or Solid Line in Purple where Approximately Located; Short Dash in Black or Solid Line in Orange where Inferred; Dotted Line in Black or Solid Line in Rose where Concealed; Query (?) indicates additional uncertainty. Evidence of historic offset indicated by year of earthquake-associated event or C for displacement caused by fault creep.

SEISMIC HAZARD ZONES

Liquefaction Zones
Areas where historical occurrence of liquefaction, or local geological, geotechnical and ground water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Earthquake-Induced Landslide Zones
Areas where previous occurrence of landslide movement, or local topographic, geological, geotechnical and subsurface water conditions indicate a potential for permanent ground displacements such that mitigation as defined in Public Resources Code Section 2693(c) would be required.

Reference: California Geological Survey - Seismic Hazard Zones Oakland West Quadrangle (2016)

ATLAS
CONSOLIDATED ENGINEERING LABORATORIES
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Seismic Hazards Zones Map

Central Administrative Center
Cole Campus
1011 Union Street, Oakland, California 94607

84-04726-PWA	May 2020	Plate 6

LEGEND

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0288G

FIRM

FLOOD INSURANCE RATE MAP

ALAMEDA COUNTY, CALIFORNIA
AND INCORPORATED AREAS

PANEL 288 OF 725

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAYWARD, CITY OF	065033	0288	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
06001C0288G

EFFECTIVE DATE
AUGUST 3, 2009

Federal Emergency Management Agency

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.

FLOODWAY AREAS IN ZONE AE

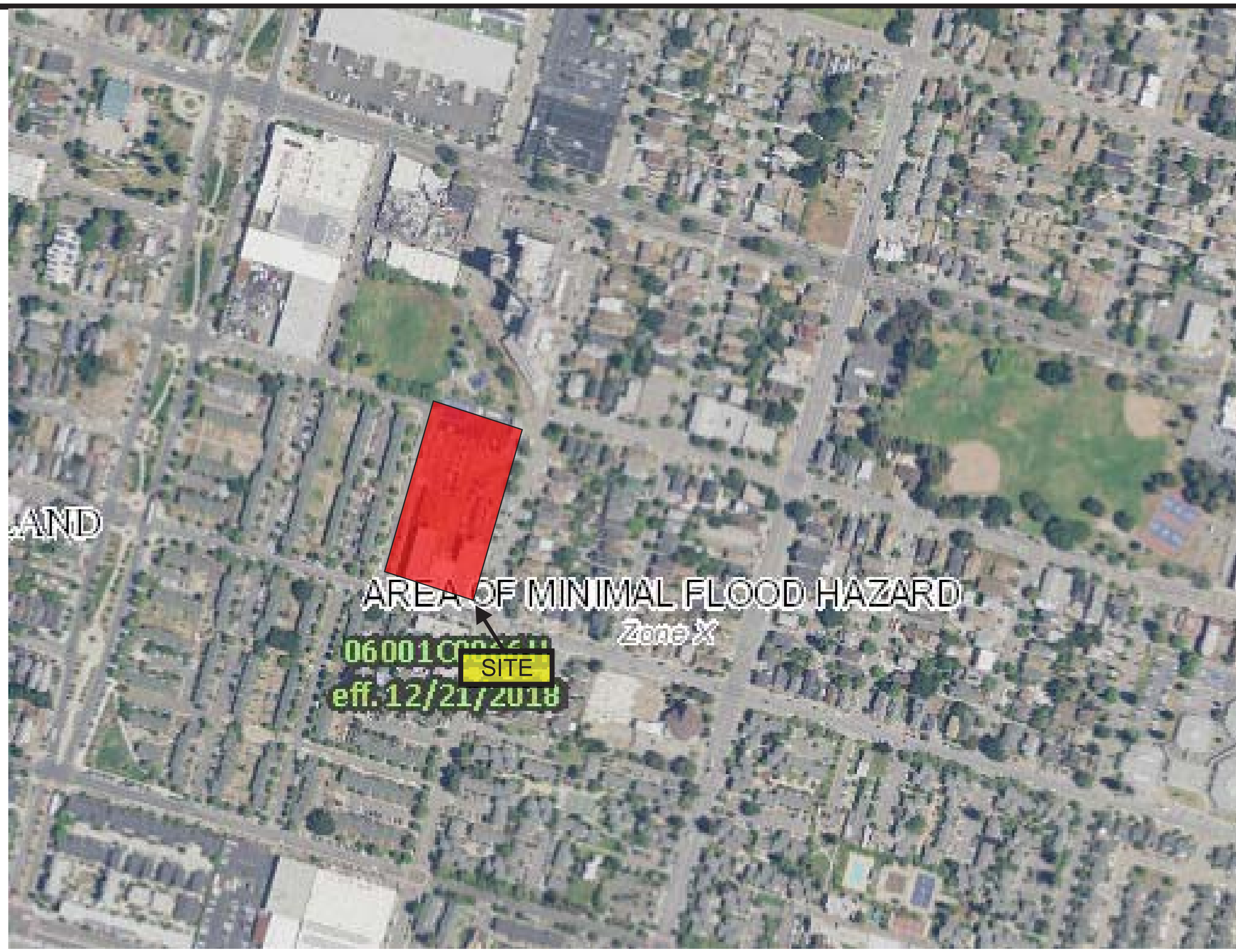
The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

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.



N

500ft 1000ft

Scale

CONSOLIDATED ENGINEERING LABORATORIES

— AN ATLAS COMPANY —

Flood Hazard Map

Central Administrative Center
Cole Campus
1011 Union Street, Oakland, California 94607

84-04726-PWA	May 2020	Plate 7

APPENDIX A

FIELD EXPLORATION

Key to Boring Log Symbols

Boring Logs (B-1 through B-5)

Boring Logs (Geosphere 2015 Borings B-1 and B-2)

Cone Penetration Test Results

UNIFIED SOIL CLASSIFICATION (ASTM D-2487)

Material Types	Criteria for Assigning Soil Group Names			Group Symbol	Soil Group Names	Legend
Coarse Grained Soils	Gravels >50% of Coarse Fraction Passes on No. 4 Sieve	Clean Gravels <5% Fines	Cu≥4 and 1≤Cc≤3	GW	Well-Graded Gravel	
			Cu≥4 and/or 1>Cc>3	GP	Poorly-Graded Gravel	
>50% Retained on No. 200 Sieve		Gravels with Fines >12% Fines	Fines Classify as ML or MH	GM	Silty Gravel	
			Fines Classify as CL or CH	GC	Clayey Gravel	
	Sands ≥50% of Coarse Fraction Passes on No. 4 Sieve	Clean Sands <5% Fines	Cu<6 and 1≤Cc≤3	SW	Well-Graded Sand	
			Cu<6 and/or 1>Cc>3	SP	Poorly-Graded Sand	
		Sands and Fines >12% Fines	Fines Classify as ML or MH	SM	Silty Sand	
			Fines Classify as CL or CH	SC	Clayey Sand	
Fine Grained Soils	Silts and Clays	Inorganic	PI>7 and Plots≥"A" Line	CL	Lean Clay	
			PI<4 and Plots<"A" Line	ML	Silt	
≥50% Passes No. 200 Sieve	Liquid Limits<50	Organic	LL (Oven Dried)/LL(Not Dried <0.75)	OL	Organic Silt	
	Silts and Clays	Inorganic	PI Plots≥"A" Line	CH	Fat Clay	
			PI Plots<"A" Line	MH	Elastic Silt	
	Liquid Limits≥50	Organic	LL (Oven Dried)/LL(Not Dried <0.75)	OH	Organic Clay	
Highly Organic Soils		Primarily Organic Matter, Dark in Color and Organic Odor		PT	Peat	

PENETRATION RESISTANCE (RECORDED AS BLOWS/0.5 FEET)

SAND AND GRAVEL		SILT AND CLAY		
RELATIVE DENSITY	N-VALUE (BLOWS/FOOT)*	CONSISTENCY	N-VALUE (BLOWS/FOOT)*	COMPRESSIVE STRENGTH
Very Loose	0 - 3	Very Soft	0 - 1	0 - 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.50
Medium Dense	11 - 29	Medium Stiff	5 - 7	0.50 - 1.0
Dense	30 - 49	Stiff	8 - 14	1.0 - 2.0
Very Dense	50 +	Very Stiff	15 - 29	2.0 - 4.0
		Hard	30 +	Over 4.0

SOIL MOISTURE

DESCRIPTOR	DESCRIPTION
Dry	Dry of Standard Proctor Optimum
Damp	Sand Dry
Moist	Near Standard Proctor Optimum
Wet	Wet of Satandard Proctor Optimum
Saturated	Free Water in Sample

PARTICLES SIZES

COMPONENTS		SIZE OR SIEVE NUMBER
Boulders		Over 12 Inches
Cobbles		3 to 12 Inches
Gravels	-Coarse	3/4 to 3 Inches
	-Fine	Number 4 to 3/4 Inch
Sand	-Coarse	Number 10 to Number 4
	-Medium	Number 40 to Number 10
	-Fine	Number 200 to Number 40
Fines (Silt and Clay)		Below Number 200

Grab Bulk Sample

Standard Penetration Test

2.5 Inch Modified California

Shelby Tube

No Recovery

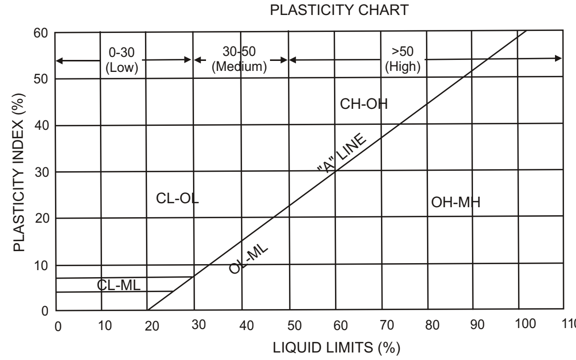
Initial Water Level Reading

Final Water Level Reading

Blow Count
The number of blows of the sampling hammer required to drive the sampler through each of three 6-inch increments. Less than three increments may be reported if more than 50 blows are counted for any increment. The notation 50/5" indicates 50 blows recorded for 5 inches of penetration.

N-Value
Number of blows 140 LB hammer falling 30 inches to drive a 2 inch outside diameter (1-3/8 inch I.D) split barrel sampler the last 12 inches of an 18 inch drive (ASTM-1586 Standard Penetration Test)

PLASTICITY CHART



CU -Consolidated Undrained triaxial test completed. Refer to laboratory results
DS - Results of Direct Shear test in terms of total cohesion (C, KSF) or effective cohesion and friction angles (C', KSF and degrees)
LL - Liquid Limit
PI - Plasticity Index
PP - Pocket Penetrometer test
TV - Torvane Shear Test results in terms of undrained shear strength (KSF)
UC - Unconfined Compression test results in terms of undrained shear strength (KSF)
#200 - Percent passing number 200 sieve
Cu - Coefficient of Uniformity
Cc - Coefficient of Concavity

General Notes

1. The boring locations were determined by pacing, sighting and/or measuring from site features. Locations are approximate. Elevations of borings (if included) were determined by interpolation between plan contours or from another source that will be identified in the report or on the project site plan. The location and elevation of borings should be considered accurate only to the degree implied by the method used.

2. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.

3. Water level readings in the drill holes were recorded at time and under conditions stated on the boring logs. This data has been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, tides, temperature and other factors at the time measurements were made.

4. The boring logs and attached data should only be used in accordance with the report.

CONSOLIDATED ENGINEERING
LABORATORIES

KEY TO EXPLORATORY BORING LOGS

CONSOLIDATED ENGINEERING LABORATORIES
2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

BORING NUMBER B-1

CLIENT Oakland Unified School District
PROJECT NAME Cole Campus - Central Administrative Center
PROJECT NUMBER 84-04726-PWA
PROJECT LOCATION 1011 Union Street Oakland, California 94607
DATE STARTED 11/9/19 **COMPLETED** 11/9/19
GROUND ELEVATION 17.2 ft **HOLE SIZE** 8"
DRILLING CONTRACTOR Exploration Geoservices Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA B-53R
∇ **AT TIME OF DRILLING** 19.00 ft / Elev -1.80 ft
LOGGED BY AK **CHECKED BY** AL
AT END OF DRILLING ---
NOTES Elevations from Martin M. Ron Associates (2015)
∇ **AFTER DRILLING** 18.00 ft / Elev -0.80 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		**AC 1"** :	GB 1-1									
		AB 6" :										
		(SP) **POORLY GRADED SAND** : Medium dense, dark brown, moist, fine grained sand with brick and concrete fragments.	MC 1-2		12-5-6 (11)		103	7				
		[FILL]										
5		(SC) **CLAYEY SAND** : Medium dense, brown, moist, with fine grained sand.	MC 1-3		4-7-7 (14)		107	7				16
		Becomes very dense.	MC 1-4		12-21-33 (54)							
10		Becomes dense.	SPT 1-5		20-23-24 (47)							
15		Becomes very dense and brown with Increased clay content.	SPT 1-6		25-28-22 (50)							
20		∇ ∇ Becomes wet and dense.	SPT 1-7		13-17-16 (33)			18				
25		Becomes very dense.	SPT 1-8		22-50/5"							
		(SP-SM) **POORLY GRADED SAND WITH SILT** : Very dense, brown, wet, with fine grained sand.										
30			SPT 1-9		28-43-44 (87)							
35			SPT 1-10		50							

(Continued Next Page)

CONSOLIDATED ENGINEERING LABORATORIES

2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

BORING NUMBER B-1

CLIENT Oakland Unified School District

PROJECT NAME Cole Campus - Central Administrative Center

PROJECT NUMBER 84-04726-PWA

PROJECT LOCATION 1011 Union Street Oakland, California 94607

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
35		(SP-SM) **POORLY GRADED SAND WITH SILT :** Very dense, brown, wet, with fine grained sand. *(continued)*										
40			SPT 1-11		34-50							
45			SPT 1-12		28-38-50/5"							
50			SPT 1-13		50							

Bottom of borehole at 50.0 feet.

BORING NUMBER B-2

CONSOLIDATED ENGINEERING LABORATORIES
2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

CLIENT Oakland Unified School District
PROJECT NAME Cole Campus - Central Administrative Center
PROJECT NUMBER 84-04726-PWA
PROJECT LOCATION 1011 Union Street Oakland, California 94607
DATE STARTED 11/9/19 **COMPLETED** 11/9/19
GROUND ELEVATION 16.7 ft **HOLE SIZE** 8"
DRILLING CONTRACTOR Exploration Geoservices Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA B-53R
AT TIME OF DRILLING 19.00 ft / Elev -2.30 ft
LOGGED BY AK **CHECKED BY** AL
AT END OF DRILLING ---
NOTES Elevations from Martin M. Ron Associates (2015)
AFTER DRILLING 18.00 ft / Elev -1.30 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		**AC 1"** :	GB 2-1									
		AB 4" :										
		(SP) **POORLY GRADED SAND** : Loose, dark brown, moist, with fine grained sand.	MC 2-2		2-2-3 (5)		102	6				
		(SC) **CLAYEY SAND** : Medium dense, light orangish brown, moist. with fine grained sand.										
5			MC 2-3		3-5-7 (12)		100	8				
		Becomes dense.	MC 2-4		11-18-26 (44)							
10		(SM) **SILTY SAND** : Dense, brown, moist, with fine grained sand.	SPT 2-5		18-20-24 (44)							
		(SC) **CLAYEY SAND** : Very dense, brown, very moist, with fine grained sand.										
15			SPT 2-6		16-18-36 (54)			16				
20		Becomes wet and dense.	SPT 2-7		9-13-17 (30)			20				16

Bottom of borehole at 20.0 feet.

CONSOLIDATED ENGINEERING LABORATORIES

2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

BORING NUMBER B-3

CLIENT Oakland Unified School District
PROJECT NAME Cole Campus - Central Administrative Center
PROJECT NUMBER 84-04726-PWA
PROJECT LOCATION 1011 Union Street Oakland, California 94607
DATE STARTED 11/9/19 **COMPLETED** 11/9/19
GROUND ELEVATION 16.6 ft **HOLE SIZE** 8"
DRILLING CONTRACTOR Exploration Geoservices Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA B-53R
AT TIME OF DRILLING 19.00 ft / Elev -2.40 ft
LOGGED BY AK **CHECKED BY** AL
AT END OF DRILLING ---
NOTES Elevations from Martin M. Ron Associates (2015)
Elevations from Martin M. Ron Associates (2015)
AFTER DRILLING 18.00 ft / Elev -1.40 ft

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		**TOPSOIL** :	GB 3-1									
		(SP) **POORLY GRADED SAND** : Loose, dark brown, moist, with fine grained sand.	SPT 3-2		3-2-4 (6)							
		(SC) **CLAYEY SAND** : Loose, orangish brown, moist, with fine grained sand.	SPT 3-3		3-4-5 (9)							
5		Becomes brown.										
		Becomes very dense.	SPT 3-4		18-23-32 (55)			12				21
		(SM) **SILTY SAND** : Very dense, orangish brown, moist, with fine grained sand.	SPT 3-5		18-24-37 (61)							
10												
		(SC) **CLAYEY SAND** : Medium dense, brown, moist, with fine grained sand.										
15			SPT 3-6		7-8-13 (21)			17				
20		Becomes wet and very dense.	SPT 3-7		16-38-50 (88)			18				

Bottom of borehole at 20.0 feet.

CONSOLIDATED ENGINEERING LABORATORIES

2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

BORING NUMBER B-4

CLIENT Oakland Unified School District
PROJECT NAME Cole Campus - Central Administrative Center
PROJECT NUMBER 84-04726-PWA
PROJECT LOCATION 1011 Union Street Oakland, California 94607
DATE STARTED 11/9/19 **COMPLETED** 11/9/19
GROUND ELEVATION 16.5 ft **HOLE SIZE** 8"
DRILLING CONTRACTOR Exploration Geoservices Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA B-53R
AT TIME OF DRILLING 19.00 ft / Elev -2.50 ft
LOGGED BY AK **CHECKED BY** AL
AT END OF DRILLING ---
NOTES Elevations from Martin M. Ron Associates (2015)
AFTER DRILLING 18.00 ft / Elev -1.50 ft

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	**TOPSOIL** :	GB 4-1									
	(SP) **POORLY GRADED SAND** : Loose, dark brown, moist, with fine grained sand.	MC 4-2		4-3-3 (6)							
	(SM) **SILTY SAND** : Loose, dark brown, moist, with roots, with fine grained sand.										
5	Becomes brown.	MC 4-3		3-3-4 (7)		102	8				
	Becomes very dense and orangish brown.	MC 4-4		21-33-38 (71)							
10		SPT 4-5		20-32-36 (68)							
	(SC) **CLAYEY SAND** : Medium dense, brown,very moist, with fine grained sand.										
15		SPT 4-6		6-7-9 (16)			17				39
20	Becomes wet and very dense.	SPT 4-7		12-24-34 (58)			19				

Bottom of borehole at 20.0 feet.

BORING NUMBER B-5

CONSOLIDATED ENGINEERING LABORATORIES
2001 Crow Canyon Road, Suite 210
San Ramon, CA 94583-5368
Telephone: (925) 314-7180

CLIENT Oakland Unified School District
PROJECT NAME Cole Campus - Central Administrative Center
PROJECT NUMBER 84-04726-PWA
PROJECT LOCATION 1011 Union Street Oakland, California 94607
DATE STARTED 5/2/20 **COMPLETED** 5/2/20
GROUND ELEVATION 16 ft **HOLE SIZE** 8"
DRILLING CONTRACTOR Exploration Geoservices Inc.
GROUND WATER LEVELS:
DRILLING METHOD HSA B-61
AT TIME OF DRILLING 17.00 ft / Elev -1.00 ft
LOGGED BY AL **CHECKED BY** CD
AT END OF DRILLING 14.00 ft / Elev 2.00 ft
NOTES Elevations from Martin M. Ron Associates (2015)
AFTER DRILLING ---

DEPTH (ft)	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	FINES CONTENT (%)
0	**AC 1"** :										
	AB? 5" :										
	(SM) **SILTY SAND** : Loose, dark brown, moist, med grained with some gravel and brick pieces. [FILL]	MC 5-1		2-3-5 (8)		101	7				
	(SM) **SILTY SAND** : Loose, brown, moist, with trace gravel. Becomes med dense, light brown to orange brown.	MC 5-2		4-6-14 (20)		108	12				
5											
	Becomes very dense, orange brown. [50/6" MC]	MC 5-3		14-33							
10		SPT 5-4		15-30-38 (68)							
	(SC-SM) **SILTY CLAYEY SAND** : Med dense, brown with iron stains, wet, high fines, low plasticity.										
15		SPT 5-5		11-6-8 (14)			17	17	12	5	41
	(SM) **SILTY SAND** : Very dense, brown, wet, corase sand.										
20		SPT 5-6		9-28-50/4"							
25	Becomes olive brown.	SPT 5-7		21-42-50/5"							
		SPT 5-8		32-50							

Bottom of borehole at 29.5 feet.

BORING NUMBER B-1

Geosphere Consultants, Inc.
AN ETS COMPANY
Geotechnical Engineering · Engineering Geology
Environmental Management · Water Resources

2001 Crow Canyon Road
San Ramon, CA

CLIENT Oakland Unified School District
PROJECT NAME Cole Elementary School Site PEC Portables
PROJECT NUMBER 91-03424-A
PROJECT LOCATION 1011 Union Street, Oakland, CA 94607
DATE STARTED 1/23/15 **COMPLETED** 1/23/15
GROUND ELEVATION 17 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Geo-Ex
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight CME-75
AT TIME OF DRILLING ---
LOGGED BY NAA **CHECKED BY** CTD
AT END OF DRILLING 20.00 ft / Elev -3.00 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		**1" ASPHALT PAVEMENT**										
		2" Orange-brown SANDY GRAVEL										
		(SC) **CLAYEY SAND** : Dark-brown, fine, moist, very loose	MC 2-1		1-1-1 (2)							
5		(SM) **SILTY SAND** : Orange-brown, fine-to-coarse, moist, dense, friable	MC 2-2		15-15-29 (44)		116	13				
10		(SC) **CLAYEY SAND** : Mottled orange-tan-brown, fine-to-coarse, moist, dense	MC 2-3		14-16-20 (36)		119	16				
15		(SM) **SILTY SAND** : Mottled orange-tan-brown, fine-to-coarse, moist, medium dense	SPT 2-4		8-9-12 (21)							
20		(SP-SM) **SAND** : Mottled orange-tan-brown, medium coarse, wet, dense, w/ trace Silt	SPT 2-5		11-19-20 (39)							
25		(SP-SM) **SAND** : Olive-brown, very dense, wet, medium coarse, w/ Silt										
30												

(Continued Next Page)

BORING NUMBER B-1

Geosphere Consultants, Inc.
AN ETS COMPANY
Geotechnical Engineering · Engineering Geology
Environmental Management · Water Resources

2001 Crow Canyon Road
San Ramon, CA

CLIENT Oakland Unified School District

PROJECT NAME Cole Elementary School Site PEC Portables

PROJECT NUMBER 91-03424-A

PROJECT LOCATION 1011 Union Street, Oakland, CA 94607

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
30		(SP-SM) **SAND** : Olive-brown, very dense, wet, medium coarse, w/ Silt *(continued)*	SPT 2-6		20-29-40 (69)							12
35												
40			SPT 2-7		23-34-47 (81)							9
45		(CL-ML) **SILTY CLAY** : Brown & Gray, moist, very stiff, high plasticity, w/ orange stains and fine-grained sand										
50			SPT 2-8		9-9-9 (18)							

Bottom of borehole at 50.0 feet.

Geosphere Consultants, Inc.
AN ETS COMPANY
Geotechnical Engineering · Engineering Geology
Environmental Management · Water Resources
2001 Crow Canyon Road
San Ramon, CA

BORING NUMBER B-2

CLIENT Oakland Unified School District
PROJECT NAME Cole Elementary School Site PEC Portables
PROJECT NUMBER 91-03424-A
PROJECT LOCATION 1011 Union Street, Oakland, CA 94607
DATE STARTED 1/23/15 **COMPLETED** 1/23/15
GROUND ELEVATION 17 ft **HOLE SIZE** 6"
DRILLING CONTRACTOR Geo-Ex
GROUND WATER LEVELS:
DRILLING METHOD Solid Flight CME-75
AT TIME OF DRILLING 15.00 ft / Elev 2.00 ft
LOGGED BY NAA **CHECKED BY** CTD
AT END OF DRILLING 20.00 ft / Elev -3.00 ft
NOTES
AFTER DRILLING ---

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT	ATTERBERG LIMITS: PLASTIC LIMIT	ATTERBERG LIMITS: PLASTICITY INDEX	FINES CONTENT (%)
0		**1" ASPHALT PAVEMENT**										
		2" Orange-brown SANDY GRAVEL										
		(SC) **CLAYEY SAND** : Dark-brown, fine, moist, very loose, w/ fine gravel										
			MC 1-1		2-1-1 (2)							17
5		becomes light-orange brown, increasing coarseness										
		becomes dark Yellowish-Brown and dense, DS: C = 0.3 ksf, Phi = 31 deg.	MC 1-2		2-5-8 (13)							
			SPT 1-3		6-10-15 (25)			13				
10		clay content decreases, medium dense	MC 1-4		8-16-26 (42)		115	16				
15		becomes very moist, increasing clay content	SPT 1-5		6-7-7 (14)							46
20		becomes medium-to-coarse, very moist-to-wet	SPT 1-6		6-10-11 (21)							
		(SP-SM) **SAND** : Olive-brown, coarse, wet, very dense										
25												

(Continued Next Page)

BORING NUMBER B-2

Geosphere Consultants, Inc.
AN ETS COMPANY
Geotechnical Engineering · Engineering Geology
Environmental Management · Water Resources

2001 Crow Canyon Road
San Ramon, CA

CLIENT Oakland Unified School District

PROJECT NAME Cole Elementary School Site PEC Portables

PROJECT NUMBER 91-03424-A

PROJECT LOCATION 1011 Union Street, Oakland, CA 94607

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	SPT BLOW COUNTS (N VALUE)	POCKET PEN. (tsf)	DRY UNIT WT. (pcf)	MOISTURE CONTENT (%)	ATTERBERG LIMITS			FINES CONTENT (%)
									LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	
25		(SP-SM) **SAND** : Olive-brown, coarse, wet, very dense *(continued)*	SPT 1-7		12-25-28 (53)							
		Color changes to Tan & Orange, N=50/3" at D=29'	SPT 1-8		26							
30												

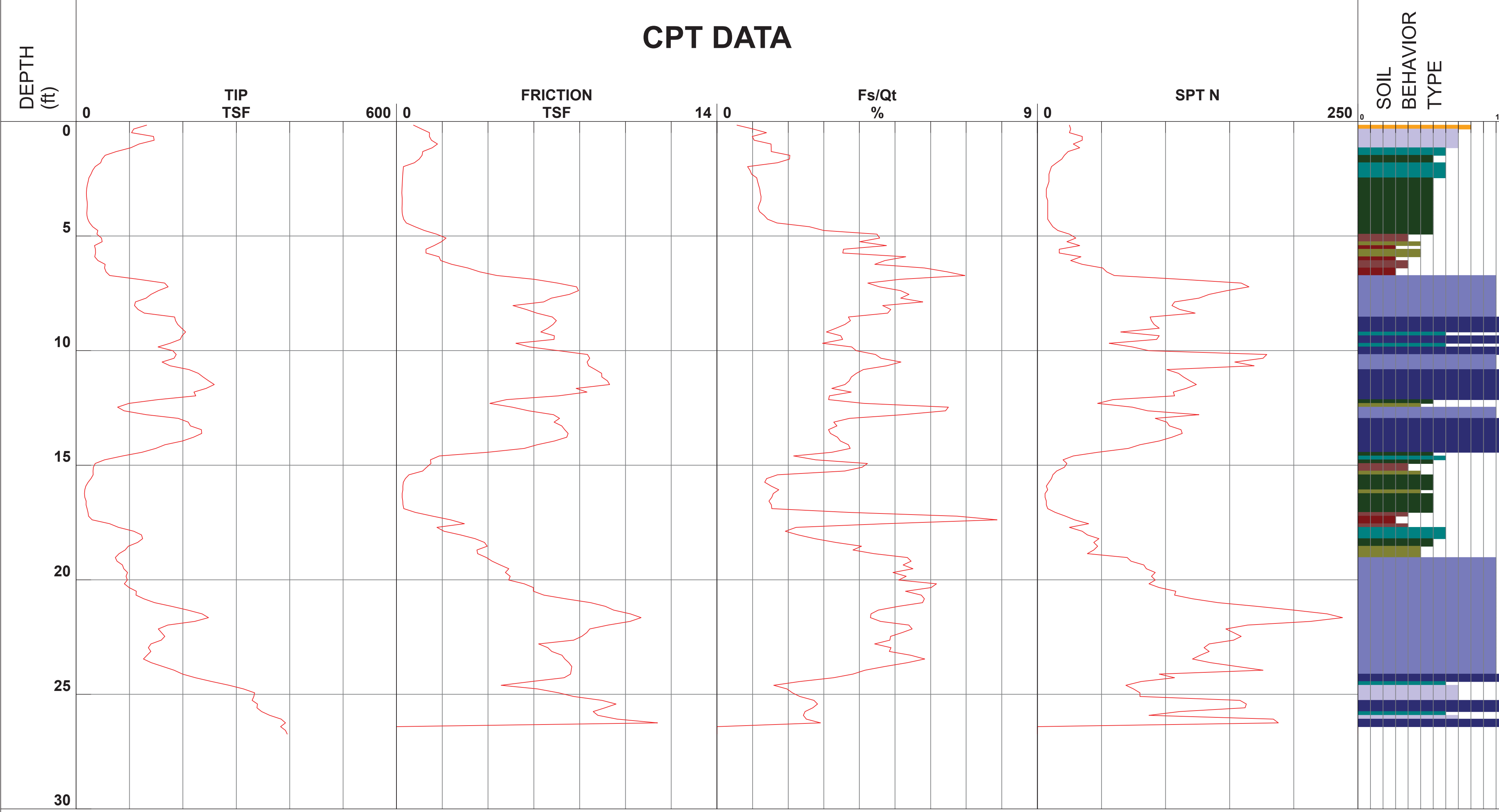
Refusal at 30.0 feet.
Bottom of borehole at 30.0 feet.

CEL

Project	Cole Campus	Operator	JM-AJ	Filename	SDF(326).cpt
Job Number	84-04726-PW	Cone Number	DDG1489	GPS	
Hole Number	CPT-01	Date and Time	11/9/2019 9:27:06 AM	Maximum Depth	26.74 ft
EST GW Depth During Test		14.80 ft			

Net Area Ratio .8

CPT DATA



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

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Project ID: CEL
Data File: SDF(326).cpt
CPT Date: 11/9/2019 9:27:06 AM
GW During Test: 14 ft

Page: 1
Sounding ID: CPT-01
Project No: 84-04726-PW
Cone/Rig: DDG1489

. Depth ft	. qc PS tsf	* qc1n PS -	. q1ncs PS -	* qt PS tsf	. Slv Stss tsf	. pore prss (psi)	. Frct Rato %	* Mat Typ Zon	* Material Behavior Description	. Unit Wght pcf	. Qc to N	* SPT R-N1 60%	. SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	. Und Shr tsf	. OCR -	* Fin Ic %	* D50 mm	* Ic SBT Indx	* Nk -
0.33	107.9	173.1	184.2	107.9	1.1	0.0	1.0	6	clean SAND to silty SAND	125	5.0	35	22	31	85	48	-	-	7	0.350	1.74	16
0.49	103.8	166.4	190.3	103.8	1.4	0.1	1.4	6	clean SAND to silty SAND	125	5.0	33	21	31	84	48	-	-	9	0.350	1.85	16
0.66	144.9	232.4	231.9	144.9	1.4	0.0	1.0	6	clean SAND to silty SAND	125	5.0	46	29	40	95	48	-	-	5	0.350	1.64	16
0.82	146.3	234.7	236.6	146.3	1.5	0.0	1.0	6	clean SAND to silty SAND	125	5.0	47	29	41	95	48	-	-	5	0.350	1.66	16
0.98	117.8	189.0	215.0	117.8	1.8	0.0	1.5	6	clean SAND to silty SAND	125	5.0	38	24	35	88	48	-	-	9	0.350	1.84	16
1.15	102.4	164.2	192.6	102.4	1.6	0.0	1.5	6	clean SAND to silty SAND	125	5.0	33	20	31	83	48	-	-	10	0.350	1.88	16
1.31	75.3	120.8	153.1	75.3	1.1	0.0	1.5	6	clean SAND to silty SAND	125	5.0	24	15	23	73	48	-	-	12	0.350	1.97	16
1.48	54.5	87.3	138.4	54.5	1.1	0.1	2.1	5	silty SAND to sandy SILT	120	4.0	22	14	18	63	48	-	-	18	0.200	2.16	16
1.64	48.7	78.1	129.8	48.7	1.0	0.1	2.0	5	silty SAND to sandy SILT	120	4.0	20	12	17	59	48	-	-	19	0.200	2.20	16
1.80	46.0	73.8	116.6	46.0	0.8	0.1	1.7	5	silty SAND to sandy SILT	120	4.0	18	12	15	57	47	-	-	18	0.200	2.16	16
1.97	35.6	57.1	79.9	35.6	0.3	0.0	0.9	5	silty SAND to sandy SILT	120	4.0	14	9	12	48	46	-	-	15	0.200	2.07	16
2.13	31.0	49.8	75.9	31.0	0.3	0.1	0.9	5	silty SAND to sandy SILT	120	4.0	12	8	10	44	45	-	-	17	0.200	2.14	16
2.30	27.8	44.5	73.0	27.8	0.3	0.1	1.0	5	silty SAND to sandy SILT	120	4.0	11	7	9	40	44	-	-	19	0.200	2.19	16
2.46	24.1	38.6	72.1	24.1	0.3	0.2	1.1	5	silty SAND to sandy SILT	120	4.0	10	6	8	36	43	-	-	22	0.200	2.27	16
2.62	22.5	36.1	70.8	22.5	0.3	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	9	6	8	33	42	-	-	23	0.200	2.30	16
2.79	20.9	33.5	69.6	20.9	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	8	31	42	-	-	24	0.200	2.34	16
2.95	19.6	31.4	68.7	19.6	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	7	29	41	-	-	25	0.200	2.37	16
3.12	19.3	30.9	68.6	19.3	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	7	28	41	-	-	25	0.200	2.38	16
3.28	19.5	31.2	69.5	19.5	0.2	0.2	1.3	5	silty SAND to sandy SILT	120	4.0	8	5	7	29	40	-	-	26	0.200	2.38	16
3.45	20.3	32.5	70.4	20.3	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	7	30	40	-	-	25	0.200	2.36	16
3.61	21.0	33.7	70.4	21.0	0.3	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	8	31	40	-	-	24	0.200	2.34	16
3.77	20.9	33.6	69.4	20.9	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	8	31	40	-	-	24	0.200	2.33	16
3.94	20.1	32.3	69.4	20.1	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	7	30	40	-	-	25	0.200	2.36	16
4.10	20.3	32.6	72.8	20.3	0.3	0.2	1.3	5	silty SAND to sandy SILT	120	4.0	8	5	7	30	39	-	-	26	0.200	2.38	16
4.27	22.1	35.4	77.4	22.1	0.3	0.2	1.4	5	silty SAND to sandy SILT	120	4.0	9	6	8	33	40	-	-	25	0.200	2.37	16
4.43	25.4	40.8	88.3	25.4	0.4	0.2	1.7	5	silty SAND to sandy SILT	120	4.0	10	6	9	37	40	-	-	25	0.200	2.36	16
4.59	31.1	49.9	118.7	31.1	0.8	0.2	2.6	5	silty SAND to sandy SILT	120	4.0	12	8	12	44	41	-	-	27	0.200	2.42	16
4.76	40.6	65.1	144.2	40.6	1.2	0.2	3.0	5	silty SAND to sandy SILT	120	4.0	16	10	15	53	42	-	-	25	0.200	2.38	16
4.92	39.0	62.6	178.4	39.0	1.8	0.3	4.5	4	clayy SILT to silty CLAY	115	2.0	31	20	15	-	-	2.7	9.9	31	0.070	2.52	15
5.09	47.4	76.1	197.7	47.4	2.2	0.2	4.6	4	clayy SILT to silty CLAY	115	2.0	38	24	18	-	-	3.3	9.9	29	0.070	2.47	15
5.25	48.9	78.5	185.9	48.9	2.0	-0.3	4.0	4	clayy SILT to silty CLAY	115	2.0	39	24	18	-	-	3.4	9.9	27	0.070	2.41	15
5.41	34.5	55.3	174.7	34.5	1.6	0.5	4.8	4	clayy SILT to silty CLAY	115	2.0	28	17	14	-	-	2.4	9.9	34	0.070	2.57	15
5.58	36.2	58.1	150.8	36.3	1.3	2.5	3.6	4	clayy SILT to silty CLAY	115	2.0	29	18	14	-	-	2.5	9.9	29	0.070	2.46	15
5.74	36.4	58.4	150.7	36.5	1.3	2.6	3.6	4	clayy SILT to silty CLAY	115	2.0	29	18	14	-	-	2.5	9.9	29	0.070	2.46	15
5.91	35.0	56.2	-	35.1	1.9	2.9	5.4	4	clayy SILT to silty CLAY	115	2.0	28	18	14	-	-	2.5	9.9	35	0.070	2.60	15
6.07	40.9	65.6	188.0	41.0	1.9	3.4	4.8	4	clayy SILT to silty CLAY	115	2.0	33	20	16	-	-	2.9	9.9	32	0.070	2.52	15
6.23	54.4	86.5	207.1	54.5	2.4	3.7	4.5	4	clayy SILT to silty CLAY	115	2.0	43	27	20	-	-	3.8	9.9	27	0.070	2.42	15
6.40	53.3	83.7	241.1	53.4	3.1	3.2	5.9	9	very stiff fine SOIL	120	2.0	42	27	21	61	42	-	-	32	0.250	2.52	30
6.56	56.2	87.2	262.9	56.3	3.6	3.4	6.5	9	very stiff fine SOIL	120	2.0	44	28	22	62	42	-	-	33	0.250	2.55	30
6.73	63.0	96.4	290.4	63.1	4.4	3.8	7.0	9	very stiff fine SOIL	120	2.0	48	32	24	66	43	-	-	33	0.250	2.55	30
6.89	116.7	176.5	337.5	116.8	6.0	3.6	5.2	9	very stiff fine SOIL	120	2.0	88	58	39	86	46	-	-	22	0.250	2.29	30
7.05	165.9	247.9	379.3	165.9	7.0	2.8	4.2	9	very stiff fine SOIL	120	2.0	100	83	51	95	47	-	-	17	0.250	2.14	30
7.22	172.3	254.6	401.5	172.4	7.9	1.6	4.6	9	very stiff fine SOIL	120	2.0	100	86	53	95	47	-	-	18	0.250	2.16	30
7.38	154.3	225.4	395.1	154.3	8.0	1.4	5.2	9	very stiff fine SOIL	120	2.0	100	77	49	94	47	-	-	20	0.250	2.23	30
7.55	140.1	202.5	378.2	140.2	7.6	1.8	5.4	9	very stiff fine SOIL	120	2.0	100	70	44	90	46	-	-	22	0.250	2.27	30
7.71	131.1	187.3	350.9	131.1	6.8	2.5	5.2	9	very stiff fine SOIL	120	2.0	94	66	41	88	46	-	-	22	0.250	2.28	30
7.87	111.2	157.2	338.2	111.2	6.4	2.9	5.8	9	very stiff fine SOIL	120	2.0	79	56	36	82	45	-	-	25	0.250	2.36	30
8.04	109.2	152.9	291.5	109.3	5.1	4.0	4.7	9	very stiff fine SOIL	120	2.0	76	55	34	81	45	-	-	22	0.250	2.29	30
8.20	116.1	160.9	309.1	116.2	5.7	3.5	4.9	9	very stiff fine SOIL	120	2.0	80	58	36	83	45	-	-	22	0.250	2.29	30
8.37	127.8	175.4	322.5	127.9	6.1	4.3	4.8	9	very stiff fine SOIL	120	2.0	88	64	38	86	45	-	-	21	0.250	2.26	30
8.53	184.6	250.8	358.2	184.6	6.8	1.6	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.2	9.9	15	0.250	2.08	16
8.69	186.2	250.7	360.6	186.2	7.0	1.5	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.3	9.9	16	0.250	2.09	16
8.86	190.4	254.0	357.3	190.4	6.8	1.6	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.6	9.9	15	0.250	2.07	16
9.02	197.6	261.4	354.1	197.7	6.6	1.7	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	13.1	9.9	14	0.250	2.04	16
9.19	205.1	268.9	350.0	205.1	6.3	1.6	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	13.6	9.9	13	0.250	2.00	16
9.35	198.3	257.8	356.1	198.3	6.9	1.6	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	13.1	9.9	15	0.250	2.06	16
9.51	194.9	251.3	351.8	194.9	6.9	1.0	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.9	9.9	15	0.250	2.07	16
9.68	176.0	225.1	301.8	176.0	5.2	-0.7	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	45	-	-	11.6	9.9	14	0.250	2.03	16
9.84	153.6	194.8	303.7	153.6	5.8	-0.9	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	41	-	-	10.1	9.9	17	0.250	2.15	16
10.01	181.1	227.8	343.7	181.0	7.1	-0.9	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	12.0	9.9	17	0.250	2.13	16
10.17	187.4	234.0	373.8	187.4	8.3	-3.6	4.5	9	very stiff fine SOIL	120	2.0	100	94	49	95	46	-	-	18	0.250	2.17	30
10.34	183.3	227.0	372.9	183.2	8.4	-3.2	4.6	9	very stiff fine SOIL	120	2.0	100	92	48	94	46	-	-	19	0.250	2.19	30
10.50	161.1	197.9	363.8	161.1	8.3	-2.2	5.2	9	very stiff fine SOIL	120	2.0	99	81	43	90	45	-	-	21	0.250	2.26	30
10.66	176.0	214.5	366.0	175.9	8.4	-0.8	4.8	9	very stiff fine SOIL	120	2.0	100	88	46	92	46	-	-	20	0.250	2.22	30
10.83	211.2	255.5	382.0	211.2	8.7	-2.0	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	13.9	9.9	16	0.250	2.12	16
10.99	228.8	274.8	393.6	228.8	9.0	-1.9	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	56	-	-	15.1	9.9	15	0.250	2.09	16
11.16	237.7	283.4	396.0	237.7	9.0	-1.9	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	15.7	9.9	15	0.250	2.07	16
11.32	248.2	293.9	404.1	248.2	9.2	-1.7	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	16.4	9.9	14	0.250	2.05	16
11.48	258.8	304.3	409.6	258.8	9.3	-1.6	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	61	-	-	17.1	9.9	14	0.250	2.03	16
11.65	243.2	284.0	371.9	243.2	7.8	-1.6	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	56	-	-	16.1	9.9	13	0.250	2.01	16
11.81	220.6	255.9	367.2	220.6	8.3	-1.2	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	14.6	9.9	15	0.250	2.09	16
11.98	224.0	258.1	342.7	224.0	7.1	-1.3	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	14.8	9.9	14	0.250	2.02	16
12.14	153.2	175.4	259.1	153.2	4.8	-1.6	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	36	-	-	10.1	9.9	16	0.250	2.11	16
12.30	98.9	112.4	228.2	98.8	4.1	-1.3	4.2	9	very stiff fine SOIL	120	2.0	56	49	25	71	42	-	-	23	0.250	2.32	30
12.47	77.8	87.8	265.4	77.8	5.1	-0.1	6.6	9	very stiff fine SOIL	120	2.0	44	39	22	63	41	-	-	33	0.250	2.55	30
12.63	90.0	100.9	283.1	90.0	5.8	0.2	6.5	9	very stiff fine SOIL	120	2.0	50	45	25	67	41	-	-	31	0.250	2.51	30
12.80	131.4	146.5	304.8	131.4	6.9	0.3	5.2	9	very stiff fine SOIL	120	2.0	73	66	33	80	43	-	-	24	0.250	2.34	30
12.96	191.3	211.8	319.3	191.3	7.1	-0.1	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	12.6	9.9	17	0.250	2.13	16
13.12	209.9	231.1	320.7	209.9	6.9	-0.6	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	46	-	-	13.9	9.9	15	0.250	2.06	16
13.29	214.1	234.3	327.7	214.1	7.2	-0.3	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	14.1	9.9	15	0.250	2.07	16
13.45	234.6	255.2	338.8	234.6	7.3	-0.4	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	15.5	9.9	14	0.250	2.02	16
13.62	235.2	254.4	340.3	235.2	7.5	-0.8	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	15.5	9.9	14	0.250	2.03	16
13.78	220.0	236.5	330.5	220.0	7.4	-0.6	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	14.5	9.9	15	0.250	2.07	16
13.94	199.2	212.9	309.8	199.2	6.9	-0.5	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	13.1	9.9	16	0.250	2.10	16
14.11	166.4	177.4	282.2	166.4	6.1	-0.4	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	37	-	-	11.0	9.9	18	0.250	2.17	16
14.27	149.3	158.7	264.7	149.3	5.6	-0.3	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	34	-	-	9.8	9.9	19	0.250	2.20	16
14.44	123.3	130.8	217.9	123.3	4.0	-0.7	3.2	5	silty SAND to sandy SILT	120	4.0	33	31	28	76	43	-	-	19	0.200	2.20	16
14.60	87.0	92.0	146.8	86.9	1.9	-0.9	2.2	5	silty SAND to sandy SILT	120	4.0	23	22	19	64	41	-	-	18	0.200	2.17	16
14.76	53.3	56.2	130.7	53.3	1.5	-0.5	2.8	5	silty SAND to sandy SILT	120	4.0	14	13	13	48	38	-	-	27	0.200	2.40	16
14.93	35.6	41.8	-	35.6	1.5	-0.2	4.3	4	clayy SILT to silty CLAY	115	2.0	21	18	11	-	-	2.5	9.9	37	0.070	2.63	15
15.09	32.3	37.7	-	32.3	1.3	-0.3	4.2	4	clayy SILT to silty CLAY	115	2.0	19	16	10	-	-	2.2	9.9	38	0.070	2.65	15
15.26	31.8	36.9	-	31.8	1.1	-0.4	3.7	4	clayy SILT to silty CLAY	115	2.0	18	16	10	-	-	2.2	9.9	36	0.070	2.62	15
15.42	31.9	33.3	83.6	31.9	0.5	-0.4	1.7	5	silty SAND to sandy SILT	120	4.0	8	8	8	31	35	-	-	28	0.200	2.45	16

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

Middle Earth Geo Testing

Project ID: CEL
Data File: SDF(326).cpt
CPT Date: 11/9/2019 9:27:06 AM
GW During Test: 14 ft

Sounding ID: CPT-01
Project No: 84-04726-PW
Cone/Rig: DDG1489

. . Depth ft	. qc PS tsf	* qc1n PS -	. q1ncs PS -	* qt PS tsf	. Slv Stss tsf	. pore prss (psi)	. Frct Rato %	* Mat Typ Zon	* Material Behavior Description	. Unit Wght pcf	. Qc to N	* SPT R-N1 60%	. SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	. Und Shr tsf	. OCR - -	* Fin Ic %	* D50 - mm	* Ic SBT Indx	* Nk - -
15.58	27.8	29.0	72.9	27.8	0.4	-0.5	1.4	5	silty SAND to sandy SILT	120	4.0	7	7	7	26	34	-	-	28	0.200	2.45	16
15.75	22.4	23.3	67.2	22.4	0.3	-0.4	1.4	5	silty SAND to sandy SILT	120	4.0	6	6	6	19	32	-	-	32	0.200	2.52	16
15.91	18.3	20.8	-	18.3	0.3	-0.4	1.6	4	clayy SILT to silty CLAY	115	2.0	10	9	5	-	-	1.2	6.5	35	0.070	2.60	15
16.08	16.2	18.3	-	16.2	0.3	-0.4	1.8	4	clayy SILT to silty CLAY	115	2.0	9	8	5	-	-	1.1	5.7	40	0.070	2.68	15
16.24	15.7	17.6	-	15.7	0.2	-0.4	1.7	4	clayy SILT to silty CLAY	115	2.0	9	8	5	-	-	1.0	5.5	39	0.070	2.68	15
16.40	16.2	18.2	-	16.2	0.2	-0.4	1.6	4	clayy SILT to silty CLAY	115	2.0	9	8	5	-	-	1.1	5.6	38	0.070	2.66	15
16.57	18.8	20.0	-	18.8	0.3	-0.4	1.5	4	clayy SILT to silty CLAY	115	2.0	10	9	5	-	-	1.3	6.6	36	0.070	2.61	15
16.73	18.6	20.6	-	18.6	0.3	-0.3	1.6	4	clayy SILT to silty CLAY	115	2.0	10	9	5	-	-	1.3	6.5	36	0.070	2.60	15
16.90	20.4	21.5	70.2	20.4	0.3	-0.3	1.6	4	clayy SILT to silty CLAY	115	2.0	11	10	5	-	-	1.4	7.1	35	0.070	2.59	15
17.06	22.2	24.4	-	22.2	0.8	-0.2	3.9	4	clayy SILT to silty CLAY	115	2.0	12	11	7	-	-	1.5	7.7	44	0.070	2.77	15
17.23	23.4	25.6	-	23.4	1.6	-0.1	7.1	3	silty CLAY to CLAY	115	1.5	17	16	8	-	-	1.6	8.1	54	0.005	2.93	15
17.39	30.0	32.6	-	30.0	2.4	0.1	8.1	3	silty CLAY to CLAY	115	1.5	22	20	10	-	-	2.1	9.9	52	0.005	2.90	15
17.55	62.7	63.4	186.9	62.7	3.0	0.1	4.8	4	clayy SILT to silty CLAY	115	2.0	32	31	16	-	-	4.4	9.9	32	0.070	2.53	15
17.72	79.5	80.1	138.4	79.5	1.8	0.5	2.3	5	silty SAND to sandy SILT	120	4.0	20	20	17	60	40	-	-	20	0.200	2.22	16
17.88	108.2	108.8	155.0	108.2	2.1	1.3	1.9	5	silty SAND to sandy SILT	120	4.0	27	27	22	70	41	-	-	15	0.200	2.08	16
18.05	122.5	122.9	179.3	122.5	2.8	1.0	2.3	5	silty SAND to sandy SILT	120	4.0	31	31	25	74	42	-	-	16	0.200	2.10	16
18.21	124.7	124.8	196.4	124.7	3.4	-2.3	2.8	5	silty SAND to sandy SILT	120	4.0	31	31	26	74	42	-	-	18	0.200	2.16	16
18.37	115.2	115.0	206.1	115.1	3.8	-2.9	3.4	5	silty SAND to sandy SILT	120	4.0	29	29	25	72	42	-	-	21	0.200	2.25	16
18.54	97.7	97.3	210.0	97.6	4.0	-2.7	4.1	4	clayy SILT to silty CLAY	115	2.0	49	49	22	-	-	6.8	9.9	25	0.070	2.36	15
18.70	91.9	91.3	196.3	91.8	3.5	-2.6	3.9	4	clayy SILT to silty CLAY	115	2.0	46	46	21	-	-	6.4	9.9	25	0.070	2.36	15
18.87	80.5	79.8	199.7	80.4	3.5	-2.5	4.5	4	clayy SILT to silty CLAY	115	2.0	40	40	19	-	-	5.6	9.9	28	0.070	2.44	15
19.03	73.4	72.6	214.8	73.4	3.9	-2.2	5.4	4	clayy SILT to silty CLAY	115	2.0	36	37	18	-	-	5.1	9.9	32	0.070	2.54	15
19.19	76.6	75.6	221.7	76.6	4.2	-1.8	5.5	9	very stiff fine SOIL	120	2.0	38	38	19	58	39	-	-	32	0.250	2.53	30
19.36	86.6	85.3	229.0	86.6	4.5	-1.7	5.3	9	very stiff fine SOIL	120	2.0	43	43	21	62	40	-	-	30	0.250	2.48	30
19.52	89.1	87.5	239.5	89.1	4.9	-1.5	5.6	9	very stiff fine SOIL	120	2.0	44	45	21	63	40	-	-	30	0.250	2.49	30
19.69	96.2	94.3	232.6	96.2	4.8	-1.3	5.0	9	very stiff fine SOIL	120	2.0	47	48	22	65	40	-	-	28	0.250	2.44	30
19.85	93.4	91.3	239.4	93.4	5.0	-1.3	5.4	9	very stiff fine SOIL	120	2.0	46	47	22	64	40	-	-	29	0.250	2.47	30
20.01	96.0	93.6	236.5	96.0	4.9	-1.0	5.2	9	very stiff fine SOIL	120	2.0	47	48	22	65	40	-	-	28	0.250	2.45	30
20.18	90.5	88.0	258.1	90.5	5.6	-0.9	6.2	9	very stiff fine SOIL	120	2.0	44	45	22	63	40	-	-	32	0.250	2.53	30
20.34	99.4	96.5	266.2	99.4	6.0	-0.3	6.1	9	very stiff fine SOIL	120	2.0	48	50	23	66	40	-	-	31	0.250	2.50	30
20.51	112.9	109.3	262.2	112.9	6.0	0.1	5.4	9	very stiff fine SOIL	120	2.0	55	56	26	70	41	-	-	27	0.250	2.42	30
20.67	112.2	108.4	274.6	112.2	6.4	0.8	5.8	9	very stiff fine SOIL	120	2.0	54	56	26	70	41	-	-	29	0.250	2.45	30
20.83	126.7	122.1	295.6	126.7	7.4	1.0	5.9	9	very stiff fine SOIL	120	2.0	61	63	29	74	42	-	-	27	0.250	2.43	30
21.00	147.0	141.3	318.8	147.0	8.5	0.6	5.8	9	very stiff fine SOIL	120	2.0	71	73	33	78	42	-	-	26	0.250	2.39	30
21.16	178.8	171.5	331.0	178.8	9.1	0.6	5.1	9	very stiff fine SOIL	120	2.0	86	89	38	85	43	-	-	22	0.250	2.29	30
21.33	209.3	200.3	340.9	209.3	9.5	0.4	4.6	9	very stiff fine SOIL	120	2.0	100	100	43	90	44	-	-	19	0.250	2.21	30
21.49	236.1	225.4	359.7	236.1	10.2	0.3	4.4	9	very stiff fine SOIL	120	2.0	100	100	47	94	45	-	-	18	0.250	2.17	30
21.65	248.0	236.3	370.6	248.0	10.7	0.1	4.3	9	very stiff fine SOIL	120	2.0	100	100	49	95	45	-	-	18	0.250	2.16	30
21.82	222.3	211.3	355.6	222.3	10.2	0.1	4.6	9	very stiff fine SOIL	120	2.0	100	100	45	92	44	-	-	19	0.250	2.21	30
21.98	171.6	162.8	331.6	171.6	9.2	0.3	5.4	9	very stiff fine SOIL	120	2.0	81	86	37	83	43	-	-	24	0.250	2.33	30
22.15	153.9	145.7	314.1	153.9	8.4	0.4	5.5	9	very stiff fine SOIL	120	2.0	73	77	33	79	42	-	-	25	0.250	2.36	30
22.31	159.8	150.9	310.3	159.8	8.3	0.6	5.2	9	very stiff fine SOIL	120	2.0	75	80	34	81	43	-	-	24	0.250	2.33	30
22.47	166.0	156.4	304.8	166.0	8.1	0.5	4.9	9	very stiff fine SOIL	120	2.0	78	83	35	82	43	-	-	23	0.250	2.30	30
22.64	159.4	149.9	296.5	159.4	7.7	0.2	4.9	9	very stiff fine SOIL	120	2.0	75	80	33	80	43	-	-	23	0.250	2.31	30
22.80	140.2	131.5	260.6	140.2	6.2	0.1	4.5	9	very stiff fine SOIL	120	2.0	66	70	29	76	42	-	-	23	0.250	2.31	30
22.97	135.3	126.6	270.4	135.3	6.6	0.1	4.9	9	very stiff fine SOIL	120	2.0	63	68	29	75	42	-	-	25	0.250	2.35	30
23.13	140.1	130.8	273.8	140.1	6.8	0.0	4.9	9	very stiff fine SOIL	120	2.0	65	70	30	76	42	-	-	24	0.250	2.34	30
23.30	132.9	123.8	285.4	132.9	7.2	-0.1	5.5	9	very stiff fine SOIL	120	2.0	62	66	29	74	42	-	-	26	0.250	2.40	30
23.46	126.0	117.2	289.6	126.0	7.4	0.5	5.9	9	very stiff fine SOIL	120	2.0	59	63	28	72	41	-	-	28	0.250	2.44	30
23.62	140.5	130.4	290.8	140.6	7.5	0.6	5.4	9	very stiff fine SOIL	120	2.0	65	70	30	76	42	-	-	26	0.250	2.38	30
23.79	162.6	150.6	292.1	162.6	7.7	0.4	4.8	9	very stiff fine SOIL	120	2.0	75	81	33	81	43	-	-	22	0.250	2.30	30
23.95	183.3	169.4	292.4	183.3	7.6	0.2	4.2	9	very stiff fine SOIL	120	2.0	85	92	36	84	43	-	-	20	0.250	2.22	30
24.12	199.2	183.6	294.1	199.2	7.6	0.3	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	39	-	-	13.1	9.9	18	0.250	2.17	16
24.28	223.5	205.7	295.4	223.5	7.3	0.2	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	42	-	-	14.7	9.9	15	0.250	2.09	16
24.44	253.8	233.1	285.3	253.8	5.9	0.0	2.3	6	clean SAND to silty SAND	125	5.0	47	51	45	95	45	-	-	11	0.350	1.94	16
24.61	286.6	262.6	285.4	286.6	4.6	-0.3	1.6	6	clean SAND to silty SAND	125	5.0	53	57	47	95	45	-	-	8	0.350	1.77	16
24.77	313.5	286.6	322.3	313.5	6.2	-0.4	2.0	6	clean SAND to silty SAND	125	5.0	57	63	53	95	46	-	-	9	0.350	1.82	16
24.94	334.5	305.1	346.0	334.5	7.1	-0.6	2.1	6	clean SAND to silty SAND	125	5.0	61	67	56	95	46	-	-	9	0.350	1.84	16
25.10	332.9	302.9	352.5	332.8	7.7	-0.4	2.3	6	clean SAND to silty SAND	125	5.0	61	67	57	95	46	-	-	10	0.350	1.87	16
25.26	329.6	299.3	365.7	329.6	9.0	-0.7	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	21.8	9.9	11	0.250	1.93	16
25.43	339.6	307.8	378.5	339.6	9.6	-0.7	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	22.4	9.9	11	0.250	1.94	16
25.59	338.7	306.4	371.3	338.6	9.1	-0.9	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	58	-	-	22.4	9.9	11	0.250	1.92	16
25.76	347.4	313.7	369.1	347.3	8.6	-1.5	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	22.9	9.9	10	0.250	1.89	16
25.92	362.6	326.8	379.8	362.5	8.8	-1.6	2.4	8	stiff SAND to clayy SAND	115	1.0	100	100	61	-	-	23.9	9.9	10	0.250	1.87	16
26.08	384.0	345.4	401.5	383.9	9.6	-1.7	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	65	-	-	25.4	9.9	10	0.250	1.87	16
26.25	392.2	352.2	426.4	392.2	11.4	-1.9	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	67	-	-	25.9	9.9	11	0.250	1.92	16

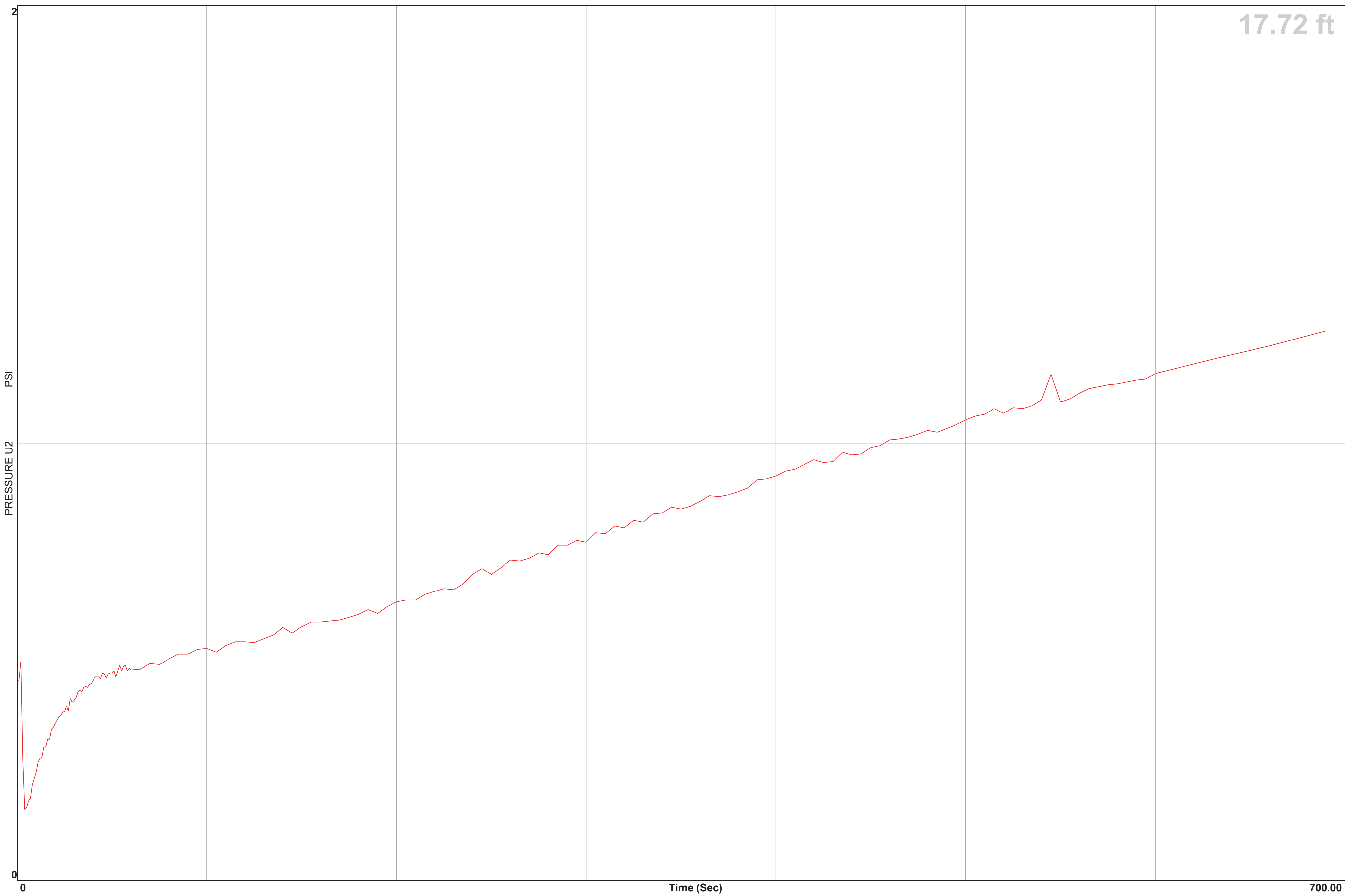
* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

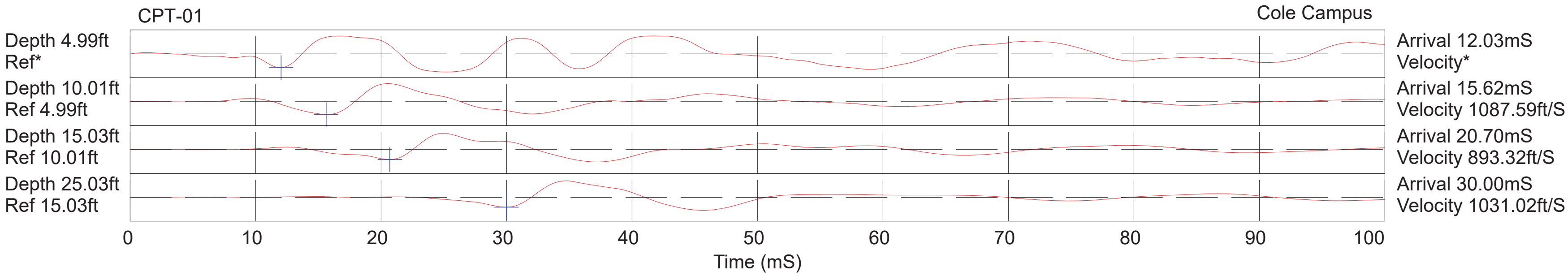
Middle Earth Geo Testing

CEL

Location	Cole Campus	Operator	JM-AJ
Job Number	84-04726-PW	Cone Number	DDG1489
Hole Number	CPT-01	Date and Time	11/9/2019 9:27:06 AM
Equilized Pressure	1.2	EST GW Depth During Test	14.8

GPS





Hammer to Rod String Distance (ft): 5.83
* = Not Determined

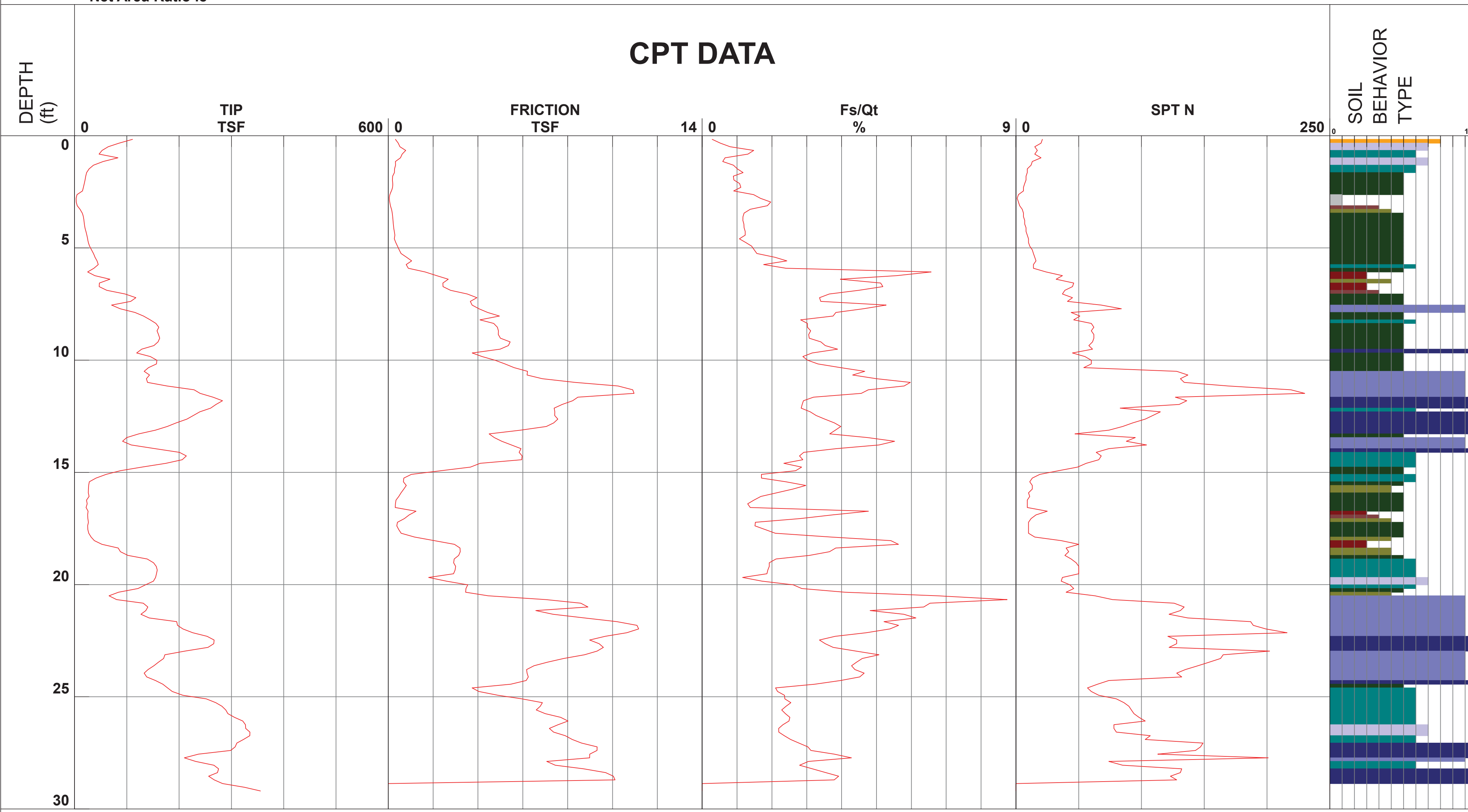
COMMENT:

CEL

Project	Cole Campus	Operator	JM-AJ	Filename	SDF(325).cpt
Job Number	84-04726-PW	Cone Number	DDG1489	GPS	
Hole Number	CPT-02	Date and Time	11/9/2019 8:49:20 AM	Maximum Depth	29.20 ft
EST GW Depth During Test		13.40 ft			

Net Area Ratio .8

CPT DATA



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

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Cole Campus

Project ID: CEL
Data File: SDF(325).cpt
CPT Date: 11/9/2019 8:49:20 AM
GW During Test: 13 ft

Page: 1
Sounding ID: CPT-02
Project No: 84-04726-PW
Cone/Rig: DDG1489

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	* qt PS tsf	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	* SPT R-N1 60%	SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* D50 mm	* Ic SBT Indx	* Nk -
0.33	85.2	136.6	136.6	85.2	0.4	0.0	0.5	6	clean SAND to silty SAND	125	5.0	27	17	23	77	48	-	-	5	0.350	1.63	16
0.49	64.4	103.2	117.3	64.4	0.5	0.1	0.8	6	clean SAND to silty SAND	125	5.0	21	13	19	68	48	-	-	9	0.350	1.84	16
0.66	52.6	84.4	119.5	52.6	0.8	0.2	1.5	5	silty SAND to sandy SILT	120	4.0	21	13	17	61	48	-	-	15	0.200	2.08	16
0.82	46.9	75.3	107.0	46.9	0.6	0.1	1.3	5	silty SAND to sandy SILT	120	4.0	19	12	15	58	48	-	-	15	0.200	2.08	16
0.98	83.1	133.3	138.3	83.1	0.5	0.2	0.7	6	clean SAND to silty SAND	125	5.0	27	17	23	76	48	-	-	6	0.350	1.70	16
1.15	54.8	87.9	98.5	54.8	0.3	0.0	0.6	6	clean SAND to silty SAND	125	5.0	18	11	16	63	48	-	-	9	0.350	1.82	16
1.31	36.2	58.1	81.7	36.2	0.3	0.0	0.9	5	silty SAND to sandy SILT	120	4.0	15	9	12	49	48	-	-	15	0.200	2.07	16
1.48	27.8	44.6	73.9	27.8	0.3	0.0	1.0	5	silty SAND to sandy SILT	120	4.0	11	7	9	40	46	-	-	19	0.200	2.20	16
1.64	23.2	37.2	72.4	23.2	0.3	0.0	1.2	5	silty SAND to sandy SILT	120	4.0	9	6	8	34	45	-	-	22	0.200	2.30	16
1.80	21.4	34.3	63.1	21.4	0.2	0.1	0.9	5	silty SAND to sandy SILT	120	4.0	9	5	7	32	44	-	-	21	0.200	2.27	16
1.97	20.2	32.4	62.1	20.2	0.2	0.0	0.9	5	silty SAND to sandy SILT	120	4.0	8	5	7	30	43	-	-	22	0.200	2.29	16
2.13	18.6	29.9	64.3	18.6	0.2	0.1	1.1	5	silty SAND to sandy SILT	120	4.0	7	5	7	27	42	-	-	25	0.200	2.36	16
2.30	16.9	27.1	63.0	16.9	0.2	0.1	1.1	5	silty SAND to sandy SILT	120	4.0	7	4	6	24	42	-	-	27	0.200	2.40	16
2.46	15.2	24.3	56.1	15.2	0.1	0.1	0.9	5	silty SAND to sandy SILT	120	4.0	6	4	6	20	41	-	-	26	0.200	2.40	16
2.62	4.8	7.8	-	4.8	0.1	0.1	1.5	3	silty CLAY to CLAY	115	1.5	5	3	2	-	-	0.3	9.7	55	0.005	2.95	15
2.79	3.0	4.8	-	3.0	0.0	0.1	1.8	3	silty CLAY to CLAY	115	1.5	3	2	2	-	-	0.2	5.5	71	0.005	3.18	15
2.95	3.3	5.2	-	3.3	0.1	0.1	2.1	3	silty CLAY to CLAY	115	1.5	3	2	2	-	-	0.2	5.7	71	0.005	3.17	15
3.12	5.2	8.3	-	5.2	0.1	0.2	1.9	3	silty CLAY to CLAY	115	1.5	6	3	3	-	-	0.4	8.8	57	0.005	2.98	15
3.28	10.5	16.8	-	10.5	0.1	0.2	1.4	4	clayy SILT to silty CLAY	115	2.0	8	5	4	-	-	0.7	9.9	37	0.070	2.63	15
3.45	14.8	23.7	62.6	14.8	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	6	4	6	19	39	-	-	30	0.200	2.47	16
3.61	16.9	27.1	64.6	16.9	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	7	4	6	24	39	-	-	27	0.200	2.42	16
3.77	17.9	28.8	65.9	17.9	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	7	4	7	26	39	-	-	26	0.200	2.40	16
3.94	18.7	30.0	67.6	18.7	0.2	0.1	1.2	5	silty SAND to sandy SILT	120	4.0	7	5	7	27	39	-	-	26	0.200	2.39	16
4.10	20.1	32.2	69.7	20.1	0.2	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	8	5	7	30	39	-	-	25	0.200	2.36	16
4.27	21.8	35.0	72.5	21.8	0.3	0.2	1.2	5	silty SAND to sandy SILT	120	4.0	9	5	8	32	40	-	-	24	0.200	2.34	16
4.43	23.6	37.8	74.9	23.6	0.3	0.2	1.3	5	silty SAND to sandy SILT	120	4.0	9	6	8	35	40	-	-	23	0.200	2.31	16
4.59	25.0	40.1	72.4	25.0	0.3	0.2	1.1	5	silty SAND to sandy SILT	120	4.0	10	6	9	37	40	-	-	21	0.200	2.25	16
4.76	26.6	42.7	79.2	26.6	0.3	0.2	1.3	5	silty SAND to sandy SILT	120	4.0	11	7	9	39	40	-	-	21	0.200	2.27	16
4.92	28.7	46.1	86.1	28.7	0.4	0.2	1.4	5	silty SAND to sandy SILT	120	4.0	12	7	10	41	40	-	-	22	0.200	2.27	16
5.09	32.7	52.4	93.3	32.7	0.5	0.1	1.5	5	silty SAND to sandy SILT	120	4.0	13	8	11	46	41	-	-	21	0.200	2.24	16
5.25	36.3	58.2	100.1	36.3	0.6	0.1	1.6	5	silty SAND to sandy SILT	120	4.0	15	9	12	49	41	-	-	20	0.200	2.22	16
5.41	39.2	62.9	118.2	39.2	0.8	0.1	2.1	5	silty SAND to sandy SILT	120	4.0	16	10	14	52	42	-	-	22	0.200	2.28	16
5.58	42.9	68.8	132.9	42.9	1.0	0.2	2.4	5	silty SAND to sandy SILT	120	4.0	17	11	15	55	42	-	-	22	0.200	2.29	16
5.74	45.3	72.7	117.9	45.3	0.8	0.4	1.8	5	silty SAND to sandy SILT	120	4.0	18	11	15	56	42	-	-	18	0.200	2.18	16
5.91	37.1	59.4	123.4	37.1	0.9	0.0	2.4	5	silty SAND to sandy SILT	120	4.0	15	9	13	50	41	-	-	24	0.200	2.34	16
6.07	25.0	40.1	-	25.1	1.6	2.7	6.7	3	silty CLAY to CLAY	115	1.5	27	17	11	-	-	1.7	9.9	44	0.005	2.77	15
6.23	38.6	61.4	202.0	38.7	2.2	4.5	5.6	4	clayy SILT to silty CLAY	115	2.0	31	19	16	-	-	2.7	9.9	35	0.070	2.59	15
6.40	67.6	106.1	215.6	67.6	2.7	2.5	4.0	9	very stiff fine SOIL	120	2.0	53	34	24	69	43	-	-	23	0.250	2.33	30
6.56	47.6	73.7	209.0	47.6	2.4	3.2	5.2	4	clayy SILT to silty CLAY	115	2.0	37	24	18	-	-	3.3	9.9	31	0.070	2.51	15
6.73	47.0	72.0	208.3	47.1	2.4	2.1	5.2	4	clayy SILT to silty CLAY	115	2.0	36	24	18	-	-	3.3	9.9	32	0.070	2.52	15
6.89	61.8	93.5	217.3	61.8	2.8	2.8	4.5	9	very stiff fine SOIL	120	2.0	47	31	22	65	43	-	-	27	0.250	2.40	30
7.05	96.6	144.6	246.1	96.7	3.5	2.2	3.7	8	stiff SAND to clayy SAND	115	1.0	100	97	31	-	-	6.4	9.9	19	0.250	2.21	16
7.22	117.4	173.8	265.8	117.5	4.0	1.7	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	36	-	-	7.8	9.9	17	0.250	2.14	16
7.38	107.4	157.3	250.5	107.5	3.7	1.8	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	33	-	-	7.1	9.9	18	0.250	2.17	16
7.55	70.8	102.6	251.6	70.8	3.7	2.8	5.3	9	very stiff fine SOIL	120	2.0	51	35	24	68	43	-	-	28	0.250	2.43	30
7.71	87.5	125.3	258.8	87.6	4.0	4.9	4.6	9	very stiff fine SOIL	120	2.0	63	44	28	74	44	-	-	24	0.250	2.33	30
7.87	115.5	163.8	273.1	115.6	4.4	3.4	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	35	-	-	7.6	9.9	19	0.250	2.20	16
8.04	131.9	185.2	292.5	132.0	5.0	3.0	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	39	-	-	8.7	9.9	18	0.250	2.16	16
8.20	144.7	201.2	272.7	144.8	4.1	3.6	2.8	5	silty SAND to sandy SILT	120	4.0	50	36	40	90	46	-	-	14	0.200	2.04	16
8.37	155.7	214.4	293.3	155.8	4.7	4.0	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	10.3	9.9	14	0.250	2.05	16
8.53	161.2	219.8	298.7	161.3	4.9	3.9	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	10.6	9.9	14	0.250	2.04	16
8.69	157.8	213.2	295.8	157.8	4.9	2.4	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	10.4	9.9	15	0.250	2.06	16
8.86	160.6	215.0	295.4	160.6	4.9	2.8	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	10.6	9.9	14	0.250	2.05	16
9.02	162.8	216.1	297.1	162.9	5.0	2.7	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	10.8	9.9	14	0.250	2.05	16
9.19	159.6	210.0	304.3	159.7	5.4	2.2	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	10.5	9.9	16	0.250	2.10	16
9.35	151.8	198.0	296.9	151.8	5.4	0.6	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	41	-	-	10.0	9.9	17	0.250	2.12	16
9.51	128.3	166.0	277.3	128.3	5.0	-1.4	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	35	-	-	8.5	9.9	19	0.250	2.20	16
9.68	118.7	152.3	236.6	118.7	3.7	0.0	3.2	5	silty SAND to sandy SILT	120	4.0	38	30	32	81	44	-	-	17	0.200	2.15	16
9.84	144.7	184.1	258.4	144.7	4.2	0.1	2.9	5	silty SAND to sandy SILT	120	4.0	46	36	37	87	45	-	-	15	0.200	2.07	16
10.01	157.4	198.5	277.8	157.4	4.8	-0.7	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	40	-	-	10.4	9.9	15	0.250	2.07	16
10.17	156.8	196.2	286.9	156.8	5.2	-2.4	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	40	-	-	10.3	9.9	16	0.250	2.10	16
10.34	141.4	175.6	290.8	141.3	5.6	-3.6	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	37	-	-	9.3	9.9	19	0.250	2.20	16
10.50	133.3	164.2	304.8	133.2	6.2	-3.4	4.7	9	very stiff fine SOIL	120	2.0	82	67	36	83	44	-	-	21	0.250	2.27	30
10.66	143.4	175.3	304.0	143.3	6.2	-3.0	4.3	9	very stiff fine SOIL	120	2.0	88	72	38	86	45	-	-	20	0.250	2.23	30
10.83	137.3	166.6	320.5	137.3	6.9	-2.8	5.0	9	very stiff fine SOIL	120	2.0	83	69	37	84	44	-	-	22	0.250	2.29	30
10.99	139.5	167.9	359.2	139.5	8.3	-1.3	6.0	9	very stiff fine SOIL	120	2.0	84	70	38	84	44	-	-	25	0.250	2.36	30
11.16	176.8	211.3	406.5	176.8	10.2	0.6	5.8	9	very stiff fine SOIL	120	2.0	100	88	47	92	45	-	-	22	0.250	2.29	30
11.32	228.7	271.3	429.8	228.7	10.9	0.2	4.8	9	very stiff fine SOIL	120	2.0	100	100	57	95	46	-	-	18	0.250	2.16	30
11.48	240.2	282.8	432.8	240.2	11.0	0.1	4.6	9	very stiff fine SOIL	120	2.0	100	100	59	95	47	-	-	17	0.250	2.14	30
11.65	264.8	309.6	396.3	264.8	8.5	0.1	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	60	-	-	17.5	9.9	13	0.250	1.98	16
11.81	282.9	328.5	402.4	282.9	8.2	0.0	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	63	-	-	18.7	9.9	11	0.250	1.94	16
11.98	270.6	312.2	384.3	270.6	7.8	-0.1	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	60	-	-	17.9	9.9	11	0.250	1.94	16
12.14	260.3	298.2	369.4	260.2	7.4	-1.3	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	17.2	9.9	12	0.250	1.95	16
12.30	239.5	272.6	355.0	239.5	7.4	-0.8	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	54	-	-	15.8	9.9	13	0.250	2.00	16
12.47	227.0	256.7	346.2	227.0	7.4	-0.7	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	15.0	9.9	14	0.250	2.03	16
12.63	214.9	241.6	341.4	214.9	7.6	-0.7	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	14.2	9.9	15	0.250	2.08	16
12.80	194.4	217.1	327.7	194.4	7.4	-0.4	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	45	-	-	12.8	9.9	17	0.250	2.13	16
12.96	177.3	196.8	313.7	177.3	7.0	-0.2	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	41	-	-	11.7	9.9	18	0.250	2.17	16
13.12	154.4	170.9	280.3	154.4	5.9	-0.2	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	36	-	-	10.2	9.9	19	0.250	2.19	16
13.29	122.9	135.7	237.7	122.9	4.5	-0.7	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	29	-	-	8.1	9.9	20	0.250	2.23	16
13.45	99.7	109.7	244.7	99.7	4.7	-0.4	4.8	9	very stiff fine SOIL	120	2.0	55	50	25	70	42	-	-	26	0.250	2.38	30
13.62	91.8	100.7	256.9	91.8	5.1	0.4	5.6	9	very stiff fine SOIL	120	2.0	50	46	24	67	41	-	-	29	0.250	2.45	30
13.78	108.2	118.4	265.8	108.2	5.5	1.3	5.1	9	very stiff fine SOIL	120	2.0	59	54	27	73	42	-	-	26	0.250	2.38	30
13.94	153.9	167.9	278.3	154.0	5.9	1.4	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	36	-	-	10.1	9.9	19	0.250	2.20	16
14.11	200.5	218.1	293.0	200.5	5.8	0.0	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	43	-	-	13.2	9.9	14	0.250	2.03	16
14.27	213.9	232.1	302.0	213.9	6.0	-0.8	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	46	-	-	14.1	9.9	13	0.250	2.00	16
14.44	205.9	222.8	296.8	205.9	6.0	-1.1	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	13.6	9.9	14	0.250	2.02	16
14.60	175.1	188.9	243.3	175.0	4.1	-1.1	2.4	5	silty SAND to sandy SILT	120	4.0	47	44	37	88	44	-	-	13	0.200	1.99	16
14.76	128.6	138.3	212.6	128.6	3.7	-0.6	2.9	5	silty SAND to sandy SILT	120	4.0	35	32	29	78	43	-	-	17	0.200	2.14	16
14.93	87.8	94.2	164.8	87.8	2.4	-0.4	2.7	5	silty SAND to sandy SILT	120	4.0	24	22	20	65	41	-	-	20	0.200	2.23	16
15.09	60.4	64.7	109.9	60.5	1.0	0.2	1.7	5	silty SAND to sandy SILT	120	4.0	16	15	14	53	39	-	-	19	0.200	2.21	16
15.26	40.9	43.7	92.3	40.9	0.7	0.5	1.7	5	silty SAND to sandy SILT	120	4.0	11	10	10	40	37	-	-	24	0.200	2.35	16
15.42	28.2	30.0	95.4	28.2	0.7	0.6	2.5	4	clayy SILT to silty CLAY	115	2.0	15	14	8	-	-	1.9	9.9	34	0.070	2.58	15

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

Middle Earth Geo Testing

Cole Campus

Project ID: CEL
Data File: SDF(325).cpt
CPT Date: 11/9/2019 8:49:20 AM
GW During Test: 13 ft

Sounding ID: CPT-02
Project No: 84-04726-PW
Cone/Rig: DDG1489

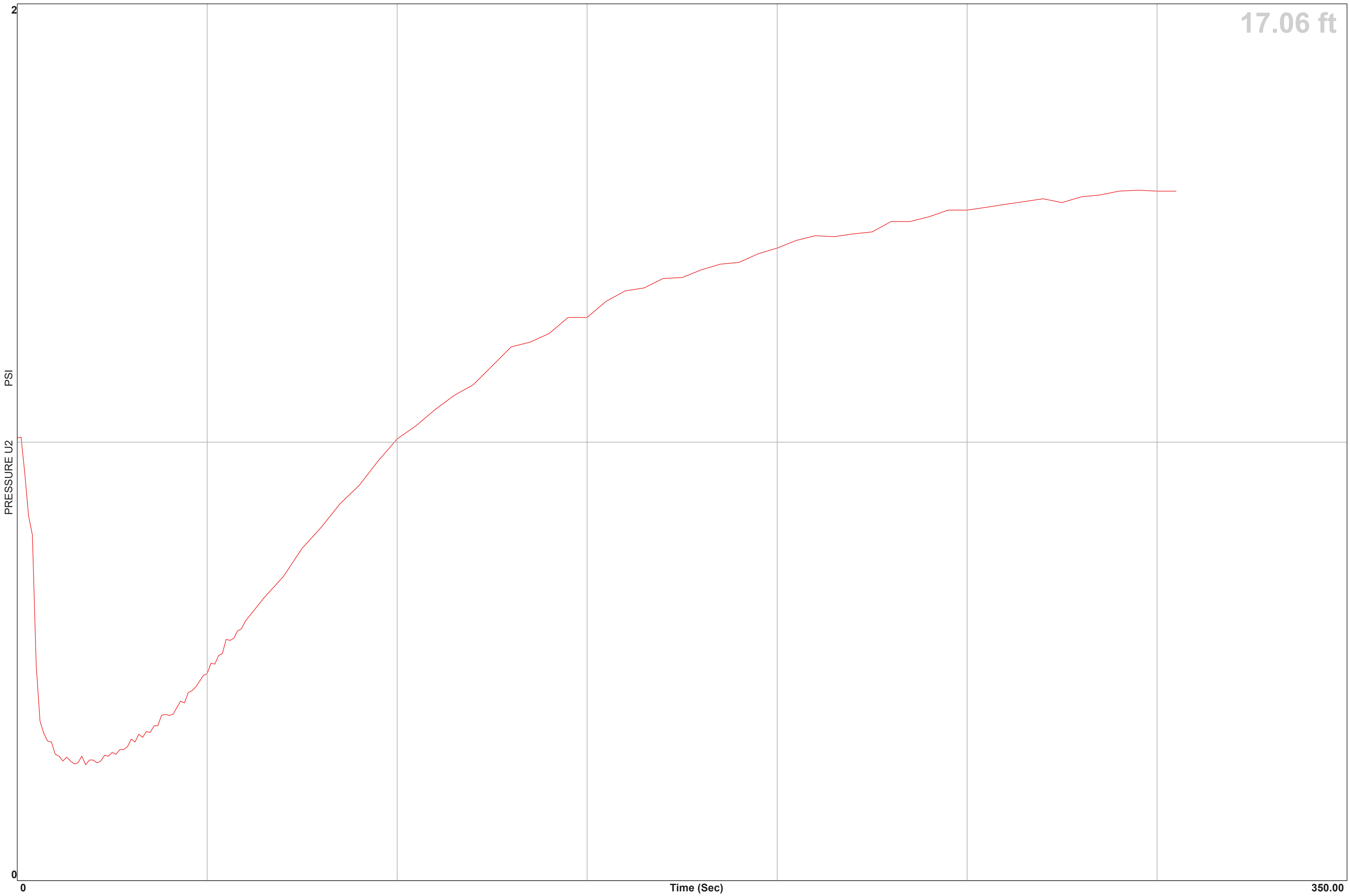
Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	* qt PS tsf	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	* SPT R-N1 60%	SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* D50 - mm	* Ic SBT Indx	* Nk -
15.58	27.0	32.2	-	27.0	0.8	0.7	3.1	4	clayy SILT to silty CLAY	115	2.0	16	14	8	-	-	1.8	9.9	36	0.070	2.61	15
15.75	26.6	29.4	-	26.6	0.7	0.8	2.7	4	clayy SILT to silty CLAY	115	2.0	15	13	8	-	-	1.8	9.9	36	0.070	2.61	15
15.91	26.4	27.9	88.1	26.5	0.6	0.8	2.2	4	clayy SILT to silty CLAY	115	2.0	14	13	7	-	-	1.8	9.9	34	0.070	2.57	15
16.08	27.8	29.3	79.8	27.8	0.5	0.7	1.7	5	silty SAND to sandy SILT	120	4.0	7	7	7	26	34	-	-	30	0.200	2.49	16
16.24	23.1	24.2	71.2	23.1	0.3	0.8	1.5	5	silty SAND to sandy SILT	120	4.0	6	6	6	20	33	-	-	32	0.200	2.53	16
16.40	24.2	25.4	68.3	24.3	0.3	0.7	1.4	5	silty SAND to sandy SILT	120	4.0	6	6	6	22	33	-	-	30	0.200	2.48	16
16.57	22.2	23.2	68.2	22.2	0.3	0.8	1.4	5	silty SAND to sandy SILT	120	4.0	6	6	6	19	32	-	-	32	0.200	2.53	16
16.73	25.9	29.8	-	25.9	1.2	0.8	5.0	3	silty CLAY to CLAY	115	1.5	20	17	8	-	-	1.8	9.4	45	0.005	2.78	15
16.90	24.9	28.5	-	25.0	0.9	0.9	3.9	4	clayy SILT to silty CLAY	115	2.0	14	12	8	-	-	1.7	9.0	42	0.070	2.72	15
17.06	25.6	29.1	-	25.6	0.7	1.0	2.9	4	clayy SILT to silty CLAY	115	2.0	15	13	8	-	-	1.7	9.2	37	0.070	2.63	15
17.23	26.7	27.6	75.1	26.7	0.4	2.2	1.6	5	silty SAND to sandy SILT	120	4.0	7	7	7	24	33	-	-	30	0.200	2.49	16
17.39	24.9	25.7	73.3	25.0	0.4	2.8	1.6	5	silty SAND to sandy SILT	120	4.0	6	6	6	22	33	-	-	31	0.200	2.52	16
17.55	25.6	26.3	80.2	25.6	0.5	2.9	1.9	4	clayy SILT to silty CLAY	115	2.0	13	13	7	-	-	1.7	9.1	33	0.070	2.55	15
17.72	27.3	28.0	87.7	27.4	0.6	3.3	2.2	4	clayy SILT to silty CLAY	115	2.0	14	14	7	-	-	1.9	9.7	34	0.070	2.57	15
17.88	31.7	35.2	-	31.8	1.2	3.3	3.8	4	clayy SILT to silty CLAY	115	2.0	18	16	9	-	-	2.2	9.9	38	0.070	2.65	15
18.05	37.9	41.8	-	37.9	2.0	3.6	5.6	3	silty CLAY to CLAY	115	1.5	28	25	11	-	-	2.6	9.9	41	0.005	2.71	15
18.21	52.4	57.6	-	52.5	3.0	3.7	5.7	4	clayy SILT to silty CLAY	115	2.0	29	26	15	-	-	3.6	9.9	36	0.070	2.62	15
18.37	83.5	84.9	189.6	83.6	3.2	3.0	3.9	4	clayy SILT to silty CLAY	115	2.0	42	42	20	-	-	5.8	9.9	26	0.070	2.38	15
18.54	87.8	89.0	188.8	87.8	3.2	2.7	3.7	4	clayy SILT to silty CLAY	115	2.0	44	44	20	-	-	6.1	9.9	24	0.070	2.35	15
18.70	102.2	103.3	186.0	102.2	3.1	3.1	3.1	5	silty SAND to sandy SILT	120	4.0	26	26	22	68	41	-	-	21	0.200	2.25	16
18.87	139.0	140.2	190.0	139.0	2.9	1.6	2.1	5	silty SAND to sandy SILT	120	4.0	35	35	28	78	43	-	-	14	0.200	2.04	16
19.03	151.0	152.0	194.8	151.0	2.9	-1.2	1.9	6	clean SAND to silty SAND	125	5.0	30	30	30	81	43	-	-	13	0.350	1.99	16
19.19	156.3	156.8	199.1	156.2	3.0	-4.9	1.9	6	clean SAND to silty SAND	125	5.0	31	31	31	82	43	-	-	12	0.350	1.98	16
19.36	158.2	158.3	199.2	158.1	3.0	-6.4	1.9	6	clean SAND to silty SAND	125	5.0	32	32	31	82	43	-	-	12	0.350	1.97	16
19.52	156.6	156.3	196.5	156.5	2.9	-6.3	1.9	6	clean SAND to silty SAND	125	5.0	31	31	30	82	43	-	-	12	0.350	1.97	16
19.69	155.0	154.3	173.0	154.9	1.8	-6.3	1.2	6	clean SAND to silty SAND	125	5.0	31	31	28	81	43	-	-	9	0.350	1.82	16
19.85	150.9	149.8	186.0	150.8	2.6	-6.6	1.7	6	clean SAND to silty SAND	125	5.0	30	30	29	80	43	-	-	12	0.350	1.95	16
20.01	135.8	134.4	201.0	135.7	3.5	-6.5	2.6	5	silty SAND to sandy SILT	120	4.0	34	34	28	77	42	-	-	16	0.200	2.12	16
20.18	121.3	119.8	195.2	121.2	3.5	-5.9	2.9	5	silty SAND to sandy SILT	120	4.0	30	30	25	73	42	-	-	18	0.200	2.18	16
20.34	84.2	83.0	195.1	84.1	3.4	-5.8	4.2	4	clayy SILT to silty CLAY	115	2.0	41	42	19	-	-	5.9	9.9	27	0.070	2.41	15
20.51	65.9	67.5	-	65.8	4.5	-4.9	6.9	9	very stiff fine SOIL	120	2.0	34	33	18	54	38	-	-	37	0.250	2.64	30
20.67	80.4	82.0	-	80.4	7.0	-4.1	8.9	9	very stiff fine SOIL	120	2.0	41	40	22	60	39	-	-	39	0.250	2.67	30
20.83	131.4	128.5	327.3	131.3	8.6	-2.8	6.6	9	very stiff fine SOIL	120	2.0	64	66	31	75	42	-	-	29	0.250	2.45	30
21.00	140.2	136.8	332.8	140.1	8.9	-3.2	6.4	9	very stiff fine SOIL	120	2.0	68	70	32	77	42	-	-	28	0.250	2.43	30
21.16	136.5	132.9	275.4	136.5	6.6	-2.9	4.9	9	very stiff fine SOIL	120	2.0	66	68	30	76	42	-	-	24	0.250	2.34	30
21.33	127.0	123.3	295.9	126.9	7.3	-3.0	5.8	9	very stiff fine SOIL	120	2.0	62	63	29	74	42	-	-	27	0.250	2.42	30
21.49	142.8	138.3	327.4	142.8	8.8	-1.1	6.2	9	very stiff fine SOIL	120	2.0	69	71	32	78	42	-	-	27	0.250	2.41	30
21.65	195.4	188.9	356.2	195.4	10.2	-1.7	5.3	9	very stiff fine SOIL	120	2.0	94	98	42	88	44	-	-	22	0.250	2.28	30
21.82	196.8	189.8	374.3	196.8	11.1	-1.5	5.7	9	very stiff fine SOIL	120	2.0	95	98	42	88	44	-	-	23	0.250	2.31	30
21.98	207.3	199.5	375.6	207.3	11.2	-1.4	5.4	9	very stiff fine SOIL	120	2.0	100	100	44	90	44	-	-	22	0.250	2.28	30
22.15	225.9	216.9	366.9	225.9	10.6	-1.4	4.7	9	very stiff fine SOIL	120	2.0	100	100	46	93	44	-	-	19	0.250	2.21	30
22.31	253.5	242.8	355.9	253.5	9.7	-1.3	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	16.7	9.9	16	0.250	2.11	16
22.47	266.9	255.1	349.0	266.9	9.0	-1.4	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	17.6	9.9	14	0.250	2.05	16
22.64	266.3	254.0	355.0	266.2	9.4	-1.7	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	17.6	9.9	15	0.250	2.07	16
22.80	255.2	242.9	353.6	255.2	9.6	-2.0	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	16.8	9.9	16	0.250	2.10	16
22.97	211.2	200.6	336.2	211.2	9.3	-2.0	4.4	9	very stiff fine SOIL	120	2.0	100	100	43	90	44	-	-	19	0.250	2.20	30
23.13	172.6	163.6	320.6	172.6	8.7	-1.5	5.1	9	very stiff fine SOIL	120	2.0	82	86	36	83	43	-	-	23	0.250	2.30	30
23.30	170.3	161.0	299.7	170.3	7.8	-1.7	4.6	9	very stiff fine SOIL	120	2.0	81	85	35	83	43	-	-	21	0.250	2.27	30
23.46	160.5	151.4	282.7	160.4	7.1	-2.2	4.5	9	very stiff fine SOIL	120	2.0	76	80	33	81	43	-	-	22	0.250	2.27	30
23.62	151.8	142.9	268.1	151.7	6.5	-2.4	4.3	9	very stiff fine SOIL	120	2.0	71	76	31	79	42	-	-	22	0.250	2.28	30
23.79	140.8	132.3	259.9	140.7	6.2	-2.7	4.4	9	very stiff fine SOIL	120	2.0	66	70	29	76	42	-	-	23	0.250	2.30	30
23.95	133.2	124.9	260.5	133.2	6.2	-3.0	4.7	9	very stiff fine SOIL	120	2.0	62	67	28	74	42	-	-	24	0.250	2.34	30
24.12	138.1	129.2	261.1	138.1	6.2	-3.1	4.6	9	very stiff fine SOIL	120	2.0	65	69	29	75	42	-	-	23	0.250	2.32	30
24.28	154.9	144.5	258.7	154.8	6.1	-3.3	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	31	-	-	10.2	9.9	21	0.250	2.25	16
24.44	168.8	157.2	245.2	168.8	5.5	-3.8	3.3	5	silty SAND to sandy SILT	120	4.0	39	42	33	82	43	-	-	17	0.200	2.15	16
24.61	177.8	165.2	213.1	177.7	3.7	-4.8	2.1	5	silty SAND to sandy SILT	120	4.0	41	44	32	84	43	-	-	13	0.200	1.99	16
24.77	186.8	173.2	222.6	186.7	4.0	-6.2	2.2	5	silty SAND to sandy SILT	120	4.0	43	47	34	85	43	-	-	13	0.200	1.99	16
24.94	207.3	191.8	247.2	207.1	4.9	-6.2	2.4	5	silty SAND to sandy SILT	120	4.0	48	52	38	88	44	-	-	13	0.200	1.99	16
25.10	251.9	232.5	286.5	251.7	6.0	-6.5	2.4	6	clean SAND to silty SAND	125	5.0	47	50	45	95	45	-	-	11	0.350	1.94	16
25.26	270.0	248.7	308.9	269.9	6.9	-7.0	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	17.8	9.9	12	0.250	1.95	16
25.43	281.8	259.1	313.4	281.7	6.8	-7.5	2.4	6	clean SAND to silty SAND	125	5.0	52	56	49	95	45	-	-	11	0.350	1.92	16
25.59	289.1	265.1	314.5	288.9	6.6	-7.7	2.3	6	clean SAND to silty SAND	125	5.0	53	58	50	95	45	-	-	10	0.350	1.90	16
25.76	293.3	268.4	321.7	293.1	7.0	-8.1	2.4	6	clean SAND to silty SAND	125	5.0	54	59	51	95	45	-	-	11	0.350	1.91	16
25.92	305.8	279.2	337.4	305.6	7.7	-8.1	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	20.2	9.9	11	0.250	1.92	16
26.08	321.8	293.3	350.1	321.6	8.0	-8.2	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	56	-	-	21.2	9.9	11	0.250	1.91	16
26.25	326.9	297.4	346.8	326.8	7.6	-8.1	2.3	6	clean SAND to silty SAND	125	5.0	59	65	56	95	46	-	-	10	0.350	1.88	16
26.41	327.3	297.1	341.5	327.2	7.2	-8.2	2.2	6	clean SAND to silty SAND	125	5.0	59	65	55	95	46	-	-	9	0.350	1.86	16
26.58	335.4	303.7	348.0	335.2	7.4	-8.2	2.2	6	clean SAND to silty SAND	125	5.0	61	67	56	95	46	-	-	9	0.350	1.85	16
26.74	335.1	302.7	353.6	334.9	7.9	-8.3	2.4	6	clean SAND to silty SAND	125	5.0	61	67	57	95	46	-	-	10	0.350	1.88	16
26.90	323.1	291.3	350.1	322.9	8.2	-8.3	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	55	-	-	21.3	9.9	11	0.250	1.91	16
27.07	310.4	279.3	348.3	310.2	8.6	-8.3	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	54	-	-	20.5	9.9	12	0.250	1.96	16
27.23	307.1	275.8	355.8	306.9	9.3	-8.4	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	54	-	-	20.3	9.9	13	0.250	1.99	16
27.40	298.5	267.6	351.3	298.4	9.3	-8.4	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	19.7	9.9	13	0.250	2.01	16
27.56	237.0	212.1	323.1	236.8	9.0	-8.3	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	15.6	9.9	17	0.250	2.14	16
27.72	209.9	187.5	316.9	209.8	9.0	-7.4	4.3	9	very stiff fine SOIL	120	2.0	94	100	40	88	43	-	-	19	0.250	2.21	30
27.89	231.7	206.6	287.5	231.6	7.1	-7.0	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	42	-	-	15.3	9.9	15	0.250	2.06	16
28.05	266.4	237.1	307.5	266.3	7.4	-7.3	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	17.6	9.9	13	0.250	2.00	16
28.22	275.5	244.7	330.1	275.3	8.7	-8.1	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	18.2	9.9	14	0.250	2.04	16
28.38	273.2	242.3	344.0	273.1	9.7	-8.3	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	18.0	9.9	15	0.250	2.08	16
28.54	256.5	227.0	343.9	256.3	10.0	-8.2	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	16.9	9.9	17	0.250	2.13	16
28.71	267.2	236.1	347.8	267.1	10.1	-8.0	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	17.6	9.9	16	0.250	2.11	16

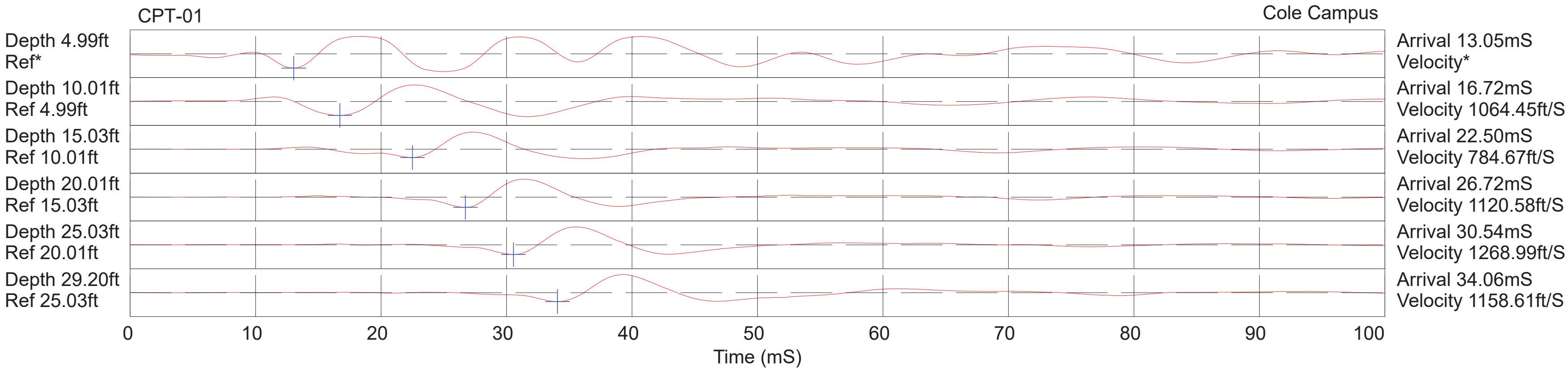
* Indicates the parameter was calculated using the normalized point stress.
The parameters listed above were determined using empirical correlations.
A Professional Engineer must determine their suitability for analysis and design.

Middle Earth Geo Testing

CEL

Location	Cole Campus	Operator	JM-AJ		
Job Number	84-04726-PW	Cone Number	DDG1489	GPS	
Hole Number	CPT-02	Date and Time	11/9/2019 8:49:20 AM		
Equilized Pressure	1.5	EST GW Depth During Test	13.4		





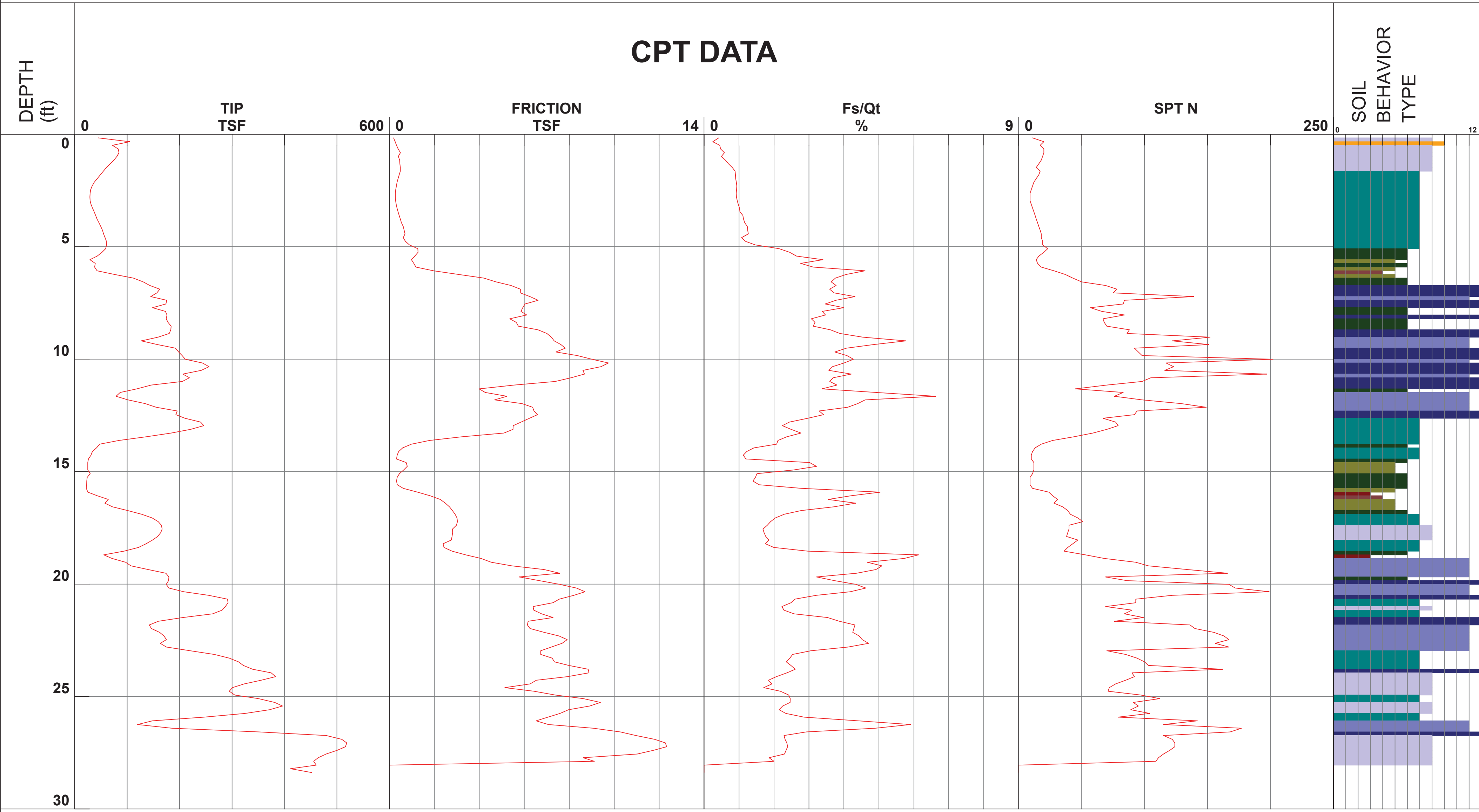
Hammer to Rod String Distance (ft): 5.83
* = Not Determined

COMMENT:

CEL

Project	Cole Campus	Operator	JM-AJ	Filename	SDF(324).cpt
Job Number	84-04726-PW	Cone Number	DDG1489	GPS	
Hole Number	CPT-03	Date and Time	11/9/2019 7:51:37 AM	Maximum Depth	28.38 ft
EST GW Depth During Test		14.00 ft			

Net Area Ratio .8



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

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Cole Campus

Project ID: CEL
Data File: SDF(324).cpt
CPT Date: 11/9/2019 7:51:37 AM
GW During Test: 14 ft

Page: 1
Sounding ID: CPT-03
Project No: 84-04726-PW
Cone/Rig: DDG1489

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	* qt PS tsf	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	* SPT R-N1 60%	SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* D50 mm	* Ic SBT Indx	* Nk -
0.33	104.9	168.3	168.3	104.9	0.3	0.1	0.2	6	clean SAND to silty SAND	125	5.0	34	21	27	84	48	-	-	5	0.350	1.39	16
0.49	71.9	115.3	116.1	71.9	0.3	0.8	0.4	6	clean SAND to silty SAND	125	5.0	23	14	20	72	48	-	-	5	0.350	1.66	16
0.66	83.1	133.3	133.3	83.1	0.4	0.5	0.5	6	clean SAND to silty SAND	125	5.0	27	17	23	76	48	-	-	5	0.350	1.62	16
0.82	84.3	135.2	136.9	84.3	0.5	0.1	0.6	6	clean SAND to silty SAND	125	5.0	27	17	24	77	48	-	-	5	0.350	1.66	16
0.98	80.5	129.1	129.1	80.5	0.4	-0.1	0.5	6	clean SAND to silty SAND	125	5.0	26	16	22	75	48	-	-	5	0.350	1.64	16
1.15	74.7	119.8	125.8	74.7	0.5	-0.2	0.6	6	clean SAND to silty SAND	125	5.0	24	15	21	73	48	-	-	6	0.350	1.72	16
1.31	67.5	108.3	118.9	67.5	0.5	-0.2	0.7	6	clean SAND to silty SAND	125	5.0	22	14	20	70	48	-	-	8	0.350	1.79	16
1.48	60.3	96.7	111.9	60.3	0.5	-0.1	0.8	6	clean SAND to silty SAND	125	5.0	19	12	18	66	48	-	-	10	0.350	1.87	16
1.64	54.6	87.5	106.1	54.5	0.5	-0.2	0.9	6	clean SAND to silty SAND	125	5.0	17	11	17	63	48	-	-	11	0.350	1.92	16
1.80	48.9	78.4	98.6	48.9	0.4	-0.2	0.9	6	clean SAND to silty SAND	125	5.0	16	10	15	59	48	-	-	12	0.350	1.97	16
1.97	43.0	68.9	90.8	43.0	0.4	-0.1	0.9	6	clean SAND to silty SAND	125	5.0	14	9	14	55	47	-	-	13	0.350	2.01	16
2.13	37.2	59.7	83.7	37.2	0.3	-0.2	0.9	5	silty SAND to sandy SILT	120	4.0	15	9	12	50	46	-	-	15	0.200	2.07	16
2.30	33.1	53.1	78.8	33.1	0.3	-0.2	0.9	5	silty SAND to sandy SILT	120	4.0	13	8	11	46	45	-	-	16	0.200	2.12	16
2.46	30.6	49.0	75.5	30.6	0.3	-0.2	0.9	5	silty SAND to sandy SILT	120	4.0	12	8	10	43	44	-	-	17	0.200	2.14	16
2.62	29.2	46.9	73.5	29.2	0.3	-0.2	0.9	5	silty SAND to sandy SILT	120	4.0	12	7	10	42	44	-	-	18	0.200	2.16	16
2.79	28.9	46.4	73.3	28.9	0.3	-0.1	0.9	5	silty SAND to sandy SILT	120	4.0	12	7	10	42	43	-	-	18	0.200	2.16	16
2.95	29.4	47.1	74.5	29.4	0.3	-0.1	1.0	5	silty SAND to sandy SILT	120	4.0	12	7	10	42	43	-	-	18	0.200	2.16	16
3.12	31.0	49.7	77.3	31.0	0.3	-0.1	1.0	5	silty SAND to sandy SILT	120	4.0	12	8	10	44	43	-	-	17	0.200	2.15	16
3.28	33.8	54.2	81.8	33.8	0.3	-0.1	1.0	5	silty SAND to sandy SILT	120	4.0	14	8	11	47	43	-	-	17	0.200	2.13	16
3.45	37.1	59.5	86.5	37.1	0.4	-0.1	1.0	5	silty SAND to sandy SILT	120	4.0	15	9	12	50	43	-	-	16	0.200	2.10	16
3.61	39.8	63.8	92.2	39.8	0.4	-0.1	1.1	5	silty SAND to sandy SILT	120	4.0	16	10	13	52	44	-	-	16	0.200	2.09	16
3.77	42.6	68.3	96.5	42.6	0.5	-0.1	1.1	5	silty SAND to sandy SILT	120	4.0	17	11	14	54	44	-	-	15	0.200	2.08	16
3.94	46.2	74.1	102.3	46.2	0.5	-0.1	1.2	5	silty SAND to sandy SILT	120	4.0	19	12	15	57	44	-	-	15	0.200	2.06	16
4.10	49.7	79.7	109.1	49.7	0.6	0.0	1.2	5	silty SAND to sandy SILT	120	4.0	20	12	16	60	44	-	-	14	0.200	2.05	16
4.27	52.7	84.5	113.5	52.7	0.7	-0.1	1.3	6	clean SAND to silty SAND	125	5.0	17	11	17	61	44	-	-	14	0.350	2.03	16
4.43	55.1	88.4	117.4	55.1	0.7	-0.1	1.3	6	clean SAND to silty SAND	125	5.0	18	11	17	63	44	-	-	14	0.350	2.02	16
4.59	57.8	92.6	115.8	57.8	0.6	-0.1	1.1	6	clean SAND to silty SAND	125	5.0	19	12	18	64	44	-	-	12	0.350	1.96	16
4.76	60.2	96.6	122.2	60.2	0.7	-0.1	1.2	6	clean SAND to silty SAND	125	5.0	19	12	19	66	44	-	-	12	0.350	1.97	16
4.92	60.8	97.4	130.9	60.8	0.9	-0.1	1.5	5	silty SAND to sandy SILT	120	4.0	24	15	19	66	44	-	-	14	0.200	2.03	16
5.09	58.8	94.4	148.4	58.8	1.3	-0.2	2.2	5	silty SAND to sandy SILT	120	4.0	24	15	20	65	44	-	-	18	0.200	2.16	16
5.25	52.1	83.6	147.1	52.1	1.3	-0.2	2.5	5	silty SAND to sandy SILT	120	4.0	21	13	18	61	43	-	-	20	0.200	2.24	16
5.41	42.9	68.7	138.6	42.9	1.1	0.1	2.7	5	silty SAND to sandy SILT	120	4.0	17	11	15	55	42	-	-	23	0.200	2.32	16
5.58	28.8	46.3	133.4	29.0	1.0	6.1	3.4	4	clayy SILT to silty CLAY	115	2.0	23	14	11	-	-	2.0	9.9	32	0.070	2.52	15
5.74	39.3	63.1	136.3	39.7	1.1	20.2	2.8	5	silty SAND to sandy SILT	120	4.0	16	10	14	52	41	-	-	25	0.200	2.36	16
5.91	37.8	60.7	143.1	38.0	1.2	11.0	3.2	4	clayy SILT to silty CLAY	115	2.0	30	19	14	-	-	2.6	9.9	27	0.070	2.41	15
6.07	42.6	68.1	188.7	43.5	2.0	46.2	4.6	4	clayy SILT to silty CLAY	115	2.0	34	21	17	-	-	3.0	9.9	31	0.070	2.50	15
6.23	76.2	120.2	234.1	77.0	3.1	43.6	4.1	9	very stiff fine SOIL	120	2.0	60	38	27	73	44	-	-	23	0.250	2.30	30
6.40	111.8	174.1	281.0	112.0	4.2	10.6	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	37	-	-	7.4	9.9	18	0.250	2.18	16
6.56	130.6	201.0	304.1	130.7	4.7	7.3	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	42	-	-	8.6	9.9	17	0.250	2.13	16
6.73	143.2	217.9	327.5	143.4	5.4	8.6	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	45	-	-	9.5	9.9	17	0.250	2.13	16
6.89	162.3	244.2	346.9	162.5	5.8	7.0	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	10.7	9.9	15	0.250	2.08	16
7.05	156.6	232.8	340.7	156.6	5.8	1.2	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	10.3	9.9	16	0.250	2.10	16
7.22	144.9	213.2	345.1	145.1	6.3	9.0	4.3	9	very stiff fine SOIL	120	2.0	100	72	45	92	46	-	-	18	0.250	2.18	30
7.38	175.5	255.2	366.4	175.9	6.6	22.9	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	11.6	9.9	15	0.250	2.09	16
7.55	173.7	250.1	347.9	173.9	6.0	9.1	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	11.5	9.9	15	0.250	2.06	16
7.71	148.4	211.5	330.0	148.7	5.9	13.1	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	9.8	9.9	17	0.250	2.15	16
7.87	173.1	244.2	338.1	173.2	5.9	7.1	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	11.4	9.9	15	0.250	2.06	16
8.04	175.9	245.7	343.5	176.0	6.1	2.5	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	11.6	9.9	15	0.250	2.07	16
8.20	174.5	241.3	322.1	174.5	5.4	1.6	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	11.5	9.9	14	0.250	2.03	16
8.37	177.9	243.8	328.9	177.9	5.6	0.7	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	11.8	9.9	14	0.250	2.04	16
8.53	183.8	249.6	332.6	183.8	5.7	-0.5	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	12.1	9.9	14	0.250	2.02	16
8.69	183.1	246.3	350.0	183.1	6.6	-1.4	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	12.1	9.9	15	0.250	2.08	16
8.86	180.2	240.3	355.7	180.2	7.0	-1.8	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	11.9	9.9	16	0.250	2.11	16
9.02	158.7	209.8	350.9	158.7	7.2	-1.3	4.6	9	very stiff fine SOIL	120	2.0	100	79	45	91	46	-	-	19	0.250	2.20	30
9.19	127.0	166.3	349.5	127.1	7.3	4.1	5.8	9	very stiff fine SOIL	120	2.0	83	63	38	84	45	-	-	24	0.250	2.35	30
9.35	157.6	204.6	358.0	158.2	7.6	31.3	4.9	9	very stiff fine SOIL	120	2.0	100	79	44	91	46	-	-	20	0.250	2.23	30
9.51	192.1	247.3	371.3	192.4	7.8	12.0	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.7	9.9	17	0.250	2.12	16
9.68	198.1	252.8	362.4	198.3	7.4	10.7	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	13.1	9.9	15	0.250	2.09	16
9.84	204.8	259.2	384.7	204.9	8.4	9.1	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	13.5	9.9	16	0.250	2.12	16
10.01	210.8	264.8	399.4	211.0	9.0	10.9	4.3	9	very stiff fine SOIL	120	2.0	100	100	55	95	47	-	-	17	0.250	2.13	30
10.17	243.3	303.1	427.7	243.7	9.7	18.4	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	61	-	-	16.1	9.9	15	0.250	2.07	16
10.34	256.2	316.7	426.1	256.3	9.4	6.4	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	63	-	-	16.9	9.9	14	0.250	2.03	16
10.50	241.4	296.2	399.7	241.4	8.6	1.1	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	15.9	9.9	14	0.250	2.04	16
10.66	206.1	251.0	381.7	206.1	8.7	1.4	4.2	9	very stiff fine SOIL	120	2.0	100	100	52	95	46	-	-	17	0.250	2.13	30
10.83	218.9	264.6	372.6	219.0	8.1	2.1	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	14.5	9.9	15	0.250	2.07	16
10.99	205.1	246.0	349.2	205.0	7.4	-1.4	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	13.5	9.9	15	0.250	2.08	16
11.16	146.1	174.1	282.9	146.1	5.6	0.4	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	37	-	-	9.6	9.9	18	0.250	2.18	16
11.32	118.4	140.0	232.1	118.4	4.0	2.2	3.4	5	silty SAND to sandy SILT	120	4.0	35	30	30	78	43	-	-	19	0.200	2.20	16
11.48	86.7	101.9	240.6	87.0	4.3	11.2	5.0	9	very stiff fine SOIL	120	2.0	51	43	24	68	42	-	-	27	0.250	2.41	30
11.65	78.9	92.0	275.2	79.7	5.2	40.6	6.7	9	very stiff fine SOIL	120	2.0	46	39	23	64	41	-	-	33	0.250	2.54	30
11.81	101.5	117.5	249.6	102.3	4.7	39.1	4.6	9	very stiff fine SOIL	120	2.0	59	51	27	72	42	-	-	24	0.250	2.35	30
11.98	134.1	154.2	283.8	134.6	5.9	25.4	4.4	9	very stiff fine SOIL	120	2.0	77	67	34	81	44	-	-	21	0.250	2.26	30
12.14	155.3	177.3	298.0	155.6	6.4	15.5	4.1	8	stiff SAND to clayy SAND	115	1.0	100	100	38	-	-	10.2	9.9	19	0.250	2.21	16
12.30	195.5	221.8	311.8	195.5	6.4	1.3	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	45	-	-	12.9	9.9	15	0.250	2.07	16
12.47	192.8	217.3	312.4	192.9	6.6	4.8	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	12.7	9.9	16	0.250	2.09	16
12.63	210.1	235.3	312.2	210.1	6.2	1.1	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	13.9	9.9	13	0.250	2.02	16
12.80	240.0	267.1	322.4	239.9	5.9	-1.0	2.4	6	clean SAND to silty SAND	125	5.0	53	48	51	95	46	-	-	11	0.350	1.92	16
12.96	246.1	272.1	319.2	246.0	5.5	-3.1	2.2	6	clean SAND to silty SAND	125	5.0	54	49	51	95	46	-	-	10	0.350	1.88	16
13.12	220.8	242.6	300.5	220.8	5.5	-3.0	2.5	6	clean SAND to silty SAND	125	5.0	49	44	47	95	46	-	-	12	0.350	1.95	16
13.29	184.0	200.8	270.5	183.9	5.1	-3.1	2.8	5	silty SAND to sandy SILT	120	4.0	50	46	40	90	45	-	-	14	0.200	2.03	16
13.45	136.7	148.3	205.6	136.6	3.2	-3.7	2.4	5	silty SAND to sandy SILT	120	4.0	37	34	30	80	43	-	-	15	0.200	2.06	16
13.62	84.4	91.0	144.7	84.4	1.8	-3.5	2.1	5	silty SAND to sandy SILT	120	4.0	23	21	19	64	41	-	-	18	0.200	2.17	16
13.78	47.4	50.8	107.8	47.4	1.0	1.1	2.1	5	silty SAND to sandy SILT	120	4.0	13	12	12	45	37	-	-	24	0.200	2.35	16
13.94	41.6	44.3	85.7	41.6	0.6	1.9	1.5	5	silty SAND to sandy SILT	120	4.0	11	10	10	40	37	-	-	22	0.200	2.30	16
14.11	33.6	35.7	73.8	33.7	0.4	2.0	1.3	5	silty SAND to sandy SILT	120	4.0	9	8	8	33	35	-	-	24	0.200	2.34	16
14.27	31.0	32.8	69.3	31.0	0.3	2.1	1.2	5	silty SAND to sandy SILT	120	4.0	8	8	7	30	35	-	-	24	0.200	2.35	16
14.44	26.3	27.8	67.3	26.3	0.3	2.1	1.2	5	silty SAND to sandy SILT	120	4.0	7	7	7	25	34	-	-	27	0.200	2.43	16
14.60	24.8	29.1	-	24.8	0.7	2.1	3.1	4	clayy SILT to silty CLAY	115	2.0	15	12	8	-	-	1.7	9.3	38	0.070	2.65	15
14.76	24.8	29.0	-	24.8	0.8	2.1	3.3	4	clayy SILT to silty CLAY	115	2.0	15	12	8	-	-	1.7	9.2	39	0.070	2.67	15
14.93	24.8	28.9	-	24.9	0.6	2.1	2.7	4	clayy SILT to silty CLAY	115	2.0	14	12	7	-	-	1.7	9.2	36	0.070	2.61	15
15.09	29.6	30.9	77.3	29.6	0.4	1.3	1.6	5	silty SAND to sandy SILT	120	4.0	8	7	7	28	34	-	-	28	0.200	2.44	16
15.26	23.7	24.7	71.1	23.7	0.3	2.2	1.5	5	silty SAND to sandy SILT	120	4.0	6	6	6	21	33	-	-	32	0.200	2.52	16
15.42	22.8	23.7	68.8	22.8	0.3	2.1	1.5	5	silty SAND to sandy SILT	120	4.0	6	6	6	19	32	-	-	32	0.200	2.53	16

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

Middle Earth Geo Testing

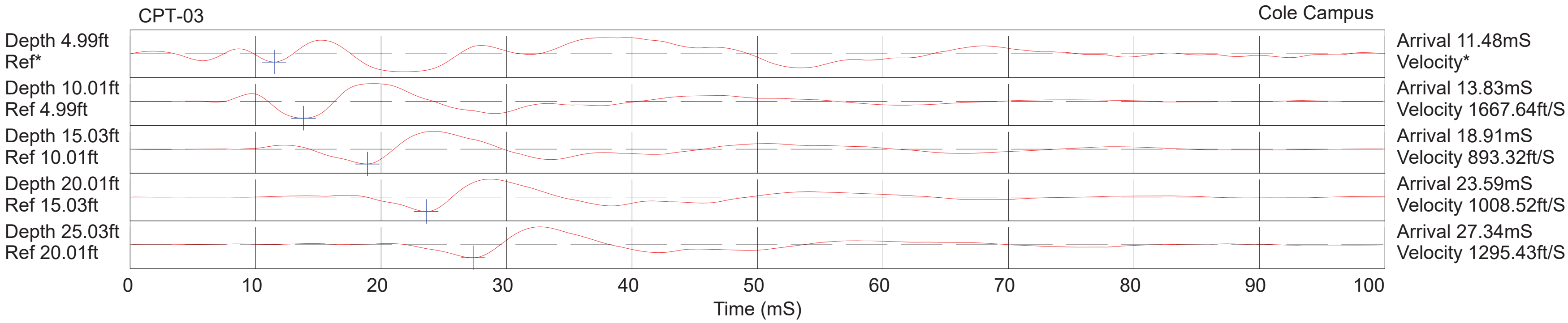
Cole Campus

Project ID: CEL	Page: 2
Data File: SDF(324).cpt	Sounding ID: CPT-03
CPT Date: 11/9/2019 7:51:37 AM	Project No: 84-04726-PW
GW During Test: 14 ft	Cone/Rig: DDG1489

. . Depth ft	. qc PS tsf	* qc1n PS -	. q1ncs PS -	* qt PS tsf	. Slv Stss tsf	. pore prss (psi)	. Frct Rato %	* Mat Typ Zon	* Material Behavior Description	. Unit Wght pcf	. Qc to N	* SPT R-N1 60%	. SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	. Und Shr tsf	. OCR -	* Fin Ic %	* D50 - mm	* Ic SBT Indx	* Nk - -
15.58	22.6	23.4	72.3	22.6	0.4	1.9	1.6	4	clayy SILT to silty CLAY	115	2.0	12	11	6	-	-	1.5	8.1	33	0.070	2.56	15
15.75	22.2	25.1	-	22.2	0.6	2.0	2.9	4	clayy SILT to silty CLAY	115	2.0	13	11	7	-	-	1.5	7.9	40	0.070	2.68	15
15.91	24.9	28.2	-	25.0	1.3	2.2	5.2	3	silty CLAY to CLAY	115	1.5	19	17	8	-	-	1.7	8.9	47	0.005	2.81	15
16.08	43.0	45.8	151.6	43.0	1.8	2.5	4.3	4	clayy SILT to silty CLAY	115	2.0	23	21	12	-	-	3.0	9.9	35	0.070	2.60	15
16.24	64.0	65.7	160.4	64.0	2.3	0.5	3.6	4	clayy SILT to silty CLAY	115	2.0	33	32	15	-	-	4.5	9.9	28	0.070	2.43	15
16.40	57.4	58.8	171.6	57.5	2.5	0.9	4.4	4	clayy SILT to silty CLAY	115	2.0	29	29	15	-	-	4.0	9.9	32	0.070	2.53	15
16.57	72.2	73.8	173.6	72.3	2.7	1.9	3.8	4	clayy SILT to silty CLAY	115	2.0	37	36	17	-	-	5.0	9.9	27	0.070	2.41	15
16.73	101.0	103.0	176.2	101.0	2.8	-0.3	2.8	5	silty SAND to sandy SILT	120	4.0	26	25	22	68	41	-	-	20	0.200	2.22	16
16.90	127.5	129.7	185.9	127.5	2.9	-3.1	2.3	5	silty SAND to sandy SILT	120	4.0	32	32	26	76	42	-	-	15	0.200	2.09	16
17.06	147.6	149.7	196.2	147.5	3.0	-3.5	2.1	5	silty SAND to sandy SILT	120	4.0	37	37	29	80	43	-	-	13	0.200	2.01	16
17.23	159.3	161.2	202.4	159.2	3.0	-3.9	1.9	6	clean SAND to silty SAND	125	5.0	32	32	31	83	43	-	-	12	0.350	1.96	16
17.39	165.2	166.6	204.4	165.1	3.0	-4.5	1.8	6	clean SAND to silty SAND	125	5.0	33	33	32	84	43	-	-	11	0.350	1.94	16
17.55	166.8	167.8	201.5	166.7	2.8	-5.2	1.7	6	clean SAND to silty SAND	125	5.0	34	33	32	84	43	-	-	11	0.350	1.91	16
17.72	164.0	164.5	199.5	163.9	2.8	-5.3	1.7	6	clean SAND to silty SAND	125	5.0	33	33	31	83	43	-	-	11	0.350	1.92	16
17.88	158.3	158.4	195.4	158.2	2.8	-5.5	1.8	6	clean SAND to silty SAND	125	5.0	32	32	30	82	43	-	-	11	0.350	1.94	16
18.05	148.3	148.0	188.8	148.2	2.8	-5.8	1.9	6	clean SAND to silty SAND	125	5.0	30	30	29	80	43	-	-	12	0.350	1.98	16
18.21	136.1	135.5	174.1	136.0	2.4	-6.1	1.8	6	clean SAND to silty SAND	125	5.0	27	27	26	77	42	-	-	13	0.350	1.99	16
18.37	121.7	120.8	168.3	121.6	2.4	-6.5	2.0	5	silty SAND to sandy SILT	120	4.0	30	30	24	73	42	-	-	15	0.200	2.06	16
18.54	94.0	93.1	172.7	93.9	2.8	-6.5	3.0	5	silty SAND to sandy SILT	120	4.0	23	24	20	65	40	-	-	21	0.200	2.27	16
18.70	55.3	57.2	-	55.4	3.4	3.2	6.3	3	silty CLAY to CLAY	115	1.5	38	37	15	-	-	3.8	9.9	38	0.005	2.65	15
18.87	71.3	70.2	220.4	71.3	4.1	2.7	5.8	9	very stiff fine SOIL	120	2.0	35	36	18	55	39	-	-	34	0.250	2.57	30
19.03	97.0	95.3	226.0	97.0	4.5	0.4	4.7	9	very stiff fine SOIL	120	2.0	48	48	22	65	40	-	-	27	0.250	2.41	30
19.19	107.1	105.0	250.2	107.1	5.4	0.8	5.1	9	very stiff fine SOIL	120	2.0	53	54	25	69	41	-	-	27	0.250	2.42	30
19.36	140.0	137.0	283.4	140.0	6.9	0.5	5.0	9	very stiff fine SOIL	120	2.0	68	70	31	77	42	-	-	24	0.250	2.34	30
19.52	173.8	169.6	300.0	173.7	7.6	-1.1	4.4	9	very stiff fine SOIL	120	2.0	85	87	37	84	43	-	-	20	0.250	2.24	30
19.69	179.6	174.9	262.0	179.6	5.8	-2.9	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	36	-	-	11.8	9.9	17	0.250	2.12	16
19.85	178.9	173.8	280.4	178.8	6.7	-4.1	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	37	-	-	11.8	9.9	18	0.250	2.18	16
20.01	174.5	169.2	298.8	174.4	7.6	-4.9	4.4	9	very stiff fine SOIL	120	2.0	85	87	37	84	43	-	-	20	0.250	2.24	30
20.18	179.7	173.8	315.1	179.6	8.3	-5.1	4.7	9	very stiff fine SOIL	120	2.0	87	90	38	85	43	-	-	21	0.250	2.26	30
20.34	208.1	200.8	326.9	208.0	8.7	-4.0	4.2	9	very stiff fine SOIL	120	2.0	100	100	42	90	44	-	-	18	0.250	2.18	30
20.51	255.6	246.1	333.2	255.5	8.2	-4.8	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	16.9	9.9	14	0.250	2.04	16
20.67	291.3	279.8	341.1	291.1	7.6	-6.3	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	54	-	-	19.2	9.9	11	0.250	1.93	16
20.83	292.4	280.3	337.3	292.3	7.3	-7.4	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	19.3	9.9	11	0.250	1.91	16
21.00	287.2	274.7	321.3	287.0	6.4	-8.1	2.2	6	clean SAND to silty SAND	125	5.0	55	57	52	95	46	-	-	10	0.350	1.88	16
21.16	281.0	268.2	317.4	280.9	6.4	-8.7	2.3	6	clean SAND to silty SAND	125	5.0	54	56	51	95	45	-	-	10	0.350	1.89	16
21.33	263.1	250.4	311.6	262.9	6.8	-9.2	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	17.4	9.9	12	0.250	1.95	16
21.49	206.1	195.8	295.5	205.9	7.3	-9.1	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	40	-	-	13.6	9.9	17	0.250	2.13	16
21.65	159.6	151.3	262.0	159.4	6.2	-9.2	3.9	8	stiff SAND to clayy SAND	115	1.0	100	100	33	-	-	10.5	9.9	20	0.250	2.23	16
21.82	142.2	134.5	260.0	142.0	6.1	-8.9	4.4	9	very stiff fine SOIL	120	2.0	67	71	30	77	42	-	-	22	0.250	2.29	30
21.98	146.2	138.0	262.5	146.0	6.3	-8.9	4.3	9	very stiff fine SOIL	120	2.0	69	73	30	78	42	-	-	22	0.250	2.29	30
22.15	161.8	152.4	277.3	161.7	6.9	-8.6	4.3	9	very stiff fine SOIL	120	2.0	76	81	33	81	43	-	-	21	0.250	2.26	30
22.31	170.1	159.9	292.3	169.9	7.5	-9.0	4.5	9	very stiff fine SOIL	120	2.0	80	85	35	82	43	-	-	21	0.250	2.26	30
22.47	174.8	163.9	300.3	174.6	7.9	-9.4	4.6	9	very stiff fine SOIL	120	2.0	82	87	36	83	43	-	-	21	0.250	2.26	30
22.64	163.1	152.6	294.3	163.0	7.7	-9.6	4.7	9	very stiff fine SOIL	120	2.0	76	82	34	81	43	-	-	22	0.250	2.29	30
22.80	174.9	163.2	284.2	174.7	7.2	-9.5	4.2	8	stiff SAND to clayy SAND	115	1.0	100	100	35	-	-	11.5	9.9	20	0.250	2.23	16
22.97	220.0	205.0	286.1	219.8	6.7	-9.6	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	41	-	-	14.5	9.9	15	0.250	2.07	16
23.13	266.2	247.6	307.1	266.0	6.7	-9.9	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	17.6	9.9	12	0.250	1.95	16
23.30	294.9	273.6	329.5	294.7	7.2	-10.6	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	19.5	9.9	11	0.250	1.92	16
23.46	312.3	289.3	340.4	312.1	7.3	-10.6	2.4	6	clean SAND to silty SAND	125	5.0	58	62	54	95	46	-	-	10	0.350	1.89	16
23.62	321.5	297.1	353.4	321.3	8.0	-10.8	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	56	-	-	21.2	9.9	10	0.250	1.90	16
23.79	339.2	312.8	374.0	339.0	8.8	-10.9	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	22.4	9.9	11	0.250	1.91	16
23.95	374.6	344.8	394.8	374.4	8.9	-11.1	2.4	8	stiff SAND to clayy SAND	115	1.0	100	100	64	-	-	24.7	9.9	9	0.250	1.85	16
24.12	383.2	352.0	388.1	382.9	7.9	-11.1	2.1	6	clean SAND to silty SAND	125	5.0	70	77	64	95	47	-	-	8	0.350	1.79	16
24.28	355.4	325.8	353.4	355.2	6.5	-11.3	1.8	6	clean SAND to silty SAND	125	5.0	65	71	59	95	46	-	-	7	0.350	1.77	16
24.44	323.0	295.4	329.4	322.7	6.3	-11.4	1.9	6	clean SAND to silty SAND	125	5.0	59	65	54	95	46	-	-	8	0.350	1.81	16
24.61	300.7	274.4	300.5	300.4	5.1	-11.8	1.7	6	clean SAND to silty SAND	125	5.0	55	60	50	95	45	-	-	8	0.350	1.78	16
24.77	294.6	268.2	313.4	294.3	6.4	-11.8	2.2	6	clean SAND to silty SAND	125	5.0	54	59	50	95	45	-	-	10	0.350	1.88	16
24.94	305.1	277.1	331.5	304.9	7.4	-11.8	2.4	6	clean SAND to silty SAND	125	5.0	55	61	53	95	45	-	-	11	0.350	1.91	16
25.10	350.3	317.5	372.4	350.1	8.6	-11.5	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	60	-	-	23.1	9.9	10	0.250	1.88	16
25.26	381.6	345.2	399.2	381.4	9.4	-12.1	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	64	-	-	25.2	9.9	10	0.250	1.86	16
25.43	396.2	357.7	401.7	395.9	8.9	-12.3	2.3	8	stiff SAND to clayy SAND	115	1.0	100	100	66	-	-	26.2	9.9	9	0.250	1.82	16
25.59	371.6	334.9	375.3	371.3	8.0	-12.2	2.2	6	clean SAND to silty SAND	125	5.0	67	74	61	95	46	-	-	9	0.350	1.82	16
25.76	324.9	292.2	342.6	324.6	7.6	-12.3	2.3	6	clean SAND to silty SAND	125	5.0	58	65	55	95	46	-	-	10	0.350	1.88	16
25.92	247.0	221.6	294.7	246.8	7.1	-12.3	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	16.3	9.9	14	0.250	2.02	16
26.08	148.0	132.5	261.3	147.7	6.5	-13.1	4.5	9	very stiff fine SOIL	120	2.0	66	74	30	76	42	-	-	23	0.250	2.31	30
26.25	119.7	107.0	278.4	119.5	7.1	-12.8	6.0	9	very stiff fine SOIL	120	2.0	54	60	26	69	41	-	-	29	0.250	2.47	30
26.41	185.5	165.4	316.2	185.2	9.1	-12.2	4.9	9	very stiff fine SOIL	120	2.0	83	93	37	84	43	-	-	22	0.250	2.29	30
26.58	351.3	312.8	387.8	351.1	10.3	-12.2	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	60	-	-	23.2	9.9	12	0.250	1.95	16
26.74	479.5	426.2	468.8	479.3	11.0	-12.1	2.3	8	stiff SAND to clayy SAND	115	1.0	100	100	77	-	-	31.7	9.9	8	0.250	1.79	16
26.90	509.1	451.7	494.7	508.9	11.8	-12.1	2.3	8	stiff SAND to clayy SAND	115	1.0	100	100	82	-	-	33.7	9.9	8	0.250	1.78	16
27.07	518.8	459.4	504.8	518.6	12.3	-11.9	2.4	8	stiff SAND to clayy SAND	115	1.0	100	100	83	-	-	34.3	9.9	8	0.250	1.79	16
27.23	516.4	456.5	503.1	516.2	12.3	-11.7	2.4	8	stiff SAND to clayy SAND	115	1.0	100	100	83	-	-	34.1	9.9	8	0.250	1.79	16
27.40	500.5	441.6	486.6	500.2	11.7	-11.6	2.4	8	stiff SAND to clayy SAND	115	1.0	100	100	80	-	-	33.1	9.9	8	0.250	1.79	16
27.56	479.5	422.3	465.8	479.2	11.0	-11.6	2.3	8	stiff SAND to clayy SAND	115	1.0	100	100	77	-	-	31.7	9.9	8	0.250	1.80	16
27.72	464.3	408.2	429.4	464.0	8.6	-11.5	1.9	6	clean SAND to silty SAND	125	5.0	82	93	72	95	47	-	-	7	0.350	1.72	16
27.89	455.7	399.8	429.4	455.4	9.1	-11.4	2.0	6	clean SAND to silty SAND	125	5.0	80	91	72	95	47	-	-	7	0.350	1.75	16

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

Middle Earth Geo Testing



Hammer to Rod String Distance (ft): 5.83
* = Not Determined

COMMENT:

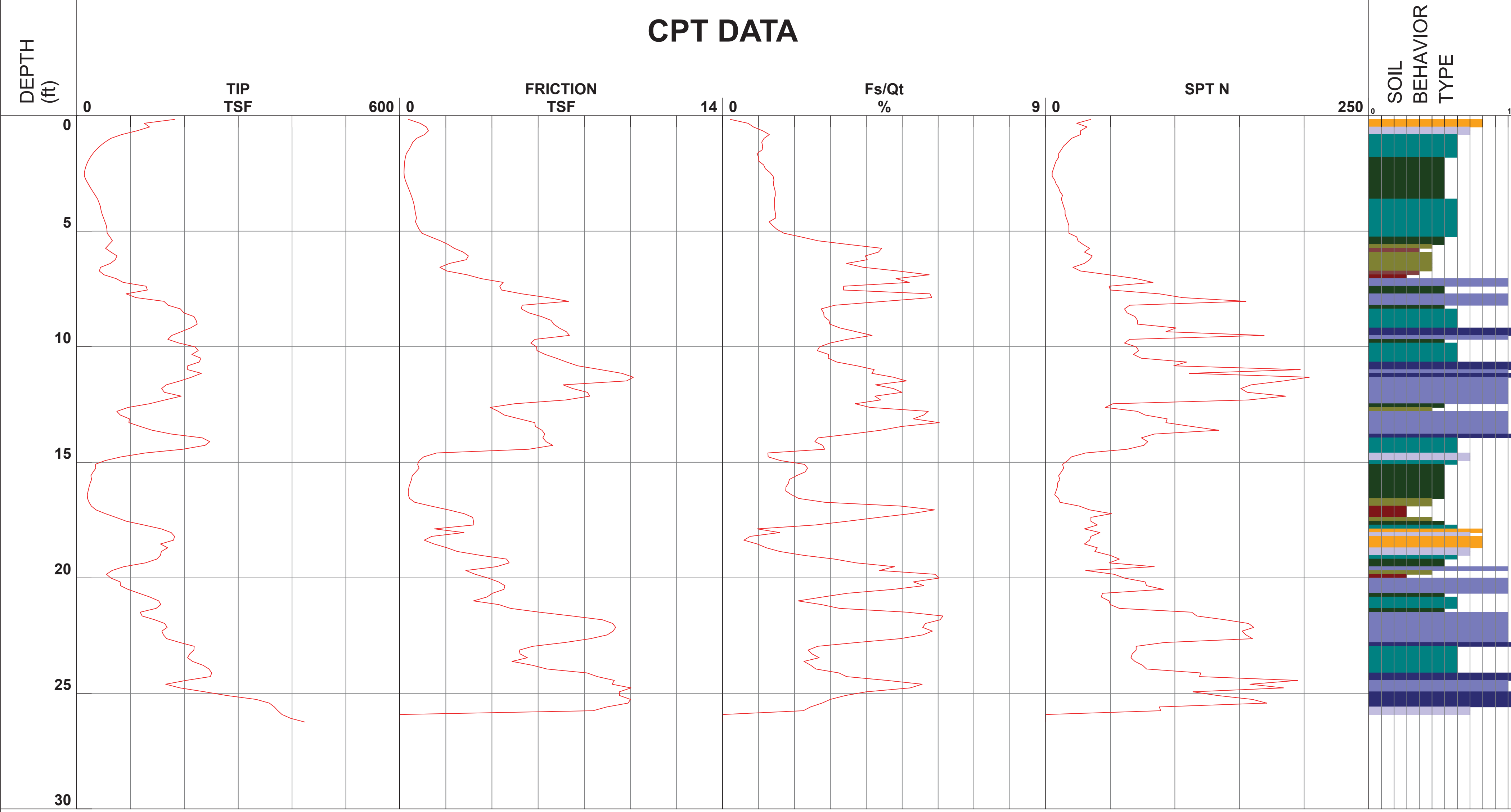
Middle Earth
GEO TESTING INC.

CEL

Middle Earth Geo Testing Inc.

Project	Cole Campus	Operator	JM-AJ	Filename	SDF(327).cpt
Job Number	84-04726-PW	Cone Number	DDG1489	GPS	
Hole Number	CPT-04	Date and Time	11/9/2019 10:51:04 AM	Maximum Depth	26.25 ft
EST GW Depth During Test		13.00 ft			

Net Area Ratio .8



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

Cone Size 10cm squared

S*Soil behavior type and SPT based on data from UBC-1983

Cole Campus

Project ID: CEL
Data File: SDF(327).cpt
CPT Date: 11/9/2019 10:51:04 AM
GW During Test: 13 ft

Sounding ID: CPT-04
Project No: 84-04726-PW
Cone/Rig: DDG1489

. . Depth ft	. qc PS tsf	* qc1n PS -	. q1ncs PS -	* qt PS tsf	. Slv Stss tsf	. pore prss (psi)	. Frct Rato %	* Mat Typ Zon	* Material Behavior Description	. Unit Wght pcf	. Qc to N	* SPT R-N1 60%	. SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	. Und Shr tsf	. OCR -	* Fin Ic %	* D50 - mm	* Ic SBT Indx	* Nk - -
0.33	125.4	201.1	201.1	125.4	0.9	0.0	0.7	6	clean SAND to silty SAND	125	5.0	40	25	34	90	48	-	-	5	0.350	1.58	16
0.49	135.3	217.0	217.0	135.3	1.2	0.0	0.9	6	clean SAND to silty SAND	125	5.0	43	27	37	93	48	-	-	5	0.350	1.62	16
0.66	112.1	179.8	193.3	112.1	1.2	0.1	1.1	6	clean SAND to silty SAND	125	5.0	36	22	32	86	48	-	-	7	0.350	1.76	16
0.82	83.4	133.8	158.1	83.4	1.1	0.0	1.3	6	clean SAND to silty SAND	125	5.0	27	17	25	77	48	-	-	10	0.350	1.89	16
0.98	63.3	101.5	125.4	63.3	0.7	0.1	1.2	6	clean SAND to silty SAND	125	5.0	20	13	20	68	48	-	-	12	0.350	1.95	16
1.15	52.4	84.0	108.4	52.4	0.6	0.1	1.1	6	clean SAND to silty SAND	125	5.0	17	10	16	61	48	-	-	13	0.350	1.99	16
1.31	43.6	70.0	97.2	43.6	0.5	0.0	1.1	5	silty SAND to sandy SILT	120	4.0	17	11	14	55	48	-	-	15	0.200	2.06	16
1.48	36.2	58.1	87.0	36.2	0.4	0.0	1.1	5	silty SAND to sandy SILT	120	4.0	15	9	12	49	47	-	-	17	0.200	2.12	16
1.64	30.0	48.1	75.2	30.0	0.3	0.0	1.0	5	silty SAND to sandy SILT	120	4.0	12	8	10	43	46	-	-	18	0.200	2.15	16
1.80	25.0	40.2	70.3	25.0	0.3	0.1	1.0	5	silty SAND to sandy SILT	120	4.0	10	6	9	37	45	-	-	20	0.200	2.23	16
1.97	21.4	34.3	65.9	21.4	0.2	0.1	1.0	5	silty SAND to sandy SILT	120	4.0	9	5	8	32	43	-	-	22	0.200	2.29	16
2.13	17.9	28.6	64.8	17.9	0.2	0.1	1.1	5	silty SAND to sandy SILT	120	4.0	7	4	7	26	42	-	-	26	0.200	2.39	16
2.30	16.1	25.7	63.7	16.1	0.2	0.1	1.2	5	silty SAND to sandy SILT	120	4.0	6	4	6	22	41	-	-	28	0.200	2.44	16
2.46	14.3	22.9	64.1	14.3	0.2	0.1	1.3	5	silty SAND to sandy SILT	120	4.0	6	4	6	18	40	-	-	31	0.200	2.50	16
2.62	14.3	22.9	65.9	14.3	0.2	0.1	1.4	5	silty SAND to sandy SILT	120	4.0	6	4	6	18	40	-	-	32	0.200	2.52	16
2.79	17.4	27.8	70.8	17.4	0.2	0.1	1.4	5	silty SAND to sandy SILT	120	4.0	7	4	7	25	41	-	-	29	0.200	2.45	16
2.95	21.5	34.4	76.0	21.5	0.3	0.2	1.4	5	silty SAND to sandy SILT	120	4.0	9	5	8	32	41	-	-	25	0.200	2.37	16
3.12	25.5	40.9	82.1	25.5	0.4	0.2	1.4	5	silty SAND to sandy SILT	120	4.0	10	6	9	38	42	-	-	23	0.200	2.32	16
3.28	29.7	47.7	88.3	29.7	0.4	0.2	1.5	5	silty SAND to sandy SILT	120	4.0	12	7	10	43	43	-	-	21	0.200	2.27	16
3.45	34.4	55.1	94.6	34.4	0.5	0.2	1.5	5	silty SAND to sandy SILT	120	4.0	14	9	12	47	43	-	-	20	0.200	2.22	16
3.61	38.7	62.0	99.6	38.7	0.6	0.2	1.4	5	silty SAND to sandy SILT	120	4.0	16	10	13	51	43	-	-	18	0.200	2.17	16
3.77	41.6	66.7	103.7	41.6	0.6	0.2	1.5	5	silty SAND to sandy SILT	120	4.0	17	10	14	54	44	-	-	17	0.200	2.15	16
3.94	44.0	70.5	107.0	44.0	0.6	0.3	1.5	5	silty SAND to sandy SILT	120	4.0	18	11	15	55	44	-	-	17	0.200	2.13	16
4.10	45.6	73.1	109.5	45.6	0.7	0.3	1.5	5	silty SAND to sandy SILT	120	4.0	18	11	15	57	44	-	-	16	0.200	2.12	16
4.27	47.0	75.4	111.9	47.0	0.7	0.3	1.5	5	silty SAND to sandy SILT	120	4.0	19	12	16	58	44	-	-	16	0.200	2.12	16
4.43	49.4	79.2	115.2	49.4	0.7	0.3	1.5	5	silty SAND to sandy SILT	120	4.0	20	12	16	59	44	-	-	16	0.200	2.10	16
4.59	52.8	84.6	114.9	52.8	0.7	0.3	1.3	5	silty SAND to sandy SILT	120	4.0	21	13	17	61	44	-	-	14	0.200	2.04	16
4.76	54.9	88.0	120.5	54.9	0.8	0.3	1.4	5	silty SAND to sandy SILT	120	4.0	22	14	18	63	44	-	-	14	0.200	2.05	16
4.92	56.1	90.0	125.6	56.1	0.8	0.4	1.5	5	silty SAND to sandy SILT	120	4.0	23	14	18	64	44	-	-	15	0.200	2.06	16
5.09	56.5	90.7	131.8	56.5	1.0	0.1	1.7	5	silty SAND to sandy SILT	120	4.0	23	14	19	64	44	-	-	16	0.200	2.10	16
5.25	61.7	99.0	153.4	61.7	1.3	0.1	2.2	5	silty SAND to sandy SILT	120	4.0	25	15	21	67	44	-	-	17	0.200	2.15	16
5.41	66.3	106.3	175.0	66.3	1.8	0.1	2.7	5	silty SAND to sandy SILT	120	4.0	27	17	23	69	44	-	-	19	0.200	2.19	16
5.58	59.9	96.1	190.9	59.9	2.1	0.2	3.5	5	silty SAND to sandy SILT	120	4.0	24	15	21	66	43	-	-	23	0.200	2.31	16
5.74	53.4	85.7	206.1	53.4	2.4	0.9	4.5	4	clayy SILT to silty CLAY	115	2.0	43	27	20	-	-	3.8	9.9	27	0.070	2.42	15
5.91	63.5	101.9	222.4	63.6	2.8	1.5	4.4	9	very stiff fine SOIL	120	2.0	51	32	23	68	43	-	-	25	0.250	2.37	30
6.07	75.0	120.2	231.3	75.0	3.0	0.4	4.0	8	stiff SAND to clayy SAND	115	1.0	100	75	27	-	-	4.9	9.9	22	0.250	2.29	16
6.23	71.6	113.4	225.7	71.6	2.9	1.0	4.0	9	very stiff fine SOIL	120	2.0	57	36	25	71	44	-	-	23	0.250	2.31	30
6.40	62.7	98.1	191.4	62.7	2.2	1.2	3.5	5	silty SAND to sandy SILT	120	4.0	25	16	22	66	43	-	-	23	0.200	2.30	16
6.56	44.4	68.6	172.1	44.4	1.7	1.9	4.0	4	clayy SILT to silty CLAY	115	2.0	34	22	16	-	-	3.1	9.9	28	0.070	2.45	15
6.73	41.9	64.0	190.0	42.0	2.0	3.1	4.9	4	clayy SILT to silty CLAY	115	2.0	32	21	16	-	-	2.9	9.9	32	0.070	2.54	15
6.89	50.8	76.7	229.0	50.9	2.9	3.5	5.8	9	very stiff fine SOIL	120	2.0	38	25	19	58	42	-	-	33	0.250	2.54	30
7.05	73.1	109.0	245.9	73.2	3.5	3.7	4.9	9	very stiff fine SOIL	120	2.0	55	37	25	70	43	-	-	26	0.250	2.39	30
7.22	86.3	127.3	280.2	86.4	4.5	3.5	5.2	9	very stiff fine SOIL	120	2.0	64	43	29	75	44	-	-	25	0.250	2.37	30
7.38	128.8	187.7	280.1	128.8	4.3	3.9	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	39	-	-	8.5	9.9	16	0.250	2.12	16
7.55	131.2	189.4	281.5	131.3	4.4	0.9	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	39	-	-	8.7	9.9	16	0.250	2.12	16
7.71	91.7	130.9	304.0	91.7	5.3	1.4	5.8	9	very stiff fine SOIL	120	2.0	65	46	30	76	44	-	-	27	0.250	2.40	30
7.87	110.3	155.9	338.0	110.4	6.4	3.1	5.9	9	very stiff fine SOIL	120	2.0	78	55	36	82	45	-	-	25	0.250	2.36	30
8.04	162.1	226.7	368.5	162.2	7.3	2.8	4.5	9	very stiff fine SOIL	120	2.0	100	81	48	94	46	-	-	18	0.250	2.18	30
8.20	169.7	235.0	318.1	169.8	5.3	2.2	3.1	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	11.2	9.9	14	0.250	2.04	16
8.37	192.6	264.1	331.3	192.6	5.3	1.2	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.7	9.9	12	0.250	1.96	16
8.53	198.8	270.1	340.3	198.8	5.6	-0.3	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	13.1	9.9	12	0.250	1.97	16
8.69	217.6	292.9	363.2	217.6	6.1	-0.8	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	56	-	-	14.4	9.9	12	0.250	1.95	16
8.86	221.6	295.7	371.9	221.6	6.6	-0.6	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	14.6	9.9	12	0.250	1.97	16
9.02	223.8	296.0	373.2	223.8	6.7	-0.5	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	14.8	9.9	12	0.250	1.97	16
9.19	211.6	277.5	366.8	211.6	6.9	-0.5	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	55	-	-	14.0	9.9	13	0.250	2.02	16
9.35	194.0	252.3	361.1	194.0	7.2	-1.0	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	12.8	9.9	15	0.250	2.09	16
9.51	176.7	227.8	354.5	176.7	7.4	-1.1	4.2	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	11.7	9.9	17	0.250	2.15	16
9.68	169.3	216.5	313.3	169.3	5.9	-0.9	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	44	-	-	11.2	9.9	16	0.250	2.10	16
9.84	189.7	240.6	318.4	189.7	5.7	-1.1	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	48	-	-	12.5	9.9	13	0.250	2.02	16
10.01	219.8	276.6	342.0	219.8	5.9	-2.2	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	53	-	-	14.5	9.9	12	0.250	1.95	16
10.17	225.8	281.9	344.5	225.7	5.9	-5.2	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	54	-	-	14.9	9.9	11	0.250	1.93	16
10.34	213.9	265.0	340.8	213.8	6.3	-5.0	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	52	-	-	14.1	9.9	13	0.250	1.99	16
10.50	230.8	283.8	359.3	230.7	6.8	-5.1	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	55	-	-	15.3	9.9	12	0.250	1.97	16
10.66	227.7	277.8	363.5	227.6	7.2	-5.1	3.2	8	stiff SAND to clayy SAND	115	1.0	100	100	55	-	-	15.0	9.9	13	0.250	2.01	16
10.83	206.2	249.7	359.5	206.1	7.7	-4.8	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	13.6	9.9	16	0.250	2.09	16
10.99	206.1	247.8	378.8	206.0	8.7	-4.7	4.2	9	very stiff fine SOIL	120	2.0	100	100	51	95	46	-	-	17	0.250	2.14	30
11.16	231.8	276.6	406.5	231.7	9.6	-5.0	4.2	8	stiff SAND to clayy SAND	115	1.0	100	100	57	-	-	15.3	9.9	16	0.250	2.11	16
11.32	212.9	252.3	408.1	212.8	10.1	-5.5	4.8	9	very stiff fine SOIL	120	2.0	100	100	53	95	46	-	-	18	0.250	2.18	30
11.48	191.9	225.8	394.3	191.8	9.8	-5.5	5.1	9	very stiff fine SOIL	120	2.0	100	96	49	94	46	-	-	20	0.250	2.23	30
11.65	166.3	194.2	322.2	166.2	7.1	-5.3	4.3	9	very stiff fine SOIL	120	2.0	97	83	41	89	45	-	-	19	0.250	2.20	30
11.81	157.8	183.0	329.8	157.7	7.5	-4.9	4.8	9	very stiff fine SOIL	120	2.0	91	79	40	87	45	-	-	21	0.250	2.25	30
11.98	162.9	187.6	344.9	162.8	8.1	-4.7	5.0	9	very stiff fine SOIL	120	2.0	94	81	41	88	45	-	-	21	0.250	2.26	30
12.14	194.3	222.2	351.9	194.2	8.2	-4.7	4.3	9	very stiff fine SOIL	120	2.0	100	97	47	93	45	-	-	18	0.250	2.16	30
12.30	163.9	186.2	319.1	163.8	7.2	-4.9	4.4	9	very stiff fine SOIL	120	2.0	93	82	40	88	45	-	-	20	0.250	2.22	30
12.47	135.0	152.4	256.2	134.9	5.0	-4.9	3.7	8	stiff SAND to clayy SAND	115	1.0	100	100	32	-	-	8.9	9.9	19	0.250	2.21	16
12.63	95.5	107.1	221.8	95.4	3.9	-4.8	4.1	9	very stiff fine SOIL	120	2.0	54	48	24	69	42	-	-	24	0.250	2.34	30
12.80	74.6	83.1	238.5	74.5	4.3	-4.4	5.8	9	very stiff fine SOIL	120	2.0	42	37	20	61	40	-	-	32	0.250	2.52	30
12.96	80.9	89.6	244.1	80.8	4.5	-4.2	5.7	9	very stiff fine SOIL	120	2.0	45	40	22	63	41	-	-	30	0.250	2.49	30
13.12	97.7	107.9	260.0	97.7	5.2	-4.4	5.4	9	very stiff fine SOIL	120	2.0	54	49	25	70	42	-	-	27	0.250	2.42	30
13.29	97.0	106.7	280.2	96.9	5.9	-4.4	6.1	9	very stiff fine SOIL	120	2.0	53	48	26	69	42	-	-	29	0.250	2.47	30
13.45	117.9	129.3	276.1	117.8	5.9	-4.8	5.0	9	very stiff fine SOIL	120	2.0	65	59	29	75	43	-	-	25	0.250	2.35	30
13.62	140.1	153.2	283.0	140.0	6.2	-4.4	4.4	9	very stiff fine SOIL	120	2.0	77	70	34	81	43	-	-	21	0.250	2.27	30
13.78	175.8	191.7	292.6	175.7	6.3	-4.4	3.6	8	stiff SAND to clayy SAND	115	1.0	100	100	40	-	-	11.6	9.9	17	0.250	2.14	16
13.94	233.3	253.8	318.0	233.3	6.2	-4.7	2.7	8	stiff SAND to clayy SAND	115	1.0	100	100	49	-	-	15.4	9.9	12	0.250	1.96	16
14.11	247.1	268.0	328.3	247.0	6.3	-5.0	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	16.3	9.9	11	0.250	1.94	16
14.27	238.4	257.9	327.2	238.3	6.6	-5.2	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	50	-	-	15.7	9.9	12	0.250	1.98	16
14.44	196.9	212.4	284.4	196.8	5.6	-5.3	2.9	8	stiff SAND to clayy SAND	115	1.0	100	100	42	-	-	13.0	9.9	14	0.250	2.03	16
14.60	127.7	137.4	160.7	127.6	1.6	-5.7	1.3	6	clean SAND to silty SAND	125	5.0	27	26	26	77	43	-	-	10	0.350	1.88	16
14.76	82.6	88.6	118.0	82.5	1.0	-5.4	1.3	6	clean SAND to silty SAND	125	5.0	18	17	18	63	41	-	-	14	0.350	2.02	16
14.93	52.8	56.5	100.5	52.7	0.8	-5.0	1.6	5	silty SAND to sandy SILT	120	4.0	14	13	12	48	38	-	-	20	0.200	2.24	16
15.09	34.2	36.5	99.5	34.1	0.8	-4.5	2.3	4	clayy SILT to silty CLAY	115	2.0	18	17	9	-	-	2.4	9.9	30	0.070	2.49	15
15.26	35.5	37.7	102.7	35.4	0.8	-4.4	2.4	4	clayy SILT to silty CLAY	115	2.0	19	18	9	-	-	2.4	9.9	30	0.070	2.49	15
15.42	30.6	32.4	95.8	30.5	0.7	-4.5	2.4	4	clayy SILT to silty CLAY	115	2.0	16	15	8	-	-	2.1	9.9	32	0.070	2.54	15

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

Middle Earth Geo Testing

Cole Campus

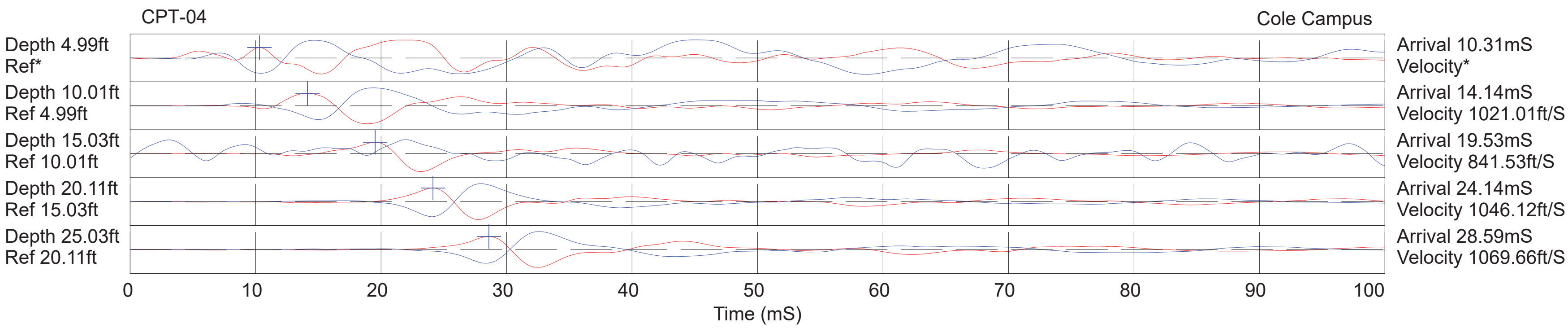
Project ID: CEL
Data File: SDF(327).cpt
CPT Date: 11/9/2019 10:51:04 AM
GW During Test: 13 ft

Sounding ID: CPT-04
Project No: 84-04726-PW
Cone/Rig: DDG1489

Depth ft	qc PS tsf	* qc1n PS -	q1ncs PS -	* qt PS tsf	Slv Stss tsf	pore prss (psi)	Frct Rato %	* Mat Typ Zon	* Material Behavior Description	Unit Wght pcf	Qc to N	* SPT R-N1 60%	SPT R-N 60%	* SPT IcN1 60%	* Rel Den %	* Ftn Ang deg	Und Shr tsf	OCR -	* Fin Ic %	* D50 - mm	* Ic SBT Indx	* Nk -
15.58	26.4	28.0	86.3	26.4	0.5	-4.5	2.1	4	clayy SILT to silty CLAY	115	2.0	14	13	7	-	-	1.8	9.9	33	0.070	2.56	15
15.75	27.6	29.2	83.5	27.6	0.5	-4.5	1.9	4	clayy SILT to silty CLAY	115	2.0	15	14	7	-	-	1.9	9.9	31	0.070	2.52	15
15.91	24.7	26.0	80.0	24.6	0.5	-4.6	1.9	4	clayy SILT to silty CLAY	115	2.0	13	12	7	-	-	1.7	9.2	33	0.070	2.56	15
16.08	22.8	24.0	76.7	22.8	0.4	-4.6	1.8	4	clayy SILT to silty CLAY	115	2.0	12	11	6	-	-	1.6	8.4	34	0.070	2.58	15
16.24	21.2	23.2	76.0	21.2	0.4	-4.6	1.8	4	clayy SILT to silty CLAY	115	2.0	12	11	6	-	-	1.4	7.8	35	0.070	2.59	15
16.40	19.6	22.7	-	19.5	0.4	-4.7	2.0	4	clayy SILT to silty CLAY	115	2.0	11	10	6	-	-	1.3	7.1	37	0.070	2.62	15
16.57	20.1	23.2	-	20.1	0.4	-4.6	2.2	4	clayy SILT to silty CLAY	115	2.0	12	10	6	-	-	1.4	7.3	37	0.070	2.64	15
16.73	23.0	26.3	-	22.9	0.7	-4.6	3.0	4	clayy SILT to silty CLAY	115	2.0	13	11	7	-	-	1.6	8.3	39	0.070	2.67	15
16.90	27.4	31.2	-	27.3	1.4	-4.6	5.1	3	silty CLAY to CLAY	115	1.5	21	18	9	-	-	1.9	9.9	45	0.005	2.78	15
17.06	35.8	40.6	-	35.7	2.1	-4.6	6.1	3	silty CLAY to CLAY	115	1.5	27	24	11	-	-	2.5	9.9	43	0.005	2.74	15
17.23	53.3	57.0	-	53.2	2.8	-4.6	5.3	4	clayy SILT to silty CLAY	115	2.0	28	27	15	-	-	3.7	9.9	35	0.070	2.60	15
17.39	72.7	74.8	192.2	72.6	3.2	-4.7	4.4	4	clayy SILT to silty CLAY	115	2.0	37	36	18	-	-	5.1	9.9	29	0.070	2.46	15
17.55	92.5	95.0	189.4	92.4	3.2	-4.8	3.5	5	silty SAND to sandy SILT	120	4.0	24	23	21	65	41	-	-	23	0.200	2.31	16
17.72	124.6	127.6	193.4	124.5	3.2	-4.9	2.6	5	silty SAND to sandy SILT	120	4.0	32	31	26	75	42	-	-	17	0.200	2.13	16
17.88	157.1	160.5	171.8	157.0	1.5	-5.2	1.0	6	clean SAND to silty SAND	125	5.0	32	31	29	83	43	-	-	7	0.350	1.75	16
18.05	175.4	178.7	208.4	175.3	2.8	-5.3	1.6	6	clean SAND to silty SAND	125	5.0	36	35	33	86	44	-	-	10	0.350	1.87	16
18.21	181.7	184.6	184.6	181.6	1.4	-5.4	0.8	6	clean SAND to silty SAND	125	5.0	37	36	32	87	44	-	-	5	0.350	1.64	16
18.37	179.8	182.1	182.1	179.7	1.1	-5.3	0.6	6	clean SAND to silty SAND	125	5.0	36	36	31	87	44	-	-	5	0.350	1.57	16
18.54	155.8	157.4	169.2	155.7	1.5	-5.3	1.0	6	clean SAND to silty SAND	125	5.0	31	31	28	82	43	-	-	7	0.350	1.76	16
18.70	169.0	170.2	188.7	168.9	2.1	-2.0	1.2	6	clean SAND to silty SAND	125	5.0	34	34	31	85	44	-	-	8	0.350	1.80	16
18.87	157.3	158.1	189.5	157.3	2.5	-1.9	1.6	6	clean SAND to silty SAND	125	5.0	32	31	30	82	43	-	-	11	0.350	1.91	16
19.03	155.3	155.6	209.3	155.3	3.5	-2.1	2.3	5	silty SAND to sandy SILT	120	4.0	39	39	31	82	43	-	-	14	0.200	2.03	16
19.19	148.7	148.6	232.0	148.7	4.6	-2.1	3.1	5	silty SAND to sandy SILT	120	4.0	37	37	31	80	43	-	-	17	0.200	2.15	16
19.36	127.7	127.3	231.4	127.7	4.7	-2.2	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	28	-	-	8.4	9.9	21	0.250	2.26	16
19.52	87.6	87.1	219.3	87.6	4.2	-1.6	4.9	9	very stiff fine SOIL	120	2.0	44	44	21	62	40	-	-	28	0.250	2.45	30
19.69	65.6	65.1	180.9	65.6	2.9	-0.9	4.4	4	clayy SILT to silty CLAY	115	2.0	33	33	16	-	-	4.6	9.9	31	0.070	2.50	15
19.85	55.4	57.5	-	55.4	3.3	-0.8	6.0	3	silty CLAY to CLAY	115	1.5	38	37	15	-	-	3.8	9.9	37	0.005	2.64	15
20.01	63.6	65.8	-	63.6	3.8	-0.4	6.1	9	very stiff fine SOIL	120	2.0	33	32	17	53	38	-	-	36	0.250	2.61	30
20.18	80.6	79.4	223.4	80.6	4.3	-0.8	5.4	9	very stiff fine SOIL	120	2.0	40	40	19	59	39	-	-	31	0.250	2.51	30
20.34	81.4	80.0	231.9	81.4	4.6	-0.5	5.7	9	very stiff fine SOIL	120	2.0	40	41	20	60	40	-	-	32	0.250	2.53	30
20.51	95.2	93.3	226.0	95.2	4.5	-0.3	4.8	9	very stiff fine SOIL	120	2.0	47	48	22	65	40	-	-	27	0.250	2.43	30
20.67	116.0	113.4	208.8	116.0	4.0	-0.3	3.5	5	silty SAND to sandy SILT	120	4.0	28	29	25	71	41	-	-	21	0.200	2.26	16
20.83	135.7	132.4	205.0	135.7	3.8	-0.6	2.8	5	silty SAND to sandy SILT	120	4.0	33	34	28	76	42	-	-	17	0.200	2.15	16
21.00	152.5	148.5	197.1	152.5	3.2	-1.0	2.1	5	silty SAND to sandy SILT	120	4.0	37	38	29	80	43	-	-	14	0.200	2.02	16
21.16	156.2	151.7	222.4	156.1	4.3	-1.2	2.8	5	silty SAND to sandy SILT	120	4.0	38	39	31	81	43	-	-	16	0.200	2.11	16
21.33	147.5	142.9	231.6	147.5	4.8	-1.2	3.3	5	silty SAND to sandy SILT	120	4.0	36	37	30	79	43	-	-	18	0.200	2.18	16
21.49	117.9	113.9	263.2	117.8	6.1	-0.2	5.2	9	very stiff fine SOIL	120	2.0	57	59	26	71	41	-	-	26	0.250	2.40	30
21.65	121.7	117.4	299.2	121.7	7.5	1.5	6.2	9	very stiff fine SOIL	120	2.0	59	61	28	72	41	-	-	29	0.250	2.45	30
21.82	145.1	139.6	326.5	145.2	8.8	1.8	6.1	9	very stiff fine SOIL	120	2.0	70	73	32	78	42	-	-	27	0.250	2.41	30
21.98	163.5	156.9	334.2	163.5	9.2	1.7	5.7	9	very stiff fine SOIL	120	2.0	78	82	36	82	43	-	-	25	0.250	2.35	30
22.15	168.0	160.9	336.2	168.0	9.4	1.1	5.6	9	very stiff fine SOIL	120	2.0	80	84	36	83	43	-	-	24	0.250	2.34	30
22.31	158.3	151.2	334.1	158.3	9.2	1.3	5.9	9	very stiff fine SOIL	120	2.0	76	79	35	81	43	-	-	25	0.250	2.37	30
22.47	161.3	153.8	327.6	161.3	9.0	1.5	5.6	9	very stiff fine SOIL	120	2.0	77	81	35	81	43	-	-	25	0.250	2.35	30
22.64	167.5	159.4	310.4	167.6	8.3	1.4	5.0	9	very stiff fine SOIL	120	2.0	80	84	35	82	43	-	-	23	0.250	2.30	30
22.80	191.7	181.9	289.1	191.7	7.2	1.4	3.8	8	stiff SAND to clayy SAND	115	1.0	100	100	38	-	-	12.6	9.9	18	0.250	2.17	16
22.97	218.3	206.7	271.8	218.3	5.8	0.9	2.7	5	silty SAND to sandy SILT	120	4.0	52	55	41	91	44	-	-	13	0.200	2.01	16
23.13	217.8	205.8	261.1	217.8	5.2	0.0	2.4	5	silty SAND to sandy SILT	120	4.0	51	54	40	91	44	-	-	12	0.200	1.97	16
23.30	209.9	197.9	257.5	209.9	5.2	-0.3	2.5	5	silty SAND to sandy SILT	120	4.0	49	52	39	90	44	-	-	13	0.200	2.00	16
23.46	205.8	193.6	260.8	205.8	5.5	-0.3	2.7	5	silty SAND to sandy SILT	120	4.0	48	51	39	89	44	-	-	14	0.200	2.03	16
23.62	215.0	201.8	253.2	215.0	4.9	-0.3	2.3	6	clean SAND to silty SAND	125	5.0	40	43	39	90	44	-	-	12	0.350	1.96	16
23.79	234.6	219.7	277.3	234.6	5.8	-0.4	2.5	5	silty SAND to sandy SILT	120	4.0	55	59	43	93	44	-	-	12	0.200	1.97	16
23.95	245.8	229.7	292.3	245.8	6.4	-0.4	2.6	8	stiff SAND to clayy SAND	115	1.0	100	100	45	-	-	16.2	9.9	12	0.250	1.98	16
24.12	250.7	233.8	322.1	250.7	8.1	-1.0	3.3	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	16.5	9.9	14	0.250	2.05	16
24.28	248.3	231.1	328.2	248.3	8.6	-0.9	3.5	8	stiff SAND to clayy SAND	115	1.0	100	100	47	-	-	16.4	9.9	15	0.250	2.08	16
24.44	203.2	188.8	330.1	203.2	9.3	-0.6	4.6	9	very stiff fine SOIL	120	2.0	94	100	41	88	44	-	-	20	0.250	2.23	30
24.61	165.4	153.3	326.6	165.5	9.2	1.7	5.6	9	very stiff fine SOIL	120	2.0	77	83	35	81	43	-	-	25	0.250	2.35	30
24.77	191.8	177.4	343.0	191.9	10.0	2.8	5.3	9	very stiff fine SOIL	120	2.0	89	96	39	86	43	-	-	22	0.250	2.30	30
24.94	238.0	219.7	339.6	238.1	9.5	1.6	4.0	8	stiff SAND to clayy SAND	115	1.0	100	100	46	-	-	15.7	9.9	17	0.250	2.15	16
25.10	278.6	256.6	353.1	278.6	9.5	0.2	3.4	8	stiff SAND to clayy SAND	115	1.0	100	100	51	-	-	18.4	9.9	14	0.250	2.05	16
25.26	333.6	306.7	385.0	333.6	10.0	-0.7	3.0	8	stiff SAND to clayy SAND	115	1.0	100	100	59	-	-	22.0	9.9	12	0.250	1.96	16
25.43	357.8	328.2	396.2	357.7	9.9	-0.4	2.8	8	stiff SAND to clayy SAND	115	1.0	100	100	63	-	-	23.6	9.9	11	0.250	1.92	16
25.59	367.0	336.1	389.7	367.0	9.0	-0.1	2.5	8	stiff SAND to clayy SAND	115	1.0	100	100	63	-	-	24.2	9.9	10	0.250	1.87	16
25.76	373.6	341.5	386.0	373.6	8.4	0.1	2.3	6	clean SAND to silty SAND	125	5.0	68	75	63	95	46	-	-	9	0.350	1.83	16

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

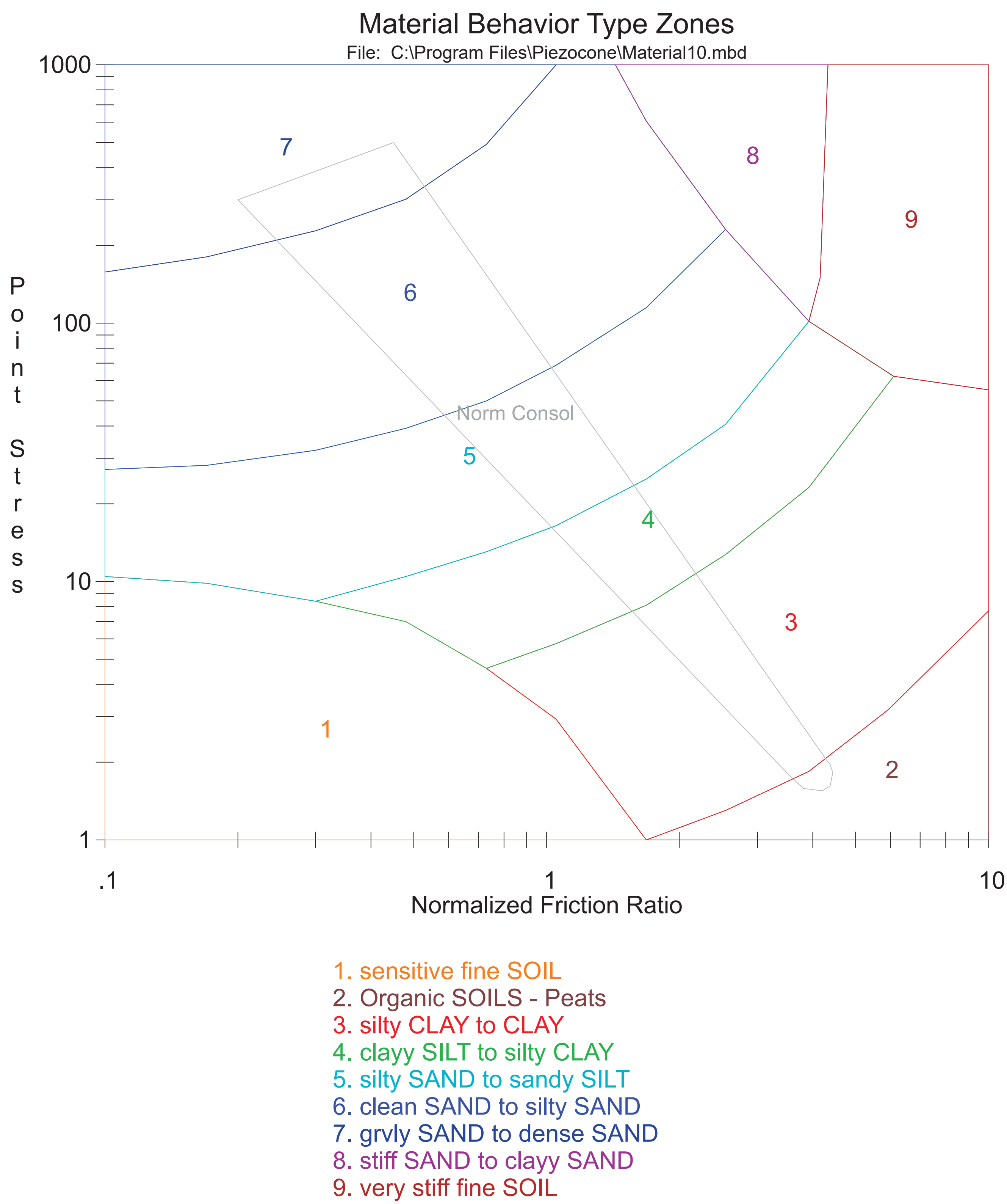
Middle Earth Geo Testing



Hammer to Rod String Distance (ft): 5.83
* = Not Determined

COMMENT:

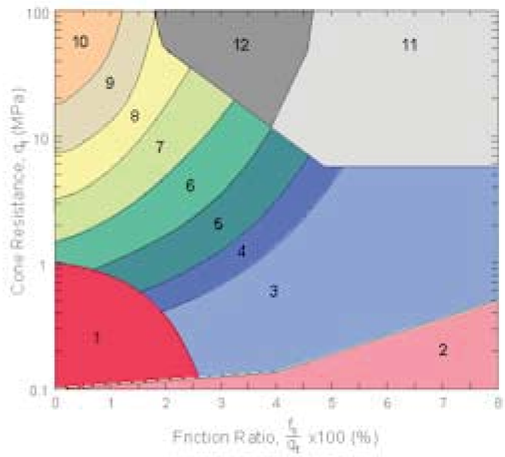
Middle Earth
Geo Testing Inc.

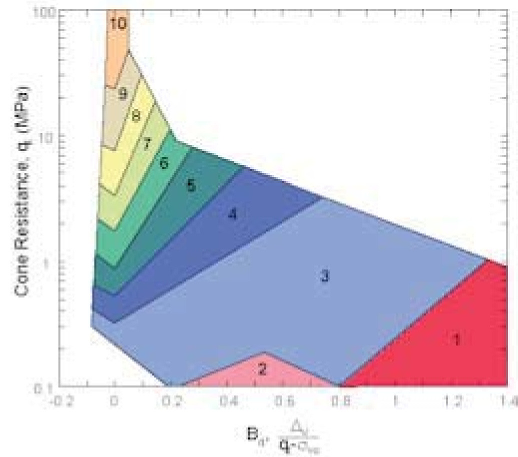


Material Behavior Type Zones
File: C:\Program Files\Piezocone\Material10.mbd
Point Stress
Normalized Friction Ratio
1000
100
10
1
.1
1
10
Norm Consol
1
2
3
4
5
6
7
8
9
1. sensitive fine SOIL
2. Organic SOILS - Peats
3. silty CLAY to CLAY
4. clayy SILT to silty CLAY
5. silty SAND to sandy SILT
6. clean SAND to silty SAND
7. grvly SAND to dense SAND
8. stiff SAND to clayy SAND
9. very stiff fine SOIL

CPT Soil Behavior Type Legend

Robertson et al. 1986

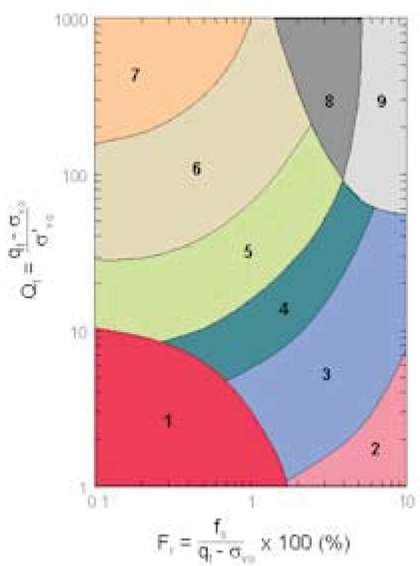


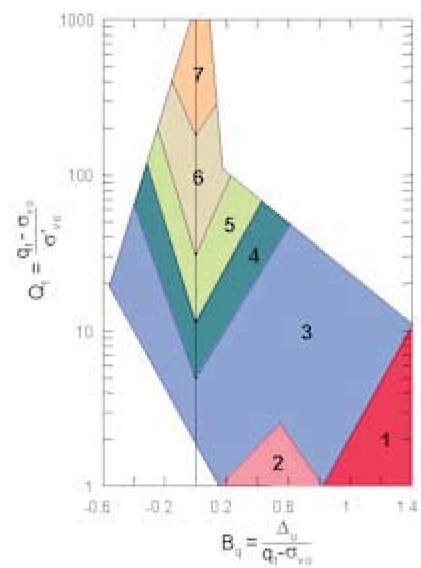


Zone	Soil Behavior Type
1	Sensitive, Fine Grained
2	Organic Material
3	Clay
4	Silty Clay to Clay
5	Clayey Silt to Silty Clay
6	Sandy Silt to Clayey Silt
7	Silty Sand to Sandy Silt
8	Sand to Silty Sand
9	Sand
10	Gravelly Sand to Sand
11	Very Stiff Fine Grained*
12	Sand to Clayey Sand*

*Overconsolidated or Cemented

Robertson et al. 1990





Zone	Soil Behavior Type
1	Sensitive, Fine Grained
2	Organic Soils-Peats
3	Clays; Clay to Silty Clay
4	Silt Mixtures; Clayey Silt to Silty Clay
5	Sand Mixtures; Silty Sand to Sandy Silt
6	Sands; Clean Sands to Silty Sands
7	Gravelly Sand to Sand
8	Very Stiff Sand to Clayey Sand*
9	Very Stiff Fine Grained*

*Overconsolidated or Cemented

APPENDIX B

LABORATORY TEST RESULTS

Atterberg Limits Results
Particle Size Distribution Report
Consolidated Undrained Direct Shear Report (2)
R-Value Test Report
Corrosivity Tests Summary

CONSOLIDATED ENGINEERING LABORATORIES
2001 Crow Canyon Road, Suite 200
San Ramon, CA 94583-5368
Telephone: (925) 314-7100

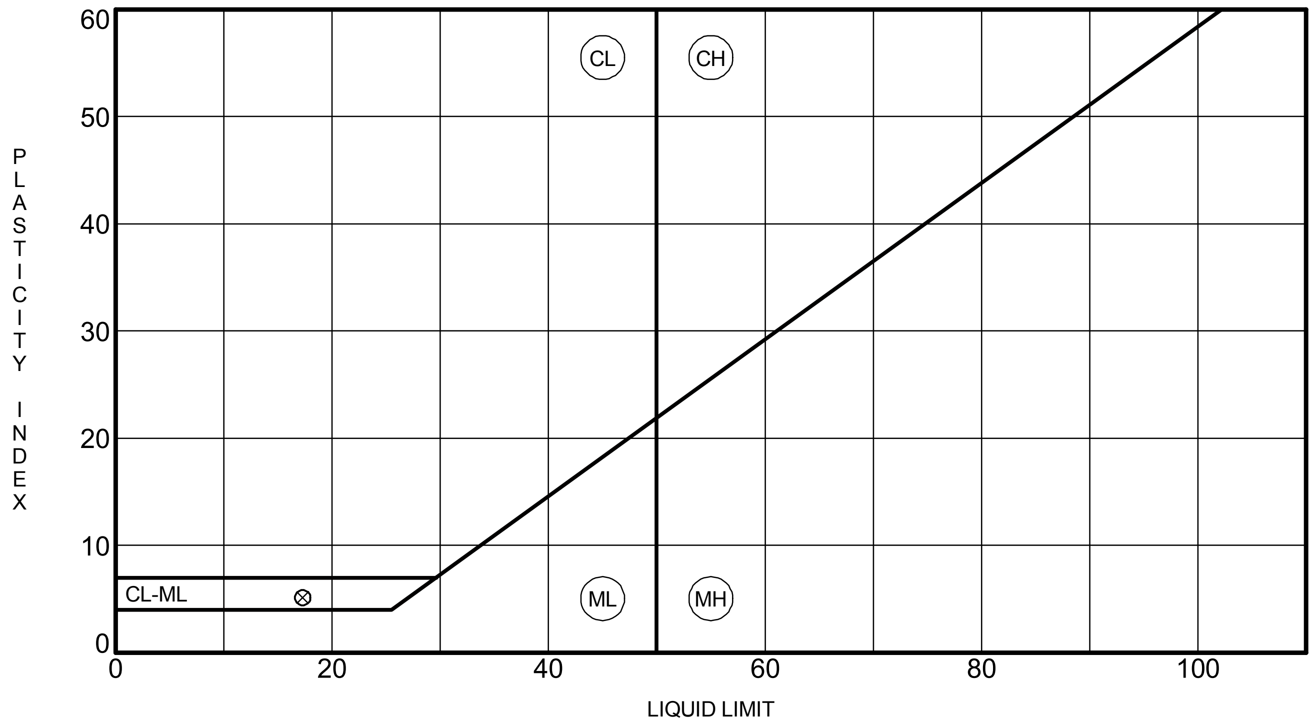
ATTERBERG LIMITS RESULTS

CLIENT Oakland Unified School District

PROJECT NAME Cole Campus - Central Administrative Center

PROJECT NUMBER 84-04726-PWA

PROJECT LOCATION 1011 Union Street Oakland, California 94607



	Specimen Identification		LL	PL	PI	Fines	Classification
⊗	**B-5**	**14.0**	**17**	**12**	**5**	**41**	**SILTY CLAYEY SAND(SC-SM)**

PARTICLE SIZE DISTRIBUTION

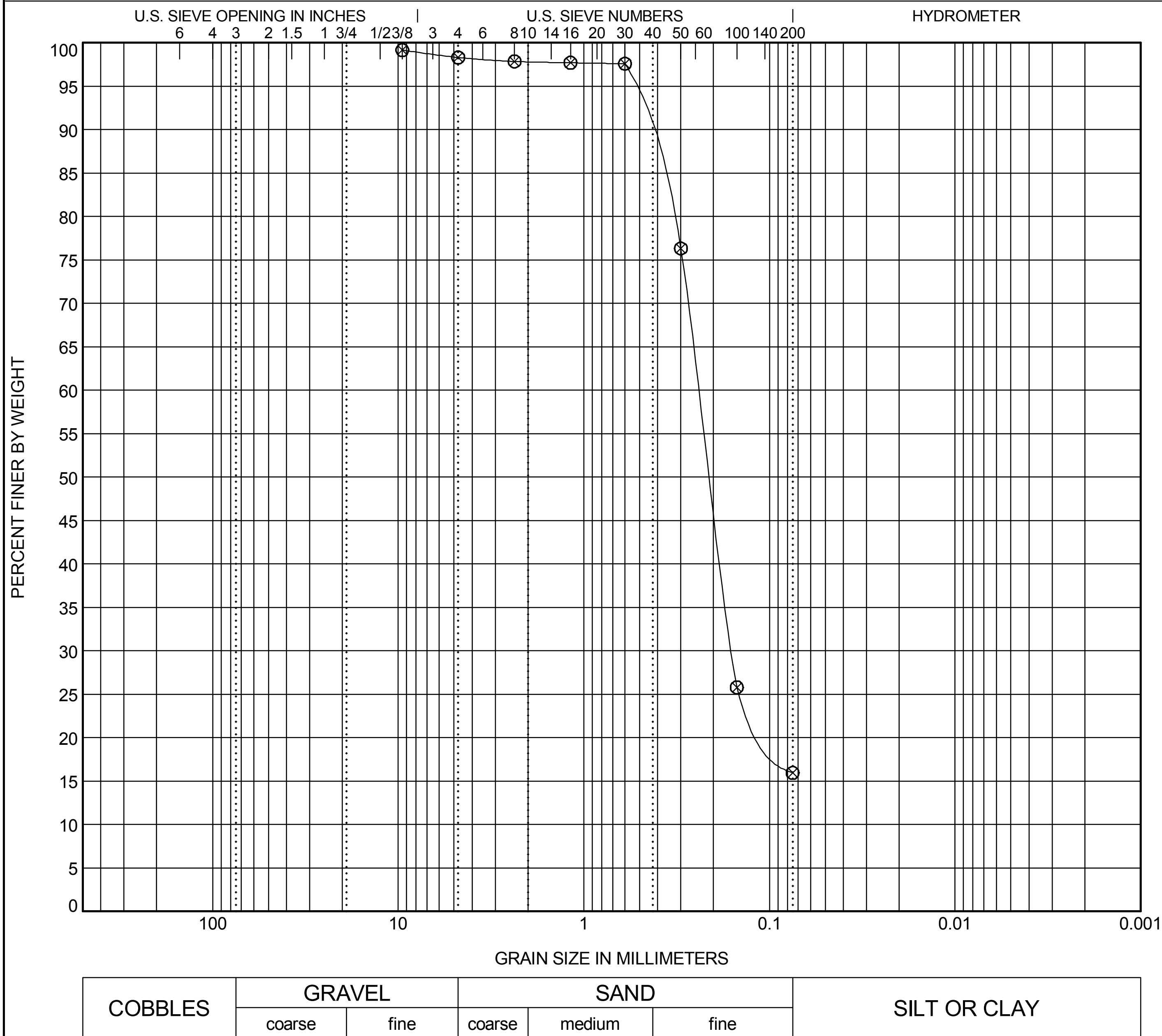
Geosphere Consultants, Inc.
AN ATLAS COMPANY
Geotechnical Engineering · Engineering Geology
Environmental Management · Water Resources

CLIENT Oakland Unified School District

PROJECT NAME Cole Campus - Central Administrative Center

PROJECT NUMBER 84-04726-PWA

PROJECT LOCATION 1011 Union Street Oakland, California 94607



Specimen Identification		Classification	LL	PL	PI	Cc	Cu
⊗ **B-1**	**Depth: 4.5'**	**CLAYEY SAND (SC)**					

Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
⊗ **B-1**	**Depth: 4.5'**	**9.5**	**0.24**	**0.159**		**0.9**	**82.4**	**16.0**	

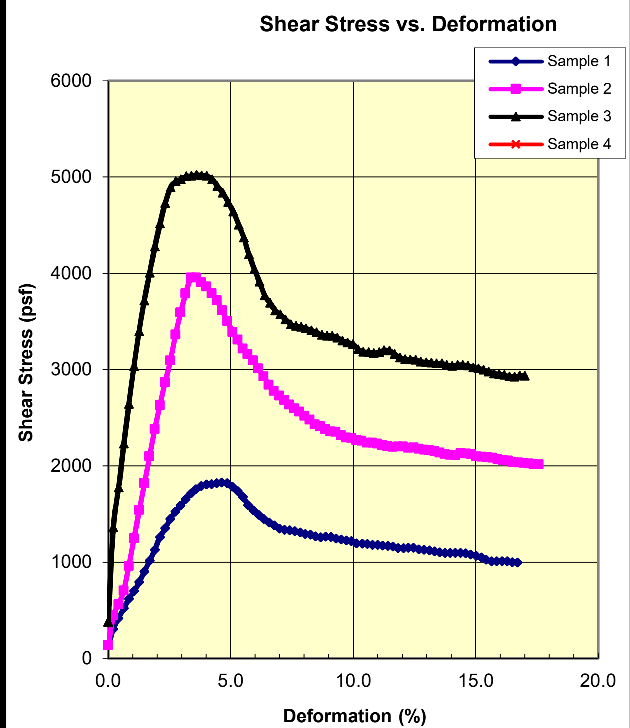
Consolidated Undrained Direct Shear (ASTM D3080M)

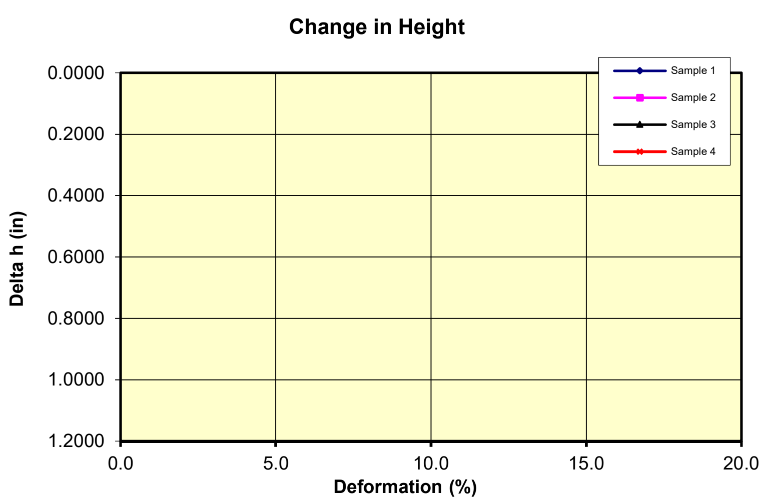
COOPER TESTING LABORATORY

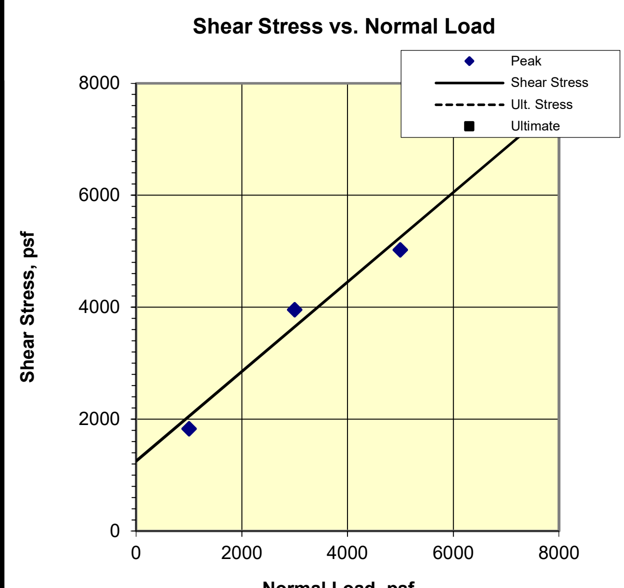
CTL Job #:	291-124	Project #:	84-04726-PWA	By:	MD
Client:	Consolidated Engineering	Date:	11/26/2019	Checked:	PJ
Project Name:	Cole Campus	Remolding Info:			

Phi (deg)	38.7	Ult. Phi (deg)	
Cohesion (psf)	1250	Ult. Cohesion (psf)	

Specimen Data	1	2	3	4
Boring:	1	1	1	
Sample:	1-4	1-4	1-4	
Depth (ft):	7	7	7	
Visual Description:	Yellowish Brown Clayey SAND	Yellowish Brown Clayey SAND	Yellowish Brown Clayey SAND	
Normal Load (psf)	1000	3000	5000	
Dry Mass of Specimen (g)	137.4	140.8	139.4	
Initial Height (in)	1.01	1.00	1.00	
Initial Diameter (in)	2.41	2.41	2.41	
Initial Void Ratio	0.478	0.437	0.443	
Initial Moisture (%)	14.9	14.7	14.2	
Initial Wet Density (pcf)	131.0	134.5	133.4	
Initial Dry Density (pcf)	114.1	117.3	116.8	
Initial Saturation (%)	84.0	90.7	86.4	
ΔHeight Consol (in)	0.0084	0.0258	0.0263	
At Test Void Ratio	0.465	0.400	0.405	
At Test Moisture (%)	15.6	14.6	14.5	
At Test Wet Density (pcf)	132.9	138.0	137.4	
At Test Dry Density (pcf)	115.0	120.4	120.0	
At Test Saturation (%)	90.3	98.6	96.7	
Strain Rate (%/min)	1.1	1.1	1.2	
Strengths Picked at	Peak	Peak	Peak	
Shear Stress (psf)	1828	3955	5022	
ΔHeight (in) at Peak				
Ultimate Stress (psf)				







Remarks: *DS-CU* A fully undrained condition may not be attained in this test. ΔH is not measured during undrained direct shear tests.

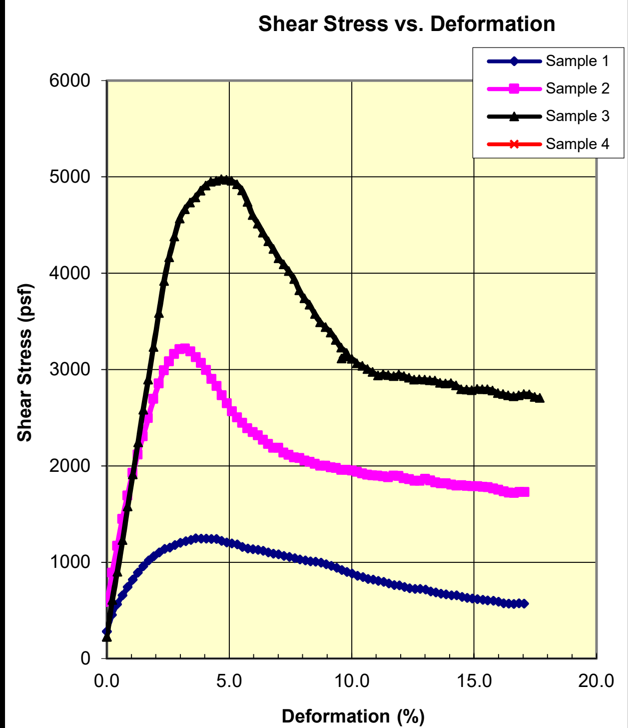
Consolidated Undrained Direct Shear (ASTM D3080M)

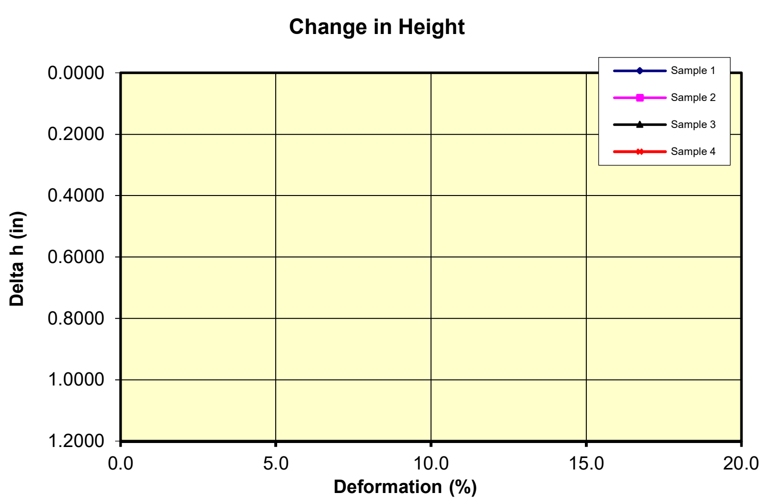
COOPER TESTING LABORATORY

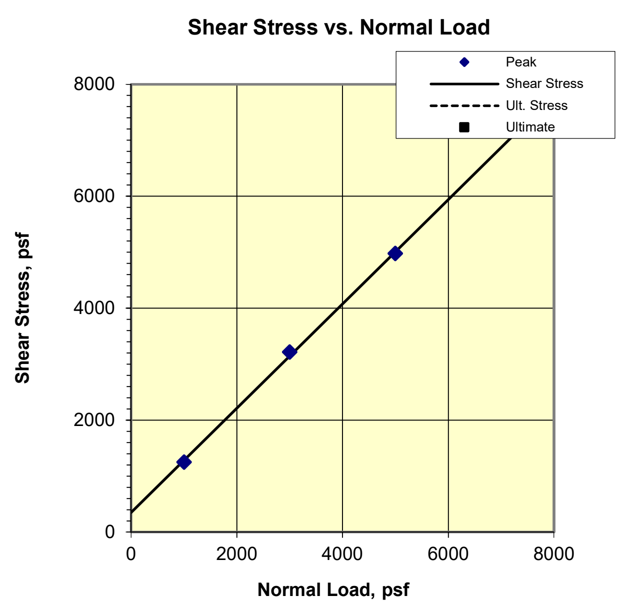
CTL Job #:	291-124	Project #:	84-04726-PWA	By:	MD
Client:	Consolidated Engineering	Date:	11/26/2019	Checked:	PJ
Project Name:	Cole Campus	Remolding Info:			

Phi (deg)	43.0	Ult. Phi (deg)	
Cohesion (psf)	350	Ult. Cohesion (psf)	

Specimen Data	1	2	3	4
Boring:	2	2	2	
Sample:	2-4	2-4	2-4	
Depth (ft):	7	7	7	
Visual Description:	Yellowish Brown Clayey SAND	Yellowish Brown Clayey SAND	Yellowish Brown Clayey SAND	
Normal Load (psf)	1000	3000	5000	
Dry Mass of Specimen (g)	132.5	138.0	139.1	
Initial Height (in)	1.00	1.01	1.00	
Initial Diameter (in)	2.40	2.40	2.40	
Initial Void Ratio	0.508	0.457	0.438	
Initial Moisture (%)	12.7	12.8	13.4	
Initial Wet Density (pcf)	125.9	130.5	132.9	
Initial Dry Density (pcf)	111.8	115.7	117.2	
Initial Saturation (%)	67.3	75.5	82.5	
ΔHeight Consol (in)	0.0147	0.0134	0.0303	
At Test Void Ratio	0.486	0.438	0.394	
At Test Moisture (%)	14.1	13.6	13.7	
At Test Wet Density (pcf)	129.5	133.2	137.5	
At Test Dry Density (pcf)	113.4	117.2	120.9	
At Test Saturation (%)	78.5	83.9	94.0	
Strain Rate (%/min)	1.2	1.2	1.1	
Strengths Picked at	Peak	Peak	Peak	
Shear Stress (psf)	1248	3215	4975	
ΔHeight (in) at Peak				
Ultimate Stress (psf)				

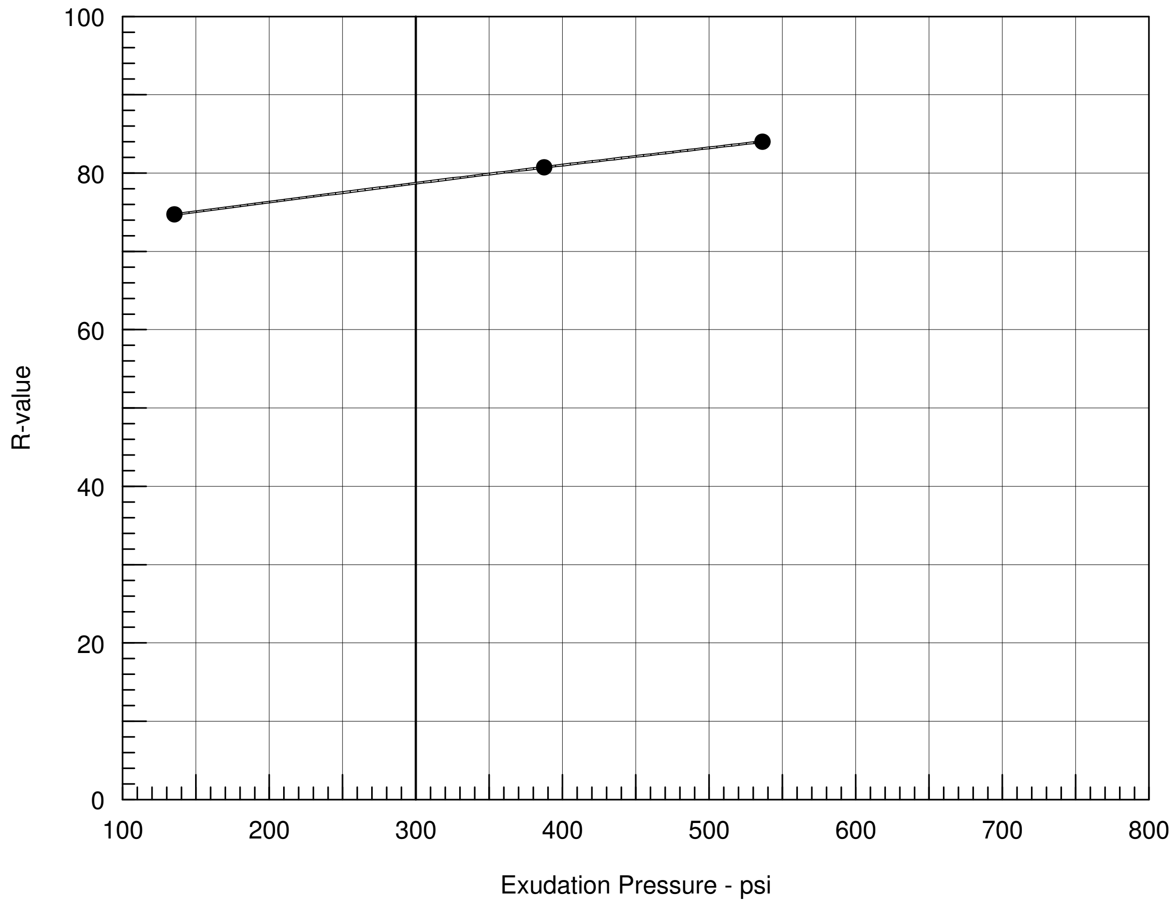






Remarks: *DS-CU* A fully undrained condition may not be attained in this test. ΔH is not measured during undrained direct shear tests.

R-VALUE TEST REPORT



Resistance R-Value and Expansion Pressure - ASTM D2844

No.	Compact. Pressure psi	Density pcf	Moist. %	Expansion Pressure psi	Horizontal Press. psi @ 160 psi	Sample Height in.	Exud. Pressure psi	R Value	R Value Corr.
1	300	118.5	11.1	0.00	31	2.45	135	75	75
2	300	118.7	9.8	0.00	20	2.50	536	84	84
3	300	120.1	10.5	0.00	24	2.45	388	81	81

Test Results	Material Description
R-value at 300 psi exudation pressure = 79	Brown Sand Sampled by A. Knox on 11/9/19

Project No.: 8404726PWA
Project: OUSD - Cole Campus Central Admin Center (GES & GHR)
Location: 1011 Union St. Oakland, CA / Boring 1 0-5'
Sample Number: 10S191127-2
Date: 11/27/2019

Tested by: MT
Checked by: KC
Remarks:

R-VALUE TEST REPORT

CONSOLIDATED ENGINEERING LABORATORIES

Figure 10S191127-2

COOPER TESTING LABORATORY

Corrosivity Tests Summary

CTL # 291-124 **Date:** 11/21/2019 **Tested By:** PJ **Checked:** PJ
Client: Consolidated Engineering **Project:** Cole Campus **Proj. No:** 84-04726-PWA
Remarks:

Sample Location or ID			Resistivity @ 15.5 °C (Ohm-cm)			Chloride	Sulfate		pH	ORP		Sulfide	Moisture	Soil Visual Description
			As Rec.	Min	Sat.	mg/kg	mg/kg	%		(Redox)		Qualitative	At Test	
						Dry Wt.	Dry Wt.	Dry Wt.		E_H (mv)	At Test	by Lead	%	
Boring	Sample, No.	Depth, ft.	ASTM G57	Cal 643	ASTM G57	ASTM D4327	ASTM D4327	ASTM D4327	ASTM G51	ASTM G200	Temp °C	Acetate Paper	ASTM D2216	
2	2-1	0.0-5.0	-	-	23,762	2	47	0.0047	8.1	501	20	Negtaive	6.0	Very Dark Brown Silty SAND

APPENDIX C

SEISMIC SETTLEMENT ANALYSIS RESULT

TABLE OF CONTENTS

LIQUEFACTION ANALYSIS REPORT

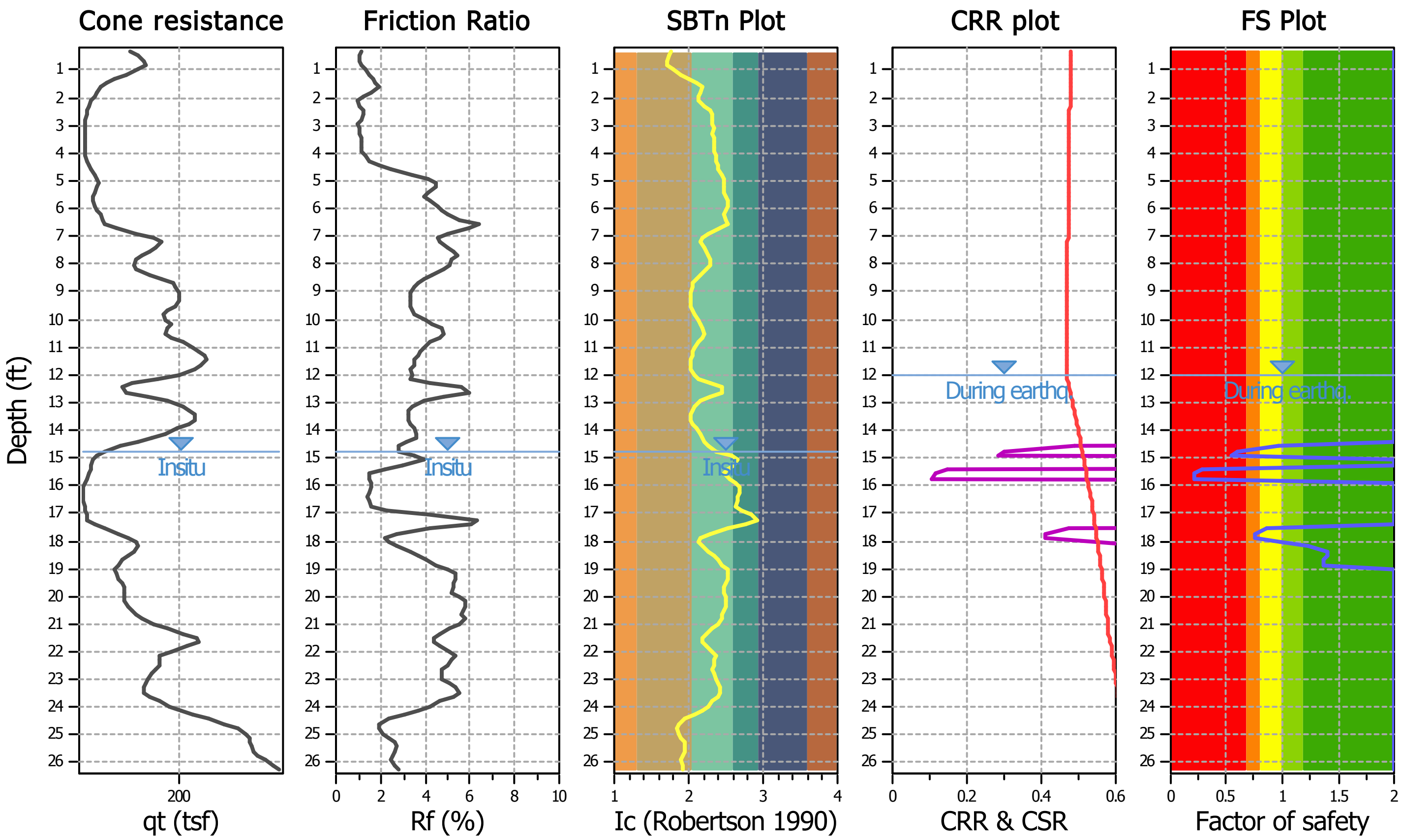
Project title : Cole CampusCole Campus – Central

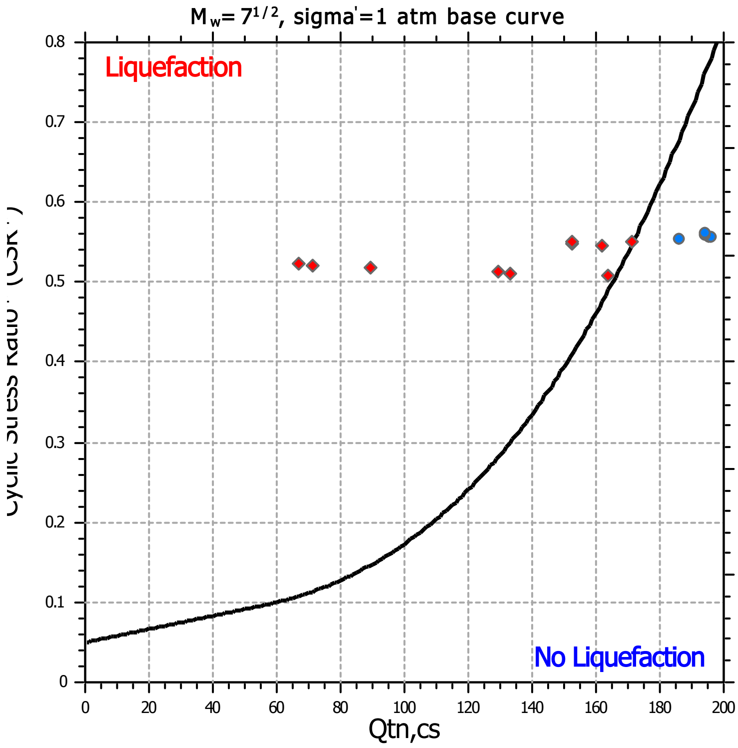
Location : Oakland

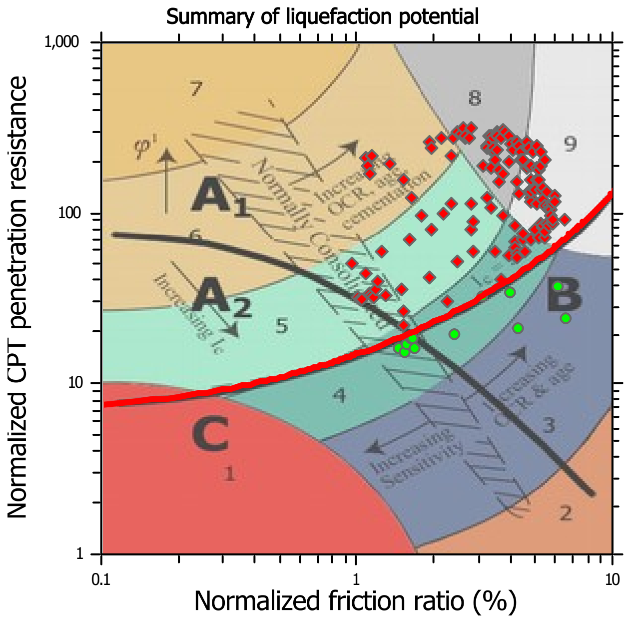
CPT file : CPT-01

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	14.80 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	12.00 ft	Fill height:	N/A	Limit depth applie	No
Points to test:	Based on Ic value	Average results interv	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method basec
Peak ground acceleration:	0.70	Unit weight calculatior	Based on SBT	K_σ applied:	Yes		

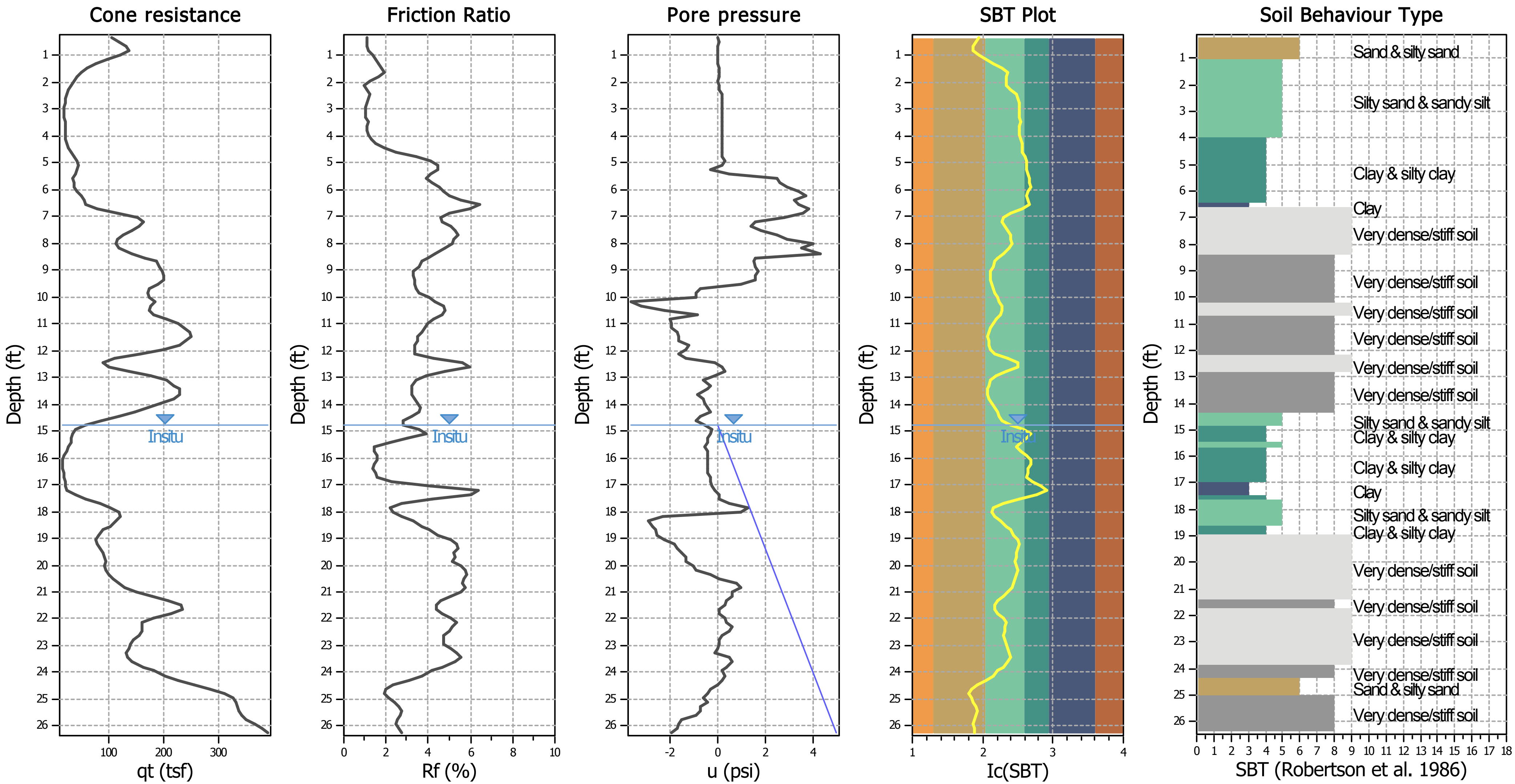






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



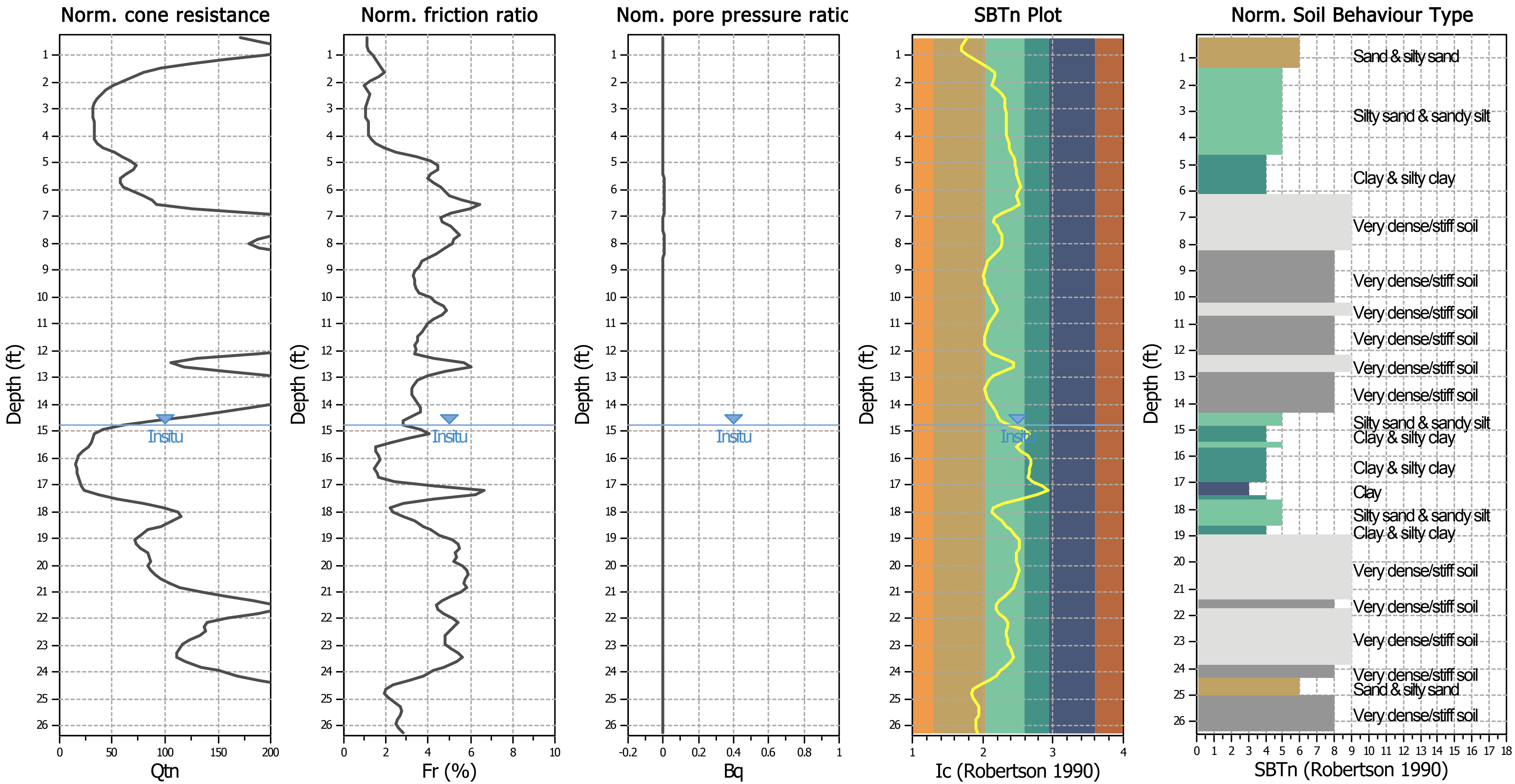
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots (normalized)



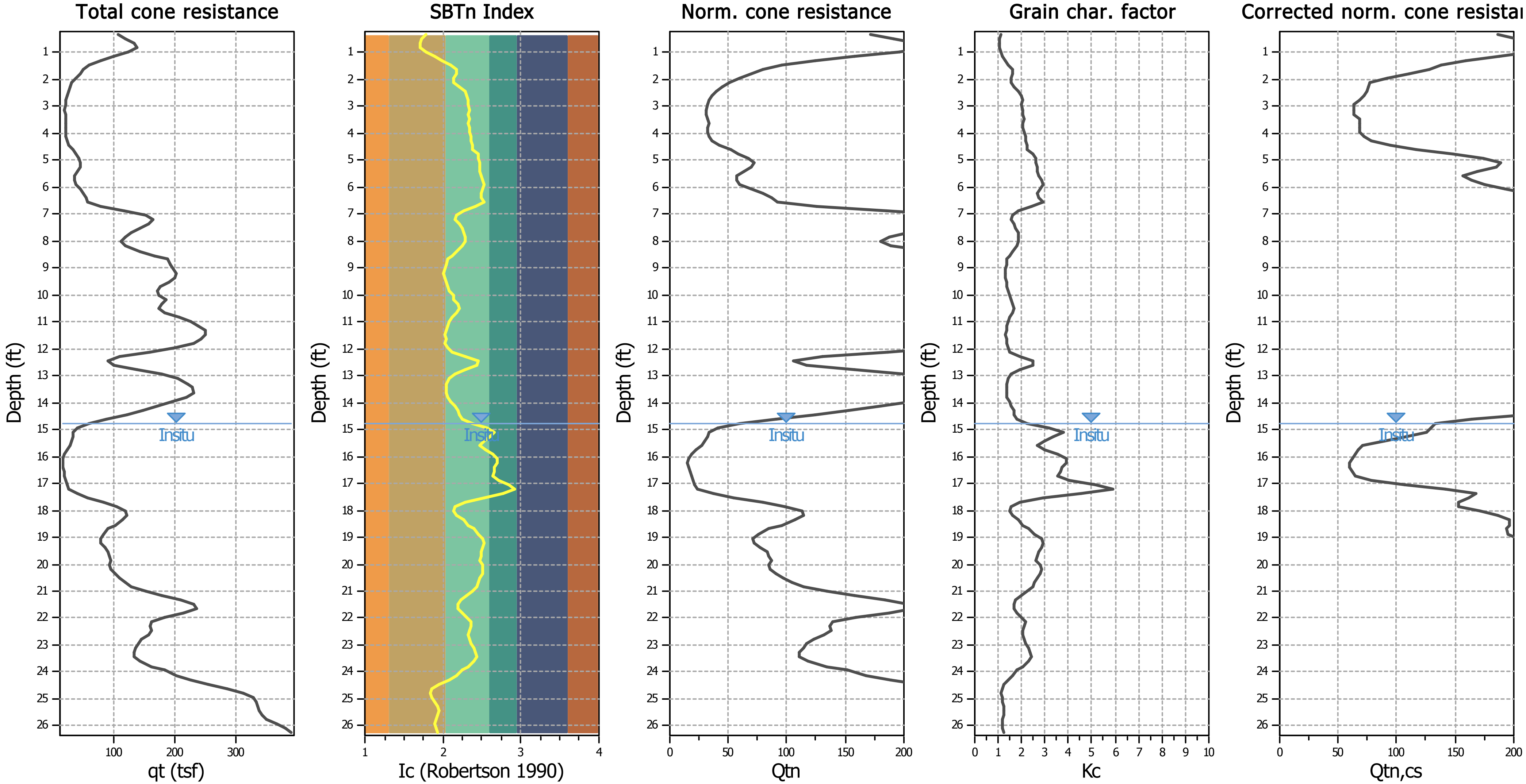
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

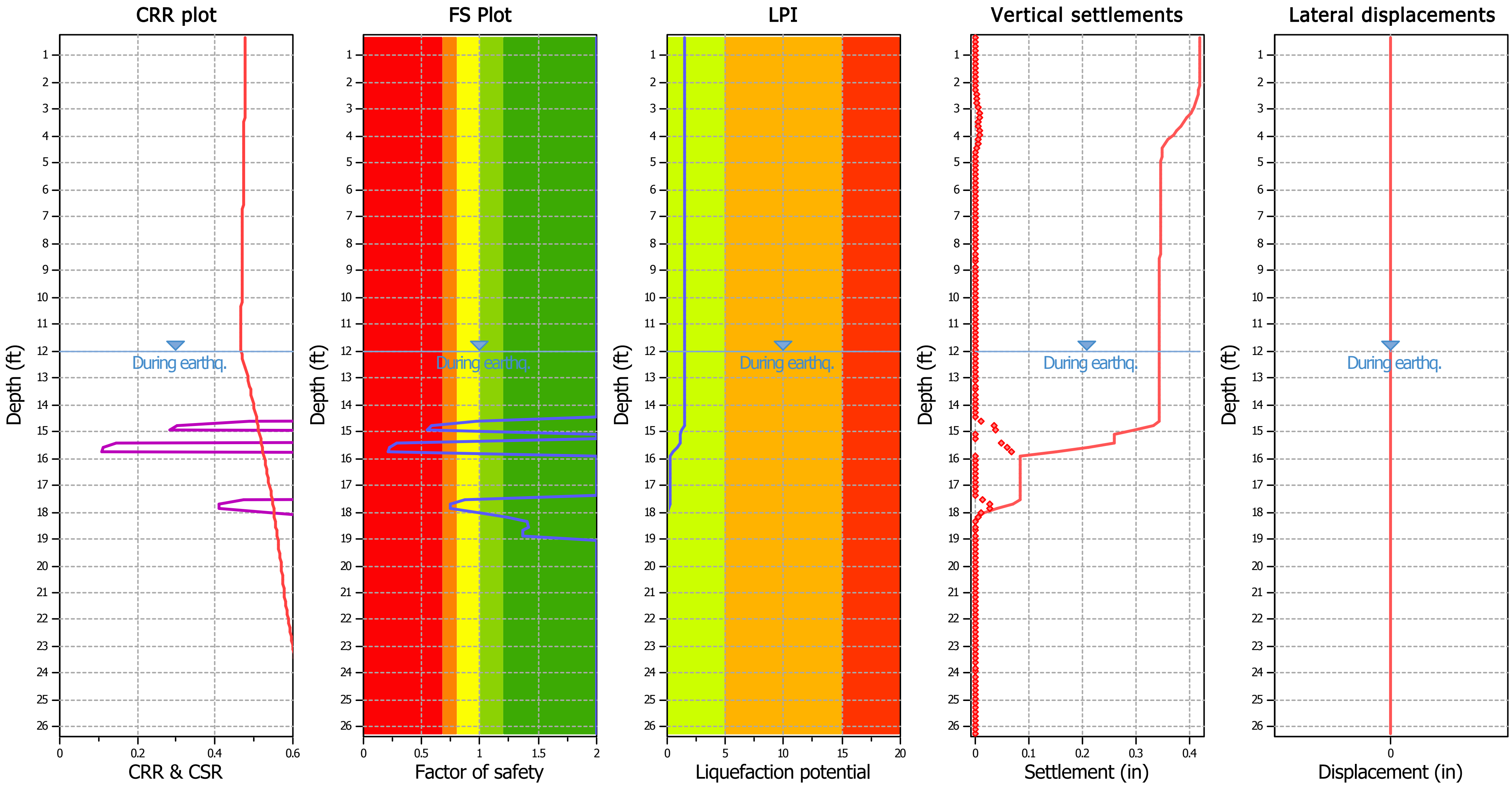
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

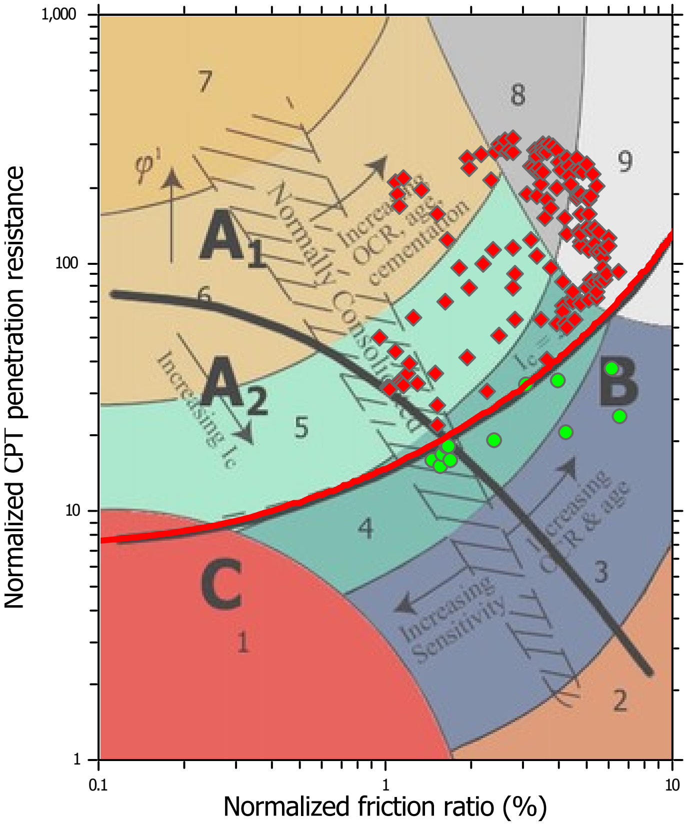
F.S. color scheme

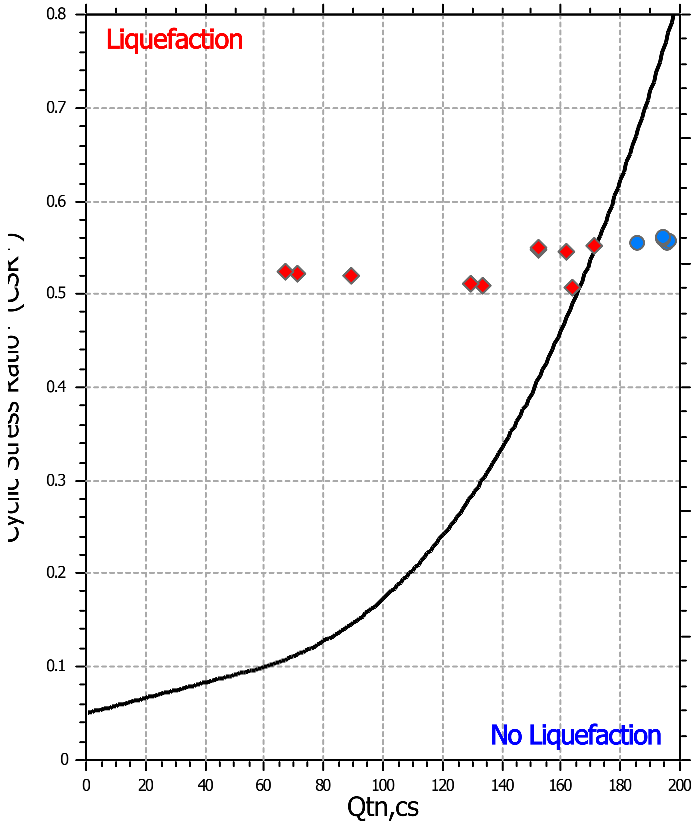
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

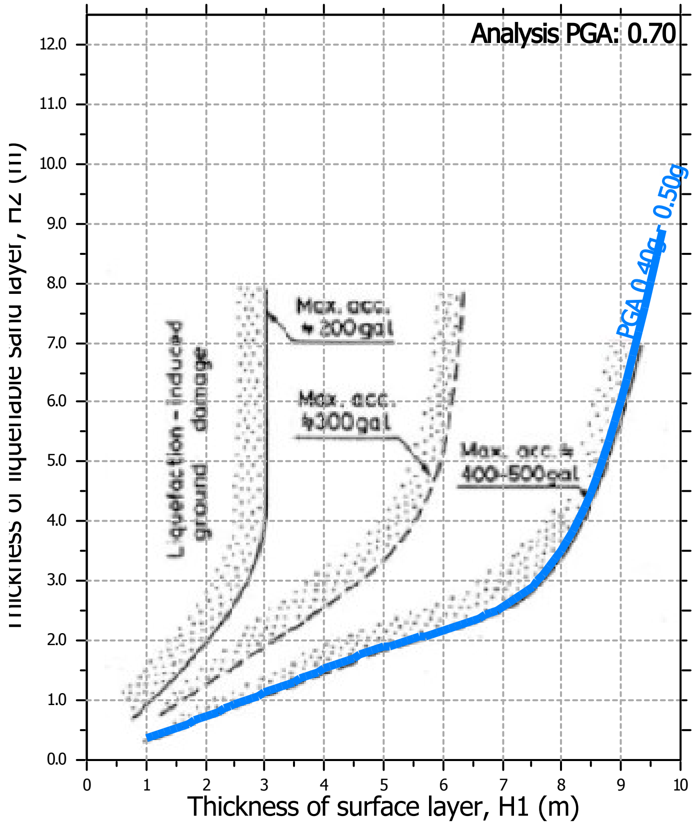
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



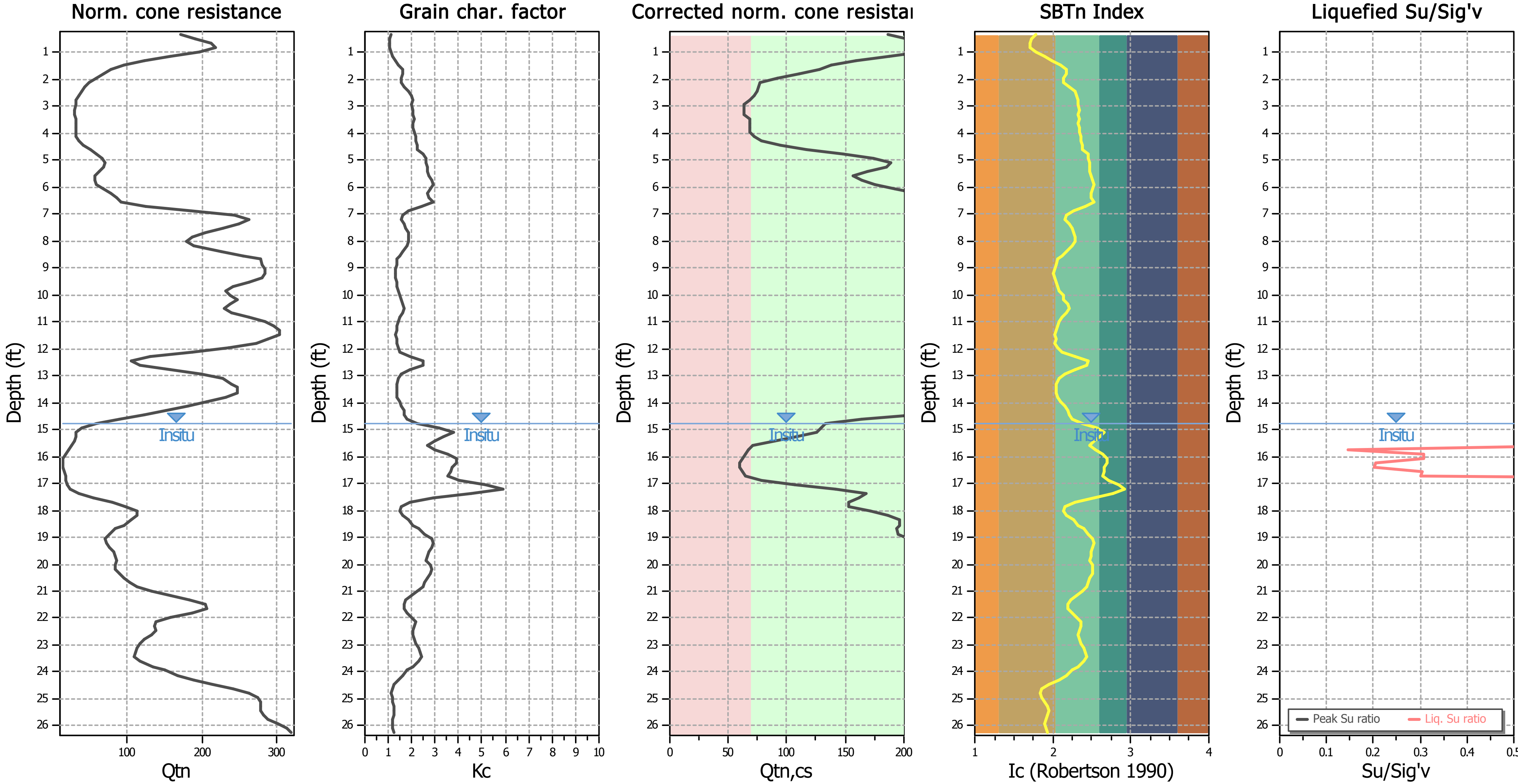




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

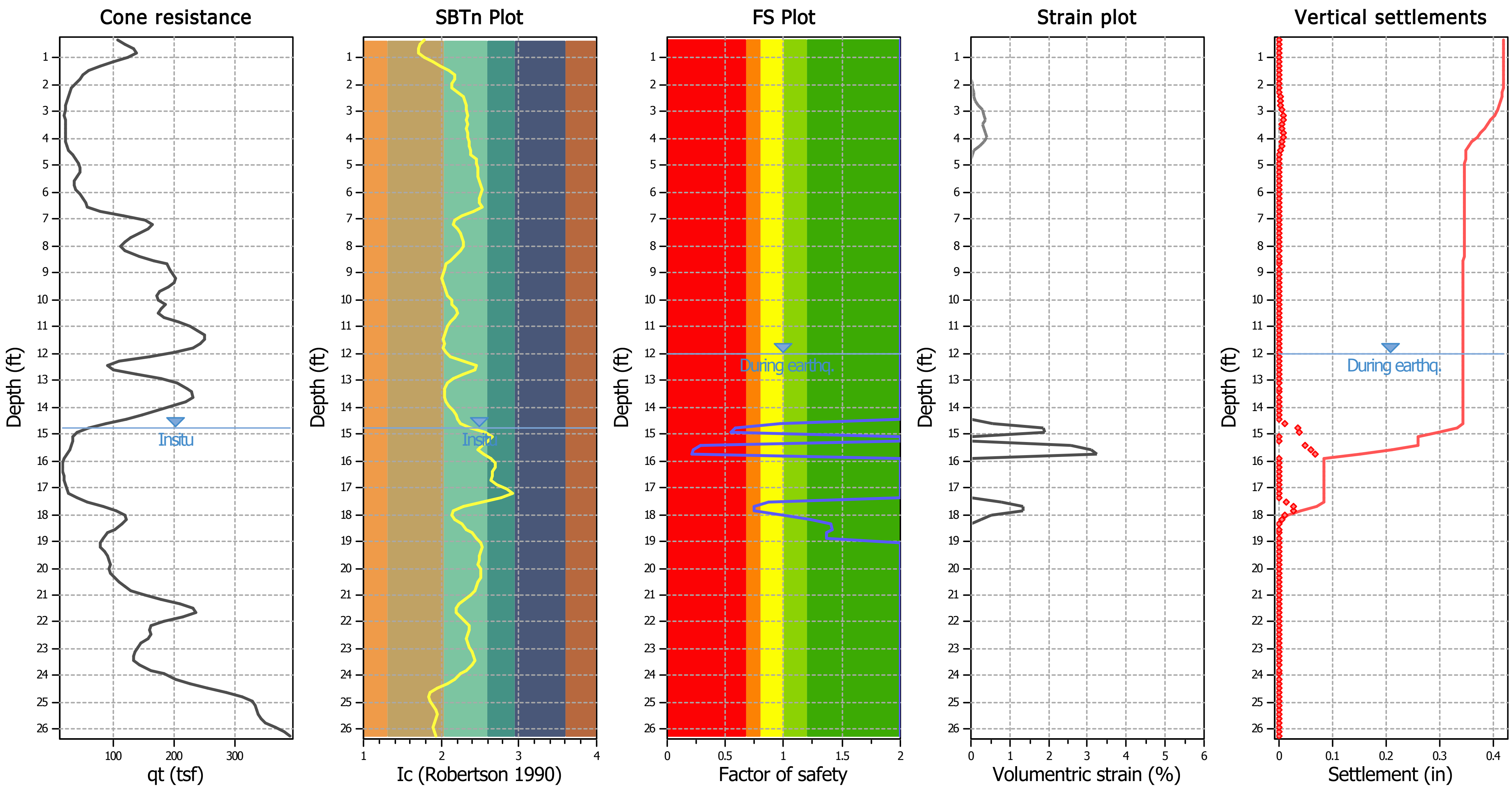
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.80 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t: Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c: Soil Behaviour Type Index
FS: Calculated Factor of Safety against liquefaction
Volumentric strain: Post-liquefaction volumentric strain

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.33	1.77	171.13	1.09	186.20	36	906	0.48	0.001	0.00	10.08	0.00	0.000
0.49	1.73	190.93	1.06	202.24	38	959	0.48	0.002	0.00	10.08	0.00	0.000
0.66	1.70	211.48	1.04	219.50	41	1020	0.48	0.002	0.00	10.08	0.00	0.000
0.82	1.71	218.96	1.04	228.37	43	1066	0.48	0.003	0.00	10.08	0.00	0.000
0.98	1.79	196.18	1.10	215.48	41	1058	0.48	0.003	0.00	10.08	0.00	0.000
1.15	1.89	158.14	1.18	186.98	37	974	0.48	0.004	0.00	10.08	0.00	0.000
1.31	1.99	124.22	1.28	159.51	33	862	0.48	0.006	0.00	10.08	0.00	0.000
1.48	2.10	95.45	1.45	138.20	30	760	0.48	0.008	0.00	10.08	0.00	0.000
1.64	2.18	79.74	1.61	128.52	29	703	0.48	0.010	0.01	10.08	0.01	0.000
1.80	2.17	69.61	1.59	110.39	25	605	0.48	0.015	0.01	10.08	0.01	0.000
1.97	2.14	60.11	1.54	92.43	20	508	0.48	0.025	0.02	10.08	0.02	0.000
2.13	2.14	50.35	1.53	76.86	17	422	0.48	0.048	0.06	10.08	0.05	0.001
2.30	2.22	44.18	1.71	75.44	17	410	0.48	0.062	0.07	10.08	0.06	0.001
2.46	2.28	39.61	1.89	74.99	18	399	0.48	0.077	0.09	10.08	0.08	0.001
2.62	2.31	35.90	1.99	71.45	17	376	0.48	0.112	0.14	10.08	0.11	0.002
2.79	2.32	33.48	2.02	67.74	16	355	0.48	0.165	0.21	10.08	0.18	0.004
2.95	2.32	31.75	2.01	63.80	15	335	0.48	0.249	0.35	10.08	0.29	0.006
3.12	2.33	30.99	2.06	63.81	15	333	0.48	0.293	0.41	10.08	0.34	0.007
3.28	2.33	31.35	2.04	63.80	15	334	0.48	0.327	0.45	10.08	0.38	0.007
3.45	2.35	32.25	2.10	67.79	16	352	0.48	0.282	0.36	10.08	0.30	0.006
3.61	2.33	32.98	2.05	67.76	16	354	0.47	0.306	0.40	10.08	0.33	0.006
3.77	2.33	32.86	2.06	67.76	16	354	0.47	0.343	0.44	10.08	0.37	0.007
3.94	2.34	32.47	2.09	67.78	16	353	0.47	0.389	0.50	10.08	0.42	0.009
4.10	2.36	33.10	2.16	71.58	17	369	0.47	0.339	0.40	10.08	0.34	0.006
4.27	2.37	35.92	2.19	78.54	19	404	0.47	0.240	0.25	10.08	0.21	0.004
4.43	2.38	41.69	2.25	93.85	23	479	0.47	0.124	0.11	10.08	0.09	0.002
4.59	2.39	51.58	2.26	116.76	29	594	0.47	0.062	0.04	10.08	0.03	0.001
4.76	2.45	58.85	2.51	147.80	37	730	0.47	0.037	0.02	10.08	0.01	0.000
4.92	2.46	67.57	2.58	174.34	44	854	0.47	0.028	0.01	10.08	0.01	0.000
5.09	2.47	71.99	2.62	188.41	48	919	0.47	0.025	0.01	10.08	0.01	0.000
5.25	2.48	69.57	2.66	185.35	47	900	0.47	0.027	0.01	10.08	0.01	0.000
5.41	2.48	63.57	2.67	169.54	43	823	0.47	0.035	0.01	10.08	0.01	0.000
5.58	2.50	56.88	2.76	157.08	40	754	0.47	0.045	0.02	10.08	0.02	0.000
5.74	2.52	57.15	2.86	163.39	42	776	0.47	0.044	0.02	10.08	0.02	0.000
5.91	2.53	59.66	2.93	174.92	46	824	0.47	0.040	0.01	10.08	0.01	0.000
6.07	2.50	69.29	2.79	193.00	50	924	0.47	0.032	0.01	10.08	0.01	0.000
6.23	2.48	79.08	2.68	211.62	54	1026	0.47	0.027	0.01	10.08	0.01	0.000
6.40	2.49	87.25	2.73	237.86	61	1147	0.47	0.023	0.01	10.08	0.01	0.000
6.56	2.53	91.84	2.92	268.16	70	1266	0.47	0.020	0.00	10.08	0.00	0.000
6.73	2.42	125.78	2.40	301.67	75	1511	0.47	0.016	0.00	10.08	0.00	0.000
6.89	2.27	184.51	1.85	341.97	79	1829	0.47	0.013	0.00	10.08	0.00	0.000
7.05	2.17	243.01	1.60	389.69	87	2134	0.47	0.011	0.00	10.08	0.00	0.000
7.22	2.16	263.11	1.58	414.61	92	2274	0.47	0.010	0.00	10.08	0.00	0.000
7.38	2.20	249.27	1.67	416.97	94	2271	0.47	0.010	0.00	10.08	0.00	0.000
7.55	2.24	227.19	1.77	401.74	92	2169	0.47	0.011	0.00	10.08	0.00	0.000
7.71	2.28	204.11	1.87	381.91	89	2039	0.47	0.013	0.00	10.08	0.00	0.000
7.87	2.28	187.56	1.88	352.56	82	1880	0.47	0.014	0.00	10.08	0.00	0.000
8.04	2.28	179.51	1.89	339.29	79	1807	0.47	0.016	0.00	10.08	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
8.20	2.25	188.40	1.79	336.61	77	1814	0.47	0.016	0.00	10.08	0.00	0.000
8.37	2.17	225.32	1.59	359.11	80	1997	0.47	0.014	0.00	10.08	0.00	0.000
8.53	2.11	254.34	1.47	374.94	82	2159	0.47	0.013	0.00	10.08	0.00	0.000
8.69	2.06	278.51	1.39	385.88	82	2278	0.47	0.013	0.00	10.08	0.00	0.000
8.86	2.05	279.95	1.36	382.04	81	2292	0.47	0.013	0.00	10.08	0.00	0.000
9.02	2.02	283.44	1.32	375.28	79	2285	0.47	0.013	0.00	10.08	0.00	0.000
9.19	2.02	283.08	1.32	373.72	78	2307	0.47	0.013	0.00	10.08	0.00	0.000
9.35	2.03	279.00	1.33	372.44	78	2327	0.47	0.013	0.00	10.08	0.00	0.000
9.51	2.04	262.80	1.35	354.99	75	2244	0.47	0.014	0.00	10.08	0.00	0.000
9.68	2.07	240.49	1.39	335.44	72	2143	0.47	0.016	0.00	10.08	0.00	0.000
9.84	2.09	232.40	1.43	332.68	72	2145	0.47	0.016	0.00	10.08	0.00	0.000
10.01	2.13	236.79	1.52	359.43	79	2325	0.47	0.015	0.00	10.08	0.00	0.000
10.17	2.15	247.88	1.54	382.59	84	2496	0.47	0.014	0.00	10.08	0.00	0.000
10.34	2.19	237.70	1.64	388.84	87	2535	0.47	0.014	0.00	10.08	0.00	0.000
10.50	2.20	230.50	1.68	386.18	87	2533	0.47	0.014	0.00	10.08	0.00	0.000
10.66	2.18	239.04	1.62	387.24	87	2592	0.47	0.014	0.00	10.08	0.00	0.000
10.83	2.13	262.92	1.50	395.41	86	2719	0.47	0.013	0.00	10.08	0.00	0.000
10.99	2.08	284.08	1.42	404.22	87	2830	0.47	0.013	0.00	10.08	0.00	0.000
11.16	2.06	295.27	1.39	409.73	87	2905	0.47	0.013	0.00	10.08	0.00	0.000
11.32	2.04	303.73	1.36	413.25	87	2961	0.47	0.013	0.00	10.08	0.00	0.000
11.48	2.02	302.09	1.33	402.82	85	2914	0.47	0.013	0.00	10.08	0.00	0.000
11.65	2.04	288.37	1.35	389.11	82	2845	0.47	0.014	0.00	10.08	0.00	0.000
11.81	2.03	271.70	1.35	365.65	77	2700	0.47	0.015	0.00	10.08	0.00	0.000
11.98	2.07	234.66	1.40	328.13	70	2448	0.47	0.017	0.00	10.08	0.00	0.000

Total estimated settlement: 0.08

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.14	278.09	2.00	0.00	1.00	0.00	12.30	251.21	2.00	0.00	1.00	0.00
12.47	265.73	2.00	0.00	1.00	0.00	12.63	291.30	2.00	0.00	1.00	0.00
12.80	302.27	2.00	0.00	1.00	0.00	12.96	314.01	2.00	0.00	1.00	0.00
13.12	322.81	2.00	0.00	1.00	0.00	13.29	327.95	2.00	0.00	1.00	0.00
13.45	333.59	2.00	0.00	1.00	0.00	13.62	333.59	2.00	0.00	1.00	0.00
13.78	323.92	2.00	0.00	1.00	0.00	13.94	303.97	2.00	0.00	1.00	0.00
14.11	282.10	2.00	0.00	1.00	0.00	14.27	252.13	2.00	0.00	1.00	0.00
14.44	209.71	2.00	0.00	1.00	0.00	14.60	163.96	0.97	0.56	1.00	0.01
14.76	133.35	0.59	1.85	1.00	0.04	14.93	129.65	0.55	1.89	1.00	0.04
15.09	126.07	2.00	0.00	1.00	0.00	15.26	107.83	2.00	0.00	1.00	0.00
15.42	89.53	0.28	2.56	1.00	0.05	15.58	71.11	0.22	3.09	1.00	0.06

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
15.75	66.84	0.21	3.25	1.00	0.07	15.91	65.16	2.00	0.00	1.00	0.00
16.08	62.72	2.00	0.00	1.00	0.00	16.24	59.47	2.00	0.00	1.00	0.00
16.40	59.09	2.00	0.00	1.00	0.00	16.57	62.08	2.00	0.00	1.00	0.00
16.73	64.70	2.00	0.00	1.00	0.00	16.90	78.44	2.00	0.00	1.00	0.00
17.06	106.97	2.00	0.00	1.00	0.00	17.23	141.85	2.00	0.00	1.00	0.00
17.39	167.72	2.00	0.00	1.00	0.00	17.55	161.67	0.87	0.77	1.00	0.01
17.72	152.57	0.75	1.35	1.00	0.03	17.88	152.62	0.75	1.35	1.00	0.03
18.05	171.02	0.99	0.54	1.00	0.01	18.21	186.23	1.23	0.26	1.00	0.01
18.37	195.78	1.40	0.00	1.00	0.00	18.54	196.42	1.41	0.00	1.00	0.00
18.70	194.40	1.37	0.00	1.00	0.00	18.87	194.66	1.37	0.00	1.00	0.00
19.03	203.20	2.00	0.00	1.00	0.00	19.19	212.61	2.00	0.00	1.00	0.00
19.36	220.63	2.00	0.00	1.00	0.00	19.52	224.17	2.00	0.00	1.00	0.00
19.69	227.86	2.00	0.00	1.00	0.00	19.85	226.78	2.00	0.00	1.00	0.00
20.01	234.34	2.00	0.00	1.00	0.00	20.18	242.52	2.00	0.00	1.00	0.00
20.34	250.39	2.00	0.00	1.00	0.00	20.51	255.04	2.00	0.00	1.00	0.00
20.67	264.43	2.00	0.00	1.00	0.00	20.83	282.09	2.00	0.00	1.00	0.00
21.00	299.23	2.00	0.00	1.00	0.00	21.16	312.57	2.00	0.00	1.00	0.00
21.33	325.28	2.00	0.00	1.00	0.00	21.49	338.15	2.00	0.00	1.00	0.00
21.65	342.31	2.00	0.00	1.00	0.00	21.82	331.73	2.00	0.00	1.00	0.00
21.98	313.60	2.00	0.00	1.00	0.00	22.15	299.97	2.00	0.00	1.00	0.00
22.31	291.58	2.00	0.00	1.00	0.00	22.47	285.91	2.00	0.00	1.00	0.00
22.64	270.33	2.00	0.00	1.00	0.00	22.80	258.97	2.00	0.00	1.00	0.00
22.97	251.91	2.00	0.00	1.00	0.00	23.13	259.16	2.00	0.00	1.00	0.00
23.30	264.99	2.00	0.00	1.00	0.00	23.46	269.70	2.00	0.00	1.00	0.00
23.62	271.72	2.00	0.00	1.00	0.00	23.79	271.76	2.00	0.00	1.00	0.00
23.95	273.04	2.00	0.00	1.00	0.00	24.12	273.23	2.00	0.00	1.00	0.00
24.28	269.66	2.00	0.00	1.00	0.00	24.44	266.95	2.00	0.00	1.00	0.00
24.61	278.12	2.00	0.00	1.00	0.00	24.77	297.88	2.00	0.00	1.00	0.00
24.94	317.69	2.00	0.00	1.00	0.00	25.10	330.33	2.00	0.00	1.00	0.00
25.26	339.86	2.00	0.00	1.00	0.00	25.43	345.38	2.00	0.00	1.00	0.00
25.59	346.18	2.00	0.00	1.00	0.00	25.76	346.54	2.00	0.00	1.00	0.00
25.92	355.92	2.00	0.00	1.00	0.00	26.08	373.10	2.00	0.00	1.00	0.00
26.25	386.53	2.00	0.00	1.00	0.00						

Total estimated settlement: 0.34

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

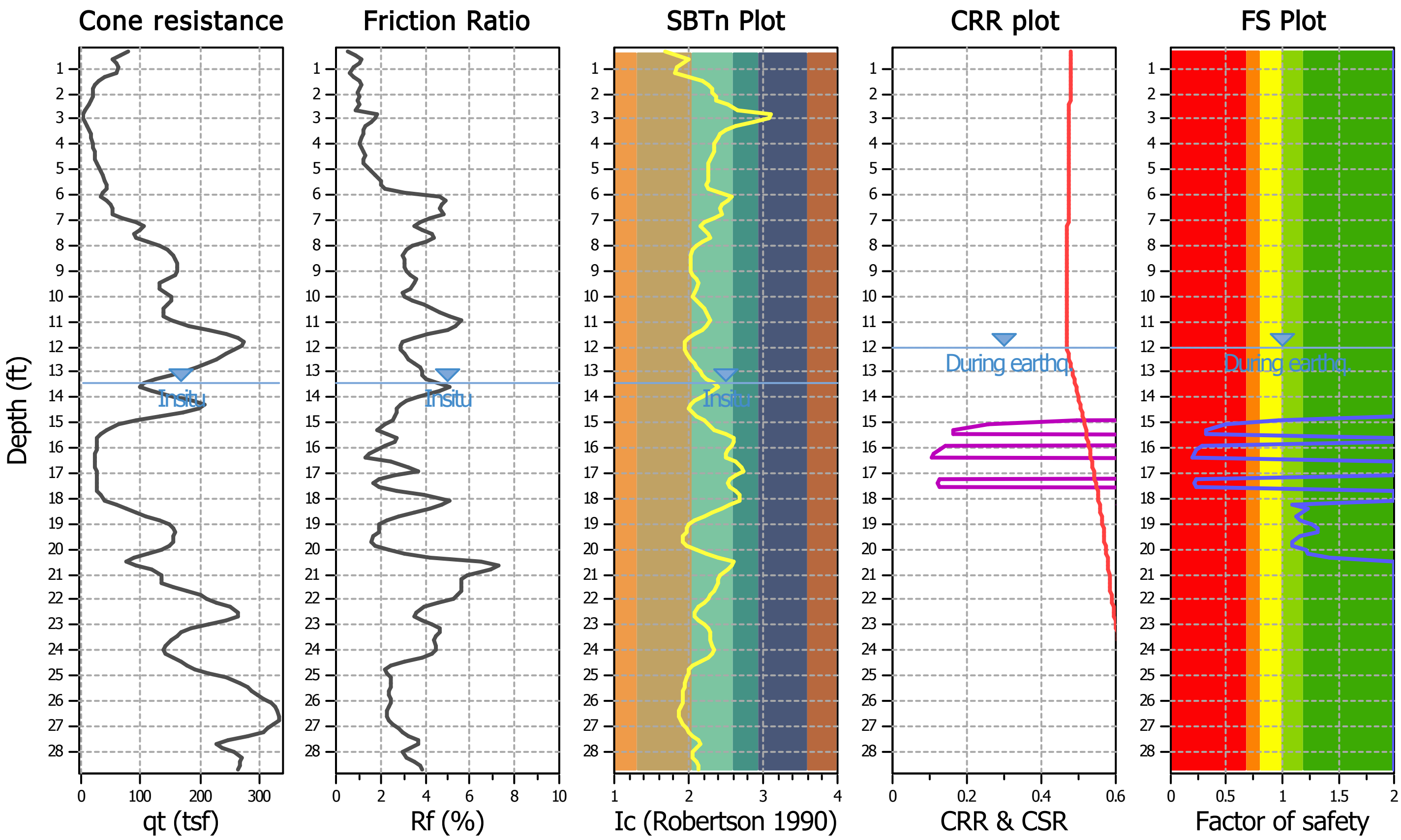
LIQUEFACTION ANALYSIS REPORT

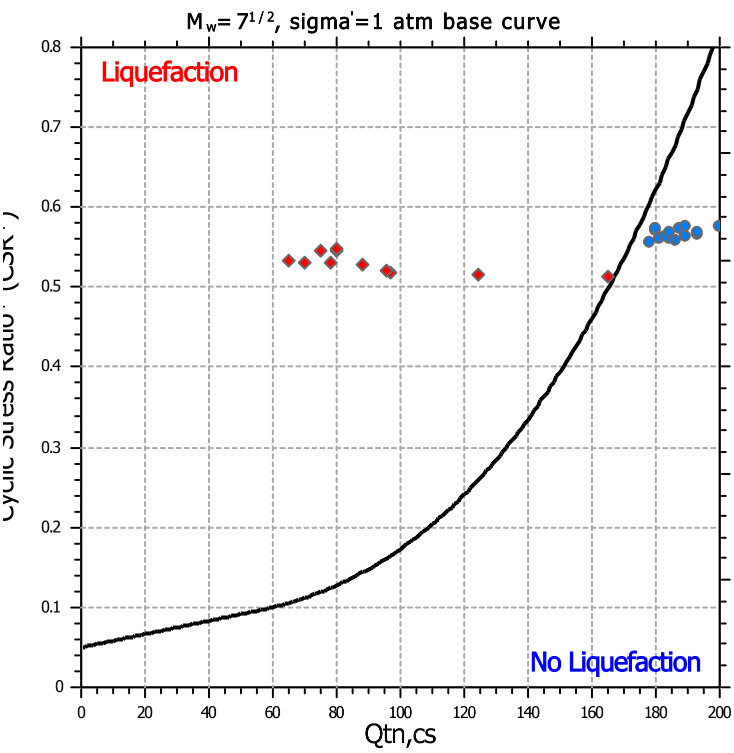
Project title : Cole CampusCole Campus – Central
CPT file : CPT-02

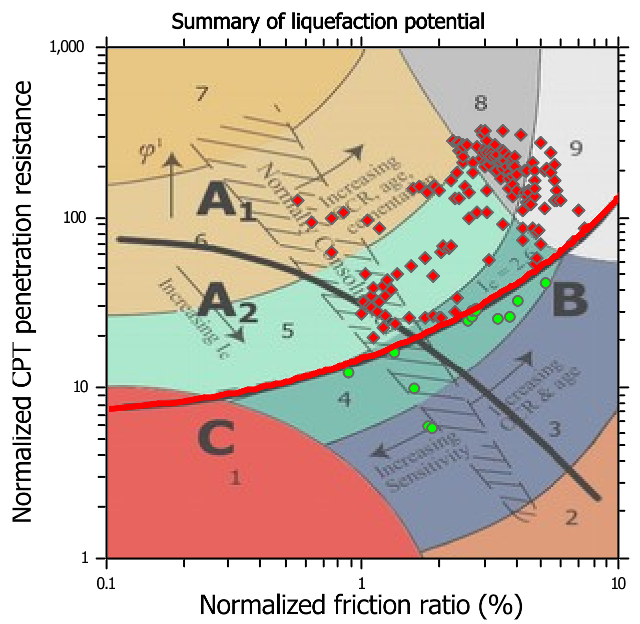
Location : Oakland

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	13.40 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	12.00 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:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.70	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

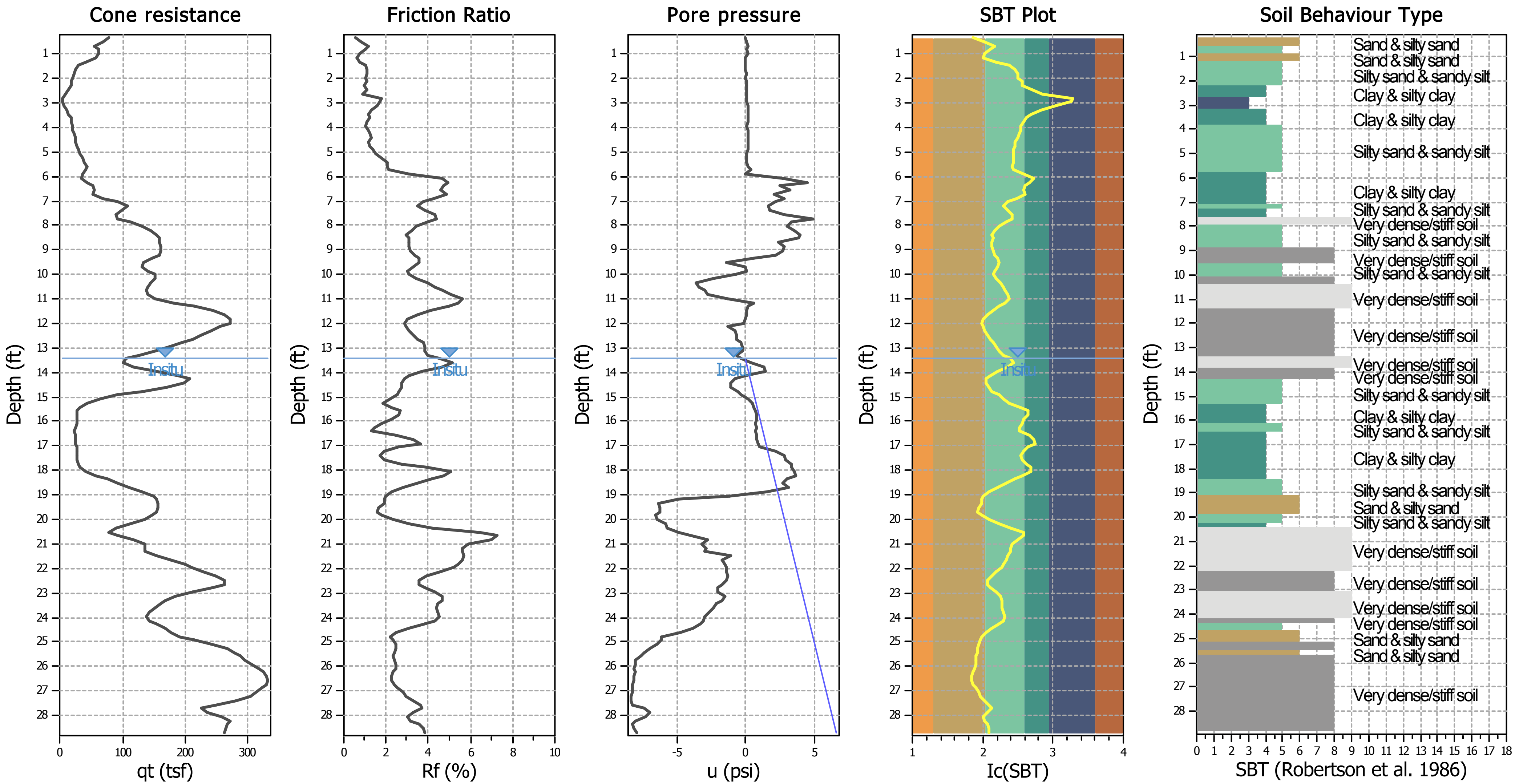






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



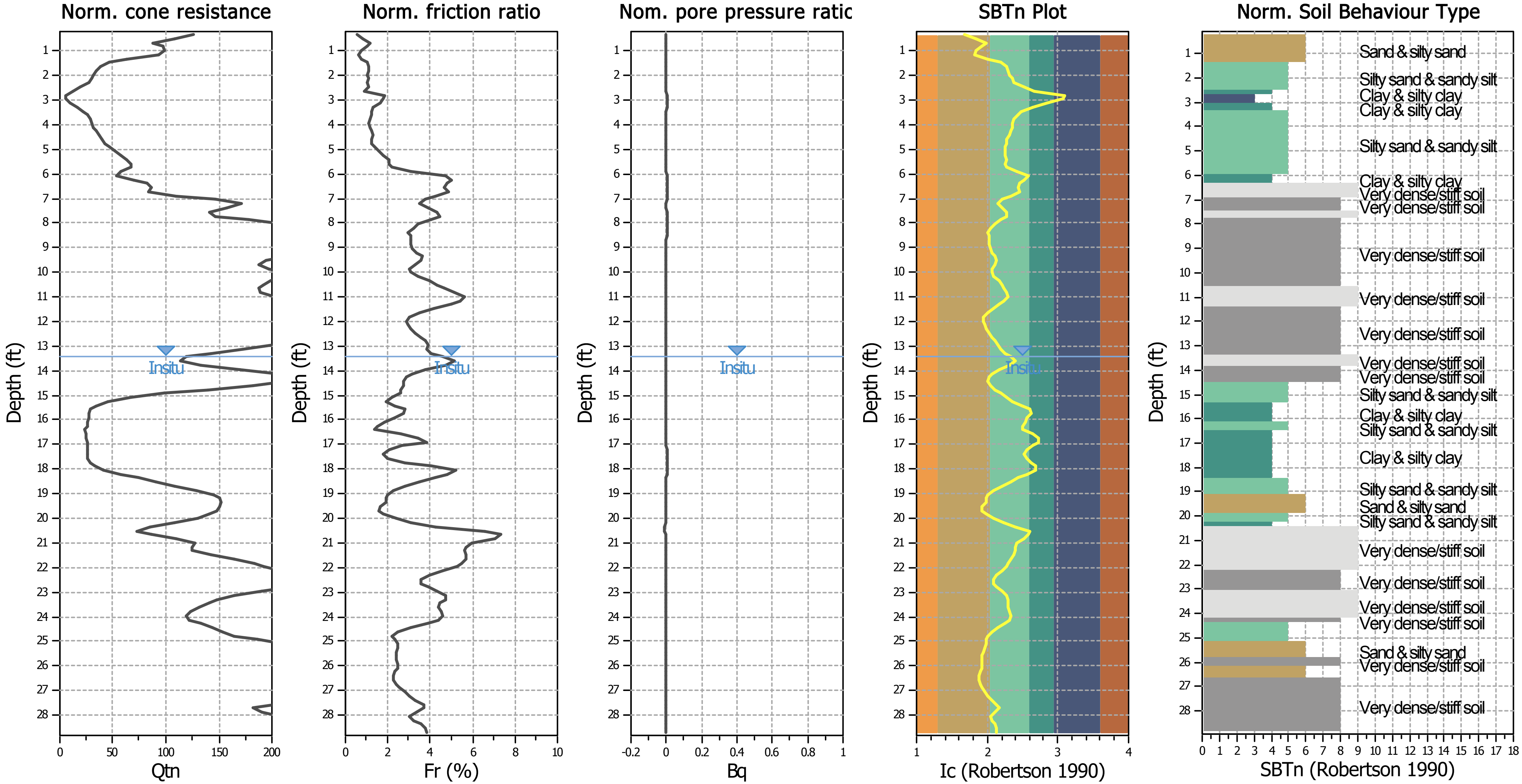
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

CPT basic interpretation plots (normalized)



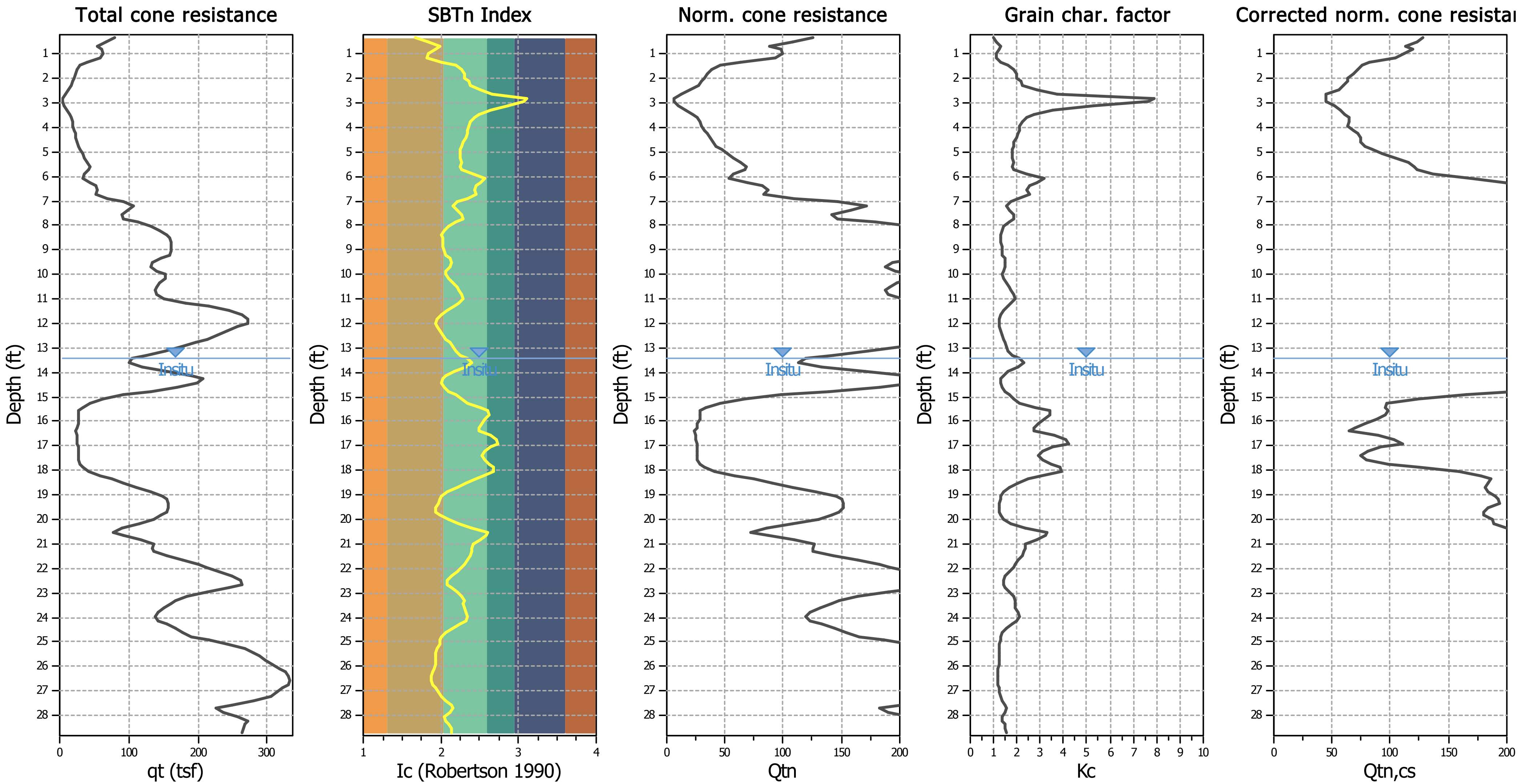
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

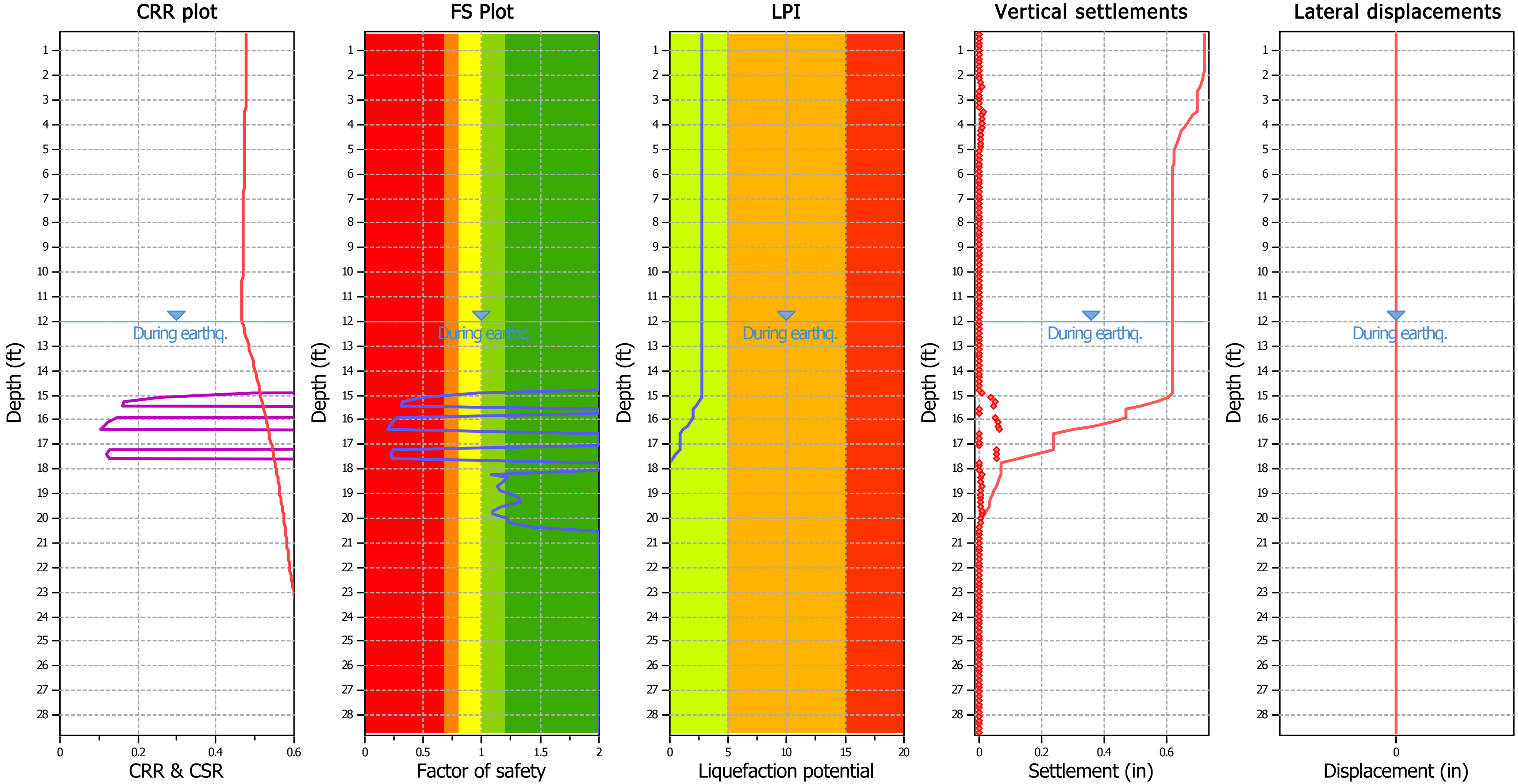
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

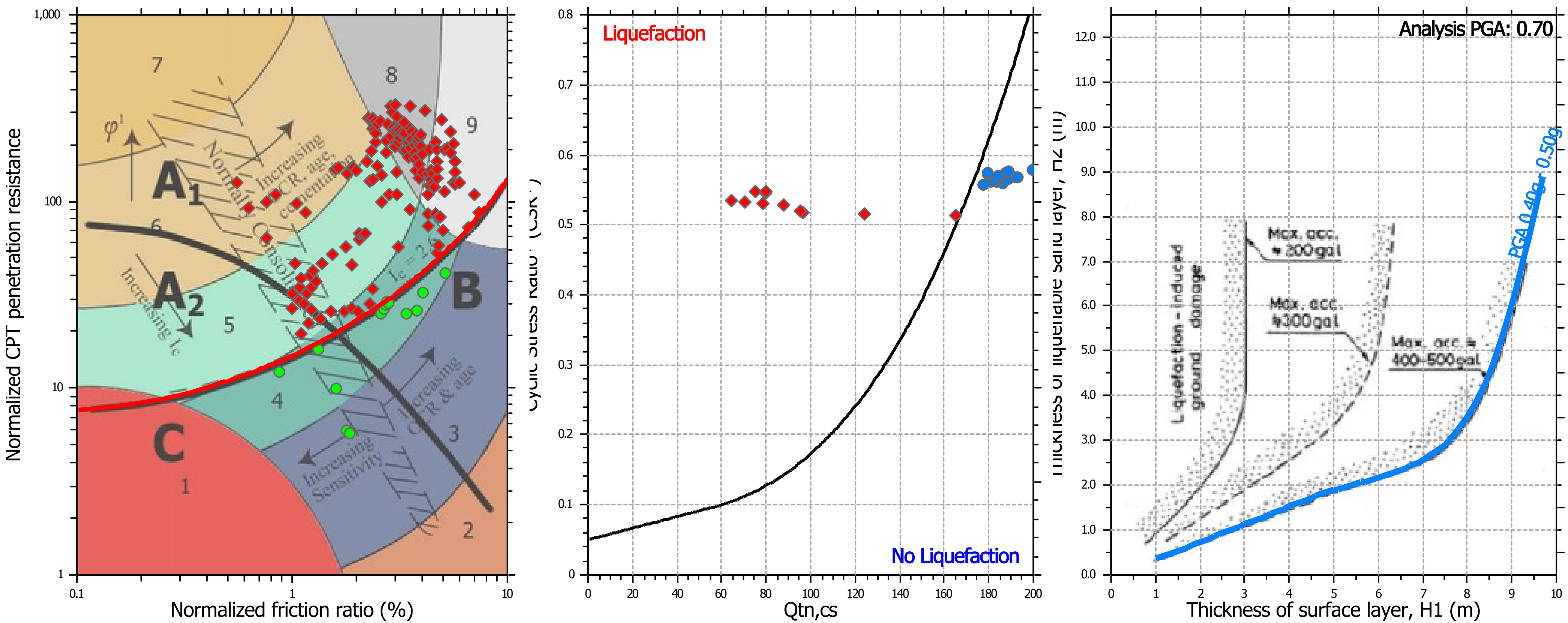
F.S. color scheme

- 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

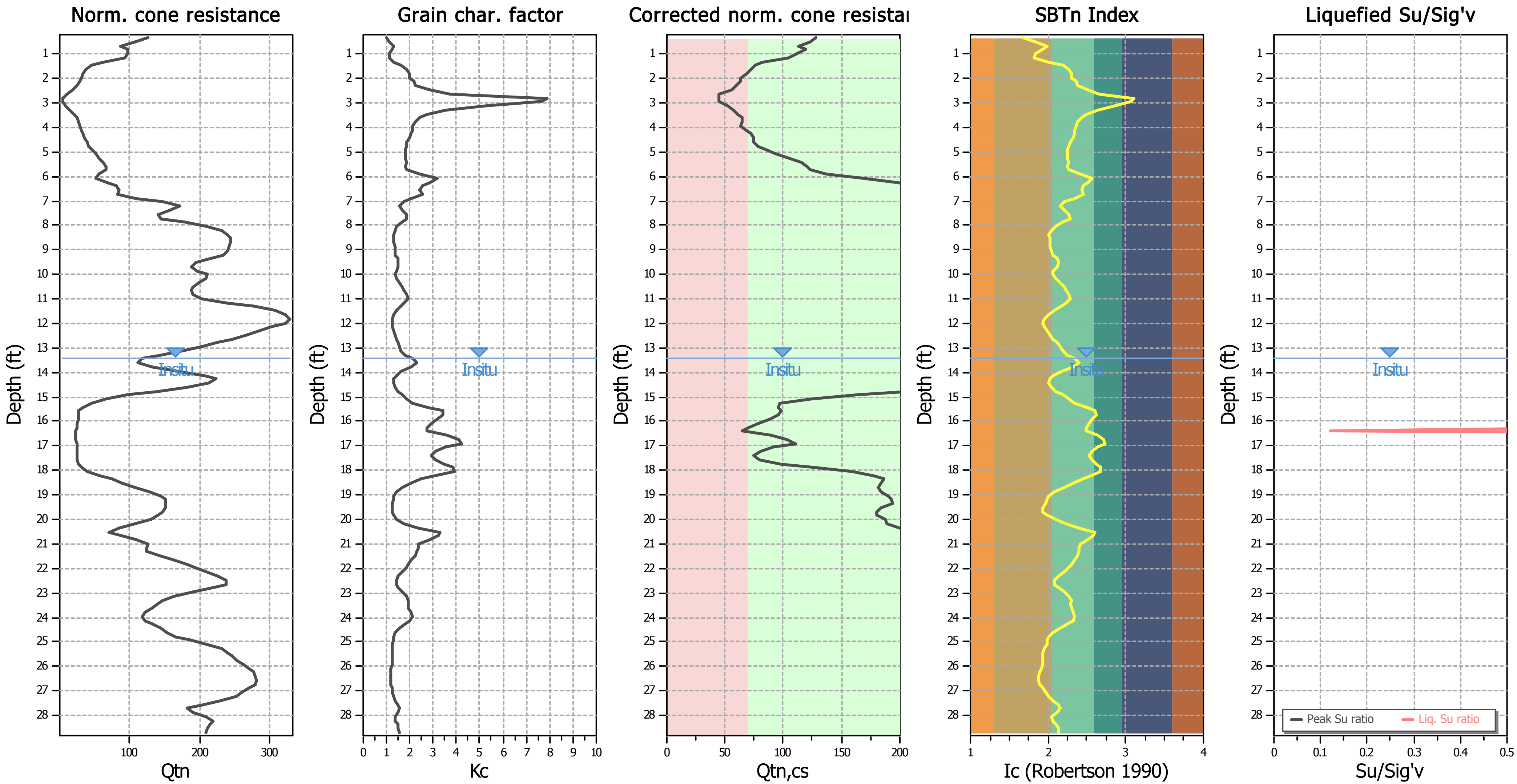
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

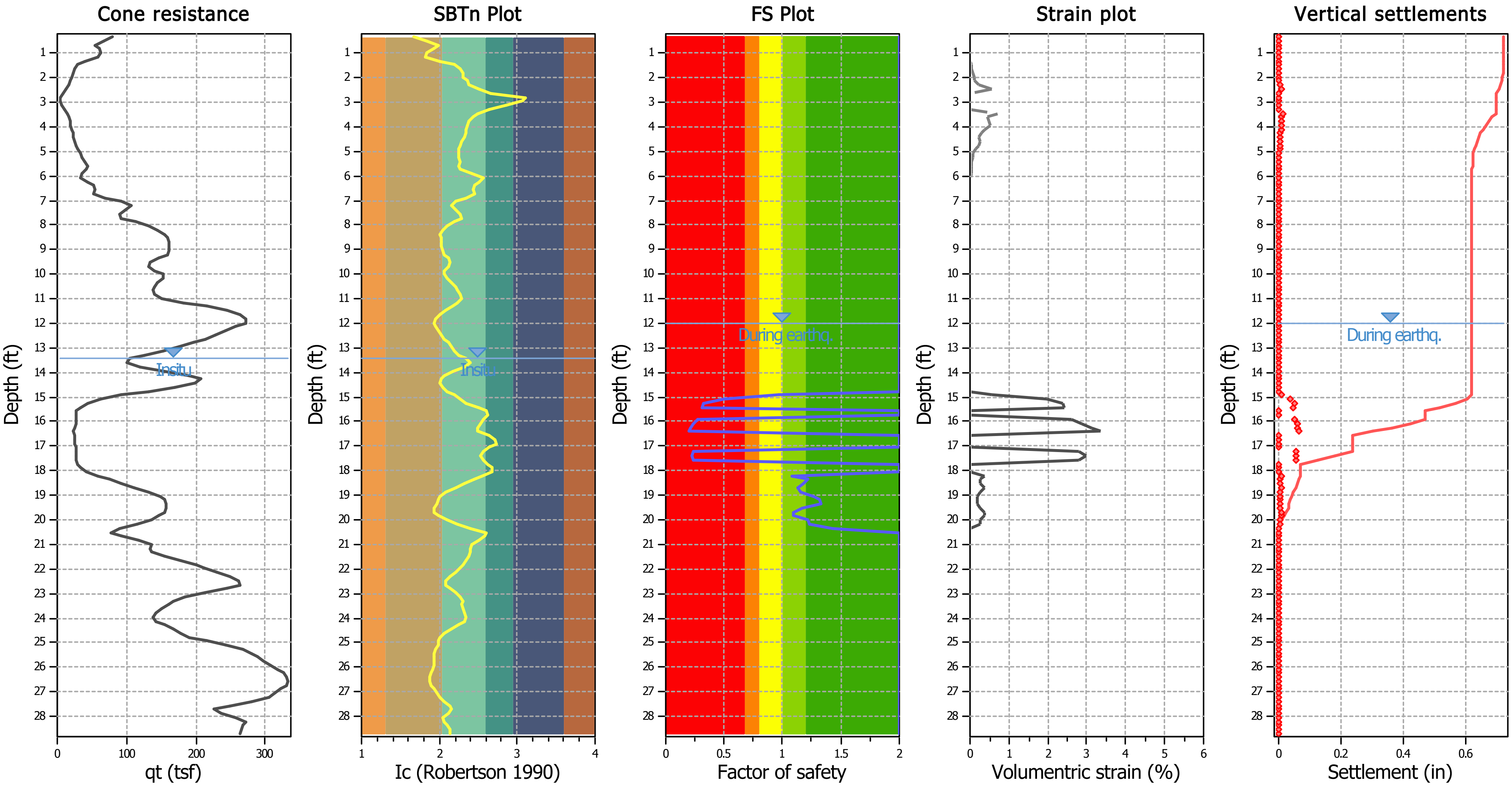
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.40 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.33	1.68	125.72	1.02	128.36	24	588	0.48	0.002	0.00	10.08	0.00	0.000
0.49	1.84	108.24	1.13	122.75	24	620	0.48	0.003	0.00	10.08	0.00	0.000
0.66	2.00	87.72	1.29	113.50	24	615	0.48	0.004	0.00	10.08	0.00	0.000
0.82	1.93	97.72	1.22	118.99	24	630	0.48	0.005	0.00	10.08	0.00	0.000
0.98	1.84	98.88	1.14	112.42	22	569	0.48	0.007	0.01	10.08	0.01	0.000
1.15	1.82	93.13	1.12	104.12	20	520	0.48	0.010	0.01	10.08	0.01	0.000
1.31	2.00	63.50	1.30	82.35	17	446	0.48	0.016	0.02	10.08	0.02	0.000
1.48	2.18	46.56	1.63	75.89	17	415	0.48	0.024	0.03	10.08	0.02	0.000
1.64	2.27	38.62	1.85	71.53	17	383	0.48	0.036	0.04	10.08	0.04	0.001
1.80	2.30	34.54	1.96	67.74	16	358	0.48	0.054	0.07	10.08	0.06	0.001
1.97	2.31	32.06	1.99	63.80	15	336	0.48	0.083	0.12	10.08	0.10	0.002
2.13	2.36	29.64	2.15	63.87	15	330	0.48	0.106	0.14	10.08	0.12	0.002
2.30	2.38	26.95	2.21	59.65	15	306	0.48	0.179	0.26	10.08	0.22	0.004
2.46	2.52	19.55	2.86	55.81	15	265	0.48	0.455	0.67	10.08	0.56	0.011
2.62	2.66	12.09	3.70	44.72	0	0	0.48	0.000	0.00	0.00	0.00	0.000
2.79	3.10	5.70	7.90	45.05	0	0	0.48	0.000	0.00	0.00	0.00	0.000
2.95	3.08	5.91	7.64	45.15	0	0	0.48	0.000	0.00	0.00	0.00	0.000
3.12	2.86	9.91	5.29	52.46	0	0	0.48	0.000	0.00	0.00	0.00	0.000
3.28	2.63	16.06	3.54	56.84	0	0	0.48	0.000	0.00	0.00	0.00	0.000
3.45	2.49	22.31	2.71	60.40	15	292	0.48	0.636	0.87	10.08	0.72	0.015
3.61	2.43	26.26	2.45	64.30	16	320	0.47	0.424	0.55	10.08	0.46	0.009
3.77	2.39	28.33	2.26	63.99	16	326	0.47	0.432	0.58	10.08	0.49	0.009
3.94	2.35	30.03	2.13	63.85	15	331	0.47	0.452	0.62	10.08	0.52	0.011
4.10	2.35	32.11	2.11	67.80	16	352	0.47	0.361	0.46	10.08	0.39	0.007
4.27	2.33	34.72	2.06	71.48	17	373	0.47	0.296	0.36	10.08	0.30	0.006
4.43	2.32	37.33	2.01	74.97	18	394	0.47	0.250	0.29	10.08	0.24	0.005
4.59	2.28	39.88	1.88	75.00	17	400	0.47	0.254	0.30	10.08	0.25	0.005
4.76	2.26	42.60	1.84	78.40	18	420	0.47	0.221	0.25	10.08	0.21	0.004
4.92	2.26	46.71	1.81	84.74	20	455	0.47	0.167	0.17	10.08	0.14	0.003
5.09	2.25	51.89	1.80	93.47	22	503	0.47	0.121	0.11	10.08	0.09	0.002
5.25	2.25	57.49	1.81	104.03	24	559	0.47	0.087	0.07	10.08	0.06	0.001
5.41	2.27	62.94	1.84	116.03	27	621	0.47	0.066	0.05	10.08	0.04	0.001
5.58	2.24	67.75	1.78	120.73	28	651	0.47	0.061	0.04	10.08	0.03	0.001
5.74	2.27	66.61	1.84	122.81	28	658	0.47	0.062	0.04	10.08	0.03	0.001
5.91	2.42	57.02	2.40	137.10	34	686	0.47	0.058	0.03	10.08	0.03	0.001
6.07	2.57	53.45	3.16	169.05	45	778	0.47	0.044	0.02	10.08	0.01	0.000
6.23	2.51	69.79	2.84	198.42	51	944	0.47	0.029	0.01	10.08	0.01	0.000
6.40	2.46	81.88	2.55	209.09	53	1028	0.47	0.026	0.01	10.08	0.01	0.000
6.56	2.43	86.34	2.45	211.42	53	1052	0.47	0.026	0.01	10.08	0.01	0.000
6.73	2.46	83.22	2.57	213.91	54	1050	0.47	0.027	0.01	10.08	0.01	0.000
6.89	2.34	109.44	2.08	227.30	54	1184	0.47	0.023	0.01	10.08	0.01	0.000
7.05	2.22	147.12	1.71	251.43	57	1365	0.47	0.018	0.01	10.08	0.00	0.000
7.22	2.15	171.52	1.56	267.61	59	1469	0.47	0.017	0.00	10.08	0.00	0.000
7.38	2.21	157.69	1.69	267.01	60	1452	0.47	0.018	0.00	10.08	0.00	0.000
7.55	2.28	141.68	1.87	265.28	62	1416	0.47	0.019	0.00	10.08	0.00	0.000
7.71	2.28	146.02	1.88	274.69	64	1465	0.47	0.019	0.00	10.08	0.00	0.000
7.87	2.19	178.72	1.65	294.84	66	1609	0.47	0.017	0.00	10.08	0.00	0.000
8.04	2.10	209.33	1.46	304.72	66	1676	0.47	0.016	0.00	10.08	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
8.20	2.05	230.84	1.37	316.42	67	1734	0.47	0.016	0.00	10.08	0.00	0.000
8.37	2.01	240.55	1.32	317.03	66	1768	0.47	0.016	0.00	10.08	0.00	0.000
8.53	2.02	244.39	1.33	324.40	68	1834	0.47	0.016	0.00	10.08	0.00	0.000
8.69	2.02	243.63	1.33	324.08	68	1857	0.47	0.016	0.00	10.08	0.00	0.000
8.86	2.03	241.15	1.34	322.05	68	1872	0.47	0.016	0.00	10.08	0.00	0.000
9.02	2.04	239.61	1.35	324.28	69	1909	0.47	0.016	0.00	10.08	0.00	0.000
9.19	2.06	233.40	1.39	324.80	69	1933	0.47	0.016	0.00	10.08	0.00	0.000
9.35	2.11	215.98	1.47	317.74	69	1899	0.47	0.017	0.00	10.08	0.00	0.000
9.51	2.13	194.16	1.51	292.96	64	1765	0.47	0.019	0.00	10.08	0.00	0.000
9.68	2.11	187.26	1.48	276.54	60	1697	0.47	0.021	0.01	10.08	0.00	0.000
9.84	2.07	196.74	1.40	275.50	59	1726	0.47	0.021	0.01	10.08	0.00	0.000
10.01	2.06	211.44	1.39	293.12	62	1862	0.47	0.019	0.00	10.08	0.00	0.000
10.17	2.10	209.15	1.45	303.92	66	1942	0.47	0.018	0.00	10.08	0.00	0.000
10.34	2.16	198.11	1.58	313.26	70	1994	0.47	0.018	0.00	10.08	0.00	0.000
10.50	2.20	191.14	1.68	320.51	72	2034	0.47	0.018	0.00	10.08	0.00	0.000
10.66	2.24	188.13	1.76	331.53	76	2100	0.47	0.017	0.00	10.08	0.00	0.000
10.83	2.27	189.55	1.85	350.58	81	2216	0.47	0.016	0.00	10.08	0.00	0.000
10.99	2.29	202.89	1.91	387.46	91	2455	0.47	0.015	0.00	10.08	0.00	0.000
11.16	2.24	238.71	1.77	421.40	97	2772	0.47	0.013	0.00	10.08	0.00	0.000
11.32	2.18	276.74	1.61	445.50	99	3037	0.47	0.012	0.00	10.08	0.00	0.000
11.48	2.09	306.48	1.43	437.80	94	3077	0.47	0.012	0.00	10.08	0.00	0.000
11.65	2.01	321.82	1.32	423.62	89	3014	0.47	0.012	0.00	10.08	0.00	0.000
11.81	1.95	327.75	1.24	405.40	83	2883	0.47	0.013	0.00	10.08	0.00	0.000
11.98	1.94	322.14	1.22	394.47	80	2825	0.47	0.014	0.00	10.08	0.00	0.000

Total estimated settlement: 0.10

Abbreviations

Q_{tn}:	Equivalent clean sand normalized cone resistance
K_c:	Fines correction factor
$Q_{tn,cs}$:	Post-liquefaction volumentric strain
G_{max}:	Small strain shear modulus
CSR:	Soil cyclic stress ratio
γ:	Cyclic shear strain
$e_{vol(15)}$:	Volumetric strain after 15 cycles
N_c:	Equivalent number of cycles
e_v:	Volumetric strain
Settle.:	Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.14	377.94	2.00	0.00	1.00	0.00
12.30	364.46	2.00	0.00	1.00	0.00
12.47	355.37	2.00	0.00	1.00	0.00
12.63	346.34	2.00	0.00	1.00	0.00
12.80	334.90	2.00	0.00	1.00	0.00
12.96	313.68	2.00	0.00	1.00	0.00
13.12	282.42	2.00	0.00	1.00	0.00
13.29	256.82	2.00	0.00	1.00	0.00
13.45	248.74	2.00	0.00	1.00	0.00
13.62	259.70	2.00	0.00	1.00	0.00
13.78	268.05	2.00	0.00	1.00	0.00
13.94	275.39	2.00	0.00	1.00	0.00
14.11	288.92	2.00	0.00	1.00	0.00
14.27	296.25	2.00	0.00	1.00	0.00
14.44	279.77	2.00	0.00	1.00	0.00
14.60	249.68	2.00	0.00	1.00	0.00
14.76	205.12	2.00	0.00	1.00	0.00
14.93	164.84	0.97	0.56	1.00	0.01
15.09	124.12	0.50	1.96	1.00	0.04
15.26	96.77	0.32	2.40	1.00	0.05
15.42	95.56	0.31	2.43	1.00	0.05
15.58	97.65	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
15.75	95.49	2.00	0.00	1.00	0.00	15.91	88.08	0.27	2.59	1.00	0.05
16.08	78.29	0.24	2.86	1.00	0.06	16.24	70.18	0.21	3.12	1.00	0.06
16.40	64.72	0.20	3.34	1.00	0.06	16.57	88.97	2.00	0.00	1.00	0.00
16.73	102.66	2.00	0.00	1.00	0.00	16.90	110.37	2.00	0.00	1.00	0.00
17.06	92.54	2.00	0.00	1.00	0.00	17.23	80.18	0.23	2.80	1.00	0.06
17.39	74.84	0.22	2.96	1.00	0.06	17.55	79.90	0.23	2.81	1.00	0.05
17.72	97.53	2.00	0.00	1.00	0.00	17.88	124.71	2.00	0.00	1.00	0.00
18.05	158.81	2.00	0.00	1.00	0.00	18.21	177.82	1.08	0.38	1.00	0.01
18.37	186.38	1.22	0.26	1.00	0.01	18.54	184.07	1.18	0.27	1.00	0.01
18.70	181.20	1.13	0.37	1.00	0.01	18.87	183.34	1.16	0.27	1.00	0.01
19.03	189.57	1.26	0.18	1.00	0.00	19.19	192.90	1.32	0.18	1.00	0.00
19.36	193.32	1.32	0.18	1.00	0.00	19.52	184.44	1.17	0.27	1.00	0.01
19.69	179.92	1.09	0.38	1.00	0.01	19.85	179.96	1.09	0.38	1.00	0.01
20.01	187.70	1.21	0.26	1.00	0.01	20.18	189.24	1.23	0.26	1.00	0.01
20.34	199.76	1.42	0.00	1.00	0.00	20.51	239.43	2.00	0.00	1.00	0.00
20.67	282.40	2.00	0.00	1.00	0.00	20.83	311.73	2.00	0.00	1.00	0.00
21.00	303.35	2.00	0.00	1.00	0.00	21.16	292.37	2.00	0.00	1.00	0.00
21.33	290.66	2.00	0.00	1.00	0.00	21.49	315.62	2.00	0.00	1.00	0.00
21.65	341.02	2.00	0.00	1.00	0.00	21.82	356.56	2.00	0.00	1.00	0.00
21.98	358.85	2.00	0.00	1.00	0.00	22.15	351.57	2.00	0.00	1.00	0.00
22.31	342.59	2.00	0.00	1.00	0.00	22.47	339.65	2.00	0.00	1.00	0.00
22.64	338.38	2.00	0.00	1.00	0.00	22.80	332.88	2.00	0.00	1.00	0.00
22.97	320.26	2.00	0.00	1.00	0.00	23.13	304.11	2.00	0.00	1.00	0.00
23.30	287.21	2.00	0.00	1.00	0.00	23.46	270.57	2.00	0.00	1.00	0.00
23.62	257.91	2.00	0.00	1.00	0.00	23.79	250.47	2.00	0.00	1.00	0.00
23.95	247.72	2.00	0.00	1.00	0.00	24.12	246.28	2.00	0.00	1.00	0.00
24.28	241.01	2.00	0.00	1.00	0.00	24.44	225.05	2.00	0.00	1.00	0.00
24.61	214.18	2.00	0.00	1.00	0.00	24.77	215.48	2.00	0.00	1.00	0.00
24.94	239.01	2.00	0.00	1.00	0.00	25.10	266.43	2.00	0.00	1.00	0.00
25.26	287.16	2.00	0.00	1.00	0.00	25.43	295.57	2.00	0.00	1.00	0.00
25.59	299.46	2.00	0.00	1.00	0.00	25.76	306.79	2.00	0.00	1.00	0.00
25.92	317.69	2.00	0.00	1.00	0.00	26.08	325.45	2.00	0.00	1.00	0.00
26.25	326.71	2.00	0.00	1.00	0.00	26.41	326.28	2.00	0.00	1.00	0.00
26.58	328.16	2.00	0.00	1.00	0.00	26.74	330.30	2.00	0.00	1.00	0.00
26.90	329.50	2.00	0.00	1.00	0.00	27.07	329.40	2.00	0.00	1.00	0.00
27.23	329.24	2.00	0.00	1.00	0.00	27.40	319.68	2.00	0.00	1.00	0.00
27.56	306.27	2.00	0.00	1.00	0.00	27.72	287.78	2.00	0.00	1.00	0.00
27.89	281.36	2.00	0.00	1.00	0.00	28.05	287.13	2.00	0.00	1.00	0.00
28.22	304.12	2.00	0.00	1.00	0.00	28.38	314.56	2.00	0.00	1.00	0.00
28.54	319.80	2.00	0.00	1.00	0.00	28.71	320.45	2.00	0.00	1.00	0.00

Total estimated settlement: 0.62

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

LIQUEFACTION ANALYSIS REPORT

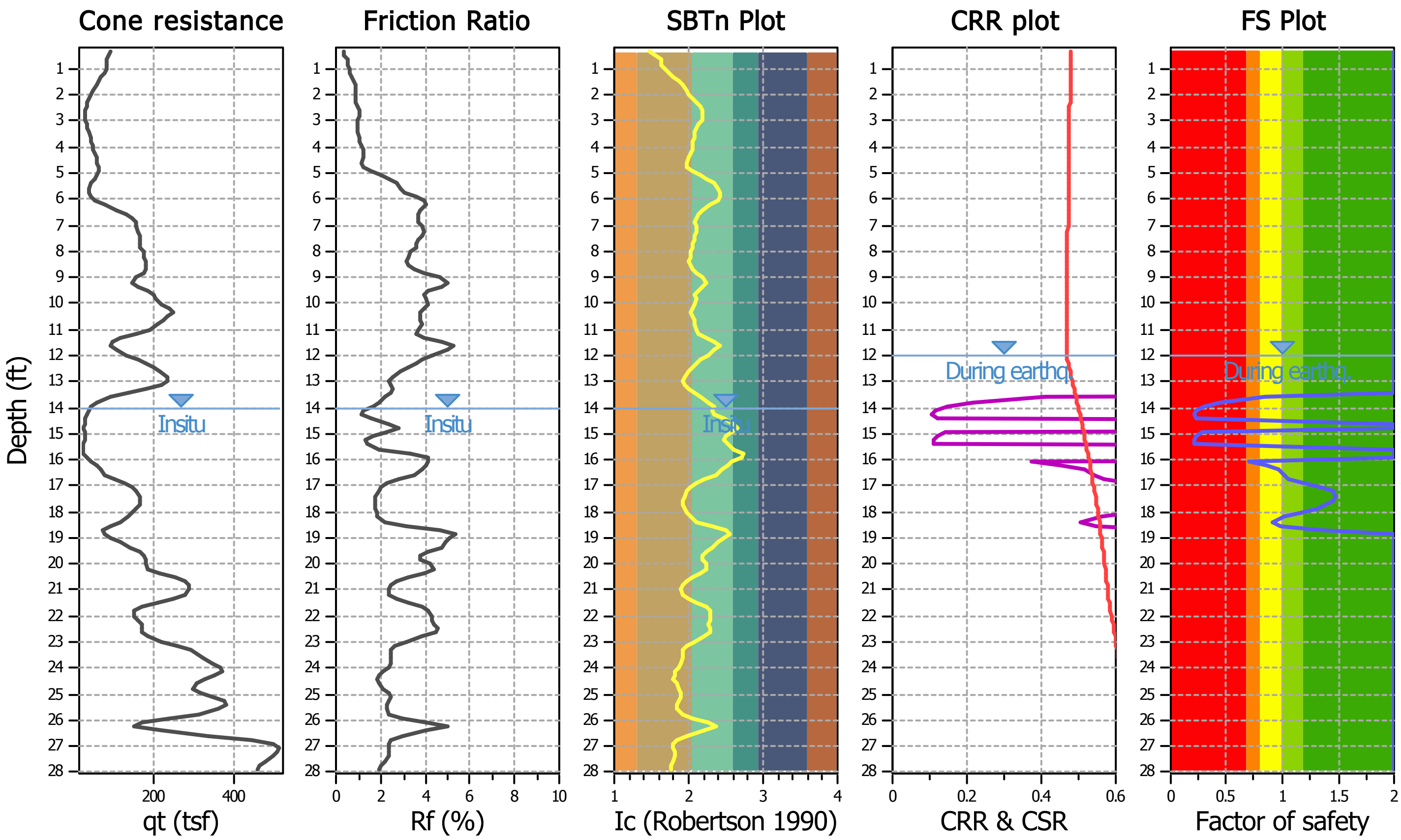
Project title : Cole CampusCole Campus – Central

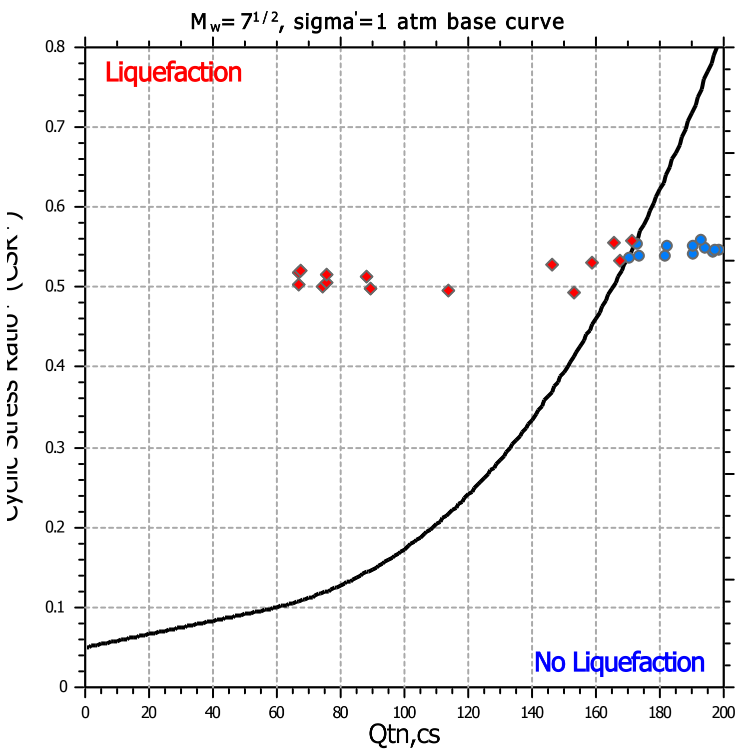
Location : Oakland

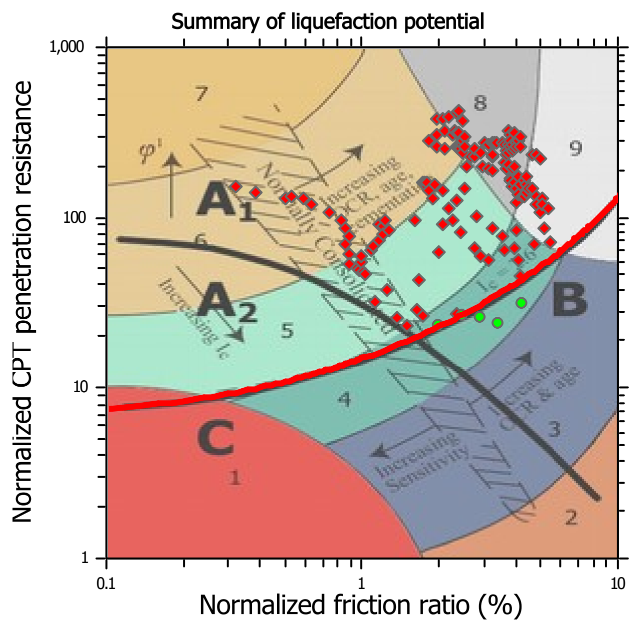
CPT file : CPT-03

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	14.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	12.00 ft	Fill height:	N/A	Limit depth applie	No
Points to test:	Based on Ic value	Average results interv:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method basec
Peak ground acceleration:	0.70	Unit weight calculatior	Based on SBT	K_σ applied:	Yes		

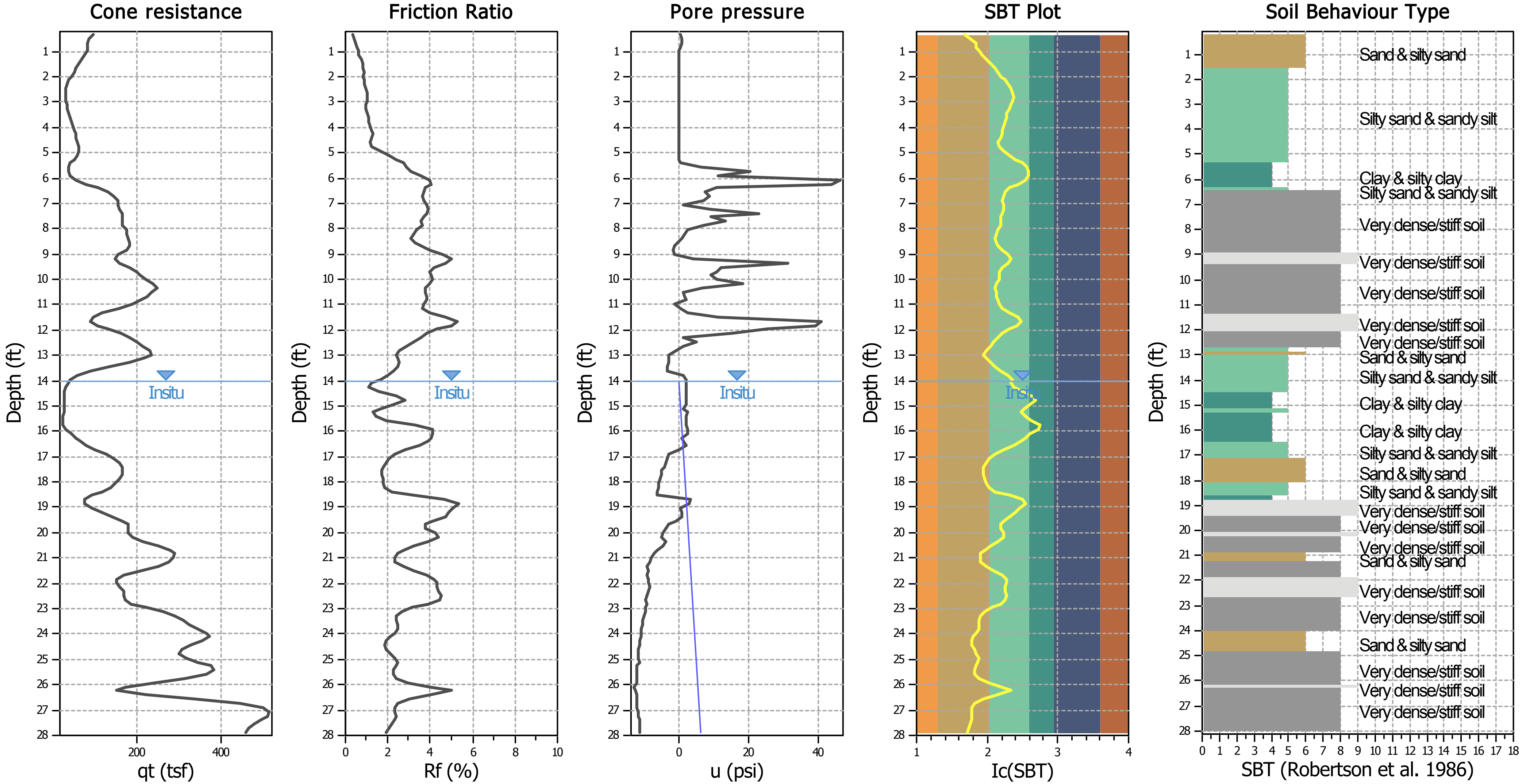






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



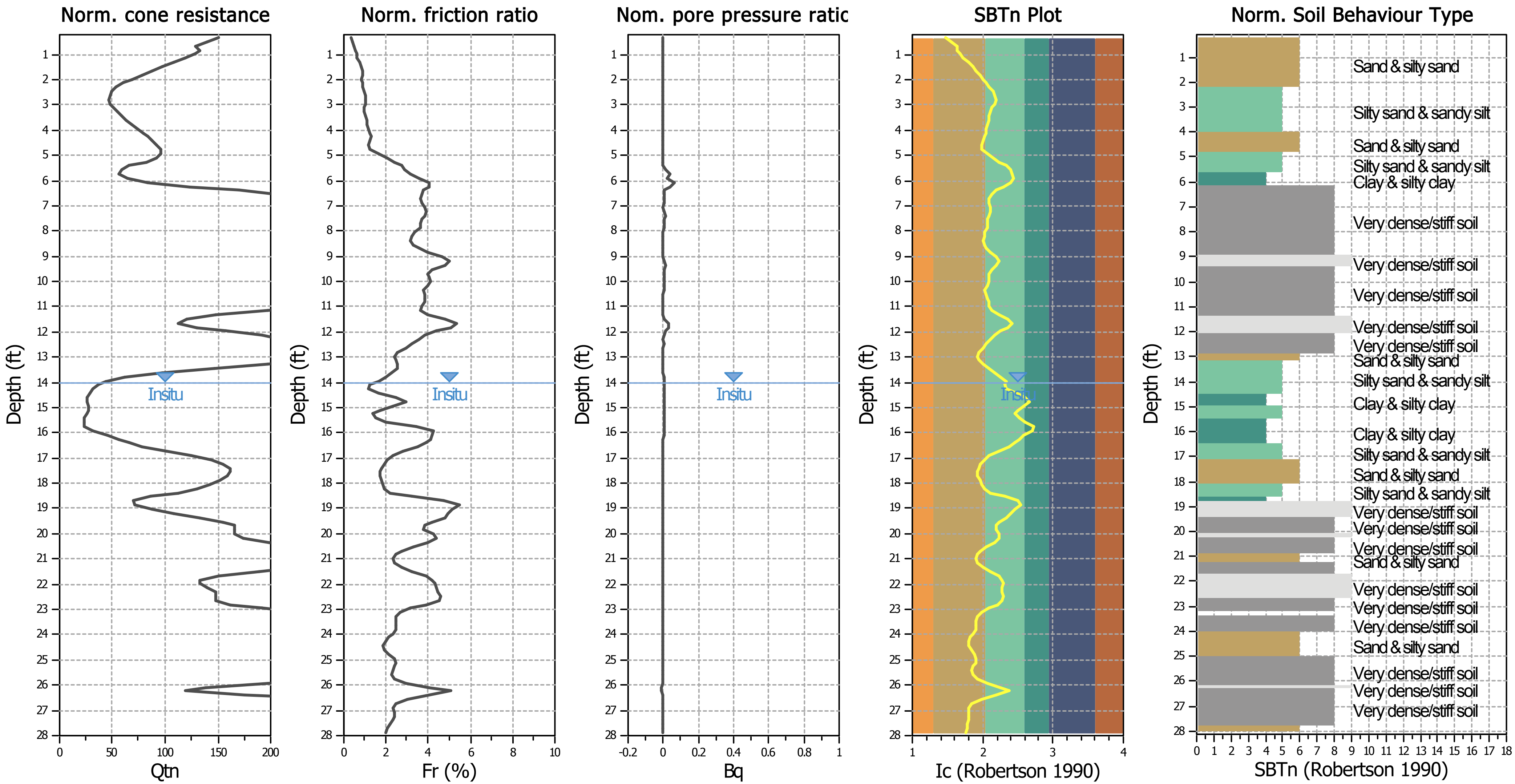
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

CPT basic interpretation plots (normalized)



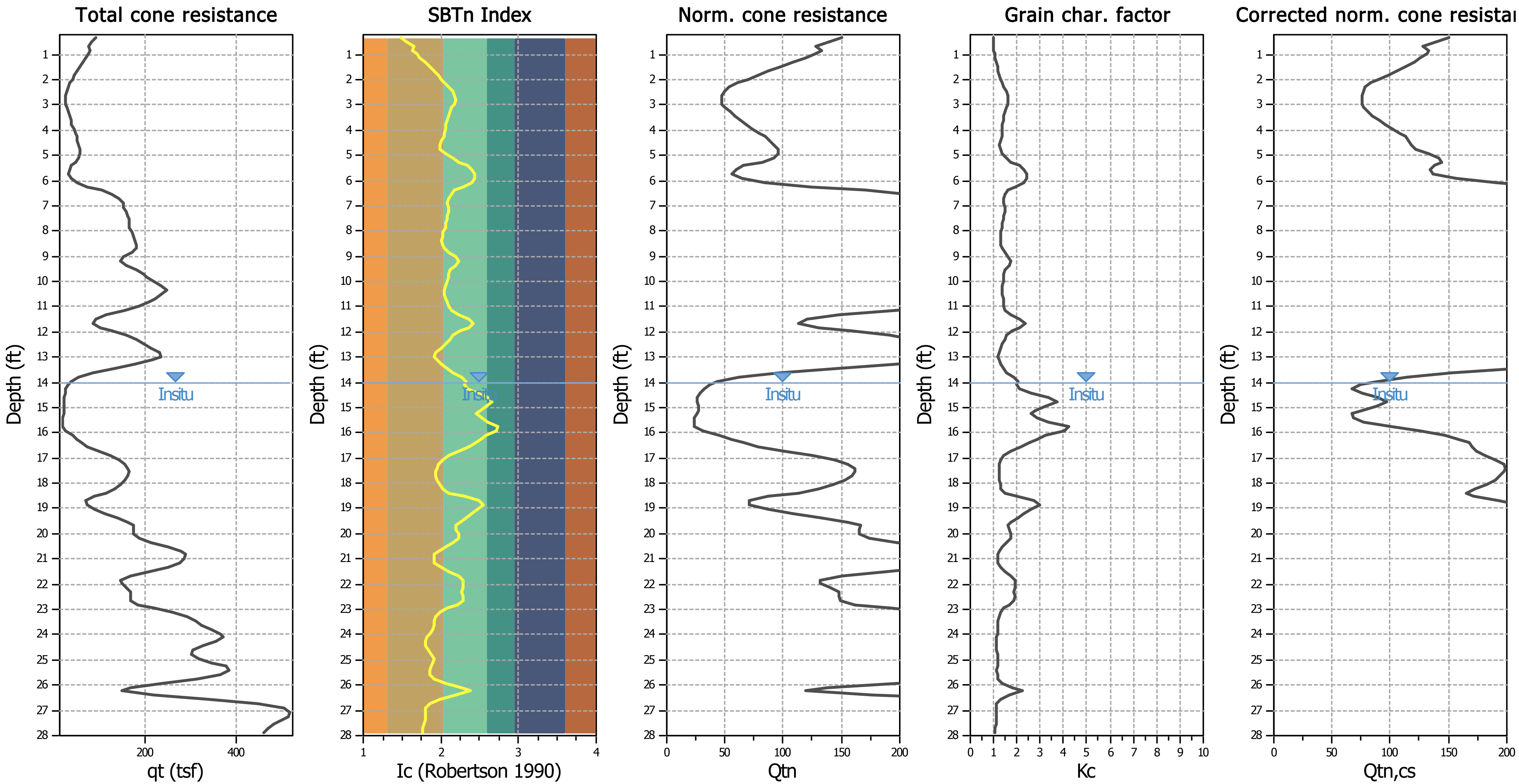
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

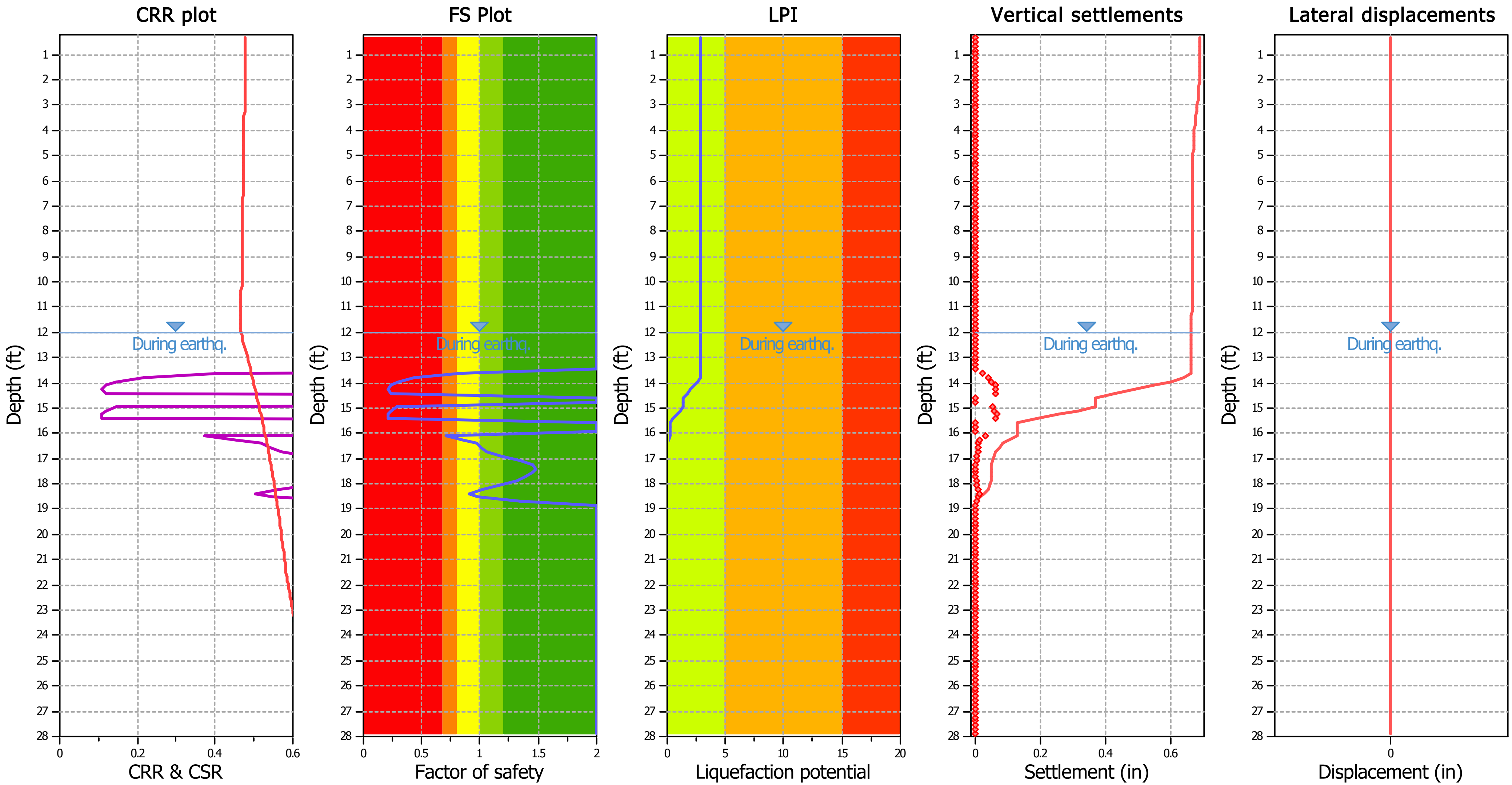
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

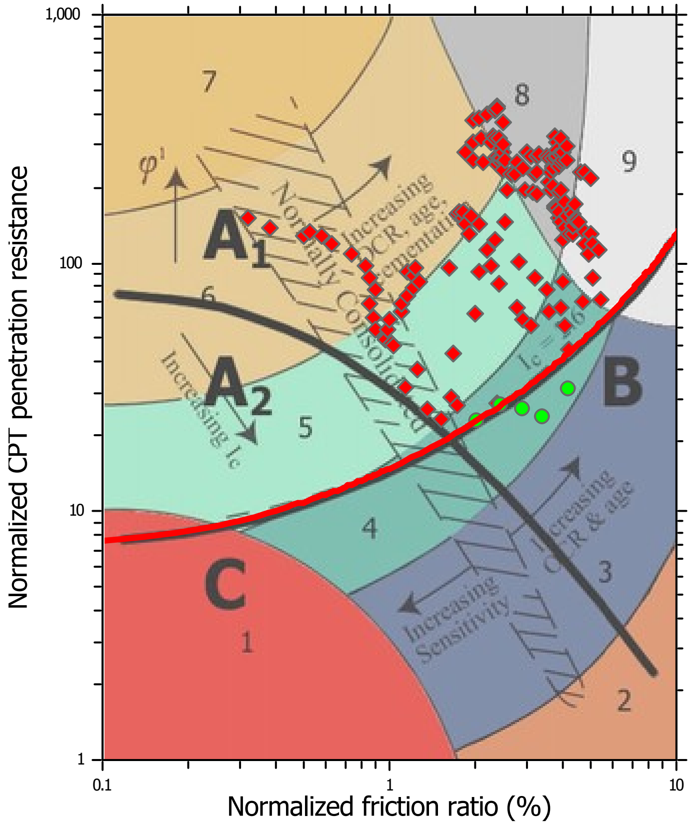
F.S. color scheme

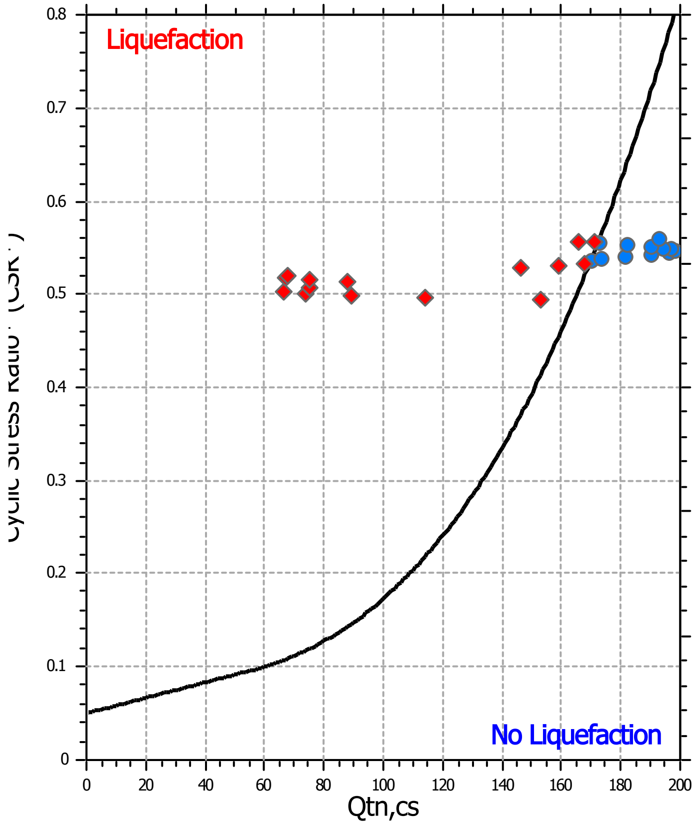
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

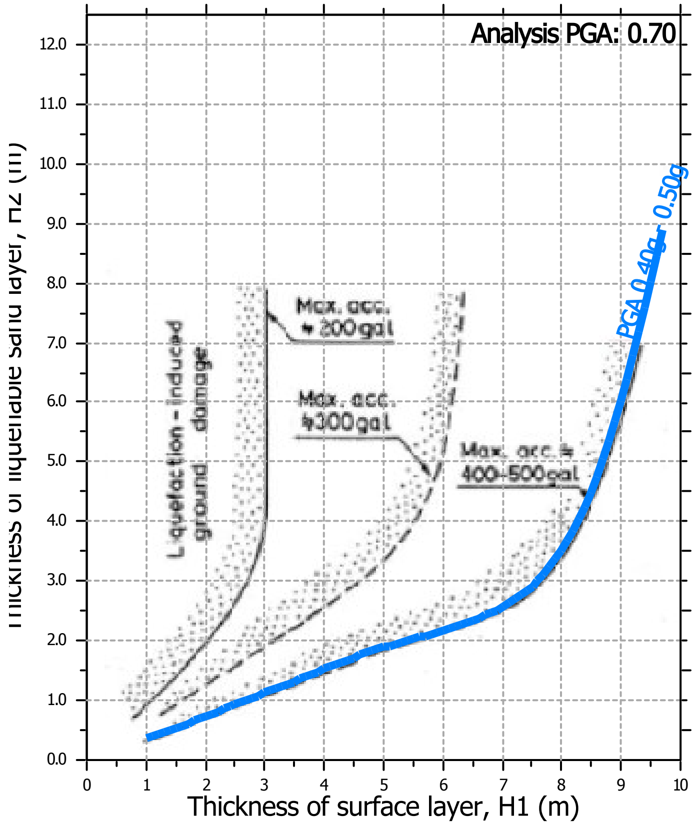
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



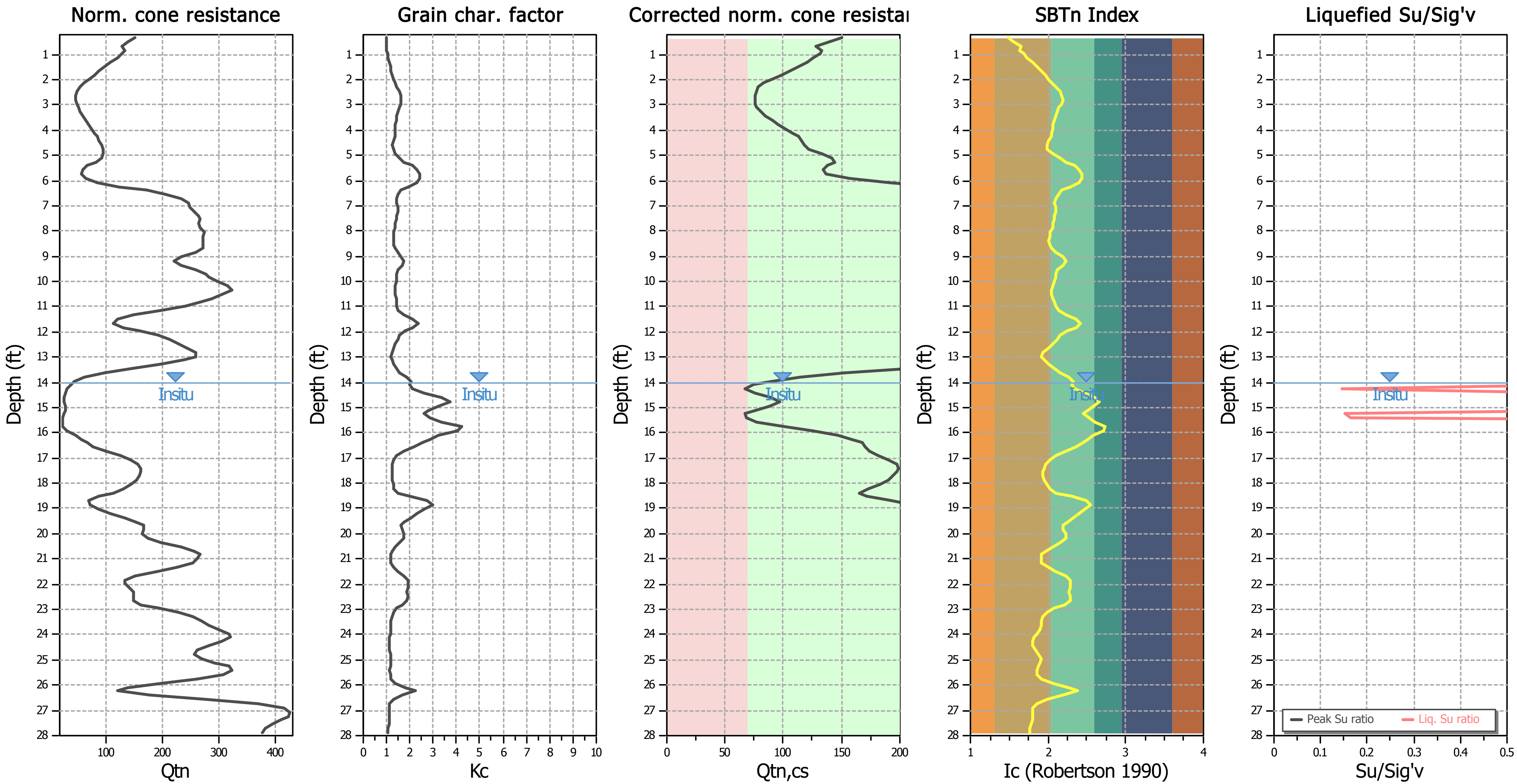




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

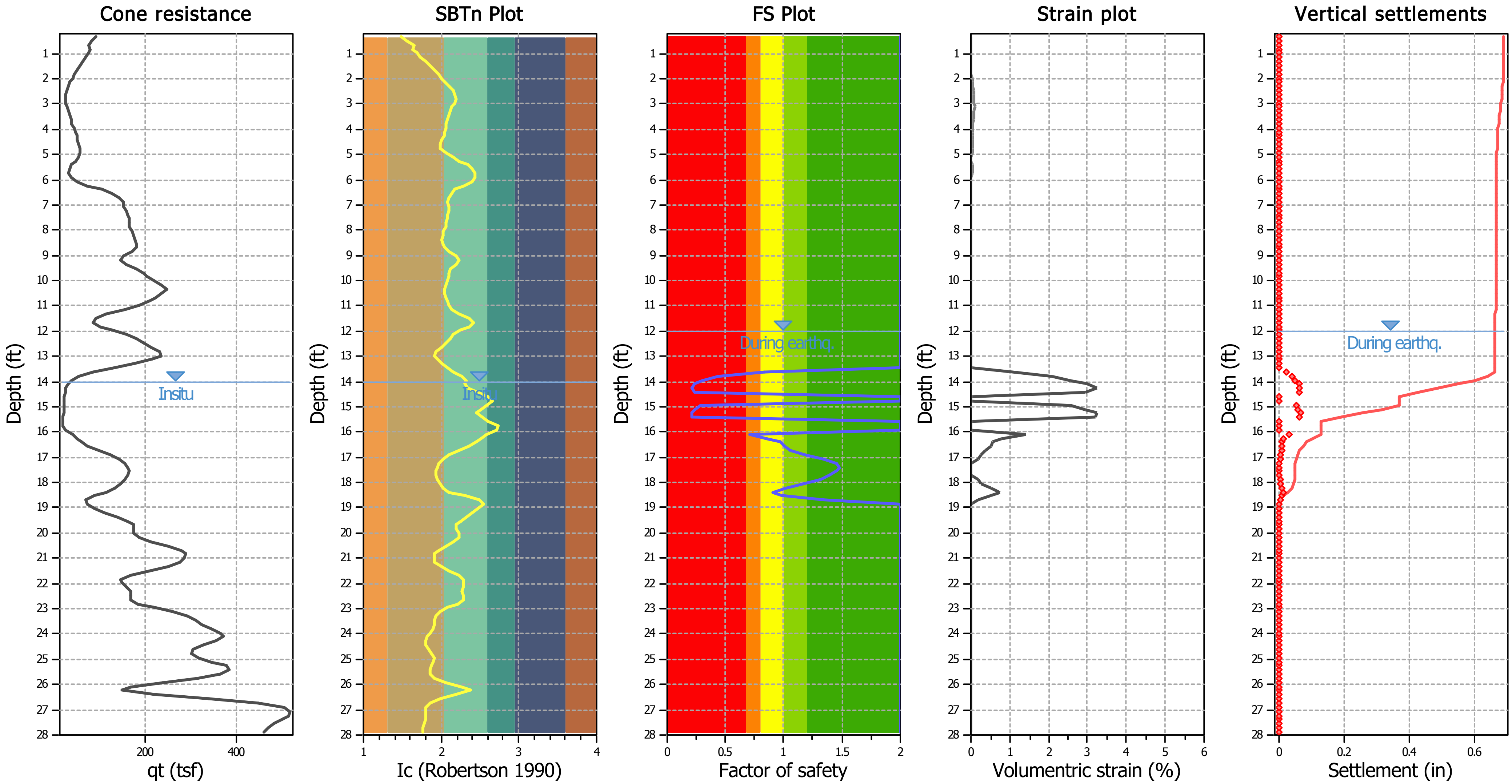
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.33	1.48	150.84	1.00	150.84	26	551	0.48	0.002	0.00	10.08	0.00	0.000
0.49	1.55	139.16	1.00	139.16	25	556	0.48	0.003	0.00	10.08	0.00	0.000
0.66	1.64	128.11	1.00	128.00	23	576	0.48	0.004	0.00	10.08	0.00	0.000
0.82	1.64	132.69	1.00	132.43	24	595	0.48	0.005	0.00	10.08	0.00	0.000
0.98	1.68	128.17	1.03	131.48	24	604	0.48	0.006	0.00	10.08	0.00	0.000
1.15	1.73	119.16	1.06	125.80	24	594	0.48	0.008	0.01	10.08	0.01	0.000
1.31	1.80	108.32	1.11	120.06	23	595	0.48	0.009	0.01	10.08	0.01	0.000
1.48	1.87	97.54	1.16	113.01	22	581	0.48	0.011	0.01	10.08	0.01	0.000
1.64	1.91	87.57	1.20	105.26	21	553	0.48	0.014	0.01	10.08	0.01	0.000
1.80	1.96	78.29	1.25	98.17	20	526	0.48	0.018	0.02	10.08	0.01	0.000
1.97	2.00	68.95	1.30	89.37	19	484	0.48	0.025	0.03	10.08	0.02	0.000
2.13	2.05	60.48	1.38	83.16	18	456	0.48	0.034	0.04	10.08	0.03	0.001
2.30	2.10	53.82	1.45	78.02	17	429	0.48	0.047	0.06	10.08	0.05	0.001
2.46	2.15	49.52	1.55	76.62	17	421	0.48	0.057	0.07	10.08	0.06	0.001
2.62	2.18	47.26	1.61	76.04	17	416	0.48	0.067	0.08	10.08	0.07	0.001
2.79	2.18	46.60	1.63	75.90	17	415	0.48	0.078	0.09	10.08	0.08	0.002
2.95	2.17	47.55	1.60	76.11	17	417	0.48	0.085	0.10	10.08	0.09	0.002
3.12	2.14	50.16	1.53	76.81	17	422	0.48	0.092	0.11	10.08	0.09	0.002
3.28	2.12	54.27	1.49	80.78	18	444	0.48	0.084	0.10	10.08	0.08	0.002
3.45	2.09	58.97	1.44	84.91	18	467	0.48	0.077	0.09	10.08	0.07	0.001
3.61	2.09	63.67	1.43	91.28	20	502	0.47	0.066	0.07	10.08	0.06	0.001
3.77	2.06	68.53	1.39	95.35	20	523	0.47	0.062	0.06	10.08	0.05	0.001
3.94	2.05	73.82	1.38	101.60	22	557	0.47	0.056	0.05	10.08	0.04	0.001
4.10	2.04	79.21	1.36	107.72	23	590	0.47	0.050	0.04	10.08	0.04	0.001
4.27	2.04	83.96	1.35	113.41	24	620	0.47	0.047	0.04	10.08	0.03	0.001
4.43	2.01	88.28	1.31	115.44	24	627	0.47	0.049	0.04	10.08	0.03	0.001
4.59	1.98	92.28	1.27	117.49	24	633	0.47	0.050	0.04	10.08	0.03	0.001
4.76	1.99	95.32	1.28	122.21	25	660	0.47	0.048	0.04	10.08	0.03	0.001
4.92	2.06	95.84	1.39	133.49	28	733	0.47	0.039	0.03	10.08	0.02	0.000
5.09	2.15	91.48	1.55	142.01	31	780	0.47	0.035	0.02	10.08	0.02	0.000
5.25	2.24	81.88	1.76	143.89	33	778	0.47	0.037	0.02	10.08	0.02	0.000
5.41	2.34	65.85	2.09	137.87	33	717	0.47	0.048	0.03	10.08	0.02	0.000
5.58	2.39	59.14	2.27	134.41	33	683	0.47	0.058	0.03	10.08	0.03	0.001
5.74	2.43	56.47	2.43	137.23	34	685	0.47	0.061	0.03	10.08	0.03	0.001
5.91	2.43	64.16	2.45	157.09	39	782	0.47	0.045	0.02	10.08	0.02	0.000
6.07	2.39	84.08	2.27	191.09	47	972	0.47	0.029	0.01	10.08	0.01	0.000
6.23	2.29	123.69	1.91	235.80	55	1254	0.47	0.019	0.01	10.08	0.00	0.000
6.40	2.18	170.50	1.62	276.74	62	1513	0.47	0.015	0.00	10.08	0.00	0.000
6.56	2.13	206.10	1.51	311.91	68	1715	0.47	0.013	0.00	10.08	0.00	0.000
6.73	2.10	233.10	1.45	337.43	73	1856	0.47	0.012	0.00	10.08	0.00	0.000
6.89	2.09	246.96	1.43	353.28	76	1942	0.47	0.011	0.00	10.08	0.00	0.000
7.05	2.10	247.85	1.46	362.10	78	1992	0.47	0.011	0.00	10.08	0.00	0.000
7.22	2.10	255.03	1.46	372.29	81	2048	0.47	0.011	0.00	10.08	0.00	0.000
7.38	2.09	264.23	1.43	377.70	81	2077	0.47	0.012	0.00	10.08	0.00	0.000
7.55	2.07	266.12	1.41	374.86	80	2059	0.47	0.012	0.00	10.08	0.00	0.000
7.71	2.06	264.69	1.39	367.98	78	2019	0.47	0.013	0.00	10.08	0.00	0.000
7.87	2.06	265.80	1.39	369.36	79	2027	0.47	0.013	0.00	10.08	0.00	0.000
8.04	2.03	273.68	1.34	365.38	77	2037	0.47	0.013	0.00	10.08	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
8.20	2.02	271.56	1.32	359.47	75	2035	0.47	0.014	0.00	10.08	0.00	0.000
8.37	2.00	270.51	1.31	353.17	74	2030	0.47	0.014	0.00	10.08	0.00	0.000
8.53	2.02	272.47	1.33	362.55	76	2111	0.47	0.014	0.00	10.08	0.00	0.000
8.69	2.05	271.86	1.37	372.60	79	2193	0.47	0.013	0.00	10.08	0.00	0.000
8.86	2.11	259.35	1.47	380.03	82	2246	0.47	0.013	0.00	10.08	0.00	0.000
9.02	2.18	232.81	1.63	379.43	85	2215	0.47	0.014	0.00	10.08	0.00	0.000
9.19	2.23	220.58	1.73	381.69	87	2220	0.47	0.014	0.00	10.08	0.00	0.000
9.35	2.20	232.44	1.66	385.27	87	2303	0.47	0.014	0.00	10.08	0.00	0.000
9.51	2.12	259.13	1.50	387.56	85	2409	0.47	0.013	0.00	10.08	0.00	0.000
9.68	2.09	275.63	1.44	396.32	85	2514	0.47	0.013	0.00	10.08	0.00	0.000
9.84	2.09	280.99	1.44	405.49	88	2603	0.47	0.012	0.00	10.08	0.00	0.000
10.01	2.09	297.58	1.43	426.60	92	2776	0.47	0.012	0.00	10.08	0.00	0.000
10.17	2.06	315.35	1.39	437.93	93	2893	0.47	0.011	0.00	10.08	0.00	0.000
10.34	2.03	323.24	1.35	435.70	92	2917	0.47	0.011	0.00	10.08	0.00	0.000
10.50	2.05	304.50	1.38	418.80	89	2834	0.47	0.012	0.00	10.08	0.00	0.000
10.66	2.07	285.90	1.40	400.11	86	2734	0.47	0.013	0.00	10.08	0.00	0.000
10.83	2.08	267.91	1.43	382.57	82	2641	0.47	0.014	0.00	10.08	0.00	0.000
10.99	2.10	240.11	1.45	347.34	75	2421	0.47	0.016	0.00	10.08	0.00	0.000
11.16	2.13	196.62	1.52	298.87	66	2092	0.47	0.019	0.00	10.08	0.00	0.000
11.32	2.24	147.69	1.76	260.21	60	1780	0.47	0.025	0.01	10.08	0.01	0.000
11.48	2.35	120.29	2.13	256.43	62	1669	0.47	0.028	0.01	10.08	0.01	0.000
11.65	2.41	112.84	2.35	264.83	65	1686	0.47	0.028	0.01	10.08	0.01	0.000
11.81	2.35	130.44	2.12	277.15	67	1849	0.47	0.025	0.01	10.08	0.00	0.000
11.98	2.25	158.06	1.81	285.38	66	2027	0.47	0.022	0.01	10.08	0.00	0.000

Total estimated settlement: 0.02

Abbreviations

Q_{tn}: Equivalent clean sand normalized cone resistance
K_c: Fines correction factor
$Q_{tn,cs}$: Post-liquefaction volumentric strain
G_{max}: Small strain shear modulus
CSR: Soil cyclic stress ratio
γ: Cyclic shear strain
$e_{vol(15)}$: Volumetric strain after 15 cycles
N_c: Equivalent number of cycles
e_v: Volumetric strain
Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.14	302.96	2.00	0.00	1.00	0.00	12.30	312.04	2.00	0.00	1.00	0.00
12.47	315.20	2.00	0.00	1.00	0.00	12.63	316.56	2.00	0.00	1.00	0.00
12.80	317.00	2.00	0.00	1.00	0.00	12.96	312.82	2.00	0.00	1.00	0.00
13.12	294.91	2.00	0.00	1.00	0.00	13.29	258.22	2.00	0.00	1.00	0.00
13.45	208.09	2.00	0.00	1.00	0.00	13.62	153.01	0.84	1.09	1.00	0.02
13.78	113.96	0.44	2.10	1.00	0.04	13.94	89.30	0.29	2.56	1.00	0.05
14.11	74.09	0.24	2.99	1.00	0.06	14.27	66.71	0.21	3.26	1.00	0.06
14.44	75.36	0.24	2.95	1.00	0.06	14.60	89.01	2.00	0.00	1.00	0.00
14.76	96.36	2.00	0.00	1.00	0.00	14.93	88.22	0.28	2.59	1.00	0.05
15.09	75.42	0.23	2.94	1.00	0.06	15.26	67.11	0.21	3.24	1.00	0.07
15.42	67.76	0.21	3.22	1.00	0.06	15.58	76.58	2.00	0.00	1.00	0.00

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
15.75	100.90	2.00	0.00	1.00	0.00	15.91	125.23	2.00	0.00	1.00	0.00
16.08	146.38	0.70	1.43	1.00	0.03	16.24	159.05	0.86	0.79	1.00	0.02
16.40	167.45	0.97	0.55	1.00	0.01	16.57	170.39	1.01	0.54	1.00	0.01
16.73	173.83	1.06	0.38	1.00	0.01	16.90	181.80	1.18	0.27	1.00	0.01
17.06	190.62	1.34	0.18	1.00	0.00	17.23	196.92	1.46	0.00	1.00	0.00
17.39	198.45	1.48	0.00	1.00	0.00	17.55	197.48	1.46	0.00	1.00	0.00
17.72	194.33	1.39	0.00	1.00	0.00	17.88	190.49	1.31	0.18	1.00	0.00
18.05	182.37	1.17	0.27	1.00	0.01	18.21	173.11	1.02	0.53	1.00	0.01
18.37	165.72	0.91	0.74	1.00	0.01	18.54	171.41	0.98	0.54	1.00	0.01
18.70	193.13	1.34	0.18	1.00	0.00	18.87	211.15	2.00	0.00	1.00	0.00
19.03	226.02	2.00	0.00	1.00	0.00	19.19	247.21	2.00	0.00	1.00	0.00
19.36	270.57	2.00	0.00	1.00	0.00	19.52	273.82	2.00	0.00	1.00	0.00
19.69	273.57	2.00	0.00	1.00	0.00	19.85	272.91	2.00	0.00	1.00	0.00
20.01	289.83	2.00	0.00	1.00	0.00	20.18	304.18	2.00	0.00	1.00	0.00
20.34	312.48	2.00	0.00	1.00	0.00	20.51	319.96	2.00	0.00	1.00	0.00
20.67	325.13	2.00	0.00	1.00	0.00	20.83	321.64	2.00	0.00	1.00	0.00
21.00	313.40	2.00	0.00	1.00	0.00	21.16	304.75	2.00	0.00	1.00	0.00
21.33	294.05	2.00	0.00	1.00	0.00	21.49	275.56	2.00	0.00	1.00	0.00
21.65	260.59	2.00	0.00	1.00	0.00	21.82	250.78	2.00	0.00	1.00	0.00
21.98	255.52	2.00	0.00	1.00	0.00	22.15	265.63	2.00	0.00	1.00	0.00
22.31	276.99	2.00	0.00	1.00	0.00	22.47	281.98	2.00	0.00	1.00	0.00
22.64	279.29	2.00	0.00	1.00	0.00	22.80	272.34	2.00	0.00	1.00	0.00
22.97	274.79	2.00	0.00	1.00	0.00	23.13	291.21	2.00	0.00	1.00	0.00
23.30	309.14	2.00	0.00	1.00	0.00	23.46	324.00	2.00	0.00	1.00	0.00
23.62	337.92	2.00	0.00	1.00	0.00	23.79	355.03	2.00	0.00	1.00	0.00
23.95	365.80	2.00	0.00	1.00	0.00	24.12	359.87	2.00	0.00	1.00	0.00
24.28	339.18	2.00	0.00	1.00	0.00	24.44	311.30	2.00	0.00	1.00	0.00
24.61	297.96	2.00	0.00	1.00	0.00	24.77	298.03	2.00	0.00	1.00	0.00
24.94	320.33	2.00	0.00	1.00	0.00	25.10	347.25	2.00	0.00	1.00	0.00
25.26	369.28	2.00	0.00	1.00	0.00	25.43	370.47	2.00	0.00	1.00	0.00
25.59	352.25	2.00	0.00	1.00	0.00	25.76	316.45	2.00	0.00	1.00	0.00
25.92	273.53	2.00	0.00	1.00	0.00	26.08	252.64	2.00	0.00	1.00	0.00
26.25	265.21	2.00	0.00	1.00	0.00	26.41	293.99	2.00	0.00	1.00	0.00
26.58	354.99	2.00	0.00	1.00	0.00	26.74	422.64	2.00	0.00	1.00	0.00
26.90	461.15	2.00	0.00	1.00	0.00	27.07	471.27	2.00	0.00	1.00	0.00
27.23	468.20	2.00	0.00	1.00	0.00	27.40	455.45	2.00	0.00	1.00	0.00
27.56	433.18	2.00	0.00	1.00	0.00	27.72	415.51	2.00	0.00	1.00	0.00
27.89	404.02	2.00	0.00	1.00	0.00						

Total estimated settlement: 0.66

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

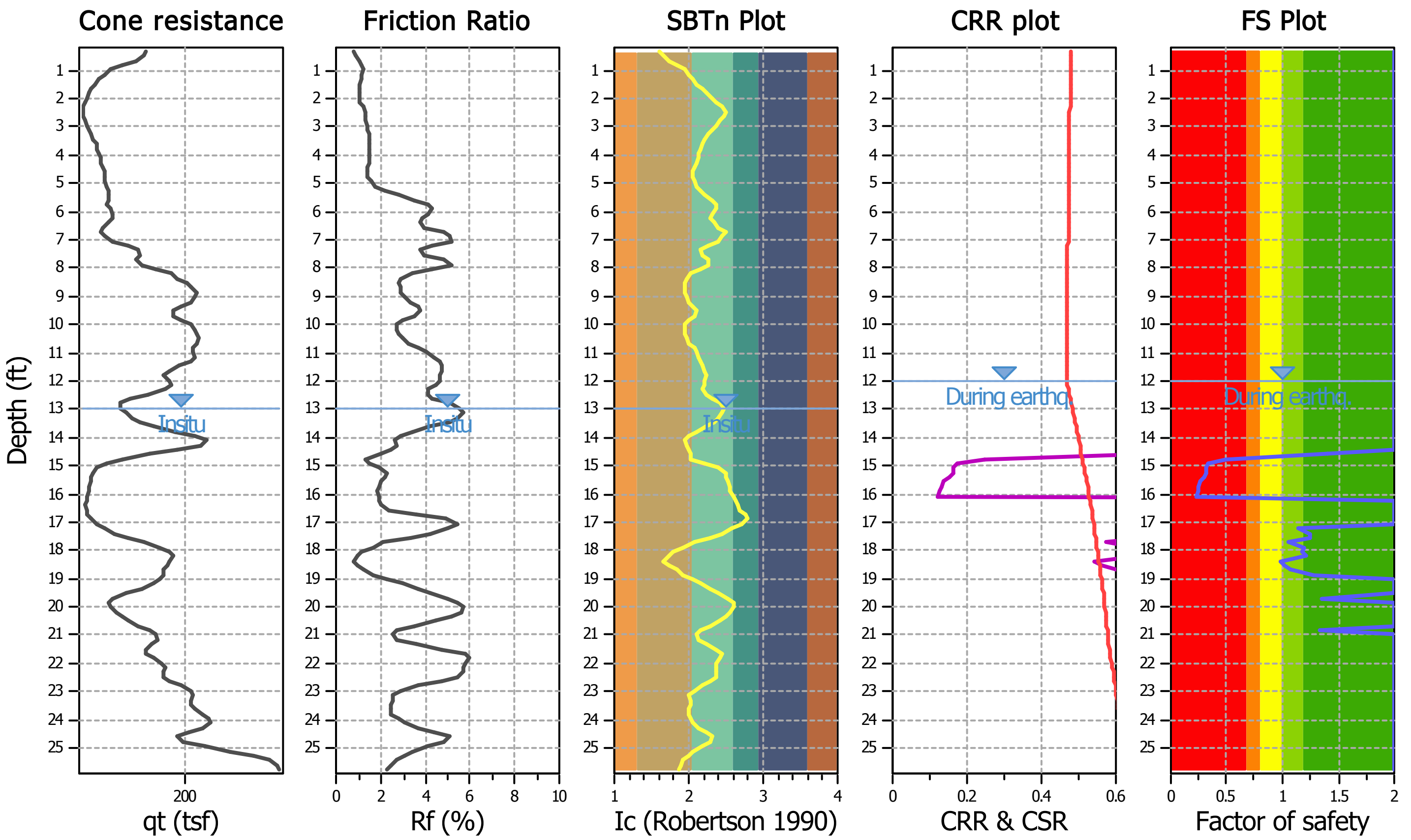
LIQUEFACTION ANALYSIS REPORT

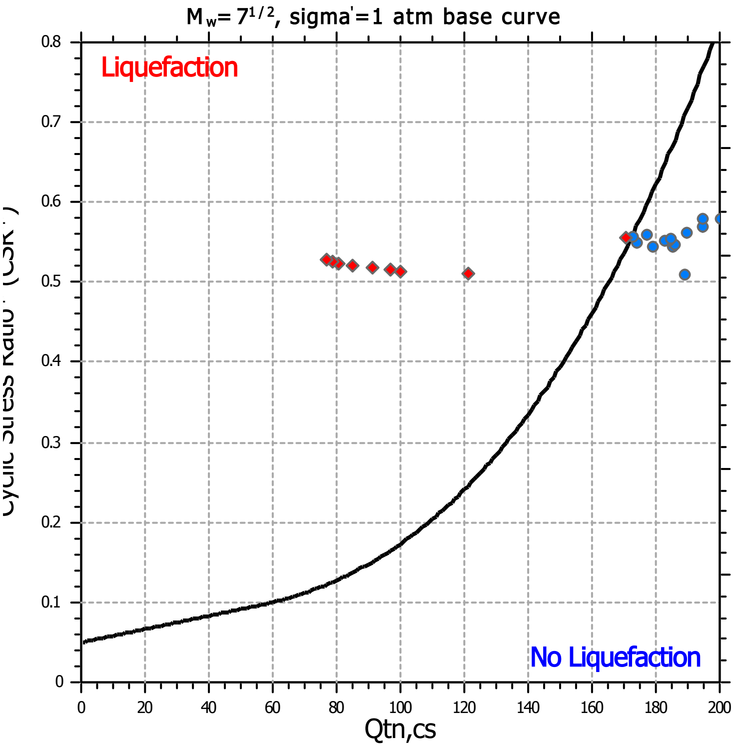
Project title : Cole CampusCole Campus – Central | Location : Oakland

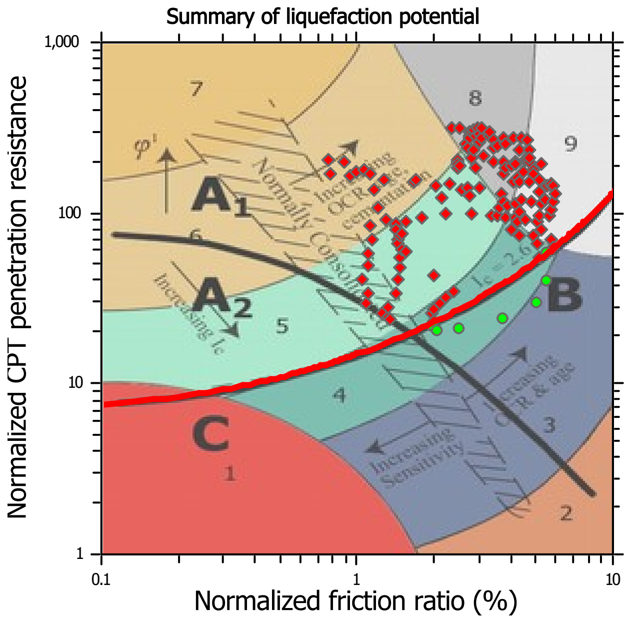
CPT file : CPT-04

Input parameters and analysis data

Analysis method:	NCEER (1998)	G.W.T. (in-situ):	13.00 ft	Use fill:	No	Clay like behavior applied:	Sands only
Fines correction method:	NCEER (1998)	G.W.T. (earthq.):	12.00 ft	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interva	3	Fill weight:	N/A	Limit depth applie	No
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.70	Unit weight calculatior	Based on SBT	K_σ applied:	Yes	MSF method:	Method basec







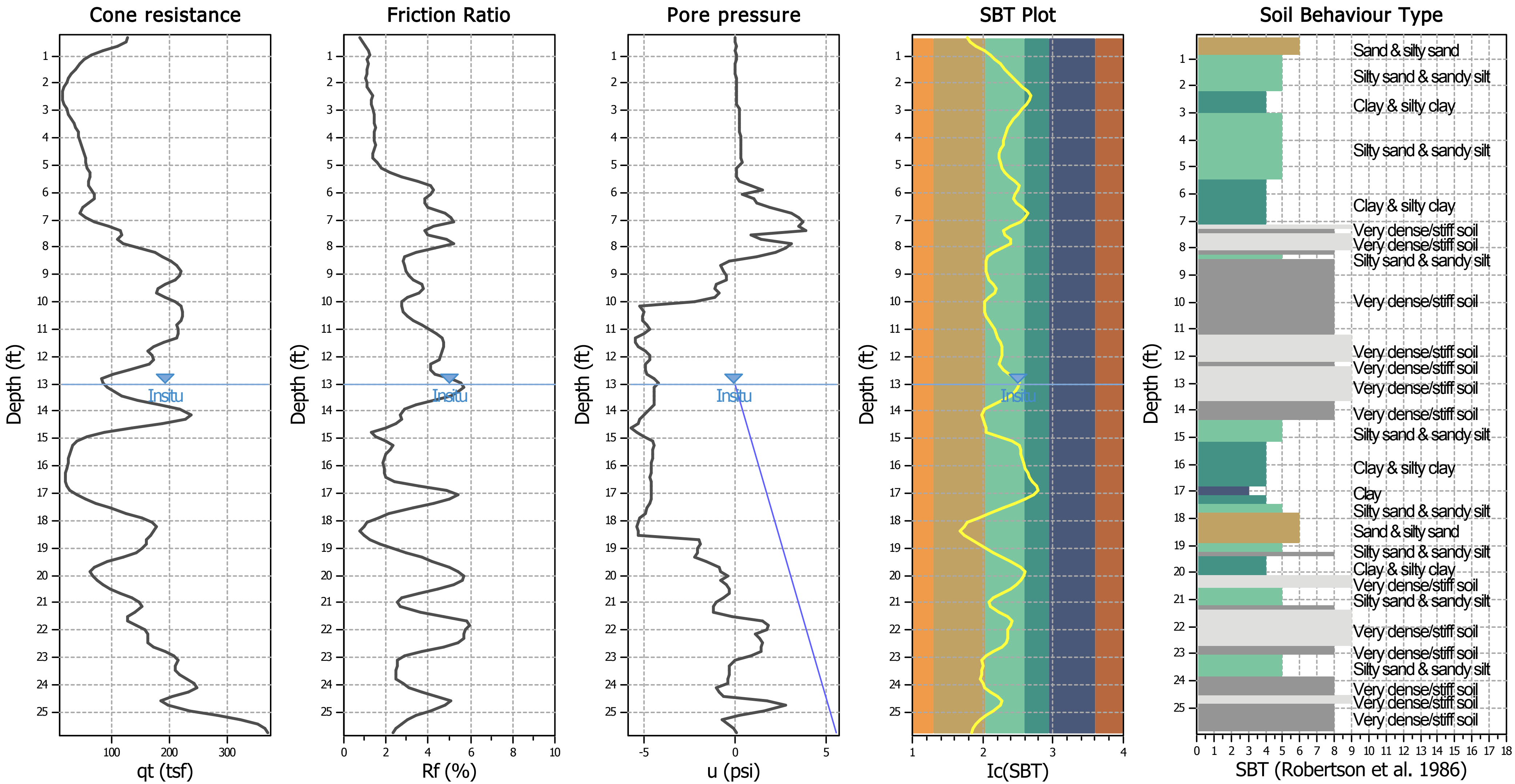
Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading

Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry

Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening

Zone C: Cyclic liquefaction and strength loss possible depending on soil plasticity, brittleness/sensitivity, strain to peak undrained strength and ground geometry

CPT basic interpretation plots



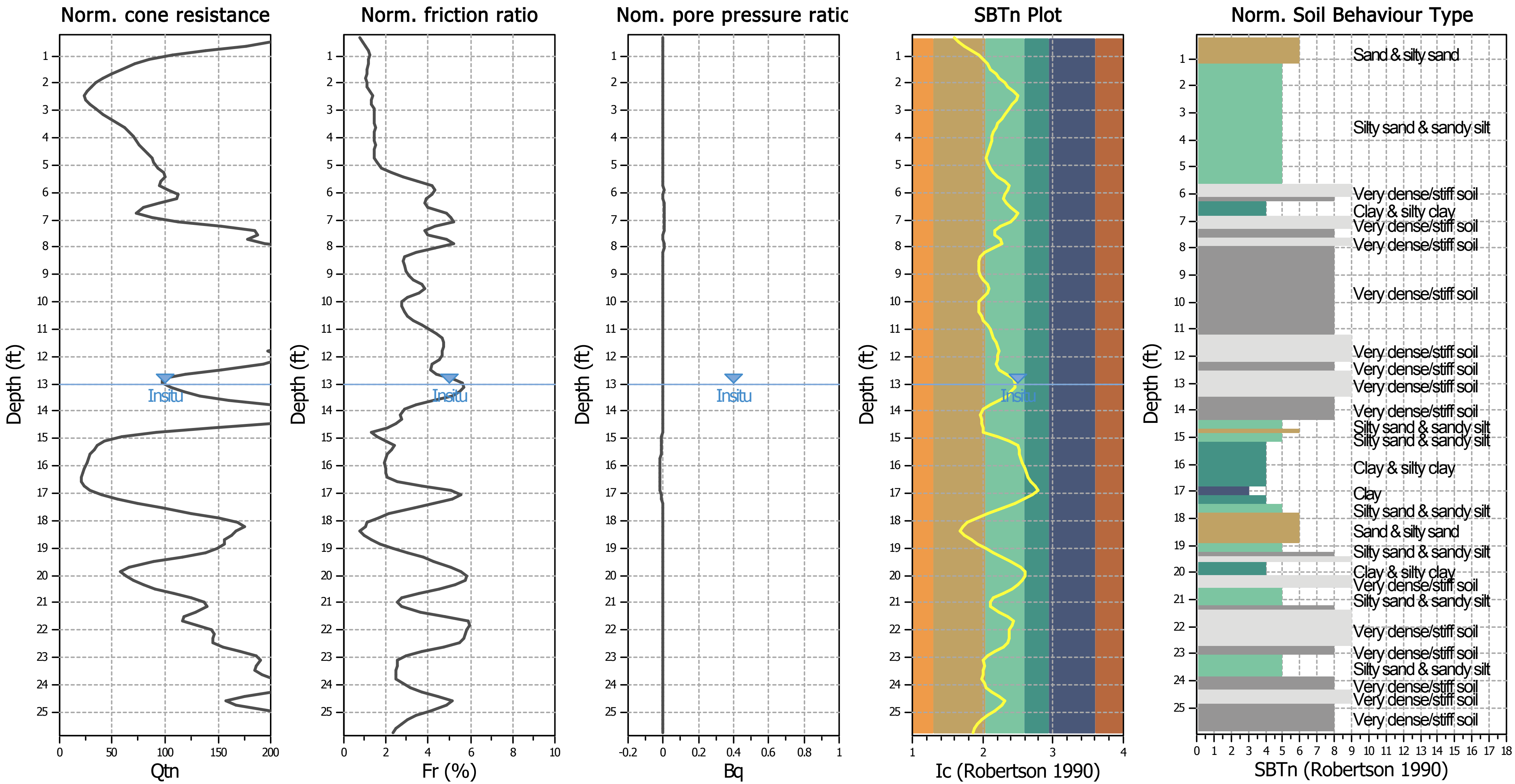
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

CPT basic interpretation plots (normalized)



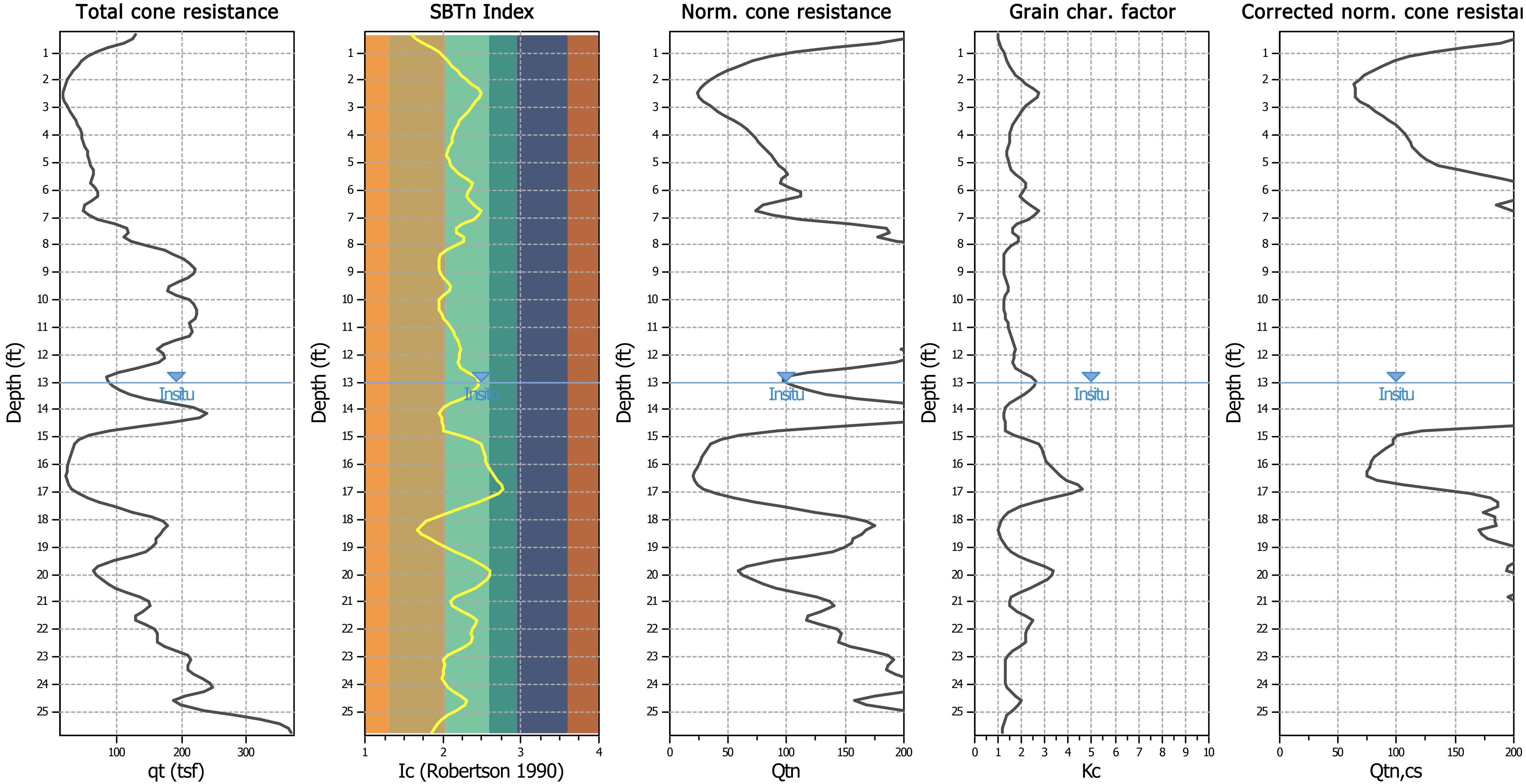
Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

SBTn legend

1. Sensitive fine grained
2. Organic material
3. Clay to silty clay
4. Clayey silt to silty
5. Silty sand to sandy silt
6. Clean sand to silty sand
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

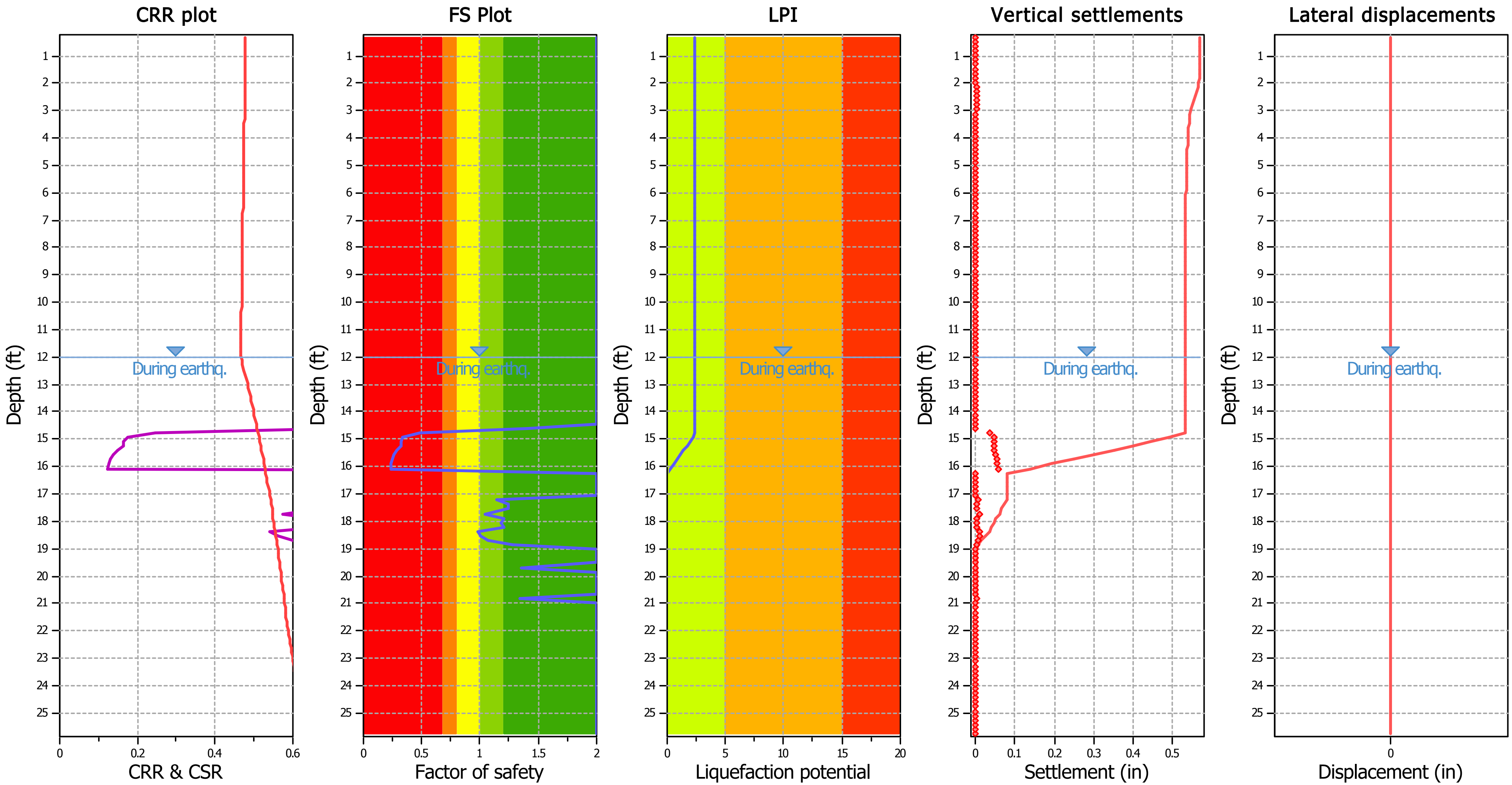
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

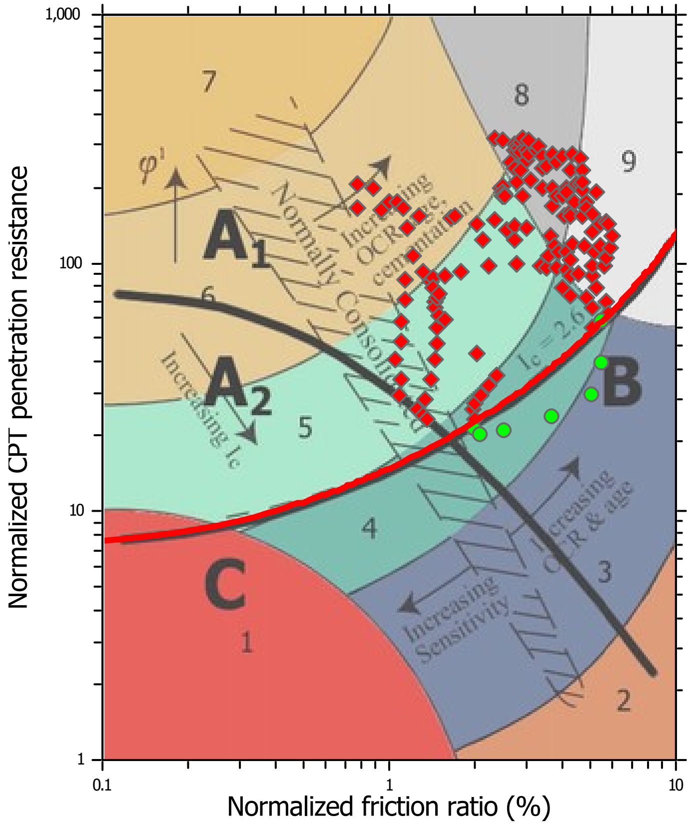
F.S. color scheme

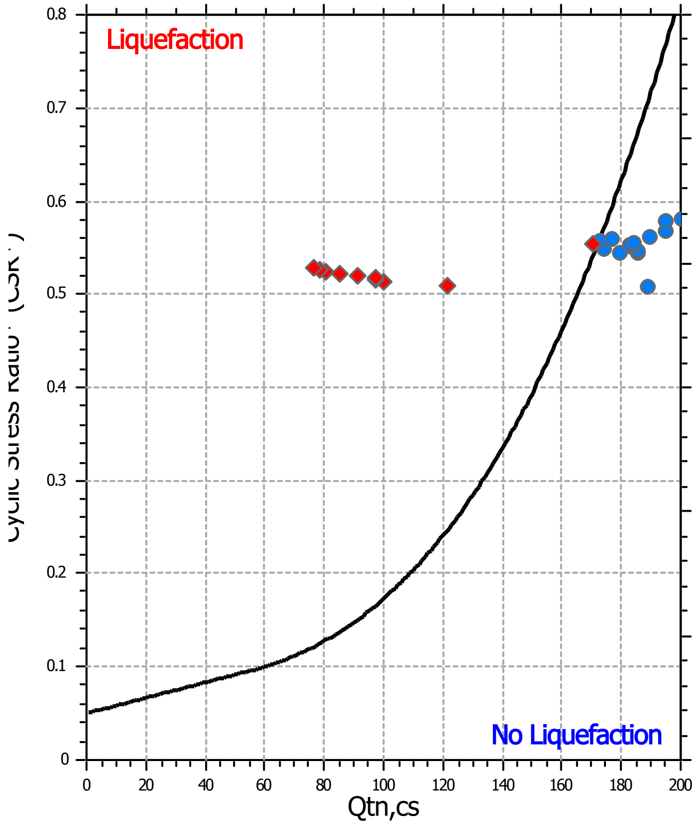
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

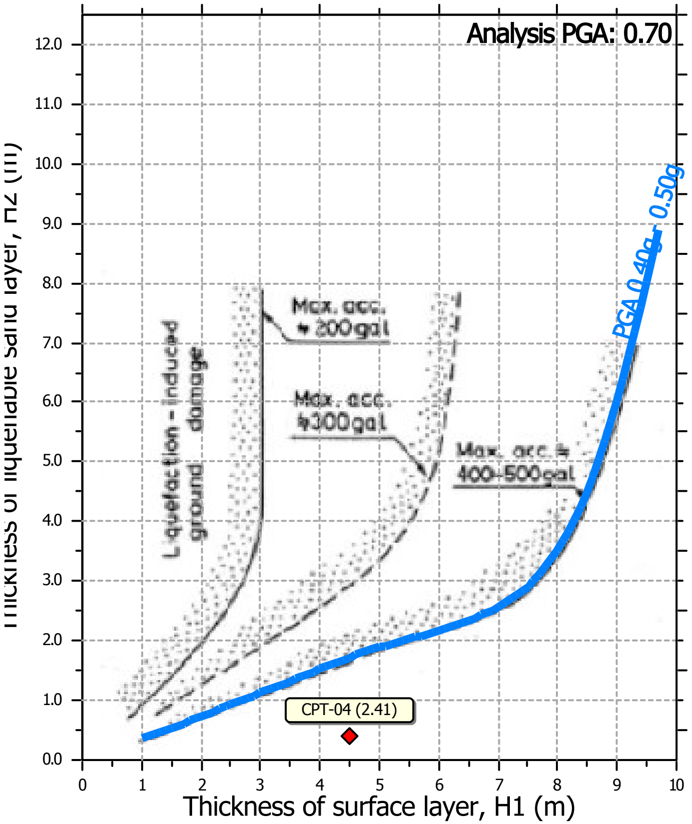
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



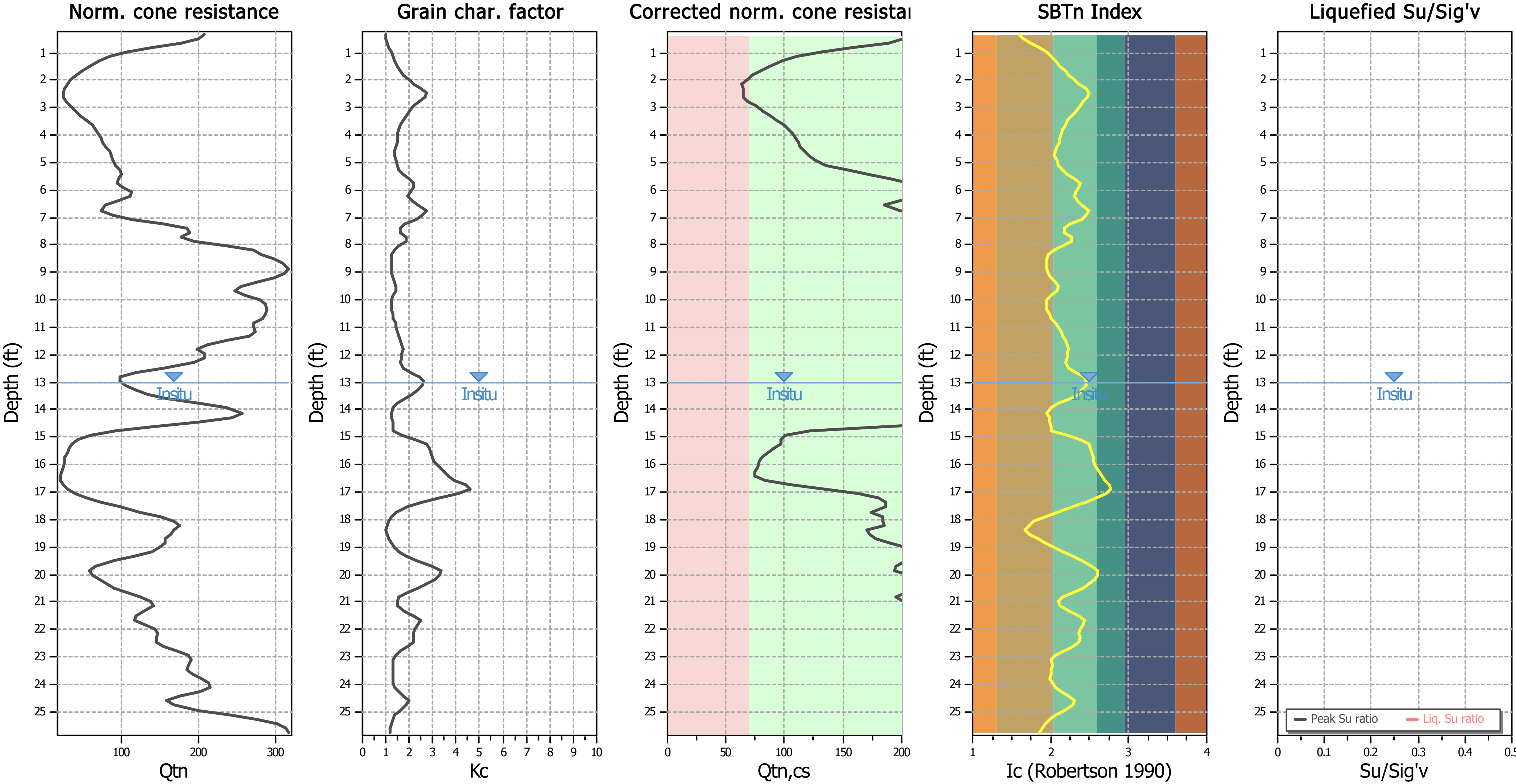




Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

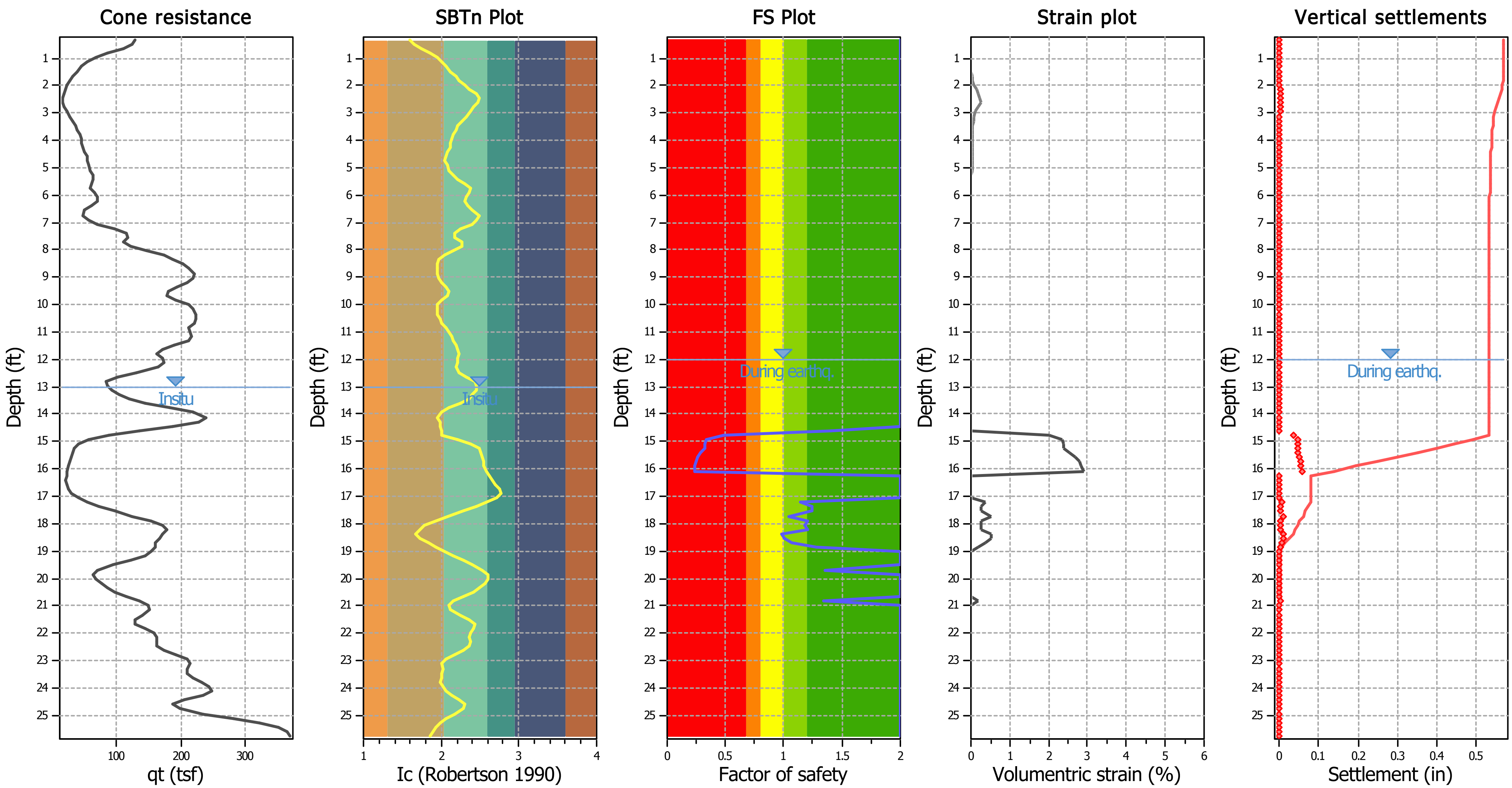
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	NCEER (1998)	Depth to water table (erthq.):	12.00 ft	Fill weight:	N/A
Fines correction method:	NCEER (1998)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.70	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	13.00 ft	Fill height:	N/A	Limit depth:	N/A

Estimation of post-earthquake settlements



Abbreviations

q_t:	Total cone resistance (cone resistance q_c corrected for pore water effects)
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

:: Post-earthquake settlement of dry sands ::

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
0.33	1.60	206.74	1.00	206.74	37	881	0.48	0.001	0.00	10.08	0.00	0.000
0.49	1.65	199.60	1.01	200.62	37	906	0.48	0.002	0.00	10.08	0.00	0.000
0.66	1.74	177.09	1.07	189.07	36	903	0.48	0.002	0.00	10.08	0.00	0.000
0.82	1.85	138.52	1.14	158.38	31	806	0.48	0.003	0.00	10.08	0.00	0.000
0.98	1.94	106.53	1.23	131.26	27	699	0.48	0.005	0.00	10.08	0.00	0.000
1.15	2.00	85.20	1.30	110.55	23	599	0.48	0.008	0.01	10.08	0.01	0.000
1.31	2.06	70.67	1.39	98.29	21	539	0.48	0.011	0.01	10.08	0.01	0.000
1.48	2.12	58.66	1.49	87.21	19	480	0.48	0.018	0.02	10.08	0.02	0.000
1.64	2.18	48.69	1.63	79.26	18	433	0.48	0.027	0.03	10.08	0.03	0.000
1.80	2.24	40.75	1.76	71.74	16	388	0.48	0.044	0.06	10.08	0.05	0.001
1.97	2.31	34.25	1.98	67.74	16	357	0.48	0.070	0.09	10.08	0.08	0.002
2.13	2.36	29.47	2.17	63.88	15	329	0.48	0.116	0.16	10.08	0.13	0.003
2.30	2.45	25.66	2.51	64.41	16	318	0.48	0.160	0.21	10.08	0.17	0.004
2.46	2.49	23.72	2.73	64.86	17	312	0.48	0.205	0.26	10.08	0.21	0.004
2.62	2.48	24.40	2.65	64.69	16	314	0.48	0.231	0.29	10.08	0.24	0.005
2.79	2.42	28.24	2.42	68.27	17	341	0.48	0.180	0.22	10.08	0.18	0.004
2.95	2.37	34.23	2.20	75.18	18	386	0.48	0.118	0.13	10.08	0.11	0.002
3.12	2.32	40.80	2.00	81.54	19	429	0.48	0.087	0.09	10.08	0.08	0.002
3.28	2.26	47.69	1.84	87.69	20	470	0.48	0.069	0.07	10.08	0.06	0.001
3.45	2.22	54.75	1.71	93.78	21	509	0.48	0.058	0.05	10.08	0.05	0.001
3.61	2.19	61.10	1.63	99.73	22	545	0.47	0.051	0.04	10.08	0.04	0.001
3.77	2.15	66.23	1.56	103.14	23	566	0.47	0.049	0.04	10.08	0.04	0.001
3.94	2.13	69.91	1.52	106.28	23	584	0.47	0.049	0.04	10.08	0.03	0.001
4.10	2.12	72.79	1.50	109.18	24	600	0.47	0.048	0.04	10.08	0.03	0.001
4.27	2.11	75.67	1.48	112.06	24	616	0.47	0.048	0.04	10.08	0.03	0.001
4.43	2.08	79.51	1.43	113.39	24	623	0.47	0.050	0.04	10.08	0.03	0.001
4.59	2.07	83.72	1.40	116.84	25	641	0.47	0.049	0.04	10.08	0.03	0.001
4.76	2.05	87.29	1.38	120.05	26	658	0.47	0.049	0.04	10.08	0.03	0.001
4.92	2.07	89.26	1.41	125.95	27	692	0.47	0.045	0.03	10.08	0.03	0.001
5.09	2.10	92.88	1.46	135.67	29	746	0.47	0.039	0.02	10.08	0.02	0.000
5.25	2.15	98.33	1.56	153.73	34	844	0.47	0.031	0.02	10.08	0.01	0.000
5.41	2.22	100.13	1.72	171.97	39	933	0.47	0.026	0.01	10.08	0.01	0.000
5.58	2.31	95.68	1.98	189.90	45	1000	0.47	0.024	0.01	10.08	0.01	0.000
5.74	2.37	94.17	2.19	206.64	50	1061	0.47	0.023	0.01	10.08	0.01	0.000
5.91	2.36	102.24	2.15	220.20	53	1136	0.47	0.021	0.01	10.08	0.01	0.000
6.07	2.32	111.97	2.03	227.15	54	1190	0.47	0.020	0.01	10.08	0.01	0.000
6.23	2.30	111.53	1.96	218.08	51	1153	0.47	0.022	0.01	10.08	0.01	0.000
6.40	2.34	95.13	2.08	198.25	47	1032	0.47	0.028	0.01	10.08	0.01	0.000
6.56	2.40	79.23	2.33	184.80	46	933	0.47	0.036	0.01	10.08	0.01	0.000
6.73	2.49	72.86	2.73	199.25	51	959	0.47	0.035	0.01	10.08	0.01	0.000
6.89	2.46	88.22	2.56	226.07	57	1110	0.47	0.027	0.01	10.08	0.01	0.000
7.05	2.40	111.99	2.32	260.00	64	1314	0.47	0.021	0.01	10.08	0.00	0.000
7.22	2.25	153.75	1.81	277.79	64	1494	0.47	0.018	0.00	10.08	0.00	0.000
7.38	2.17	184.82	1.59	293.93	65	1611	0.47	0.016	0.00	10.08	0.00	0.000
7.55	2.18	187.68	1.62	303.62	68	1661	0.47	0.016	0.00	10.08	0.00	0.000
7.71	2.26	177.75	1.84	326.24	76	1749	0.47	0.015	0.00	10.08	0.00	0.000
7.87	2.27	194.29	1.86	361.04	84	1930	0.47	0.014	0.00	10.08	0.00	0.000
8.04	2.15	236.05	1.56	368.90	82	2025	0.47	0.013	0.00	10.08	0.00	0.000

:: Post-earthquake settlement of dry sands :: (continued)

Depth (ft)	Ic	Q_{tn}	Kc	$Q_{tn,cs}$	$N_{1,60}$ (blows)	G_{max} (tsf)	CSR	Shear, γ (%)	$e_{vol(15)}$ (%)	N_c	e_v (%)	Settle. (in)
8.20	2.04	271.34	1.35	366.95	78	2071	0.47	0.013	0.00	10.08	0.00	0.000
8.37	1.97	280.45	1.26	353.43	73	2029	0.47	0.014	0.00	10.08	0.00	0.000
8.53	1.94	298.23	1.23	367.01	75	2130	0.47	0.013	0.00	10.08	0.00	0.000
8.69	1.94	308.64	1.23	380.68	78	2239	0.47	0.013	0.00	10.08	0.00	0.000
8.86	1.95	316.60	1.24	391.17	80	2332	0.47	0.012	0.00	10.08	0.00	0.000
9.02	1.97	311.44	1.26	392.63	81	2377	0.47	0.012	0.00	10.08	0.00	0.000
9.19	2.01	297.09	1.31	388.46	81	2387	0.47	0.013	0.00	10.08	0.00	0.000
9.35	2.06	275.14	1.39	383.40	82	2378	0.47	0.013	0.00	10.08	0.00	0.000
9.51	2.09	253.53	1.44	365.48	79	2285	0.47	0.014	0.00	10.08	0.00	0.000
9.68	2.07	247.10	1.41	347.93	75	2211	0.47	0.015	0.00	10.08	0.00	0.000
9.84	2.00	259.87	1.30	338.69	71	2185	0.47	0.015	0.00	10.08	0.00	0.000
10.01	1.95	278.91	1.24	346.41	71	2250	0.47	0.015	0.00	10.08	0.00	0.000
10.17	1.94	286.00	1.23	352.98	72	2315	0.47	0.015	0.00	10.08	0.00	0.000
10.34	1.96	288.04	1.25	358.79	73	2384	0.47	0.015	0.00	10.08	0.00	0.000
10.50	1.98	287.11	1.27	365.80	76	2466	0.47	0.014	0.00	10.08	0.00	0.000
10.66	2.01	282.48	1.32	371.87	78	2541	0.47	0.014	0.00	10.08	0.00	0.000
10.83	2.07	271.44	1.40	379.40	81	2621	0.47	0.014	0.00	10.08	0.00	0.000
10.99	2.10	271.78	1.46	395.70	86	2753	0.47	0.013	0.00	10.08	0.00	0.000
11.16	2.13	272.73	1.51	412.00	90	2885	0.47	0.013	0.00	10.08	0.00	0.000
11.32	2.16	265.10	1.57	416.35	92	2927	0.47	0.013	0.00	10.08	0.00	0.000
11.48	2.19	236.29	1.64	388.51	87	2734	0.47	0.014	0.00	10.08	0.00	0.000
11.65	2.22	211.69	1.70	360.90	82	2547	0.47	0.016	0.00	10.08	0.00	0.000
11.81	2.23	197.86	1.73	342.51	78	2434	0.47	0.017	0.00	10.08	0.00	0.000
11.98	2.21	206.57	1.70	350.61	79	2532	0.47	0.016	0.00	10.08	0.00	0.000

Total estimated settlement: 0.04

Abbreviations

- Q_{tn}: Equivalent clean sand normalized cone resistance
- K_c: Fines correction factor
- $Q_{tn,cs}$: Post-liquefaction volumentric strain
- G_{max}: Small strain shear modulus
- CSR: Soil cyclic stress ratio
- γ: Cyclic shear strain
- $e_{vol(15)}$: Volumetric strain after 15 cycles
- N_c: Equivalent number of cycles
- e_v: Volumetric strain
- Settle.: Calculated settlement

:: Post-earthquake settlement due to soil liquefaction ::

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
12.14	345.98	2.00	0.00	1.00	0.00	12.30	315.92	2.00	0.00	1.00	0.00
12.47	271.17	2.00	0.00	1.00	0.00	12.63	240.99	2.00	0.00	1.00	0.00
12.80	238.31	2.00	0.00	1.00	0.00	12.96	252.01	2.00	0.00	1.00	0.00
13.12	266.40	2.00	0.00	1.00	0.00	13.29	276.70	2.00	0.00	1.00	0.00
13.45	282.96	2.00	0.00	1.00	0.00	13.62	284.60	2.00	0.00	1.00	0.00
13.78	294.02	2.00	0.00	1.00	0.00	13.94	308.69	2.00	0.00	1.00	0.00
14.11	320.50	2.00	0.00	1.00	0.00	14.27	309.19	2.00	0.00	1.00	0.00
14.44	257.15	2.00	0.00	1.00	0.00	14.60	189.38	1.40	0.00	1.00	0.00
14.76	121.35	0.48	1.99	1.00	0.04	14.93	100.29	0.34	2.33	1.00	0.05
15.09	97.04	0.32	2.39	1.00	0.05	15.26	97.05	0.32	2.39	1.00	0.05
15.42	91.27	0.29	2.52	1.00	0.05	15.58	85.10	0.26	2.67	1.00	0.05

:: Post-earthquake settlement due to soil liquefaction :: (continued)

Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)	Depth (ft)	$Q_{tn,cs}$	FS	e_v (%)	DF	Settlement (in)
15.75	80.74	0.25	2.78	1.00	0.06	15.91	78.51	0.24	2.85	1.00	0.05
16.08	76.61	0.23	2.91	1.00	0.06	16.24	74.45	2.00	0.00	1.00	0.00
16.40	74.78	2.00	0.00	1.00	0.00	16.57	82.71	2.00	0.00	1.00	0.00
16.73	104.98	2.00	0.00	1.00	0.00	16.90	134.62	2.00	0.00	1.00	0.00
17.06	162.48	2.00	0.00	1.00	0.00	17.23	179.60	1.14	0.38	1.00	0.01
17.39	185.78	1.24	0.26	1.00	0.01	17.55	186.16	1.25	0.26	1.00	0.01
17.72	174.49	1.05	0.53	1.00	0.01	17.88	184.09	1.20	0.27	1.00	0.01
18.05	183.28	1.18	0.27	1.00	0.01	18.21	184.88	1.21	0.26	1.00	0.01
18.37	170.55	0.98	0.54	1.00	0.01	18.54	173.13	1.01	0.53	1.00	0.01
18.70	177.43	1.07	0.38	1.00	0.01	18.87	189.95	1.28	0.18	1.00	0.00
19.03	203.59	2.00	0.00	1.00	0.00	19.19	216.70	2.00	0.00	1.00	0.00
19.36	219.06	2.00	0.00	1.00	0.00	19.52	204.26	2.00	0.00	1.00	0.00
19.69	195.16	1.36	0.00	1.00	0.00	19.85	193.27	2.00	0.00	1.00	0.00
20.01	206.72	2.00	0.00	1.00	0.00	20.18	216.94	2.00	0.00	1.00	0.00
20.34	220.18	2.00	0.00	1.00	0.00	20.51	213.82	2.00	0.00	1.00	0.00
20.67	204.29	2.00	0.00	1.00	0.00	20.83	195.13	1.34	0.18	1.00	0.00
21.00	200.76	2.00	0.00	1.00	0.00	21.16	208.94	2.00	0.00	1.00	0.00
21.33	228.51	2.00	0.00	1.00	0.00	21.49	254.09	2.00	0.00	1.00	0.00
21.65	286.37	2.00	0.00	1.00	0.00	21.82	307.54	2.00	0.00	1.00	0.00
21.98	319.20	2.00	0.00	1.00	0.00	22.15	320.92	2.00	0.00	1.00	0.00
22.31	318.75	2.00	0.00	1.00	0.00	22.47	310.07	2.00	0.00	1.00	0.00
22.64	295.03	2.00	0.00	1.00	0.00	22.80	275.31	2.00	0.00	1.00	0.00
22.97	260.62	2.00	0.00	1.00	0.00	23.13	251.25	2.00	0.00	1.00	0.00
23.30	247.07	2.00	0.00	1.00	0.00	23.46	244.40	2.00	0.00	1.00	0.00
23.62	250.83	2.00	0.00	1.00	0.00	23.79	261.18	2.00	0.00	1.00	0.00
23.95	282.33	2.00	0.00	1.00	0.00	24.12	297.88	2.00	0.00	1.00	0.00
24.28	307.86	2.00	0.00	1.00	0.00	24.44	307.38	2.00	0.00	1.00	0.00
24.61	313.85	2.00	0.00	1.00	0.00	24.77	315.07	2.00	0.00	1.00	0.00
24.94	322.17	2.00	0.00	1.00	0.00	25.10	336.50	2.00	0.00	1.00	0.00
25.26	355.19	2.00	0.00	1.00	0.00	25.43	367.51	2.00	0.00	1.00	0.00
25.59	368.19	2.00	0.00	1.00	0.00	25.76	364.99	2.00	0.00	1.00	0.00

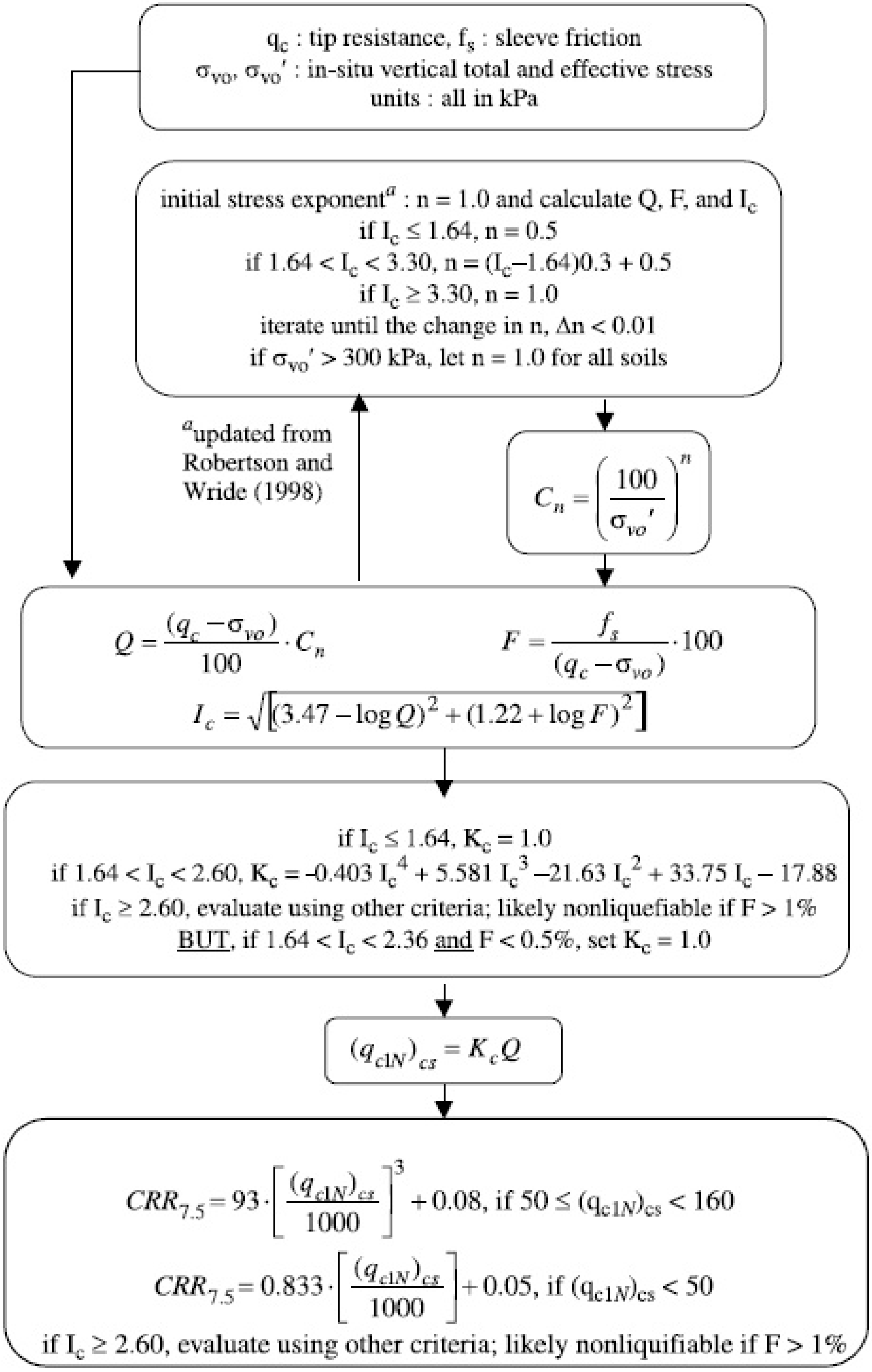
Total estimated settlement: 0.53

Abbreviations

$Q_{tn,cs}$: Equivalent clean sand normalized cone resistance
FS: Factor of safety against liquefaction
e_v (%): Post-liquefaction volumentric strain
DF: e_v depth weighting factor
Settlement: Calculated settlement

Procedure for the evaluation of soil liquefaction resistance, NCEER (1998)

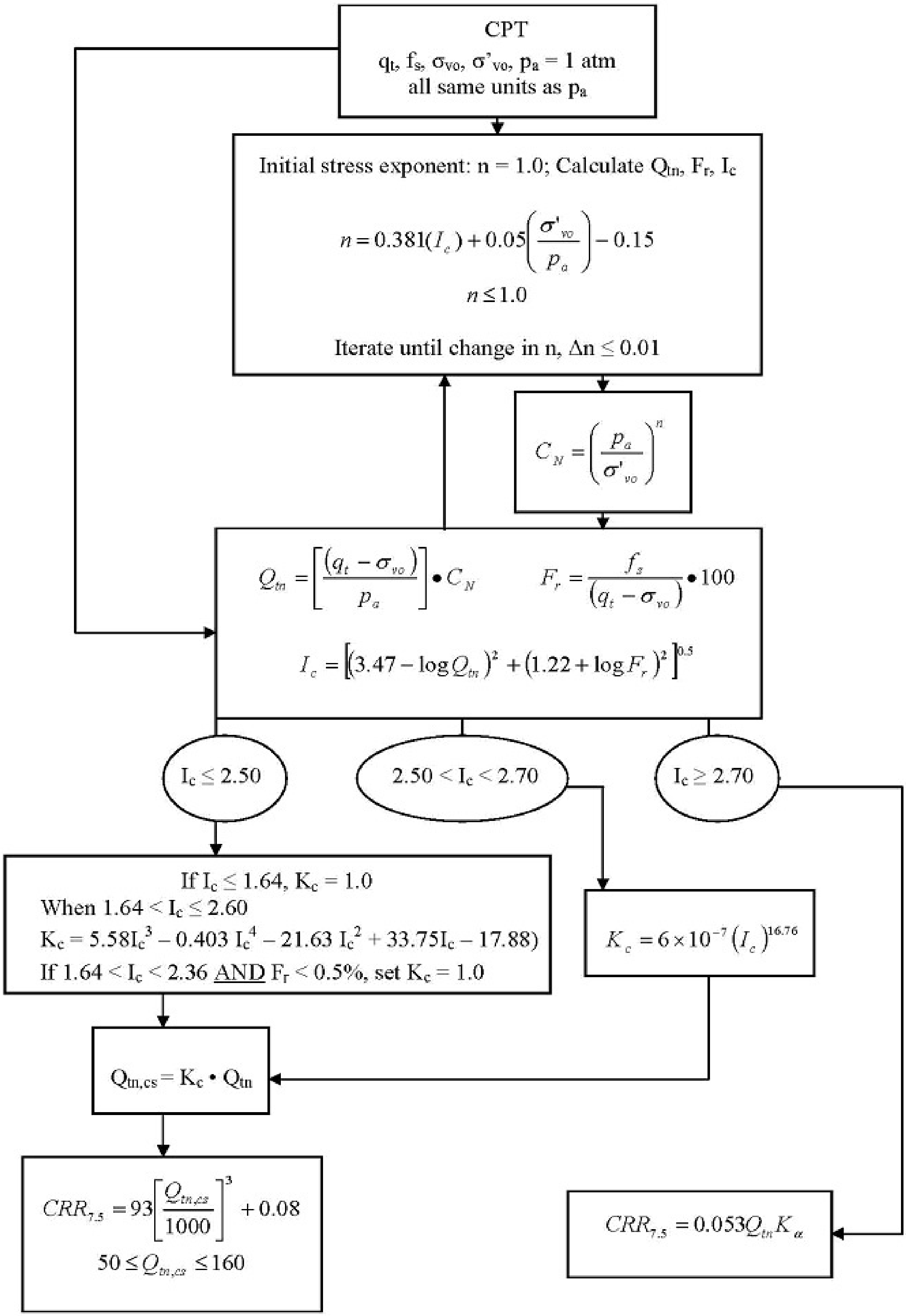
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:



[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

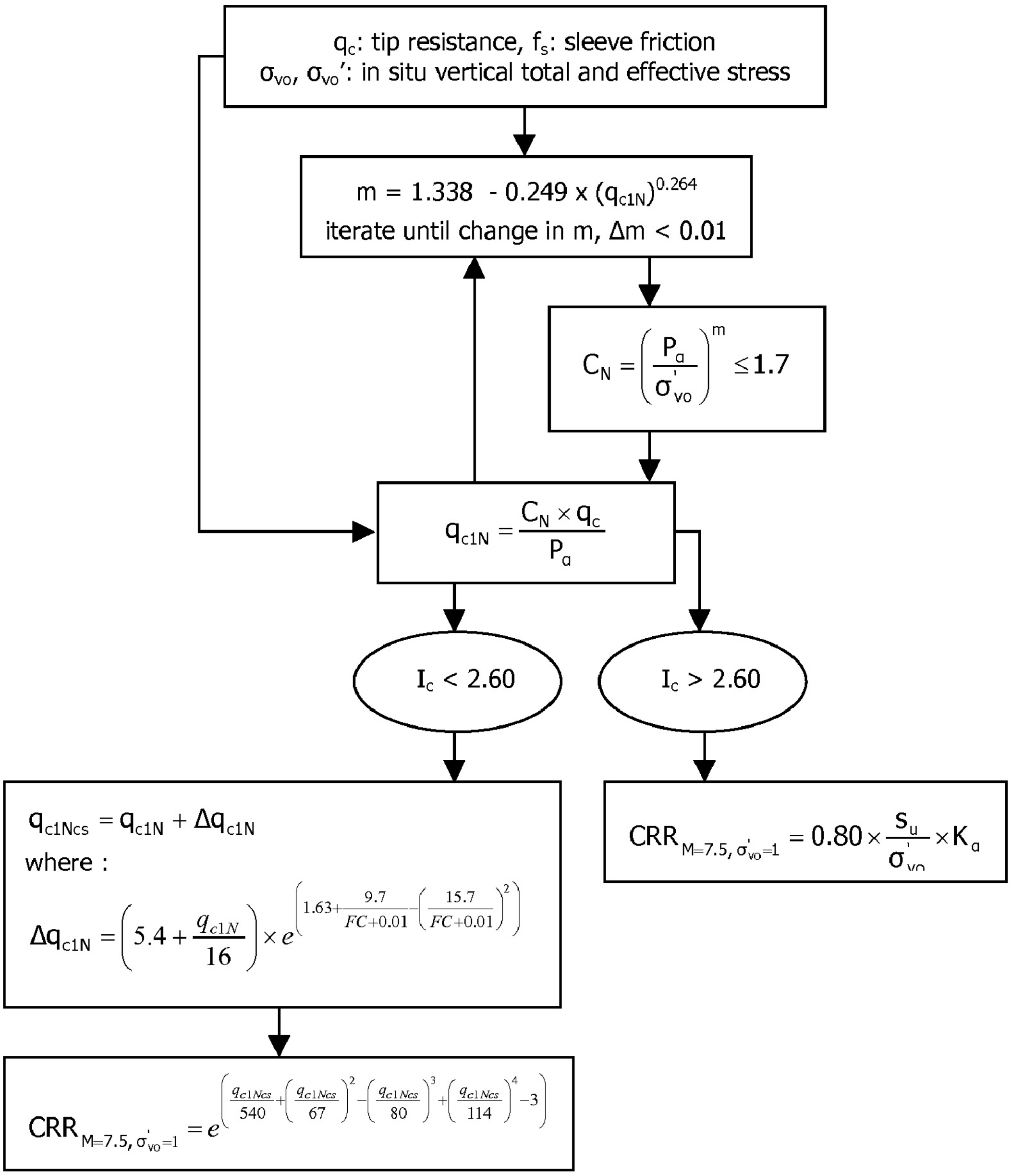
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. This procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of Soils). The revised procedure is presented below in the form of a flowchart[1]:

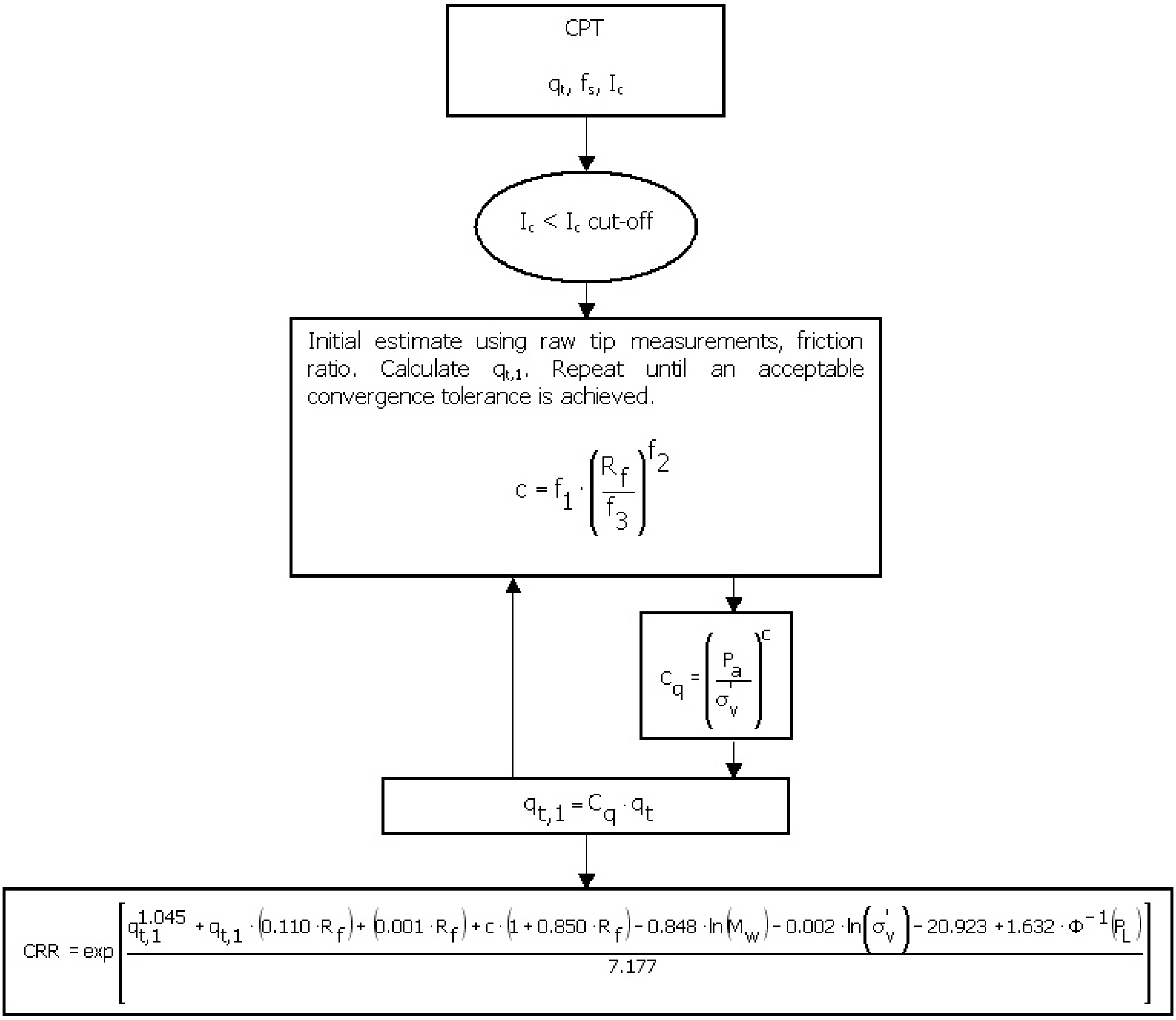


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of soil liquefaction resistance, Boulanger & Idriss(2014)

$$FS_{liq} = \frac{CRR_{M=7.5,\sigma'_v=1atm}}{CSR_{M=7.5,\sigma'_v=1atm}}$$

$$CSR_{M=7.5,\sigma'_v=1atm} = 0.65\frac{\sigma_v}{\sigma'_v}\frac{a_{\max}}{g}r_d\frac{1}{MSF}\frac{1}{K_\sigma}$$

$$r_d = \exp\left[\alpha(z)+\beta(z)\cdot M\right]$$

$$\alpha(z) = -1.012-1.126\sin\left(\frac{z}{11.73}+5.133\right)$$

$$\beta(z) = 0.106+0.118\sin\left(\frac{z}{11.28}+5.142\right)$$

$$K_\sigma = 1-C_\sigma \ln\left(\frac{\sigma'_v}{P_a}\right)\leq 1.1$$

$$C_\sigma = \frac{1}{37.3-8.27\left(q_{c1Ncs}\right)^{0.264}}\leq 0.3$$

$$MSF = 1+\left(MSF_{max}-1\right)\left(8.64\exp\left(\frac{-M}{4}\right)-1.325\right)$$

$$MSF_{max} = 1.09+\left(\frac{q_{c1Ncs}}{180}\right)^3\leq 2.2$$

σ'_v and σ_v at start of earthquake shaking

$$CRR_{M=7.5,\sigma'_v=1atm} = \exp\left(\frac{q_{c1Ncs}}{113}+\left(\frac{q_{c1Ncs}}{1000}\right)^2-\left(\frac{q_{c1Ncs}}{140}\right)^3+\left(\frac{q_{c1Ncs}}{137}\right)^4-2.80\right)$$

$$q_{c1Ncs} = q_{c1N}+\Delta q_{c1N}$$

$$\Delta q_{c1N} = \left(11.9+\frac{q_{c1N}}{14.6}\right)\exp\left(1.63-\frac{9.7}{FC+2}-\left(\frac{15.7}{FC+2}\right)^2\right)$$

$$q_{c1N} = C_{N\sigma}\frac{q_c}{P_a}$$

$$C_{N\sigma} = \left(\frac{P_a}{\sigma'_v}\right)^m\leq 1.7$$

$$m = 1.338-0.249\left(q_{c1Ncs}\right)^{0.264}\quad with\quad 0.264\leq m\leq 0.782$$

$$FC = 80\left(I_C+C_{FC}\right)-137\quad with\quad 0\%\leq FC\leq 100\%$$

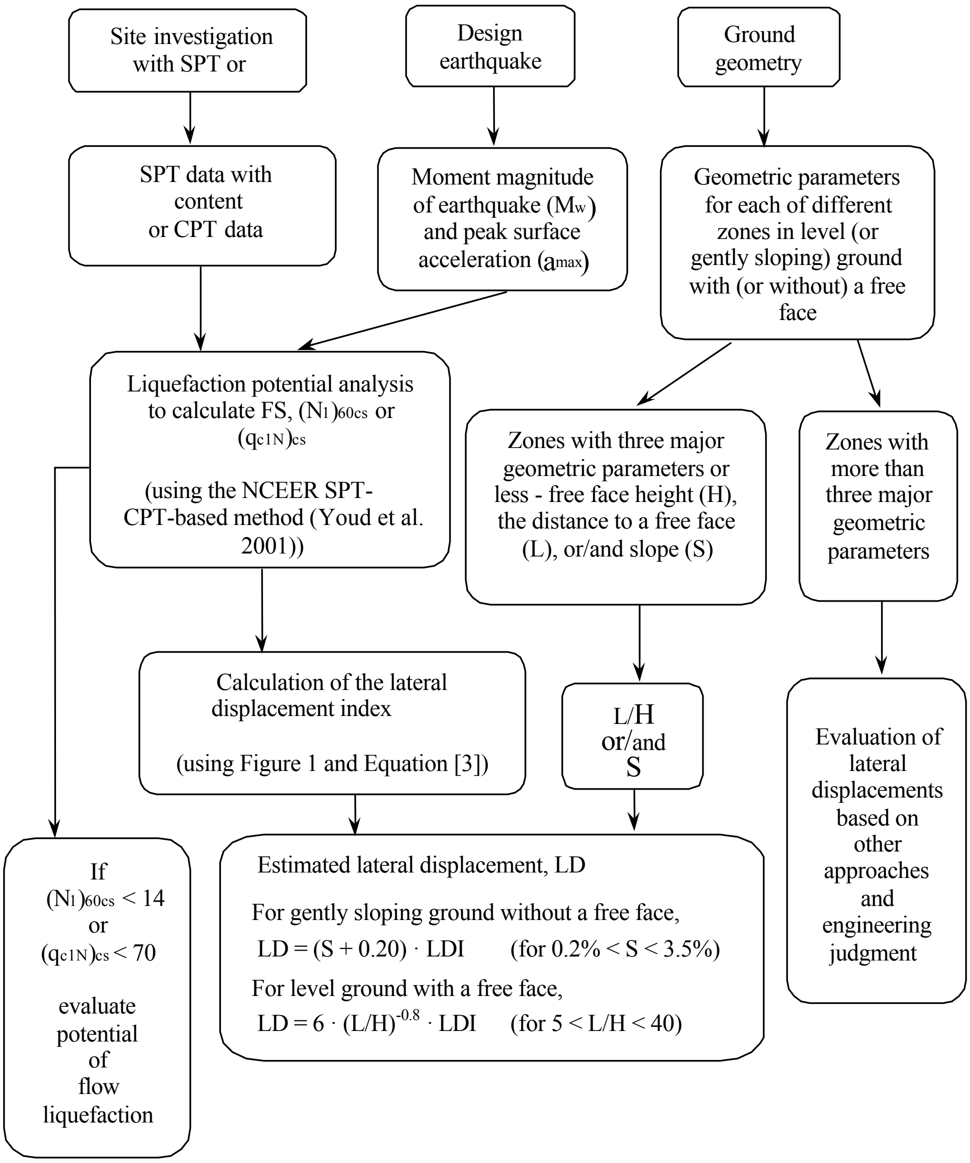
$$I_c = \left[\left(3.47-\log(Q)\right)^2+\left(1.22+\log(F)\right)^2\right]^{0.5}$$

$$Q = \left(\frac{q_c-\sigma_{vc}}{P_a}\right)\left(\frac{P_a}{\sigma'_{vc}}\right)^n\ with\ 0.5\leq n\leq 1.0\ per\ Robertson\ \&\ Wride\ (1998)$$

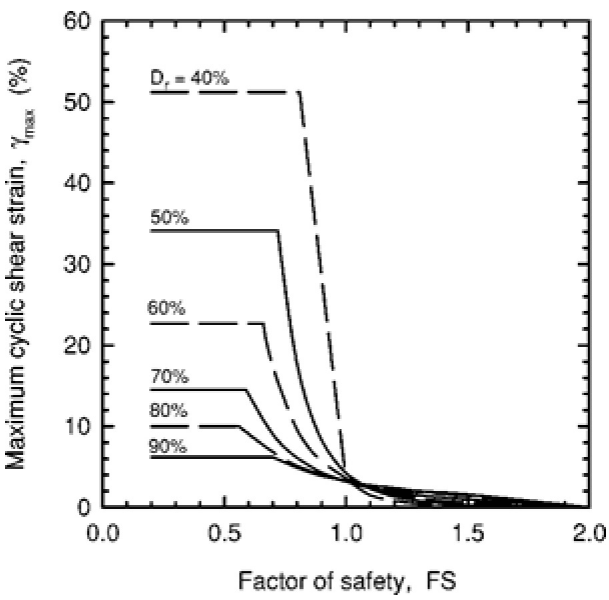
$$F = \left(\frac{f_s}{q_c-\sigma_{vc}}\right)\cdot 100\%$$

σ'_v at time of CPT sounding

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



[1] Flow chart illustrating major steps in estimating liquefaction-induced lateral spreading displacements using the proposed approach



[1] Figure 1

$$LDI = \int_0^{Z_{max}} \gamma_{max} dz$$

[1] Equation [3]

[1] "Estimating liquefaction-induced ground settlements from CPT for level ground", G. Zhang, P.K. Robertson, and R.W.I. Brachman

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

$$\tau_{av} = CSR^{*} \cdot \sigma_{v0}' = 0.65 \cdot \frac{\alpha_{max}}{g} \cdot \sigma_{v0} \cdot \tau_{a}$$

↓

Estimate small shear strain modulus, G_0

$$G_0 = 0.0188 \cdot \left[10^{(0.55 I_c - 1.68)}\right] \cdot (q_t - \sigma_v)$$

↓

Estimate shear strain amplitude, γ

(based on Pradel (1998))

$$\gamma = \left[\frac{1 + \alpha \cdot e^{bR}}{1 + \alpha}\right] \cdot R \cdot 100\ (\%)$$

$$R = \frac{\tau_{av}}{G_0}\ (\text{Note } \tau_{av} \text{ and } G_0 \text{ same units})$$

$$\alpha = 0.0389 \cdot \left(\frac{\sigma_v}{p_a}\right) + 0.124$$

$$b = 6400 \cdot \left(\frac{\sigma_v}{p_a}\right)$$

↓

Estimate volumetric strain in 15 cycles

$$\varepsilon_{vol(15)} = \gamma \cdot \left[\frac{(N_1)_{60,cs}}{20}\right]^{-1.20}$$

$$(N_1)_{60,cs} = \frac{Q_{tn,cs}}{8.5 \cdot \left[1 - \frac{I_c}{4.6}\right]}$$

↓

Volumetric strain in design earthquake

$$\Sigma_{vol} = \varepsilon_{vol(15)} \cdot \left[\frac{N_c}{15}\right]^{0.45}$$

$$N_c = (M - 4)^{2.17}$$

↓

Seismic settlement, s

$$s = 2 \cdot \int_0^{GWT} \Sigma_{vol} \cdot dz$$

Robertson, P.K. and Lisheng, S., 2010, "Estimation of seismic compression in dry soils using the CPT" FIFTH INTERNATIONAL CONFERENCE ON RECENT ADVANCES IN GEOTECHNICAL EARTHQUAKE ENGINEERING AND SOIL DYNAMICS, Symposium in honor of professor I. M. Idriss, San Diego, CA

Liquefaction Potential Index (LPI) calculation procedure

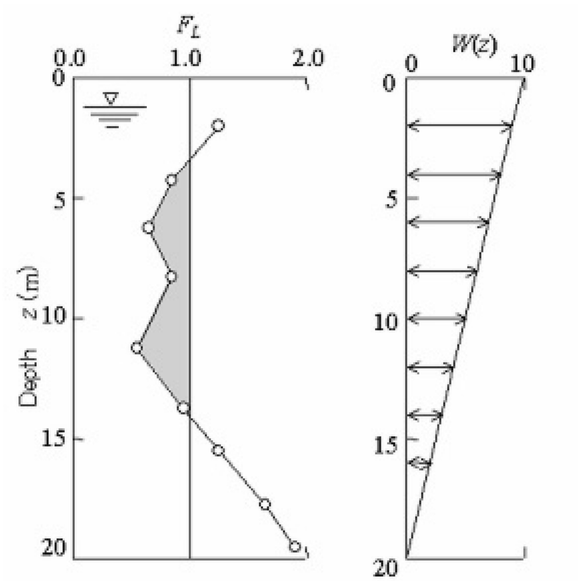
Calculation of the Liquefaction Potential Index (LPI) is used to interpret the liquefaction assessment calculations in terms of severity over depth. The calculation procedure is based on the methology developed by Iwasaki (1982) and is adopted by AFPS.

To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\text{LPI} = \int_0^{20} (10 - 0{,}5_z) \times F_L \times d_z$$

where:
F_L = 1 - F.S. when F.S. less than 1
F_L = 0 when F.S. greater than 1
z depth of measurment in meters

Values of LPI range between zero (0) when no test point is characterized as liquefiable and 100 when all points are characterized as susceptible to liquefaction. Iwasaki proposed four (4) discrete categories based on the numeric value of LPI:



Graphical presentation of the LPI calculation procedure

APPENDIX D

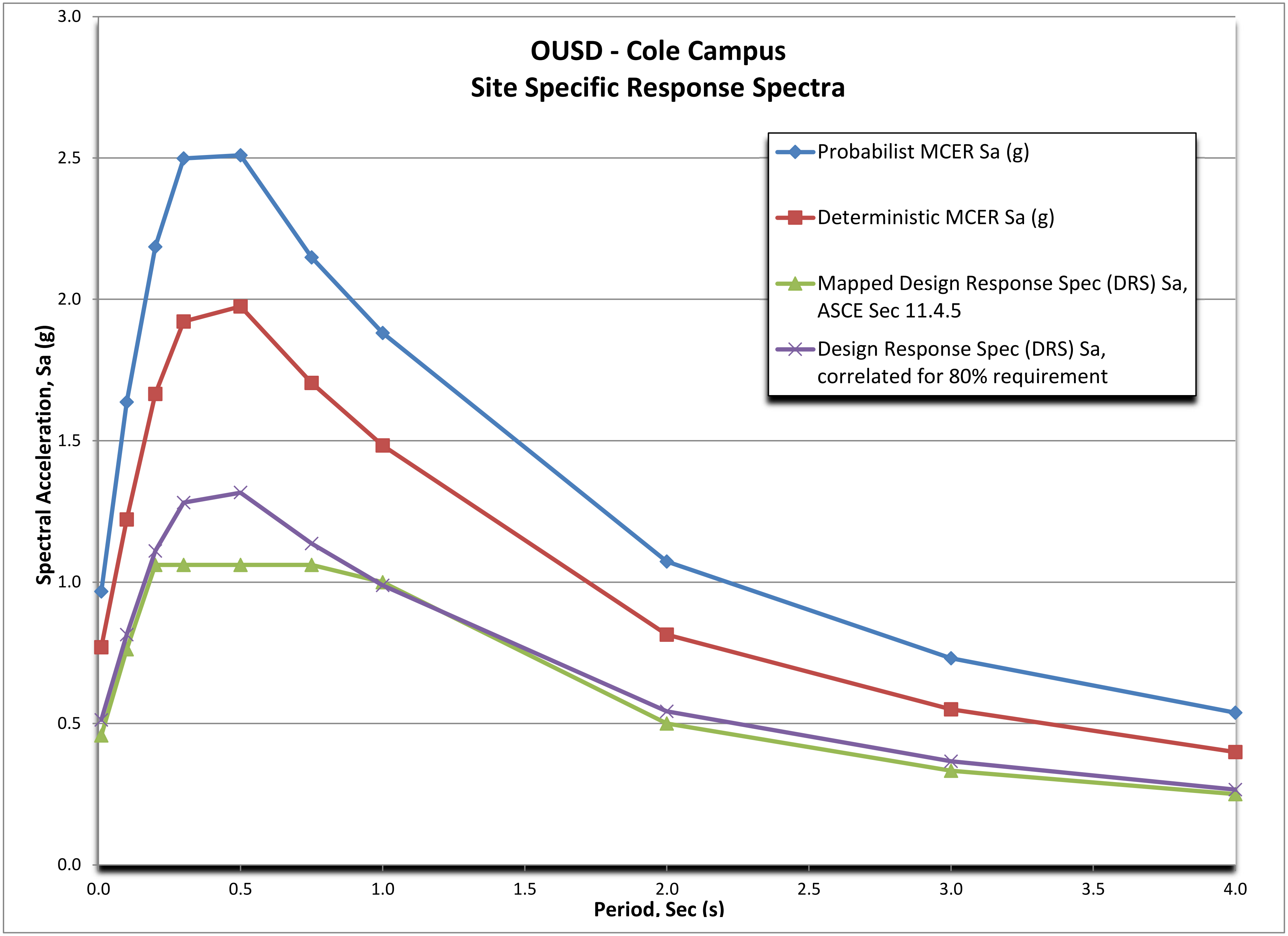
SITE SPECIFIC GROUND MOTION ANALYSIS
Summary Results
Site Specific Response Spectra

Cole Campus: Site Specific Seismic Ground Motion Analysis Summary Table

Period (s)	Probabilist MCER Sa (g)	Deterministic MCER Sa (g)	Site Specific MCER Sa (g)	Site Specific Design Response Spec (DRS) Sa, ASCE Sec 21.3	Mapped Design Response Spec (DRS) Sa, ASCE Sec 11.4.5	% DRS ASCE Sec 21.3 vs 11.4.5	80% of Mapped DRS (ASCE 11.4.5)	Design Response Spec (DRS) Sa, correlated for 80% requirement	per 21.4
0.010	0.967	0.769	0.769	0.513	0.458	112%	0.367	0.513	S_{DS}, 90% of max from 0.2 to 5s
0.100	1.637	1.222	1.222	0.815	0.762	107%	0.610	0.815	
0.200	2.186	1.665	1.665	1.110	1.061	105%	0.849	**1.110**	
0.300	2.499	1.922	1.922	1.281	1.061	121%	0.849	1.281	
0.500	2.510	1.975	1.975	1.317	1.061	124%	0.849	1.317	
0.750	2.148	1.705	1.705	1.136	1.061	107%	0.849	1.136	S_{D1}, max value of Tsa from1 to 5s for $v_{s,30} \leq$ 365.76 m/s
1.000	1.881	1.483	1.483	0.989	1.000	99%	0.800	**0.989**	
2.000	1.073	0.814	0.814	0.543	0.500	109%	0.400	0.543	
3.000	0.731	0.550	0.550	0.367	0.333	110%	0.267	0.367	
4.000	0.538	0.399	0.399	0.266	0.250	106%	0.200	0.266	
5.000	0.420	0.302	0.302	0.201	0.200	101%	0.160	0.201	
PGA	0.896	0.700	**0.700**						

Parameters	Value from Site Specific	Value from Mapped ASCE, Sec 11.4	% Ratio of Site Specific Vs. ASCE
S_{MS}	1.778	1.592	112
S_{M1}	1.650	1.500	110
S_{DS}	1.185	1.061	112
S_{D1}	1.100	1.000	110
T_0	0.186	0.188	**Fig 11.4-1**
T_S	0.928	0.942	**Fig 11.4-1**
T_L	-	8	**Fig 22-12**

F_a	1	**Table 11.4-1**
F_V	2.5	**Section 21.3**
S_S	1.592	**Fig 22-1**
S_1	0.6	**Fig 22-2**
C_{RS}	0.927	**Fig 22-17**
C_{R1}	0.912	**Fig 22-18**


OUSD - Cole Campus
Site Specific Response Spectra
Probabilist MCER Sa (g)
Deterministic MCER Sa (g)
Mapped Design Response Spec (DRS) Sa, ASCE Sec 11.4.5
Design Response Spec (DRS) Sa, correlated for 80% requirement
Spectral Acceleration, Sa (g)
Period, Sec (s)
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0

California
Department of Conservation
California Geological Survey

Gavin Newsom, Governor
David Shabazian, Director

Tadashi Nakadegawa
Acting Deputy Chief of Facilities
Oakland Unified School District
1000 Broadway, Suite 300,
Oakland, CA 94607

September 10, 2020

Subject: **Engineering Geology and Seismology Review for Central Administrative Center at Cole Campus – New Buildings 1011 Union Street, Oakland, CA CGS Application No. 01-CGS4511**

Dear Mr. Nakadegawa:

In accordance with your request and transmittal of documents received on July 17, 2020, the California Geological Survey (CGS) has reviewed the engineering geology and seismology aspects of the consulting report prepared for the subject project at the Central Administrative Center at Cole Campus in Oakland. It is our understanding that this project involves construction of a new two-story office building and a single-story multi-purpose building. This review was performed in accordance with Title 24, California Code of Regulations, 2019 California Building Code (CBC) and followed CGS Note 48 guidelines. We reviewed the following report:

> **Geotechnical Engineering and Geologic Hazards Study, Cole Campus – Central Administrative Center, Oakland, California:** Consolidated Engineering Laboratories, 2001 Crow Canyon Road, Suite 200, San Ramon, California 94583; company Project No. 84-04726-PWA, report dated May 22, 2020, 42 pages, 7 plates, 4 appendices.

Based on our review, the consultants provide a reasonable assessment of most of the engineering geology and seismology issues with respect to the proposed improvements. The principal concerns identified by the consultants are the potential for strong ground shaking. Their evaluation indicates surface fault rupture and deep-seated slope instability are not design concerns for the project.

However, CGS notes that the consultants have not included the possibility of rupture of all the segments of the Hayward fault together as is considered in the UCERF 3 community fault model, for their deterministic MCE_R spectrum used as input in the site-specific ground motion hazard analysis. The consultants are requested to **revise their site-specific ground motion analysis based on this recommendation and provide updated site-specific ground motion parameters, design response spectrum, and PGA_M.** The consultants are also requested to update their liquefaction analyses with the updated PGA_M, as needed.

In conclusion, ***the engineering geology and seismology issues at this site are not adequately assessed in the referenced reports***. It is recommended that additional information be provided as requested in the attached Note 48 Checklist Review Comments portion of this letter. The consultants are reminded that one copy of all supplemental documents should be submitted, should include the CGS application number, and should be uploaded directly to CGS at this link: https://www.conservation.ca.gov/cgs/upload-school. If you have any further questions about this review letter, please contact the primary reviewer at ((Jacqueline.bott@conservation.ca.gov).

Respectfully submitted,

Jacqueline Bott
Engineering Geologist
PG 1759, CEG 2382

CERTIFIED ENGINEERING GEOLOGIST
Jacqueline Bott
No. 2382
★ STATE OF CALIFORNIA ★

Concur:

Jennifer Thornburg
Senior Engineering Geologist
PG 5476, CEG 2240

CERTIFIED ENGINEERING GEOLOGIST
Jennifer Thornburg
No. 2240
★ STATE OF CALIFORNIA ★

Enclosures:

Note 48 Checklist Review Comments
Keyed to: *Note 48 - Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings*

Copies to:

Joel E. Baldwin II, *Certified Engineering Geologist*, and Corey T. Dare, *Registered Geotechnical Engineer*
Consolidated Engineering Laboratories, 2001 Crow Canyon Road, #200, San Ramon CA 94583

Philip Luo, *Architect*
Shah Kawaski Architects, 570 10th Street, Suite 201, Oakland, CA 94607

Karen Van Dorn, *Senior Architect*
Division of State Architect, 1515 Clay Street, Suite 1201, Oakland, CA 94612

Note 48 Checklist Review Comments

In the numbered paragraphs below, this review is keyed to the paragraph numbers of California Geological Survey Note 48 (November, 2019 edition), *Checklist for the Review of Engineering Geology and Seismology Reports for California Public Schools, Hospitals, and Essential Services Buildings.*

Project Location

1. Site Location Map, Street Address, County Name: Adequately addressed.
2. Plot Plan with Exploration Data with Building Footprint: Adequately addressed.
3. Site Coordinates: Adequately addressed. Latitude and Longitude provided in report: 37.8082°N, 122.2897°W

Engineering Geology/Site Characterization

4. Regional Geology and Regional Fault Maps: Adequately addressed.
5. Geologic Map of Site: Not addressed by the consultants, therefore not reviewed.
6. Geologic Hazard Zones: Adequately addressed. The consultants report the site is located within a Seismic Hazard Zone for liquefaction as identified by the State of California. The consultants report the site is not currently within a designated Earthquake Fault Zone as defined by the State.
7. Subsurface Geology: Adequately addressed. The consultants report the site is underlain by Pleistocene-epoch Merritt sand, consisting of beach or near-shore deposits. They report encountering dark brown sand to silty sand layers (Merritt sand) with frequent lenses of medium dense to very dense clayey to silty sand to a depth of 27 feet, which is underlain by fine clean sand to the maximum depth explored of 50 feet. In boring B-1 the consultants report they encountered loose undocumented fill comprised of sand with brick and concrete fragments. They also report free ground water was encountered between 13 to 19 feet in their various subsurface investigations.
8. Geologic Cross Sections: Adequately addressed.
9. Geotechnical Testing of Representative Samples: Adequately addressed.
10. Consideration of Geology in Geotechnical Engineering Recommendations: Adequately addressed.
11. Conditional Geotechnical Topics: Not applicable.

Seismology & Calculation of Earthquake Ground Motion

12. Evaluation of Historic Seismicity: Adequately addressed.
13. Classify the Geologic Subgrade (Site Class): Adequately addressed. The consultants classify the site soil profile as Site Class D, Stiff Soil, based on the measured average shear-wave velocity in CPT soundings of 300 m/sec. This classification appears reasonable based on the data presented.
14. General Procedure Ground Motion Analysis: Adequately addressed. The consultants report the following parameters derived from a map-based analysis:
    $S_S = 1.592$ and $S_1 = 0.60$
    $S_{DS} = 1.061$
15. Site-Specific Ground Motion Hazard Analysis: **Additional information is requested**. The consultants' probabilistic MCE spectrum appears reasonable based on comparison with

results from the National Seismic Hazard Model (from Petersen and others, 2014) but their deterministic MCE spectrum appears low. CGS notes that the consultants used a M 7.2 on the Hayward (North) fault to calculate their deterministic spectrum, **but they should consider the potential for the whole Hayward fault to rupture for this analysis**, as is considered in both UCERF2 and UCERF 3 community fault models. The consultants are requested to revise their site-specific ground motion analysis using the appropriate magnitude for their deterministic spectrum. The consultants should also check whether PGA_M used in their liquefaction analysis is also appropriate and according to ASCE 7-16 Section 21.5.3.

16. Deaggregated Seismic Source Parameters: Adequately addressed.
17. Time Histories of Earthquake Ground Motion: Not applicable.

Fault Rupture Hazard Evaluation

18. Active Faulting & Coseismic Deformation Across Site: Adequately addressed. The consultants report no faults are known to be present within or project towards the site. The consultants conclude the potential for fault ground rupture and surface manifestations from fault creep are very low to nil.

Liquefaction/Seismic Settlement Analysis

19. Geologic Setting for Occurrence of Liquefaction: Adequately addressed. The consultants report they analyzed their boring and CPT data for the potential for liquefaction settlement as they believe the soils below the water table include layers that may be susceptible to liquefaction in response to strong ground shaking. The consultants' approach appears reasonable.
20. Seismic Settlement Calculations: **Additional information is requested**. The consultants are requested to revise their seismic settlement calculations based on their response to Item 15, using a revised PGA_M, as needed.
21. Other Liquefaction Effects: Adequately addressed. The consultants report there are no significant free faces present at the site and there are no significant continuous liquefiable subsurface layers underlying the site based on their subsurface investigation. They conclude the potential for lateral spreading is low. This conclusion appears reasonable based on the data presented.
22. Mitigation Options for Liquefaction/Seismic Settlement: Not applicable.

Slope Stability Analysis

23. Geologic Setting for Occurrence of Landslides: Adequately addressed. The consultants consider the site is not susceptible to landsliding. This conclusion appears reasonable based on the data presented.
24. Determination of Static and Dynamic Strength Parameters: Not applicable.
25. Determination of Pseudo-Static Coefficient (K_{eq}): Not applicable.
26. Identify Critical Slip Surfaces for Static and Dynamic Analyses: Not applicable.
27. Dynamic Site Conditions: Not applicable.
28. Mitigation Options for Landsliding/Other Slope Failure: Not applicable.

Other Geologic Hazards or Adverse Site Conditions

29. Expansive Soils: Adequately addressed. The consultants report the near-surface soils are generally of very low expansion potential.
30. Corrosive/Reactive Geochemistry of the Geologic Subgrade: Adequately addressed. The consultants report the site soils should have a negligible impact on buried concrete structures and non-corrosive rating to cast and ductile iron pipes based on corrosion testing
31. Conditional Geologic Assessment: Adequately addressed. No significant conditional hazards of potential concern were identified by the consultants.

Report Documentation

32. Geology, Seismology, and Geotechnical References: Adequately addressed.
33. Certified Engineering Geologist: Adequately addressed.
    Joel E. Baldwin II, Certified Engineering Geologist #1132
34. Registered Geotechnical Engineer: Adequately addressed.
    Corey T. Dare, Registered Geotechnical Engineer #2013