GEOTECHNICAL EXPLORATION REPORT
PROPOSED GREAT WOLF LODGE RESORT HOTEL
CITY OF GARDEN GROVE, CALIFORNIA

Prepared for:

MCWHINNEY DEVELOPMENT

2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Project No. 602778-002

May 27, 2011
(Revised July 23, 2013)

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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McWhinney Development
2725 Rocky Mountain Avenue, Suite 200
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Attention: Mr. Trae Rigby, Director of Commercial Development

Subject: Geotechnical Exploration Report
Proposed Great Wolf Lodge Resort Hotel
City of Garden Grove, California

In response to your request, Leighton Consulting, Inc. (Leighton) is pleased to present this revised preliminary geotechnical exploration report encompassing supplementary phases of exploration and the results of our recent value engineering effort based on updated details for the proposed Great Wolf Lodge Resort Hotel project in the City of Garden Grove, California.

Our exploration showed that the site is underlain by up to 5 feet of fill over alluvium. The alluvium generally consists of sand with layers of silt and clay. Groundwater was encountered at 19 to 26 feet below ground surface (bgs) in our explorations. The historic high groundwater level is reported to be 15 to 20 feet bgs. Based on the results of our explorations and engineering analysis, the proposed project is feasible from a geotechnical standpoint. We appreciate the opportunity to continue to work with you on this project. If you have any questions, or if we can be of further service, please call us at your convenience. The undersigned can be reached at (949) 681-4263 and (213) 542-1681, respectively.

Respectfully submitted,

LEIGHTON CONSULTING, INC.

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1.0 INTRODUCTION

1.1 Site Location and Proposed Development

The project site is rectangular in shape, approximately 11.5 acres in area bounded by Harbor Boulevard from the east, the southern terminus of Leda Lane and commercial development from the north, an existing mobile home park from the west, and by commercial development from the south (Figure 1, Site Location Map). The site coordinates are latitude N33.77949, longitude W117.91555. Previously existing structures onsite have been demolished and removed leaving an uneven surface consisting predominately of sand and gravel. The central portion of the site is mantled by a thin layer of wood chips. Site topography is relatively flat with site elevations ranging from approximately Elevation +105 feet mean sea level (msl) in the southern portion to approximately Elevation +108 feet msl in the northern portion.

Based on our current understanding, the planned development includes a T-shaped Hotel Tower, a Lobby Core building, an indoor-outdoor waterpark and waterslides, a parking structure, and a restaurant building.

About 1 to 7 feet of additional fill is planned to establish the design finish floor at Elevation +112 feet mean sea level (msl) for the proposed hotel tower and parking structure. The current ground surface ranges from Elevation +105 to +111 msl. The other structures are proposed at or below existing grade as shown in the table below.

Proposed Structure	Maximum Column Load (kips)	Finish Floor Elevation (feet)
Hotel Tower	835	112
Hotel Tower Basement	925	98
Lobby Core Building	680	98
Indoor Water Park	435	98
Outdoor Pools and Slides	200	103
Parking Structure	650	112
Restaurant	50	112
Mechanical Sub-basements	13	88

1.2 Purpose and Scope

Leighton Consulting, Inc. (Leighton) performed a series of geotechnical explorations over the course of several years (Leighton 2009, 2010, 2011a, 2012) to characterize the subsurface conditions of the site.

The purpose of this report is to summarize the results of prior explorations, consolidate recommendations for various aspects of the project provided in prior reports, and incorporate the results of our value engineering effort into one comprehensive geotechnical document.

Tasks performed during previous geotechnical explorations and the current study include:

- Reviewed readily available geotechnical reports, geology, groundwater and seismic hazard maps available that are pertinent to the site.

- Coordinated with the City of Garden Grove for obtaining access to site areas to perform the field investigation.

- Located and marked the boring locations prior to field explorations. Underground Service Alert (USA) was notified to locate the public utilities in the exploration area prior to our field investigation. Boring and Cone Penetrometer Test (CPT) locations were marked in the field based upon input from the design team and foundation contractor.

- Performed subsurface explorations consisting of 12 hollow stem auger borings (B-1 through B-12) to a maximum depth of approximately 81.5 feet and 14 Cone Penetrometer Tests (CPT-1 through CPT-14) to a maximum depth of 100 feet. We collected relatively undisturbed ring samples, Standard Penetration Test (SPT) samples, and bulk samples of the subsurface soils from the borings. Boring and CPT logs are included in Appendix B.

- Attended a site meeting on April 26, 2012 with the survey team, dewatering contractor, representatives from Turner Construction and the City of Garden Grove to locate the pumping well (PW-1) and hollow stem auger borings (B-9, B-10/MW-2, B-11 and B-12) and Cone Penetrometer Test (CPT) locations (CPT-10, CPT-11, CPT-13 and CPT-14). Pumping well PW-1 and Monitoring well MW-1 were installed by others.

- Provided a cursory review of the aquifer characterization and pump test data procedures and methods used during the aquifer testing and groundwater analysis data performed by Foothill Dewatering Inc. (Foothill). Groundwater data, procedures, and pretreatment information is included in Appendix C.

- Performed geotechnical laboratory testing on selected soil samples to evaluate engineering characteristics. Laboratory test results are included in Appendix D.

- Performed geotechnical engineering analyses of collected data including:

  - A site-specific ground motion study in accordance with Section 21.2 of ASCE/SEI 7-05;

  - Evaluation of the liquefaction potential at the project site;

  - An estimation of the dynamic and static settlement potential;

  - Review, analysis, and incorporation of collected geotechnical data;

  - Analysis of temporary and permanent earth retaining structures, including below grade walls;

  - Pavement design recommendations; and

  - Screening of corrosion potential of concrete and metal in contact with onsite soils.

- Prepared several geotechnical reports, addenda, and technical memoranda presenting our findings, conclusions and preliminary recommendations. Leighton's previous submittals for this project are listed in Appendix A.

- Prepared this report encompassing four prior phases of exploration and the results of our recent value engineering.

1.3 Prior Explorations

As part of our 2009 study, Leighton performed a field exploration consisting of four hand auger borings (HA-1 through HA-4) to a depth of approximately 5 feet to classify the fill and extrapolate the approximate depth across the site. Eight CPT soundings (CPT-1 through CPT-8), extended to approximately 100 feet, were advanced to aid in deeper interpretation of the alluvial soils and to obtain shear wave velocities (Leighton, 2010). On March 21-23, 2011, borings B-1 through B-8 were drilled to depths ranging from 24.5 to 81.5 feet below grade (2011a). Samples were collected for geotechnical laboratory testing. Additionally, two CPT's (CPT-9 and CPT-10) were extended to approximately 100 feet.

As part of our May 2012 combined aquifer characterization and geotechnical study, CPT-11, CPT-12, CPT-13, and CPT-14 were advanced to depths of 84 to 98 feet. Borings B-9, B-10, B-11b, and B-12 were drilled to 81.5 feet. Boring B-10 was converted to a 2-inch-diameter monitoring well upon completion and partial backfill of the boring to 60 feet below grade for use during the aquifer characterization (Appendix C).

Borings were logged by a certified engineering geologist from our staff. Sampling was generally conducted at 5-foot intervals except where noted on the boring logs (Appendix B). Field testing consisted of performing the Standard Penetration Test (SPT) in accordance with ASTM[1] Standards D1586 and D3550. The samplers were driven with successive drops of a 140-pound automatic hammer free-falling 30 inches. The number of blows required to advance the samplers 18-inches are indicated on the boring logs at 6-inch intervals (Appendix B). In addition, representative bulk samples of the subsurface soils were collected from the borings.

Each collected sample was reviewed and described in general conformance with the Unified Soil Classification System (USCS). The descriptions were entered on the boring logs, which are included in Appendix B of this report. All samples were sealed and packaged for transportation to our laboratory. During drilling, the borings were measured for depth to groundwater and then backfilled using soil cuttings excavated during the drilling operations and bentonite grout upon completion of the drilling operation. Excess soil was spread onsite.

Locations of the prior explorations (2009, 2010, 2011a, 2012) are shown on Plate 1, Boring and Cross Section Location Map. Boring and CPT logs are included in Appendix B. The data obtained from Leighton's prior studies listed in Appendix A were reviewed and utilized in preparation of this report.

[1] ASTM : American Society of Testing and Materials currently known as ASTM International

1.4 Geotechnical Laboratory Testing

Geotechnical laboratory tests were performed on selected soil samples obtained during the field exploration programs. The laboratory testing program was designed to evaluate the physical and engineering characteristics of the onsite soils. Tests performed during this investigation include:

- In-situ moisture content and density (ASTM D2216 and ASTM D2937);
- Atterberg Limits (ASTM 4318);
- Direct Shear (ASTM D 3080);
- Unconsolidated Undrained Triaxial Compression (ASTM D2850);
- One Dimensional Consolidation (ASTM D 2435);
- R-Value (CTM[2] 301); and
- Corrosion Suite (CTM 532/643, CTM 417 Part II, CTM 422).

The results of the in-situ moisture content and dry density tests are shown on the boring logs in Appendix B. Results of the remaining laboratory tests are presented in Appendix D.

[2] CTM : California Testing Method (California Department of Transportation Testing Standard)

2.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

2.1 Site Geology

The subject site is located in the Downey Plain within the southeastern margin of the Los Angeles Basin, a large structural depression within the Peninsular Ranges geomorphic province of California. In general, the Downey Plain is bordered by the Coyote and Peralta Hills on the north, the Santa Ana Mountains and Tustin Plain to the east, the Pacific Ocean to the south and Los Angeles Coastal Plain to the west. Several broadly warped coastal mesas represent uplifted areas along the active Newport-Inglewood structural fault zone. These mesas are separated by erosional gaps which were created by historic routes of the Santa Ana River.

The site lies near the lower reaches of the Santa Ana River and associated floodplain (Figure 2, Regional Geology Map). The surface distribution of Holocene sediments, as recorded in early editions of regional soil survey maps (Eckmann and others, 1919) suggests that the Santa Ana River has recently wandered back and forth across the Downey Plain from Alamitos Bay to Newport Bay. Historical accounts, documents, and results of our study further support widespread sheet flooding and marine transgression as being the dominant depositional process associated with the Santa Ana River floodplain.

Generally, the near-surface Quaternary age young alluvial soils range in depths from 5 to 65 feet below grade and are characterized as thinly bedded to massive, loose to medium dense, silty fine grained sands with varying proportions of silt and clay capping the site to thinly bedded, to massive, soft to stiff, laminated silt and clay with occasional thin beds of predominately fine grained sands. A transition to marine sediments, characterized by the dominantly grey, clayey paleosol and presence of seashells was encountered at approximately 17 to 21 feet below grade. Below a depth ranging from approximately 65 to 75 feet below grade, older alluvial fan sediments representing an erosional boundary were encountered which, consisted of dense, fine to coarse grained gravelly sands with thin beds of well indurated, hard silts and clays (Plate 2, Geotechnical Cross Sections AA’ and BB’).

Presented below are brief descriptions of the geologic units at the site. The generalized stratigraphy of the subsurface soils at the site is presented on Plate 2. Boring and CPT locations are presented on Plate 1.

Artificial Fill, Undocumented (Afu): The majority of the site is mantled with an uneven surface consisting predominately of sand and gravel. The central portion of the site is mantled with a thin layer of wood chips capping fill soils. Based on material encountered in Boring B-11, a reinforced concrete obstruction was present over a small area at a depth of five feet (Plate 1). Fill was encountered down to approximately five feet. However, deeper fill may be encountered at the site between the boring locations. The onsite artificial fill generally consists of stiff sandy silts to medium dense silty sands with varying proportions of crushed aggregate gravels. We are unaware of any fill placement documentation. Therefore, all existing fill at the site is classified as undocumented fill.

Quaternary Young Alluvial Fan (Qyf): The upper alluvial soils at the site (5-65 feet below grade) consist of young, Quaternary age (<1.8 million years old), unconsolidated alluvial fan sediments deposited over a broad gently sloping alluvial plain. Based on the material encountered in the borings and interpreted from CPT soundings, the site is mantled with a relatively continuous layer of massive, silty, fine grained sand with occasional gravel overlying laminated to thinly bedded, soft to medium stiff, moist to wet, sandy clays and silts with interbedded loose to medium dense, wet sandy soils varying from cohesionless sands with fine gravels to silty, clayey sands.

Quaternary Old Alluvial Fan (Qof): Underlying the upper alluvial soils at depths ranging from 65 to 70 feet below grade are dense, fine to coarse grained, gravelly sands with thin beds of well indurated, hard silts and clays.

2.2 Geologic Structure

Geologic structure of the alluvial materials is anticipated to be generally massive; however, it can be interpreted, based on a geologic depositional environment typical of flood plain deposits that cross-stratification (channel trough cross-stratification or transverse bar-tabular cross-stratification) sedimentary structure exists at depth. Relevance of these sedimentary features includes local impermeable zones with the high potential for perched groundwater development on top of less permeable clayey strata anticipated at or near the lower design elevations. Therefore introduction of stormwater runoff as part of Water Quality Management Practices (WQMP) is not recommended.

2.3 Groundwater

Groundwater was encountered at approximately 19 to 26 feet below ground surface (bgs) corresponding to Elevations +78 to +87.5 feet msl. Depth to groundwater is shown on Plate 2.

The historic high groundwater level is reported to be 15 to 20 feet bgs (CGS, 2001). Accordingly, a groundwater level at Elevation +93 feet msl should be assumed for design.

Aquifer characterization, pump test data, and pretreatment information is included in Appendix C.

3.0 SEISMIC HAZARDS EVALUATION

3.1 Primary Seismic Hazards

Surface Fault Rupture: The fault classification system adopted by the California Division of Mines and Geology (CDMG), relative to the state legislation delineating the Earthquake Fault Zones along active or potentially active faults (Alquist-Priolo Act), is used for structures. An active fault is one that is known to have moved in Holocene time (the last 11,000 years). A fault that is known to have moved during the last 1.8 million years (Pleistocene time), but has not been proven by direct evidence to have either moved or not moved within the last 11,000 years, is considered to be potentially active. Any fault that has not moved during both Holocene and Pleistocene time, (that is no movement within the last 1.8 million years) is considered to be inactive.

Based on our review of available literature, the project site is not located within an Alquist-Priolo Earthquake Fault Zone (Figure 3, Regional Fault Map) and no known active or potentially active faults are mapped traversing the site (Hart and Bryant, 2007).

The nearest known active zoned fault, the Newport-Inglewood fault, is located approximately 8.3 miles from the project site. Other significant faults in the region include the San Joaquin Hills Blind Thrust, Whittier fault, Upper Elysian Park Blind Thrust, Compton Thrust and Elsinore fault zone. The San Andreas Fault, the largest fault in California is mapped approximately 42.6 miles northeast of the project site. Considering the locations of these faults relative to the site, the potential for surface fault rupture at the site is considered low.

Ground Shaking: The intensity of ground shaking at a given location depends primarily upon the earthquake magnitude, the distance from the source, and the site response characteristics. In addition to the major faults mentioned above, all other regional faults are capable of producing moderate to severe ground shaking at the site.

The magnitude of ground shaking is generally characterized by using the peak horizontal ground acceleration (pga_h). To take into consideration the impact of regional faults, a site-specific ground motion study was performed using the computer program EZ-FRISK (Risk Engineering, 2011) to estimate ground motion parameters for the site. Three attenuation relationships (Boore and

Atkinson, 2008; Campbell and Bozorgnia, 2008; and Chiou and Youngs, 2008) were used in the analysis. The results of the analyses suggest that the Maximum Considered Earthquake (MCE) pga_h is approximately 0.59g. Based on the current California Building Code (2010), the design pga_h is approximately 0.39g (i.e., two-third of the MCE). Results of the analyses, including site-specific response spectra for a structural damping ratio of five percent of critical damping, are included in Appendix E.

3.2 Secondary Seismic Hazards

In general, secondary seismic hazards for sites in the region could include soil liquefaction, earthquake-induced settlement, lateral displacement, landsliding, seiches, and tsunamis. The potential for secondary seismic hazards at the subject site is discussed below.

Liquefaction Potential: Liquefaction is the loss of soil strength or stiffness due to a buildup of pore-water pressure during prolonged and strong ground shaking. Liquefaction is associated primarily with loose (low density), saturated, fine- to medium-grained, cohesionless soils. Effects of severe liquefaction can include sand boils, excessive settlement, bearing capacity failures, and lateral spreading.

The site is located within an area designated as potentially liquefiable on the California Seismic Hazard Zone Map for the Anaheim Quadrangle (Figure 4, Seismic Hazards Map). Groundwater was encountered during our current exploration at depths ranging from 19.4 to 23 feet bgs. The historic high groundwater level was reported to be on the order of 15 to 20 feet bgs (CGS, 2001).

The results of our analyses using the historic high groundwater level of 15-20 feet bgs across the site and the design seismic event suggest that there is a potential for liquefaction at the site. The most susceptible soil layers appear to be between the depths of approximately 22 to 35 feet. Since the liquefiable soils are currently overlain by at least 15 feet of non-liquefiable soils, the potential for surface manifestations, such as sand boils or shallow bearing capacity failures of shallow foundations, is considered low. The results of our analysis are presented in Appendix F, Liquefaction Evaluation.

<u>Seismically-Induced Settlement:</u> Seismically-induced settlement occurs primarily within loose to moderately dense sandy soil, including liquefiable soil due to a reduction in volume during and shortly after an earthquake event.

Based on our engineering analysis and using a historic groundwater elevation of 15-20 feet across the site, median values of the total seismically-induced settlement of the upper 50 feet is expected to be generally on the order of 1 inch; localized conditions and the planned excavation for the mechanical pump rooms at Elevation +88 feet could produce higher settlements of up to 1½ inches. Considering the varying thickness of the liquefiable soils, seismically-induced differential settlement may be assumed to be on the order of one-half of the total settlement over a distance of 30 feet. The results of our analyses are included in Appendix F.

<u>Liquefaction-Induced Lateral Ground Failure:</u> Lateral ground displacement due to liquefaction will include lateral spreading (for ground slope less than six percent), flow failure (for ground slope steeper than six percent), and ground oscillation. Although the subsurface soils at the site are susceptible to liquefaction, the potential for development of lateral spreading and flow failure is considered low since the site is relatively flat and constrained.

Ground oscillation is a phenomenon that forms cracks and ridges due to random vertical and lateral movements of broken blocks of non-liquefiable soils overlying liquefiable soil in response to earthquake motion. Ground oscillation usually occurs on relatively level ground surface where lateral spreading does not occur. The occurrence of ground oscillation may cause damage to pavements, walkways, pipelines, and other lightly loaded near-surface structures. Since most of the site is overlain by at least 15 feet of non-liquefiable soils, the potential for ground oscillation occurrence at the site is considered low.

<u>Seismically-Induced Landslides:</u> Since the site is relatively flat and is not located within a zone of potential seismic landslides based on the CDMG Seismic Hazard Zone Map for the Anaheim Quadrangle (CGS, 1998), the potential for seismically-induced landslides at the site is considered low.

<u>Earthquake-Induced Flooding:</u> Strong seismic ground motion can cause dams and levees to fail, resulting in damage to structures and properties located downstream. The closest water retaining structure is Prado Dam, located

approximately 20 miles upstream from the site. Therefore, the potential for earthquake-induced flooding to affect the site is considered low.

Seiches and Tsunamis: Seiches are large waves generated in enclosed bodies of water in response to ground shaking. Tsunamis are waves generated in large bodies of water by fault displacement or major ground movement. Based on the inland tsunamis are not considered to be a hazard.

The indoor-outdoor water park is proposed to have several pools as part of the design. Dependent upon the magnitude and duration of an earthquake, small waves could be generated resulting in loss of water over the top of the pool during a seismic event.

4.0 SUMMARY OF FINDINGS

Presented below is a summary of key findings of the geologic and geotechnical conditions encountered at the site during our current exploration.

- The site is underlain by approximately 3 to 5 feet of undocumented artificial fill overlying Quaternary age alluvium. Deeper fill and remnants of past site improvements should be expected to be encountered between explored locations. Undocumented fill is unsuitable for support of structures and critical infrastructure.

- Quaternary age (younger) alluvium consisting of a layer of sand extended to a depth of approximately 15 to 17 feet across the site. Underlying this layer of sand is predominately interbedded clays and silts with occasional sand layers extending to approximately 65 to 70 feet bgs.

- Older alluvium was encountered below the young alluvium to the maximum depth explored and consists of interbedded dense to very dense gravelly sands to hard, well indurated silts and clays.

- Groundwater was measured at approximately 19.4 to 23 feet bgs. The historic high groundwater level at the site is reported to be on the order of 15 to 20 feet bgs across the site.

- The project site is not located within an Alquist-Priolo Earthquake Fault Zone and no known active or potentially active faults are mapped traversing the site. Fault rupture is not considered a hazard at the site.

- The primary seismic hazard at the site will be the potential for damage due to earthquake ground shaking. Based on the probabilistic seismic hazard analysis, the site-specific peak ground acceleration for the MCE event is 0.59g. The deaggregated mean fault distance and earthquake magnitude are 10½ miles and 6.9, respectively. The corresponding site-specific peak ground acceleration is 0.39g.

- The site is located within a liquefaction hazard zone. Engineering analysis indicated that the potentially liquefiable soils exist at depths of 22 to 35 feet bgs. The potential for manifestation of liquefaction at the ground surface is considered low due to the depth of the liquefiable soils.

- The seismically-induced settlement of the upper 50 feet was estimated to be on the order of 1 inch with differential settlement on the order of one-half the total settlement over a distance of 30 feet. Localized conditions may have higher seismically-induced settlements of up to 1½ inches. The occurrence of seismically-induced settlement in the soils may result in ground subsidence at the ground surface.

- Due to the depth of the liquefiable soils, the potential for lateral ground failure due to liquefaction is considered low.

- The site is mantled with 15 to 17 feet of relatively non-expansive sandy soils. Most of the potentially expansive clayey soils are located below groundwater and do not expect to be affected by change in moisture. Therefore, the potential for expansive soil affecting the performance of the planned development is considered low.

- The proposed structures may be supported on shallow spread type foundations if the recommendations in this report are implemented.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based upon the results of our analyses, we conclude that the proposed improvements are feasible from a geotechnical standpoint.

In the following sections, recommendations are provided for site grading, foundation design, seismic design, slabs-on-grade, shoring, walls below grade, and pavement design. These recommendations have been developed based on the exhibited engineering properties of the onsite soils and their anticipated behavior both during and after construction and/or a design seismic event. The options provided below are based upon our current understanding of the project and our discussions with the project team.

5.1 Earthwork

All earthwork should be performed in accordance with the *Earthwork and Grading Guide Specifications* presented in Appendix G, unless specifically revised or amended below or by future review of project plans.

Site Clearance: Prior to construction, all surface improvements (existing wells and concrete pads), underground utilities and other obstructions in the area planned for construction should be removed. Pumping and monitoring wells should be backfilled in accordance with Orange County Healthcare Agency (OCHCA) guidelines. All vegetation in the area of construction should be removed and hauled offsite. Resulting removal cavities should be properly backfilled and compacted as recommended below.**Error! Reference source not found.**

Overexcavation and Recompaction: The site is mantled with approximately 5 feet of undocumented artificial fill; deeper deposits of undocumented artificial fill may be found across the site. The fill soils in their current conditions are unsuitable to provide structural support for the proposed development and should be removed and replaced as engineered fill.

Subgrade Preparation: Prior to placement of fill, the exposed subgrade surfaces, including all excavation or removal bottoms, should be observed by the geotechnical consultant to verify that suitable competent soil is exposed. The exposed soils should be scarified to a depth of eight inches, brought to two- to three-percent above optimum moisture content, and recompacted to a minimum of 90 percent relative compaction based on ASTM Test Method D1557.

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If the subgrade soils are wet and soft, especially at the indoor water park and subbasement levels, stabilizing the subgrade soils using crushed rock or crushed rock with geogrid to provide a competent base for construction activities and the compaction of the required fill may be considered. Using lime to treat the upper 12-inches of the subgrade may also be considered. It is necessary for the geotechnical consultant to evaluate the subgrade conditions during grading in order to provide specific subgrade stabilization methods and recommendations.

When grading is interrupted by heavy rains, fill operations should not be resumed until the moisture content and the dry density of the placed fill are tested and deemed suitable.

General Fill Placement for Compaction: The onsite soils, less any debris or organic matter, may be used in fills. Cobbles larger than six inches in largest dimension should not be used. Any required import material should consist of relatively non-expansive soils with an Expansion Index (EI) of less than 20. The imported materials should contain sufficient fines (binder material) so as to be relatively impermeable and result in a stable subgrade when compacted. All proposed import materials should be tested and approved by the geotechnical engineer of record prior to being placed at the site.

All fill should be placed in thin, loose lifts not exceeding eight inches in thickness, moisture-conditioned as necessary and compacted using appropriate equipment to obtain a minimum of 90 percent relative compaction as determined by ASTM Test Method D1557. Aggregate base should also be compacted to a minimum of 95 percent relative compaction.

Utility Trench Backfill: Pipeline trenches should be backfilled with compacted fill in accordance with Sections 306-1.2 and 306-1.3 of the *Standard Specifications for Public Works Construction,* ("Greenbook"), 2012 Edition. Prior to backfilling trenches, pipes should be bedded in and covered with either:

1. **Sand:** A uniform, granular material that has a Sand Equivalent (SE) of 30 or greater and a maximum particle size of ¾-inches (or as specified by the pipe manufacturer), water densified in place, or

2. **CLSM:** Controlled Low Strength Material (CLSM) conforming to Section 201-6 of the *Standard Specifications for Public Works Construction,* ("Greenbook"), 2012 Edition.

Pipe bedding should extend at least 4-inches below the pipeline invert and at least 12 inches over the top of the pipeline. Pipe bedding should be water-densified in-place.

Above the pipe zone, trenches can be backfilled with excavated onsite soils **free of** debris, organic and oversized material greater-than (>) 6-inches (15 cm) in largest dimension. Oversized rock (cobbles and/or boulders) should either be removed from the alignment, or pulverized for use in backfill. Gravel larger than ¾-inch (2 cm) in diameter should be mixed with at least 80-percent soil (by weight) passing the No. 4 sieve. Native soil backfill over the pipe bedding zone should be placed in thin lifts, moisture conditioned as necessary, and mechanically compacted using a minimum standard of 90 percent relative compaction, relative to the ASTM D 1557 laboratory maximum dry density outside of structure pads or 95 percent within structure pads. Any imported base should be compacted to 95 percent relative compaction, relative to the ASTM D 1557 laboratory maximum density, regardless of depth.

Temporary Excavations: The contractor is responsible for all temporary excavations and trenches excavated at the site and is responsible for design of temporary shoring. Shoring, bracing and benching should be performed by the contractor in accordance with the current edition of the California Construction Safety Orders (see: http://www.dir.ca.gov/title8/sb4a6.html). Native soils conform to OSHA soil Type C within the upper 15-20 feet. Therefore, if workers are to enter unshored excavation, temporary cut slopes should be cut no steeper than 1½:1 (horizontal:vertical), for a height no-greater-than (≤) 20 feet (California Construction Safety Orders, Appendix B to Section 1541.1, Table B-1). Surcharge loads should not be permitted within a horizontal distance equal to the height of excavation or 5 feet, whichever is greater, measured from the top of the excavation; unless the excavation is shored or shielded appropriately as described in the following section.

During construction, soil conditions should be regularly evaluated to verify that conditions are as anticipated. The contractor is responsible for providing the "competent person" required by OSHA standards to evaluate soil conditions. Soil types will vary, but Type C soils can be expected within 15-20 feet in fill and alluvium. Close coordination between the competent person and Leighton Consulting, Inc. should be maintained to facilitate construction while providing safe excavations. Construction vehicle should not be allowed to drive within a horizontal distance from the top-of-slope less-than-or-equal-to (≤) the height of the cut slope.

Spoil piles from the excavation(s) and construction equipment should be kept away from the sides of the trenches. Surcharge loads should not be permitted within a horizontal distance equal to the height of cut or 5 feet, whichever is greater, measured from the top of the cut, unless the cut is shored appropriately.

Temporary Shoring: Excavations may be supported by several methods including cross-braced hydraulic shoring, conventional shields, sheet piles, soldier piles and wood lagging, and/or possibly soil nailing. The choice should be left to the contractor's judgment since economic considerations and/or the individual contractor's construction experience may determine which method is more economical and/or appropriate. Shoring systems should be designed by a California licensed civil or structural engineer. The contractor and shoring designer should also perform additional geotechnical studies as necessary to refine the means and methods of shoring construction. The contractor should forward temporary excavation support system plans to the owner and us for pre-construction review.

Support of all adjacent existing structures and infrastructure without distress is the contractor's responsibility. In addition, it should be the contractor's responsibility to undertake a pre-construction survey including (1) establishing surface survey monuments adjacent to existing sensitive structures and infrastructure to measure ground movement adjacent to excavations, and (2) photographing and otherwise documenting adjacent property conditions prior to excavation. Surface monuments should be established and read by a California licensed Professional Land Surveyor (PLS), with an accuracy on the order of 1/10th of an inch. Geotechnical design parameters for shoring design are presented below.

5.2 Foundations

Spread footings established on undisturbed native soils or engineered fill may be used to support the proposed structures. Spread footing design recommendations are presented in the following subsections:

Minimum Embedment and Width: Footings should have a minimum embedment depth of 24 inches and have a minimum width of 24 inches.

Allowable Bearing Capacity: Footings may be designed to impose an allowable bearing pressure of *4*,000 pounds per square foot (psf). A one third increase in the bearing value for short duration loading, such as wind or seismic forces may be used. The ultimate bearing capacity can be taken as *12*,000 psf, which does not incorporate a factor of safety. A resistance factor of 0.5 should be used for bearing capacity evaluation with factored loads. The recommended bearing value is a net value, and the weight of concrete in the footings can be taken as 150 pounds per cubic foot (pcf); the weight of soil backfill can be neglected when determining the downward loads.

Footings for ancillary structures may be designed to impose an allowable bearing pressure of 2,000 psf. The foundation should be at least 24 inches wide and embedded 24 inches below lowest adjacent grade. A one third increase in the bearing value for short duration loading, such as wind or seismic forces may be used. The ultimate bearing capacity can be taken as 6,000 psf, which does not incorporate a factor of safety. A resistance factor of 0.5 should be used for bearing capacity evaluation with factored loads. The recommended bearing value is a net value, and the weight of concrete in the footings can be taken as 150 pounds per cubic foot (pcf); the weight of soil backfill can be neglected when determining the downward loads.

Lateral Load Resistance: Lateral loads can be resisted by soil friction and by the passive resistance. A coefficient of friction of 0.35 can be used between the footings and the floor slab and the supporting soils. The passive resistance of undisturbed natural soils or engineered fill soils can be assumed to be equal to the pressure developed by a fluid with a density of 350 pounds per cubic foot (pcf). The maximum passive pressure should not exceed 3,500 psf. A one-third increase in the passive resistance of the soils can be combined without reduction in determining the total lateral resistance. Below the design groundwater level (Elevation +93.0 feet msl), the passive resistance should be reduced to 175 pcf to account for buoyancy.

Settlement: The estimated total settlement of the structures supported on spread footings as recommended above due to static loading is on the order of 1 inch. The differential settlement between adjacent columns is estimated to be less than ½ inch over a horizontal distance of 30 feet. Due to variations in subsurface conditions, up to 2 inches of settlement may occur at some locations. However, since the bulk of the settlement is anticipated to occur during construction, the potential for additional settlement is deemed manageable. Roughly half of the settlement is anticipated to occur within 1 month of load placement. About 85 percent of the settlement is anticipated to occur within 3 months of load placement.

5.3 Seismic Design Parameters

Based on the shear wave velocities measured during cone penetrometer testing and the results from the Southern California Earthquake Center's (SCEC's) Community Velocity Model (CVM), the site is classified as a Site Class F in accordance with the current building code (2010 CBC). The corresponding site-specific seismic design parameters based on Section 21.3 of ASCE/SEI 7-05 are presented in the following table.

Parameter	Design Value
MCE (5% damped) spectral response acceleration parameter at short period (0.2 sec), S_{MS}	1.221
MCE (5% damped) spectral response acceleration parameter at long period (1.0 sec), S_{M1}	0.960
Design (5% damped) spectral response acceleration parameter at short period (0.2 sec), S_{DS}	0.814
Design (5% damped) spectral response acceleration parameter at long period (1.0 sec) sec, S_{D1}	0.640

5.4 Floor Slabs

5.4.1 Subgrade Preparation

All floor slabs for at-grade structure should be supported on a minimum of 12 inches of compacted fill or other improved subgrade discussed in this report. For below grade floor slabs in the waterpark, the exposed subgrade is anticipated to be soft and near saturation and will require mitigation. The recommended mitigation alternatives will include using crushed rock, or crushed rock with geogrid and/or lime treated subgrade. It is necessary for the geotechnical engineer to evaluate the subgrade condition upon exposure to provide the appropriate subgrade mitigation measures.

Due to the relief of the existing overburden during basement excavation, the subgrade soil may experience a heaving of approximately 1-inch after excavation. The heaving should be monitored during construction of the basement.

5.4.2 Floor Slab Support

For design of conventional slab-on-grade in the hotel, lobby core, and the water park, a net allowable bearing pressure of 750 psf may be used for designing the slab thickness and reinforcement.

Installation of vapor retarder under the slab for the at-grade structure should be considered. Leighton does not practice in the field of moisture vapor transmission evaluation and mitigation. Therefore, we recommend that a qualified person be consulted to provide recommendations for mitigation, if deemed necessary.

A subdrain system consisting of 12-inches crushed rock and perforated drain pipes should be installed under the floor slab of the waterpark to prevent the potential for building up hydrostatic pressure under the slab. The drain pipe should be at least 4 inches in diameter and wrapped by geotextile to prevent fines from entering the pipes. The subdrain system should be discharged to an approved drainage system.

Groundwater discharges fall under the purview of the Regional Water Quality Control Board. A National Pollutant Discharge Elimination System (NPDES) permit is required for groundwater related discharge to municipal systems. Groundwater was characterized at the site prior to and after the aquifer test. Results of the chemical analysis are provided in Appendix C of this report.

5.5 Lateral Earth Pressures

The following lateral pressures coefficient can be used for design of conventional retaining walls, cantilever shoring up to 15 feet deep, and thrust blocks for piping support. It is assumed that the retaining walls will be backfilled with low expansive soil.

We recommend that retaining walls be backfilled with imported non-expansive soils, and constructed with a backdrain in accordance with the recommendations provided on Figure 4, *Retaining Wall Backfill and Subdrain Detail*. Based on these recommendations, the following parameters may be used for retaining wall design, for walls with non-expansive, level and drained backfill:

Retaining Wall Design Earth Pressures

Retaining Wall Condition	Equivalent Fluid Pressure (pounds-per-cubic-foot)	
	Level Backfill	2:1 Backfill
Active (cantilever)	34	43
At-Rest (braced)	53	70
Passive (resistance)	300*	

*For level and drained backfill above groundwater only, not to exceed 4,000 psf

Below the design groundwater level (Elevation +93.0 feet msl), the passive resistance should be reduced to 150 pounds per cubic foot (pcf) to account for buoyancy.

Cantilever walls that are designed to yield at least 0.001H, where H is equal to the wall height, may be designed using the active condition. Rigid walls and walls braced at the top should be designed using the at-rest condition. Passive pressure is used to compute soil resistance to lateral structural movement.

Total depth of retained earth for design of walls should be measured as the vertical height of the stem below the ground surface at the wall face for stem design, or measured at the heel of the footing for overturning and sliding. A total unit weight of 118 pounds per cubic foot (pcf) may be assumed for the soil above groundwater in calculating lateral earth pressure.

For portion of the earth retaining structures located below groundwater, a submerged unit weight of 62.6 pcf and a unit weight of 62.4 pcf can be used for calculating lateral earth pressure and hydrostatic pressure, respectively.

In addition to the recommended earth pressure, the walls should be designed to resist any applicable surcharge loads due to foundation, storage, traffic, or other anticipated loads.

For the design of tied-back shoring supporting level ground, a uniform distribution of lateral earth pressure plus any surcharge loadings occurring as a result of traffic and adjacent foundations should be used. The recommended earth pressure for the above groundwater portion and below groundwater portion of the shoring may be assumed as 25$\boldsymbol{H_d}$ psf and 14$\boldsymbol{H_w}$ psf, respectively, where ***H*** is the respective height of the wall in feet. Since dewatering inside the excavation is anticipated, hydrostatic pressure of 62.4 psf per foot of depth below groundwater should be added to the external lateral earth pressure. The sheet piles should extend to sufficient depth below the excavation to prevent bottom heave inside the excavation.

The above values do not contain an appreciable factor of safety. The structural engineer should apply the applicable factors of safety and/or load factors during design.

In addition to the recommended earth pressure, the upper 10 feet of shoring adjacent to streets should be designed to resist a uniform lateral pressure 100 psf, acting as a result of an assumed 300 psf surcharge behind the shoring due to normal street traffic. If the traffic is kept back at least 10 feet from the shoring, the traffic surcharge may be neglected. We can determine lateral surcharge pressures for specific cases, such as construction crane, concrete trucks, and other heavy construction equipment adjacent to shoring, if requested.

Walls and shoring extending below a 1:1 (horizontal:vertical) plane extending downward from the bottoms of adjacent building foundations should be designed to support the lateral surcharge pressure from the foundations when their locations and imposed loads are known.

5.5.1 Retaining Wall Drainage

Adequate drainage may be provided by a subdrain system positioned behind the walls. This system should consist of a 4-inch minimum diameter perforated pipe placed near the base of the wall (perforations placed downward). The pipe should be bedded and backfilled with pervious backfill material described in Section 300-3.5.2 of the Standard Specifications for Public Works Construction (Green Book), 2012 Edition. This pervious backfill should extend at least 2 feet out from the wall and to within 2 feet of the outside finished grade. This pervious backfill and pipe should be wrapped in filter fabric, such as Mirafi 140N or equivalent, placed as described in Section 300-8.1 of the Standard Specifications for Public Works Construction (Green Book), 2012 Edition. The subdrain outlet should be connected to a free-draining outlet or sump.

Miradrain or Enkadrain drainage geocomposites, or similar, may be used for wall drainage as an alternative to the Class 2 Permeable Material or drain rock backfill, particularly where horizontal space is limited adjacent to shoring or near vertical cuts. Drainage geocomposites should be connected to a perforated drainpipe at the base of the wall.

5.5.2 Anchor Design

Tie-back friction anchors may be used to resist lateral loads. For design purposes, it may be assumed that the active wedge adjacent to the shoring is defined by a plane drawn at 30 degrees from the vertical through the bottom of the excavation. The anchors should extend beyond the potential active wedge to develop the desired capacities.

The capacities of anchors should be determined by testing of the initial anchors as outlined in the following section. For design purposes, it may be estimated that drilled friction anchors will develop an average friction value of 500 psf. For post-grouted anchors, it may be estimated that the anchors could develop an average friction of up to 1,500 psf. Only the frictional resistance developed beyond the active wedge would be effective in resisting lateral loads. If the anchors are spaced at least four times the diameter of the drilled hole on centers, no reduction in the capacity of the anchors need be considered due to group action.

5.5.3 Anchor Installation

The anchors may be installed at angles of 20 to 40 degrees below the horizontal. Caving of the anchor holes should be anticipated and provisions made to minimize such caving. Mining (removal of soils from the anchor holes without advancing the drilling auger) of the sandy and gravelly soils could occur and the shoring contractor should take special care to prevent or at least minimize such mining.

The conventional anchors should be filled with concrete placed by pumping from the tip out, and the concrete should extend from the tip of the anchor to no less than a distance of five feet from the active wedge. To minimize chances of caving, we suggest that the portion of the anchor shaft within the active wedge be backfilled with sand before testing the anchor. This portion of the shaft should be filled tightly and flush with the face of the excavation.

The sand backfill may contain a small amount of cement to allow the sand to be placed by pumping.

During installation, each row of anchors should be proof-loaded and approved before excavation can proceed. The tie-back anchor capacity should be checked for each stage of the excavation to ensure adequate support of the system is maintained. Performance tests may also be required on selected tieback anchors. The number of anchors to be tested should be determined based on the results of the testing program.

The installation of the anchors and the testing of the completed anchors should be observed by the geotechnical consultant.

5.5.4 Deflection

The performance of the shoring system should be monitored on a regular basis during and after installation. The monitoring should consist of surveying of the lateral and vertical locations of the tops of all the soldier piles. The survey data should be submitted to the shoring engineer and geotechnical consultant for review. It is recommended that the maximum deflection behind the shoring be limited to between one-half inch to one inch.

We recommend that the adjacent existing structures and streets be surveyed for horizontal and vertical locations. Also, a survey of existing cracks and offsets in the streets should be performed and recorded along with photographic records.

5.6 Basement Walls

5.6.1 Lateral Earth Pressures

At-rest earth pressure should be used in designing the permanent basement walls. The at-rest pressure coefficient may be assumed to be 0.5. A total unit weight of 118 pcf may be assumed for the soil above groundwater in calculating lateral earth pressure.

An adequate subdrain system should be installed behind the basement wall so that external hydrostatic pressure will not develop against the basement walls. For basement below groundwater, a submerged unit weight of 62.6

pcf and a unit weight of 62.4 pcf can be used for calculating lateral earth pressure and hydrostatic pressure, respectively.

The above values do not contain an appreciable factor of safety. The structural engineer should apply the applicable factors of safety and/or load factors during design.

In addition to the recommended earth pressures, the walls adjacent to vehicular traffic areas should be designed to resist a uniform lateral pressure of 100 psf, acting as a result of an assumed 300 psf surcharge behind the walls due to normal traffic. If the traffic is kept back at least 10 feet from the walls, the traffic surcharge may be neglected.

Walls extending below a 1:1 (horizontal:vertical) plane extending downward from the bottoms of adjacent building foundations should be designed to support the lateral surcharge pressure from those building foundations.

5.6.2 Seismic Lateral Earth Pressure

In addition to the above-mentioned lateral earth pressures, retaining walls and walls below grade with more than six feet of unbalanced earth (where the difference in height of retained soil from one side of the building to the other is greater than six feet) should be designed to support a seismic active earth pressure in addition to the lateral earth pressure given above. The recommended seismic active earth pressure distribution should be an invert triangle with the maximum pressure equal to 20***H*** psf, where ***H*** is the wall height in feet.

5.6.3 Backfill

All required backfill should be mechanically compacted in layers; jetting of backfill should not be permitted other than in utility trenches were there are multiple utility lines and or the composition of subgrade soils support jetting as an acceptable alternative to mechanical compaction. Proper compaction of backfill will be necessary to minimize settlement of the backfill and to minimize settlement of overlying slabs, concrete flatwork, and paving. Backfill should be compacted to at least 90% of the maximum dry density obtained by ASTM Test Method D 1557. The excavated soils may be used in the compacted backfill; however, cobbles larger than six inches in diameter should be omitted from the backfill to minimize possible damage to the walls. Also, clay soils should not be used for backfill behind walls.

Some settlement of the backfill should be anticipated, and any utilities supported therein should be designed to accept differential settlement, particularly at the points of entry to the building. Also, provisions should be made for some settlement of concrete walks supported on backfill.

5.6.4 Drainage

Building walls below grade should be waterproofed or at least dampproofed, depending upon the degree of moisture protection desired. Surface drainage should be designed to direct water away from foundations and toward approved drainage devices. Irrigation of landscaping should be controlled to maintain, as much as possible, consistent moisture content sufficient to provide healthy plant growth without over-watering. Water should not be allowed to flow uncontrolled toward the structures. Area drains should be able to capture all excess irrigation and splash-over water and direct to a suitable outlet. Irrigation or excess pool water should not be allowed to pond.

5.7 Preliminary Pavement Design

Near surface onsite soils consist of silty sand to sand with minor gravel. For preliminary design purposes, we used an R-value of 10 for our pavement analysis to account for soil variations upon completion of grading. We have performed the pavement design using the method in the Caltrans Highway Design Manual (Caltrans, 2008) with various Traffic Indices (TIs). Calculated minimum asphalt pavement sections are tabulated below:

Asphalt Pavement Section Thickness

General Traffic Condition	Design Traffic Index (TI)	Asphalt Concrete (inches)	Aggregate Base* (inches)
Automobile Parking	4.0	3.0	6.5
	4.5	3.5	7.0
Automobile Driveways	5.0	4.0	7.5
	5.5	4.5	8.5
Truck Access & Parking Areas	6.0	5.0	9.5
	6.5	5.5	10.5
	7.0	6.0	11.5

* Minimum R-value of aggregate base assumed for design is 78

Appropriate Traffic Index (TI) data should be selected by the project Civil Engineer or traffic engineering consultant and appropriate R-value of the subgrade soils will need to be determined after completion of rough grading to finalize the pavement design. Final pavement sections should be in general accordance with the city standards.

Subgrade soils in the upper 24 inches of the driveways and parking areas should be properly compacted to at least 90 percent relative compaction (ASTM D 1557-09) and should be moisture-conditioned to above optimum moisture contents, and kept in this condition until the pavement section is constructed. Minimum relative compaction requirements for aggregate base should be 95 percent of the maximum laboratory density (ASTM D 1557).

Asphalt concrete, Portland Cement Concrete (PCC) and aggregate base should conform to Caltrans Standard Specifications (2010 Edition, see: http://www.dot.ca.gov/hq/esc/oe/specifications/std_specs/2010_StdSpecs/2010_StdSpecs.pdf) or the Standard Specifications for Public Works Construction (Green Book), 2012 Edition, as listed below:

- **Hot Mixed Asphalt (HMA)**: Hot Mixed Asphalt (HMA) pavement should be Type B and should conform to Section 39 of the Caltrans Standard Specifications. As an alternative, asphalt concrete can conform to Section 203-6 of the *Standard Specifications for Public Works Construction* (Green Book), 2012 Edition.

- **<u>Portland Cement Concrete (PCC)</u>**: Portland Cement Concrete (PCC) pavement should conform to Section 40 of the Caltrans Standard Specifications. PCC pavement materials should conform to Section 90 of the Caltrans Standard Specifications, or Section 302-6 of the *Standard Specifications for Public Works Construction* (Green Book), 2012 Edition.

- **<u>Class 2 Aggregate Base (AB)</u>**: Class 2 aggregate base should conform to Section 26-1.02A of the Caltrans Standard Specifications. Crushed aggregate base or crushed miscellaneous base can conform to Sections 200-2.2 and 200-2.4 of the *Standard Specifications for Public Works Construction* (Green Book), 2012 Edition, respectively.

5.8 <u>Corrosion Protection Measures</u>

The chemical analysis test results for the onsite soils from the current and prior explorations are included in Appendix C of this report. Based on the test results, concrete and steel in direct contact with the onsite soil is expected to have negligible sulfate and chloride exposure. However, the onsite soil is considered corrosive to buried ferrous metals. It is recommended that a corrosion engineer be consulted for mitigation measures respect to protection of underground utility piping against corrosive soils.

5.9 <u>Additional Geotechnical Services</u>

The geotechnical recommendations presented in this report are based on subsurface conditions as interpreted from limited subsurface explorations and limited laboratory testing. Our conclusions and recommendations presented in this report should be reviewed and verified by Leighton during site construction and revised accordingly if exposed geotechnical conditions vary from our preliminary findings and interpretations. The recommendations presented in this report are only valid if Leighton verifies the site conditions during construction. Geotechnical observation and testing should be provided during the following activities:

- Grading and excavation of the site;

- Overexcavation and compaction;

- Compaction of all fill materials;

- Excavation and installation of foundations;
- Shoring installation;
- After excavation of all slabs and footings and prior to placement of steel or concrete to confirm the slabs and footings are founded in firm, compacted fill;
- Utility trench backfilling and compaction;
- Pavement subgrade preparation and base course compaction; and
- When any conditions are encountered that vary significantly form the conditions described in this report.

Leighton should review the grading and foundation plans and specifications, when available, to comment on the geotechnical aspects. Our recommendations should be revised, as necessary, based on future plans and incorporated into the final design plans and specifications.

6.0 LIMITATIONS

Leighton's work was performed using the degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical consultants practicing in this or similar localities. No other warranty, express or implied, is made as to the conclusions and professional opinions included in this report.

As in many projects, conditions revealed in excavations may be at variance with preliminary findings. If this occurs, the changed conditions must be evaluated by the geotechnical consultant and additional recommendations be obtained, as warranted.

The identification and testing of hazardous, toxic or contaminated materials were outside the scope of Leighton's work. Should such materials be encountered at any time, or their existence is suspected, all measures stipulated in local, county, state and federal regulations, as applicable, should be implemented.

This report is issued with the understanding that it is the responsibility of the owner or a duly authorized agent acting on behalf of the owner to ensure that the information and recommendations contained herein are brought to the attention of the necessary design consultants for the project and incorporated into the project plans and specifications and that the necessary steps are taken to see that the contractors carry out such recommendations in the field.

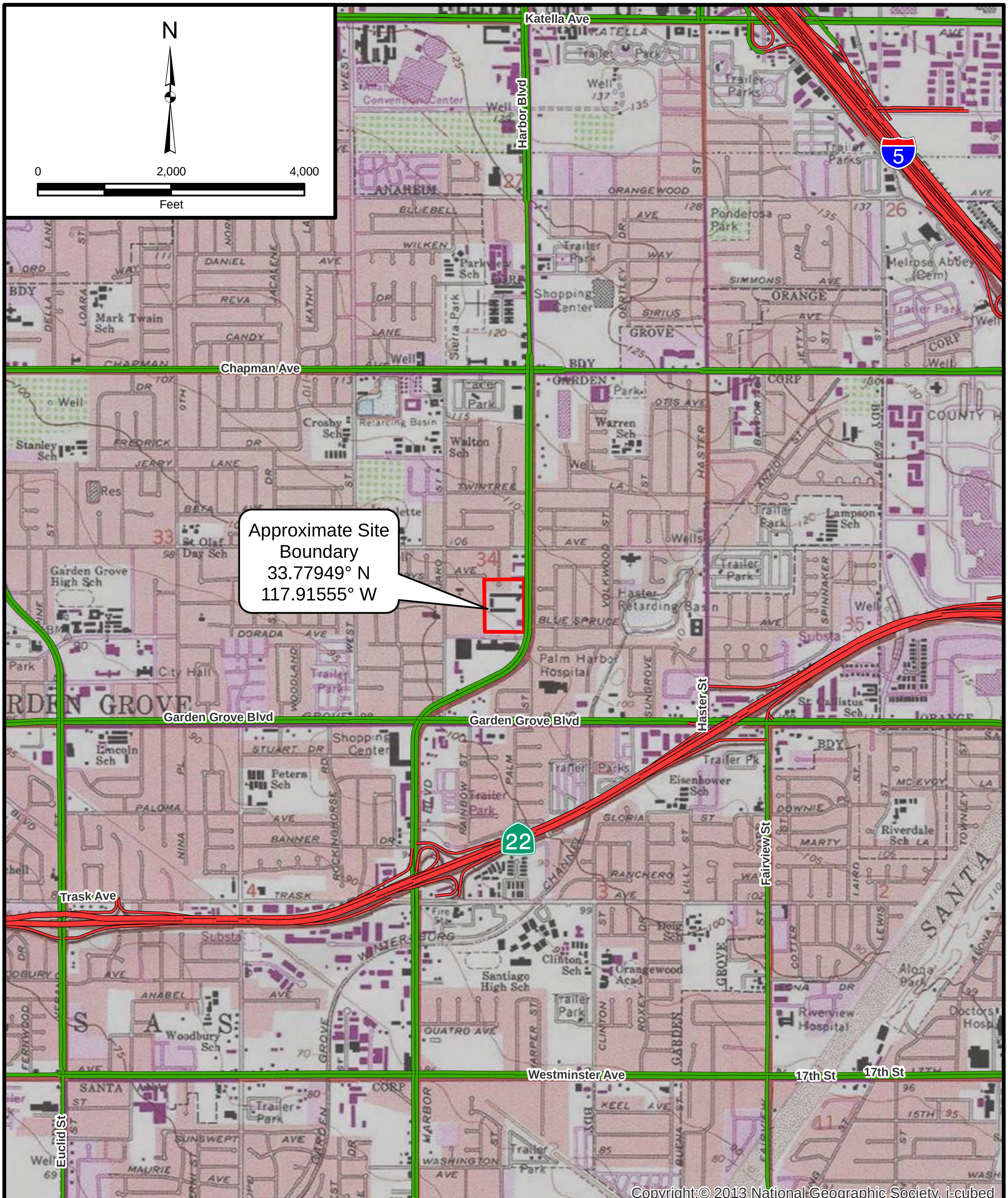
The findings of this report are considered valid as of the present date; however, changes in the condition of a property can occur with the passage of time, whether due to natural processes or the work of man on the subject or adjacent properties. In addition, changes in standards of practice may occur from legislation or the broadening of knowledge. Accordingly, the findings of this report may at some future time be invalidated wholly or partially by changes outside Leighton's control.

The conclusions and recommendations in this report are based in part upon data that were obtained from a necessarily limited number of observations, site visits, excavations, samples and tests. Such information can be obtained only with respect to the specific locations explored, and therefore may not completely define all subsurface conditions throughout the site. The nature of many sites is that differing geotechnical and/or geological conditions can occur within small distances and under varying climatic conditions. Furthermore, changes in subsurface conditions can and do occur over time. Therefore, the findings, conclusions, and recommendations presented in this report should be considered preliminary if unanticipated conditions are encountered and additional explorations, testing and analyses may be necessary to develop alternative recommendations.

This report has been prepared for the express use of McWhinney Development and its design consultants, and only as related expressly to the assessment of the geotechnical constraints of developing the subject site and for construction purposes. This report may not be used by others or for other projects without the express written consent of McWhinney Development and our firm.

If parties other than Leighton are engaged to provide construction geotechnical services, they must be notified that they will be required to assume complete responsibility for the geotechnical phase of the project by concurring with the findings and recommendations in this report or by providing alternative recommendations.

Any persons using this report for bidding or construction purposes should perform such independent investigations as they deem necessary to satisfy themselves as to the surface and/or subsurface conditions to be encountered and the procedures to be used in the performance of work on the subject site.



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Scale: 1 " = 2,000 '	Date: July, 2013

Base Map: ESRI Resource Center, 2010
Thematic Info:USGS, 2006, Geologic map of the San Bernardino and Santa Ana 30'x60' quadrangles, California, Version 1.0
Open File Report 2006-1217 Map Legend
Author: (mmurphy)

SITE LOCATION MAP

McWhinney Development
Garden Grove, California

Figure 1

Leighton

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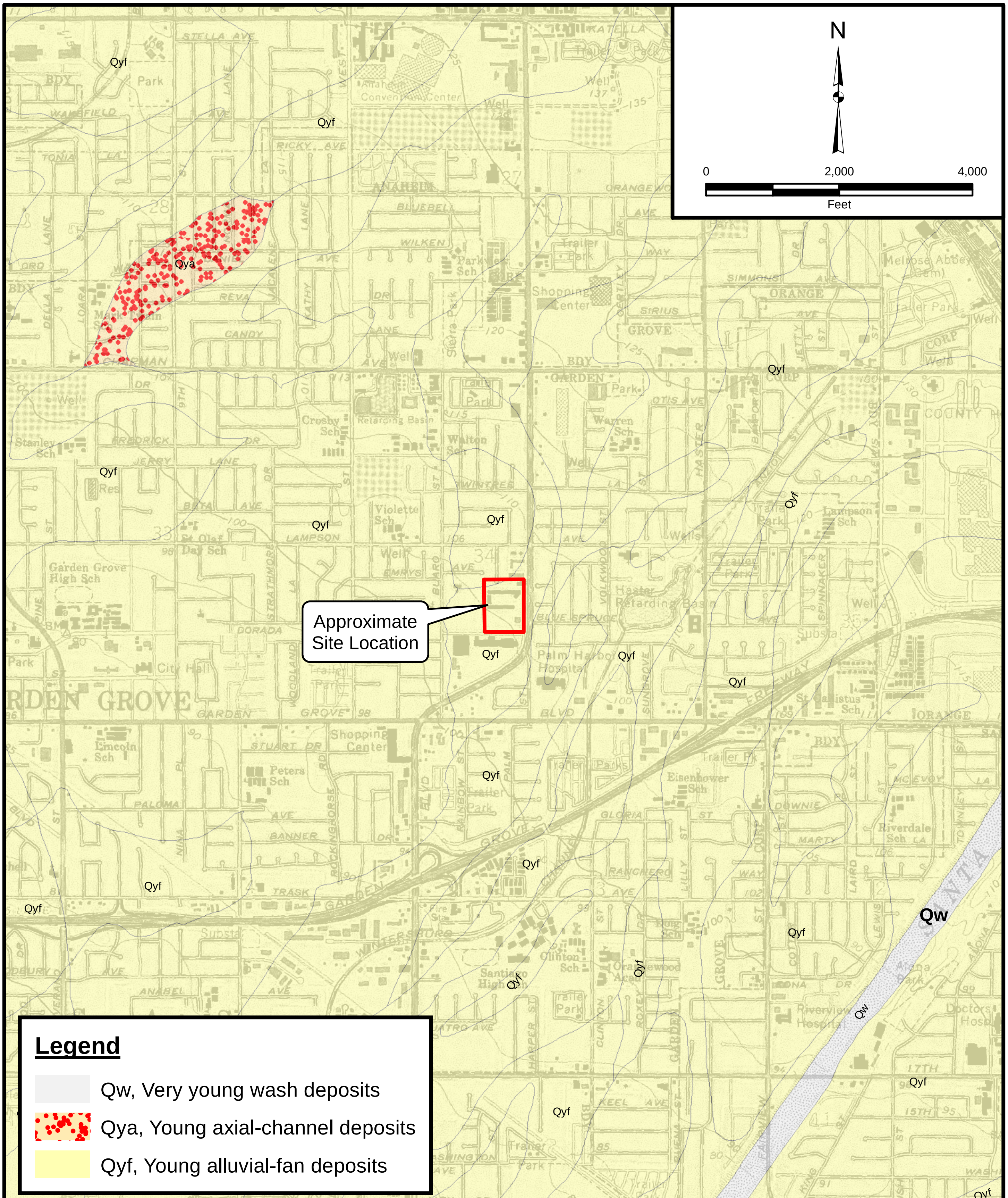

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Open File Report 2006-1217 Map Legend
Author: (mmurphy)

REGIONAL GEOLOGY MAP

McWhinney Development
Garden Grove, California

Figure 2

Leighton

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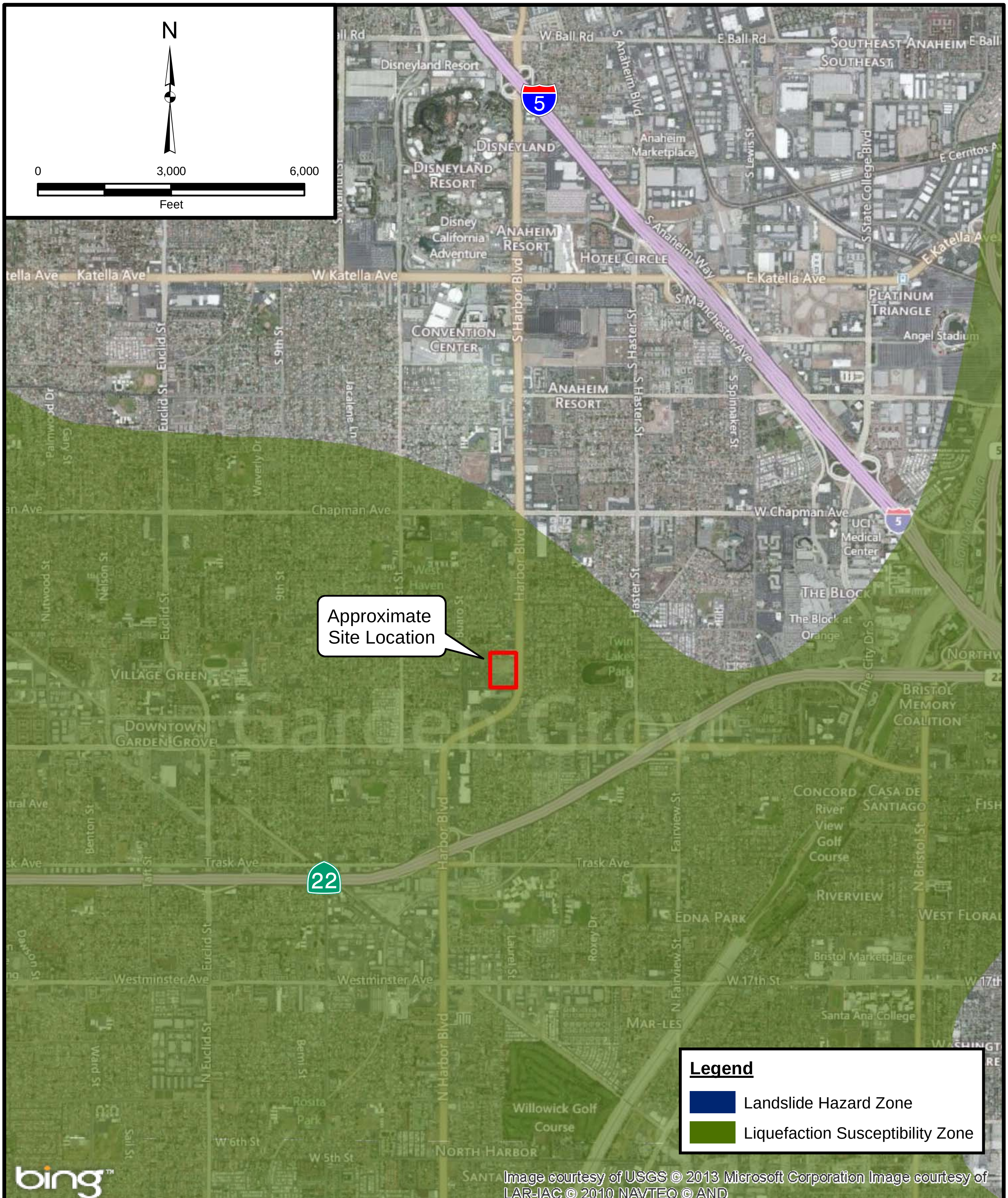

Project:602778-004	Eng/Geol: VPI/JAR	Figure 3
Scale: 1 " = 3,000 '	Date: July, 2013	

Base Map: ESRI Resource Center, 2010
Thematic Info:USGS, 2006, Geologic map of the San Bernardino and Santa Ana 30'x60' quadrangles, California, Version 1.0
Open File Report 2006-1217 Map Legend
Author: (mmurphy)

SEISMIC HAZARDS MAP

McWhinney Development
Garden Grove, California

Leighton

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APPENDIX A

APPENDIX A

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Leighton

APPENDIX A (Cont'd)

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APPENDIX B

GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 1 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 4-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
				BB-1						
105								SP	@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), lite brown, slightly moist, fine grained, poorly graded	
	5			R1	3 5 10			SP-SM	@5': SAND with Silt (SP-SM), medium dense, lite brown, dry, fine grained, micaceus, poorly graded	
100										
	10			R2	7 10 11	105	3	SP	@10': SAND (SP), medium dense, lite brwn, dry, fine grained with thin beds of silt and laminated clay	
95										
	15			R3	6 11 14				@15': micaceous	
90				R4	1 3 3			CL	@18': Silty Sandy CLAY (CL), soft, lite grey, very moist, micaceous with very thin beds of fine grained sand and silt	AL, CN
	20									
								SP		
85									@23': encounter groundwater, measured @ 23.5 feet below ground surface during drilling	
	25			R5	3 14 16	104	21		@25': SAND with Silt (SP-SM), medium dense, lite brown, wet, fine grained, micaceous	
								ML	@26.5': thinly bedded Clayey SILT (ML) with fine grained sand, micaceous	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	2 4 6			CL	@30': Silty CLAY with Sand (CLs), firm, olive grey to blackish grey, moist, fine grained sand, micaceous with thinly bedded fine grained sand	
75								SM		
	35			R7	5 14 18				@35': Silty SAND (SM), medium dense, greyish black, wet, fine grained sand, micaceous	
70										
	40			R8	3 7 10			CL	@40': Silty CLAY (CL), stiff, mottled olive brown to medium grey, very moist, micaceous, laminated, coarse sand sized calcareous nodules	
65										
	45			R9	5 11 11			SM CL	@45': Silty SAND (SM), medium desne, dark grey, wet, fine grained, micaceous becomes Silty CLAY (CL) @ 46', stiff, olive brown to grey, very moist, micaceous with trace of fine grained sand	
60										
	50			R9	3 8 10			SM	@50': Silty SAND (SM), medium dense, greyish black, wet, fine grained, micaceous	
55										
	55			R11	3 5 9			CL	@55': Silty CLAY (CL), stiff, olive brown to medium grey, wet, some fine sand in clayey matrix	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 3 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R12	5 6 11			ML-CL	@60': Clayey SILT to Silty CLAY (ML-CL), stiff, olive brown to orange brown to dark grey, wet, micaceous, thinly bedded, soft sediment deformation as undulating uneven abrupt contacts	
45										
	65			R13	9 10 14			ML	@65': Sandy SILT (ML), stiff, dark grey, wet, fine grained, micaceus, trace clay, organic debris (buried plant matter), charcoal flakes	
40										
	70			R14	16 50/5"			CL SP	@70': **Quaternary Old alluvial fan (Qof)** Sandy CLAY (CL), hard, mottled olive brown to grey, slightly moist, coarse sand, some silt @71': Gravelly SAND (SPg), dense, orange brown, wet, coarse sand, fine rounded gravel	
35										
	75			R15	8 9 21			ML	@75': Sandy SILT (ML), stiff, olive grey to orange brown, moist, fine grained sand	
30								GP	@78': encountered gravel, small cobbles during drilling @80': SAND (SP), dense, orange brown, very moist, fine to coarse sand with thinly bedded silty clay	
	80			R16	5 13 48			SP		
25									Total depth 81.5' Groundwater measured at 23.5' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling then capped with cold patch asphalt	
	85									
20										
	90									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 **Sheet** 1 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 107' **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 10-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris and some fine angular gravel	
105				BB-1						
									@3': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), lite brown, slightly moist, fine grained, micaceous, poorly graded	
	5			R1	7 9 14					
100										
	10			R2	5 9 10	99	3	SP-SM	@10': SAND with Silt (SP-SM), medium dense, lite brown, fine grained, micaceous, poorly graded	DS
95										
	15			R3	9 19 26			ML	@15': Sandy SILT (ML), hard, olive brown, very moist, micaceous, with thin beds of fine sand	
90										
								CL	@18': Silty CLAY (CL), soft, olive brown, very moist, micaceous, trace fine grained sand as thinly interbedded deposits <1" thick	
	20			R4	3 4 5	93	30			Tx, AL
85										
									@23': measured groundwater @ 23' below ground surface during drilling	
	25			R5	6 12 18			ML	@25': Sandy SILT o Silty SAND (ML-SM), very stiff to medium dense, olive brown, wet, fine grained, micaceous, thinly bedded	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 **Sheet** 2 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 107' **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	2 4 4	84	41	CL	@30': Silty CLAY (CL), soft, greyish black, very moist, micaeous with thinly bedded fine grained sand	
75										
	35			S1	2 4 6			SM ML-CL	@35': Silty SAND (SM), lose, olive brown to grey, fine grained, wet @36': Silty CLAY to Clayey SILT (ML-CL), soft, olive grey, wet, micaceous	
70										
	40			R7	2 4 6				@40': with thin beds of fine frained sandy silt	
65										
	45			R8	8 9 7	100	26	CL	@45': Silty CLAY (CL), stiff, grey, wet, micaceous, some fine sand and calcareous nodules	Tx
60										
	50			S2	2 5 12			SM	@50': soft @51': Silty SAND (SM), medium dense, grey, wet, fine grained sand, poorly graded	
55										
	55			S3	0 4 6			CL	@55': CLAY (CL), soft, olive grey, wet, some thin interbeds of fine grained sand and fine gravel sized calcareous nodules	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 **Sheet** 3 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 107' **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R9	4 9 13	87	36	ML	@60': Clayey SILT (ML), stiff, mottled orange brown to olive brown, moist, fine gravel sized calcareous nodules	
45										
	65			S4	4 6 7			ML-CL	@65': Silty CLAY to Clayey SILT (ML-CL), firm, greyish black, moist with thin interbeds of sandy silt	
40										
	70			R10	19 50/6"	115	13	SP	@70': **Quaternary Old alluvial fan (Qof)** drilling becomes difficult to advance, sampler refusal at 71' bgs SAND (SP), very dense, lite yellow brown, wet, fine to coarse sand, some mica, well graded	
35										
	75			S5	11 24 31				@75': coarse sand and fine gravel, wet	
30										
									@80': SAND (SP), with bedded SILT (ML), dense, yellow brown to orange brown, moist silt to wet sand, trace clay in matrix	
	80			R11	7 12 41			SP ML		
25									Total depth 81.5' Groundwater measured at 23' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 1 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0							GM SM	@0': **Artifical fill (Afu) undocumented** Sandy GRAVEL (GM), at surface, 1' thick, reddish brown sandy matrix, fine to coarse sand, fine to coarse angular to sub rounded gravel and aspahlt debris @1': SIlty SAND (SM), dark brown, moist, fine grained, trace asphalt debris	
105				BB-1						
									@3': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), medium dense, brown, slightly moist, fine grained, micaceous	
	5			R1	6 7 10					
100										
	10			R2	9 10 13	100	4	SP-SM	@10': SAND with Silt (SP-SM), medium dense, lite brown, dry, fine grained	
95										
	15			R3	5 12 17			ML	@15': Sandy SILT (ML), very stiff, oxidized orange brown, dry, fine grained	
90										
	20			R4	0 3 4	90	33	CL	@20': Silty CLAY (CL), soft, olive brown, moist, trace coarse sand sized calcareous nodules with interbedded fine grained sand	AL, DS, CN
85									@23.3': measured groundwater @23.3' bgs during drilling	
	25			R5	2 8 7			SM-ML	@25': Sandy SILT to Silty SAND (ML-SM), stiff to medium dense, olive brown, wet, fine grained, micaceous, thinly interbedded	
80										
	30									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	5 4 5	98	25	SP CL	@30': SAND (SP), soft, loose, dark grey, wet, fine to coarse grained, well graded, abrupt contact with underlying clay @31.5': CLAY (CL), dark grey, moist, trace fine grained sand	
75										
	35			R7	7 17 15			SP	@35': SAND (SP), medium dense, grey, wet, medium to coarse grained sand, trace fine rounded gravel with tin interbeds of sandy clay	
70										
	40			R8	3 5 8			CH	@40': Silty fat CLAY (CH), stiff, mottled olive brown to medium grey, moist, micaceous with thin beds of silt and fine grained sand	AL, CN
65										
	45			R9	4 6 6				@45': Sandy CLAY (CL), stiff, mottled olive brown to grey, moist, micaceous,	
60										
	50			R10	4 12 22	102	24	SM-ML ML	@50': Sandy SILT (ML), soft, olive brown, wet, some clay	
55										
	55			R11	4 8 10			CL-ML	@55': Silty CLAY (CL) to Clayey SILT (ML), stiff, olive brown, moist, trace coarse sand sized calcareous concretions	
50										
	60									

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

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 3 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R12	4 8 12			CL	@60': Silty CLAY (CL), stiff, mottled olive brown to orange brown, oxidized, trace coarse sand sized calcareous nodules	
45										
	65			S1	0 2 4				@65': soft, thinly bedded silt and clay, micaceous	
40										
	70			S2	10 21 25			SP	@70': **<u>Quaternary Old alluvial fan (Qof)</u>** SAND (SP), very dense, lite yellow brown, wet, fine to coarse sand, some fine rounded gravel, well graded	
35										
	75									
30									@80': Sandy CLAY (CL), soft, orange brown, moist, oxidized, fine to coarse sand	
	80			S3	4 13 30			SP CL	@80.5': SAND (SP), dense, lite grey to orange brown, wet, fine to coarse sand	
									Total depth 81.5' Groundwater measured at 23.3' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
25										
	85									
20										
	90									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 1 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SP	@0': **Artifical fill (Afu) undocumented** SAND (SP) subgrade, lite brown, dry, medium to coarse sand, asphalt debris	
				BB-1						
105										
									@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), loose, lite grey, very moist, fine grained, poorly graded	
	5			R1	4 5 8					
100										
	10			R2	5 6 7			SM	@10': SAND (SP), loose, lite grey, moist, fine grained sand @11': becomes Silty SAND (SM), loose,mottled lite grey to lite brown, moist	
95										
	15			R3	8 14 19			SP	@15': SAND (SP), medium dense, greyish white, dry, fine to medium sand and fine, rounded gravel	
90										
	20			R4	6 3 4			CL	@20': SAND (SP), loose, tannish brown, moist, medium to coarse sand @21': becomes CLAY (CL), stiff, brown to dark grey, very moist, some fine sand, thinly bedded	
85										
	25			R5	2 4 8			SM	@25': Silty CLAY (CL), stiff, bluish grey, moist, fine grained sand @26.5': becomes SIlty SAND (SM), loose, grey, very moist, fine grained @25.4': measured groundwater at 23.4' bgs during drilling	
80										
	30									

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

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

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GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 2 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	10 21 22			SP	@30': SAND (SP), medium dense, lite grey, wet, fine to medium grained sand	
75										
	35			R7	4 12 20			CL	@36': Silty CLAY (CL), grey, moist, laminated	
70										
	40			R8	3 5 8				@40': Fat CLAY (CH), stiff, grey, very moist, trace fine grained sand and silt	AL, CN
65										
	45			R9	4 5 8				@45': Silty CLAY (CL), firm, grey, wet	
60										
	50			R10	4 11 15			SM	@50': Silty SAND (SM), medium dense, grey, wet, fine grained	
55										
	55			R11	4 8 10			CL	@55': Silty Sandy CLAY (CLs), stiff, grey, moist, fine grained sand	
50										
	60									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

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GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 3 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R12	6 8 11			CL	@60': Silty CLAY (CL), stiff, mottled grey and brown, very moist	
45										
	65			R13	3 11 26			ML	@65': **Quaternary Old alluvial fan (Qof)** CLAY (CL), hard, mottled grey and olive green, moist, some silt and fine grained sand @66': Sandy SILT (MLs), hard, mottled olive bronw to orange brown, wet, fine grained sand	
40										
	70			R14	8 9 13			SP	@70': Sandy SILT (MLs), stiff, bluish grey, moist, fine grained sand @71': Silty Clayey SAND (SM-SC), medium dense, brown, wet, fine to medium grained sand	
35										
	75			R15	11 17 15				@75': SAND (SP), medium dense, brown, wet, fine grained sand, trace silt	
30									@80': CLAY (CL), stiff, brown, very moist, laminated, some tine beds of fine to medium sand	
	80			S1	5 13 11			CL		
									Total depth 81.5' Groundwater measured at 25.4' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
25										
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-5

Date 3-23-11 **Sheet** 1 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77846 W 117.91640

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
105	0							SM	@0': **Artifical fill (Afu) undocumented** 3.5-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris, micaceous	RV, CR
				R1 BB-1	3 4 5			ML	@2': Sandy SILT (ML), soft, mottled dark brown to blackish brown, moist, fine grained, trace clay	
									@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), medium dense, llite grey to lite brown, dry, fine grained, micaceous, poorly graded	
100	5			R2	4 8 8			SP		
				R3	4 5 7			ML	@7': Sandy SILT (ML), stiff, dark brown, moist, fine grained, micaceous	CN
95	10			S1	2 3 4			SM	@10': Silty SAND (SM), loose, lite brown, slightly moist, fine grained, micaceous, poorly graded	
90	15			S2	2 5 9			ML SM	@15': Clayey SILT (ML), firm, olive brown to orange brown, moist, micaceous @16': Silty SAND (SM), medium dense, orange brown, moist, fine grained, micaceous	
								ML-CL	@19': Clayey SILT to Silty CLAY (ML-CL), firm, olive brown to orange brown, very moist, micaceous, trace fine sand, @22': becomes sandy, fine grained	
85	20			R4	3 5 5	93	31			Tx
								SP		
									@23.2': measured groundwater during drilling	
80	25			S3	0 2 6			SM	@25': Silty SAND (SM), loose, brown, wet, fine grained	
								CL	@26.5': CLAY (CL), firm, olive brown to grey, moist	
	30									

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

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

GEOTECHNICAL BORING LOG B-5

Date 3-23-11 **Sheet** 2 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77846 W 117.91640

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
75	30			R5	3 4 7			SM CL	@30': Silty SAND (SM), loose, dark grey, wet, fine grained, micaceous,poorly graded, uneven abrupt contact with Clay below	CN
									@31': CLAY (CL), firm, olive brown to greyish black, moist	
70	35			S4	5 7 11			SM	@36.5': Silty SAND (SM), medium dense, greyish black, wet, fine grained	
65	40			R6	2 5 11			CL	@40': Silty CLAY (CL), stiff, olive brown to grey, very moist	
									@45': Silty SAND (SM), loose, dark grey, wet, fine grained sand, micaceous, poorly graded	
60	45			S5	2 3 4			SM CL	@46': Silty CLAY (CL), firm, dark grey, moist, trace fine grained sand, micaceous	
									Total depth 46.5' Groundwater measured at 23.2' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
55	50									
50	55									
	60									

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

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

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GEOTECHNICAL BORING LOG B-6

Date 3-21-11 **Sheet** 1 **of** 1
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 107' **Location** N 33.77898 W 117.91653

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 9-inches asphalt concrete over Silty SAND (SM) subgrade, dark brown, dry, fine grained sand, micaceous, trace wire debris and concrete fragments @2': Silty SAND (SM), medium dense, dark brown, moist, fine to coarse sand, trace fine angular gravel	
105				R1 BB-1	4 7 9					
	5								@4': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), lite brown, slightly moist, fine grained, poorly graded	
100				R2	5 7 11			ML	@7': Sandy SILT (ML), stiff, olive brown, moist, fine grained sand, micaceous	
	10									
95				R3	8 12 13			SP-SM	@12': SAND with Silt (SP-SM), medium dense, lite grey, dry, fine grained, porly graded	
	15									
90				R4	6 5 6			ML	@17': loose, moist @18': Sandy SILT (ML), soft, olkive brown, moist, fine grained, micaceous	
	20									
85				R5	4 5 9			ML-CL	@23': Clayey SILT to Sily CLAY (ML-CL), firm, dark grey, moist, trace fine sand, porous, sparse voids to 1-3 mm in size, unlined, thinly bedded	
	25								Total depth 24.5 Groundwater not encountered during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
80										
	30									

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

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

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GEOTECHNICAL BORING LOG B-7

Date 3-23-11 **Sheet** 1 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77808 W 117.91544

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION — The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 2-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
105										
				R1 BB-1	3 7 11			ML SP	@2': Sandy SILT (MLs), stiff, mottled lite brown to drak brown, moist, fine grained, micaceous, some asphalt fragments, trace clay @3': **Quaternary young alluvial fan (Qyf)** SAND (SP), medium dense, lite brown, slightly moist, fine grained, poorly graded	
	5			S1	2 5 5					
100										
				R2	3 7 10				@7': medium dense, trace coarse grained sand	
	10			S2	2 3 4				@10': loose, dry	
95										
	15			R3	9 14 14			SM	@15': Silty SAND (SM), medium dense, olive brown, very moist, fine grained, micaceous	
90										
				R4	1 2 6			CL	@19': Sandy CLAY (CLs), soft, olive brown, very moist, fine grained sand, micaceous	
	20									
85								SM	@21': Silty SAND (SM), greyish brown, wet, fine grained sand @21.8': measured groundwater at 21.8' during drilling	
	25			S3	2 3 12			CL	@25': Silty CLAY (CL), soft, olive brown, very moist, laminated to thinly bedded with fine grained sand	
80								SM		
				R5	3 4 6			CL	@28.5': Silty SAND (SM), loose, brown, wet, fine grained overlying Sandy CLAY (CLs), soft, medium grey, very moist	
	30									

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

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

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GEOTECHNICAL BORING LOG B-7

Date 3-23-11 **Sheet** 2 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77808 W 117.91544

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30									
75									Total depth 30' Groundwater measured at 21.8' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
	35									
70										
	40									
65										
	45									
60										
	50									
55										
	55									
50										
	60									

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

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

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

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GEOTECHNICAL BORING LOG B-8

Date	3-22-11	**Sheet**	1 **of** 3
Project	602778-002- McWhinney Development	**Logged / Sampled By**	J Roe
Drilling Co.	Martini	**Type of Rig**	CME-75
Hole Diameter	8	**Drive Weight**	140 Lbs Autohammer
Drop	30"		
Elevation Top of Hole	106'	**Location**	N 33.77939 W 117.91585

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
105	0			BB-1				SP	@0': **Artifical fill (Afu) undocumented** 4-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
100	5			S1	6 6 6				@4': **Quaternary young alluvial fan (Qyf)** SAND (SP),medium dense, lite brown, slightly moist, fine grained, trace fine rounded gravel	
95	10			R1	7 10 13			SM	@10': Silty SAND (SM), medium dense, brown, moist, fine grained sand	
90	15			S2	2 6 9			SP	@15': SAND (SP), medium dense, lite brown, moist, fine to mdeium grained sand	
85	20			R2	5 5 5			CL	@20': SAND (SP), loose, orange brown, wet, coarse grained sand, becomes CLAY (CL), medium stiff, grey, wet, encounter perched groundwater during drilling	
				R3	3 4 7				@22': CLAY (CL), stiff, grey, moist, trace calcareous nodules	
80	25			S3	2 3 3			ML	@25': Sandy SILT (MLs), stiff, lite grey, very moist, fine grained sand	
	30									

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

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

GEOTECHNICAL BORING LOG B-8

Date 3-22-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By** J Roe
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77939 W 117.91585

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
75	30			R4	8 13 16			SP-SM SM	@30': SAND with Silt (SP-SM), medium dense, grey, wet, fine grained, becomes Silty SAND (SM), medium dense, grey, wet, fine grined	
				R5	8 8 10			ML	@32': Silty SAND (SM), medium dense, grey, very moist, fine grained, becomes Sandy SILT (MLs), stiff, grey, very moist, fine grained sand	
70	35			R6	4 10 15			SP	@35': SAND (SP), medium dense, grey, wet, fine grained	
65	40			R7	2 5 6			CL	@40': Silty CLAY (CL), stiff, brown, very moist, laminated	
				R8	3 5 8				@42': mottled grey to brown	
60	45			R9	2 5 9				@45': Sandy CLAY (CLs), stiff, grey, very moist, fine grained sand, becomes Clayey SAND (SC), loose, grey, wet, fine grained	
				R10	2 5 6			ML	@47': Sandy SILT (MLs), stiff, lite grey, wet, fine grained sand	
55	50			S4	2 4 7			CL	@50': Silty CLAY (CL), stiff, greyish brown, very moist, fine grained sand	
50	55			R11	4 7 10				@55': CLAY (CL), stiff, mottled olive brown to grey, moist	
	60									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-8

Date 3-22-11 **Sheet** 3 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By** J Roe
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77939 W 117.91585

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
45	60			R12	3 9 11			ML CL	@60': Sandy SILT (MLs), stiff, mottled brown to grey, very moist, fine grained sand, becomes CLAY (CL), stiff, mottled grey to brown, very moist	
40	65			R13	4 14 20			SM	@66': **Quaternary Old alluvial fan (Qof)** Silty SAND (SM), dense, grey, very moist, fine grained sand	
35	70			S5	11 27 48			SP	@70': SAND (SP), very dense, tannish brown, moist, fine grained	
30	75									
25	80			S6	5 13 14			SM	@80': Silty SAND (SM), medium dense, brown, very moist, fine grained	
									Total depth 81.5' Groundwater measured at 20' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
20	85									
	90									

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

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

GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM-SC	@0': **Artificial fill (Afu) undocumented** Silty to Clayey SAND, orange brown, very moist, fine to medium sand, trace crushed aggregate and asphalt debris	
	5			R-1	5 7 10			SP	@5': **Quaternary young alluvial fan (Qyf)** SAND, light olive brown, moist, medium dense, fine-grained, micaceous	
	10			R-2	5 7 10			SP	@10': SAND, light olive brown, moist, medium dense, fine to coarse grained, micaceous	
	15			R-3	4 10 13			SP	@15': SAND, light olive brown, moist, medium dense, fine grained, some silt content	
				R-4	3 3 6			CL	@17': CLAY, dark brown, moist, stiff, sample disturbed	
	20			R-5	2 4 7			CL	@20': Silty CLAY, dark brown, moist, stiff, micaceous, transitions to SILT	
				R-6	5 10 16			SM	@22': Silty SAND, dark olive, wet, medium dense, fine grained, micaceous, groundwater encountered during drilling.	
	25			R-7	4 17 30			ML	@25': SILT, olive, wet, hard, micaceous, transitions to SAND, light olive brown, fine-coarse grained	
				R-8	6 18 14			SM	@27': Silty SAND, dark olive brown, medium dense, wet, coarse grained	
	30									

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

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

GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	30			R-9	2 3 4			CL-ML	@30': Silty CLAY to Clayey SILT, dark grey, soft, wet, micaceous, embedded roots, paleosol, marine silts and clays	
	35			R-10	3 6 11			ML	@35': SILT, dark grey, wet, stiff, micaceous	
	40			R-11	3 5 8			CL-ML	@40': Silty CLAY to Clayey SILT, dark olive brown, very moist, stiff, micaceous	
	45			R-12	8 5 7			ML	@45': SILT, dark oilve grey, very moist, stiff, pockets of interbedded clay	
	50			R-13	8 12 16			SM	@50': Silty SAND, dark olive brown, very moist, medium dense, fine grained sand	
	55			R-14	4 8 10			ML	@55': Clayey SILT, dark olive brown, very moist, stiff, micaceous	
	60									

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

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

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

GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			R-15	6 12 13			CL	@60': Silty CLAY, dark grey, very moist, stiff, trace of oxidation along soil faces, micaceous	
	65			R-16	6 8 12			CL	@65': CLAY, dark grey, moist, stiff, trace of rootlets, iron preciptation along soil faces, moderately well developed paleosol	
	70			R-17	14 36 37			SP	**Quaternary old alluvial fan (Qof)** @70': SAND, light olive, very moist, dense, fine to coarse grained	
	75			R-18	14 30 22			SP	@75': SAND, light olive, wet, dense, fine to coarse grained, trace of silt	
	80			R-19	16 22 32			SP	@80': SAND, olive, wet, dense, trace of silts and interbedded layer of clay, fine to coarse grained	
									Total depth: 81.5 feet. Groundwater initially encountered at 22.0 feet during drilling, and rose to 20.8 feet after 10 minutes. Boring backfilled with bentonite mixed with soil cuttings upon completion of drilling.	
	85									
	90									

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

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

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0			B-1				SM	@0': **Artificial fill (Afu) undocumented** Silty SAND, brown, slightly moist, fine to coarse grained sand, some fine gravels	
105									**Quaternary young alluvial fan (Qyf)** @3': SAND, light grey brown, slightly moist, soft, fine sand, micaceous	
	5			R-1	3 4 5			SP		
100										
	10			R-2	3 8 9			SM	@10': Silty SAND, grey brown, moist, medium dense, fine-grained with a trace of coarse-grained sand	
95										
	15			R-3	2 6 6			SP	@15': SAND, light brown, moist, medium dense, fine-grained sand	
90										
	20			R-4	4 4 5			SP	@20': SAND, light grey, slightly moist, loose, fine-grained with a trace of coarse-grained sand, abrupt contact with below	
								CL	@21': CLAY, dark grey, very moist, soft, paleosol, marine clay	
				R-5	2 4 6			CL	@22': CLAY, grey, moist, soft	
85										
∇	25			R-6	2 5 12			SM	@25': Silty SAND, medium grey, very moist, medium dense, fine-grained sand, micaceous, groundwater encountered during drilling	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-7	5 6 11			ML	@30': Sandy SILT, grey, moist, stiff, fine-grained sand, micaceous	
75										
	35			R-8	2 5 9			SM	@35': Silty SAND, grey, very moist, medium dense, fine-grained sand, micaceous, few carbonate nodules	
70										
	40			R-9	3 4 4			SM	@40': Silty SAND, grey brown, very moist, loose, fine-grained sand, micaceous, abrupt contact with below	
								CL	@41': CLAY, grey brown, very moist, soft, few carbonate nodules, paleosol	
65										
	45			R-10	2 3 6			CL	@45': Sandy CLAY, grey, wet, stiff, fine to medium-grained sand, micaceous	
60										
	50			R-11	2 3 8			CL	@50': Silty CLAY, grey, wet, stiff, traces of fine-grained sand, few carbonate nodules, micaceous, paleosol	
55										
	55			R-12	2 4 6			SP	@55: SAND, grey, wet, medium dense, fine to medium grained sand, micaceous, abrupt contact with below	
								CL	@56': CLAY, grey, very moist, stiff	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			R-13	3 6 14			CL	@56': CLAY, grey, very moist, stiff @60': CLAY, grey brown, moist, very stiff	
45								SP	@61': SAND, grey brown, very moist, medium dense, fine-grained sand, some oxidation staining	
	65			R-14	6 19 24			SP	**Quaternary old alluvial fan (Qof)** @65': SAND, grey, very moist, dense, micaceous, traces of very fine sand	
40	70			R-15	5 8 13			ML	@70': SILT, grey brown, moist, stiff, micaceous, traces of fine-grained sand	
35	75			R-16	9 31 50/4"			SP	@75': SAND, light brown, very moist, very dense, medium to very coarse-grained sand	
30	80			R-17	4 8 14			SM	@80': Silty SAND, grey brown, wet, medium dense, very fine-grained sand, micaceous	
								ML	@81': SILT, grey brown, wet, stiff, micaceous	
25	85								Total depth: 81.5 feet. Groundwater encountered at 25 feet during drilling. Boring converted to monitoring well (B-10/MW-2-003) upon completion of drilling. Installed 2-inch diameter well casing to 60 ft. 40 ft. of slotted .020 casing. 20 ft. of solid 2-inch casing to surface. See Figure C4 - Monitoring Well Construction Diagram for details.	
20	90									

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

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

GEOTECHNICAL BORING LOG B-11

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0			B-1				GC	@0': **Artificial fill (Afu) undocumented** Sandy GRAVEL with clay, dark brown, moist, fine to coarse grained sand, fine to coarse grained gravel, wood chips at surface	
105										
	5			R-1	5 6 8			SM	@5': Silty SAND, brown, moist, fine to coarse grained sand, trace of fine to coarse grained gravel. Concrete rebar encountered @6.5'. Boring offset 60 feet southeast, resumed as B-11b. Total depth: 6.5 feet. No groundwater encountered. Boring backfilled with soil cuttings upon completion of drilling.	
100										
	10									
95										
	15									
90										
	20									
85										
	25									
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	0			B-1				GM-GC	@0': **Artificial fill (Afu) undocumented** Sandy GRAVEL with silt and clay, brown to grey brown, moist, fine to coarse sand, fine to coarse crushed aggregate	
105	5									
100				R-1	8 10 15			SP	**Quaternary young alluvial fan (Qyf)** @7': SAND, olive brown, moist, medium dense, fine to medium grained	
	10			R-2	5 6 8			SP	@10': SAND, light olive grey, moist, medium dense, grades from coarse in upper half of sample to fine grained in lower half.	
95	15			R-3	6 11 15			CL	@15': Silty Sandy CLAY, dark olive brown, moist, very stiff, fine grained sand, transitions to silty sand	
								SM	@16': Silty SAND, dark brown, moist, fine grained	
90	20			R-4	2 2 2			CL	@20': CLAY, dark brown, moist, soft, trace of oxidation, paleosol	
85				R-5	3 3 5			MH	@22': Organic SILT, dark grey, moist, some clay content, trace of organics/rootlets, marine silt	
	25			R-6	3 5 11			CH	@25': Fat CLAY, dark grey, moist, trace of organics/rootlets, paleosol, moderate development of blocky soil structure	
80	30									

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

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

GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	**SOIL DESCRIPTION** *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	30			R-7	6 10 11			ML	@30': Clayey SILT, dark grey, very moist, stiff, micaceous, shells, groundwater encountered @30.0 feet during drilling	
75										
	35			R-8	6 12 11			ML	@35': Sandy SILT, dark olive, very moist, stiff, fine grained sand, shells	
70										
	40			R-9	2 3 4			SM	@40': Silty SAND, dark olive, wet, loose fine grained sand	
65										
	45			R-10	3 4 8			SM	@45': Silty SAND, dark olive, wet, loose, fine grained sand	
60										
	50			R-11	2 4 17			ML	@50': Sandy SILT, dark olive green, wet, stiff, fine grained sand	
55										
	55			R-12	3 6 10			CL	@55': CLAY, dark olive brown, moist, stiff	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	60			R-13	8 7			SM	@60': Silty SAND, olive grey, very moist, medium dense, fine grained, micaceous	
					11			CL	@61': CLAY, dark olive green, moist, stiff	
45										
	65			R-14	13 14 15			SM	@65': Silty SAND, olive green, very moist, medium dense, fine grained, interbedded layers of clay	
40										
	70			R-15	17 21 27			SP-SM	**Quaternary old alluvial fan (Qof)** @70': SAND with silt, olive green, wet, dense, fine to coarse grained	
35										
	75			R-16	20 28 30			SP(g)	@75': Gravelly SAND, olive green, very moist, dense, fine to coarse grained sand, fine to coarse grained gravel	
30										
	80			R-17	10 14 30			ML	@80': SILT, dark olive, very moist, transitions to sand, olive green, wet, fine to coarse grained	
									Total depth: 81.5 feet. Groundwater encountered at 30.0 feet during drilling. Backfilled with soil cuttings mixed with bentonite grout upon completion of drilling.	
25										
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0			B-1				SM	@0': **Artificial fill (Afu) undocumented** Silty SAND, light brown, slightly moist, fine to coarse-grained sand	
105									**Quaternary young alluvial fan (Qyf)** @2': SAND, light grey brown, slightly moist, medium dense, fine to medium-grained sand, micaceous	
	5			R-1	3 5 8			SP		
100										
	10			R-2	3 6 8			SP-SM	@10': SAND to Silty SAND, grey brown, moist, meduim dense, fine to medium-grained sand, micaceous	
95										
	15			R-3	7 14 19			SP	@15': SAND, light brown, slightly moist, dense, fine to medium-grained sand, micaceous	
90										
	20			R-4	5 13 7			SP(g)	@20': Gravelly SAND, light brown, slightly moist, medium dense, fine to coarse-grained sand, some fine to coarse-grained rounded gravels	
				R-5	2 3 6			CL	@22': CLAY, grey, moist, soft, micaceous, paleosol, marine clay	
85										
	25			R-6	2 5 13			ML	@25': SILT, grey brown, moist, soft, micaceous	
								SP	@26': SAND, grey brown, moist, medium dense, fine-grained sand, groundwater encountered during drilling	
80										
	30									

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

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
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- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-7	5 8 23			SP	@26': SAND, grey brown, moist, medium dense, fine-grained sand, groundwater encountered during drilling @30': SAND, grey brown, very moist to wet, dense, fine to medium-grained sand, micaceous	
75										
	35			R-8	5 8 10			SP	@35': SAND, grey brown, wet, medium dense, fine to medium-grained sand, micaceous	
70										
	40			R-9	3 5 11			SP	@40': SAND, grey brown, wet, medium dense, fine to medium-grained sand, micaceous	
65										
	45			R-10	5 5 9			CL	@45': CLAY, grey brown, very moist, stiff, abrupt contact with below	
								SM	@46': Silty SAND, grey brown, very moist, medium dense, fine to medium-grained sand	
60										
	50			R-11	3 6 11			SM	@50': Silty SAND, grey brown, wet, medium dense, fine-grained sand	
55										
	55			R-12	3 5 9			CL-ML	@55': Silty CLAY to Clayey SILT, grey, very moist to wet, stiff, micaceous	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	60			R-13	4 9			ML	@60': SILT, grey brown, moist, stiff, micaceous	
					10			CL	@61': CLAY, grey brown, moist, stiff, micaceous	
45										
	65			R-14	4 8 12			ML	@65': SILT, blue grey, moist, very stiff, micaceous	
40										
	70			R-15	5 9 10			SM	@70': Silty SAND, grey brown, very moist, medium dense, fine to medium-grained sand	
35										
	75			R-16	14 44 41			SP	**Quaternary old alluvial fan (Qof)** @75': Gravelly SAND, light brown, wet, very dense, medium to very coarse-grained sand, fine rounded gravels	
30										
	80			R-17	9 10 23			CL	@80': CLAY, grey brown, very moist, stiff	
									Total depth: 81.5 feet. Groundwater encountered at 26.0 feet depth during drilling. Boring backfilled with soil cuttings and bentonite grout upon completion of drilling.	
25										
	85									
20										
	90									

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

TYPE OF TESTS:
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CN CONSOLIDATION
- CO COLLAPSE
- CR CORROSION
- CU UNDRAINED TRIAXIAL
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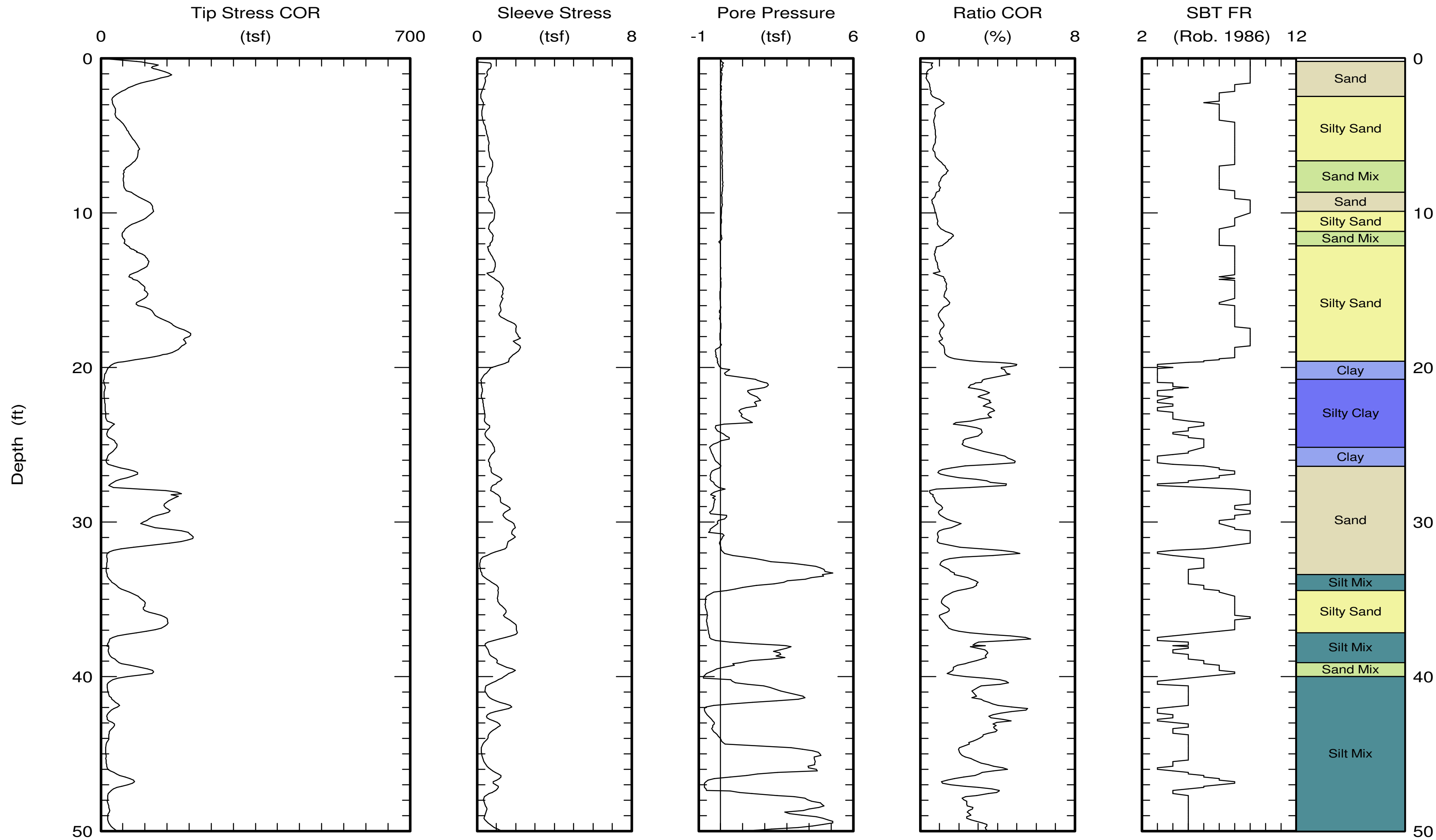
- PP POCKET PENETROMETER
- RV R VALUE
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- SG SPECIFIC GRAVITY
- UC UNCONFINED COMPRESSIVE STRENGTH

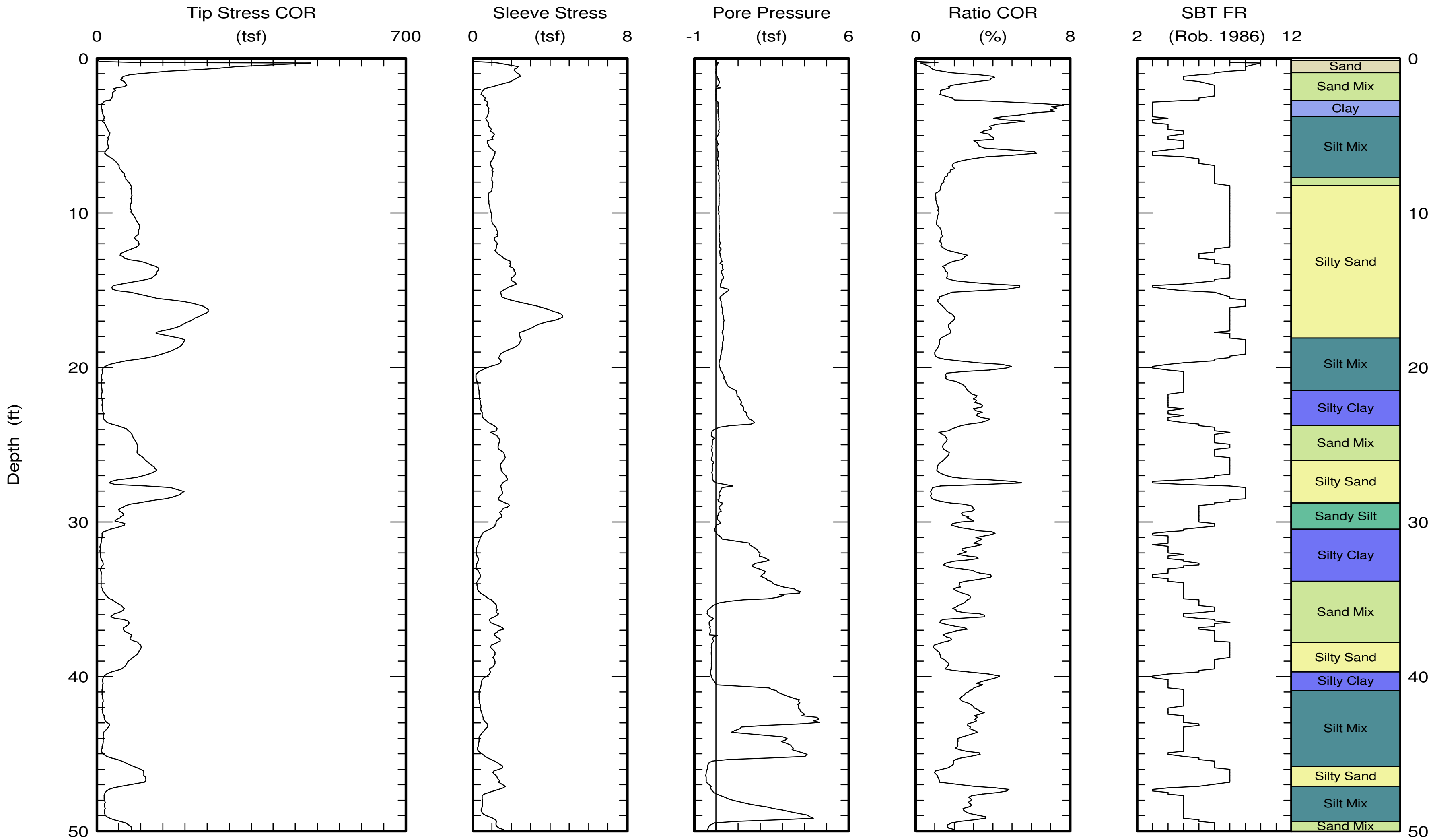
Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-1 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 50.46 (ft)

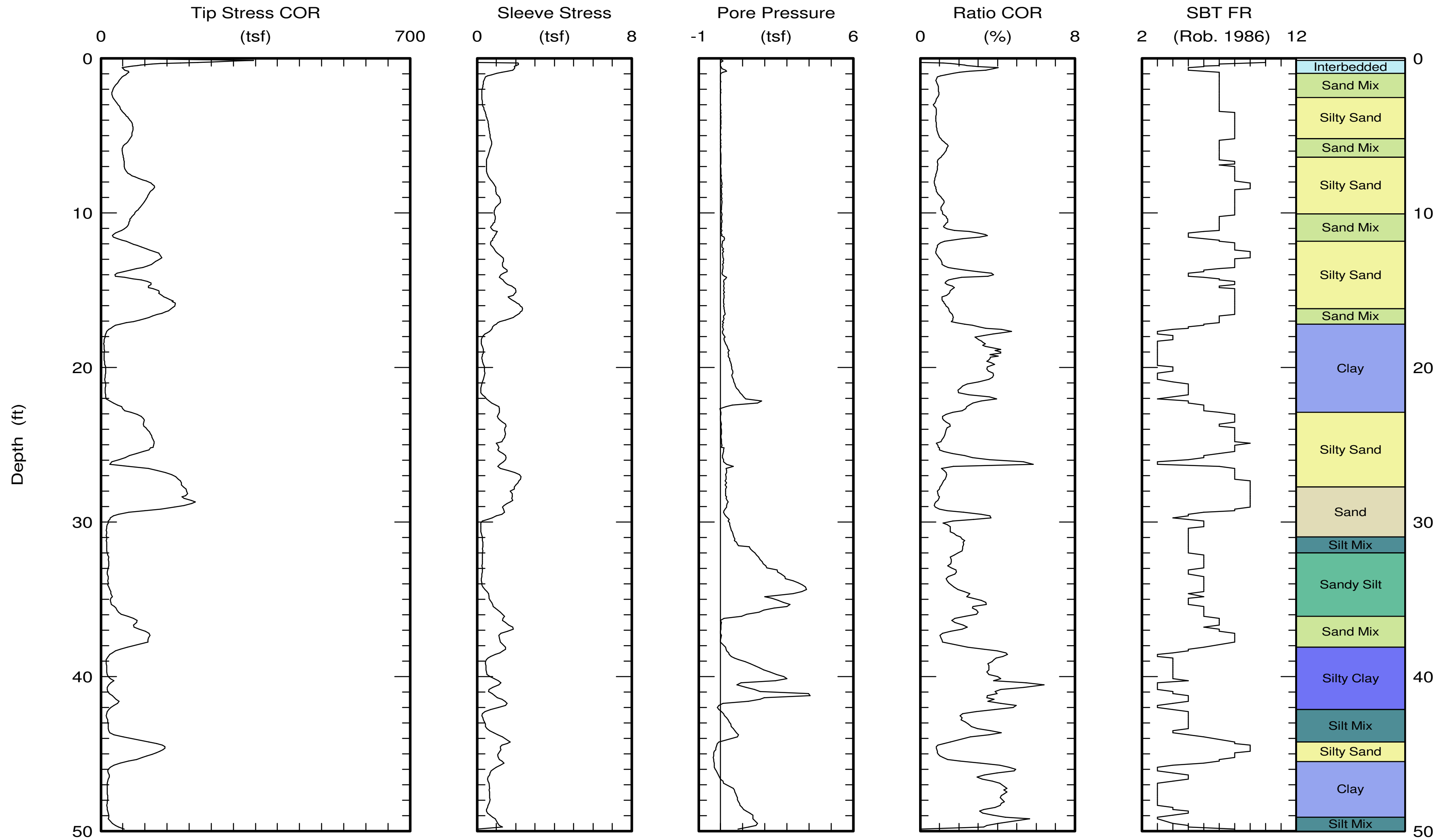
Page 1 of 2

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-2 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 50.28 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-3 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



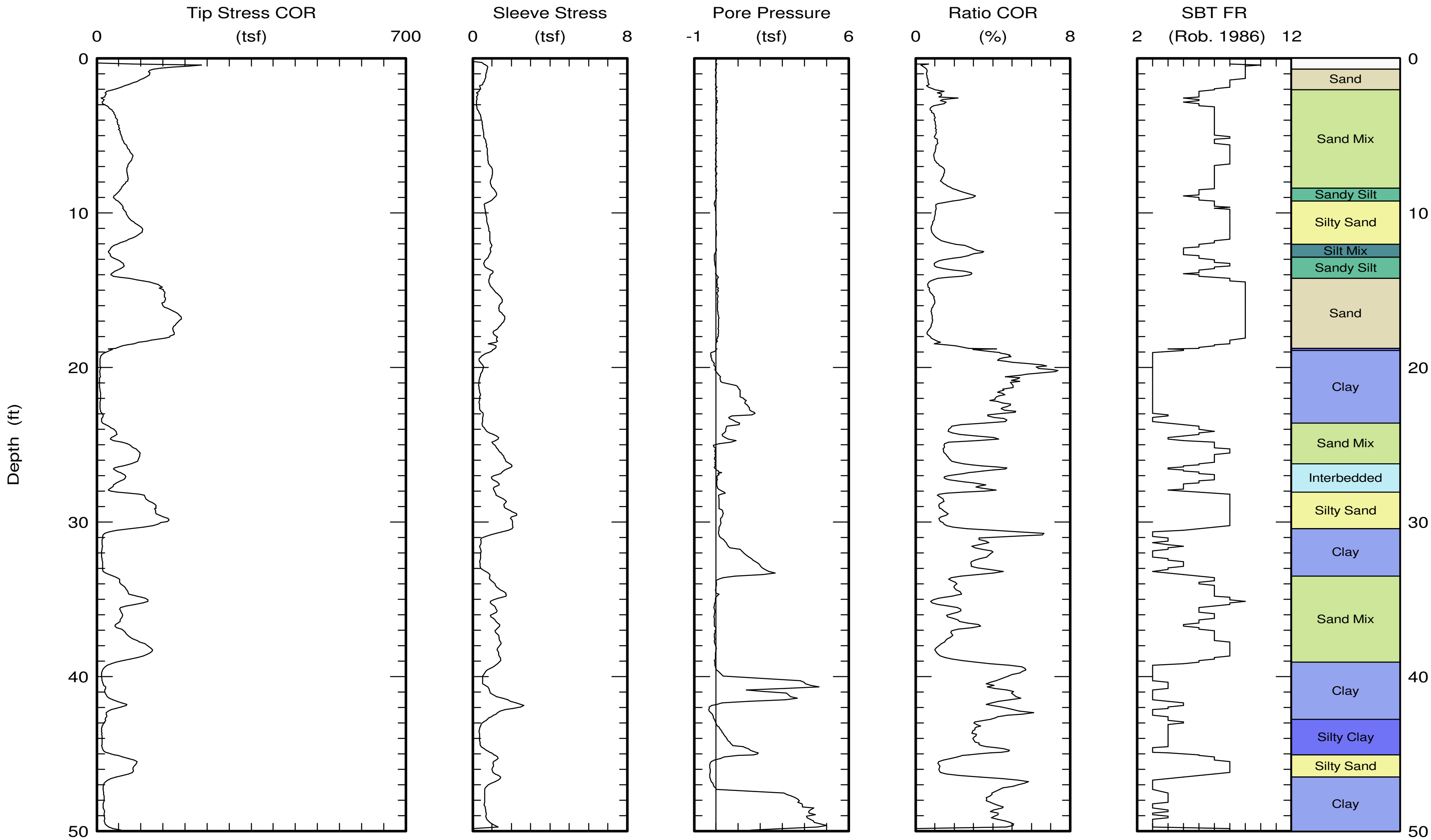
Maximum depth: 50.23 (ft)

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-4
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd



Maximum depth: 50.14 (ft)
Page 1 of 2

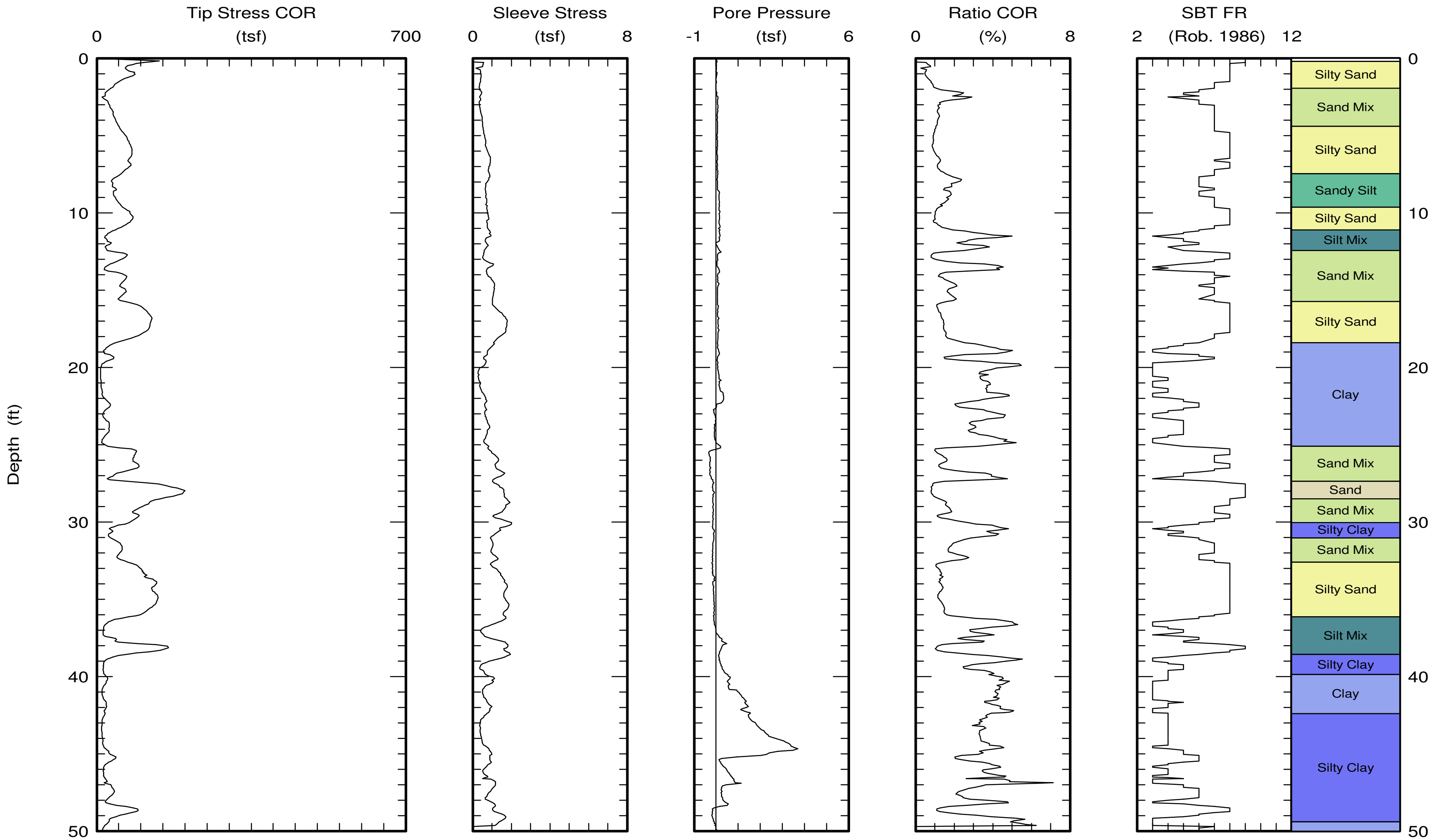
Test ID: CPT-4
File: Z30N0904C.ECP

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

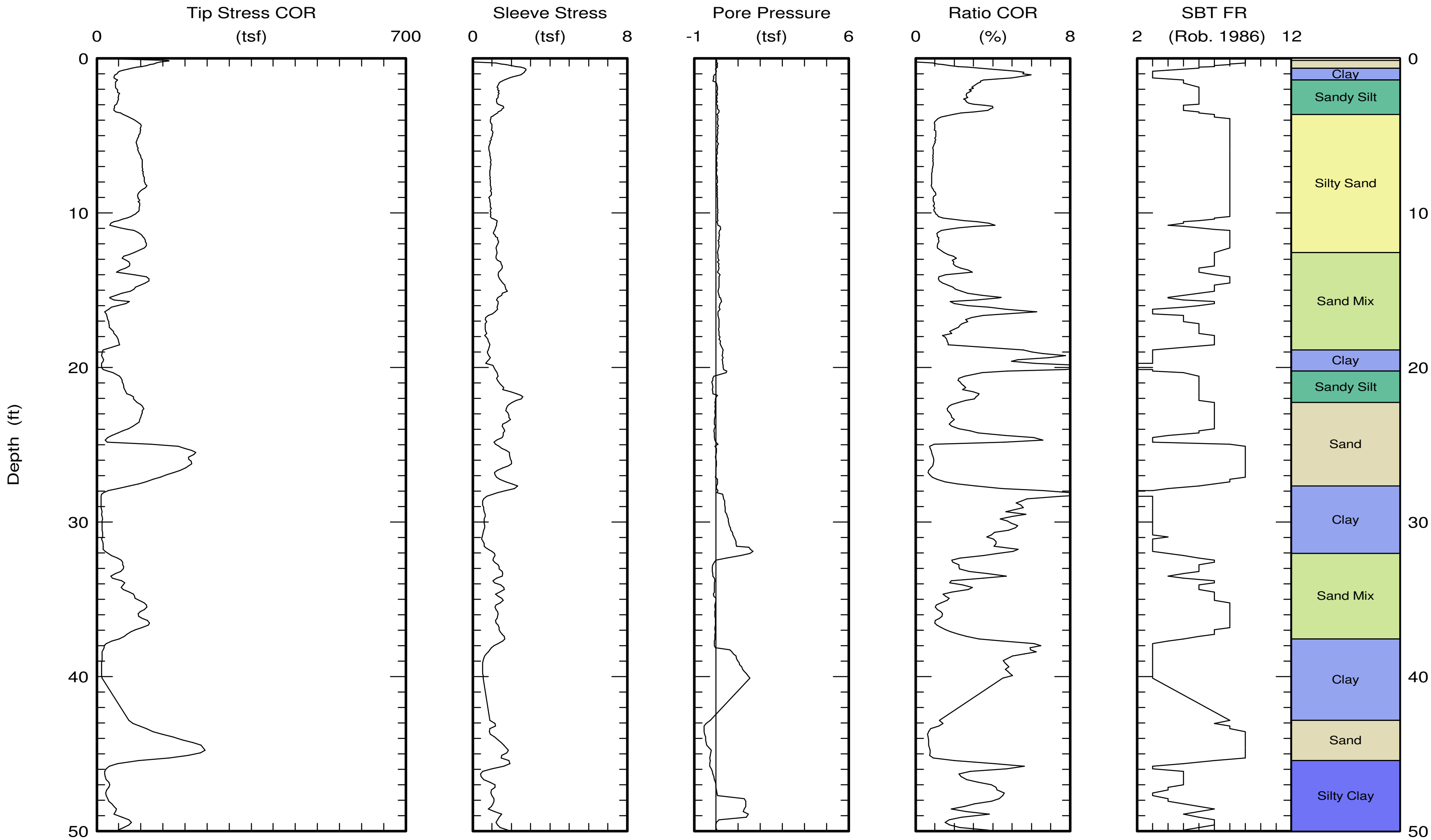
Date: 30/Nov/2009
Test ID: CPT-5
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd



Maximum depth: 50.02 (ft)

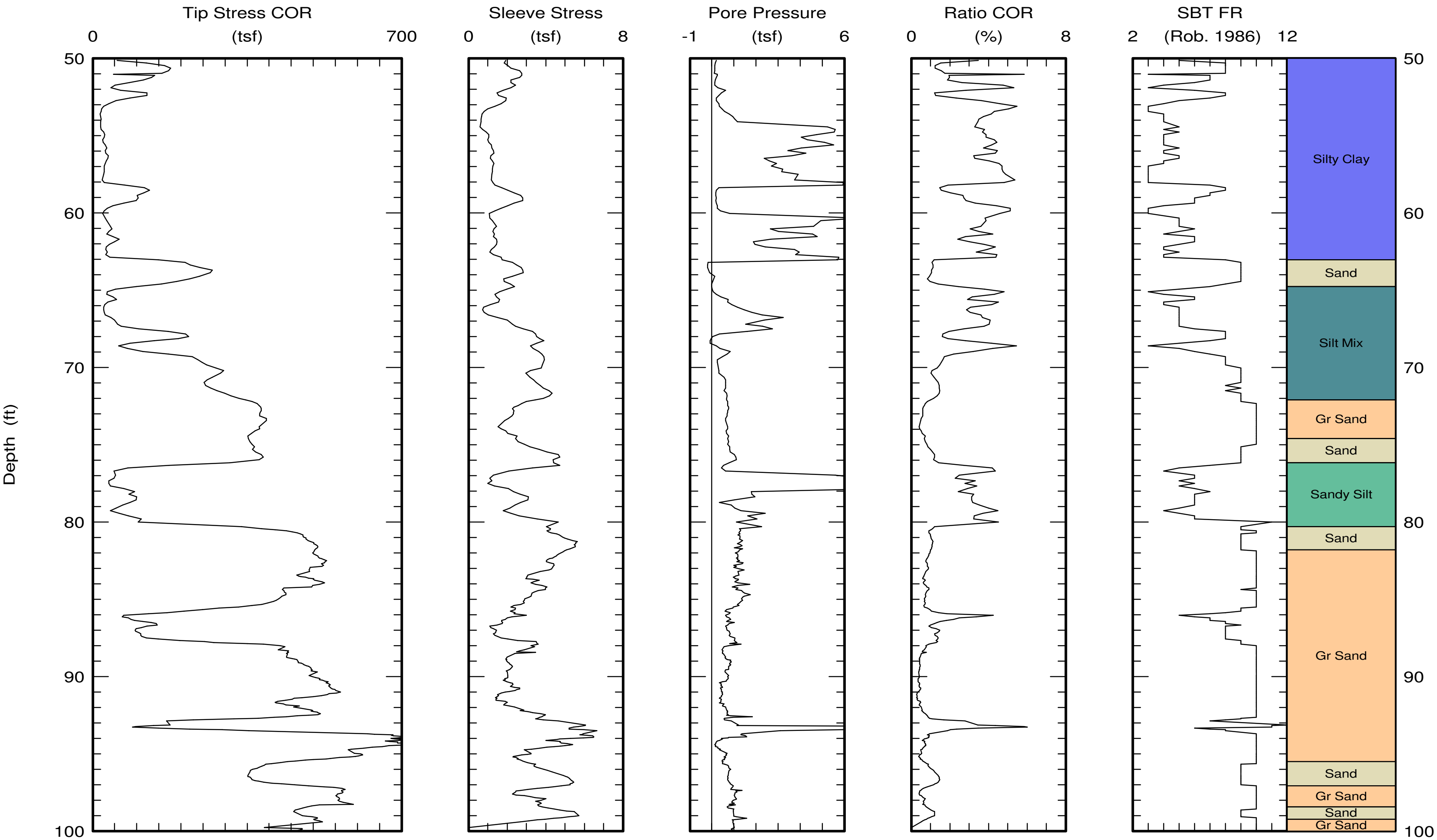
Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-6 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 100.12 (ft)

Test ID: CPT-6
File: Z30N0906C.ECP

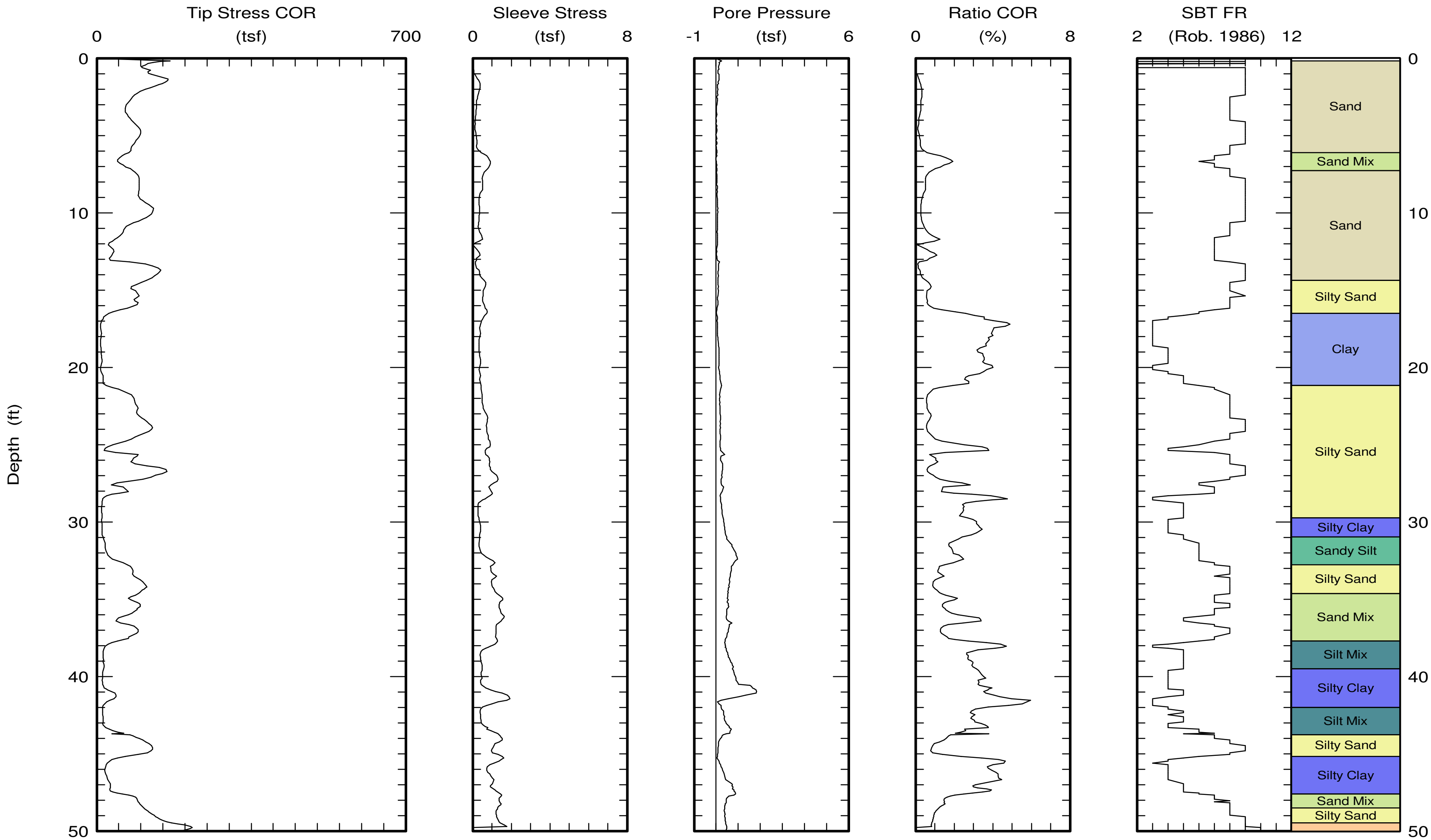
Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-6 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 100.12 (ft)

Test ID: CPT-6
File: Z30N0906C.ECP

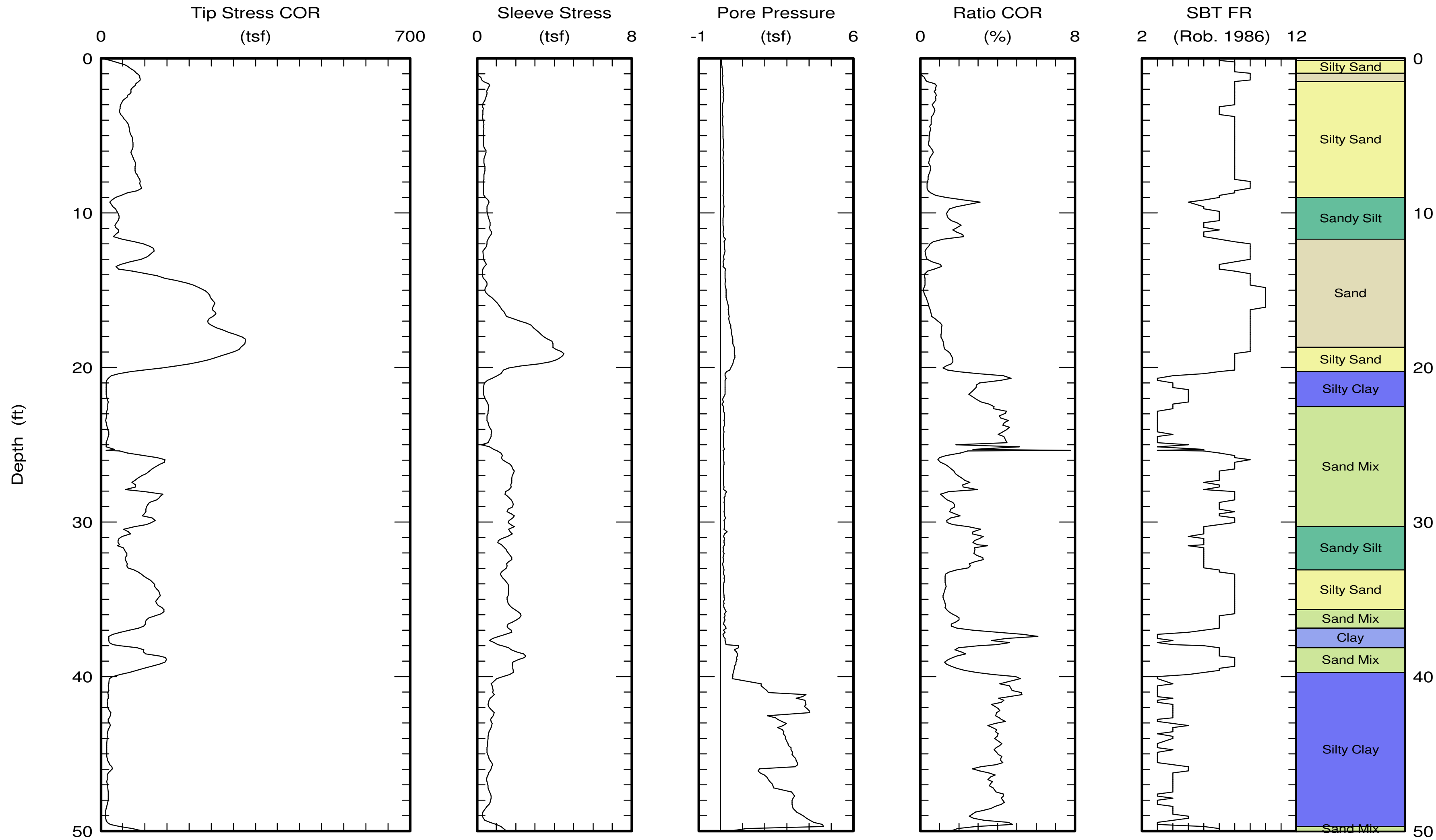
Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-7 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 50.07 (ft)

Page 1 of 2

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-8 Project: GardenGrove
	Customer: Leighton Consulting Job Site:	



Maximum depth: 84.30 (ft)

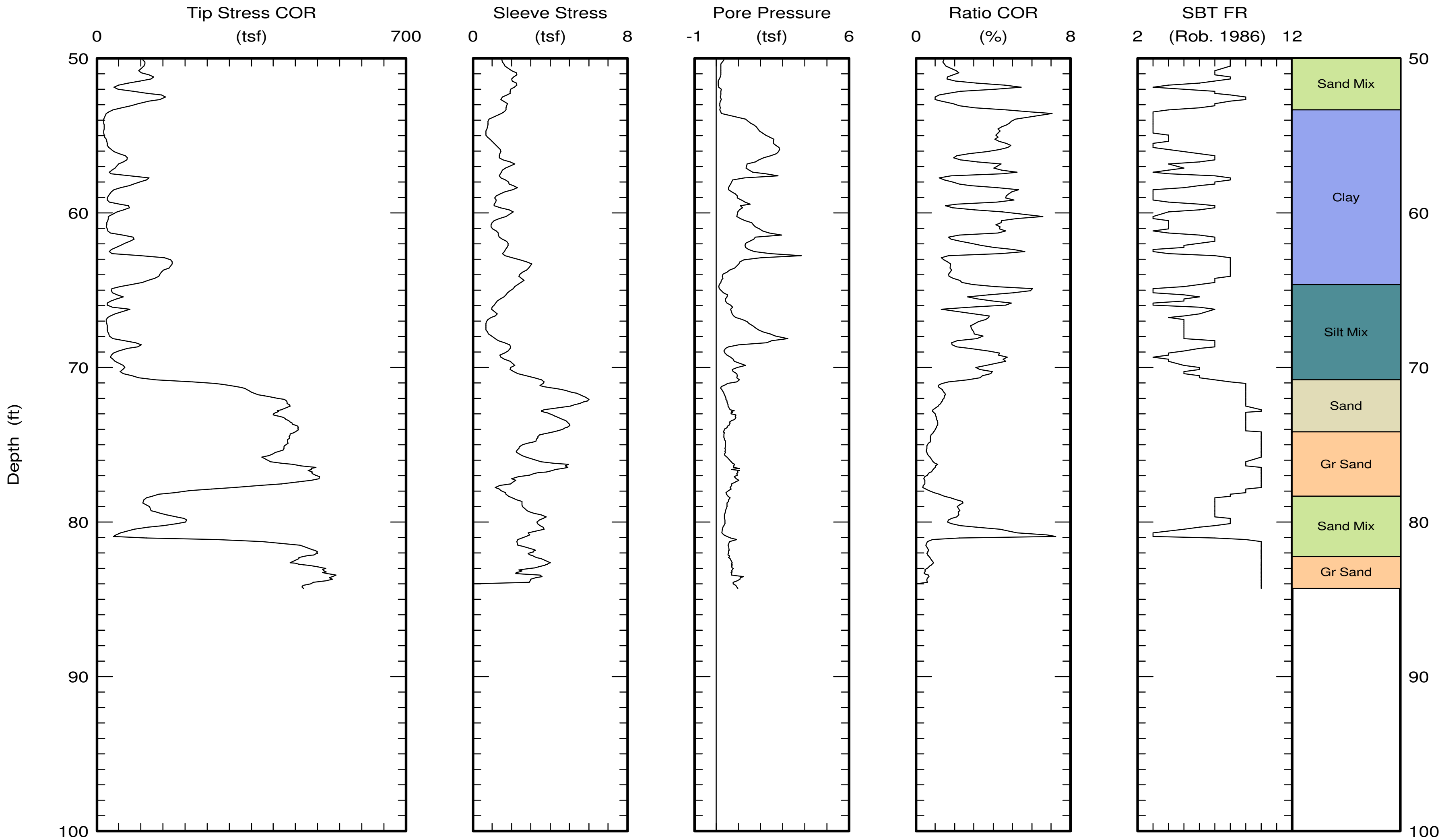
Page 1 of 2

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-8
Project: GardenGrove

Customer: Leighton Consulting
Job Site:



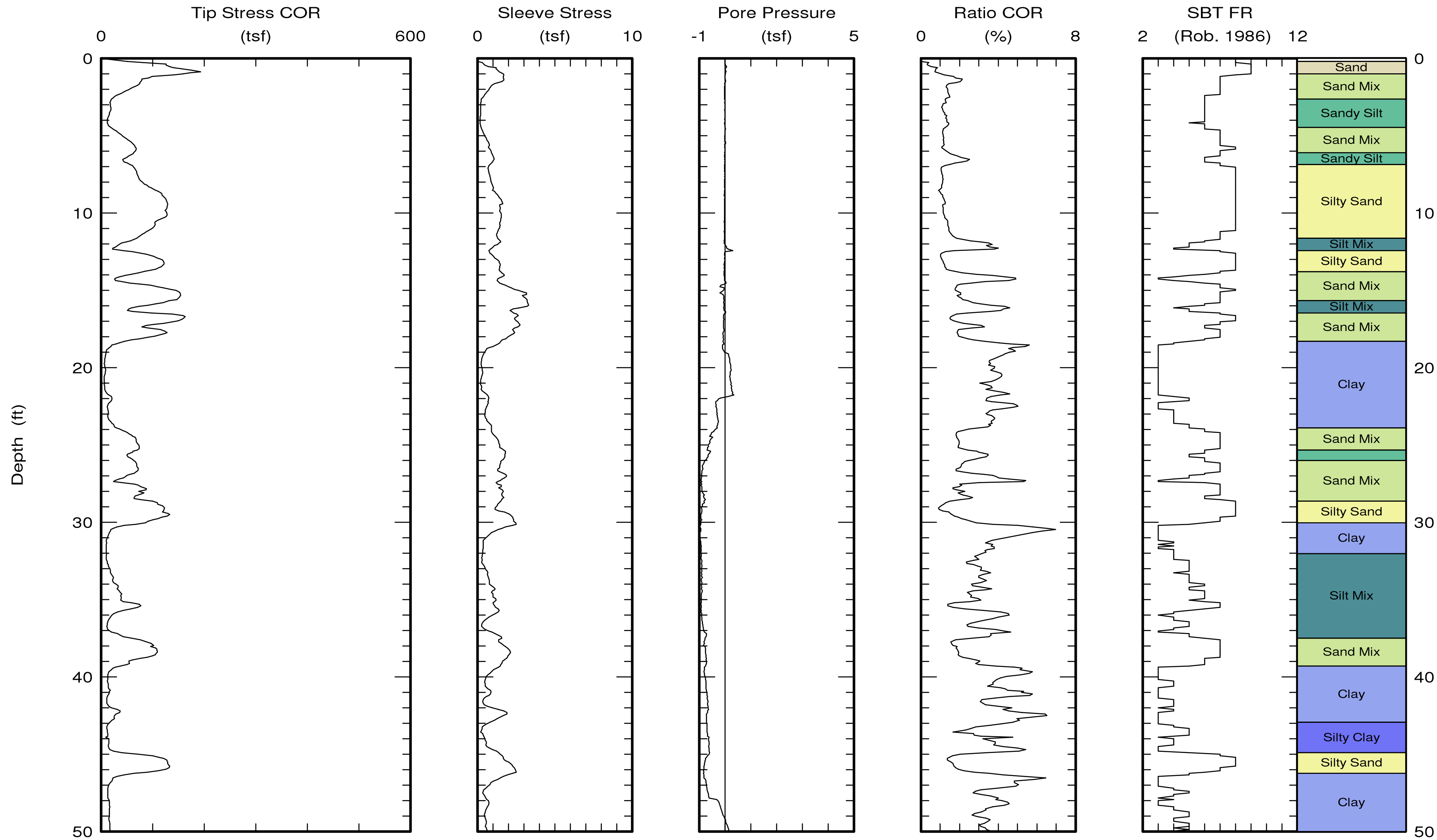
Maximum depth: 84.30 (ft)

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
www.kehoetesting.com

CPT Data
30 ton rig

Date: 21/Mar/2011
Test ID: CPT-9
Project: GardenGrove

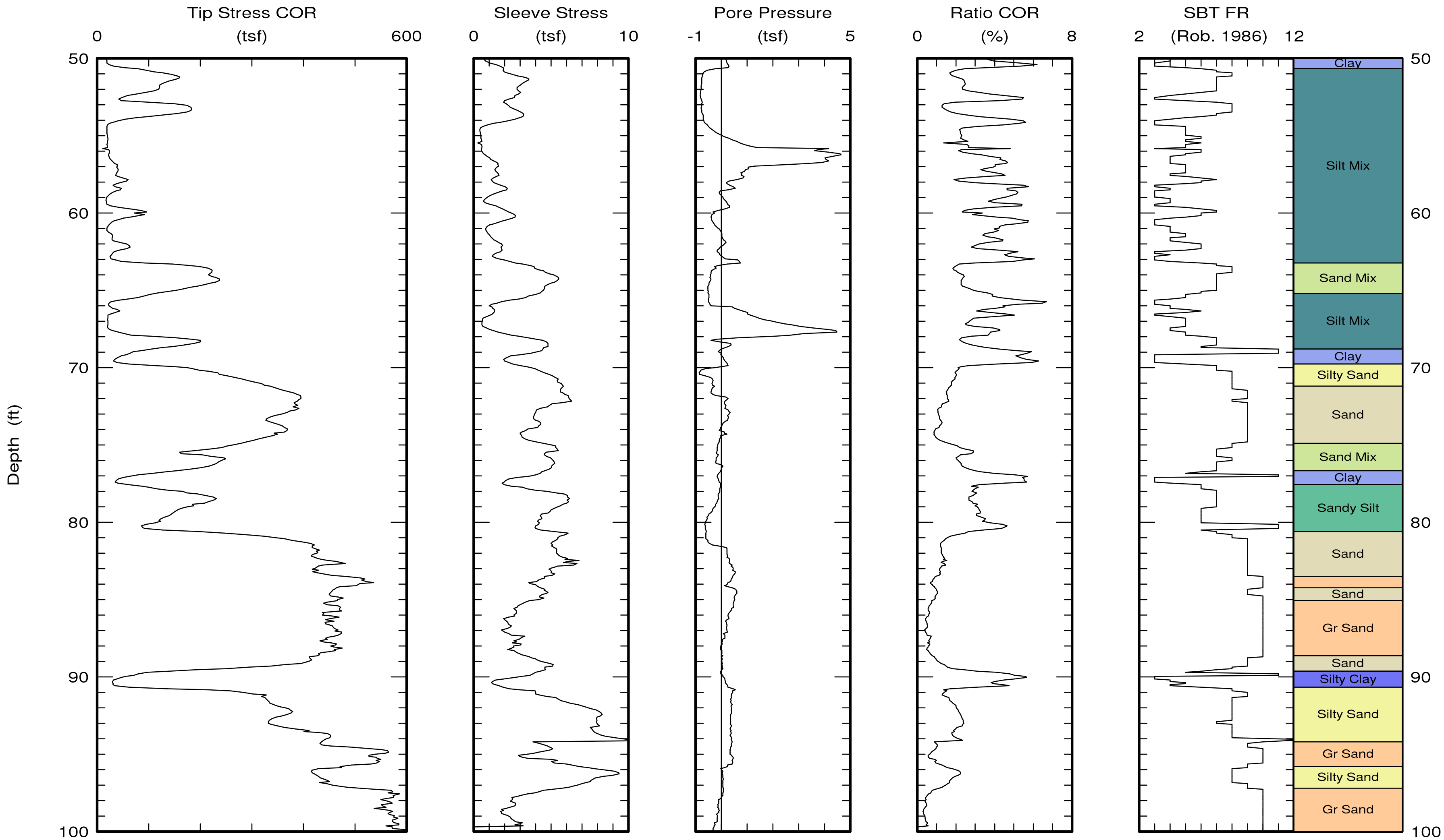
Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd.



Maximum depth: 100.01 (ft)
Page 1 of 3

Test ID: CPT-9
File: Z21M1102C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-9 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

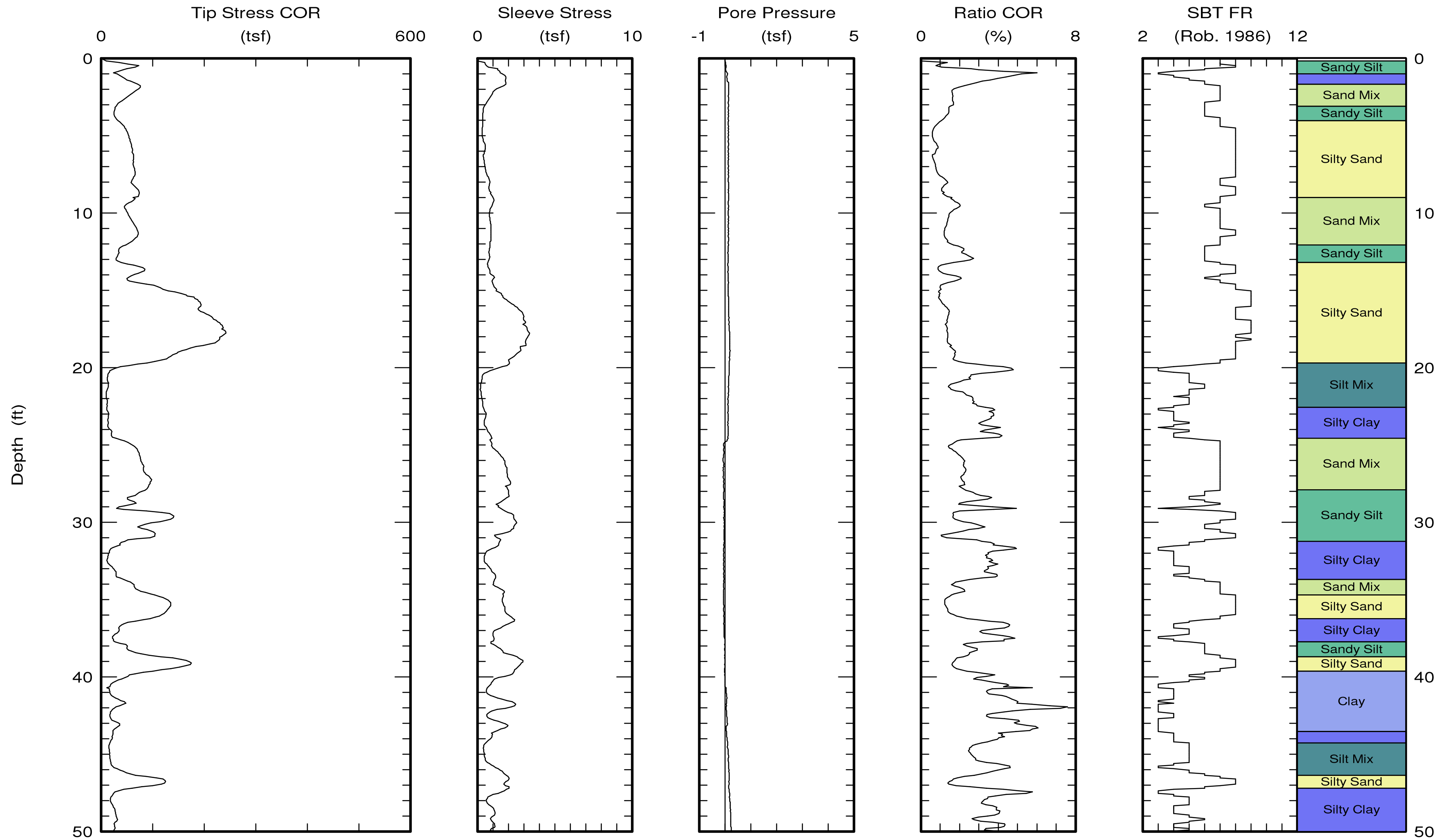


Maximum depth: 100.01 (ft)

Page 2 of 3

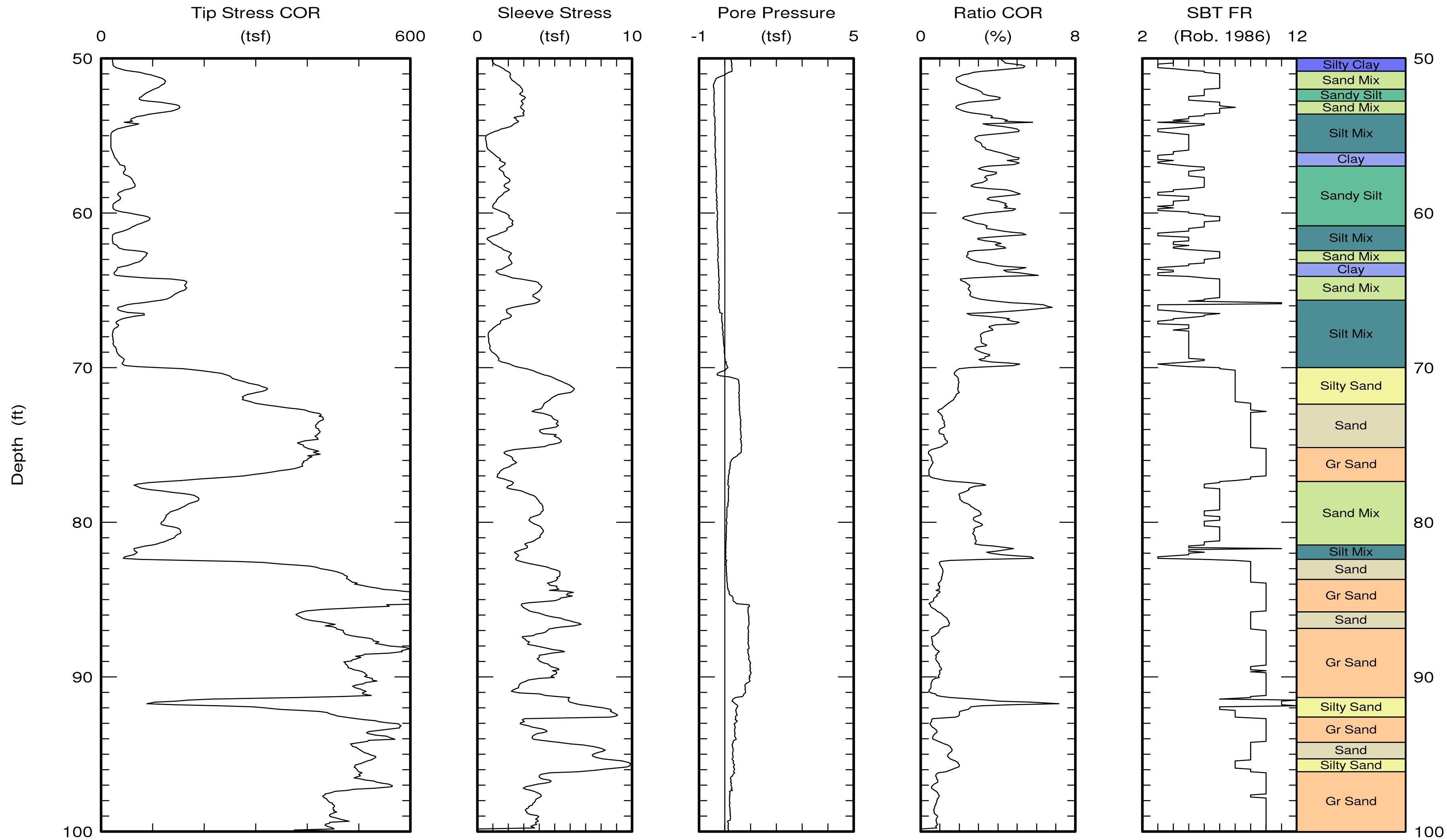
Test ID: CPT-9
File: Z21M1102C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-10 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



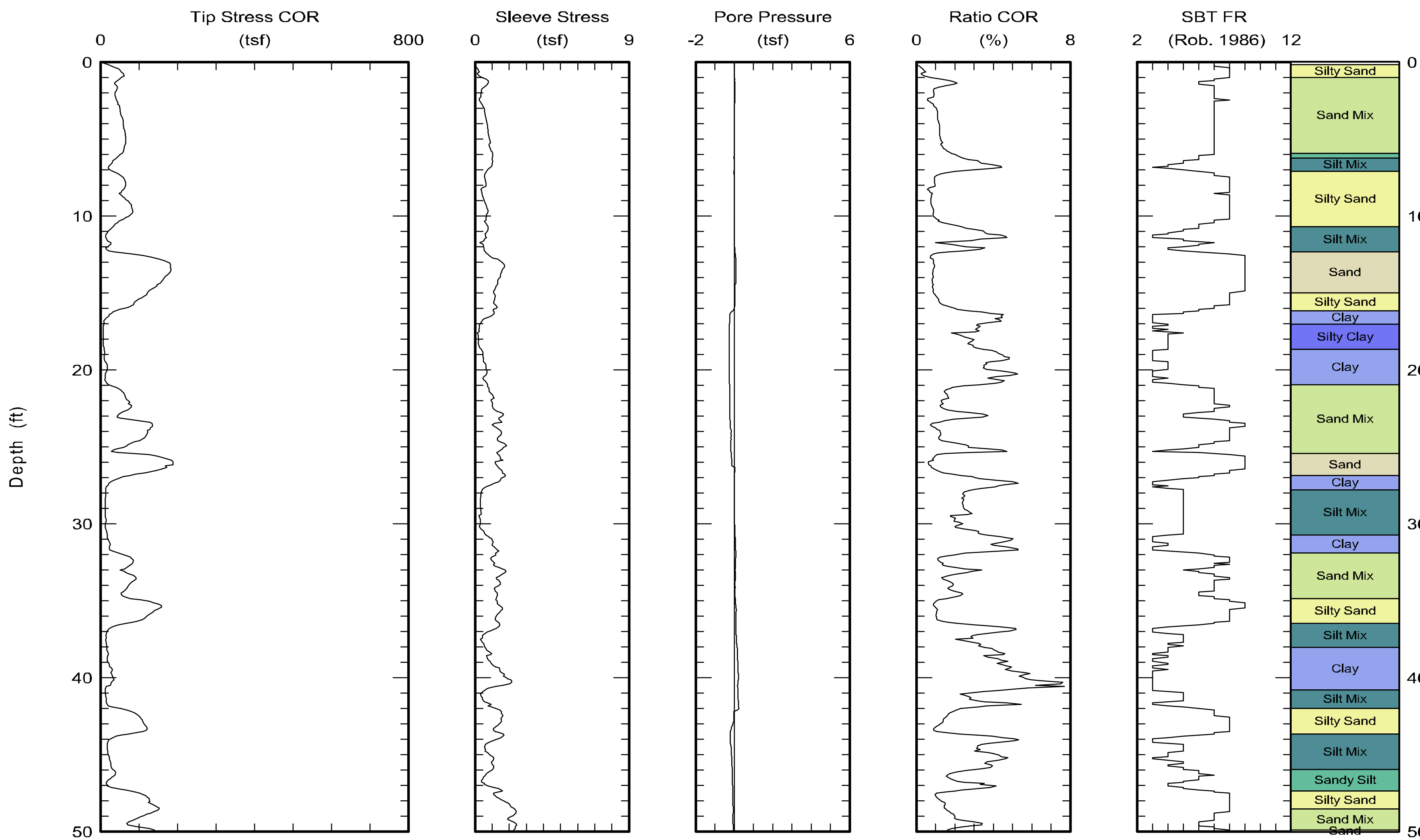
Maximum depth: 100.16 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-10 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 100.16 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-11 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

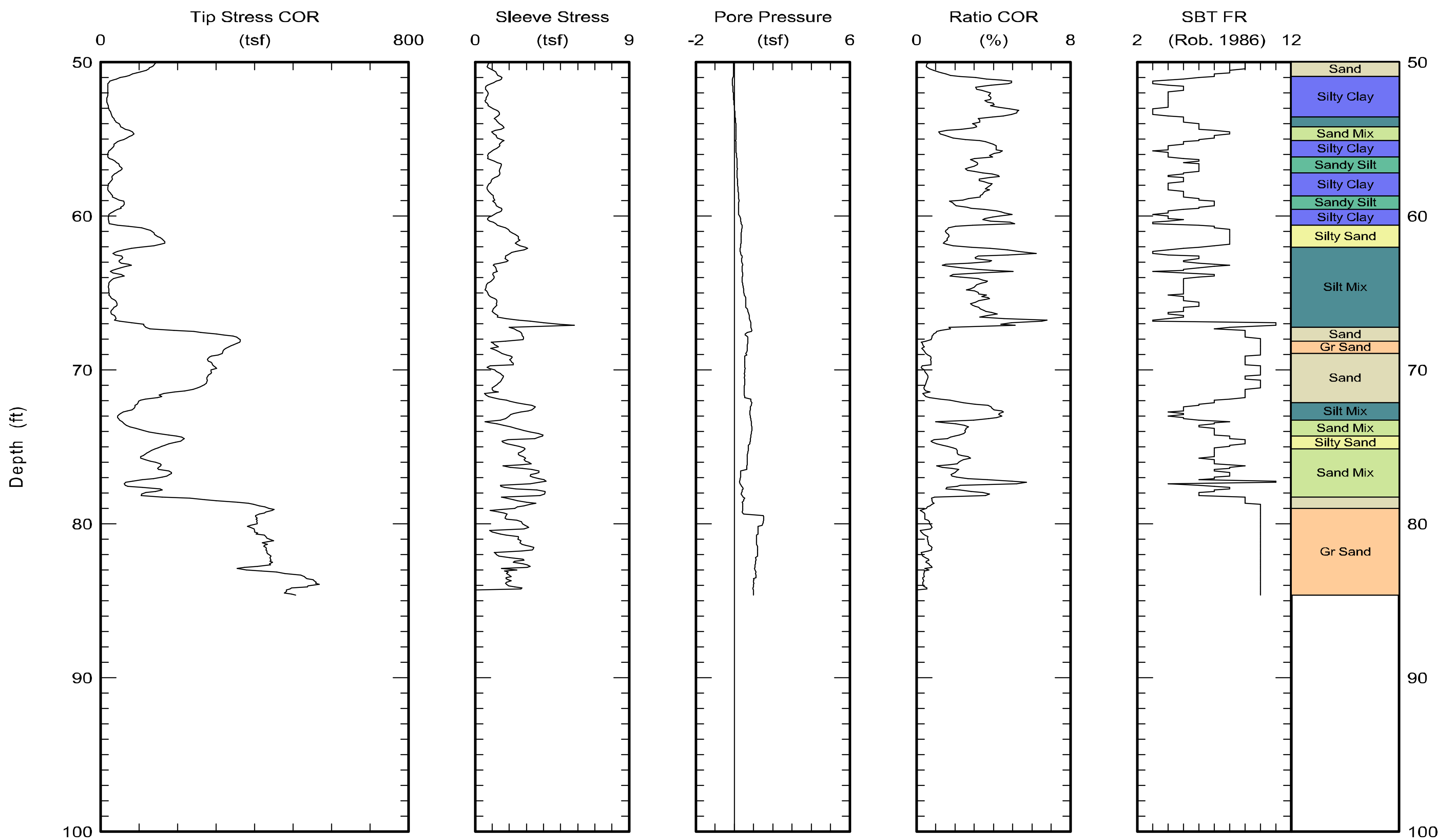


Maximum depth: 84.66 (ft)

Page 1 of 2

Test ID: CPT-11
File: Z27A1202C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-11 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

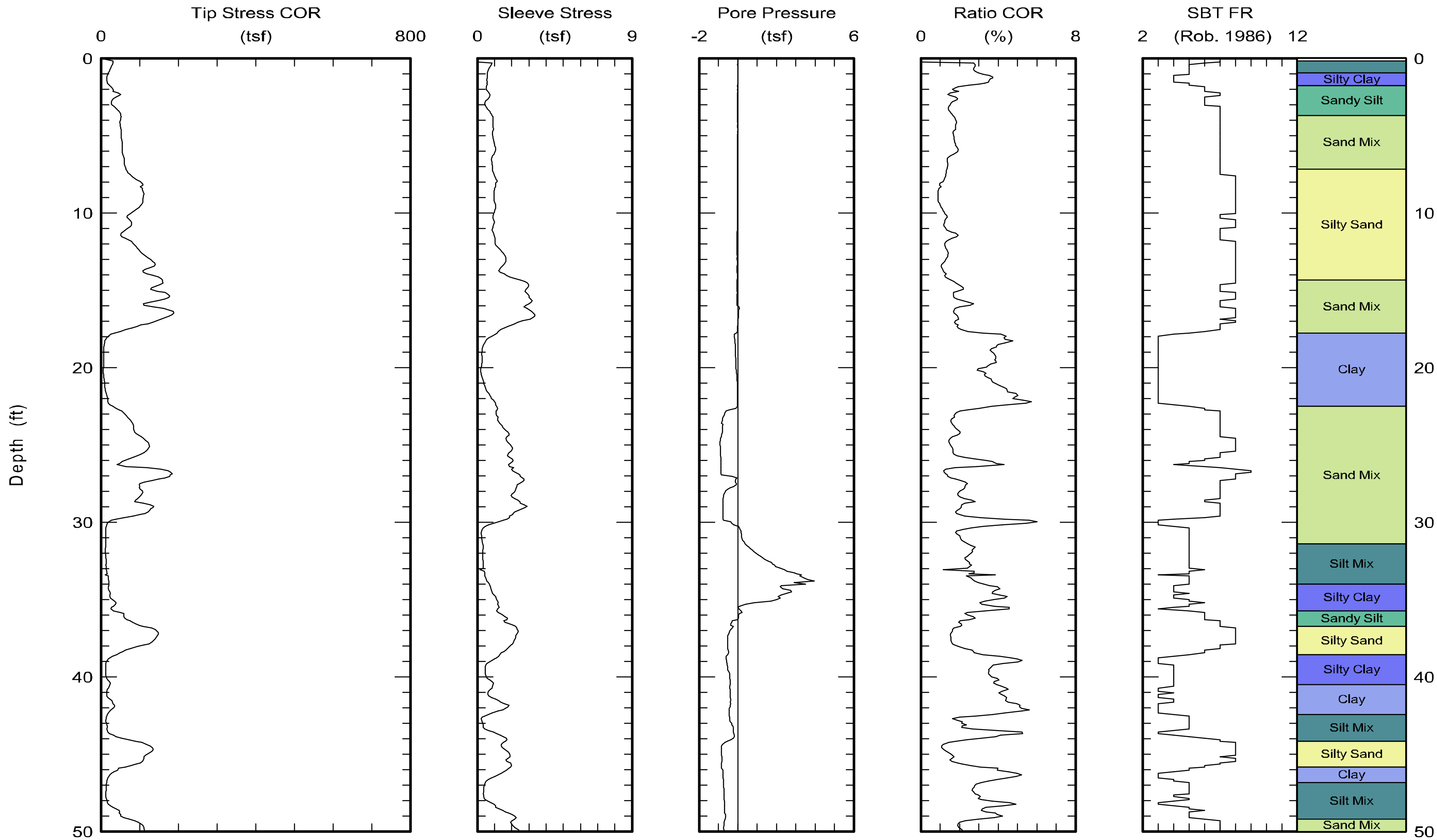


Maximum depth: 84.66 (ft)

Page 2 of 2

Test ID: CPT-11
File: Z27A1202C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	Date: 26/Apr/2012 Test ID: CPT-12 Project: GardenGrove



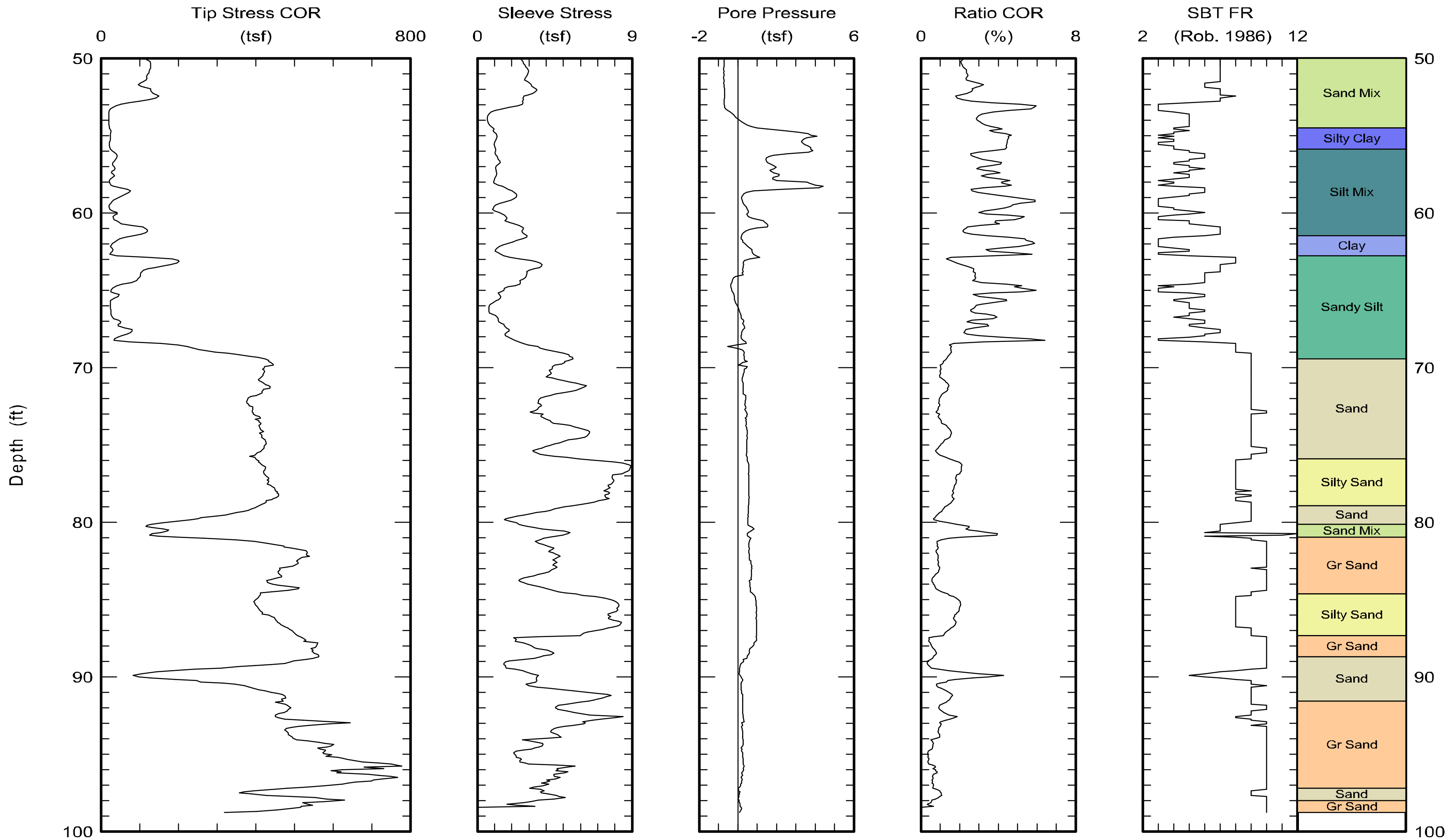
Maximum depth: 98.78 (ft)

Page 1 of 2

Test ID: CPT-12
File: Z26A1204C.ECP

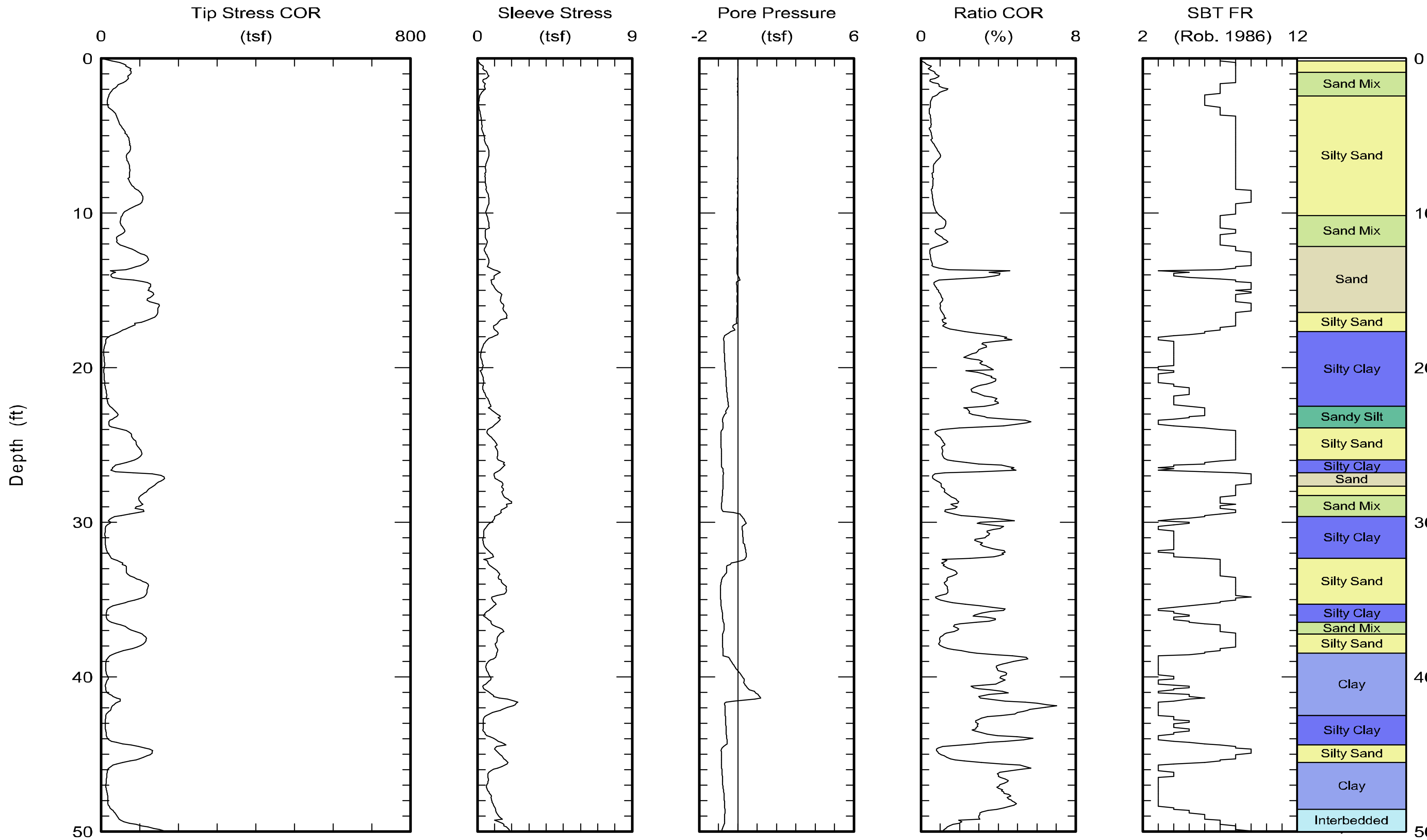
Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
www.kehoetesting.com

CPT Data 30 ton rig		Date: 26/Apr/2012 Test ID: CPT-12 Project: GardenGrove
Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.		



Maximum depth: 98.78 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-13 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

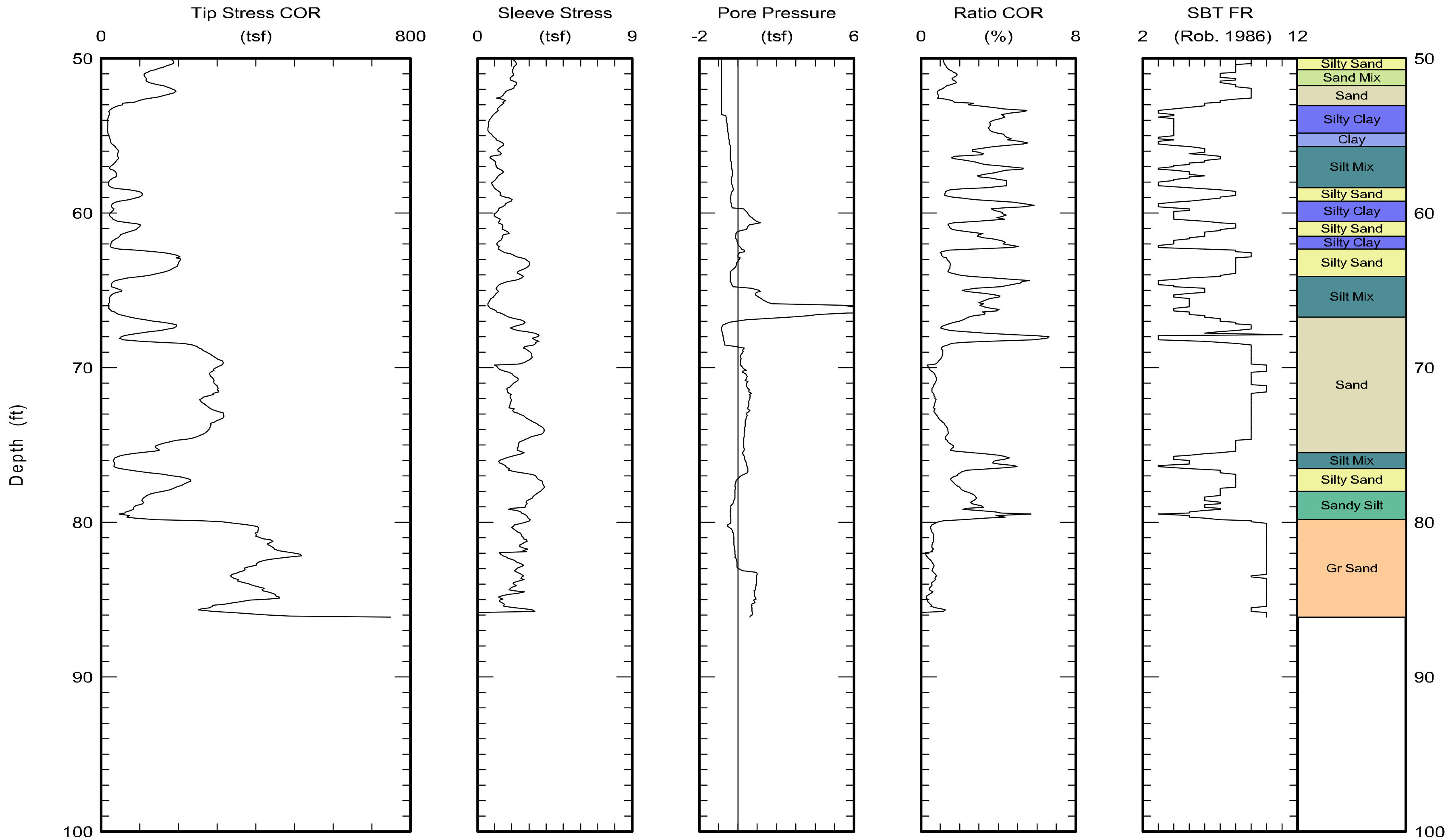


Maximum depth: 86.16 (ft)

Page 1 of 2

Test ID: CPT-13
File: Z27A1201C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-13 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 86.16 (ft)

Page 2 of 2

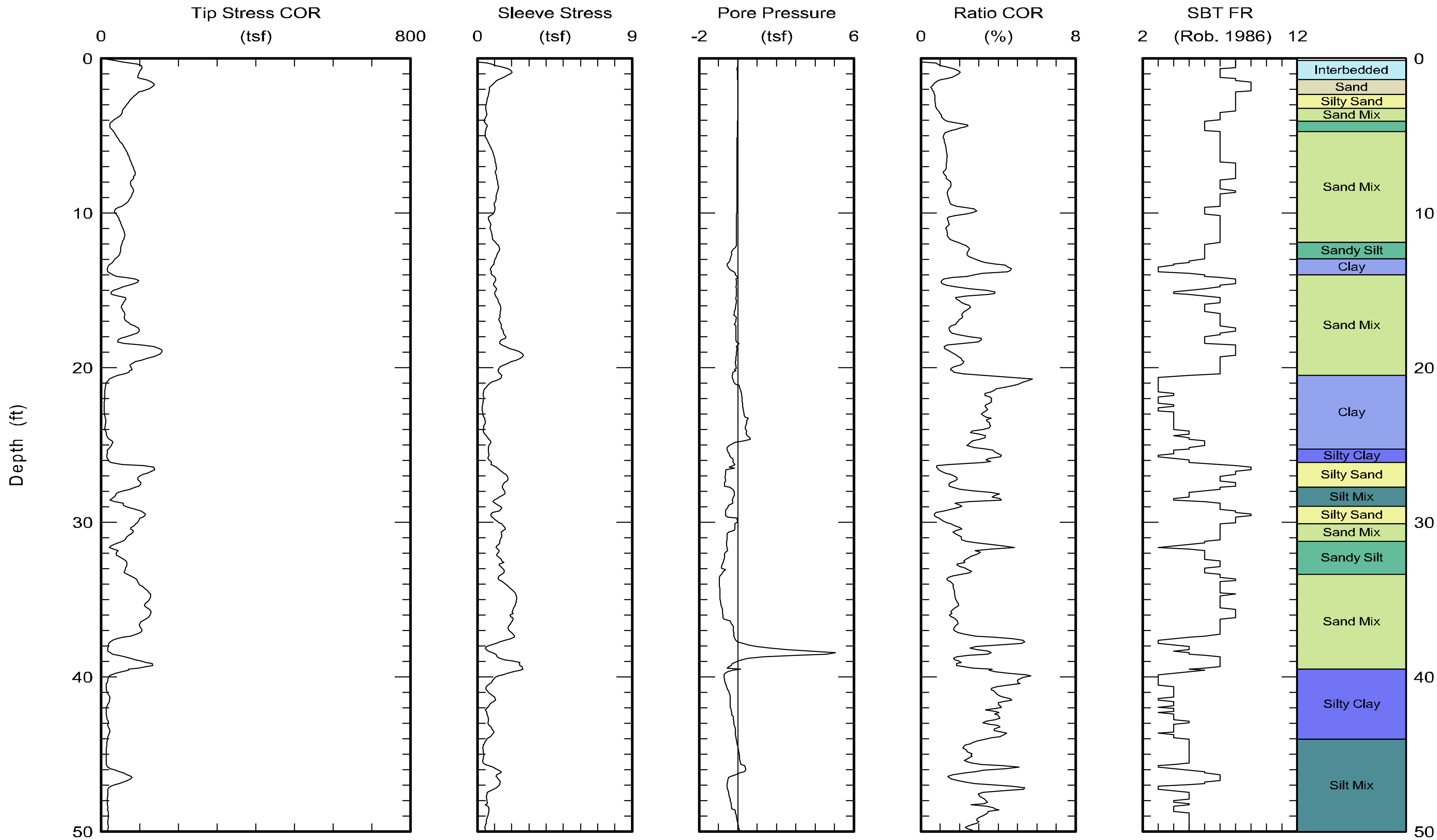
Test ID: CPT-13
File: Z27A1201C.ECP

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
www.kehoetesting.com

CPT Data
30 ton rig

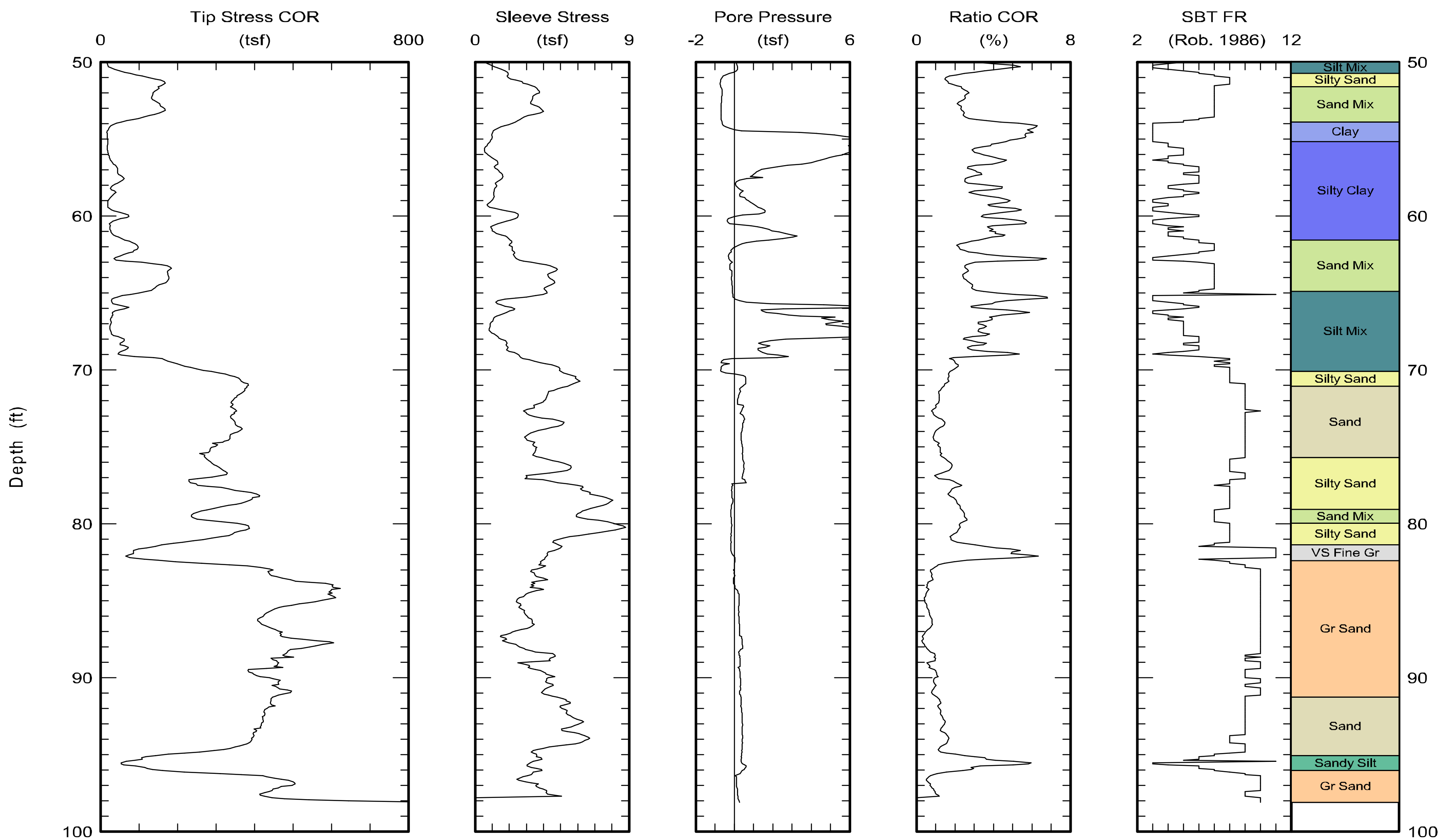
Date: 26/Apr/2012
Test ID: CPT-14
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd.



Maximum depth: 98.11 (ft)
Page 1 of 2

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 26/Apr/2012 Test ID: CPT-14 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 98.11 (ft)

Page 2 of 2

Test ID: CPT-14

File: Z26A1201C.ECP

GEOTECHNICAL BORING LOG HA-1

Date 11-30-09 **Sheet** 1 **of** 1

Project 602778-001 Garden Grove Central Hub **Logged / Sampled By** Joe Roe

Drilling Co. Hand Auger **Type of Rig**

Hole Diameter 4 inches **Drive Weight** N/A **Drop** 0"

Elevation Top of Hole 107' **Location** Garden Grove, California

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical Fill (Af)** 3-inches Asphalt Concrete over Silty SAND (SM), brown, moist, fine grained with aspahlt debris Gravel 1%, Sand 66%, Fines 33%	
105				BB-1				ML	@1" Sandy SILT (ML), dark grey to orange brown, moist, fine grained sand, micaceous, oxidized	SA,CR
								SP-SM	@2': SAND with Silt (SP-SM), brown, moist, fine to coarse grained sand, trace mica with thinly bedded silty CLAY (CL), olive green, oxidized, low pasticity, micaeous	
	5								Total Depth of Boring: 5 feet No groundwater encountered while drilling Boring backfilled with excess soil cuttings upon completion	
100										
	10									
95										
	15									
90										
	20									
85										
	25									
80										
	30									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG HA-2

Date 11-30-09 **Sheet** 1 **of** 1
Project 602778-001 Garden Grove Central Hub **Logged / Sampled By** Joe Roe
Drilling Co. Hand Auger **Type of Rig**
Hole Diameter 4 inches **Drive Weight** N/A **Drop** 0"
Elevation Top of Hole 106' **Location** Garden Grove, California

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0								@0': **Artifical Fill (Af)**	
105								GM	3-inches crushed miscallaneous aggregate over Sandy GRAVEL (GM), loose, dry, fine to coarse sand in matrix, fine to coarse crushed miscallaneous aggregate	SA,CR
				BB-1				SM	@1': Silty SAND (SM), brown, moist, fine to coarse grained sand with minor asphalt debris Gravel 11%, Sand 58%, Fines 31%	
								ML	@2.5': Sandy SILT (ML), lite brown, moist, fine grained sand, micaceous	
	5									
100									Total Depth of Boring: 5 feet No groundwater encountered while drilling Boring backfilled with excess soil cuttings upon completion	
	10									
95										
	15									
90										
	20									
85										
	25									
80										
	30									

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

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

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

GEOTECHNICAL BORING LOG HA-3

Date	11-30-09	**Sheet**	1 **of** 1
Project	602778-001 Garden Grove Central Hub	**Logged / Sampled By**	Joe Roe
Drilling Co.	Hand Auger	**Type of Rig**	
Hole Diameter	4 inches	**Drive Weight**	N/A
Drop	0"		
Elevation Top of Hole	106'	**Location**	Garden Grove, California

Elevation Feet	Depth Feet	Graphic Log (N, S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0								@0': **Artifical Fill (Af)** Silty SAND (SM), moderately indurated, brown, dry, fine to coarse grained sand, rootlets, piles of mulch at surface,	
105								GM	@.5': aggregate base (GM), fine to coarse, angular gravel, medium to coarse grained sandy matrix, dry with some silt	SA,CR
				BB-1				SM	@1.2': Silty SAND (SM), brown, dry, fine to coarse grained sand Gravel 13%, Sand 69%, Fines 18%	
								SP	@3': **Quaternary Alluvial Fan (Qyf)** SAND (SP), brown, dry, fine to coarse sand, unconsolidated, loose, flowing sand	
	5									
100									Total Depth of Boring: 5 feet No groundwater encountered while drilling Boring backfilled with excess soil cuttings upon completion	
	10									
95										
	15									
90										
	20									
85										
	25									
80										
	30									

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

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

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

GEOTECHNICAL BORING LOG HA-4

Date	11-30-09	**Sheet**	1 **of** 1
Project	602778-001 Garden Grove Central Hub	**Logged / Sampled By**	Joe Roe
Drilling Co.	Hand Auger	**Type of Rig**	
Hole Diameter	4 inches	**Drive Weight**	N/A
Drop	0"		
Elevation Top of Hole	105'	**Location**	Garden Grove, California

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION **The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.**	Type of Tests
105	0			BB-1				SM	@0': **Artifical Fill (Af)** Silty SAND (SM), loose,lite brown to olive brown, dry, fine grained sand, some fine angular gravel, minor organic debris (rootlets), micaceous Gravel 3%, Sand 72%, Fines 25%	SA,CR
								SP-SM	@3': SAND with Silt (SP-SM), brown, slightly moist, predominately fine grained sand, trace coarse sand and fine gravel	
								SP	@4': SAND (SP), lite brown, slightly moist, fine to medium grained sand, trace fine gravel	
100	5								Total Depth of Boring: 5 feet No groundwater encountered while drilling Boring backfilled with excess soil cuttings upon completion	
95	10									
90	15									
85	20									
80	25									
75	30									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

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

APPENDIX C

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

August 6, 2012

Project No. 602778-003

To: McWhinney Development
2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Attention: Mr. Trae Rigby

Subject: Results of Laboratory Analysis in Groundwater for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California

Introduction

Leighton Consulting, Inc. (Leighton Consulting) is pleased to present this letter summarizing the results of laboratory analysis in groundwater for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California.

Groundwater Laboratory Analysis Results

On July 21, 2011 Leighton Consulting personnel collected one groundwater sample from monitoring well MW-1 and submitted it to TestAmerica, a California-certified (ELAP) laboratory. The groundwater sample was analyzed for the following constituents in compliance with the National Pollutant Discharge Elimination System (NPDES) permit application process:

- Volatile Organic Compounds (VOCs) with Oxygenates by EPA Method 8260B;
- Silica Gel Treated Hexane Extractable Material (TPH) by EPA Method 1664A; and
- Hexane Extractable Material (Oil and Grease) by EPA Method 1664A.

17781 Cowan | Irvine, CA 92614-6009
949.253.9836 | Fax 949.250.1114 | www.leightongroup.com

Results for additional laboratory analyses conducted on the groundwater can be found in Leighton Consulting's *Groundwater Sampling and Laboratory Analysis Results for National Pollutant Discharge Elimination System (NPDES) for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California,* dated August 8, 2011 (attached).
TPH and oil and grease were not detected above the method detection limits in the groundwater sample collected for the Great Wolf Lodge Resort Hotel.

One VOC, methylene chloride, was detected at a concentration of 1.1J micrograms per liter (µg/L). This concentration was J-flagged indicating it is an estimated value and was detected at a level less than the reporting limit and greater than or equal to the method detection limit and is of limited reliability. This concentration is below levels of concern.

Based upon this information, the groundwater is not impacted by hazardous materials in this location.

If you have any questions regarding this letter-report, please call the undersigned at (949) 681-4287.

Respectfully Submitted,

LEIGHTON CONSULTING, INC.

REGISTERED PROFESSIONAL GEOLOGIST
BRYNN F. McCULLOCH
No. 8798
Exp: 5/30/14
STATE OF CALIFORNIA

Brynn McCulloch PG 8798
Project Geologist

BFM/lr

Attachment: Groundwater Sampling and Laboratory Analysis Results for National Pollutant Discharge Elimination System (NPDES) for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California

Distribution: (4) Addressee

GROUNDWATER SAMPLING AND LABORATORY ANALYSIS RESULTS FOR NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) FOR THE GREAT WOLF LODGE RESORT HOTEL, CITY OF GARDEN GROVE, CALIFORNIA

Prepared for:

MCWHINNEY DEVELOPMENT

2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Project No. 602778-003

August 8, 2011

Leighton Consulting, Inc.

A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

August 8, 2011

Project No. 602778-003

To: McWhinney Development
2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Attention: Mr. Trae Rigby

Subject: Groundwater Sampling and Laboratory Analysis Results for National Pollutant Discharge Elimination System (NPDES) for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California

Introduction

Leighton Consulting, Inc. is pleased to present the groundwater sampling and laboratory analysis results for the National Pollutant Discharge Elimination System (NPDES) for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California. The intent of the sampling and analysis was to characterize the groundwater constituents for a dewatering contractor to obtain a discharge permit under the existing NPDES permit for the City of Garden Grove or if required by the Regional Water Quality Control Board to obtain a separate permit under Order No. R8-2009-0030 NPDES No. CAS618030 as amended by Order No. R8-2010-0062.

Monitoring Well MW-1

The monitoring well (MW-1) was installed by others to a depth of forty feet below ground surface prior to the groundwater sampling event under an approved application for well construction permit by the Orange County Health Care Agency (OCHCA). A copy of the approved well installation permit is included in Appendix A. On July 21, 2011 the depth to groundwater, as measured from the top of the casing (TOC) prior to the sampling event was 19.46 feet which corresponds to an elevation of 87.54 feet. Elevation of the ground surface was provided by the civil engineer for the project and is reported as 107.00 feet. Groundwater was pumped from MW-1 using a low flow pump at a rate of approximately .16 gallons per minute (GPM). Approximately 2.65 feet of drawdown was achieved after seventy five minutes of pumping where equilibrium was reached between drawdown and the low pumping rate. The pump was then shut down and groundwater returned to static level of 19.46 feet below ground surface (87.54 ft. elevation) after thirty six minutes.

<u>Groundwater Sampling and Laboratory Analysis</u>

During the pumping event monitoring well (MW-1) was purged a minimum of three well volumes (approximately 10.04 gallons) and allowed to return to static water levels prior to sampling. The groundwater sampling activities were completed under the oversight of a California-licensed Professional/Engineering Geologist (PG/CEG).

On July 21, 2011 Leighton Consulting Inc. personnel collected one groundwater sample and submitted to TestAmerica, a California-certified (ELAP) laboratory. The groundwater sample was tested for the following constituents: Silica Gel treated Hexane Extract Material 1664 and Hexane Extract Maerial 1664; 8081A Pesticides; 8260+MTBE+OXY+K,LL; Biological Oxygen Demand BOD-SM5210B; Total Suspended Solids TSS-SM2540D; Total Dissolved Solids TDS-SM2540C; pH; Nitorgen-NO3+NO2; Chlorine, Redisual-SM4500-Cl G; CAM Metals; TKN-351.2 Phosphate P, ortho-365.3 and Total Sulfide. A copy of the chain of custody form and a complete analytical report are included in Appendix A.

If you have any questions regarding this report, please call the undersigned at (949) 681-4263.

REGISTERED PROFESSIONAL GEOLOGIST
JOE A. ROE
No. 2456
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Respectfully Submitted,

LEIGHTON CONSULTING, INC.

Joe Roe

Joe Roe PG, CEG 2456
Project Geologist

JAR/gv

Attachment: Appendix A

Distribution: (4) Addressee

APPLICATION FOR WELL CONSTRUCTION PERMIT

JUL 13 2011

ORANGE COUNTY HEALTH CARE AGENCY
ENVIRONMENTAL HEALTH DIVISION

1241 E. DYER ROAD, SUITE 120
SANTA ANA, CA 92705-4720

(714) 443-6000
FAX: (714) 443-6481

ENVIRONMENTAL HLTH

WELL PERMIT NUMBER 11-07-15

CITY: Garden Grove, CA

DATE: July 13, 2011

WELL LOCATION (ADDRESS IF AVAILABLE): 12900 Harbor Blvd, Garden Grove, CA (see attached map)

NAME OF WELL OWNER: McWhinney Development

ADDRESS: 2725 Rocky Mountain Ave., Suite 200

CITY: Loveland, CO ZIP: 80538 TELEPHONE: 970-776-4028

NAME OF CONSULTING FIRM: Leighton Consulting, Inc.

BUSINESS ADDRESS: 17781 Cowan

CITY: Irvine, CA ZIP: 92614 TELEPHONE: 949-250-1421

NAME OF DRILLING CO.: Malcolm Drilling C-57 LICENSE NO.: 259543

CITY: Irwindale, CA ZIP: 91706 TELEPHONE: 626-338-0035

TYPE OF WELL (CHECK)

- PRIVATE DOMESTIC ☐
- PUBLIC DOMESTIC ☐
- IRRIGATION ☐
- CATHODIC ☐
- PROBE SURVEY ☐
- MONITORING ☒
- SOIL BORING ☐
- OTHER ☐
- TOTAL NUMBER: 1

A. WELLS – SUBMIT A WELL CONSTRUCTION DIAGRAM (INCLUDE DIMENSIONS) Attached

B. SOIL BORINGS AND PROBES –
TOTAL DEPTH
SEALING MATERIAL

C. PROPOSED START DATE: July 15, 2011

DIAGRAM OF WELL SITE *(Use additional sheets and/or attachments)*

site location map
site plan
well construction diagram
(attached)

☒ SITE PLAN ATTACHED

I hereby agree to comply in every respect with all requirements of the Health Care Agency and with all ordinances and laws of the County of Orange and of the State of California pertaining to well construction, reconstruction and destruction, including the requirements to maintain the integrity of all significant confining zones.

APPLICANT'S SIGNATURE: [signature] DATE: 7/13/11

PRINT NAME: Jeff Pflueger jpflueger@leightongroup.com

PHONE NUMBER: 949-250-1421 FAX NUMBER: 949-250-1114

FOR ACCOUNTING USE ONLY:

HSO NO. 334437 CHECK NO. 19684

DATE 7.13.11 AMOUNT 328

INTL. AH

APPROVAL BY OTHER AGENCIES:

JURISDICTION

REMARKS

AUTHORIZED SIGNATURE DATE

DISPOSITION OF PERMIT (DO NOT FILL IN):

☒ **APPROVED** SUBJECT TO THE FOLLOWING CONDITIONS:

A. NOTIFY THIS AGENCY AT LEAST **48 HOURS**

☒ PRIOR TO START. Please call if start date change

☐ PRIOR TO SEALING THE ANNULAR SPACE OR FILLING OF THE CONDUCTOR CASING.

B. ☐ SUBMIT TO THE AGENCY WITHIN 30 DAYS AFTER COMPLETION OF WORK, A WELL COMPLETION REPORT AND/OR DRILLING LOGS. PLEASE REFERENCE PERMIT NO.

C. ☒ SECURE ALL MONITORING WELLS TO PREVENT TAMPERING.

D. ☐ OTHER

☐ **DENIED**

PERMIT ISSUED BY: Juan Arzora DATE: 07.14.2011

PRINT NAME: Juan Arzora PHONE NUMBER: 7144336287

WHEN SIGNED BY ORANGE COUNTY HEALTH CARE AGENCY REPRESENTATIVE, THIS APPLICATION IS A PERMIT.

F272-09.0803 (R11/01)

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

17461 Derian Avenue. Suite 100, Irvine, CA 92614 (949) 261-1022 Fax:(949) 260-3297

LABORATORY REPORT

Prepared For: Leighton Consulting, Inc.
17781 Cowan, Suite 140
Irvine, CA 92614
Attention: Joe Roe

Project: 602778-003

Sampled: 07/21/11
Received: 07/21/11
Issued: 08/01/11 16:33

NELAP #01108CA California ELAP#2706 CSDLAC #10256 AZ #AZ0671 NV #CA01531

The results listed within this Laboratory Report pertain only to the samples tested in the laboratory. The analyses contained in this report were performed in accordance with the applicable certifications as noted. All soil samples are reported on a wet weight basis unless otherwise noted in the report. This Laboratory Report is confidential and is intended for the sole use of TestAmerica and its client. This report shall not be reproduced, except in full, without written permission from TestAmerica. The Chain of Custody, 1 page, is included and is an integral part of this report.
This entire report was reviewed and approved for release.

CASE NARRATIVE

SAMPLE RECEIPT:	Samples were received intact, at 10°C, on ice and with chain of custody documentation.
HOLDING TIMES:	Not all holding times were met. Results were qualified where the sample analysis did not occur within method specified holding time requirements.
PRESERVATION:	Samples requiring preservation were verified prior to sample analysis.
QA/QC CRITERIA:	All analyses met method criteria, except as noted in the report with data qualifiers.
COMMENTS:	Results that fall between the MDL and RL are 'J' flagged.
SUBCONTRACTED:	No analyses were subcontracted to an outside laboratory.

LABORATORY ID	CLIENT ID	MATRIX
IUG2022-01	MW-1	Water

Reviewed By:

TestAmerica Irvine

Patty Mata
Project Manager

17461 Derian Avenue. Suite 100, Irvine, CA 92614 (949) 261-1022 Fax:(949) 260-3297

Leighton Consulting, Inc.
17781 Cowan, Suite 140
Irvine, CA 92614
Attention: Joe Roe

Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
Received: 07/21/11

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: ug/l									
Acetone	EPA 8260B	11G3172	4.5	10	ND	1	07/27/11	07/28/11	
Benzene	EPA 8260B	11G3172	0.28	0.50	ND	1	07/27/11	07/28/11	
Bromobenzene	EPA 8260B	11G3172	0.27	1.0	ND	1	07/27/11	07/28/11	
Bromochloromethane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
Bromodichloromethane	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
Bromoform	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
Bromomethane	EPA 8260B	11G3172	0.42	1.0	ND	1	07/27/11	07/28/11	
2-Butanone (MEK)	EPA 8260B	11G3172	4.7	10	ND	1	07/27/11	07/28/11	
n-Butylbenzene	EPA 8260B	11G3172	0.37	1.0	ND	1	07/27/11	07/28/11	
sec-Butylbenzene	EPA 8260B	11G3172	0.25	1.0	ND	1	07/27/11	07/28/11	
tert-Butylbenzene	EPA 8260B	11G3172	0.22	1.0	ND	1	07/27/11	07/28/11	
Carbon tetrachloride	EPA 8260B	11G3172	0.28	0.50	ND	1	07/27/11	07/28/11	
Chlorobenzene	EPA 8260B	11G3172	0.36	1.0	ND	1	07/27/11	07/28/11	
Chloroethane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
Chloroform	EPA 8260B	11G3172	0.33	1.0	ND	1	07/27/11	07/28/11	
Chloromethane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
2-Chlorotoluene	EPA 8260B	11G3172	0.28	1.0	ND	1	07/27/11	07/28/11	
4-Chlorotoluene	EPA 8260B	11G3172	0.29	1.0	ND	1	07/27/11	07/28/11	
1,2-Dibromo-3-chloropropane	EPA 8260B	11G3172	0.97	5.0	ND	1	07/27/11	07/28/11	
Dibromochloromethane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
1,2-Dibromoethane (EDB)	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
Dibromomethane	EPA 8260B	11G3172	0.36	1.0	ND	1	07/27/11	07/28/11	
1,2-Dichlorobenzene	EPA 8260B	11G3172	0.32	1.0	ND	1	07/27/11	07/28/11	
1,3-Dichlorobenzene	EPA 8260B	11G3172	0.35	1.0	ND	1	07/27/11	07/28/11	
1,4-Dichlorobenzene	EPA 8260B	11G3172	0.37	1.0	ND	1	07/27/11	07/28/11	
Dichlorodifluoromethane	EPA 8260B	11G3172	0.26	2.0	ND	1	07/27/11	07/28/11	
1,1-Dichloroethane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
1,2-Dichloroethane	EPA 8260B	11G3172	0.28	0.50	ND	1	07/27/11	07/28/11	
1,1-Dichloroethene	EPA 8260B	11G3172	0.42	1.0	ND	1	07/27/11	07/28/11	
cis-1,2-Dichloroethene	EPA 8260B	11G3172	0.32	1.0	ND	1	07/27/11	07/28/11	
trans-1,2-Dichloroethene	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
1,2-Dichloropropane	EPA 8260B	11G3172	0.35	1.0	ND	1	07/27/11	07/28/11	
1,3-Dichloropropane	EPA 8260B	11G3172	0.32	1.0	ND	1	07/27/11	07/28/11	
2,2-Dichloropropane	EPA 8260B	11G3172	0.34	1.0	ND	1	07/27/11	07/28/11	
cis-1,3-Dichloropropene	EPA 8260B	11G3172	0.22	0.50	ND	1	07/27/11	07/28/11	
trans-1,3-Dichloropropene	EPA 8260B	11G3172	0.32	0.50	ND	1	07/27/11	07/28/11	
1,1-Dichloropropene	EPA 8260B	11G3172	0.28	1.0	ND	1	07/27/11	07/28/11	
Ethylbenzene	EPA 8260B	11G3172	0.25	0.50	ND	1	07/27/11	07/28/11	
Hexachlorobutadiene	EPA 8260B	11G3172	0.38	1.0	ND	1	07/27/11	07/28/11	
2-Hexanone	EPA 8260B	11G3172	2.6	10	ND	1	07/27/11	07/28/11	
Isopropylbenzene	EPA 8260B	11G3172	0.25	1.0	ND	1	07/27/11	07/28/11	

TestAmerica Irvine

Patty Mata
Project Manager

17461 Derian Avenue. Suite 100, Irvine, CA 92614 (949) 261-1022 Fax:(949) 260-3297

Leighton Consulting, Inc.
17781 Cowan, Suite 140
Irvine, CA 92614
Attention: Joe Roe

Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
Received: 07/21/11

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water) - cont.									
Reporting Units: ug/l									
p-Isopropyltoluene	EPA 8260B	11G3172	0.28	1.0	ND	1	07/27/11	07/28/11	
4-Methyl-2-pentanone (MIBK)	EPA 8260B	11G3172	3.5	10	ND	1	07/27/11	07/28/11	
Methylene chloride	EPA 8260B	11G3172	0.95	5.0	**1.1**	1	07/27/11	07/28/11	J
Naphthalene	EPA 8260B	11G3172	0.41	1.0	ND	1	07/27/11	07/28/11	
n-Propylbenzene	EPA 8260B	11G3172	0.27	1.0	ND	1	07/27/11	07/28/11	
Styrene	EPA 8260B	11G3172	0.20	1.0	ND	1	07/27/11	07/28/11	
1,1,1,2-Tetrachloroethane	EPA 8260B	11G3172	0.27	1.0	ND	1	07/27/11	07/28/11	
1,1,2,2-Tetrachloroethane	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
Tetrachloroethene	EPA 8260B	11G3172	0.32	1.0	ND	1	07/27/11	07/28/11	
Toluene	EPA 8260B	11G3172	0.36	0.50	ND	1	07/27/11	07/28/11	
1,2,3-Trichlorobenzene	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
1,2,4-Trichlorobenzene	EPA 8260B	11G3172	0.48	1.0	ND	1	07/27/11	07/28/11	
1,1,1-Trichloroethane	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
1,1,2-Trichloroethane	EPA 8260B	11G3172	0.30	1.0	ND	1	07/27/11	07/28/11	
Trichloroethene	EPA 8260B	11G3172	0.26	1.0	ND	1	07/27/11	07/28/11	
Trichlorofluoromethane	EPA 8260B	11G3172	0.34	1.0	ND	1	07/27/11	07/28/11	
1,2,3-Trichloropropane	EPA 8260B	11G3172	0.40	1.0	ND	1	07/27/11	07/28/11	
1,2,4-Trimethylbenzene	EPA 8260B	11G3172	0.23	1.0	ND	1	07/27/11	07/28/11	
1,3,5-Trimethylbenzene	EPA 8260B	11G3172	0.26	1.0	ND	1	07/27/11	07/28/11	
Vinyl chloride	EPA 8260B	11G3172	0.40	0.50	ND	1	07/27/11	07/28/11	
m,p-Xylenes	EPA 8260B	11G3172	0.60	1.0	ND	1	07/27/11	07/28/11	
o-Xylene	EPA 8260B	11G3172	0.30	0.50	ND	1	07/27/11	07/28/11	
Xylenes, Total	EPA 8260B	11G3172	0.90	1.5	ND	1	07/27/11	07/28/11	
Di-isopropyl Ether (DIPE)	EPA 8260B	11G3172	0.25	1.0	ND	1	07/27/11	07/28/11	
Ethyl tert-Butyl Ether (ETBE)	EPA 8260B	11G3172	0.28	1.0	ND	1	07/27/11	07/28/11	
Methyl-tert-butyl Ether (MTBE)	EPA 8260B	11G3172	0.32	1.0	ND	1	07/27/11	07/28/11	
tert-Amyl Methyl Ether (TAME)	EPA 8260B	11G3172	0.33	1.0	ND	1	07/27/11	07/28/11	
tert-Butanol (TBA)	EPA 8260B	11G3172	6.5	10	ND	1	07/27/11	07/28/11	
Surrogate: 4-Bromofluorobenzene (80-120%)					*99 %*				
Surrogate: Dibromofluoromethane (80-120%)					*104 %*				
Surrogate: Toluene-d8 (80-120%)					*101 %*				

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Irvine, CA 92614
Attention: Joe Roe

Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
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ORGANOCHLORINE PESTICIDES (EPA 3510C/8081A)

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: ug/l									
4,4'-DDD	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
4,4'-DDE	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
4,4'-DDT	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Aldrin	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
alpha-BHC	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
beta-BHC	EPA 8081A	11G3054	0.028	0.094	ND	0.943	07/26/11	07/27/11	
delta-BHC	EPA 8081A	11G3054	0.019	0.19	ND	0.943	07/26/11	07/27/11	
Dieldrin	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Endosulfan I	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Endosulfan II	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Endosulfan sulfate	EPA 8081A	11G3054	0.019	0.19	ND	0.943	07/26/11	07/27/11	
Endrin	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Endrin aldehyde	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Endrin ketone	EPA 8081A	11G3054	0.038	0.094	ND	0.943	07/26/11	07/27/11	
gamma-BHC (Lindane)	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Heptachlor	EPA 8081A	11G3054	0.028	0.094	ND	0.943	07/26/11	07/27/11	
Heptachlor epoxide	EPA 8081A	11G3054	0.028	0.094	ND	0.943	07/26/11	07/27/11	
Methoxychlor	EPA 8081A	11G3054	0.019	0.094	ND	0.943	07/26/11	07/27/11	
Chlordane	EPA 8081A	11G3054	0.19	0.94	ND	0.943	07/26/11	07/27/11	
Toxaphene	EPA 8081A	11G3054	0.47	4.7	ND	0.943	07/26/11	07/27/11	
Surrogate: Decachlorobiphenyl (45-120%)					*87 %*				
Surrogate: Tetrachloro-m-xylene (35-115%)					*77 %*				

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HEXANE EXTRACTABLE MATERIAL

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: mg/l									
Hexane Extractable Material (Oil & Grease)	EPA 1664A	11G3530	1.3	4.7	ND	1	07/29/11	07/29/11	
SilicaGel Treated Hexane Extractable Material(TPH)	EPA 1664A	11G3531	1.3	4.7	ND	1	07/29/11	07/29/11	

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METALS

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: mg/l									
Mercury	EPA 7470A	11G2933	0.00010	0.00020	ND	1	07/25/11	07/26/11	
Antimony	EPA 6010B	11G3426	0.0070	0.010	ND	1	07/28/11	07/29/11	
Arsenic	EPA 6010B	11G3426	0.0070	0.010	ND	1	07/28/11	07/29/11	
Barium	EPA 6010B	11G3426	0.0060	0.010	**0.24**	1	07/28/11	07/29/11	
Beryllium	EPA 6010B	11G3426	0.00090	0.0040	**0.0012**	1	07/28/11	07/29/11	J
Cadmium	EPA 6010B	11G3426	0.0020	0.0050	ND	1	07/28/11	07/29/11	
Chromium	EPA 6010B	11G3426	0.0020	0.0050	**0.021**	1	07/28/11	07/29/11	
Cobalt	EPA 6010B	11G3426	0.0020	0.010	**0.0060**	1	07/28/11	07/29/11	J
Copper	EPA 6010B	11G3426	0.0030	0.010	**0.025**	1	07/28/11	07/29/11	
Lead	EPA 6010B	11G3426	0.0040	0.0050	**0.0085**	1	07/28/11	07/29/11	
Molybdenum	EPA 6010B	11G3426	0.0020	0.020	**0.0073**	1	07/28/11	07/29/11	J
Nickel	EPA 6010B	11G3426	0.0020	0.010	**0.014**	1	07/28/11	07/29/11	
Selenium	EPA 6010B	11G3426	0.0080	0.010	**0.016**	1	07/28/11	07/29/11	
Silver	EPA 6010B	11G3426	0.0060	0.010	ND	1	07/28/11	07/29/11	
Thallium	EPA 6010B	11G3426	0.0070	0.010	ND	1	07/28/11	07/29/11	
Vanadium	EPA 6010B	11G3426	0.0030	0.010	**0.045**	1	07/28/11	07/29/11	
Zinc	EPA 6010B	11G3426	0.0060	0.020	**0.065**	1	07/28/11	07/29/11	

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INORGANICS

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: mg/l									
Total Nitrogen	[CALC]	[CALC]	N/A	0.50	**0.53**	1	07/25/11	07/25/11	
Total Kjeldahl Nitrogen	EPA 351.2	11G2935	0.15	0.50	**0.53**	1	07/25/11	07/25/11	
Biochemical Oxygen Demand	SM5210B	11G2698	0.50	2.0	**1.1**	1	07/22/11	07/27/11	J
Nitrate-N	EPA 300.0	11G2464	0.060	0.11	ND	1	07/21/11	07/21/11	
Nitrite-N	EPA 300.0	11G2464	0.090	0.15	ND	1	07/21/11	07/21/11	
Orthophosphate - P	EPA 365.3	11G2522	0.020	0.050	**0.020**	1	07/21/11	07/21/11	J
Residual Chlorine	SM 4500-Cl G	11G2652	0.060	0.10	ND	1	07/22/11	07/22/11	HFT
Sulfide	SM4500-S C, D	11G3121	0.020	0.10	ND	1	07/26/11	07/26/11	
Total Dissolved Solids	SM2540C	11G2576	1.0	10	**1100**	1	07/22/11	07/22/11	
Total Suspended Solids	SM 2540D	11G2960	2.0	20	**870**	1	07/25/11	07/25/11	

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INORGANICS

Analyte	Method	Batch	MDL Limit	Reporting Limit	Sample Result	Dilution Factor	Date Extracted	Date Analyzed	Data Qualifiers
Sample ID: IUG2022-01 (MW-1 - Water)									
Reporting Units: pH Units									
pH	SM4500-H,B	11G2623	0.10	0.10	**7.7**	1	07/22/11	07/22/11	HFT

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SHORT HOLD TIME DETAIL REPORT

	Hold Time (in days)	Date/Time Sampled	Date/Time Received	Date/Time Extracted	Date/Time Analyzed
Sample ID: MW-1 (IUG2022-01) - Water					
[CALC]	2	07/21/2011 10:20	07/21/2011 11:41	07/25/2011 14:56	07/25/2011 21:00
EPA 300.0	2	07/21/2011 10:20	07/21/2011 11:41	07/21/2011 17:45	07/21/2011 17:58
EPA 365.3	2	07/21/2011 10:20	07/21/2011 11:41	07/21/2011 15:00	07/21/2011 17:17
SM 4500-Cl G	0	07/21/2011 10:20	07/21/2011 11:41	07/22/2011 10:18	07/22/2011 10:20
SM4500-H,B	0	07/21/2011 10:20	07/21/2011 11:41	07/22/2011 07:10	07/22/2011 07:10
SM5210B	2	07/21/2011 10:20	07/21/2011 11:41	07/22/2011 14:30	07/27/2011 09:50

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Blank Analyzed: 07/27/2011 (11G3172-BLK1)											
Acetone	ND	10	4.5	ug/l							
Benzene	ND	0.50	0.28	ug/l							
Bromobenzene	ND	1.0	0.27	ug/l							
Bromochloromethane	ND	1.0	0.40	ug/l							
Bromodichloromethane	ND	1.0	0.30	ug/l							
Bromoform	ND	1.0	0.40	ug/l							
Bromomethane	ND	1.0	0.42	ug/l							
2-Butanone (MEK)	ND	10	4.7	ug/l							
n-Butylbenzene	ND	1.0	0.37	ug/l							
sec-Butylbenzene	ND	1.0	0.25	ug/l							
tert-Butylbenzene	ND	1.0	0.22	ug/l							
Carbon tetrachloride	ND	0.50	0.28	ug/l							
Chlorobenzene	ND	1.0	0.36	ug/l							
Chloroethane	ND	1.0	0.40	ug/l							
Chloroform	ND	1.0	0.33	ug/l							
Chloromethane	ND	1.0	0.40	ug/l							
2-Chlorotoluene	ND	1.0	0.28	ug/l							
4-Chlorotoluene	ND	1.0	0.29	ug/l							
1,2-Dibromo-3-chloropropane	ND	5.0	0.97	ug/l							
Dibromochloromethane	ND	1.0	0.40	ug/l							
1,2-Dibromoethane (EDB)	ND	1.0	0.40	ug/l							
Dibromomethane	ND	1.0	0.36	ug/l							
1,2-Dichlorobenzene	ND	1.0	0.32	ug/l							
1,3-Dichlorobenzene	ND	1.0	0.35	ug/l							
1,4-Dichlorobenzene	ND	1.0	0.37	ug/l							
Dichlorodifluoromethane	ND	2.0	0.26	ug/l							
1,1-Dichloroethane	ND	1.0	0.40	ug/l							
1,2-Dichloroethane	ND	0.50	0.28	ug/l							
1,1-Dichloroethene	ND	1.0	0.42	ug/l							
cis-1,2-Dichloroethene	ND	1.0	0.32	ug/l							
trans-1,2-Dichloroethene	ND	1.0	0.30	ug/l							

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Blank Analyzed: 07/27/2011 (11G3172-BLK1)											
1,2-Dichloropropane	ND	1.0	0.35	ug/l							
1,3-Dichloropropane	ND	1.0	0.32	ug/l							
2,2-Dichloropropane	ND	1.0	0.34	ug/l							
cis-1,3-Dichloropropene	ND	0.50	0.22	ug/l							
trans-1,3-Dichloropropene	ND	0.50	0.32	ug/l							
1,1-Dichloropropene	ND	1.0	0.28	ug/l							
Ethylbenzene	ND	0.50	0.25	ug/l							
Hexachlorobutadiene	ND	1.0	0.38	ug/l							
2-Hexanone	ND	10	2.6	ug/l							
Isopropylbenzene	ND	1.0	0.25	ug/l							
p-Isopropyltoluene	ND	1.0	0.28	ug/l							
4-Methyl-2-pentanone (MIBK)	ND	10	3.5	ug/l							
Methylene chloride	ND	5.0	0.95	ug/l							
Naphthalene	ND	1.0	0.41	ug/l							
n-Propylbenzene	ND	1.0	0.27	ug/l							
Styrene	ND	1.0	0.20	ug/l							
1,1,1,2-Tetrachloroethane	ND	1.0	0.27	ug/l							
1,1,2,2-Tetrachloroethane	ND	1.0	0.30	ug/l							
Tetrachloroethene	ND	1.0	0.32	ug/l							
Toluene	ND	0.50	0.36	ug/l							
1,2,3-Trichlorobenzene	ND	1.0	0.30	ug/l							
1,2,4-Trichlorobenzene	ND	1.0	0.48	ug/l							
1,1,1-Trichloroethane	ND	1.0	0.30	ug/l							
1,1,2-Trichloroethane	ND	1.0	0.30	ug/l							
Trichloroethene	ND	1.0	0.26	ug/l							
Trichlorofluoromethane	ND	1.0	0.34	ug/l							
1,2,3-Trichloropropane	ND	1.0	0.40	ug/l							
1,2,4-Trimethylbenzene	ND	1.0	0.23	ug/l							
1,3,5-Trimethylbenzene	ND	1.0	0.26	ug/l							
Vinyl chloride	ND	0.50	0.40	ug/l							
m,p-Xylenes	ND	1.0	0.60	ug/l							

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Blank Analyzed: 07/27/2011 (11G3172-BLK1)											
o-Xylene	ND	0.50	0.30	ug/l							
Xylenes, Total	ND	1.5	0.90	ug/l							
Di-isopropyl Ether (DIPE)	ND	1.0	0.25	ug/l							
Ethyl tert-Butyl Ether (ETBE)	ND	1.0	0.28	ug/l							
Methyl-tert-butyl Ether (MTBE)	ND	1.0	0.32	ug/l							
tert-Amyl Methyl Ether (TAME)	ND	1.0	0.33	ug/l							
tert-Butanol (TBA)	ND	10	6.5	ug/l							
Surrogate: 4-Bromofluorobenzene	*23.9*			*ug/l*	*25.0*		*96*	*80-120*			
Surrogate: Dibromofluoromethane	*22.6*			*ug/l*	*25.0*		*90*	*80-120*			
Surrogate: Toluene-d8	*24.8*			*ug/l*	*25.0*		*99*	*80-120*			
LCS Analyzed: 07/27/2011 (11G3172-BS1)											
Acetone	27.3	10	4.5	ug/l	25.0		109	30-140			
Benzene	22.3	0.50	0.28	ug/l	25.0		89	70-120			
Bromobenzene	25.6	1.0	0.27	ug/l	25.0		102	75-120			
Bromochloromethane	23.4	1.0	0.40	ug/l	25.0		94	70-130			
Bromodichloromethane	26.2	1.0	0.30	ug/l	25.0		105	70-135			
Bromoform	22.7	1.0	0.40	ug/l	25.0		91	55-130			
Bromomethane	24.6	1.0	0.42	ug/l	25.0		98	65-140			
2-Butanone (MEK)	24.8	10	4.7	ug/l	25.0		99	40-140			
n-Butylbenzene	23.7	1.0	0.37	ug/l	25.0		95	70-130			
sec-Butylbenzene	23.6	1.0	0.25	ug/l	25.0		95	70-125			
tert-Butylbenzene	24.8	1.0	0.22	ug/l	25.0		99	70-125			
Carbon tetrachloride	30.6	0.50	0.28	ug/l	25.0		122	65-140			
Chlorobenzene	24.9	1.0	0.36	ug/l	25.0		99	75-120			
Chloroethane	22.2	1.0	0.40	ug/l	25.0		89	60-140			
Chloroform	21.4	1.0	0.33	ug/l	25.0		85	70-130			
Chloromethane	23.2	1.0	0.40	ug/l	25.0		93	50-140			
2-Chlorotoluene	23.5	1.0	0.28	ug/l	25.0		94	70-125			
4-Chlorotoluene	24.4	1.0	0.29	ug/l	25.0		97	75-125			
1,2-Dibromo-3-chloropropane	24.9	5.0	0.97	ug/l	25.0		100	50-135			
Dibromochloromethane	27.1	1.0	0.40	ug/l	25.0		108	70-140			

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Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
Received: 07/21/11

METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
LCS Analyzed: 07/27/2011 (11G3172-BS1)											
1,2-Dibromoethane (EDB)	24.9	1.0	0.40	ug/l	25.0		100	75-125			
Dibromomethane	23.5	1.0	0.36	ug/l	25.0		94	70-125			
1,2-Dichlorobenzene	24.7	1.0	0.32	ug/l	25.0		99	75-120			
1,3-Dichlorobenzene	24.6	1.0	0.35	ug/l	25.0		98	75-120			
1,4-Dichlorobenzene	24.5	1.0	0.37	ug/l	25.0		98	75-120			
Dichlorodifluoromethane	24.3	2.0	0.26	ug/l	25.0		97	35-155			
1,1-Dichloroethane	21.2	1.0	0.40	ug/l	25.0		85	70-125			
1,2-Dichloroethane	23.1	0.50	0.28	ug/l	25.0		92	60-140			
1,1-Dichloroethene	23.8	1.0	0.42	ug/l	25.0		95	70-125			
cis-1,2-Dichloroethene	23.6	1.0	0.32	ug/l	25.0		94	70-125			
trans-1,2-Dichloroethene	21.8	1.0	0.30	ug/l	25.0		87	70-125			
1,2-Dichloropropane	22.4	1.0	0.35	ug/l	25.0		90	70-125			
1,3-Dichloropropane	23.5	1.0	0.32	ug/l	25.0		94	70-120			
2,2-Dichloropropane	28.1	1.0	0.34	ug/l	25.0		112	65-140			
cis-1,3-Dichloropropene	26.7	0.50	0.22	ug/l	25.0		107	75-125			
trans-1,3-Dichloropropene	27.3	0.50	0.32	ug/l	25.0		109	70-125			
1,1-Dichloropropene	24.0	1.0	0.28	ug/l	25.0		96	75-130			
Ethylbenzene	23.8	0.50	0.25	ug/l	25.0		95	75-125			
Hexachlorobutadiene	25.7	1.0	0.38	ug/l	25.0		103	65-135			
2-Hexanone	23.0	10	2.6	ug/l	25.0		92	45-140			
Isopropylbenzene	24.9	1.0	0.25	ug/l	25.0		100	75-130			
p-Isopropyltoluene	26.1	1.0	0.28	ug/l	25.0		104	75-125			
4-Methyl-2-pentanone (MIBK)	22.0	10	3.5	ug/l	25.0		88	45-140			
Methylene chloride	22.9	5.0	0.95	ug/l	25.0		92	55-130			
Naphthalene	27.0	1.0	0.41	ug/l	25.0		108	55-135			
n-Propylbenzene	23.5	1.0	0.27	ug/l	25.0		94	75-130			
Styrene	25.9	1.0	0.20	ug/l	25.0		104	75-130			
1,1,1,2-Tetrachloroethane	28.6	1.0	0.27	ug/l	25.0		114	70-130			
1,1,2,2-Tetrachloroethane	23.2	1.0	0.30	ug/l	25.0		93	55-130			
Tetrachloroethene	26.1	1.0	0.32	ug/l	25.0		104	70-125			
Toluene	23.2	0.50	0.36	ug/l	25.0		93	70-120			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
LCS Analyzed: 07/27/2011 (11G3172-BS1)											
1,2,3-Trichlorobenzene	25.8	1.0	0.30	ug/l	25.0		103	65-125			
1,2,4-Trichlorobenzene	26.9	1.0	0.48	ug/l	25.0		108	70-135			
1,1,1-Trichloroethane	27.0	1.0	0.30	ug/l	25.0		108	65-135			
1,1,2-Trichloroethane	24.3	1.0	0.30	ug/l	25.0		97	70-125			
Trichloroethene	25.5	1.0	0.26	ug/l	25.0		102	70-125			
Trichlorofluoromethane	28.0	1.0	0.34	ug/l	25.0		112	65-145			
1,2,3-Trichloropropane	22.9	1.0	0.40	ug/l	25.0		91	60-130			
1,2,4-Trimethylbenzene	25.6	1.0	0.23	ug/l	25.0		102	75-125			
1,3,5-Trimethylbenzene	25.3	1.0	0.26	ug/l	25.0		101	75-125			
Vinyl chloride	25.7	0.50	0.40	ug/l	25.0		103	55-135			
m,p-Xylenes	49.1	1.0	0.60	ug/l	50.0		98	75-125			
o-Xylene	24.2	0.50	0.30	ug/l	25.0		97	75-125			
Xylenes, Total	73.4	1.5	0.90	ug/l	75.0		98	70-125			
Di-isopropyl Ether (DIPE)	19.3	1.0	0.25	ug/l	25.0		77	60-135			
Ethyl tert-Butyl Ether (ETBE)	19.7	1.0	0.28	ug/l	25.0		79	65-135			
Methyl-tert-butyl Ether (MTBE)	19.3	1.0	0.32	ug/l	25.0		77	60-135			
tert-Amyl Methyl Ether (TAME)	22.6	1.0	0.33	ug/l	25.0		90	60-135			
tert-Butanol (TBA)	134	10	6.5	ug/l	125		107	70-135			
Surrogate: 4-Bromofluorobenzene	*23.7*			*ug/l*	*25.0*		*95*	*80-120*			
Surrogate: Dibromofluoromethane	*22.7*			*ug/l*	*25.0*		*91*	*80-120*			
Surrogate: Toluene-d8	*24.4*			*ug/l*	*25.0*		*98*	*80-120*			
Matrix Spike Analyzed: 07/27/2011 (11G3172-MS1)					**Source: IUG2308-02**						
Acetone	15.5	10	4.5	ug/l	25.0	ND	62	20-150			
Benzene	23.0	0.50	0.28	ug/l	25.0	ND	92	65-125			
Bromobenzene	26.9	1.0	0.27	ug/l	25.0	ND	108	70-125			
Bromochloromethane	25.6	1.0	0.40	ug/l	25.0	ND	102	65-135			
Bromodichloromethane	28.4	1.0	0.30	ug/l	25.0	ND	113	70-135			
Bromoform	24.0	1.0	0.40	ug/l	25.0	ND	96	55-135			
Bromomethane	25.3	1.0	0.42	ug/l	25.0	ND	101	55-145			
2-Butanone (MEK)	18.6	10	4.7	ug/l	25.0	ND	74	30-145			
n-Butylbenzene	23.9	1.0	0.37	ug/l	25.0	ND	96	65-135			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Matrix Spike Analyzed: 07/27/2011 (11G3172-MS1)					**Source: IUG2308-02**						
sec-Butylbenzene	24.5	1.0	0.25	ug/l	25.0	ND	98	70-125			
tert-Butylbenzene	25.9	1.0	0.22	ug/l	25.0	ND	104	65-130			
Carbon tetrachloride	32.4	0.50	0.28	ug/l	25.0	ND	129	65-140			
Chlorobenzene	27.1	1.0	0.36	ug/l	25.0	ND	108	75-125			
Chloroethane	24.2	1.0	0.40	ug/l	25.0	ND	97	55-140			
Chloroform	23.5	1.0	0.33	ug/l	25.0	ND	94	65-135			
Chloromethane	24.1	1.0	0.40	ug/l	25.0	ND	96	45-145			
2-Chlorotoluene	25.3	1.0	0.28	ug/l	25.0	ND	101	65-135			
4-Chlorotoluene	25.7	1.0	0.29	ug/l	25.0	ND	103	70-135			
1,2-Dibromo-3-chloropropane	24.6	5.0	0.97	ug/l	25.0	ND	98	45-145			
Dibromochloromethane	29.2	1.0	0.40	ug/l	25.0	ND	117	65-140			
1,2-Dibromoethane (EDB)	26.6	1.0	0.40	ug/l	25.0	ND	106	70-130			
Dibromomethane	24.9	1.0	0.36	ug/l	25.0	ND	100	65-135			
1,2-Dichlorobenzene	25.0	1.0	0.32	ug/l	25.0	ND	100	75-125			
1,3-Dichlorobenzene	25.8	1.0	0.35	ug/l	25.0	ND	103	75-125			
1,4-Dichlorobenzene	25.2	1.0	0.37	ug/l	25.0	ND	101	75-125			
Dichlorodifluoromethane	25.6	2.0	0.26	ug/l	25.0	ND	102	25-155			
1,1-Dichloroethane	22.9	1.0	0.40	ug/l	25.0	ND	92	65-130			
1,2-Dichloroethane	24.4	0.50	0.28	ug/l	25.0	ND	97	60-140			
1,1-Dichloroethene	24.6	1.0	0.42	ug/l	25.0	ND	99	60-130			
cis-1,2-Dichloroethene	24.6	1.0	0.32	ug/l	25.0	ND	98	65-130			
trans-1,2-Dichloroethene	23.5	1.0	0.30	ug/l	25.0	ND	94	65-130			
1,2-Dichloropropane	23.6	1.0	0.35	ug/l	25.0	ND	94	65-130			
1,3-Dichloropropane	25.7	1.0	0.32	ug/l	25.0	ND	103	65-135			
2,2-Dichloropropane	30.7	1.0	0.34	ug/l	25.0	ND	123	60-145			
cis-1,3-Dichloropropene	27.5	0.50	0.22	ug/l	25.0	ND	110	70-130			
trans-1,3-Dichloropropene	29.3	0.50	0.32	ug/l	25.0	ND	117	65-135			
1,1-Dichloropropene	25.2	1.0	0.28	ug/l	25.0	ND	101	70-135			
Ethylbenzene	26.2	0.50	0.25	ug/l	25.0	ND	105	65-130			
Hexachlorobutadiene	29.2	1.0	0.38	ug/l	25.0	ND	117	60-135			
2-Hexanone	20.7	10	2.6	ug/l	25.0	ND	83	25-140			

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Report Number: IUG2022

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Matrix Spike Analyzed: 07/27/2011 (11G3172-MS1)					**Source: IUG2308-02**						
Isopropylbenzene	25.7	1.0	0.25	ug/l	25.0	ND	103	70-135			
p-Isopropyltoluene	26.7	1.0	0.28	ug/l	25.0	ND	107	65-130			
4-Methyl-2-pentanone (MIBK)	21.7	10	3.5	ug/l	25.0	ND	87	40-140			
Methylene chloride	23.9	5.0	0.95	ug/l	25.0	ND	96	50-135			
Naphthalene	27.9	1.0	0.41	ug/l	25.0	ND	112	50-140			
n-Propylbenzene	24.2	1.0	0.27	ug/l	25.0	ND	97	70-135			
Styrene	25.9	1.0	0.20	ug/l	25.0	ND	104	50-145			
1,1,1,2-Tetrachloroethane	31.2	1.0	0.27	ug/l	25.0	ND	125	65-140			
1,1,2,2-Tetrachloroethane	23.6	1.0	0.30	ug/l	25.0	ND	94	55-135			
Tetrachloroethene	27.8	1.0	0.32	ug/l	25.0	ND	111	65-130			
Toluene	24.7	0.50	0.36	ug/l	25.0	ND	99	70-125			
1,2,3-Trichlorobenzene	27.8	1.0	0.30	ug/l	25.0	ND	111	60-135			
1,2,4-Trichlorobenzene	29.3	1.0	0.48	ug/l	25.0	ND	117	65-135			
1,1,1-Trichloroethane	28.5	1.0	0.30	ug/l	25.0	ND	114	65-140			
1,1,2-Trichloroethane	25.3	1.0	0.30	ug/l	25.0	ND	101	65-130			
Trichloroethene	26.1	1.0	0.26	ug/l	25.0	ND	105	65-125			
Trichlorofluoromethane	30.3	1.0	0.34	ug/l	25.0	ND	121	60-145			
1,2,3-Trichloropropane	22.9	1.0	0.40	ug/l	25.0	ND	91	55-135			
1,2,4-Trimethylbenzene	25.4	1.0	0.23	ug/l	25.0	ND	101	55-135			
1,3,5-Trimethylbenzene	26.7	1.0	0.26	ug/l	25.0	ND	107	70-130			
Vinyl chloride	26.2	0.50	0.40	ug/l	25.0	ND	105	45-140			
m,p-Xylenes	51.0	1.0	0.60	ug/l	50.0	ND	102	65-130			
o-Xylene	25.9	0.50	0.30	ug/l	25.0	ND	104	65-125			
Xylenes, Total	77.0	1.5	0.90	ug/l	75.0	ND	103	60-130			
Di-isopropyl Ether (DIPE)	20.7	1.0	0.25	ug/l	25.0	ND	83	60-140			
Ethyl tert-Butyl Ether (ETBE)	22.0	1.0	0.28	ug/l	25.0	ND	88	60-135			
Methyl-tert-butyl Ether (MTBE)	20.2	1.0	0.32	ug/l	25.0	ND	81	55-145			
tert-Amyl Methyl Ether (TAME)	23.0	1.0	0.33	ug/l	25.0	ND	92	60-140			
tert-Butanol (TBA)	140	10	6.5	ug/l	125	ND	112	65-140			
Surrogate: 4-Bromofluorobenzene	*24.5*			*ug/l*	*25.0*		*98*	*80-120*			
Surrogate: Dibromofluoromethane	*23.8*			*ug/l*	*25.0*		*95*	*80-120*			
Surrogate: Toluene-d8	*24.4*			*ug/l*	*25.0*		*98*	*80-120*			

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METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Matrix Spike Analyzed: 07/27/2011 (11G3172-MS1)						**Source: IUG2308-02**					
Matrix Spike Dup Analyzed: 07/27/2011 (11G3172-MSD1)						**Source: IUG2308-02**					
Acetone	15.8	10	4.5	ug/l	25.0	ND	63	20-150	2	35	
Benzene	23.0	0.50	0.28	ug/l	25.0	ND	92	65-125	0.3	20	
Bromobenzene	26.2	1.0	0.27	ug/l	25.0	ND	105	70-125	3	20	
Bromochloromethane	24.4	1.0	0.40	ug/l	25.0	ND	98	65-135	5	25	
Bromodichloromethane	28.5	1.0	0.30	ug/l	25.0	ND	114	70-135	0.4	20	
Bromoform	24.1	1.0	0.40	ug/l	25.0	ND	96	55-135	0.6	25	
Bromomethane	24.8	1.0	0.42	ug/l	25.0	ND	99	55-145	2	25	
2-Butanone (MEK)	18.2	10	4.7	ug/l	25.0	ND	73	30-145	2	40	
n-Butylbenzene	24.0	1.0	0.37	ug/l	25.0	ND	96	65-135	0.4	20	
sec-Butylbenzene	24.5	1.0	0.25	ug/l	25.0	ND	98	70-125	0.2	20	
tert-Butylbenzene	25.6	1.0	0.22	ug/l	25.0	ND	102	65-130	1	20	
Carbon tetrachloride	32.4	0.50	0.28	ug/l	25.0	ND	130	65-140	0.2	25	
Chlorobenzene	27.1	1.0	0.36	ug/l	25.0	ND	108	75-125	0.1	20	
Chloroethane	23.1	1.0	0.40	ug/l	25.0	ND	92	55-140	5	25	
Chloroform	22.0	1.0	0.33	ug/l	25.0	ND	88	65-135	6	20	
Chloromethane	22.9	1.0	0.40	ug/l	25.0	ND	92	45-145	5	25	
2-Chlorotoluene	24.1	1.0	0.28	ug/l	25.0	ND	96	65-135	5	20	
4-Chlorotoluene	24.9	1.0	0.29	ug/l	25.0	ND	99	70-135	3	20	
1,2-Dibromo-3-chloropropane	25.8	5.0	0.97	ug/l	25.0	ND	103	45-145	5	30	
Dibromochloromethane	28.9	1.0	0.40	ug/l	25.0	ND	116	65-140	0.9	25	
1,2-Dibromoethane (EDB)	26.6	1.0	0.40	ug/l	25.0	ND	106	70-130	0.08	25	
Dibromomethane	24.8	1.0	0.36	ug/l	25.0	ND	99	65-135	0.6	25	
1,2-Dichlorobenzene	25.2	1.0	0.32	ug/l	25.0	ND	101	75-125	0.6	20	
1,3-Dichlorobenzene	25.3	1.0	0.35	ug/l	25.0	ND	101	75-125	2	20	
1,4-Dichlorobenzene	24.2	1.0	0.37	ug/l	25.0	ND	97	75-125	4	20	
Dichlorodifluoromethane	24.8	2.0	0.26	ug/l	25.0	ND	99	25-155	3	30	
1,1-Dichloroethane	22.4	1.0	0.40	ug/l	25.0	ND	90	65-130	2	20	
1,2-Dichloroethane	25.0	0.50	0.28	ug/l	25.0	ND	100	60-140	3	20	
1,1-Dichloroethene	24.1	1.0	0.42	ug/l	25.0	ND	96	60-130	2	20	
cis-1,2-Dichloroethene	24.3	1.0	0.32	ug/l	25.0	ND	97	65-130	1	20	

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VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Batch: 11G3172 Extracted: 07/27/11

Matrix Spike Dup Analyzed: 07/27/2011 (11G3172-MSD1) **Source: IUG2308-02**

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
trans-1,2-Dichloroethene	22.5	1.0	0.30	ug/l	25.0	ND	90	65-130	4	20	
1,2-Dichloropropane	23.4	1.0	0.35	ug/l	25.0	ND	94	65-130	0.9	20	
1,3-Dichloropropane	26.0	1.0	0.32	ug/l	25.0	ND	104	65-135	1	25	
2,2-Dichloropropane	29.7	1.0	0.34	ug/l	25.0	ND	119	60-145	3	25	
cis-1,3-Dichloropropene	27.9	0.50	0.22	ug/l	25.0	ND	111	70-130	1	20	
trans-1,3-Dichloropropene	30.8	0.50	0.32	ug/l	25.0	ND	123	65-135	5	25	
1,1-Dichloropropene	25.1	1.0	0.28	ug/l	25.0	ND	100	70-135	0.4	20	
Ethylbenzene	26.2	0.50	0.25	ug/l	25.0	ND	105	65-130	0.2	20	
Hexachlorobutadiene	27.1	1.0	0.38	ug/l	25.0	ND	108	60-135	8	20	
2-Hexanone	21.2	10	2.6	ug/l	25.0	ND	85	25-140	2	35	
Isopropylbenzene	25.1	1.0	0.25	ug/l	25.0	ND	100	70-135	2	20	
p-Isopropyltoluene	25.4	1.0	0.28	ug/l	25.0	ND	102	65-130	5	20	
4-Methyl-2-pentanone (MIBK)	22.6	10	3.5	ug/l	25.0	ND	90	40-140	4	35	
Methylene chloride	23.1	5.0	0.95	ug/l	25.0	ND	93	50-135	3	20	
Naphthalene	26.4	1.0	0.41	ug/l	25.0	ND	106	50-140	6	30	
n-Propylbenzene	23.6	1.0	0.27	ug/l	25.0	ND	94	70-135	3	20	
Styrene	25.7	1.0	0.20	ug/l	25.0	ND	103	50-145	0.8	30	
1,1,1,2-Tetrachloroethane	31.1	1.0	0.27	ug/l	25.0	ND	124	65-140	0.5	20	
1,1,2,2-Tetrachloroethane	23.3	1.0	0.30	ug/l	25.0	ND	93	55-135	1	30	
Tetrachloroethene	27.6	1.0	0.32	ug/l	25.0	ND	111	65-130	0.6	20	
Toluene	24.6	0.50	0.36	ug/l	25.0	ND	98	70-125	0.4	20	
1,2,3-Trichlorobenzene	27.2	1.0	0.30	ug/l	25.0	ND	109	60-135	2	20	
1,2,4-Trichlorobenzene	27.5	1.0	0.48	ug/l	25.0	ND	110	65-135	6	20	
1,1,1-Trichloroethane	27.5	1.0	0.30	ug/l	25.0	ND	110	65-140	3	20	
1,1,2-Trichloroethane	25.9	1.0	0.30	ug/l	25.0	ND	104	65-130	2	25	
Trichloroethene	26.0	1.0	0.26	ug/l	25.0	ND	104	65-125	0.7	20	
Trichlorofluoromethane	28.8	1.0	0.34	ug/l	25.0	ND	115	60-145	5	25	
1,2,3-Trichloropropane	23.3	1.0	0.40	ug/l	25.0	ND	93	55-135	2	30	
1,2,4-Trimethylbenzene	25.8	1.0	0.23	ug/l	25.0	ND	103	55-135	2	25	
1,3,5-Trimethylbenzene	25.5	1.0	0.26	ug/l	25.0	ND	102	70-130	5	20	
Vinyl chloride	25.1	0.50	0.40	ug/l	25.0	ND	100	45-140	4	30	

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Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
Received: 07/21/11

METHOD BLANK/QC DATA

VOLATILE ORGANICS with OXYGENATES by GC/MS (EPA 8260B)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3172 Extracted: 07/27/11											
Matrix Spike Dup Analyzed: 07/27/2011 (11G3172-MSD1)					**Source: IUG2308-02**						
m,p-Xylenes	50.2	1.0	0.60	ug/l	50.0	ND	100	65-130	2	25	
o-Xylene	24.9	0.50	0.30	ug/l	25.0	ND	100	65-125	4	20	
Xylenes, Total	75.1	1.5	0.90	ug/l	75.0	ND	100	60-130	2	20	
Di-isopropyl Ether (DIPE)	19.4	1.0	0.25	ug/l	25.0	ND	78	60-140	6	25	
Ethyl tert-Butyl Ether (ETBE)	21.2	1.0	0.28	ug/l	25.0	ND	85	60-135	4	25	
Methyl-tert-butyl Ether (MTBE)	19.8	1.0	0.32	ug/l	25.0	ND	79	55-145	2	25	
tert-Amyl Methyl Ether (TAME)	22.6	1.0	0.33	ug/l	25.0	ND	90	60-140	2	30	
tert-Butanol (TBA)	132	10	6.5	ug/l	125	ND	105	65-140	6	25	
Surrogate: 4-Bromofluorobenzene	*25.0*			*ug/l*	*25.0*		*100*	*80-120*			
Surrogate: Dibromofluoromethane	*23.6*			*ug/l*	*25.0*		*95*	*80-120*			
Surrogate: Toluene-d8	*26.0*			*ug/l*	*25.0*		*104*	*80-120*			

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METHOD BLANK/QC DATA

ORGANOCHLORINE PESTICIDES (EPA 3510C/8081A)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3054 Extracted: 07/26/11											
Blank Analyzed: 07/27/2011 (11G3054-BLK1)											
4,4'-DDD	ND	0.10	0.020	ug/l							
4,4'-DDE	ND	0.10	0.020	ug/l							
4,4'-DDT	ND	0.10	0.020	ug/l							
Aldrin	ND	0.10	0.020	ug/l							
alpha-BHC	ND	0.10	0.020	ug/l							
beta-BHC	ND	0.10	0.030	ug/l							
delta-BHC	ND	0.20	0.020	ug/l							
Dieldrin	ND	0.10	0.020	ug/l							
Endosulfan I	ND	0.10	0.020	ug/l							
Endosulfan II	ND	0.10	0.020	ug/l							
Endosulfan sulfate	ND	0.20	0.020	ug/l							
Endrin	ND	0.10	0.020	ug/l							
Endrin aldehyde	ND	0.10	0.020	ug/l							
Endrin ketone	ND	0.10	0.040	ug/l							
gamma-BHC (Lindane)	ND	0.10	0.020	ug/l							
Heptachlor	ND	0.10	0.030	ug/l							
Heptachlor epoxide	ND	0.10	0.030	ug/l							
Methoxychlor	ND	0.10	0.020	ug/l							
Chlordane	ND	1.0	0.20	ug/l							
Toxaphene	ND	5.0	0.50	ug/l							
Surrogate: Decachlorobiphenyl	*0.421*			*ug/l*	*0.500*		*84*	*45-120*			
Surrogate: Tetrachloro-m-xylene	*0.415*			*ug/l*	*0.500*		*83*	*35-115*			
LCS Analyzed: 07/27/2011 (11G3054-BS1)											
4,4'-DDD	0.549	0.10	0.020	ug/l	0.500		110	55-120			
4,4'-DDE	0.526	0.10	0.020	ug/l	0.500		105	50-120			
4,4'-DDT	0.506	0.10	0.020	ug/l	0.500		101	55-120			
Aldrin	0.467	0.10	0.020	ug/l	0.500		93	40-115			
alpha-BHC	0.517	0.10	0.020	ug/l	0.500		103	45-115			
beta-BHC	0.449	0.10	0.030	ug/l	0.500		90	55-115			
delta-BHC	0.492	0.20	0.020	ug/l	0.500		98	55-115			
Dieldrin	0.494	0.10	0.020	ug/l	0.500		99	55-115			

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METHOD BLANK/QC DATA

ORGANOCHLORINE PESTICIDES (EPA 3510C/8081A)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3054 Extracted: 07/26/11											
LCS Analyzed: 07/27/2011 (11G3054-BS1)											
Endosulfan I	0.480	0.10	0.020	ug/l	0.500		96	55-115			
Endosulfan II	0.410	0.10	0.020	ug/l	0.500		82	55-120			
Endosulfan sulfate	0.500	0.20	0.020	ug/l	0.500		100	60-120			
Endrin	0.520	0.10	0.020	ug/l	0.500		104	55-115			
Endrin aldehyde	0.481	0.10	0.020	ug/l	0.500		96	50-120			
Endrin ketone	0.507	0.10	0.040	ug/l	0.500		101	55-120			
gamma-BHC (Lindane)	0.502	0.10	0.020	ug/l	0.500		100	45-115			
Heptachlor	0.481	0.10	0.030	ug/l	0.500		96	45-115			
Heptachlor epoxide	0.402	0.10	0.030	ug/l	0.500		80	55-115			
Methoxychlor	0.487	0.10	0.020	ug/l	0.500		97	60-120			
Surrogate: Decachlorobiphenyl	*0.417*			*ug/l*	*0.500*		*83*	*45-120*			
Surrogate: Tetrachloro-m-xylene	*0.414*			*ug/l*	*0.500*		*83*	*35-115*			
LCS Dup Analyzed: 07/27/2011 (11G3054-BSD1)											
4,4'-DDD	0.546	0.10	0.020	ug/l	0.500		109	55-120	0.6	30	
4,4'-DDE	0.515	0.10	0.020	ug/l	0.500		103	50-120	2	30	
4,4'-DDT	0.513	0.10	0.020	ug/l	0.500		103	55-120	1	30	
Aldrin	0.463	0.10	0.020	ug/l	0.500		93	40-115	0.8	30	
alpha-BHC	0.507	0.10	0.020	ug/l	0.500		101	45-115	2	30	
beta-BHC	0.445	0.10	0.030	ug/l	0.500		89	55-115	0.9	30	
delta-BHC	0.490	0.20	0.020	ug/l	0.500		98	55-115	0.3	30	
Dieldrin	0.492	0.10	0.020	ug/l	0.500		98	55-115	0.4	30	
Endosulfan I	0.468	0.10	0.020	ug/l	0.500		94	55-115	3	30	
Endosulfan II	0.409	0.10	0.020	ug/l	0.500		82	55-120	0.4	30	
Endosulfan sulfate	0.501	0.20	0.020	ug/l	0.500		100	60-120	0.2	30	
Endrin	0.519	0.10	0.020	ug/l	0.500		104	55-115	0.2	30	
Endrin aldehyde	0.480	0.10	0.020	ug/l	0.500		96	50-120	0.08	30	
Endrin ketone	0.505	0.10	0.040	ug/l	0.500		101	55-120	0.4	30	
gamma-BHC (Lindane)	0.500	0.10	0.020	ug/l	0.500		100	45-115	0.4	30	
Heptachlor	0.483	0.10	0.030	ug/l	0.500		97	45-115	0.4	30	
Heptachlor epoxide	0.398	0.10	0.030	ug/l	0.500		80	55-115	0.8	30	
Methoxychlor	0.481	0.10	0.020	ug/l	0.500		96	60-120	1	30	

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METHOD BLANK/QC DATA

ORGANOCHLORINE PESTICIDES (EPA 3510C/8081A)

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3054 Extracted: 07/26/11											
LCS Dup Analyzed: 07/27/2011 (11G3054-BSD1)											
Surrogate: Decachlorobiphenyl	*0.422*			*ug/l*	*0.500*		*84*	*45-120*			
Surrogate: Tetrachloro-m-xylene	*0.413*			*ug/l*	*0.500*		*83*	*35-115*			

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METHOD BLANK/QC DATA

HEXANE EXTRACTABLE MATERIAL

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3530 Extracted: 07/29/11											
Blank Analyzed: 07/29/2011 (11G3530-BLK1)											
Hexane Extractable Material (Oil & Grease)	ND	5.0	1.4	mg/l							
LCS Analyzed: 07/29/2011 (11G3530-BS1)											**MNR1**
Hexane Extractable Material (Oil & Grease)	18.9	5.0	1.4	mg/l	20.0		94	78-114			
LCS Dup Analyzed: 07/29/2011 (11G3530-BSD1)											
Hexane Extractable Material (Oil & Grease)	18.7	5.0	1.4	mg/l	20.0		94	78-114	1	11	
Batch: 11G3531 Extracted: 07/29/11											
Blank Analyzed: 07/29/2011 (11G3531-BLK1)											
SilicaGel Treated Hexane Extractable Material(TPH)	ND	5.0	1.4	mg/l							
LCS Analyzed: 07/29/2011 (11G3531-BS1)											**MNR1**
SilicaGel Treated Hexane Extractable Material(TPH)	9.30	5.0	1.4	mg/l	10.0		93	70-110			
LCS Dup Analyzed: 07/29/2011 (11G3531-BSD1)											
SilicaGel Treated Hexane Extractable Material(TPH)	8.90	5.0	1.4	mg/l	10.0		89	70-110	4	15	

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METHOD BLANK/QC DATA

METALS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G2933 Extracted: 07/25/11											
Blank Analyzed: 07/26/2011 (11G2933-BLK1)											
Mercury	ND	0.00020	0.00010	mg/l							
LCS Analyzed: 07/26/2011 (11G2933-BS1)											
Mercury	0.00769	0.00020	0.00010	mg/l	0.00800		96	80-120			
Matrix Spike Analyzed: 07/26/2011 (11G2933-MS1)					**Source: IUG1909-01**						
Mercury	0.00656	0.00020	0.00010	mg/l	0.00800	ND	82	70-130			
Matrix Spike Dup Analyzed: 07/26/2011 (11G2933-MSD1)					**Source: IUG1909-01**						
Mercury	0.00658	0.00020	0.00010	mg/l	0.00800	ND	82	70-130	0.4	20	
Batch: 11G3426 Extracted: 07/28/11											
Blank Analyzed: 07/29/2011 (11G3426-BLK1)											
Antimony	ND	0.010	0.0070	mg/l							
Arsenic	ND	0.010	0.0070	mg/l							
Barium	ND	0.010	0.0060	mg/l							
Beryllium	ND	0.0040	0.00090	mg/l							
Cadmium	ND	0.0050	0.0020	mg/l							
Chromium	ND	0.0050	0.0020	mg/l							
Cobalt	ND	0.010	0.0020	mg/l							
Copper	ND	0.010	0.0030	mg/l							
Lead	ND	0.0050	0.0040	mg/l							
Molybdenum	ND	0.020	0.0020	mg/l							
Nickel	ND	0.010	0.0020	mg/l							
Selenium	ND	0.010	0.0080	mg/l							
Silver	ND	0.010	0.0060	mg/l							
Thallium	ND	0.010	0.0070	mg/l							
Vanadium	ND	0.010	0.0030	mg/l							
Zinc	ND	0.020	0.0060	mg/l							

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METHOD BLANK/QC DATA

METALS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3426 Extracted: 07/28/11											
LCS Analyzed: 07/29/2011 (11G3426-BS1)											
Antimony	0.965	0.010	0.0070	mg/l	1.00		97	80-120			
Arsenic	0.952	0.010	0.0070	mg/l	1.00		95	80-120			
Barium	0.986	0.010	0.0060	mg/l	1.00		99	80-120			
Beryllium	0.986	0.0040	0.00090	mg/l	1.00		99	80-120			
Cadmium	0.942	0.0050	0.0020	mg/l	1.00		94	80-120			
Chromium	0.987	0.0050	0.0020	mg/l	1.00		99	80-120			
Cobalt	0.956	0.010	0.0020	mg/l	1.00		96	80-120			
Copper	0.989	0.010	0.0030	mg/l	1.00		99	80-120			
Lead	0.971	0.0050	0.0040	mg/l	1.00		97	80-120			
Molybdenum	0.932	0.020	0.0020	mg/l	1.00		93	80-120			
Nickel	0.978	0.010	0.0020	mg/l	1.00		98	80-120			
Selenium	0.918	0.010	0.0080	mg/l	1.00		92	80-120			
Silver	0.500	0.010	0.0060	mg/l	0.500		100	80-120			
Thallium	0.959	0.010	0.0070	mg/l	1.00		96	80-120			
Vanadium	0.987	0.010	0.0030	mg/l	1.00		99	80-120			
Zinc	0.938	0.020	0.0060	mg/l	1.00		94	80-120			
Matrix Spike Analyzed: 07/29/2011 (11G3426-MS1)					**Source: IUG2143-01**						
Antimony	0.928	0.010	0.0070	mg/l	1.00	ND	93	75-125			
Arsenic	0.932	0.010	0.0070	mg/l	1.00	0.00878	92	75-125			
Barium	1.04	0.010	0.0060	mg/l	1.00	0.122	92	75-125			
Beryllium	0.953	0.0040	0.00090	mg/l	1.00	ND	95	75-125			
Cadmium	0.875	0.0050	0.0020	mg/l	1.00	ND	88	75-125			
Chromium	0.928	0.0050	0.0020	mg/l	1.00	ND	93	75-125			
Cobalt	0.874	0.010	0.0020	mg/l	1.00	ND	87	75-125			
Copper	0.948	0.010	0.0030	mg/l	1.00	ND	95	75-125			
Lead	0.886	0.0050	0.0040	mg/l	1.00	ND	89	75-125			
Molybdenum	0.887	0.020	0.0020	mg/l	1.00	ND	89	75-125			
Nickel	0.899	0.010	0.0020	mg/l	1.00	0.0166	88	75-125			
Selenium	0.870	0.010	0.0080	mg/l	1.00	ND	87	75-125			
Silver	0.476	0.010	0.0060	mg/l	0.500	ND	95	75-125			
Thallium	0.884	0.010	0.0070	mg/l	1.00	ND	88	75-125			

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METHOD BLANK/QC DATA

METALS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3426 Extracted: 07/28/11											
Matrix Spike Analyzed: 07/29/2011 (11G3426-MS1)						**Source: IUG2143-01**					
Vanadium	0.956	0.010	0.0030	mg/l	1.00	0.0144	94	75-125			
Zinc	0.889	0.020	0.0060	mg/l	1.00	ND	89	75-125			
Matrix Spike Dup Analyzed: 07/29/2011 (11G3426-MSD1)						**Source: IUG2143-01**					
Antimony	0.909	0.010	0.0070	mg/l	1.00	ND	91	75-125	2	20	
Arsenic	0.911	0.010	0.0070	mg/l	1.00	0.00878	90	75-125	2	20	
Barium	1.02	0.010	0.0060	mg/l	1.00	0.122	90	75-125	2	20	
Beryllium	0.927	0.0040	0.00090	mg/l	1.00	ND	93	75-125	3	20	
Cadmium	0.853	0.0050	0.0020	mg/l	1.00	ND	85	75-125	3	20	
Chromium	0.908	0.0050	0.0020	mg/l	1.00	ND	91	75-125	2	20	
Cobalt	0.856	0.010	0.0020	mg/l	1.00	ND	86	75-125	2	20	
Copper	0.924	0.010	0.0030	mg/l	1.00	ND	92	75-125	3	20	
Lead	0.868	0.0050	0.0040	mg/l	1.00	ND	87	75-125	2	20	
Molybdenum	0.865	0.020	0.0020	mg/l	1.00	ND	87	75-125	2	20	
Nickel	0.871	0.010	0.0020	mg/l	1.00	0.0166	85	75-125	3	20	
Selenium	0.848	0.010	0.0080	mg/l	1.00	ND	85	75-125	3	20	
Silver	0.466	0.010	0.0060	mg/l	0.500	ND	93	75-125	2	20	
Thallium	0.866	0.010	0.0070	mg/l	1.00	ND	87	75-125	2	20	
Vanadium	0.924	0.010	0.0030	mg/l	1.00	0.0144	91	75-125	3	20	
Zinc	0.862	0.020	0.0060	mg/l	1.00	ND	86	75-125	3	20	

TestAmerica Irvine

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Attention: Joe Roe

Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
Received: 07/21/11

METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G2464 Extracted: 07/21/11											
Blank Analyzed: 07/21/2011 (11G2464-BLK1)											
Nitrate-N	ND	0.11	0.060	mg/l							
Nitrite-N	ND	0.15	0.090	mg/l							
LCS Analyzed: 07/21/2011 (11G2464-BS1)											
Nitrate-N	1.15	0.11	0.060	mg/l	1.13		101	90-110			
Nitrite-N	1.56	0.15	0.090	mg/l	1.52		103	90-110			
Matrix Spike Analyzed: 07/21/2011 (11G2464-MS1)					**Source: IUG1984-02**						
Nitrate-N	13.5	2.2	1.2	mg/l	11.3	ND	119	80-120			
Nitrite-N	24.1	3.0	1.8	mg/l	15.2	ND	159	80-120			*M1*
Matrix Spike Analyzed: 07/22/2011 (11G2464-MS2)					**Source: IUG2101-02**						
Nitrate-N	15.7	2.2	1.2	mg/l	11.3	2.95	113	80-120			
Nitrite-N	18.3	3.0	1.8	mg/l	15.2	ND	120	80-120			
Matrix Spike Dup Analyzed: 07/21/2011 (11G2464-MSD1)					**Source: IUG1984-02**						
Nitrate-N	11.2	2.2	1.2	mg/l	11.3	ND	99	80-120	18	20	
Nitrite-N	23.7	3.0	1.8	mg/l	15.2	ND	156	80-120	2	20	*M1*
Batch: 11G2522 Extracted: 07/21/11											
Blank Analyzed: 07/21/2011 (11G2522-BLK1)											
Orthophosphate - P	ND	0.050	0.020	mg/l							
LCS Analyzed: 07/21/2011 (11G2522-BS1)											
Orthophosphate - P	0.531	0.050	0.020	mg/l	0.500		106	90-110			

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METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G2522 Extracted: 07/21/11											
Matrix Spike Analyzed: 07/21/2011 (11G2522-MS1)						**Source: IUG1928-01**					
Orthophosphate - P	0.634	0.050	0.020	mg/l	0.500	0.0714	112	75-125			
Matrix Spike Dup Analyzed: 07/21/2011 (11G2522-MSD1)						**Source: IUG1928-01**					
Orthophosphate - P	0.637	0.050	0.020	mg/l	0.500	0.0714	113	75-125	0.5	20	
Batch: 11G2576 Extracted: 07/22/11											
Blank Analyzed: 07/22/2011 (11G2576-BLK1)											
Total Dissolved Solids	ND	10	1.0	mg/l							
LCS Analyzed: 07/22/2011 (11G2576-BS1)											
Total Dissolved Solids	1000	10	1.0	mg/l	1000		100	90-110			
Duplicate Analyzed: 07/22/2011 (11G2576-DUP1)						**Source: IUG2022-01**					
Total Dissolved Solids	1090	10	1.0	mg/l		1090			0.2	10	
Batch: 11G2623 Extracted: 07/22/11											
Duplicate Analyzed: 07/22/2011 (11G2623-DUP1)						**Source: IUG2071-01**					
pH	6.14	0.10	0.10	pH Units		6.11			0.5	5	
Duplicate Analyzed: 07/22/2011 (11G2623-DUP2)						**Source: IUG2106-04**					
pH	7.75	0.10	0.10	pH Units		7.75			0	5	
Batch: 11G2652 Extracted: 07/22/11											
Blank Analyzed: 07/22/2011 (11G2652-BLK1)											
Residual Chlorine	ND	0.10	0.060	mg/l							

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INORGANICS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G2652 Extracted: 07/22/11											
Duplicate Analyzed: 07/22/2011 (11G2652-DUP1)					**Source: IUG2022-01**						
Residual Chlorine	ND	0.10	0.060	mg/l		ND				20	
Batch: 11G2698 Extracted: 07/22/11											
Blank Analyzed: 07/27/2011 (11G2698-BLK1)											
Biochemical Oxygen Demand	ND	2.0	0.50	mg/l							
LCS Analyzed: 07/27/2011 (11G2698-BS1)											
Biochemical Oxygen Demand	201	100	25	mg/l	198		102	85-115			
LCS Dup Analyzed: 07/27/2011 (11G2698-BSD1)											
Biochemical Oxygen Demand	209	100	25	mg/l	198		106	85-115	4	20	
Batch: 11G2935 Extracted: 07/25/11											
Blank Analyzed: 07/25/2011 (11G2935-BLK1)											
Total Kjeldahl Nitrogen	ND	0.50	0.15	mg/l							
LCS Analyzed: 07/25/2011 (11G2935-BS1)											
Total Kjeldahl Nitrogen	4.64	0.50	0.15	mg/l	5.00		93	90-110			
Matrix Spike Analyzed: 07/25/2011 (11G2935-MS1)					**Source: IUG1984-02**						
Total Kjeldahl Nitrogen	29.4	5.0	1.5	mg/l	5.00	21.0	168	90-110			*MHA*
Matrix Spike Analyzed: 07/25/2011 (11G2935-MS2)					**Source: IUG2047-01**						
Total Kjeldahl Nitrogen	6.90	0.50	0.15	mg/l	5.00	1.85	101	90-110			

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METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G2935 Extracted: 07/25/11											
Matrix Spike Dup Analyzed: 07/25/2011 (11G2935-MSD1)					**Source: IUG1984-02**						
Total Kjeldahl Nitrogen	25.2	5.0	1.5	mg/l	5.00	21.0	84	90-110	16	20	*MHA*
Matrix Spike Dup Analyzed: 07/25/2011 (11G2935-MSD2)					**Source: IUG2047-01**						
Total Kjeldahl Nitrogen	6.78	0.50	0.15	mg/l	5.00	1.85	99	90-110	2	20	
Batch: 11G2960 Extracted: 07/25/11											
Blank Analyzed: 07/25/2011 (11G2960-BLK1)											
Total Suspended Solids	ND	10	1.0	mg/l							
LCS Analyzed: 07/25/2011 (11G2960-BS1)											
Total Suspended Solids	989	10	1.0	mg/l	1000		99	85-115			
Duplicate Analyzed: 07/25/2011 (11G2960-DUP1)					**Source: IUG2302-01**						
Total Suspended Solids	14.0	10	1.0	mg/l		14.0			0	10	
Batch: 11G3121 Extracted: 07/26/11											
Blank Analyzed: 07/26/2011 (11G3121-BLK1)											
Sulfide	ND	0.10	0.020	mg/l							
LCS Analyzed: 07/26/2011 (11G3121-BS1)											
Sulfide	0.631	0.10	0.020	mg/l	0.580		109	80-120			
Matrix Spike Analyzed: 07/26/2011 (11G3121-MS1)					**Source: IUG2357-03**						
Sulfide	0.766	0.10	0.020	mg/l	0.580	0.121	111	70-130			

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Project ID: 602778-003

Report Number: IUG2022

Sampled: 07/21/11
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METHOD BLANK/QC DATA

INORGANICS

Analyte	Result	Reporting Limit	MDL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Data Qualifiers
Batch: 11G3121 Extracted: 07/26/11											
Matrix Spike Dup Analyzed: 07/26/2011 (11G3121-MSD1)					**Source: IUG2357-03**						
Sulfide	0.753	0.10	0.020	mg/l	0.580	0.121	109	70-130	2	30	

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DATA QUALIFIERS AND DEFINITIONS

HFT	The holding time for this test is immediate. It was analyzed in the laboratory as soon as possible after receipt.
J	Estimated value. Analyte detected at a level less than the Reporting Limit (RL) and greater than or equal to the Method Detection Limit (MDL). The user of this data should be aware that this data is of limited reliability.
M1	The MS and/or MSD were above the acceptance limits due to sample matrix interference. See Blank Spike (LCS).
MHA	Due to high levels of analyte in the sample, the MS/MSD calculation does not provide useful spike recovery information. See Blank Spike (LCS).
MNR1	There was no MS/MSD analyzed with this batch due to insufficient sample volume. See Blank Spike/Blank Spike Duplicate.
ND	Analyte NOT DETECTED at or above the reporting limit or MDL, if MDL is specified.
RPD	Relative Percent Difference

ADDITIONAL COMMENTS

For 8260 analyses:

Due to the high water solubility of alcohols and ketones, the calibration criteria for these compounds is <30% RSD. The average % RSD of all compounds in the calibration is 15%, in accordance with EPA methods.

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Certification Summary

TestAmerica Irvine

Method	Matrix	Nelac	California
[CALC]	Water		
EPA 1664A	Water	X	X
EPA 300.0	Water	X	N/A
EPA 351.2	Water		X
EPA 365.3	Water	X	X
EPA 6010B	Water	X	X
EPA 7470A	Water	X	X
EPA 8081A	Water	X	X
EPA 8260B	Water	X	X
SM 2540D	Water	X	X
SM 4500-Cl G	Water		
SM2540C	Water	X	N/A
SM4500-H,B	Water	X	N/A
SM4500-S C, D	Water	X	
SM5210B	Water	X	X

Nevada and NELAP provide analyte specific accreditations. Analyte specific information for TestAmerica may be obtained by contacting the laboratory or visiting our website at www.testamericainc.com

TestAmerica Irvine

Patty Mata
Project Manager

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

CHAIN OF COSTODY FORM

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TAL-0013(1007)

IUG2022

Client Name/Address: Leighton Consulting Inc.

Project/PO Number: 602778-003

Project Manager: Joe Roe

Phone Number: 949-295-8304

Sampler: JROE@leightongroup.com

Fax Number: 949-250-1114

Analysis Required

Sample Description	Sample Matrix	Container Type	# of Cont.	Sampling Date	Sampling Time	Preservatives	1664 Si treated Hexane extra 1664	8081A pesticides	8260 MTBE+OXY + K, LL	BOD SM5210 B	TSS SM2540D TDS SM2540C pH NO3+NO2	Cl Residual SM4500 Cl-G	CAM Metals	TKN 351.2 Phos, P, orth 365.3	Sulfide Total	Special Instructions
MW-1	H_2O	1L Amber	2	21Jul 2011	1009	HCl	✓									
		1L Amber	2		1008			✓								
		40ML VOA	3		0955	HCl			✓							
		1L Poly	1		1020					✓						
		1 500mL Poly	1		0953						✓					
		125mL Poly	1		1012							✓				
		500mL Poly	1		1015	HNO_3							✓			
		500mL Poly	1		1017	H_2SO_4								✓		
MW-1	H_2O	250mL Poly	1	21Jul	1013	NaOH									✓	
																1419 1212

Relinquished By:	Date/Time:	Received By:	Date/Time:	Turnaround Time: (Check)
Joe Roe	1141 21Jul11			same day ___ 72 hours ___
Relinquished By:	Date/Time:	Received By:	Date/Time:	24 hours ___ 5 days ___ 48 hours ___ normal ✓
Relinquished By:	Date/Time:	Received in Lab By: V. Barnell	Date/Time: 7/21/11 11:41	Sample Integrity: (Check) intact ✓ on ice ✓ 10.3

Note: By relinquishing samples to TestAmerica, client agrees to pay for the services requested on this chain of custody form and any additional analyses performed on this project. Payment for services is due within 30 days from the date of invoice. Sample(s) will be disposed of after 30 days.

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

TRANSMITTAL

To:	McWhinney Development 2725 Rocky Mountain Avenue, Suite 200 Loveland, Colorado 80538-8716	Date: September 18, 2012 Project No. 602778-004
Attention:	Mr. Trae Rigby	

Transmitted:		The Following:		For:	
X	Mail/Overnight	____	Draft Report	X	Your Use
____	Courier	X	Final Report	____	As Requested
____	Pick Up	____	Extra Report		
		____	Proposal		
		____	Other		

Subject: Revised Report of Additional Borings and Aquifer Characterization for Proposed Great Wolf Lodge Resort Hotel, City of Garden Grove, California

LEIGHTON CONSULTING, INC.

By: Joe Roe

Distribution: (4) Addressee

REVISED REPORT OF ADDITIONAL BORINGS AND AQUIFER CHARACTERIZATION PROPOSED GREAT WOLF LODGE RESORT HOTEL CITY OF GARDEN GROVE, CALIFORNIA

Prepared for:

MCWHINNEY DEVELOPMENT

2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Project No. 602778-004

May 22, 2012
Revised September 17, 2012

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

May 22, 2012
(Revised September 17, 2012)

Project No. 602778-004

McWhinney Development
2725 Rocky Mountain Avenue, Suite 200
Loveland, Colorado 80538-8716

Attention: Mr. Trae Rigby, Director of Commercial Development

Subject: Revised Report of Additional Borings and Aquifer Characterization Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California

In response to your request and in accordance with our proposal dated March 21, 2012, Leighton Consulting, Inc. (Leighton) is presenting this revised report of additional geotechnical borings and aquifer characterization performed by Foothill Engineering and Dewatering Inc. for the proposed Great Wolf Lodge Resort Hotel project in the City of Garden Grove, California. The intent of this report is to update the existing subsurface data presented in the report entitled "Geotechnical Exploration Report for the Proposed Great Wolf Lodge Resort Hotel, City of Garden Grove", California, dated May 27, 2011. The additional borings were selected by the ground improvement subcontractor in areas occupied by a former mobile home park and northern residential and commercial structures. No laboratory testing or geotechnical analysis was performed as part of this investigation.

Groundwater elevations, recorded on April 26, 2012 from the existing and current wells installed onsite in preparation for the aquifer characterization indicate the level at which groundwater can rise (potentiometric surface) below the site is at approximate elevation 86.2 feet.

Conversely, groundwater elevations measured on July 21, 2011 were recorded at elevation 87.5 feet, which, indicate minor fluctuations should be expected during construction. Historical high groundwater elevations at the site are on the order of elevation 93 feet.

According to the Preliminary Plans for the Great Wolf Lodge and Waterpark Construction, Sheets A0.0, A01.0 and A1.0, GMP Pricing Package, date August 15, 2011, Leighton understands the first floor (FF) of the Mechanical basements is at elevation 88.0 feet. The 9-story T-shaped Hotel Tower consists of a below grade Lobby Core and basement under the east wing. FF elevations of Hotel Tower are proposed at 112.0 feet with the Lobby Core and basement level at FF elevation of 98.0 feet. The Indoor Waterpark is a below grade structure containing mechanical sub-basements with a proposed FF of 98.0 feet with mechanical subbasements at FF elevation 88.0 feet. The FF of the parking structure adjacent to the Lobby Core is at elevation112.0 feet.

Structures constructed between elevations 98.0 to 112.0 feet are not expected to encounter groundwater during construction. The mechanical sub basements are proposed at FF elevation 88.0 feet and should expect to encounter groundwater and/or soft soils at subgrade and footing elevations dependent upon the groundwater elevation at the time of construction. Foundation support improvements consisting of stone columns are planned under the Hotel and Waterpark for mitigation of potential static and earthquake-induced settlement (seismic). Groundwater should be expected to be encountered during stone column installations. Dewatering to provide a stable subgrade will be required during construction of the mechanical sub-basements.

Boring and Cone Penetrometer Test (CPT) locations were chosen by others in order to provide additional subsurface data in previously unexplored locations. The borings and CPT's were completed on April 24 and 26, 2012. Locations are provided on Plate 1 included with this report. All borings and CPT's conducted as parts of past and current explorations are included in Appendix A. The results of the pump test and aquifer characterization provided by Foothill Engineering and Dewatering, Inc., are presented in Appendix B.

We appreciate the opportunity to work with you on this project. If you have any questions, or if we can be of further service, please call us at your convenience, the undersigned can be reached at (949) 681-4263 and (213) 542-1682, respectively.

Respectfully submitted,

LEIGHTON CONSULTING, INC.

Joe Roe

Joe Roe PG CEG 2456
Project Geologist

Vincent P. Ip, PE GE 2522
Senior Principal Engineer

JAR/VPI/lr

Distribution: (4) Addressee

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- 1.2 Purpose and Scope 1
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Figure 1– Site Location Map
Figure 2 – Regional Geology Map
Figure 3 – MW-1-002 Monitoring Well Construction Diagram
Figure 4 – B-10/MW-2-003 Monitoring Well Construction Diagram
Figure 5 – PW-1-001 Pumping Well Construction Diagram

Plate 1 – Revised Boring and Cross Section Location Map
Plate 2 – Revised Geotechnical Cross Sections AA' and BB'

Appendix A – Boring and Cone Penetrometer Test Logs
Appendix B – Dewatering Data and NPDES Permit

1.0 INTRODUCTION

1.1 Site Location and Proposed Development

The project site is rectangular in shape, approximately 11.5 acres in size and bound by Harbor Boulevard to the east, the southern terminus of Leda Lane and commercial development to the north, westerly by an existing mobile home park and southerly by commercial development (Figure 1, Site Location Map). The mobile home park, northern building and residences along Leda Lane have been demolished and removed from the site leaving an uneven surface consisting predominately of sands and gravels. The central portion of the site is mantled by a thin layer of wood chips. Site topography is relatively flat with site elevations ranging from approximately 105 feet mean sea level (msl) in the southern portion to approximately 108 feet msl in the northern portion of the site with local variations in between.

Based on our current understanding, the structures consist of a T-shaped Hotel Tower with below grade elements consisting of a Lobby Core and basement under the east wing. First Floor (FF) elevations of Hotel Tower are proposed at FF 112.0 feet with the Lobby Core and partial basement level at FF elevation of 98.0 feet. The Parking Structure is proposed to be constructed at grade with a FF elevation of 112.0 feet. Several elevator pits are proposed with FF elevations of approximately 94.0 feet. The Indoor Waterpark is a below grade structure with a proposed FF elevation of 98.0 feet and contains mechanical subbasements at FF elevation 88.0 feet.

1.2 Purpose and Scope

Previous geotechnical assessments of the subsurface conditions below the site identified design considerations for the project (Leighton, 2010, 2011a) and the impact of settlement on the proposed underground utilities and new superstructures (Leighton 2011b). The purpose of this current geotechnical exploration was to update the subsurface stratigraphic information of the site to include additional information in unexplored locations occupied by a former mobile home park, northern residences and commercial structures, and to install an additional monitoring well for use during the aquifer characterization performed by Foothill Engineering and Dewatering, Inc.

A brief description of the tasks performed during this geotechnical exploration is as follows:

- Located and marked the boring locations prior to field exploration. Underground Service Alert (USA) was notified to locate the public utilities in the exploration area prior to our field investigation. Boring and Cone Penetrometer Test (CPT) locations were marked in the field based upon input from the design team and foundation contractor.

- Attended a site meeting on April 26, 2012 with the survey team, dewatering contractor, representatives from Turner Construction and the City of Garden Grove to locate the pumping well (PW-1) and hollow stem auger borings (B-9, B-10/MW-2, B-11 and B-12) and Cone Penetrometer Test (CPT) locations (CPT-10, CPT-11, CPT-13 and CPT-14).

- Obtained a drilling and well installation permit from the County of Orange Health Care Agency Regulatory Health Services Environmental Health Department (OCHCA).

- Acquired a flow meter from the City of Garden Grove in order to supply water needed during installation of the pumping well (PW-1).

- Performed a subsurface exploration consisting of drilling, logging, and sampling of five (5) hollow stem auger borings (B-9, B-10, B-11, B-11b and B-12) at the site. The borings were drilled to 81.5 feet below existing grade and initially logged by a representative from our staff. Boring B-11 was terminated at 6.5 feet below ground surface due to concrete reinforced obstructions encountered below grade. Bulk soil and relatively undisturbed samples from the hollow-stem augers were collected at selected depth intervals and transported to our laboratory for storage. No geotechnical laboratory testing was included as part of this report. The boring and CPT locations (B-1 through B-8; CPT-1 through CPT-10) from past explorations (Leighton 2010, 2011a) and the current exploration (B-9, through B-12; CPT-11 through CPT-14) are shown on Plate 1 – Revised Boring and Cross Section Location Map.

- Converted one boring (B-10) to a 2-inch diameter monitoring well (MW-2) upon completion and partial backfill of the boring to 60 feet below grade. Construction details of the existing monitoring well (MW-1) and recently constructed monitoring well (B10/MW-2) are shown on Figures 3 and 4 – Monitoring Well Construction Diagrams.

- Performed a subsurface exploration consisting of advancement of four (4) Cone Penetrometer Test soundings (CPT's) to depths ranging from approximately 84 to 98 feet below existing grade. The CPT exploration locations (CPT-1 through CPT-10) from past explorations (Leighton, 2010, 2011a) and the current investigation (CPT-11, CPT-12, CPT-13 and CPT-14) are shown on Plate 1 – Revised Boring and Cross Section Location Map.

- Foothill Engineering and Dewatering Inc. (Foothill) prior to the pump test installed a 60-foot deep, 12-inch diameter dewatering well (PW-1) consisting of 40-feet of .030 slotted pvc casing with 20-feet of solid pvc piping to ground surface. A 2-inch diameter, 2-hp pump submersible pump capable of 80 gallons per minute discharge was lowered into the casing and connected to the ground surface via a solid 2-inch diameter pvc pipe fitted with check and gate valves to control output and potential backflow into the pump. It is not our scope. Updated the existing geologic cross sections A-A' and B-B' based on our interpretation of the recovered samples from the borings, CPT data and Foothill's drill log for PW-1. Groundwater elevations from recent measurements (April 26, 2012) are shown with respect to the proposed finish floor elevations. Geologic Cross Sections are presented on Plate 2, Revised Geotechnical Cross Sections AA' and BB'.

- Provided a cursory review of the aquifer characterization and pump test data procedures and methods used during the aquifer testing and groundwater analysis data by Foothill Dewatering Inc. Groundwater data, procedures and pretreatment information is included in Appendix B of this report.

1.3 Prior Explorations

As part of our 2010 study, Leighton performed a field exploration consisting of advancement of four hand auger borings (HA-1 through HA-4) to depths of approximately 5 feet to classify the fill and extrapolate the approximate depth across the site. Eight Cone Penetration Test (CPT-1 through CPT-8), extended to approximately 100 feet were advanced to aid in deeper interpretation of the alluvial soils, provide shear wave velocities and plan future boring locations targeting specific sampling depths. On March 21-23, 2012 borings (B-1 through B-8) were drilled to depths ranging from 24.5 to 81.5 feet below grade (2011a). Samples were collected for geotechnical laboratory testing. Additionally, two CPT's (CPT-9 and CPT-10) were extended to approximate 100 foot depths. Locations of the prior explorations (2010, 2011a) are shown along with

Leighton's current explorations on Plate 1, Revised Boring and Cross Section Location Map. Boring logs of current and prior explorations are included in Appendix A. The data obtained from Leighton's prior studies was reviewed and utilized in preparation of this report.

1.4 Current Exploration

Cone Penetrometer Test (CPT) soundings (CPT-11, CPT-12, CPT-13 and CPT-14) were advanced to depths of 84 to 98 feet below current grade. Borings (B-9, B-10, B-11b and B-12) were drilled to 81.5 feet below current grade. Boring B-11 was drilled in several locations within a twenty foot radial distance southeast from the original planned location (see Plate 1). At a depth of approximately 5 feet, at several locations, drilling operations encountered a buried concrete obstruction containing rebar reinforcement. The approximate area of this subsurface obstruction is shown on Plate 1 as it relates to the original planned location of B-11. It should be noted that this boundary is approximate and could relate to buried concrete rubble or a concrete remnant of previous foundations. Borings were originally logged by a representative from our staff. Sampling was generally conducted at 5-foot intervals except where noted on the boring logs (Appendix A). Based on review of current and prior CPT data (Appendix A) prior to and during the current investigation, specific depths were targeted to obtain discrete samples of subsurface soil to confirm our interpretations. Field testing consisted of performing the Standard Penetration Test (SPT) in accordance with ASTM1 Standards D1586 and D3550. The samplers were driven with successive drops of a 140-pound automatic hammer free-falling 30 inches. The number of blows required to advance the samplers 18-inches are indicated on the boring logs at 6-inch intervals (Appendix A). In addition, representative bulk samples of the subsurface soils were collected from the borings. No laboratory testing was performed as part of the current exploration.

Each collected sample was reviewed and described in general conformance with the Unified Soil Classification System (USCS). The descriptions were entered on the boring logs, which are included in Appendix A of this report. All samples were sealed and packaged for transportation to our laboratory. During drilling, the borings were measured for depth to groundwater and then backfilled using soil cuttings excavated during the drilling operations and bentonite grout upon completion of the drilling operation. Excess soil was spread onsite.

[1] ASTM : American Society of Testing and Materials currently known as ASTM International

2.0 SITE GEOLOGY AND SUBSURFACE CONDITIONS

2.1 Site Geology

The subject site is located in the Downey Plain within the southeastern margin of the Los Angeles Basin, a large structural depression within the Peninsular Ranges geomorphic province of California. In general, the Downey Plain is bordered by the Coyote and Peralta Hills on the north, the Santa Ana Mountains and Tustin Plain to the east, the Pacific Ocean to the south and Los Angeles Coastal Plain to the west. Several broadly warped coastal mesas represent uplifted areas along the active Newport-Inglewood structural fault zone. These mesas are separated by erosional gaps which were created by historic routes of the Santa Ana River.

The site lies near the lower reaches of the Santa Ana River and associated floodplain (Figure 2, Regional Geology Map). The surface distribution of Holocene sediments, as recorded in early editions of regional soil survey maps (Eckmann and others, 1919) suggests that the Santa Ana River has recently wandered back and forth across the Downey Plain from Alamitos Bay to Newport Bay. Historical accounts, documents and results of our study further support the process of widespread sheet flooding and marine transgression as being the dominant depositional process associated with the Santa Ana River floodplain.

Generally, the near-surface Quaternary age young alluvial soils range in depths from 4 to 70 feet below grade and are characterized as thinly bedded to massive, loose to medium dense, silty fine grained sands with varying proportions of silt and clay capping the site to thinly bedded, to massive, soft to stiff, laminated silt and clay with occasional thin beds of predominately fine grained sands. A transition to Marine sediments, characterized by the dominantly grey, clayey paleosol and presence of seashells was encountered at approximately 17 to 21 feet below grade. Below a depth ranging from approximately 65 to 75 feet below grade older alluvial fan sediments representing an erosional boundary were encountered which, consisted of dense, fine to coarse grained gravelly sands with thin beds of well indurated, hard silts and clays (Plate 2).

2.2 Geologic Units of the Subsurface Soil

Presented below are brief descriptions of the geologic units at the site. Based on interpretation of the borings and CPT sounding data, the generalized stratigraphy

Leighton

of the subsurface soils at the site is presented on Plate 2, Revised Geotechnical Cross Section AA' and BB'. Boring and CPT locations are presented on Plate 1.

Artificial Fill, Undocumented: Map Symbol (Afu): The majority of the site is mantled with an uneven surface consisting predominately of sands and gravels. The central portion of the site is mantled with a thin layer of wood chips capping sandy-silty fill soils. Based on material encountered in our boring B-11 a concrete reinforced obstruction was present over a small area at a depth of five feet (Plate 1). Fill is expected to range in depths of up to five feet. However, deeper fill may be present at the site between the borings. The onsite artificial fill generally consists of stiff consistency sandy silts to medium dense silty sands with varying proportions of crushed aggregate gravels

Quaternary Young Alluvial Fan: Map Symbol (Qyf): The native soils at the site consist of young, Quaternary age (<1.8 million years old), unconsolidated alluvial fan sediments deposited over a broad gently sloping alluvial plain. Based on the material encountered in the borings and interpreted from CPT soundings the site (Plate 2), is mantled with a relatively continuous layer of massive, silty, fine grained sand with occasional gravel overlying laminated to thinly bedded, soft to medium stiff, moist to wet marine sandy clays and silts with interbedded loose to medium dense, wet sandy soils varying from cohesionless sands with fine gravels to silty, clayey sands.

Quaternary Old Alluvial Fan: Map Symbol (Qof): Underlying the younger alluvial soils at depths ranging from 65 to 70 feet below grade (Plate 2) are dense, fine to coarse grained gravelly sands with thin beds of well indurated, hard silts and clays.

Geologic Structure: Geologic structure of the alluvial materials is interpreted to be generally massive (Plate 2). However, based upon our investigations and the depositional environment typical of floodplains and marine transgression that cross-stratification (channel trough cross-stratification or transverse bar-tabular cross-stratification), paleo channels and planar erosional surfaces exists at depth. Relevance of these sedimentary features include local impermeable zones with the potential for perched groundwater development on top of less permeable clayey strata to zones of higher permeability (sand lenses) which can readily transmit water.

2.3 Groundwater

Groundwater was encountered and measured to approximately 22 to 26 feet below ground surface during drilling at boring locations B-9, B-10, B-11b and B-12 corresponding to elevations 78 to 83 feet. On April 26, 2012 groundwater elevations were measured in the pumping well (PW-1) installed by Foothill and in monitoring wells MW-1 and MW-2. The following table lists the current groundwater data based upon the readings from the wells recorded on April 26, 2012 and the depth to groundwater encountered during the drilling process in the borings conducted on April 24 and 26, 2012. Elevations of ground surface and top of casing were provided by others, therefore groundwater elevations should be considered approximate.

Table 1: Groundwater Elevations in Borings and Wells

Boring and Wells	Surface Elevation (ft.)	Total Depth of Boring and Well (ft.)	Depth to Groundwater (ft.)	Groundwater Elevation (ft.)
B-9	105.0	81.5	22.0	83.0
B-10	108.0	81.5	25.0	83.0
B-11b	108.0	81.5	30.0	78.0
B-12	108.0	81.5	26.0	82.0
MW-1	107.0	40.0	21.2	85.8
MW-1*	107.0	60.0	19.5	87.5
B-10/MW-2	108.7	60.0	31.8	76.9
PW-1	105.8	60.0	24.2	81.6

*Measured on July 21, 2011 (Leighton, 2011c)

Depth to groundwater varies across the site due to the confining nature of the clayey sediments below the site. At boring B-11b, depth to groundwater encountered during the drilling process was on the order of 30 feet below ground surface corresponding to an approximate elevation of 78.0 feet. The sediments encountered between 22 to 30 feet below grade at this location consist of lower permeability organic silts and clays. Groundwater within these less permeable materials will slowly transmit water to areas of higher permeability. It should also be noted that at boring location B-9, groundwater was encountered at 22.0 feet below grade during drilling and rose 1.2 feet over a period of ten minutes indicating the groundwater below the site is under slight hydraulic pressure. This condition is likely best represented by the potentiometric surface (groundwater elevation) noted in MW-1 above (Leighton, 2011c). Fluctuations should be expected during and after significant rainfall events or as local pumping practices, if any, continue.

Depth to groundwater is shown on Plate 2 – Revised Geotechnical Cross Sections A-A’ and B-B’.

2.4 Aquifer Characterization and Pumping Test

It is our understanding that the excavation methods being considered for construction of the below grade elements is to drive sheet piles to design depths then dewater from outside the excavation to lower groundwater to a suitable level to provide a safe working environment, additionally, we understand soldier beams and lagging are also being considered, however, no shoring plans have yet been provided for our review. Our current borings at the site encountered groundwater at elevations ranging from approximately 78 to 85.8 feet. Controlling subsurface water isa critical factor in the construction of the Mechanical sub-basements as neither excavation nor construction can be safely carried out with the presence of excessive subsurface water.

The constant rate pumping tests were conducted by Foothill Engineering and Dewatering Inc. (Foothill) parallel with our current subsurface exploration for the proposed Great Wolf Lodge Resort Hotel project. The primary purpose of the aquifer test was to estimate the hydraulic properties of the underlying aquifer to aid Foothill in the design of a dewatering system to lower the phreatic surface during construction.

The numbering system 001, 002 and 003, assigned to each data logger by Foothill and its corresponding Leighton counterpart is as follows: 001, corresponds to PW-1; 002 – corresponds to MW-1; and, 003 – corresponds to B-10/MW-2. Static groundwater levels were recorded in the wells prior to initiating the pump test and were as follows: PW-1-001 at 25.4 feet bgs; MW-1-002 at 21.3 feet bgs; B-10/MW-2-003 at 30.5 feet bgs. Groundwater pump test data and procedures conducted by Foothill for the pump test are included in Appendix B. The schematic well diagrams of the as-built configurations of the wells are shown on Figures 3, 4 and 5- Pumping and Monitoring Well Construction Diagrams.

According to Foothill pumping began from PW-1-001 on April 30, 2012 at 0815 hours under average constant rate of 8.0 gallons per minute (gpm) for 2736 minutes until the pump was shut down on May 2, 2012 at 06:15 hours generating approximately 21,888 gallons of discharge. The test was conducted in three well groups (PW-1-001, MW-1-002 and B-10/MW-2-003 – see Plate 1) spaced at 50 foot intervals and fitted with transducers (data loggers) set at 30 second recording intervals during the pump test to measure and record the drawdown over the pumping interval. Manual readings were also taken at 1-hour intervals for the first four hours then at 3-hour intervals for the remaining duration as indicated by Foothill data (Appendix B). Well recovery was not recorded. Based on the output graphs (Appendix B) it appears the data loggers did not start recording until approximately 330 minutes into the pump test. Pumping and monitoring well locations are shown on Plate 1 with this report. The pump test results and graphical representations of drawdown provided by Foothill are included in Appendix B.

An average discharge rate of 8-gpm was generated for the duration of the constant rate drawdown pump test using a submersible pump capable of up to 80-gpm discharge. Based on drawdown data provided by the manual readings beginning at 85 minutes into the test the pumping well (PW-1-001) recorded 15.1 feet with a total of 23.4 feet of drawdown over the testing interval. Monitoring well B-10/MW-1-002 recorded 0.4 feet of drawdown over the entire interval suggesting the well is positioned within the semi-confined, low permeability clayey alluvium below the site transmitting groundwater slowly over time. Monitoring well MW-2-003 recorded 6.3 feet of drawdown in the first 85 minutes with a total of 8.9 feet of drawdown over the testing interval suggesting the sandy layers encountered within PW-1-001 and MW-2-03 are hydraulically connected. The following table lists the static groundwater levels measured from the ground surface and drawdown measured in feet with approximated corresponding ground surface elevations determined from survey staking provided by others.

Table 2: Static Groundwater-Drawdown and Elevations

Wells	Depth of Well (ft.)	Surface Elevation (ft.)	Static Groundwater Elevation (ft.)	Total Drawdown (ft.)	Drawdown Elevation (ft.)
MW-1-002	40.0	107.0	21.3	.4	85.3
MW-2-003	60.0	108.7	30.5	8.9	69.3
PW-1-001	60.0	105.8	25.4	23.4	57.0

Groundwater removed during the test period was discharged to a Pure Effect holding tank, pumped though primary bag filters then through several activated carbon tanks before discharging to the local sewer in accordance with the terms and conditions of the Discharge Authorization and Monitoring and Reporting Program No. R8-2009-0003-042 under General Permit No. R8-2009-0003, NPDES No. CAG998001 as approved by the Regional Water Quality Control Board (RWQCB) for the Santa Ana Region. National Pollutant Discharge Elimination System (NPDES) permits are included for reference in Appendix B of this report.

2.5 Concluding Remarks

Prior to the pump test, measured groundwater depths ranged from approximately 21.2 feet to 31.8 feet below ground surface (76.9 to 85.8 feet elevation) across the site. Relatively impermeable clay and permeable sands and gravels allow groundwater to be partially connected owing to the dis-continuous to semi-continuous nature of the sediments which comprise the alluvial aquifer below the site. The alluvial aquifer system is considered to be semi-confined and subject to components of atmospheric pressure and horizontal and vertical flow within the aquifer.

Based on the greatest drawdown achieved in MW-2-003 of 8.9 feet, a 12-inch diameter dewatering well 60 feet deep will yield more than 8-gpm and produce greater than a 100-foot diameter drawdown cone of depression to a maximum depth of approximately 23.4 feet (not considering casing storage).

Analyses of the early drawdown data from the manual readings (B-10/MW-2-003) indicate the greatest drawdown recorded (6.3 feet) occurs within the first 85 minutes slowing to an average of approximately 0.15 feet per hour. Data from the pumping well (PW-1-001) and monitoring well MW-1-002 are unreliable due to turbulence in the pumping well and confinement of MW-1-002 in low permeable clays. Based on what we feel is the most reliable data recorded from B-10/MW-2-002 indicate that during the spread of the cone of depression in the sediments, higher permeability sands initially transmitted groundwater to the wells where at approximately 85 minutes the cone spread into finer grained sediments that have a lower transmissivity value thereby reducing the amount of drawdown that can be achieved overtime to approximately 0.15 feet per hour or less.

Transmissivity was calculated using the solution method by Cooper and Jacob (1946) as shown below:

Transmissivity was calculated from the pumping rate (8 gpm), the slope of the time-drawdown graph and the following equation: **T = 264Q/Δs**

T = coefficient of transmissivity, in gpd/ft;
Q = pumping rate in gpm; and
Δs = slope of the time drawdown graph over the period of one log cycle.

Hydraulic conductivity was calculated using the value of transmissivity and aquifer thickness and the following equation: **K=T/b**

T = calculated transmissivity value; and
b = saturated thickness of the aquifer.

The thickness of the aquifer was assumed to be the static water column height in the pumping well (PW-1-001) as 34.6 feet. The calculated hydraulic values conducted by Leighton and provided by Foothill for monitoring well B-10/MW-2-002 are summarized in the following table.

Table 3: Hydraulic Conductivities and Transmissivity

Monitoring Well ID	Transmissivity (gpd/ft)	Hydraulic Conductivity (gpd/ft^2)	Pumping Rate (gpm)
B-10/MW-2-003	960	27.7	8.0
B-10/MW-2-003*	1069	30.8	8.0

*Data supplied by Foothill Engineering and Dewatering Inc.

Transmissivity and hydraulic conductivity of the semi-confined aquifer range from approximately 960-1069 gallons per day/foot (gpd/ft) and 27.7 to 30.8 gallons per day/foot^2 (gpd/ft^2), respectively. The semi-confined aquifer has a low yield with hydraulic values within the range of published values for clay and fine sand mixtures (Driscoll, 1995). The range of transmissivity and hydraulic conductivity should not be considered out of the ordinary for these types of aquifer testing and can be explained by numerous influencing factors, such as aquifer heterogeneity, delayed drainage effects, partial penetration of the wells, well efficiency, components of vertical and horizontal flow, and other pumping wells operating during testing. The average values of transmissivity and hydraulic conductivity are approximately 1,014 gpd/ft and 29.2 gpd/ft^2, respectively.

2.6 Construction Considerations

The amount of groundwater to be removed during construction will depend on many factors but primarily on 1) the hydrogeologic characteristics of the aquifer; 2) the depth of groundwater to be lowered; and 3) the size of the excavation. As stated previously, results of the pumping test suggest that the aquifer underneath the site is considered a low yield aquifer. It is anticipated, based upon Foothill's dewatering recommendations (Appendix B) consisting of an estimated number of 9 to 10 wells, installed at 140 feet on center with a projected combined flow rate of 80 to 100–gpm will yield approximately 115,200 to 144,000 gallons per day during construction of the below grade structures within the zone of influence of groundwater. To allow construction of the mechanical sub-basements and to provide stable working subgrade, it is recommended that the groundwater be lowered to about three feet for sandy subgrade and five feet for clay below the excavation bottom.

Based upon the current, highest recorded groundwater levels below the site (El. 85.8 feet) groundwater drawdown during construction is on the order of several feet. With adequate penetration, the conceptually proposed sheetpile excavation method will provide relatively impervious sidewalls along the excavation (cofferdam). It is anticipated that the dewatering effort required for the cofferdam system would be significantly less than dewatering from outside the excavation. The cofferdam can effectively reduce the amount of daily discharge mentioned above. Groundwater entering the excavation could be managed by using localized dewatering points inside the cofferdam. Alternatively, based upon current groundwater elevations with respect to first floor elevations of the subbasements, a soldier beam and lagging method, if used during construction, should expect wet soils at subgrade elevations with the potential for seepage behind the lagging into the excavation should groundwater elevations rise above the subgrade elevation during construction efforts, however, at the time of this revision, no shoring plans have been provided for our review to confirm the shoring methods being considered.

The most significant impact of dewatering on the surrounding environments will be the potential for ground subsidence. Ground subsidence may cause damage to roadways, existing underground utilities, and other improvements within the zone of influence of dewatering. Prior to the start of dewatering activities, survey of the site and its vicinity should be performed to document its conditions. The site conditions should also be monitored during the course of construction. All water encountered during construction must be disposed in such a manner that will not damage public or private property or create a nuisance for health and in compliance with the requirements of the governing agencies. It should be noted that the design, implementation, inspection, monitoring and maintenance of the dewatering and treatment system shall be in full compliance with applicable Federal, State, and local laws and regulations that govern water quality.

Our opinion above is solely based on the data and recommendations provided by Foothill Engineering and Dewatering Inc., included in Appendix B. Foothill should be allowed to review our data and provide comment as applicable. It is still the sole responsibility of the dewatering contractor to install, maintain and operate a dewatering system at the site.

2.7 Final Design and Construction Support

Because of the complex nature of this project, it is recommended that Leighton be retained to provide support during development of the final plans and specifications. Leighton should review the precise grading, shoring and foundation plans and specifications, when available, to comment on the geotechnical aspects. Our recommendations provided in the referenced reports for the project should be revised, as necessary, based on future plans and incorporated into the final design plans and specifications.

Our conclusions and recommendations presented in the referenced reports for the project should be reviewed and verified by Leighton during site construction and revised accordingly, if exposed geotechnical conditions vary from our findings and interpretations.

Geotechnical observation and testing are recommended to be performed during the following activities:

- Excavation of site during subgrade preparation;
- Shoring Installation;

- Ground improvement installation;
- Compaction of all fill materials;
- Excavation of foundations;
- After excavation of all slabs and footings and prior to placement of steel or concrete to confirm the slabs and footings are founded in suitable bearing soils;
- Utility trench backfilling and compaction; and
- Pavement subgrade preparation and base course placement.

When conditions are encountered during construction that are not consistent with the conditions described herein.

3.0 REFERENCES

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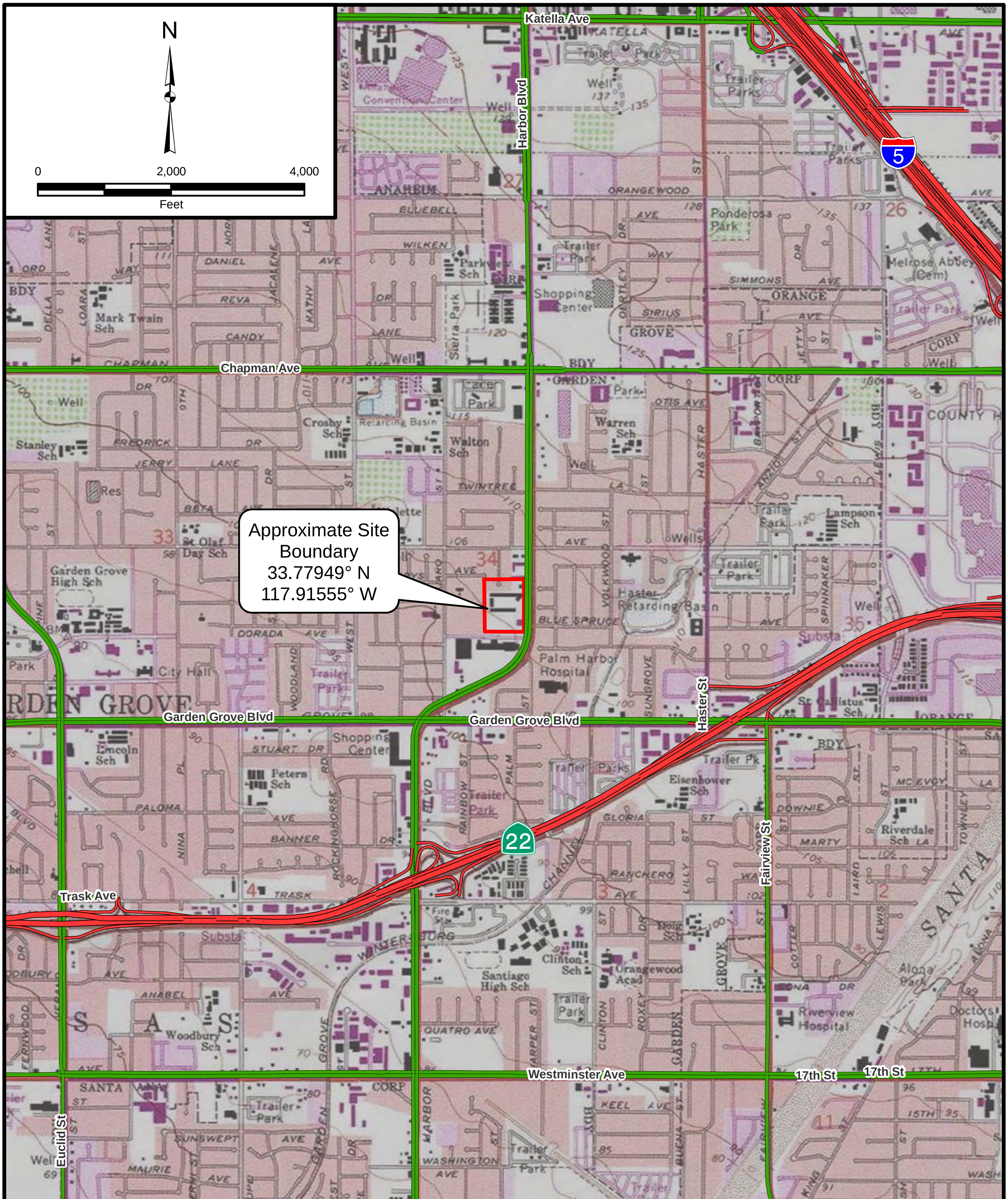
_____, 2011a, Preliminary Geotechnical Exploration Report for the Proposed Great Wolf Lodge Resort Hotel, City of Garden Grove, California, Project No. 602778-002, dated May 27, 2011.

_____, 2011b, Addendum 1 to Preliminary Geotechnical Exploration Report for the Proposed Great Wolf Lodge Resort Hotel, City of Garden Grove, California, Project No. 602788-003, dated June 23, 2011.

_____, 2011c, Groundwater Sampling and Laboratory Analysis Results for National Pollutant Discharge Elimination System (NPDES) for the Great Wolf Lodge Resort Hotel, City of Garden Grove, California, dated August 8, 2011.

_____, 2012, Revised Cost Estimate for Additional Borings and Aquifer Characterization for Proposed Great Wolf Lodge Resort Hotel, City of Garden Grove, California, dated December 1, 2011, revised date March 21, 2012



Project:602778-004	Eng/Geol: VPI/JAR
Scale: 1 " = 2,000 '	Date: May, 2012

Base Map: ESRI Resource Center, 2010
Thematic Info:USGS, 2006, Geologic map of the San Bernardino and Santa Ana 30'x60' quadrangles, California, Version 1.0
Open File Report 2006-1217 Map Legend
Author: (mmurphy)

SITE LOCATION MAP

McWhinney Development
Garden Grove, California

Figure 1

Leighton

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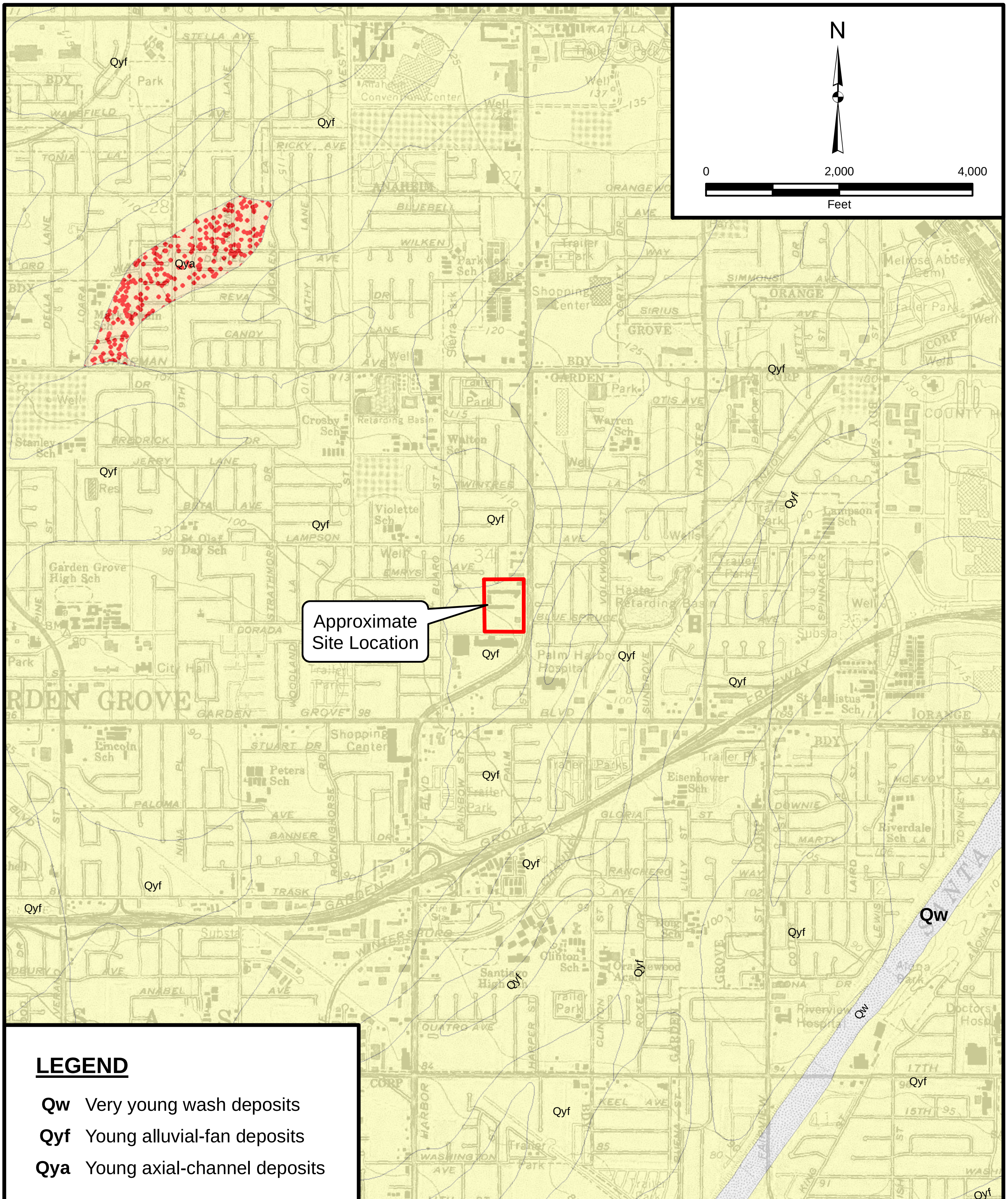

LEGEND

Qw Very young wash deposits

Qyf Young alluvial-fan deposits

Qya Young axial-channel deposits

Project:602778-004	Eng/Geol: VPI/JAR	REGIONAL GEOLOGY MAP	Figure 2
Scale: 1 " = 2,000 '	Date: May, 2012	McWhinney Development Garden Grove, California	Leighton

Base Map: ESRI Resource Center, 2010
Thematic Info:USGS, 2006, Geologic map of the San Bernardino and Santa Ana 30'x60' quadrangles, California, Version 1.0
Open File Report 2006-1217 Map Legend
Author: (mmurphy)

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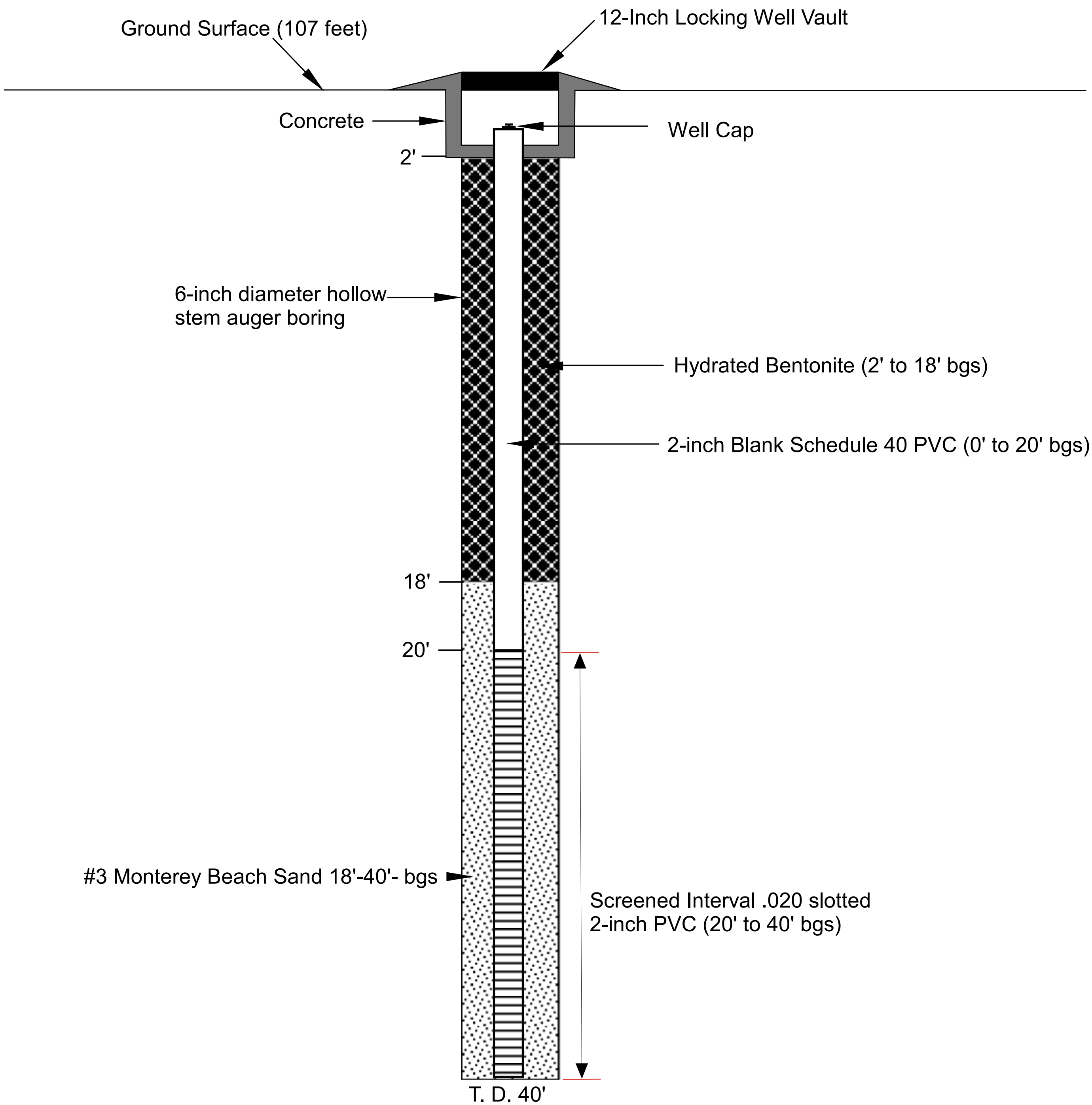
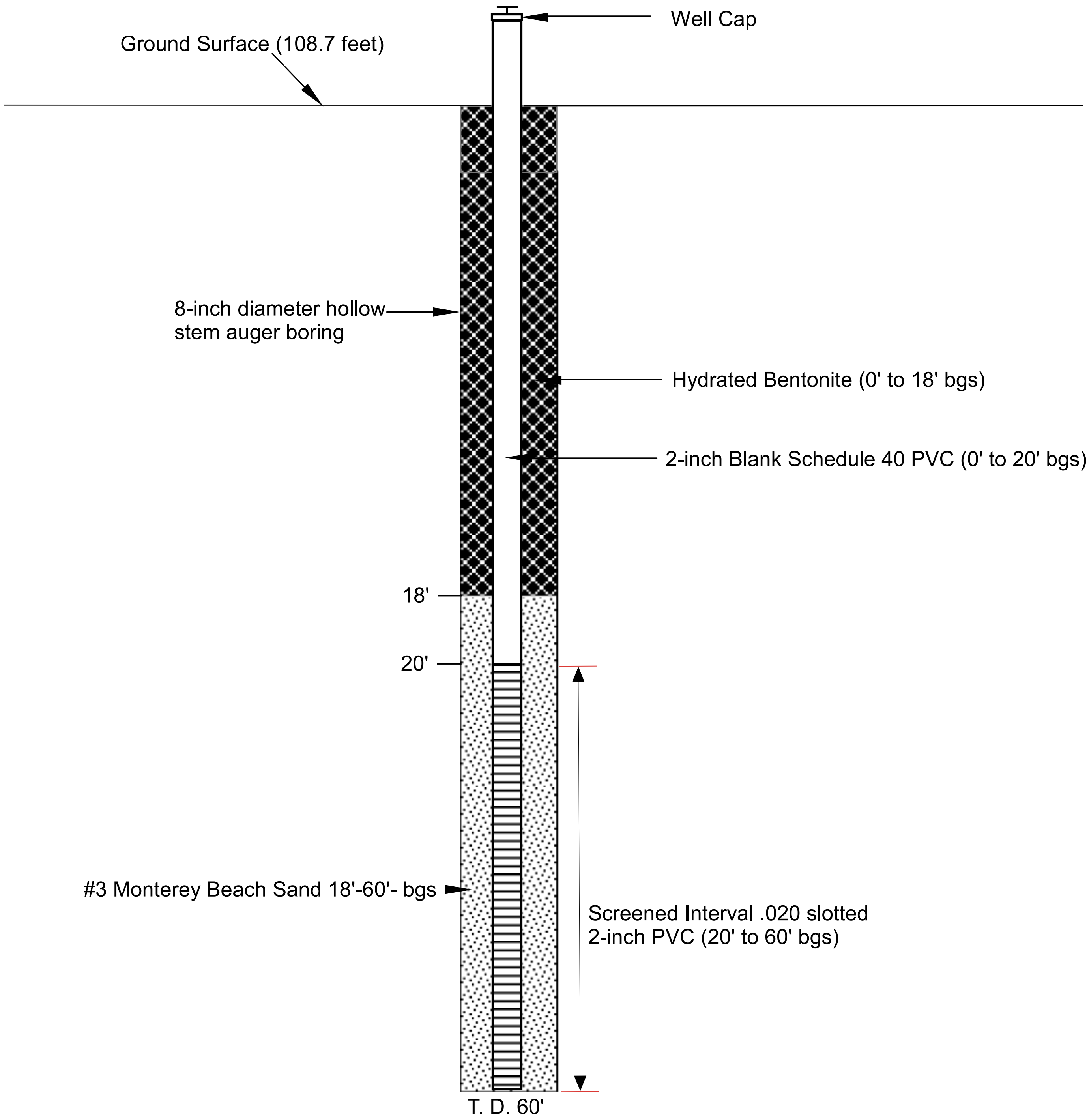
Monitoring Well MW-1-002



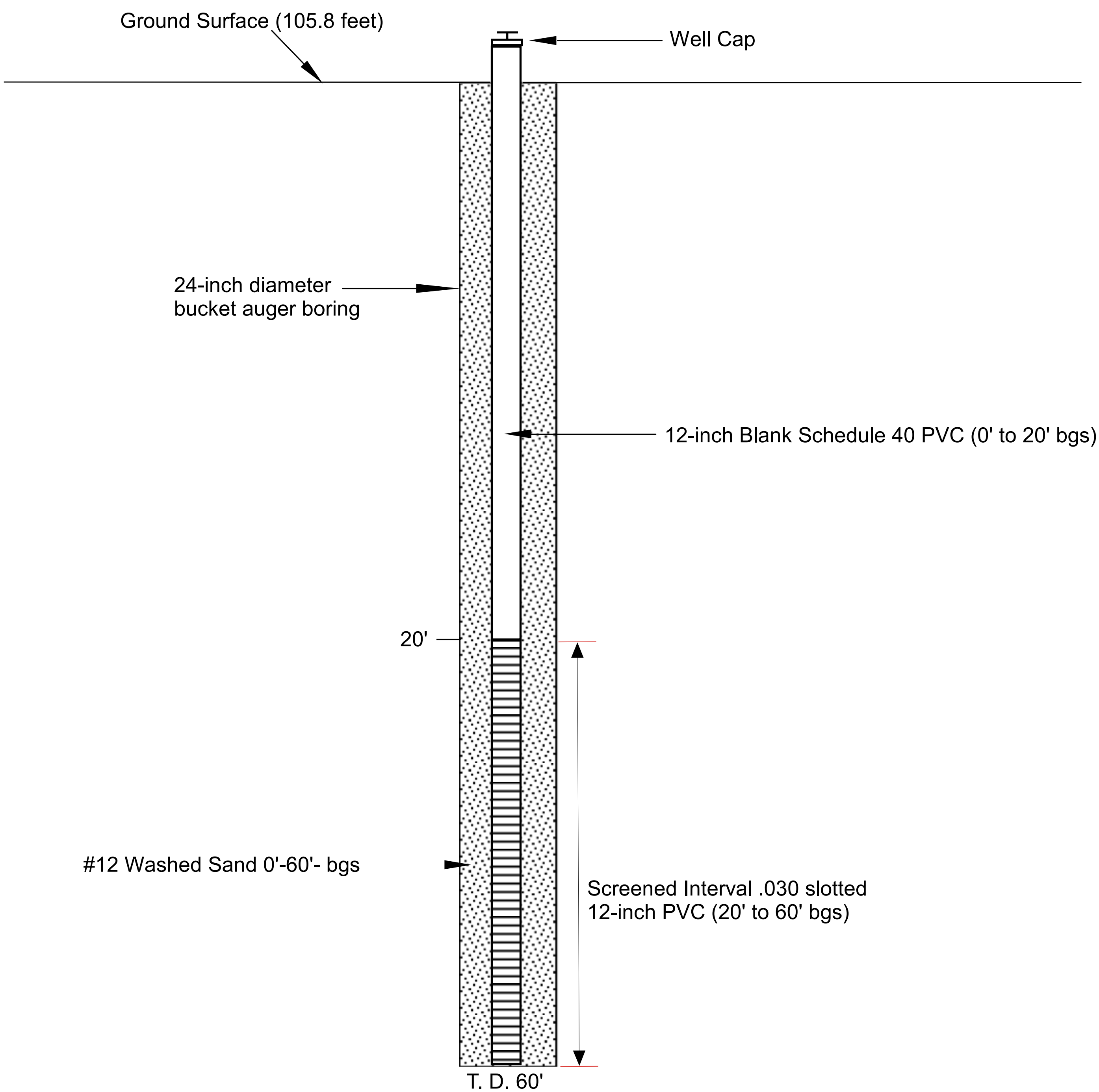
Monitoring Well MW-1-002 Construction Diagram, Garden Grove, California	Leighton Consulting, Inc.	**Well Diagram** **As Shown** **May 2012** **Figure 3**

Monitoring Well B-10/MW-2-003



Monitoring Well B-10/MW-2-003 Construction Diagram, Garden Grove, California	Leighton Consulting, Inc.	**Well Diagram** **As Shown** **May 2012** **Figure 4**

Pumping Well PW-1-001



See Appendix B for Detailed Schematic of Pumping Well Installation provided by Foothill

Pumping Well PW-1-001 Construction Diagram, Garden Grove, California	Leighton Consulting, Inc.	**Well Diagram**
		As Shown
		May 2012
		Figure 5

APPENDIX A

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM	@0': **Artificial fill (Afu) undocumented** Silty SAND, brown, slightly moist, fine to coarse grained sand, some fine gravels	
105									**Quaternary young alluvial fan (Qyf)** @3': SAND, light grey brown, slightly moist, soft, fine sand, micaceous	
	5			R-1	3 4 5			SP		
100										
	10			R-2	3 8 9			SM	@10': Silty SAND, grey brown, moist, medium dense, fine-grained with a trace of coarse-grained sand	
95										
	15			R-3	2 6 6			SP	@15': SAND, light brown, moist, medium dense, fine-grained sand	
90										
	20			R-4	4 4 5			SP	@20': SAND, light grey, slightly moist, loose, fine-grained with a trace of coarse-grained sand, abrupt contact with below	
								CL	@21': CLAY, dark grey, very moist, soft, paleosol, marine clay	
				R-5	2 4 6			CL	@22': CLAY, grey, moist, soft	
85										
▽	25			R-6	2 5 12			SM	@25': Silty SAND, medium grey, very moist, medium dense, fine-grained sand, micaceous, groundwater encountered during drilling	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	30			R-7	5 6 11			ML	@30': Sandy SILT, grey, moist, stiff, fine-grained sand, micaceous	
75										
	35			R-8	2 5 9			SM	@35': Silty SAND, grey, very moist, medium dense, fine-grained sand, micaceous, few carbonate nodules	
70										
	40			R-9	3 4 4			SM	@40': Silty SAND, grey brown, very moist, loose, fine-grained sand, micaceous, abrupt contact with below	
								CL	@41': CLAY, grey brown, very moist, soft, few carbonate nodules, paleosol	
65										
	45			R-10	2 3 6			CL	@45': Sandy CLAY, grey, wet, stiff, fine to medium-grained sand, micaceous	
60										
	50			R-11	2 3 8			CL	@50': Silty CLAY, grey, wet, stiff, traces of fine-grained sand, few carbonate nodules, micaceous, paleosol	
55										
	55			R-12	2 4 6			SP	@55: SAND, grey, wet, medium dense, fine to medium grained sand, micaceous, abrupt contact with below	
								CL	@56': CLAY, grey, very moist, stiff	
50										
	60									

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

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

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

GEOTECHNICAL BORING LOG B-10/MW-2

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			R-13	3 6 14			CL SP	@56': CLAY, grey, very moist, stiff @60': CLAY, grey brown, moist, very stiff @61': SAND, grey brown, very moist, medium dense, fine-grained sand, some oxidation staining	
45										
	65			R-14	6 19 24			SP	**Quaternary old alluvial fan (Qof)** @65': SAND, grey, very moist, dense, micaceous, traces of very fine sand	
40										
	70			R-15	5 8 13			ML	@70': SILT, grey brown, moist, stiff, micaceous, traces of fine-grained sand	
35										
	75			R-16	9 31 50/4"			SP	@75': SAND, light brown, very moist, very dense, medium to very coarse-grained sand	
30										
	80			R-17	4 8 14			SM ML	@80': Silty SAND, grey brown, wet, medium dense, very fine-grained sand, micaceous @81': SILT, grey brown, wet, stiff, micaceous	
25									Total depth: 81.5 feet. Groundwater encountered at 25 feet during drilling. Boring converted to monitoring well (B-10/MW-2-003) upon completion of drilling. Installed 2-inch diameter well casing to 60 ft. 40 ft. of slotted .020 casing. 20 ft. of solid 2-inch casing to surface. See Figure 4 - Monitoring Well Construction Diagram for details.	
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-11

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				GC	@0': **Artificial fill (Afu) undocumented** Sandy GRAVEL with clay, dark brown, moist, fine to coarse grained sand, fine to coarse grained gravel, wood chips at surface	
105										
	5			R-1	5 6 8			SM	@5': Silty SAND, brown, moist, fine to coarse grained sand, trace of fine to coarse grained gravel. Concrete rebar encountered @6.5'. Boring offset 60 feet southeast, resumed as B-11b.	
									Total depth: 6.5 feet. No groundwater encountered. Boring backfilled with soil cuttings upon completion of drilling.	
100										
	10									
95										
	15									
90										
	20									
85										
	25									
80										
	30									

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

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

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GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0			B-1				GM-GC	@0': **Artificial fill (Afu) undocumented** Sandy GRAVEL with silt and clay, brown to grey brown, moist, fine to coarse sand, fine to coarse crushed aggregate	
105										
	5									
				R-1	8 10 15			SP	**Quaternary young alluvial fan (Qyf)** @7': SAND, olive brown, moist, medium dense, fine to medium grained	
100										
	10			R-2	5 6 8			SP	@10': SAND, light olive grey, moist, medium dense, grades from coarse in upper half of sample to fine grained in lower half.	
95										
	15			R-3	6 11 15			CL	@15': Silty Sandy CLAY, dark olive brown, moist, very stiff, fine grained sand, transitions to silty sand	
								SM	@16': Silty SAND, dark brown, moist, fine grained	
90										
	20			R-4	2 2 2			CL	@20': CLAY, dark brown, moist, soft, trace of oxidation, paleosol	
				R-5	3 3 5			MH	@22': Organic SILT, dark grey, moist, some clay content, trace of organics/rootlets, marine silt	
85										
	25			R-6	3 5 11			CH	@25': Fat CLAY, dark grey, moist, trace of organics/rootlets, paleosol, moderate development of blocky soil structure	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	30			R-7	6 10 11			ML	@30': Clayey SILT, dark grey, very moist, stiff, micaceous, shells, groundwater encountered @30.0 feet during drilling	
75										
	35			R-8	6 12 11			ML	@35': Sandy SILT, dark olive, very moist, stiff, fine grained sand, shells	
70										
	40			R-9	2 3 4			SM	@40': Silty SAND, dark olive, wet, loose fine grained sand	
65										
	45			R-10	3 4 8			SM	@45': Silty SAND, dark olive, wet, loose, fine grained sand	
60										
	50			R-11	2 4 17			ML	@50': Sandy SILT, dark olive green, wet, stiff, fine grained sand	
55										
	55			R-12	3 6 10			CL	@55': CLAY, dark olive brown, moist, stiff	
50										
	60									

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

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

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GEOTECHNICAL BORING LOG B-11b

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION *This Soil Description applies only to a location of the exploration at the time of sampling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.*	Type of Tests
	60			R-13	8 7 11			SM	@60': Silty SAND, olive grey, very moist, medium dense, fine grained, micaceous	
								CL	@61': CLAY, dark olive green, moist, stiff	
45										
	65			R-14	13 14 15			SM	@65': Silty SAND, olive green, very moist, medium dense, fine grained, interbedded layers of clay	
40										
	70			R-15	17 21 27			SP-SM	**Quaternary old alluvial fan (Qof)** @70': SAND with silt, olive green, wet, dense, fine to coarse grained	
35										
	75			R-16	20 28 30			SP(g)	@75': Gravelly SAND, olive green, very moist, dense, fine to coarse grained sand, fine to coarse grained gravel	
30										
	80			R-17	10 14 30			ML	@80': SILT, dark olive, very moist, transitions to sand, olive green, wet, fine to coarse grained	
25									Total depth: 81.5 feet. Groundwater encountered at 30.0 feet during drilling. Backfilled with soil cuttings mixed with bentonite grout upon completion of drilling.	
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM	@0': **Artificial fill (Afu) undocumented** Silty SAND, light brown, slightly moist, fine to coarse-grained sand	
105									**Quaternary young alluvial fan (Qyf)** @2': SAND, light grey brown, slightly moist, medium dense, fine to medium-grained sand, micaceous	
	5			R-1	3 5 8			SP		
100										
	10			R-2	3 6 8			SP-SM	@10': SAND to Silty SAND, grey brown, moist, meduim dense, fine to medium-grained sand, micaceous	
95										
	15			R-3	7 14 19			SP	@15': SAND, light brown, slightly moist, dense, fine to medium-grained sand, micaceous	
90										
	20			R-4	5 13 7			SP(g)	@20': Gravelly SAND, light brown, slightly moist, medium dense, fine to coarse-grained sand, some fine to coarse-grained rounded gravels	
85				R-5	2 3 6			CL	@22': CLAY, grey, moist, soft, micaceous, paleosol, marine clay	
	25			R-6	2 5 13			ML	@25': SILT, grey brown, moist, soft, micaceous	
								SP	@26': SAND, grey brown, moist, medium dense, fine-grained sand, groundwater encountered during drilling	
80										
	30									

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	30			R-7	5 8 23			SP	@26': SAND, grey brown, moist, medium dense, fine-grained sand, groundwater encountered during drilling @30': SAND, grey brown, very moist to wet, dense, fine to medium-grained sand, micaceous	
75										
	35			R-8	5 8 10			SP	@35': SAND, grey brown, wet, medium dense, fine to medium-grained sand, micaceous	
70										
	40			R-9	3 5 11			SP	@40': SAND, grey brown, wet, medium dense, fine to medium-grained sand, micaceous	
65										
	45			R-10	5 5 9			CL	@45': CLAY, grey brown, very moist, stiff, abrupt contact with below	
								SM	@46': Silty SAND, grey brown, very moist, medium dense, fine to medium-grained sand	
60										
	50			R-11	3 6 11			SM	@50': Silty SAND, grey brown, wet, medium dense, fine-grained sand	
55										
	55			R-12	3 5 9			CL-ML	@55': Silty CLAY to Clayey SILT, grey, very moist to wet, stiff, micaceous	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-12

Project No.	602778-004	**Date Drilled**	4-24-12
Project	McWhinney Development	**Logged By**	JMP
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	108'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JMP

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N–S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	60			R-13	4 9 10			ML	@60': SILT, grey brown, moist, stiff, micaceous	
								CL	@61': CLAY, grey brown, moist, stiff, micaceous	
45										
	65			R-14	4 8 12			ML	@65': SILT, blue grey, moist, very stiff, micaceous	
40										
	70			R-15	5 9 10			SM	@70': Silty SAND, grey brown, very moist, medium dense, fine to medium-grained sand	
35										
	75			R-16	14 44 41			SP	**Quaternary old alluvial fan (Qof)** @75': Gravelly SAND, light brown, wet, very dense, medium to very coarse-grained sand, fine rounded gravels	
30										
	80			R-17	9 10 23			CL	@80': CLAY, grey brown, very moist, stiff	
									Total depth: 81.5 feet. Groundwater encountered at 26.0 feet depth during drilling. Boring backfilled with soil cuttings and bentonite grout upon completion of drilling.	
25										
	85									
20										
	90									

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

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

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GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0			B-1				SM-SC	@0': **Artificial fill (Afu) undocumented** Silty to Clayey SAND, orange brown, very moist, fine to medium sand, trace crushed aggregate and asphalt debris	
	5			R-1	5 7 10			SP	@5': **Quaternary young alluvial fan (Qyf)** SAND, light olive brown, moist, medium dense, fine-grained, micaceous	
	10			R-2	5 7 10			SP	@10': SAND, light olive brown, moist, medium dense, fine to coarse grained, micaceous	
	15			R-3	4 10 13			SP	@15': SAND, light olive brown, moist, medium dense, fine grained, some silt content	
				R-4	3 3 6			CL	@17': CLAY, dark brown, moist, stiff, sample disturbed	
	20			R-5	2 4 7			CL	@20': Silty CLAY, dark brown, moist, stiff, micaceous, transitions to SILT	
				R-6	5 10 16			SM	@22': Silty SAND, dark olive, wet, medium dense, fine grained, micaceous, groundwater encountered during drilling.	
	25			R-7	4 17 30			ML	@25': SILT, olive, wet, hard, micaceous, transitions to SAND, light olive brown, fine-coarse grained	
				R-8	6 18 14			SM	@27': Silty SAND, dark olive brown, medium dense, wet, coarse grained	
	30									

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

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

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

GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R-9	2 3 4			CL-ML	@30': Silty CLAY to Clayey SILT, dark grey, soft, wet, micaceous, embedded roots, paleosol, marine silts and clays	
	35			R-10	3 6 11			ML	@35': SILT, dark grey, wet, stiff, micaceous	
	40			R-11	3 5 8			CL-ML	@40': Silty CLAY to Clayey SILT, dark olive brown, very moist, stiff, micaceous	
	45			R-12	8 5 7			ML	@45': SILT, dark oilve grey, very moist, stiff, pockets of interbedded clay	
	50			R-13	8 12 16			SM	@50': Silty SAND, dark olive brown, very moist, medium dense, fine grained sand	
	55			R-14	4 8 10			ML	@55': Clayey SILT, dark olive brown, very moist, stiff, micaceous	
	60									

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

TYPE OF TESTS:
- -200 % FINES PASSING
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GEOTECHNICAL BORING LOG B-9

Project No.	602778-004	**Date Drilled**	4-26-12
Project	McWhinney Development	**Logged By**	JY
Drilling Co.	Martini	**Hole Diameter**	8"
Drilling Method	Hollow Stem Auger - 140lb - Autohammer - 30" Drop	**Ground Elevation**	'
Location	See Plate 1, Revised Boring and Cross Section Location Map	**Sampled By**	JY

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	60			R-15	6 12 13			CL	@60': Silty CLAY, dark grey, very moist, stiff, trace of oxidation along soil faces, micaceous	
	65			R-16	6 8 12			CL	@65': CLAY, dark grey, moist, stiff, trace of rootlets, iron preciptation along soil faces, moderately well developed paleosol	
	70			R-17	14 36 37			SP	**<u>Quaternary old alluvial fan (Qof)</u>** @70': SAND, light olive, very moist, dense, fine to coarse grained	
	75			R-18	14 30 22			SP	@75': SAND, light olive, wet, dense, fine to coarse grained, trace of silt	
	80			R-19	16 22 32			SP	@80': SAND, olive, wet, dense, trace of silts and interbedded layer of clay, fine to coarse grained	
									Total depth: 81.5 feet. Groundwater initially encountered at 22.0 feet during drilling, and rose to 20.8 feet after 10 minutes. Boring backfilled with bentonite mixed with soil cuttings upon completion of drilling.	
	85									
	90									

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

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

SUMMARY

OF

CONE PENETRATION TEST DATA

Project:

12591 Harbor Blvd.
Garden Grove, CA
April 26-27, 2012

Prepared for:

Mr. Joe Roe
Leighton Consulting
17781 Cowan
Irvine, CA 92614-6009
Office (800) 253-4567 / Fax (949) 250-1114

Prepared by:

KEHOE TESTING & ENGINEERING
5415 Industrial Drive
Huntington Beach, CA 92649-1518
Office (714) 901-7270 / Fax (714) 901-7289

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2. **SUMMARY OF FIELD WORK**
3. **FIELD EQUIPMENT & PROCEDURES**
4. **CONE PENETRATION TEST DATA & INTERPRETATION**

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- CPT Plots
- CPT Classification/Soil Behavior Chart
- Interpretation Output (CPTINT)
- CPTINT Correlation Table

SUMMARY

OF

CONE PENETRATION TEST DATA

1. INTRODUCTION

This report presents the results of a Cone Penetration Test (CPT) program carried out for the project located at 12591 Harbor Blvd. in Garden Grove, California. The work was performed by Kehoe Testing & Engineering (KTE) on April 26-27, 2012. The scope of work was performed as directed by Leighton Consulting personnel.

2. SUMMARY OF FIELD WORK

The fieldwork consisted of performing CPT soundings at four locations to determine the soil lithology. Groundwater measurements and hole collapse depths provided in **TABLE 2.1** are for information only. The readings indicate the apparent depth to which the hole is open and the apparent water level (if encountered) in the CPT probe hole at the time of measurement upon completion of the CPT. KTE does not warrant the accuracy of the measurements and the reported water levels may not represent the true or stabilized groundwater levels.

LOCATION	DEPTH OF CPT (ft)	COMMENTS/NOTES:
CPT-11	85	Refusal, hole open to 5 ft (dry)
CPT-12	99	Refusal, hole open to 16 ft (dry)
CPT-13	86	Refusal, hole open to 7 ft (dry)
CPT-14	98	Refusal, hole open to 28 ft (dry)

TABLE 2.1 - Summary of CPT Soundings

3. FIELD EQUIPMENT & PROCEDURES

The CPT soundings were carried out by **KTE** using an integrated electronic cone system manufactured by Vertek. The CPT soundings were performed in accordance with ASTM standards (D5778). The cone penetrometers were pushed using a 30-ton CPT rig. The cone used during the program was a 15 cm^2 cone and recorded the following parameters at approximately 2.5 cm depth intervals:

- Cone Resistance (qc)
- Sleeve Friction (fs)
- Dynamic Pore Pressure (u)
- Inclination
- Penetration Speed
- Pore Pressure Dissipation (at selected depths)

The above parameters were recorded and viewed in real time using a portable computer and stored on a diskette for future analysis and reference. A complete set of baseline readings was taken prior to each sounding to determine temperature shifts and any zero load offsets. Monitoring base line readings ensures that the cone electronics are operating properly.

4. CONE PENETRATION TEST DATA & INTERPRETATION

The Cone Penetration Test data is presented in graphical form in the attached Appendix. Penetration depths are referenced to ground surface. The soil classification on the CPT plots is derived from the CPT Classification Chart (Robertson, 1986) and presents major soil lithologic changes. The stratigraphic interpretation is based on relationships between cone resistance (qc), sleeve friction (fs), and penetration pore pressure (u). The friction ratio (Rf), which is sleeve friction divided by cone resistance, is a calculated parameter that is used to infer soil behavior type. Generally, cohesive soils (clays) have high friction ratios, low cone resistance and generate excess pore water pressures. Cohesionless soils (sands) have lower friction ratios, high cone bearing and generate little (or negative) excess pore water pressures.

Output from the interpretation program CPTINT provides averaged CPT data over one-foot intervals. The CPTINT output includes Soil Classification Zones, SPT N Values and Undrained Shear Strength (Su). A summary of the equations used for the tabulated parameters is provided in the CPTINT Correlation Table in the Appendix.

The interpretation of soils encountered on this project was carried out using correlations developed by Robertson et al, 1986. It should be noted that it is not always possible to clearly identify a soil type based on qc, fs and u. In these situations, experience, judgment and an assessment of the pore pressure data should be used to infer the soil behavior type.

If you have any questions regarding this information, please do not hesitate to call our office at (714) 901-7270.

Sincerely,

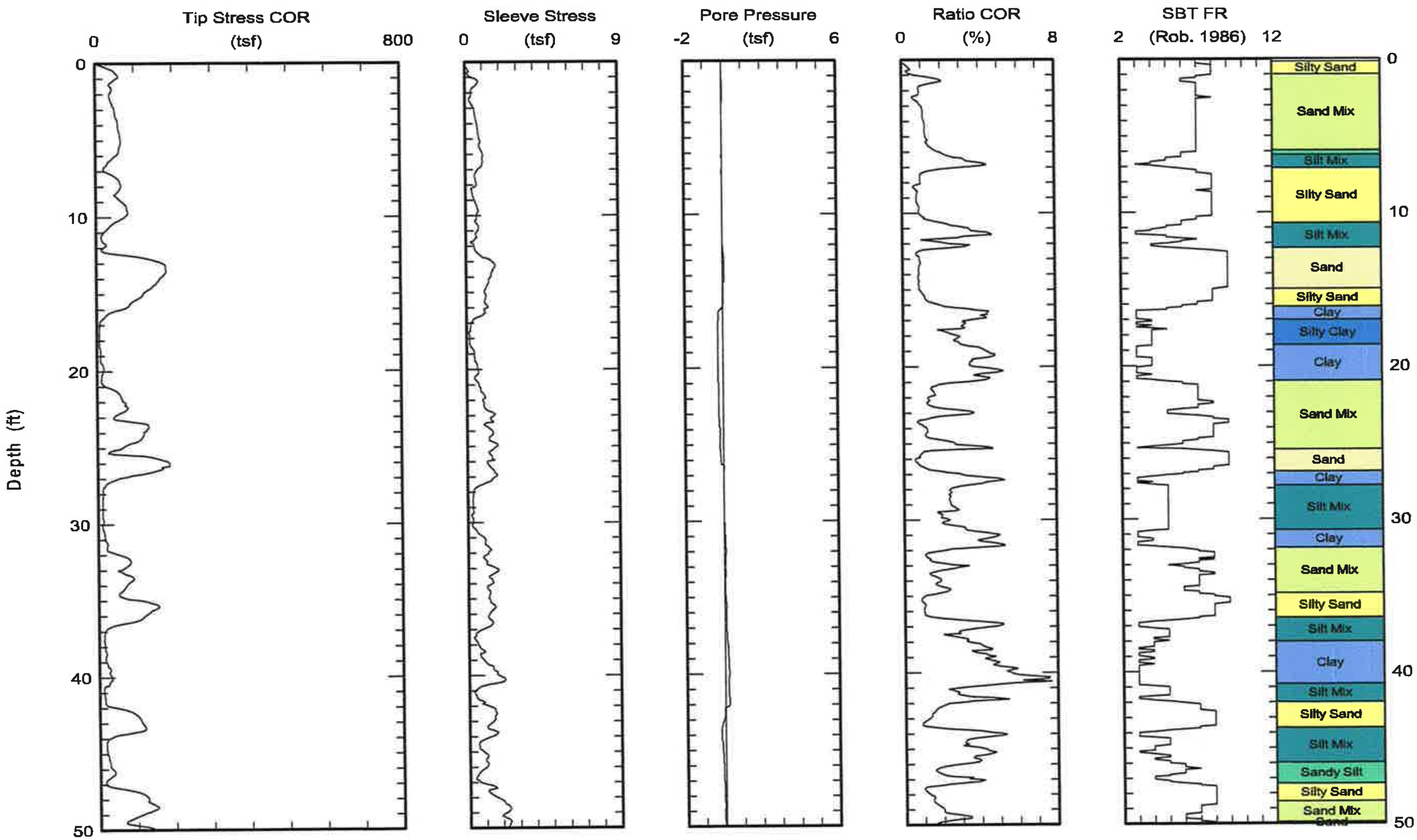
KEHOE TESTING & ENGINEERING

Richard W. Koester, Jr.
General Manager

05/01/12-dp-191-1416-2

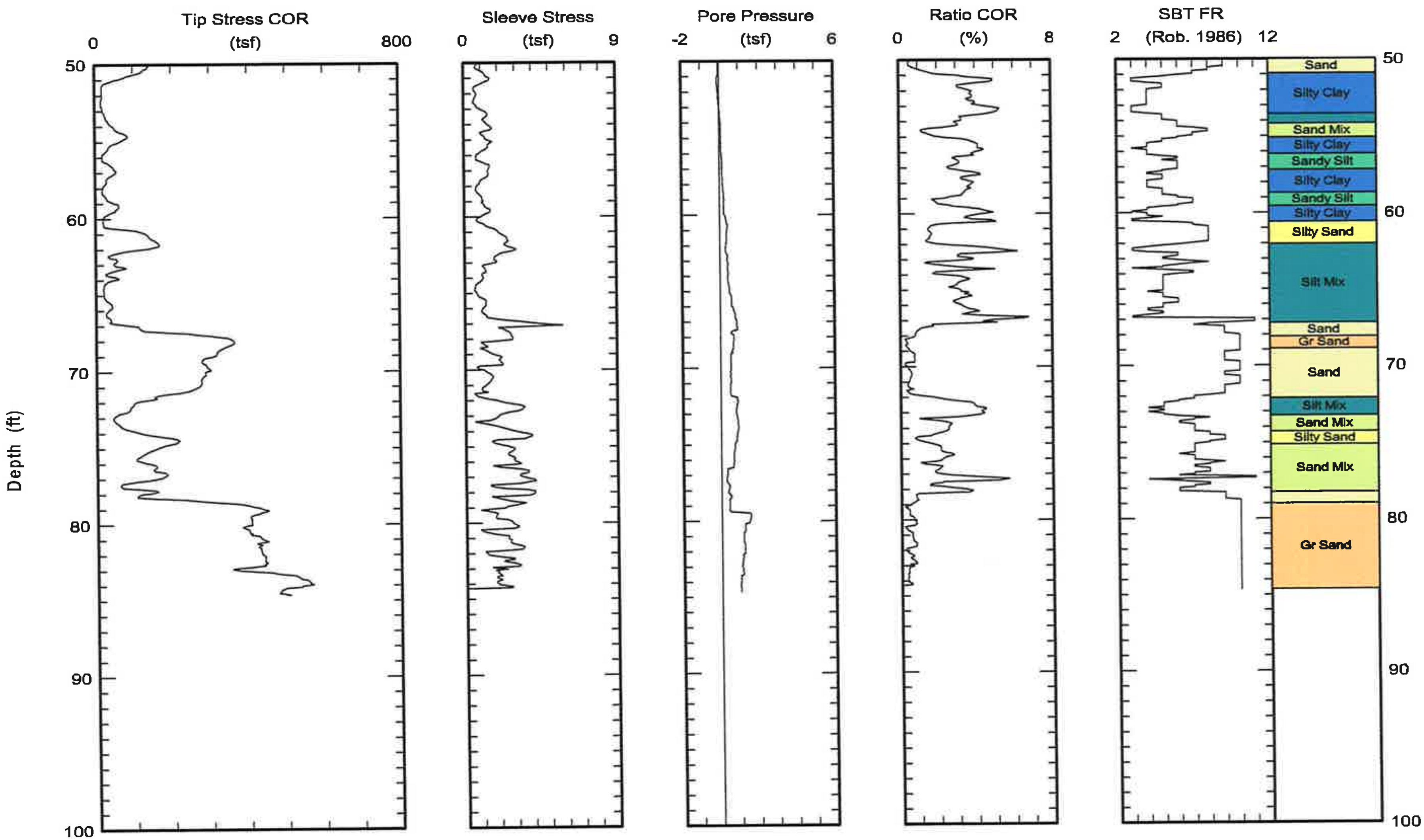
APPENDIX

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-11 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



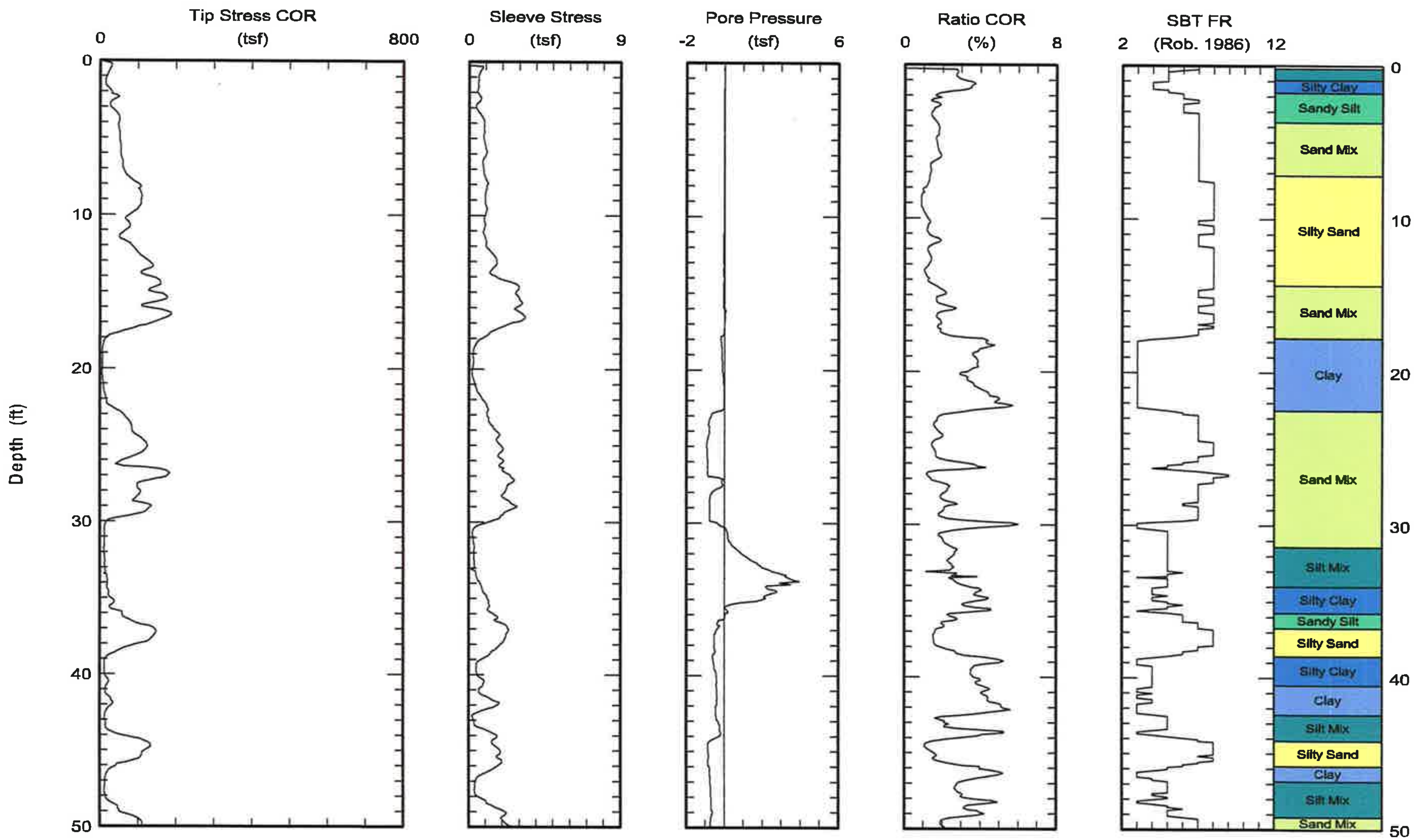
Maximum depth: 84.66 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-11 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



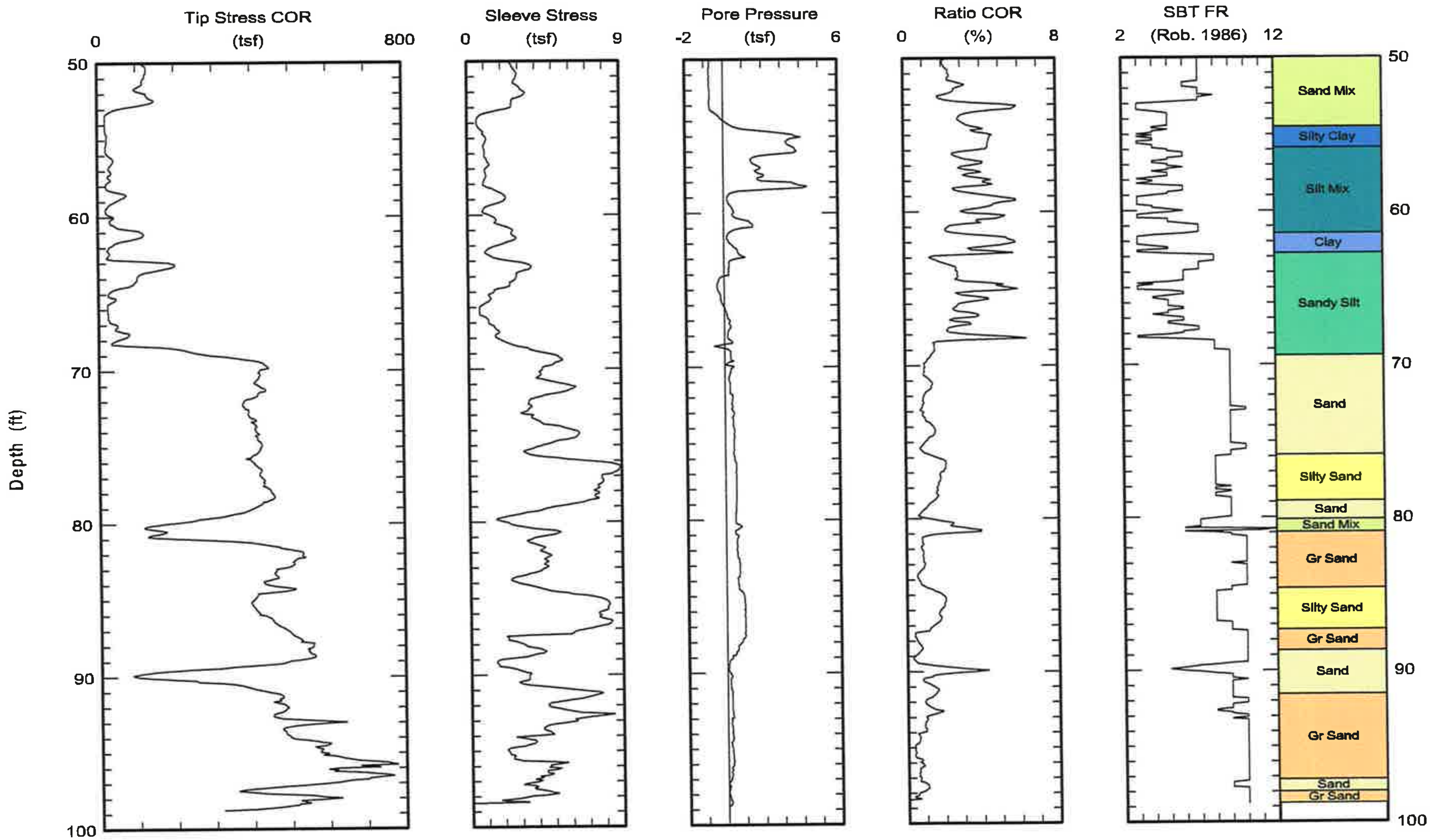
Maximum depth: 84.66 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 26/Apr/2012 Test ID: CPT-12 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 98.78 (ft)

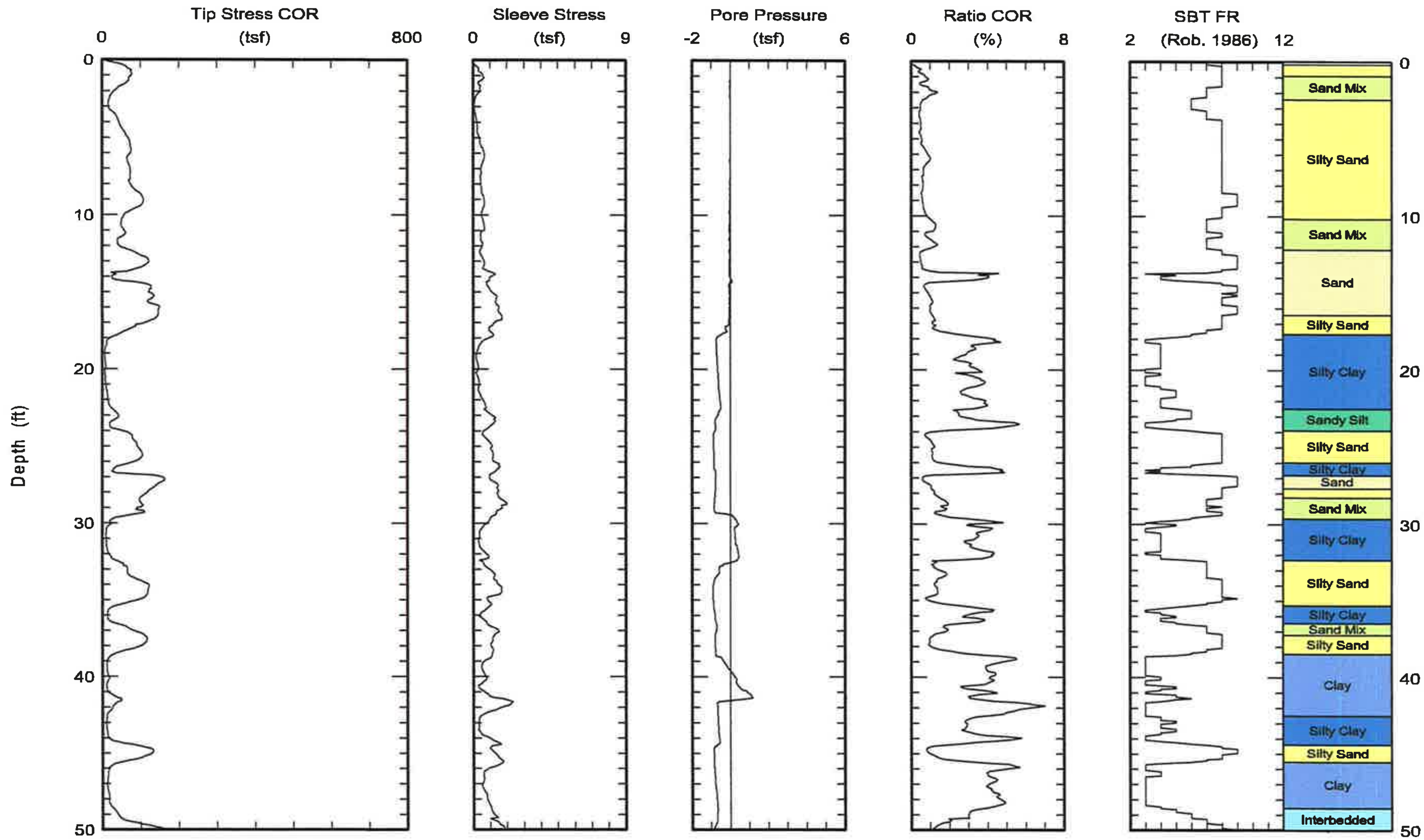
Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 26/Apr/2012 Test ID: CPT-12 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 98.78 (ft)
Page 2 of 2

Test ID: CP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-13 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

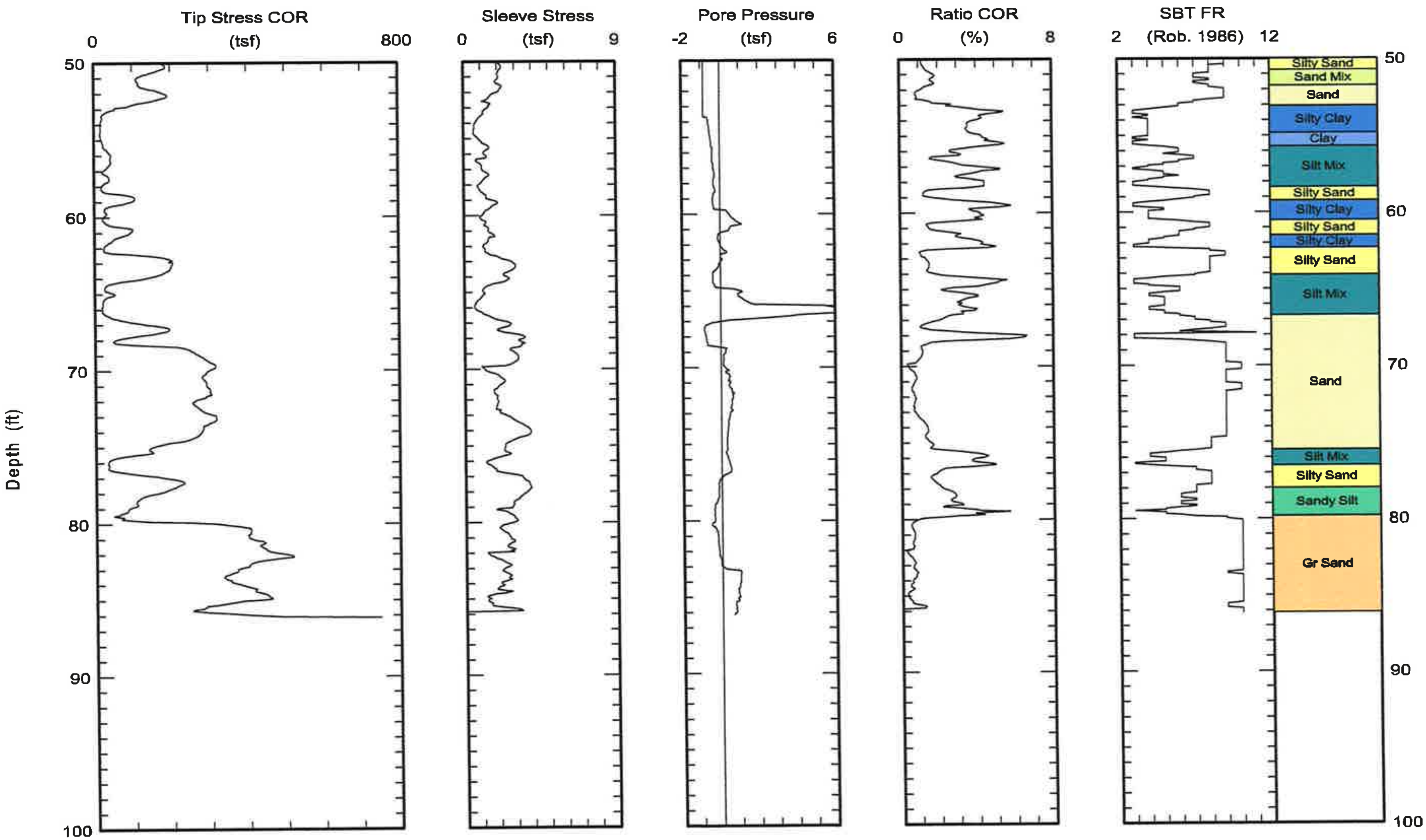


Maximum depth: 86.16 (ft)

Page 1 of 2

Test ID: CP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 27/Apr/2012 Test ID: CPT-13 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 86.16 (ft)

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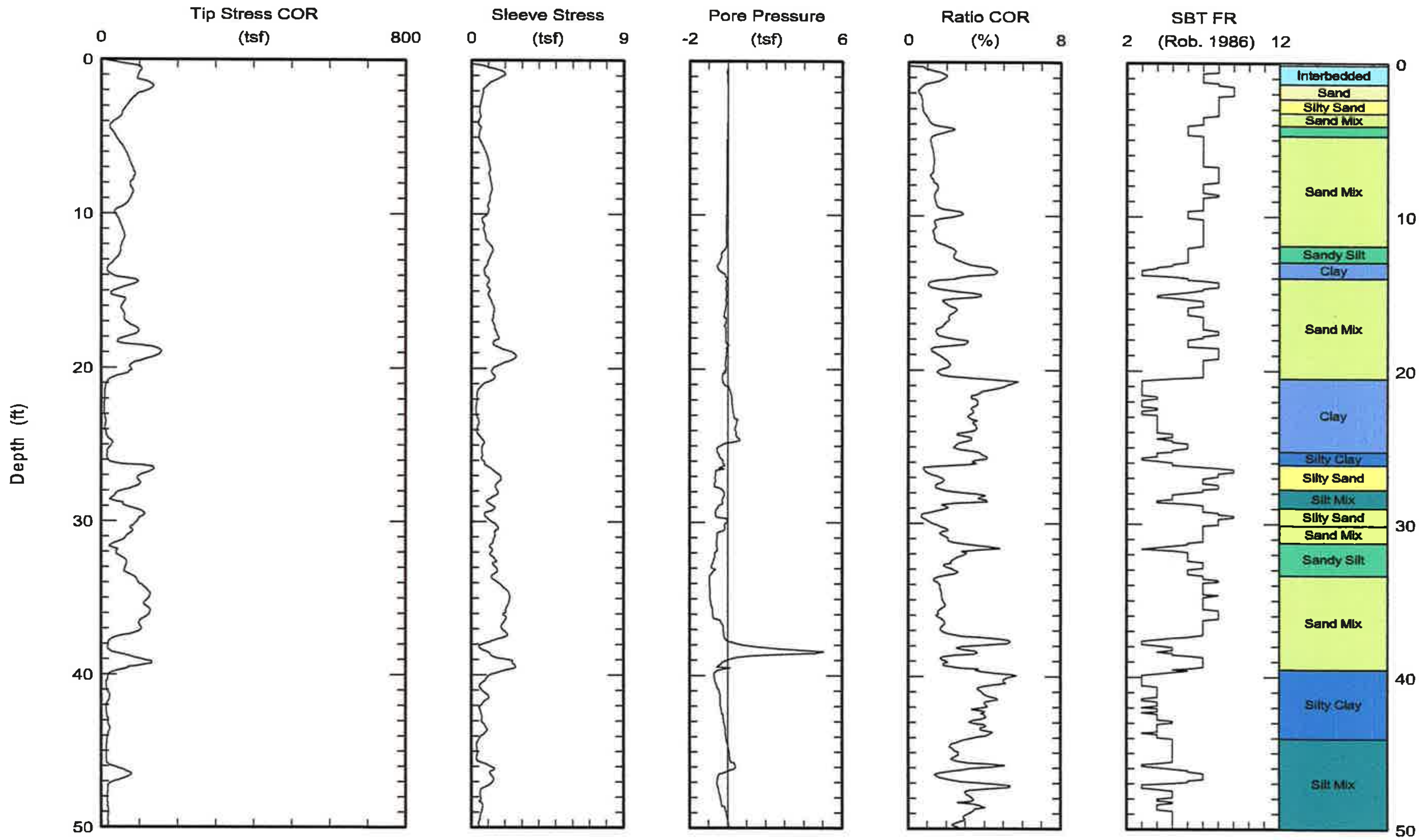
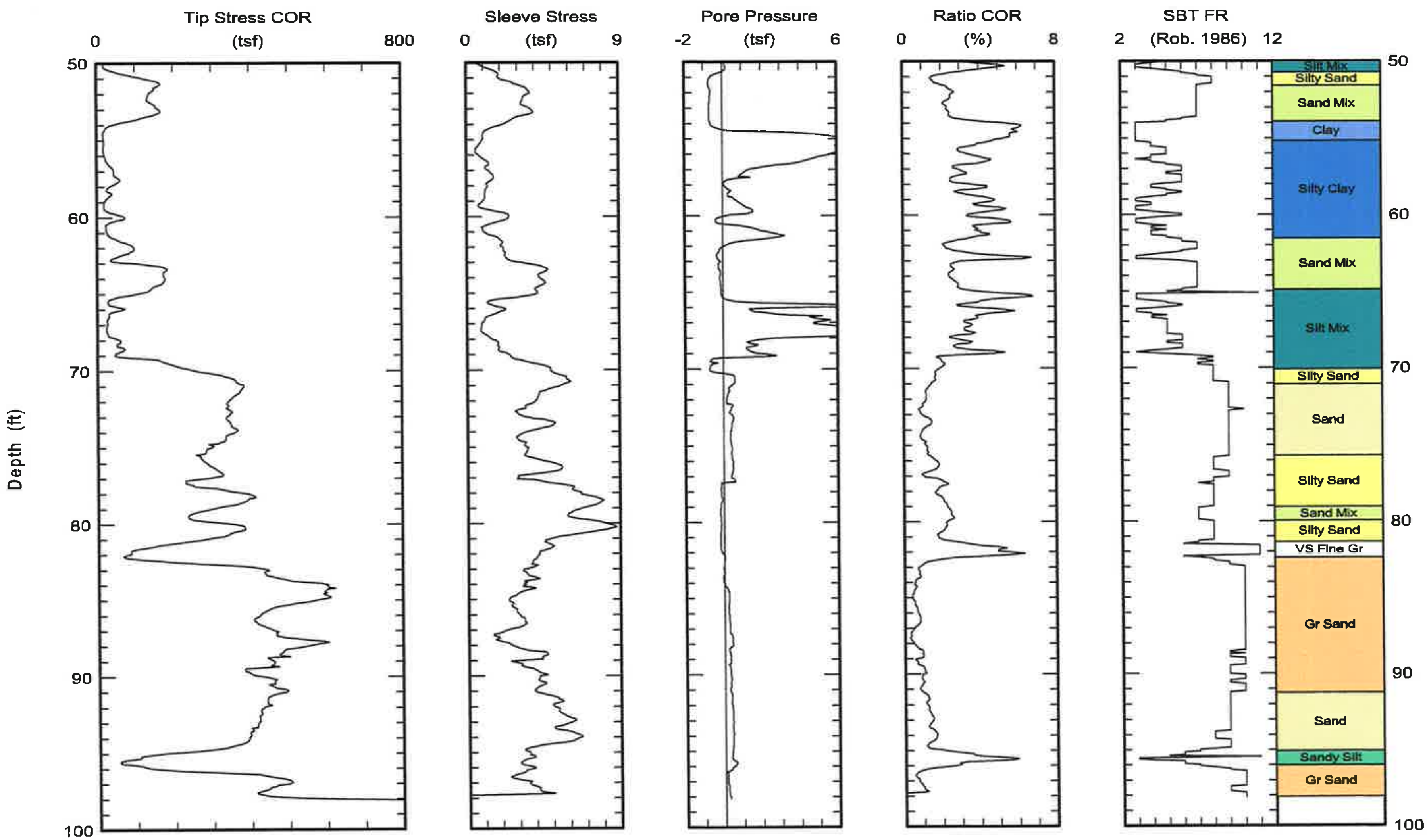
Test ID: CP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 26/Apr/2012 Test ID: CPT-14 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 98.11 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 26/Apr/2012 Test ID: CPT-14 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 98.11 (ft)

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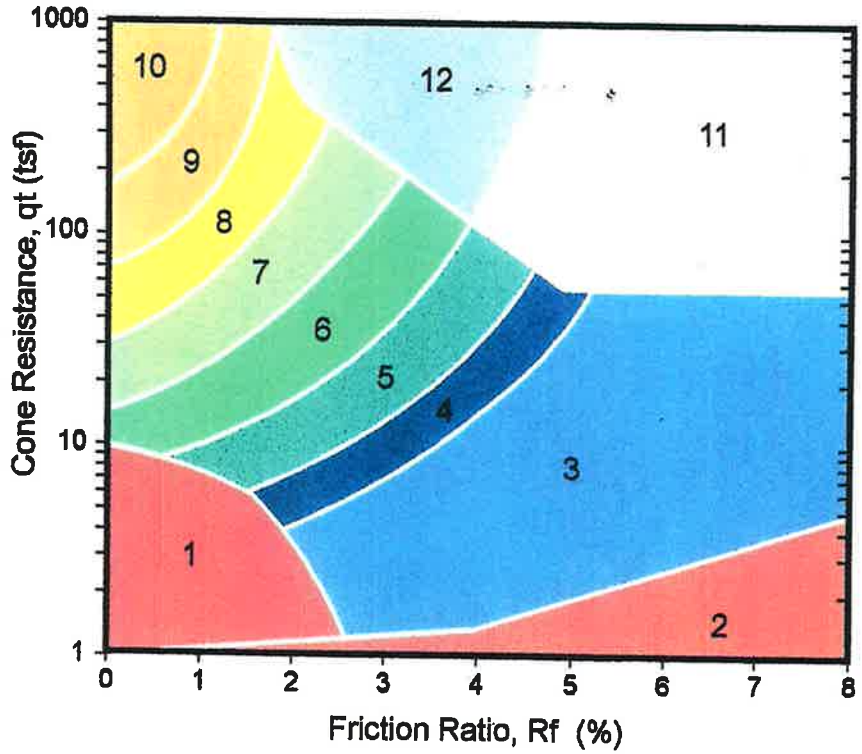
Test ID: CP

KEHOE TESTING & ENGINEERING

CPT Classification Chart

(after Robertson and Campanella, 1988)



Zone	q_t / N	Soil Behavior Type	UCSCS
1	2	sensitive fine grained	OL-OH
2	1	organic material	Pt-OH
3	1	clay	CH
4	1.5	silty clay to clay	CL-CH
5	2	clayey silt to silty clay	ML-CL
6	2.5	sandy silt to clayey silt	MH-ML
7	3	silty sand to sandy silt	SM-ML
8	4	sand to silty sand	SP-SM
9	5	sand	SP
10	6	gravelly sand to sand	SW-SP
11	1	very stiff fine grained *	CL-MH
12	2	sand to clayey sand *	SP-SC

* overconsolidated or cemented

INPUT FILE: C:\temp\CPT-11.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
0.500	45.150	0.165	0.365	8	11	17	9E9
1.500	42.150	0.582	1.380	7	13	20	9E9
2.500	43.617	0.363	0.833	7	14	21	9E9
3.500	55.233	0.617	1.116	7	18	27	9E9
4.500	63.000	0.765	1.214	7	20	30	9E9
5.500	62.583	0.900	1.438	7	20	30	9E9
6.500	33.267	0.982	2.951	5	16	24	2.192
7.500	52.200	0.612	1.172	7	17	26	9E9
8.500	58.900	0.445	0.756	8	14	21	9E9
9.500	79.500	0.662	0.832	8	19	29	9E9
10.500	44.729	0.674	1.507	7	14	20	9E9
11.500	19.017	0.540	2.840	5	9	12	1.221
12.500	92.867	0.898	0.967	8	22	27	9E9
13.500	179.167	1.592	0.888	9	34	39	9E9
14.500	146.117	1.248	0.854	9	28	31	9E9
15.500	97.200	1.167	1.200	8	23	24	9E9
16.500	25.300	0.827	3.272	5	12	12	1.617
17.500	7.783	0.222	2.866	4	5	5	0.444
18.500	8.683	0.285	3.301	3	8	7	0.500
19.500	13.683	0.547	4.020	3	13	11	0.827
20.500	15.386	0.627	4.080	3	15	13	0.941
21.500	59.183	0.920	1.555	7	19	15	9E9
22.500	67.217	1.238	1.844	7	21	16	9E9
23.500	110.017	1.342	1.220	8	26	20	9E9
24.500	101.150	1.528	1.511	8	24	18	9E9
25.500	106.817	1.485	1.390	8	26	18	9E9
26.500	140.500	1.483	1.056	8	34	23	9E9
27.500	24.617	0.948	3.852	4	16	11	1.528
28.500	13.083	0.320	2.446	5	6	4	0.756
29.500	13.517	0.310	2.293	5	6	4	0.780
30.500	15.067	0.460	3.050	5	7	4	0.881
31.500	29.586	1.143	3.861	4	19	11	1.845
32.500	75.483	1.168	1.547	7	24	14	9E9
33.500	80.783	1.482	1.834	7	26	15	9E9
34.500	68.633	1.230	1.792	7	22	12	9E9
35.500	142.117	1.422	1.000	9	27	15	9E9
36.500	67.733	1.265	1.867	7	22	12	9E9
37.500	15.183	0.480	3.161	4	10	5	0.859
38.500	18.317	0.753	4.102	4	12	6	1.067
39.500	26.800	1.335	4.969	3	26	13	1.630
40.500	24.267	1.487	6.110	3	23	12	1.457
41.499	19.743	0.619	3.124	5	9	5	1.151
42.499	98.583	1.528	1.551	7	31	16	9E9
43.499	84.817	1.345	1.586	7	27	14	9E9
44.499	18.850	0.698	3.708	4	12	6	1.074
45.499	26.083	1.030	3.951	4	17	9	1.552
46.499	28.167	0.578	2.056	6	11	6	1.686
47.499	84.383	1.253	1.486	7	27	14	9E9
48.499	136.833	2.152	1.572	8	33	17	9E9
49.499	95.217	2.222	2.333	7	30	15	9E9

INPUT FILE: C:\temp\CPT-11.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
50.499	118.333	1.003	0.848	8	28	14	9E9
51.499	27.433	1.003	3.662	5	13	7	1.617
52.499	18.729	0.736	3.931	4	12	6	1.033
53.499	32.467	1.300	4.004	4	21	11	1.946
54.499	69.967	1.335	1.907	7	22	11	9E9
55.499	32.817	1.280	3.898	5	16	8	1.962
56.499	38.500	1.168	3.033	5	18	9	2.337
57.499	33.733	1.173	3.477	5	16	8	2.015
58.499	26.600	0.882	3.308	5	13	7	1.538
59.499	48.050	1.298	2.700	6	18	9	2.962
60.499	47.683	1.200	2.514	6	18	9	2.935
61.499	151.567	2.375	1.566	8	36	18	9E9
62.499	60.229	2.196	3.640	5	29	15	3.766
63.499	50.800	1.162	2.283	6	19	10	3.132
64.499	23.383	0.740	3.153	5	11	6	1.300
65.499	33.867	1.110	3.268	5	16	8	1.996
66.499	40.333	1.833	4.530	4	26	13	2.425
67.499	224.883	3.040	1.351	8	54	27	9E9
68.499	338.617	1.442	0.426	10	54	27	9E9
69.499	290.767	1.770	0.609	10	46	23	9E9
70.499	280.917	1.448	0.515	10	45	23	9E9
71.499	200.833	0.992	0.494	9	38	19	9E9
72.499	78.071	2.689	3.436	6	30	15	4.918
73.499	72.833	1.830	2.507	6	28	14	4.564
74.499	185.317	2.850	1.537	8	44	22	9E9
75.499	123.333	2.807	2.273	7	39	20	9E9
76.499	165.167	3.067	1.856	8	40	20	9E9
77.499	107.383	3.143	2.925	6	41	21	6.846
78.499	276.417	2.738	0.990	9	53	27	9E9
79.499	417.933	1.943	0.465	10	67	34	9E9
80.499	404.500	2.168	0.536	10	65	33	9E9
81.499	432.300	2.673	0.618	10	69	35	9E9
82.499	430.300	2.358	0.548	10	69	35	9E9
83.499	507.329	1.969	0.388	10	81	41	9E9
84.499	512.300	2.700	0.527	10	82	41	9E9

INPUT FILE: C:\temp\CPT-12.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
0.500	25.167	0.585	2.325	6	10	15	1.676
1.500	20.000	0.552	2.758	5	10	15	1.327
2.500	35.383	0.588	1.663	6	14	21	2.349
3.500	45.717	0.727	1.590	7	15	23	9E9
4.500	51.333	0.905	1.763	7	16	24	9E9
5.500	54.533	0.983	1.803	7	17	26	9E9
6.500	58.983	0.890	1.509	7	19	29	9E9
7.500	75.250	0.967	1.285	8	18	27	9E9
8.500	107.700	1.020	0.947	8	26	39	9E9
9.500	102.583	1.012	0.986	8	25	38	9E9
10.500	74.471	0.937	1.259	8	18	25	9E9
11.500	64.800	0.982	1.515	7	21	27	9E9
12.500	105.333	1.425	1.353	8	25	31	9E9
13.500	126.117	1.468	1.164	8	30	35	9E9
14.500	147.633	2.595	1.758	8	35	38	9E9
15.500	151.600	3.002	1.980	7	48	50	9E9
16.500	166.367	3.092	1.858	8	40	40	9E9
17.500	78.517	1.628	2.074	7	25	24	9E9
18.500	10.550	0.440	4.171	3	10	9	0.628
19.500	7.050	0.267	3.783	3	7	6	0.390
20.500	7.671	0.263	3.439	3	7	6	0.426
21.500	13.017	0.600	4.609	3	12	10	0.780
22.500	35.717	1.080	3.027	5	17	13	2.287
23.500	77.700	1.305	1.683	7	25	19	9E9
24.500	105.450	1.757	1.669	7	34	25	9E9
25.500	105.450	1.923	1.826	7	34	24	9E9
26.500	113.383	2.065	1.824	7	36	25	9E9
27.500	123.733	2.457	1.986	7	39	26	9E9
28.500	104.650	2.273	2.175	7	33	22	9E9
29.500	97.300	2.160	2.223	7	31	20	9E9
30.500	14.367	0.485	3.372	4	9	6	0.835
31.500	12.300	0.303	2.448	5	6	4	0.697
32.500	12.933	0.328	2.475	5	6	4	0.752
33.500	17.083	0.485	2.740	5	8	5	1.044
34.500	22.000	0.890	3.964	4	14	8	1.356
35.500	38.033	1.212	3.177	5	18	10	2.398
36.500	88.717	1.858	2.096	7	28	15	9E9
37.500	139.217	2.205	1.585	8	33	17	9E9
38.500	51.567	1.422	2.762	6	20	10	3.274
39.500	13.283	0.508	3.851	3	13	7	0.719
40.500	19.133	0.770	4.035	4	12	6	1.107
41.499	24.829	1.159	4.677	3	24	12	1.482
42.499	17.367	0.613	3.542	4	11	6	0.981
43.499	25.517	0.898	3.527	5	12	6	1.520
44.499	118.017	1.592	1.350	8	28	14	9E9
45.499	92.667	1.865	2.016	7	30	15	9E9
46.499	22.300	0.957	4.322	4	14	7	1.286
47.499	13.433	0.377	2.829	5	6	3	0.694
48.499	33.583	1.242	3.710	5	16	8	2.033
49.499	91.000	2.135	2.350	7	29	15	9E9

INPUT FILE: C:\temp\CPT-12.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
50.499	125.217	2.758	2.205	7	40	20	9E9
51.499	112.633	2.952	2.624	7	36	18	9E9
52.499	116.400	2.937	2.526	7	37	19	9E9
53.499	23.817	1.010	4.256	4	15	8	1.364
54.499	22.533	0.878	3.841	4	15	8	1.302
55.499	23.367	1.052	4.370	4	15	8	1.378
56.499	35.767	1.165	3.224	5	17	9	2.178
57.499	29.517	1.053	3.527	5	14	7	1.756
58.499	49.900	1.718	3.412	5	24	12	3.119
59.499	28.850	1.375	4.761	3	28	14	1.683
60.499	48.500	1.817	3.730	5	23	12	2.999
61.499	84.383	2.618	3.100	6	32	16	5.379
62.499	57.643	1.527	2.644	6	22	11	3.595
63.499	143.667	3.298	2.295	7	46	23	9E9
64.499	66.200	2.290	3.463	5	32	16	4.145
65.499	31.450	1.130	3.595	5	15	8	1.828
66.499	29.300	0.890	3.034	5	14	7	1.684
67.499	61.500	1.618	2.630	6	24	12	3.826
68.499	151.083	2.908	1.925	7	48	24	9E9
69.499	403.567	5.110	1.266	9	77	39	9E9
70.499	417.167	4.397	1.054	9	80	40	9E9
71.499	419.350	5.427	1.294	9	80	40	9E9
72.499	385.957	3.554	0.921	9	74	37	9E9
73.499	409.233	4.723	1.154	9	78	39	9E9
74.499	420.850	5.718	1.358	9	81	41	9E9
75.499	407.767	4.265	1.046	9	78	39	9E9
76.499	419.450	8.508	2.028	8	100	50	9E9
77.499	437.767	7.728	1.765	8	105	53	9E9
78.499	440.150	7.053	1.602	9	84	42	9E9
79.499	321.833	3.107	0.965	9	62	31	9E9
80.499	145.567	3.850	2.643	7	47	24	9E9
81.499	423.567	3.945	0.931	9	81	41	9E9
82.499	516.233	4.573	0.886	10	82	41	9E9
83.499	452.329	3.371	0.745	10	72	36	9E9
84.499	444.883	5.375	1.208	9	85	43	9E9
85.499	406.583	8.023	1.972	8	97	49	9E9
86.499	463.050	7.890	1.703	8	111	56	9E9
87.499	525.167	3.797	0.723	10	84	42	9E9
88.499	549.950	3.622	0.658	10	88	44	9E9
89.499	280.533	2.287	0.815	9	54	27	9E9
90.499	301.600	3.680	1.220	9	58	29	9E9
91.499	468.400	6.467	1.381	9	90	45	9E9
92.499	483.067	6.163	1.276	9	93	47	9E9
93.499	512.700	4.793	0.935	10	82	41	9E9
94.499	572.517	3.038	0.531	10	91	46	9E9
95.499	683.567	3.417	0.500	10	109	55	9E9
96.499	677.400	4.477	0.661	10	108	54	9E9
97.499	477.917	3.947	0.826	10	76	38	9E9
98.499	565.700	3.120	0.552	10	90	45	9E9

INPUT FILE: C:\temp\CPT-13.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
0.500	62.433	0.313	0.502	8	15	23	9E9
1.500	56.017	0.470	0.839	8	13	20	9E9
2.500	20.450	0.157	0.766	6	8	12	1.353
3.500	33.267	0.157	0.471	7	11	17	9E9
4.500	55.433	0.285	0.514	8	13	20	9E9
5.500	74.050	0.498	0.673	8	18	27	9E9
6.500	69.300	0.605	0.873	8	17	26	9E9
7.500	73.733	0.465	0.631	8	18	27	9E9
8.500	90.833	0.533	0.587	8	22	33	9E9
9.500	93.500	0.618	0.661	8	22	33	9E9
10.500	54.229	0.604	1.114	7	17	24	9E9
11.500	48.817	0.492	1.007	7	16	21	9E9
12.500	94.350	0.507	0.537	8	23	28	9E9
13.500	77.267	0.852	1.102	8	19	22	9E9
14.500	94.700	0.928	0.980	8	23	25	9E9
15.500	131.967	1.360	1.031	8	32	33	9E9
16.500	142.150	1.565	1.101	8	34	33	9E9
17.500	68.467	1.110	1.622	7	22	21	9E9
18.500	12.200	0.465	3.848	3	12	11	0.729
19.500	8.600	0.242	2.854	4	5	4	0.484
20.500	8.686	0.300	3.500	3	8	7	0.487
21.500	13.433	0.410	3.079	4	9	7	0.799
22.500	27.583	0.797	2.902	5	13	10	1.738
23.500	31.117	1.105	3.568	5	15	11	1.968
24.500	81.967	0.813	0.994	8	20	15	9E9
25.500	99.817	1.138	1.142	8	24	17	9E9
26.500	60.083	1.320	2.204	6	23	16	3.884
27.500	145.717	1.318	0.906	9	28	19	9E9
28.500	105.233	1.657	1.577	7	34	22	9E9
29.500	69.600	1.275	1.833	7	22	14	9E9
30.500	14.500	0.507	3.474	4	9	6	0.847
31.500	12.886	0.461	3.561	4	8	5	0.734
32.500	45.633	0.768	1.684	7	15	9	9E9
33.500	86.933	1.285	1.481	7	28	16	9E9
34.500	116.883	1.410	1.208	8	28	16	9E9
35.500	35.000	0.800	2.298	6	13	7	2.175
36.500	37.917	0.835	2.211	6	14	8	2.368
37.500	108.300	1.232	1.139	8	26	14	9E9
38.500	47.933	1.075	2.250	6	18	9	3.027
39.500	13.450	0.565	4.211	3	13	7	0.732
40.500	14.633	0.563	3.832	4	9	5	0.814
41.499	32.814	1.549	4.711	3	31	16	2.021
42.499	15.283	0.648	4.289	3	14	7	0.833
43.499	13.167	0.477	3.653	4	8	4	0.691
44.499	89.917	1.253	1.396	8	21	11	9E9
45.499	66.317	1.495	2.259	6	25	13	4.224
46.499	15.167	0.638	4.256	3	14	7	0.809
47.499	15.683	0.672	4.319	3	15	8	0.841
48.499	26.050	1.003	3.876	4	17	9	1.526
49.499	83.400	1.490	1.790	7	27	14	9E9

INPUT FILE: C:\temp\CPT-13.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
50.499	164.550	2.110	1.284	8	39	20	9E9
51.499	128.750	2.090	1.626	8	31	16	9E9
52.499	137.771	1.574	1.144	8	33	17	9E9
53.499	24.183	1.005	4.185	4	15	8	1.381
54.499	18.117	0.672	3.735	4	11	6	0.975
55.499	31.300	1.245	3.986	4	20	10	1.854
56.499	40.333	1.085	2.695	6	15	8	2.452
57.499	31.683	1.238	3.915	4	20	10	1.872
58.499	61.467	1.092	1.778	7	20	10	9E9
59.499	44.417	1.593	3.589	5	21	11	2.715
60.499	51.100	1.220	2.380	6	20	10	3.169
61.499	57.833	1.510	2.610	6	22	11	3.603
62.499	117.414	1.719	1.464	8	28	14	9E9
63.499	180.500	2.737	1.516	8	43	22	9E9
64.499	47.183	1.713	3.631	5	23	12	2.880
65.499	26.650	0.875	3.247	5	13	7	1.527
66.499	53.300	1.465	2.705	6	21	11	3.336
67.499	146.700	2.693	1.837	7	47	24	9E9
68.499	176.800	3.157	1.786	8	42	21	9E9
69.499	299.933	2.685	0.895	9	57	29	9E9
70.499	288.867	1.903	0.659	9	55	28	9E9
71.499	294.517	1.878	0.638	9	56	28	9E9
72.499	280.186	2.033	0.725	9	54	27	9E9
73.499	295.550	3.315	1.121	9	57	29	9E9
74.499	223.467	3.072	1.374	8	54	27	9E9
75.499	93.317	2.177	2.330	7	30	15	9E9
76.499	75.050	1.978	2.634	6	29	15	4.692
77.499	208.117	3.718	1.787	8	50	25	9E9
78.499	115.283	3.122	2.709	6	44	22	7.360
79.499	96.883	2.697	2.785	6	37	19	6.127
80.499	389.967	2.340	0.600	10	62	31	9E9
81.499	439.950	2.688	0.611	10	70	35	9E9
82.499	448.183	1.952	0.435	10	72	36	9E9
83.499	357.586	2.387	0.667	10	57	29	9E9
84.499	431.650	1.915	0.443	10	69	35	9E9
85.499	320.917	1.767	0.550	10	51	26	9E9
86.499	581.100	0.000	0.000	10	9E9	9E9	9E9

INPUT FILE: C:\temp\CPT-14.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
0.500	87.667	1.232	1.405	8	21	32	9E9
1.500	120.033	1.103	0.919	8	29	44	9E9
2.500	84.517	0.600	0.710	8	20	30	9E9
3.500	52.733	0.497	0.942	7	17	26	9E9
4.500	28.917	0.482	1.666	6	11	17	1.909
5.500	52.650	0.658	1.250	7	17	26	9E9
6.500	74.217	0.992	1.336	7	24	36	9E9
7.500	85.450	1.107	1.295	8	20	30	9E9
8.500	80.433	1.173	1.459	7	26	39	9E9
9.500	58.950	1.035	1.756	7	19	29	9E9
10.500	47.829	0.756	1.580	7	15	21	9E9
11.500	58.933	0.903	1.534	7	19	25	9E9
12.500	48.133	1.185	2.464	6	18	22	3.155
13.500	23.217	0.860	3.715	4	15	17	1.488
14.500	69.483	1.027	1.478	7	22	24	9E9
15.500	47.917	1.142	2.383	6	18	19	3.131
16.500	58.733	1.320	2.247	6	23	23	3.848
17.500	85.850	1.432	1.668	7	27	26	9E9
18.500	91.550	1.597	1.744	7	29	26	9E9
19.500	116.650	2.245	1.925	7	37	32	9E9
20.500	47.571	1.201	2.527	6	18	15	3.086
21.500	10.667	0.418	3.922	3	10	8	0.623
22.500	8.900	0.305	3.401	3	9	7	0.506
23.500	11.417	0.402	3.503	4	7	5	0.669
24.500	20.283	0.568	2.793	5	10	7	1.257
25.500	18.833	0.635	3.387	5	9	6	1.146
26.500	95.950	1.152	1.201	8	23	16	9E9
27.500	93.900	1.615	1.722	7	30	20	9E9
28.500	41.150	1.268	3.087	5	20	13	2.623
29.500	98.133	1.078	1.100	8	23	15	9E9
30.500	83.067	1.443	1.740	7	26	16	9E9
31.500	44.357	1.254	2.834	6	17	10	2.822
32.500	58.900	1.338	2.277	6	23	14	3.785
33.500	80.133	1.413	1.767	7	26	15	9E9
34.500	120.167	2.087	1.739	7	38	21	9E9
35.500	122.167	2.147	1.759	7	39	21	9E9
36.500	109.300	1.920	1.759	7	35	19	9E9
37.500	59.367	1.732	2.917	6	23	12	3.805
38.500	39.817	0.920	2.285	6	15	8	2.527
39.500	84.900	2.232	2.631	6	32	16	5.493
40.500	16.250	0.753	4.669	3	15	8	0.910
41.499	19.400	0.811	4.198	4	12	6	1.119
42.499	15.800	0.582	3.693	4	10	5	0.877
43.499	20.100	0.810	4.037	4	13	7	1.160
44.499	14.967	0.375	2.508	5	7	4	0.815
45.499	15.683	0.522	3.319	4	10	5	0.862
46.499	61.967	1.260	2.036	7	20	10	9E9
47.499	19.733	0.767	3.905	4	13	7	1.115
48.499	17.850	0.612	3.436	4	11	6	0.989
49.499	18.467	0.510	2.762	5	9	5	1.030

INPUT FILE: C:\temp\CPT-14.CSV

" Depth " (feet)	Qc(avg) (TSF)	Fs(avg) (TSF)	Rf (%)	Rf Zone (zone #)	Spt N (blow/ft)	Spt N1 (blow/ft)	Su (TSF)
50.499	44.167	1.362	3.083	6	17	9	2.739
51.499	151.050	2.920	1.935	7	48	24	9E9
52.499	144.757	3.487	2.412	7	46	23	9E9
53.499	111.900	3.080	2.756	6	43	22	7.232
54.499	20.000	1.210	5.898	3	20	10	1.146
55.499	17.683	0.692	3.663	4	12	6	1.033
56.499	31.133	1.137	3.567	5	15	8	1.894
57.499	50.117	1.460	2.905	6	19	10	3.116
58.499	30.550	1.133	3.698	5	15	8	1.805
59.499	30.733	1.363	4.403	4	20	10	1.822
60.499	38.300	1.642	4.279	4	24	12	2.311
61.499	53.933	1.740	3.203	6	21	11	3.370
62.499	73.186	2.379	3.251	6	28	14	4.623
63.499	174.050	4.427	2.544	7	56	28	9E9
64.499	149.533	4.342	2.904	7	48	24	9E9
65.499	47.817	2.198	4.562	4	31	16	2.945
66.499	32.667	1.447	4.338	4	21	11	1.952
67.499	30.167	1.013	3.227	5	15	8	1.818
68.499	59.000	1.905	3.213	6	23	12	3.673
69.499	167.667	3.637	2.168	7	54	27	9E9
70.499	335.750	5.597	1.667	8	80	40	9E9
71.499	368.383	4.615	1.253	9	71	36	9E9
72.499	344.500	3.420	0.993	9	66	33	9E9
73.499	353.667	4.497	1.271	9	68	34	9E9
74.499	321.867	3.213	0.998	9	62	31	9E9
75.499	276.300	3.808	1.378	9	53	27	9E9
76.499	310.717	4.723	1.520	8	74	37	9E9
77.499	285.767	5.352	1.873	8	68	34	9E9
78.499	376.700	7.475	1.984	8	90	45	9E9
79.499	264.417	6.525	2.468	7	84	42	9E9
80.499	357.700	7.485	2.093	8	86	43	9E9
81.499	159.350	4.715	2.960	7	51	26	9E9
82.499	206.417	3.978	1.927	8	49	25	9E9
83.499	490.214	3.553	0.725	10	78	39	9E9
84.499	597.917	3.075	0.514	10	95	48	9E9
85.499	468.067	2.740	0.585	10	75	38	9E9
86.499	427.500	3.145	0.736	10	68	34	9E9
87.499	525.950	1.917	0.364	10	84	42	9E9
88.499	481.667	3.923	0.814	10	77	39	9E9
89.499	424.383	3.542	0.834	10	68	34	9E9
90.499	463.533	4.198	0.906	10	74	37	9E9
91.499	453.133	4.903	1.082	9	87	44	9E9
92.499	425.217	5.618	1.321	9	81	41	9E9
93.499	404.629	5.947	1.469	9	78	39	9E9
94.499	317.817	4.522	1.422	9	61	31	9E9
95.499	97.450	3.465	3.553	6	37	19	6.109
96.499	411.750	3.097	0.752	10	66	33	9E9
97.499	453.867	2.683	0.591	10	72	36	9E9
98.499	865.400	0.000	0.000	10	9E9	9E9	9E9

CPTCP.TBL - CPTINT Correlation and Parameters Table File
-------------with NOTES & References at end-------------

Program: CPTINT - CPT Cone Interpretation Program
Version: 5.2
Table File by: Dr. R. G. (DICK) Campanella, P.Eng.
Rev. Dated: April 3, 2002

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
Depth average see NOTE #1	Depth averaged over specified range (see menu)		All	All
Parameter Averaging	Averaged over range specified for depth. If no values exist, your choice is zero's or no value		All	All
Qc, Tip Stress	measured tip force/area	#6,#8	All	All
Qt corrtd for U2 see NOTE #2	Qt = Qc + (1 - a) x U2 and a = tip area ratio Defaults to U2 if given or uses U1 or U3 times Const.	#6,#8	All	All
[Note: Input value from input file is used if defined, not calculated]				
Q (Qt Normalized)	$Q = \frac{Qt - sv}{sv'}$	#9 & 13	All	All
Fs	measured sleeve force/area	#6,#8	All	All
Rf Friction Ratio (if Rf>8, Rf=8)	$Rf = \frac{Fs}{Qt} \times 100\%$	#6,#8	All	All
F (Rf Normalized)	$F = \frac{Fs}{(Qt - sv)} \times 100\%$	#9 & 13	All	All
Gamma Total Unit Weight (Soil + Water) see NOTE #3	Based on Rf or Bq Classif. Zone Zone # / Gamma = kN/m^3 1 Qt<4bar 15.70 1 Qt=4bar 17.30 2 Rf<5% 13.36 2 Rf=5% 11.80 2 Bq Zone 12.58 3 Qt<10bar 18.86 3 Qt=10bar 19.65 4, 5 & 6 Qt<20bar 18.86 4, 5 & 6 Qt=20bar 19.65 7 18.86 8 & 9 19.65 10 20.44 11 & 12 21.22		All	All

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
U Penetration Pore Pressure see NOTE #4	U1,measured on Face of tip U2,measured Behind Tip at shoulder (std location) U3,measured Behind Friction Sleeve		All	All
Water Table	Depth below ground surface to where pore pressure = 0 Make negative if water level is above ground		All	All
Uo Hydrostatic Pore Pressure see NOTE #4	Uo = water depth,Hw x unit weight water, Gamma or Uo=Hw=depth-depth to water table if depth<water table,Uo = 0		All	All
dU Excess Pore Pressure	dU = U2 - Uo Defaults to U2 if given or uses U1 or U3 x const.		All	All
DPPR (Differential Pore Pressure Ratio)	$DPPR = \frac{dU}{Qt} = \frac{U - Uo}{Qt}$ Defaults to U2 if given or uses U1 or U3 x const.	#6,#8	All	All
Bq	$Bq = \frac{dU}{Qt - sv}$	# 4 # 8 # 13	All	All
OS (Overburden Stress)	OS = sv = S (Gamma x Depth)		All	All
EOS (Effective Overburden Stress)	EOS = sv' = OS - Uo = sv - Uo		All	All
Rf Zone Soil Behavior Type see NOTE #5	Classification chart for Qc and Rf Zone # = Soil Behavior Type 1=sensitive fine grained 2=organic material 3=clay 4=silty clay 5=clayey silt 6=sandy silt 7=silty sand 8=fine sand 9=sand 10=gravelly sand 11=very stiff fine grained ¥ 12=sand to clayey sand ¥ ¥ overconsolidated or cemented	#6 #8, Fig4.3	All	1<Qt<1000bar 0<Rf<8%

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
Bq Zone Soil Behavior Type	Classification chart for Qc and Bq (same zone #'s as Rf above)	#8 Fig 4.3	All	0<Qt<1000bar -0.1<Bq<1.4
Spt N(60) Standard Penetration Test (Blows/foot) at 60% Energy After R&C(1983) see NOTE #6	Qt/N ratio per zone Zone # / Qt/N: 1 / 2; 2 / 1; 3 / 1; 4 / 1.5; 5 / 2; 6 / 2.5 Zone # / Qt/N: 7 / 3; 8 / 4; 9 / 5; 10 / 6; 11 / 1; 12 / 2	# 7 # 8 Fig 4.2	All	All
Spt N1(60) Normalized for Overburden str	Spt N1(60) = Cn x Spt N(60) where Cn = (sv')^(-0.77)	# 8	All	0.5<Cn<1.5
Dr Relative Density see NOTE #7	Specific Sands: $Dr = \frac{100}{C2} * \ln\left[\frac{Qc}{C0\ sv'^{C1}}\right]$ where: All are NC & UNAGED	# 8		
Compressibility	Sand / C0 / C1 / C2			
moderate	Ticino / 17.37 / .558 / 2.58	# 1	/	7 to 10
high	Schmertmann / 15.32 / .520 / 2.75	# 1	Sand--	0<Qt<500bar 0<sv'<5bar
			\	
all	ALL SANDS: NC, OC, ALL TESTS $Dr = C3 + C4\log_{10}\left[\frac{\left(\frac{Qc}{C1}\right)}{\left(\frac{sv'+C2}{C0}\right)}\right]$ where: C0 / C1 / C2 / C3 / C4 0.100 / 0.0981 / 0.5 / -98 / 66	# 5	Sand	7 to 10 (6 possible)
Phi Friction Angle	Methods: 1) Robertson & Campanella 2) Durgunoglu & Mitchell 3) Janbu beta = +15 degree 4) Janbu beta = 0 degree 5) Janbu beta = -15 degree	 #6, #8 # 2 #6, #8 #6, #8 #6, #8	/ Sand-- \	7 to 10 & 6 0<Qt<500bar 0<sv'<4bar 29<phi<49

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
Gmax Maximum Shear Modulus at very small strains	Clay: Gmax = alpha x Qt Sand: Digitized figure of Qc vs Gmax with interpolation between sv'curves, R&C method	# 8 Fig4.18 # 6 # 8 Fig4.13	Clay Sand	1 to 6 (6 possible) 7 to 10 .25<sv'<8bar
CSR(Qc), t/s LEVEL ground Liquefaction SAND Resistance see NOTE #8	Seed's CSR vs N1(60) graph for specified equake Magnitude. Can include silty sand corr. for Zone 7. N1(60) from CPT correlations.	# 11 # 12	Sand	7 to 10 (6 possible)
CSR(Eq), t/s Cyclic Stress Ratio applied by design quake	$CSR(Eq) = 0.65 \frac{Amax}{g} \frac{sv}{svo'} rd$ Amax=max surface acceleratn including Amplification	# 12 # 3	Sand	7 to 10 (6 possible)
[Note: Input value from input file is used if defined, & not calculated]				
rd Reduction Factor to find CSR(Eq)	Digitized graph to use for depth vs rd: 1) Seed's mean 2) Fraser Delta	# 12 # 3	Sand	(6 possible) 7 to 10 0<depth<30m
FL, Safety Factor against Liquefaction	FL = CSR(Qc)/CSR(Eq)	# 3	Sand	7 to 10 (6 possible)
Qcr Critical Bearng required to resist Liquefctn	Qcr backcalculated from CSR(Eq) for a specified FL. Qcr is only for the given GWT,EOS,OS,Amax/g & Eq.Mag	# 12	Sand	7 to 10 (6 possible)
Su, Undrained Shear Strength of CLAY METHODS:	Nk: $Su = \frac{Qc - st}{Nk}$	# 8	Clay	1 to 6
	Nke: $Su = \frac{Qt - U2}{Nke}$		Clay	1 to 6
	Nkt: $Su = \frac{Qt - sv}{Nkt}$		Clay	1 to 6
	Nc: $Su = \frac{Qt}{Nc}$		Clay	1 to 6
see NOTE #9	NdU: $Su = \frac{dU2\ (dU1\ or\ dU3)}{NdU}$		Clay	1 to 6

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
Su/EOS	$Su/EOS = \frac{Su}{sv'}$	# 8	Clay	1 to 6
Ko (NC) Normally Consolidated	$(Ko)NC = 1 - \sin(f)$ see NOTE #10	# 8	Sand	7 to 10 (6 possible)
Ko (OC) Over Consolidated	$(Ko)OC = (Ko)NC \times OCR^{0.42}$	# 8	Sand	7 to 10 (6 possible)
E25 Youngs Modulus	E25 = alpha x Qt where user input alpha	# 8 4.11&12	Sand	(6) 7 to 10 0<Qt<500bar
M Constrained Modulus	CLAY: M = alpha x Qt where user input alpha SAND: Methods: Qt: M = alpha x Qt Baldi: $\frac{M}{Qt} = C0 \times pa \left(\frac{sv'}{pa}\right)^{C1} \times OCR^{C2} \times \exp(C3\ Dr)$	# 8 Tabl4.3 # 8 Fig4.10	Clay Sand Sand	1 to 6 7 to 10 (6 possible) 7 to 10
OCR (Clay) Over- Consolidation Ratio see NOTE #11	$OCR = \left[\frac{\frac{Su}{svo'}}{\left(\frac{Su}{svo'}\right)_{NC}}\right]^{1.25}$	# 6 # 8 Fig4.19	Clay	1 to 6
Ic Material Index After J&D(1993) see NOTE #18	$Ic = \left[\left(3-\log_{10}(Q(1-Bq))\right)^{2} + \left(1.5+1.3\log_{10} F\right)^{2}\right]^{0.5}$	# 13 # 17	All	All
Spt N(60) Standard Penetration Test (Blows/foot) at 60% Energy After J&D(1993) see NOTE #16	Qc/N = 8.5(1-(Ic/4.75)) where Qc in bars	# 13	All	All

Parameter	Methods	Refer. Number	Valid Soil Type	Valid Zone
State Parameter State, (e-units) Current Void Void Ratio minus Critical Void Ratio	$\text{State} = \dfrac{\ln\left\lvert\dfrac{3M + 8.5M/F}{Q(1-Bq)}\right\rvert}{11.9 - 1.33F}$ $M = \dfrac{6 \text{ Sin fcv}}{3 - \text{Sin fcv}}$ fcv = const. vol. Phi angle	# 14	All	All
Fines Content FC(%) Percent less than #200 Sieve After Davies,99	FC(%) = 42.4179(Ic) - 54.8574 FC(%) = 0% if Ic < 1.2933 FC(%) = 100% if Ic > 3.6508	# 15	All	All
OCR (Clay) Overcons. Ratio by Pore Press. U1 & U2 or U1 & U3 see NOTE #17	OCR = 0.5 + 1.50(PPD) PPD = (U1 - U2)/Uo or PPD = (U1 - U3)/Uo and default 0.5 & 1.5 are settable	# 16	Clay	1 to 6

1. Depth averaging may be in 0.5, 1, 2.5 or 5 ft. intervals or 0.1, 0.25, 0.5 or 1.0 m intervals, or no depth averaging if zero is selected. The average is the mean value of the readings in the interval. The depth value is the mid-depth of the averaged interval. It is convenient to start at half the depth averaging interval. For example, if you want "even" depths and the depth averaging is set at 0.50 m then start at 0.25 to get values of depth of 0.5, 1.0, 1.5, etc.

2. Basic input CPTU data columns are for Depth, Qc, Fs, U1, U2, U3, INC and TEMP may be selected. In addition the following parameters may also be specified as an INPUT data column: Qt, Gamma, Uo, Spt N, Rf Zone, Bq Zone and CSR(EQ). These values will be used where required to obtain other interpreted parameters. If they are not specified the program will estimate them when they are required. For example, you can create an OUTPUT data file of any of the above parameters and then edit some or all of the values to suite your measurements or your desires to specify their values. You can do that with "Gamma" values to input your measurements of unit weight, or with "Uo" if you want to input values of pore water pressure other than hydrostatic, or with any of the other input parameters. You would use your edited file of adjusted data as your new INPUT data file. Thus, you can specify these parameters if you want to override the Program's values.

You can also use the designated value of "9E9" to denote an unknown value.

You can use the "OTHER" designation to input other data that exists on your input file and identify its units. This allows you to output it, without operating on it, if you choose.

It is best NOT to use depth averaging when using input data that is not continuous at regular depth intervals. Always use DEPTH AVERAGING with extreme caution since the program averages ALL INPUT parameters over the interval chosen irregardless of soil type. Careful use of start and end depth choises can make depth averaging very effective.

3. Since there is no data in the file within the initial depth interval, a default Gamma (unit weight) must be specified from the surface to the starting depth. This is done in the "Param" Menu in units of kN/m^3 (1kN/m^3=6.36pcf). Also, you can specify the values of Gamma to be used by the program as in NOTE #2 above.

4. If pore pressures are not measured by the cone then the program will take Qc as being equal to Qt for all interpretations requiring Qt. Also, Uo may be specified in the input file as a column of Uo vs depth values, if the water pressures are not hydrostatic. See NOTE #2 for more info on customizing input data.

5. You can choose to use either the Rf classif. Zone or the Bq classif. Zone to divide soil into Undrained Parameters (Zones 1 to 6) and Drained Parameters (Zones 7 to 10) in the "Param" Menu. (However, in order to use the Bq Zone you must have Pore Pressure, U2, data.) Also, you may choose to switch Zone 6 to a Drained Zone from its Undrained Zone status. This is done if you feel that the soil identified as Zone 6 (sandy silt) is really coaser (using other sources of information) and/or you want it analyzed as a Drained rather than Undrained soil. Finally, the soil behavior names in each zone were shortened in version 5.0 for simplicity. For example, Zone 6 was named "sandy silt to clayey silt" but was shortened to "sandy silt".

6. Spt N is the same as Spt N(60) for 60% transferred energy. This value is calculated from the Qt/N ratios given for each Soil Zone (you can specify either Rf or Bq Zone) and these values are used in the Level Ground Liquefaction analysis. Values of Spt N may be specified in the Input File, if indepedently measured values are to be used. We suggest that you not use depth averaging if you only have selected Spt N values at a few depths. You may use "9E9" for missing data.

7. If Dr values are negative then soil is very loose or likely more of an undrained soil like a silty sand rather than a drained soil for which the Dr correlations were developed. Use Dr interpretations very cautiously since they also assume the soil is free draining, uncemented, unaged and has the same compressibility of grains as the soil used for the correlations in chamber calibration tests.

8. The simplified sand liquefaction analysis for level ground according to Seed et al requires Spt N1(60) and earthquake magnitude to obtain the cyclic stress ratio to cause liquefaction, CSR(Qc). The design maximum ground acceleration, the depth-reduction factor, Rd, and overburden total and effective stresses are required to calculate the cyclic stress ratio applied by the design earthquake, CSR(EQ). The program estimates the N1(60) values from the cone stresses, the operator identifies the earthquake magnitude and Seed et al chart is used to get CSR(Qc). The program also calculates CSR(EQ) from the user specified maximum ground acceleration including any amplification factors, the calculated overburden stresses and either Seed's mean or the Fraser Delta Rd factor. The Fraser Delta is used only when amplification factors of the order of 2 or more are used. See Reference Nos. 3, 6, 11 and 12 for more information. The user can INPUT specific values for Spt N, CSR(EQ), Soil Zones, Gamma's, etc. in order to customize the analysis for the existing data base of information. It is recommended that you do not use depth averaging when using specific input data but make calculations at specific depths where external input data exists. The calculated value of Qcr is the minimum value of cone bearing stress required at a given depth such that the factor of safety against liquefaction, or the ratio FL = CSR(Qc)/CSR(EQ) have the specified value for a given earthquake magnitude, max. ground acceleration, depth reduction factor, and calculated overburden stresses. This value of Qcr is useful to identify the required minimum level of soil improvement for a given design condition.

9. The NdU method to calculate undrained shear strength has been extended to allow the user to choose either dU1, or dU2 or dU3 provided such pore pressure measurements exist.

10. The Overconsolidation Ratio, OCR, for the sand must be estimated by the user in the "Param" menu if you want to estimate Ko in the sand layers. For the typical normally consolidated sand, OCR = 1.0.

11. It is currently only possible to estimate the OCR for a clay, which makes use of the correlations obtained from extensive laboratory tests.

12. An improved calculation and print routine was added to version 5.0 which uses swap routines to reduce memory requirements, but slows down the calculations.

13. The classification charts for Rf has been extended at all boundaries such that values of Rf>8 and values of Qc<1.00 are possible. The Bq classification chart which requires dU2 and can now accept values of Bq>1.2 and Qt<1. Unfortunately, this feature does not work.

14. Version 5.1ppd added several enhancements to the program. You may input an average vertical flow gradient, which is applied over the entire profile depth to be analysed so adjust the depth of interest accordingly. Zero gives hydrostatic and no flow, a negative gradient is upward flow which increases pore pressure and reduces vertical effective stress. A positive gradient gives downward flow.

15. A State Parameter or current void ratio minus critical void ratio is calculated according to the paper by Ref. 14, Plewes, Davies and Jefferies, 1994.

16. An alternate method to estimate SPT from CPT is provided according to Ref. 13, Jefferies and Davies, 1993 in ASTM.

17. An alternate method to estimate OCR in clays is provided which uses the measured pore pressure difference, ppd, so both U1 and U2 or U1 and U3 must be measured at the same time. (see Ref. 16)

18. Version 5.2 added the value Ic (Material Index) according to Jefferies & Davies, 1993, 1991 (Ref. 13 & 17) which combines all Normalized parameters Q, F and Bq.
(Note: QtN was changed to Q and RfN to F.)

18A. In Version 5.2, if at any depth the value of Bq>1 (in very sensitive saturated soil)then Bq is made equal to 0.99. Also, if Rf>8 it is made 7.99. These changes have a negligable effect on the results.

19. FC(%) or percent of dry weight less than #200 sieve (.074mm) was also added according to Davies, 1999 Ref.#15)

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GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 1 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 4-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
				BB-1						
105								SP	@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), lite brown, slightly moist, fine grained, poorly graded	
	5			R1	3 5 10			SP-SM	@5': SAND with Silt (SP-SM), medium dense, lite brown, dry, fine grained, micaceus, poorly graded	
100										
	10			R2	7 10 11	105	3	SP	@10': SAND (SP), medium dense, lite brwn, dry, fine grained with thin beds of silt and laminated clay	
95										
	15			R3	6 11 14				@15': micaceous	
90				R4	1 3 3			CL	@18': Silty Sandy CLAY (CL), soft, lite grey, very moist, micaceous with very thin beds of fine grained sand and silt	AL, CN
	20									
								SP		
85									@23': encounter groundwater, measured @ 23.5 feet below ground surface during drilling	
	25			R5	3 14 16	104	21		@25': SAND with Silt (SP-SM), medium dense, lite brown, wet, fine grained, micaceous	
								ML	@26.5': thinly bedded Clayey SILT (ML) with fine grained sand, micaceous	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	2 4 6			CL	@30': Silty CLAY with Sand (CLs), firm, olive grey to blackish grey, moist, fine grained sand, micaceous with thinly bedded fine grained sand	
75								SM		
	35			R7	5 14 18				@35': Silty SAND (SM), medium dense, greyish black, wet, fine grained sand, micaceous	
70										
	40			R8	3 7 10			CL	@40': Silty CLAY (CL), stiff, mottled olive brown to medium grey, very moist, micaceous, laminated, coarse sand sized calcareous nodules	
65										
	45			R9	5 11 11			SM CL	@45': Silty SAND (SM), medium desne, dark grey, wet, fine grained, micaceous becomes Silty CLAY (CL) @ 46', stiff, olive brown to grey, very moist, micaceous with trace of fine grained sand	
60										
	50			R9	3 8 10			SM	@50': Silty SAND (SM), medium dense, greyish black, wet, fine grained, micaceous	
55										
	55			R11	3 5 9			CL	@55': Silty CLAY (CL), stiff, olive brown to medium grey, wet, some fine sand in clayey matrix	
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-1

Date 3-23-11 **Sheet** 3 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77831 W 117.91697

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R12	5 6 11			ML-CL	@60': Clayey SILT to Silty CLAY (ML-CL), stiff, olive brown to orange brown to dark grey, wet, micaceous, thinly bedded, soft sediment deformation as undulating uneven abrupt contacts	
45										
	65			R13	9 10 14			ML	@65': Sandy SILT (ML), stiff, dark grey, wet, fine grained, micaceus, trace clay, organic debris (buried plant matter), charcoal flakes	
40										
	70			R14	16 50/5"			CL SP	@70': <u>**Quaternary Old alluvial fan (Qof)**</u> Sandy CLAY (CL), hard, mottled olive brown to grey, slightly moist, coarse sand, some silt @71': Gravelly SAND (SPg), dense, orange brown, wet, coarse sand, fine rounded gravel	
35										
	75			R15	8 9 21			ML	@75': Sandy SILT (ML), stiff, olive grey to orange brown, moist, fine grained sand	
30								GP	@78': encountered gravel, small cobbles during drilling	
									@80': SAND (SP), dense, orange brown, very moist, fine to coarse sand with thinly bedded silty clay	
	80			R16	5 13 48			SP		
25									Total depth 81.5' Groundwater measured at 23.5' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling then capped with cold patch asphalt	
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 **Sheet** 1 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 107' **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	0							SM	@0': **Artifical fill (Afu) undocumented** 10-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris and some fine angular gravel	
105				BB-1						
									@3': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), lite brown, slightly moist, fine grained, micaceous, poorly graded	
	5			R1	7 9 14					
100										
	10			R2	5 9 10	99	3	SP-SM	@10': SAND with Silt (SP-SM), medium dense, lite brown, fine grained, micaceous, poorly graded	DS
95										
	15			R3	9 19 26			ML	@15': Sandy SILT (ML), hard, olive brown, very moist, micaceous, with thin beds of fine sand	
90								CL	@18': Silty CLAY (CL), soft, olive brown, very moist, micaceous, trace fine grained sand as thinly interbedded deposits <1" thick	
	20			R4	3 4 5	93	30			Tx, AL
85									@23': measured groundwater @ 23' below ground surface during drilling	
	25			R5	6 12 18			ML	@25': Sandy SILT o Silty SAND (ML-SM), very stiff to medium dense, olive brown, wet, fine grained, micaceous, thinly bedded	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 | **Sheet** 2 **of** 3

Project 602778-002- McWhinney Development | **Logged / Sampled By**

Drilling Co. Martini | **Type of Rig** CME-75

Hole Diameter 8 | **Drive Weight** 140 Lbs Autohammer | **Drop** 30"

Elevation Top of Hole 107' | **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	2 4 4	84	41	CL	@30': Silty CLAY (CL), soft, greyish black, very moist, micaeous with thinly bedded fine grained sand	
75										
	35			S1	2 4 6			SM ML-CL	@35': Silty SAND (SM), lose, olive brown to grey, fine grained, wet @36': Silty CLAY to Clayey SILT (ML-CL), soft, olive grey, wet, micaceous	
70										
	40			R7	2 4 6				@40': with thin beds of fine frained sandy silt	
65										
	45			R8	8 9 7	100	26	CL	@45': Silty CLAY (CL), stiff, grey, wet, micaceous, some fine sand and calcareous nodules	Tx
60										
	50			S2	2 5 12			SM	@50': soft @51': Silty SAND (SM), medium dense, grey, wet, fine grained sand, poorly graded	
55										
	55			S3	0 4 6			CL	@55': CLAY (CL), soft, olive grey, wet, some thin interbeds of fine grained sand and fine gravel sized calcareous nodules	
50										
	60									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-2

Date 3-21-11 **Sheet** 3 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 107' **Location** N 33.77896 W 117.91590

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R9	4 9 13	87	36	ML	@60': Clayey SILT (ML), stiff, mottled orange brown to olive brown, moist, fine gravel sized calcareous nodules	
45										
	65			S4	4 6 7			ML-CL	@65': Silty CLAY to Clayey SILT (ML-CL), firm, greyish black, moist with thin interbeds of sandy silt	
40										
	70			R10	19 50/6"	115	13	SP	@70': **Quaternary Old alluvial fan (Qof)** drilling becomes difficult to advance, sampler refusal at 71' bgs SAND (SP), very dense, lite yellow brown, wet, fine to coarse sand, some mica, well graded	
35										
	75			S5	11 24 31				@75': coarse sand and fine gravel, wet	
30										
	80			R11	7 12 41			SP ML	@80': SAND (SP), with bedded SILT (ML), dense, yellow brown to orange brown, moist silt to wet sand, trace clay in matrix	
25									Total depth 81.5' Groundwater measured at 23' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 1 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							GM SM	@0': **Artifical fill (Afu) undocumented** Sandy GRAVEL (GM), at surface, 1' thick, reddish brown sandy matrix, fine to coarse sand, fine to coarse angular to sub rounded gravel and aspahlt debris @1': SIlty SAND (SM), dark brown, moist, fine grained, trace asphalt debris	
				BB-1						
105									@3': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), medium dense, brown, slightly moist, fine grained, micaceous	
	5			R1	6 7 10					
100										
	10			R2	9 10 13	100	4	SP-SM	@10': SAND with Silt (SP-SM), medium dense, lite brown, dry, fine grained	
95										
	15			R3	5 12 17			ML	@15': Sandy SILT (ML), very stiff, oxidized orange brown, dry, fine grained	
90										
	20			R4	0 3 4	90	33	CL	@20': Silty CLAY (CL), soft, olive brown, moist, trace coarse sand sized calcareous nodules with interbedded fine grained sand	AL, DS, CN
85									@23.3': measured groundwater @23.3' bgs during drilling	
	25			R5	2 8 7			SM-ML	@25': Sandy SILT to Silty SAND (ML-SM), stiff to medium dense, olive brown, wet, fine grained, micaceous, thinly interbedded	
80										
	30									

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	30			R6	5 4 5	98	25	SP CL	@30': SAND (SP), soft, loose, dark grey, wet, fine to coarse grained, well graded, abrupt contact with underlying clay @31.5': CLAY (CL), dark grey, moist, trace fine grained sand	
75										
	35			R7	7 17 15			SP	@35': SAND (SP), medium dense, grey, wet, medium to coarse grained sand, trace fine rounded gravel with tin interbeds of sandy clay	
70										
	40			R8	3 5 8			CH	@40': Silty fat CLAY (CH), stiff, mottled olive brown to medium grey, moist, micaceous with thin beds of silt and fine grained sand	AL, CN
65										
	45			R9	4 6 6				@45': Sandy CLAY (CL), stiff, mottled olive brown to grey, moist, micaceous,	
60										
	50			R10	4 12 22	102	24	SM-ML ML	@50': Sandy SILT (ML), soft, olive brown, wet, some clay	
55										
	55			R11	4 8 10			CL-ML	@55': Silty CLAY (CL) to Clayey SILT (ML), stiff, olive brown, moist, trace coarse sand sized calcareous concretions	
50										
	60									

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

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

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

GEOTECHNICAL BORING LOG B-3

Date 3-21-11 **Sheet** 3 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 108' **Location** N 33.77957 W 117.91578

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	60			R12	4 8 12			CL	@60': Silty CLAY (CL), stiff, mottled olive brown to orange brown, oxidized, trace coarse sand sized calcareous nodules	
45										
	65			S1	0 2 4				@65': soft, thinly bedded silt and clay, micaceous	
40										
	70			S2	10 21 25			SP	@70': **Quaternary Old alluvial fan (Qof)** SAND (SP), very dense, lite yellow brown, wet, fine to coarse sand, some fine rounded gravel, well graded	
35										
	75									
30										
	80			S3	4 13 30			SP CL	@80': Sandy CLAY (CL), soft, orange brown, moist, oxidized, fine to coarse sand @80.5': SAND (SP), dense, lite grey to orange brown, wet, fine to coarse sand	
25									Total depth 81.5' Groundwater measured at 23.3' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
	85									
20										
	90									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 1 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
	0							SP	@0': **Artifical fill (Afu) undocumented** SAND (SP) subgrade, lite brown, dry, medium to coarse sand, asphalt debris	
				BB-1						
105										
									@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), loose, lite grey, very moist, fine grained, poorly graded	
	5			R1	4 5 8					
100										
	10			R2	5 6 7			SM	@10': SAND (SP), loose, lite grey, moist, fine grained sand @11': becomes Silty SAND (SM), loose,mottled lite grey to lite brown, moist	
95										
	15			R3	8 14 19			SP	@15': SAND (SP), medium dense, greyish white, dry, fine to medium sand and fine, rounded gravel	
90										
	20			R4	6 3 4			CL	@20': SAND (SP), loose, tannish brown, moist, medium to coarse sand @21': becomes CLAY (CL), stiff, brown to dark grey, very moist, some fine sand, thinly bedded	
85										
	25			R5	2 4 8			SM	@25': Silty CLAY (CL), stiff, bluish grey, moist, fine grained sand @26.5': becomes SIlty SAND (SM), loose, grey, very moist, fine grained @25.4': measured groundwater at 23.4' bgs during drilling	
80										
	30									

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

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

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

GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30			R6	10 21 22			SP	@30': SAND (SP), medium dense, lite grey, wet, fine to medium grained sand	
75										
	35			R7	4 12 20			CL	@36': Silty CLAY (CL), grey, moist, laminated	
70										
	40			R8	3 5 8				@40': Fat CLAY (CH), stiff, grey, very moist, trace fine grained sand and silt	AL, CN
65										
	45			R9	4 5 8				@45': Silty CLAY (CL), firm, grey, wet	
60										
	50			R10	4 11 15			SM	@50': Silty SAND (SM), medium dense, grey, wet, fine grained	
55										
	55			R11	4 8 10			CL	@55': Silty Sandy CLAY (CLs), stiff, grey, moist, fine grained sand	
50										
	60									

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

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

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

GEOTECHNICAL BORING LOG B-4

Date 3-22-11 **Sheet** 3 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 108' **Location** N 33.77977 W 117.91693

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION	Type of Tests
									The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	
	60			R12	6 8 11			CL	@60': Silty CLAY (CL), stiff, mottled grey and brown, very moist	
45										
	65			R13	3 11 26			ML	@65': **Quaternary Old alluvial fan (Qof)** CLAY (CL), hard, mottled grey and olive green, moist, some silt and fine grained sand @66': Sandy SILT (MLs), hard, mottled olive bronw to orange brown, wet, fine grained sand	
40										
	70			R14	8 9 13			SP	@70': Sandy SILT (MLs), stiff, bluish grey, moist, fine grained sand @71': Silty Clayey SAND (SM-SC), medium dense, brown, wet, fine to medium grained sand	
35										
	75			R15	11 17 15				@75': SAND (SP), medium dense, brown, wet, fine grained sand, trace silt	
30									@80': CLAY (CL), stiff, brown, very moist, laminated, some tine beds of fine to medium sand	
	80			S1	5 13 11			CL		
									Total depth 81.5' Groundwater measured at 25.4' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
25										
	85									
20										
	90									

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

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

GEOTECHNICAL BORING LOG B-5

Date 3-23-11 **Sheet** 1 **of** 2

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 106' **Location** N 33.77846 W 117.91640

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
105	0							SM	@0': **Artifical fill (Afu) undocumented** 3.5-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris, micaceous	RV, CR
				R1 BB-1	3 4 5			ML	@2': Sandy SILT (ML), soft, mottled dark brown to blackish brown, moist, fine grained, trace clay	
									@3': **Quaternary young alluvial fan (Qyf)** SAND (SP), medium dense, llite grey to lite brown, dry, fine grained, micaceous, poorly graded	
100	5			R2	4 8 8			SP		
				R3	4 5 7			ML	@7': Sandy SILT (ML), stiff, dark brown, moist, fine grained, micaceous	CN
95	10			S1	2 3 4			SM	@10': Silty SAND (SM), loose, lite brown, slightly moist, fine grained, micaceous, poorly graded	
90	15			S2	2 5 9			ML SM	@15': Clayey SILT (ML), firm, olive brown to orange brown, moist, micaceous @16': Silty SAND (SM), medium dense, orange brown, moist, fine grained, micaceous	
								ML-CL	@19': Clayey SILT to Silty CLAY (ML-CL), firm, olive brown to orange brown, very moist, micaceous, trace fine sand, @22': becomes sandy, fine grained	
85	20			R4	3 5 5	93	31			Tx
								SP		
									@23.2': measured groundwater during drilling	
80	25			S3	0 2 6			SM	@25': Silty SAND (SM), loose, brown, wet, fine grained	
								CL	@26.5': CLAY (CL), firm, olive brown to grey, moist	
	30									

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

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

GEOTECHNICAL BORING LOG B-5

Date 3-23-11 **Sheet** 2 **of** 2

Project 602778-002- McWhinney Development **Logged / Sampled By**

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 106' **Location** N 33.77846 W 117.91640

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
75	30			R5	3 4 7			SM CL	@30': Silty SAND (SM), loose, dark grey, wet, fine grained, micaceous,poorly graded, uneven abrupt contact with Clay below @31': CLAY (CL), firm, olive brown to greyish black, moist	CN
70	35			S4	5 7 11			SM	@36.5': Silty SAND (SM), medium dense, greyish black, wet, fine grained	
65	40			R6	2 5 11			CL	@40': Silty CLAY (CL), stiff, olive brown to grey, very moist	
60	45			S5	2 3 4			SM CL	@45': Silty SAND (SM), loose, dark grey, wet, fine grained sand, micaceous, poorly graded @46': Silty CLAY (CL), firm, dark grey, moist, trace fine grained sand, micaceous	
									Total depth 46.5' Groundwater measured at 23.2' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
55	50									
50	55									
	60									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

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

GEOTECHNICAL BORING LOG B-6

Date	3-21-11	**Sheet**	1 **of** 1
Project	602778-002- McWhinney Development	**Logged / Sampled By**	
Drilling Co.	Martini	**Type of Rig**	CME-75
Hole Diameter	8	**Drive Weight**	140 Lbs Autohammer — **Drop** 30"
Elevation Top of Hole	107'	**Location**	N 33.77898 W 117.91653

SOIL DESCRIPTION

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

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	Soil Description	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 9-inches asphalt concrete over Silty SAND (SM) subgrade, dark brown, dry, fine grained sand, micaceous, trace wire debris and concrete fragments	
105				R1 BB-1	4 7 9				@2': Silty SAND (SM), medium dense, dark brown, moist, fine to coarse sand, trace fine angular gravel	
	5								@4': **Quaternary young alluvial fan (Qyf)** Silty SAND (SM), lite brown, slightly moist, fine grained, poorly graded	
100				R2	5 7 11			ML	@7': Sandy SILT (ML), stiff, olive brown, moist, fine grained sand, micaceous	
	10									
95				R3	8 12 13			SP-SM	@12': SAND with Silt (SP-SM), medium dense, lite grey, dry, fine grained, porly graded	
	15									
90				R4	6 5 6			ML	@17': loose, moist @18': Sandy SILT (ML), soft, olkive brown, moist, fine grained, micaceous	
	20									
85				R5	4 5 9			ML-CL	@23': Clayey SILT to Sily CLAY (ML-CL), firm, dark grey, moist, trace fine sand, porous, sparse voids to 1-3 mm in size, unlined, thinly bedded	
	25								Total depth 24.5 Groundwater not encountered during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
80										
	30									

SAMPLE TYPES:

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

TYPE OF TESTS:

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

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

GEOTECHNICAL BORING LOG B-7

Date 3-23-11 **Sheet** 1 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77808 W 117.91544

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	0							SM	@0': **Artifical fill (Afu) undocumented** 2-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
105										
				R1 BB-1	3 7 11			ML SP	@2': Sandy SILT (MLs), stiff, mottled lite brown to drak brown, moist, fine grained, micaceous, some asphalt fragments, trace clay @3': **Quaternary young alluvial fan (Qyf)** SAND (SP), medium dense, lite brown, slightly moist, fine grained, poorly graded	
	5									
100				S1	2 5 5					
				R2	3 7 10				@7': medium dense, trace coarse grained sand	
	10									
95				S2	2 3 4				@10': loose, dry	
	15									
90				R3	9 14 14			SM	@15': Silty SAND (SM), medium dense, olive brown, very moist, fine grained, micaceous	
				R4	1 2 6			CL	@19': Sandy CLAY (CLs), soft, olive brown, very moist, fine grained sand, micaceous	
	20									
85									@21': Silty SAND (SM), greyish brown, wet, fine grained sand	
								SM	@21.8': measured groundwater at 21.8' during drilling	
	25									
80				S3	2 3 12			CL	@25': Silty CLAY (CL), soft, olive brown, very moist, laminated to thinly bedded with fine grained sand	
								SM		
				R5	3 4 6			CL	@28.5': Silty SAND (SM), loose, brown, wet, fine grained overlying Sandy CLAY (CLs), soft, medium grey, very moist	
	30									

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

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

GEOTECHNICAL BORING LOG B-7

Date 3-23-11 **Sheet** 2 **of** 2
Project 602778-002- McWhinney Development **Logged / Sampled By**
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77808 W 117.91544

Elevation Feet	Depth Feet	Graphic Log (N / S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
	30									
75									Total depth 30' Groundwater measured at 21.8' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
	35									
70										
	40									
65										
	45									
60										
	50									
55										
	55									
50										
	60									

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

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

GEOTECHNICAL BORING LOG B-8

Date 3-22-11 **Sheet** 1 **of** 3

Project 602778-002- McWhinney Development **Logged / Sampled By** J Roe

Drilling Co. Martini **Type of Rig** CME-75

Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"

Elevation Top of Hole 106' **Location** N 33.77939 W 117.91585

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
105	0							SP	@0': **Artifical fill (Afu) undocumented** 4-inches asphalt concrete over Silty SAND (SM) subgrade, brown, dry, fine to coarse sand, asphalt debris	
				BB-1						
									@4': **Quaternary young alluvial fan (Qyf)** SAND (SP),medium dense, lite brown, slightly moist, fine grained, trace fine rounded gravel	
100	5			S1	6 6 6					
95	10			R1	7 10 13			SM	@10': Silty SAND (SM), medium dense, brown, moist, fine grained sand	
90	15			S2	2 6 9			SP	@15': SAND (SP), medium dense, lite brown, moist, fine to mdeium grained sand	
85	20			R2	5 5 5			CL	@20': SAND (SP), loose, orange brown, wet, coarse grained sand, becomes CLAY (CL), medium stiff, grey, wet, encounter perched groundwater during drilling	
				R3	3 4 7				@22': CLAY (CL), stiff, grey, moist, trace calcareous nodules	
80	25			S3	2 3 3			ML	@25': Sandy SILT (MLs), stiff, lite grey, very moist, fine grained sand	
	30									

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

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

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

GEOTECHNICAL BORING LOG B-8

Date 3-22-11 **Sheet** 2 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By** J Roe
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77939 W 117.91585

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
75	30			R4	8 13 16			SP-SM SM	@30': SAND with Silt (SP-SM), medium dense, grey, wet, fine grained, becomes Silty SAND (SM), medium dense, grey, wet, fine grined	
				R5	8 8 10			ML	@32': Silty SAND (SM), medium dense, grey, very moist, fine grained, becomes Sandy SILT (MLs), stiff, grey, very moist, fine grained sand	
70	35			R6	4 10 15			SP	@35': SAND (SP), medium dense, grey, wet, fine grained	
65	40			R7	2 5 6			CL	@40': Silty CLAY (CL), stiff, brown, very moist, laminated	
				R8	3 5 8				@42': mottled grey to brown	
60	45			R9	2 5 9				@45': Sandy CLAY (CLs), stiff, grey, very moist, fine grained sand, becomes Clayey SAND (SC), loose, grey, wet, fine grained	
				R10	2 5 6			ML	@47': Sandy SILT (MLs), stiff, lite grey, wet, fine grained sand	
55	50			S4	2 4 7			CL	@50': Silty CLAY (CL), stiff, greyish brown, very moist, fine grained sand	
50	55			R11	4 7 10				@55': CLAY (CL), stiff, mottled olive brown to grey, moist	
	60									

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

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

GEOTECHNICAL BORING LOG B-8

Date 3-22-11 **Sheet** 3 **of** 3
Project 602778-002- McWhinney Development **Logged / Sampled By** J Roe
Drilling Co. Martini **Type of Rig** CME-75
Hole Diameter 8 **Drive Weight** 140 Lbs Autohammer **Drop** 30"
Elevation Top of Hole 106' **Location** N 33.77939 W 117.91585

Elevation Feet	Depth Feet	Graphic Log (N S)	Attitudes	Sample No.	Blows Per 6 Inches	Dry Density pcf	Moisture Content, %	Soil Class. (U.S.C.S.)	SOIL DESCRIPTION The Soil Description applies only to a location of the exploration at the time of drilling. Subsurface conditions may differ at other locations and may change with time. The description is a simplification of the actual conditions encountered. Transitions between soil types may be gradual.	Type of Tests
45	60			R12	3 9 11			ML CL	@60': Sandy SILT (MLs), stiff, mottled brown to grey, very moist, fine grained sand, becomes CLAY (CL), stiff, mottled grey to brown, very moist	
40	65			R13	4 14 20			SM	@66': **Quaternary Old alluvial fan (Qof)** Silty SAND (SM), dense, grey, very moist, fine grained sand	
35	70			S5	11 27 48			SP	@70': SAND (SP), very dense, tannish brown, moist, fine grained	
30	75									
25	80			S6	5 13 14			SM	@80': Silty SAND (SM), medium dense, brown, very moist, fine grained	
									Total depth 81.5' Groundwater measured at 20' bgs during drilling Boring backfilled with soil cuttings and benonite grout upon completion of drilling	
20	85									
	90									

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

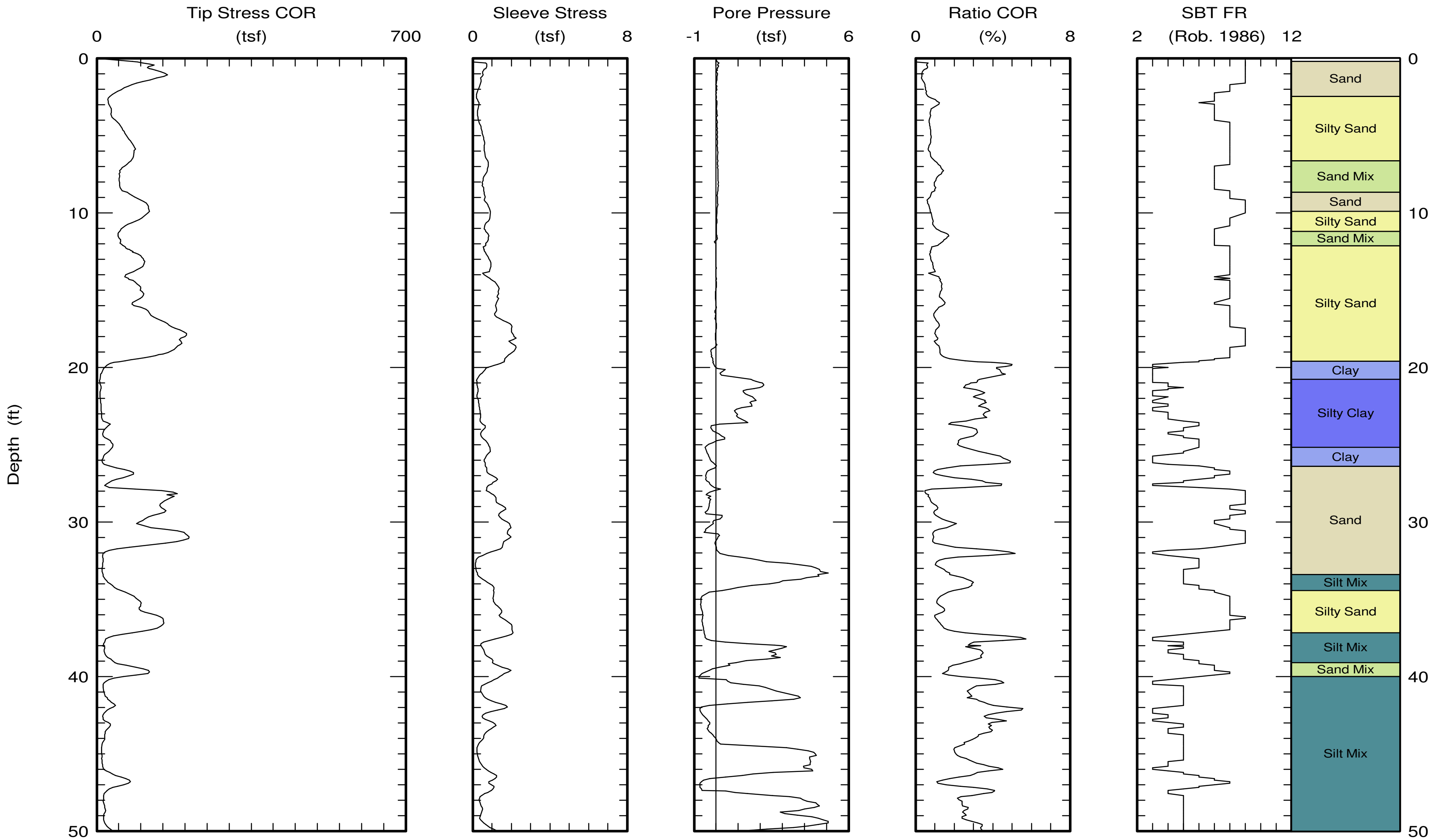
TYPE OF TESTS:
- DS DIRECT SHEAR
- MD MAXIMUM DENSITY
- CN CONSOLIDATION
- CR CORROSION
- UC UNCONFINED COMPRESSIVE STRENGTH
- SA SIEVE ANALYSIS
- SE SAND EQUIVALENT
- EI EXPANSION INDEX
- RV R VALUE
- -200 % FINES PASSING
- AL ATTERBERG LIMITS
- CO COLLAPSE
- PP POCKET PENETROMETER

Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-1
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd



Maximum depth: 50.46 (ft)
Page 1 of 2

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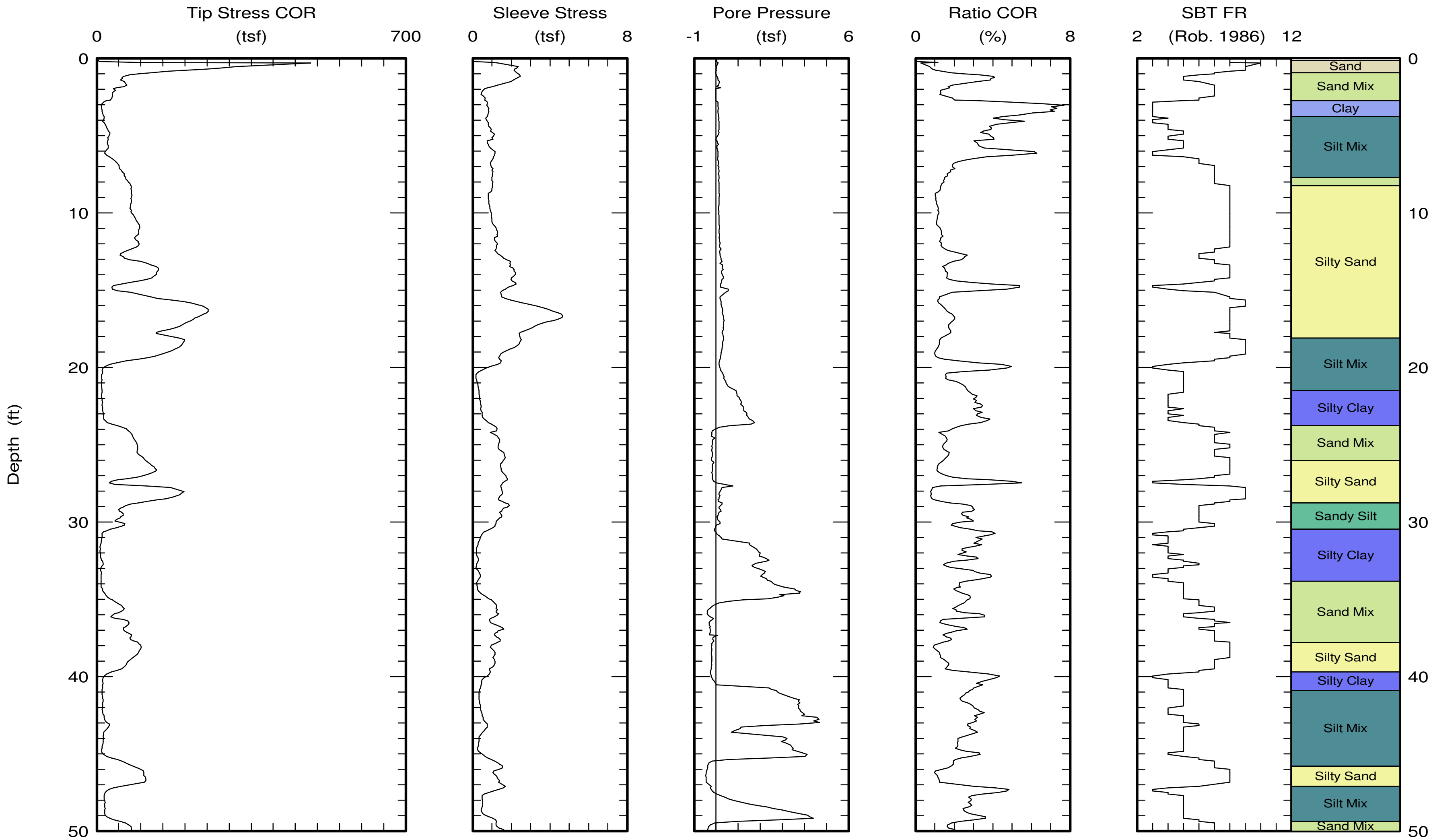
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-2
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd

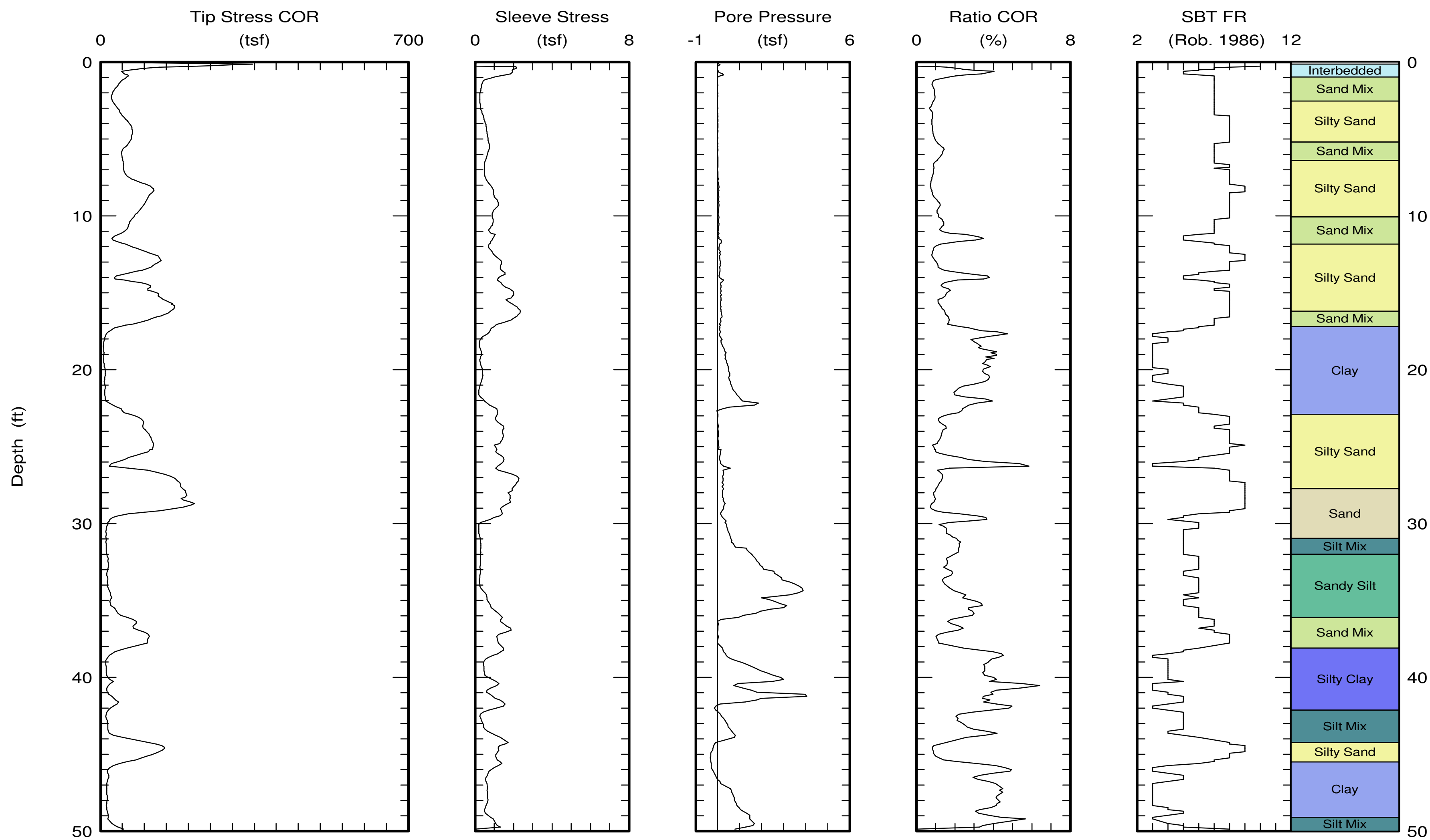


Maximum depth: 50.28 (ft)

Page 1 of 2

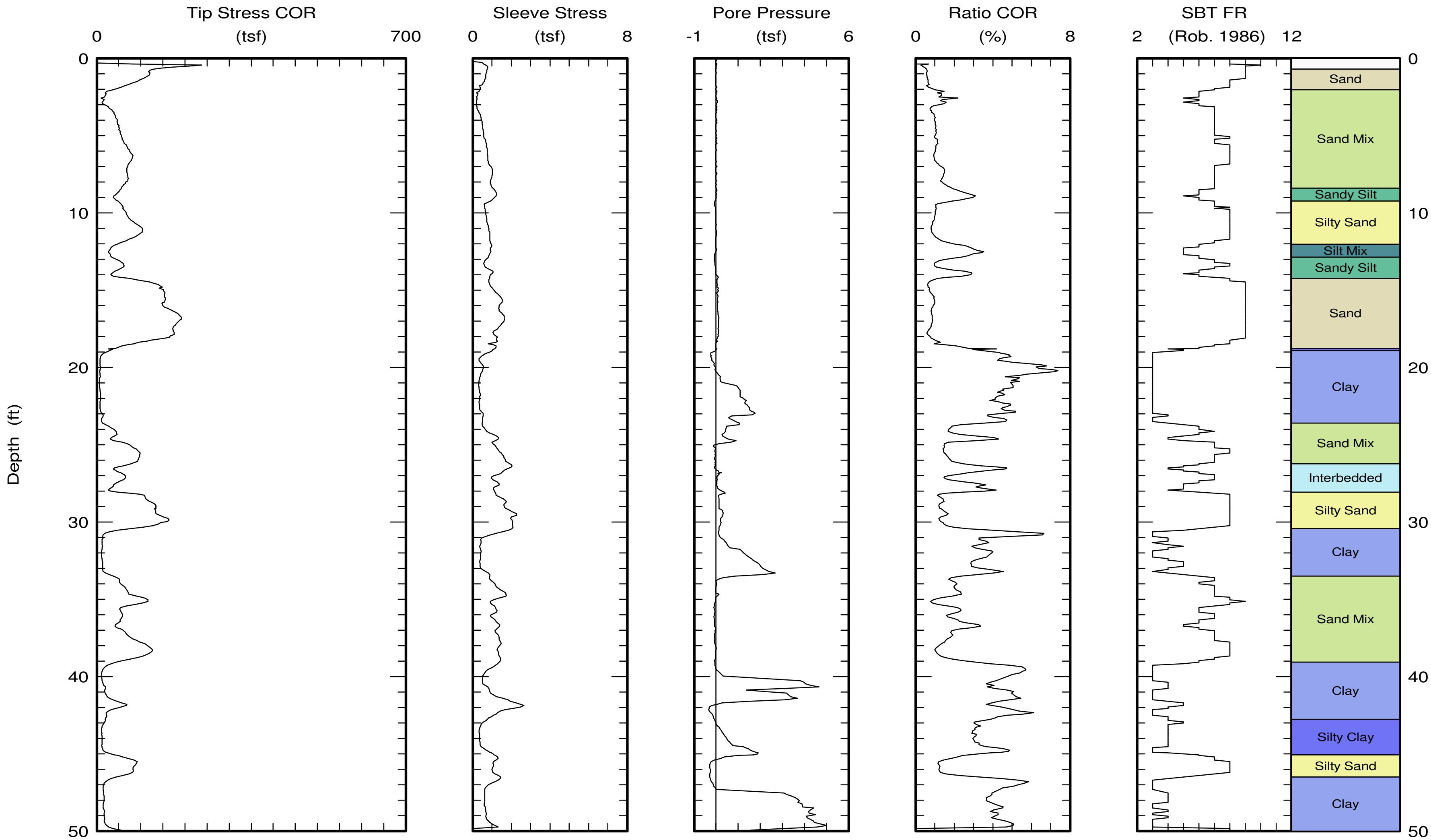
Test ID: CPT-2
File: Z30N0902C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-3 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 50.23 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-4 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



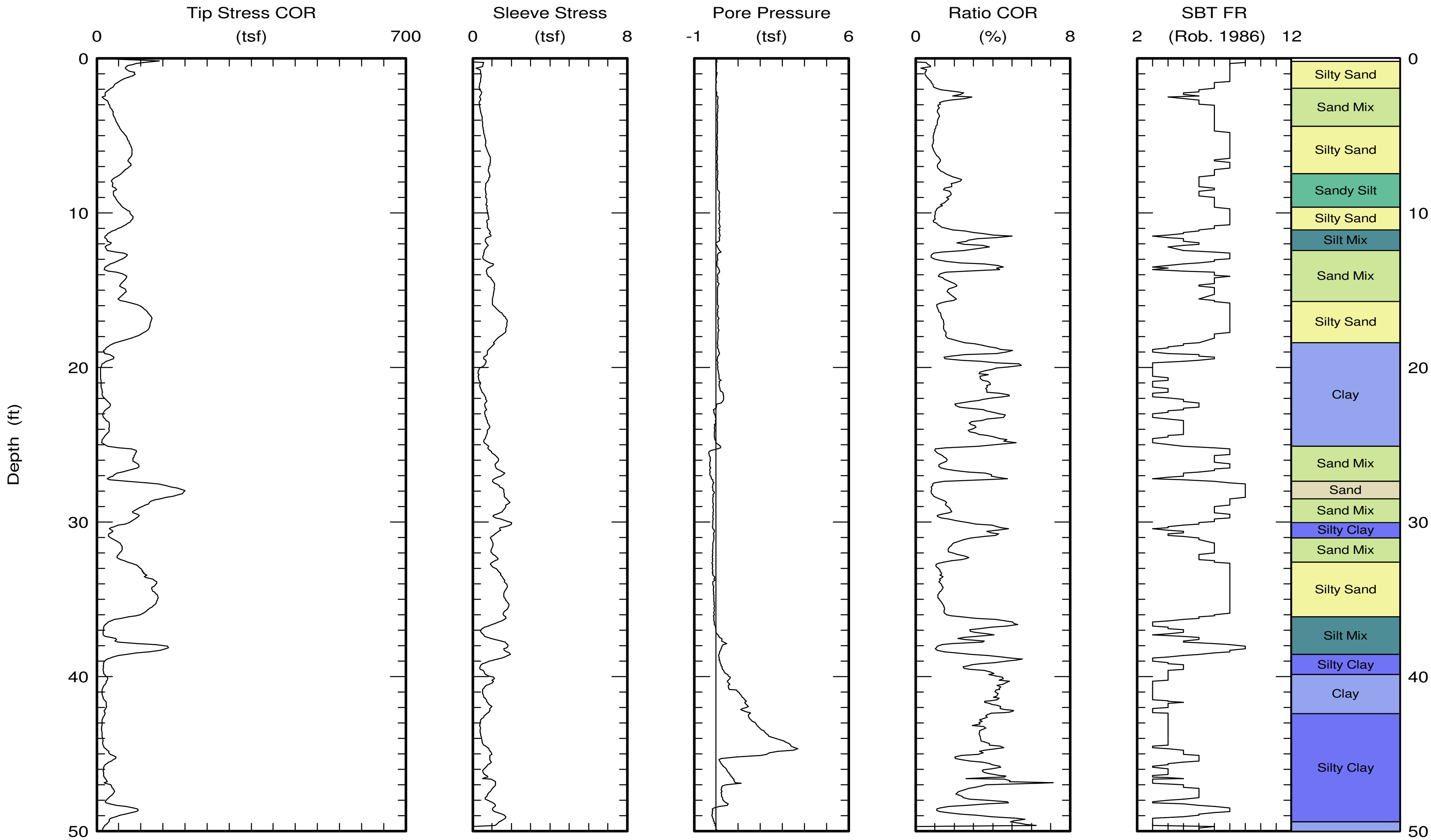
Maximum depth: 50.14 (ft)

Page 1 of 2

Test ID: CPT-4

File: Z30N0904C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-5 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	



Maximum depth: 50.02 (ft)

Kehoe Testing & Engineering
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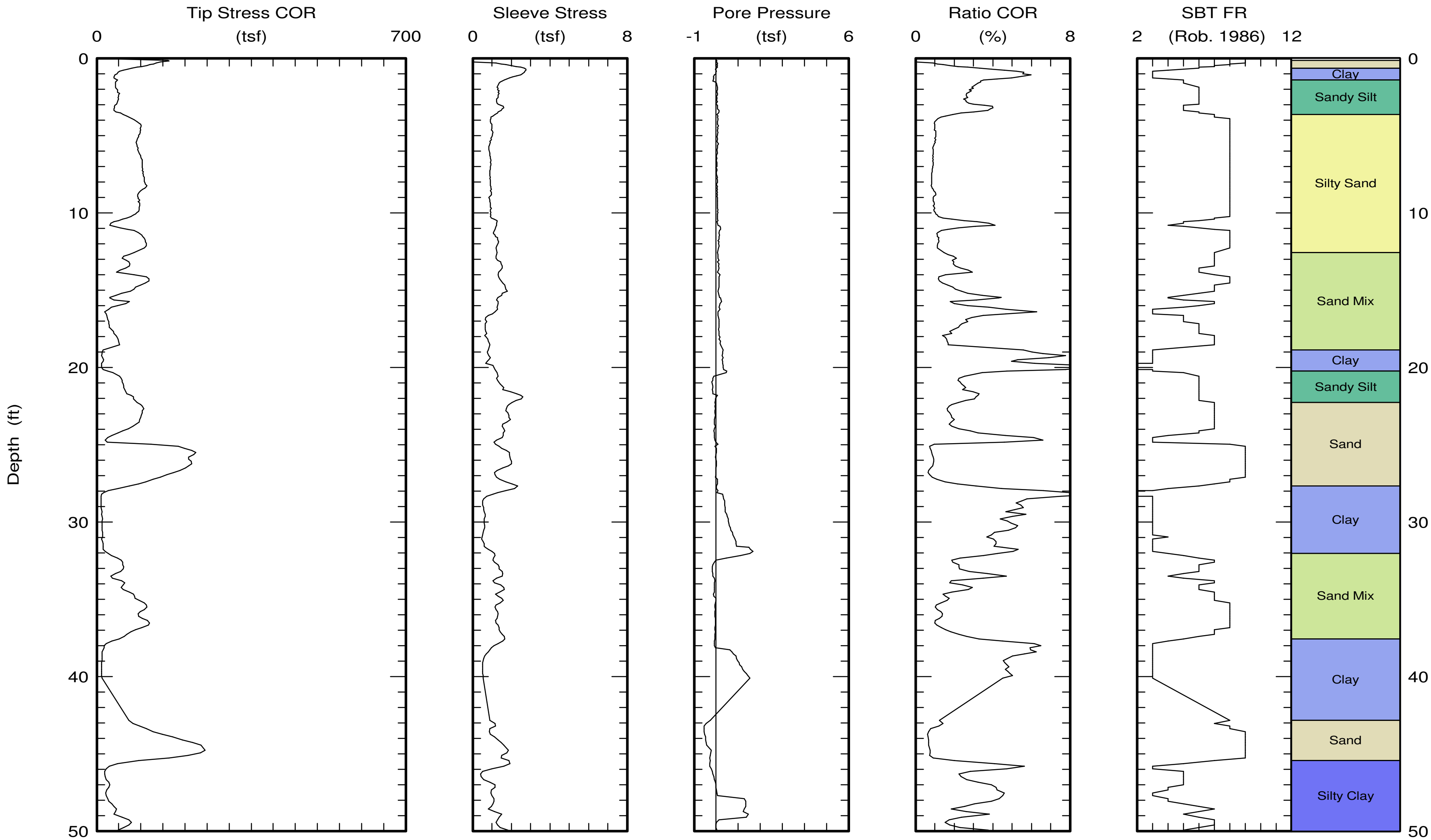
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-6
Project: GardenGrove

Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd



Maximum depth: 100.12 (ft)
Page 1 of 3

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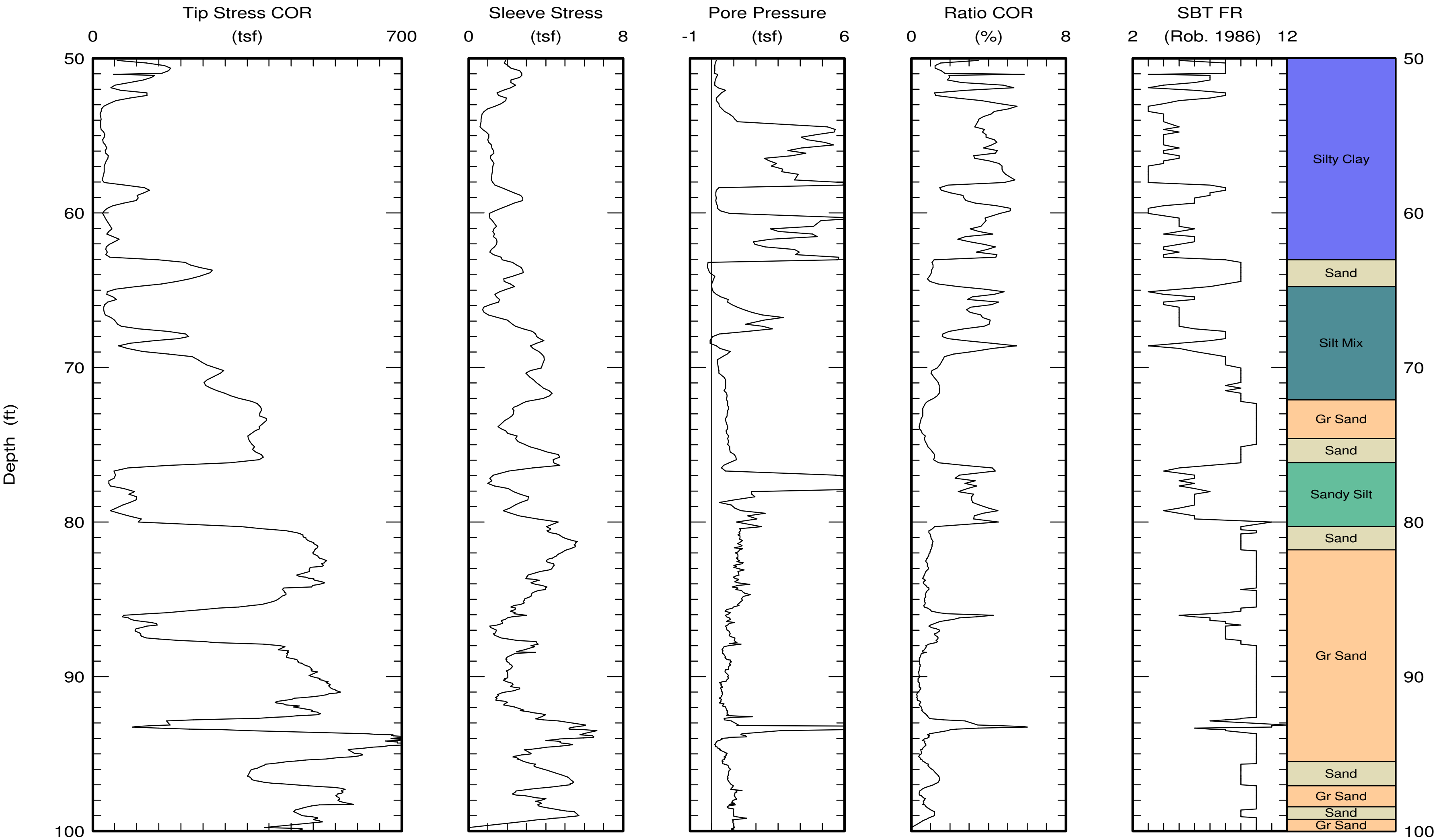
skehoe@msn.com

CPT Data
30 ton rig

Date: 30/Nov/2009
Test ID: CPT-6
Project: GardenGrove

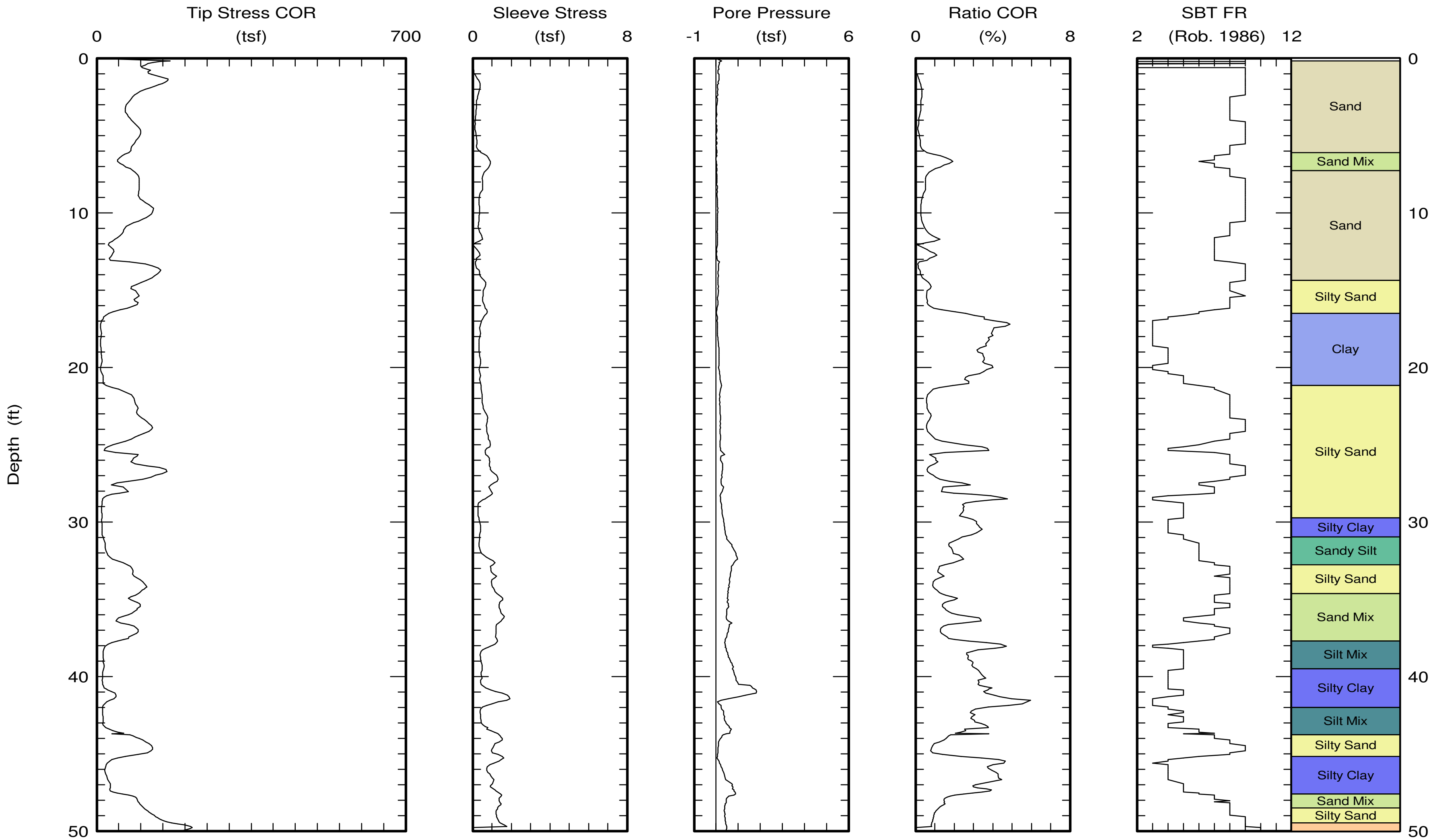
Customer: Leighton Consulting
Job Site: 12591 Harbor Blvd



Maximum depth: 100.12 (ft)
Page 2 of 3

Test ID: CPT-6
File: Z30N0906C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-7 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd	

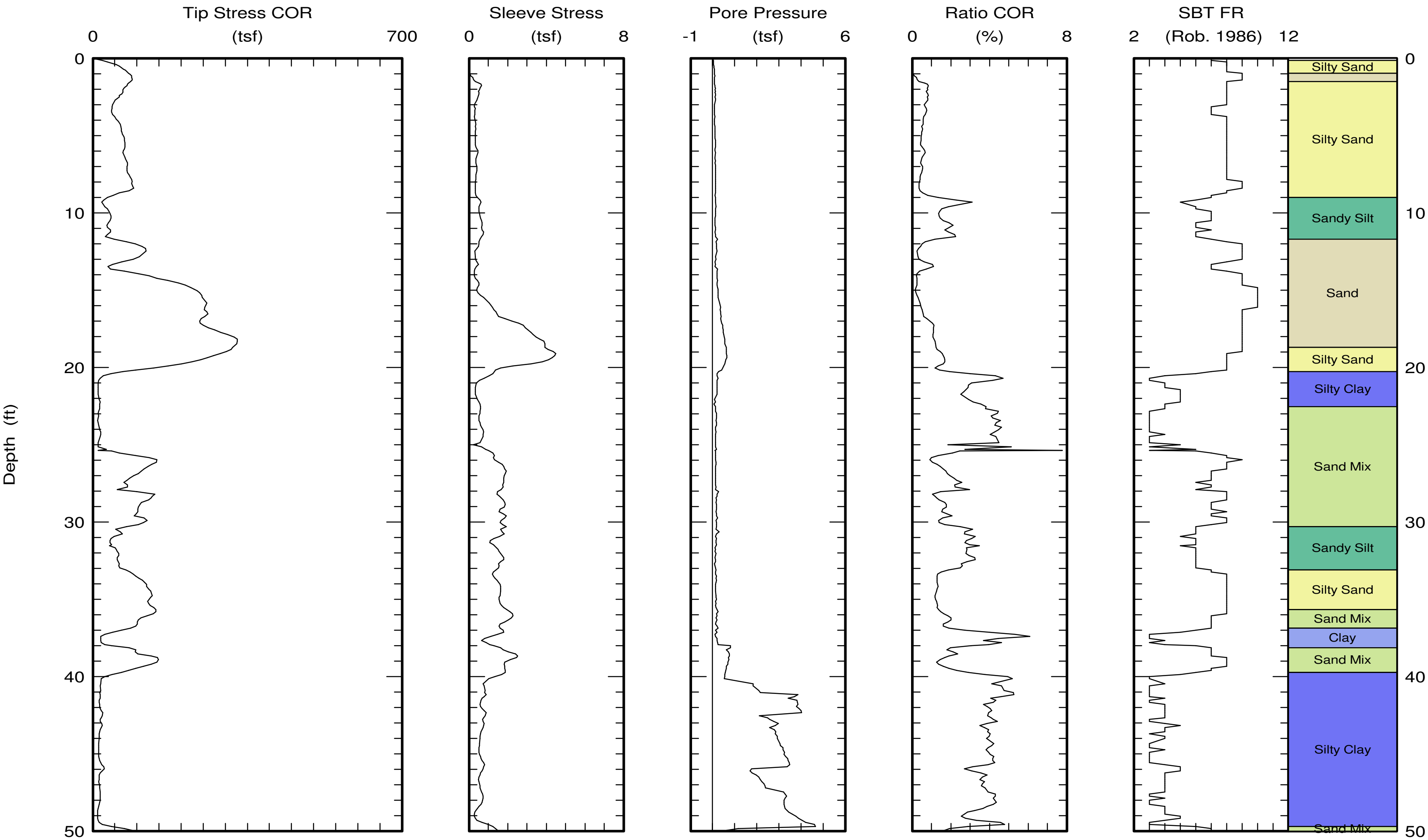


Maximum depth: 50.07 (ft)

Page 1 of 2

Test ID: CPT-7
File: Z30N0908C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com skehoe@msn.com	CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-8 Project: GardenGrove
	Customer: Leighton Consulting Job Site:	



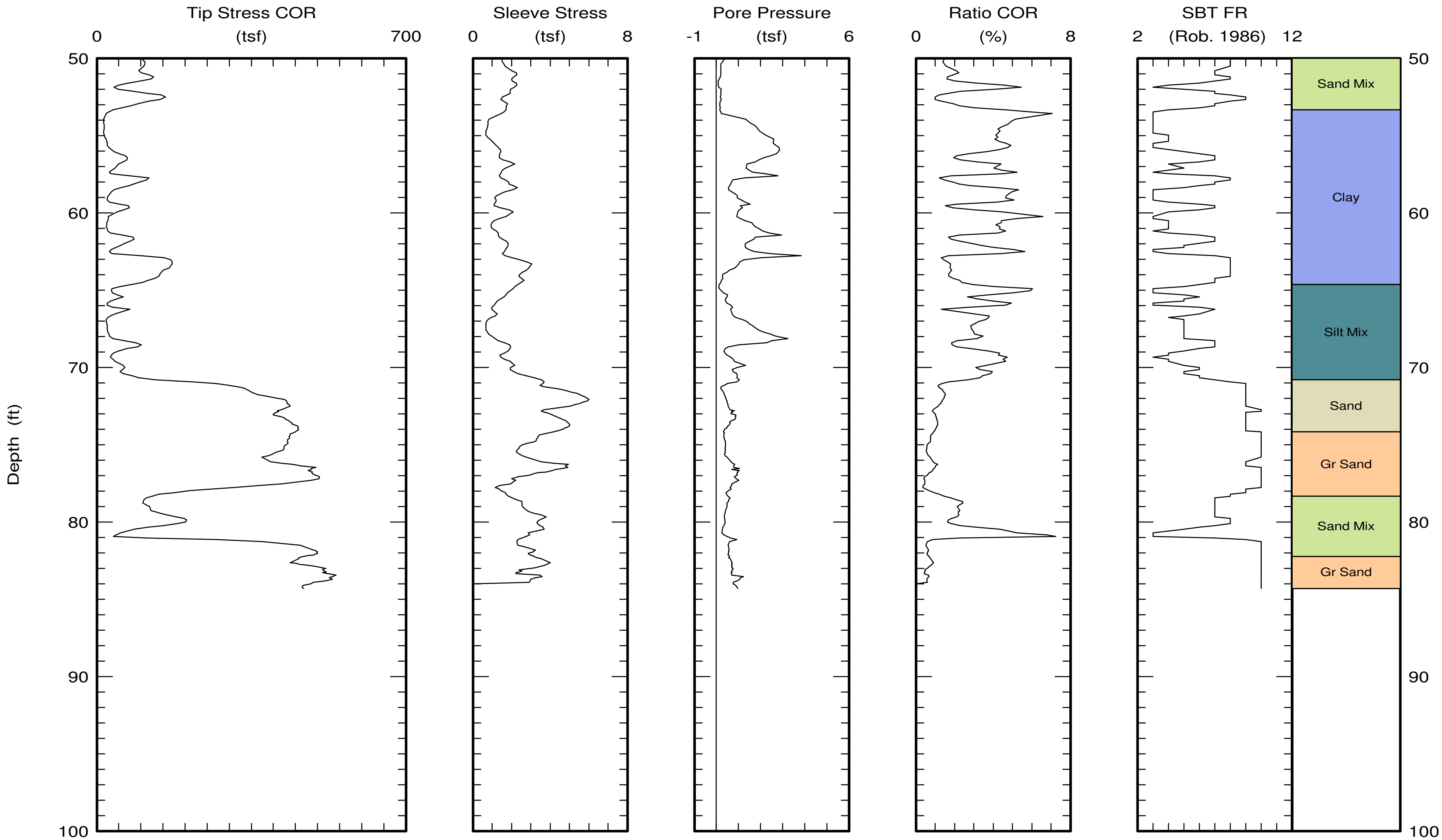
Maximum depth: 84.30 (ft)

Page 1 of 2

Test ID: CPT-8
File: Z30N0910C.ECP

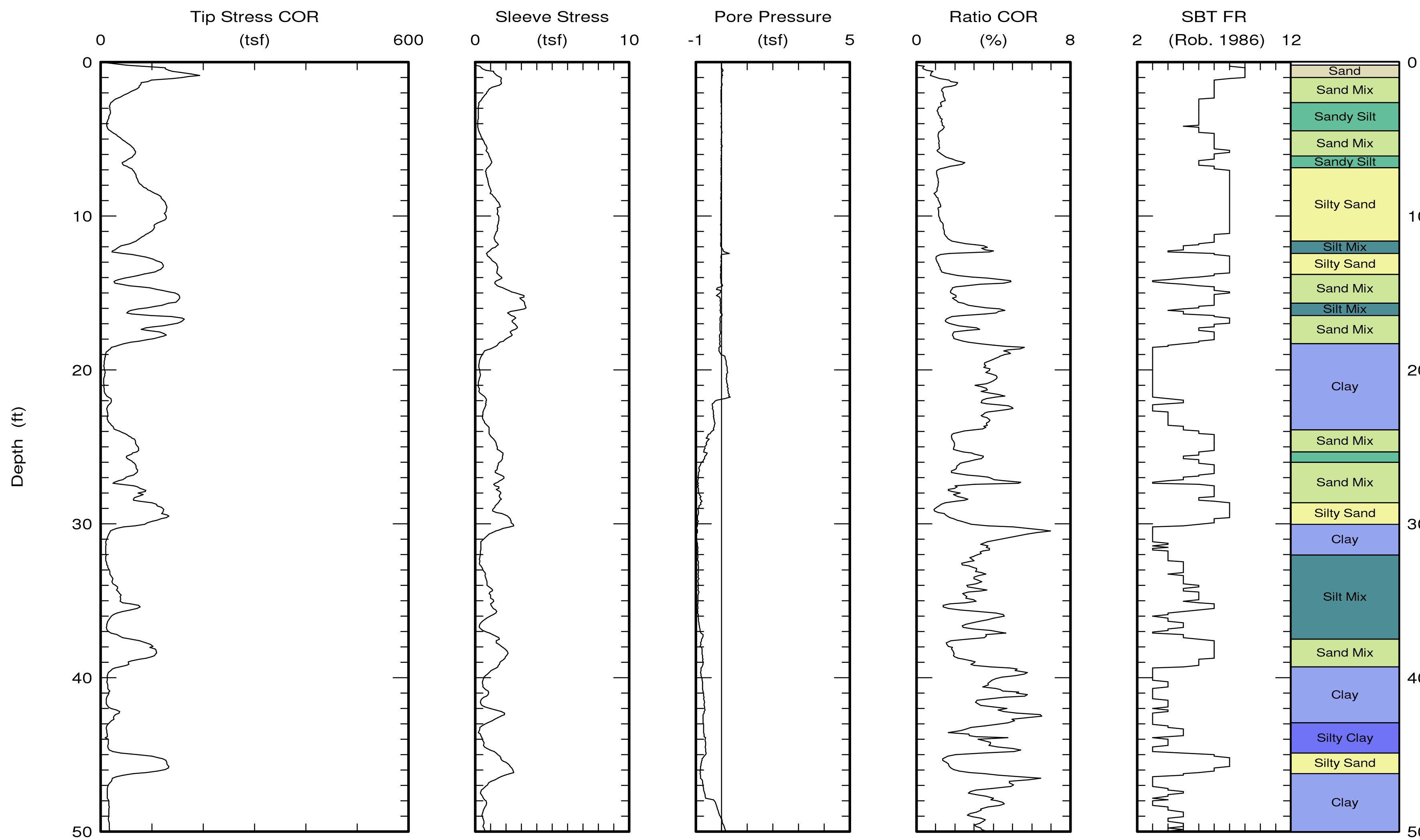
Kehoe Testing & Engineering
Office: (714) 901-7270
Fax: (714) 901-7289
rich@kehoetesting.com
skehoe@msn.com

CPT Data 30 ton rig	Date: 30/Nov/2009 Test ID: CPT-8 Project: GardenGrove
Customer: Leighton Consulting Job Site:	



Maximum depth: 84.30 (ft)

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-9 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

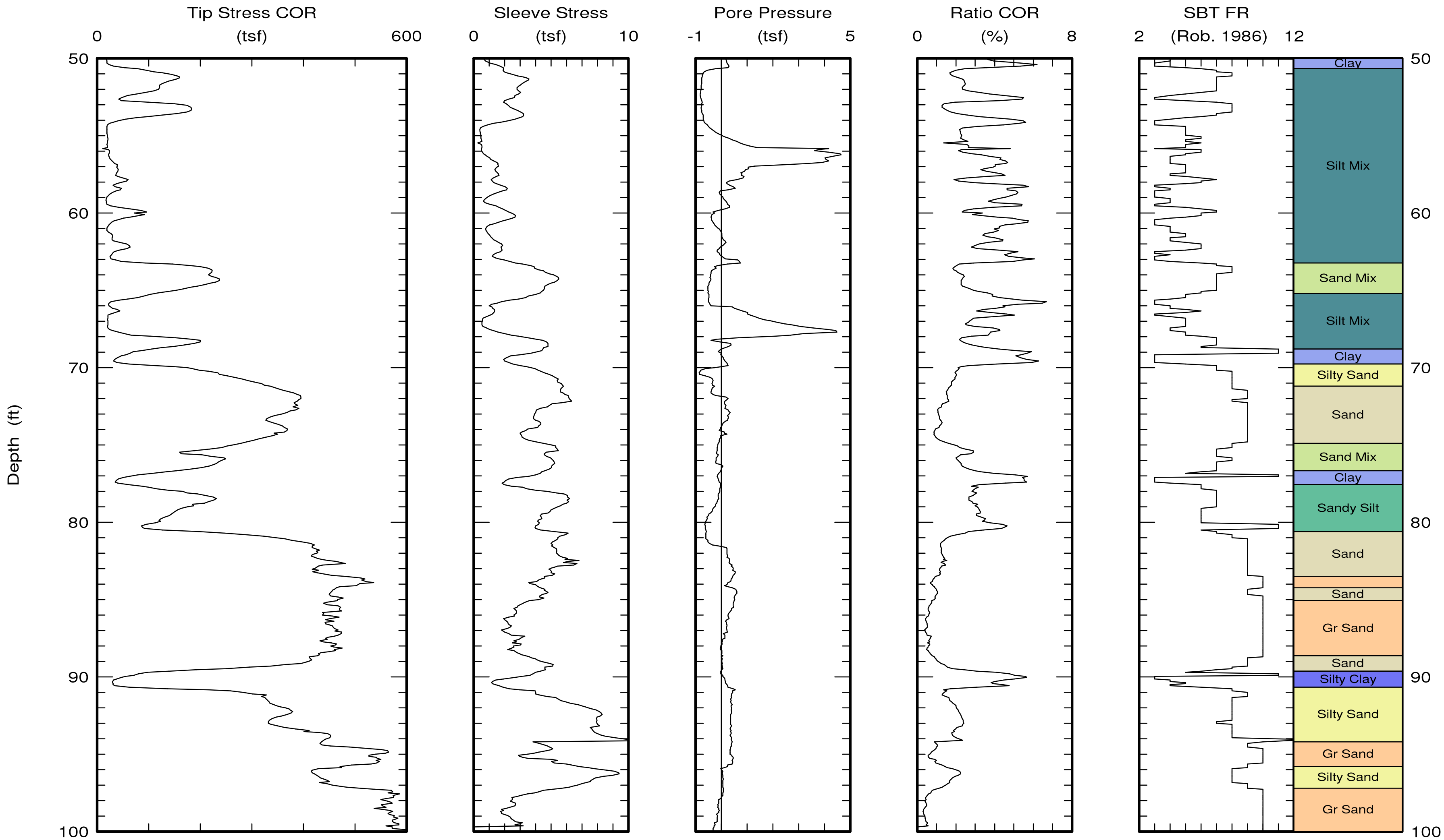


Maximum depth: 100.01 (ft)

Page 1 of 3

Test ID: CPT-9
File: Z21M1102C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-9 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

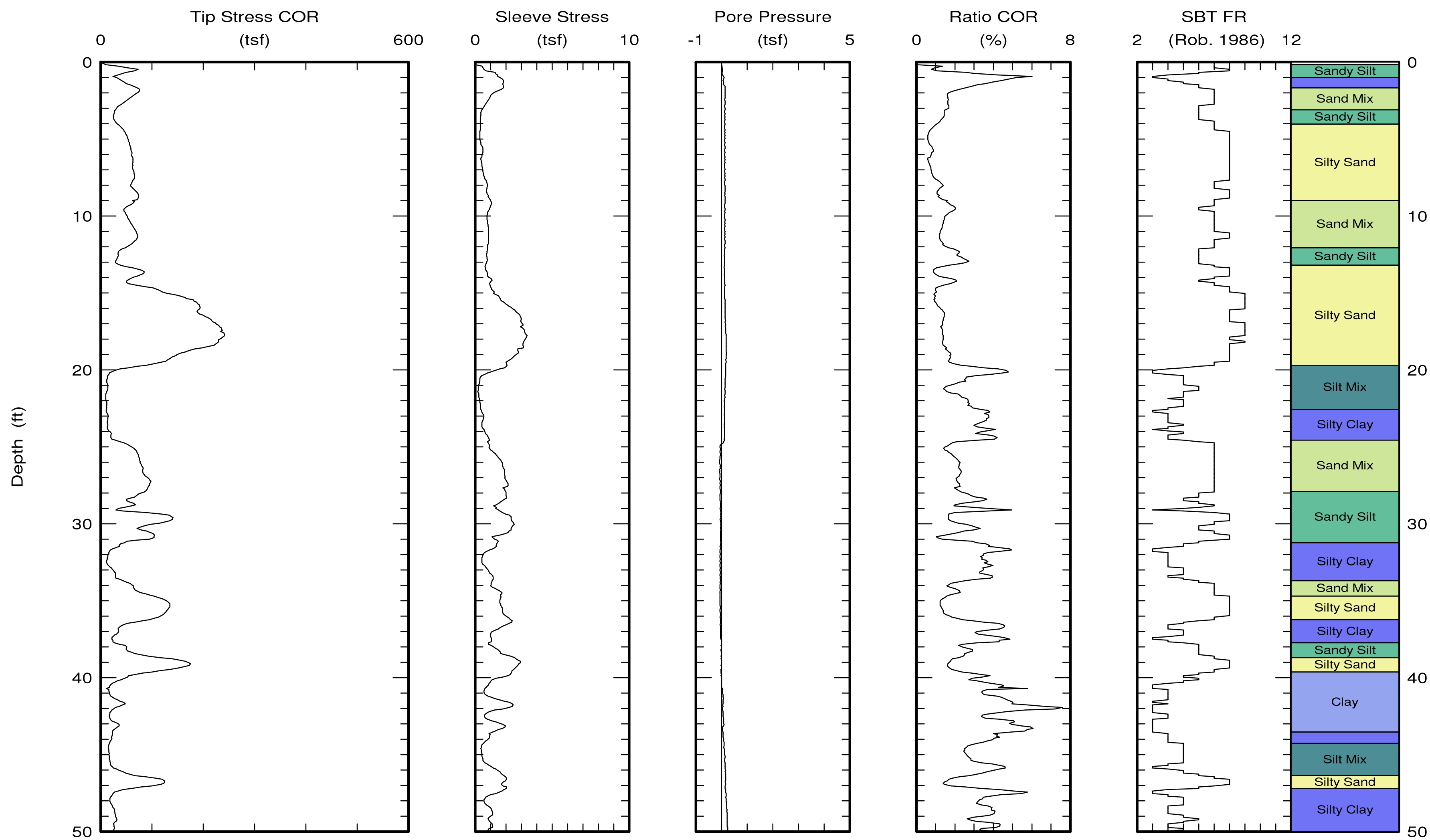


Maximum depth: 100.01 (ft)

Page 2 of 3

Test ID: CPT-9
File: Z21M1102C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-10 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	

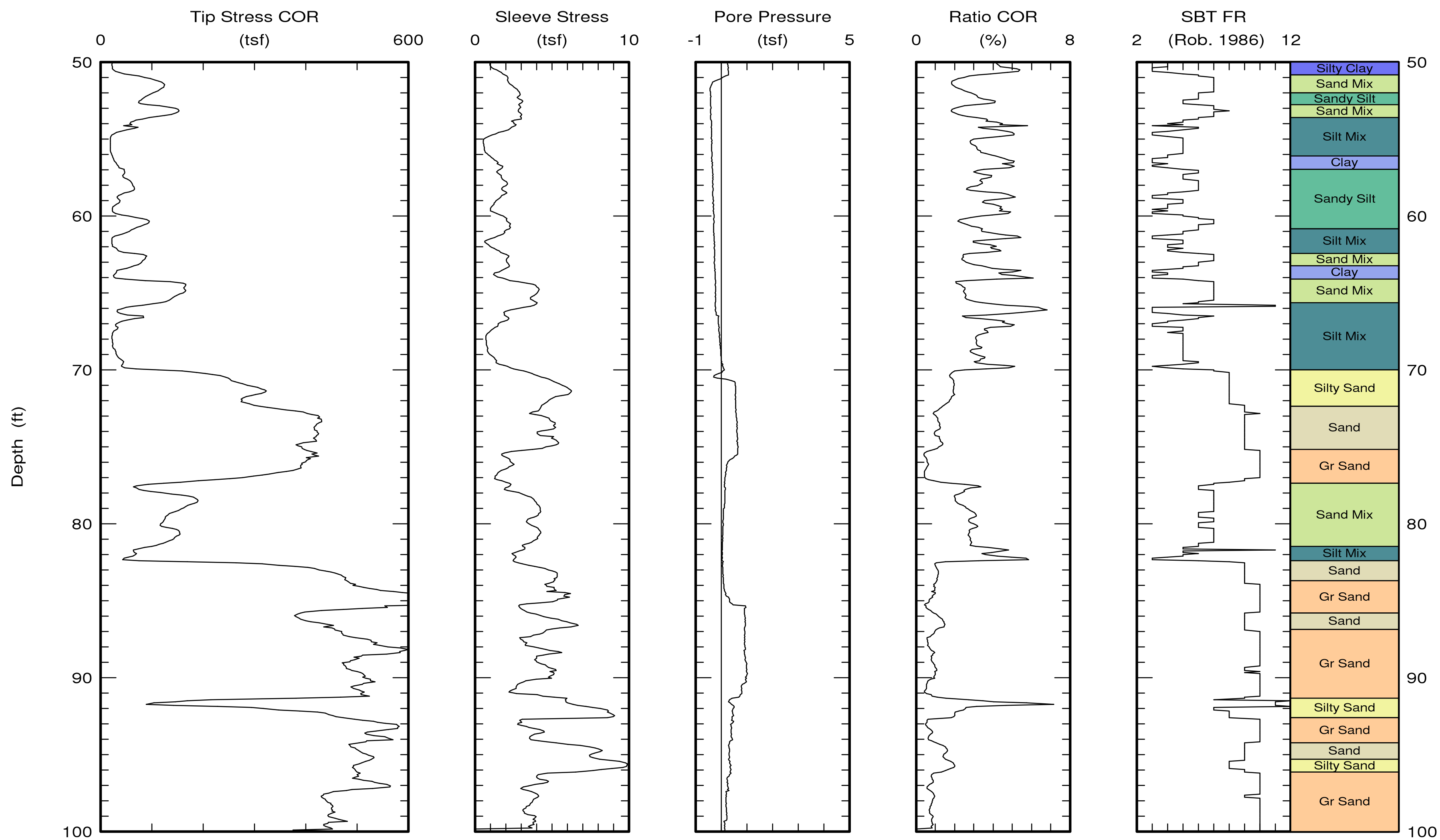


Maximum depth: 100.16 (ft)

Page 1 of 3

Test ID: CPT-10
File: Z21M1103C.ECP

Kehoe Testing & Engineering Office: (714) 901-7270 Fax: (714) 901-7289 rich@kehoetesting.com www.kehoetesting.com	CPT Data 30 ton rig	Date: 21/Mar/2011 Test ID: CPT-10 Project: GardenGrove
	Customer: Leighton Consulting Job Site: 12591 Harbor Blvd.	



Maximum depth: 100.16 (ft)

Page 2 of 3

Test ID: CPT-10
File: Z21M1103C.ECP

APPENDIX B

FOOTHILL
ENGINEERING &
DEWATERING, INC.
905 E. Third St. Corona Ca. 91719
(951) 737-5391 FAX (951) 737-0792
Contractors License Class A 443557

To: Joe Roe
Leighton & Assoc.

Date: 5/11/12

Re: Pump Test Results for Turner/Great Wolf Lodge, Garden Grove

Joe,

On April 24, 2012, we drilled a 24 " dia. - 60 ft. deep well with 12" dia. PVC screen, 40 ft., & plain casing of 20 ft. We then installed a submersible pump, and set up to perform a 48 hour pump test.

On April 30, at 8:15 AM, we started the pump test at a flow rate of 8 GPM.

We had available 2 Monitoring wells. MW2 was existing at 50 ft. distance from pumping well, and the other, MW3, was at 100 ft. distance from pumping well, recently installed.

The pumping well had 15 ft. of drawdown in first 60 minutes, with a total of 23 ft. of drawdown. And, the farthest monitoring well, MW3, had 6 ft. of drawdown in the first 60 minutes, with a total of 9 ft. of drawdown. (Please note first 60 minutes not included on Data Logger sheets-unknown).

MW2 had virtually no reaction to the pump test, and is believed to be sealed/plugged off.

Since MW2 was not reactive, some extrapolating of information is needed.

Find attached Drillers Log, Onsite Pump Test Sheet, Pump Test Tabular Form, Data Logger Results Sheets (3) for Wells # 1, 2, 3, Handwritten result curve & calculation, Well Calculation Results based on Single Well, Cooper & Jacob Straight Line Method Sheet, 3 Sheets Describing Foothill's In House Groundwater Computer Modeling Program, 2 Sheets of Modeling Results (2 different assumed permeabilities) for project dewatering design.

As per Foothill's Program Results, for the project, approx. 300 ft. x 400 ft. x 30 ft. deep, using either a .003 or .004 permeability coefficient, & 55 ft. depth of Aquifer, a total number of 9 to10 wells on 150 to 140 ft. centers around the project's perimeter resulted in a safety factor of 1.4 to 1.8.

A total project expected flow rate would be approx. 80 to 100 GPM.

My recommendation (back page) is 10 wells – 60 ft. deep, on approx. 140 ft. centers, at a permeability of .004, results in a safety factor of 2.5. This affords for a pump to go down without instant problems.

If you have any questions, please feel free to call me @ 951-258-9421 cell.

Sincerely, Mark Mugridge

Foothill Drilling Inc.

Soils Lithology Report

1001 E. 3rd St., Corona, CA 92879

Project Name: GREAT WOLF TURNER   Location: HARBOR + LAMPSON, G.G.

Boring Location:

Elev.	Depth	Sample	Graphic	Description
	0-3			SILTY MED. SAND, MOIST BROWN, FIRM
	3-5			TAN, MED. SAND, DRY, FIRM
5	5-11			BROWN, FINE SAND, SLIGHTLY MOIST, FIRM
10	11-12			BROWN, CLAY, SOFT, MOIST
15	12-16			BROWN, SILTY SAND, FINE, FIRM
	16-17			CLAYEY, FINE SAND, SOFT MOIST
20	17-21			DARK GREY, SOFT, CLAY, MOIST
	21-23			DARK GREY, SILTY CLAY, VERY MOIST
25	23-28			D. GREY, SILTY FINE SAND, SOFT, MOIST
30	28-33			BLACK CLAY, SOFT MOIST
35	33-38			D. GREY, FINE SAND, FIRM, MOIST
40	38-41			D. GREY, CLAY, STIFF MOIST
	41-45			D. GREY, MED. SAND, FIRM, WET
45	45-46			GREY, CLAY, STIFF, MOIST
	46-48			GREY, CLAYEY FINE SAND MOIST, FIRM
	48-49			GREY, CLAY, SOFT, MOIST
	49-52			GREY, MED. SAND FIRM, WET
	52-60			GREY, CLAY, STIFF, MOIST

V *Static Water Level

Date: 4-24-12

Boring No. #1

Logged By: BILL

Drilled By: JACK

Bore Depth: 60'

Bore Diameter: 24"

Type Of Rig: BR-1

Sampling Method:

Screen Length (ft.) 40'

Plain Casing Length (ft.) 20'

Filter Type: 50/50 BLEND

Drill Fluid: GUAR

Notes and Remarks, Pumping:

Please Note: Depths and Soils definition is by visual assessment during a system installation process. Some accuracy may be compromised for expedience.

Page ____ Of ____

PROJECT NAME: Turner 9488 4/30 - 5/2/12

PROJECT LOCATION: Garden Grove

DESIGNATED PUMPING WELL(S), THIS SHEET:

TOC ELEv. #1 #2 #3

**Drawdown Totals Are From Static, Measured from Top Of Casing, Unless Specified Otherwise

**Elapsed Time Is In Minutes And Hundredths Of Minutes, Totaled From The Beginning

	Pumped well: TOTAL FLOW(s)		VOLUMES		Piezo #1, TOTAL DEPTH= Distance from pumped well>				Piezo #2, TOTAL DEPTH= Distance from pumped well>				
	Time	GPM	flow meter reading	Depth to water	Time	Depth to Water	Total Drawdown		Time	Depth to Water	Total Drawdown		MIN
	7:50			25.4		21.3	Static	0.00	0.00	30.5	Static	0.00	
	8:15	7.9	1533532										
	9:15	8.0	34048	40.5		21.3				36.8	[illegible]	6.3	85
	10:15	7.8	34477	42.1		21.3				36.9	[illegible]	6.4	145
	11:15	7.7	34938	42.6		21.3				37.0		6.5	205
	12:15pm	7.8	35413	45.4		21.4				37.0			
Noon	3:15pm	7.4	36822	44.4		21.4				37.2		6.7	505
	6:15pm	7.7	38222	45.0		21.5				37.7		7.2	805
	9:15pm	7.8	39650	46.2		21.4				37.9		7.4	985
	12:15	8.0	41208	46.5		21.5				38.1		7.6	
	3:15	7.6	42410	46.6		21.6				38.2		7.7	
	6:15	7.6	43814	47.2		21.6				38.5		8.0	
	9:15	7.8	45225	47.4		21.6				38.6		8.1	1531
	12:15	7.6	46614	47.7		21.7				38.8		8.3	
	3:15	7.8	48009	48.0		21.7				38.9		8.4	1831
	6:15	7.5	49400	47.8		21.7				39.0		8.5	
PM	9:15	8.0	50818	48.6		21.7				39.2		8.7	~~1531~~ 2425
	12:15	7.7	52219	48.2		21.7				39.3		8.8	
	3:15	7.7	53871	48.8		21.8				39.4		8.9	2571
	6:15	7.7	54986										

PROJECT NAME: Turner 9488 | TOC I
PROJECT LOCATION: Garden Grove | #1
DESIGNATED PUMPING WELL(S), THIS SHEET: | #3

**Drawdown Totals Are From Static, Measured from Top Of Casing, Unless Specified Otherwise

**Elapsed Time Is In Minutes And Hundredths Of Minutes, Totaled From The Beginning

Pumped well				Piezo #1, TOTAL DEPTH=______				Piezo #2, TOTAL DEPTH=____		
TOTAL FLOW(s)		VOLUMES		Distance from pumped well> 50 FT.				Distance from pumped well> 100 FT.		
Time	GPM	flow meter reading	Depth to water	Time	Depth to Water	Total Drawdown		Time	Depth to Water	Total Drawdown
			25.4		21.3	Static	0.00	0.00	30.5	Static
7:50 AM	7.9	33,532.0								-
8:05 AM	8.0	34,048.0	40.5		21.3				36.8	
9:15 AM	7.8	34,477.0	42.1		21.3				36.9	
10:15 AM	7.7	34,938.0	42.6		21.4				37.0	
12:12 PM	78.0	35,413.0	43.1		21.4				37.0	
3:15 PM	7.4	36,822.0	44.4		21.5				37.2	
6:15 PM	7.7	38,222.0	45.0		21.4				37.7	
9:15 PM	7.8	39,650.0	46.2		21.5				37.9	
12:15 AM	8.0	41,208.0	46.5		21.6				38.1	
3:15 AM	7.6	42,410.0	46.6		21.6				38.2	
6:15 AM	7.6	43,814.0	47.2		21.6				38.5	
9:15 AM	7.8	45,225.0	47.4		21.7				38.6	
12:15 PM	7.6	46,614.0	47.7		21.7				38.8	
3:15 PM	7.8	48,009.0	48.0		21.7				38.9	
6:15 PM	7.5	49,400.0	47.8		21.7				39.0	
9:15 PM	8.0	50,818.0	48.6		21.7				39.2	
12:15 AM	7.7	52,219.0	48.2		21.7				39.3	
3:15 AM	7.7	53,817.0	48.8		21.8				39.4	
6:15 AM	7.7	54,986.0								
9:15 AM										-
										-
										-
										-
										-
										-
										-
										-
										-
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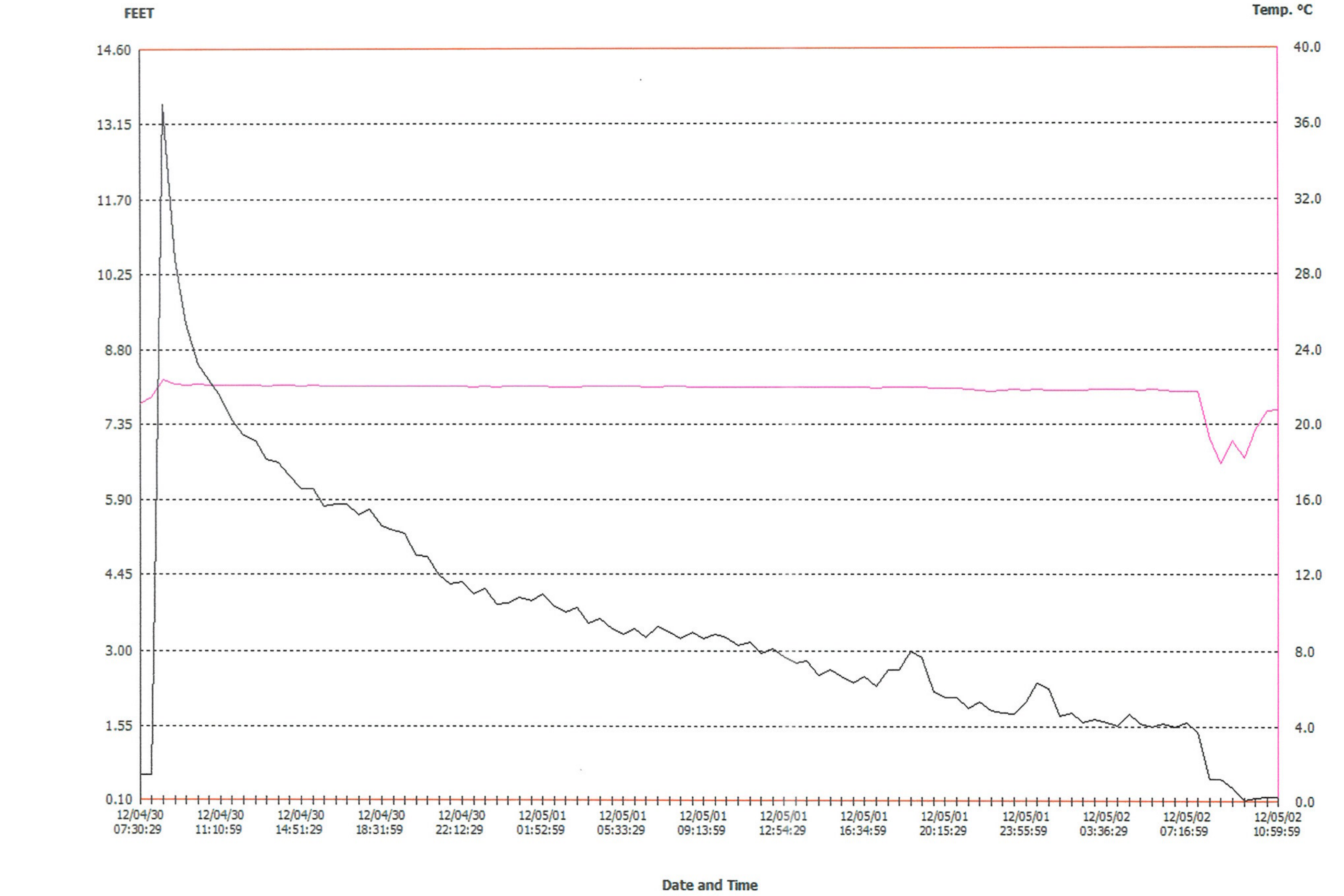
										-
										-
										-
										-
										-

Graph shows trend only and should not be used for analytical purposes.

Height of water above transducer.

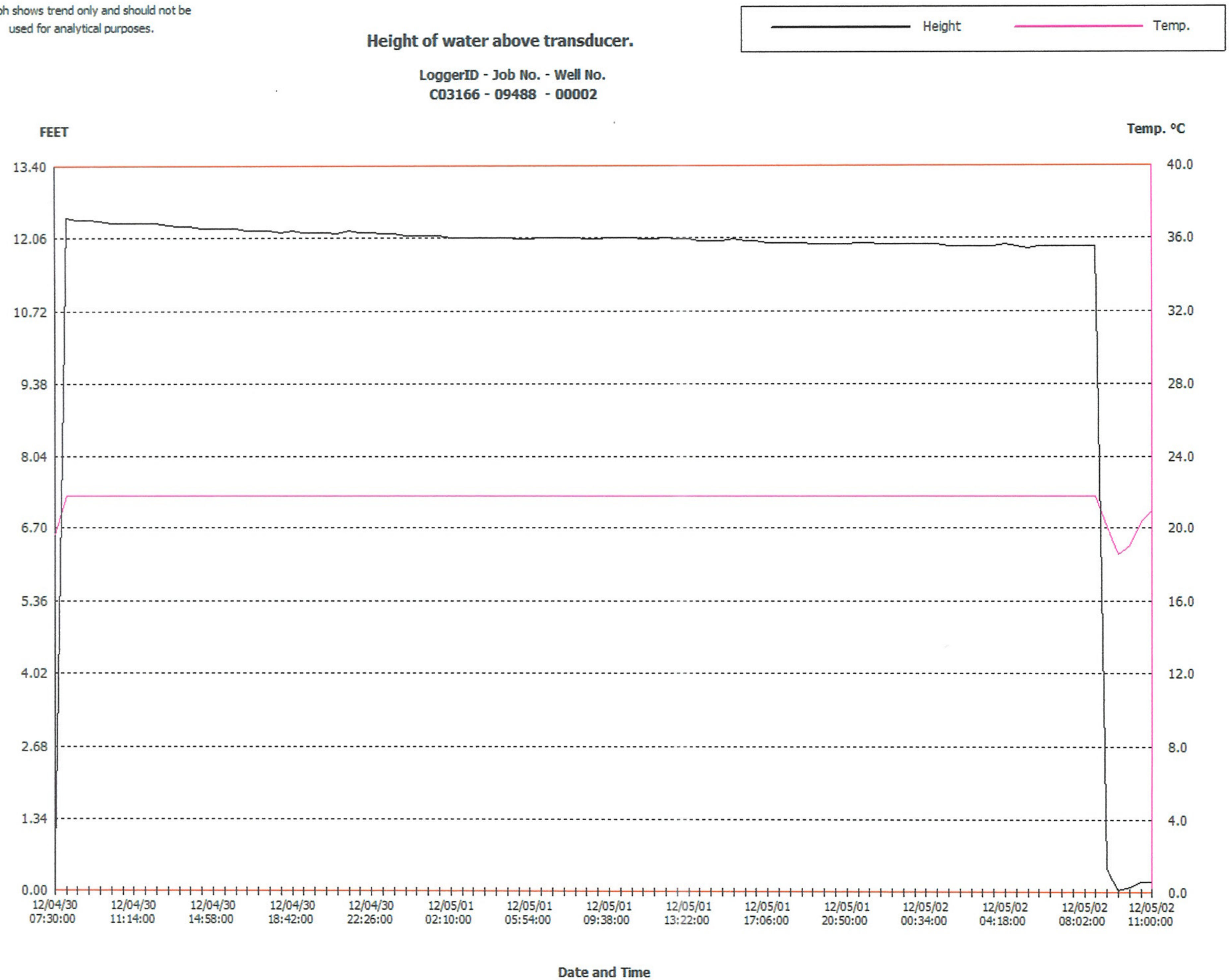
LoggerID - Job No. - Well No.
C03167 - 09488 - 00001



Graph shows trend only and should not be used for analytical purposes.

Height of water above transducer.

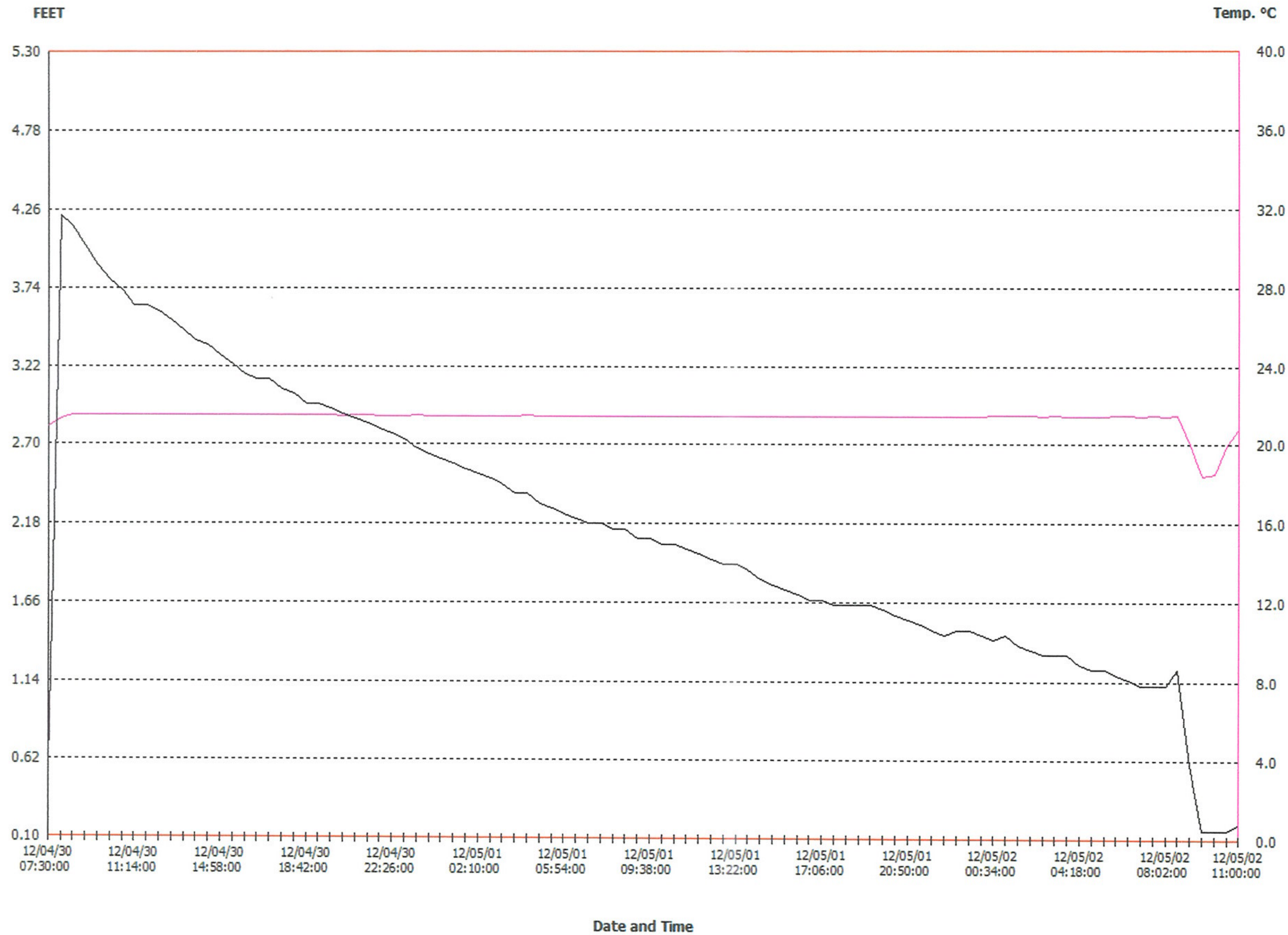
LoggerID - Job No. - Well No.
C03166 - 09488 - 00002



Graph shows trend only and should not be used for analytical purposes.

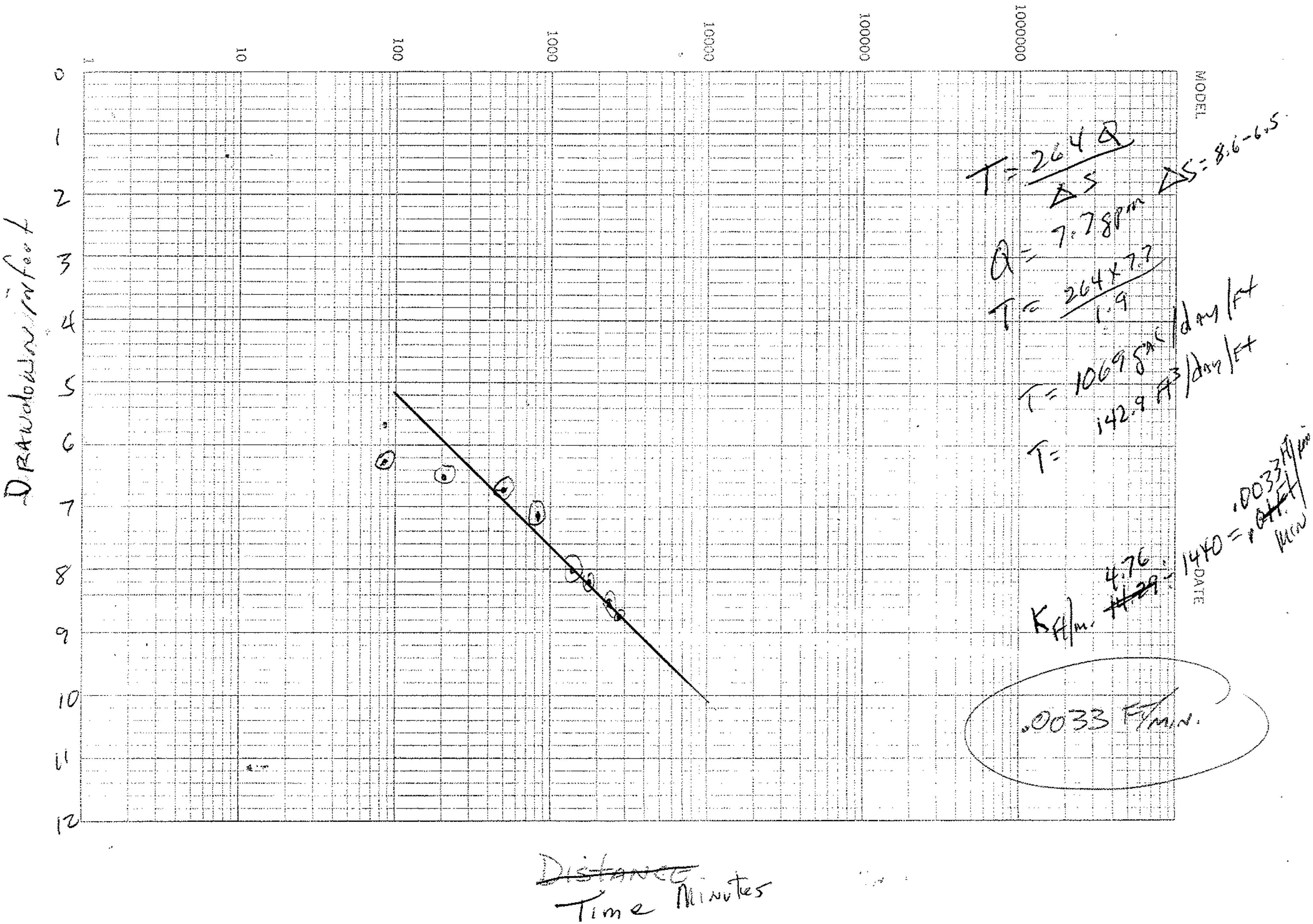
Height of water above transducer.

LoggerID - Job No. - Well No.
C03165 - 09488 - 00003



K&E SEMI-LOGARITHMIC 7 CYCLES X 60 DIVISIONS
KEUFFEL & ESSER CO. MADE IN U.S.A.

46 6463

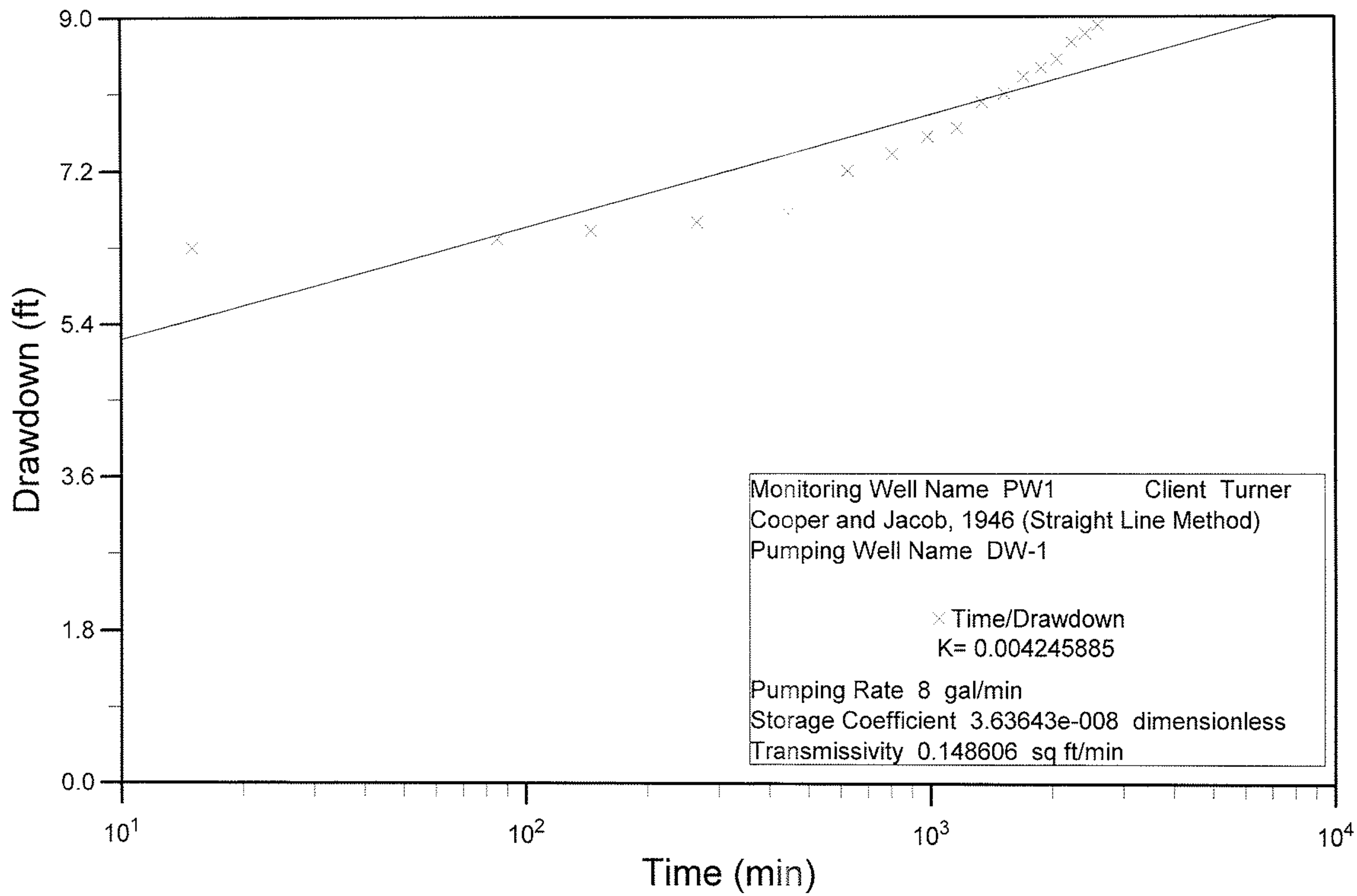


Well Calculation Results
GreatWolf Waterpark - Unconfined Well

Water Table Height	**30**	Well Spacing	**40.00**
Drawdown	**9**	TotalFlow (GPM)	**11.29**
Saturated Thickness	**30**	Total Flow 1 Well (GPM)	**11.29**
Well Diameter	**24**	Total Flow (CFM)	**1.51**
Well Depth	**30**	One Well Discharge (CFM)	**1.51**
Number of Wells	**1**	Max Flow at Drawdown (GPM)	**29.08**
Permeability Coefficient	**0.003**	Water Height / Depth	**12.02**
Distance from Line Source	**0**	Aquifer Saftey Factor	**2.576**
Exacvation Length	**10**	Screen Area per Well	**36.22**
Exacvation Width	**10**	Equivalent Radius	**6.37**
Radius of Influence	**111.86**	Fully Penetrating Well Wetted Depth	**12.02**

Well actually yielded 7.7gpm
Difference probably in
Well efficiency

Cooper and Jacob



Foothill
ENGINEERING &
DEWATERING, INC.
905 E. Third St. Corona Ca. 92879
(951) 737-5391 FAX (951) 737-0792
Contractors License Class A 443557

Ground Water Control
Dewatering Program
(Groundwater Computer Modeling)

Subject: Program terms, definitions, output explanation and limitations.

This program uses computer modeling based on several established groundwater equations. The program is based on homogeneous soils. While true homogeneous soils are not common in nature, good results can be obtained in relatively homogenous soils. It should be noted that highly stratified soils tend to yield less accurate results, in part, due to the differences in vertical to horizontal permeability in such soils.

First, the data in entered on the input screen of a new, or edited in an open project.

The well calculations are then performed and will yield flow rates required to dewater the proposed excavation area based on an equivalent radius method. It should be noted that when entering the excavation dimensions, the most accurate results will be obtained if the excavation is relatively square.
For long, narrow excavations such as trenches, you may want to consider modeling a portion of the excavation which is no more than 3:1 in length to width, and applying that modeled section, as appropriate to the entire excavation. The most useful information provided by the well calculations is the well yield which will be used later in the grid calculations.

The well calculation may be run as "artesian well", "unconfined well" The grid calculations may be run as "circular artesian aquifer" , "circular unconfined aquifer" , "line source artesian aquifer" or "line source unconfined aquifer"

It is very important to remember that all well depth is the depth from the original water table, **not** from the ground surface.

Next, if needed, the grid calculations are done. Note that the well calculations must be done prior to this operation as the grid program uses data generated from the well calculations.

The Grid calculations are done as a separate operation based on the current data input page
The grid calculations are a much more comprehensive calculation which corrects for the discrepancies caused by the conversion of the excavation area to equivalent radius.

Note that it is possible to edit the data input information after running the well results, however, that any changes made to this data **will** effect the grid calculation output.
This feature allows, for example, that the well discharge rate can be adjusted to demonstrate the effect of different size pumps in the wells on the drawdown over the grid area. This kind of data adjustment should only be done by a user who has a clear understanding of this program. Entering flow rates that are not achievable in the field will result in grid calculation output which will not be reached when the system is in operation.

The following explains terms used by this program for both input and output data.

1. **Water table height:** This dimension is a measurement of the height of the aquifer in feet measured from water table surface to bottom of aquifer (usually referred to as "H")(input data).

2. **Drawdown**: This dimension is the lowering required in feet from original water level to subgrade (usually referred to as "H_o")(Input data).

3. **Saturated thickness**: This dimension only applies in the "confined well computation". In an unconfined situation, the dimension is the same as "water table height". In the confined situation, this dimension is the thickness of the confined aquifer (input data)

4. **Well Diameter**: This dimension in inches is the diameter of the drill borehole. (Usually referred to as "RW") (Input data)

5. **Well Depth:** This dimension is the depth of the well in feet from water table to bottom of well. (Input data)

6. **Number of wells:** This number is a computation based on mathematical formulas using equivalent radius to determine number of wells required based upon input data. Note that the number of wells may also be entered directly. Changing the number of wells will cause changes in the safety factor.

7. **Permeability Coefficient:** This is a measurement of hydraulic conductivity in feet/min units. This input data usually based upon pump tests or sieve analysis of the aquifer. (Usually referred to as "K").

8. **Distance from line source:** This dimension is used when a source of recharge lies within the radius of the influence of the dewatering (Usually referred to as "L")(Input data)

9. **Excavation length:** Dimension of excavation in feet based upon location of wells (Input data)

10. **Excavation width:** Same as above second dimension.

11. **Radius of influence:** This is a computation based upon permeability and drawdown without any effect of line source. This calculated distance is from the edge of the excavation to a point where drawdown is zero. The drawdown is logarithmic with distance.

12. **Well Spacing:** This is a computation based on the calculated number of wells and the excavation length and width.

13. **Total flow:** This is the computed total flow required to achieve drawdown.

14. **Total flow/well:** This is the computed flow required by each well to achieve the total flow.

15. **Total flow (CFM) :** Same as total flow in CFM as compared to GPM.

16. **One well discharge:** Same as total flow/well in CFM compared to GPM.

17. **Max flow at drawdown**: This is a computation of max flow that can be achieved based upon number of wells, depth, and permeability. It usually exceeds the required pumping rate and is the basis for the aquifer safety factor.

18. **Water table height/depth:** Is the computed height of water in the well (pumping level) to achieve drawdown. Measurement is from bottom of well to pumping level in feet.

19. **Aquifer safety factor:** Is the calculated ratio of max flow at drawdown to total flow.

20. **Screen area per well:** Is a calculation of screen area opening required to maintain entrance velocities at or below .1 ft/sec.

21. **Equivalent radius:** Is a computation based upon excavation length and width converting the excavation to an equivalent circle.

22. **Fully penetrating well wetted depth:** Is the calculated depth of water from bottom of aquifer to pumping level at drawdown based upon 100% well efficiency.

23. **Artesian well:** An artesian aquifer is a confined aquifer containing groundwater that will flow upward through a well, called an artesian well, without the need for pumping. Water may even reach the ground surface if the natural pressure is high enough, in which case the well is called a flowing artesian well.

24. **Unconfined well:** A well with no confining aquaiclude or aquitard between the bottom of the aquifer and the surface

25. **Circular artesian aquifer:** A circular artesian aquifer is where the global source of water entering the confined aquifer is essentially from all directions, or, for the purposes of this program enters the project area generally from all horizontal directions.

26. **Circular unconfined aquifer :** A circular unconfined aquifer is where the global source of water entering the unconfined aquifer is essentially from all directions, or, for the purposes of this program enters the project area generally from all horizontal directions.

27. **Line source artesian aquifer:** A circular unconfined aquifer is where the global source of water entering the unconfined aquifer is essentially from all directions, or, for the purposes of this program enters the project area generally from all directions.

28. **Line source artesian aquifer:** A line source artesian aquifer where the source of water entering the confined aquifer is primarily from one direction such as from an adjacent river or such.

29. **Line source unconfined aquifer:** A line source unconfined aquifer where the source of water entering the aquifer is primarily from one direction such as from an adjacent river or such.

Well Calculation Results
GreatWolfWaterparkGardenGrove - Unconfined Well

Water Table Height	**30**	Well Spacing	**140.00**
Drawdown	**10**	TotalFlow (GPM)	**82.70**
Saturated Thickness	**30**	Total Flow 1 Well (GPM)	**8.27**
Well Diameter	**24**	Total Flow (CFM)	**11.06**
Well Depth	**30**	One Well Discharge (CFM)	**1.11**
Number of Wells	**10**	Max Flow at Drawdown (GPM)	**14.74**
Permeability Coefficient	**0.003**	Water Height / Depth	**6.09**
Distance from Line Source	**0**	Aquifer Saftey Factor	**1.782**
Exacvation Length	**400**	Screen Area per Well	**26.53**
Exacvation Width	**300**	Equivalent Radius	**220.53**
Radius of Influence	**337.74**	Fully Penetrating Well Wetted Depth	**6.09**

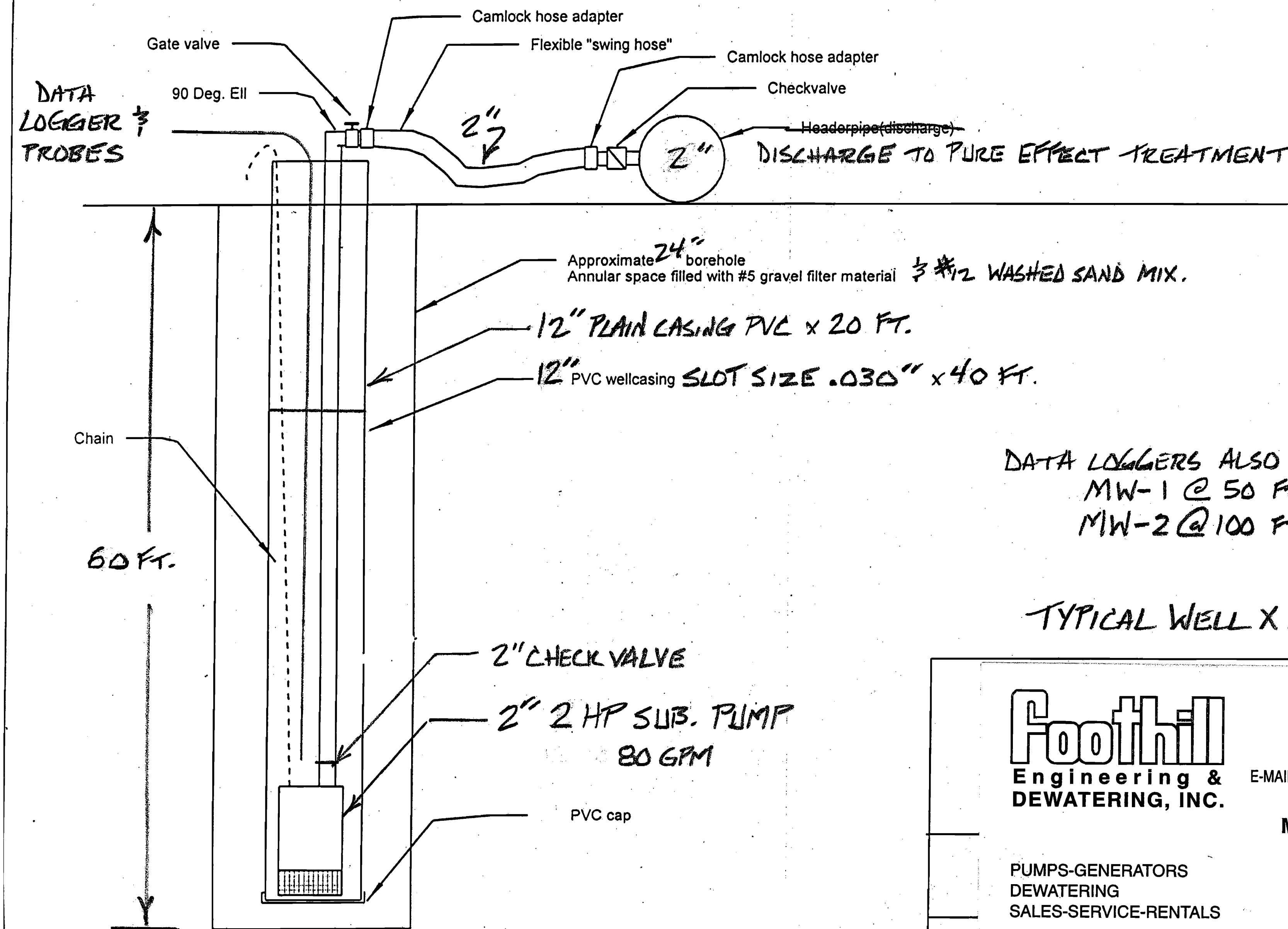
Well Calculation Results
GreatWolfWaterparkGardenGrove - Unconfined Well

Water Table Height	**30**	Well Spacing	**155.56**
Drawdown	**10**	TotalFlow (GPM)	**98.21**
Saturated Thickness	**30**	Total Flow 1 Well (GPM)	**10.91**
Well Diameter	**24**	Total Flow (CFM)	**13.13**
Well Depth	**30**	One Well Discharge (CFM)	**1.46**
Number of Wells	**9**	Max Flow at Drawdown (GPM)	**14.95**
Permeability Coefficient	**0.004**	Water Height / Depth	**5.35**
Distance from Line Source	**0**	Aquifer Saftey Factor	**1.370**
Exacvation Length	**400**	Screen Area per Well	**35.01**
Exacvation Width	**300**	Equivalent Radius	**220.53**
Radius of Influence	**355.88**	Fully Penetrating Well Wetted Depth	**5.35**

Well Calculation Results
GreatWolfWaterparkGardenGrove - Unconfined Well

Water Table Height	**30**	Well Spacing	**140.00**
Drawdown	**10**	TotalFlow (GPM)	**98.21**
Saturated Thickness	**30**	Total Flow 1 Well (GPM)	**9.82**
Well Diameter	**24**	Total Flow (CFM)	**13.13**
Well Depth	**30**	One Well Discharge (CFM)	**1.31**
Number of Wells	**10**	Max Flow at Drawdown (GPM)	**24.47**
Permeability Coefficient	**0.004**	Water Height / Depth	**8.76**
Distance from Line Source	**0**	Aquifer Saftey Factor	**2.492**
Exacvation Length	**400**	Screen Area per Well	**31.51**
Exacvation Width	**300**	Equivalent Radius	**220.53**
Radius of Influence	**355.88**	Fully Penetrating Well Wetted Depth	**8.76**

DEWATERING WELL / PUMP TEST WELL - GREAT WOLF GARDEN GROVE



DATA LOGGERS ALSO INSTALLED:
MW-1 @ 50 FT.
MW-2 @ 100 FT.

TYPICAL WELL X SECTION

Foothill
Engineering & DEWATERING, INC.

24 HR. (951) 737-5391
FAX: (951) 737-0792
E-MAIL: mark@foothill-dewatering.com

MARK MUGRIDGE

PUMPS-GENERATORS
DEWATERING
SALES-SERVICE-RENTALS

905 E. 3rd Street
Corona, CA 92879-1604
CA A-LIC #443557

California Regional Water Quality Control Board
Santa Ana Region

3737 Main Street, Suite 500, Riverside, California 92501-3348
Phone (951) 782-4130 • FAX (951) 781-6288 • TDD (951) 782-3221
www.waterboards.ca.gov/santaana

Linda S. Adams
Secretary for Environmental Protection

Arnold Schwarzenegger
Governor

May 26, 2009

Robert Robinson, President
Pure Effect, Inc.
611 West Palm Avenue
Orange, CA 92868

DISCHARGE AUTHORIZATION AND MONITORING AND REPORTING PROGRAM NO. R8-2009-0003-042, UNDER GENERAL PERMIT NO. R8-2009-0003, NPDES NO. CAG998001, PURE EFFECT INCORPORATED, ORANGE, ORANGE COUNTY

Dear Mr. Robinson:

On May 12, 2009, you submitted a complete Notice of Intent to discharge wastewater from various sites under the terms and conditions of the Regional Board's renewed general permit, Order No. R8-2009-0003.

Effective immediately, you are authorized to discharge wastewater under the terms and conditions of Order No. R8-2009-0003. Enclosed is Monitoring and Reporting Program (MRP) No. R8-2009-0003-042, which specifies the frequency of sampling and the constituents to be monitored. Modifications to the sampling frequency and constituents to be monitored can be considered on a case-by-case basis.

Please note that changes in the California Water Code require the Regional Board to assess a mandatory minimum penalty of $3,000 for each month your monthly monitoring reports are overdue.

Order No. R8-2009-0003 will expire on March 1, 2014. If you wish to terminate coverage under this general permit prior to that time, please notify us immediately upon project completion so that we can rescind your authorization and avoid billing you an annual fee.

The following agencies have requested that they be contacted regarding local agency requirements for discharges within their jurisdiction:

1. Riverside County Flood Control and Water Conservation District - Jason Uhley at (951) 955-1273.
2. San Bernardino County Department of Public Works, Flood Control - Naresh Varma at (909) 387-7995.
3. Orange County Public Works, Flood Control - Andy Ngo at (714) 834-4368

If you have any questions regarding the Discharge Authorization or the M&RP, please contact Julio Lara of our Compliance Section at (951) 782-4901 or email at Jlara@waterbords.ca.gov.

Sincerely,

for Gerard J. Thibeault
Executive Officer

Enclosures: MRP No. R8-2009-0003-042

cc w/o enc: US EPA Permits Issuance Section (WTR-5) - Doug Eberhardt
Riverside County Flood Control and Water Conservation District – Jason Uhley
San Bernardino County Flood Control and Transportation Department – Naresh Varma
Orange County Public Works, Flood Control – Andy Ngo

JIS/PureElnc042

Attachment E – Monitoring and Reporting Program

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Attachment E – Monitoring and Reporting Program (MRP)

The Code of Federal Regulations (CFR) at 40 CFR §122.48 requires that all NPDES permits specify monitoring and reporting requirements. CWC Sections 13267 and 13383 also authorize the Regional Water Quality Control Board (Regional Water Board) to require technical and monitoring reports. This MRP establishes monitoring and reporting requirements that implement the federal and California regulations.

I. GENERAL MONITORING PROVISIONS

A. General Monitoring Provision

1. All sampling and sample preservation shall be in accordance with the current edition of "Standard Methods for the Examination of Water and Wastewater" (American Public Health Association).

2. All laboratory analyses[1], [2] shall be performed in accordance with test procedures under 40 CFR 136 (revised as of April 11, 2007) "Guidelines Establishing Test Procedures for the Analysis of Pollutants," promulgated by the United States Environmental Protection Agency (EPA), unless otherwise specified in this MRP. In addition, the Regional Water Board and/or EPA, at their discretion, may specify test methods that are more sensitive than those specified in 40 CFR 136.

3. Chemical, bacteriological, and bioassay analyses shall be conducted at a laboratory certified for such analyses by the California Department of Public Health in accordance with the provision of Water Code Section 13176, or conducted at a laboratory certified for such analyses by the EPA or at laboratories approved by the Regional Water Board's Executive Officer.

4. In conformance with federal regulations 40 CFR 122.45(c), analyses to determine compliance with the effluent limitations for metals shall be conducted using the total recoverable method. For Chromium (VI), the dissolved method in conformance with 40 CFR 136 may be used to measure compliance with the Chromium (VI) limitation.

---

1 *For Selenium testing use modified EPA Method 200.8 using a Dynamic Reaction Cell (DRC) with an ICP-MS and with reporting limit below 1 ug/L*

2 *For testing organic volatile compounds use EPA Method 8260B and report entire suite of detected constituents*

5. The Discharger shall require its testing laboratory to calibrate the analytical system down to the minimum level (ML)[3] specified in Attachment "H" for priority pollutants with effluent limitations in this Order, unless an alternative reporting level is approved by the Regional Water Board's Executive Officer. When there is more than one ML value for a given substance, the Discharger shall use the ML values, and their associated analytical methods, listed in Attachment "H" that are below the calculated effluent limitation. The Discharger may select any one of those cited analytical methods for compliance determination. If no ML value is below the effluent limitation, then the lowest ML value and its associated analytical method, listed in Attachment "H" shall be used. Any internal quality control data associated with the sample must be reported when requested by the Executive Officer. The Regional Water Board will reject the quantified laboratory data if quality control data is unavailable or unacceptable.

6. The Discharger shall report the results of analytical determinations for the presence of chemical constituents in a sample using the following reporting protocols:

   a. Sample results greater than or equal to the reported ML shall be reported as measured by the laboratory (i.e., the measured chemical concentration in the sample).
   b. Sample results less than the reported ML, but greater than or equal to the laboratory's current Method Detection Limit (MDL)[4] shall be reported as "Detected, but Not Quantified," or "DNQ." The estimated chemical concentration of the sample shall also be reported.
   c. Sample results not detected above the laboratory's MDL shall be reported as "not detected" or "ND."

7. The Discharger shall submit to the Regional Water Board reports necessary to determine compliance with effluent limitations in this Order. The Discharger shall report with each sample result:

   a. The reporting level achieved by the testing laboratory; and
   b. The laboratory's current MDL, as determined by the procedure found in 40 CFR 136 (revised as of April 11, 2007).

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3 *Minimum level is the concentration at which the entire analytical system must give a recognizable signal and acceptable point. The ML is the concentration in a sample that is equivalent to the concentration of the lowest calibration standard analyzed by a specific analytical procedure, assuming that all the method specified sample weights, volumes, and processing steps have been followed.*

4 *MDL is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analytical concentration is greater than zero, as defined in 40 CFR 136, Appendix B, revised as of April 11, 2007.*

8. For receiving water monitoring and for those priority pollutants without effluent limitations, the Discharger shall require its testing laboratory to quantify constituent concentrations to the lowest achievable MDL as determined by the procedure found in 40 CFR 136 (revised as of April 11, 2007)[5]. In situations where the most stringent applicable receiving water objective (freshwater or human health (consumption of organisms only), as specified for that pollutant in 40 CFR 131.38[6] is below the minimum level value specified in Attachment "H" and the Discharger cannot achieve an MDL value for that pollutant below the ML value, the Discharger shall submit justification why a lower MDL value cannot be achieved. Justification shall be submitted together with monthly monitoring reports.

9. The Discharger shall have, and implement an acceptable written quality assurance (QA) plan for laboratory analyses. Duplicate chemical analyses must be conducted on a minimum of ten percent (10%) of the samples, or at least one sample per month, whichever is greater. A similar frequency shall be maintained for analyzing spiked samples. When requested by the Regional Water Board or EPA, the Discharger will participate in the NPDES discharge monitoring report QA performance study.

10. For every item of monitoring data where the requirements are not met, the monitoring report shall include a statement discussing the reasons for noncompliance, the actions undertaken or proposed that will bring the discharge into full compliance with requirements at the earliest time, and an estimate of the date when the Discharger will be in compliance. The Discharger shall notify the Regional Water Board by letter when compliance with the time schedule has been achieved.

11. The Discharger shall assure that records of all monitoring information are maintained and accessible for a period of at least five years (this retention period supercedes the retention period specified in Section IV.A. of Attachment D) from the date of the sample, report, or application. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or by the request of the Regional Water Board at any time. Records of monitoring information shall include:

    a. The information listed in Attachment D- IV Standard Provisions – Records, subparagraph B. of this Order;
    b. The laboratory which performed the analyses;
    c. The date(s) analyses were performed;
    d. The individual(s) who performed the analyses;
    e. The modification(s) to analytical techniques or methods used;
    f. All sampling and analytical results, including
        (1) Units of measurement used;
        (2) Minimum reporting level for the analysis (minimum level);

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5 *For Selenium testing use modified EPA Method 200.8 using a Dynamic Reaction Cell (DRC) with an ICP-MS and with reporting limit below 1 ug/L*

6 *See Federal Register/ Vol. 65, No. 97 / Thursday, May 18, 2000 / Rules and Regulations.*

(3) Results less than the reporting level but above the method detection limit (MDL);
(4) Data qualifiers and a description of the qualifiers;
(5) Quality control test results (and a written copy of the laboratory quality assurance plan);
(6) Dilution factors, if used; and
(7) Sample matrix type.

g. All monitoring equipment calibration and maintenance records;
h. All original strip charts from continuous monitoring devices;
i. All data used to complete the application for this Order; and,
j. Copies of all reports required by this Order.
k. Electronic data and information generated by the Supervisory Control And Data Acquisition (SCADA) System.

12. The flow measurement system shall be calibrated at least once per year or more frequently, to ensure continued accuracy.

13. All monitoring instruments and devices used by the Discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy. In the event that continuous monitoring equipment is out of service for greater than a 24-hour period, the Discharger shall obtain a representative grab sample each day the equipment is out of service. The Discharger shall correct the cause(s) of failure of the continuous monitoring equipment as soon as practicable. In its monitoring report, the Discharger shall specify the period(s) during which the equipment was out of service and if the problem has not been corrected, shall identify the steps which the Discharger is taking or proposes to take to bring the equipment back into service and the schedule for these actions.

14. Monitoring and reporting shall be in accordance with the following:

a. Samples and measurements taken for the purpose of monitoring shall be representative of the monitored activity.

b. The monitoring and reporting of influent, effluent, and sludge shall be done more frequently as necessary to maintain compliance with this Order and or as specified in this order.

c. Whenever the Discharger monitors any pollutant more frequently than is required by this Order, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the discharge monitoring report specified by the Executive Officer.

d. A "grab" sample is defined as any individual sample collected in less than 15 minutes.

e. A composite sample is defined as a combination of no fewer than eight individual grab samples obtained over the specified sampling period. The volume of each individual grab sample shall be proportional to the discharge flow rate at the time of sampling. The compositing period shall equal the specific sampling period, or 24 hours, if no period is specified.

f. Daily samples shall be collected on each day of the week.

g. Monthly samples shall be collected on any representative day of each month.

h. Quarterly samples: A representative sample shall be taken on any representative day of January, April, July, and October and test results shall be reported in either micrograms/liter (ug/L) or milligrams/liter (mg/L) or nanograms/L (ng/L), as appropriate, by the last day of the month following the month that the sample was taken.

i. Semi-annual samples shall be collected in January and July.

j. Annual samples shall be collected in January to December.

II. MONITORING LOCATIONS

The Discharger shall establish monitoring locations to demonstrate compliance with the effluent limitations, discharge specifications, and other requirements in this Order: The sample station shall be located where representative samples of the discharge can be obtained. The volume of daily discharge shall be recorded daily on a permanent log.

III. INFLUENT MONITORING REQUIREMENTS – NOT APPLICABLE

IV. EFFLUENT MONITORING REQUIREMENTS

A. The following shall constitute the effluent monitoring program for discharges other than decant filter backwash wastewater and/or sludge dewatering filtrate water. If there is no discharge see Section VIII.B.5., below.

1. For intermittent (less than daily) discharge flow of less than 25,000 gallons per day (gpd), effluent monitoring is as follows:

Table 1. Effluent Monitoring Program for Flow Less than 25,000 GPD

Parameter	Unit	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method and Minimum Level
Flow	gpd	measured	Each discharge event	--

Table 1. Effluent Monitoring Program for Flow Less than 25,000 GPD

Parameter	Unit	Sample Type	Minimum Sampling Frequency	Required Analytical Test Method and Minimum Level
Oil & Grease[7]	mg/L	Grab	Once monthly; see also Section IV.A.3.	See Section I.A.2. above, of this MRP
Total Petroleum Hydrocarbons[8]	mg/L	Grab	"	EPA METHOD 8015 Modified
Total Residual Chlorine[9]	mg/L	Grab	"	See Section I.A.2. above, of this MRP
Total Suspended Solids	mg/L	"	"	"
Total Inorganic Nitrogen (TIN)	mg/L	"	Annually, see also Section IV.A.3.	"
Total Dissolved Solids	mg/L	Grab	"	"
pH[10]	Std. Units	"	"	"
Hardness[10]	mg/L	"	"	"
Pollutants listed in Attachment "I" [10, 11]	µg/L	Grab	Once during the first[12] 30 minutes of the discharge and annually thereafter; see also Section IV.A.4. and IV.A.5.	See Section I.A.2. & I.A.3. above, of this MRP

2. For discharge flow of 25,000 gpd or more, effluent monitoring is as follows:

Table 2. Effluent Monitoring Program for Flow Over 25,000 GPD

Parameter	Unit	Sample Type See also IV.A.6., below	Minimum Sampling Frequency	Required Analytical Test Method and Minimum Level
Flow	gpd	measured	Daily	--

7 *Not applicable to discharges from established water supply systems where no oil and grease are expected.*

8 *Applies when dewatering operations are near suspected petroleum hydrocarbon contaminated sites or when diesel or gasoline powered generator is used in the dewatering operations.*

9 *Unless it is known that chlorine is not in the discharge.*

10 *Applies to discharges from groundwater dewatering projects.*

11 *For testing organic volatile compounds use EPA Method 8260B and report entire suite of detected constituents.*

12 *If the pollutants were monitored at the outset during the application process, the Discharger may submit the analytical results in lieu of the first sampling event.*

Table 2. Effluent Monitoring Program for Flow Over 25,000 GPD

Parameter	Unit	Sample Type See also IV.A.6., below	Minimum Sampling Frequency	Required Analytical Test Method and Minimum Level
Oil & Grease[13]	mg/L	Grab	During the first 30 minutes of the discharge, then monthly; see also Section IV.A.3.	See Section I.A.2. above, of this MRP
Total Petroleum Hydrocarbons[14]	mg/L	Grab	During the first 30 minutes of the discharge, then monthly; see also Section IV.A.3.	EPA METHOD 8015 Modified
Total Residual Chlorine[15]	mg/L	Grab	"	See Section I.A.2. above, of this MRP
Total Suspended Solids	mg/L	"	"	"
Total Inorganic Nitrogen (TIN)	mg/L	"	Semi-annually	"
Total Dissolved Solids	mg/L	Grab	Semi-annually	"
pH[16]	Std. Units	"	Annually	"
Hardness[16]	mg/L	"	"	"
Pollutants listed in Attachment "I" [16, 17]	µg/L	Grab	Once during the first[18] 30 minutes of the discharge and annually thereafter; see also Section IV.A.4., and IV.A.5.	See Section I.A.2. & I.A.3. above, of this MRP

13 *Not applicable to discharges from established water supply systems where no oil and grease are expected.*

14 *Applies when dewatering operations are near suspected petroleum hydrocarbon contaminated sites or when diesel or gasoline powered generator is used in the dewatering operations.*

15 *Unless it is known that chlorine is not in the discharge.*

16 *Applies to discharges from groundwater dewatering projects.*

17 *For testing organic volatile compounds use EPA Method 8260B and report entire suite of detected constituents.*

18 *If the pollutants were monitored at the outset during the application process, the Discharger may submit the analytical results in lieu of the first sampling event.*

3. Should any of the weekly, bi-monthly, monthly, quarterly or annual monitoring for a specific constituent show effluent concentrations above the effluent limit, the frequency of monitoring for that constituent shall be increased to weekly or as directed by the Executive Officer. To return to the monitoring frequency specified, the Discharger shall request and receive approval from the Regional Water Board's Executive Officer or designee. (See also Provision VII.C.6.a. of the Order regarding conditions that necessitate termination of the discharge.)

4. Should the annual monitoring for a specific constituent show effluent concentrations above the values specified in Attachment I, the monitoring frequency for that constituent shall be increased to weekly for one quarter or as directed by the Executive Officer. To return to the monitoring frequency specified, the Discharger shall request and receive approval from the Regional Water Board's Executive Officer or designee. (See also Provision VII.C.6.a. of the Order regarding conditions that necessitate termination of the discharge.)

5. Should two consecutive annual monitoring results for all the constituents specified in Attachment I show values below those listed in Attachment "I", the Discharger may stop monitoring for the pollutants listed in Attachment I.

6. If the discharge does not last for more than a day, one composite sample shall be taken for the duration of the discharge and shall be analyzed.

V. WHOLE EFFLUENT TOXICITY TESTING REQUIREMENTS – NOT APPLICABLE

VI. LAND DISCHARGE MONITORING REQUIREMENTS – NOT APPLICABLE.

VII. RECEIVING WATER MONITORING REQUIREMENTS

Whenever there is a discharge and the Discharger asserts that there are no surface waters at the point where the discharge reaches the stream, the Discharger shall record on a permanent log the following information: (a) the date(s), time(s), and duration(s) of the discharge; (b) a description of the location where the discharge(s) percolated into the ground, (c) the climatic condition in the area during the discharge and (d) the name of the individual(s) who performed the observation. This information shall be submitted with the required quarterly report.

VIII. REPORTING REQUIREMENTS

A. General Monitoring and Reporting Requirements

1. The Discharger shall comply with all Standard Provisions (Attachment D) related to monitoring, reporting, and recordkeeping.

2. All analytical data shall be reported with method detection limit[19] (MDLs) and with identification of either reporting level or limits of quantitation (LOQs).

3. Laboratory data for effluent samples must quantify each constituent down to the down to ML specified in Attachment "H" for priority pollutants. Any internal quality control data associated with the sample must be reported when requested by the Executive Officer. The Regional Water Board will reject the quantified laboratory data if quality control data are unavailable or unacceptable.

4. Discharge monitoring data shall be submitted in a format acceptable to the Regional Water Board. Specific reporting format may include preprinted forms and/or electronic media. The results of all monitoring required by this Order shall be reported to the Regional Water Board, and shall be submitted in such a format as to allow direct comparison with the limitations and requirements of this Order.

5. The Discharger shall submit to the Regional Water Board reports necessary to determine compliance with effluent limitations in this Order and shall follow the chemical nomenclature and sequential order of priority pollutant constituents shown in Attachment "G" – Priority Pollutant Lists. The Discharger shall report with each sample result:

   a. The reporting level achieved by the testing laboratory; and
   b. The laboratory's current MDL, as determined by the procedure found in 40 CFR 136 (revised as of April 11, 2007).

6. For non-priority pollutants monitoring, all analytical data shall be reported with identification of method detection limits, as determined by the procedure found in 40 CFR 136 (revised as of April 11, 2007).

7. The State or Regional Water Board may notify the Discharger to discontinue submittal of hard copies of reports. When such notification is given, the Discharger shall stop submitting hard copies of required monitoring reports.

B. Reporting Requirements:

1. All monitoring reports, or information submitted to the Regional Water Board shall be signed and certified in accordance with 40 CFR 122.22 and shall be submitted under penalty of perjury.

2. All reports shall be arranged in a tabular format to clearly show compliance or noncompliance with each discharge limitation.

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19 *The standardized test procedure to be used to determine the method detection limit (MDL) is given at Appendix B, 'Definition and Procedure for the Determination of the Method Detection Limit' of 40 CFR 136.*

3. Five days prior to any discharge from locations already reported, the Discharger shall notify the Regional Board staff by phone or by a fax letter indicating the date and time of the proposed discharge.

4. Five days prior to any planned discharge[20] from locations not yet reported, the discharger shall notify the Regional Board staff by phone or by a fax letter indicating the following:

    a. Specific type of the proposed wastewater discharge (see listing on Finding 1 of the Order);
    b. The estimated average and maximum daily flow rates;
    c. The frequency and duration of the discharge;
    d. The affected receiving water(s);
    e. A description of the proposed treatment system (if appropriate); and
    f. A description of the path from the point of initial discharge to the ultimate location of discharge (fax a map if possible);

5. If no discharge occurs during the previous monitoring period, a letter to that effect shall be submitted in lieu of a monitoring report specified in Table 4, below.

6. Noncompliance Reporting

    a. The discharger shall report any noncompliance that may endanger health or the environment. Any information shall be provided to the Executive Officer (951-782-4130) and the Office of Emergency Services (1-800-852-7550) orally within 24 hours from the time the discharger becomes aware of the circumstances. A written submission shall also be provided within 5 days of the time the discharger becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, the period of noncompliance, including exact dates and times and, if the noncompliance has not been corrected, the anticipated time it is expected to continue, and, steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.
    b. Any violation of a maximum daily discharge limitation for any of the pollutants listed in this Order shall be included as information that must be reported within 24 hours.
    c. The Regional Water Board may waive the above required written report on a case-by-case basis.

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[20] *For those unplanned discharges, as much prior notification as possible is required before any discharge is initiated.*

7. Except for data determined to be confidential under Section 308 of the Clean Water Act (CWA), all reports prepared in accordance with the terms of this Order shall be available for public inspection at the offices of the Regional Water Quality Control Board and the Regional Administrator of EPA. As required by the CWA, effluent data shall not be considered confidential.

8. Monitoring reports shall be submitted by the 30th day of each month following the monitoring period and shall include:

    a. The results of all chemical analyses for the previous month, and annual samples whenever applicable,

    b. The daily flow data,

    c. A summary of the month's activities including a report detailing compliance or noncompliance with the task for the specific schedule date, and

    d. For every item of monitoring data where the requirements are not met, the monitoring report shall include a statement discussing the reasons for noncompliance, and of the actions undertaken or proposed which will bring the discharger into full compliance with requirements at the earliest time, and an estimate of the date when the discharger will be in compliance. The discharger shall notify the Regional Water Board by letter when compliance with the time schedule has been achieved.

9. For Dischargers discharging at a volume equal to or greater than 150,000 gallons per day, the Discharger shall submit semi-annual reports that tabulate all measured flows and measured parameters within the most recent six month period. Where discharges associated with these projects last less than 6 months, a report covering the period of discharges shall be submitted. Copies of these monitoring reports shall be submitted to the Regional Water Board and to the Water Quality Director of the Orange County Water District at P.O. Box 8300, Fountain Valley, CA 92728-8300.

C. Self Monitoring Reports (SMRs)

1. At any time during the term of this permit, the State or Regional Water Board may notify the Discharger to electronically submit Self-Monitoring Reports (SMRs) using the State Water Board's California Integrated Water Quality System (CIWQS) Program Web site (http://www.waterboards.ca.gov/ciwqs/index.html). Until such notification is given, the Discharger shall submit hard copy SMRsin accordance with the requirements described in subsection B.5 below. The CIWQS Web site will provide additional directions for SMR submittal in the event there will be service interruption for electronic submittal.

2. The Discharger shall report in the SMR the results for all monitoring specified in this MRP under sections III through IX. Additionally, the Discharger shall report in the SMR the results of any special studies, acute and chronic toxicity testing, TRE/TIE, PMP, and Pollution Prevention Plan required by Special Provisions – VI.C. of this Order. The Discharger shall submit monthly, quarterly, and annual SMRs including the results of all required monitoring using USEPA-approved test methods or other test methods specified in this Order. If the Discharger monitors any pollutant more frequently than required by this Order, the results of this monitoring shall be included in the calculations and reporting of the data submitted in the SMR.

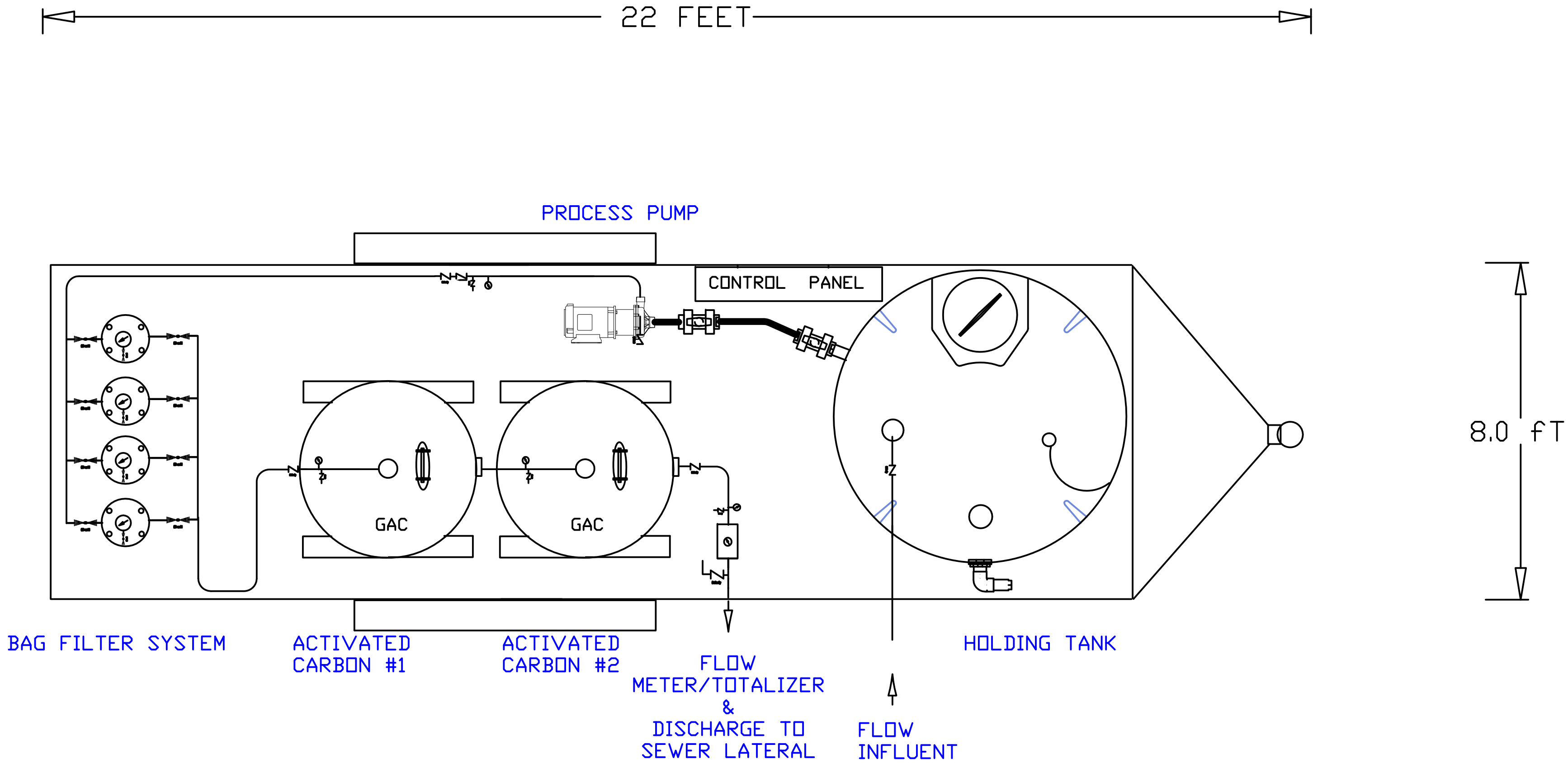
3. Monitoring periods and reporting for all required monitoring shall be completed according to the following schedule:

Table 3. Monitoring Periods and Reporting Schedule

Sampling Frequency	Monitoring Period Begins On...	Monitoring Period	SMR Due Date
Continuous	Day after permit effective date	All	30th day of the month following the sampling month.
Hourly	Day after permit effective date	Hourly	30th day of the month following the sampling month.
Daily	Day after permit effective date	Midnight through 11:59 PM or any 24-hour period that reasonably represents a calendar day for purposes of sampling.	30th day of the month following the sampling month.
Weekly	Sunday following permit effective date or on permit effective date if on a Sunday	Sunday through Saturday	30th day of the month following the sampling month.
Monthly	First day of calendar month following permit effective date or on permit effective date if that date is first day of the month	1st day of calendar month through last day of calendar month	30th day of the month following the sampling month.
Quarterly	Closest of January 1, April 1, July 1, or October 1 following (or on) permit effective date	January 1 through March 31 April 1 through June 30 July 1 through September 30 October 1 through December 31	April 30 July 30 October 30 January 30
Semiannually	Closest of January 1 or July 1 following (or on) permit effective date	January 1 through June 30 July 1 through December 31	July 30 January 30
Annually	See Table 1	See Table 1	30th day of the month following the sampling month.
Per Discharge Event	Anytime during the discharge event or as soon as possible after aware of the event	At a time when sampling can characterize the discharge event	30th day of the month following the sampling month.

D. Other Reports – Not Applicable

NOTES: Power FOR trailer mounted process pump, 230 Volt, 3 Phase.Discharge to local sewer system.



PLAN VIEW

TYPICAL Portable Groundwater/Dewatering Treatment System

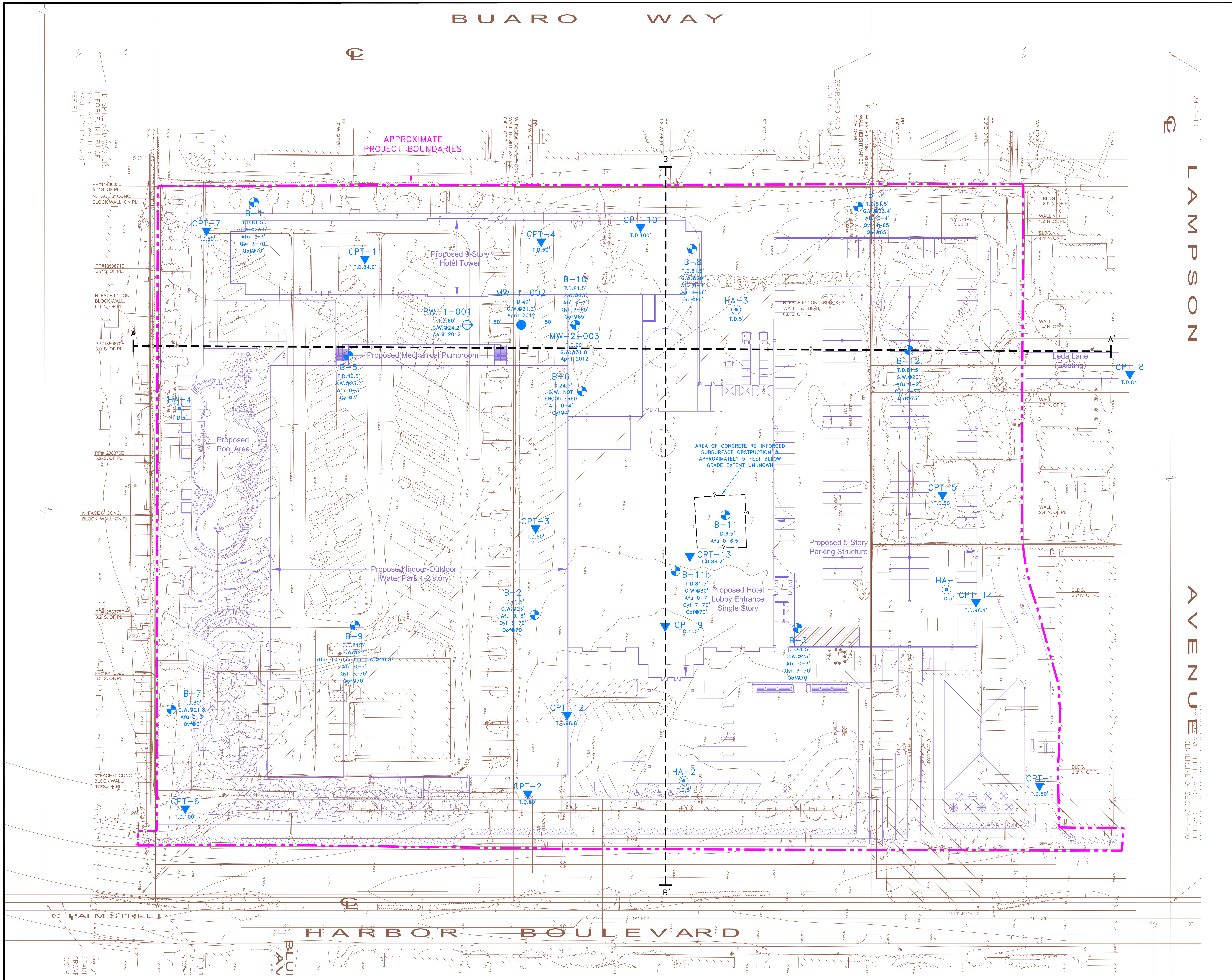
Design flow rate: Groundwater system - 150 GPM

INIT	APPROVALS	DATE
MES	Mike Slaby	3-03-2011

601 W. Valencia Dr.
Fullerton CA 92832
(714) 639-7873
Fax: (714) 639-8530
www.pureeffect.com

SIZE C | CAGE CODE | DWG NO. | REV | SCALE | SHEET

REVISION HISTORY: REV | DESCRIPTION | INCORP BY | DATE | CHECKED



EXPLANATION

Afu	ARTIFICIAL FILL, UNDOCUMENTED SILTY SANDS TO SANDY SILTS WITH CLAY AND GRAVEL. TYPICALLY DARK BROWN WITH MINOR AMOUNTS OF CONCRETE, ASPHALT AND OTHER MAN MADE DEBRIS.
Qyf	QUATERNARY YOUNG ALLUVIAL FAN DEPOSITS, CONSISTING PREDOMINATELY OF SOFT TO LOOSE, MASSIVE, FINE TO COARSE SAND, OVERLYING THIN TO THICKLY BEDDED CLAY TO SILTY CLAY UNIT OF MARINE ORIGIN. UNIT CONTAINS CONTINUOUS TO SEMI-CONTINUOUS SAND LENSES WITH VARYING PROPORTIONS OF ROUNDED GRAVELS. DEPOSITIONAL ENVIRONMENT OF SANTA ANA RIVER FLOODPLAN INCLUDING MARINE TRANSGRESSION.
Qof	QUATERNARY OLD ALLUVIAL FAN DEPOSITS CONSISTING OF DENSE SANDS AND GRAVELS TYPICAL OF PALEO-SANTA ANA RIVER FLOODPLAN. FINE TO COARSE SANDS AND ROUNDED GRAVELS WITH OCCASSIONAL CLAY AND SILT LAMINAE
B-12 T.D.81.5' G.W.@26' Afu 0-2' Qyf 2-75' Qof@75'	APPROXIMATE LOCATION OF HOLLOW STEM AUGER BORINGS (B-1 THROUGH B-8, LEIGHTON 2010, 2011) AND B-9 THROUGH B-12, THIS INVESTIGATIION. BORING SHOWN WITH TOTAL DEPTH (T.D.), DEPTH TO UNITS, AND DETH TO GROUNDWATER (G.W.) ENCOUNTERED DURING DRILLING.
CPT-14 T.D.98.1'	APPROXIMATE LOCATION OF CONE PENETROMETER TEST (CPT) LOCATIONS (CPT-1 THROUGH CPT-10, LEIGHTON 2010, 2011) AND CPT-11 THROUGH CPT-14, THIS INVESTIGATION.
B-10 T.D.81.5' MW-2-003 T.D.60' G.W.@31.8'	APPROXIMATE LOCATION OF HOLLOW STEM AUGER BORING CONVERTED TO A 2-INCH DIAMETER MONITORING WELL. BORING AND MONITORING WELL SHOWN WITH TOTAL DEPTH (T.D.) UPON COMPLETION. SEE FIGURE 4, THIS REPORT. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT.
MW-1-002 T.D.40'	APPROXIMATE LOCATION OF EXISTING MONITORING WELL MW-1, SHOWN WITH TOTAL DEPTH (T.D.) AND DEPTH TO GROUNDWATER, INSTALLED BY OTHERS. SEE FIGURE 3, THIS REPORT. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT.
PW-1-001 T.D.60'	APPROXIMATE LOCATION OF PUMPING WELL PW-1-001 SHOWN WITH TOTAL DEPTH (T.D.) INSTALLED BY FOOTHILL ENGINEERING AND DEWATERING INC., 2012. SEE FIGURE 5, THIS REPORT. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT.
HA-4 T.D.5'	APPROXIMATE LOCATION OF HAND AUGER (H.A.) BORING SHOWING WITH TOTAL DEPTH (T.D.)
B B'	APPROXIMATE LOCATION OF REVISED GEOTECHNICAL CROSS SECTIONS

REVISED BORING AND CROSS SECTION LOCATION MAP

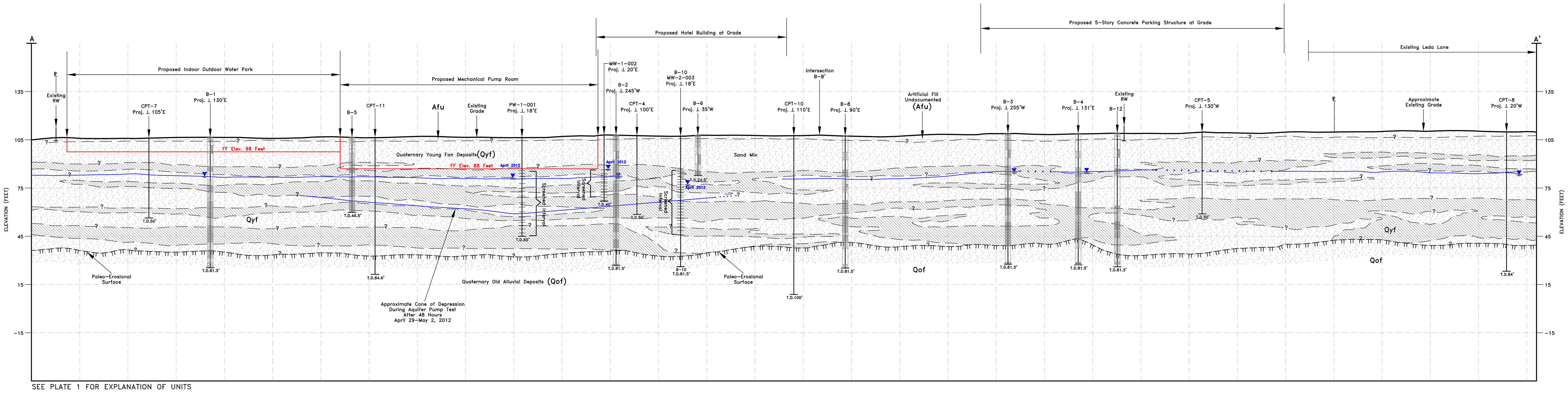
McWHINNEY DEVELOPMENT
HARBOR BOULEVARD, GARDEN GROVE, CALIFORNIA

PLATE 1

Proj: 602778-004	Eng/Geol: VPI/JAR
Scale: 1"=30'	Date: 5/12

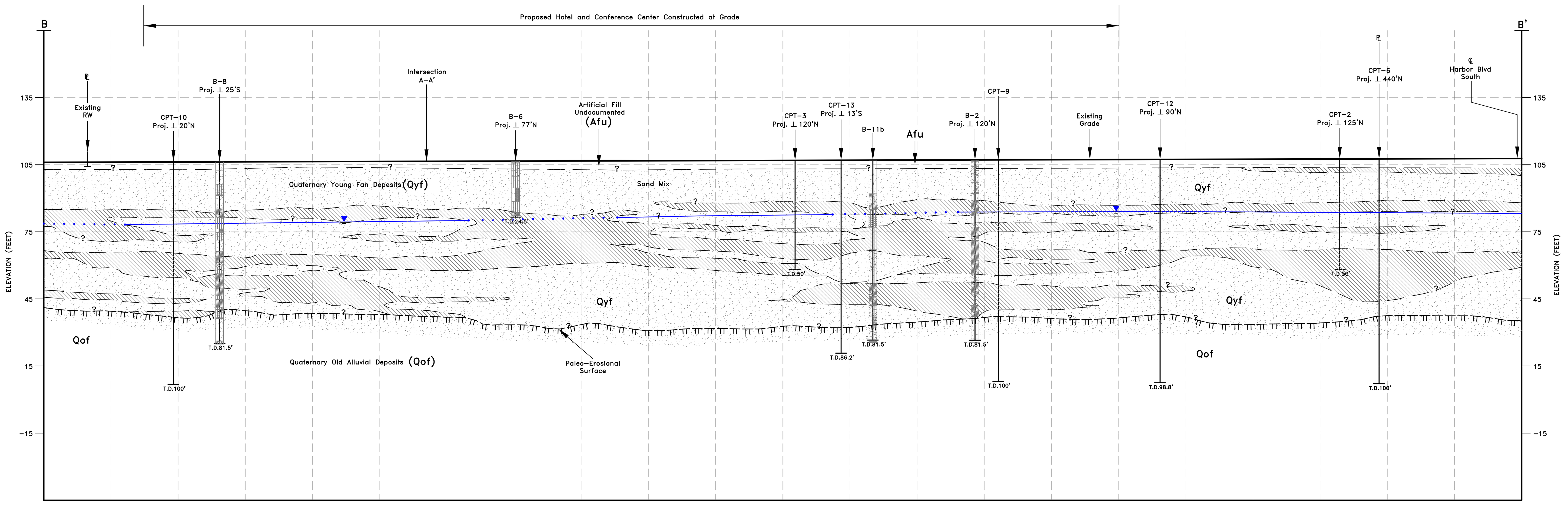
Drafted By: BQT | Checked By: BQT | P:\DRAFTING\602778\004\OF_2012-04-19\PLATE1.DWG (05-22-12 4:25:31PM) Plotted by: mmurphy

Leighton



SEE PLATE 1 FOR EXPLANATION OF UNITS

N-S



SEE PLATE 1 FOR EXPLANATION OF UNITS

E-W

EXPLANATION

CROSS SECTION GRAPHICS

- SANDMIX, CONSISTS OF VARYING PROPORTIONS OF SILTY, CLAYEY SANDS AND GRAVELS WITH SANDY SILTS (SP, SM, SP-SM)
- SILTY, SAND CLAY TO CLAYEY, SANDY SILT (ML-CL, CL, ML, CH AND MH)
- APPROXIMATE PALEO-EROSIONAL SURFACE, Qyf/Qof TRANSITION, QUERIED WHERE UNCERTAIN
- GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, QUERIED WHERE UNCERTAIN
- MEASURED DEPTH TO GROUNDWATER FROM ORIGINAL GRADE. QUERIED WHERE UNCERTAIN, DOTTED LINE BEST REPRESENTS APPROXIMATE POTENTIOMETRIC SURFACE AT TIME OF DRILLING (MARCH 2011 AND APRIL 2012)

BORING GRAPHICS

- Silty Sandy Clay, Lean to Fat Clay (CL-CH) (ML-CL)
- Silt to Clay in Varying Proportion (CL-ML)
- Sandy Clayey Silt to Organic Silt (ML-MH)
- Sand to Sand With Gravel (SP)
- Silty Sand (SM)
- Sand With Silt (SP-SM)

REVISED GEOTECHNICAL CROSS SECTIONS A-A' AND B-B'

Mc WHINNEY DEVELOPMENT
HARBOR BOULEVARD, GARDEN GROVE, CALIFORNIA

PLATE 2

Proj: 602778-004	Eng/Geol: VPI/JAR
Scale: 1"=30'	Date: 5/12

Drafted By: BQT | Checked By: BQT | P:\DRAFTING\602778\004\OF_2012-04-19\PLATE2-SECTIONS A-B.DWG (05-22-12 2:40:02PM) Plotted by: btran

Leighton

APPENDIX D

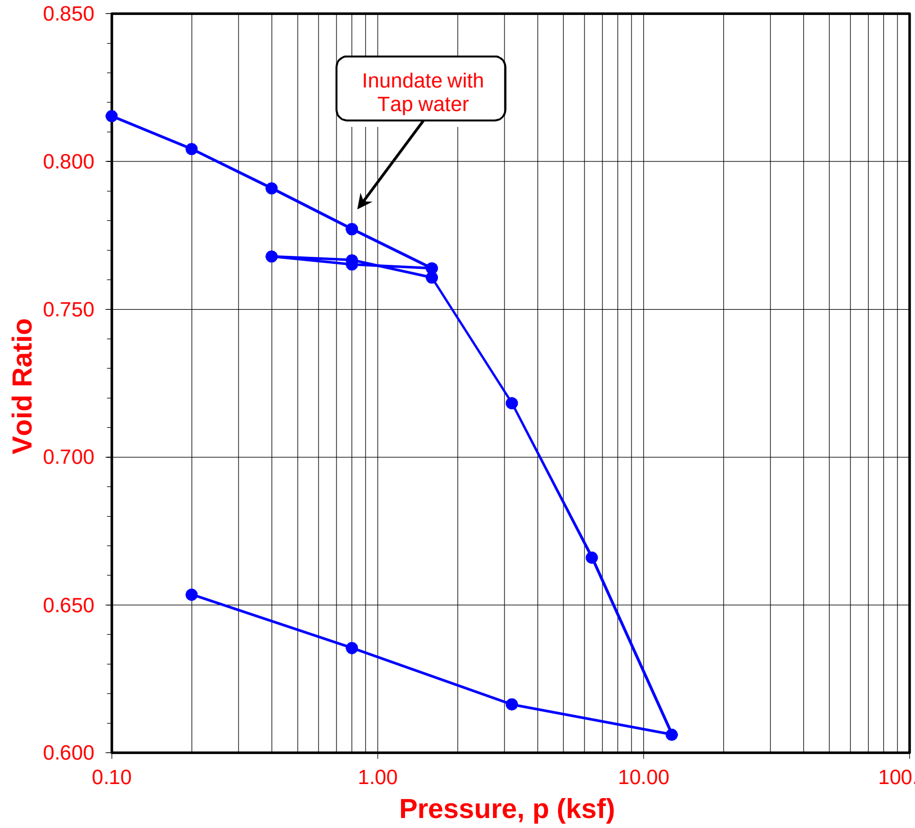
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Garden Grove	Tested By: F. Tabibkhoei	Date: 04/04/11
Project No.:	602778-002	Checked By: J. Ward	Date: 04/20/11
Boring No.:	B-1	Depth (ft.): 18.0	
Sample No.:	R-4	Sample Type: Drive	
Soil Identification:	Olive gray lean clay (CL)		

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	188.30
Weight of Ring (g)	43.60
Height after consol. (in.)	0.9061
Before Test	
Wt.Wet Sample+Cont. (g)	324.70
Wt.of Dry Sample+Cont. (g)	258.23
Weight of Container (g)	37.96
Initial Moisture Content (%)	30.2
Initial Dry Density (pcf)	92.4
Initial Saturation (%)	99
Initial Vertical Reading (in.)	0.3670
After Test	
Wt.of Wet Sample+Cont. (g)	219.73
Wt. of Dry Sample+Cont. (g)	193.20
Weight of Container (g)	38.09
Final Moisture Content (%)	23.79
Final Dry Density (pcf)	102.3
Final Saturation (%)	99
Final Vertical Reading (in.)	0.2711
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

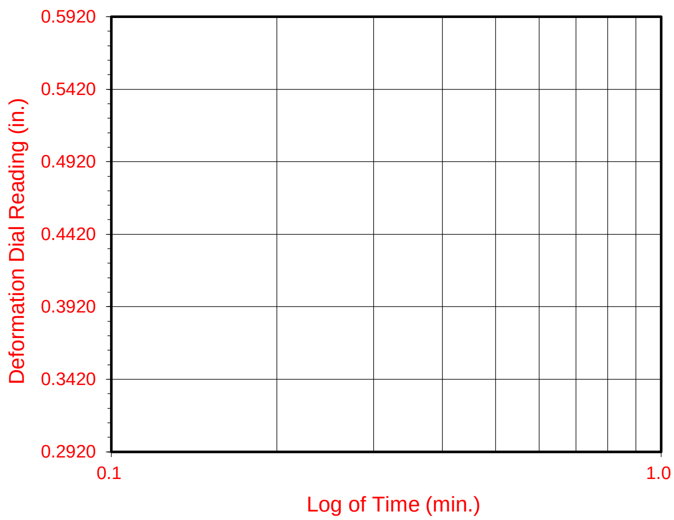


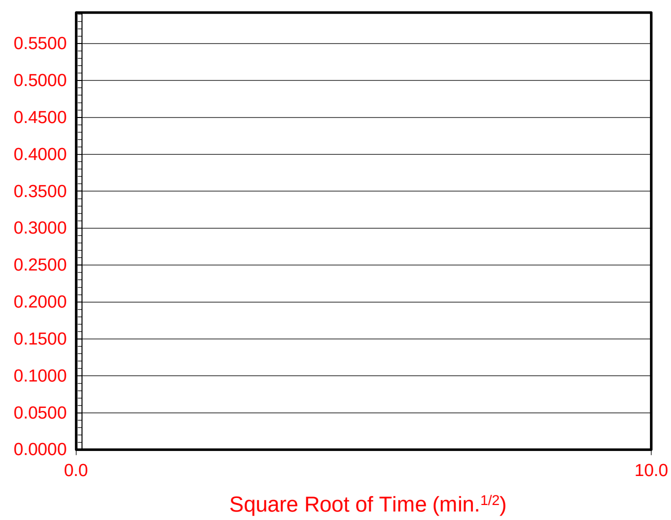
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3618	0.9948	0.00	0.52	0.815	0.52
0.20	0.3553	0.9883	0.04	1.17	0.804	1.13
0.40	0.3476	0.9806	0.08	1.94	0.791	1.86
0.80	0.3397	0.9727	0.12	2.73	0.777	2.61
0.80	0.3397	0.9727	0.12	2.74	0.777	2.62
1.60	0.3318	0.9648	0.18	3.52	0.764	3.34
0.80	0.3331	0.9661	0.12	3.39	0.765	3.27
0.40	0.3350	0.9680	0.08	3.20	0.768	3.12
0.80	0.3339	0.9669	0.12	3.31	0.767	3.19
1.60	0.3301	0.9631	0.18	3.70	0.761	3.52
3.20	0.3060	0.9390	0.26	6.10	0.718	5.84
6.40	0.2760	0.9090	0.40	9.11	0.666	8.71
12.80	0.2415	0.8745	0.57	12.56	0.606	11.99
3.20	0.2489	0.8819	0.39	11.82	0.616	11.43
0.80	0.2606	0.8936	0.26	10.64	0.635	10.38
0.20	0.2711	0.9041	0.20	9.59	0.654	9.39

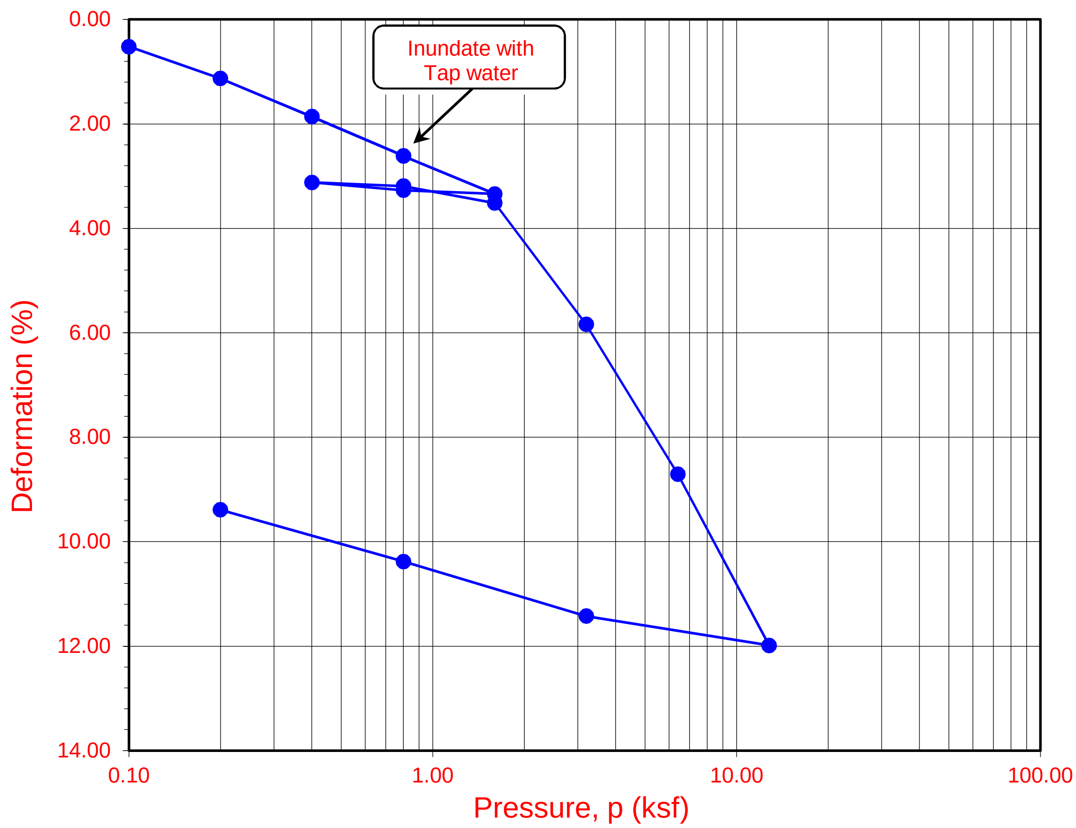
No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-4**	**18.0**	**30.2**	**23.8**	**92.4**	**102.3**	**0.825**	**0.654**	**99**	**99**

Soil Identification: Olive gray lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Garden Grove

04-11

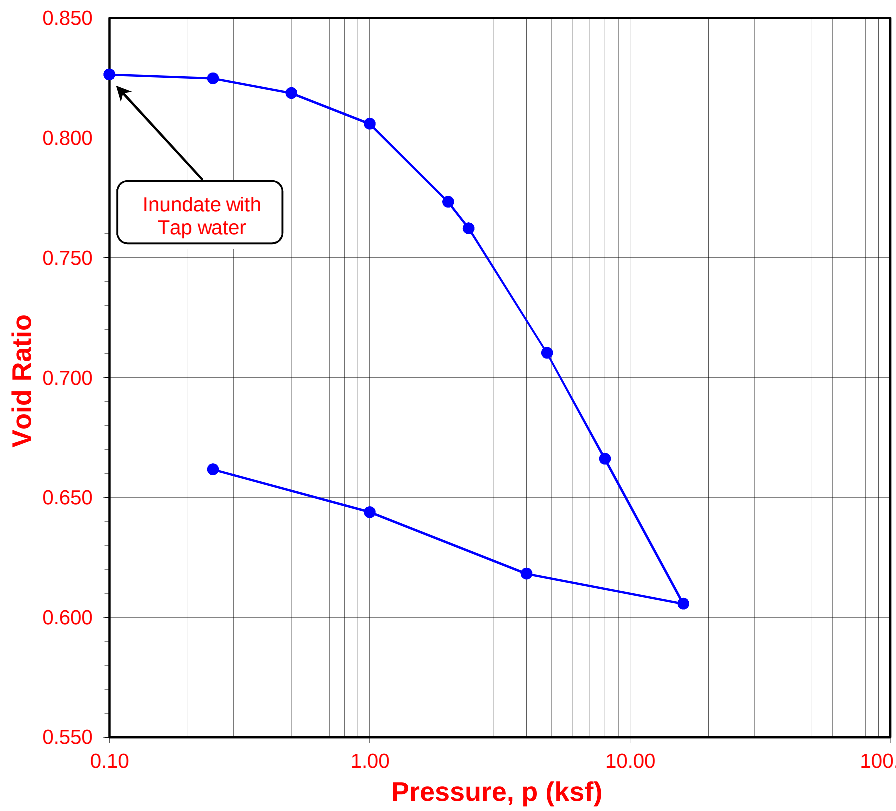
Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Project Name:	Proposed Great Wolf Lodge	Tested By:	A. Santos	Date:	07/01/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	07/18/11
Boring No.:	B-1	Depth (ft.):	30.0		
Sample No.:	R-6	Sample Type:	Drive		
Soil Identification:	Brown lean clay (CL)				

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	189.09
Weight of Ring (g)	40.91
Height after consol. (in.)	0.9097
Before Test	
Wt.Wet Sample+Cont. (g)	240.21
Wt.of Dry Sample+Cont. (g)	195.44
Weight of Container (g)	61.54
Initial Moisture Content (%)	33.4
Initial Dry Density (pcf)	92.3
Initial Saturation (%)	109
Initial Vertical Reading (in.)	0.2581
After Test	
Wt.of Wet Sample+Cont. (g)	220.03
Wt. of Dry Sample+Cont. (g)	192.81
Weight of Container (g)	37.55
Final Moisture Content (%)	23.80
Final Dry Density (pcf)	104.5
Final Saturation (%)	105
Final Vertical Reading (in.)	0.1649
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

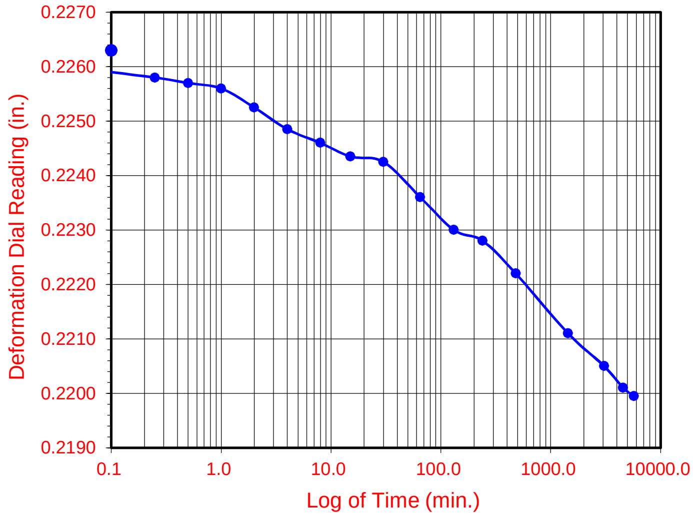


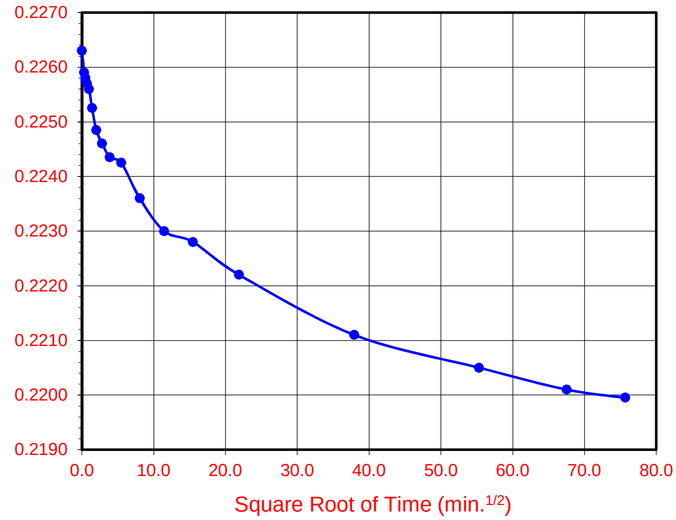
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.2580	0.9999	0.00	0.01	0.826	0.01
0.10	0.2580	0.9999	0.00	0.01	0.826	0.01
0.25	0.2566	0.9985	0.05	0.15	0.825	0.10
0.50	0.2527	0.9946	0.11	0.54	0.819	0.43
1.00	0.2451	0.9870	0.17	1.31	0.806	1.14
2.00	0.2263	0.9682	0.26	3.18	0.773	2.92
2.40	0.2200	0.9619	0.29	3.82	0.762	3.53
4.80	0.1901	0.9320	0.43	6.80	0.710	6.37
8.00	0.1646	0.9065	0.56	9.35	0.666	8.79
16.00	0.1294	0.8713	0.77	12.87	0.606	12.10
4.00	0.1389	0.8808	0.51	11.92	0.618	11.41
1.00	0.1541	0.8960	0.40	10.41	0.644	10.01
0.25	0.1649	0.9068	0.29	9.32	0.662	9.03

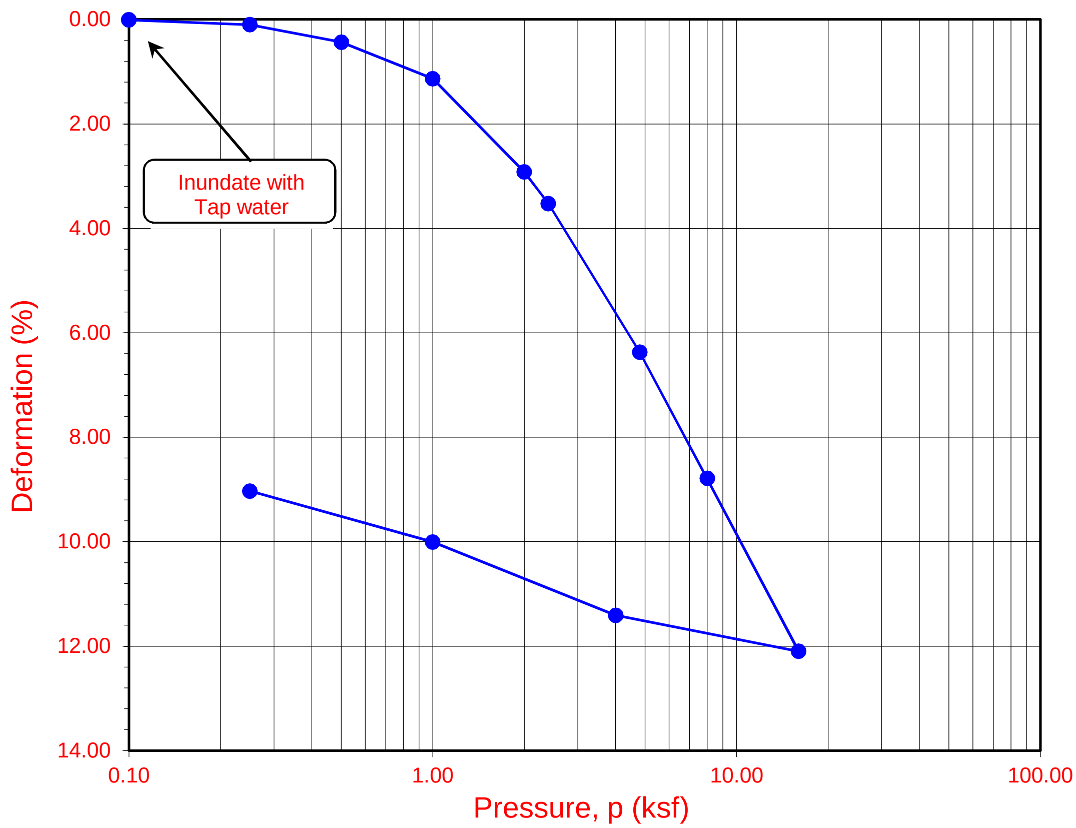
Time Readings @ 2.4 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
7/7/11	8:15:00	0.0	0.0	0.2263
7/7/11	8:15:06	0.1	0.3	0.2259
7/7/11	8:15:15	0.2	0.5	0.2258
7/7/11	8:15:30	0.5	0.7	0.2257
7/7/11	8:16:00	1.0	1.0	0.2256
7/7/11	8:17:00	2.0	1.4	0.2253
7/7/11	8:19:00	4.0	2.0	0.2249
7/7/11	8:23:00	8.0	2.8	0.2246
7/7/11	8:30:00	15.0	3.9	0.2244
7/7/11	8:45:00	30.0	5.5	0.2243
7/7/11	9:20:00	65.0	8.1	0.2236
7/7/11	10:26:00	131.0	11.4	0.2230
7/7/11	12:15:00	240.0	15.5	0.2228
7/7/11	16:15:00	480.0	21.9	0.2222
7/8/11	8:15:00	1440.0	37.9	0.2211
7/9/11	11:15:00	3060.0	55.3	0.2205
7/10/11	12:15:00	4560.0	67.5	0.2201
7/11/11	7:45:00	5730.0	75.7	0.2200

Time Readings @ 2.4 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-6**	**30.0**	**33.4**	**23.8**	**92.3**	**104.5**	**0.827**	**0.662**	**100**	**100**

Soil Identification: Brown lean clay (CL)

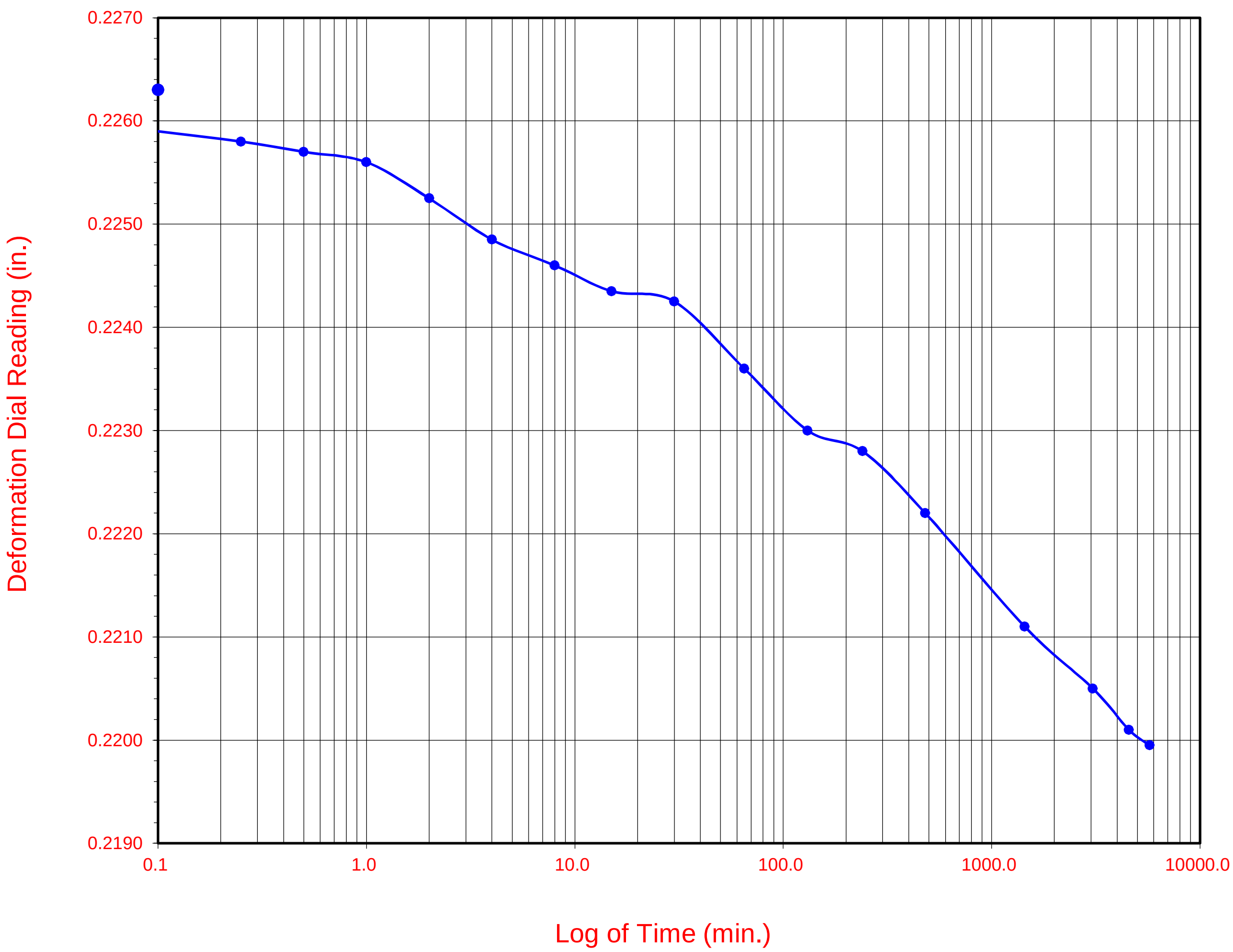
Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

Time Readings @ 2.4 ksf



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<tr><td>Initial</td><td>Final</td><td>Initial</td><td>Final</td><td>Initial</td><td>Final</td><td>Initial</td><td>Final</td></tr>
<tr><td>B-1</td><td>R-6</td><td>30.0</td><td>33.4</td><td>23.8</td><td>92.3</td><td>104.5</td><td>0.827</td><td>0.662</td><td>100</td><td>100</td></tr>
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Soil Identification: Brown lean clay (CL)

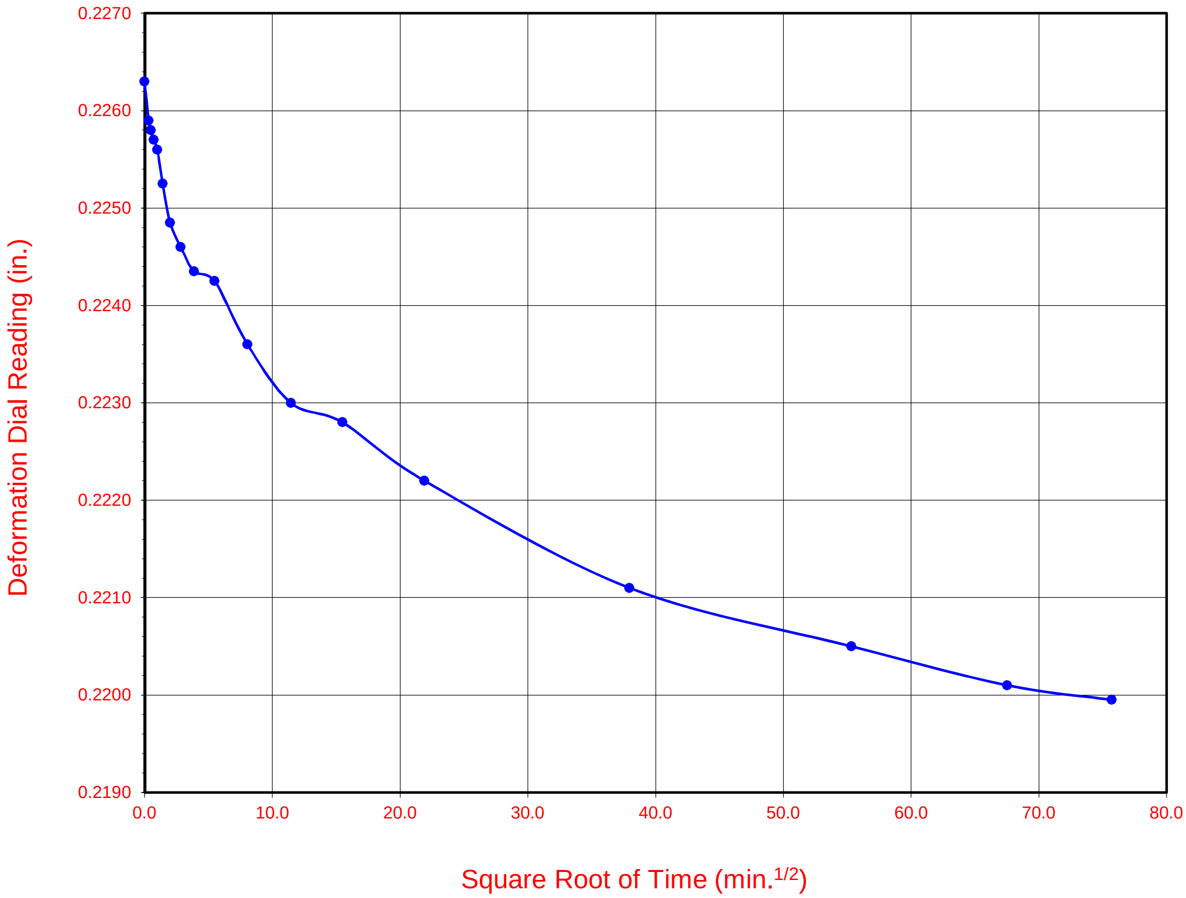
Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

Time Readings @ 2.4 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-6**	**30.0**	**33.4**	**23.8**	**92.3**	**104.5**	**0.827**	**0.662**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton	**ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS** **(ASTM D 2435)**	Project No.: 602778-002 Proposed Great Wolf Lodge 07-11

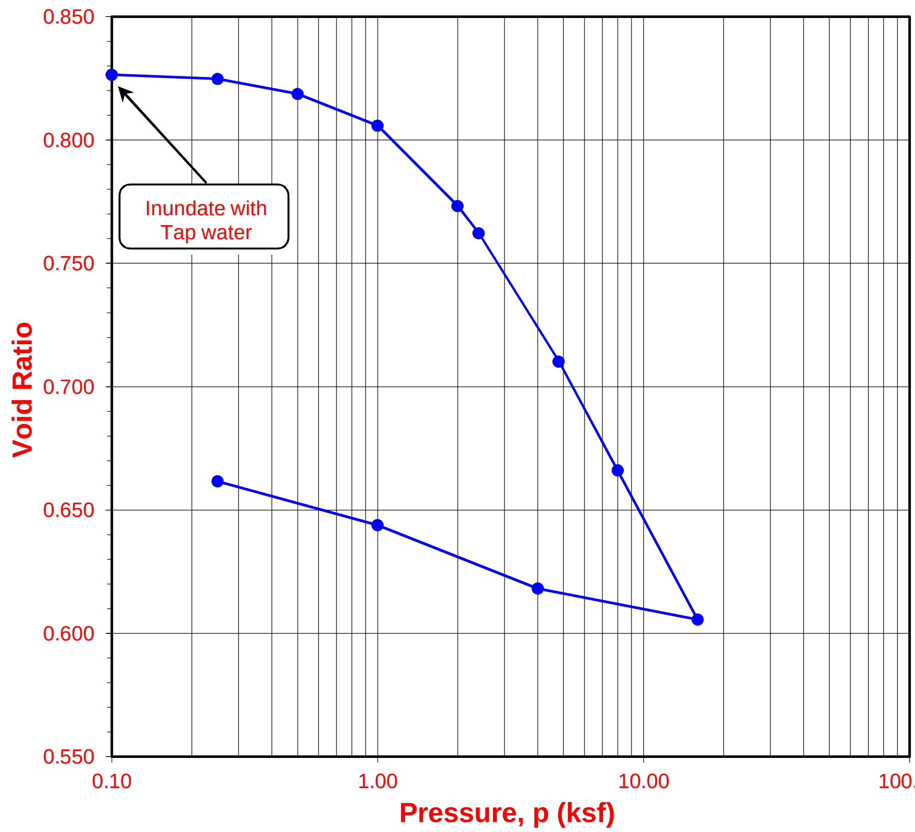
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Proposed Great Wolf Lodge	Tested By: A. Santos	Date: 07/01/11
Project No.:	602778-002	Checked By: J. Ward	Date: 07/18/11
Boring No.:	B-1	Depth (ft.): 30.0	
Sample No.:	R-6	Sample Type: Drive	
Soil Identification:	Brown lean clay (CL)		

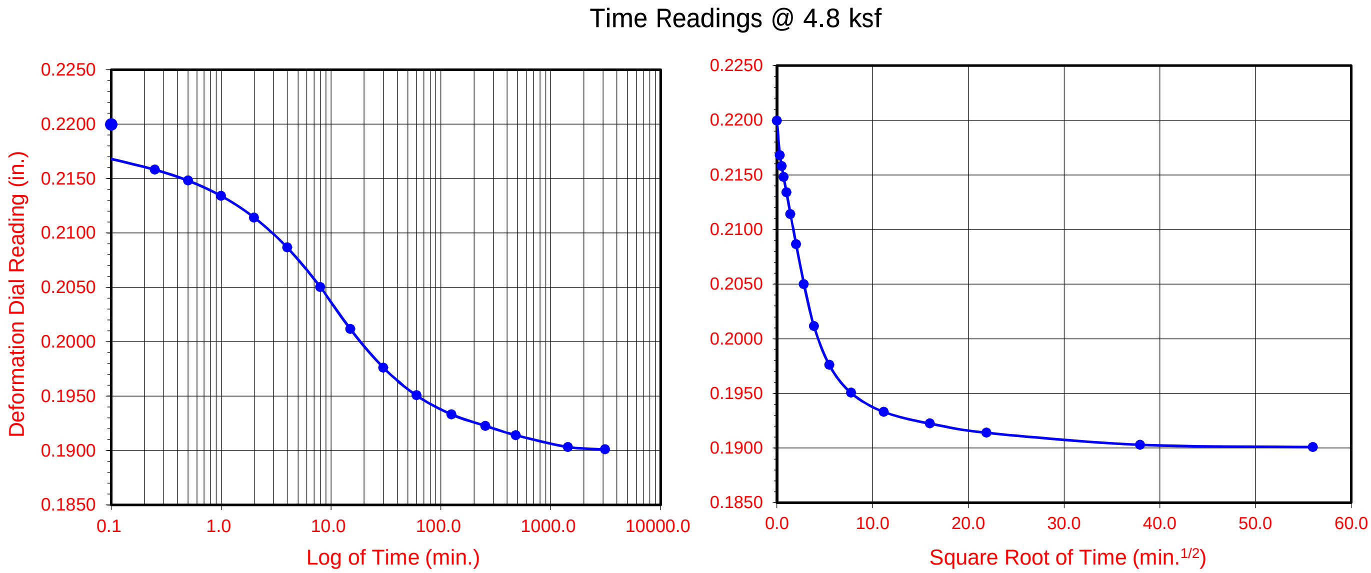
Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	189.09
Weight of Ring (g)	40.91
Height after consol. (in.)	0.9097
Before Test	
Wt.Wet Sample+Cont. (g)	240.21
Wt.of Dry Sample+Cont. (g)	195.44
Weight of Container (g)	61.54
Initial Moisture Content (%)	33.4
Initial Dry Density (pcf)	92.3
Initial Saturation (%)	109
Initial Vertical Reading (in.)	0.2581
After Test	
Wt.of Wet Sample+Cont. (g)	220.03
Wt. of Dry Sample+Cont. (g)	192.81
Weight of Container (g)	37.55
Final Moisture Content (%)	23.80
Final Dry Density (pcf)	104.5
Final Saturation (%)	105
Final Vertical Reading (in.)	0.1649
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

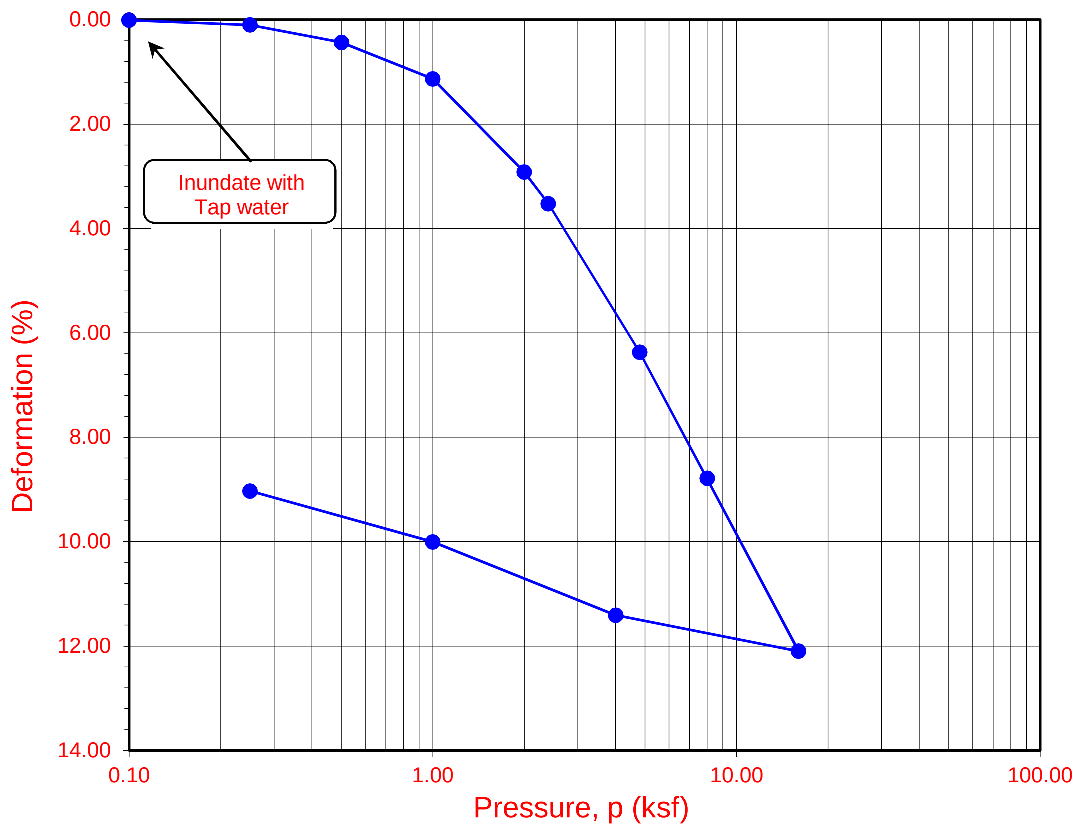


Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.2580	0.9999	0.00	0.01	0.826	0.01
0.10	0.2580	0.9999	0.00	0.01	0.826	0.01
0.25	0.2566	0.9985	0.05	0.15	0.825	0.10
0.50	0.2527	0.9946	0.11	0.54	0.819	0.43
1.00	0.2451	0.9870	0.17	1.31	0.806	1.14
2.00	0.2263	0.9682	0.26	3.18	0.773	2.92
2.40	0.2200	0.9619	0.29	3.82	0.762	3.53
4.80	0.1901	0.9320	0.43	6.80	0.710	6.37
8.00	0.1646	0.9065	0.56	9.35	0.666	8.79
16.00	0.1294	0.8713	0.77	12.87	0.606	12.10
4.00	0.1389	0.8808	0.51	11.92	0.618	11.41
1.00	0.1541	0.8960	0.40	10.41	0.644	10.01
0.25	0.1649	0.9068	0.29	9.32	0.662	9.03

Time Readings @ 4.8 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
7/11/11	7:45:00	0.0	0.0	0.2200
7/11/11	7:45:06	0.1	0.3	0.2168
7/11/11	7:45:15	0.2	0.5	0.2158
7/11/11	7:45:30	0.5	0.7	0.2148
7/11/11	7:46:00	1.0	1.0	0.2134
7/11/11	7:47:00	2.0	1.4	0.2114
7/11/11	7:49:00	4.0	2.0	0.2087
7/11/11	7:53:00	8.0	2.8	0.2050
7/11/11	8:00:00	15.0	3.9	0.2012
7/11/11	8:15:00	30.0	5.5	0.1976
7/11/11	8:45:00	60.0	7.7	0.1951
7/11/11	9:50:00	125.0	11.2	0.1933
7/11/11	12:00:00	255.0	16.0	0.1923
7/11/11	15:45:00	480.0	21.9	0.1914
7/12/11	7:45:00	1440.0	37.9	0.1903
7/13/11	12:00:00	3135.0	56.0	0.1901





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-6**	**30.0**	**33.4**	**23.8**	**92.3**	**104.5**	**0.827**	**0.662**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

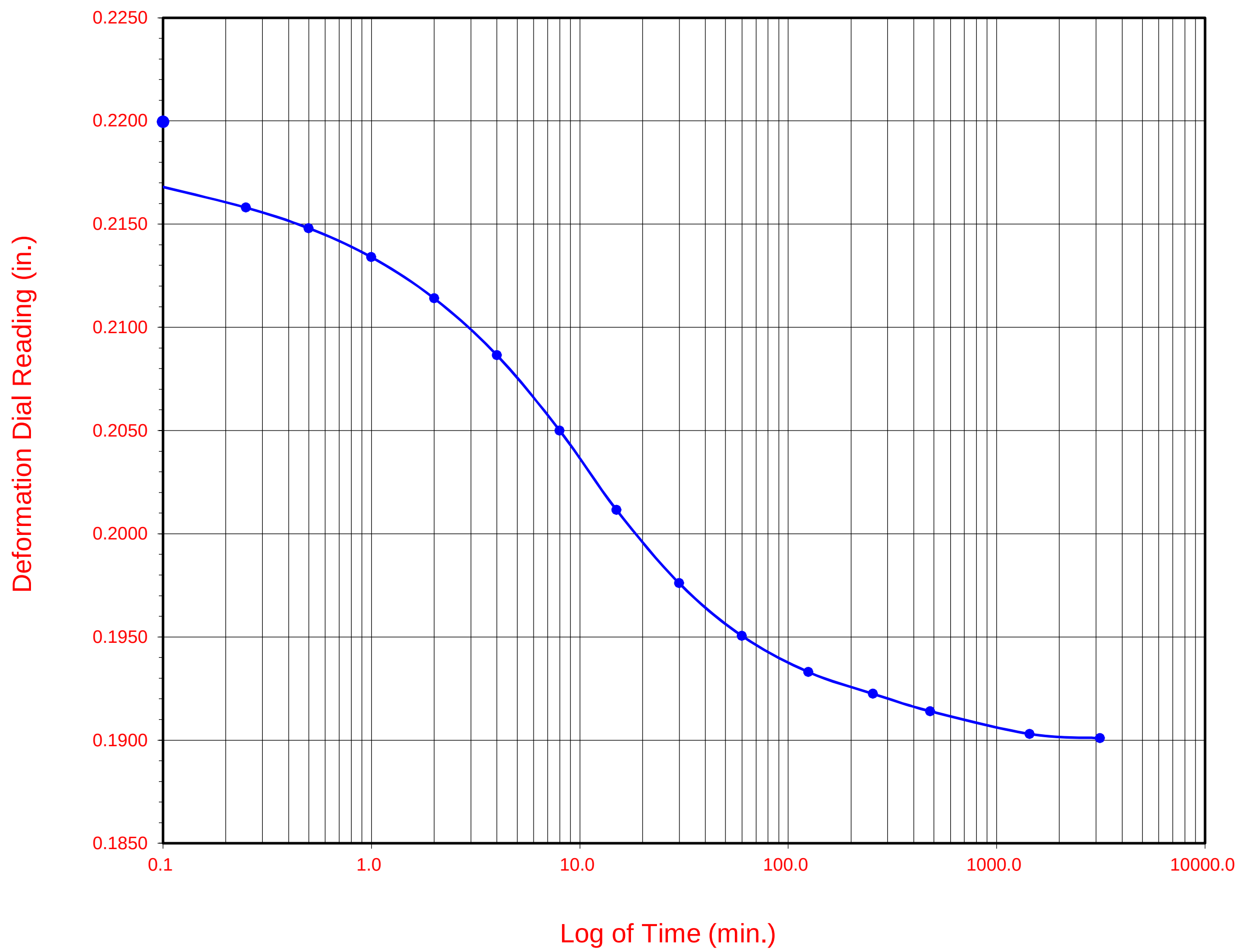
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

Time Readings @ 4.8 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-6**	**30.0**	**33.4**	**23.8**	**92.3**	**104.5**	**0.827**	**0.662**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

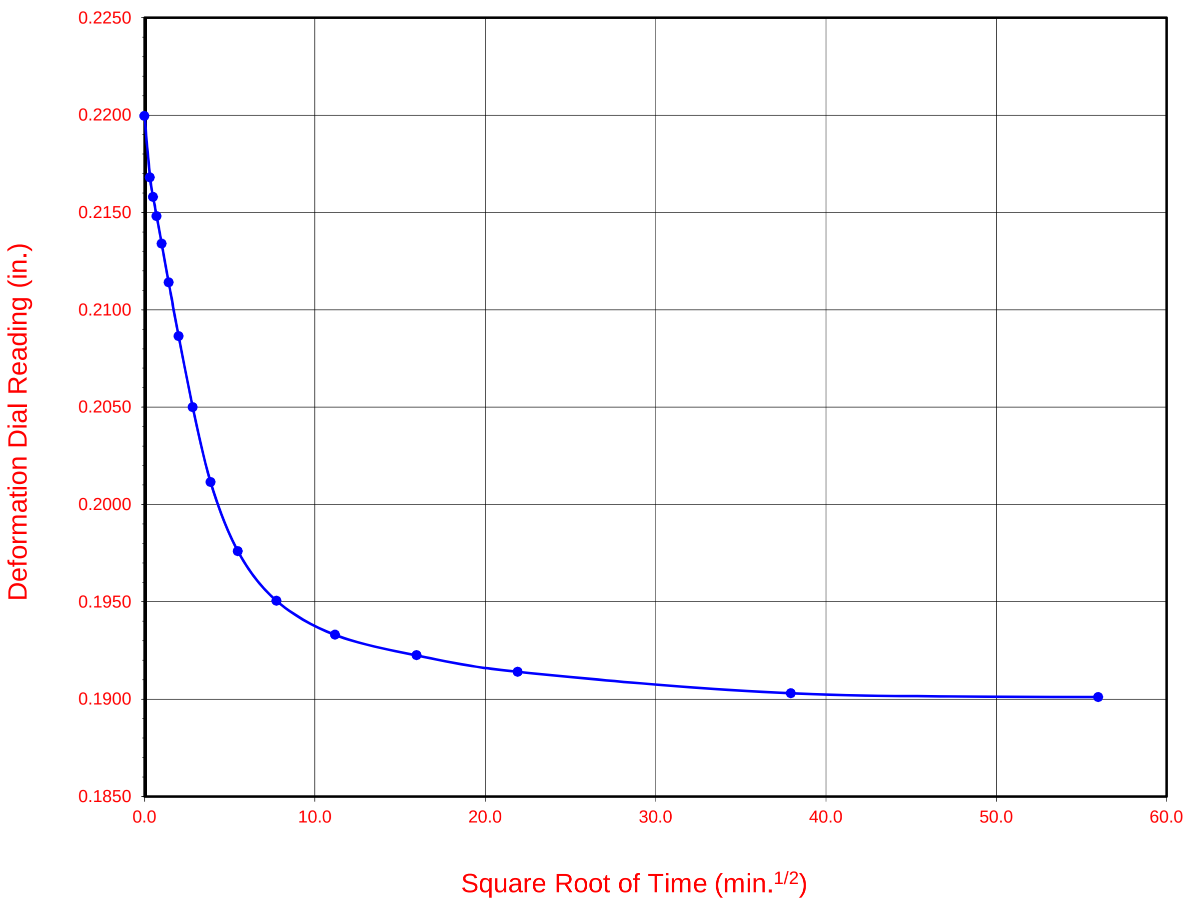
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

Time Readings @ 4.8 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-1	**R-6**	**30.0**	**33.4**	**23.8**	**92.3**	**104.5**	**0.827**	**0.662**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

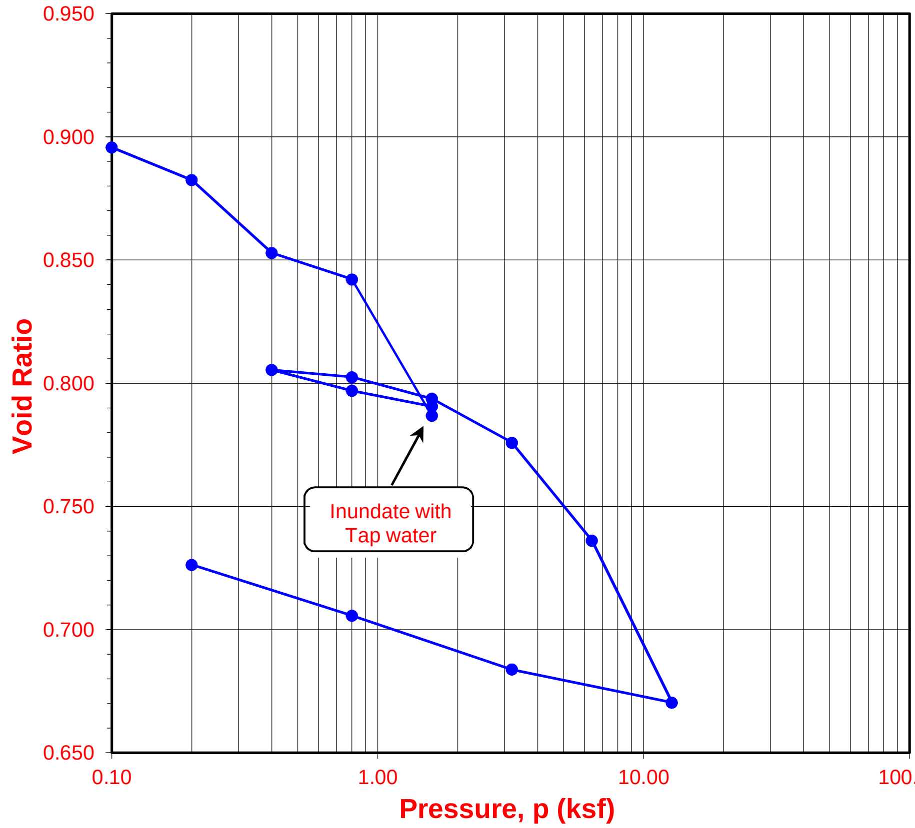
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Garden Grove	Tested By: F. Tabibkhoei	Date: 04/04/11
Project No.:	602778-002	Checked By: J. Ward	Date: 04/20/11
Boring No.:	B-3	Depth (ft.): 20.0	
Sample No.:	R-4	Sample Type: Drive	
Soil Identification:	Grayish brown lean clay (CL)		

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	185.87
Weight of Ring (g)	44.50
Height after consol. (in.)	0.9020
Before Test	
Wt.Wet Sample+Cont. (g)	304.90
Wt.of Dry Sample+Cont. (g)	238.10
Weight of Container (g)	38.00
Initial Moisture Content (%)	33.4
Initial Dry Density (pcf)	88.1
Initial Saturation (%)	99
Initial Vertical Reading (in.)	0.3138
After Test	
Wt.of Wet Sample+Cont. (g)	217.07
Wt. of Dry Sample+Cont. (g)	188.20
Weight of Container (g)	37.91
Final Moisture Content (%)	27.29
Final Dry Density (pcf)	97.5
Final Saturation (%)	101
Final Vertical Reading (in.)	0.2147
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

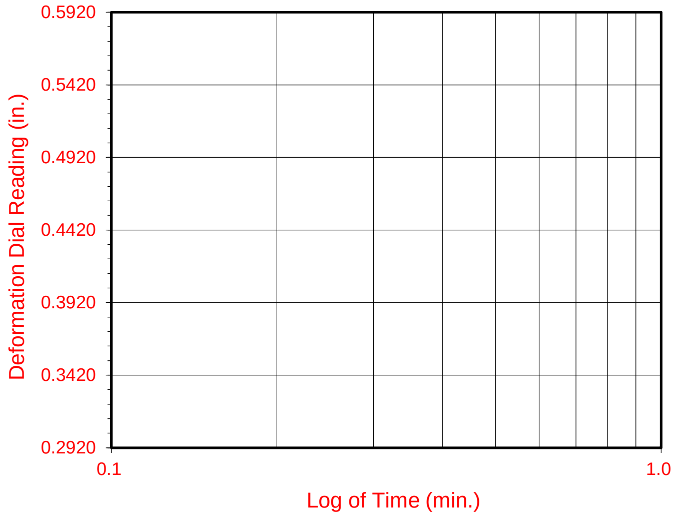


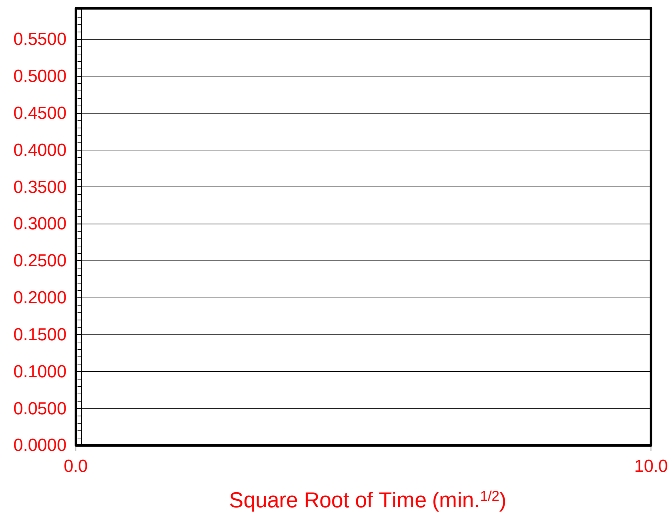
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3043	0.9905	0.00	0.95	0.896	0.95
0.20	0.2971	0.9833	0.03	1.67	0.882	1.64
0.40	0.2814	0.9676	0.06	3.25	0.853	3.19
0.80	0.2755	0.9617	0.09	3.84	0.842	3.75
1.60	0.2462	0.9324	0.13	6.77	0.787	6.64
1.60	0.2481	0.9343	0.13	6.57	0.791	6.44
0.80	0.2518	0.9380	0.09	6.20	0.797	6.11
0.40	0.2566	0.9428	0.06	5.73	0.805	5.67
0.80	0.2547	0.9409	0.09	5.91	0.802	5.82
1.60	0.2497	0.9359	0.13	6.41	0.794	6.28
3.20	0.2395	0.9257	0.22	7.43	0.776	7.21
6.40	0.2174	0.9036	0.35	9.64	0.736	9.29
12.80	0.1816	0.8678	0.50	13.23	0.670	12.73
3.20	0.1904	0.8766	0.32	12.34	0.684	12.02
0.80	0.2030	0.8892	0.20	11.08	0.706	10.88
0.20	0.2147	0.9009	0.11	9.91	0.726	9.80

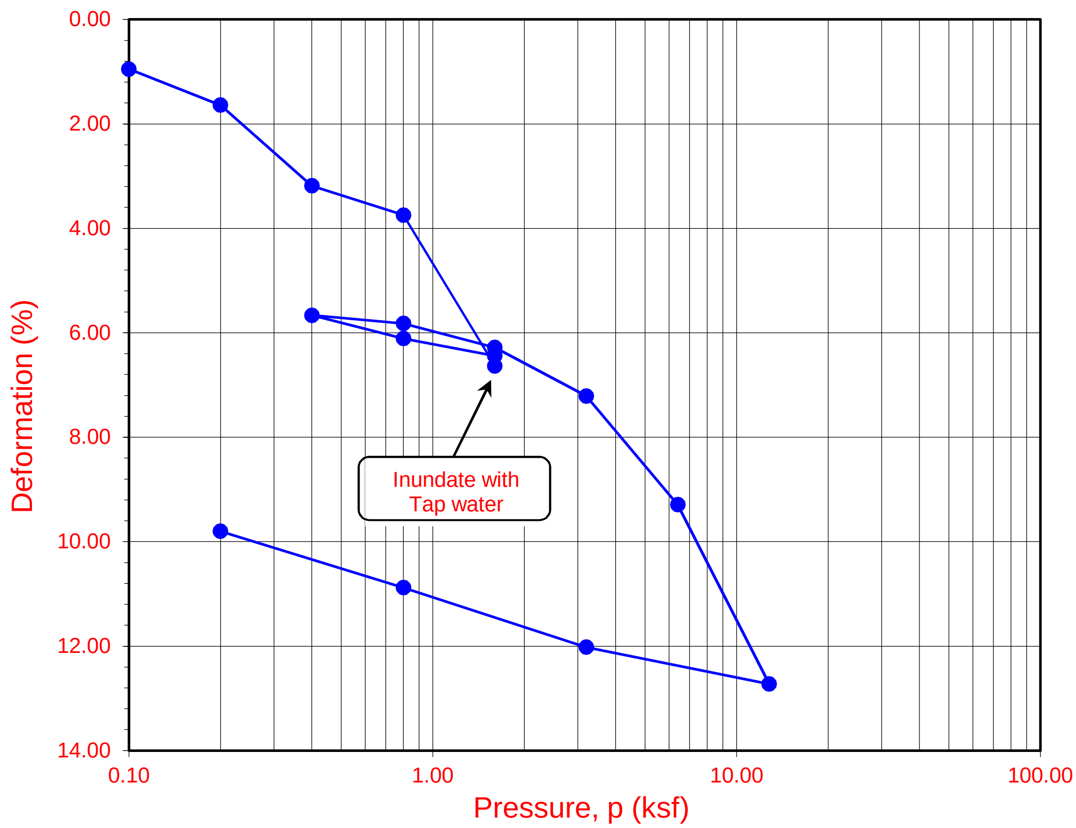
No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-3	**R-4**	**20.0**	**33.4**	**27.3**	**88.1**	**97.5**	**0.914**	**0.726**	**99**	**100**

Soil Identification: Grayish brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Garden Grove

04-11

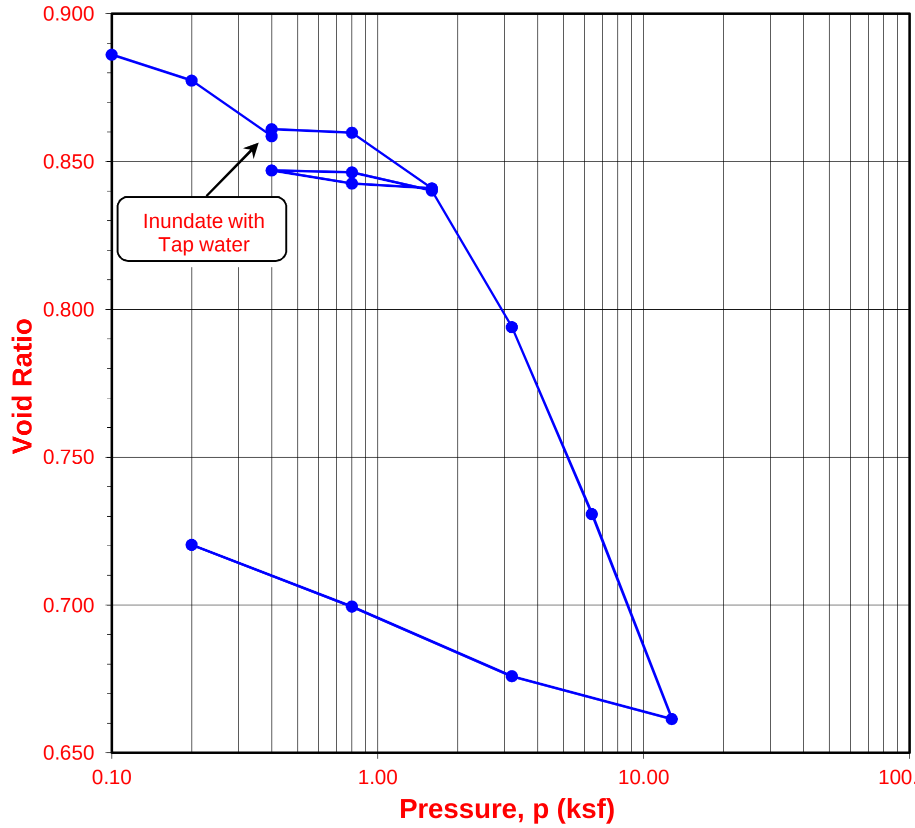
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Garden Grove	Tested By:	F. Tabibkhoei	Date:	04/04/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	04/18/11
Boring No.:	B-3	Depth (ft.):	40.0		
Sample No.:	R-8	Sample Type:	Drive		
Soil Identification:	Olive fat clay (CH)				

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	188.70
Weight of Ring (g)	44.20
Height after consol. (in.)	0.9105
Before Test	
Wt.Wet Sample+Cont. (g)	326.30
Wt.of Dry Sample+Cont. (g)	252.27
Weight of Container (g)	38.30
Initial Moisture Content (%)	34.6
Initial Dry Density (pcf)	89.2
Initial Saturation (%)	105
Initial Vertical Reading (in.)	0.2768
After Test	
Wt.of Wet Sample+Cont. (g)	220.94
Wt. of Dry Sample+Cont. (g)	191.38
Weight of Container (g)	38.96
Final Moisture Content (%)	27.31
Final Dry Density (pcf)	98.8
Final Saturation (%)	104
Final Vertical Reading (in.)	0.1845
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

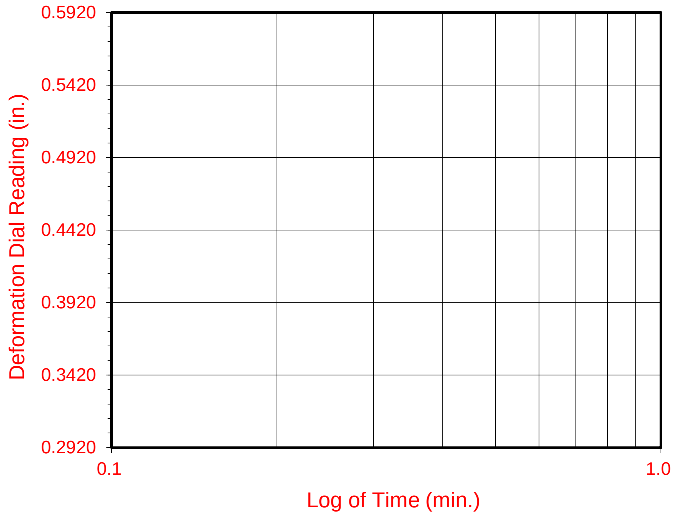


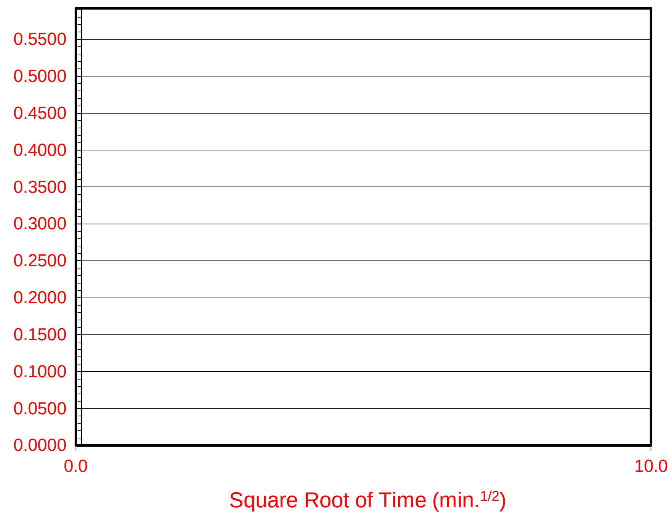
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2751	0.9983	0.00	0.17	0.886	0.17
0.20	0.2701	0.9933	0.03	0.67	0.877	0.64
0.40	0.2596	0.9828	0.09	1.73	0.859	1.64
0.40	0.2608	0.9840	0.09	1.60	0.861	1.51
0.80	0.2596	0.9828	0.15	1.72	0.860	1.57
1.60	0.2489	0.9721	0.22	2.79	0.841	2.57
0.80	0.2505	0.9737	0.15	2.63	0.843	2.48
0.40	0.2534	0.9766	0.09	2.34	0.847	2.25
0.80	0.2525	0.9757	0.15	2.44	0.846	2.29
1.60	0.2485	0.9717	0.22	2.83	0.840	2.61
3.20	0.2229	0.9461	0.34	5.39	0.794	5.05
6.40	0.1878	0.9110	0.50	8.90	0.731	8.40
12.80	0.1492	0.8724	0.69	12.76	0.661	12.07
3.20	0.1592	0.8824	0.46	11.77	0.676	11.31
0.80	0.1726	0.8958	0.37	10.43	0.699	10.06
0.20	0.1845	0.9077	0.28	9.23	0.720	8.95

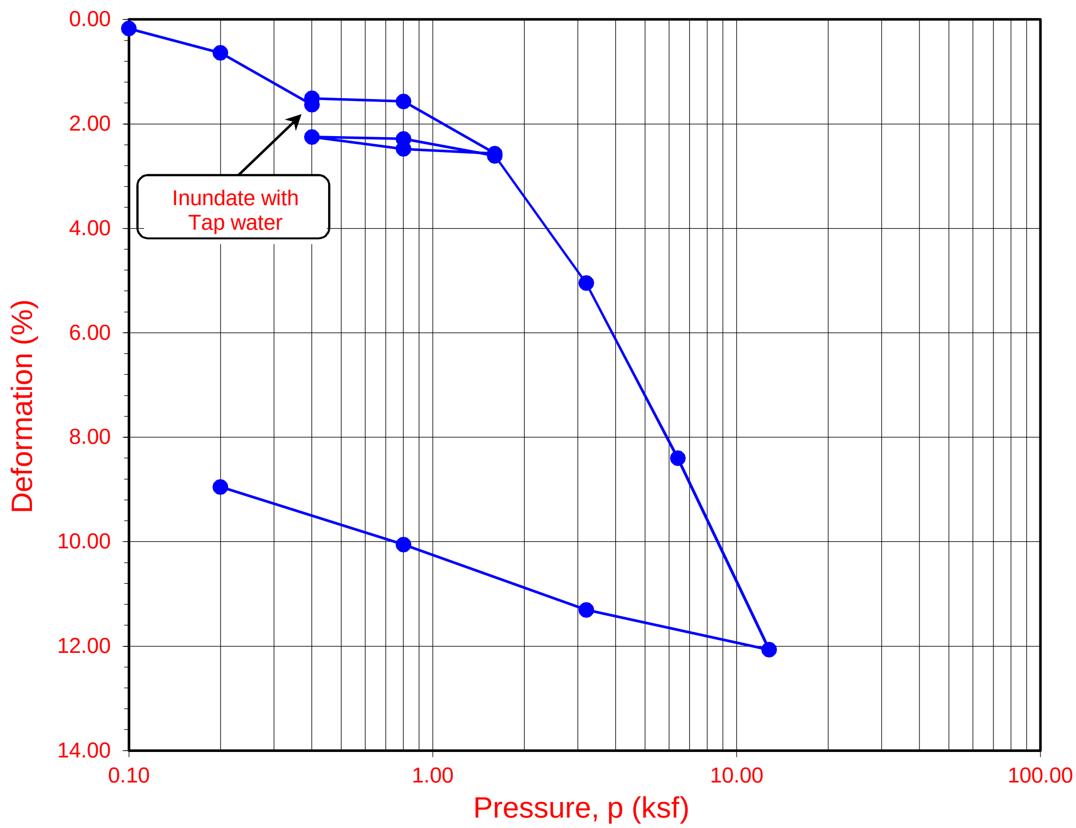
No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-3	**R-8**	**40.0**	**34.6**	**27.3**	**89.2**	**98.8**	**0.889**	**0.720**	**100**	**100**

Soil Identification: Olive fat clay (CH)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Garden Grove

04-11

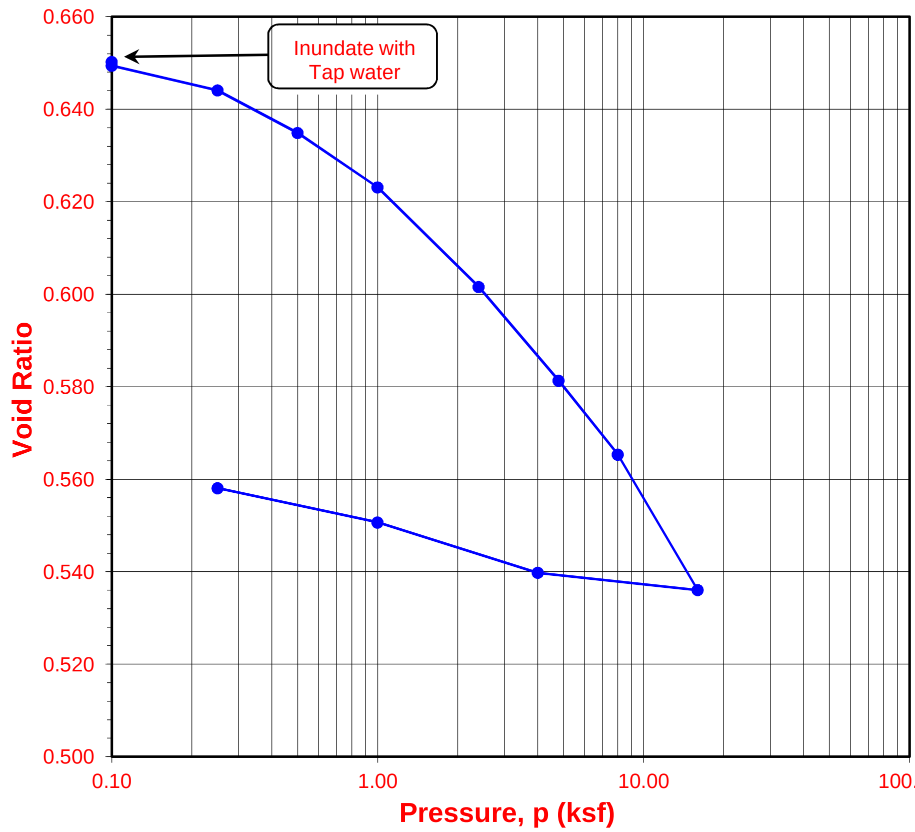
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Proposed Great Wolf Lodge	Tested By: A. Santos	Date: 07/01/11
Project No.:	602778-002	Checked By: J. Ward	Date: 07/18/11
Boring No.:	B-4	Depth (ft.): 55.0	
Sample No.:	R-11	Sample Type: Drive	
Soil Identification:	Brown lean clay (CL)		

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	196.60
Weight of Ring (g)	43.33
Height after consol. (in.)	0.9437
Before Test	
Wt.Wet Sample+Cont. (g)	223.02
Wt.of Dry Sample+Cont. (g)	191.48
Weight of Container (g)	64.05
Initial Moisture Content (%)	24.8
Initial Dry Density (pcf)	102.1
Initial Saturation (%)	103
Initial Vertical Reading (in.)	0.2930
After Test	
Wt.of Wet Sample+Cont. (g)	231.03
Wt. of Dry Sample+Cont. (g)	205.60
Weight of Container (g)	39.12
Final Moisture Content (%)	20.65
Final Dry Density (pcf)	108.4
Final Saturation (%)	101
Final Vertical Reading (in.)	0.2350
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

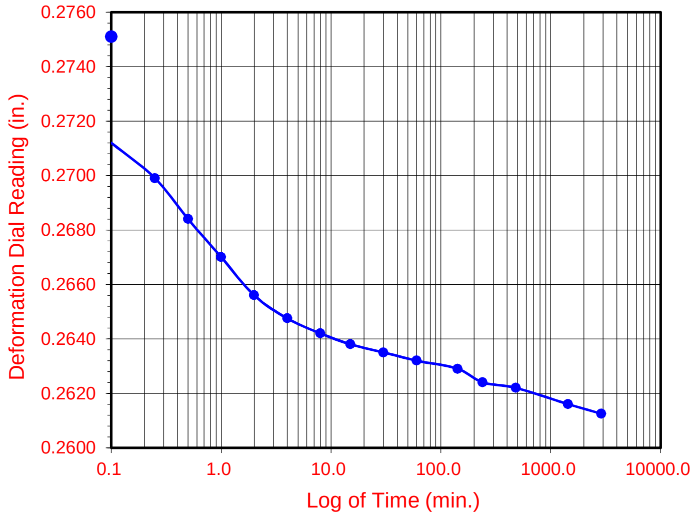


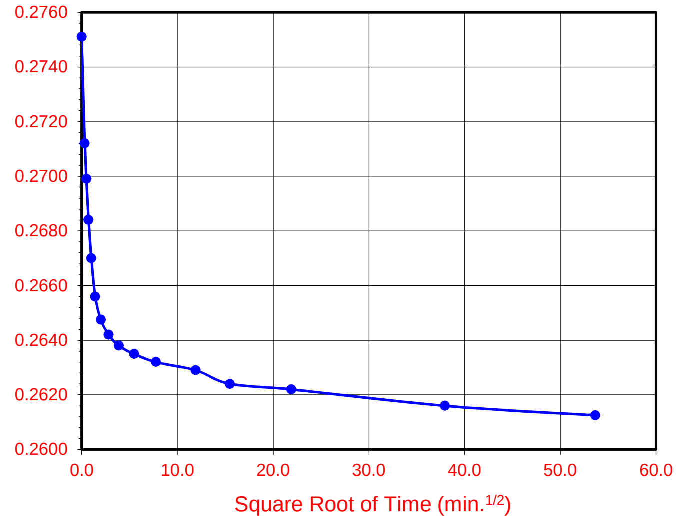
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.2925	0.9995	0.00	0.05	0.650	0.05
0.10	0.2920	0.9990	0.00	0.10	0.649	0.10
0.25	0.2885	0.9955	0.03	0.45	0.644	0.42
0.50	0.2826	0.9896	0.06	1.04	0.635	0.98
1.00	0.2751	0.9821	0.10	1.79	0.623	1.69
2.40	0.2613	0.9683	0.18	3.17	0.602	2.99
4.80	0.2479	0.9549	0.29	4.52	0.581	4.23
8.00	0.2368	0.9438	0.43	5.62	0.565	5.19
16.00	0.2171	0.9241	0.63	7.60	0.536	6.97
4.00	0.2217	0.9287	0.39	7.13	0.540	6.74
1.00	0.2297	0.9367	0.25	6.33	0.551	6.08
0.25	0.2350	0.9420	0.17	5.80	0.558	5.63

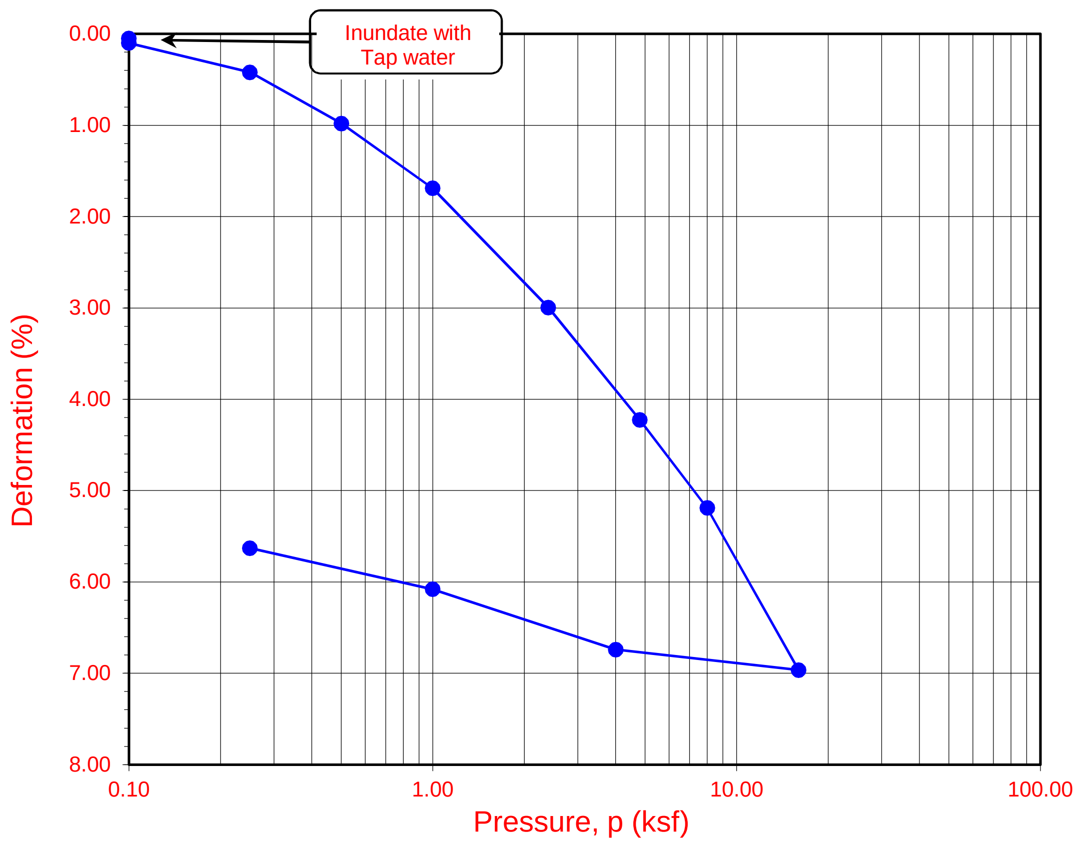
Time Readings @ 2.4 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
7/6/11	9:10:00	0.0	0.0	0.2751
7/6/11	9:10:06	0.1	0.3	0.2712
7/6/11	9:10:15	0.2	0.5	0.2699
7/6/11	9:10:30	0.5	0.7	0.2684
7/6/11	9:11:00	1.0	1.0	0.2670
7/6/11	9:12:00	2.0	1.4	0.2656
7/6/11	9:14:00	4.0	2.0	0.2648
7/6/11	9:18:00	8.0	2.8	0.2642
7/6/11	9:25:00	15.0	3.9	0.2638
7/6/11	9:40:00	30.0	5.5	0.2635
7/6/11	10:10:00	60.0	7.7	0.2632
7/6/11	11:32:00	142.0	11.9	0.2629
7/6/11	13:10:00	240.0	15.5	0.2624
7/6/11	17:10:00	480.0	21.9	0.2622
7/7/11	9:10:00	1440.0	37.9	0.2616
7/8/11	9:10:00	2880.0	53.7	0.2613

Time Readings @ 2.4 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

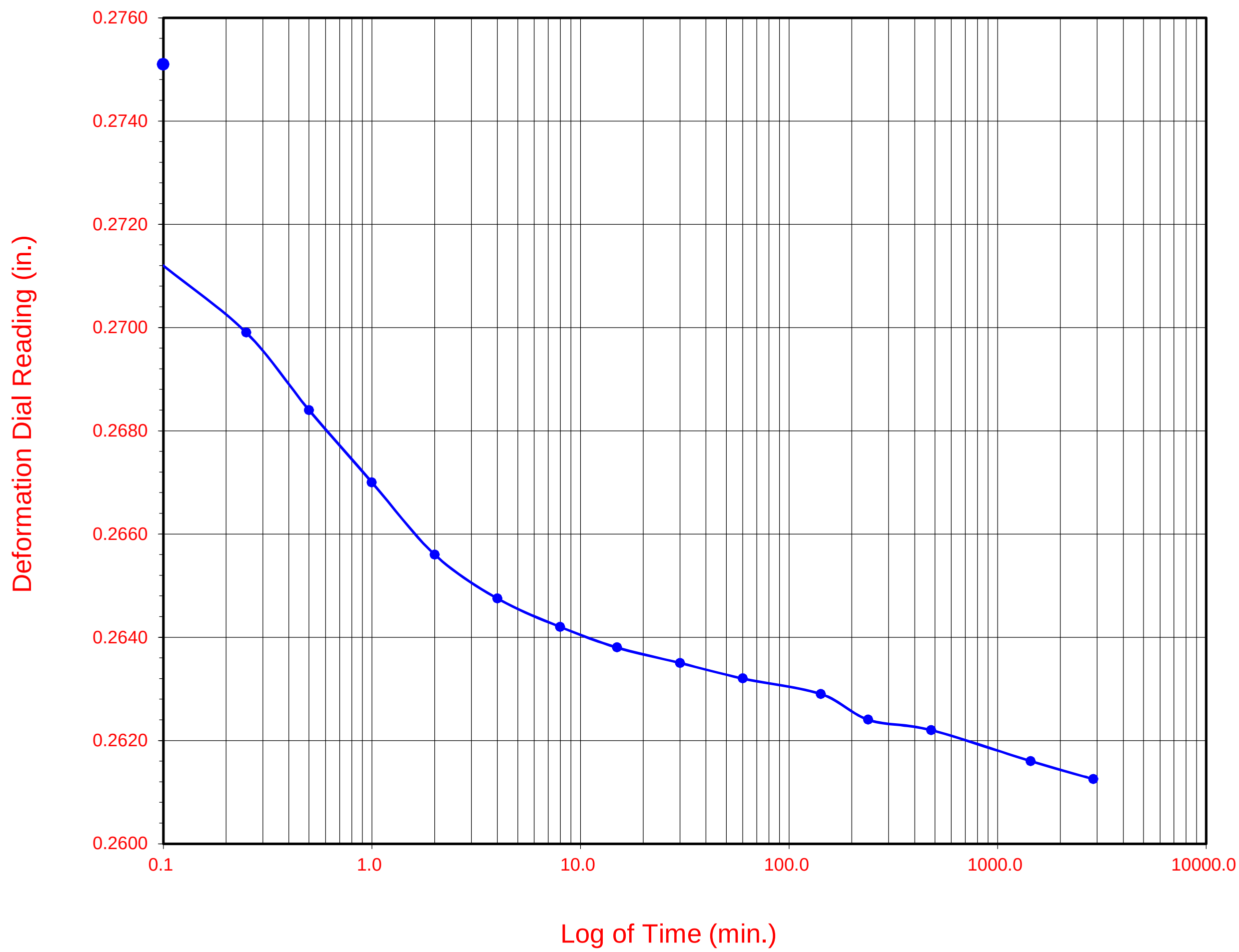
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

Time Readings @ 2.4 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

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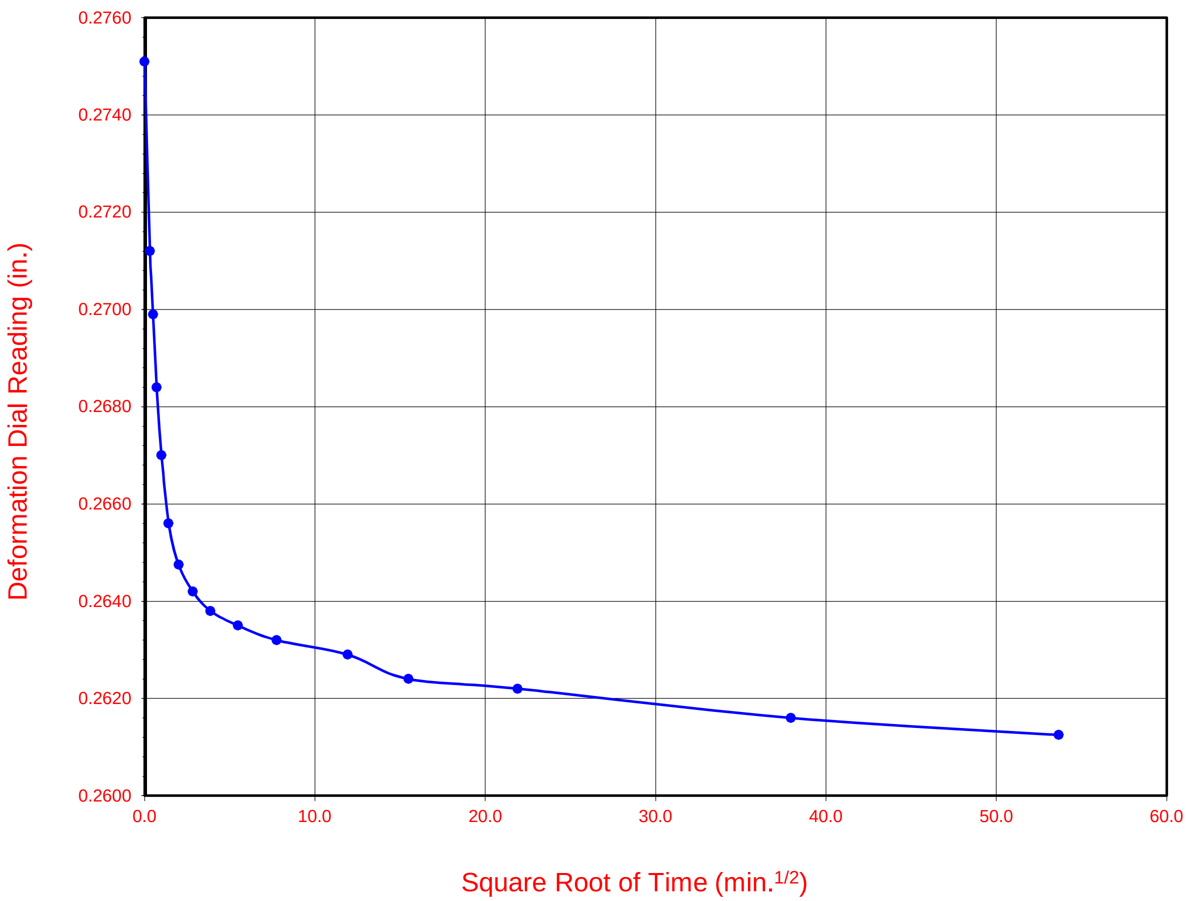
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

Time Readings @ 2.4 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

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ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

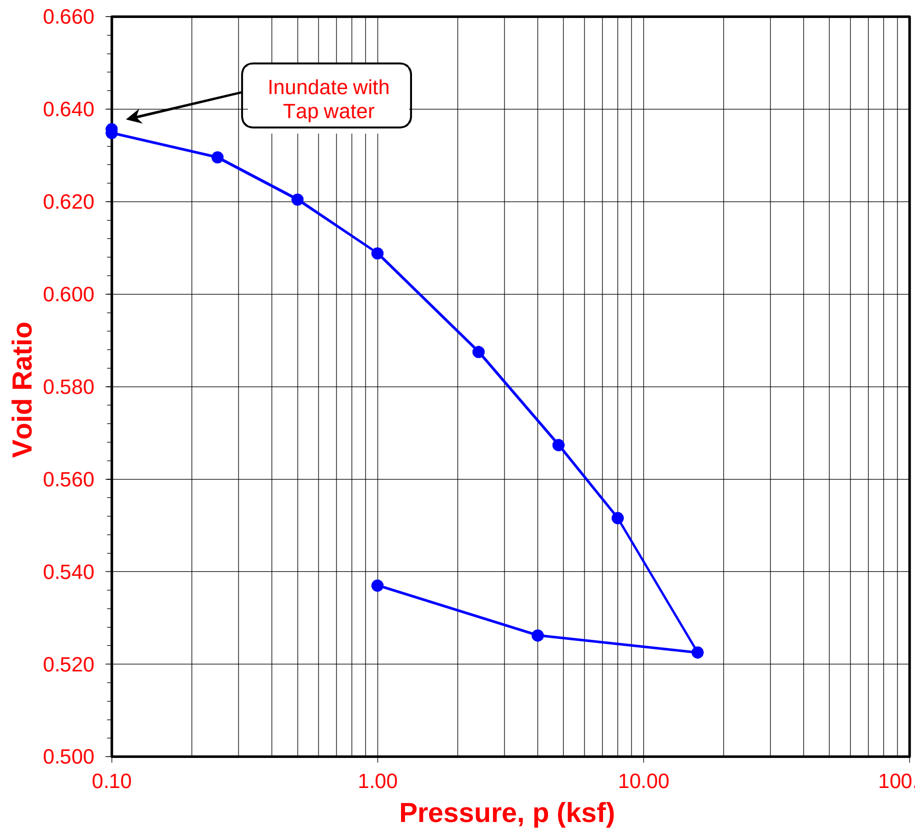
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Proposed Great Wolf Lodge	Tested By:	A. Santos	Date:	07/01/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	07/11/11
Boring No.:	B-4	Depth (ft.):	55.0		
Sample No.:	R-11	Sample Type:	Drive		
Soil Identification:	Brown lean clay (CL)				

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	196.60
Weight of Ring (g)	41.97
Height after consol. (in.)	1.0000
Before Test	
Wt.Wet Sample+Cont. (g)	223.02
Wt.of Dry Sample+Cont. (g)	191.48
Weight of Container (g)	64.05
Initial Moisture Content (%)	24.8
Initial Dry Density (pcf)	103.0
Initial Saturation (%)	105
Initial Vertical Reading (in.)	0.2930
After Test	
Wt.of Wet Sample+Cont. (g)	
Wt. of Dry Sample+Cont. (g)	
Weight of Container (g)	
Final Moisture Content (%)	0.00
Final Dry Density (pcf)	-34.9
Final Saturation (%)	0
Final Vertical Reading (in.)	
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

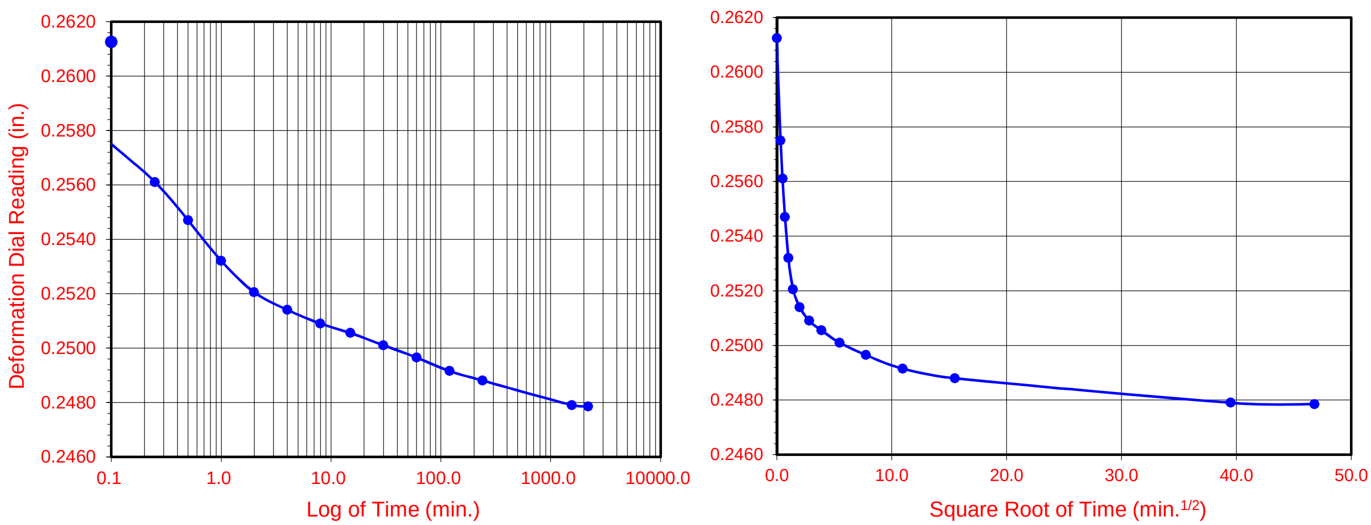


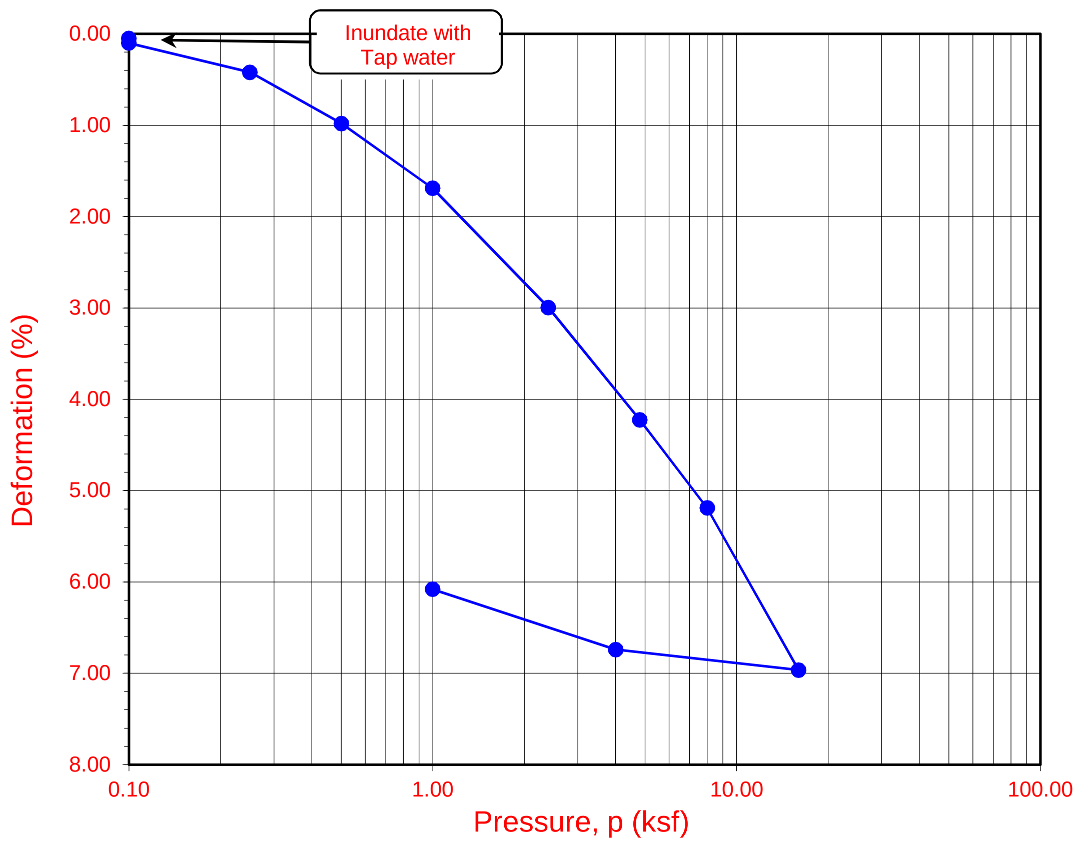
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2925	0.9995	0.00	0.05	0.636	0.05
0.10	0.2920	0.9990	0.00	0.10	0.635	0.10
0.25	0.2885	0.9955	0.03	0.45	0.630	0.42
0.50	0.2826	0.9896	0.06	1.04	0.620	0.98
1.00	0.2751	0.9821	0.10	1.79	0.609	1.69
2.40	0.2613	0.9683	0.18	3.17	0.588	2.99
4.80	0.2479	0.9549	0.29	4.52	0.567	4.23
8.00	0.2368	0.9438	0.43	5.62	0.552	5.19
16.00	0.2171	0.9241	0.63	7.60	0.523	6.97
4.00	0.2217	0.9287	0.39	7.13	0.526	6.74
1.00	0.2297	0.9367	0.25	6.33	0.537	6.08

Time Readings @ 4.8 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
7/8/11	9:20:00	0.0	0.0	0.2613
7/8/11	9:20:06	0.1	0.3	0.2575
7/8/11	9:20:15	0.2	0.5	0.2561
7/8/11	9:20:30	0.5	0.7	0.2547
7/8/11	9:21:00	1.0	1.0	0.2532
7/8/11	9:22:00	2.0	1.4	0.2521
7/8/11	9:24:00	4.0	2.0	0.2514
7/8/11	9:28:00	8.0	2.8	0.2509
7/8/11	9:35:00	15.0	3.9	0.2506
7/8/11	9:50:00	30.0	5.5	0.2501
7/8/11	10:20:00	60.0	7.7	0.2497
7/8/11	11:20:00	120.0	11.0	0.2492
7/8/11	13:20:00	240.0	15.5	0.2488
7/9/11	11:20:00	1560.0	39.5	0.2479
7/9/11	21:50:00	2190.0	46.8	0.2479

Time Readings @ 4.8 ksf





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**0.0**	**103.0**	**-34.9**	**0.637**	**0.000**	**100**	**0**

Soil Identification: Brown lean clay (CL)

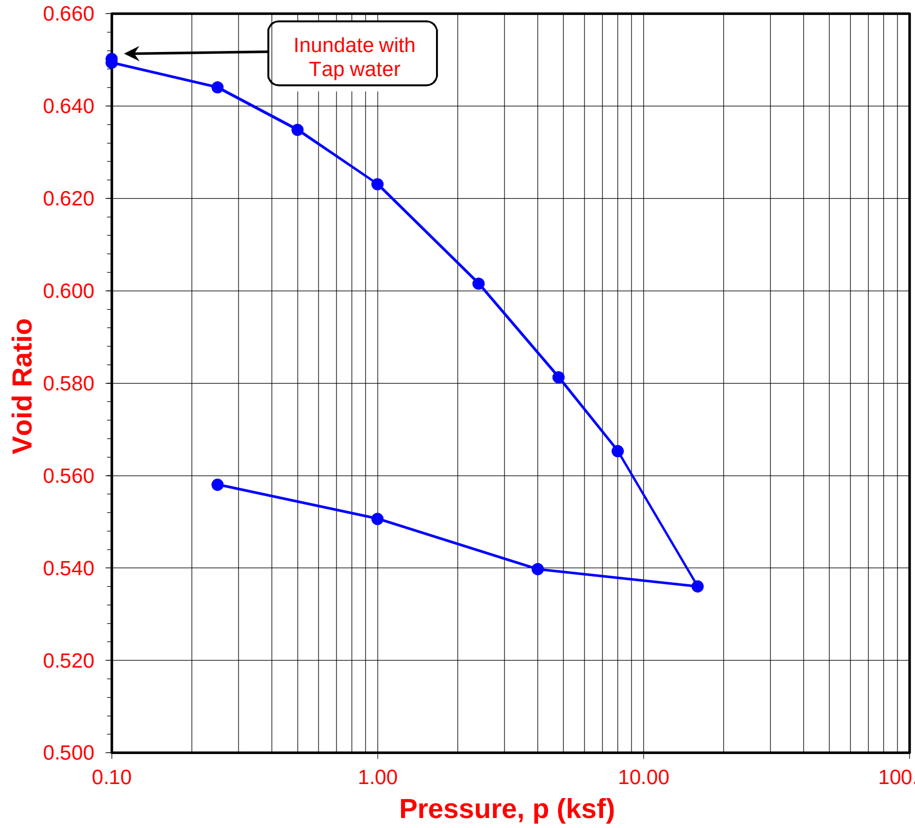
Leighton	**ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS** **(ASTM D 2435)**	Project No.: 602778-002 Proposed Great Wolf Lodge 07-11

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Project Name:	Proposed Great Wolf Lodge	Tested By: A. Santos	Date: 07/01/11
Project No.:	602778-002	Checked By: J. Ward	Date: 07/18/11
Boring No.:	B-4	Depth (ft.): 55.0	
Sample No.:	R-11	Sample Type: Drive	
Soil Identification:	Brown lean clay (CL)		

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	196.60
Weight of Ring (g)	43.33
Height after consol. (in.)	0.9437
Before Test	
Wt.Wet Sample+Cont. (g)	223.02
Wt.of Dry Sample+Cont. (g)	191.48
Weight of Container (g)	64.05
Initial Moisture Content (%)	24.8
Initial Dry Density (pcf)	102.1
Initial Saturation (%)	103
Initial Vertical Reading (in.)	0.2930
After Test	
Wt.of Wet Sample+Cont. (g)	231.03
Wt. of Dry Sample+Cont. (g)	205.60
Weight of Container (g)	39.12
Final Moisture Content (%)	20.65
Final Dry Density (pcf)	108.4
Final Saturation (%)	101
Final Vertical Reading (in.)	0.2350
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

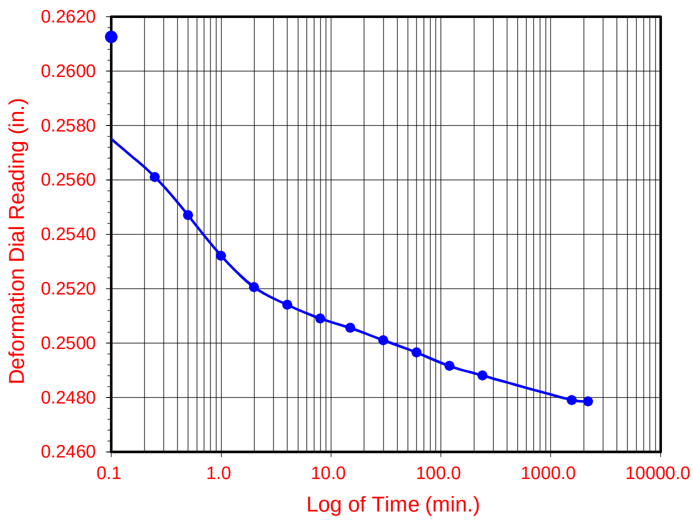


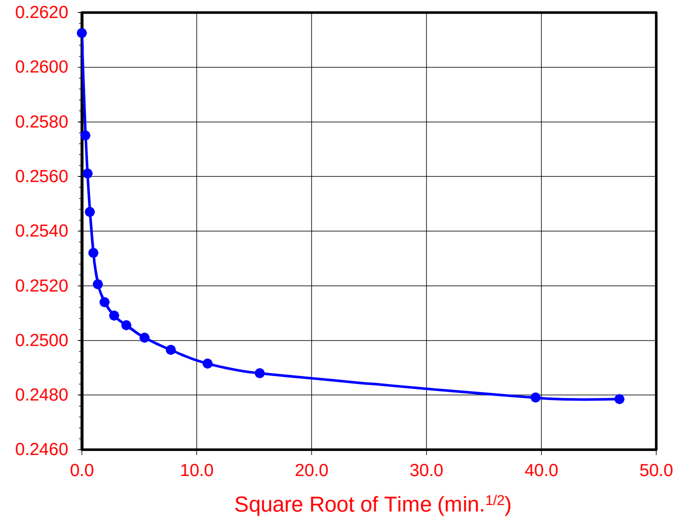
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.2925	0.9995	0.00	0.05	0.650	0.05
0.10	0.2920	0.9990	0.00	0.10	0.649	0.10
0.25	0.2885	0.9955	0.03	0.45	0.644	0.42
0.50	0.2826	0.9896	0.06	1.04	0.635	0.98
1.00	0.2751	0.9821	0.10	1.79	0.623	1.69
2.40	0.2613	0.9683	0.18	3.17	0.602	2.99
4.80	0.2479	0.9549	0.29	4.52	0.581	4.23
8.00	0.2368	0.9438	0.43	5.62	0.565	5.19
16.00	0.2171	0.9241	0.63	7.60	0.536	6.97
4.00	0.2217	0.9287	0.39	7.13	0.540	6.74
1.00	0.2297	0.9367	0.25	6.33	0.551	6.08
0.25	0.2350	0.9420	0.17	5.80	0.558	5.63

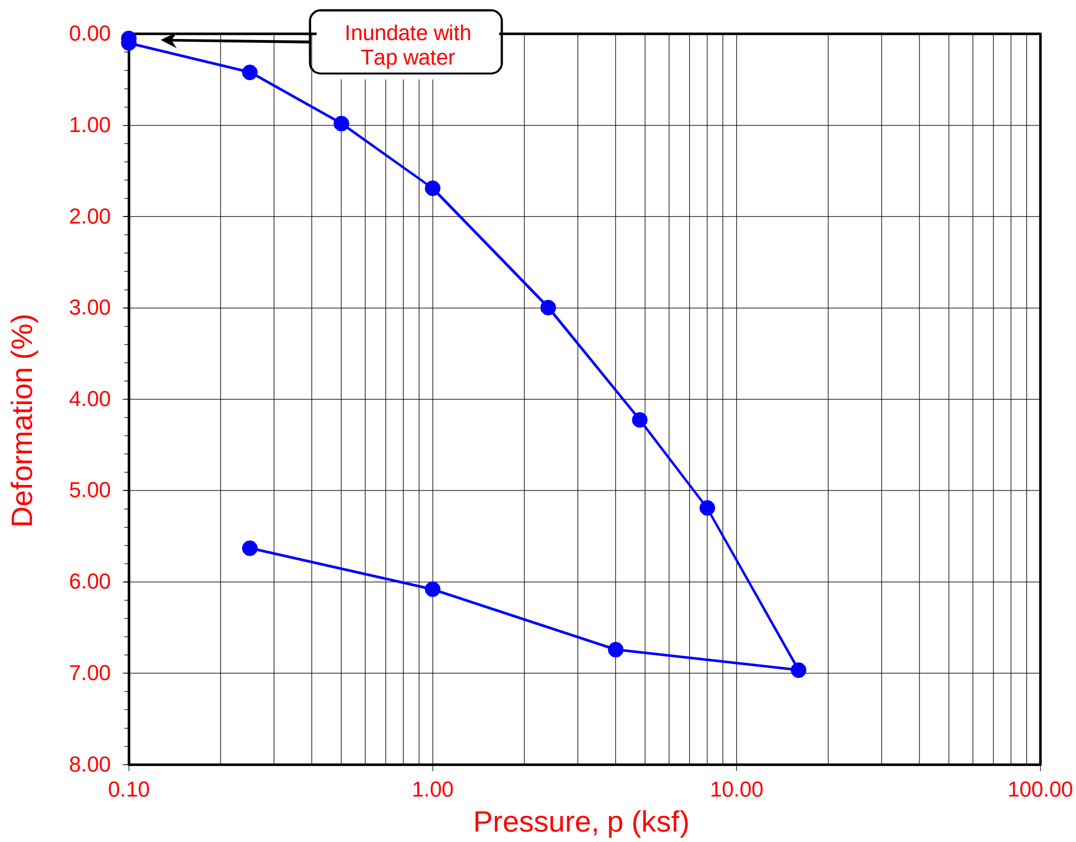
Time Readings @ 4.8 ksf

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)
7/8/11	9:20:00	0.0	0.0	0.2613
7/8/11	9:20:06	0.1	0.3	0.2575
7/8/11	9:20:15	0.2	0.5	0.2561
7/8/11	9:20:30	0.5	0.7	0.2547
7/8/11	9:21:00	1.0	1.0	0.2532
7/8/11	9:22:00	2.0	1.4	0.2521
7/8/11	9:24:00	4.0	2.0	0.2514
7/8/11	9:28:00	8.0	2.8	0.2509
7/8/11	9:35:00	15.0	3.9	0.2506
7/8/11	9:50:00	30.0	5.5	0.2501
7/8/11	10:20:00	60.0	7.7	0.2497
7/8/11	11:20:00	120.0	11.0	0.2492
7/8/11	13:20:00	240.0	15.5	0.2488
7/9/11	11:20:00	1560.0	39.5	0.2479
7/9/11	21:50:00	2190.0	46.8	0.2479

Time Readings @ 4.8 ksf







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

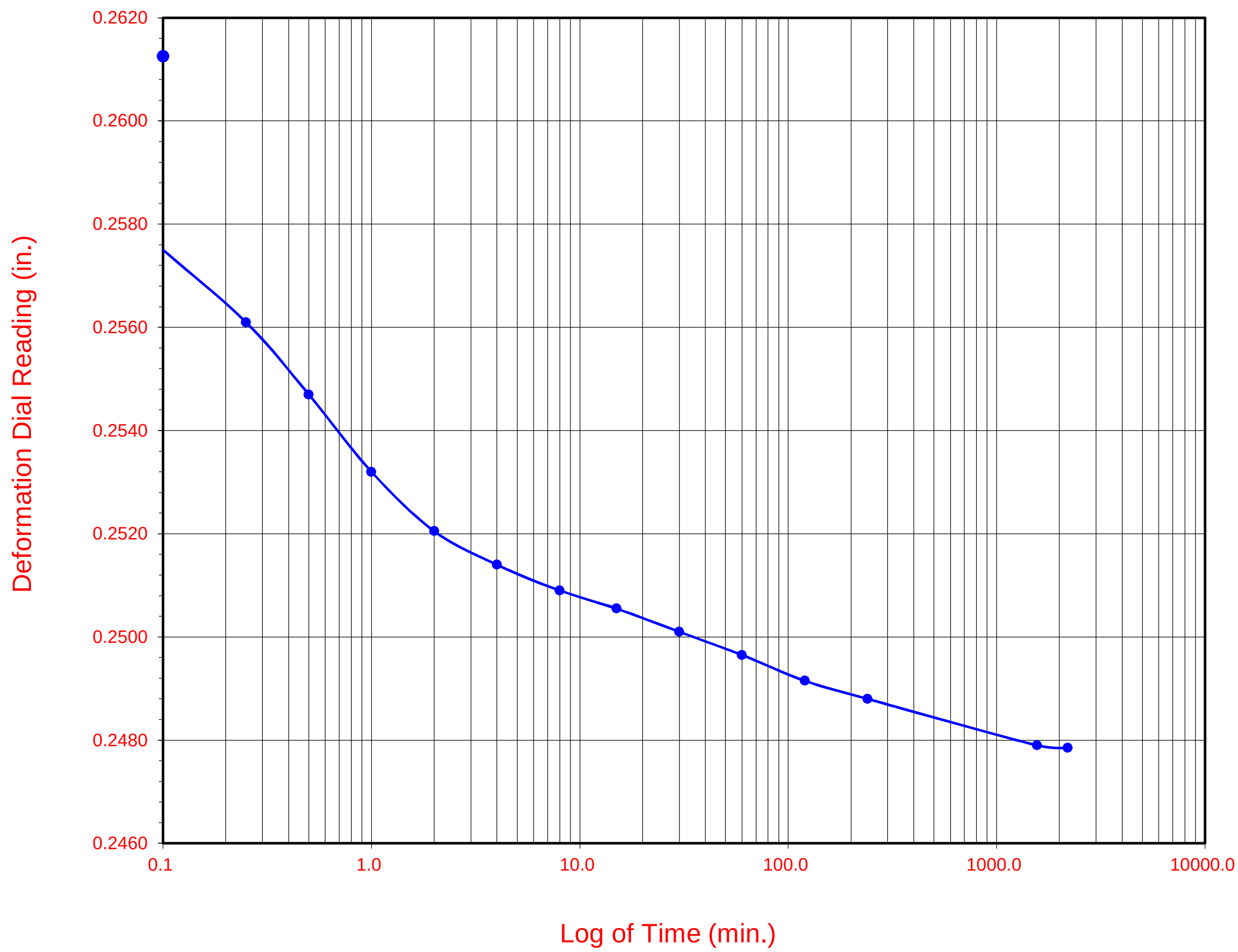
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

Time Readings @ 4.8 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

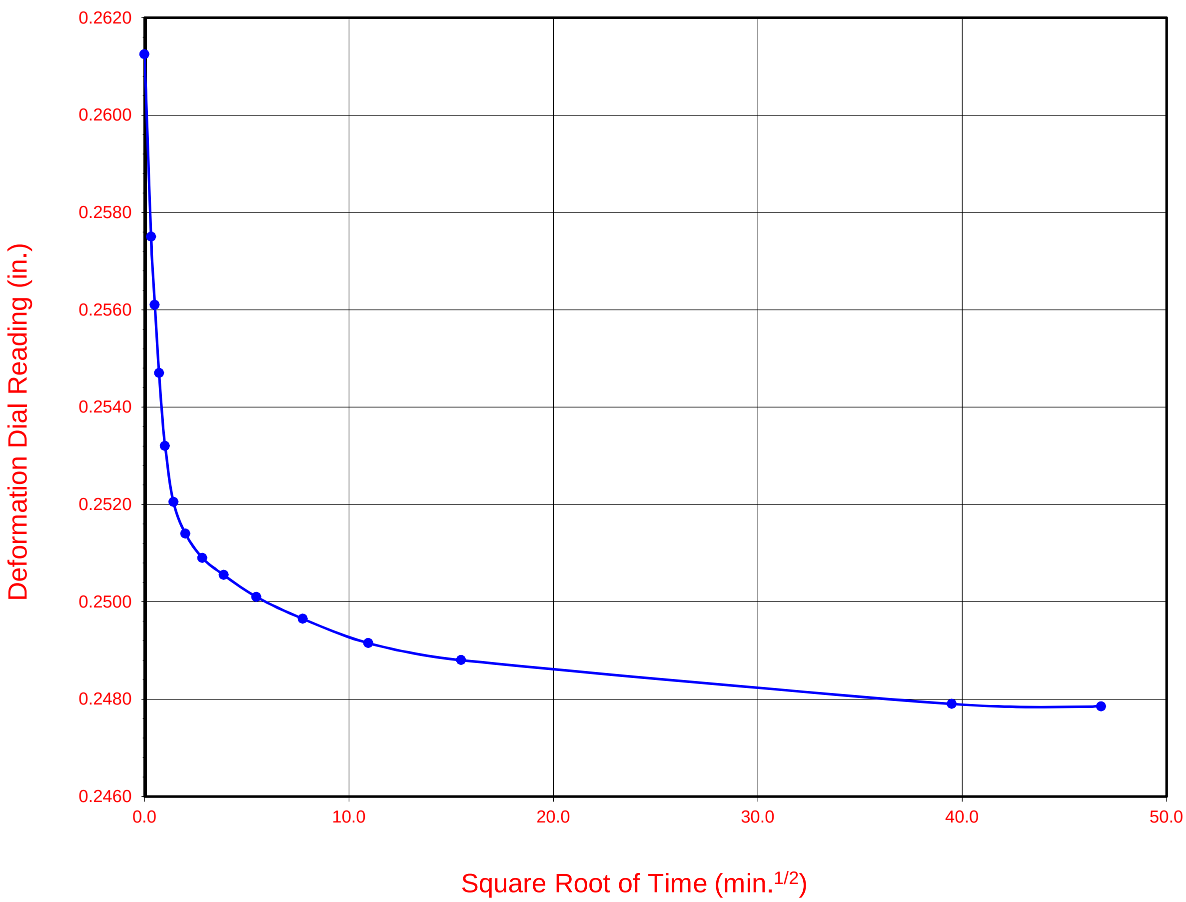
Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

Time Readings @ 4.8 ksf



Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-11**	**55.0**	**24.8**	**20.6**	**102.1**	**108.4**	**0.651**	**0.558**	**100**	**100**

Soil Identification: Brown lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Proposed Great Wolf Lodge

07-11

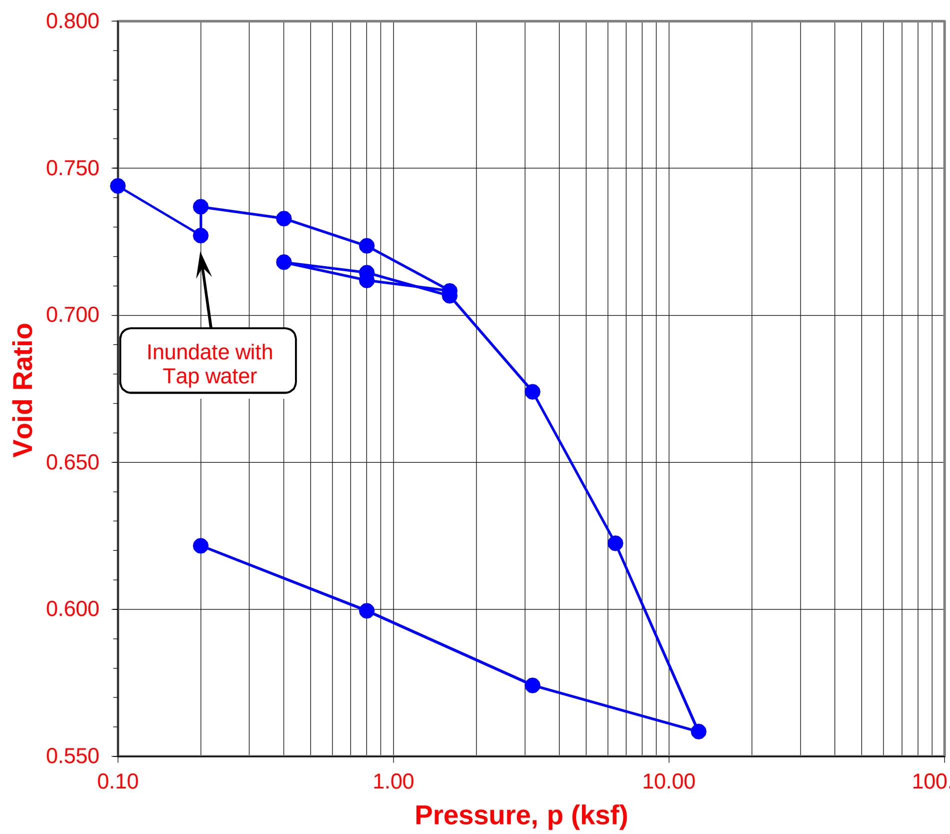
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

ASTM D 2435

Leighton

Project Name:	Garden Grove	Tested By: F. Tabibkhoei	Date: 04/06/11
Project No.:	602778-002	Checked By: J. Ward	Date: 04/19/11
Boring No.:	B-4	Depth (ft.):	40.0
Sample No.:	R-8	Sample Type:	Drive
Soil Identification:	Gray lean clay (CL)		

Sample Diameter (in.):	2.416
Sample Thickness (in.):	1.000
Weight of Sample + ring (g):	189.38
Weight of Ring (g):	43.30
Height after consol. (in.):	0.9209
Before Test	
Wt. of Wet Sample+Cont. (g):	188.85
Wt. of Dry Sample+Cont. (g):	156.97
Weight of Container (g):	38.10
Initial Moisture Content (%)	26.8
Initial Dry Density (pcf)	95.7
Initial Saturation (%):	95
Initial Vertical Reading (in.)	0.1056
After Test	
Wt. of Wet Sample+Cont. (g):	221.50
Wt. of Dry Sample+Cont. (g):	191.12
Weight of Container (g):	37.80
Final Moisture Content (%)	27.61
Final Dry Density (pcf):	99.3
Final Saturation (%):	107
Final Vertical Reading (in.)	0.1848
Specific Gravity (assumed):	2.70
Water Density (pcf):	62.43

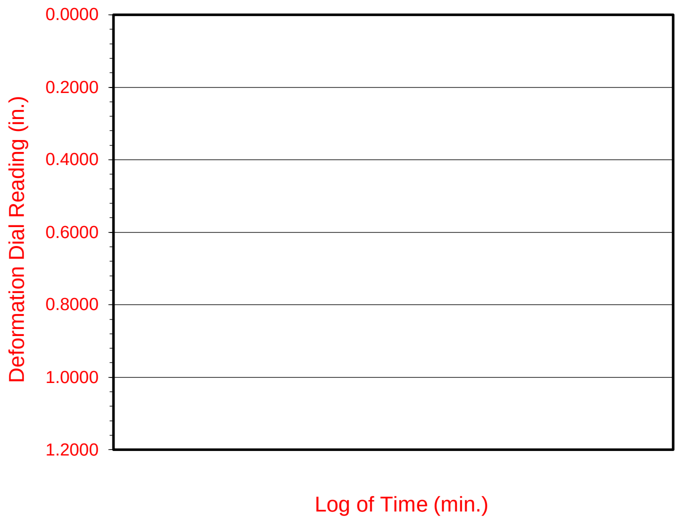


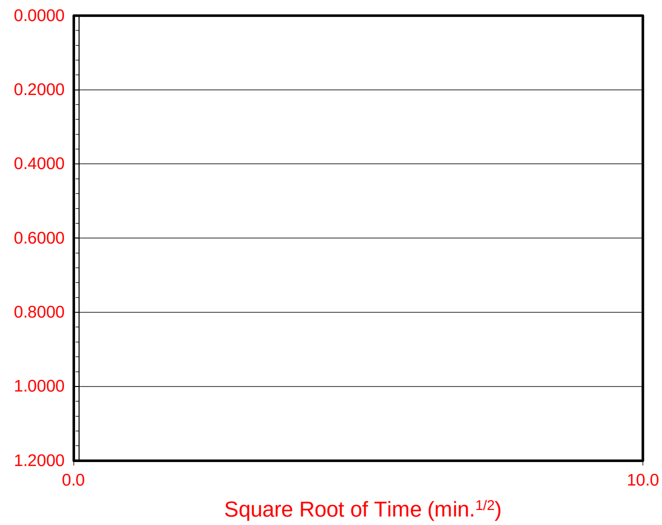
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deforma-tion (%)
0.10	0.1153	0.9903	0.00	0.97	0.744	0.97
0.20	0.1249	0.9808	0.00	1.93	0.727	1.93
0.20	0.1193	0.9863	0.00	1.37	0.737	1.37
0.40	0.1216	0.9841	0.00	1.60	0.733	1.60
0.80	0.1269	0.9788	0.00	2.13	0.724	2.13
1.60	0.1356	0.9701	0.00	3.00	0.708	3.00
0.80	0.1335	0.9721	0.00	2.79	0.712	2.79
0.40	0.1300	0.9756	0.00	2.44	0.718	2.44
0.80	0.1320	0.9736	0.00	2.64	0.715	2.64
1.60	0.1365	0.9691	0.00	3.09	0.707	3.09
3.20	0.1550	0.9506	0.00	4.94	0.674	4.94
6.40	0.1843	0.9213	0.00	7.87	0.622	7.87
12.80	0.2207	0.8850	0.00	11.51	0.558	11.51
3.20	0.2117	0.8939	0.00	10.61	0.574	10.61
0.80	0.1973	0.9083	0.00	9.17	0.600	9.17
0.20	0.1848	0.9209	0.00	7.92	0.622	7.92

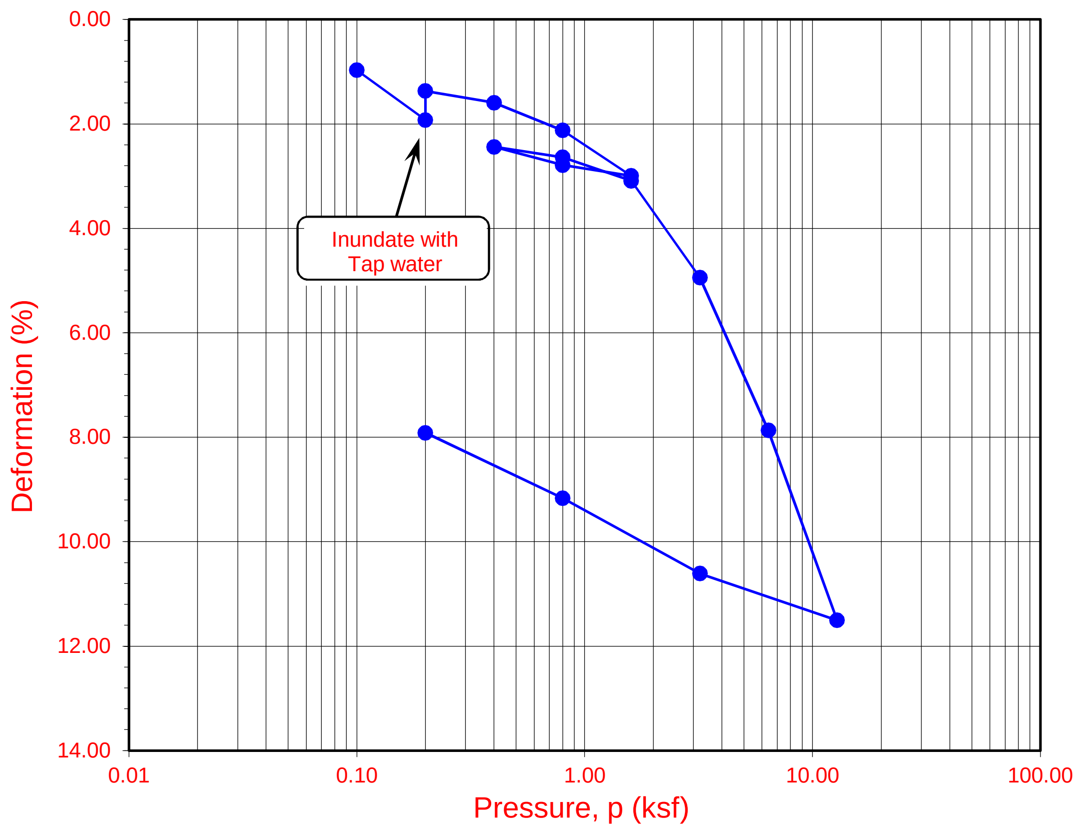
No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-4	**R-8**	**40**	**26.8**	**27.6**	**95.7**	**99.3**	**0.761**	**0.622**	**95**	**100**

Soil Identification: Gray lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
ASTM D 2435

Project No.: 602778-002

Garden Grove

04-11

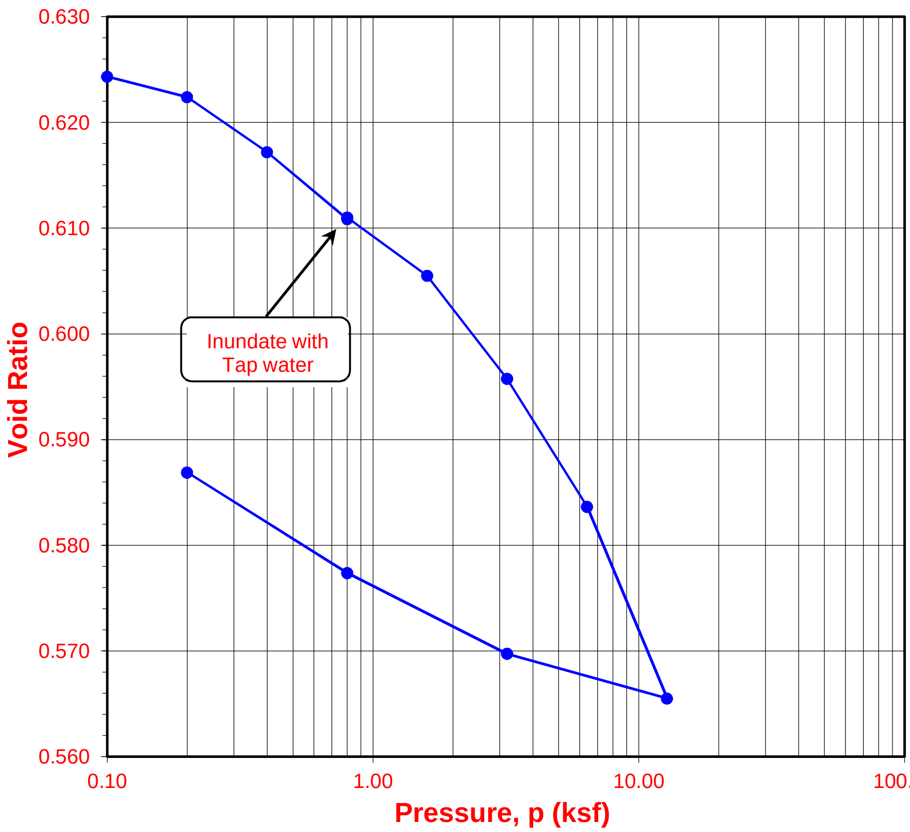
ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Leighton

Project Name:	Garden Grove	Tested By:	F. Tabibkhoei	Date:	04/04/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	04/18/11
Boring No.:	B-5	Depth (ft.):	7.0		
Sample No.:	R-3	Sample Type:	Drive		
Soil Identification:	Brown silty sand (SM)				

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	182.00
Weight of Ring (g)	41.03
Height after consol. (in.)	0.9764
Before Test	
Wt.Wet Sample+Cont. (g)	171.50
Wt.of Dry Sample+Cont. (g)	156.26
Weight of Container (g)	38.60
Initial Moisture Content (%)	13.0
Initial Dry Density (pcf)	103.7
Initial Saturation (%)	56
Initial Vertical Reading (in.)	0.3267
After Test	
Wt.of Wet Sample+Cont. (g)	225.13
Wt. of Dry Sample+Cont. (g)	201.70
Weight of Container (g)	38.30
Final Moisture Content (%)	19.15
Final Dry Density (pcf)	104.1
Final Saturation (%)	84
Final Vertical Reading (in.)	0.3010
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

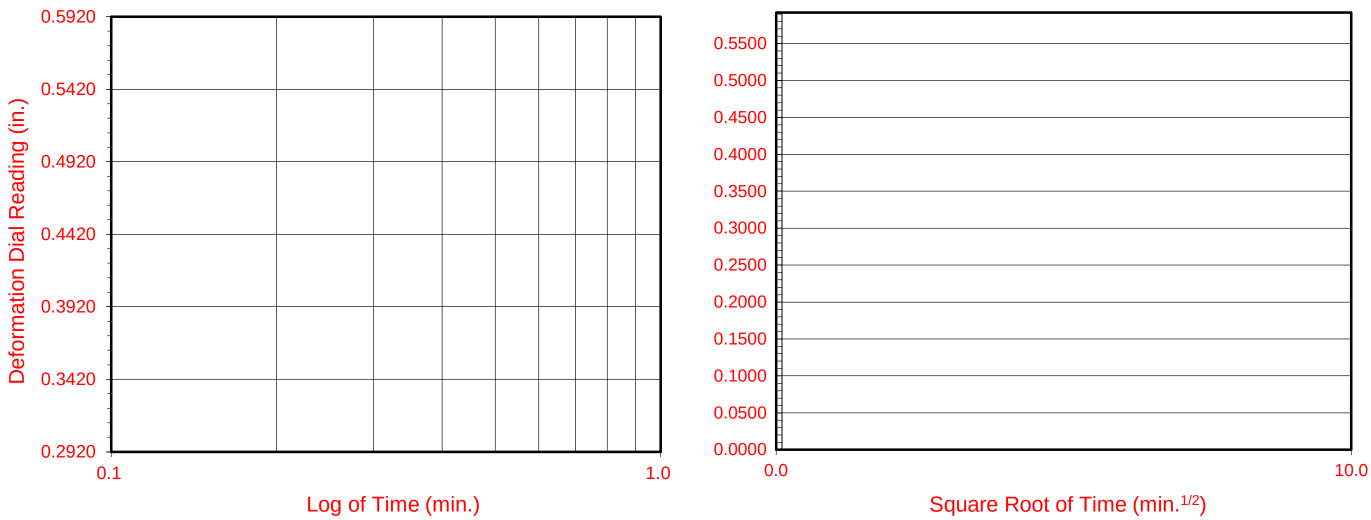


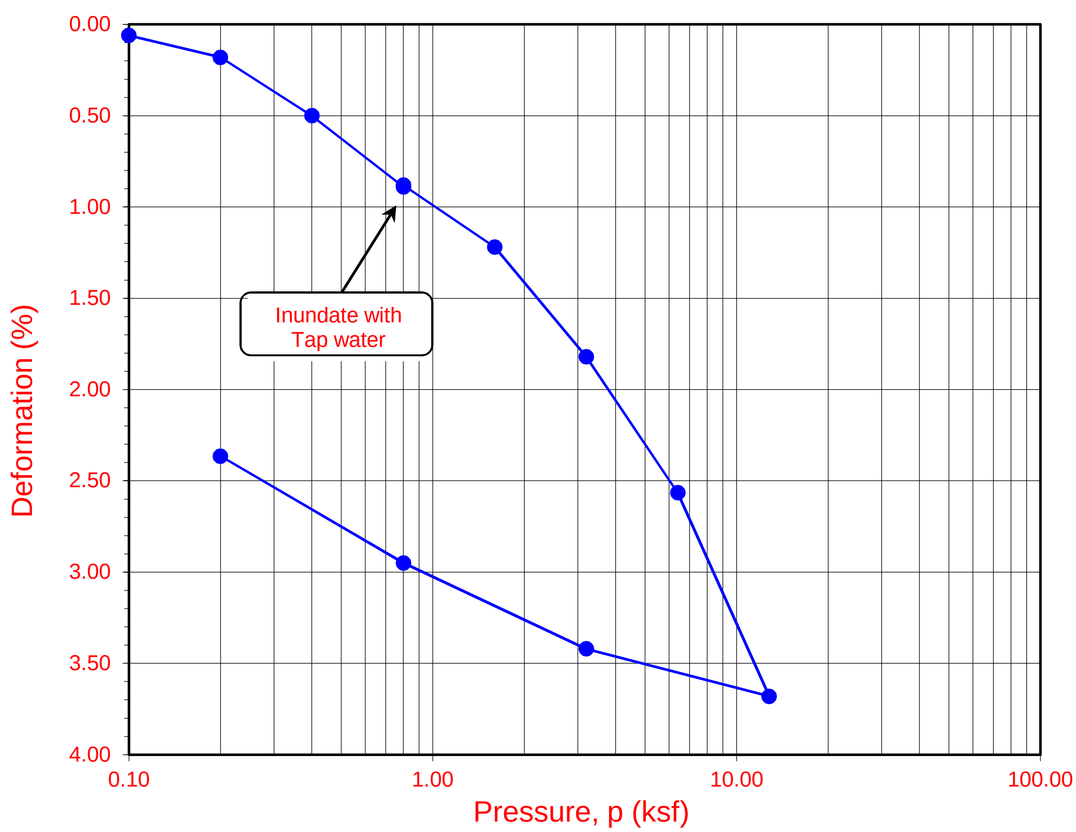
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3261	0.9994	0.00	0.06	0.624	0.06
0.20	0.3246	0.9979	0.03	0.21	0.622	0.18
0.40	0.3210	0.9943	0.07	0.57	0.617	0.50
0.80	0.3167	0.9900	0.11	1.00	0.611	0.89
0.80	0.3168	0.9901	0.11	0.99	0.611	0.88
1.60	0.3127	0.9860	0.18	1.40	0.605	1.22
3.20	0.3060	0.9793	0.25	2.07	0.596	1.82
6.40	0.2973	0.9706	0.38	2.95	0.584	2.57
12.80	0.2839	0.9572	0.60	4.28	0.566	3.68
3.20	0.2886	0.9619	0.39	3.81	0.570	3.42
0.80	0.2944	0.9677	0.28	3.23	0.577	2.95
0.20	0.3010	0.9743	0.21	2.57	0.587	2.36

No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings





Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-5	**R-3**	**7.0**	**13.0**	**19.1**	**103.7**	**104.1**	**0.625**	**0.587**	**56**	**84**

Soil Identification: Brown silty sand (SM)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Garden Grove

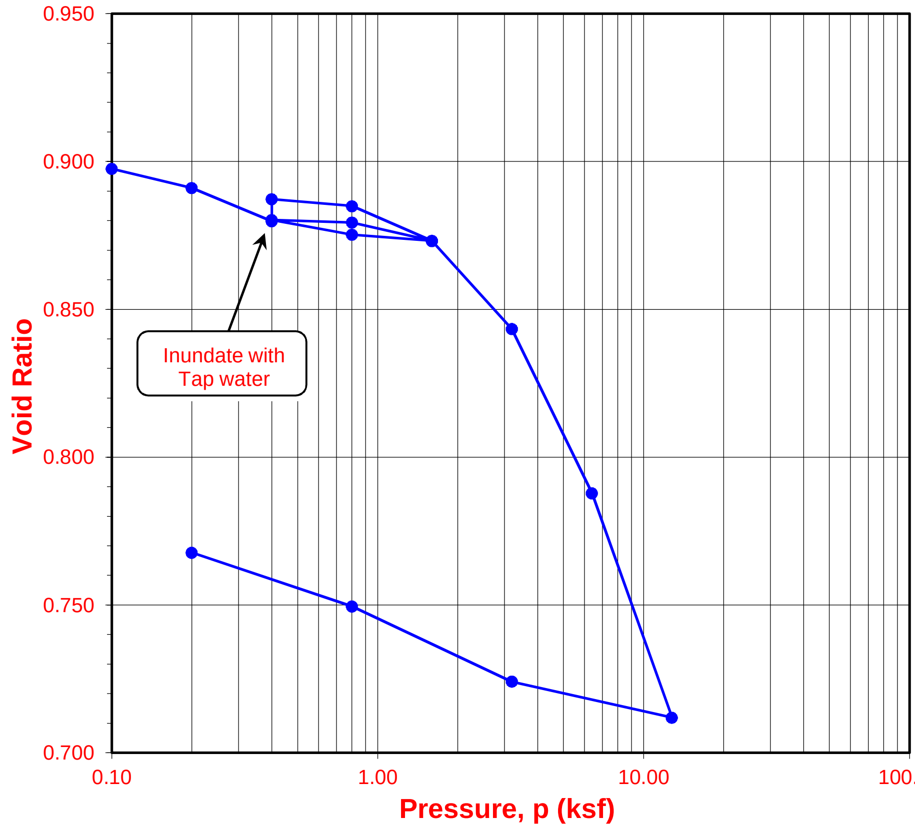
04-11

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS

(ASTM D 2435)

Project Name:	Garden Grove	Tested By:	F. Tabibkhoei	Date:	04/04/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	04/18/11
Boring No.:	B-5	Depth (ft.):	30.0		
Sample No.:	R-5	Sample Type:	Drive		
Soil Identification:	Gray lean clay (CL)				

Sample Diameter (in.)	2.416
Sample Thickness (in.)	1.000
Wt. of Sample + Ring (g)	186.00
Weight of Ring (g)	43.26
Height after consol. (in.)	0.9295
Before Test	
Wt.Wet Sample+Cont. (g)	178.40
Wt.of Dry Sample+Cont. (g)	143.06
Weight of Container (g)	38.60
Initial Moisture Content (%)	33.8
Initial Dry Density (pcf)	88.6
Initial Saturation (%)	101
Initial Vertical Reading (in.)	0.3353
After Test	
Wt.of Wet Sample+Cont. (g)	219.71
Wt. of Dry Sample+Cont. (g)	187.96
Weight of Container (g)	38.55
Final Moisture Content (%)	29.91
Final Dry Density (pcf)	94.9
Final Saturation (%)	104
Final Vertical Reading (in.)	0.2633
Specific Gravity (assumed)	2.70
Water Density (pcf)	62.43

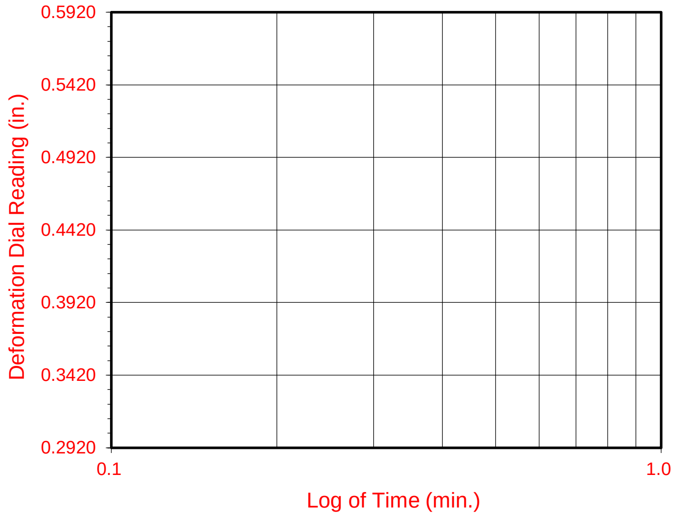


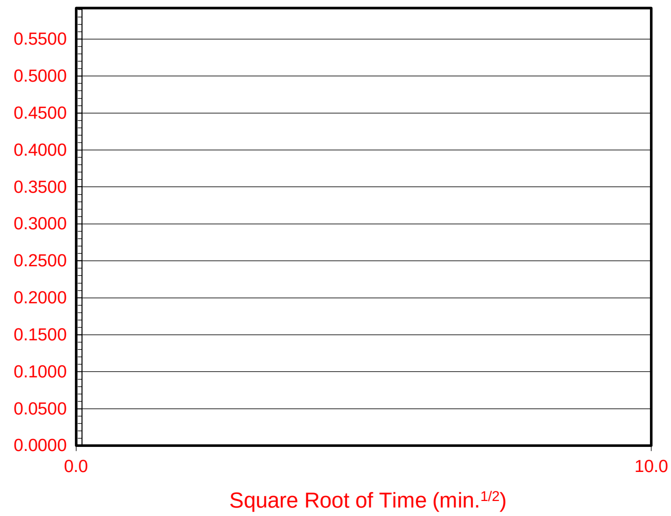
Pressure (p) (ksf)	Final Reading (in.)	Apparent Thickness (in.)	Load Compliance (%)	Deformation % of Sample Thickness	Void Ratio	Corrected Deformation (%)
0.10	0.3330	0.9977	0.00	0.23	0.898	0.23
0.20	0.3294	0.9941	0.02	0.59	0.891	0.57
0.40	0.3232	0.9879	0.05	1.21	0.880	1.16
0.40	0.3271	0.9918	0.05	0.82	0.887	0.77
0.80	0.3256	0.9903	0.08	0.97	0.885	0.89
1.60	0.3189	0.9836	0.14	1.65	0.873	1.51
0.80	0.3205	0.9852	0.08	1.48	0.875	1.40
0.40	0.3234	0.9881	0.05	1.19	0.880	1.14
0.80	0.3227	0.9874	0.08	1.27	0.879	1.19
1.60	0.3188	0.9835	0.14	1.65	0.873	1.51
3.20	0.3024	0.9671	0.22	3.30	0.843	3.08
6.40	0.2718	0.9365	0.35	6.35	0.788	6.00
12.80	0.2299	0.8946	0.55	10.54	0.712	9.99
3.20	0.2384	0.9031	0.34	9.69	0.724	9.35
0.80	0.2529	0.9176	0.23	8.24	0.750	8.01
0.20	0.2633	0.9280	0.15	7.20	0.768	7.05

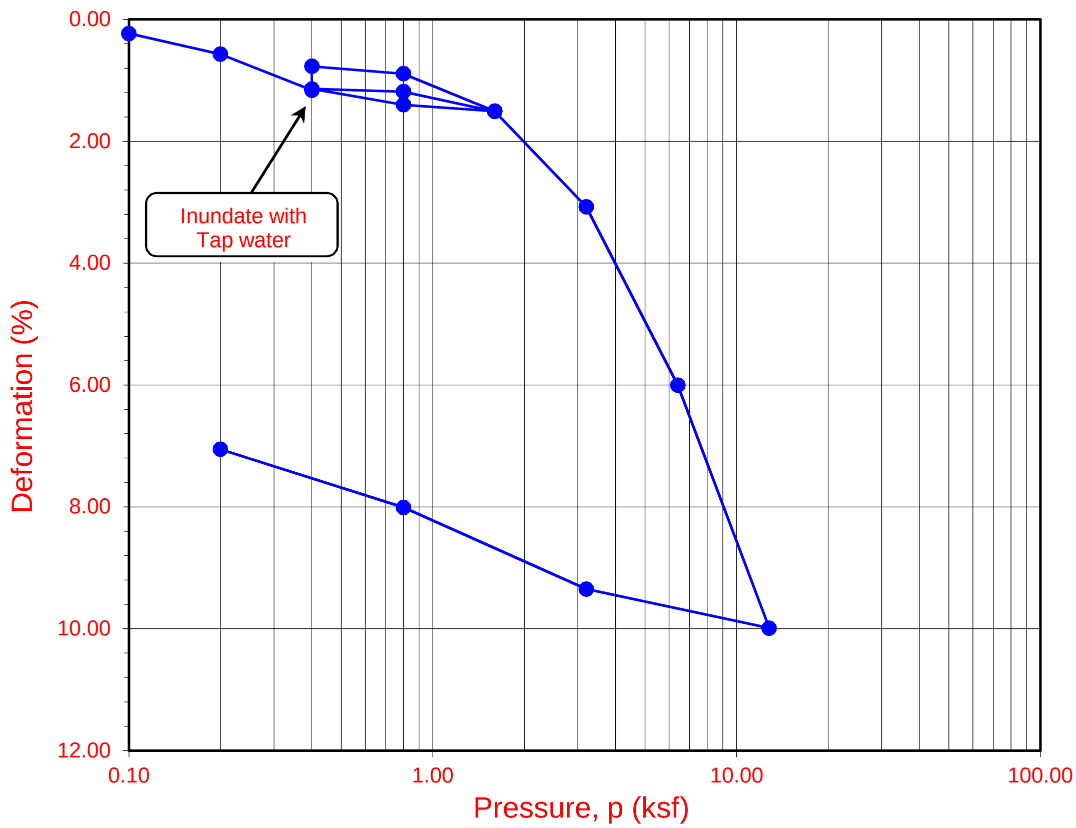
No Time Readings

Date	Time	Elapsed Time (min)	Square Root of Time	Dial Rdgs. (in.)

No Time Readings







Boring No.	Sample No.	Depth (ft.)	Moisture Content (%)		Dry Density (pcf)		Void Ratio		Degree of Saturation (%)	
			Initial	Final	Initial	Final	Initial	Final	Initial	Final
B-5	**R-5**	**30.0**	**33.8**	**29.9**	**88.6**	**94.9**	**0.902**	**0.768**	**100**	**100**

Soil Identification: Gray lean clay (CL)

Leighton

ONE-DIMENSIONAL CONSOLIDATION PROPERTIES of SOILS
(ASTM D 2435)

Project No.: 602778-002

Garden Grove

04-11

Leighton

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name:	Garden Grove	Tested By :	V. Juliano	Date:	04/14/11
Project No. :	602778-002	Data Input By:	J. Ward	Date:	04/20/11

Boring No.	B-5			
Sample No.	BB-1			
Sample Depth (ft)	0-5			
Soil Identification:	Olive (SM)			
Wet Weight of Soil + Container (g)	202.80			
Dry Weight of Soil + Container (g)	196.60			
Weight of Container (g)	62.80			
Moisture Content (%)	4.63			
Weight of Soaked Soil (g)	100.10			

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	19			
Crucible No.	20			
Furnace Temperature (°C)	830			
Time In / Time Out	7:15/8:00			
Duration of Combustion (min)	45			
Wt. of Crucible + Residue (g)	21.2327			
Wt. of Crucible (g)	21.2297			
Wt. of Residue (g) (A)	0.0030			
PPM of Sulfate (A) x 41150	123.45			
PPM of Sulfate, Dry Weight Basis	**129**			

CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30			
ml of AgNO3 Soln. Used in Titration (C)	0.9			
PPM of Chloride (C -0.2) * 100 * 30 / B	70			
PPM of Chloride, Dry Wt. Basis	**73**			

pH TEST, DOT California Test 532/643

pH Value	**7.46**			
Temperature °C	20.9			

SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

Leighton

Project Name:	Garden Grove	Tested By :	V. Juliano Date: 04/18/11
Project No. :	602778-002	Data Input By:	J. Ward Date: 04/20/11
Boring No.:	B-5	Depth (ft.) :	0-5
Sample No. :	BB-1		

Soil Identification:* Olive (SM)

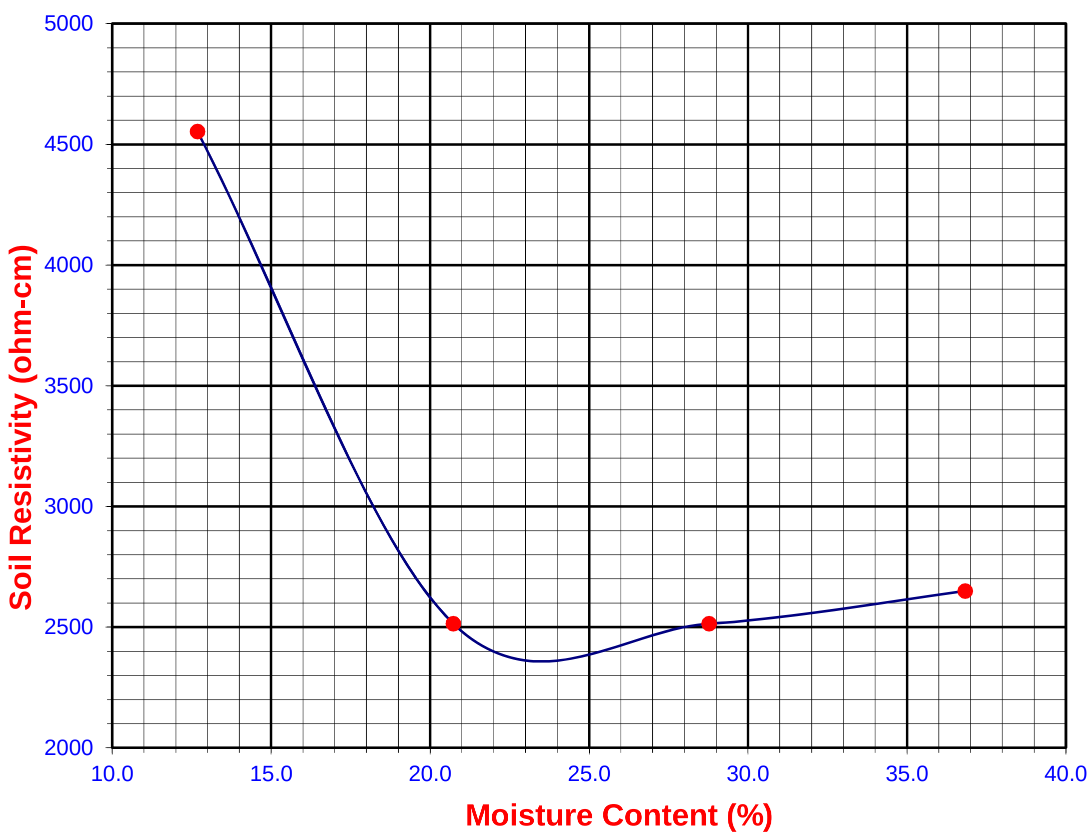
*California Test 643 requires soil specimens to consist only of portions of samples passing through the No. 8 US Standard Sieve before resistivity testing. Therefore, this test method may not be representative for coarser materials.

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	12.68	670	4553
2	200	20.73	370	2514
3	300	28.78	370	2514
4	400	36.83	390	2650
5				

Moisture Content (%) (MCi)	4.63
Wet Wt. of Soil + Cont. (g)	202.80
Dry Wt. of Soil + Cont. (g)	196.60
Wt. of Container (g)	62.80
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.795

MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
2360	**23.5**	**129**	**73**	**7.46**	**20.9**



Leighton

TESTS for SULFATE CONTENT
CHLORIDE CONTENT and pH of SOILS

Project Name:	Garden Grove	Tested By :	V. Juliano	Date:	12/16/09
Project No. :	602778-001	Data Input By:	J. Ward	Date:	12/22/09

Boring No.	HA-1 & HA-2 combined	HA-3 & HA-4 combined		
Sample No.	BB-1 from each	BB-1 from each		
Sample Depth (ft)	0-5	0-5		
Soil Identification:	Olive (SM)	Olive (SM)		
Wet Weight of Soil + Container (g)	176.90	175.40		
Dry Weight of Soil + Container (g)	165.70	171.00		
Weight of Container (g)	57.20	38.00		
Moisture Content (%)	10.32	3.31		
Weight of Soaked Soil (g)	100.20	100.60		

SULFATE CONTENT, DOT California Test 417, Part II

Beaker No.	6	8		
Crucible No.	23	27		
Furnace Temperature (°C)	830	830		
Time In / Time Out	8:10 / 8:55	8:10 / 8:55		
Duration of Combustion (min)	45	45		
Wt. of Crucible + Residue (g)	18.4167	17.6437		
Wt. of Crucible (g)	18.4154	17.6408		
Wt. of Residue (g) (A)	0.0013	0.0029		
PPM of Sulfate (A) x 41150	53.49	119.34		
PPM of Sulfate, Dry Weight Basis	**60**	**123**		

CHLORIDE CONTENT, DOT California Test 422

ml of Chloride Soln. For Titration (B)	30	30		
ml of AgNO3 Soln. Used in Titration (C)	0.7	0.7		
PPM of Chloride (C -0.2) * 100 * 30 / B	50	50		
PPM of Chloride, Dry Wt. Basis	**56**	**52**		

pH TEST, DOT California Test 532/643

pH Value	**7.16**	**7.02**		
Temperature °C	19.8	19.7		

Leighton

SOIL RESISTIVITY TEST

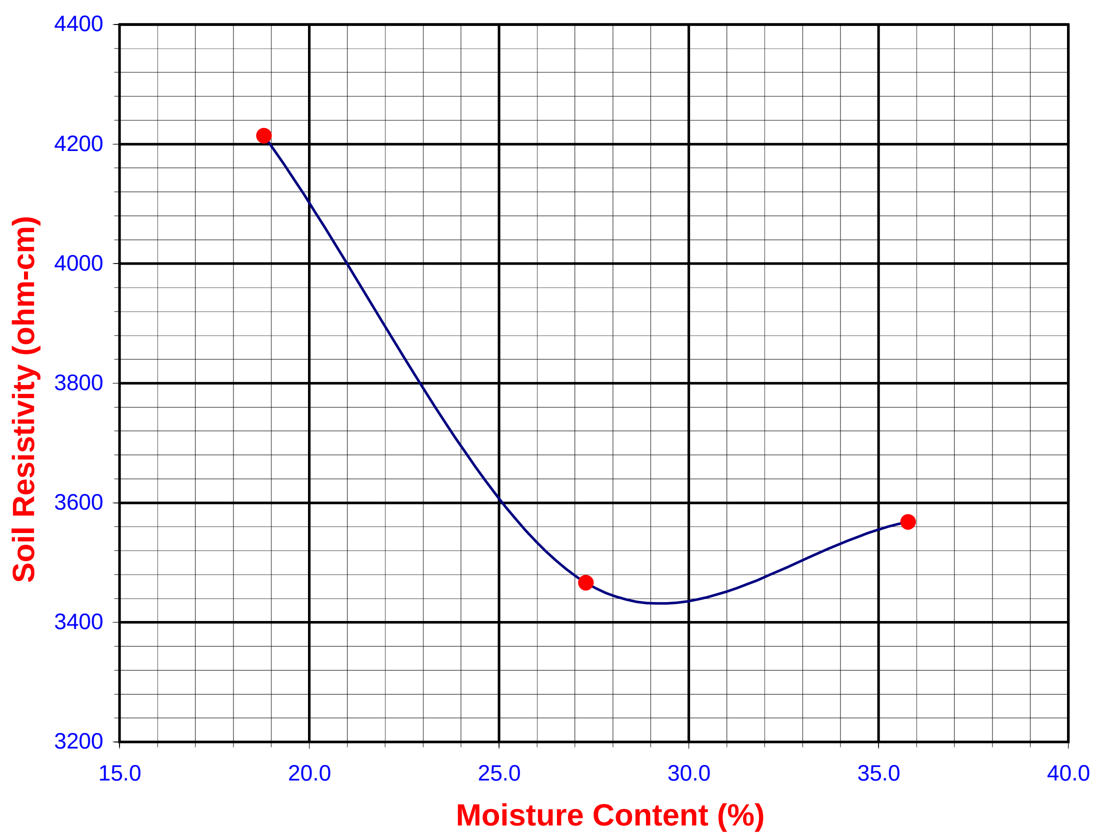
DOT CA TEST 532 / 643

Project Name:	Garden Grove	Tested By :	V. Juliano Date: 12/21/09
Project No. :	602778-001	Data Input By:	J. Ward Date: 12/22/09
Boring No.:	HA-1 & HA-2 combined	Depth (ft.) :	0-5
Sample No. :	BB-1 from each		
Soil Identification:	Olive (SM)		

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	100	18.81	620	4214
2	200	27.30	510	3466
3	300	35.78	525	3568
4				
5				

Moisture Content (%) (MCi)	10.32
Wet Wt. of Soil + Cont. (g)	176.90
Dry Wt. of Soil + Cont. (g)	165.70
Wt. of Container (g)	57.20
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.796
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
3430	**29.3**	**60**	**56**	**7.16**	**19.8**



SOIL RESISTIVITY TEST

DOT CA TEST 532 / 643

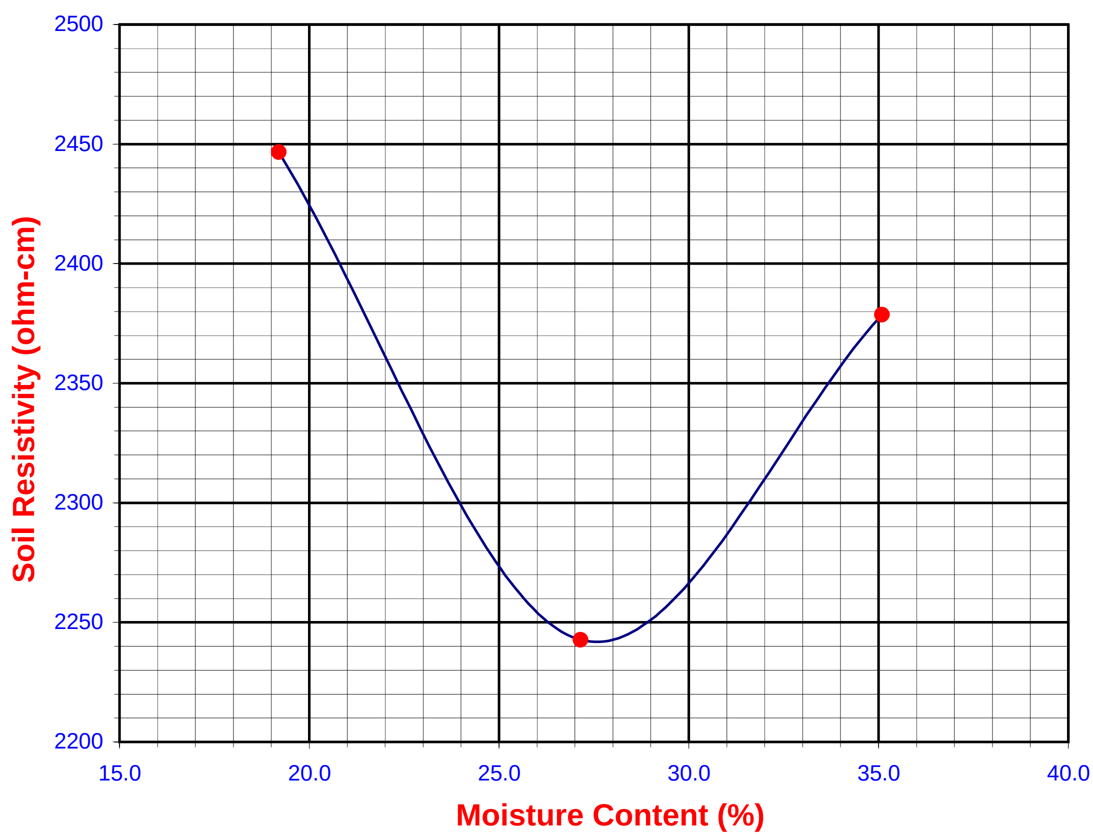
Leighton

Project Name:	Garden Grove		Tested By :	V. Juliano	Date: 12/21/09
Project No. :	602778-001		Data Input By:	J. Ward	Date: 12/22/09
Boring No.:	HA-3 & HA-4 combined		Depth (ft.) :	0-5	
Sample No. :	BB-1 from each				
Soil Identification:	Olive (SM)				

Specimen No.	Water Added (ml) (Wa)	Adjusted Moisture Content (MC)	Resistance Reading (ohm)	Soil Resistivity (ohm-cm)
1	200	19.20	360	2447
2	300	27.15	330	2243
3	400	35.10	350	2379
4				
5				

Moisture Content (%) (MCi)	3.31
Wet Wt. of Soil + Cont. (g)	175.40
Dry Wt. of Soil + Cont. (g)	171.00
Wt. of Container (g)	38.00
Container No.	
Initial Soil Wt. (g) (Wt)	1300.00
Box Constant	6.796
MC =(((1+Mci/100)x(Wa/Wt+1))-1)x100	

Min. Resistivity (ohm-cm)	Moisture Content (%)	Sulfate Content (ppm)	Chloride Content (ppm)	Soil pH	
				pH	Temp. (°C)
DOT CA Test 532 / 643		DOT CA Test 417 Part II	DOT CA Test 422	DOT CA Test 532 / 643	
2242	**27.6**	**123**	**52**	**7.02**	**19.7**



Leighton

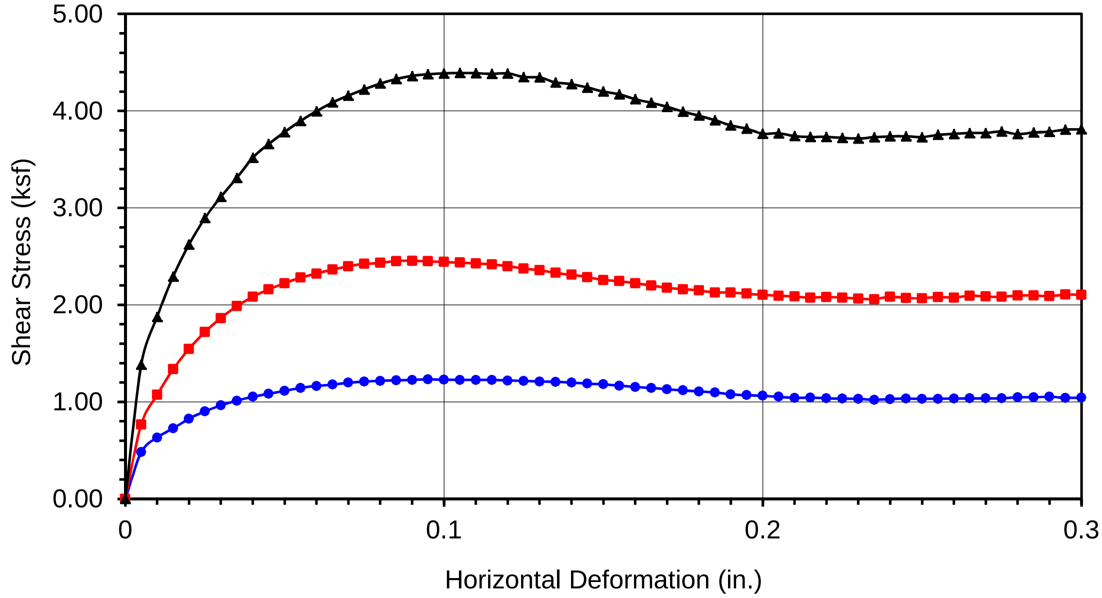
DIRECT SHEAR TEST

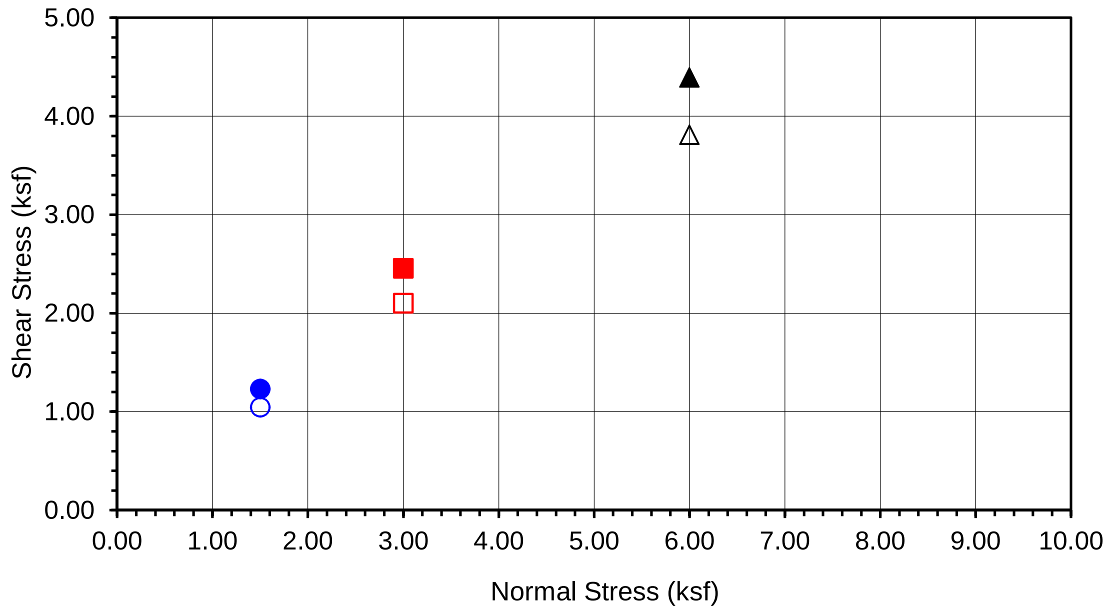
Consolidated Undrained

Project Name:	Garden Grove	Tested By:	F. Tabibkhoei	Date:	04/06/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	04/11/11
Boring No.:	B-2	Sample Type:	Drive		
Sample No.:	R-2	Depth (ft.):	10.0		

Soil Identification: Brown silty sand (SM)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	164.60	167.10	167.10
Weight of Ring(gm):	42.70	44.70	45.00
Before Shearing			
Weight of Wet Sample+Cont.(gm):	178.30	178.30	178.30
Weight of Dry Sample+Cont.(gm):	174.19	174.19	174.19
Weight of Container(gm):	38.90	38.90	38.90
Vertical Rdg.(in): Initial	0.0000	0.2433	0.2370
Vertical Rdg.(in): Final	-0.0108	0.2548	0.2628
After Shearing			
Weight of Wet Sample+Cont.(gm):	174.14	178.75	175.38
Weight of Dry Sample+Cont.(gm):	150.42	153.78	151.01
Weight of Container(gm):	38.61	39.74	38.83
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**B-2**
Sample No.	**R-2**
Depth (ft)	**10**

Sample Type:

Drive

Soil Identification:

Brown silty sand (SM)

Normal Stress (kip/ft²)	1.500	3.000	6.000
Peak Shear Stress (kip/ft²)	● 1.232	■ 2.455	▲ 4.392
Shear Stress @ End of Test (ksf)	○ 1.044	□ 2.103	△ 3.810
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	3.04	3.04	3.04
Dry Density (pcf)	98.4	98.8	98.6
Saturation (%)	11.5	11.6	11.5
Soil Height Before Shearing (in.)	0.9892	0.9885	0.9742
Final Moisture Content (%)	21.2	21.9	21.7

Leighton

DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 602778-002

Garden Grove

04-11

DIRECT SHEAR TEST

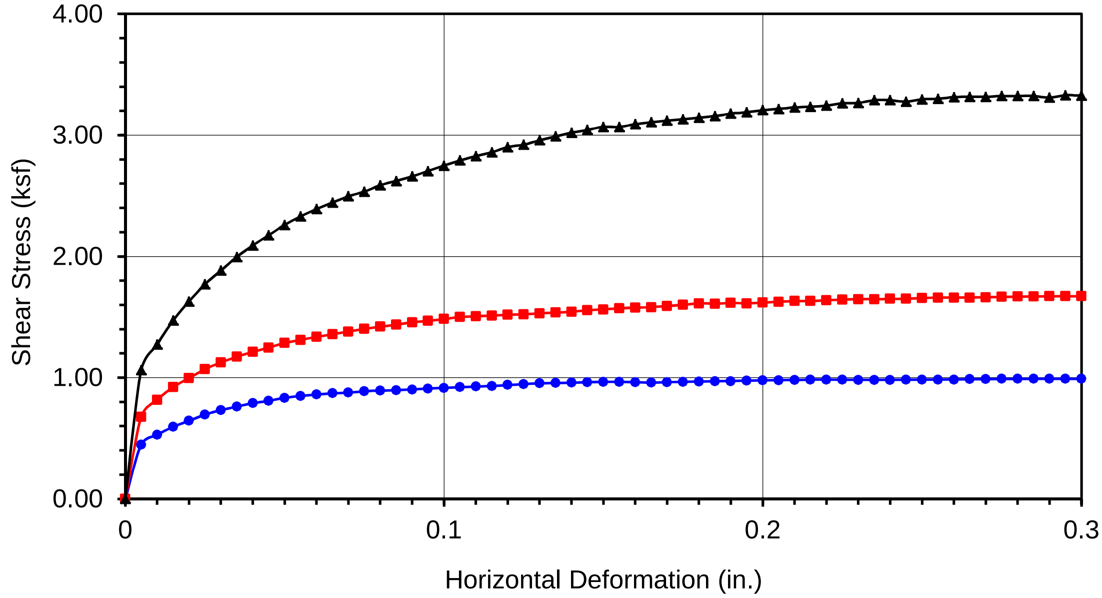
Consolidated Undrained

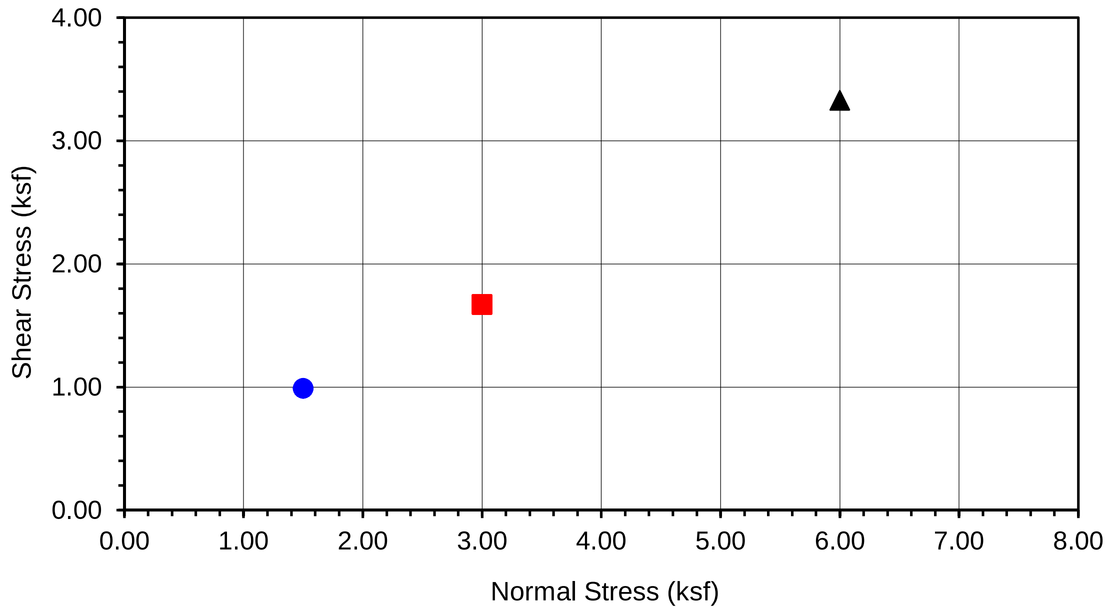
Leighton

Project Name:	Garden Grove	Tested By:	F. Tabibkhoei	Date:	04/04/11
Project No.:	602778-002	Checked By:	J. Ward	Date:	04/11/11
Boring No.:	B-3	Sample Type:	Drive		
Sample No.:	R-4	Depth (ft.):	20.0		

Soil Identification: Grayish brown lean clay (CL)

Sample Diameter(in):	2.415	2.415	2.415
Sample Thickness(in.):	1.000	1.000	1.000
Weight of Sample + ring(gm):	187.40	187.80	188.90
Weight of Ring(gm):	42.00	43.30	45.10
Before Shearing			
Weight of Wet Sample+Cont.(gm):	304.90	304.90	304.90
Weight of Dry Sample+Cont.(gm):	238.10	238.10	238.10
Weight of Container(gm):	38.00	38.00	38.00
Vertical Rdg.(in): Initial	0.0000	0.2714	0.2444
Vertical Rdg.(in): Final	-0.0310	0.3326	0.3479
After Shearing			
Weight of Wet Sample+Cont.(gm):	178.42	176.30	170.67
Weight of Dry Sample+Cont.(gm):	146.34	145.48	142.88
Weight of Container(gm):	37.73	37.96	38.11
Specific Gravity (Assumed):	2.70	2.70	2.70
Water Density(pcf):	62.43	62.43	62.43





Boring No.	**B-3**
Sample No.	**R-4**
Depth (ft)	**20**

Sample Type:

Drive

Soil Identification:

Grayish brown lean clay (CL)

Normal Stress (kip/ft²)	1.500	3.000	6.000
Peak Shear Stress (kip/ft²)	● 0.990	■ 1.672	▲ 3.329
Shear Stress @ End of Test (ksf)	○ 0.990	□ 1.672	△ 3.326
Deformation Rate (in./min.)	0.0500	0.0500	0.0500
Initial Sample Height (in.)	1.000	1.000	1.000
Diameter (in.)	2.415	2.415	2.415
Initial Moisture Content (%)	33.38	33.38	33.38
Dry Density (pcf)	90.7	90.1	89.7
Saturation (%)	104.9	103.5	102.4
Soil Height Before Shearing (in.)	0.9690	0.9388	0.8965
Final Moisture Content (%)	29.5	28.7	26.5

Leighton

DIRECT SHEAR TEST RESULTS

Consolidated Undrained

Project No.: 602778-002

Garden Grove

04-11

Boring No.	B-1	B-1	B-2	B-2	B-2	B-3	B-3	B-3
Sample No.	R-2	R-5	R-6	R-9	R-10	R-2	R-6	R-10
Depth (ft.)	10.0	25.0	30.0	60.0	70.0	10.0	30.0	50.0
Sample Type	Drive	Drive	Drive	Drive	Drive	Drive	Drive	Drive
Soil Identification	Gray silty sand (SM)	Top: Gray (SM); Bot: Gray (CL)	Gray lean clay (CL)	Gray lean clay (CL)	Gray silty sand (SM)	Gray silty sand (SM)	Gray silty sand (SM)	Gray sandy silt s(ML)
Pocket Penetrometer (tons/ft^2)	2.50	2.25	1.50	2.25	3.25	1.50	1.50	2.50
Weight Soil + Rings / Tube (g)	1050.19	980.74	1122.54	1121.14	1209.16	1014.72	192.78	1175.52
Weight of Rings / Tube (g)	266.40	222.00	266.40	266.40	266.40	266.40	44.40	266.40
Average Length (in.)	6.00	5.00	6.00	6.00	6.00	6.00	1.00	6.00
Average Diameter (in.)	2.416	2.416	2.416	2.416	2.416	2.416	2.416	2.416
Wet. Wt. of Soil + Cont. (g)	219.06	300.53	189.21	208.79	221.81	289.03	269.05	198.03
Dry Wt. of Soil + Cont. (g)	213.34	254.67	144.40	163.98	200.11	280.50	222.39	167.53
Weight of Container (g)	38.73	38.36	35.86	38.10	38.87	37.33	37.52	39.70
Container No.								
Wet Density	108.6	126.1	118.6	118.4	130.6	103.6	123.3	125.9
Moisture Content (%)	**3**	**21**	**41**	**36**	**13**	**4**	**25**	**24**
Dry Density (pcf)	**105**	**104**	**84**	**87**	**115**	**100**	**98**	**102**
Degree of Saturation (%)	14.7	92.3	110.5	103.3	78.2	13.9	95.7	97.9

Leighton

MOISTURE & DENSITY of SOILS

ASTM D 2216 & ASTM D 2937

Project Name: Garden Grove
Project No.: 602778-002
Client Name: LCI/Irvine
Tested By: S. Felter Date: 04/01/11

ATTERBERG LIMITS

ASTM D 4318

Project Name:	Garden Grove	Tested By:	G. Bathala	Date:	04/12/11
Project No. :	602778-002	Input By:	J. Ward	Date:	04/13/11
Boring No.:	B-1	Checked By:	J. Ward		
Sample No.:	R-4	Depth (ft.)	18.0		
Soil Identification:	Olive gray lean clay (CL)				

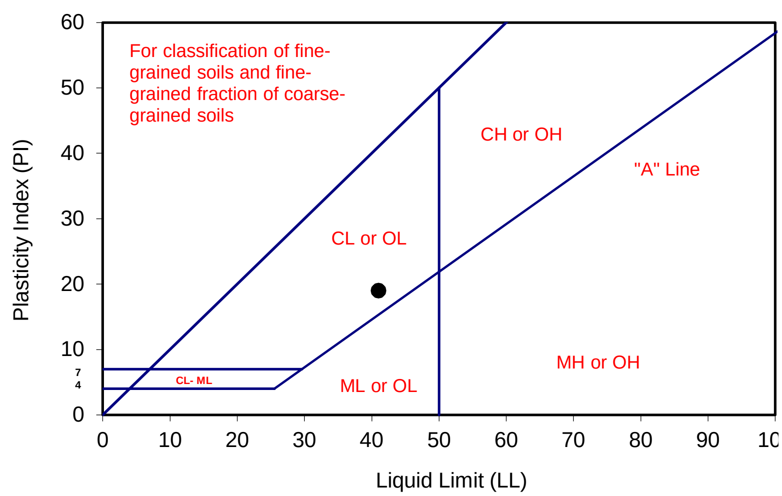
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			33	24	17	
Wet Wt. of Soil + Cont. (g)	28.17	26.69	25.28	26.40	24.99	
Dry Wt. of Soil + Cont. (g)	25.52	24.32	21.93	22.60	21.51	
Wt. of Container (g)	13.47	13.53	13.55	13.49	13.48	
Moisture Content (%) [Wn]	21.99	21.96	39.98	41.71	43.34	

Liquid Limit	**41**
Plastic Limit	**22**
Plasticity Index	**19**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 15.33

One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



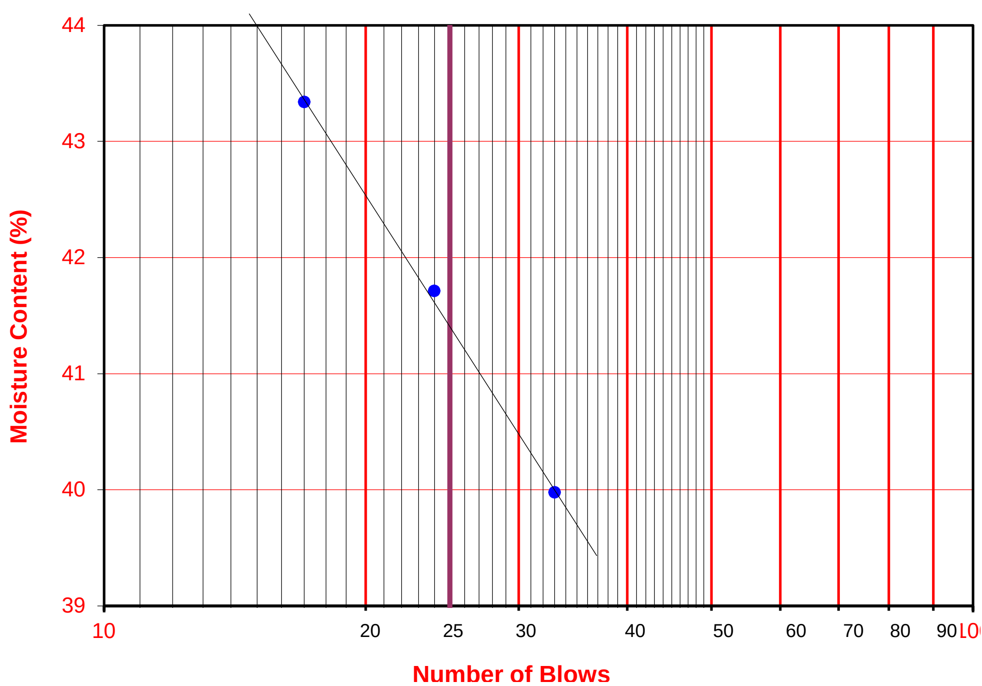
PROCEDURES USED

☐ Wet Preparation
Multipoint - Wet

X Dry Preparation
Multipoint - Dry

X Procedure A
Multipoint Test

☐ Procedure B
One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Garden Grove	Tested By:	V. Juliano	Date:	04/12/11
Project No. :	602778-002	Input By:	J. Ward	Date:	04/13/11
Boring No.:	B-2	Checked By:	J. Ward		
Sample No.:	R-4	Depth (ft.)	20.0		
Soil Identification:	Grayish brown lean clay (CL)				

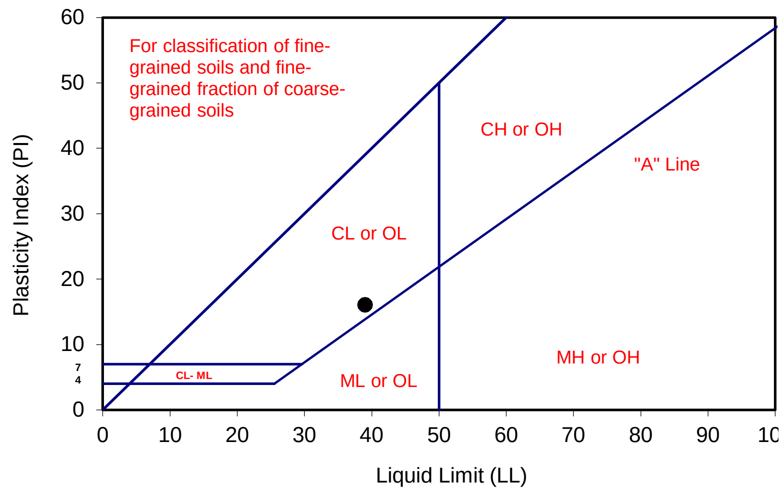
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	28	19	
Wet Wt. of Soil + Cont. (g)	8.48	8.74	13.34	15.04	12.76	
Dry Wt. of Soil + Cont. (g)	7.10	7.31	9.98	11.12	9.36	
Wt. of Container (g)	1.08	1.07	1.03	1.00	1.05	
Moisture Content (%) [Wn]	22.92	22.92	37.54	38.74	40.91	

Liquid Limit	**39**
Plastic Limit	**23**
Plasticity Index	**16**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 13.87

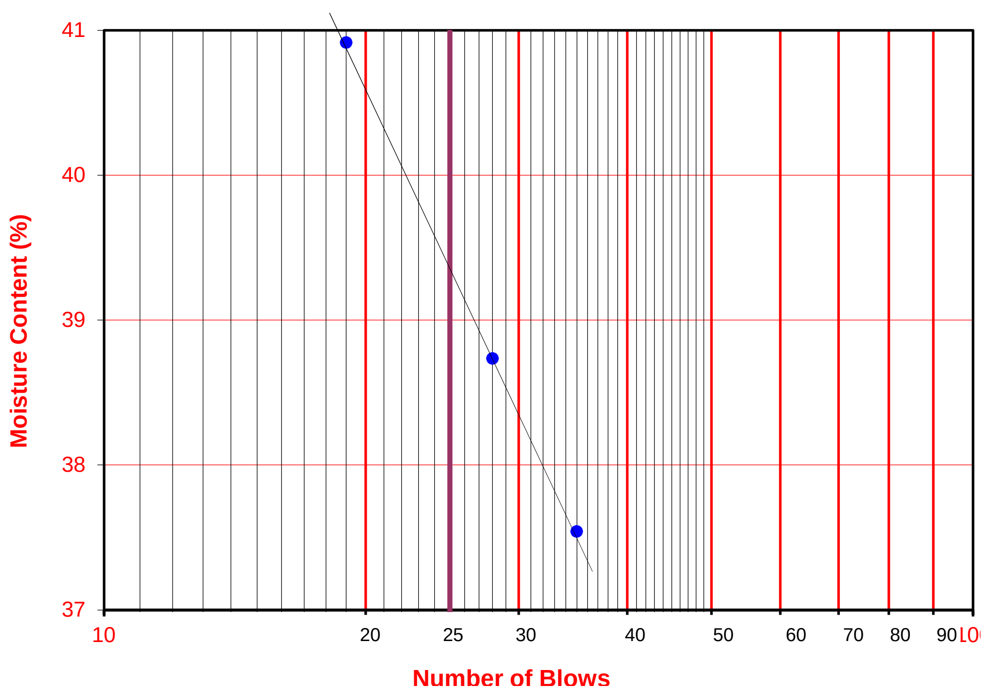
One - Point Liquid Limit Calculation

$LL = W_n(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Project Name:	Garden Grove	Tested By:	G. Bathala	Date:	04/12/11
Project No. :	602778-002	Input By:	J. Ward	Date:	04/13/11
Boring No.:	B-3	Checked By:	J. Ward		
Sample No.:	R-4	Depth (ft.)	20.0		
Soil Identification:	Grayish brown lean clay (CL)				

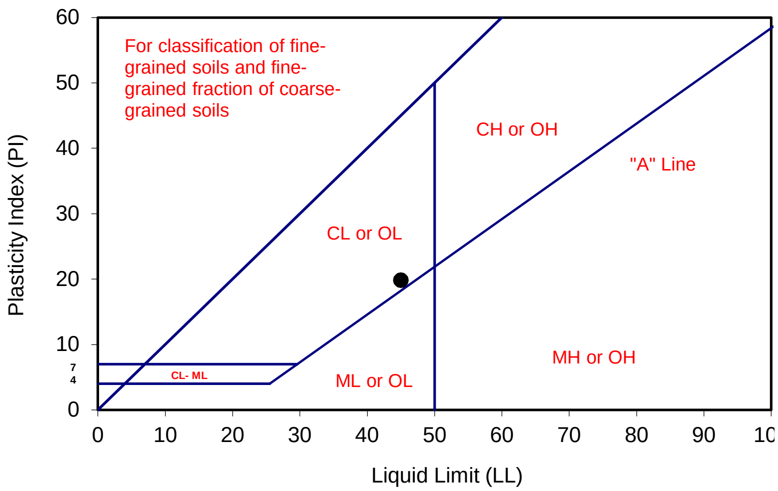
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			32	23	18	
Wet Wt. of Soil + Cont. (g)	30.00	28.37	25.33	24.35	24.58	
Dry Wt. of Soil + Cont. (g)	26.67	25.39	21.75	20.96	21.06	
Wt. of Container (g)	13.53	13.48	13.56	13.49	13.56	
Moisture Content (%) [Wn]	25.34	25.02	43.71	45.38	46.93	

Liquid Limit	**45**
Plastic Limit	**25**
Plasticity Index	**20**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 18.25

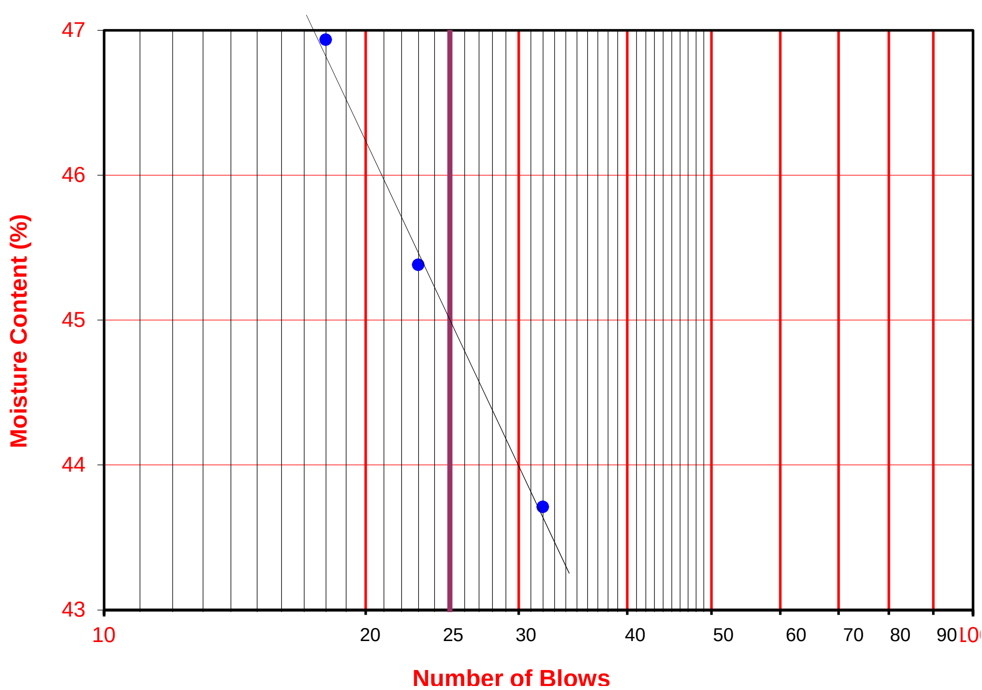
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

[ ]	Wet Preparation Multipoint - Wet
[X]	Dry Preparation Multipoint - Dry
[X]	Procedure A Multipoint Test
[ ]	Procedure B One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Garden Grove	Tested By:	G. Bathala	Date:	04/12/11
Project No. :	602778-002	Input By:	J. Ward	Date:	04/13/11
Boring No.:	B-3	Checked By:	J. Ward		
Sample No.:	R-8	Depth (ft.)	40.0		
Soil Identification:	Olive fat clay (CH)				

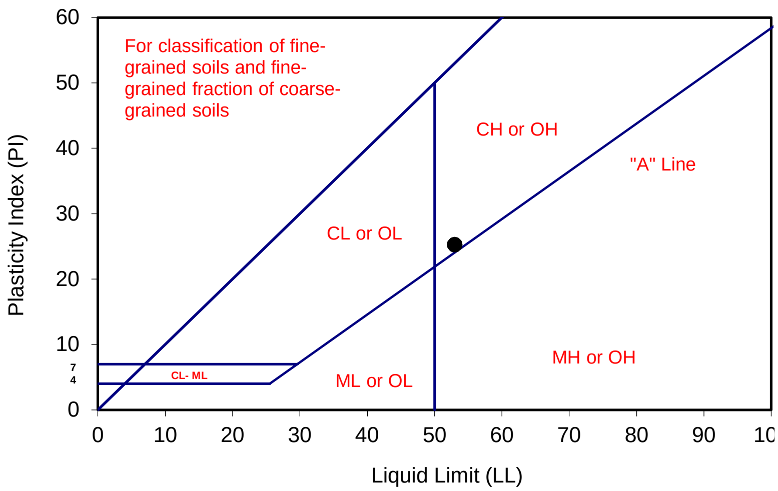
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			35	28	23	16
Wet Wt. of Soil + Cont. (g)	27.71	27.32	25.74	25.88	26.77	24.51
Dry Wt. of Soil + Cont. (g)	24.64	24.32	21.66	21.68	22.16	20.55
Wt. of Container (g)	13.51	13.57	13.48	13.58	13.55	13.53
Moisture Content (%) [Wn]	27.58	27.91	49.88	51.85	53.54	56.41

Liquid Limit	**53**
Plastic Limit	**28**
Plasticity Index	**25**
Classification	**CH**

PI at "A" - Line = 0.73(LL-20) | 24.09

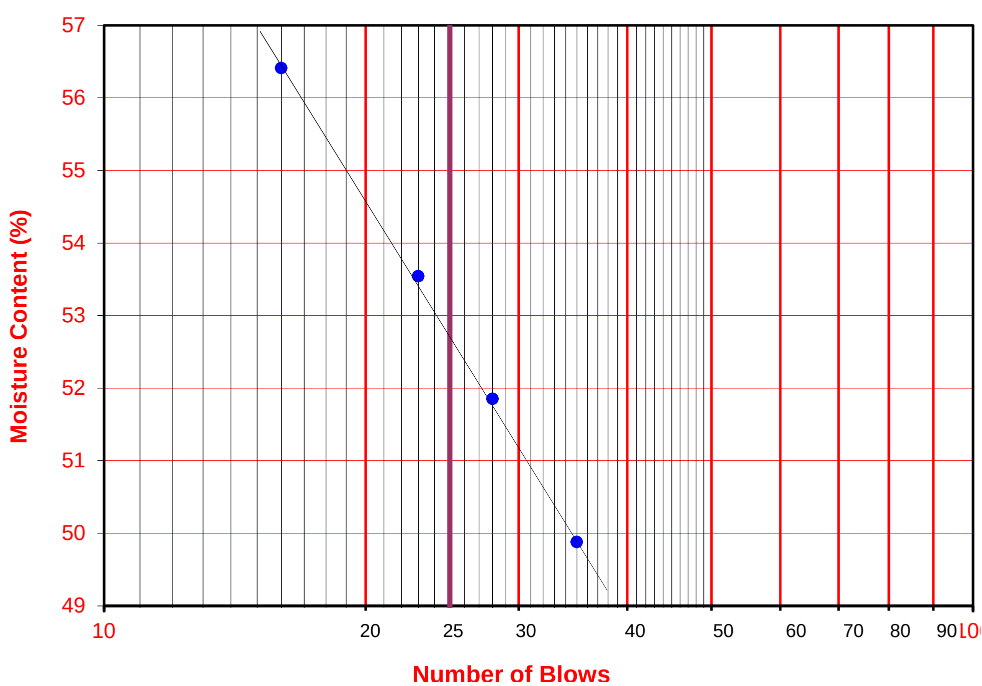
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



ATTERBERG LIMITS

ASTM D 4318

Leighton

Project Name:	Garden Grove	Tested By:	V. Juliano	Date:	04/12/11
Project No. :	602778-002	Input By:	J. Ward	Date:	04/13/11
Boring No.:	B-4	Checked By:	J. Ward		
Sample No.:	R-8	Depth (ft.)	40.0		
Soil Identification:	Olive sandy lean clay s(CL)				

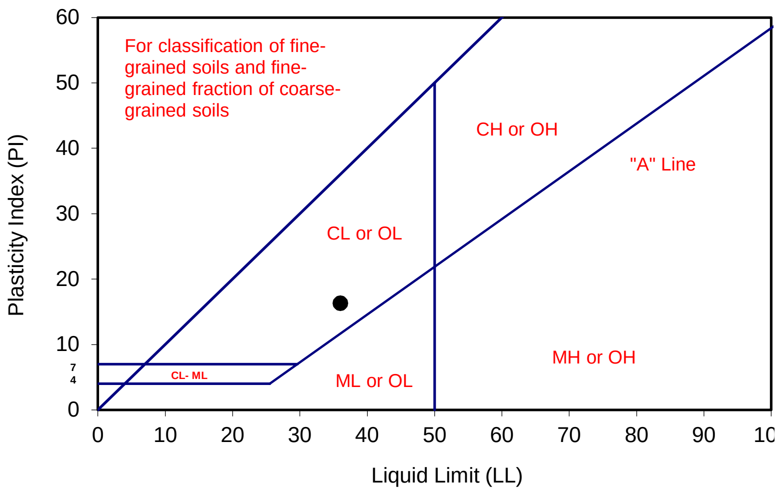
TEST	PLASTIC LIMIT		LIQUID LIMIT			
NO.	1	2	1	2	3	4
Number of Blows [N]			34	26	17	
Wet Wt. of Soil + Cont. (g)	9.29	9.23	16.20	14.32	13.62	
Dry Wt. of Soil + Cont. (g)	7.90	7.92	12.33	10.83	10.21	
Wt. of Container (g)	1.03	1.06	1.06	1.04	1.08	
Moisture Content (%) [Wn]	20.23	19.10	34.34	35.65	37.35	

Liquid Limit	**36**
Plastic Limit	**20**
Plasticity Index	**16**
Classification	**CL**

PI at "A" - Line = 0.73(LL-20) | 11.68

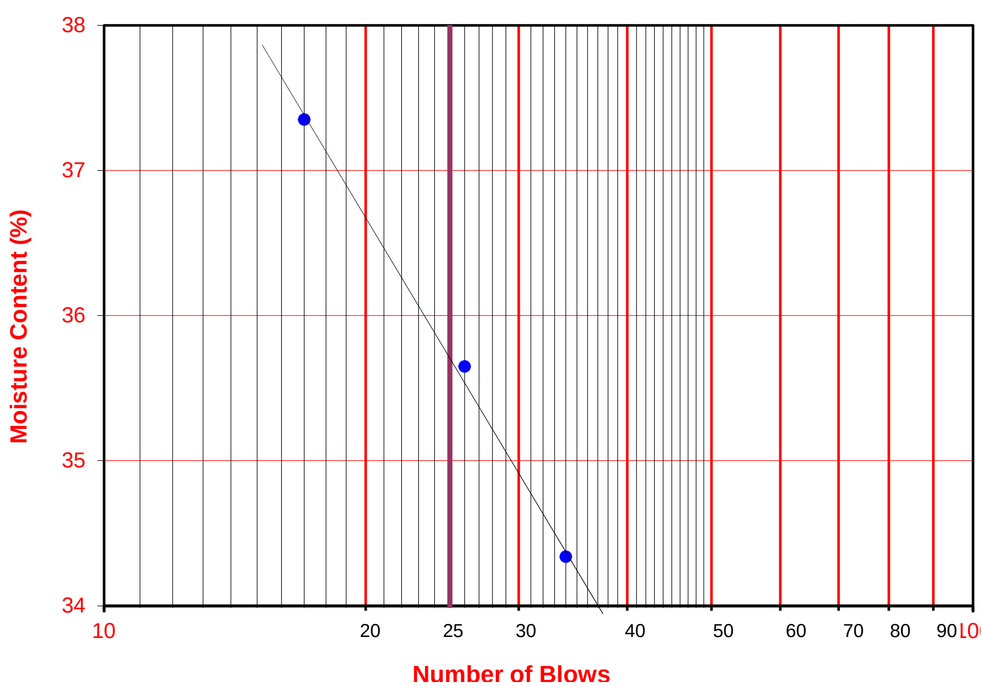
One - Point Liquid Limit Calculation

$LL = Wn(N/25)^{0.121}$



PROCEDURES USED

- [ ] Wet Preparation
  Multipoint - Wet
- [X] Dry Preparation
  Multipoint - Dry
- [X] Procedure A
  Multipoint Test
- [ ] Procedure B
  One-point Test



Leighton

R-VALUE TEST RESULTS

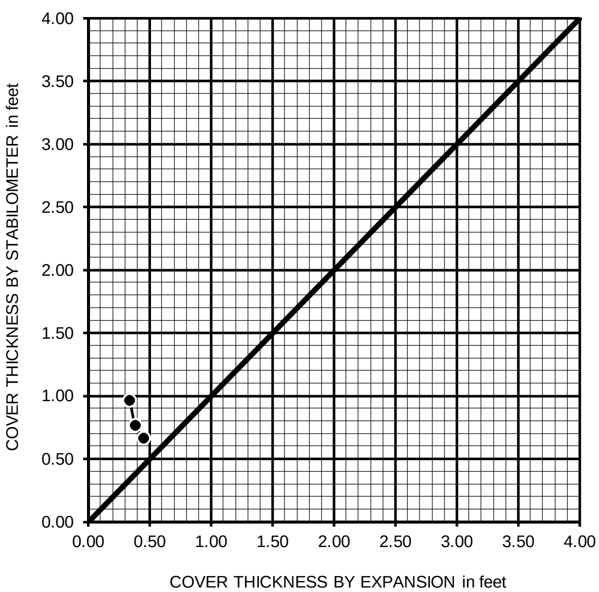
DOT CA 301

PROJECT NAME:	Garden Grove	PROJECT NUMBER:	602778-002
BORING NUMBER:	B-5	DEPTH (FT.):	0-5
SAMPLE NUMBER:	BB-1	TECHNICIAN:	S. Felter
SAMPLE DESCRIPTION:	Olive (SM)	DATE COMPLETED:	4/19/2011

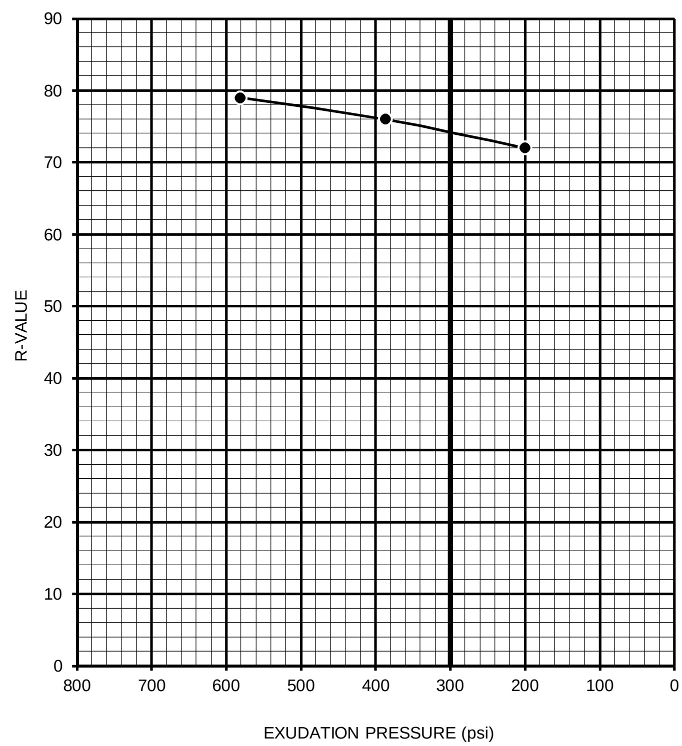
TEST SPECIMEN	a	b	c
MOISTURE AT COMPACTION %	9.7	10.1	10.6
HEIGHT OF SAMPLE, Inches	2.47	2.46	2.53
DRY DENSITY, pcf	123.6	123.6	123.2
COMPACTOR PRESSURE, psi	350	350	300
EXUDATION PRESSURE, psi	582	388	200
EXPANSION, Inches x 10exp-4	29	23	20
STABILITY Ph 2,000 lbs (160 psi)	22	25	29
TURNS DISPLACEMENT	4.23	4.32	4.47
R-VALUE UNCORRECTED	79	76	72
R-VALUE CORRECTED	79	76	72

DESIGN CALCULATION DATA	a	b	c
GRAVEL EQUIVALENT FACTOR	1.0	1.0	1.0
TRAFFIC INDEX	5.0	5.0	5.0
STABILOMETER THICKNESS, ft.	0.34	0.38	0.45
EXPANSION PRESSURE THICKNESS, ft.	0.97	0.77	0.67

EXPANSION PRESSURE CHART



EXUDATION PRESSURE CHART



R-VALUE BY EXPANSION:	68
R-VALUE BY EXUDATION:	74
EQUILIBRIUM R-VALUE:	68

PARTICLE-SIZE ANALYSIS of SOILS
ASTM D 6913

Leighton

Project Name:	Garden Grove	Tested By:	G. Berdy	Date:	12/16/09
Project No.:	602778-001	Checked By:	J. Ward	Date:	12/17/09
Exploration No.:	HA-1	Depth (feet):	0-5		
Sample No.:	BB-1				
Soil Identification:	Olive silty sand (SM), asphalt noted				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	SP-1	731	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	2012.70	577.31	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	230.68	77.22	Wt. of Container No.______(g)	1.00	1.00
Dry Wt. of Soil (g)	1782.02	500.09	Moisture Content (%)	0.00	0.00

Passing #4 Material After Wet Sieve	Container No.	731
	Wt. of Dry Soil + Container (g)	439.18
	Wt. of Container (g)	77.22
	Dry Wt. of Soil Retained on # 200 Sieve (g)	361.96

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
6"	152.400			
3"	75.000			
1 1/2	37.500			
3/4"	19.000	0.00		100.0
3/8"	9.500	4.37		99.8
#4	4.750	12.59		99.3
#8	2.360		9.30	97.5
#16	1.180		45.05	90.4
#30	0.600		117.52	76.0
#50	0.300		207.13	58.2
#100	0.150		281.66	43.4
#200	0.075		335.44	32.7
PAN				

GRAVEL: **1 %**

SAND: **66 %**

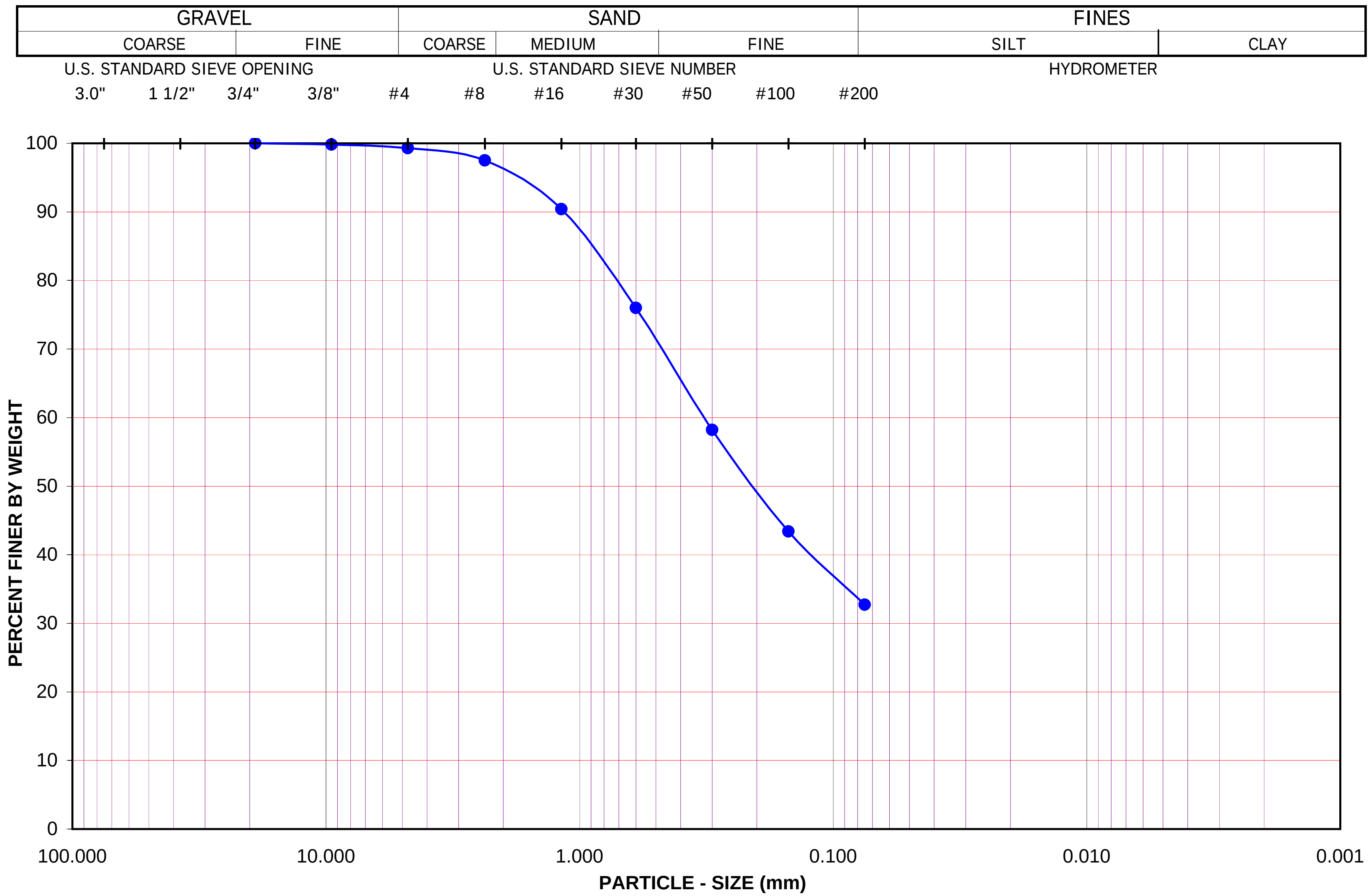
FINES: **33 %**

GROUP SYMBOL **SM**

Cu = D60/D10 = ______

Cc = $(D30)^2/(D60*D10)$ = ______

Remarks: ______



Project Name: Garden Grove

Project No.: 602778-001

Exploration No.: HA-1 Sample No.: BB-1

Depth (feet): 0-5 Soil Type : SM

Soil Identification: Olive silty sand (SM), asphalt noted

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 1 : 66 : 33

Dec-09

PARTICLE-SIZE ANALYSIS of SOILS
ASTM D 6913

Leighton

Project Name:	Garden Grove	Tested By:	G. Berdy	Date:	12/16/09
Project No.:	602778-001	Checked By:	J. Ward	Date:	12/17/09
Exploration No.:	HA-2	Depth (feet):	0-5		
Sample No.:	BB-1				
Soil Identification:	Olive silty sand (SM), asphalt noted				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	CP-3	724	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	4107.40	543.00	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	223.49	77.32	Wt. of Container No.______(g)	1.00	1.00
Dry Wt. of Soil (g)	3883.91	465.68	Moisture Content (%)	0.00	0.00

Passing #4 Material After Wet Sieve		
	Container No.	724
	Wt. of Dry Soil + Container (g)	401.58
	Wt. of Container (g)	77.32
	Dry Wt. of Soil Retained on # 200 Sieve (g)	324.26

U. S. Sieve Size	(mm.)	Cumulative Weight of Dry Soil Retained (g) Whole Sample	Sample Passing #4	Percent Passing (%)
6"	152.400			
3"	75.000	0.00		100.0
1 1/2	37.500	39.19		99.0
3/4"	19.000	71.28		98.2
3/8"	9.500	248.16		93.6
#4	4.750	406.15		89.5
#8	2.360		15.96	86.4
#16	1.180		45.71	80.7
#30	0.600		100.61	70.2
#50	0.300		161.65	58.4
#100	0.150		237.08	43.9
#200	0.075		303.31	31.2
PAN				

GRAVEL: **11 %**

SAND: **58 %**

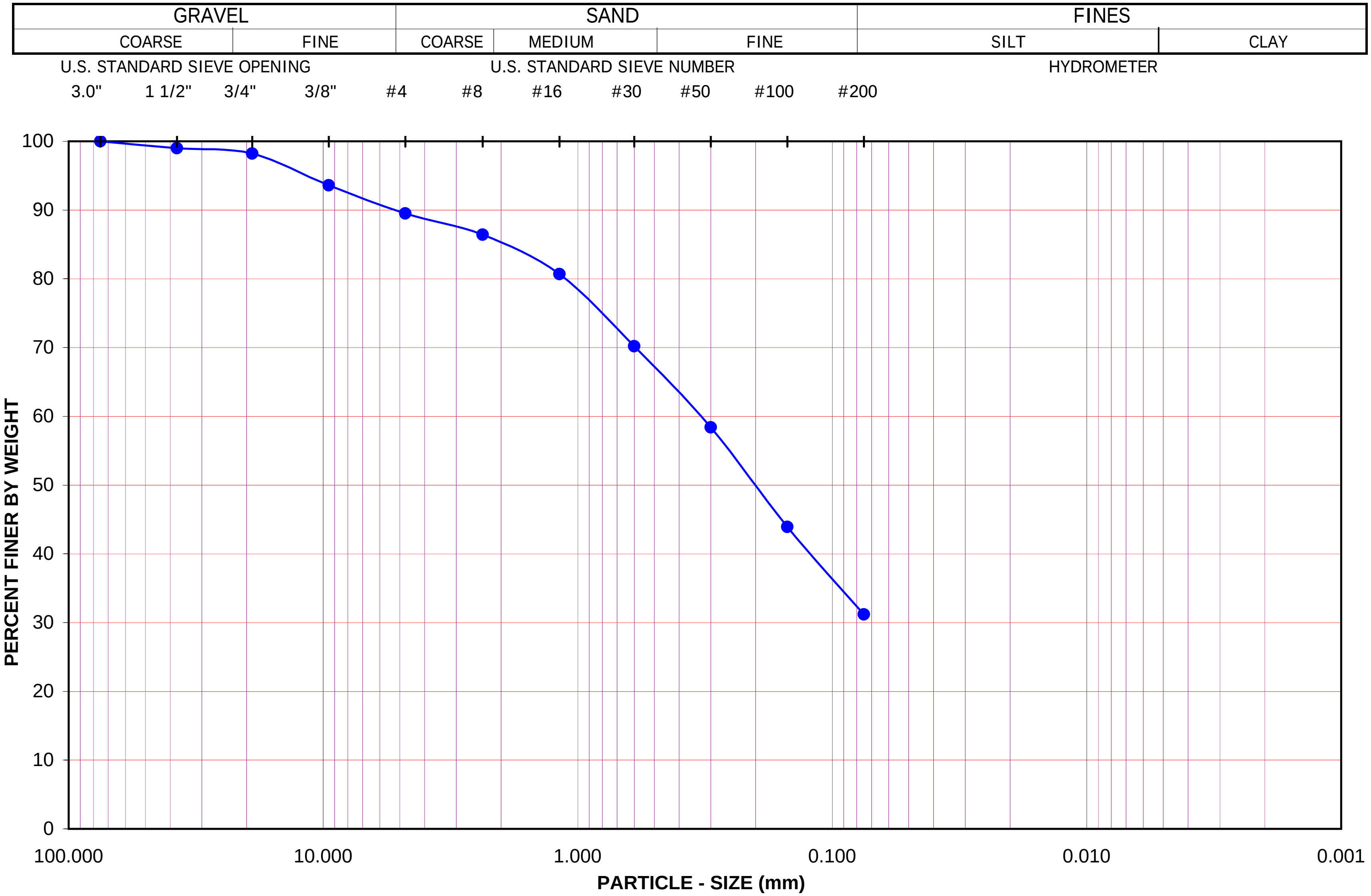
FINES: **31 %**

GROUP SYMBOL **SM**

Cu = D60/D10 = ______

Cc = $(D30)^2/(D60*D10)$ = ______

Remarks: ______



Project Name: Garden Grove

Project No.: 602778-001

Leighton

PARTICLE - SIZE DISTRIBUTION
ASTM D 6913

Exploration No.: HA-2 | Sample No.: BB-1

Depth (feet): 0-5 | Soil Type : SM

Soil Identification: Olive silty sand (SM), asphalt noted

GR:SA:FI : (%) 11 : 58 : 31

Dec-09

SA HA-2, BB-1 @ 0-5

Leighton

PARTICLE-SIZE ANALYSIS of SOILS

ASTM D 6913

Project Name:	Garden Grove	Tested By:	G. Berdy	Date:	12/16/09
Project No.:	602778-001	Checked By:	J. Ward	Date:	12/17/09
Exploration No.:	HA-3	Depth (feet):	0-5		
Sample No.:	BB-1				
Soil Identification:	Olive silty sand (SM)				

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	CP-2	733	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	5235.20	630.00	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	224.46	76.56	Wt. of Container No.______(g)	1.00	1.00
Dry Wt. of Soil (g)	5010.74	553.44	Moisture Content (%)	0.00	0.00

Passing #4 Material After Wet Sieve		
	Container No.	733
	Wt. of Dry Soil + Container (g)	530.52
	Wt. of Container (g)	76.56
	Dry Wt. of Soil Retained on # 200 Sieve (g)	453.96

U. S. Sieve Size		Cumulative Weight of Dry Soil Retained (g)		Percent Passing (%)
	(mm.)	Whole Sample	Sample Passing #4	
6"	152.400			
3"	75.000			
1 1/2	37.500	0.00		100.0
3/4"	19.000	70.18		98.6
3/8"	9.500	341.48		93.2
#4	4.750	624.14		87.5
#8	2.360		31.88	82.5
#16	1.180		87.72	73.6
#30	0.600		184.31	58.4
#50	0.300		291.72	41.4
#100	0.150		384.00	26.8
#200	0.075		438.94	18.1
PAN				

GRAVEL: **13 %**

SAND: **69 %**

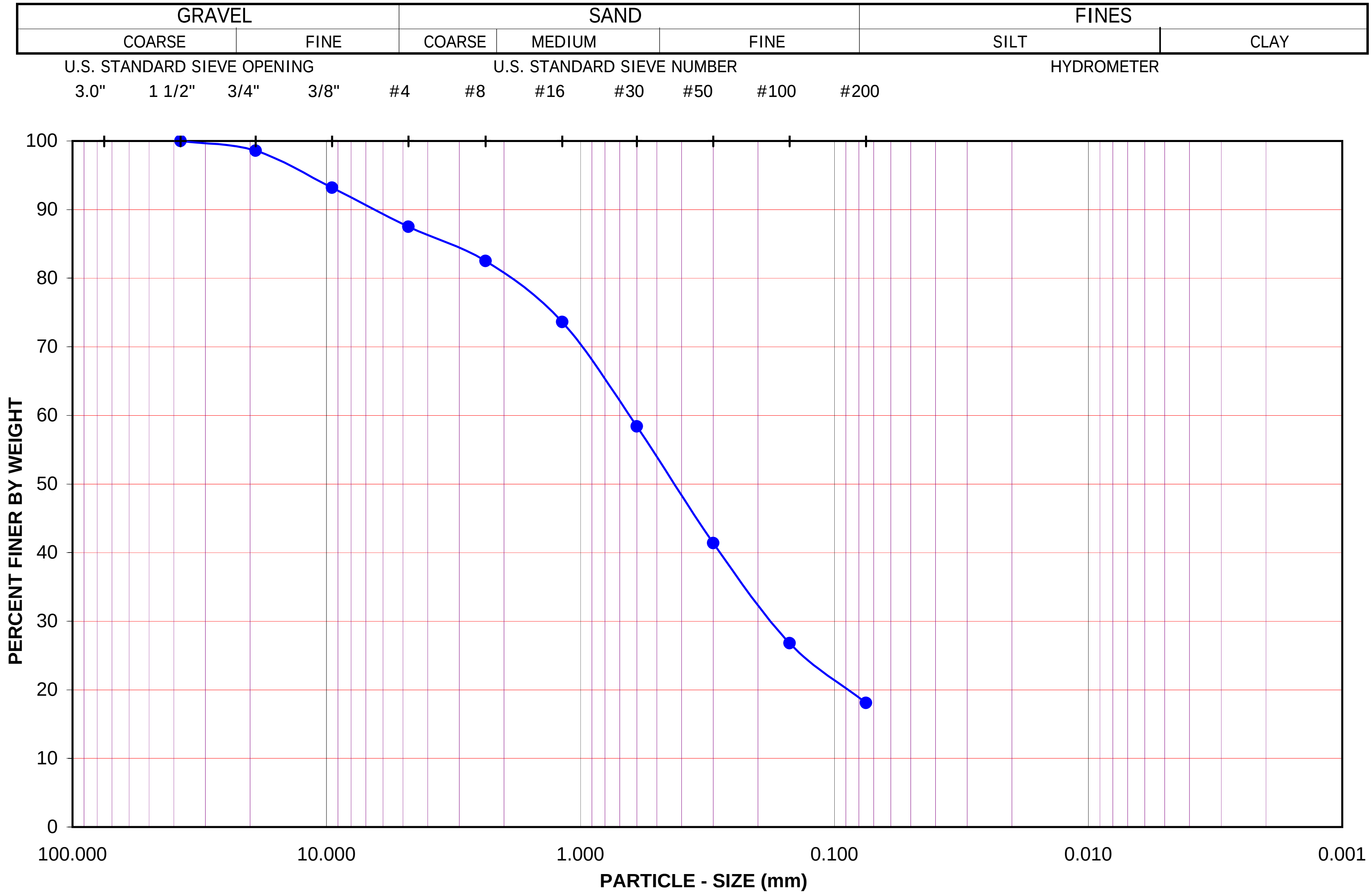
FINES: **18 %**

GROUP SYMBOL **SM**

$Cu = D60/D10 =$ ______

$Cc = (D30)^2/(D60*D10) =$ ______

Remarks: ______



Project Name: Garden Grove

Project No.: 602778-001

Exploration No.: HA-3 Sample No.: BB-1

Depth (feet): 0-5 Soil Type : SM

Soil Identification: Olive silty sand (SM)

GR:SA:FI : (%) 13 : 69 : 18

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

Dec-09

SA HA-3, BB-1 @ 0-5

PARTICLE-SIZE ANALYSIS of SOILS
ASTM D 6913

Leighton

Project Name: Garden Grove
Project No.: 602778-001
Exploration No.: HA-4
Sample No.: BB-1
Soil Identification: Olive silty sand (SM), asphalt noted

Tested By: G. Berdy Date: 12/16/09
Checked By: J. Ward Date: 12/17/09
Depth (feet): 0-5

Calculation of Dry Weights	Whole Sample	Sample Passing #4	Moisture Contents	Whole Sample	Sample passing #4
Container No.:	CP-20	952	Wt. of Air-Dry Soil + Cont.(g)	0.00	0.00
Wt. Air-Dried Soil + Cont.(g)	3379.00	621.08	Wt. of Dry Soil + Cont. (g)	0.00	0.00
Wt. of Container (g)	223.75	108.14	Wt. of Container No.______(g)	1.00	1.00
Dry Wt. of Soil (g)	3155.25	512.94	Moisture Content (%)	0.00	0.00

Passing #4 Material After Wet Sieve		
	Container No.	952
	Wt. of Dry Soil + Container (g)	507.33
	Wt. of Container (g)	108.14
	Dry Wt. of Soil Retained on # 200 Sieve (g)	399.19

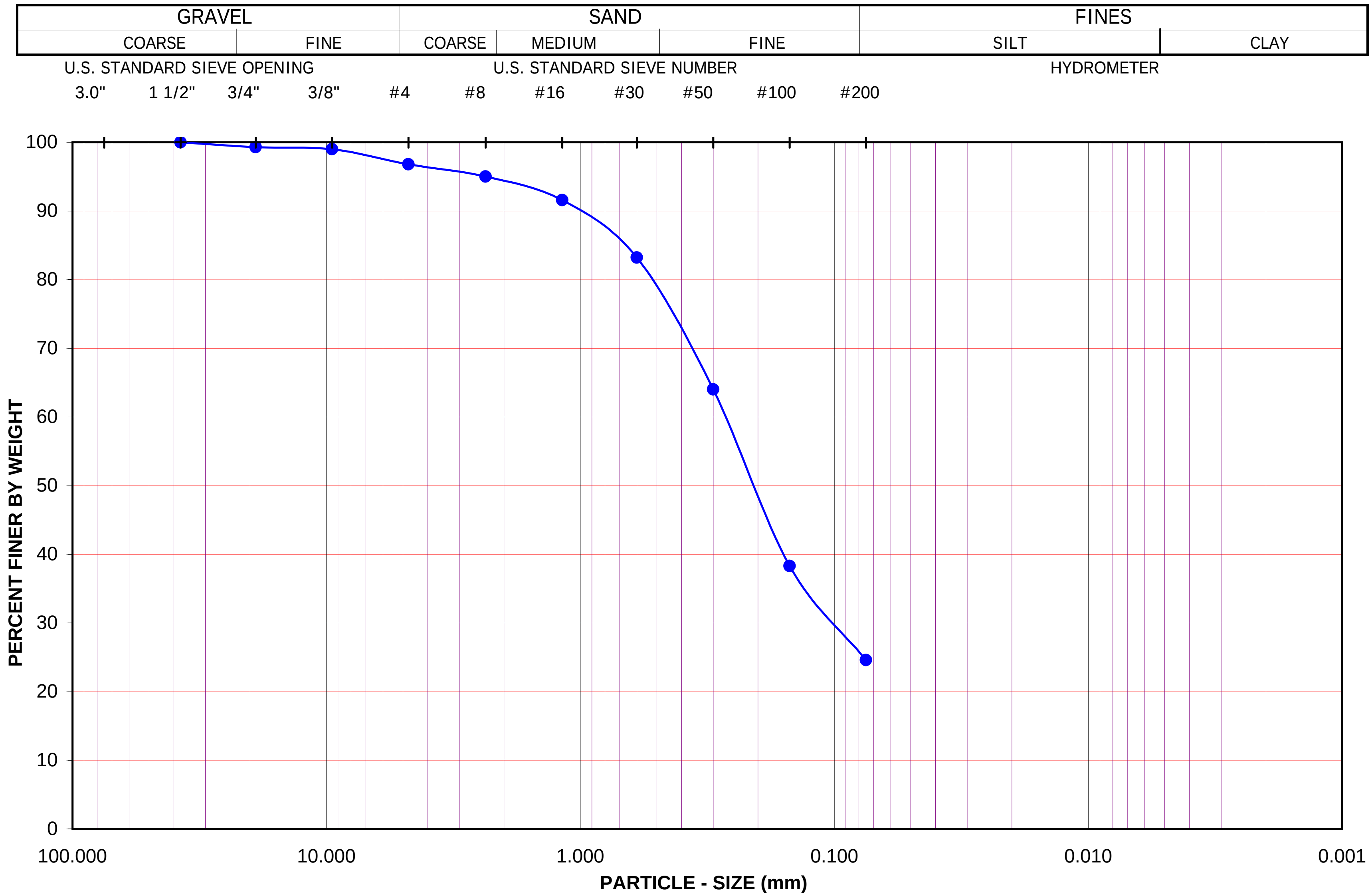
U. S. Sieve Size	(mm.)	Cumulative Weight of Dry Soil Retained (g) Whole Sample	Sample Passing #4	Percent Passing (%)
6"	152.400			
3"	75.000			
1 1/2	37.500	0.00		100.0
3/4"	19.000	20.78		99.3
3/8"	9.500	30.25		99.0
#4	4.750	100.88		96.8
#8	2.360		9.40	95.0
#16	1.180		27.75	91.6
#30	0.600		72.24	83.2
#50	0.300		173.87	64.0
#100	0.150		309.86	38.3
#200	0.075		382.70	24.6
PAN				

GRAVEL: **3 %**
SAND: **72 %**
FINES: **25 %**
GROUP SYMBOL **SM**

$Cu = D60/D10 =$ ______

$Cc = (D30)^2/(D60*D10) =$ ______

Remarks: ______



Project Name: Garden Grove

Project No.: 602778-001

Exploration No.: HA-4 Sample No.: BB-1

Depth (feet): 0-5 Soil Type : SM

Soil Identification: Olive silty sand (SM), asphalt noted

Leighton

PARTICLE - SIZE DISTRIBUTION ASTM D 6913

GR:SA:FI : (%) 3 : 72 : 25

Dec-09

SA HA-4, BB-1 @ 0-5

Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name:	Garden Grove	Tested by:	A. Santos
Project No:	602778-002	Checked by:	J. Ward
Boring No.:	B-2	Sample Type:	Drive
Sample No.:	R-4	Depth(ft):	20.0
Sample Description:	Grayish brown lean clay (CL)		

Date: 04/07/11
Date: 04/11/11

Diameter (in)	1	2.416
	2	2.416
	3	2.415
	Average	2.416
Height (in)	1	5.642
	2	5.634
	3	5.639
	Average	5.638

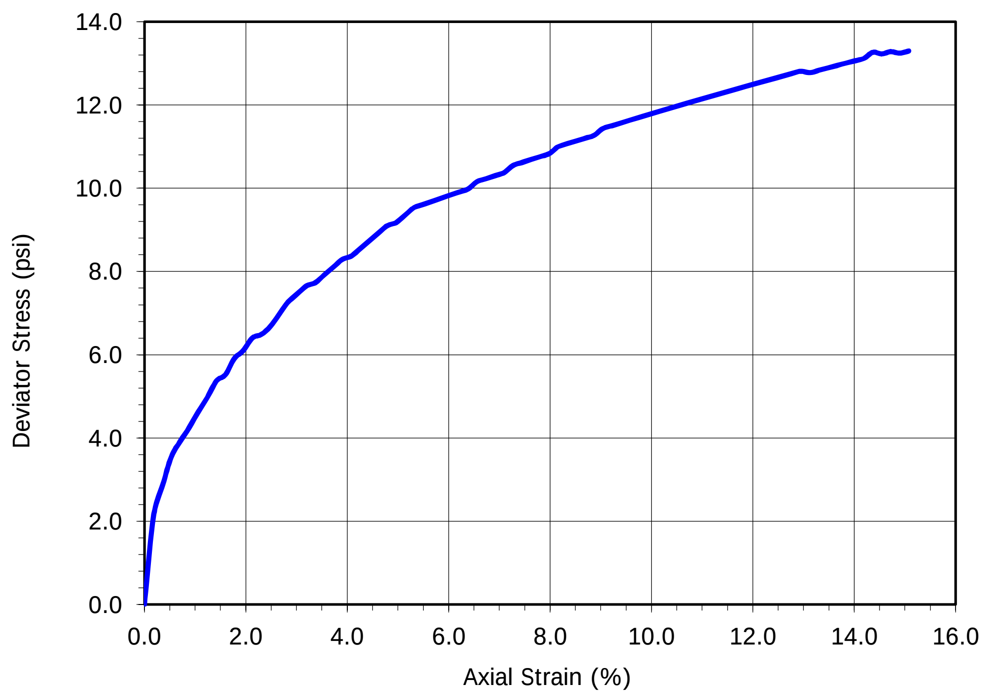
Weight of Sample + Tube / Rings (g)	821.10
Weight of Tube / Rings (g)	0.00
Weight of Wet Sample + Container (g)	927.40
Weight of Dry Sample + Container (g)	737.60
Weight of Container (g)	107.70
Specific Gravity (assumed)	2.70
Confining Pressure (psi)	13.9
Rate of Deformation (in/min)	0.045

Sample Properties	
Moisture Content (%)	30.13
Dry Density (pcf)	93.0
Void Ratio	0.811
% Saturation	100.3

At Failure*	
Deviator stress (psi)	**13.30**
Minor principal total stress (psi)	**13.90**
Major principal total stress (psi)	**27.20**
Axial strain (%)	**15.08**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name:	Garden Grove	Tested by:	A. Santos
Project No:	602778-002	Checked by:	J. Ward
Boring No.:	B-2	Sample Type:	Drive
Sample No.:	R-8	Depth(ft):	45.0
Sample Description:	Grayish olive silty sand and lean clay (SM) & (CL)		

Date: 04/07/11
Date: 04/11/11

Diameter (in)	1	2.413
	2	2.417
	3	2.425
	Average	2.418
Height (in)	1	5.340
	2	5.346
	3	5.347
	Average	5.344

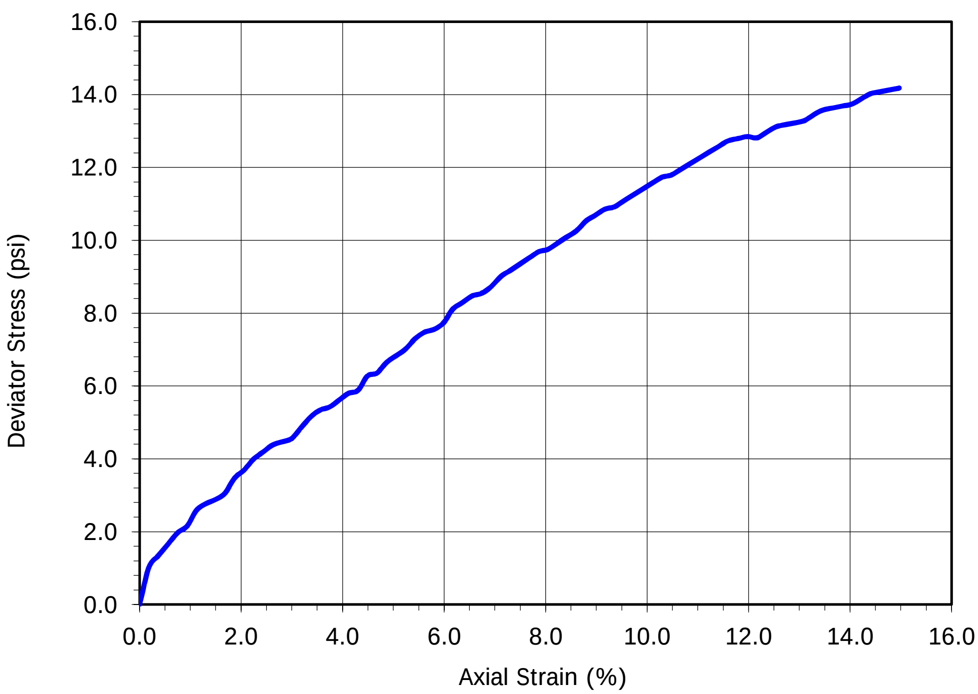
Weight of Sample + Tube / Rings (g)	812.10
Weight of Tube / Rings (g)	0.00
Weight of Wet Sample + Container (g)	918.50
Weight of Dry Sample + Container (g)	752.70
Weight of Container (g)	109.00
Specific Gravity (assumed)	2.70
Confining Pressure (psi)	17.4
Rate of Deformation (in/min)	0.045

Sample Properties	
Moisture Content (%)	25.76
Dry Density (pcf)	100.2
Void Ratio	0.681
% Saturation	102.1

At Failure*	
Deviator stress (psi)	**14.18**
Minor principal total stress (psi)	**17.40**
Major principal total stress (psi)	**31.58**
Axial strain (%)	**14.97**

* Stress values have been corrected for membrane effects

Stress - Strain Curve



Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils

ASTM D 2850

Project Name:	Garden Grove	Tested by:	A. Santos	Date:	04/07/11
Project No:	602778-002	Checked by:	J. Ward	Date:	04/11/11
Boring No.:	B-5	Sample Type:	Drive		
Sample No.:	R-4	Depth(ft):	20.0		
Sample Description:	Grayish brown sandy silt s(ML)				

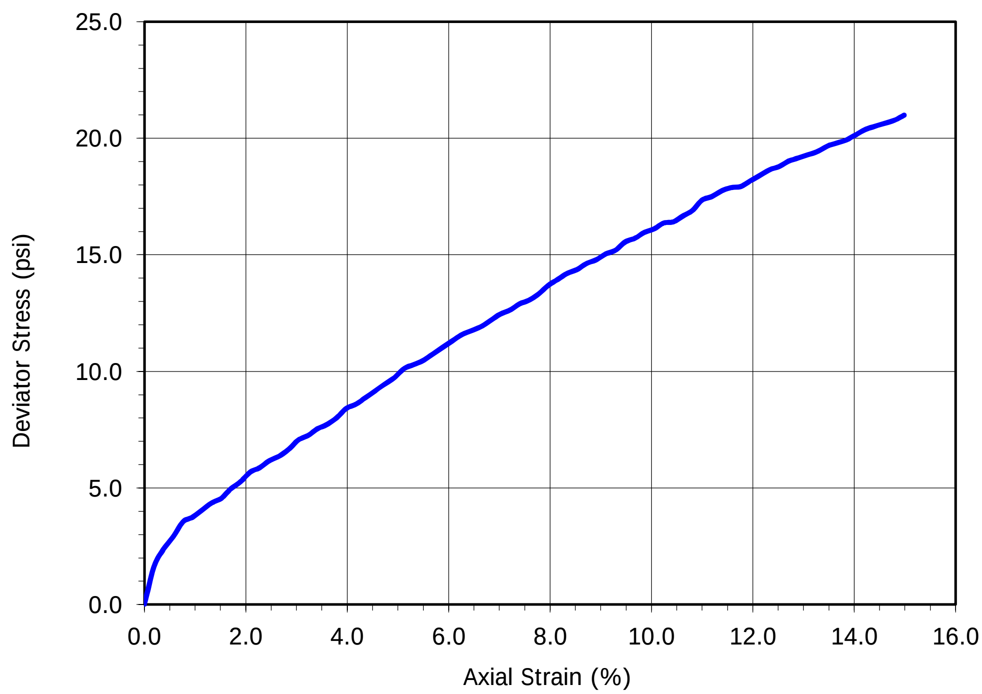
Diameter (in)	1	2.419
	2	2.411
	3	2.405
	Average	2.412
Height (in)	1	5.270
	2	5.272
	3	5.275
	Average	5.272
Weight of Sample + Tube / Rings (g)		763.60
Weight of Tube / Rings (g)		0.00
Weight of Wet Sample + Container (g)		869.80
Weight of Dry Sample + Container (g)		691.60
Weight of Container (g)		107.70
Specific Gravity (assumed)		2.70
Confining Pressure (psi)		13.9
Rate of Deformation (in/min)		0.045

Sample Properties	
Moisture Content (%)	30.52
Dry Density (pcf)	92.5
Void Ratio	0.821
% Saturation	100.4

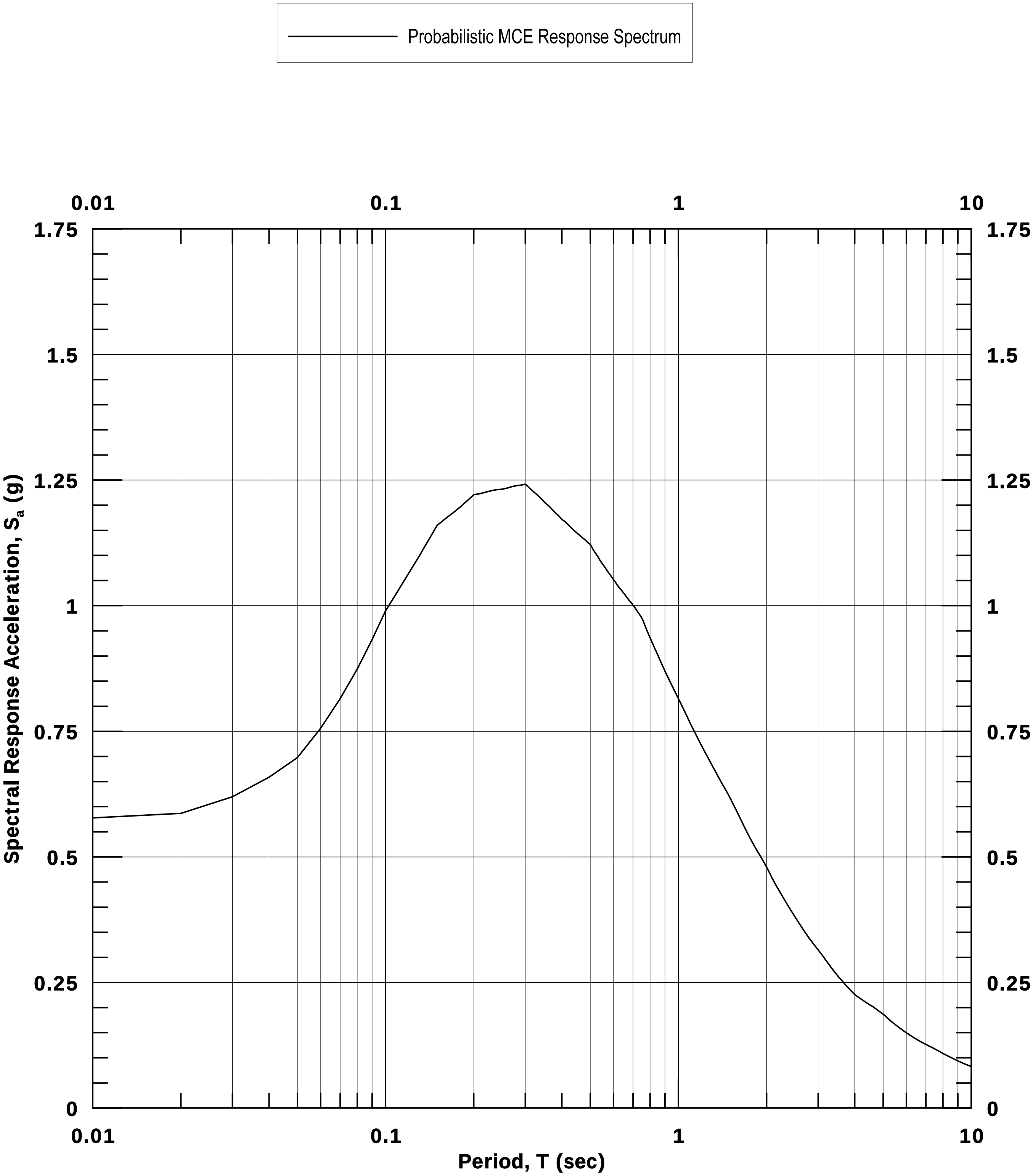
At Failure*	
Deviator stress (psi)	**20.99**
Minor principal total stress (psi)	**13.90**
Major principal total stress (psi)	**34.89**
Axial strain (%)	**14.98**

* Stress values have been corrected for membrane effects

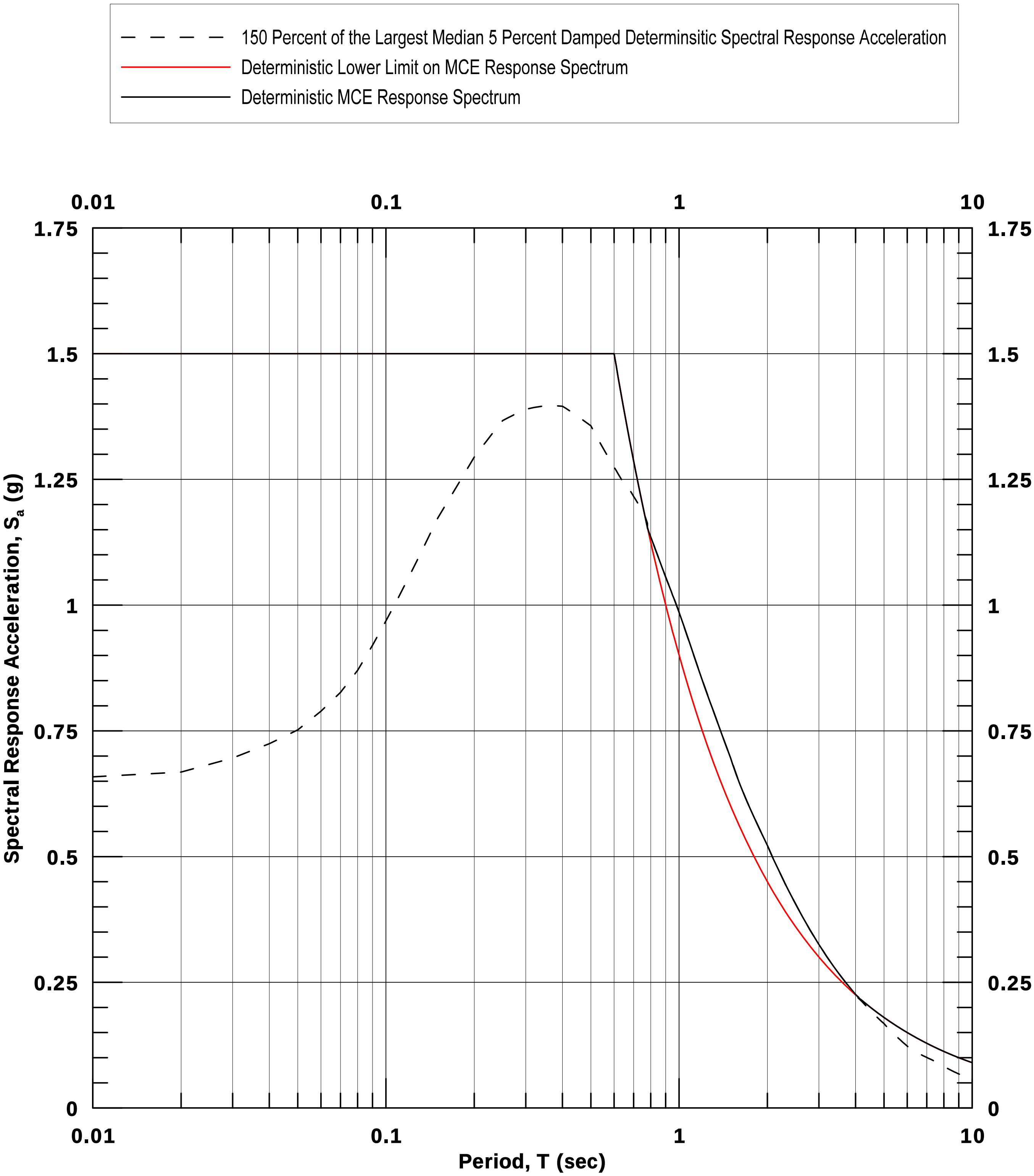
Stress - Strain Curve



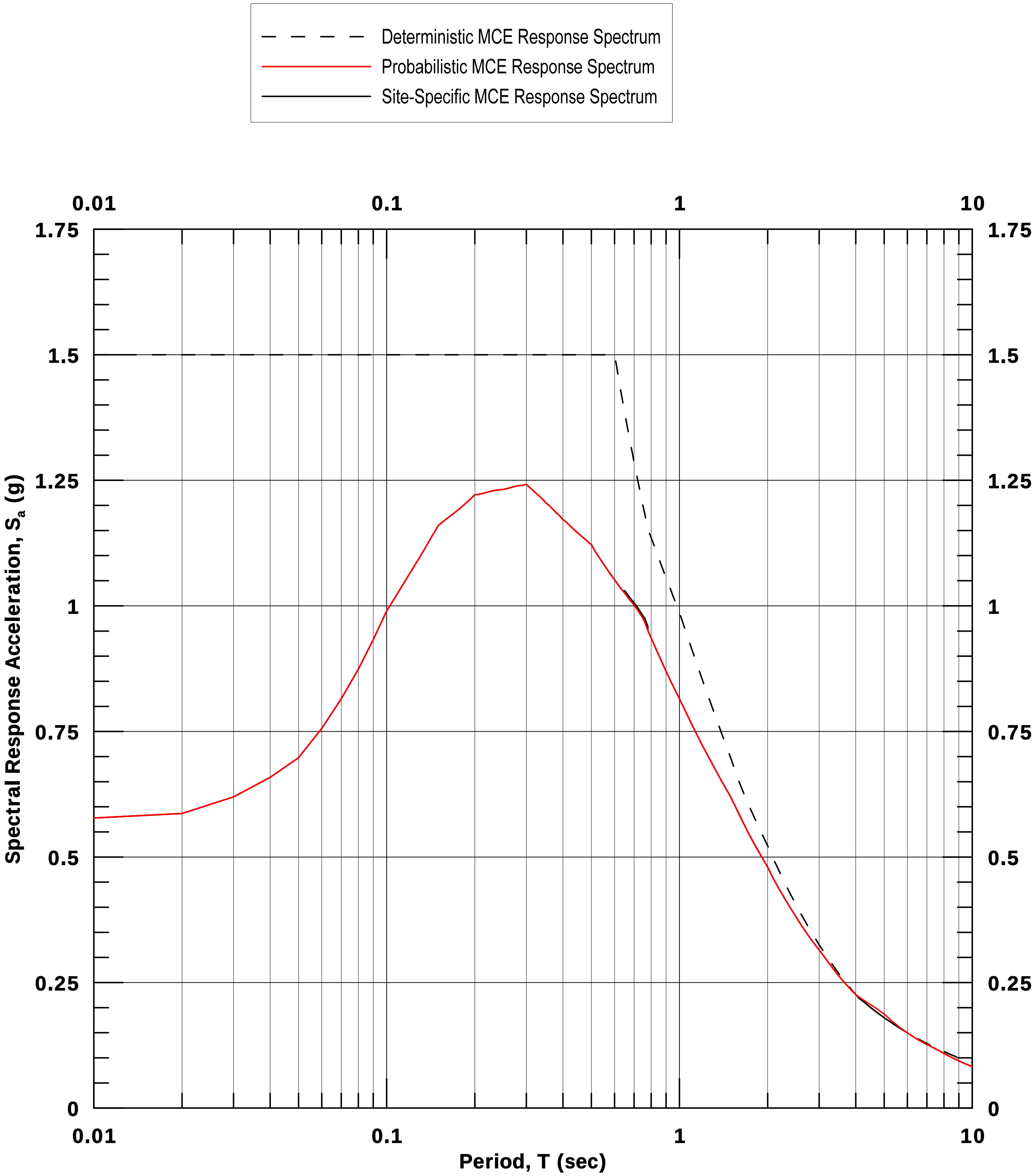
APPENDIX E



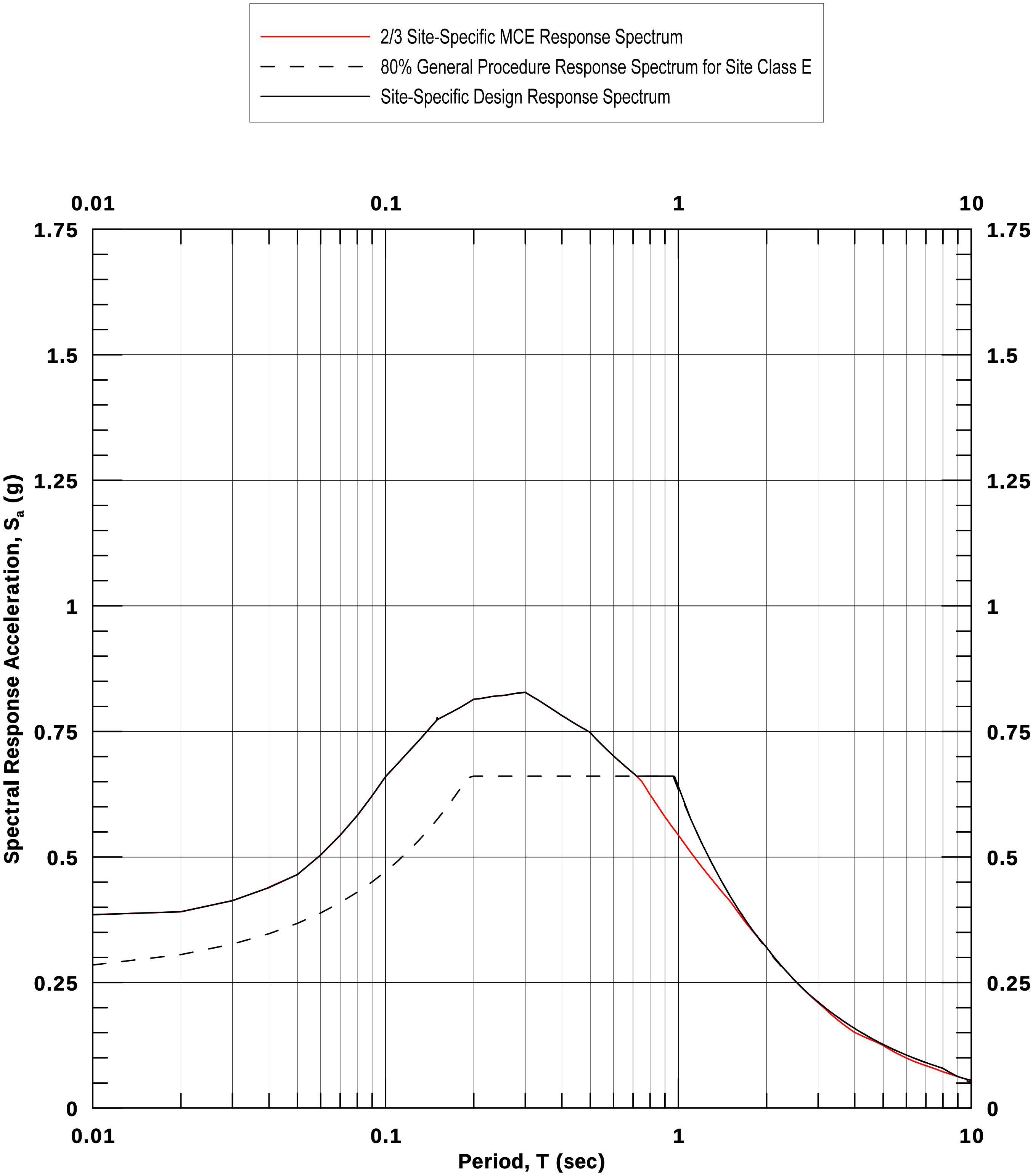
Probabilistic MCE Response Spectrum	**Geotechnical Exploration Report Design Phase of the Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California**	**Project No.** 602778-002 **Date:** July 2013 Leighton **Figure E-1**



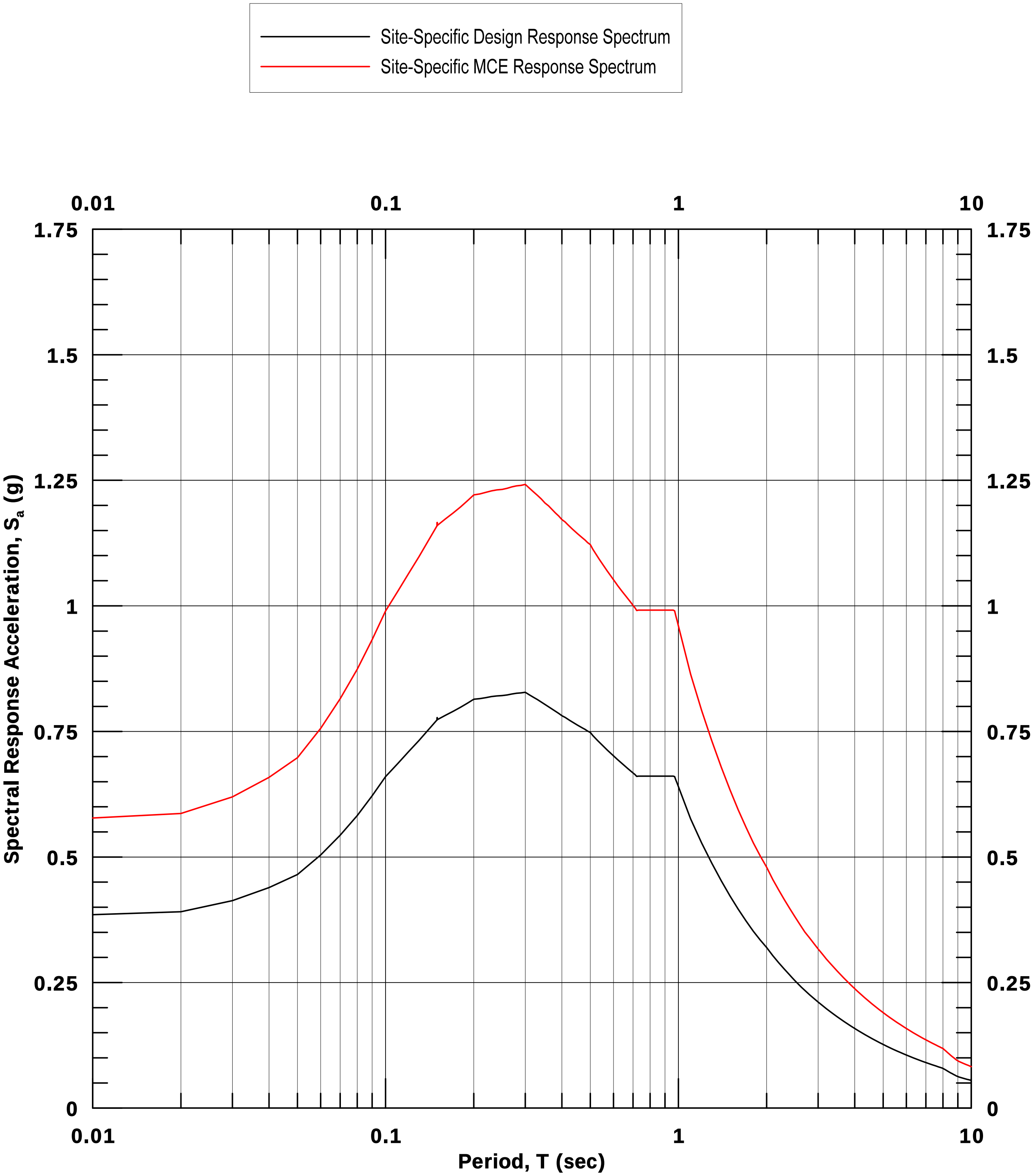
Deterministic MCE Response Spectrum	**Geotechnical Exploration Report Design Phase of the Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California**	**Project No.** **602778-002** **Date:** **July 2013** **Figure E-2**



Site-Specific MCE Response Spectrum	Geotechnical Exploration Report Design Phase of the Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California	Project No. 602778-002 Date: July 2013 Leighton Figure E-3



Site-Specific Design Response Spectrum	Geotechnical Exploration Report Design Phase of the Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California	Project No. 602778-002 Date: July 2013 Leighton Figure E-4



Site-Specific Response Spectra for Use in Design	**Geotechnical Exploration Report Design Phase of the Proposed Great Wolf Lodge Resort Hotel City of Garden Grove, California**	**Project No.** **602778-002** **Date:** **July 2013** Leighton **Figure E-5**

Table E-1: Probabilistic MCE Spectral Response Acceleration

Period T (sec)	Spectral Response Acceleration $S_{aM\ P}$ (g)
0.01	0.5777
0.02	0.5865
0.03	0.6196
0.04	0.6585
0.05	0.6977
0.06	0.7560
0.07	0.8151
0.08	0.8738
0.09	0.9326
0.10	0.9899
0.11	1.029
0.12	1.065
0.13	1.098
0.14	1.130
0.15	1.160
0.16	1.173
0.17	1.185
0.18	1.197
0.19	1.209
0.20	1.221
0.21	1.223
0.22	1.226
0.23	1.229
0.24	1.231
0.25	1.232
0.26	1.234
0.27	1.237
0.28	1.239
0.29	1.240
0.30	1.242
0.31	1.234
0.32	1.227
0.33	1.220
0.34	1.213
0.35	1.205
0.36	1.199
0.37	1.192
0.38	1.185
0.39	1.179
0.40	1.172
0.41	1.167
0.42	1.161

Table E-1: Probabilistic MCE Spectral Response Acceleration

Period T (sec)	Spectral Response Acceleration $S_{aM\,P}$ (g)
0.43	1.155
0.44	1.150
0.45	1.145
0.46	1.140
0.47	1.135
0.48	1.131
0.49	1.126
0.50	1.122
0.51	1.113
0.52	1.105
0.53	1.098
0.54	1.090
0.55	1.083
0.56	1.077
0.57	1.070
0.58	1.064
0.59	1.058
0.60	1.052
0.61	1.046
0.62	1.040
0.63	1.035
0.64	1.030
0.65	1.025
0.66	1.020
0.67	1.015
0.68	1.010
0.69	1.006
0.70	1.001
0.71	0.9962
0.72	0.9908
0.73	0.9856
0.74	0.9806
0.75	0.9756
0.76	0.9672
0.77	0.9591
0.78	0.9512
0.79	0.9436
0.80	0.9362
0.81	0.9289
0.82	0.9218
0.83	0.9150
0.84	0.9083

Table E-1: Probabilistic MCE Spectral Response Acceleration

Period T (sec)	Spectral Response Acceleration $S_{aM\ P}$ (g)
0.85	0.9018
0.86	0.8951
0.87	0.8884
0.88	0.8820
0.89	0.8757
0.90	0.8695
0.91	0.8635
0.92	0.8577
0.93	0.8520
0.94	0.8464
0.95	0.8410
0.96	0.8356
0.97	0.8302
0.98	0.8251
0.99	0.8200
1.0	0.8150
1.1	0.7642
1.2	0.7210
1.3	0.6830
1.4	0.6485
1.5	0.6181
1.6	0.5841
1.7	0.5529
1.8	0.5258
1.9	0.5023
2.0	0.4796
2.1	0.4554
2.2	0.4341
2.3	0.4149
2.4	0.3975
2.5	0.3805
2.6	0.3651
2.7	0.3507
2.8	0.3376
2.9	0.3257
3.0	0.3149
3.1	0.3040
3.2	0.2929
3.3	0.2820
3.4	0.2720
3.5	0.2630
3.6	0.2547

Table E-1: Probabilistic MCE Spectral Response Acceleration

Period T (sec)	Spectral Response Acceleration $S_{aM\ P}$ (g)
3.7	0.2467
3.8	0.2393
3.9	0.2323
4.0	0.2259
4.1	0.2213
4.2	0.2170
4.3	0.2130
4.4	0.2091
4.5	0.2055
4.6	0.2021
4.7	0.1985
4.8	0.1945
4.9	0.1907
5.0	0.1872
5.1	0.1824
5.2	0.1780
5.3	0.1738
5.4	0.1698
5.5	0.1661
5.6	0.1625
5.7	0.1590
5.8	0.1558
5.9	0.1527
6.0	0.1498
6.1	0.1469
6.2	0.1442
6.3	0.1417
6.4	0.1392
6.5	0.1369
6.6	0.1346
6.7	0.1325
6.8	0.1304
6.9	0.1284
7.0	0.1266
7.1	0.1247
7.2	0.1230
7.3	0.1213
7.4	0.1197
7.5	0.1181
7.6	0.1160
7.7	0.1140
7.8	0.1121

Table E-1: Probabilistic MCE Spectral Response Acceleration

Period T (sec)	Spectral Response Acceleration $S_{aM\ P}$ (g)
7.9	0.1103
8.0	0.1086
8.1	0.1070
8.2	0.1054
8.3	0.1038
8.4	0.1024
8.5	0.1010
8.6	0.09958
8.7	0.09805
8.8	0.09659
8.9	0.09519
9.0	0.09385
9.1	0.09256
9.2	0.09132
9.3	0.09013
9.4	0.08894
9.5	0.08779
9.6	0.08668
9.7	0.08561
9.8	0.08458
9.9	0.08359
10.0	0.08263

Table E-2: Deterministic MCE Spectral Response Acceleration

Period T (sec)	150% of the Largest Median 5 Percent Damped Deterministic Spectral Response Accerelation 150% $S_{a\ DSHA}$ (g)	Deterministic Lower Limit on MCE Response Spectrum $S_{aM\ LL}$ (g)	Deterministic MCE Spectral Response Acceleration $S_{aM\ D}$ (g)
0.01	0.6585	1.500	1.500
0.02	0.6680	1.500	1.500
0.03	0.6960	1.500	1.500
0.04	0.7244	1.500	1.500
0.05	0.7520	1.500	1.500
0.06	0.7892	1.500	1.500
0.07	0.8265	1.500	1.500
0.08	0.8703	1.500	1.500
0.09	0.9201	1.500	1.500
0.10	0.9687	1.500	1.500
0.11	1.014	1.500	1.500
0.12	1.057	1.500	1.500
0.13	1.098	1.500	1.500
0.14	1.136	1.500	1.500
0.15	1.173	1.500	1.500
0.16	1.200	1.500	1.500
0.17	1.226	1.500	1.500
0.18	1.250	1.500	1.500
0.19	1.273	1.500	1.500
0.20	1.295	1.500	1.500
0.21	1.311	1.500	1.500
0.22	1.326	1.500	1.500
0.23	1.340	1.500	1.500
0.24	1.354	1.500	1.500
0.25	1.367	1.500	1.500
0.26	1.372	1.500	1.500
0.27	1.377	1.500	1.500
0.28	1.382	1.500	1.500
0.29	1.386	1.500	1.500
0.30	1.389	1.500	1.500
0.31	1.391	1.500	1.500
0.32	1.393	1.500	1.500
0.33	1.394	1.500	1.500
0.34	1.395	1.500	1.500
0.35	1.396	1.500	1.500
0.36	1.396	1.500	1.500
0.37	1.396	1.500	1.500
0.38	1.396	1.500	1.500
0.39	1.396	1.500	1.500
0.40	1.396	1.500	1.500
0.41	1.392	1.500	1.500
0.42	1.388	1.500	1.500
0.43	1.384	1.500	1.500
0.44	1.380	1.500	1.500
0.45	1.376	1.500	1.500
0.46	1.372	1.500	1.500
0.47	1.368	1.500	1.500
0.48	1.364	1.500	1.500
0.49	1.360	1.500	1.500
0.50	1.357	1.500	1.500
0.51	1.347	1.500	1.500
0.52	1.338	1.500	1.500
0.53	1.329	1.500	1.500
0.54	1.321	1.500	1.500
0.55	1.312	1.500	1.500
0.56	1.304	1.500	1.500
0.57	1.297	1.500	1.500
0.58	1.289	1.500	1.500
0.59	1.282	1.500	1.500
0.60	1.275	1.500	1.500
0.61	1.268	1.475	1.475
0.62	1.261	1.452	1.452
0.63	1.254	1.429	1.429
0.64	1.247	1.406	1.406
0.65	1.247	1.385	1.385
0.66	1.241	1.364	1.364
0.67	1.234	1.343	1.343
0.68	1.228	1.324	1.324
0.69	1.222	1.304	1.304
0.70	1.216	1.286	1.286
0.71	1.210	1.268	1.268
0.72	1.204	1.250	1.250
0.73	1.198	1.233	1.233
0.74	1.193	1.216	1.216
0.75	1.187	1.200	1.200
0.76	1.182	1.184	1.184
0.77	1.172	1.169	1.169
0.78	1.163	1.154	1.154
0.78	1.154	1.154	1.154
0.79	1.145	1.139	1.145
0.80	1.136	1.125	1.136
0.81	1.127	1.111	1.127
0.82	1.119	1.098	1.119
0.83	1.111	1.084	1.111
0.84	1.103	1.071	1.103
0.85	1.095	1.059	1.095
0.86	1.087	1.047	1.087
0.87	1.079	1.034	1.079
0.88	1.071	1.023	1.071
0.89	1.063	1.011	1.063
0.90	1.056	1.000	1.056
0.91	1.049	0.9890	1.049
0.92	1.041	0.9783	1.041
0.93	1.034	0.9677	1.034
0.94	1.027	0.9574	1.027
0.95	1.020	0.9474	1.020
0.96	1.013	0.9375	1.013

Table E-2: Deterministic MCE Spectral Response Acceleration

Period T (sec)	150% of the Largest Median 5 Percent Damped Deterministic Spectral Response Accerelation 150% $S_{a\ DSHA}$ (g)	Deterministic Lower Limit on MCE Response Spectrum $S_{aM\ LL}$ (g)	Deterministic MCE Spectral Response Acceleration $S_{aM\ D}$ (g)
0.97	1.006	0.9278	1.006
0.98	0.9996	0.9184	0.9996
0.99	0.9930	0.9091	0.9930
1.0	0.9864	0.9000	0.9864
1.1	0.9146	0.8182	0.9146
1.2	0.8511	0.7500	0.8511
1.3	0.7941	0.6923	0.7941
1.4	0.7425	0.6429	0.7425
1.5	0.6953	0.6000	0.6953
1.6	0.6488	0.5625	0.6488
1.7	0.6107	0.5294	0.6107
1.8	0.5783	0.5000	0.5783
1.9	0.5490	0.4737	0.5490
2.0	0.5222	0.4500	0.5222
2.1	0.4946	0.4286	0.4946
2.2	0.4697	0.4091	0.4697
2.3	0.4461	0.3913	0.4461
2.4	0.4248	0.3750	0.4248
2.5	0.4050	0.3600	0.4050
2.6	0.3866	0.3462	0.3866
2.7	0.3695	0.3333	0.3695
2.8	0.3536	0.3214	0.3536
2.9	0.3389	0.3103	0.3389
3.0	0.3252	0.3000	0.3252
3.1	0.3122	0.2903	0.3122
3.2	0.3000	0.2813	0.3000
3.3	0.2886	0.2727	0.2886
3.4	0.2780	0.2647	0.2780
3.5	0.2679	0.2571	0.2679
3.6	0.2586	0.2500	0.2586
3.7	0.2496	0.2432	0.2496
3.8	0.2414	0.2368	0.2414
3.9	0.2334	0.2308	0.2334
4.0	0.2259	0.2250	0.2259
4.1	0.2189	0.2195	0.2195
4.1	0.2189	0.2195	0.2195
4.2	0.2120	0.2143	0.2143
4.3	0.2055	0.2093	0.2093
4.4	0.1992	0.2045	0.2045
4.5	0.1934	0.2000	0.2000
4.6	0.1878	0.1957	0.1957
4.7	0.1824	0.1915	0.1915
4.8	0.1773	0.1875	0.1875
4.9	0.1725	0.1837	0.1837
5.0	0.1679	0.1800	0.1800
5.1	0.1623	0.1765	0.1765
5.2	0.1571	0.1731	0.1731
5.3	0.1521	0.1698	0.1698
5.4	0.1474	0.1667	0.1667
5.5	0.1430	0.1636	0.1636
5.6	0.1386	0.1607	0.1607
5.7	0.1344	0.1579	0.1579
5.8	0.1304	0.1552	0.1552
5.9	0.1267	0.1525	0.1525
6.0	0.1230	0.1500	0.1500
6.1	0.1195	0.1475	0.1475
6.2	0.1163	0.1452	0.1452
6.3	0.1141	0.1429	0.1429
6.4	0.1119	0.1406	0.1406
6.5	0.1099	0.1385	0.1385
6.6	0.1078	0.1364	0.1364
6.7	0.1059	0.1343	0.1343
6.8	0.1040	0.1324	0.1324
6.9	0.1022	0.1304	0.1304
7.0	0.1004	0.1286	0.1286
7.1	0.09866	0.1268	0.1268
7.2	0.09699	0.1250	0.1250
7.3	0.09537	0.1233	0.1233
7.4	0.09381	0.1216	0.1216
7.5	0.09230	0.1200	0.1200
7.6	0.09020	0.1184	0.1184
7.7	0.08819	0.1169	0.1169
7.8	0.08625	0.1154	0.1154
7.9	0.08438	0.1139	0.1139
8.0	0.08259	0.1125	0.1125
8.1	0.08085	0.1111	0.1111
8.2	0.07919	0.1098	0.1098
8.3	0.07757	0.1084	0.1084
8.4	0.07602	0.1071	0.1071
8.5	0.07452	0.1059	0.1059
8.6	0.07307	0.1047	0.1047
8.7	0.07166	0.1034	0.1034
8.8	0.07031	0.1023	0.1023
8.9	0.06900	0.1011	0.1011
9.0	0.06774	0.1000	0.1000
9.1	0.06651	0.09890	0.09890
9.2	0.06531	0.09783	0.09783
9.3	0.06416	0.09677	0.09677
9.4	0.06305	0.09574	0.09574
9.5	0.06197	0.09474	0.09474
9.6	0.06090	0.09375	0.09375
9.7	0.05988	0.09278	0.09278
9.8	0.05888	0.09184	0.09184
9.9	0.05792	0.09091	0.09091
10.0	0.05697	0.09000	0.09000

Table E-3: Site-Specific MCE Spectral Response Acceleration

Period T (sec)	Probabilistic MCE Spectral Response Acceleration $S_{aM\,P}$ (g)	Deterministic MCE Spectral Response Acceleration $S_{aM\,D}$ (g)	Site-Specific MCE Spectral Response Acceleration S_{aM} (g)
0.01	0.5777	1.500	0.5777
0.02	0.5865	1.500	0.5865
0.03	0.6196	1.500	0.6196
0.04	0.6585	1.500	0.6585
0.05	0.6977	1.500	0.6977
0.06	0.7560	1.500	0.7560
0.07	0.8151	1.500	0.8151
0.08	0.8738	1.500	0.8738
0.09	0.9326	1.500	0.9326
0.10	0.9899	1.500	0.9899
0.11	1.029	1.500	1.029
0.12	1.065	1.500	1.065
0.13	1.098	1.500	1.098
0.14	1.130	1.500	1.130
0.15	1.160	1.500	1.160
0.16	1.173	1.500	1.173
0.17	1.185	1.500	1.185
0.18	1.197	1.500	1.197
0.19	1.209	1.500	1.209
0.20	1.221	1.500	1.221
0.21	1.223	1.500	1.223
0.22	1.226	1.500	1.226
0.23	1.229	1.500	1.229
0.24	1.231	1.500	1.231
0.25	1.232	1.500	1.232
0.26	1.234	1.500	1.234
0.27	1.237	1.500	1.237
0.28	1.239	1.500	1.239
0.29	1.240	1.500	1.240
0.30	1.242	1.500	1.242
0.31	1.234	1.500	1.234
0.32	1.227	1.500	1.227
0.33	1.220	1.500	1.220
0.34	1.213	1.500	1.213
0.35	1.205	1.500	1.205
0.36	1.199	1.500	1.199
0.37	1.192	1.500	1.192
0.38	1.185	1.500	1.185
0.39	1.179	1.500	1.179
0.40	1.172	1.500	1.172
0.41	1.167	1.500	1.167
0.42	1.161	1.500	1.161
0.43	1.155	1.500	1.155
0.44	1.150	1.500	1.150
0.45	1.145	1.500	1.145
0.46	1.140	1.500	1.140
0.47	1.135	1.500	1.135
0.48	1.131	1.500	1.131
0.49	1.126	1.500	1.126
0.50	1.122	1.500	1.122
0.51	1.113	1.500	1.113
0.52	1.105	1.500	1.105
0.53	1.098	1.500	1.098
0.54	1.090	1.500	1.090
0.55	1.083	1.500	1.083
0.55	1.083	1.500	1.083
0.56	1.077	1.500	1.077
0.57	1.070	1.500	1.070
0.58	1.064	1.500	1.064
0.59	1.058	1.500	1.058
0.60	1.052	1.500	1.052
0.61	1.046	1.475	1.046
0.62	1.040	1.452	1.040
0.63	1.035	1.429	1.035
0.64	1.030	1.406	1.030
0.65	1.030	1.385	1.030
0.66	1.025	1.364	1.025
0.67	1.020	1.343	1.020
0.68	1.015	1.324	1.015
0.69	1.010	1.304	1.010
0.70	1.006	1.286	1.006
0.71	1.001	1.268	1.001
0.72	0.9962	1.250	0.9962

Table E-3: Site-Specific MCE Spectral Response Acceleration

Period T (sec)	Probabilistic MCE Spectral Response Acceleration $S_{aM\ P}$ (g)	Deterministic MCE Spectral Response Acceleration $S_{aM\ D}$ (g)	Site-Specific MCE Spectral Response Acceleration S_{aM} (g)
0.73	0.9908	1.233	0.9908
0.74	0.9856	1.216	0.9856
0.75	0.9806	1.200	0.9806
0.76	0.9756	1.184	0.9756
0.77	0.9672	1.169	0.9672
0.78	0.9591	1.154	0.9591
0.78	0.9512	1.154	0.9512
0.79	0.9436	1.145	0.9436
0.80	0.9362	1.136	0.9362
0.81	0.9289	1.127	0.9289
0.82	0.9218	1.119	0.9218
0.83	0.9150	1.111	0.9150
0.84	0.9083	1.103	0.9083
0.85	0.9018	1.095	0.9018
0.86	0.8951	1.087	0.8951
0.87	0.8884	1.079	0.8884
0.88	0.8820	1.071	0.8820
0.89	0.8757	1.063	0.8757
0.90	0.8695	1.056	0.8695
0.91	0.8635	1.049	0.8635
0.92	0.8577	1.041	0.8577
0.93	0.8520	1.034	0.8520
0.94	0.8464	1.027	0.8464
0.95	0.8410	1.020	0.8410
0.96	0.8356	1.013	0.8356
0.97	0.8302	1.006	0.8302
0.98	0.8251	0.9996	0.8251
0.99	0.8200	0.9930	0.8200
1.0	0.8150	0.9864	0.8150
1.1	0.7642	0.9146	0.7642
1.2	0.7210	0.8511	0.7210
1.3	0.6830	0.7941	0.6830
1.4	0.6485	0.7425	0.6485
1.5	0.6181	0.6953	0.6181
1.6	0.5841	0.6488	0.5841
1.7	0.5529	0.6107	0.5529
1.8	0.5258	0.5783	0.5258
1.9	0.5023	0.5490	0.5023
2.0	0.4796	0.5222	0.4796
2.1	0.4554	0.4946	0.4554
2.2	0.4341	0.4697	0.4341
2.3	0.4149	0.4461	0.4149
2.4	0.3975	0.4248	0.3975
2.5	0.3805	0.4050	0.3805
2.6	0.3651	0.3866	0.3651
2.7	0.3507	0.3695	0.3507
2.8	0.3376	0.3536	0.3376
2.9	0.3257	0.3389	0.3257
3.0	0.3149	0.3252	0.3149
3.1	0.3040	0.3122	0.3040
3.2	0.2929	0.3000	0.2929
3.3	0.2820	0.2886	0.2820
3.4	0.2720	0.2780	0.2720
3.5	0.2630	0.2679	0.2630
3.6	0.2547	0.2586	0.2547
3.7	0.2467	0.2496	0.2467
3.8	0.2393	0.2414	0.2393
3.9	0.2323	0.2334	0.2323
4.0	0.2259	0.2259	0.2259
4.1	0.2213	0.2195	0.2195
4.2	0.2170	0.2143	0.2143
4.3	0.2130	0.2093	0.2093
4.4	0.2091	0.2045	0.2045
4.5	0.2055	0.2000	0.2000
4.6	0.2021	0.1957	0.1957
4.7	0.1985	0.1915	0.1915
4.8	0.1945	0.1875	0.1875
4.9	0.1907	0.1837	0.1837
5.0	0.1872	0.1800	0.1800
5.1	0.1824	0.1765	0.1765
5.2	0.1780	0.1731	0.1731
5.3	0.1738	0.1698	0.1698
5.4	0.1698	0.1667	0.1667

Table E-3: Site-Specific MCE Spectral Response Acceleration

Period T (sec)	Probabilistic MCE Spectral Response Acceleration $S_{aM\,P}$ (g)	Deterministic MCE Spectral Response Acceleration $S_{aM\,D}$ (g)	Site-Specific MCE Spectral Response Acceleration S_{aM} (g)
5.5	0.1661	0.1636	0.1636
5.6	0.1625	0.1607	0.1607
5.7	0.1590	0.1579	0.1579
5.8	0.1558	0.1552	0.1552
5.9	0.1527	0.1525	0.1525
6.0	0.1498	0.1500	0.1498
6.1	0.1469	0.1475	0.1469
6.2	0.1442	0.1452	0.1442
6.3	0.1417	0.1429	0.1417
6.4	0.1392	0.1406	0.1392
6.5	0.1369	0.1385	0.1369
6.6	0.1346	0.1364	0.1346
6.7	0.1325	0.1343	0.1325
6.8	0.1304	0.1324	0.1304
6.9	0.1284	0.1304	0.1284
7.0	0.1266	0.1286	0.1266
7.1	0.1247	0.1268	0.1247
7.2	0.1230	0.1250	0.1230
7.3	0.1213	0.1233	0.1213
7.4	0.1197	0.1216	0.1197
7.5	0.1181	0.1200	0.1181
7.6	0.1160	0.1184	0.1160
7.7	0.1140	0.1169	0.1140
7.8	0.1121	0.1154	0.1121
7.9	0.1103	0.1139	0.1103
8.0	0.1086	0.1125	0.1086
8.1	0.1070	0.1111	0.1070
8.2	0.1054	0.1098	0.1054
8.3	0.1038	0.1084	0.1038
8.4	0.1024	0.1071	0.1024
8.5	0.1010	0.1059	0.1010
8.6	0.09958	0.1047	0.09958
8.7	0.09805	0.1034	0.09805
8.8	0.09659	0.1023	0.09659
8.9	0.09519	0.1011	0.09519
9.0	0.09385	0.1000	0.09385
9.1	0.09256	0.09890	0.09256
9.2	0.09132	0.09783	0.09132
9.3	0.09013	0.09677	0.09013
9.4	0.08894	0.09574	0.08894
9.5	0.08779	0.09474	0.08779
9.6	0.08668	0.09375	0.08668
9.7	0.08561	0.09278	0.08561
9.8	0.08458	0.09184	0.08458
9.9	0.08359	0.09091	0.08359
10.0	0.08263	0.09000	0.08263

Table E-4: Site-Specific Design Spectral Response Acceleration

Period T (sec)	⅔ Site-Specific MCE Spectral Response Acceleration ⅔ S_{aM} (g)	80% Map-Based Design Response Spectrum $S_{a\ MBDRS}$ (g)	Site-Specific Design Spectral Response Acceleration Sa (g)
0.01	0.39	0.2851	0.3851
0.02	0.39	0.3058	0.3910
0.03	0.41	0.3264	0.4131
0.04	0.44	0.3471	0.4390
0.04	0.4400	0.3471	0.4390
0.05	0.4651	0.3678	0.4651
0.06	0.5040	0.3885	0.5040
0.07	0.5434	0.4092	0.5434
0.08	0.5825	0.4299	0.5825
0.09	0.6217	0.4505	0.6217
0.10	0.6599	0.4712	0.6599
0.11	0.6860	0.4919	0.6860
0.12	0.7100	0.5126	0.7100
0.13	0.7320	0.5333	0.7320
0.14	0.7533	0.5540	0.7533
0.15	0.7733	0.5747	0.7733
0.16	0.7820	0.5953	0.7820
0.17	0.7900	0.6160	0.7900
0.18	0.7980	0.6367	0.7980
0.19	0.8060	0.6574	0.8060
0.20	0.8140	0.6610	0.8140
0.21	0.8153	0.6610	0.8153
0.22	0.8173	0.6610	0.8173
0.23	0.8193	0.6610	0.8193
0.24	0.8207	0.6610	0.8207
0.25	0.8213	0.6610	0.8213
0.26	0.8227	0.6610	0.8227
0.27	0.8247	0.6610	0.8247
0.28	0.8260	0.6610	0.8260
0.29	0.8267	0.6610	0.8267
0.30	0.8280	0.6610	0.8280
0.31	0.8227	0.6610	0.8227
0.32	0.8180	0.6610	0.8180
0.33	0.8133	0.6610	0.8133
0.34	0.8087	0.6610	0.8087
0.35	0.8033	0.6610	0.8033
0.36	0.7993	0.6610	0.7993
0.37	0.7947	0.6610	0.7947
0.38	0.7900	0.6610	0.7900
0.39	0.7860	0.6610	0.7860
0.40	0.7813	0.6610	0.7813
0.41	0.7780	0.6610	0.7780
0.42	0.7740	0.6610	0.7740
0.43	0.7700	0.6610	0.7700
0.44	0.7667	0.6610	0.7667
0.45	0.7633	0.6610	0.7633
0.46	0.7600	0.6610	0.7600
0.47	0.7567	0.6610	0.7567
0.48	0.7540	0.6610	0.7540
0.49	0.7507	0.6610	0.7507
0.50	0.7480	0.6610	0.7480
0.51	0.7420	0.6610	0.7420
0.52	0.7367	0.6610	0.7367
0.53	0.7320	0.6610	0.7320
0.54	0.7267	0.6610	0.7267
0.54	0.7267	0.6610	0.7266
0.55	0.7220	0.6610	0.7220
0.56	0.7180	0.6610	0.7180
0.57	0.7133	0.6610	0.7133
0.58	0.7093	0.6610	0.7093
0.58	0.7093	0.6610	0.7093
0.59	0.7053	0.6610	0.7053
0.60	0.7013	0.6610	0.7013
0.61	0.6973	0.6610	0.6973
0.62	0.6933	0.6610	0.6933
0.63	0.6900	0.6610	0.6900
0.64	0.6867	0.6610	0.6867
0.65	0.6833	0.6610	0.6833
0.66	0.6800	0.6610	0.6800
0.67	0.6767	0.6610	0.6767
0.68	0.6733	0.6610	0.6733
0.69	0.6707	0.6610	0.6707

Table E-4: Site-Specific Design Spectral Response Acceleration

Period T (sec)	⅔ Site-Specific MCE Spectral Response Acceleration ⅔ S_{aM} (g)	80% Map-Based Design Response Spectrum $S_{a\ MBDRS}$ (g)	Site-Specific Design Spectral Response Acceleration Sa (g)
0.70	0.6673	0.6610	0.6673
0.71	0.6641	0.6610	0.6641
0.72	0.6605	0.6610	0.6605
0.73	0.6571	0.6610	0.6610
0.74	0.6537	0.6610	0.6610
0.75	0.6504	0.6610	0.6610
0.76	0.6448	0.6610	0.6610
0.77	0.6394	0.6610	0.6610
0.78	0.6341	0.6610	0.6610
0.79	0.6291	0.6610	0.6610
0.80	0.6241	0.6610	0.6610
0.81	0.6193	0.6610	0.6610
0.82	0.6145	0.6610	0.6610
0.83	0.6100	0.6610	0.6610
0.84	0.6055	0.6610	0.6610
0.85	0.6012	0.6610	0.6610
0.86	0.5967	0.6610	0.6610
0.87	0.5923	0.6610	0.6610
0.88	0.5880	0.6610	0.6610
0.89	0.5838	0.6610	0.6610
0.90	0.5797	0.6610	0.6610
0.91	0.5757	0.6610	0.6610
0.92	0.5718	0.6610	0.6610
0.93	0.5680	0.6610	0.6610
0.94	0.5643	0.6610	0.6610
0.95	0.5607	0.6610	0.6610
0.96	0.5571	0.6600	0.6610
0.97	0.5535	0.6532	0.6600
0.98	0.5501	0.6465	0.6532
0.99	0.5467	0.6400	0.6465
1.0	0.5433	0.6336	0.6400
1.1	0.5095	0.5760	0.5760
1.2	0.4807	0.5280	0.5280
1.3	0.4553	0.4874	0.4874
1.4	0.4323	0.4526	0.4526
1.5	0.4121	0.4224	0.4224
1.6	0.3894	0.3960	0.3960
1.7	0.3686	0.3727	0.3727
1.8	0.3505	0.3520	0.3520
1.9	0.3349	0.3335	0.3349
2.0	0.3197	0.3168	0.3197
2.1	0.3036	0.3017	0.3036
2.2	0.2894	0.2880	0.2894
2.3	0.2766	0.2755	0.2766
2.4	0.2650	0.2640	0.2650
2.5	0.2537	0.2534	0.2537
2.6	0.2434	0.2437	0.2437
2.7	0.2338	0.2347	0.2338
2.8	0.2251	0.2263	0.2263
2.9	0.2171	0.2185	0.2185
3.0	0.2099	0.2112	0.2112
3.1	0.2027	0.2044	0.2044
3.2	0.1953	0.1980	0.1980
3.3	0.1880	0.1920	0.1920
3.4	0.1813	0.1864	0.1864
3.5	0.1753	0.1810	0.1810
3.6	0.1698	0.1760	0.1760
3.7	0.1645	0.1712	0.1712
3.8	0.1595	0.1667	0.1667
3.9	0.1549	0.1625	0.1625
4.0	0.1506	0.1584	0.1584
4.1	0.1475	0.1545	0.1545
4.2	0.1447	0.1509	0.1509
4.3	0.1420	0.1473	0.1473
4.4	0.1394	0.1440	0.1440
4.5	0.1370	0.1408	0.1408
4.6	0.1347	0.1377	0.1377
4.7	0.1323	0.1348	0.1348
4.8	0.1297	0.1320	0.1320
4.9	0.1271	0.1293	0.1293
5.0	0.1248	0.1267	0.1267
5.1	0.1216	0.1242	0.1242

Table E-4: Site-Specific Design Spectral Response Acceleration

Period T (sec)	⅔ Site-Specific MCE Spectral Response Acceleration ⅔ S_{aM} (g)	80% Map-Based Design Response Spectrum $S_{a\ MBDRS}$ (g)	Site-Specific Design Spectral Response Acceleration Sa (g)
5.2	0.1187	0.1218	0.1218
5.3	0.1159	0.1195	0.1195
5.4	0.1132	0.1173	0.1173
5.5	0.1107	0.1152	0.1152
5.6	0.1083	0.1131	0.1131
5.7	0.1060	0.1112	0.1112
5.8	0.1039	0.1092	0.1092
5.9	0.1018	0.1074	0.1074
6.0	0.09987	0.1056	0.1056
6.1	0.09793	0.1039	0.1039
6.2	0.09613	0.1022	0.1022
6.3	0.09447	0.1006	0.1006
6.4	0.09280	0.0990	0.09900
6.5	0.09127	0.0975	0.09748
6.6	0.08973	0.0960	0.09600
6.7	0.08833	0.0946	0.09457
6.8	0.08693	0.0932	0.09318
6.9	0.08560	0.0918	0.09183
7.0	0.08440	0.0905	0.09051
7.1	0.08313	0.0892	0.08924
7.2	0.08200	0.0880	0.08800
7.3	0.08087	0.0868	0.08679
7.4	0.07980	0.0856	0.08562
7.5	0.07873	0.0845	0.08448
7.6	0.07733	0.0834	0.08337
7.7	0.07600	0.0823	0.08229
7.8	0.07473	0.0812	0.08123
7.9	0.07353	0.0802	0.08020
8.0	0.07240	0.0792	0.07920
8.1	0.07133	0.0773	0.07726
8.2	0.07027	0.0754	0.07538
8.3	0.06920	0.0736	0.07358
8.4	0.06827	0.0718	0.07184
8.5	0.06733	0.0702	0.07016
8.6	0.06639	0.0685	0.06853
8.7	0.06537	0.0670	0.06697
8.8	0.06439	0.0655	0.06545
8.9	0.06346	0.0640	0.06399
9.0	0.06257	0.0626	0.06258
9.1	0.06171	0.0612	0.06171
9.2	0.06088	0.0599	0.06088
9.3	0.06009	0.0586	0.06009
9.4	0.05929	0.0574	0.05929
9.5	0.05853	0.0562	0.05853
9.6	0.05779	0.0550	0.05779
9.7	0.05707	0.0539	0.05707
9.8	0.05639	0.0528	0.05639
9.9	0.05573	0.0517	0.05573
10.0	0.05509	0.0507	0.05509

Table E-5: Site-Specific Design and Site-Specific MCE Response Spectra

Period T (sec)	Site-Specific Design Spectral Response Acceleration Sa (g)	Site-Specific MCE Spectral Response Acceleration SaM (g)
0.01	0.3851	0.5777
0.02	0.3910	0.5865
0.03	0.4131	0.6196
0.04	0.4390	0.6585
0.04	0.4390	0.6585
0.05	0.4651	0.6977
0.06	0.5040	0.7560
0.07	0.5434	0.8151
0.08	0.5825	0.8738
0.09	0.6217	0.9326
0.10	0.6599	0.9899
0.11	0.6860	1.029
0.12	0.7100	1.065
0.13	0.7320	1.098
0.14	0.7533	1.130
0.15	0.7733	1.160
0.16	0.7820	1.173
0.17	0.7900	1.185
0.18	0.7980	1.197
0.19	0.8060	1.209
0.20	0.8140	1.221
0.21	0.8153	1.223
0.22	0.8173	1.226
0.23	0.8193	1.229
0.24	0.8207	1.231
0.25	0.8213	1.232
0.26	0.8227	1.234
0.27	0.8247	1.237
0.28	0.8260	1.239
0.29	0.8267	1.240
0.30	0.8280	1.242
0.31	0.8227	1.234
0.32	0.8180	1.227
0.33	0.8133	1.220
0.34	0.8087	1.213
0.35	0.8033	1.205
0.36	0.7993	1.199
0.37	0.7947	1.192
0.38	0.7900	1.185
0.39	0.7860	1.179
0.40	0.7813	1.172
0.41	0.7780	1.167
0.42	0.7740	1.161
0.43	0.7700	1.155
0.44	0.7667	1.150
0.45	0.7633	1.145
0.46	0.7600	1.140
0.47	0.7567	1.135
0.48	0.7540	1.131

Table E-5: Site-Specific Design and Site-Specific MCE Response Spectra

Period T (sec)	Site-Specific Design Spectral Response Acceleration Sa (g)	Site-Specific MCE Spectral Response Acceleration SaM (g)
0.49	0.7507	1.126
0.50	0.7480	1.122
0.51	0.7420	1.113
0.52	0.7367	1.105
0.53	0.7320	1.098
0.54	0.7267	1.090
0.54	0.7266	1.090
0.55	0.7220	1.083
0.56	0.7180	1.077
0.57	0.7133	1.070
0.58	0.7093	1.064
0.58	0.7093	1.064
0.59	0.7053	1.058
0.60	0.7013	1.052
0.61	0.6973	1.046
0.62	0.6933	1.040
0.63	0.6900	1.035
0.64	0.6867	1.030
0.65	0.6833	1.025
0.66	0.6800	1.020
0.67	0.6767	1.015
0.68	0.6733	1.010
0.69	0.6707	1.006
0.70	0.6673	1.001
0.71	0.6641	0.9962
0.72	0.6605	0.9908
0.73	0.6610	0.9914
0.74	0.6610	0.9914
0.75	0.6610	0.9914
0.76	0.6610	0.9914
0.77	0.6610	0.9914
0.78	0.6610	0.9914
0.79	0.6610	0.9914
0.80	0.6610	0.9914
0.81	0.6610	0.9914
0.82	0.6610	0.9914
0.83	0.6610	0.9914
0.84	0.6610	0.9914
0.85	0.6610	0.9914
0.86	0.6610	0.9914
0.87	0.6610	0.9914
0.88	0.6610	0.9914
0.89	0.6610	0.9914
0.90	0.6610	0.9914
0.91	0.6610	0.9914
0.92	0.6610	0.9914
0.93	0.6610	0.9914
0.94	0.6610	0.9914
0.95	0.6610	0.9914

Table E-5: Site-Specific Design and Site-Specific MCE Response Spectra

Period T (sec)	Site-Specific Design Spectral Response Acceleration Sa (g)	Site-Specific MCE Spectral Response Acceleration SaM (g)
0.96	0.6610	0.9914
0.97	0.6600	0.9900
0.98	0.6532	0.9798
0.99	0.6465	0.9698
1.0	0.6400	0.9600
1.1	0.5760	0.8640
1.2	0.5280	0.7920
1.3	0.4874	0.7311
1.4	0.4526	0.6789
1.5	0.4224	0.6336
1.6	0.3960	0.5940
1.7	0.3727	0.5591
1.8	0.3520	0.5280
1.9	0.3349	0.5023
2.0	0.3197	0.4796
2.1	0.3036	0.4554
2.2	0.2894	0.4341
2.3	0.2766	0.4149
2.4	0.2650	0.3975
2.5	0.2537	0.3805
2.6	0.2437	0.3655
2.7	0.2338	0.3507
2.8	0.2263	0.3394
2.9	0.2185	0.3277
3.0	0.2112	0.3168
3.1	0.2044	0.3066
3.2	0.1980	0.2970
3.3	0.1920	0.2880
3.4	0.1864	0.2795
3.5	0.1810	0.2715
3.6	0.1760	0.2640
3.7	0.1712	0.2569
3.8	0.1667	0.2501
3.9	0.1625	0.2437
4.0	0.1584	0.2376
4.1	0.1545	0.2318
4.2	0.1509	0.2263
4.3	0.1473	0.2210
4.4	0.1440	0.2160
4.5	0.1408	0.2112
4.6	0.1377	0.2066
4.7	0.1348	0.2022
4.8	0.1320	0.1980
4.9	0.1293	0.1940
5.0	0.1267	0.1901
5.1	0.1242	0.1864
5.2	0.1218	0.1828
5.3	0.1195	0.1793
5.4	0.1173	0.1760

Table E-5: Site-Specific Design and Site-Specific MCE Response Spectra

Period T (sec)	Site-Specific Design Spectral Response Acceleration Sa (g)	Site-Specific MCE Spectral Response Acceleration SaM (g)
5.5	0.1152	0.1728
5.6	0.1131	0.1697
5.7	0.1112	0.1667
5.8	0.1092	0.1639
5.9	0.1074	0.1611
6.0	0.1056	0.1584
6.1	0.1039	0.1558
6.2	0.1022	0.1533
6.3	0.1006	0.1509
6.4	0.0990	0.1485
6.5	0.0975	0.1462
6.6	0.0960	0.1440
6.7	0.0946	0.1419
6.8	0.0932	0.1398
6.9	0.0918	0.1377
7.0	0.0905	0.1358
7.1	0.0892	0.1339
7.2	0.0880	0.1320
7.3	0.0868	0.1302
7.4	0.0856	0.1284
7.5	0.0845	0.1267
7.6	0.0834	0.1251
7.7	0.0823	0.1234
7.8	0.0812	0.1218
7.9	0.0802	0.1203
8.0	0.0792	0.1188
8.1	0.0773	0.1159
8.2	0.0754	0.1131
8.3	0.0736	0.1104
8.4	0.0718	0.1078
8.5	0.0702	0.1052
8.6	0.0685	0.1028
8.7	0.0670	0.1005
8.8	0.0655	0.0982
8.9	0.0640	0.0960
9.0	0.0626	0.0939
9.1	0.0617	0.0926
9.2	0.0609	0.0913
9.3	0.0601	0.0901
9.4	0.0593	0.0889
9.5	0.0585	0.0878
9.6	0.0578	0.0867
9.7	0.0571	0.0856
9.8	0.0564	0.0846
9.9	0.0557	0.0836
10.0	0.0551	0.0826

APPENDIX F

APPENDIX F

LIQUEFACTION ANALYSIS

Methodology

We used the computer program CLiq Version 1.7.1.14 (Geologismiki, 2006) for our analysis. A site-specific ground motion study for the site was performed as discussed in Appendix E.

Using the design pga_h of 0.39g and a modal earthquake magnitude of 6.9, liquefaction potential and seismically-induced settlement was evaluated for all CPTs at the three planned design finish elevations. For Elevation +112 feet, additional fill was modeled in the analysis to raise the ground surface up from the elevation at the time of exploration to the planned elevation. For lower planned elevations, excavations were modeled.

A groundwater level corresponding to the historic high at 15 to 20 feet below ground surface was used in the analysis.

Results

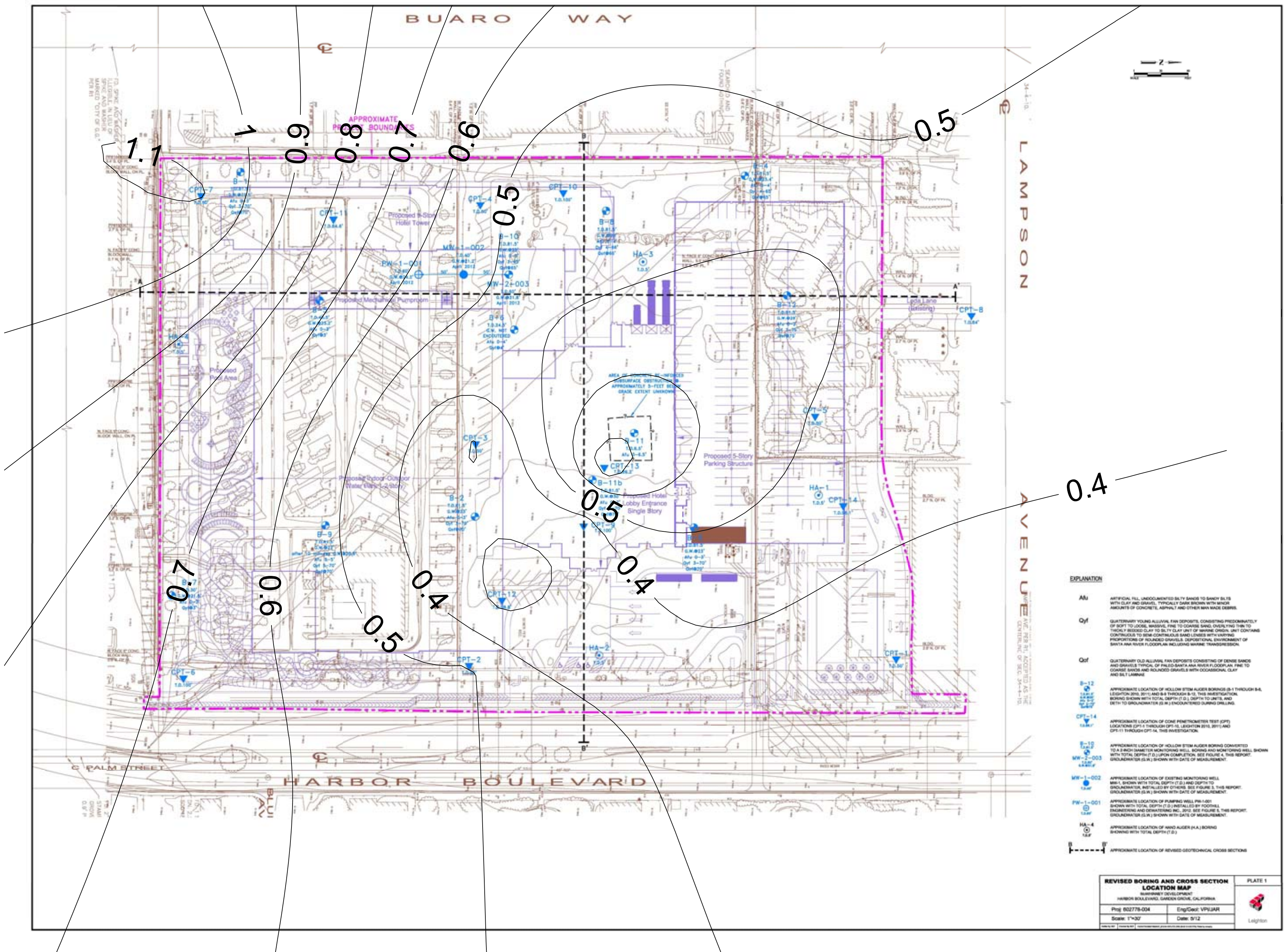
Detailed results are attached to the end of this appendix. Seismically-induced settlement contours based on the results are followed by data sheets for the three planned finish floor elevations.

Conclusions

The results of our analyses suggest that there is a potential for liquefaction at the site. The most susceptible soil layers appear to be between the depths of approximately 22 to 35 feet. Since the liquefiable soils are currently overlain by at least 15 feet of non-liquefiable soils, the potential for surface manifestations, such as sand boils or shallow bearing capacity failures of shallow foundations, is considered low.

Based on the settlement contours and the locations of planned structures at the various finish floor elevations, total seismically-induced settlement of the upper 50 feet is expected to be generally on the order of 1 inch. The planned excavation for the mechanical pump rooms at Elevation +88 feet could produce higher settlements of up to 1½ inches. However, considering that the pump rooms are limited in area and are enclosed by adjacent areas that are 10 feet higher in elevation, the estimate for the mechanical pump rooms is deemed conservative.

Considering the varying thickness of the liquefiable soils, seismically-induced differential settlement may be assumed to be on the order of one-half of the total settlement over a distance of 30 feet.

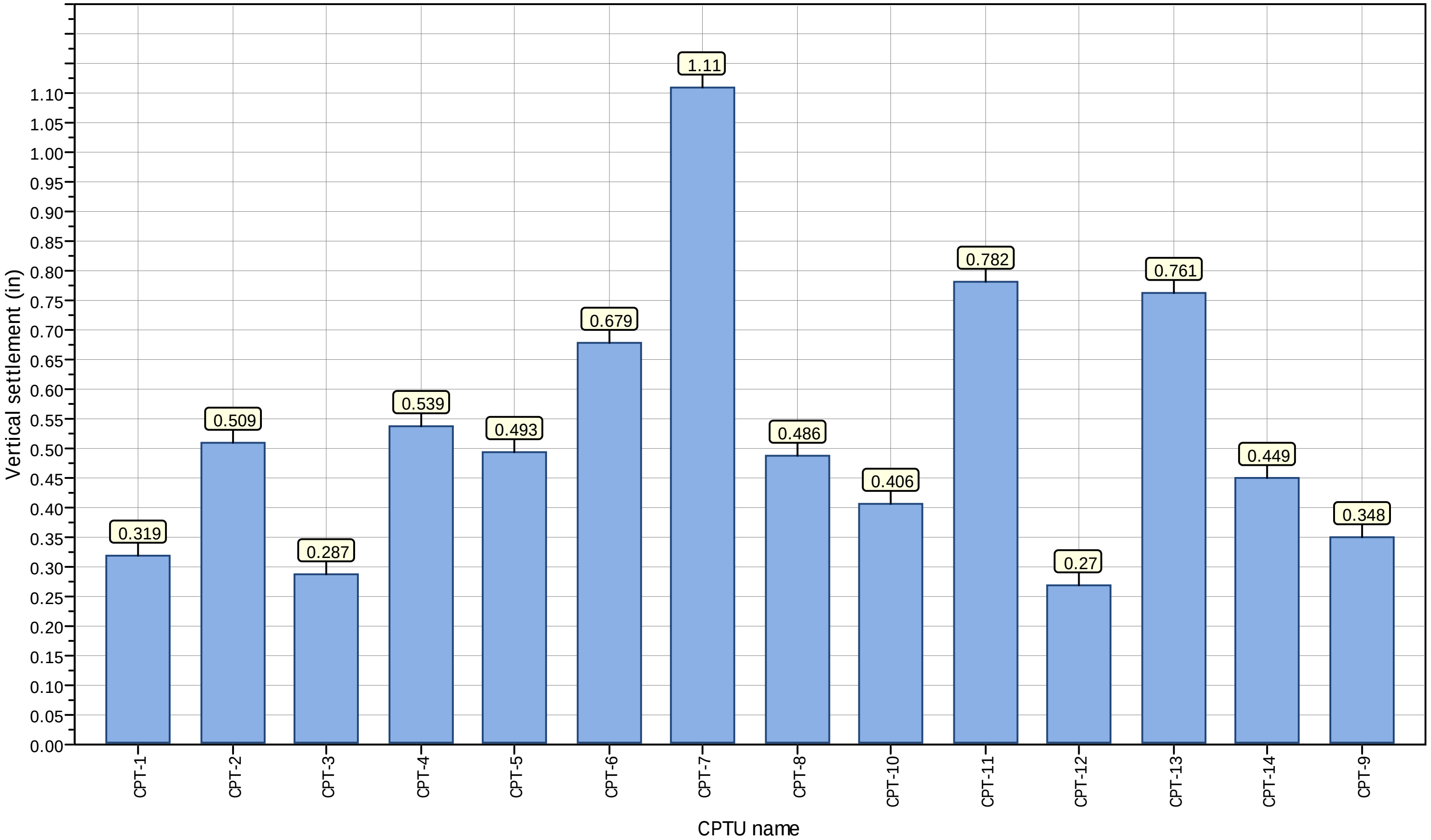


liquefaction-induced settlement
@ El 112

Project title : Great Wolf Lodge Resort

Location : 12661 Harbor Blvd., Garden Grove, CA

Overall vertical settlements report



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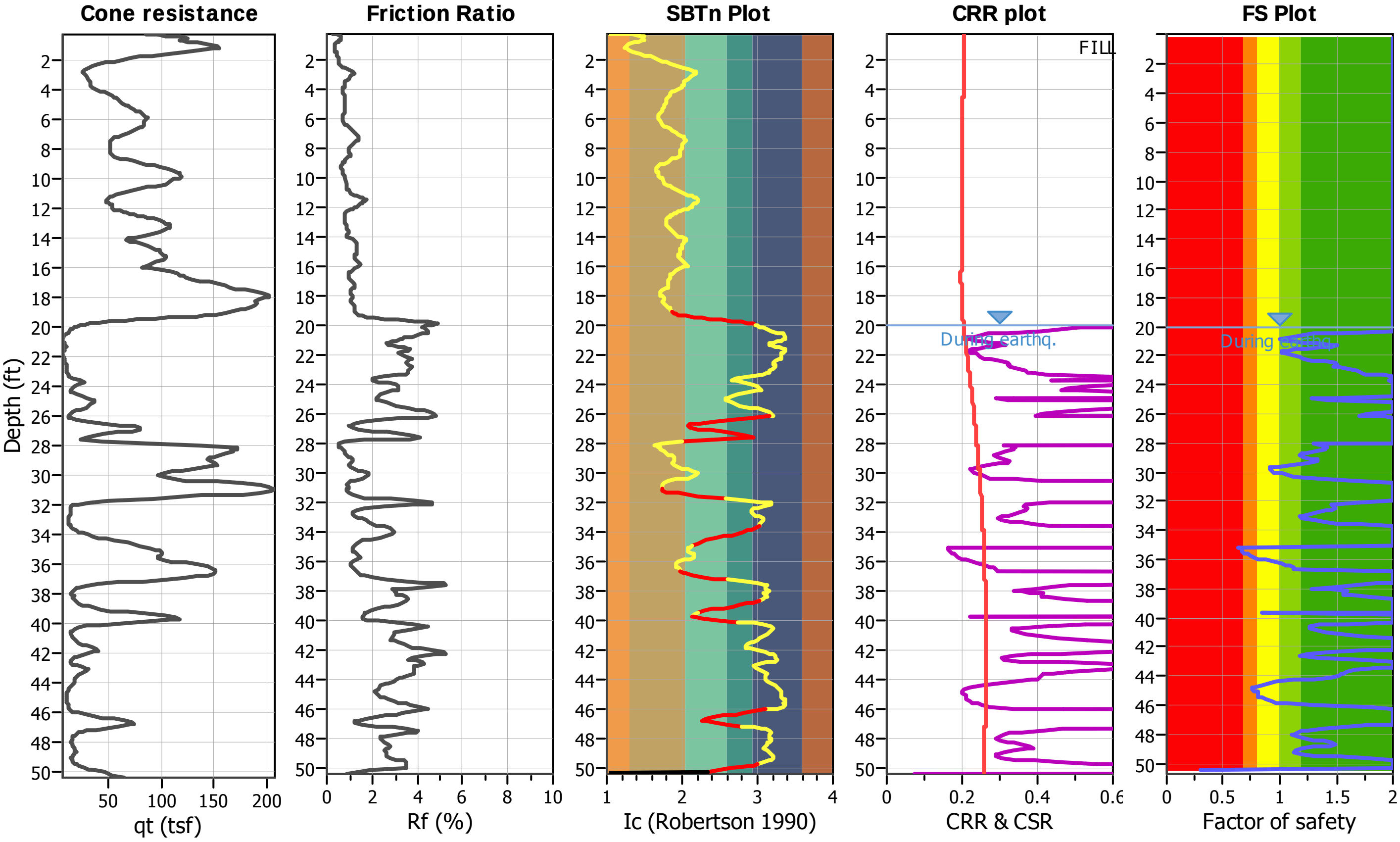
LIQUEFACTION ANALYSIS REPORT

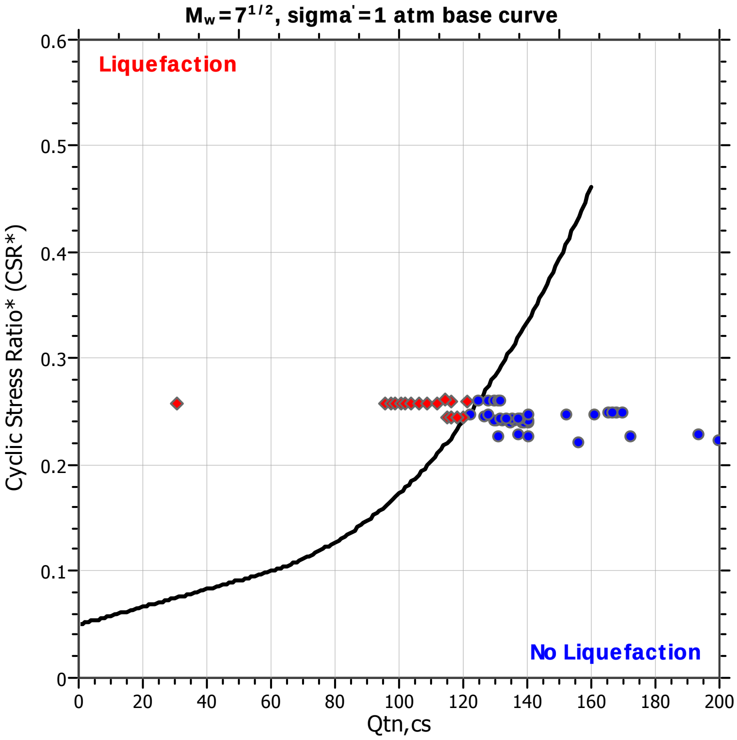
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

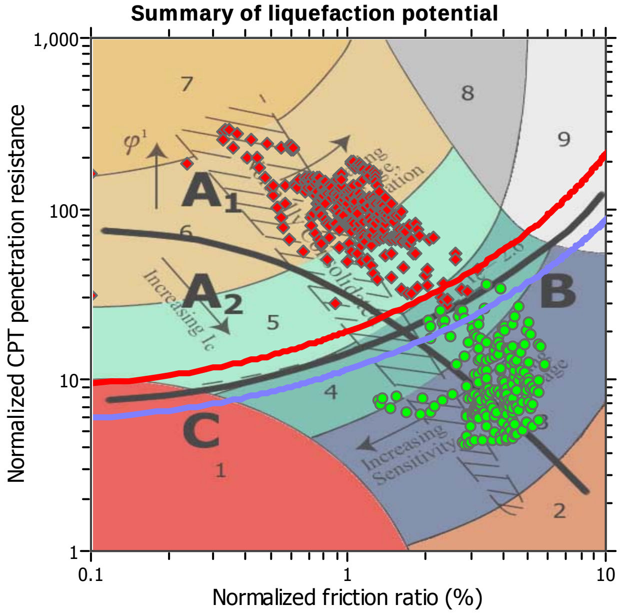
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	21.00 ft	Fill height:	1.00 ft		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth applied:	Yes
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	Limit depth:	60.00 ft
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

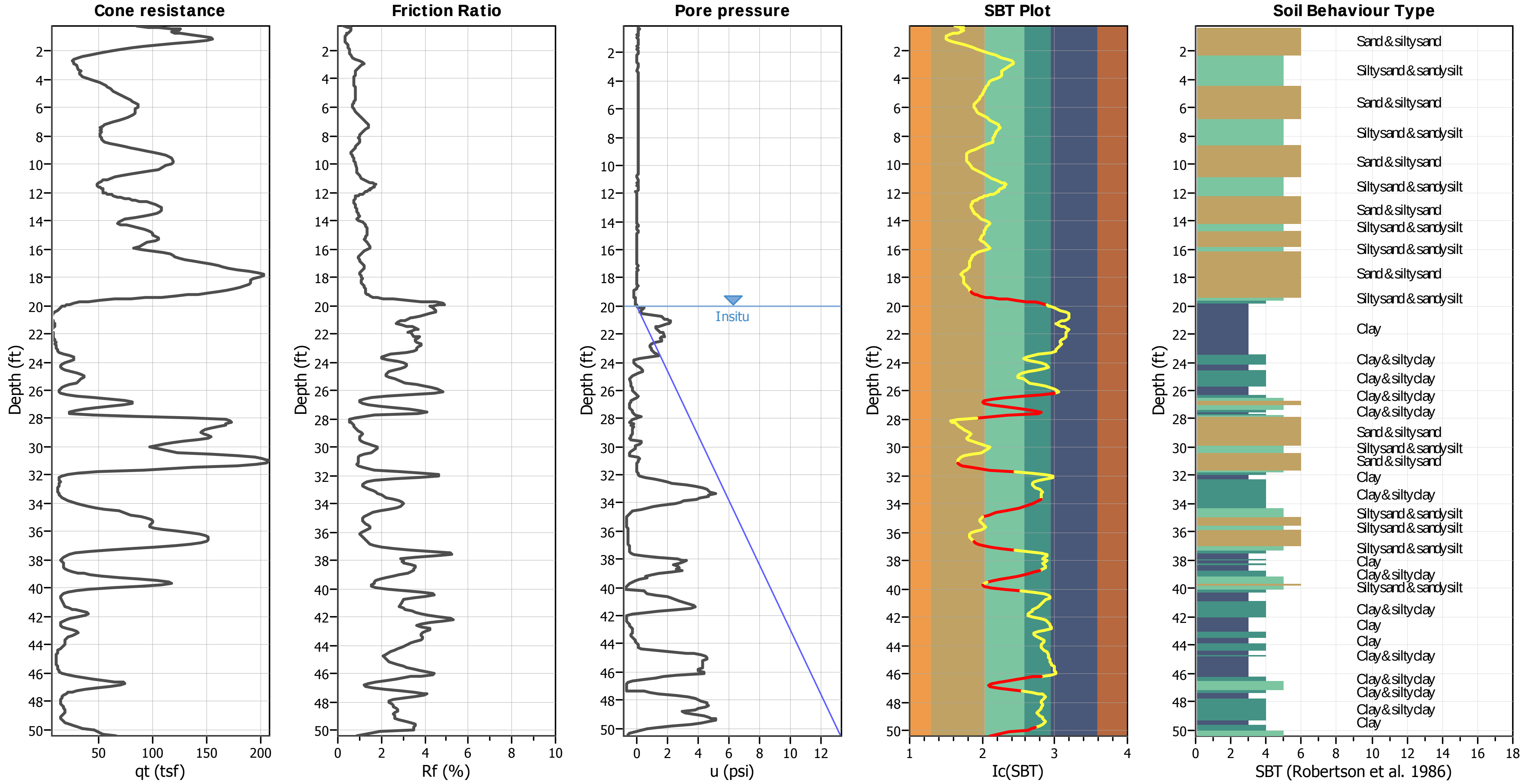






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



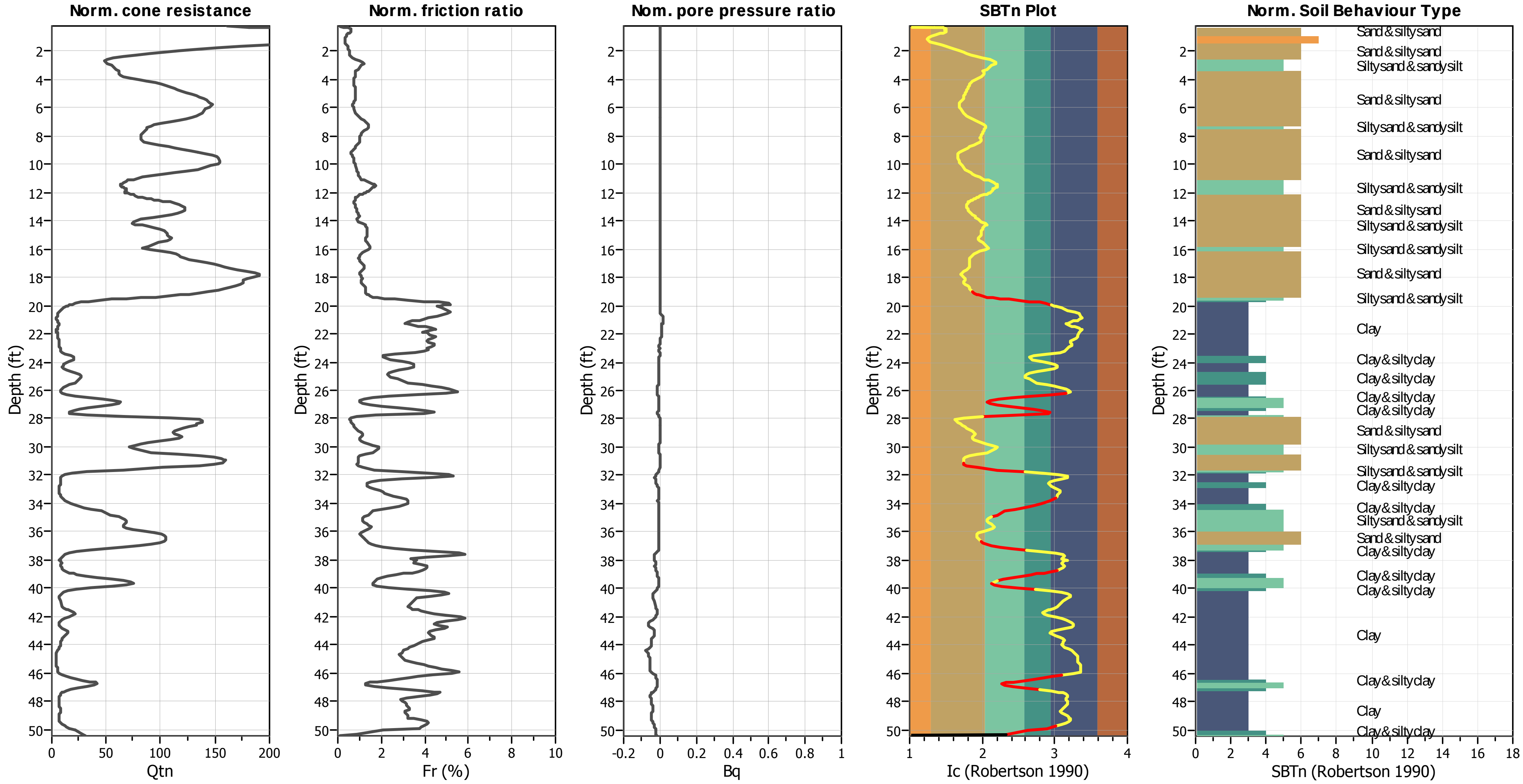
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



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Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
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SBTn legend

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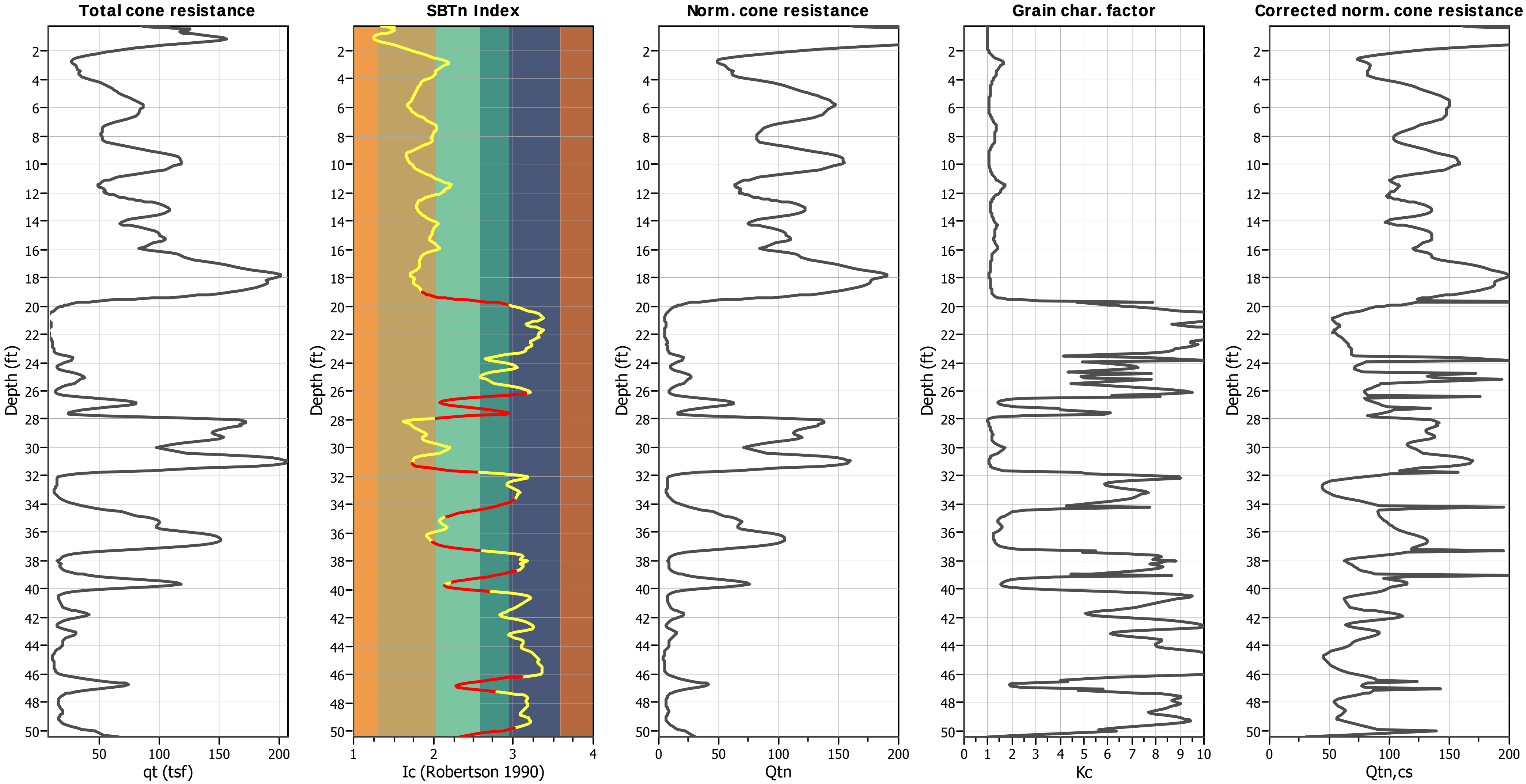
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
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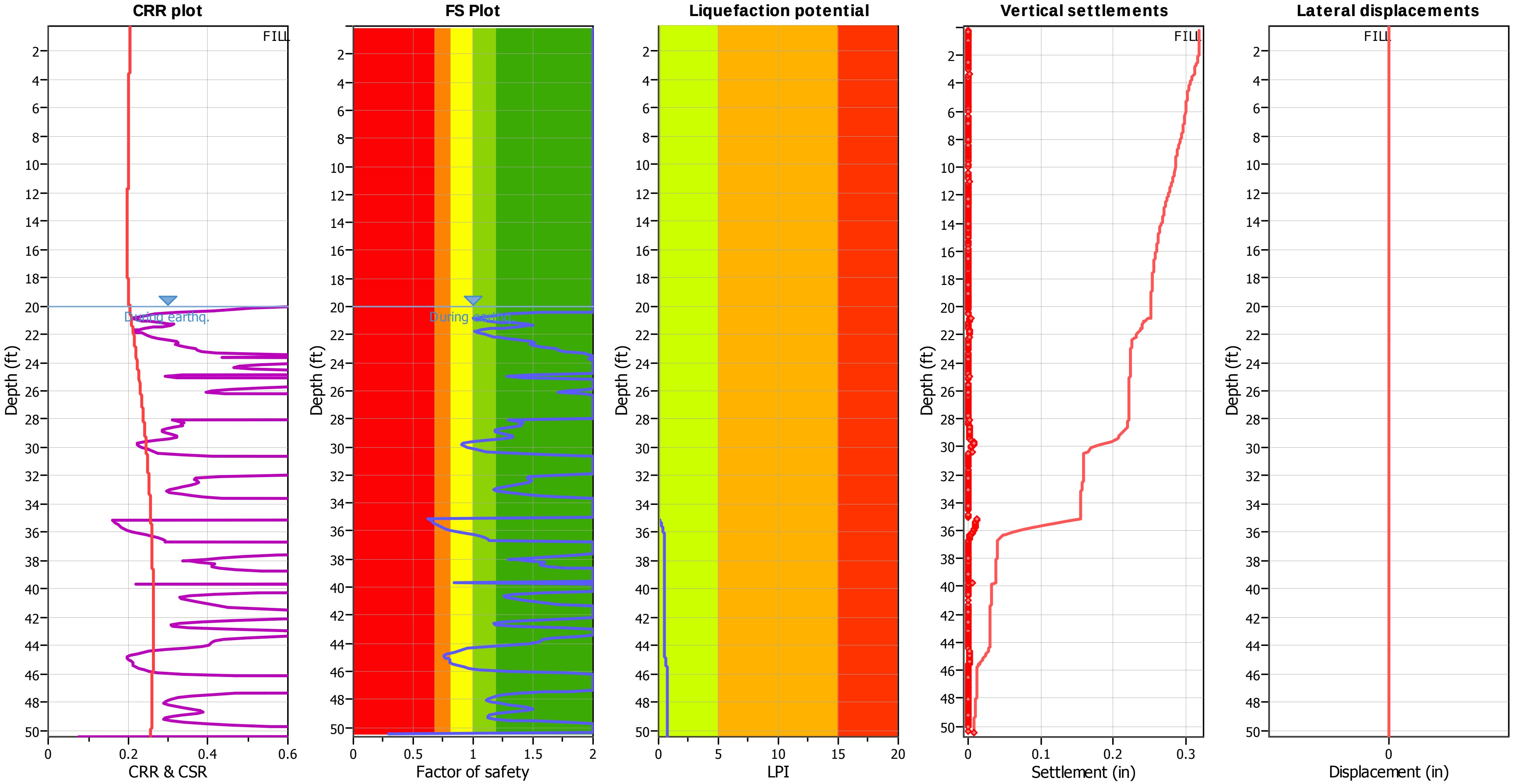
Liquefaction analysis overall plots



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Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

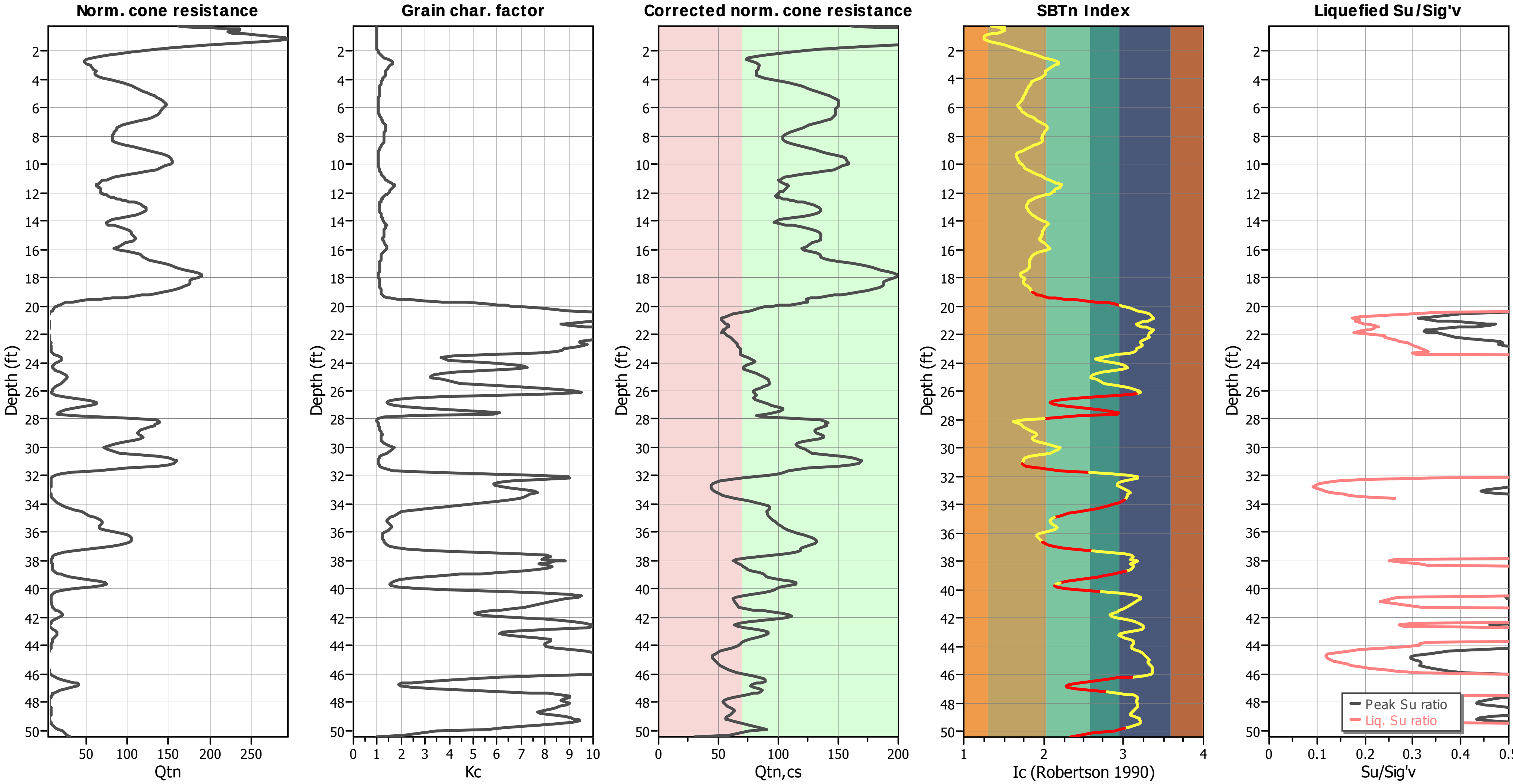
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

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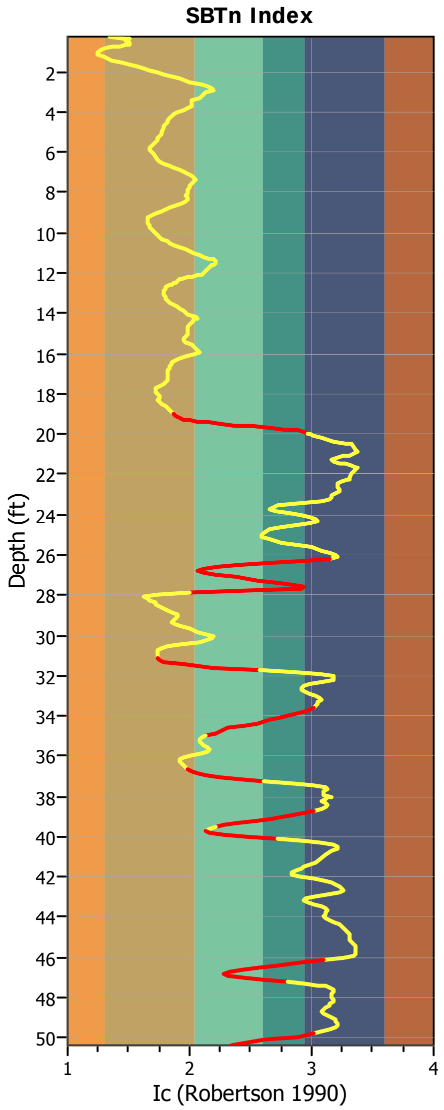
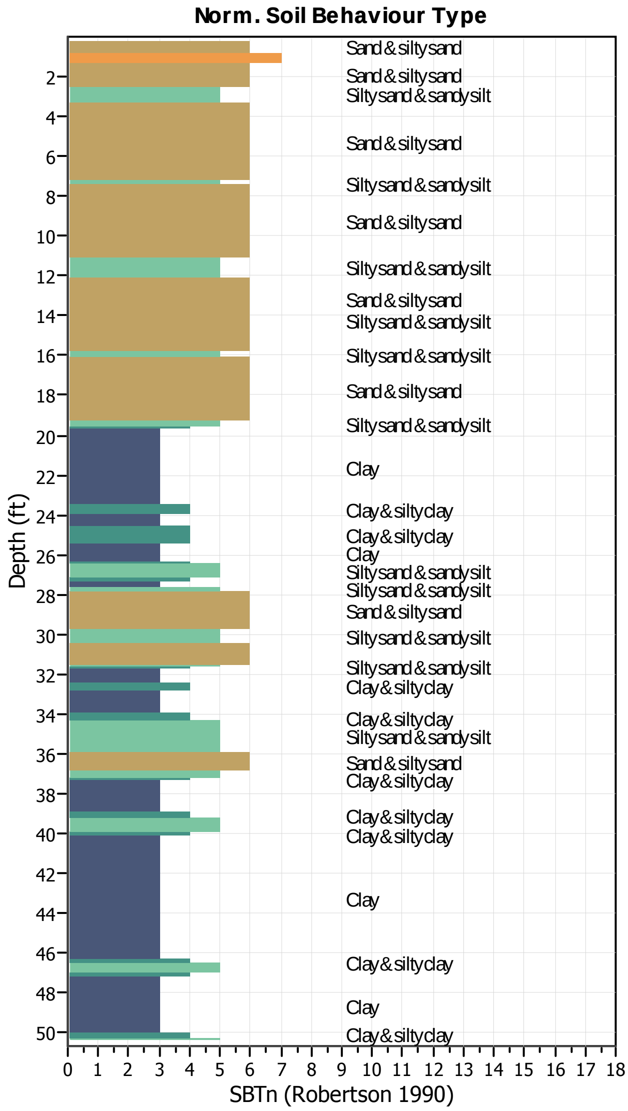
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





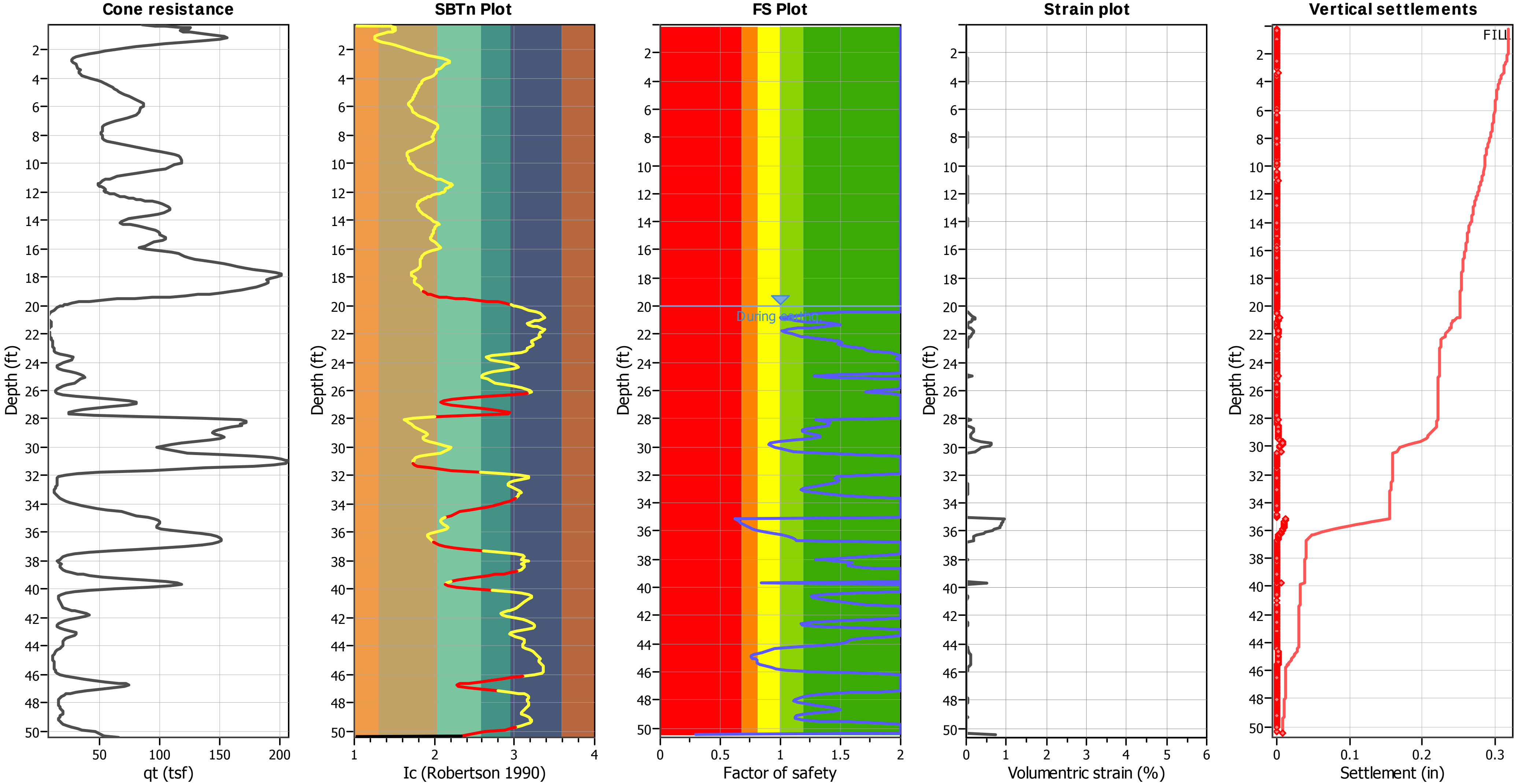
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	496
Total points excluded:	89
Exclusion percentage:	17.94%
Number of layers detected:	12

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

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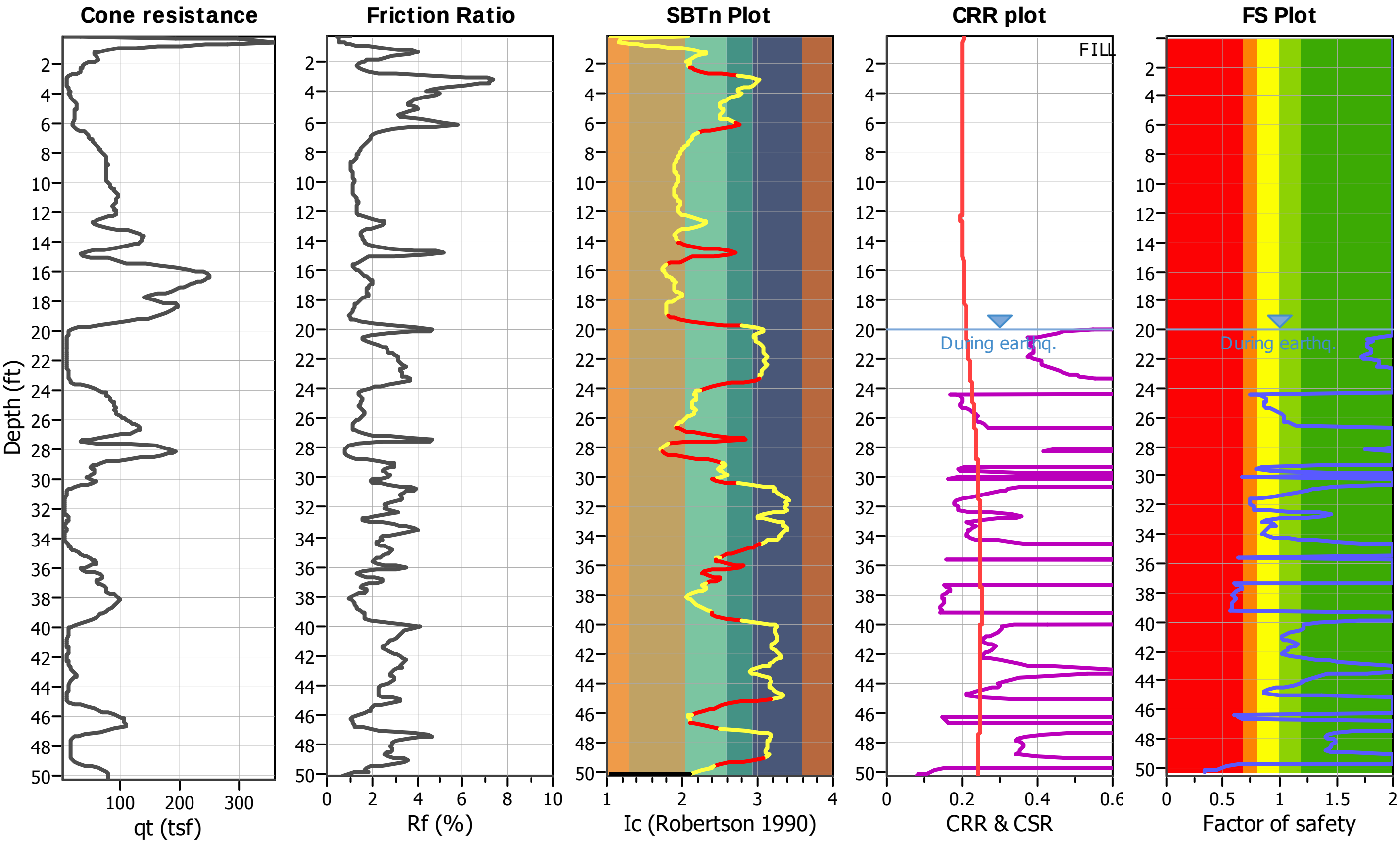
LIQUEFACTION ANALYSIS REPORT

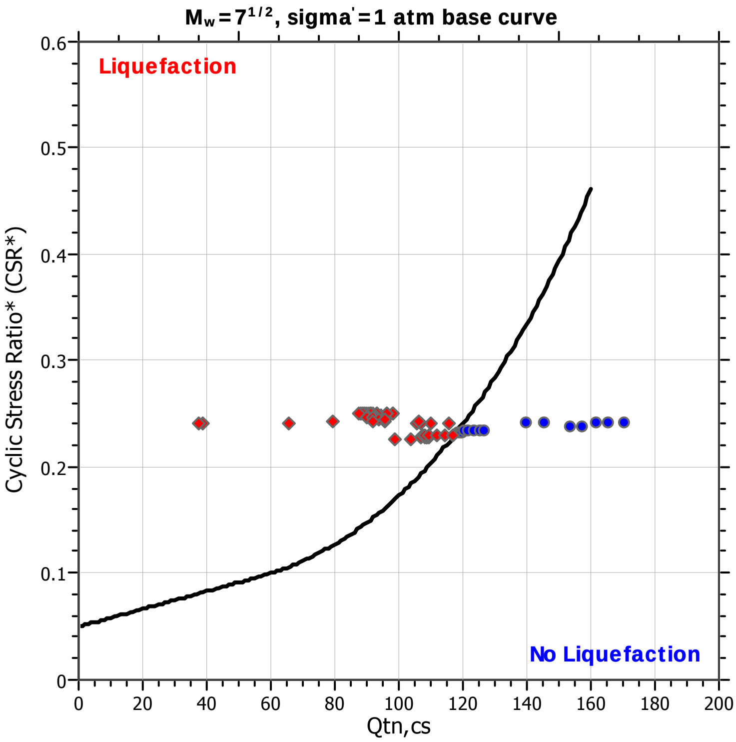
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

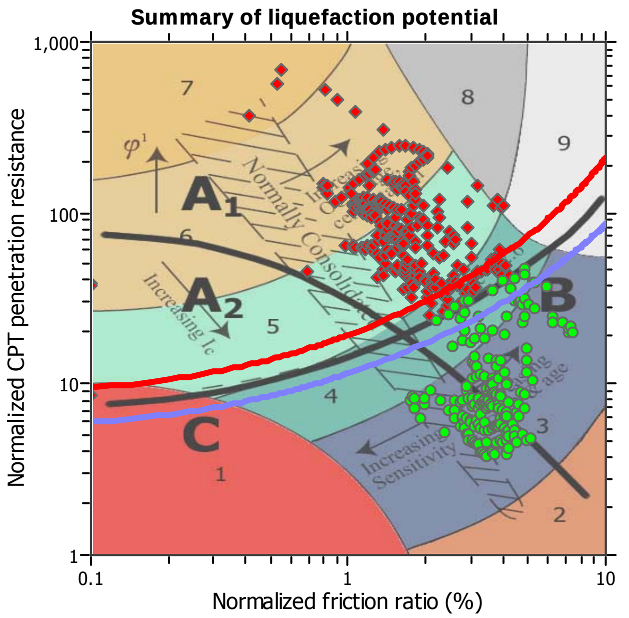
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	25.00 ft	Fill height:	5.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
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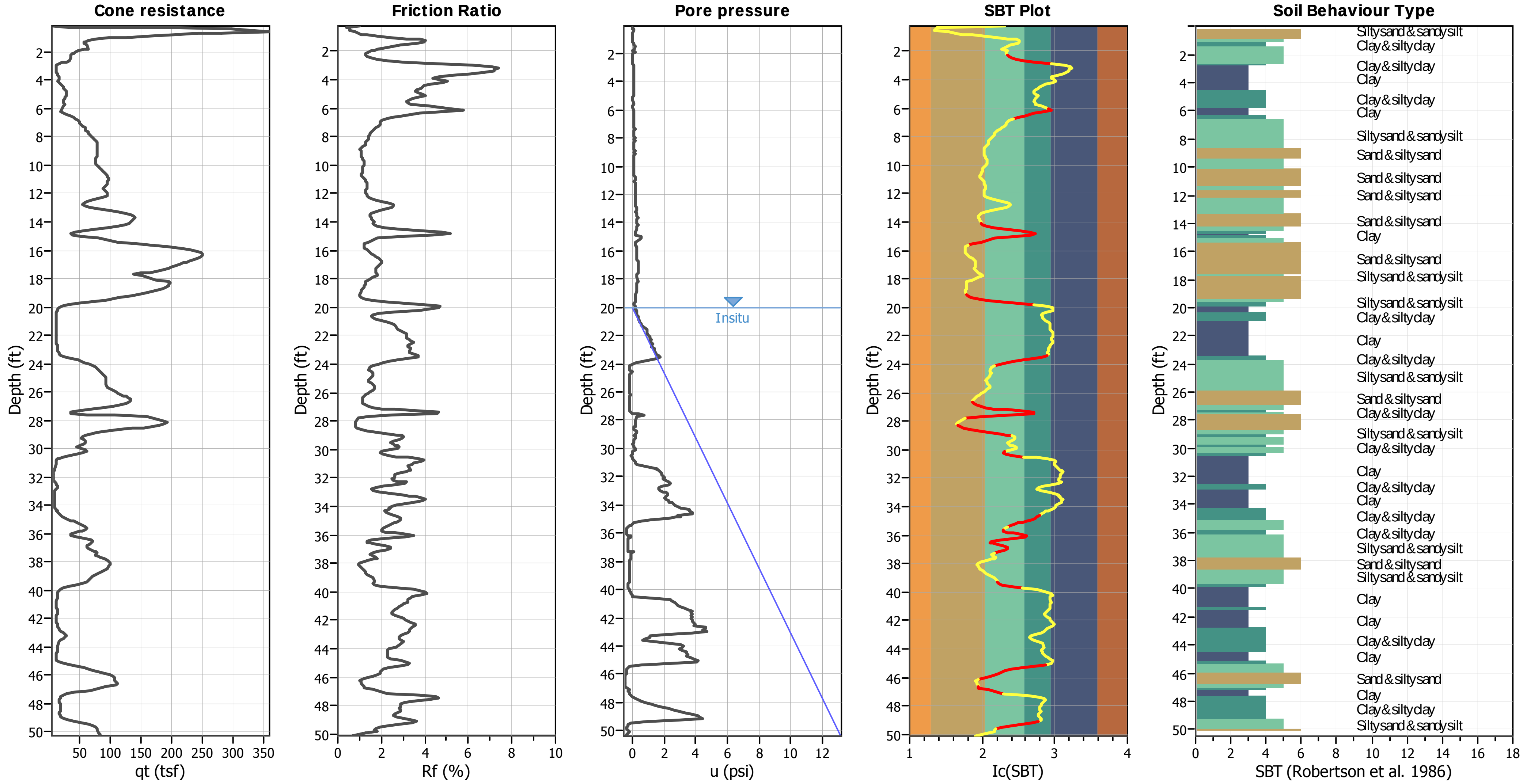
CPT basic interpretation plots



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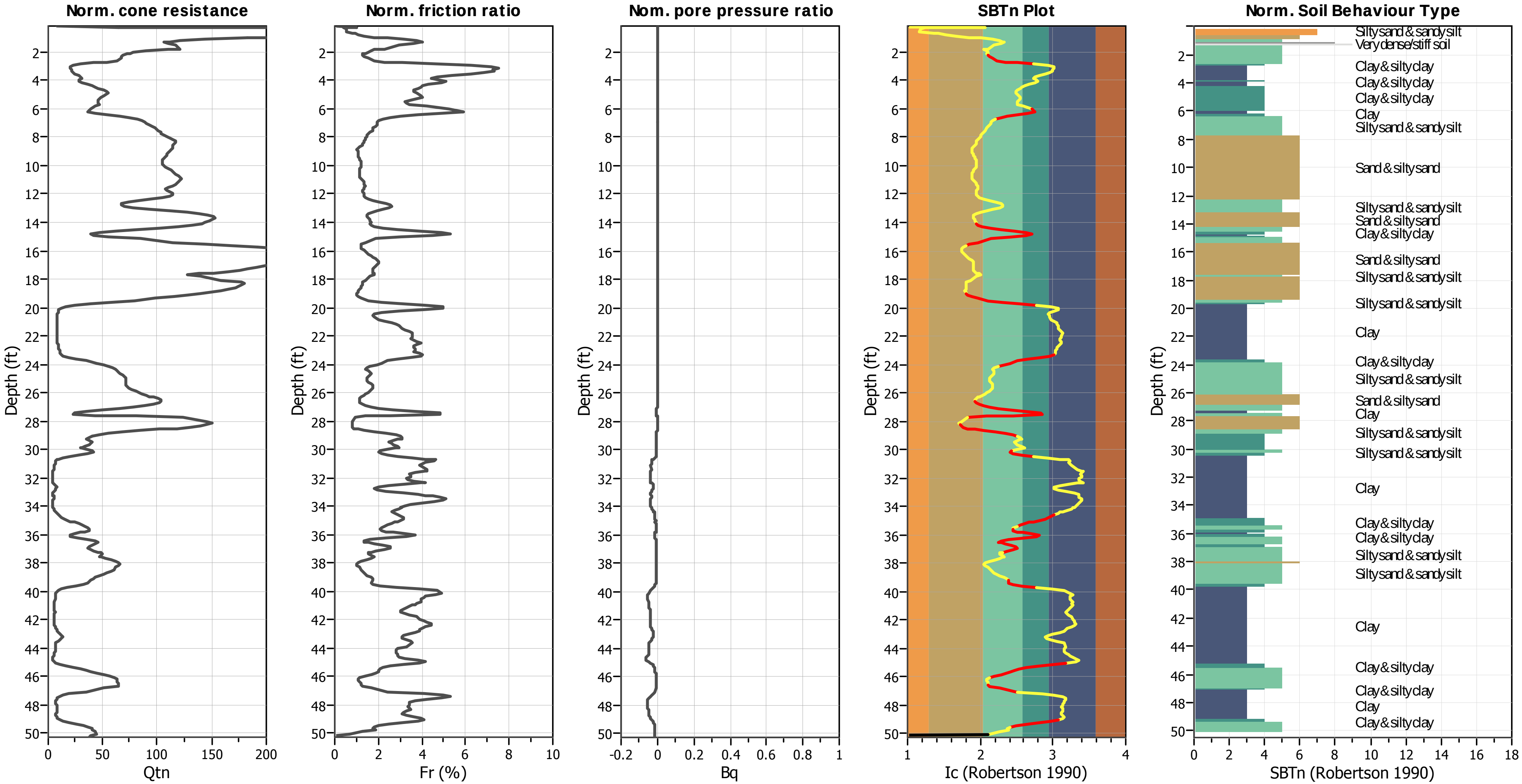
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	25.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	25.00 ft	Fill weight:	120.00 lb/ft^3
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Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

SBTn legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
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- 7. Gravely sand to sand
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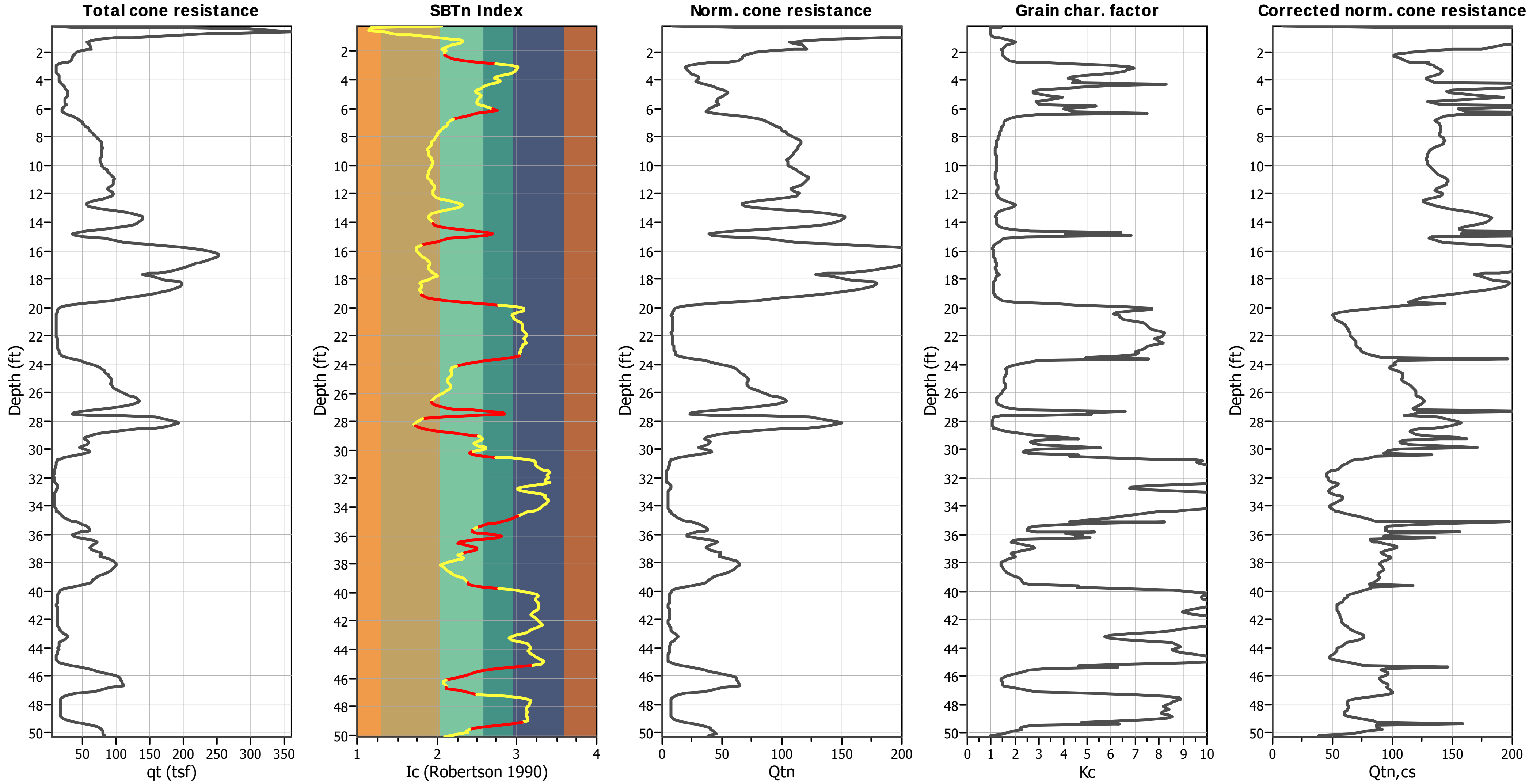
Liquefaction analysis overall plots (intermediate results)



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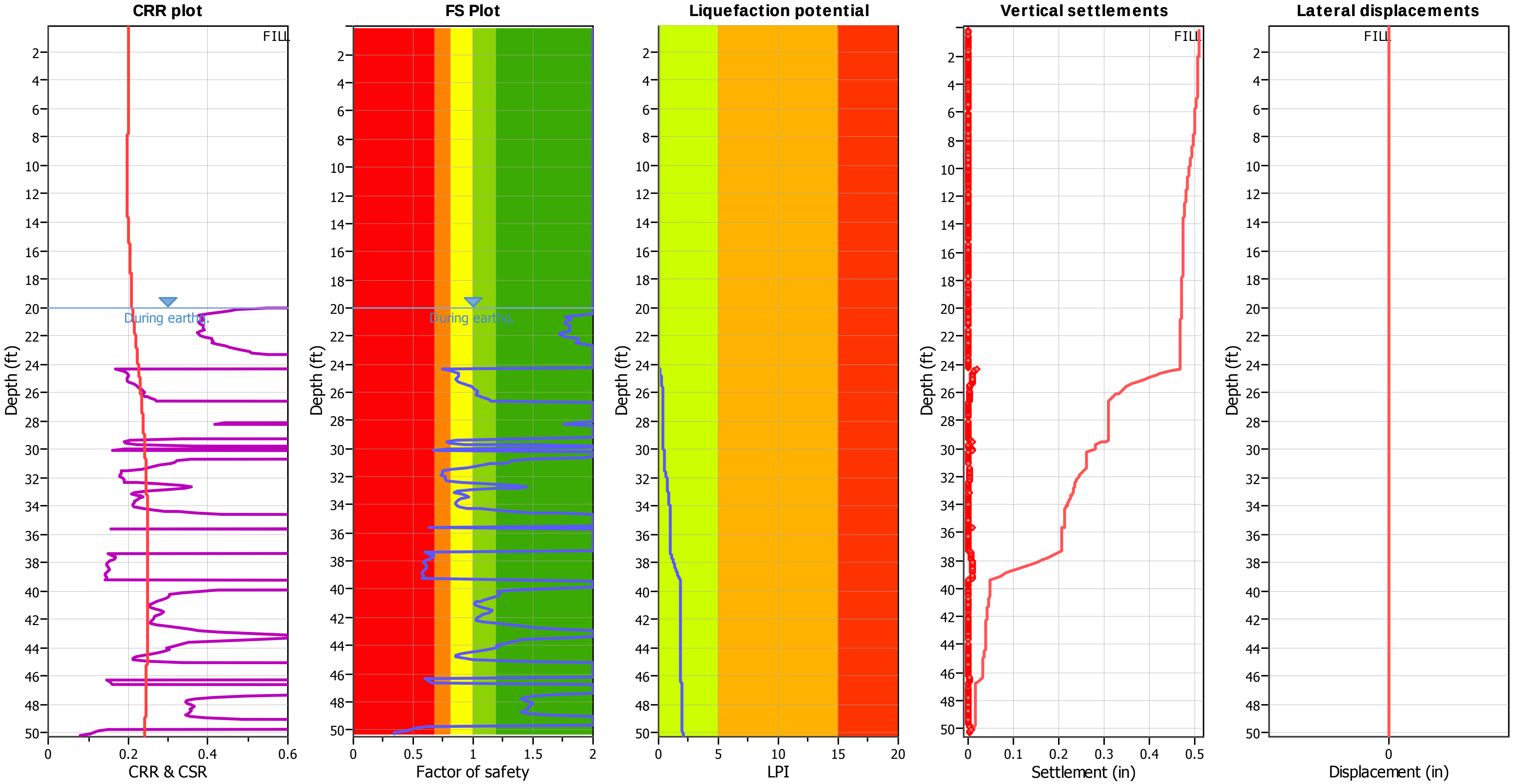
Liquefaction analysis overall plots



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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
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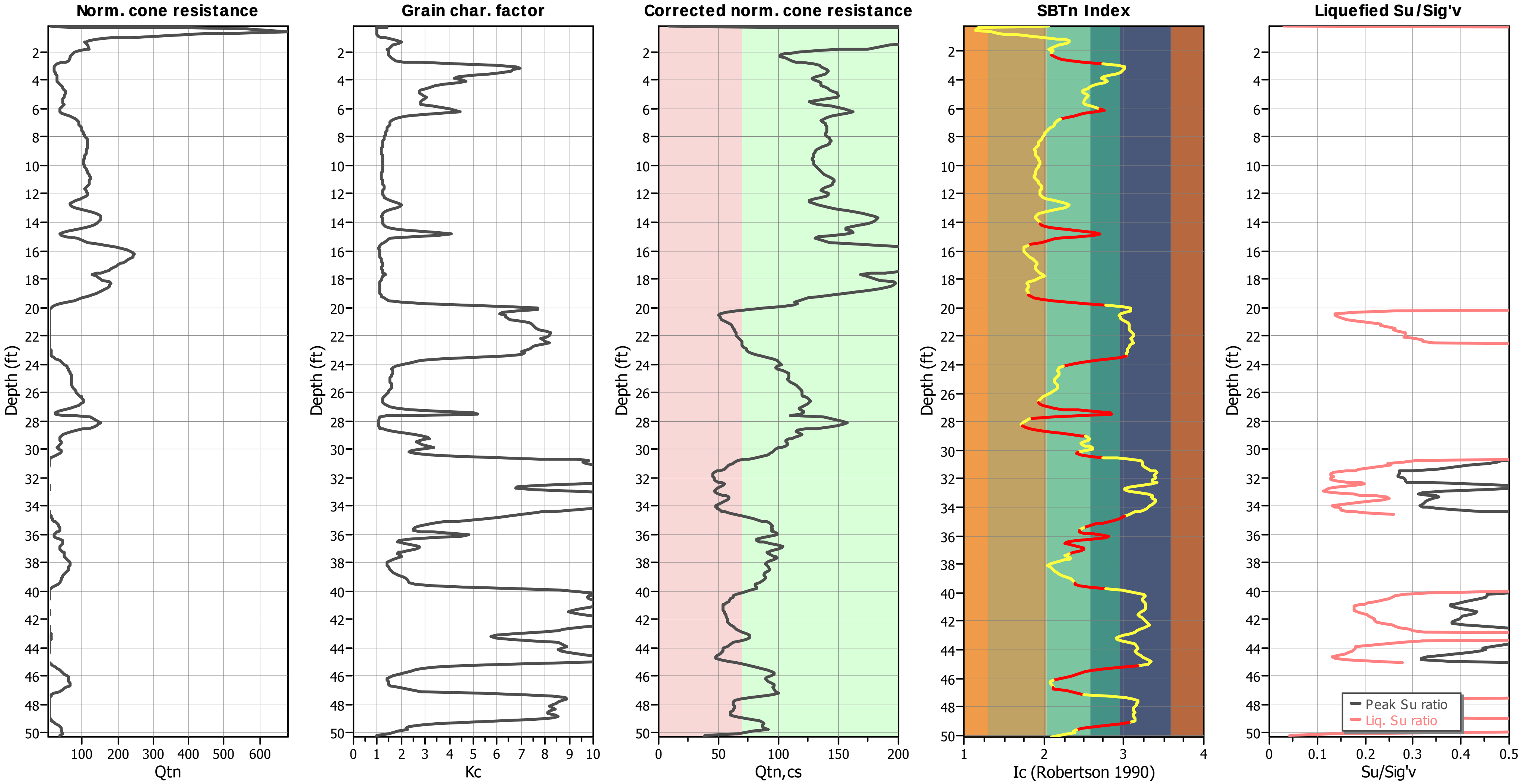
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



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Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
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Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

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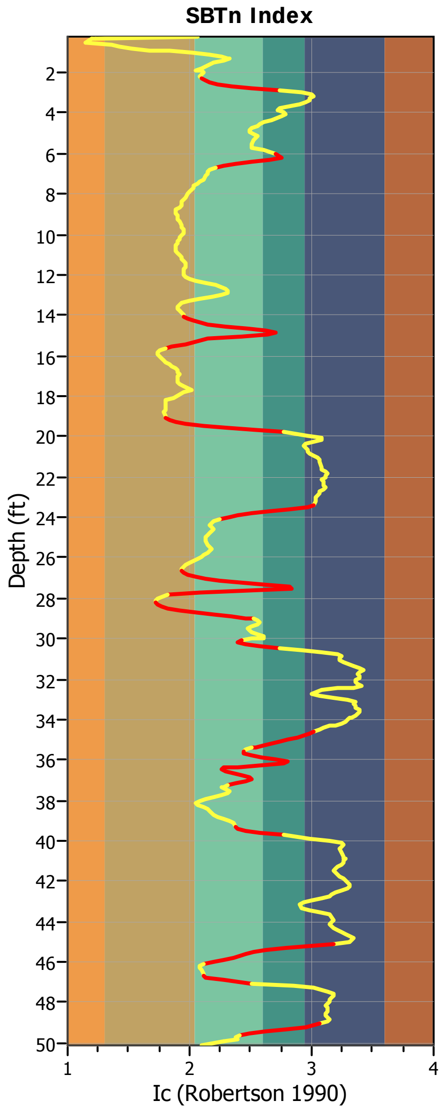
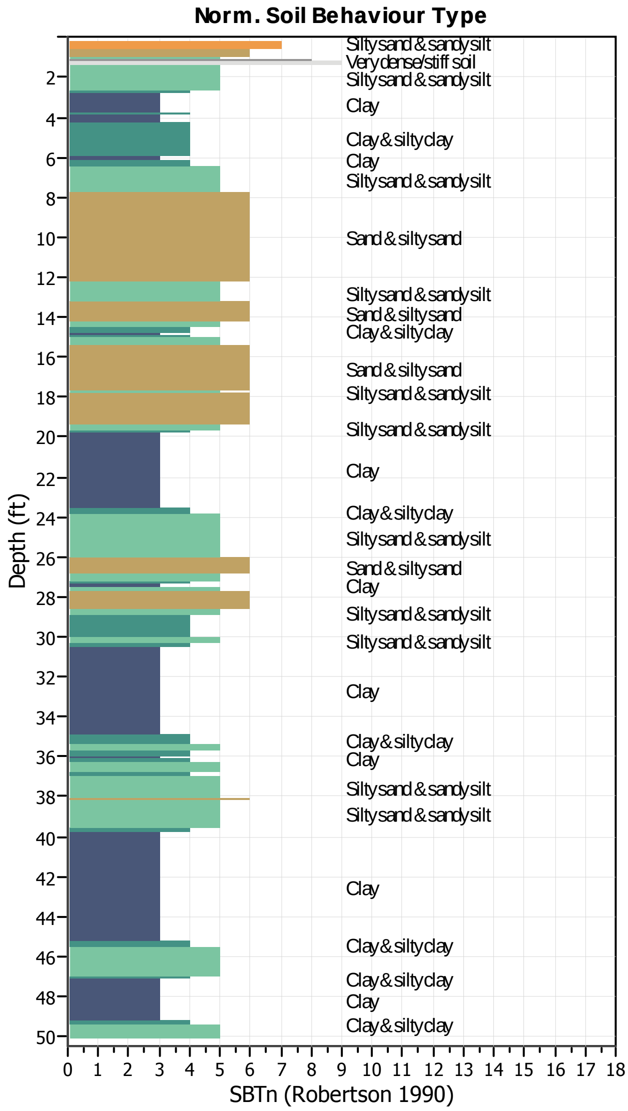
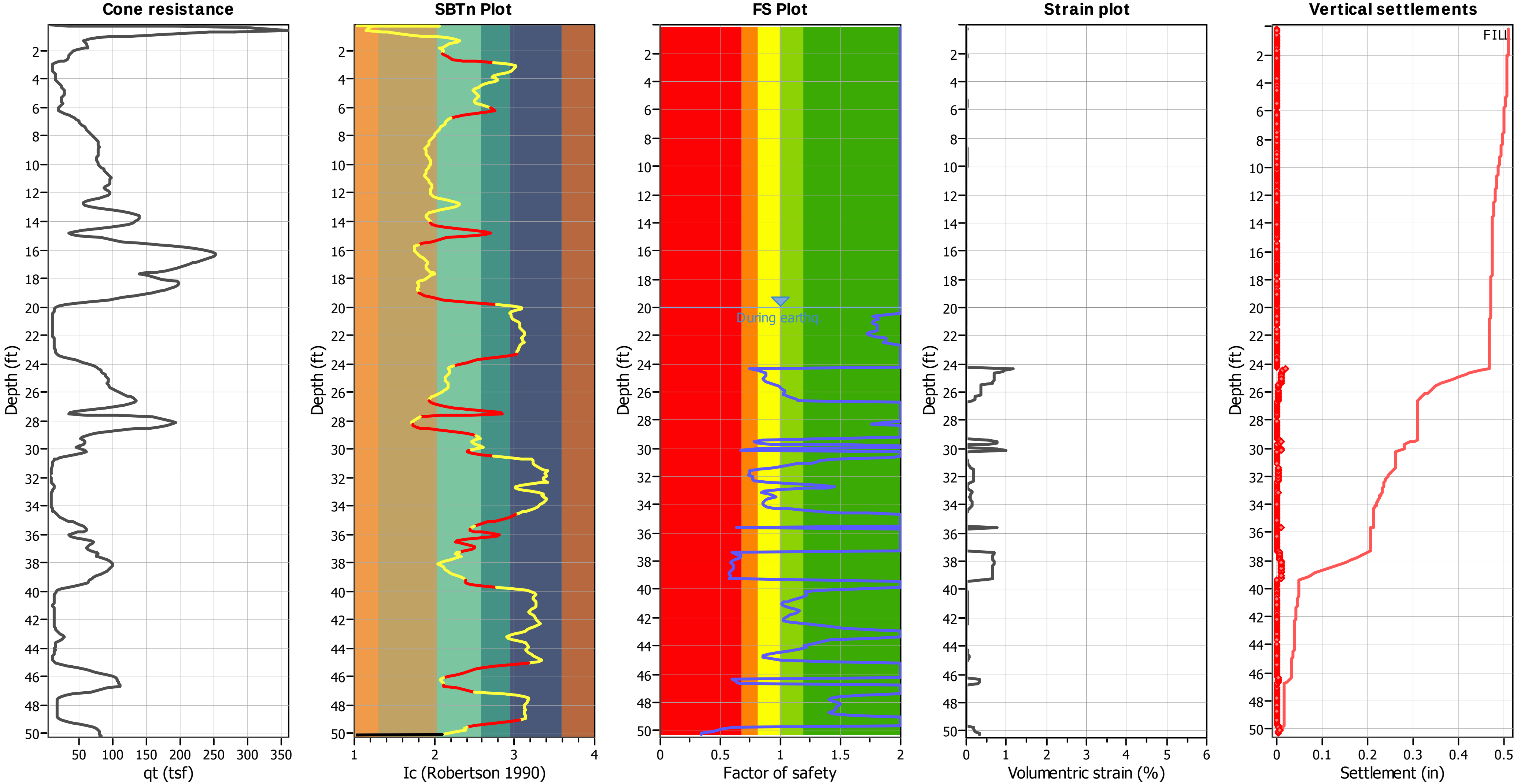




Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	483
I_c maximum check value:	3.00	Total points excluded:	129
I_c change ratio value:	0.0250	Exclusion percentage:	26.71%
Minimum number of points in layer:	4	Number of layers detected:	19

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
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Volumentric strain:	Post-liquefaction volumentric strain

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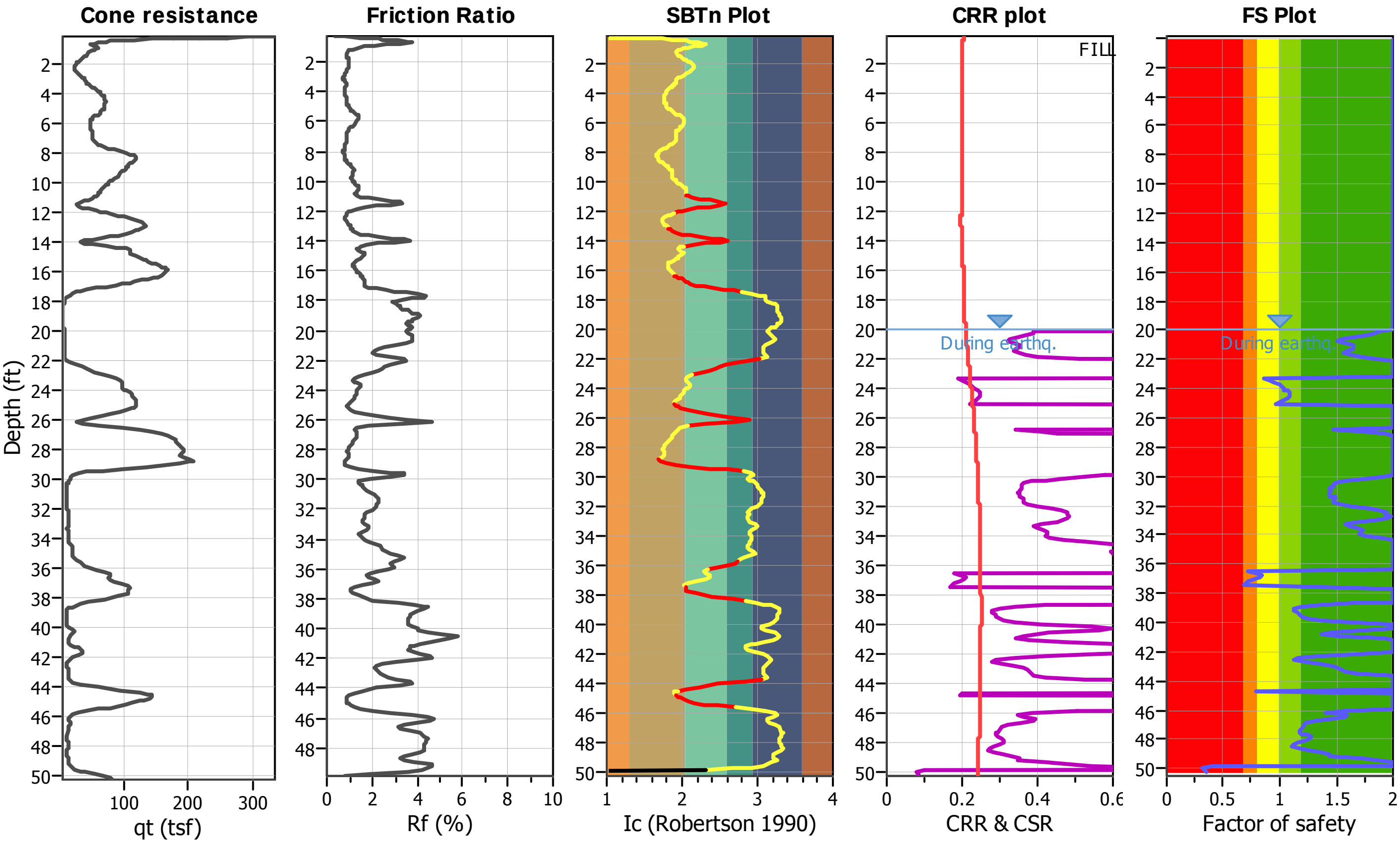
LIQUEFACTION ANALYSIS REPORT

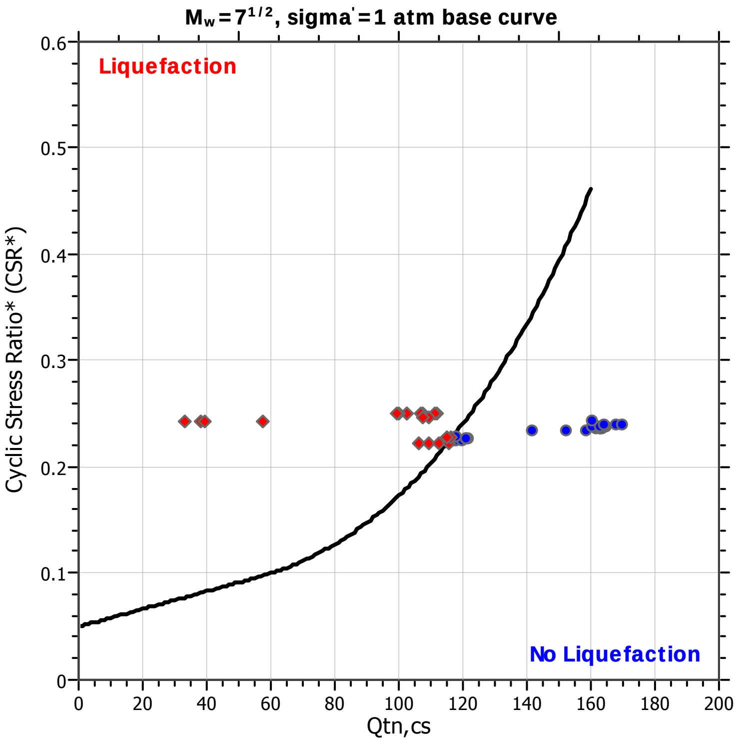
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

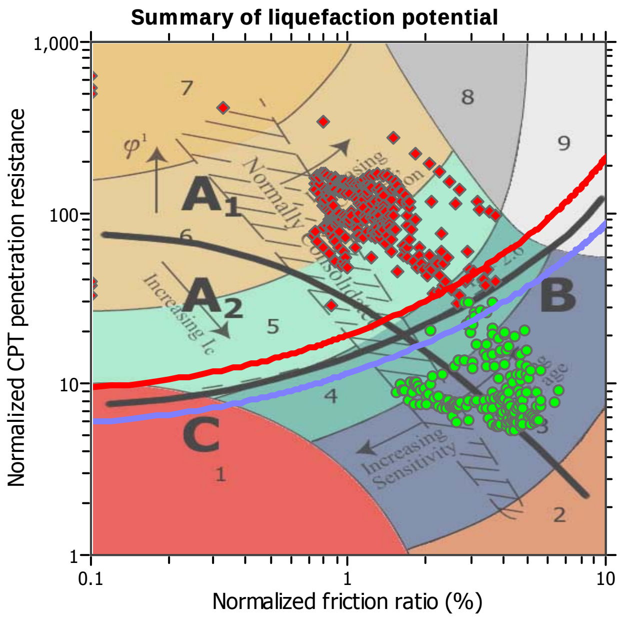
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	25.00 ft	Fill height:	5.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
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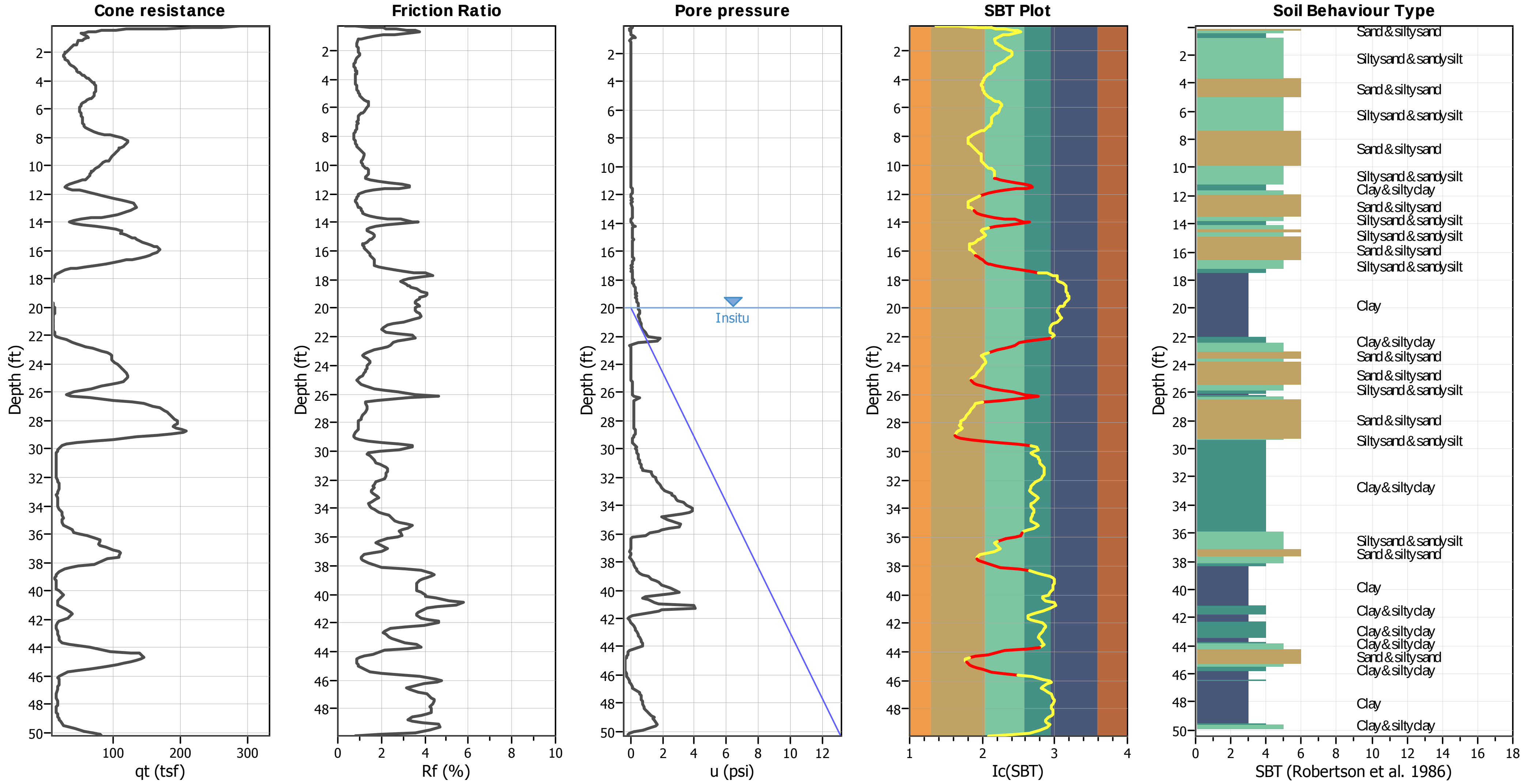
CPT basic interpretation plots



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Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
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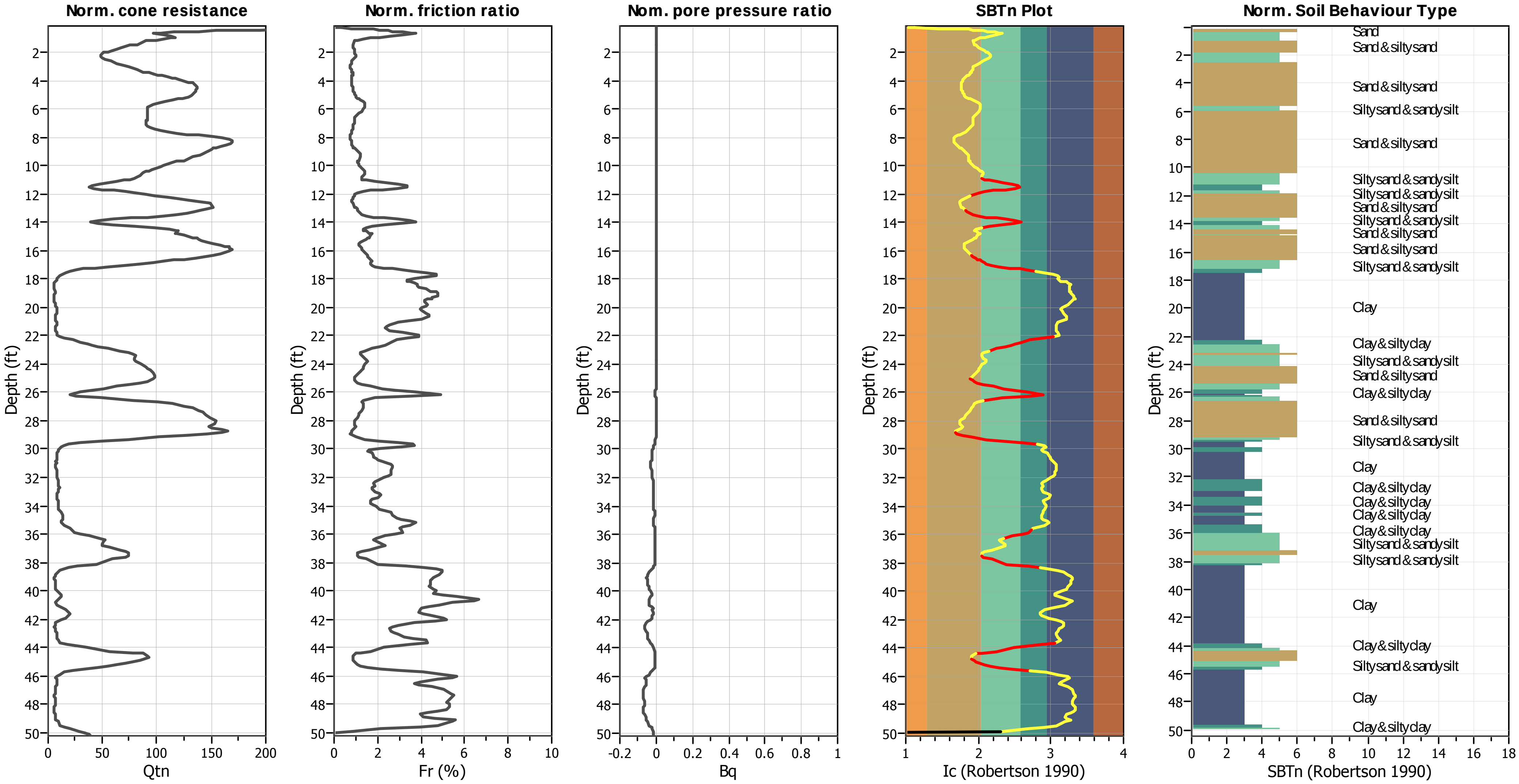
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

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SBTn legend

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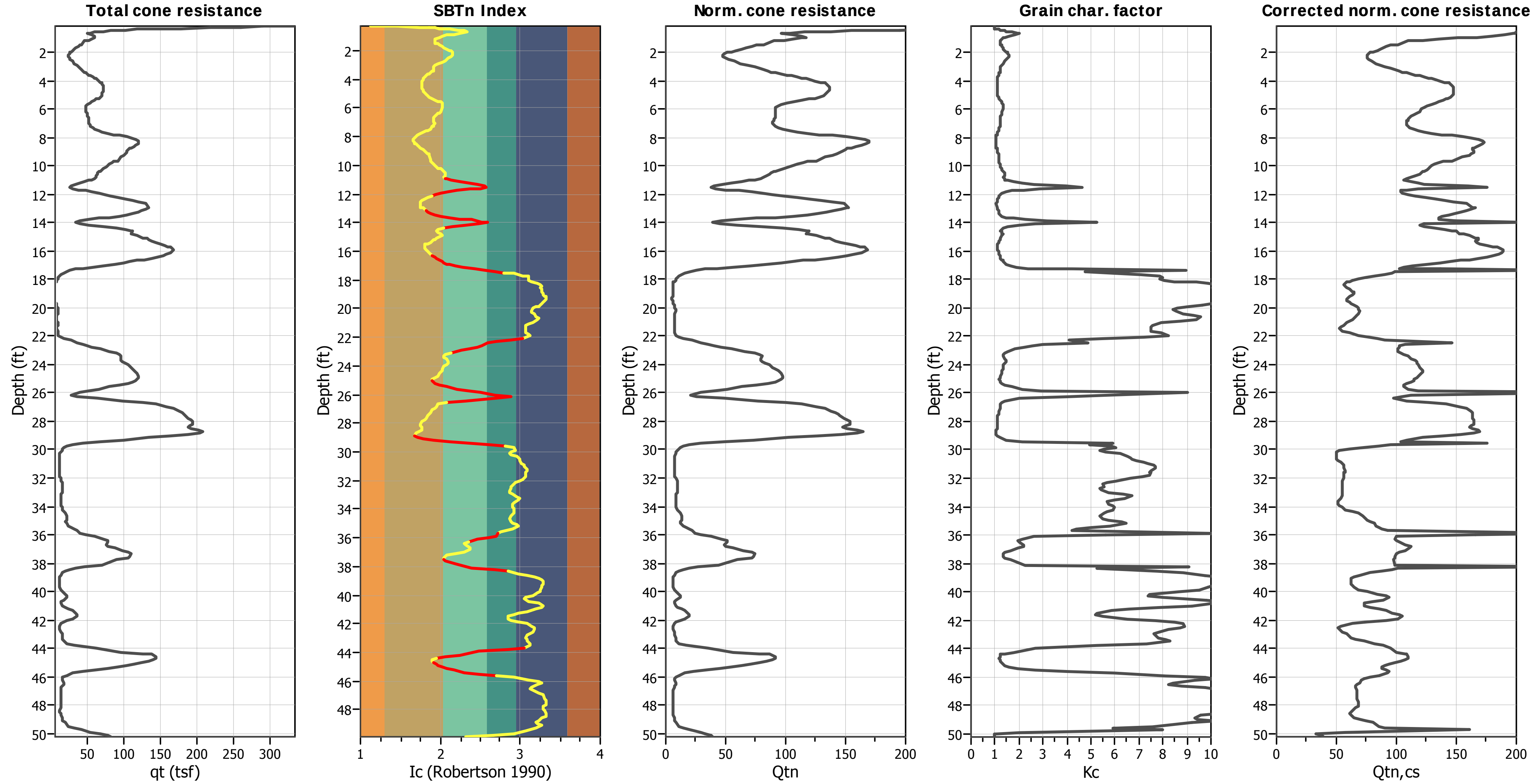
- 9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



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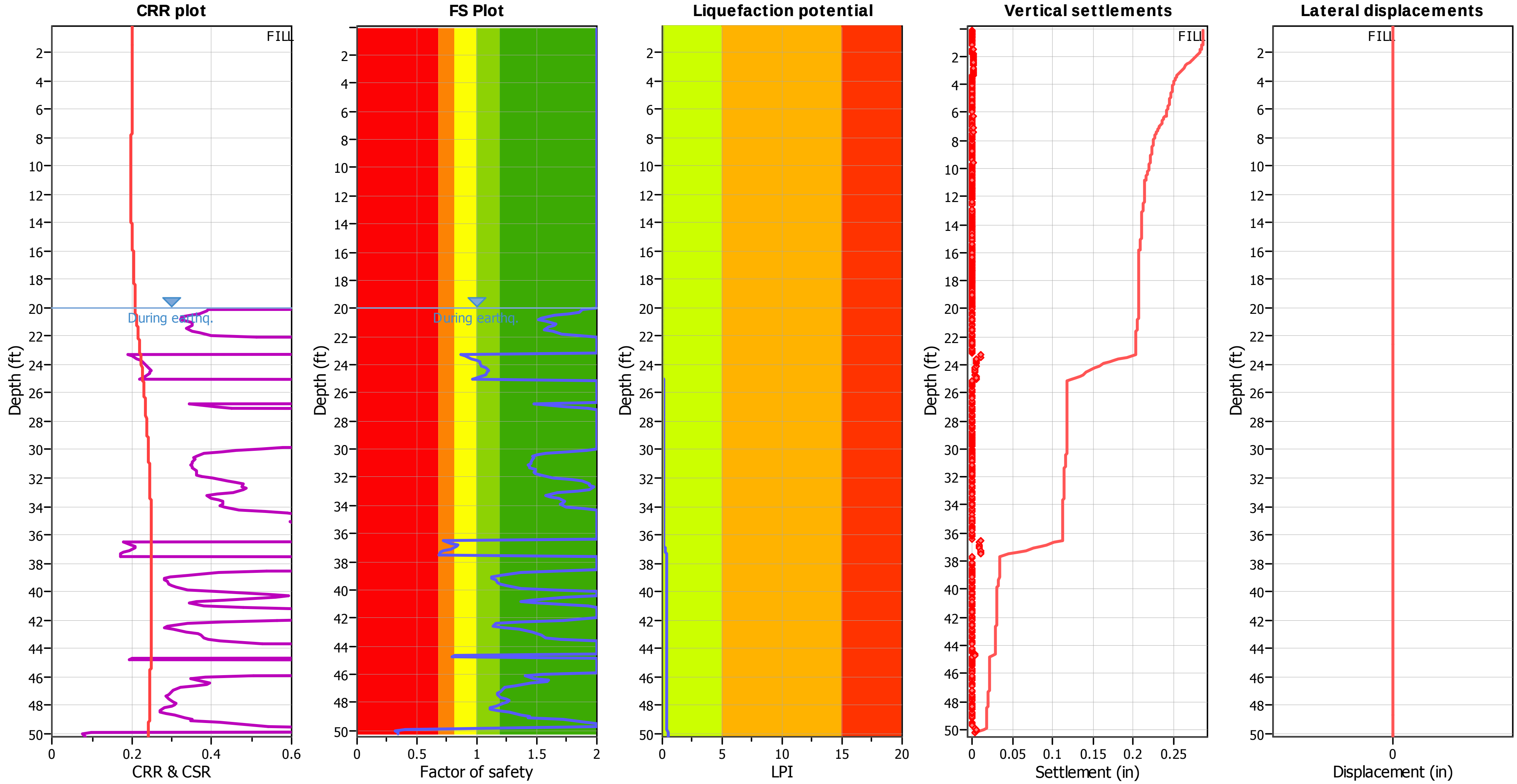
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	25.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

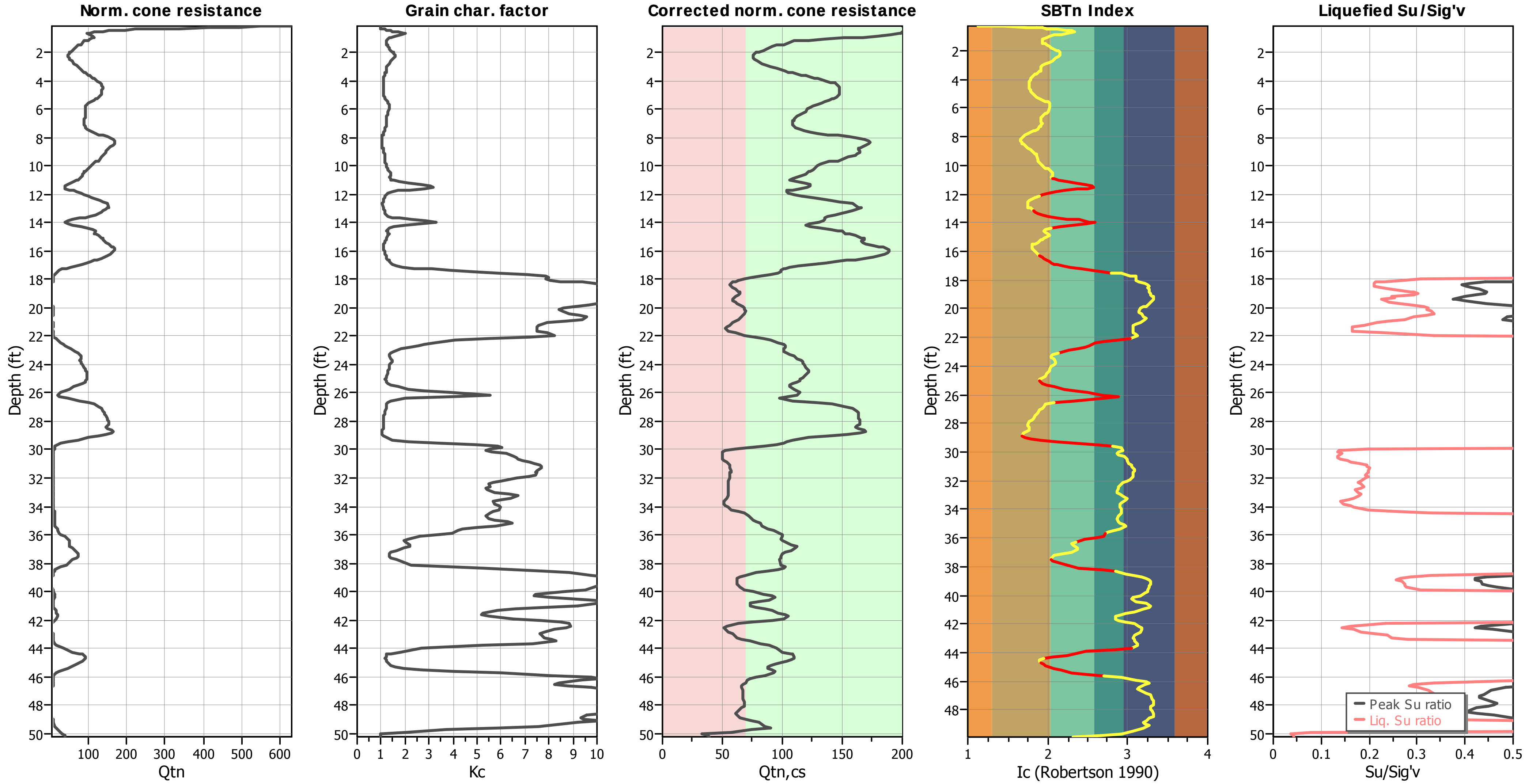
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

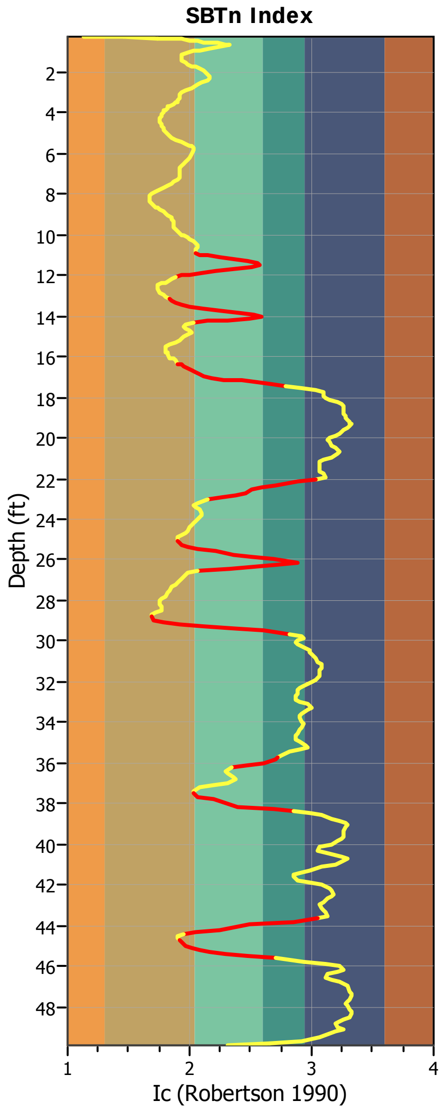
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	25.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

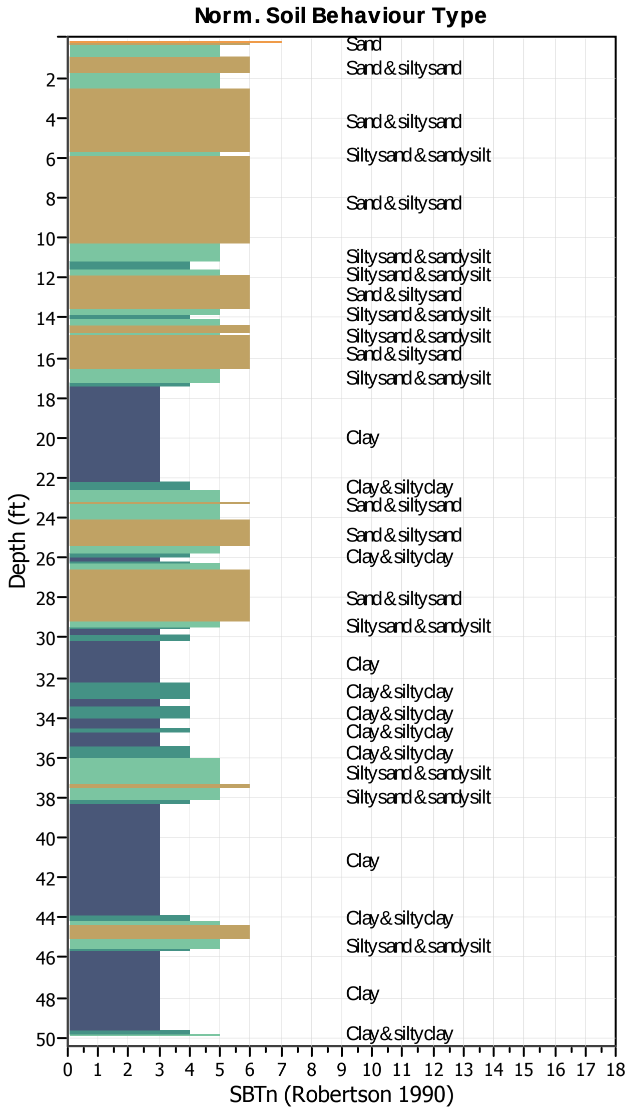
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





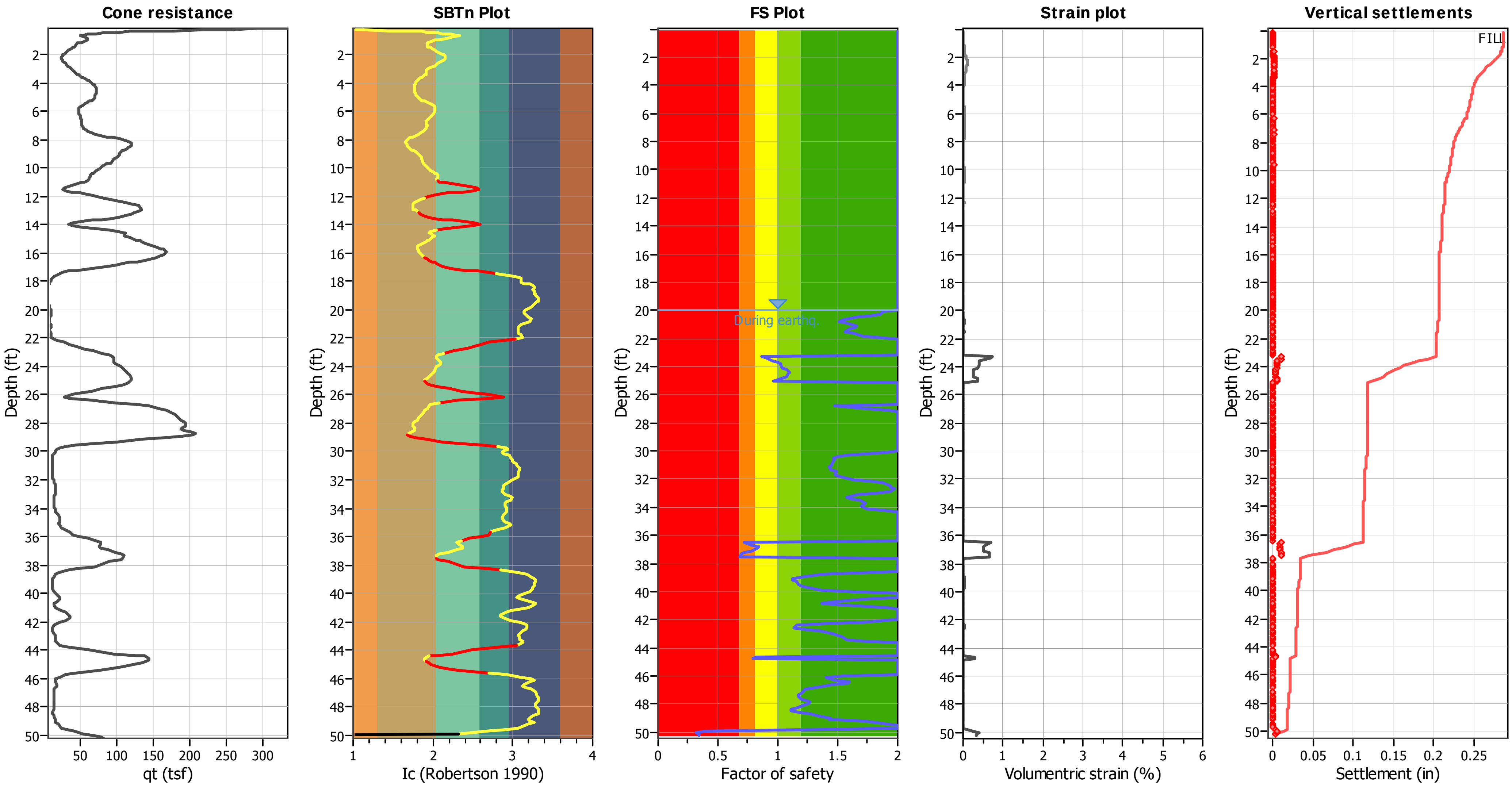
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	451
Total points excluded:	101
Exclusion percentage:	22.39%
Number of layers detected:	13

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

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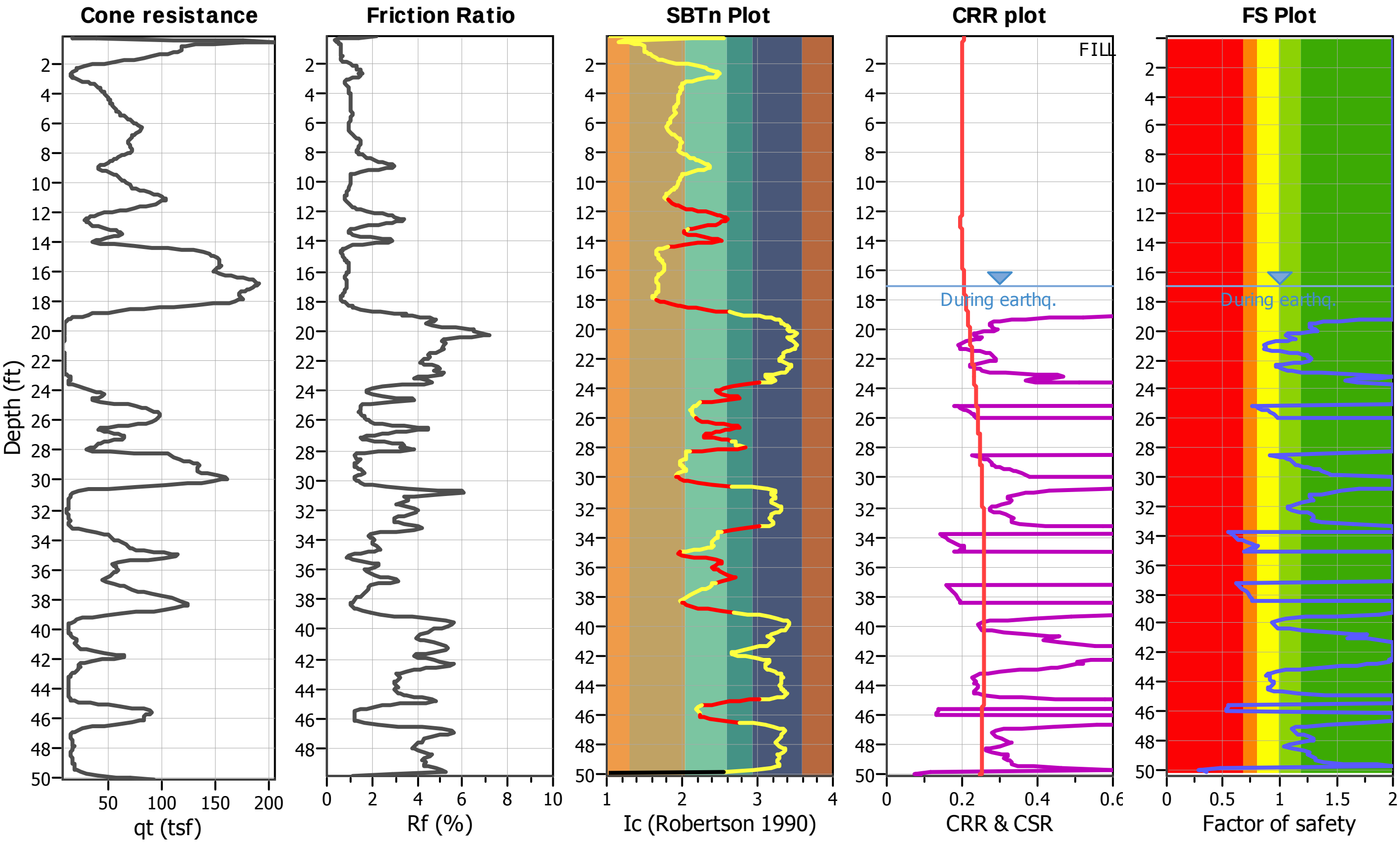
LIQUEFACTION ANALYSIS REPORT

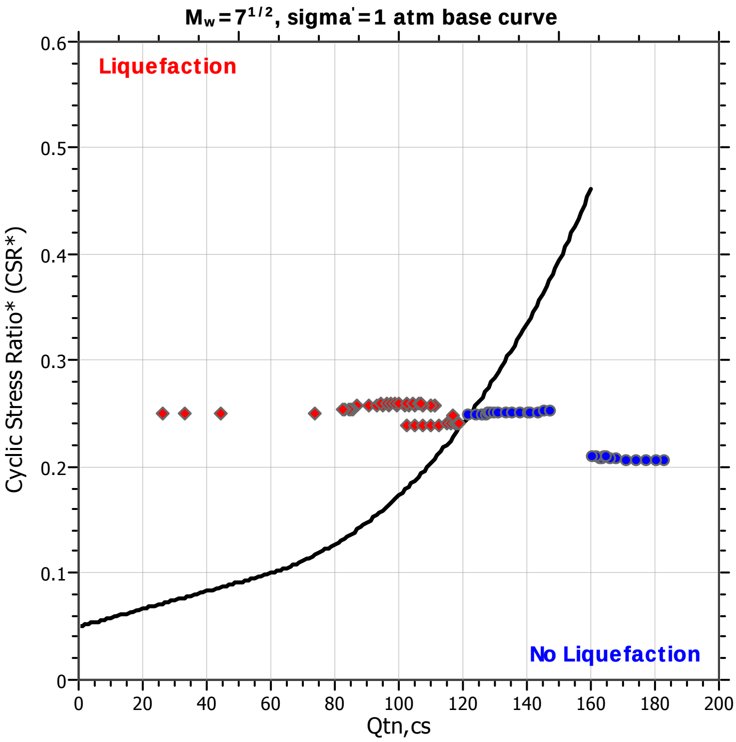
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

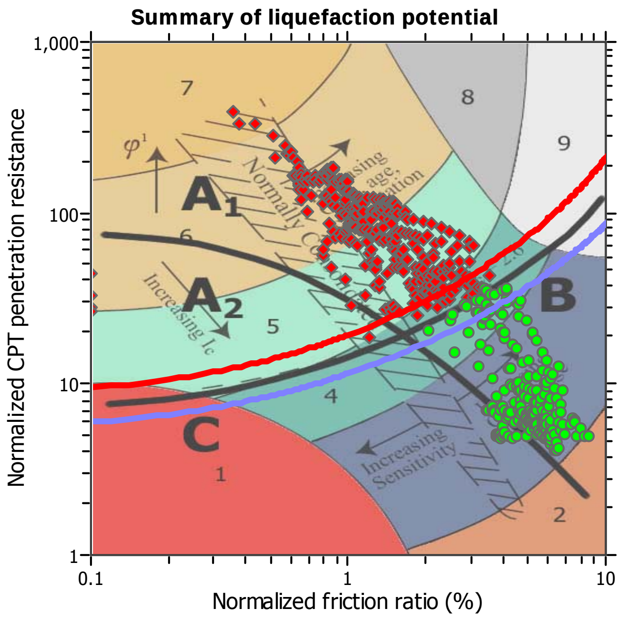
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	22.00 ft	Fill height:	5.00 ft		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth applied:	Yes
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	Limit depth:	60.00 ft
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

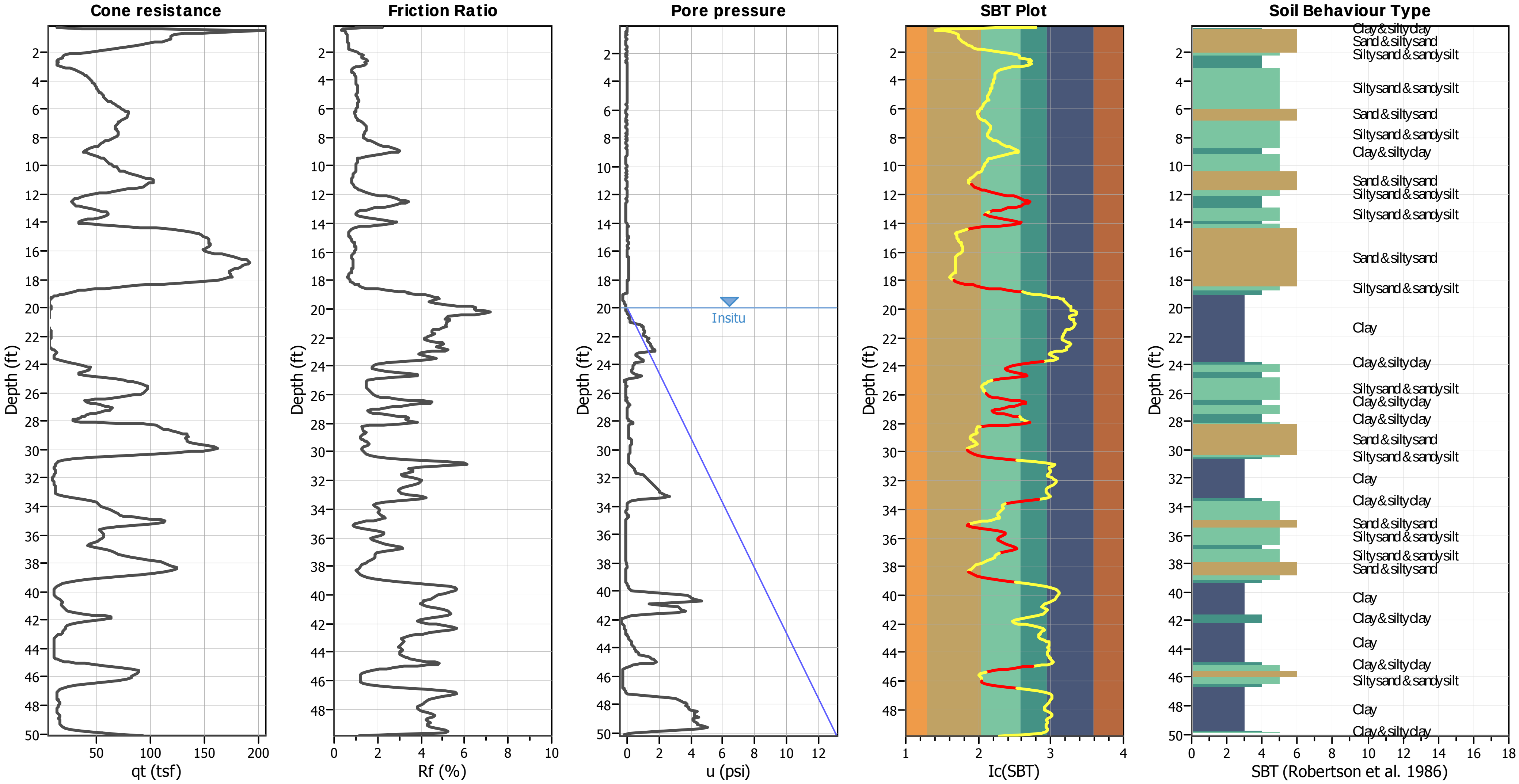






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



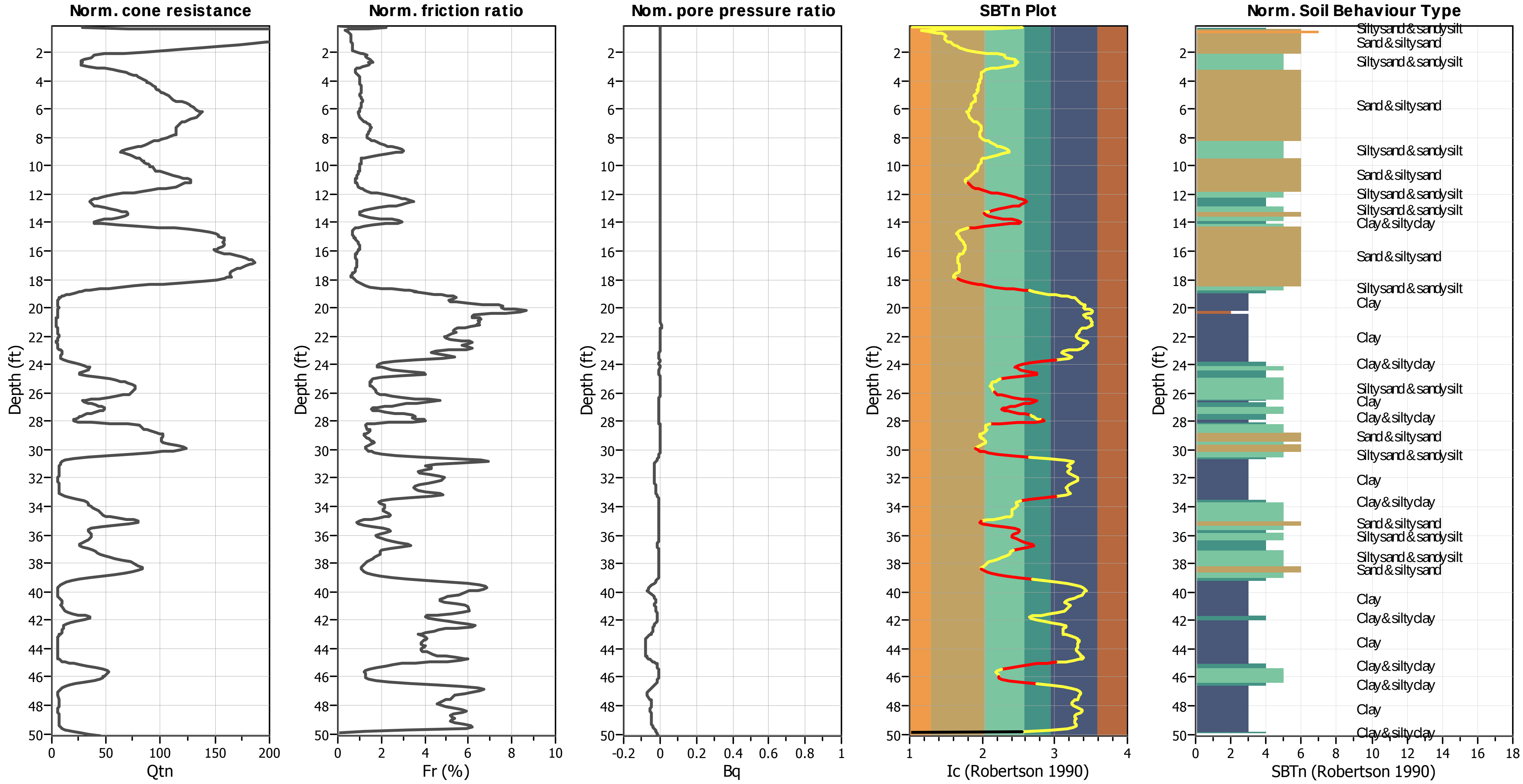
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



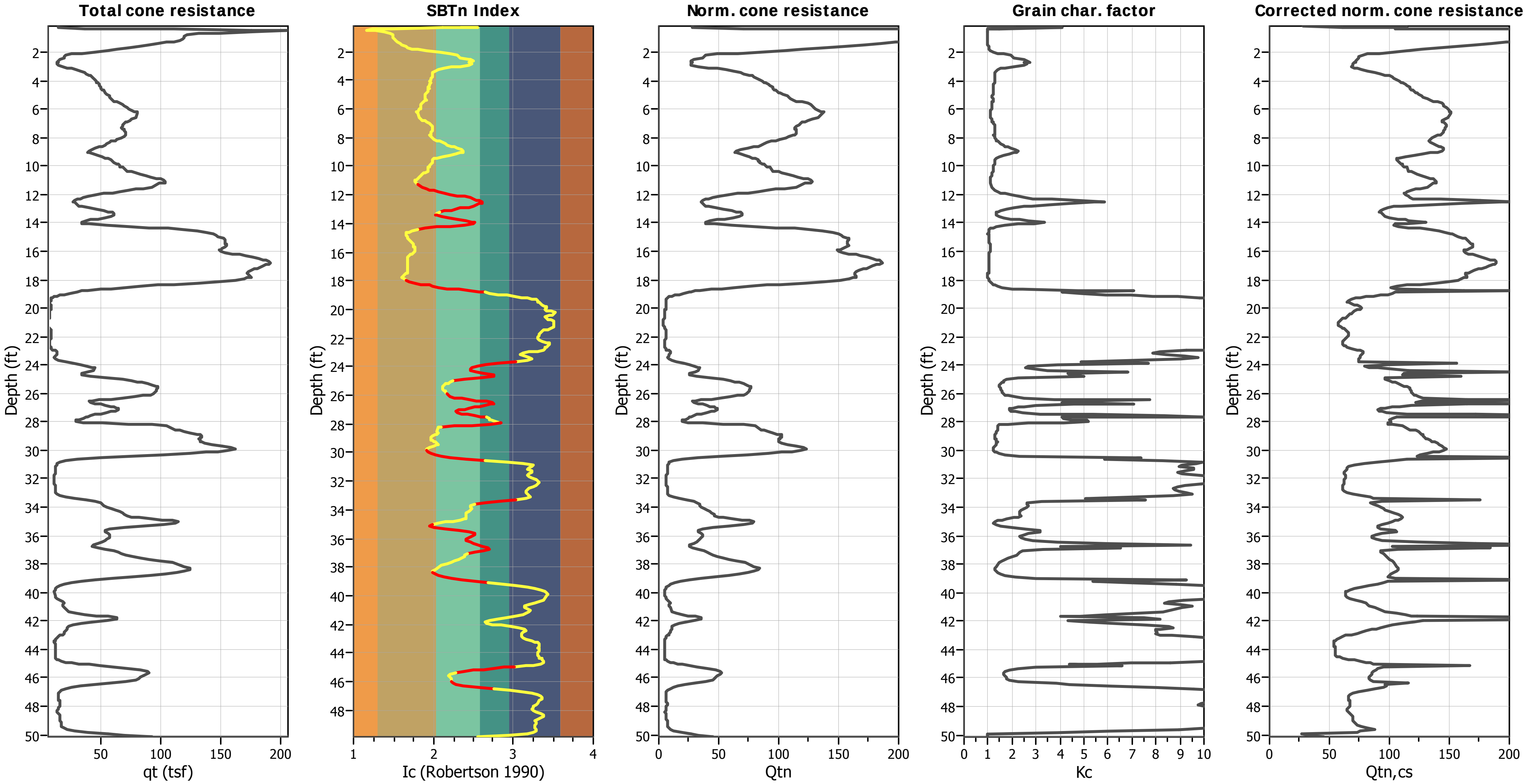
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

SBTn legend

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

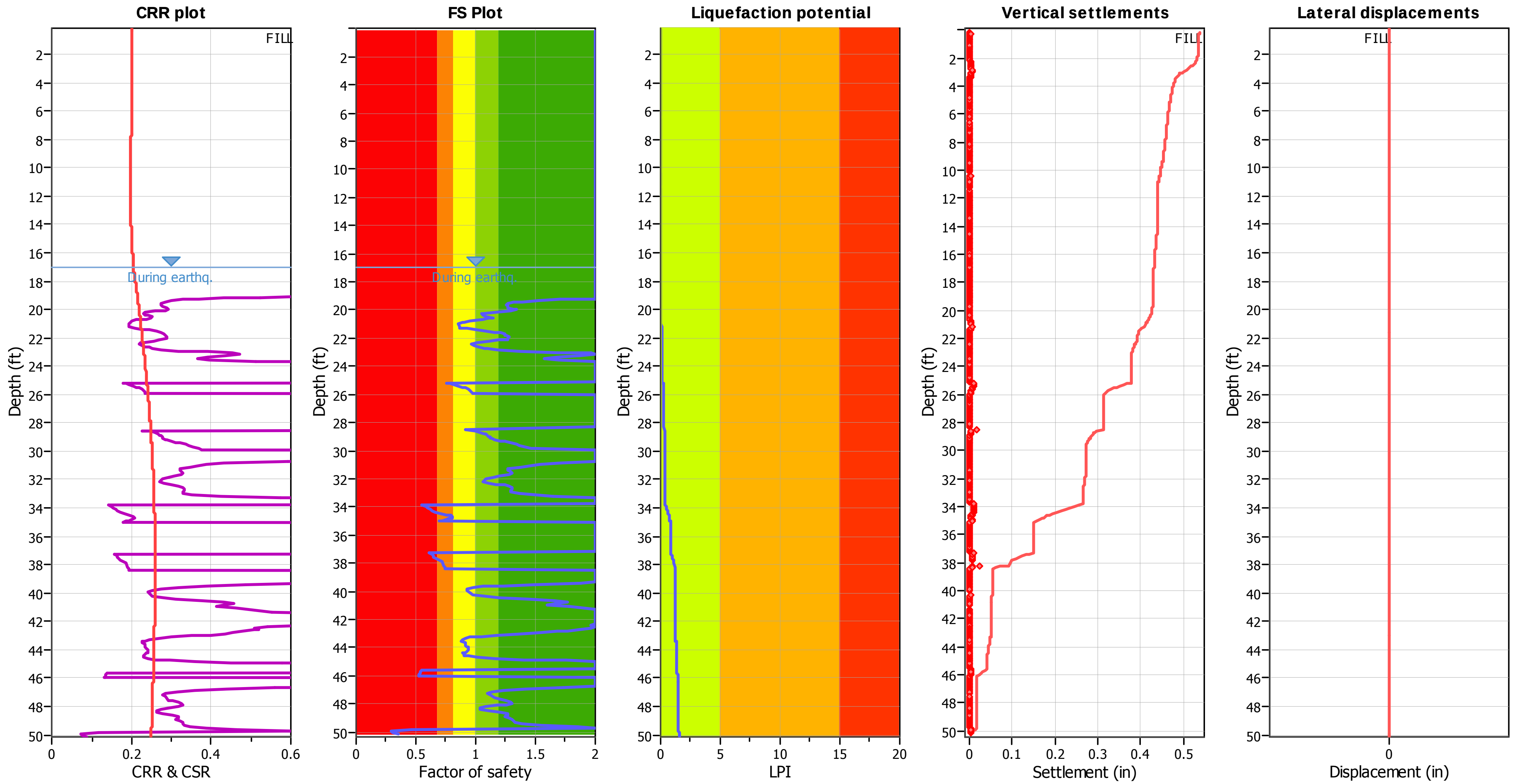
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

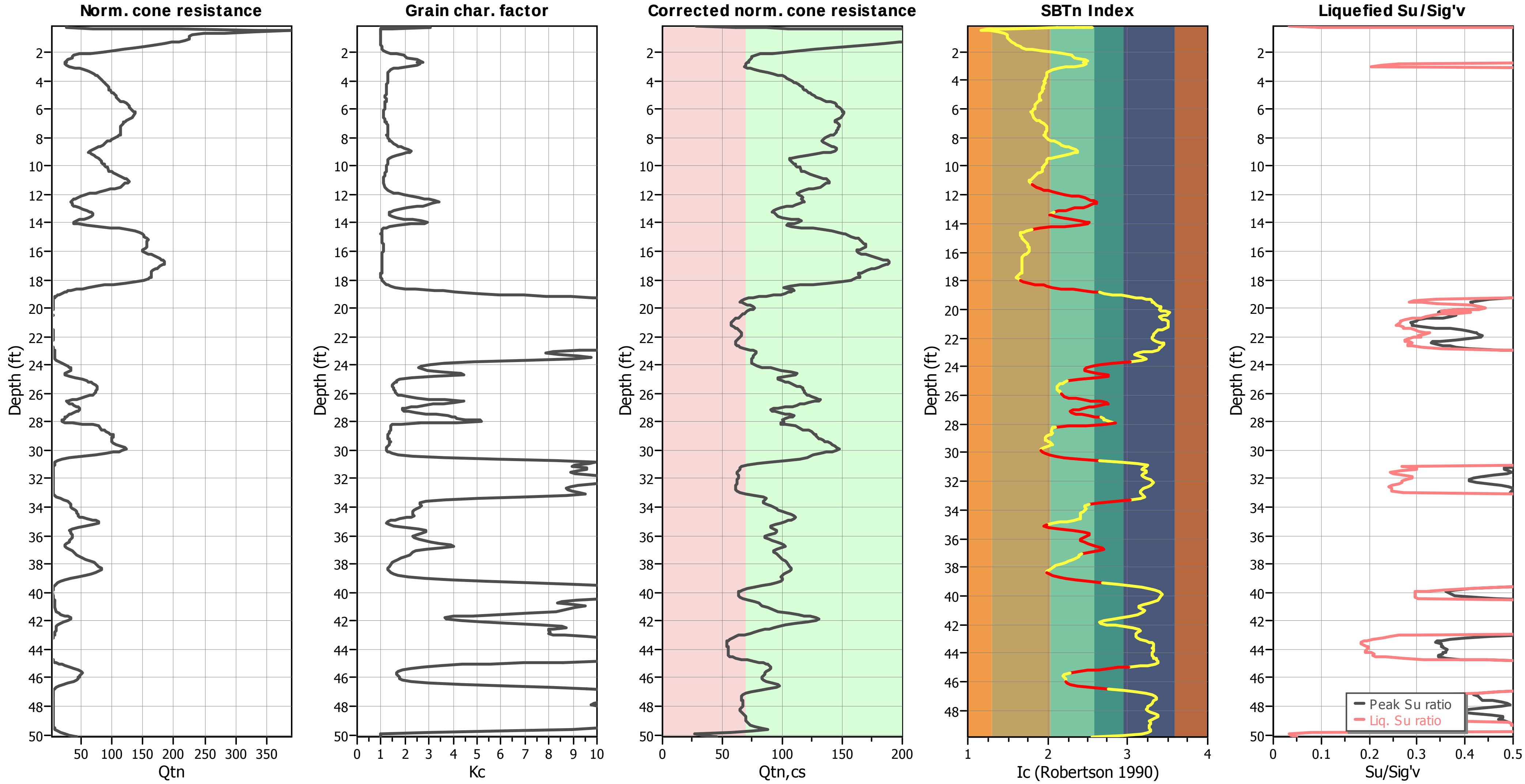
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

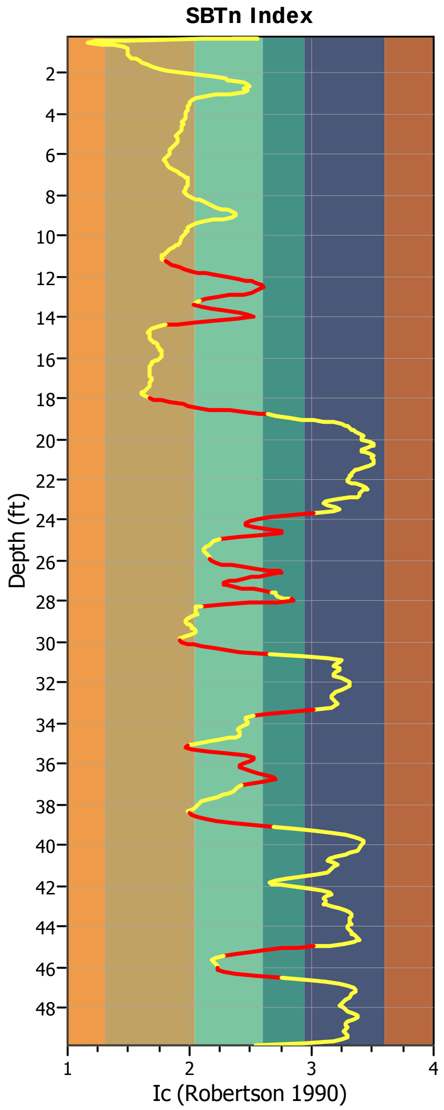
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	5.00 ft	Limit depth:	60.00 ft

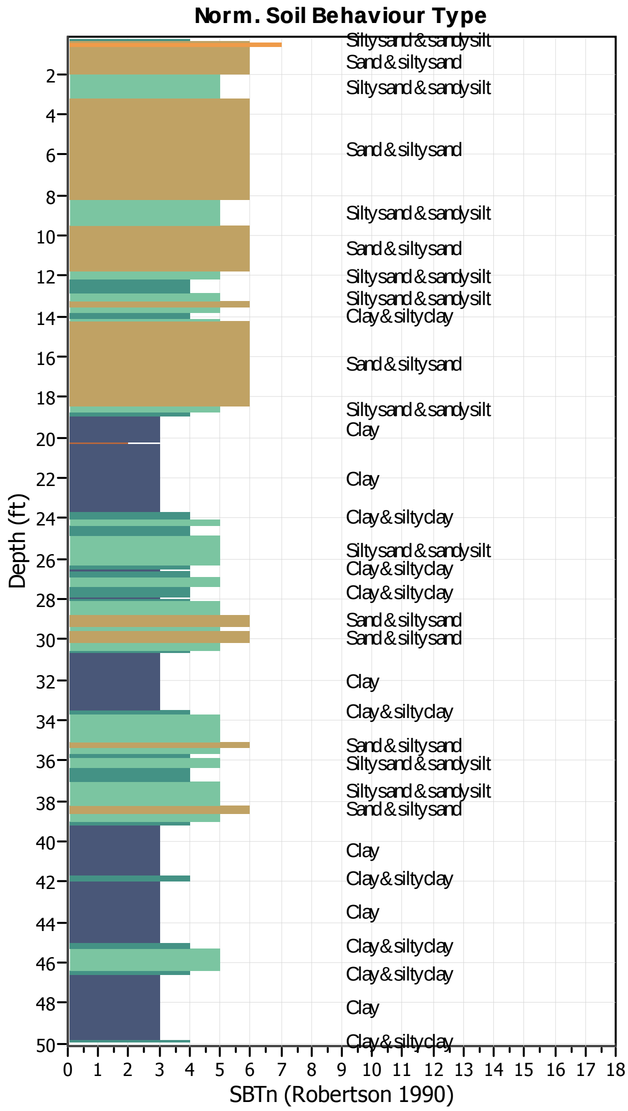
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

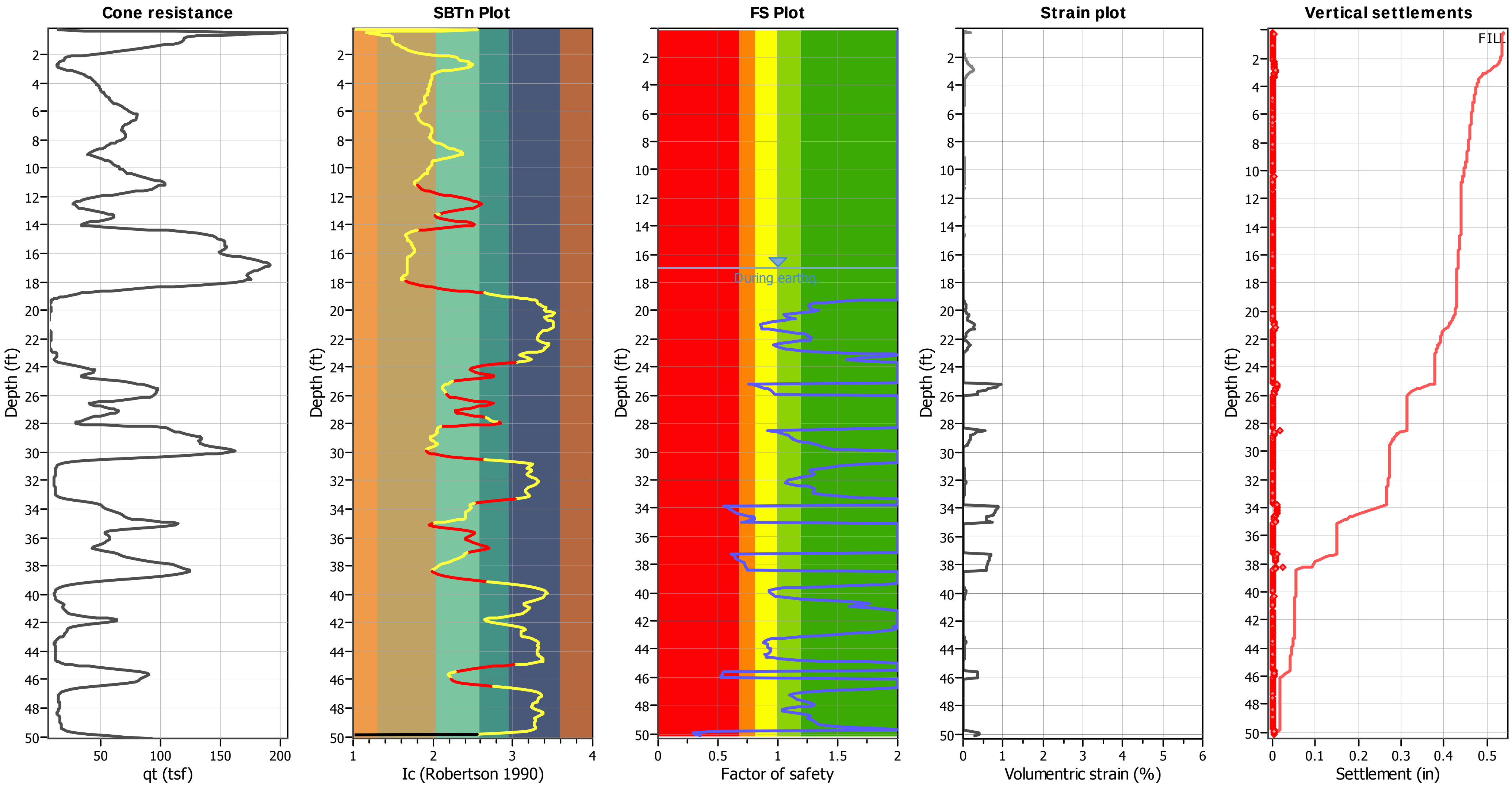
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	572
I_c maximum check value:	3.00	Total points excluded:	149
I_c change ratio value:	0.0250	Exclusion percentage:	26.05%
Minimum number of points in layer:	4	Number of layers detected:	21

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

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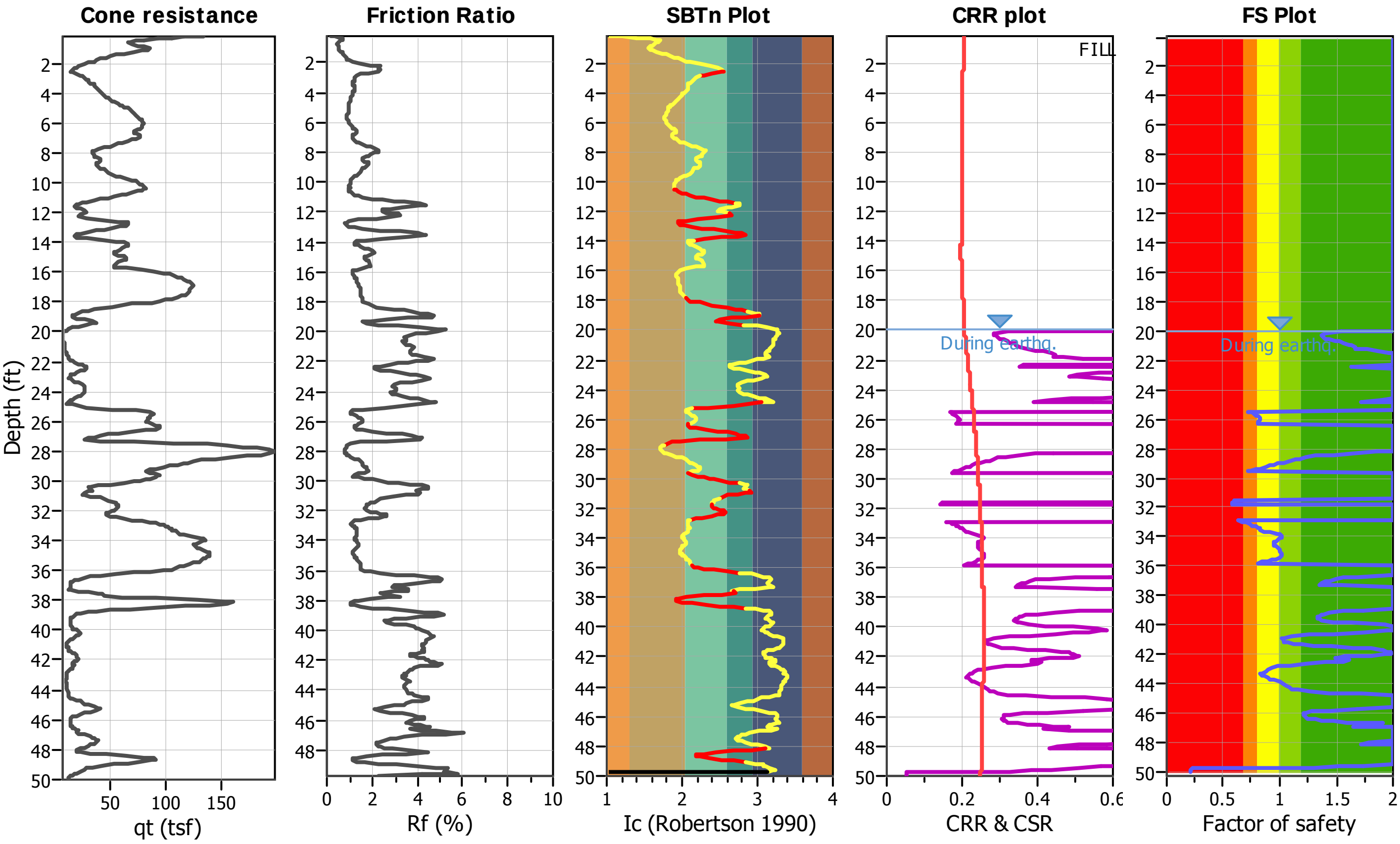
LIQUEFACTION ANALYSIS REPORT

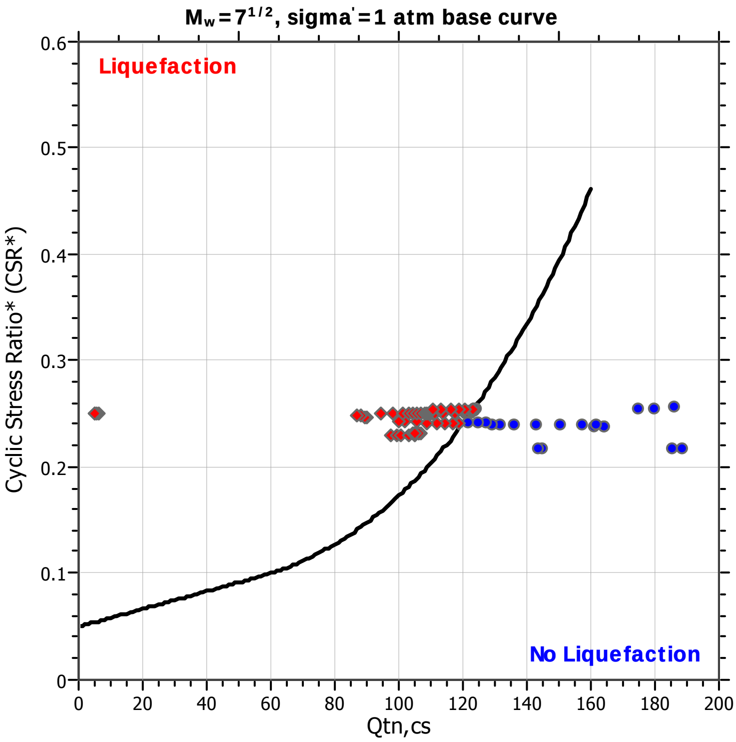
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

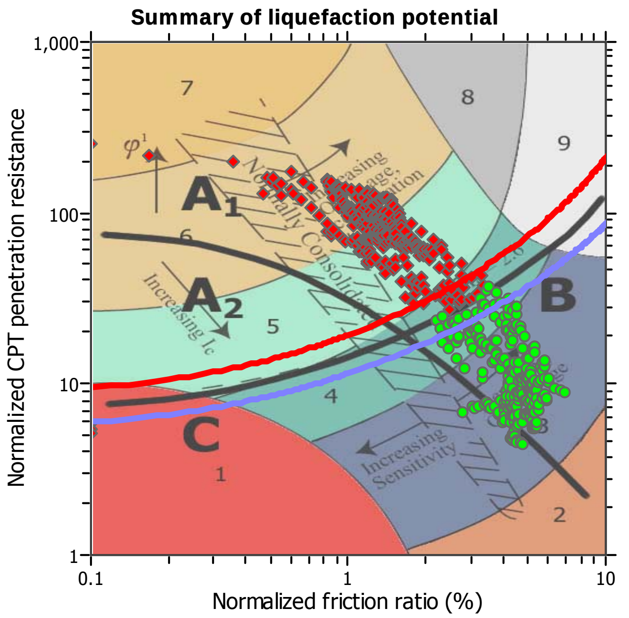
CPT file : CPT-5

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	23.00 ft	Fill height:	3.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

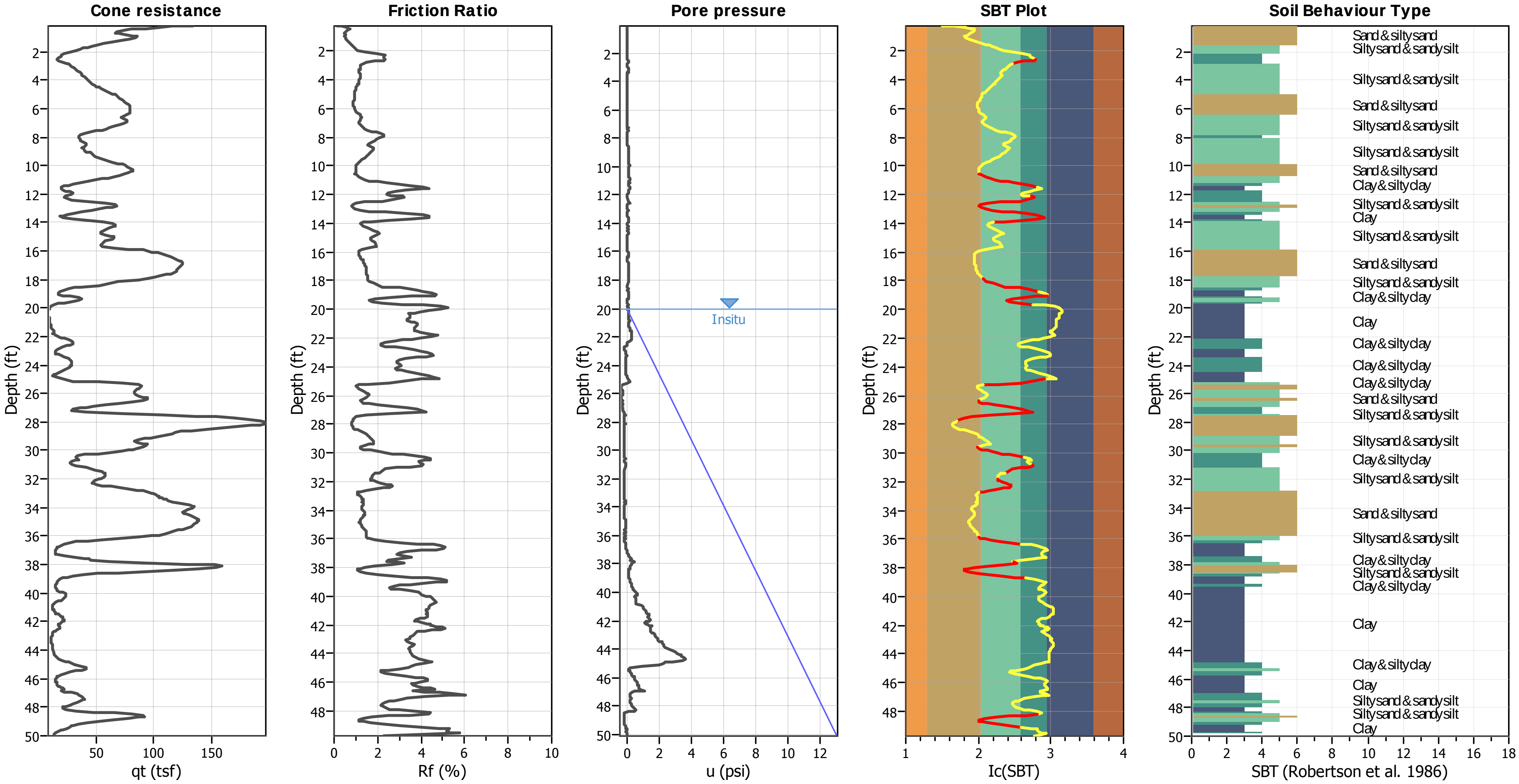






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



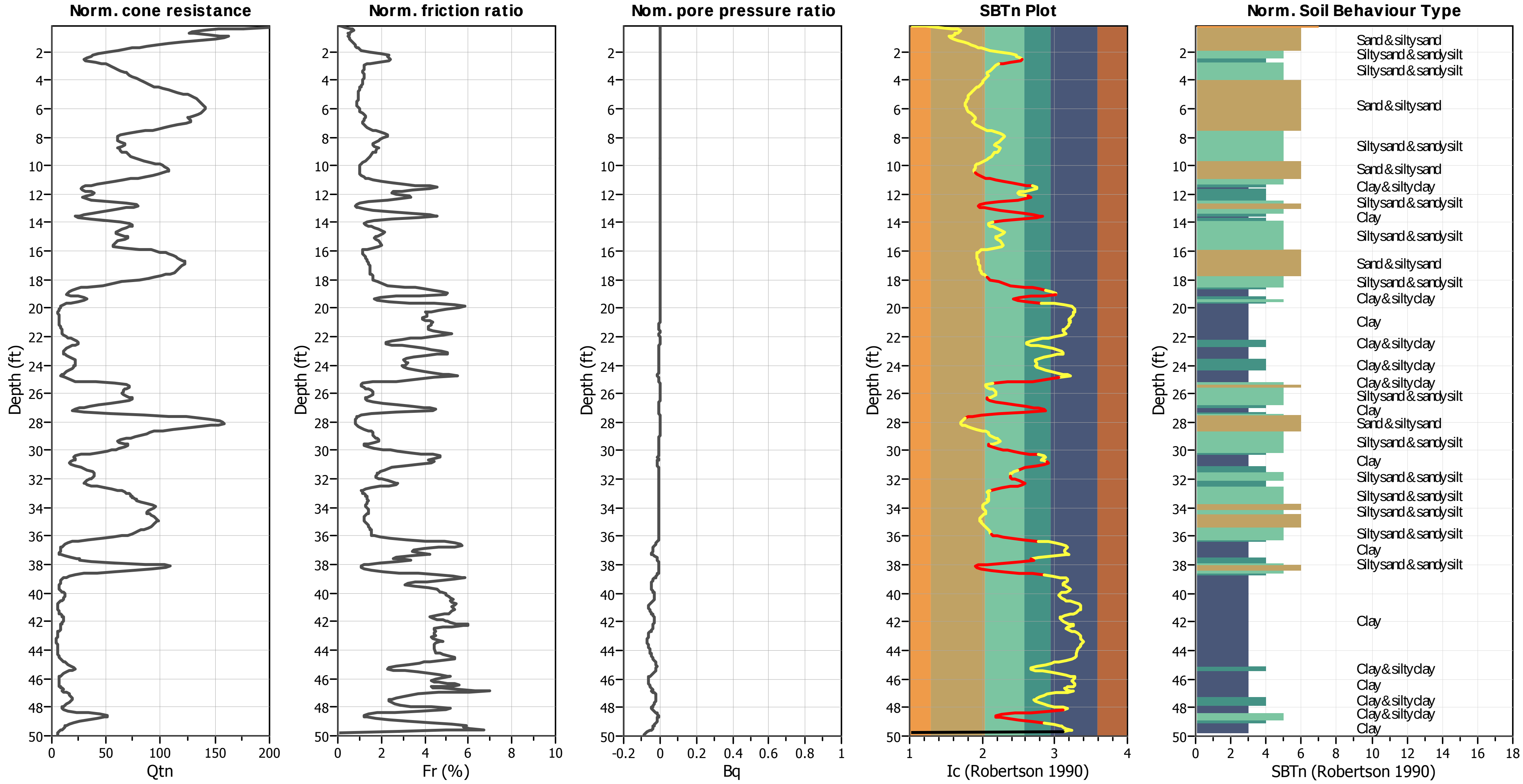
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



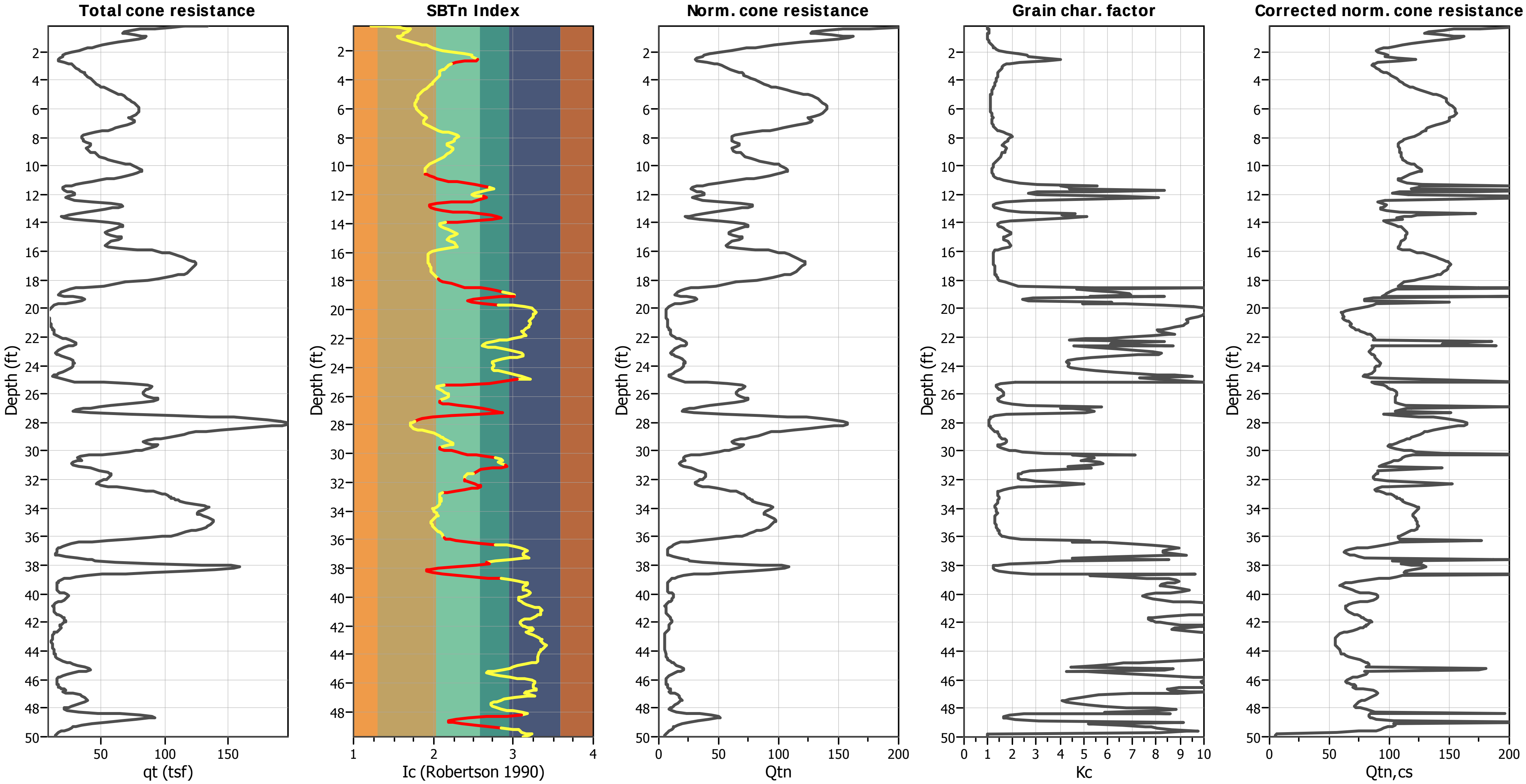
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBTn legend

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

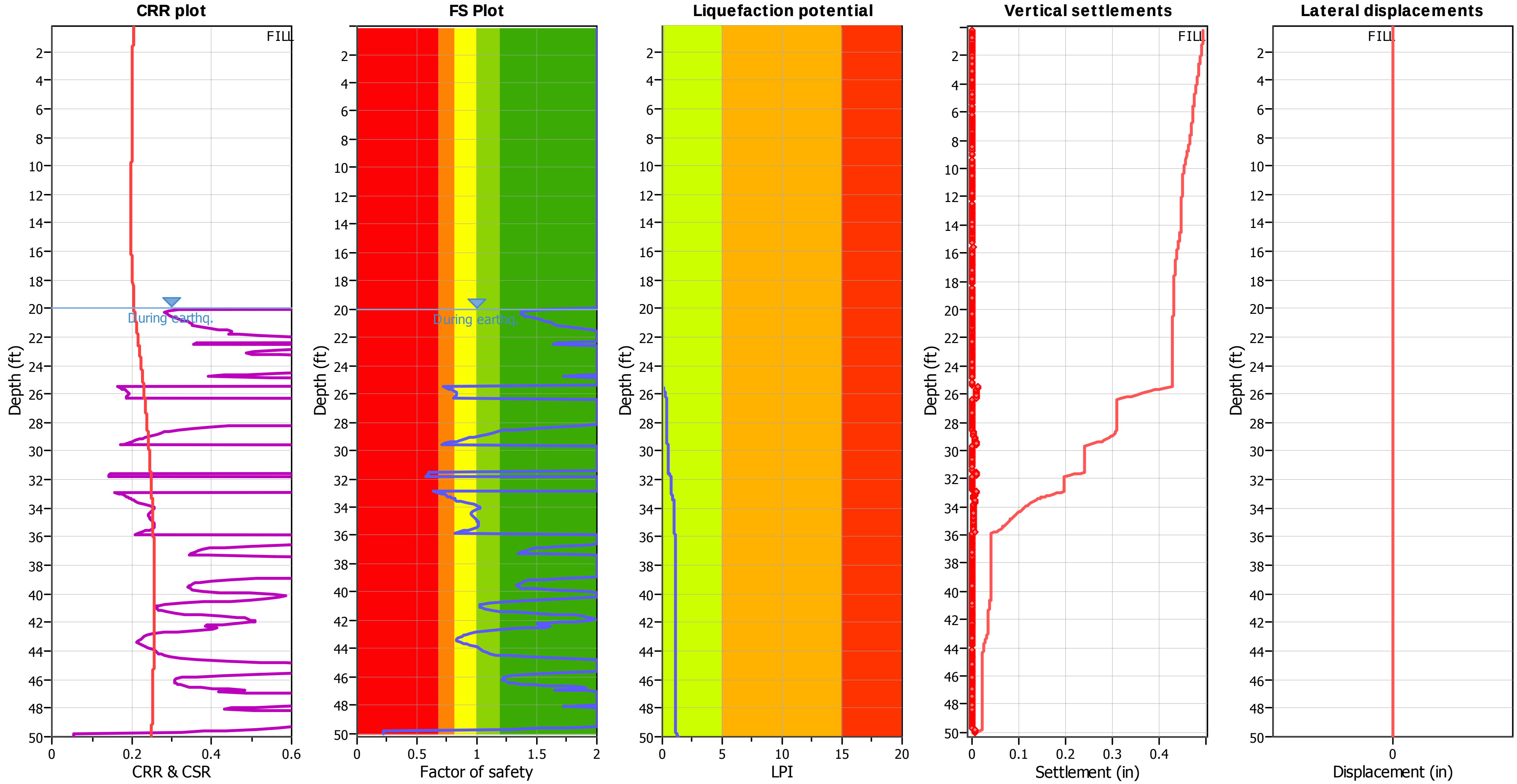
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

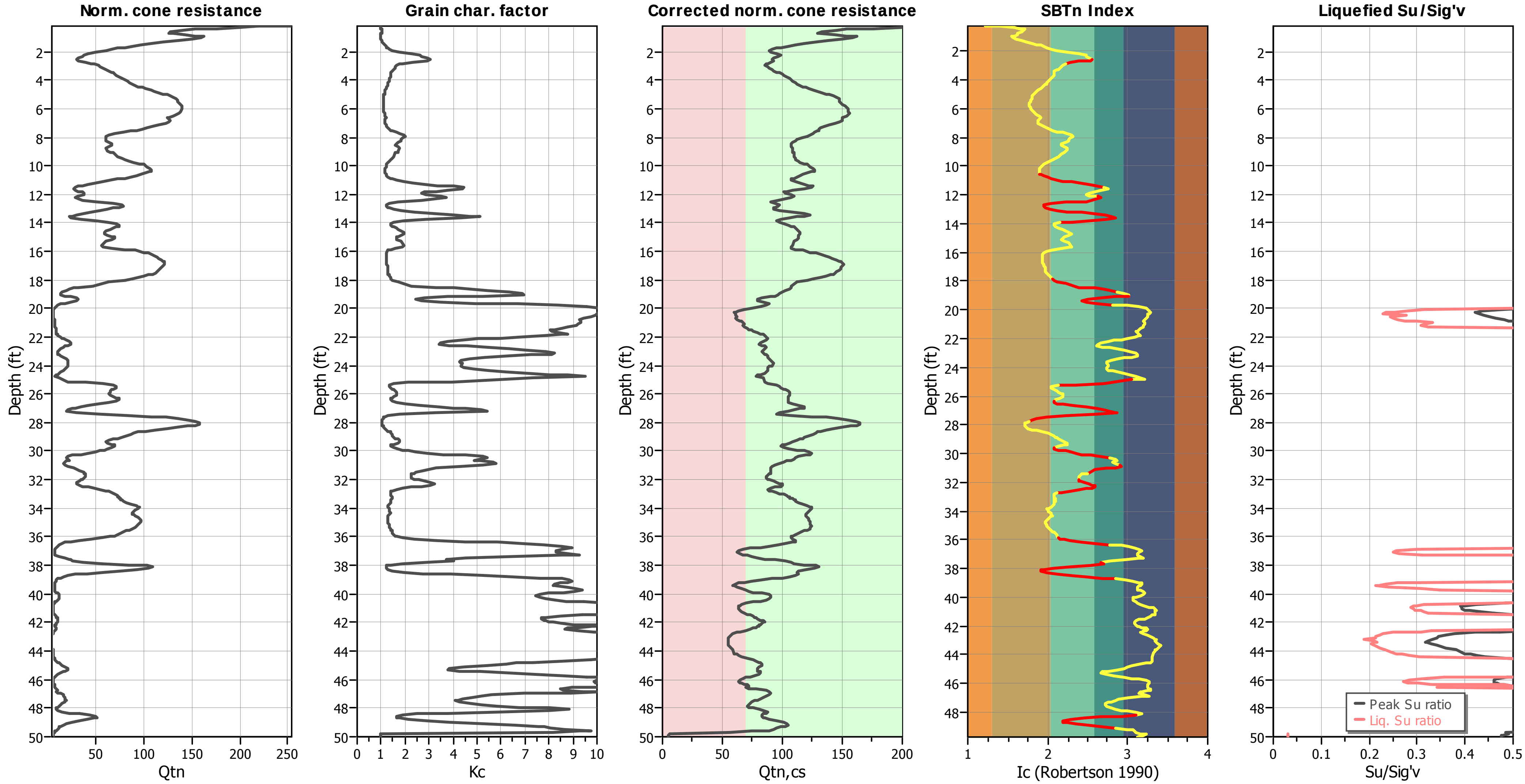
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

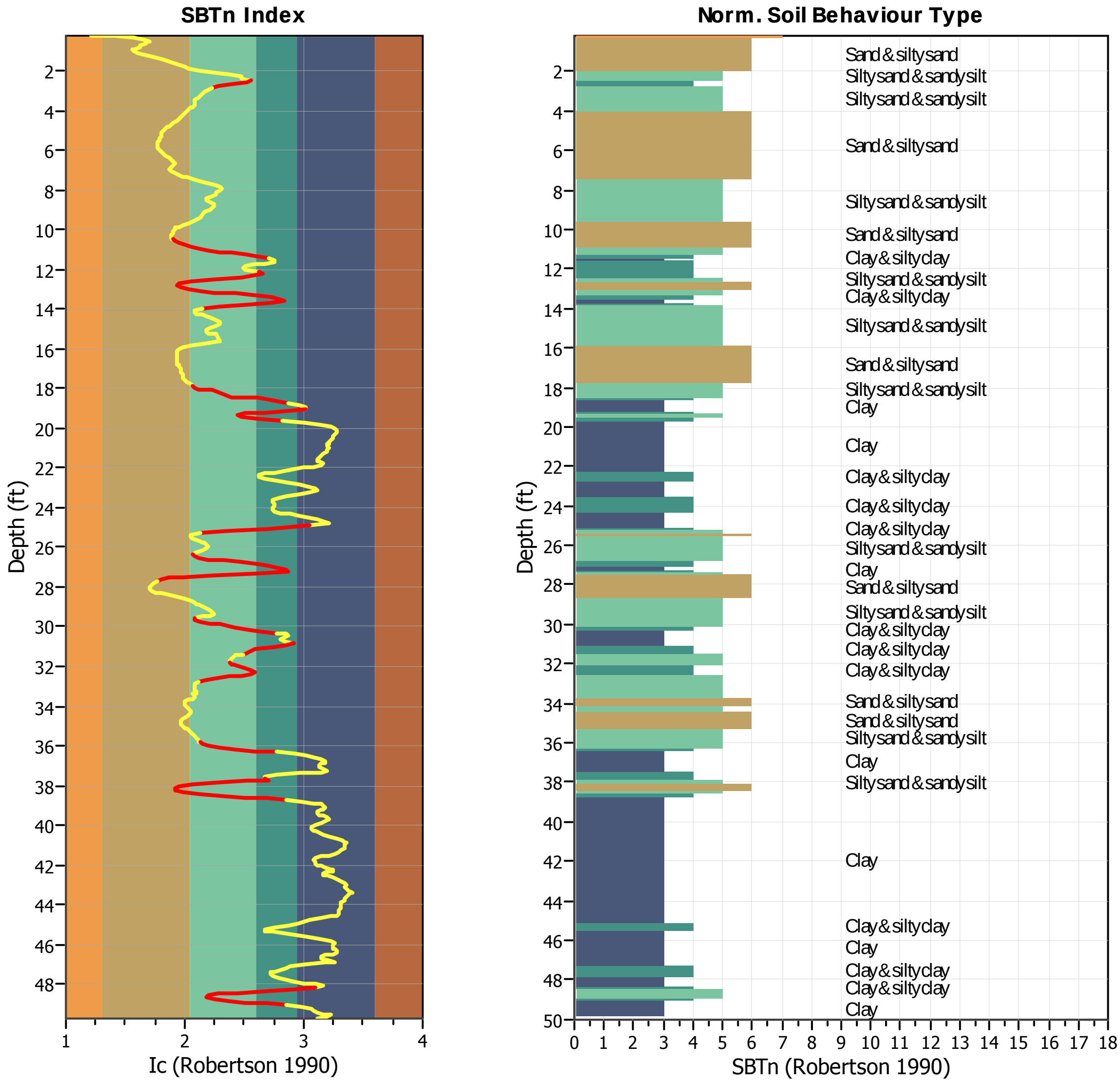
TRANSITION LAYER DETECTION ALGORITHM REPORT

Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



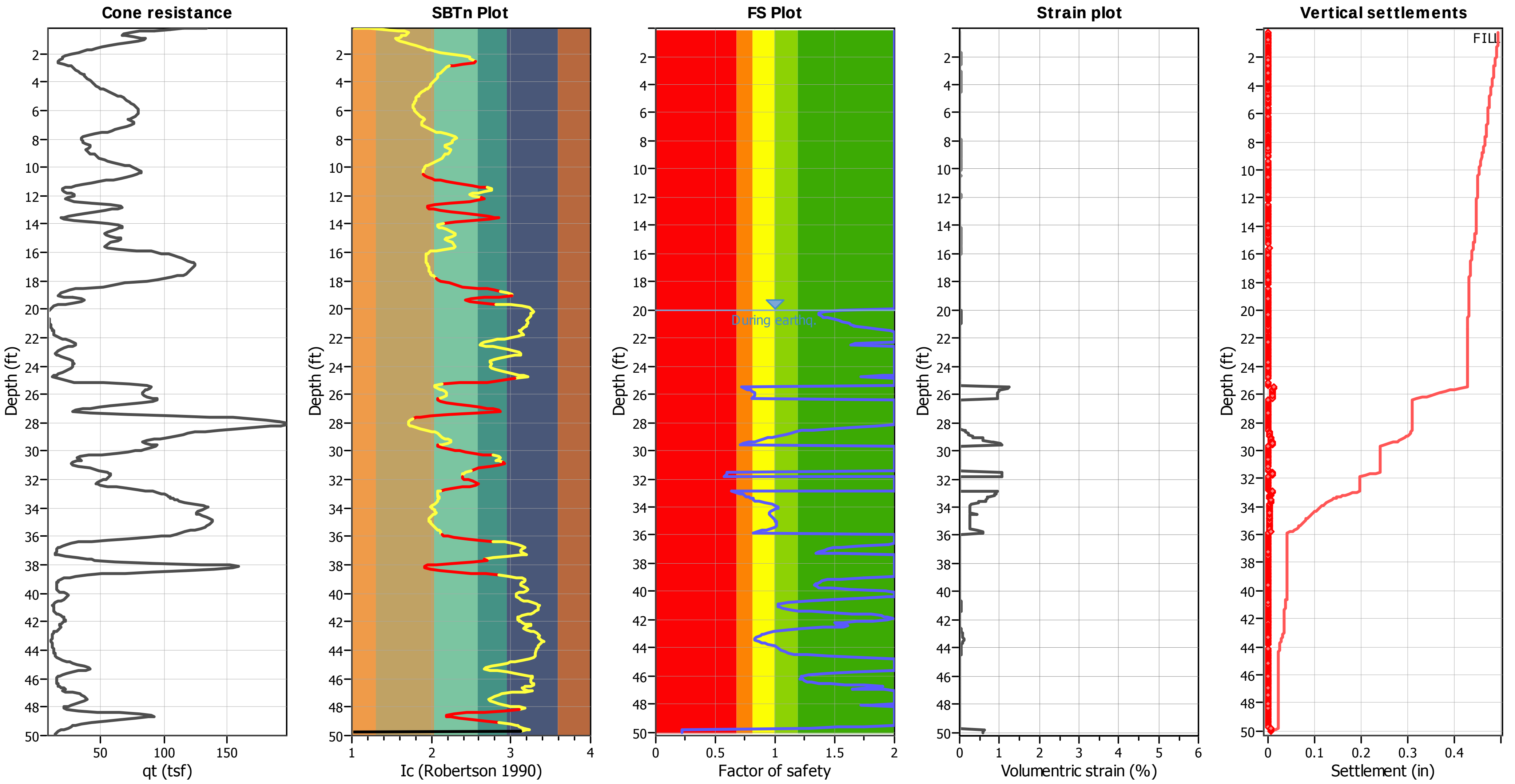
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	581
Total points excluded:	140
Exclusion percentage:	24.10%
Number of layers detected:	20

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

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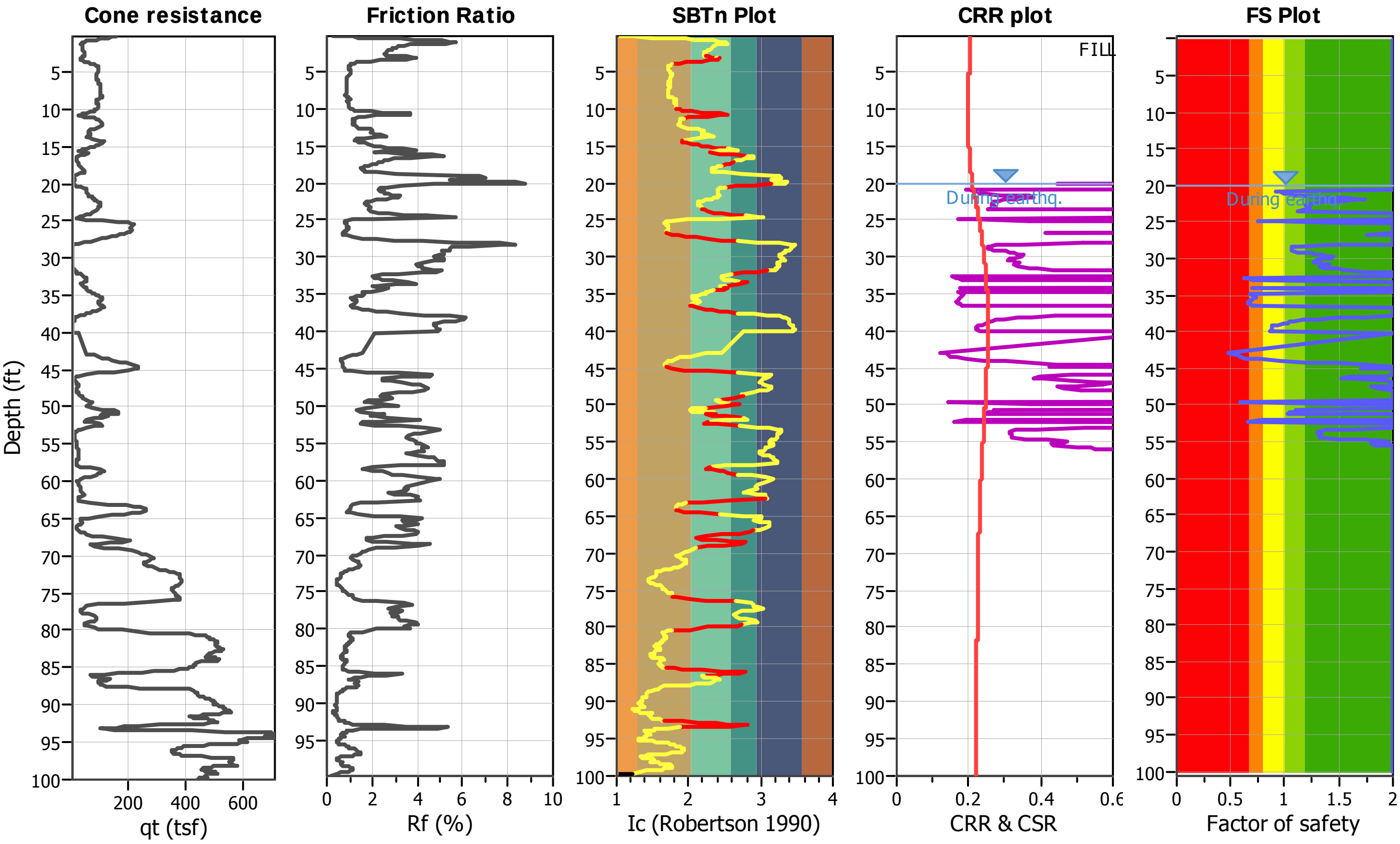
LIQUEFACTION ANALYSIS REPORT

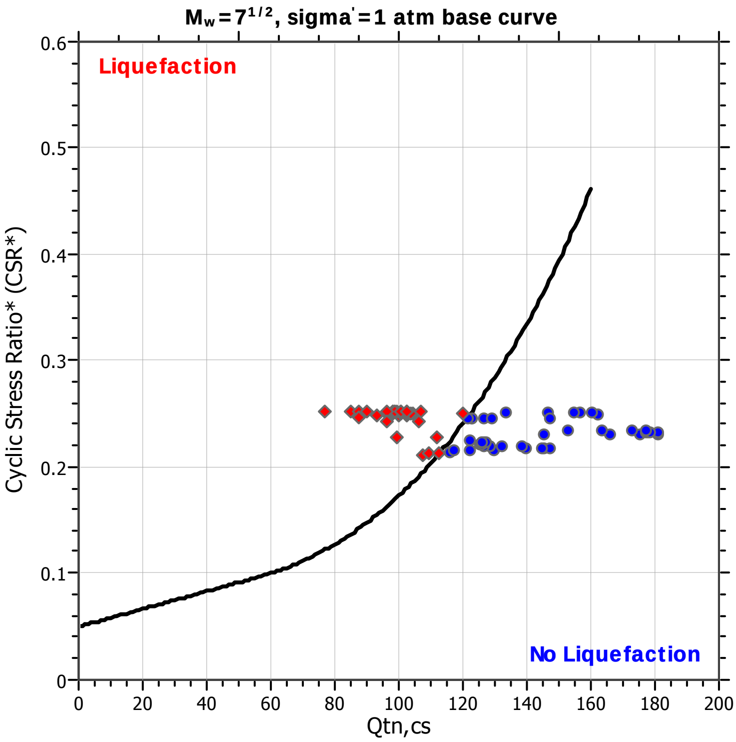
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

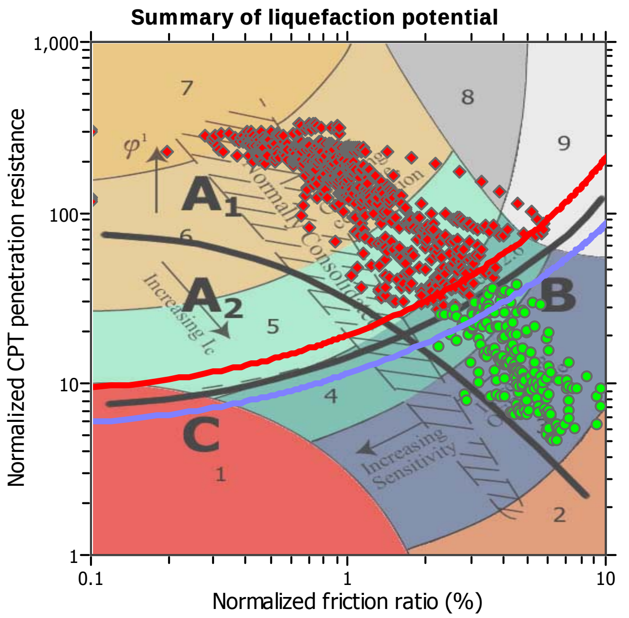
CPT file : CPT-6

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	24.00 ft	Fill height:	4.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

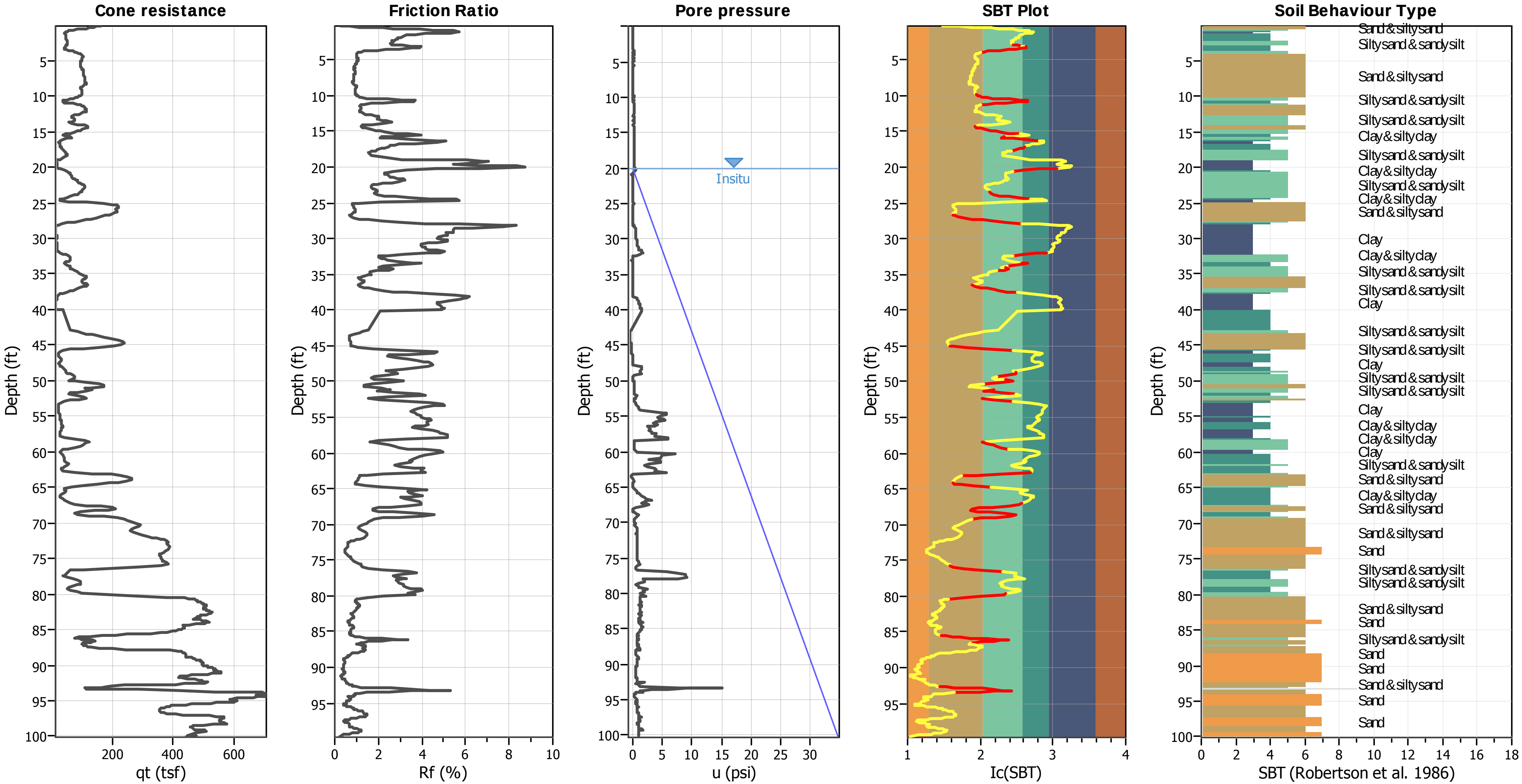






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



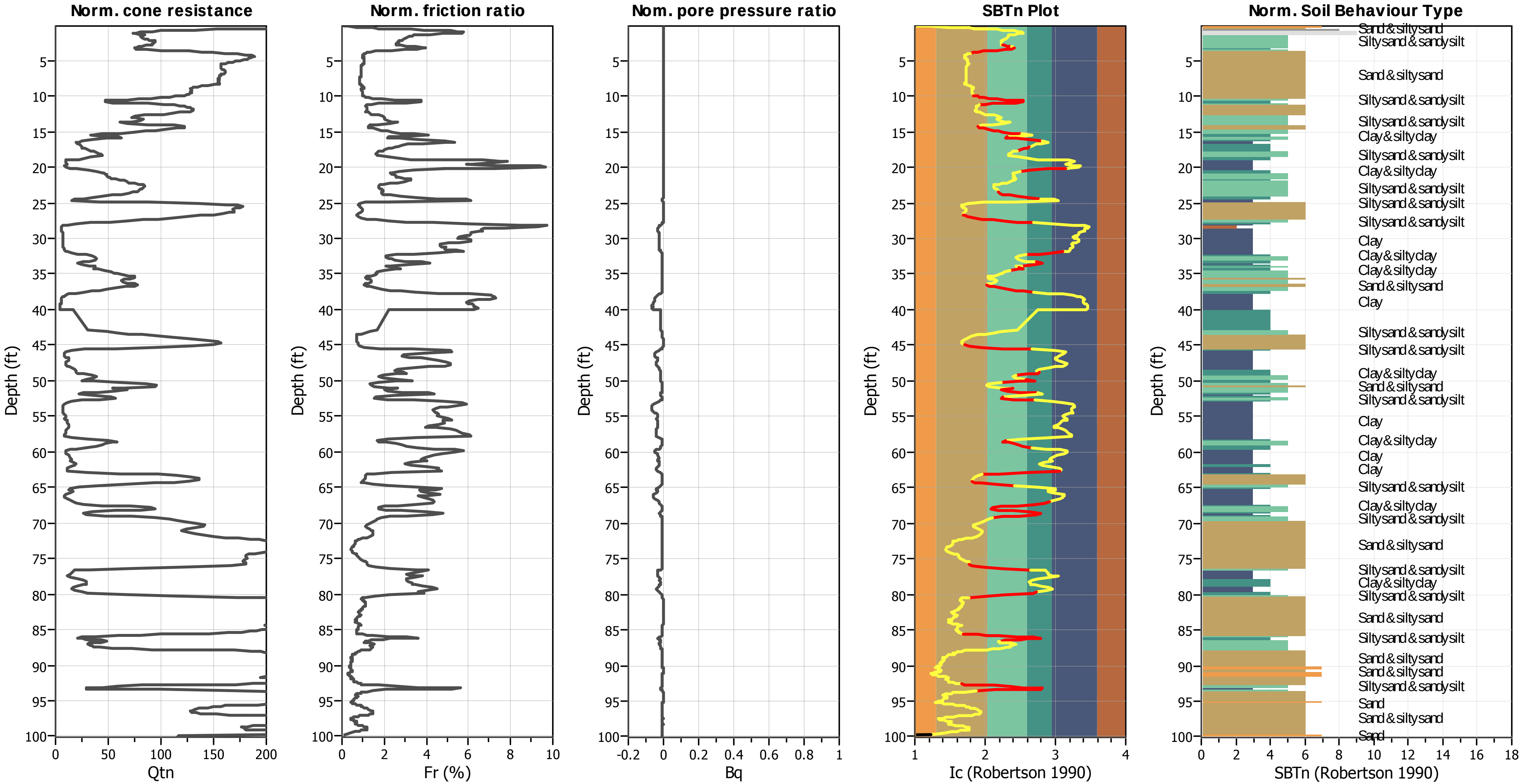
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3		
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes		
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes		
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils		
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes		
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft		

SBT legend

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

CPT basic interpretation plots (normalized)



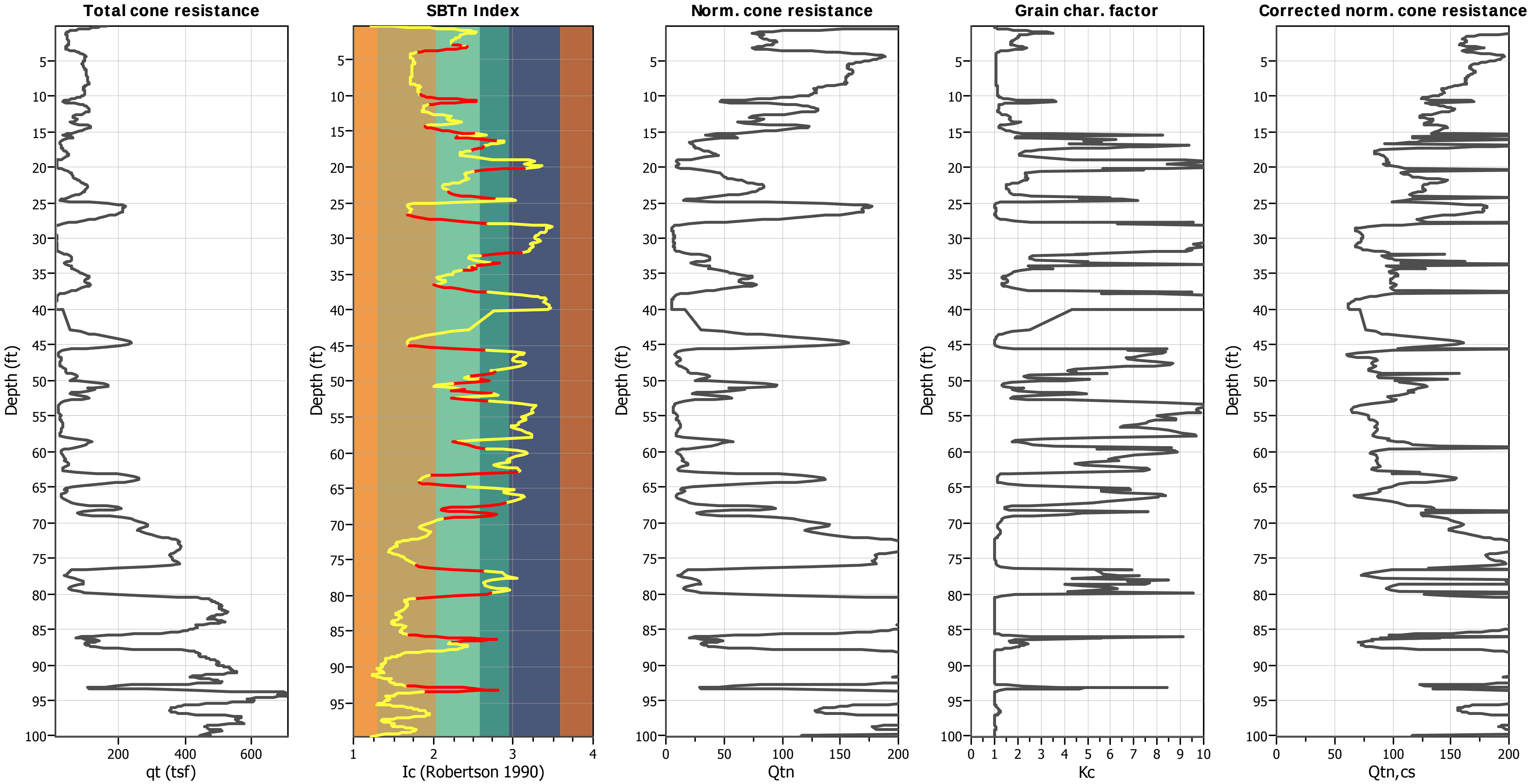
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBTn legend

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

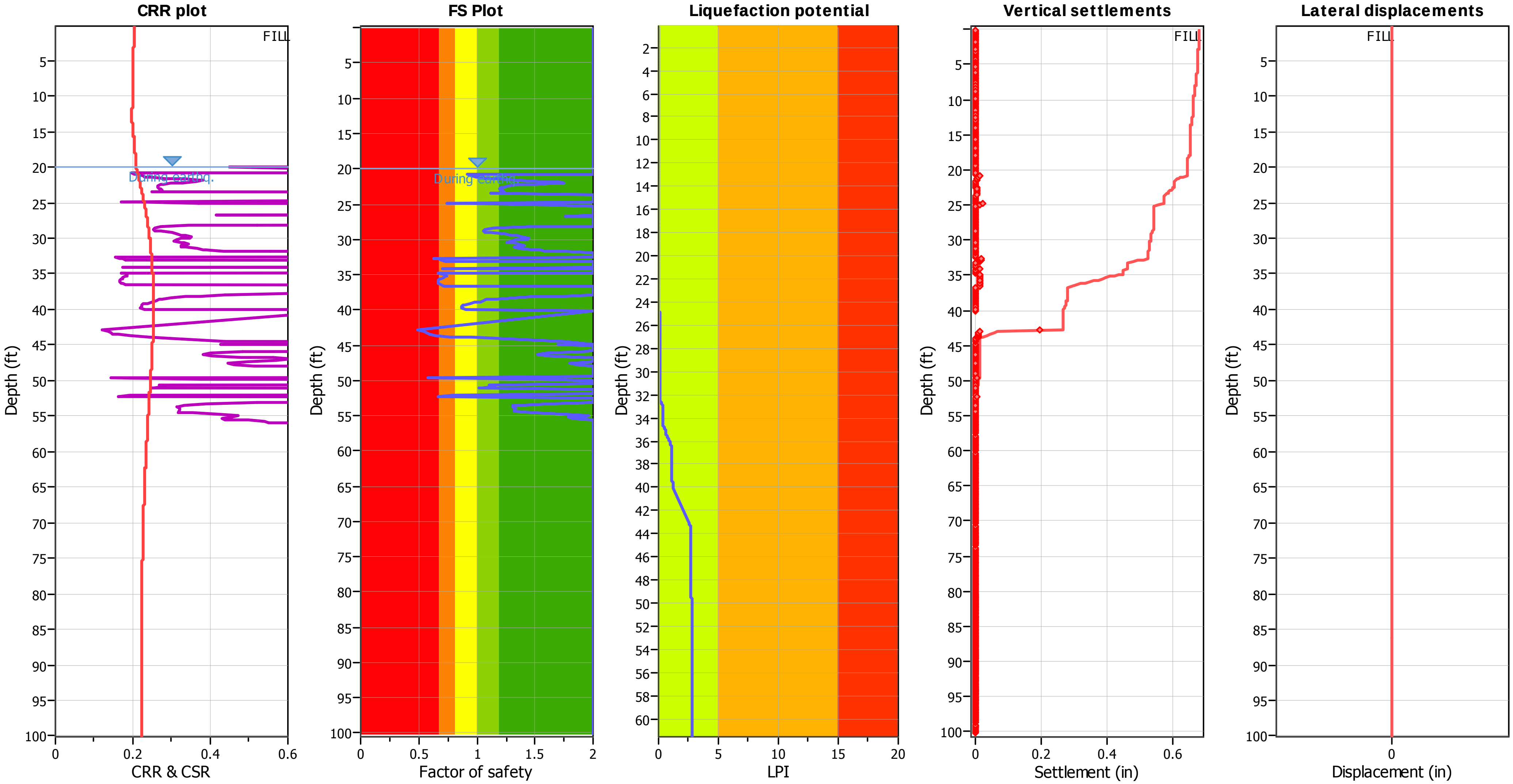
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

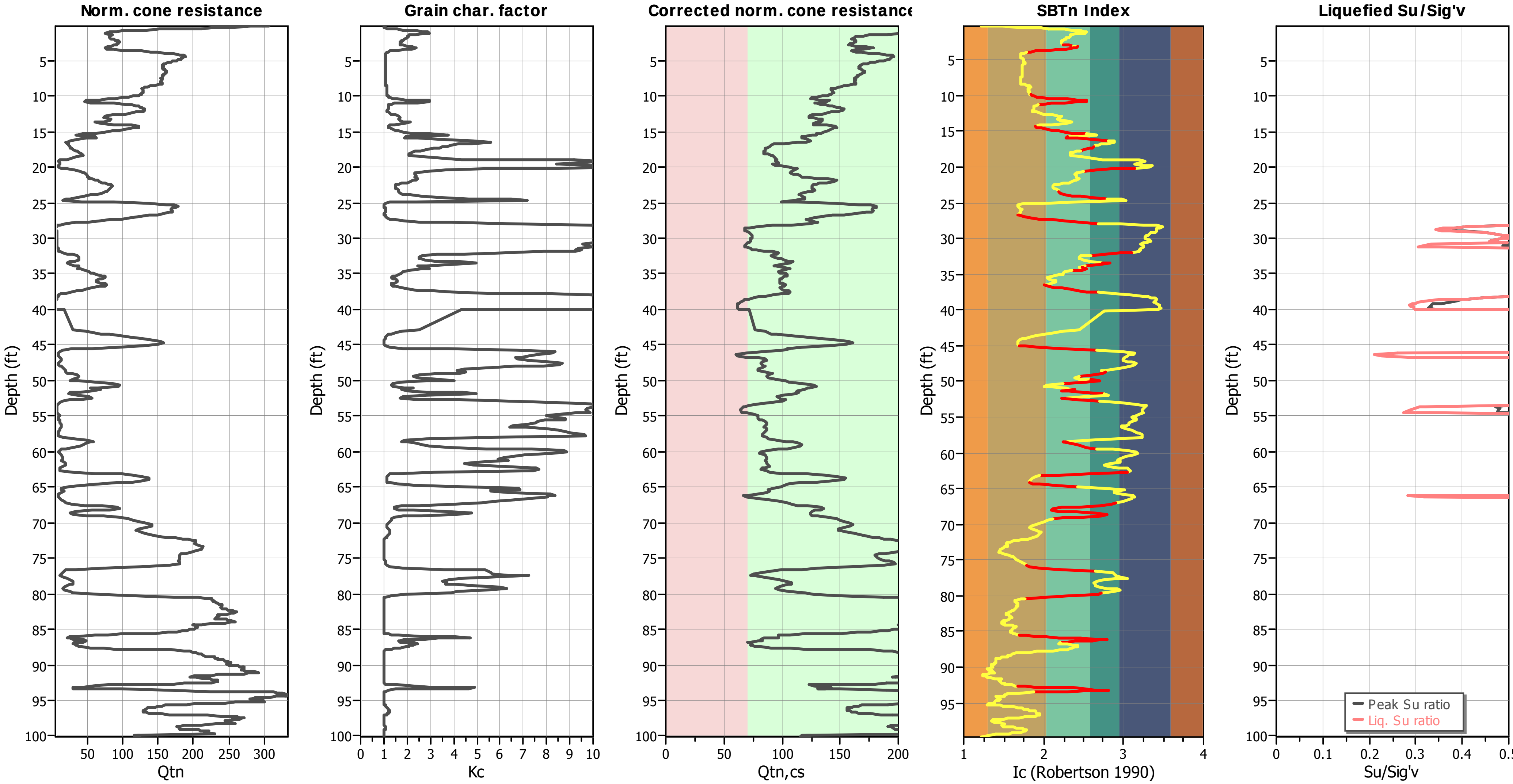
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

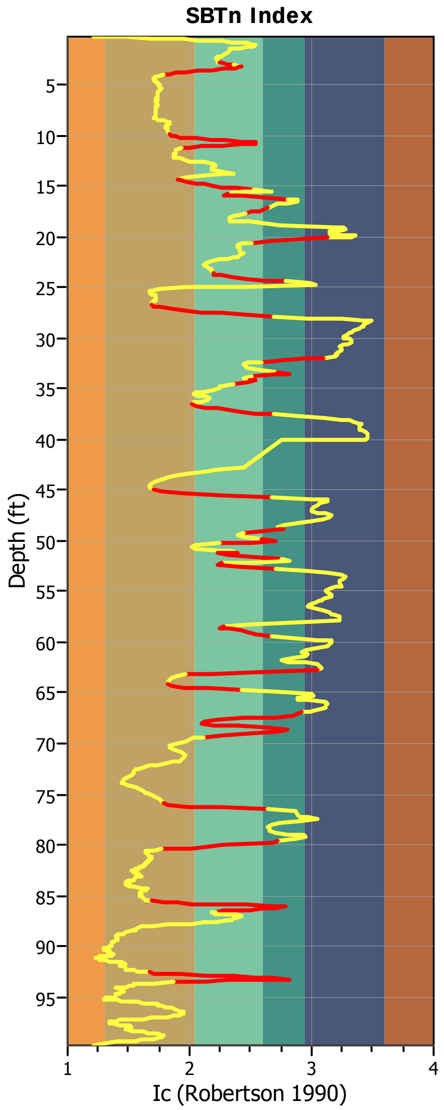
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

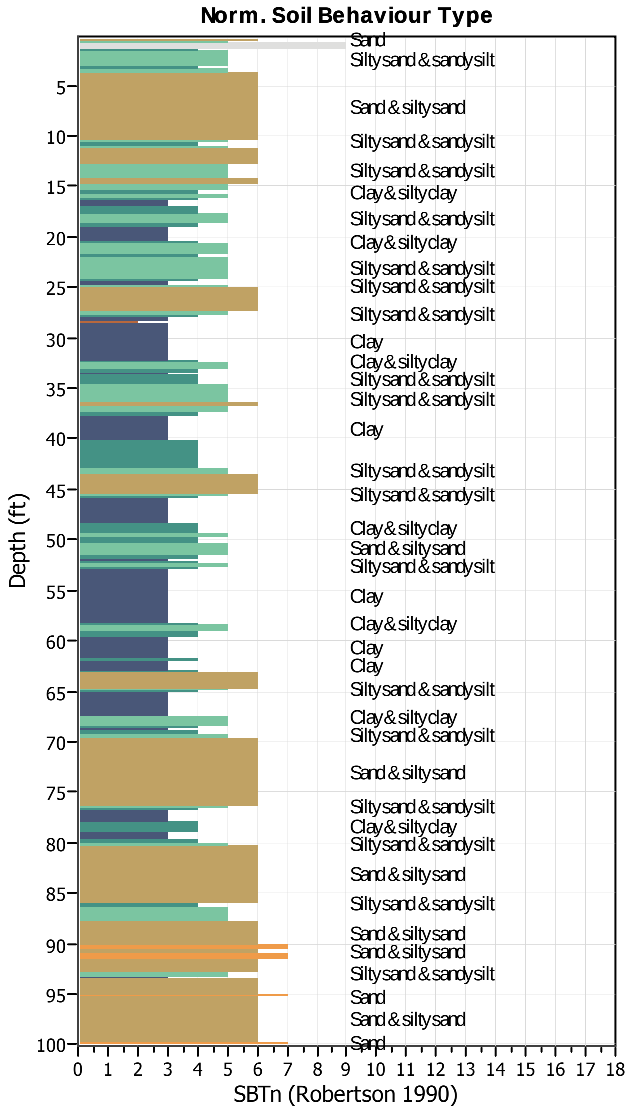
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





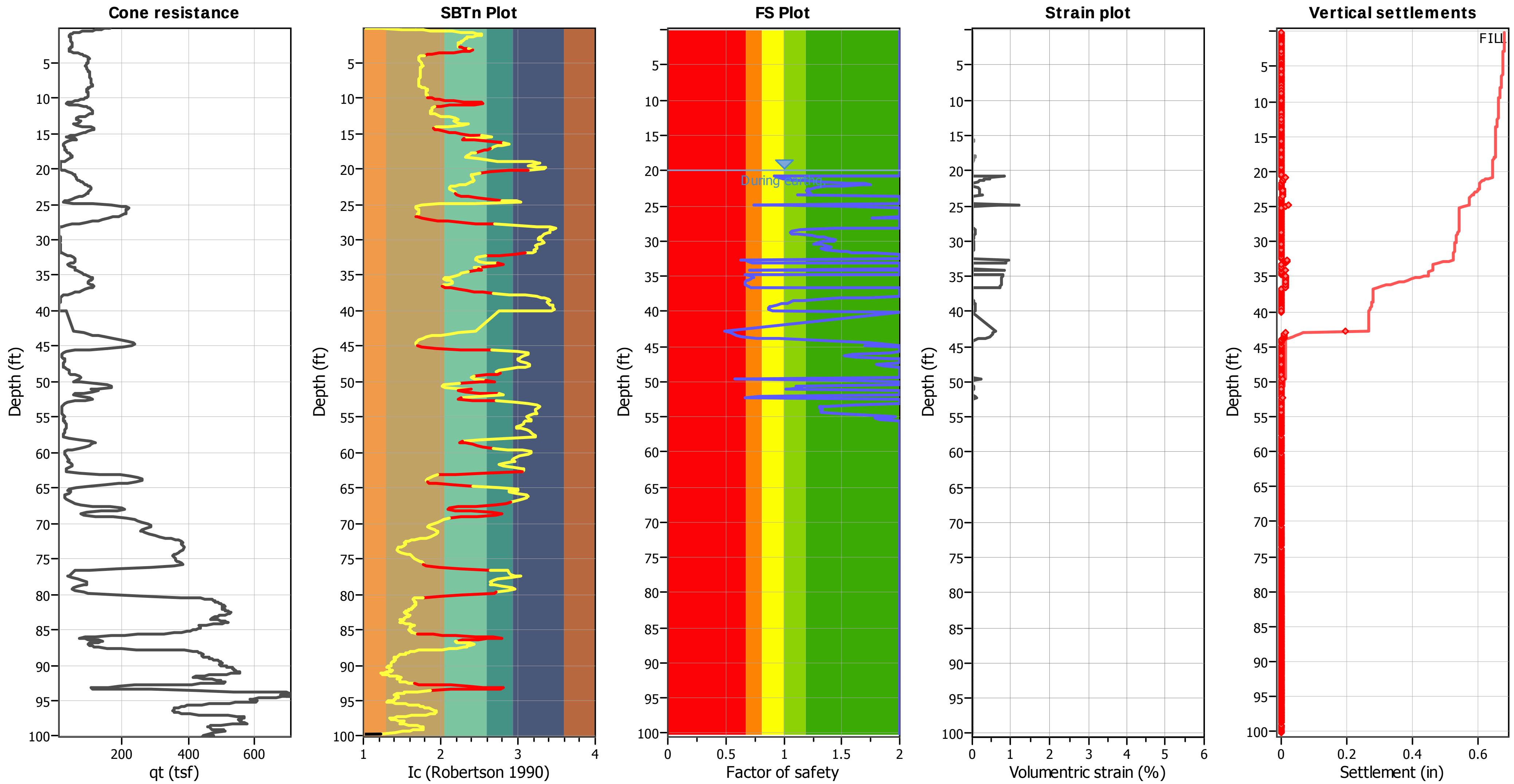
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	858
Total points excluded:	183
Exclusion percentage:	21.33%
Number of layers detected:	31

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

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LIQUEFACTION ANALYSIS REPORT

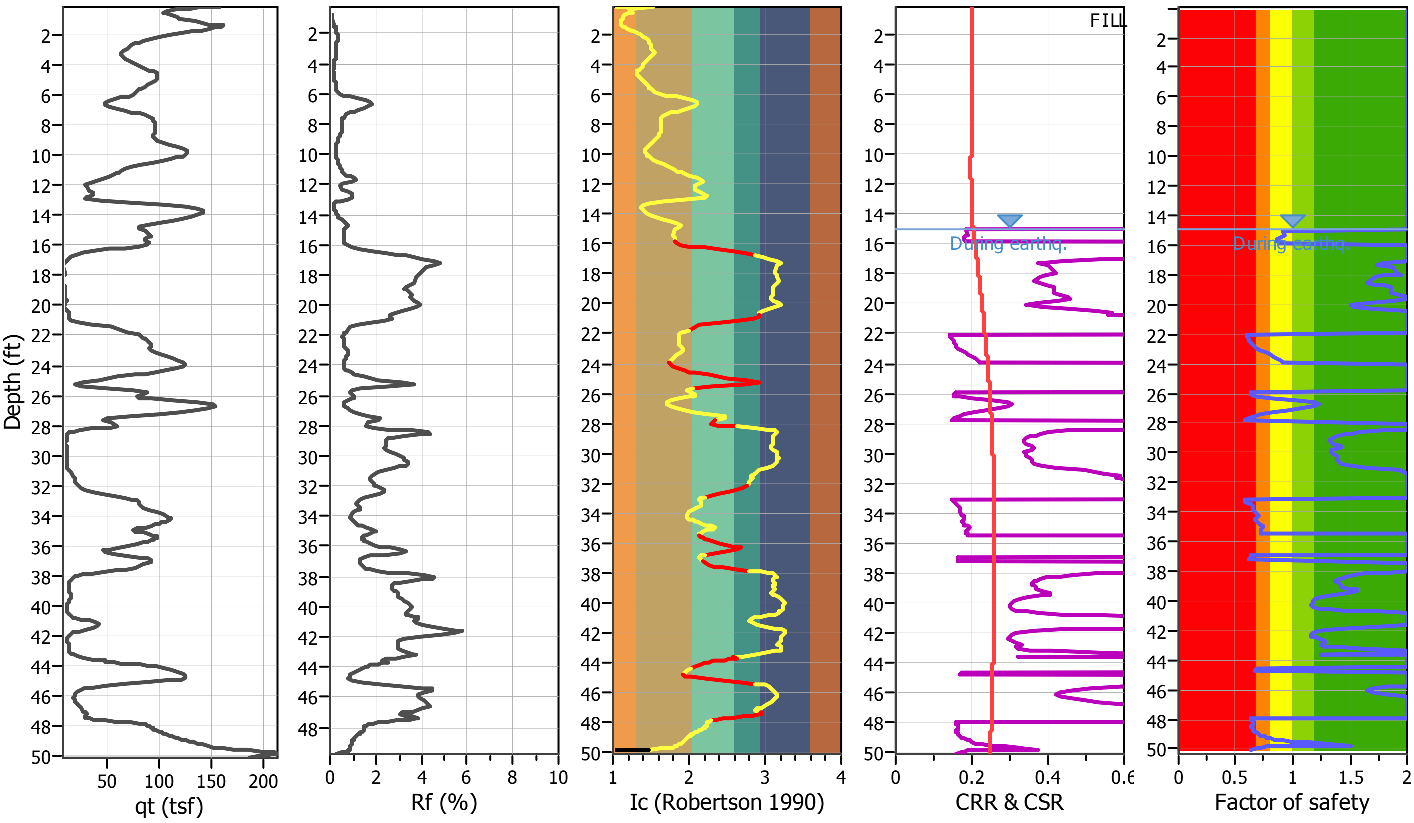
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

CPT file : CPT-7

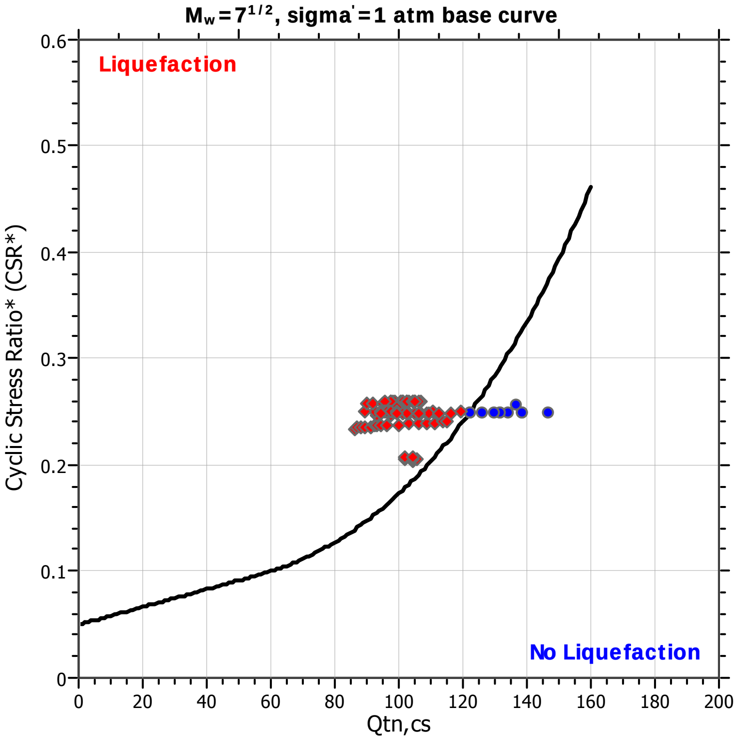
Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	22.00 ft	Fill height:	7.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

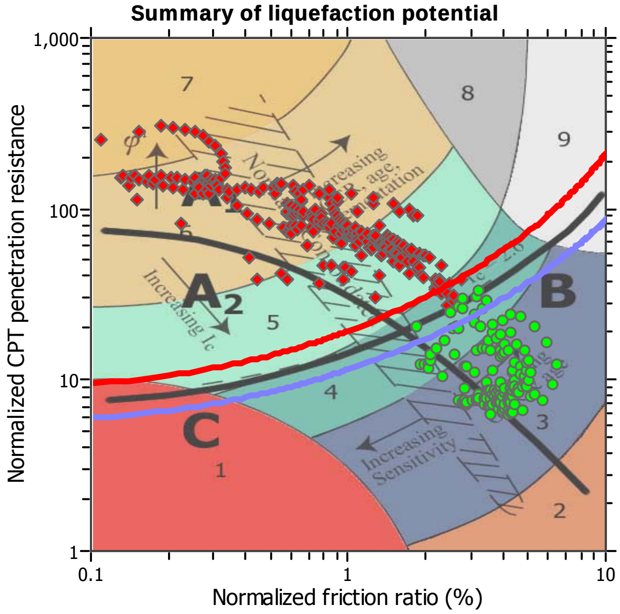
Cone resistance **Friction Ratio** **SBTn Plot** **CRR plot** **FS Plot**



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

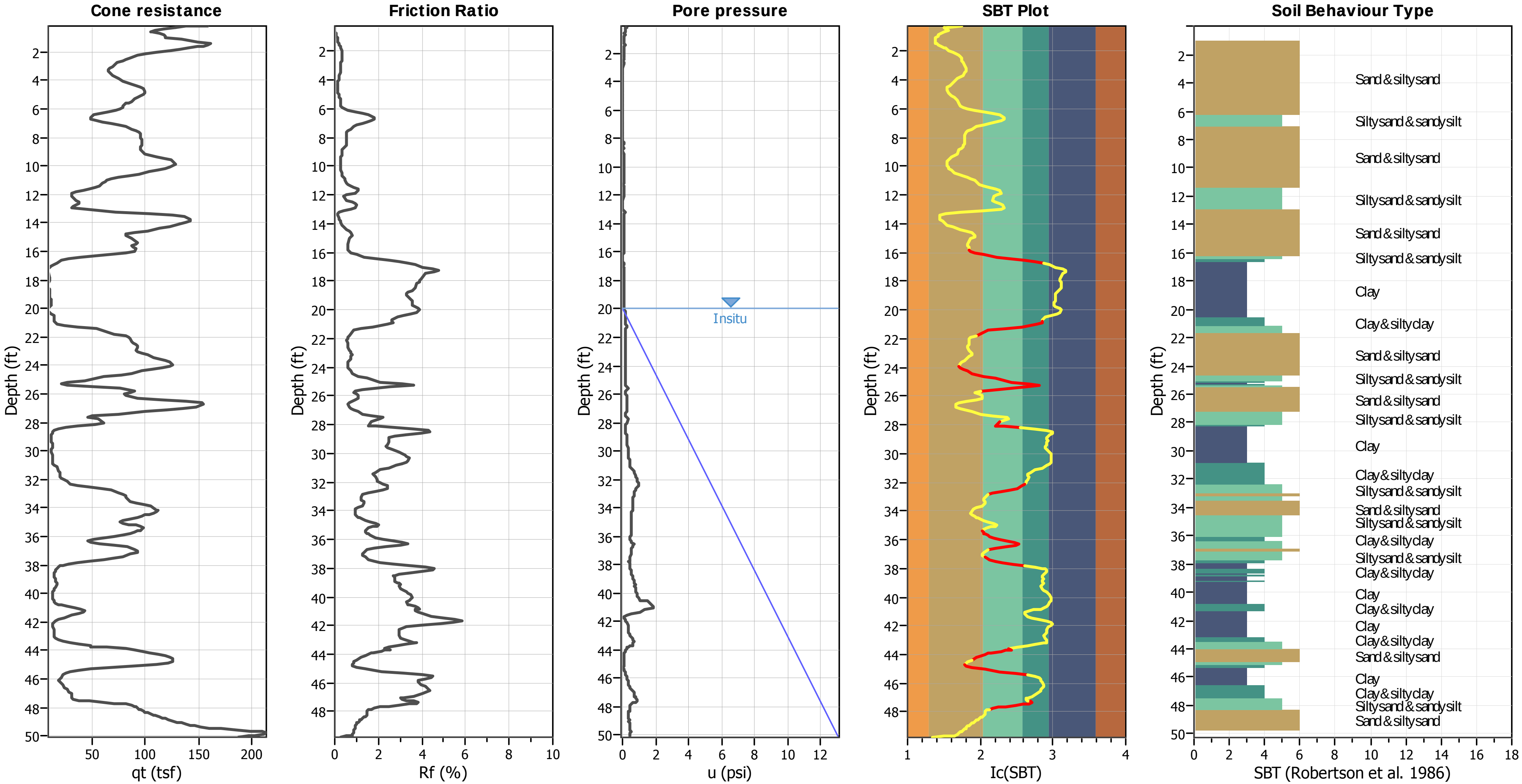


Summary of liquefaction potential



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

CPT basic interpretation plots



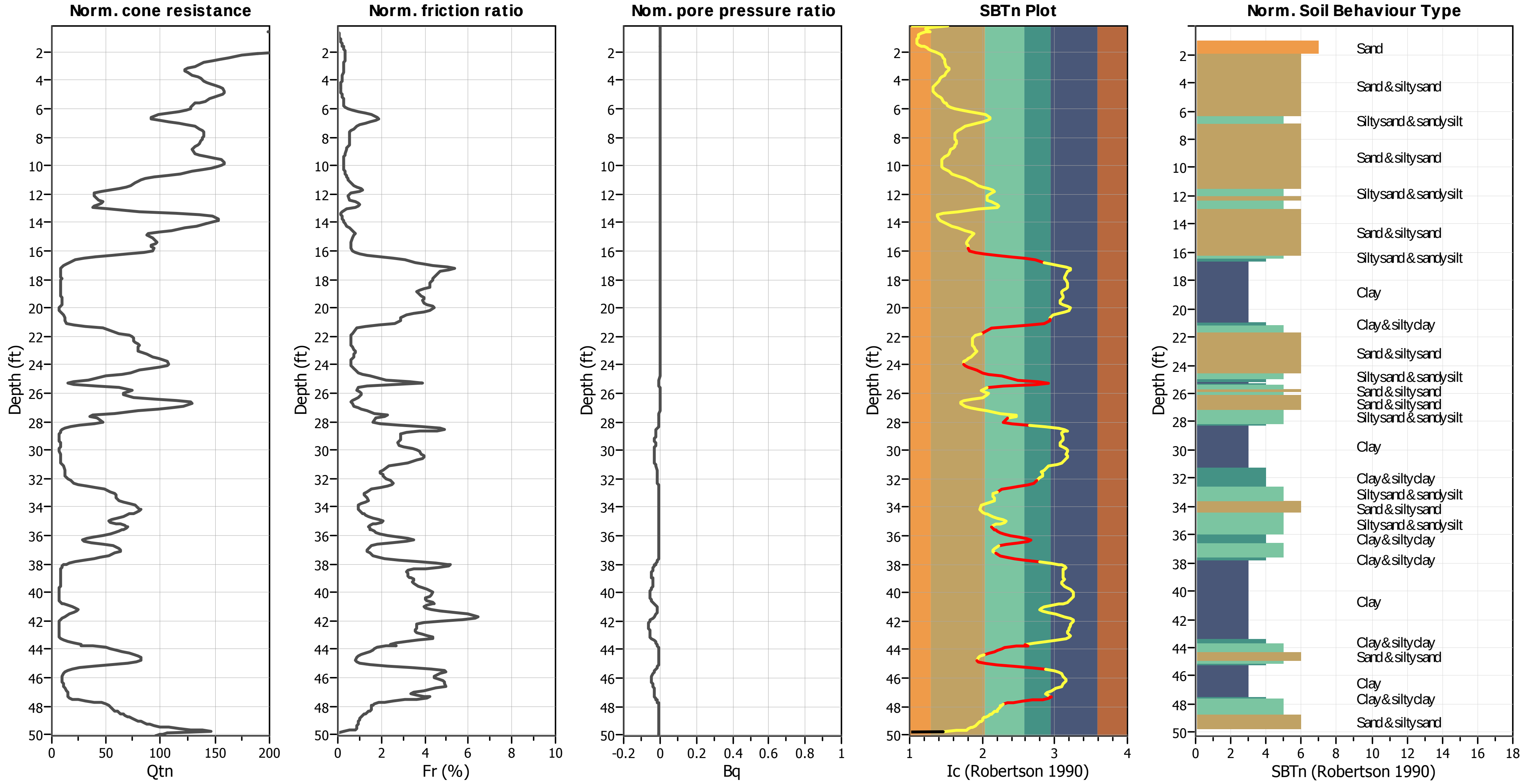
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



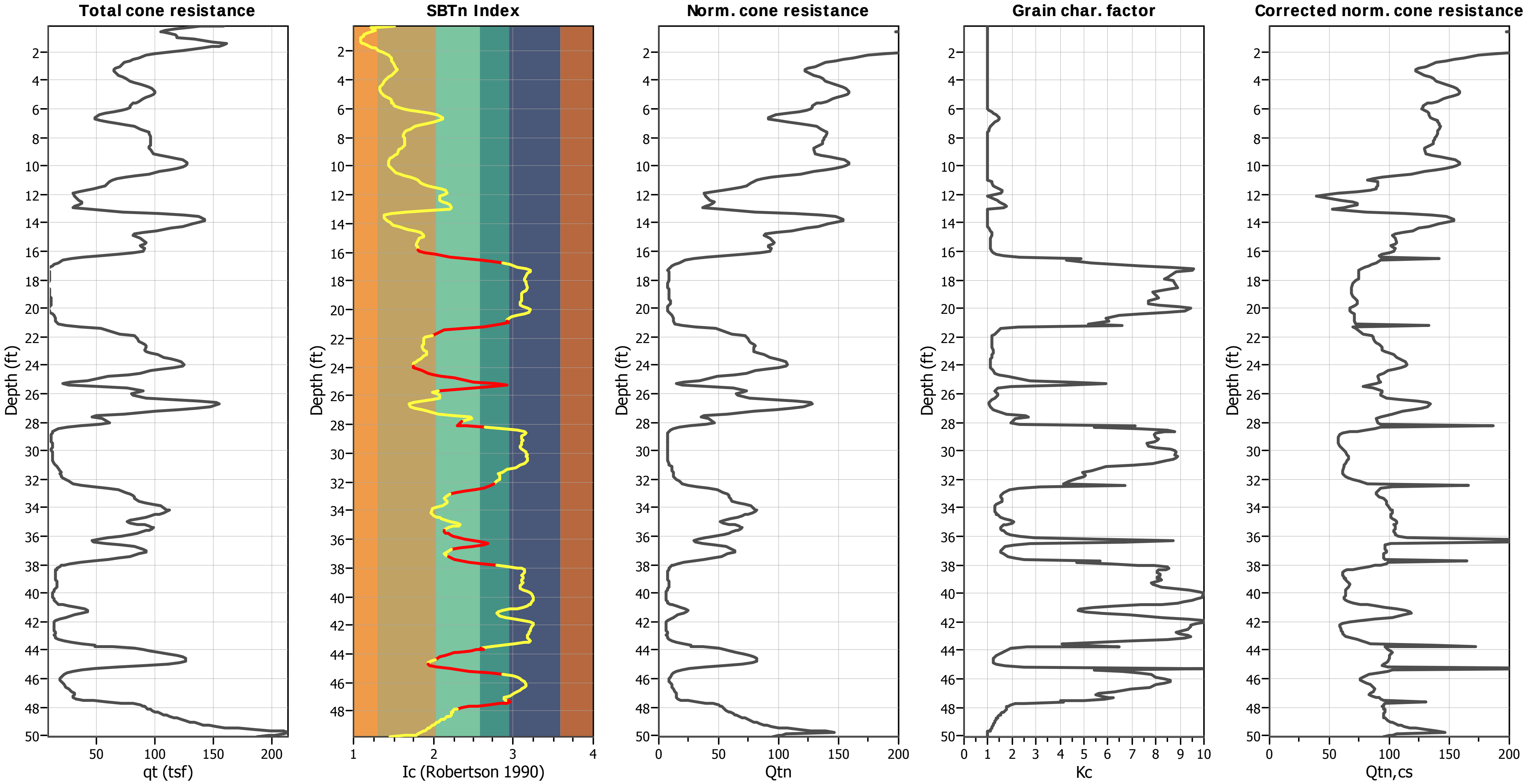
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

SBTn legend

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

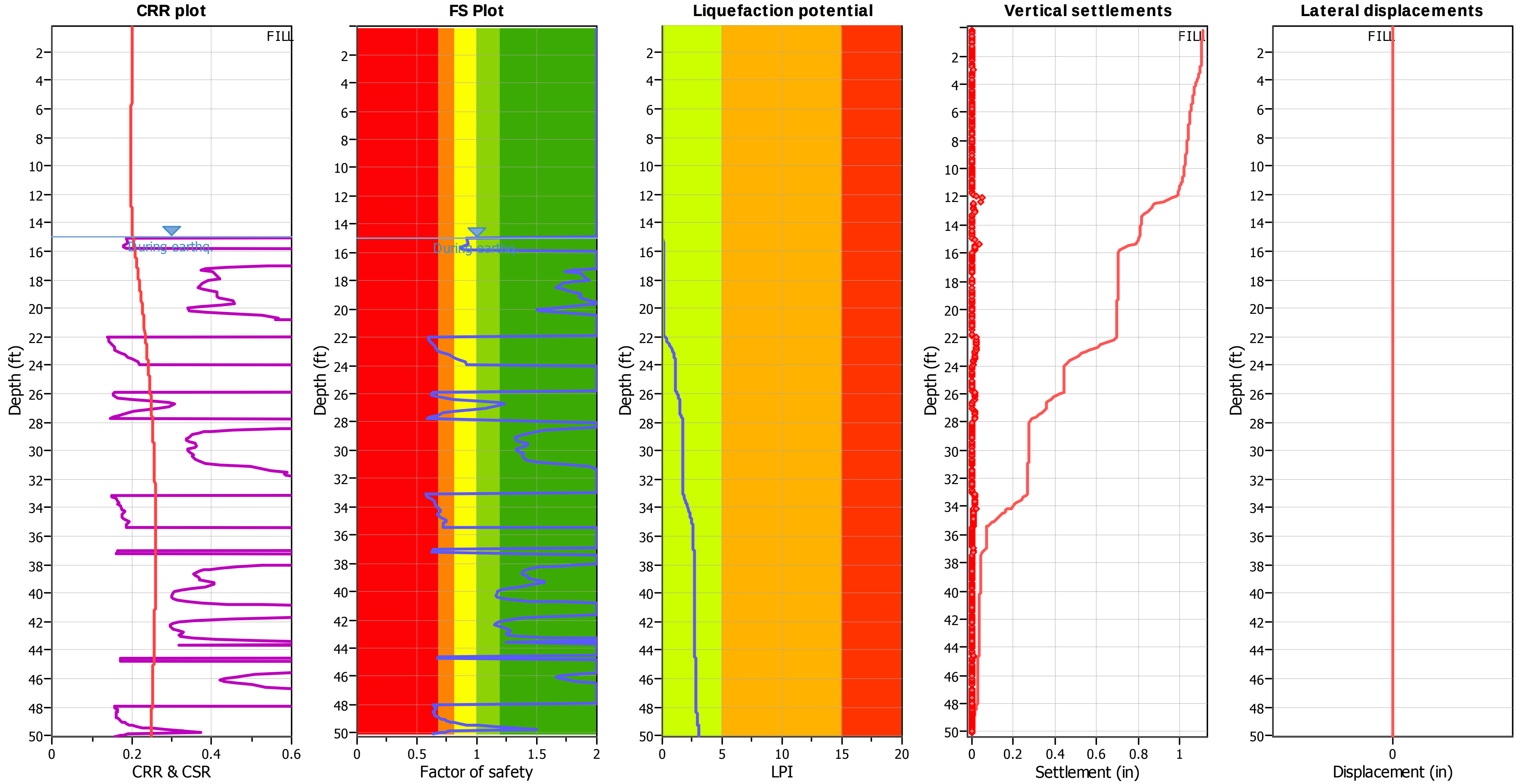
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

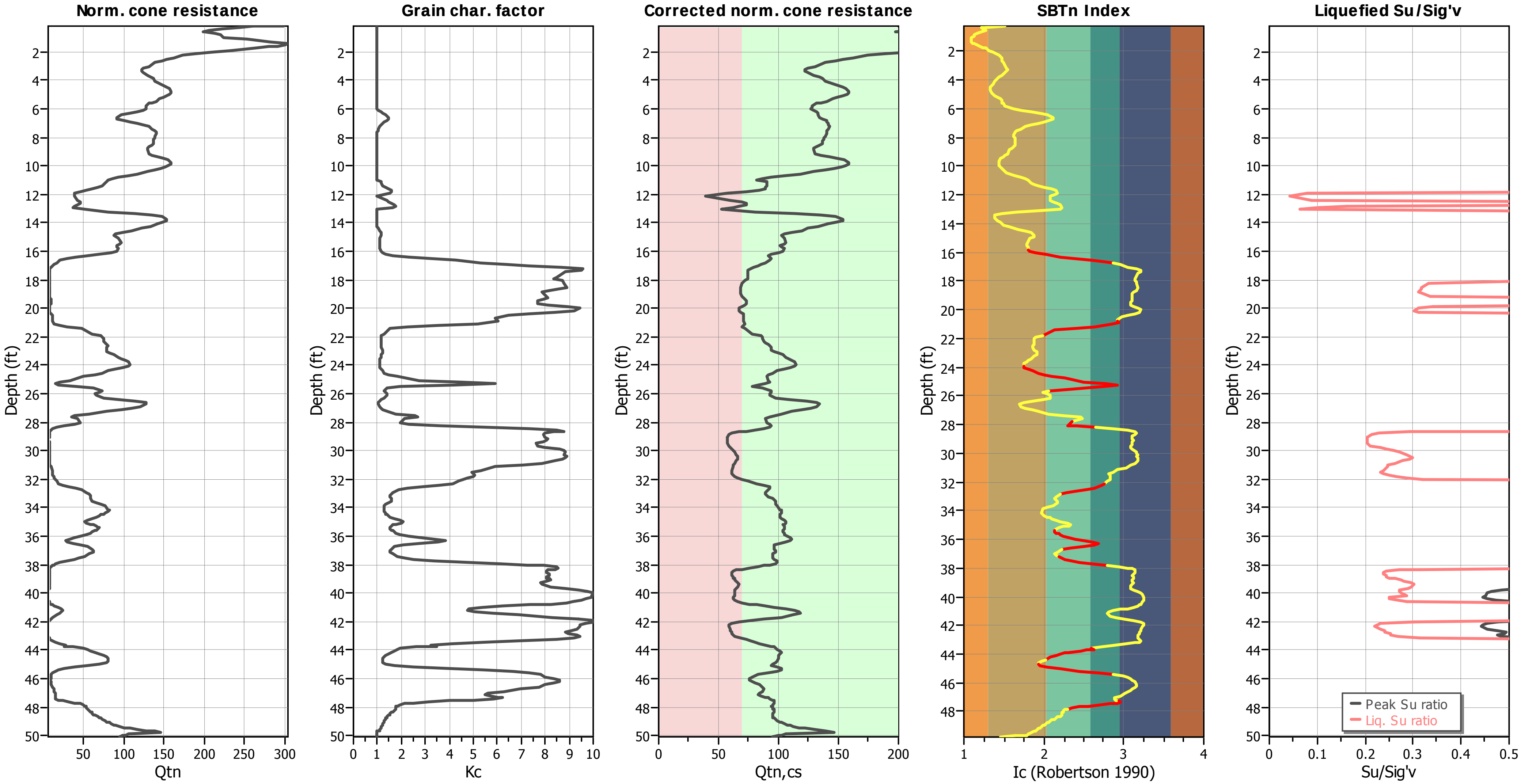
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

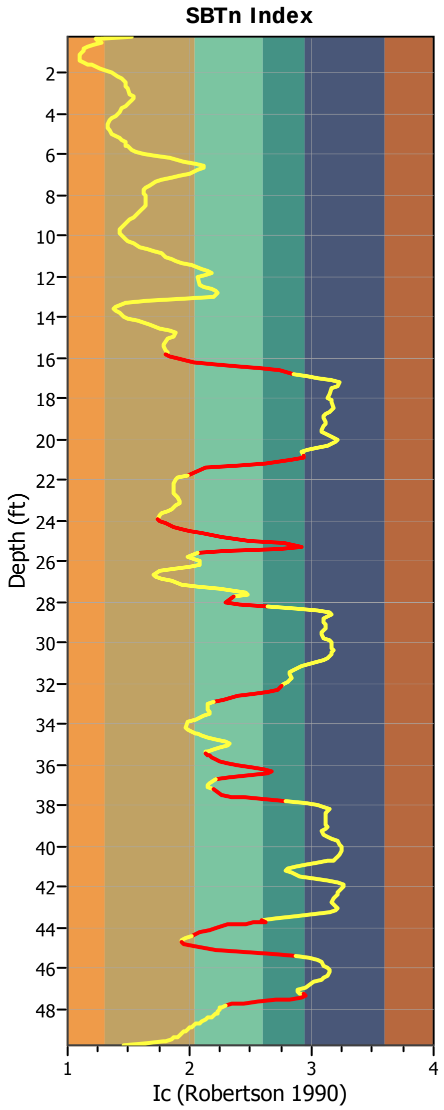
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

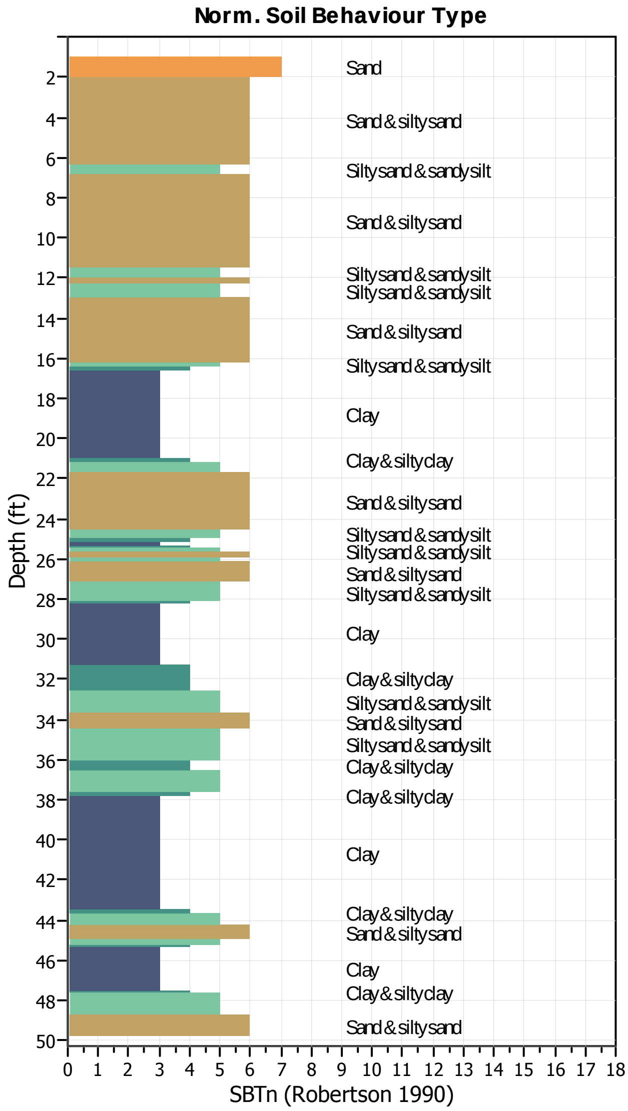
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





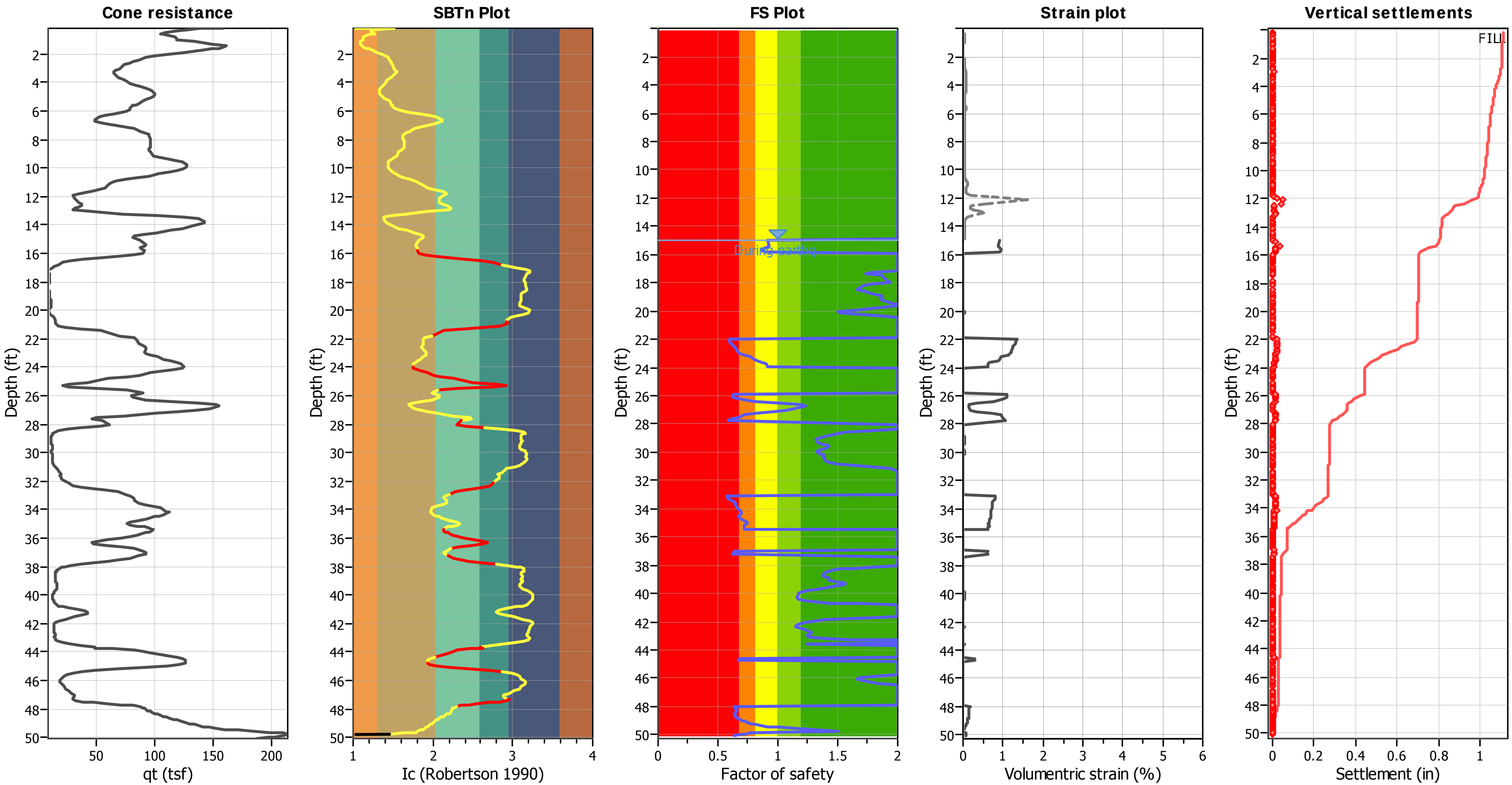
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	442
Total points excluded:	90
Exclusion percentage:	20.36%
Number of layers detected:	12

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

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17781 Cowan
Irvine, CA 92614
www.leightongroup.com

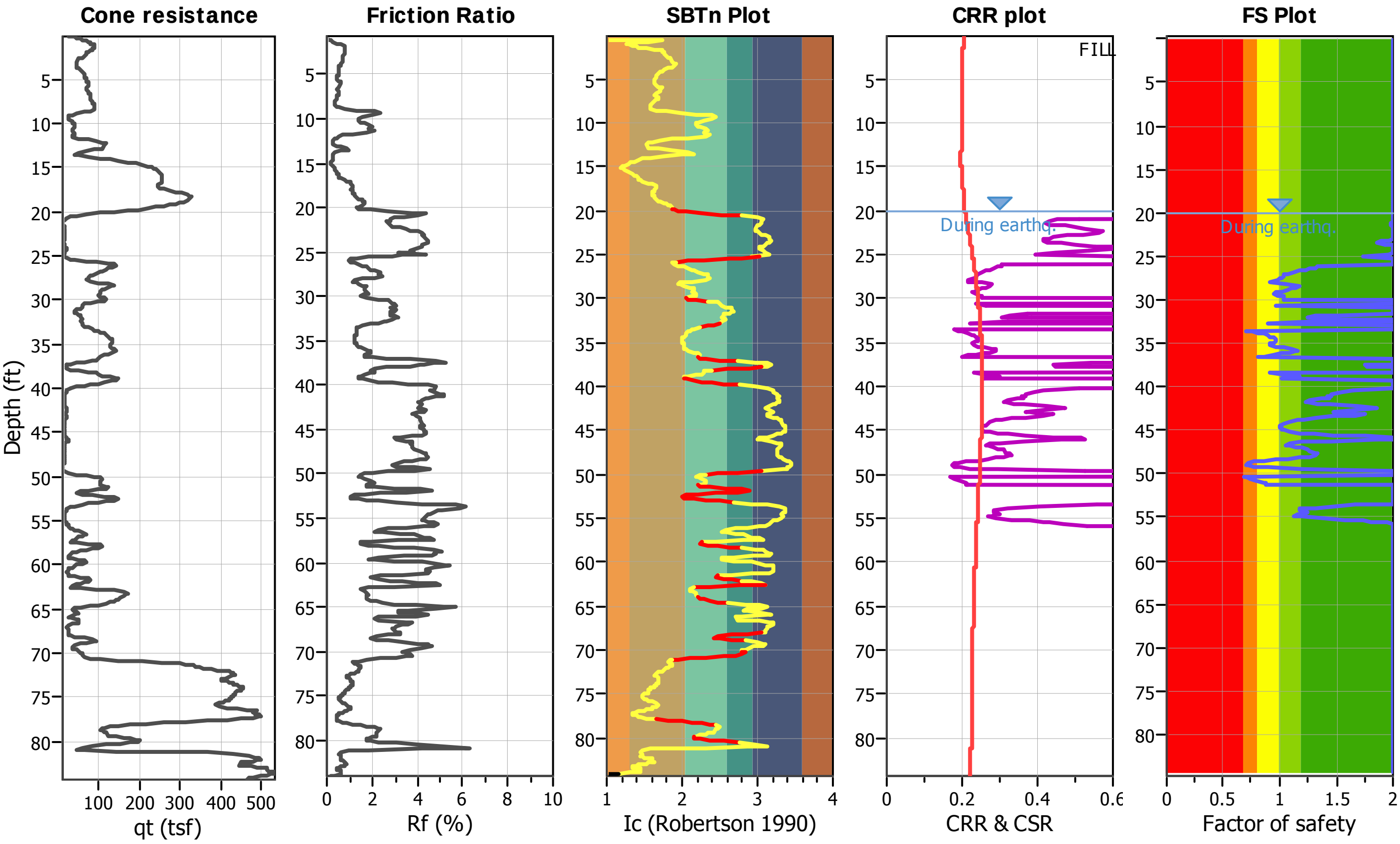
LIQUEFACTION ANALYSIS REPORT

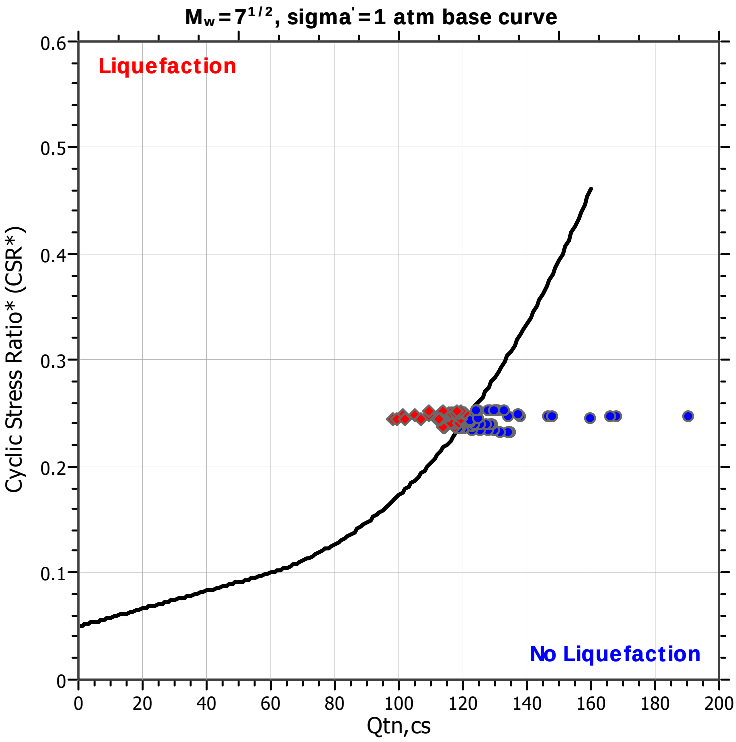
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

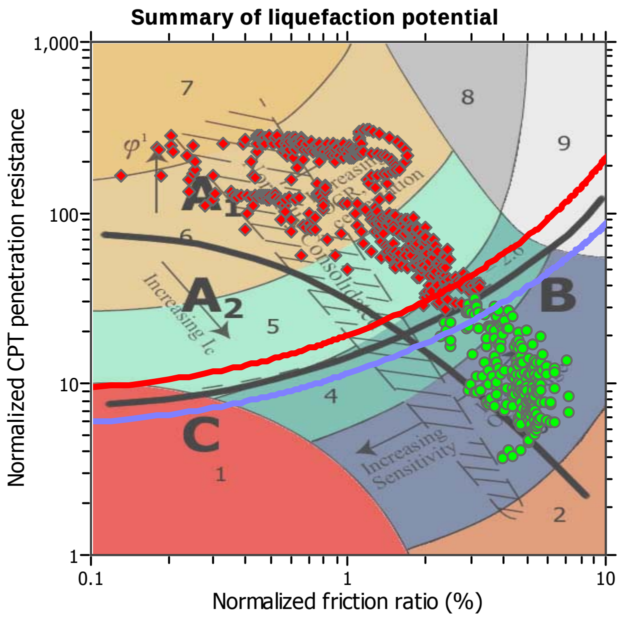
CPT file : CPT-8

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	24.00 ft	Fill height:	4.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

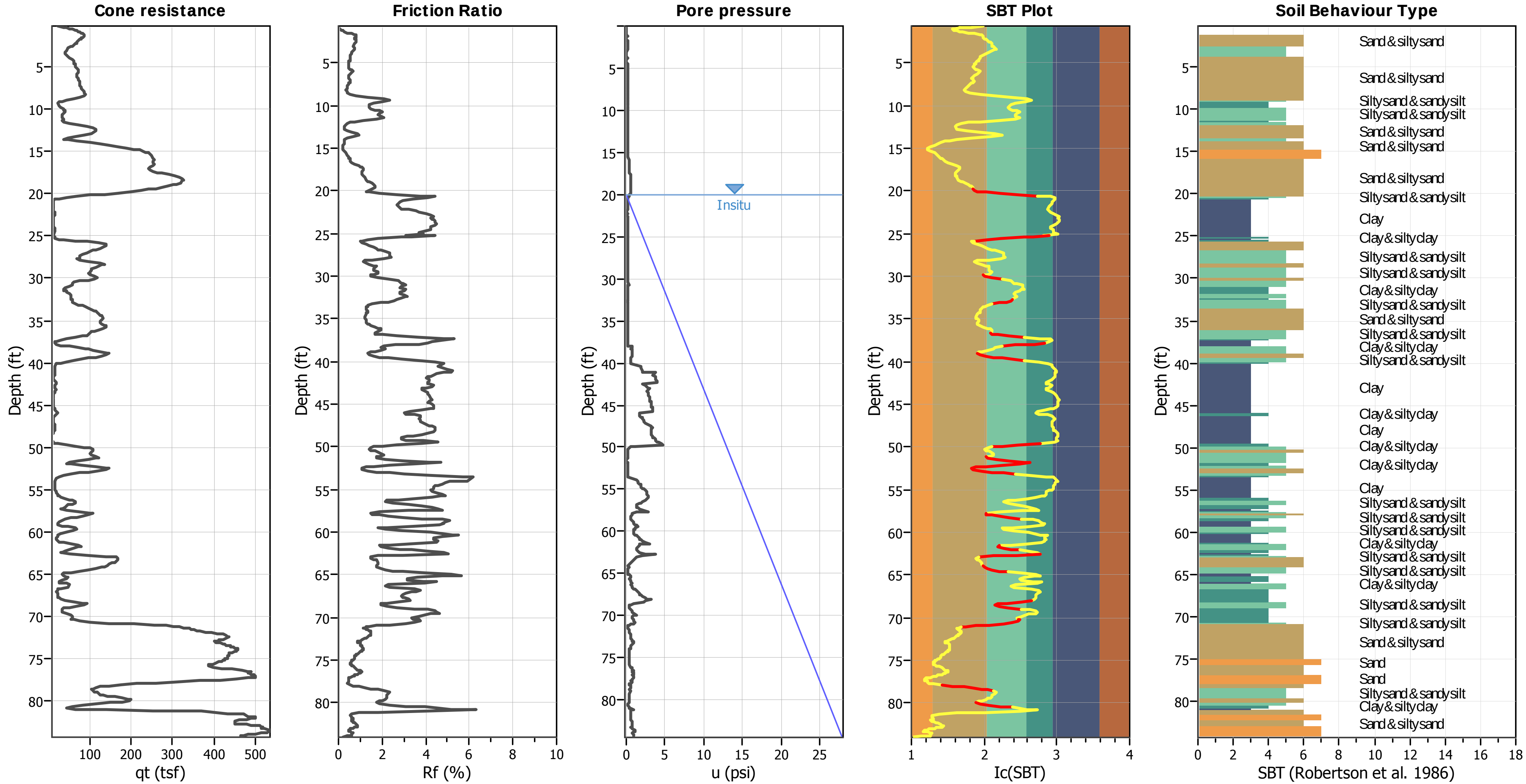






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



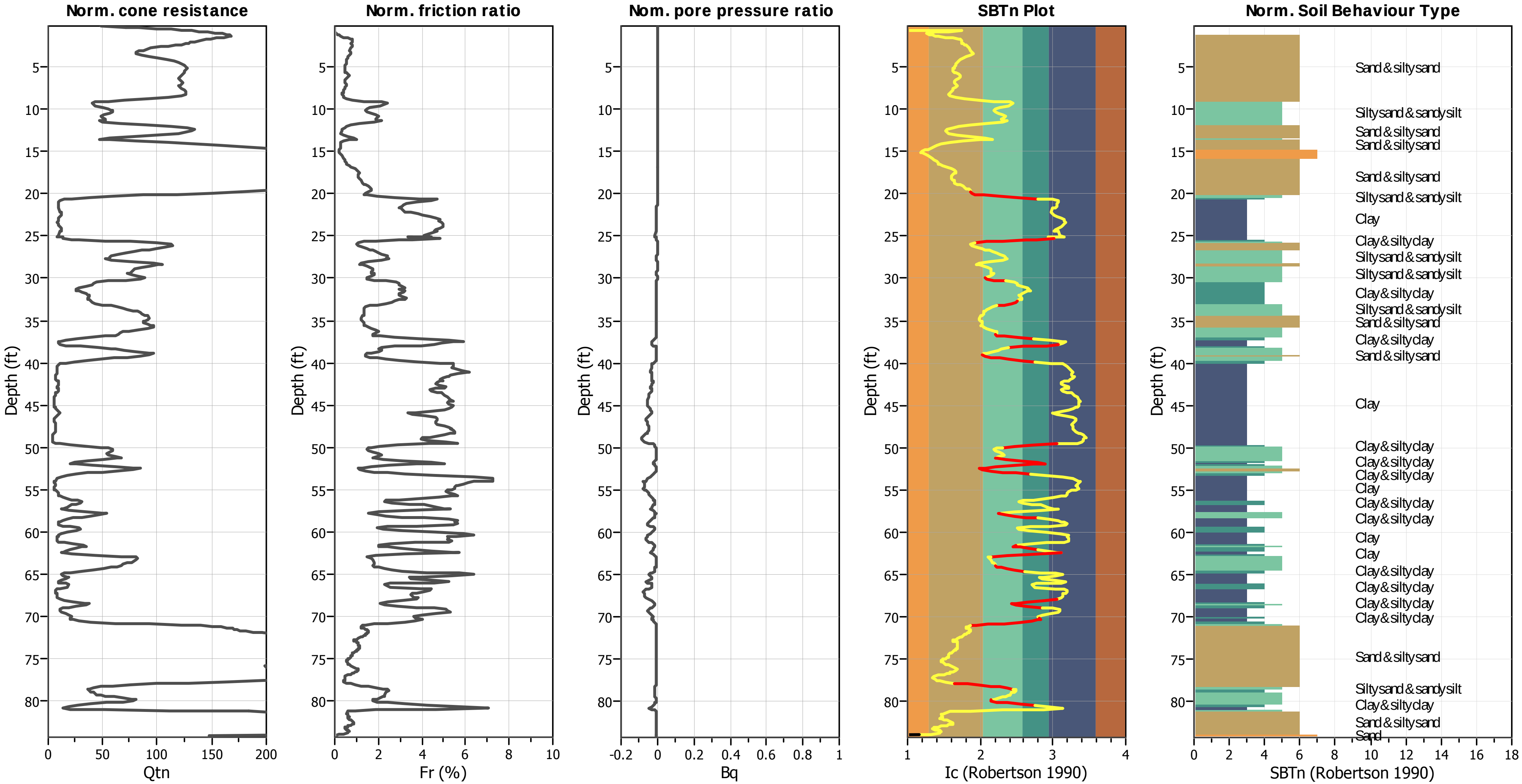
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



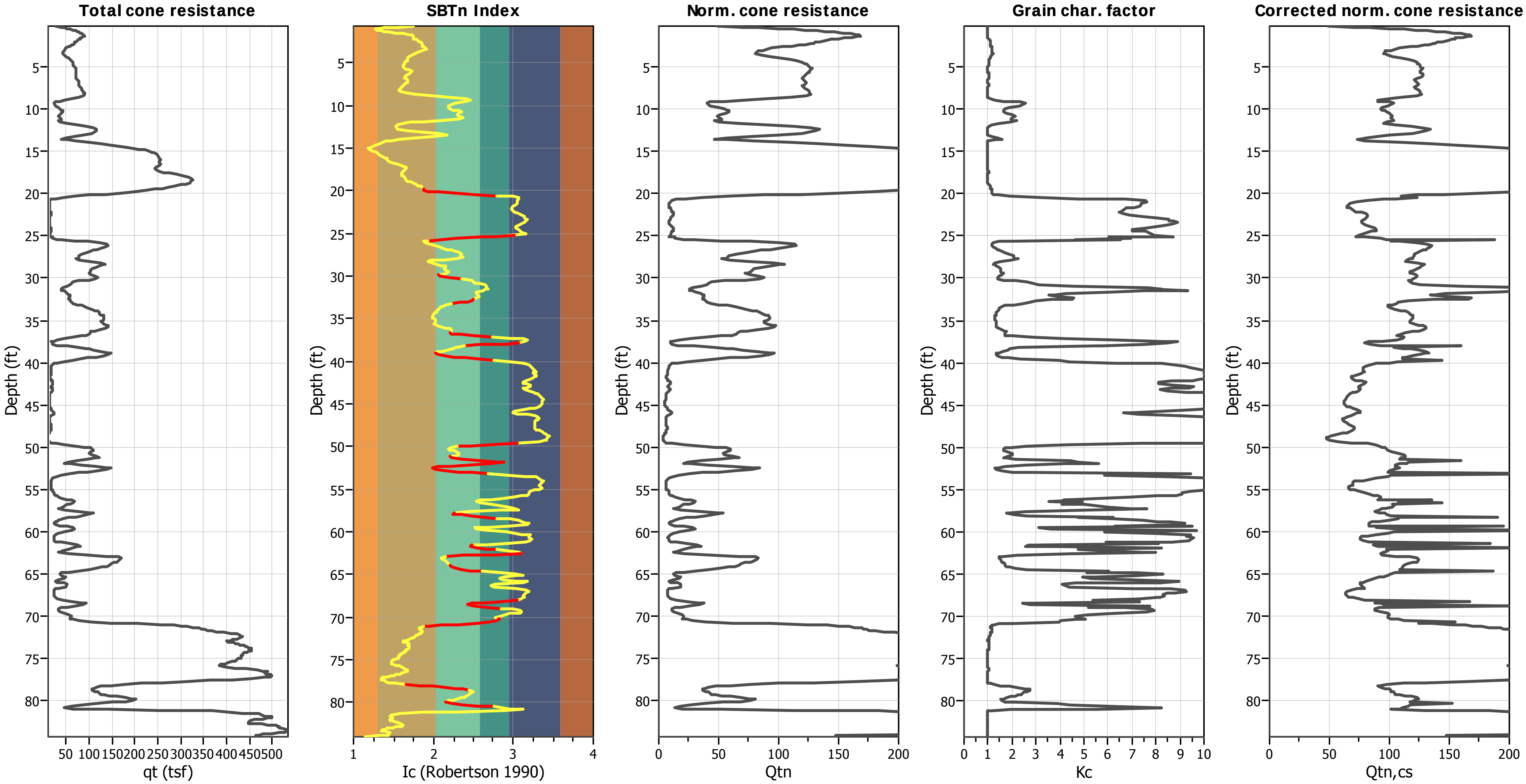
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBTn legend

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

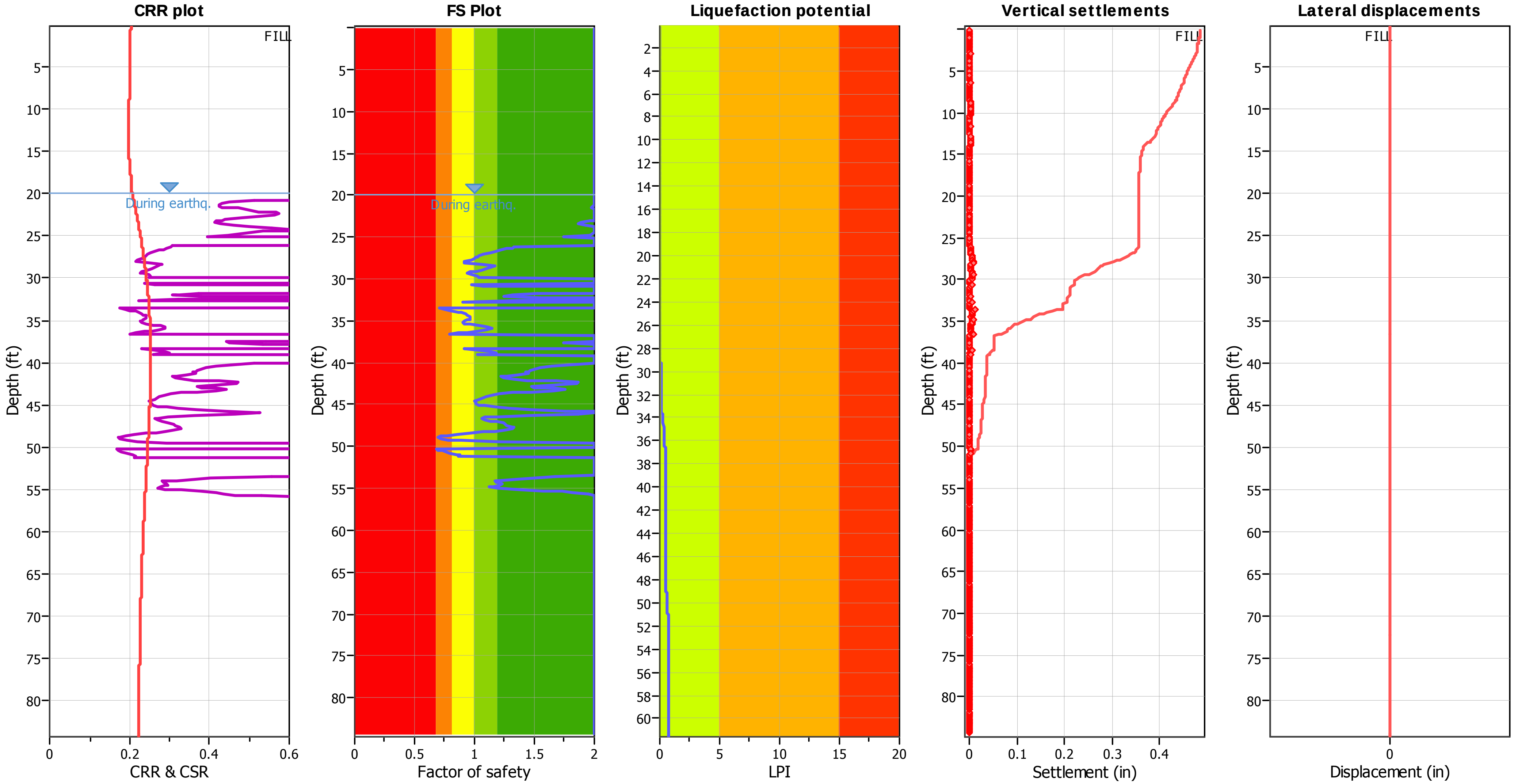
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

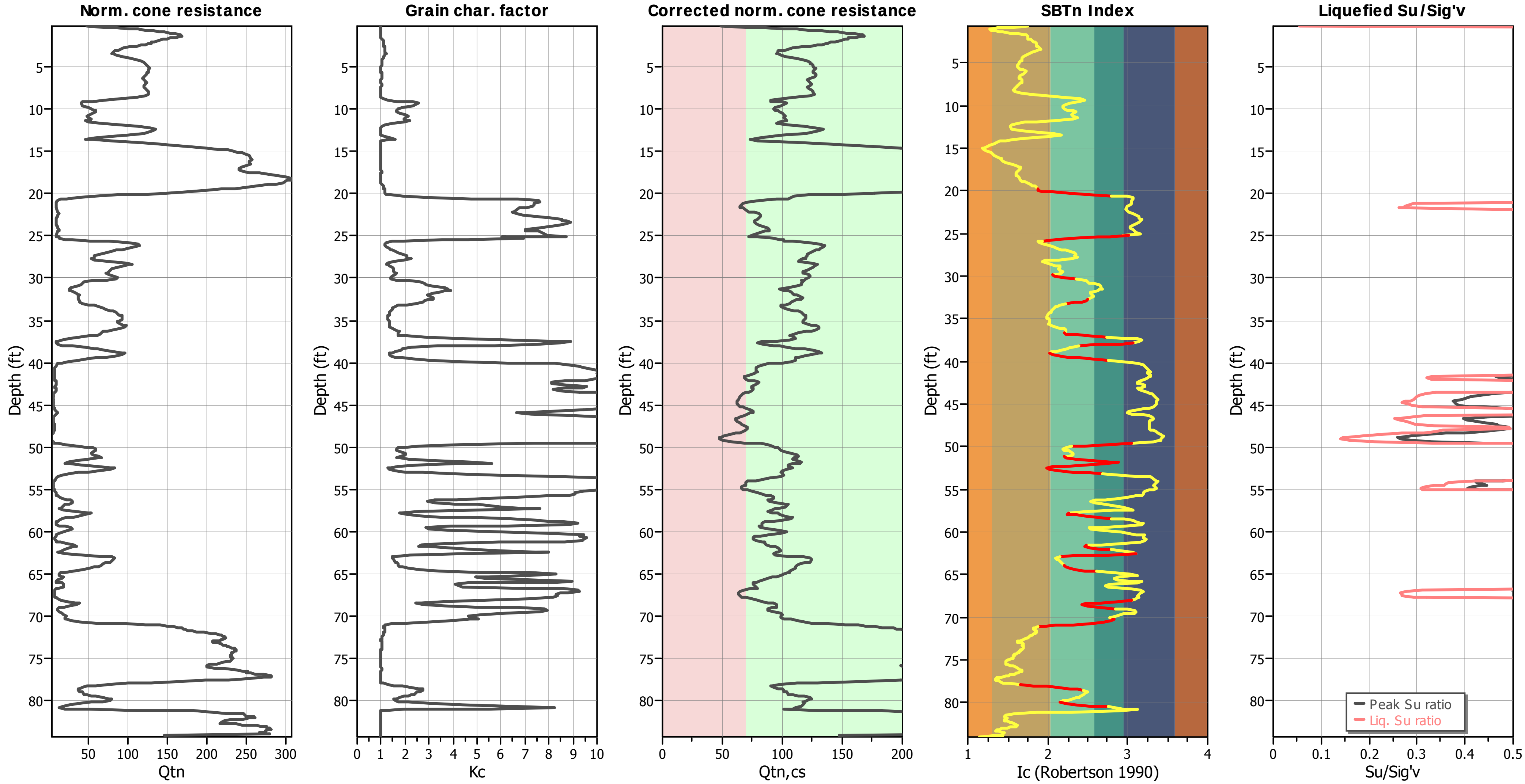
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

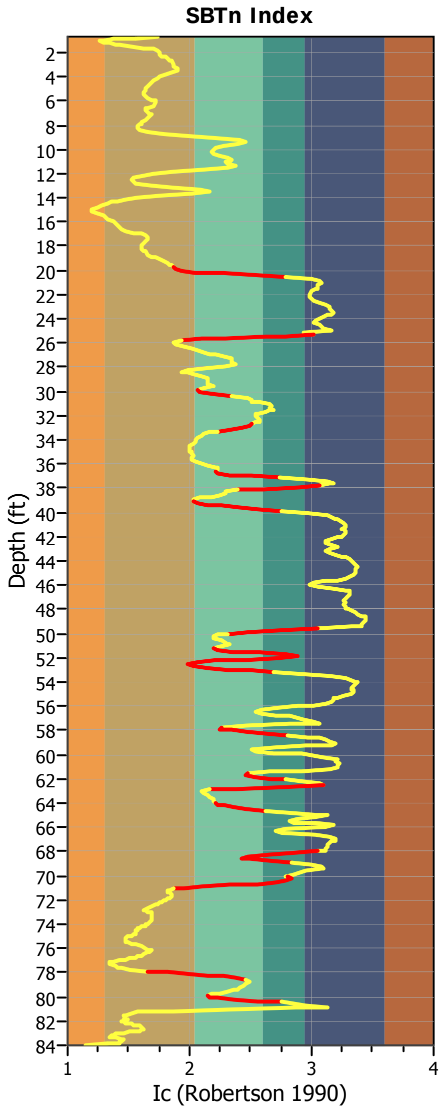
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

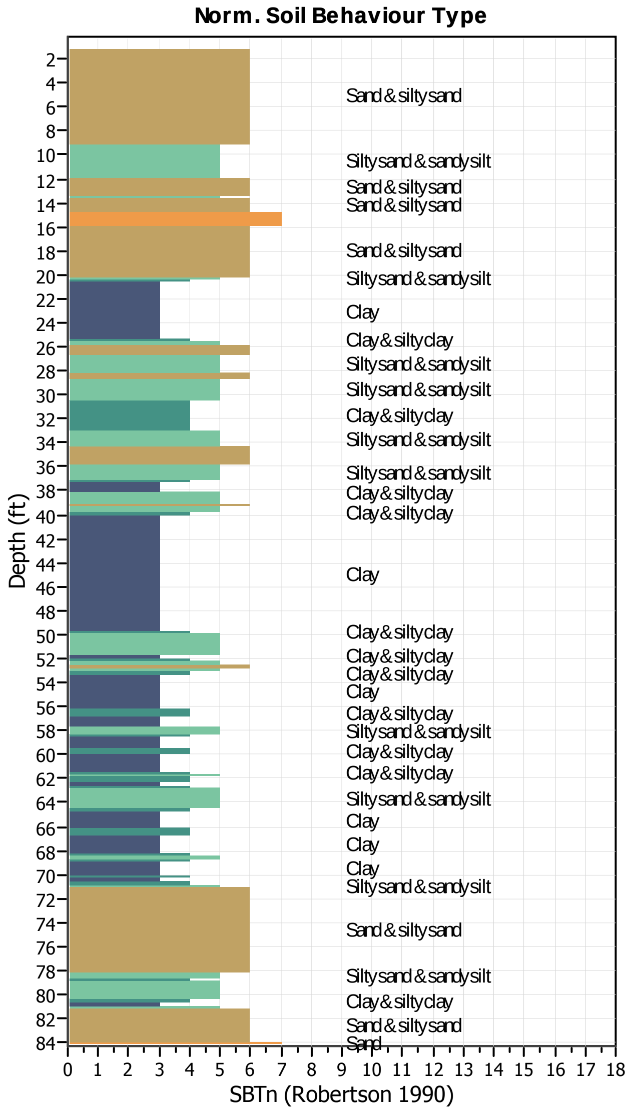
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

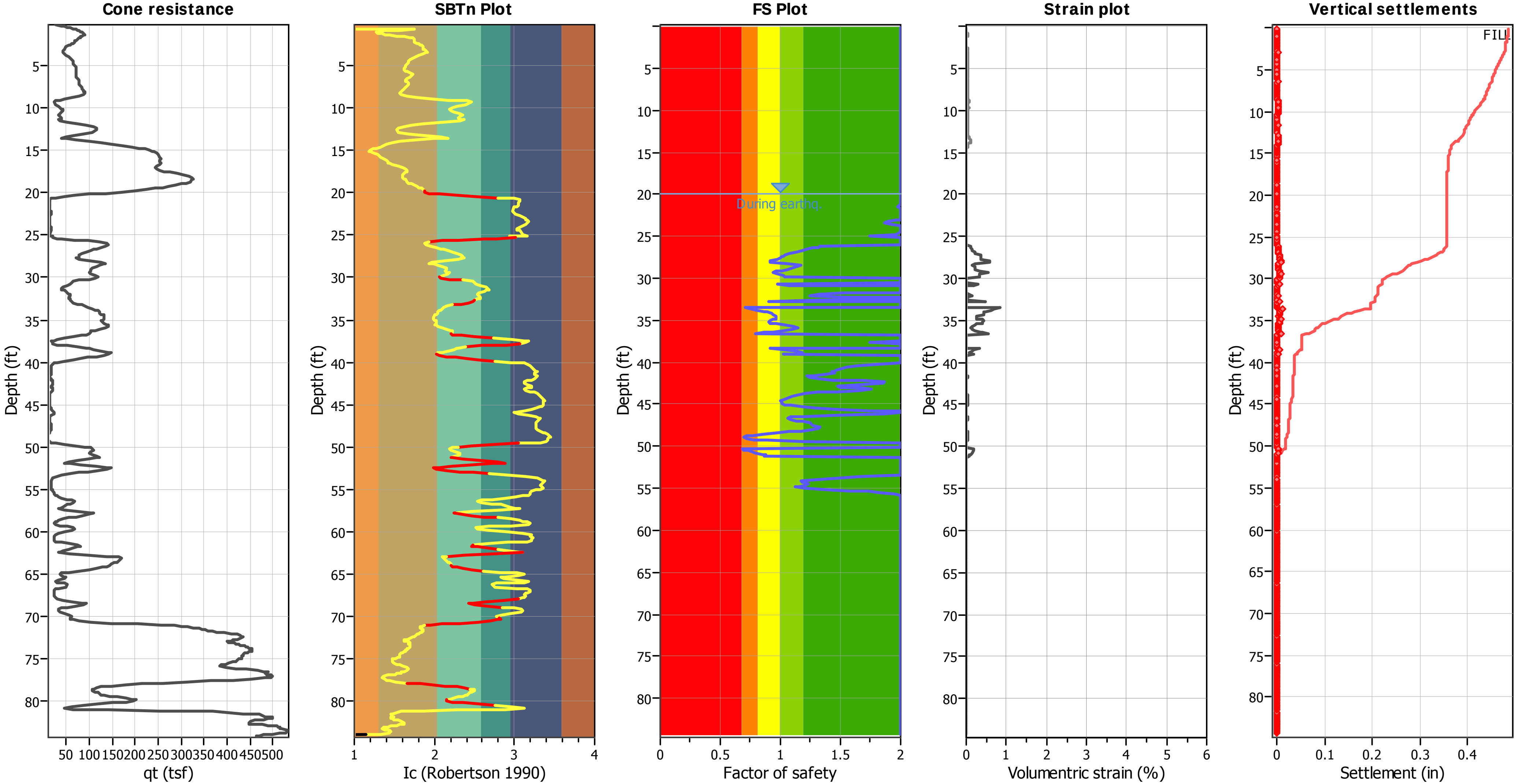
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	658
I_c maximum check value:	3.00	Total points excluded:	111
I_c change ratio value:	0.0250	Exclusion percentage:	16.87%
Minimum number of points in layer:	4	Number of layers detected:	20

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

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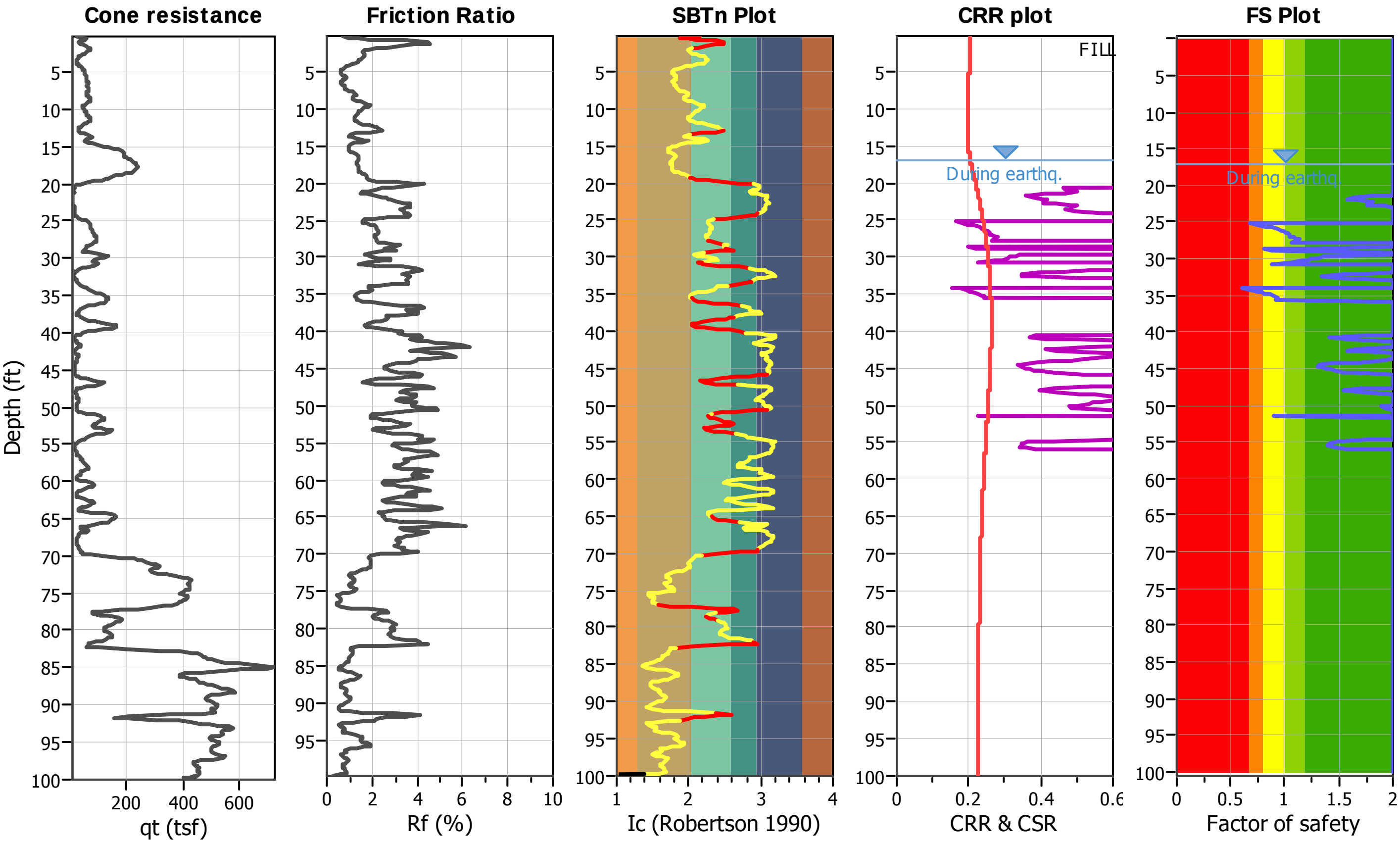
LIQUEFACTION ANALYSIS REPORT

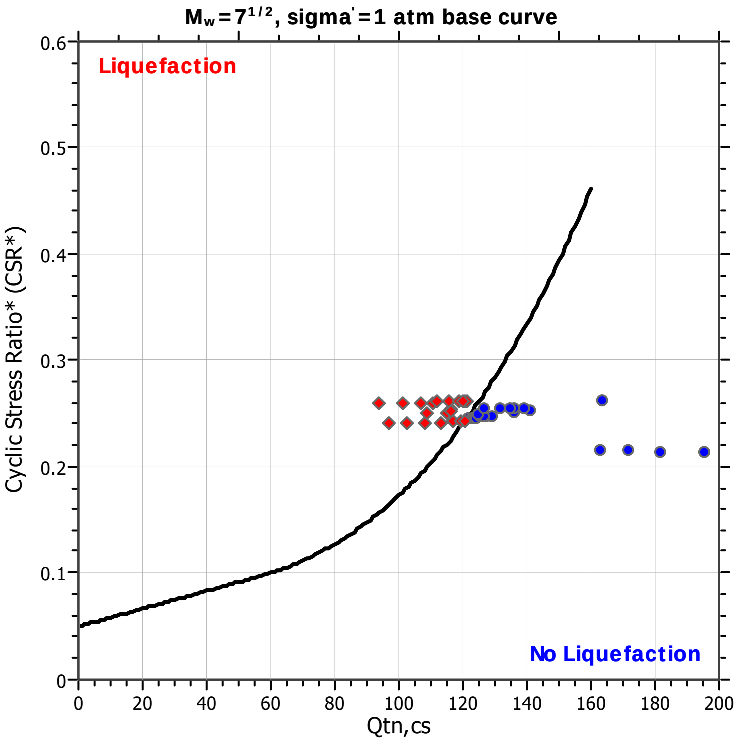
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

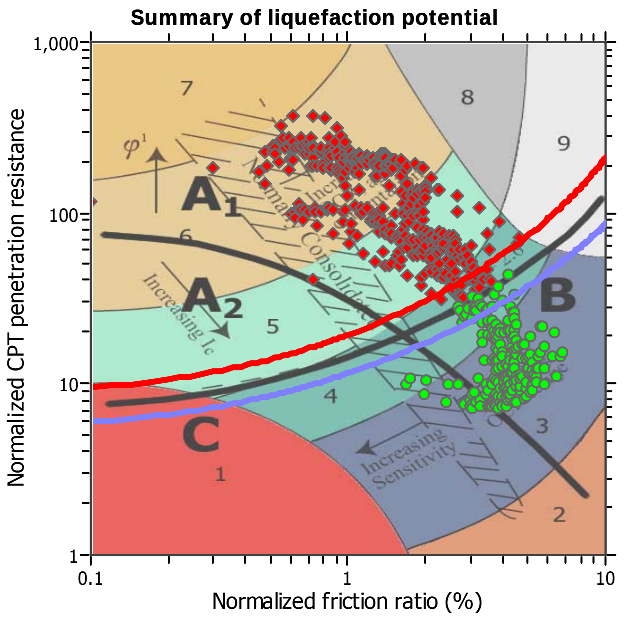
CPT file : CPT-10

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	21.00 ft	Fill height:	4.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

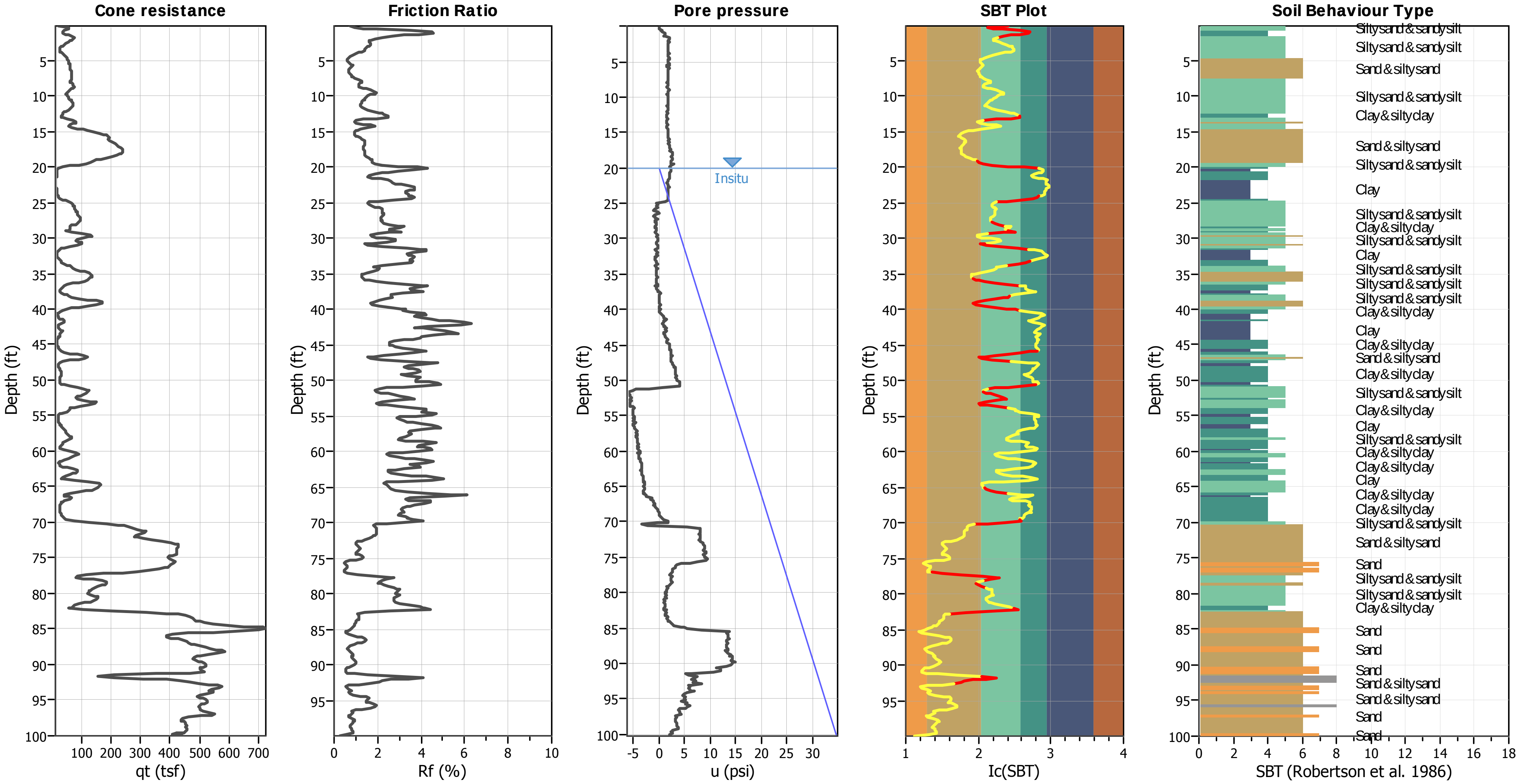






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



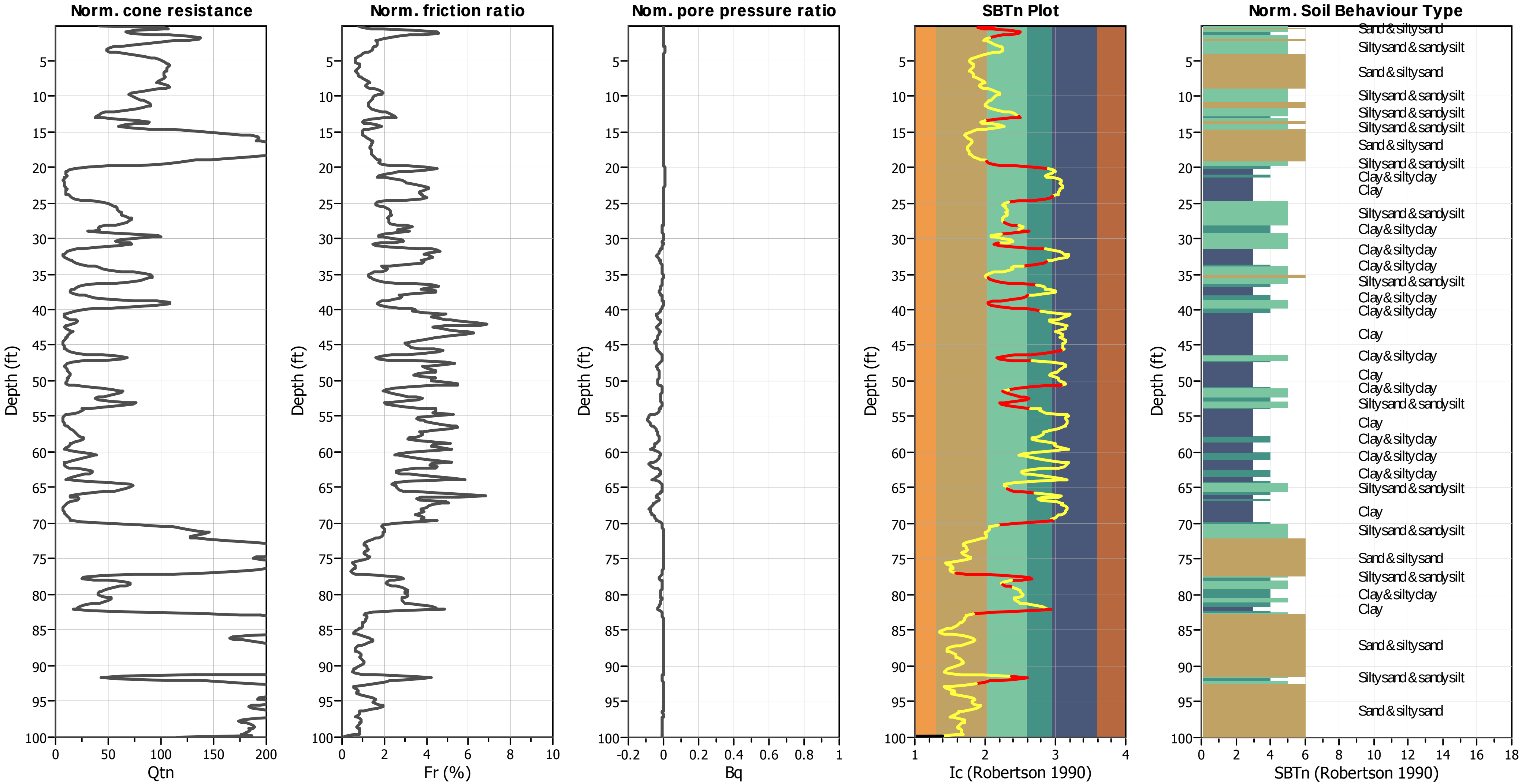
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



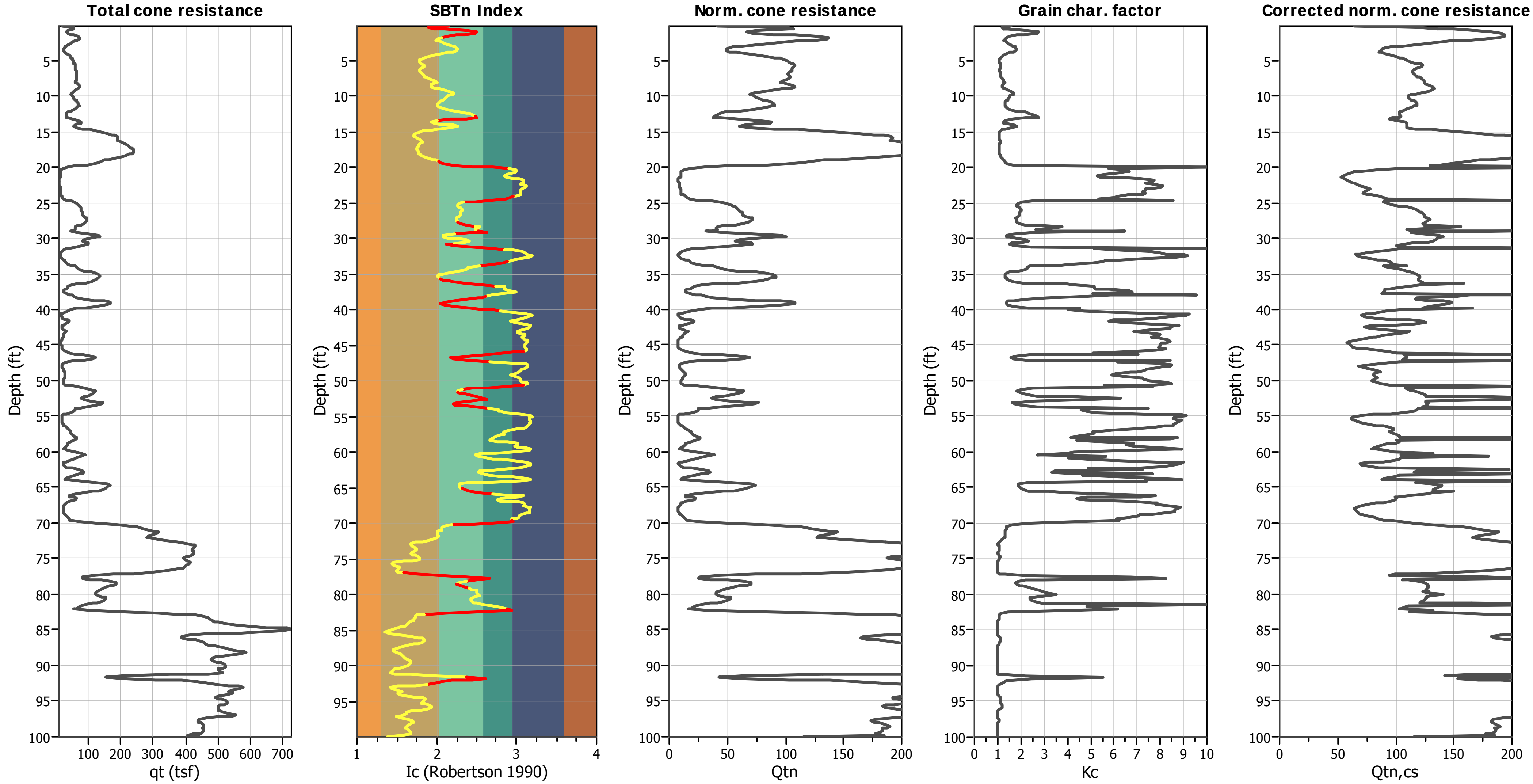
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBTn legend

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

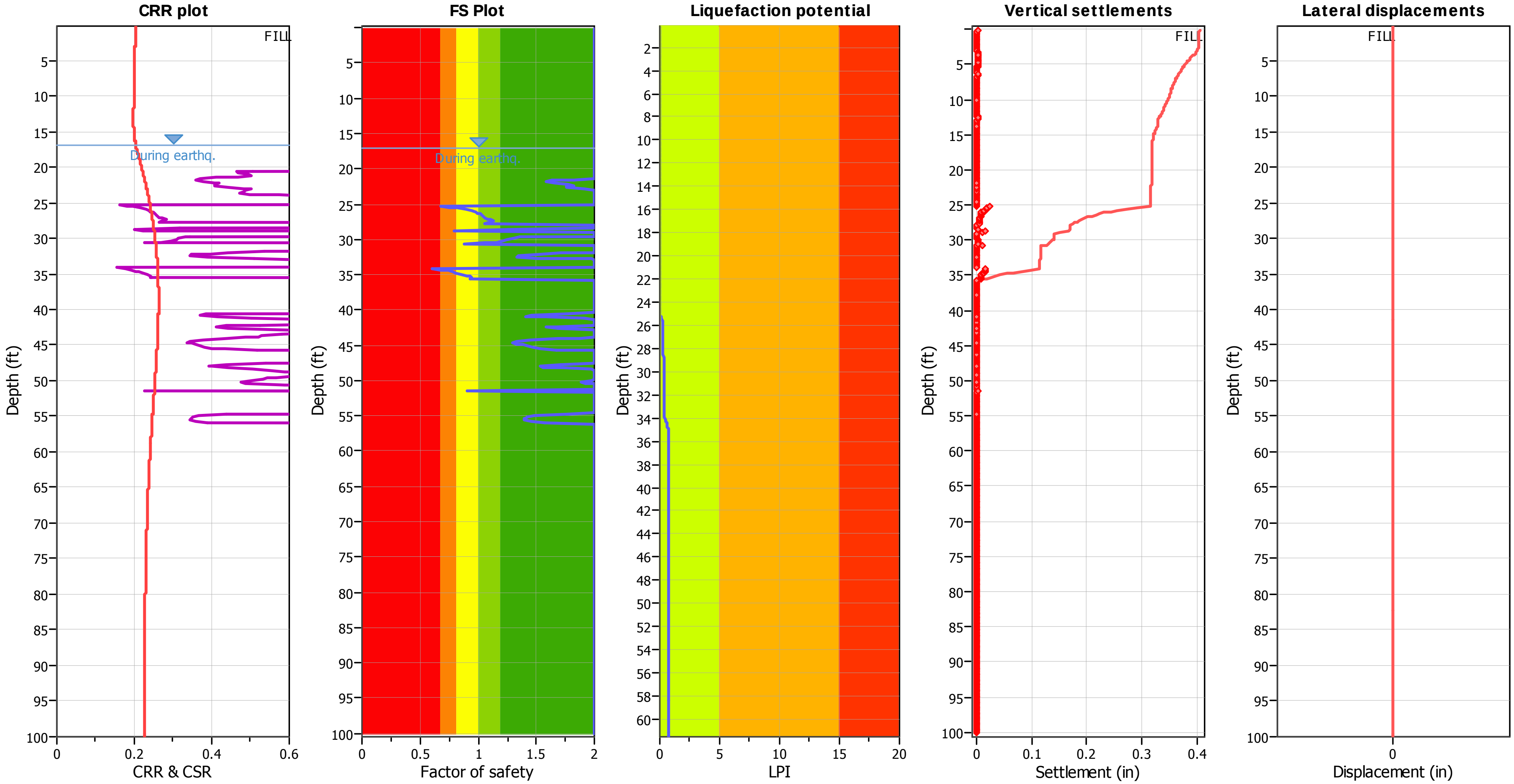
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

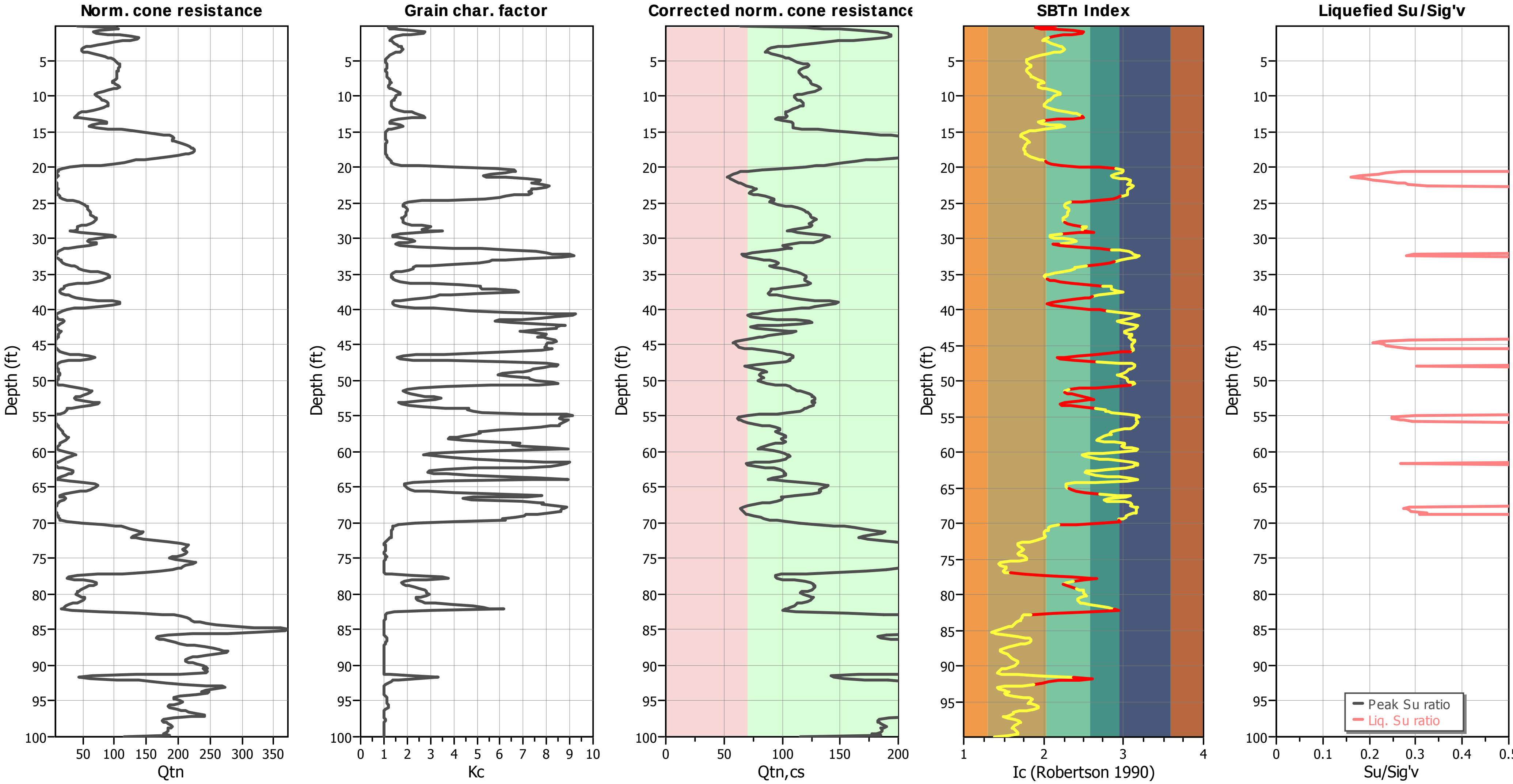
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

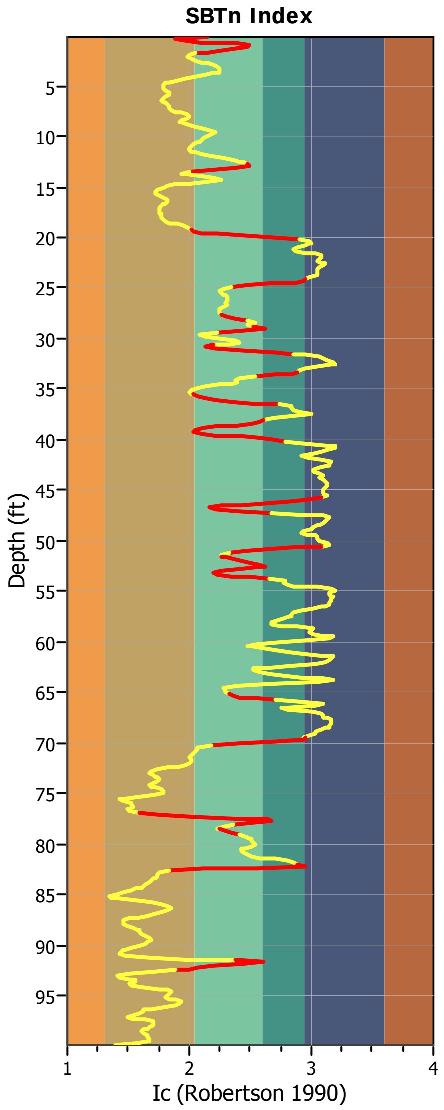
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

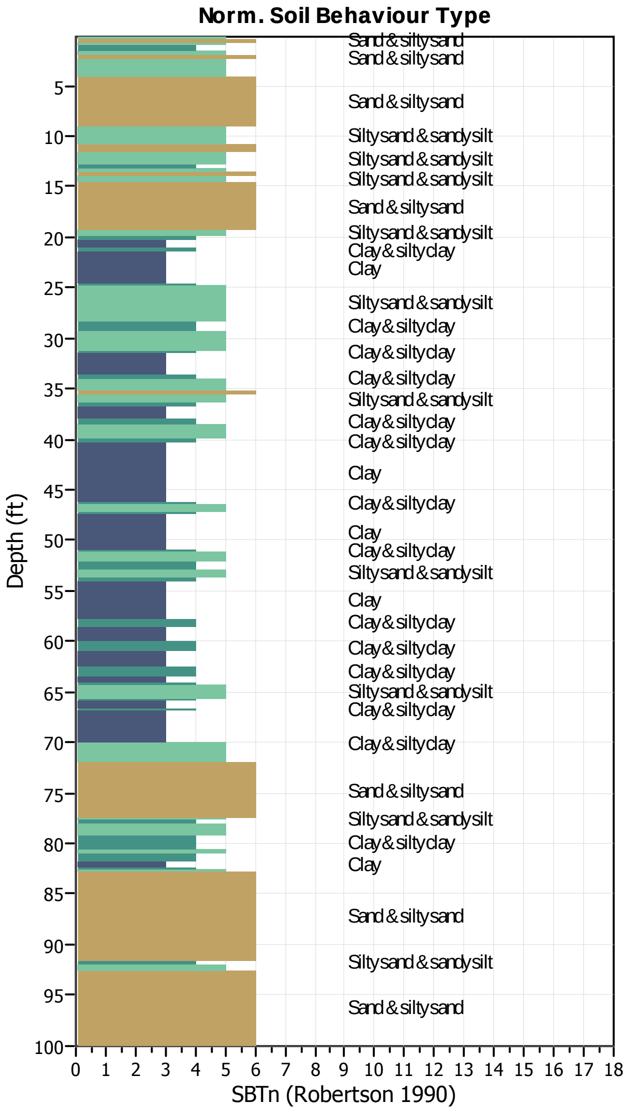
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

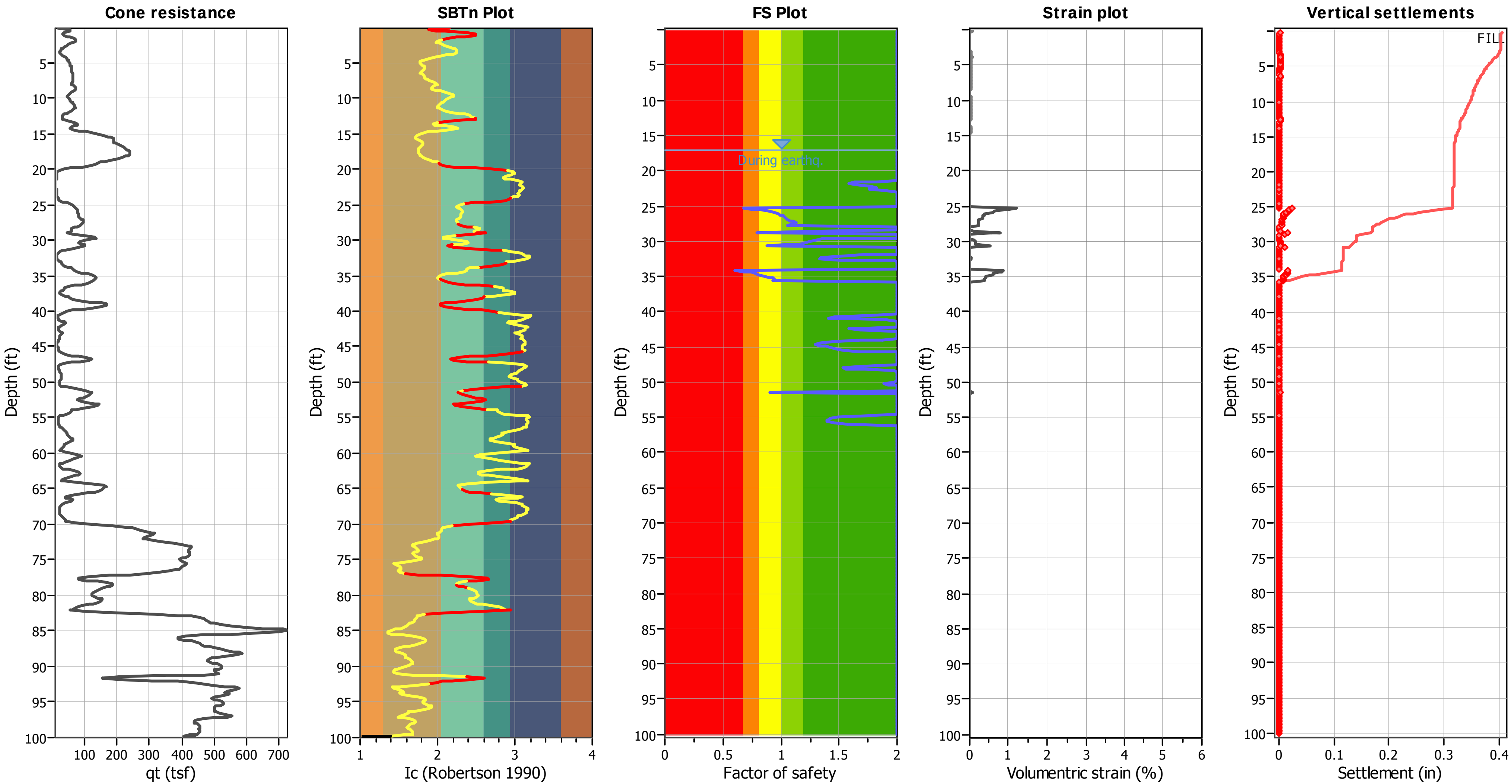
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	610
I_c maximum check value:	3.00	Total points excluded:	132
I_c change ratio value:	0.0250	Exclusion percentage:	21.64%
Minimum number of points in layer:	4	Number of layers detected:	25

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

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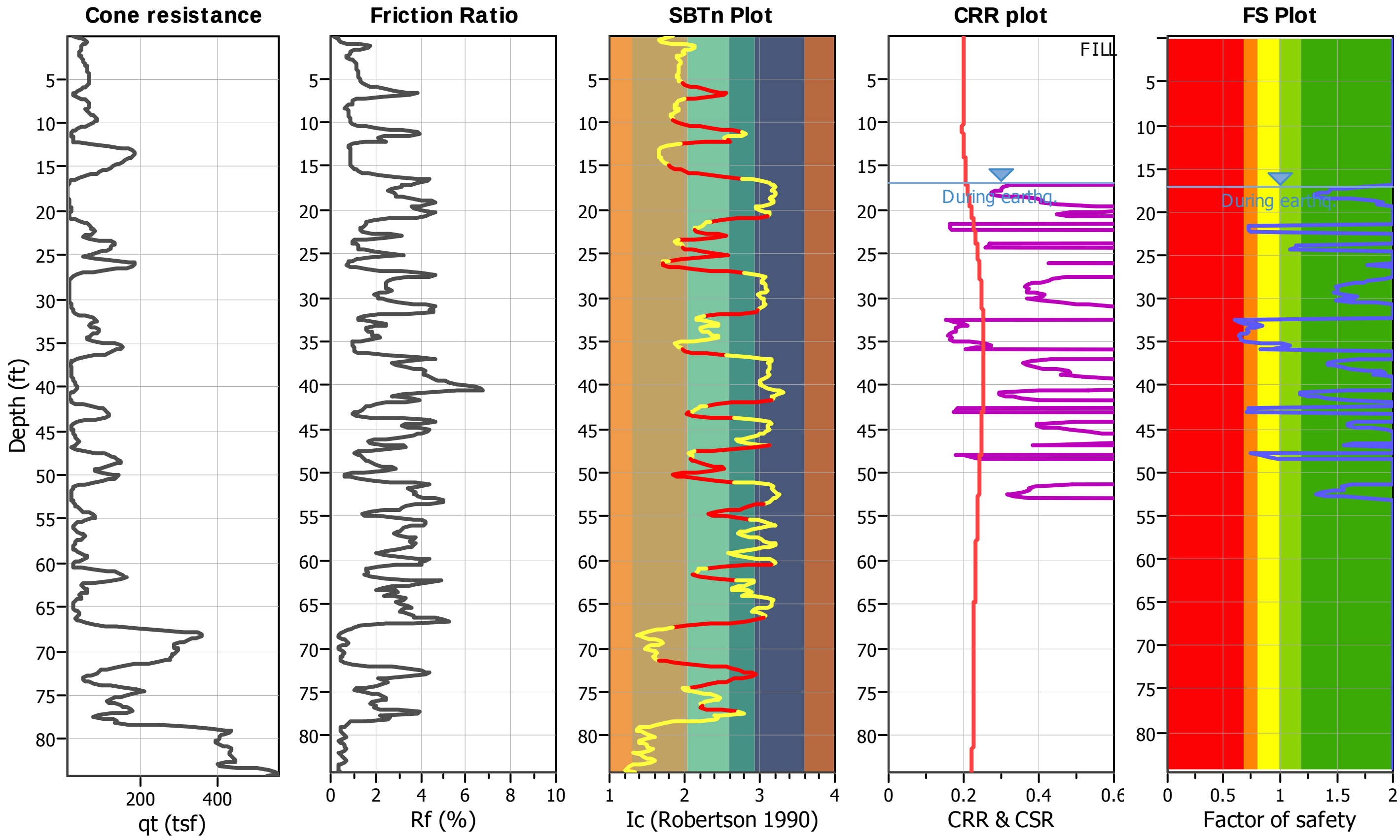
LIQUEFACTION ANALYSIS REPORT

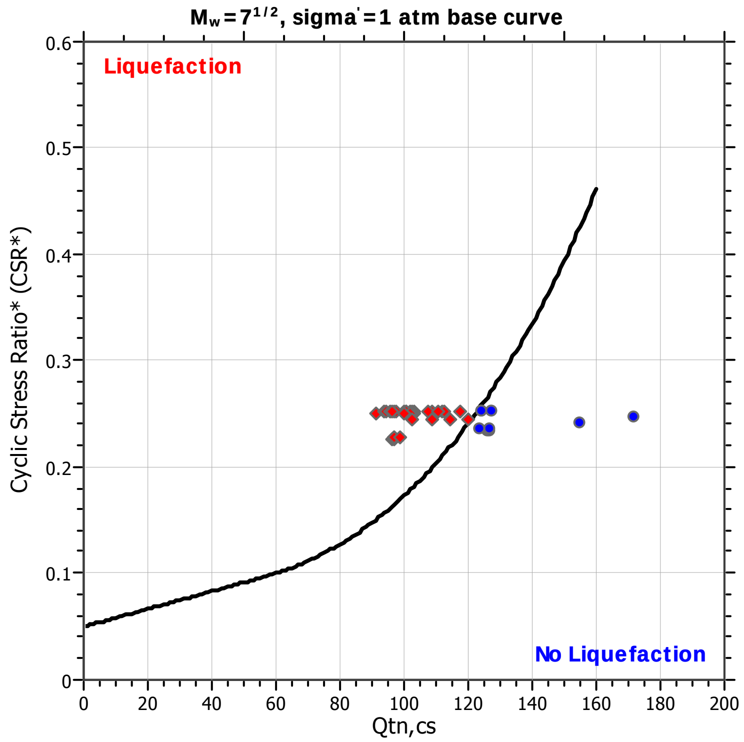
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

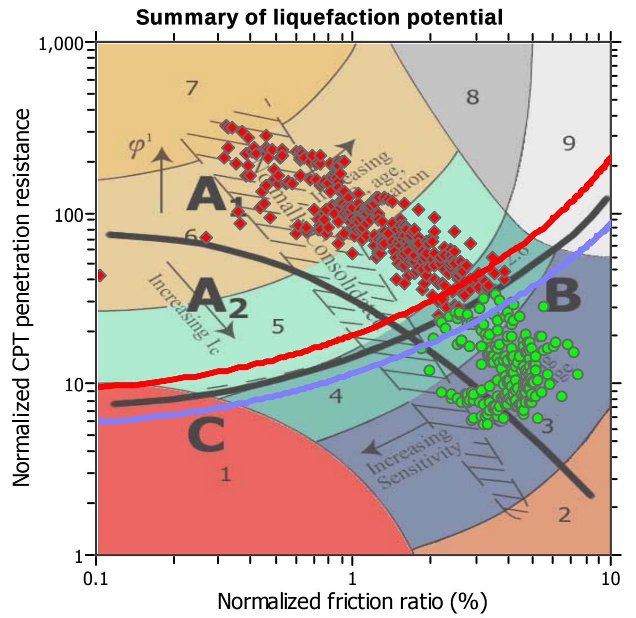
CPT file : CPT-11

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	24.00 ft	Fill height:	7.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

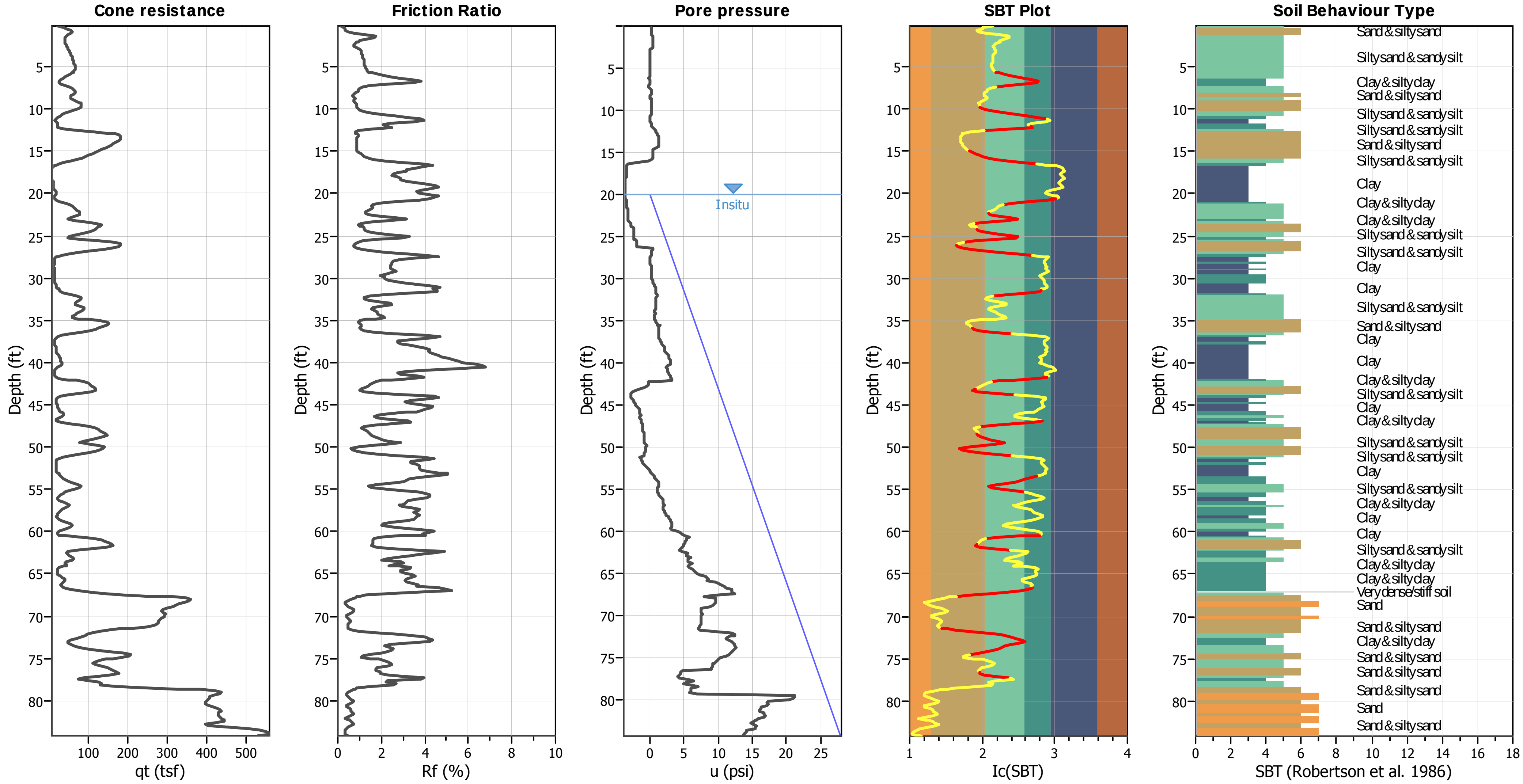






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



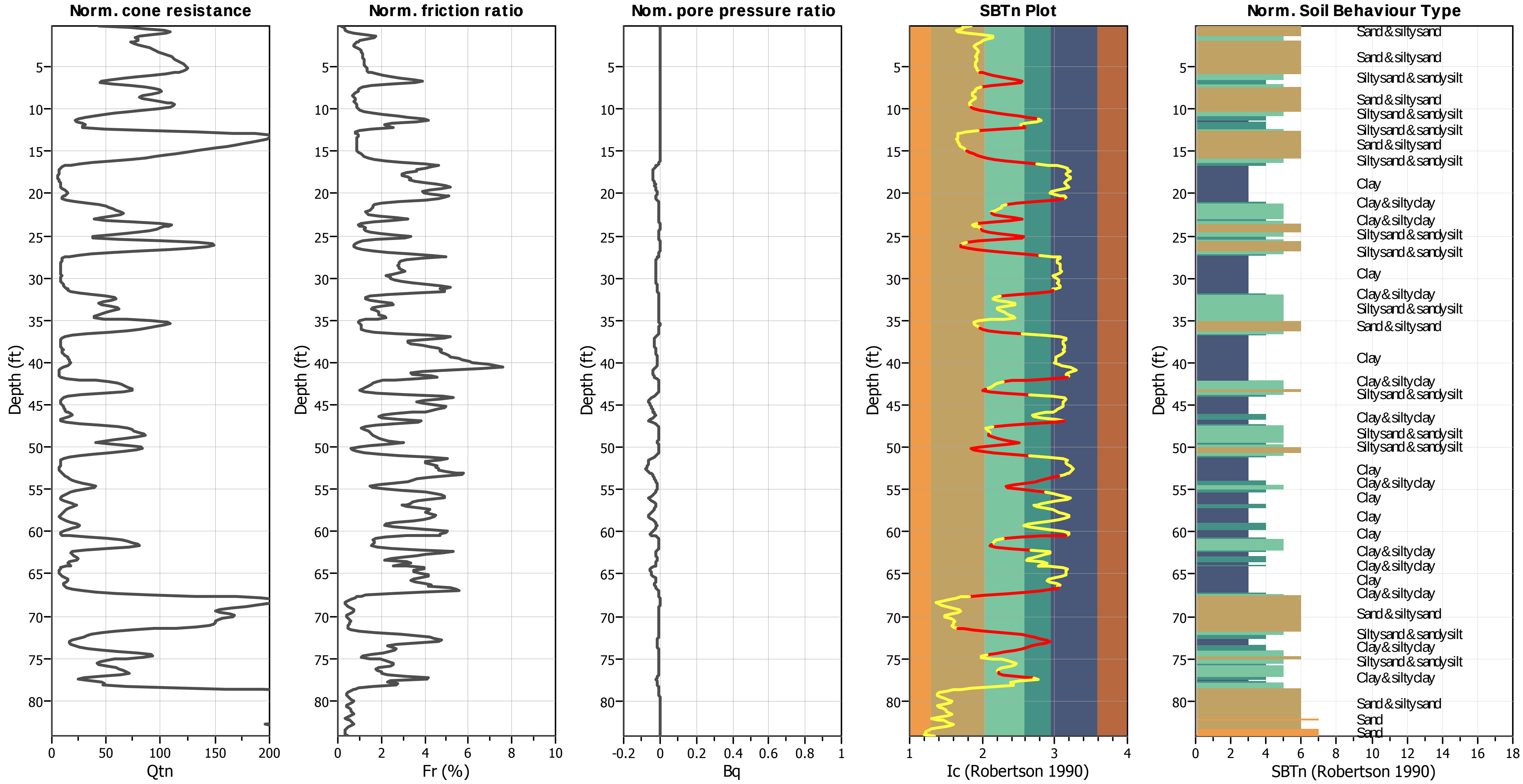
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



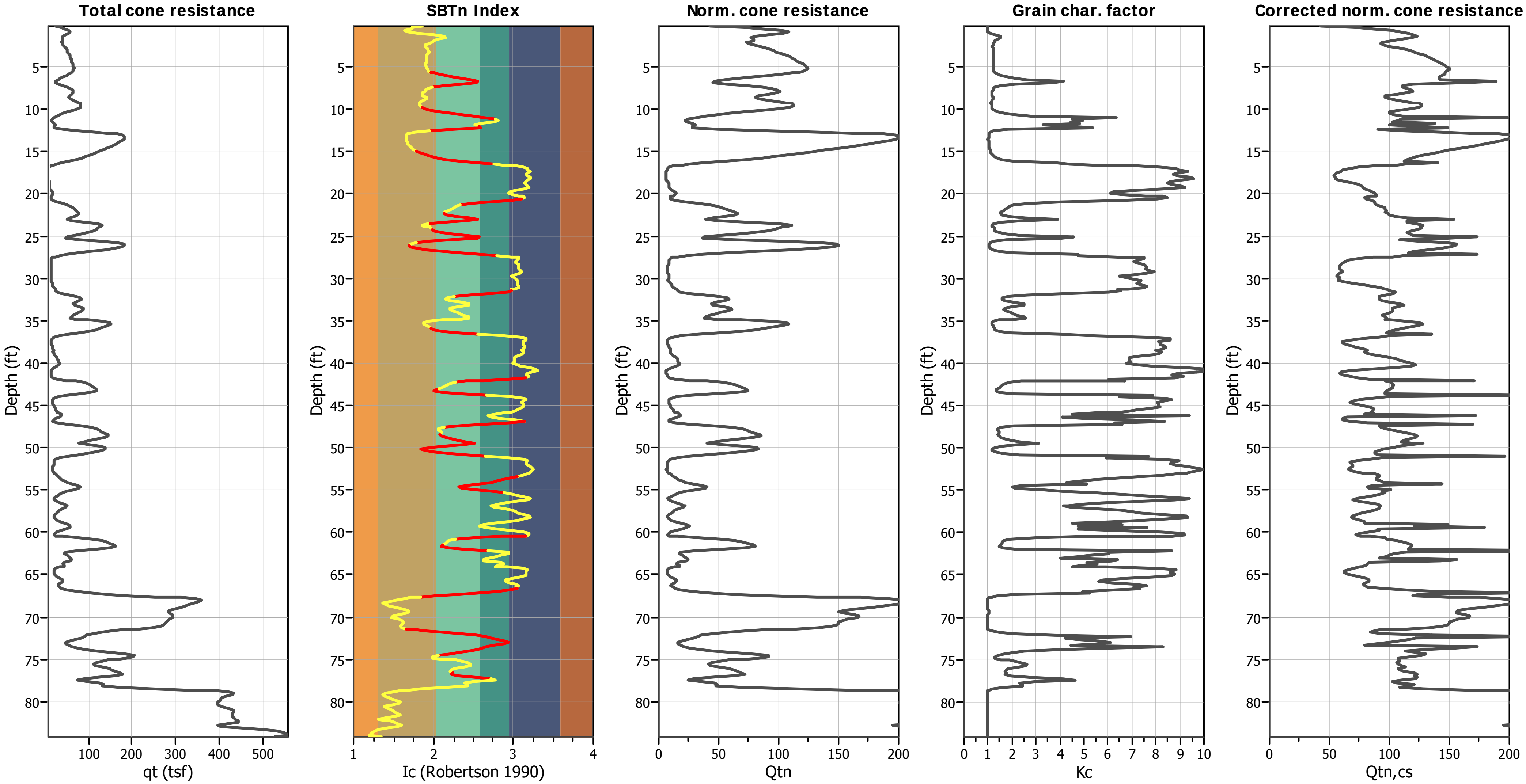
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

SBTn legend

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

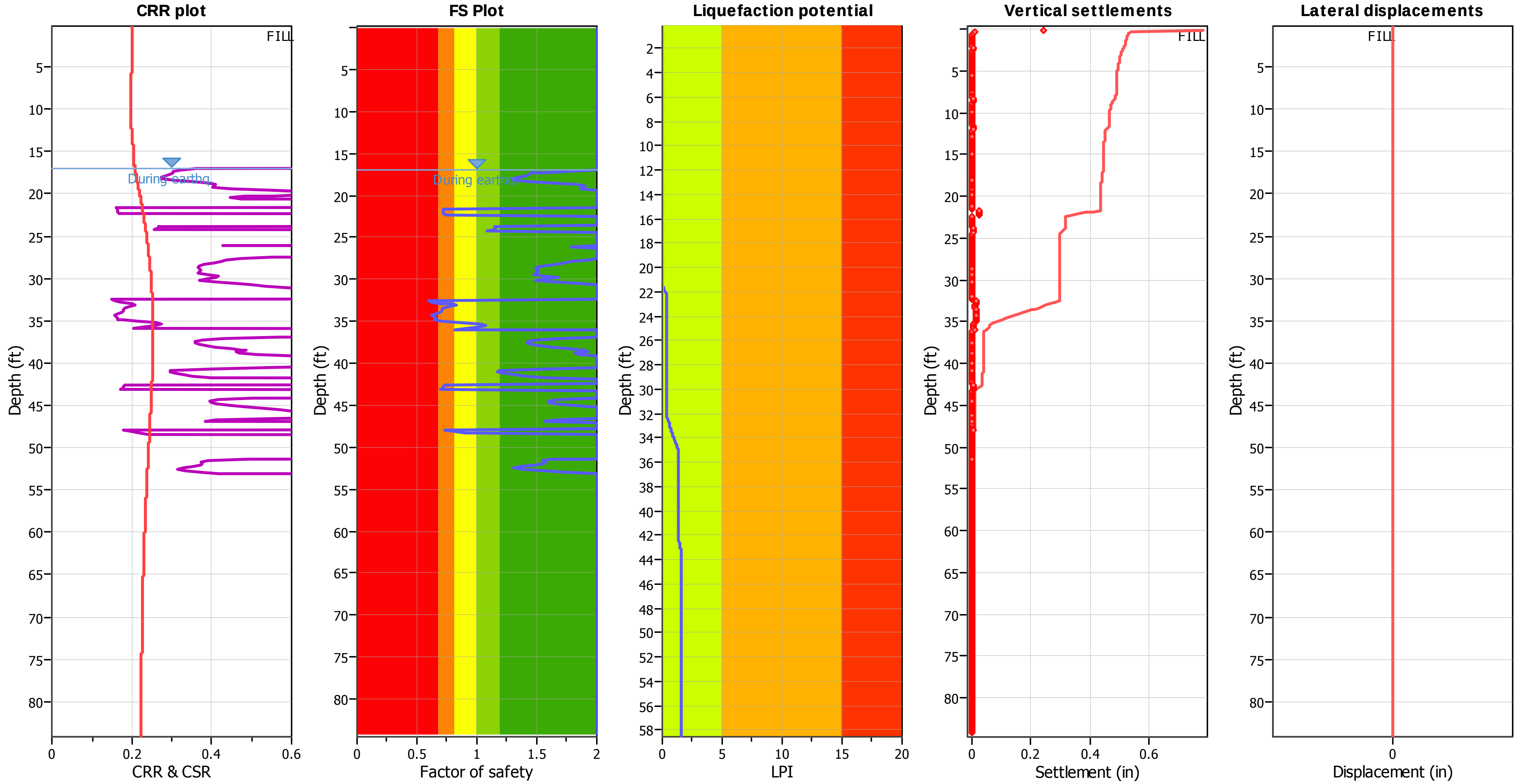
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

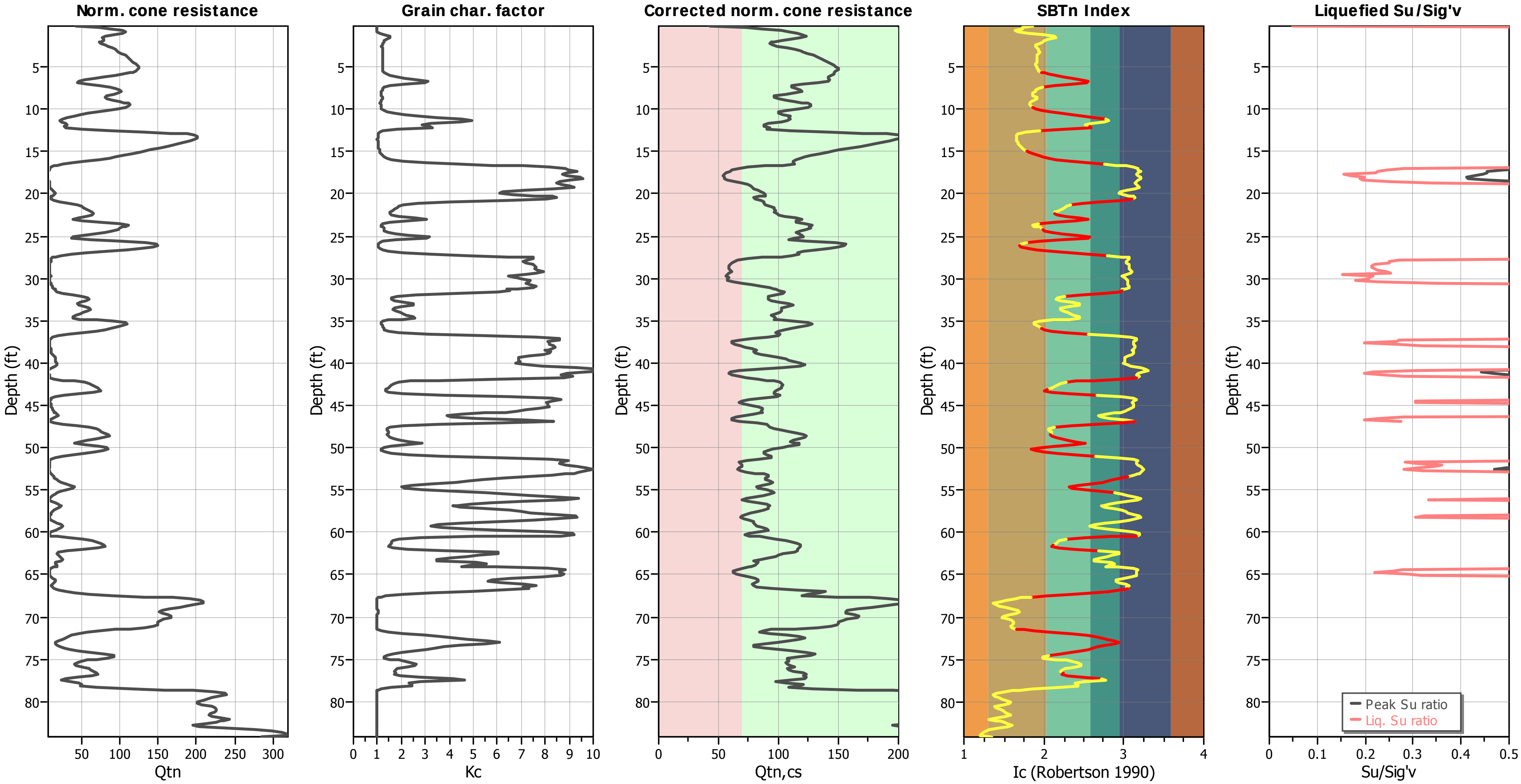
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

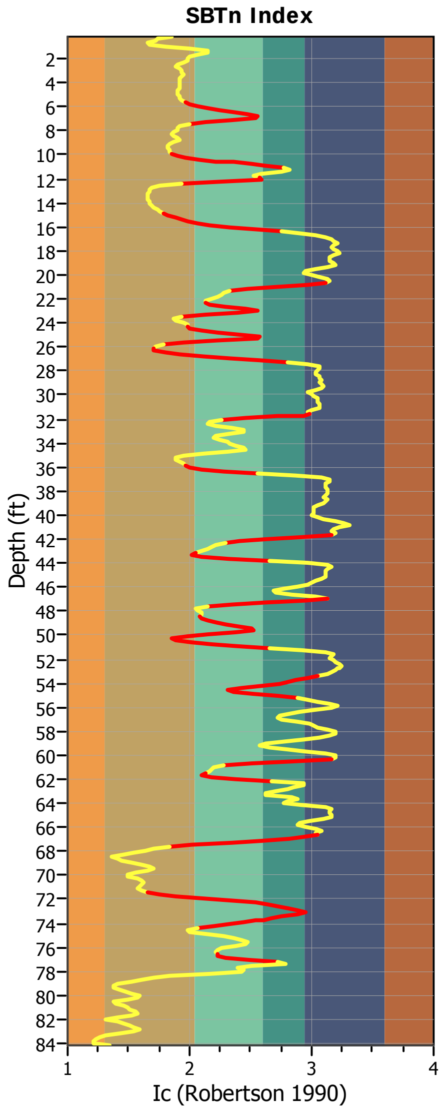
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.00 ft	Limit depth:	60.00 ft

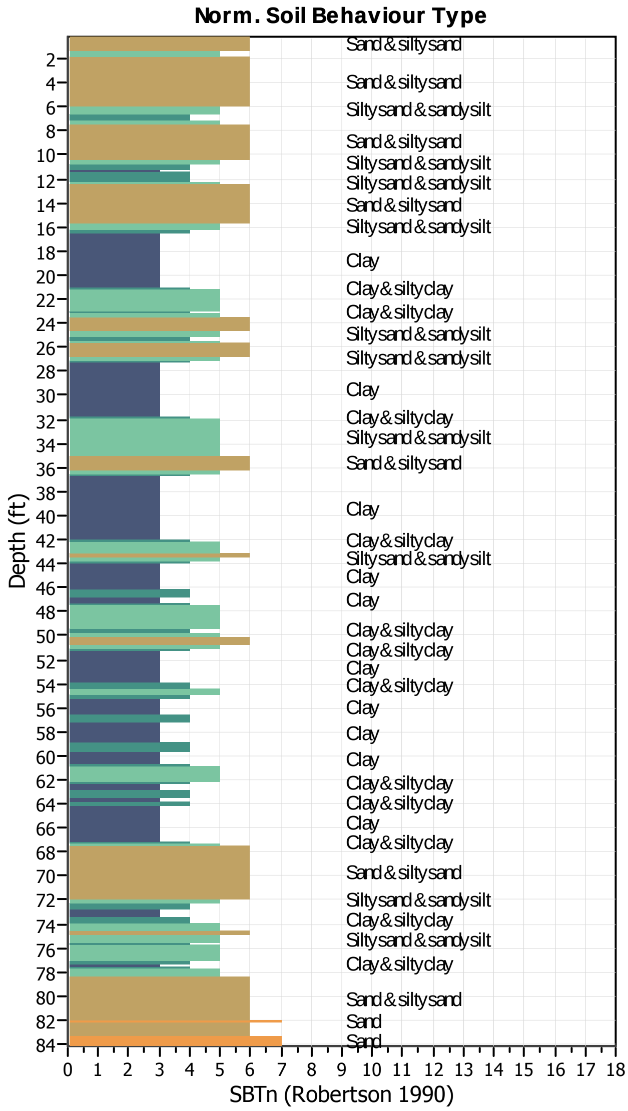
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





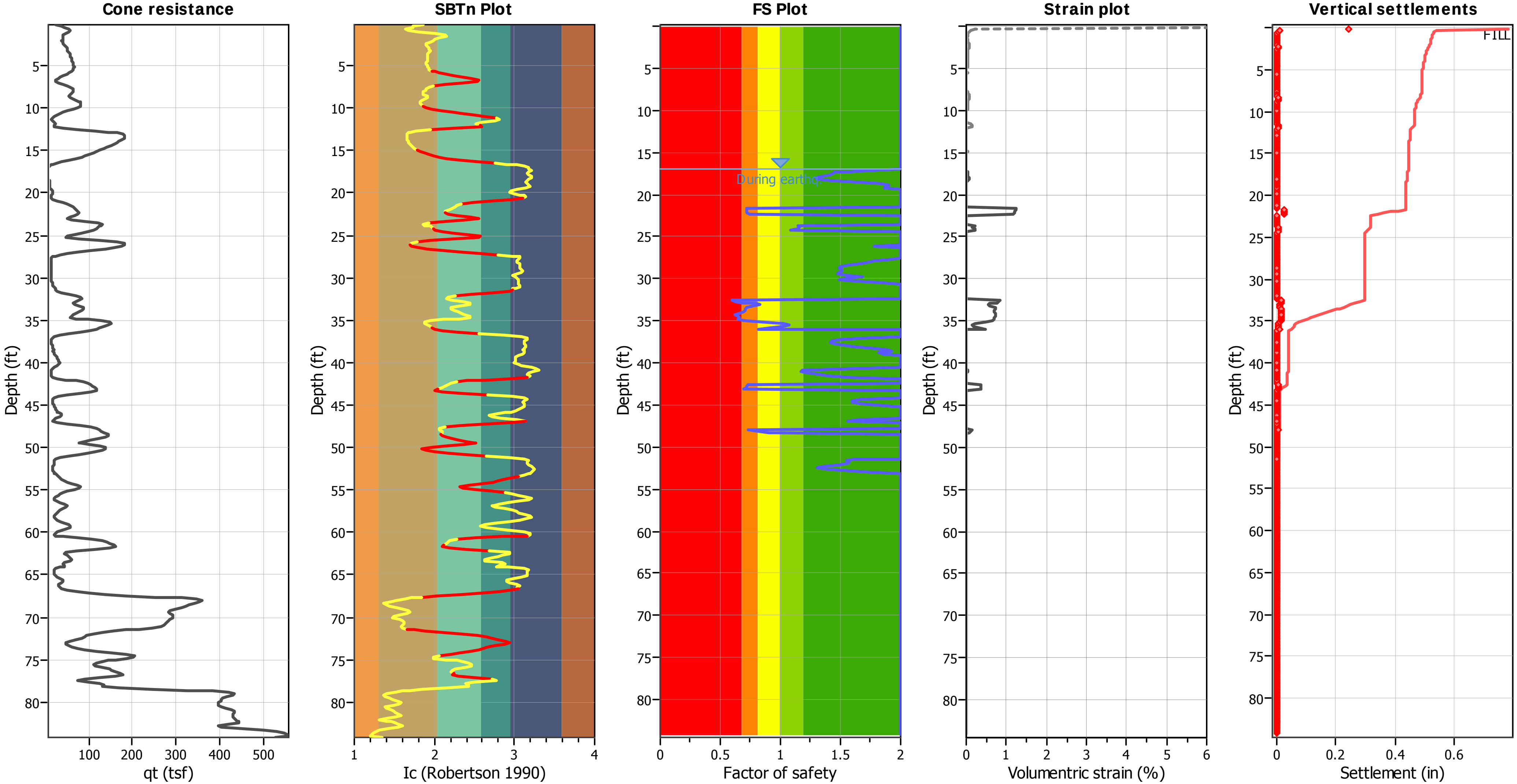
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	513
Total points excluded:	163
Exclusion percentage:	31.77%
Number of layers detected:	27

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

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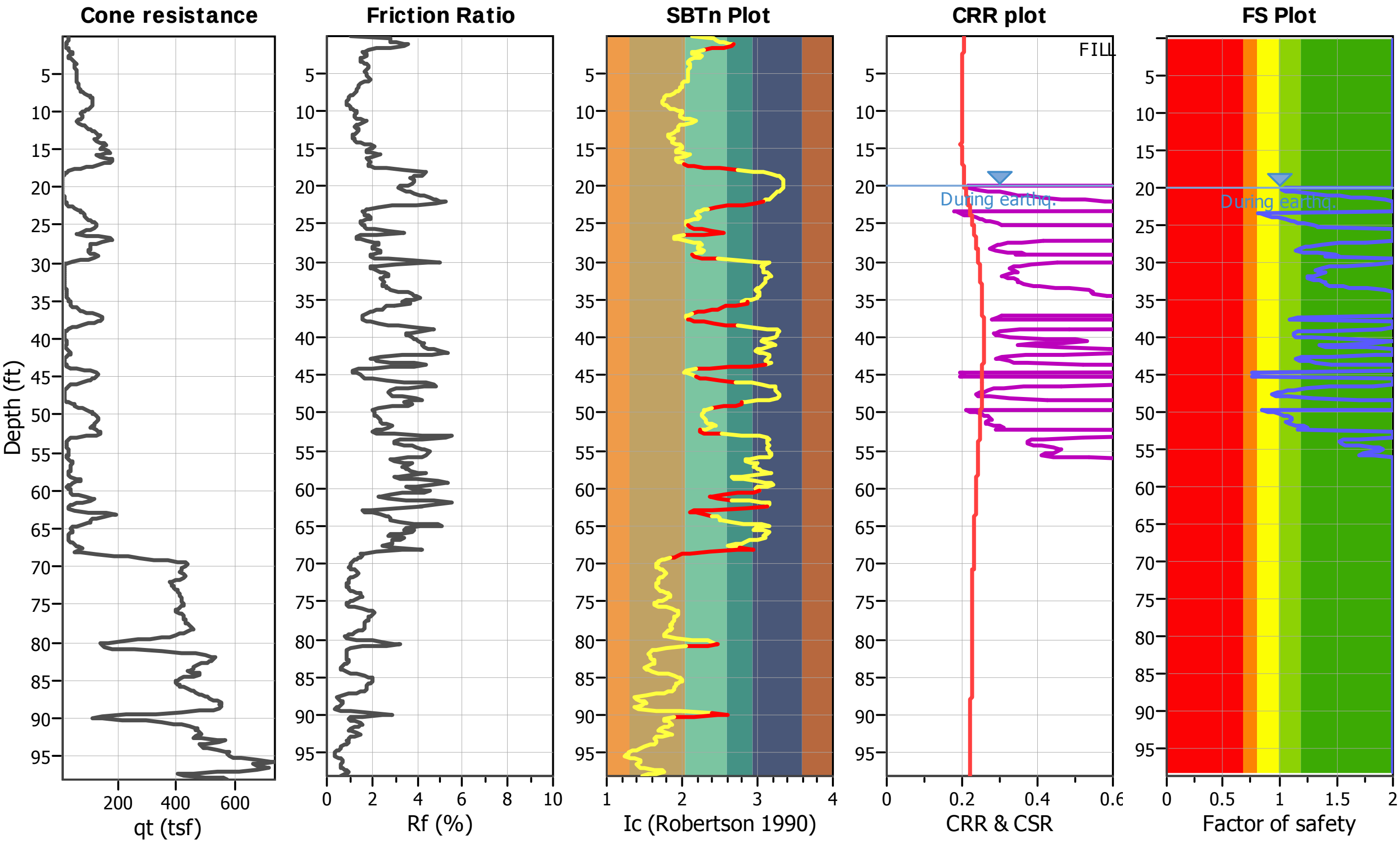
LIQUEFACTION ANALYSIS REPORT

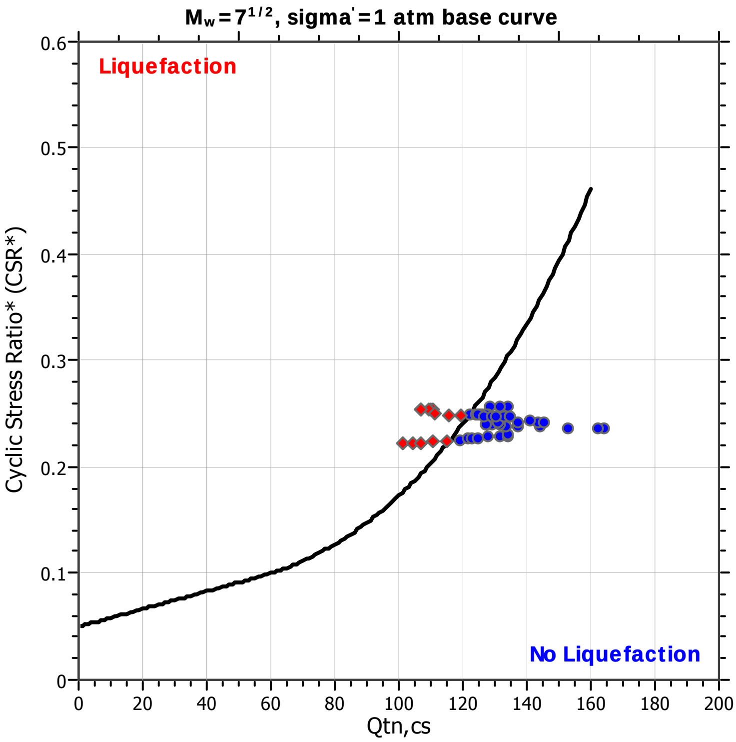
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

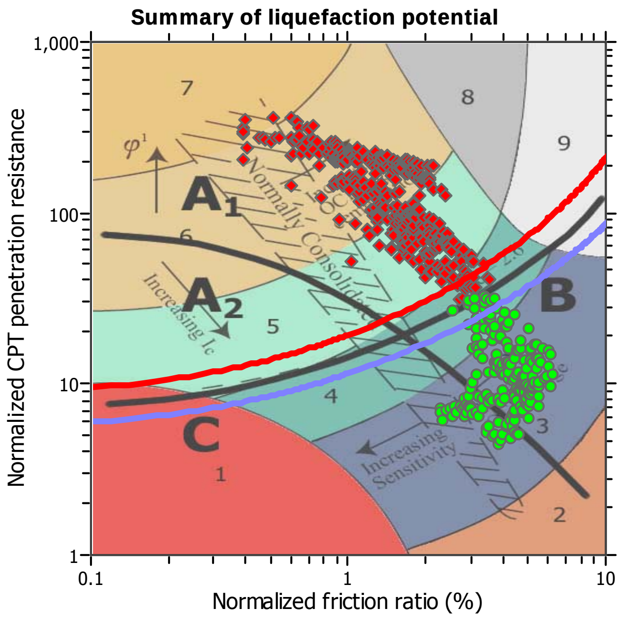
CPT file : CPT-12

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	23.00 ft	Fill height:	3.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

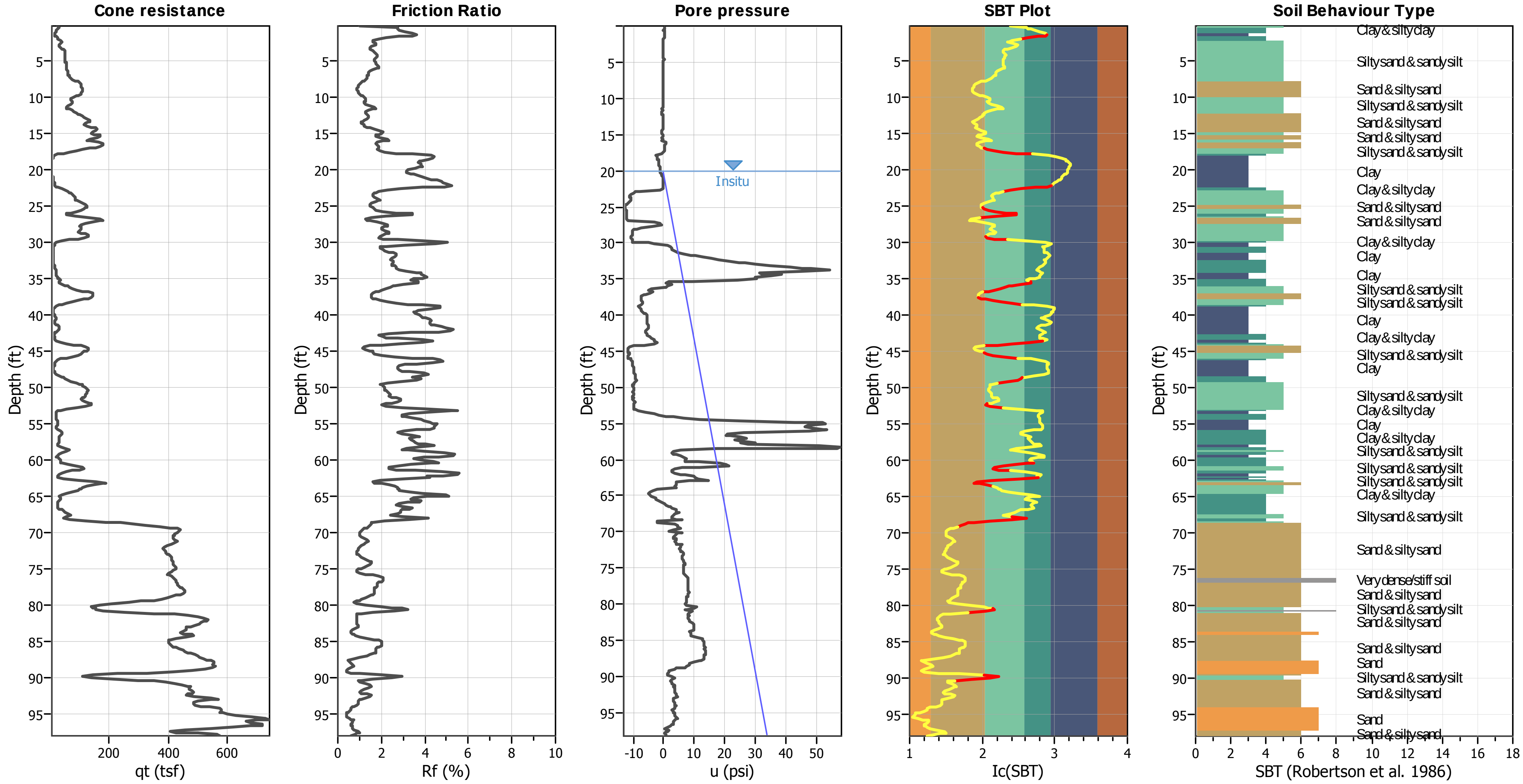






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



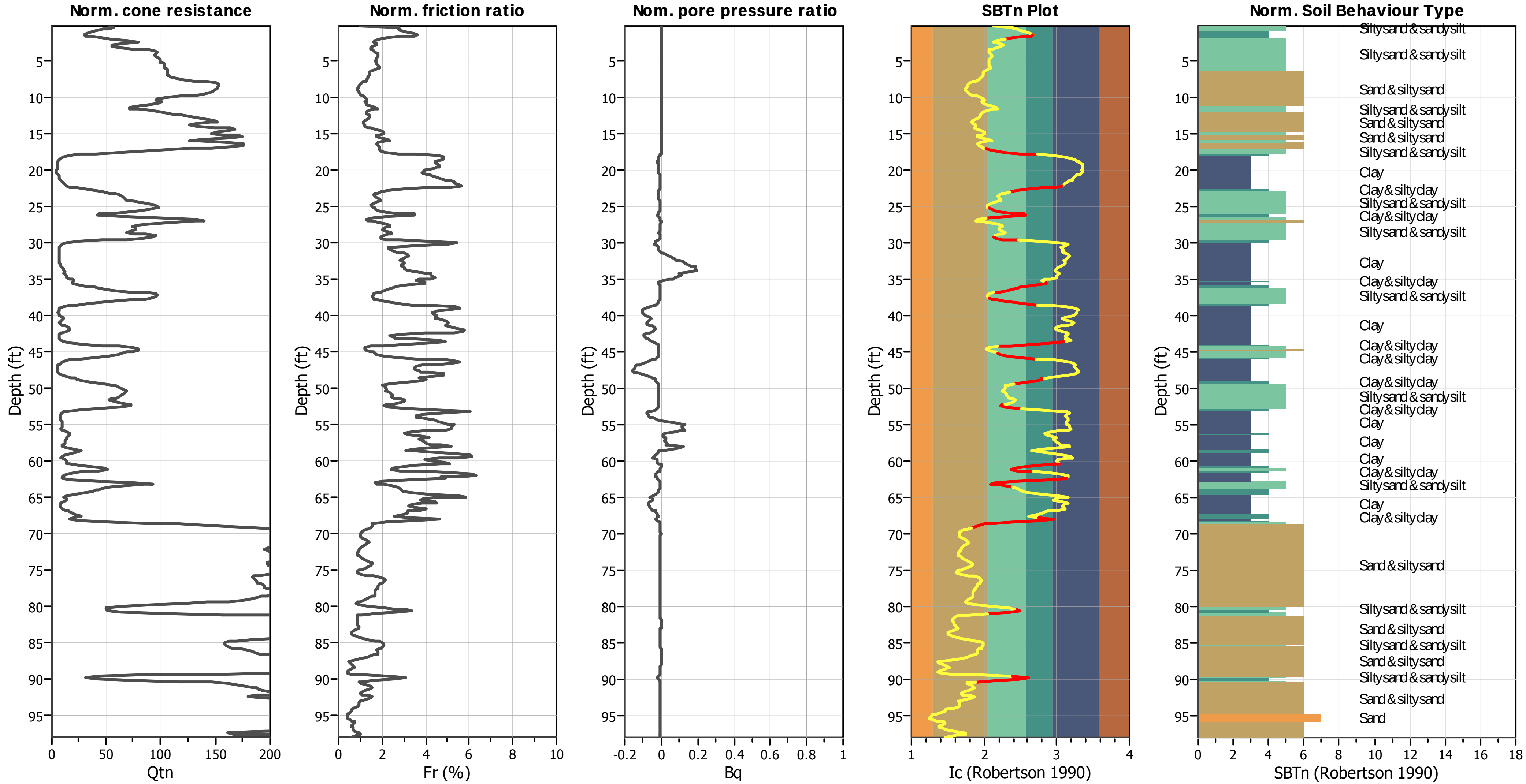
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



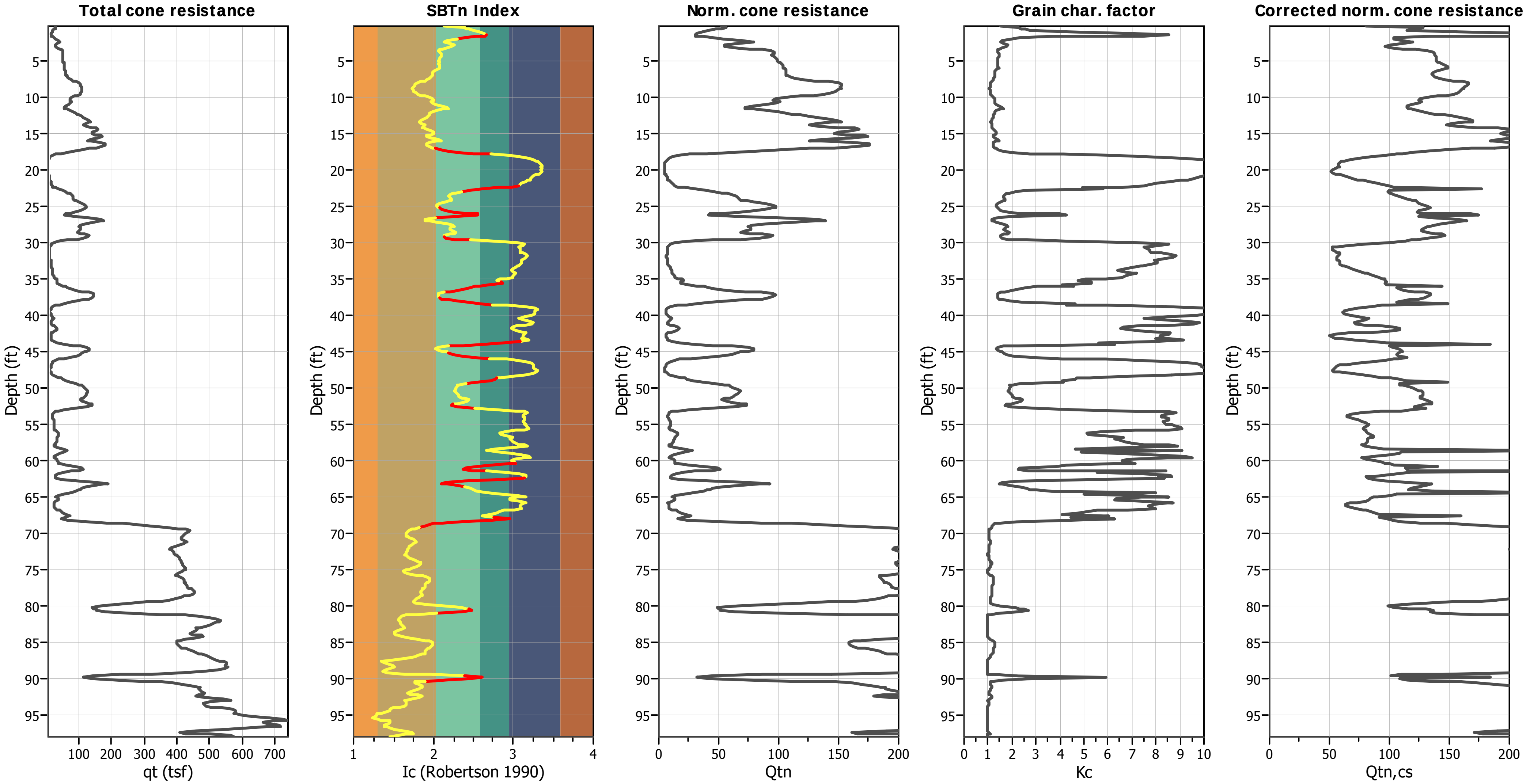
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBTn legend

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

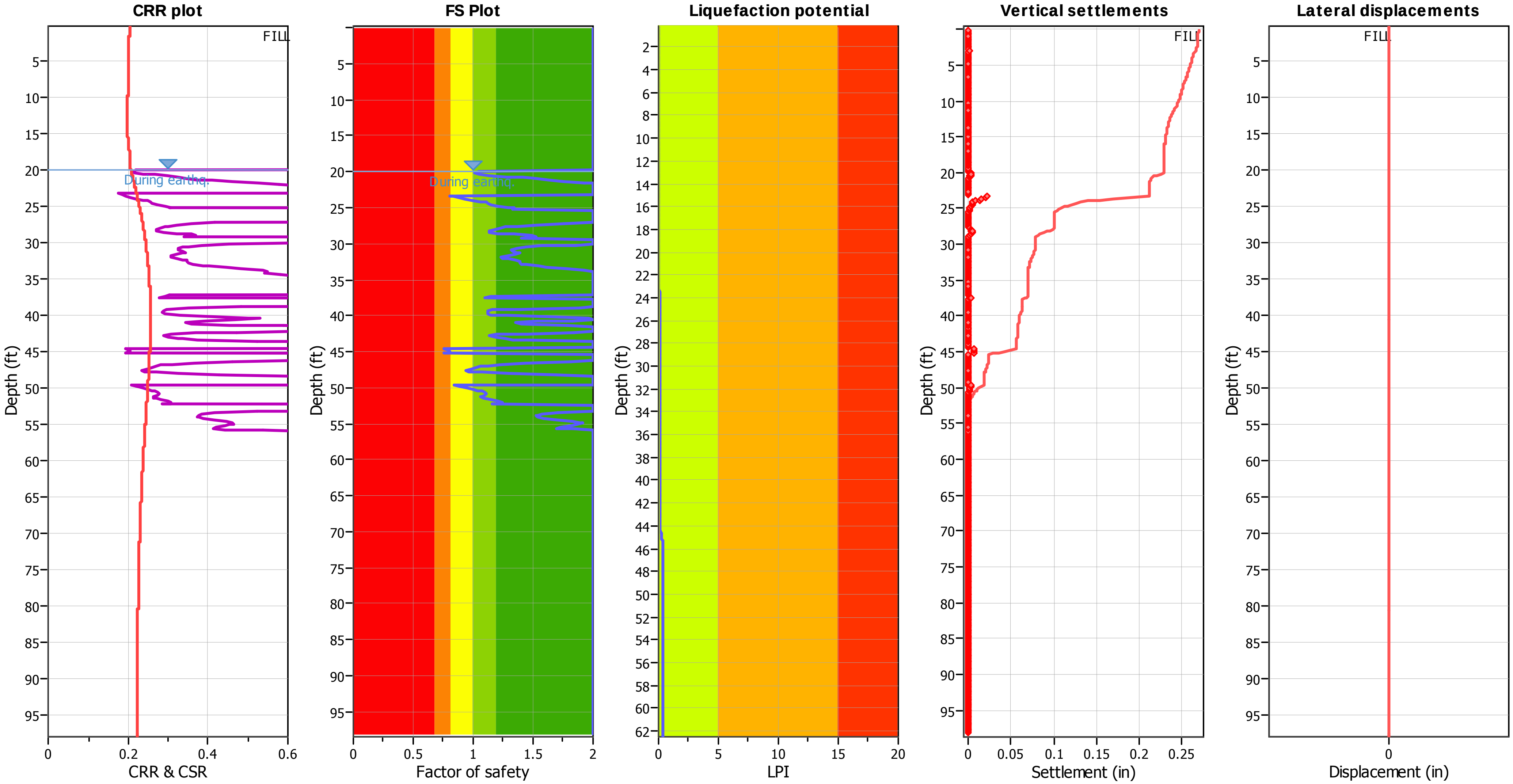
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

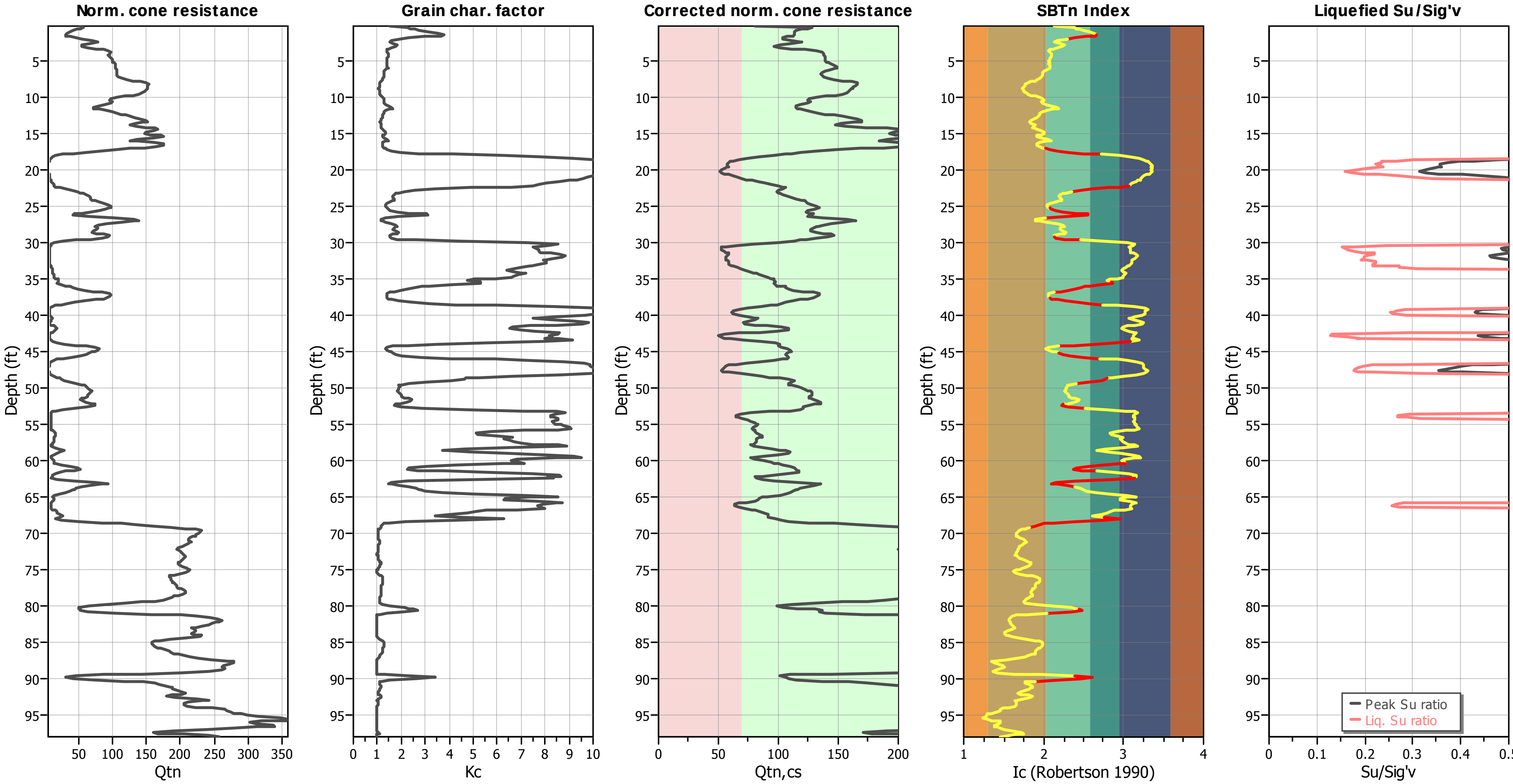
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

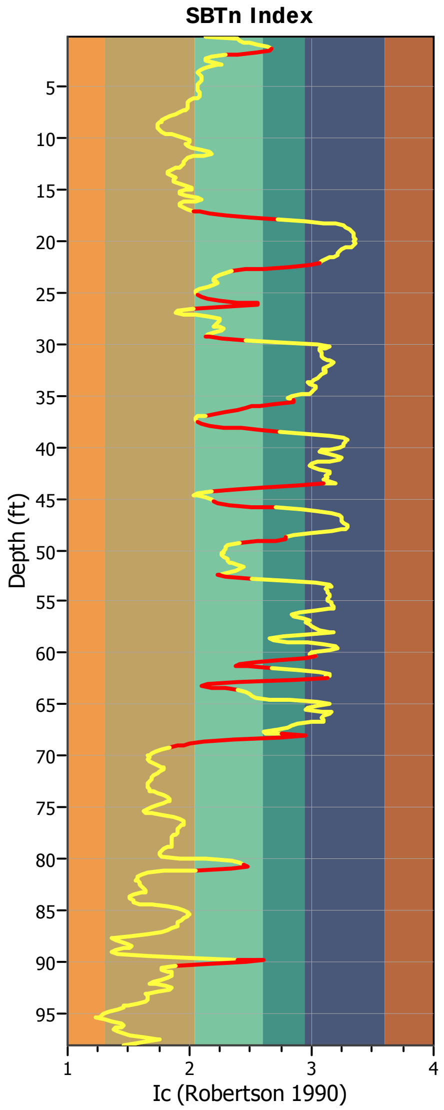
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

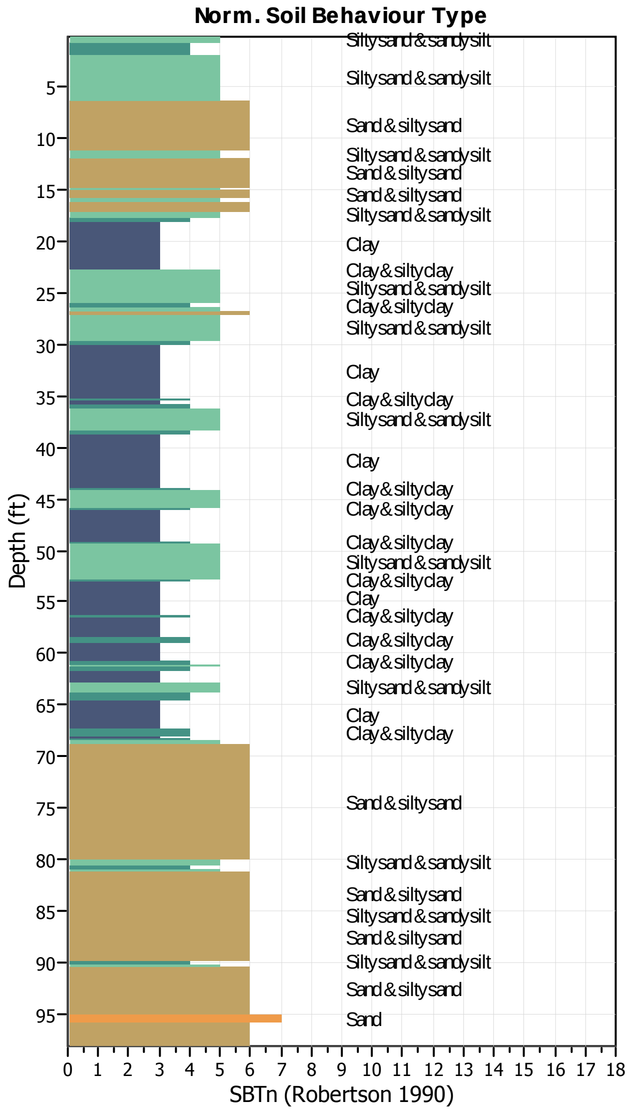
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





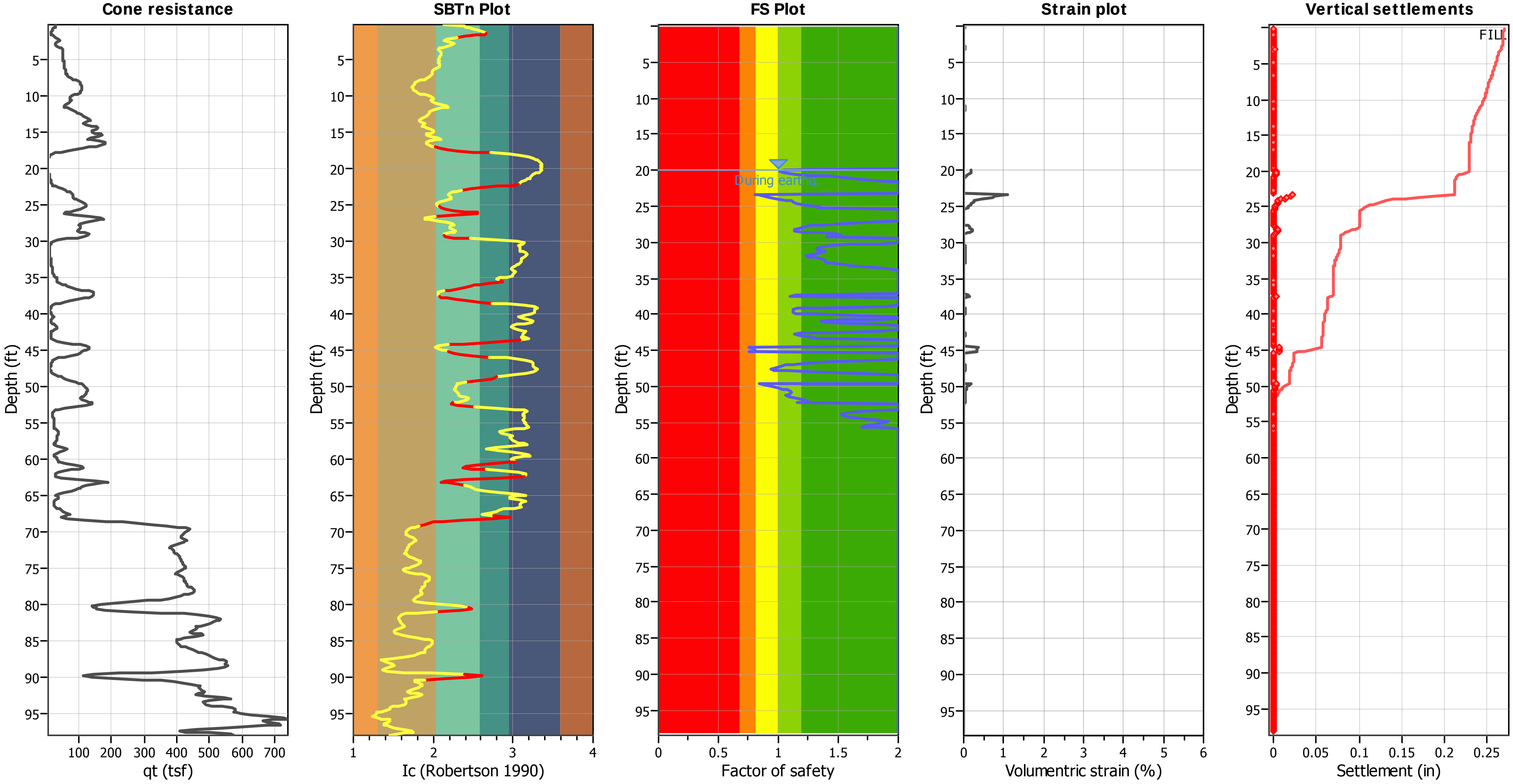
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	598
Total points excluded:	101
Exclusion percentage:	16.89%
Number of layers detected:	19

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

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17781 Cowan
Irvine, CA 92614
www.leightongroup.com

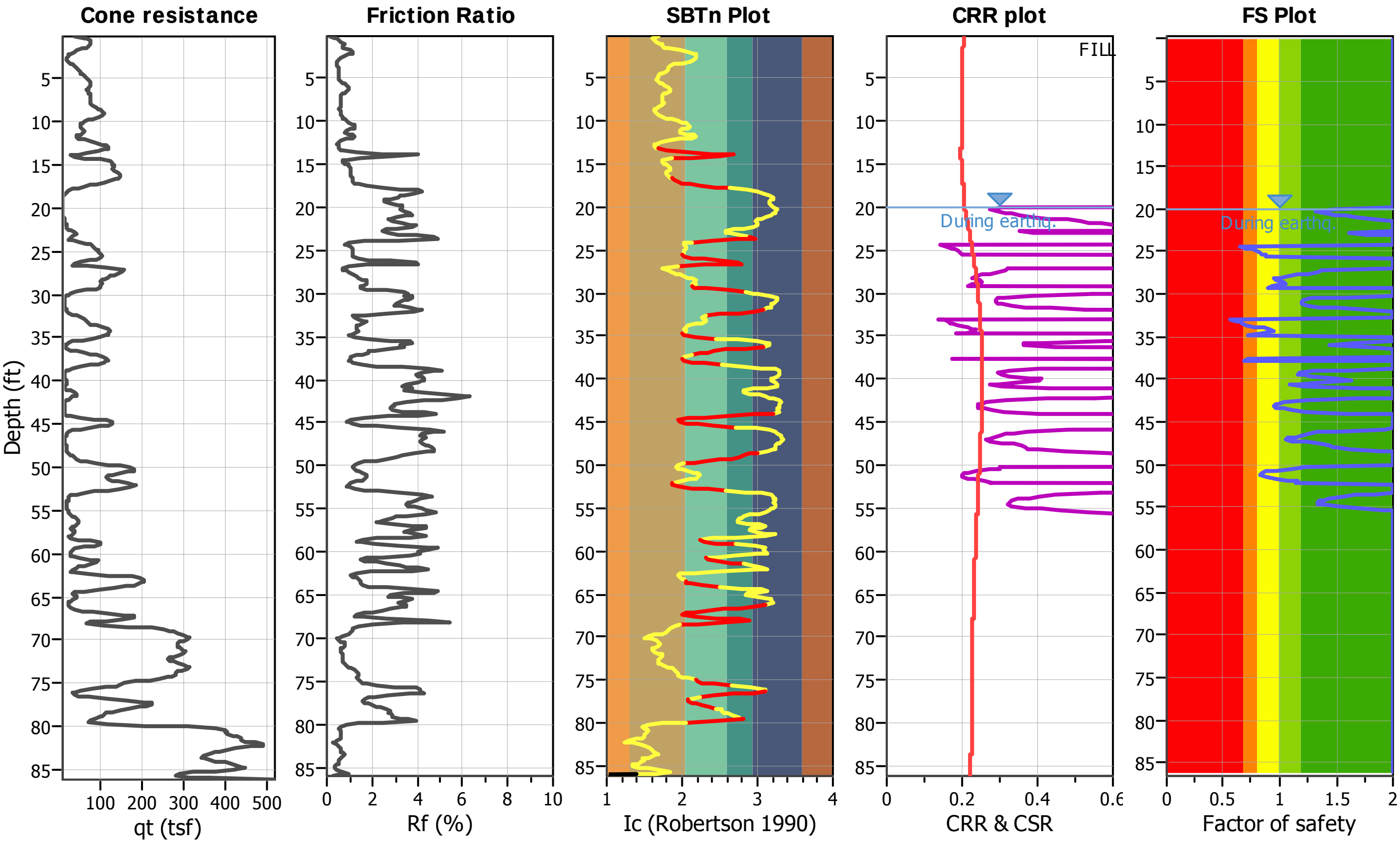
LIQUEFACTION ANALYSIS REPORT

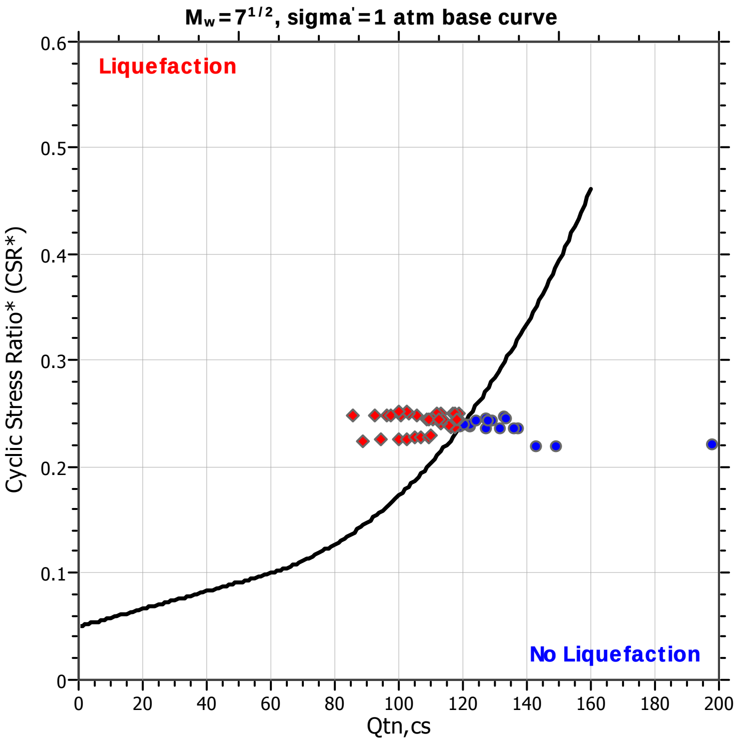
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

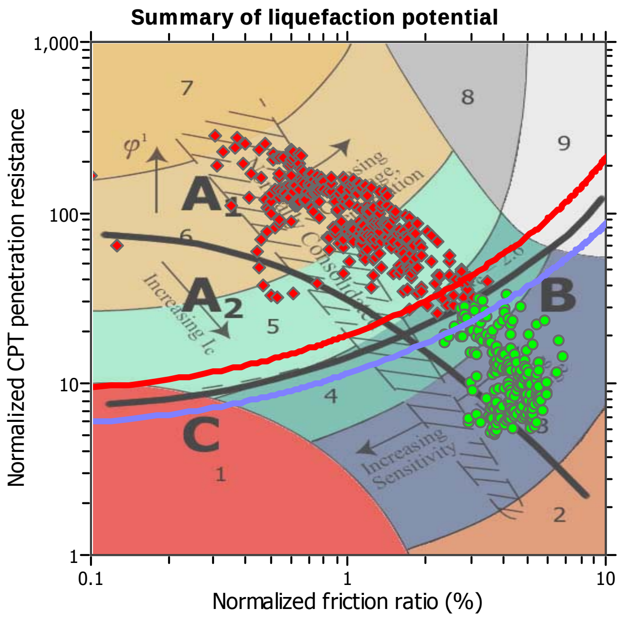
CPT file : CPT-13

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	24.00 ft	Fill height:	4.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

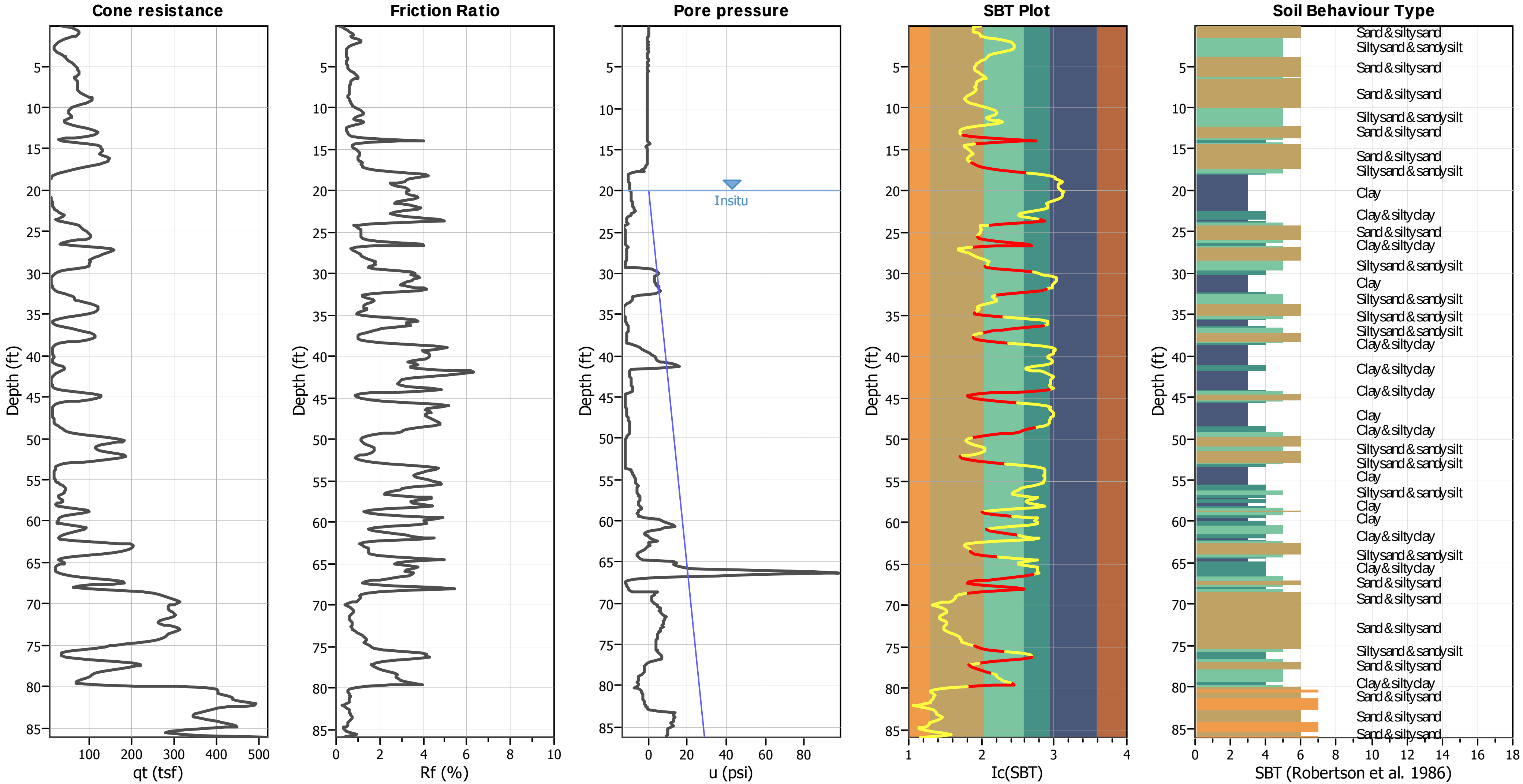






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



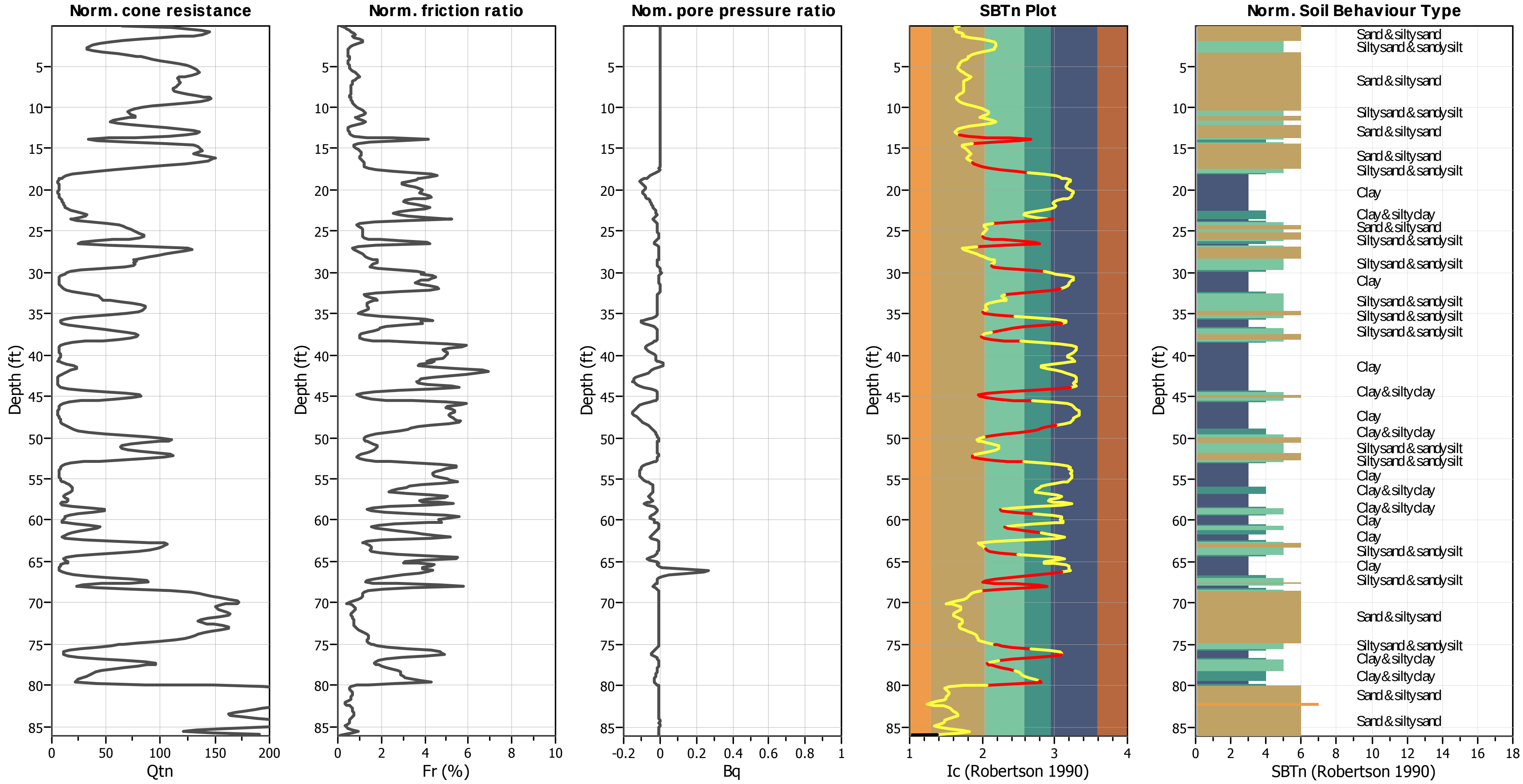
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
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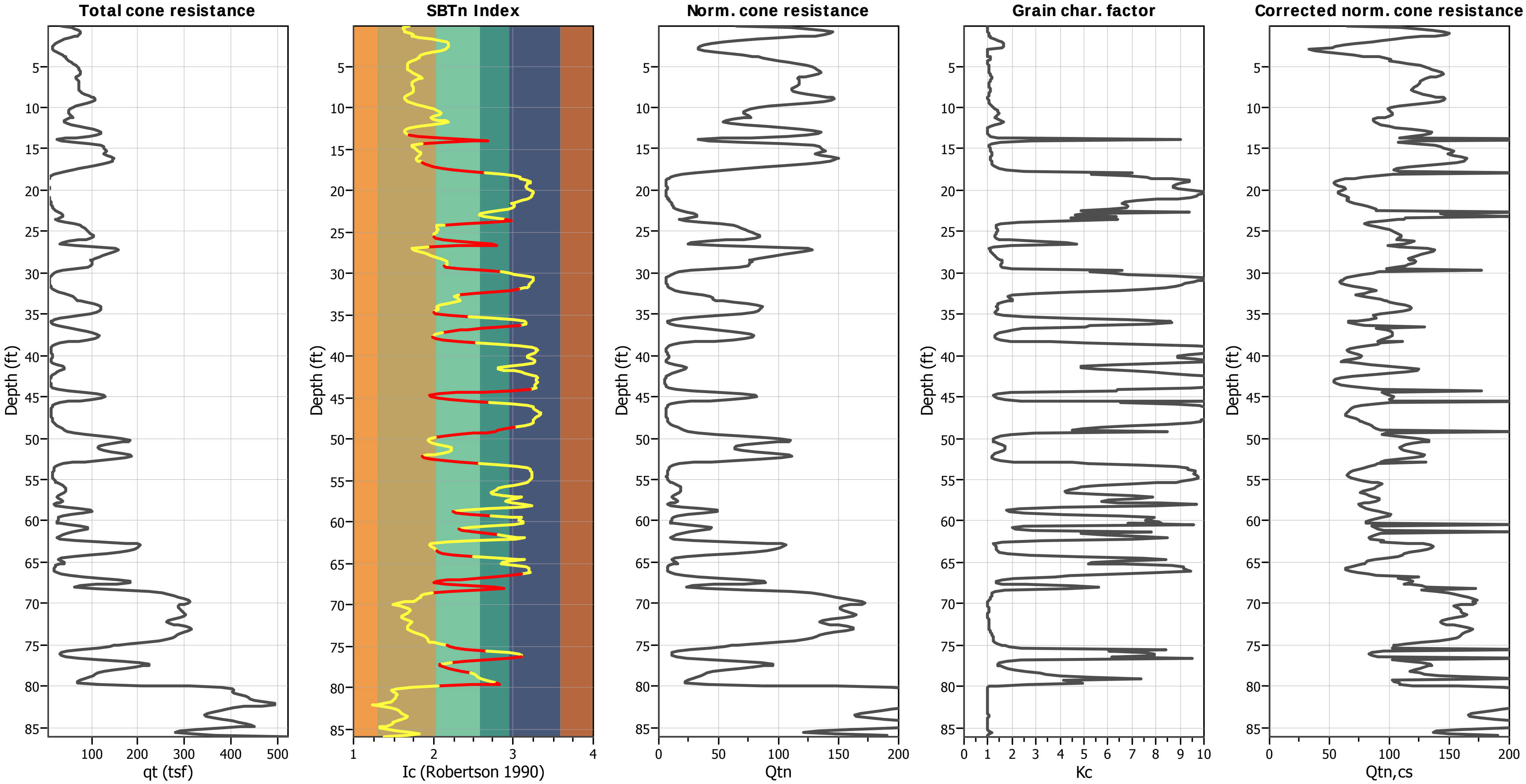
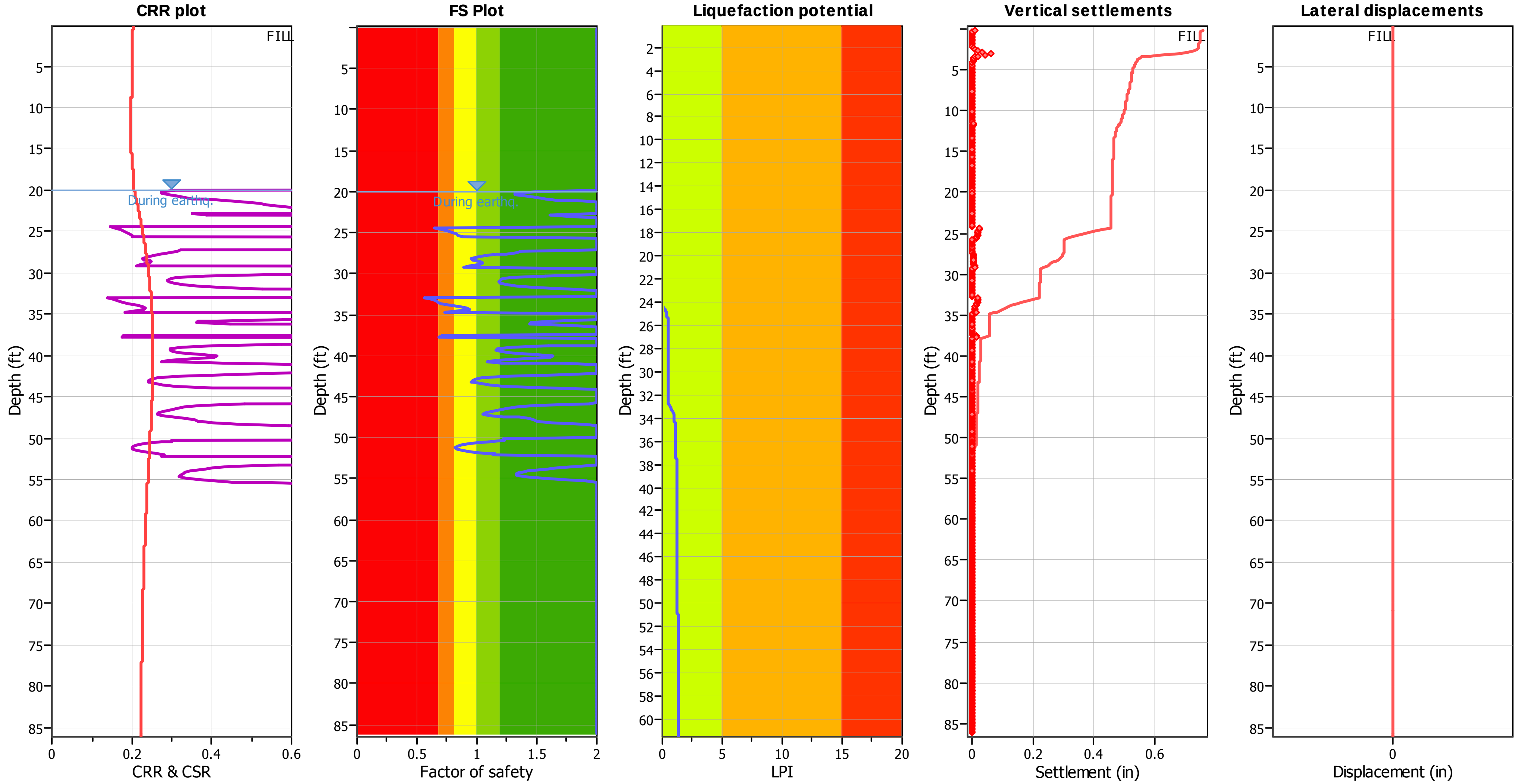
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



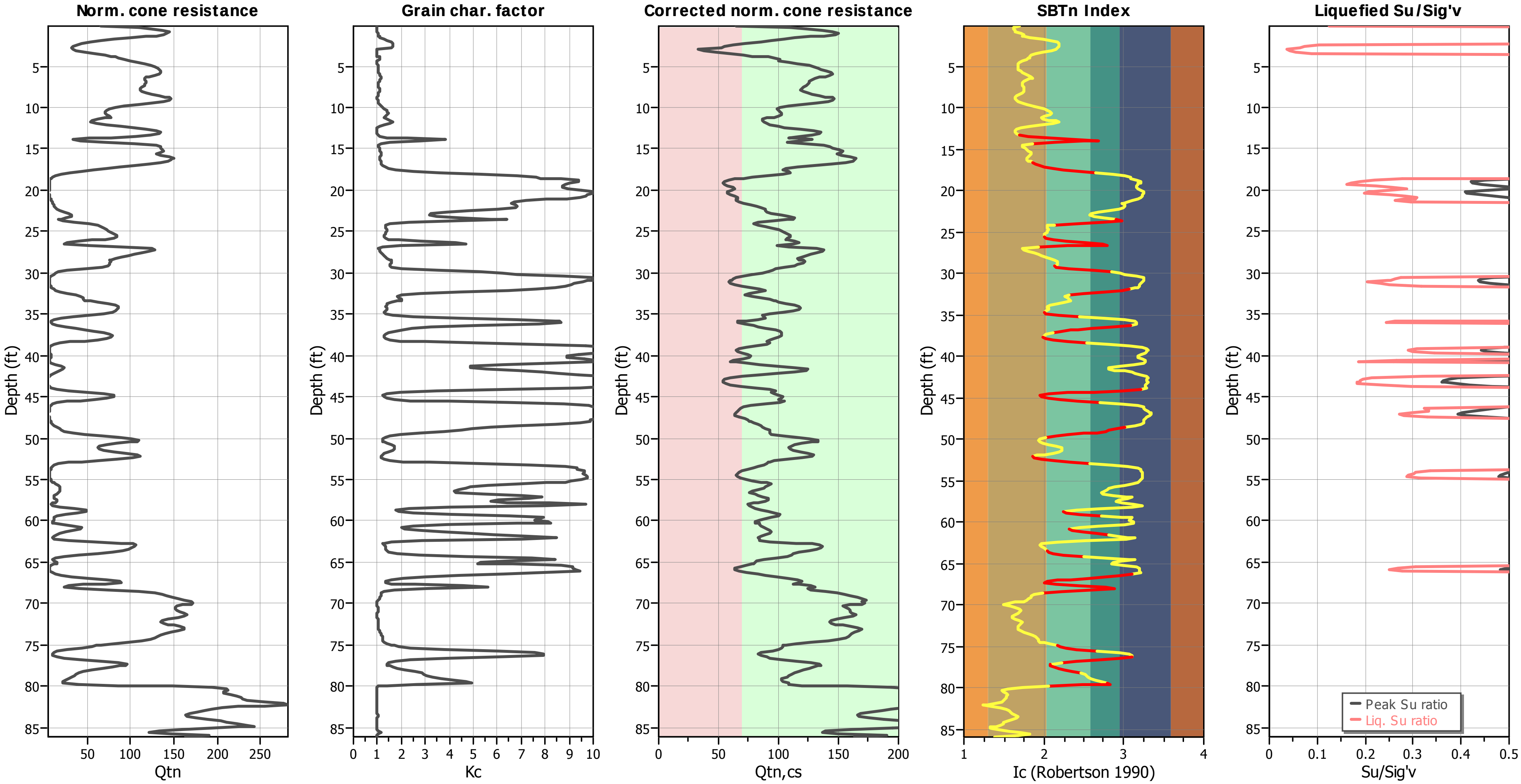
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

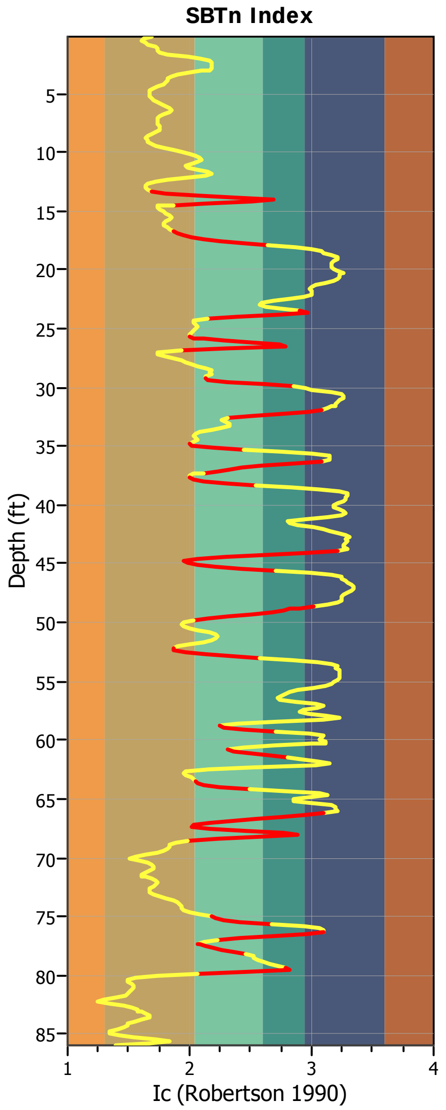
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	24.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	4.00 ft	Limit depth:	60.00 ft

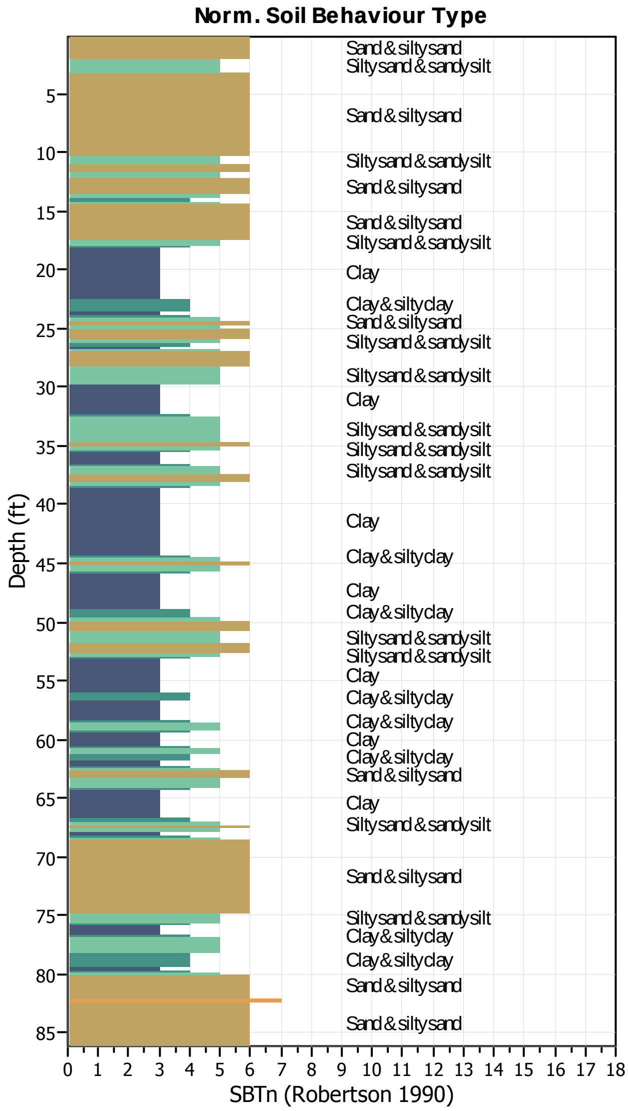
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

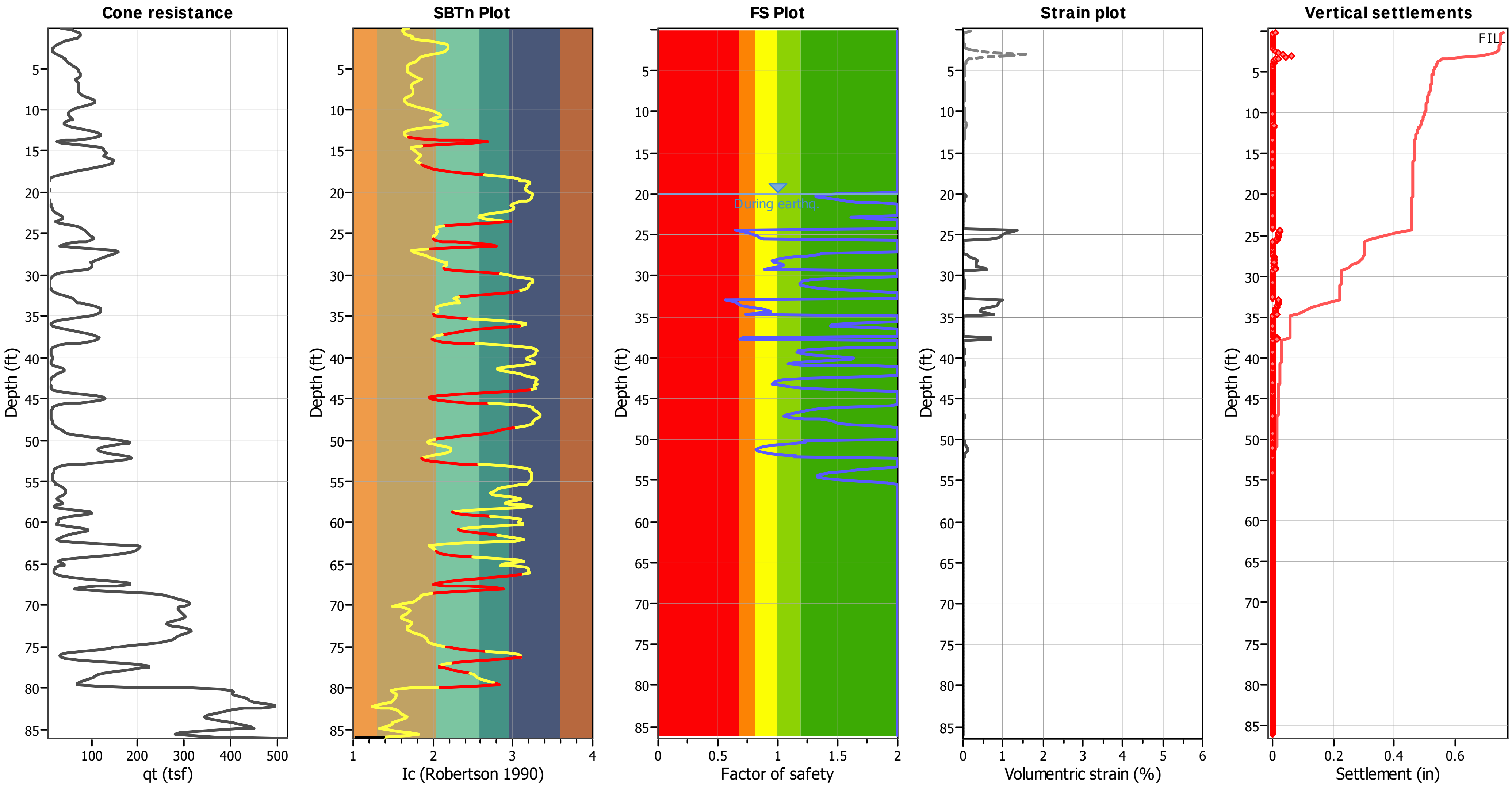
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	525
I_c maximum check value:	3.00	Total points excluded:	135
I_c change ratio value:	0.0250	Exclusion percentage:	25.71%
Minimum number of points in layer:	4	Number of layers detected:	25

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

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17781 Cowan
Irvine, CA 92614
www.leightongroup.com

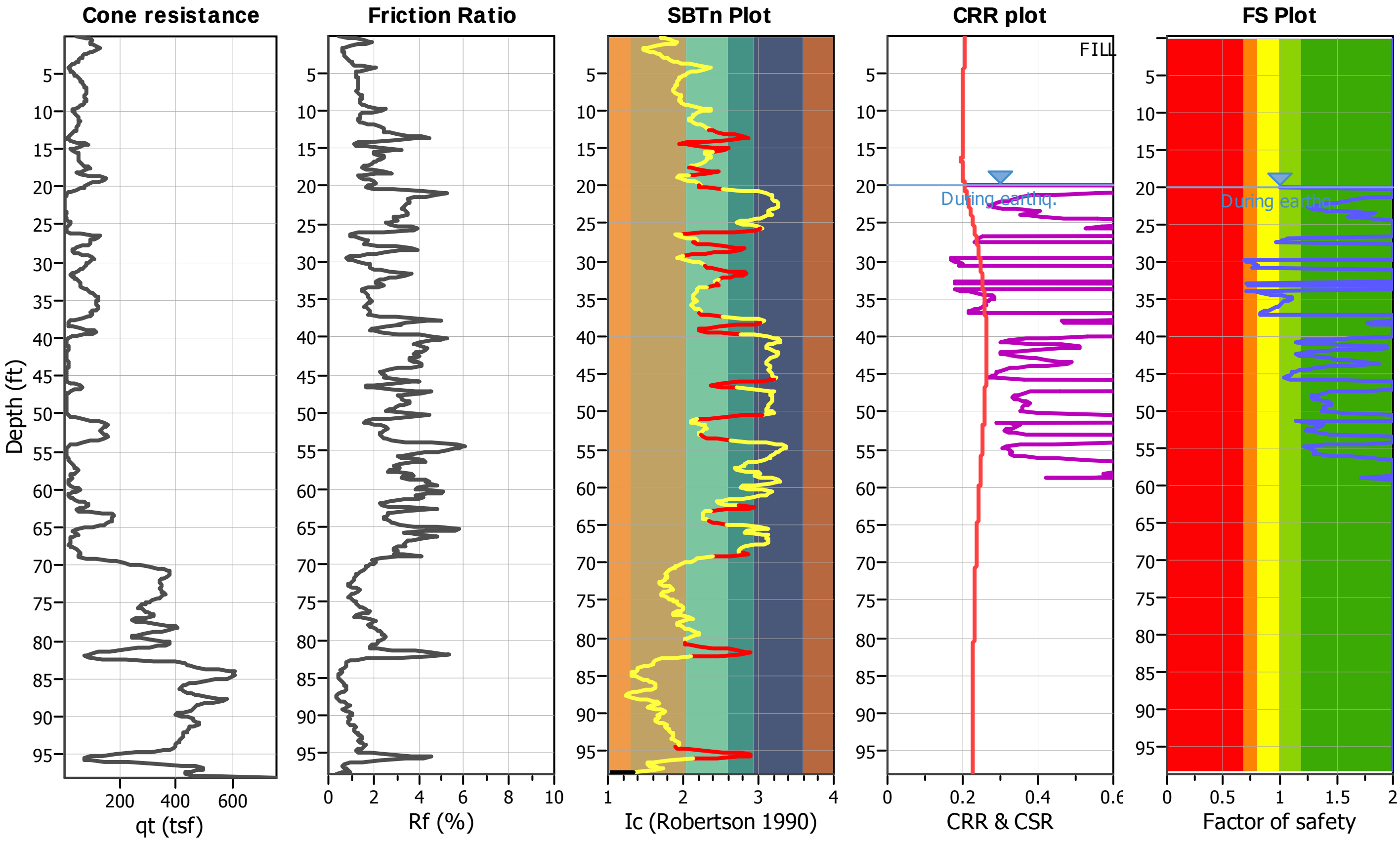
LIQUEFACTION ANALYSIS REPORT

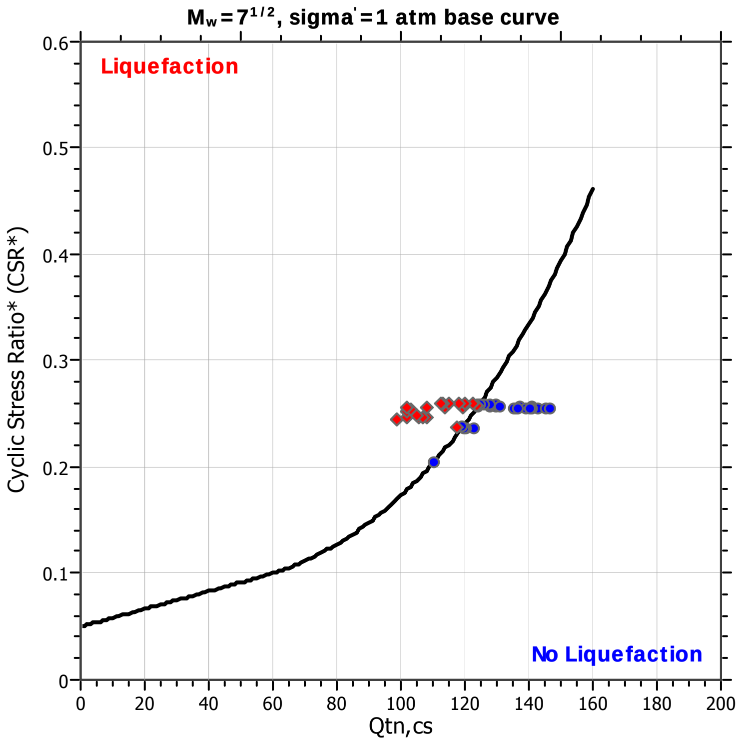
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

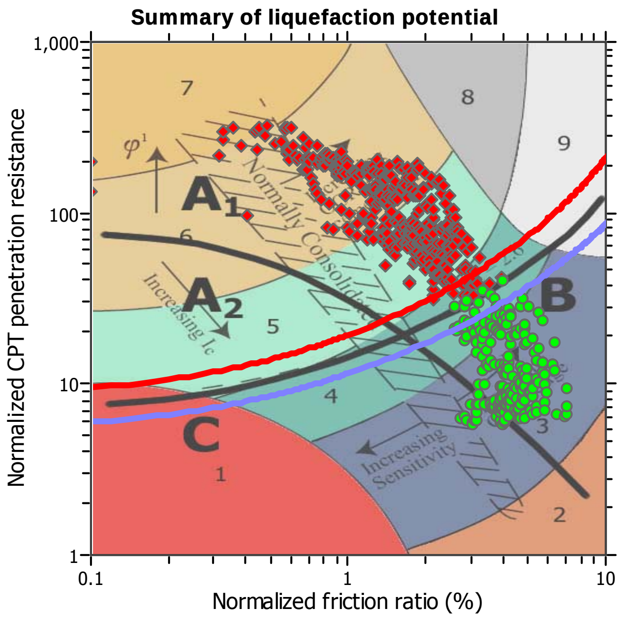
CPT file : CPT-14

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	21.00 ft	Fill height:	1.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
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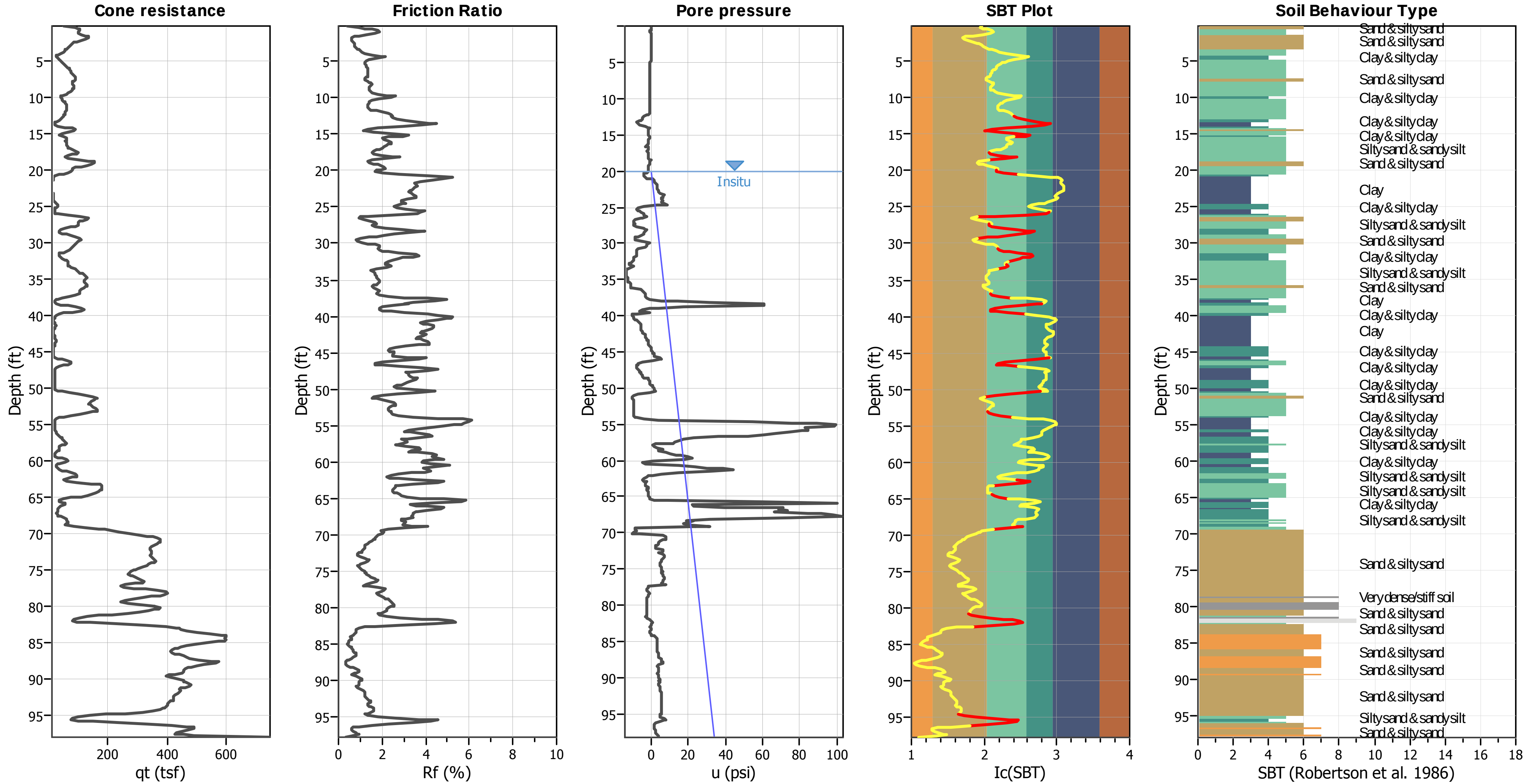
CPT basic interpretation plots



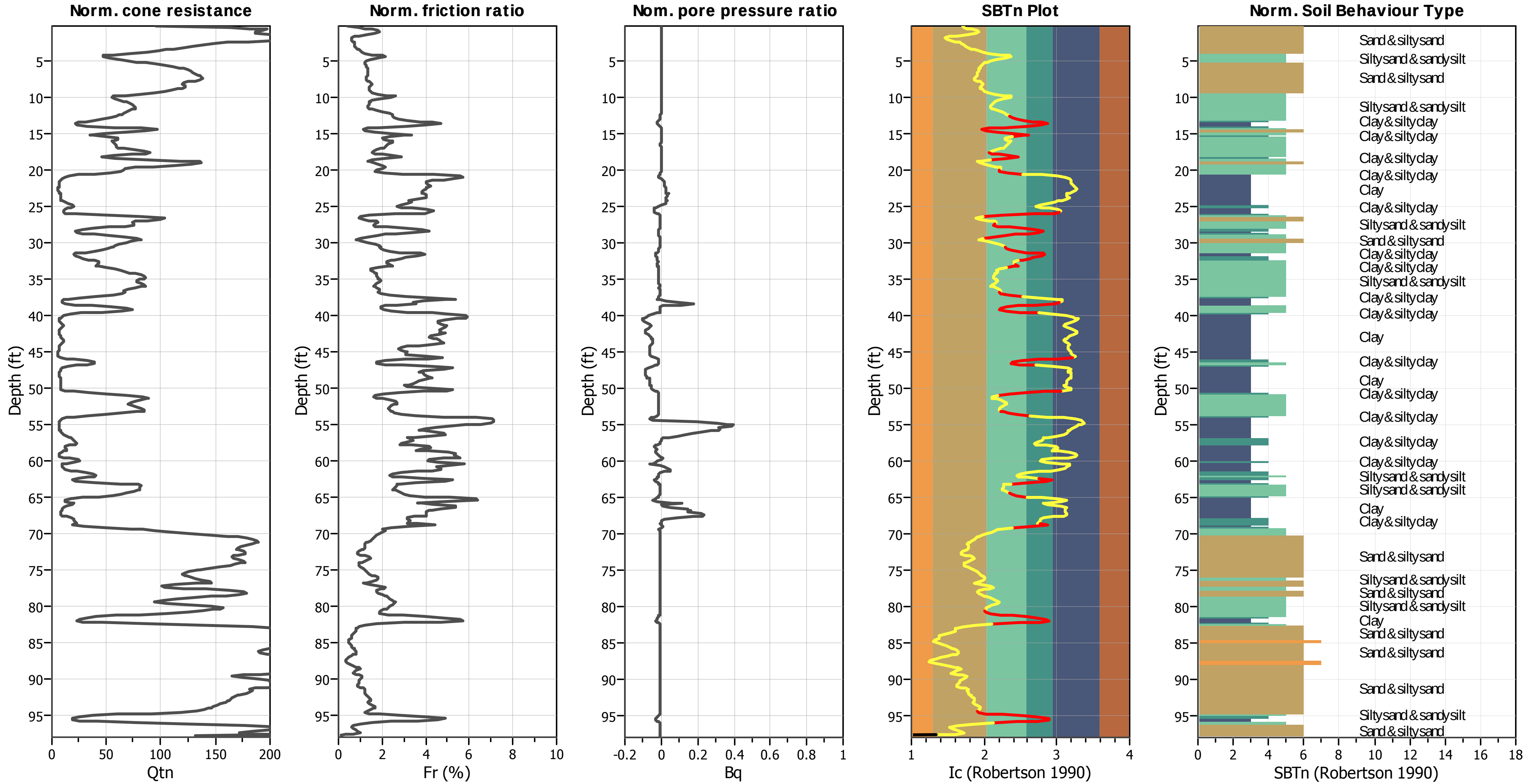
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

SBTn legend

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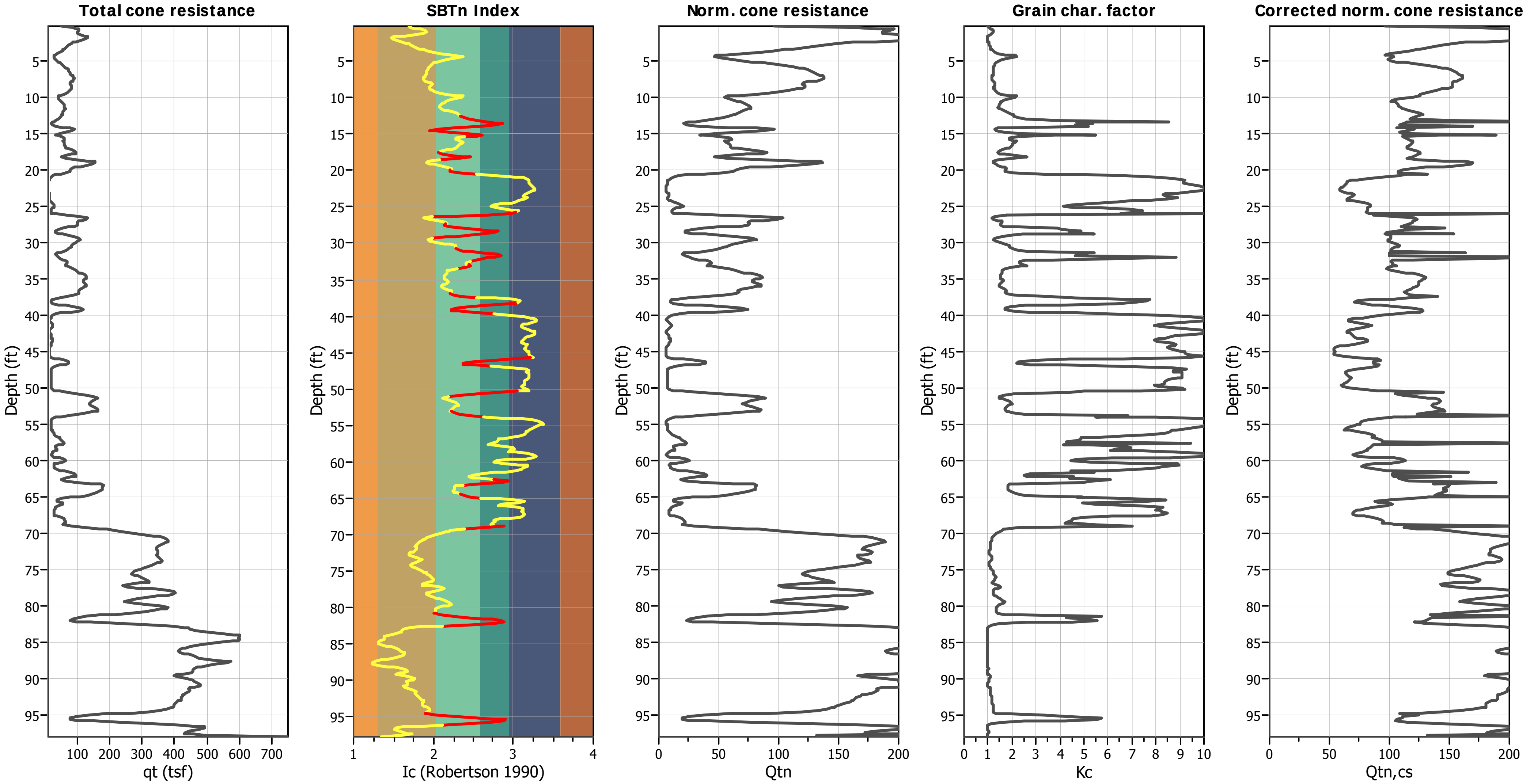
8. Very stiff sand to
9. Very stiff fine grained

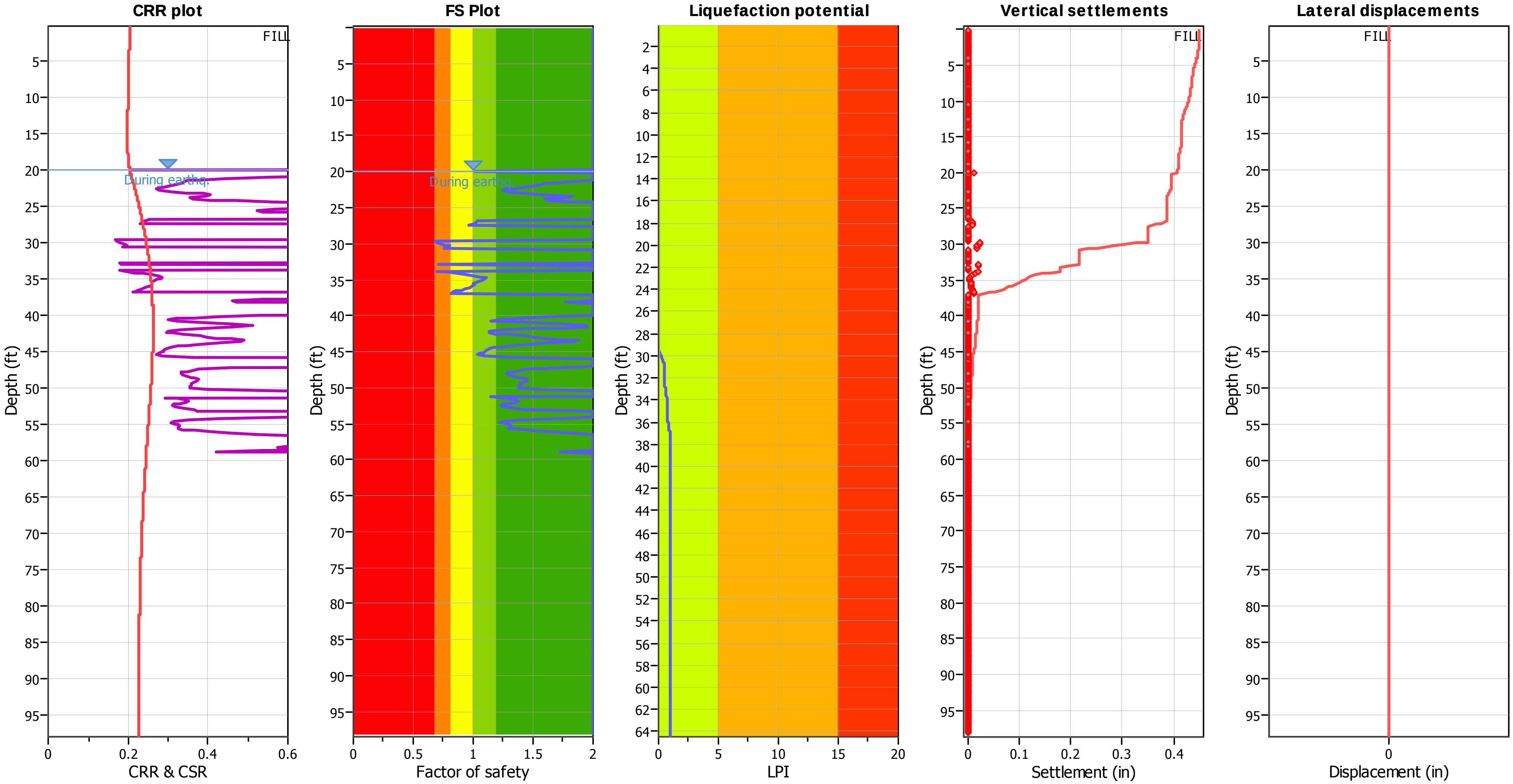
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

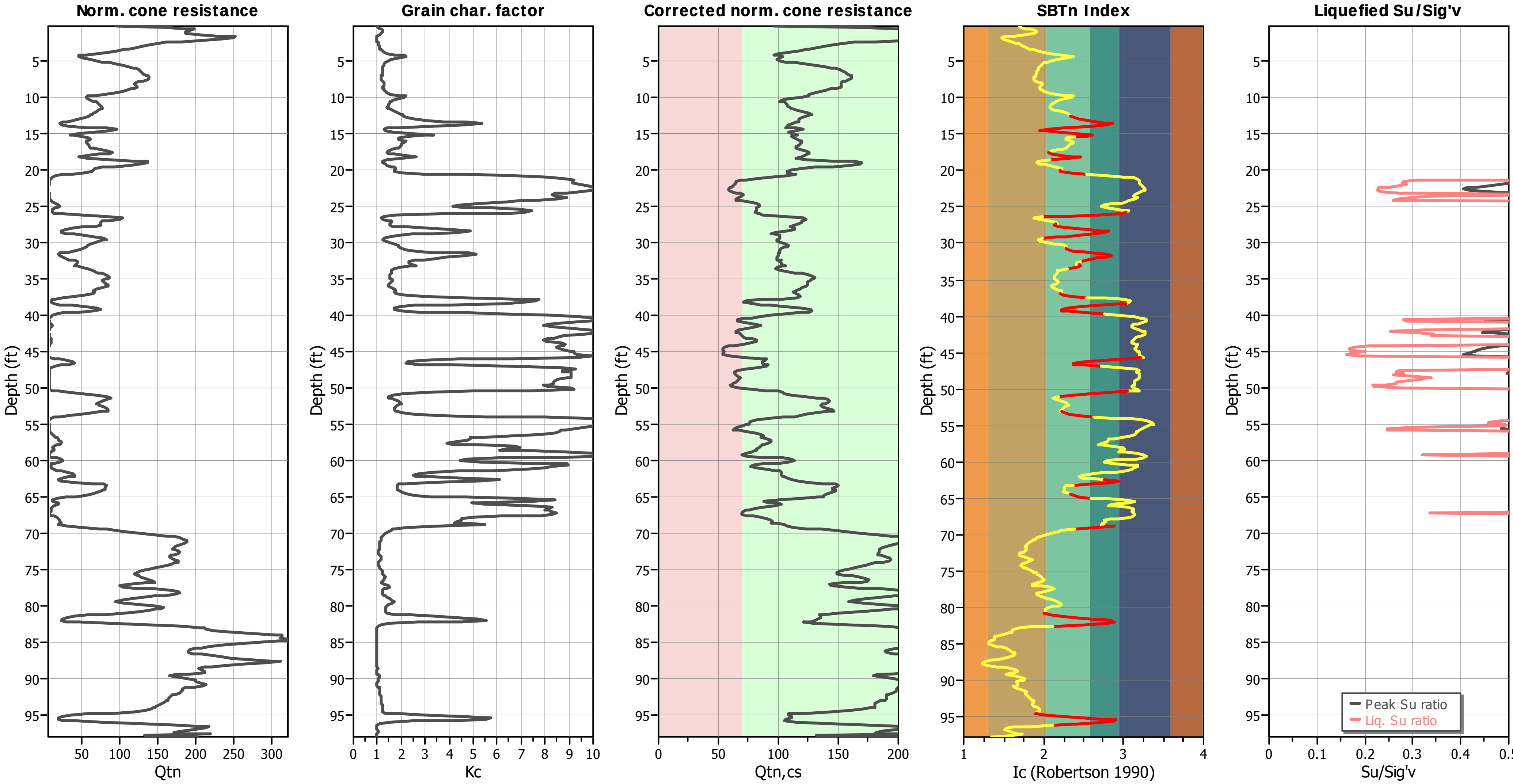
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

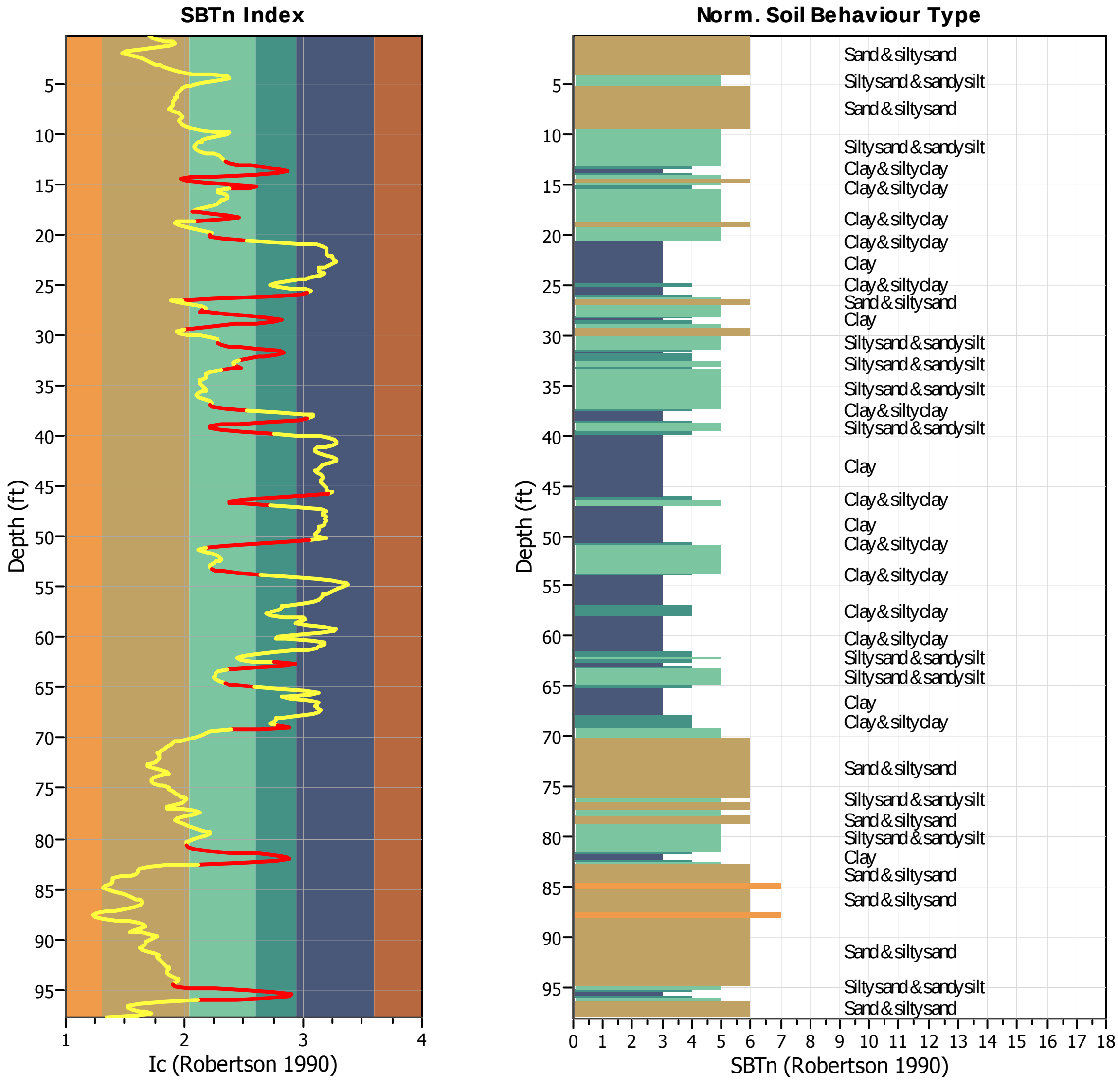
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



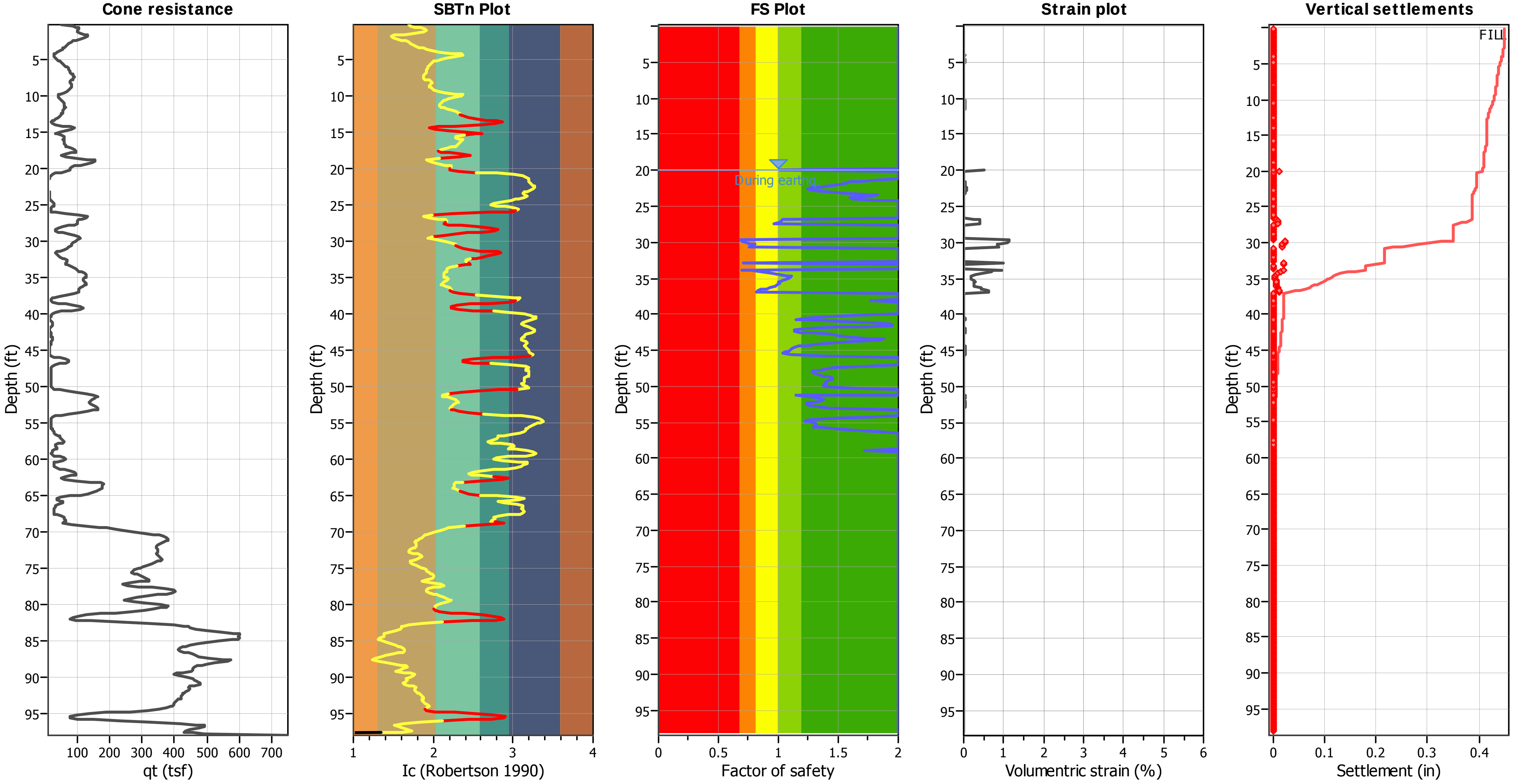
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	598
Total points excluded:	136
Exclusion percentage:	22.74%
Number of layers detected:	27

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

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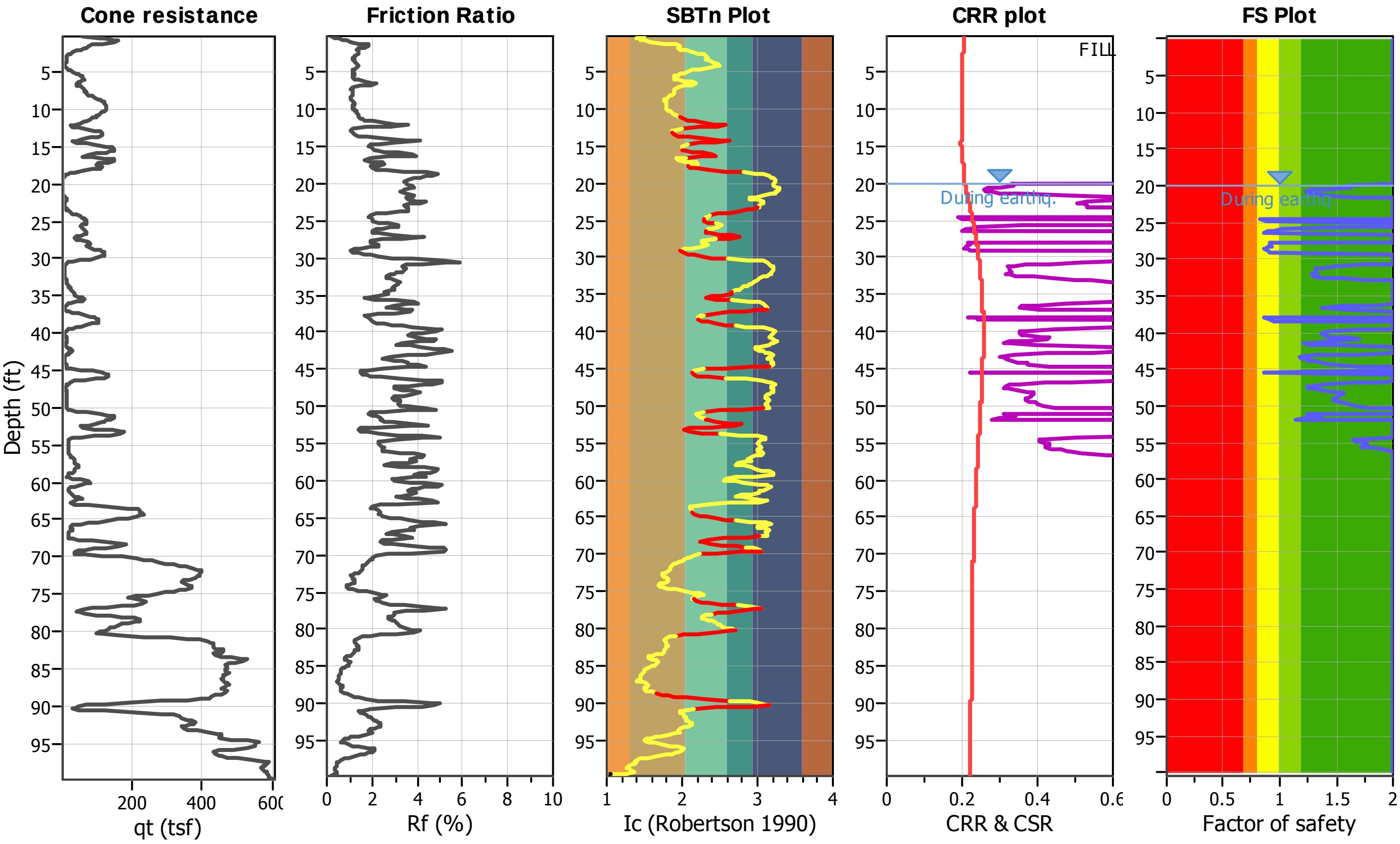
LIQUEFACTION ANALYSIS REPORT

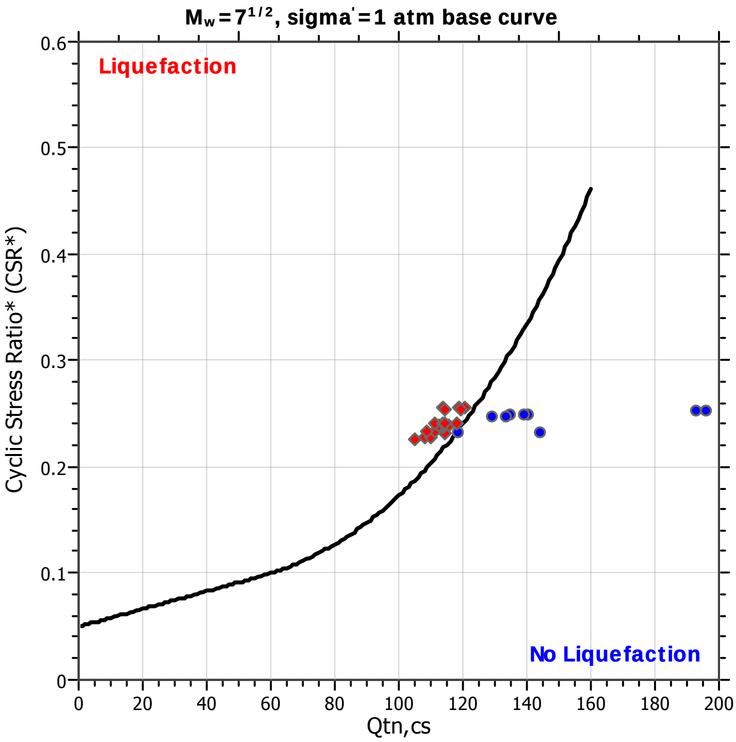
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

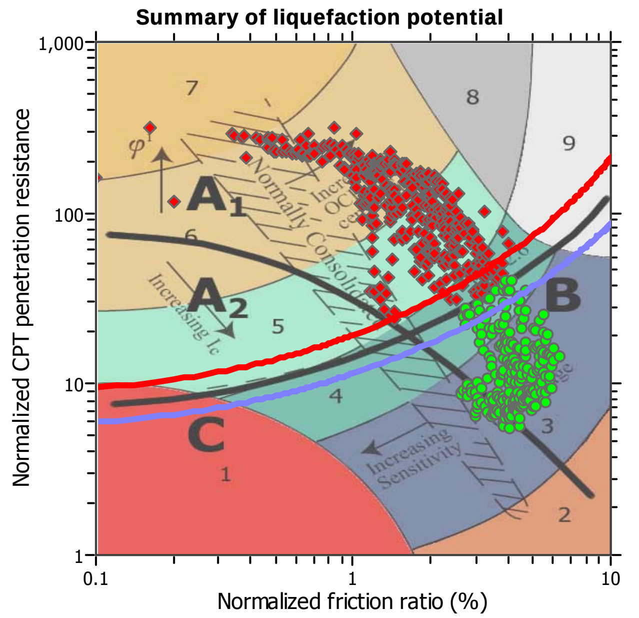
CPT file : CPT-9

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Use fill:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	23.00 ft	Fill height:	3.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	120.00 lb/ft^3	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

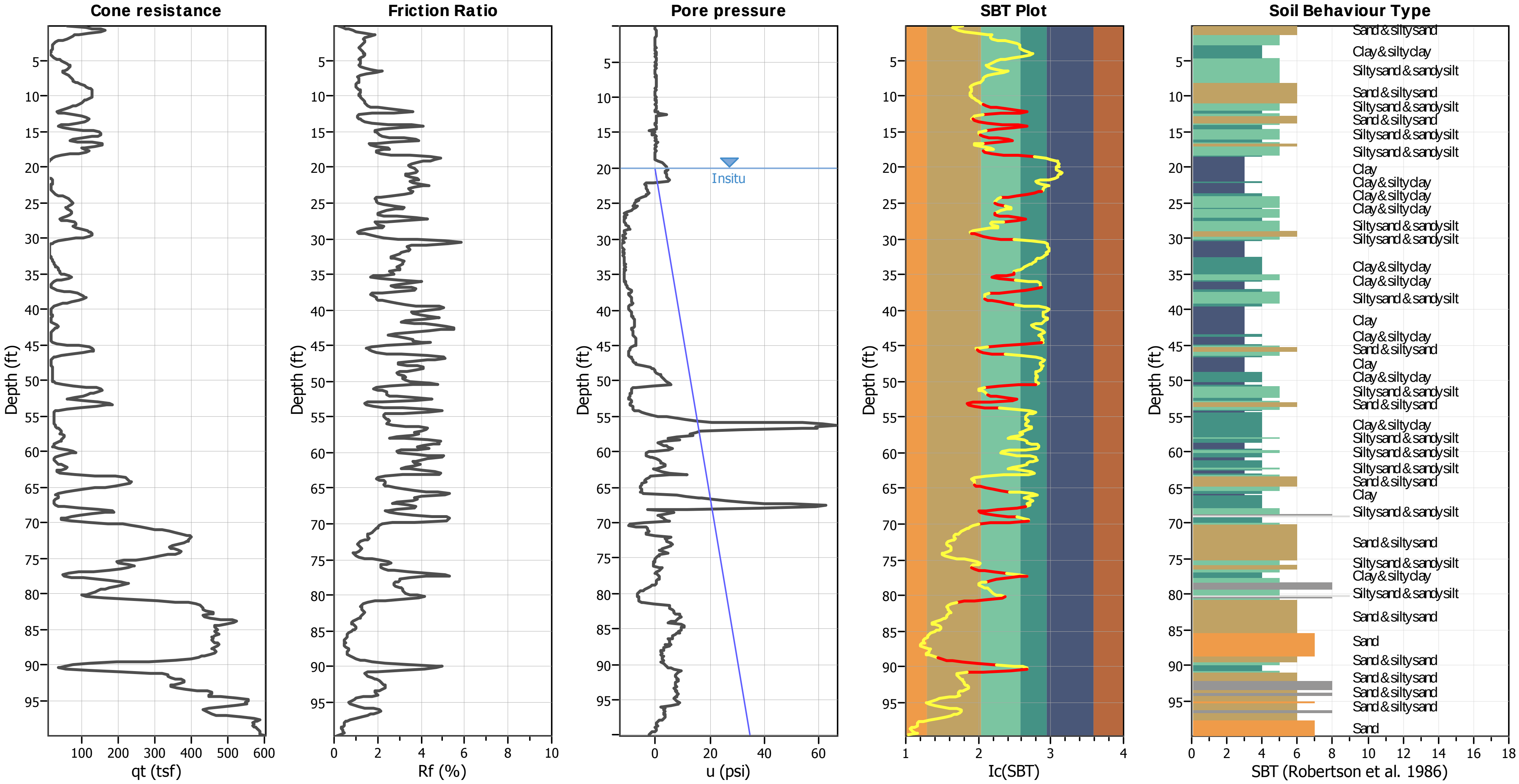






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



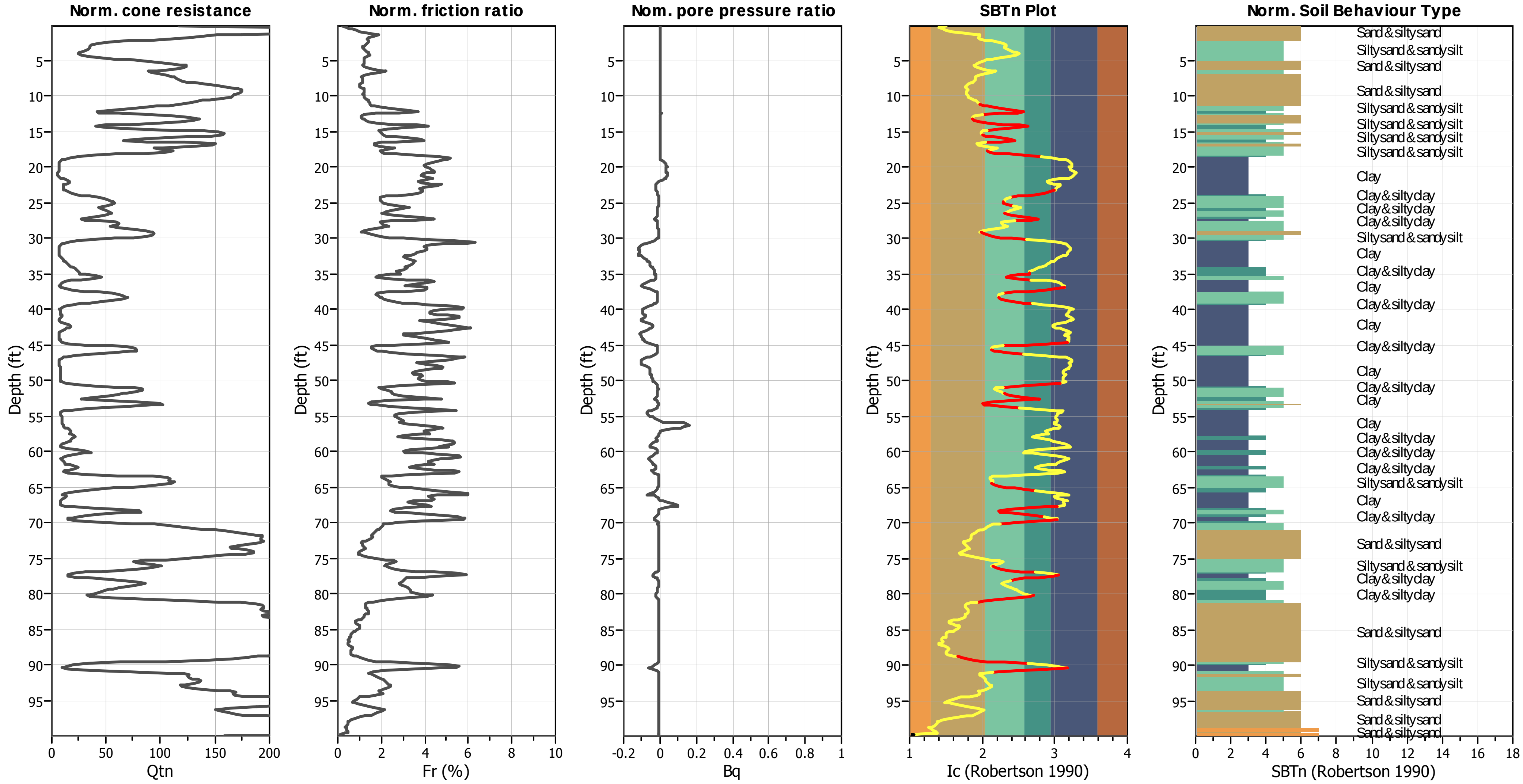
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



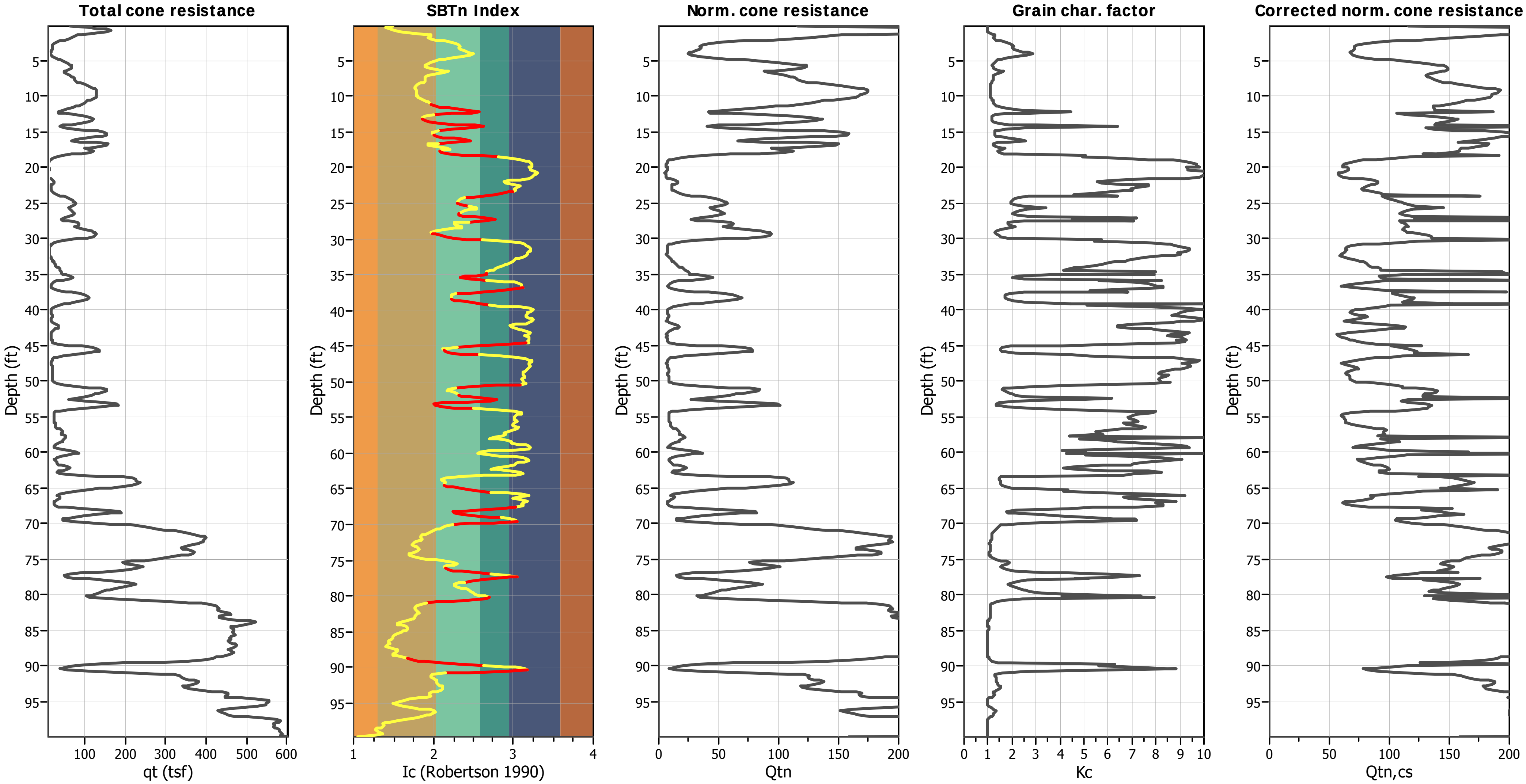
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

SBTn legend

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

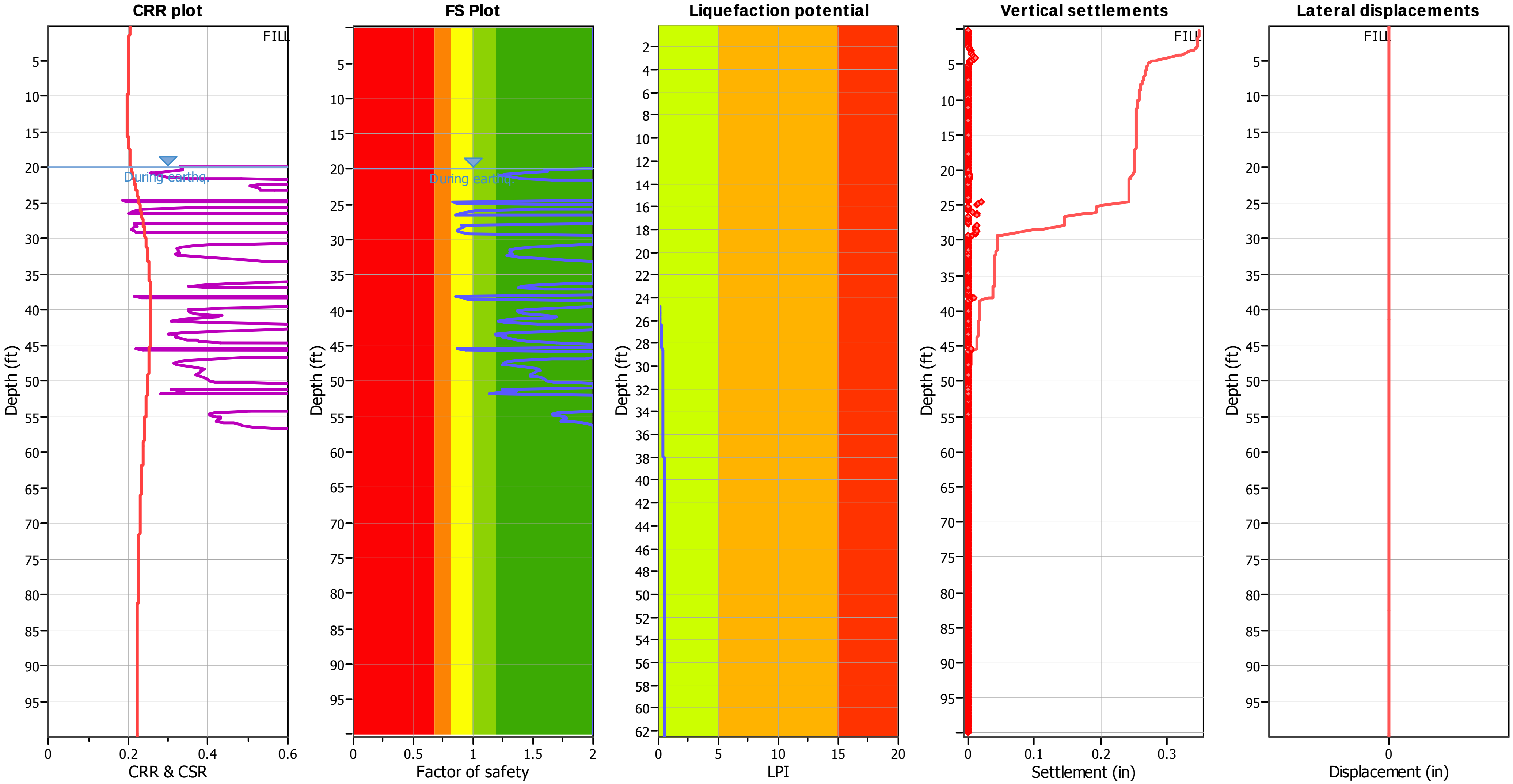
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

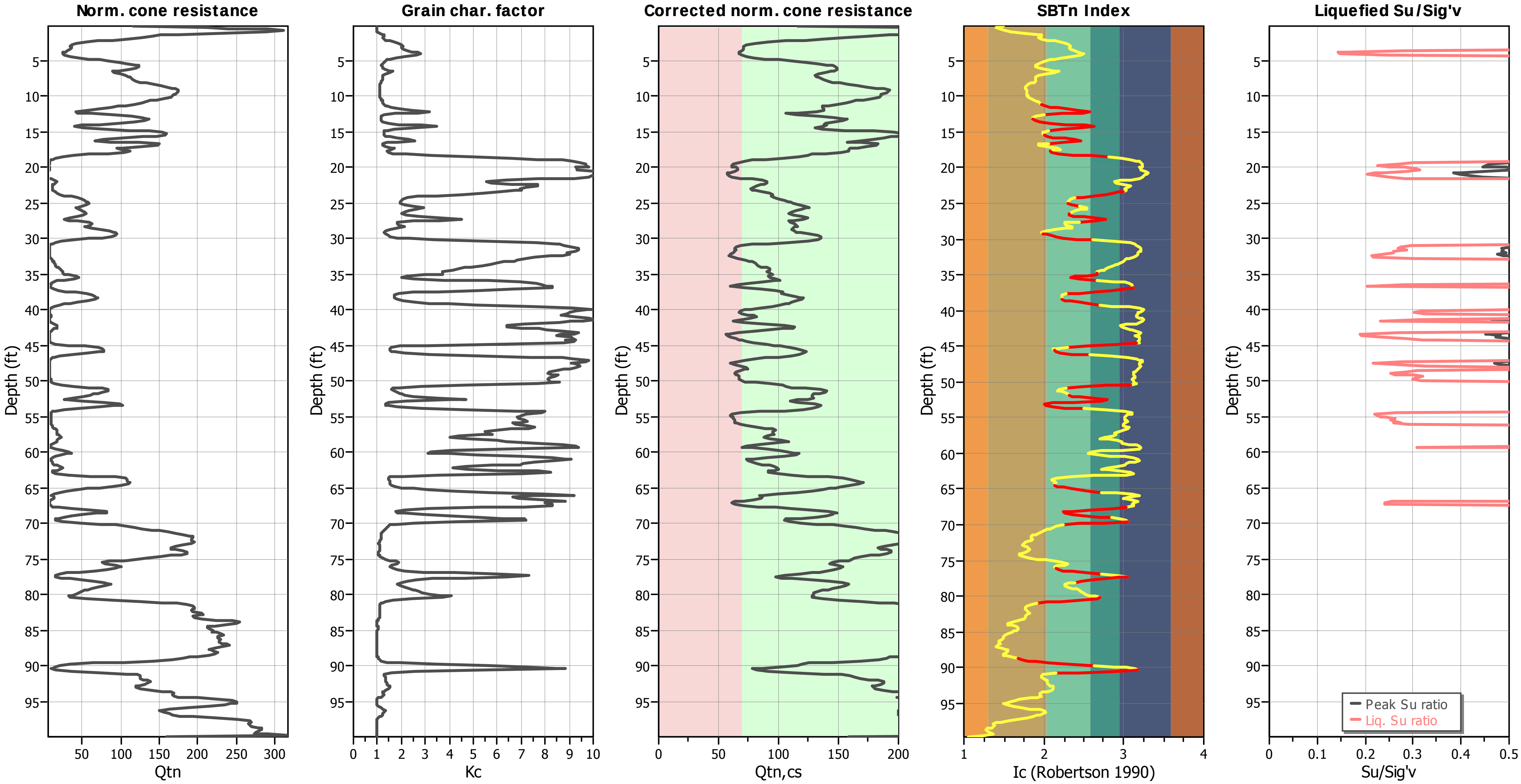
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

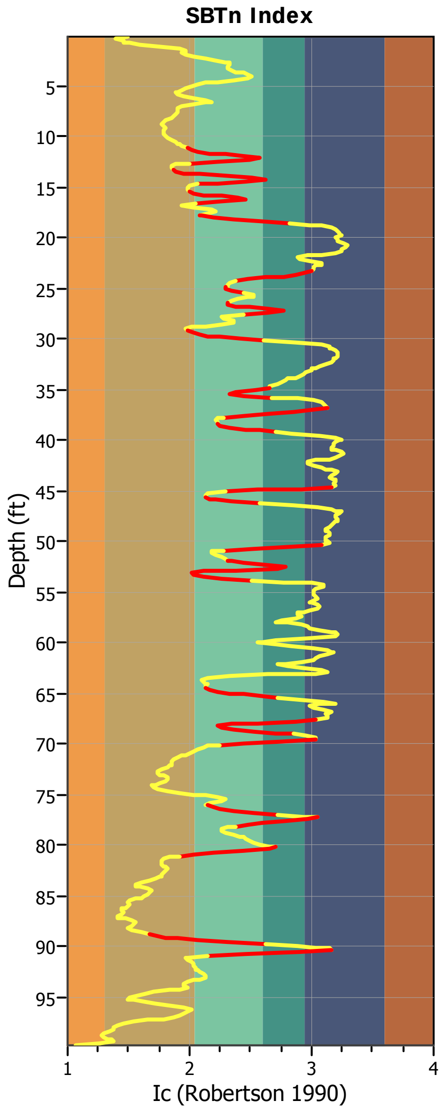
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	23.00 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	3.00 ft	Limit depth:	60.00 ft

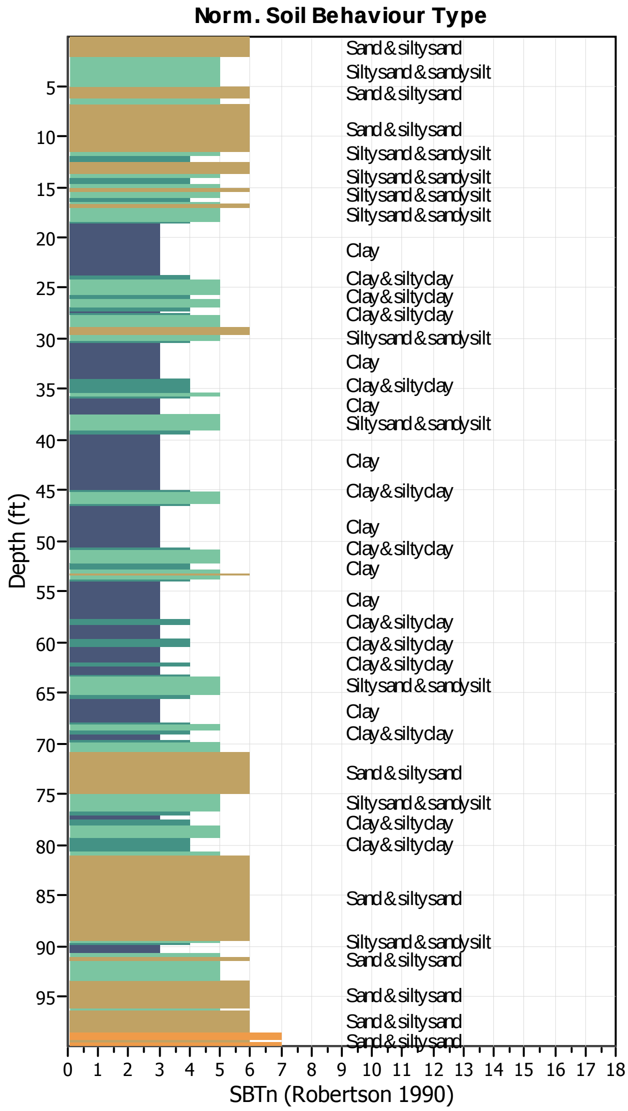
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

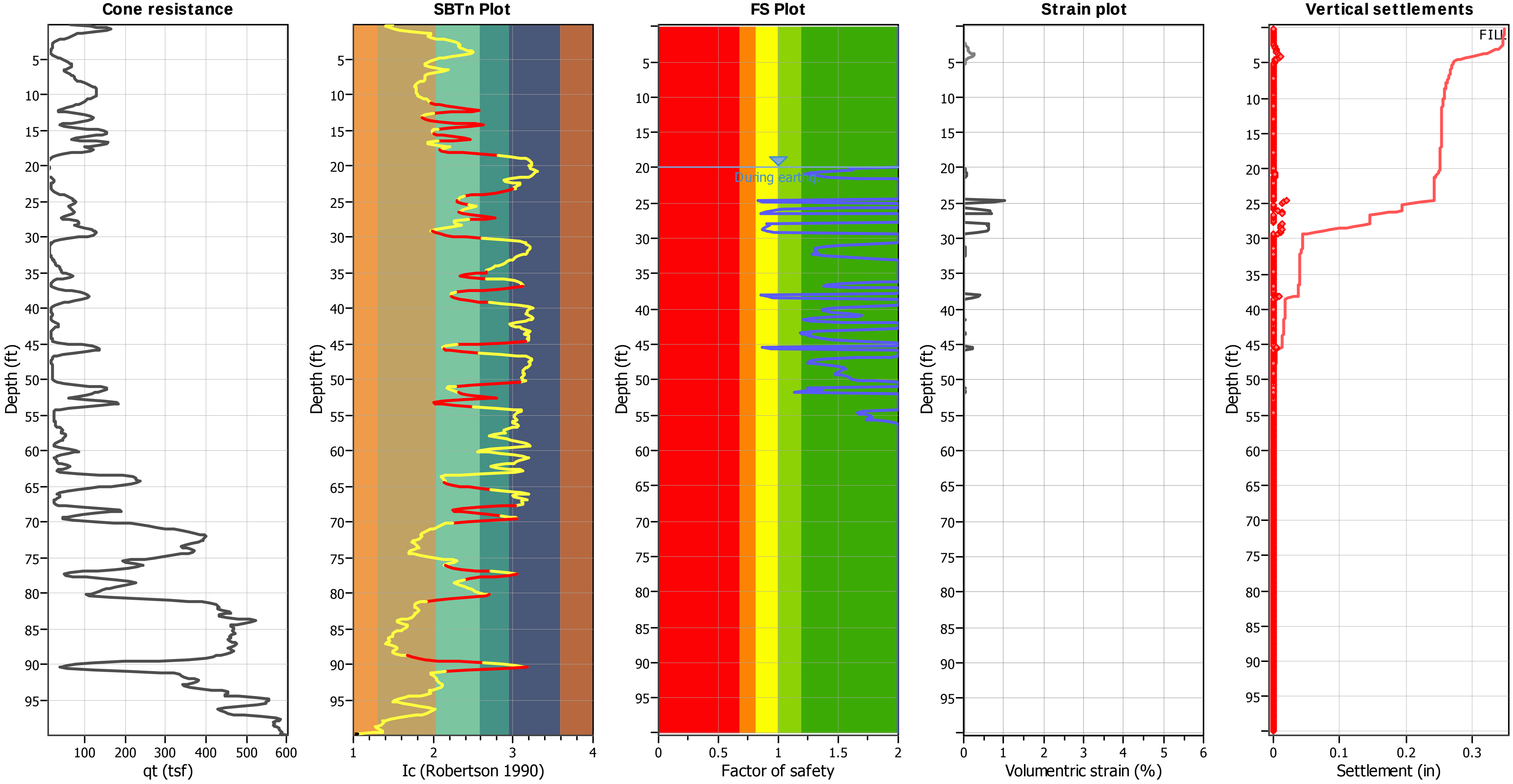
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	609
I_c maximum check value:	3.00	Total points excluded:	161
I_c change ratio value:	0.0250	Exclusion percentage:	26.44%
Minimum number of points in layer:	4	Number of layers detected:	31

Estimation of post-earthquake settlements

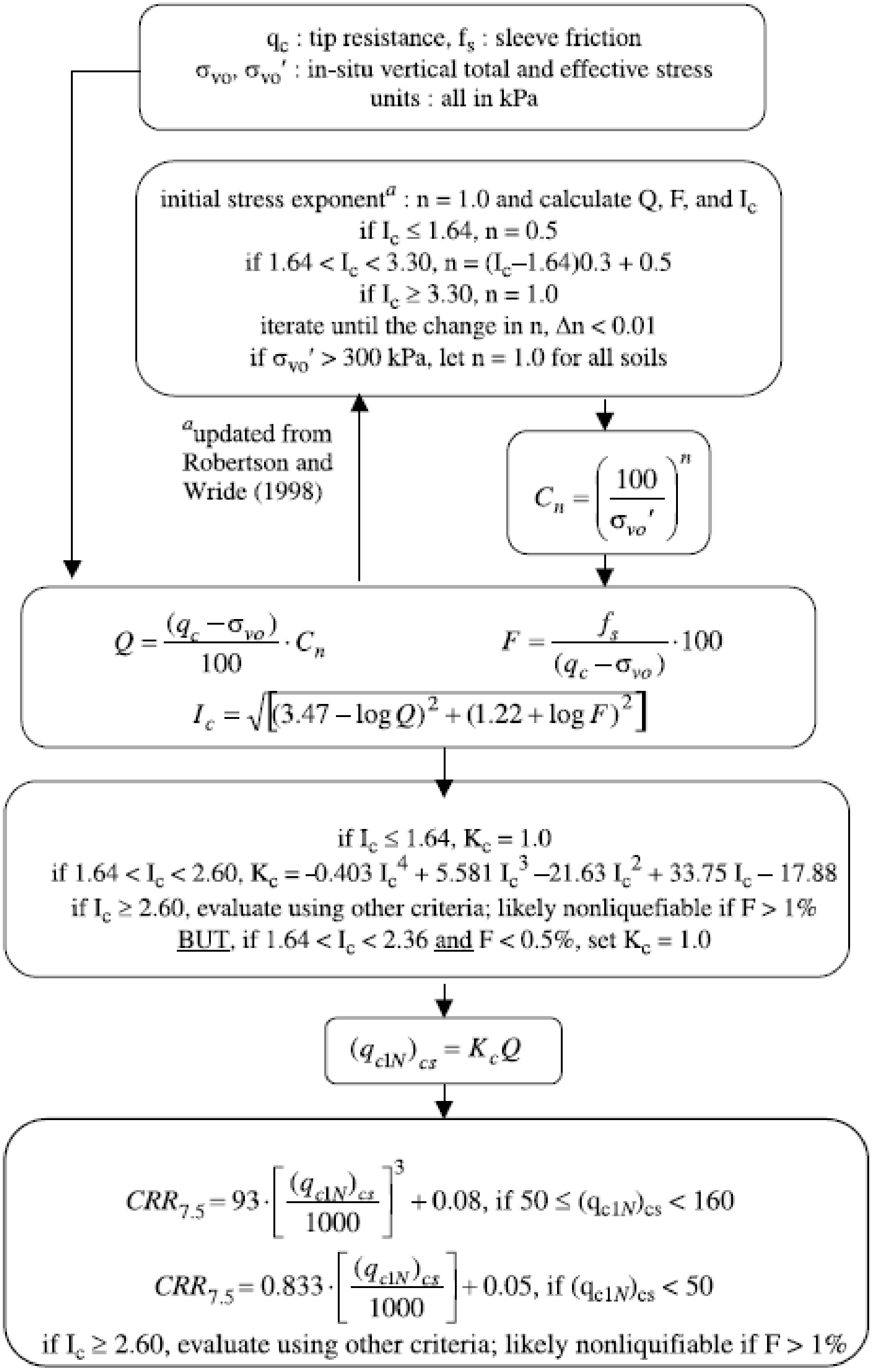


Abbreviations

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

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

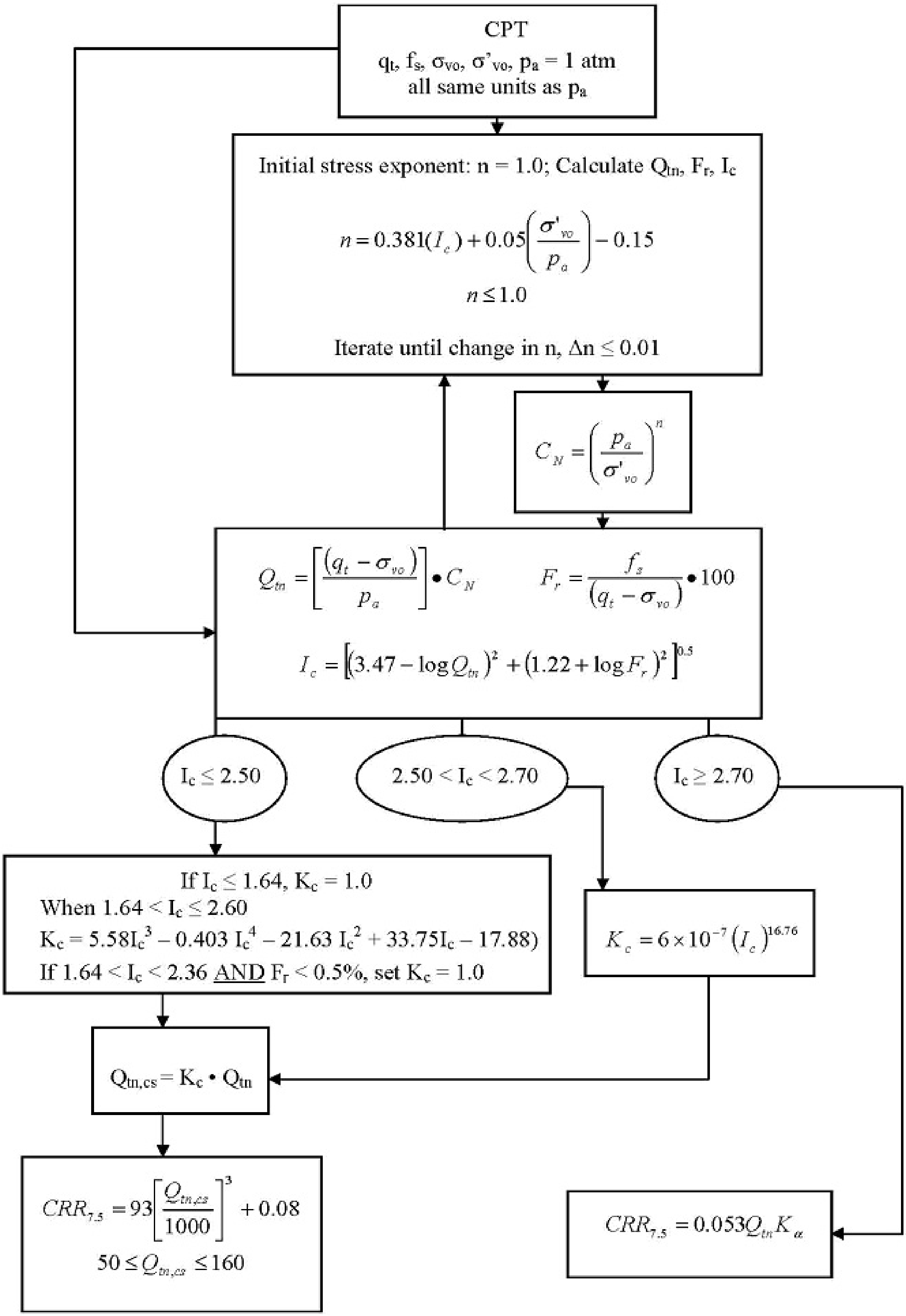
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of 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

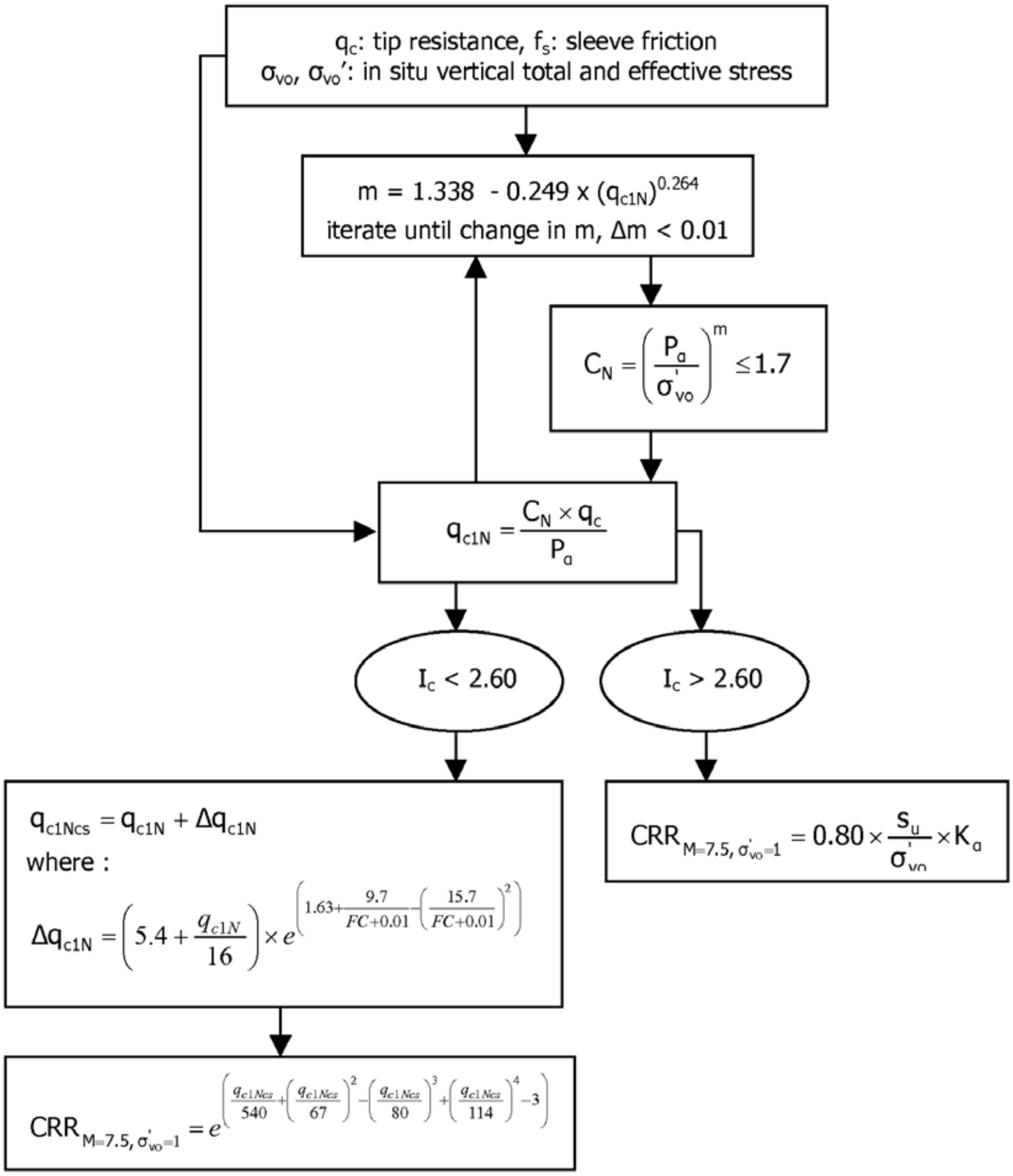
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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]:

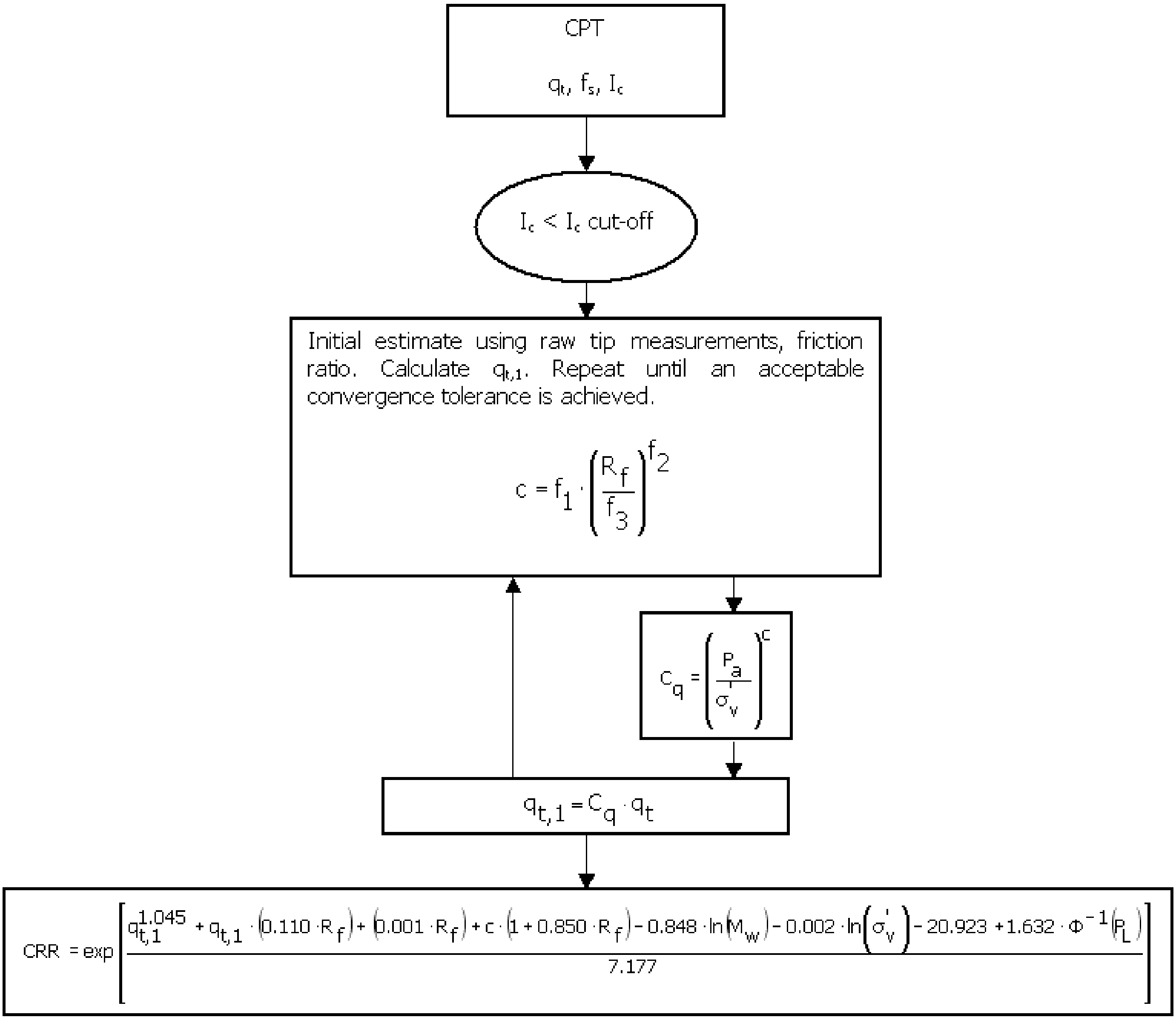


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

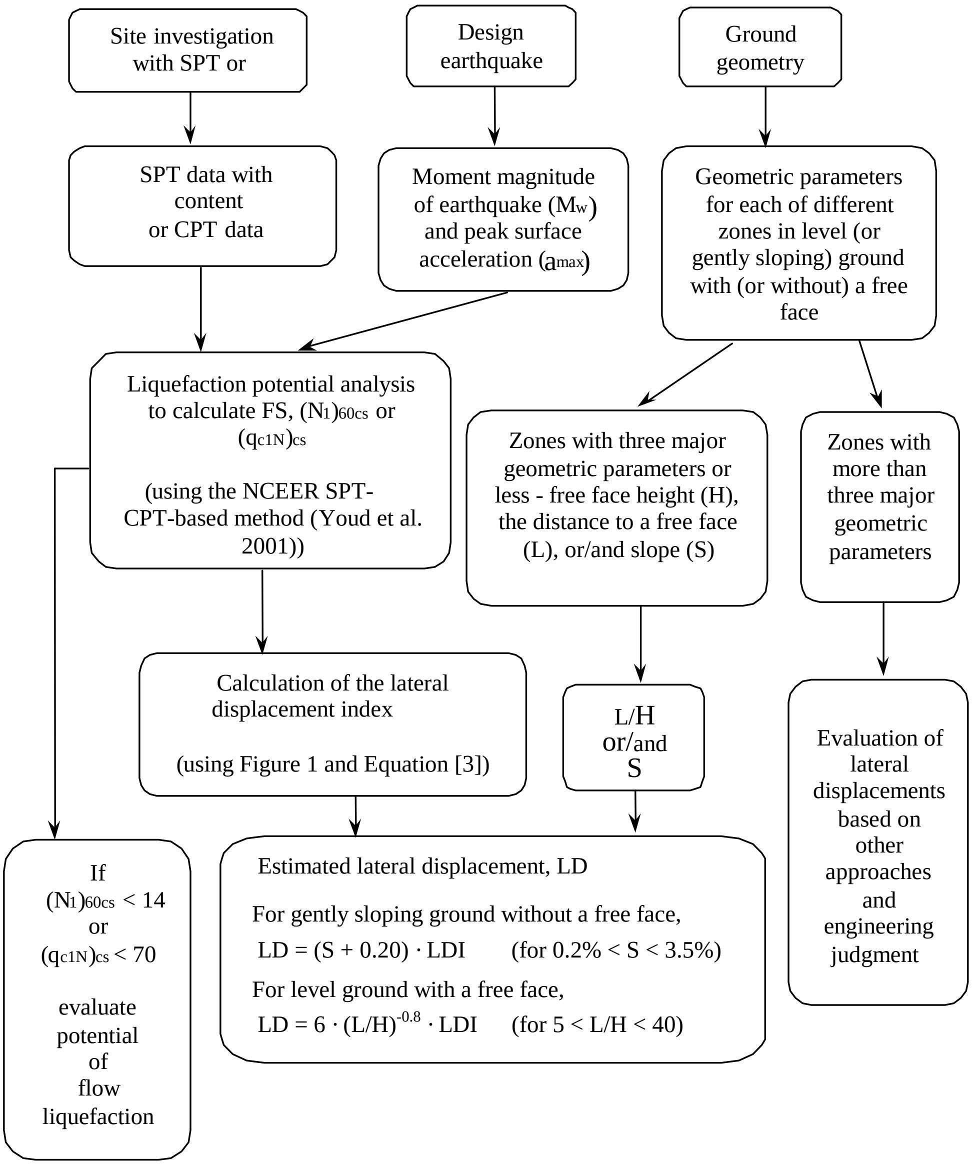
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



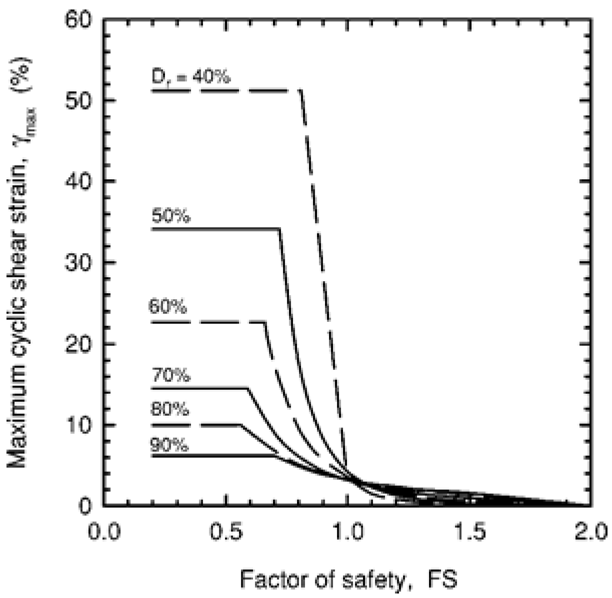
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of liquefaction-induced lateral spreading displacements



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



[1] **Figure 1**

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

[1] **Equation [3]**

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

Procedure for the estimation of seismic induced settlements in dry sands

Average shear stress, τ_{av}

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

↓

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))

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

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

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

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

↓

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.

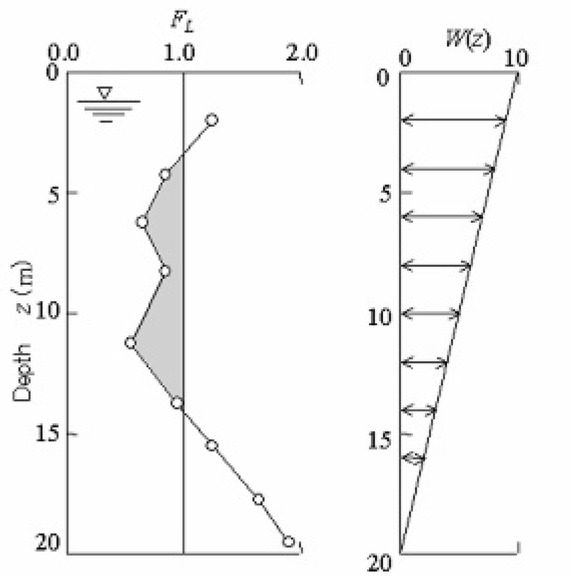
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

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

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

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

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.

- Robertson, P.K. and Wride, C.E., 1998. Cyclic Liquefaction and its Evaluation based on the CPT Canadian Geotechnical Journal, 1998, Vol. 35, August.

- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833

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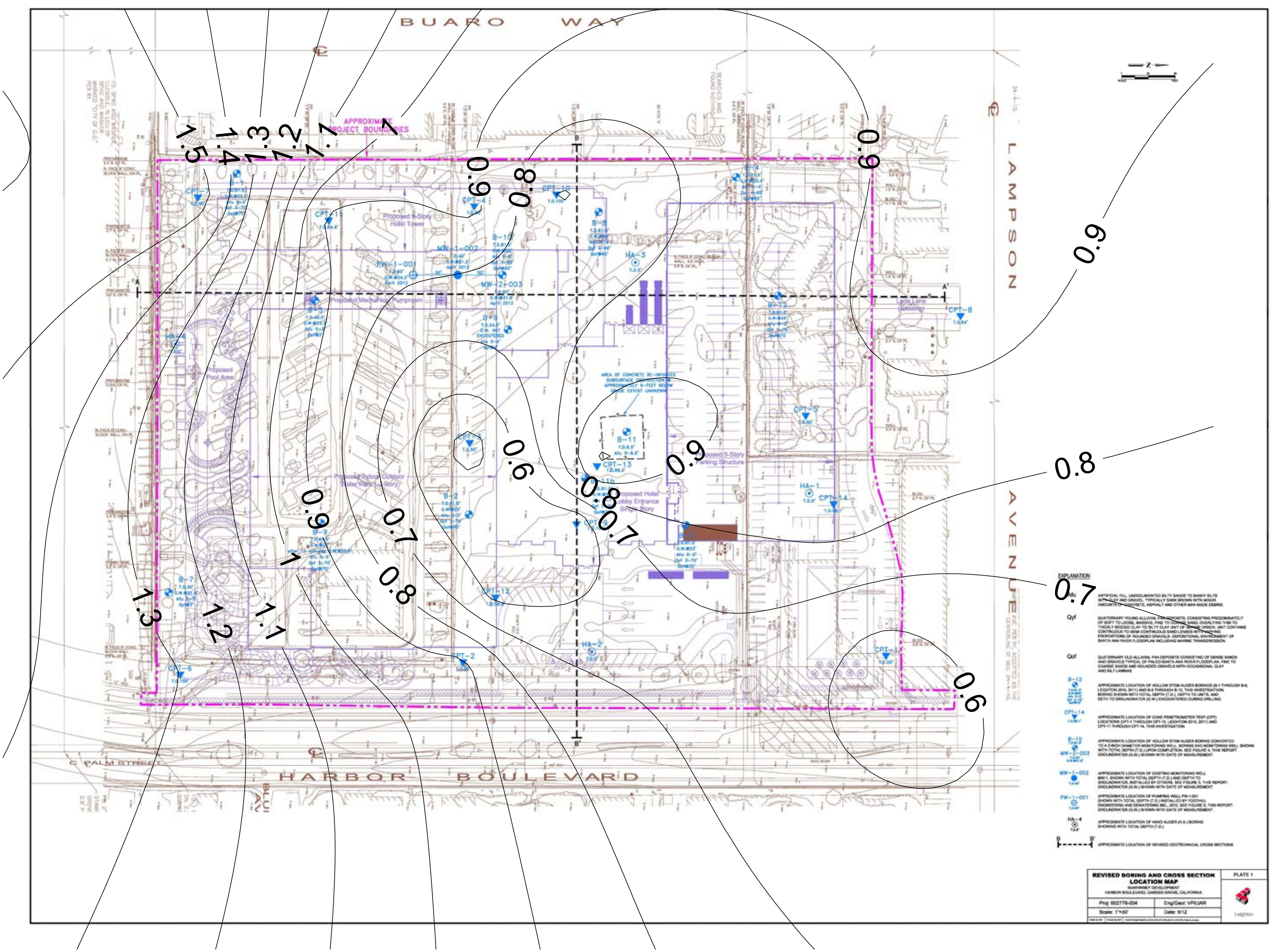
- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355

- 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
- 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

- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006



liquefaction-induced settlement
@ El 98

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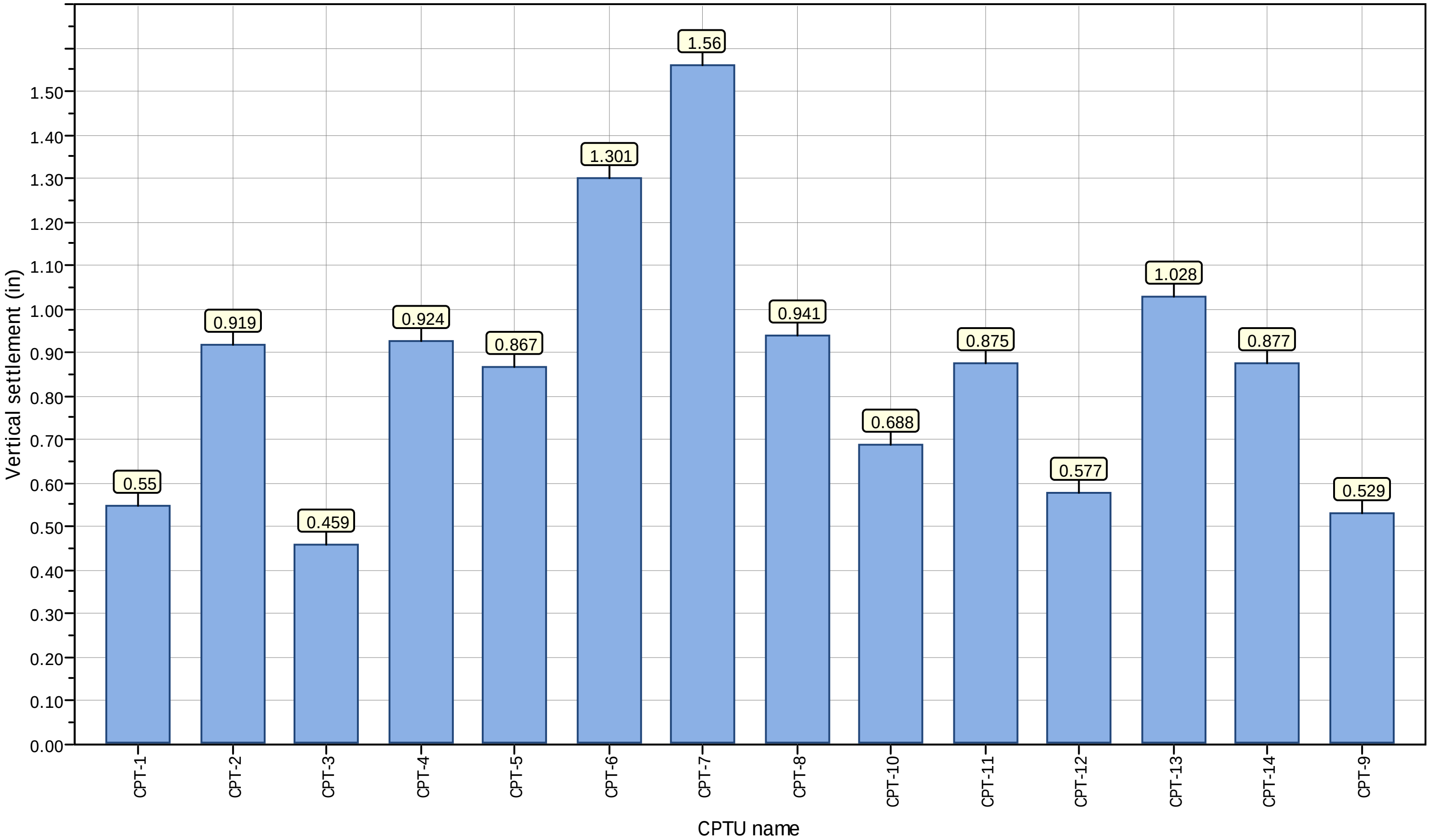
Irvine, CA 92614
www.leightongroup.com

Project title : Great Wolf Lodge Resort

Location : 12661 Harbor Blvd., Garden Grove, CA

Overall vertical settlements report



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17781 Cowan
Irvine, CA 92614
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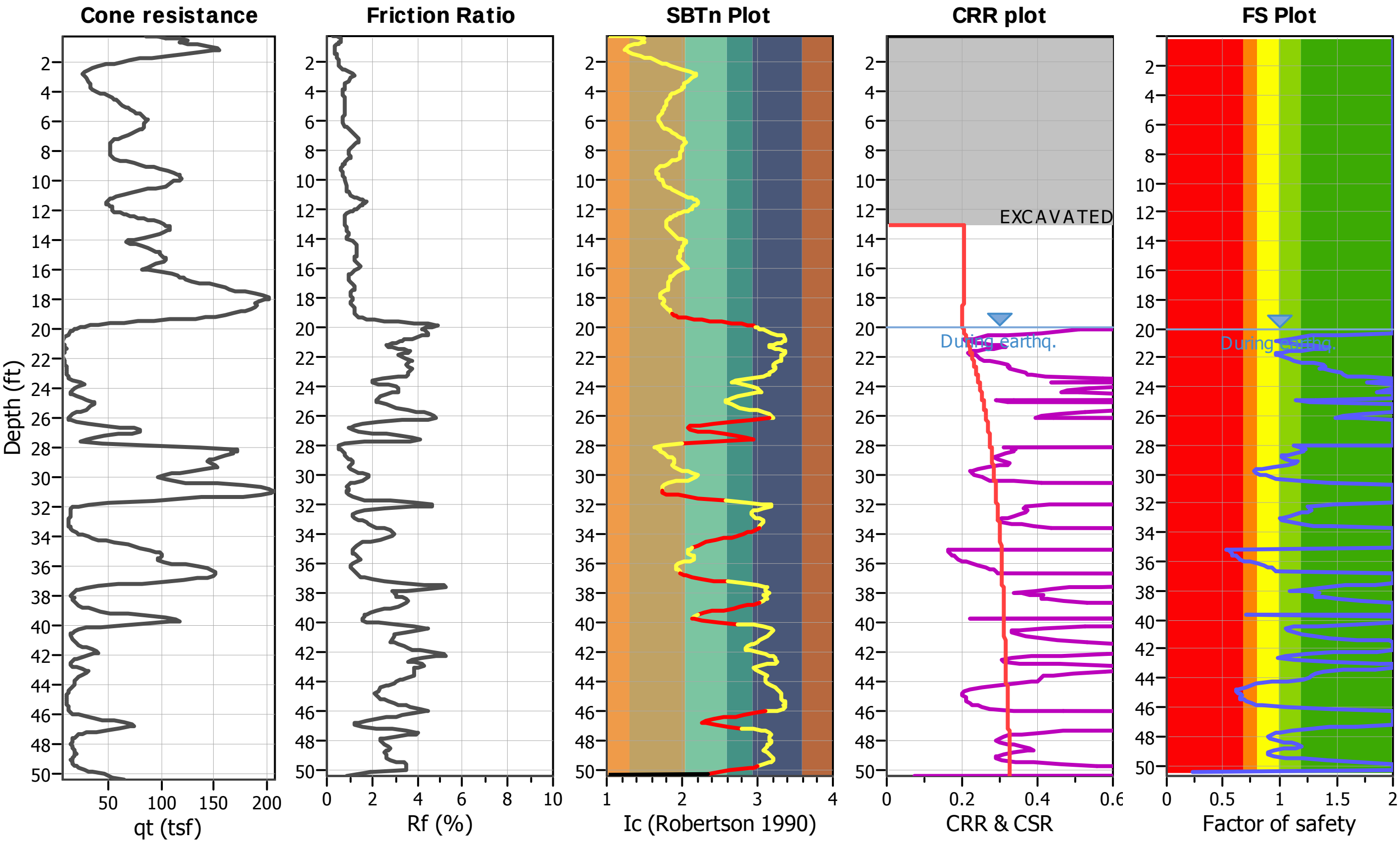
LIQUEFACTION ANALYSIS REPORT

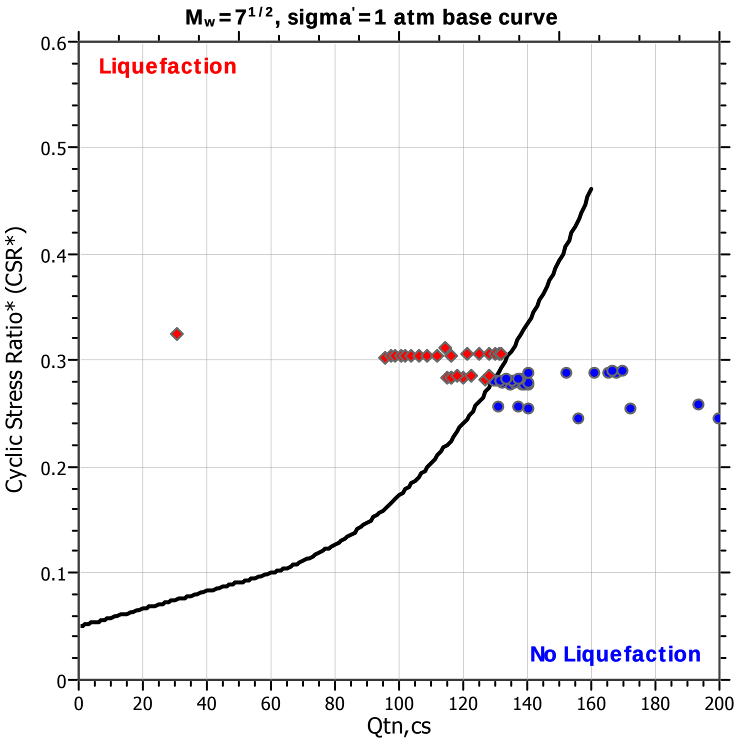
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

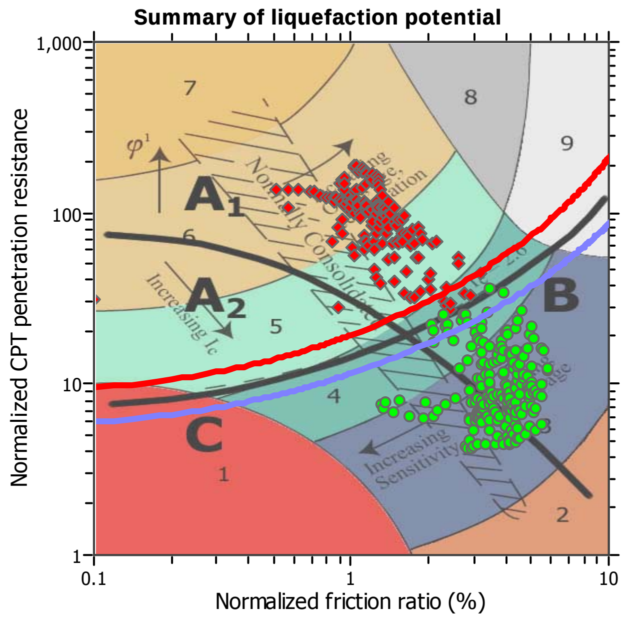
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	13.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

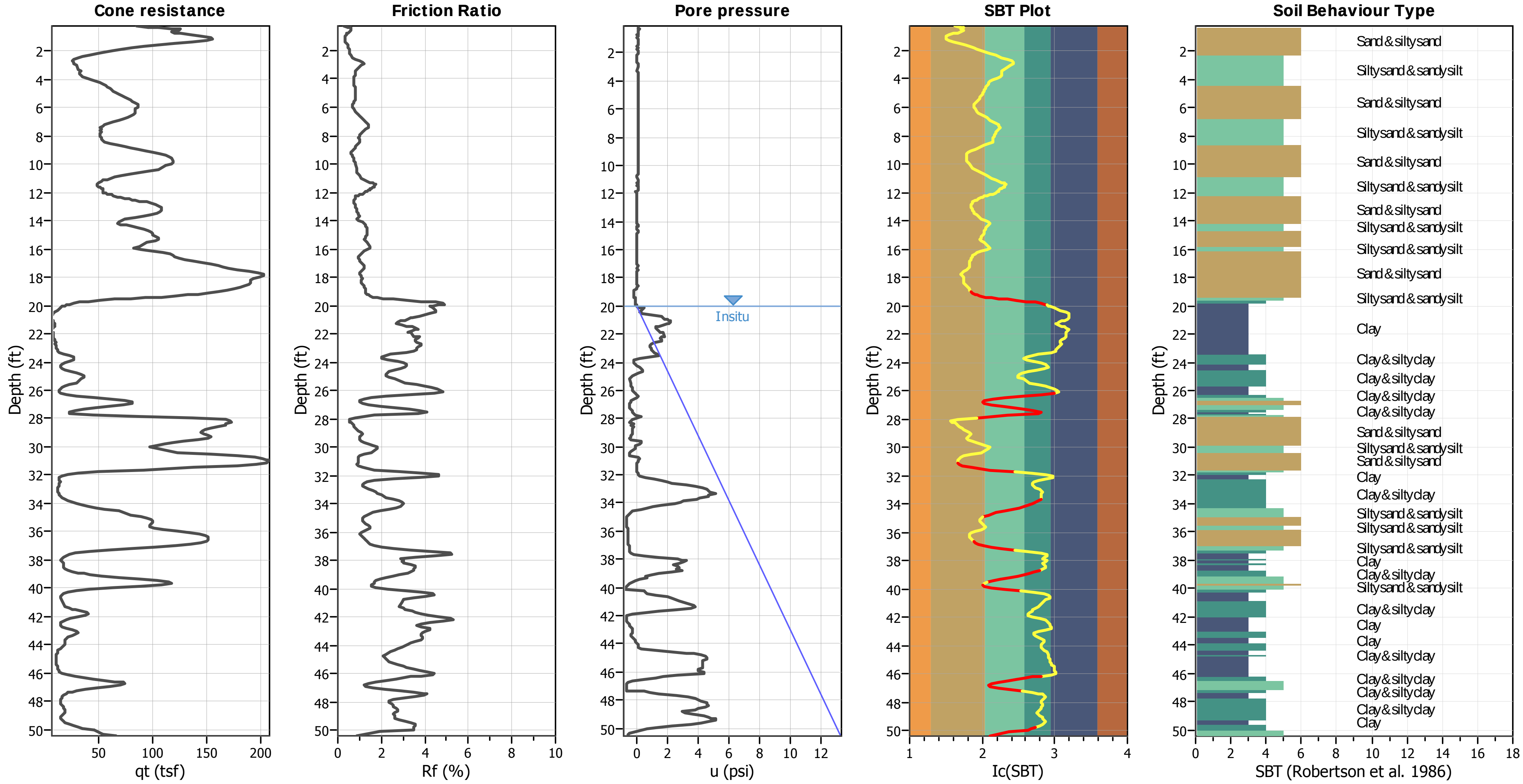






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



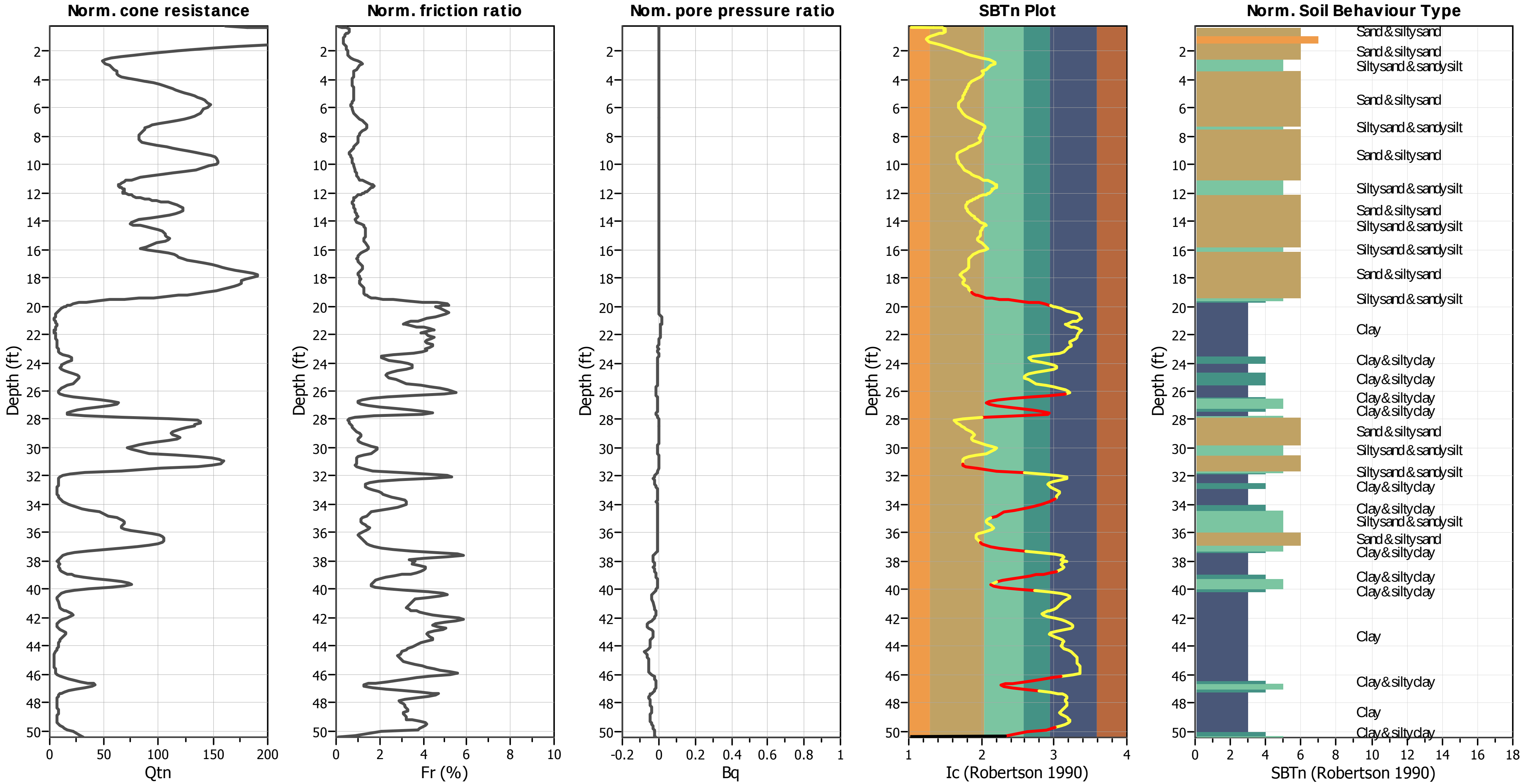
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	13.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



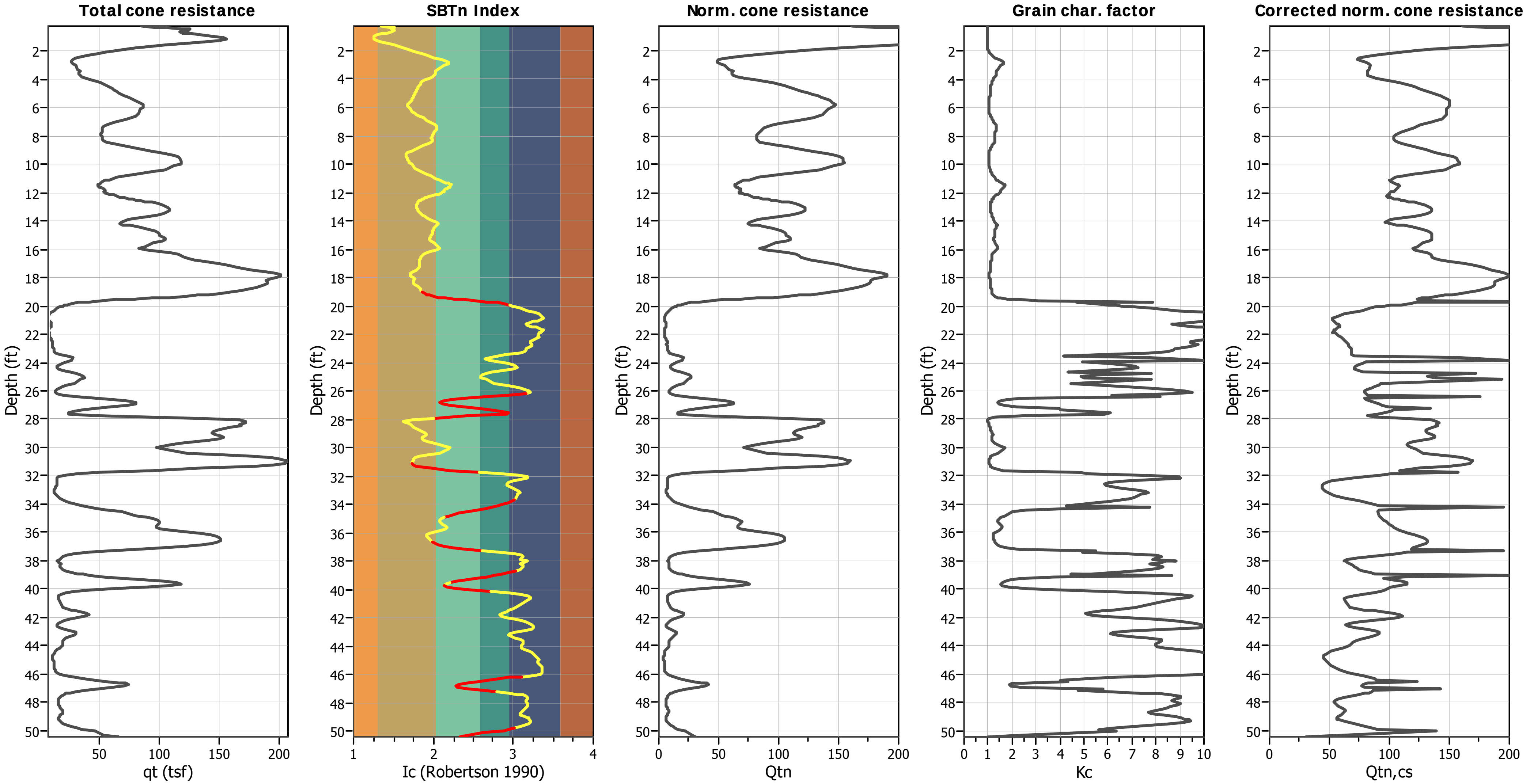
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

SBTn legend

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

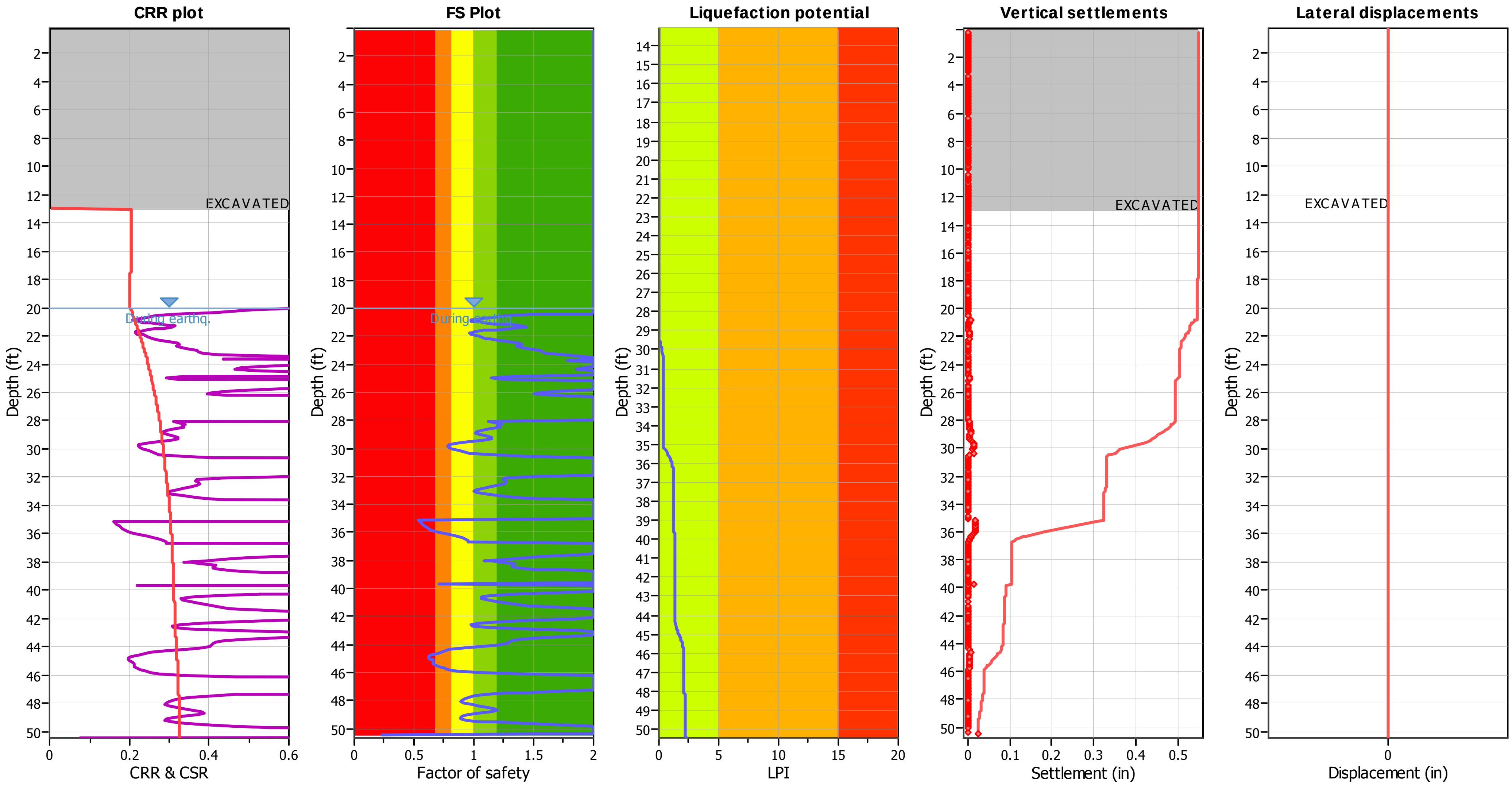
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

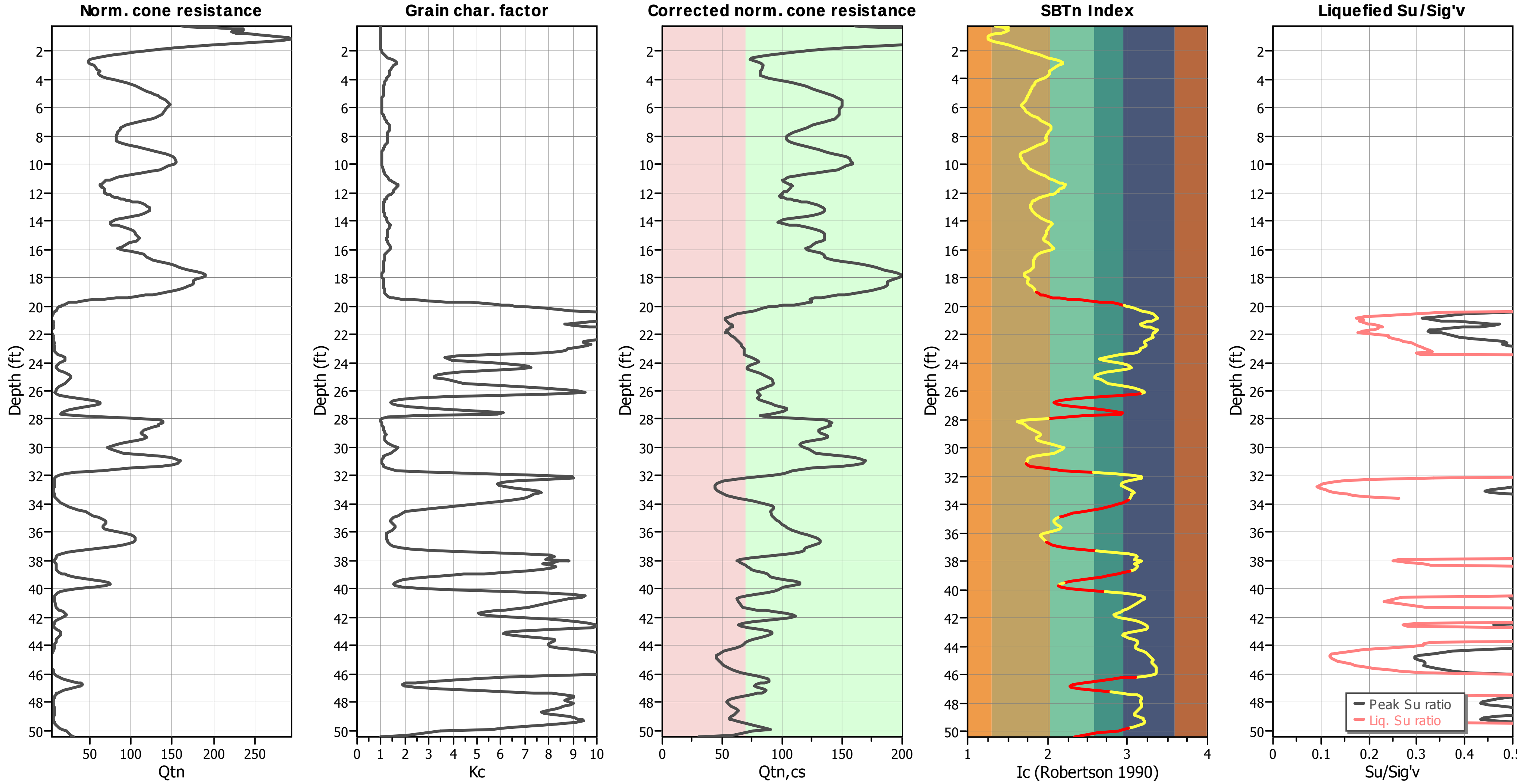
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

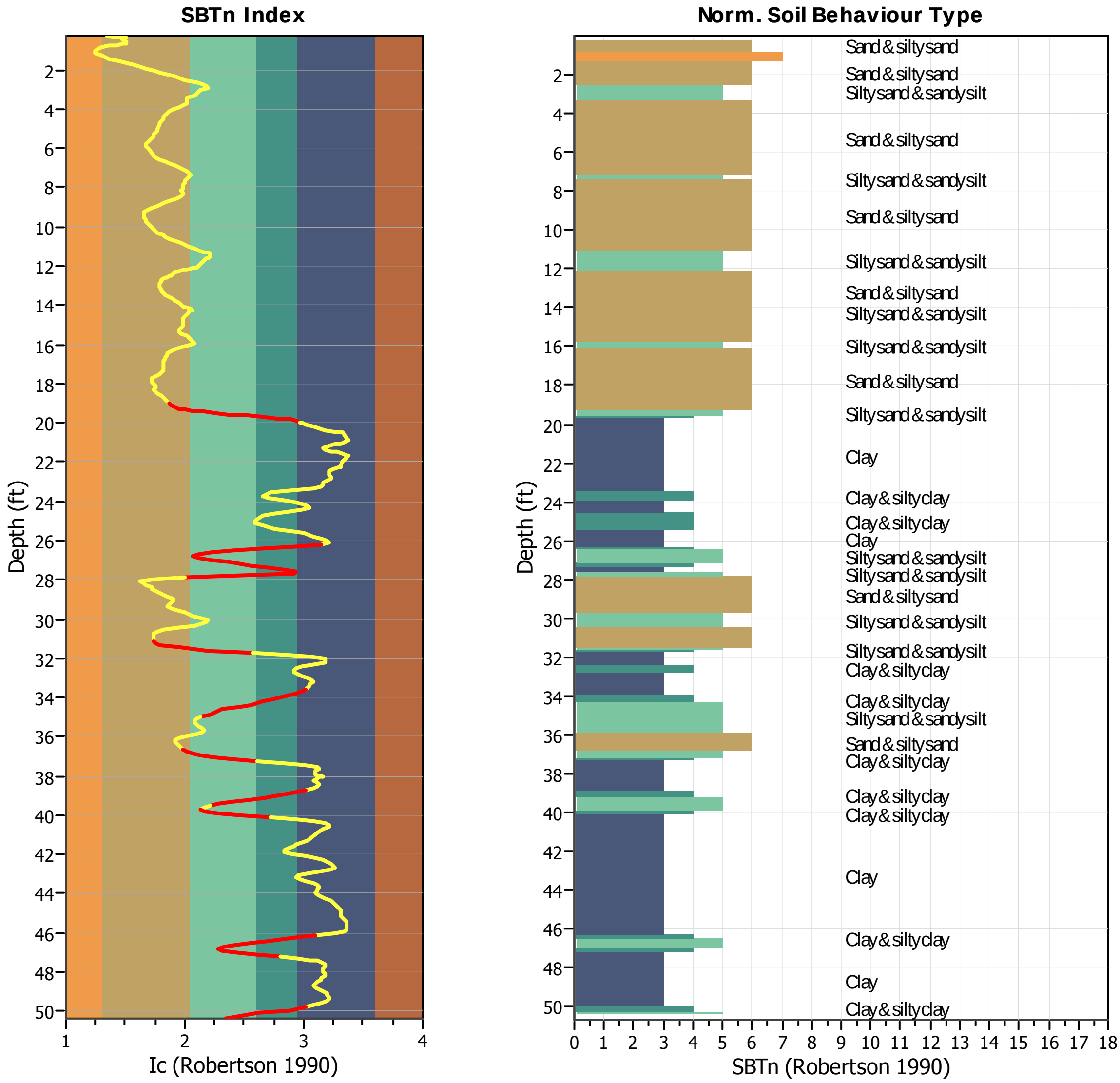
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



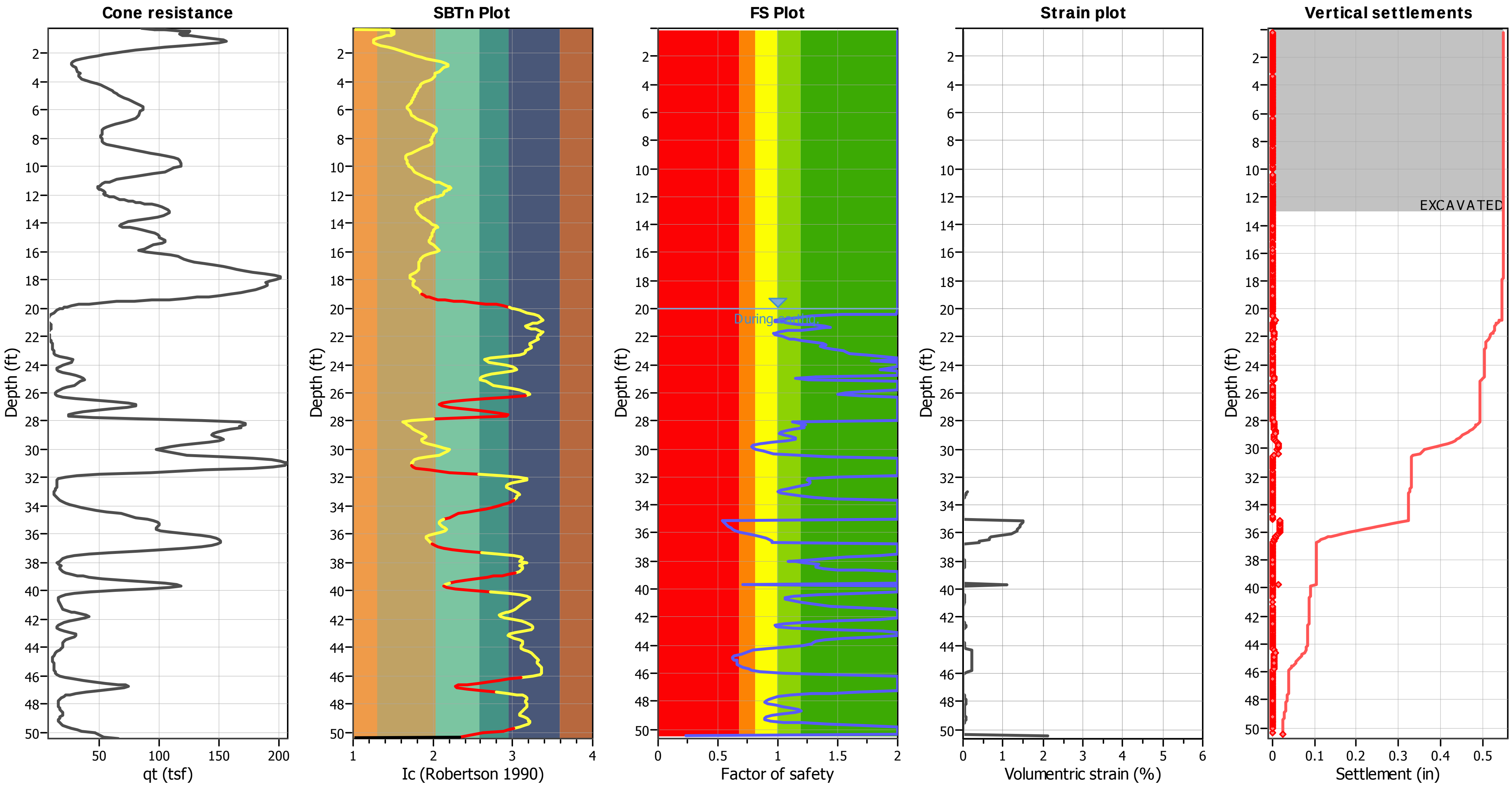
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	496
Total points excluded:	89
Exclusion percentage:	17.94%
Number of layers detected:	12

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

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Irvine, CA 92614
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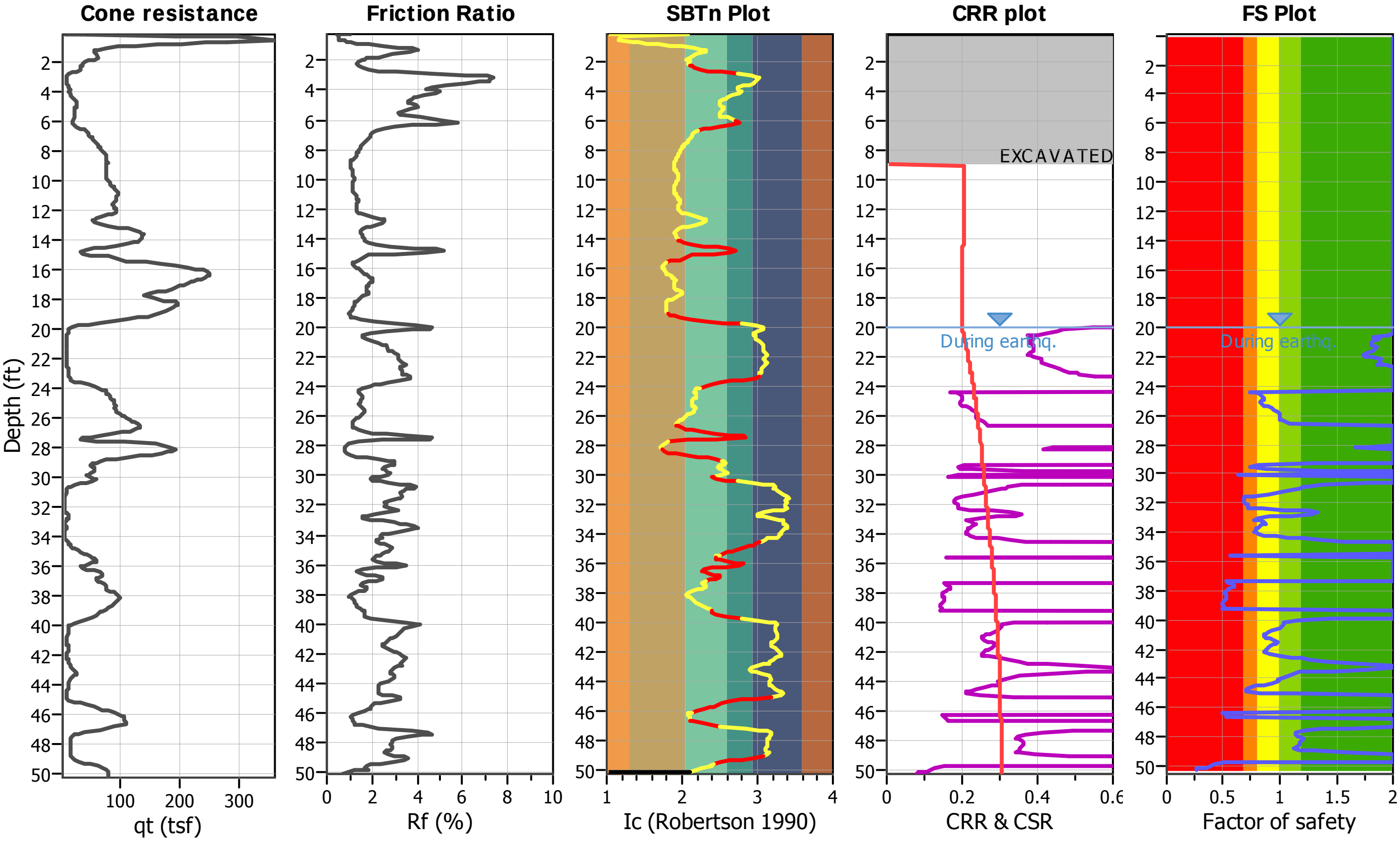
LIQUEFACTION ANALYSIS REPORT

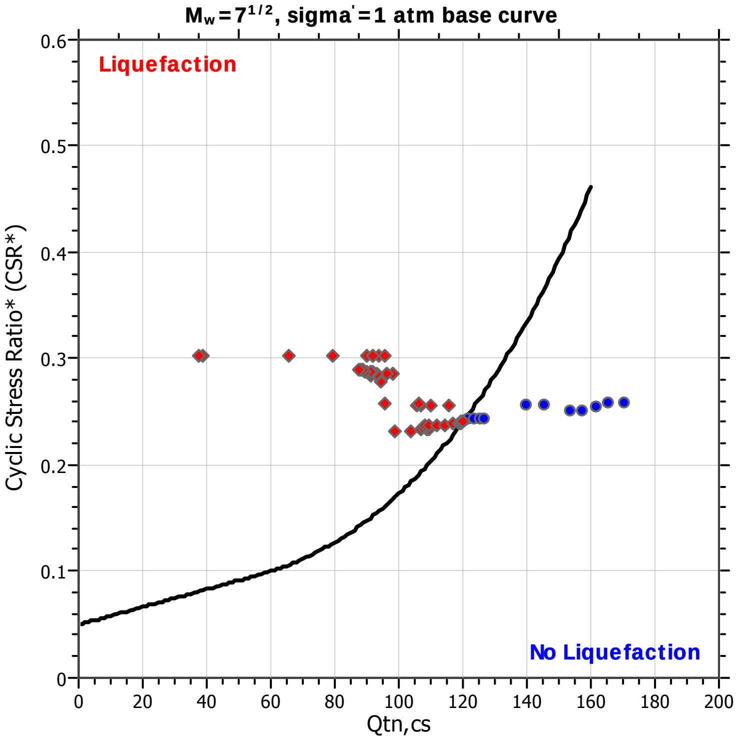
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

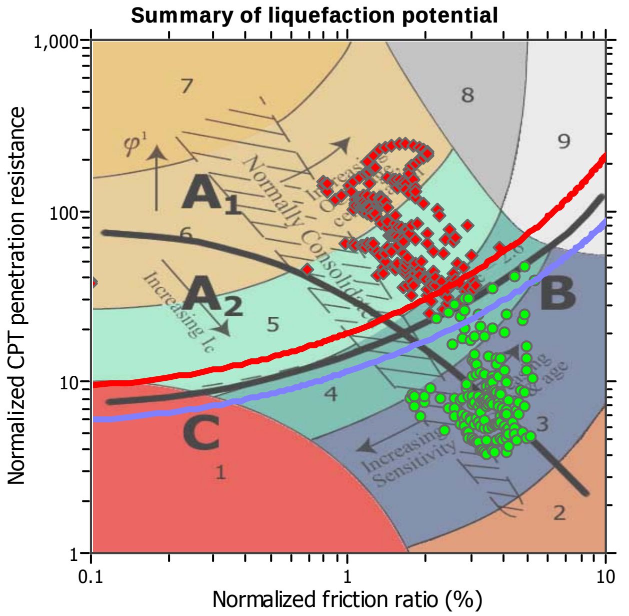
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	9.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

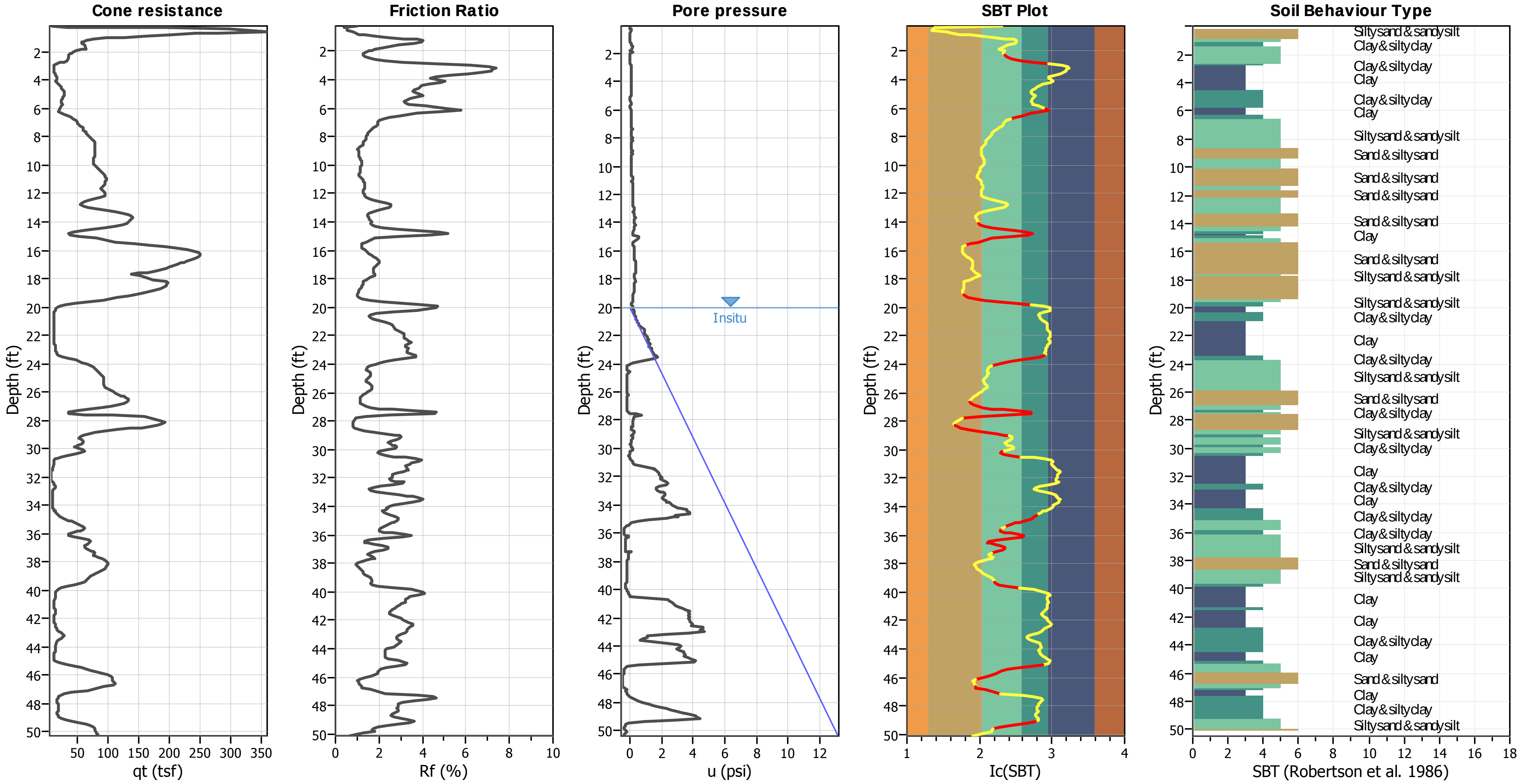






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



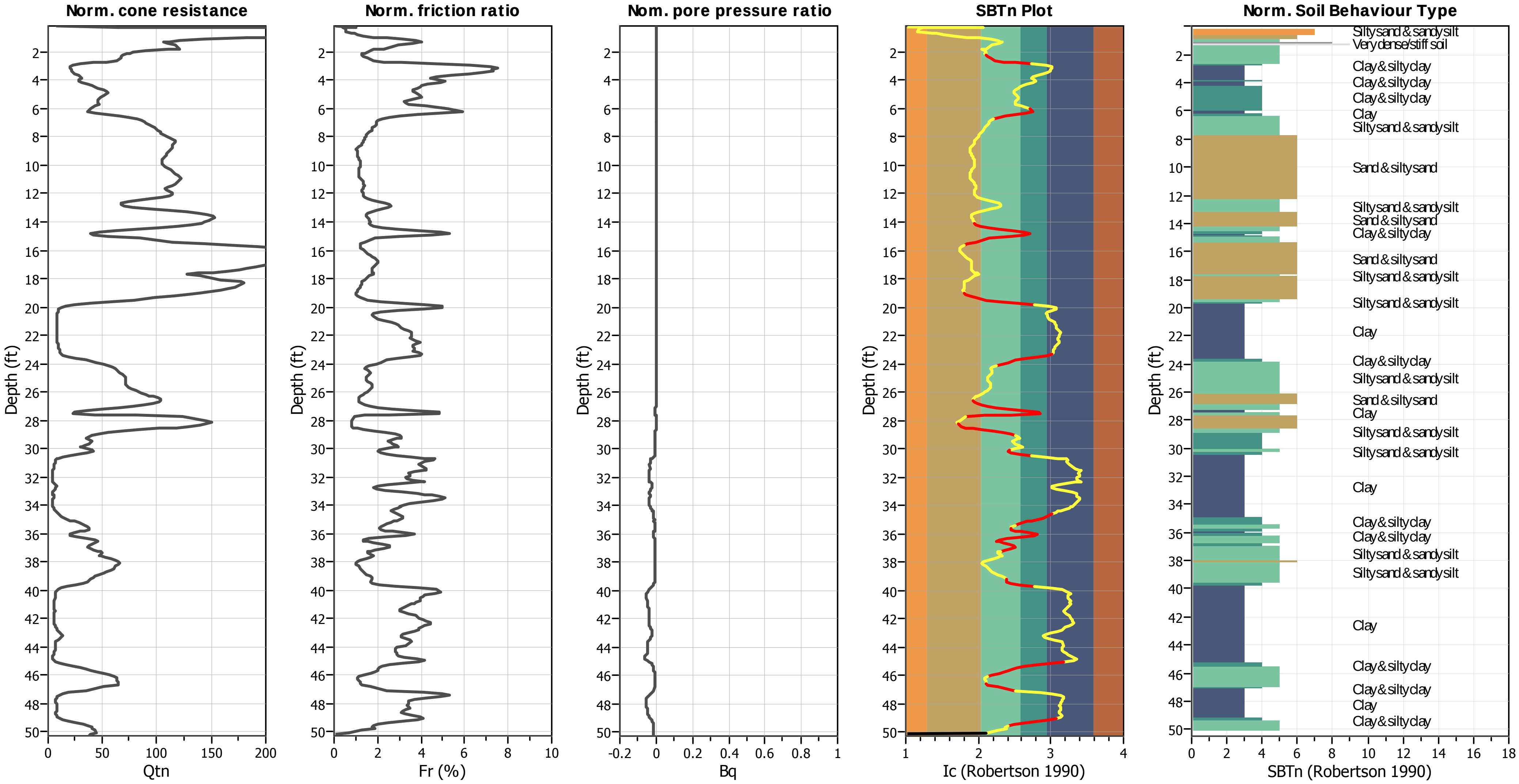
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	9.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



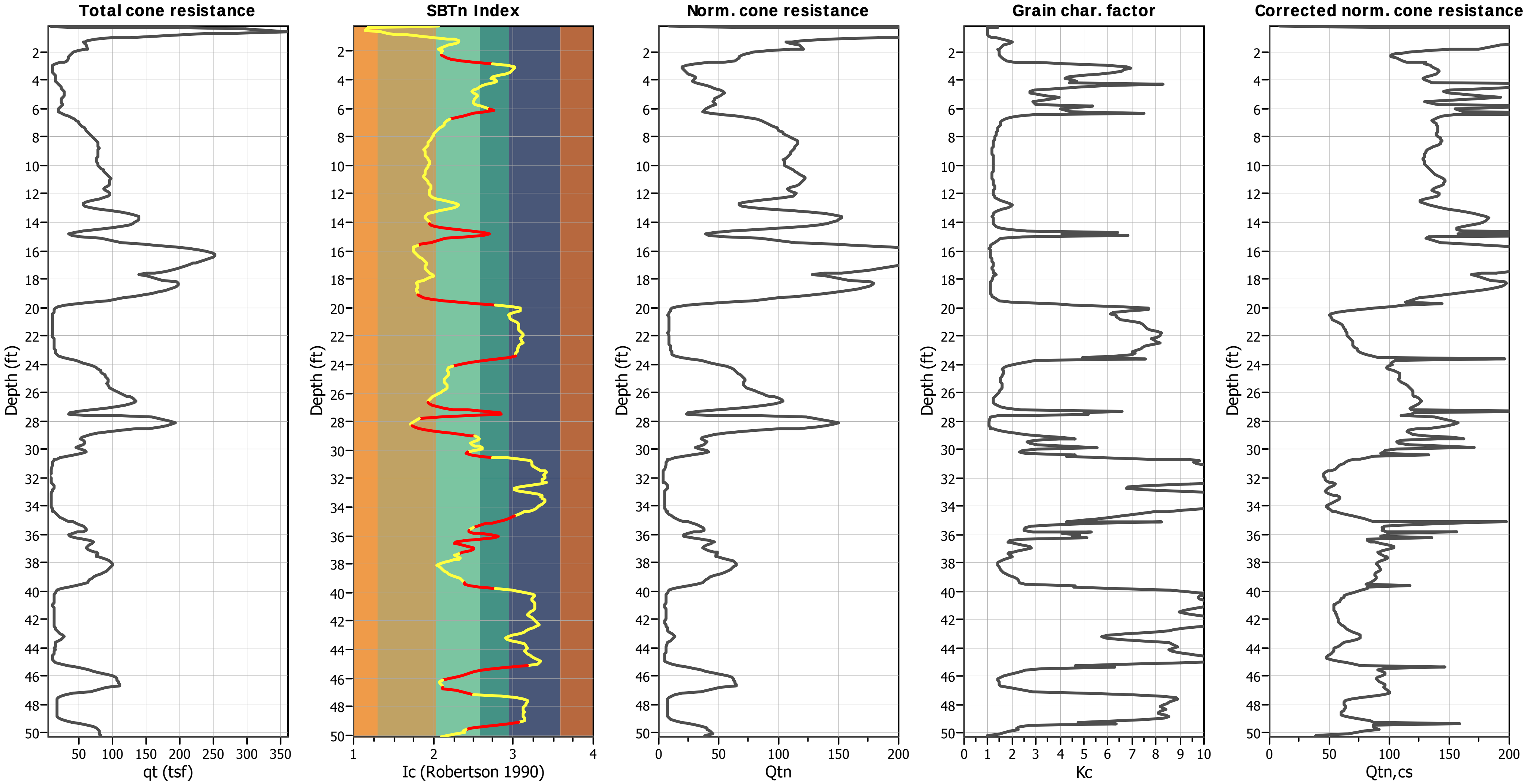
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

SBTn legend

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

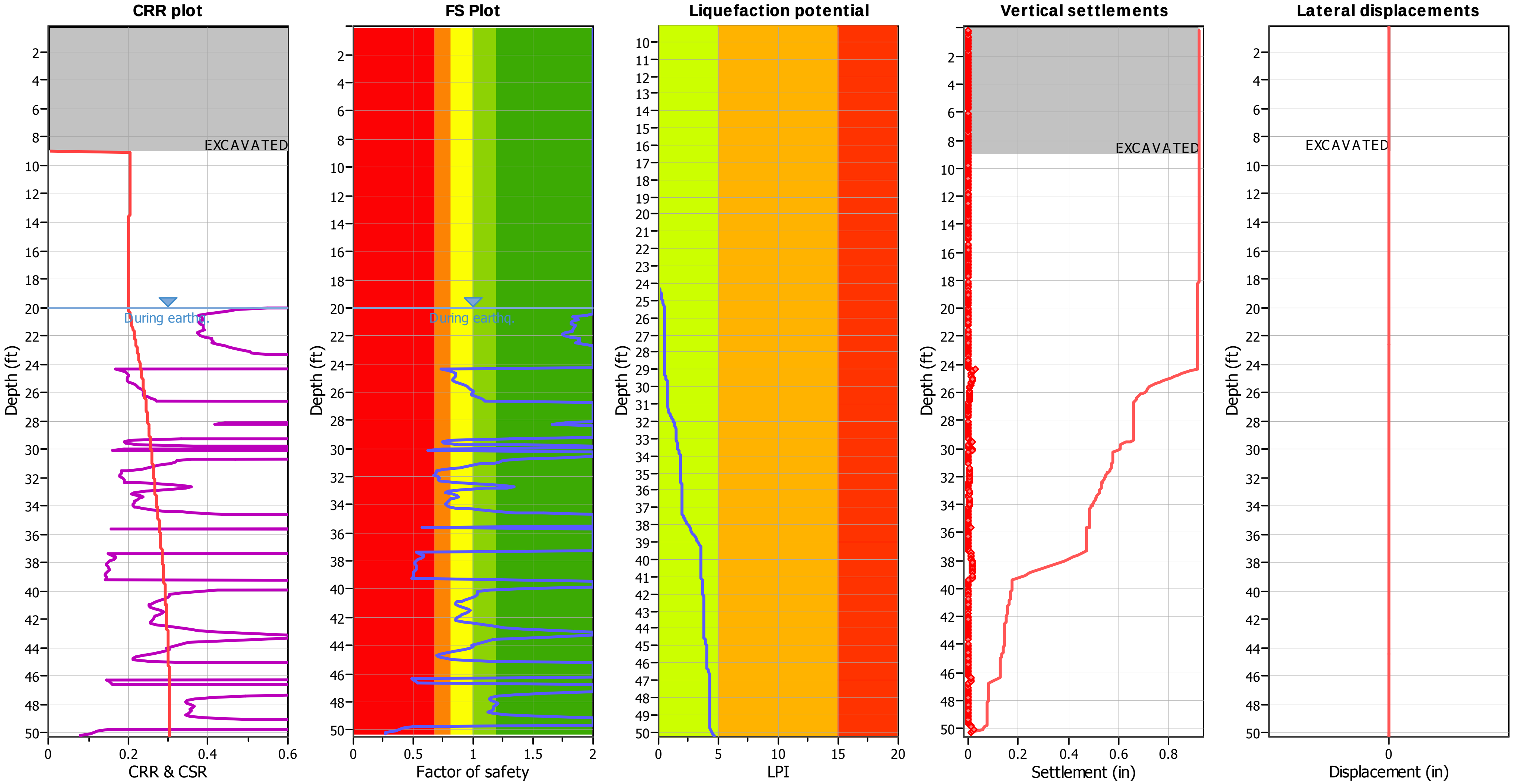
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

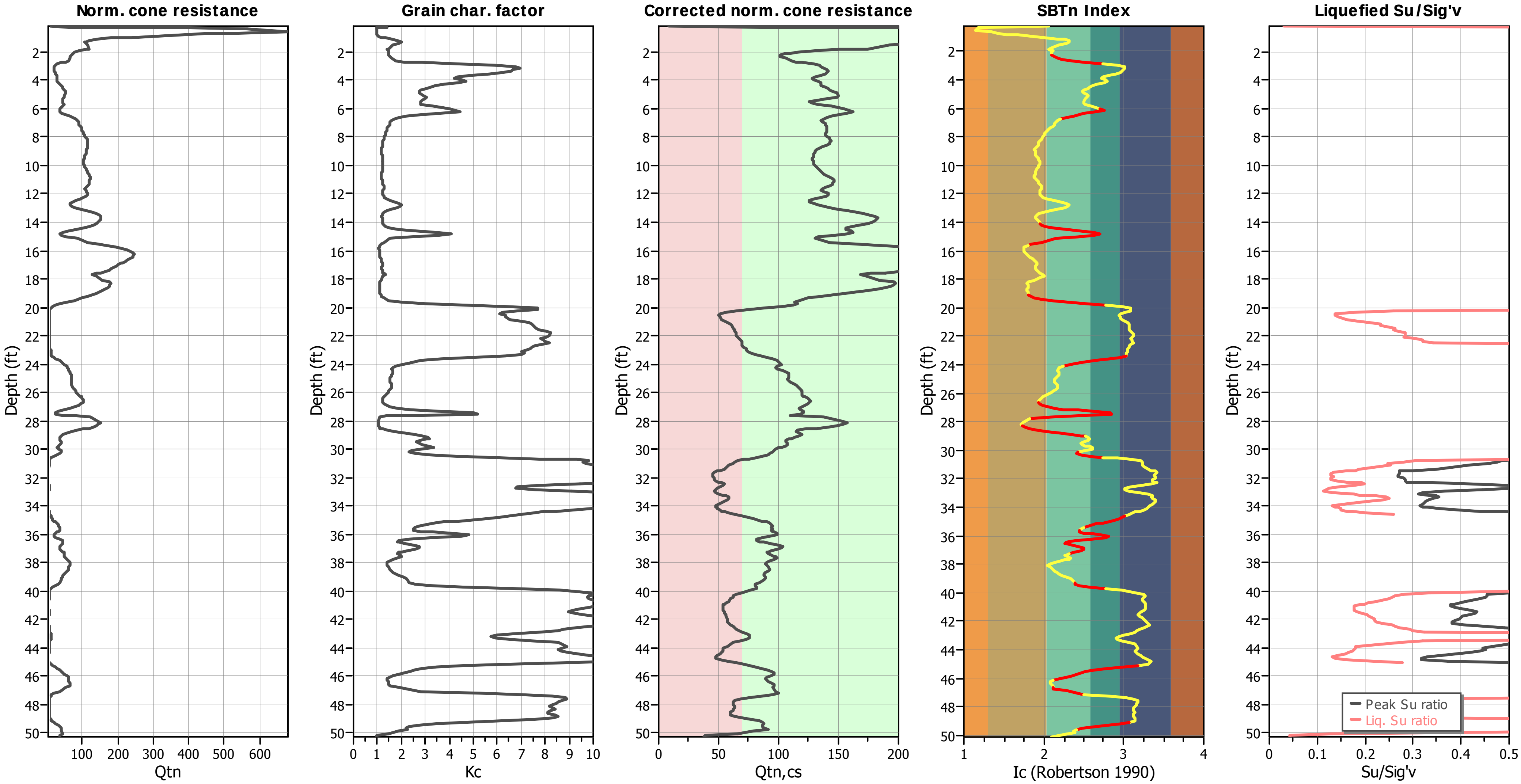
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

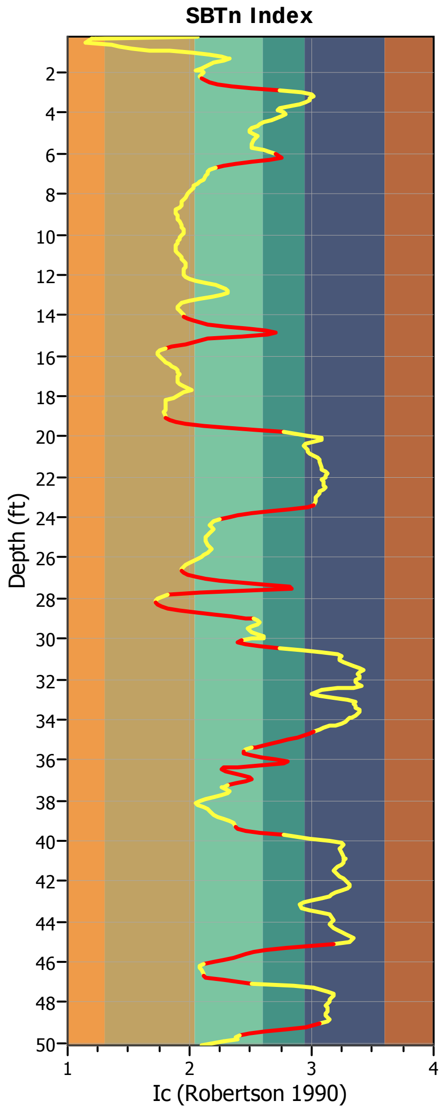
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

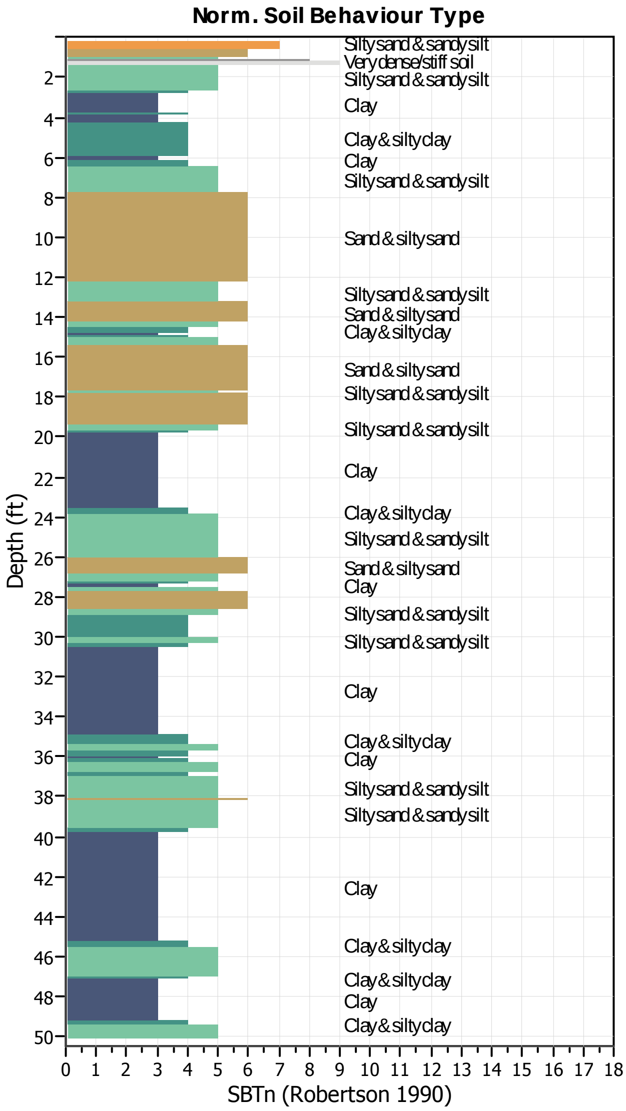
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





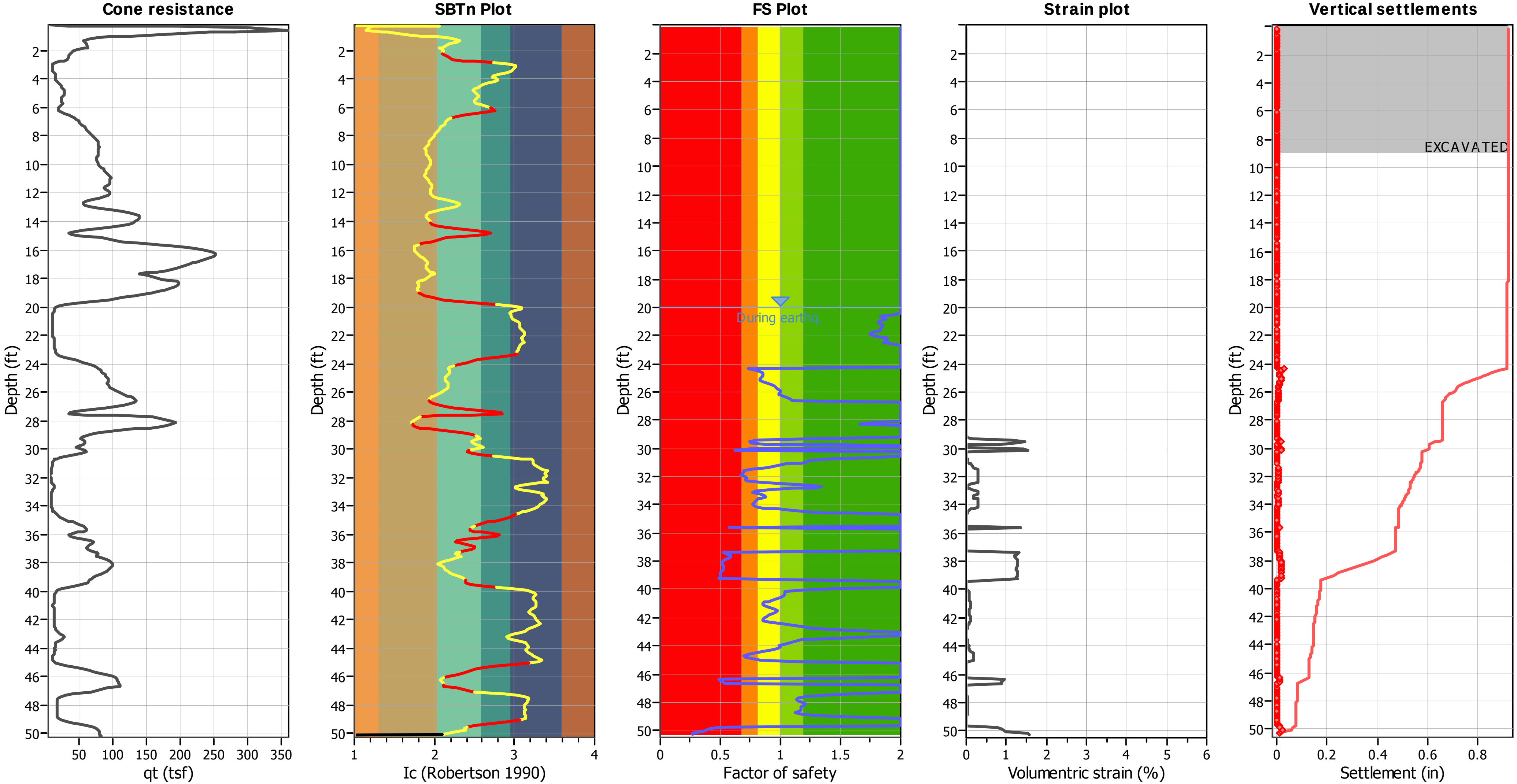
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	483
Total points excluded:	129
Exclusion percentage:	26.71%
Number of layers detected:	19

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

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Irvine, CA 92614
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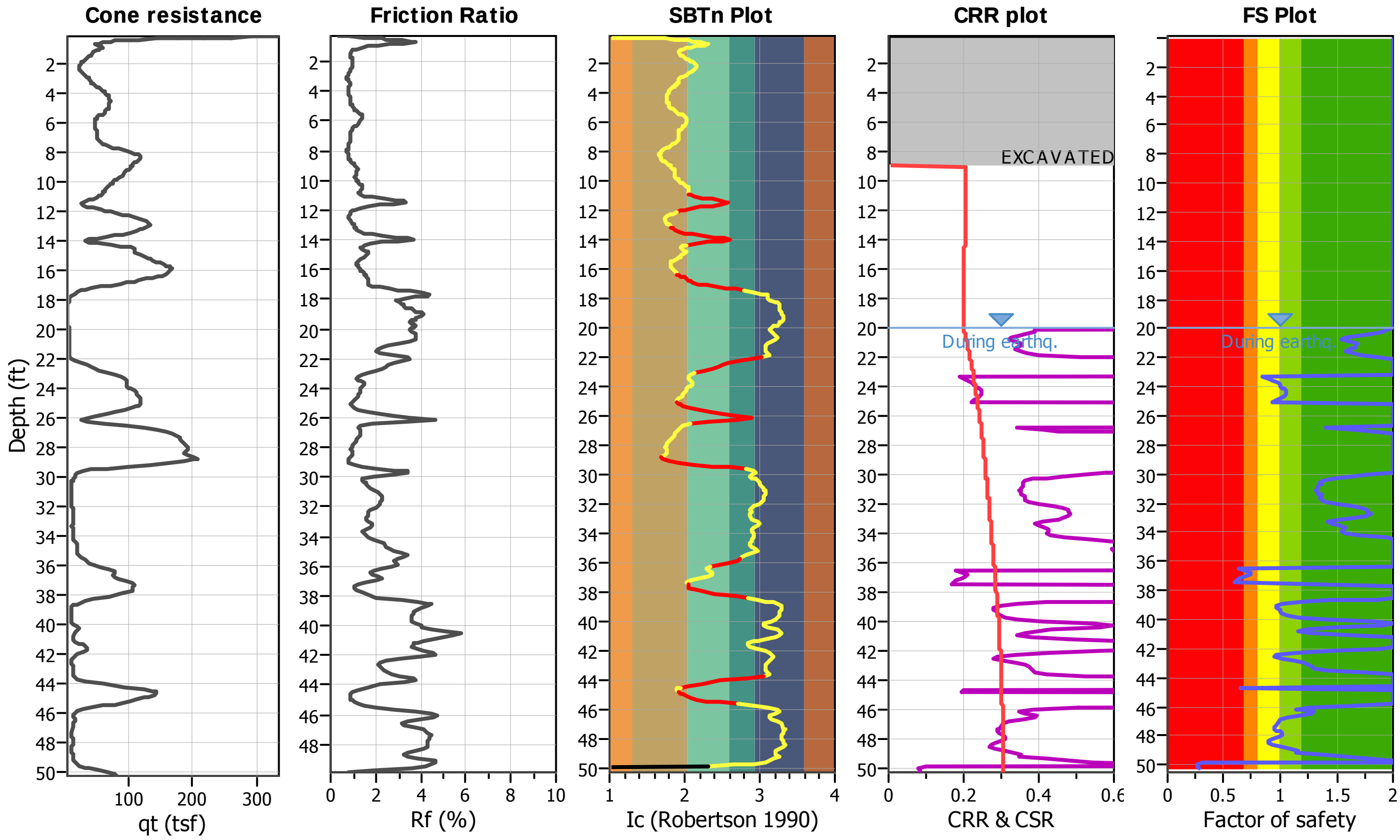
LIQUEFACTION ANALYSIS REPORT

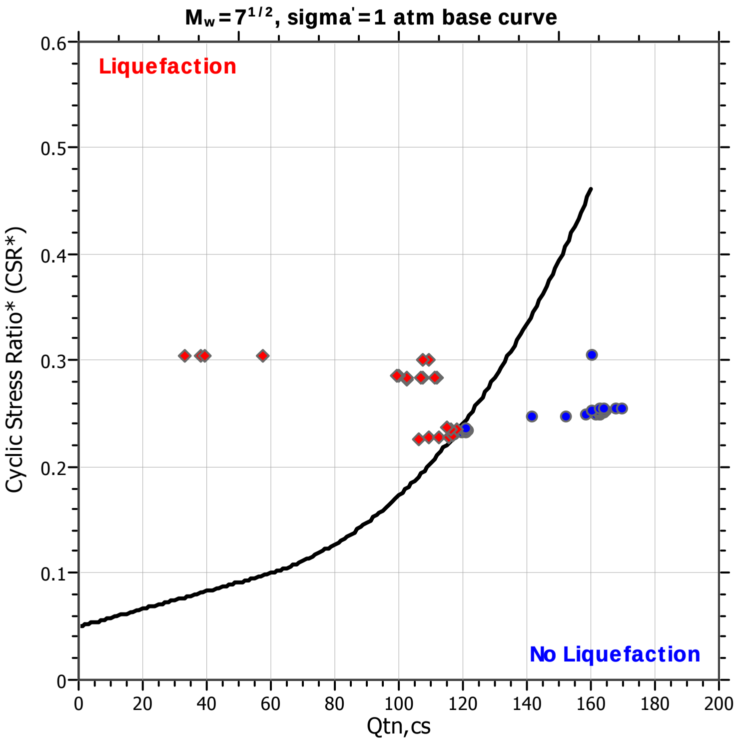
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

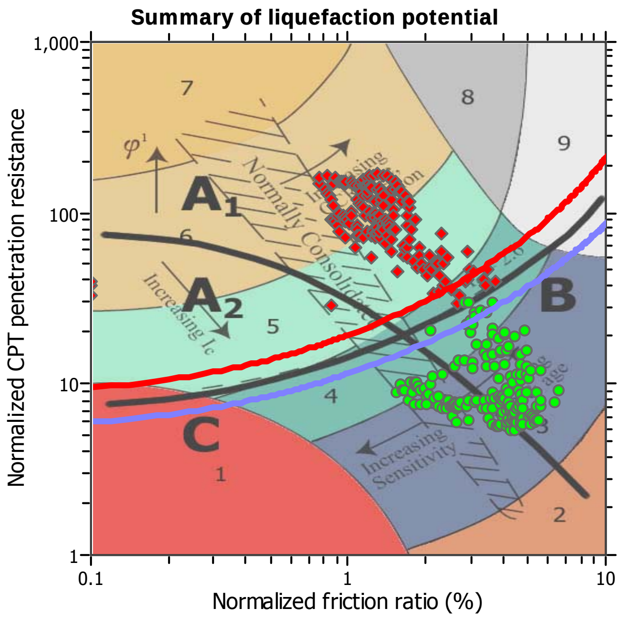
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	9.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

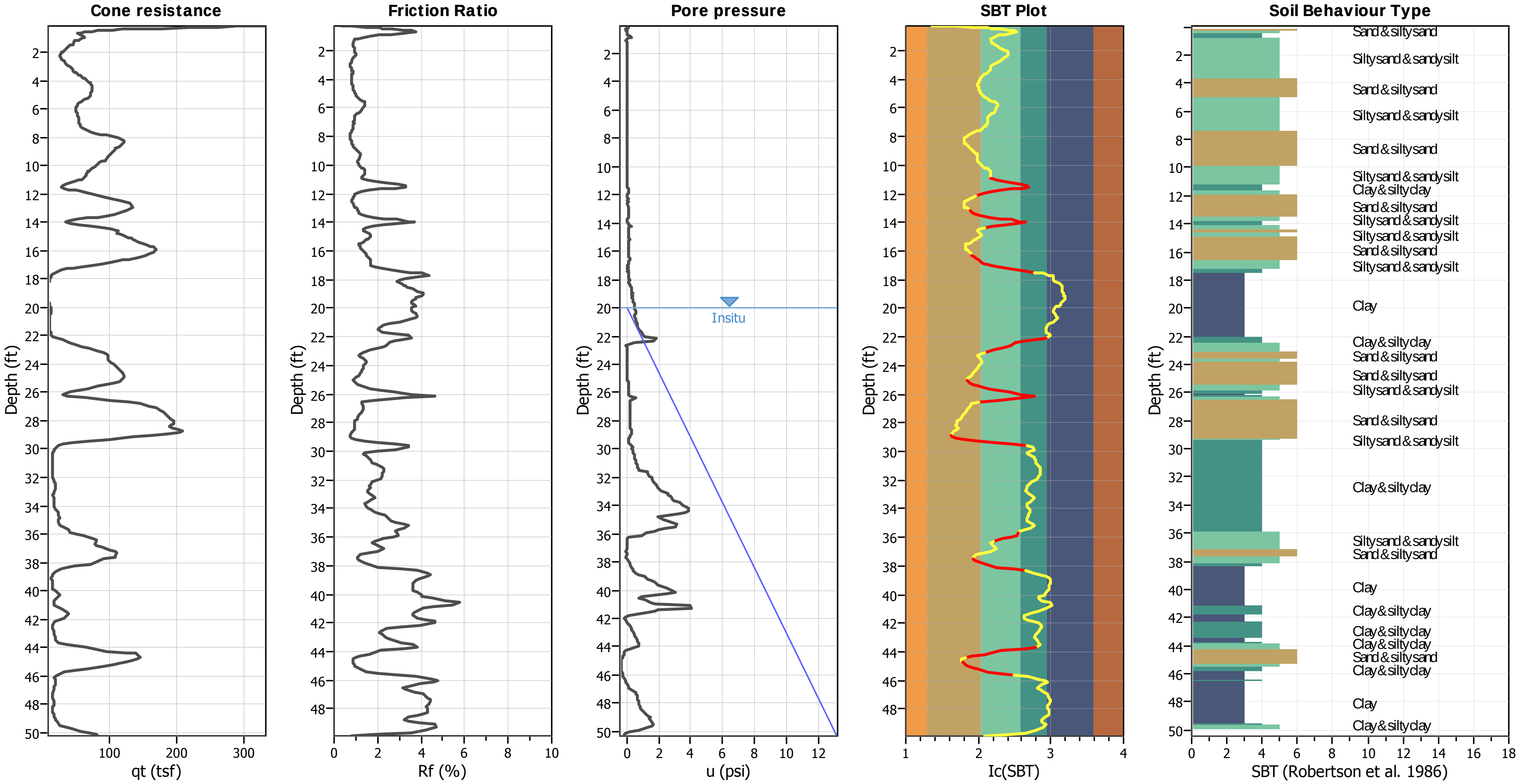






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



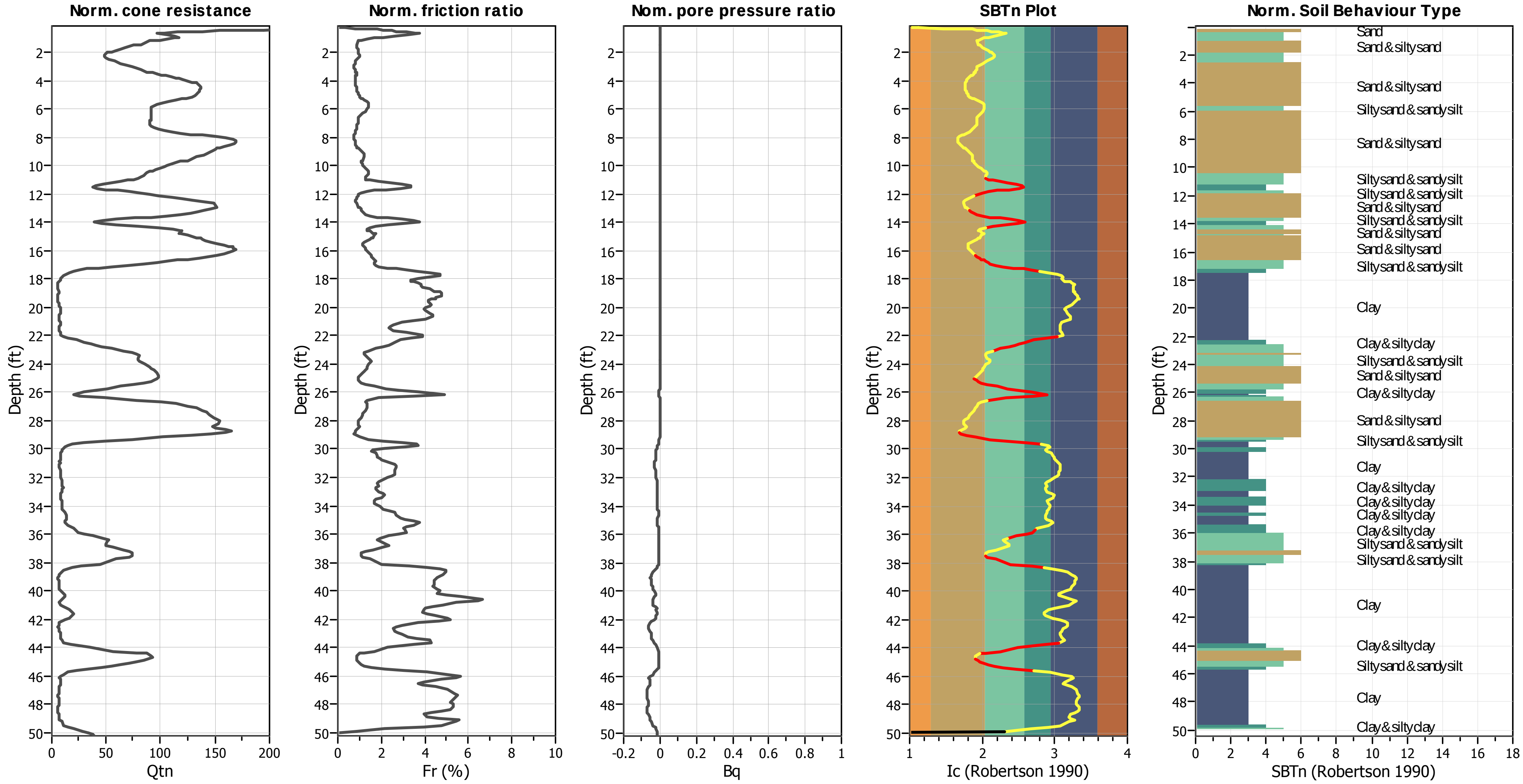
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	9.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



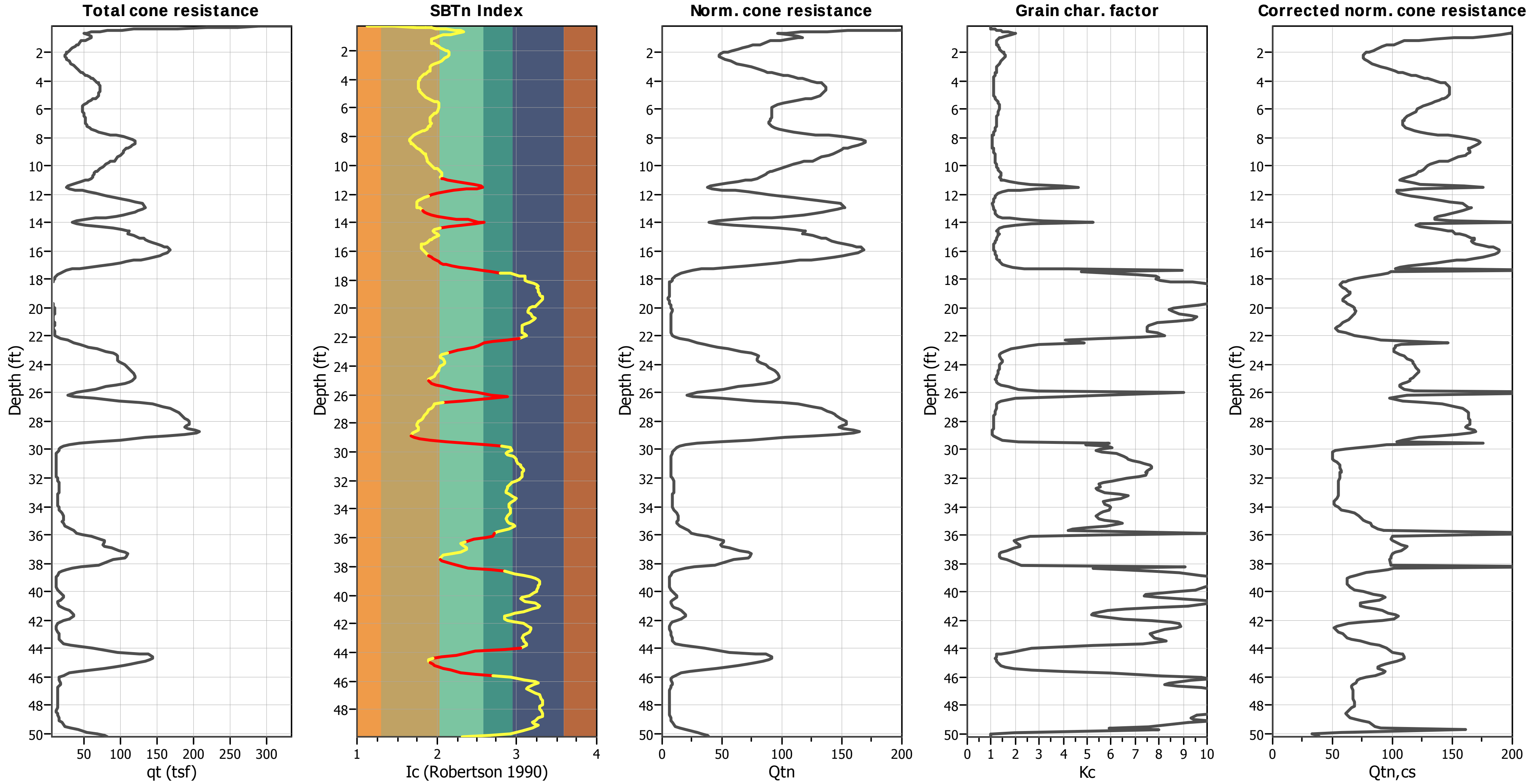
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

SBTn legend

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

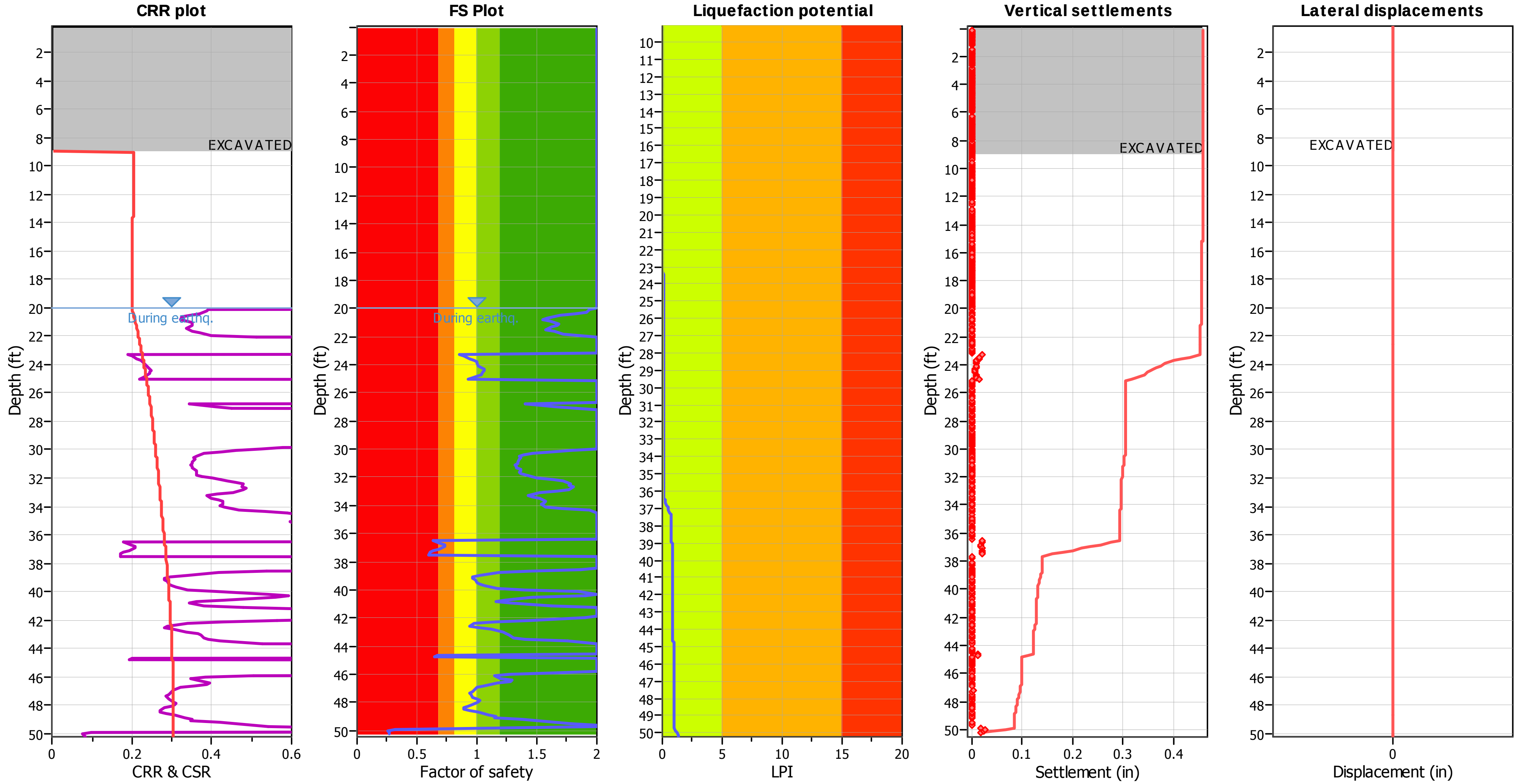
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

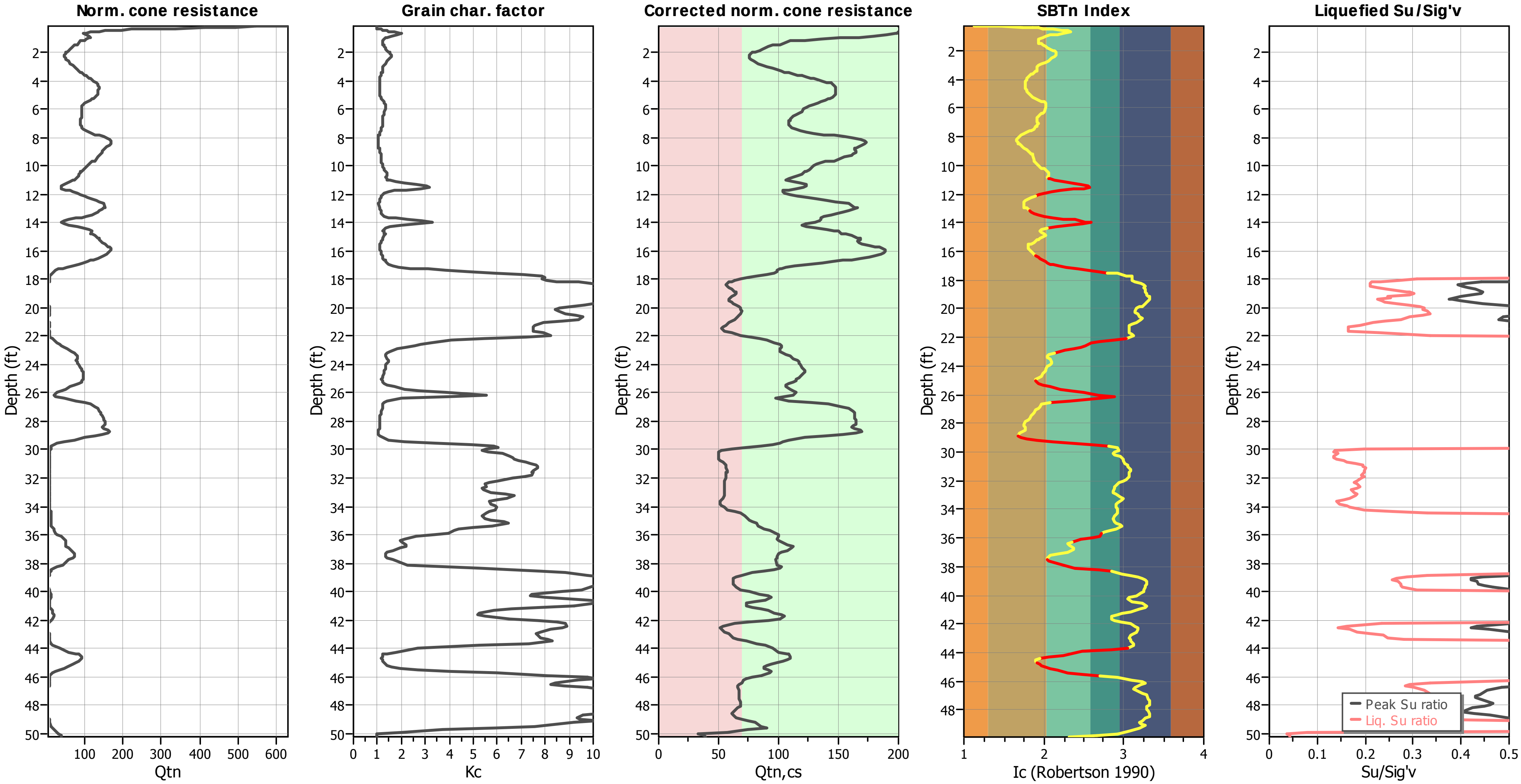
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

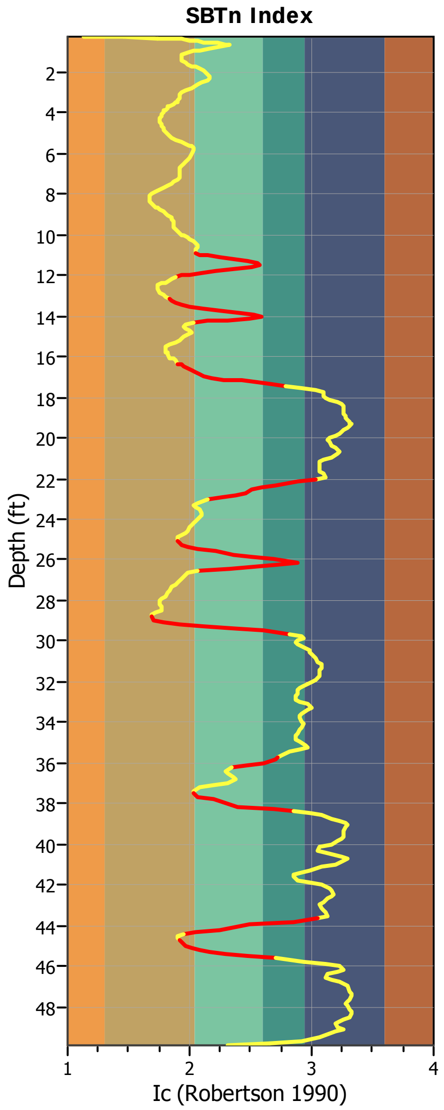
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

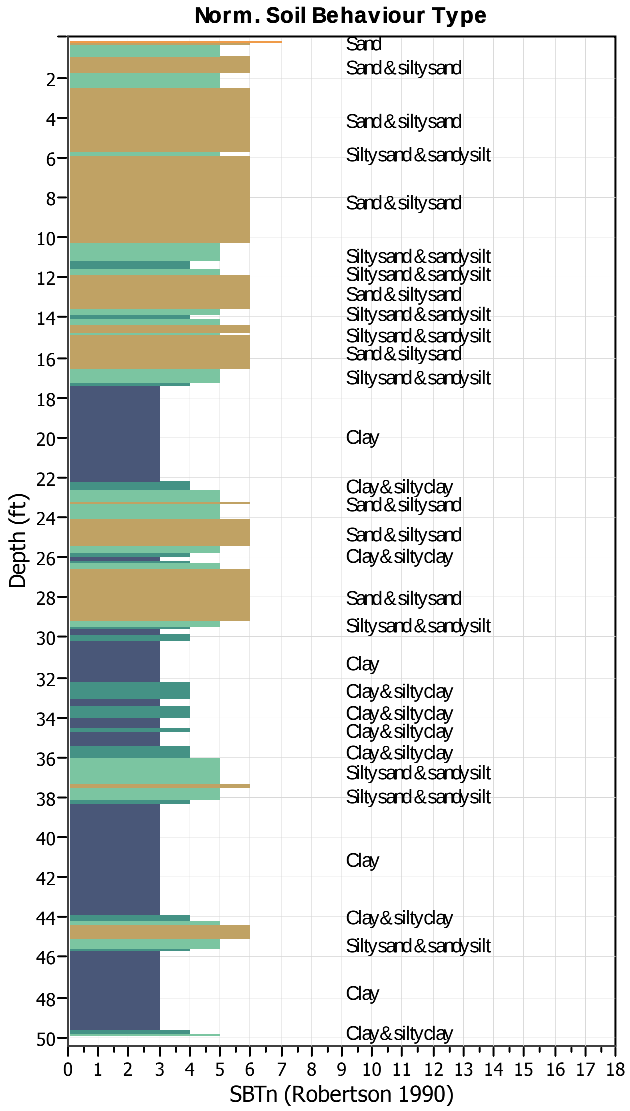
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

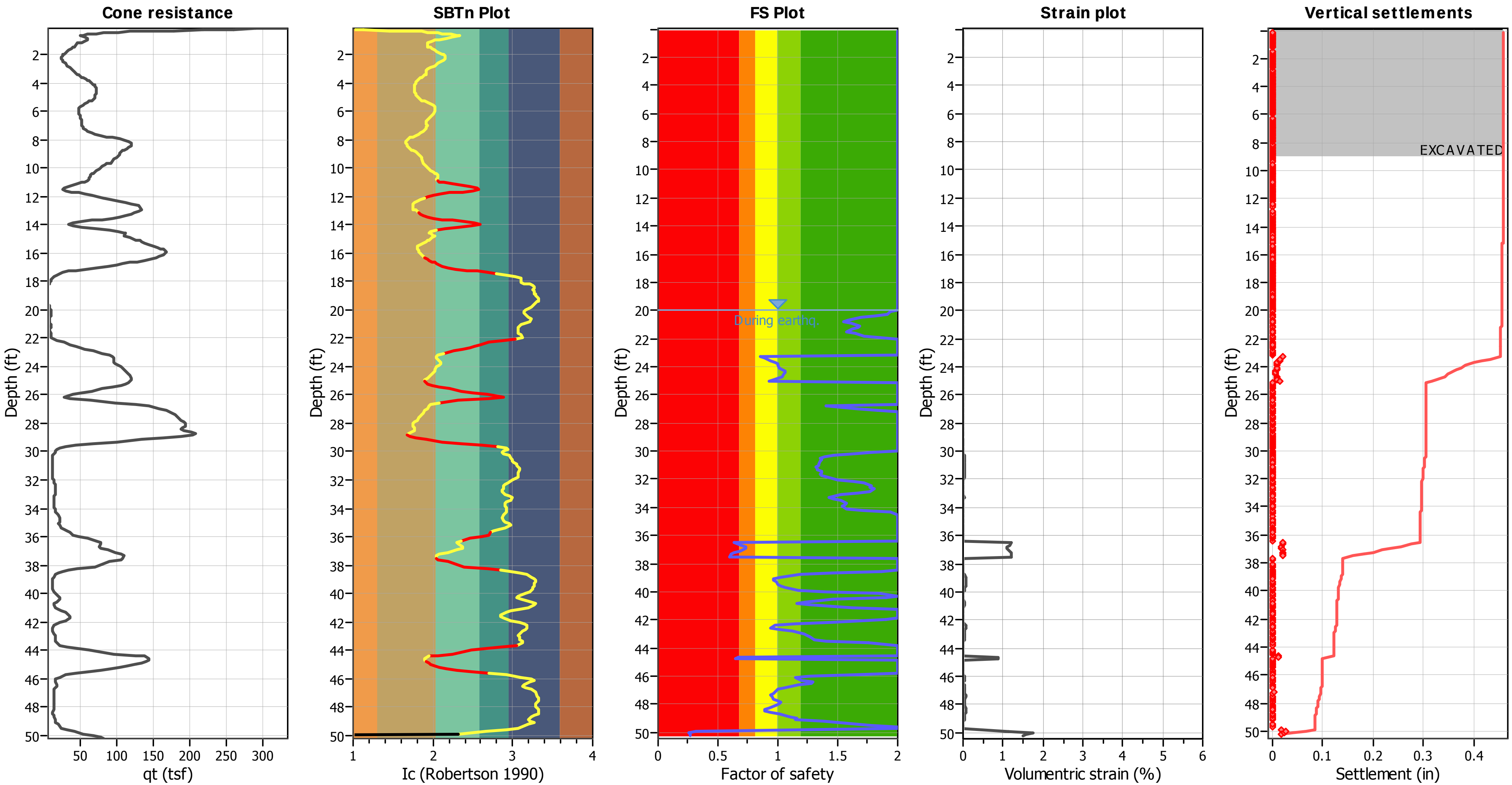
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	451
I_c maximum check value:	3.00	Total points excluded:	101
I_c change ratio value:	0.0250	Exclusion percentage:	22.39%
Minimum number of points in layer:	4	Number of layers detected:	13

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

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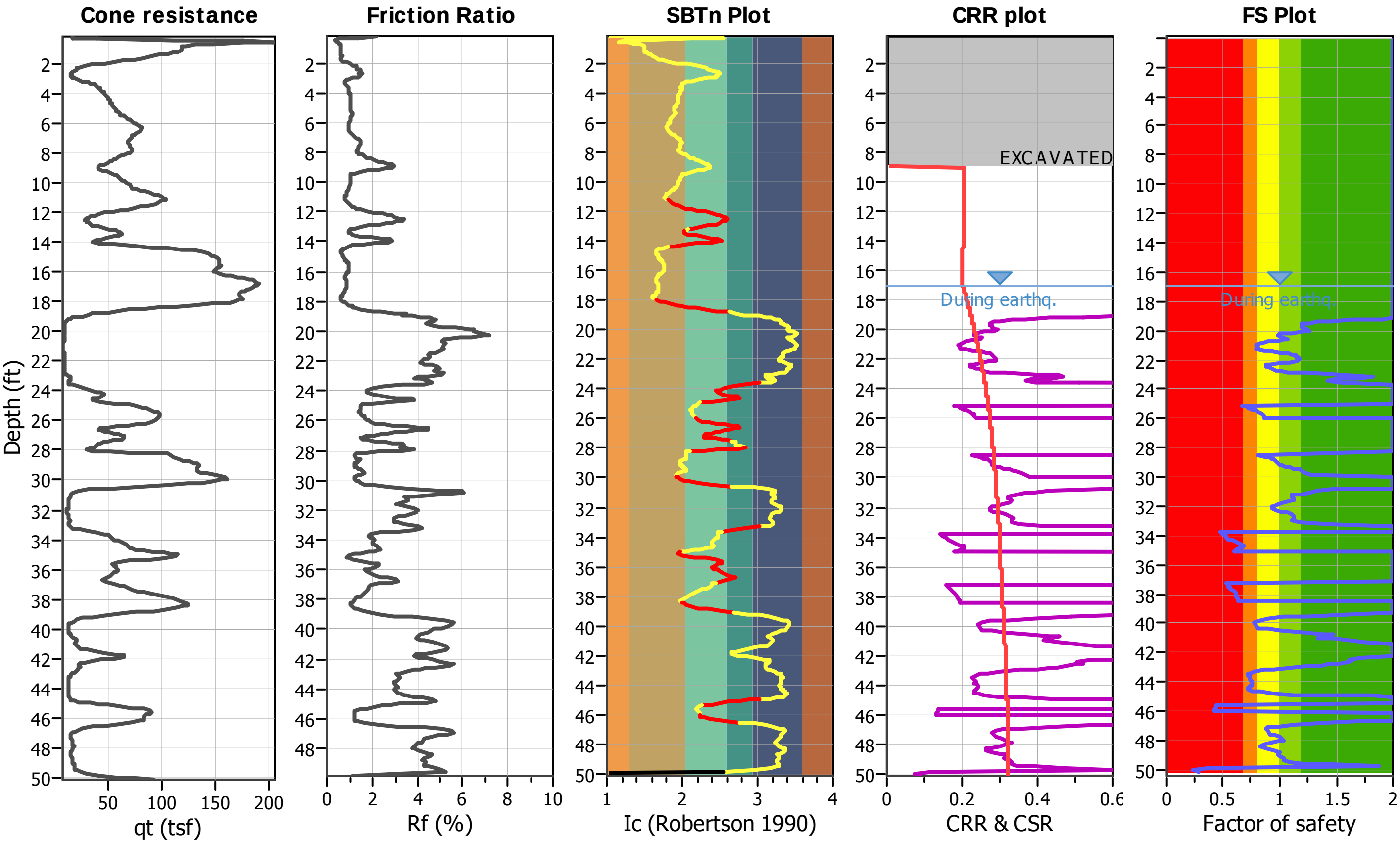
LIQUEFACTION ANALYSIS REPORT

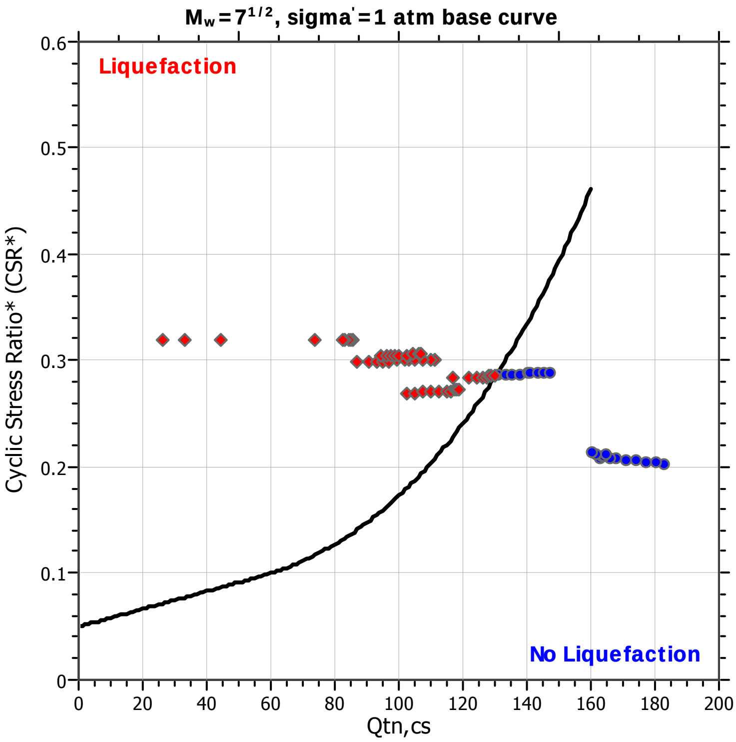
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

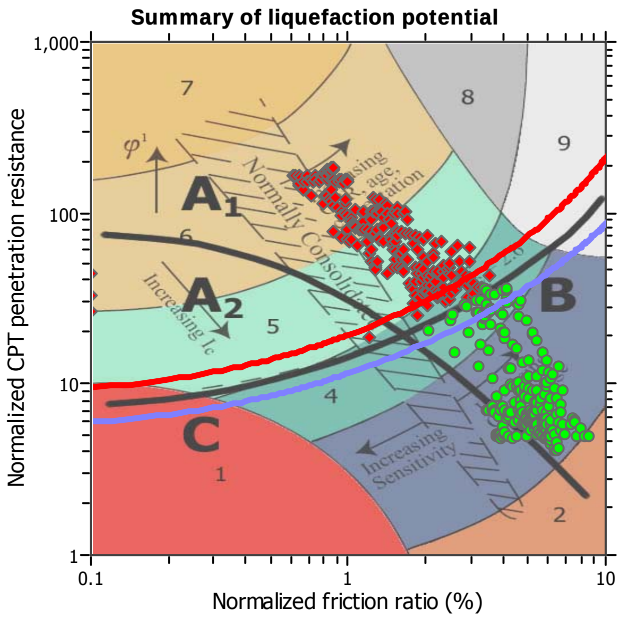
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.00 ft	Excavation depth:	9.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

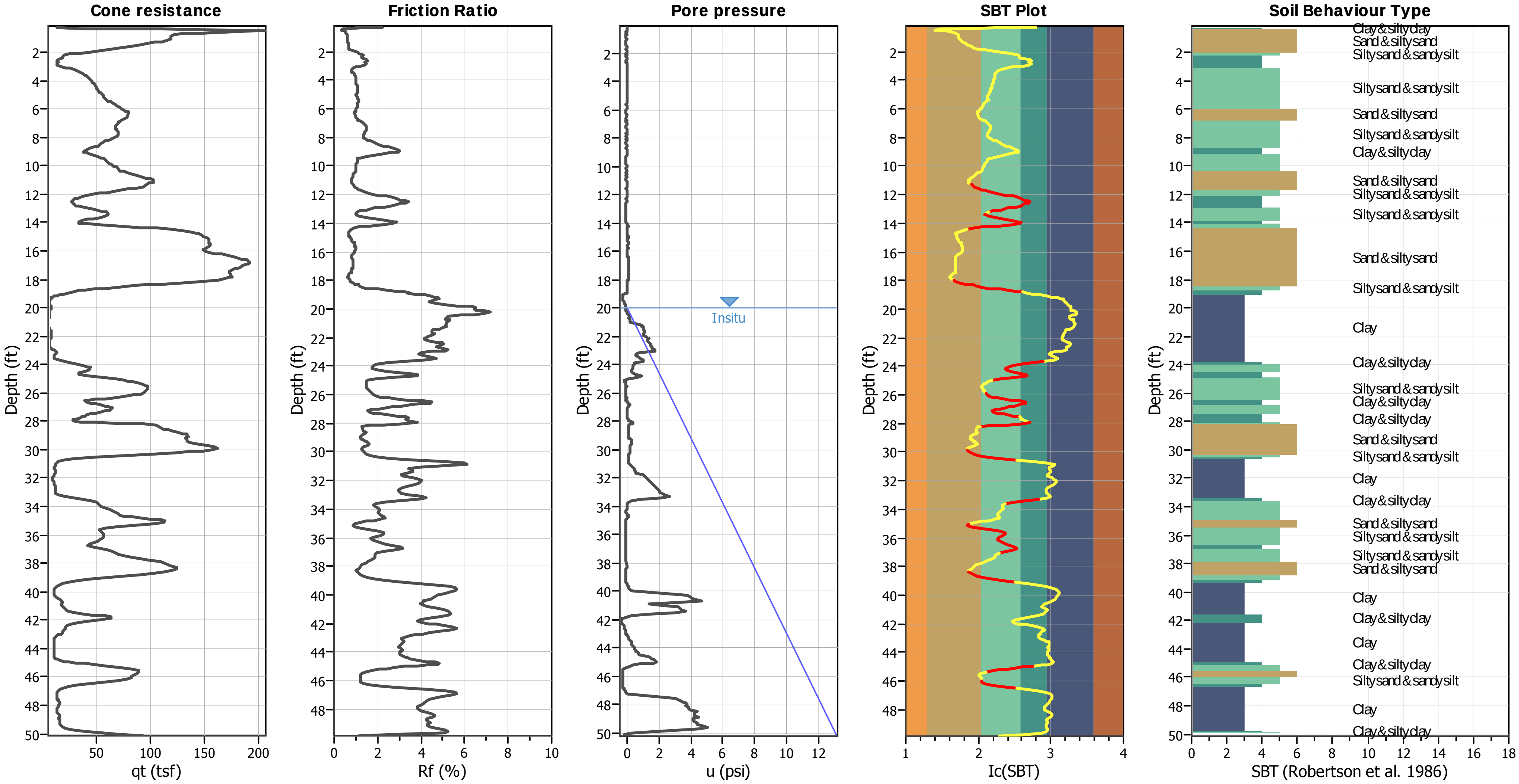






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



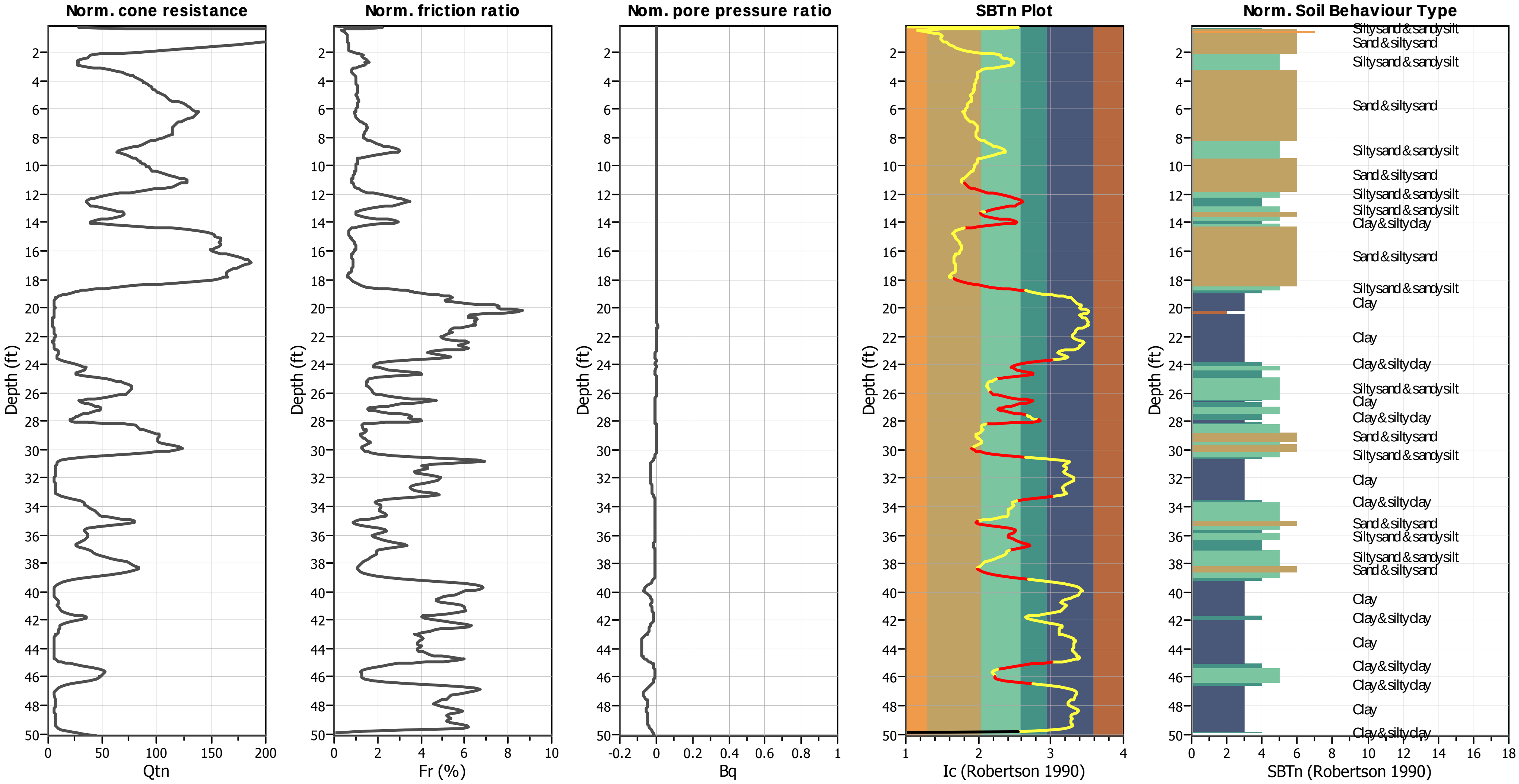
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	9.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



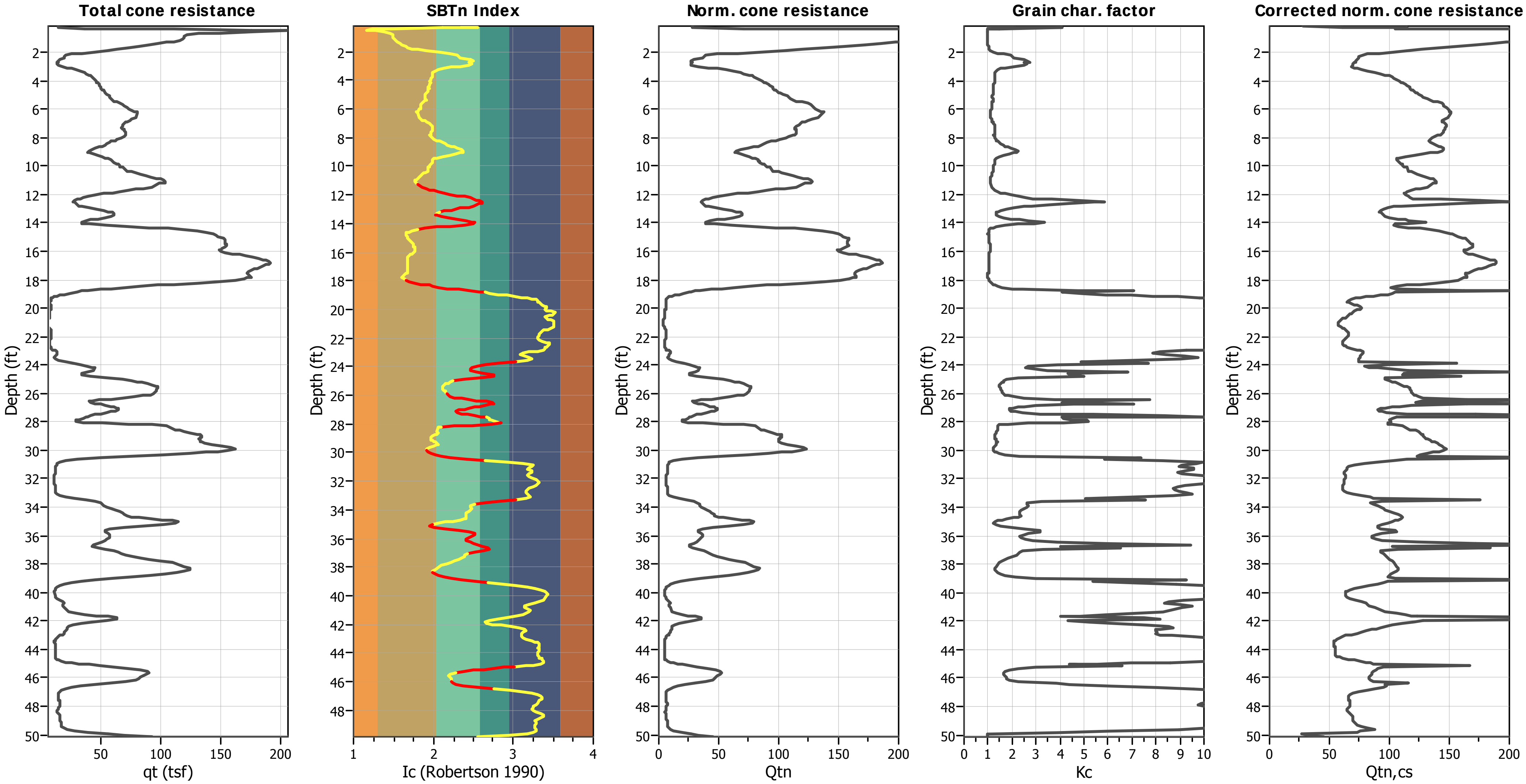
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

SBTn legend

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

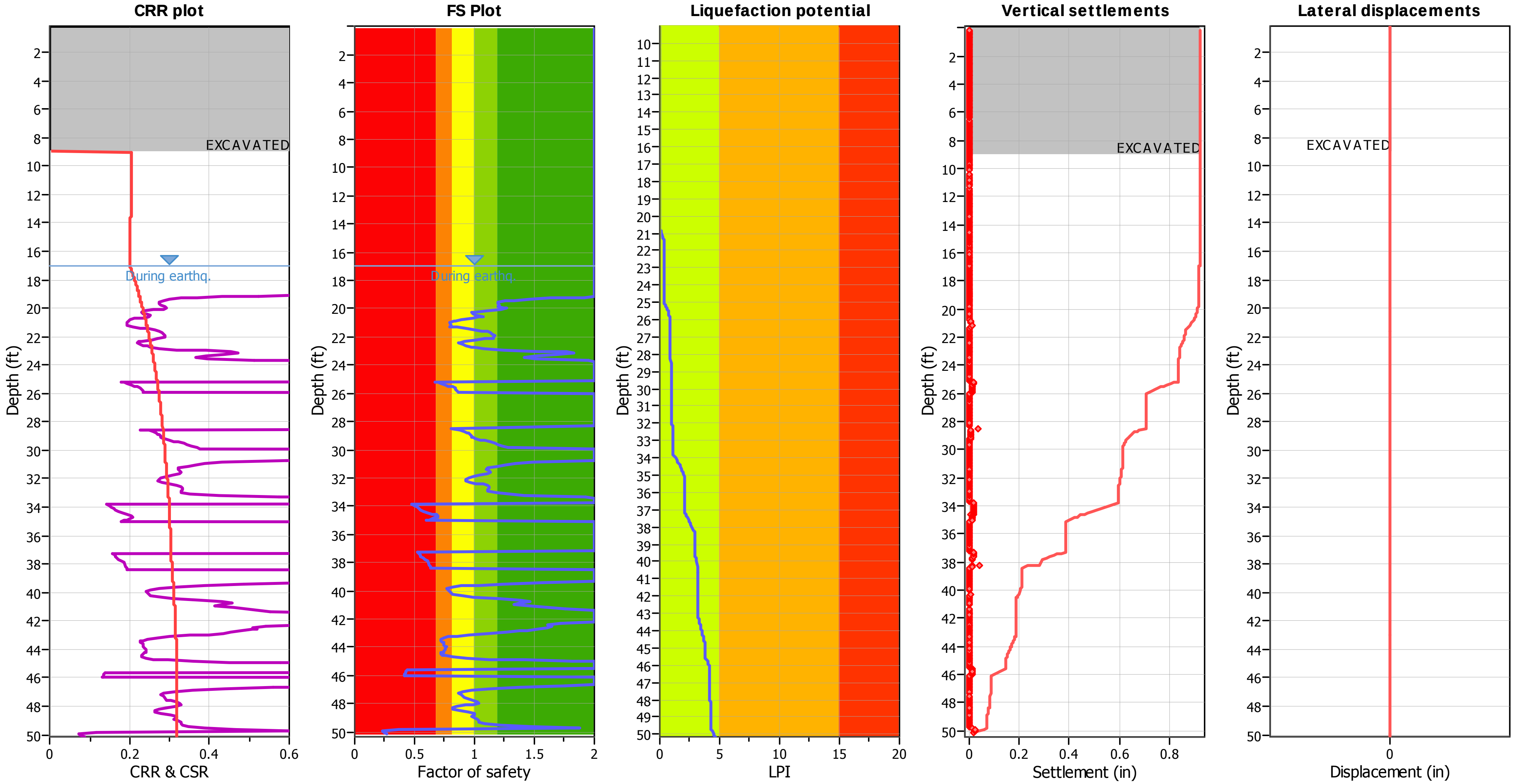
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

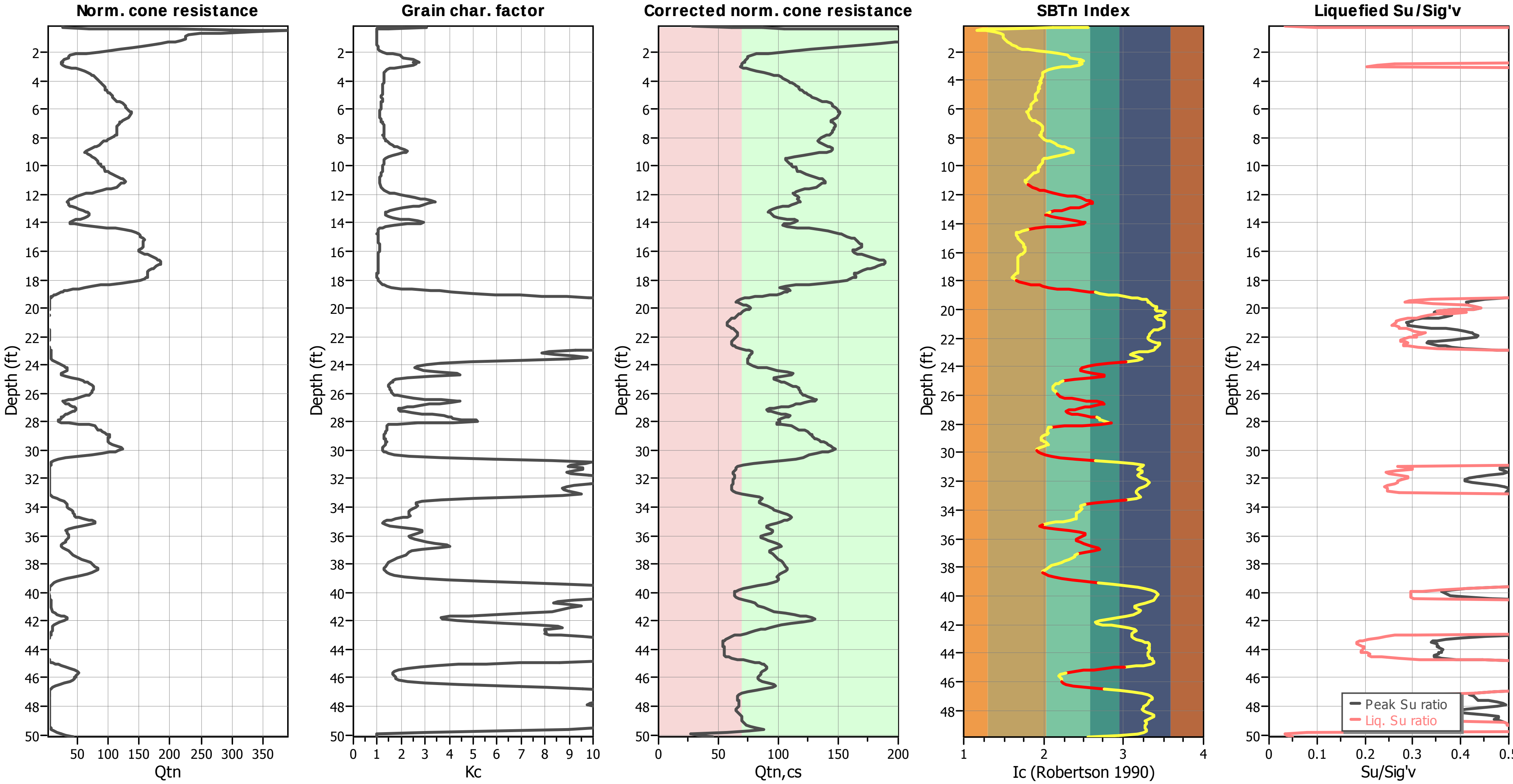
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

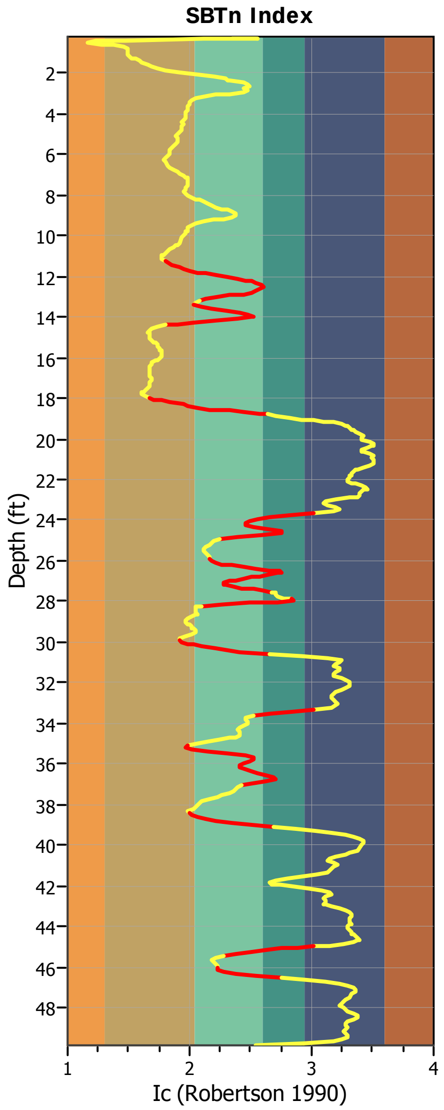
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	9.00 ft	Limit depth:	60.00 ft

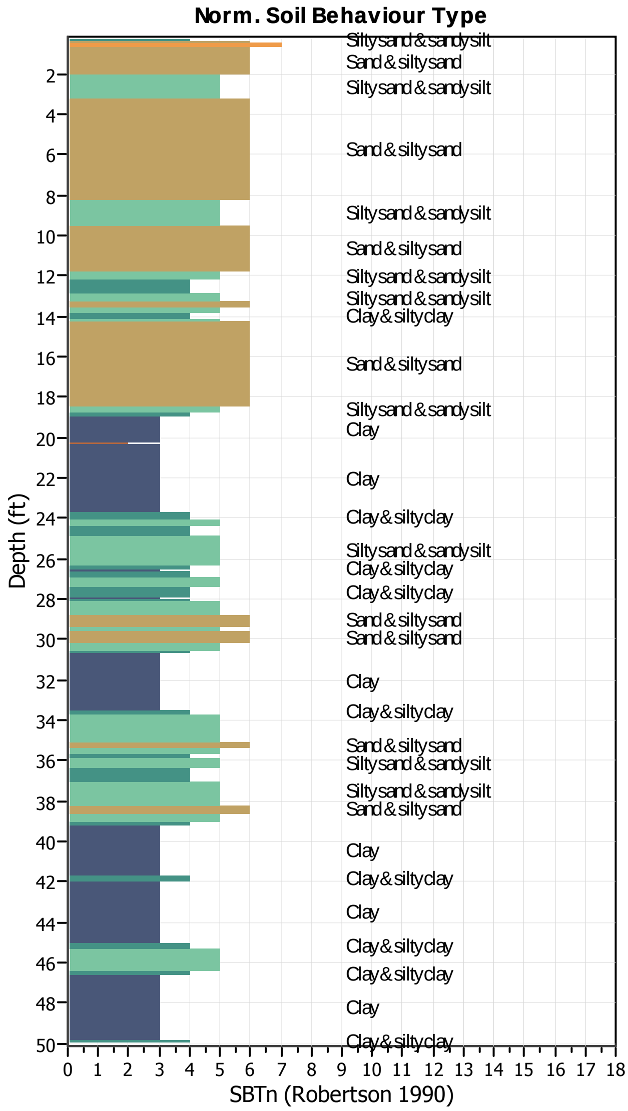
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

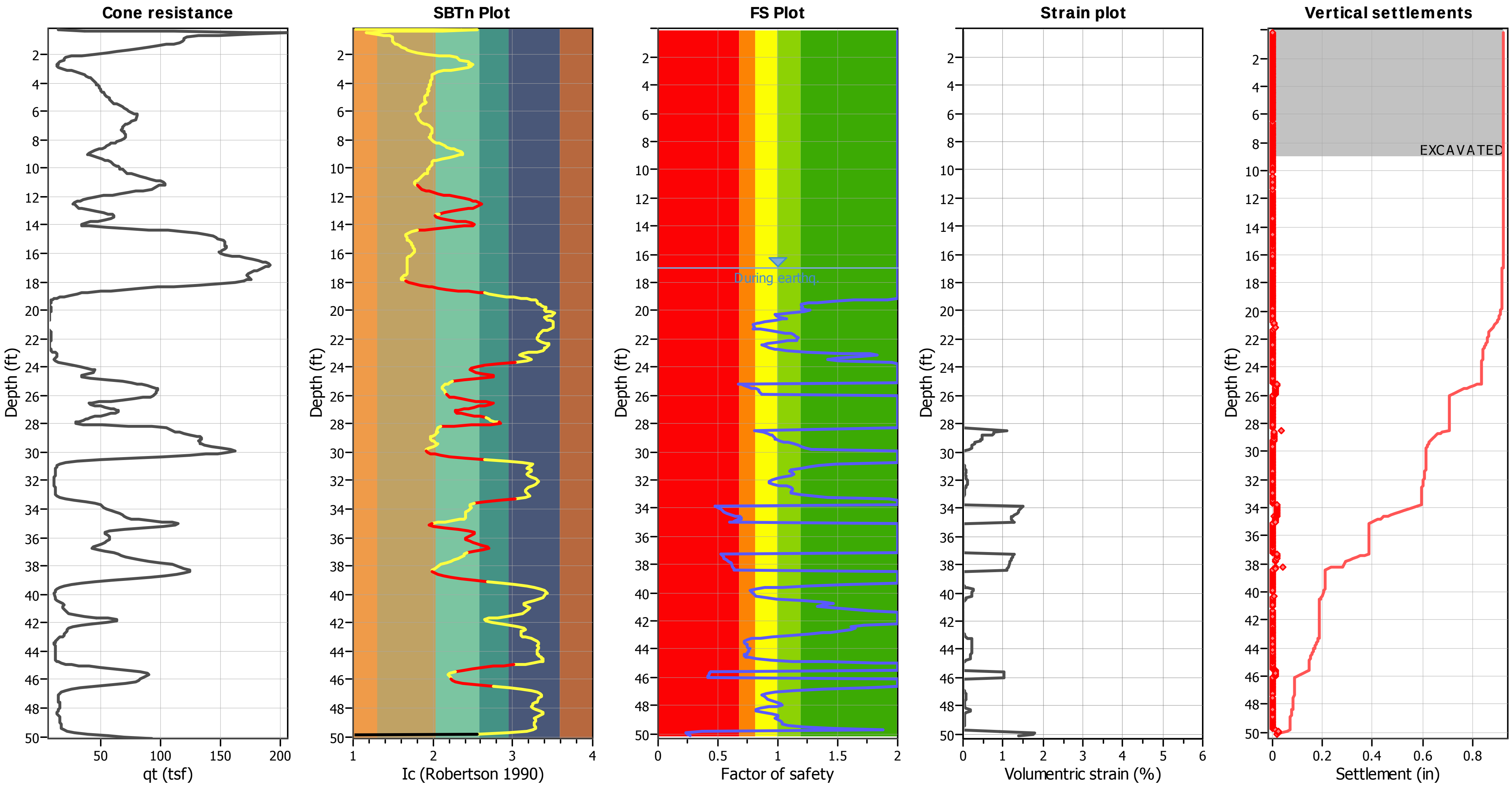
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	572
I_c maximum check value:	3.00	Total points excluded:	149
I_c change ratio value:	0.0250	Exclusion percentage:	26.05%
Minimum number of points in layer:	4	Number of layers detected:	21

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

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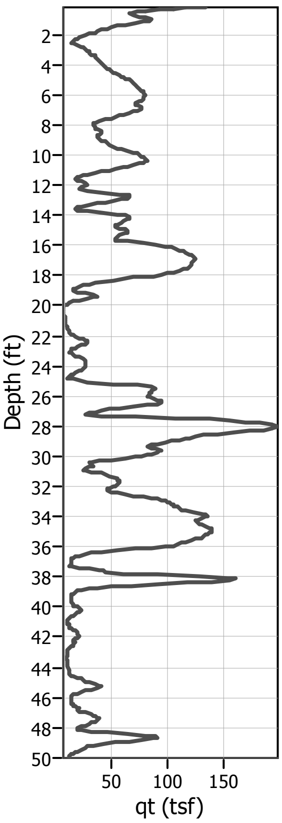
LIQUEFACTION ANALYSIS REPORT

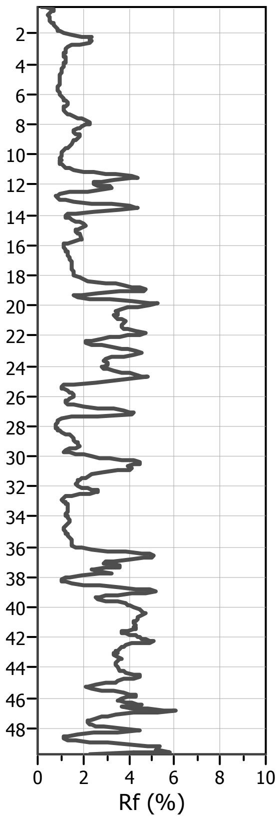
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

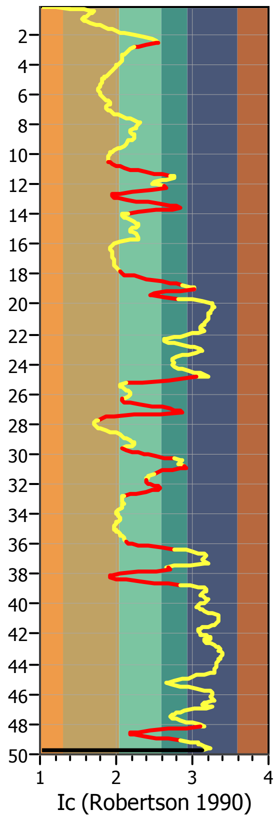
CPT file : CPT-5

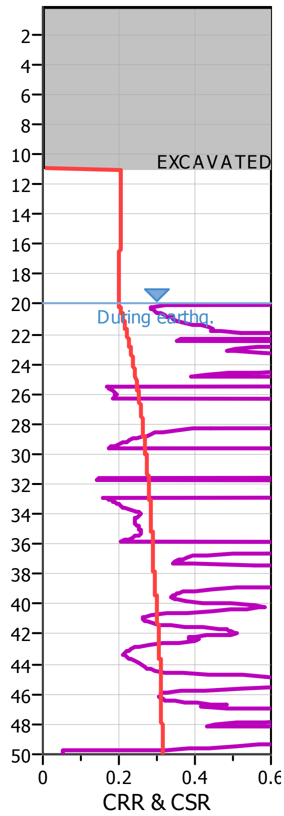
Input parameters and analysis data

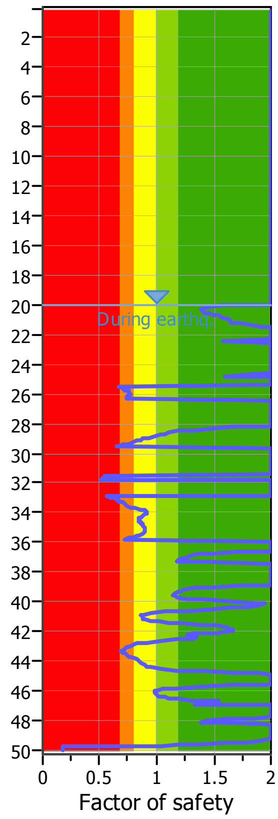
Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	11.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

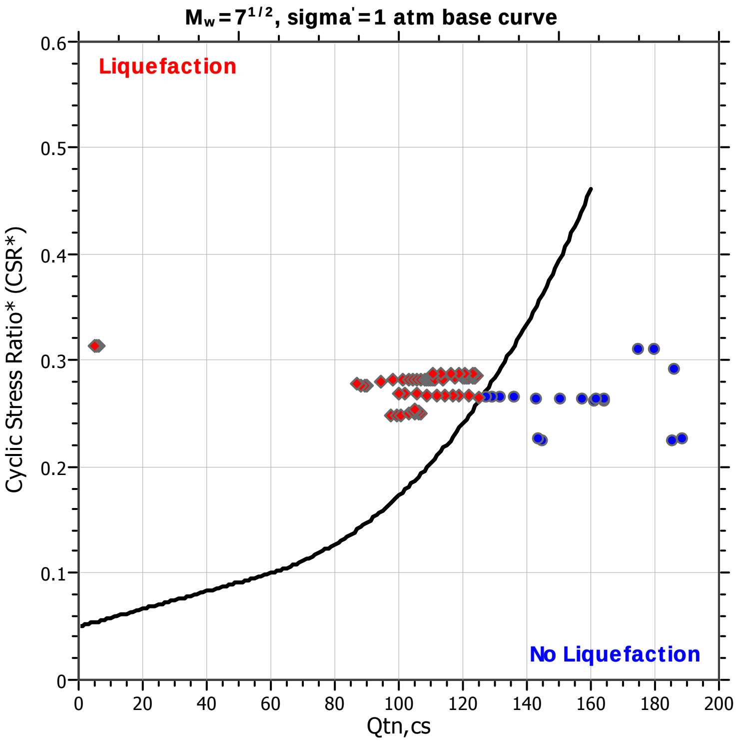


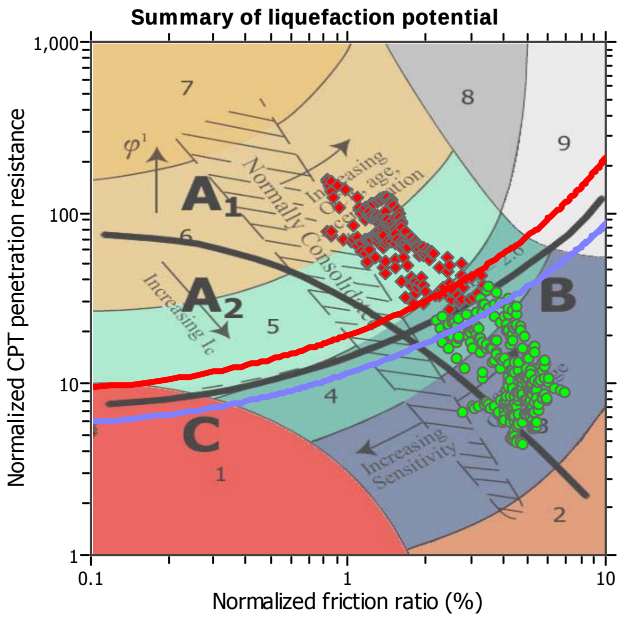






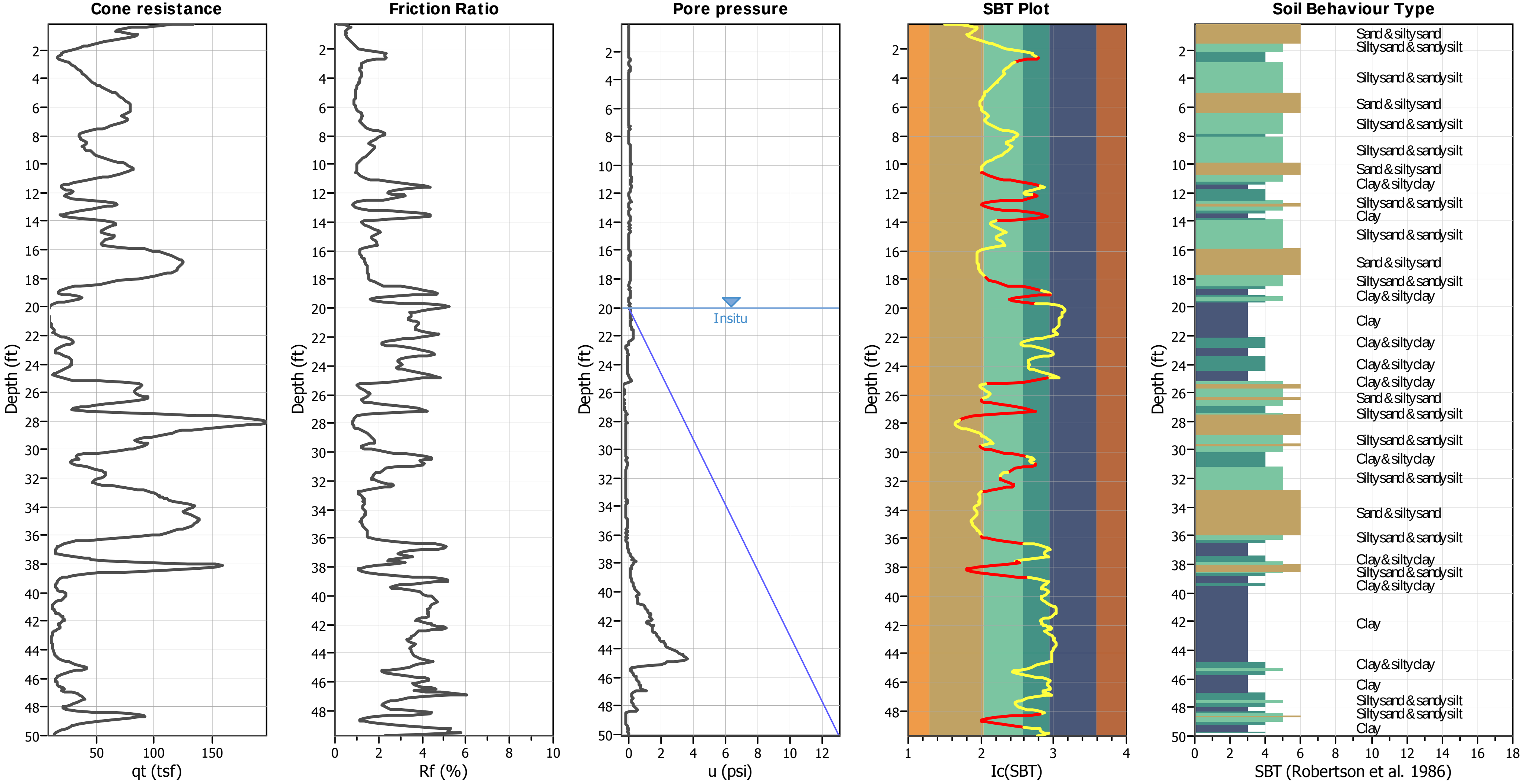






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



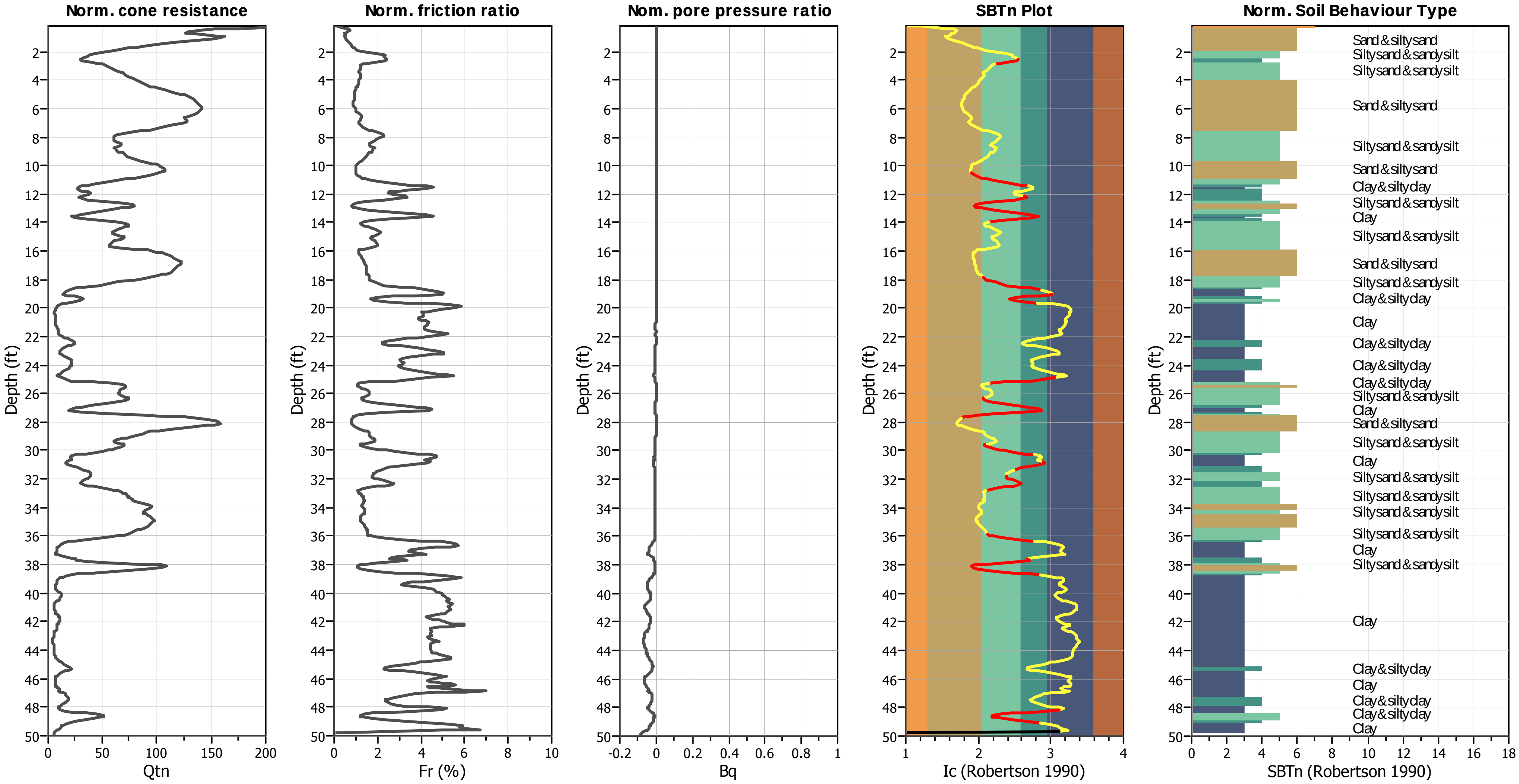
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	11.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



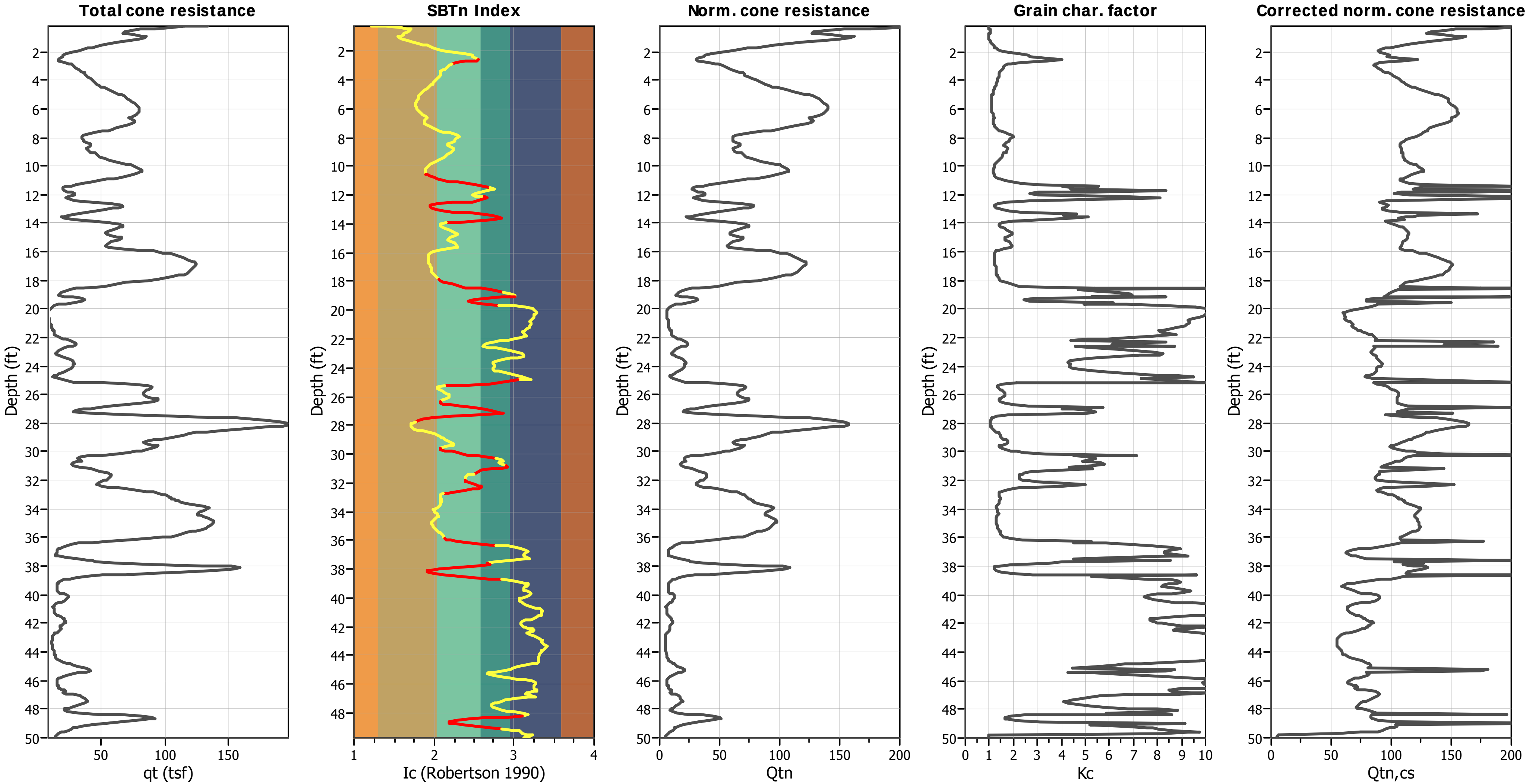
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

SBTn legend

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

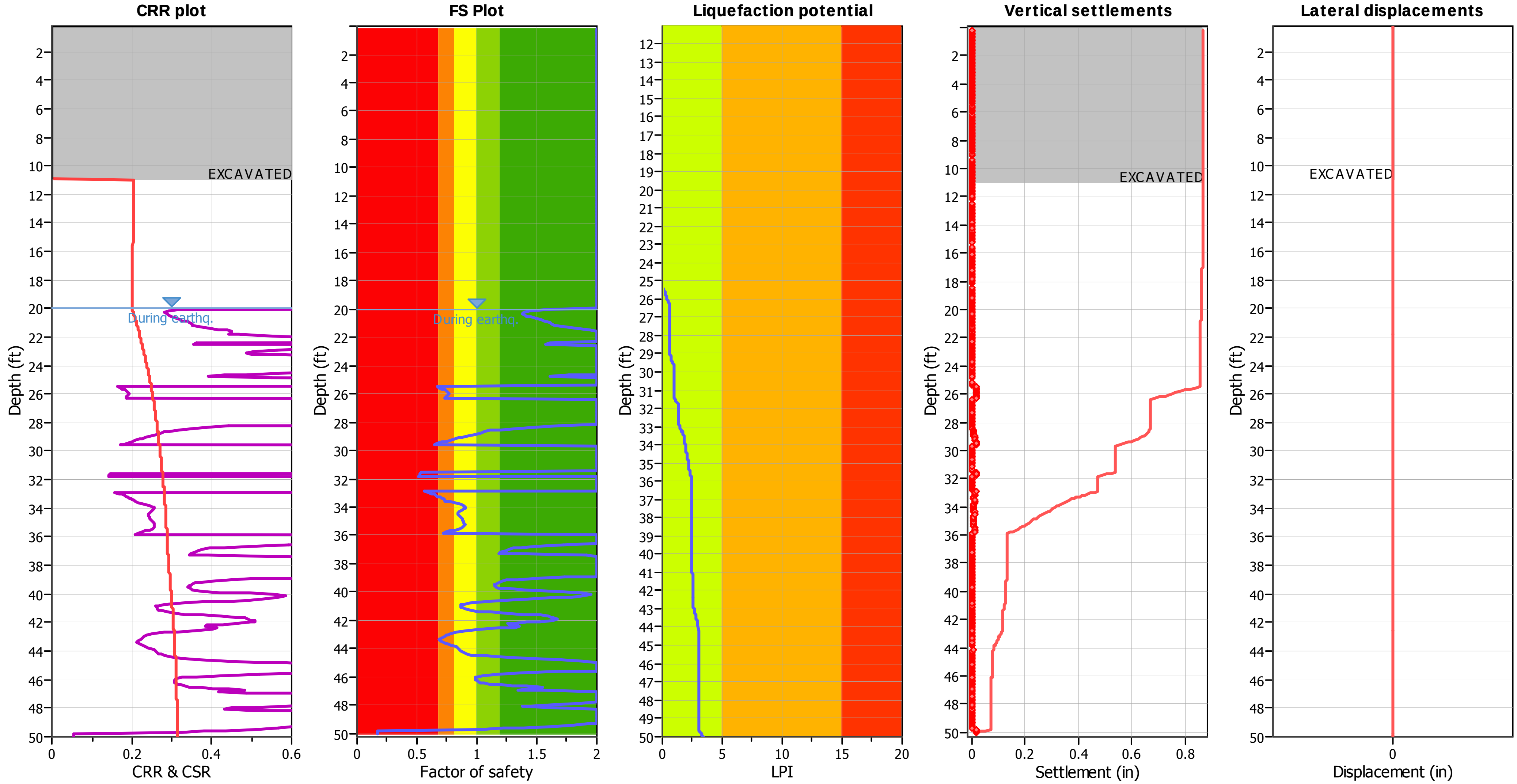
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

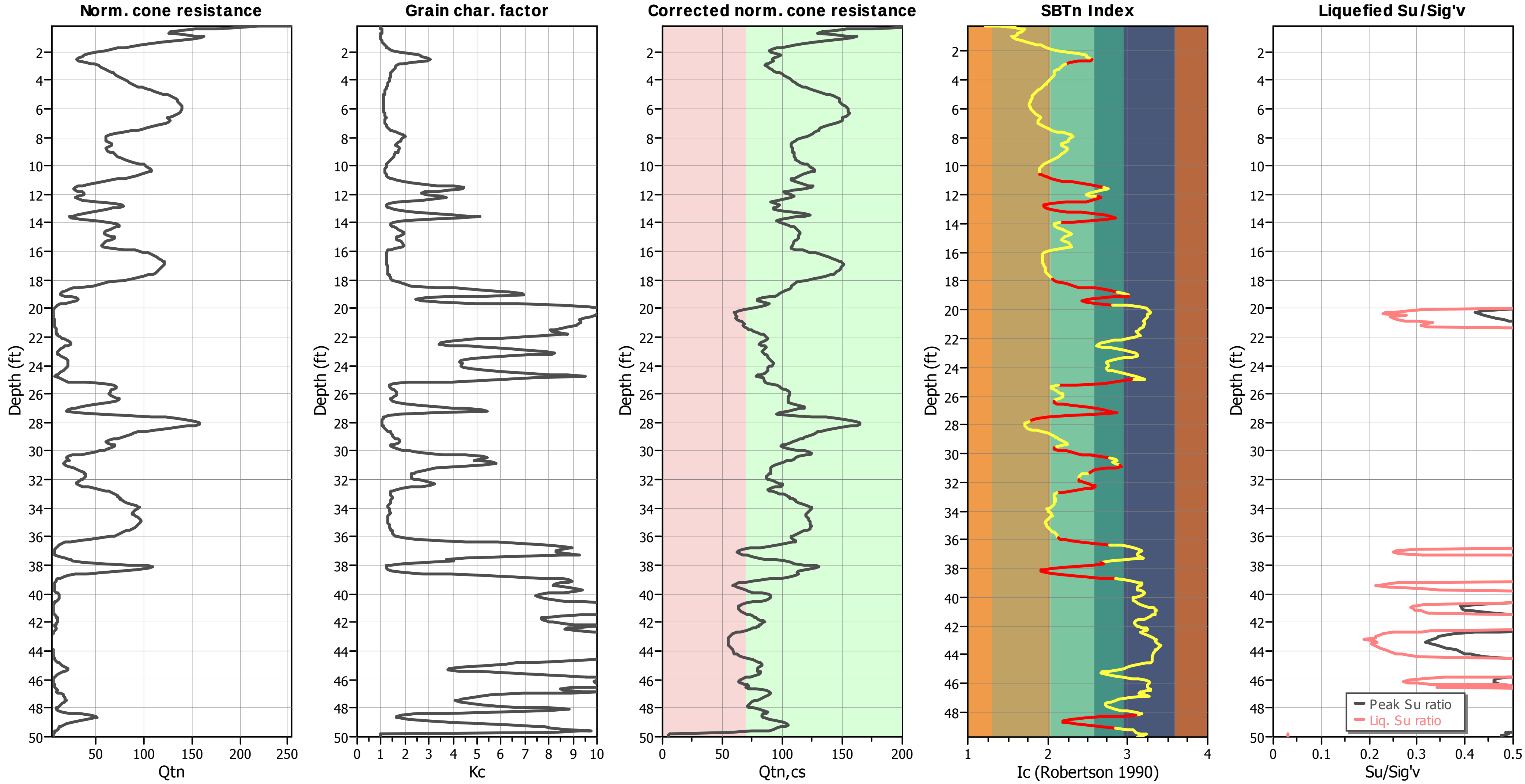
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

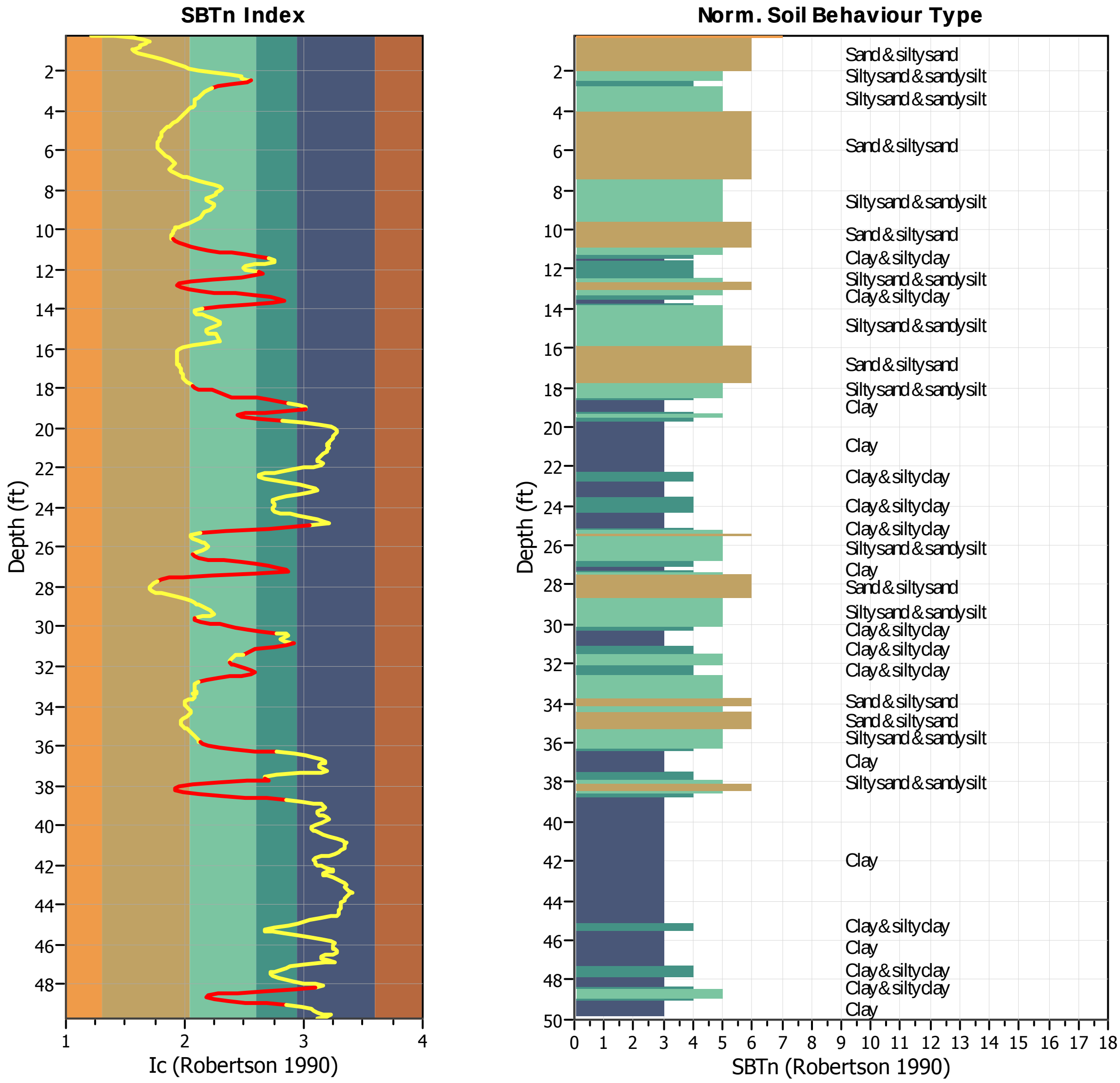
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



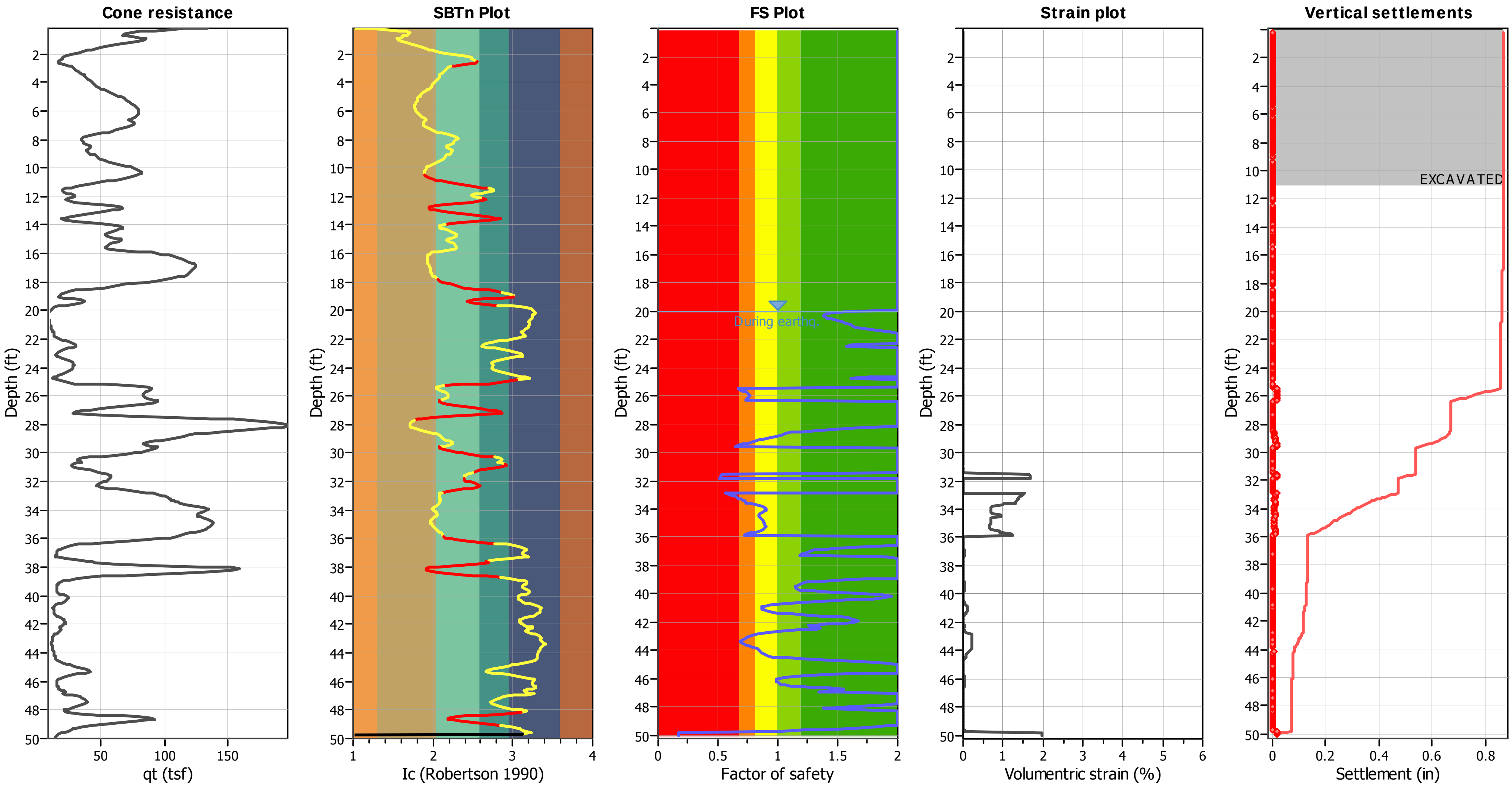
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	581
Total points excluded:	140
Exclusion percentage:	24.10%
Number of layers detected:	20

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

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Irvine, CA 92614
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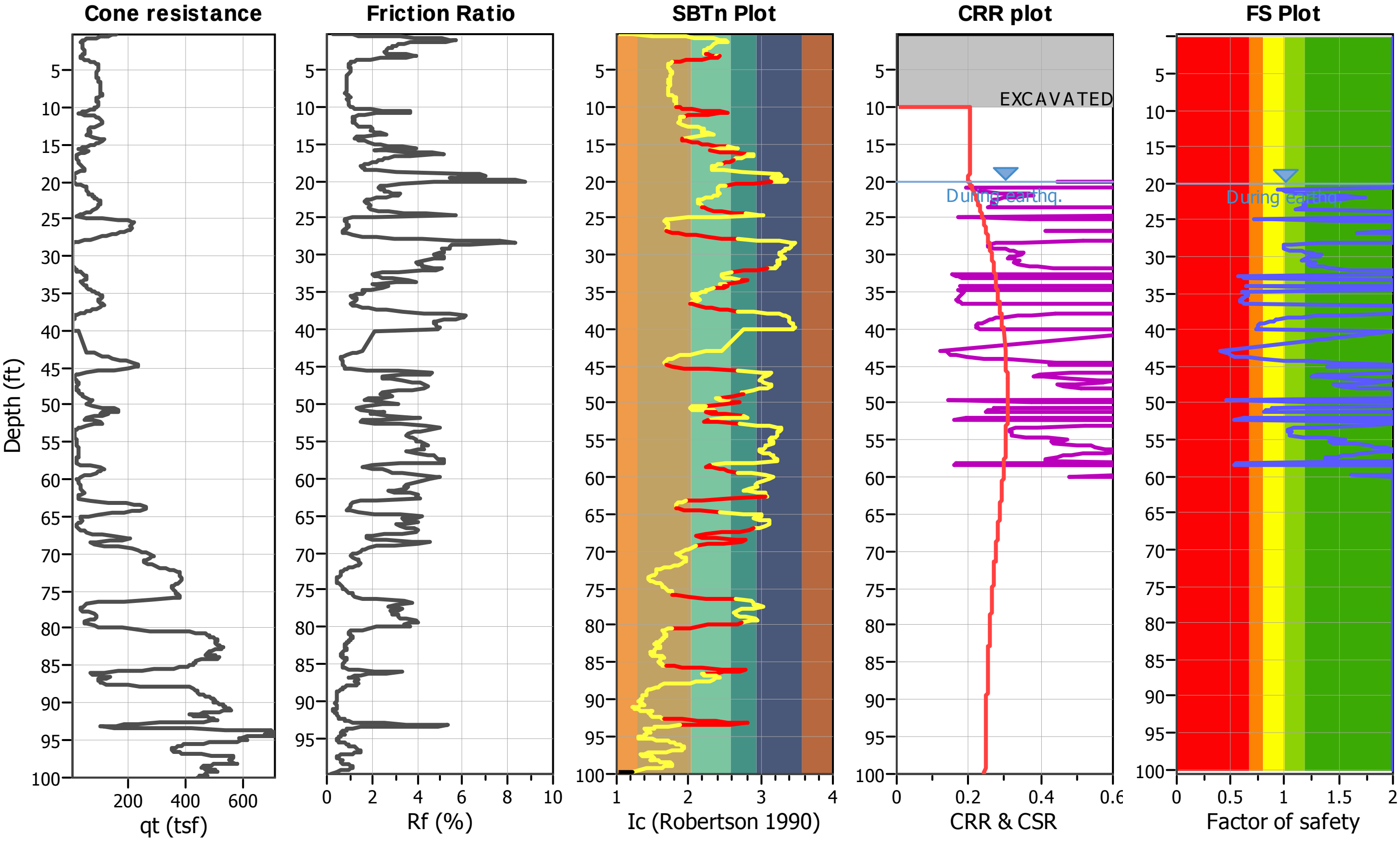
LIQUEFACTION ANALYSIS REPORT

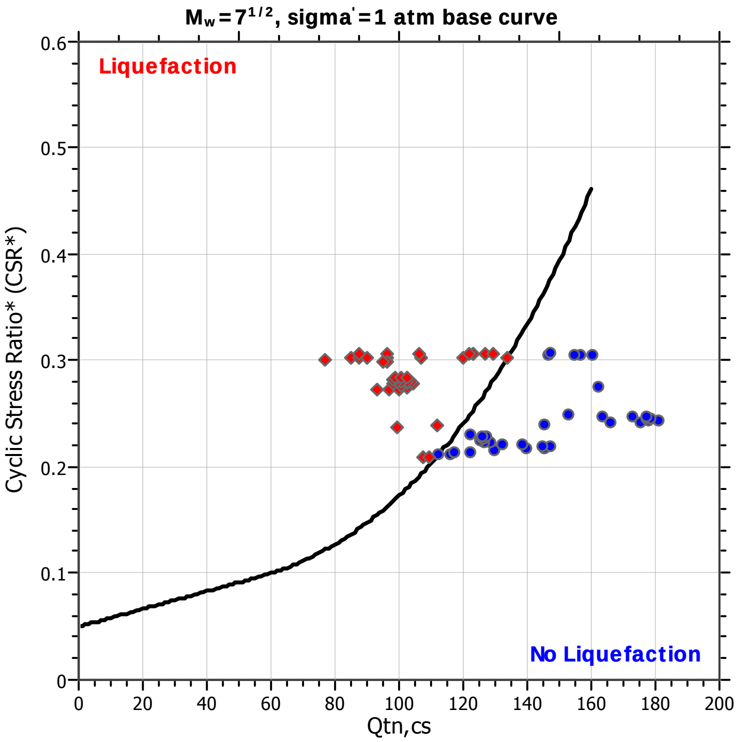
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

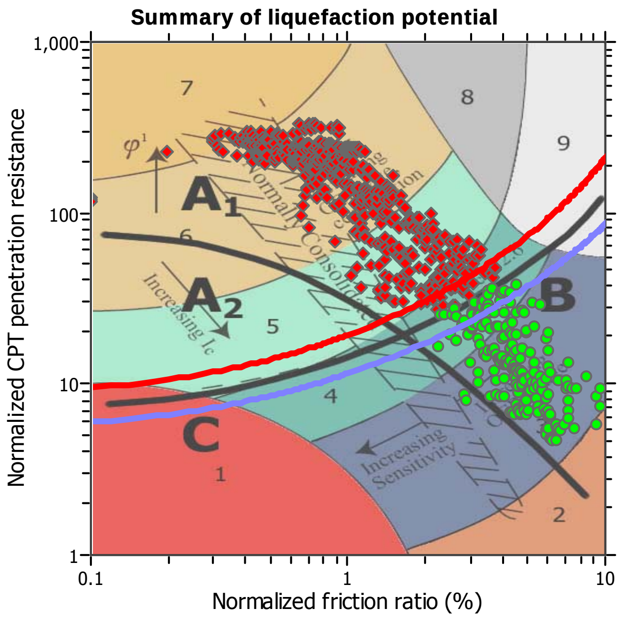
CPT file : CPT-6

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	10.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

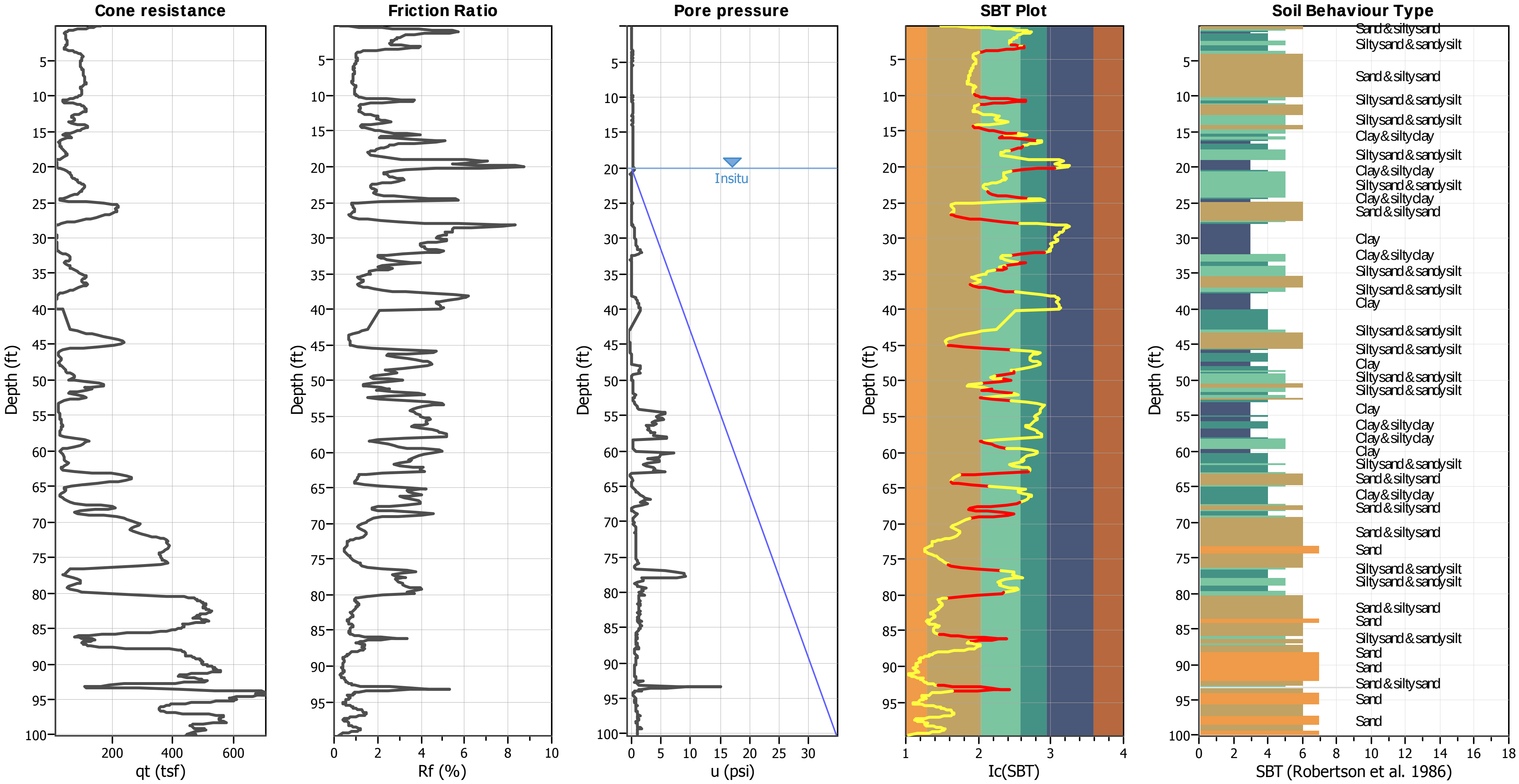






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



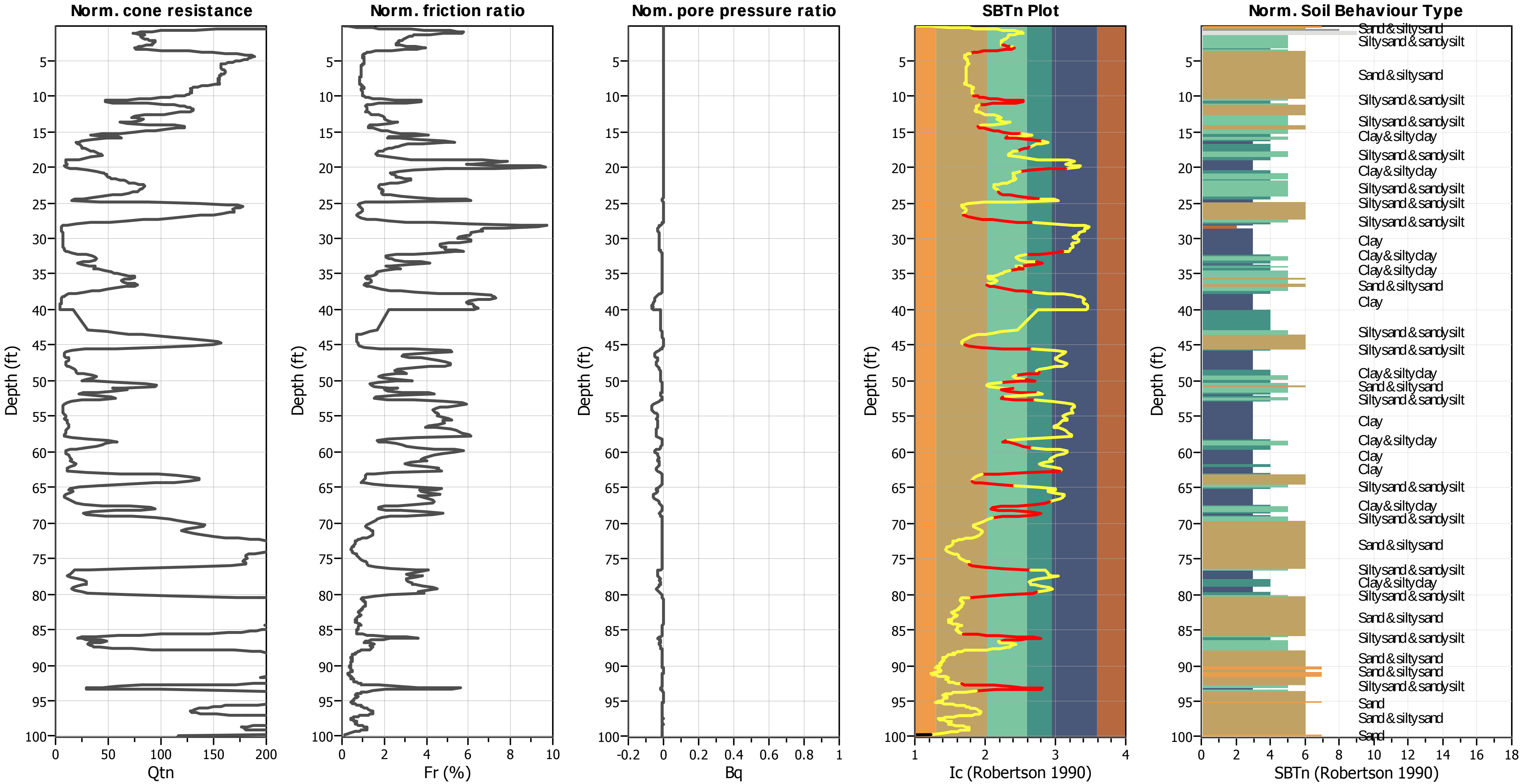
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	10.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



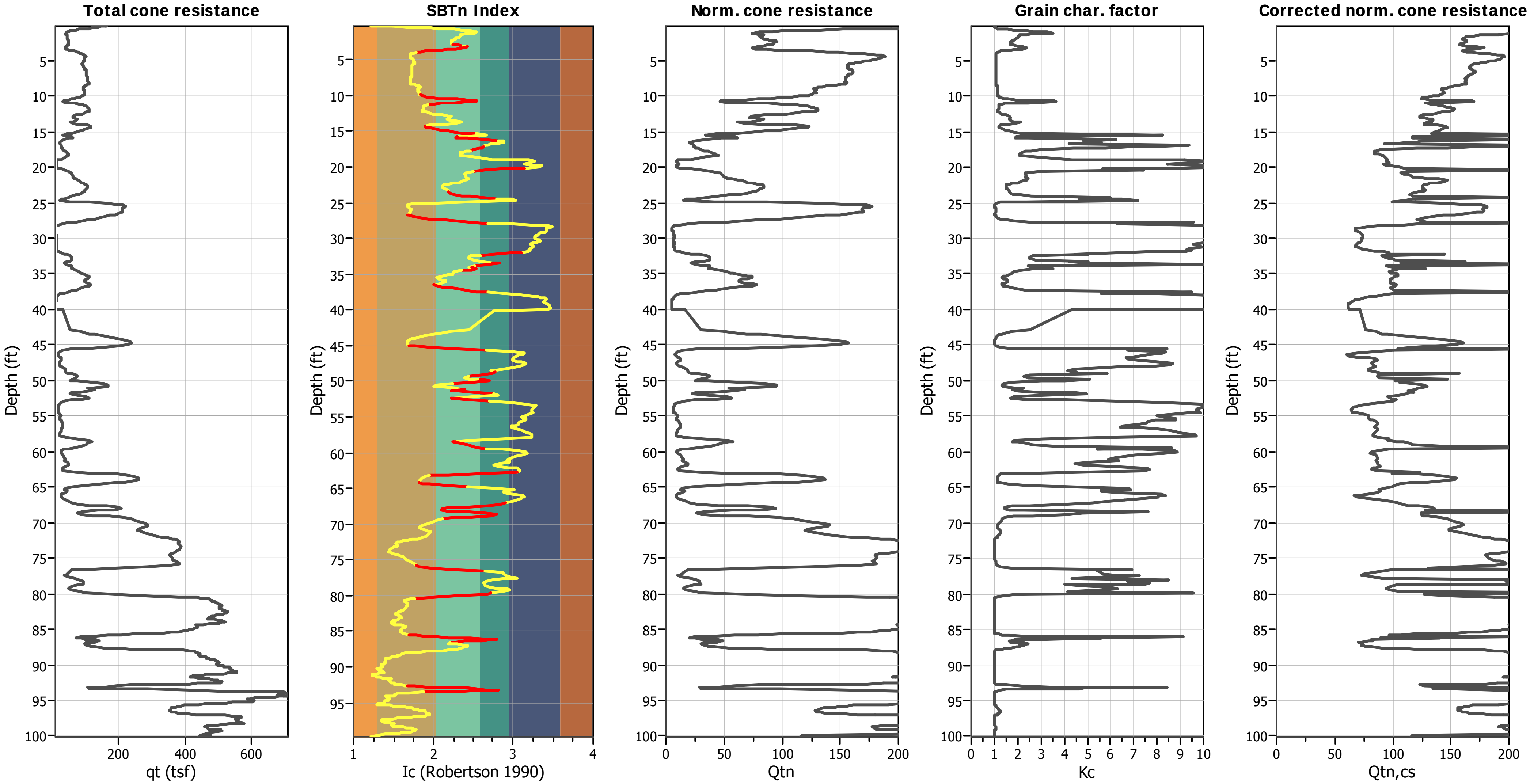
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

SBTn legend

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

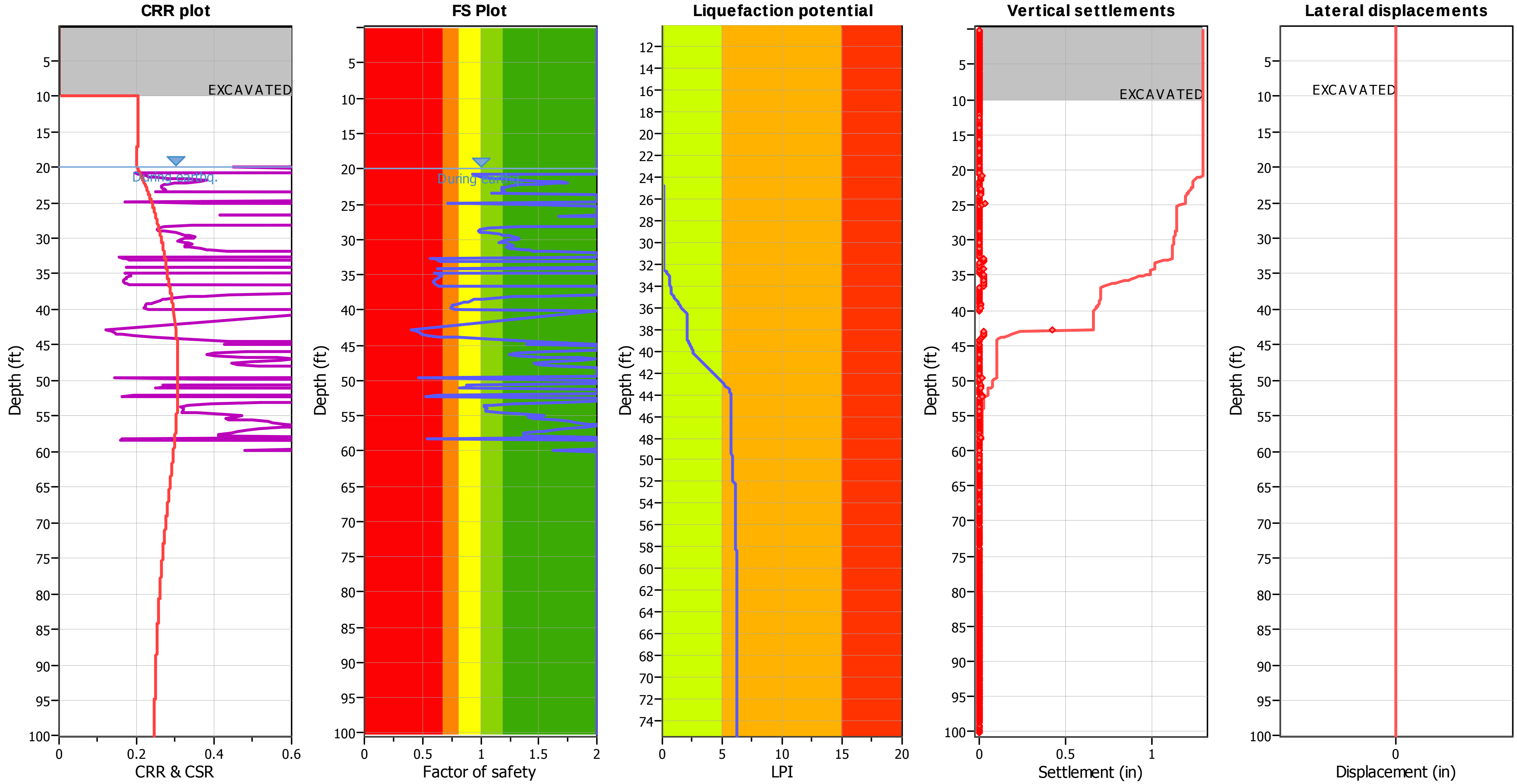
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

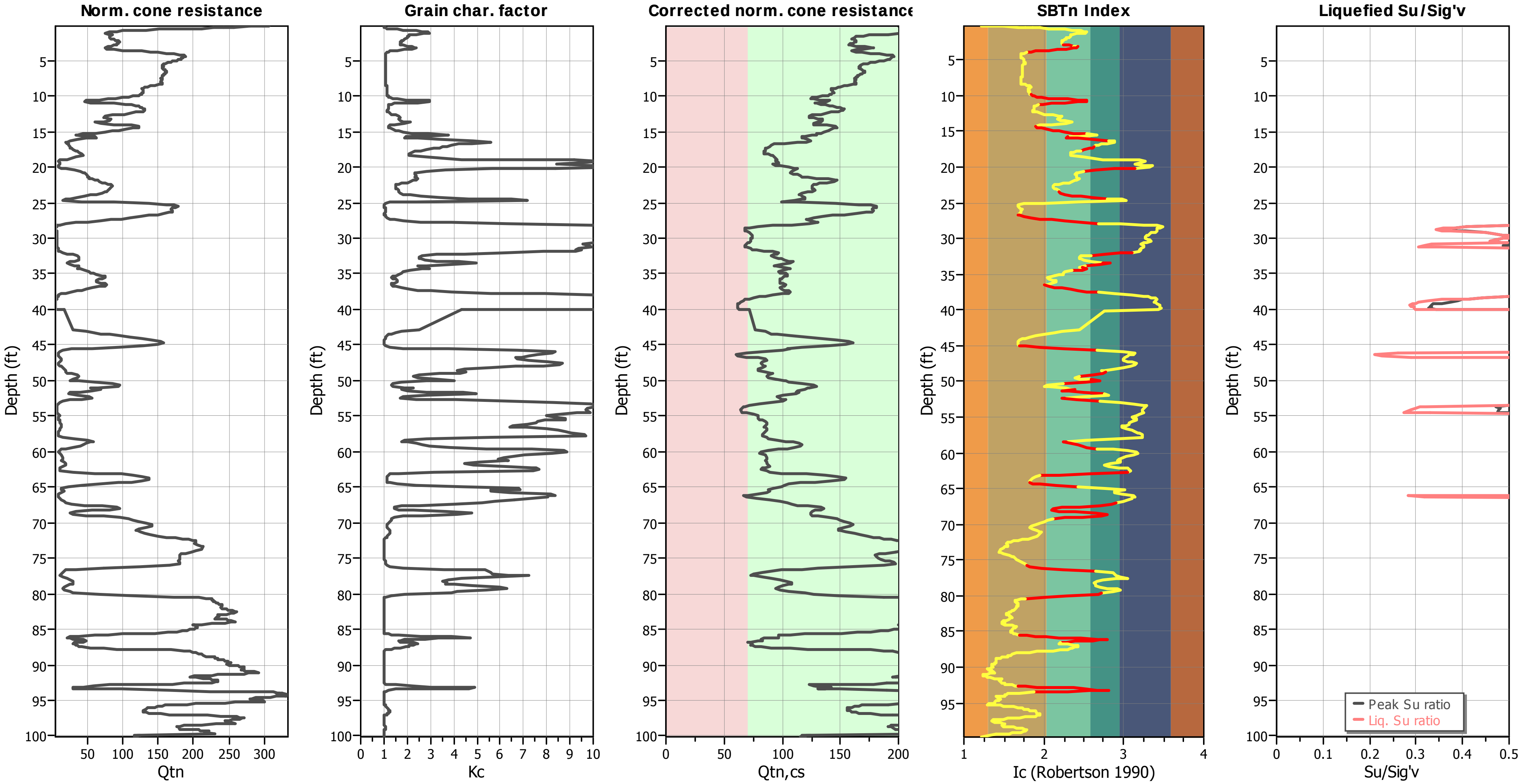
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

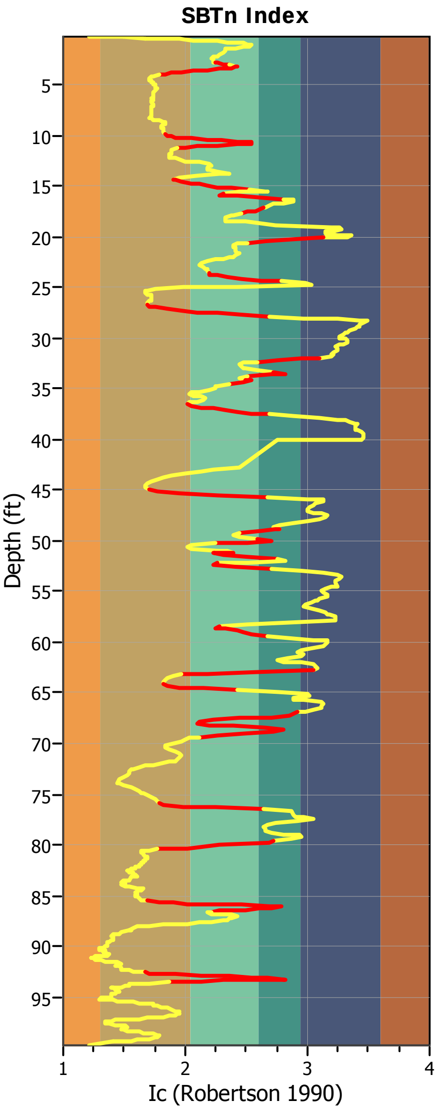
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

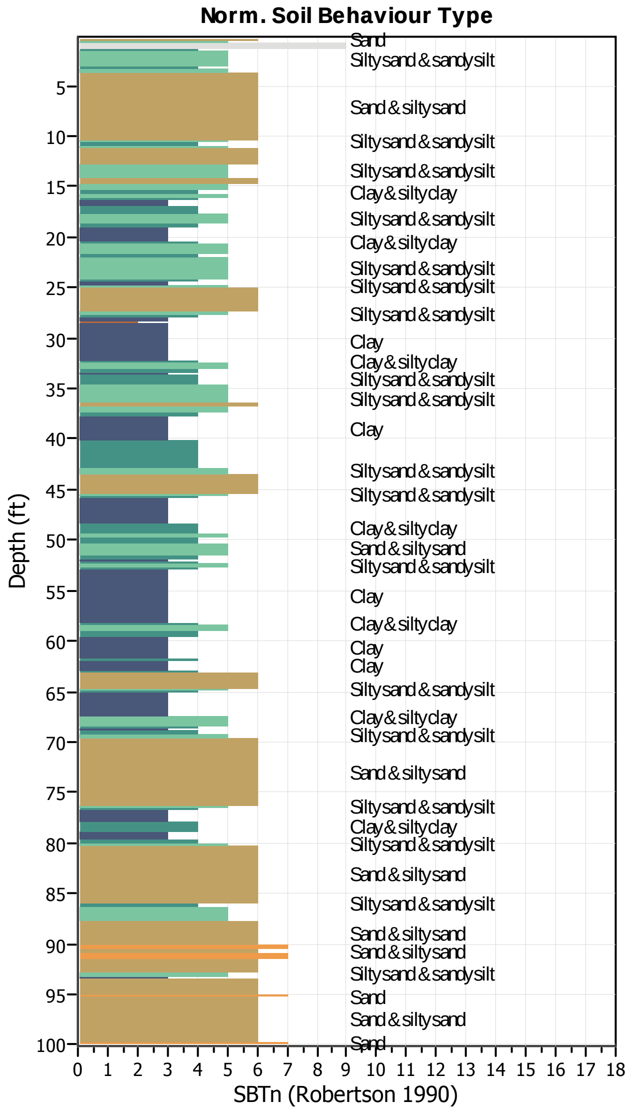
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.

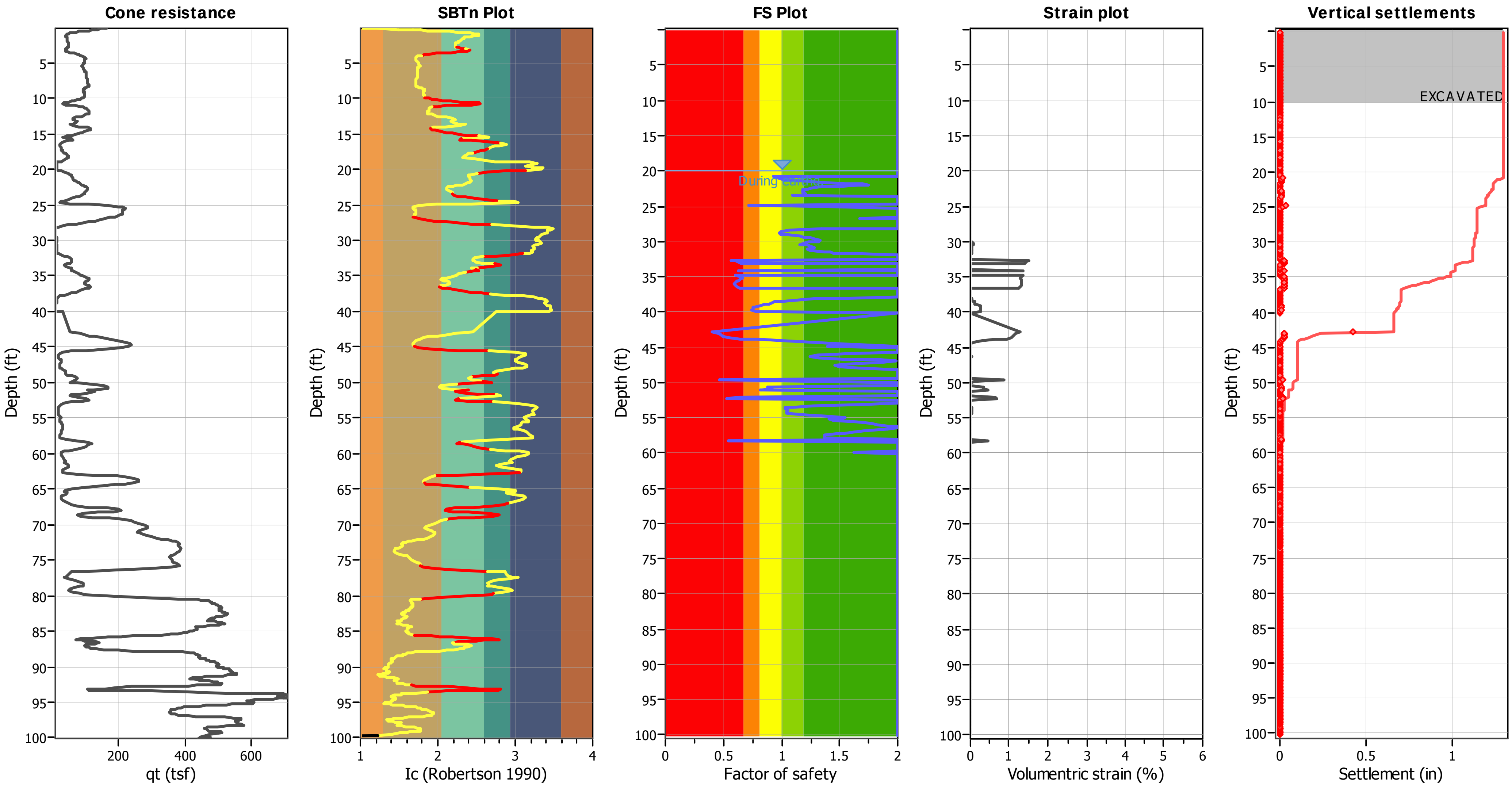




Transition layer algorithm properties	
I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics	
Total points in CPT file:	858
Total points excluded:	183
Exclusion percentage:	21.33%
Number of layers detected:	31

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

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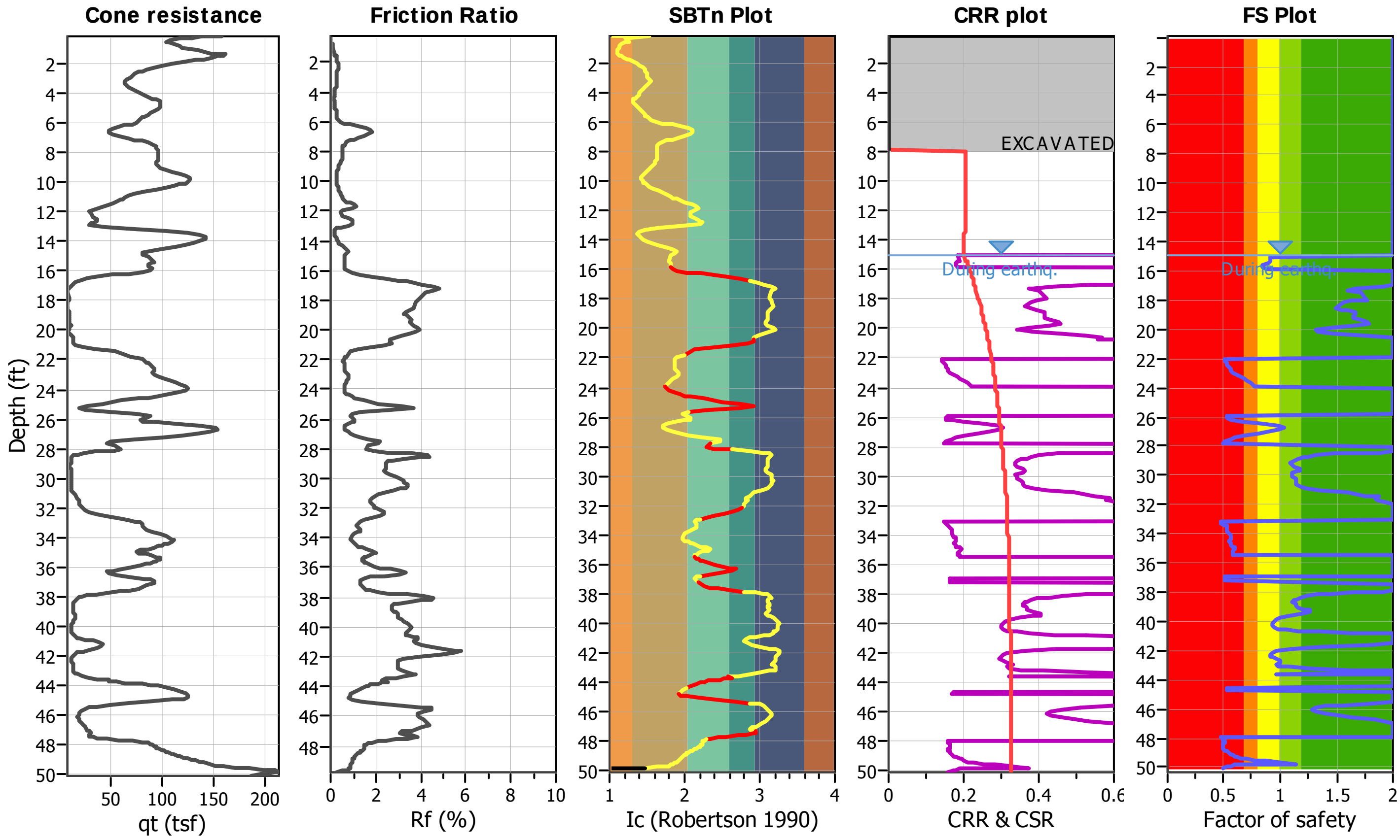
LIQUEFACTION ANALYSIS REPORT

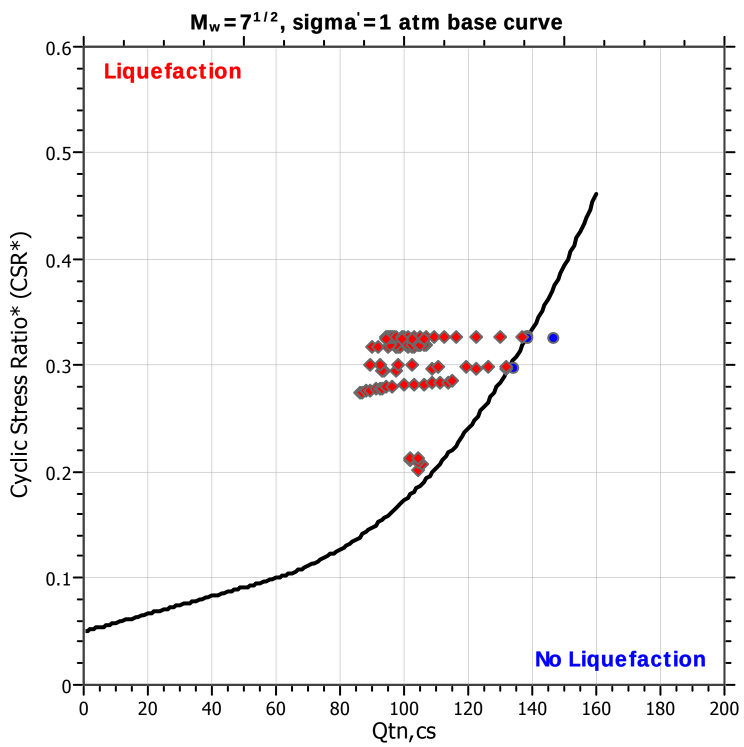
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

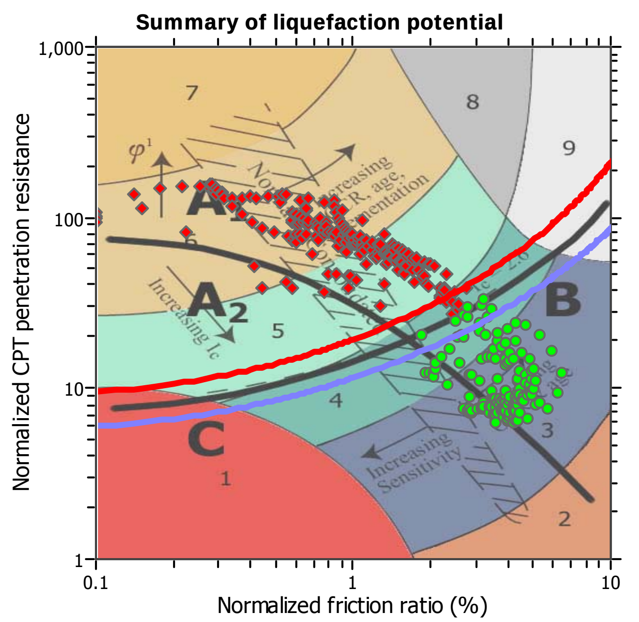
CPT file : CPT-7

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	15.00 ft	Excavation depth:	8.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

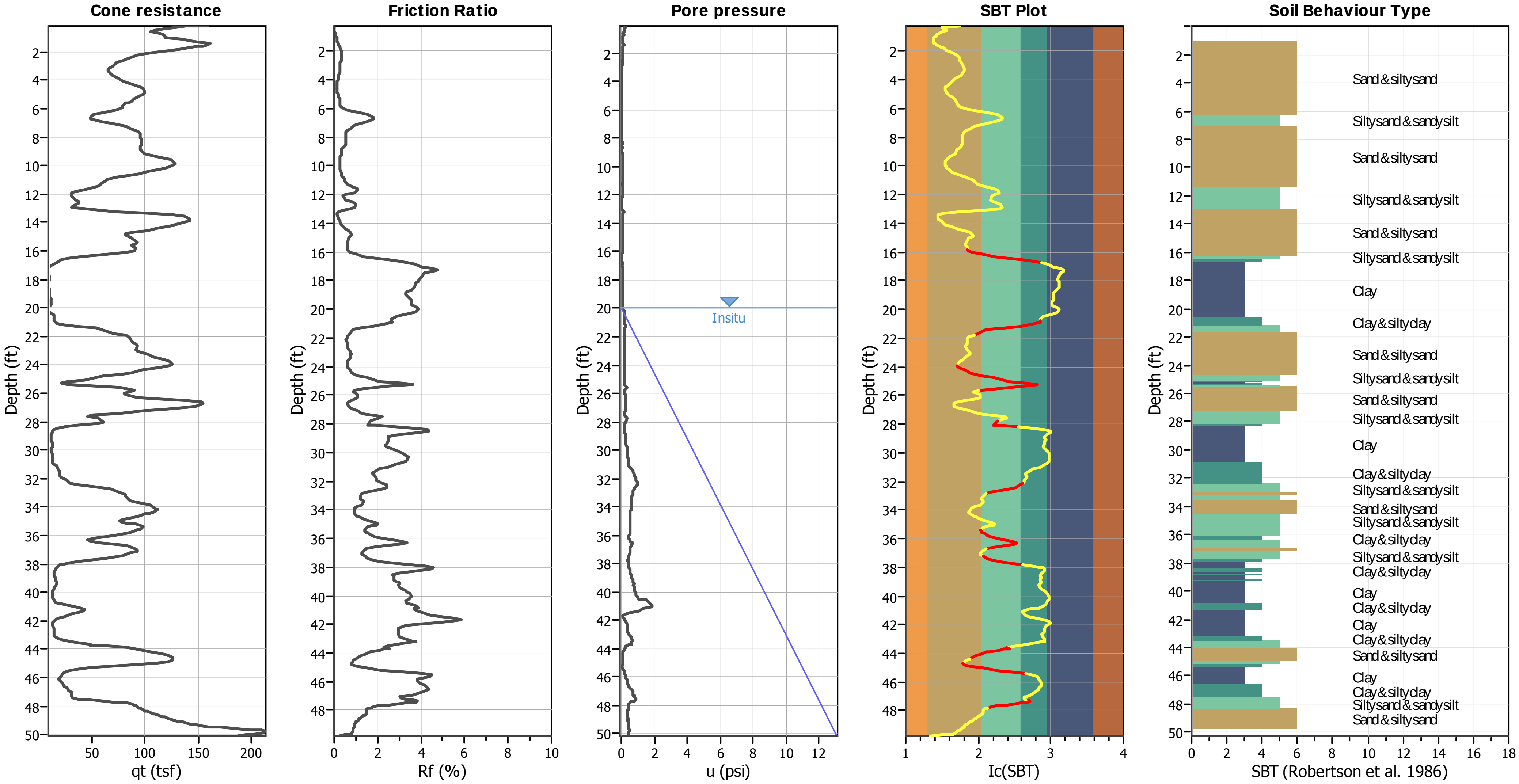






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



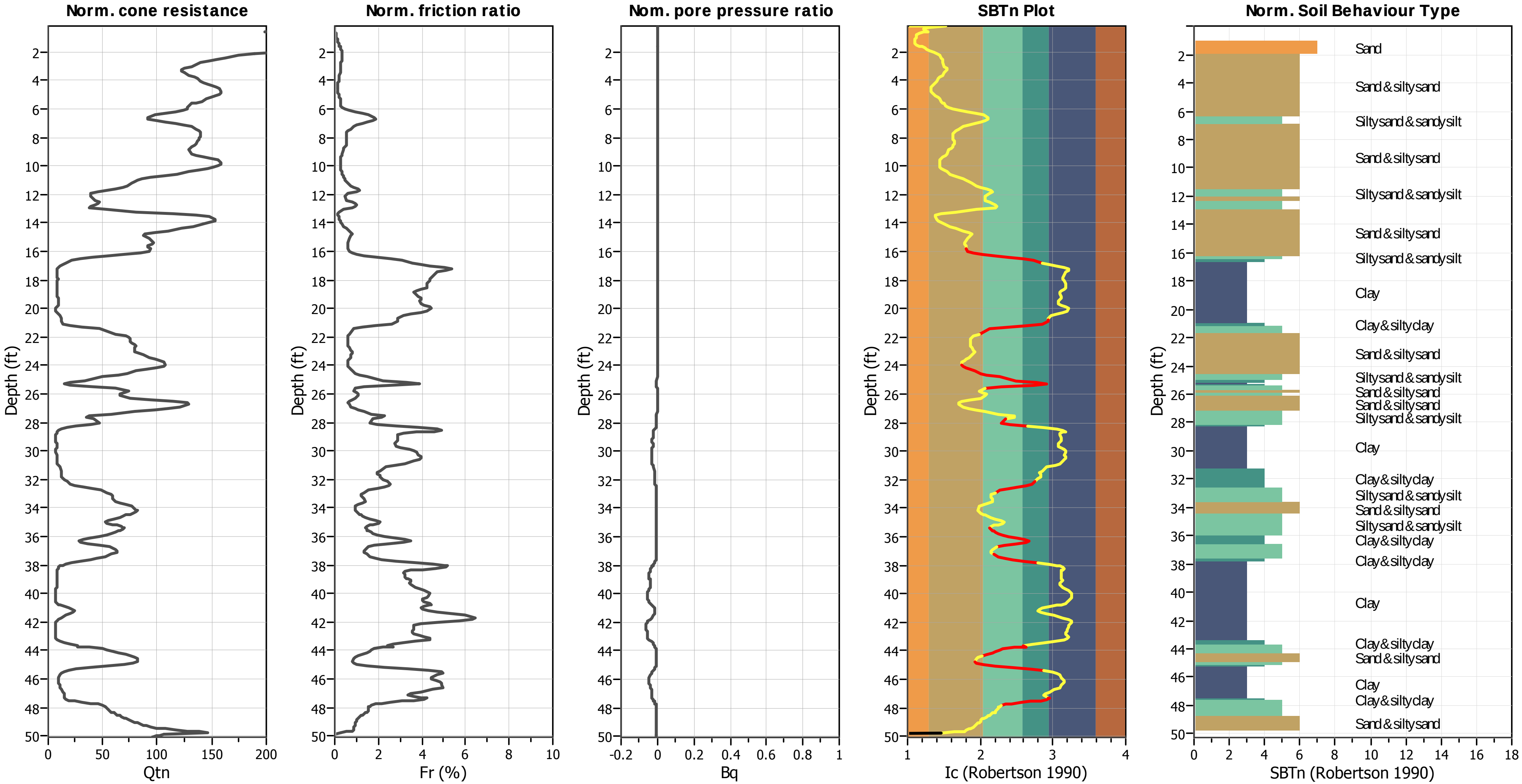
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	15.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	8.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



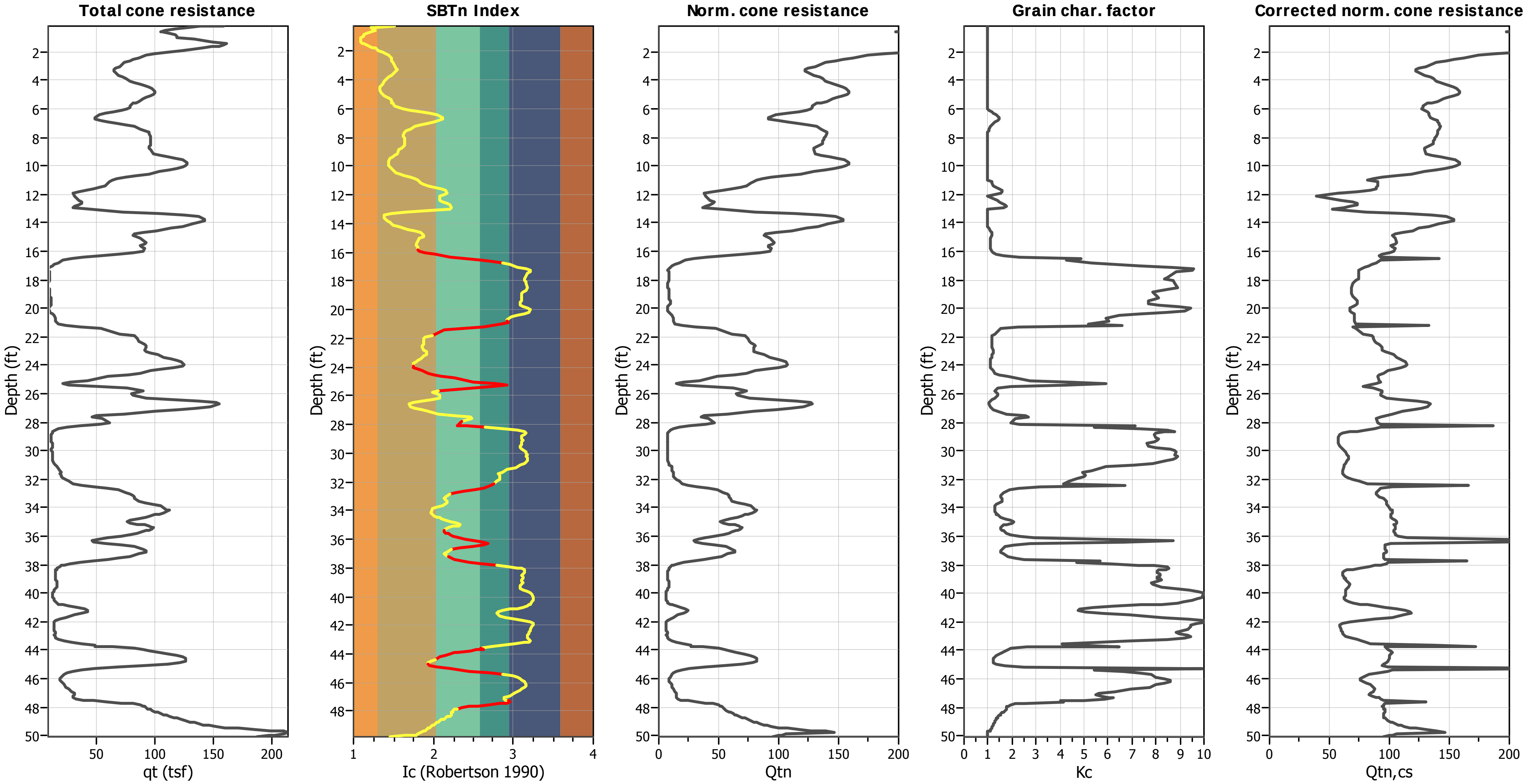
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	15.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	8.00 ft	Limit depth:	60.00 ft

SBTn legend

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

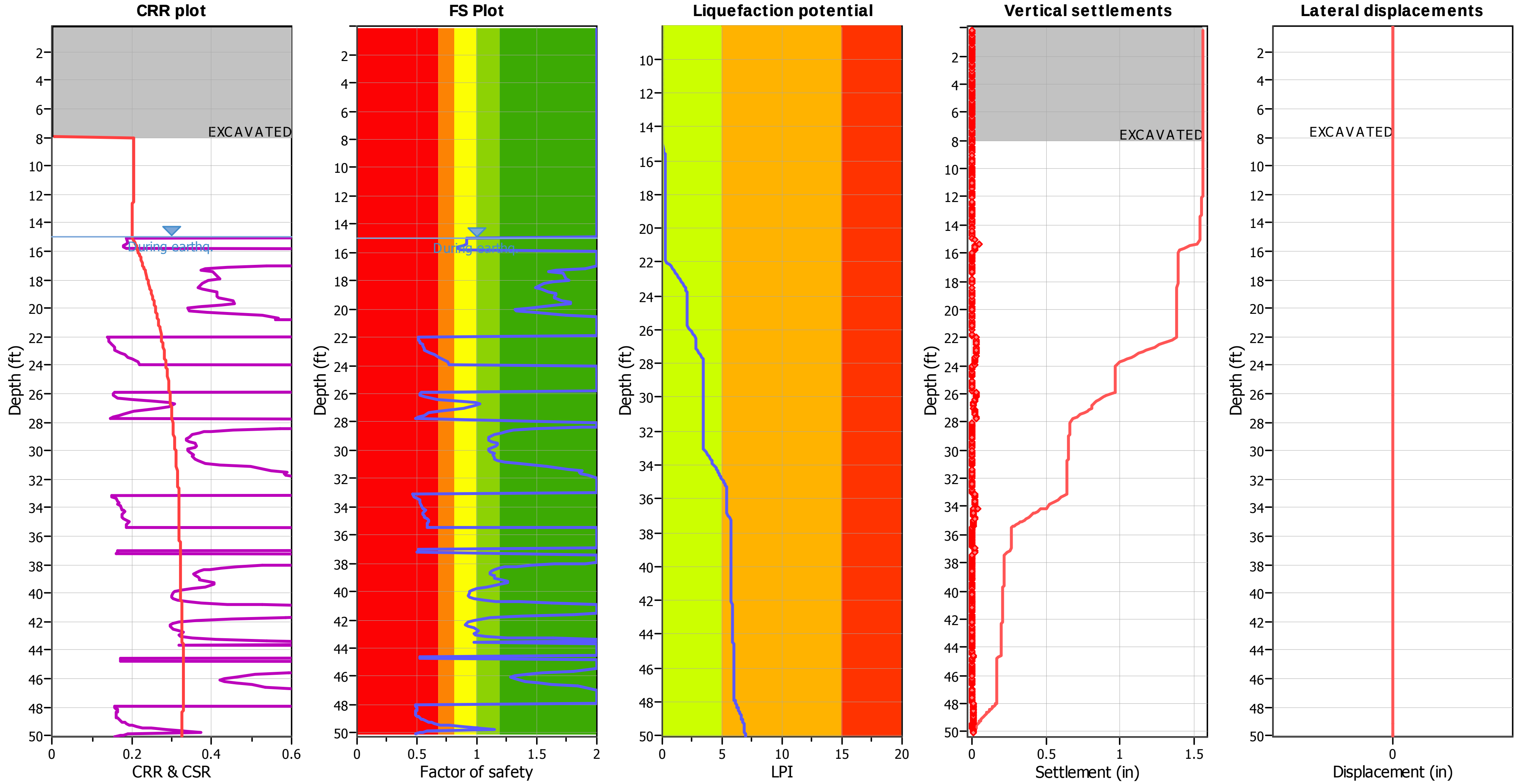
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	15.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	8.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	15.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	8.00 ft	Limit depth:	60.00 ft

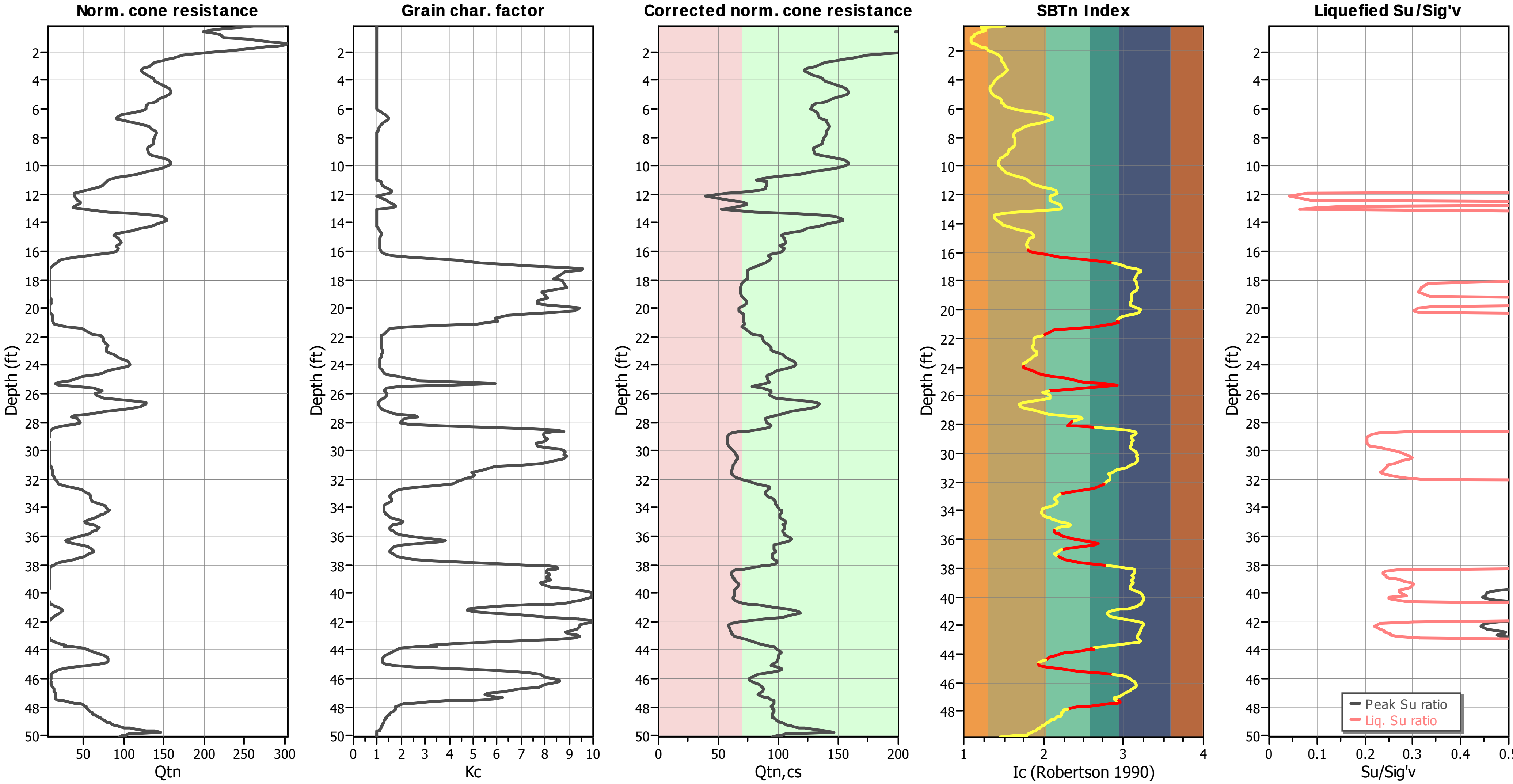
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

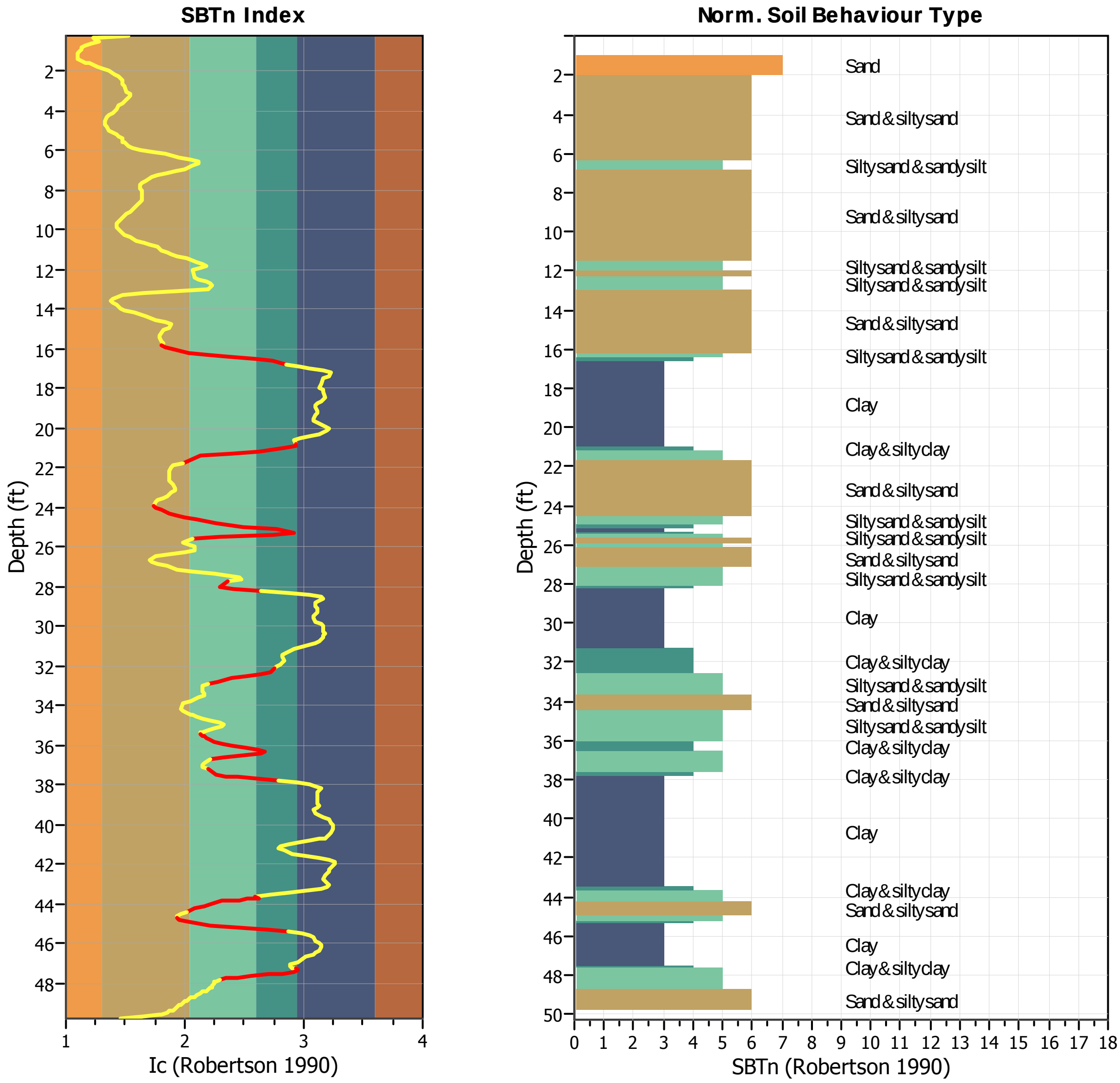
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	15.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	8.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

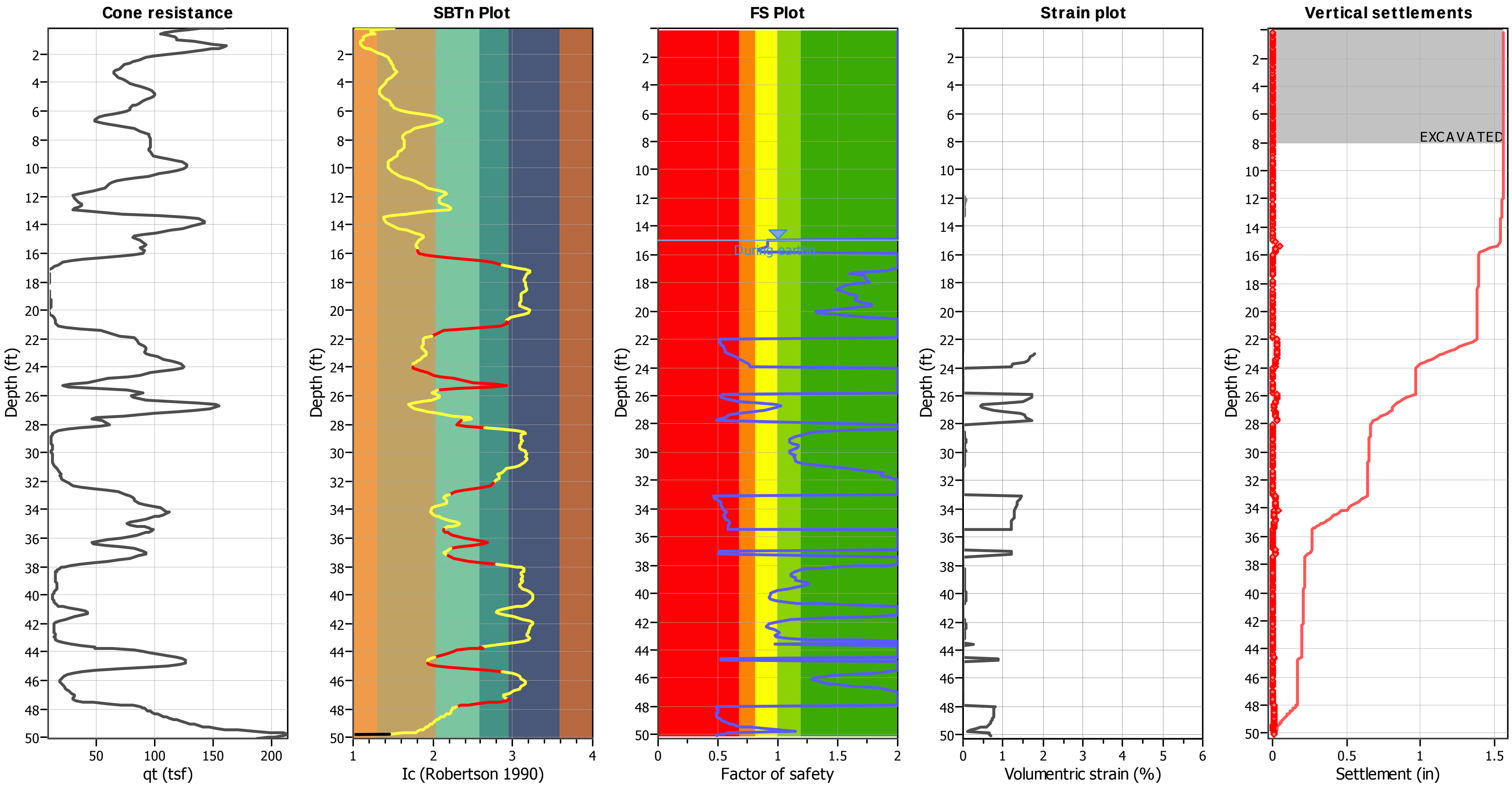
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	442
I_c maximum check value:	3.00	Total points excluded:	90
I_c change ratio value:	0.0250	Exclusion percentage:	20.36%
Minimum number of points in layer:	4	Number of layers detected:	12

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

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Irvine, CA 92614
www.leightongroup.com

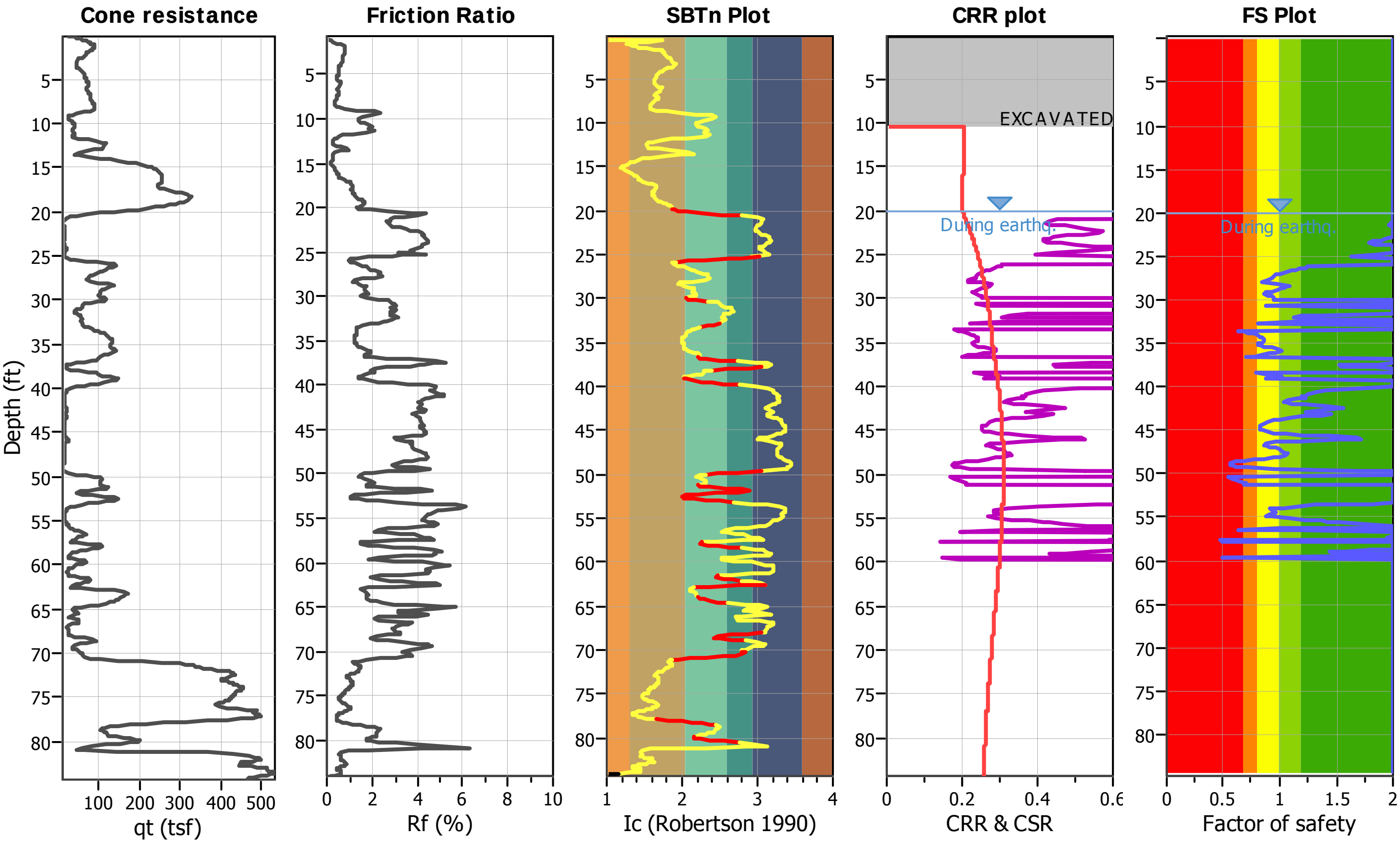
LIQUEFACTION ANALYSIS REPORT

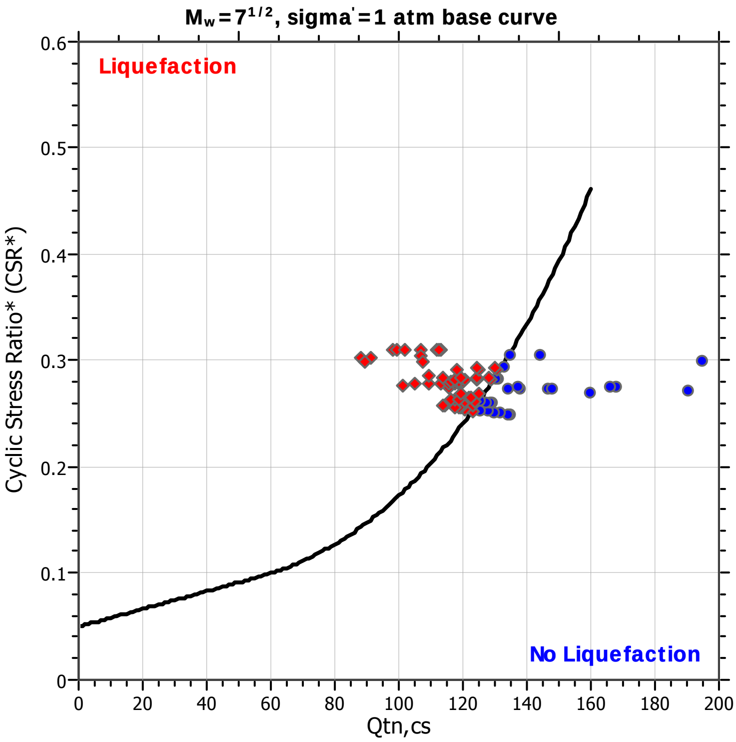
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

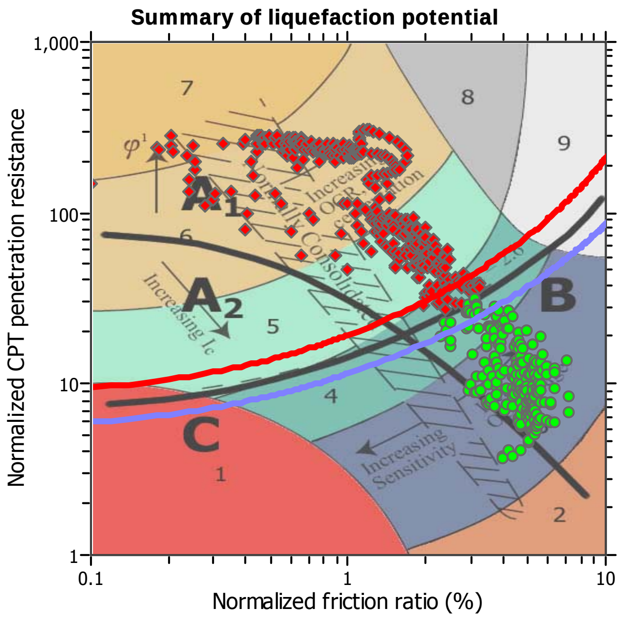
CPT file : CPT-8

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	10.50 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		







Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
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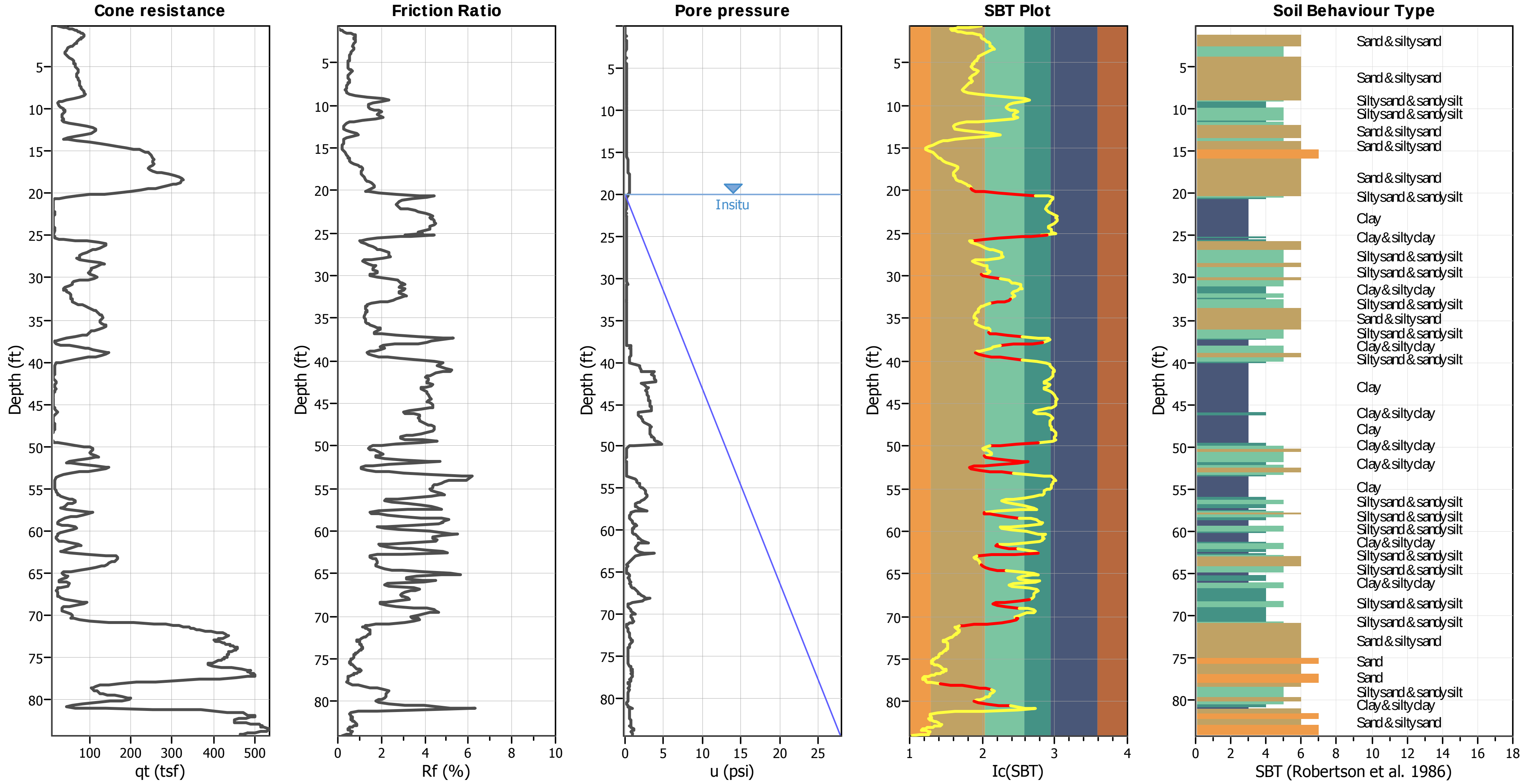
CPT basic interpretation plots



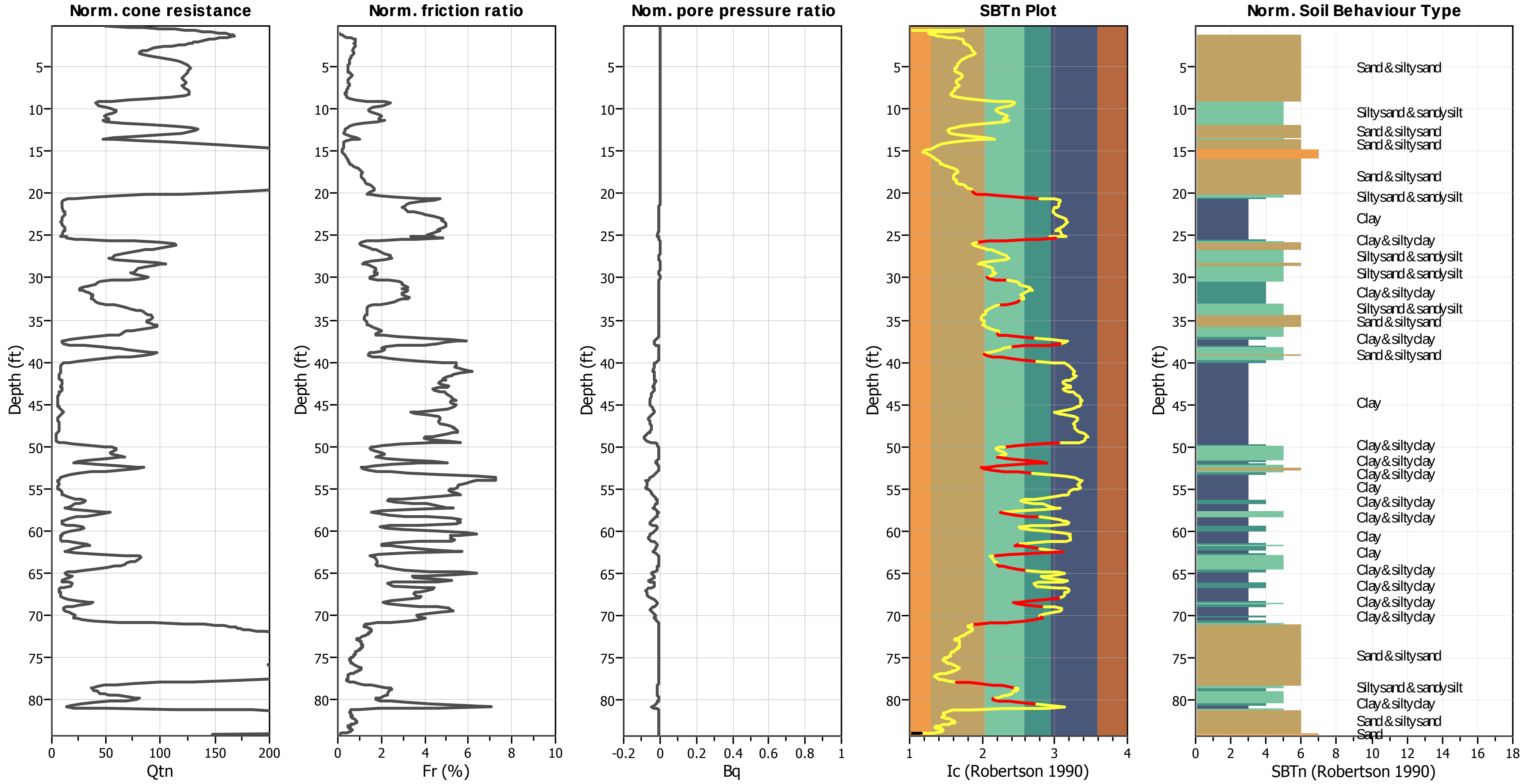
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	10.50 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



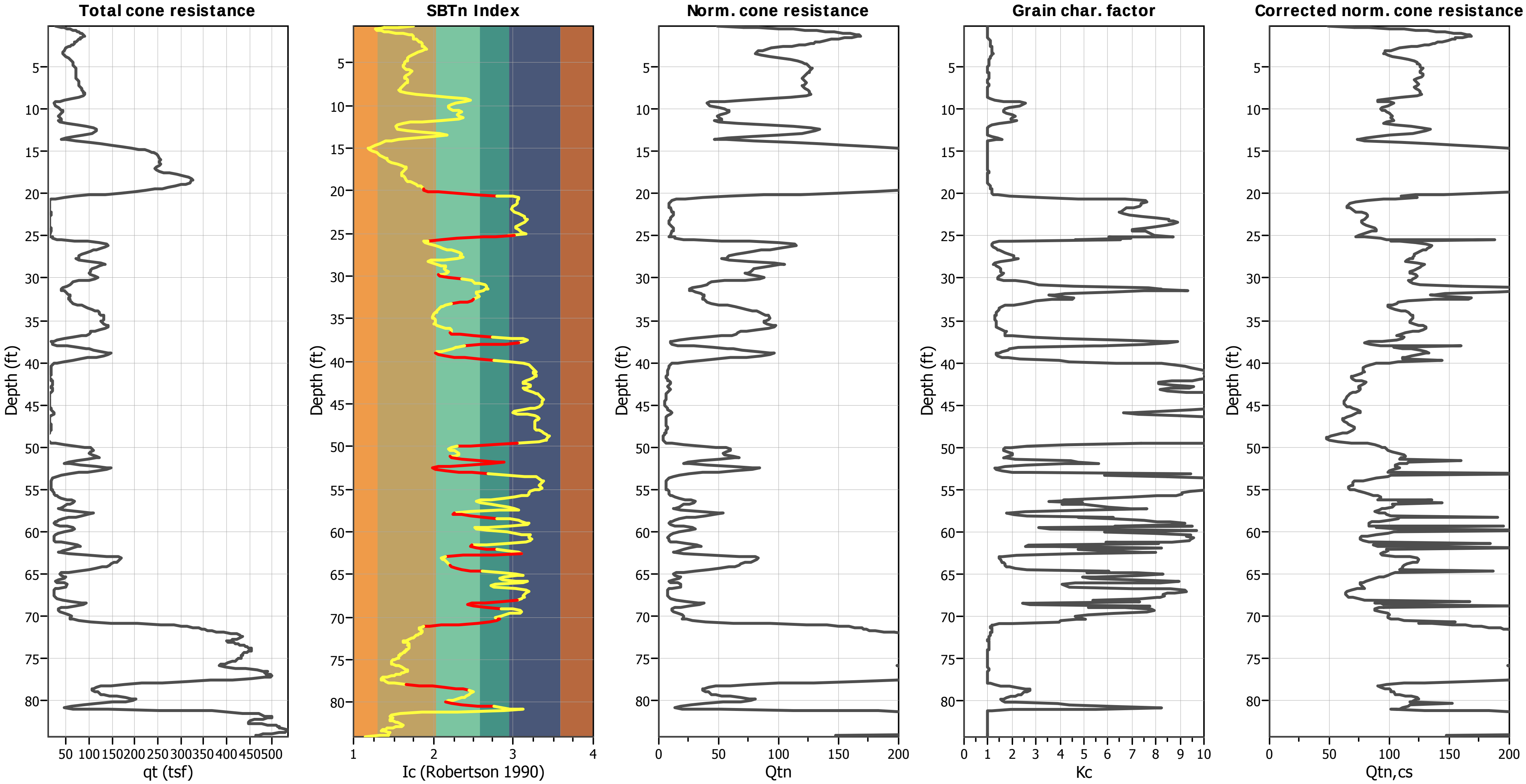
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.50 ft	Limit depth:	60.00 ft

SBTn legend

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

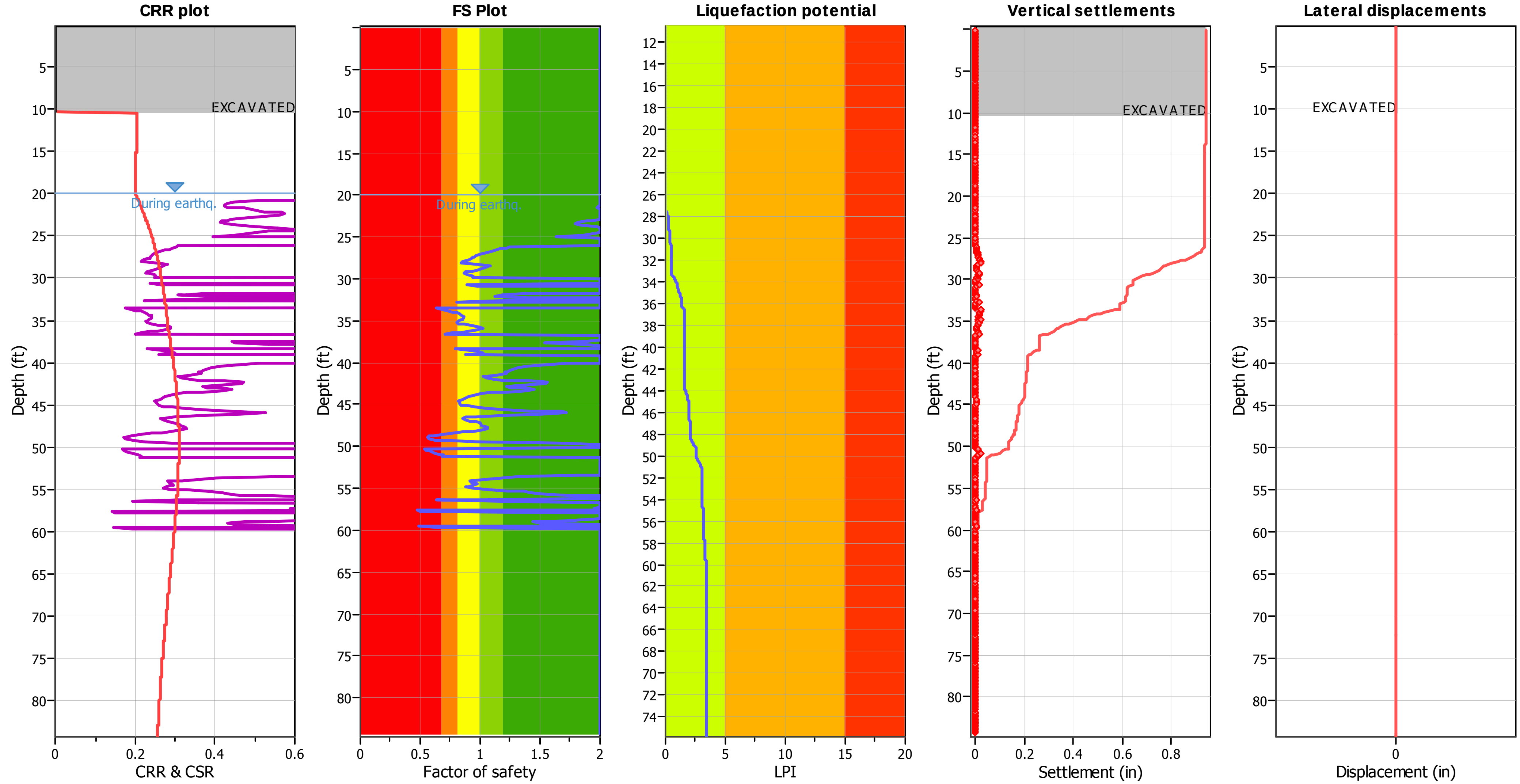
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.50 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.50 ft	Limit depth:	60.00 ft

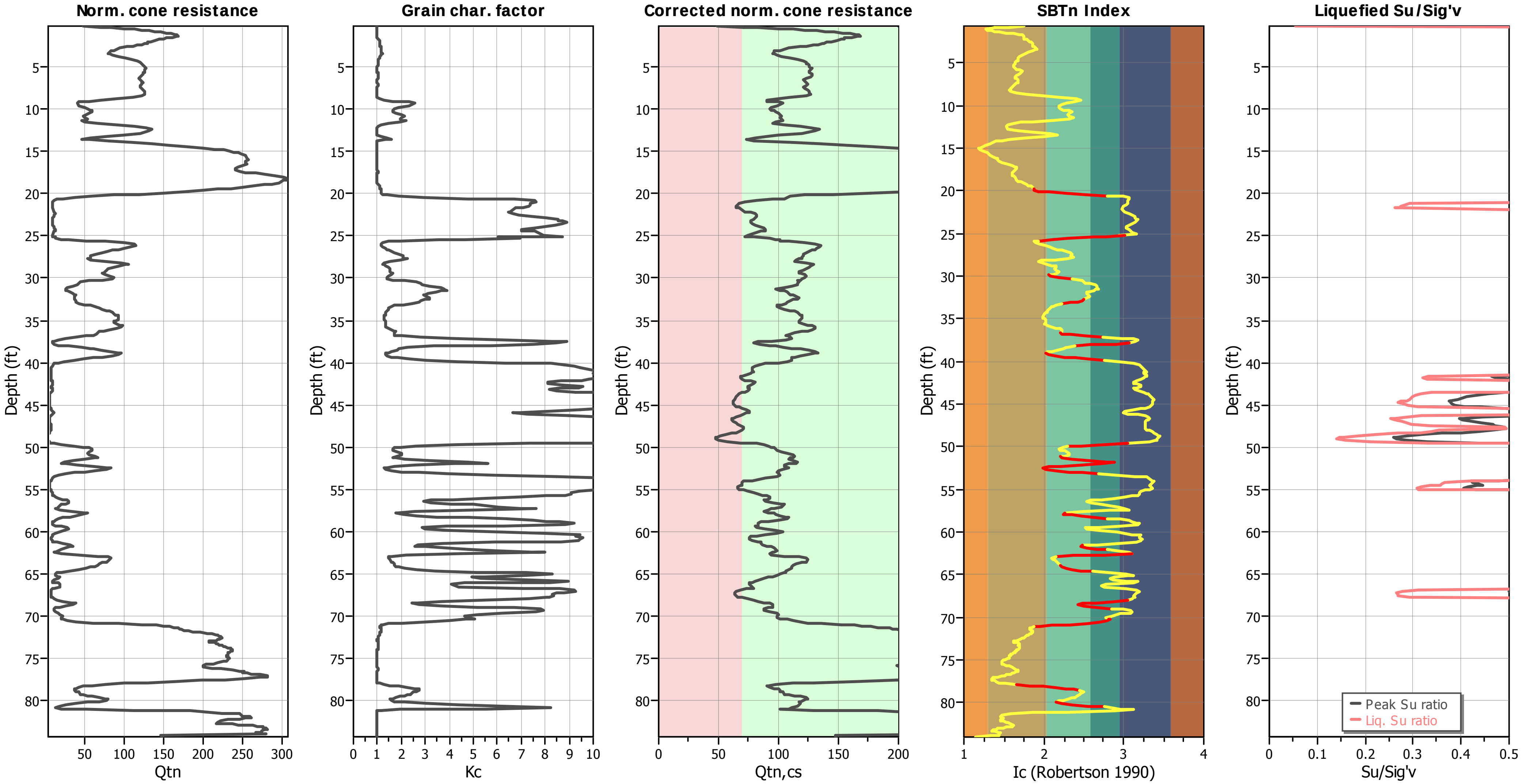
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

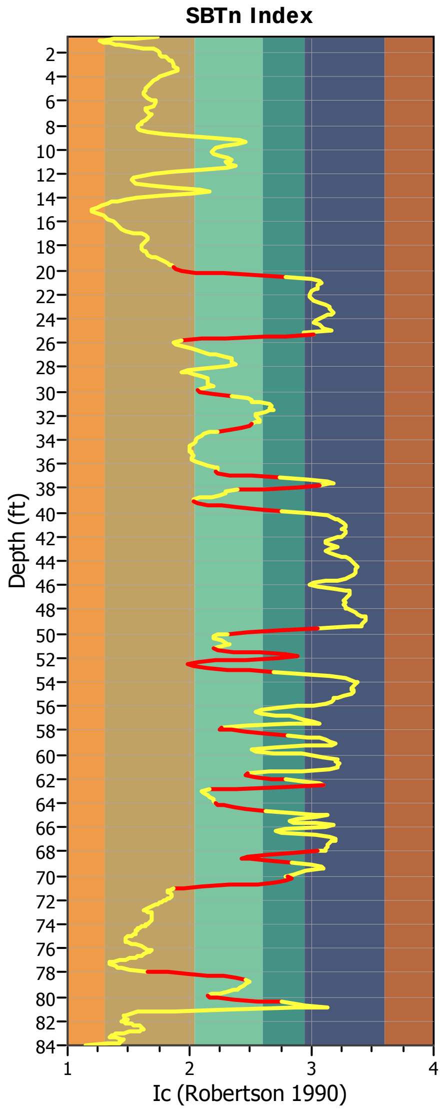
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.50 ft	Limit depth:	60.00 ft

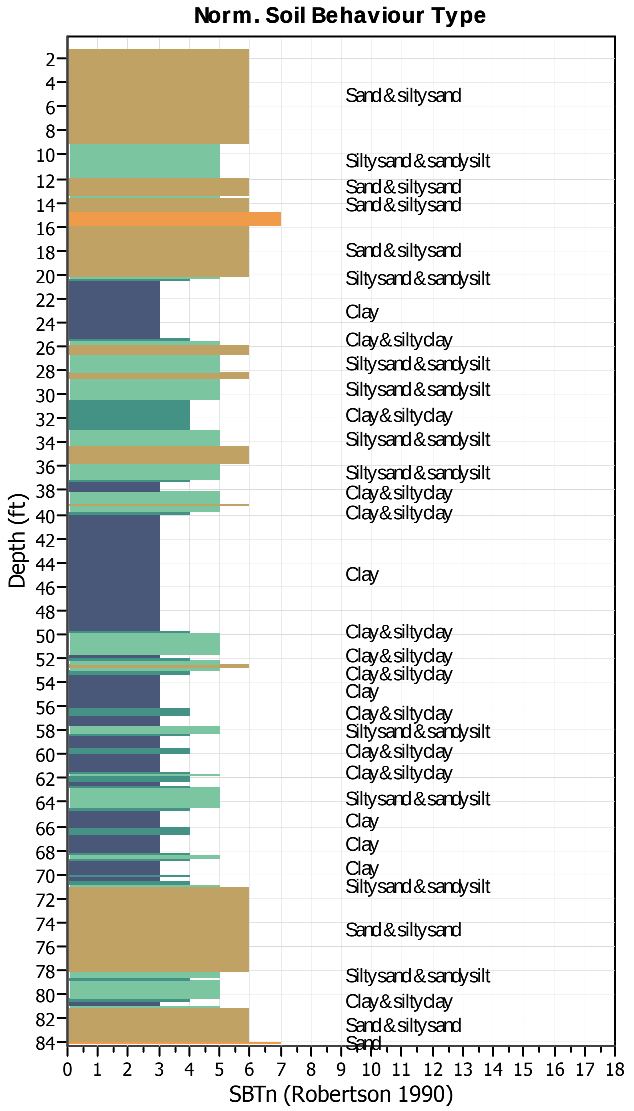
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





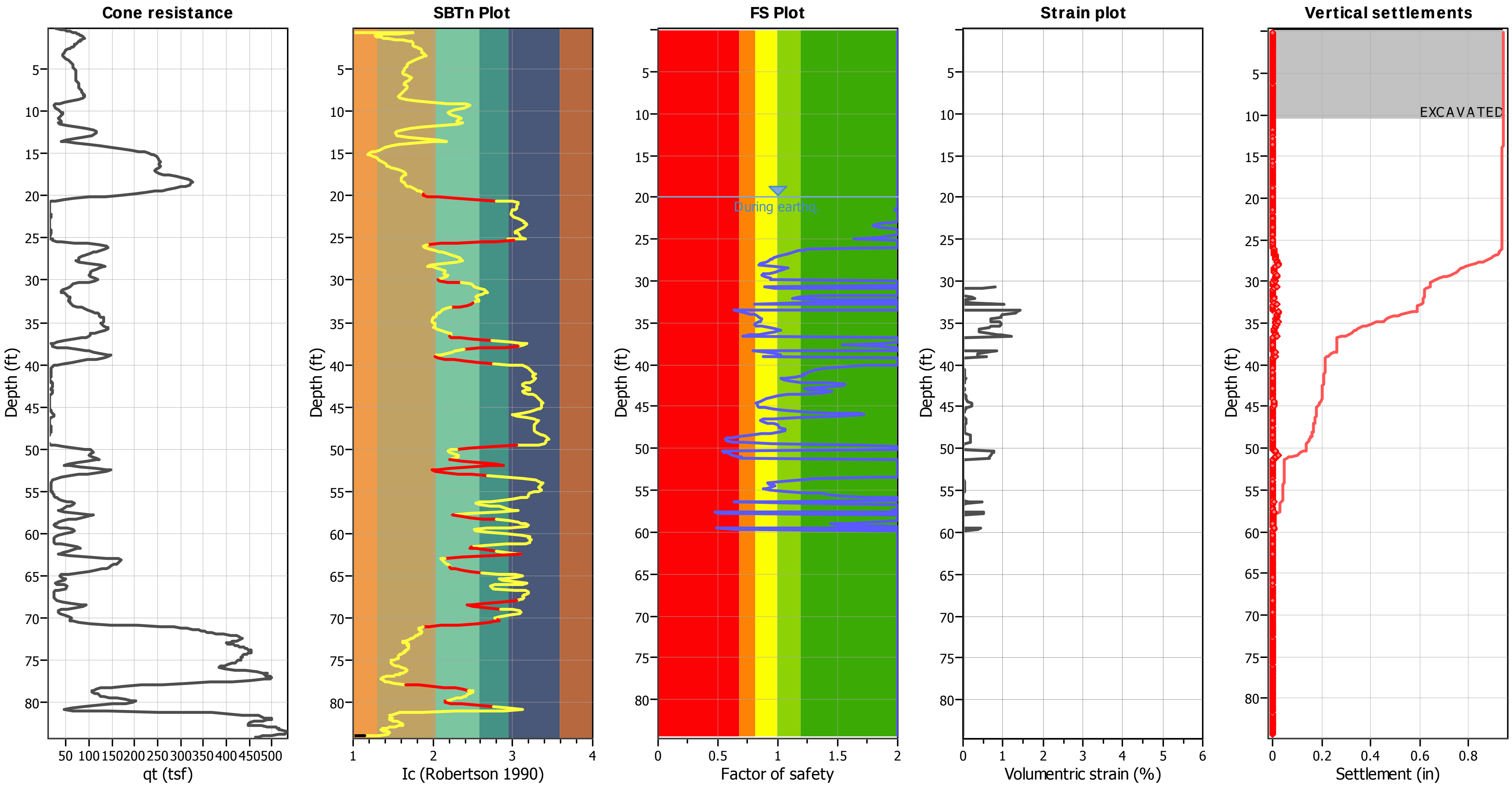
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	658
Total points excluded:	111
Exclusion percentage:	16.87%
Number of layers detected:	20

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

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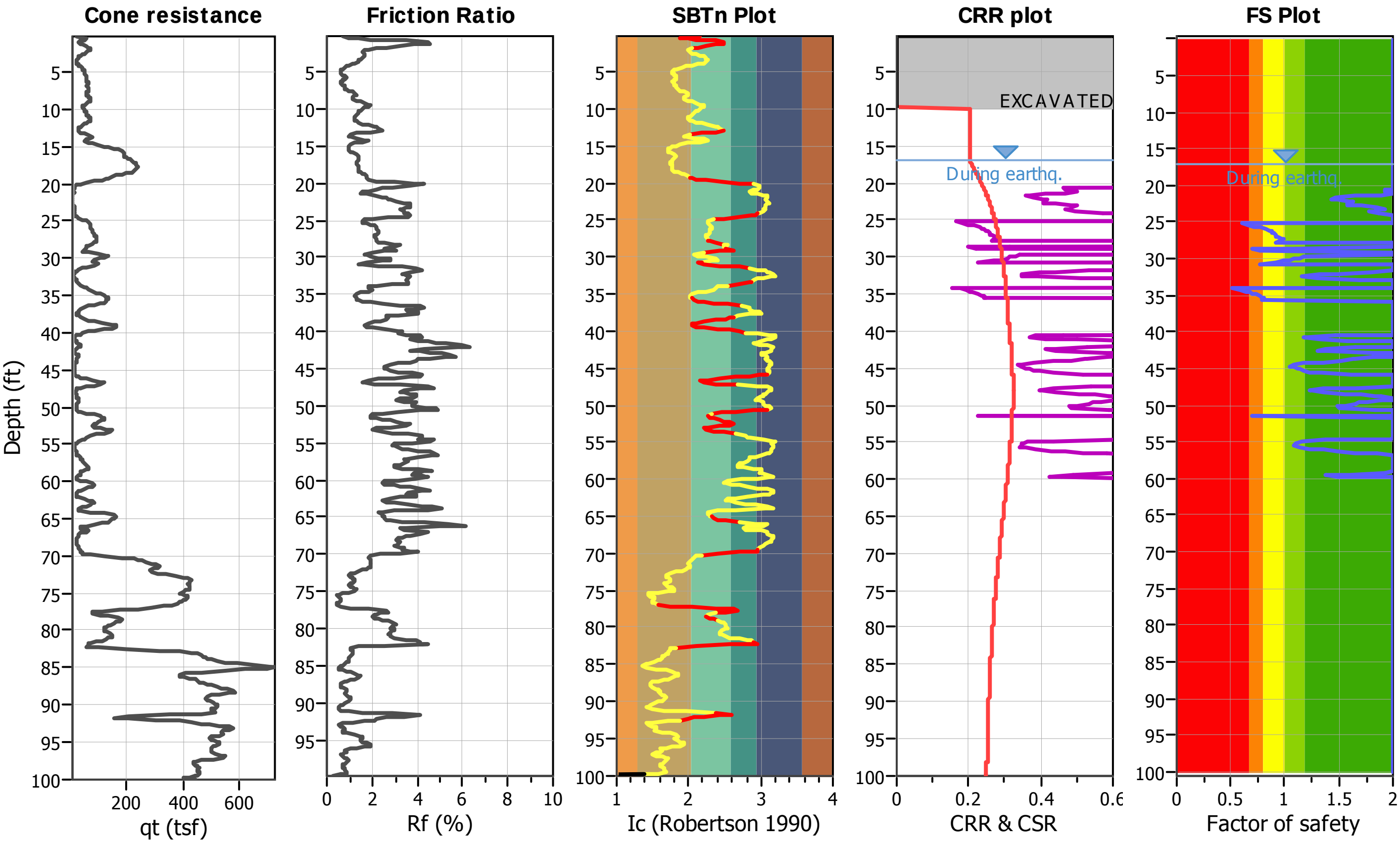
LIQUEFACTION ANALYSIS REPORT

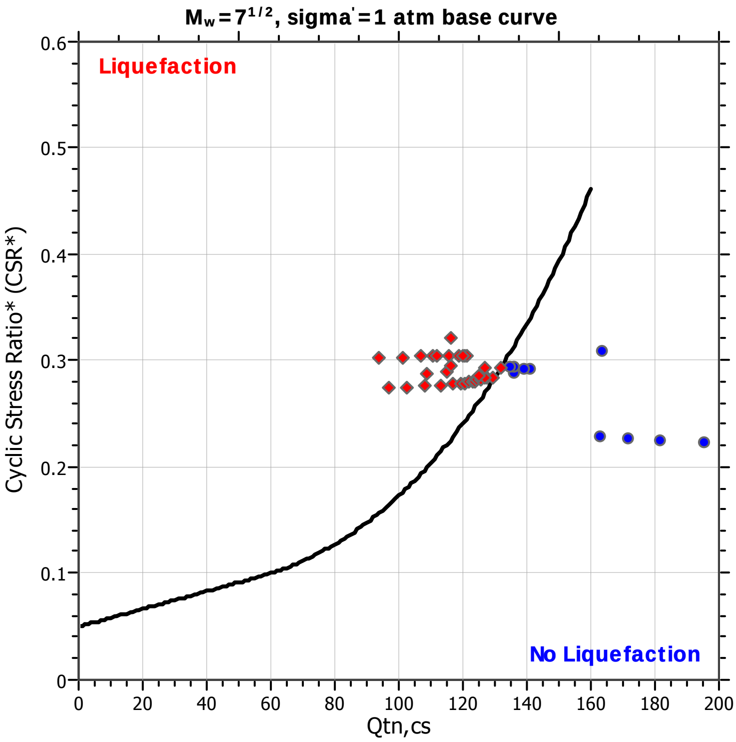
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

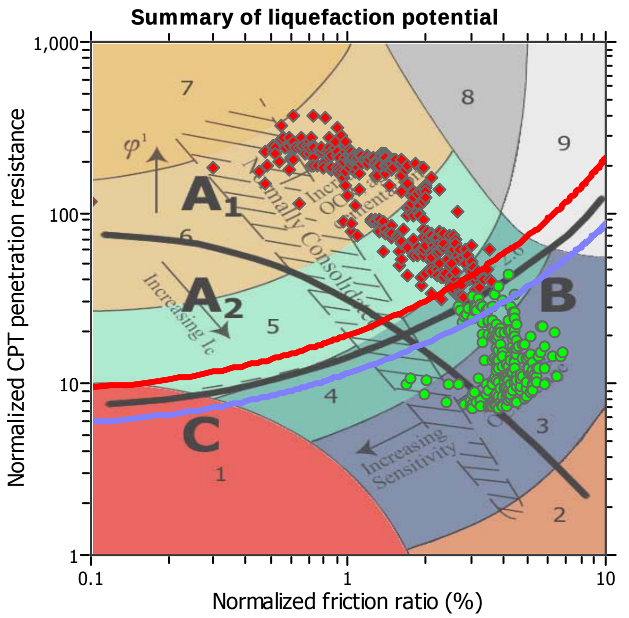
CPT file : CPT-10

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.00 ft	Excavation depth:	10.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

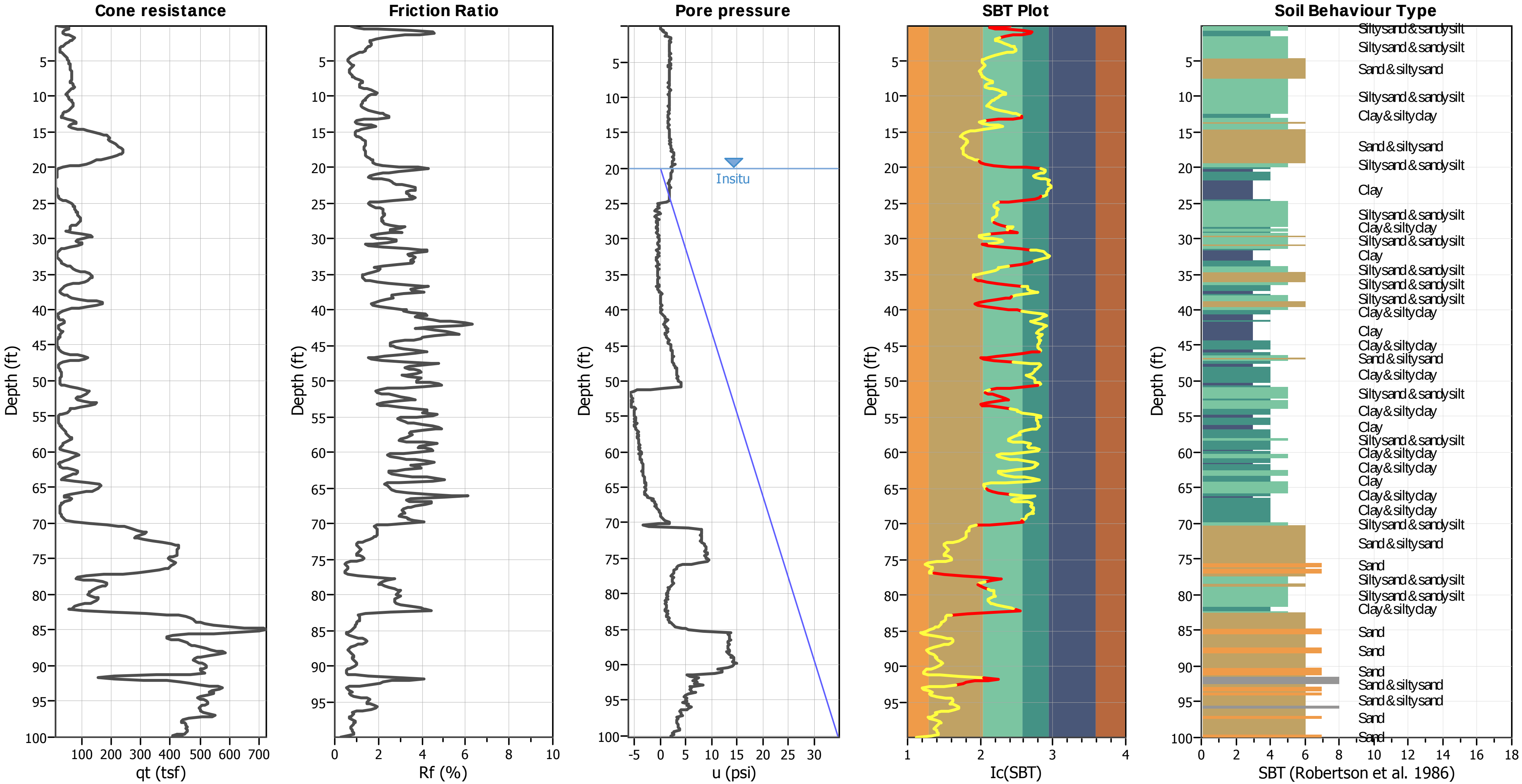






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



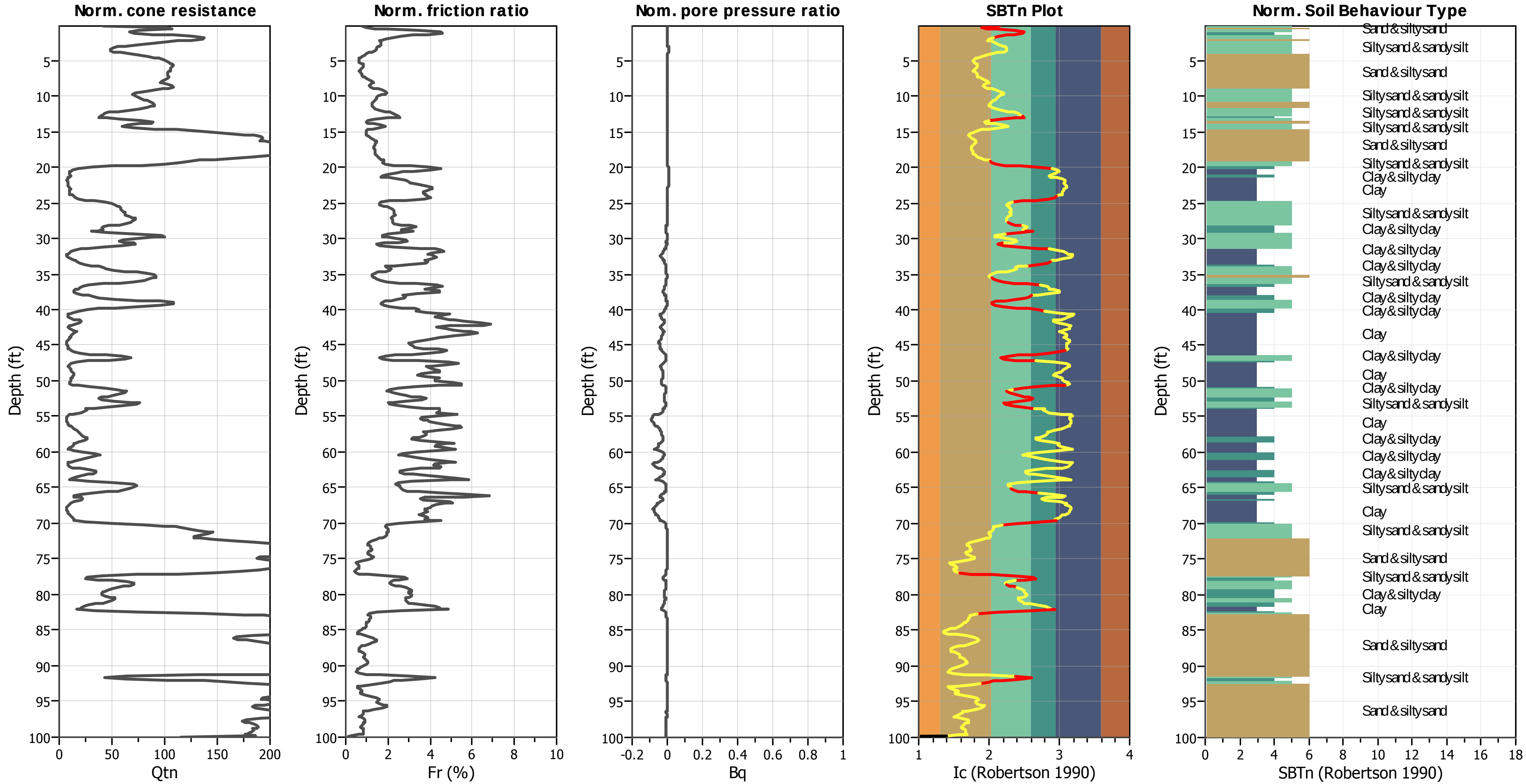
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	10.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



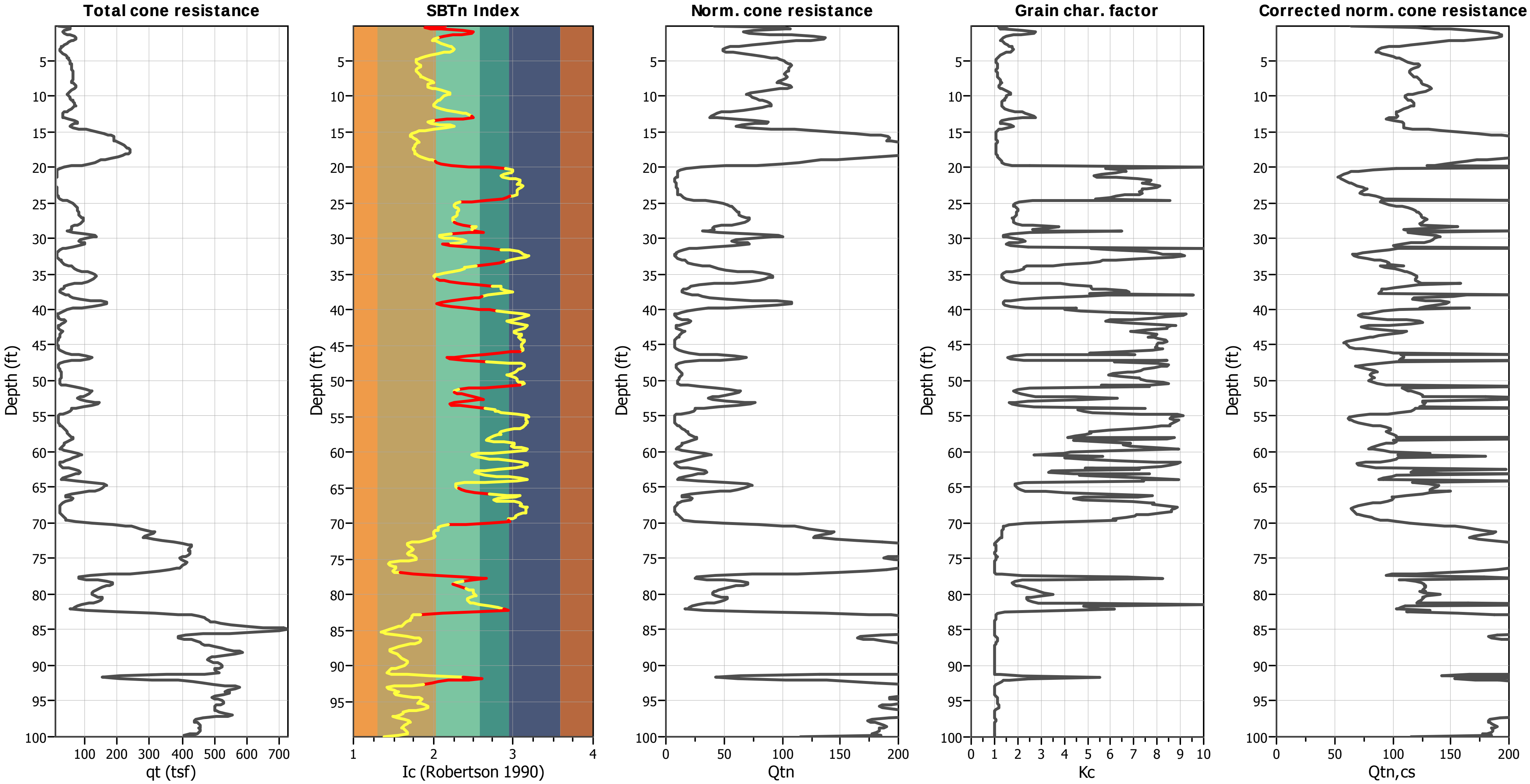
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

SBTn legend

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

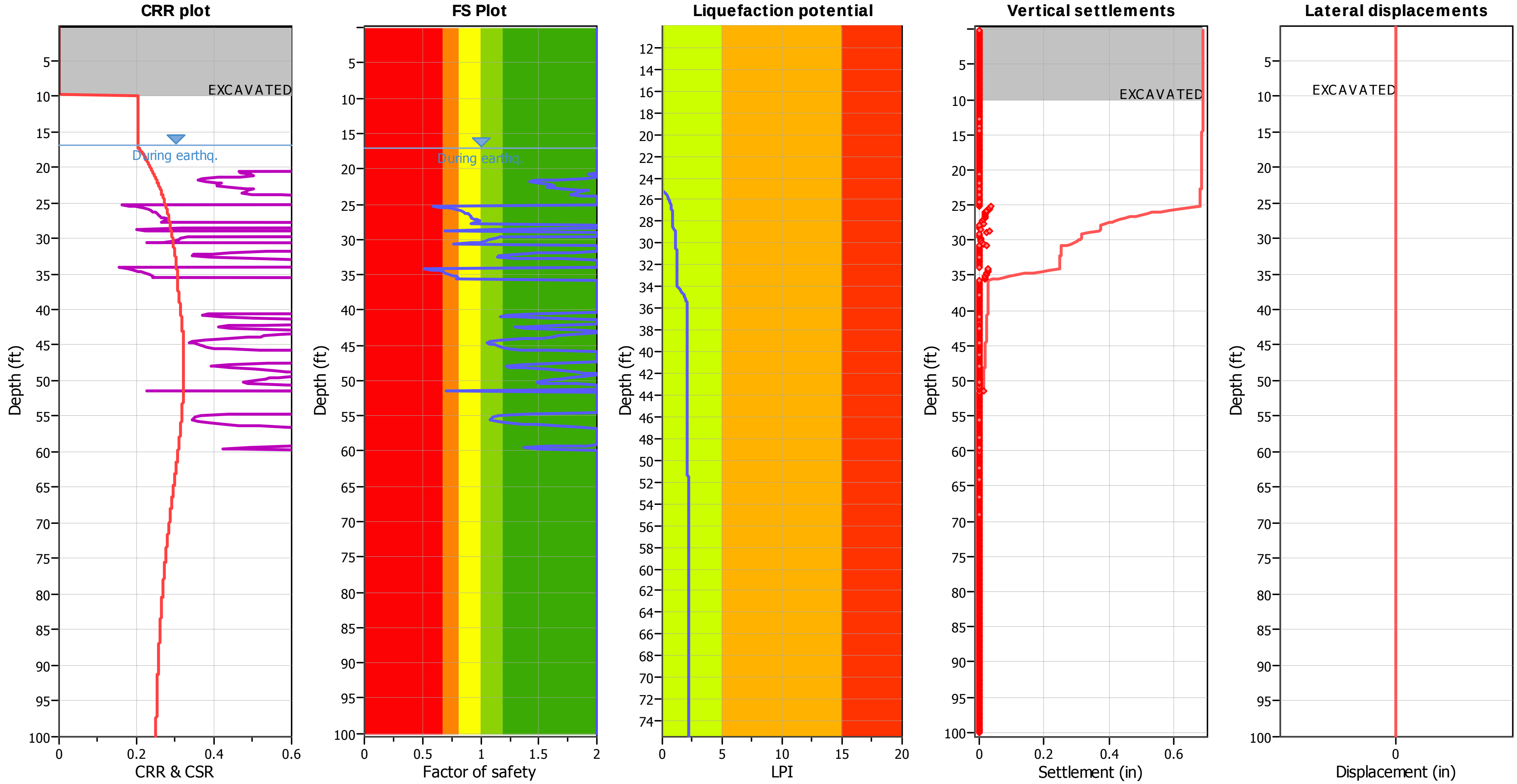
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

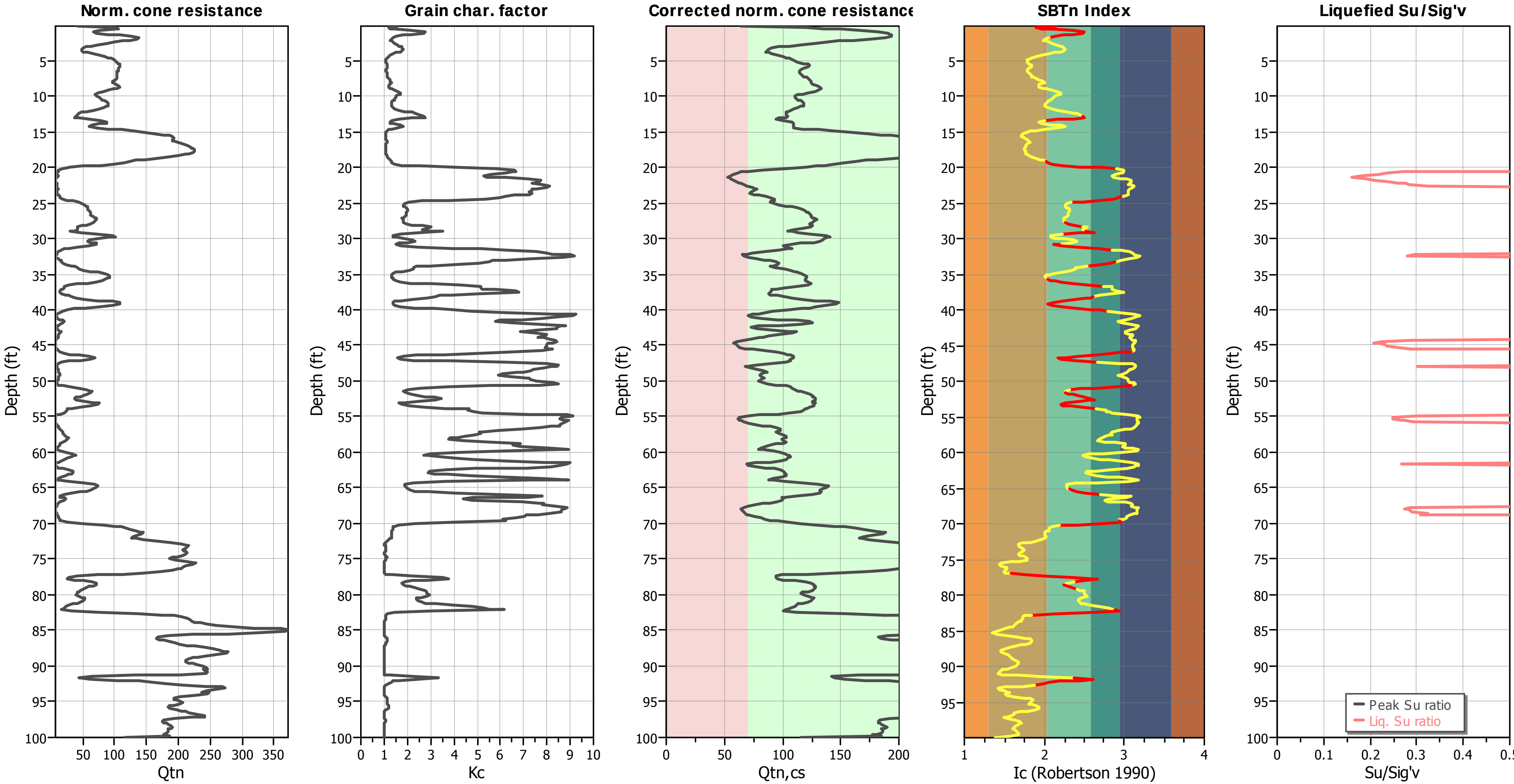
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

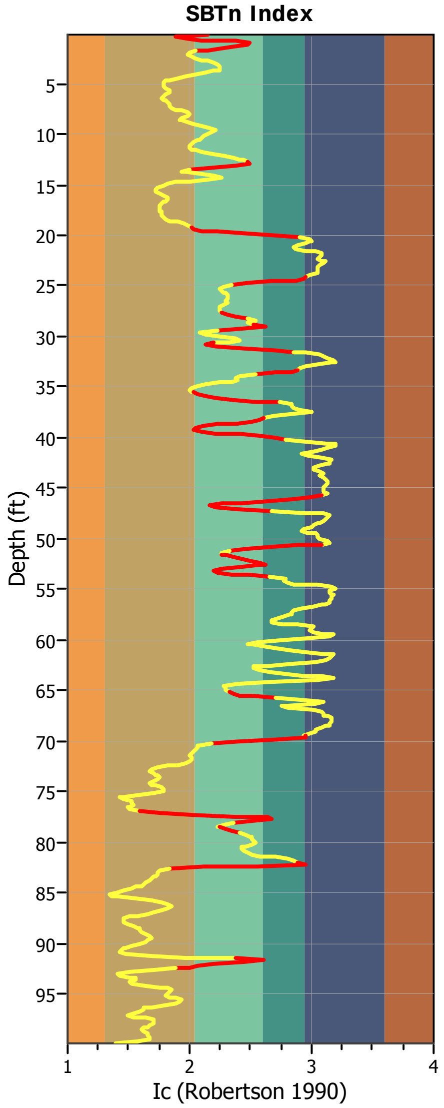
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	10.00 ft	Limit depth:	60.00 ft

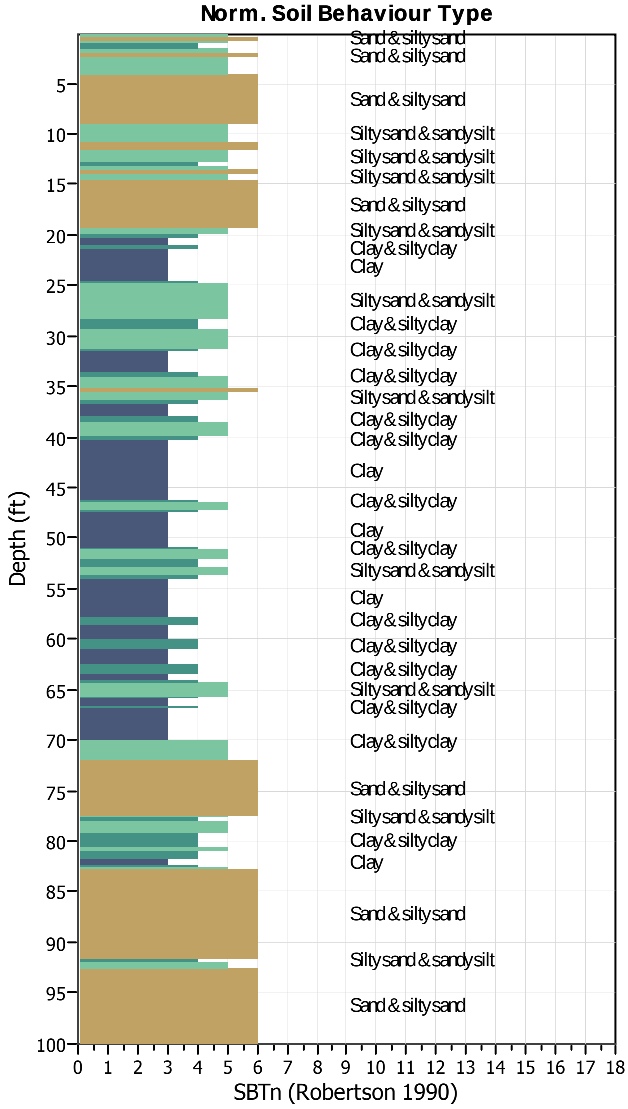
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





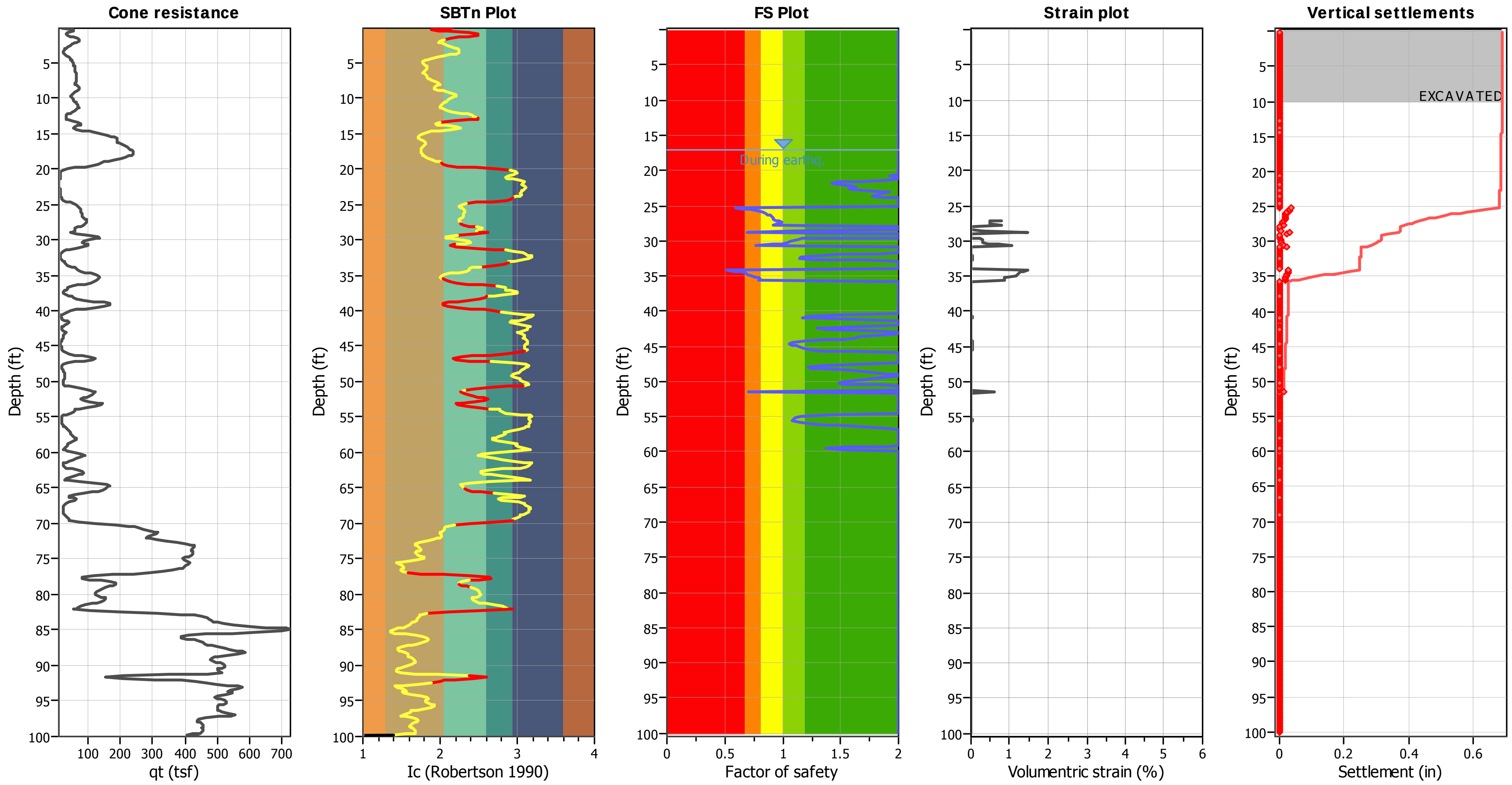
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	610
Total points excluded:	132
Exclusion percentage:	21.64%
Number of layers detected:	25

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

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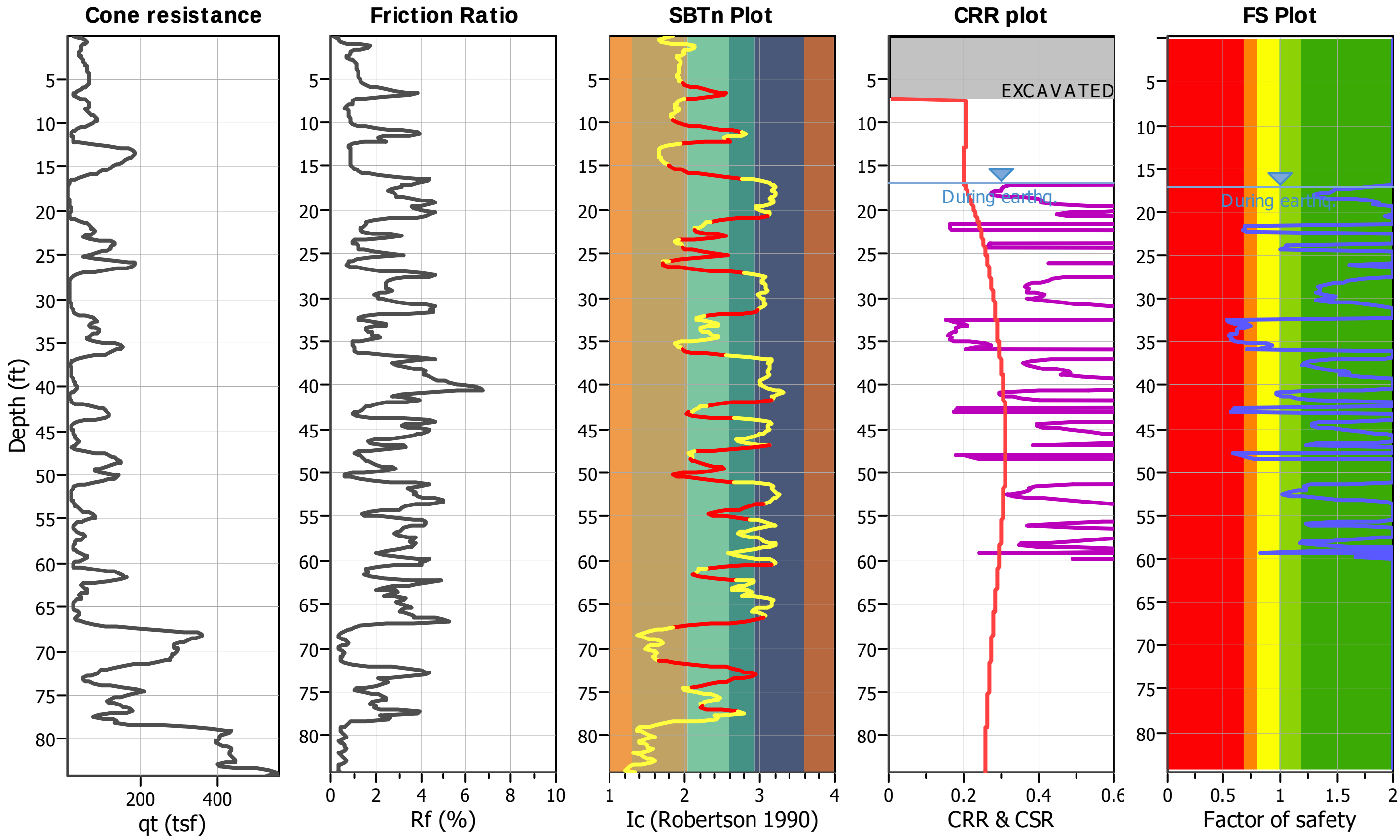
LIQUEFACTION ANALYSIS REPORT

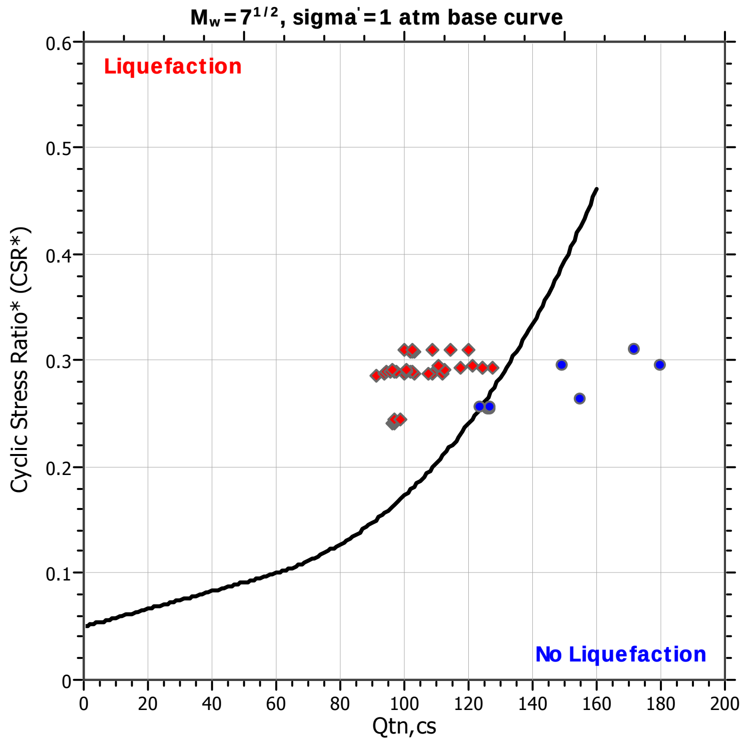
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

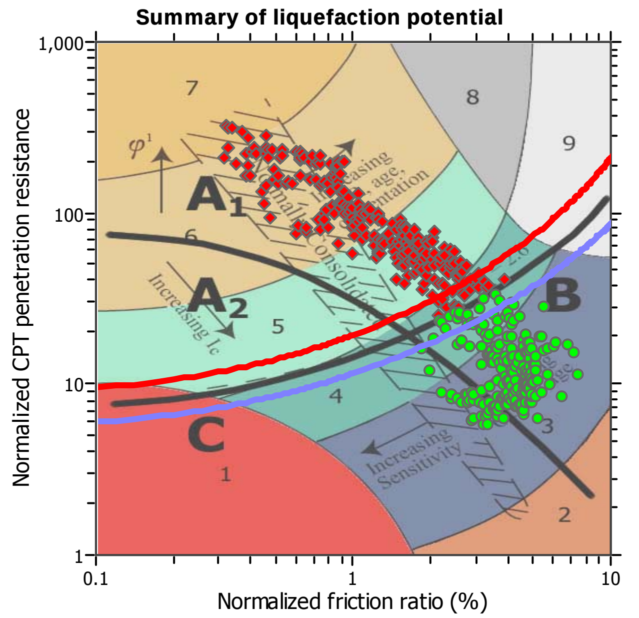
CPT file : CPT-11

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	17.00 ft	Excavation depth:	7.40 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

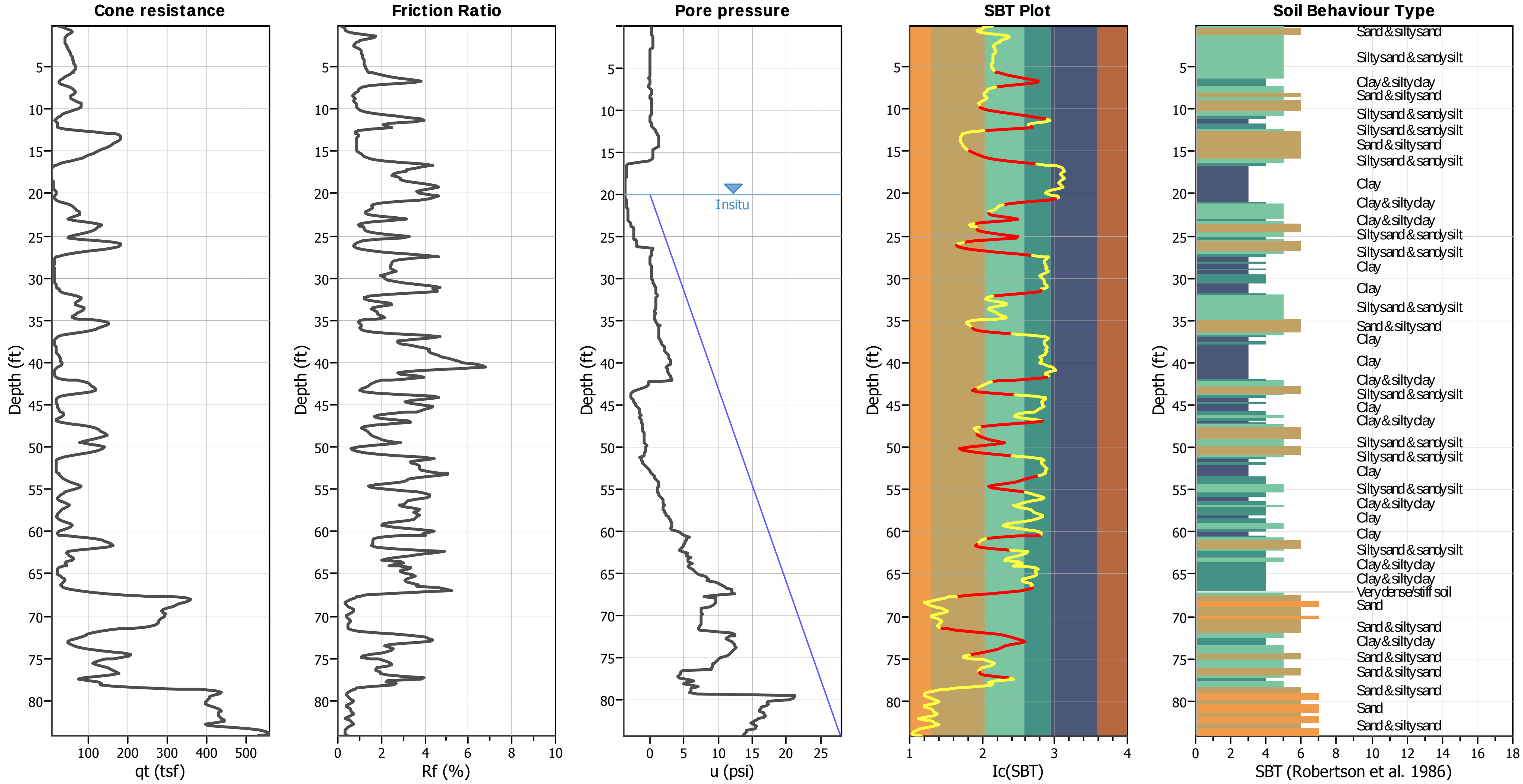






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



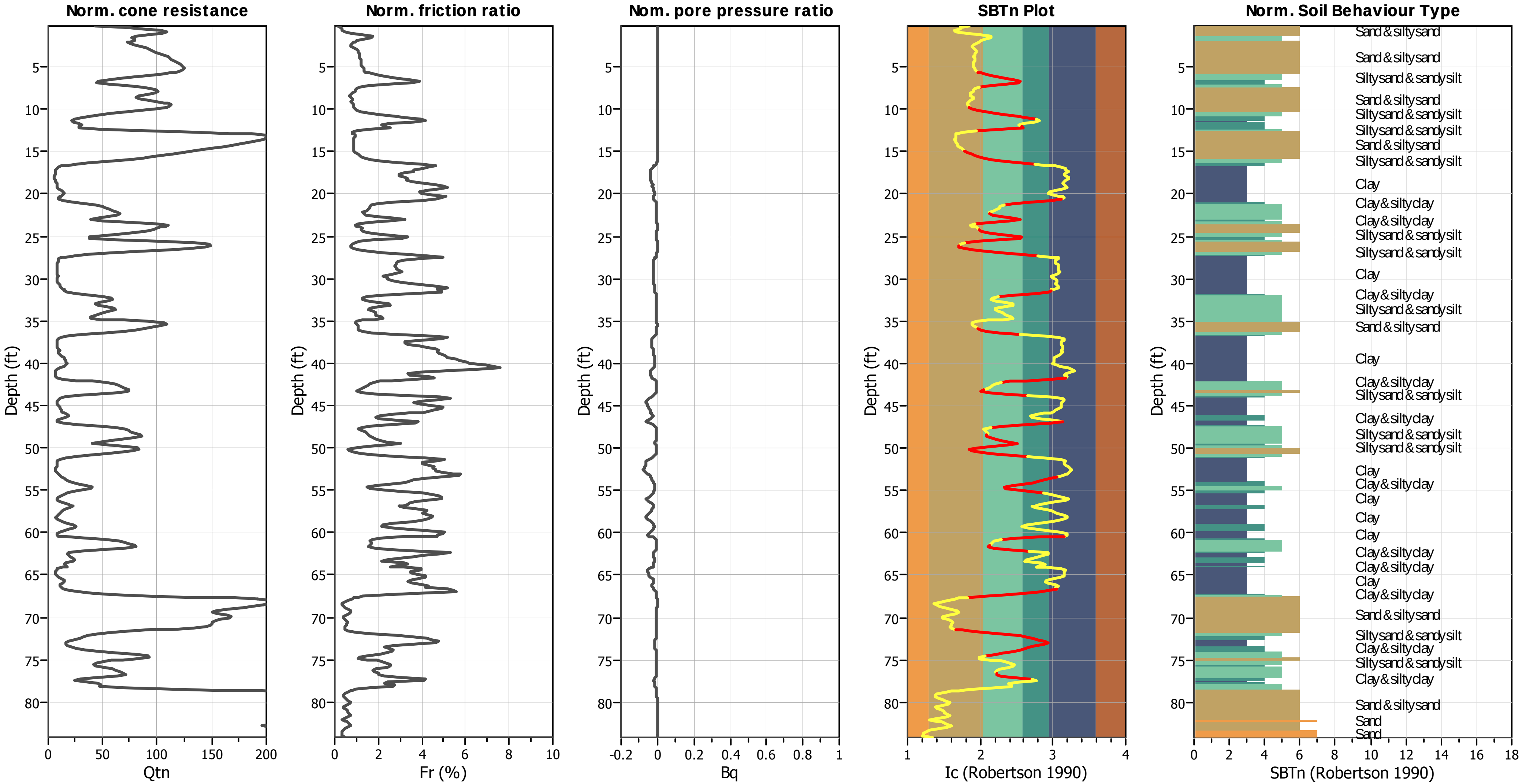
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	7.40 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



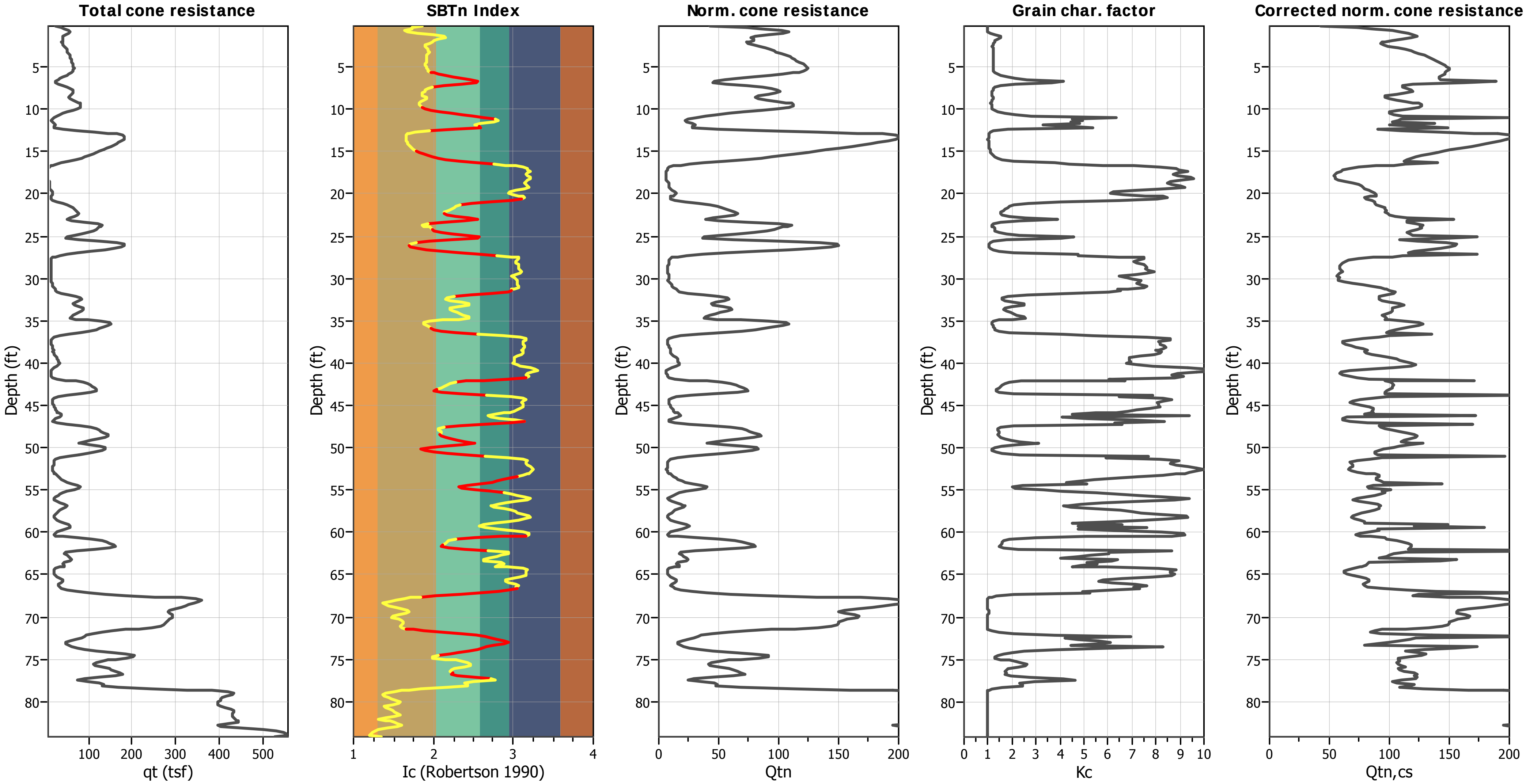
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.40 ft	Limit depth:	60.00 ft

SBTn legend

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

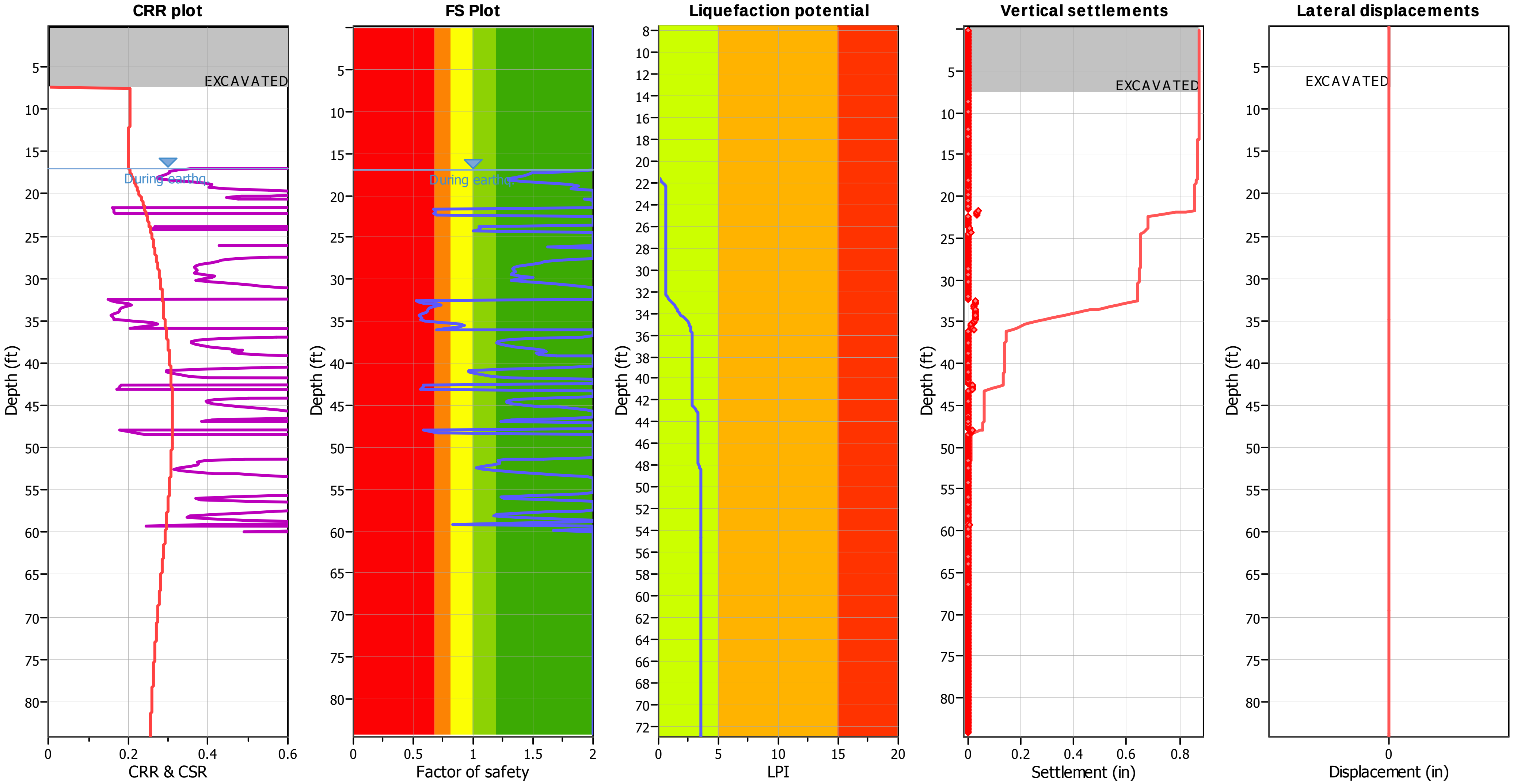
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.40 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.40 ft	Limit depth:	60.00 ft

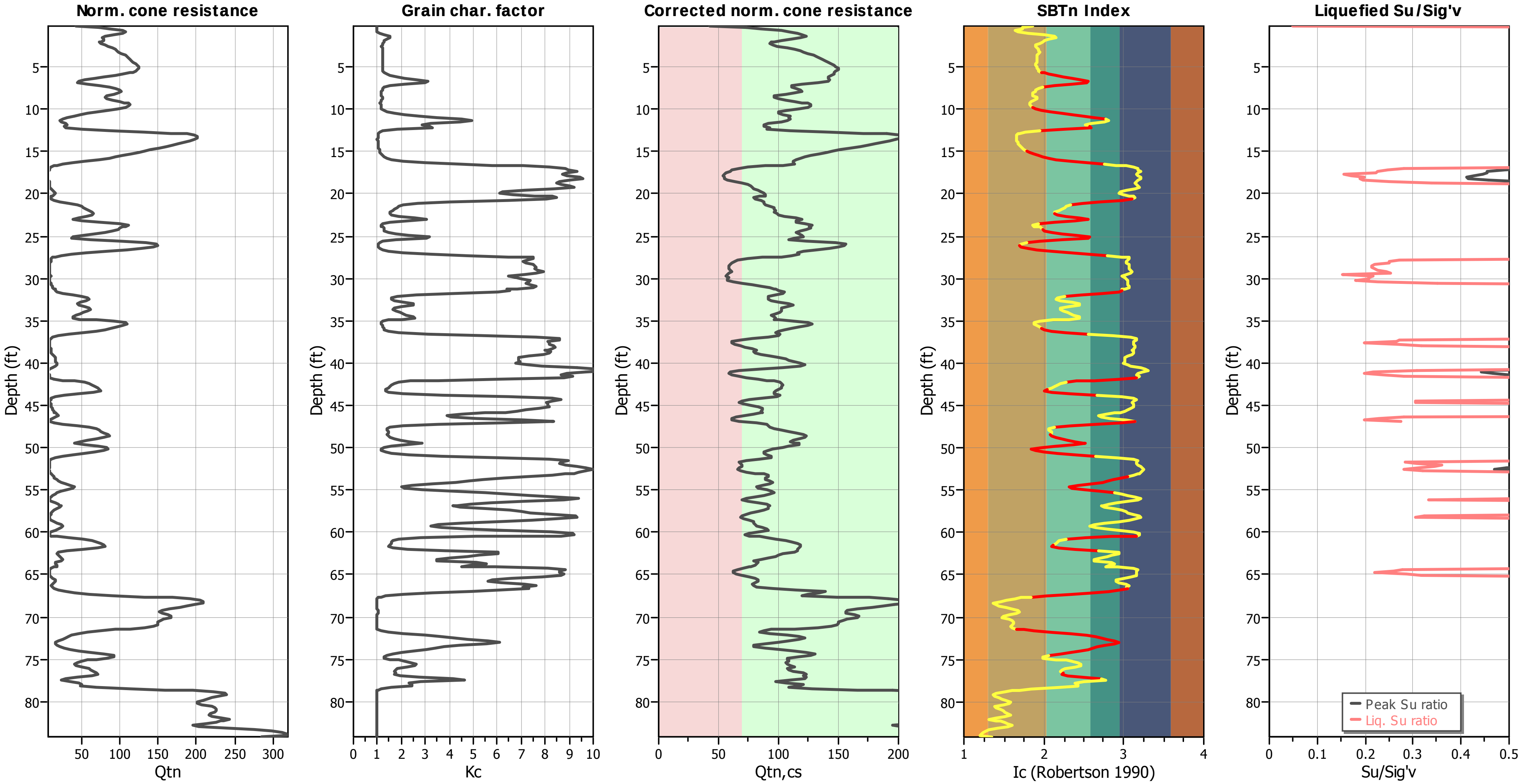
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

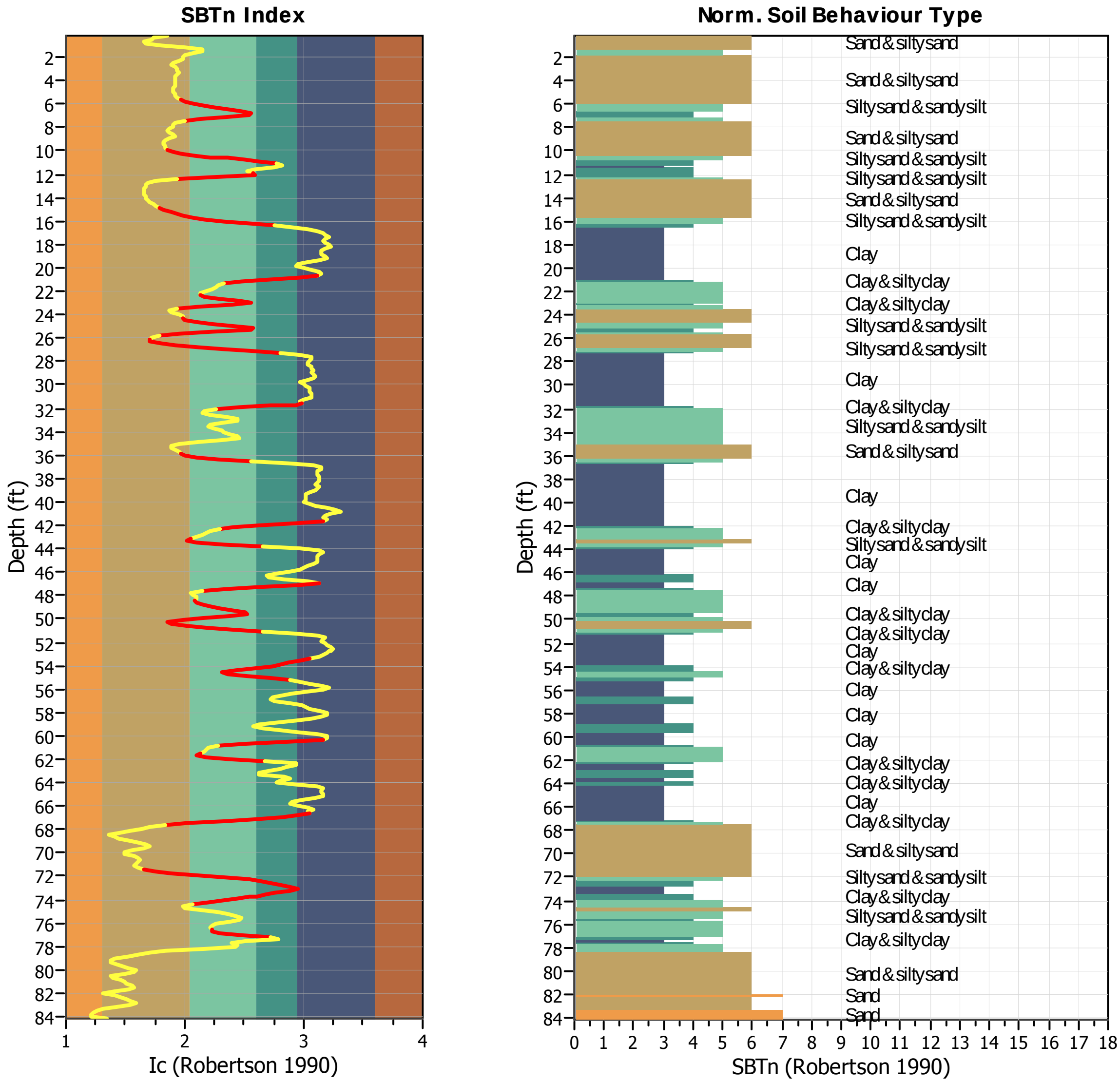
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	17.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	7.40 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



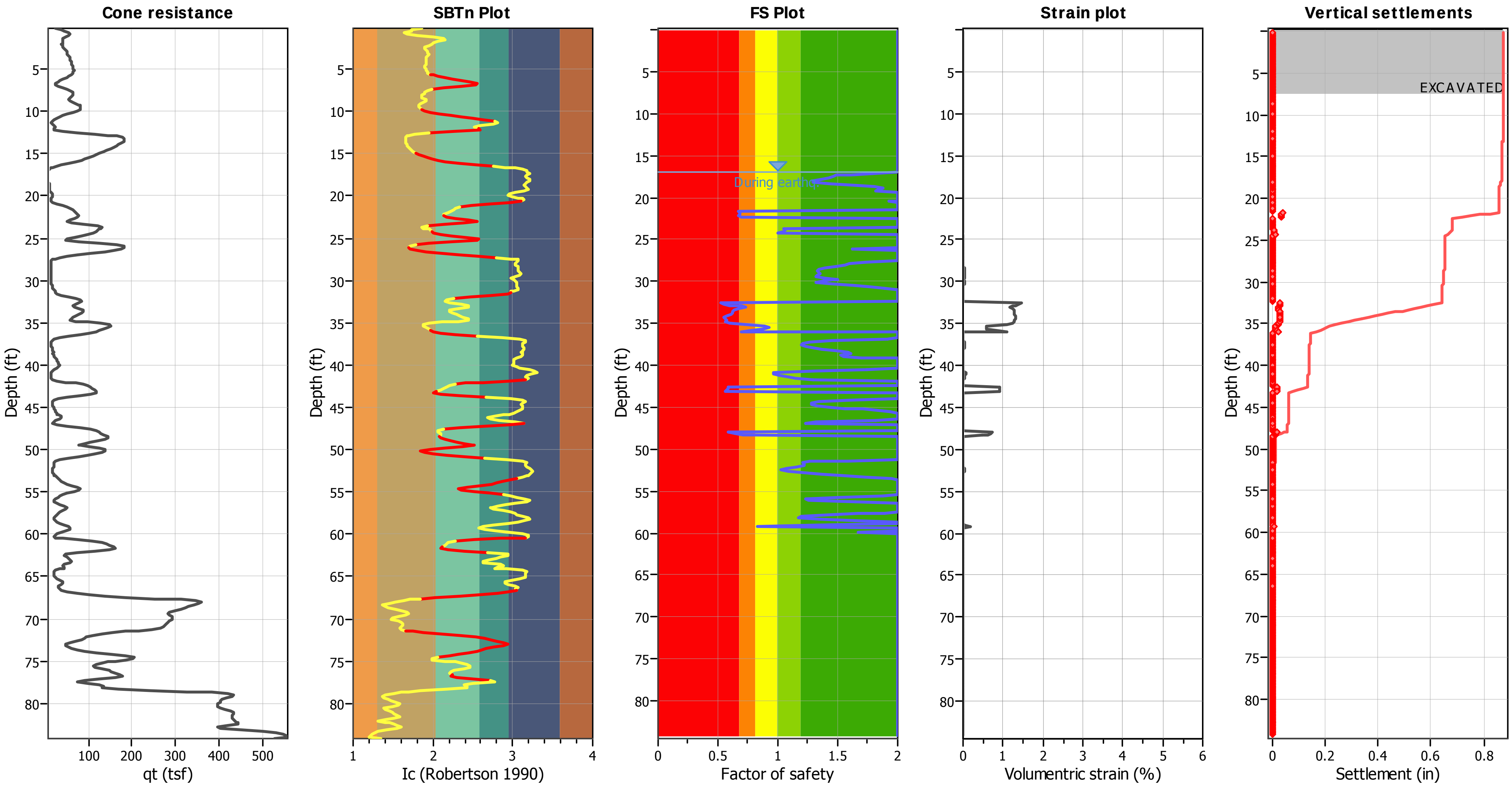
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	513
Total points excluded:	163
Exclusion percentage:	31.77%
Number of layers detected:	27

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

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Irvine, CA 92614
www.leightongroup.com

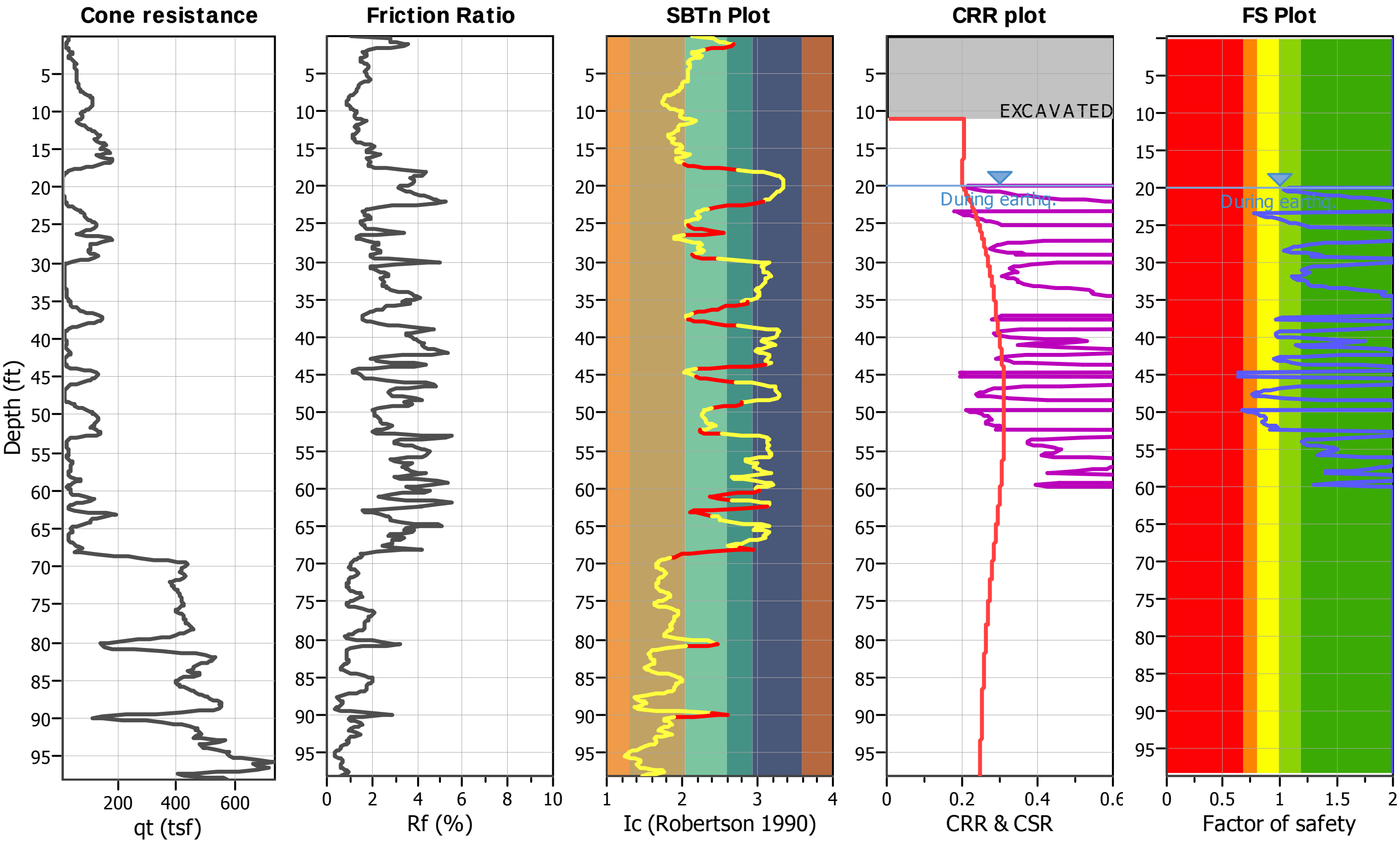
LIQUEFACTION ANALYSIS REPORT

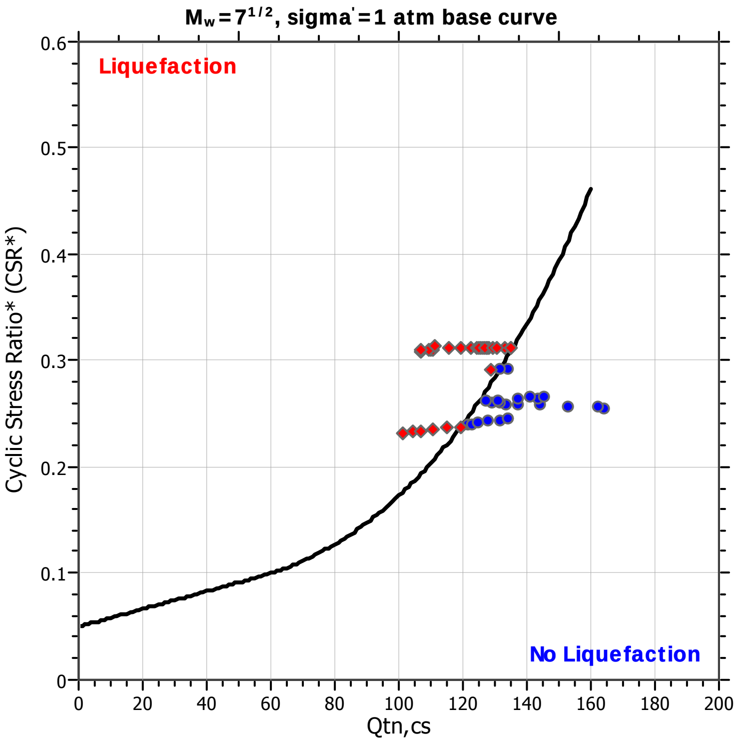
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

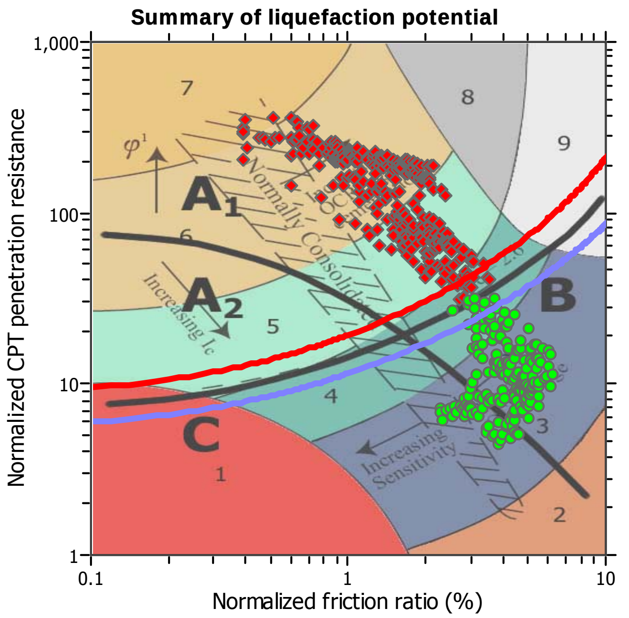
CPT file : CPT-12

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	11.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

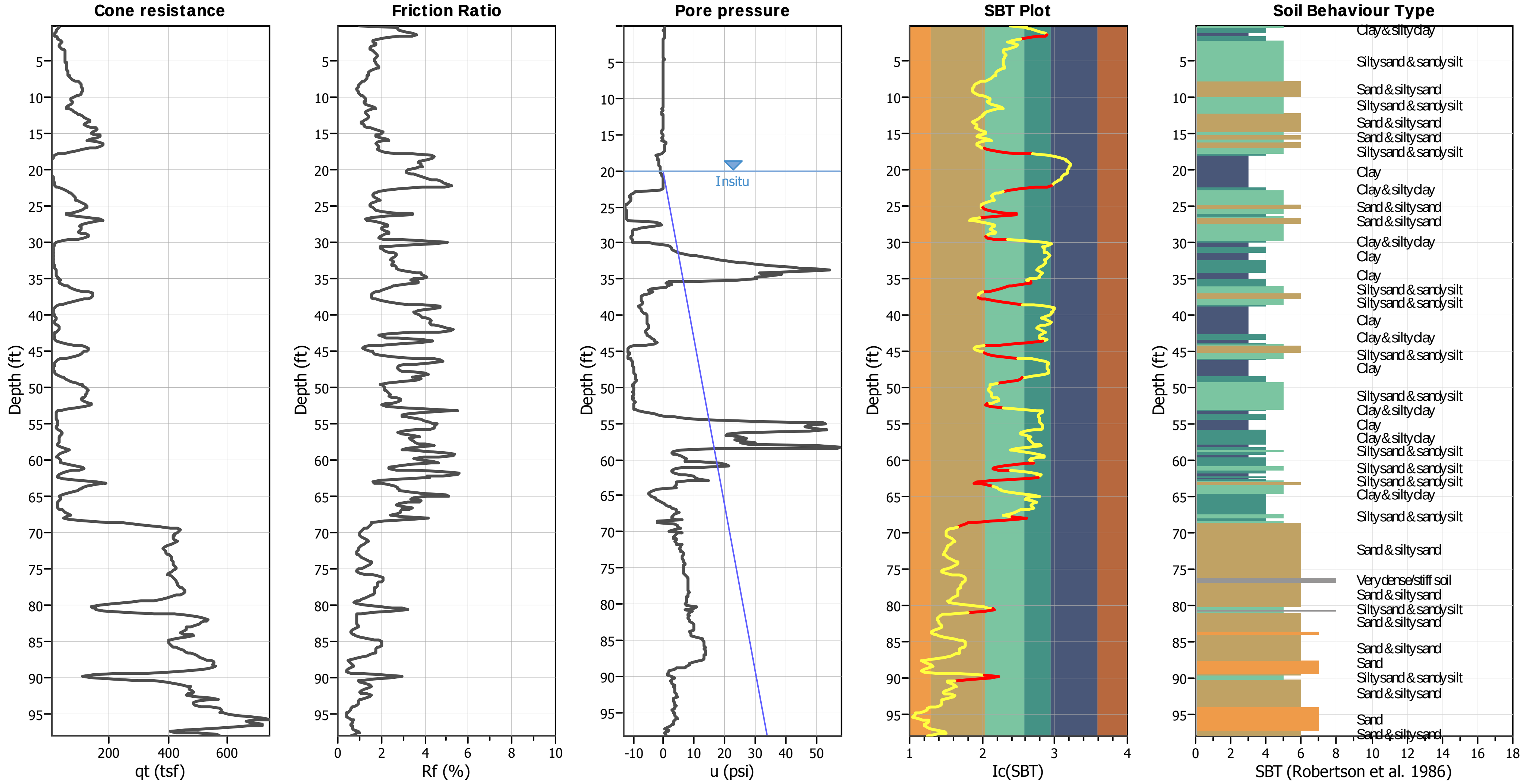






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



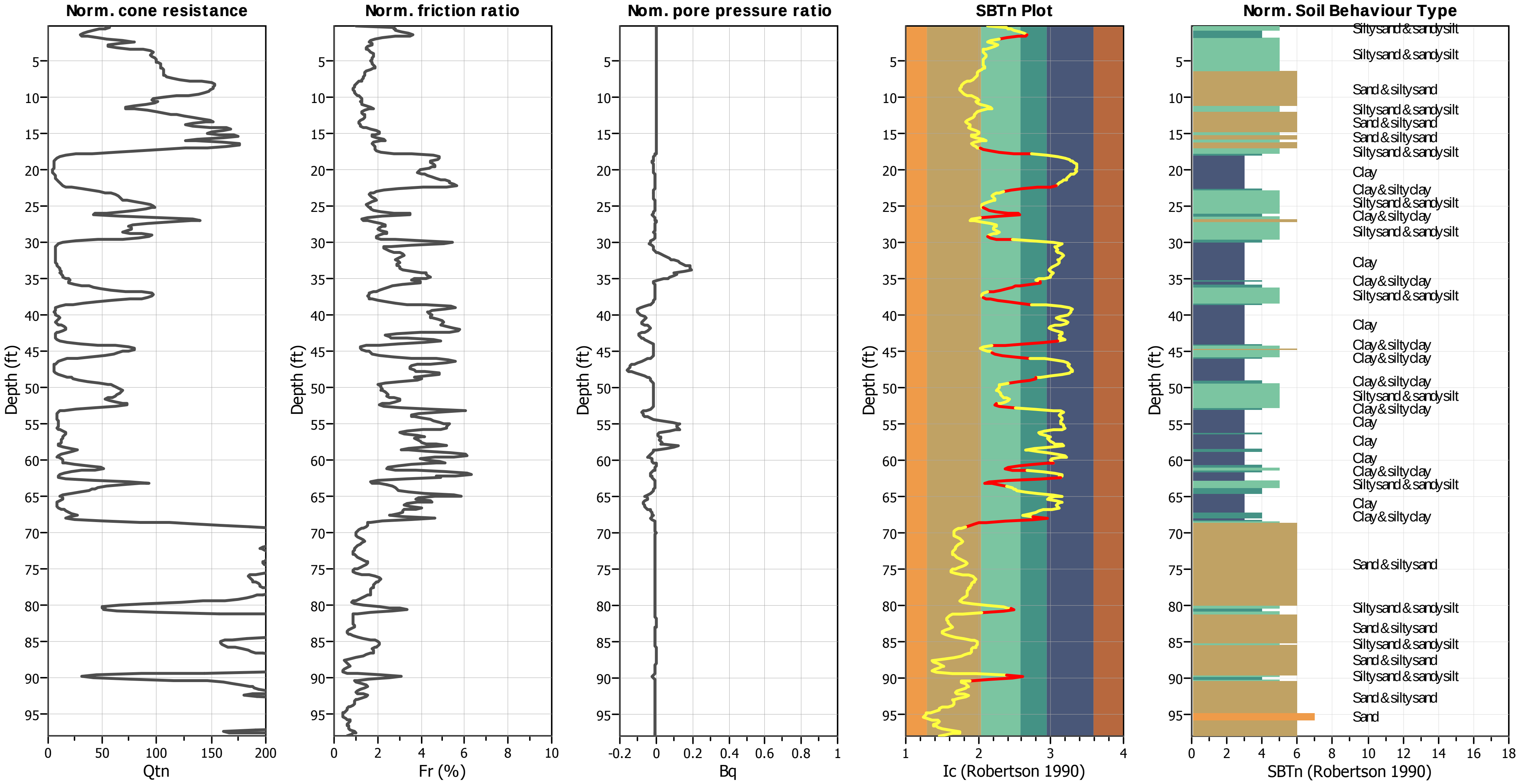
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	11.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



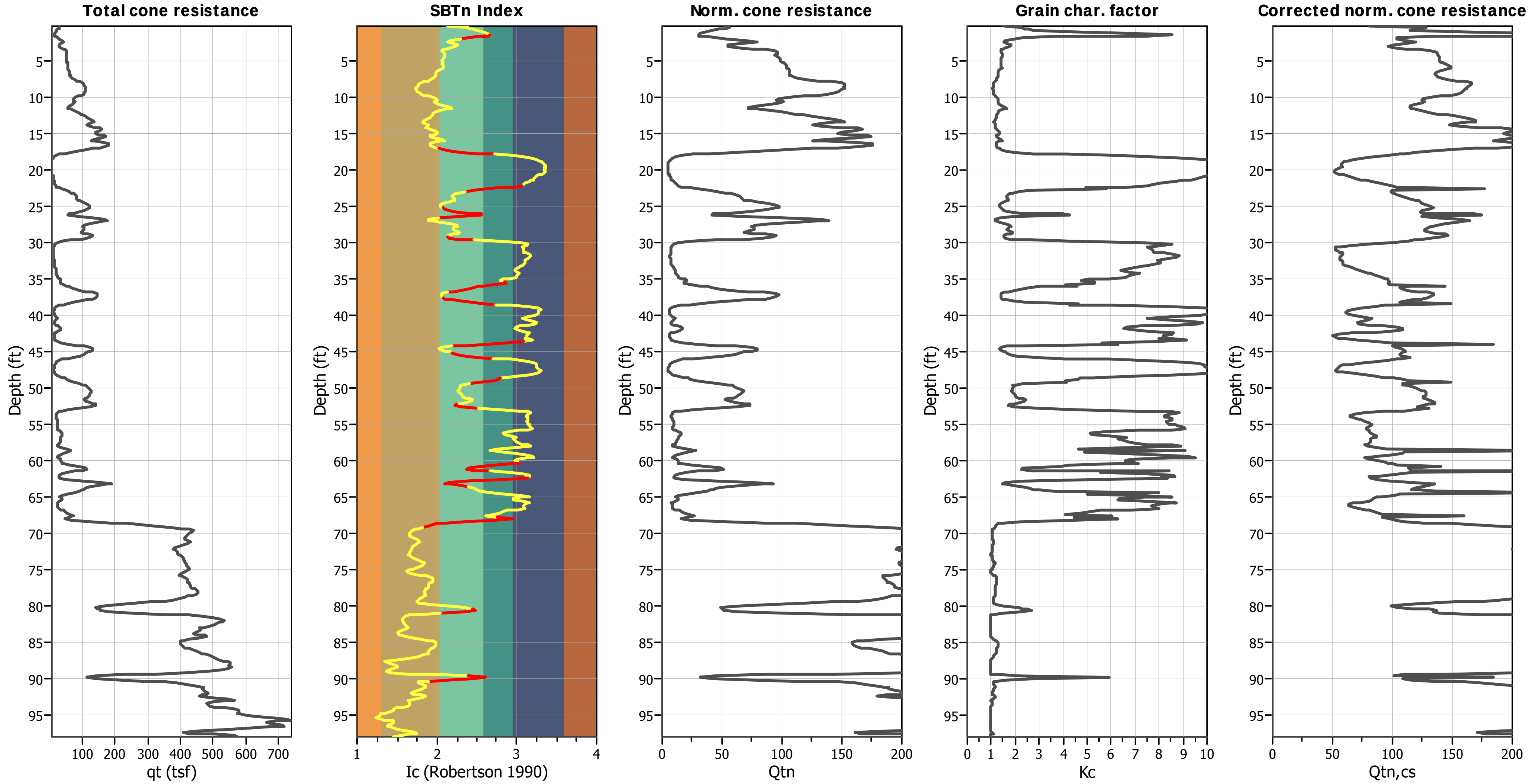
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

SBTn legend

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

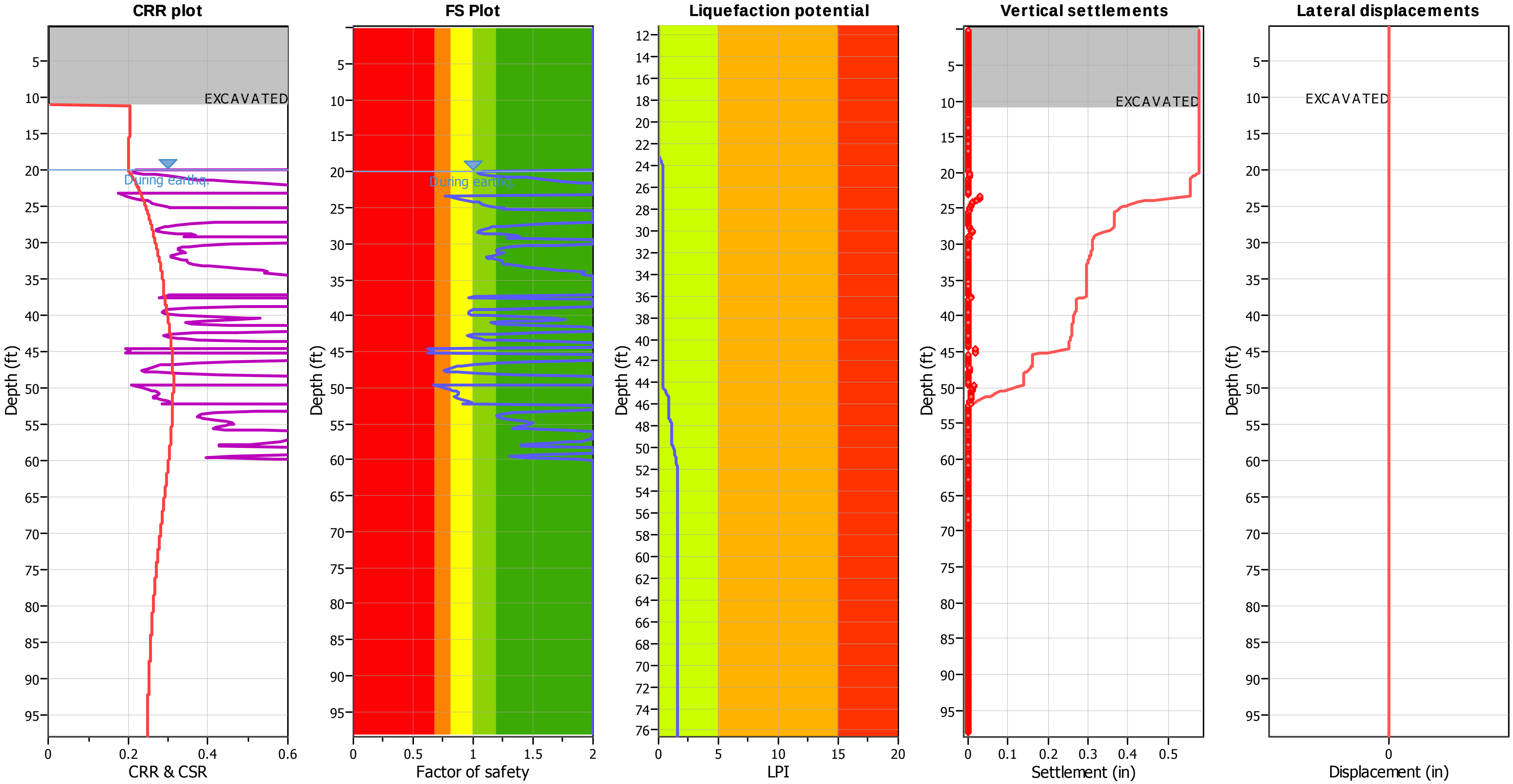
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

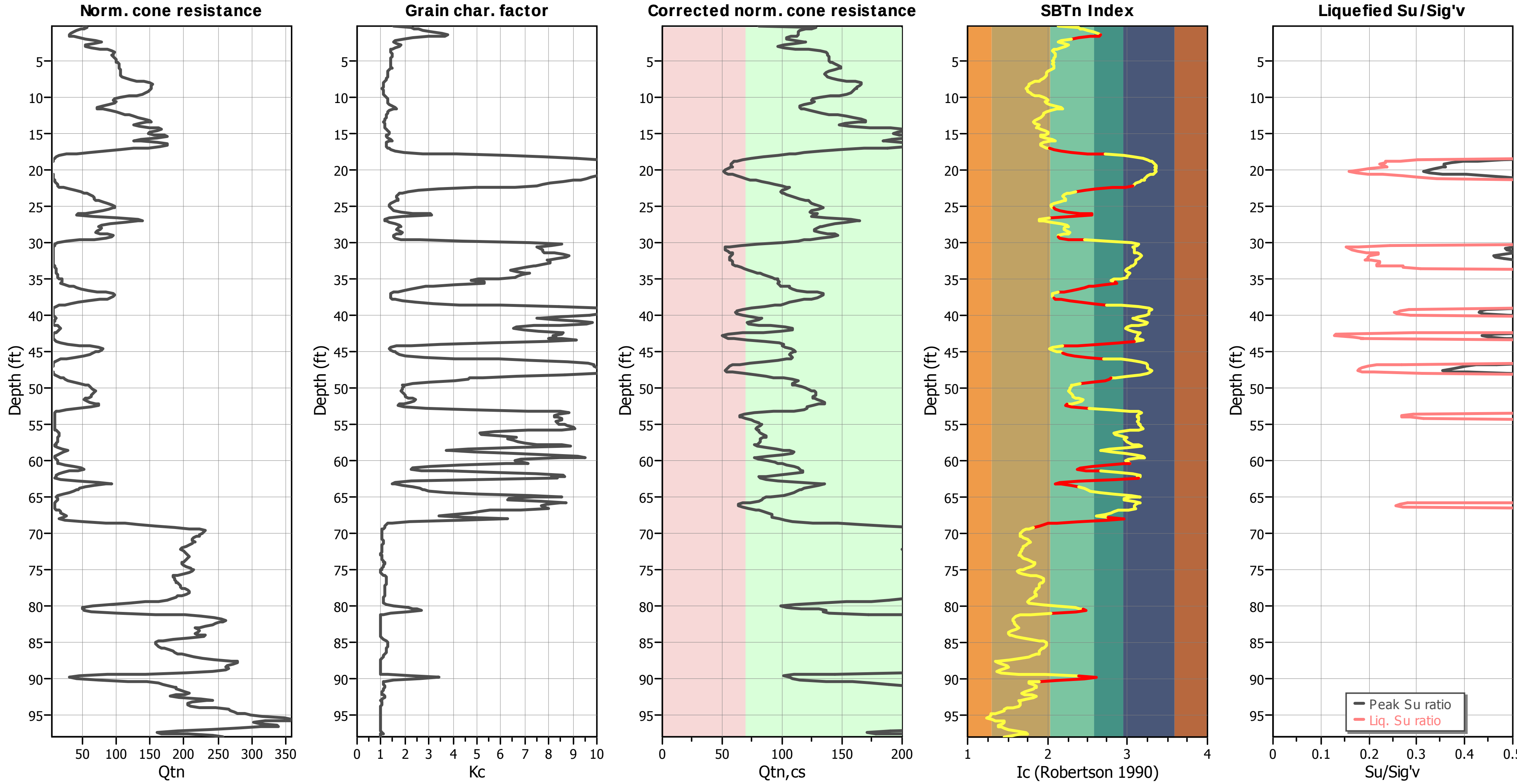
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

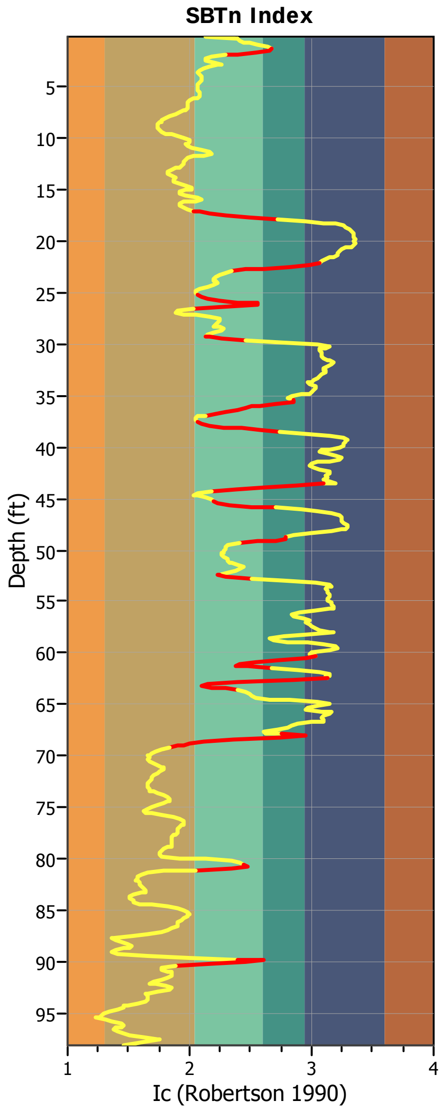
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

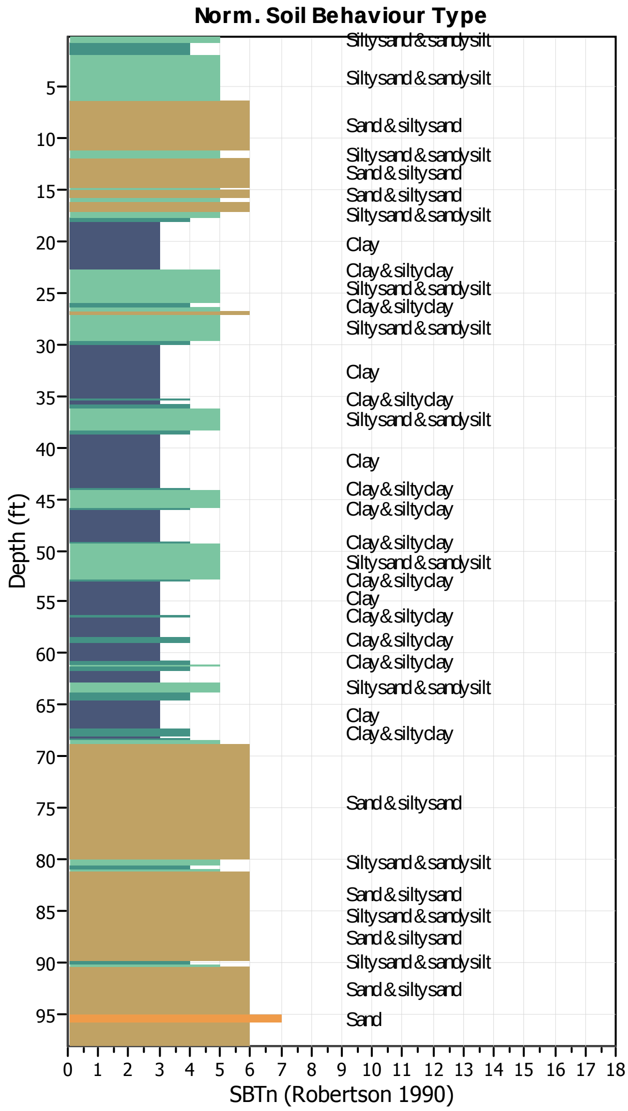
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





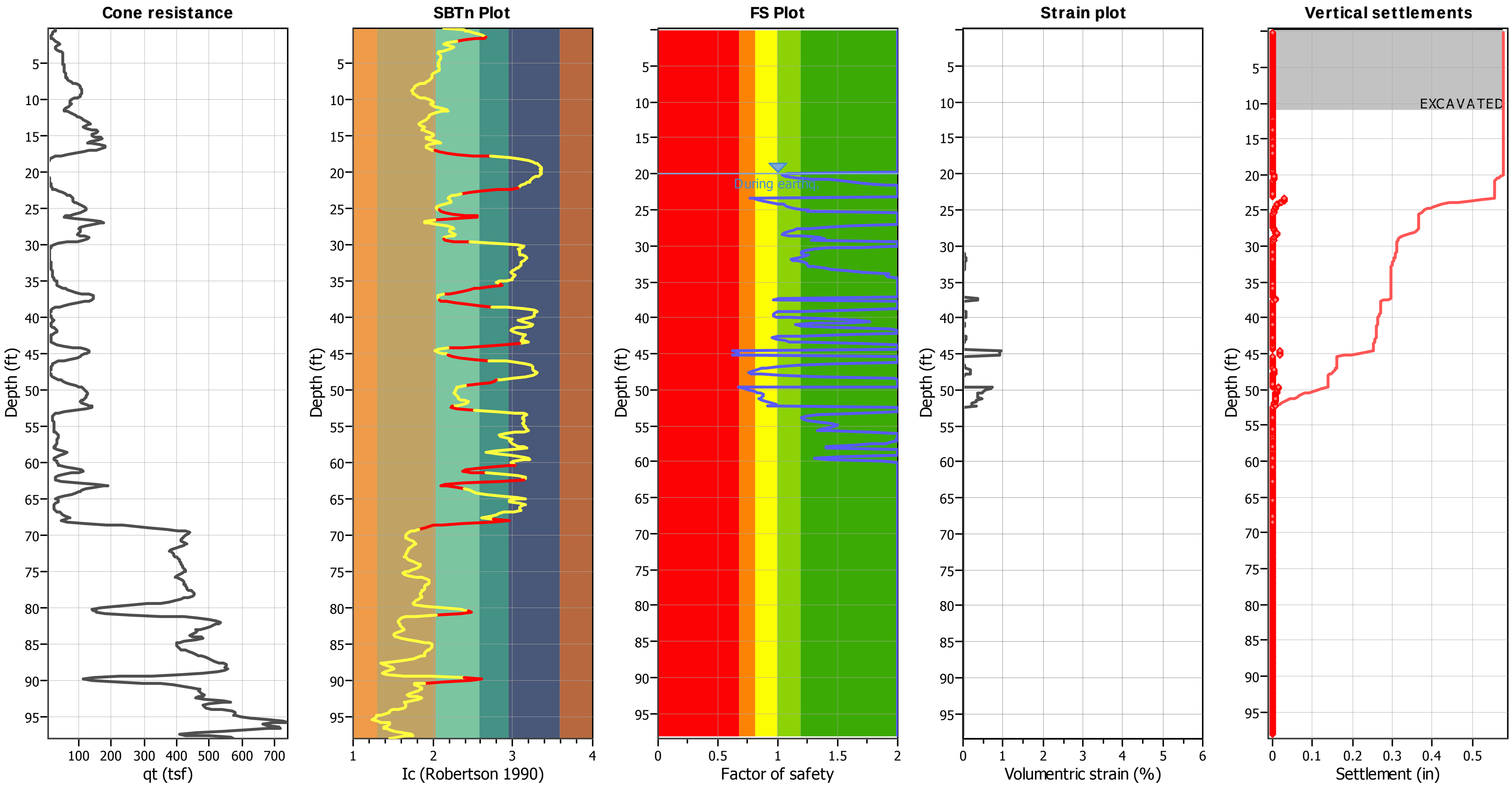
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	598
Total points excluded:	101
Exclusion percentage:	16.89%
Number of layers detected:	19

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

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Irvine, CA 92614
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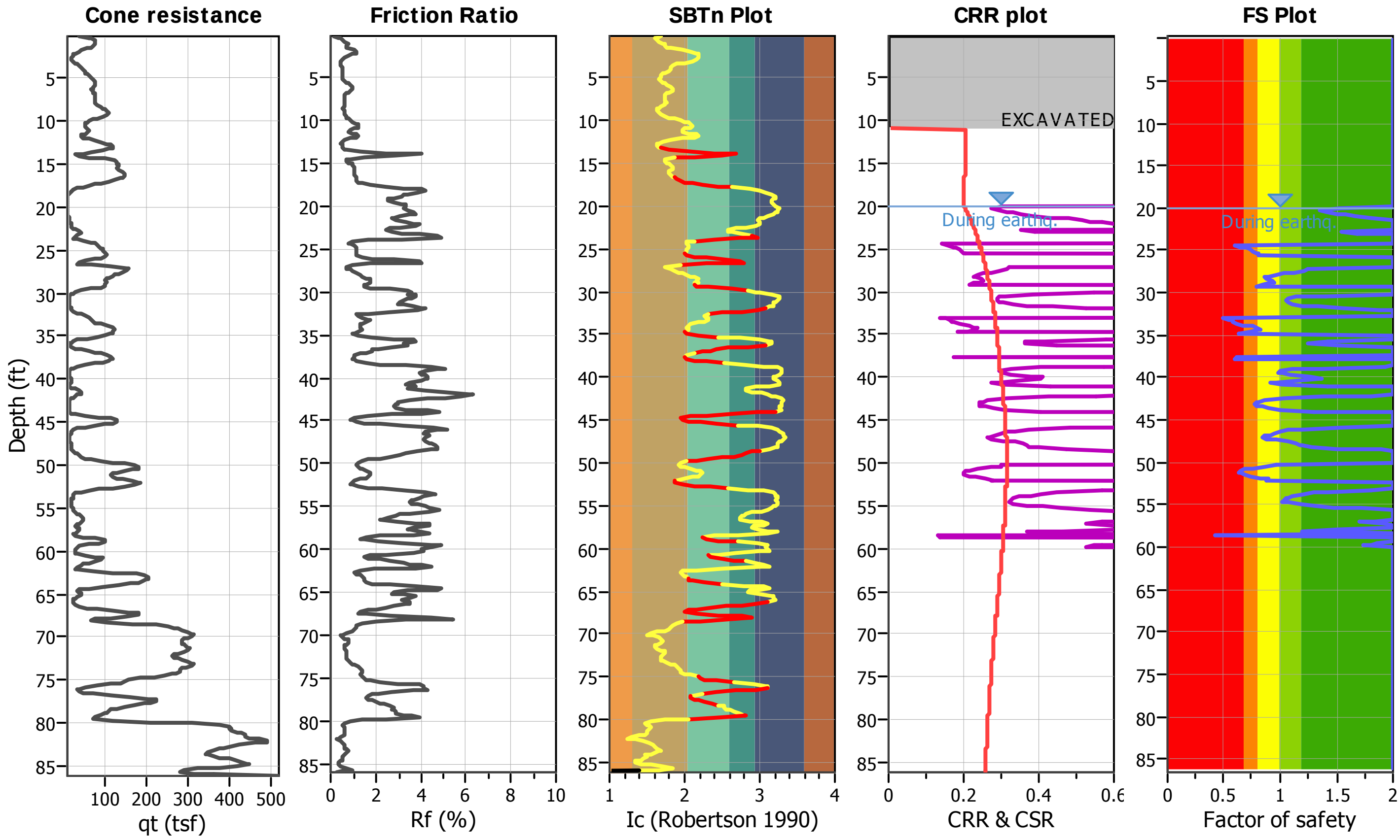
LIQUEFACTION ANALYSIS REPORT

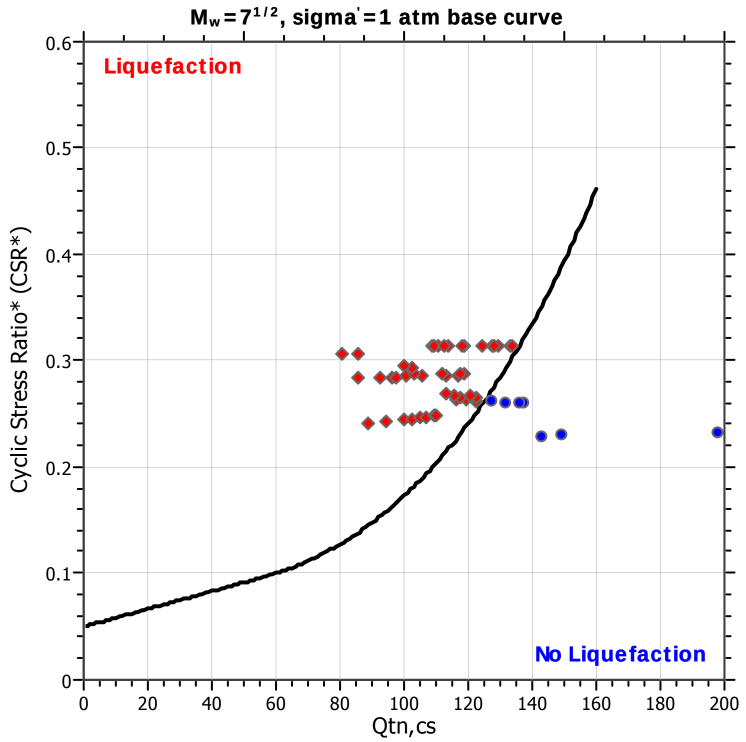
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

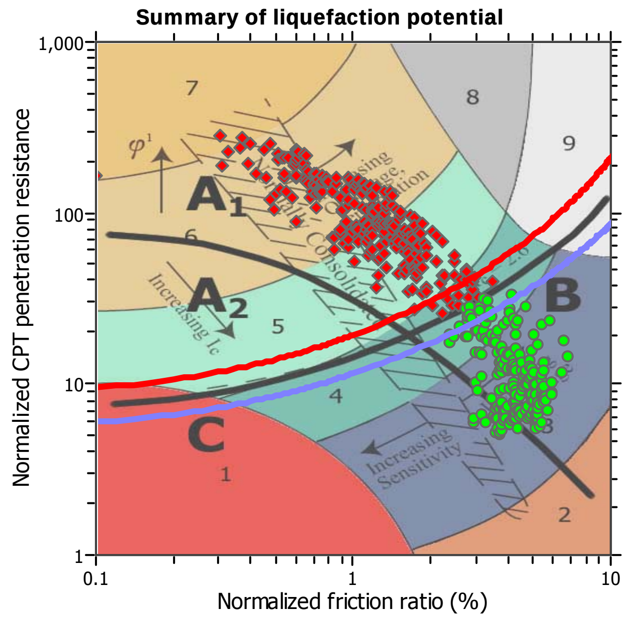
CPT file : CPT-13

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	11.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

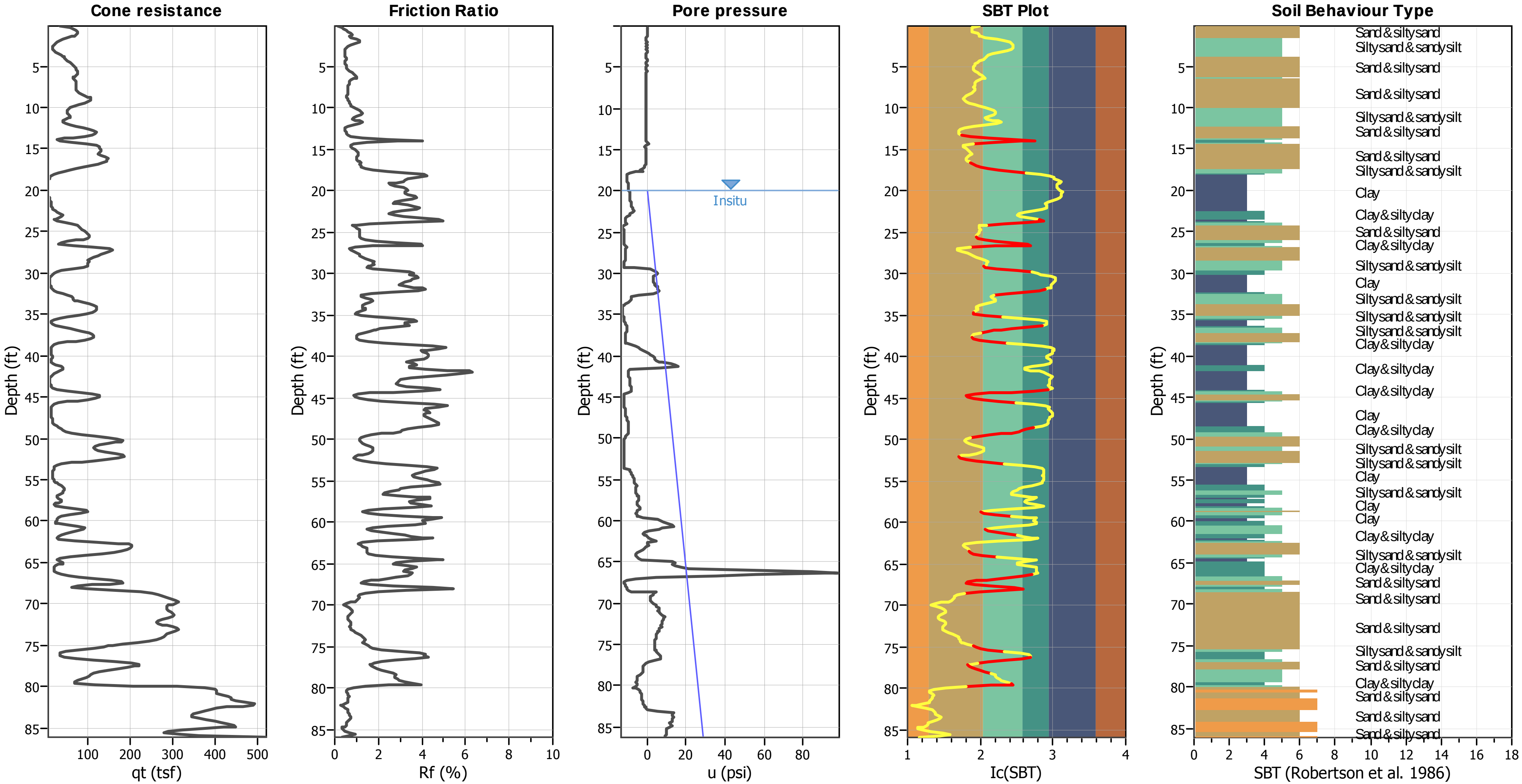






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



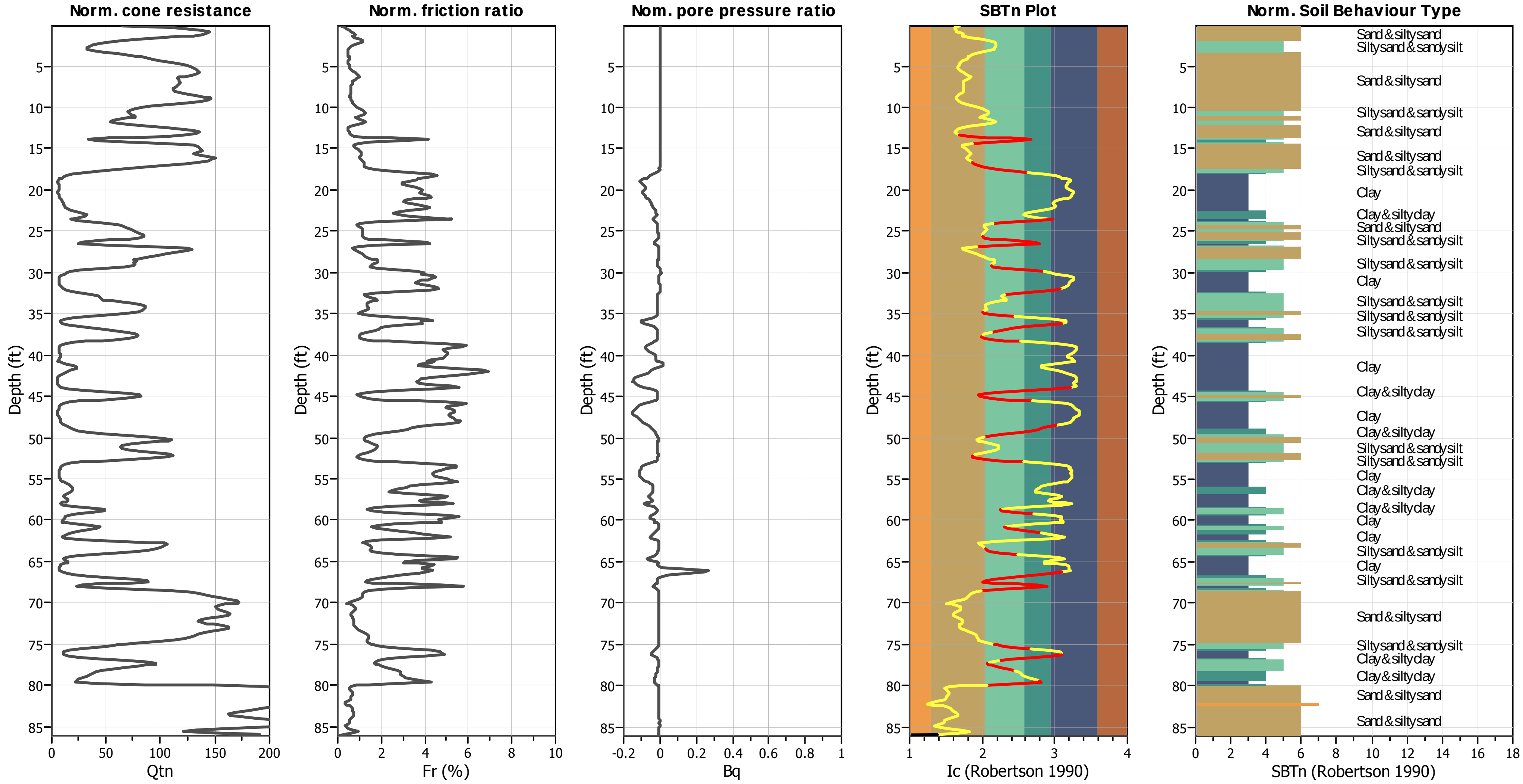
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	11.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



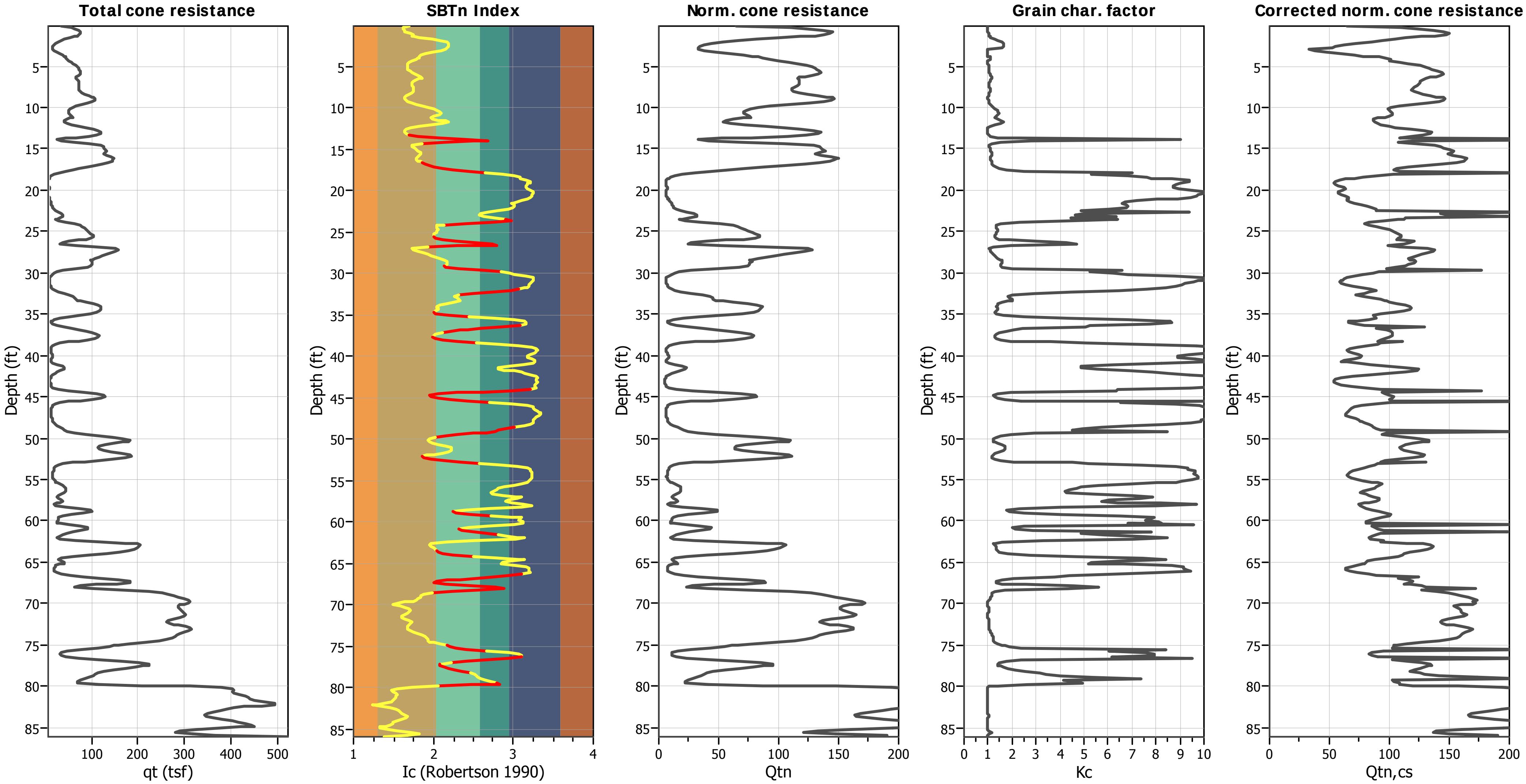
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

SBTn legend

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

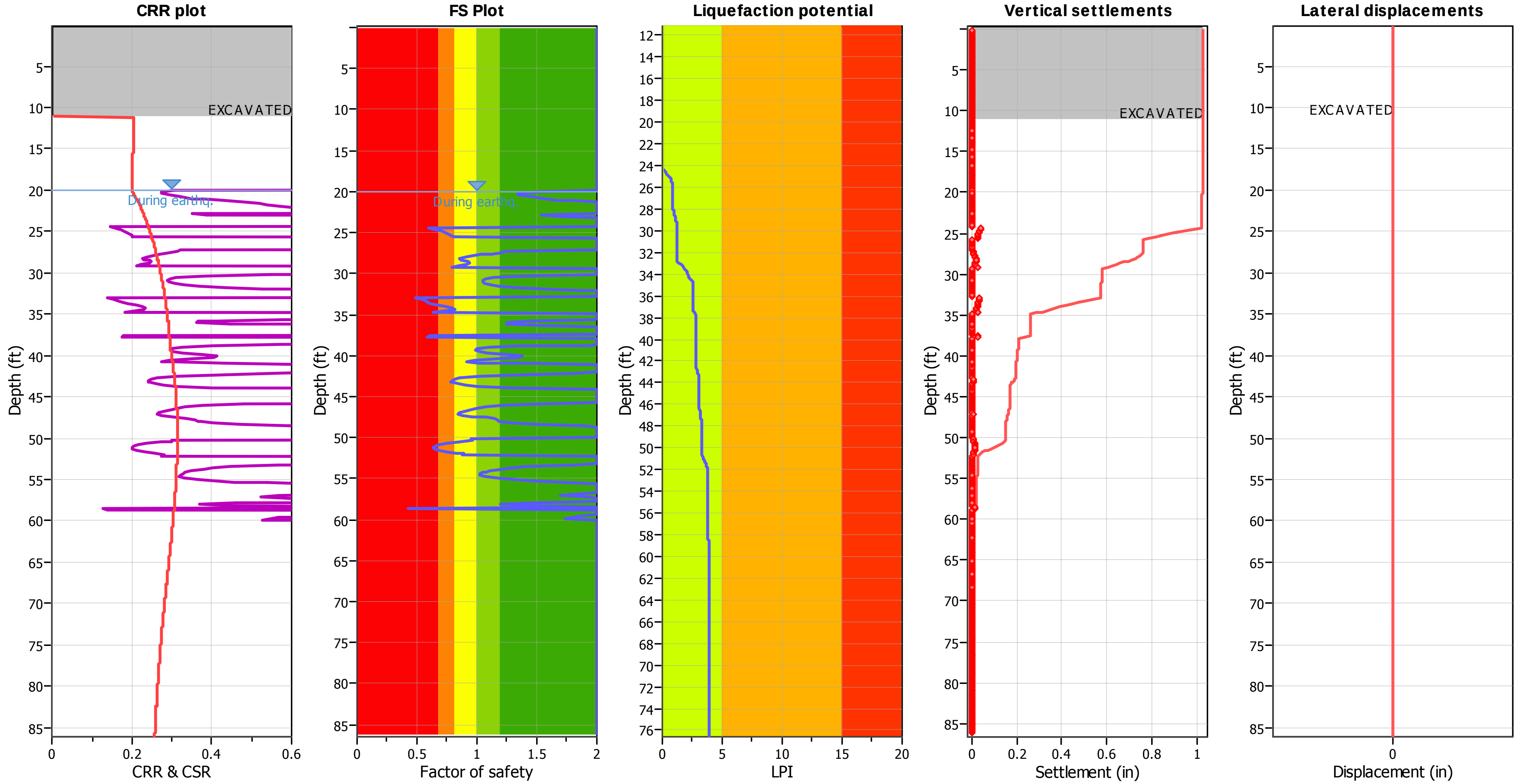
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

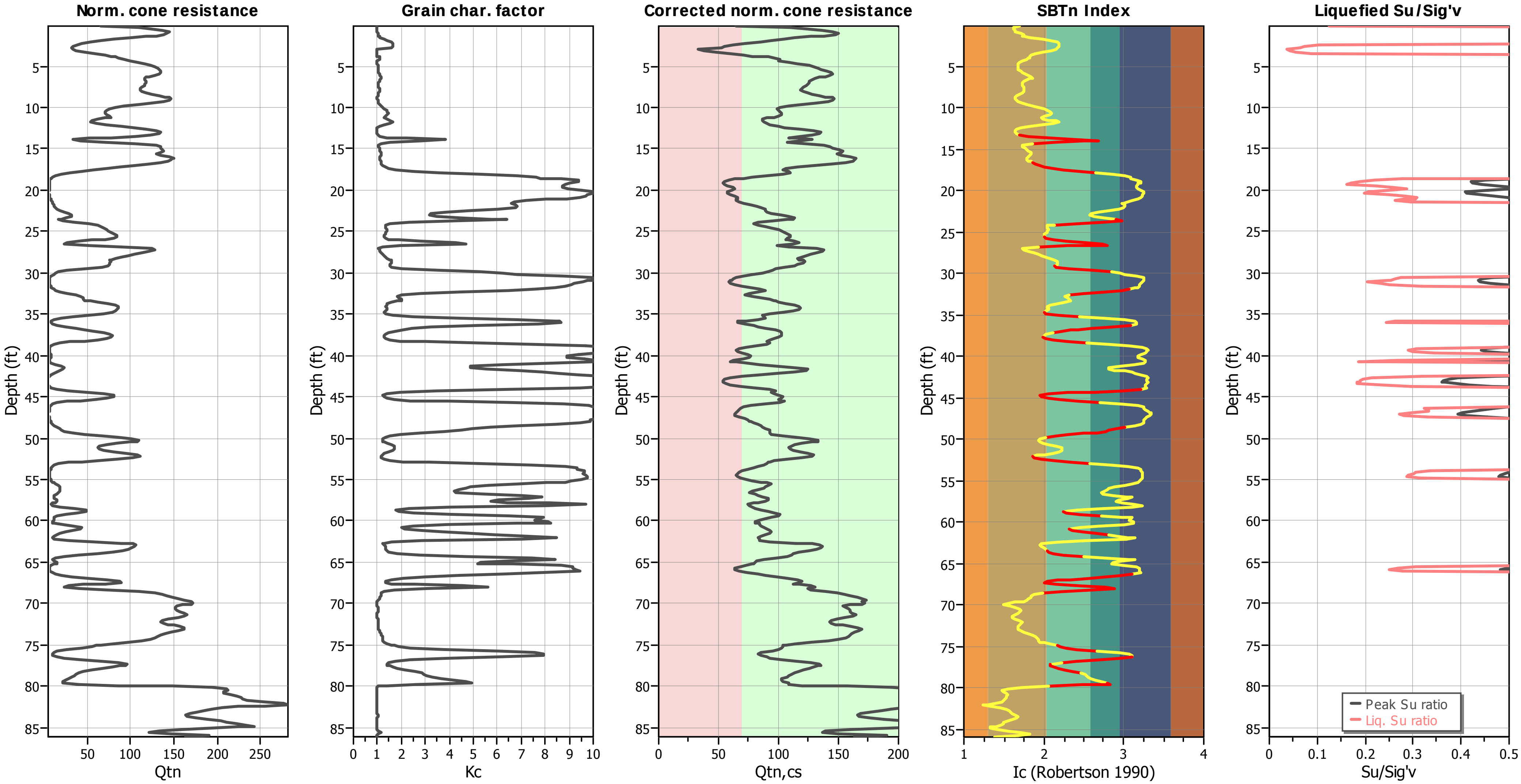
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

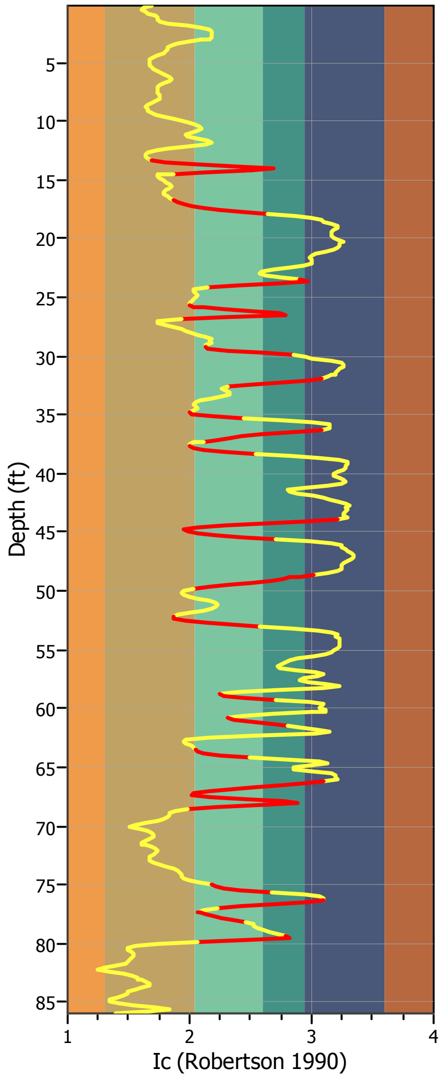
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

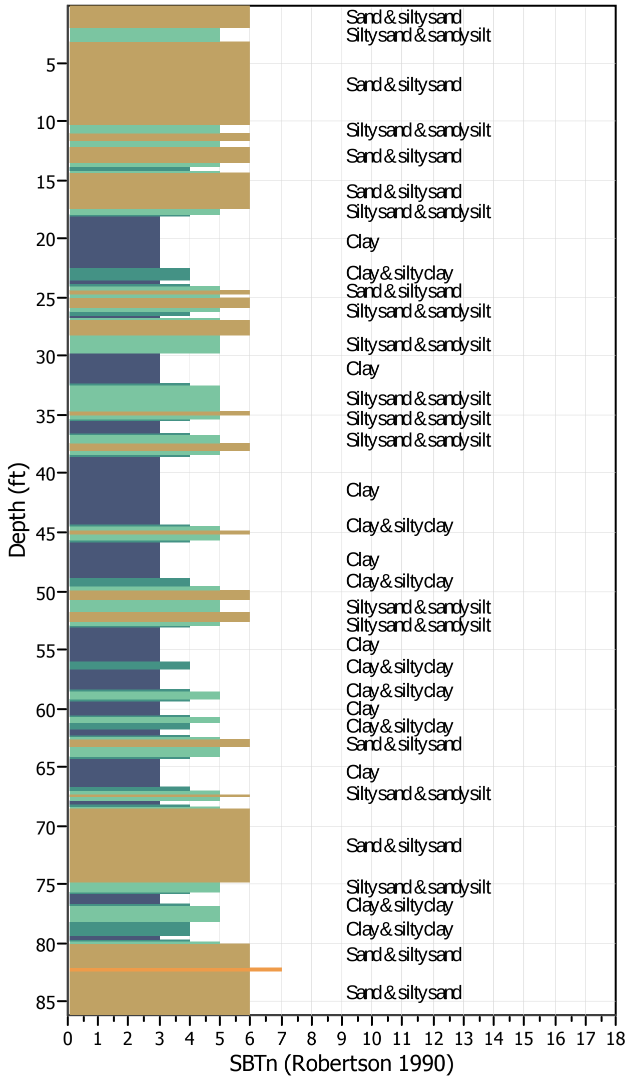
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.

SBTn Index



Norm. Soil Behaviour Type



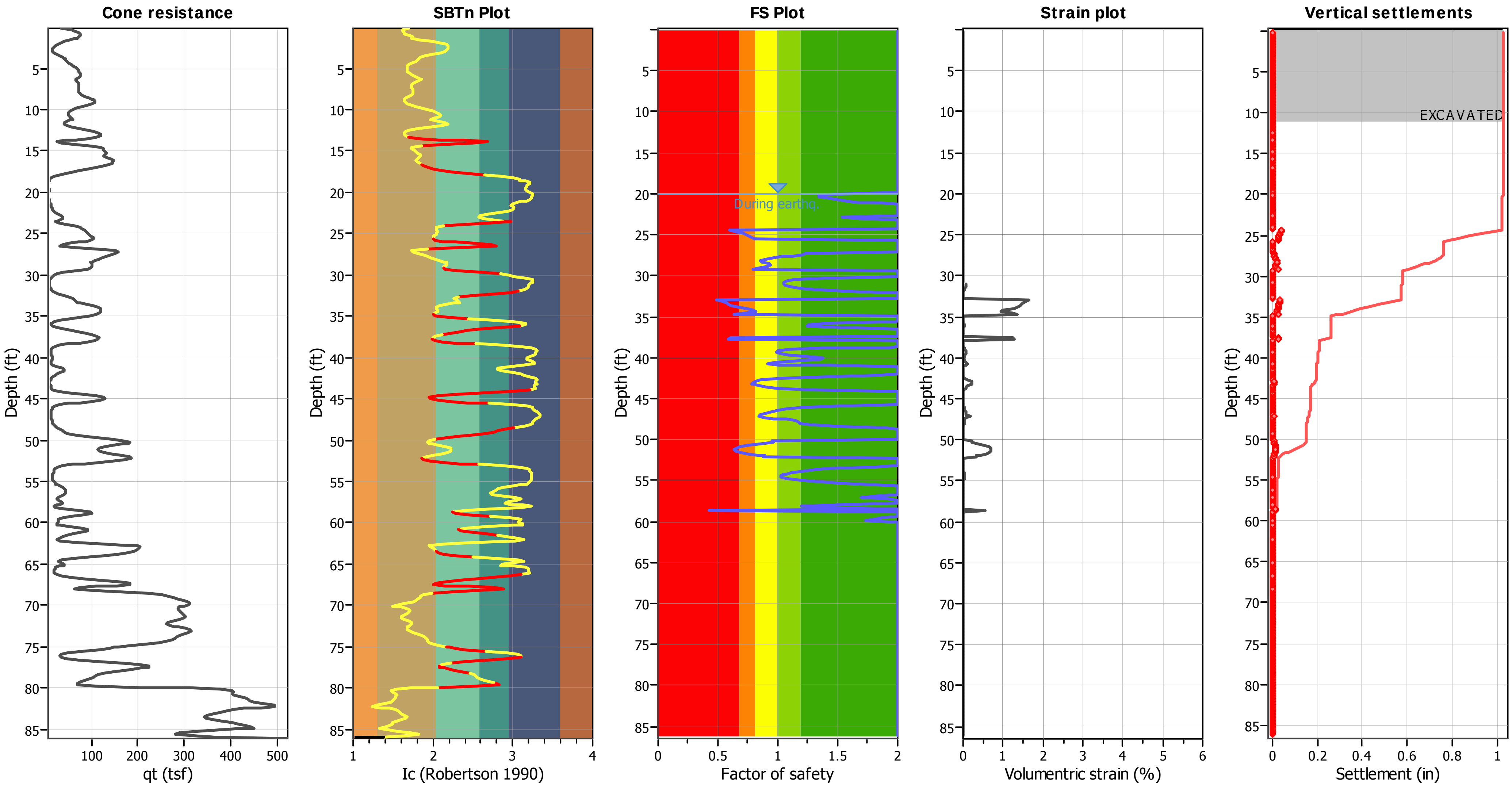
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	525
Total points excluded:	135
Exclusion percentage:	25.71%
Number of layers detected:	25

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

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17781 Cowan
Irvine, CA 92614
www.leightongroup.com

LIQUEFACTION ANALYSIS REPORT

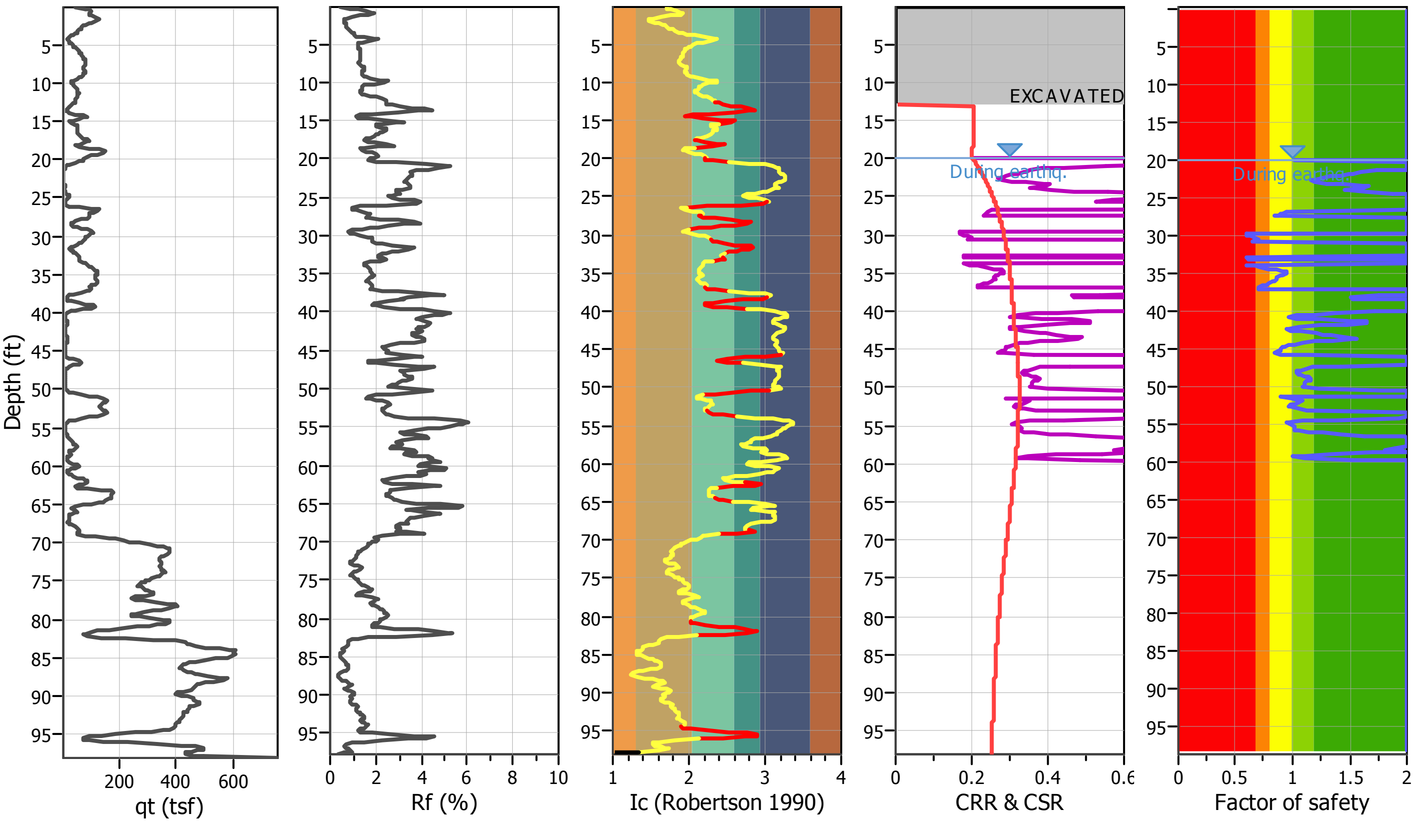
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

CPT file : CPT-14

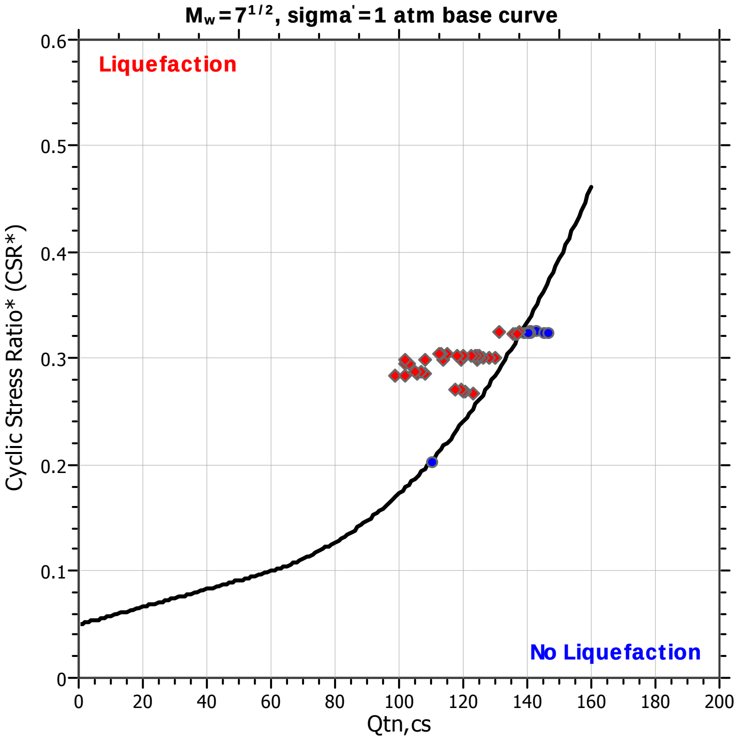
Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	13.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

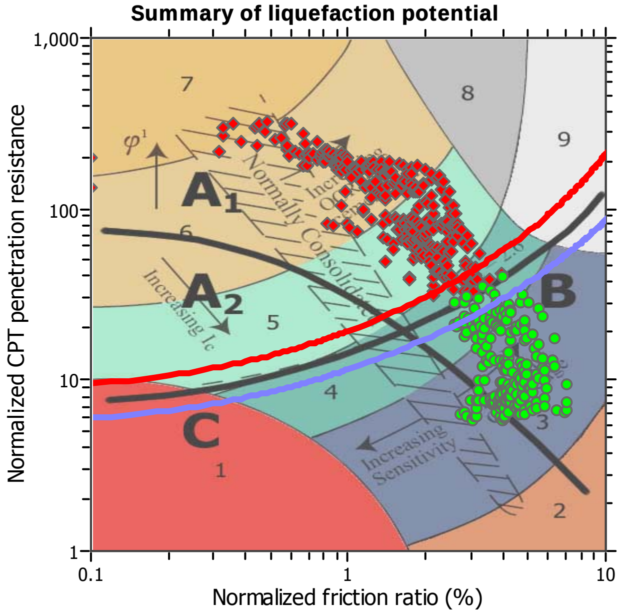
Cone resistance **Friction Ratio** **SBTn Plot** **CRR plot** **FS Plot**



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

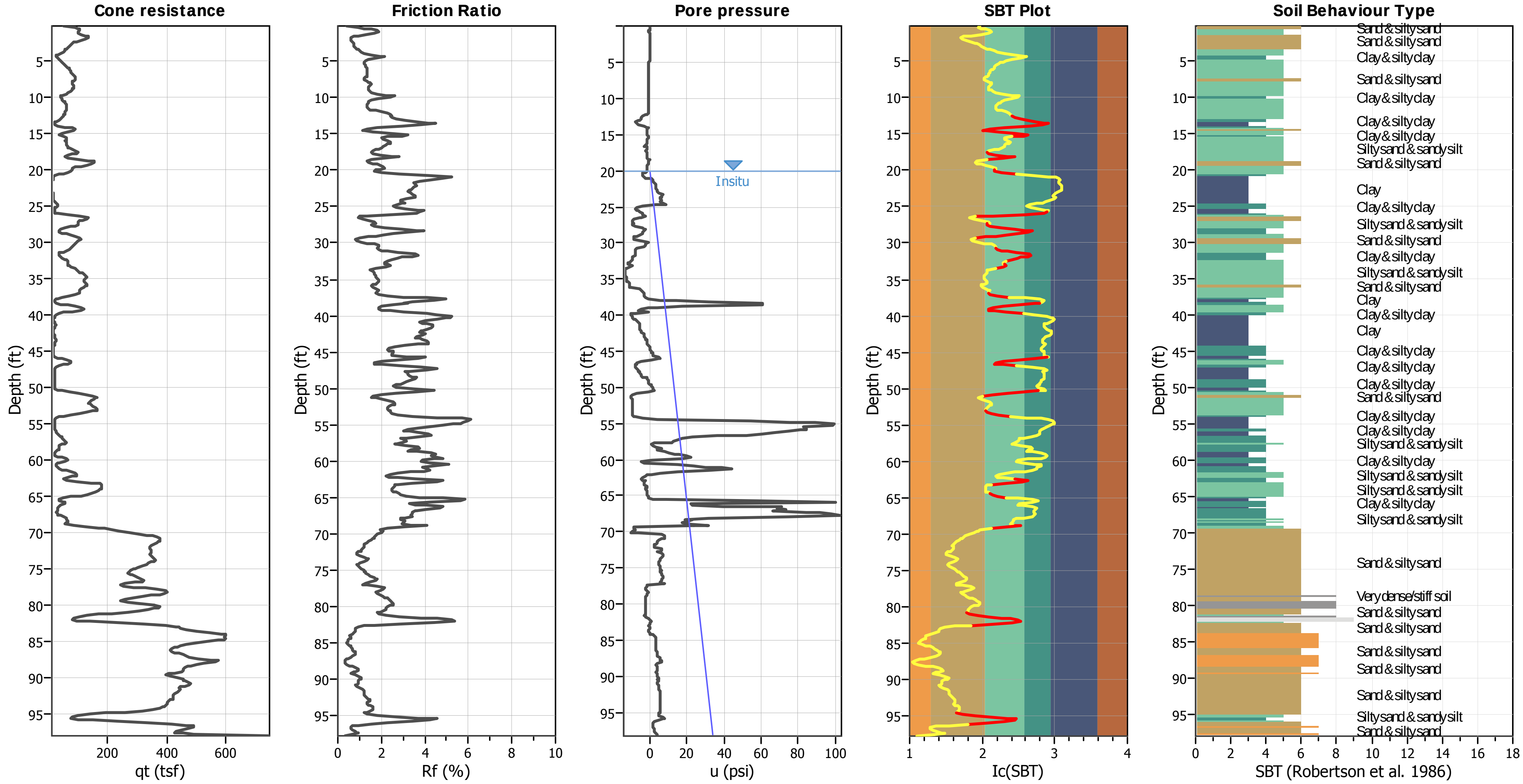


Summary of liquefaction potential



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

CPT basic interpretation plots



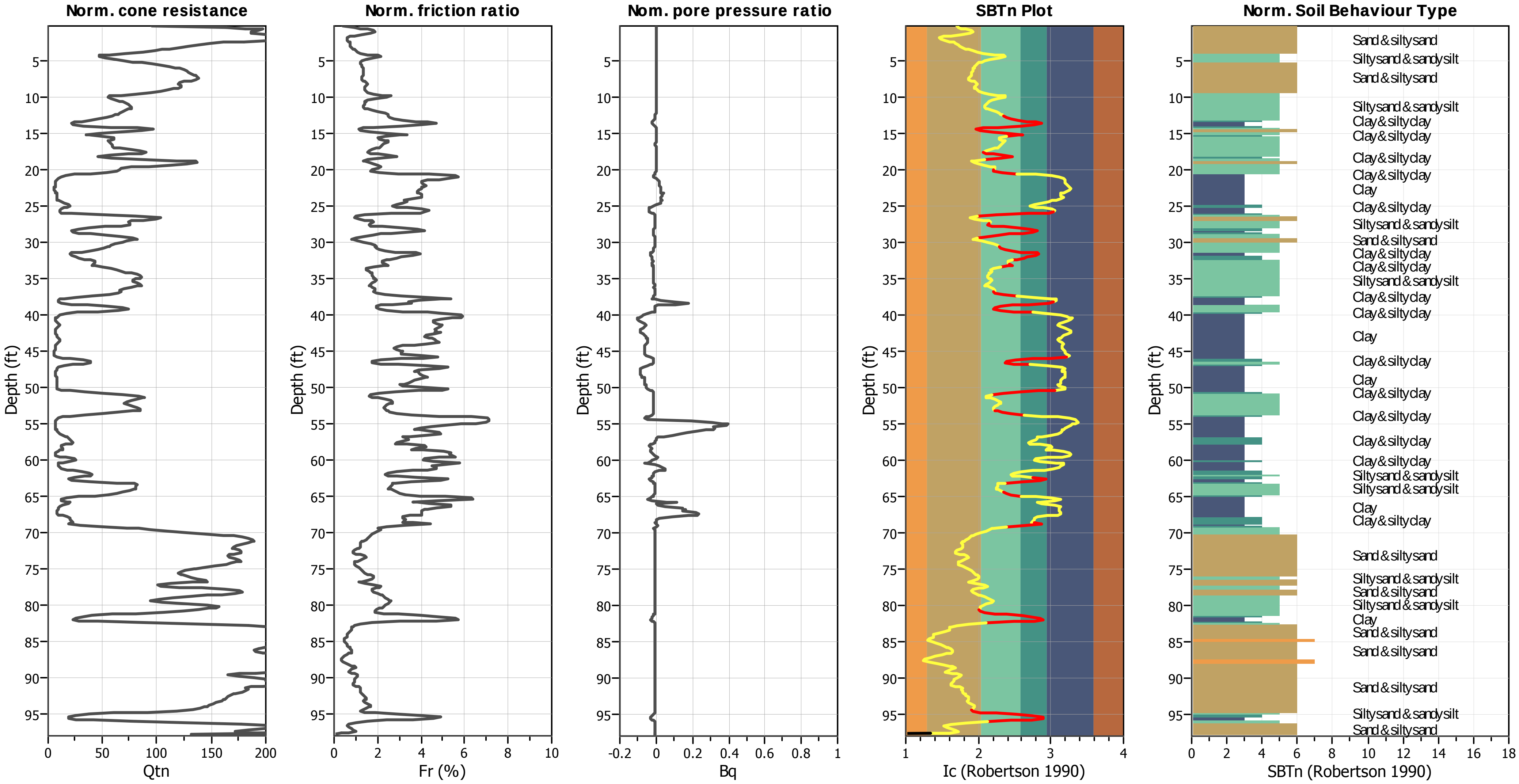
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	13.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



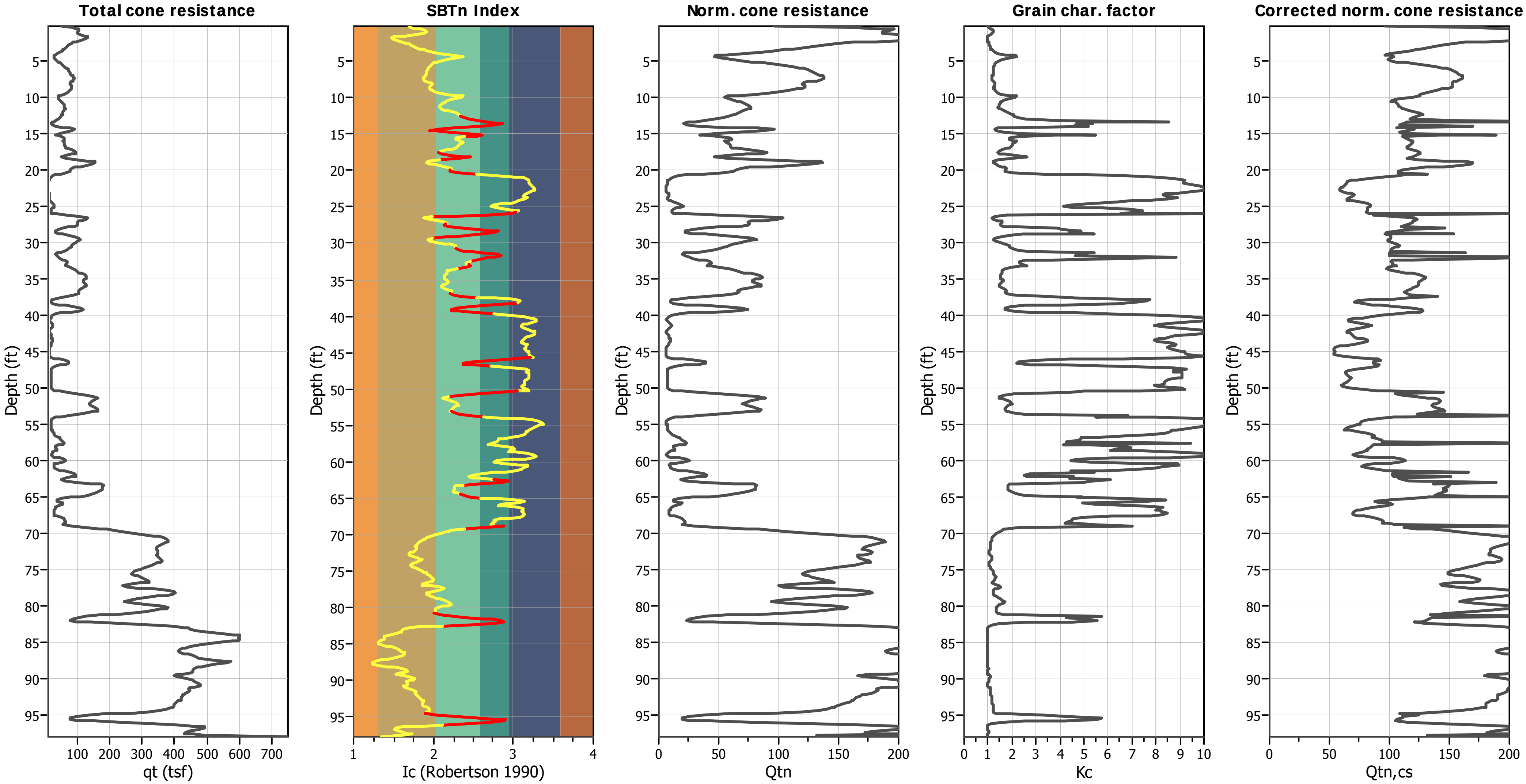
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

SBTn legend

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

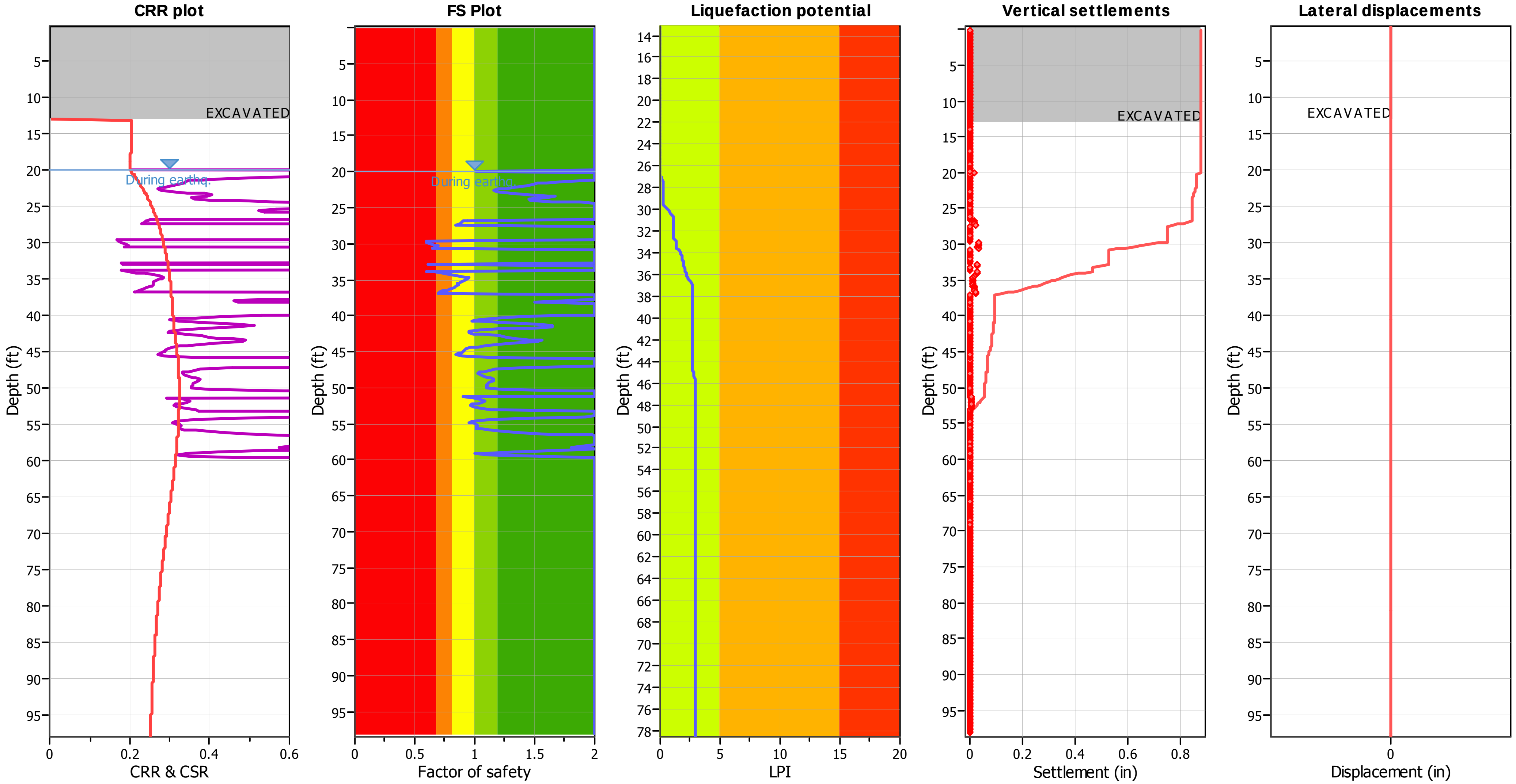
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

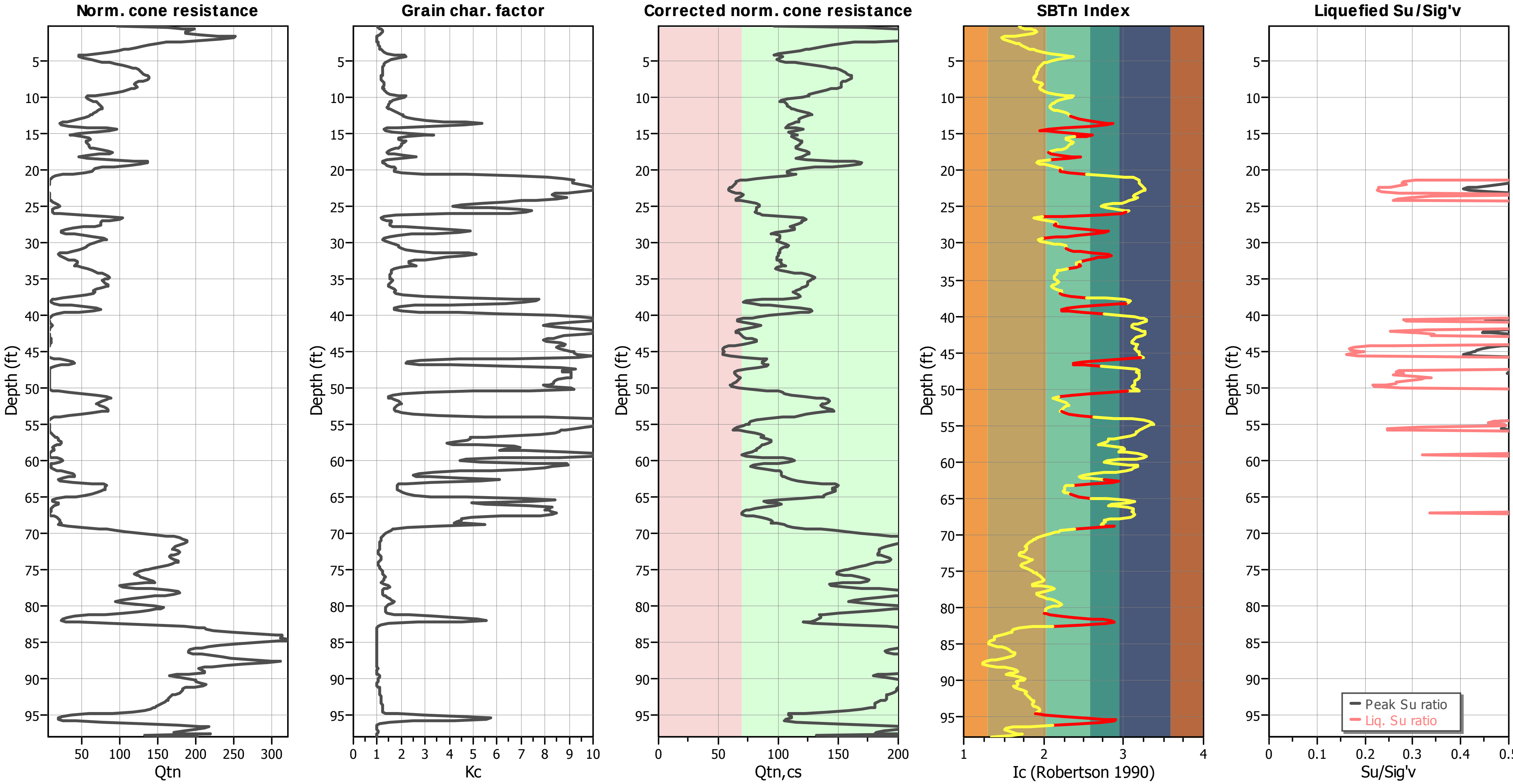
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	13.00 ft	Limit depth:	60.00 ft

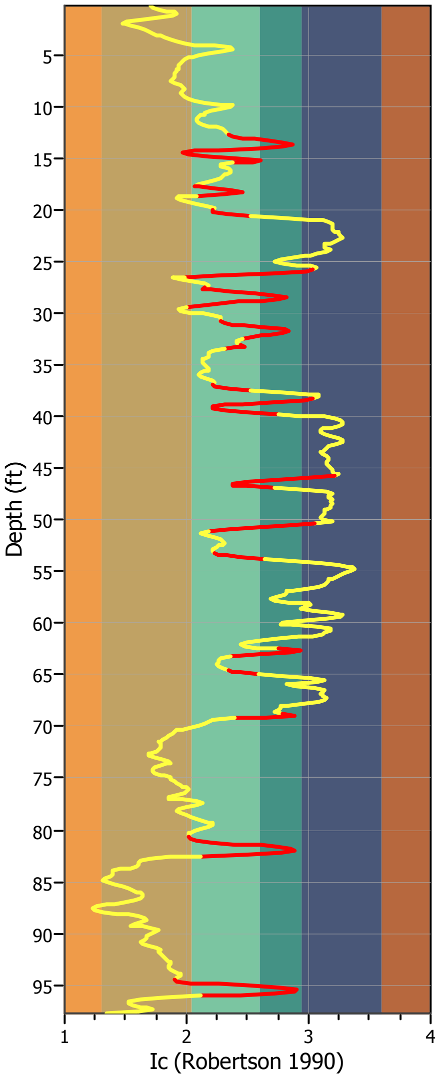
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

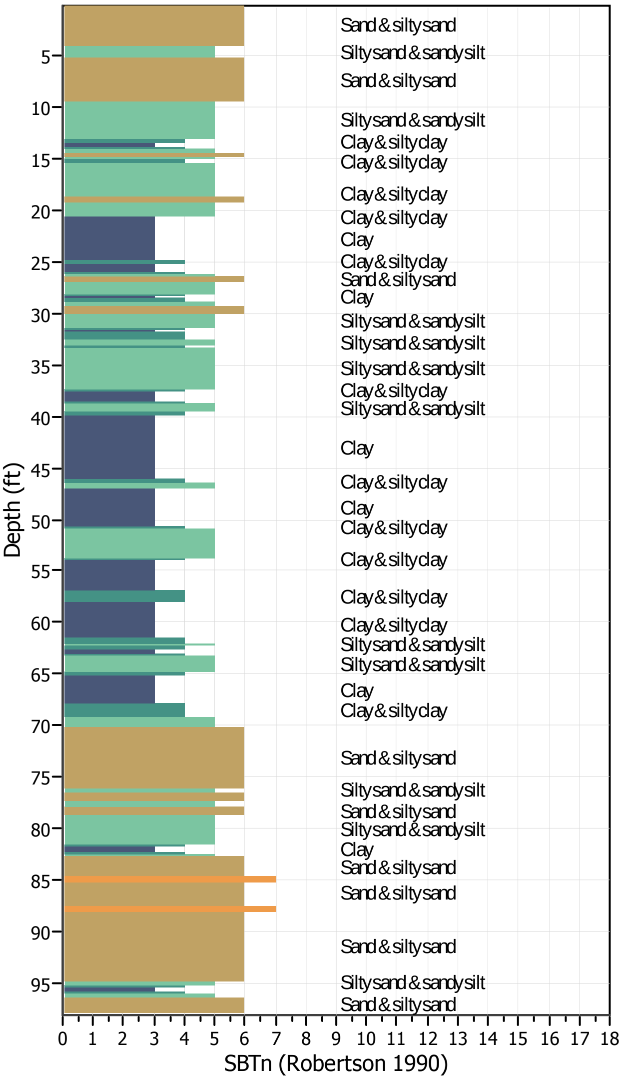
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.

SBTn Index



Norm. Soil Behaviour Type



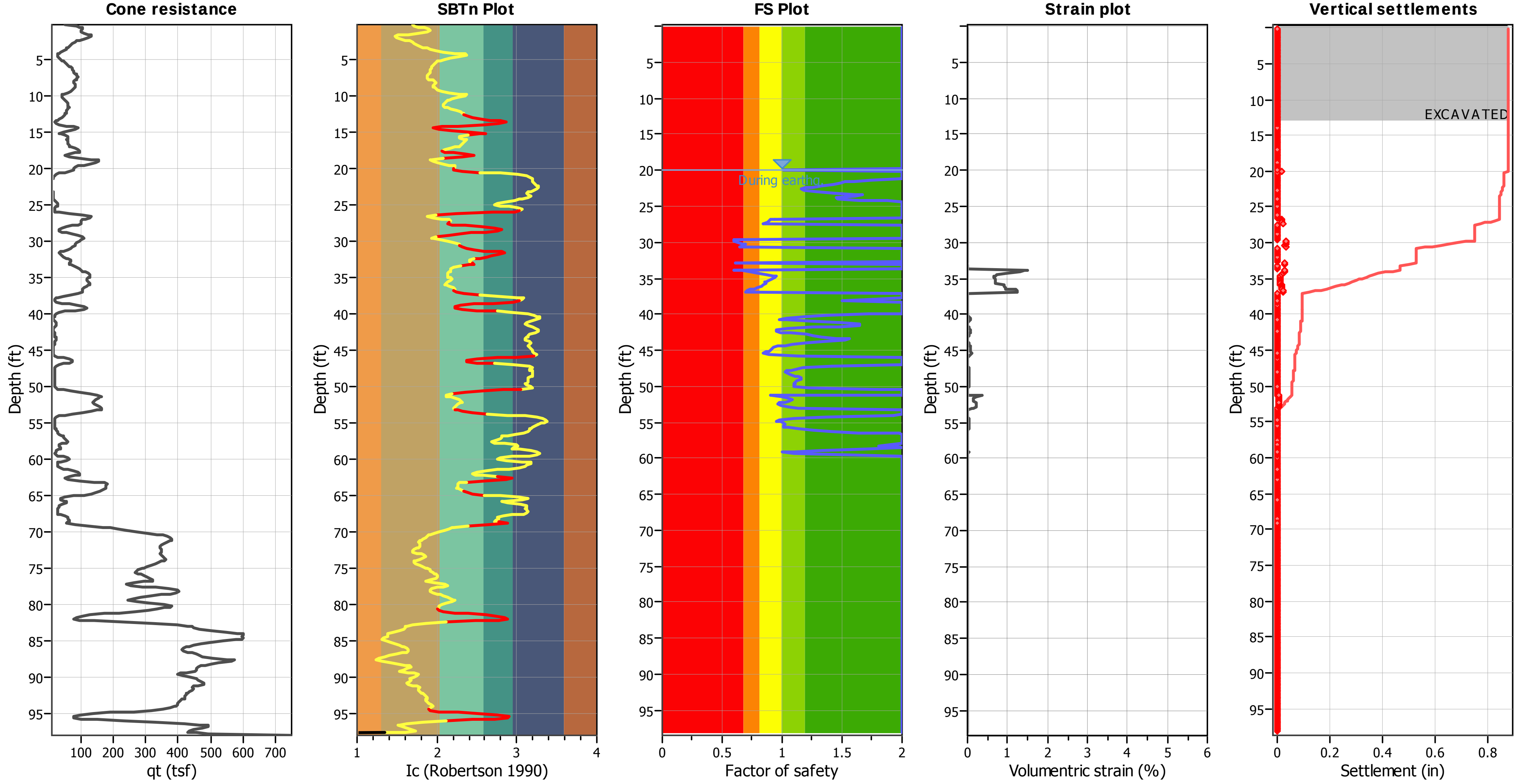
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	598
Total points excluded:	136
Exclusion percentage:	22.74%
Number of layers detected:	27

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

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Irvine, CA 92614
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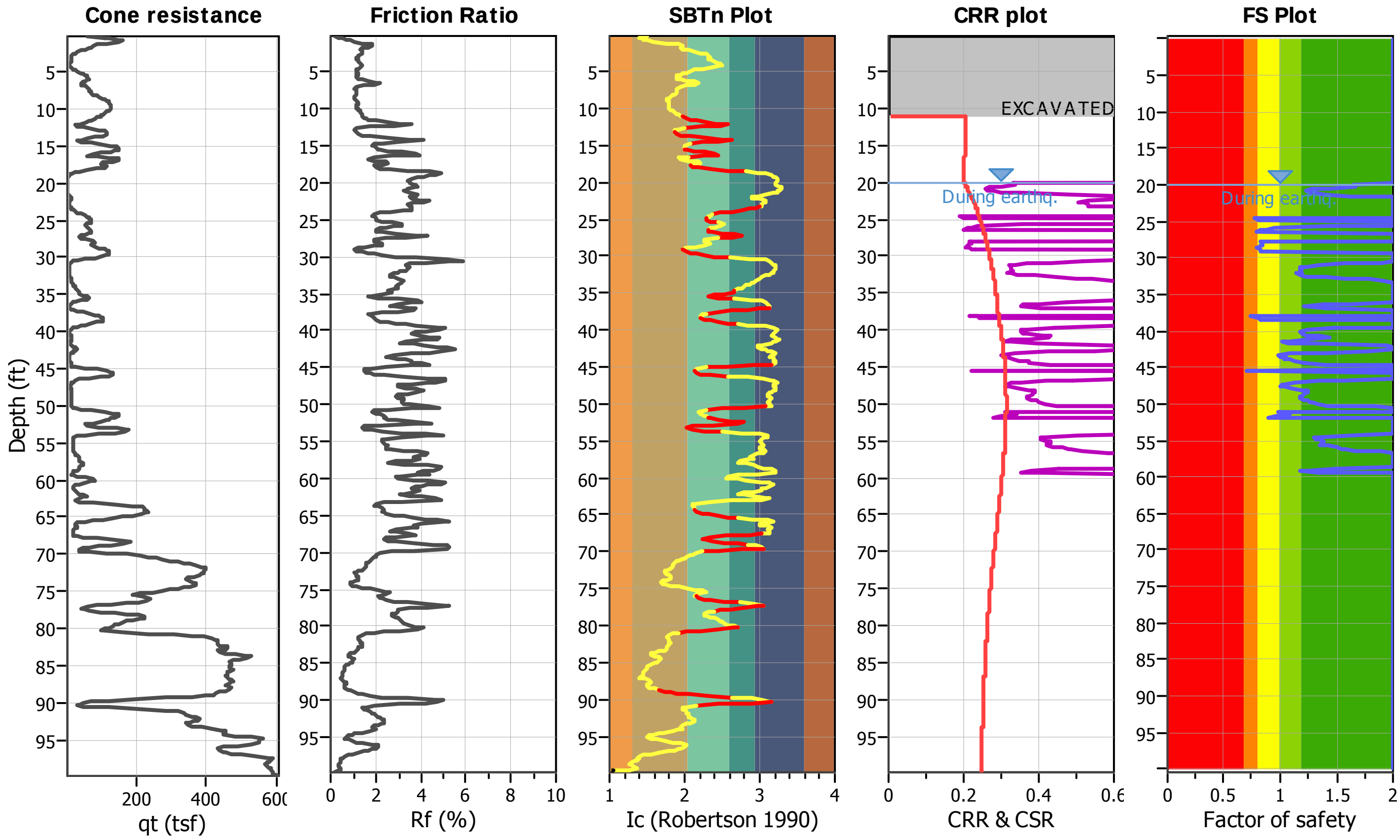
LIQUEFACTION ANALYSIS REPORT

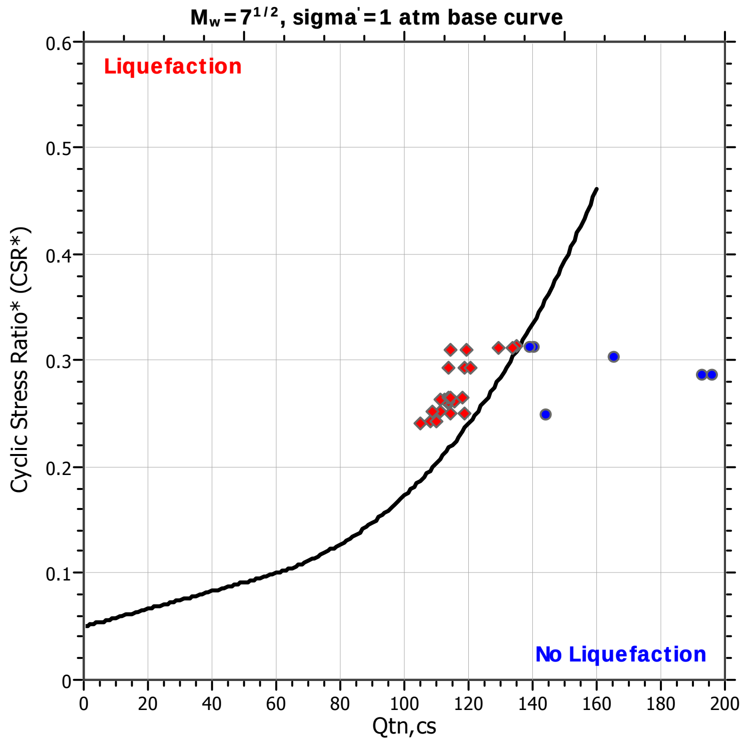
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

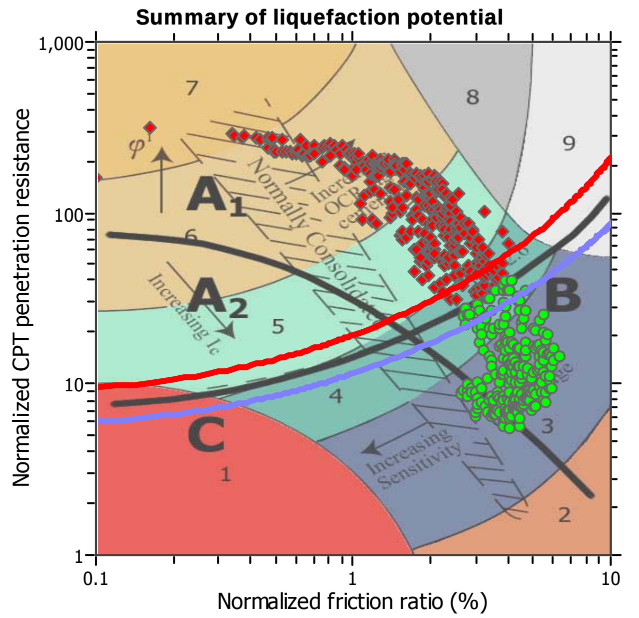
CPT file : CPT-9

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	11.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.00 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

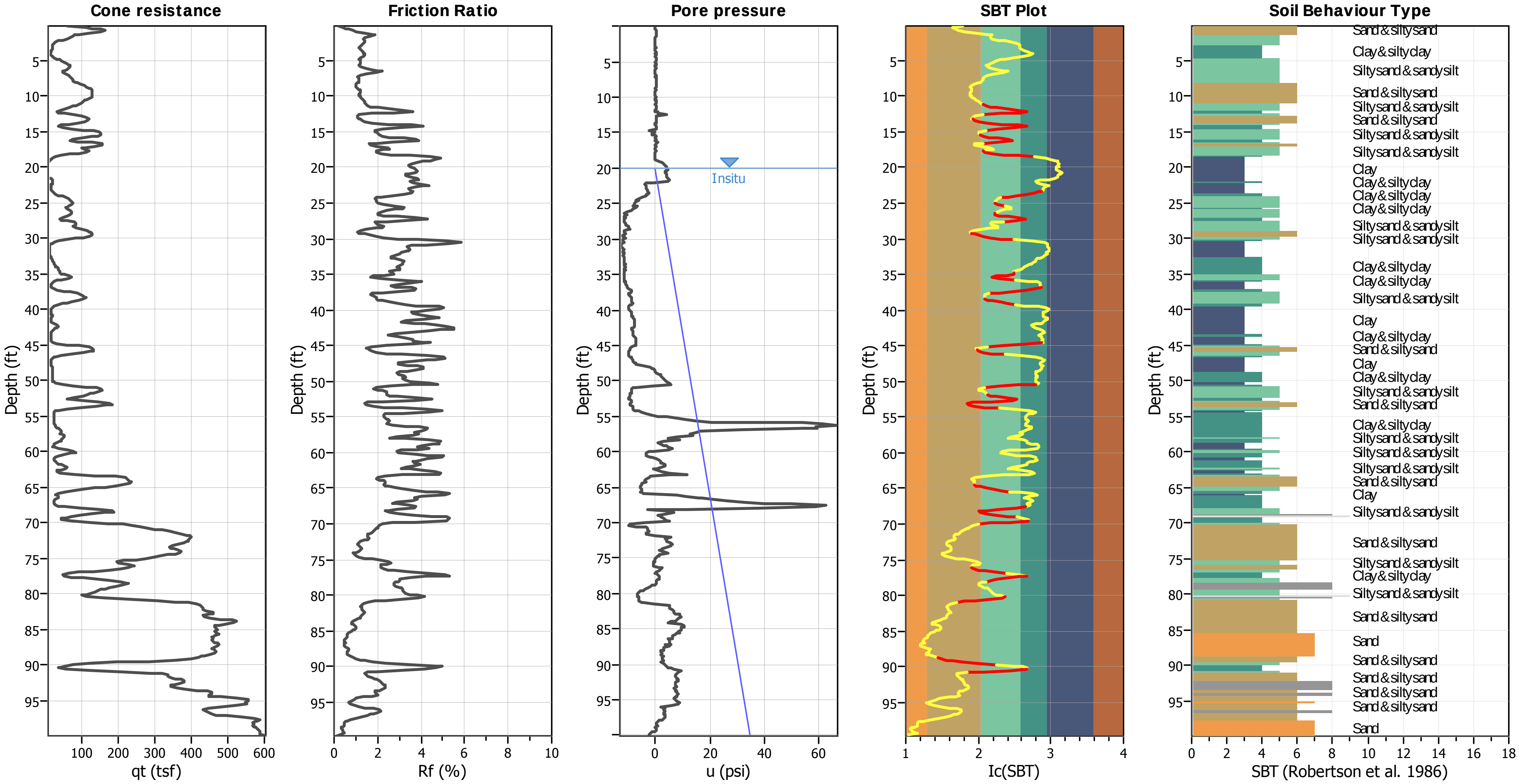






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



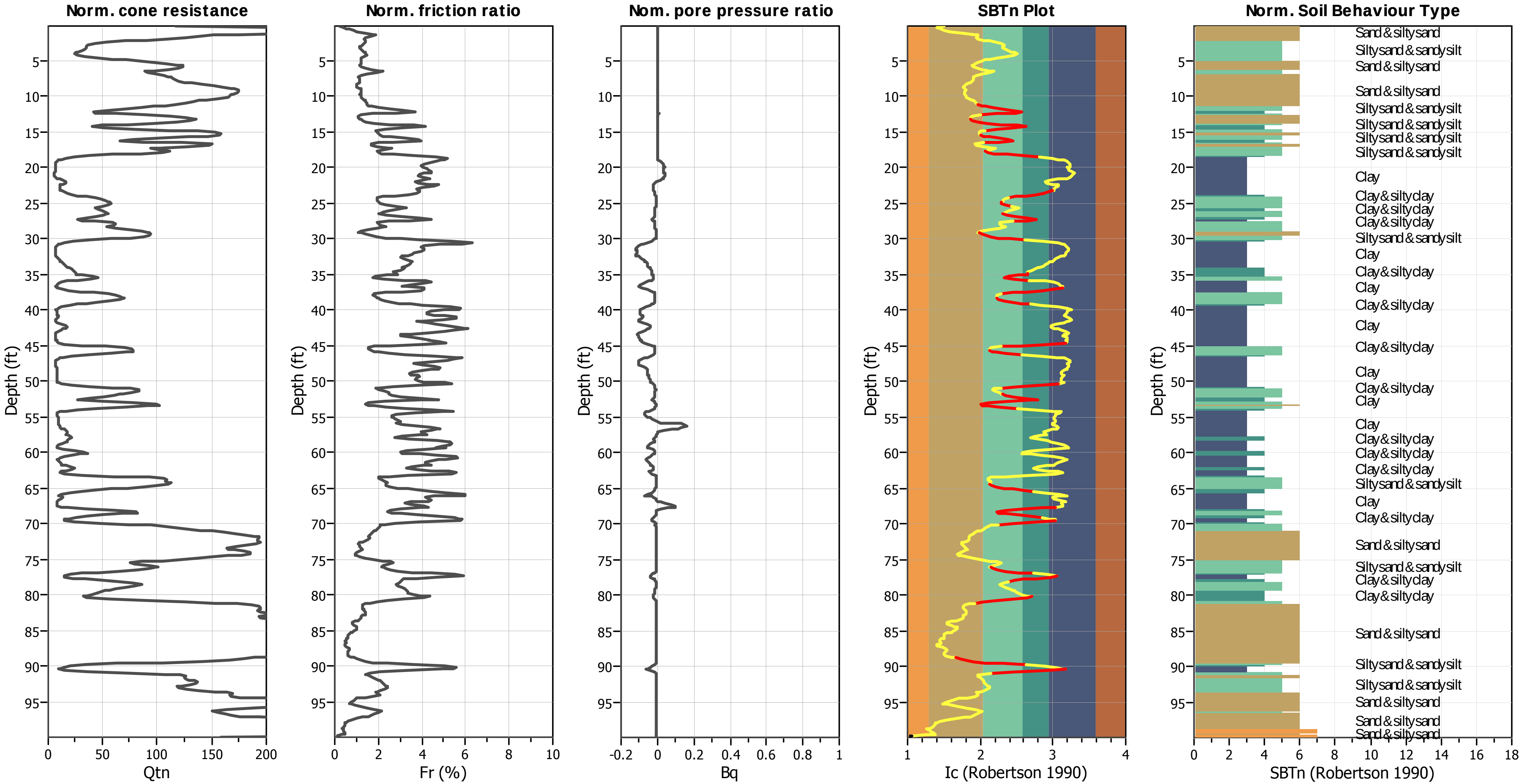
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	11.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



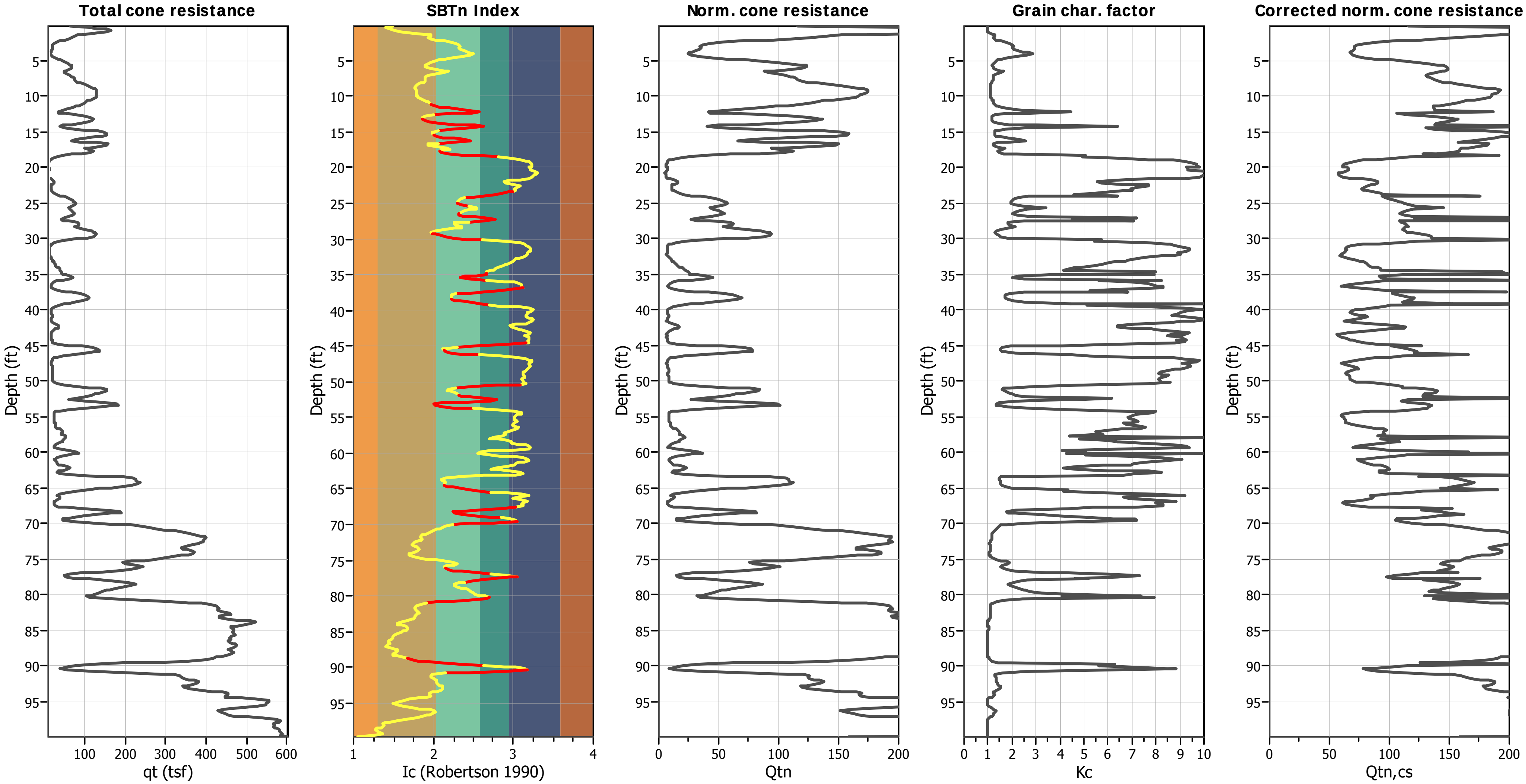
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

SBTn legend

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

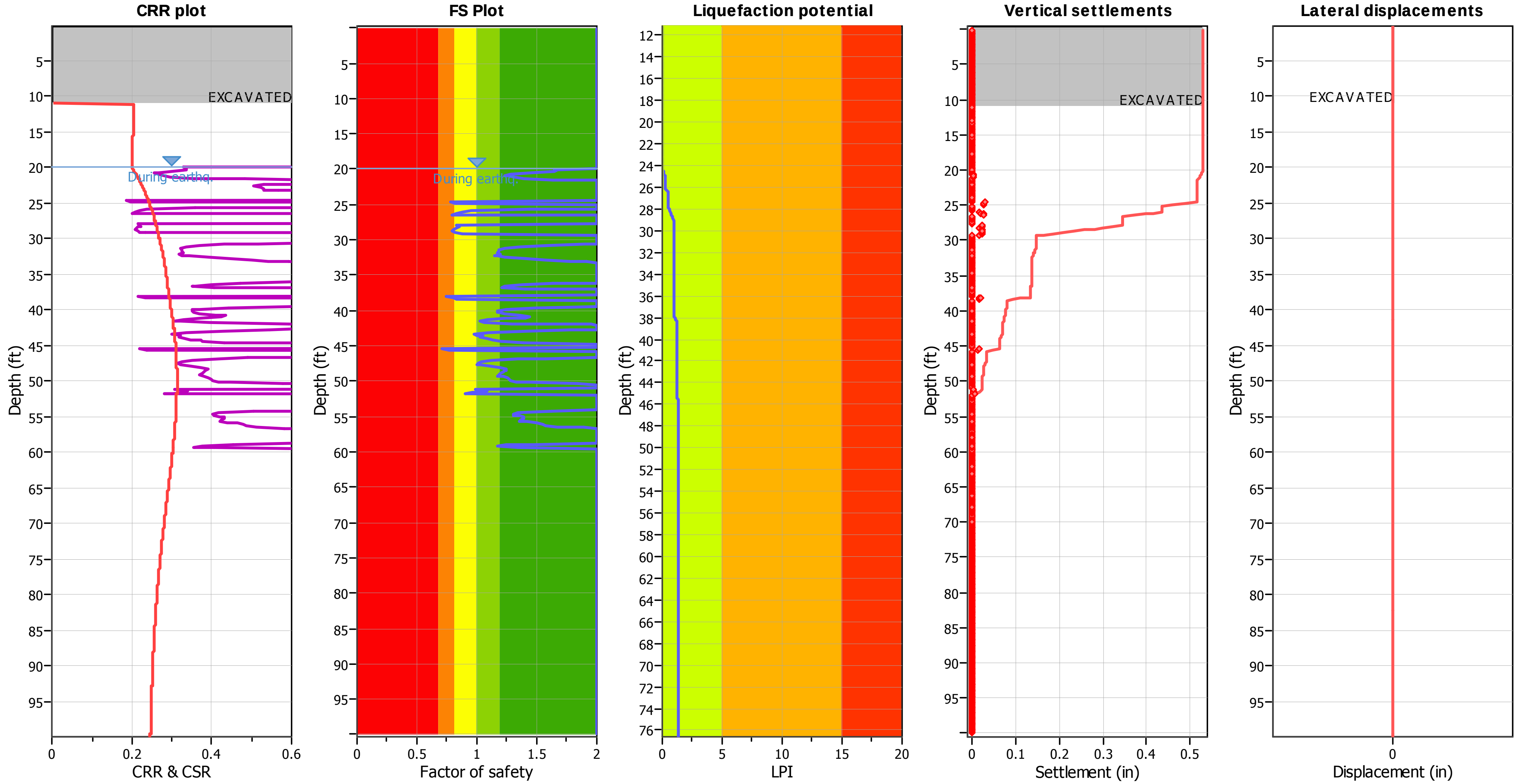
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

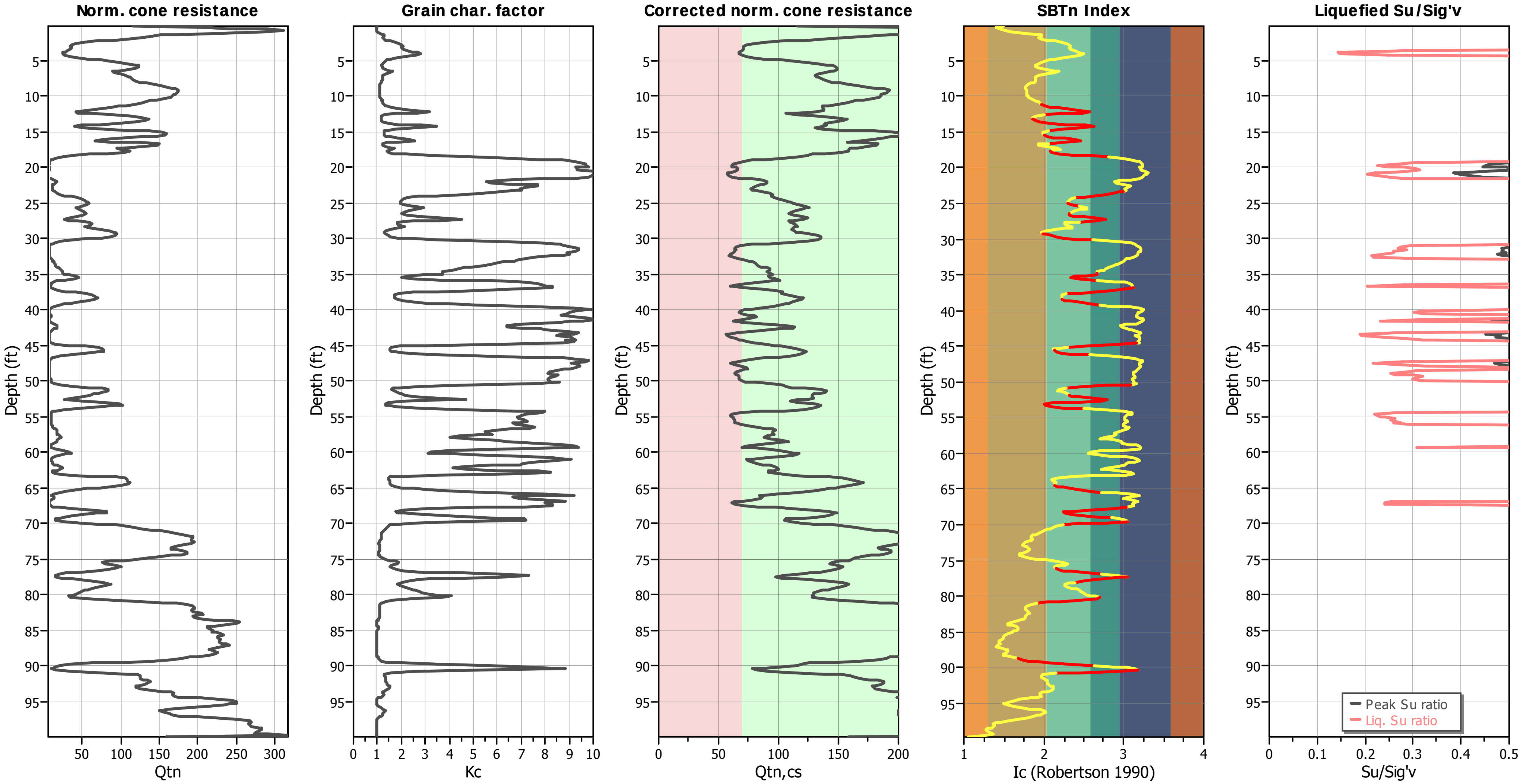
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	11.00 ft	Limit depth:	60.00 ft

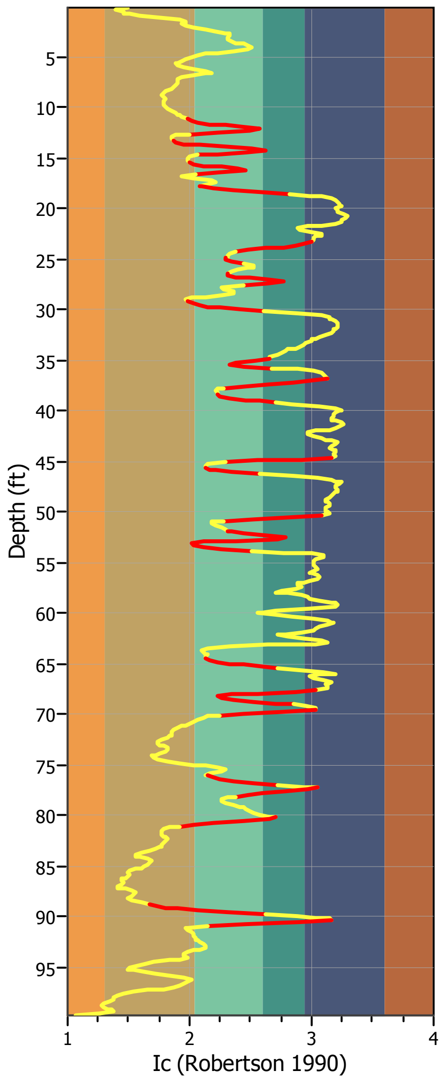
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

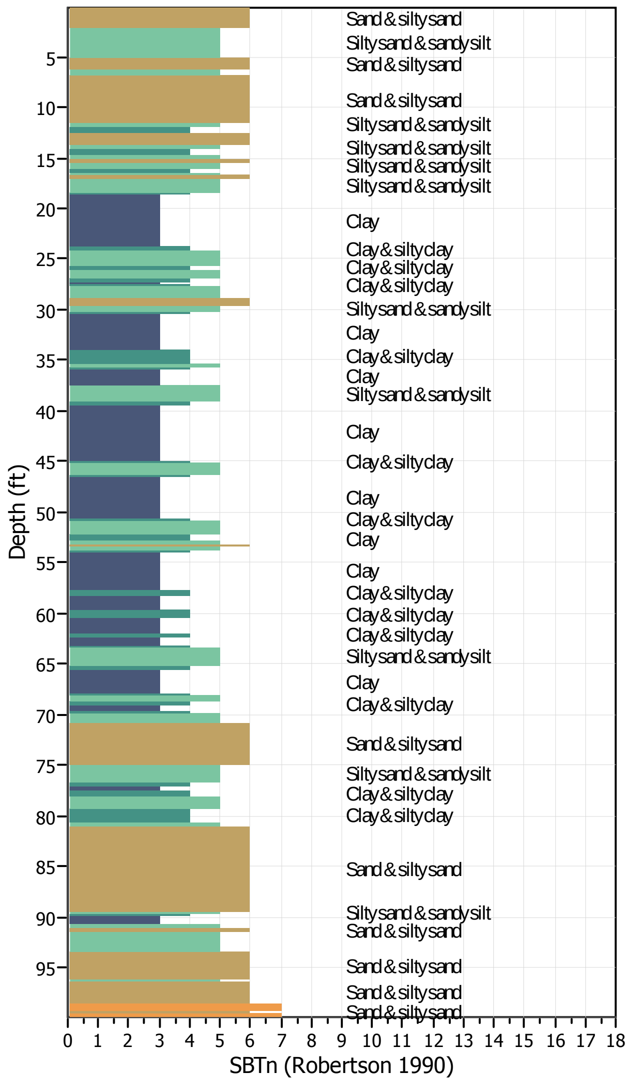
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.

SBTn Index

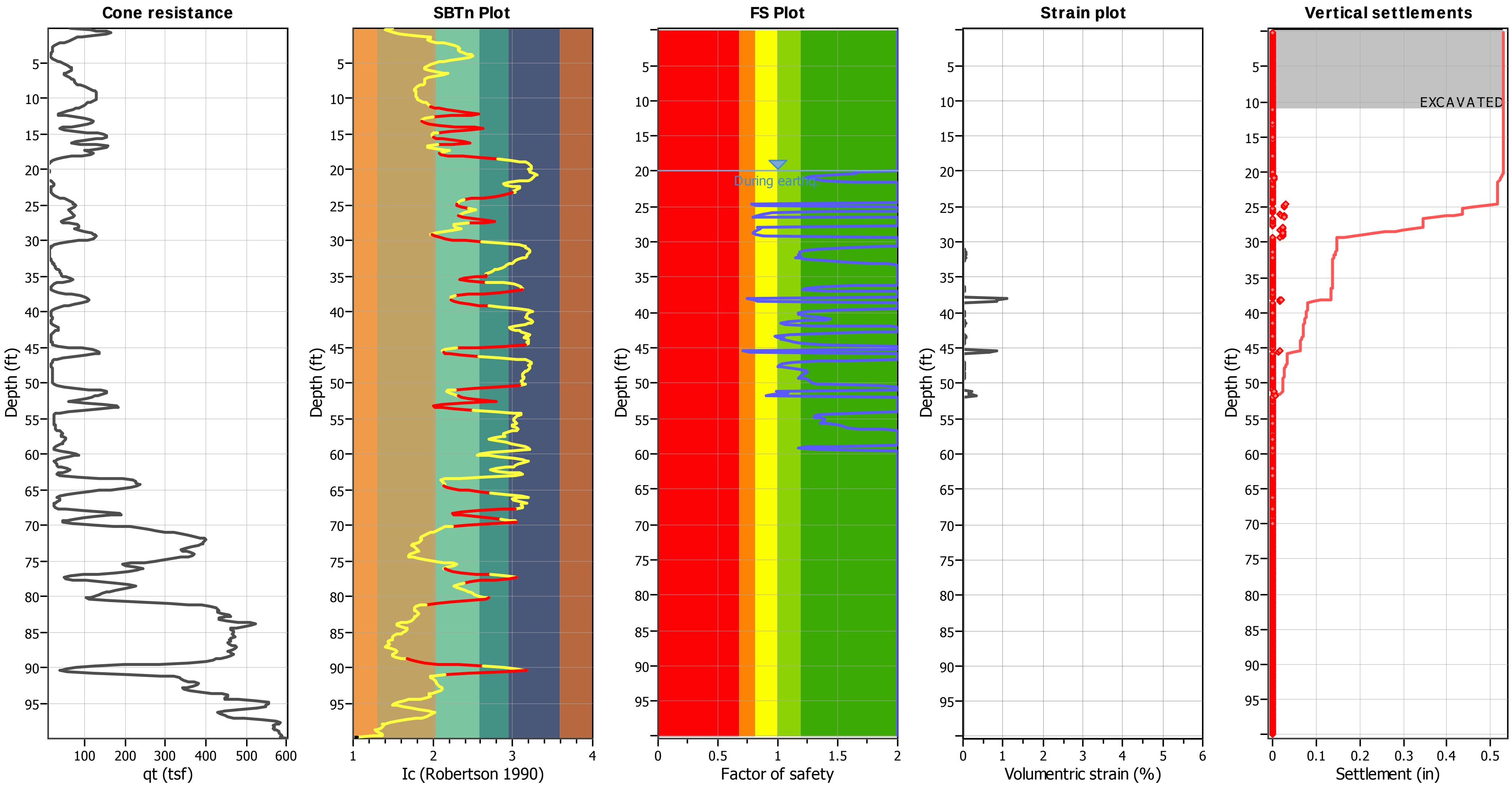


Norm. Soil Behaviour Type



Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	609
I_c maximum check value:	3.00	Total points excluded:	161
I_c change ratio value:	0.0250	Exclusion percentage:	26.44%
Minimum number of points in layer:	4	Number of layers detected:	31

Estimation of post-earthquake settlements

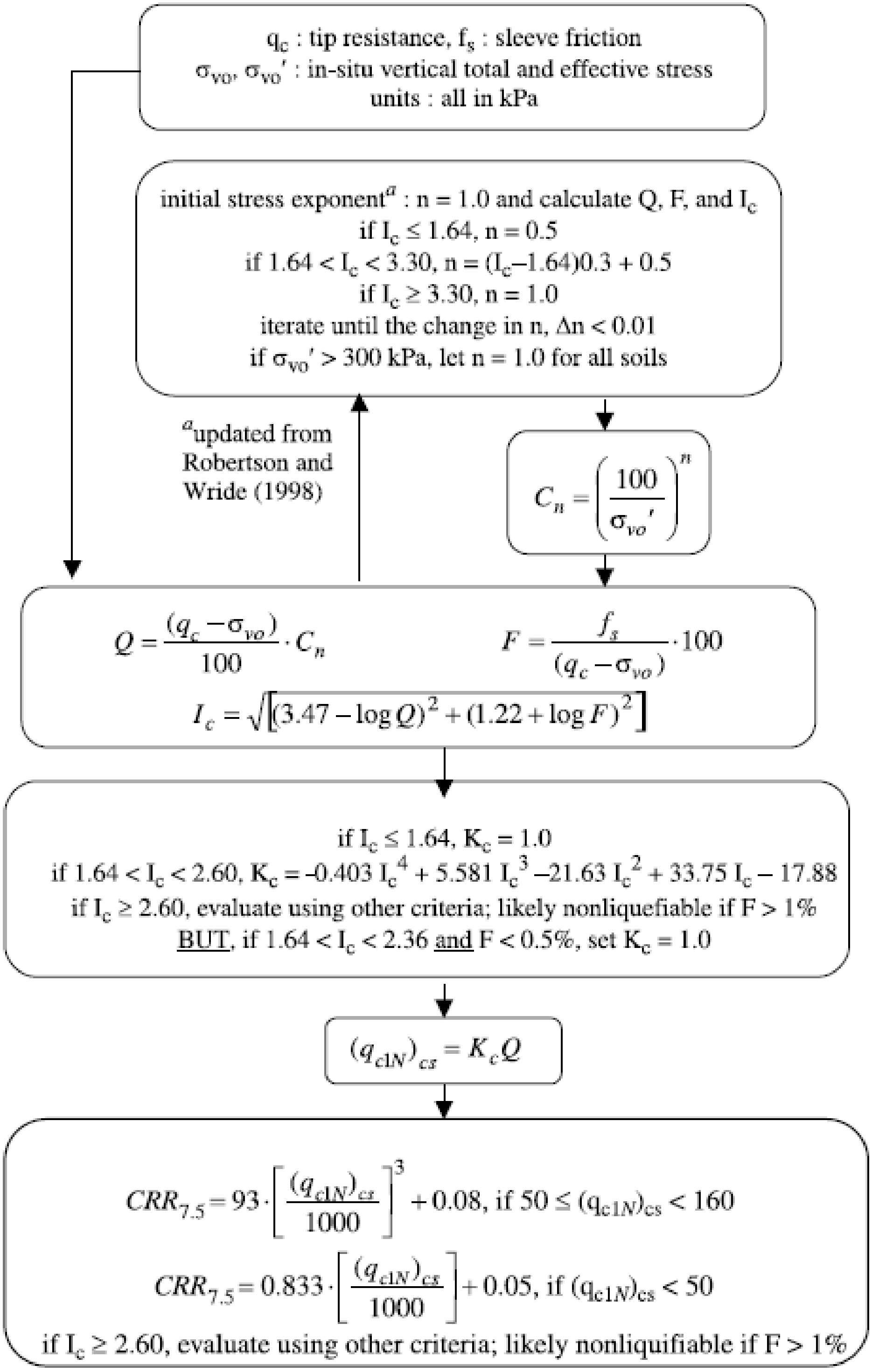


Abbreviations

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

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

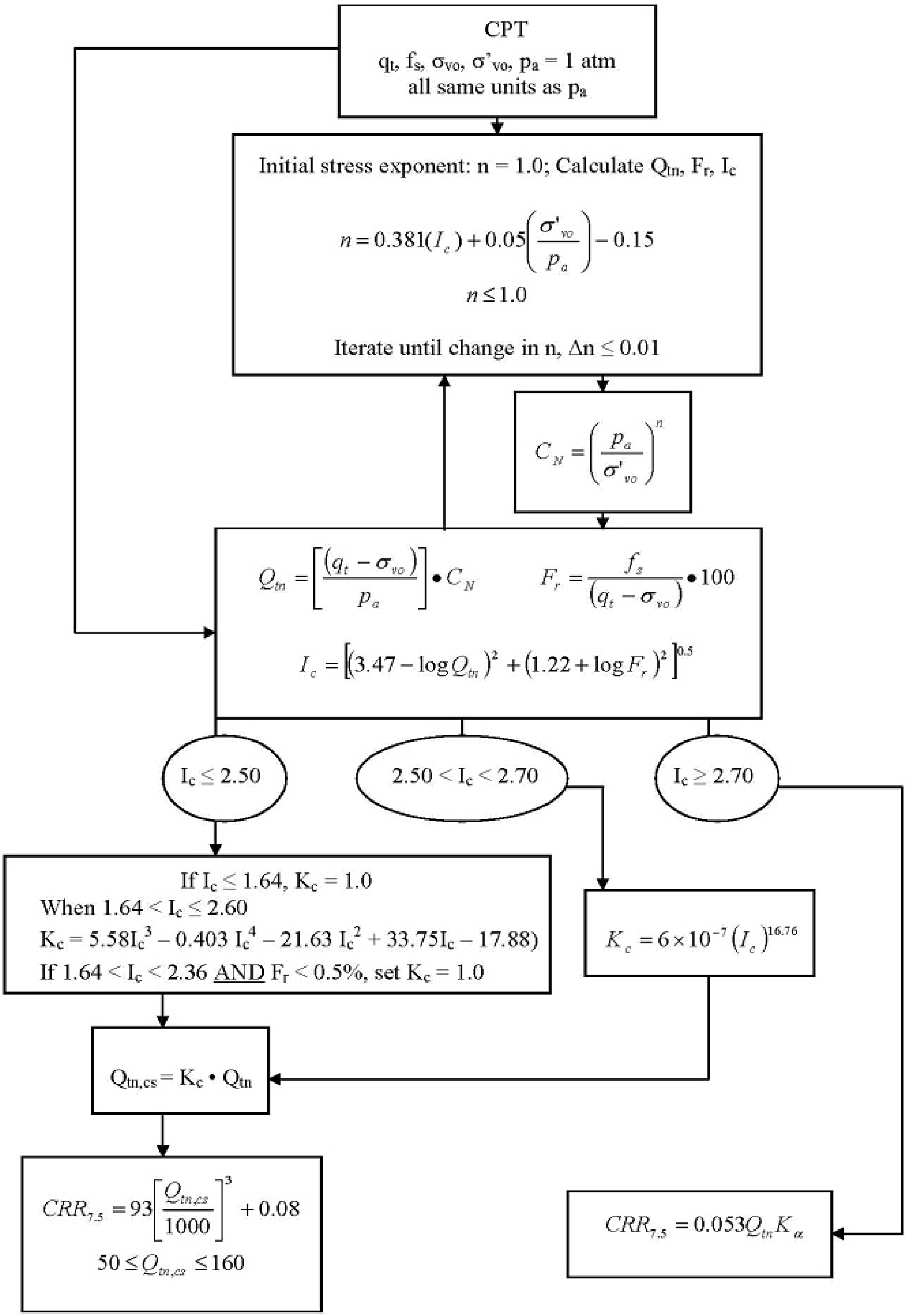
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of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



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

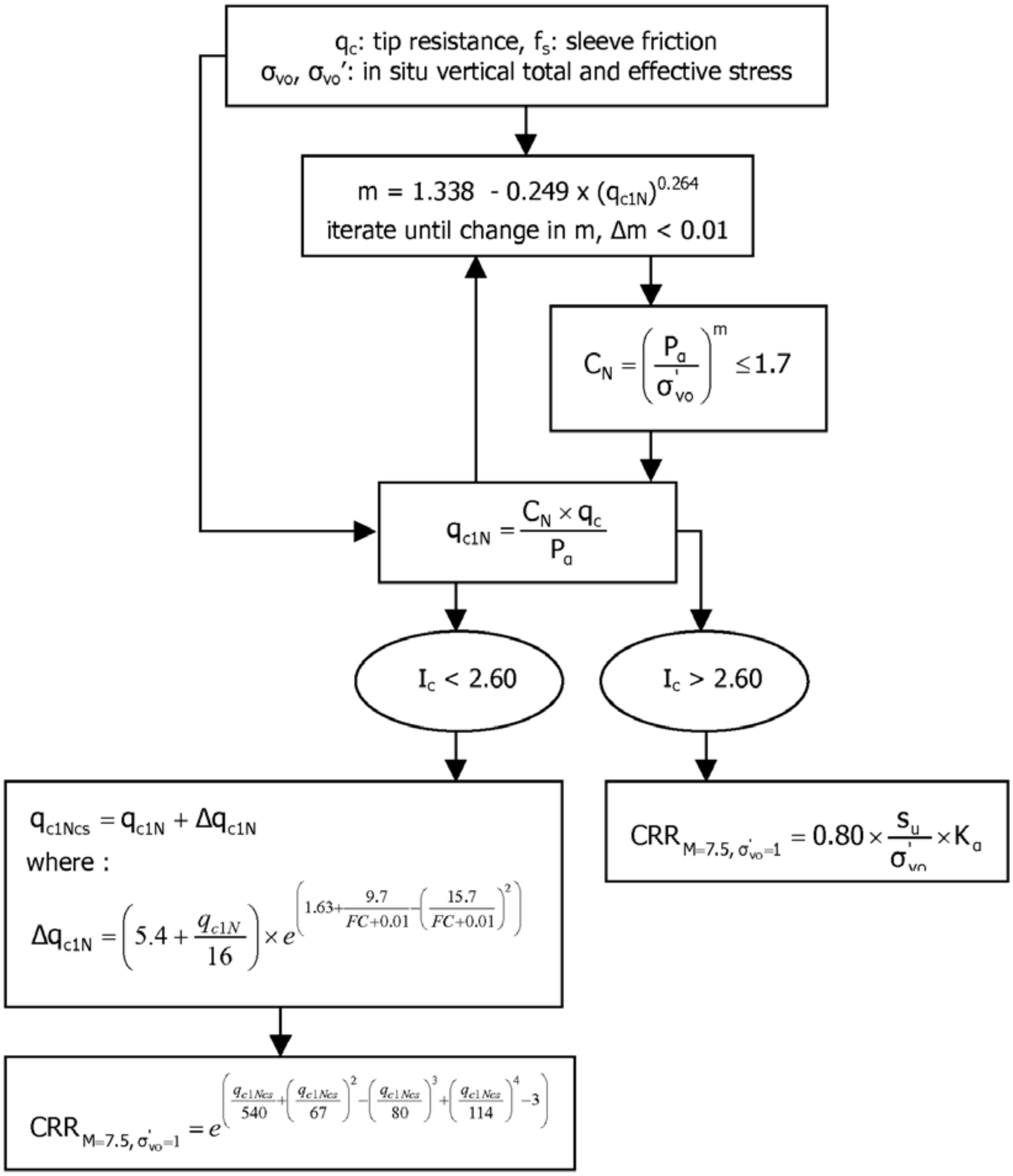
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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



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

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



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

CPT

q_t, f_s, I_c

$I_c < I_c$ cut-off

Initial estimate using raw tip measurements, friction ratio. Calculate $q_{t,1}$. Repeat until an acceptable convergence tolerance is achieved.

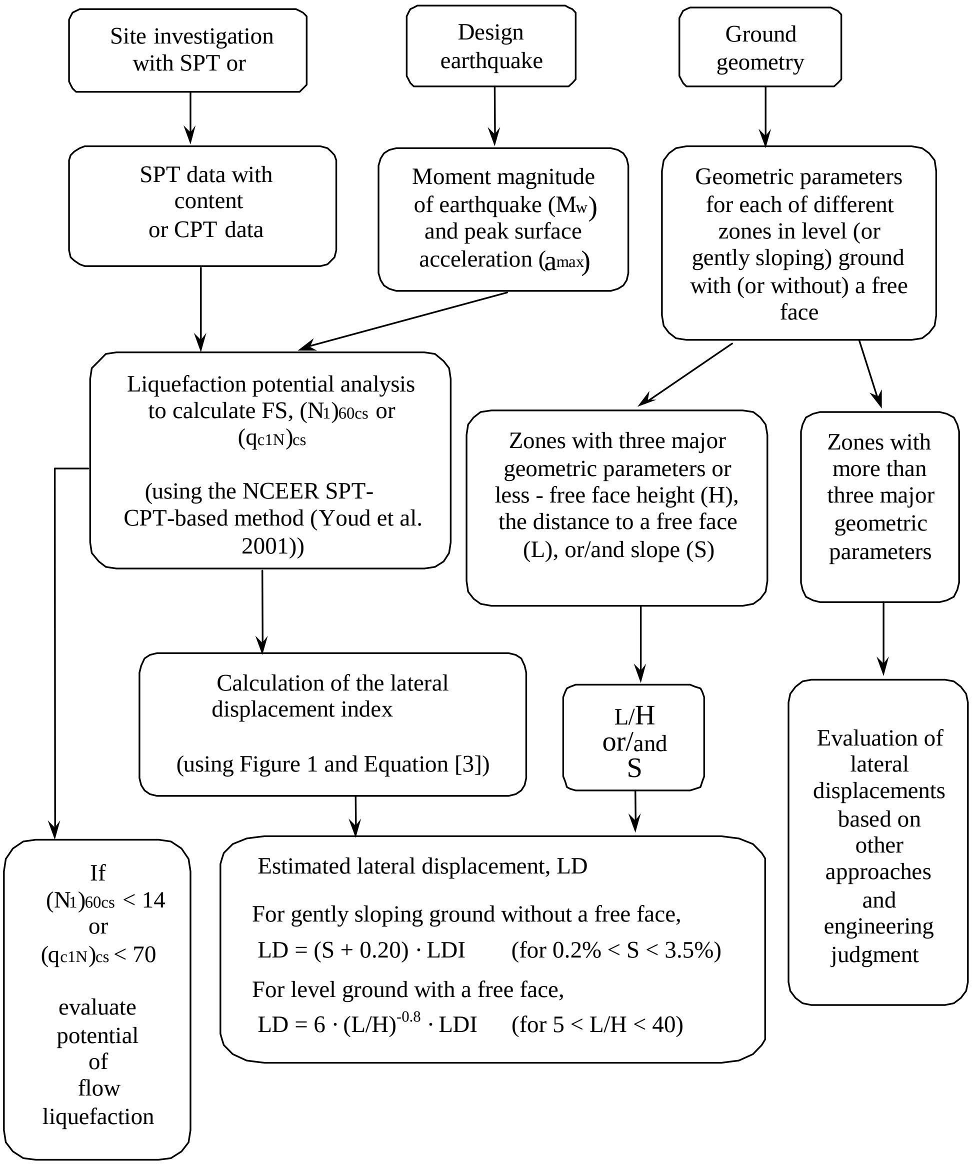
$$c = f_1 \cdot \left(\frac{R_f}{f_3}\right)^{f_2}$$

$$C_q = \left(\frac{P_a}{\sigma'_v}\right)^{c}$$

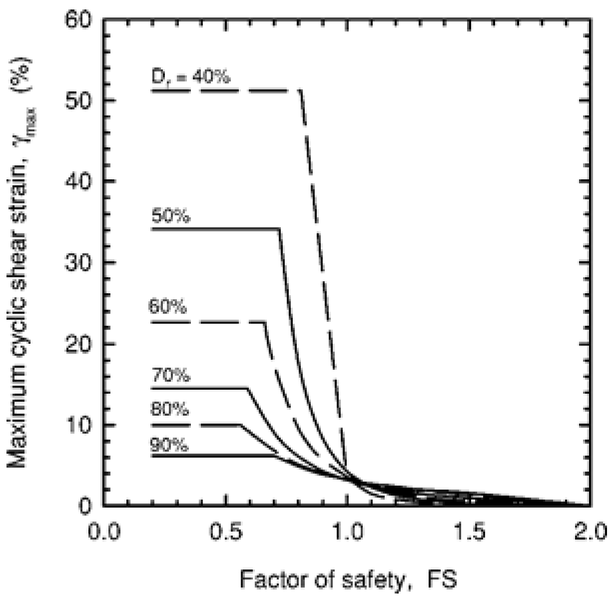
$$q_{t,1} = C_q \cdot q_t$$

$$CRR = \exp\left[\frac{q_{t,1}^{1.045} + q_{t,1} \cdot (0.110 \cdot R_f) + (0.001 \cdot R_f) + c \cdot (1 + 0.850 \cdot R_f) - 0.848 \cdot \ln(M_w) - 0.002 \cdot \ln(\sigma'_v) - 20.923 + 1.632 \cdot \Phi^{-1}(P_L)}{7.177}\right]$$

Procedure for the evaluation of 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.

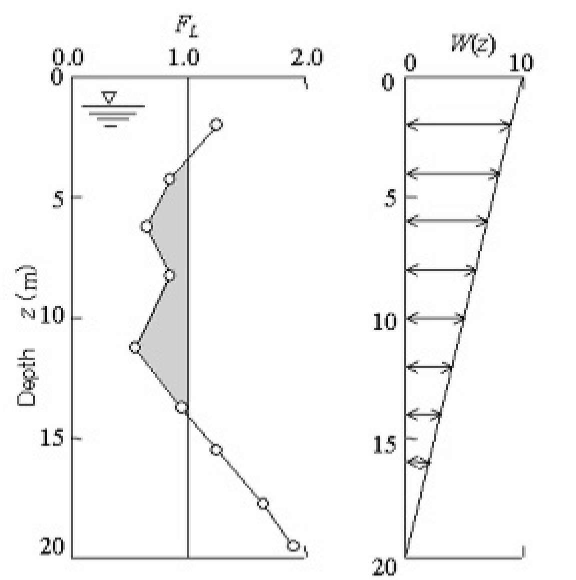
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

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

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

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

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

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- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833

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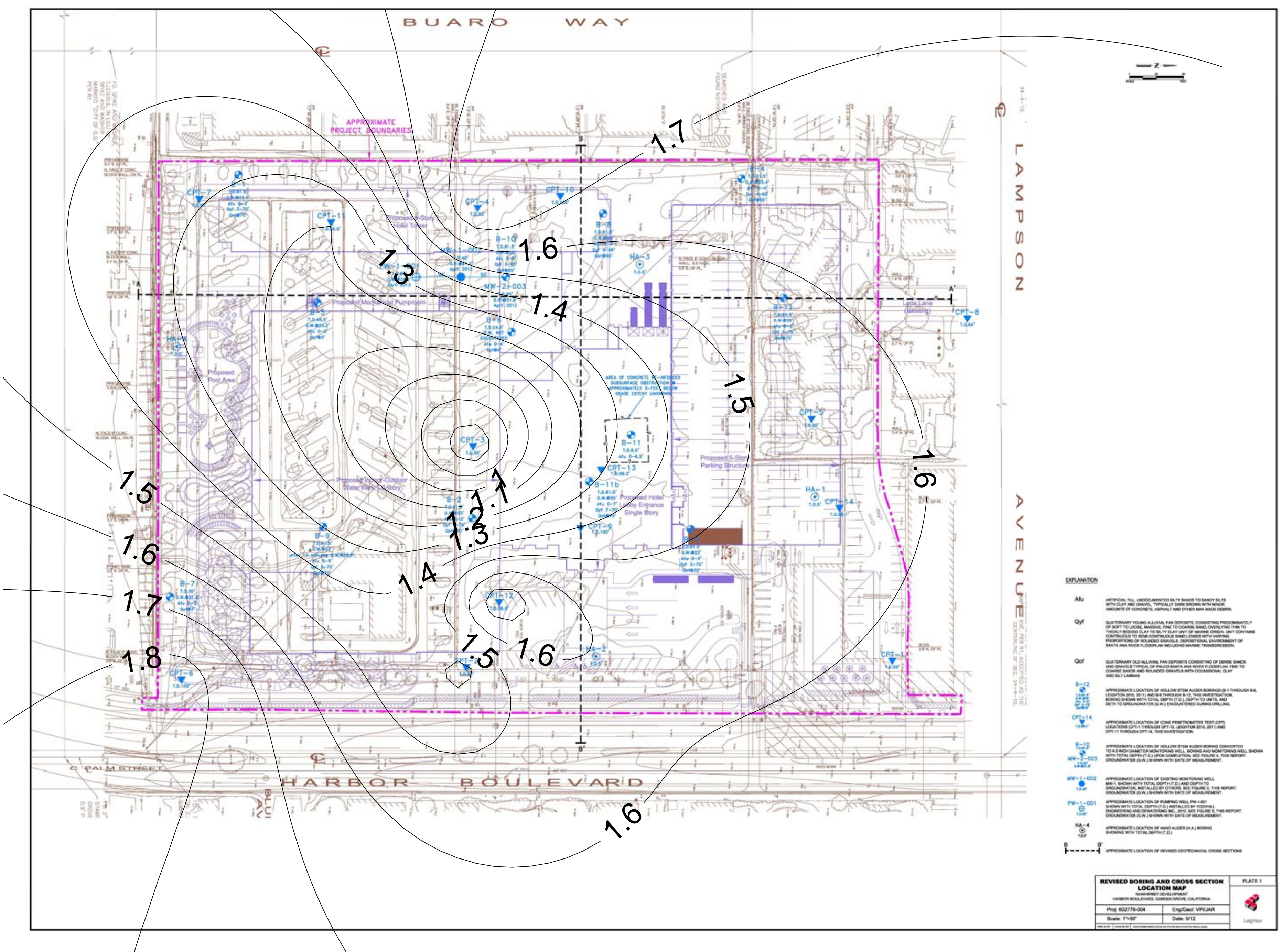
- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355

- 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

- 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

- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006

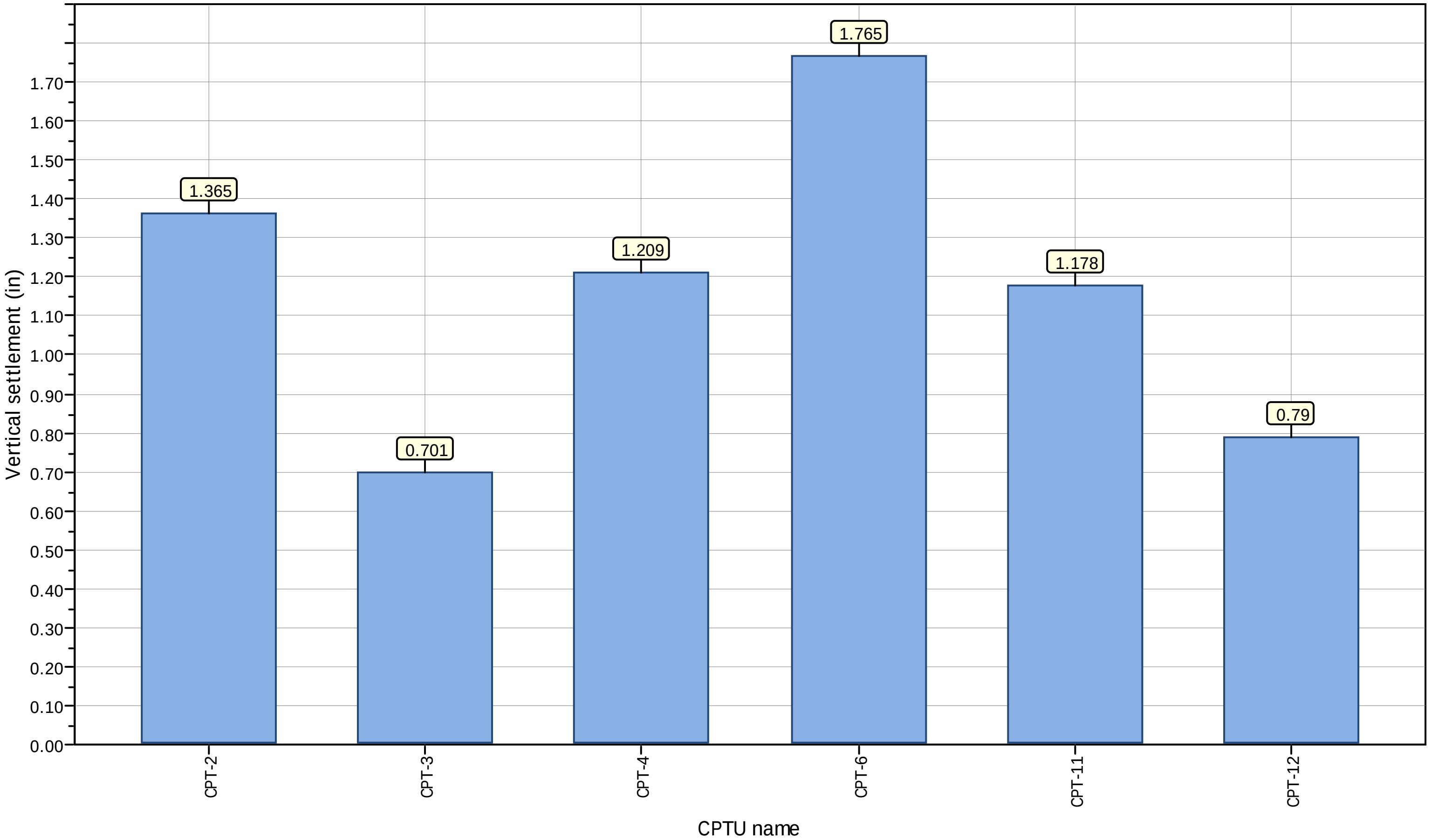


liquefaction-induced settlement
@ El 88

Project title : Great Wolf Lodge Resort

Location : 12661 Harbor Blvd., Garden Grove, CA

Overall vertical settlements report



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17781 Cowan
Irvine, CA 92614
www.leightongroup.com

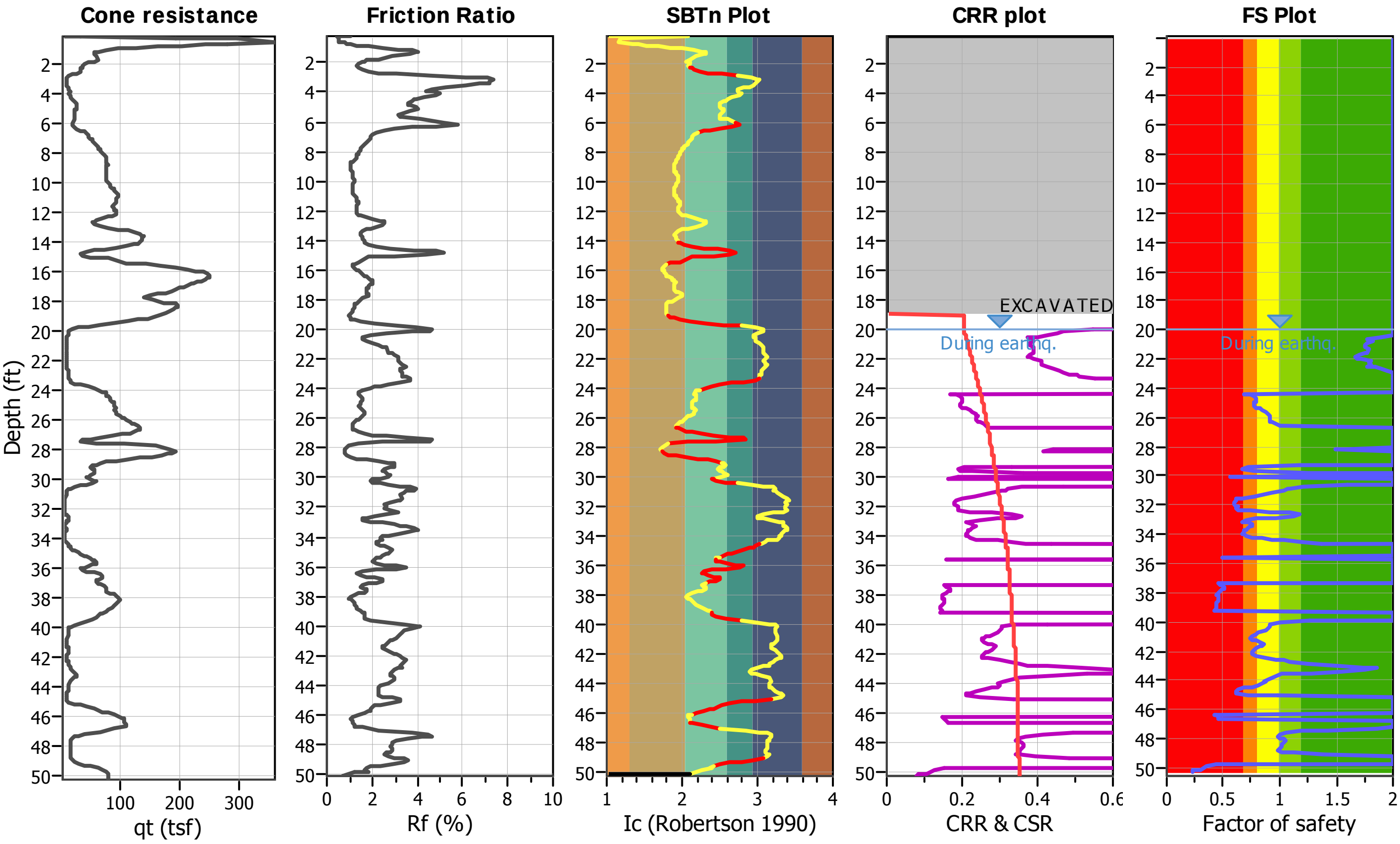
LIQUEFACTION ANALYSIS REPORT

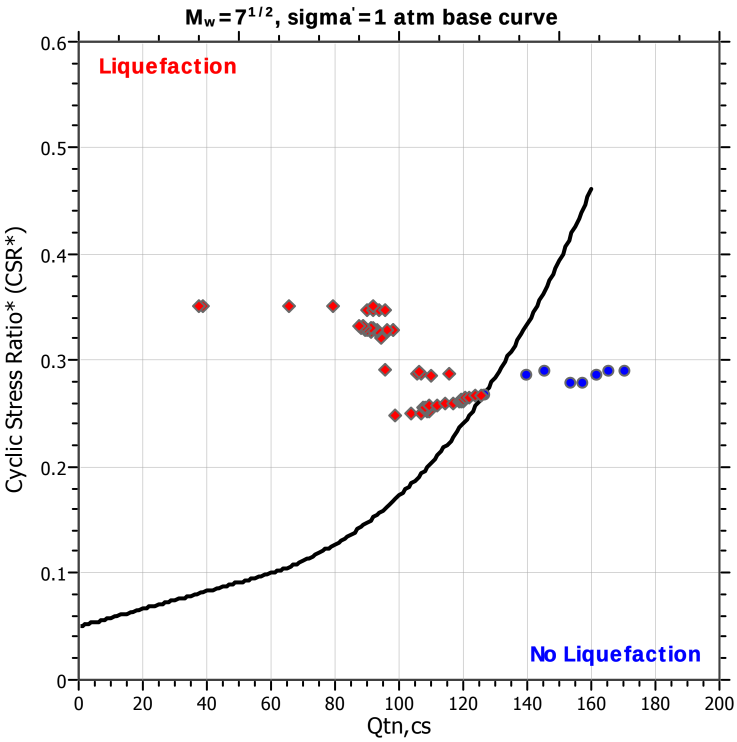
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

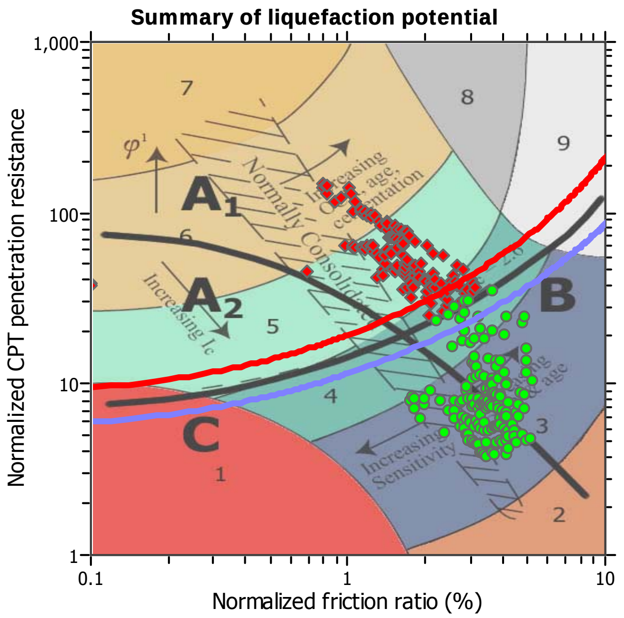
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	19.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

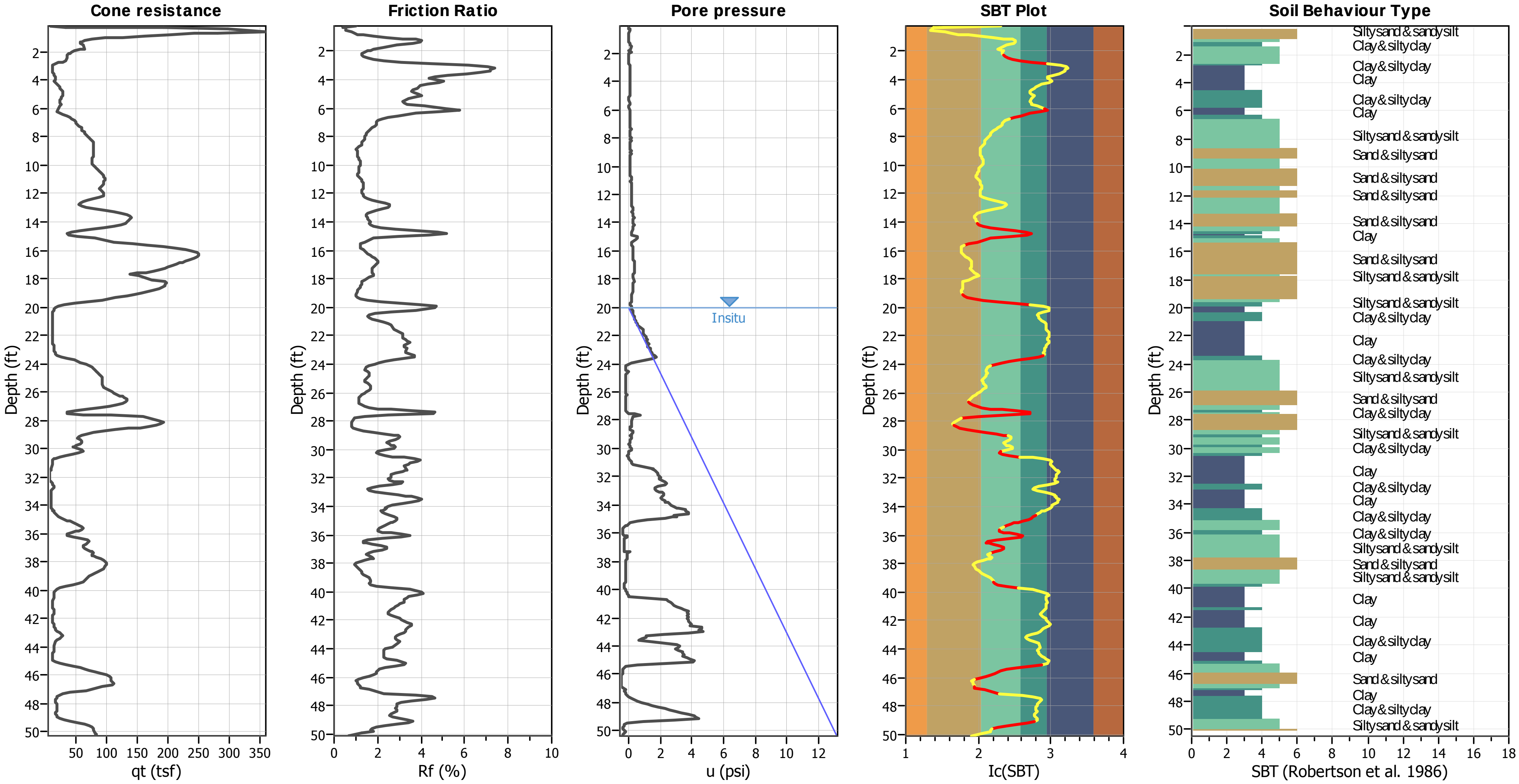






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



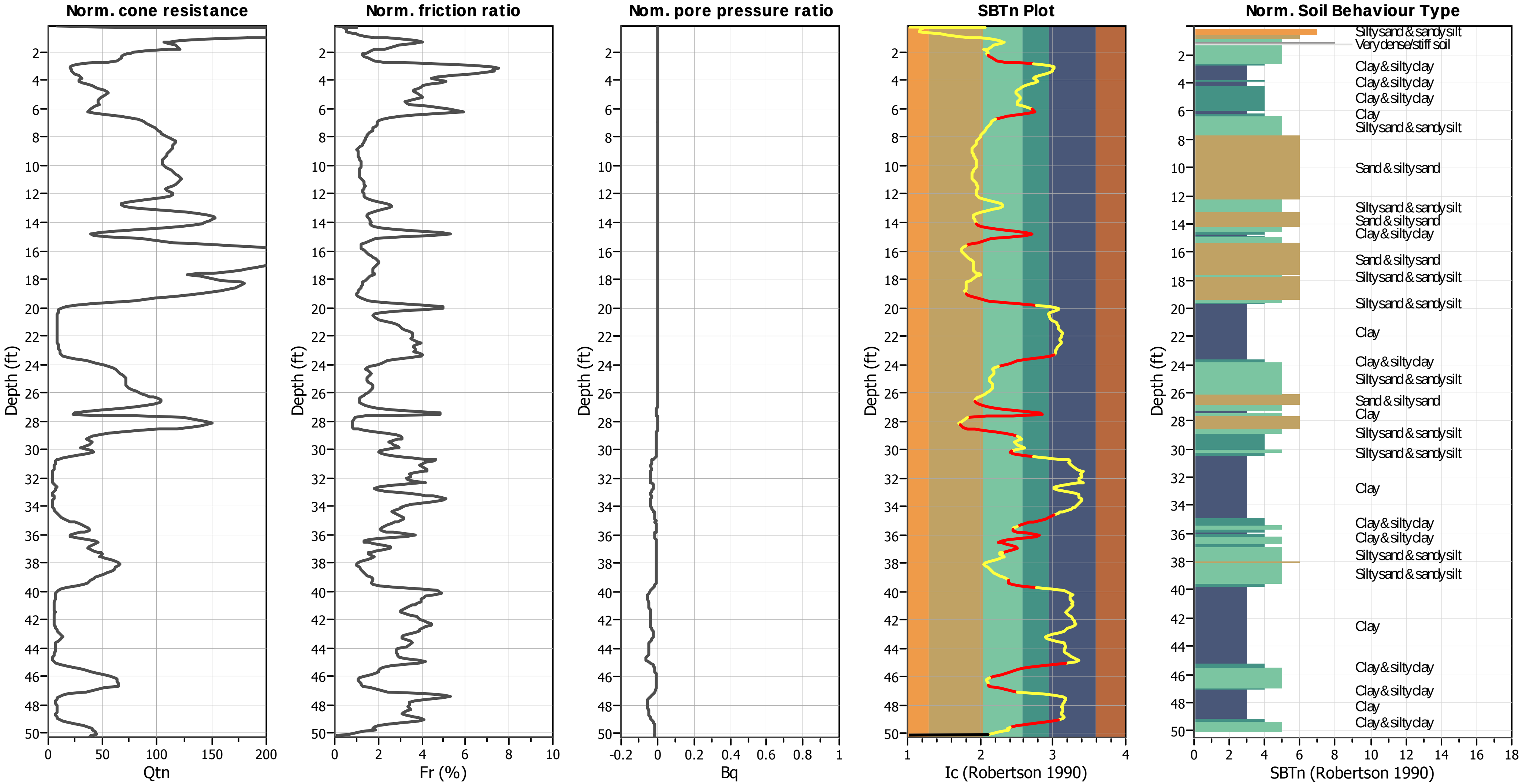
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	19.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



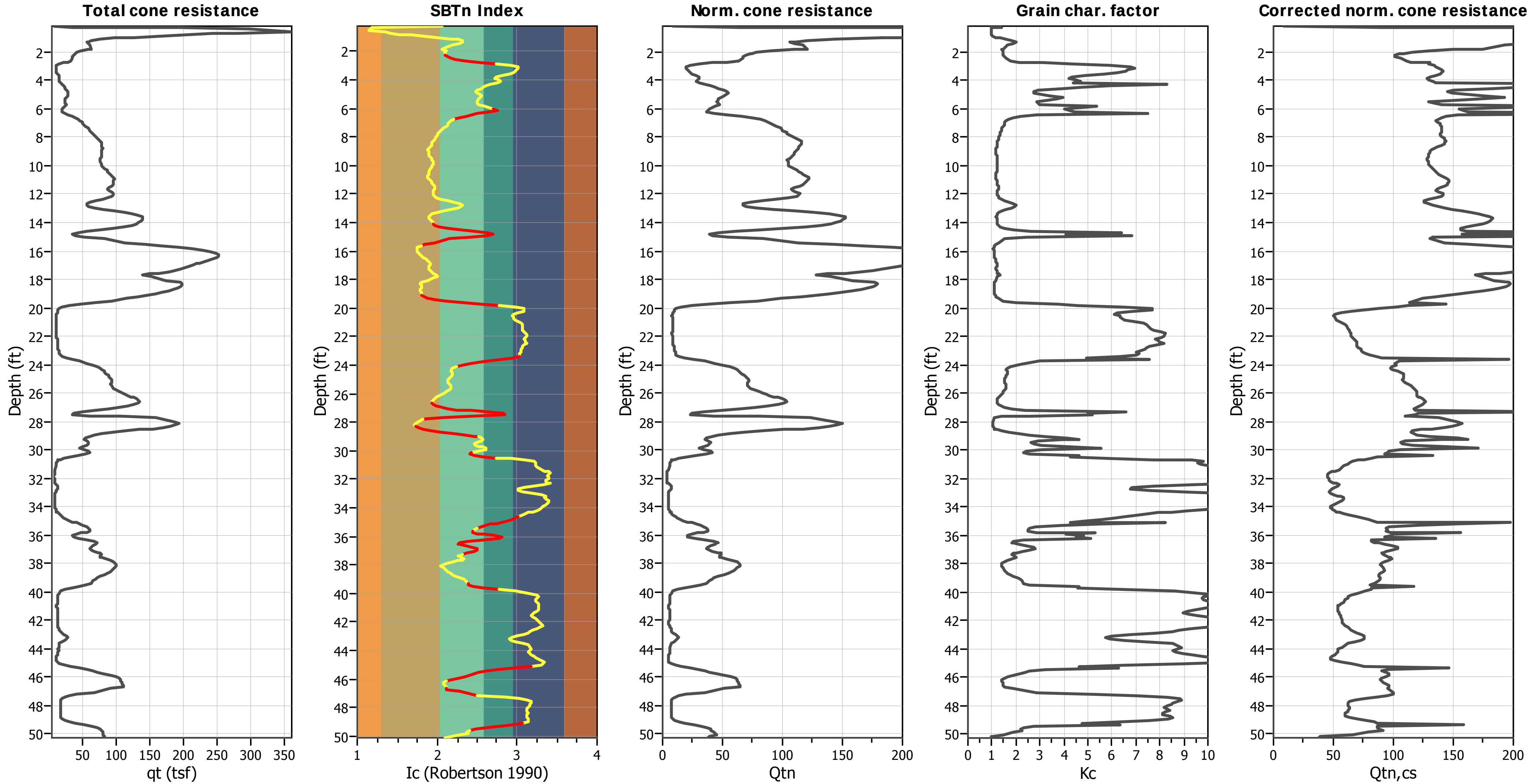
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

SBTn legend

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

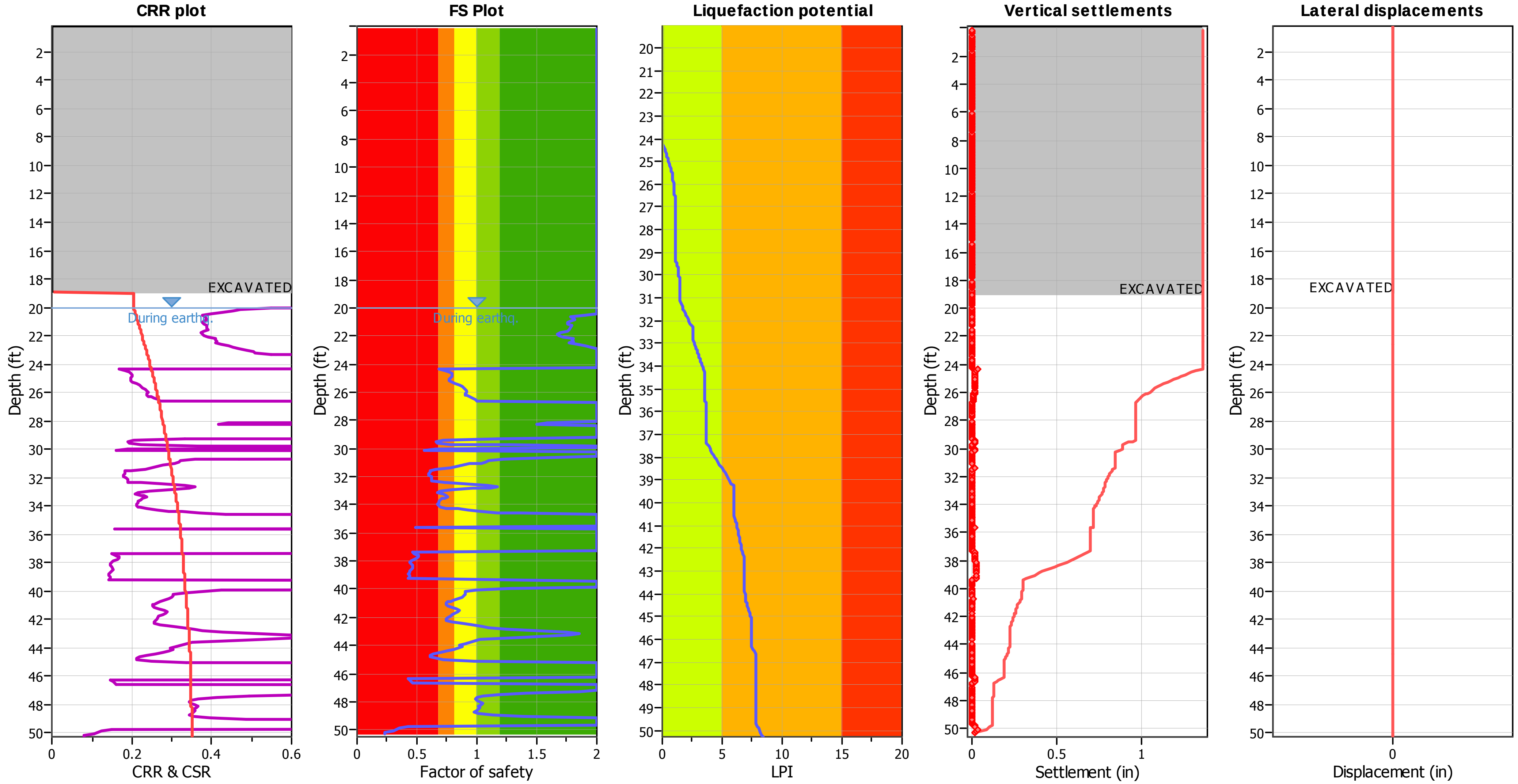
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



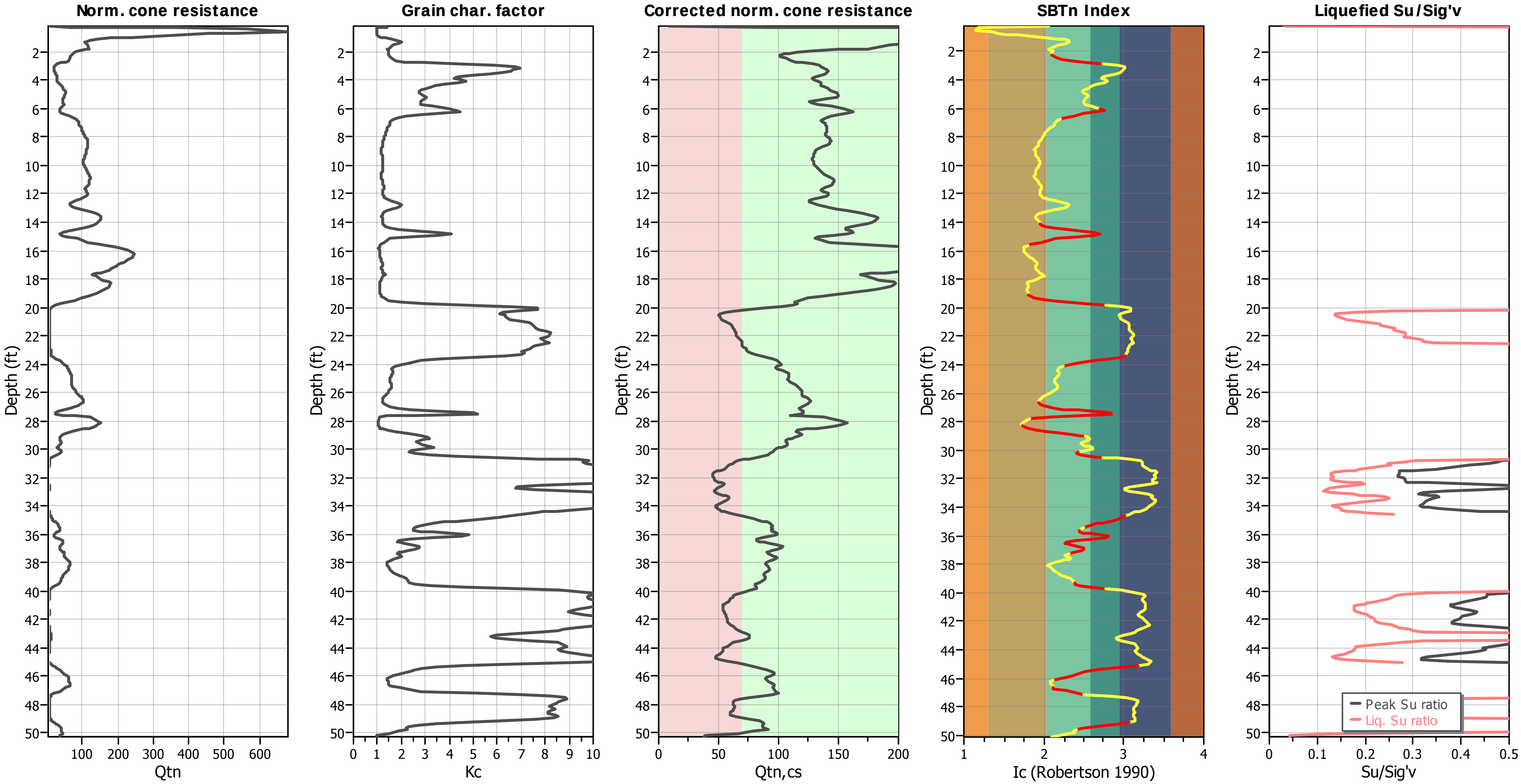
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

F.S. color scheme
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liquefaction are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme
- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

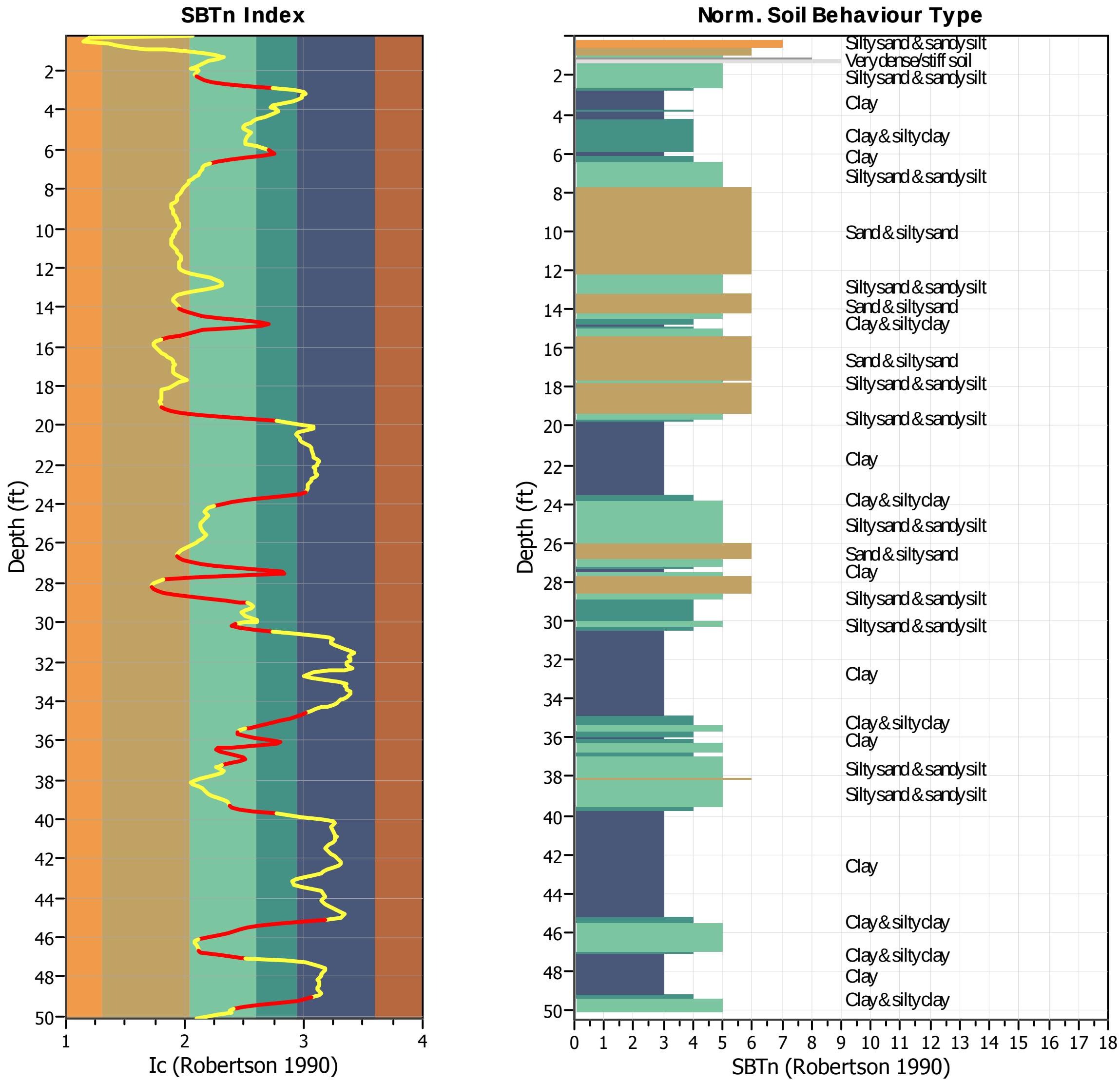
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



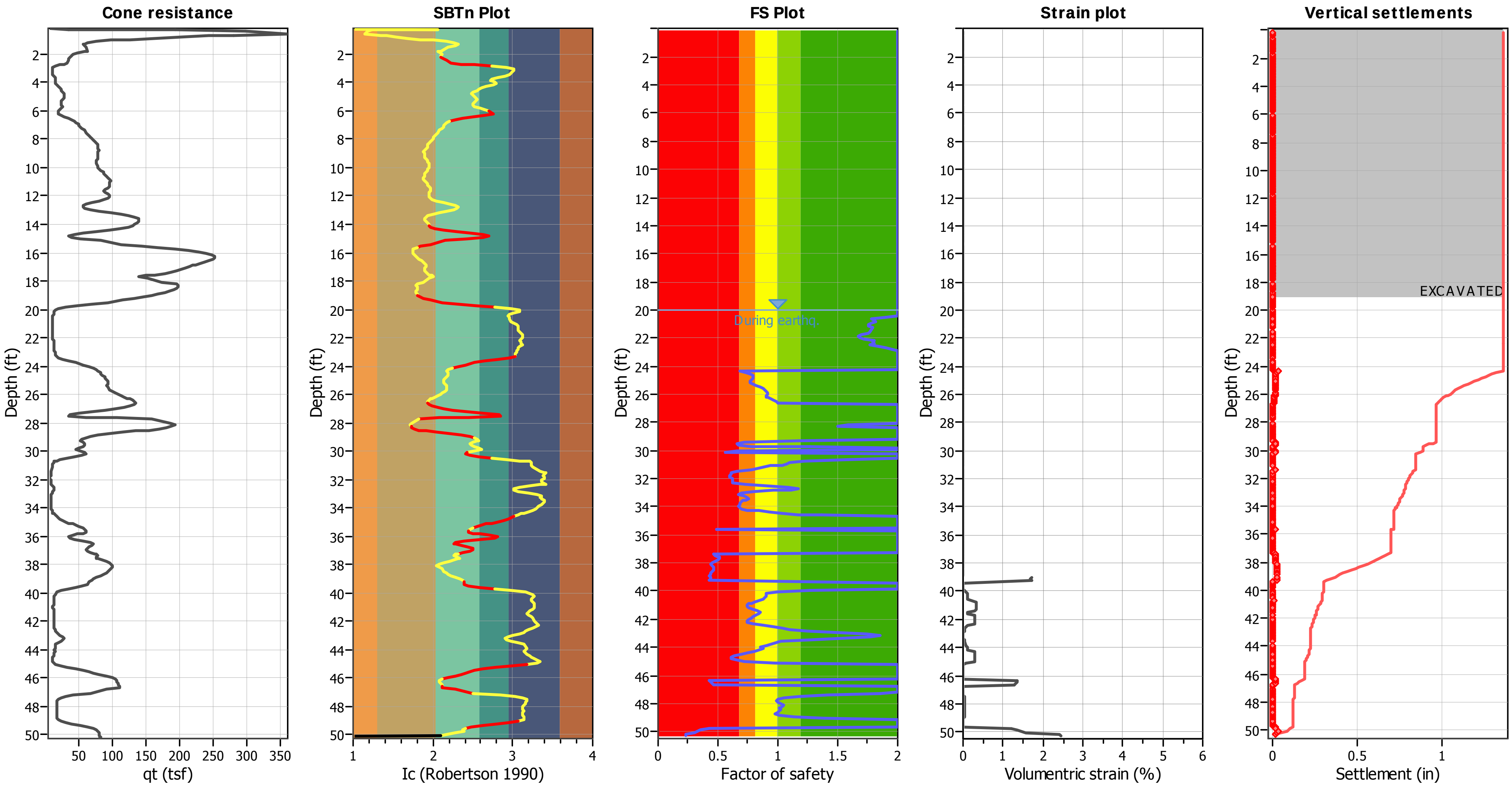
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	483
Total points excluded:	129
Exclusion percentage:	26.71%
Number of layers detected:	19

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

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Irvine, CA 92614
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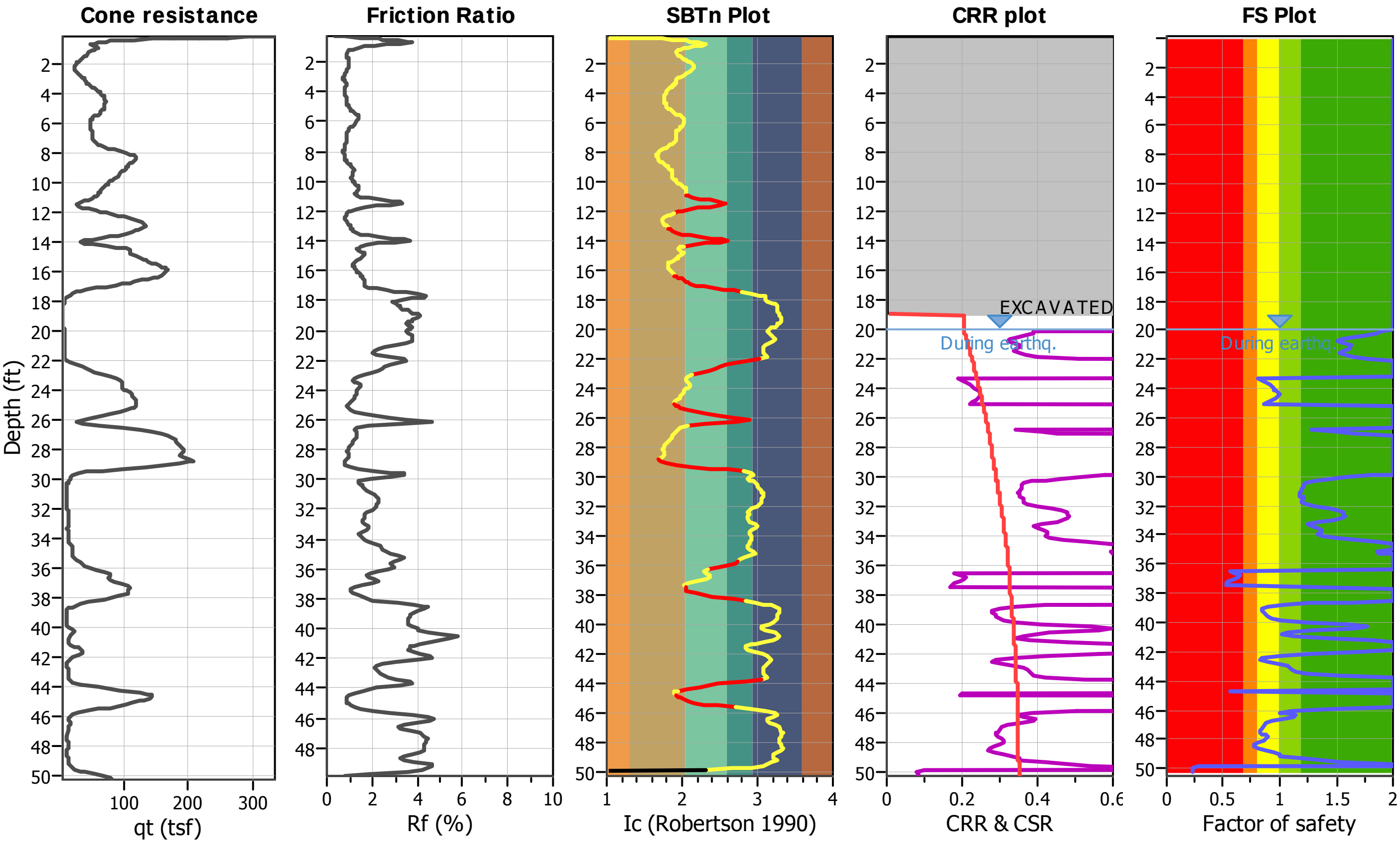
LIQUEFACTION ANALYSIS REPORT

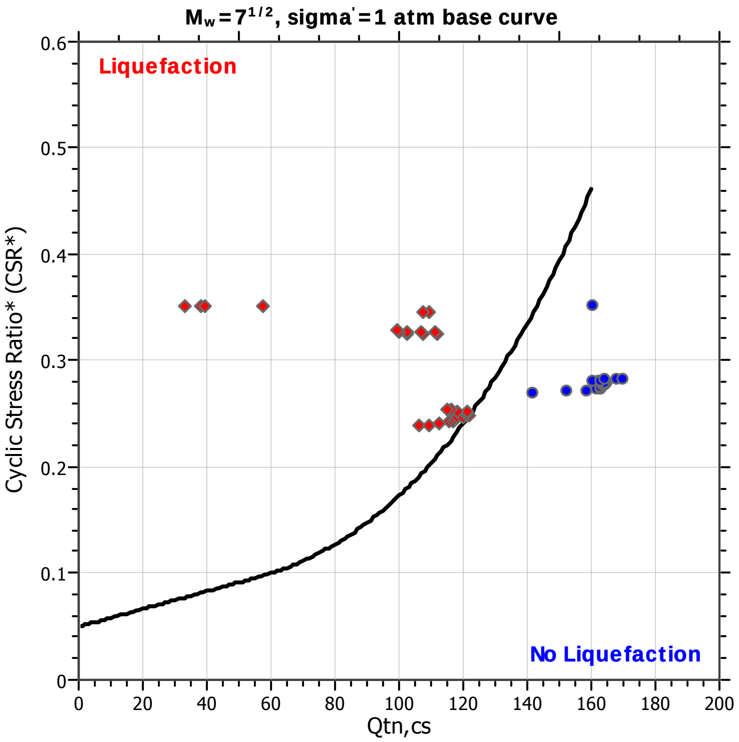
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

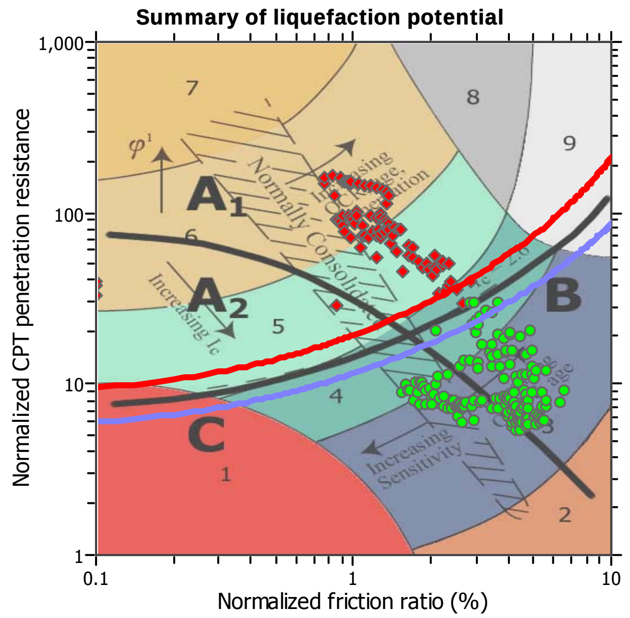
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	19.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

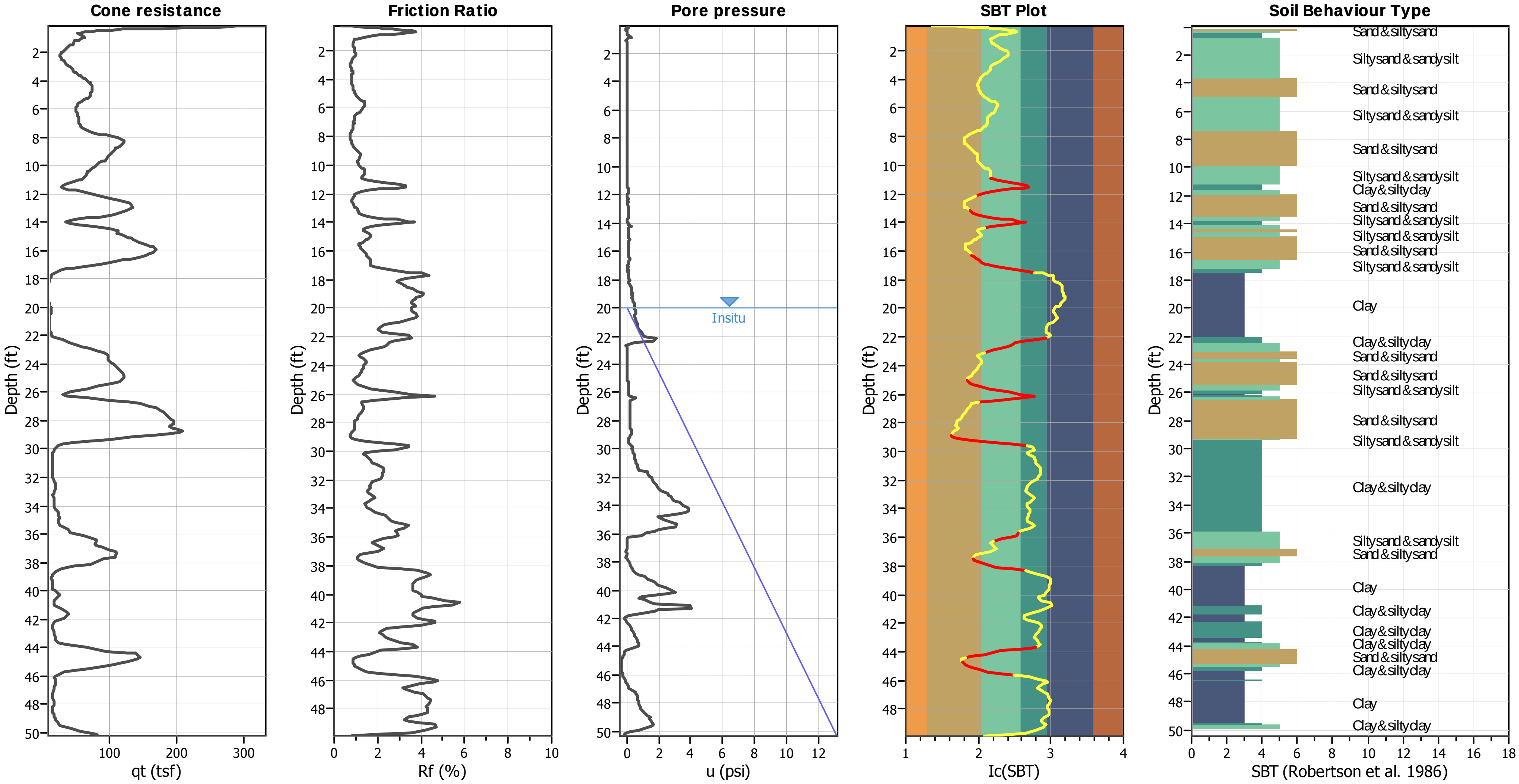






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



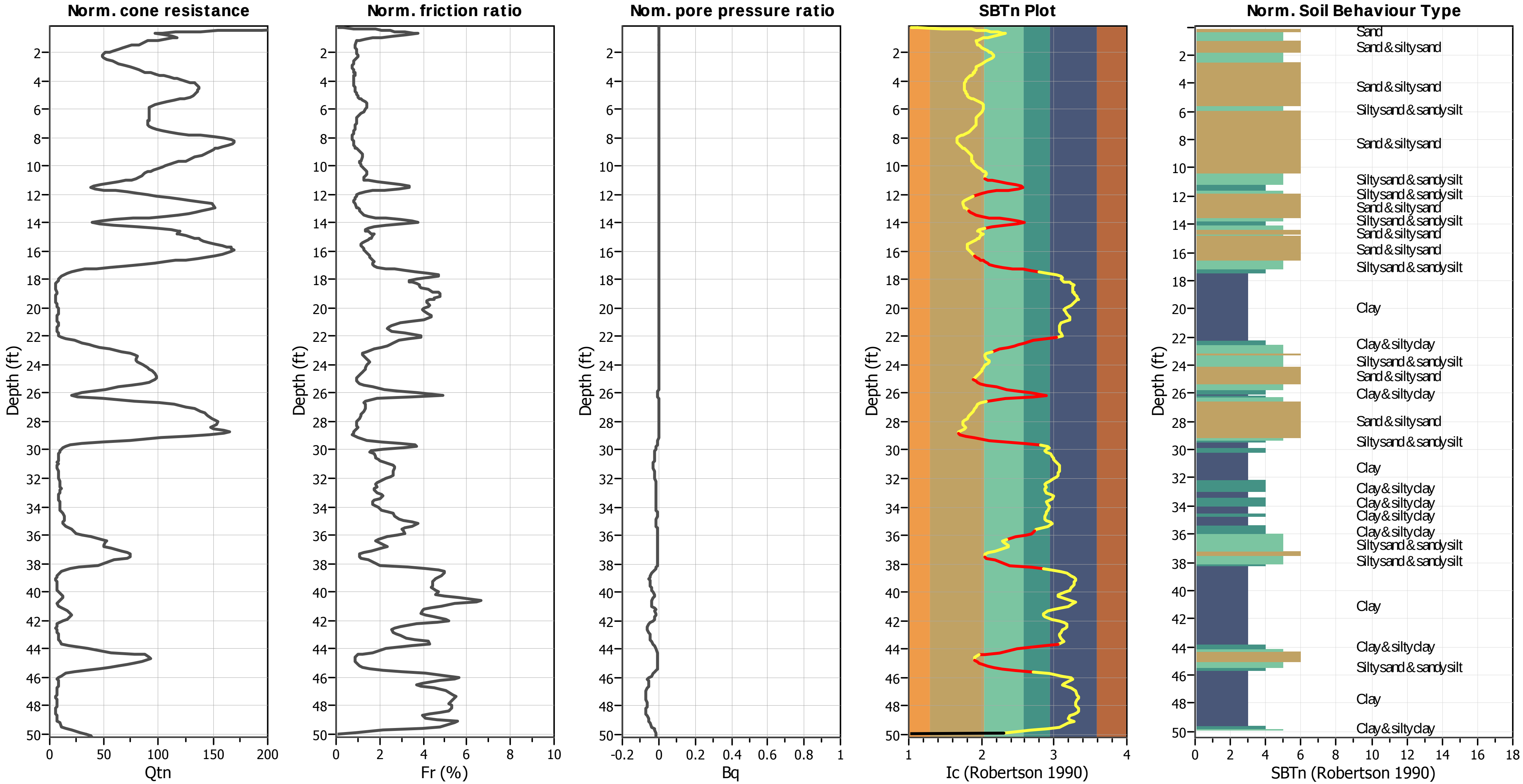
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	19.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



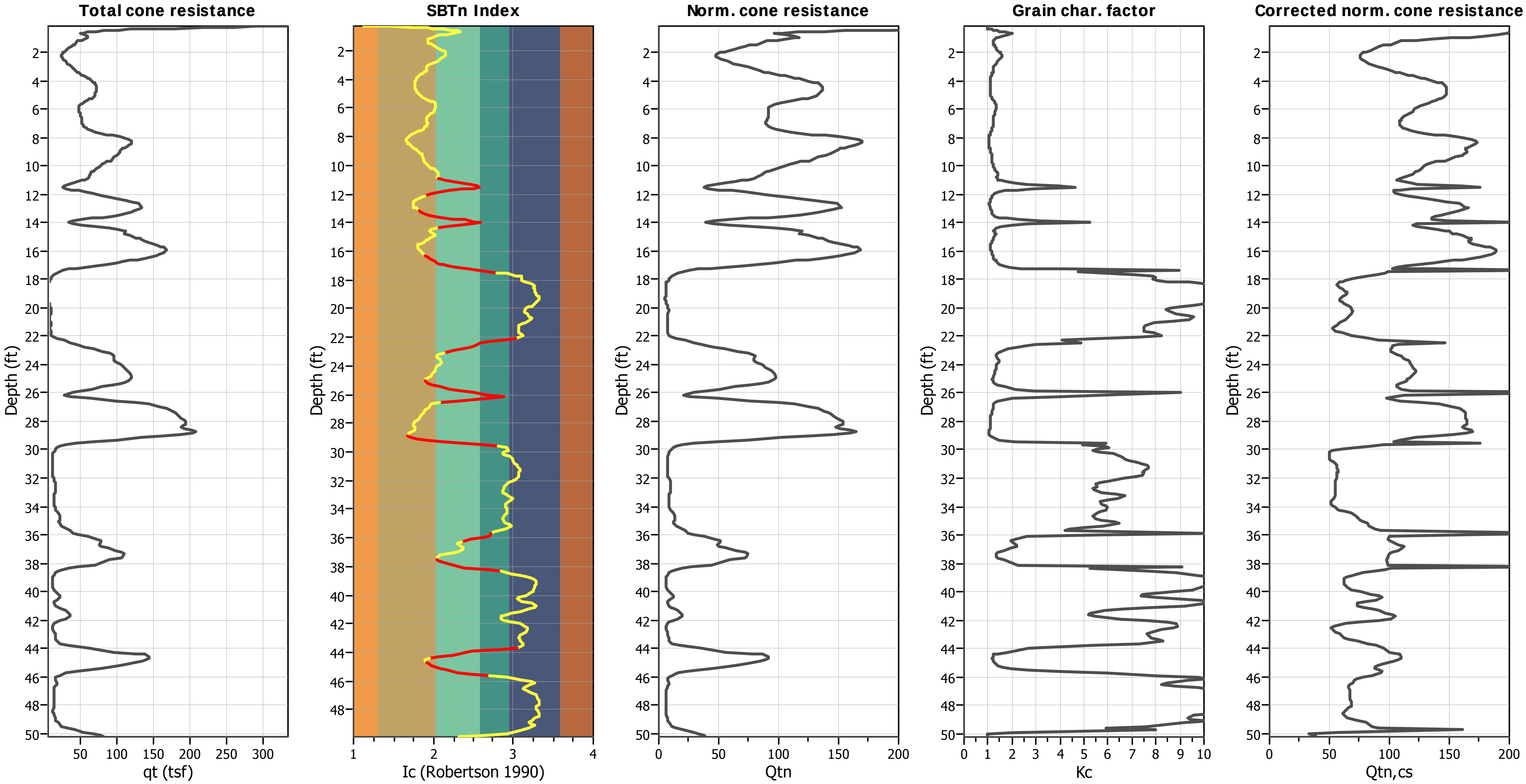
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

SBTn legend

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

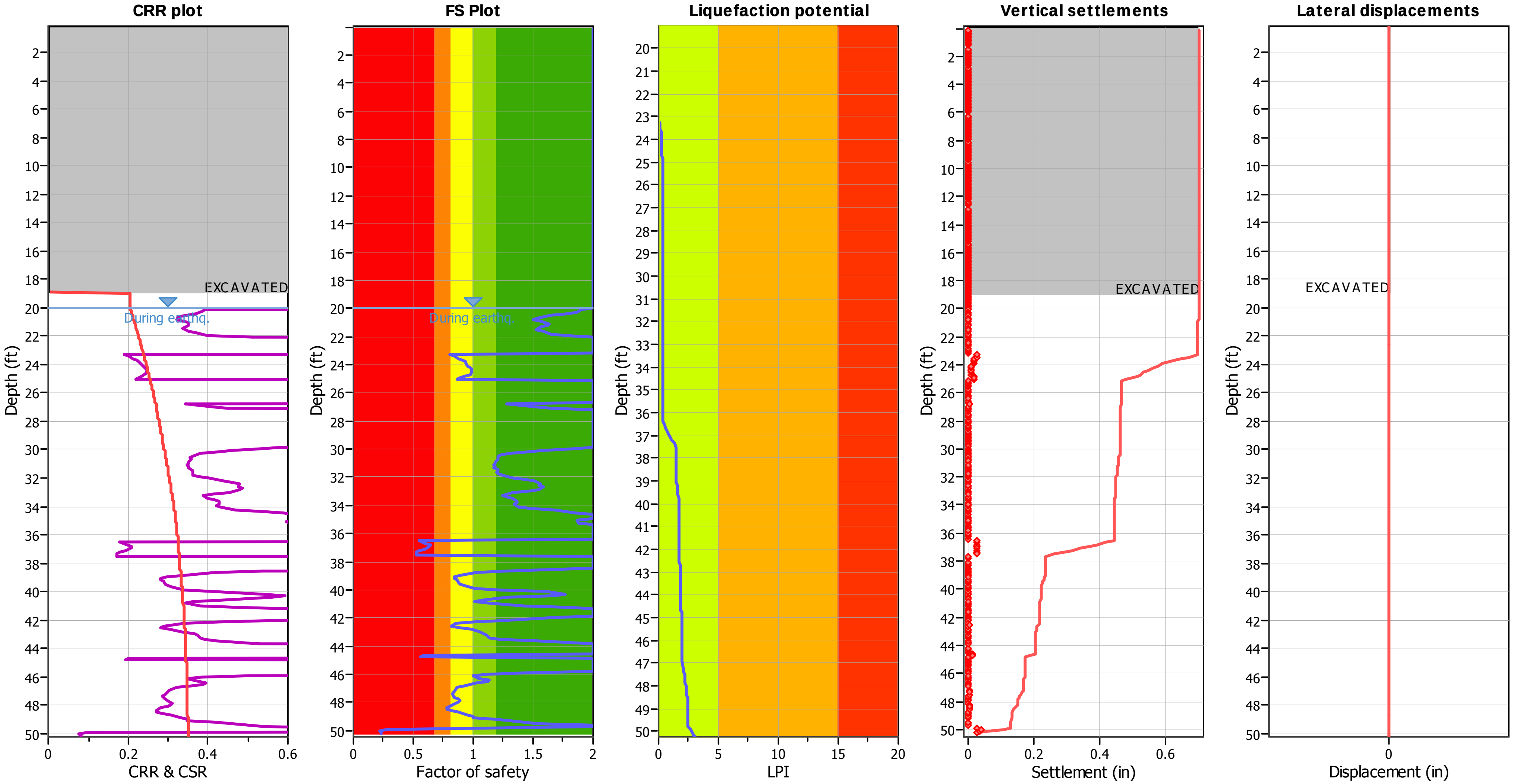
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

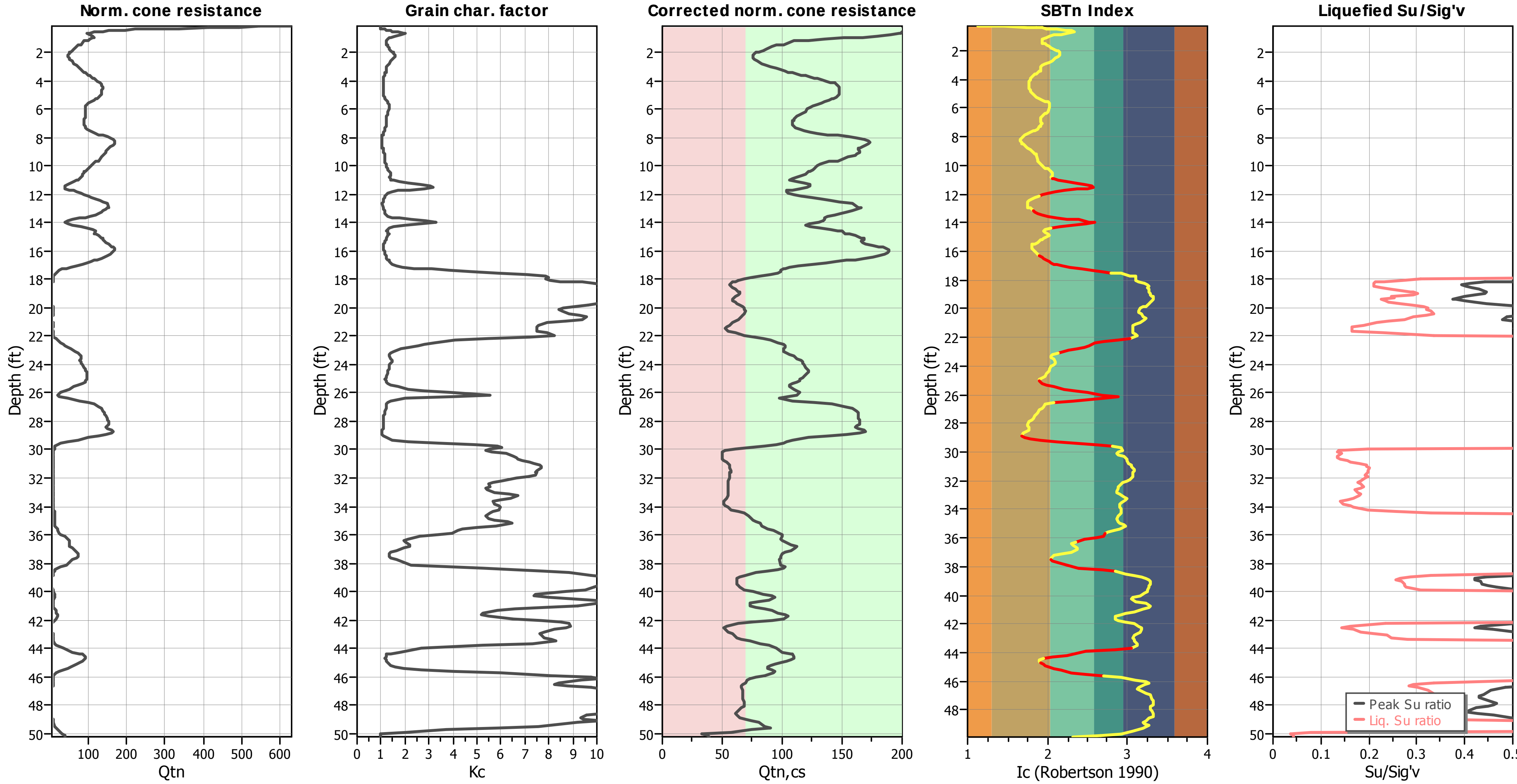
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

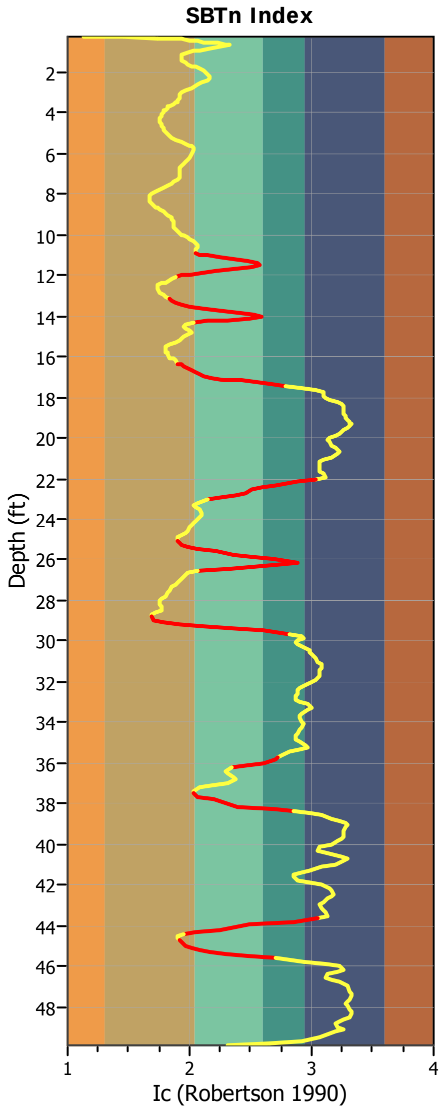
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

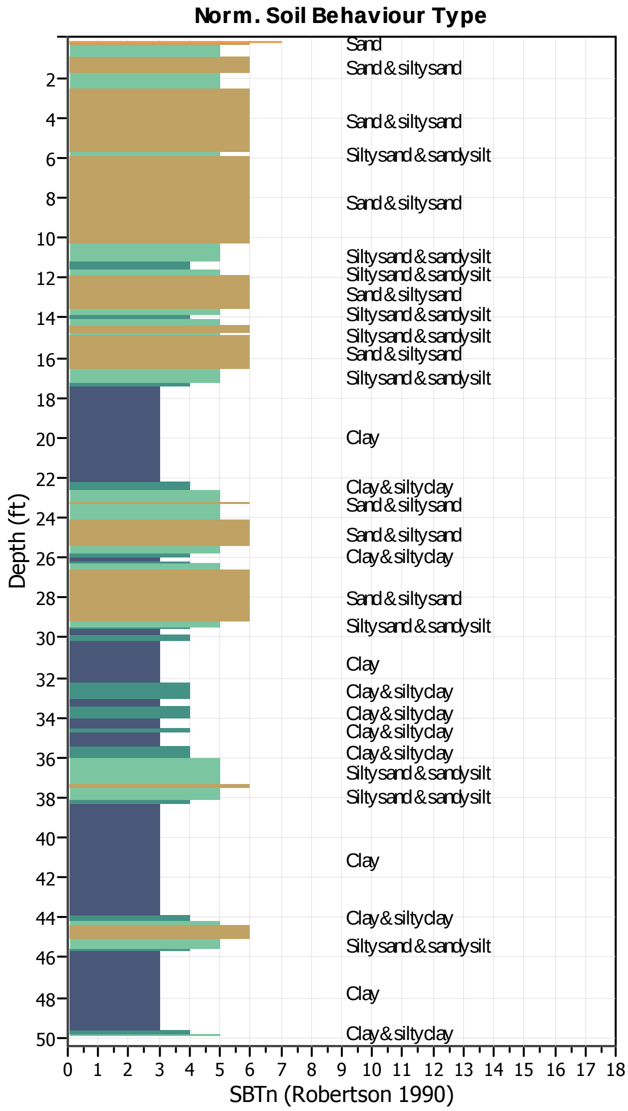
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





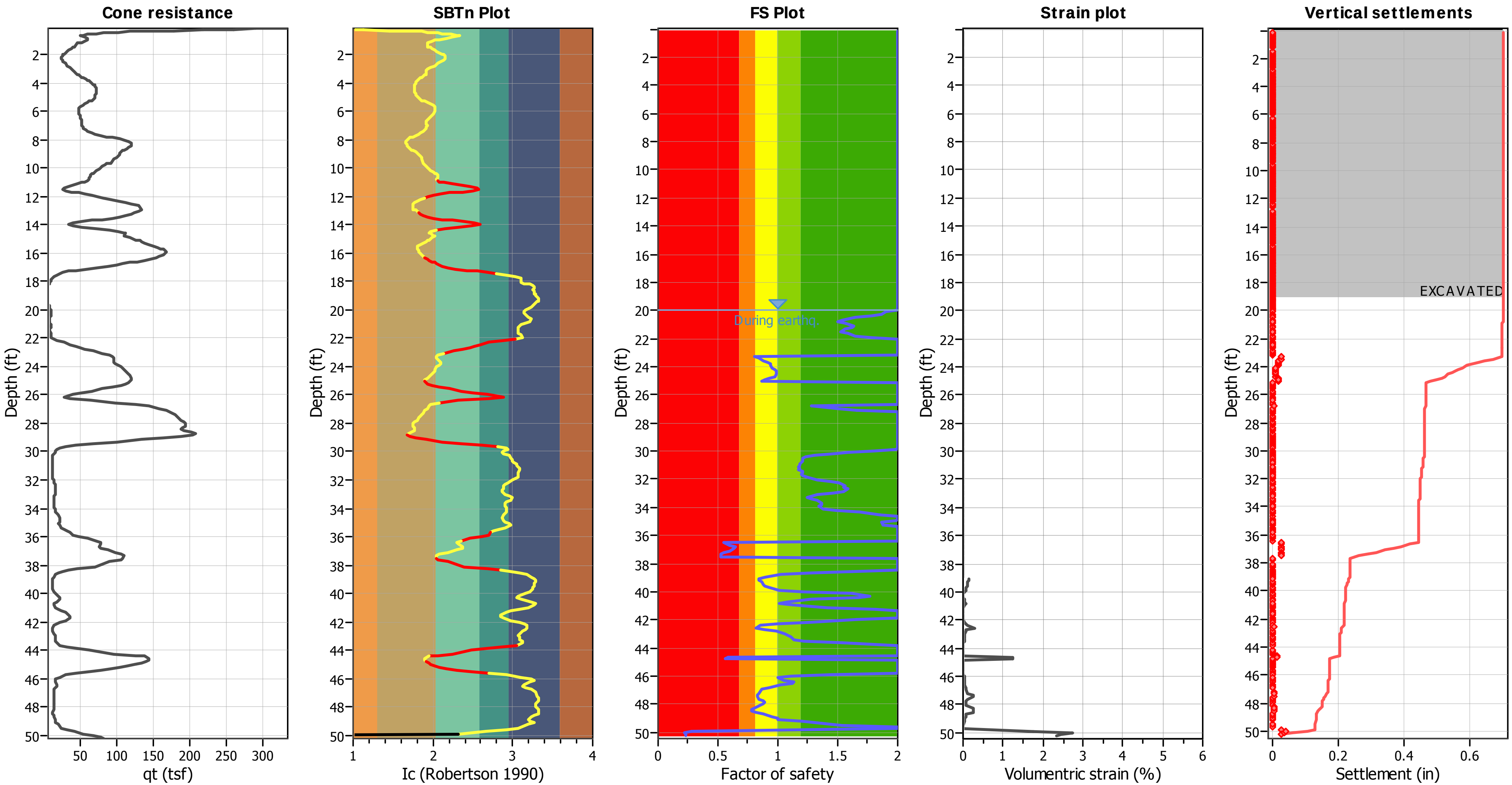
Transition layer algorithm properties

I_c minimum check value: 1.70
I_c maximum check value: 3.00
I_c change ratio value: 0.0250
Minimum number of points in layer: 4

General statistics

Total points in CPT file: 451
Total points excluded: 101
Exclusion percentage: 22.39%
Number of layers detected: 13

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

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A LEIGHTON GROUP COMPANY

Leighton and Associates, Inc.
17781 Cowan
Irvine, CA 92614
www.leightongroup.com

LIQUEFACTION ANALYSIS REPORT

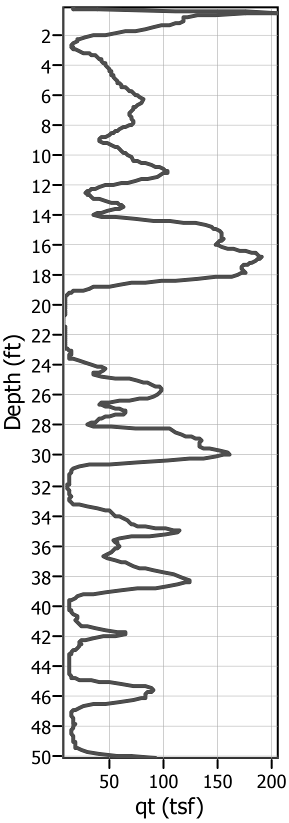
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

CPT file : CPT-4

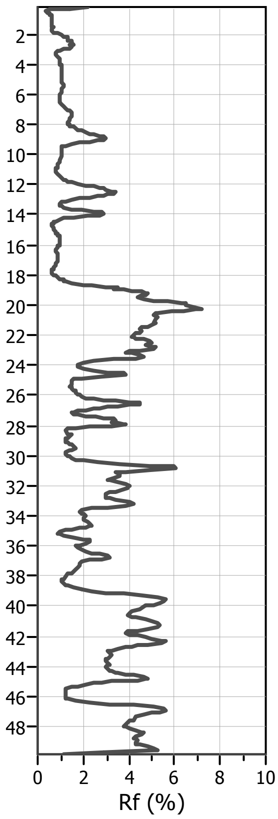
Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	20.00 ft	Excavation depth:	19.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

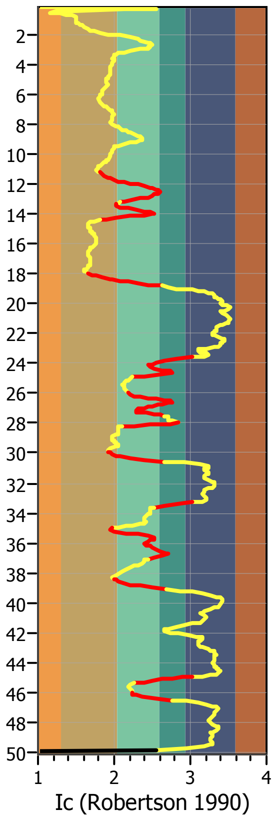
Cone resistance



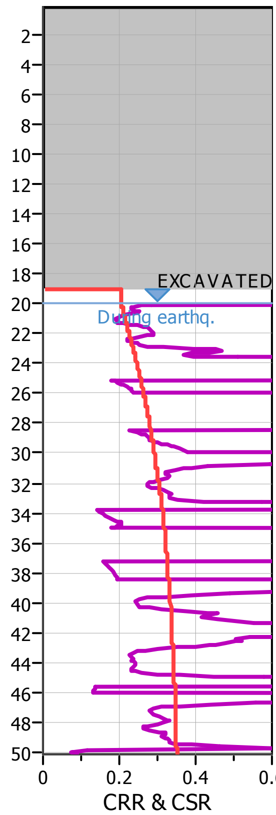
Friction Ratio



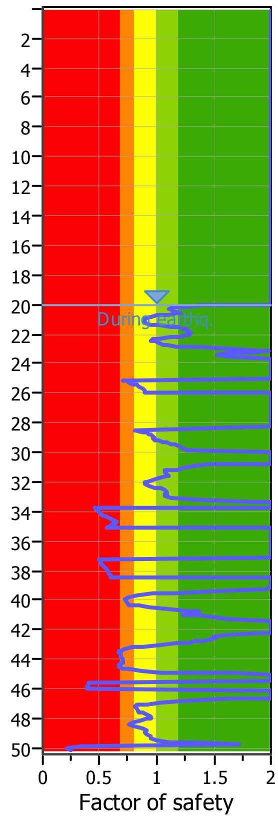
SBTn Plot



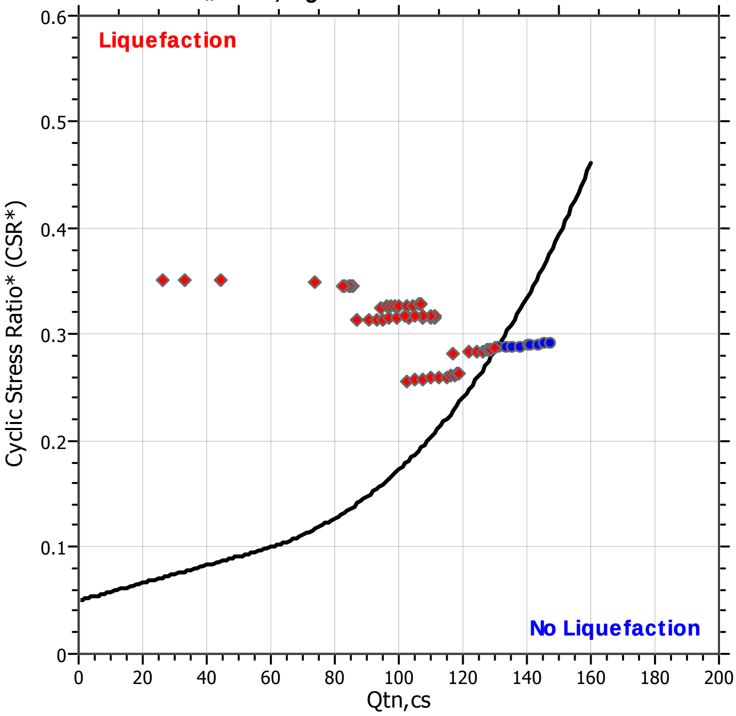
CRR plot



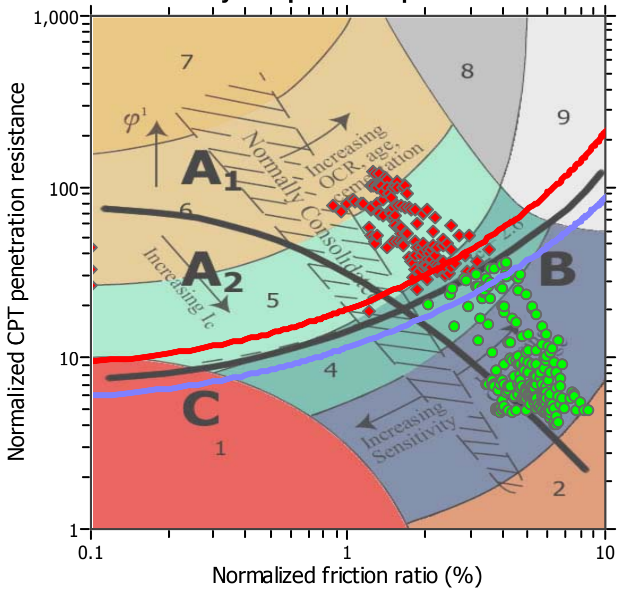
FS Plot



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

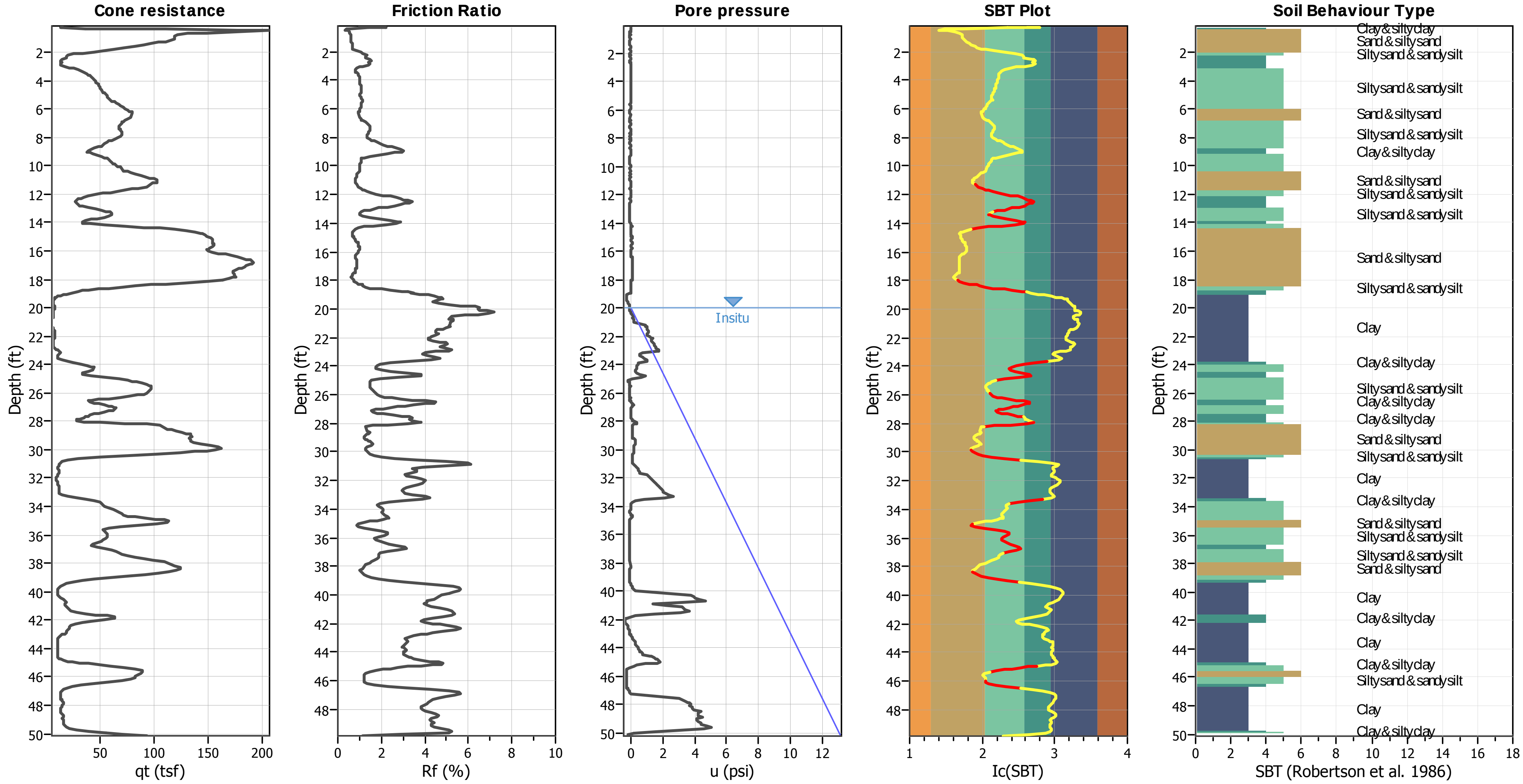


Summary of liquefaction potential



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

CPT basic interpretation plots



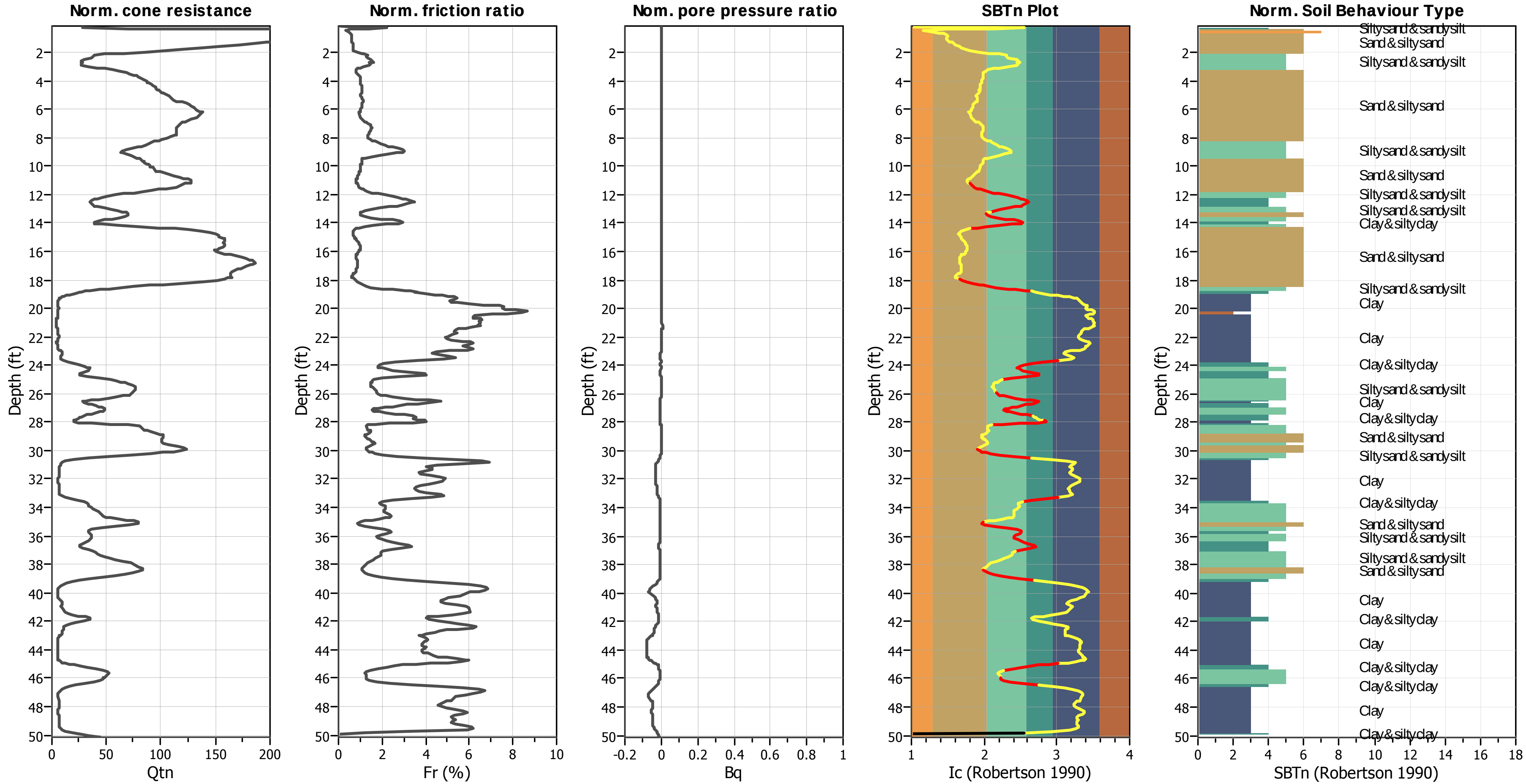
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	19.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



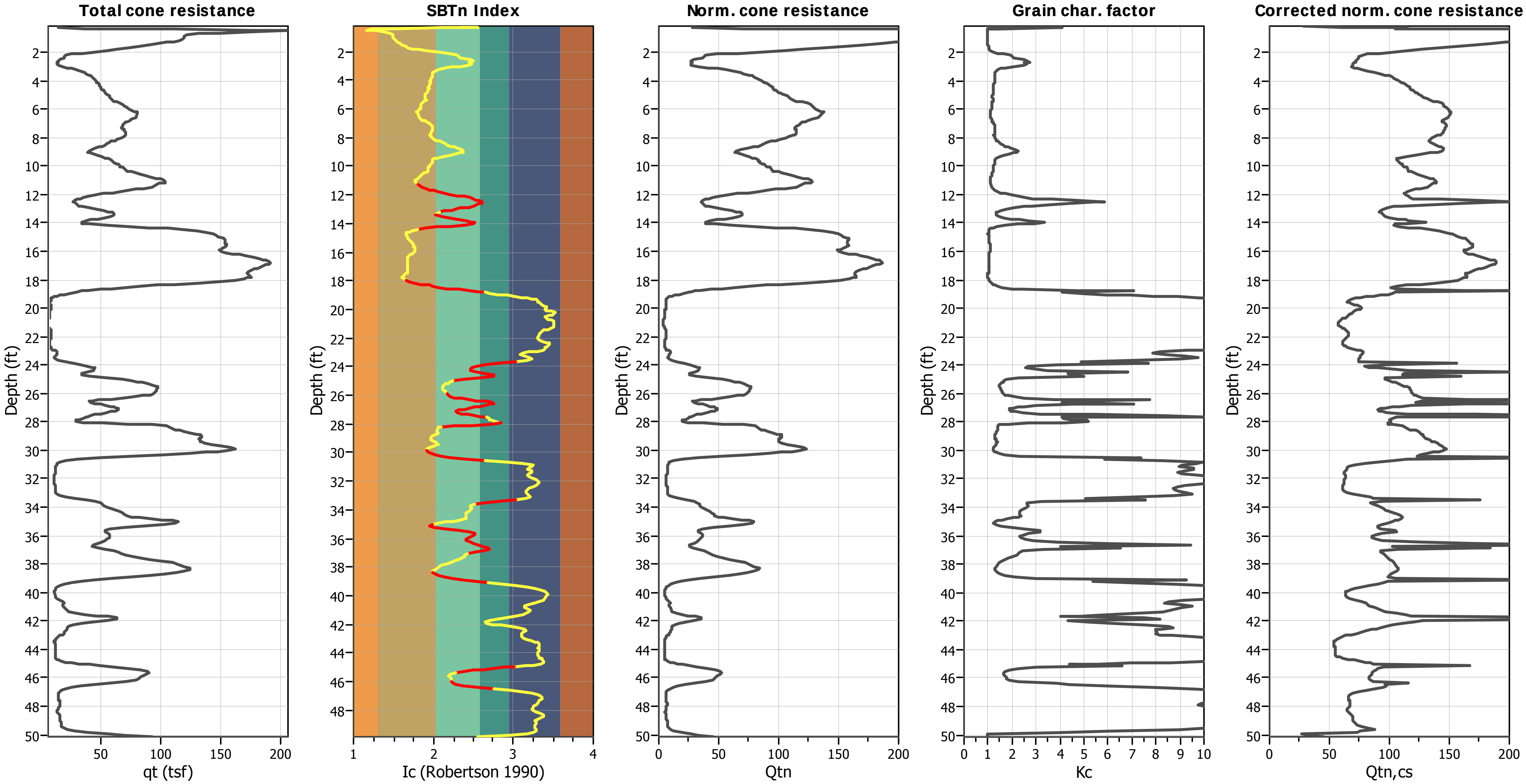
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

SBTn legend

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

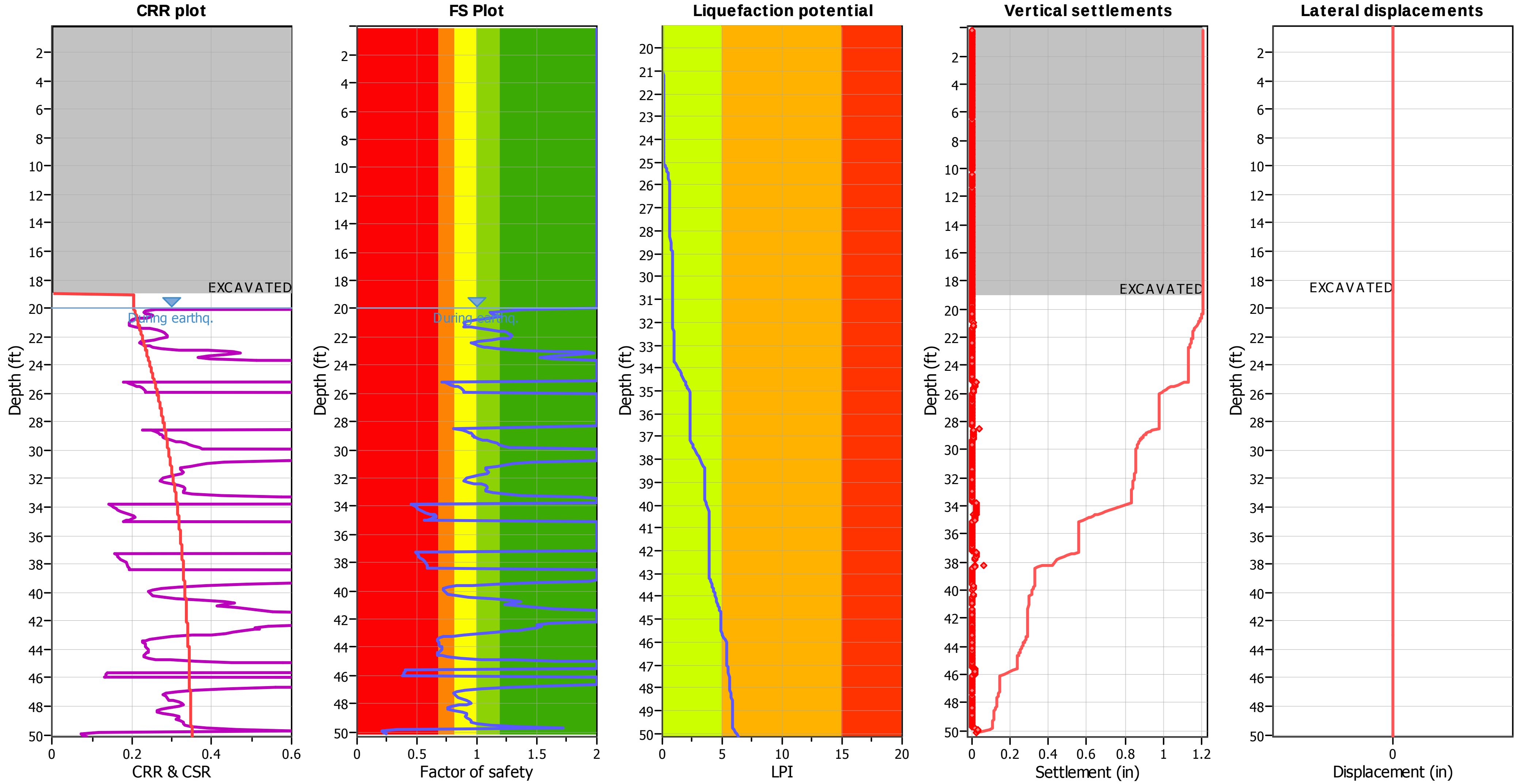
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

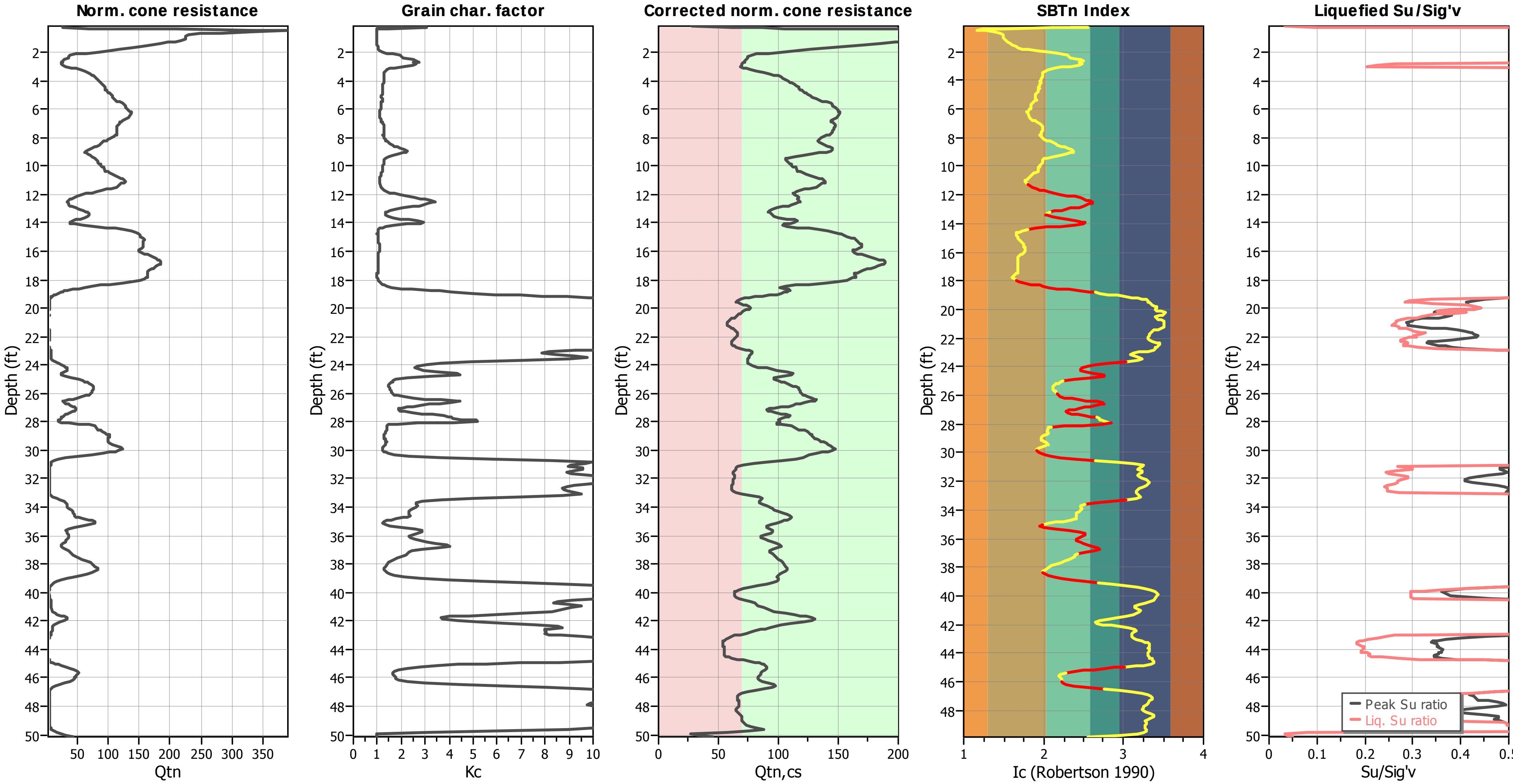
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

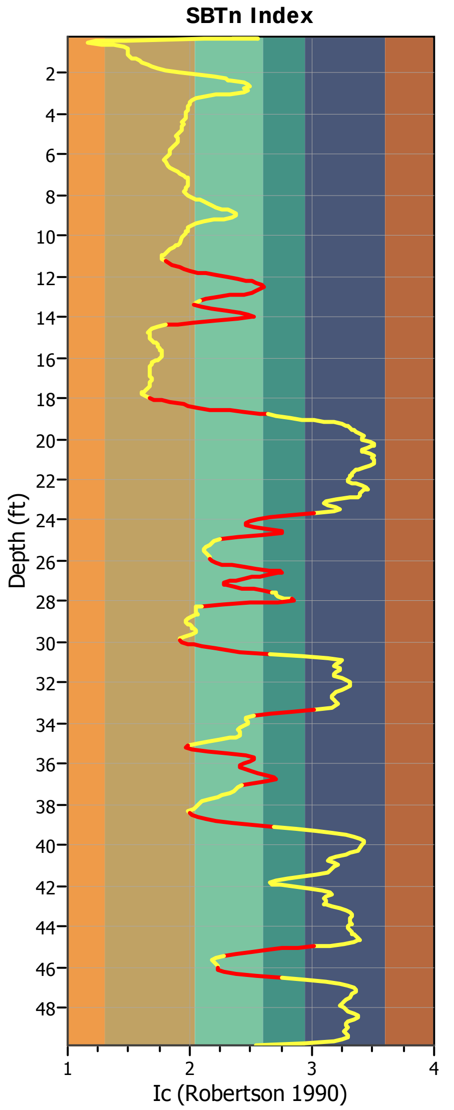
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	20.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	19.00 ft	Limit depth:	60.00 ft

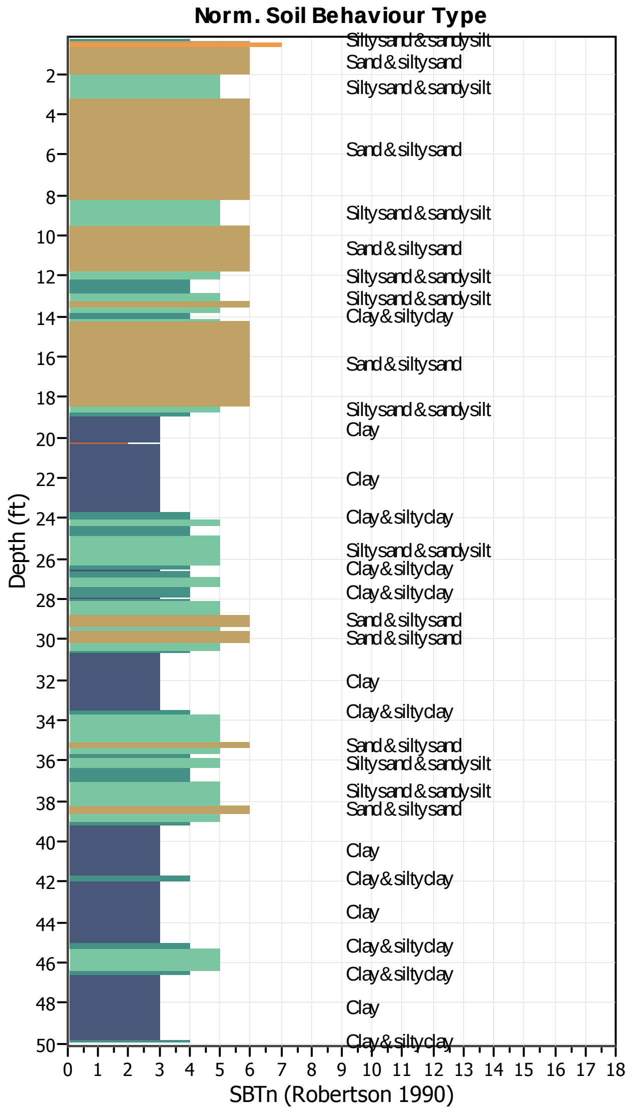
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





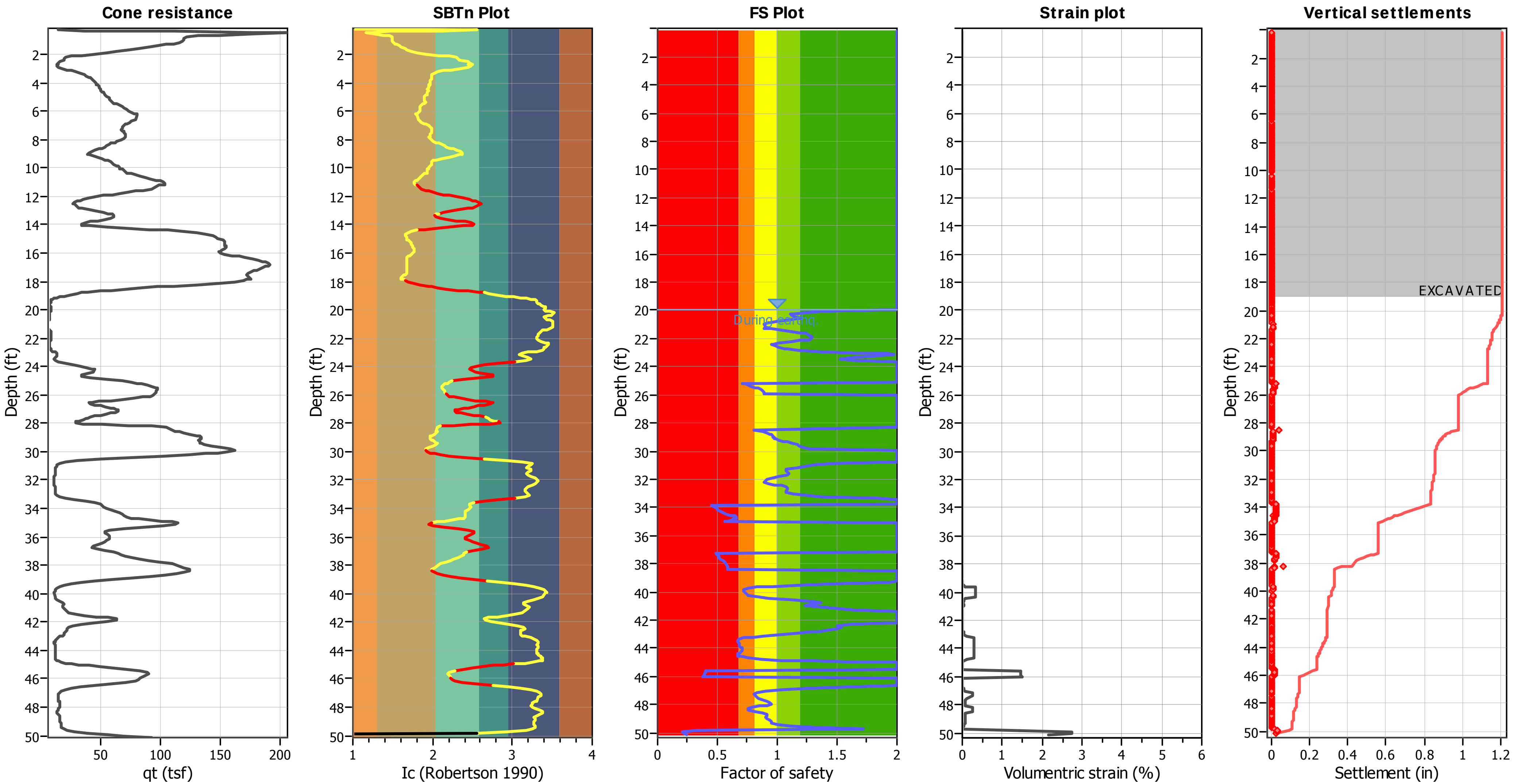
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	572
Total points excluded:	149
Exclusion percentage:	26.05%
Number of layers detected:	21

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

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A LEIGHTON GROUP COMPANY

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17781 Cowan
Irvine, CA 92614
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LIQUEFACTION ANALYSIS REPORT

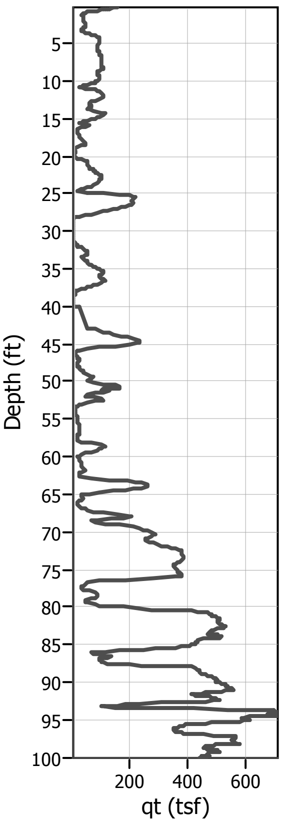
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

CPT file : CPT-6

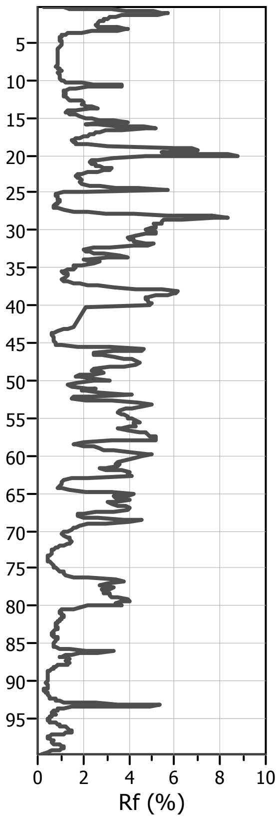
Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	21.00 ft	Excavation depth:	20.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

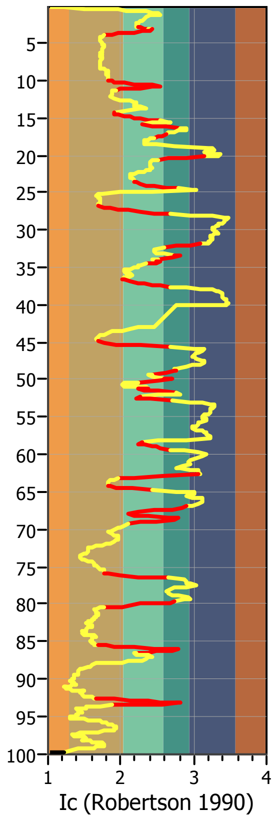
Cone resistance



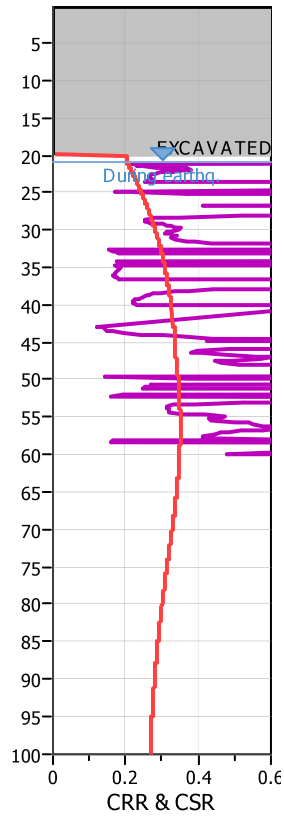
Friction Ratio



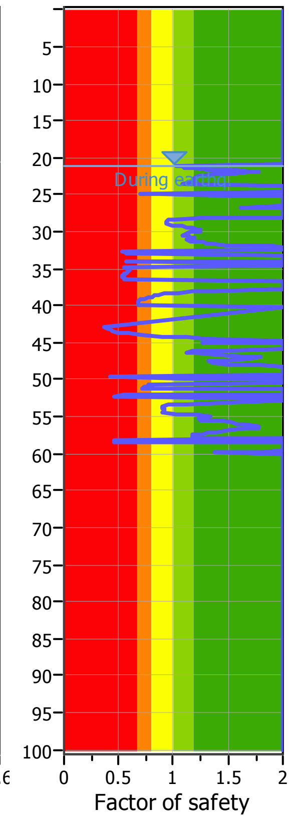
SBTn Plot



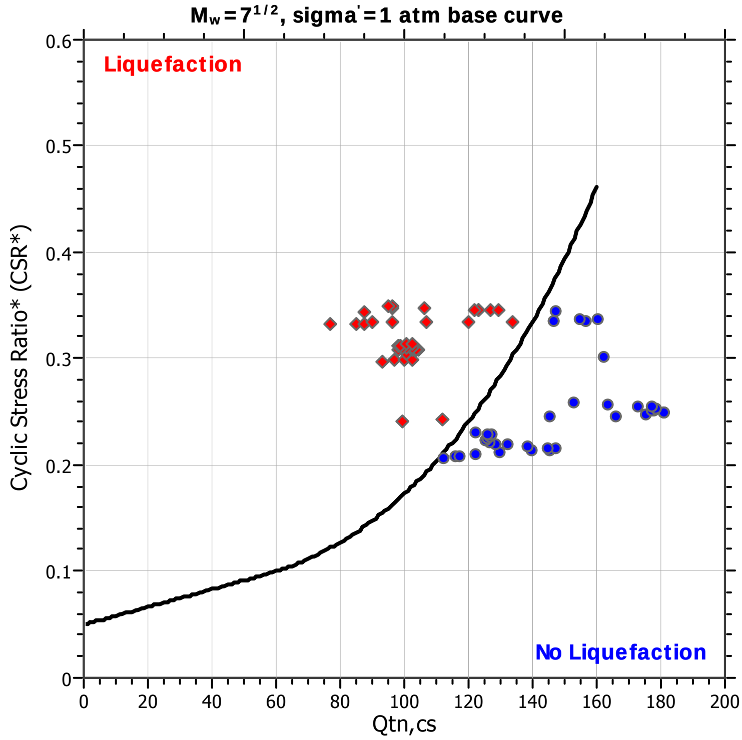
CRR plot



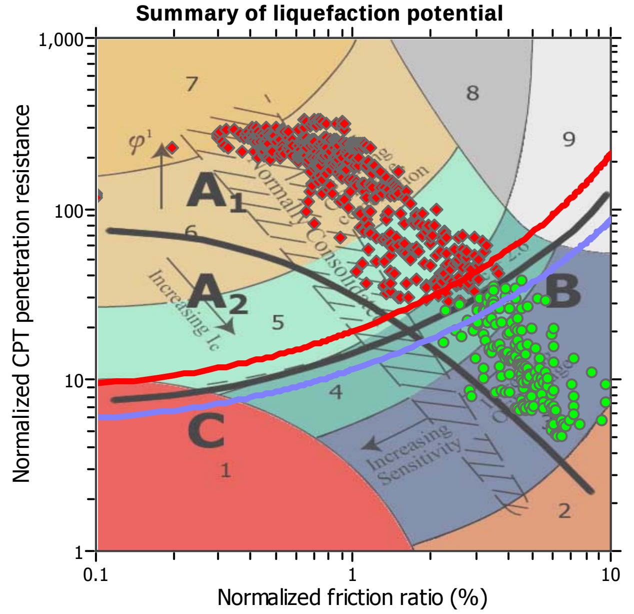
FS Plot



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

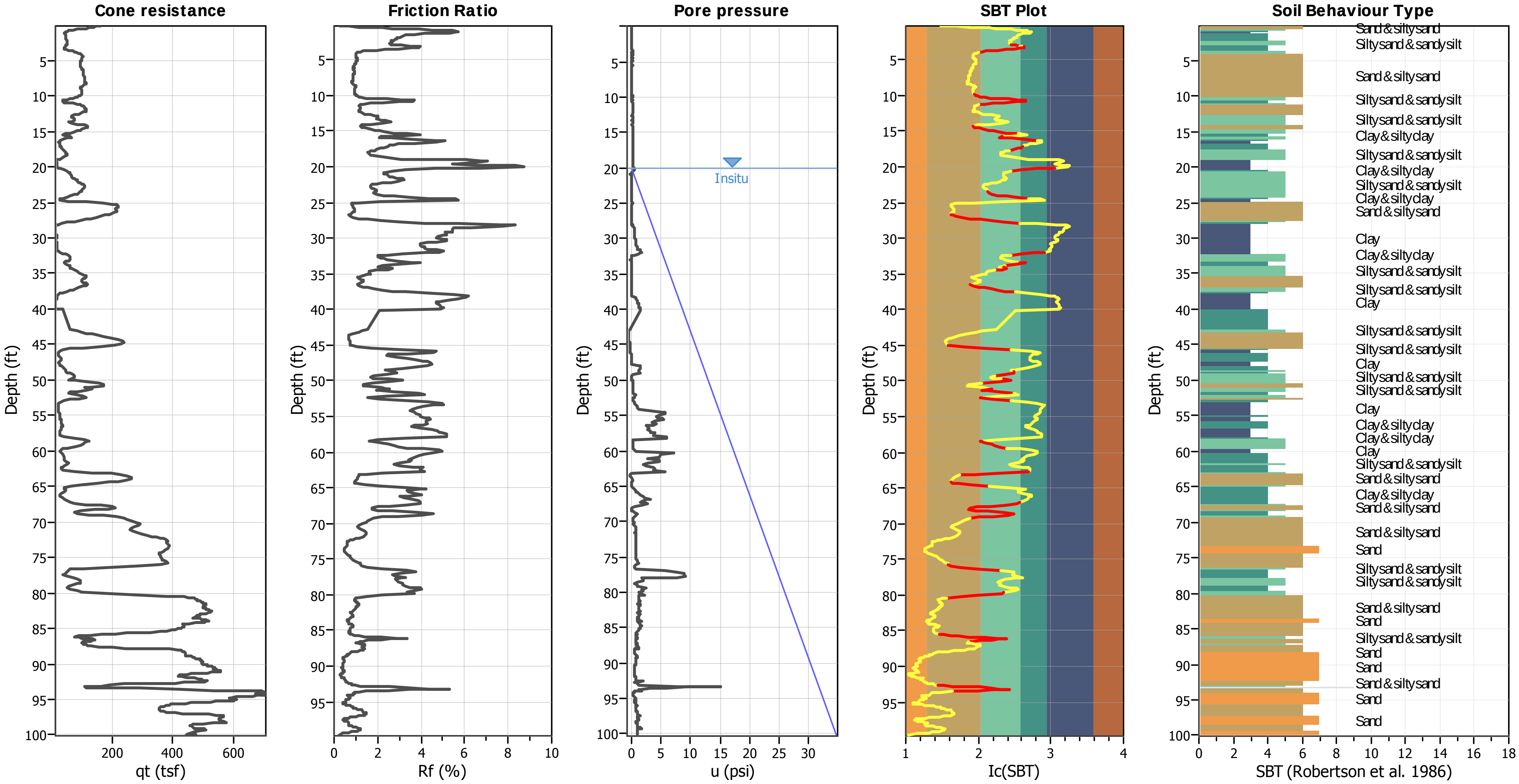


Summary of liquefaction potential



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

CPT basic interpretation plots



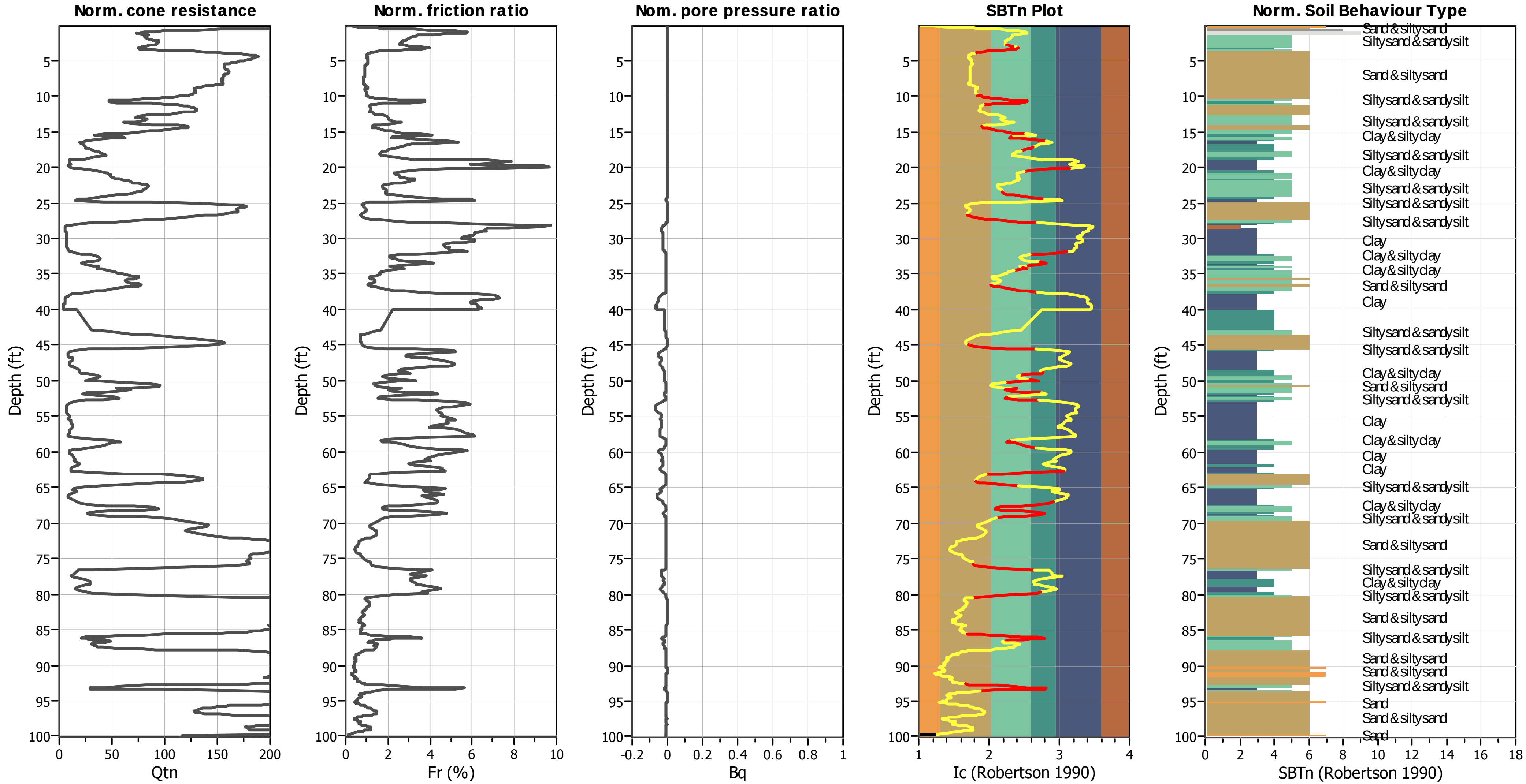
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	20.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



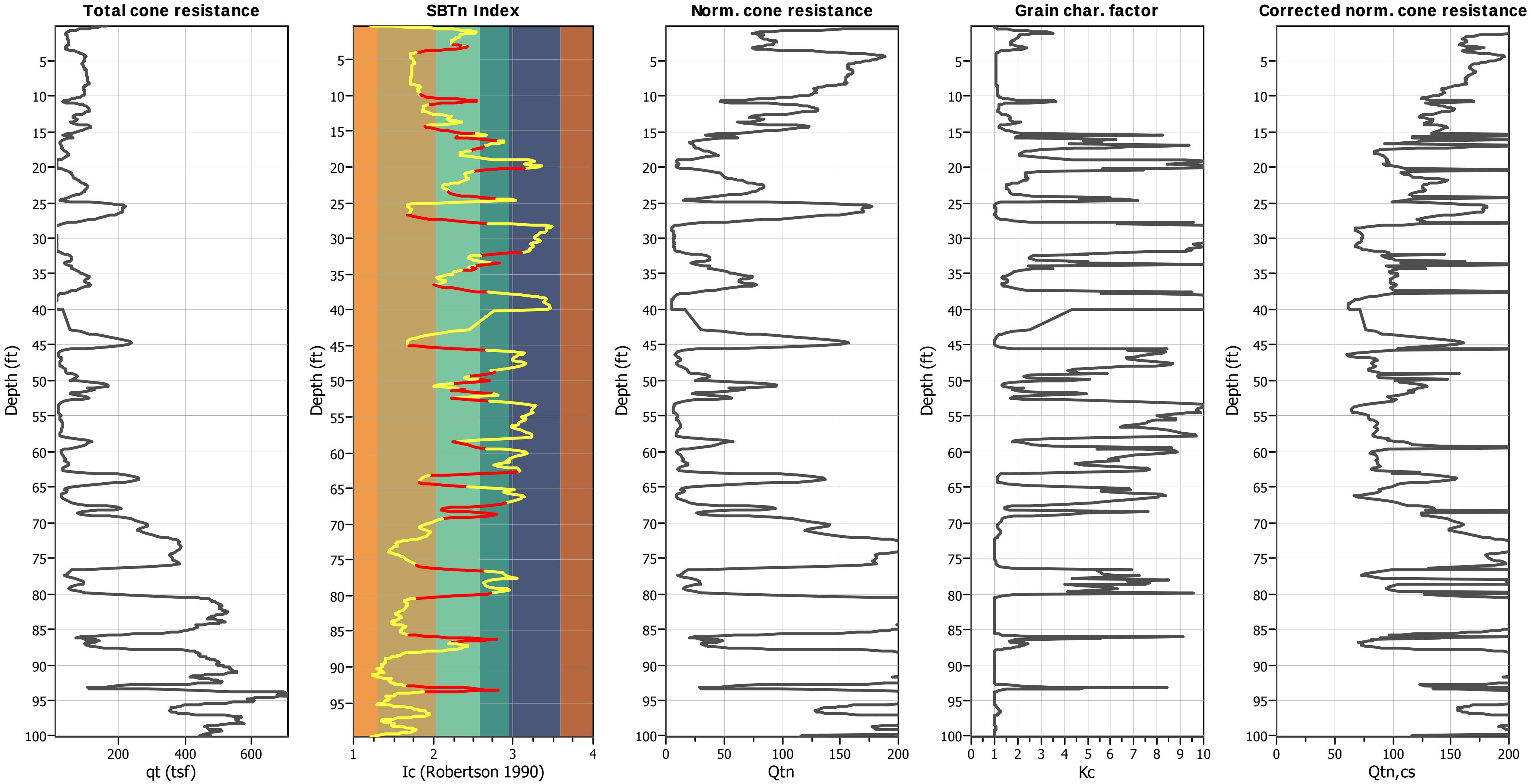
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	20.00 ft	Limit depth:	60.00 ft

SBTn legend

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

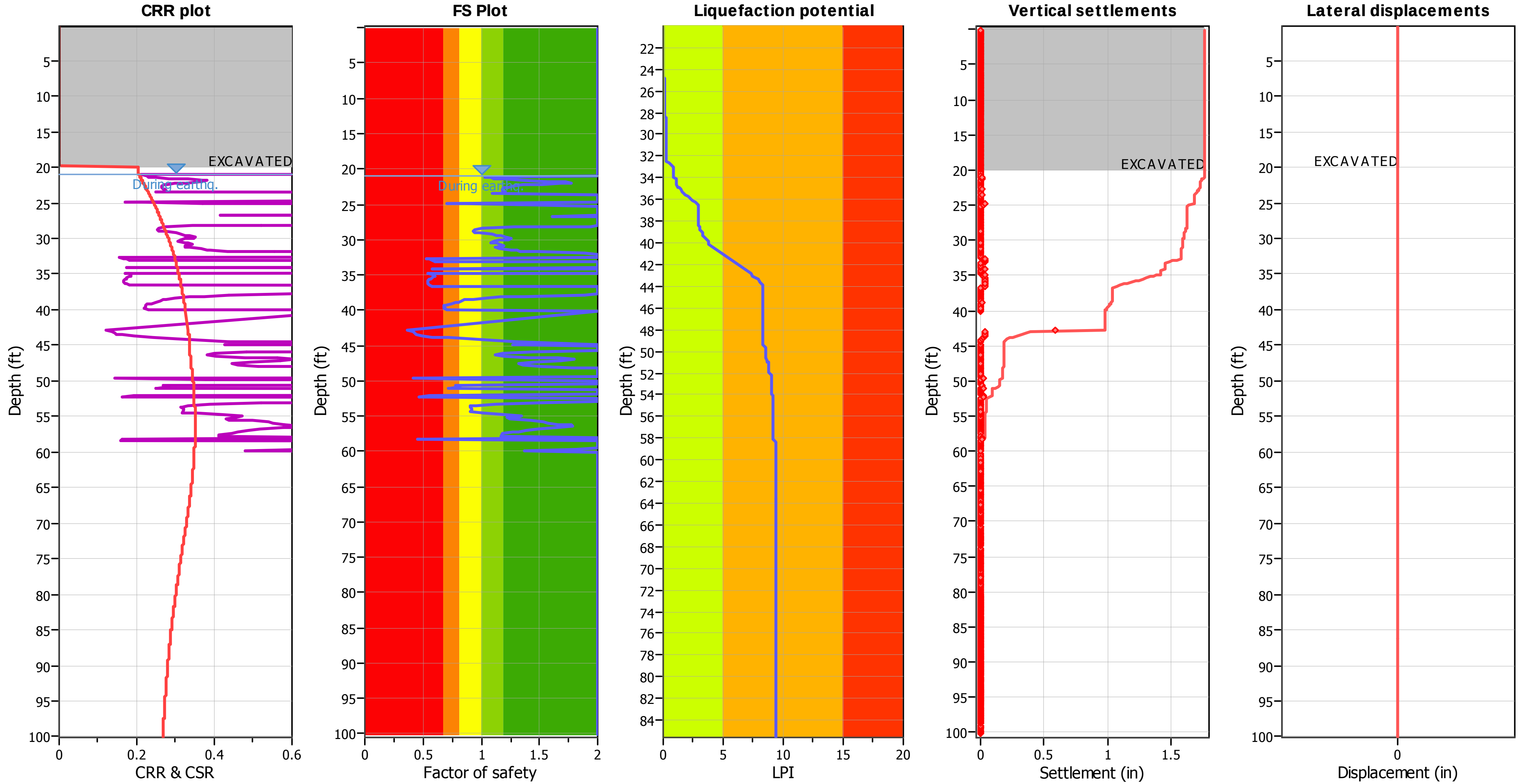
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	20.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	20.00 ft	Limit depth:	60.00 ft

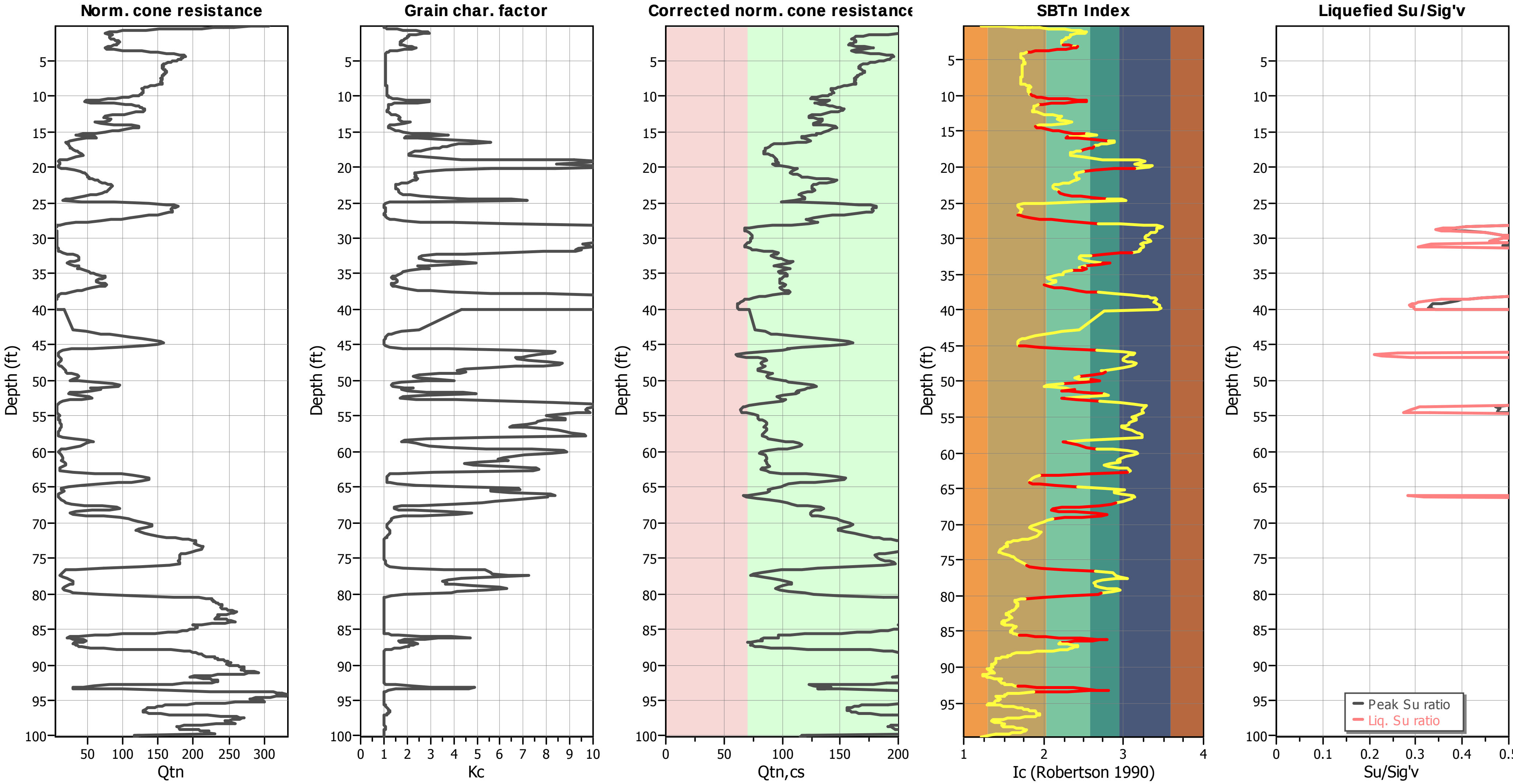
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

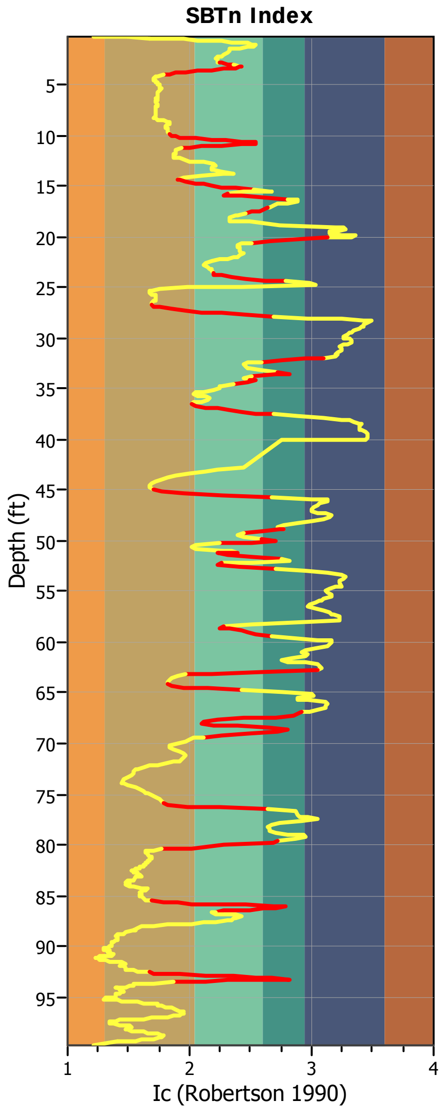
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	21.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	20.00 ft	Limit depth:	60.00 ft

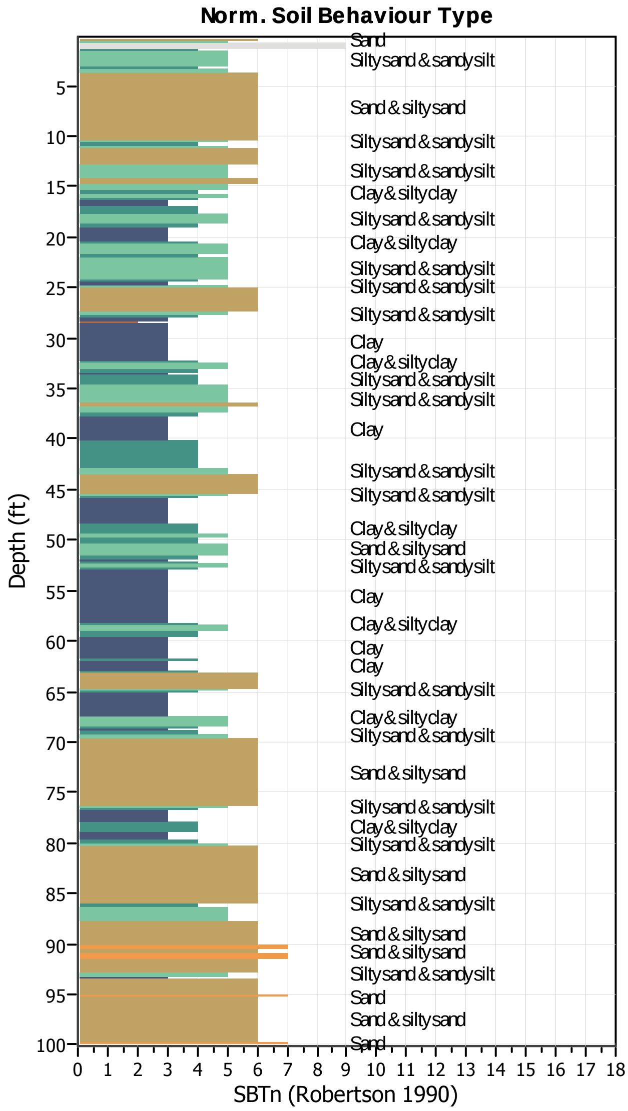
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





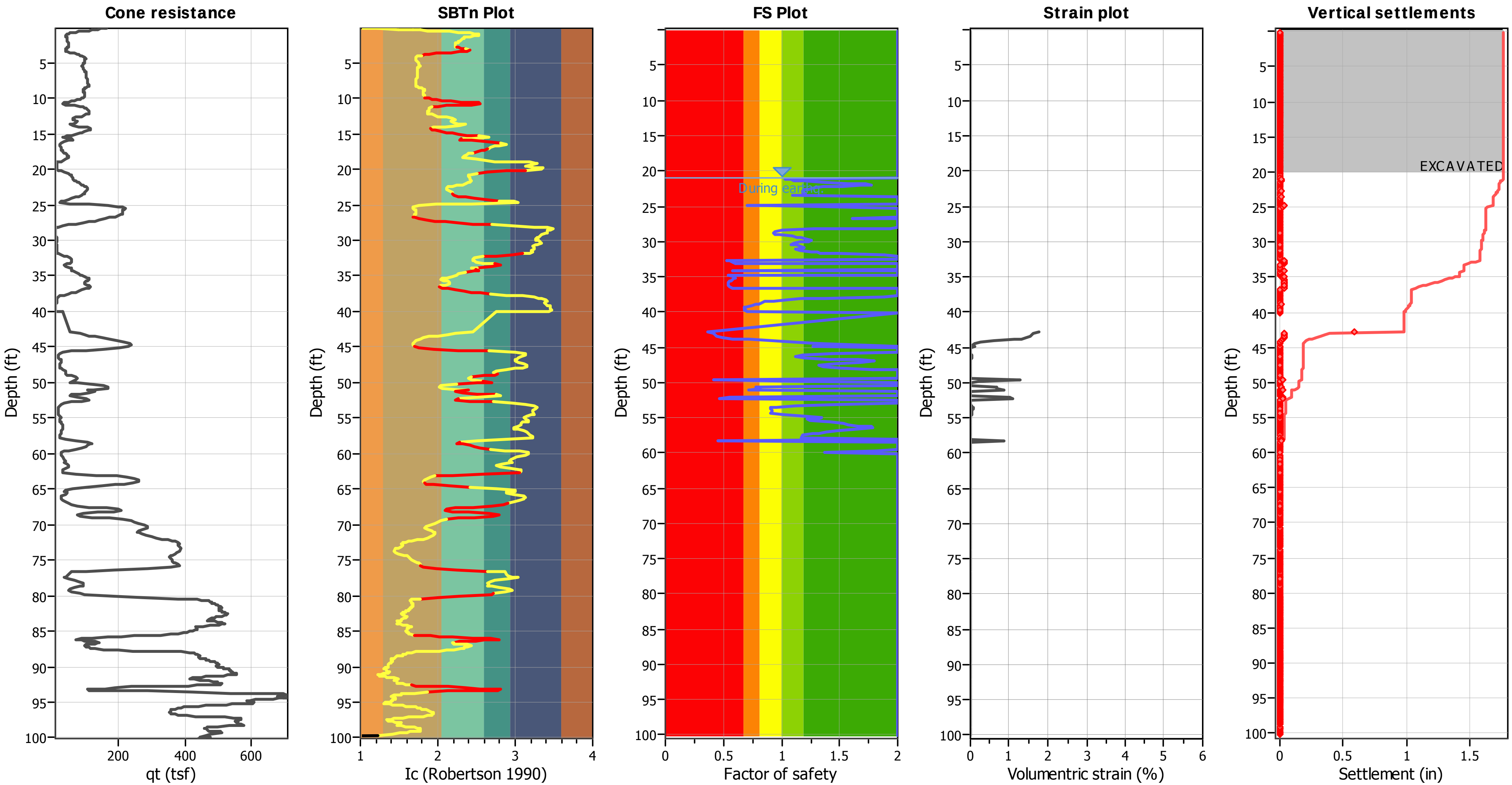
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	858
Total points excluded:	183
Exclusion percentage:	21.33%
Number of layers detected:	31

Estimation of post-earthquake settlements



Abbreviations

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

Leighton and Associates, Inc.
17781 Cowan
Irvine, CA 92614
www.leightongroup.com

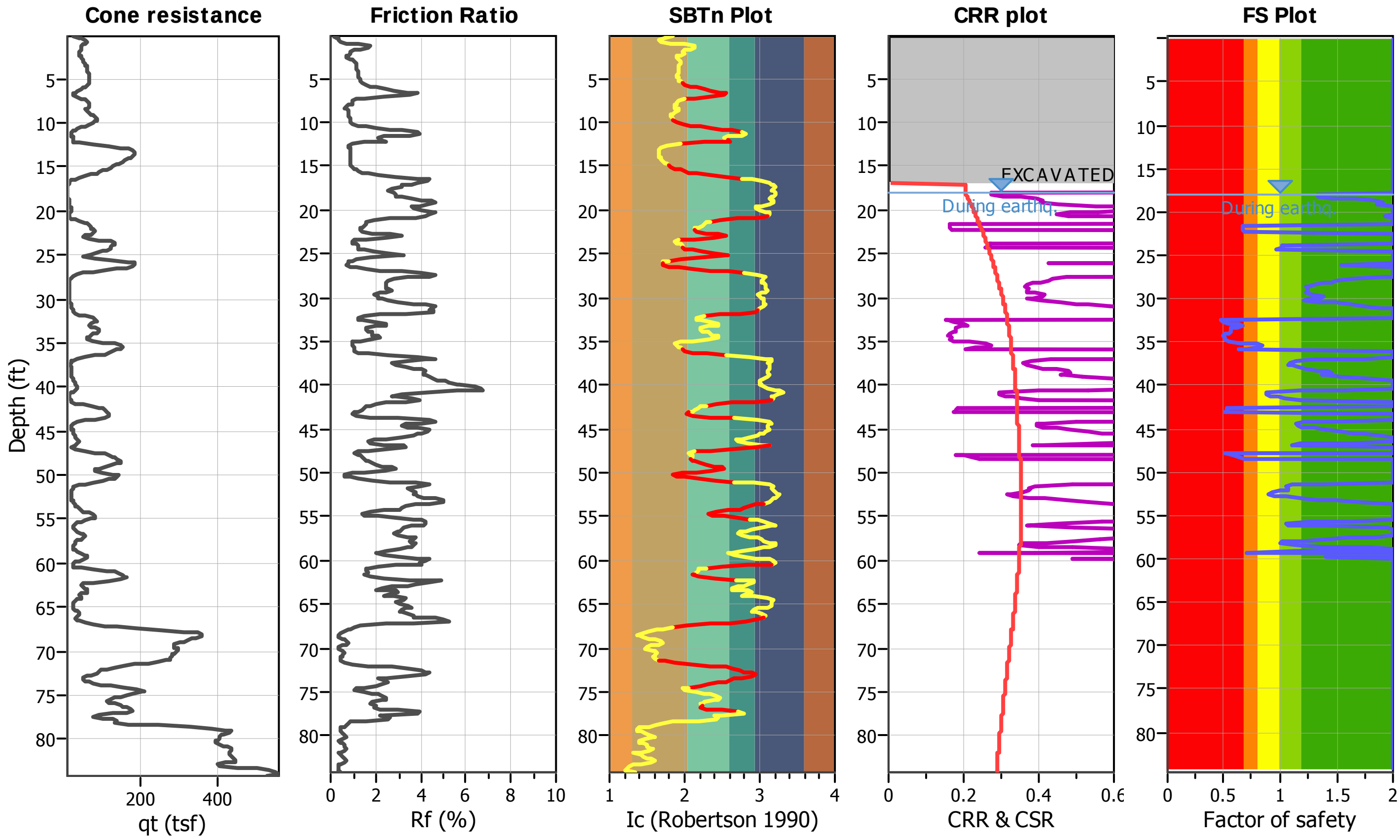
LIQUEFACTION ANALYSIS REPORT

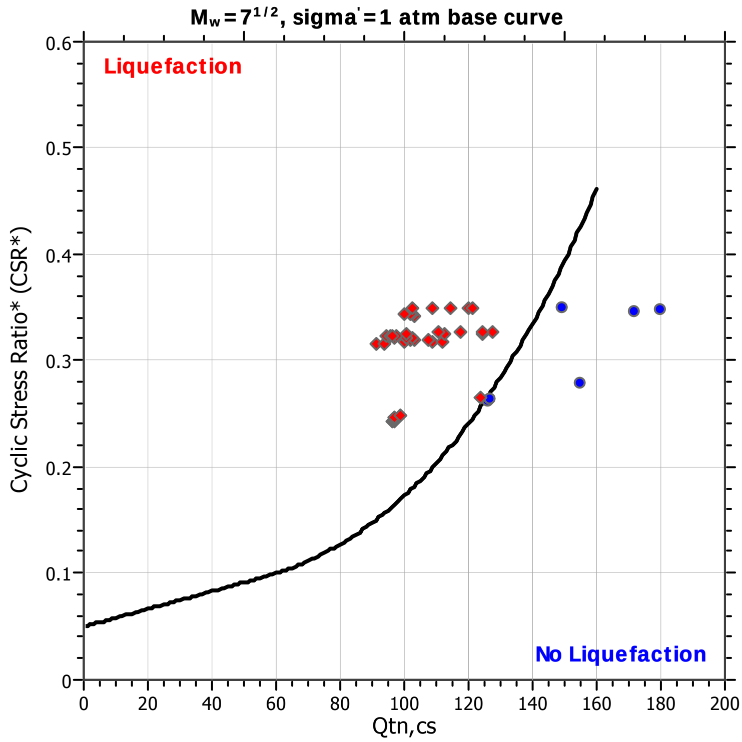
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

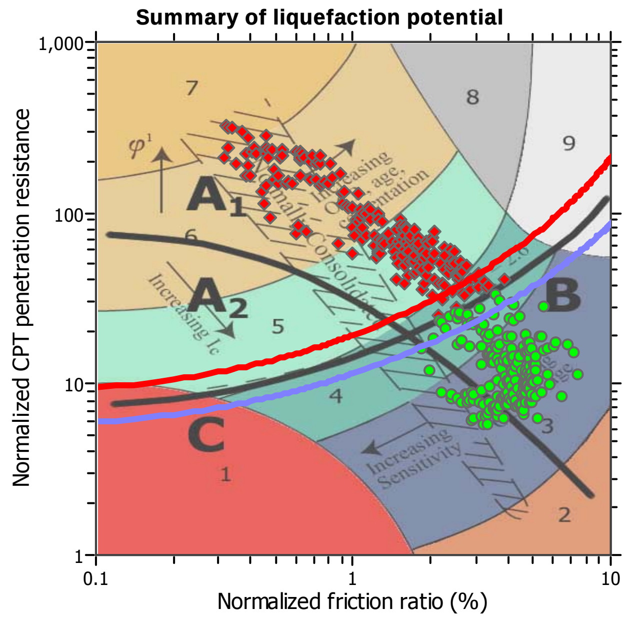
CPT file : CPT-11

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	18.00 ft	Excavation depth:	17.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

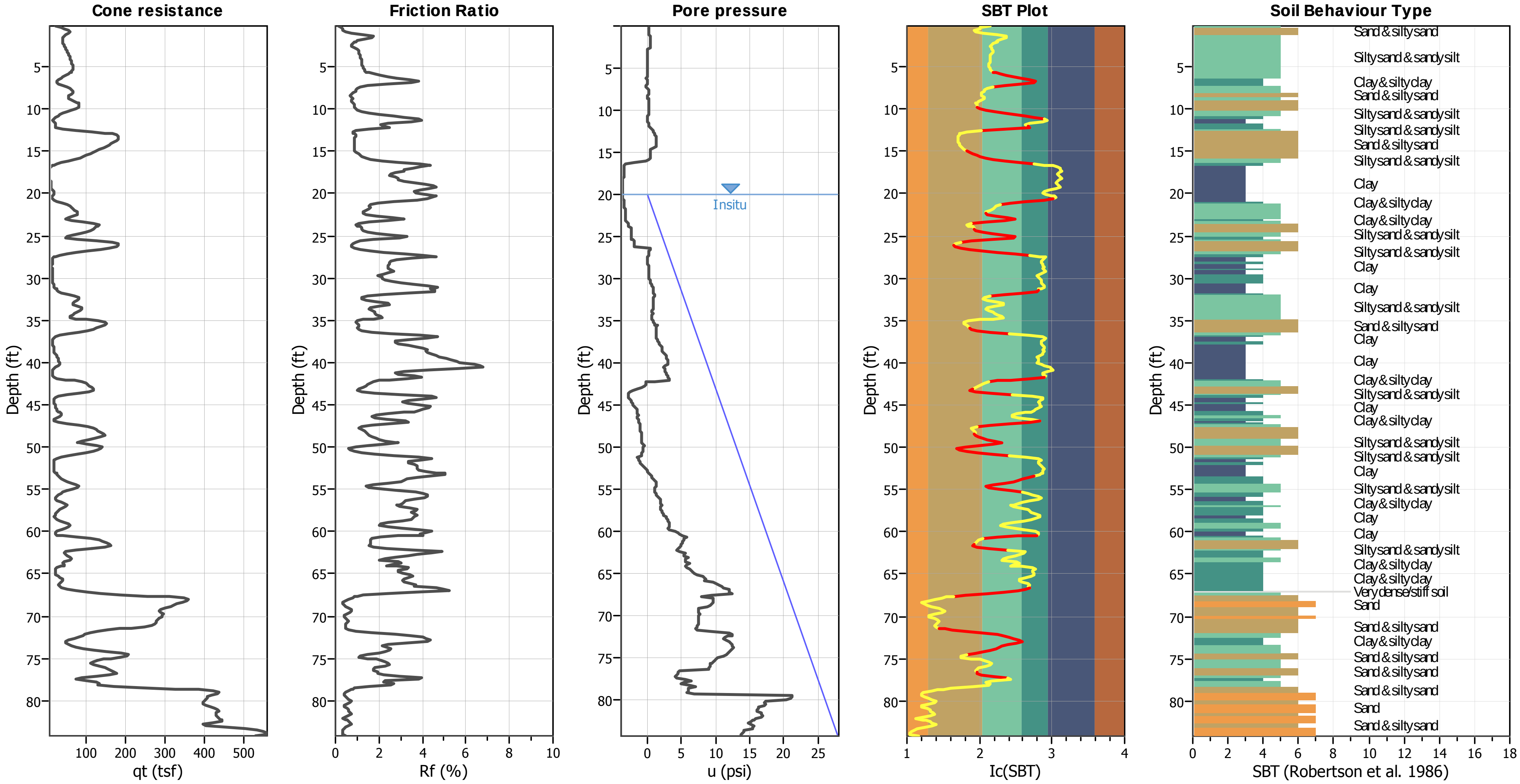






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



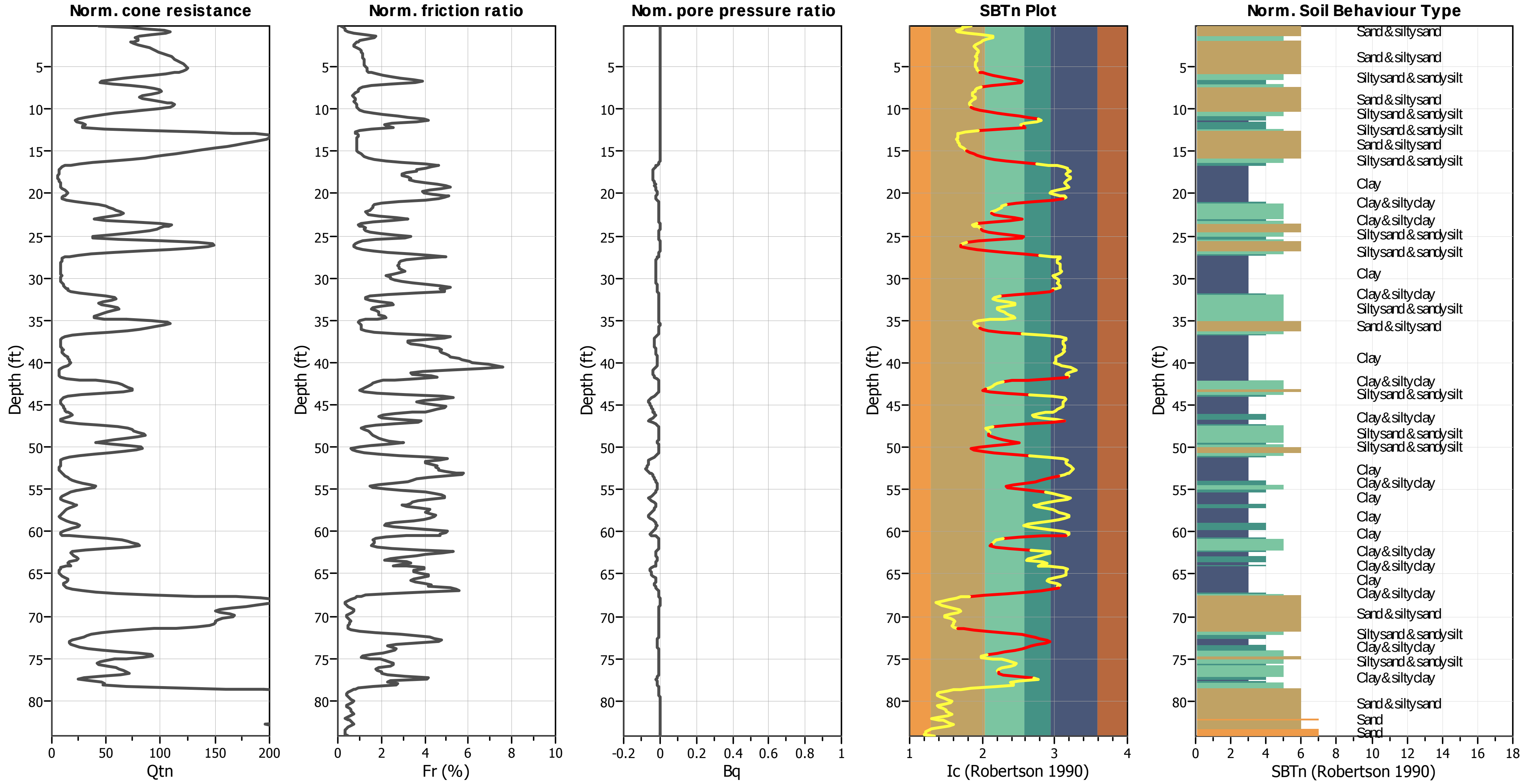
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	18.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	17.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



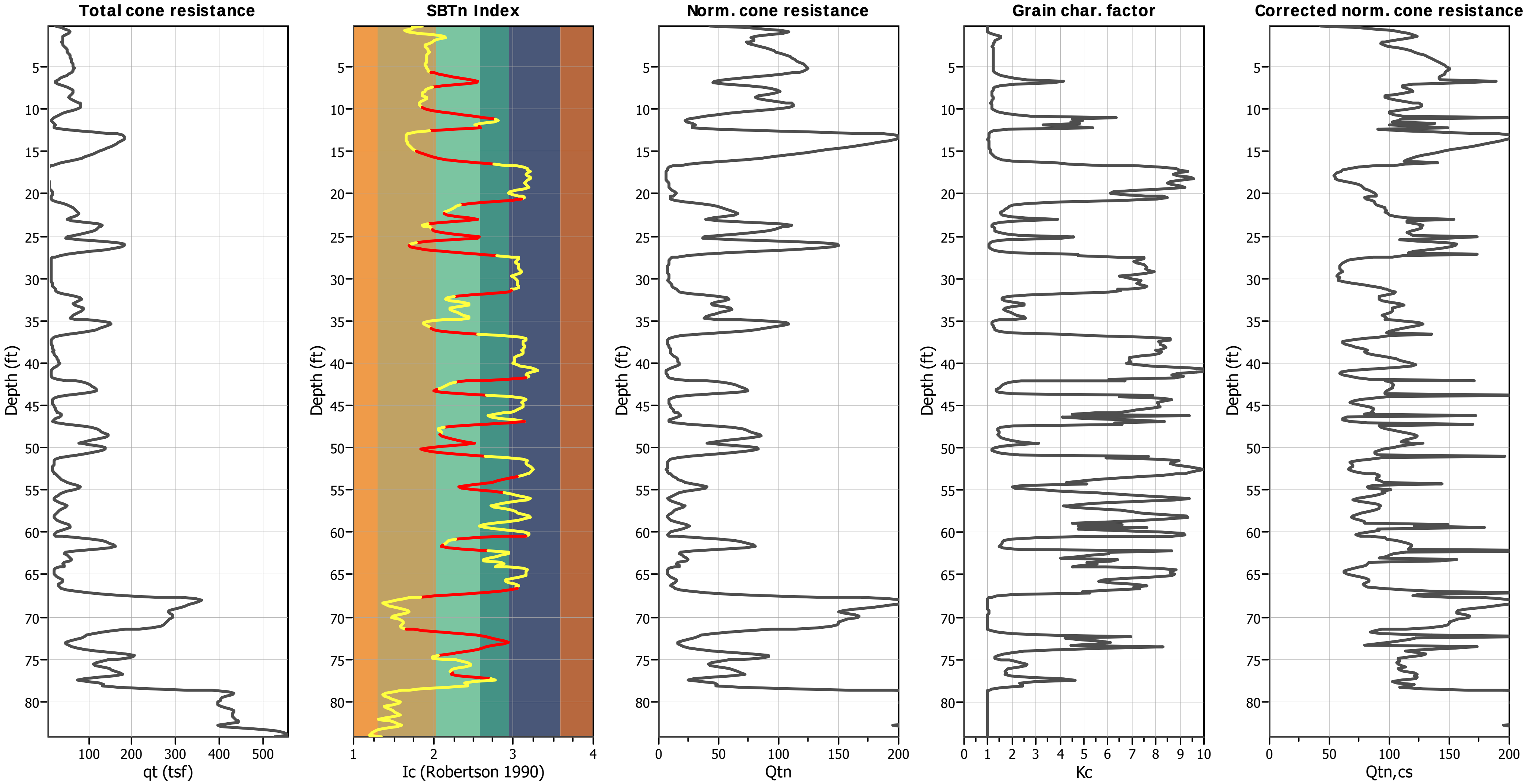
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	18.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	17.00 ft	Limit depth:	60.00 ft

SBTn legend

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

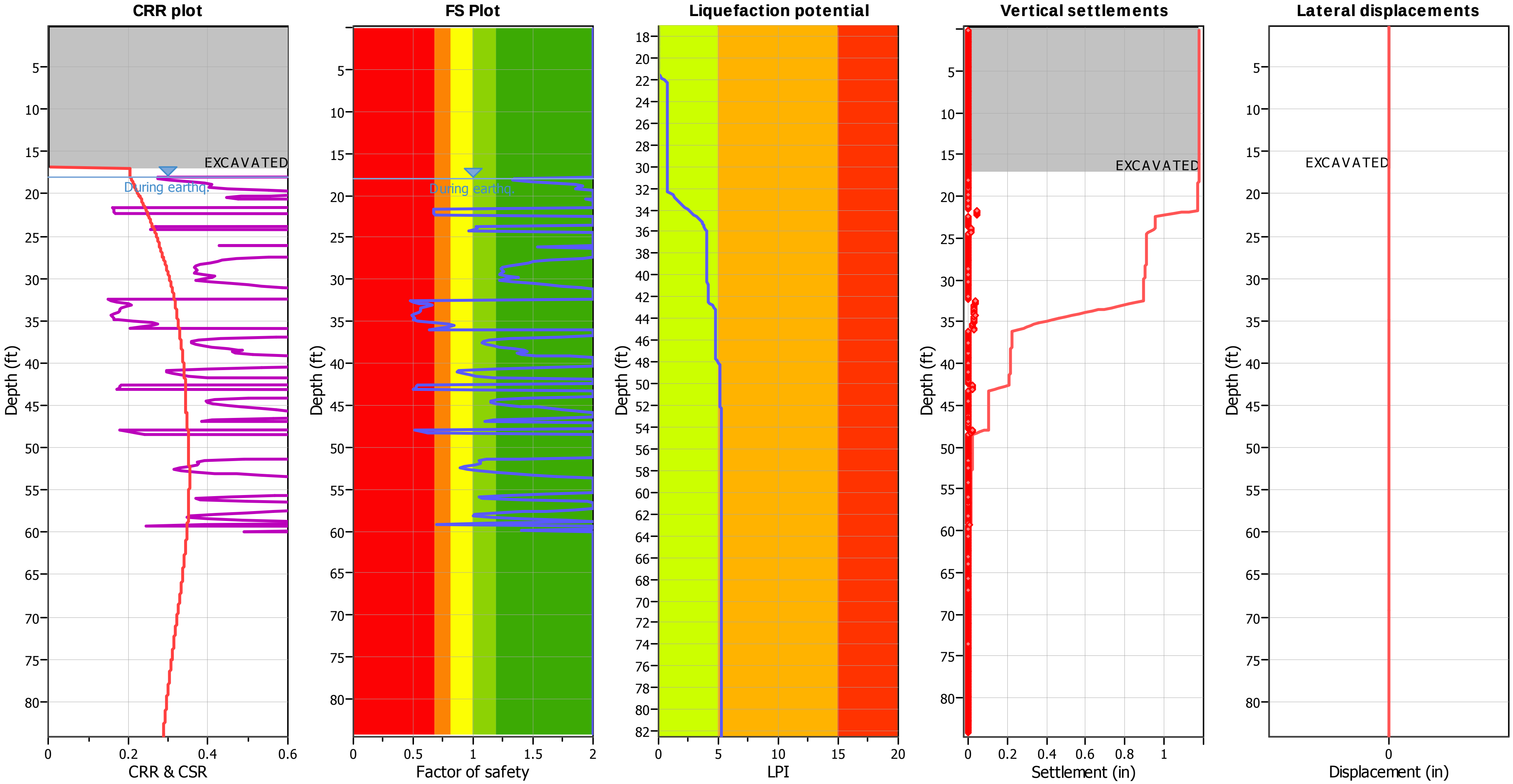
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	18.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	17.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	18.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	17.00 ft	Limit depth:	60.00 ft

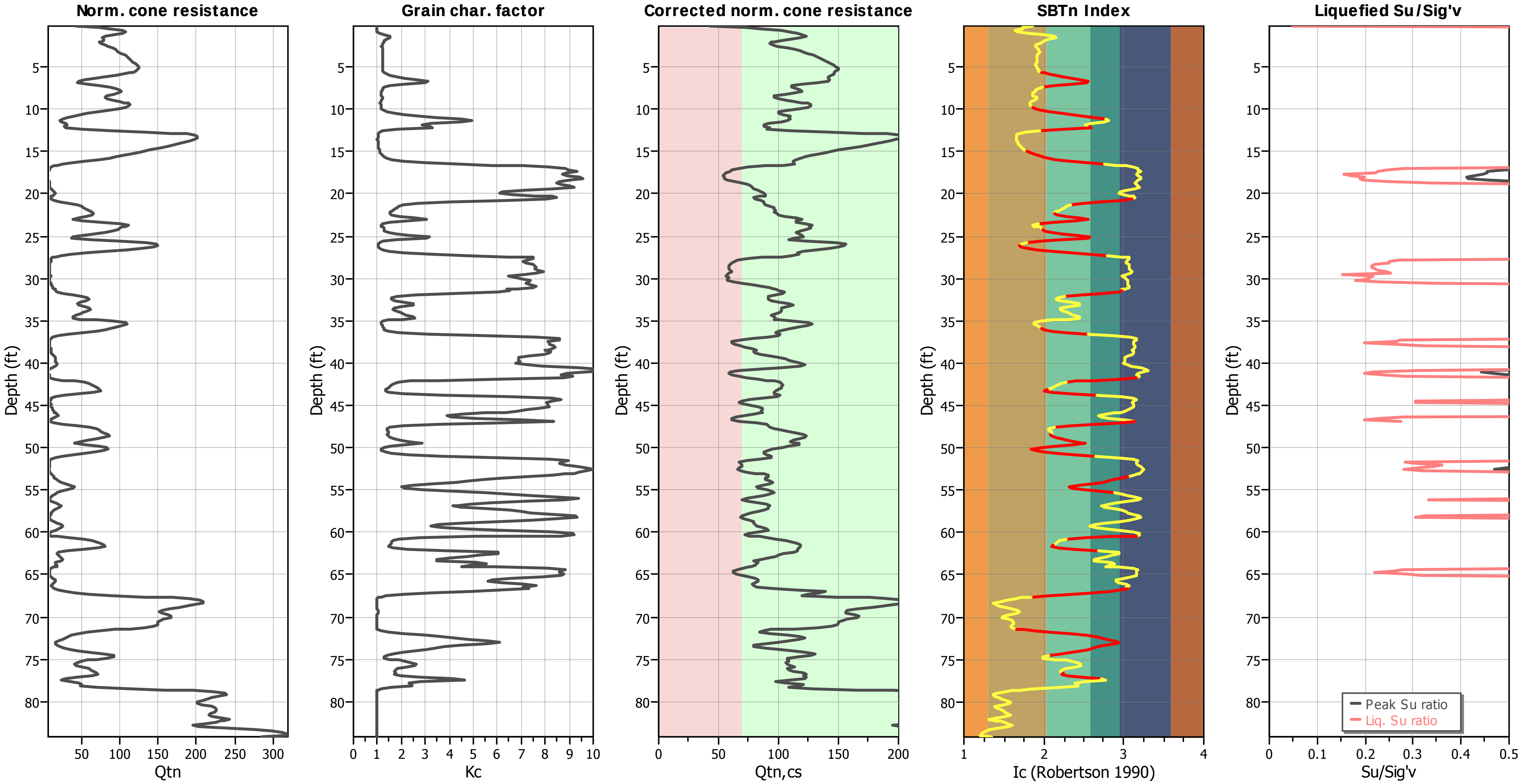
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

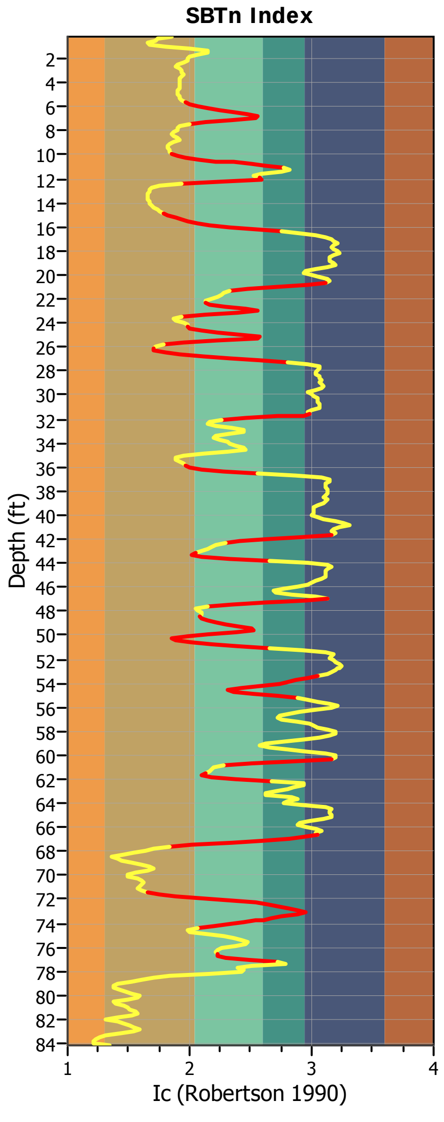
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	18.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	17.00 ft	Limit depth:	60.00 ft

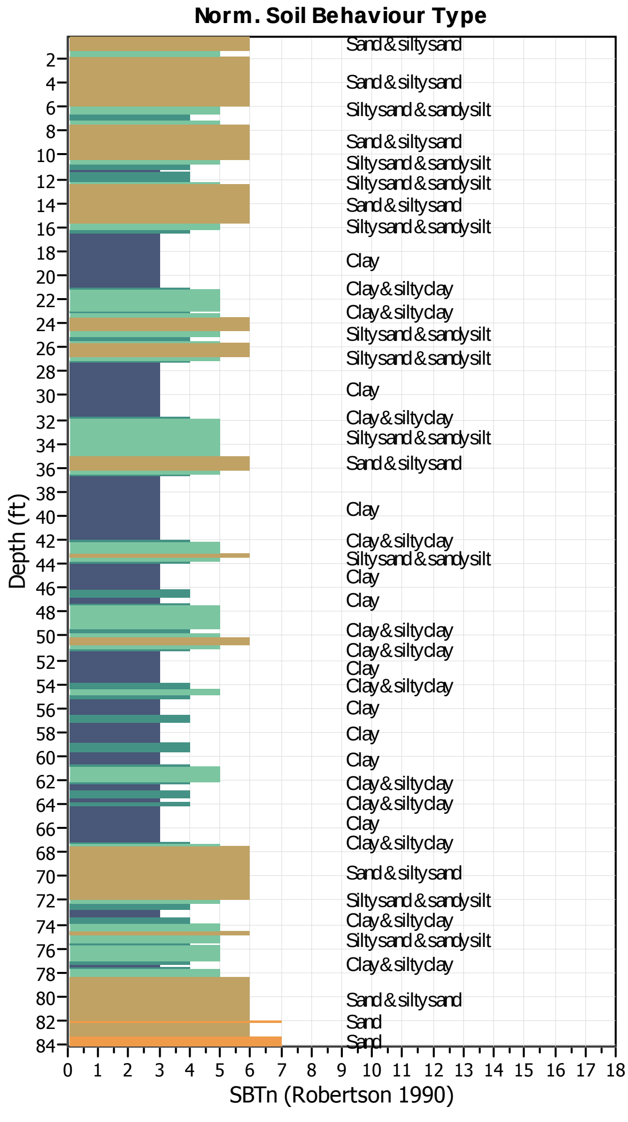
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





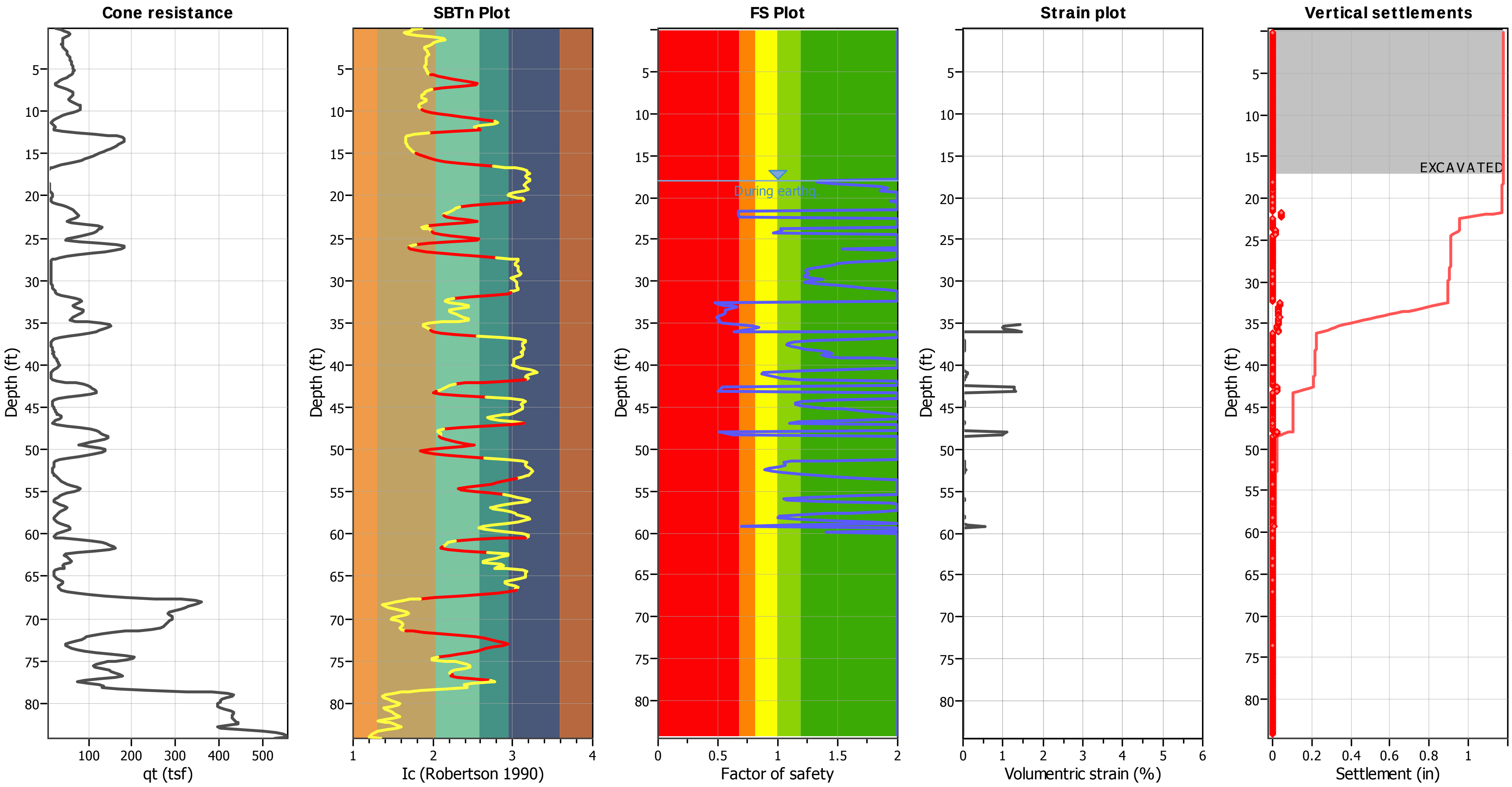
Transition layer algorithm properties

I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics

Total points in CPT file:	513
Total points excluded:	163
Exclusion percentage:	31.77%
Number of layers detected:	27

Estimation of post-earthquake settlements



Abbreviations

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

Leighton Consulting, Inc.
A LEIGHTON GROUP COMPANY

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Irvine, CA 92614
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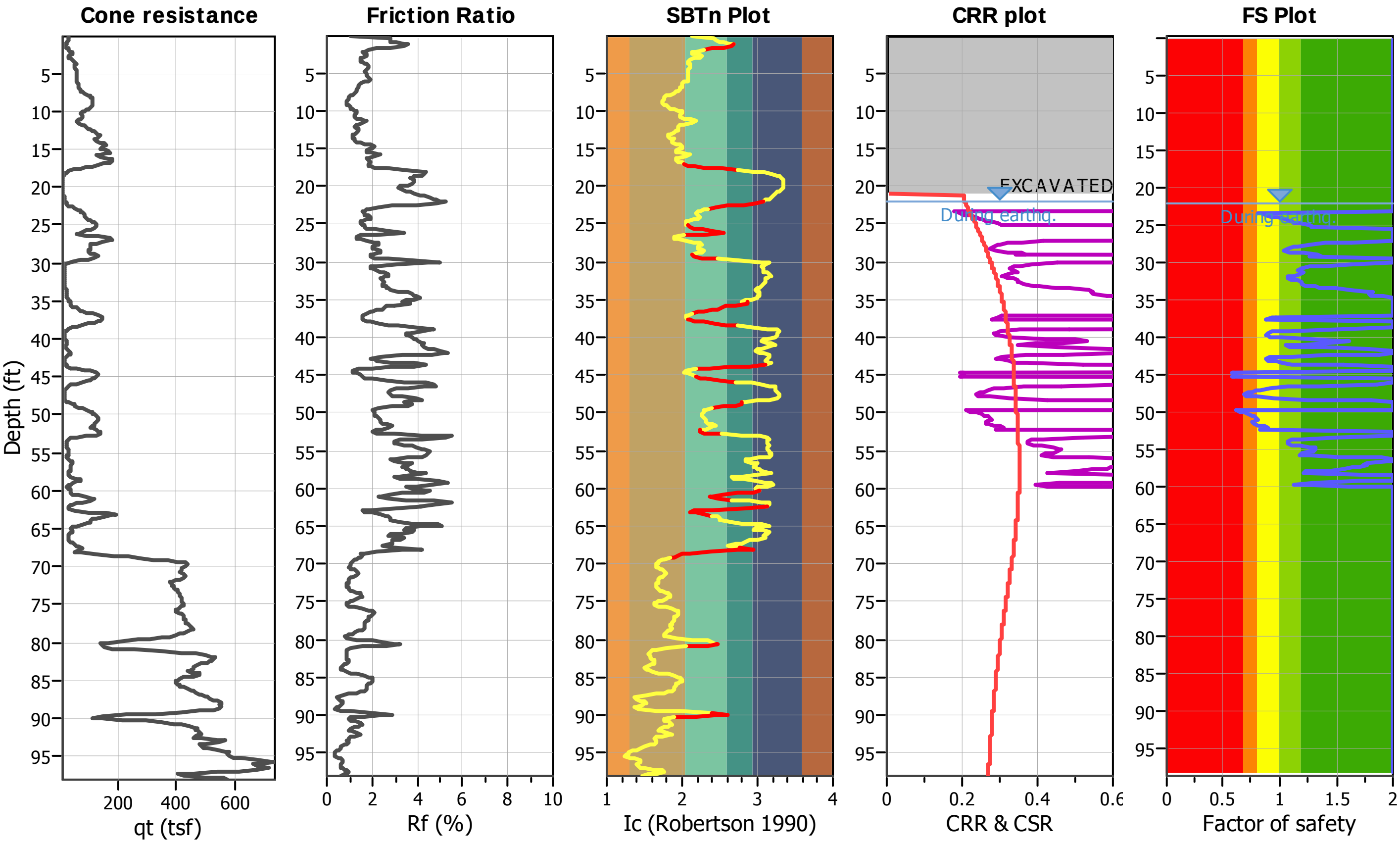
LIQUEFACTION ANALYSIS REPORT

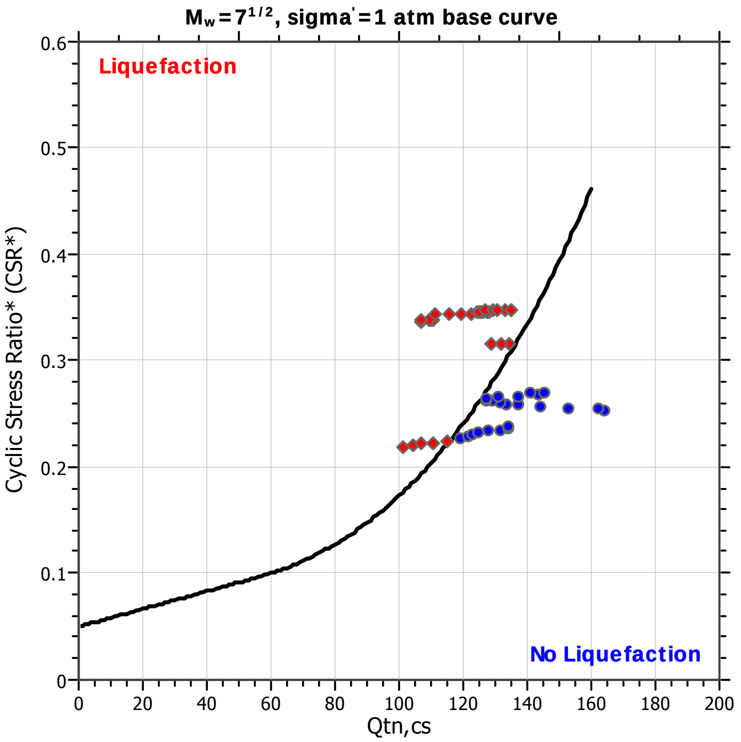
Project title : Great Wolf Lodge Resort **Location : 12661 Harbor Blvd., Garden Grove, CA**

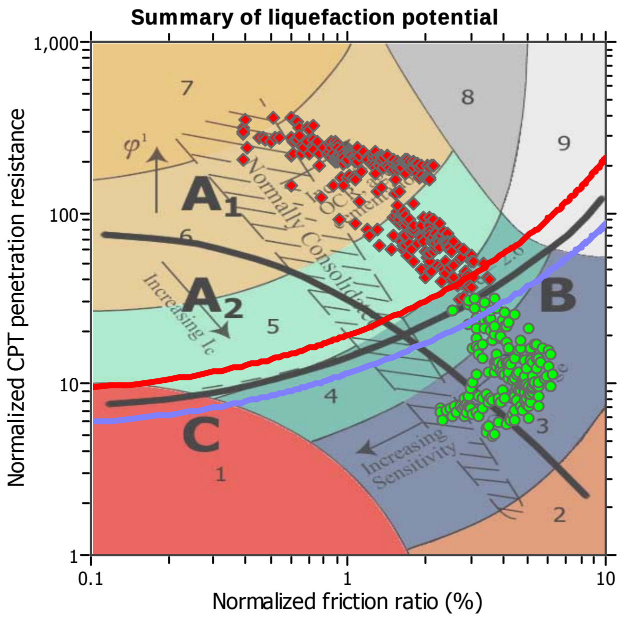
CPT file : CPT-12

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	20.00 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	22.00 ft	Excavation depth:	21.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Footing load:	0.50 tsf	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.90	Ic cut-off value:	2.60	Trans. detect. applied:	Yes		
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

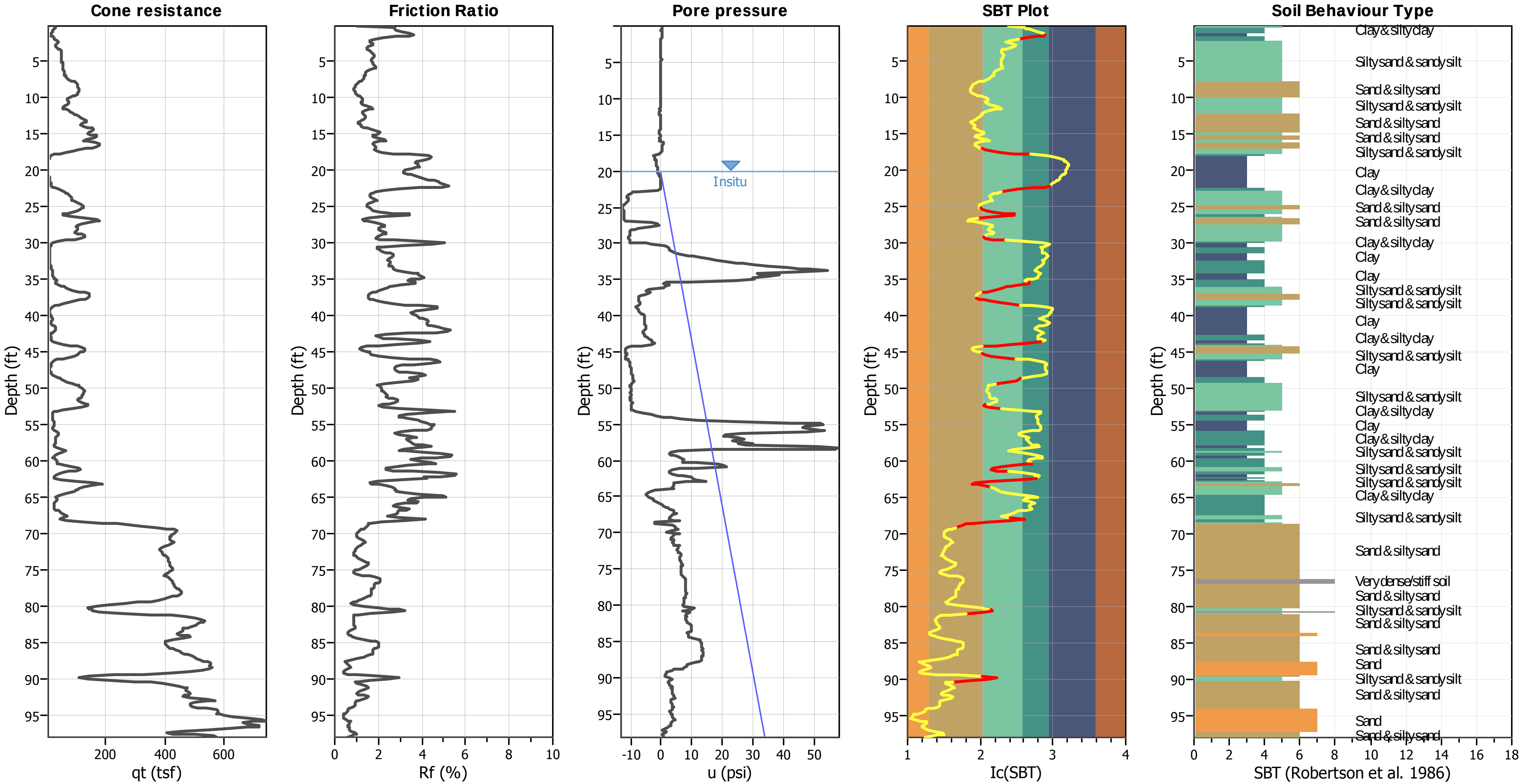






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



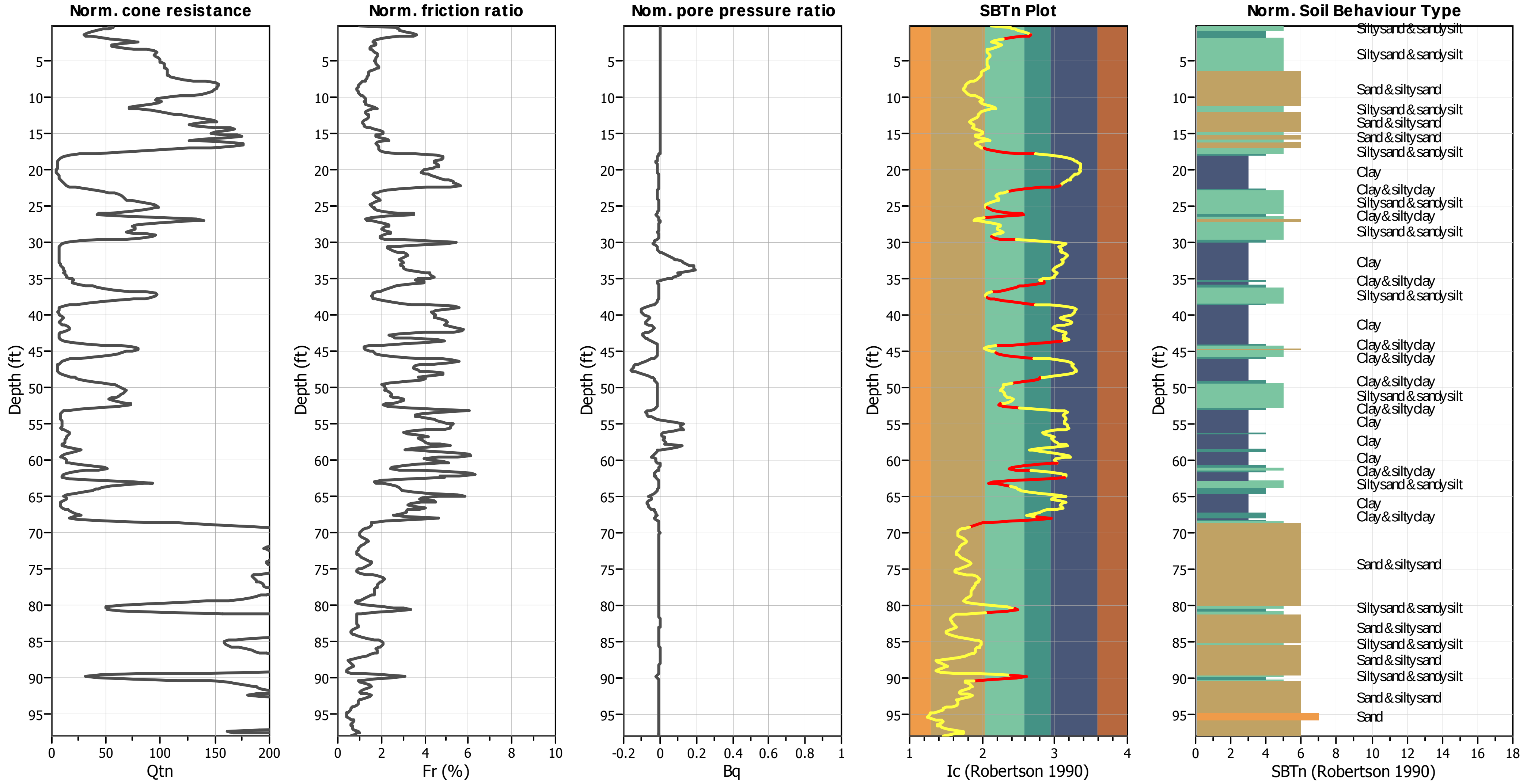
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Footing load:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Excavation depth:	21.00 ft	Limit depth:	60.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



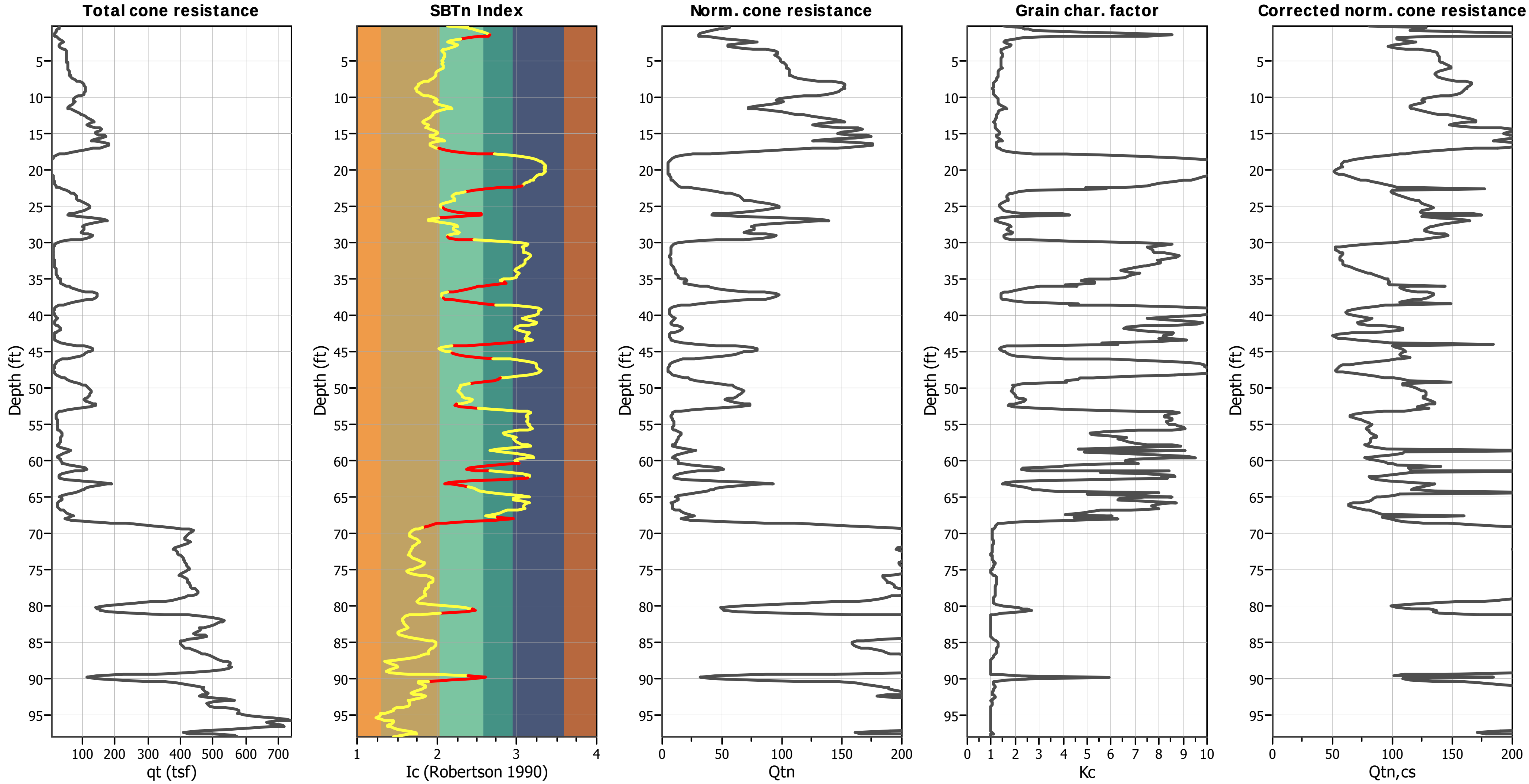
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	21.00 ft	Limit depth:	60.00 ft

SBTn legend

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

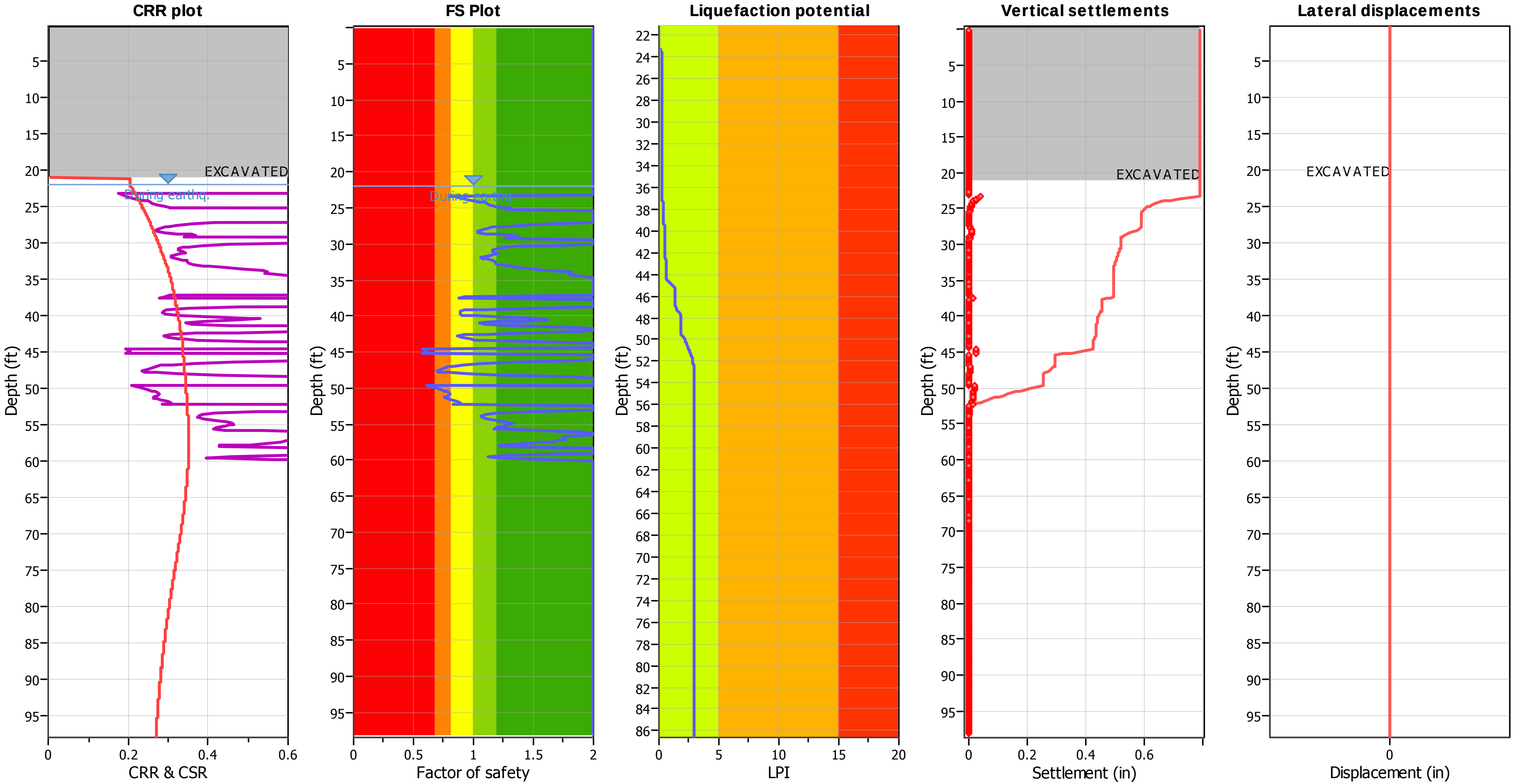
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	21.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	21.00 ft	Limit depth:	60.00 ft

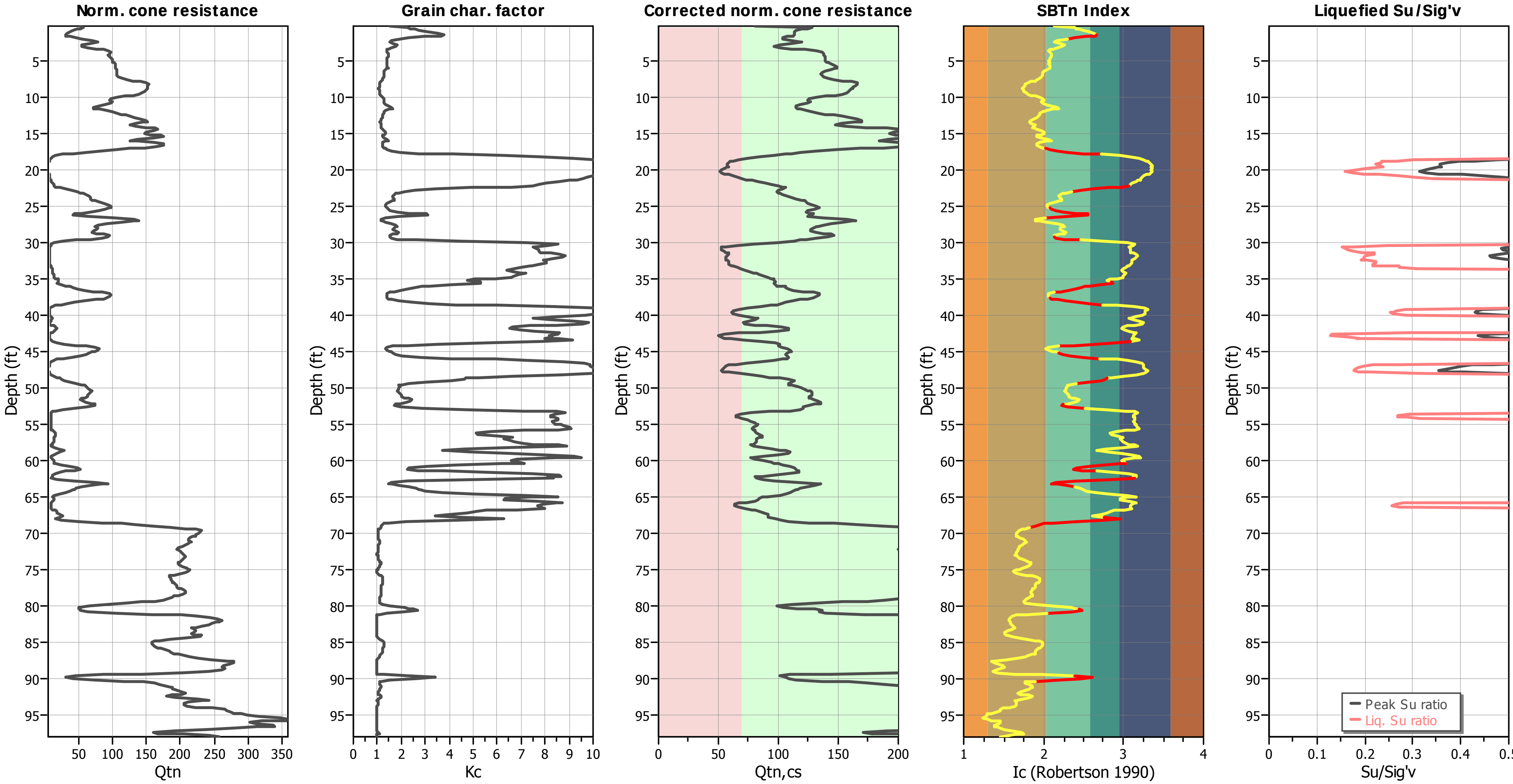
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

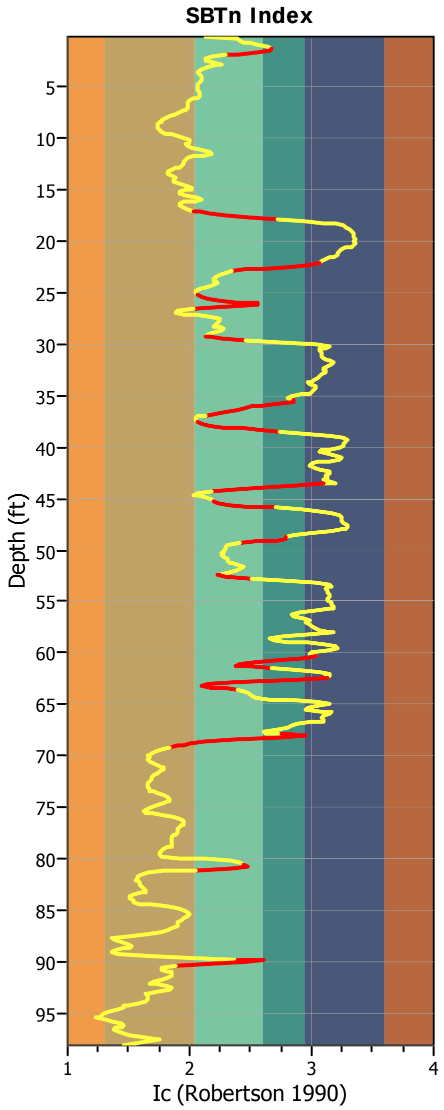
Analysis method:	Robertson (2009)	Depth to water table (erthq.):	22.00 ft	Fill weight:	0.50 tsf
Fines correction method:	Robertson (2009)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	6.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.39	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	20.00 ft	Fill height:	21.00 ft	Limit depth:	60.00 ft

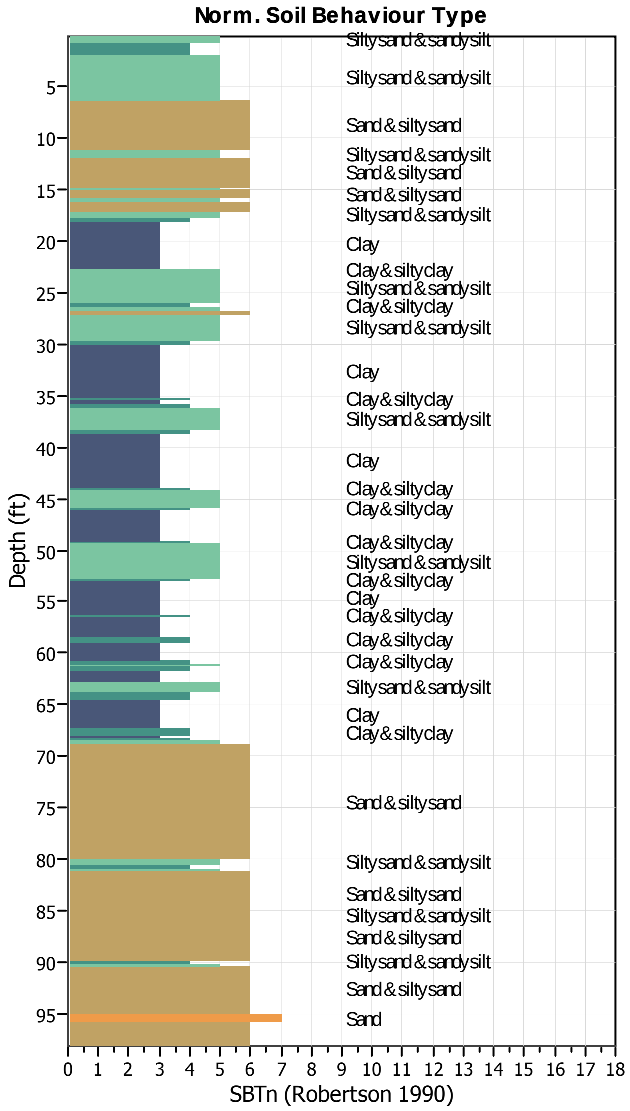
TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur when the rate of change of I_c is fast (i.e. delta I_c is small).

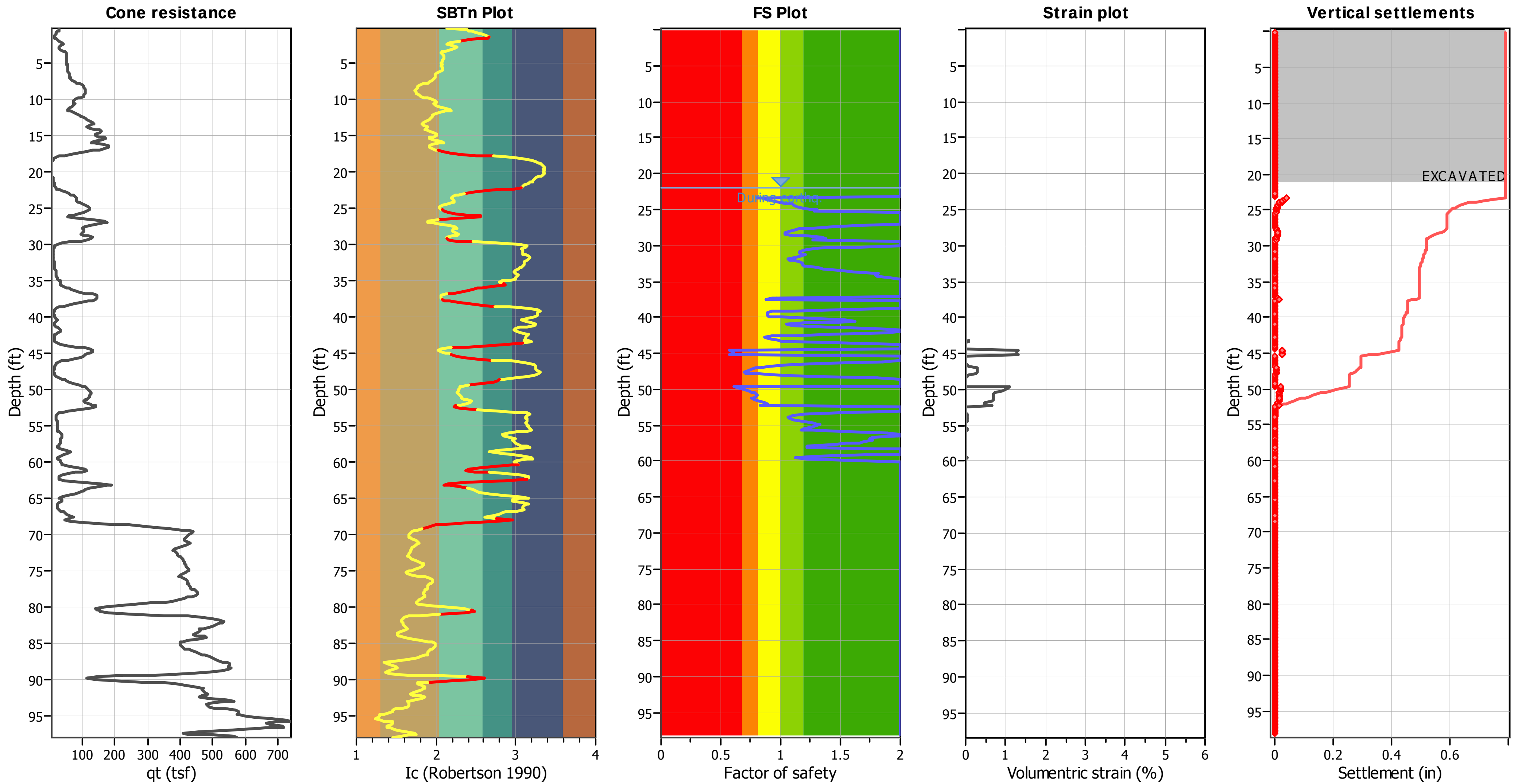
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.





Transition layer algorithm properties		**General statistics**	
I_c minimum check value:	1.70	Total points in CPT file:	598
I_c maximum check value:	3.00	Total points excluded:	101
I_c change ratio value:	0.0250	Exclusion percentage:	16.89%
Minimum number of points in layer:	4	Number of layers detected:	19

Estimation of post-earthquake settlements

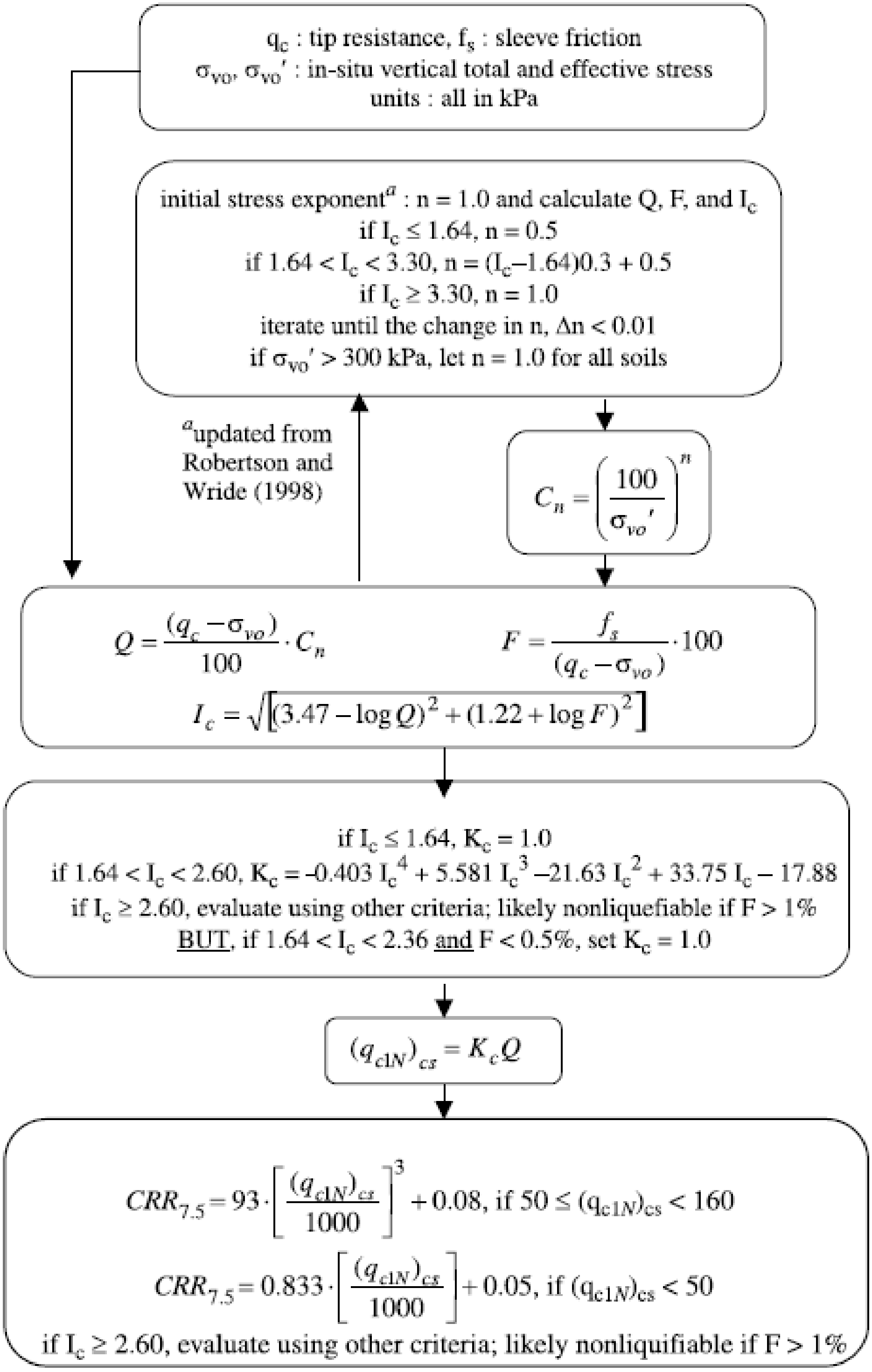


Abbreviations

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

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

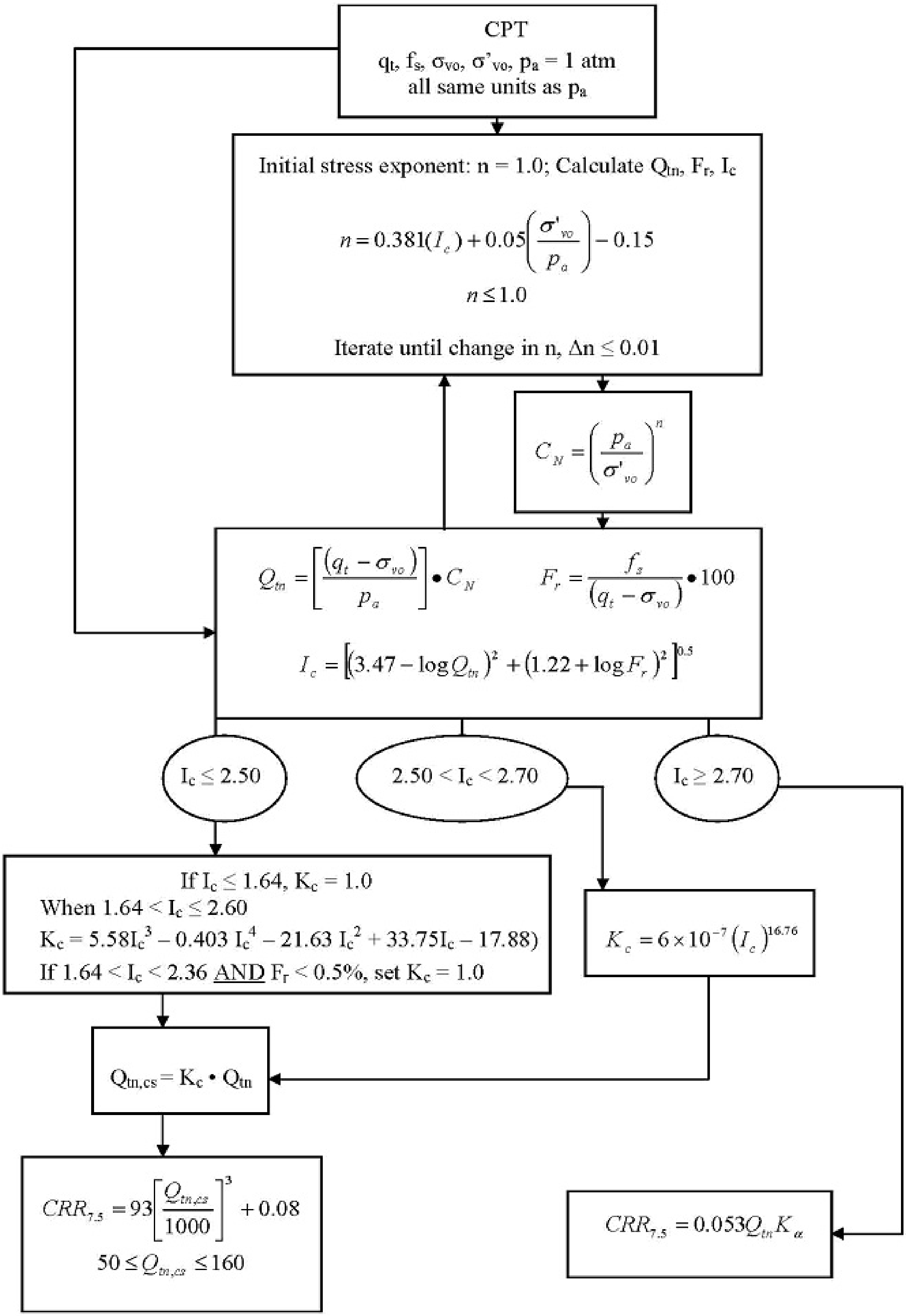
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of 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

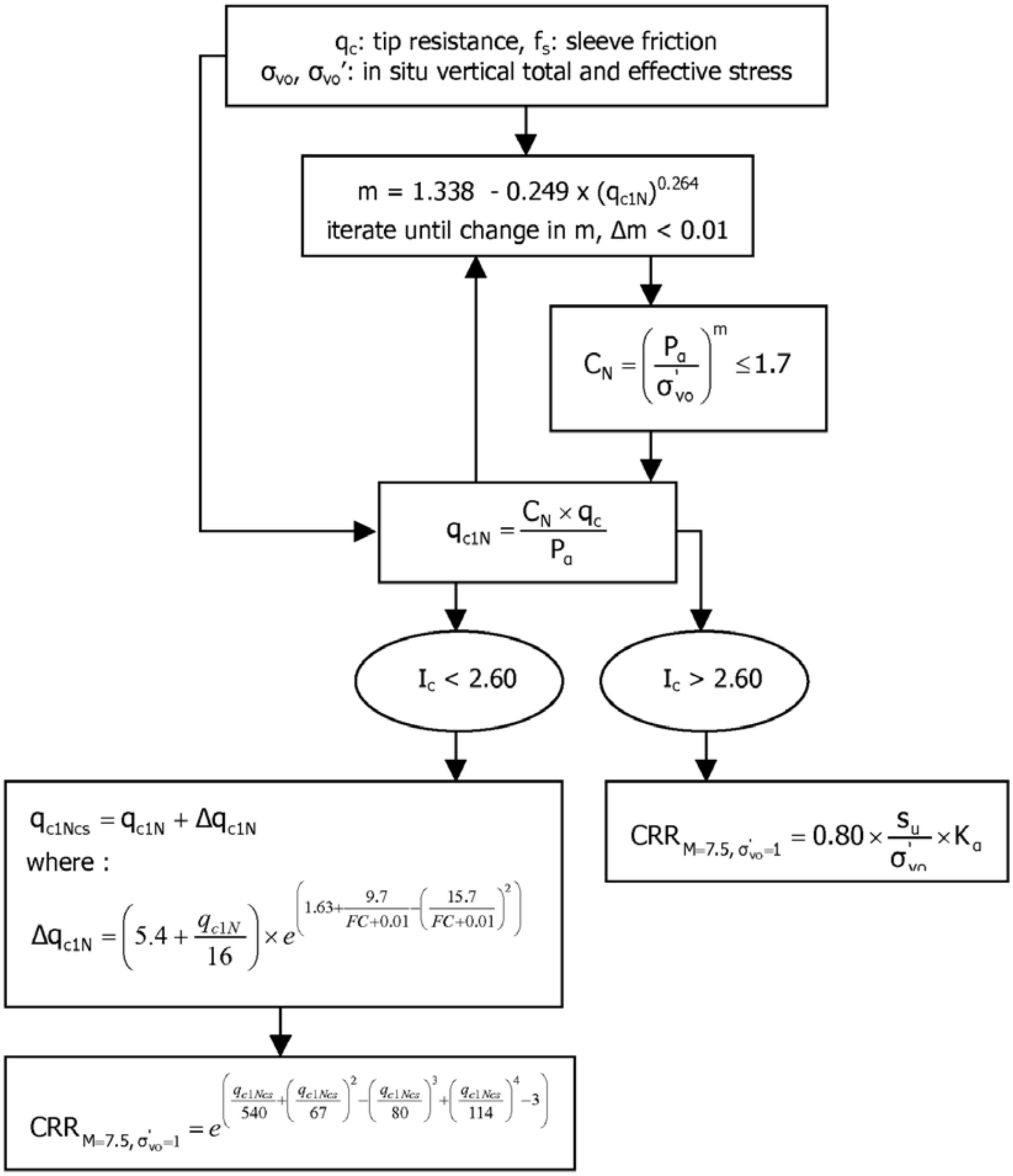
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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]:

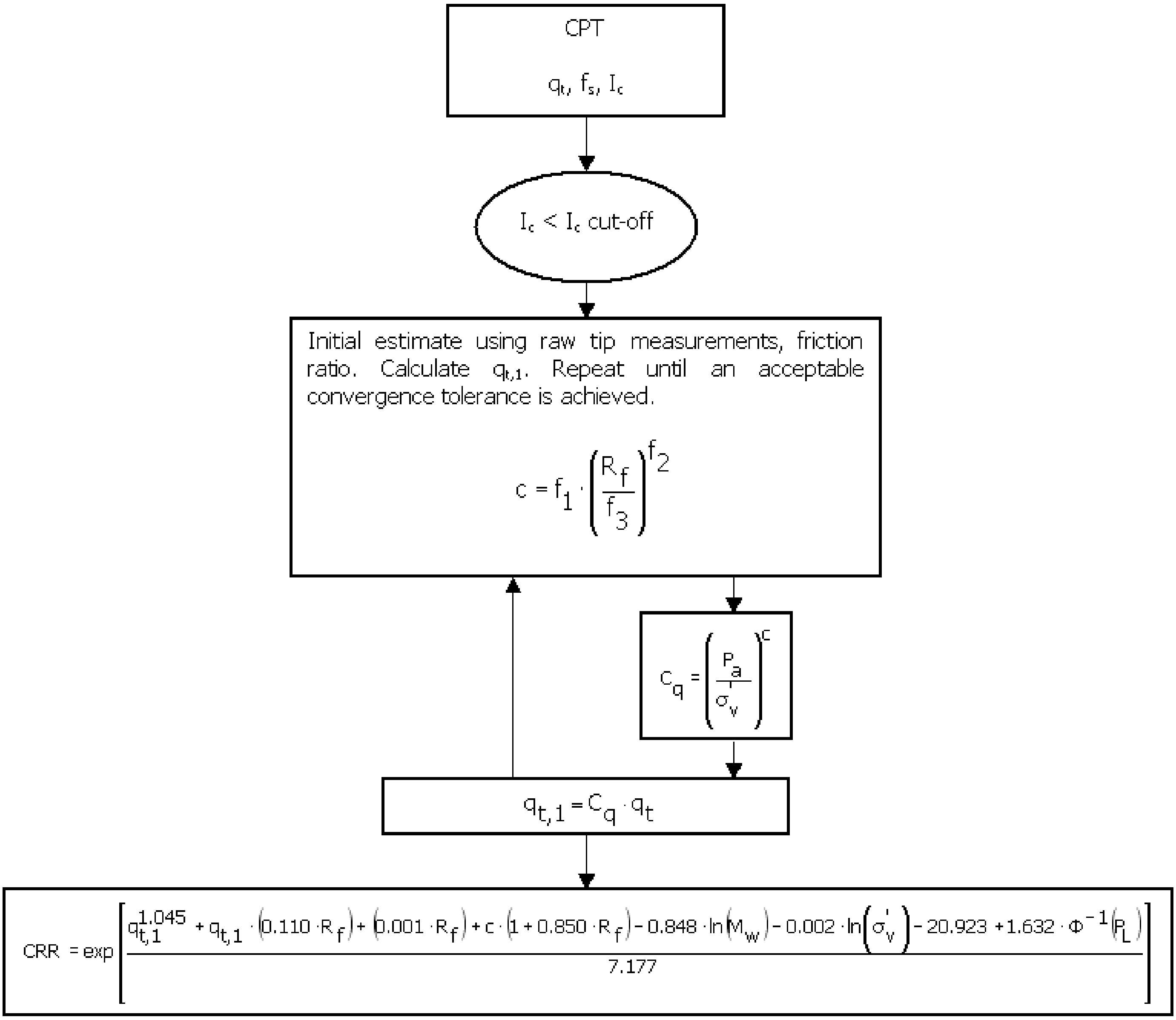


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

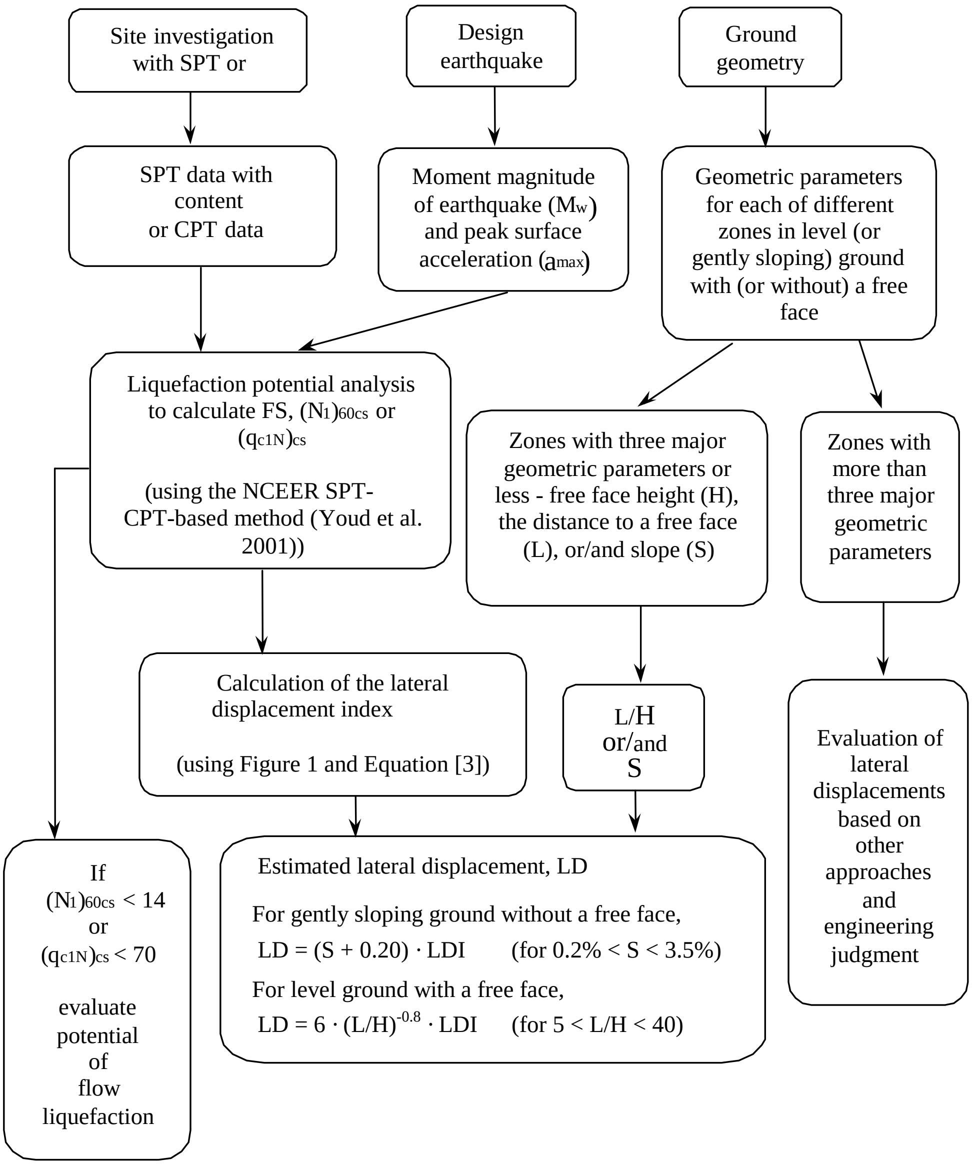
Procedure for the evaluation of soil liquefaction resistance, Idriss & Boulanger (2008)



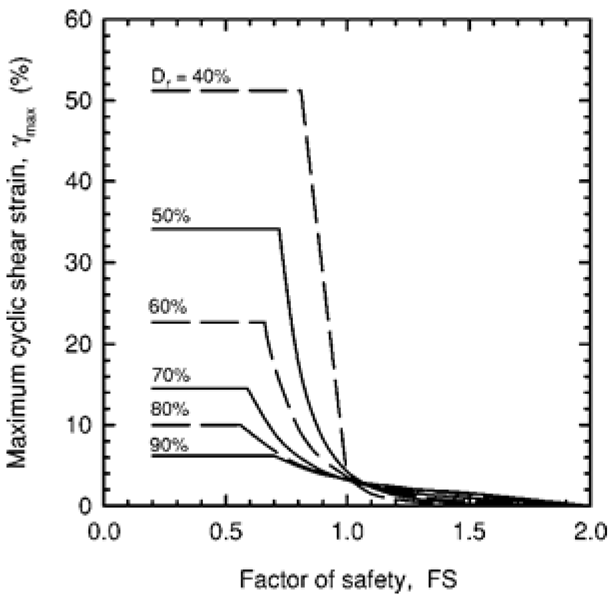
Procedure for the evaluation of soil liquefaction resistance (sandy soils), Moss et al. (2006)



Procedure for the evaluation of 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**

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

[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.

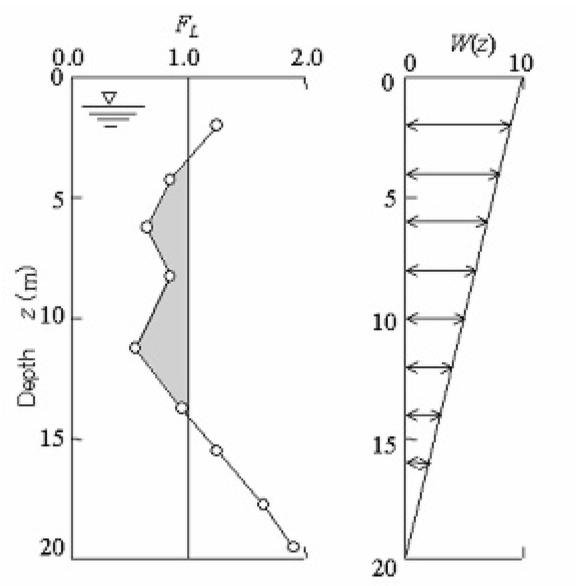
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

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

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

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

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

References

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- Boulanger, R.W. and Idriss, I. M., 2007. Evaluation of Cyclic Softening in Silts and Clays. ASCE Journal of Geotechnical and Geoenvironmental Engineering June, Vol. 133, No. 6 pp 641-652

- Robertson, P.K. and Cabal, K.L., 2007, Guide to Cone Penetration Testing for Geotechnical Engineering. Available at no cost at http://www.geologismiki.gr/

- Robertson, P.K. 1990. Soil classification using the cone penetration test. Canadian Geotechnical Journal, 27 (1), 151-8.

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- Youd, T.L., Idriss, I.M., Andrus, R.D., Arango, I., Castro, G., Christian, J.T., Dobry, R., Finn, W.D.L., Harder, L.F., Hynes, M.E., Ishihara, K., Koester, J., Liao, S., Marcuson III, W.F., Martin, G.R., Mitchell, J.K., Moriwaki, Y., Power, M.S., Robertson, P.K., Seed, R., and Stokoe, K.H., Liquefaction Resistance of Soils: Summary Report from the 1996 NCEER and 1998 NCEER/NSF Workshop on Evaluation of Liquefaction Resistance of Soils, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 127, October, pp 817-833

- Zhang, G., Robertson. P.K., Brachman, R., 2002, Estimating Liquefaction Induced Ground Settlements from the CPT, Canadian Geotechnical Journal, 39: pp 1168-1180

- Zhang, G., Robertson. P.K., Brachman, R., 2004, Estimating Liquefaction Induced Lateral Displacements using the SPT and CPT, ASCE, Journal of Geotechnical & Geoenvironmental Engineering, Vol. 130, No. 8, 861-871

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- Iwasaki, T., 1986, Soil liquefaction studies in Japan: state-of-the-art, Soil Dynamics and Earthquake Engineering, Vol. 5, No. 1, 2-70

- P.K. Robertson, 2009, Interpretation of Cone Penetration Tests - a unified approach., Canadian Geotechnical Journal, Vol. 46, No. 11, pp 1337-1355

- 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

- 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

- R. E. S. Moss, R. B. Seed, R. E. Kayen, J. P. Stewart, A. Der Kiureghian, K. O. Cetin, CPT-Based Probabilistic and Deterministic Assessment of In Situ Seismic Soil Liquefaction Potential, Journal of Geotechnical and Geoenvironmental Engineering, Vol. 132, No. 8, August 1, 2006

APPENDIX G

APPENDIX G
LEIGHTON CONSULTING, INC.
GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

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GENERAL EARTHWORK AND GRADING SPECIFICATIONS FOR ROUGH GRADING

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C - Canyon Subdrains	Rear of Text
D - Buttress or Replacement Fill Subdrains	Rear of Text
E - Transition Lot Fills and Side Hill Fills	Rear of Text

1.0 General

1.1 Intent

These General Earthwork and Grading Specifications are for the grading and earthwork shown on the approved grading plan(s) and/or indicated in the geotechnical report(s). These Specifications are a part of the recommendations contained in the geotechnical report(s). In case of conflict, the specific recommendations in the geotechnical report shall supersede these more general Specifications. Observations of the earthwork by the project Geotechnical Consultant during the course of grading may result in new or revised recommendations that could supersede these specifications or the recommendations in the geotechnical report(s).

1.2 The Geotechnical Consultant of Record

Prior to commencement of work, the owner shall employ the Geotechnical Consultant of Record (Geotechnical Consultant). The Geotechnical Consultants shall be responsible for reviewing the approved geotechnical report(s) and accepting the adequacy of the preliminary geotechnical findings, conclusions, and recommendations prior to the commencement of the grading.

Prior to commencement of grading, the Geotechnical Consultant shall review the "work plan" prepared by the Earthwork Contractor (Contractor) and schedule sufficient personnel to perform the appropriate level of observation, mapping, and compaction testing.

During the grading and earthwork operations, the Geotechnical Consultant shall observe, map, and document the subsurface exposures to verify the geotechnical design assumptions. If the observed conditions are found to be significantly different than the interpreted assumptions during the design phase, the Geotechnical Consultant shall inform the owner, recommend appropriate changes in design to accommodate the observed conditions, and notify the review agency where required. Subsurface areas to be geotechnically observed, mapped, elevations recorded, and/or tested include natural ground after it has been cleared for receiving fill but before fill is placed, bottoms of all "remedial removal" areas, all key bottoms, and benches made on sloping ground to receive fill.

The Geotechnical Consultant shall observe the moisture-conditioning and processing of the subgrade and fill materials and perform relative compaction testing of fill to determine the attained level of compaction.

The Geotechnical Consultant shall provide the test results to the owner and the Contractor on a routine and frequent basis.

1.3 The Earthwork Contractor

The Earthwork Contractor (Contractor) shall be qualified, experienced, and knowledgeable in earthwork logistics, preparation and processing of ground to receive fill, moisture-conditioning and processing of fill, and compacting fill. The Contractor shall review and accept the plans, geotechnical report(s), and these Specifications prior to commencement of grading. The Contractor shall be solely responsible for performing the grading in accordance with the plans and specifications.

The Contractor shall prepare and submit to the owner and the Geotechnical Consultant a work plan that indicates the sequence of earthwork grading, the number of "spreads" of work and the estimated quantities of daily earthwork contemplated for the site prior to commencement of grading. The Contractor shall inform the owner and the Geotechnical Consultant of changes in work schedules and updates to the work plan at least 24 hours in advance of such changes so that appropriate observations and tests can be planned and accomplished. The Contractor shall not assume that the Geotechnical Consultant is aware of all grading operations.

The Contractor shall have the sole responsibility to provide adequate equipment and methods to accomplish the earthwork in accordance with the applicable grading codes and agency ordinances, these Specifications, and the recommendations in the approved geotechnical report(s) and grading plan(s). If, in the opinion of the Geotechnical Consultant, unsatisfactory conditions, such as unsuitable soil, improper moisture condition, inadequate compaction, insufficient buttress key size, adverse weather, etc., are resulting in a quality of work less than required in these specifications, the Geotechnical Consultant shall reject the work and may recommend to the owner that construction be stopped until the conditions are rectified.

2.0 Preparation of Areas to be Filled

2.1 Clearing and Grubbing

Vegetation, such as brush, grass, roots, and other deleterious material shall be sufficiently removed and properly disposed of in a method acceptable to the owner, governing agencies, and the Geotechnical Consultant.

The Geotechnical Consultant shall evaluate the extent of these removals depending on specific site conditions. Earth fill material shall not contain more than 1 percent of organic materials (by volume). No fill lift shall contain more than 5 percent of organic matter. Nesting of the organic materials shall not be allowed.

If potentially hazardous materials are encountered, the Contractor shall stop work in the affected area, and a hazardous material specialist shall be informed immediately for proper evaluation and handling of these materials prior to continuing to work in that area.

As presently defined by the State of California, most refined petroleum products (gasoline, diesel fuel, motor oil, grease, coolant, etc.) have chemical constituents that are considered to be hazardous waste. As such, the indiscriminate dumping or spillage of these fluids onto the ground may constitute a misdemeanor, punishable by fines and/or imprisonment, and shall not be allowed.

2.2 Processing

Existing ground that has been declared satisfactory for support of fill by the Geotechnical Consultant shall be scarified to a minimum depth of 6 inches. Existing ground that is not satisfactory shall be overexcavated as specified in the following section. Scarification shall continue until soils are broken down and free of large clay lumps or clods and the working surface is reasonably uniform, flat, and free of uneven features that would inhibit uniform compaction.

2.3 Overexcavation

In addition to removals and overexcavations recommended in the approved geotechnical report(s) and the grading plan, soft, loose, dry, saturated, spongy, organic-rich, highly fractured or otherwise unsuitable ground shall be overexcavated to competent ground as evaluated by the Geotechnical Consultant during grading.

2.4 Benching

Where fills are to be placed on ground with slopes steeper than 5:1 (horizontal to vertical units), the ground shall be stepped or benched. Please see the Standard Details for a graphic illustration. The lowest bench or key shall be a minimum of 15 feet wide and at least 2 feet deep, into competent material as evaluated by the Geotechnical Consultant. Other benches shall be excavated a minimum height of 4 feet into competent material or as otherwise recommended by the Geotechnical Consultant. Fill placed on ground sloping flatter than 5:1 shall also be benched or otherwise overexcavated to provide a flat subgrade for the fill.

2.5 Evaluation/Acceptance of Fill Areas

All areas to receive fill, including removal and processed areas, key bottoms, and benches, shall be observed, mapped, elevations recorded, and/or tested prior to being accepted by the Geotechnical Consultant as suitable to receive fill. The Contractor shall obtain a written acceptance from the Geotechnical Consultant prior to fill placement. A licensed surveyor shall provide the survey control for determining elevations of processed areas, keys, and benches.

3.0 Fill Material

3.1 General

Material to be used as fill shall be essentially free of organic matter and other deleterious substances evaluated and accepted by the Geotechnical Consultant prior to placement. Soils of poor quality, such as those with unacceptable gradation, high expansion potential, or low strength shall be placed in areas acceptable to the Geotechnical Consultant or mixed with other soils to achieve satisfactory fill material.

3.2 Oversize

Oversize material defined as rock, or other irreducible material with a maximum dimension greater than 8 inches, shall not be buried or placed in fill unless location, materials, and placement methods are specifically accepted by the Geotechnical Consultant. Placement operations shall be such that nesting of oversized material does not occur and such that oversize material is completely surrounded by compacted or densified fill. Oversize material shall not be placed within 10 vertical feet of finish grade or within 2 feet of future utilities or underground construction.

3.3 Import

If importing of fill material is required for grading, proposed import material shall meet the requirements of Section 3.1. The potential import source shall be given to the Geotechnical Consultant at least 48 hours (2 working days) before importing begins so that its suitability can be determined and appropriate tests performed.

4.0 Fill Placement and Compaction

4.1 Fill Layers

Approved fill material shall be placed in areas prepared to receive fill (per Section 3.0) in near-horizontal layers not exceeding 8 inches in loose thickness. The Geotechnical Consultant may accept thicker layers if testing indicates the grading procedures can adequately compact the thicker layers. Each layer shall be spread evenly and mixed thoroughly to attain relative uniformity of material and moisture throughout.

4.2 Fill Moisture Conditioning

Fill soils shall be watered, dried back, blended, and/or mixed, as necessary to attain a relatively uniform moisture content at or slightly over optimum. Maximum density and optimum soil moisture content tests shall be performed in accordance with the American Society of Testing and Materials (ASTM Test Method D1557-91).

4.3 Compaction of Fill

After each layer has been moisture-conditioned, mixed, and evenly spread, it shall be uniformly compacted to not less than 90 percent of maximum dry density (ASTM Test Method D1557-91). Compaction equipment shall be adequately sized and be either specifically designed for soil compaction or of proven reliability to efficiently achieve the specified level of compaction with uniformity.

4.4 Compaction of Fill Slopes

In addition to normal compaction procedures specified above, compaction of slopes shall be accomplished by backrolling of slopes with sheepsfoot rollers at increments of 3 to 4 feet in fill elevation, or by other methods producing satisfactory results acceptable to the Geotechnical Consultant. Upon completion of grading, relative compaction of the fill, out to the slope face, shall be at least 90 percent of maximum density per ASTM Test Method D1557-91.

4.5 Compaction Testing

Field-tests for moisture content and relative compaction of the fill soils shall be performed by the Geotechnical Consultant. Location and frequency of tests shall be at the Consultant's discretion based on field conditions encountered. Compaction test locations will not necessarily be selected on a random basis. Test locations shall be selected to verify adequacy of compaction levels in areas that are judged to be prone to inadequate compaction (such as close to slope faces and at the fill/bedrock benches).

4.6 Frequency of Compaction Testing

Tests shall be taken at intervals not exceeding 2 feet in vertical rise and/or 1,000 cubic yards of compacted fill soils embankment. In addition, as a guideline, at least one test shall be taken on slope faces for each 5,000 square feet of slope face and/or each 10 feet of vertical height of slope. The Contractor shall assure that fill construction is such that the testing schedule can be accomplished by the Geotechnical Consultant. The Contractor shall stop or slow down the earthwork construction if these minimum standards are not met.

4.7 Compaction Test Locations

The Geotechnical Consultant shall document the approximate elevation and horizontal coordinates of each test location. The Contractor shall coordinate with the project surveyor to assure that sufficient grade stakes are established so that the Geotechnical Consultant can determine the test locations with sufficient accuracy. At a minimum, two grade stakes within a horizontal distance of 100 feet and vertically less than 5 feet apart from potential test locations shall be provided.

5.0 Subdrain Installation

Subdrain systems shall be installed in accordance with the approved geotechnical report(s), the grading plan, and the Standard Details. The Geotechnical Consultant may recommend additional subdrains and/or changes in subdrain extent, location, grade, or material depending on conditions encountered during grading. All subdrains shall be surveyed by a land surveyor/civil engineer for line and grade after installation and prior to burial. Sufficient time should be allowed by the Contractor for these surveys.

6.0 Excavation

Excavations, as well as over-excavation for remedial purposes, shall be evaluated by the Geotechnical Consultant during grading. Remedial removal depths shown on geotechnical plans are estimates only. The actual extent of removal shall be determined by the Geotechnical Consultant based on the field evaluation of exposed conditions during grading. Where fill-over-cut slopes are to be graded, the cut portion of the slope shall be made, evaluated, and accepted by the Geotechnical Consultant prior to placement of materials for construction of the fill portion of the slope, unless otherwise recommended by the Geotechnical Consultant.

7.0 Trench Backfills

7.1 Safety

The Contractor shall follow all OSHA and Cal/OSHA requirements for safety of trench excavations.

7.2 Bedding and Backfill

All bedding and backfill of utility trenches shall be performed in accordance with the applicable provisions of Standard Specifications of Public Works Construction. Bedding material shall have a Sand Equivalent greater than 30 (SE>30). The bedding shall be placed to 1 foot over the top of the conduit and densified by jetting. Backfill shall be placed and densified to a minimum of 90 percent of relative compaction from 1 foot above the top of the conduit to the surface.

The Geotechnical Consultant shall test the trench backfill for relative compaction. At least one test should be made for every 300 feet of trench and 2 feet of fill.

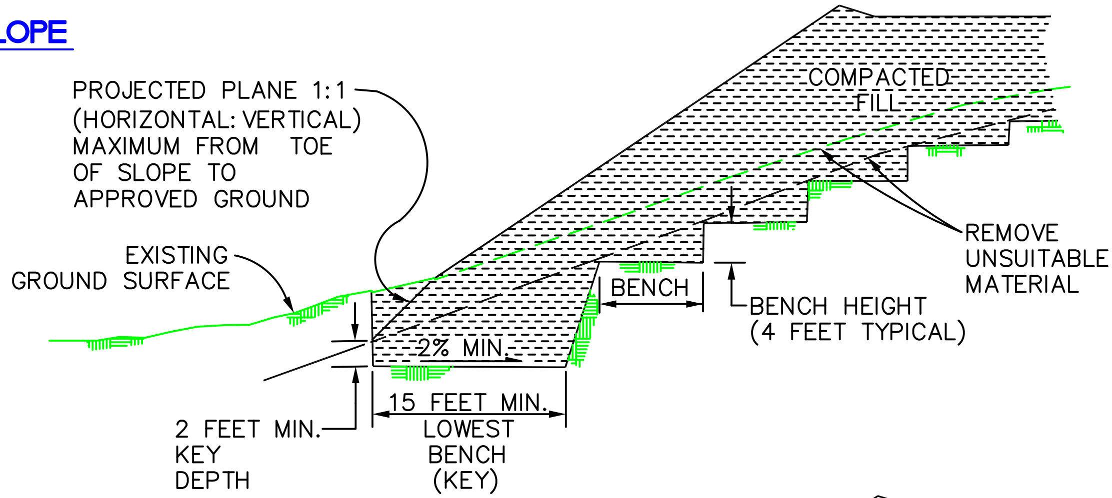
7.3 Lift Thickness

Lift thickness of trench backfill shall not exceed those allowed in the Standard Specifications of Public Works Construction unless the Contractor can demonstrate to the Geotechnical Consultant that the fill lift can be compacted to the minimum relative compaction by his alternative equipment and method.

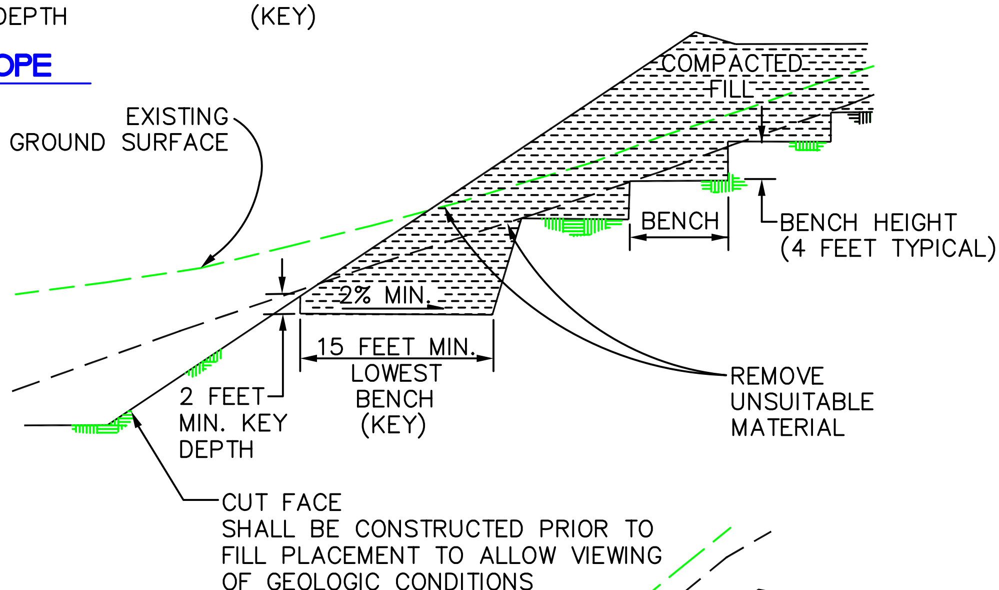
7.4 Observation and Testing

The jetting of the bedding around the conduits shall be observed by the Geotechnical Consultant.

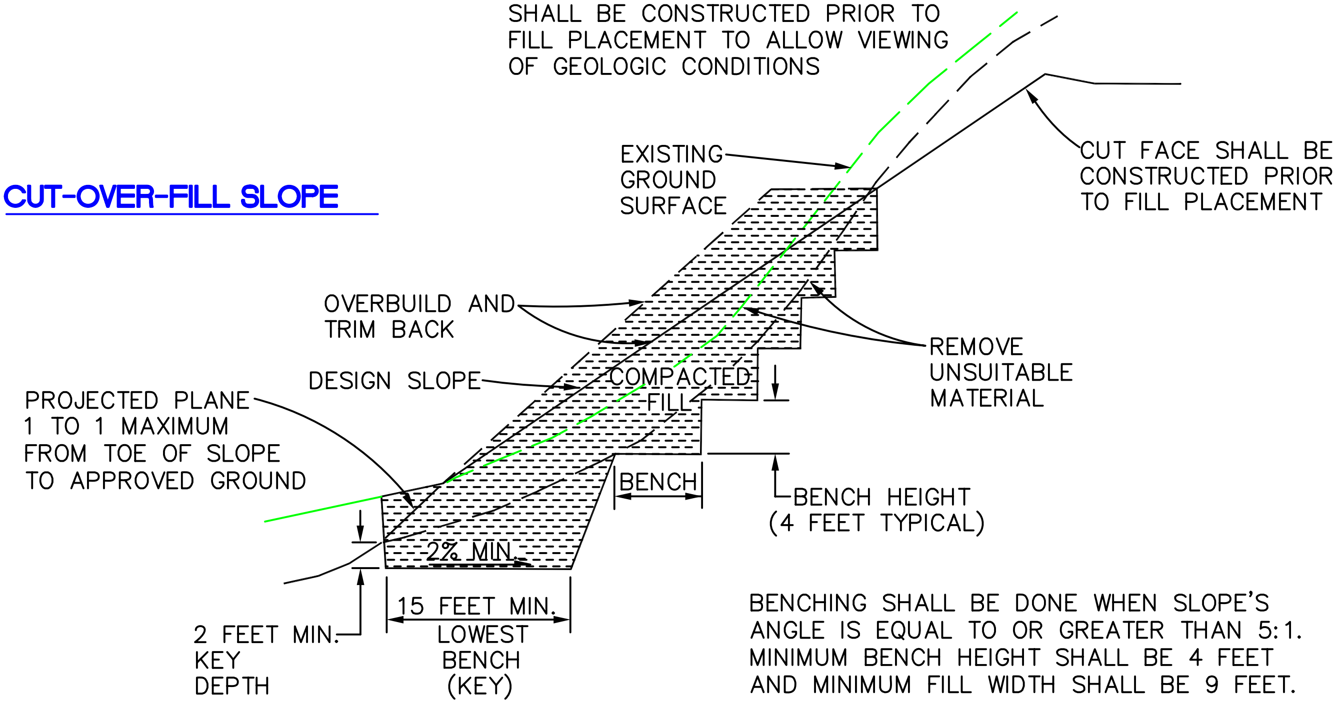
FILL SLOPE



FILL-OVER-CUT SLOPE

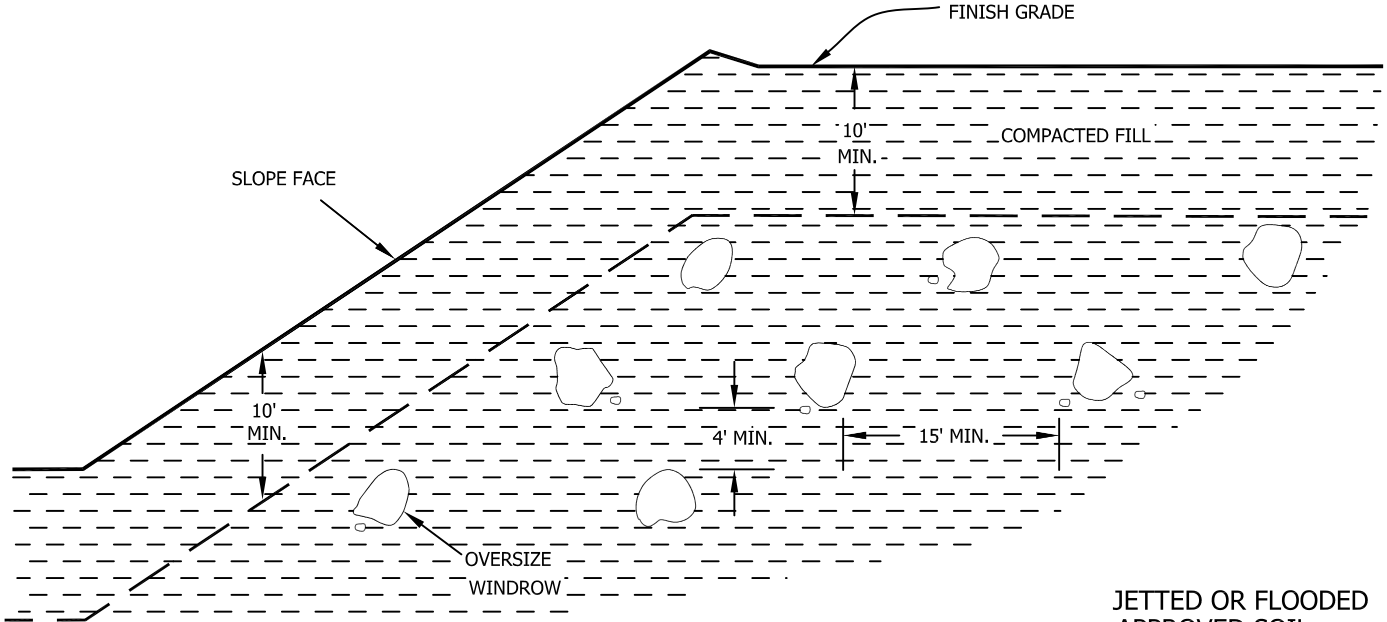


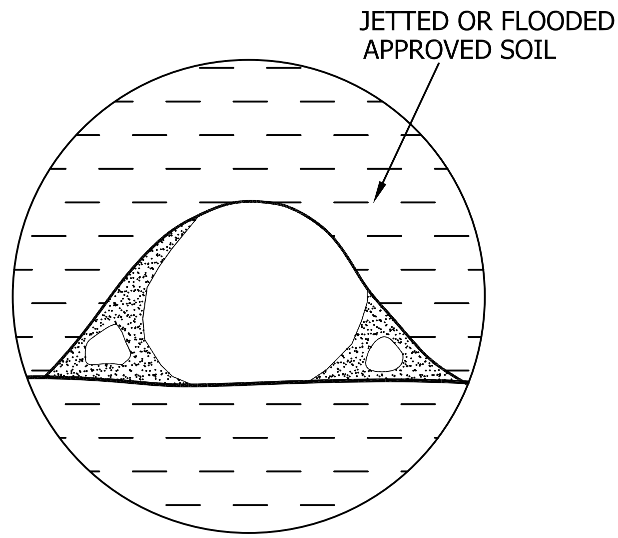
CUT-OVER-FILL SLOPE



BENCHING SHALL BE DONE WHEN SLOPE'S ANGLE IS EQUAL TO OR GREATER THAN 5:1. MINIMUM BENCH HEIGHT SHALL BE 4 FEET AND MINIMUM FILL WIDTH SHALL BE 9 FEET.

KEYING AND BENCHING	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS A	Leighton

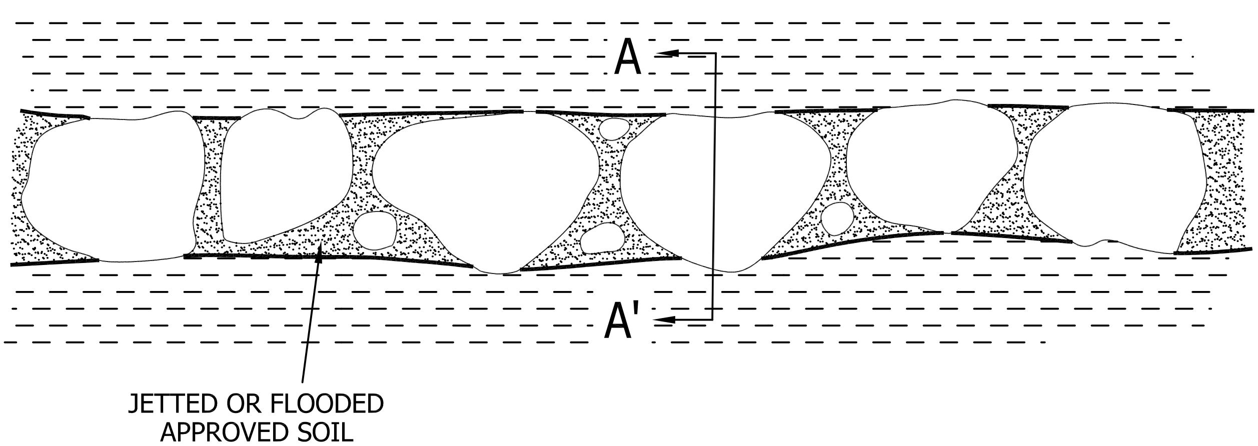




SECTION A-A'

- Oversize rock is larger than 8 inches in largest dimension.
- Backfill with approved soil jetted or flooded in place to fill all the voids.
- Do not bury rock within 10 feet of finish grade.
- Windrow of buried rock shall be parallel to the finished slope face.

PROFILE ALONG WINDROW



OVERSIZE ROCK DISPOSAL	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS B	Leighton

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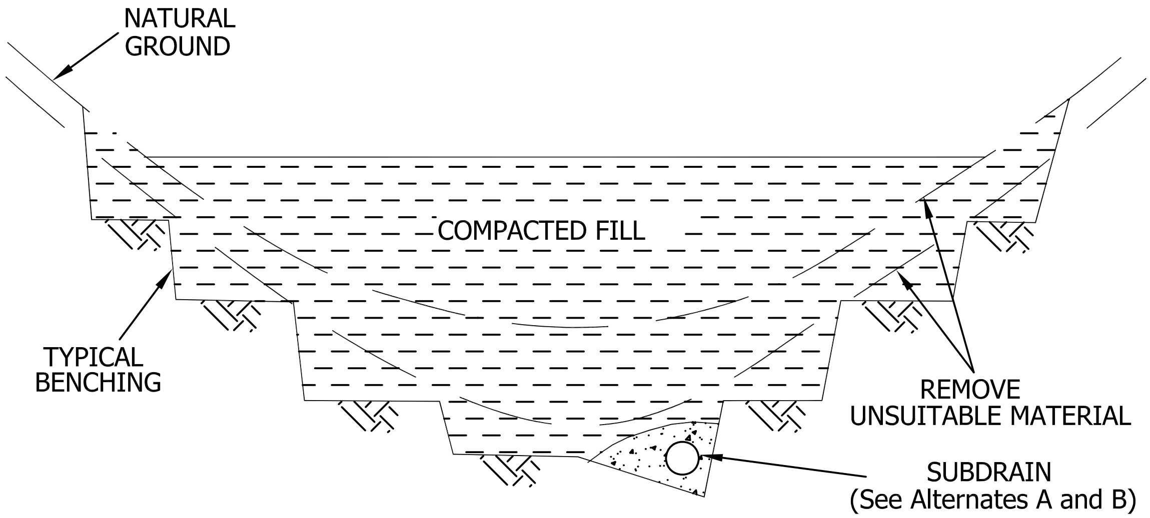
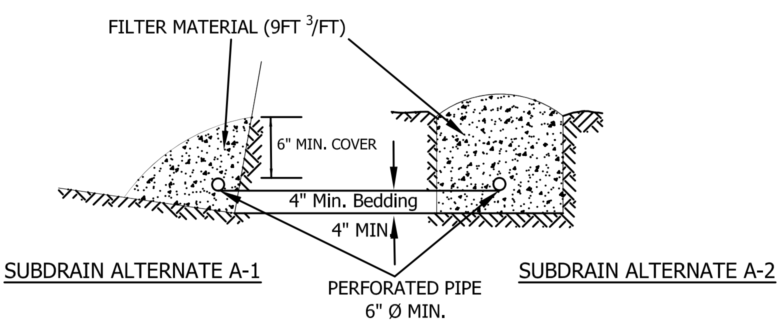


SUBDRAIN ALTERNATE A

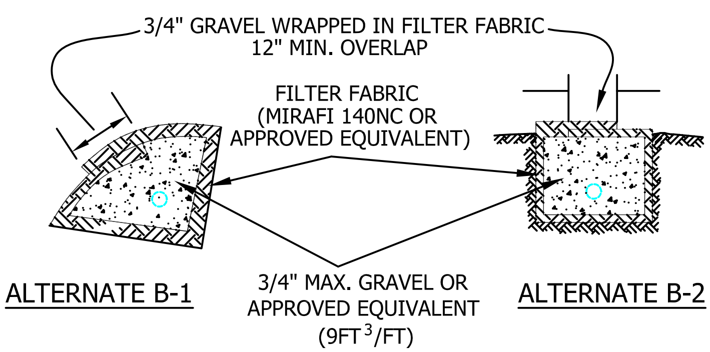


FILTER MATERIAL

FILTER MATERIAL SHALL BE CLASS 2 PERMEABLE MATERIAL PER STATE OF CALIFORNIA STANDARD SPECIFICATION, OR APPROVED ALTERNATE. CLASS 2 GRADING AS FOLLOWS:

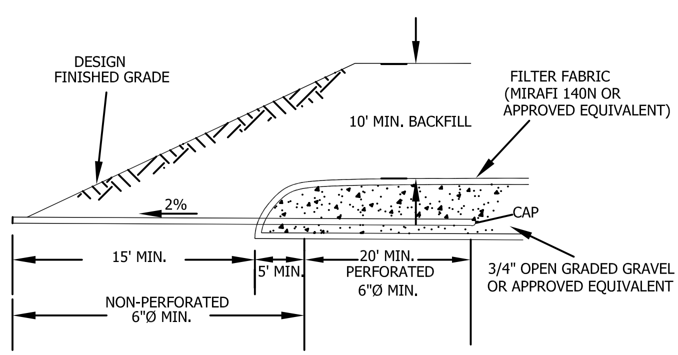
Sieve Size	Percent Passing
1"	100
3/4"	90-100
3/8"	40-100
No. 4	25-40
No. 8	18-33
No. 30	5-15
No. 50	0-7
No. 200	0-3

SUBDRAIN ALTERNATE B



○ PERFORATED PIPE IS OPTIONAL PER GOVERNING AGENCY'S REQUIREMENTS

DETAIL OF CANYON SUBDRAIN TERMINAL



CANYON SUBDRAIN	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS C	Leighton

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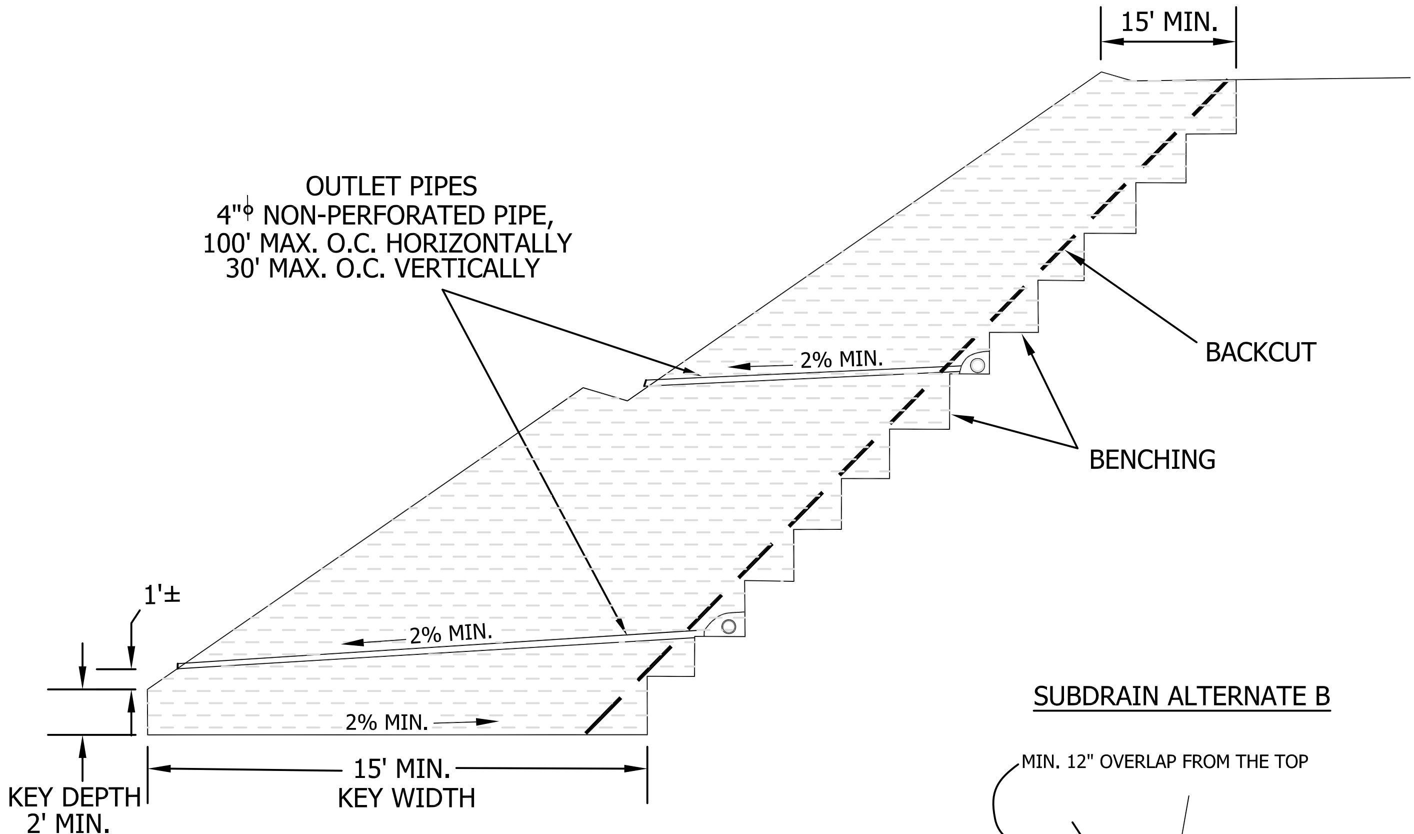
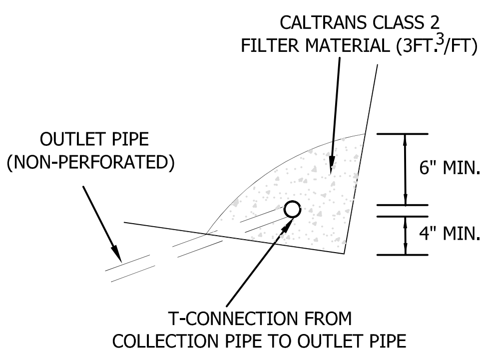
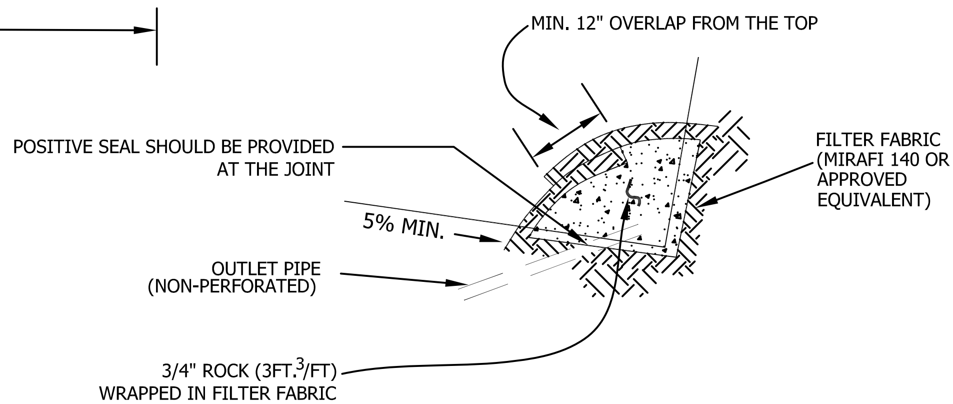


SUBDRAIN ALTERNATE A



SUBDRAIN ALTERNATE B



- SUBDRAIN INSTALLATION - Subdrain collector pipe shall be installed with perforations down or, unless otherwise designated by the geotechnical consultant. Outlet pipes shall be non-perforated pipe. The subdrain pipe shall have at least 8 perforations uniformly spaced per foot. Perforation shall be 1/4" to 1/2" if drilled holes are used. All subdrain pipes shall have a gradient at least 2% towards the outlet.
- SUBDRAIN PIPE - Subdrain pipe shall be ASTM D2751, ASTM D1527 (Schedule 40) or SDR 23.5 ABS pipe or ASTM D3034 (Schedule 40) or SDR 23.5 PVC pipe.
- All outlet pipe shall be placed in a trench and, after fill is placed above it, rodded to verify integrity.

BUTTRESS OR REPLACEMENT FILL SUBDRAINS	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS D	Leighton

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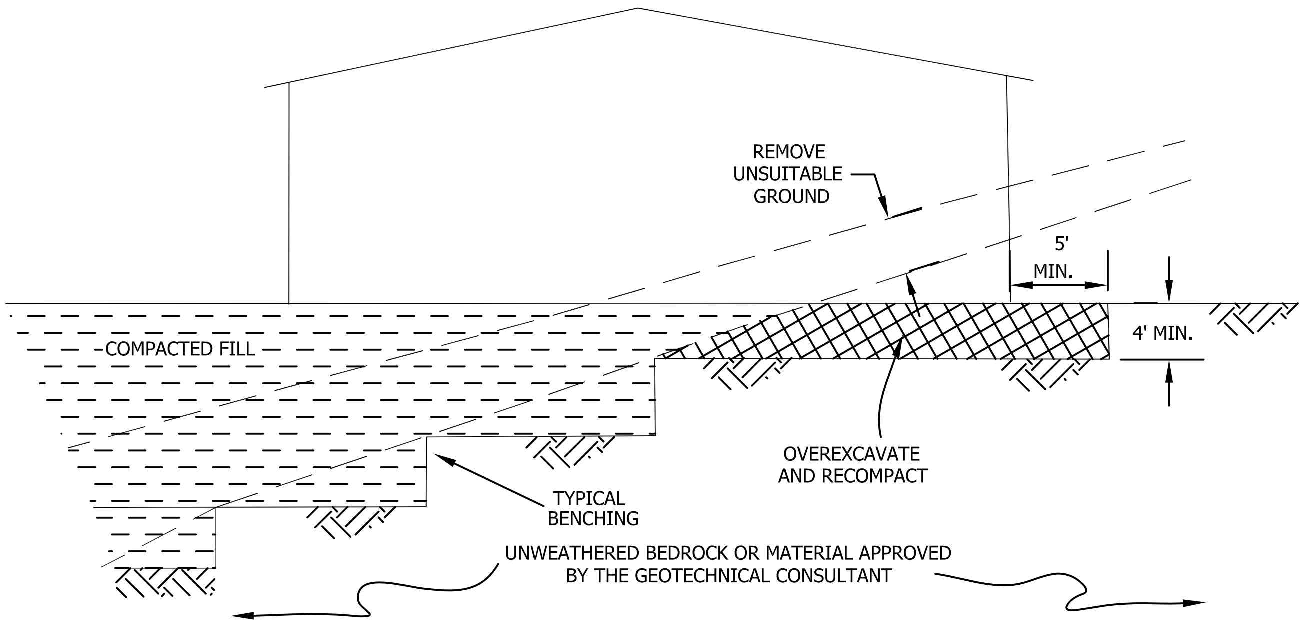
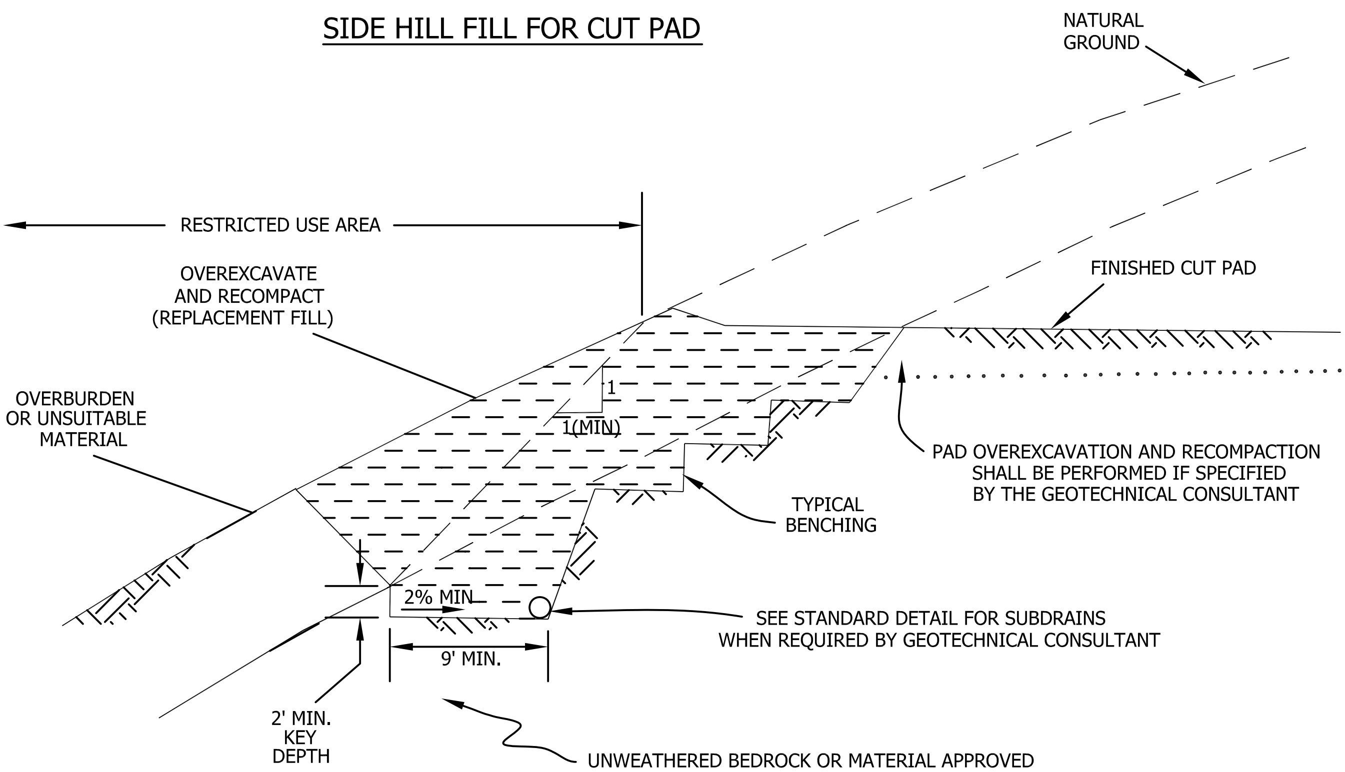
CUT-FILL TRANSITION LOT OVEREXCAVATION



SIDE HILL FILL FOR CUT PAD



TRANSITION LOT FILLS AND SIDE HILL FILLS	GENERAL EARTHWORK AND GRADING SPECIFICATIONS STANDARD DETAILS E	Leighton

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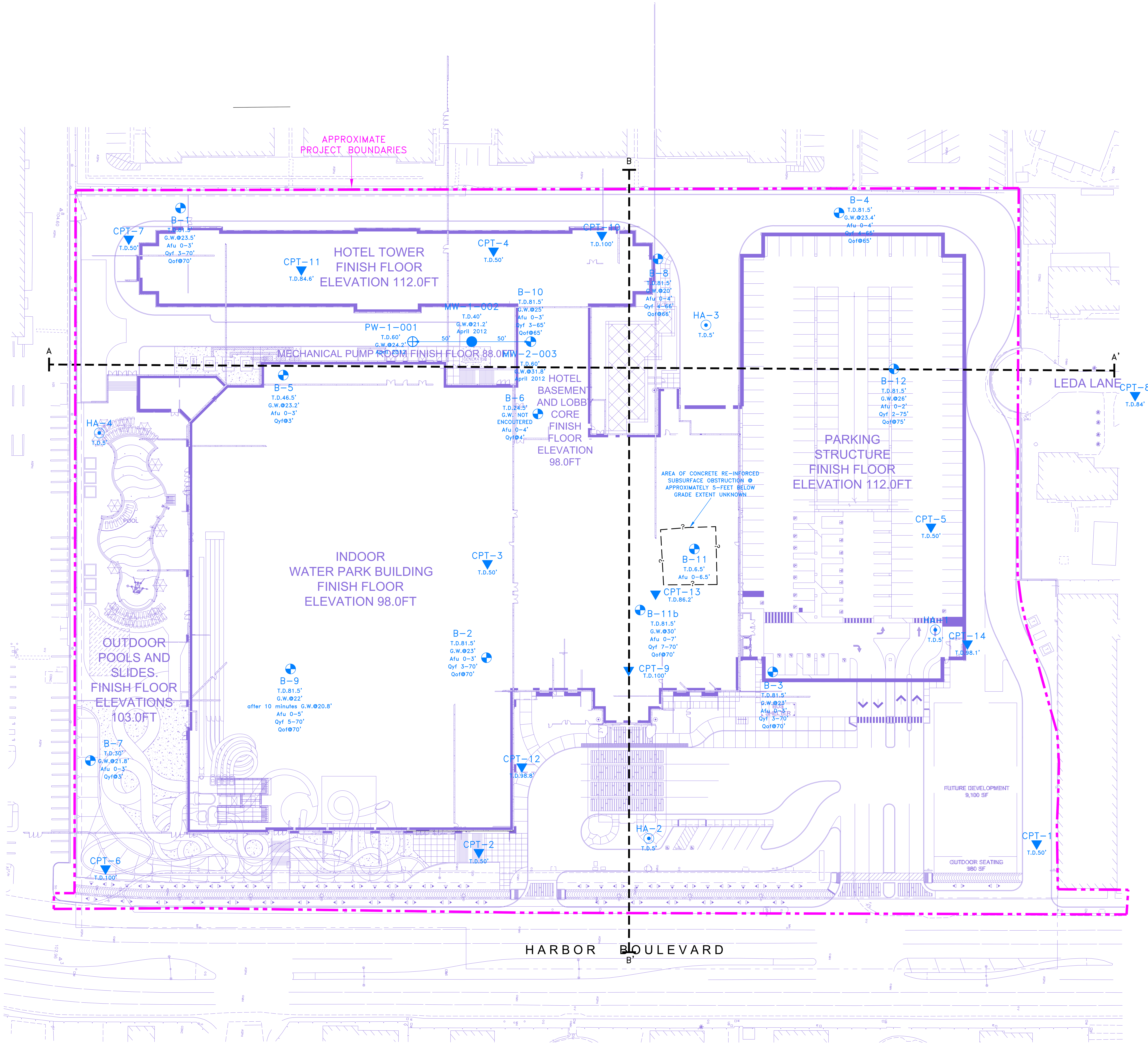


EXPLANATION

Afu	ARTIFICIAL FILL, UNDOCUMENTED SILTY SANDS TO SANDY SILTS WITH CLAY AND GRAVEL. TYPICALLY DARK BROWN WITH MINOR AMOUNTS OF CONCRETE, ASPHALT AND OTHER MAN MADE DEBRIS.
Qyf	QUATERNARY YOUNG ALLUVIAL FAN DEPOSITS, CONSISTING PREDOMINATELY OF SOFT TO LOOSE, MASSIVE, FINE TO COARSE SAND, OVERLYING THIN TO THICKLY BEDDED CLAY TO SILTY CLAY UNIT OF MARINE ORIGIN. UNIT CONTAINS CONTINUOUS TO SEMI-CONTINUOUS SAND LENSES WITH VARYING PROPORTIONS OF ROUNDED GRAVELS. DEPOSITIONAL ENVIRONMENT OF SANTA ANA RIVER FLOODPLAN INCLUDING MARINE TRANSGRESSION.
Qof	QUATERNARY OLD ALLUVIAL FAN DEPOSITS CONSISTING OF DENSE SANDS AND GRAVELS TYPICAL OF PALEO-SANTA ANA RIVER FLOODPLAN. FINE TO COARSE SANDS AND ROUNDED GRAVELS WITH OCCASSIONAL CLAY AND SILT LAMINAE
B–12 T.D.81.5' G.W.@26' Afu 0–2' Qyf 2–75' Qof@75'	APPROXIMATE LOCATION OF HOLLOW STEM AUGER BORINGS (B-1 THROUGH B-8, LEIGHTON 2010, 2011) AND B-9 THROUGH B-12, (LEIGHTON 2012) BORING SHOWN WITH TOTAL DEPTH (T.D.), DEPTH TO UNITS, AND DEPTH TO GROUNDWATER (G.W.) ENCOUNTERED DURING DRILLING. SEE APPENDIX B FOR BORING LOG DETAILS.
CPT–14 T.D.98.1'	APPROXIMATE LOCATION OF CONE PENETROMETER TEST (CPT) LOCATIONS (CPT-1 THROUGH CPT-10, LEIGHTON 2010, 2011) AND CPT-11 THROUGH CPT-14, (LEIGHTON 2012) SEE APPENDIX B FOR BORING LOG DETAILS.
B–10 T.D.81.5' MW–2–003 T.D.60' G.W.@31.8'	APPROXIMATE LOCATION OF HOLLOW STEM AUGER BORING CONVERTED TO A 2-INCH DIAMETER MONITORING WELL. BORING AND MONITORING WELL SHOWN WITH TOTAL DEPTH (T.D.) UPON COMPLETION. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT. SEE APPENDIX C, FIGURE 4 FOR WELL CONSTRUCTION DETAILS.
MW–1–002 T.D.40'	APPROXIMATE LOCATION OF EXISTING MONITORING WELL MW-1, SHOWN WITH TOTAL DEPTH (T.D.) AND DEPTH TO GROUNDWATER, INSTALLED BY OTHERS. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT. SEE APPENDIX C, FIGURE 3 FOR WELL CONSTRUCTION DETAILS.
PW–1–001 T.D.60'	APPROXIMATE LOCATION OF PUMPING WELL PW-1-001 SHOWN WITH TOTAL DEPTH (T.D.) INSTALLED BY FOOTHILL ENGINEERING AND DEWATERING INC., 2012. GROUNDWATER (G.W.) SHOWN WITH DATE OF MEASUREMENT. SEE APPENDIX C, FIGURE 5 FOR WELL CONSTRUCTION DETAILS.
HA–4 T.D.5'	APPROXIMATE LOCATION OF HAND AUGER (H.A.) BORING SHOWING WITH TOTAL DEPTH (T.D.) SEE APPENDIX B FOR LOGS.
B – – – B'	APPROXIMATE LOCATION OF GEOTECHNICAL CROSS SECTIONS

BORING AND CROSS SECTION LOCATION MAP

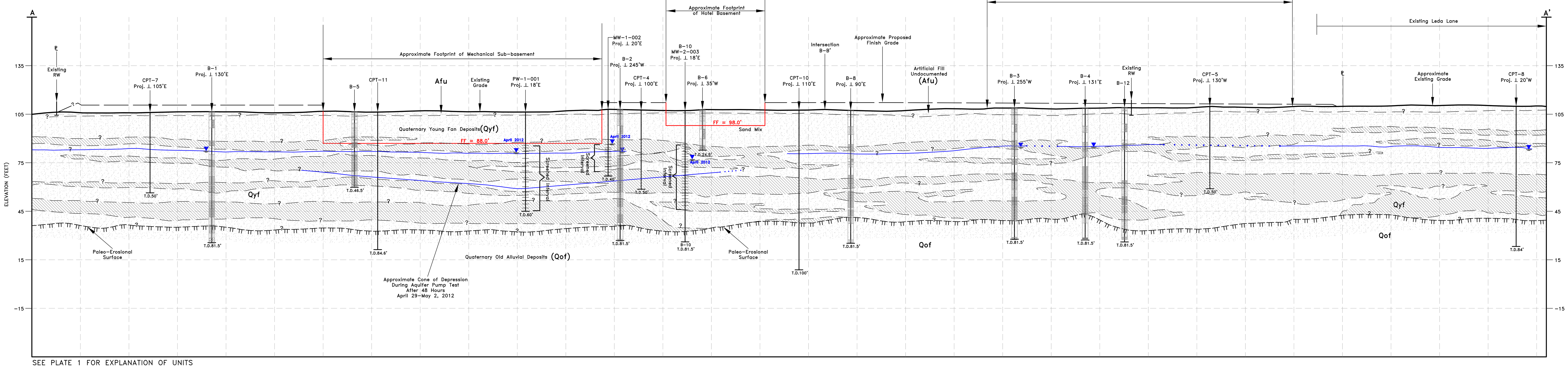
McWHINNEY DEVELOPMENT
HARBOR BOULEVARD, GARDEN GROVE, CALIFORNIA

PLATE 1

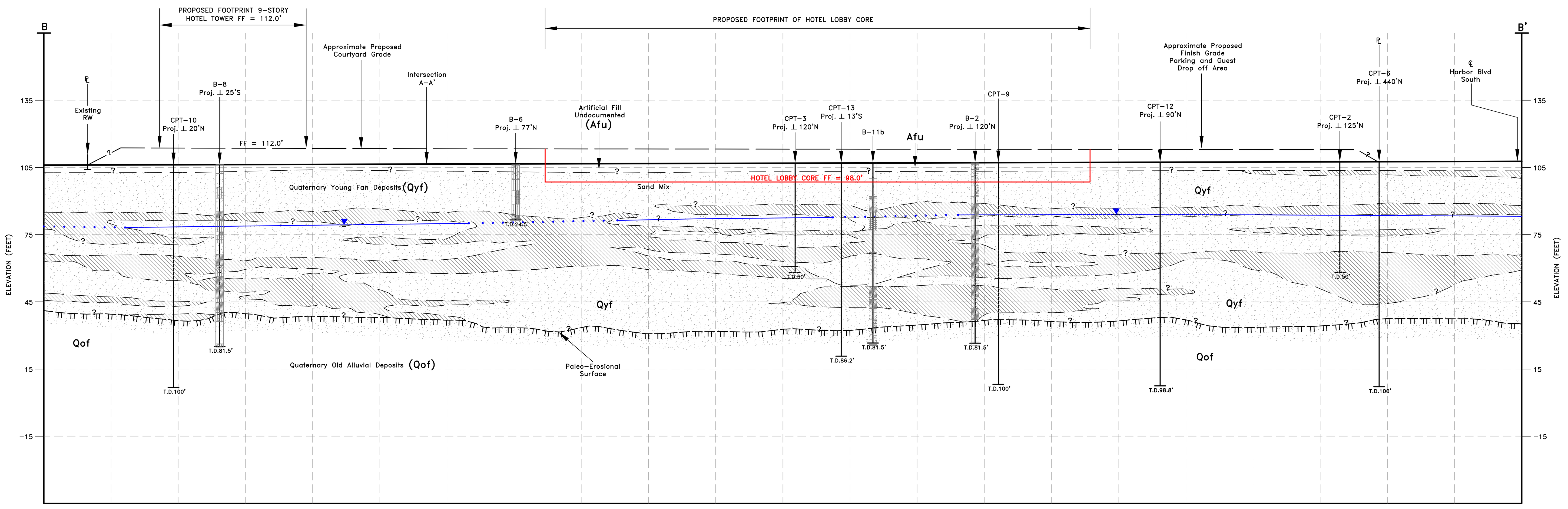
Proj: 602778-004	Eng/Geol: CCK/JAR
Scale: 1"=30'	Date: 07/2013

Drafted By: BQT | Checked By: BQT | P:\DRAFTING\602778\004\OF_2013-05-31\PLATE1.DWG (07-18-13 4:41:23PM) Plotted by: btran

Leighton



N-S



E-W

EXPLANATION

Afu ARTIFICIAL FILL, UNDOCUMENTED SILTY SANDS TO SANDY SILTS WITH CLAY AND GRAVEL. TYPICALLY DARK BROWN WITH MINOR AMOUNTS OF CONCRETE, ASPHALT AND OTHER MAN MADE DEBRIS.

Qyf QUATERNARY YOUNG ALLUVIAL FAN DEPOSITS, CONSISTING PREDOMINATELY OF SOFT TO LOOSE, MASSIVE, FINE TO COARSE SAND, OVERLYING THIN TO THICKLY BEDDED CLAY TO SILTY CLAY UNIT OF MARINE ORIGIN. UNIT CONTAINS CONTINUOUS TO SEMI-CONTINUOUS SAND LENSES WITH VARYING PROPORTIONS OF ROUNDED GRAVELS. DEPOSITIONAL ENVIRONMENT OF SANTA ANA RIVER FLOODPLAN INCLUDING MARINE TRANSGRESSION.

Qof QUATERNARY OLD ALLUVIAL FAN DEPOSITS CONSISTING OF DENSE SANDS AND GRAVELS TYPICAL OF PALEO-SANTA ANA RIVER FLOODPLAN. FINE TO COARSE SANDS AND ROUNDED GRAVELS WITH OCCASSIONAL CLAY AND SILT LAMINAE

CROSS SECTION GRAPHICS

SANDMIX, CONSISTS OF VARYING PROPORTIONS OF SILTY, CLAYEY SANDS AND GRAVELS WITH SANDY SILTS (SP, SM, SP-SM)

SILTY, SANDY CLAY TO CLAYEY, SANDY SILT (ML-CL, CL, ML, CH AND MH)

? APPROXIMATE PALEO-EROSIONAL SURFACE, Qyf/Qof TRANSITION, QUERIED WHERE UNCERTAIN

? GEOLOGIC CONTACT, DASHED WHERE APPROXIMATE, QUERIED WHERE UNCERTAIN

MEASURED DEPTH TO GROUNDWATER FROM ORIGINAL GRADE. QUERIED WHERE UNCERTAIN, DOTTED LINE BEST REPRESENTS APPROXIMATE POTENTIOMETRIC SURFACE AT TIME OF DRILLING (MARCH 2011 AND APRIL 2012)

PW-1-001 DEPICTS APPROXIMATE SCREENED INTERVAL OF PUMPING AND MONITORING WELLS. SEE APPENDIX C, FIGURE 3, 4 AND 5 FOR WELL CONSTRUCTION DETAILS. FF = FINISH FLOOR

BORING GRAPHICS (USCS)

Silty Sandy Clay, Lean to Fat Clay (CL-CH) (ML-CL)

Silt to Clay in Varying Proportion (CL-ML)

Sandy Clayey Silt to Organic Silt (ML-MH)

Sand to Sand With Gravel (SP)

Silty Sand (SM)

Sand With Silt (SP-SM)

REVISED GEOTECHNICAL CROSS SECTIONS A-A' AND B-B' Mc WHINNEY DEVELOPMENT HARBOR BOULEVARD, GARDEN GROVE, CALIFORNIA		PLATE 2
Proj: 602778-004	Eng/Geol: VPI/JAR	Leighton
Scale: 1"=30'	Date: 07/2013	
Drafted By: BQT	Checked By: BQT	P:\DRAFTING\602778\004\OF_2013-05-31\PLATE2-SECTIONS A-B.DWG (07-18-13 5:12:33PM) Plotted by: btran