GEOTECHNICAL AND FAULT RUPTURE HAZARD INVESTIGATION

Topgolf Harbor Island

North Harbor Drive and Liberatory Way
San Diego, California



McCarthy Building Companies, Inc.
12830 El Camino Real, Suite 200
San Diego, CA 92130

NOVA Project No. 2024034
October 1, 2024

NOVA Services

4373 Viewridge Avenue
Suite B
San Diego, California 92123
858.292.7575

16610 Aston Street
Irvine, CA 92606
949.388.7710

usa-nova.com

Seth Belitsky
McCarthy Building Companies, Inc.
12830 El Camino Real, Suite 200
San Diego, CA 92130

October 1, 2024
NOVA Project No. 2024034

Subject: Geotechnical and Fault Rupture Hazard Investigation
Topgolf Harbor Island
North Harbor Drive and Liberator Way
San Diego, California

Dear Mr. Belitsky:

NOVA Services, Inc. (NOVA) is pleased to present our report describing the geotechnical and fault rupture hazard investigation performed for the proposed Topgolf Harbor Island project located southwest of the intersection of North Harbor Drive and Liberator Way in San Diego, California. Our services were conducted in general accordance with our revised proposals dated April 2, 2024. This report is completed in accordance with the 2022 California Building Code (CBC), California Geological Survey Special Publication 42, and the City of San Diego Guidelines for Geotechnical Reports.

This site is considered geotechnically suitable for the proposed improvements provided the recommendations within this report are followed.

NOVA appreciates the opportunity to be of service to McCarthy Building Companies, Inc. on this project. If you have any questions regarding this report, please call us at 858.292.7575 x 417.

Sincerely,
NOVA Services, Inc.

Gillian Carzzarella Dean, PE, GE
Senior Geotechnical Engineer

REGISTERED PROFESSIONAL ENGINEER
GILLIAN C. DEAN
NO. GE3251
EXP. 9/30/25
GEOTECHNICAL
STATE OF CALIFORNIA

W. Lee Vanderhurst, CEG
Senior Engineering Geologist

CERTIFIED ENGINEERING GEOLOGIST
W. LEE VANDERHURST
No. 1125
CERTIFIED ENGINEERING GEOLOGIST
STATE OF CALIFORNIA

Tom Canady, PE
Principal Engineer

REGISTERED PROFESSIONAL ENGINEER
THOMAS B. CANADY
NO. 50057
EXP. 6/30/25
CIVIL
STATE OF CALIFORNIA

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1. INTRODUCTION

This report presents the results of the geotechnical and fault rupture hazard investigation NOVA performed for the Topgolf Harbor Island project. As currently planned, we understand the project will consist of the design and construction of an at-grade, three-story, crescent-shaped building, a parking lot, and a driving range enclosed with netting. The purpose of NOVA's work is to provide conclusions and recommendations regarding the geotechnical and fault rupture hazard aspects of the project. Figure 1-1 presents the site vicinity map. Figure 1-2 presents a site location map.

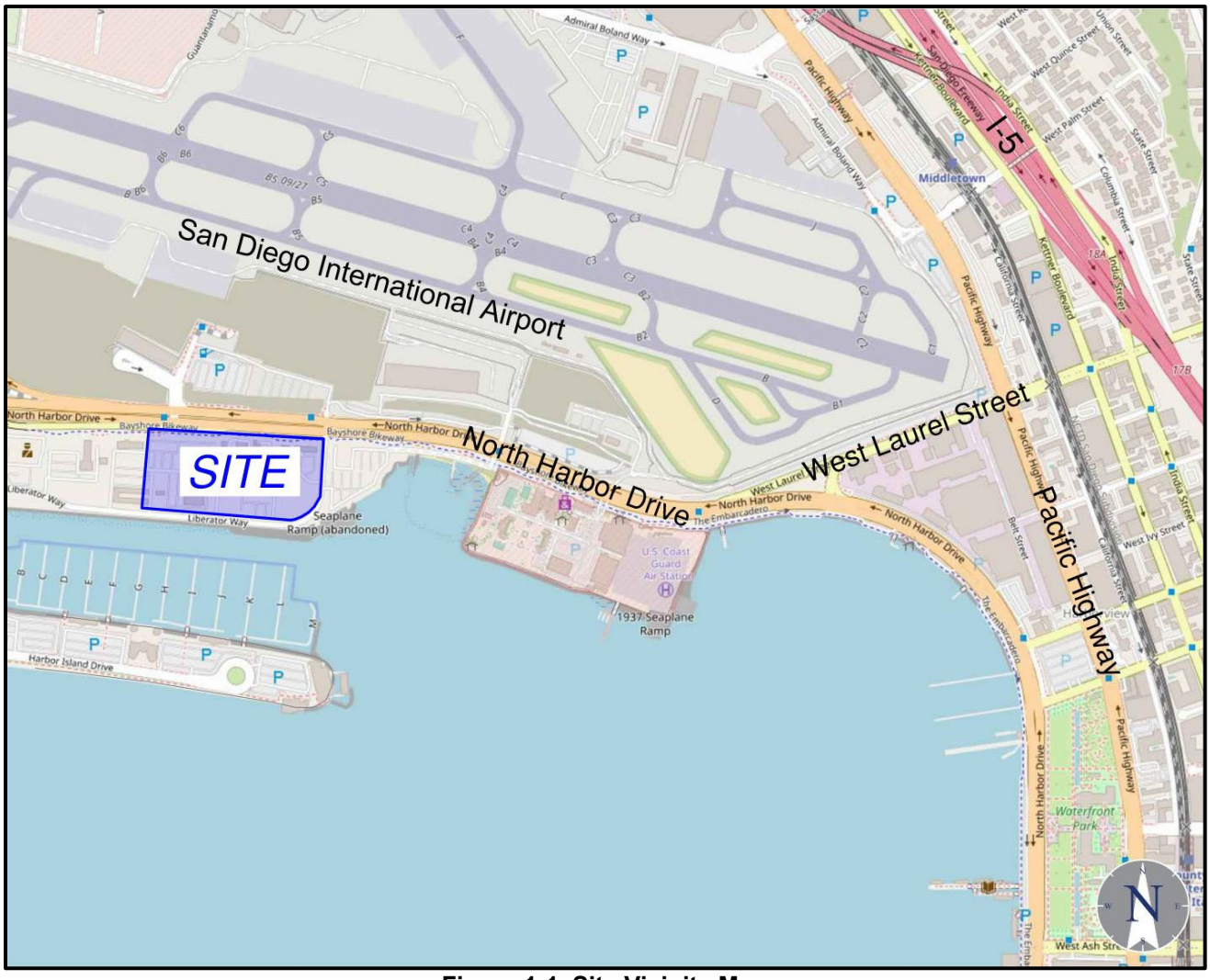

Figure 1-1. Site Vicinity Map



Figure 1-2. Site Location Map

2. SCOPE OF WORK

2.1. Field Investigation

NOVA's field investigation consisted of drilling nine borings (B-1 through B-9) to depths between about 5 and 80 feet below the ground surface (bgs) using a hand auger and CME 75, CME 85, and CME 95 drill rigs equipped with hollow-stem augers. Additionally, 50 cone penetration test (CPT) soundings (CPT-1 through CPT- 50) were advanced to depths between about 15 to 100 feet bgs. The locations and number of borings and CPT soundings were determined through coordination with the project design team and in accordance with the requested investigation layout from Topgolf.

Due to the depth of the formational material at the site, standard fault trenching methods were not feasible. Accordingly, NOVA's fault investigation used CPT soundings spaced approximately 15 feet on-center along three lines that intersected the proposed building footprint (Line 1 through Line 3). The lines extended 50 feet in either direction beyond the building footprint in accordance with Special Publication 42 (CGS, 2018) and the City of San Diego Guidelines for fault investigations (City of San Diego, 2018). Line 1 consisted of CPT-21 through CPT-33 with Boring B-2 serving as a confirmation boring. Line 2 consisted of CPT-7 through CPT-20 with Boring B-1 serving as a confirmation boring. Line 3 consisted of CPT-1 through CPT-6 and CPT-34 through CPT-39 with Boring B-5 serving as a confirmation boring. Figure 2-1 presents the approximate locations of the borings and CPTs.

NOVA geologists logged the borings and collected samples of the materials encountered for laboratory testing. A relatively undisturbed sample was obtained using a modified California (CAL) sampler, a ring-lined split tube sampler with a 3-inch outer diameter and 2½-inch inner diameter. Standard Penetration Tests (SPT) were performed in the borings using a 2-inch outer diameter and 1⅜-inch inner diameter split tube sampler. The CAL and SPT samplers were driven using automatic hammers with calibrated Energy Transfer Ratios (ETRs) of 71.9% (CME 75), 82.8% (CME 85), and 79.6% (CME 95). Borings B-1, B-2, and B-5 were continuously sampled and logged. To maximize recovery in the saturated soils, sampling generally included driving two consecutive 18-inch SPT split tube samplers followed by a 24-inch sampler of the same diameter in these borings. The number of blows needed to drive the samplers 18 and 24 inches is noted in 6-inch intervals on the logs. For the 18-inch sampler, the number of blows needed to drive the bottom 12 inches of the sampler is the field blow count, N. For the 24-inch sampler, the number of blows needed to drive the middle 12 inches of the sample is the field blow count, N. The field blow counts, N, were corrected to a standard hammer (cathead and rope) with a 60% ETR. The corrected blow counts are noted on the boring logs as N_{60}. Disturbed bulk samples were obtained from the SPT sampler and the drill cuttings. Appendix B presents logs of the borings. Soils are classified according to the Unified Soil Classification System. Appendix C presents logs of the CPT soundings.

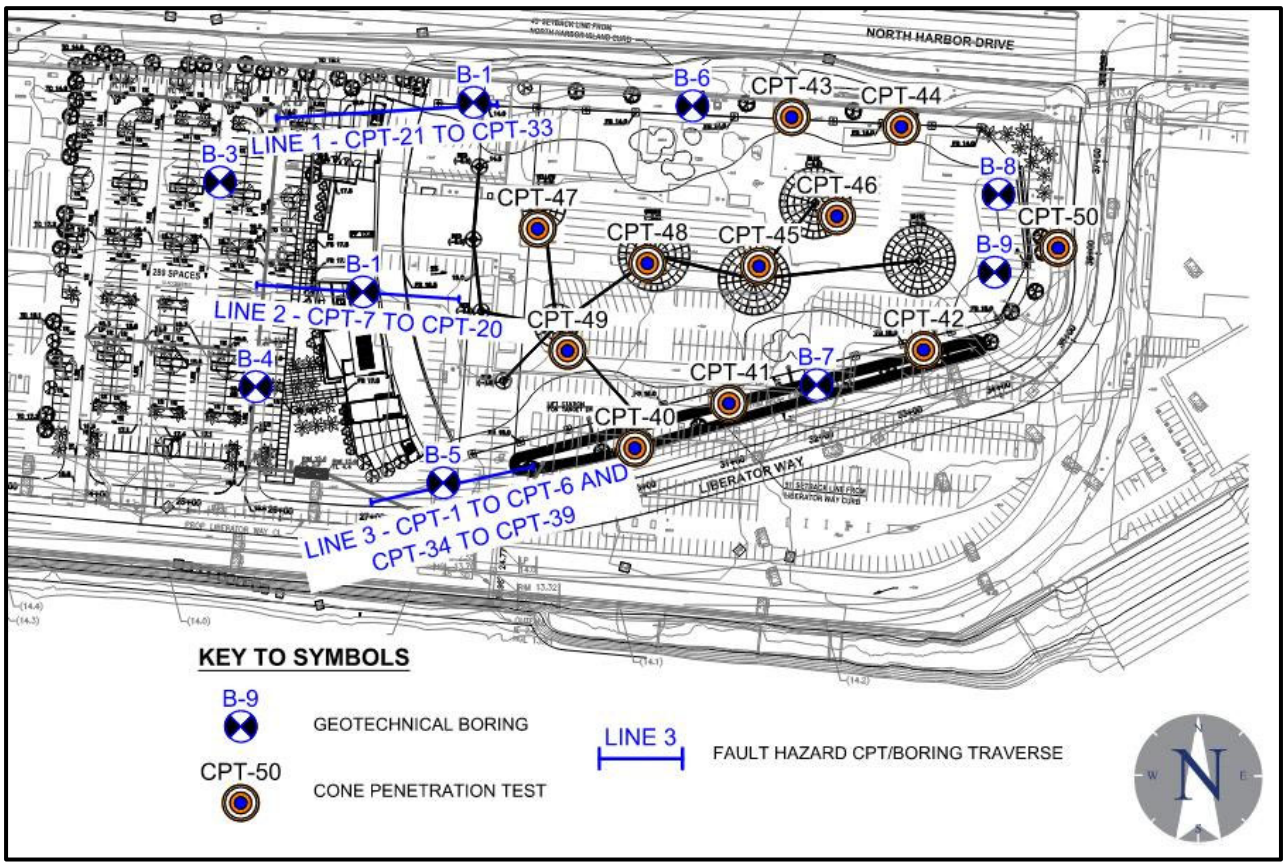

Figure 2-1. Locations of Subsurface Explorations

2.2. Laboratory Testing

NOVA tested selected samples to evaluate soil classification and engineering properties and develop geotechnical conclusions and recommendations. The laboratory tests consisted of particle-size distribution (gradation), Atterberg limits, expansion index, and corrosivity. Appendix D presents the results of the laboratory tests and brief explanations of the test procedures.

2.3. Analysis and Report Preparation

The results of the field and laboratory testing were evaluated to develop conclusions and recommendations regarding the geotechnical and fault hazard aspects of the proposed construction. This report presents our findings, conclusions, and recommendations.

3. SITE AND PROJECT DESCRIPTION

3.1. Site Description

The site consists of approximately 8.5 acres of Port of San Diego property currently being leased by Hertz and Avis rental car companies for parking and maintenance operations and by San Diego International Airport as a temporary parking lot for construction employees involved in the ongoing Terminal 1 redevelopment project. The site is bordered by North Harbor Drive on the north, Liberator Way on the east and south, and the Harbor Police Headquarters on the west. Most of the site consists of existing asphalt-surfaced parking lots with some concrete-surfaced parking and driveways, with several rental car operations buildings and large shade structures scattered across the site. Many active underground utilities exist at the site. The site is generally flat with elevations ranging between about 13 and 15 feet Mean Lower Low Water (MLLW).

3.2. Site History

The site is located on an area previously known as the Dutch Flat, which was a tidal flat. Hydraulic fill consisting of material dredged from the San Diego Harbor was placed between 1928 and 1935 (Kleinfelder, 2013). Figure 3-1 presents the site location prior to hydraulic fill placement on a nautical chart (Department of Commerce, 1933).

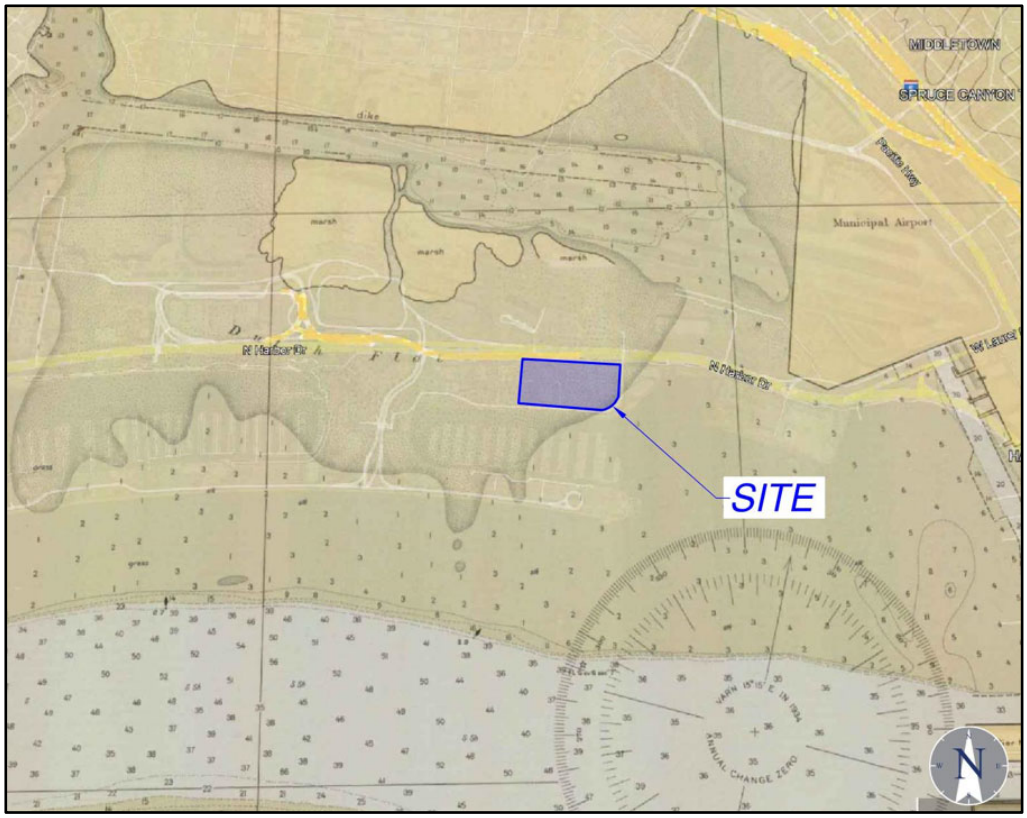

Figure 3-1. Site Location on 1933 Nautical Chart

The site parcels were developed by General Dynamics and their predecessors between the early 1940s and about 1995. The property was known as the Harbor Drive Test Facility (HDTF) and was used for a wide variety of purposes including aircraft research, testing and development, aircraft storage, fuel testing, jet engine testing, propulsion research, rocket testing, and avionics testing. The rental car companies began operations at the site following the termination of General Dynamic's lease and the demolition of the HDTF buildings in approximately 1995/1996 (Kleinfelder, 2024).

3.3. Proposed Construction

Based on our review of the provided concept plans, we understand the proposed construction will consist of a new three-story, crescent-shaped building that includes a restaurant, bar, dining area, and kitchen. The eastern portion of the site will consist of a driving range surfaced with turf. The driving range will be open on the top and enclosed with netting on the sides. The west side of the site will consist of a parking lot with 289 stalls. We understand the proposed building will be supported on shallow spread footings and/or a mat foundation following ground improvement, and the proposed net poles will be supported on deep foundations consisting of driven piles.

3.4. Anticipated Earthwork

Based on review of the current conceptual grading plan (Rick Engineering, 2024), the finished floor elevation of the proposed building will be +17.5 feet MLLW. Site elevations within the proposed driving range will range between about +14 and +15.5 feet MLLW. Site elevations within the proposed parking lot will range between about +16 and +16.5 feet MLLW. Additionally, it is NOVA's understanding that the Port of San Diego is planning to realign Liberator Way. The realignment includes raising the existing grade up to about 2 feet to the east and south of the Topgolf site. Earthwork is anticipated to consist of ground improvement, remedial and fine grading, excavating for foundations, backfilling retaining walls and underground utilities, subgrade preparation, and pavement construction.

4. GEOLOGY AND SUBSURFACE CONDITIONS

4.1. Regional Geology

The project area is located in the coastal plain portion of the Peninsular Ranges geomorphic province. This geomorphic province encompasses an area that extends approximately 900 miles from the Transverse Ranges and the Los Angeles Basin south to the southern tip of Baja California. The province varies in width from approximately 30 to 100 miles.

This area of the province has undergone several episodes of marine inundation and subsequent marine regression (coastline changes) throughout the last 54 million years. These events have resulted in the deposition of a thick sequence of marine and nonmarine sedimentary rocks on the basement igneous rocks of the Peninsular Ranges batholith and metamorphic rocks.

The western portion of the province, which includes the subject site, is underlain by unconsolidated Holocene-age marine bay deposits overlie Pleistocene marine and nonmarine terrace deposits. These Quaternary deposits are underlain by undifferentiated Tertiary sedimentary rocks that were deposited on late Cretaceous sedimentary rocks in a basin known as the San Diego embayment.

4.2. Site-Specific Geology

The sequence of geologic units encountered during the subsurface investigation includes hydraulic artificial fill (af), which was placed between 1928 and 1935 (Kleinfelder, 2013), marine bay deposits (Qmo), and old paralic deposits (Qop). The artificial fill (af) extends to about 10 feet bgs and is underlain by about 29½ to 32 feet of marine deposits. The marine deposits are underlain by old paralic deposits consisting of interbedded marine sand, silt, and clay. Figure 4-1 presents the regional geology in the vicinity of the site. Plate 1, following the text of the report provides the site geology and Plate 2 presents the geologic cross-sections. Plates 3 through 5 present CPT Lines 1 through 3 with the site geology.

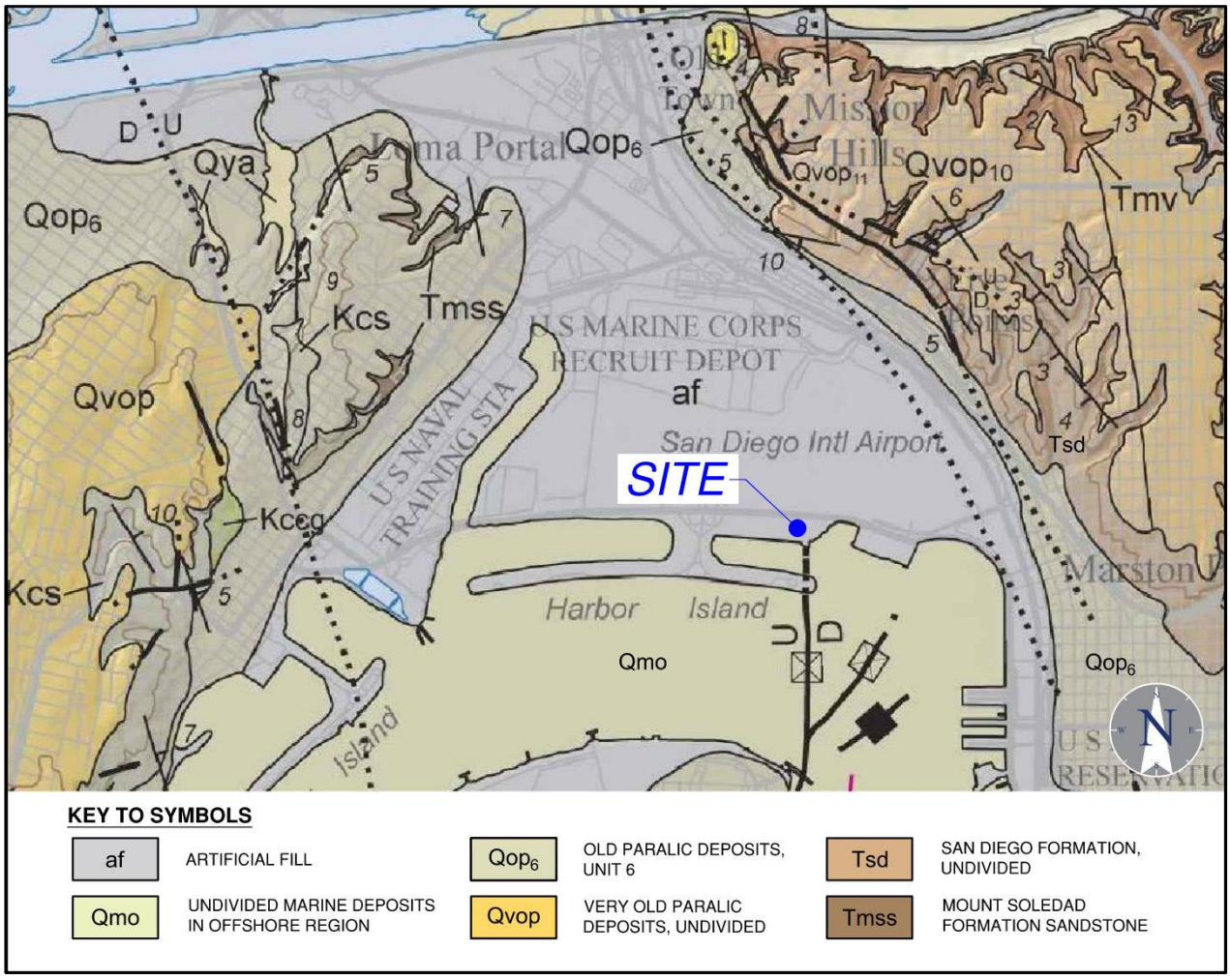

Figure 4-1. Regional Geology Map (Kennedy and Tan, 2008)

A fault study was previously conducted at San Diego International Airport by Kleinfelder in 2013. Kleinfelder evaluated faulting using similar methods to those used in this investigation. CPT Profile 100A is located directly across North Harbor Drive from the subject site. The CPTs in Kleinfelder's investigation correlate very closely with the CPTs presented in this report (Figure 4-2).

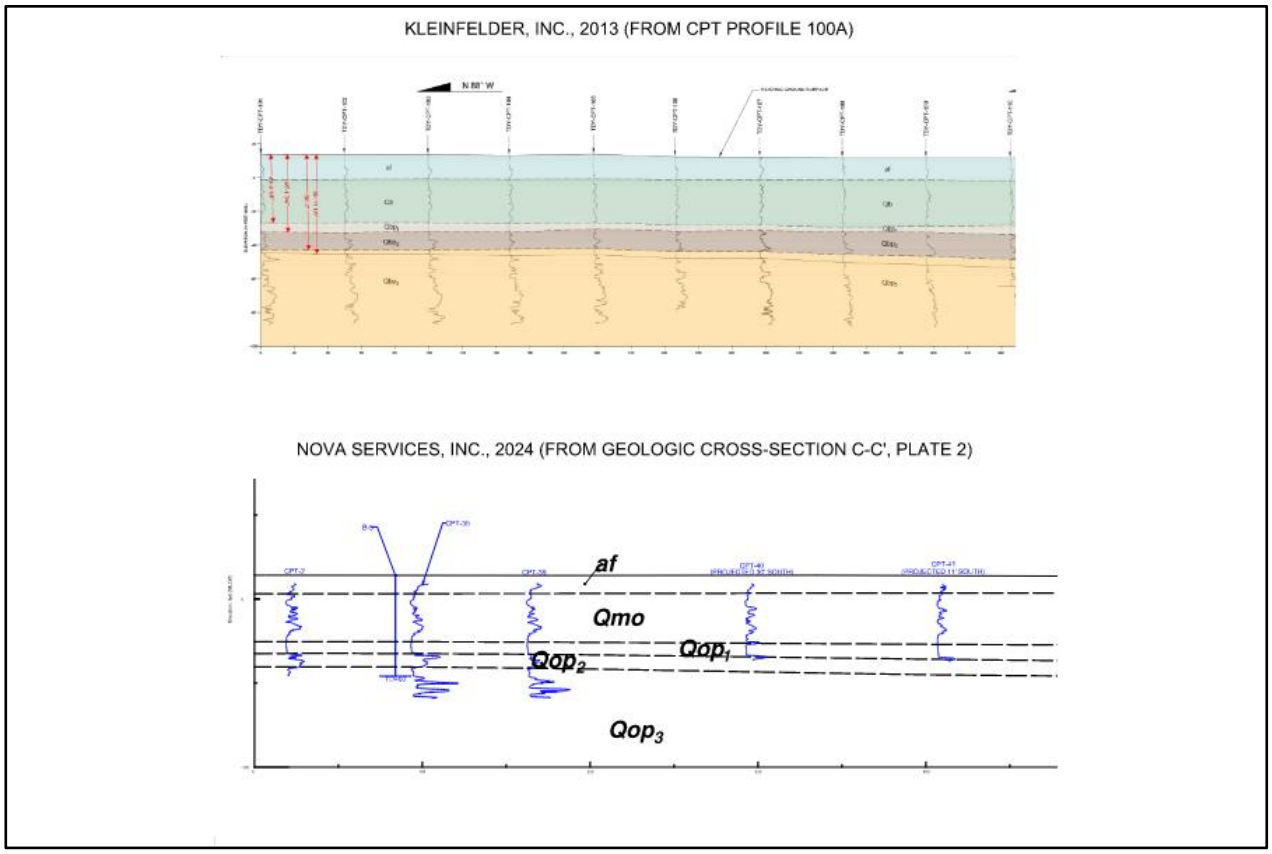

Figure 4-2. Comparison of CPT Derived Stratigraphy North (Kleinfelder, 2013) and South (NOVA) of North Harbor Drive

NOVA concurs with the age of the sedimentary units presented in their report and have used their reported ages and names for the geologic units reported below.

Fill (af): Fill was encountered beneath the existing pavement sections in each of the borings to a depth of about 10 feet bgs, corresponding to elevations of about +3½ to +4½ feet MLLW. As encountered in the borings, the fill generally consisted of loose to medium dense silty sand and poorly graded sand with silt with varying amounts of gravel, cobbles and shell fragments. NOVA has no records regarding the placement and compaction of the fill; therefore, the fill is considered undocumented and at risk for wide variations in quality.

Quaternary Offshore Marine Bay Deposits (Qmo): Holocene-age marine bay deposits were encountered beneath the fill in Borings B-1, B-2, B-5, B-6, B-7, and B-8 to depths of about 41 to 42 feet bgs, corresponding to elevations of about -27½ to -28 feet MLLW. Marine deposits were also encountered in Boring B-9 to the maximum-explored depth of about 16½ feet bgs. The marine deposits have been dated from 620 years to 6,300 years before present (b.p) (Kleinfelder, 2013). As encountered in the borings, the marine deposits consisted of interbedded very loose to dense silty sand, sandy silt, silt, poorly graded sand with silt, and

soft to very stiff silty clay with sand, sandy fat clay and fat clay. Varying amounts of scattered shells were observed in the marine deposits.

Quaternary Old Paralic Deposits (Qop): Late to middle Pleistocene old paralic deposits were encountered beneath the marine bay deposits to the maximum-explored depth of up to about 80 feet bgs. This unit consists of three marine terrace deposits. The top portion of this unit has been interpreted by Kleinfelder and Tom Rockwell (Kleinfelder, 2013) to be the Nestor Terrace subunit, below which are deposits that include fossils from the upper and lower Broadway Fauna. These subunits were age-dated as part of the San Diego International Airport geotechnical investigations, located directly across North Harbor Drive from the Topgolf site.

The NOVA and Kleinfelder investigations encountered paleosols that are representative of marine regression where the parent soils were altered during aerial exposure. NOVA has subdivided the old paralic deposits into three subunits for the purpose of correlating continuous unique stratigraphic features to evaluate faulting. The three subunits are described below and are consistent with those used in Kleinfelder, 2013 (note that the subscript numbers on the subunit map symbols do not correlate with subunit numbers used in Kennedy and Tan, 2008).

Nestor Terrace (Qop_1):

The Nestor Terrace soils, herein referenced as Qop_1, are characteristic of a paleosol; and were encountered below the marine bay deposits in Borings B-1, B-2, B-5, B-6, B-7, and B-8. These soils consisted of soft to very stiff fat clay and sandy fat clay. This unit extends to depths of about 45 to 50½ feet bgs (corresponding to elevations of about -30½ to -37 feet MMLW) west of the fault in Borings B-1, B-2, B-5, B-6, and B-7; and to a depth of about 55½ bgs (corresponding to an elevation of about -41 feet MLLW) east of the fault in Boring B-8. These soils have been age-dated to be approximately 120 ka b.p.

Upper Broadway Fauna (Qop_2):

The Upper Broadway Fauna, herein referenced as Qop_2, was encountered below Qop_1 in Borings B-1, B-2, B-5, B-6, B-7, and B-8. These soils consisted of loose to very dense silty sand, clayey sand, sandy silt, poorly graded sand, poorly graded sand with silt, poorly graded sand with clay, and very soft to very stiff fat clay and sandy clay. This unit extends to depths of about 54½ to 60 feet bgs (corresponding to elevations of about -40½ to -45½ feet MMLW) west of the fault in Borings B-1, B-2, B-5, B-6, and B-7; and to a depth of about 61½ bgs (corresponding to an elevation of about -47 feet MLLW) east of the fault in Boring B-8. These soils have been age-dated to be approximately 330 ka b.p.

Lower Broadway Fauna (Qop_3):

As seen in our borings and CPTs as well as in Kleinfelder 2013, the Lower Broadway Fauna, herein referenced as Qop_3, has a distinct fine-grained paleosol separating it from the overlying unit Qop_2. This unit was encountered below the Qop_2 in borings B-1, B-2, B-5, and B-6 to the maximum explored depths of up to about 80 feet bgs. As encountered in the borings, the upper paleosol consisted of stiff to hard fat clay, sandy fat clay, silty clay. The underlying soils

consisted of medium dense to very dense clayey sand, silty sand, and sandy silt. These soils have been age-dated to be approximately 400 ka b.p.

4.3. Groundwater

Groundwater was encountered in the borings at depths between about 10 and 11 feet bgs, corresponding to elevations of about +2½ to +4½ feet MLLW. The groundwater table is expected to be below a depth that will influence the general grading operations; however, it will be encountered during pile and ground improvement installation. Fluctuations in the groundwater level should be anticipated during and following periods of heavy rainfall. Furthermore, due to the proximity of the site to the San Diego Bay, tidal influences will also cause fluctuations of the groundwater level, with fluctuations higher for locations closer to the bay. Note the materials within about 1 to 2 feet above the static groundwater table typically have elevated moisture contents due to capillary rise. Sea level rise during the life of the project should be taken into consideration during design. An average design groundwater level of +10.88 feet MLLW has been established for design. This groundwater level considers potential sea level rise impacts.

5. FAULTING AND GROUND RUPTURE HAZARD

5.1. Required Ground Rupture Investigations

The site is located in a State of California Alquist-Priolo Earthquake Fault Zone. California is known to have active faults that can potentially cause significant damage during earthquakes. The Alquist-Priolo Earthquake Fault Zoning Act was implemented in 1972 to prevent the development of habited structures over the surface trace of active faults. The State Geologist defines an active fault as one that has had surface rupture within recent geologic time (i.e., Holocene time, <11,700 years b.p). The Earthquake Fault Zones have been delineated to encompass traces of known or suspected Holocene-active faults to address hazards associated with fault surface rupture. Where developments for human occupancy are proposed within these zones, the state requires detailed fault evaluations be performed so that engineering geologists can identify active faults and recommend setbacks from locations of possible surface fault rupture. Figure 5-1 presents the site on the Point Loma 7.5 Minute Quadrangle showing the Earthquake Fault Zones of required investigation (CGS, 2021).

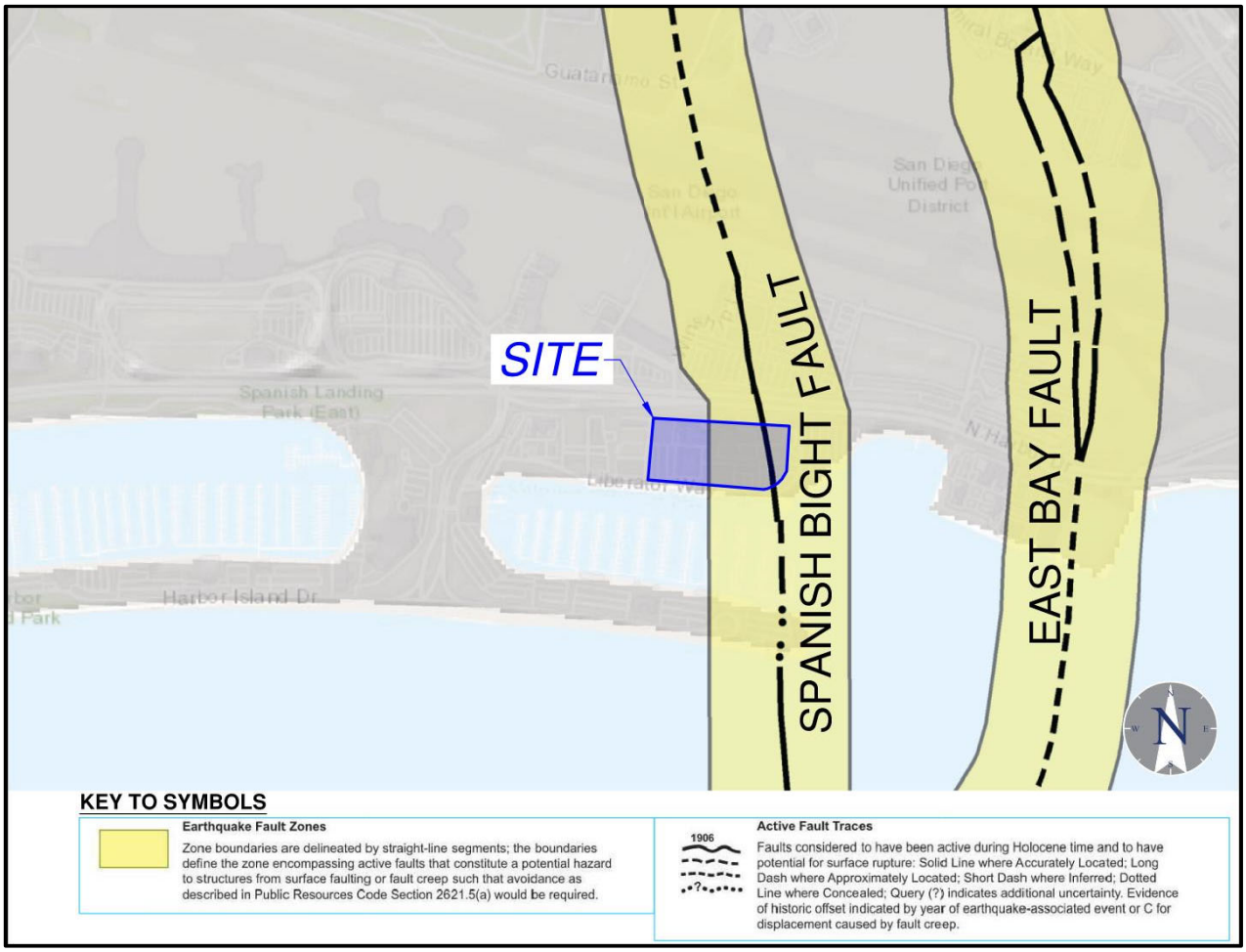

Figure 5-1 Earthquake Fault Zones of Required Investigation, Point Loma Quadrangle

In addition to the State-mandated fault investigation, the site is located within Category 11, "Active, Alquist-Priolo Earthquake Fault Zone" according to the City of San Diego Seismic Safety Study (City of San Diego, 2008). Based on this category, a subsurface fault investigation is required. Figure 5-2 presents the site as shown on the City of San Diego Seismic Safety Study. The site is also located in Geologic Hazard Category 31, which is defined as having a high potential for liquefaction.

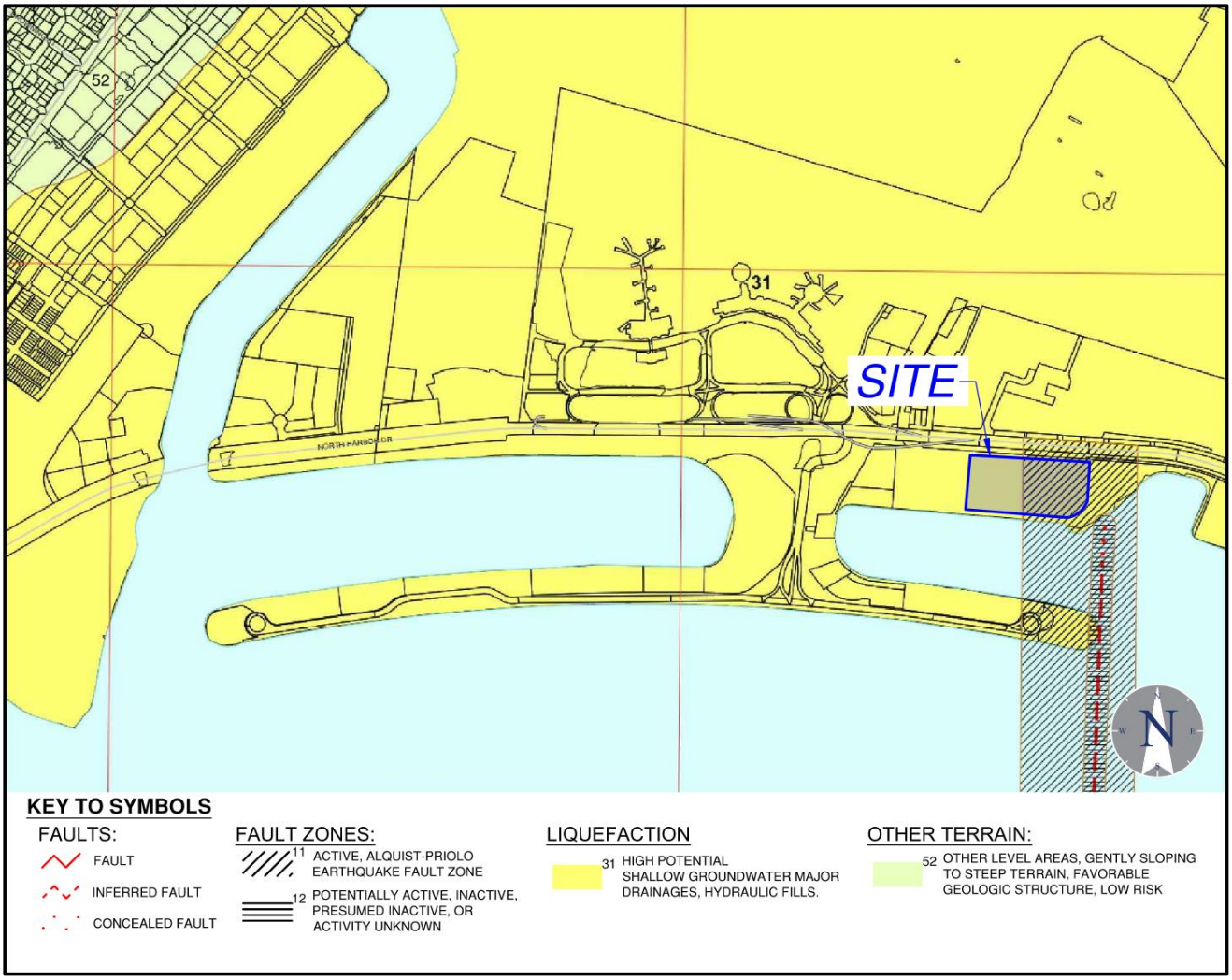

Figure 5-2. City of San Diego Seismic Safety Map, Grid Tile No. 16

5.2. Regional Faulting

The site is located in a seismically active area, as is the majority of southern California, and the potential for strong ground motion is considered significant during the design life of the proposed structure. Major known active faults in the region consist generally of en echelon, northwest striking, right-lateral, strike-slip faults. These include the San Andreas, Elsinore, and San Jacinto Faults located northeast of the site, and the San Clemente, San Diego Trough, and Agua Blanca-Coronado Bank Faults located to the west of the site. Figure 5-3 presents the known faults in the region.

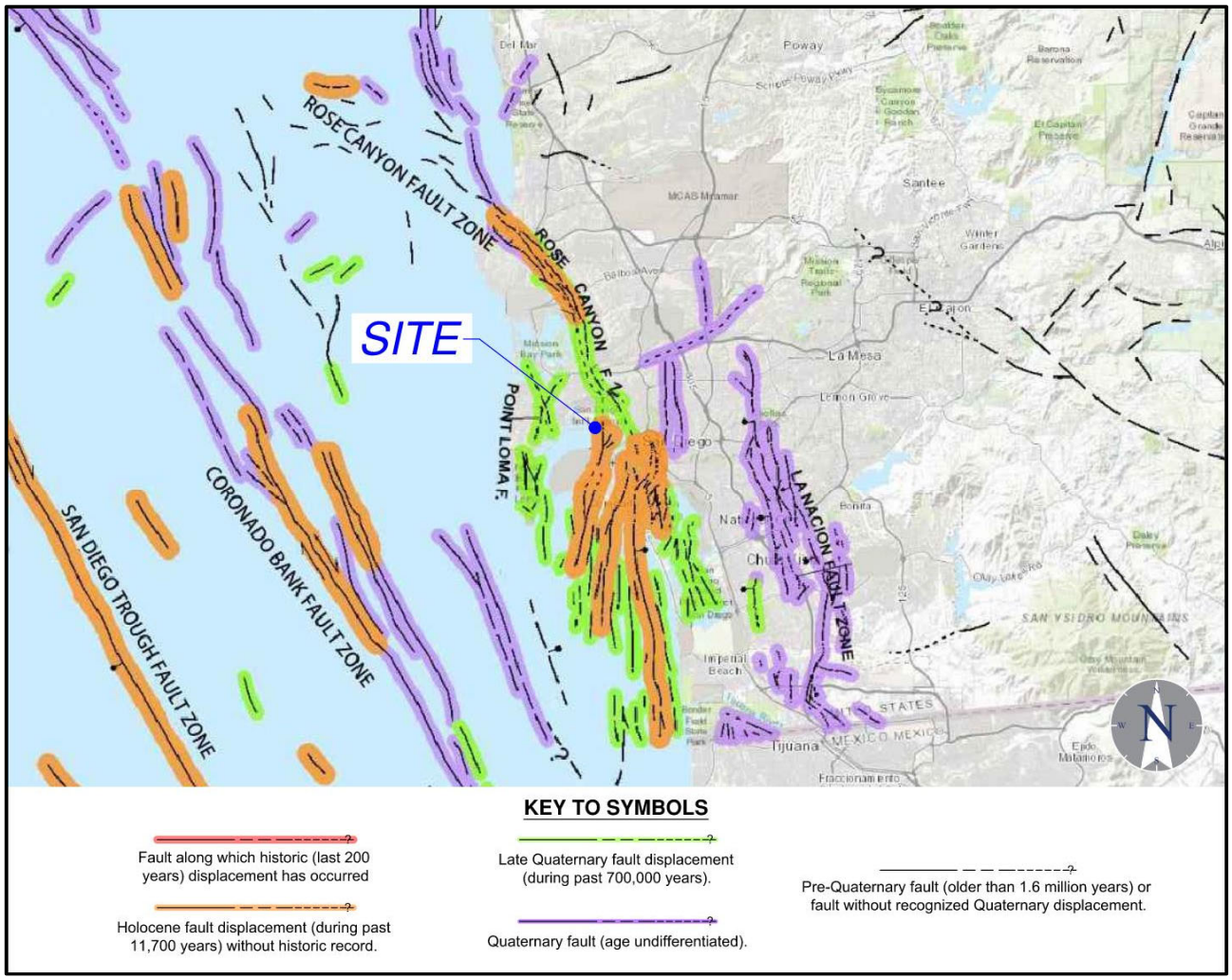

Figure 5-3. Regional Faulting in the Site Vicinity

The tectonic setting of the metropolitan San Diego area includes major north and northwest striking fault zones, the most prominent and active of which is the Newport-Inglewood/Rose Canyon Fault System (NIFZ/RCFZ). The NIFZ/RCFZ is an approximately 170 km zone that extends from Beverly Hills to San Diego Bay. The RCFZ is the portion of the fault system that returns back onshore at La Jolla Cove, at which point it continues southeastward until it goes offshore again in San Diego Bay (CGS, 2021). The USGS Unified Hazard Tool indicates the site may be subjected to a Magnitude 6.9 seismic event.

5.3. Rose Canyon Fault Zone

Four main fault strands comprise the offshore portion of the RCFZ north of La Jolla. Where the fault zone comes back onto land in La Jolla Cove, it is composed of three main strands that extend southeast to Old Town San Diego. There are two major fault strands that extend southward from Old Town. The eastern one trends southeast toward Middletown and Downtown San Diego, where it splays into the PCH/Coronado Fault, the San Diego fault, and fault splays within an area of the East Village of Downtown San Diego known as the Downtown Graben.

The major strand trending south from Old Town projects toward San Diego International Airport. This fault splays into two faults identified as the Spanish Bight Fault (SBF) on the west, and a splay of the SBF to the east, called the East Bay fault (CGS, 2021).

5.4. Spanish Bight Fault

The SBF is named after the bight that historically separated North Island from Coronado Island before it was infilled to create one island. The bight between the islands was formed by the fault. The SBF was mapped from the bight between the islands upward toward Harbor Island based on marine seismic profiles performed through San Diego Bay. This fault was mapped to dip 75 degrees eastward and have components of both normal and strike-slip movement (CGS, 2021).

5.5. Previous Fault Rupture Hazard Investigations

5.5.1 Kleinfelder TDY Fault Study, 2013

The site of the proposed Topgolf facility is located between two projects where previous fault rupture hazard reports by other consultants have been performed. A fault study of the former Teledyne Ryan manufacturing facility (TDY site) was conducted at San Diego International Airport by Kleinfelder in 2013. Kleinfelder evaluated faulting using similar methods to those used in this investigation. CPT Profile 100A is located directly across North Harbor Drive from the subject site. The depth of the geologic units encountered in the CPT soundings and borings in Kleinfelder's investigation correlate very closely with those presented in this report.

Kleinfelder performed CPTs approximately every 50 feet to depths of up to about 100 feet. In areas of suspected faulting additional CPTs and direct push borings were advanced between the original CPTs to more precisely locate the limits of the faulting, and the age of the faults they encountered. Kleinfelder located a fault within Profiles 100A and 200, and determined it was the SBF based on its known trend and location within the area north of Harbor Island. The layout of these profiles is located in Figure 5-4.

Within Profile 100A, three faults were identified, however, the faults on the west and east terminated in sediments identified to be Pleistocene in age and were therefore determined to be potentially active. The central fault, which splays upward, was interpreted to offset the contact with the Nestor terrace and underlying Upper Broadway unit. The fault did not offset the contact with the bay sediments but based on the young age of these sediments (around 6,000 years b.p.), active faulting could not be excluded. As a result, this zone was conservatively classified as active. The active fault zone is

approximately 25 feet in width in Profile 200 but narrows southward to about 19 feet in width in Profile 100A. The vertical offset was observed to be 5 to 6 feet down to the east at the lower contact of the Nestor Terrace deposits, but 6 to 7 feet within the lower stratigraphic units. Figure 5-4 presents the portion of Profile 100A where the fault zone was encountered.

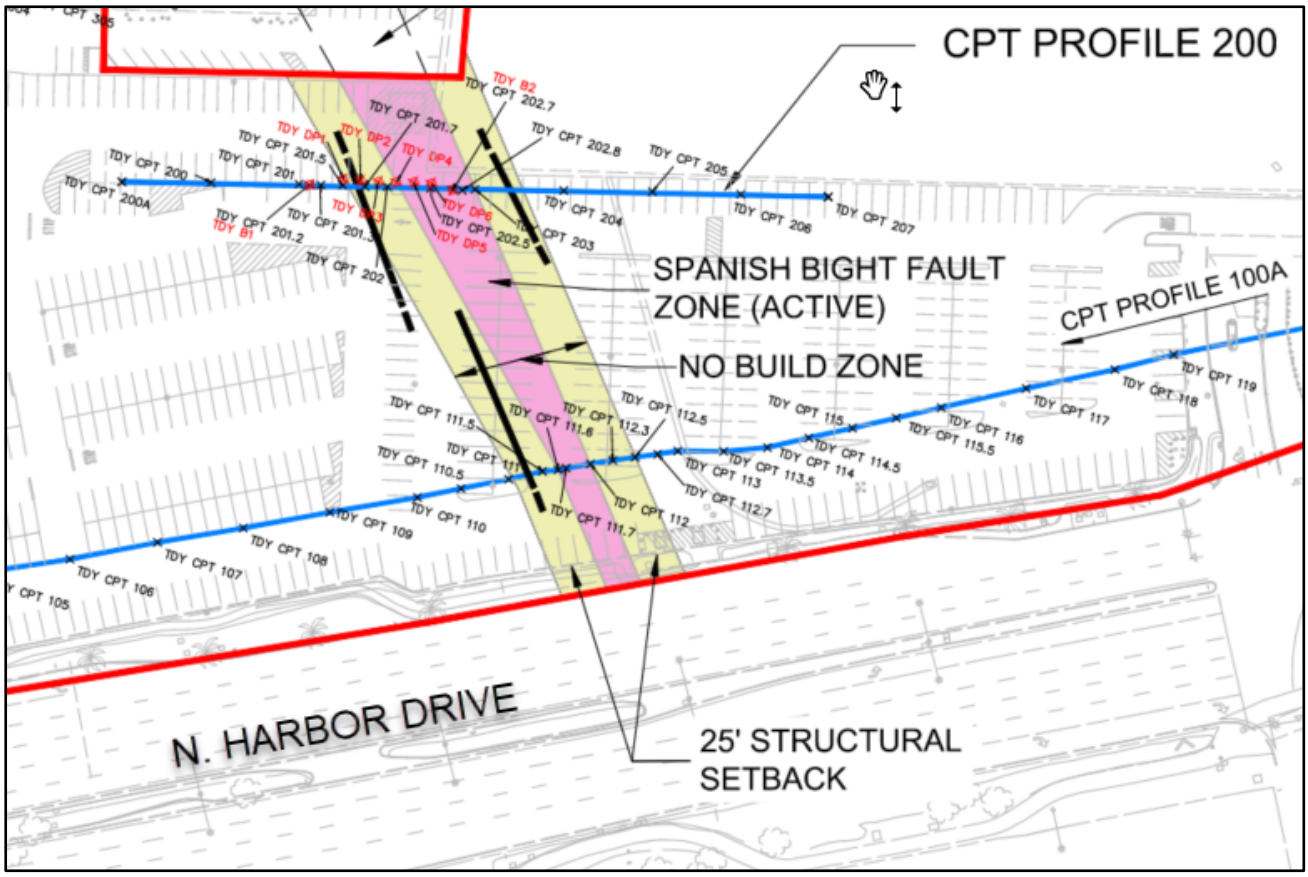

Figure 5-4. Spanish Bight Fault Zone with Structural Setbacks (Kleinfelder, 2013)

Kleinfelder recommended structural setbacks of 25 feet on either side of the active fault zone in both locations in conformance with City of San Diego standard setback zones within areas where the faulting is well-constrained. In Figure 5-4 the active fault zone is presented in pink, and the setback zones are presented in yellow. The approximate location of the fault zone is shown on Plate 1. The projected fault zone and structural setback zones identified in Kleinfelder's, 2013 project is well outside of the 50-foot structural fault setback recommended by the State of California for habitable structures, such as the Topgolf building.

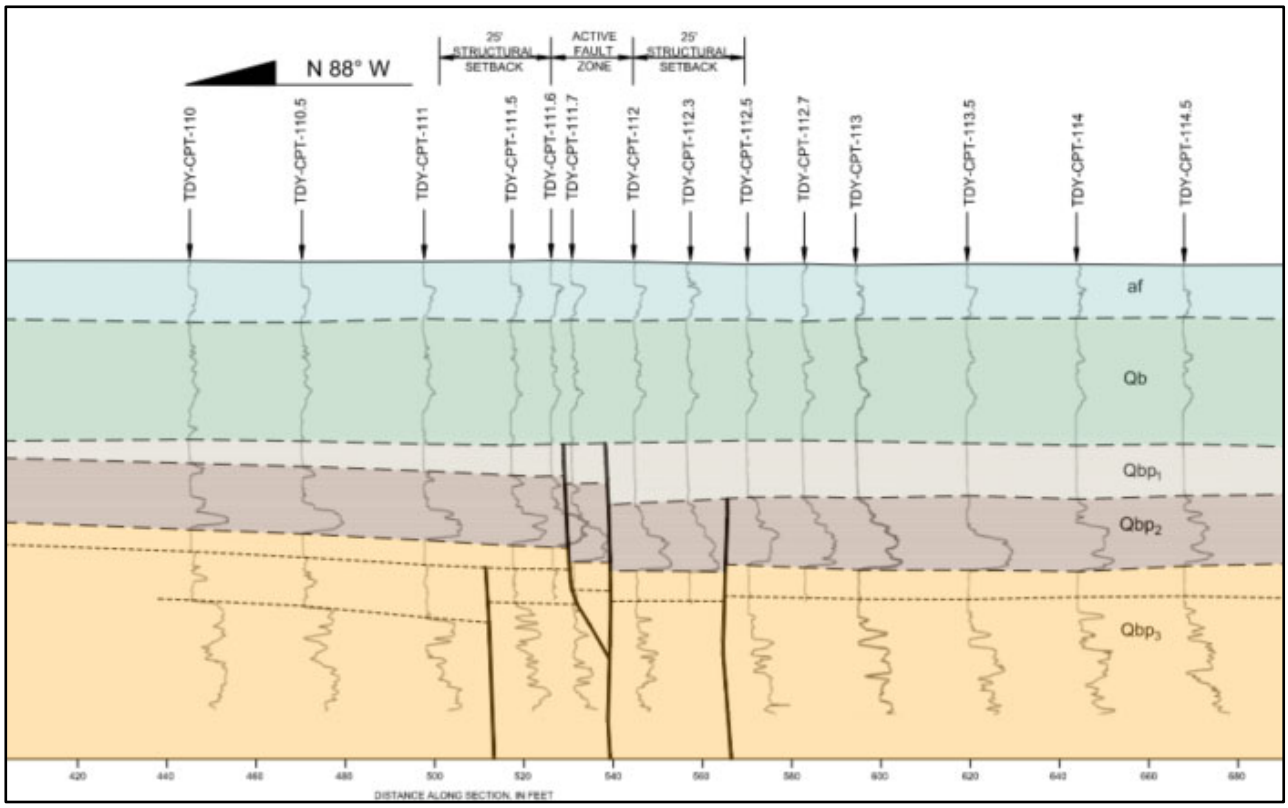

Figure 5-5. Spanish Bight Fault Zone in Profile 100A (Kleinfelder, 2013)

5.5.2 Geocon East Harbor Island Restaurant, 2011

Between 2006 and 2011, Geocon provided fault rupture hazard and geotechnical investigations for the east portion of Harbor Island at 880 Harbor Island Drive. This site was investigated in 2006 for a proposed hotel, and again in 2011 for a proposed restaurant.

Geocon's fault rupture hazard investigation included two lines of CPT soundings and four seismic reflection lines to constrain the locations of the fault zone they identified. Figure 5-6 presents the faults identified. The fault on the west was identified by Geocon as the SBF, a steeply eastward dipping normal fault, while the two faults on the east were determined to be minor antithetic faults dipping in the opposite direction. As shown in the figure, the trend of the SBF bends between Seismic Reflection Lines 1 and 2 from the northward trend that is consistent with previous reporting of the SBF within the San Diego Bay (Kennedy and Clarke, 1999 and Legg Geophysical, 2007) to N16°W.

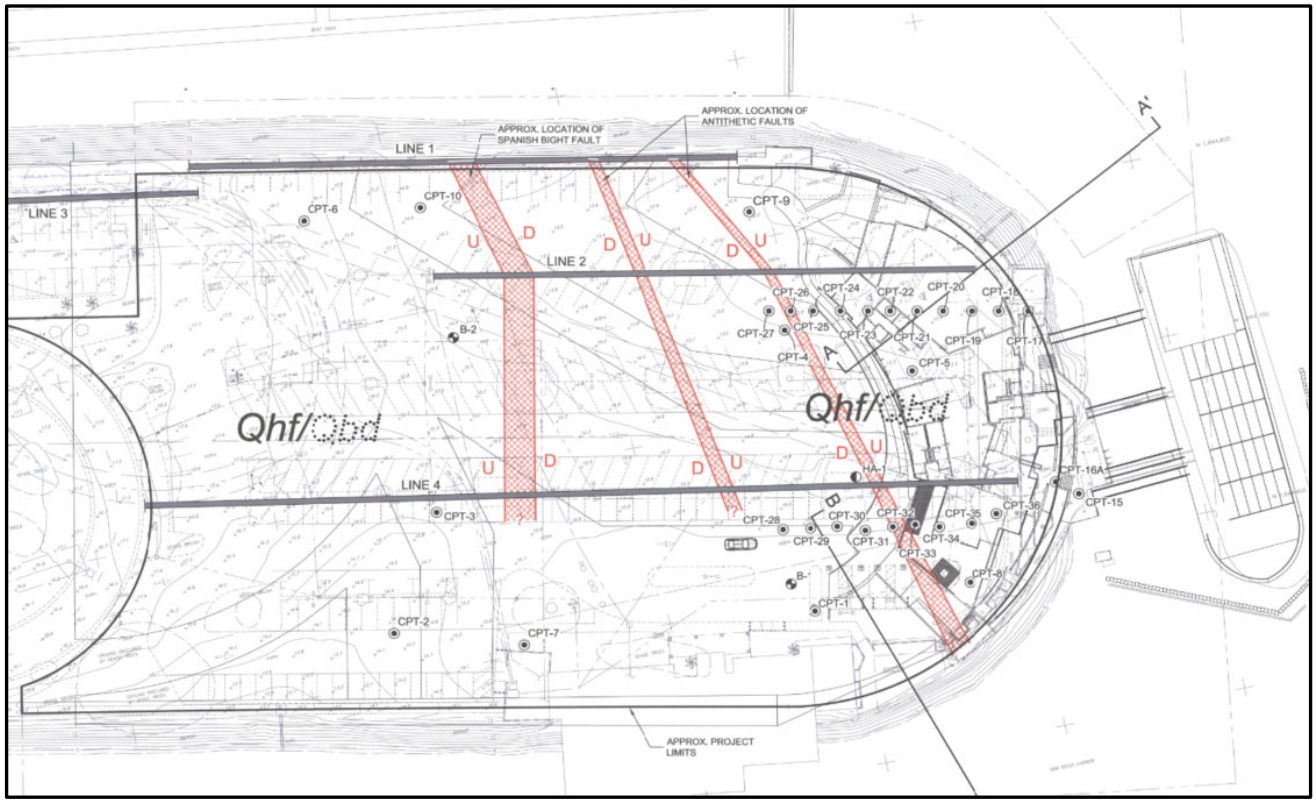

Figure 5-6. SBFZ on East Harbor Island (Geocon, 2011)

Figure 5-7 presents the projected trend of the SBF fault reported by Geocon. The northwest trending orange dashed line shows the projection of the fault with the northwestward bend. The north trending line presents the projection without the bend. If the SBF maintained the N16W trend northwestward across the adjacent marina through the Topgolf site, the fault would have been encountered in the eastern portion of NOVA's CPT Line 1 near CPTs 23/24. Additionally, offset would have been noted between CPT-39 and CPT-40, and no offset was observed (see Plate 2 – Geologic Cross-Section C).

The N16W fault would have also intersected the west end of Kleinfelder's CPT Profile 100A near CPTs 102/103. No offset was observed in these areas. The trend projected from the northwest bend is not supported by NOVA or Kleinfelder's field investigations; therefore, it is NOVA's conclusion that the fault does not project to the Topgolf site with the trend shown.

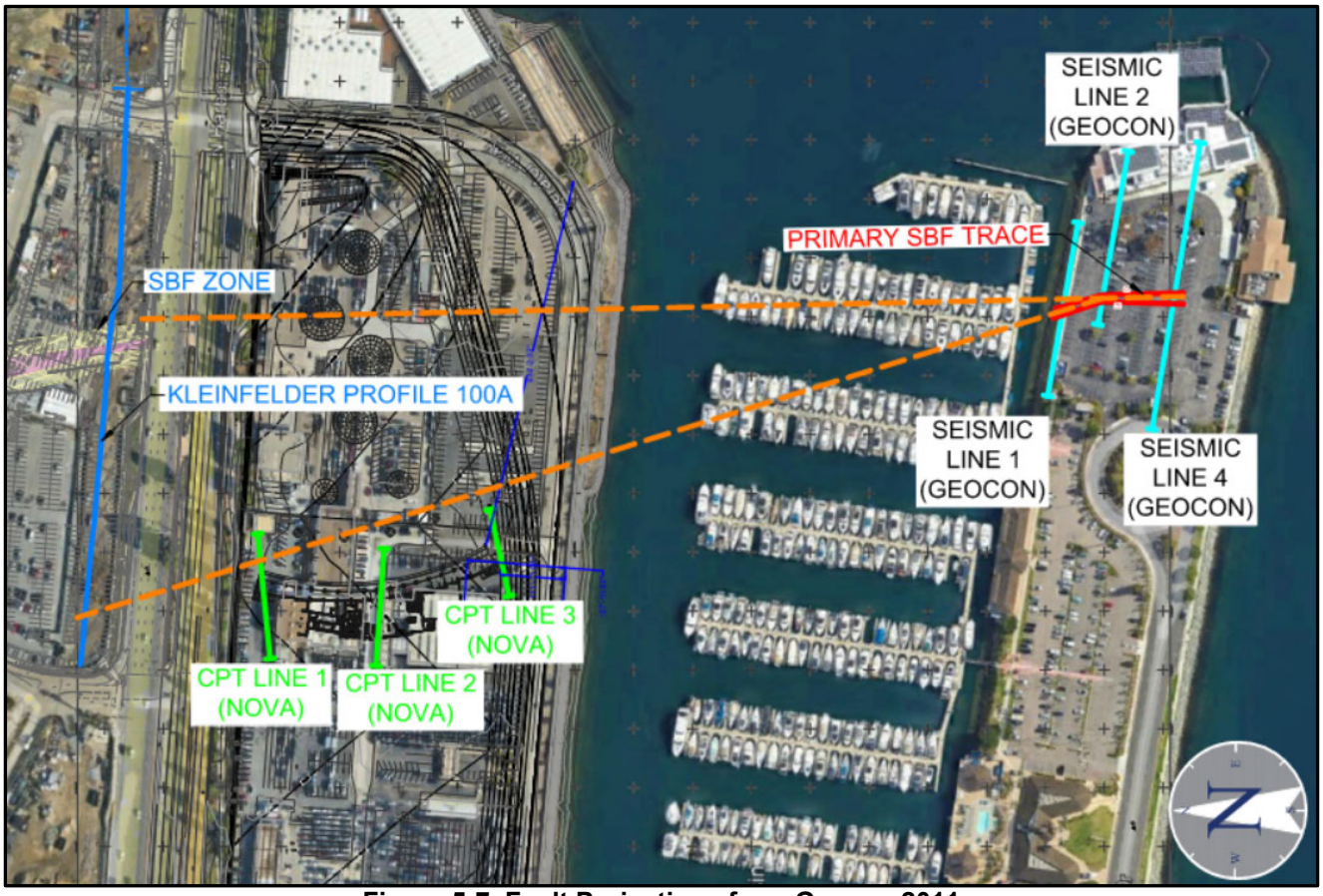

Figure 5-7. Fault Projections from Geocon 2011

5.6. Topgolf Fault Rupture Hazard Investigation

The objective of NOVA's fault rupture hazard study at the site was to investigate the proposed Topgolf building footprint for faulting, with the investigation area extending approximately 50 feet east and west of the proposed building footprint in accordance with Special Publication 42 (CGS, 2018) and the City of San Diego Guidelines for fault investigations (City of San Diego, 2018). Line 1 consists of CPT-21 through CPT-33 with Boring B-2 serving as a confirmation boring. Line 2 consists of CPT-7 through CPT-20 with Boring B-1 serving as a confirmation boring. Line 3 consists of CPT-1 through CPT-6 and CPT-34 through CPT-39 with Boring B-5 serving as a confirmation boring. Plate 1 presents the approximate locations of the borings and CPT lines.

The layout of the CPT lines was determined by choosing locations and layouts designed to intercept the projected trend of the SBF plus or minus 30 degrees of its expected trend. Where possible, CPTs were advanced approximately 15 feet on center following Appendix D of City of San Diego (2018). In four areas, CPT refusal was encountered on underground obstructions. After three to four failed attempts to move and readvance, CPT-1, CPT-25, CPT-26, and CPT-36 were abandoned. CPT-34 was inaccessible at the time of the investigation. As such, Boring B-5 was relocated to the planned location of CPT-34 to avoid a gap in the subsurface data. Upon completion of the investigation, NOVA

obtained horizontal and vertical control for each CPT location from Rick Engineering surveyors. Plate 1 presents the location of the CPTs.

Plates 3 through 5 present the subsurface profiles of Lines 1 through 3. The plates present the cone resistance and the friction ratio for each CPT to correlate the CPTs to their respective confirmation borings and provide data for correlation of the geologic contacts between CPTs. As previously discussed, the CPTs and borings encountered the same geologic units described in Kleinfelder, 2013. As presented in Section 4 of this report, we encountered the Nestor Terrace paleosol (~120 ka b.p), underlain by the Upper Broadway terrace unit (~330 ka b.p). Another paleosol was encountered at the top of the Lower Broadway terrace unit (~400 ka b.p). These stratigraphic layers are presented on Plates 2 through 5. The stratigraphy presented on Plates 3 through 5 indicates that there are no active or potentially active faults encountered to the maximum depths explored within 50 feet of the building footprint.

The precise location of the active SBF to the east of the building was beyond the scope of this investigation; however, the data collected within the proposed driving range indicates that the fault likely occurs in the vicinity of the fault zone projected from Kleinfelder's report (see Plate 1). Cross-Section C-C' (Plate 2) indicates that the contact with the Nestor Terrace and sandstone of the Upper Broadway terrace unit, is approximately 5 feet lower east of the projected fault zone. This offset distance and direction is consistent with the findings in Kleinfelder, 2013. CPT-42 was the only CPT within the proposed driving range that was advanced deep enough to encounter the contact between the Upper Broadway sandstone layer and the underlying Lower Broadway paleosol. However, comparison of CPT-39 west of the fault zone and CPT-42 east of the fault zone suggest that the contact is down-dropped on the east by as much as about 15 feet, rather than the 6 to 7 feet observed by Kleinfelder to the north of this site.

5.7. Summary and Findings of the Fault Hazard Investigation

Based on the continuity of the stratigraphy below the proposed Topgolf building area, it is NOVA's opinion that there are no active or potentially active faults below the proposed building (and within 50 feet on either side of the footprint) to the maximum explored depths of about 73 feet bgs. It is NOVA's opinion that the potential for ground rupture below the proposed building is very low. No building setbacks are recommended within the area of the building. Based on the borings and CPTs performed for the driving range, it appears likely that the Spanish Bight fault zone documented in Kleinfelder, 2013 projects through our site approximately as shown on Plate 1. NOVA does not recommend setbacks of the poles or targets with the projected fault zone, as these are not habitable structures.

6. GEOLOGIC HAZARDS

6.1. Strong Ground Motion

A geologic hazard likely to affect the project is ground shaking as a result of movement along an active fault zone in the vicinity of the subject site. The following sections discuss site class and provide seismic design parameters.

6.1.1 Site Class

Based on the results of the field explorations, the project site is classified as a Site Class D site which is defined as a stiff soil site with average shear wave velocities within the upper 100 feet of the soil profile between 600 and 1,200 ft/s, average field standard penetration resistances between 15 and 50 blows per foot, or average undrained shear strengths between 1,000 and 2,000 psf. However, as discussed in subsequent sections, liquefiable soils are present at the overall project site and, therefore, the site is classified as Site Class F in accordance with the 2022 CBC and ASCE 7-16. For Site Class F, a site response analysis is required to be performed in accordance with the requirements of 2022 California Building Code (CBC) and ASCE 7-16. However, NOVA anticipates that the proposed building will be supported on shallow spread footings and/or a mat foundation bearing on ground improvement. It is anticipated that the ground improvement design will mitigate post-liquefaction settlement to an acceptable level such that the site may be classified as Site Class D. If deep foundations are used to support the proposed building, the site will be classified as a Site Class F and a site response analysis will be required.

The proposed net poles can be supported on deep foundations. NOVA anticipates that the net poles will have a fundamental period of vibration less than or equal to 0.5 seconds. Per ASCE Section 20.3.1.1, a site response analysis is not required for structures with fundamental periods of vibration less than or equal to 0.5 seconds. Accordingly, Site Class D can be used for the seismic design of the net poles. The project structural engineer should confirm the fundamental period of the net poles to assess whether a site response analysis is needed.

6.1.2 Site-Specific Ground Motion Hazard Analysis

For a Site Class D, a site-specific ground motion hazard analysis (GMHA) is required to be performed in accordance with the requirements of 2022 California Building Code (CBC) and ASCE 7-16.

NOVA performed a GMHA as part of our investigation. As part of the analysis, base ground motions were evaluated with both a Probabilistic Seismic Hazard Analysis (PSHA) and a Deterministic Seismic Hazard Analysis (DSHA) to characterize earthquake ground shaking that may occur at the site during future seismic events.

The PSHA is based on an assessment of the recurrence of earthquakes on potential seismic sources in the region and on ground motion prediction models of different seismic sources in the region. The United States Geological Survey (USGS) Unified Hazard Tool (USGS, 2024a) was used to develop seismic hazard curves for various periods and the USGS Risk-Targeted Ground Motion Calculator (USGS, 2024b) was used to analyze ground motions for each corresponding period. Maximum

directional scale factors were applied to the results to develop the probabilistic ground motion response spectrum specific to this site.

The DSHA is represented by the 84th percentile of the spectral accelerations for different periods. The logarithmic means and standard deviations of various periods were calculated using the USGS Response Spectra Tool (USGS, 2024c) with ground motion model(s) “Combined: WUS 2018 (5.0, deep basins).” This combined model utilizes attenuation relationships of Abrahamson-et al (2014) NGA West 2, Boore-et al (2014) NGA West 2, Campbell and Bozorgnia (2014) NGA West 2, and Chiou and Youngs (2014) NGA West 2.

The deterministic ground motions are controlled by the Rose Canyon fault zone. Input parameters were obtained from the USGS Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) model, and USGS Earthquake Scenario Map (BSSC 2014), presented in Table 6-1.

Table 6-1. DSHA Input Parameters

Fault: Rose Canyon	
Mw	6.99
Type	Strike-Slip
Dip (°)	90.0
Rake (°)	180
Width (km)	6.93
R_x (km)	1.65
R_{RUP} (km)	1.65
R_{JB} (km)	1.65
V_{s30} (m/s)	220*

***Measured**

The site-specific Risk-Targeted Maximum Considered Earthquake (MCE_R) was taken as the lesser of the spectral response accelerations determined from the PSHA and DSHA for each period. The site-specific design response spectral accelerations were compared to the design response spectrum from ASCE 7-16, Section 11.4.6 (SEAOC, 2024) to verify that the values obtained from the site-specific analysis are not less than 80% of the accelerations obtained from Section 11.4.6. The site coefficients and maximum considered earthquake spectral response acceleration parameters are presented in Table 6-2. Tabulated values and graphical plots are attached in Appendix E.

Table 6-2. 2022 California Building Code/ASCE 7-16 Site-Specific Parameters

Site Coordinates	
Latitude: 32.72814	Longitude: -117.19062
Site Coefficients and Spectral Response Acceleration Parameters	**Value**
Site Class	D
Site Amplification Factor at 0.2 Second, F_a	1.000
Site Amplification Factor at 1.0 Second, F_v	1.801
Spectral Response Acceleration at Short Period, S_S	1.523g
Spectral Response Acceleration at 1-Second Period, S_1	0.695g
Spectral Response Acceleration at Short Period, Adjusted for Site Class, S_{MS}	1.523g
Spectral Response Acceleration at 1-Second Period, Adjusted for Site Class, S_{M1}	1.252g
Design Spectral Acceleration at Short Period, S_{DS}	1.015g
Design Spectral Acceleration at 1-Second Period, S_{D1}	0.834g
Peak Ground Acceleration, PGA_M	0.692g

6.2. Landslides and Slope Stability

Evidence of landslides, deep-seated landslides, or slope instabilities was not observed at the time of our field evaluation. Additionally, there are no mapped landslides in the vicinity of the project site, and these geologic units are not recognized to be prone to landsliding. Given the flat-lying, massive geologic structure of the old paralic deposits in this area, the potential for landslides or slope instabilities to occur at the site is considered very low.

6.3. Liquefaction and Dynamic Settlement

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

As previously mentioned, the site is mapped in a high liquefaction potential zone (Geologic Hazard Category 31) on the City of San Diego Seismic Safety Study map (City of San Diego, 2008). Given the relatively wet, loose/soft nature of the materials beneath the site, the presence of shallow groundwater, and proximity to active faulting, the potential for liquefaction and dynamic settlement to occur is considered high.

The results of the CPTs for the upper 60 feet were used in the liquefaction analysis program CLiq v.3.3.3.4, produced by GeoLogismiki. A deaggregated modal magnitude (M_w) of 6.89 and a Maximum Considered Earthquake (MCE) geometric mean peak ground acceleration (PGA_M) of 0.692g were used in our calculations. A design groundwater elevation of +10.88 ft MLLW was considered, which

corresponds to an average depth of about 3 feet bgs. This groundwater level considers potential sea level rise impacts. The method proposed by Boulanger & Idriss (2014) was used for the liquefaction analysis. Appendix C presents the results of the liquefaction analysis.

The results of our analyses indicate that the materials between about 3 feet and 50 feet bgs are susceptible to liquefaction. Additionally, the unsaturated fill within the upper 3 feet is susceptible to dry sand dynamic settlement. The estimated post-liquefaction and dynamic settlements are estimated to be on the order of about 5 to 8½ inches. These amounts are for free field conditions when no special remedial measure is used.

Ground improvement (i.e., stone columns) will mitigate the potential for liquefaction beneath the proposed building. Deep foundations used to support net poles will be founded on liquefiable soils and need to consider downdrag loading as a result of post-liquefaction settlements. Liquefaction hazards can be mitigated by extending the deep foundations into competent, non-liquefiable layers and accounting for the anticipated downdrag loads. It should be noted that site improvements not underlain by ground improvement or supported on deep foundations extending to non-liquefiable layers will likely experience severe post-liquefaction distress. Remediation and/or repairs will likely be needed.

6.4. Lateral Spreading

When combined with sloping ground or “free face” conditions, such as at bridge approach embankments, the loss of soil shear strength and stiffness that is associated with liquefaction can result in lateral spreading displacements (a form of seismic slope instability) that can impose lateral loads upon foundations and retaining walls.

Based on review of the current conceptual grading plan (Rick Engineering, 2024), the proposed grades at the northern portion of the site are relatively level with the existing elevations of North Harbor Drive. Accordingly, it is NOVA’s opinion that the potential for lateral spreading to occur in this area is considered low. However, proposed grades indicate sloping ground conditions up to 2 percent are planned within our site (e.g., the parking lot and the property boundary between the proposed driving range and Liberator Way). These sloping ground conditions create potential for localized lateral spreading to occur. It is NOVA’s opinion that localized horizontal displacements on the order of up to about 6 feet may occur. Ground improvement (i.e., stone columns) will mitigate the potential for lateral spread beneath the proposed building.

6.5. Flooding, Tsunamis, and Seiches

The site is mapped within an area of minimal flood hazard (FEMA, 2019). The site is located within a mapped area on the State of California Tsunami Inundation Maps (CGS, 2024); therefore, damage due to tsunamis is considered to be a potential geologic hazard. Seiches are standing waves that develop in an enclosed or partially enclosed body of water such as lakes or reservoirs. Harbors or inlets can also develop seiches. Most commonly caused by strong winds and rapid atmospheric pressure changes, seiches can be initiated by seismic events and tsunamis. San Diego Bay is at risk for development of seiches. However, the project site elevation is about 14 feet higher than the bay. Therefore, NOVA considers the risk for a seiche to affect the site to be low.

6.6. Subsidence

The site is not located in an area of known subsidence associated with fluid withdrawal (groundwater or petroleum); therefore, the potential for subsidence due to the extraction of fluids is considered low.

6.7. Hydro-Consolidation

Hydro-consolidation can occur in recently deposited sediments (less than 10,000 years old) that were deposited in a semi-arid environment. Examples of such sediments are eolian sands, alluvial fan deposits, and mudflow sediments deposited during flash floods. The pore spaces between the particle grains can re-adjust when inundated by groundwater, causing the material to consolidate. The fill and marine deposits located below the groundwater table are not considered susceptible to hydro-consolidation. The very loose to loose, undocumented, mechanically placed fill above the groundwater table may be susceptible to hydro-consolidation. Hydro-consolidation can be mitigated by performing remedial grading and installing ground improvement in accordance with the recommendations of this report.

6.8. Effect on Adjacent Properties

It is NOVA's opinion that the proposed project will not affect the structural integrity of adjacent properties or existing public improvements, and street right-of-ways located adjacent to the site if the recommendations of this report are incorporated into project design.

7. CONCLUSIONS

Based on the results of NOVA's investigation, we consider the proposed construction feasible from a geotechnical standpoint provided the recommendations contained in this report are followed. Geotechnical conditions exist that should be addressed prior to construction. Geotechnical design and construction considerations include the following.

- Based on recent fault mapping, the active Spanish Bight fault is known to cross the eastern portion of the site in the area of the proposed driving range; however, based on the CPT fault evaluation performed by NOVA, there are no active or potentially active faults below the proposed building (and within 50 feet on either side of the footprint). The primary seismic hazards at the site are the potential for moderate to severe ground shaking in response to large-magnitude earthquakes generated during the lifetime of the proposed construction, liquefaction, and lateral spreading. The risk of strong ground motion is common to all construction in southern California and is typically mitigated through building design in accordance with the CBC. The liquefaction/lateral spreading hazards can be mitigated beneath the proposed building by supporting the proposed structure on ground improvement. The liquefaction hazard can be mitigated by supporting the proposed net poles on deep foundations that extend into competent, non-liquefiable layers and account for liquefaction-related downdrag loads. The lateral spreading hazard can be mitigated by installing ground improvement in localized areas of sloping ground conditions.

- The site is underlain by fill, marine bay deposits, and old paralic deposits. The fill, marine bay deposits, and old paralic deposits within the top approximately 50 feet of the site are considered to be (i) compressible under the proposed building and new fill loads and (ii) susceptible to liquefaction. Therefore, soils within the upper 50 feet are unsuitable for support of structural or fill loads. The deeper old paralic deposits are suitable for support of structural or fill loads. The proposed building can be supported on shallow spread footings and/or a mat foundation bearing on ground improvement elements (i.e., stone columns). The proposed net poles can be supported on driven piles. Recommendations for ground improvement and driven piles are provided in this report.

- The tested on-site near-surface soils have a very low expansion potential and therefore are considered suitable for reuse as compacted fill or wall backfill. However, the interbedded clays within the marine deposits and old paralic deposits (i.e., cuttings from the proposed deep foundation predrilling, if utilized) are anticipated to be expansive and unsuitable for reuse as compacted fill or wall backfill in their current state. However, spoils generated from the deep foundation predrilling are anticipated to consist of a blend of onsite soils. It should be noted that the blended spoils are expected to meet the expansion index criteria of 50 or less.

- In general, excavations at the site should be achievable using standard heavy earthmoving equipment in good-working order with experienced operators; however, during the field investigation NOVA encountered CPT refusal on remnant underground obstructions assumed to be left in place from previous site use. These obstructions (and others not encountered during

our investigation) may be encountered during ground improvement operations and pile installation, requiring removal and/or specialized drilling equipment.

- Groundwater was encountered in the borings between 10 and 11 feet bgs corresponding to elevations of about +2½ to +4½ feet MLLW. The groundwater table is expected to be below a depth that will influence the general grading operations; however, it will be encountered during pile and ground improvement installation. Fluctuations in the groundwater level should be anticipated during and following periods of heavy rainfall. Furthermore, due to the proximity of the site to the San Diego Bay, tidal influences will also cause fluctuations of the groundwater level, with fluctuations higher for locations closer to the bay. Note the materials within about 1 to 2 feet above the static groundwater table typically have elevated moisture contents due to capillary rise. Sea level rise during the life of the project should be taken into consideration during design. An average design groundwater level of +10.88 feet MLLW has been established for design. This groundwater level considers potential sea level rise impacts.
- This site is not suitable for stormwater infiltration due to the thickness of fill across the site and presence of shallow groundwater. This site should be considered to have a “No Infiltration” condition.

8. RECOMMENDATIONS

The remainder of this report presents recommendations regarding earthwork construction as well as preliminary geotechnical recommendations for the design of the proposed improvements. These recommendations are based on empirical and analytical methods typical of the standard-of-practice in southern California. If these recommendations appear not to address a specific feature of the project, please contact NOVA for additions or revisions to the recommendations. The recommendations presented herein may need to be updated once final plans are developed.

8.1. Earthwork

Grading and earthwork should be conducted in accordance with the CBC and the recommendations of this report. The following recommendations are provided regarding specific aspects of the proposed earthwork construction. These recommendations should be considered subject to revision based on field conditions observed by a NOVA field representative during grading.

8.1.1 Site Preparation

Site preparation should begin with the removal of existing improvements, vegetation, and debris. Subsurface improvements that are to be abandoned should be removed, and the resulting excavations should be backfilled and compacted in accordance with the recommendations of this report. Pipeline abandonment can consist of capping or rerouting at the project perimeter and removal within the project perimeter. If appropriate, abandoned pipelines can be filled with grout or slurry as recommended by and observed by the geotechnical consultant.

8.1.2 Remedial Grading – Building Pad

Beneath the proposed building pad, the existing fill within the upper 2 feet of finished pad grade should be excavated and recompacted to provide a uniform thickness of compacted fill beneath interior slabs. Horizontally, excavations should extend at least 5 feet outside planned perimeter foundations or up to existing improvements or the limits of grading, whichever is less. NOVA should observe the conditions exposed in the bottom of excavations to evaluate whether additional excavation is recommended. The resulting excavation should be filled to finished pad grade with compacted fill having an expansion index (EI) of 50 or less.

8.1.3 Remedial Grading – Pedestrian Hardscape

Beneath proposed pedestrian hardscape areas, the existing fill within the upper 2 feet of planned subgrade elevation should be excavated to a depth of at least 2 feet below existing grade or planned subgrade elevation, whichever is deeper. Horizontally, excavations should extend at least 2 feet outside hardscape or up to existing improvements or the limits of grading, whichever is less. NOVA should observe the conditions exposed in the bottom of excavations to evaluate whether additional excavation is recommended. The excavation should be filled with compacted fill having an EI of 50 or less.

8.1.4 Remedial Grading – Vehicular Pavements

Beneath proposed vehicular pavement areas, the existing soils should be excavated to a depth of at least 1 foot below existing grade or planned subgrade elevation, whichever is deeper. Horizontally, excavations should extend at least 2 feet outside the planned pavement or up to existing improvements or the limits of grading, whichever is less. NOVA should observe the conditions exposed in the bottom of excavations to evaluate whether additional excavation is recommended. The excavation should be filled with material suitable for use as compacted fill.

8.1.5 Remedial Grading – Site Walls and Retaining Walls

Beneath proposed site walls and retaining walls not connected to buildings, the existing soils should be excavated to a depth of at least 2 feet below bottom of footing. Horizontally, the excavations should extend at least 2 feet outside the planned wall footing, or up to existing improvements or the limits of grading, whichever is less. NOVA should observe the conditions exposed at the bottom of excavations to evaluate whether additional excavation is recommended. Any required fill should have an EI of 50 or less.

8.1.6 Ground Improvement

Various ground improvement methods are available to mitigate liquefaction and the resulting settlements to acceptable levels, including stone columns. To reduce the potential for seismic settlement beneath the proposed building and settlement sensitive improvements, ground improvement extending from the bottom of footing/mat foundation elevation is recommended. The ground improvement should extend through the liquefiable soils to an elevation of about -36 feet MLLW. A shallower depth of ground improvement may be feasible if the estimated post-liquefaction and dynamic settlements are tolerable by the proposed structures. Horizontally, the ground improvement should extend to at least 5 feet outside the perimeter of the building and settlement sensitive improvements or up to existing improvements or limits of grading, whichever is less. Depending on the extent of ground improvement, the building design may need to incorporate a structural slab designed to span between the foundations without relying on support from the underlying soil. A contractor specializing in the design and installation of ground improvement should be contacted regarding specific recommendations for this type of construction, including the need to use a structural slab. The effectiveness of installed ground improvement can be evaluated using cone penetrometer testing, or other similar methods, and should be monitored and adjusted by the contractor to protect existing improvements. NOVA recommends that verification testing is performed after an adequate amount of time has elapsed following ground improvement installation.

8.1.7 Expansive Soil

The on-site near surface soils tested had EIs of 0 and 6, classified as very low expansion potential. To reduce the potential for expansive heave, the top 2 feet of material beneath building footings, concrete slabs-on-grade, pedestrian hardscape, and site and retaining wall footings should have an EI of 50 or less. Horizontally, the soils having an EI of 50 or less should extend at least 5 feet outside the planned perimeter building foundations, at least 2 feet outside hardscape and site/retaining wall footings, or up to existing improvements, whichever is less.

The on-site sands and cohesionless silts are anticipated to meet the EI criterion. The on-site cohesive silts and clays, however, are not expected to meet the EI criterion in their current condition. If predrilling methods are utilized to install the recommended driven piles, the spoils generated from the predrilling are anticipated to consist of a blend of onsite soils. The blended spoils are expected to generally meet the EI criterion of 50 or less.

8.1.8 Compacted Fill

Excavated soils free of organic matter, construction debris, rocks greater than 6 inches, and expansive soil as described above should generally be suitable for reuse as compacted fill. Areas to receive fill should be scarified to a depth of 6 to 8 inches, moisture conditioned to near optimum moisture content, and compacted to at least 90% relative compaction. Fill and backfill should be placed in 6- to 8-inch-thick loose lifts, moisture conditioned to near optimum moisture content, and compacted to at least 90% relative compaction. The top 12 inches of subgrade beneath pavements should be compacted to at least 95% relative compaction. The maximum density and optimum moisture content for the evaluation of relative compaction should be determined in accordance with ASTM D1557.

8.1.9 Imported Soil

Imported soil should consist of predominately granular soil, free of organic matter and rocks greater than 6 inches. Imported soil should be observed and, if appropriate, tested by NOVA prior to transport to the site to evaluate suitability for the intended use.

8.1.10 Subgrade Stabilization

Wet, unstable excavation bottoms will likely be encountered due to shallow groundwater at the site. The bottom of excavations should be firm and unyielding prior to placing compacted fill or constructing structures or improvements. If the base of excavations is saturated and yielding, it can be stabilized by placing between 1 and 2 feet of ¾-inch crushed rock on the excavation bottom. If rock is used to stabilize yielding excavation bottoms, we recommend placing the Tensar® InterAx™ NX650 reinforcing geogrid within the crushed rock (at least 6 inches of rock beneath the geogrid). The thickness of rock needed to stabilize the excavation bottom may be determined in the field by trial and error. Our experience suggests that 2 feet of crushed rock and reinforcing geogrid should generally be sufficient to stabilize most yielding conditions.

8.1.11 Excavation Characteristics

In general, excavations at the site should be achievable using standard heavy earthmoving equipment in good-working order with experienced operators; however, during the field investigation NOVA encountered CPT refusal on remnant underground obstructions assumed to be left in place from previous site use. These obstructions (and others not encountered during our investigation) may be encountered during ground improvement operations and pile installation, requiring removal and/or specialized drilling equipment. Gravel, cobbles, and potentially boulders should be anticipated that will require extra effort to screen prior to reuse as compacted fill or export from the site.

8.1.12 Oversized Material

Excavations may generate oversized material. Oversized material is defined as rocks or cemented clasts greater than 6 inches in largest dimension. Oversized material should be broken down to no greater than 6 inches in largest dimension for use in fill, used as landscape material, or disposed of off-site.

8.1.13 Temporary Excavations

Temporary excavations 3 feet deep or less can be made vertically. Deeper temporary excavations in fill and marine deposits should be laid back no steeper than 1:1 (horizontal:vertical) (h:v). It should be noted that temporary excavations made in poorly graded, cohesionless sands, may not be stable at an inclination steeper than 1½ :1 (h:v). The faces of temporary slopes should be inspected daily by the contractor's Competent Person before personnel are allowed to enter the excavation. Any zones of potential instability, sloughing, or raveling should be brought to the attention of the engineer and corrective action implemented before personnel begin working in the excavation. Excavated soils should not be stockpiled behind temporary excavations within a distance equal to the depth of the excavation. NOVA should be notified if other surcharge loads are anticipated so that lateral load criteria can be developed for the specific situation. If temporary slopes are to be maintained during the rainy season, berms are recommended along the tops of slopes to prevent runoff water from entering the excavation and eroding the slope faces.

Slopes steeper than those described above will require shoring. Additionally, temporary excavations that extend below a plane inclined at 1½:1 (h:v) downward from the outside bottom edge of existing structures or improvements will require shoring. Soldier piles and lagging, internally braced shoring, or trench boxes could be used. If trench boxes are used, the soil immediately adjacent to the trench box is not directly supported. Ground surface deformations immediately adjacent to the pit or trench could be greater where trench boxes are used compared to other methods of shoring.

8.1.14 Temporary Shoring

For design of cantilevered shoring with level backfill, an active earth pressure equal to a fluid weighing 43 pcf can be used. An additional 30 pcf should be added for 2:1 (h:v) sloping ground. These pressures do not include hydrostatic pressure based on the assumption that dewatering will be used as needed behind shoring. The surcharge loads on shoring from traffic and construction equipment working adjacent to the excavation can be modeled by assuming an additional 2 feet of soil behind the shoring. For design of soldier piles, an allowable passive pressure of 250 pounds per square foot (psf) per foot of embedment can be used above the groundwater table; and an allowable passive pressure of 120 psf per foot of embedment can be used below the groundwater table, up to a maximum of 2,500 psf. The passive resistance can be assumed to act over a width of two times the pile diameter. Continuous lagging will be required throughout. The soldier piles should be designed for the full anticipated lateral pressure; however, the pressure on the lagging will be less due to arching in the soils. For design of lagging, the earth pressure can be limited to a maximum of 400 psf.

It is the responsibility of the contractor to provide an excavation that is safe, with deflections appropriate to the site setting. Design of temporary shoring should be performed by a qualified shoring engineer. The shoring engineer should be solely responsible for the design, utilizing the indications of subsurface conditions provided in this report.

8.1.15 Groundwater Seepage

Groundwater seepage may occur locally in excavations. Additionally, if excavations extend to within about 2 to 3 feet of the groundwater table, wet, unstable subgrade conditions may be encountered. If dewatering is necessary, the dewatering method should be evaluated and implemented by an experienced dewatering subcontractor.

8.1.16 Slopes

Permanent slopes should be constructed no steeper than 2:1 (h:v). Faces of fill slopes should be compacted either by rolling with a sheepsfoot roller or other suitable equipment, or by overfilling and cutting back to design grade. Fills should be benched into sloping ground inclined steeper than 5:1 (h:v). In NOVA's opinion, slopes constructed no steeper than 2:1 (h:v) will possess an adequate factor of safety. An engineering geologist should observe cut slopes during grading to ascertain that no unforeseen adverse geologic conditions are encountered that require revised recommendations. Slopes are susceptible to surficial slope failure and erosion. Water should not be allowed to flow over the top of slope. Additionally, slopes should be planted with vegetation that will reduce the potential for erosion.

8.1.17 Surface Drainage

Final surface grades around structures should be designed to collect and direct surface water away from structures, including retaining walls, and toward appropriate drainage facilities. The ground around the structure should be graded so that surface water flows rapidly away from the structure without ponding. In general, we recommend that the ground adjacent to the structure slope away at a gradient of at least 2%. Densely vegetated areas where runoff can be impaired should have a minimum gradient of at least 5% within the first 5 feet from the structure. Roof gutters with downspouts that discharge directly into a closed drainage system are recommended on structures. Drainage patterns established at the time of fine grading should be maintained throughout the life of the proposed structures. Site irrigation should be limited to the minimum necessary to sustain landscape growth. Should excessive irrigation, impaired drainage, or unusually high rainfall occur, saturated zones of perched groundwater can develop.

8.1.18 Grading Plan Review

NOVA should review the grading plans and earthwork specifications to ascertain whether the intent of the recommendations contained in this report have been implemented and that no revised recommendations are needed due to changes in the development scheme.

8.2. Foundations

The foundation recommendations provided herein are considered generally consistent with methods typically used in southern California. Other alternatives may be available. NOVA's recommendations are only minimum criteria based on geotechnical factors and should not be considered a structural design, or to preclude more restrictive criteria of governing agencies or by the structural engineer. The design of the foundation system should be performed by the project structural engineer, incorporating the geotechnical parameters described herein and the requirements of applicable building codes.

As previously mentioned, the proposed building can be supported on spread footings and/or mat foundations with bottom levels bearing on ground improvement elements (e.g., stone columns). Site walls and retaining walls not connected to buildings can be supported on shallow spread footings bearing on compacted fill. Net poles can be supported on driven precast, prestressed concrete piles.

8.2.1 Spread Footings

Footings should extend at least 24 inches below lowest adjacent finished grade. A minimum width of 18 inches is recommended for continuous building footings and 24 inches for isolated building footings or site wall footings. An allowable bearing capacity of 4,000 psf can be used for spread footings supported on ground improvement elements designed and installed by a specialty contractor as recommended herein. An allowable bearing capacity of 2,500 psf can be used for spread footings supported on compacted fill. An allowable bearing capacity of 1,500 psf should be used below groundwater level. The allowable bearing capacity can be increased by 500 psf for each additional foot of depth below the minimum and 250 psf for each additional foot of width beyond the minimum up to maximums of 7,500 psf for footings bearing on ground improvement elements above groundwater, 5,000 psf for footings bearing on compacted fill above groundwater level, or 2,500 psf below groundwater level. The bearing value can be increased by ⅓ when considering the total of all loads, including wind or seismic forces. Footings located adjacent to or within slopes should be extended to a depth such that a minimum horizontal distance of 10 feet exists between the lower outside footing edge and the face of the slope. As previously mentioned, a structural slab designed to span between the foundations without relying on support from the underlying soil may be needed depending on the extent of ground improvement.

8.2.2 Mat Foundations

An allowable bearing capacity of 4,000 psf can be used for mat foundations supported on ground improvement elements. Mat foundations typically experience some deflection due to loads placed on the mat and the reaction of the soils underlying the mat. A design modulus of subgrade reaction, K, of 300 pounds per cubic inch (pci) can be used for the subgrade soils in evaluating such deflections. This value is based on an area of 1 square foot and should be adjusted for larger mats. Adjusted values of the modulus of subgrade reaction, K_v, can be obtained from the following equation for square mats of various widths:

$$K_V = K\left[\frac{\mathrm{B}+1}{2\mathrm{B}}\right]^2 (pci)$$

Where B is the width of the mat in feet.

Adjusted values of the modulus of subgrade reaction, K,' can be obtained from the following equation for rectangular mats:

$$K' = \frac{K_v\left(1 + 0.5\left(\frac{B}{L}\right)\right)}{1.5}\ (pci)$$

Where B is the width and L is the length of the mat in feet.

8.2.3 Lateral Resistance for Shallow Structural Elements

Lateral loads will be resisted by friction between the bottoms of footings and/or mats and passive pressure on the faces of footings, mats, and other structural elements below grade. An allowable coefficient of friction of 0.30 can be used. An allowable passive pressure of 300 psf per foot of depth below the ground surface can be used for level ground conditions where the ground is horizontal for a distance of at least 10 feet or three times the height generating the passive pressure. Half of these values should be used for passive earth pressure below groundwater. The passive pressure can be increased by ⅓ when considering the total of all loads, including wind or seismic forces. The upper 1 foot of soil should not be relied on for passive support unless the ground is covered with pavements or slabs.

8.2.4 Driven Piles

The proposed net poles can be supported on driven precast, prestressed concrete piles. Based on the proposed finished grades provided in the conceptual grading plan (Rick Engineering, 2024), top of pile elevations are assumed to vary between +14 and +15½ feet MLLW. The top of pile elevation was assumed to be +15½ feet MLLW for our pile analyses. The subsequent sections describe NOVA's methodology for axial and lateral analyses and include recommended pile capacities.

Axial Pile Analysis

The net allowable axial downward and uplift capacities of 18-inch octagonal precast concrete piles were estimated using the computer program ALLPILE. We assumed that downward support would be obtained from sidewall friction and end bearing in the old paralic deposits. Driven concrete piles may be predrilled in the upper 50 feet through the liquefiable deposits as axial capacity in the zone was ignored in computations. As previously mentioned, the top of pile was assumed to be at an elevation of +15½ feet MLLW, and groundwater was assumed to be at an elevation of +10.88 (~ +10½) feet MLLW. This groundwater elevation considers potential sea level rise impacts. Table 8-1 presents the estimated soil properties used in our axial pile analyses.

Table 8-1. Estimated Soil Properties for Axial Analyses

Layer	Soil Type	Depth Interval (feet)	Elevation (feet, MLLW)	Average N_{60}	Effective Unit Weight (pcf)	Friction Angle (ϕ, degrees)	Cohesion (psf)
1	Fill	0 to 4½	+15½ to +11	11	116.0	33	--
2	Fill	4½ to 11½	+11 to +4	11	53.6	33	--
3	Qmo	11½ to 19	+4 to -3½	2	45.6	26	150
4	Qmo	19 to 42½	-3½ to -27	16	69.6	32	1000
5	Qop_1	42½ to 56½	-27 to -41	11	67.6	--	1400
6	Qop_2/Qop_3	56½ to Termination	-41 to Termination	33	74.6	36	2000

Due to the liquefaction potential, the top 50 feet of frictional resistance was neglected. Additionally, a downdrag load of 55 kips should be added to the dead and live loads on the piles during earthquake loading conditions.

A factor of safety of 2.0 was applied to the ultimate side and tip resistances to obtain the allowable compressive (downward) capacities. Uplift resistance will be obtained by sidewall friction and weight of the pile using factors of safety of 3.0 and 1.1, respectively, for sidewall friction and the weight of the pile. The pile capacities are based on the strength of the soils; the strength of the pile section itself should be checked to verify the structural capacity of the pile. Piles in a single row should be spaced at least two pile diameters, center to center. Piles in multiple rows should be spaced at least two and a half pile diameters center to center. Additionally, piles should be embedded at least five pile diameters into competent old paralic deposits. Appendix F presents the recommended axial downward and uplift capacities of 18-inch, octagonal precast concrete piles.

Note that group effects were not considered in the capacities presented in Appendix F. Axial group effects may be estimated using the reduction factors summarized in Table 8-2. It should be noted that the group reduction factors provided below are guideline recommendations. The actual capacity of pile groups should be checked once final configurations are determined by the structural engineer.

Table 8-2. Recommended Pile Group Reduction Factors for Axial Capacities

	Pile Center-to-Center Spacing	Reduction Factor for Group Effects
Single Row of Piles	2D	0.90
	2.5D	0.95
	3D or more	1.00
Multiple Rows of Piles	2.5D	0.67
	3D	0.80
	4D or more	1.00

Notes: 1. D is the pile diameter.
2. Reference AASHTO LRFD Bridge Design Specifications, 8th Edition, with California Amendments for pile spacings in the direction of loading (2019).

Lateral Pile Analysis

Lateral capacities of 18-inch, octagonal precast concrete piles were estimated using the computer program LPile v2019.11.09. As previously mentioned, the top of pile was assumed to be at an elevation of +15½ feet MLLW. However, the lowest groundwater elevation encountered during our field investigation, +2½ MLLW, was used for our lateral analyses. During earthquake loading, the non-liquefiable 'crust' imposes a triangular distributed load at the top of the pile. Using the lowest groundwater elevation encountered during drilling maximizes the thickness of the non-liquefiable 'crust' and the resulting distributed loading at the top of the pile. Table 8-3 presents the estimated soil properties used in our lateral pile analyses.

Table 8-3. Estimated Soil Properties for Lateral Analyses

Layer	Soil Type	Depth Interval (feet)	Elevation (feet, MLLW)	Average N_{60}	Effective Unit Weight (pcf)	Friction Angle (ϕ, degrees)	Cohesion (psf)
1	Fill	0 to 11½	+15½ to +4	11	116.0	33	--
2	Qmo	11½ to 12½	+4 to +3	2	108.0	26	150
3	Qmo	12½ to 19	+3 to -3½	2	45.6	See Note 1	--
4	Qmo	19 to 42½	-3½ to -27	16	69.6	See Note 1	--
5	Qop_1	42½ to 56½	-27 to -41	11	67.6	--	1400
6	Qop_2/Qop_3	56½ to Termination	-41 to Termination	33	74.6	36	2000

1. Liquefied sand hybrid p-y curve used. Residual shear strength calculated by LPILE based on N_{60}.

'Free head' (i.e., the top of the pile is allowed to translate and rotate) conditions were considered in the lateral pile analysis. The "*p-y* method" was used to analyze the soil structure interaction of a pile under lateral loading. The *p-y* method captures the nonlinear lateral load-transfer (*p-y*) experienced by deep foundations during combined axial and lateral loading.

An axial load of 10 kips was assumed for p-delta effects. Pile head loading was not available to NOVA at the time of this report. Once pile loading becomes available, NOVA can update the lateral pile analyses, if needed. Appendix G presents the charts of lateral deflection, bending moment and shear force vs. pile length for various load cases.

The passive pressure recommendations for shallow foundations may be used for the lateral resistance of pile caps. Note that the lateral deflections, bending moments and shear forces presented in Appendix G are for single driven piles. Lateral group effects may be estimated using the group reduction factors provided in Table 8-4.

Table 8-4. Recommended Pile Group Reduction Factors for Lateral Capacities (P-Multipliers)

	Pile Center-to-Center Spacing	Reduction Factor for Group Effects		
Single Row of Piles	2.5D	0.80		
	3D	0.90		
	4D or more	1.00		
Multiple Rows of Piles		Row 1	Row 2	Row 3
	2D	0.60	0.35	0.25
	3D	0.75	0.55	0.40
	5D	1.00	0.85	0.70
	7D	1.00	1.00	0.90
	8D	1.00	1.00	1.00

Notes: 1. D is the pile diameter.
2. Reference AASHTO LRFD Bridge Design Specifications, 8th Edition, with California Amendments for pile spacings in the direction of loading (2019).

Pile Installation

While the clays should be fairly easily penetrated, layers of dense sand are present above the anticipated tip elevations. Piles may be predrilled in the upper 50 feet to reduce the potential for hard driving conditions in these layers. We recommend that wave equation analyses be performed on the selected hammer pile cushion combination to develop specified blow count criteria. We recommend that an indicator pile program be performed with Pile Driving Analyzer (PDA) measurements. The benefits of the PDA measurements include:

- monitor hammer efficiency by measuring the energy delivered to the pile.
- monitor compressive stresses at the end of pile driving to determine refusal blow count and compressive stress damage.
- monitor tensile stresses during soft driving and to assess the potential for tensile stress damage.

- confirm the ultimate dynamic friction and end bearing capacity.
- determine setup so that long term frictional uplift and downdrag capacity can be verified.
- optimize the blow count criteria.
- optimize the production pile lengths.

The indicator program should consist of driving a minimum of three test piles. A minimum set-up period of two days is recommended. Final pile driving criteria and production pile lengths should be defined after the results of the indicator pile program are available.

8.2.5 Settlement Characteristics

Static settlement is estimated to be about 1 inch total and ½ inch differential over a distance of 40 feet and should be completed shortly after structural loads are applied. Post-liquefaction dynamic settlement will depend on the level of ground improvement performed at the site. The project structural engineer should coordinate with the specialty contractor regarding the amount of tolerable settlement for the selected foundation system (i.e., shallow foundations or mat foundations). If ground improvement is not performed, post-liquefaction dynamic settlement is estimated to be on the order of about 5 to 8½ inches total and 2½ to 4¼ inches differential.

8.2.6 Foundation Plan Review

NOVA should review the foundation plans to ascertain that the intent of the recommendations in this report has been implemented and that revised recommendations are not necessary as a result of changes after this report was completed.

8.2.7 Foundation Excavation Observations

A representative from NOVA should observe the foundation excavations prior to forming or placing reinforcing steel.

8.3. Interior Slabs-On-Grade

Interior concrete slabs-on-grade should be underlain by at least 2 feet of material with an EI of 50 or less. We recommend that conventional concrete slab-on-grade floors be at least 5 inches thick and reinforced with at least No. 4 bars at 18 inches on center each way. To reduce the potential for excessive cracking, slabs should be provided with construction or ‘weakened plane’ joints at frequent intervals. The project structural engineer should design on-grade building slabs, reinforcement, and joint spacing.

Moisture protection should be installed beneath slabs where moisture-sensitive floor coverings will be used. The project architect should review the tolerable moisture transmission rate of the proposed floor covering and specify an appropriate moisture protection system. Typically, a plastic vapor barrier is used. Minimum 15-mil plastic is recommended. The plastic should comply with ASTM E1745. The vapor barrier installation should comply with ASTM E1643 and the manufacturer’s recommendations.

The slab can be placed directly on the vapor barrier. If desired, granular material can be placed beneath the plastic to provide a level surface.

8.4. Hardscape

Pedestrian hardscape should be underlain by at least 2 feet of material with an EI of 50 or less. Exterior concrete slabs should be at least 4 inches thick and reinforced with at least No. 3 bars at 18 inches on center each way. Slabs should be provided with weakened plane joints. Joints should be placed in accordance with the American Concrete Institute (ACI) guidelines. The project architect should select the final joint patterns. A 1-inch maximum size aggregate mix is recommended for concrete for exterior slabs. The corrosion potential of on-site soils with respect to reinforced concrete will need to be taken into account in concrete mix design. Coarse and fine aggregate in concrete should conform to the "Greenbook" Standard Specifications for Public Works Construction.

8.5. Conventional Retaining Walls

Conventional retaining walls can be supported on spread footings. The recommendations for spread footings provided in the foundation section of this report are also applicable to conventional retaining walls.

The active earth pressure for the design of unrestrained retaining walls with level backfill can be taken as equivalent to the pressure of a fluid weighing 35 pcf. The at-rest earth pressure for the design of restrained retaining wall with level backfill can be taken as equivalent to the pressure of a fluid weighing 55 pcf. These values assume a granular and drained backfill condition. Higher lateral earth pressures would apply if walls retain clay soils. An additional 20 pcf should be added to these values for walls with 2:1 (h:v) sloping backfill. An increase in earth pressure equivalent to an additional 2 feet of retained soil can be used to account for surcharge loads from light traffic. The above values do not include a factor of safety. Appropriate factors of safety should be incorporated into the design. If any other surcharge loads are anticipated, NOVA should be contacted for the necessary increase in soil pressure.

The seismic earth pressure can be taken as equivalent to the pressure of a fluid pressure weighing 16 pcf. This value is for level backfill and does not include a factor of safety. Appropriate factors of safety should be incorporated into the design. This pressure is in addition to the un-factored, active earth pressure. The total equivalent fluid pressure can be modeled as a triangular pressure distribution with the resultant acting at a height of H/3 up from the base of the wall, where H is the retained height of the wall. The passive pressure and bearing capacity can be increased by ⅓ in determining the seismic stability of the wall.

Retaining walls should be provided with a backdrain to reduce the accumulation of hydrostatic pressures or be designed to resist hydrostatic pressures. Backdrains can consist of a 2-foot-wide zone of ¾-inch crushed rock. The crushed rock should be separated from the adjacent soils using a non-woven filter fabric, such as Mirafi 140N or equivalent. A perforated pipe should be installed at the base of the backdrain and sloped to discharge to a suitable storm drain facility, or weep holes should be provided. As an alternative, a geocomposite drainage system such as Miradrain 6000 or equivalent

placed behind the wall and connected to a suitable storm drain facility can be used. The project architect should provide dampproofing/waterproofing specifications and details. Figure 8-1 presents typical conventional retaining wall backdrain details. Note that the guidance provided in Figure 8-1 is conceptual. A variety of options are available to drain retaining walls.

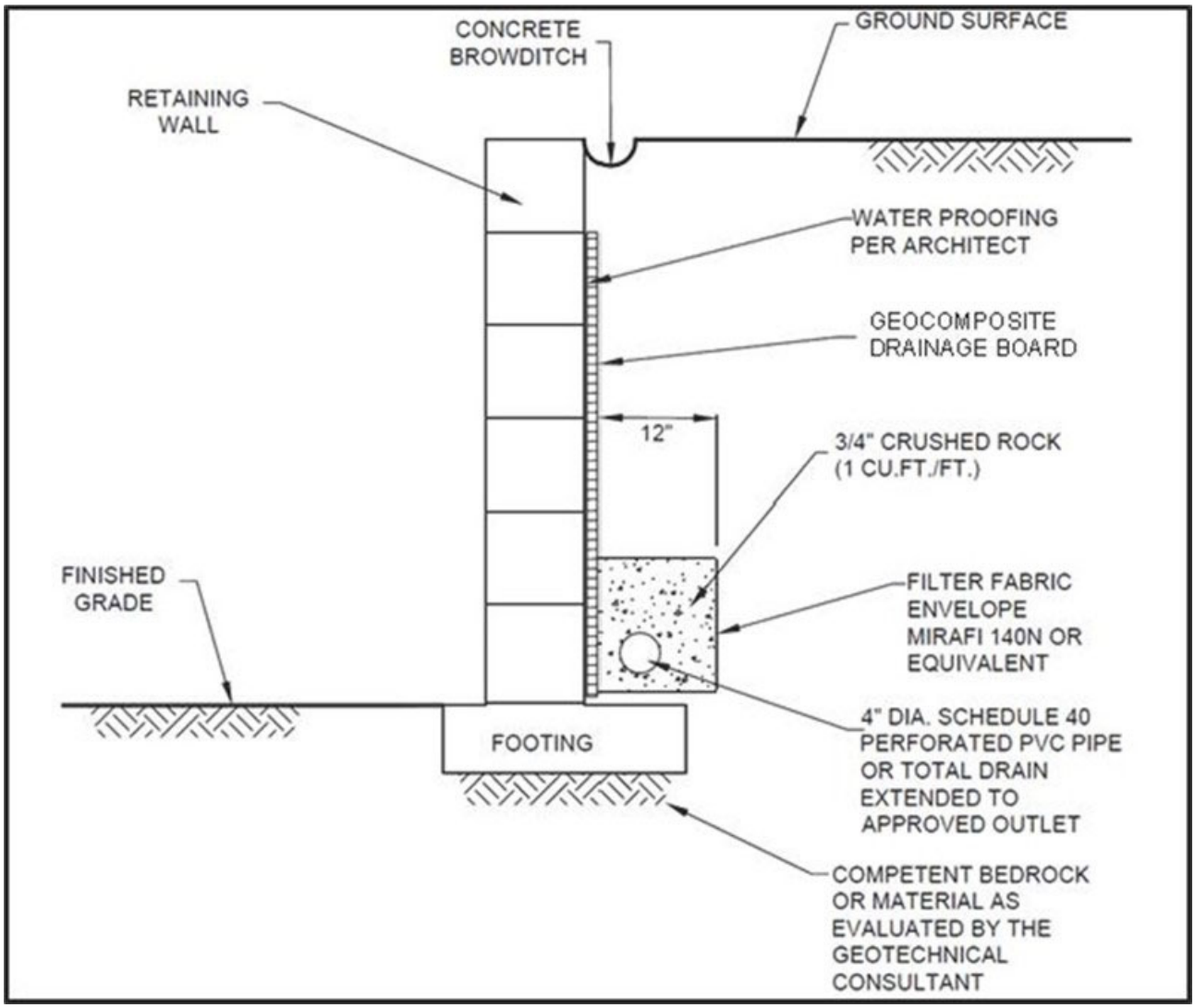

Figure 8-1. Typical Conventional Retaining Wall Backdrain Detail

Wall backfill should consist of granular, free-draining material having an EI of 20 or less. The backfill zone is defined by a 1:1 plane projected upward from the heel of the wall. Expansive or clayey soil should not be used. Additionally, backfill within 3 feet from the back of the wall should not contain rocks greater than 3 inches in dimension. Backfill should be compacted to at least 90% relative compaction. Backfill should not be placed until walls have achieved adequate structural strength. Compaction of wall backfill will be necessary to minimize settlement of the backfill and overlying settlement sensitive improvements. However, some settlement should still be anticipated. Provisions

should be made for some settlement of concrete slabs and pavements supported on backfill. Additionally, any utilities supported on backfill should be designed to tolerate differential settlement.

8.6. Pavement Section Recommendations

Based on classifications of the near-surface soils, an R-value of 20 was assumed for design of preliminary pavement sections. The actual R-value of the subgrade soils should be determined after grading, and the final pavement sections should be provided. Based on an R-value of 20, the following preliminary pavement structural sections are provided for the assumed Traffic Indexes on Table 8-5.

Table 8-5. AC and PCC Pavement Sections

Traffic Type	Traffic Index	Asphalt Concrete (inches)	Portland Cement Concrete (inches)
Parking Stalls	4.5	3 AC / 6 AB	7 PCC / 4 AB
Driveways	6.0	4 AC / 9 AB	7 PCC / 4 AB
Fire Lanes	7.5	5 AC / 12 AB	7½ PCC / 4 AB

AC: Asphalt Concrete
AB: Aggregate Base
PCC: Portland Cement Concrete

Subgrade preparation should be performed immediately prior to placement of the pavement section. The upper 12 inches of subgrade should be scarified, moisture conditioned to near optimum moisture content, and compacted to at least 95% relative compaction. All soft or yielding areas should be stabilized or removed and replaced with compacted fill or aggregate base. Aggregate base and asphalt concrete should conform to the Caltrans Standard Specifications or the “Greenbook” Standard Specifications for Public Works Construction and should be compacted to at least 95% relative compaction. Aggregate base should have an R-value of not less than 78. All materials and methods of construction should conform to good engineering practices and the minimum local standards.

8.7. Pipelines

For level ground conditions, a passive earth pressure of 300 psf per foot of depth below the lowest adjacent final grade can be used to compute allowable thrust block resistance. A value of 150 psf per foot should be used below groundwater level, if encountered.

A modulus of soil reaction (E’) of 1,500 psi can be used to evaluate the deflection of buried flexible pipelines. This value assumes that granular bedding material is placed adjacent to the pipe and is compacted to at least 90% relative compaction.

Pipe bedding as specified in the “Greenbook” Standard Specifications for Public Works Construction can be used. Bedding material should consist of clean sand having a sand equivalent not less than 20 and should extend to at least 12 inches above the top of pipe. Alternative materials meeting the intent of the bedding specifications are also acceptable. Samples of materials proposed for use as bedding should be provided to the engineer for inspection and testing before the material is imported

for use on the project. The on-site materials are not expected to meet “Greenbook” bedding specifications. The pipe bedding material should be placed over the full width of the trench. After placement of the pipe, the bedding should be brought up uniformly on both sides of the pipe to reduce the potential for unbalanced loads. No voids or uncompacted areas should be left beneath the pipe haunches. Ponding or jetting the pipe bedding should not be allowed.

Where pipeline inclinations exceed 15%, cutoff walls are recommended in trench excavations. Additionally, we do not recommend that open graded rock be used for pipe bedding or backfill because of the potential for piping erosion. The recommended bedding is clean sand having a sand equivalent not less than 20 or 2-sack sand/cement slurry. If sand/cement slurry is used for pipe bedding to at least 1 foot over the top of the pipe, cutoff walls are not considered necessary. The need for cutoff walls should be further evaluated by the project civil engineer designing the pipeline.

8.8. Working Platforms

Construction may utilize equipment (cranes, concrete pumps, concrete trucks, etc.) that impose high ground bearing pressures. The contractor is solely responsible for design, construction, and maintenance of working platforms that safely support this equipment (see OSHA Construction Standard Subpart R, CFR 1926.752). As necessary, working platforms and/or paths of heavy equipment travel should be designed in conformance with appropriate guidance (see, for example, Guide to Working Platforms, 1st Edition, January 2020, by the Deep Foundations Institute).

8.9. Corrosivity

Representative samples of the on-site soils were tested to evaluate corrosion potential. The test results are presented in Appendix D. The project design engineer can use the sulfate results in conjunction with ACI 318 to specify the water/cement ratio, compressive strength, and cementitious material types for concrete exposed to soil. It should be noted that severely elevated levels of chlorides were detected in the samples tested in Borings B-5 and B-8. A corrosion engineer should be contacted to provide specific corrosion control recommendations.

9. STORMWATER INFILTRATION FEASIBILITY CONDITION

9.1. Overview

This assessment provides an analysis of the infiltration feasibility in accordance with the criteria detailed in Section C.1: Simple Feasibility Criteria and Section C.1.1: Infiltration Feasibility Condition Letter of the referenced City of San Diego BMP Design Manual (City of San Diego, 2021). Based on these criteria, it is NOVA's opinion that this site should be considered to have a 'No-Infiltration' condition. The intent of this section of the report is to serve as the Infiltration Feasibility Condition Letter.

9.2. Infiltration Feasibility Criteria

The discussion points from the BMP Manual (City of San Diego, 2021) are reproduced below in italics followed by NOVA's response.

- *The phase of the project in which the geotechnical engineer first analyzed the site for infiltration feasibility.*

  The proposed project was first analyzed during the planning phase.

- *Results of previous geotechnical analyses conducted in the project area, if any.*

  NOVA is not aware of geotechnical analyses conducted for this site prior to this investigation.

- *The development status of the site prior to the project application (i.e., new development with raw ungraded land, or redevelopment with existing graded conditions).*

  The site is located on a historical landform near Point Loma previously known as the Dutch Flat, which was a tidal flat. Approximately 10 feet of hydraulic fill composed of material dredged from the San Diego Harbor was placed between 1928 and 1935 (Kleinfelder, 2013).

  The site parcels were developed by General Dynamics and their predecessors between the early 1940's and about 1995. The property was known as the Harbor Drive Test Facility (HDTF) and used for a wide variety of purposes including aircraft research, testing and development, aircraft storage, fuel testing, jet engine testing, propulsion research, rocket testing, and avionics testing. The rental car companies began operations at the site following the termination of General Dynamic's lease and the demolition of the HDTF buildings in approximately 1995/1996 (Kleinfelder, 2024).

  The project proposes the redevelopment of approximately 8.5 acres of Port of San Diego property that is currently being used by Hertz and Avis rental car companies for parking and maintenance operations; and by San Diego International Airport as a temporary parking lot for construction employees involved in the ongoing Terminal 1 redevelopment project.

  Most of the site consists of existing asphalt-surfaced parking lots with some concrete-surfaced parking and driveways. There are several rental car operations buildings and large shade structures scattered across the site.

- *The history of design discussions for the project footprint, resulting in the final design determination.*

The footprint of the project is designed such that the Topgolf patrons face San Diego's downtown skyline. The footprint of the building is set back from the Spanish Bight fault, which is projected to run through the east side of the site, across the future non-inhabited driving range area.

- *Full/partial infiltration BMP standard setbacks to underground utilities, structures, retaining walls, fill slopes, and natural slopes applicable to the DMA that prevent full/partial infiltration.*

Based on the BMP Manual, full and partial BMPs should not be sited within existing fill soils greater than 5 feet thick. As discussed within this report, the entire site is underlain by existing undocumented fill around 10 feet thick.

Based on the BMP Manual, full and partial BMPs should not be sited within 10 feet of existing structures and utilities. Figure 9-1 presents the known existing utilities at the site. It is anticipated that there may be other utilities that were installed as part of the rental car operations that are not shown on Figure 9-1.

Numerous Phase 1 Environmental Site Assessment studies dating from the 1990s to 2024 confirm the site has had various industrial uses. Most of those uses are associated with aviation and defense industry operations. These studies document the widespread use of a variety of industrial solvents, oil, grease, fuels, and PCBs. These and recent use of the site area for large-scale automotive rental and maintenance operations are the source of more than 30 recognized environmental conditions (RECs) after ASTM E1527.

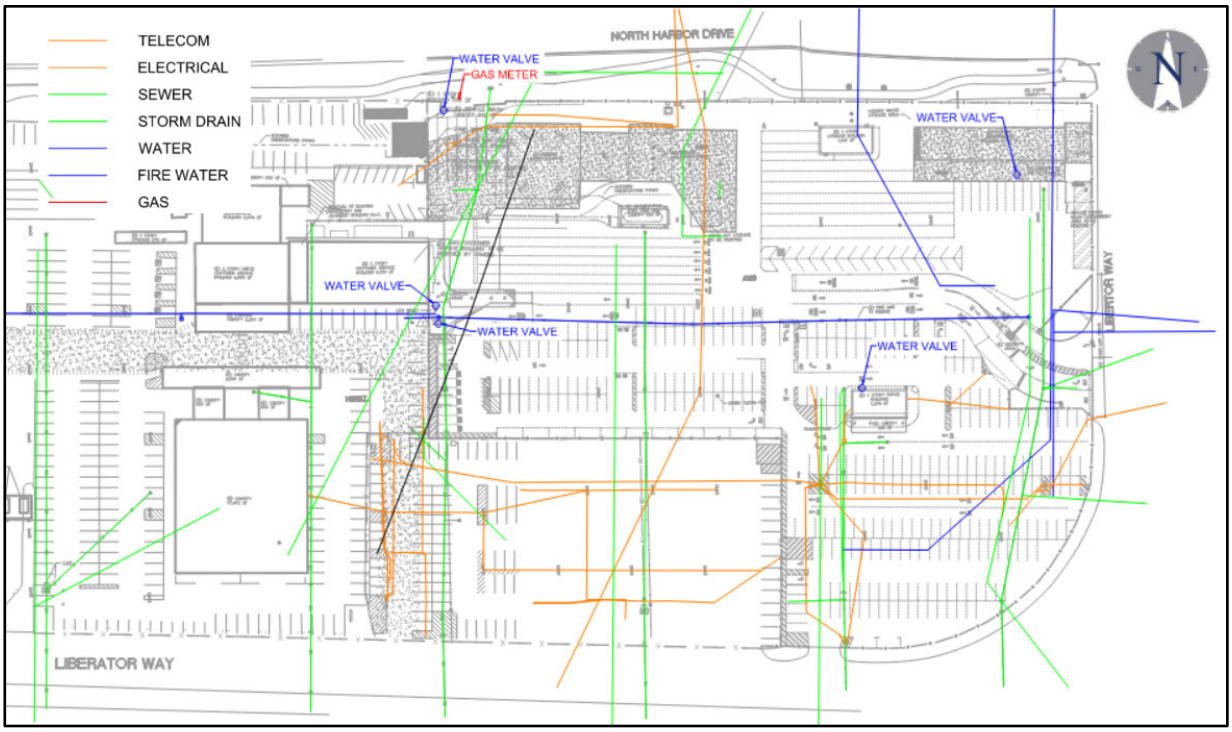

Figure 9-1. Known Existing Utility Locations

- *The physical impairments (i.e., fire road egress, public safety considerations, etc.) that prevent full/partial infiltration.*

NOVA is not aware of any such physical impairments that prevent full/partial infiltration.

- *The consideration of site design alternatives to achieve partial/full infiltration within the BMP.*

Based on the existing site conditions, per the BMP Design Manual, infiltration BMPs cannot be included in the overall design.

- *The extent site design BMPs requirements were included in the overall design.*

Based on the existing site conditions, infiltration BMPs cannot be included in the overall design.

- *Conclusion of recommendation from the geotechnical engineer regarding the DMA's infiltration condition.*

The development of infiltration BMPs is not feasible in any configuration at this site due to the thickness of undocumented fill, proximity to existing improvements, geotechnical hazards associated with introducing water into the on-site liquefiable soils, and potential site contamination.

In consideration of the risks associated with these hazards, NOVA considers the site to have a No Infiltration condition. BMP facilities should be lined throughout with an impermeable geomembrane to prevent migration of water in the fill and reduce the potential for water-related distress to adjacent structures or improvements. A subdrain system should be installed at the bottom of BMP facilities and BMPs should be kept at least 10 feet from structural foundations and utilities.

10. CLOSURE

NOVA should review project plans and specifications prior to bidding and construction to check that the intent of the recommendations in this report has been incorporated. Observations and tests should be performed during construction. If the conditions encountered during construction differ from those anticipated based on the subsurface exploration program, the presence of personnel from NOVA during construction will enable an evaluation of the exposed conditions and modifications of the recommendations in this report or development of additional recommendations in a timely manner.

NOVA should be advised of changes in the project scope so that the recommendations contained in this report can be evaluated with respect to the revised plans. Changes in recommendations will be verified in writing. The findings in this report are valid as of the date of this report. Changes in the condition of the site can, however, occur with the passage of time, whether they are due to natural processes or work on this or adjacent areas. In addition, changes in the standards of practice and government regulations can occur. Thus, the findings in this report may be invalidated wholly or in part by changes beyond NOVA's control. This report should not be relied upon after a period of two years without a review by NOVA verifying the suitability of the conclusions and recommendations to site conditions at that time.

In the performance of professional services, NOVA exercises the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing under similar conditions and in the same locality. The client recognizes that subsurface conditions may vary from those encountered at the boring locations and that the data, interpretations, and recommendations reported herein are based solely on the information obtained by NOVA. NOVA will be responsible for those data, interpretations, and recommendations, but shall not be responsible for interpretations by others of the information developed. Our services consist of professional consultation and observation only, and no warranty whatsoever, express or implied, is made or intended in connection with the work performed or to be performed by us, or by our proposal for consulting or other services, or by our furnishing of oral or written reports or findings.

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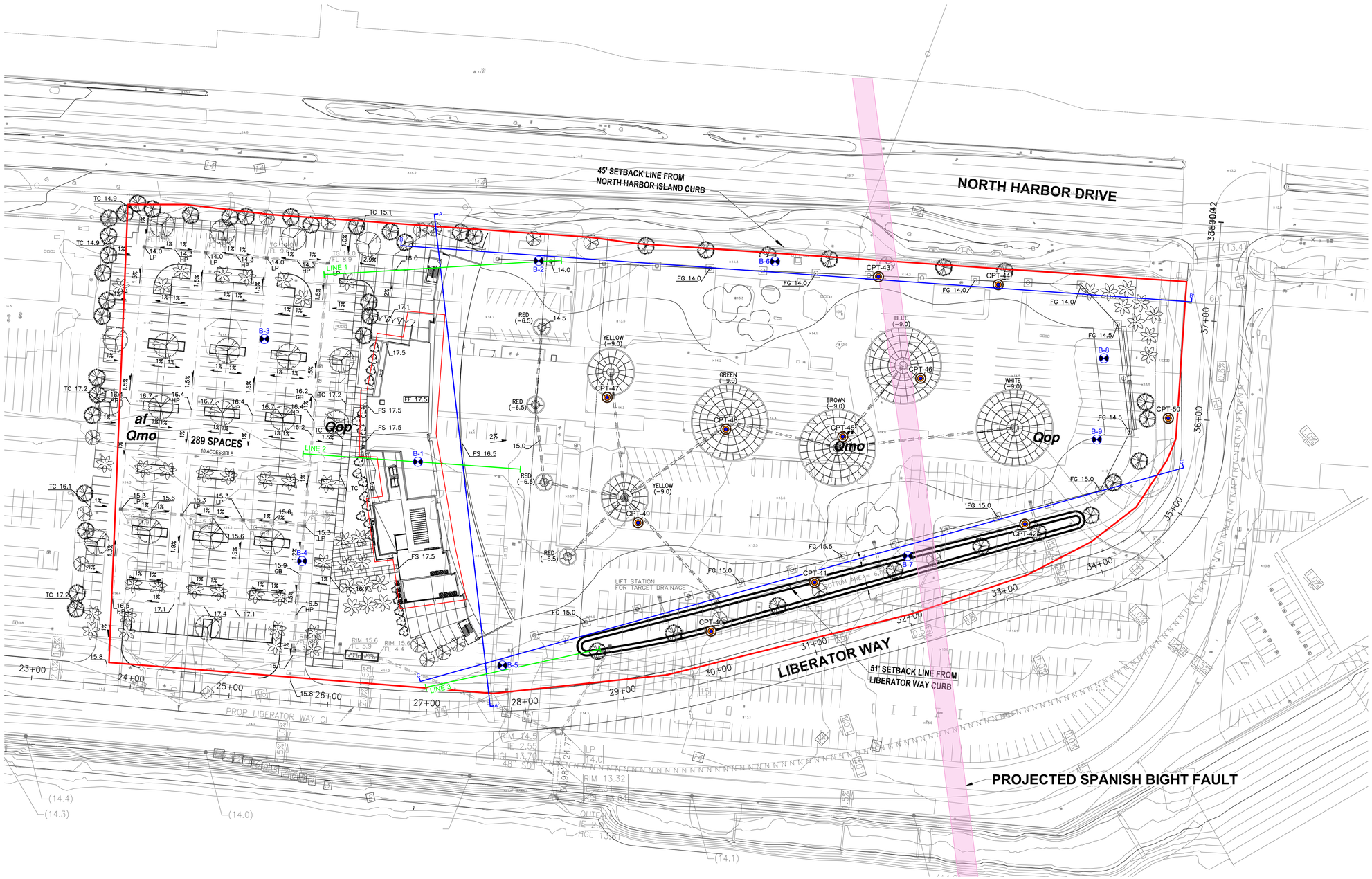
PLATES



KEY TO SYMBOLS

af	FILL
Qmo	MARINE DEPOSITS
Qop	OLD PARALIC DEPOSITS
	LIMITS OF REMEDIAL GRADING
	SITE LIMITS/ PROPERTY LEASE BOUNDARY
B-9	GEOTECHNICAL BORING
CPT-50	CONE PENETRATION TEST
C C'	GEOLOGIC CROSS-SECTION

FAULT HAZARD CPT/BORING TRAVERSES

- LINE 1: LINE 1: CPT-21 TO CPT-33 (PLATE 3)*
- LINE 2: LINE 2: CPT-7 TO CPT-20 (PLATE 4)
- LINE 3: LINE 3: CPT-1 TO CPT-6 AND CPT-34 TO CPT-39 (PLATE 5)*

NOTE: LOCATIONS APPROXIMATE

*CPT-1,CPT-25,CPT-26, AND CPT-36 ENCOUNTERED REFUSAL CPT-34 WAS INACCESSIBLE

0 50' 100'

*BASE MAP: Rick Engineering, 2024

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4373 Viewridge Avenue, Suite B
San Diego, CA 92123
P: 858.292.7575

16610 Aston Street
Irvine, CA 92606
P: 949.388.7710

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

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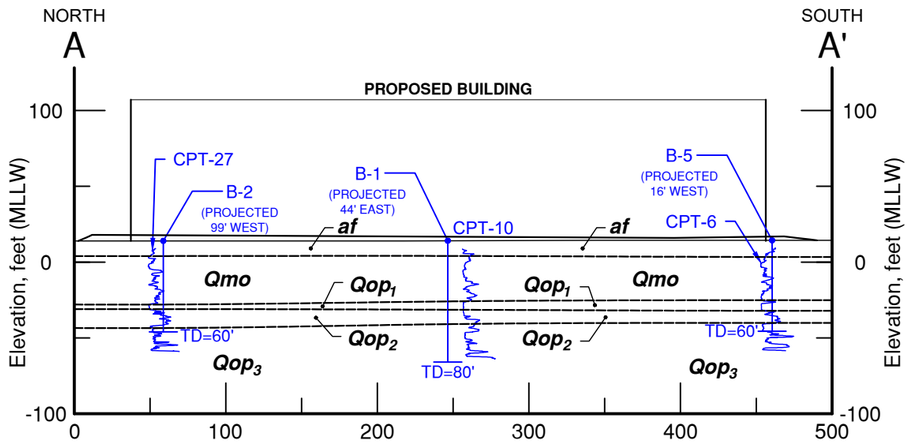
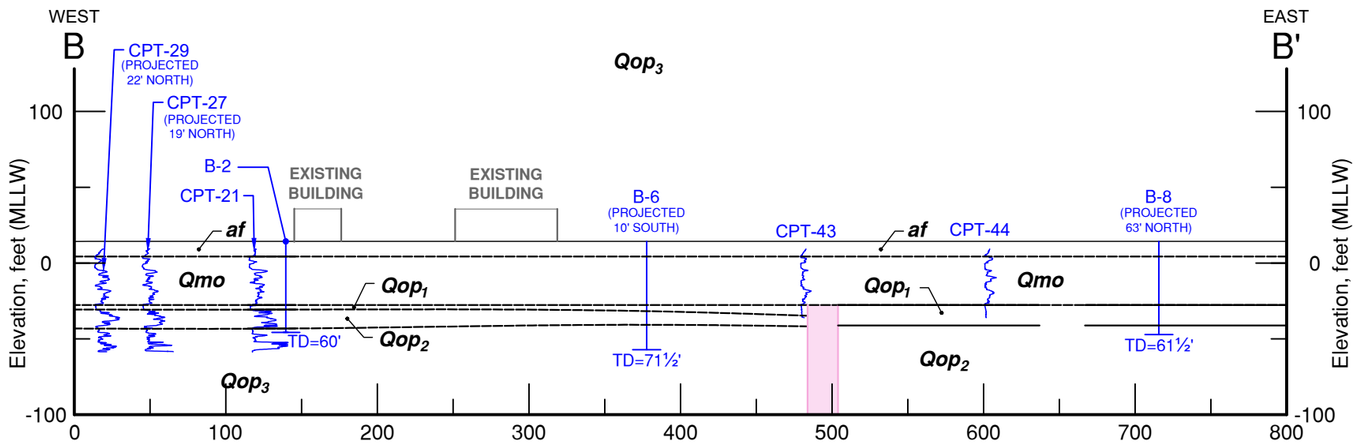
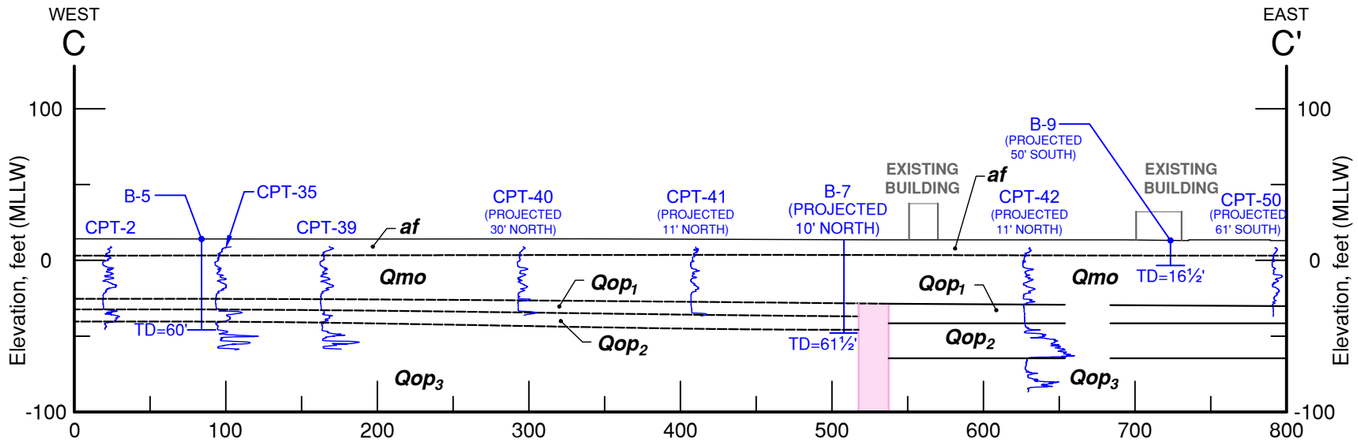
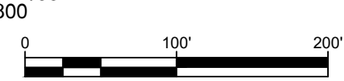
REVIEWED BY:	GD/LV
SCALE:	1"=50'
DRAWING TITLE:	

GEOTECHNICAL MAP









KEY TO SYMBOLS

af	FILL
Qmo	MARINE BAY DEPOSITS
Qop_1	OLD PARALIC DEPOSITS - NESTOR TERRACE
Qop_2	OLD PARALIC DEPOSITS - UPPER BROADWAY
Qop_3	OLD PARALIC DEPOSITS - LOWER BROADWAY
B-9 ⊥	GEOTECHNICAL BORING
CPT-50	CONE PENETRATION TEST (CONE RESISTANCE)
	SPANISH BIGHT FAULT ZONE
	INFERRED GEOLOGIC CONTACT

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San Diego, CA 92123
P: 858.292.7575

944 Calle Amanecer, Suite F
San Clemente, CA 92673
P: 949.388.7710

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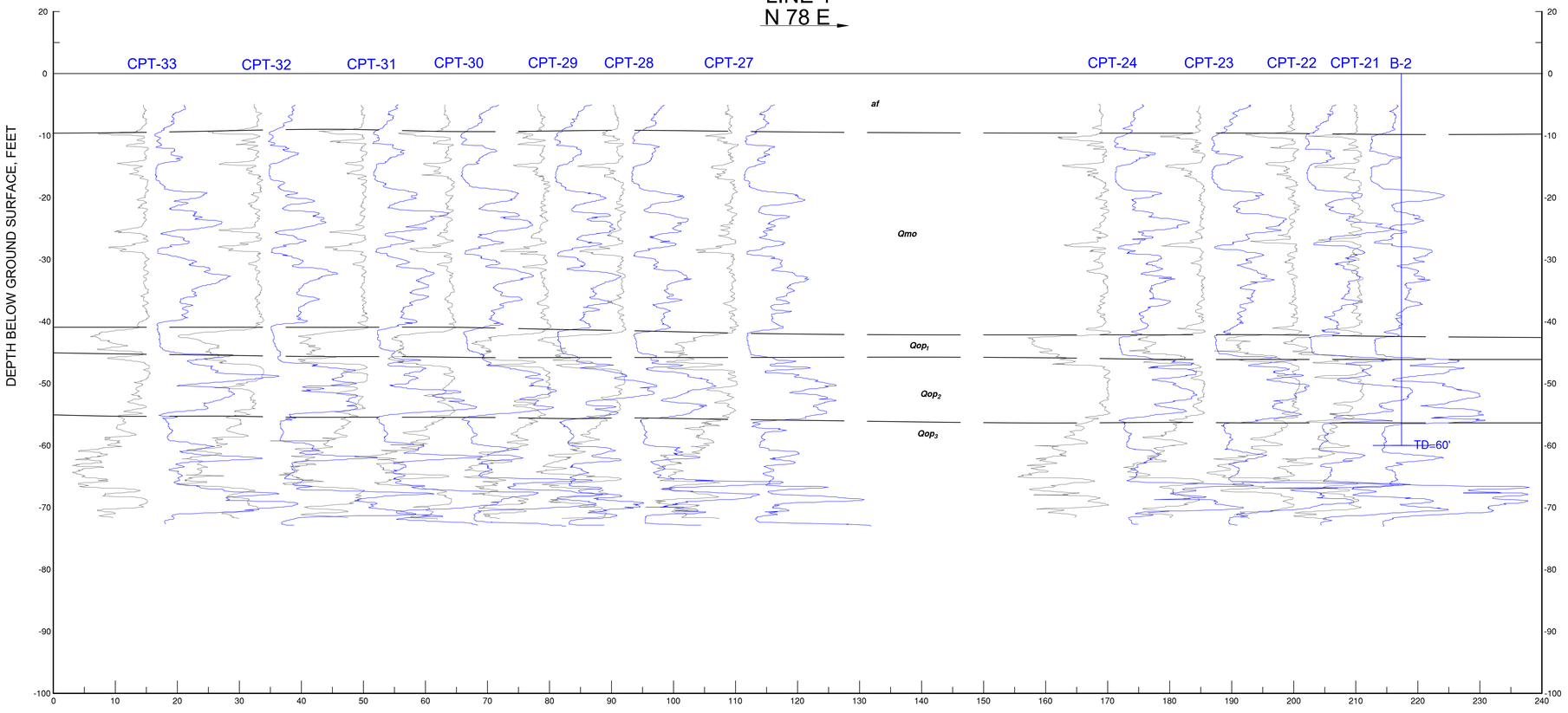
GEOLOGIC
CROSS-SECTIONS

LINE 1
N 78 E



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Qop_2	OLD PARALIC DEPOSITS - UPPER BROADWAY
Qop_3	OLD PARALIC DEPOSITS - LOWER BROADWAY
B-2	GEOTECHNICAL BORING
CPT-33	CONE PENETRATION TEST (CONE RESISTANCE)
CPT-33	CONE PENETRATION TEST (FRICTION RATIO)
—— ——	INFERRED GEOLOGIC CONTACT

0 10' 20'

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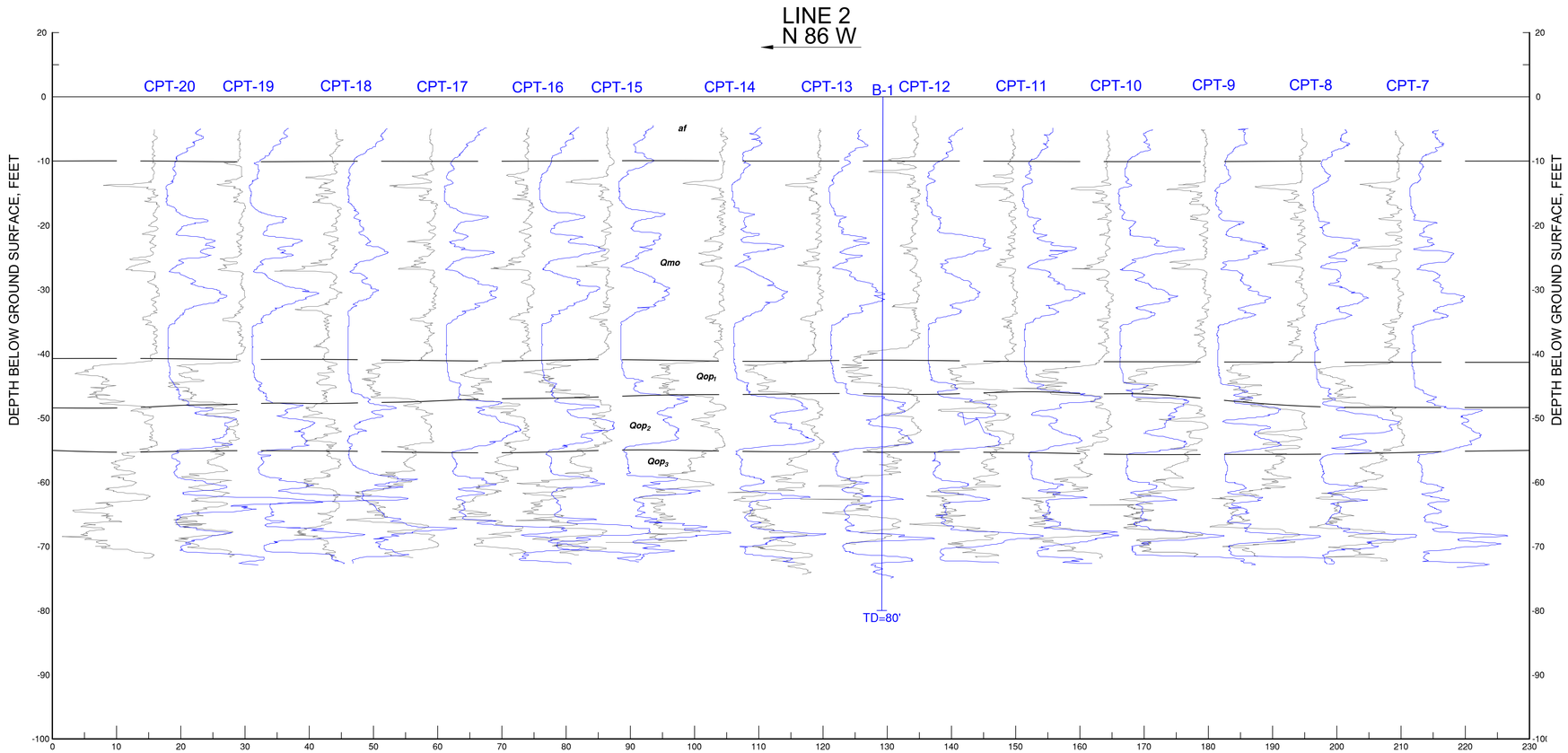
CPT PROFILE (LINE 1)



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Qop_2	OLD PARALIC DEPOSITS - UPPER BROADWAY
Qop_3	OLD PARALIC DEPOSITS - LOWER BROADWAY
B-1	GEOTECHNICAL BORING
CPT-20	CONE PENETRATION TEST (CONE RESISTANCE)
CPT-20	CONE PENETRATION TEST (FRICTION RATIO)
—— ——	INFERRED GEOLOGIC CONTACT

0 10' 20'

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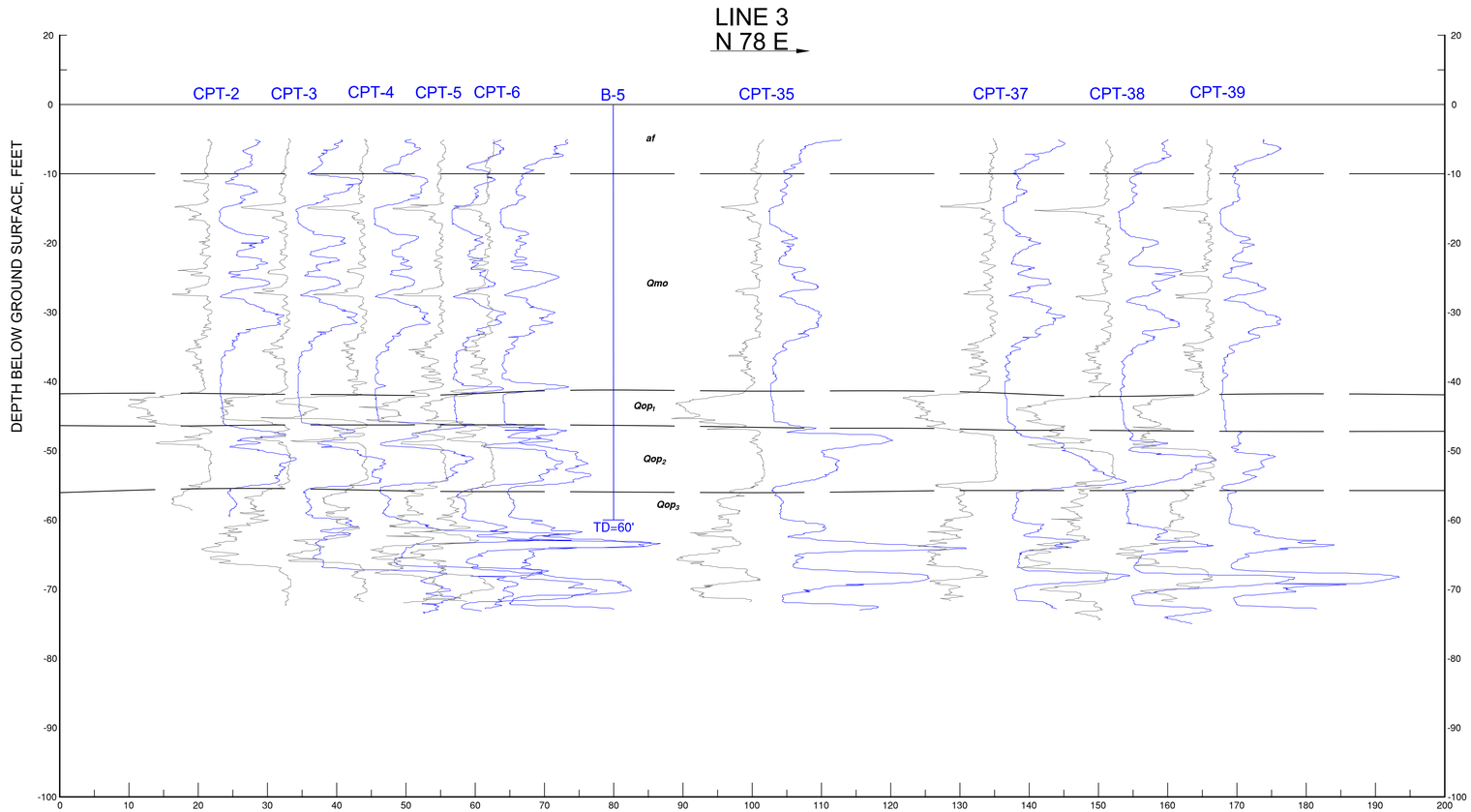

KEY TO SYMBOLS

af	FILL
Qmo	MARINE BAY DEPOSITS
Qop_1	OLD PARALIC DEPOSITS - NESTOR TERRACE
Qop_2	OLD PARALIC DEPOSITS - UPPER BROADWAY
Qop_3	OLD PARALIC DEPOSITS - LOWER BROADWAY
B-5	GEOTECHNICAL BORING
CPT-39	CONE PENETRATION TEST (CONE RESISTANCE)
CPT-39	CONE PENETRATION TEST (FRICTION RATIO)
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CPT PROFILE (LINE 3)

APPENDIX A
USE OF THE GEOTECHNICAL REPORT

Important Information About Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

The following information is provided to help you manage your risks.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.

ASFE
The Best People on Earth

8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733 Facsimile: 301/589-2017
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APPENDIX B
BORING LOGS

MAJOR DIVISIONS				TYPICAL NAMES
COARSE-GRAINED SOILS MORE THAN HALF IS COARSER THAN NO. 200 SIEVE	GRAVEL MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVEL WITH LESS THAN 15% FINES	GW	WELL-GRADED GRAVEL WITH OR WITHOUT SAND
			GP	POORLY GRADED GRAVEL WITH OR WITHOUT SAND
		GRAVEL WITH 15% OR MORE FINES	GM	SILTY GRAVEL WITH OR WITHOUT SAND
			GC	CLAYEY GRAVEL WITH OR WITHOUT SAND
	SAND MORE THAN HALF COARSE FRACTION IS FINER THAN NO. 4 SIEVE SIZE	CLEAN SAND WITH LESS THAN 15% FINES	SW	WELL-GRADED SAND WITH OR WITHOUT GRAVEL
			SP	POORLY GRADED SAND WITH OR WITHOUT GRAVEL
		SAND WITH 15% OR MORE FINES	SM	SILTY SAND WITH OR WITHOUT GRAVEL
			SC	CLAYEY SAND WITH OR WITHOUT GRAVEL
FINE-GRAINED SOILS MORE THAN HALF IS FINER THAN NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT 50% OR LESS		ML	SILT WITH OR WITHOUT SAND OR GRAVEL
			CL	LEAN CLAY WITH OR WITHOUT SAND OR GRAVEL
			OL	ORGANIC SILT OR CLAY OF LOW TO MEDIUM PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50%		MH	ELASTIC SILT WITH OR WITHOUT SAND OR GRAVEL
			CH	FAT CLAY WITH OR WITHOUT SAND OR GRAVEL
			OH	ORGANIC SILT OR CLAY OF HIGH PLASTICITY WITH OR WITHOUT SAND OR GRAVEL
HIGHLY ORGANIC SOILS			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS

- GROUNDWATER / STABILIZED
- GROUNDWATER SEEPAGE
- BULK SAMPLE
- SPT SAMPLE (ASTM D1586)
- MOD. CAL. SAMPLE (ASTM D3550)
- * UNRELIABLE BLOW COUNTS
- GEOLOGIC CONTACT
- SOIL TYPE CHANGE

LAB TEST ABBREVIATIONS

AL	ATTERBERG LIMITS
CN	CONSOLIDATION
CR	CORROSIVITY
DS	DIRECT SHEAR
EI	EXPANSION INDEX
MD	MAXIMUM DENSITY
RV	RESISTANCE VALUE
SA	SIEVE ANALYSIS
SE	SAND EQUIVALENT

LOG ABBREVIATIONS

REF	REFUSAL
PP	POCKET PENETROMETER

RELATIVE DENSITY OF COHESIONLESS SOILS		CONSISTENCY OF COHESIVE SOILS		
RELATIVE DENSITY	SPT N60 BLOWS/FOOT	CONSISTENCY	SPT N60 BLOWS/FOOT	POCKET PENETROMETER MEASUREMENT (TSF)
VERY LOOSE	0 - 4	VERY SOFT	0 - 2	0 - 0.25
LOOSE	4 - 10	SOFT	2 - 4	0.25 - 0.50
MEDIUM DENSE	10 - 30	MEDIUM STIFF	4 - 8	0.50 - 1.0
DENSE	30 - 50	STIFF	8 - 15	1.0 - 2.0
VERY DENSE	OVER 50	VERY STIFF	15 - 30	2.0 - 4.0
		HARD	OVER 30	OVER 4.0

NUMBER OF BLOWS OF 140 LB HAMMER FALLING 30 INCHES TO DRIVE A 2 INCH O.D. (1-3/8 INCH I.D.) SPLIT-BARREL SAMPLER THE LAST 12 INCHES OF AN 18-INCH DRIVE (ASTM-1586 STANDARD PENETRATION TEST).
IF THE SEATING INTERVAL (1st 6 INCH INTERVAL) IS NOT ACHEIVED, N IS REPORTED AS REF.

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SUBSURFACE EXPLORATION LEGEND

LOG OF BORING B-1

DATE DRILLED: 4/18/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13.9 MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*10 IN ASPHALT CONCRETE*	
			3 3 4 3 3 3 2 3 5 4	9 8 10			SM	**FILL (af):** *SILTY SAND; OLIVE BROWN (2.5Y 5/3), MOIST, LOOSE TO MEDIUM DENSE, FINE GRAINED, MICACEOUS* *GRAYISH BROWN (2.5Y 5/2), FINE TO MEDIUM GRAINED, SOME SHELL FRAGMENTS*	
5									
10			1 1 1 1 1 1	3			SM	**MARINE BAY DEPOSITS (Qmo):** *SILTY SAND, DARK GRAY (2.5Y 4/1), WET, VERY LOOSE, FINE TO MEDIUM GRAINED, MICACEOUS* *SHELL FRAGMENTS*	
			PUSH	1			ML	*SANDY SILT; DARK GRAY (2.5Y 4/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS*	
15			1 1 1 - 1	3			SM	*SILTY SAND; DARK GRAY (2.5Y 4/1), WET, LOOSE, FINE GRAINED, MICACEOUS, SCATTERED SHELL FRAGMENTS*	
			2 2 2 2 3 3 4 4 - 1	5 6 10				*LOOSE TO MEDIUM DENSE, FINE TO MEDIUM GRAINED, SLIGHTLY MICACEOUS*	
20			2 4 2 4 8 5 6 11 - 3	8 15 22				*LOOSE* *MEDIUM DENSE, FINE TO MEDIUM GRAINED, SLIGHTLY MICACEOUS* *NO SHELL FRAGMENTS* *SHELL FRAGMENTS*	
25			3 4 3 4 7 6 8 13 -	9 14 27				*LOOSE* *MEDIUM DENSE, INCREASE IN SILT CONTENT* *DECREASE IN SILT CONTENT*	
30									

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NORTH HARBOR DRIVE AND LIBERATOR WAY
SAN DIEGO, CALIFORNIA

DRAFTED BY:GN | PROJECT: 2024034 | FIGURE: B.1

CONTINUED LOG OF BORING B-1

DATE DRILLED: 4/18/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13.9 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			2-4-8	15			SM	**MARINE BAY DEPOSITS (Qmo):** *SILTY SAND, DARK GRAY (2.5Y 4/1), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS* *ABUNDANT SHELLS*	
			7-10-10	26			ML	*SANDY SILT; DARK GRAY (2.5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, SLIGHTLY MICACEOUS, SCATTERED SHELLS*	
			7-7-8	19					
35			5-2-3	6			CL-ML	*SILTY CLAY WITH SAND; DARK GRAY (2.5Y 4/1), WET, MEDIUM STIFF, FINE GRAINED SAND, MICACEOUS* *ABUNDANT SHELL FRAGMENTS*	
			1-2-2	5					
			2-2-2	5					
40			1-2-2	5			CH	*FAT CLAY; DARK GRAY (2.5Y 4/1), WET, MEDIUM STIFF, SCATTERED SHELLS, PP = 0.5 TSF* *STIFF, PP = 1.0 TSF*	
			3-3-4	9			CH	**OLD PARALIC DEPOSITS (Qop_1):** *SANDY FAT CLAY; MOTTLED DARK GRAY (2.5Y 4/1) AND STRONG BROWN (2.5YR 4/6), WET, STIFF, FINE GRAINED SAND* *PP = 1.25 TSF* *MOTTLED DARK GRAY (2.5Y 4/1) AND DARK YELLOWISH BROWN (10YR 4/4)*	
			2-4-4	10					
45			6-13-7	24			SC	**OLD PARALIC DEPOSITS (Qop_2):** *CLAYEY SAND; DARK YELLOWISH BROWN (10YR 4/4), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
			8-11-9	24			CH	*FAT CLAY; MOTTLED DARK GRAY (2.5Y 4.1) AND DARK YELLOWISH BROWN (10YR 4/4), WET, SOFT TO STIFF, PP = 0.25 TSF, 6-IN LENS*	
			8-14-7	28			SM	*SILTY SAND; DARK YELLOWISH BROWN (10YR 4/4), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS* *WET, DENSE, FINE TO MEDIUM GRAINED*	
50			10-15-3	32			CH	*FAT CLAY; MOTTLED DARK GRAY (2.5Y 4/1) AND DARK YELLOWISH BROWN (10YR 4/4), WET, SOFT TO STIFF, PP = 0.25 TSF, 6-IN LENS*	
			5-7-10	15			SM	*SILTY SAND; DARK YELLOWISH BROWN (10YR 4/4), WET, MEDIUM DENSE TO DENSE, FINE TO MEDIUM GRAINED* *SHELL FRAGMENTS*	
			13-21-7	44					
55			10-11-4	27			CH	**OLD PARALIC DEPOSITS (Qop_3):** *FAT CLAY; MOTTLED OLIVE BROWN (2.5Y 5/3) AND STRONG BROWN (7.5YR 4/6), WET, VERY STIFF, FINE GRAINED SAND, PP = 3.5 TSF* *SANDY FAT CLAY, FINE GRAINED SAND* *STIFF TO VERY STIFF, PP = 1.0 TSF*	
			5-7-4	15					
60			7-10	22					

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.2

CONTINUED LOG OF BORING B-1

DATE DRILLED: 4/18/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13.9 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60			6 10 15	32			SC	**OLD PARALIC DEPOSITS (Qop_3):** *CLAYEY SAND; BROWN (10YR 4/3), WET, DENSE, FINE TO MEDIUM GRAINED SAND*	
			4 5 10	19				*YELLOWISH BROWN (10YR 5/6)* *MEDIUM DENSE*	
			10 16 20	46				*DENSE*	
65			30 4 6					*MEDIUM DENSE*	
			12 10	23				*INCREASE IN CLAY CONTENT*	
			17 25	54			SM	*SILTY SAND; DARK GRAY (2.5Y 4/1), WET, VERY DENSE, FINE GRAINED SAND, MICACEOUS*	
			10 12 14	33				*MEDIUM TO COARSE GRAINED, DECREASE IN SILT CONTENT* *DENSE*	
70			15 5 9				ML	*SANDY SILT; MOTTLED DARK GRAY (2.5Y 4/1) AND DARK YELLOWISH BROWN, WET, DENSE, FINE GRAINED SAND, MICACEOUS*	
			17 8 16	33					
			20 10 14	46					
			24 25	49					
75			9 11					*2-IN LENS OF FAT CLAY; DARK GRAY (2.5Y 4/1)*	
			11 10	28				*5-IN LENS OF SANDY FAT CLAY; MOTTLED DARK GRAY (2.5Y 4/1) AND DARK YELLOWISH BROWN (10YR 3/6), MEDIUM DENSE*	
			12 14	33				*DENSE*	
			9 13 16	37					
80			21					*BORING TERMINATED AT 80 FT. GROUNDWATER ENCOUNTERED AT 11 FT. BACKFILLED WITH BENTONITE.*	
85									
90									

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.3

LOG OF BORING B-2

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.3 MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*10 IN ASPHALT CONCRETE*	
	X						SM	**FILL (af):** *SILTY SAND; OLIVE BROWN (2.5Y 4/3), MOIST, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
	X							*WITH GRAYISH BROWN (2.5Y 5.2)*	
5	X		3 4 7	14				*MEDIUM DENSE*	
	X		3 3 3	8				*LOOSE, ABOUT 50% SAMPLE RECOVERY*	
	X		2 2 2	5				*ABUNDANT MICA*	
10 ▼			1 1 1	3			ML	**MARINE BAY DEPOSITS (Qmo):** *SANDY SILT; VERY DARK GREENISH GRAY (GLEY 1 3/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS, ABOUT 30% SAMPLE RECOVERY*	
			2 5 5	9			SM	*SILTY SAND; VERY DARK GREENISH GRAY (GLEY 1 4/1), WET, LOOSE, FINE GRAINED, MICACEOUS, SHELLS*	
			1 1 2	3				*ABOUT 50% SAMPLE RECOVERY*	
15			1 1 1	3				*VERY LOOSE*	
			1 1 3	3			ML	*SANDY SILT; BLACK (10YR 2/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS*	
			4 6 9	13			SM	*SILTY SAND; BLACK (10YR 2/1), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
			9 10 10	24				*SHELL FRAGMENTS*	
20			3 4 7	14				*LOOSE TO MEDIUM DENSE, FEW SHELL FRAGMENTS*	
			3 4 4	10				*MEDIUM DENSE*	
			4 3 5	14					
25			6 7 3						
			3 6 4	12			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
			5 7 3	15			CH	*SANDY FAT CLAY; VERY DARK GRAY (10YR 3/1), STIFF, FINE GRAINED SAND, MICACEOUS*	
			7 10 13	22			SM	*SILTY SAND; VERY DARK GRAY (10YR 2/1), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS, SCATTERED SHELL FRAGMENTS*	
30									

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NORTH HARBOR DRIVE AND LIBERATOR WAY

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DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.4

CONTINUED LOG OF BORING B-2

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.3 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			5 6 8	18			ML	**MARINE BAY DEPOSITS (Qmo):** *SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
			5 8 9	22			SM	*SILTY SAND; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
			6 6 7	17			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
35			9 4 5	15			SM	*SILTY SAND; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
			7 5 5 5	13				*SHELL FRAGMENTS*	
			4 4 5	12			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, SLIGHTLY MICACEOUS, SCATTERED SHELLS*	
40			8 4 4 5	12				*ABUNDANT SHELL FRAGMENTS*	
			2 3 5	10			CH	**OLD PARALIC DEPOSITS (Qop_1):** *FAT CLAY; VERY DARK GRAY (10YR 3/1), WET, STIFF, FINE GRAINED SAND, SHELL FRAGMENTS, PP = 1.5 TSF*	
			3 1 4 6	6				*MEDIUM STIFF*	
45			7 8 18	33			SC	**OLD PARALIC DEPOSITS (Qop_2):** *CLAYEY SAND; MOTTLED DARK GRAY (10YR 4/1) AND YELLOWISH BROWN (10YR 5/6), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
			5 9 10	24			CH	*FAT CLAY; VERY DARK GRAY (10YR 3/1), WET, VERY SOFT TO SOFT, PP = 0.25 TSF, 3-IN LENS*	
			3 9 15 35	31			SP-SC	*POORLY GRADED SAND WITH CLAY; BROWN (10YR 5/3), WET, MEDIUM DENSE, FINE TO COARSE GRAINED* *DENSE*	
50			5 5 9	18				*MEDIUM DENSE*	
			3 3 4	9				*LOOSE*	
			3 4 4 6	10				*LOOSE TO MEDIUM DENSE*	
55			3 5 7 7	15				*MEDIUM DENSE*	
			5 7 7	18					
			4 6 7	17			CH	**OLD PARALIC DEPOSITS (Qop_3):** *FAT CLAY; MOTTLED LIGHT OLIVE BROWN (2.5Y 5/4) AND GRAYISH BROWN (2.5Y 5/2), WET, STIFF TO VERY STIFF, PP = 1.5 TSF* *VERY STIFF TO HARD, PP = 4.5 TSF*	
60			11						

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NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.5

CONTINUED LOG OF BORING B-2

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 95 (YELLOW) **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.3 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** MS

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~79.6%, $N_{60} \sim \frac{79.6}{60}$*N~1.28*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60							CH	**OLD PARALIC DEPOSITS (Qop_3):** *FAT CLAY; MOTTLED LIGHT OLIVE BROWN (2.5Y 5/4) AND GRAYISH BROWN (2.5Y 5/2), WET, STIFF, PP = 1.5 TSF* *HARD, PP = 4.5 TSF*	
								BORING TERMINATED AT 60 FT. GROUNDWATER ENCOUNTERED AT 10½ FT. BACKFILLED WITH BENTONITE.	
65									
70									
75									
80									
85									
90									

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TOPGOLF HARBOR ISLAND
NORTH HARBOR DRIVE AND LIBERATOR WAY
SAN DIEGO, CALIFORNIA

DRAFTED BY:GN | PROJECT: 2024034 | FIGURE: B.6

LOG OF BORING B-3

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** 3½-IN HAND AUGER **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14 MLLW **DRILLING METHOD:** HAND AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): N/A **NOTES:** N/A **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*10 IN ASPHALT CONCRETE*	
	X						SM	**FILL (af):** *SILTY SAND; LIGHT OLIVE BROWN (2.5Y 5/3), MOIST, MEDIUM DENSE, FINE GRAINED, MICACEOUS* *GRAYISH BROWN (2.5Y 5/2), SOME SHELL FRAGMENTS*	
5								*BORING TERMINATED AT 5 FT. NO GROUNDWATER ENCOUNTERED.*	
10									
15									
20									
25									
30									

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LOG OF BORING B-4

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** 3½-IN HAND AUGER **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14 MLLW **DRILLING METHOD:** HAND AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): N/A **NOTES:** N/A **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0	X							*5 IN ASPHALT CONCRETE*	
	X						SP-SM	**FILL (af):** *POORLY GRADED SAND WITH SILT; LIGHT OLIVE BROWN (2.5Y 5/3), MOIST, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS, MINOR SANDY CLAY* *GRAYISH BROWN (2.5Y 5/2), SOME SHELL FRAGMENTS*	SA AL EI
5								*BORING TERMINATED AT 5 FT. NO GROUNDWATER ENCOUNTERED.*	
10									
15									
20									
25									
30									

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SAN DIEGO, CALIFORNIA

DRAFTED BY:GN | PROJECT: 2024034 | FIGURE: B.8

LOG OF BORING B-5

DATE DRILLED: 4/22/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.1 MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*4 IN ASPHALT CONCRETE OVER 4 IN AGGREGATE BASE*	
							SM	**FILL (af):** *SILTY SAND; LIGHT OLIVE BROWN (2.5Y 5/4), MOIST, MEDIUM DENSE, FINE GRAINED, MICACEOUS* *GRAYISH BROWN (2.5Y 5/2), FINE TO MEDIUM GRAINED, SHELL FRAGMENTS* *OLIVE GRAY (5Y 4/2)* *GRAY (10YR 5/1)*	
5			PUSH	0				*ABOUT 50% SAMPLE RECOVERY* *1½-IN AND 3-IN LENSES OF SILTY SAND, GRAY (5Y-3/1), FINE TO MEDIUM GRAINED FREQUENT SHELL FRAGMENTS* *VERY LOOSE, ABUNDANT SHELL FRAGMENTS* *NO SHELL FRAGMENTS* *SOME SHELL FRAGMENTS, FINE GRAINED* *GRAY*	
10 ▼			PUSH	0			SM	**MARINE BAY DEPOSITS (Qmo):** *SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED, MICACEOUS*	
			PUSH	0					
15			PUSH	0			ML	*SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS*	
			2 3 5 7	11			SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, MEDIUM DENSE, FINE GRAINED, VERY MICACEOUS, ABUNDANT SHELL FRAGMENTS*	
20			7 11 11	25				*1½-IN AND 3-IN LENSES OF SILTY SAND, GRAY (5Y-3/1), FINE TO MEDIUM GRAINED, FREQUENT SHELL FRAGMENTS*	
			3 7 5 5	17				*DARK GRAY*	
			8 11 2	26			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
			3 5 8	11			SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
25			2 3 6	12			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS, SCATTERED SHELL FRAGMENTS*	
			5 5 9	19			SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, DENSE, FINE TO MEDIUM GRAINED SAND, MICACEOUS, SCATTERED SHELL FRAGMENTS*	
30			5 10 14 16	33			ML	*SANDY SILT; DARK GRAY (10YR 4/1), WET, DENSE, FINE GRAINED SAND, MICACEOUS, SHELL FRAGMENTS*	

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN | PROJECT: 2024034 | FIGURE: B.9

CONTINUED LOG OF BORING B-5

DATE DRILLED: 4/22/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.1 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			7 8 15	32			SM	**MARINE BAY DEPOSITS (Qmo):** *SILTY SAND; VERY DARK GRAY (10YR 3/1), WET, DENSE, FINE GRAINED, MICACEOUS*	
			6 8 8	19			ML	*SANDY SILT; DARK GRAY (10YR 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS, SOME SHELLS*	
			4 4 5	12				*VERY DARK GRAY (10YR 3/1), SCATTERED SHELLS*	
35			7 2 2	6			ML	*SILT; VERY DARK GRAY (10YR 3/1), WET, LOOSE, MICACEOUS, TRACE SHELL FRAGMENTS*	
			2 3 2	7			SM	*SILTY SAND; DARK GRAY (10Y 4/1), WET, LOOSE, FINE GRAINED, MICACEOUS*	
			3 2 2	7			ML	*SANDY SILT; VERY DARK GRAY (10YR 3/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS*	
40			3 3 PUSH				CH	*FAT CLAY WITH SAND; VERY DARK GRAY (5Y 3/1), WET, SOFT, FINE GRAINED SAND*	SA AL CR
			PUSH 2 PUSH	3				*PP = 0.5 TSF*	
			3 4 3	10			CH	**OLD PARALIC DEPOSITS (Qop_1):** *SANDY FAT CLAY; VERY DARK GRAY (5Y 3/1), LENS OF DARK GRAY (5Y 4/1), WET, STIFF, PP =1.5 TSF, FINE GRAINED SAND*	
			4 4 5	11				*LENS OF LIGHT GRAY (5Y 7/1) SILT*	
45			3 3 4	10				*MOTTLED GRAY (5Y 5/1) AND STRONG BROWN (7.5YR 4/4), STIFF TO VERY STIFF, PP = 2.5 TSF, TRACE BLACK MINERAL PRECIPITATE DEPOSITS*	
			10 10 10	28			SC	**OLD PARALIC DEPOSITS (Qop_2):** *CLAYEY SAND; DARK YELLOWISH BROWN (10YR 4/4), WET, MEDIUM DENSE, FINE TO COARSE GRAINED*	
			7 22 22	61			SM	*SILTY SAND; DARK YELLOWISH BROWN (10YR 4/4), WET, VERY DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
50			23 7 7	28			SP-SM	*POORLY GRADED SAND WITH SILT; BROWN (10YR 4/3), WET, MEDIUM DENSE, MEDIUM TO COARSE GRAINED, MICACEOUS*	
			13 10 13	36			SP	*POORLY GRADED SAND; LIGHT OLIVE BROWN (2.5Y 5/3), WET, DENSE, MEDIUM TO COARSE GRAINED, SLIGHTLY MICACEOUS*	
			13 10 10	28			SM	*SILTY SAND; LIGHT OLIVE BROWN (2.5Y 5/3), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
55			10 3 5				CH	**OLD PARALIC DEPOSITS (Qop_3):** *SANDY FAT CLAY; LIGHT OLIVE BROWN (2.5Y 5/3), WET, VERY STIFF, FINE GRAINED SAND, LIGHT BROWN SILTY SAND INCLUSION*	
			8 11 6	26				*PP = 2.5 TSF* *OLIVE BROWN (2.5YR 4/3) WITH REDDISH BROWN (5Y 4/4) STAINING, PP = 3.0, 3.5 TSF*	
			7 7 5	19				*PP = 2.25* *LENS OF COARSE GRAINED SAND*	
60			7 7 13	19			SM	*SILTY SAND; OLIVE BROWN (2.5Y 4/3), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	

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NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.10

CONTINUED LOG OF BORING B-5

DATE DRILLED: 4/22/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14.1 MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10½ **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60							SM	**OLD PARALIC DEPOSITS (Qop_3):** *SILTY SAND; OLIVE BROWN (2.5YR 4/3), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
								BORING TERMINATED AT 60 FT. GROUNDWATER ENCOUNTERED AT 10½ FT. BACKFILLED WITH BENTONITE.	
65									
70									
75									
80									
85									
90									

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DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.11

LOG OF BORING B-6

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*4 IN ASPHALT CONCRETE OVER 4 IN AGGREGATE BASE*	
	X						SM	**FILL (af):** *SILTY SAND; LIGHT OLIVE BROWN (2.5Y 5/4), MOIST, MEDIUM DENSE, FINE TO COARSE GRAINED, MICACEOUS* *REDDISH BROWN (5YR 4/4), FINE TO MEDIUM GRAINED, ABOUT 15% GRAVEL*	
5	X	⁄	5 4 3	10				*GRAYISH BROWN (10YR 5/1), NO GRAVEL, WITH SHELL FRAGMENTS* *NO SHELLS* *LOOSE*	
10 ▼		⁄	PUSH 1 1	3			ML	**MARINE BAY DEPOSITS (Qmo):** *SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS*	SA
15		⁄	PUSH	0			SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED SAND, HIGHLY MICACEOUS*	
20		⁄	3 3 4	10			SP-SM	*POORLY GRADED SAND WITH SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
							SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED, MICACEOUS, TRACE SHELL FRAGMENTS*	
25		⁄	PUSH 3 3	8			SP-SM	*POORLY GRADED SAND WITH SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
							ML	*SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS*	
30								*FAT CLAY SMEAR*	

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.12

CONTINUED LOG OF BORING B-6

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			3 3 4	10			SP-SM	**MARINE BAY DEPOSITS (Qmo):** *POORLY GRADED SAND WITH SILT; DARK GRAY (5Y 4/1), WET, LOOSE TO MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
							ML	*SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS, WITH MINOR CLAY SMEAR*	
35			5 8 11	26			CH	*FAT CLAY; VERY DARK GRAY (5Y 3/1), WET, SOFT TO MEDIUM STIFF, PP = 0.5 TSF*	
							SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS, TRACE SHELL FRAGMENTS*	
40			2 4 4	11				*SCATTERED SHELL FRAGMENTS* *INCREASE IN SILT CONTENT*	
							CH	**OLD PARALIC DEPOSITS (Qop_1):** *FAT CLAY; VERY DARK GRAY (5Y 3/1), WET, STIFF TO VERY STIFF*	
45			3 5 5	14				*WHITE MINERAL PRECIPITATE DEPOSITS, PP = 1.75, 2.75*	
							ML	**OLD PARALIC DEPOSITS (Qop_2):** *SANDY SILT; MOTTLED DARK YELLOWISH BROWN (10YR 4/4) AND VERY DARK GRAY (5Y 3/1), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
50			10 9 11	18			CH	*FAT CLAY; MOTTLED DARK GRAY (5Y 4/1) AND VERY DARK GRAY (5Y 3/1), WET, SOFT, PP = 0.5 TSF*	
							CL	*SANDY CLAY; LIGHT YELLOWISH BROWN (2.5Y 6/3), WET, STIFF TO VERY STIFF, FINE GRAINED SAND, BLACK MINERAL PRECIPITATE DEPOSITS, PP =1.75 TSF*	
55			22 25 35	83			SM	*SILTY SAND; LIGHT YELLOWISH BROWN (2.5Y 6/3), WET, VERY DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	
60									

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.13

CONTINUED LOG OF BORING B-6

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60			8 10 11	29			CL-ML	**OLD PARALIC DEPOSITS (Qop_3):** *SILTY CLAY; OLIVE BROWN (2.5Y 4/4) WITH TRACE RED IRON STAINING (2.5YR 5/6), WET, VERY STIFF, BLACK MINERAL PRECIPITATE DEPOSITS LIGHT OLIVE BROWN (2.5Y 5/3)*	
								DARK GRAY (5Y 4/1)	
65			8 10 17	37			SM	*SILTY SAND; DARK GRAY (5Y 4/1), WET, DENSE, FINE TO MEDIUM GRAINED SAND, MICACEOUS, GRADES INTO LIGHT OLIVE BROWN (2.5Y 5/4)*	
							SC	*CLAYEY SAND; OLIVE BROWN (2.5Y 4/3), WET, DENSE, FINE TO MEDIUM GRAINED, SLIGHTLY MICACEOUS*	
70			7 8 10	25				*WITH YELLOWISH RED STAINING (5YR 4/6), MEDIUM DENSE*	
								BORING TERMINATED AT 71½ FT. GROUNDWATER ENCOUNTERED AT 10 FT. BACKFILLED WITH BENTONITE.	
75									
80									
85									
90									

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DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.14

LOG OF BORING B-7

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 75 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13½ MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~71.9%, $N_{60} \sim \frac{71.9}{60}$*N~1.20*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*10 IN ASPHALT CONCRETE OVER 4 IN AGGREGATE BASE*	
	X						SM	**FILL (af):** *SILTY SAND; LIGHT OLIVE BROWN (2.5Y 5/4), MOIST, MEDIUM DENSE, FINE GRAINED, MICACEOUS, ABOUT 10-15% GRAVEL*	
	X							*GRAYISH BROWN (2.5Y 5/2), NO GRAVEL, SOME SHELL FRAGMENTS*	
5	X	/	4 8 9	20				*MINOR SHELL FRAGMENTS*	
10		/	1 2 2	5			ML	**MARINE BAY DEPOSITS (Qmo):** *SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS*	CR
15		/	PUSH 1 1	2				*DARK GRAY (5Y 4/1), WET, VERY LOOSE, FINE GRAINED SAND*	CR
20		/	8 9 15	29			SM	*SILTY SAND; MOTTLED DARK GRAY (5Y 4/1) AND LIGHT BROWN (7.5YR 6/3), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS, TRACE SHELL FRAGMENTS, 2 1/4-IN VERY DARK GRAY (5Y 3/1) LENSES*	
25		/	3 2 2	5				*FINE TO MEDIUM GRAINED*	
							ML	*SANDY SILT; DARK GRAY (5Y 4/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS,*	
30									

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CONTINUED LOG OF BORING B-7

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 75 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~71.9%, $N_{60} \sim \frac{71.9}{60}$*N~1.20*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			6 9 11	24			ML	**MARINE BAY DEPOSITS (Qmo):** *SILT WITH SAND; DARK GRAY (5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS, ABUNDANT SHELL FRAGMENTS*	SA
35			1 1 1	2				*VERY LOOSE*	
40			3 2 3	6			SM	*SILTY SAND; DARK GRAY (5Y 4/1), WET, LOOSE, FINE TO MEDIUM GRAINED SAND, MICACEOUS, WITH SOME FAT CLAY*	
							CH	**OLD PARALIC DEPOSITS (Qop_1):** *FAT CLAY; DARK GRAY (5Y 4/1), WET, SOFT TO MEDIUM STIFF, PP = 0.5 TSF*	
45			5 6 7	16				*STIFF TO VERY STIFF, PP = 2.0*	
50			7 8 13	25			SC	**OLD PARALIC DEPOSITS (Qop_2):** *CLAYEY SAND; MOTTLED YELLOWISH BROWN (10YR 5/4) AND OLIVE BROWN (2.5YR 4/3), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
								FAT CLAY SMEAR	
55			12 24 21	54			SP	*POORLY GRADED SAND; OLIVE BROWN (2.5YR 4/3), WET, VERY DENSE, MEDIUM TO COARSE GRAINED, SLIGHTLY MICACEOUS*	
							SP-SM	*POORLY GRADED SAND WITH SILT; OLIVE BROWN (2.5Y 4/3), WET, VERY DENSE, MEDIUM TO COARSE GRAINED, SLIGHTLY MICACEOUS*	
60								*FAT CLAY SMEAR*	

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.16

CONTINUED LOG OF BORING B-7

DATE DRILLED: 4/19/2024 **DRILLING EQUPMENT:** CME 75 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 13½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 11 **NOTES:** ETR~71.9%, $N_{60} \sim \frac{71.9}{60}$*N~1.20*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60		⁄	14 22 33	66			SP-SM	**OLD PARALIC DEPOSITS (Qop_2):** *POORLY GRADED SAND WITH SILT; OLIVE BROWN (2.5YR 4/3), WET, VERY DENSE, MEDIUM TO COARSE GRAINED, SLIGHTLY MICACEOUS*	
								BORING TERMINATED AT 61½ FT. GROUNDWATER ENCOUNTERED AT 11 FT. BACKFILLED WITH BENTONITE.	
65									
70									
75									
80									
85									
90									

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TOPGOLF HARBOR ISLAND
NORTH HARBOR DRIVE AND LIBERATOR WAY
SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.17

LOG OF BORING B-8

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*6 IN ASPHALT CONCRETE*	
	X						SM	**FILL (af):** *SILTY SAND; DARK YELLOWISH BROWN (10YR 3/6), MOIST, MEDIUM DENSE, FINE TO COARSE GRAINED, MICACEOUS* *WITH GRAVEL, STRONG BROWN (7.5 4/6)* *GRAYISH BROWN, NO GRAVEL*	SA
5			3 5 6	15				*OLIVE BROWN (5Y 3/5), WITH SOME CLAY*	
10 ▼			PUSH 1 1	3			ML	*VERY DARK GRAY (5Y 3/1), WET* **MARINE BAY DEPOSITS (Qmo):** *SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED SAND, MICACEOUS*	
15			PUSH	0					
20			3 4 4	11				*SLIGHT ORGANIC, SULFURIC ODOR*	
							SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS, TRACE SHELL FRAGMENTS*	CR
25			9 8 13	29				*DARK GRAY (5Y 4/1)*	CR
							ML	*SANDY SILT; DARK GRAY (5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
30									

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.18

CONTINUED LOG OF BORING B-8

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
30			5 6 7	18			CH/ ML/ SM	**MARINE BAY DEPOSITS (Qmo):** *INTERBEDDED FAT CLAY, SANDY SILT, SILTY SAND; DARK GRAY (5Y 4/1), WET, VERY STIFF AND MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
35			4 7 5	17			SM	*SILTY SAND; DARK GRAY (5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS*	
							ML	*SANDY SILT; DARK GRAY (5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS, TRACE SHELL FRAGMENTS*	
40			5 4 4	11			SM	*SILTY SAND; DARK GRAY (5Y 4/1), WET, MEDIUM DENSE, FINE GRAINED SAND, MICACEOUS SHELL FRAGMENTS*	
							CH	**OLD PARALIC DEPOSITS (Qop_1):** *FAT CLAY; DARK GRAY (5Y 4/1), WET, STIFF*	
45			5 5 9	19				*STIFF, PP=1.75 TSF* *TRACE BROWN (10YR 4/3) INCLUSION, VERY STIFF, PP=2.5 TSF*	
50			4 7 7	19				*GRAY (5Y 5/1), VERY STIFF, PP=2.5 TSF*	
55			10 9 11	28				*DARK YELLOWISH BROWN (10YR 4/4), STIFF, PP = 1.5 TSF*	
							SC	**OLD PARALIC DEPOSITS (Qop_2):** *CLAYEY SAND; DARK YELLOWISH BROWN (10YR 3/4), WET, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS*	SA
							SM	*SILTY SAND; DARK YELLOWISH BROWN (10YR 3/4), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS*	
60									

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SAN DIEGO, CALIFORNIA

DRAFTED BY:GN | PROJECT: 2024034 | FIGURE: B.19

CONTINUED LOG OF BORING B-8

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14½ MLLW **DRILLING METHOD:** HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
60		⧸	6 8 10	25			SM	**OLD PARALIC DEPOSITS (Qop_2)**: *SILTY SAND; OLIVE BROWN (2.5YR 4/3), WET, MEDIUM DENSE, FINE GRAINED, MICACEOUS* *LIGHT OLIVE BROWN (2.5Y 5/3)*	
								BORING TERMINATED AT 61½ FT. GROUNDWATER ENCOUNTERED AT 10 FT. BACKFILLED WITH BENTONITE.	
65									
70									
75									
80									
85									
90									

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DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.20

LOG OF BORING B-9

DATE DRILLED: 4/23/2024 **DRILLING EQUPMENT:** CME 85 **SAMPLE METHOD:** HAMMER: 140 LBS., DROP: 30 IN (AUTO)

ELEVATION (FT): ± 14 MLLW **DRILLING METHOD:** HAND AUGER/HOLLOW STEM AUGER **LOGGED BY:** GN

GROUNDWATER DEPTH (FT): 10 **NOTES:** ETR~82.8%, $N_{60} \sim \frac{82.8}{60}$*N~1.38*N **REVIEWED BY:** MS/GD/AN

DEPTH (FT)	BULK SAMPLE	CAL/SPT SAMPLE	BLOWS PER 6 IN N	N_{60}	MOISTURE (%)	DRY DENSITY (pcf)	SOIL CLASS. (USCS)	SOIL DESCRIPTION *SUMMARY OF SUBSURFACE CONDITIONS* *(USCS; COLOR, MOISTURE, DENSITY, GRAIN SIZE, OTHER)*	LAB TESTS
0								*6 IN ASPHALT CONCRETE*	
							SM	**FILL (af):** *SILTY SAND; DARK YELLOWISH BROWN (10YR 4/6), MOIST, MEDIUM DENSE, FINE TO MEDIUM GRAINED, MICACEOUS, ABOUT 15% COBBLES*	SA AL EI
								GRAY (5YR 3/1) WITH DARK REDDISH BROWN STAINING (5YR 3/4), MOIST, LOOSE TO MEDIUM DENSE, FINE GRAINED, WITH SHELL FRAGMENTS	
5			4 4 4	11				*GRAYISH BROWN (2.5Y 5/2), MEDIUM DENSE*	
								OLIVE BROWN (2.5YR 4/3)	
10			5 2 2	6			SM	**MARINE BAY DEPOSITS (Qmo):** *SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED, MICACEOUS*	
							ML	*SANDY SILT; VERY DARK GRAY (5Y 3/1), WET, LOOSE, FINE GRAINED SAND, MICACEOUS*	
15			PUSH 1 1	3			SM	*SILTY SAND; VERY DARK GRAY (5Y 3/1), WET, VERY LOOSE, FINE GRAINED, MICACEOUS, WITH A 3-IN LENS OF SANDY SILT*	
								BORING TERMINATED AT 16½ FT. GROUNDWATER ENCOUNTERED AT 10 FT. BACKFILLED WITH BENTONITE.	
20									
25									
30									

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TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

DRAFTED BY:GN	PROJECT: 2024034	FIGURE: B.21

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CPT DATA AND LIQUEFACTION ANALYSIS

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NOVA Services, Inc.

LIQUEFACTION ANALYSIS REPORT

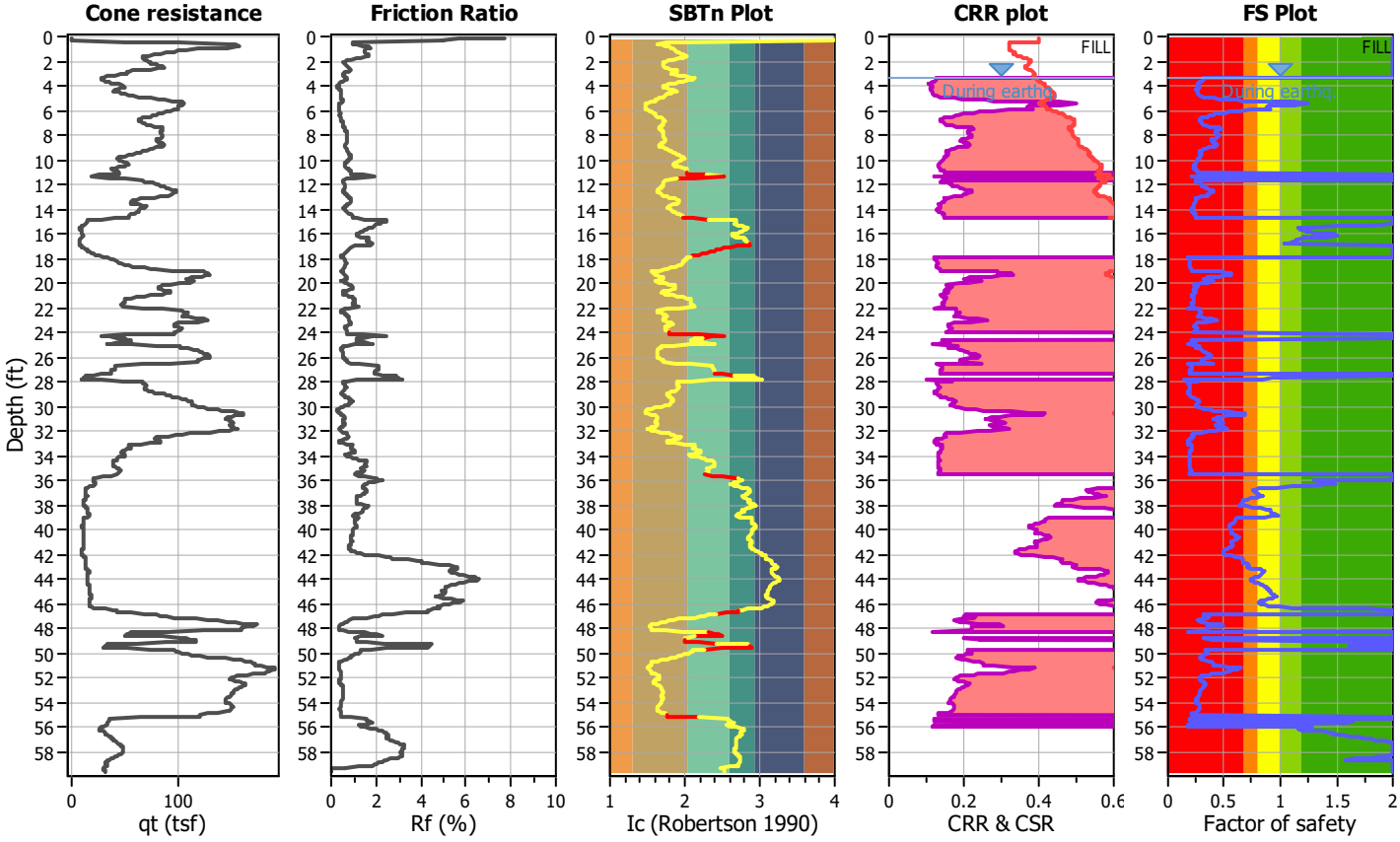
Project title : Topgolf Harbor Island

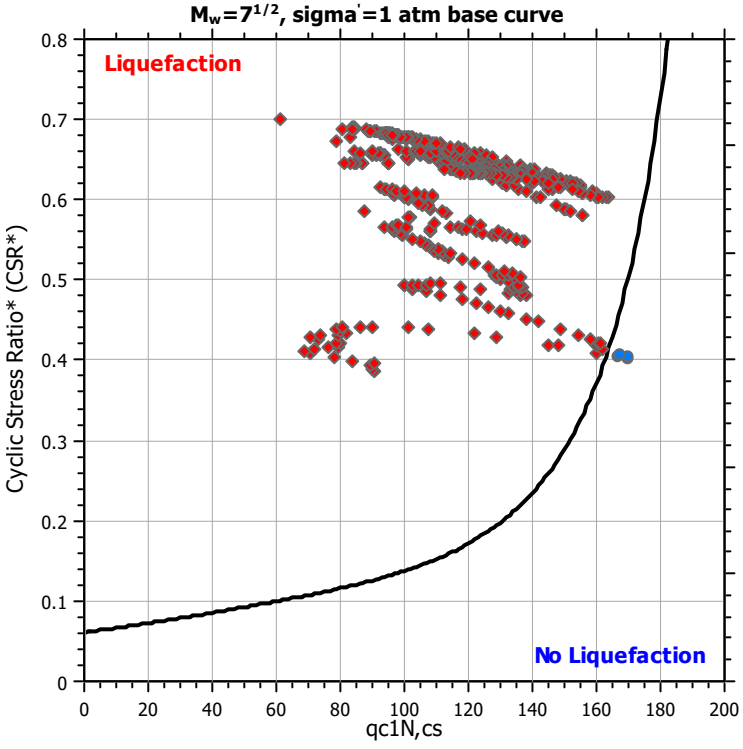
Location : North Harbor Drive and Liberator Way, San Diego, CA

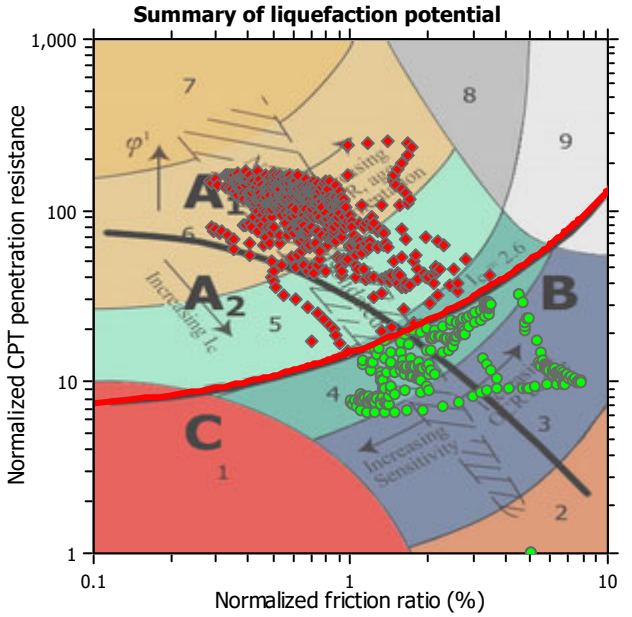
CPT file : CPT-2 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.28 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.34 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

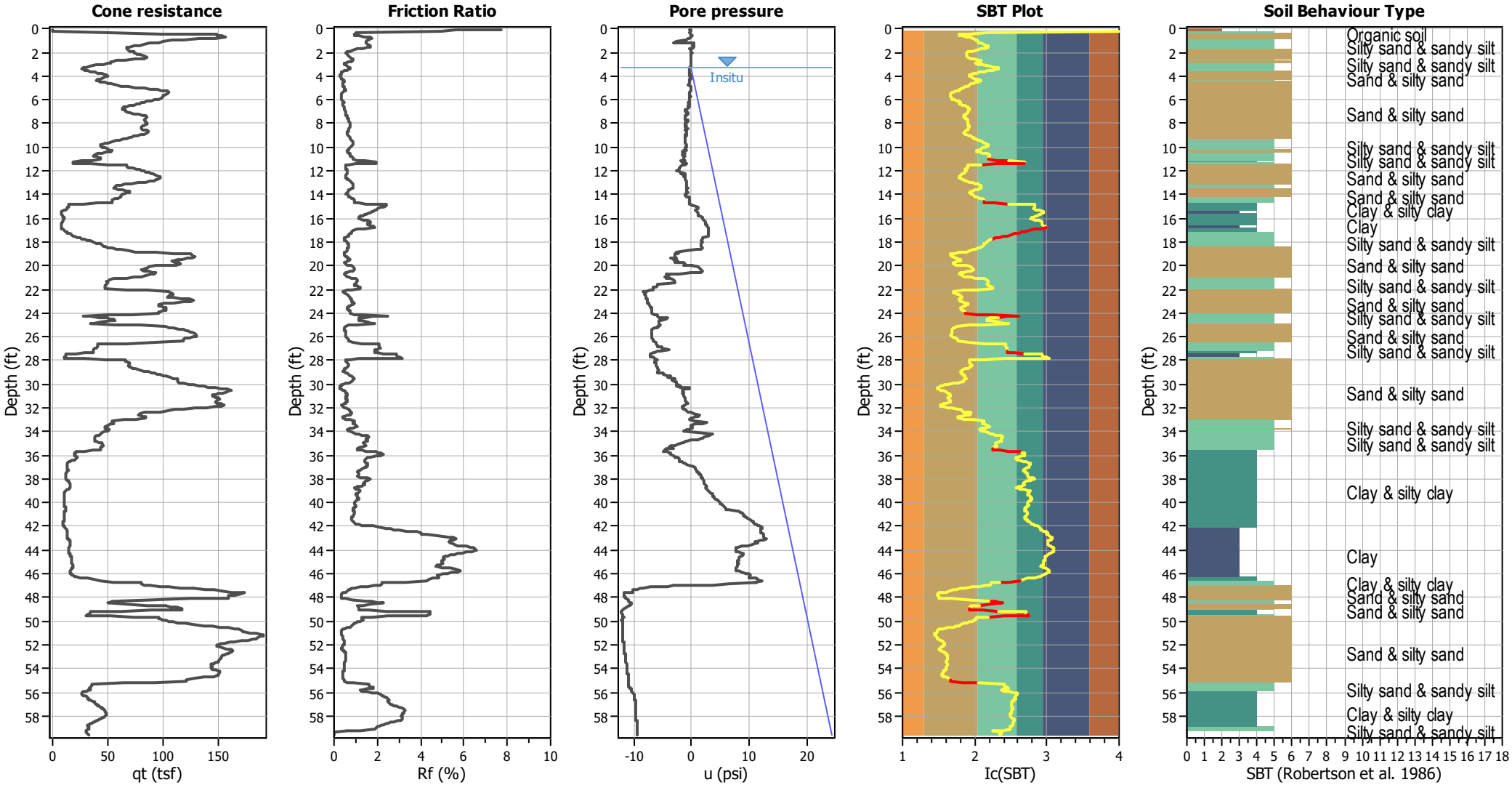






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



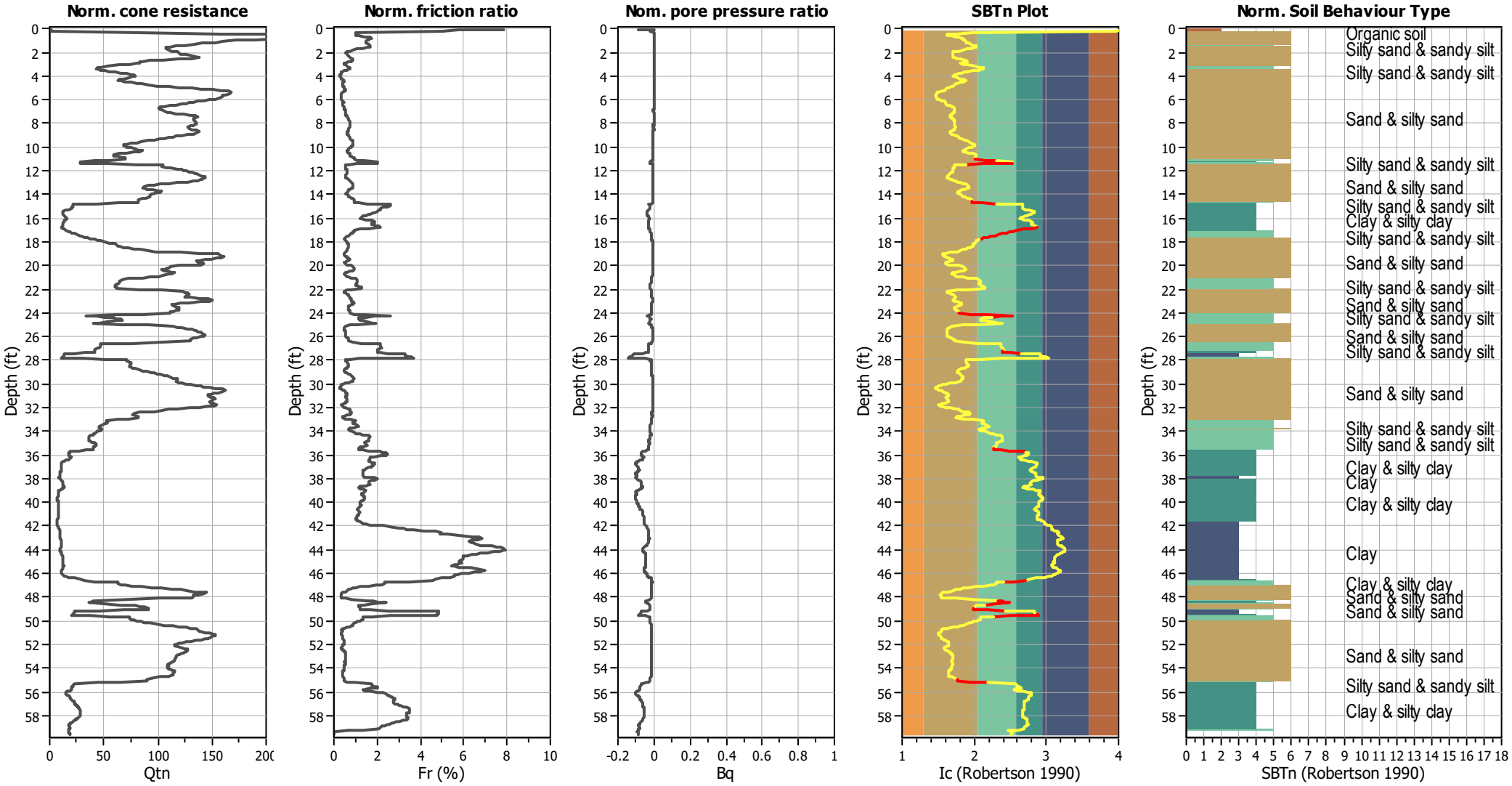
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 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)



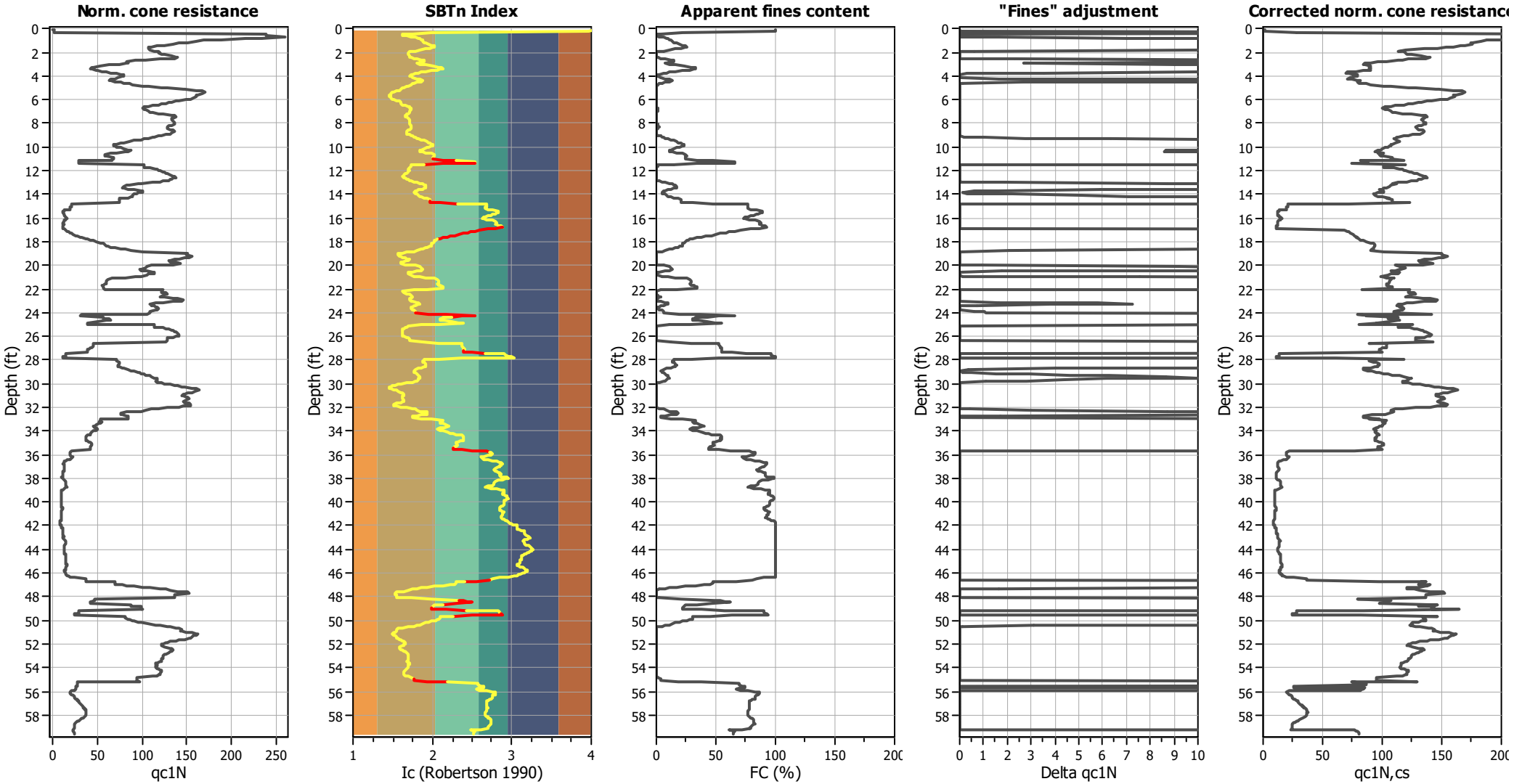
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 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

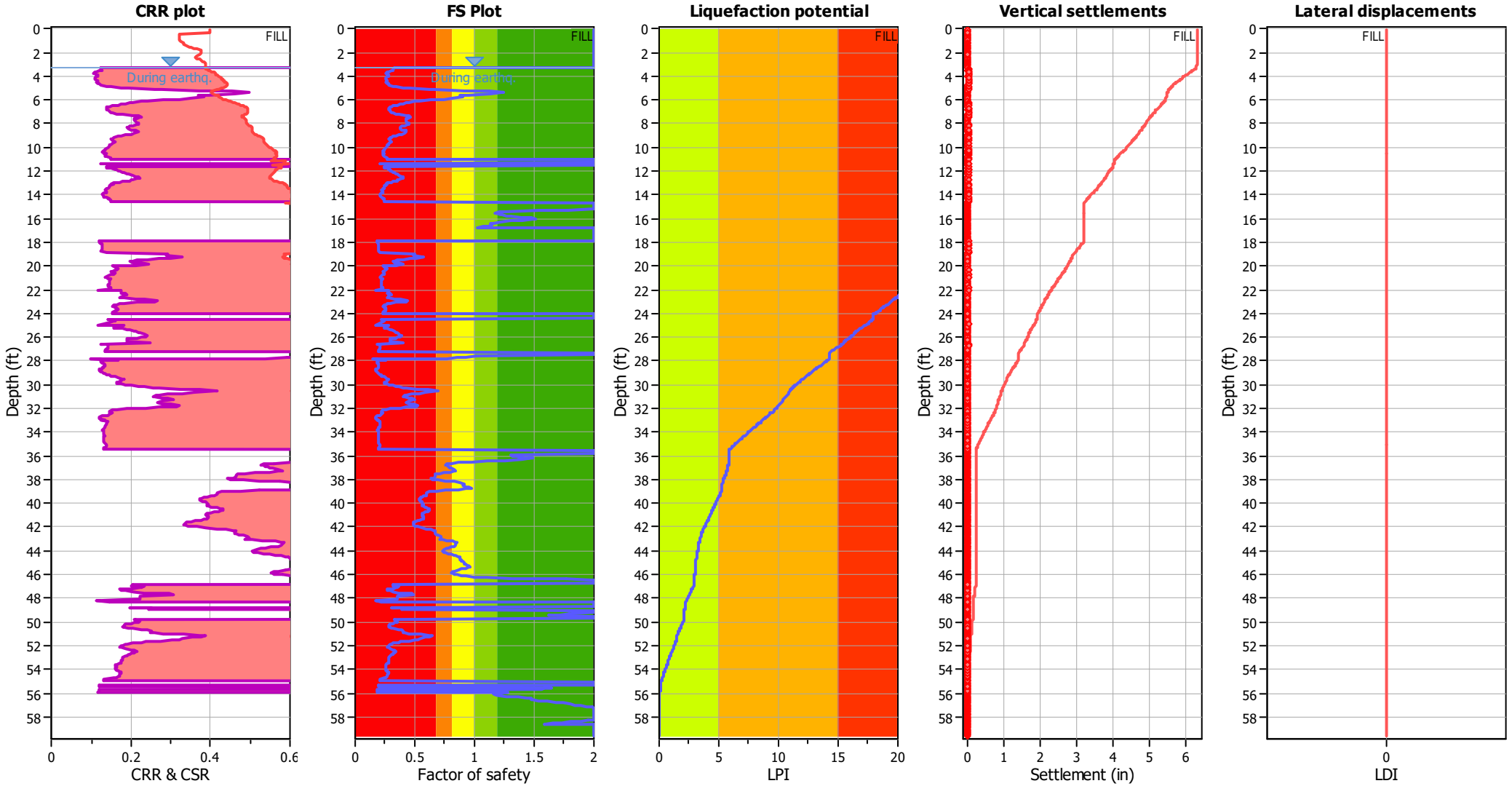
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 ft	Limit depth:	60.00 ft

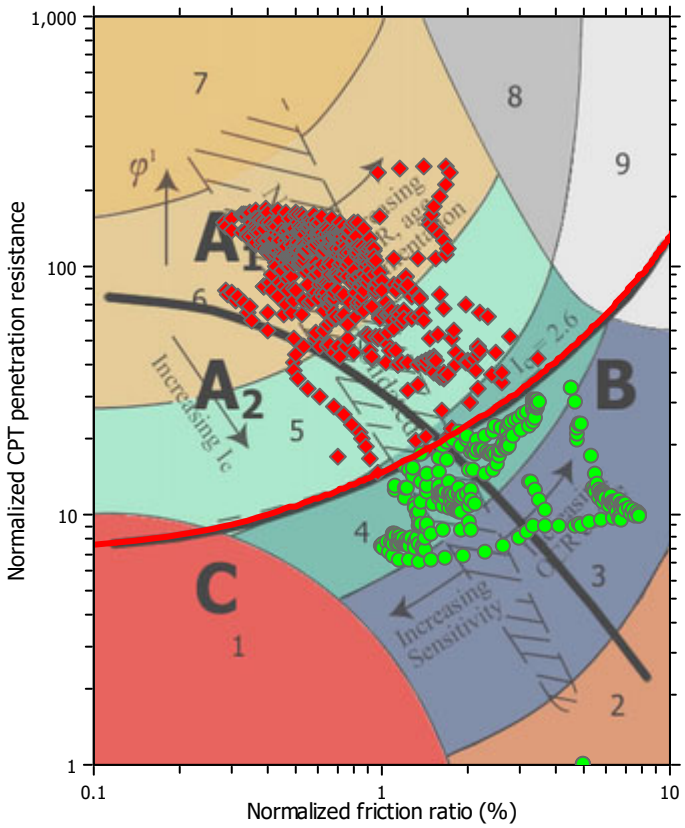
F.S. color scheme

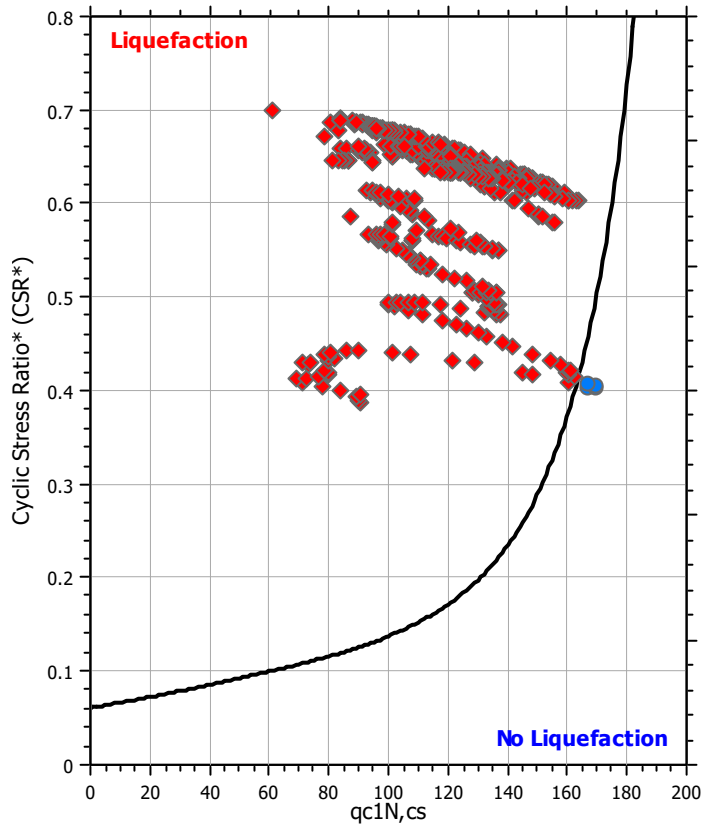
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

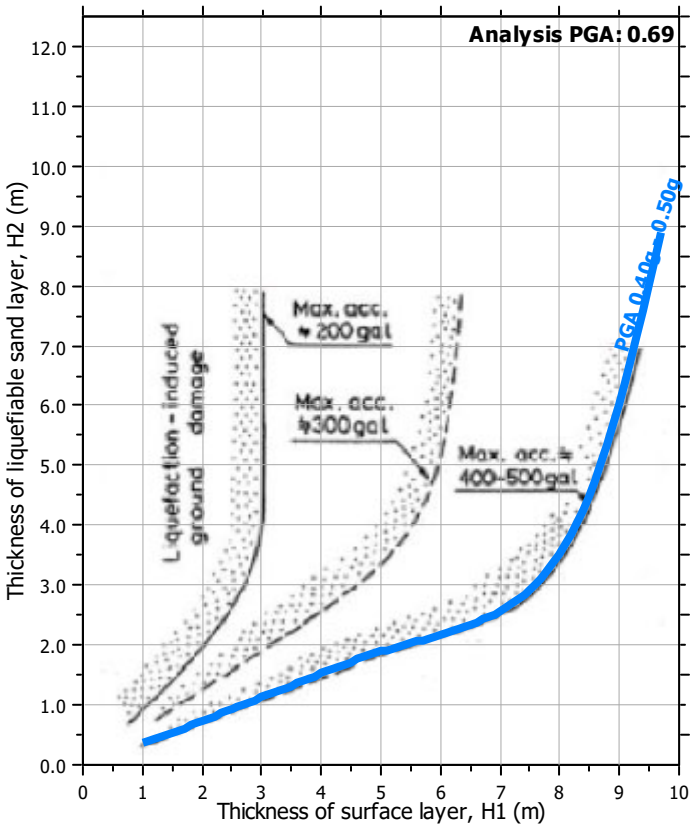
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



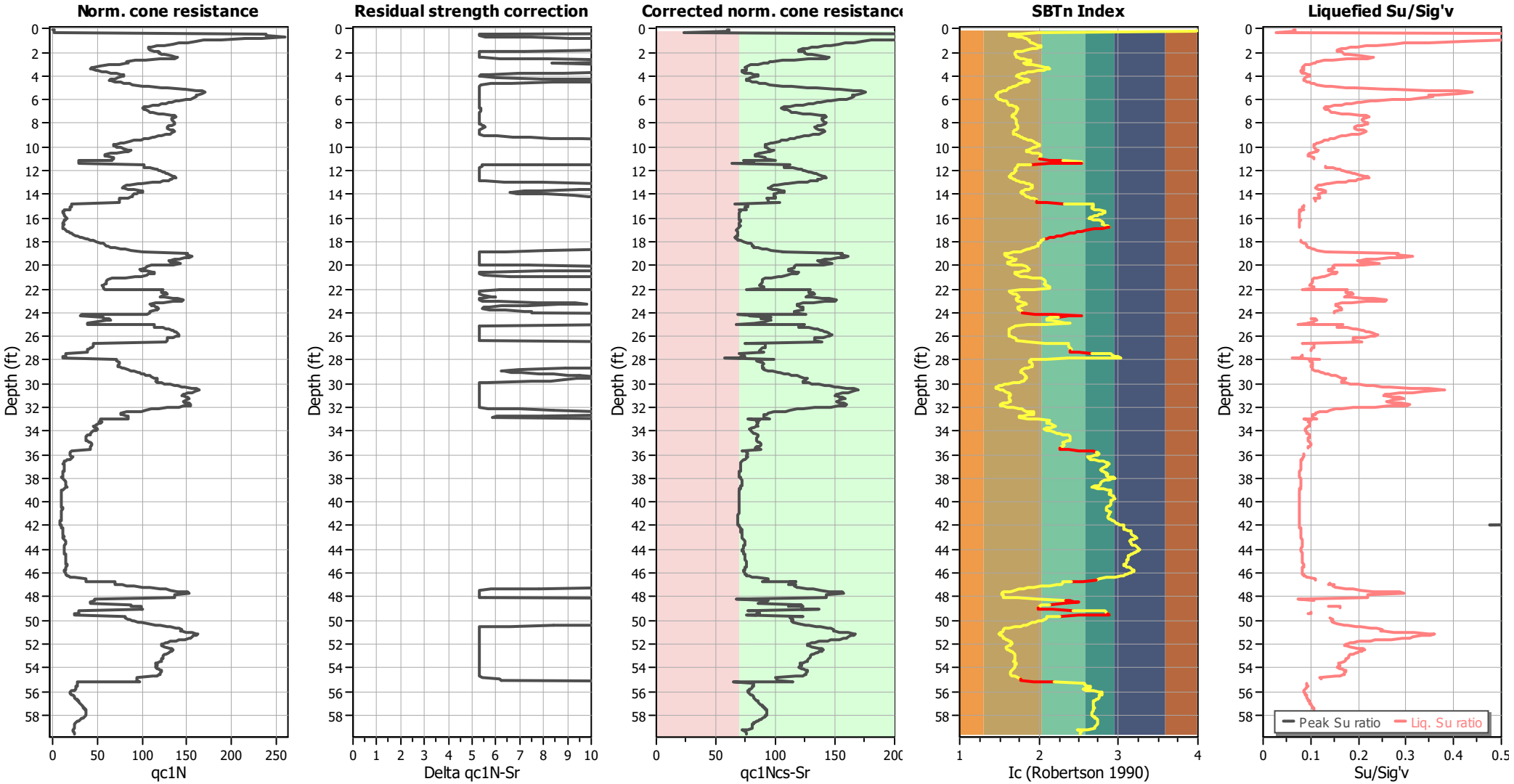




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

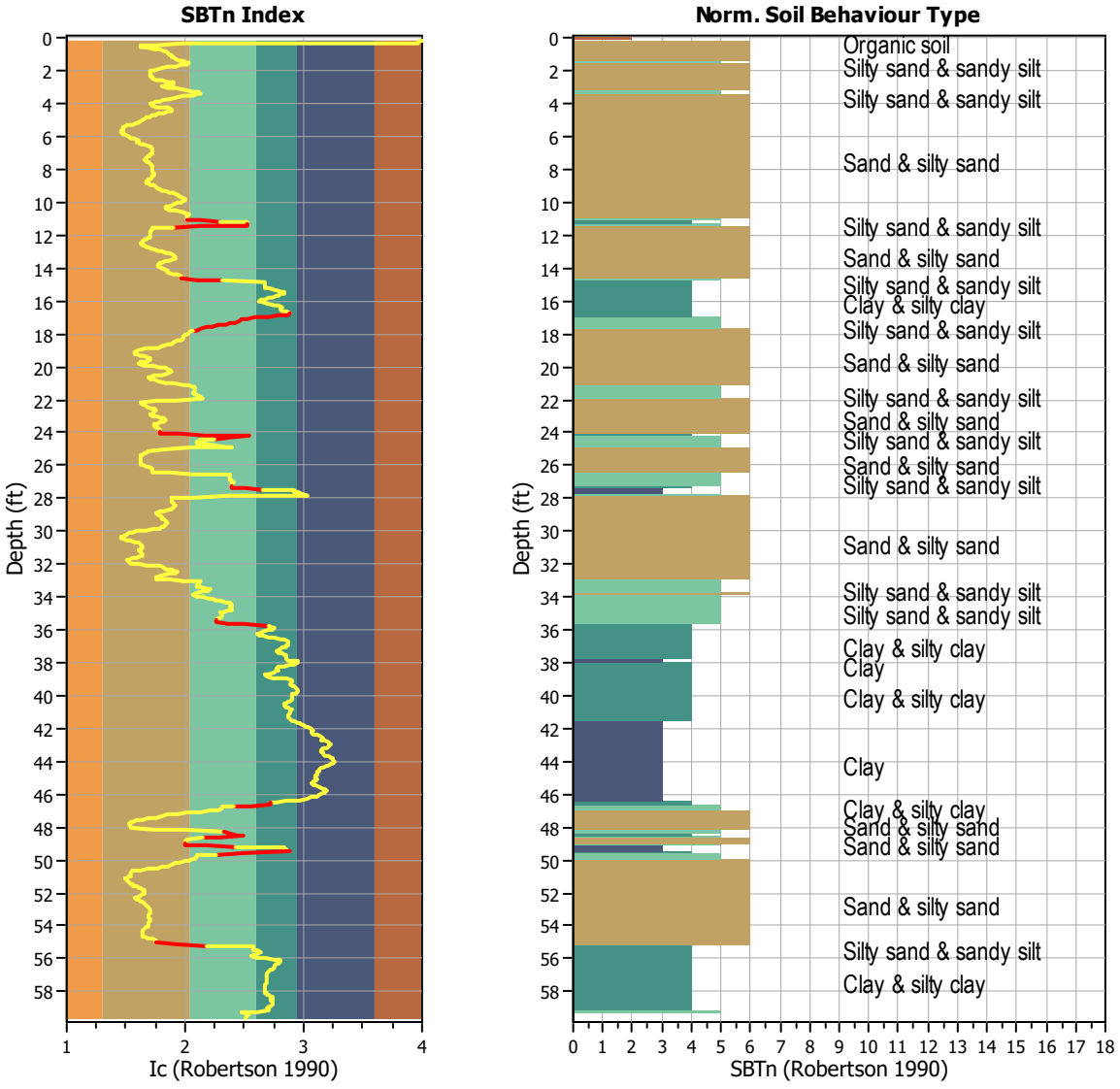
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.28 ft	Fill height:	1.34 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

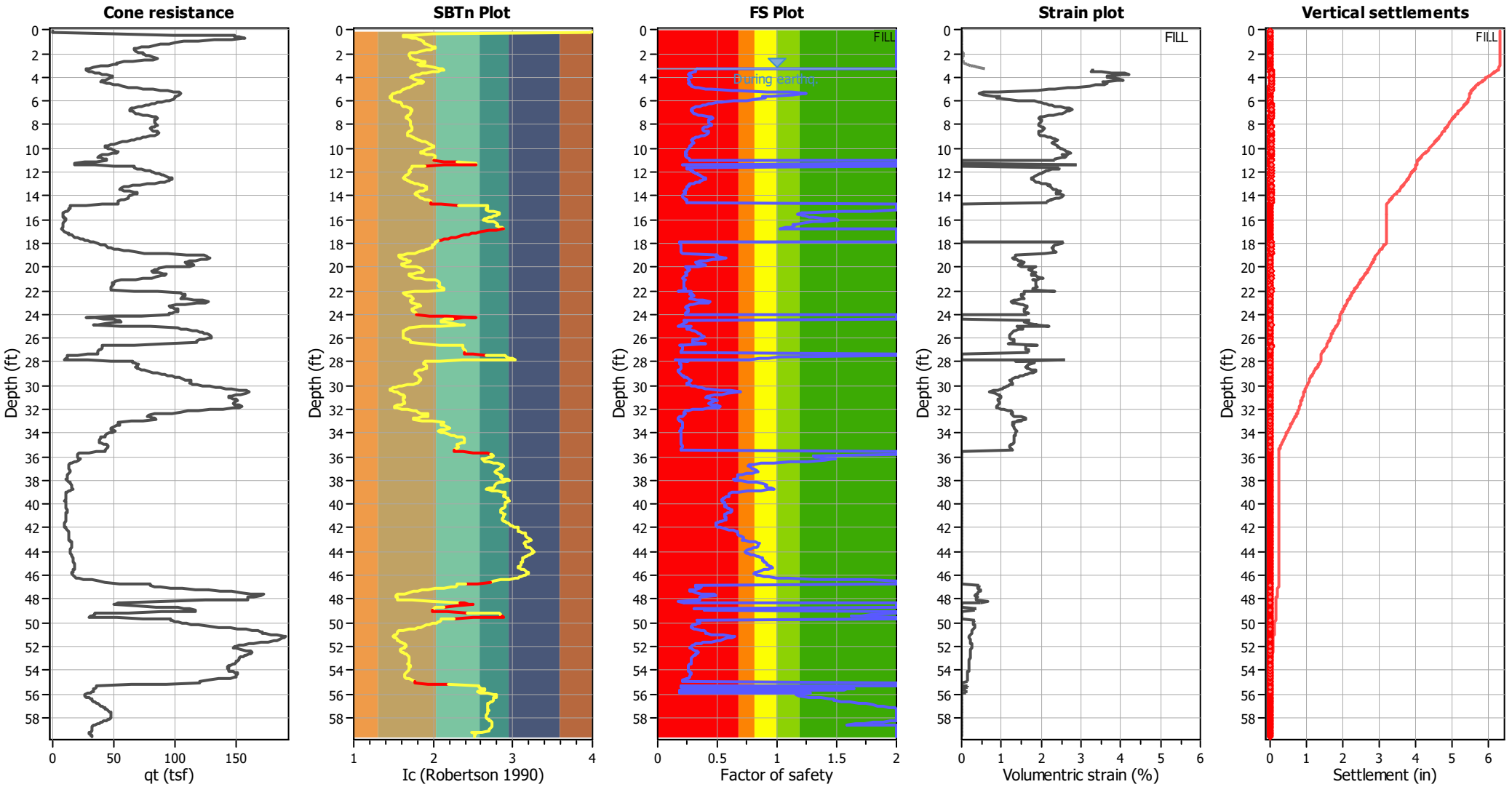
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	907
I_c maximum check value:	3.00	Total points excluded:	71
I_c change ratio value:	0.0250	Exclusion percentage:	7.83%
Minimum number of points in layer:	4	Number of layers detected:	14

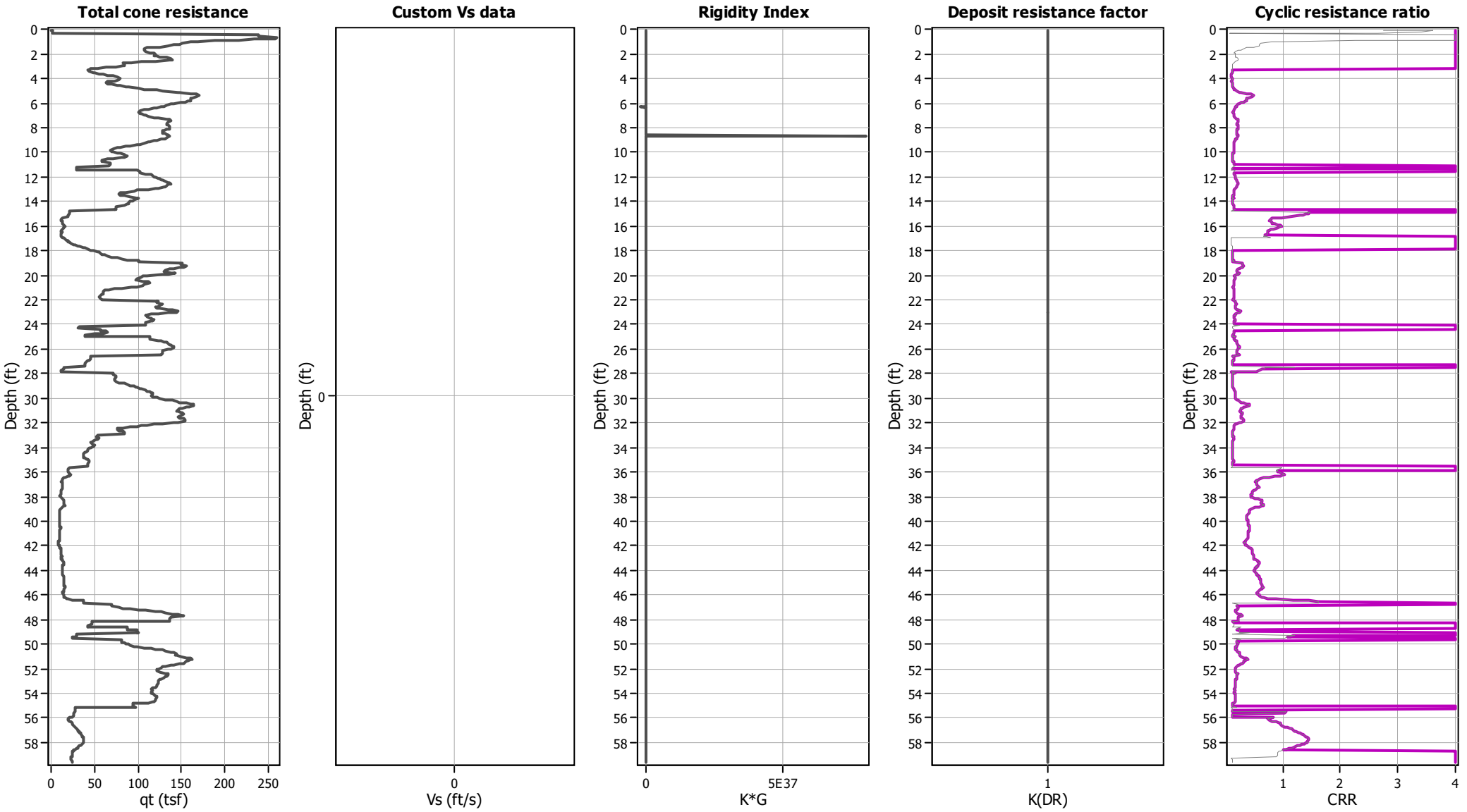
Estimation of post-earthquake settlements



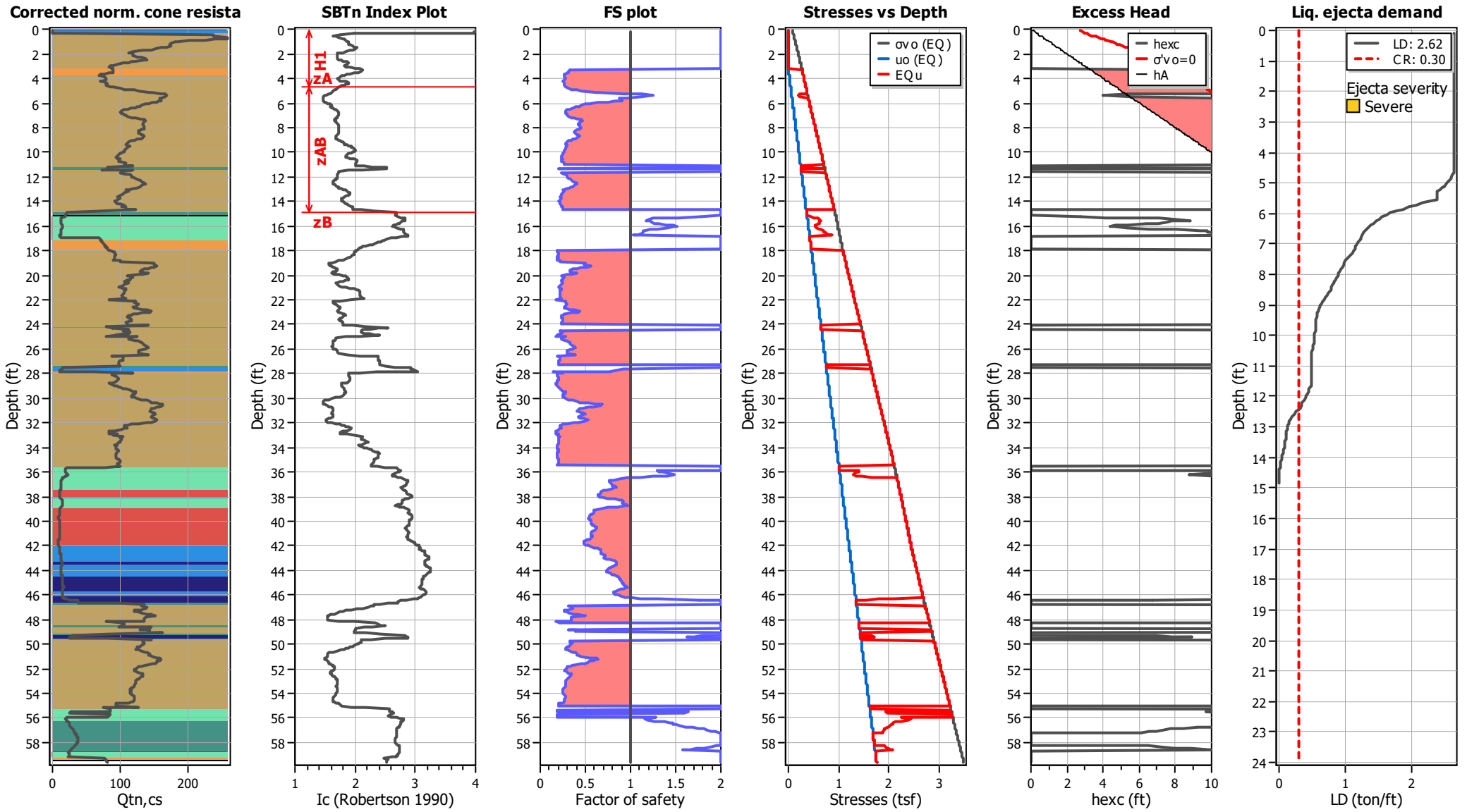
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

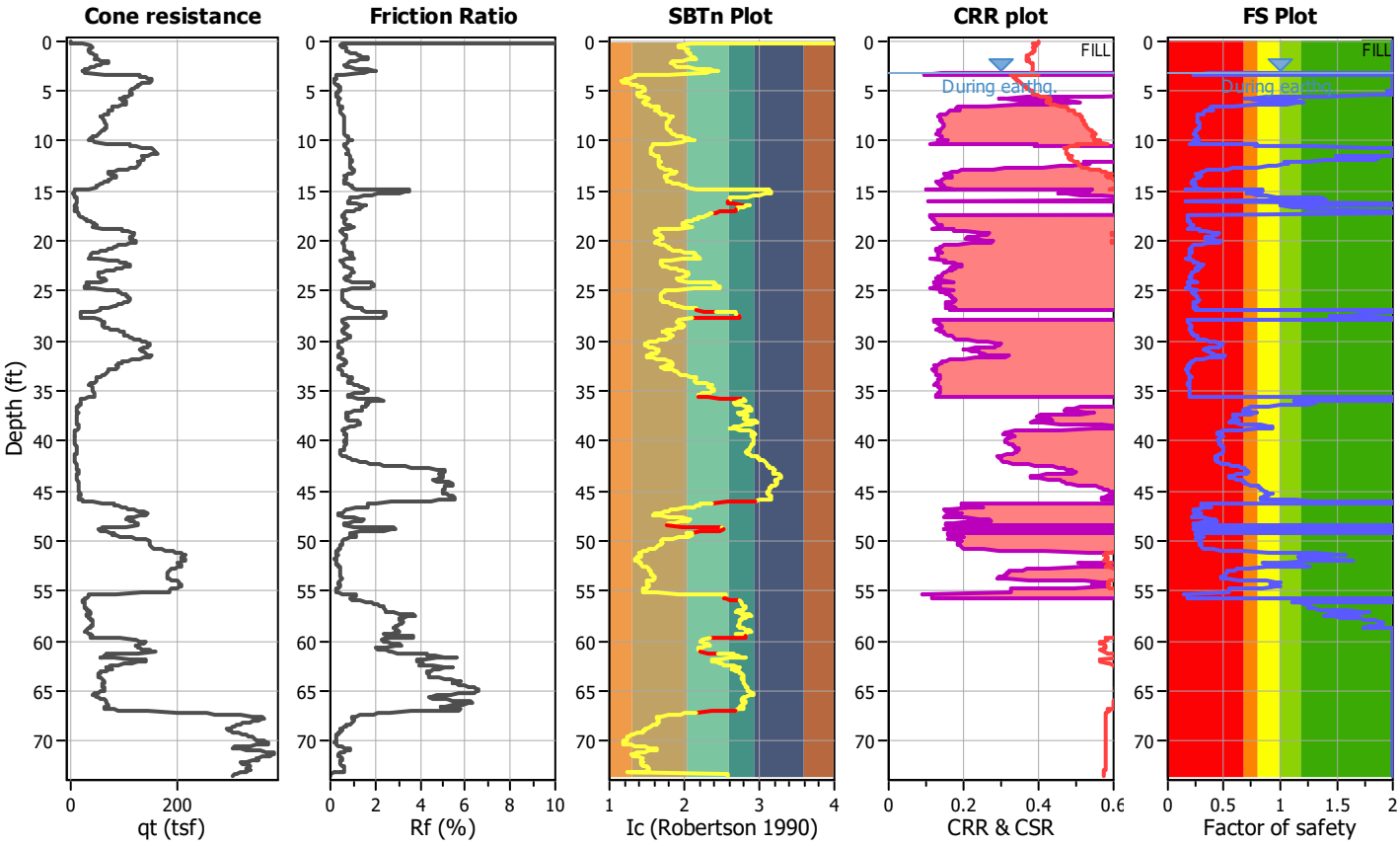
Project title : Topgolf Harbor Island

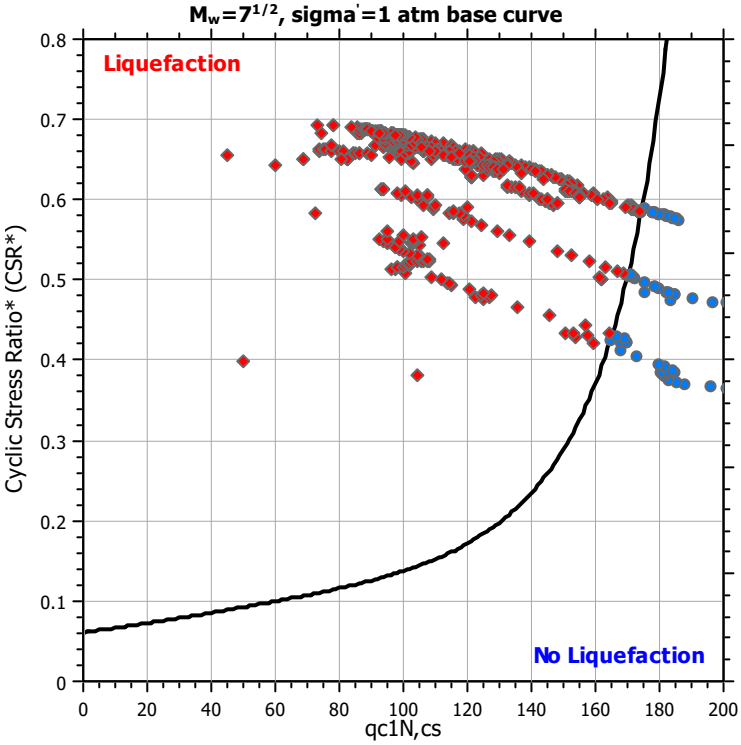
Location : North Harbor Drive and Liberator Way, San Diego, CA

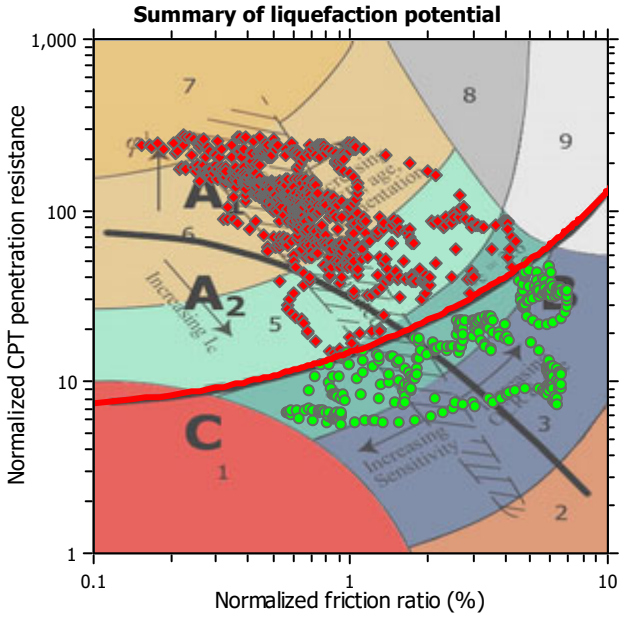
CPT file : CPT-3 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.26 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.36 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

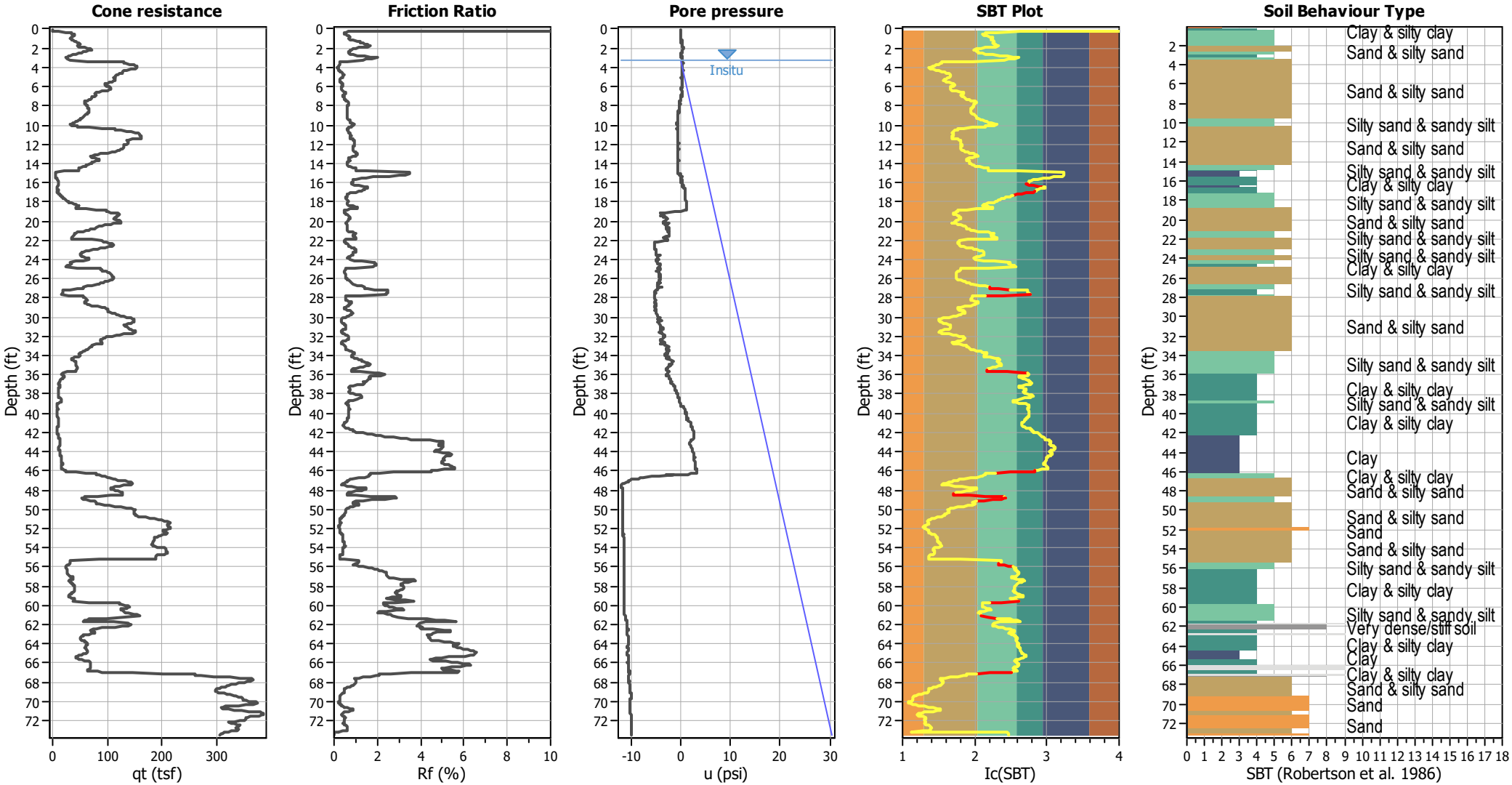






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



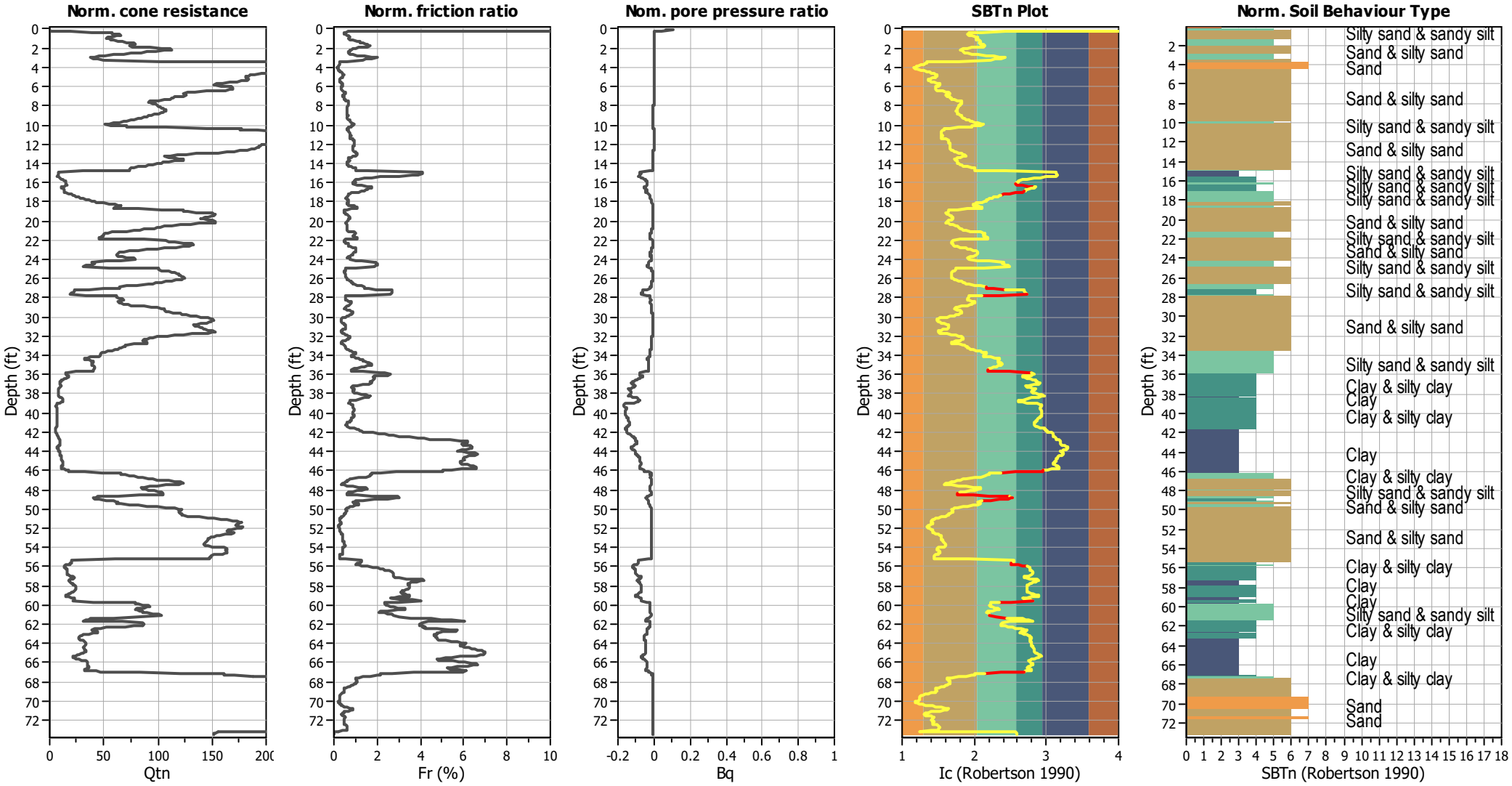
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 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)



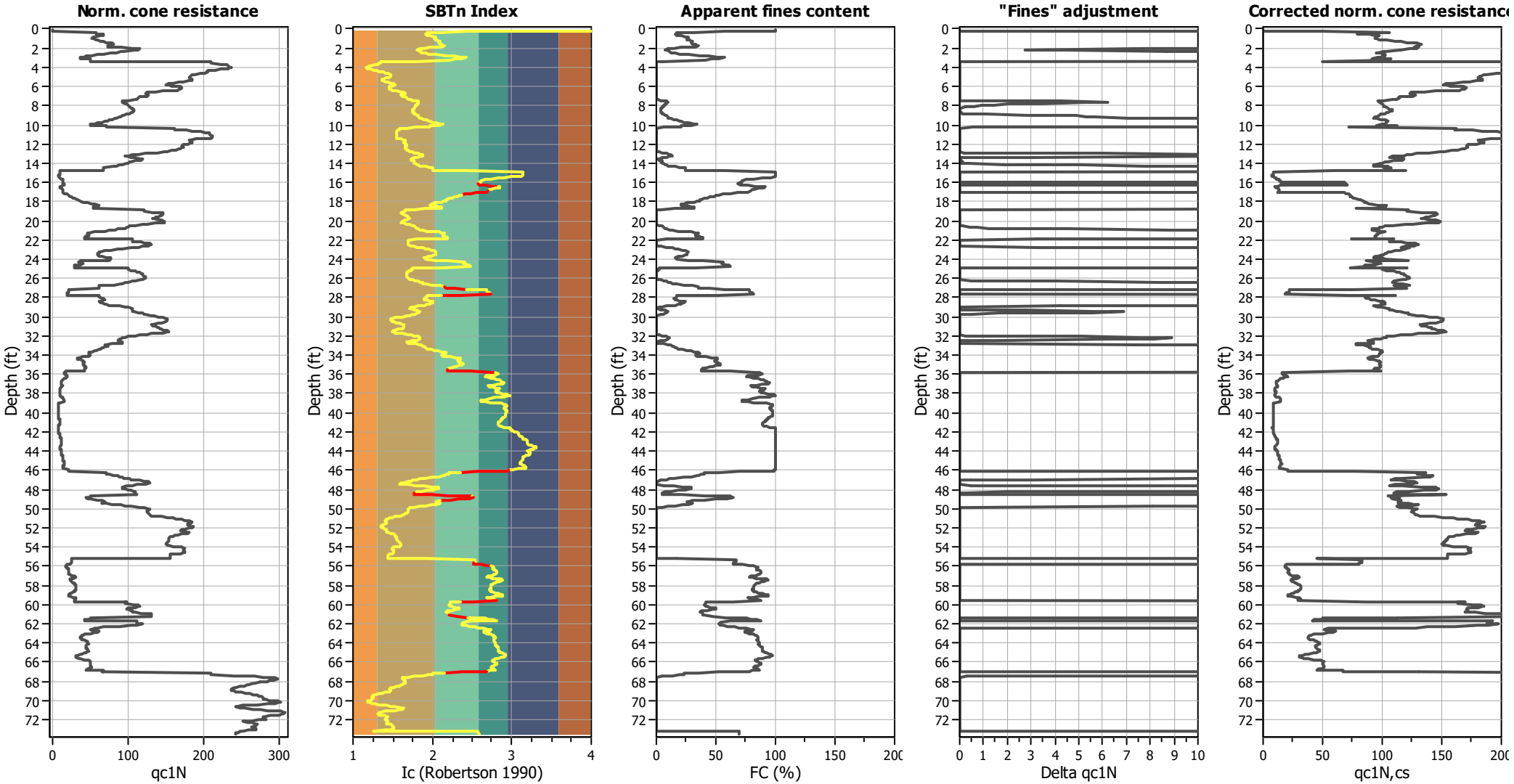
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 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

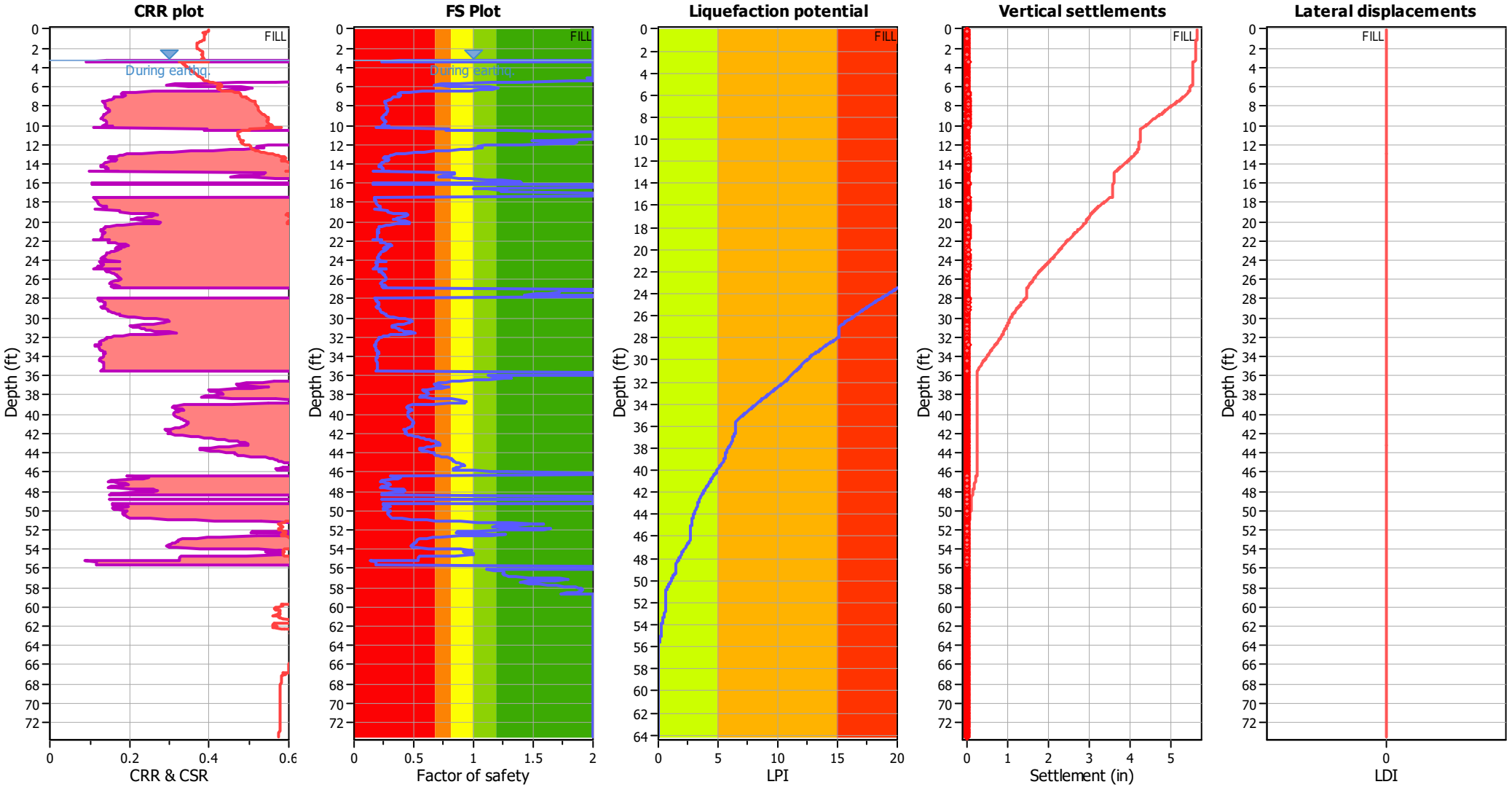
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 ft	Limit depth:	60.00 ft

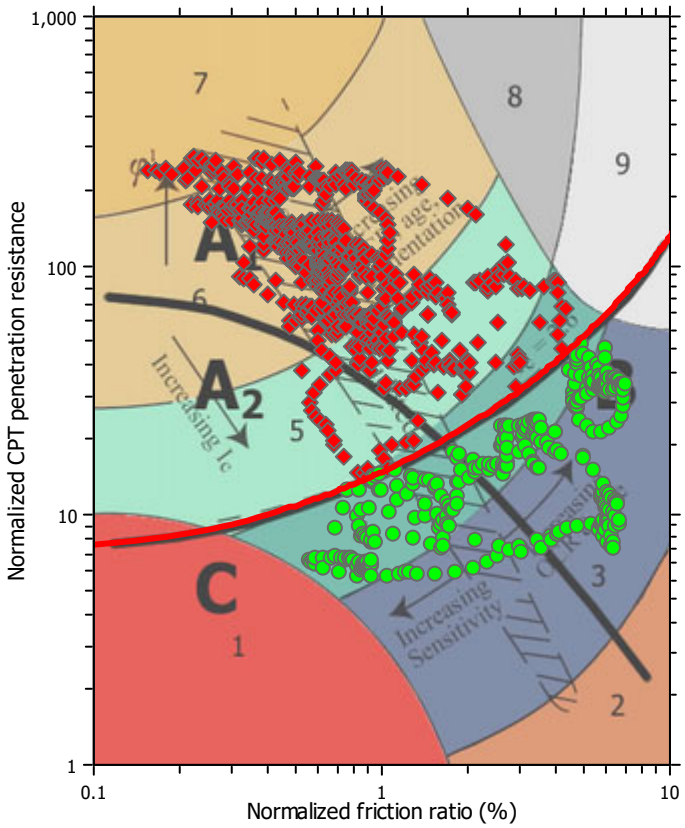
F.S. color scheme

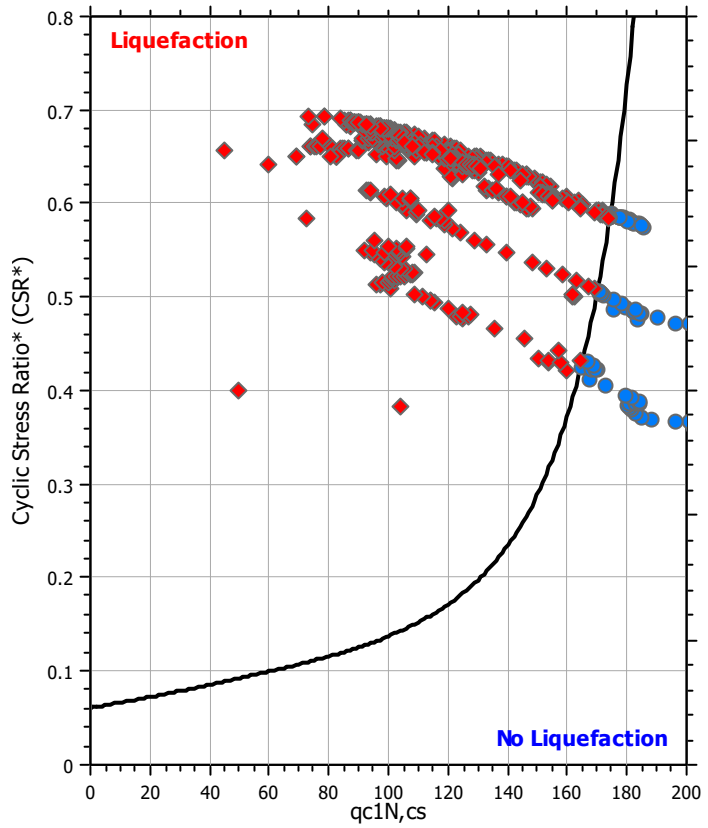
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

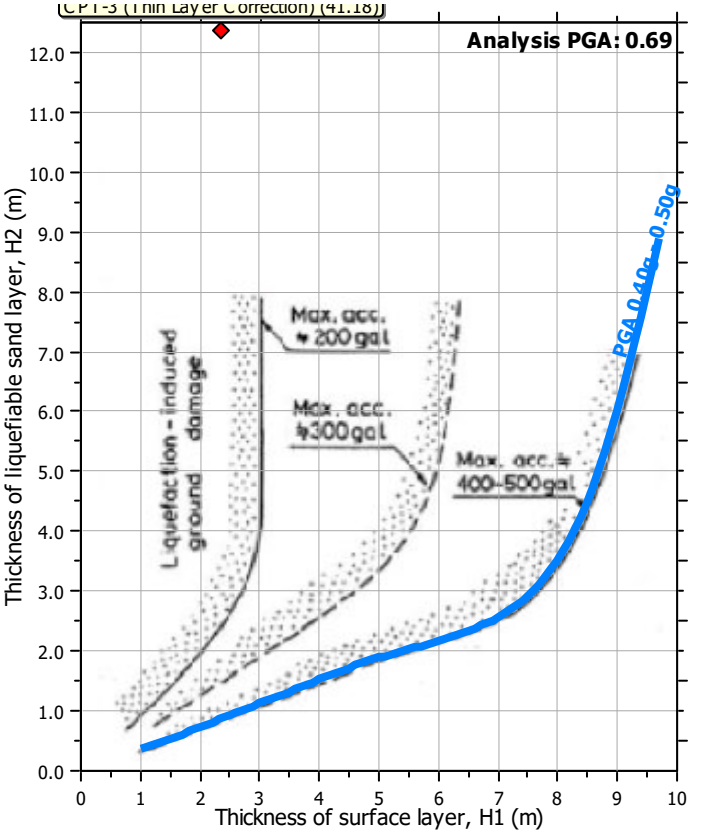
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



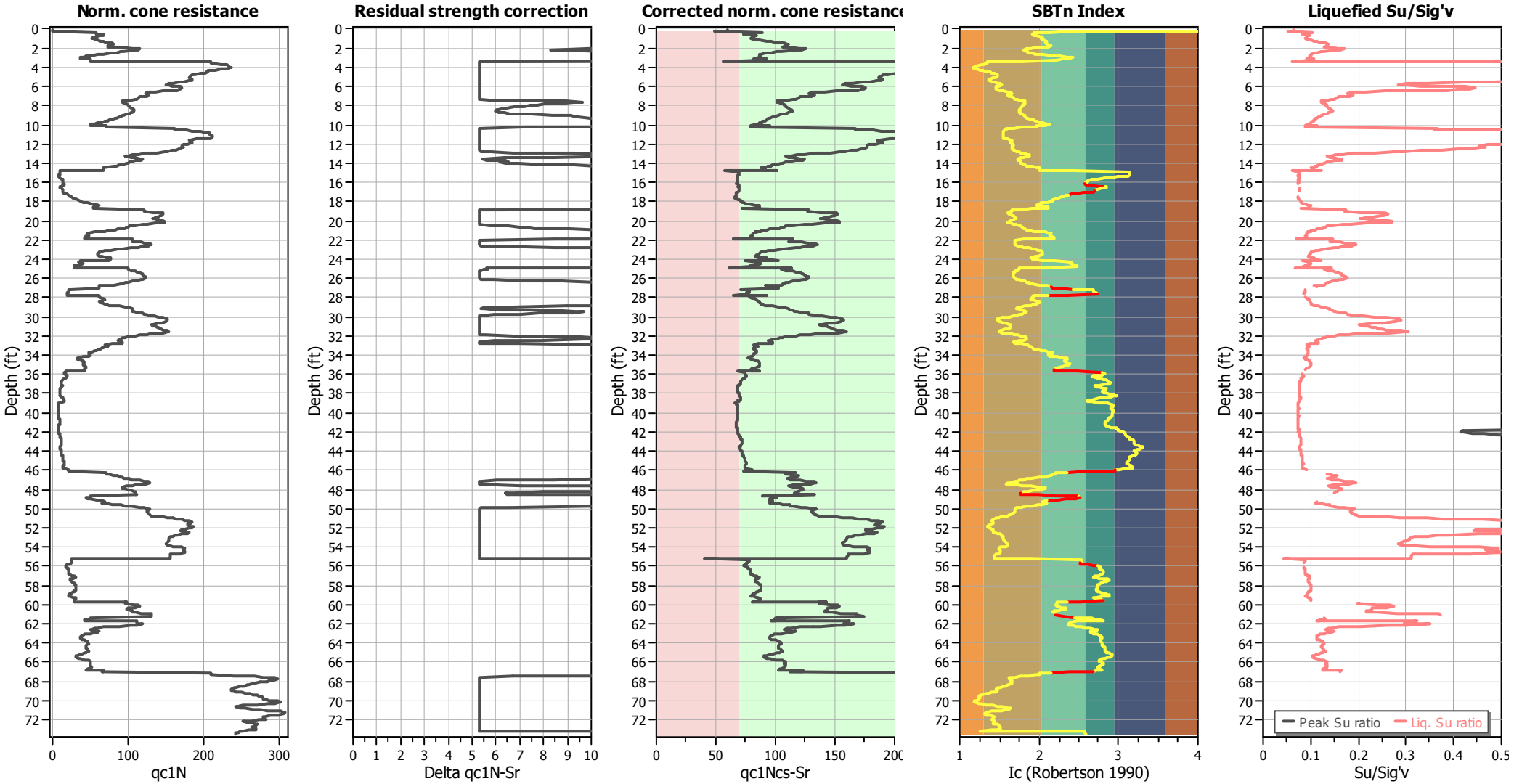




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

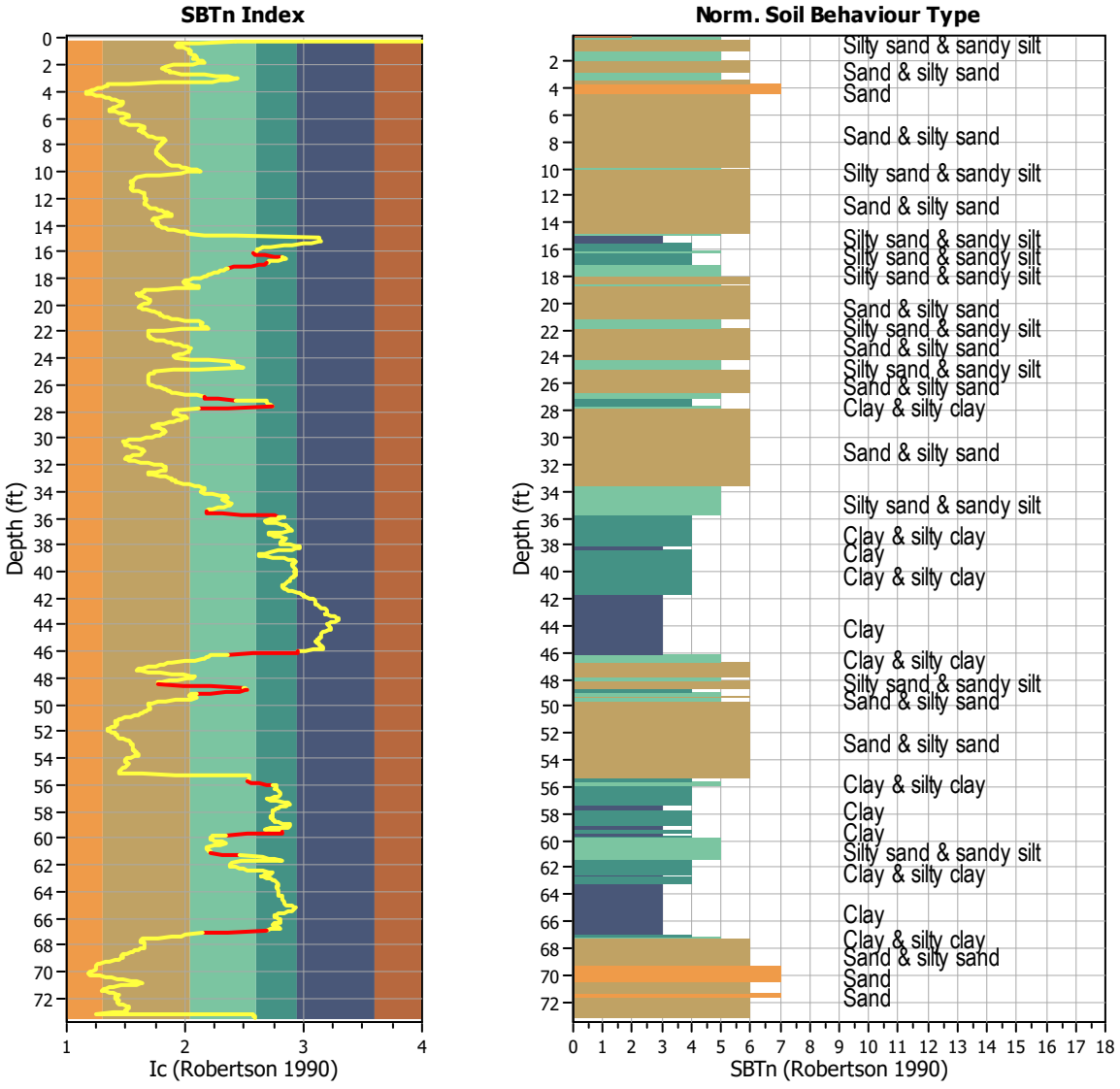
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.26 ft	Fill height:	1.36 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

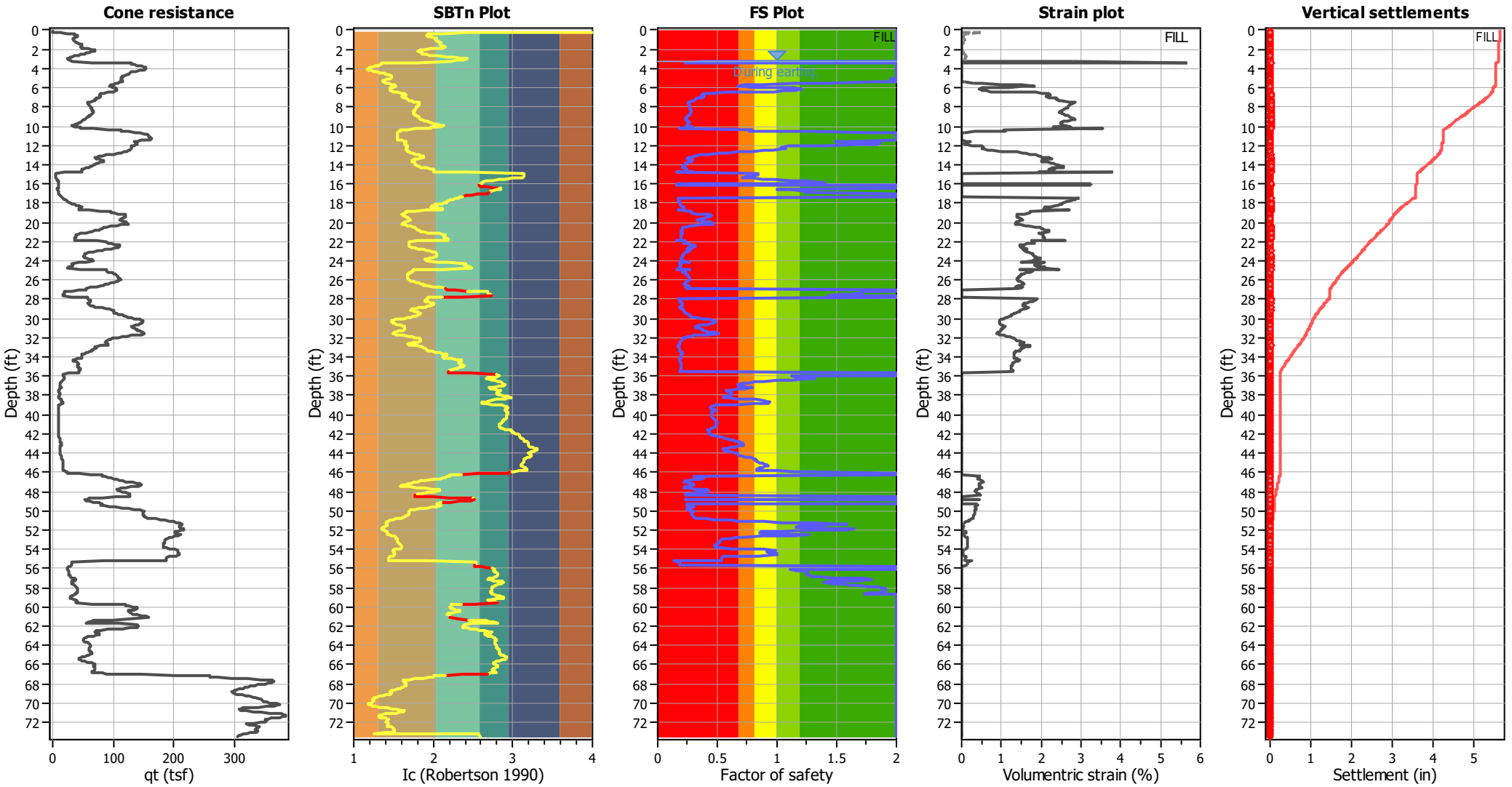
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1118
I_c maximum check value:	3.00	Total points excluded:	60
I_c change ratio value:	0.0250	Exclusion percentage:	5.37%
Minimum number of points in layer:	4	Number of layers detected:	12

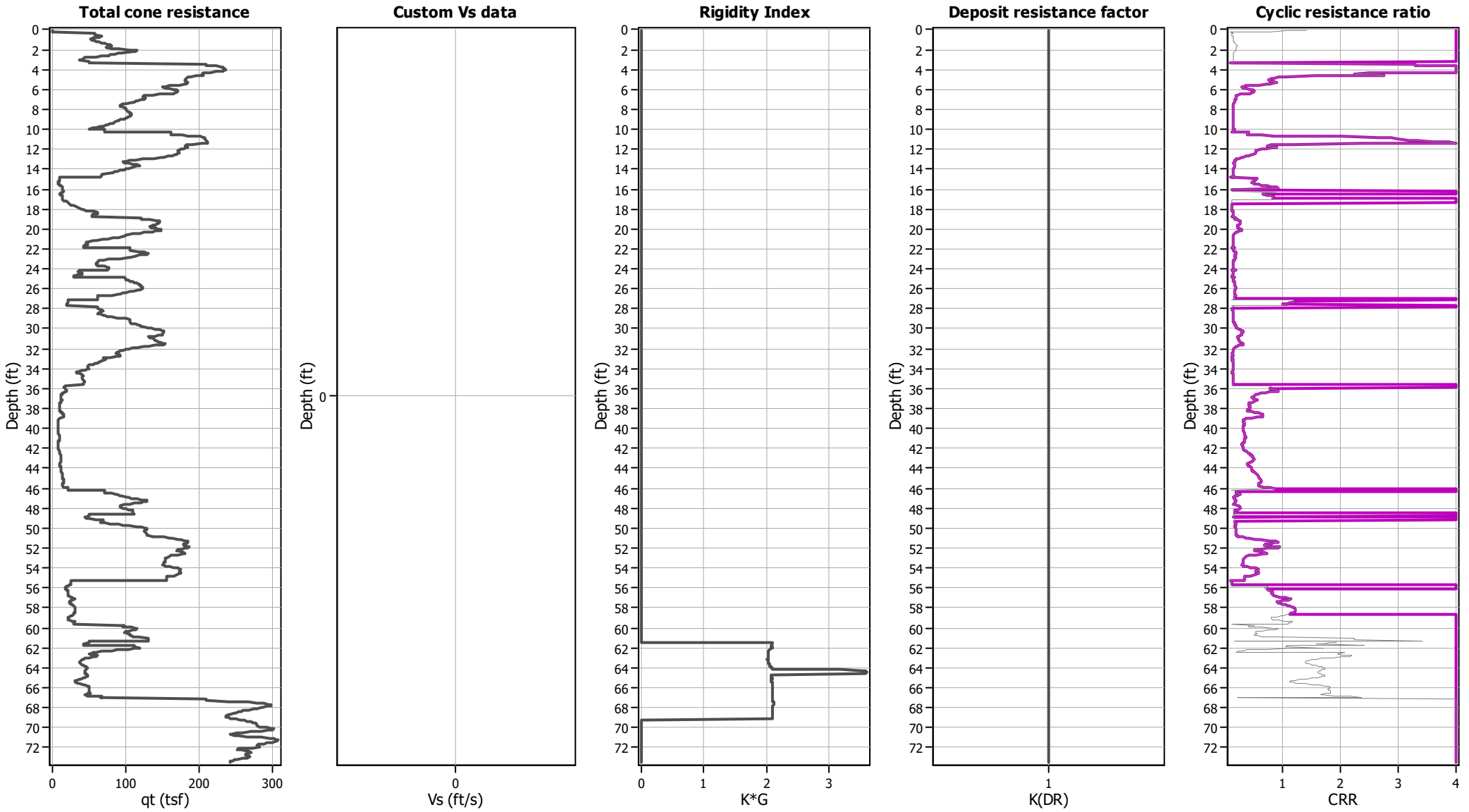
Estimation of post-earthquake settlements



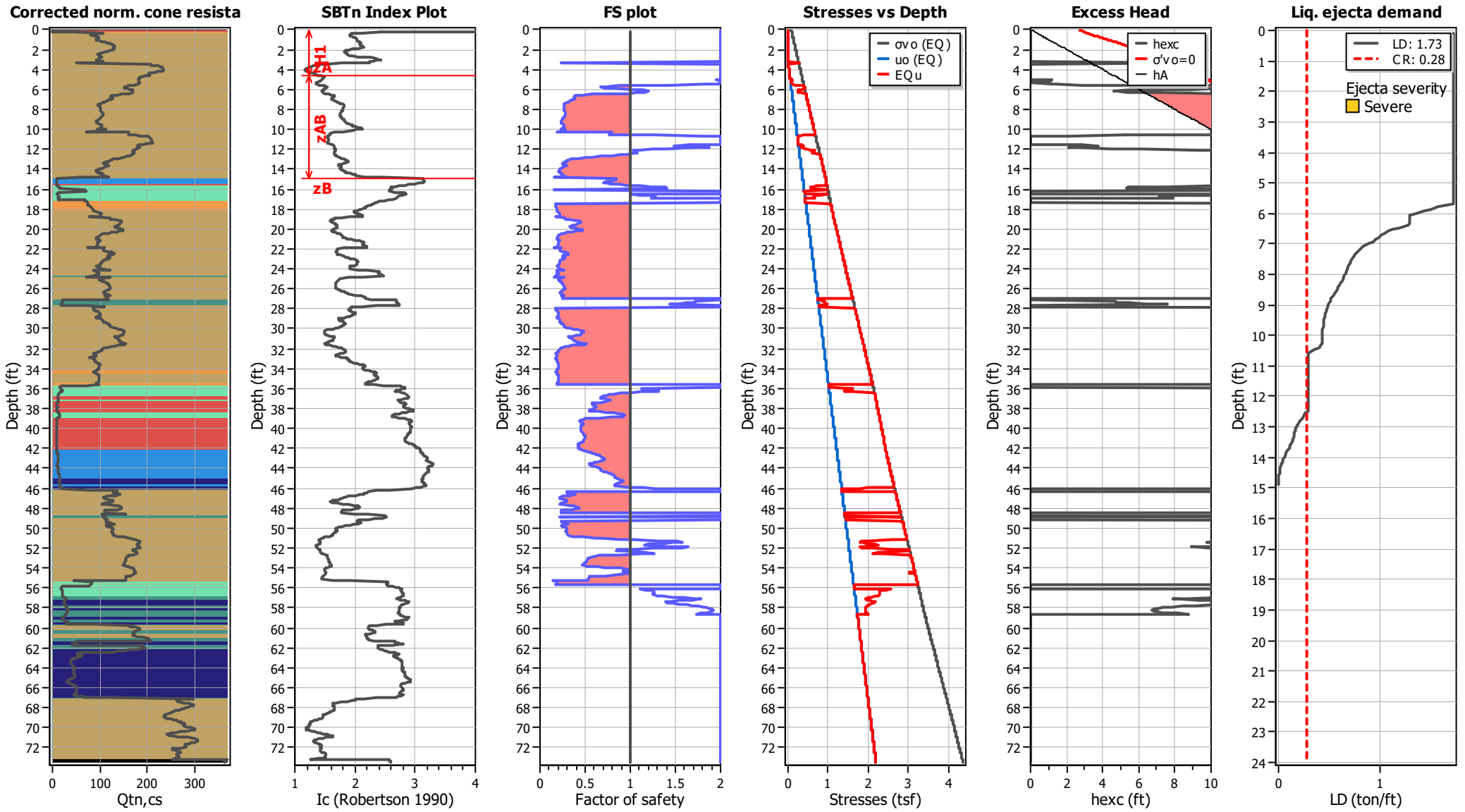
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

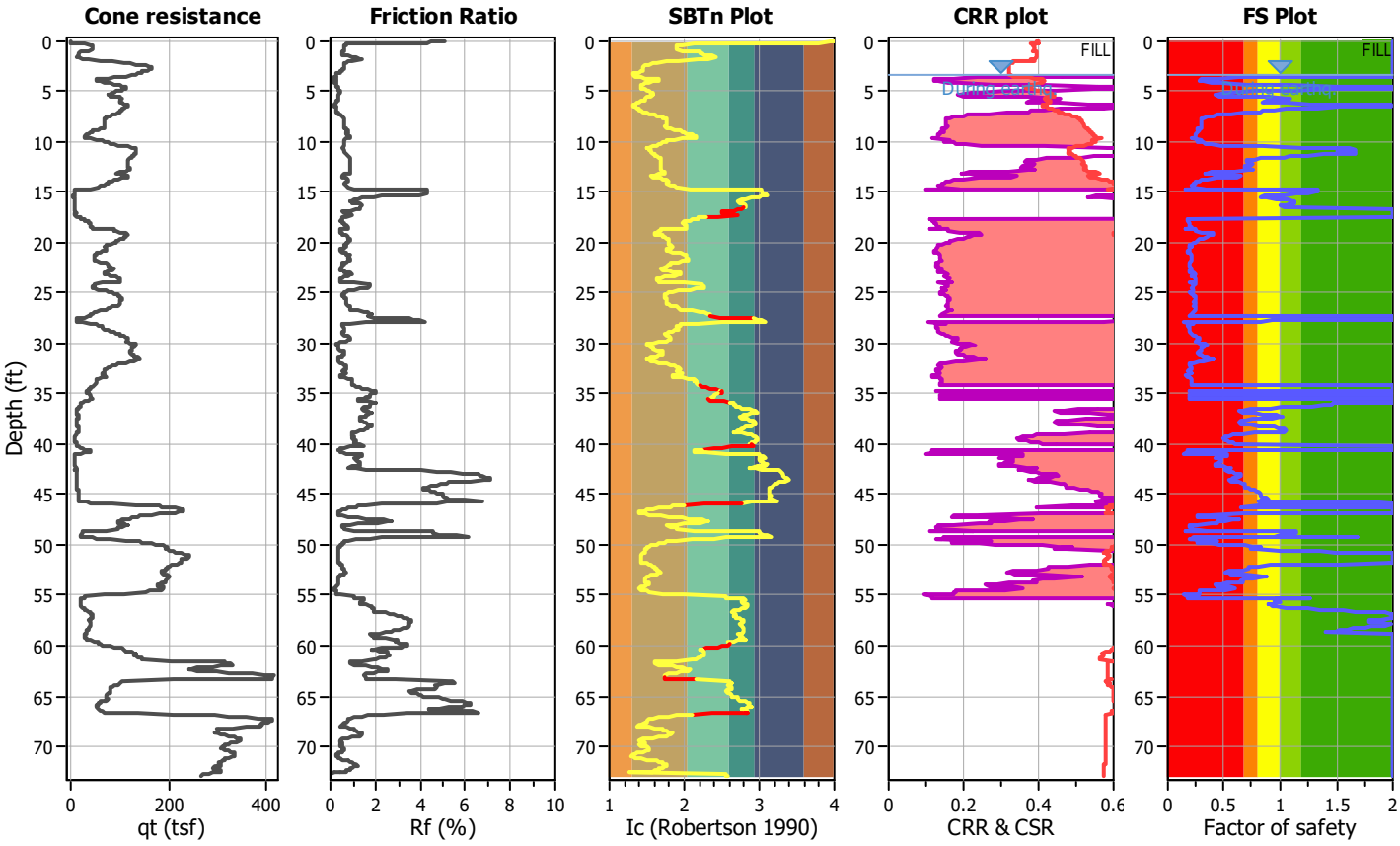
Project title : Topgolf Harbor Island

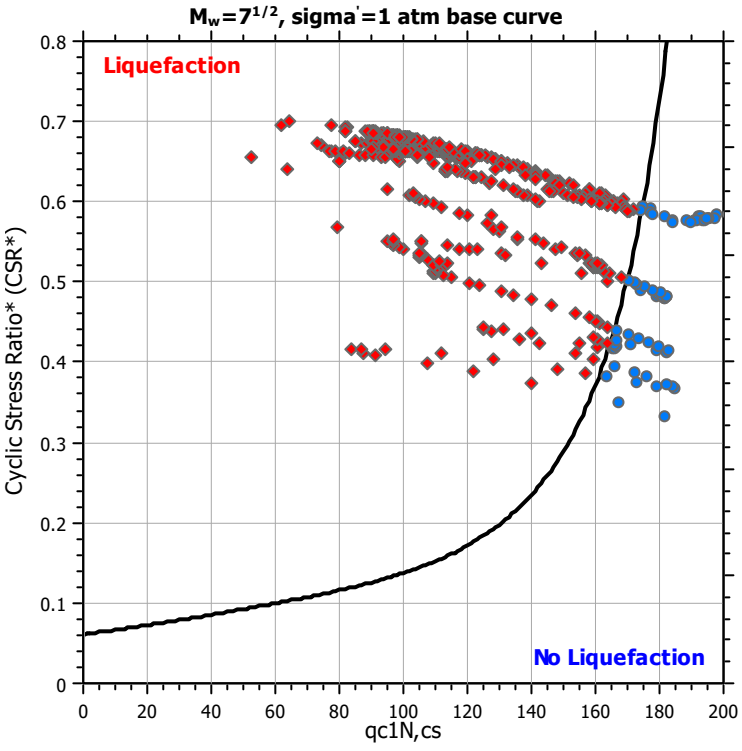
Location : North Harbor Drive and Liberator Way, San Diego, CA

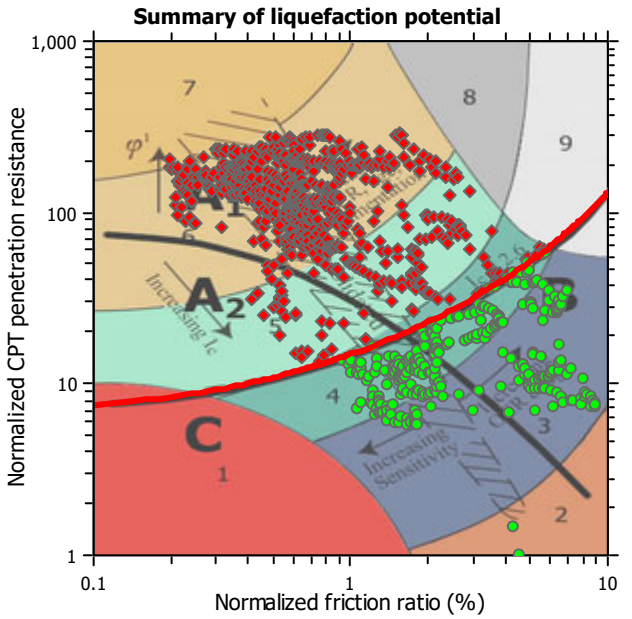
CPT file : CPT-4 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.32 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.30 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

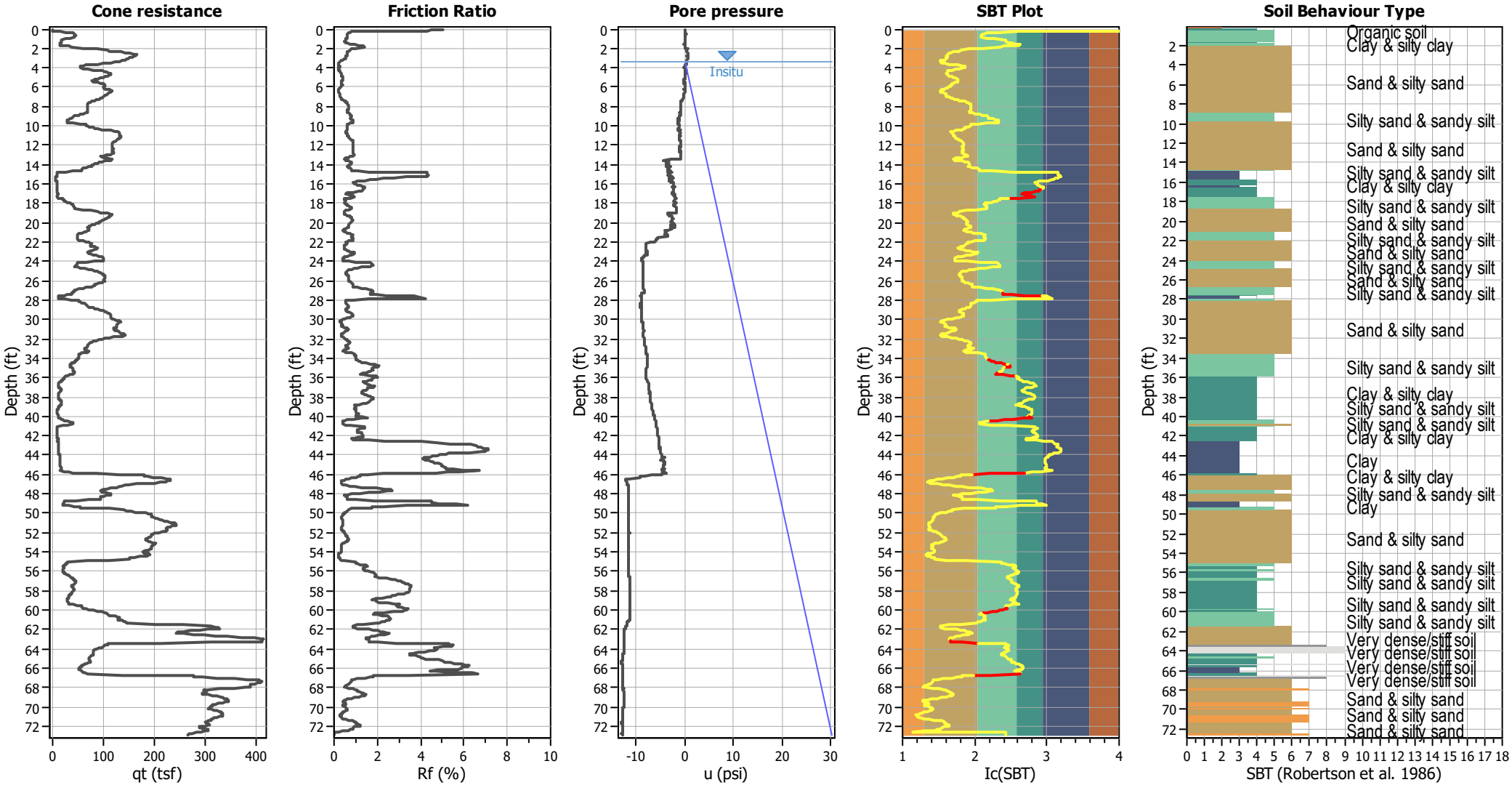






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



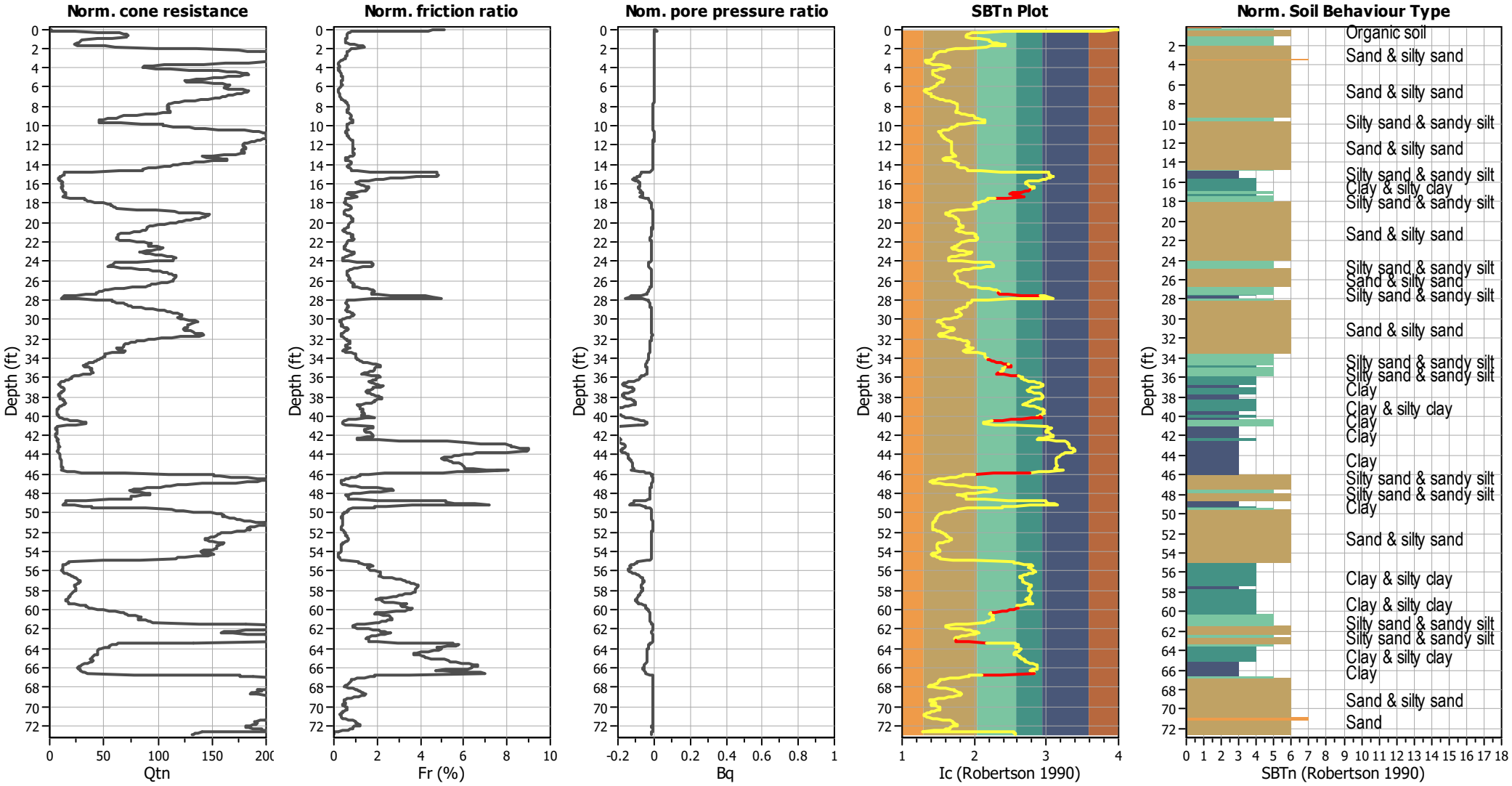
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 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)



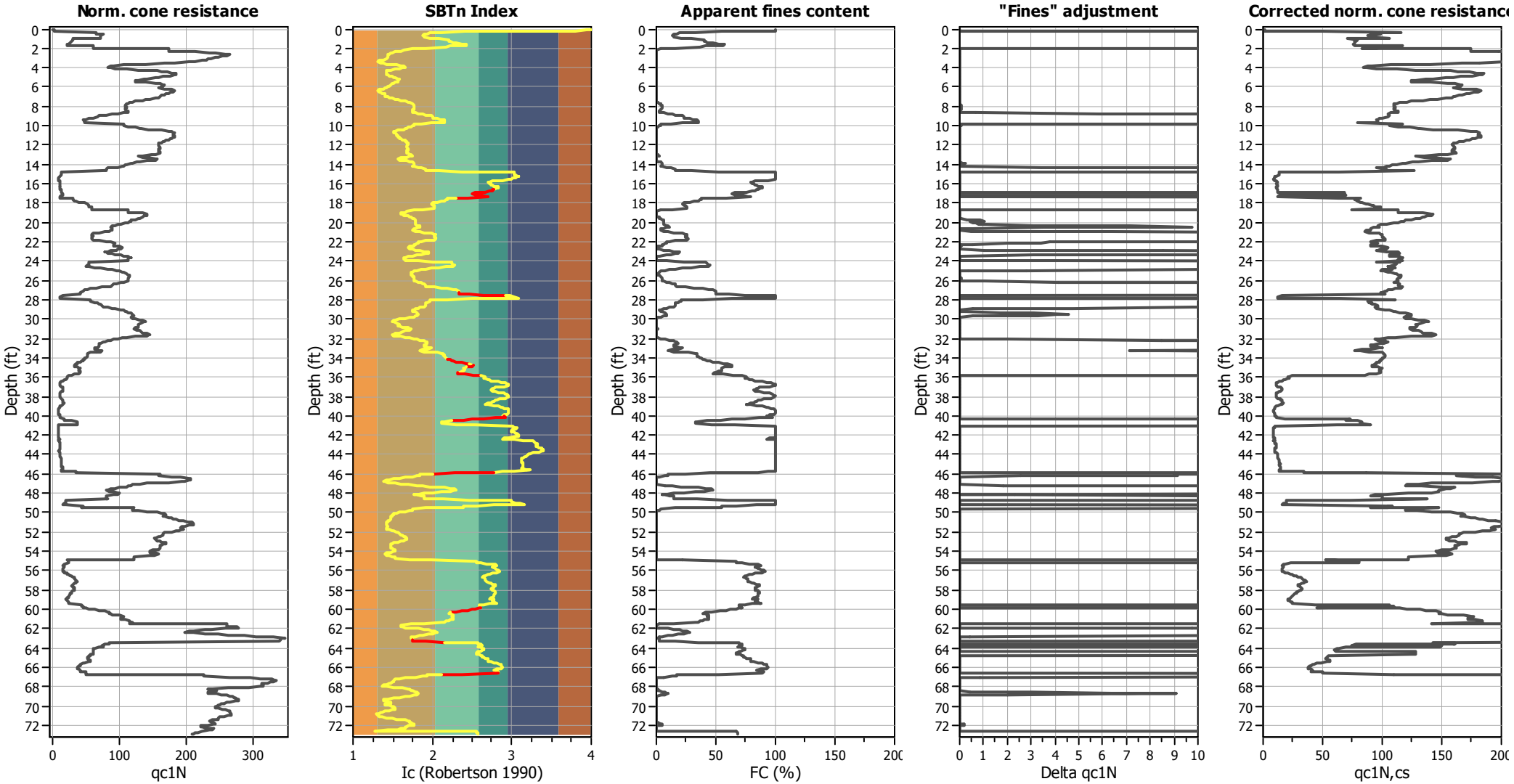
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 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

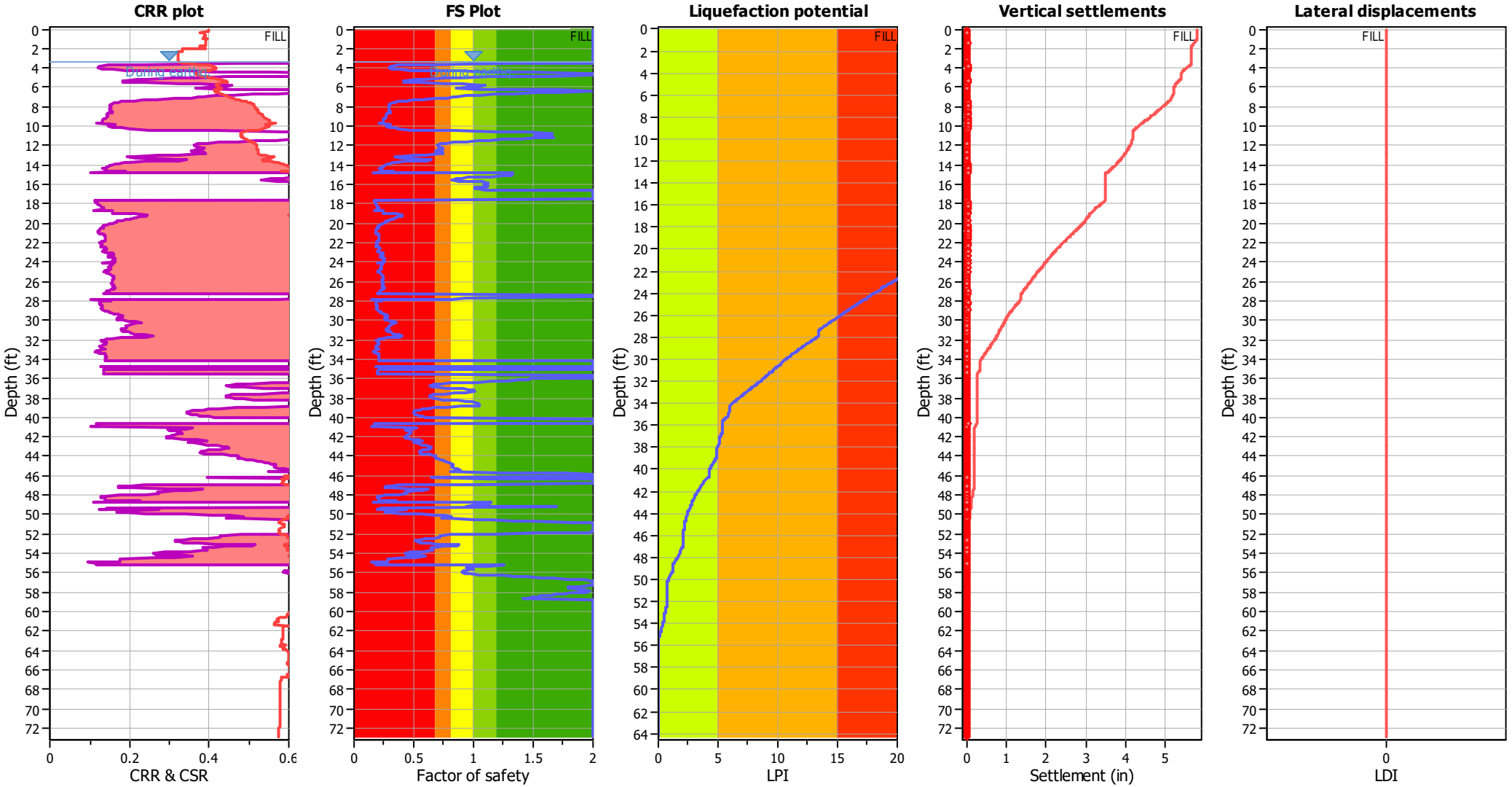
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 ft	Limit depth:	60.00 ft

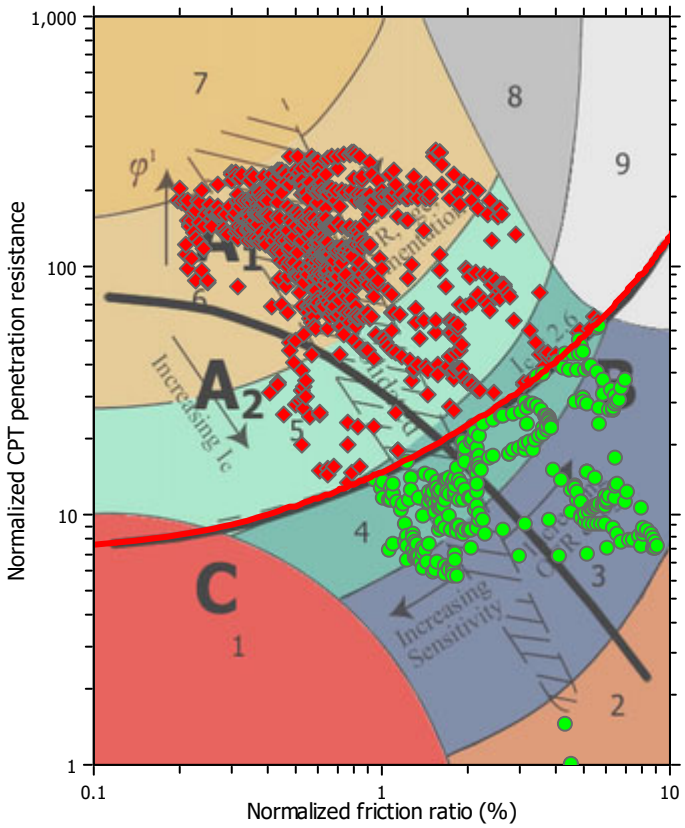
F.S. color scheme

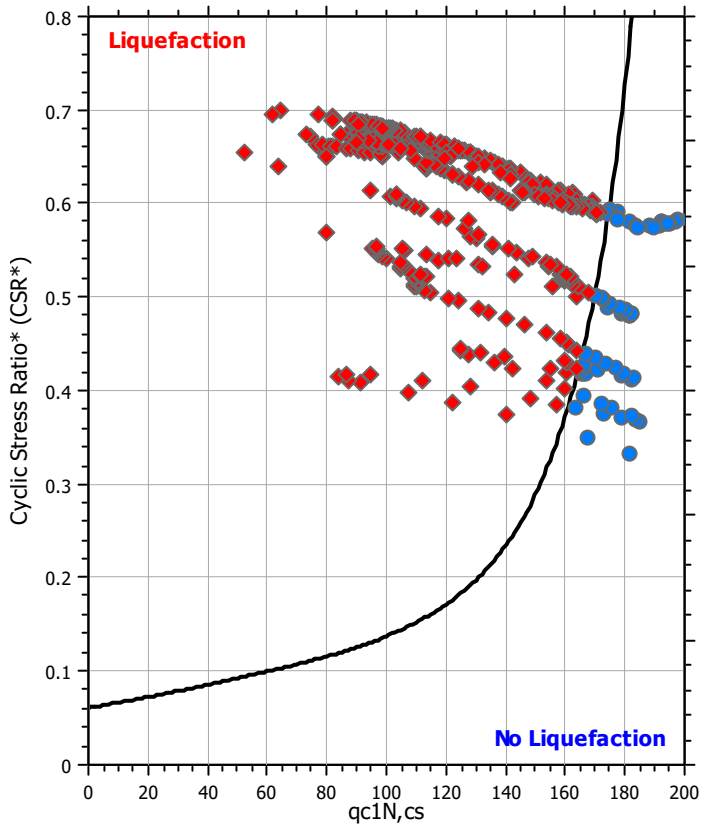
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

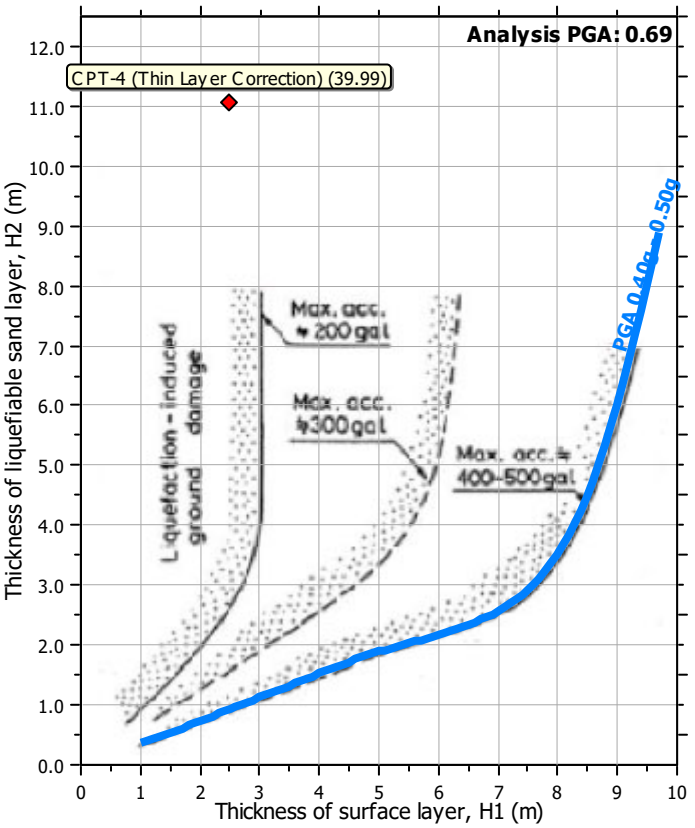
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



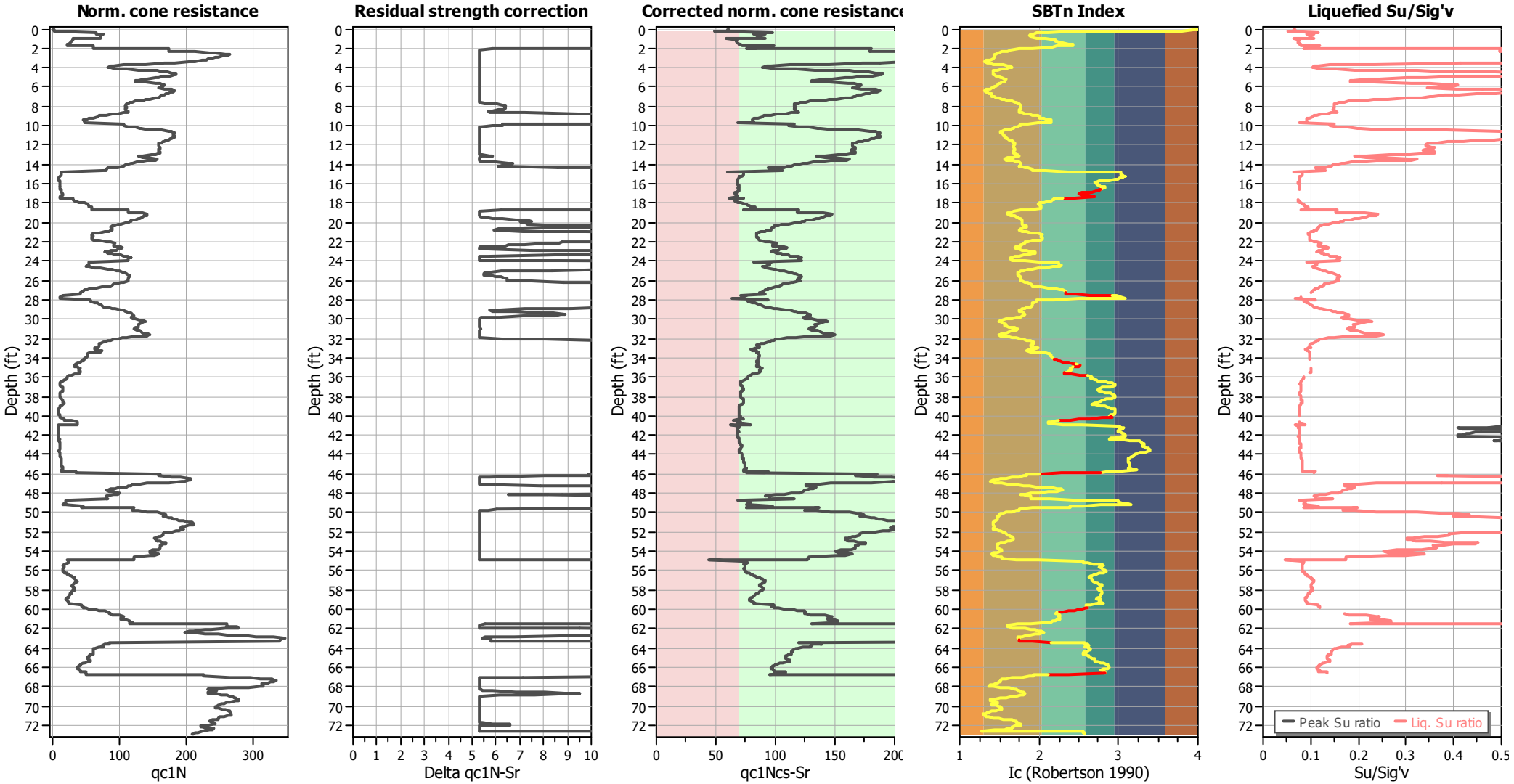




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

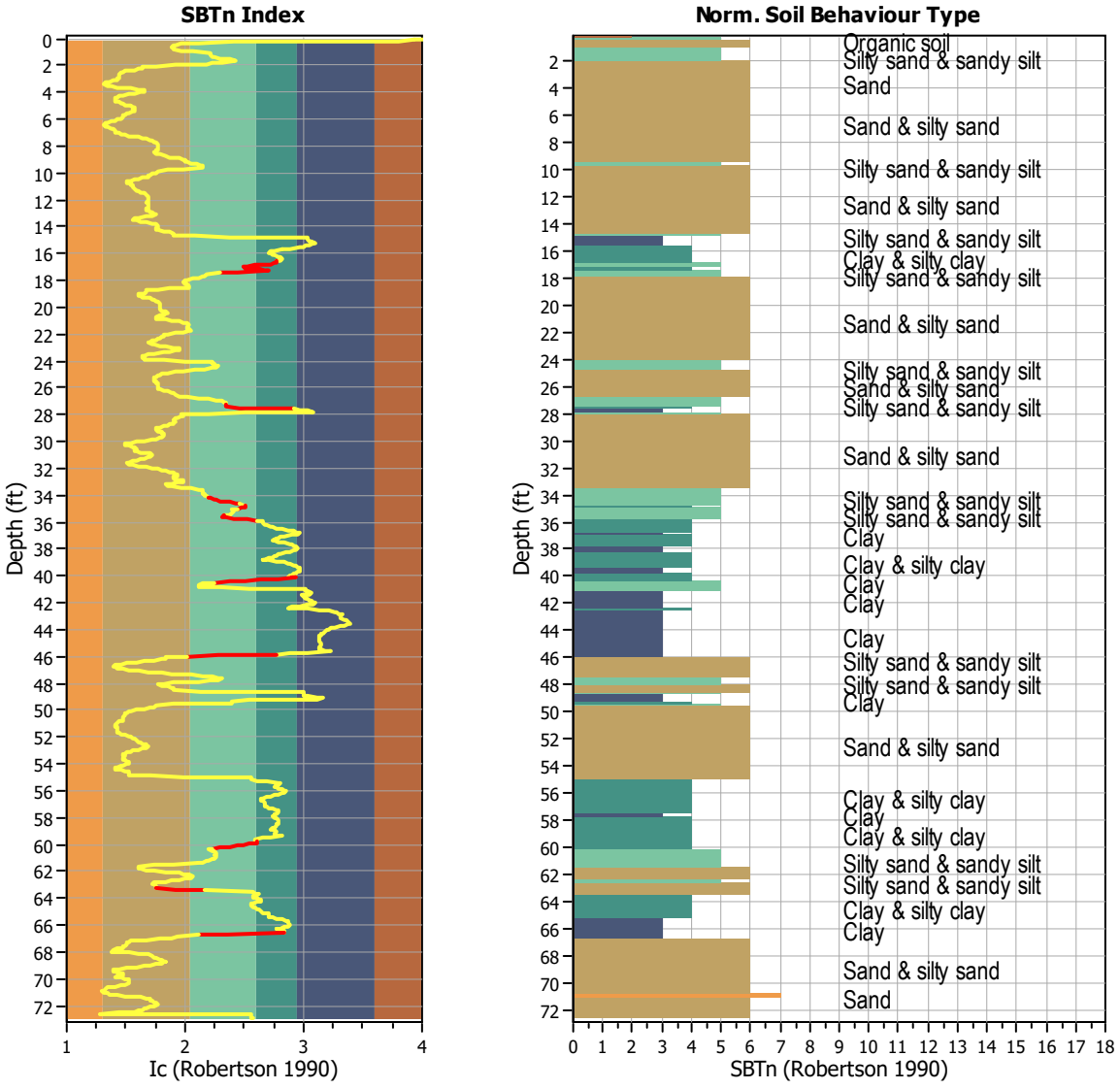
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.32 ft	Fill height:	1.30 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

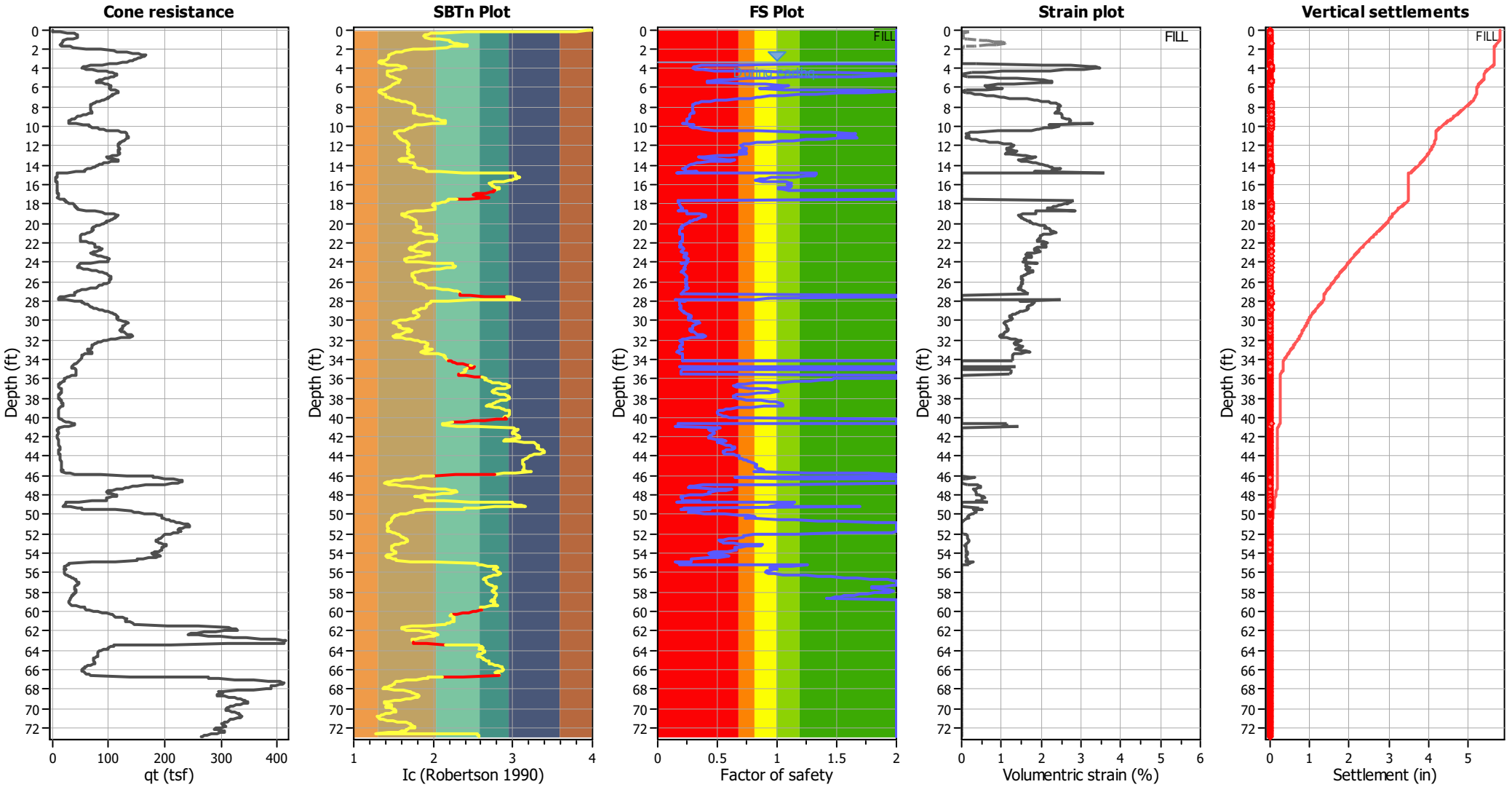
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	68
I_c change ratio value:	0.0250	Exclusion percentage:	6.14%
Minimum number of points in layer:	4	Number of layers detected:	12

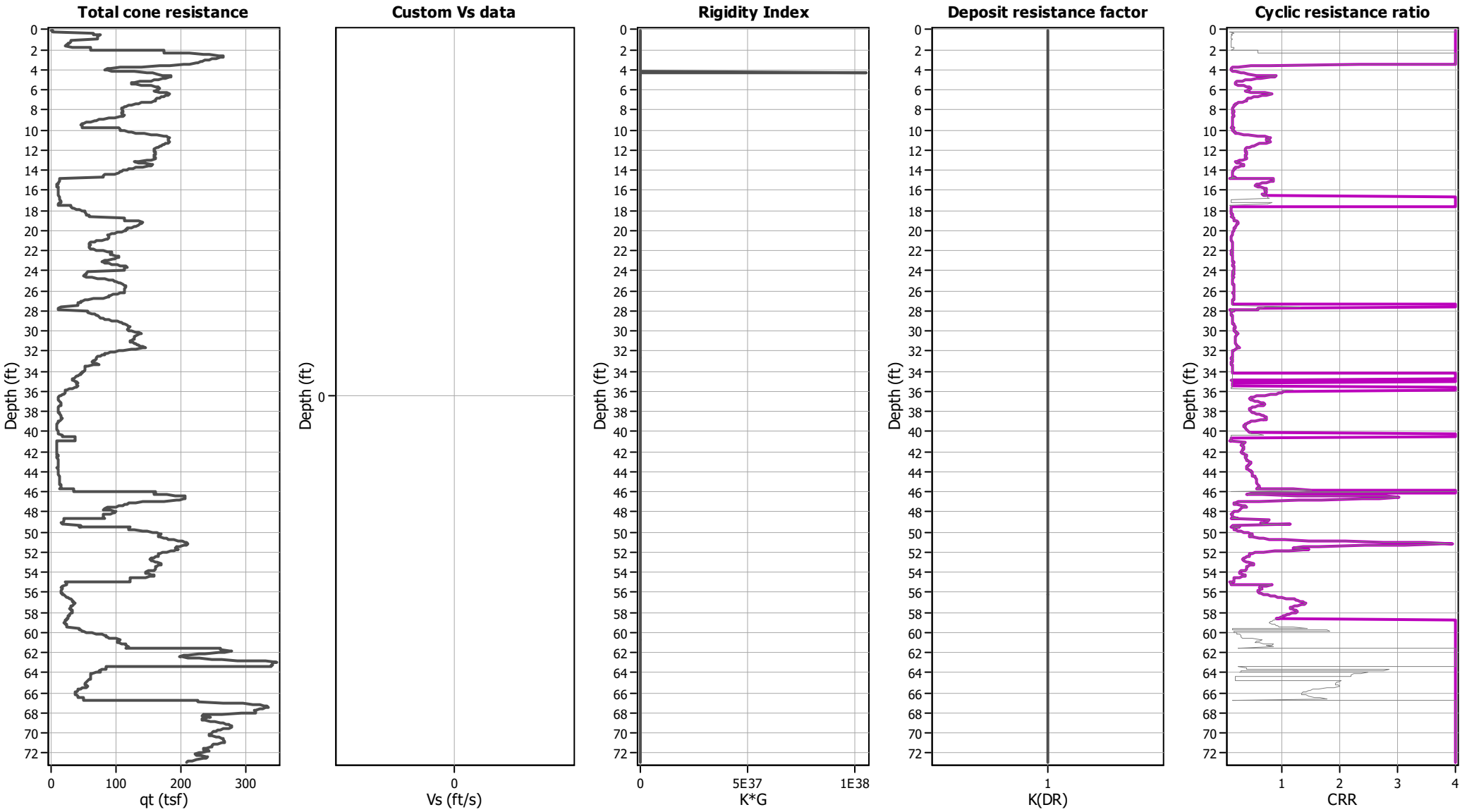
Estimation of post-earthquake settlements



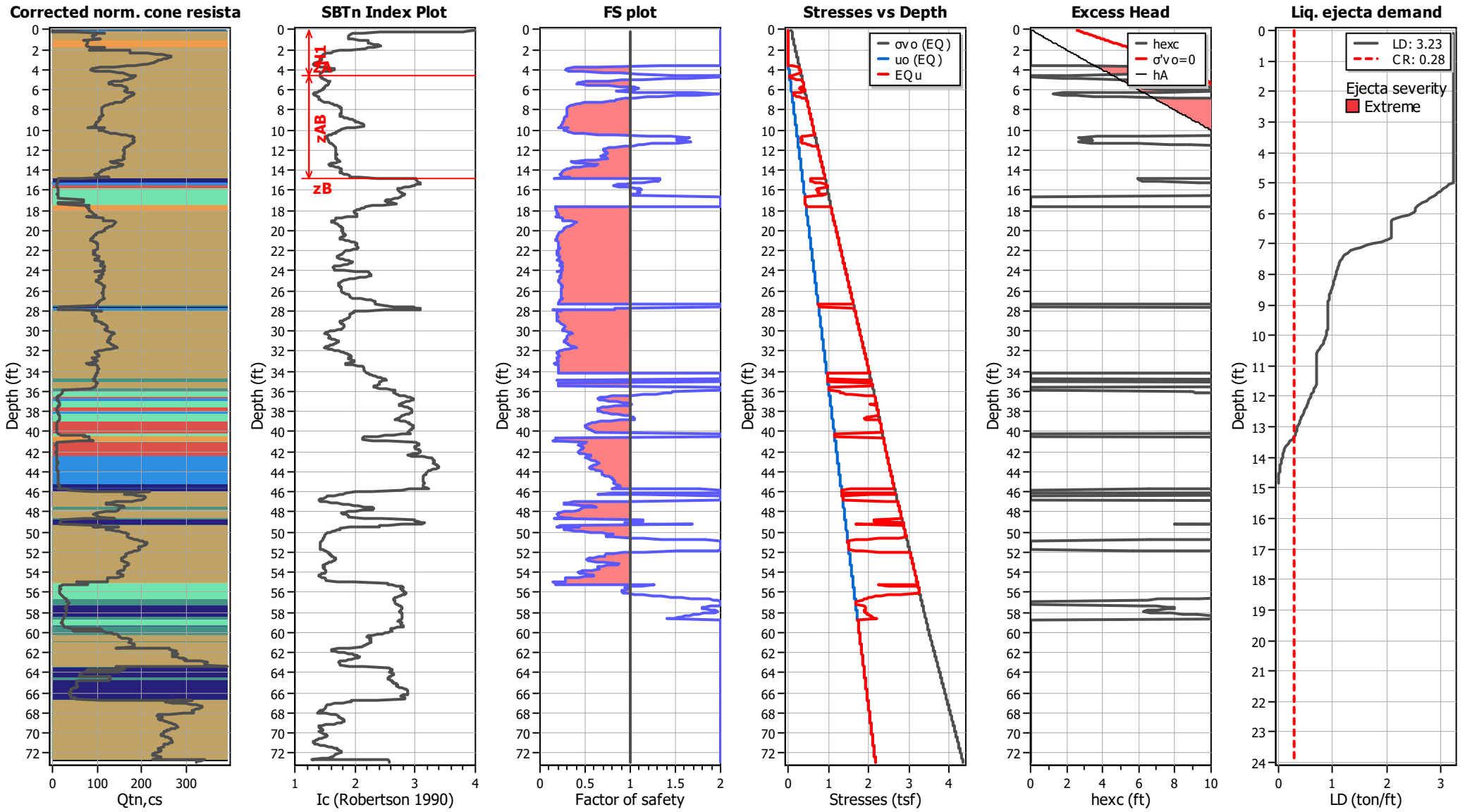
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

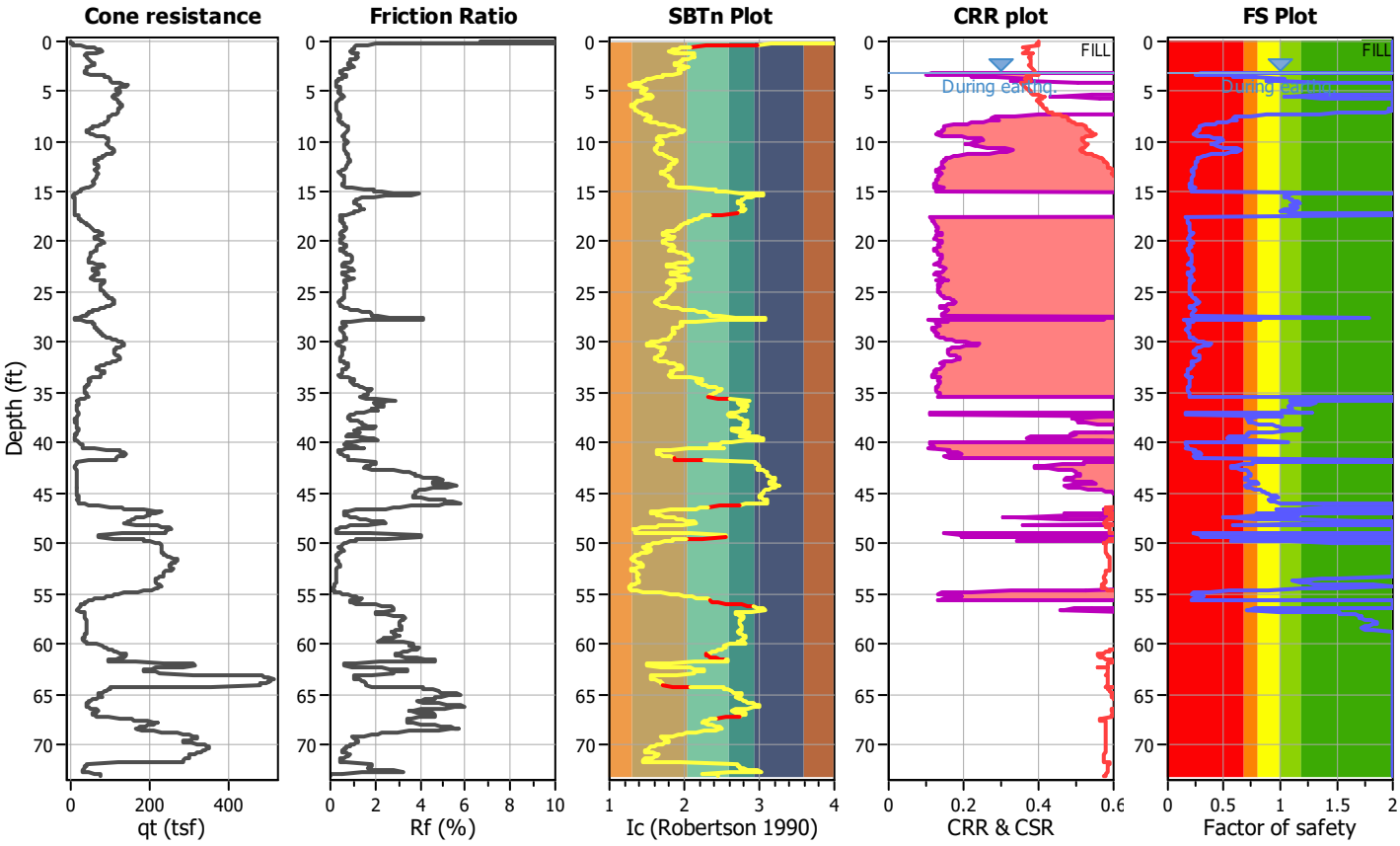
Project title : Topgolf Harbor Island

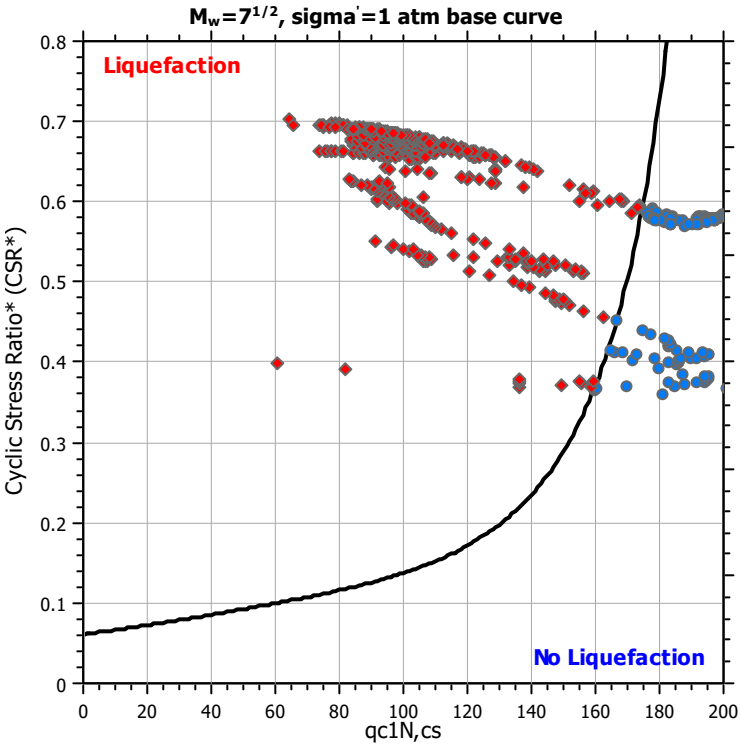
Location : North Harbor Drive and Liberator Way, San Diego, CA

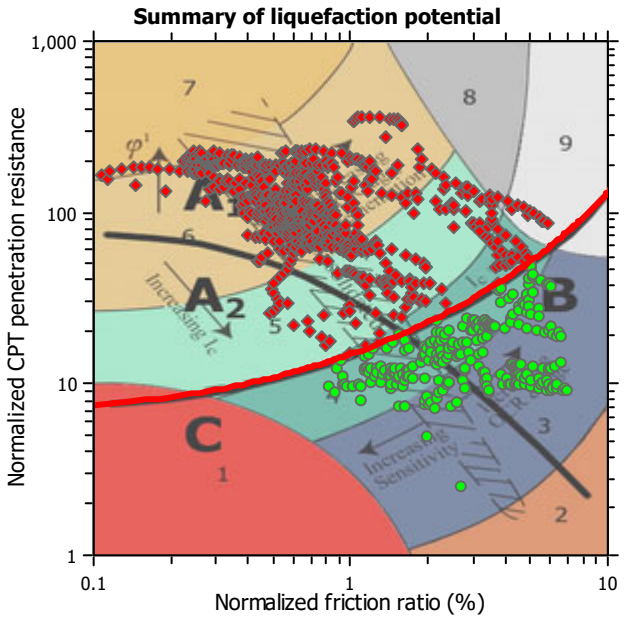
CPT file : CPT-5 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.27 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.35 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

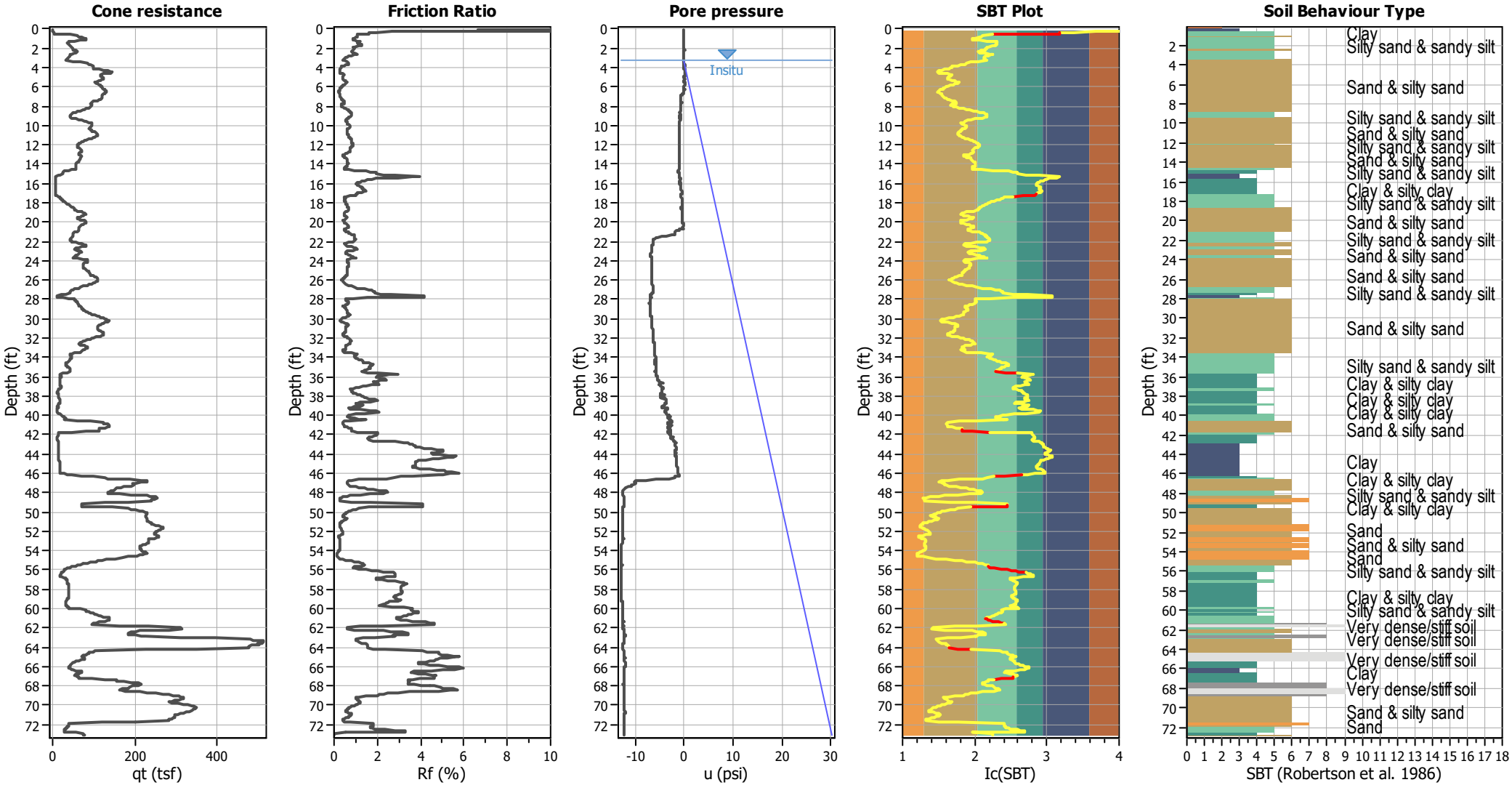






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



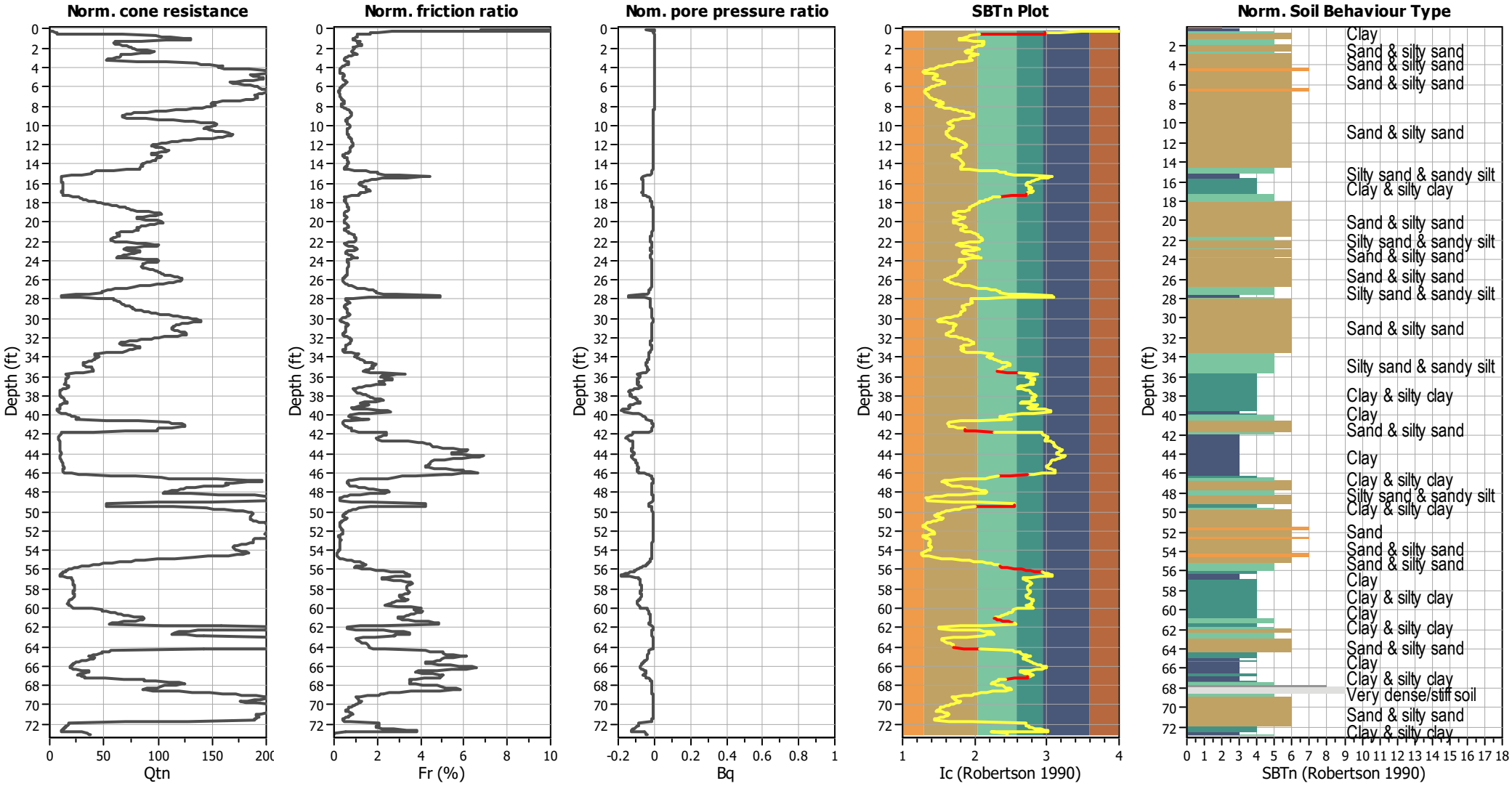
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 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)



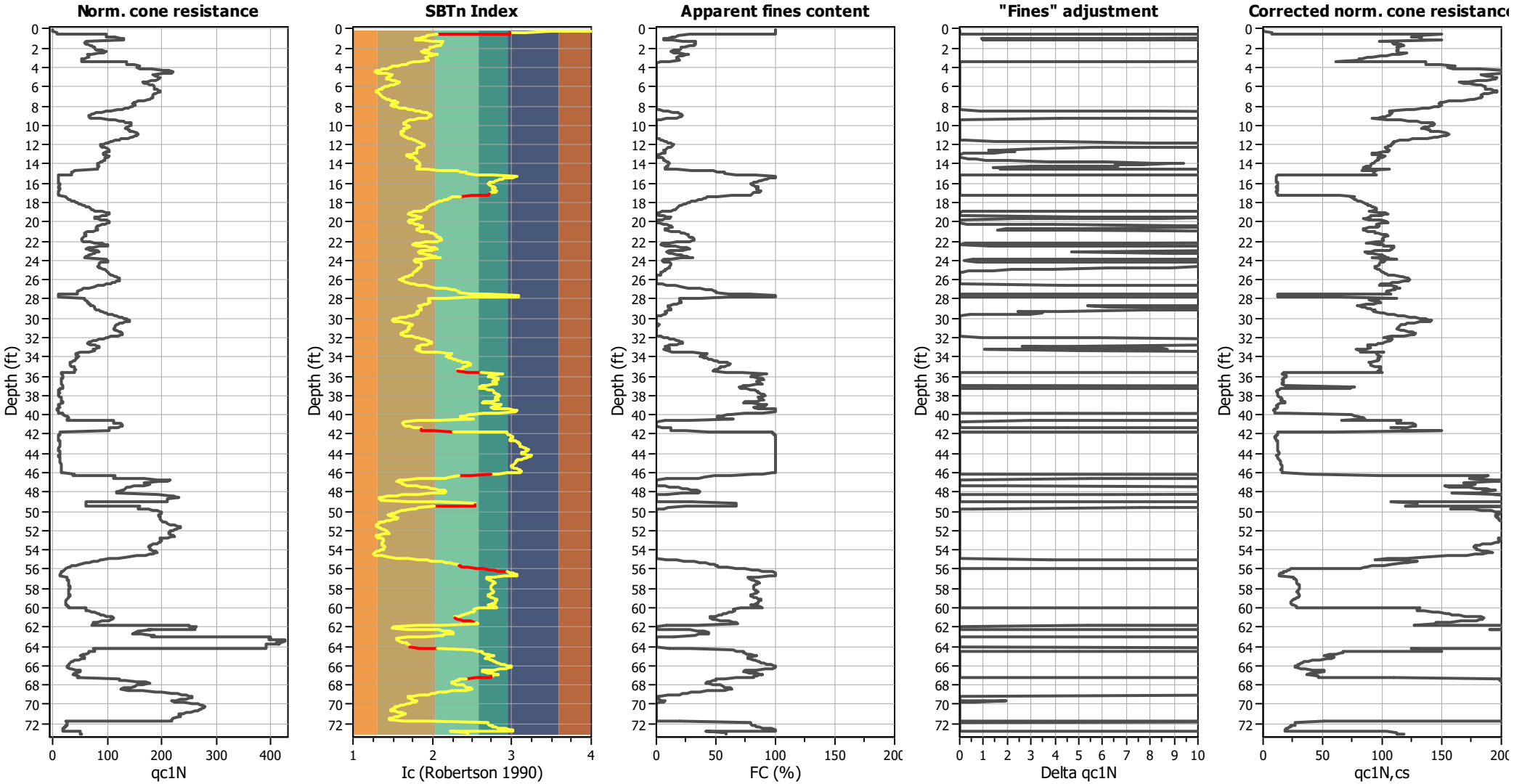
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 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

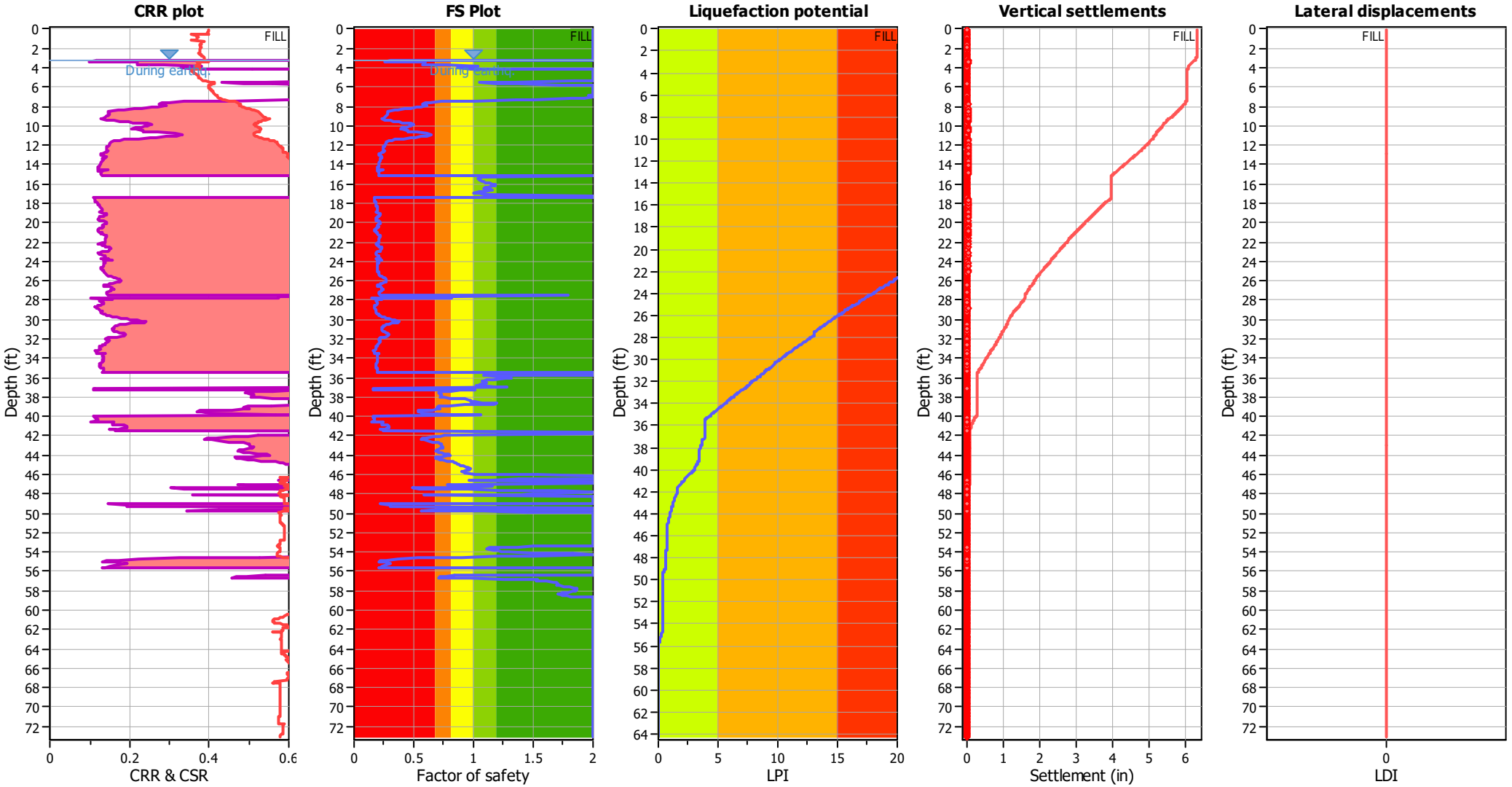
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 ft	Limit depth:	60.00 ft

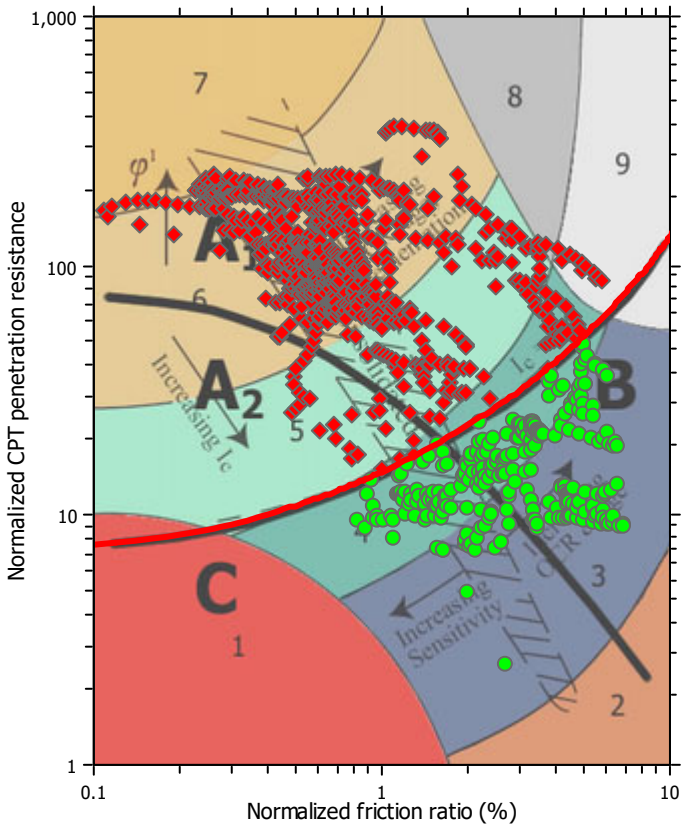
F.S. color scheme

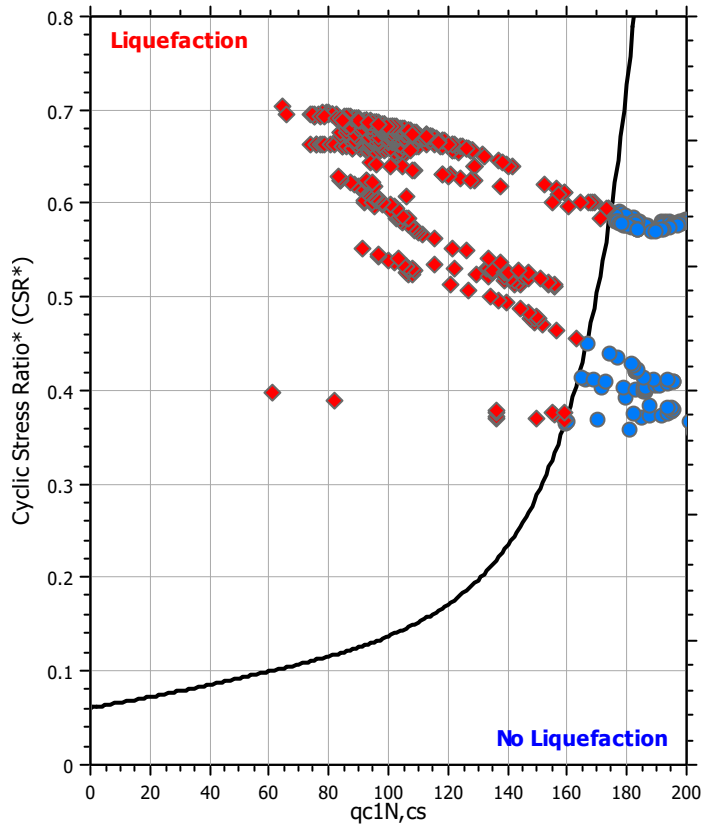
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

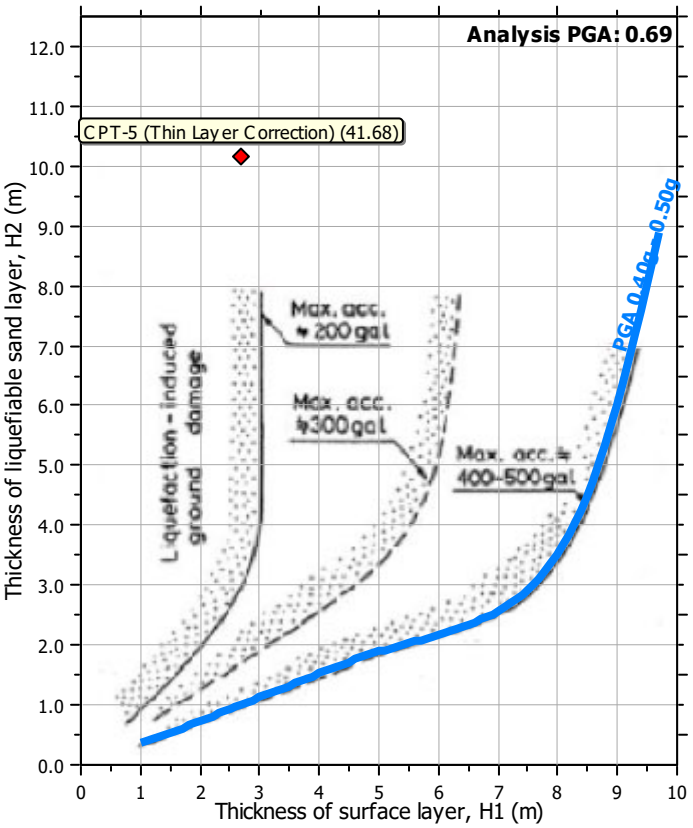
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



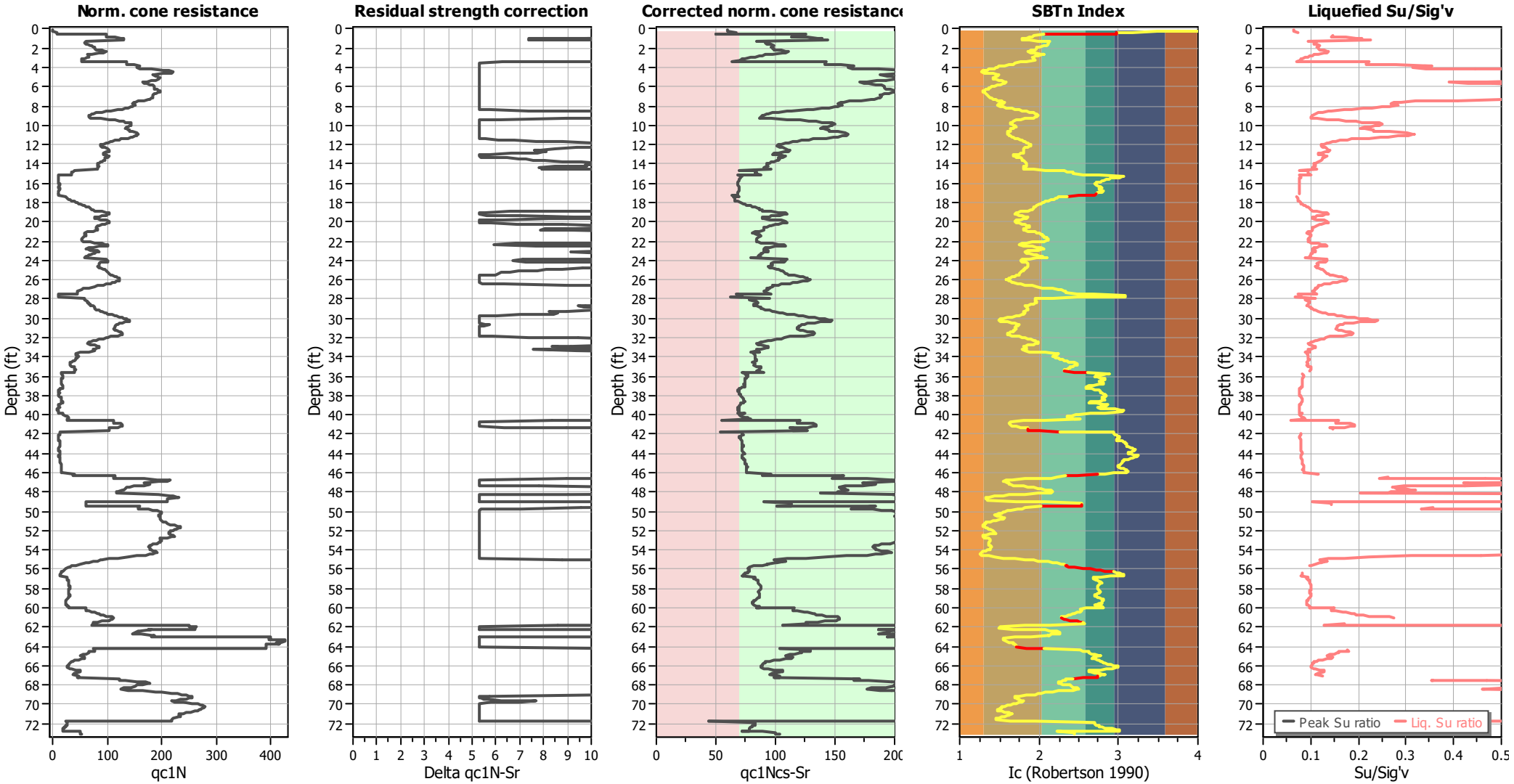




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

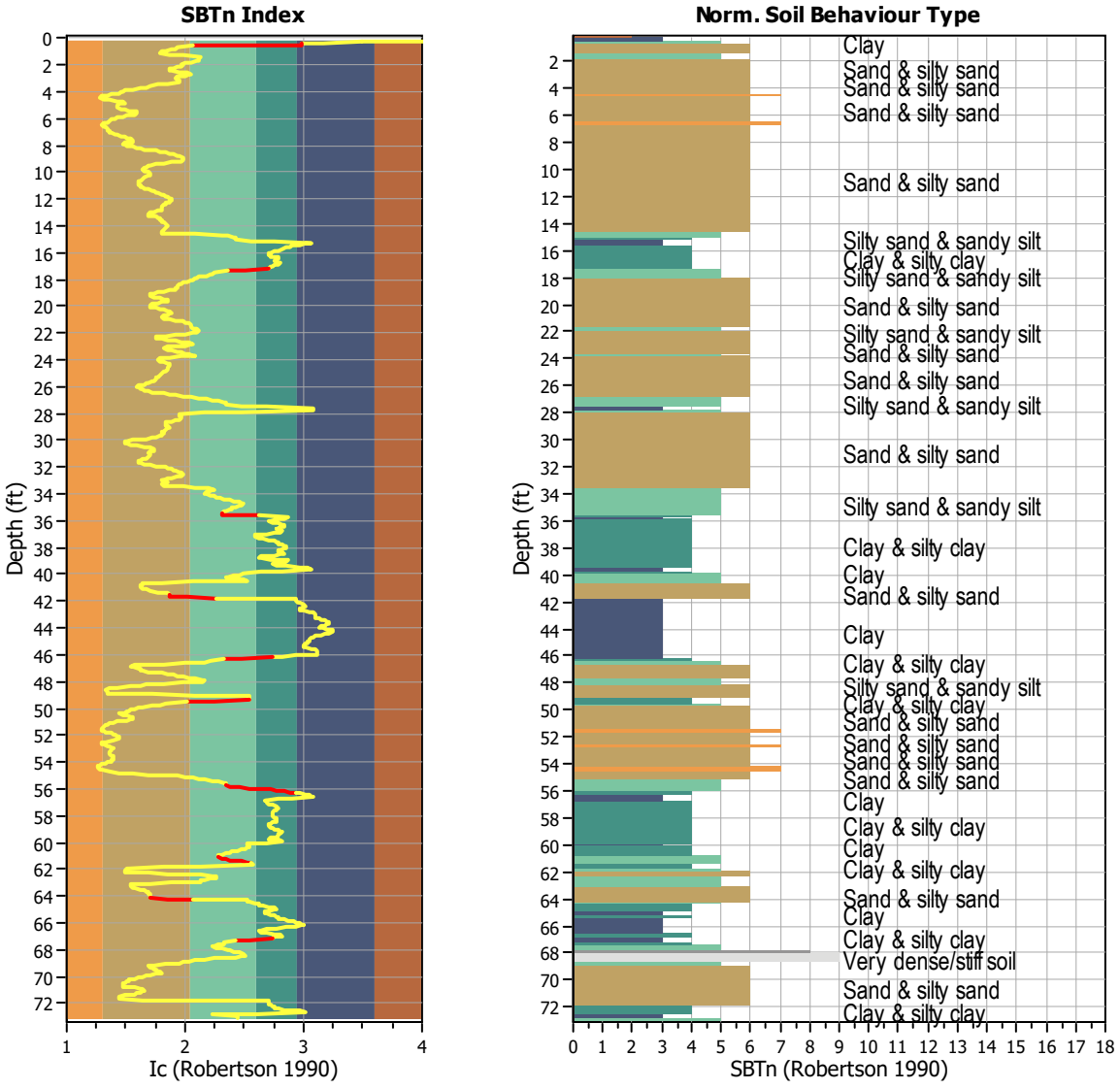
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.27 ft	Fill height:	1.35 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

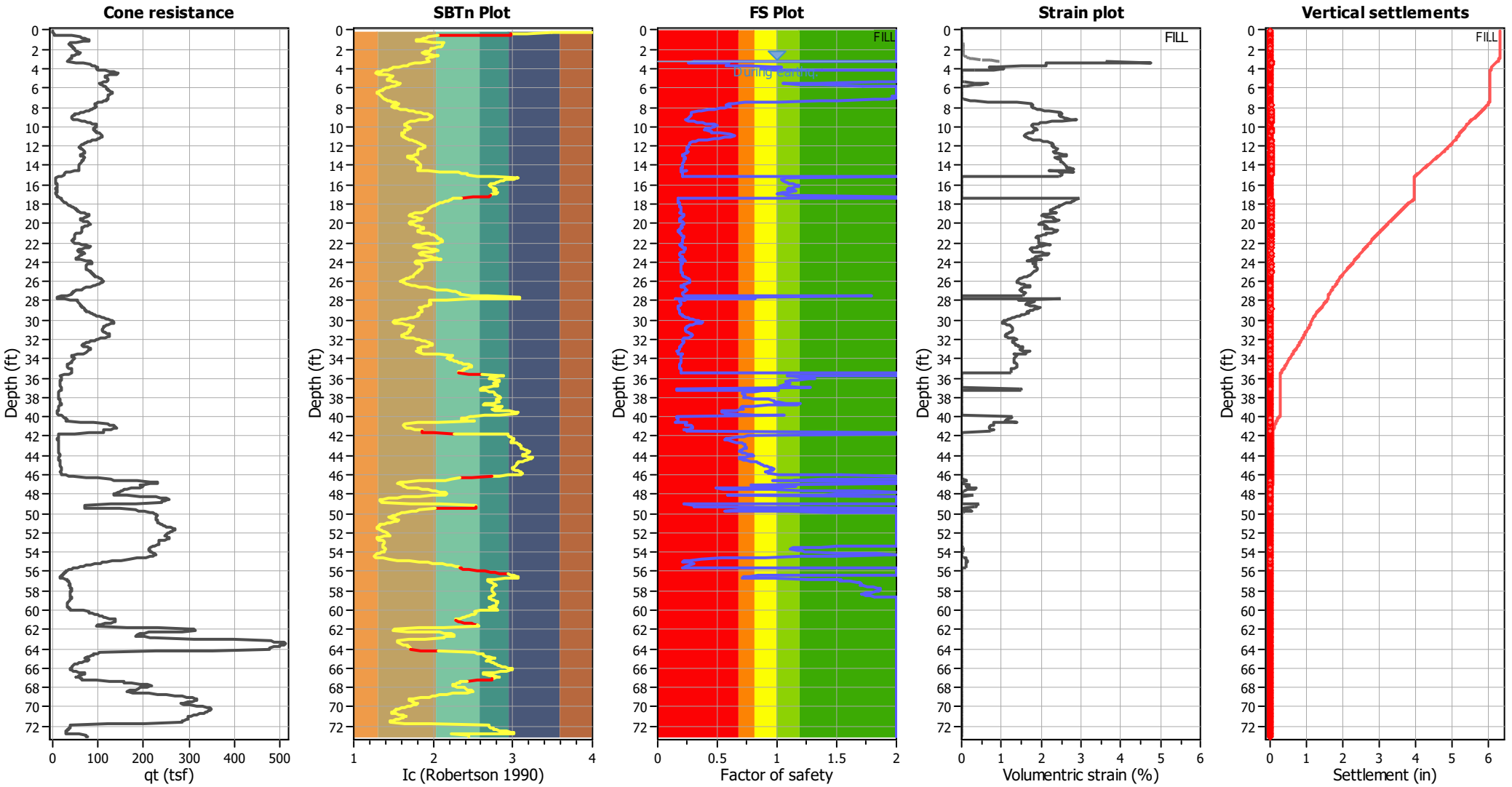
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1112
I_c maximum check value:	3.00	Total points excluded:	52
I_c change ratio value:	0.0250	Exclusion percentage:	4.68%
Minimum number of points in layer:	4	Number of layers detected:	10

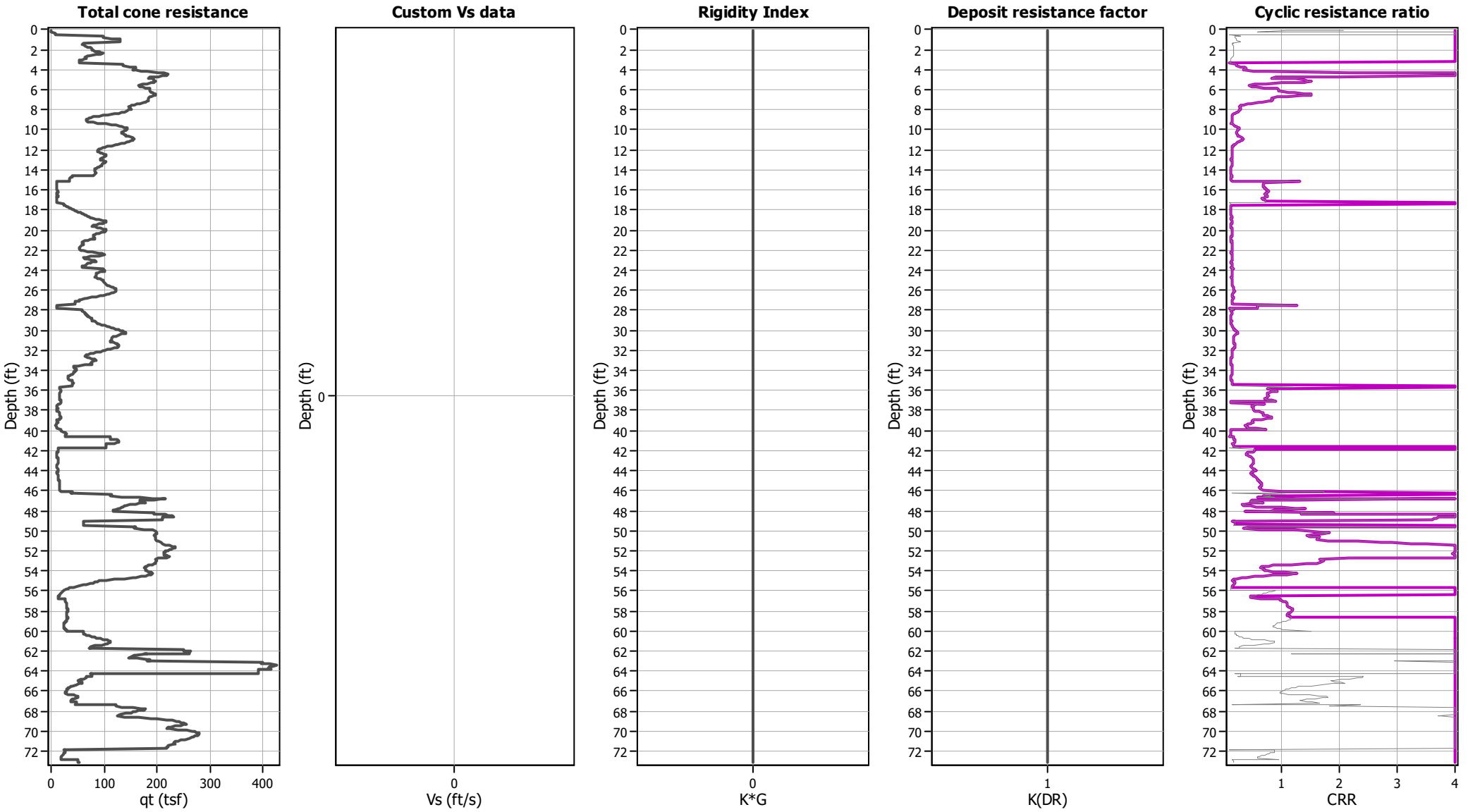
Estimation of post-earthquake settlements



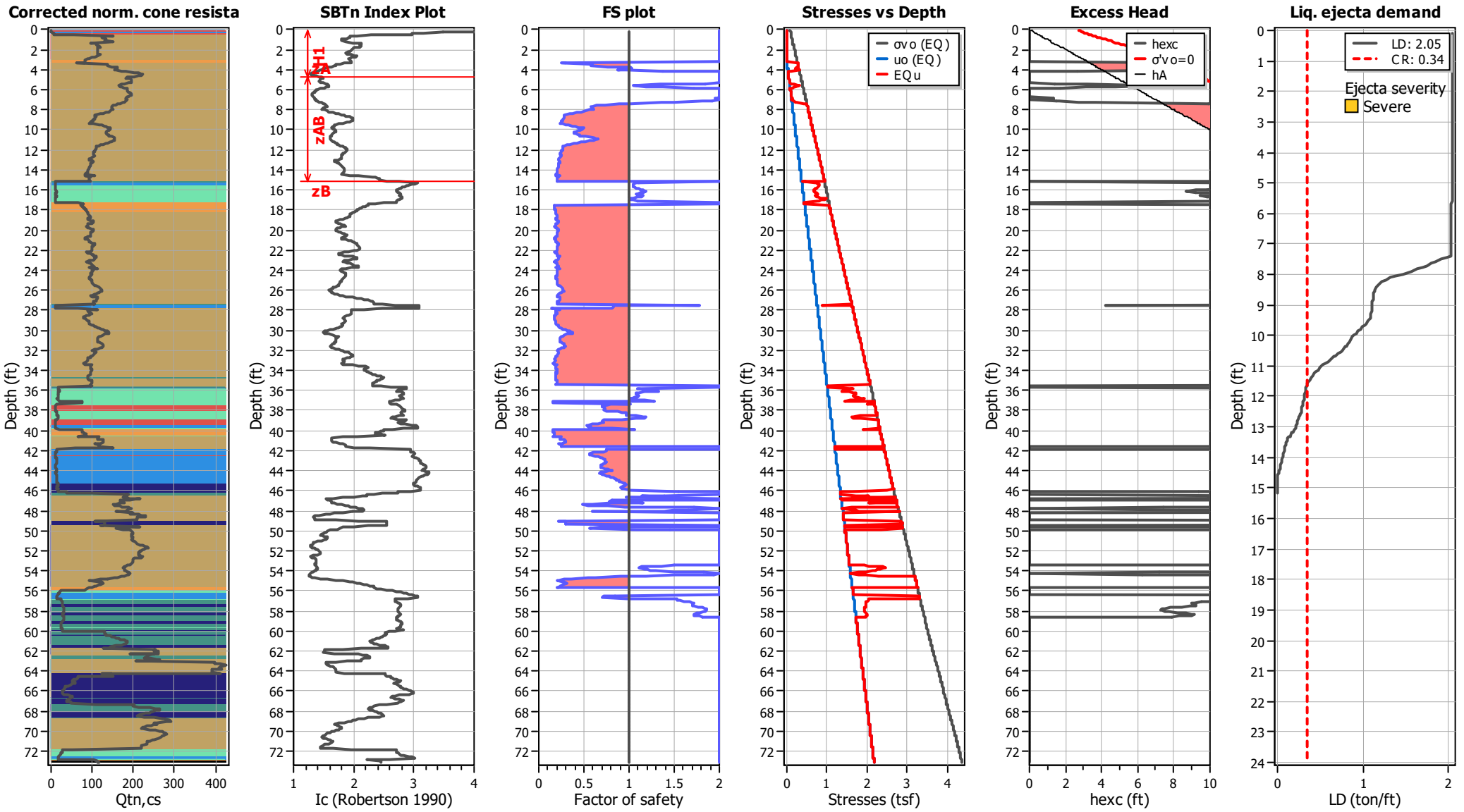
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

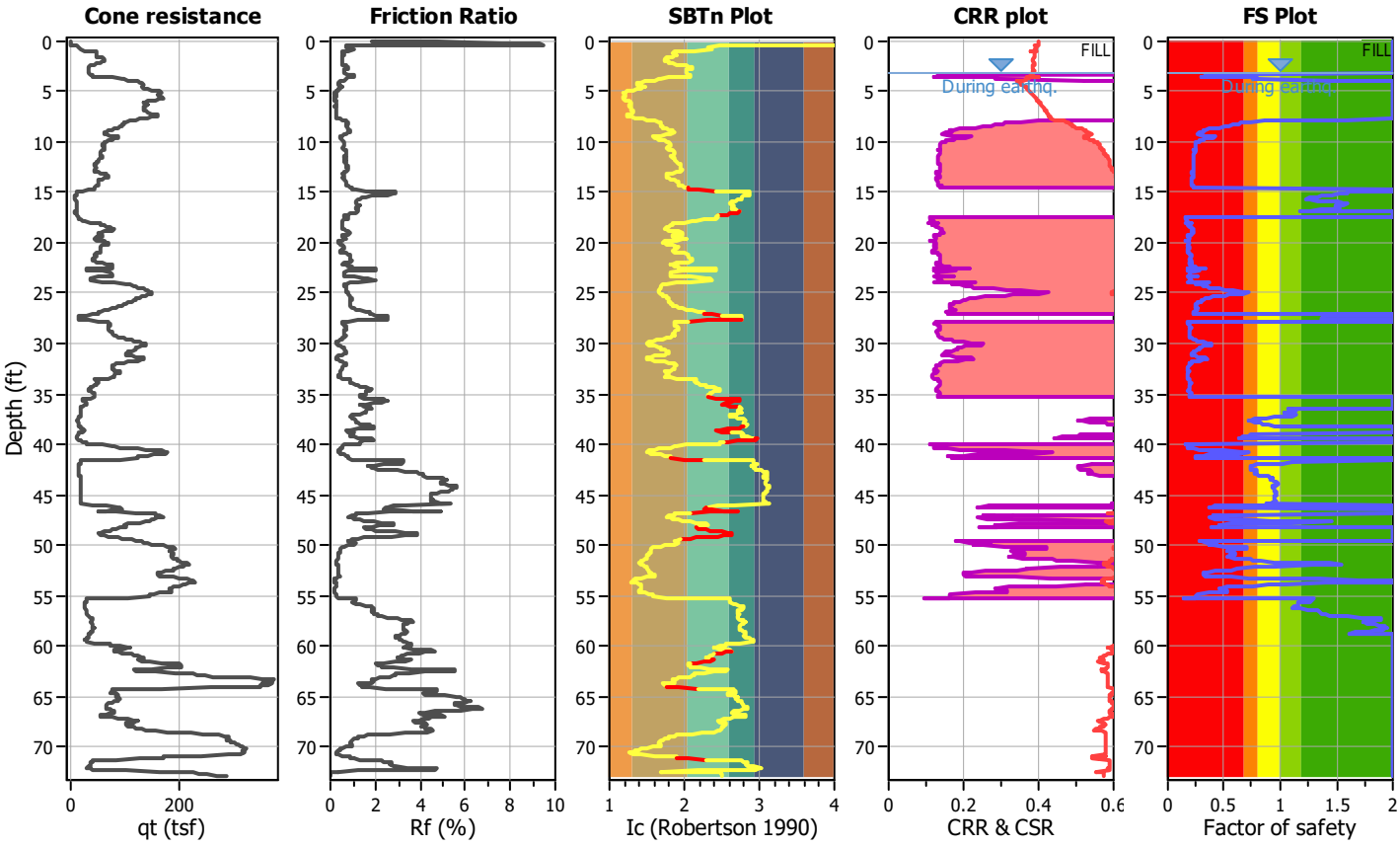
Project title : Topgolf Harbor Island

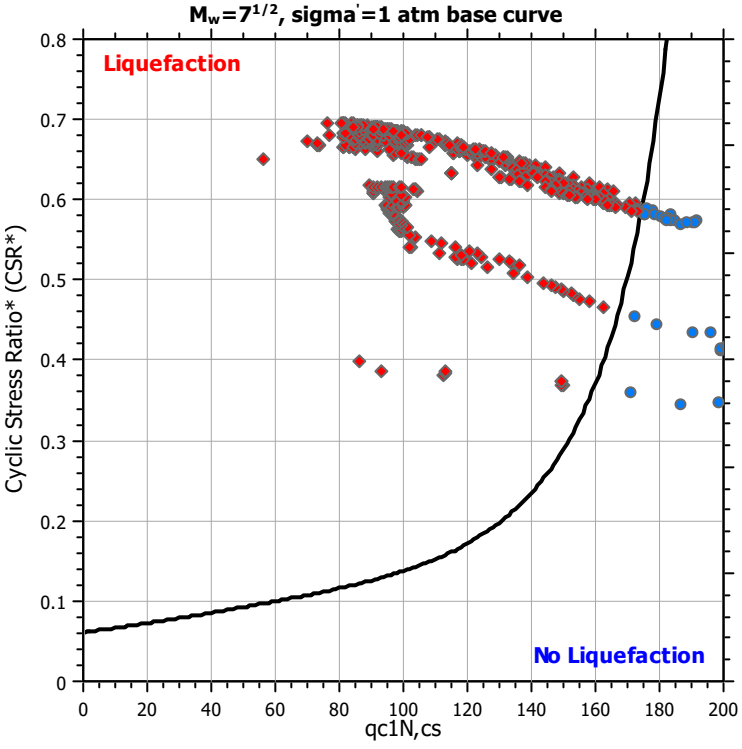
Location : North Harbor Drive and Liberator Way, San Diego, CA

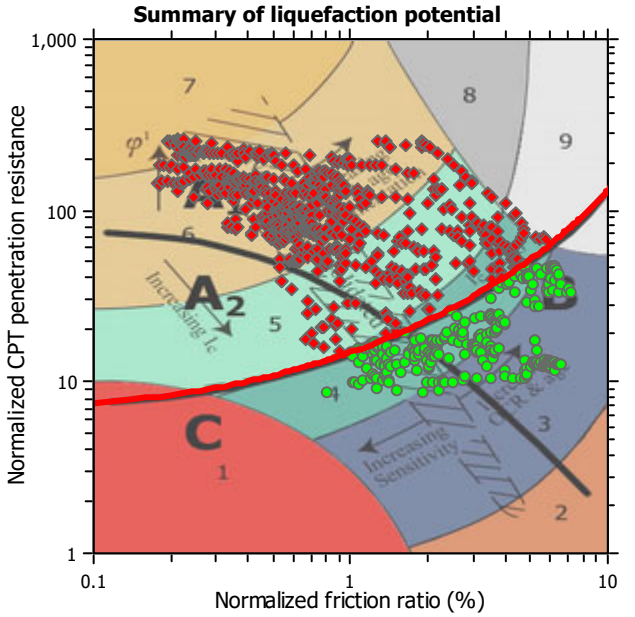
CPT file : CPT-6A (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.29 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.33 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

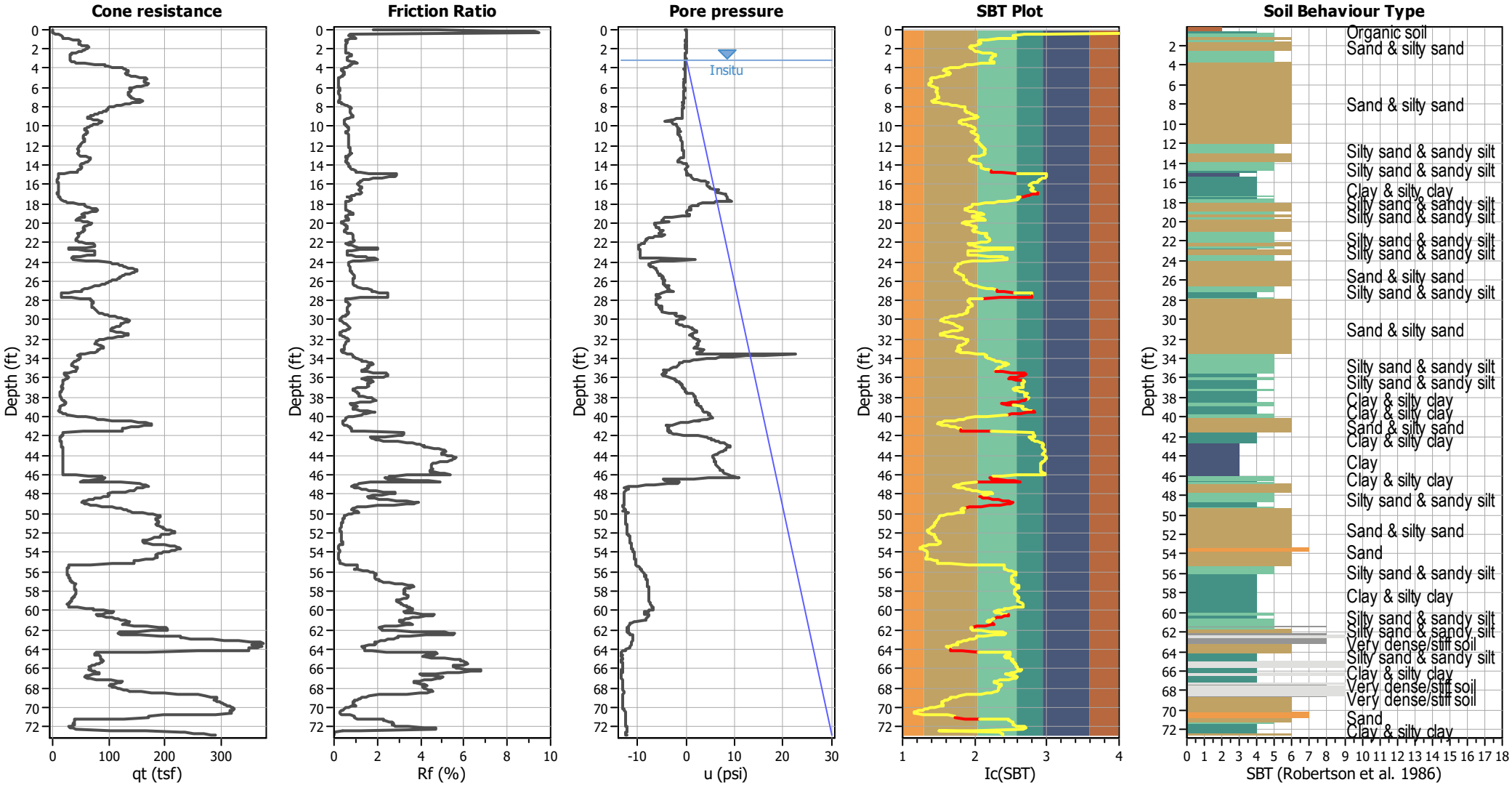






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



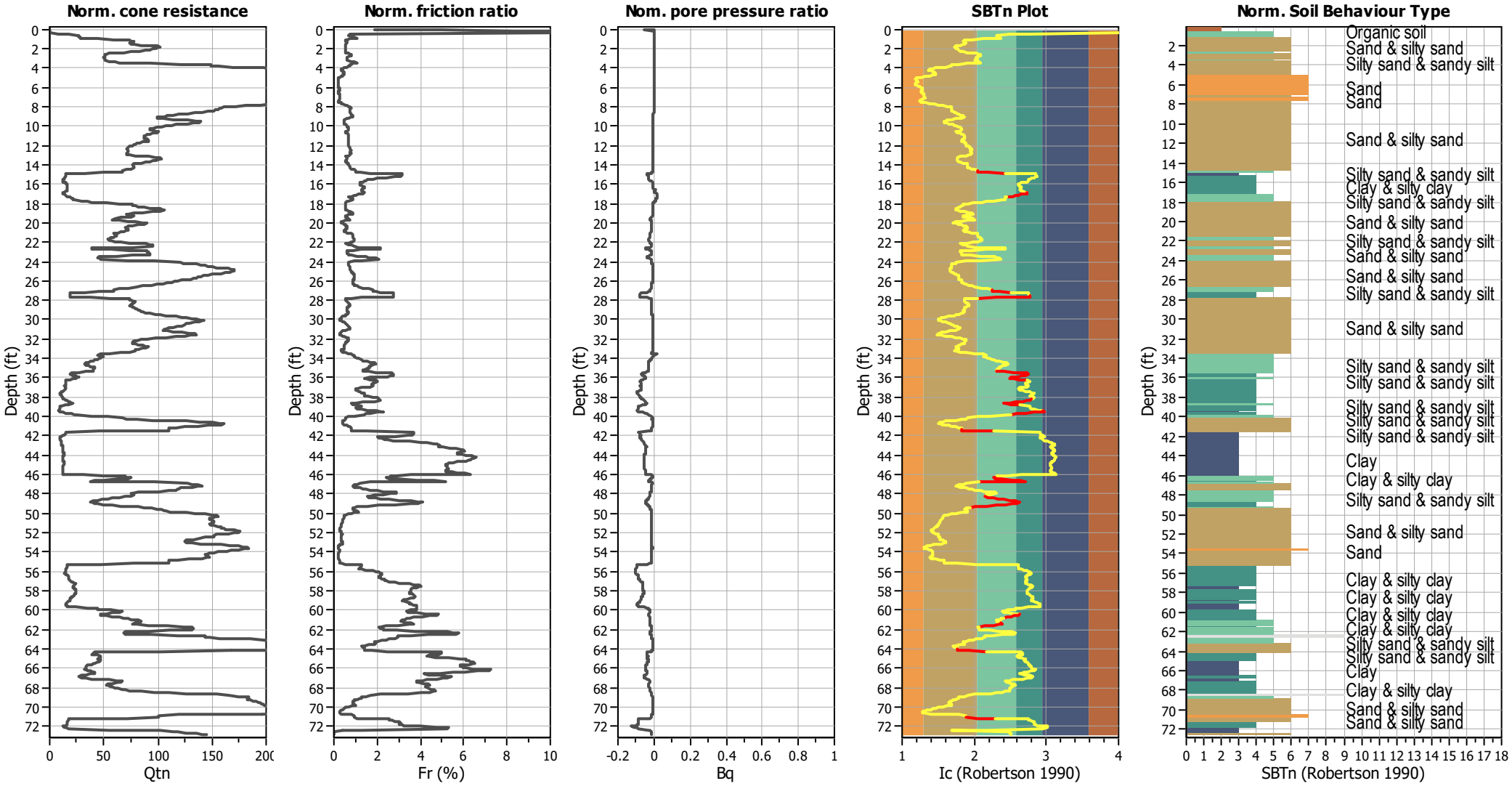
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 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)



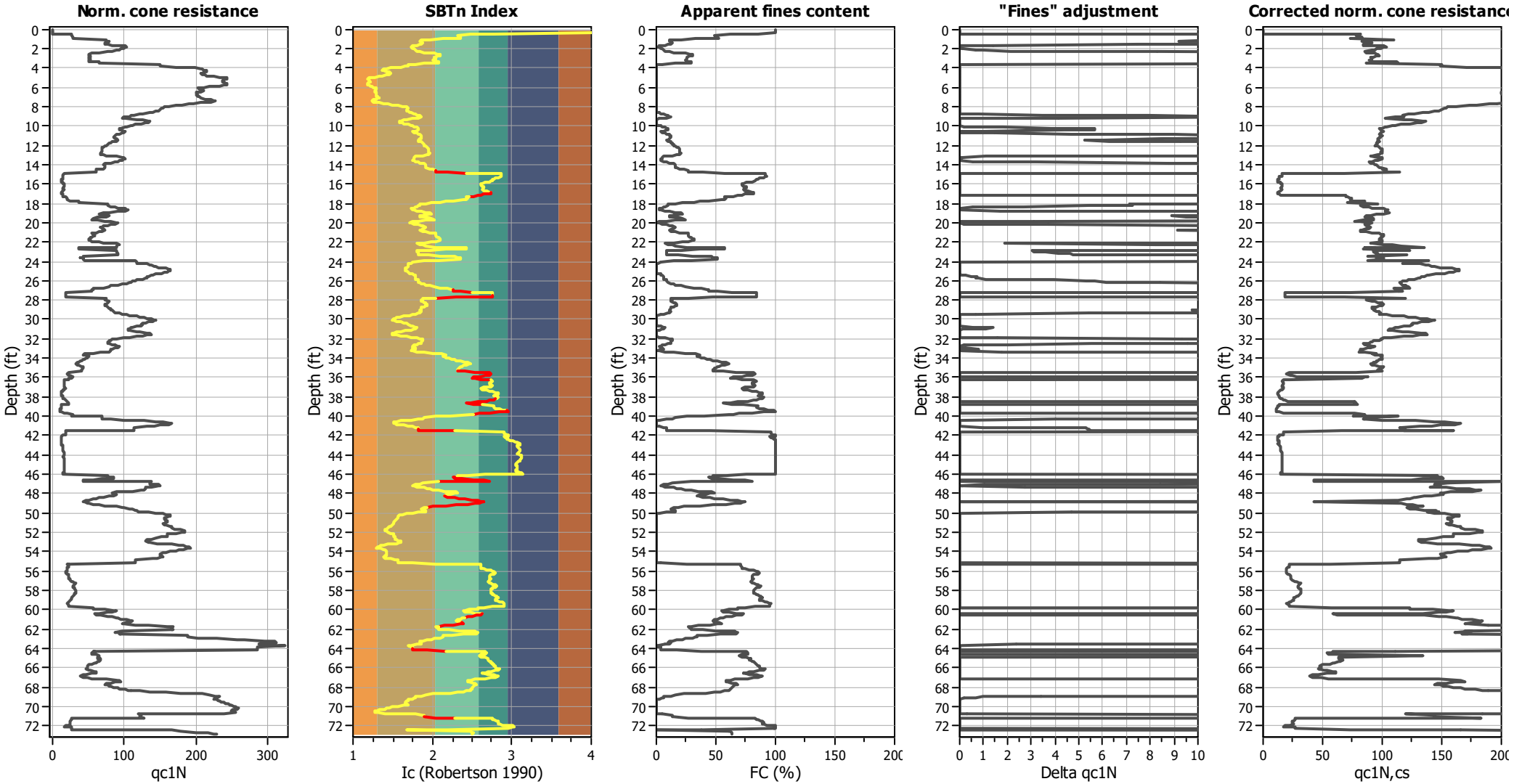
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 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

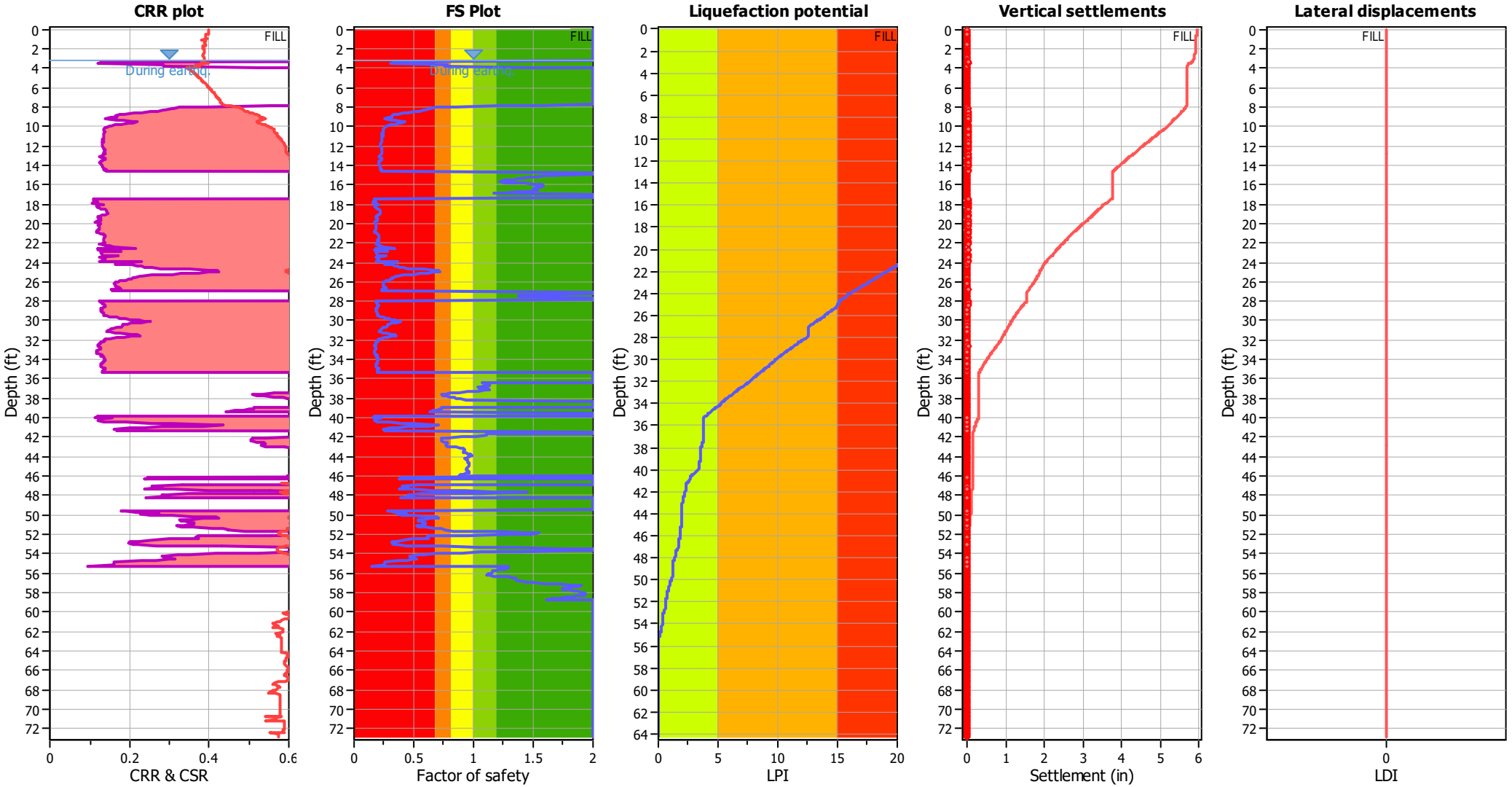
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 ft	Limit depth:	60.00 ft

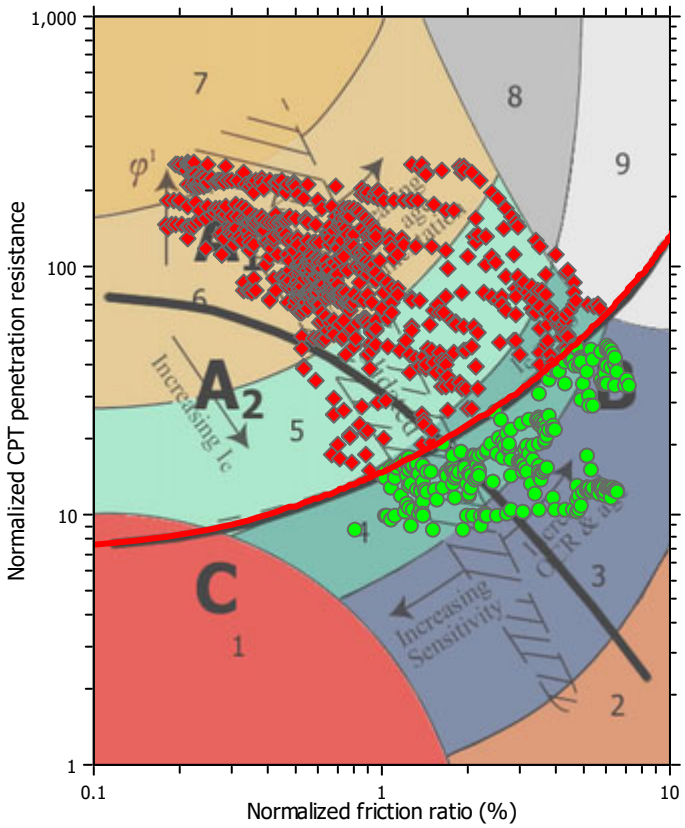
F.S. color scheme

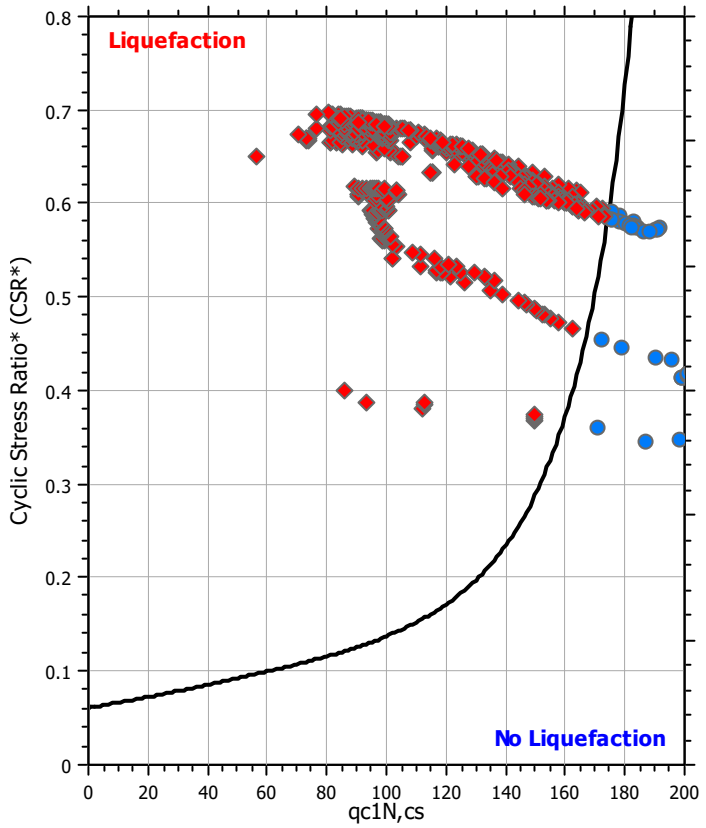
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

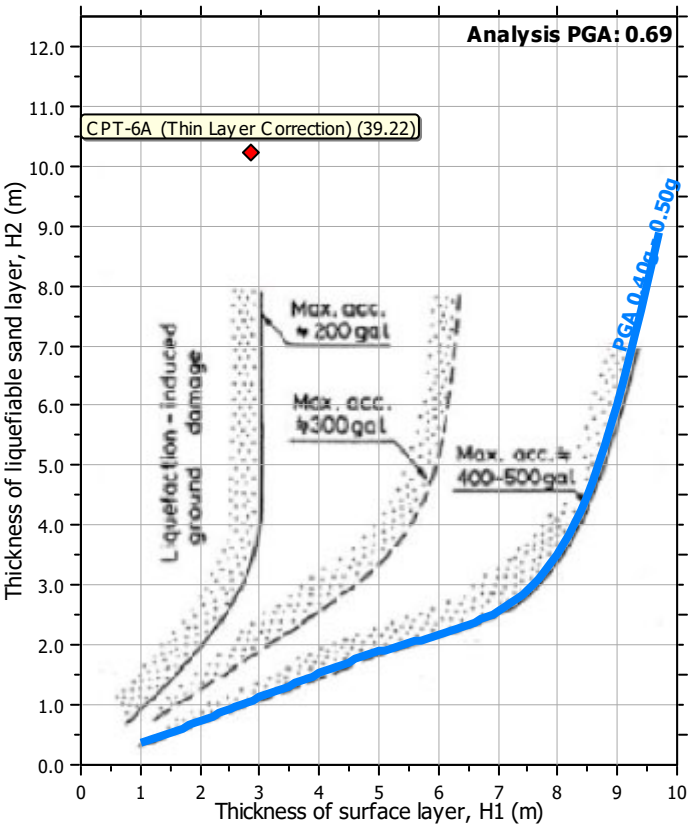
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



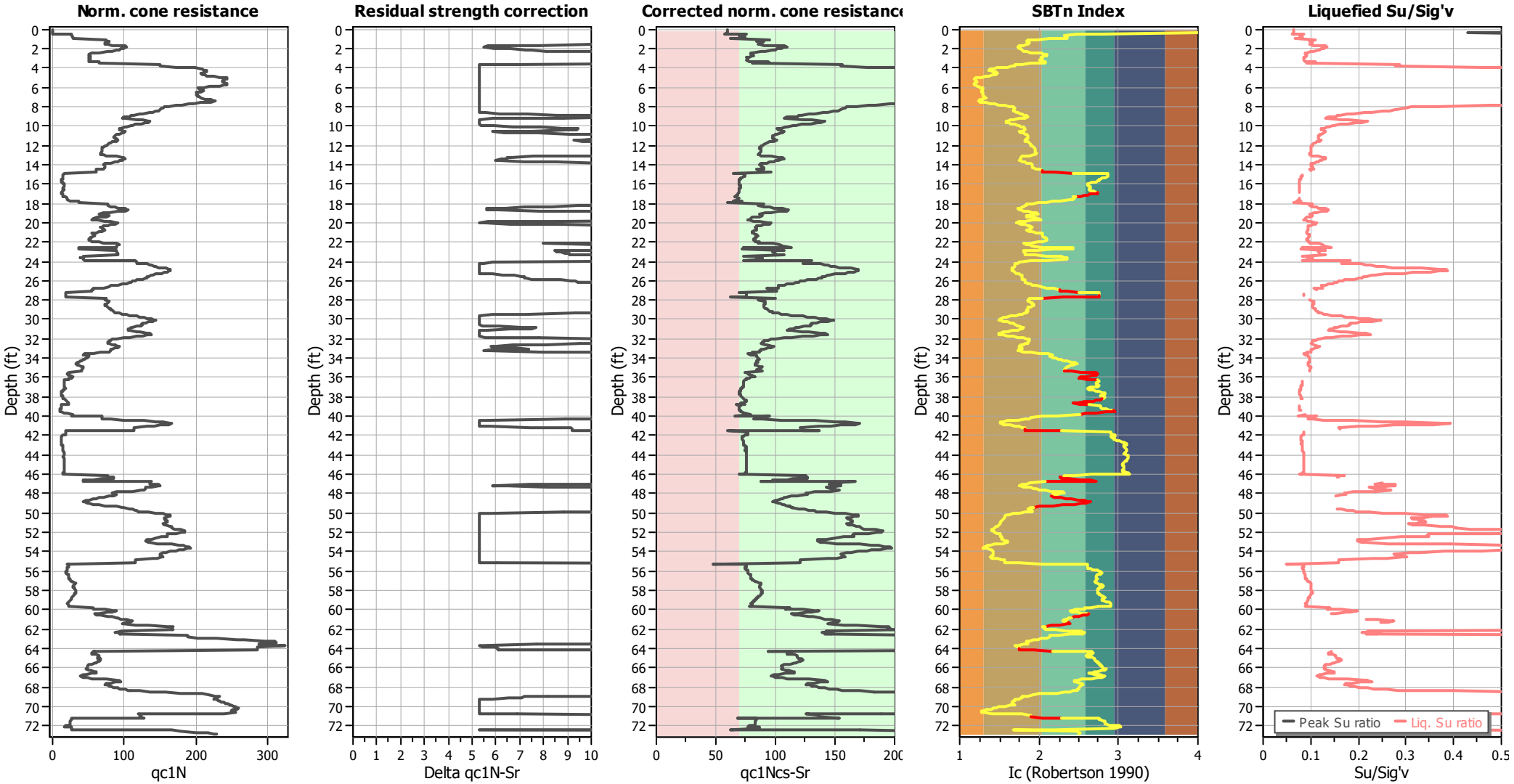




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

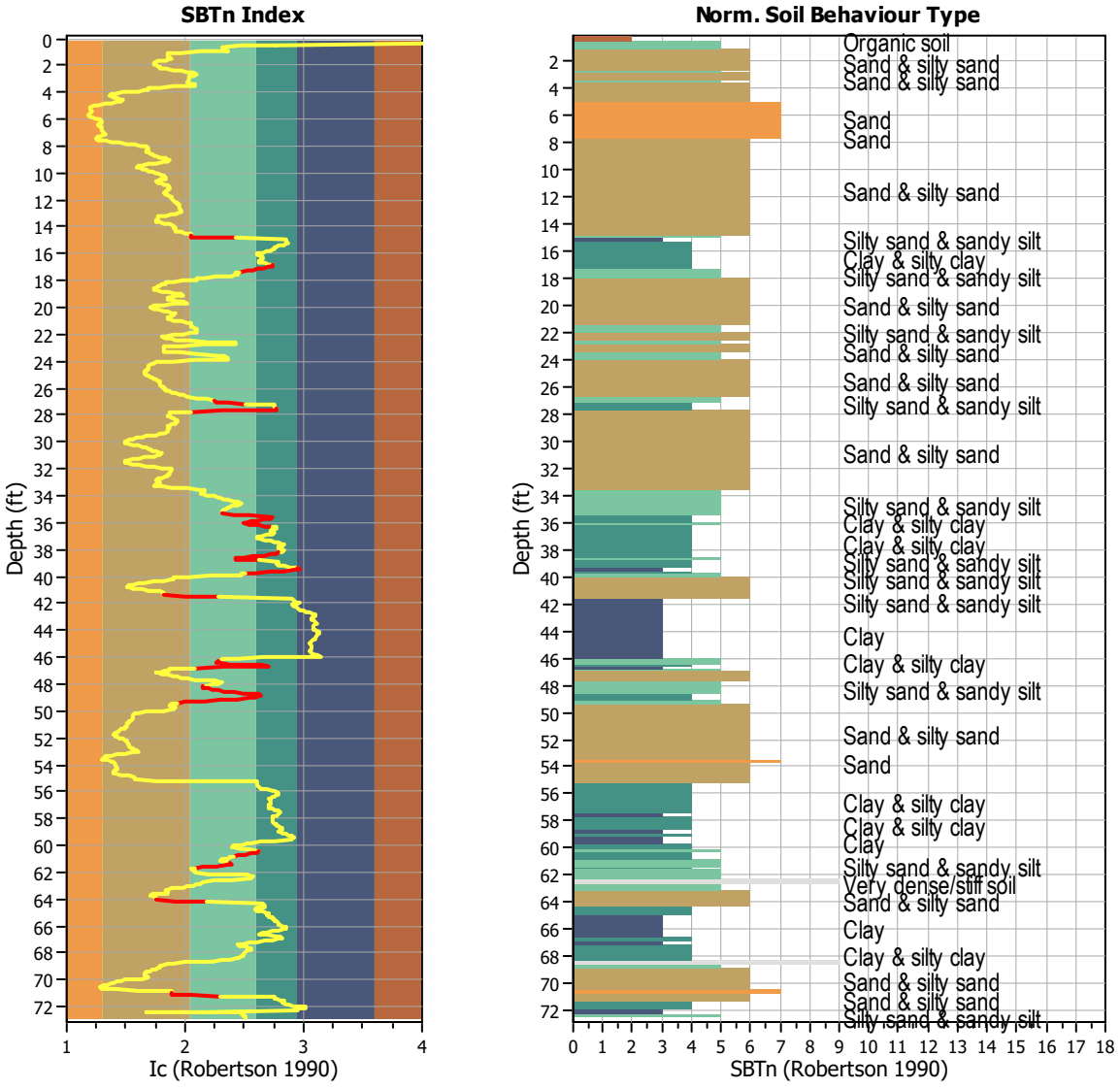
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.29 ft	Fill height:	1.33 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

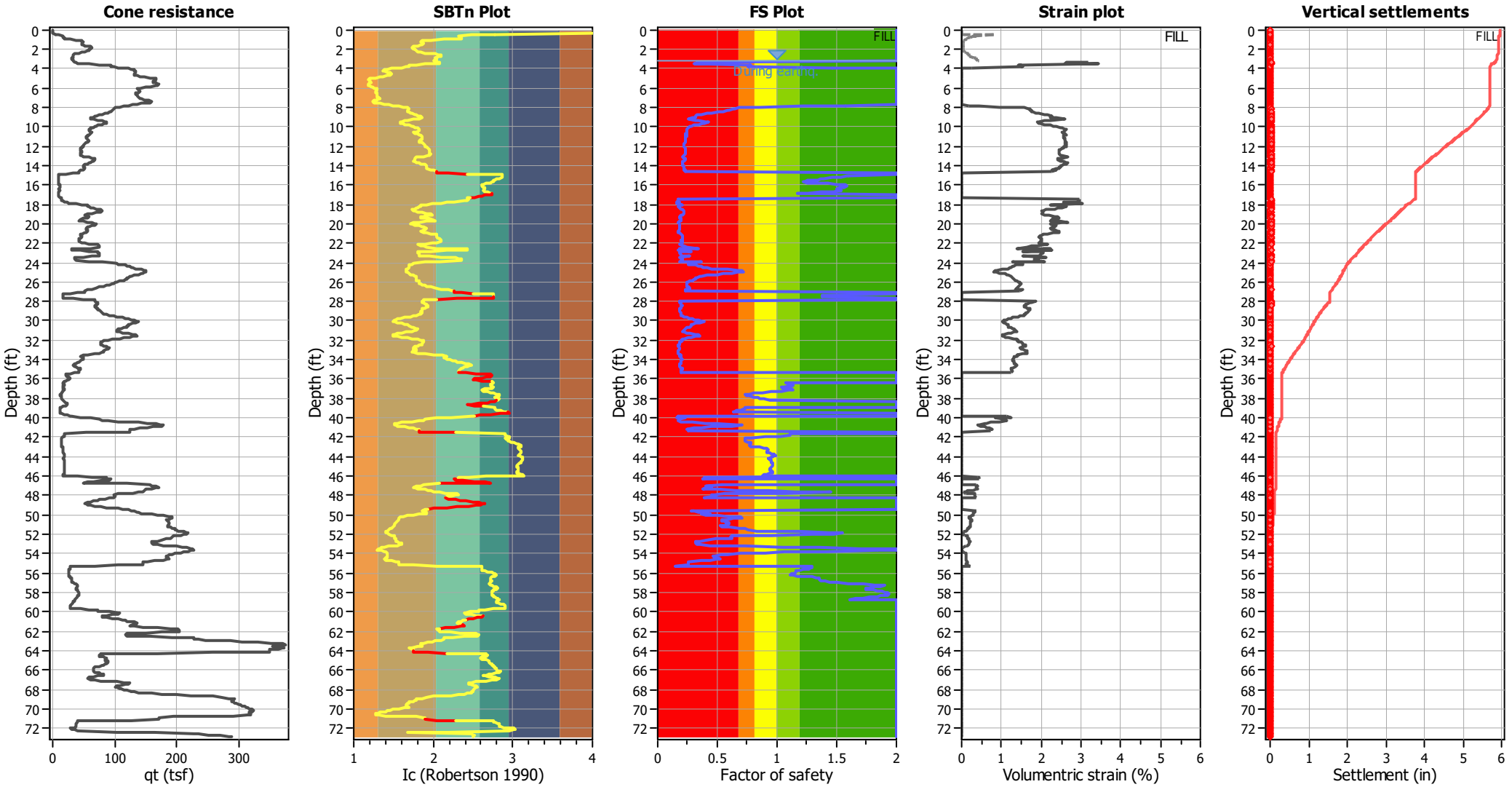
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	110
I_c change ratio value:	0.0250	Exclusion percentage:	9.93%
Minimum number of points in layer:	4	Number of layers detected:	19

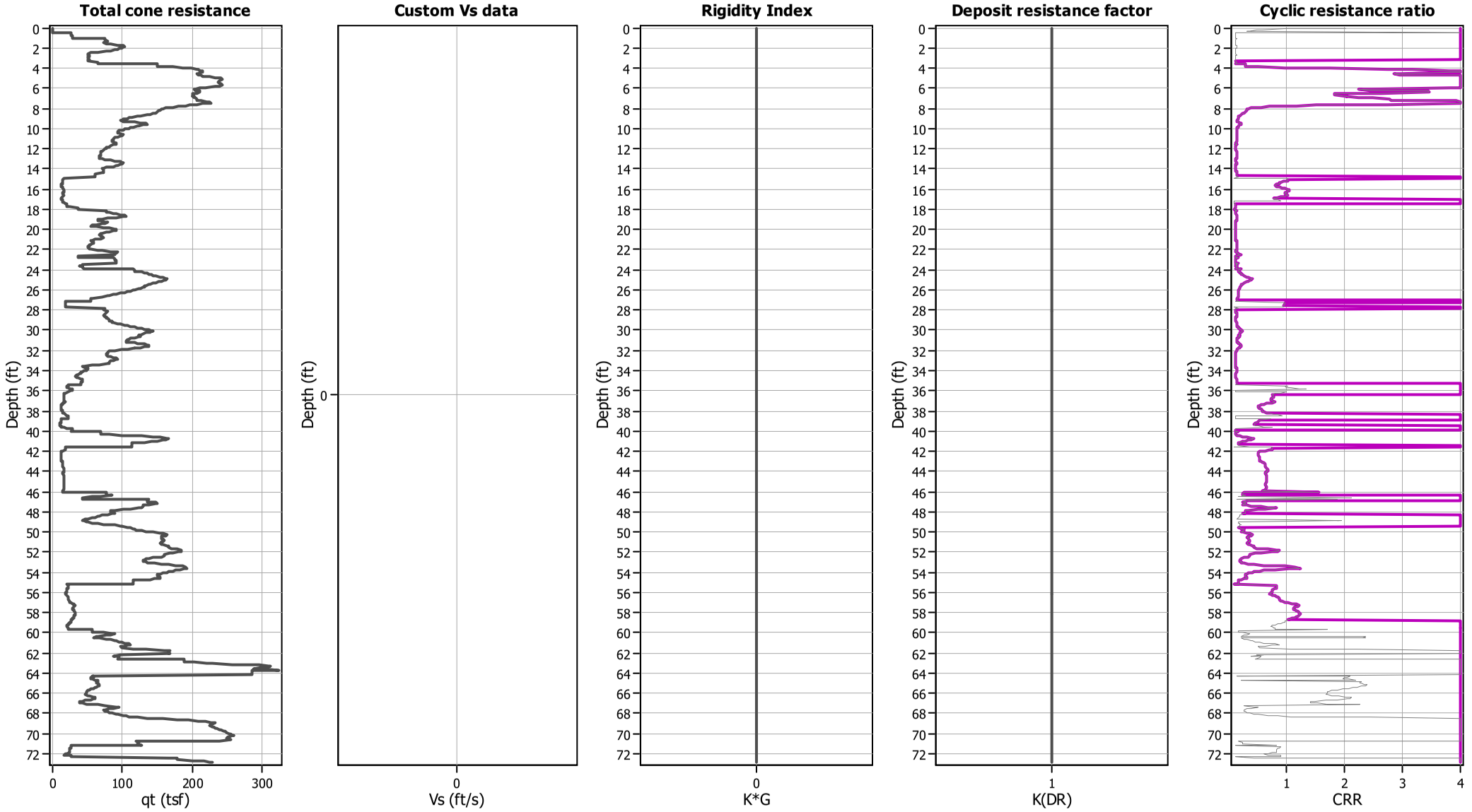
Estimation of post-earthquake settlements



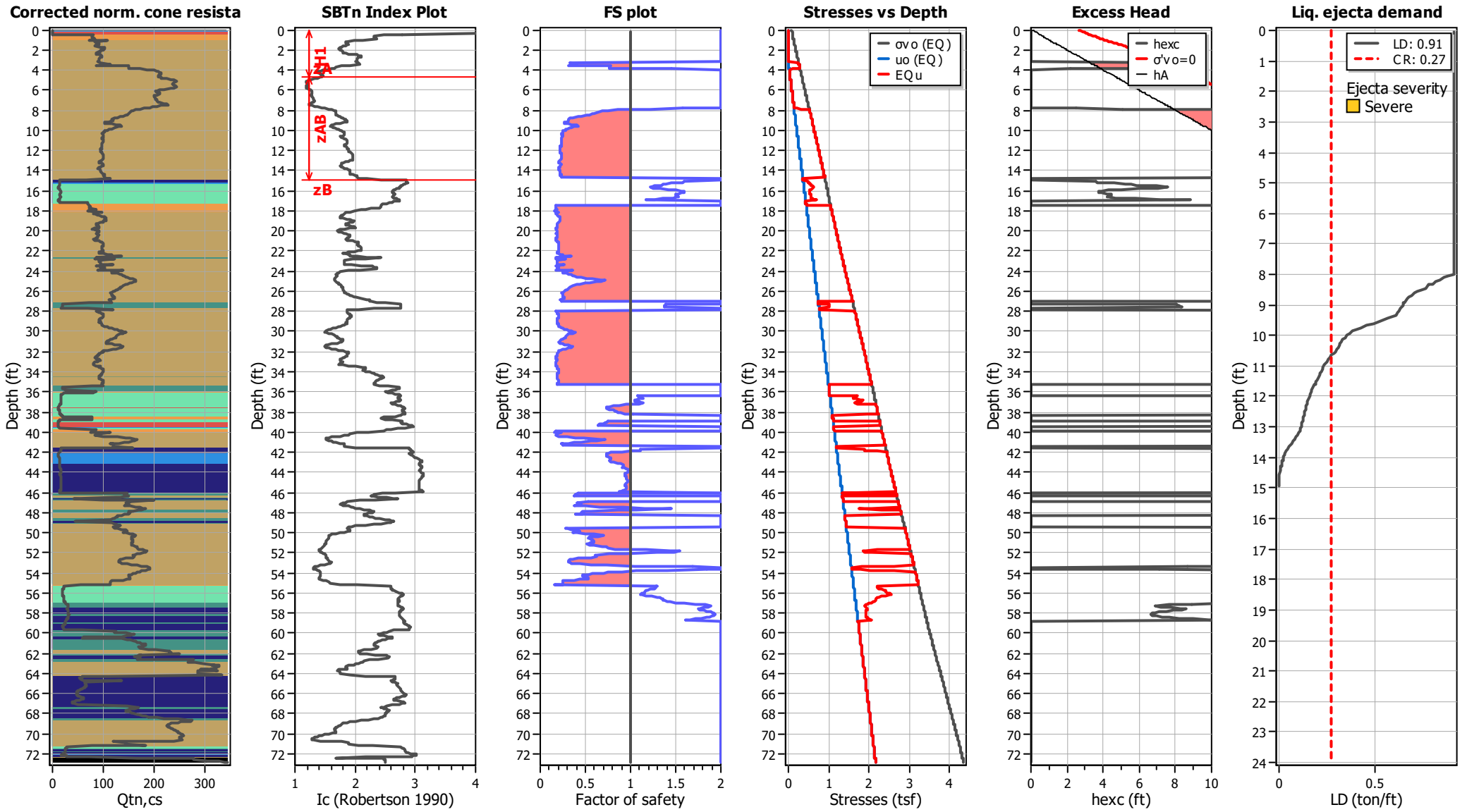
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

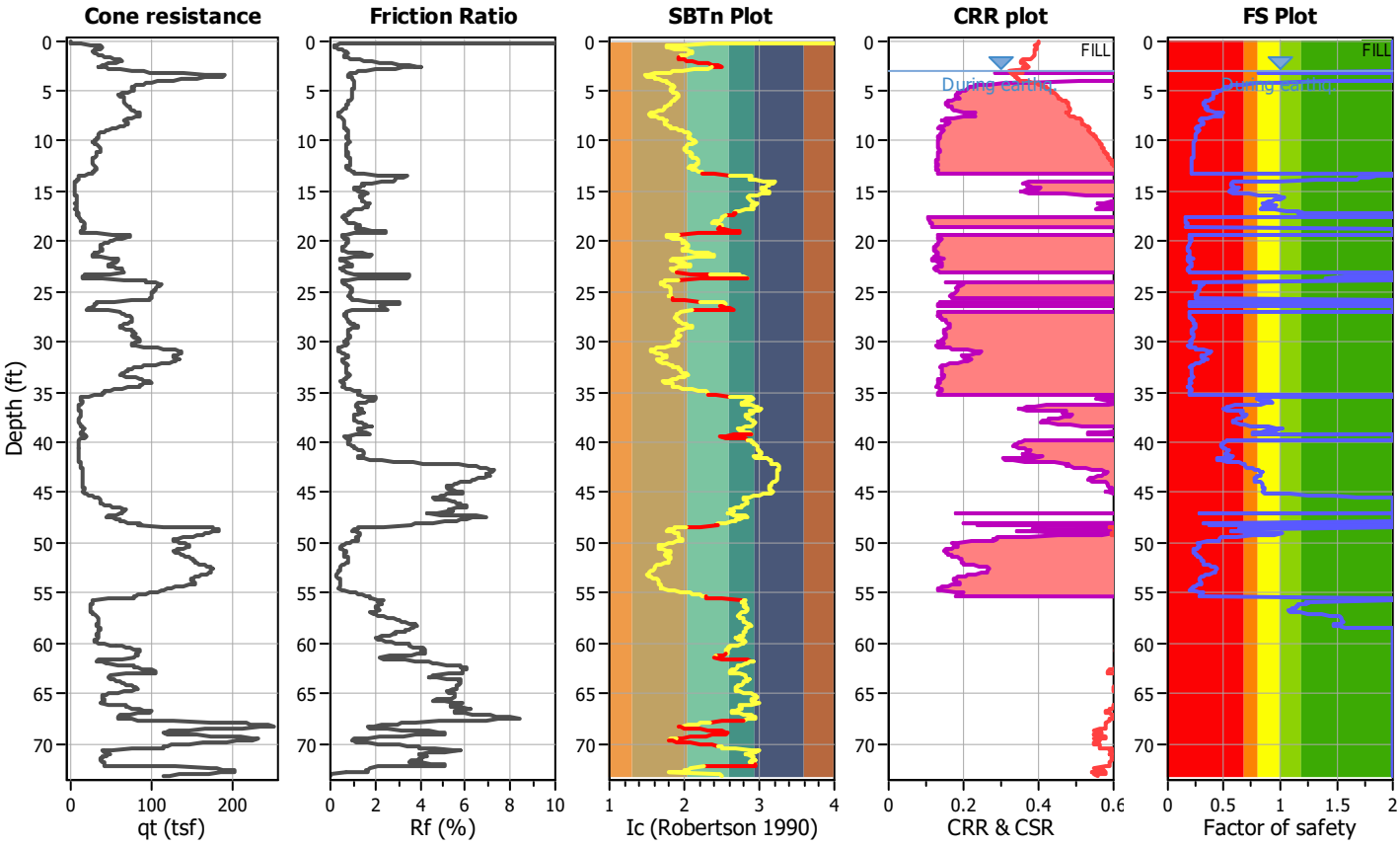
Project title : Topgolf Harbor Island

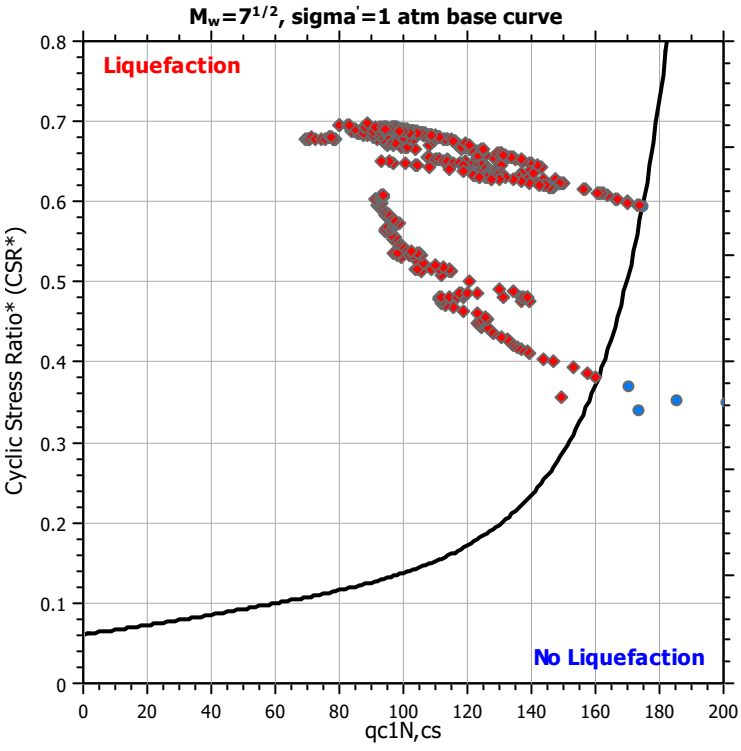
Location : North Harbor Drive and Liberator Way, San Diego, CA

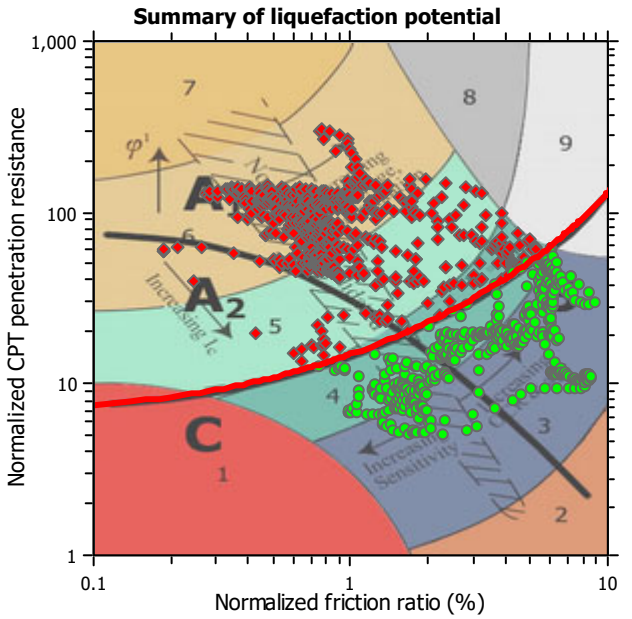
CPT file : CPT-7 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.09 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.53 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

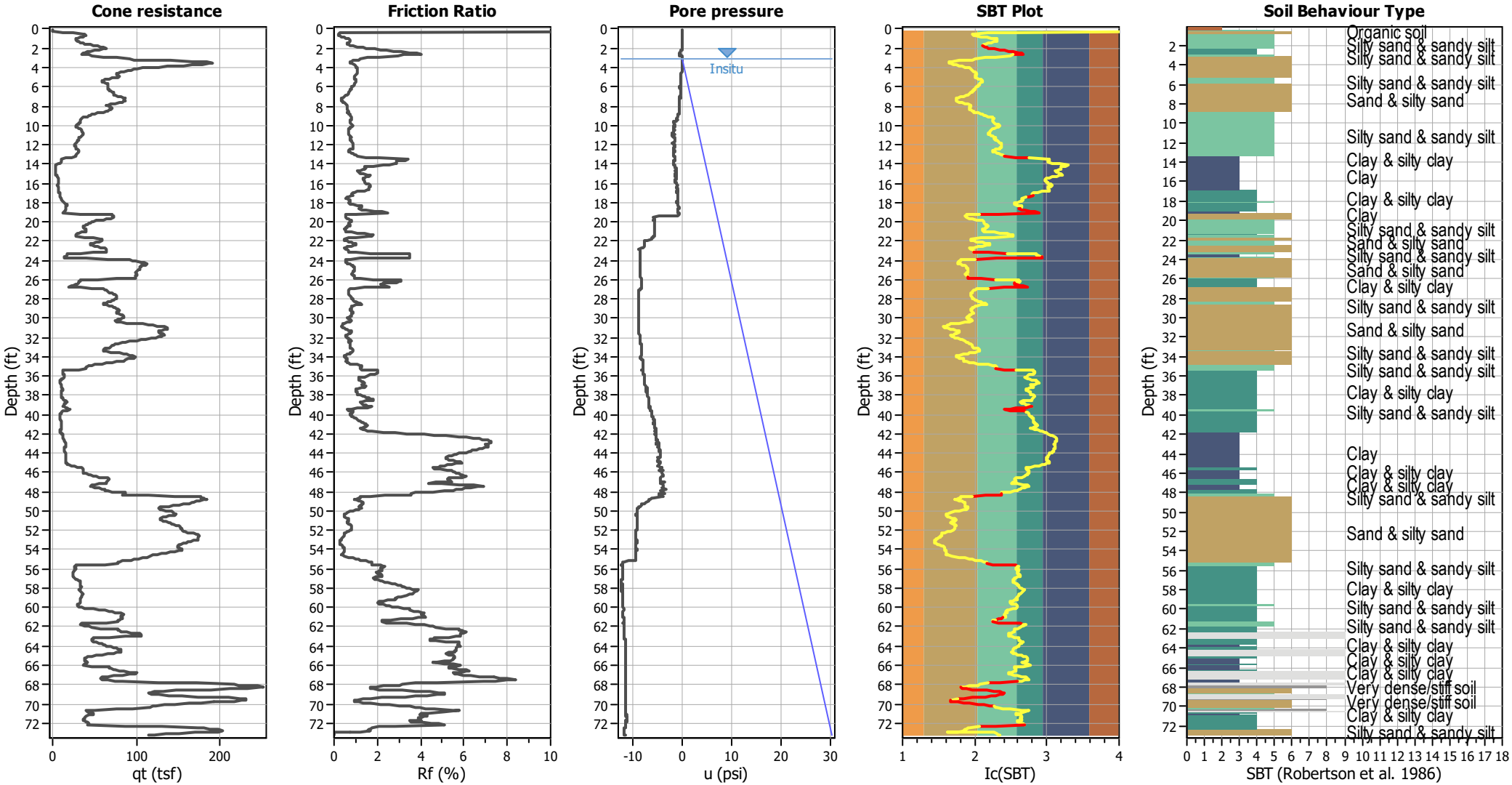






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



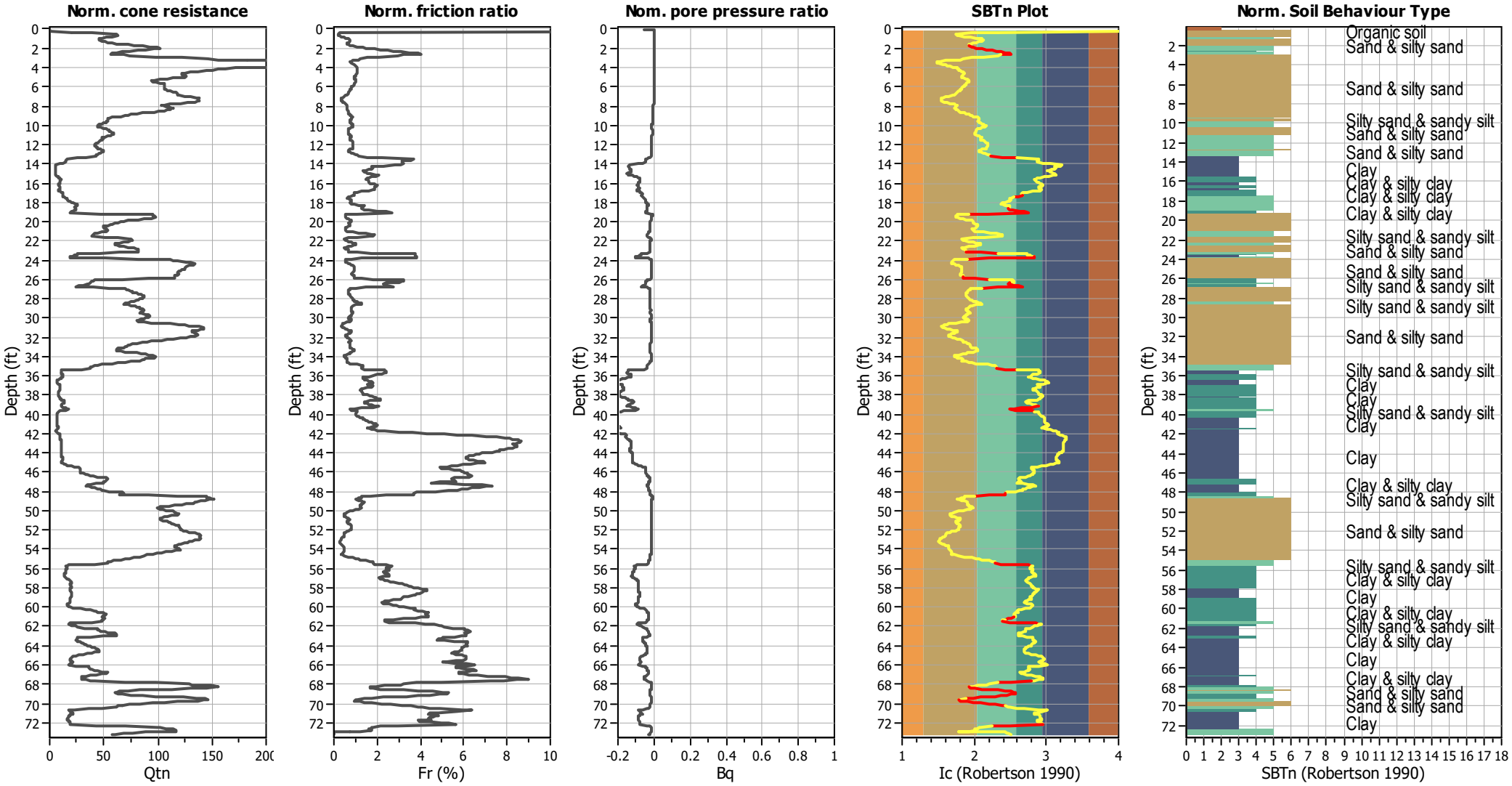
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 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)



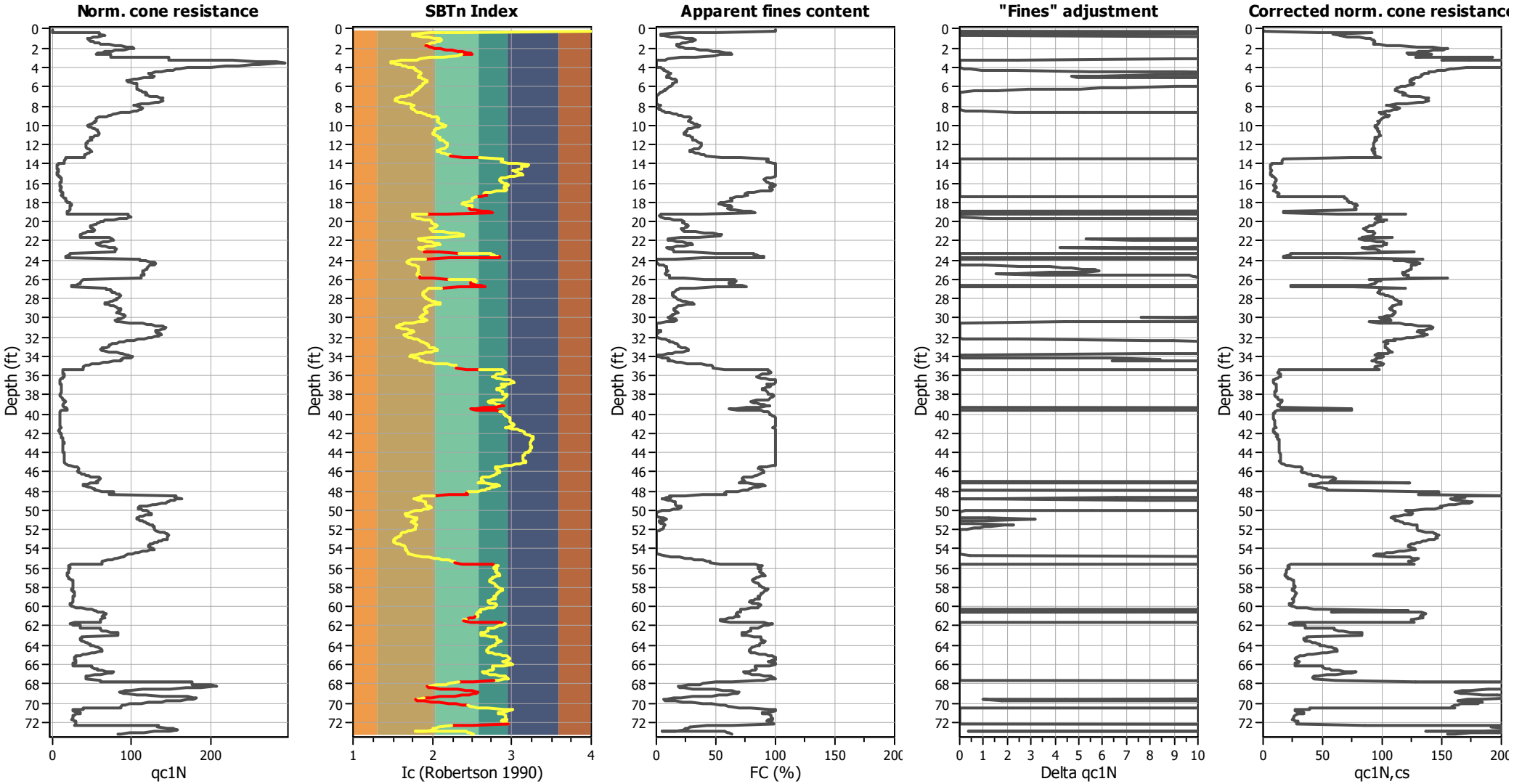
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 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

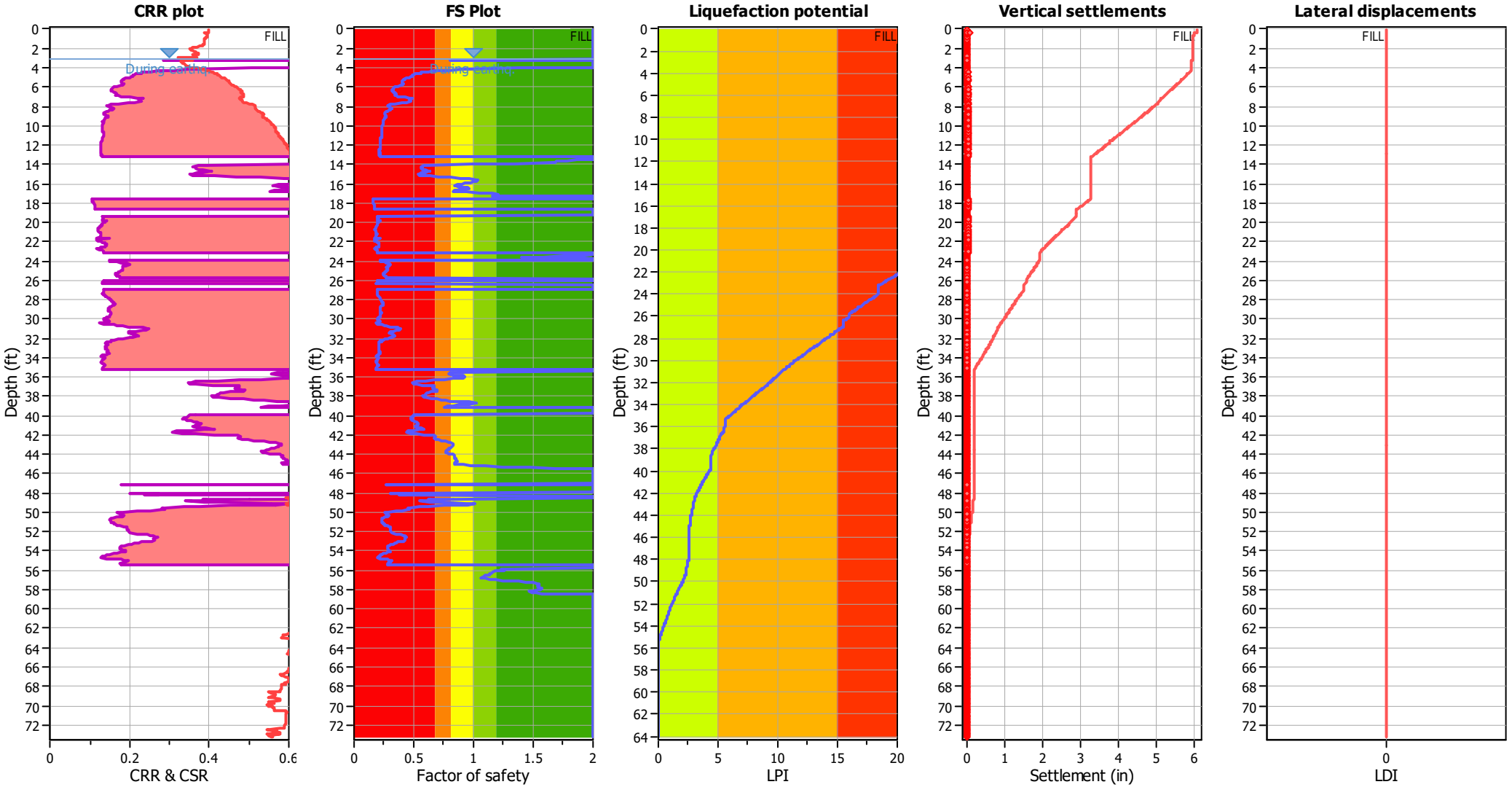
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 ft	Limit depth:	60.00 ft

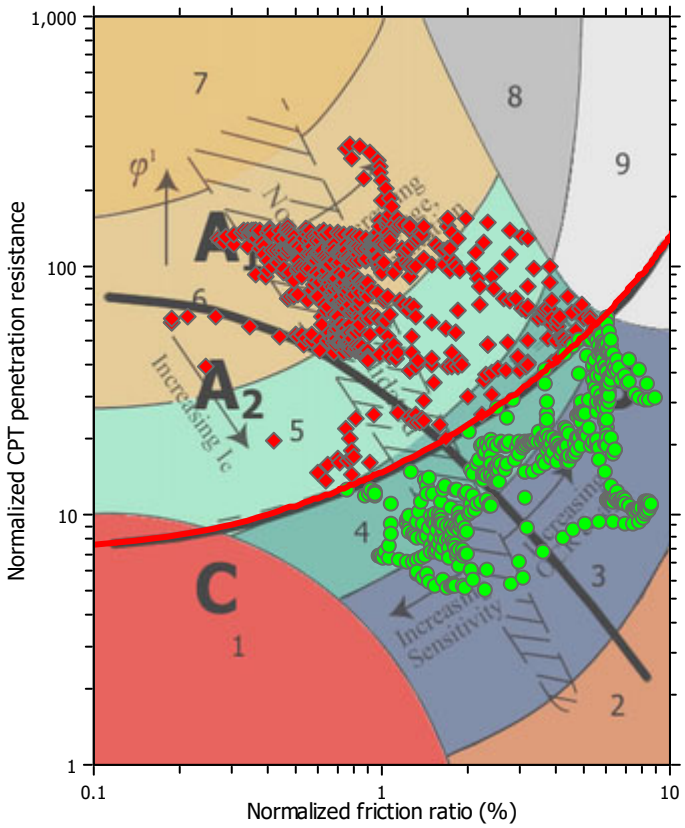
F.S. color scheme

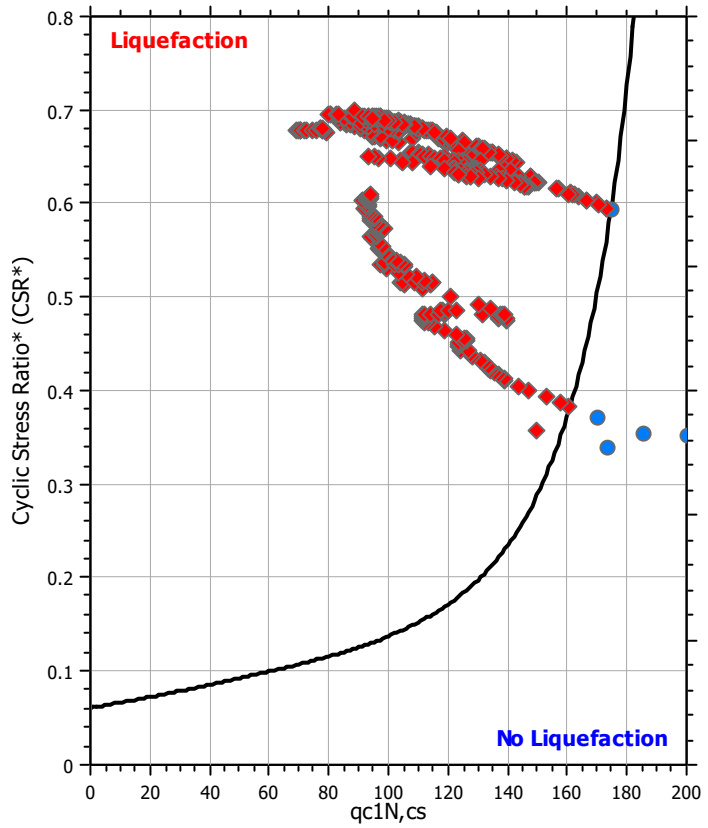
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

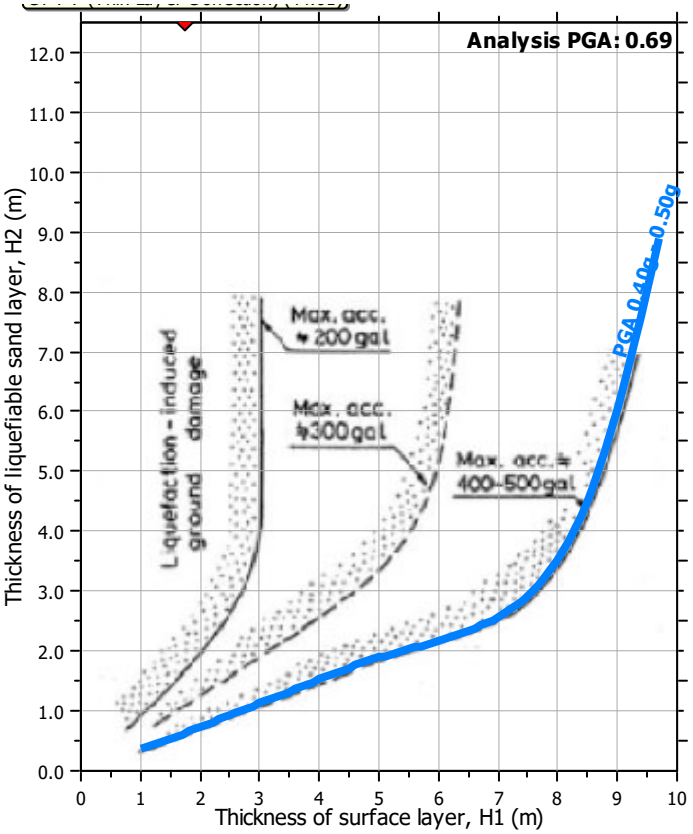
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



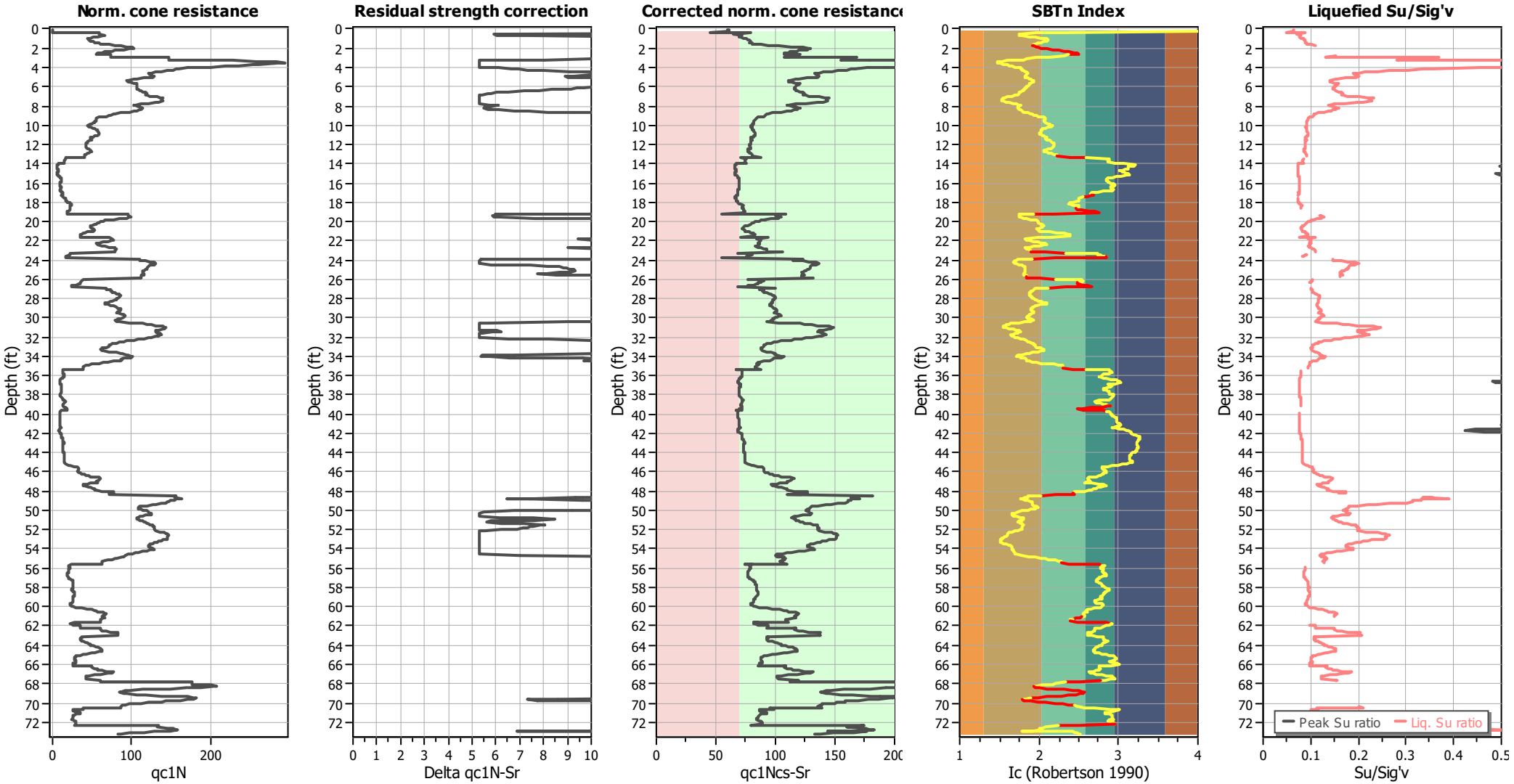




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

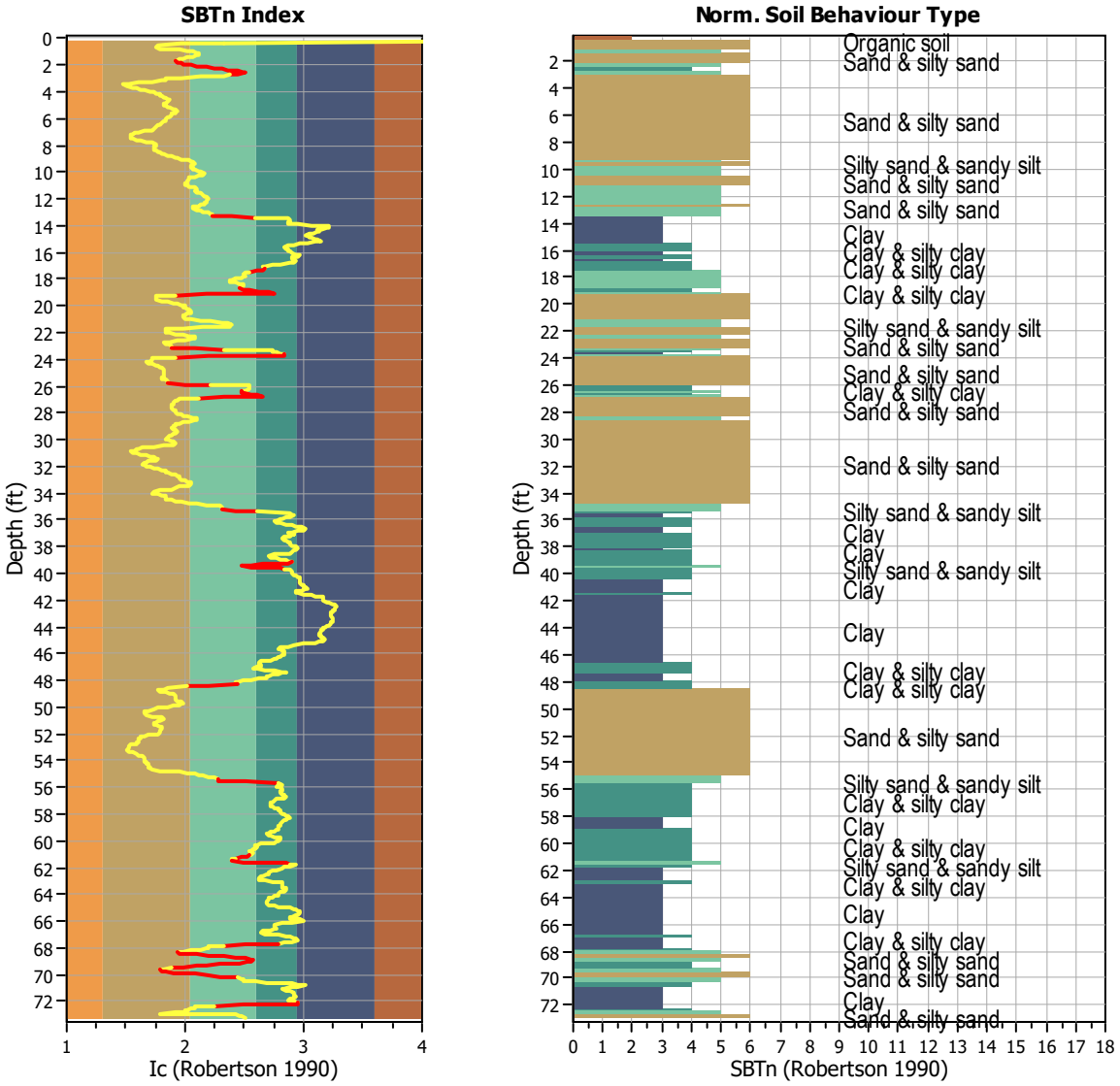
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.09 ft	Fill height:	1.53 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

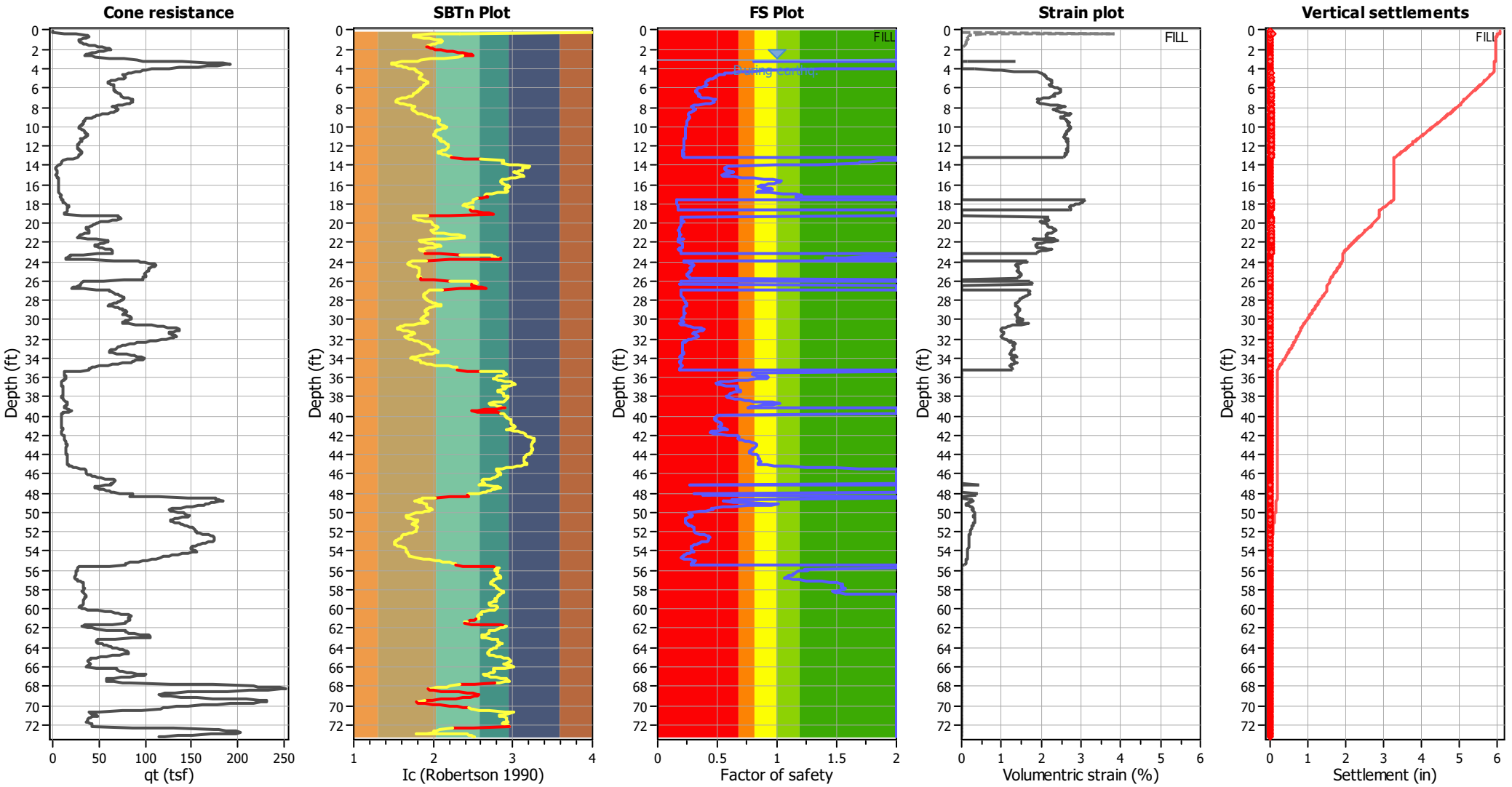
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1112
I_c maximum check value:	3.00	Total points excluded:	129
I_c change ratio value:	0.0250	Exclusion percentage:	11.60%
Minimum number of points in layer:	4	Number of layers detected:	23

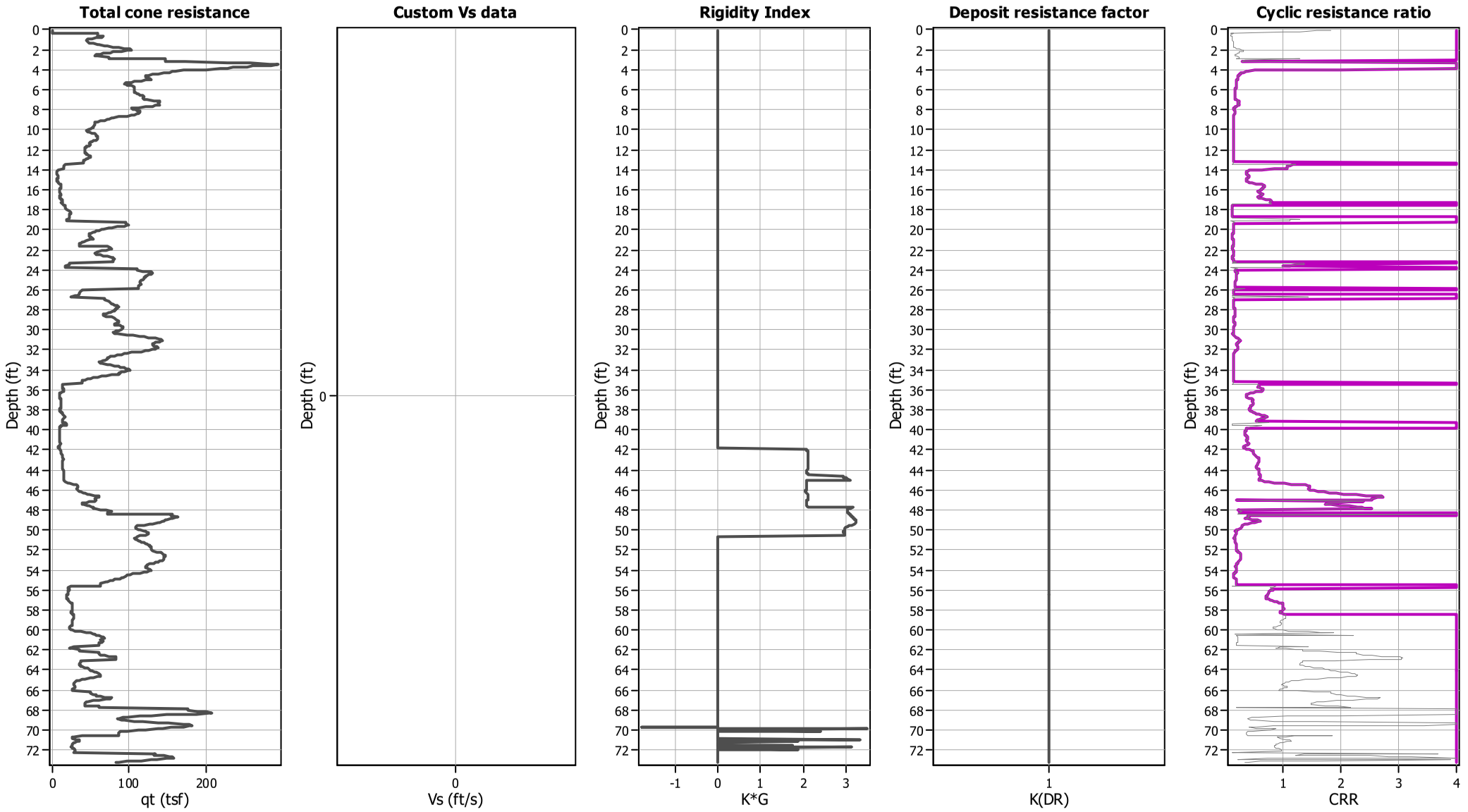
Estimation of post-earthquake settlements



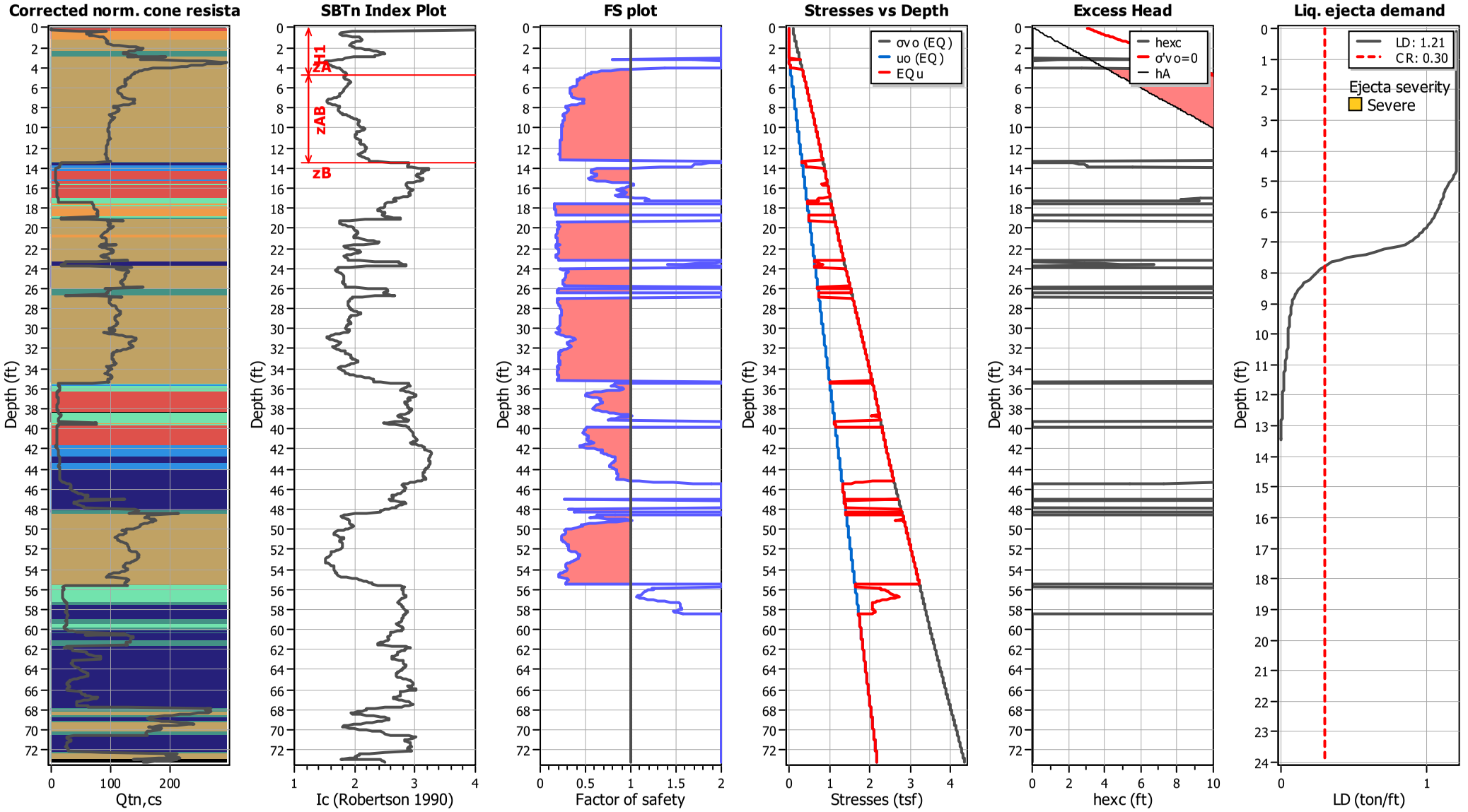
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

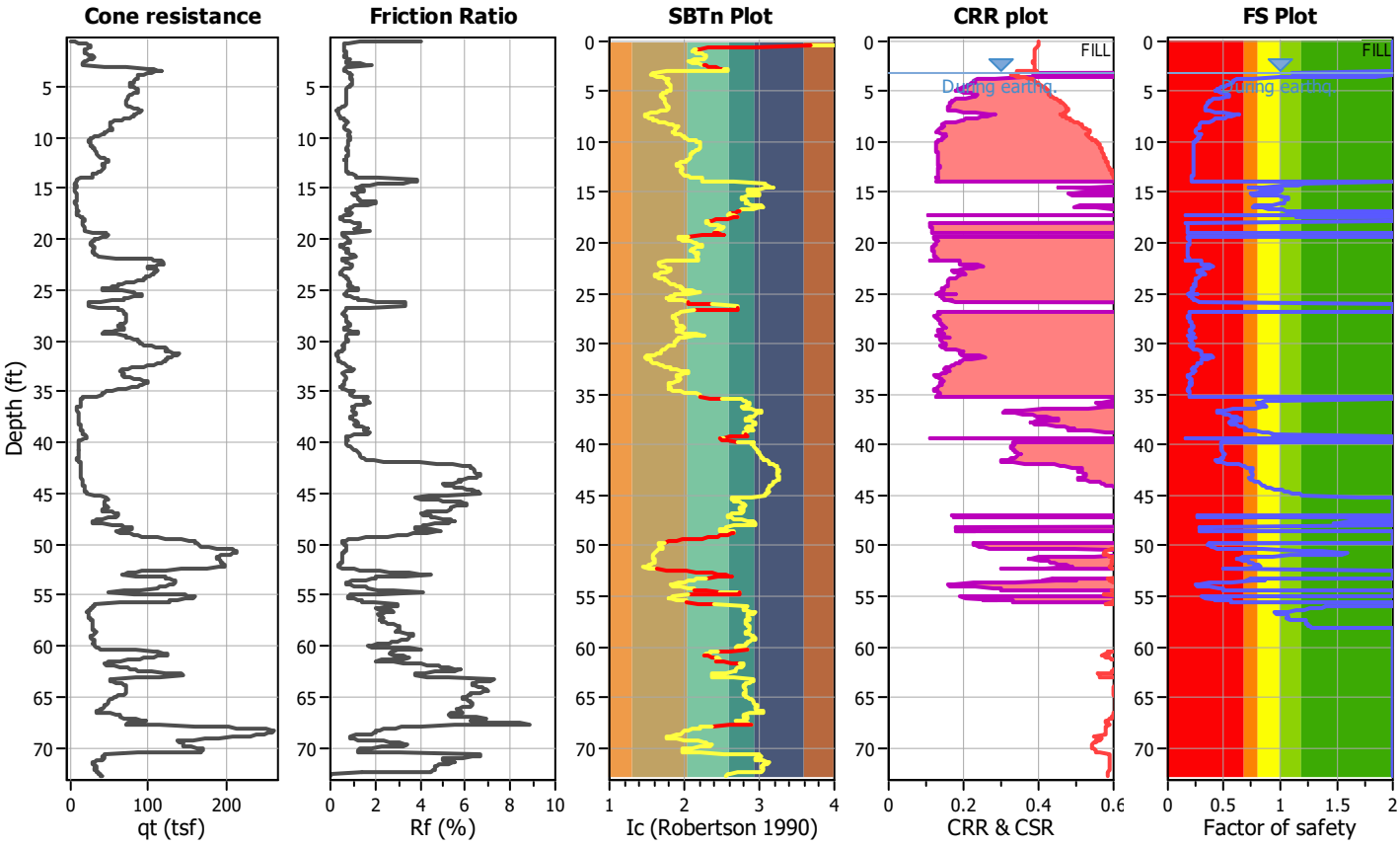
Project title : Topgolf Harbor Island

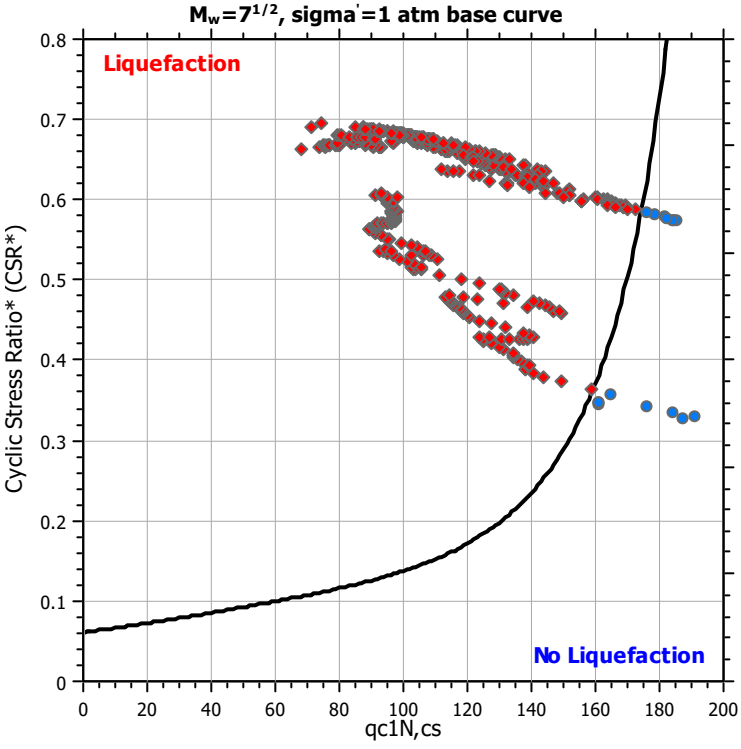
Location : North Harbor Drive and Liberator Way, San Diego, CA

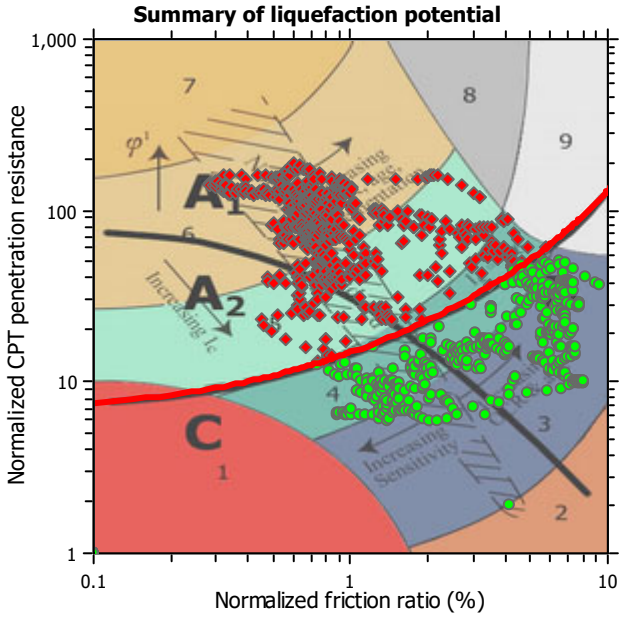
CPT file : CPT-8 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.18 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.94 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

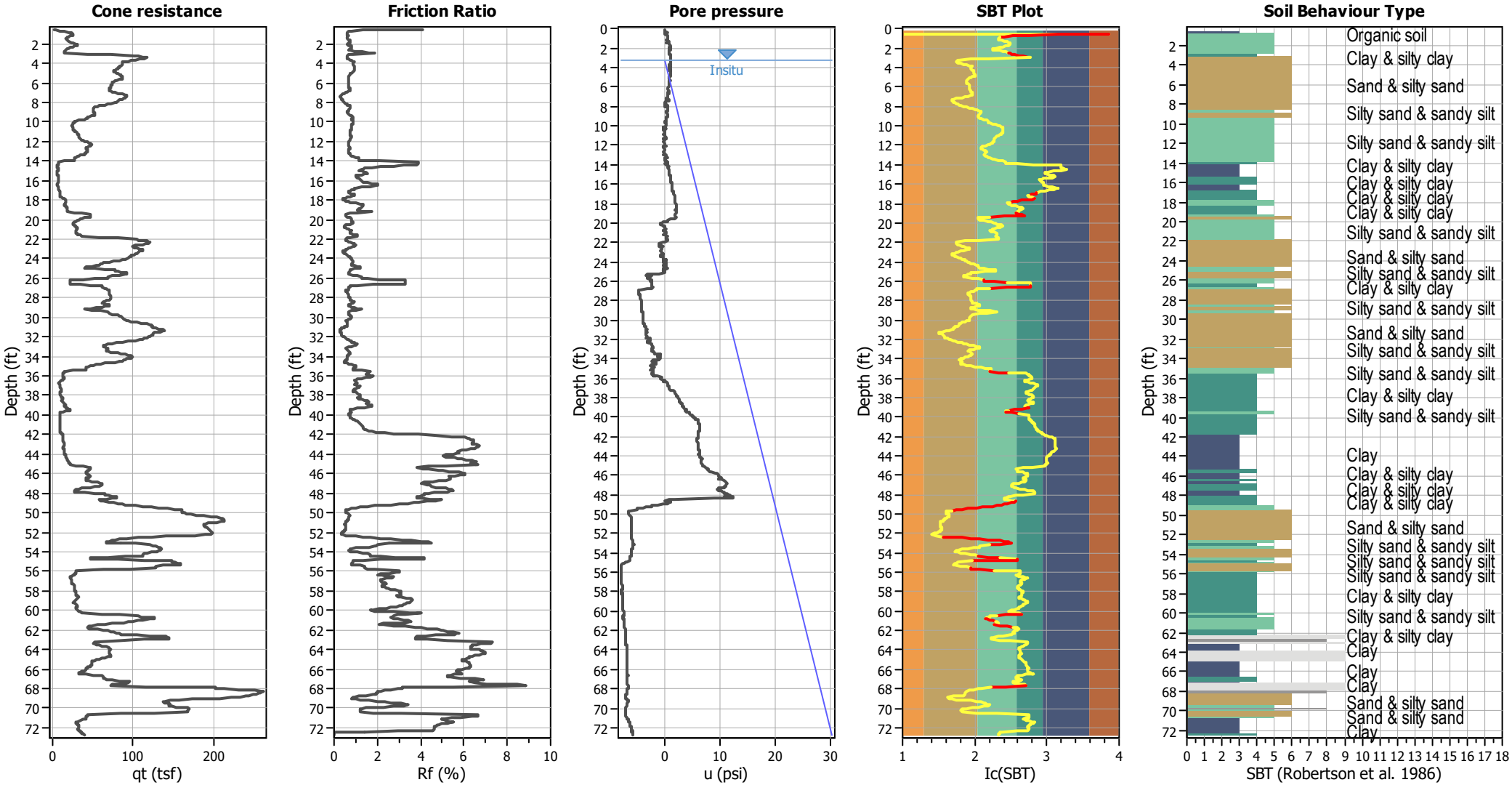






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



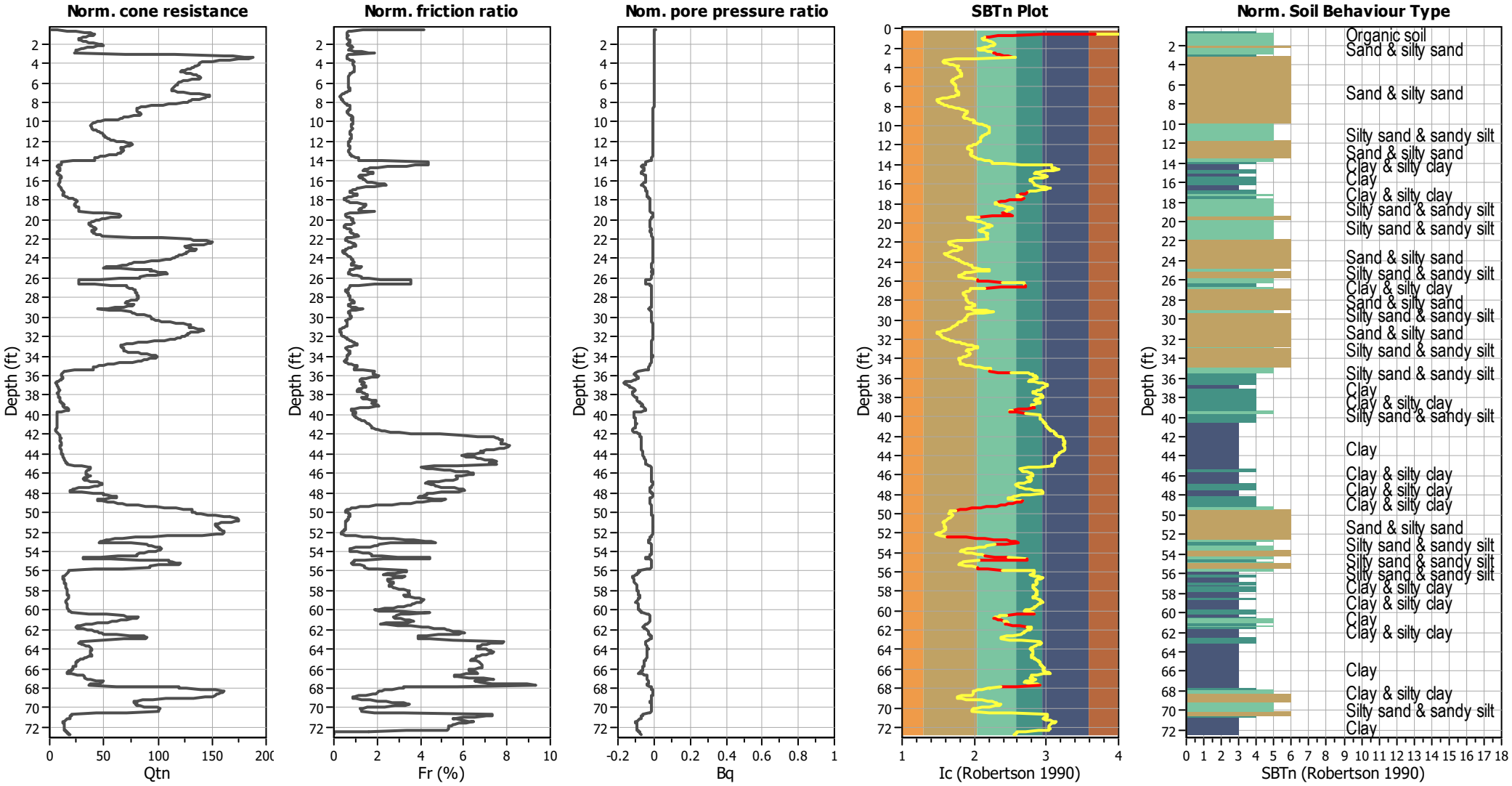
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 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)



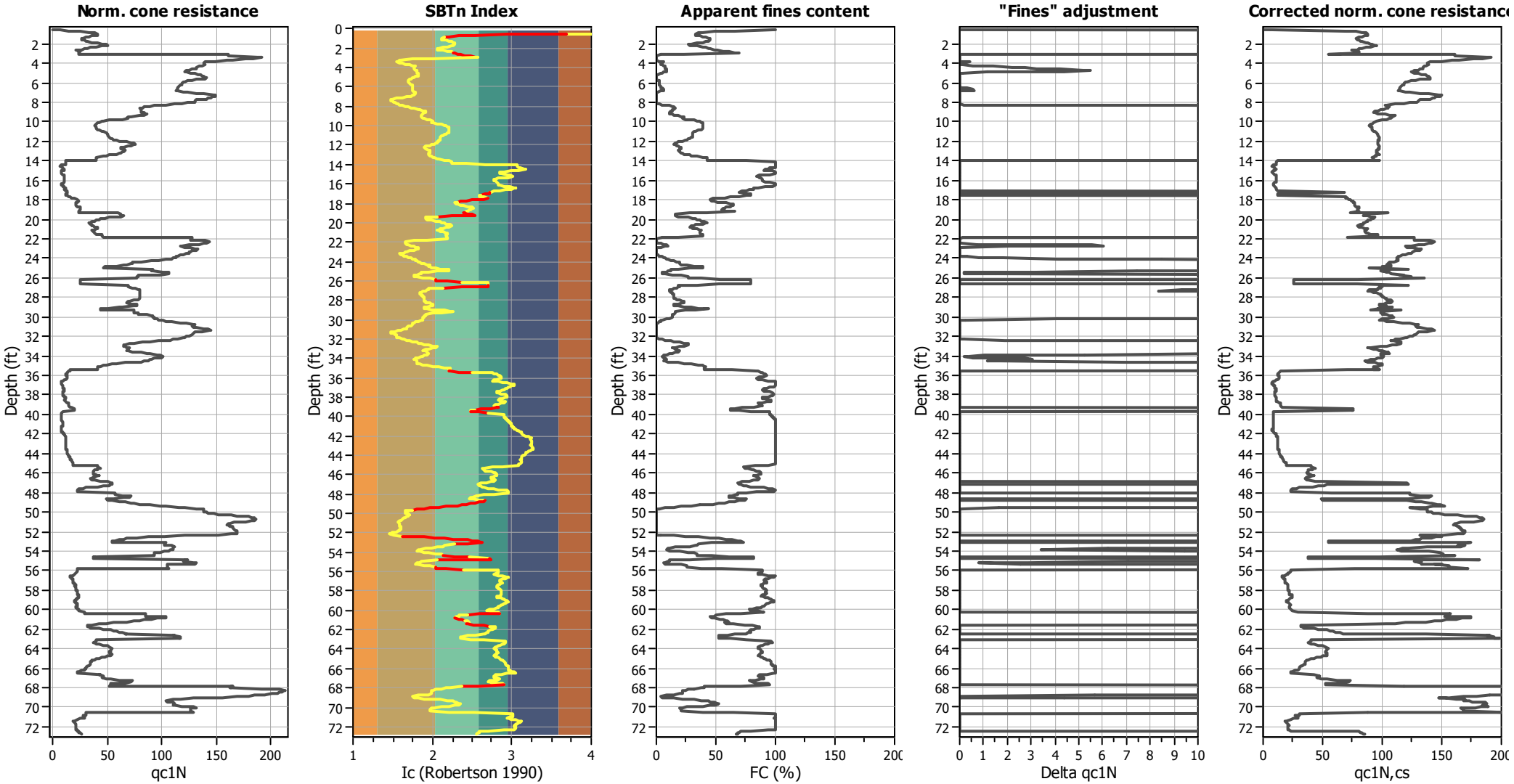
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 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

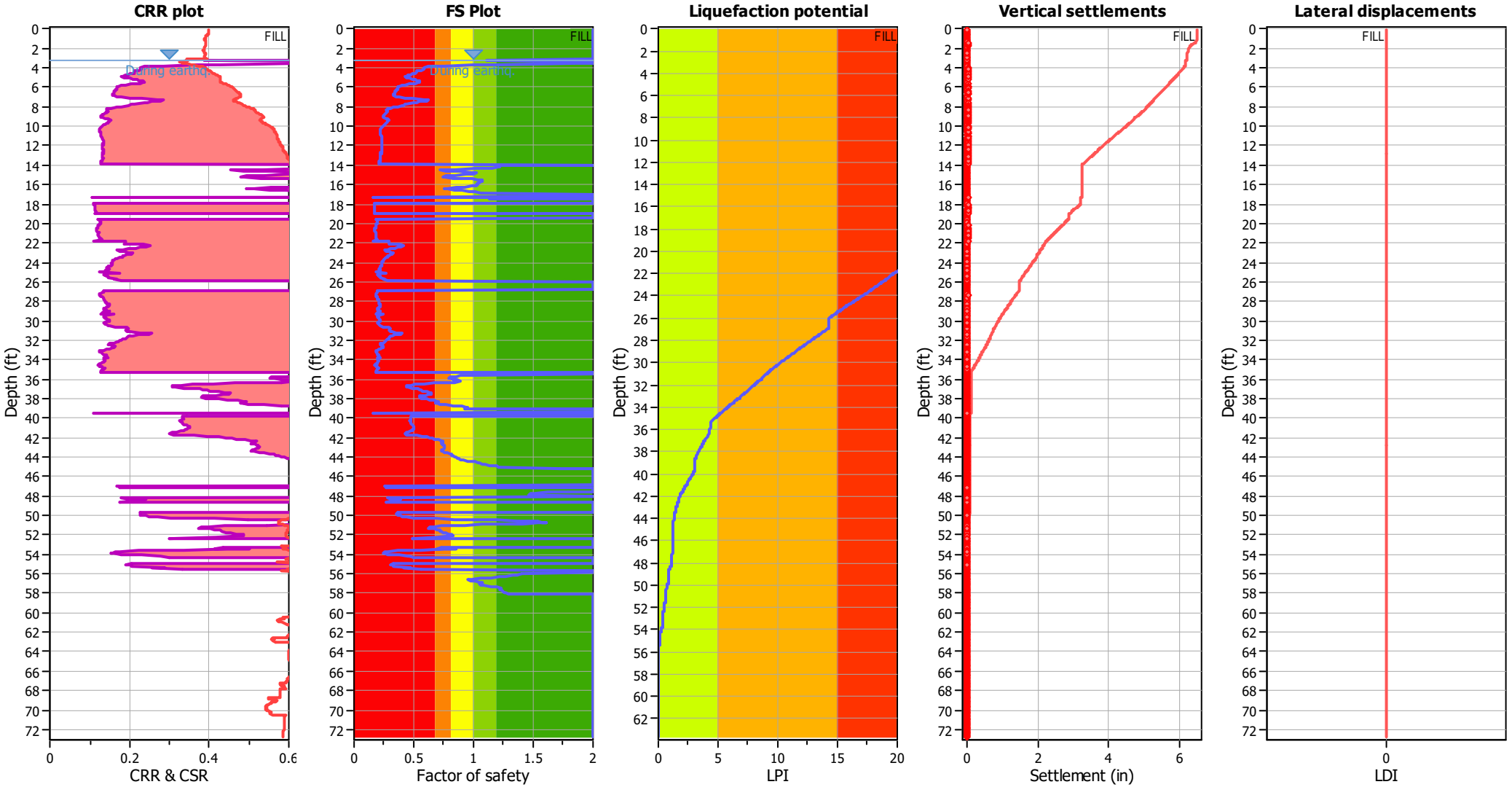
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 ft	Limit depth:	60.00 ft

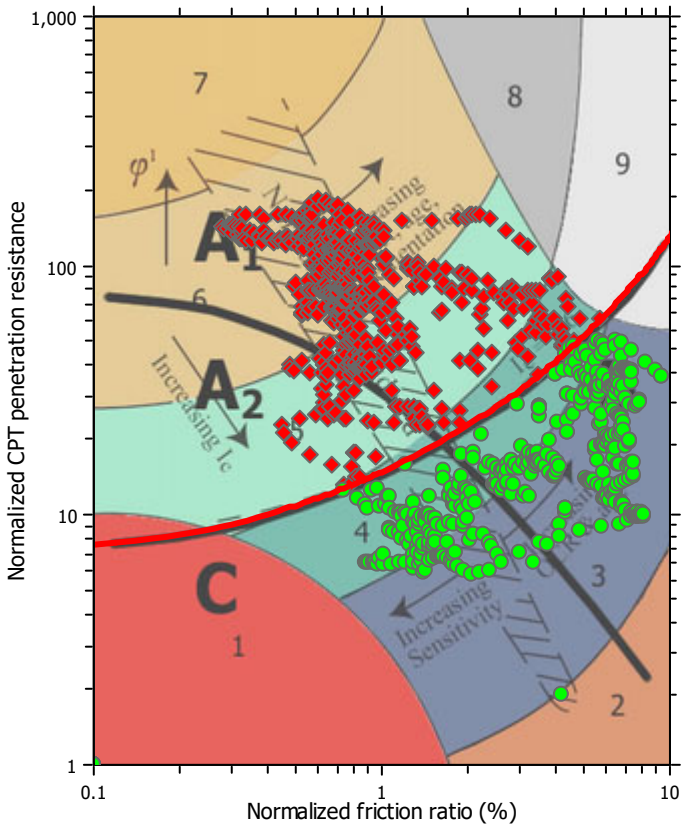
F.S. color scheme

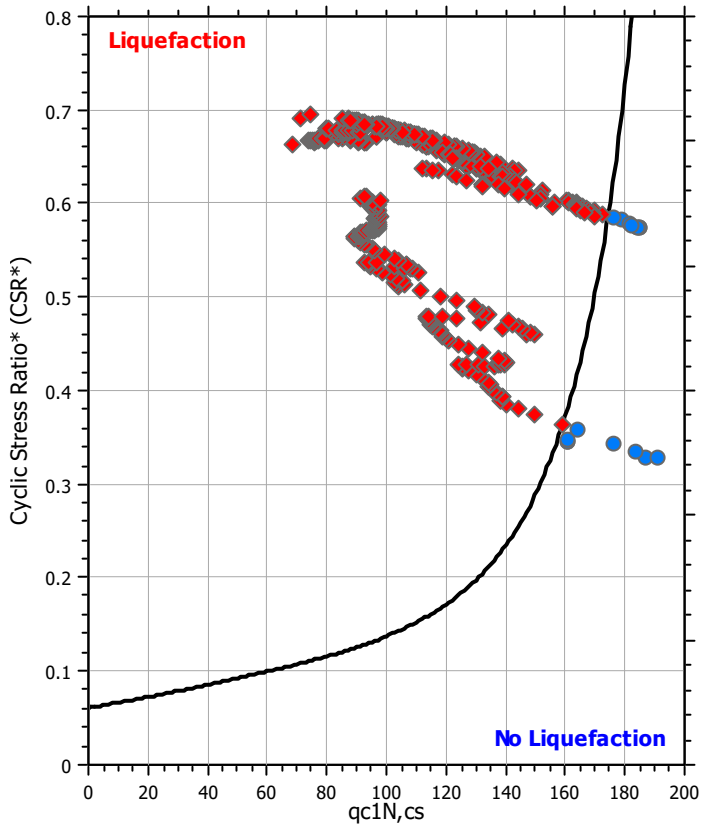
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

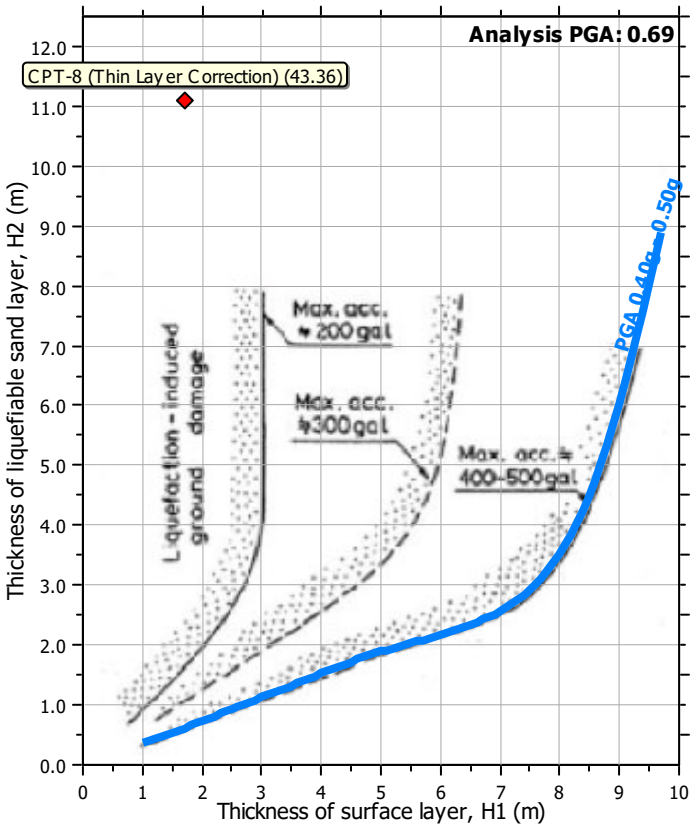
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



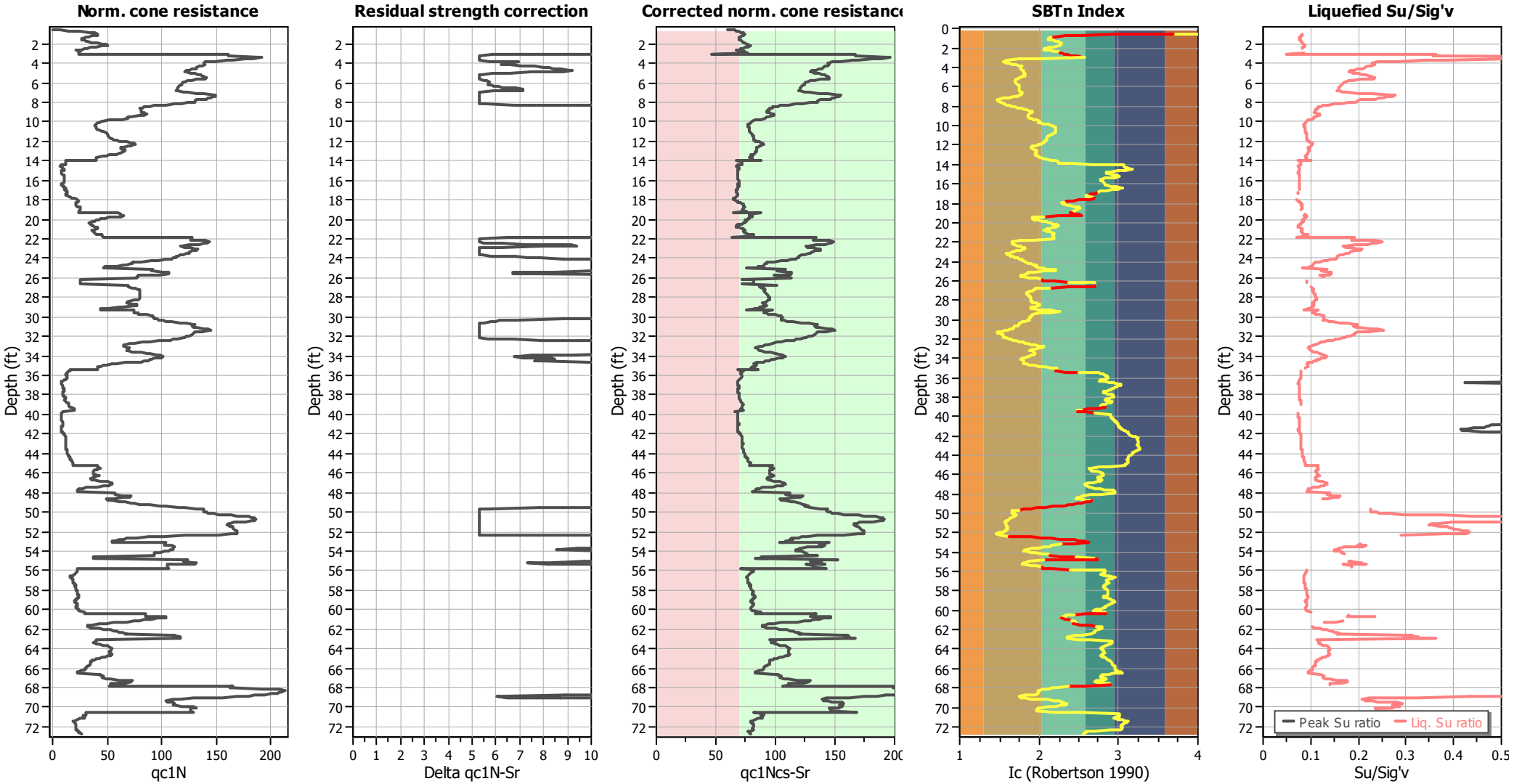




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

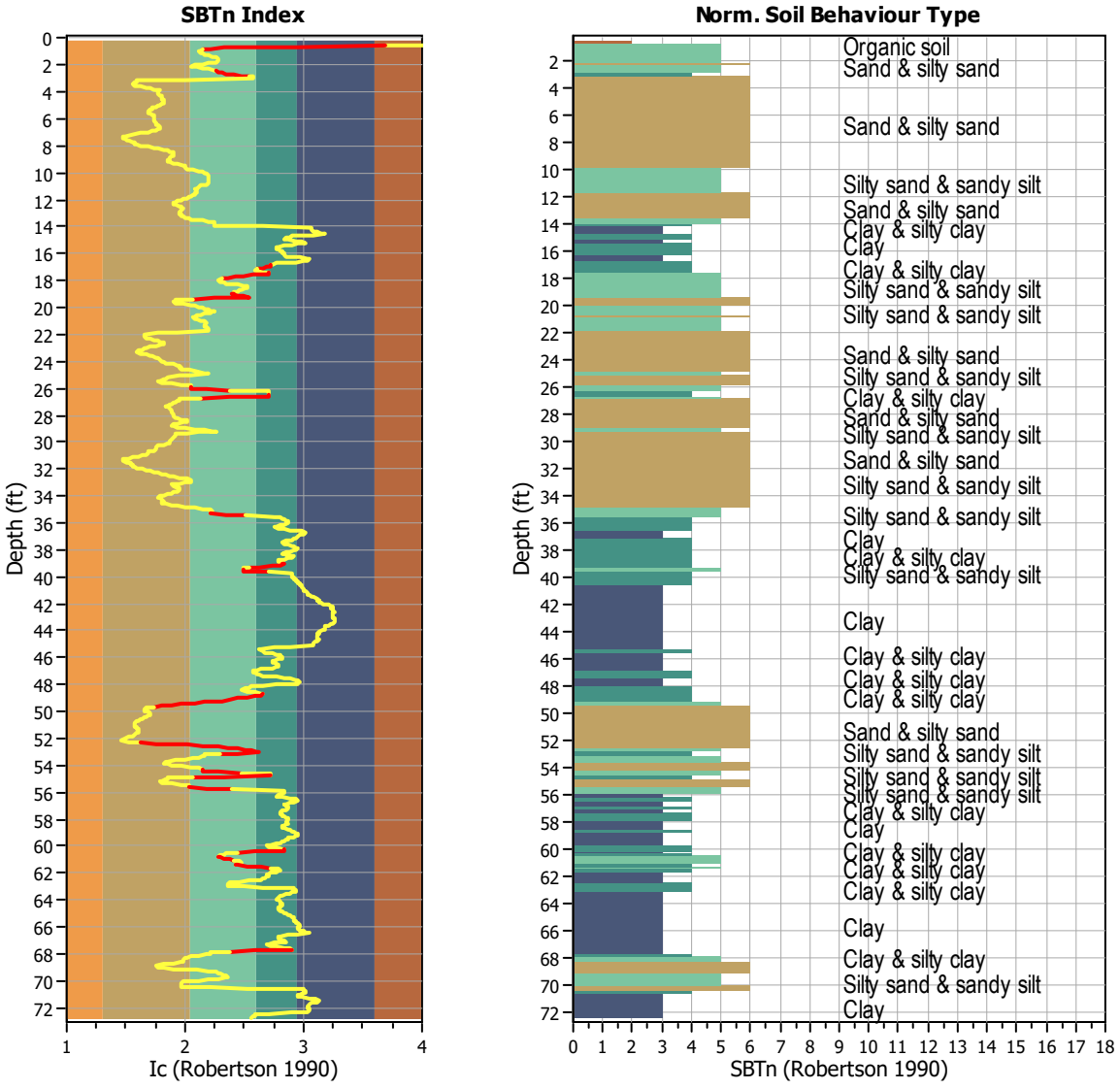
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.18 ft	Fill height:	1.94 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

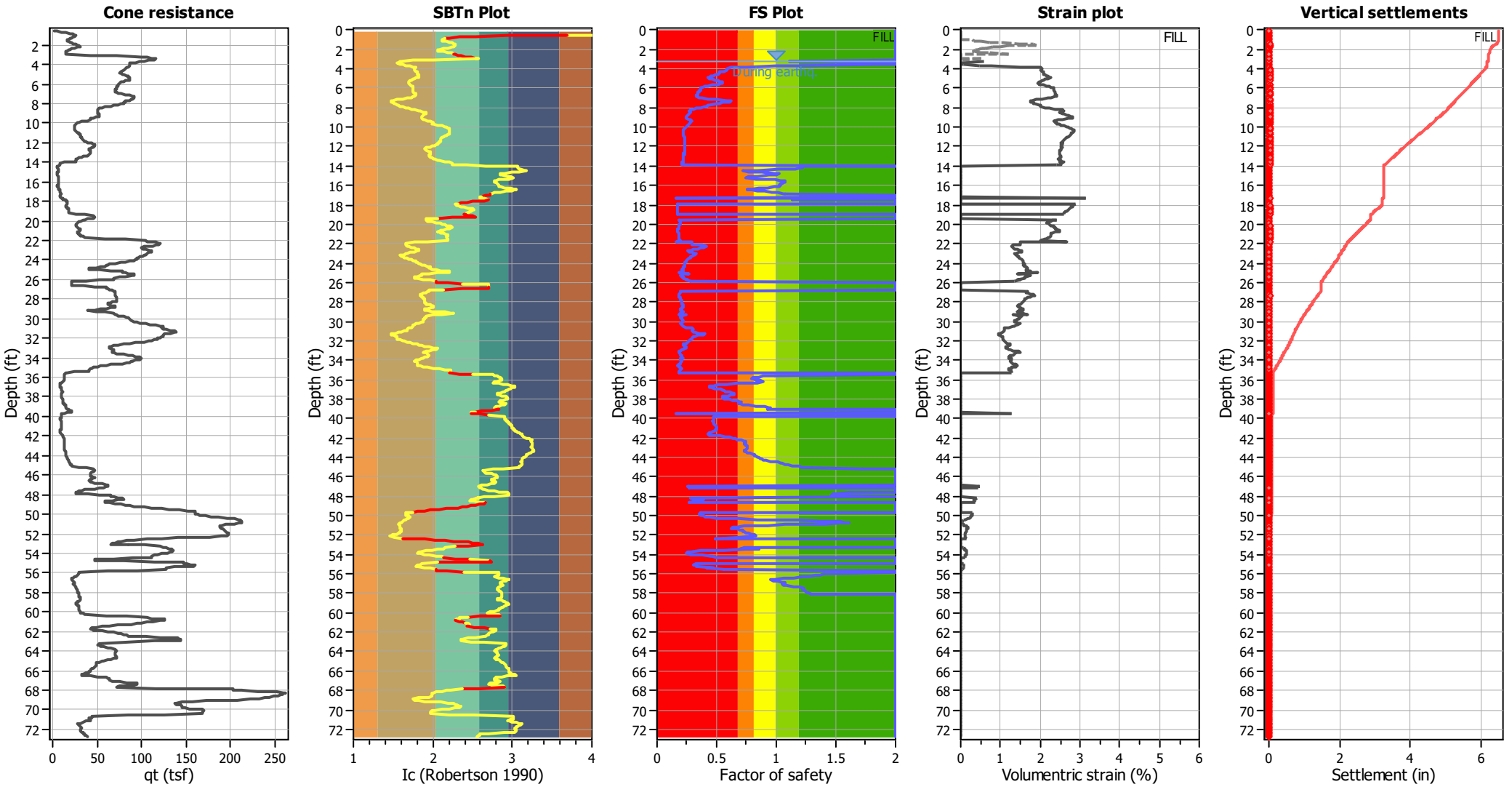
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1107
I_c maximum check value:	3.00	Total points excluded:	116
I_c change ratio value:	0.0250	Exclusion percentage:	10.48%
Minimum number of points in layer:	4	Number of layers detected:	21

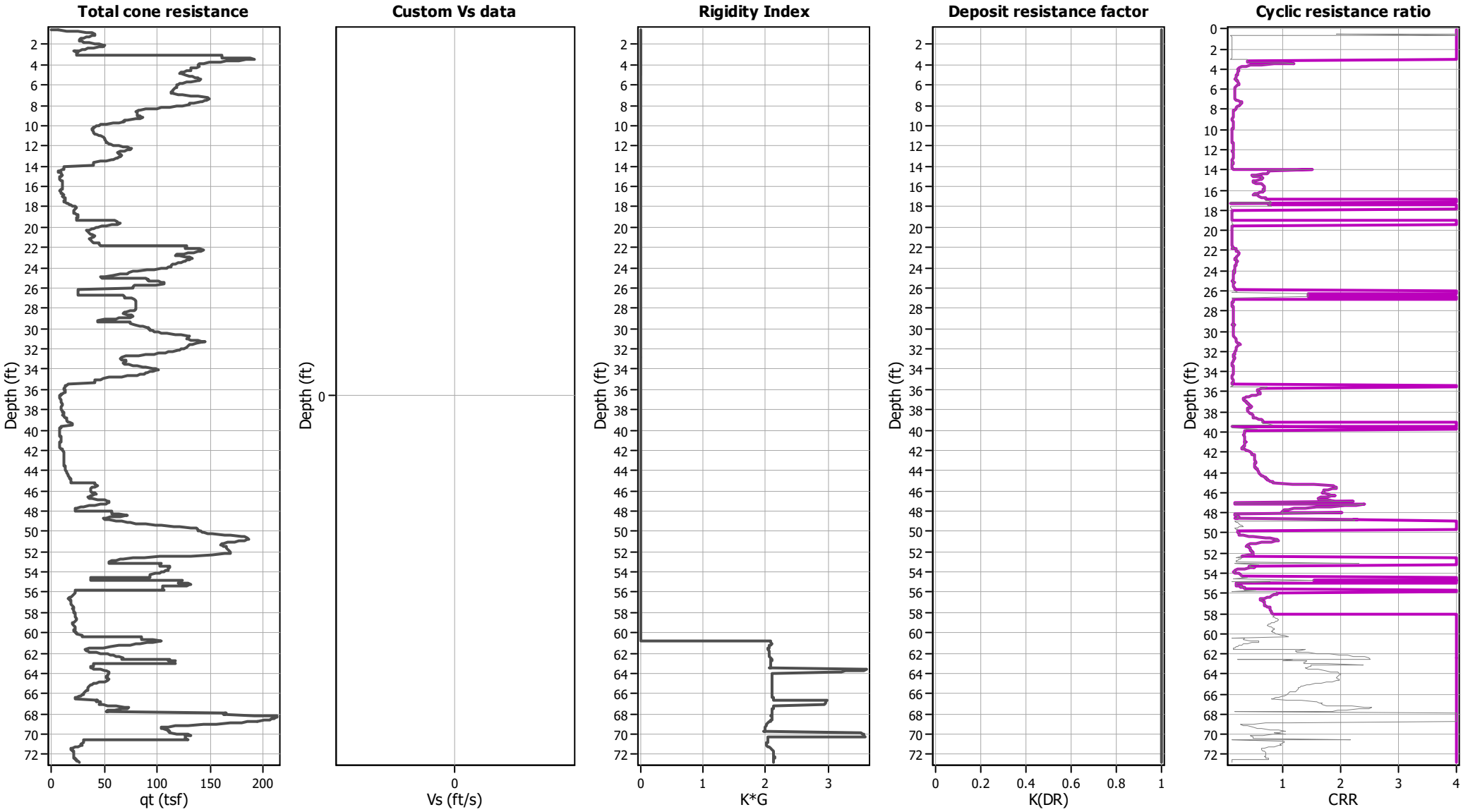
Estimation of post-earthquake settlements



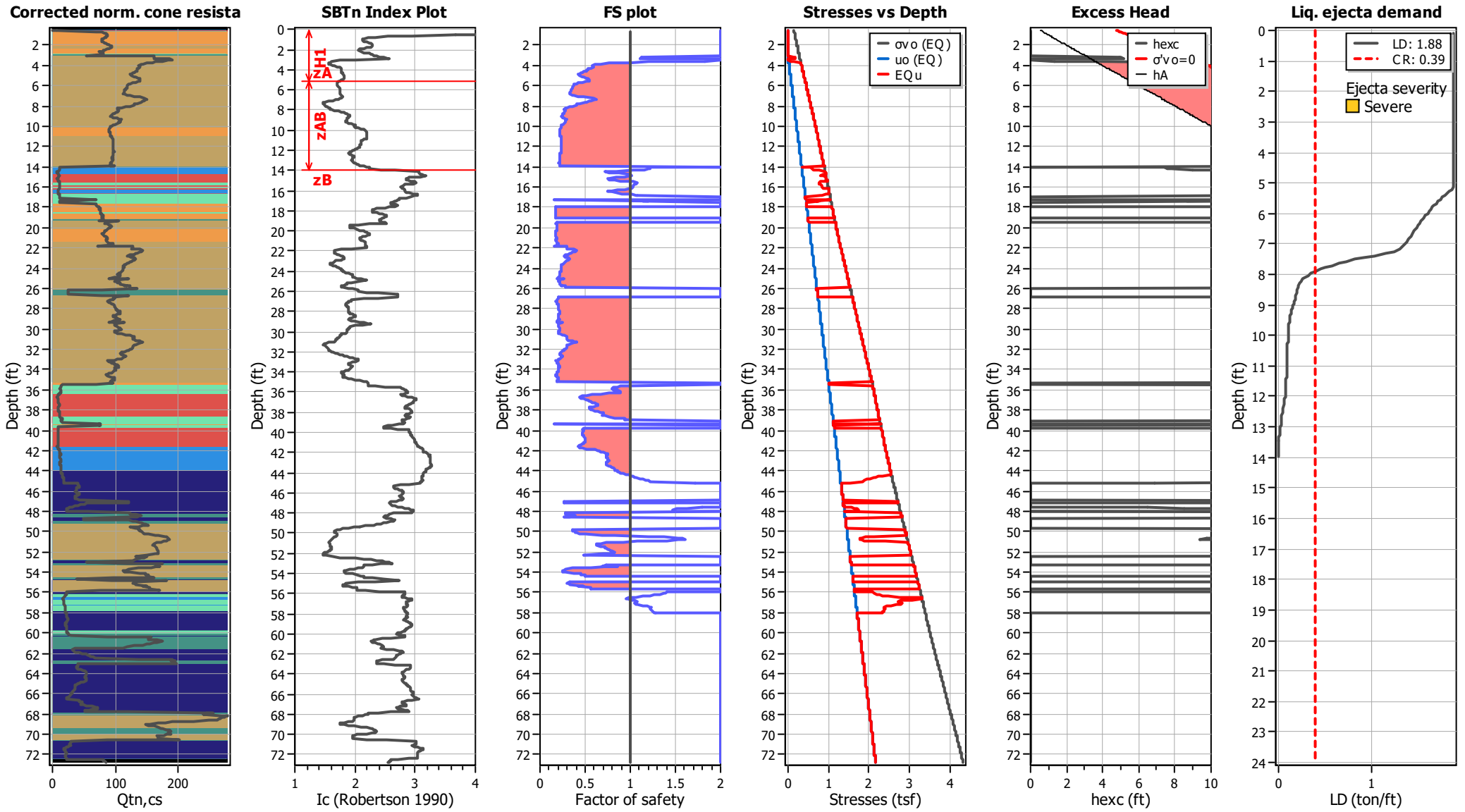
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

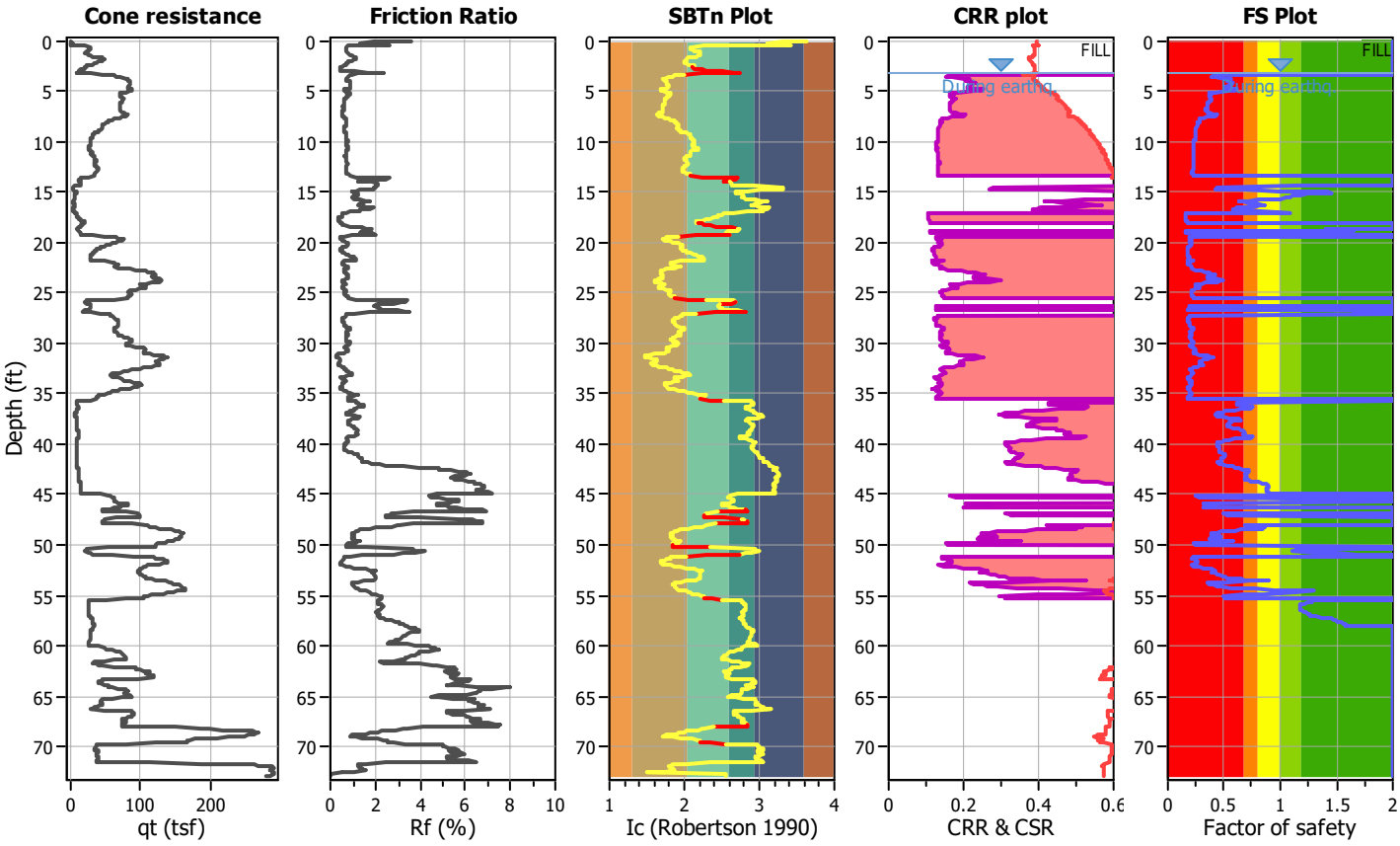
Project title : Topgolf Harbor Island

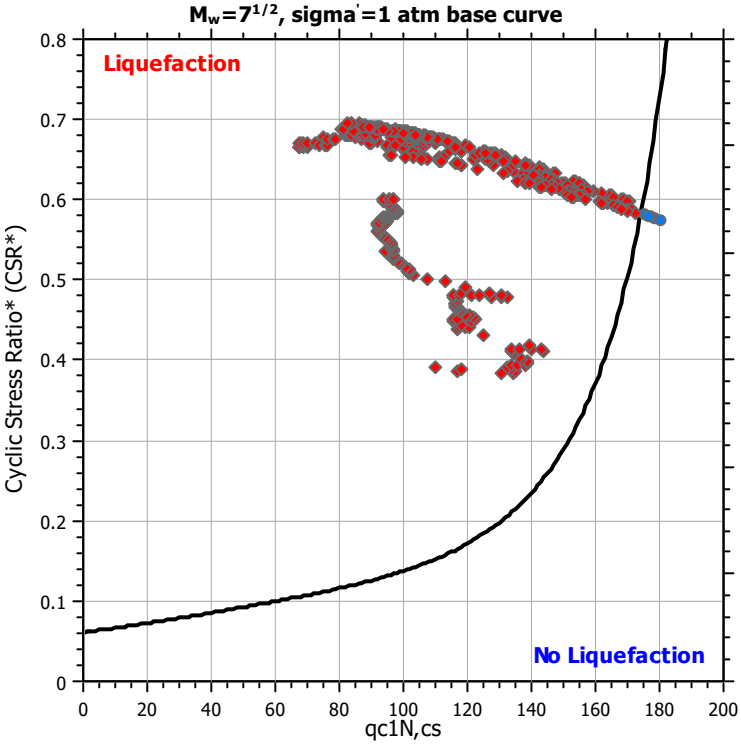
Location : North Harbor Drive and Liberator Way, San Diego, CA

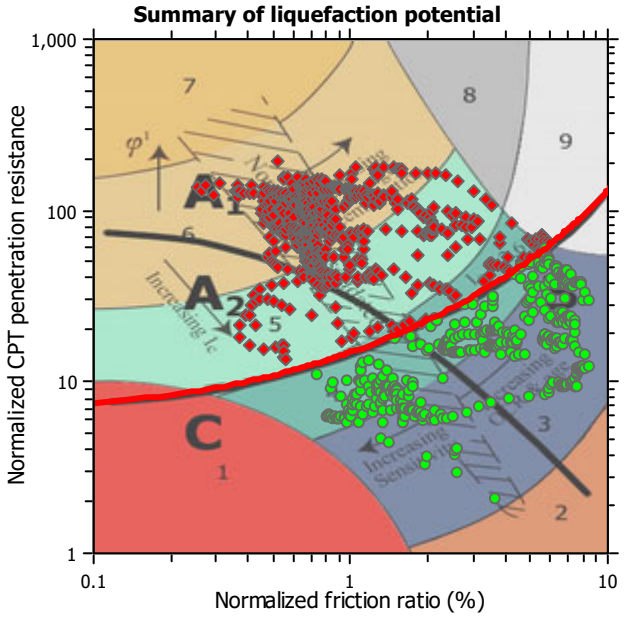
CPT file : CPT-9 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.20 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.92 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

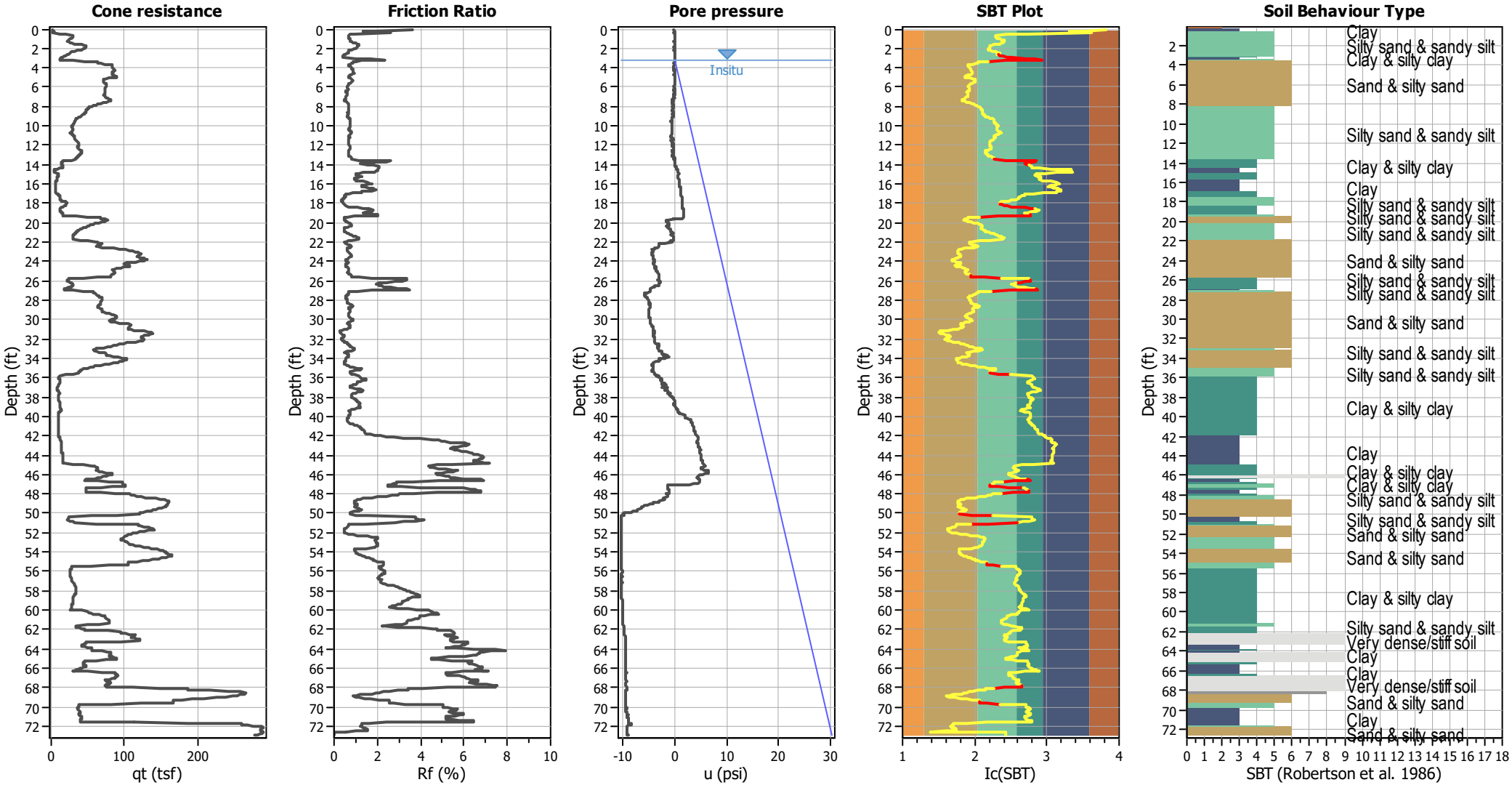






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



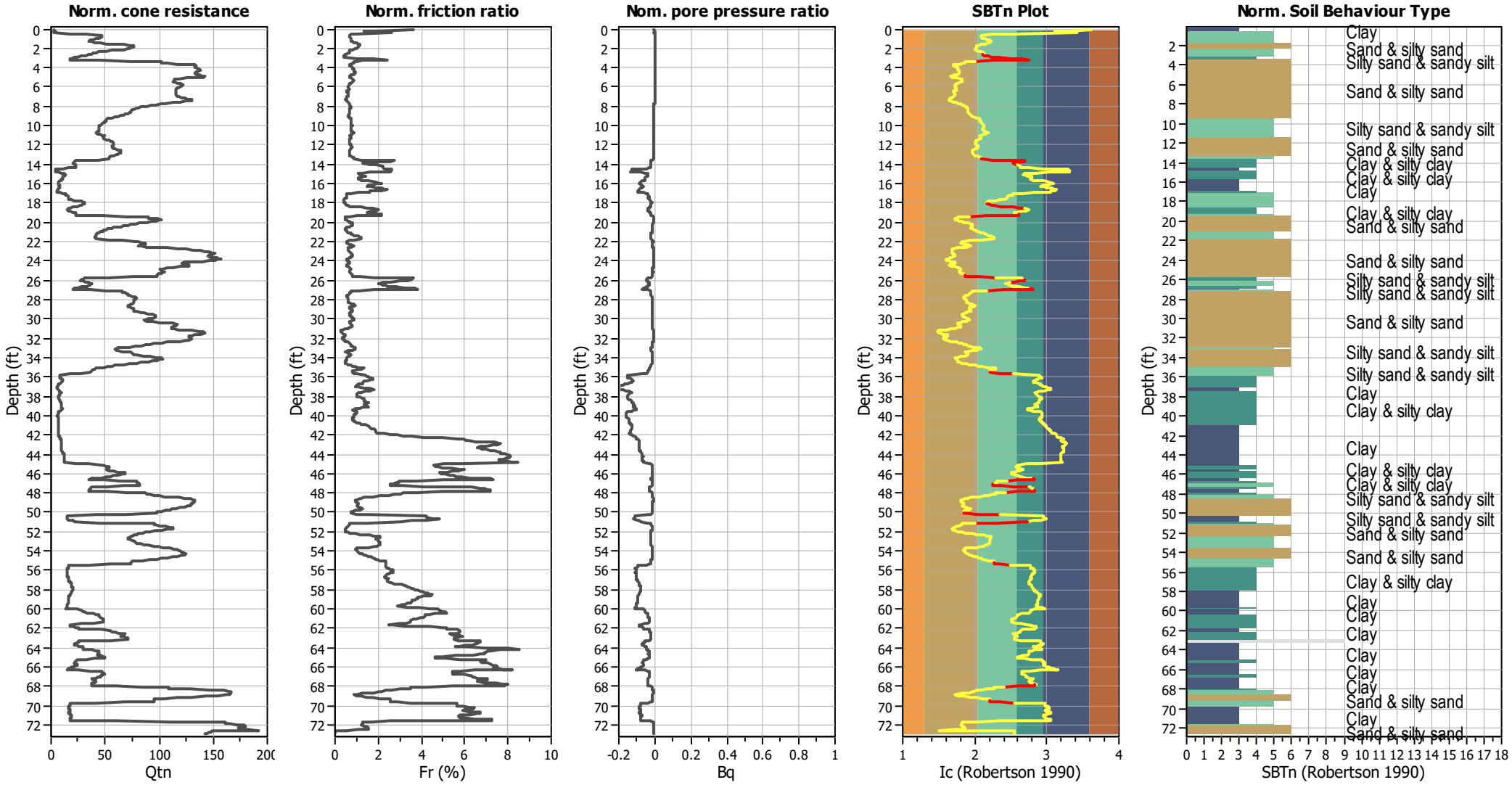
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 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)



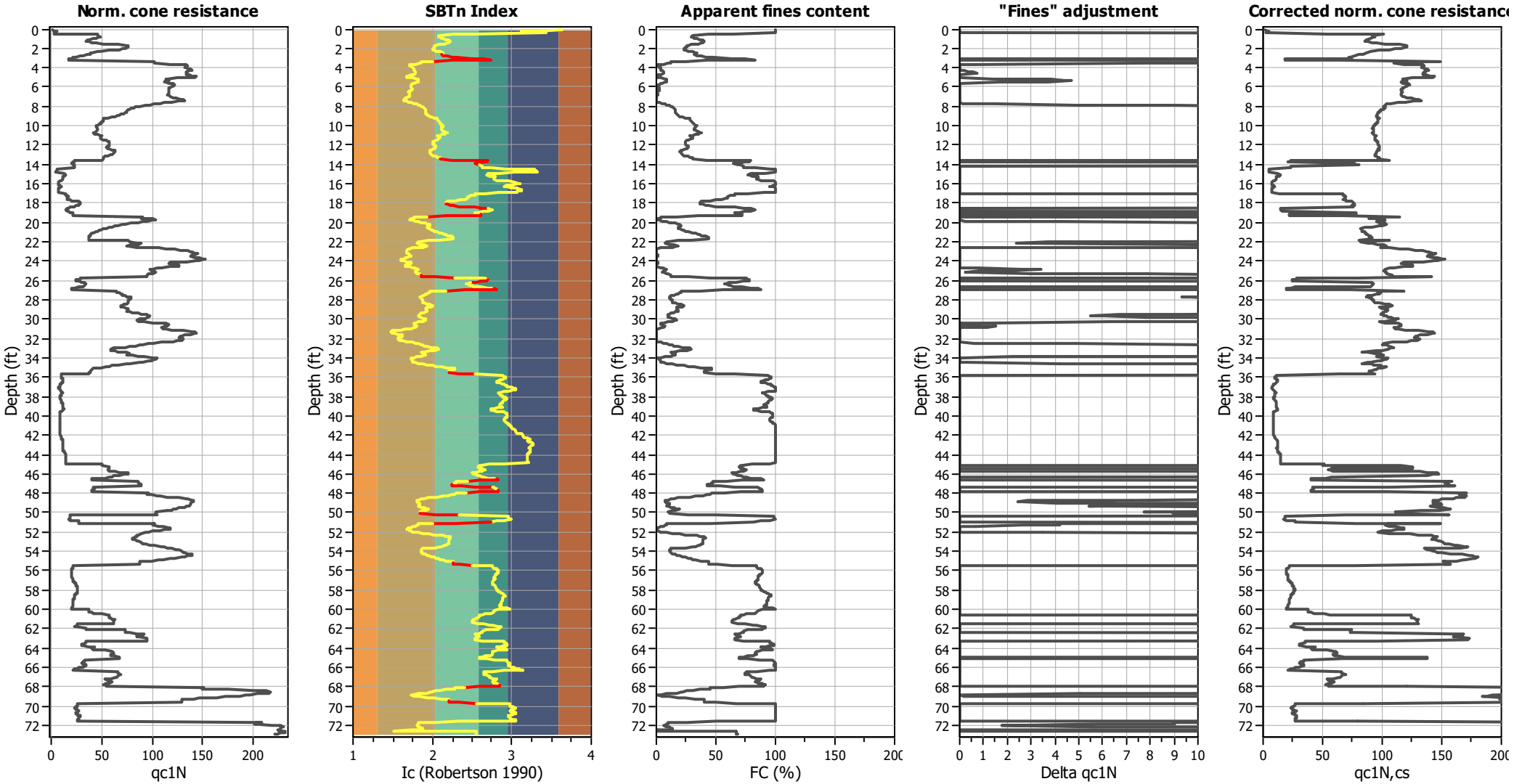
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 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

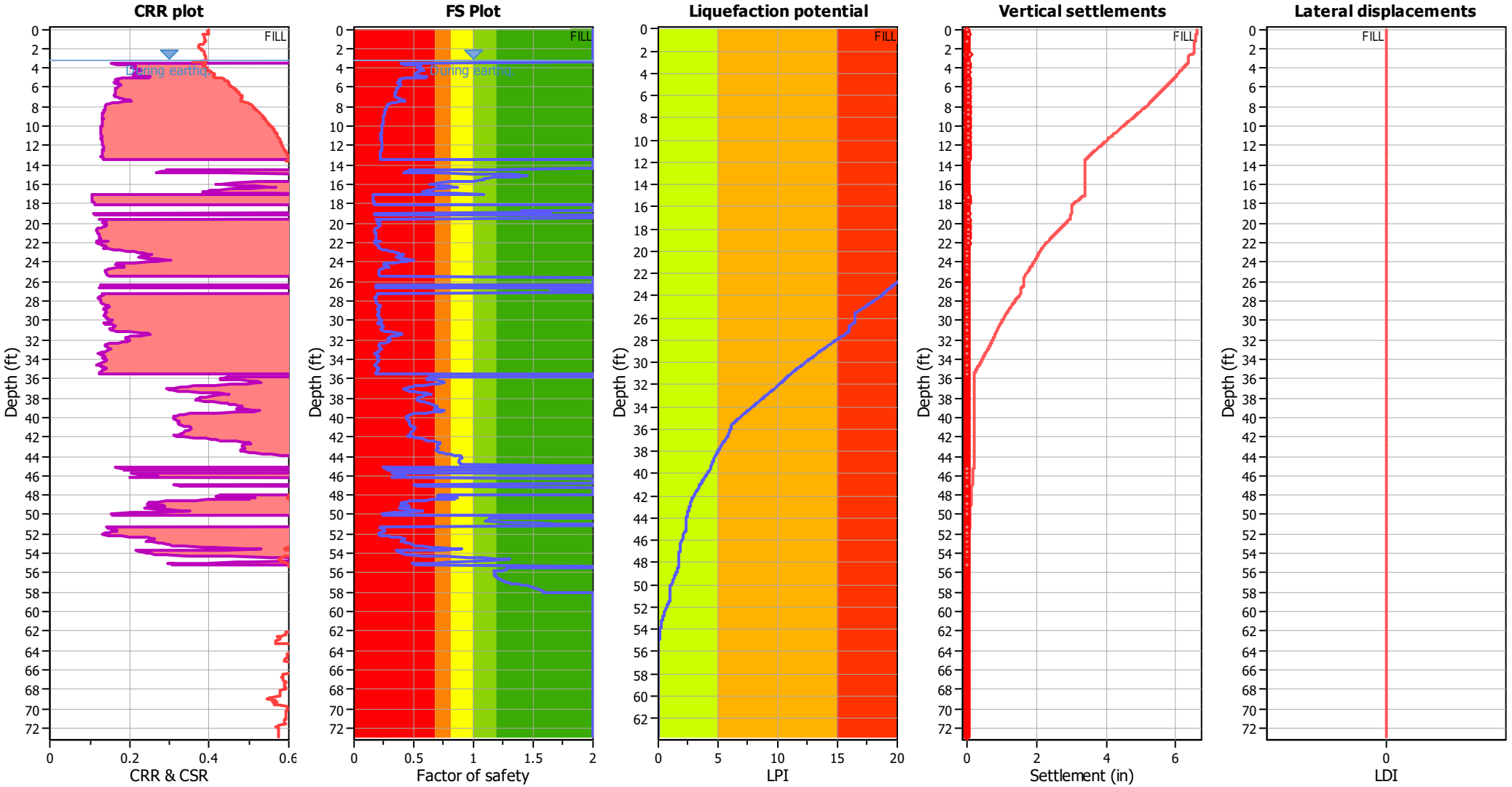
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 ft	Limit depth:	60.00 ft

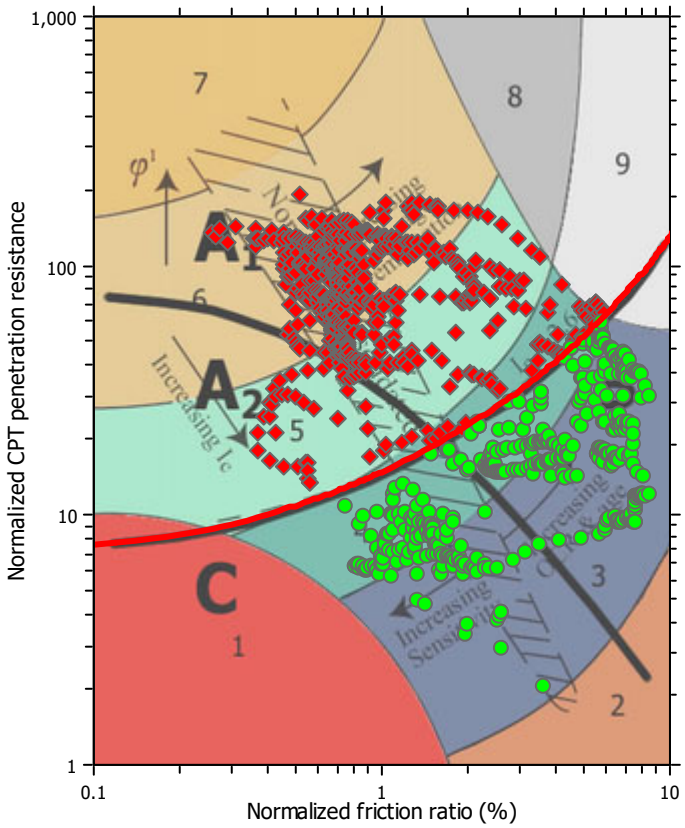
F.S. color scheme

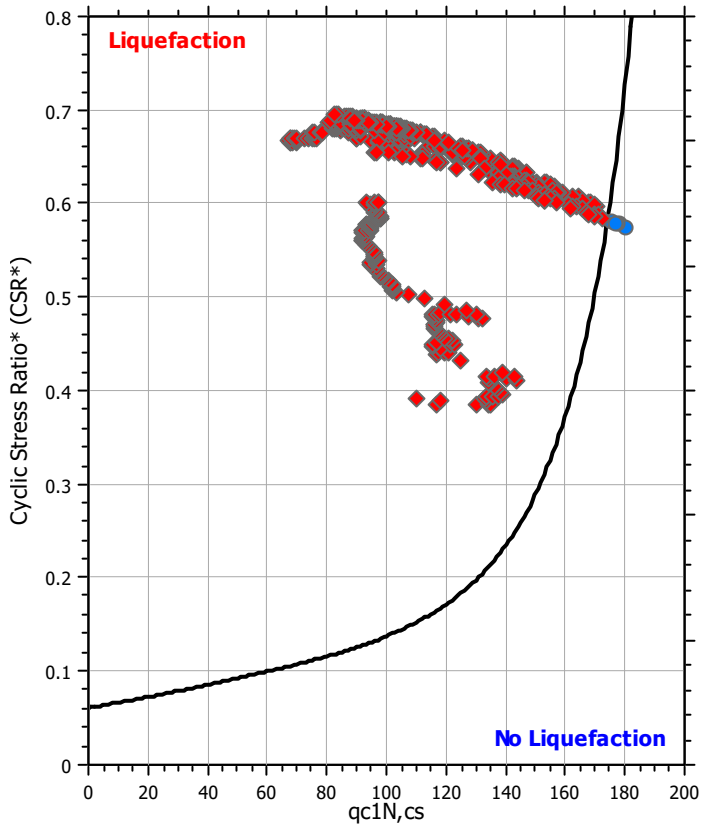
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

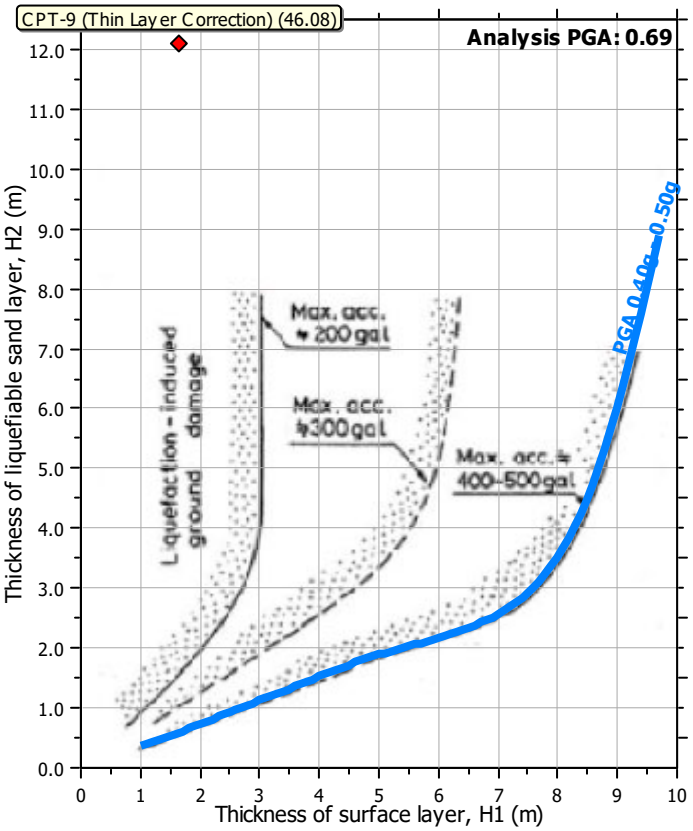
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



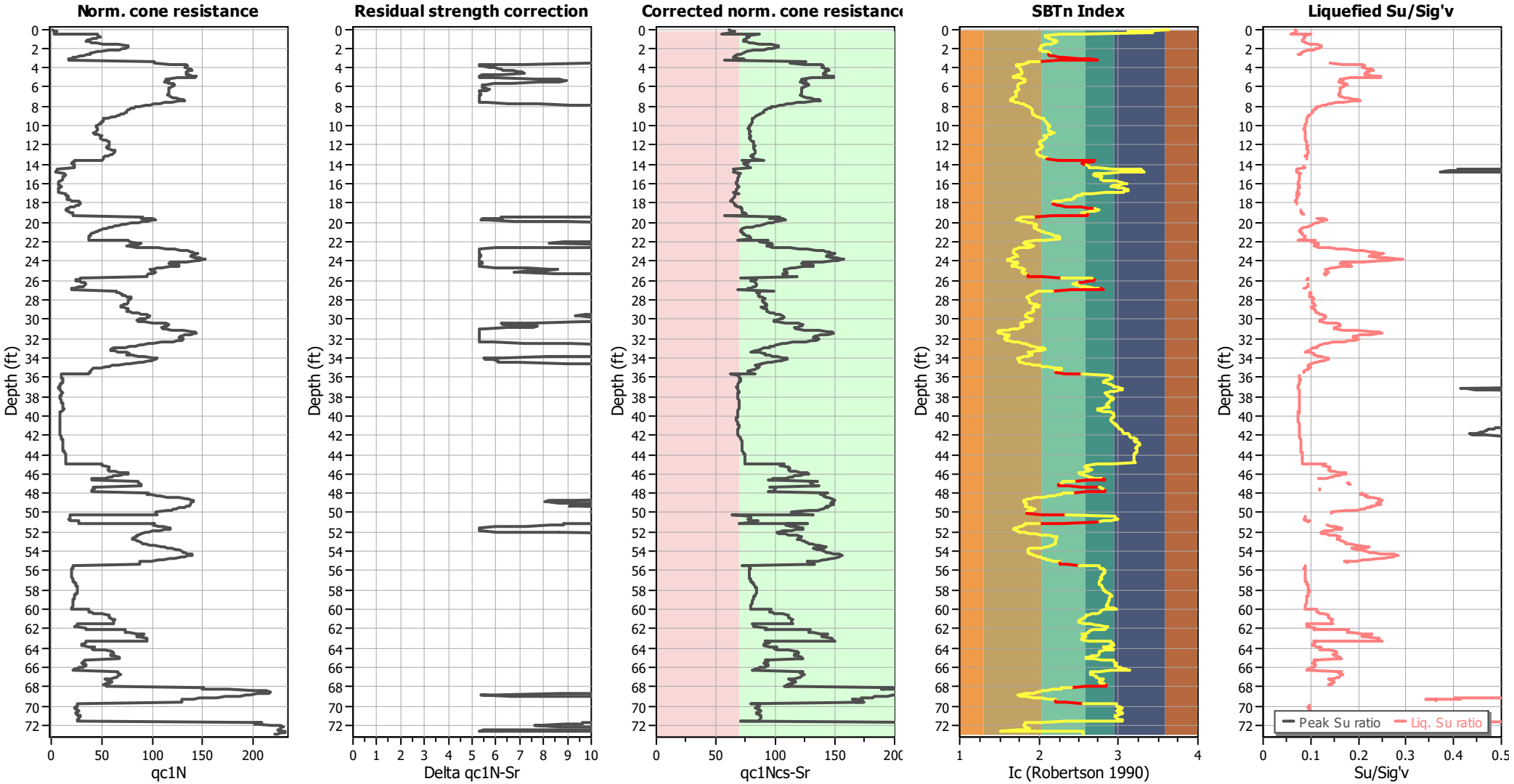




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

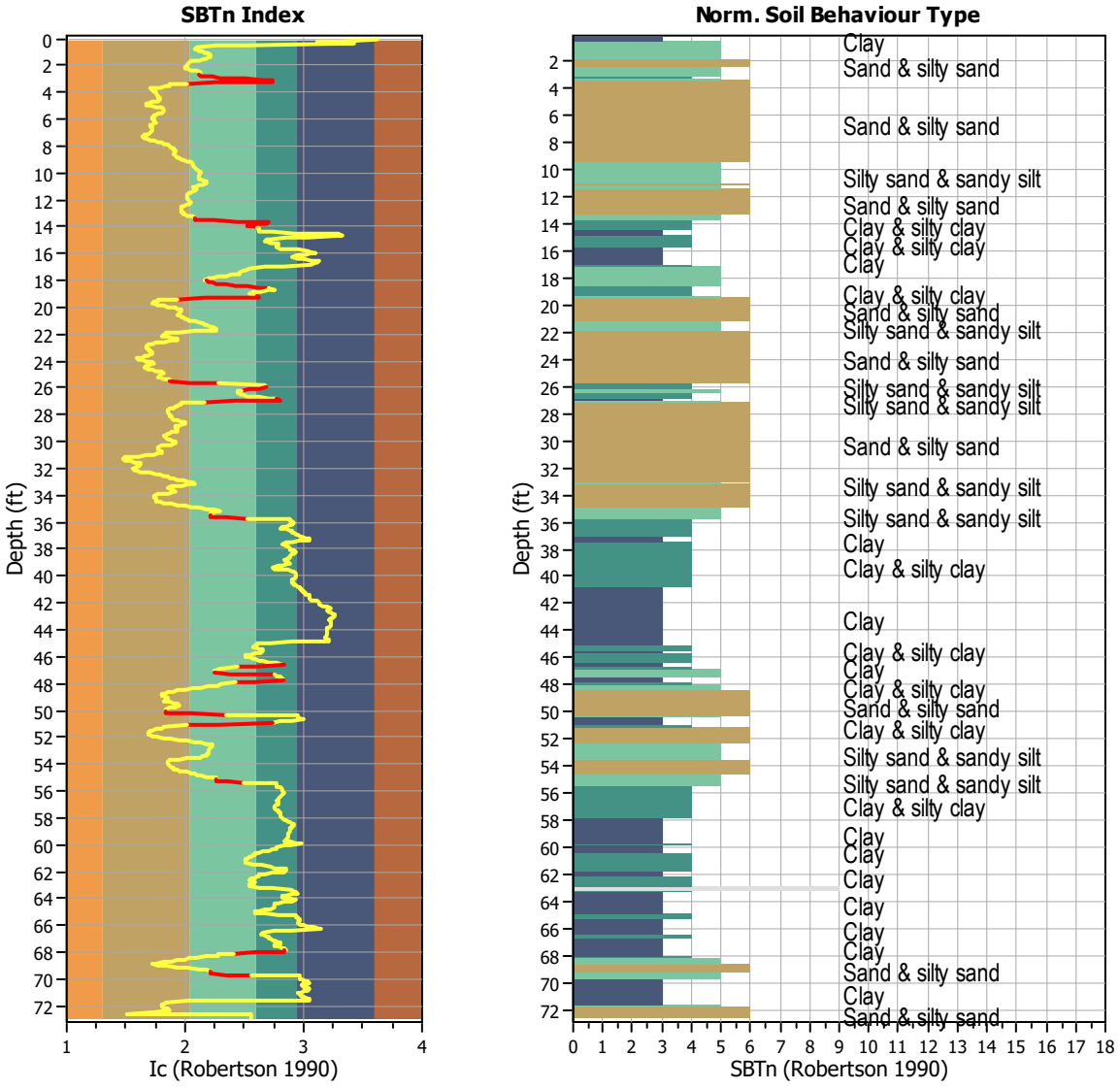
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	1.92 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

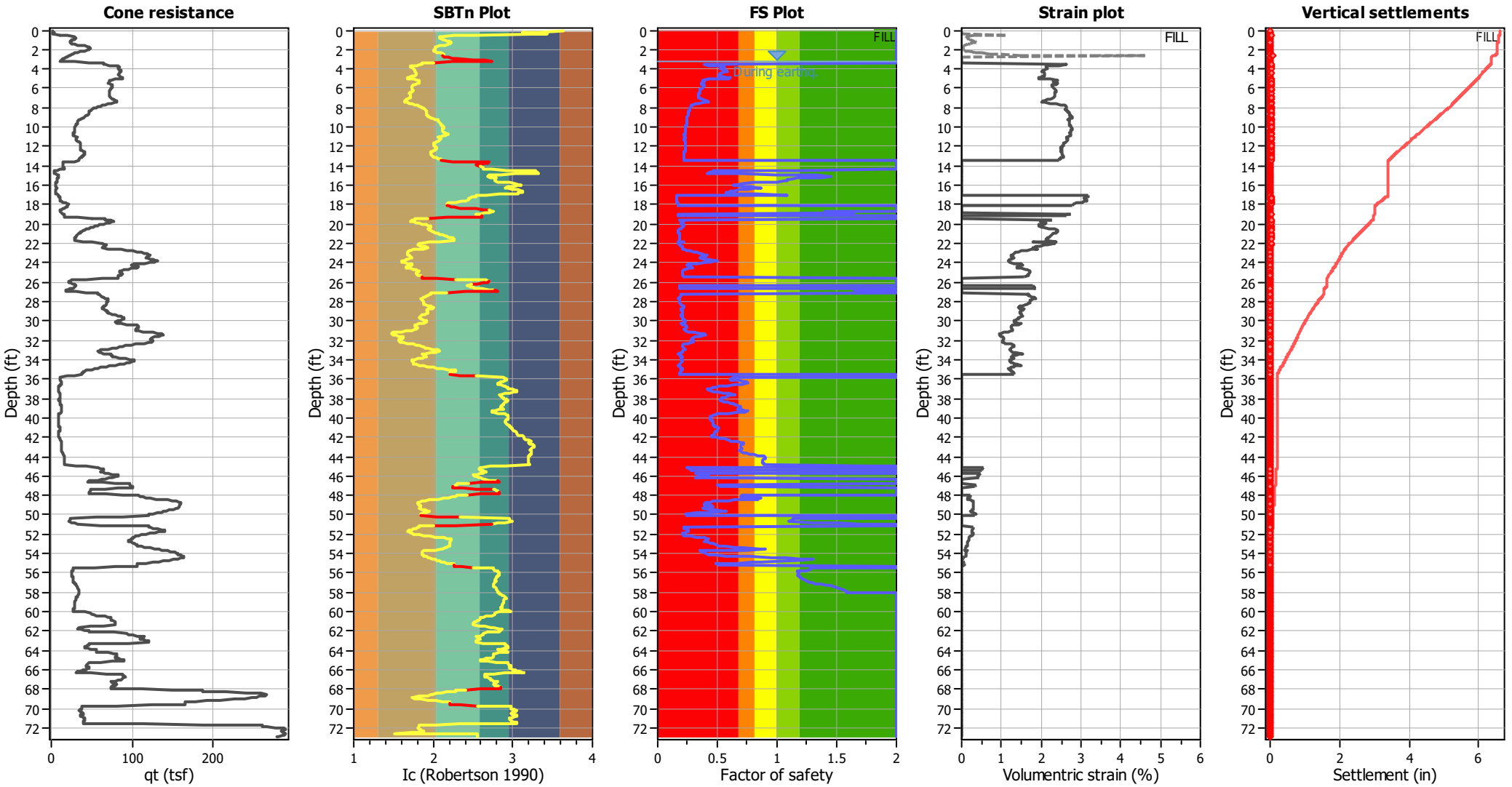
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	86
I_c change ratio value:	0.0250	Exclusion percentage:	7.76%
Minimum number of points in layer:	4	Number of layers detected:	19

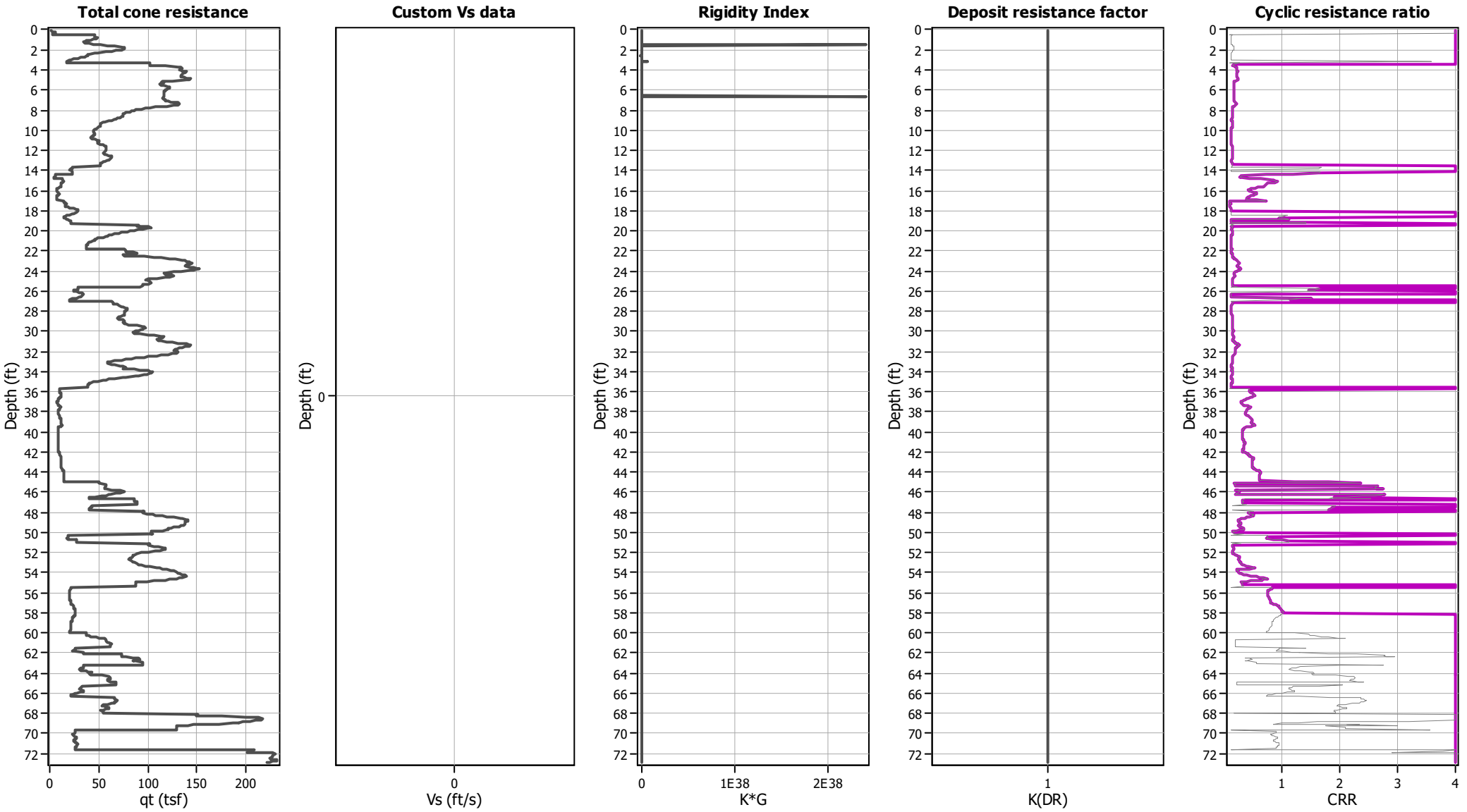
Estimation of post-earthquake settlements



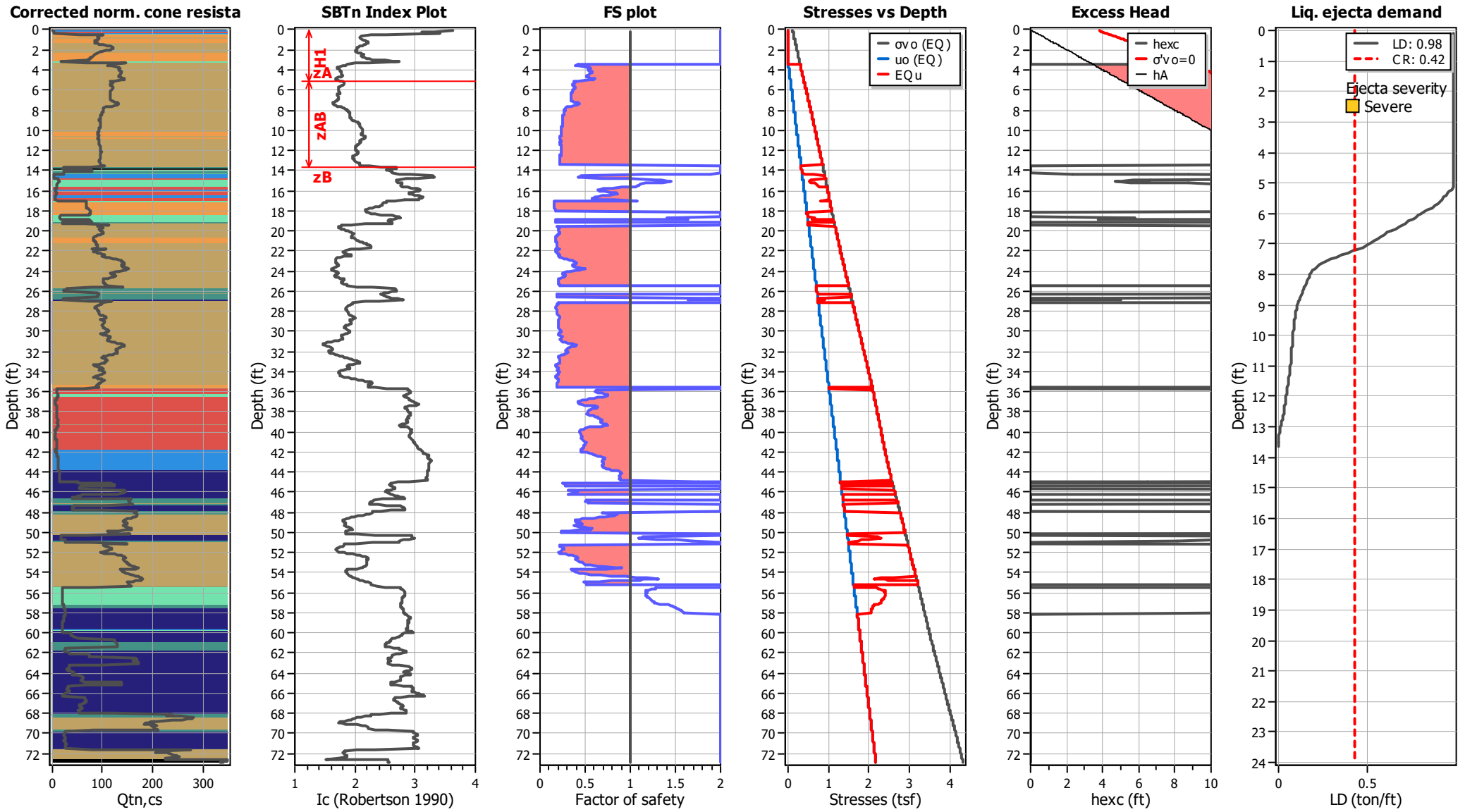
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

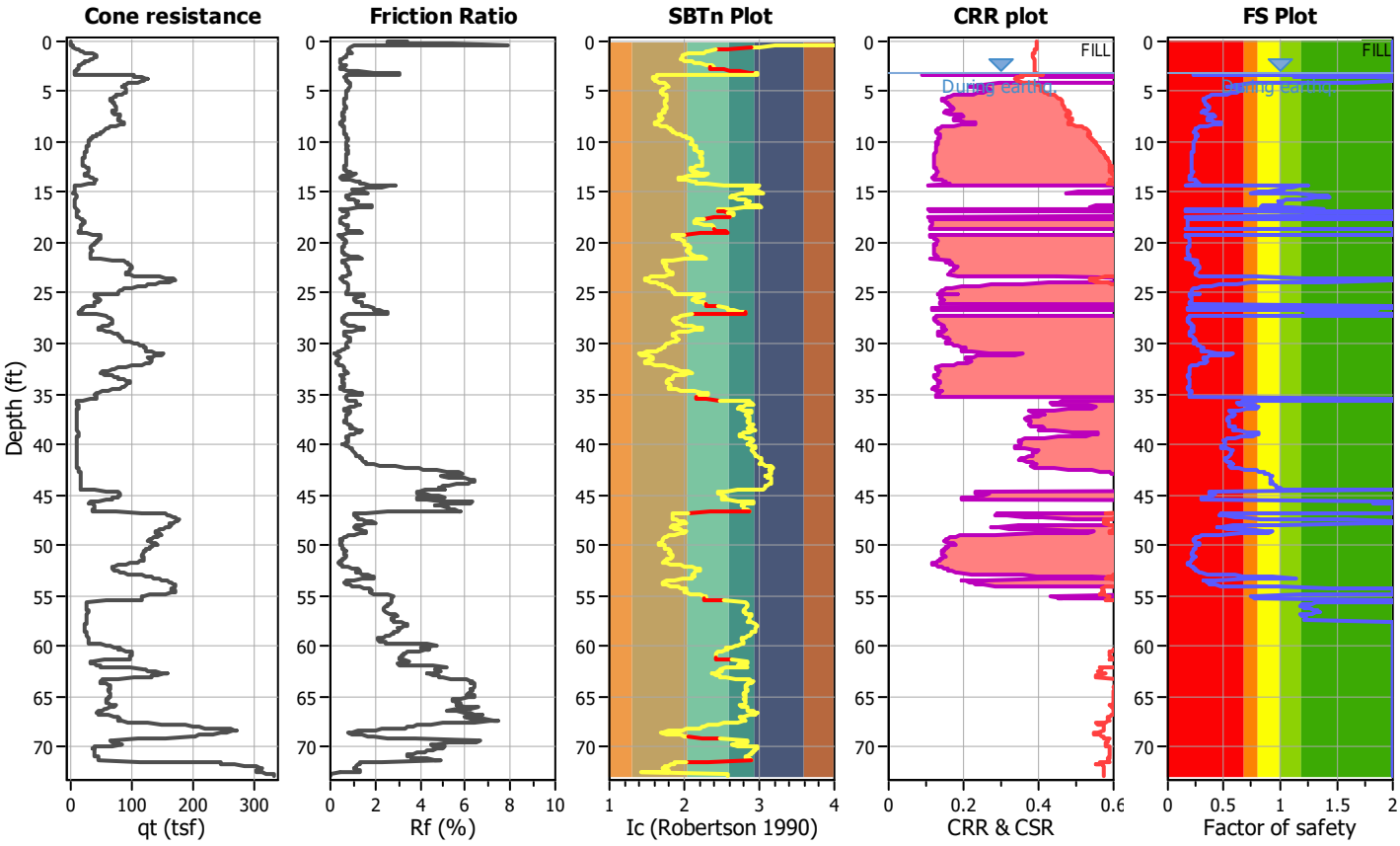
Project title : Topgolf Harbor Island

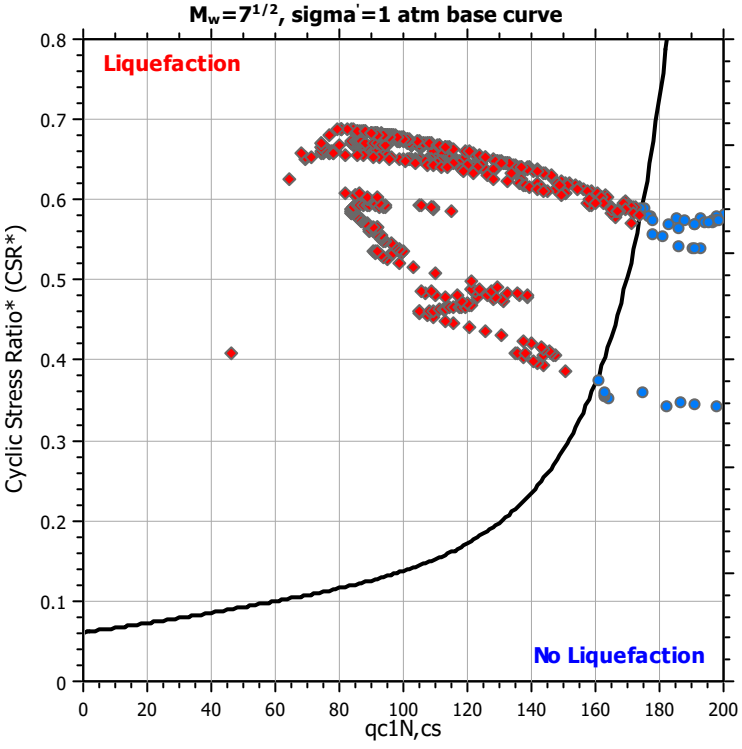
Location : North Harbor Drive and Liberator Way, San Diego, CA

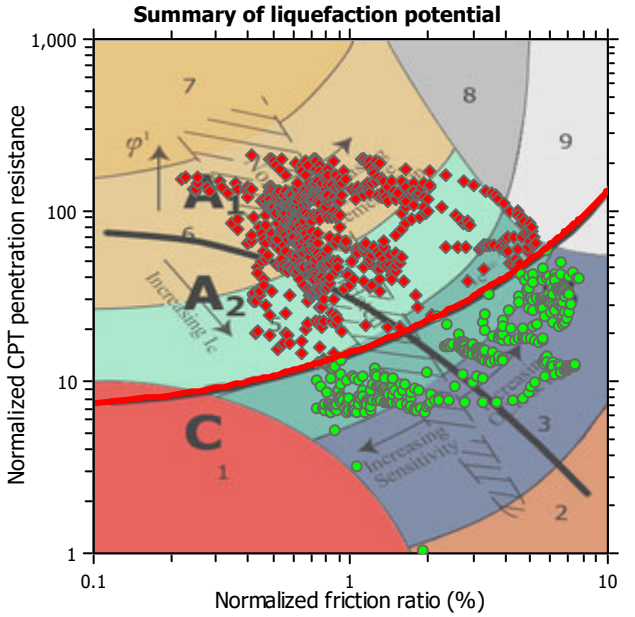
CPT file : CPT-10 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.11 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.62 ft	Fill height:	2.51 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

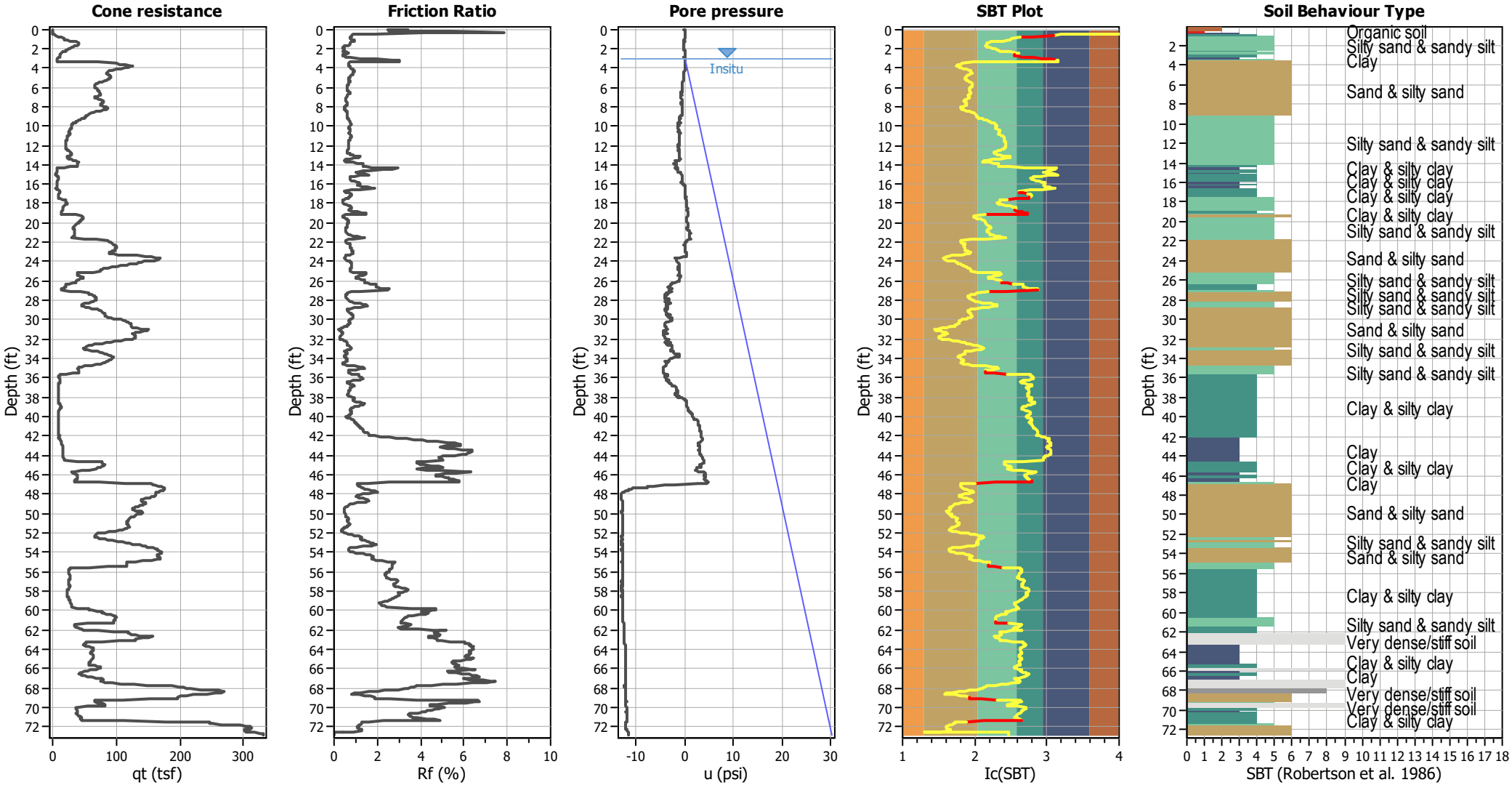






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



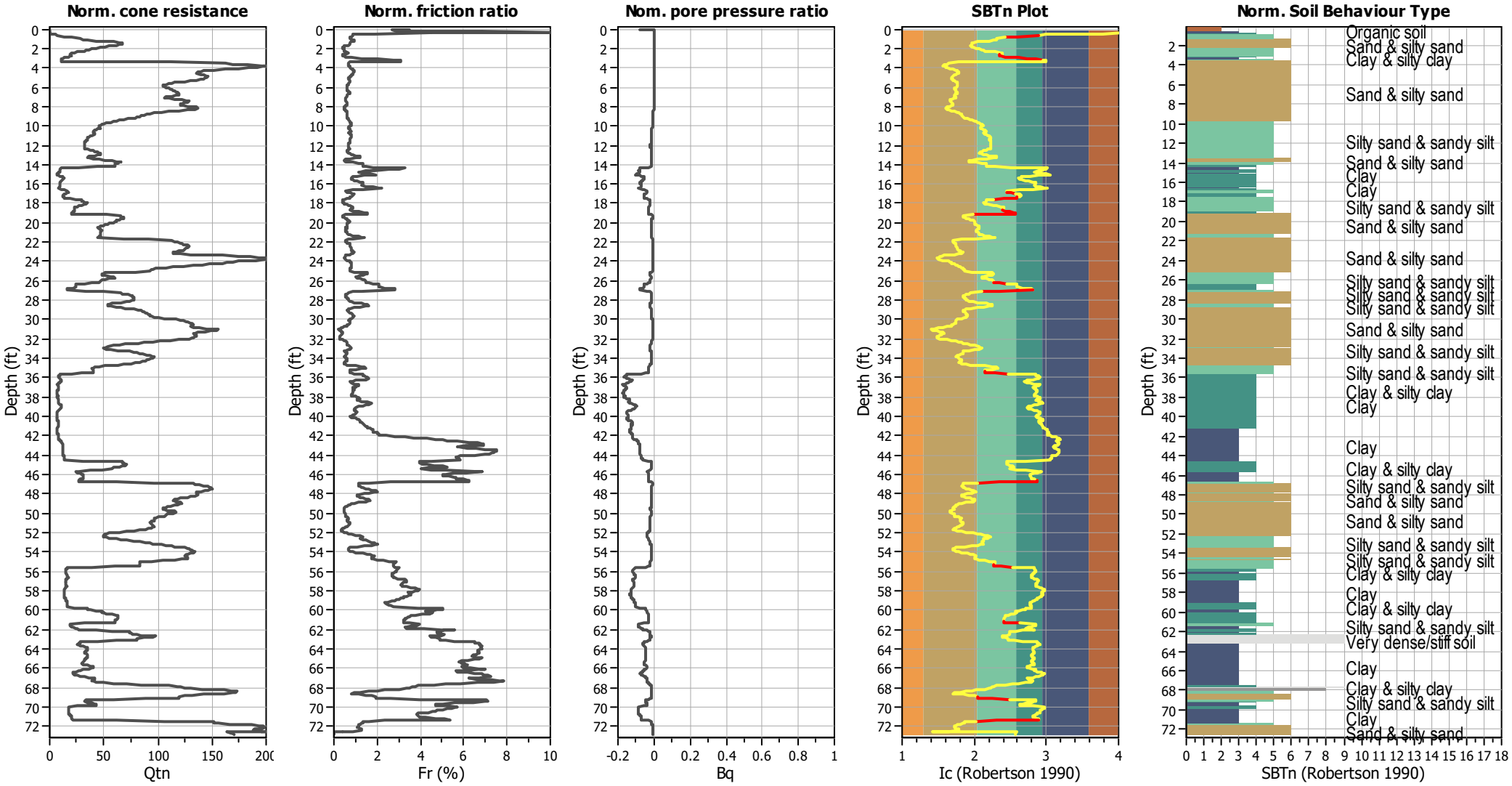
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 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)



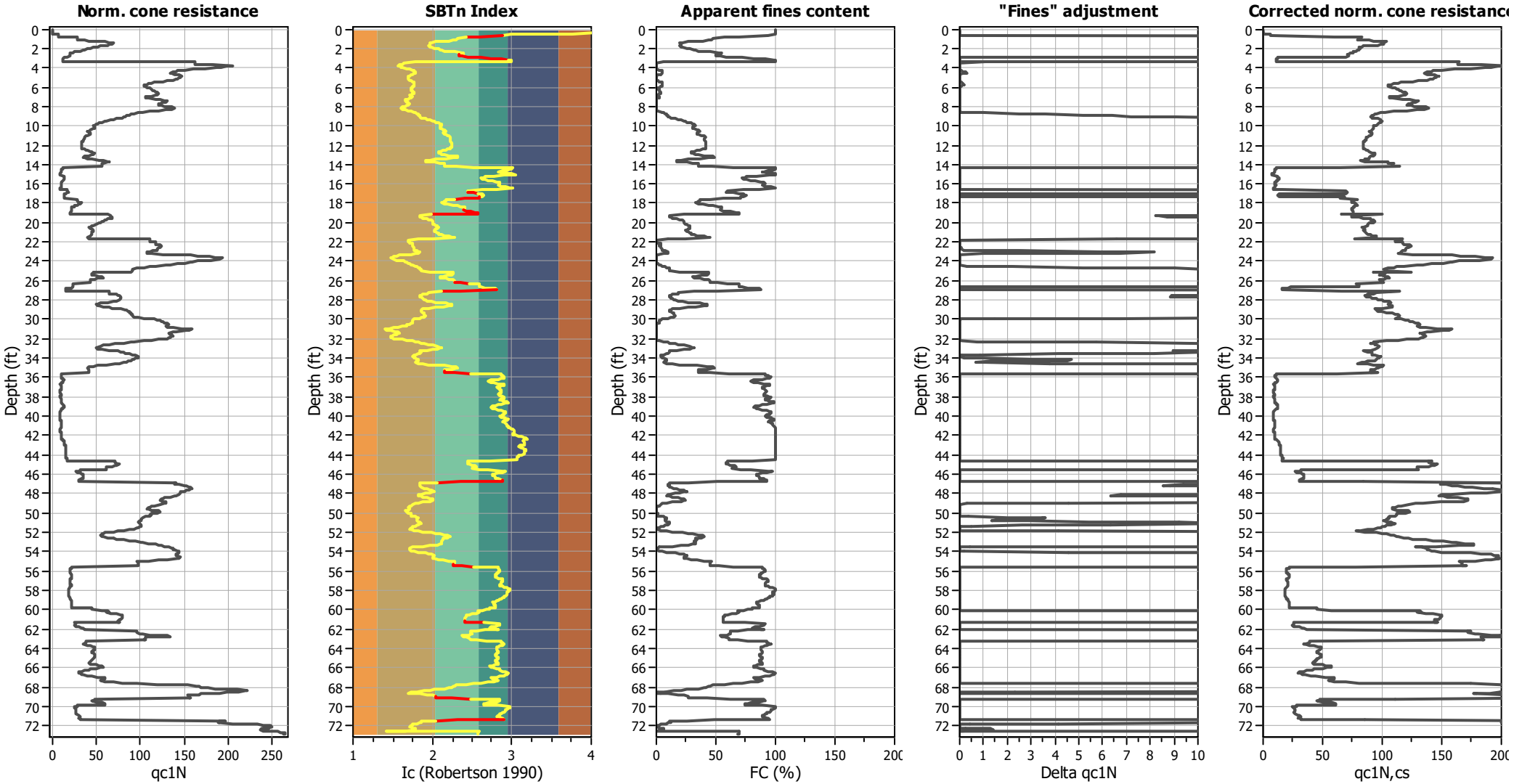
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 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

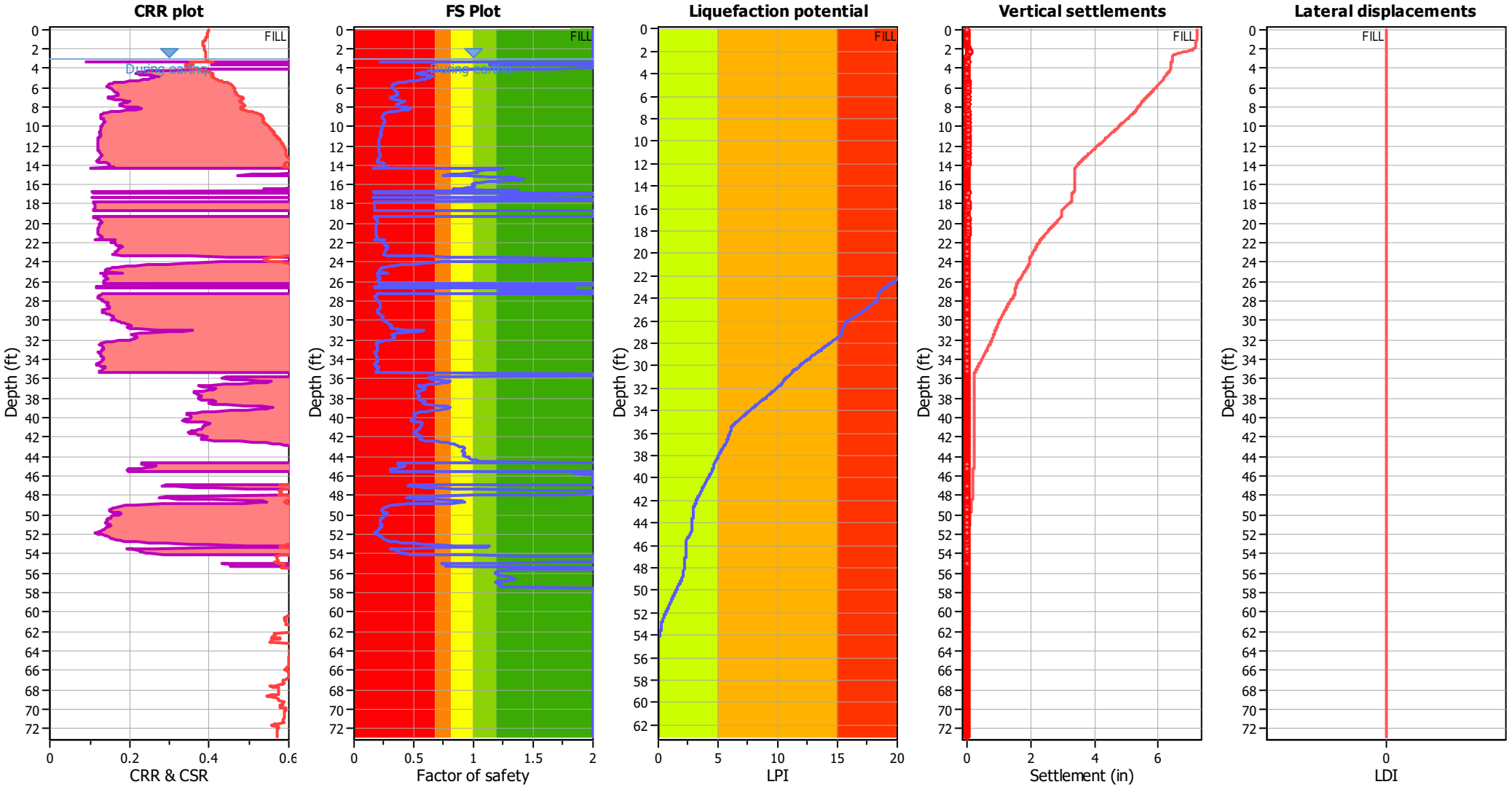
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 ft	Limit depth:	60.00 ft

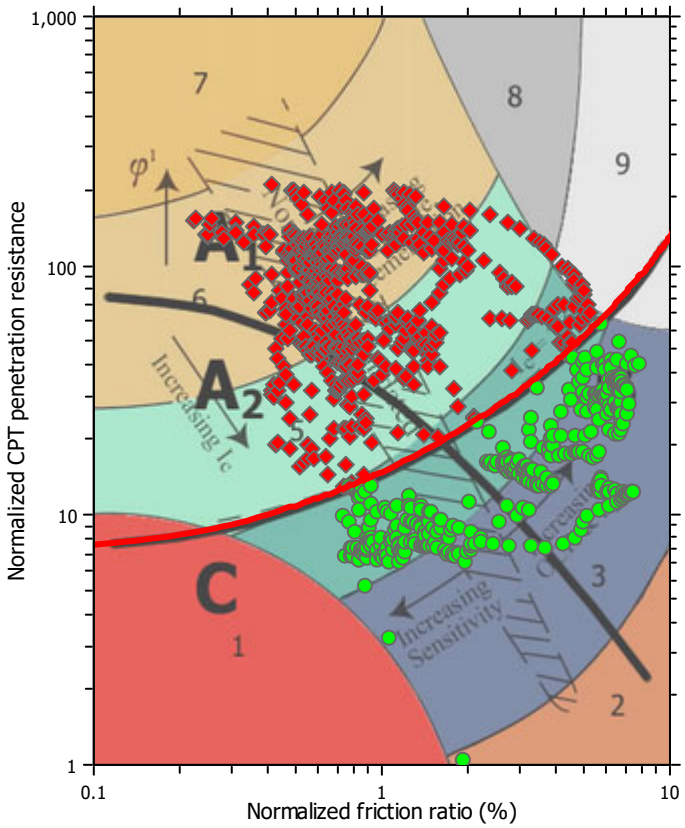
F.S. color scheme

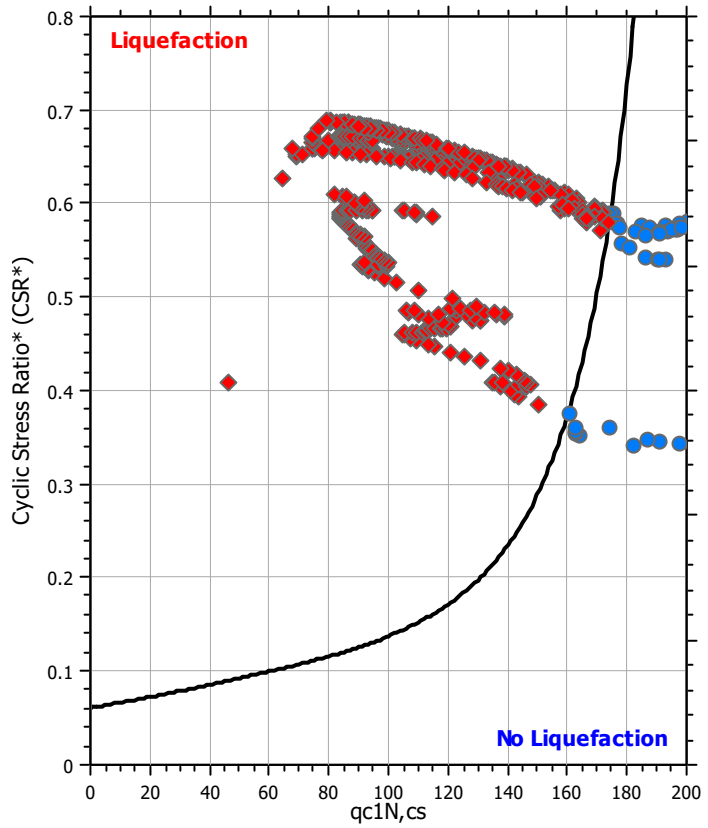
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

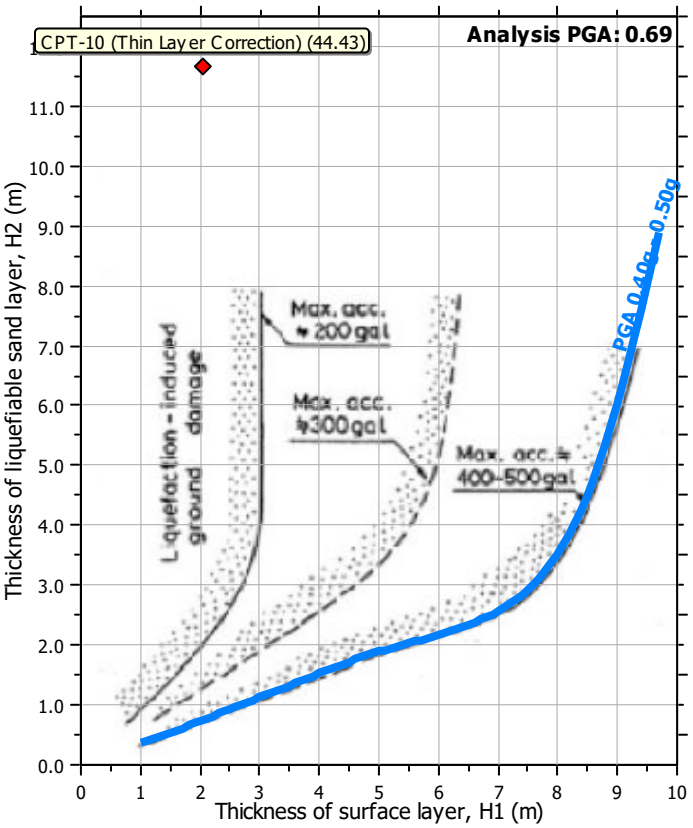
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



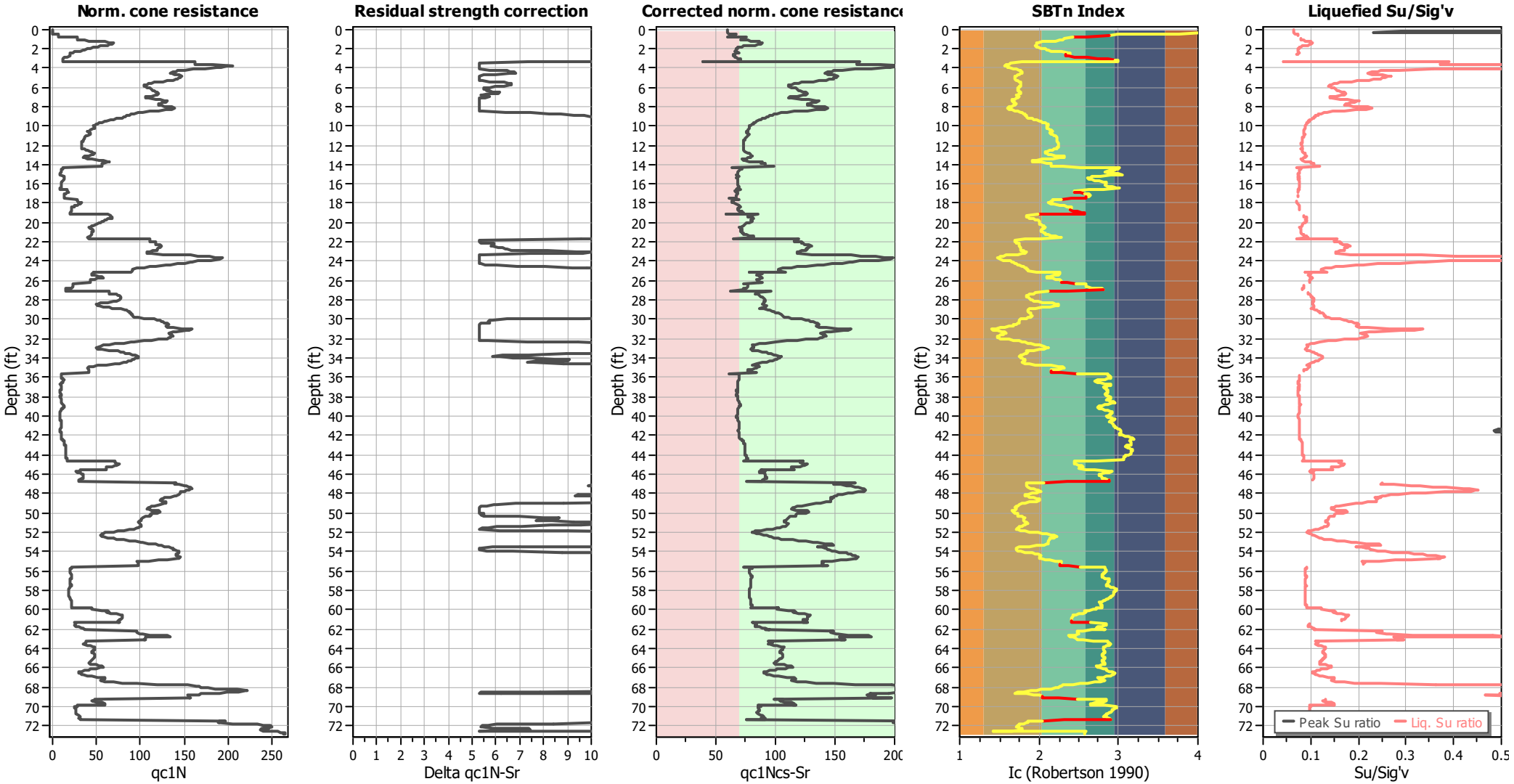




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

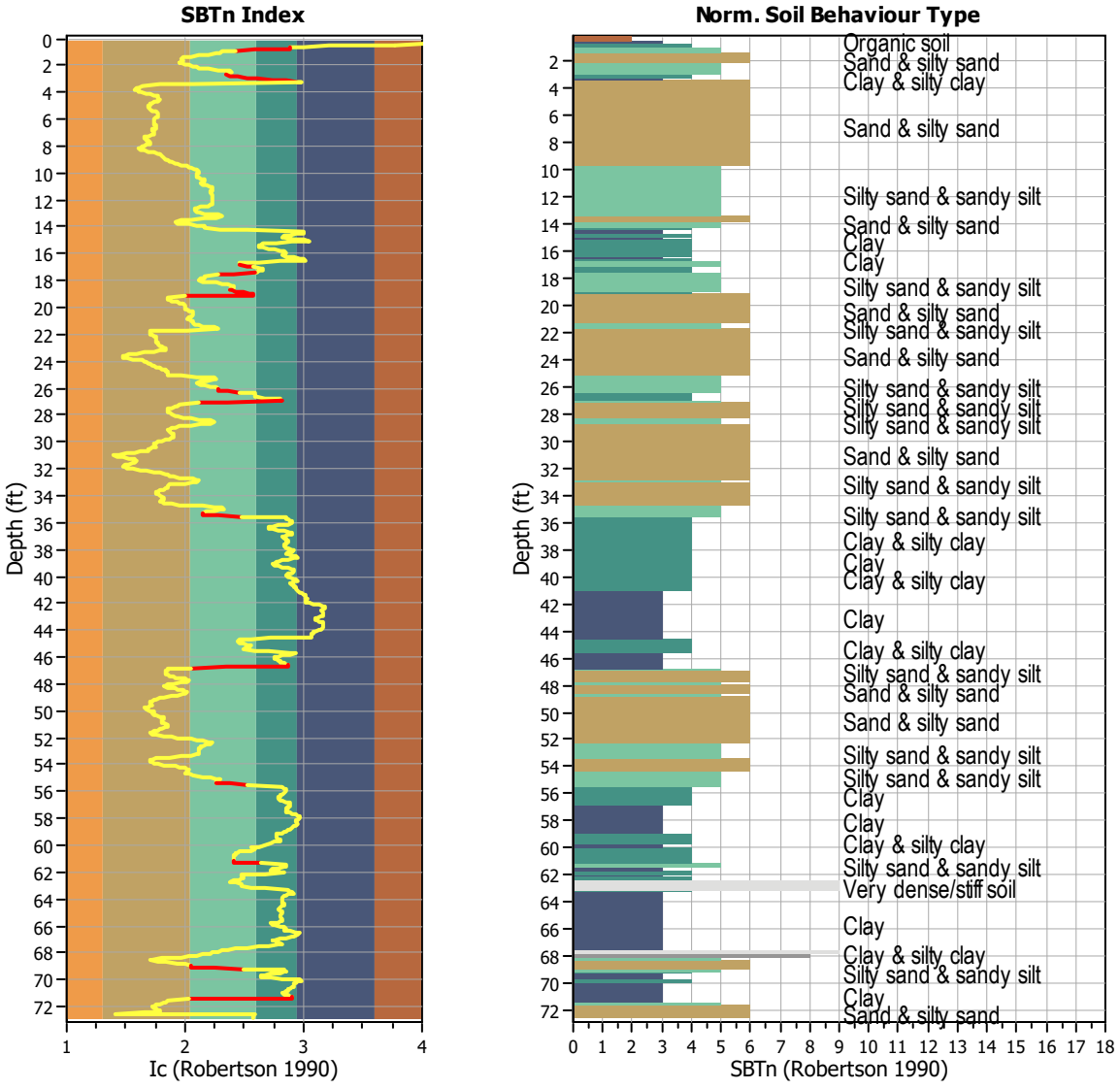
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.11 ft	Fill height:	2.51 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

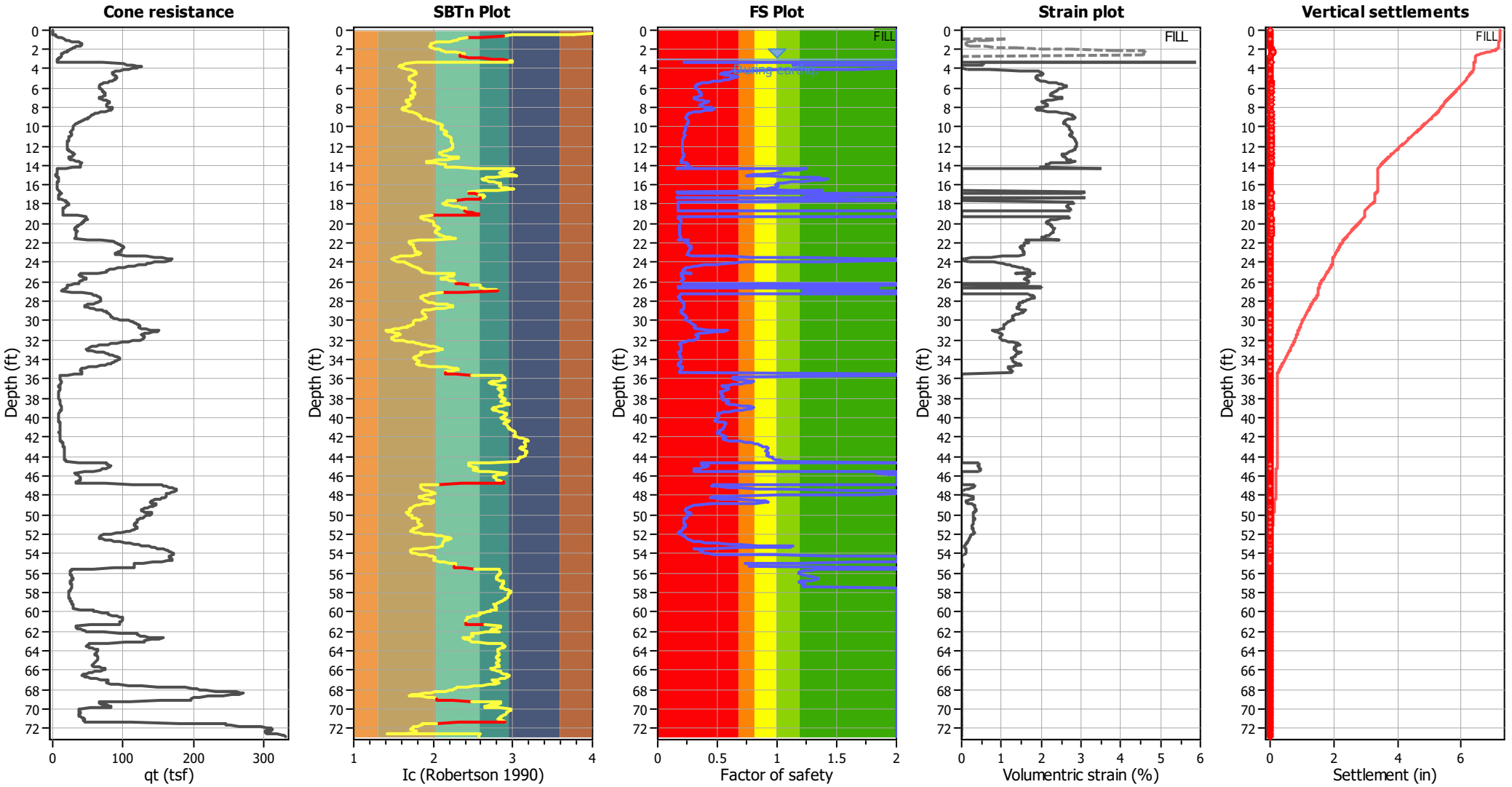
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1109
I_c maximum check value:	3.00	Total points excluded:	62
I_c change ratio value:	0.0250	Exclusion percentage:	5.59%
Minimum number of points in layer:	4	Number of layers detected:	14

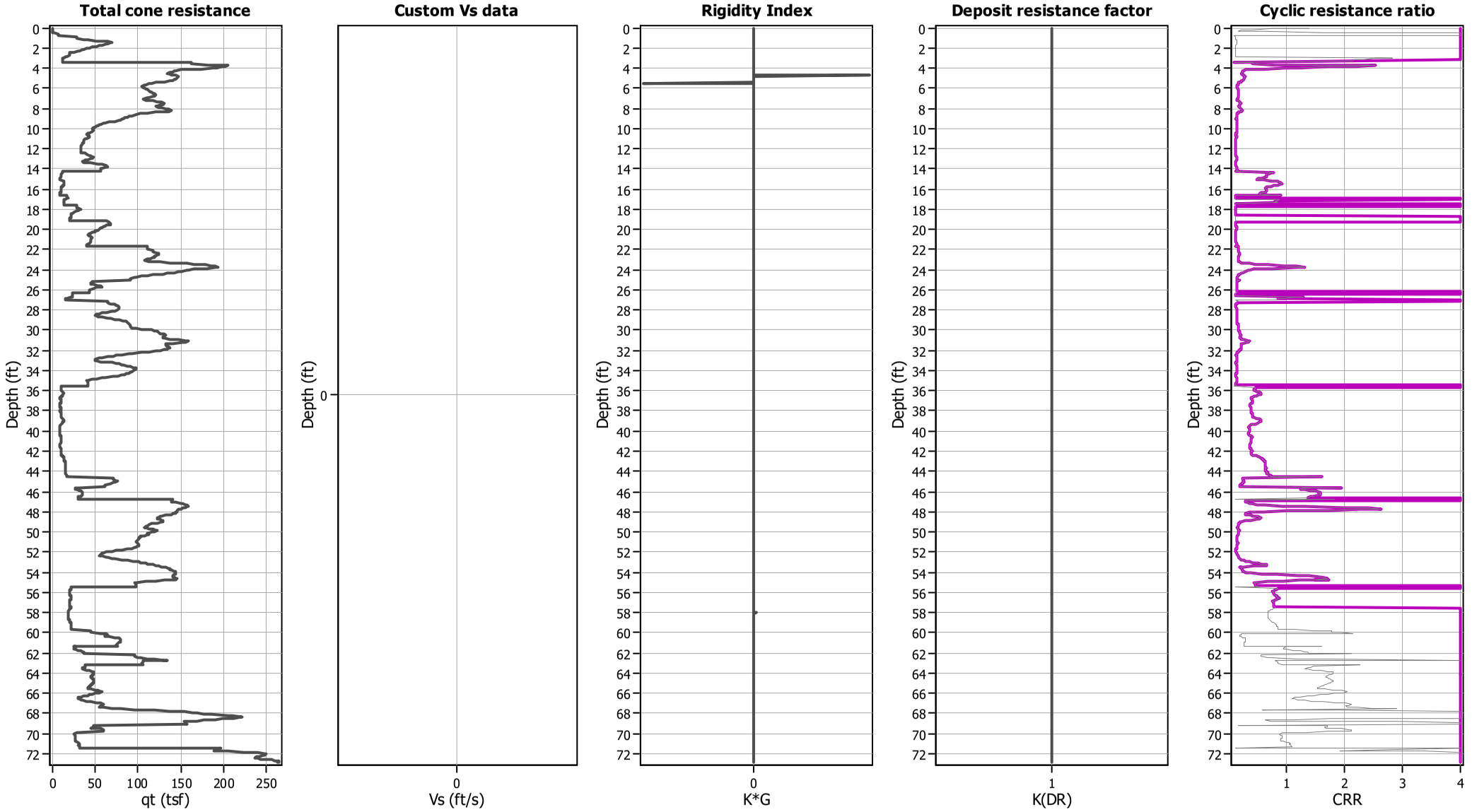
Estimation of post-earthquake settlements



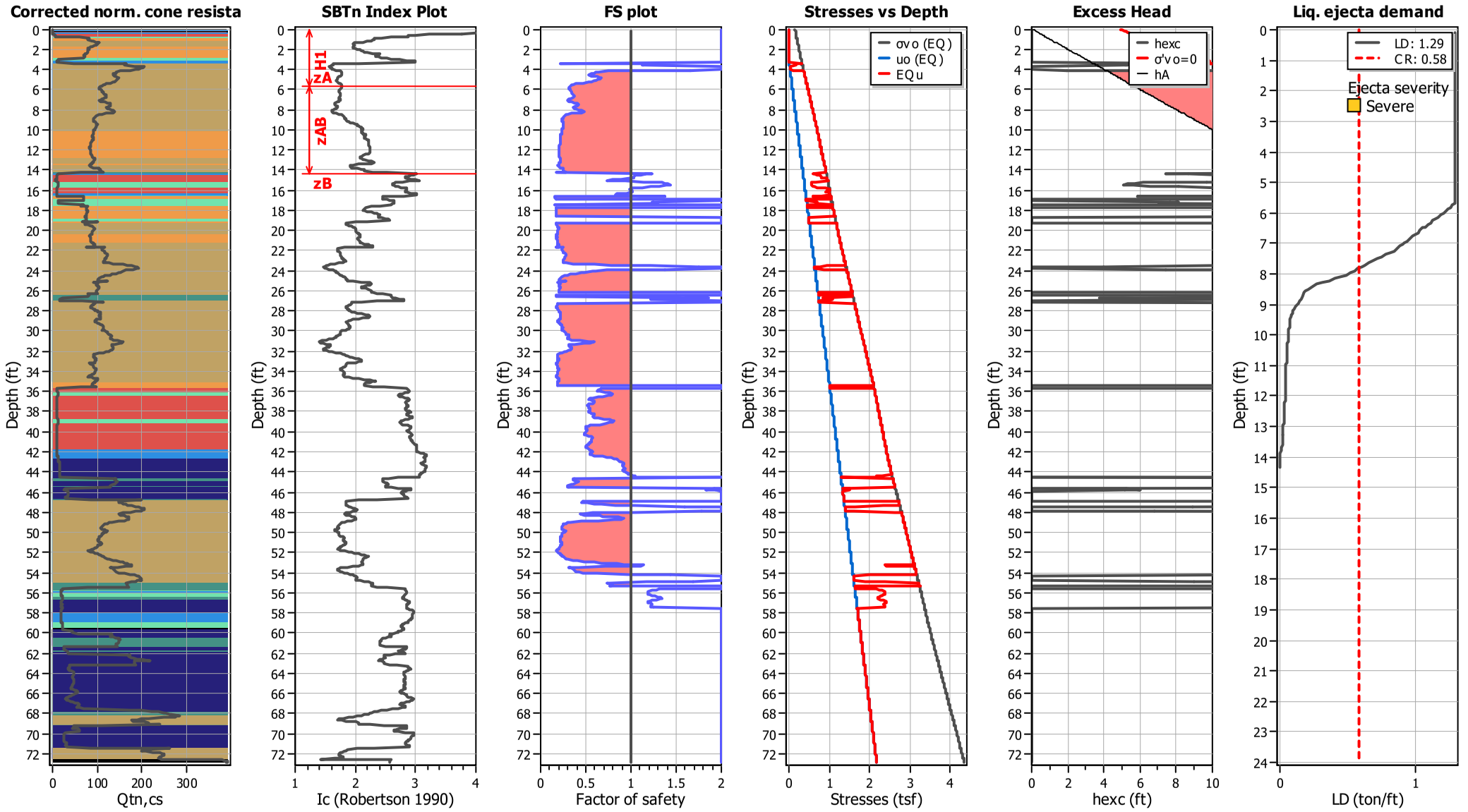
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

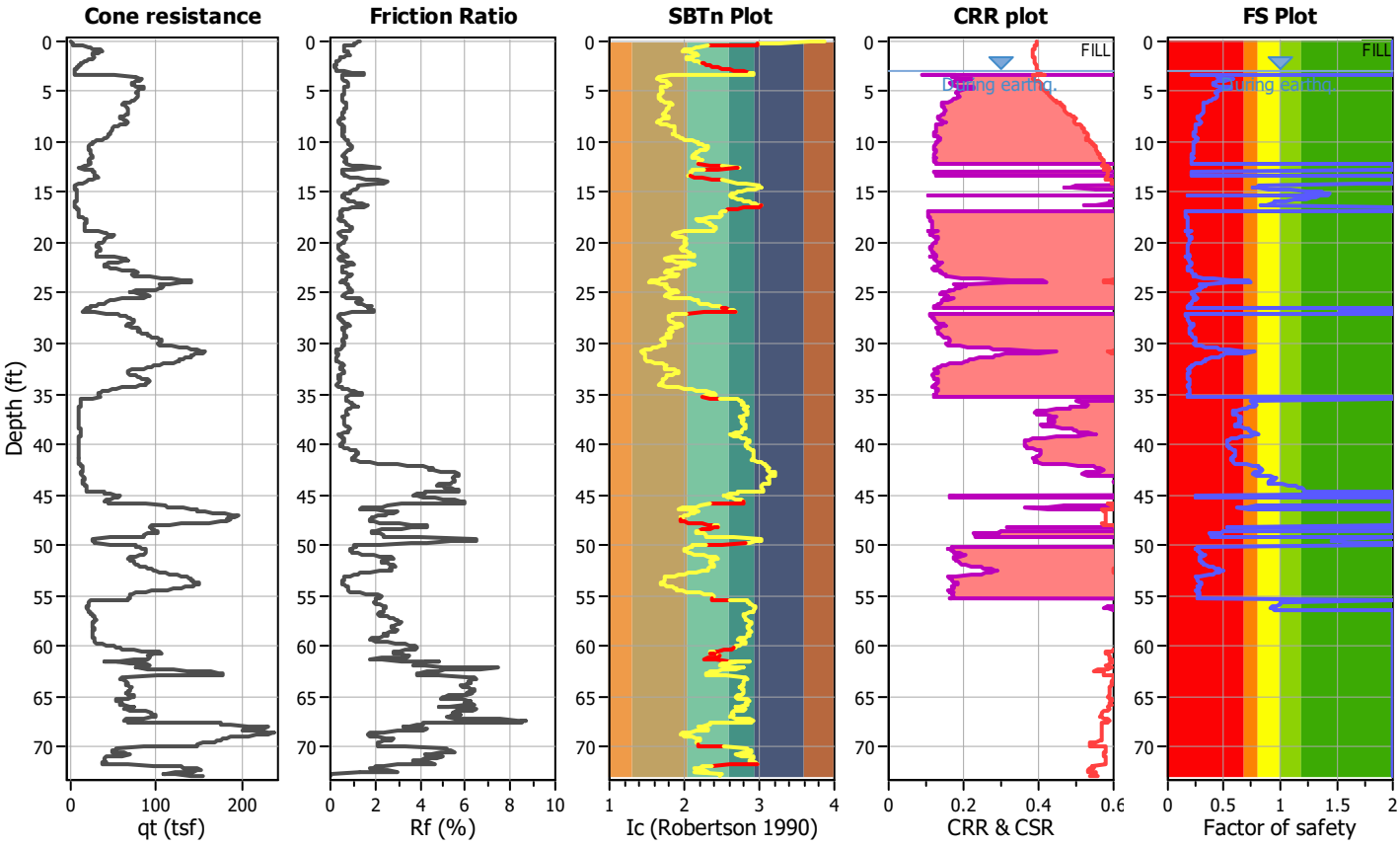
Project title : Topgolf Harbor Island

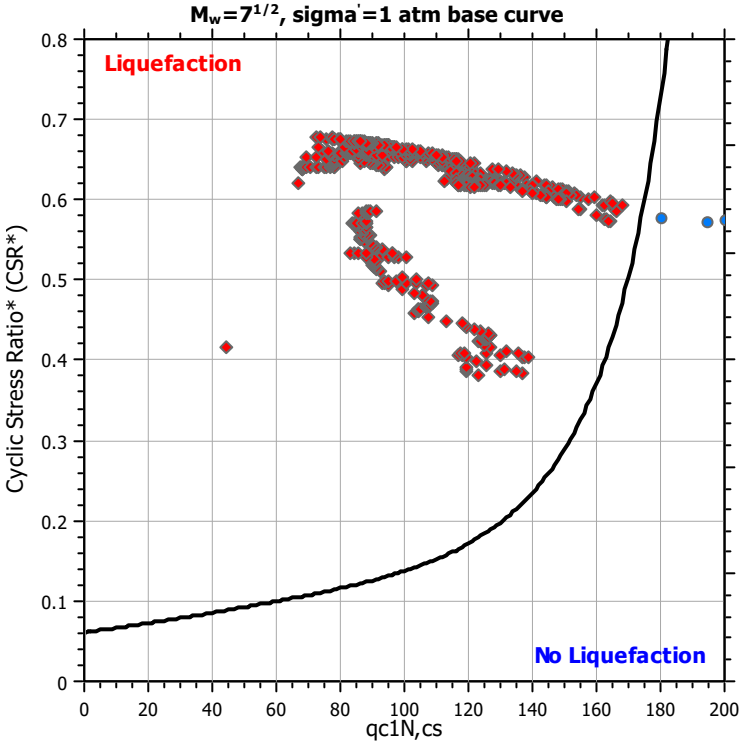
Location : North Harbor Drive and Liberator Way, San Diego, CA

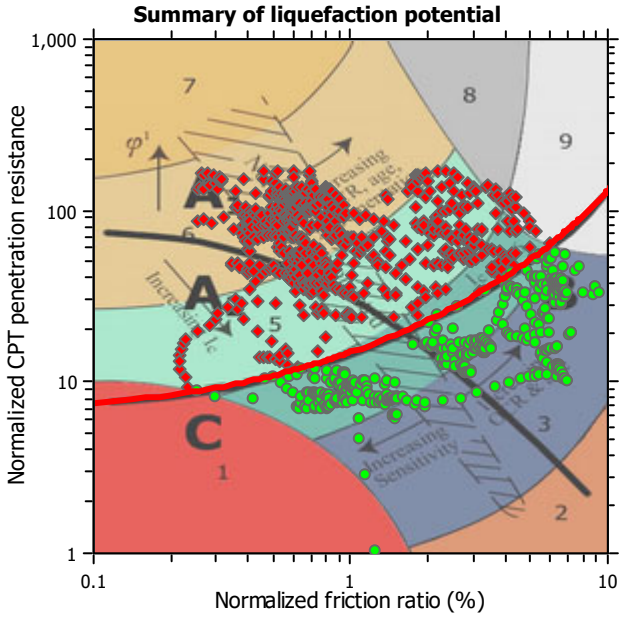
CPT file : CPT-11 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.02 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.60 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

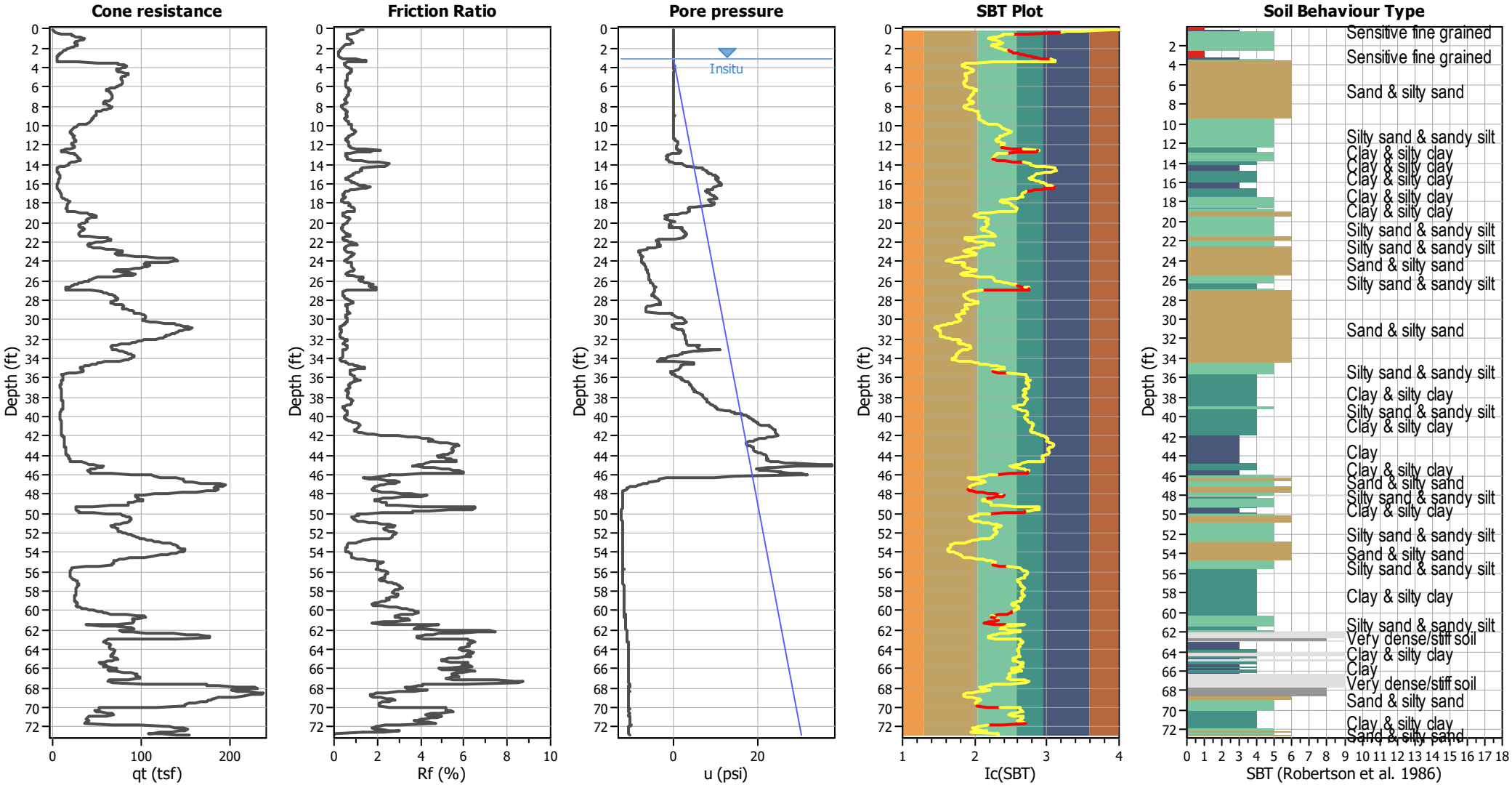






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



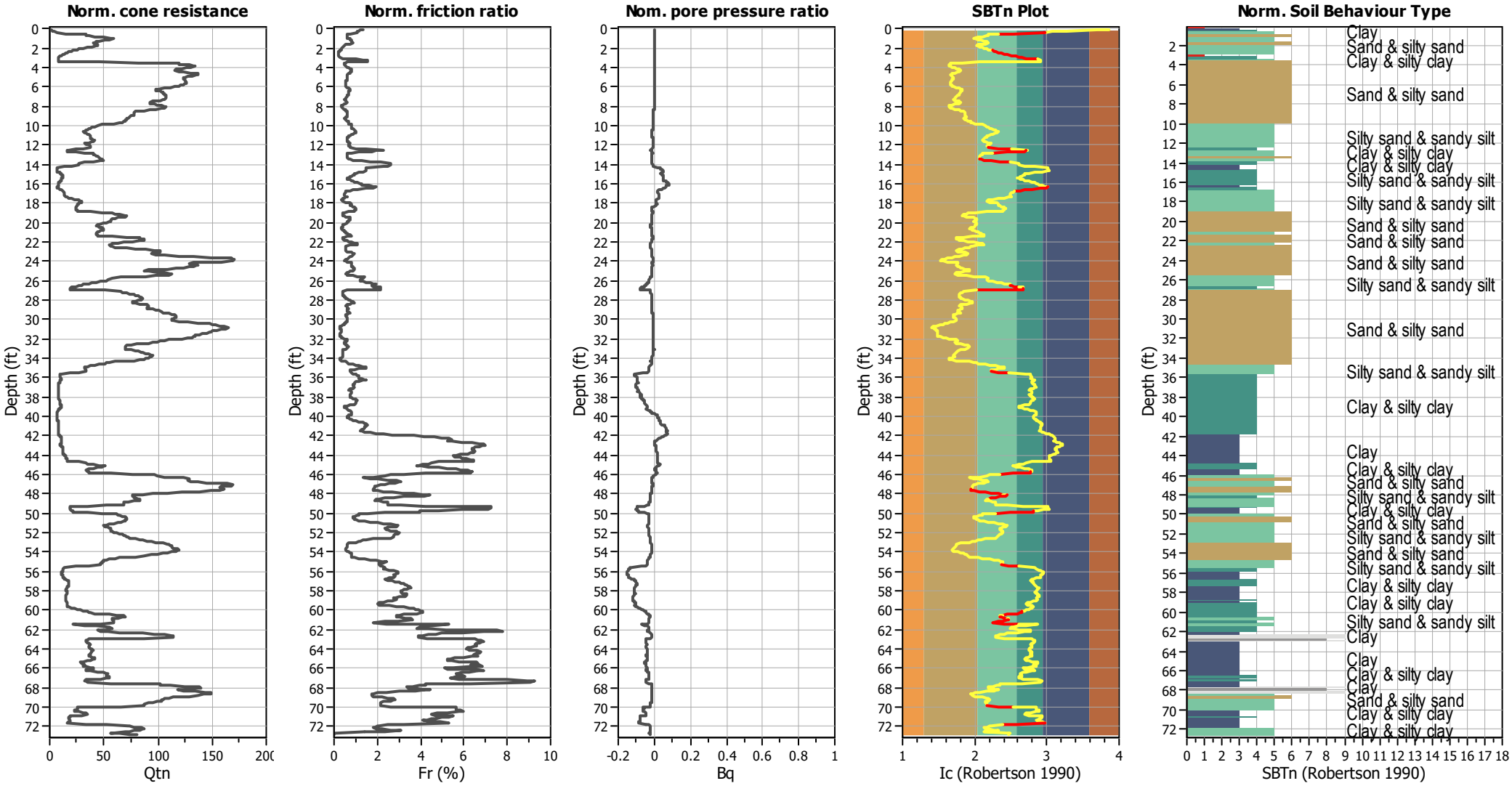
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 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)



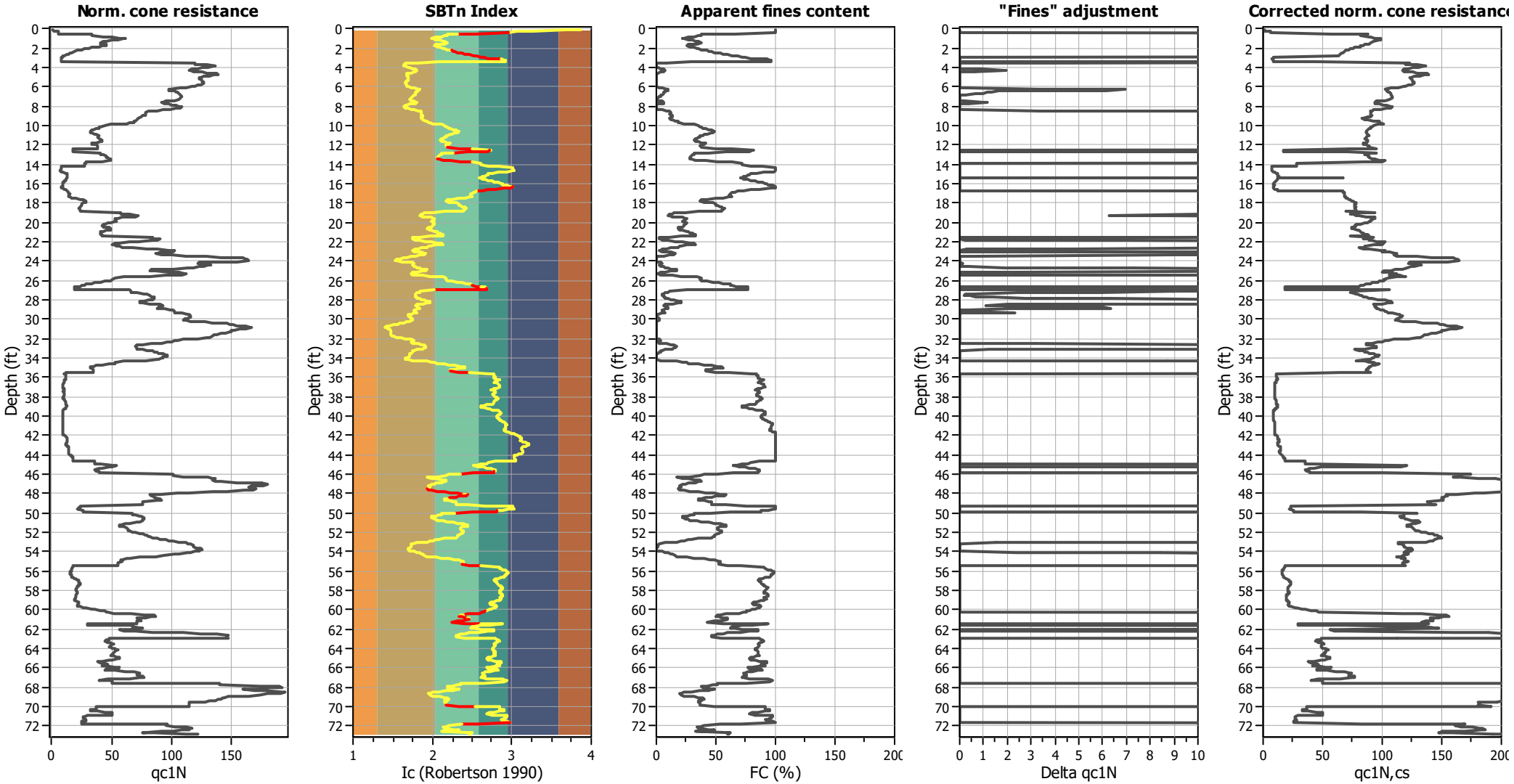
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 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

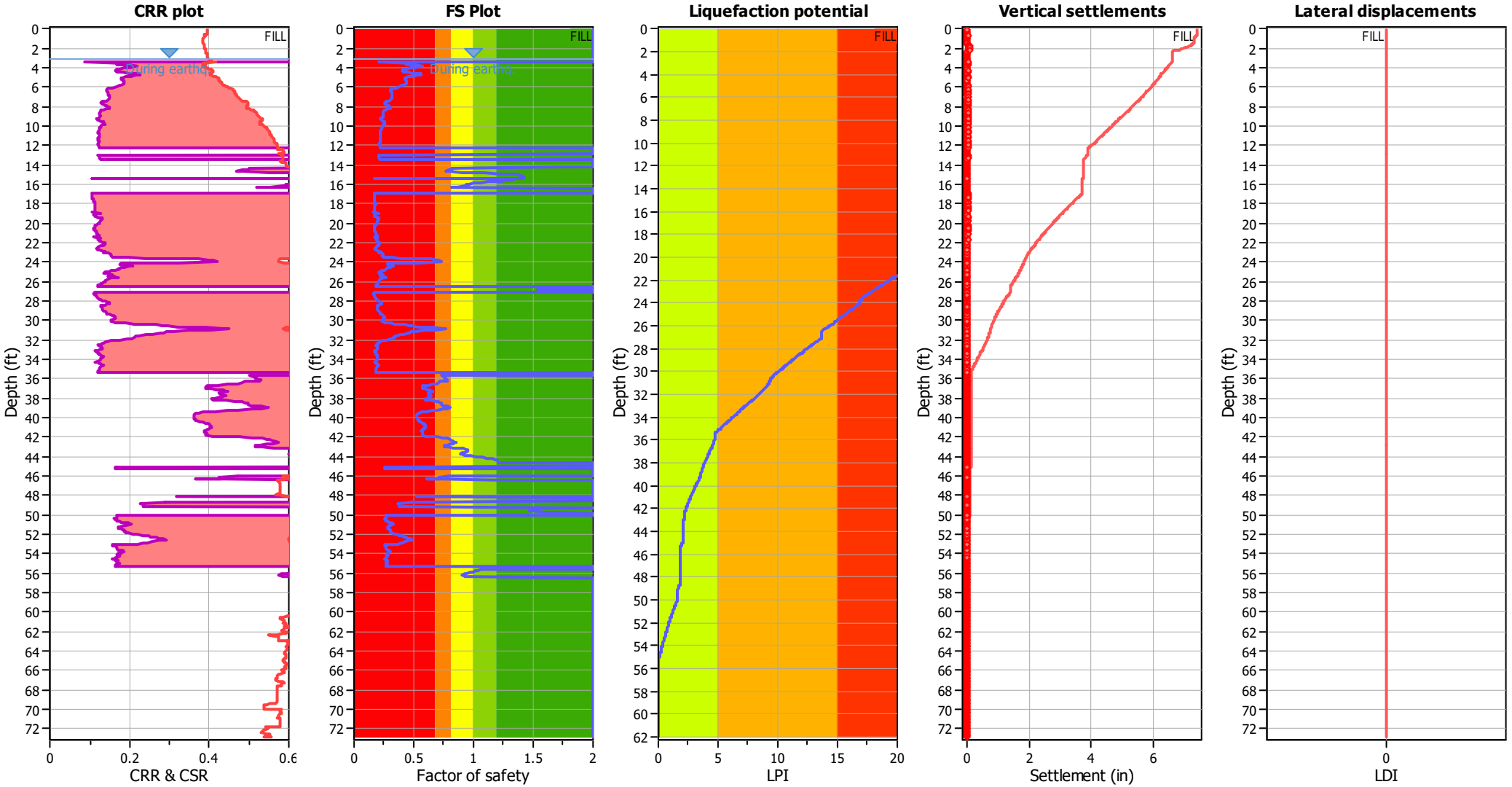
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 ft	Limit depth:	60.00 ft

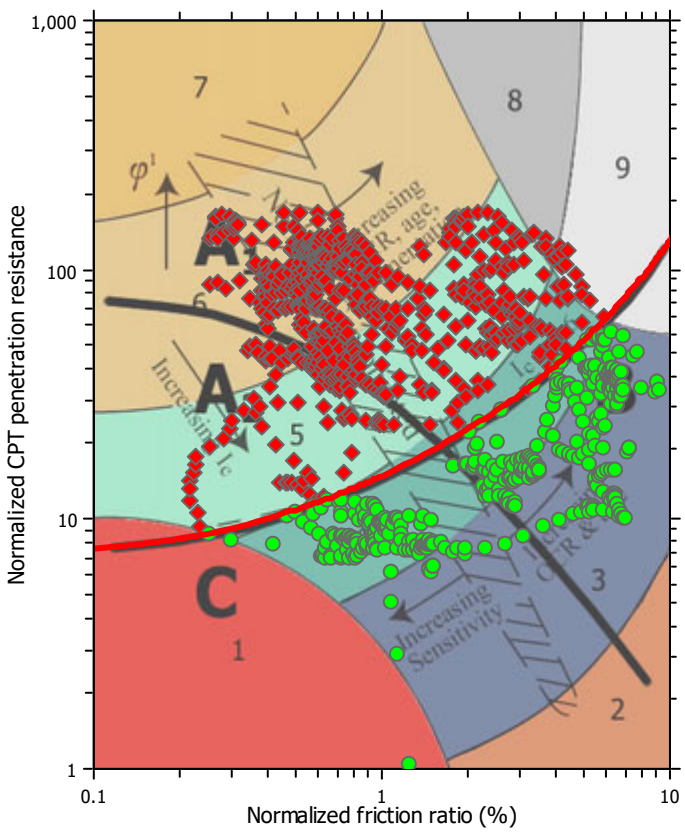
F.S. color scheme

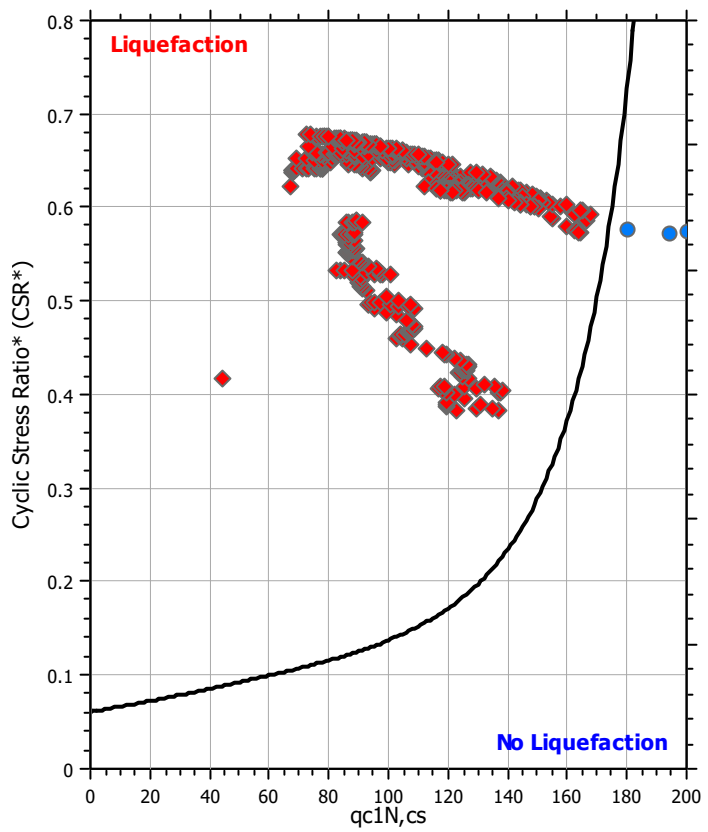
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

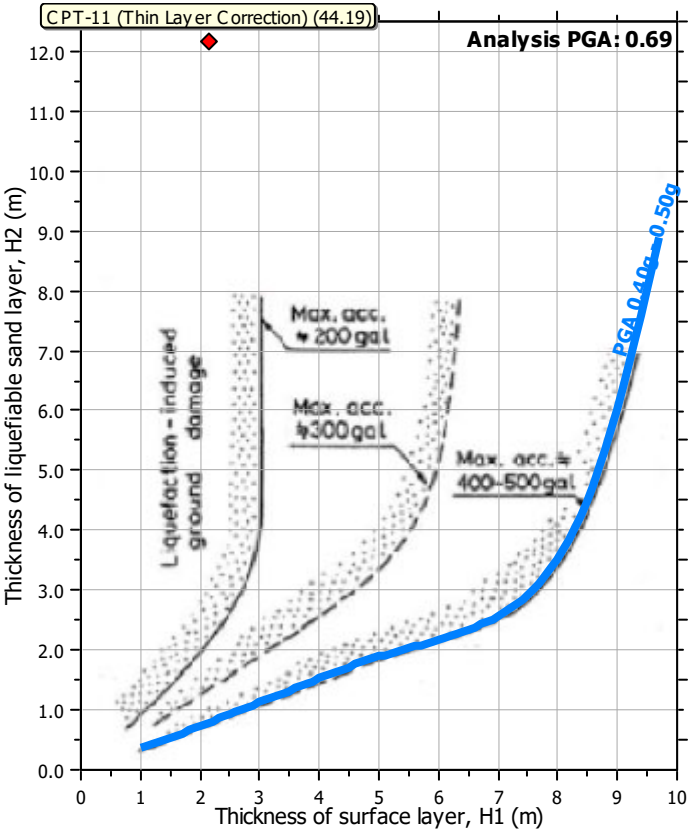
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



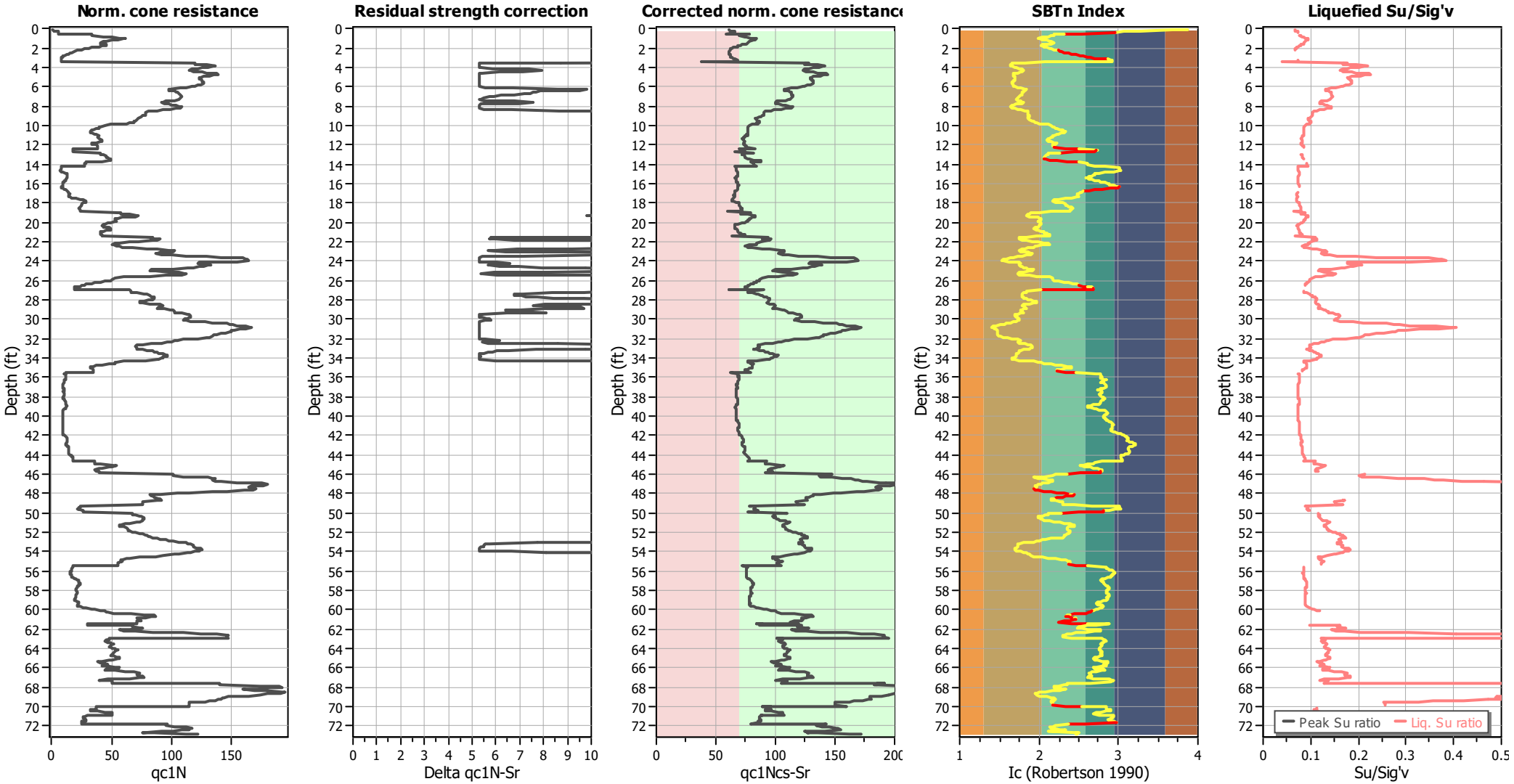




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

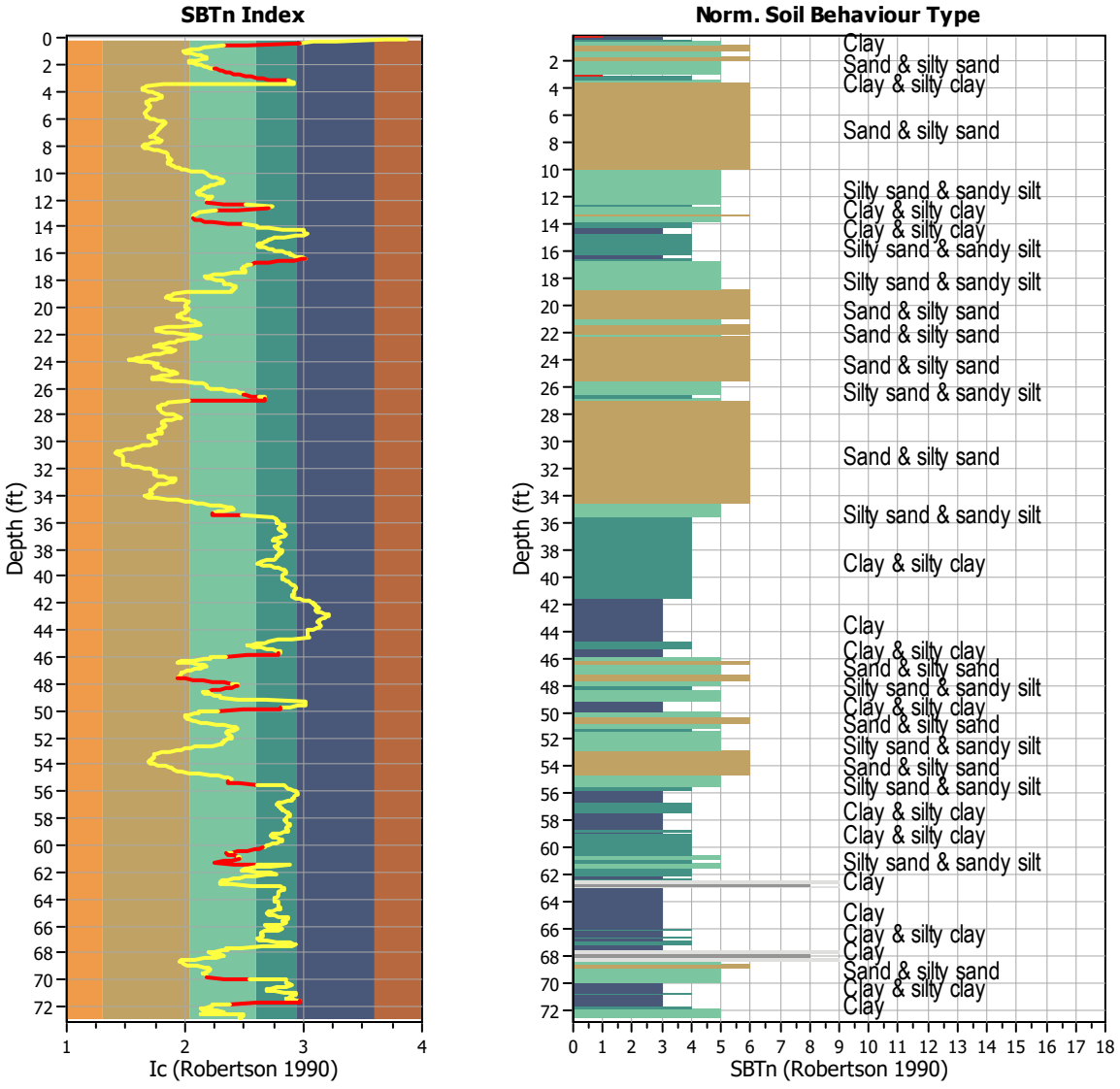
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.02 ft	Fill height:	3.60 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

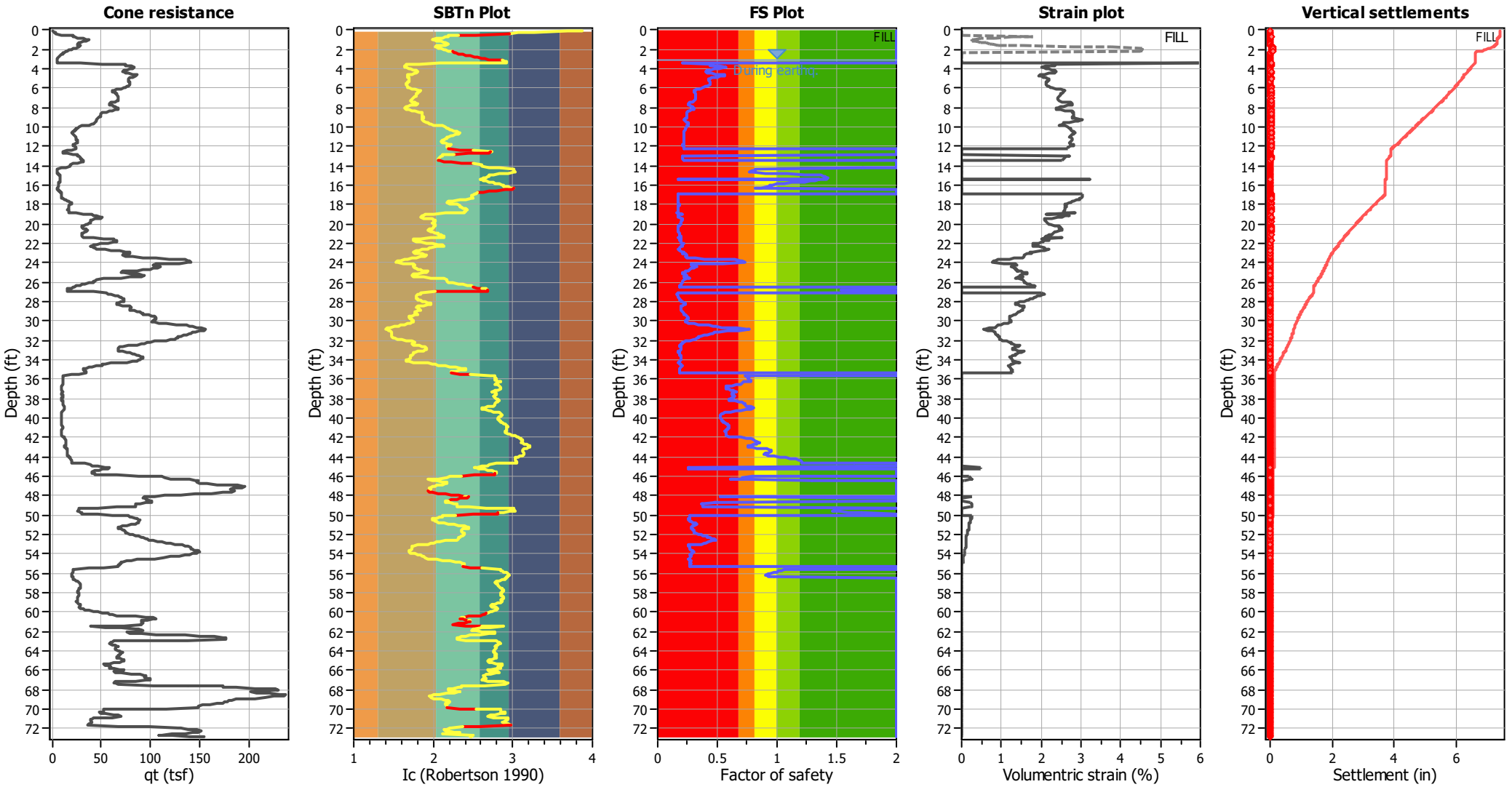
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1107
I_c maximum check value:	3.00	Total points excluded:	108
I_c change ratio value:	0.0250	Exclusion percentage:	9.76%
Minimum number of points in layer:	4	Number of layers detected:	20

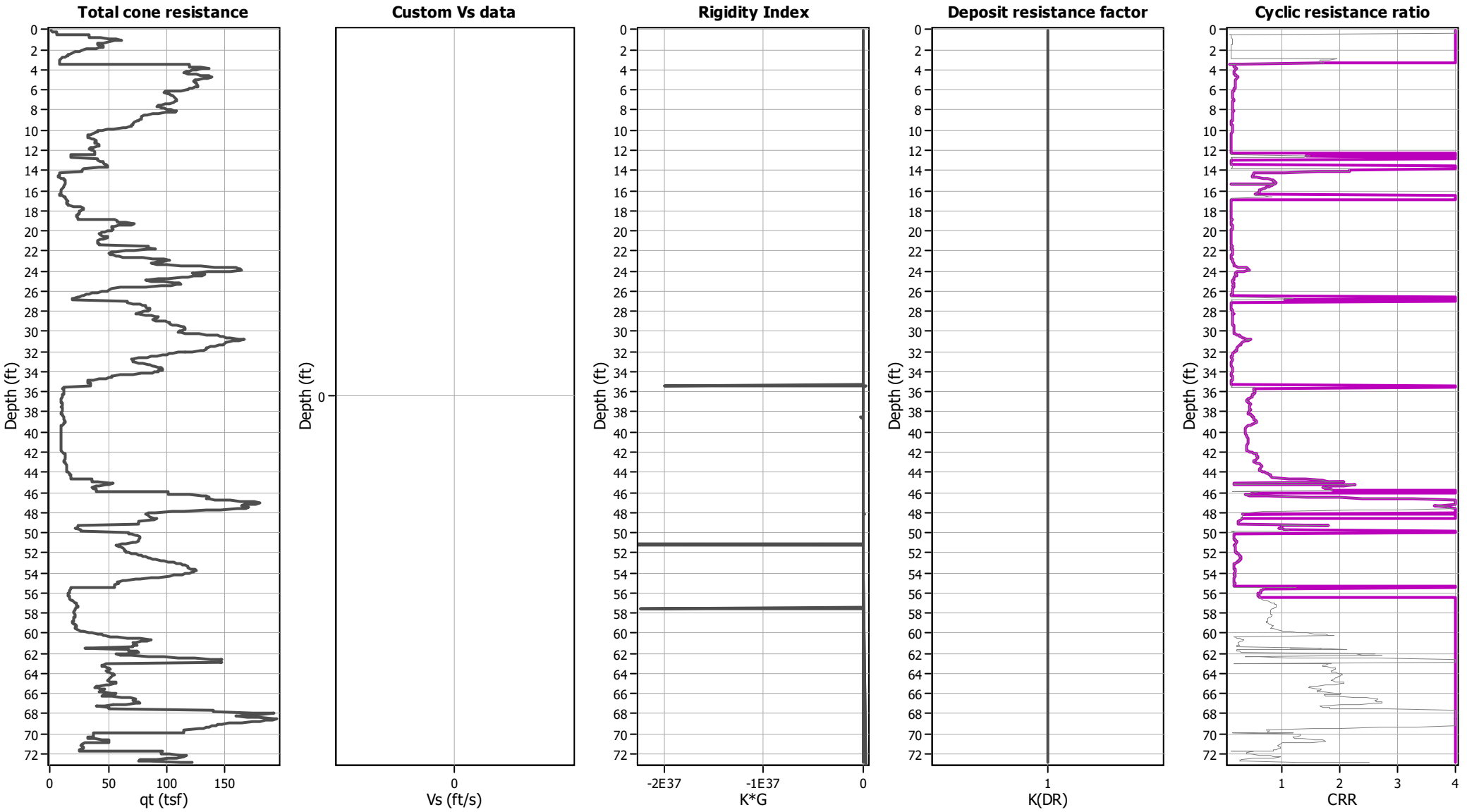
Estimation of post-earthquake settlements



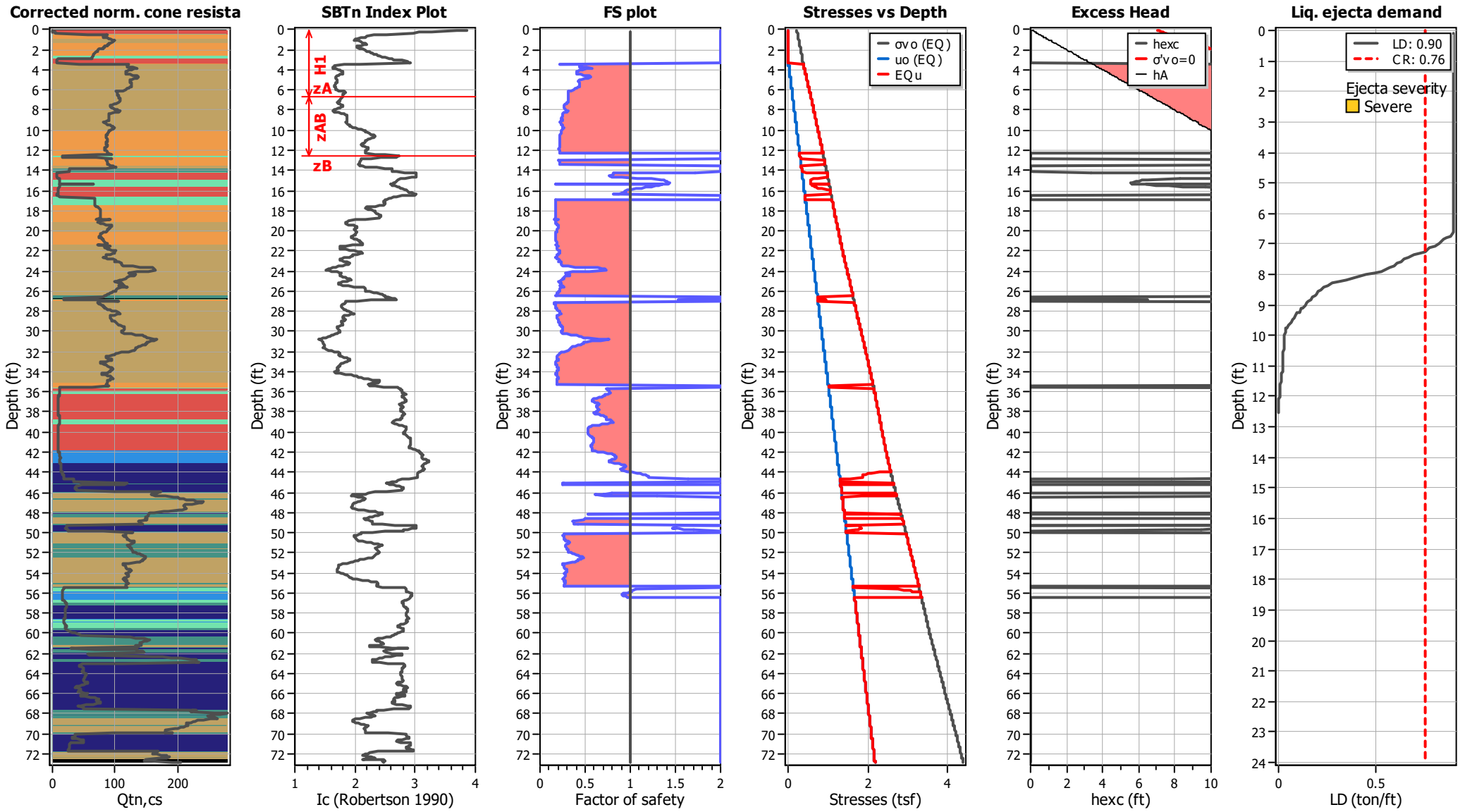
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

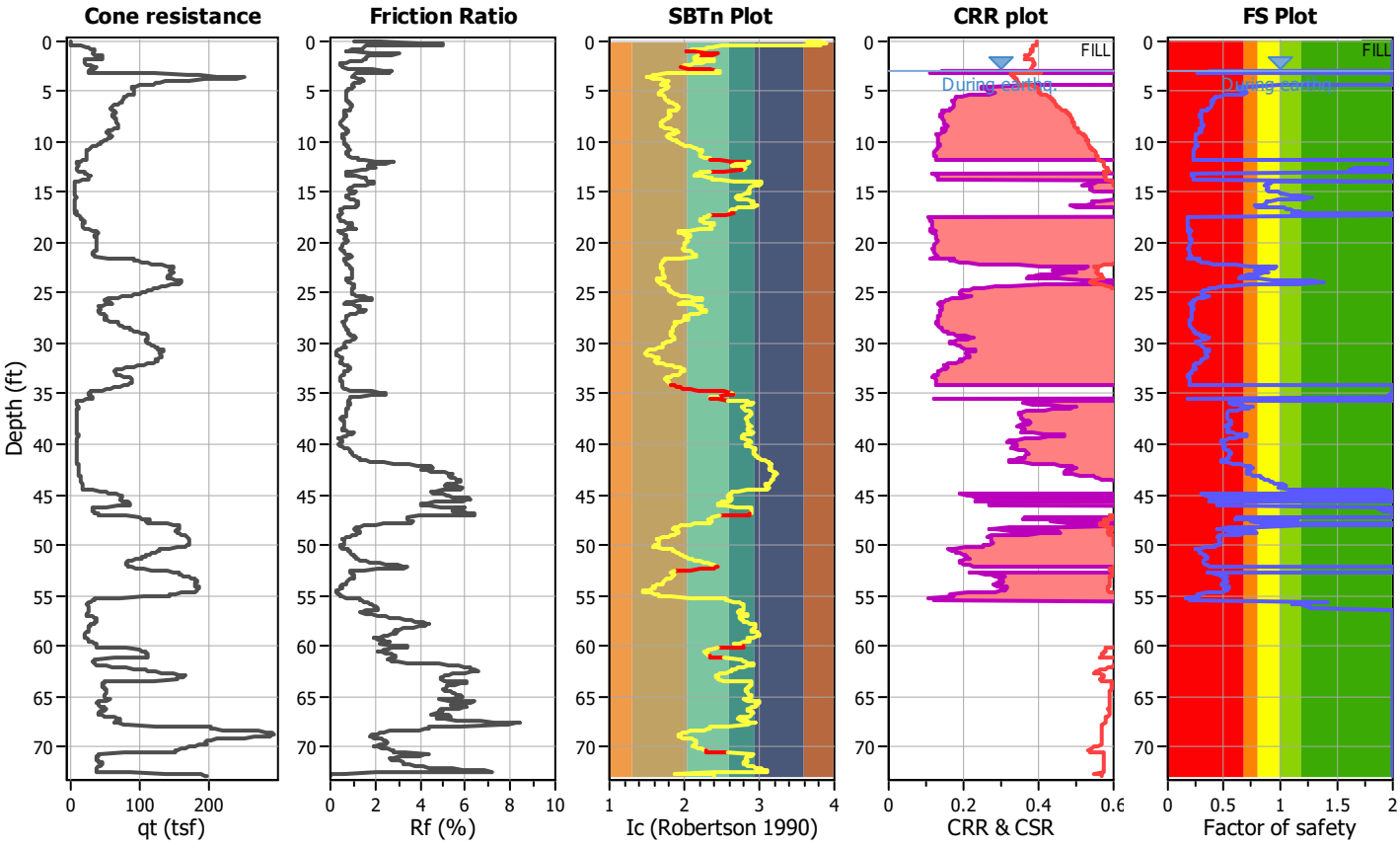
Project title : Topgolf Harbor Island

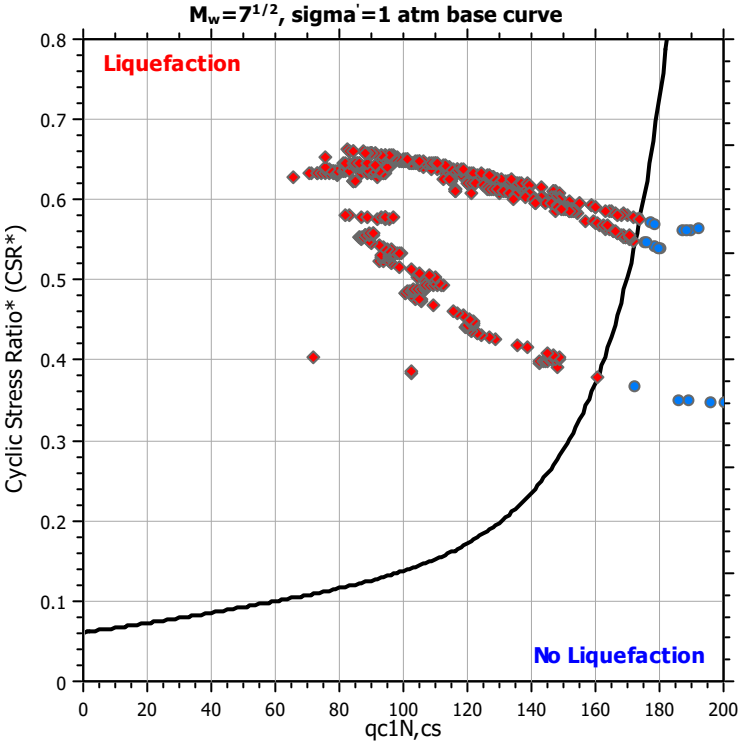
Location : North Harbor Drive and Liberator Way, San Diego, CA

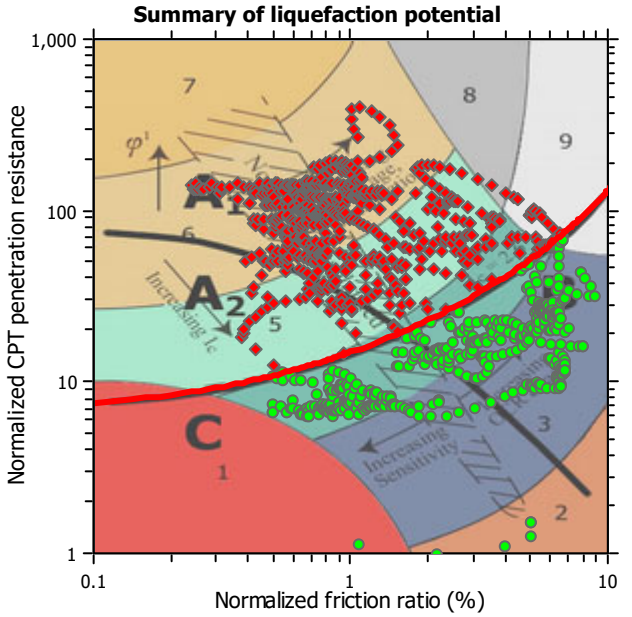
CPT file : CPT-12 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.95 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.67 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

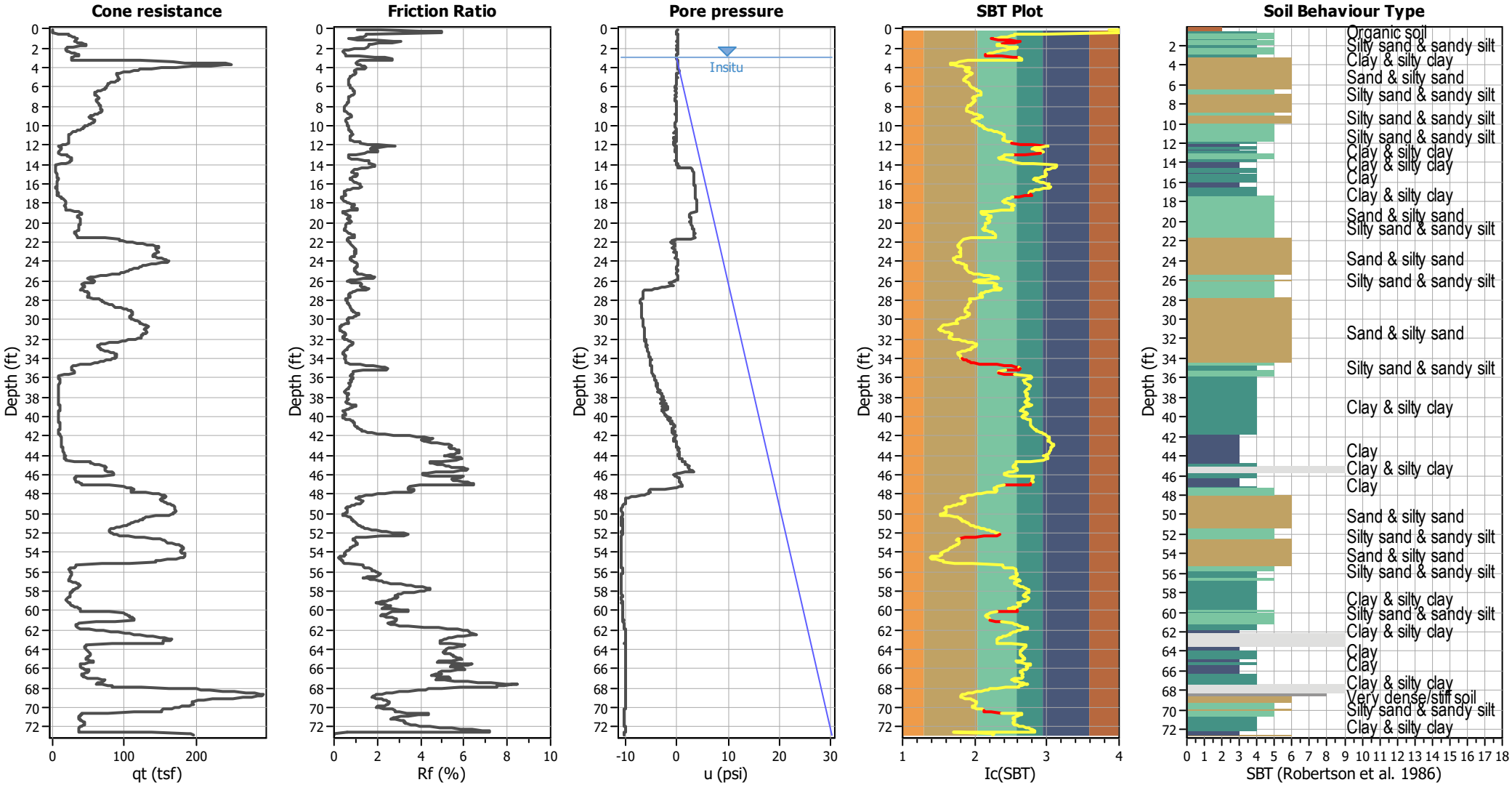






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



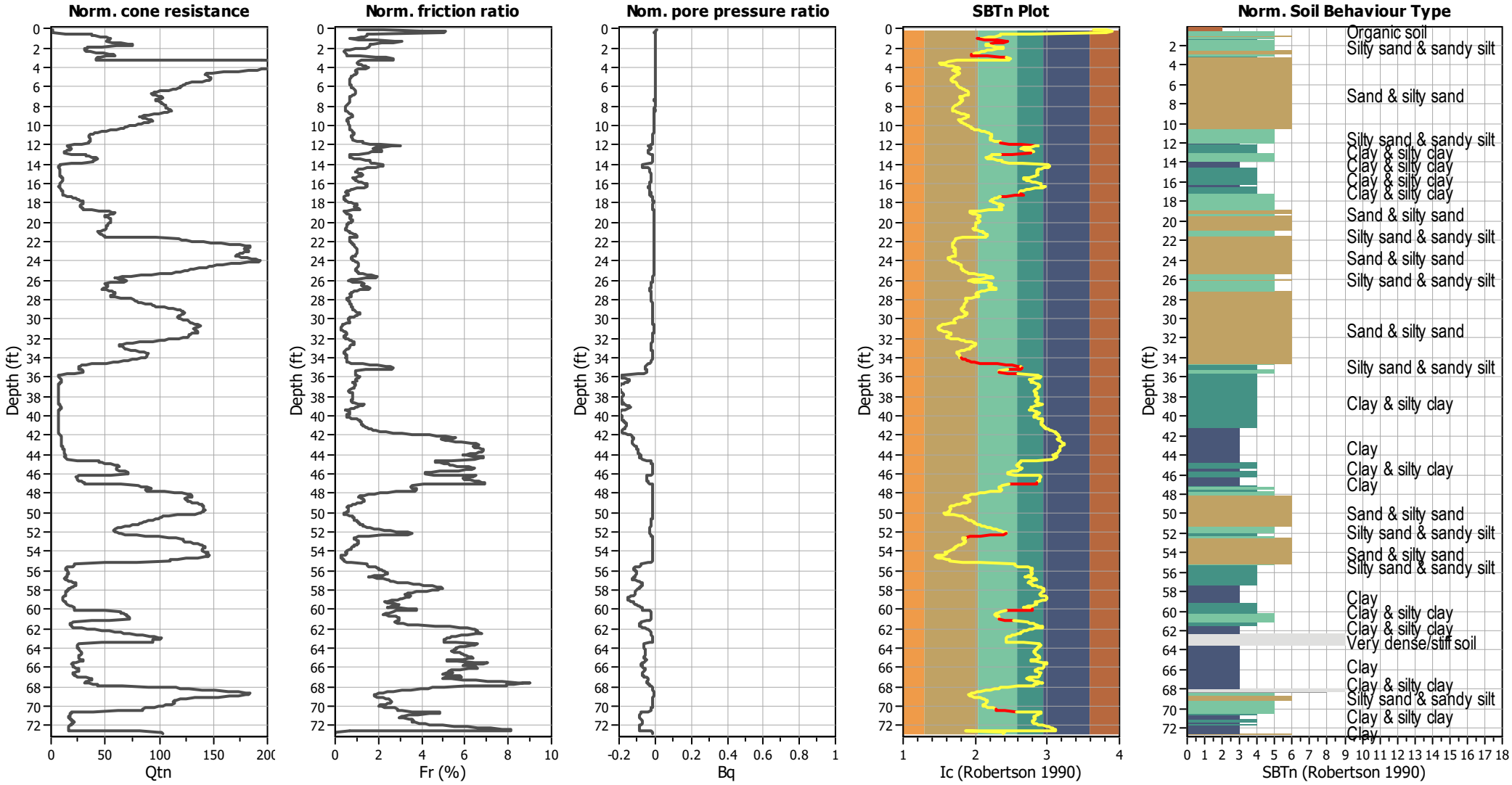
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 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)



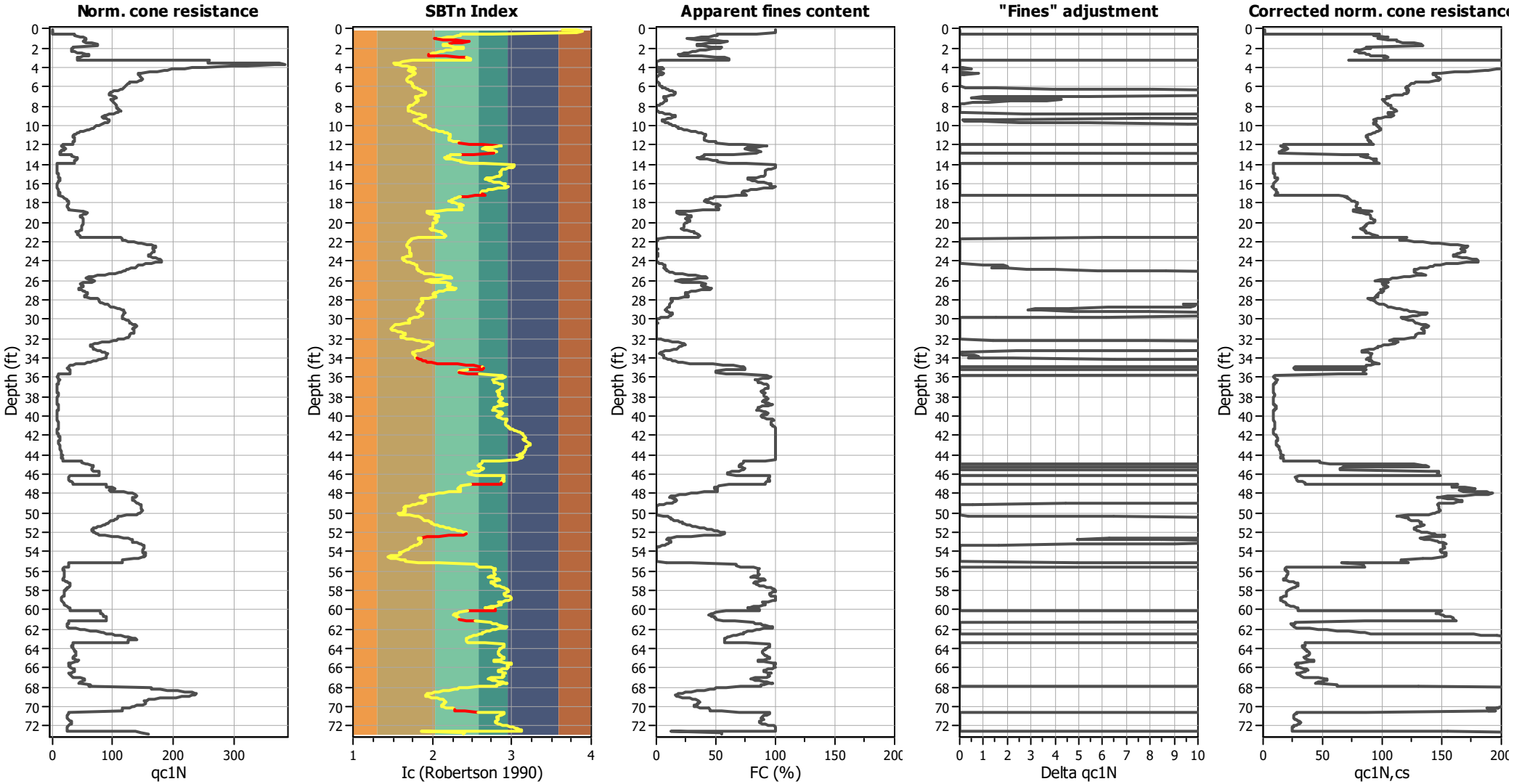
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 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

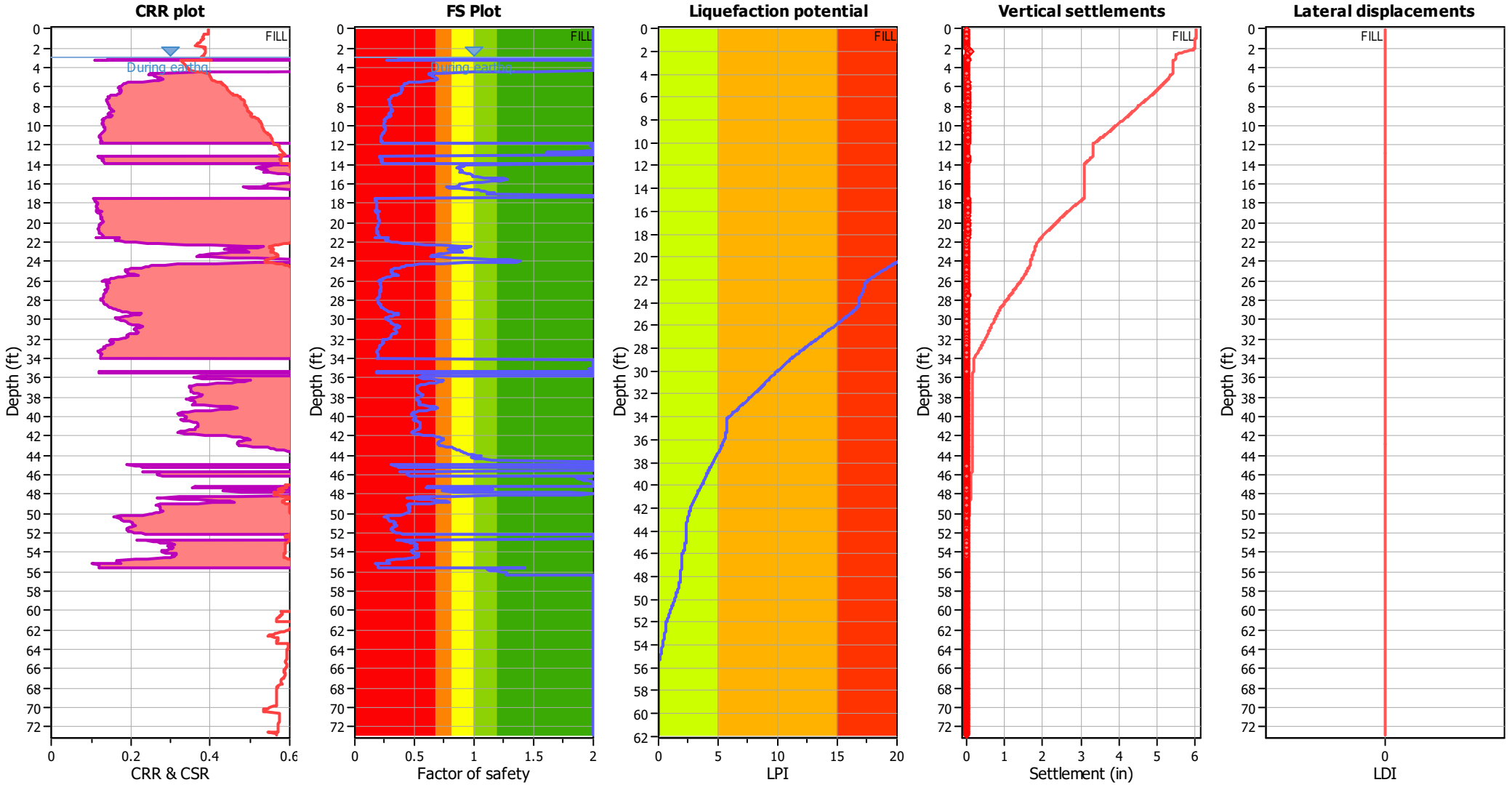
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 ft	Limit depth:	60.00 ft

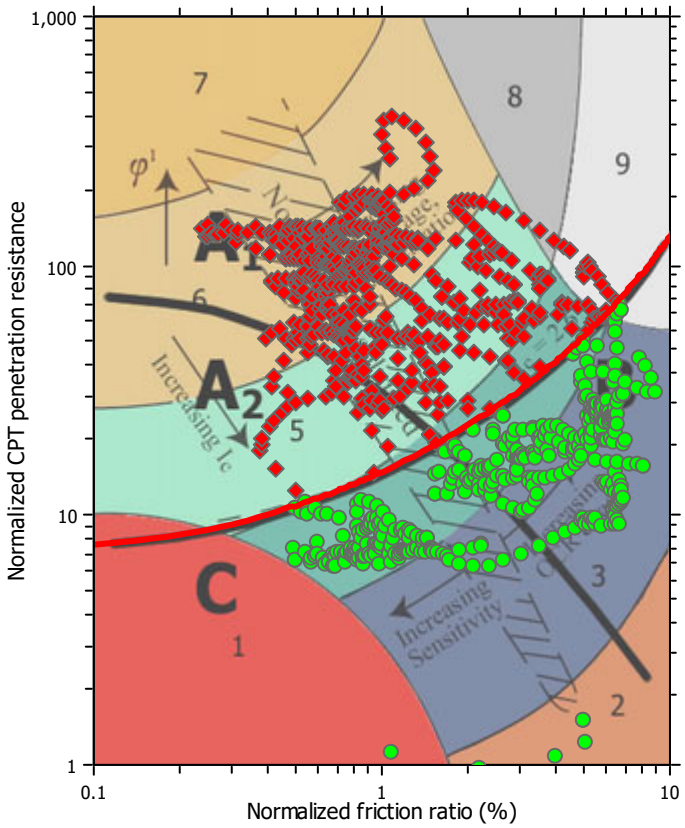
F.S. color scheme

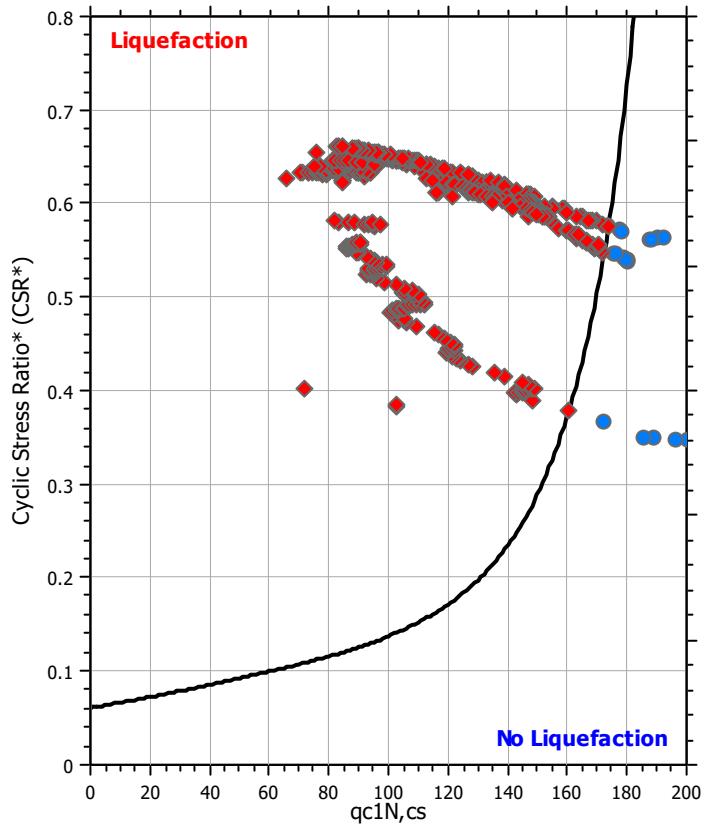
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

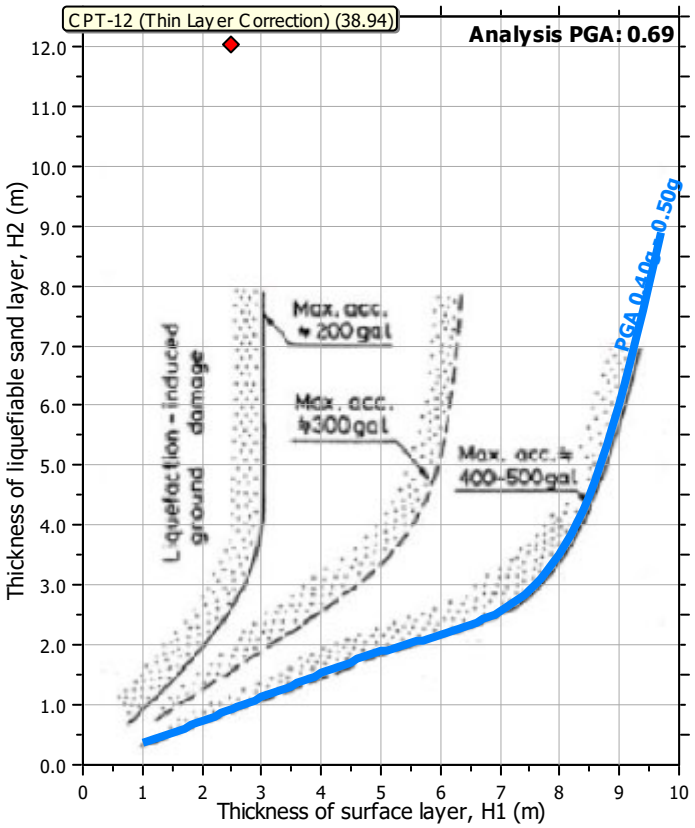
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



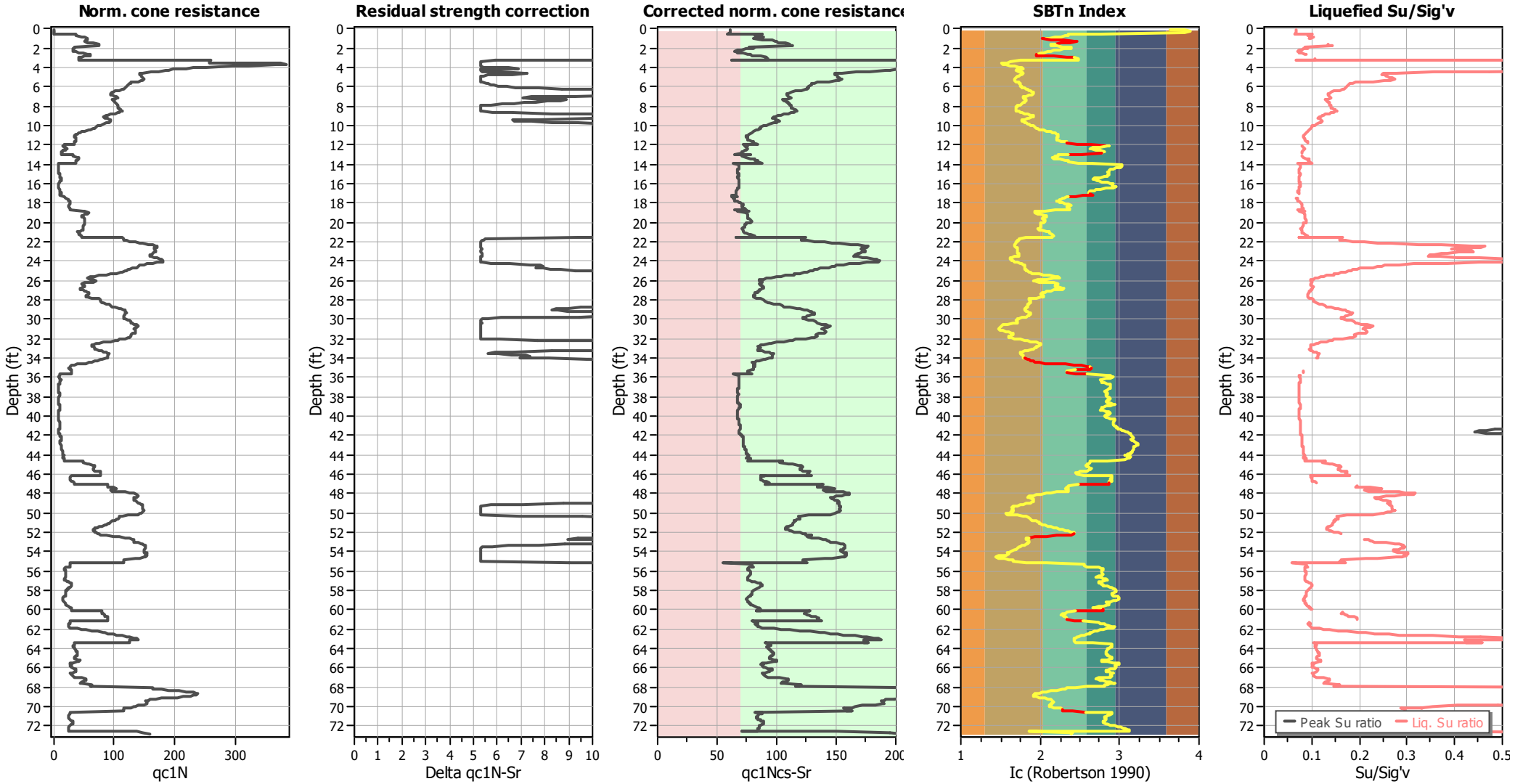




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

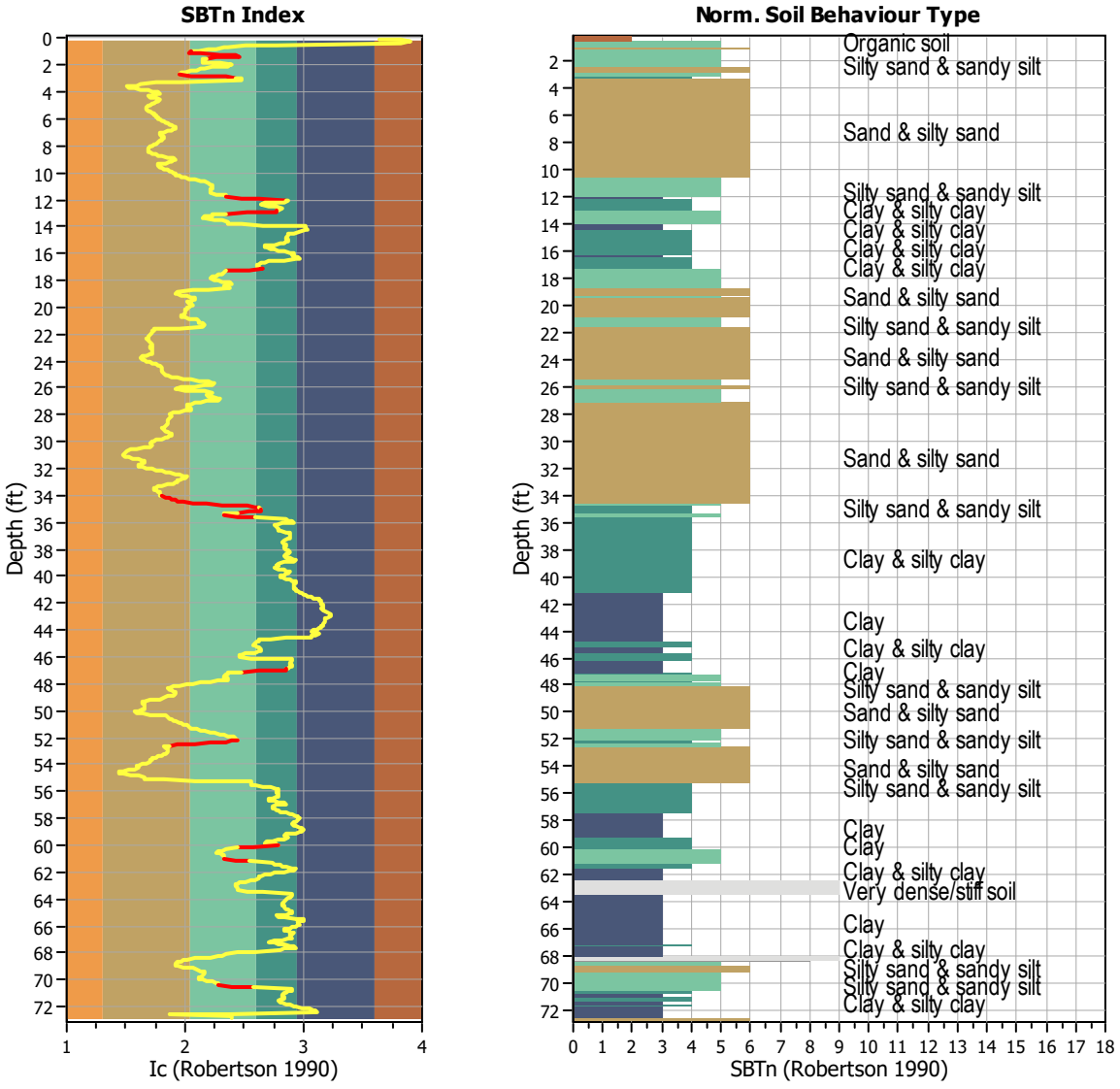
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.95 ft	Fill height:	3.67 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.



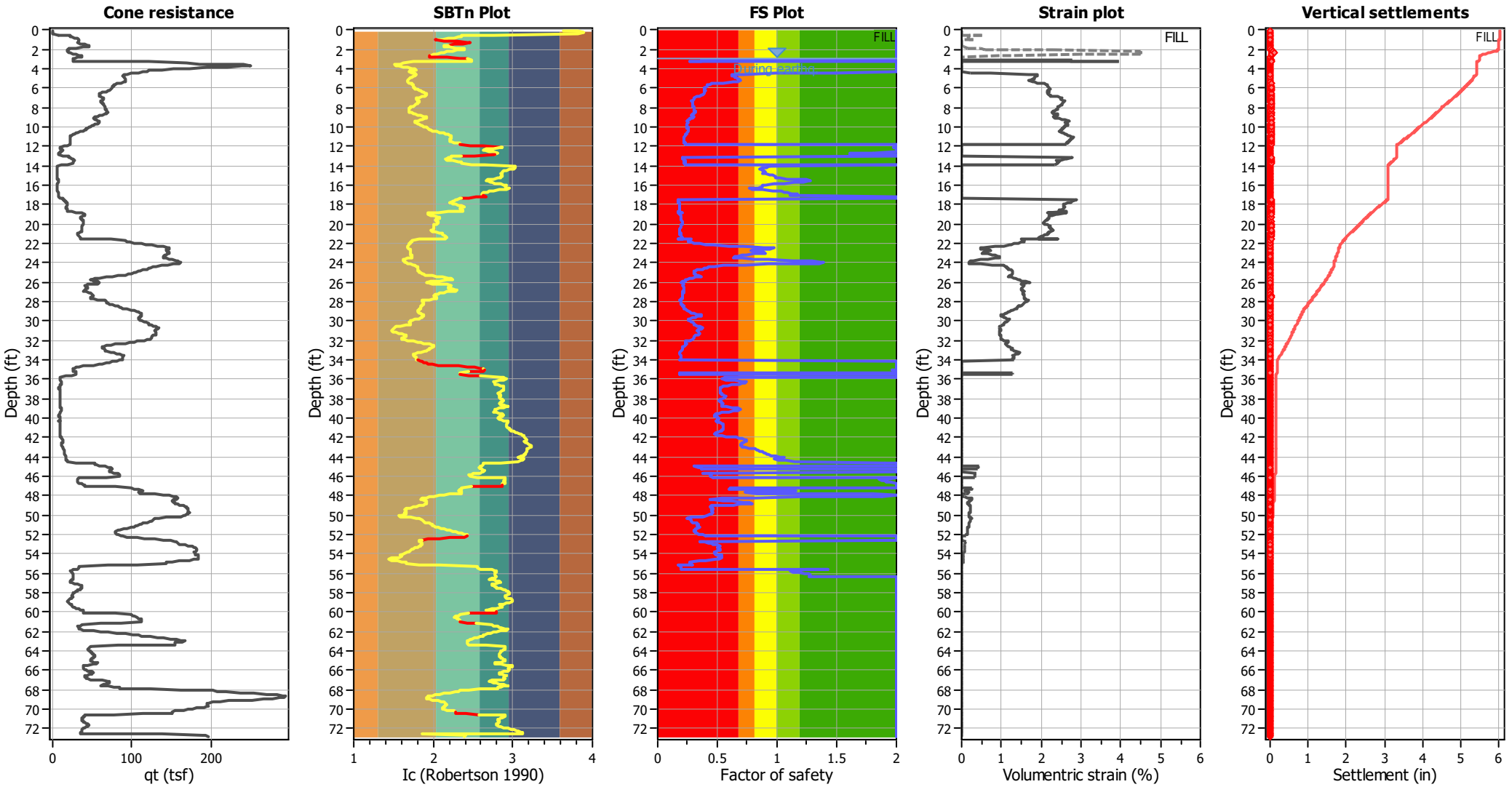
Transition layer algorithm properties

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:	1103
Total points excluded:	76
Exclusion percentage:	6.89%
Number of layers detected:	14

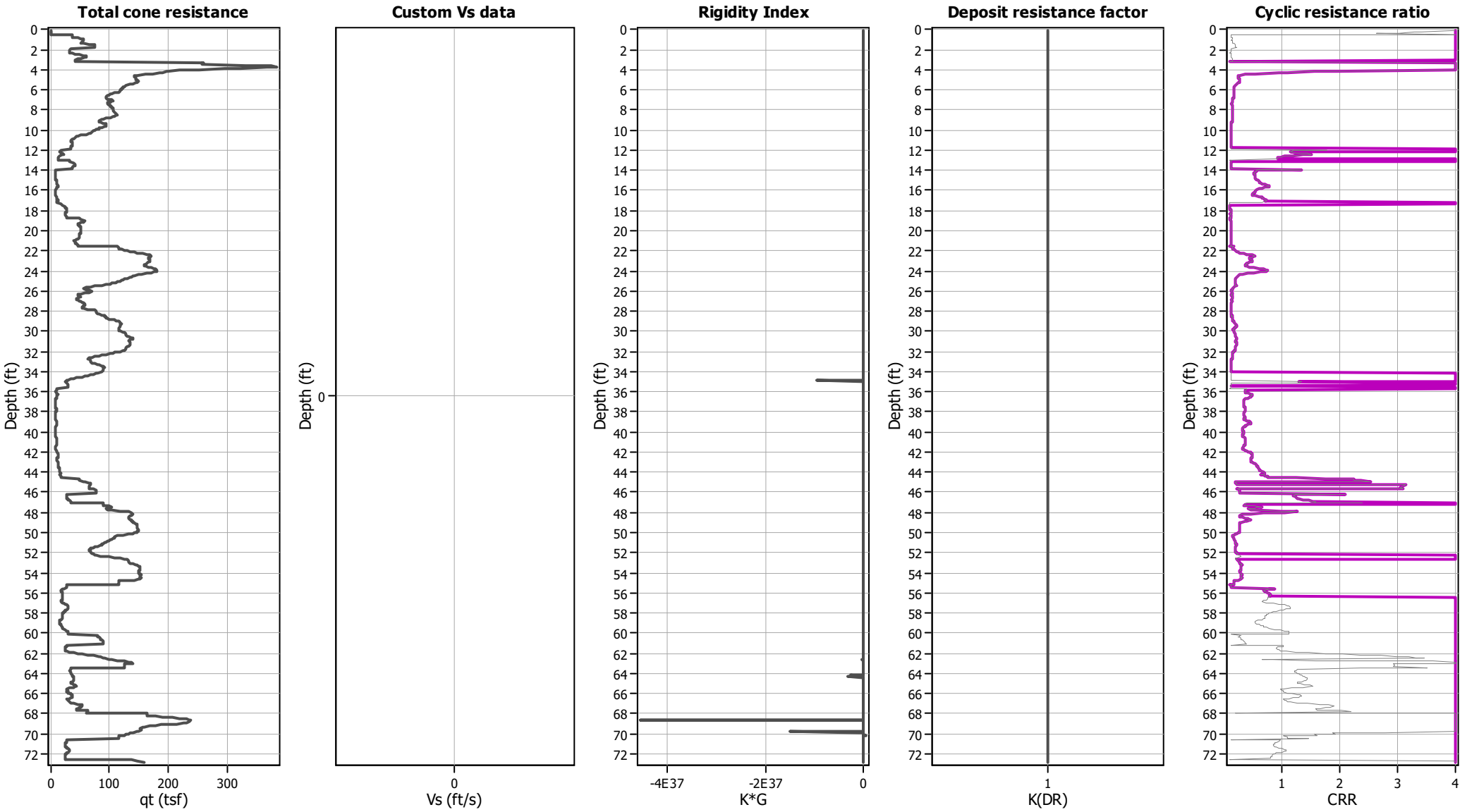
Estimation of post-earthquake settlements



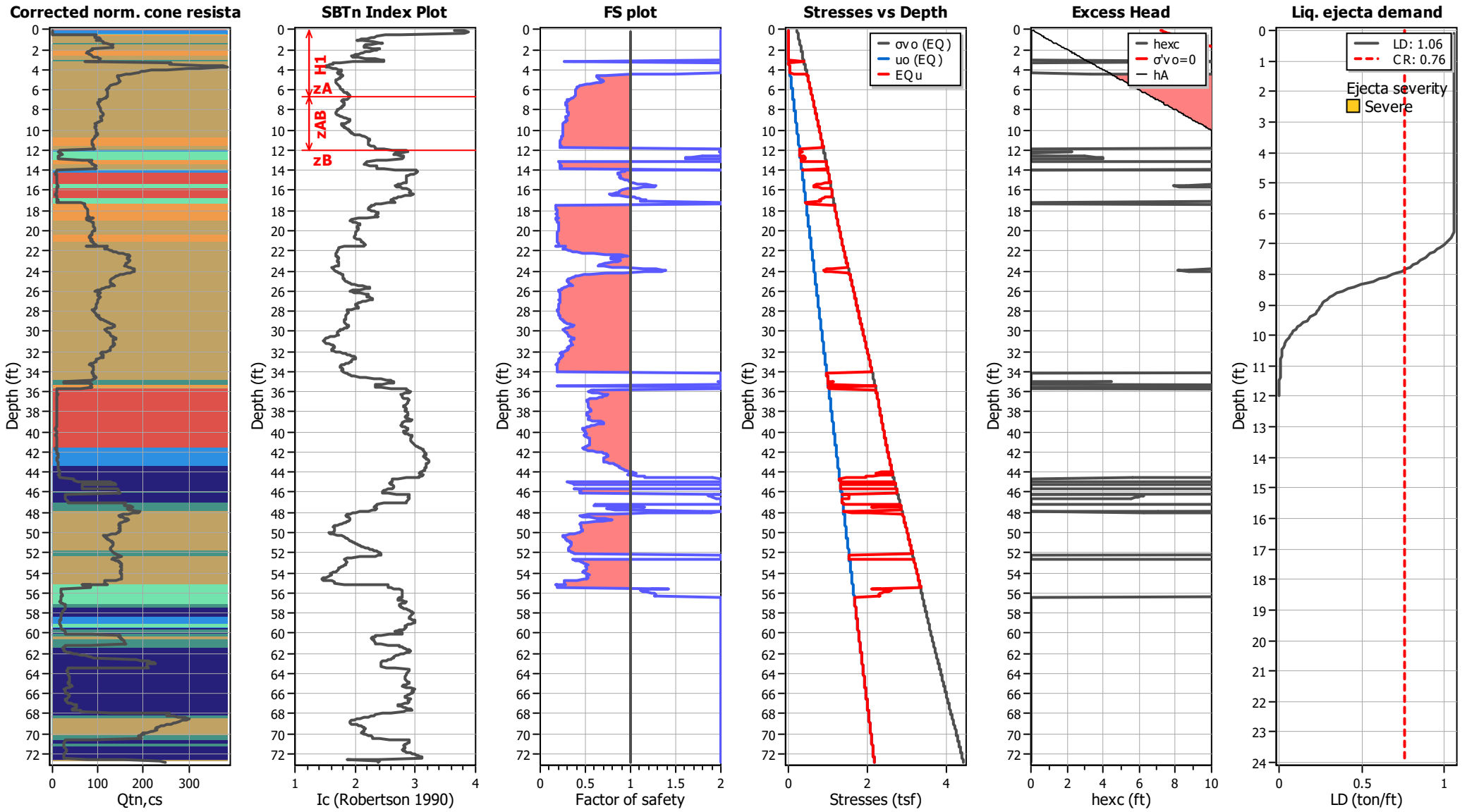
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

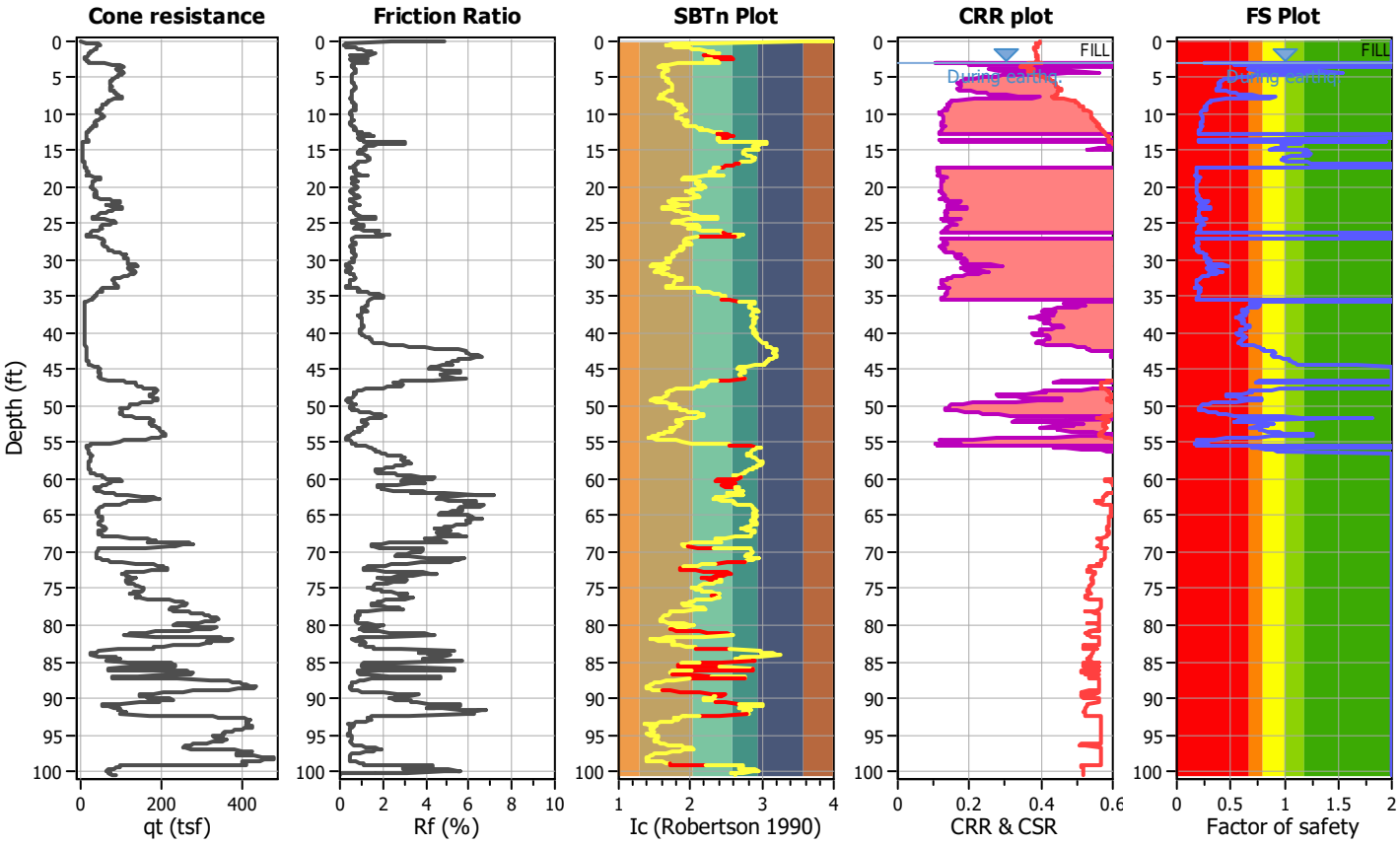
Project title : Topgolf Harbor Island

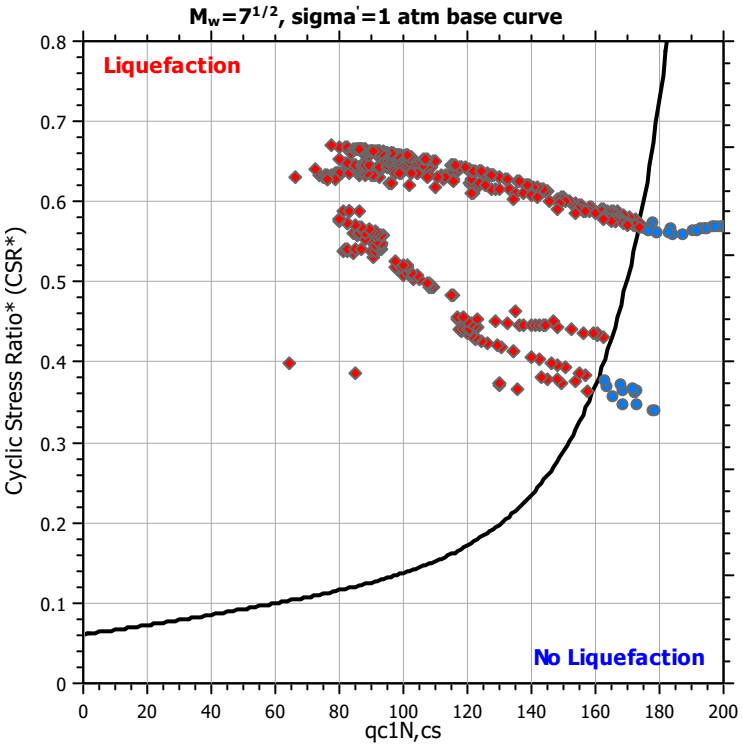
Location : North Harbor Drive and Liberator Way, San Diego, CA

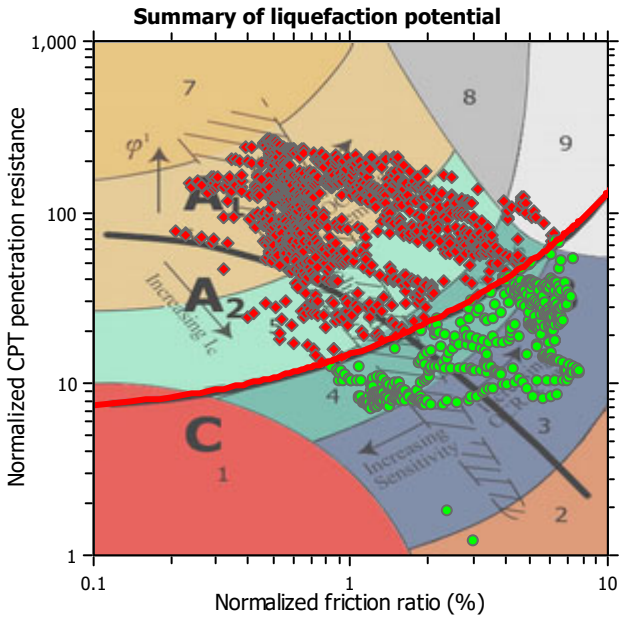
CPT file : CPT-13 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.99 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.63 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

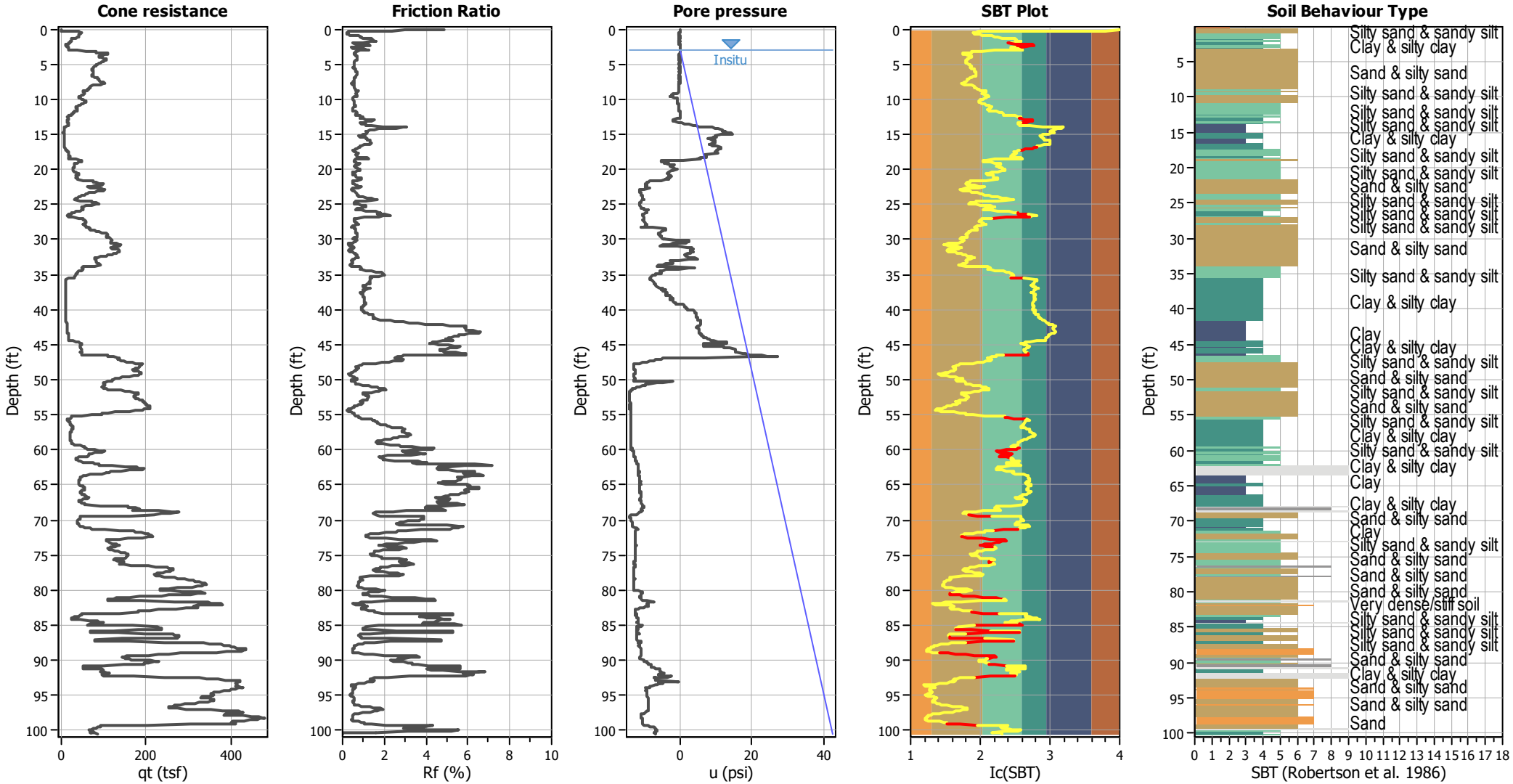






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



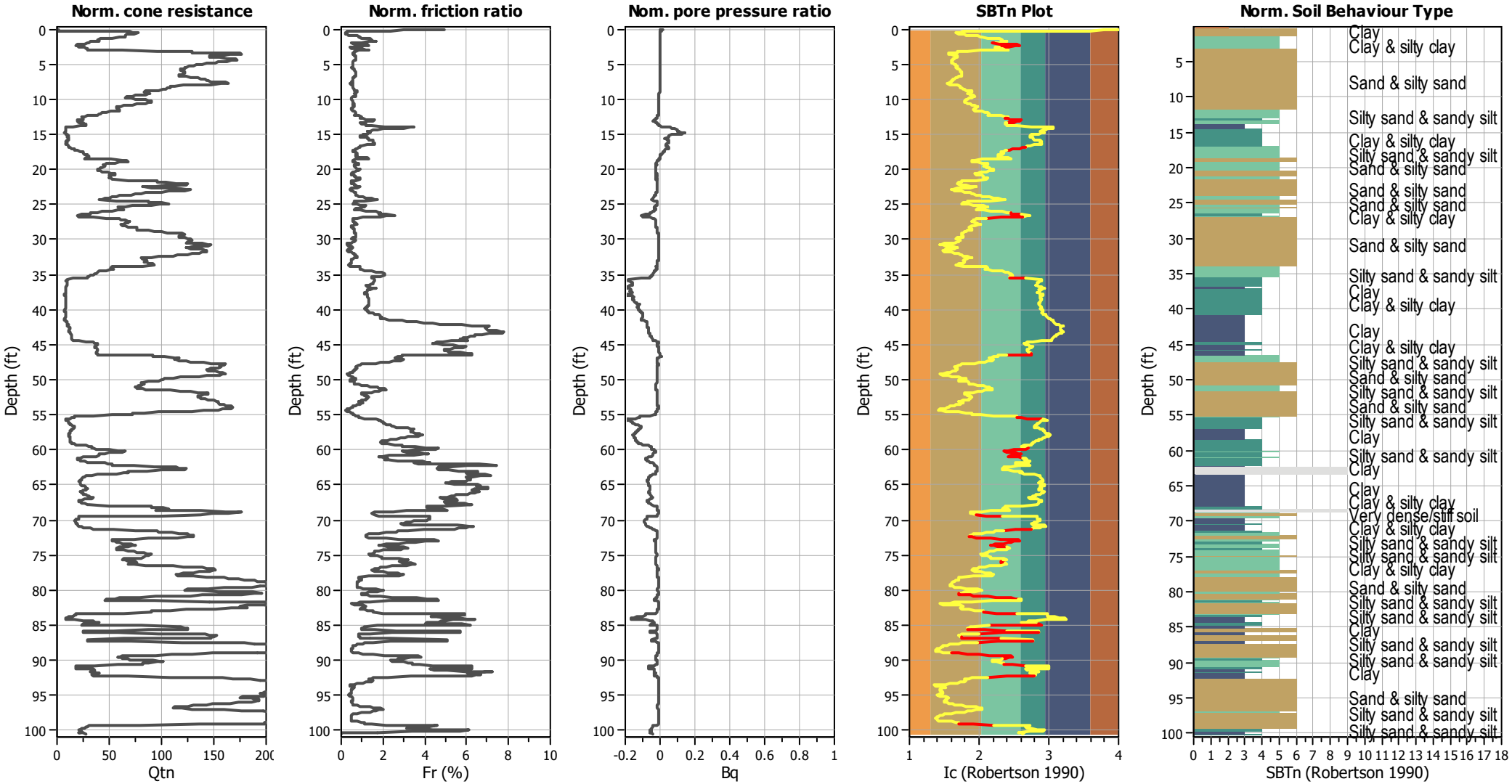
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 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)



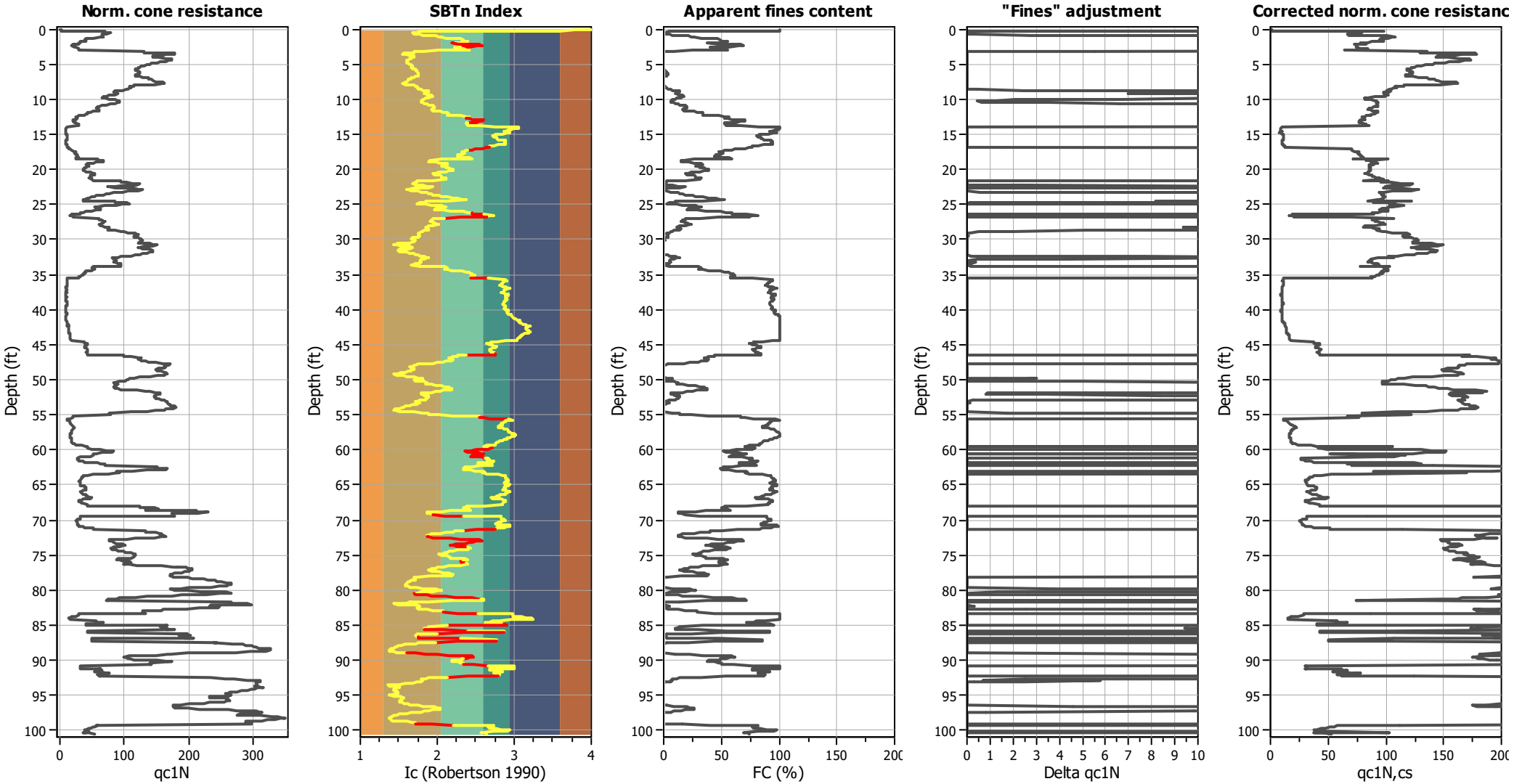
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 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

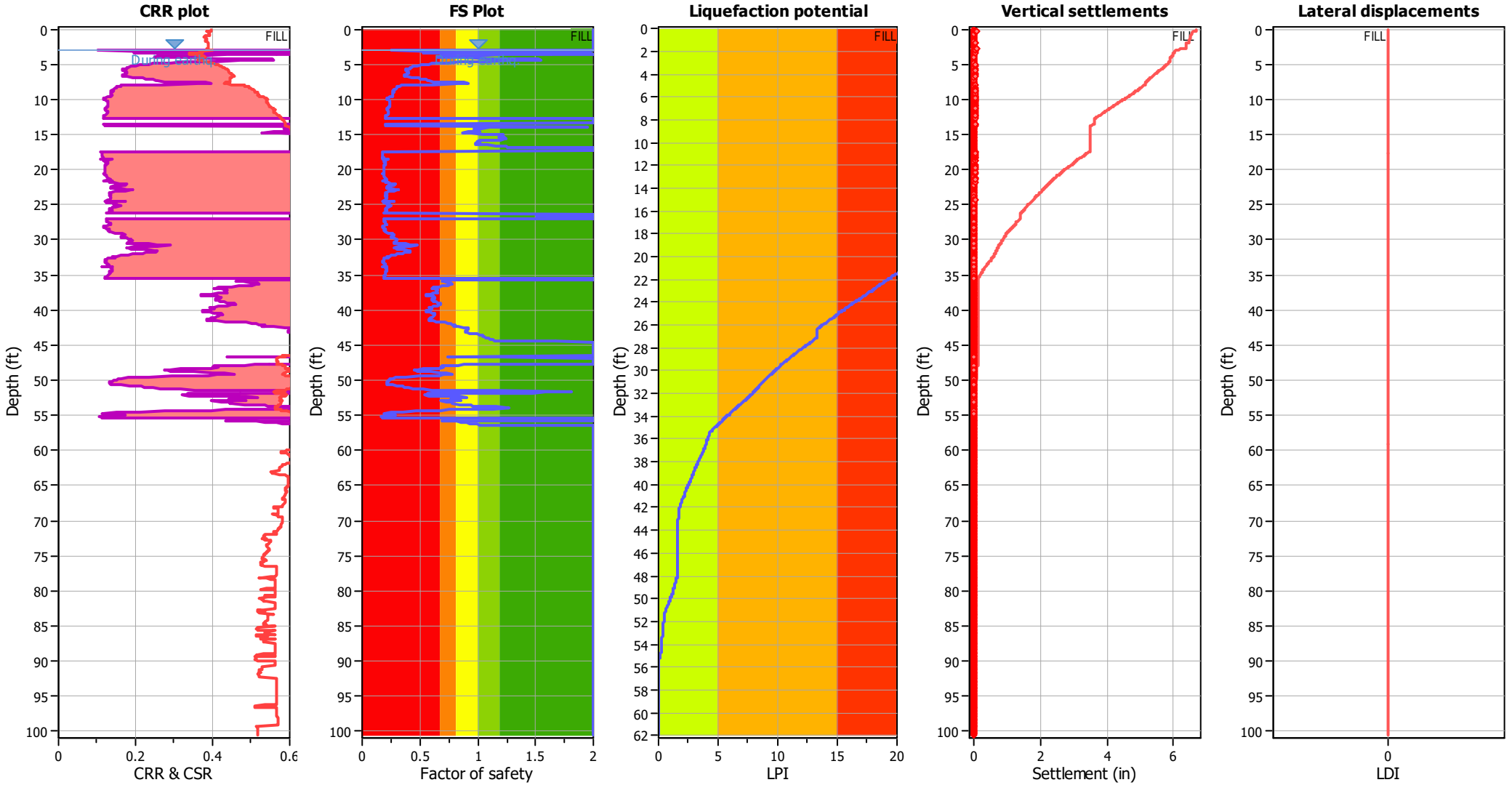
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 ft	Limit depth:	60.00 ft

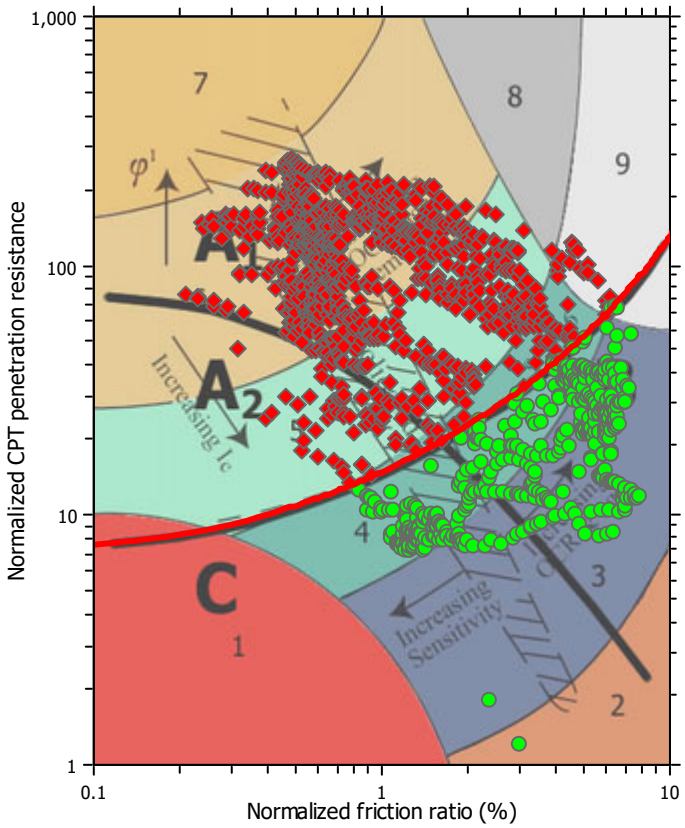
F.S. color scheme

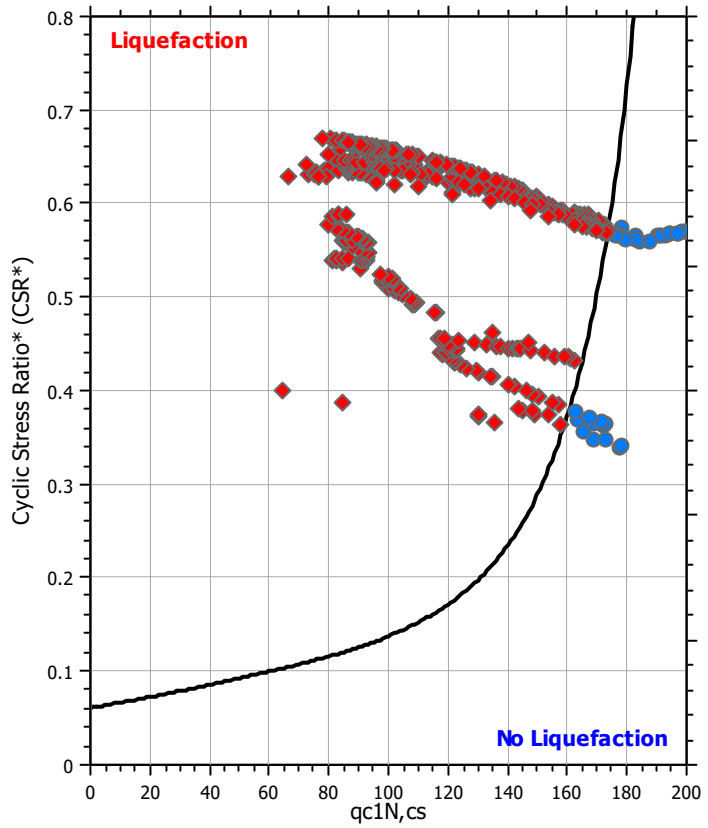
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

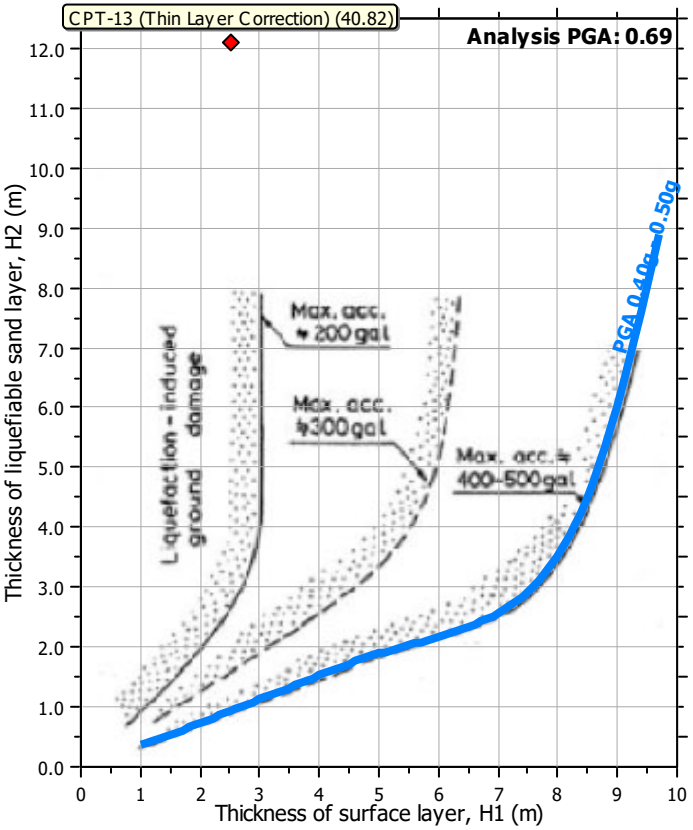
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



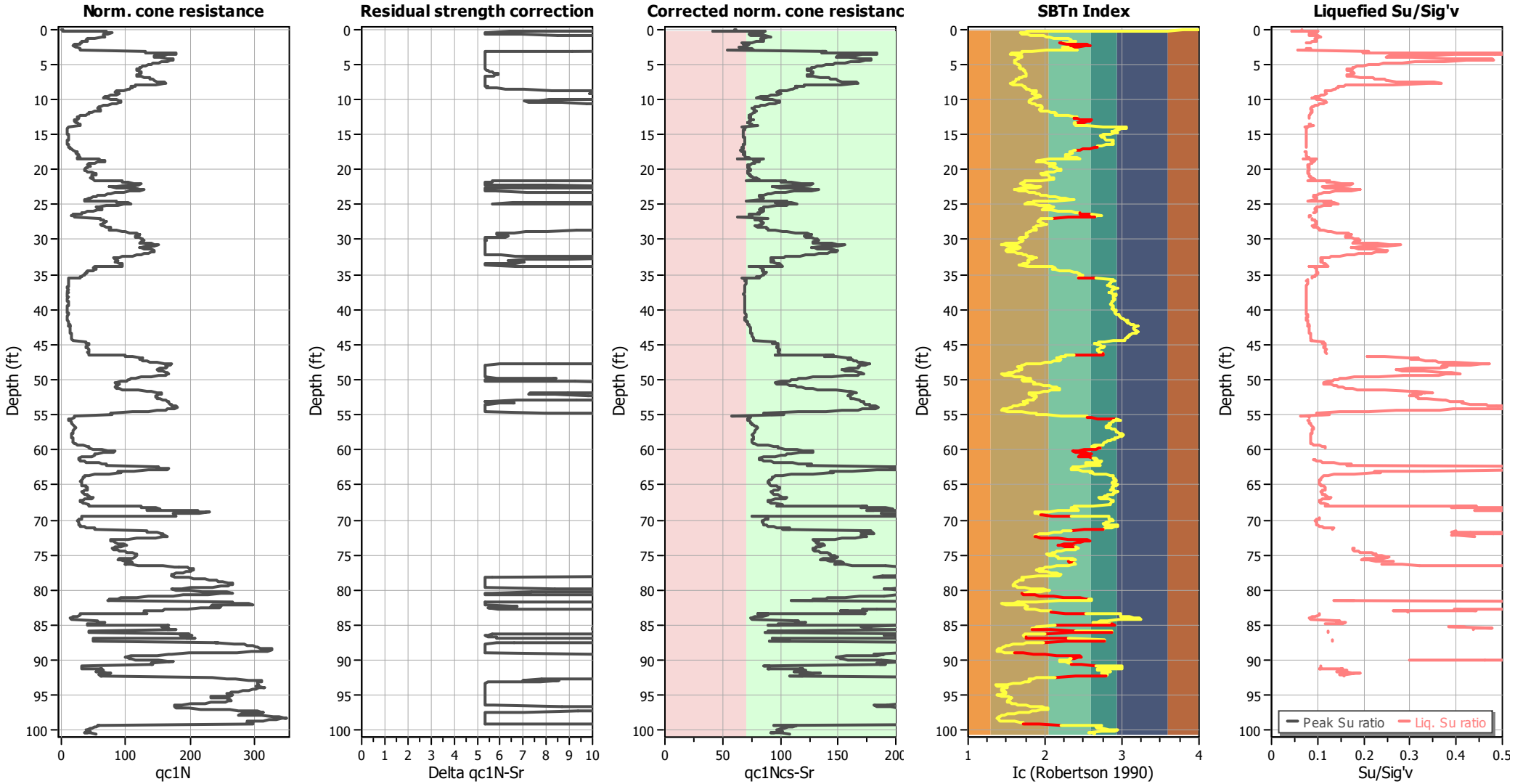




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

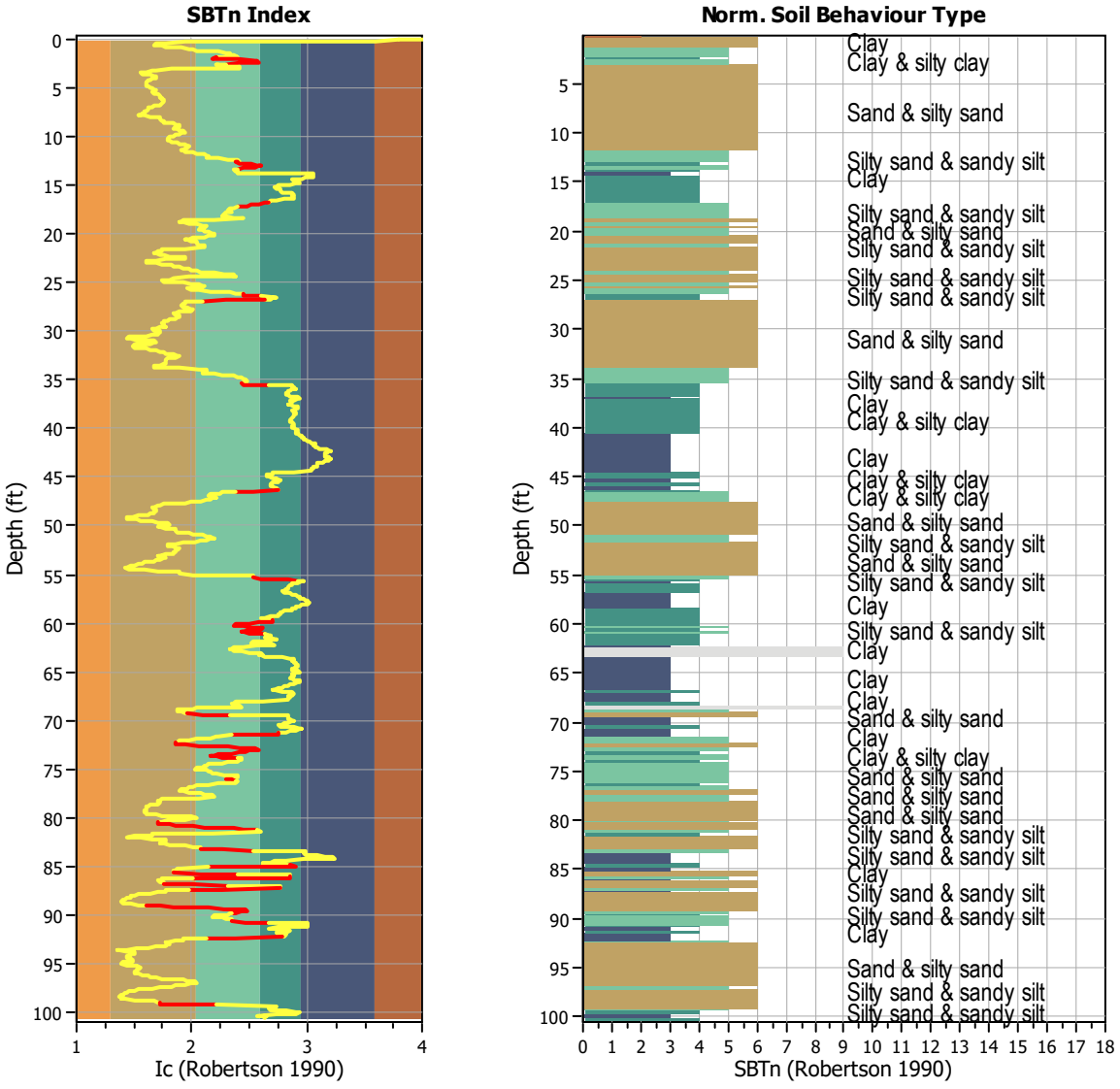
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.99 ft	Fill height:	3.63 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

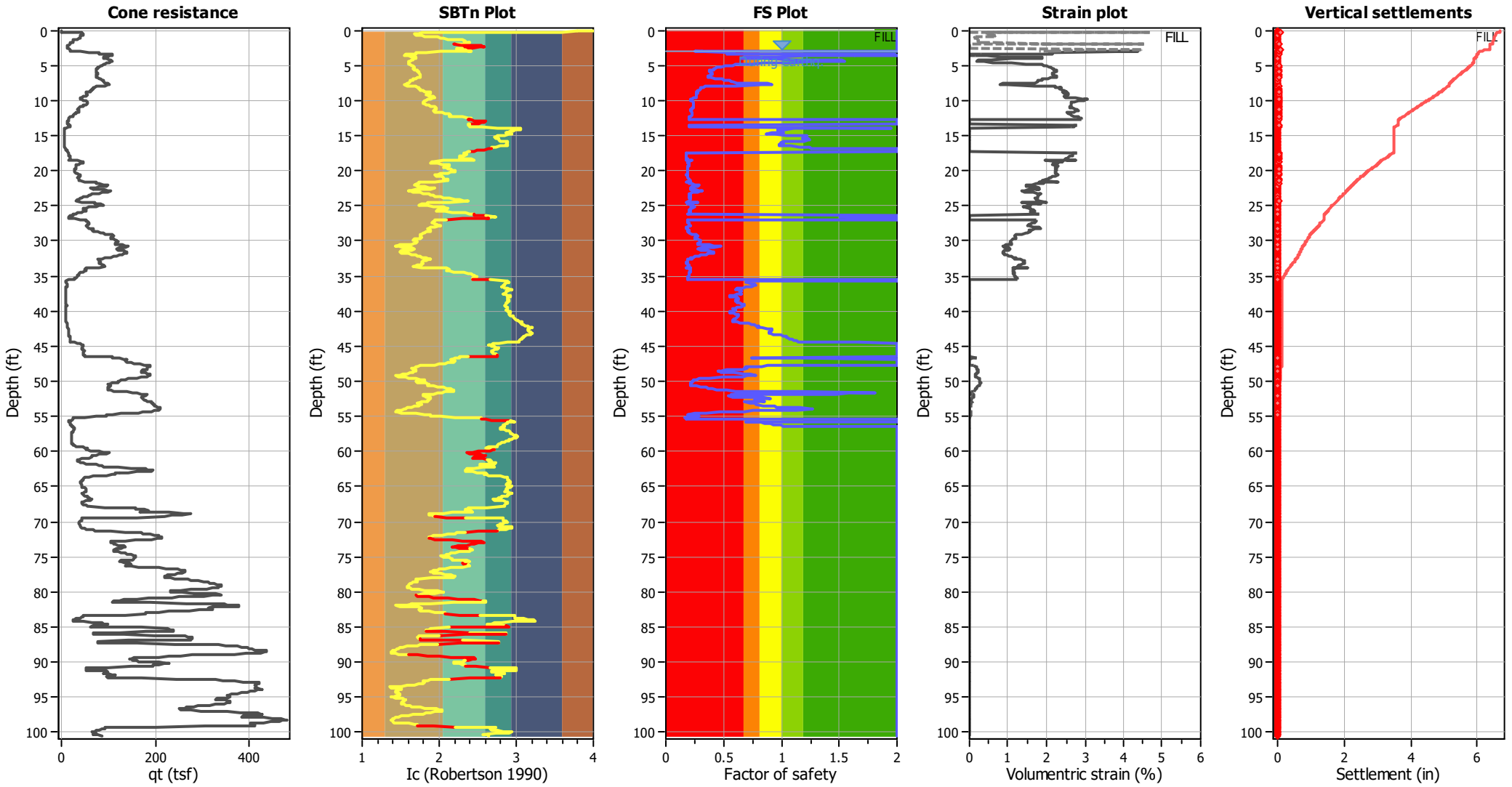
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1530
I_c maximum check value:	3.00	Total points excluded:	175
I_c change ratio value:	0.0250	Exclusion percentage:	11.44%
Minimum number of points in layer:	4	Number of layers detected:	32

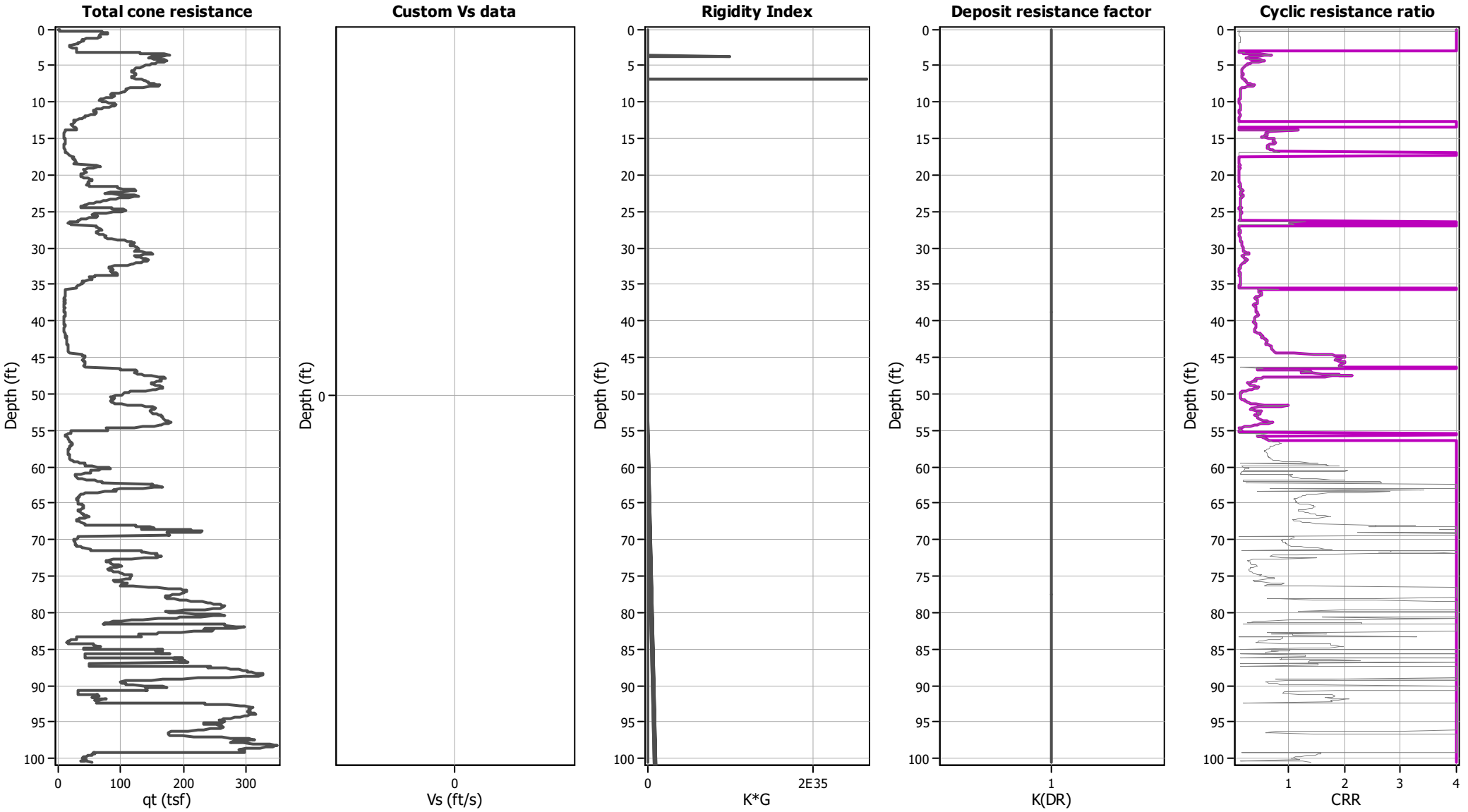
Estimation of post-earthquake settlements



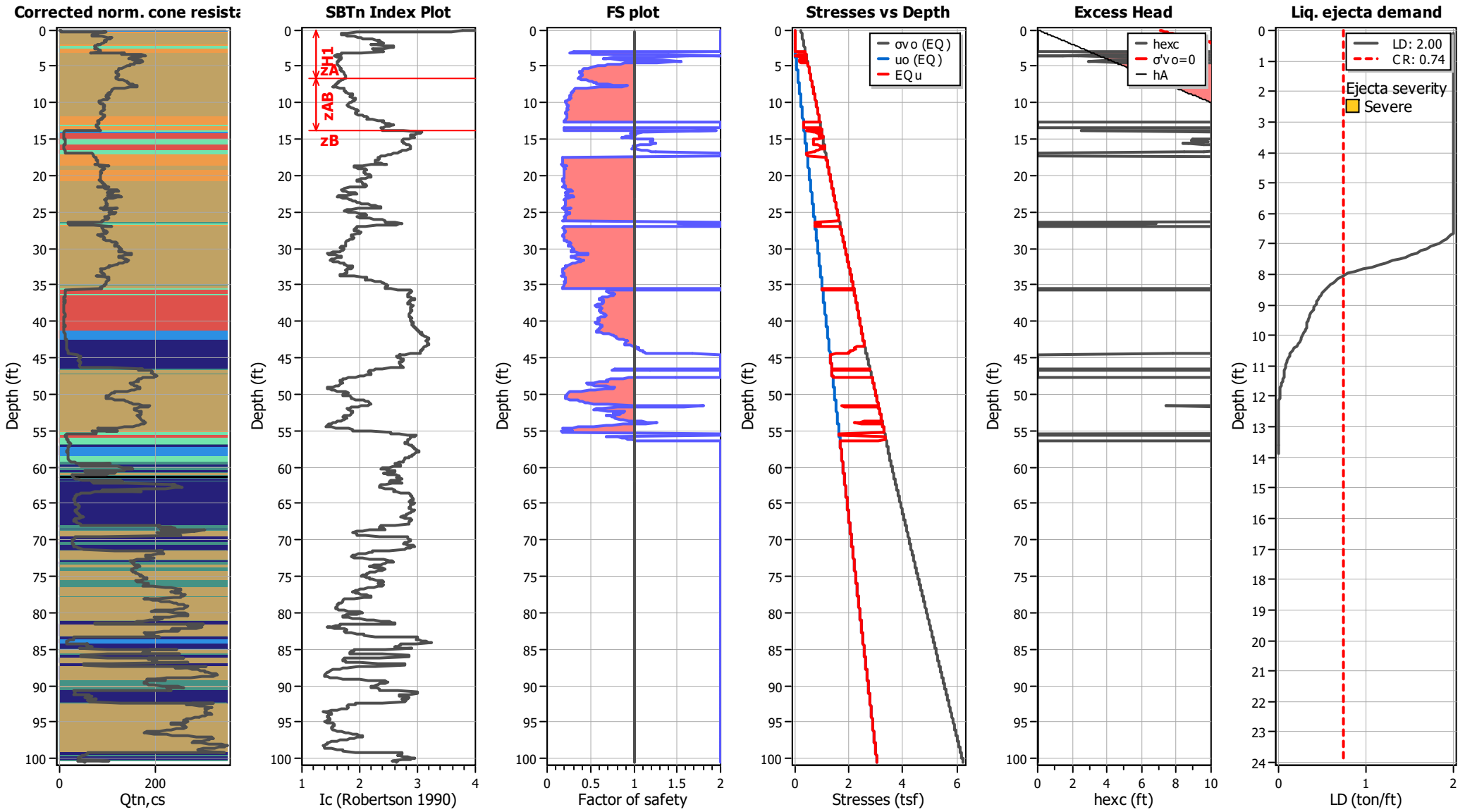
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

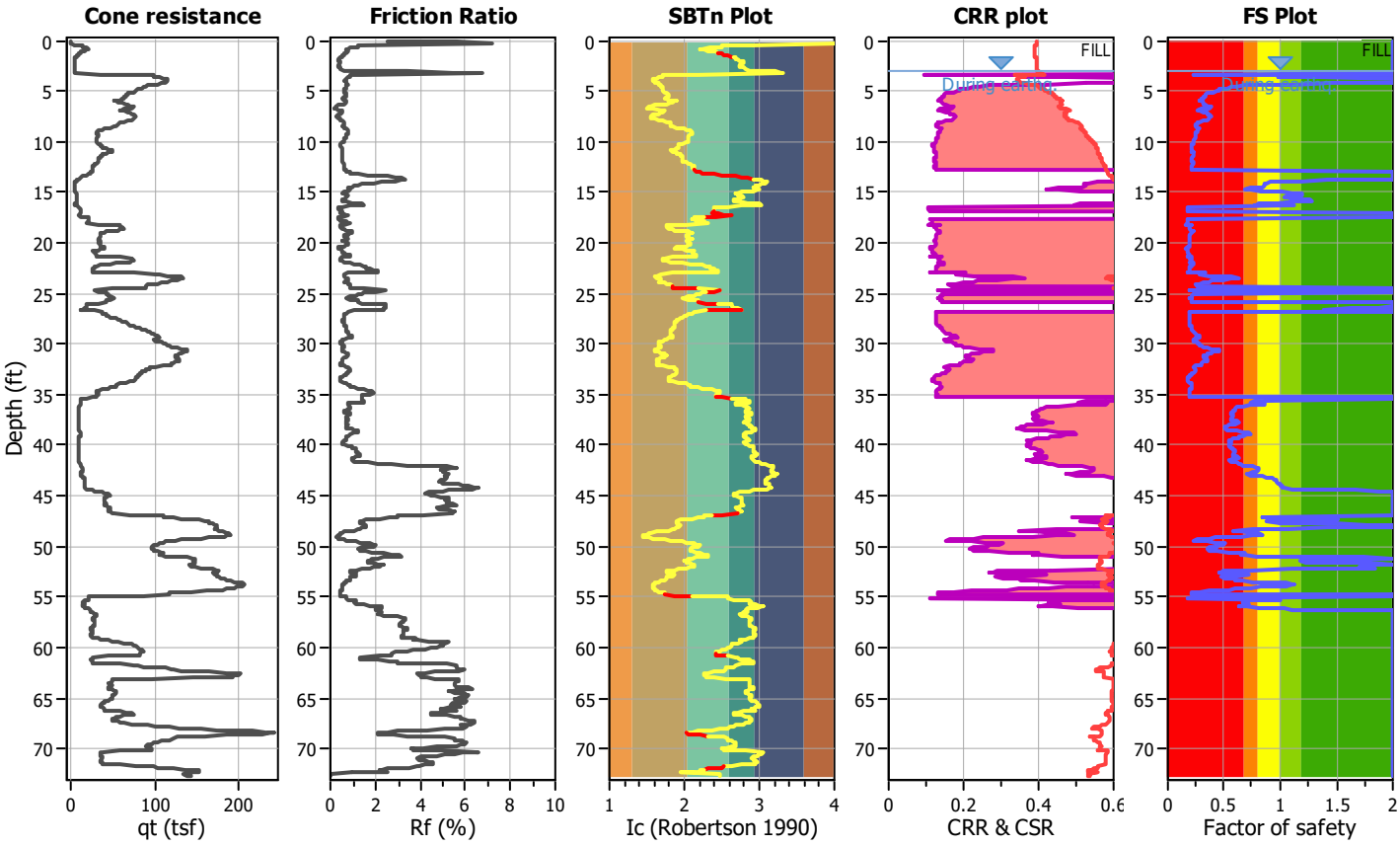
Project title : Topgolf Harbor Island

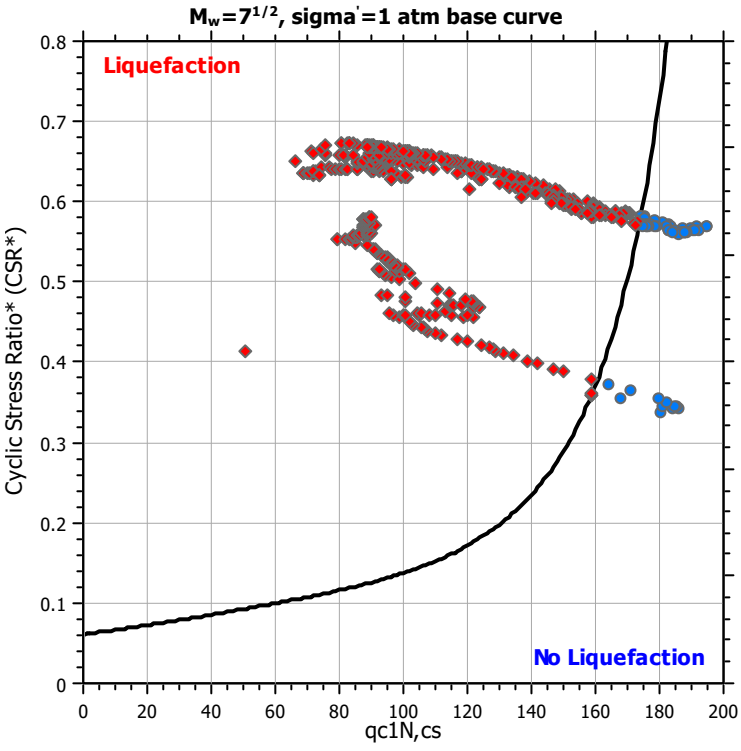
Location : North Harbor Drive and Liberator Way, San Diego, CA

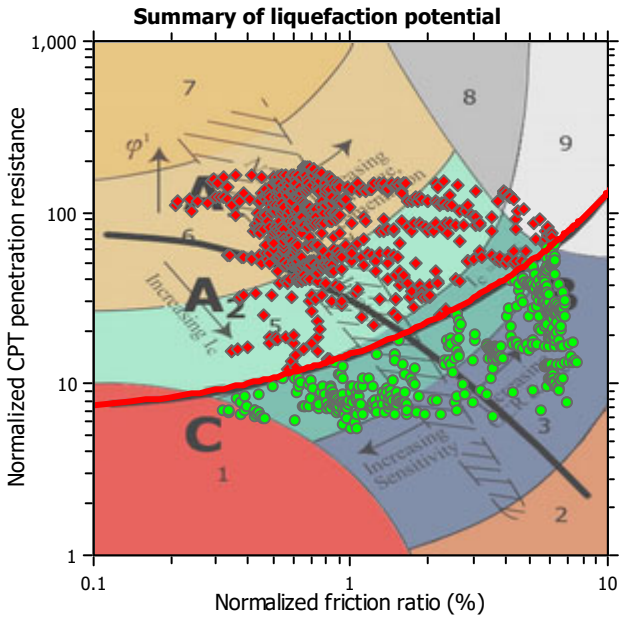
CPT file : CPT-14 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.97 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.65 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

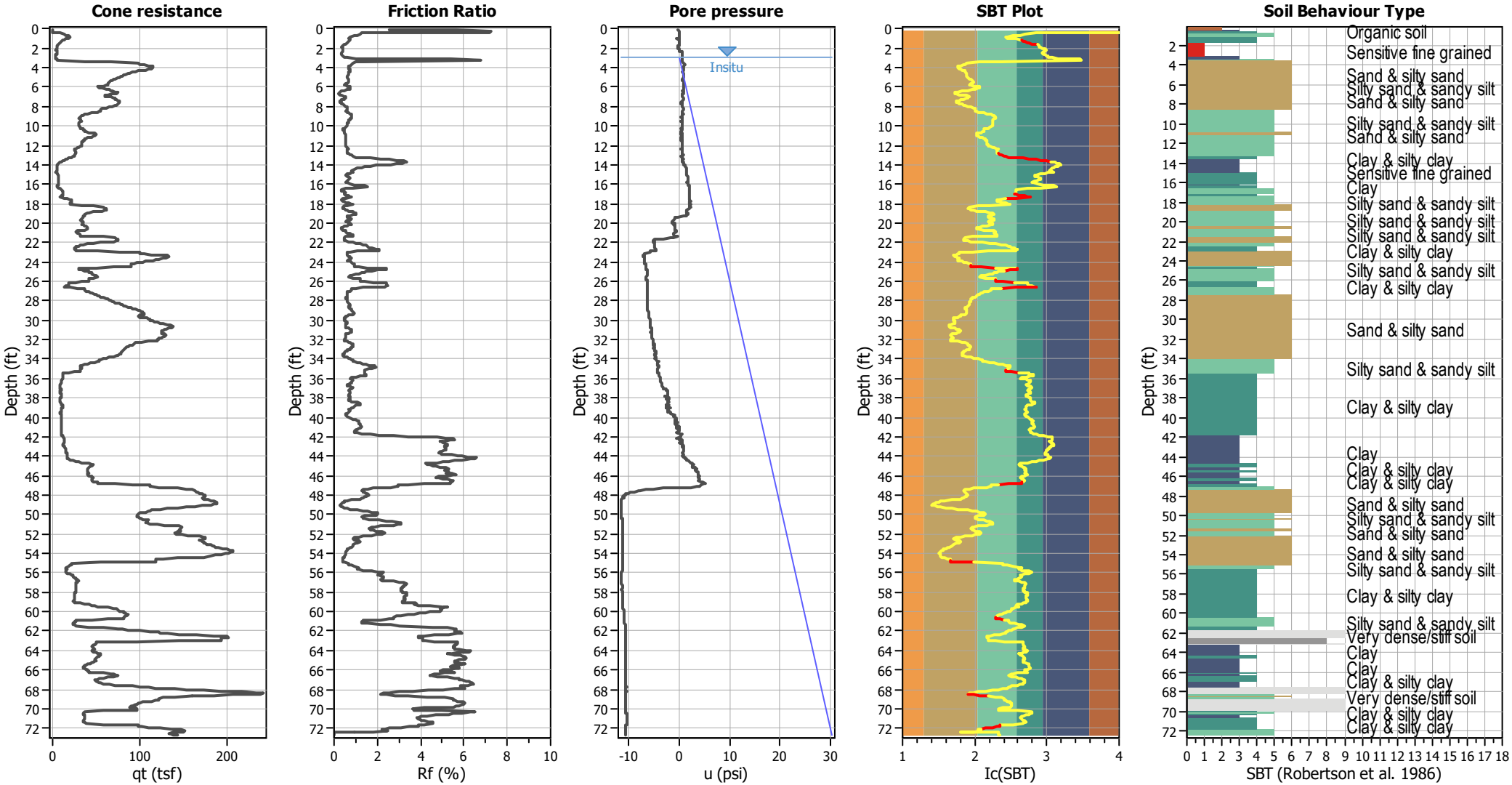






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



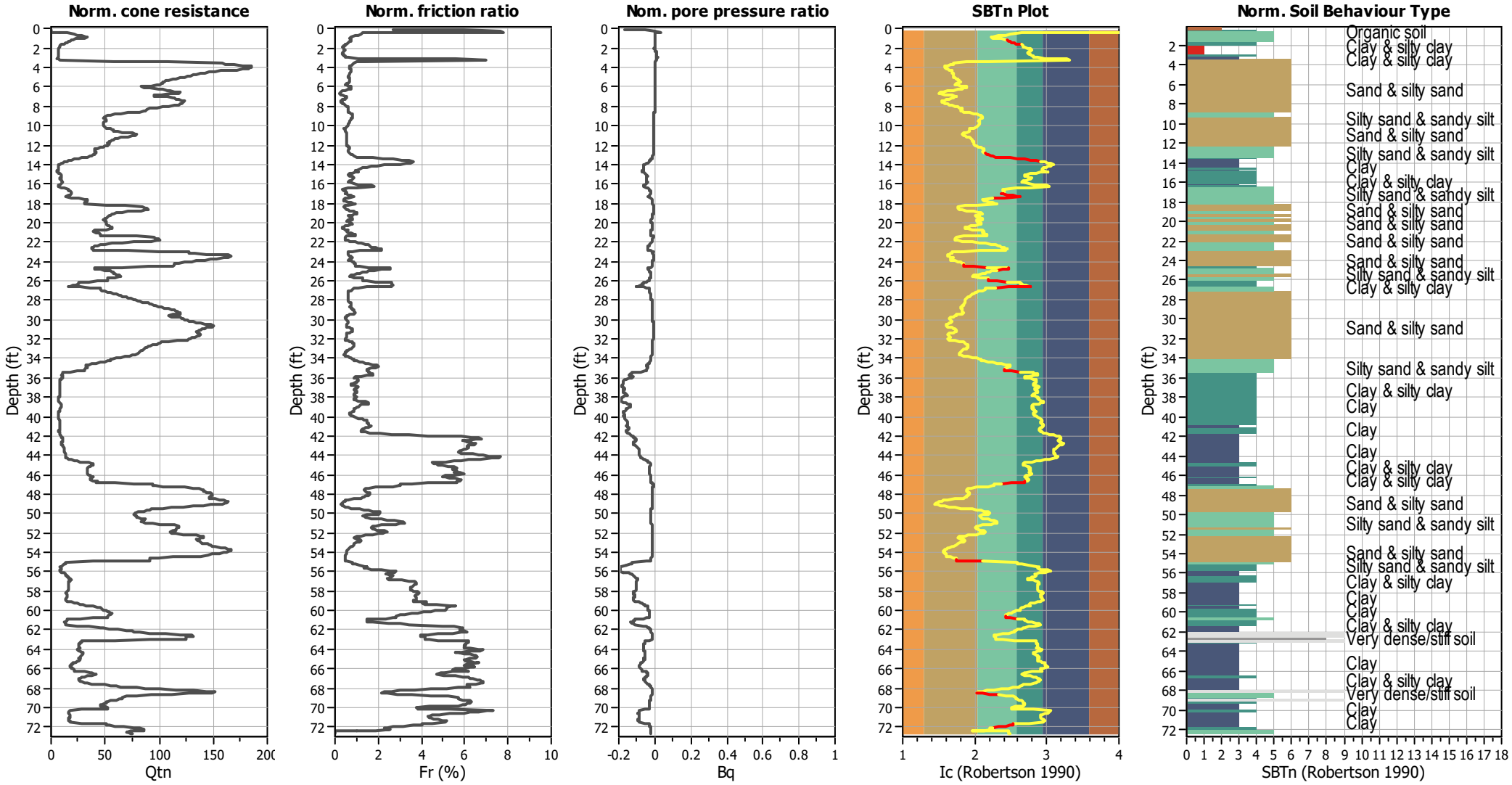
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 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)



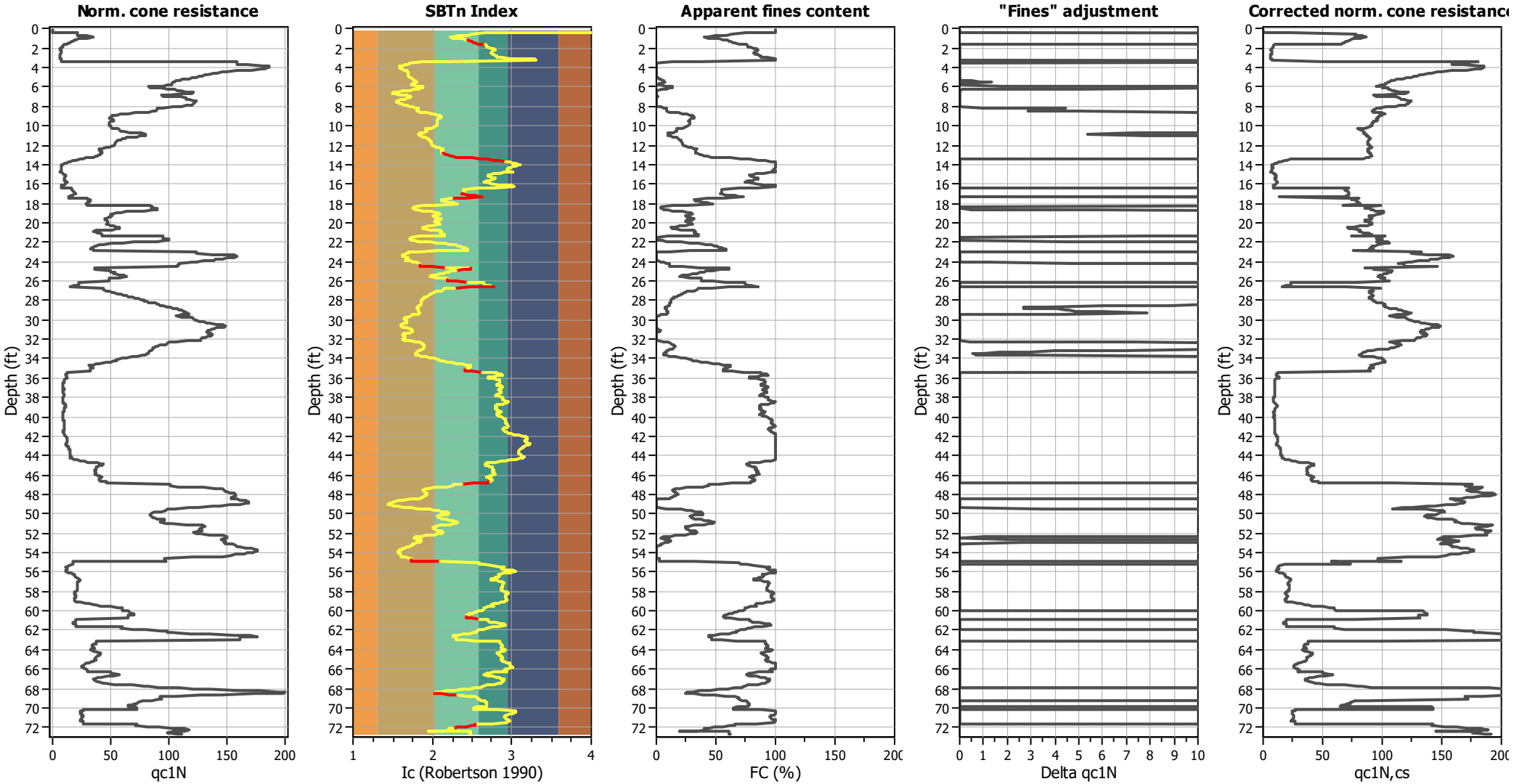
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 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

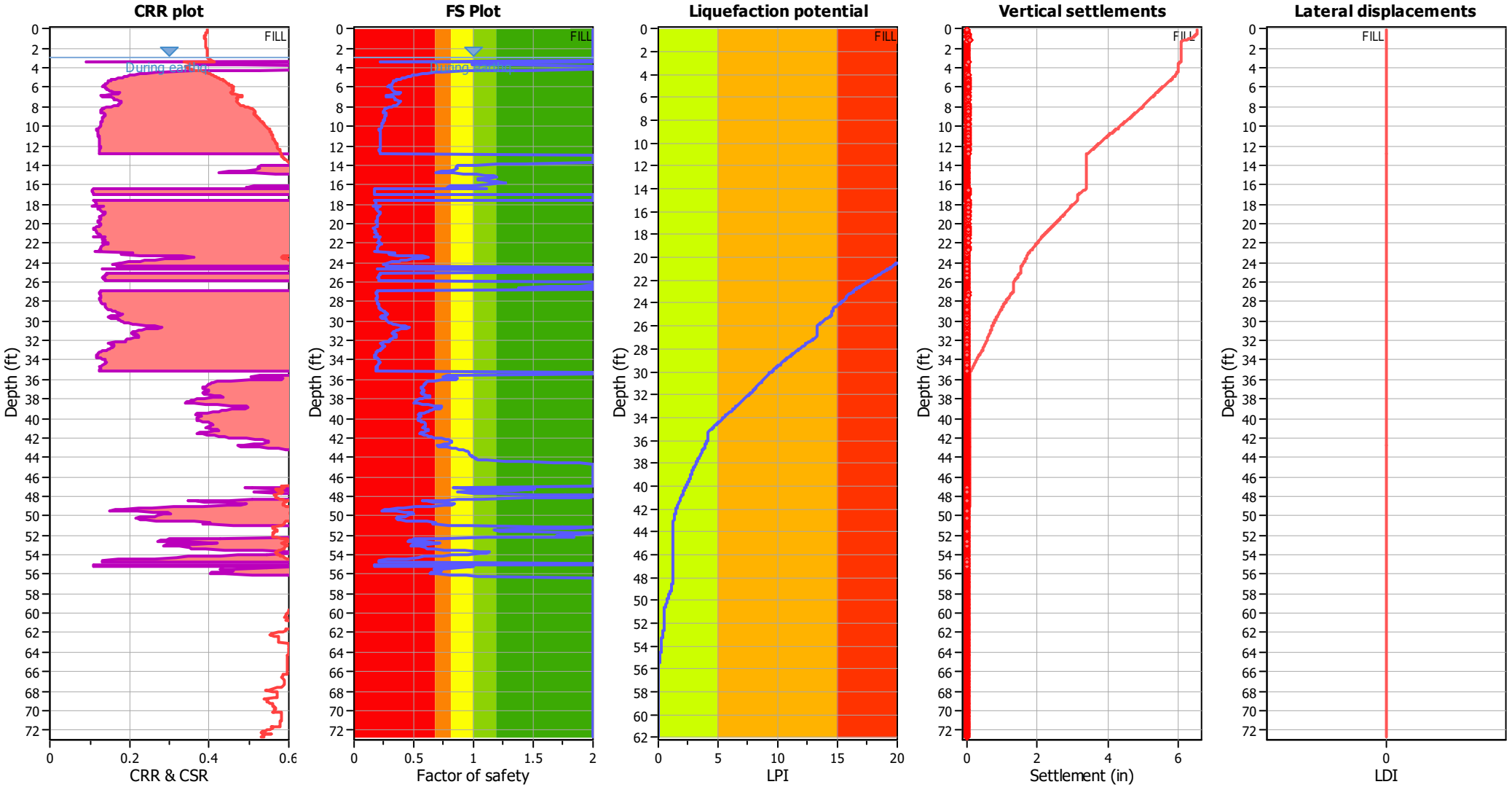
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 ft	Limit depth:	60.00 ft

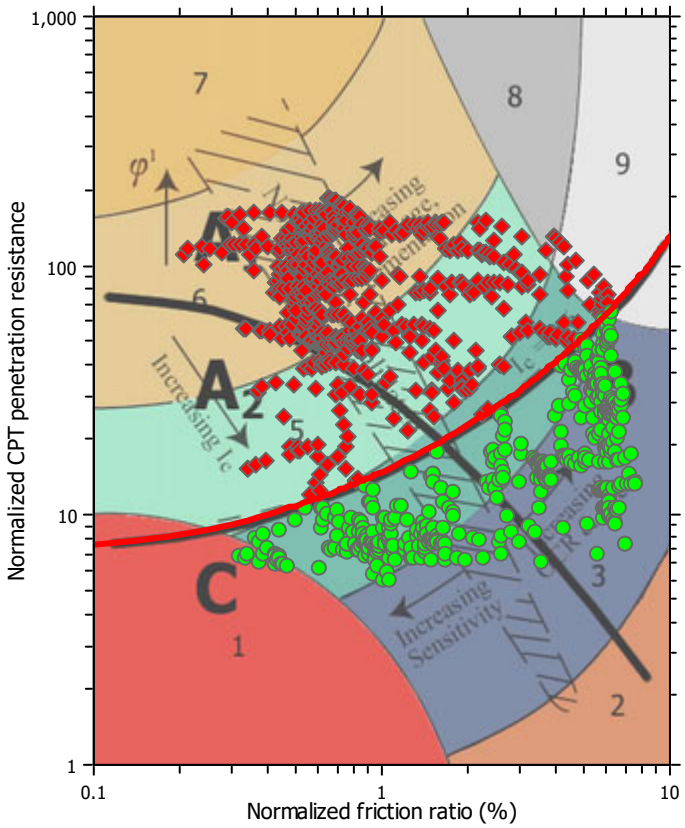
F.S. color scheme

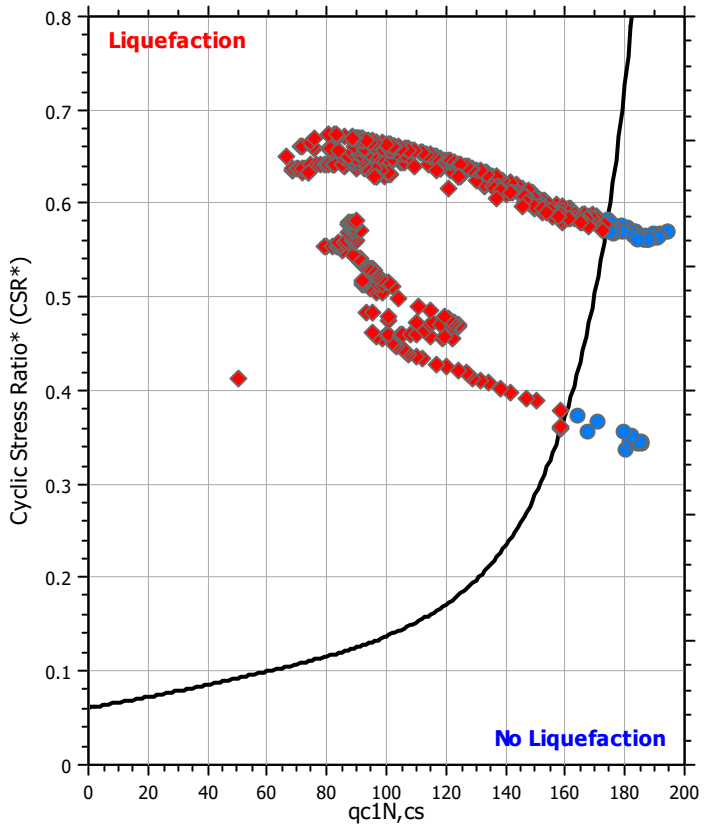
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

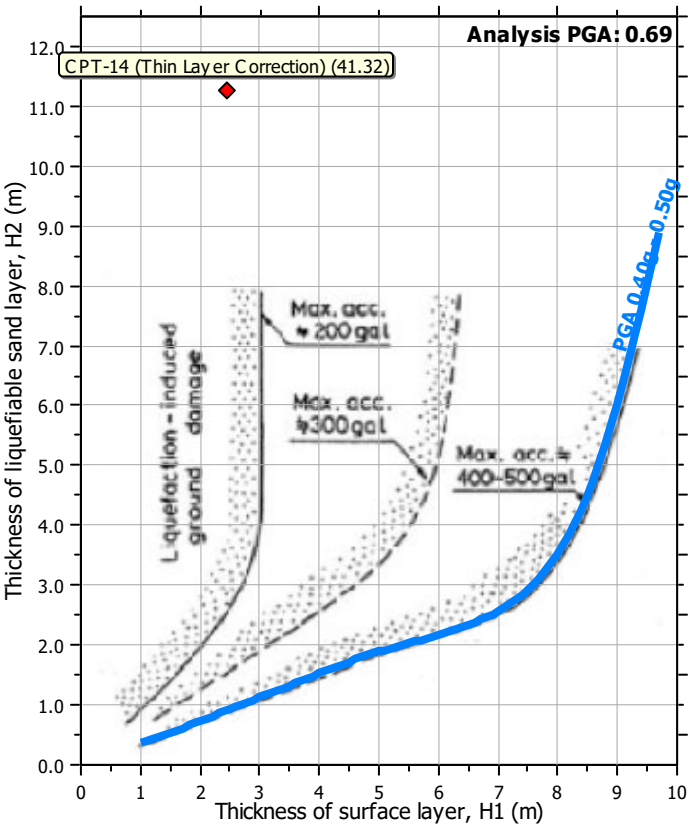
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



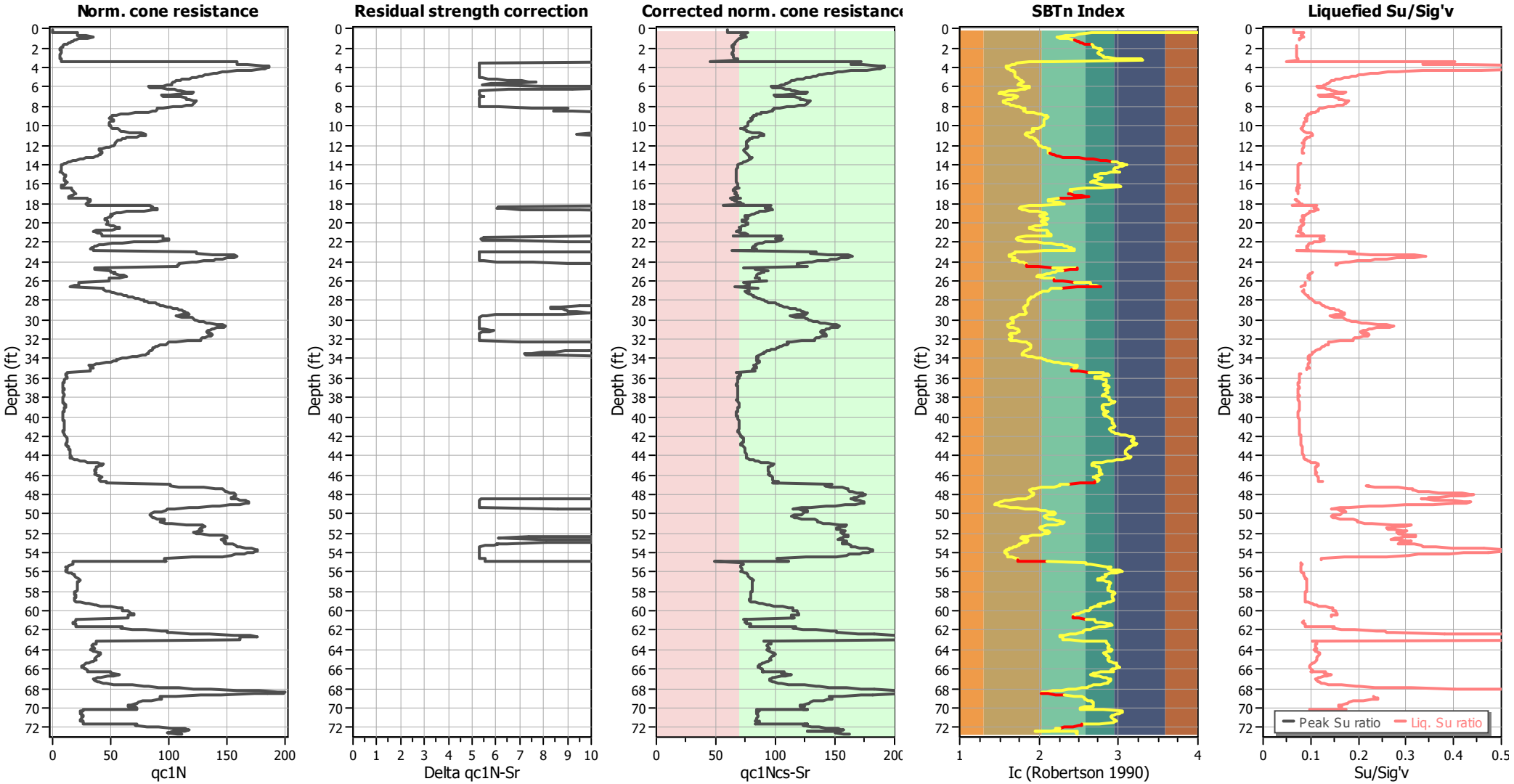




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

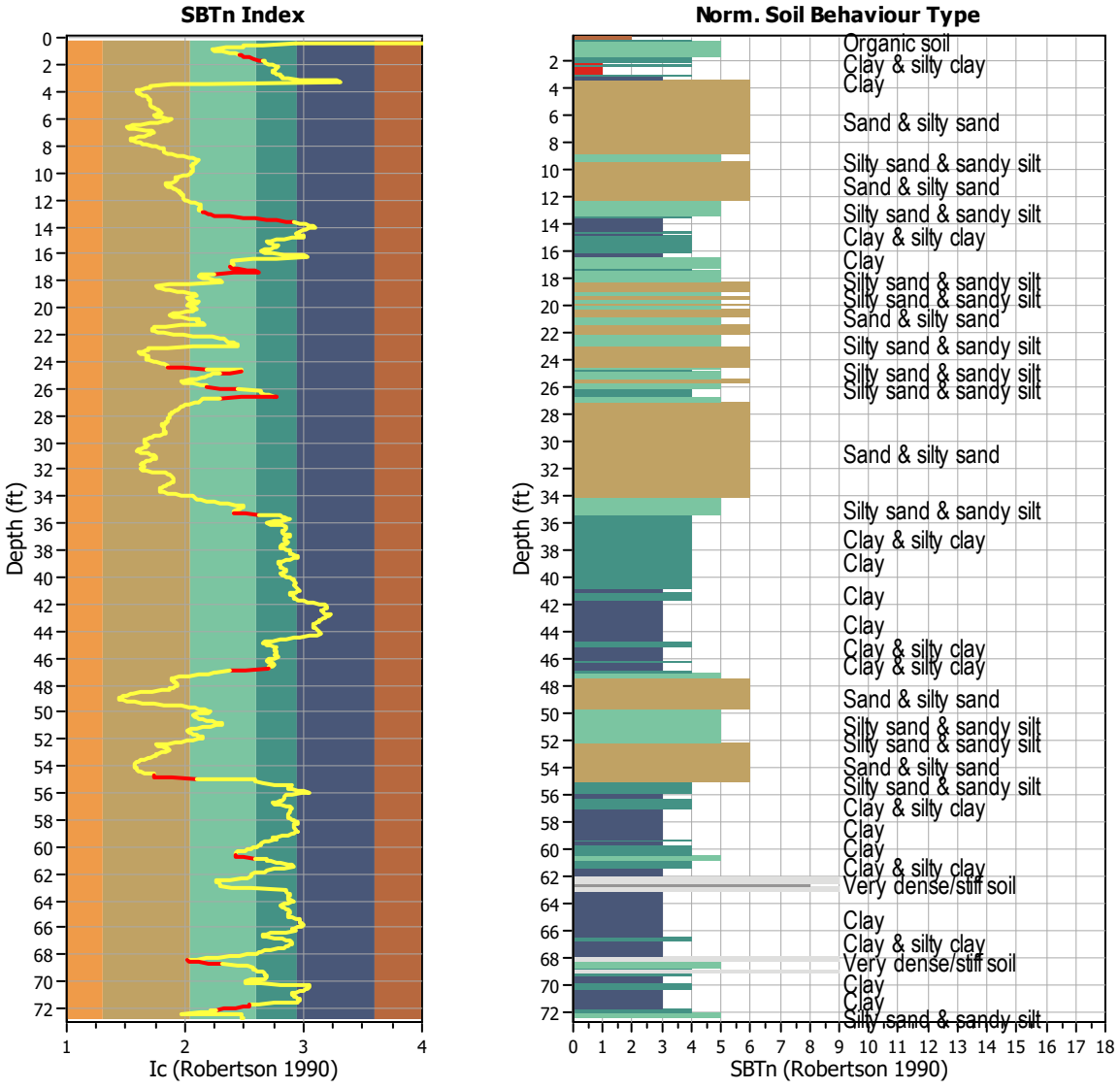
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.97 ft	Fill height:	3.65 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

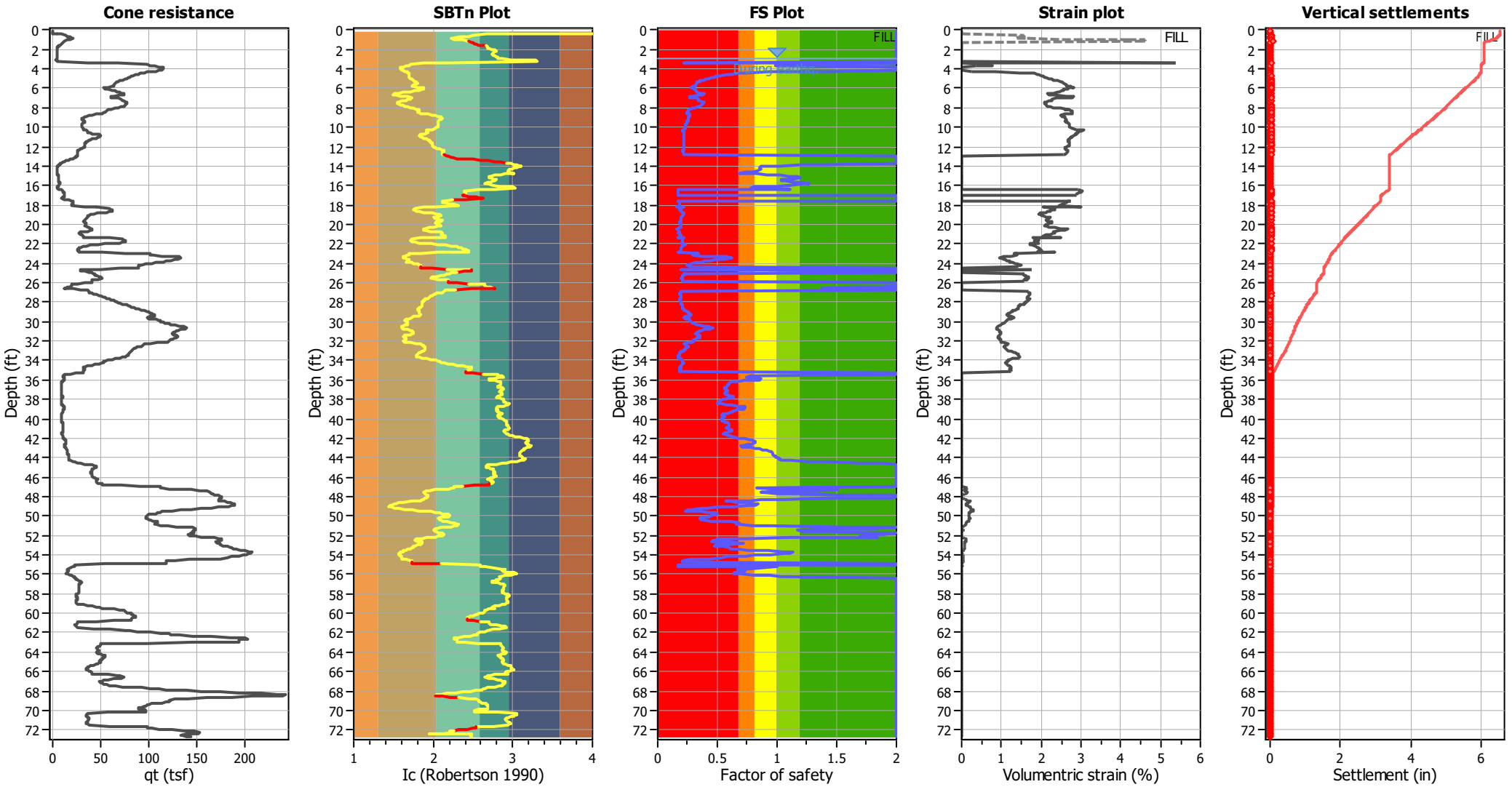
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1107
I_c maximum check value:	3.00	Total points excluded:	74
I_c change ratio value:	0.0250	Exclusion percentage:	6.68%
Minimum number of points in layer:	4	Number of layers detected:	14

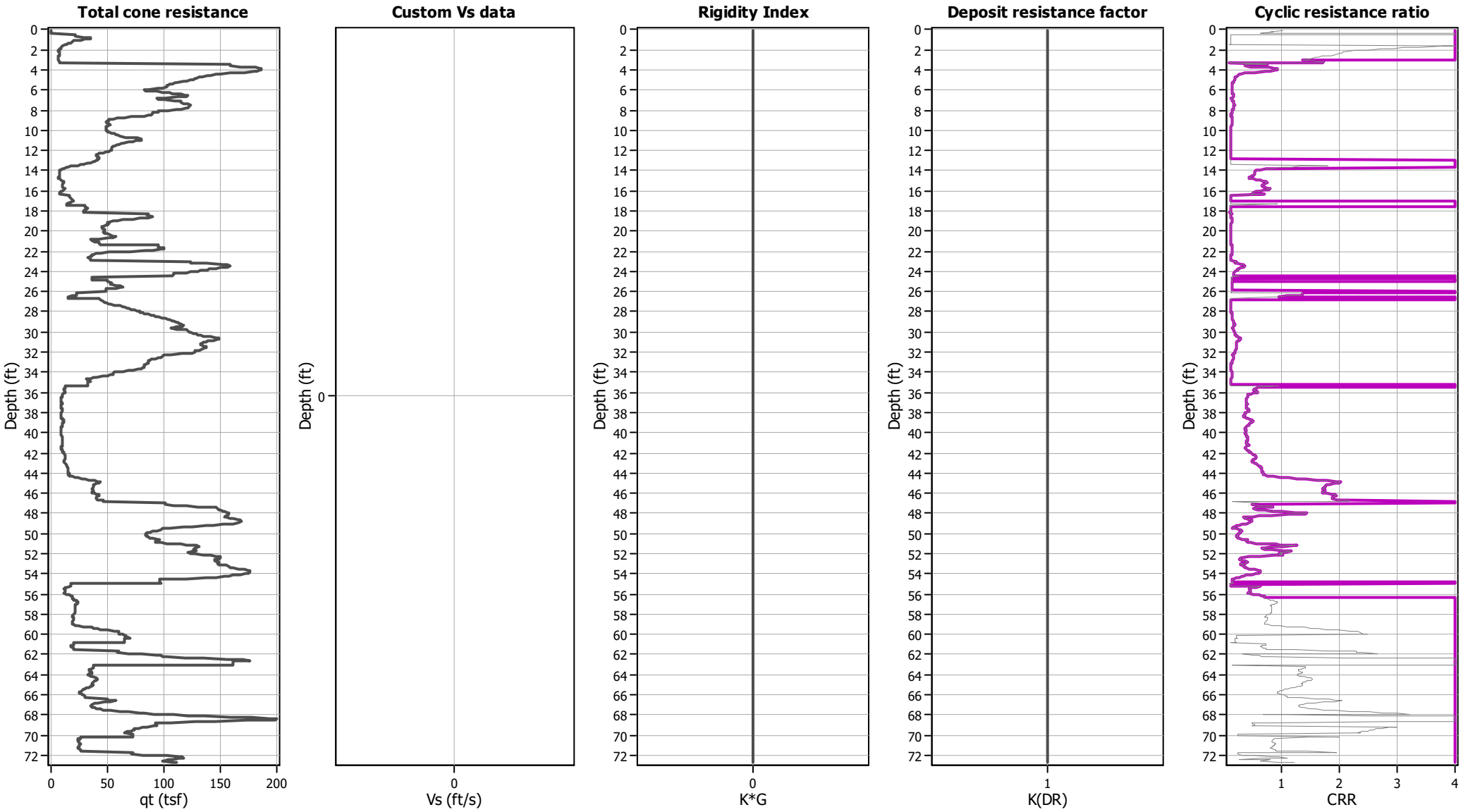
Estimation of post-earthquake settlements



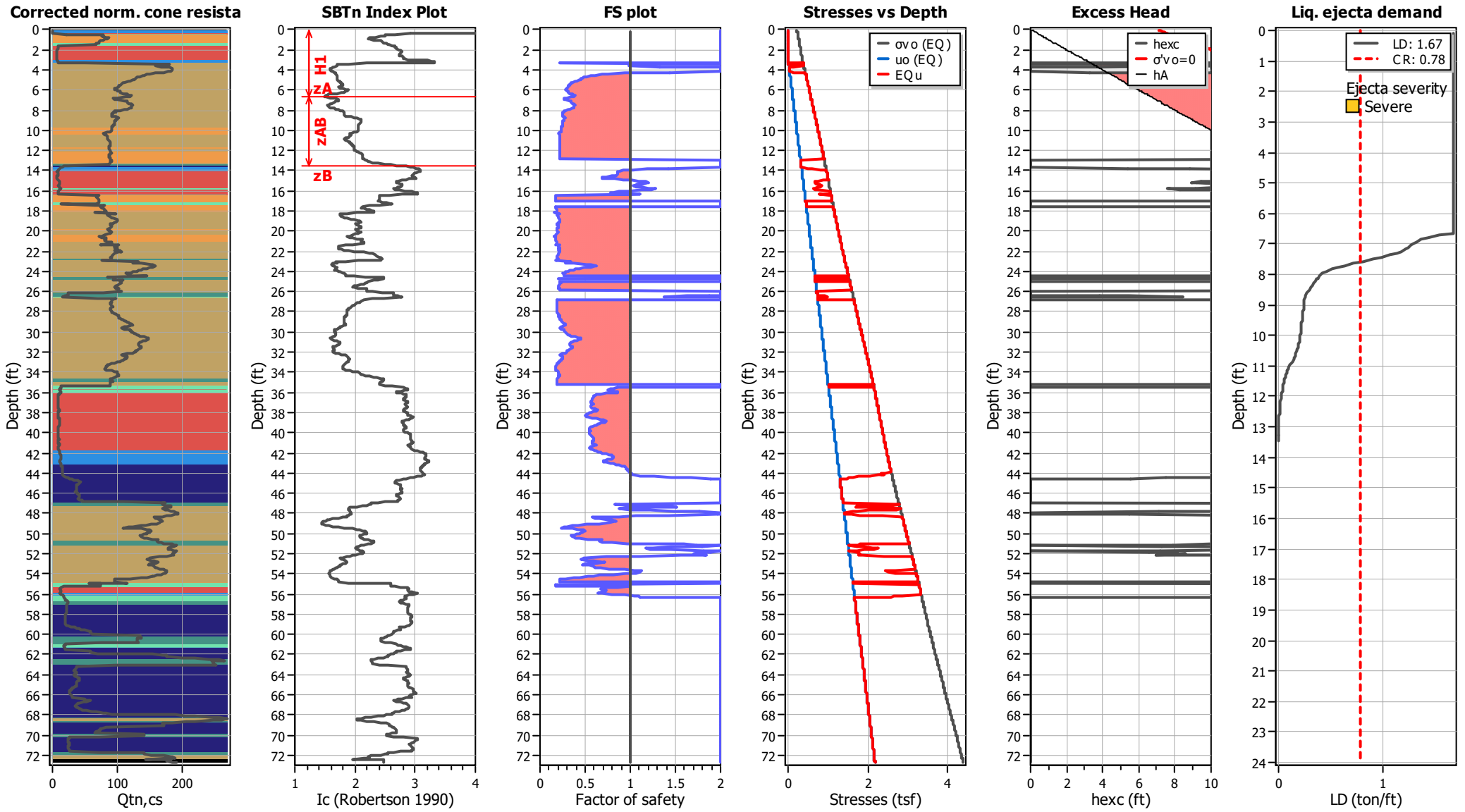
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

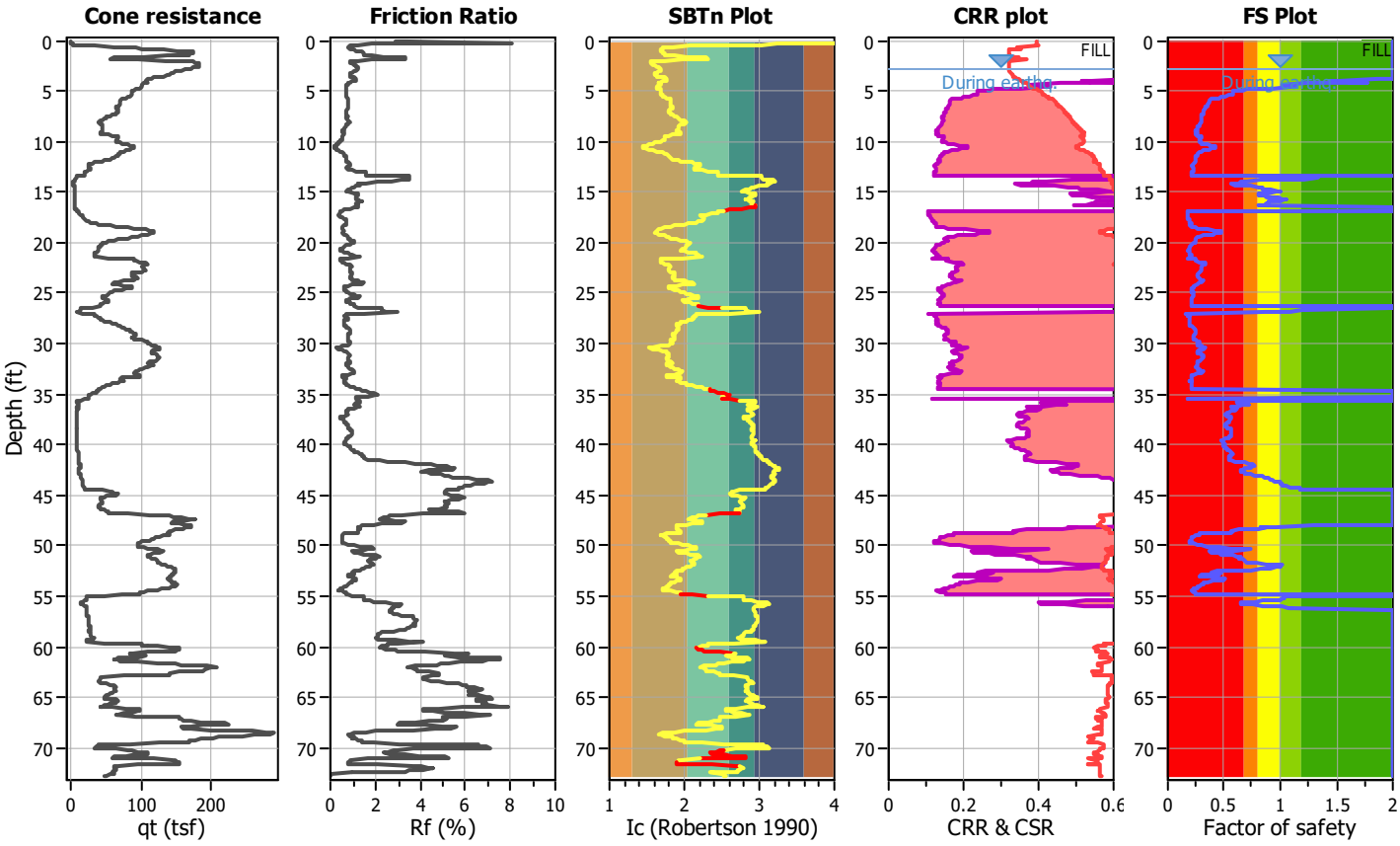
Project title : Topgolf Harbor Island

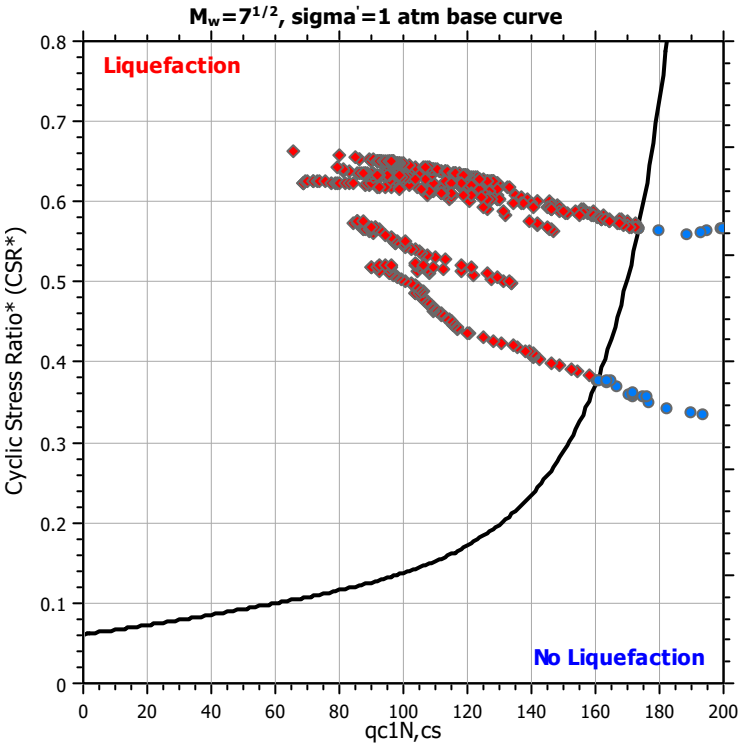
Location : North Harbor Drive and Liberator Way, San Diego, CA

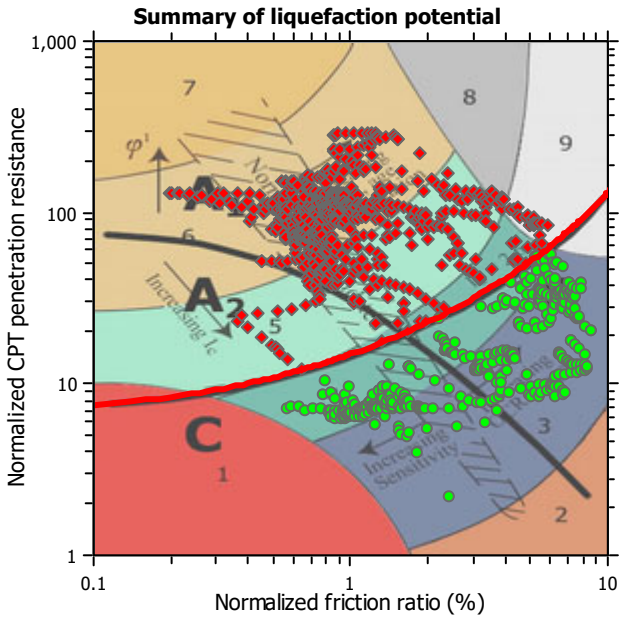
CPT file : CPT-15 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.89 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.73 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

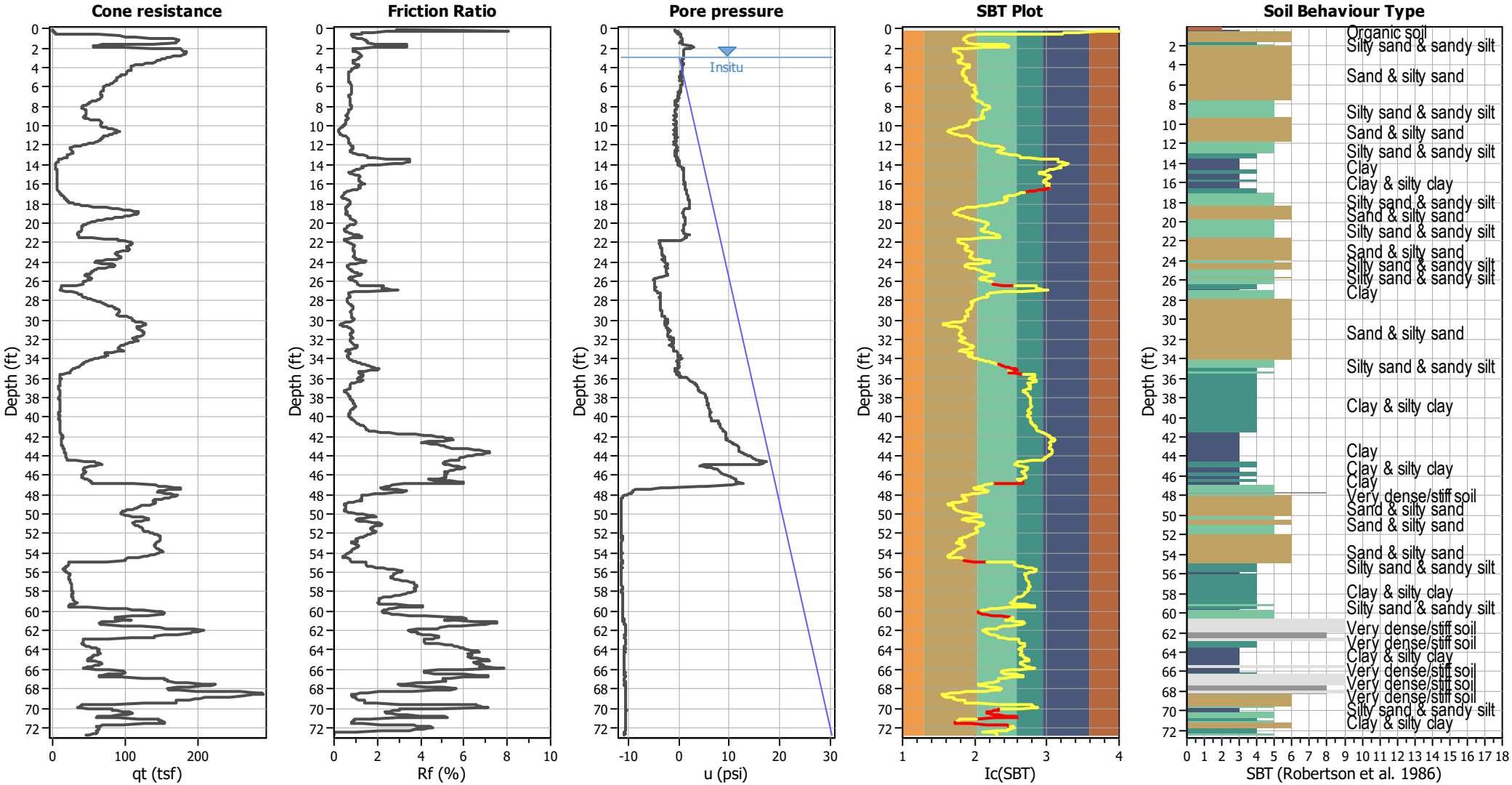






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



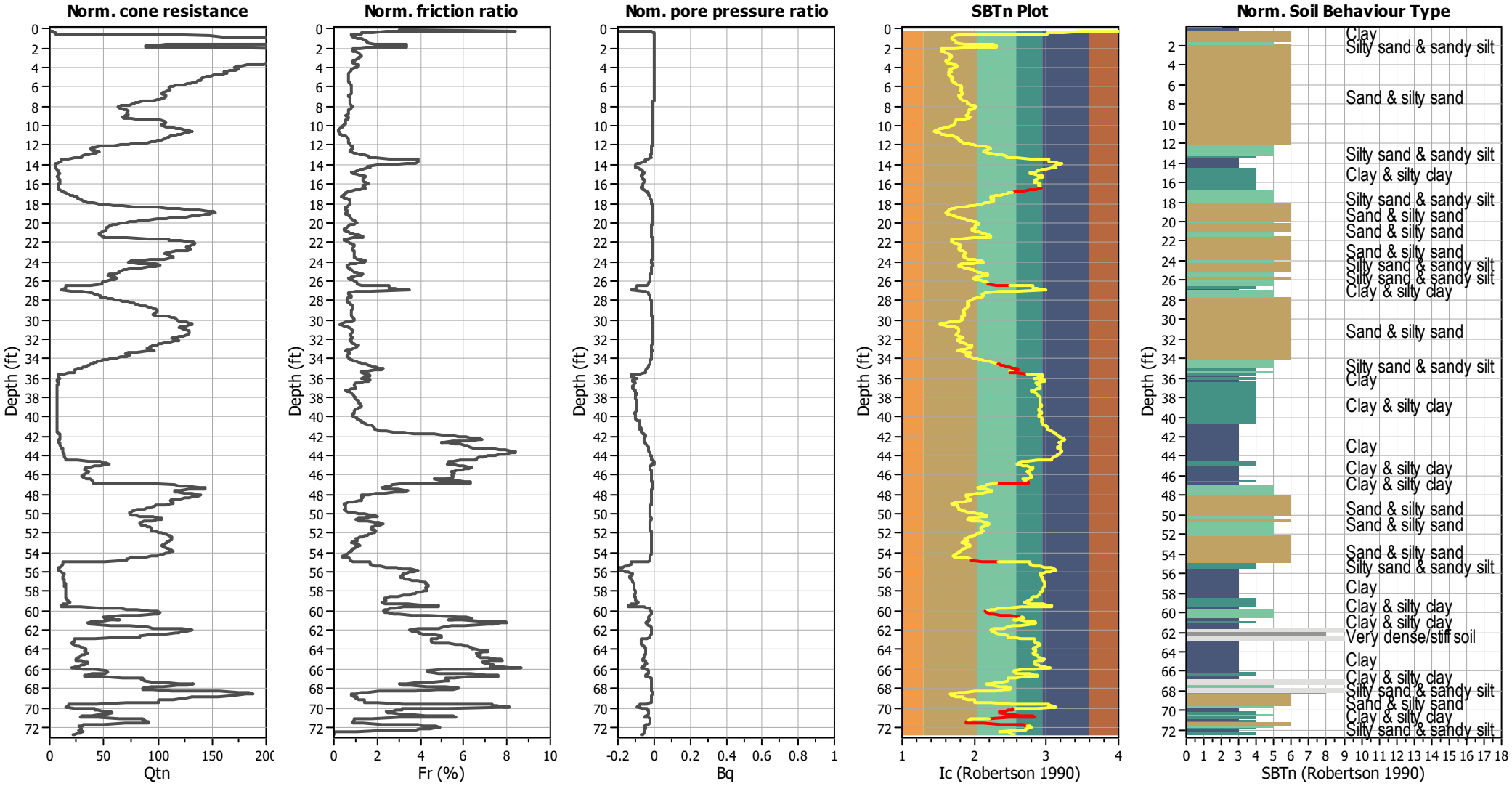
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 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)



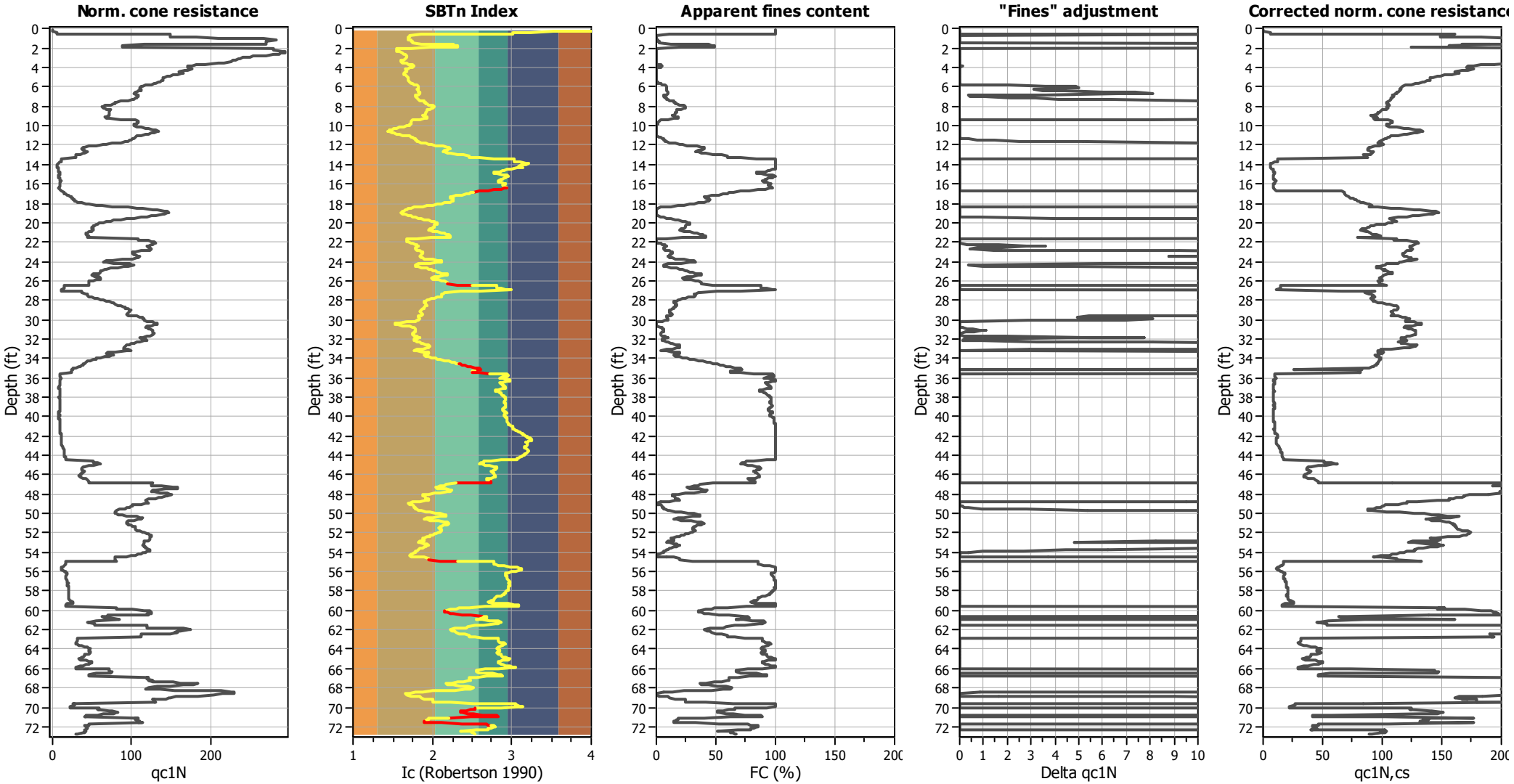
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 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

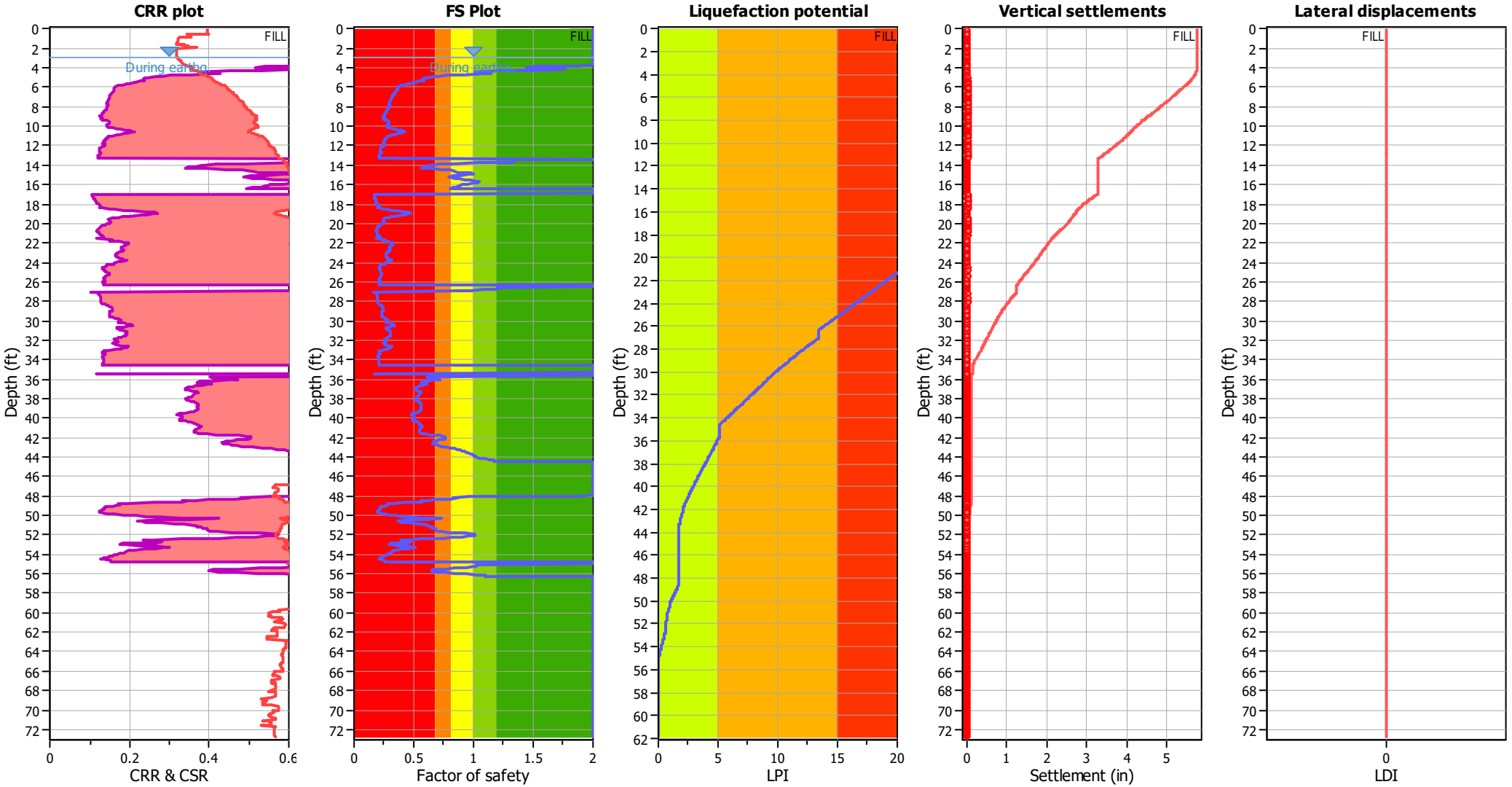
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 ft	Limit depth:	60.00 ft

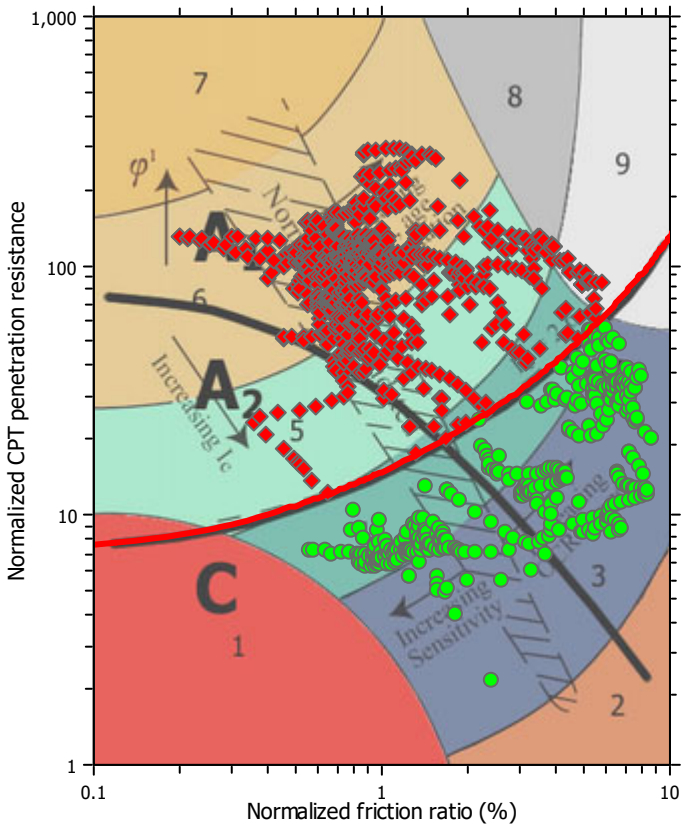
F.S. color scheme

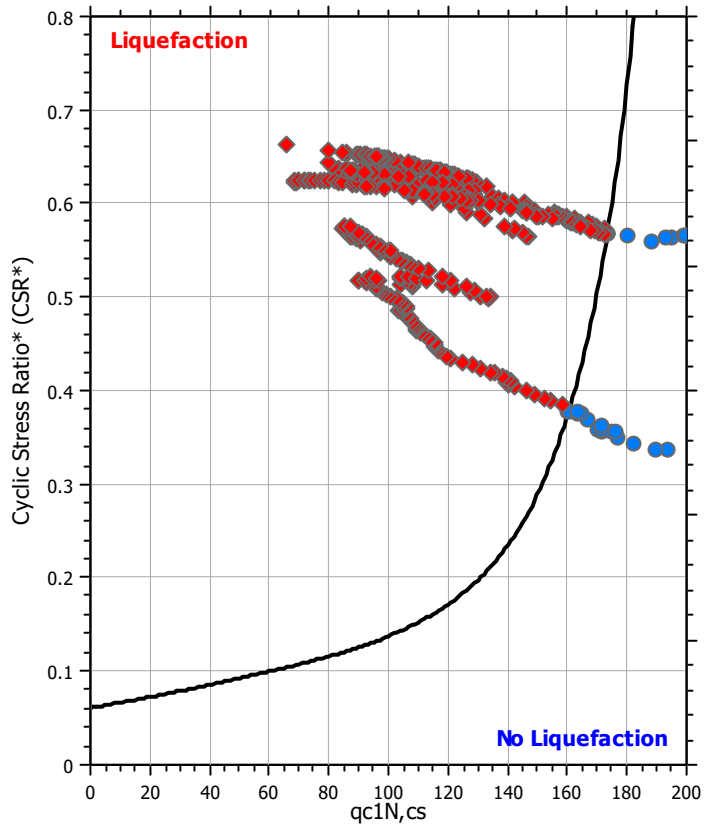
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

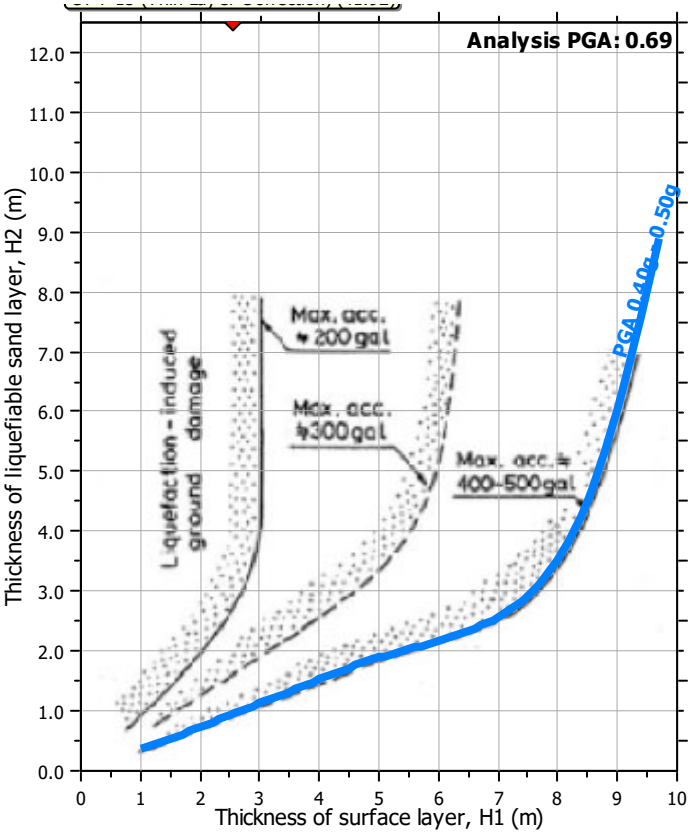
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



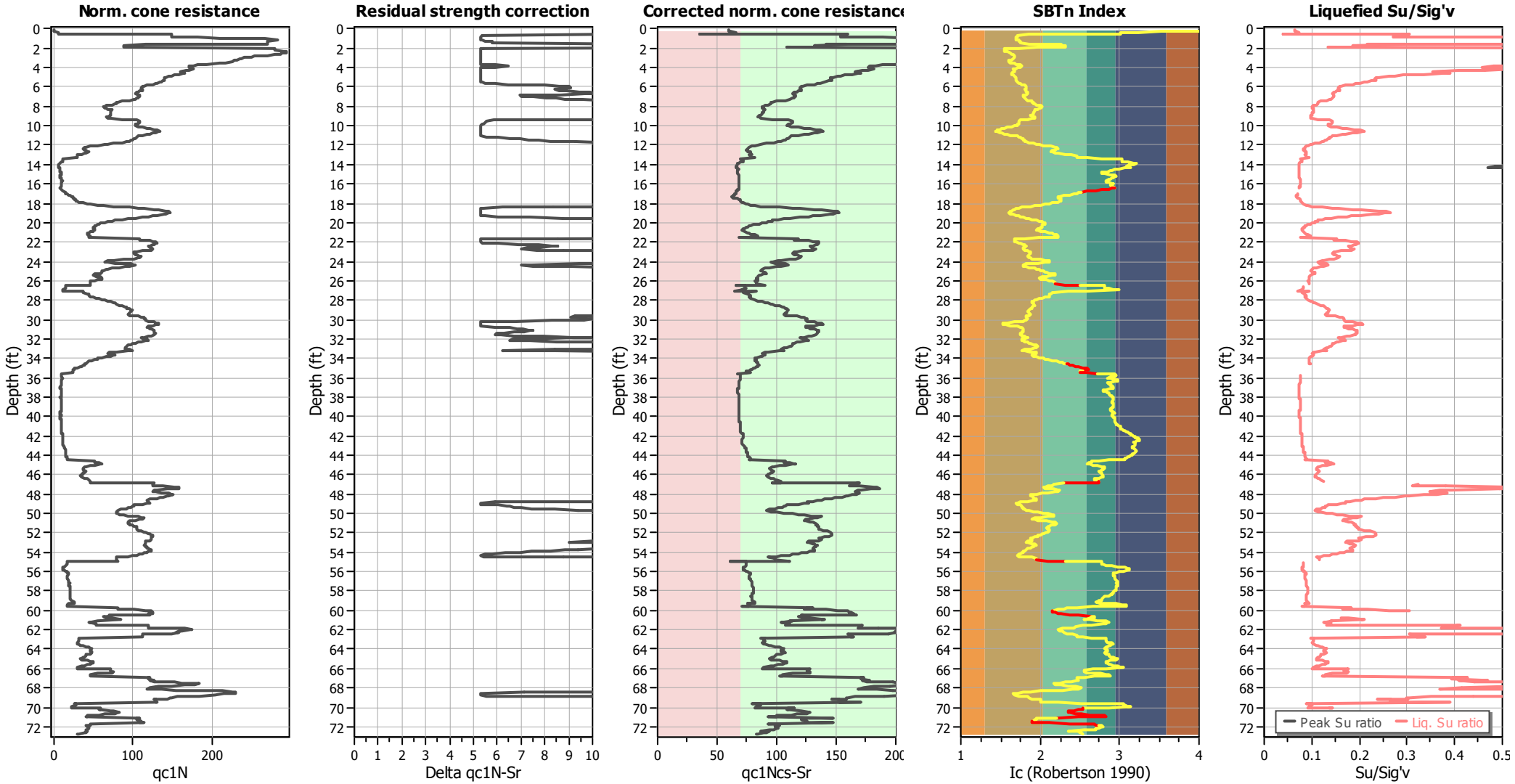




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

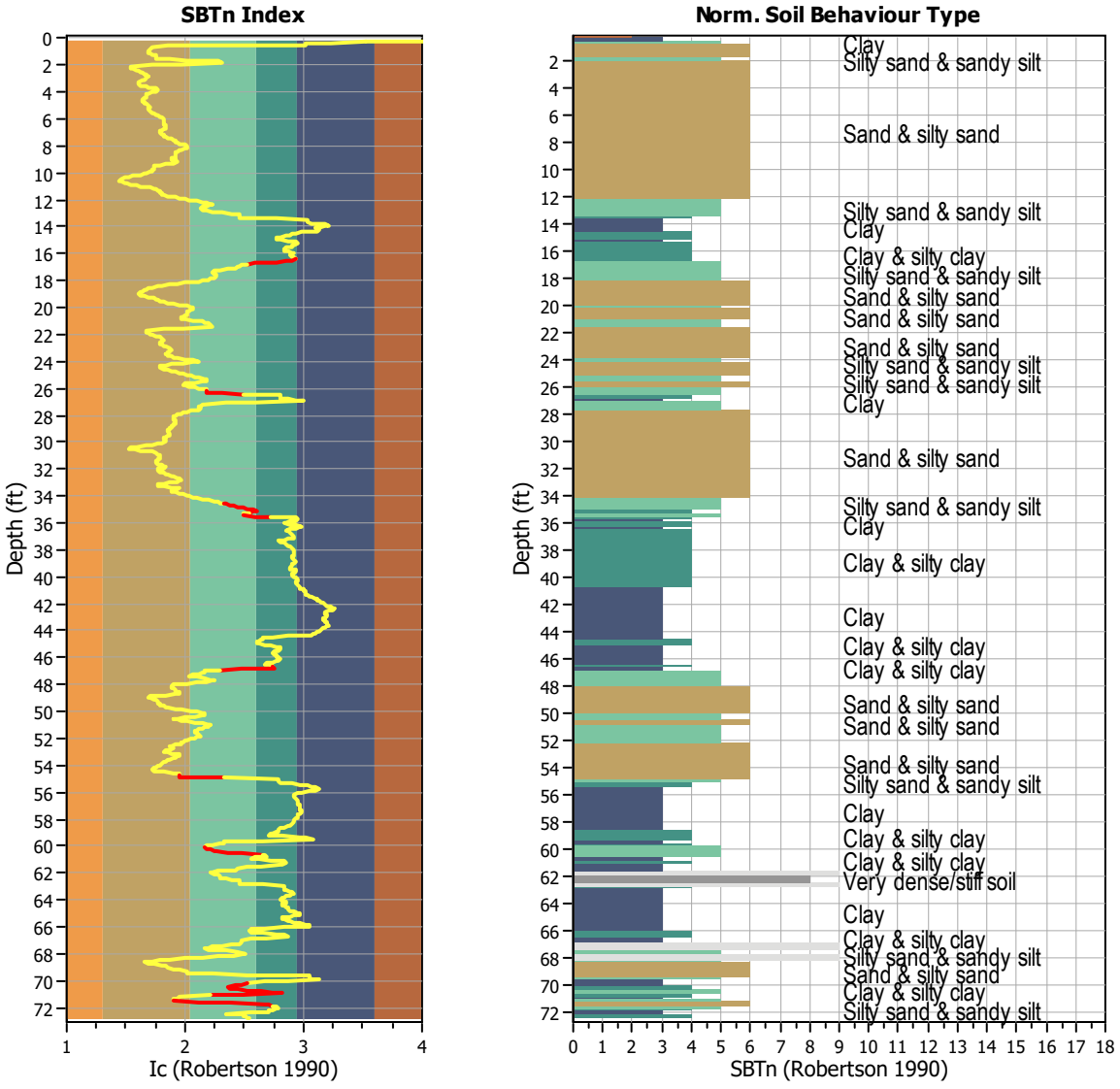
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.89 ft	Fill height:	3.73 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

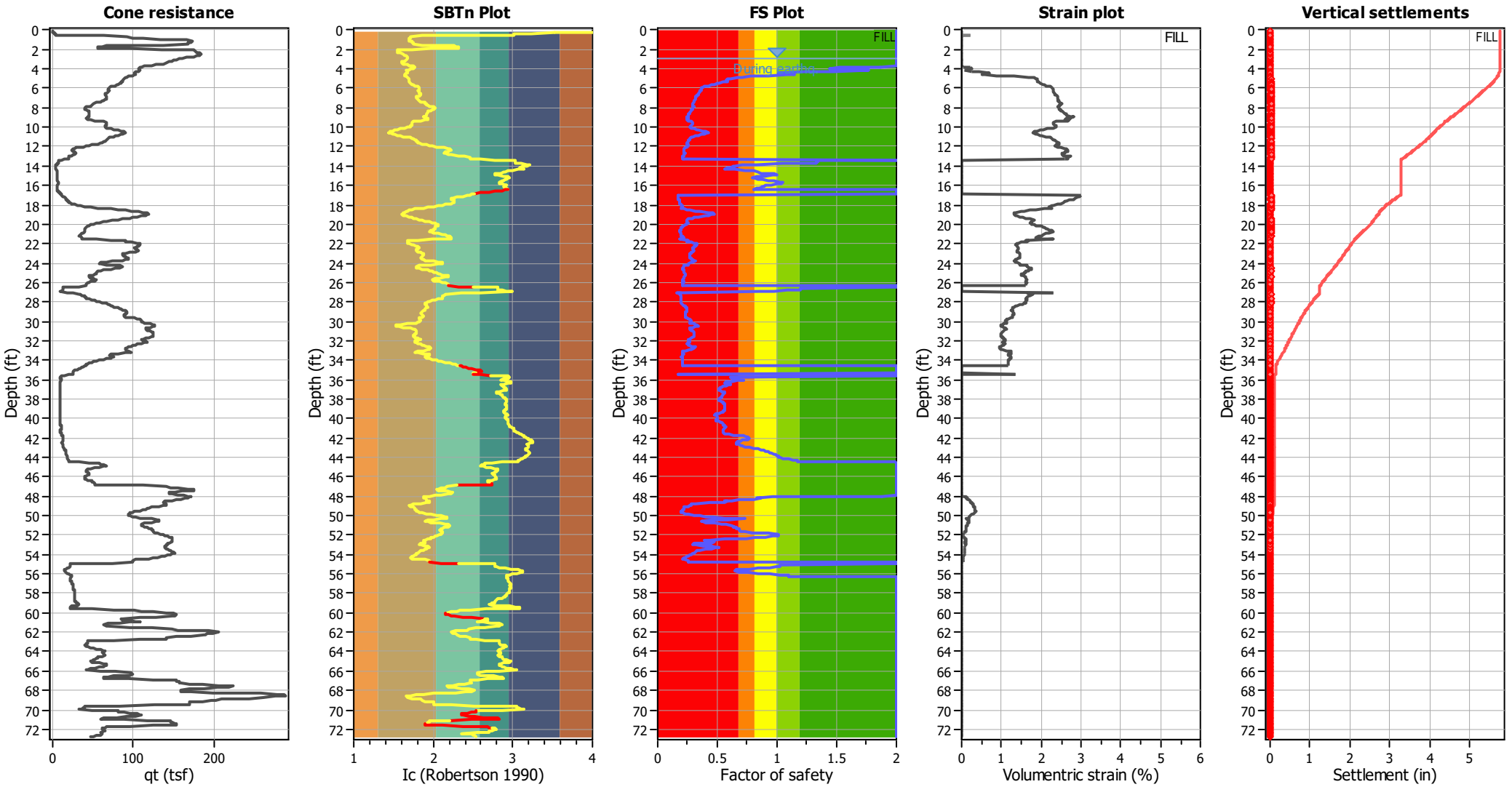
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	68
I_c change ratio value:	0.0250	Exclusion percentage:	6.14%
Minimum number of points in layer:	4	Number of layers detected:	12

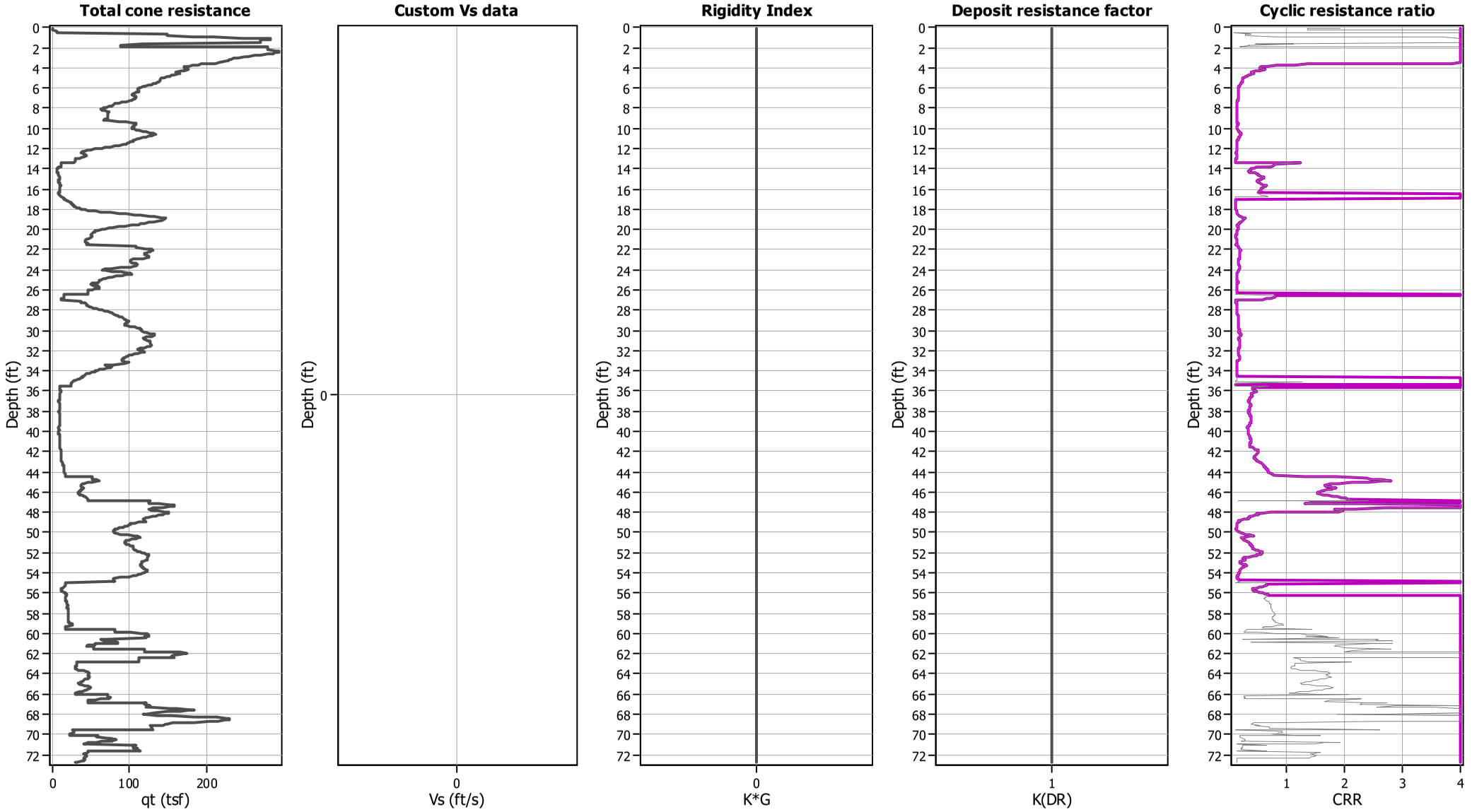
Estimation of post-earthquake settlements



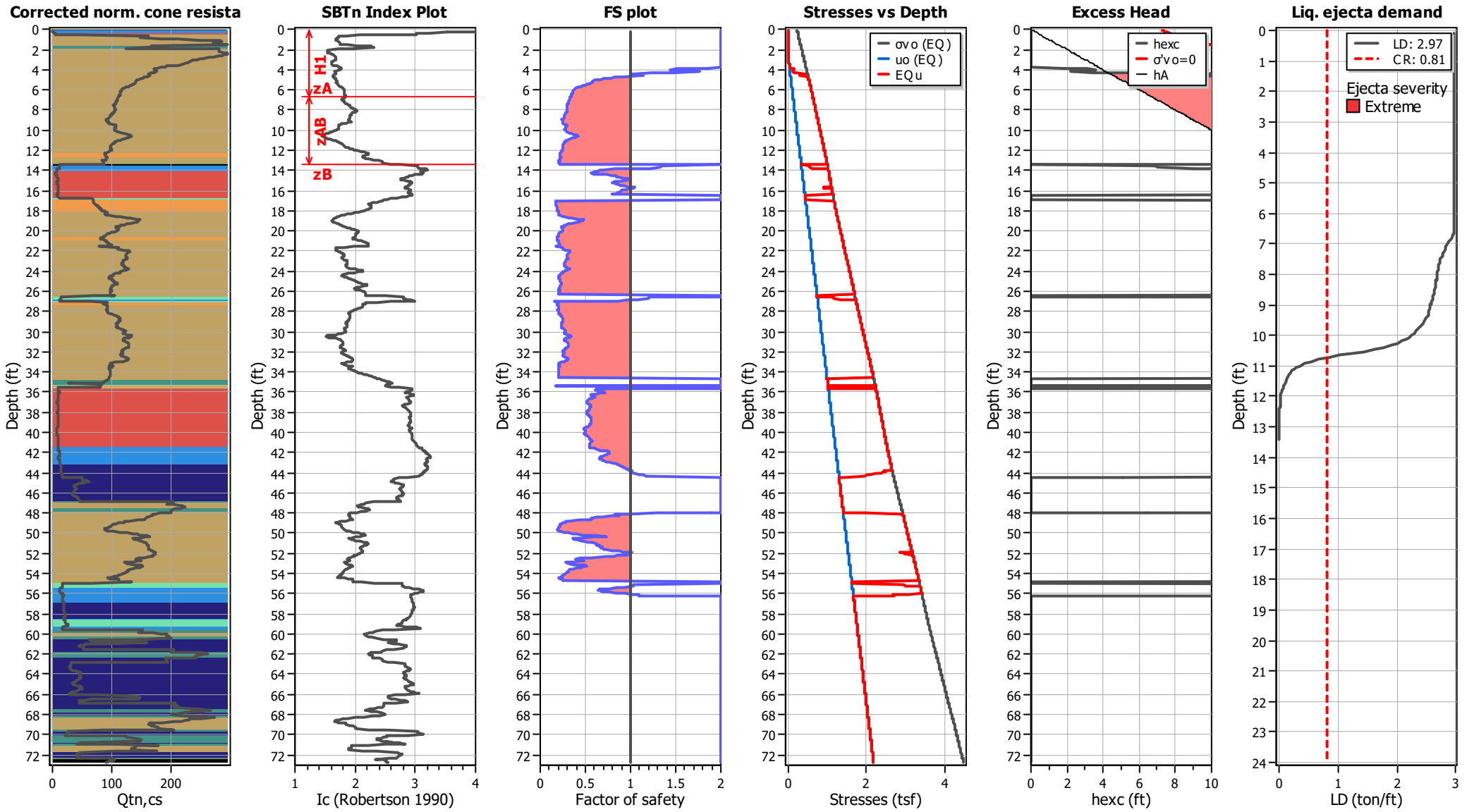
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

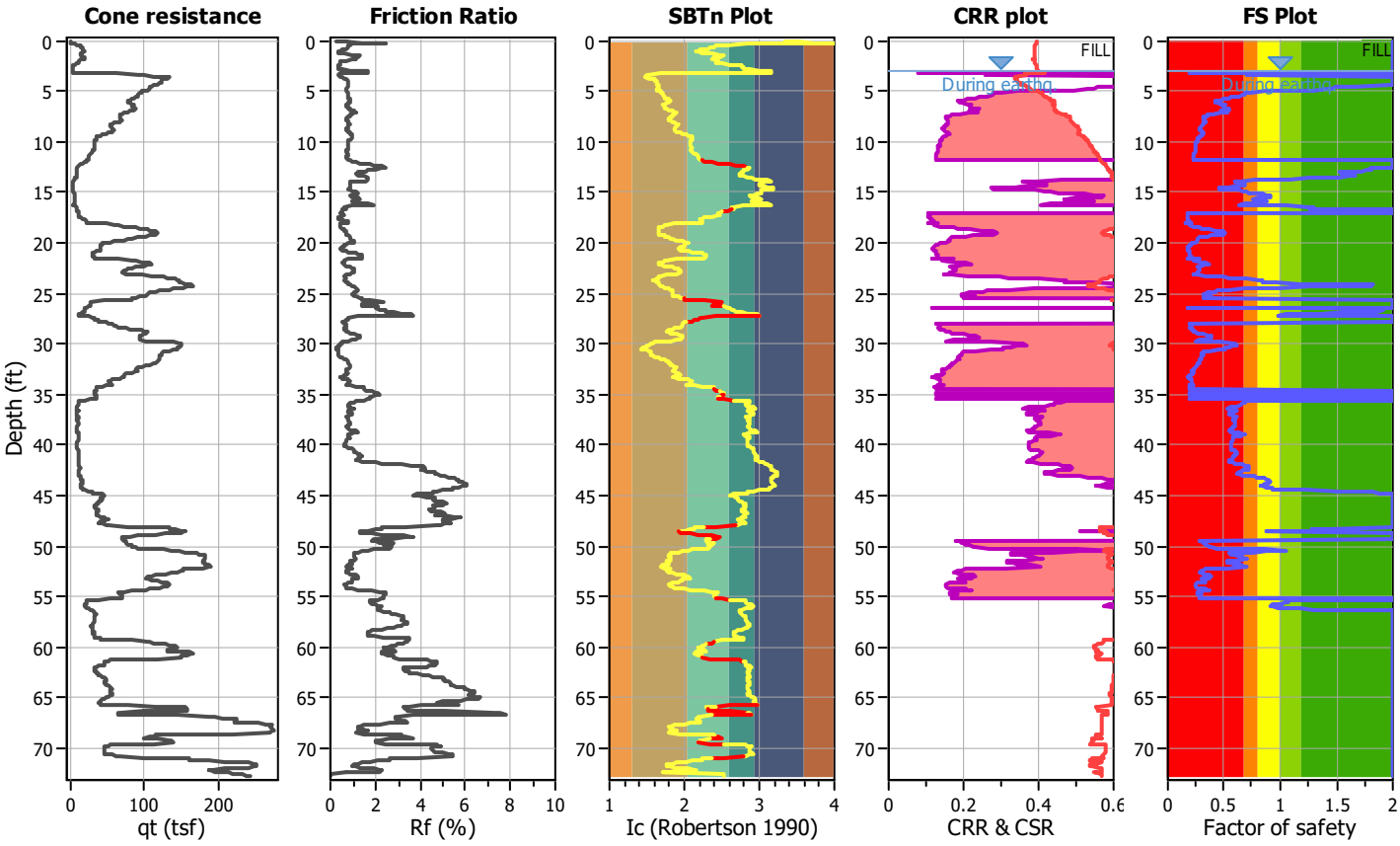
Project title : Topgolf Harbor Island

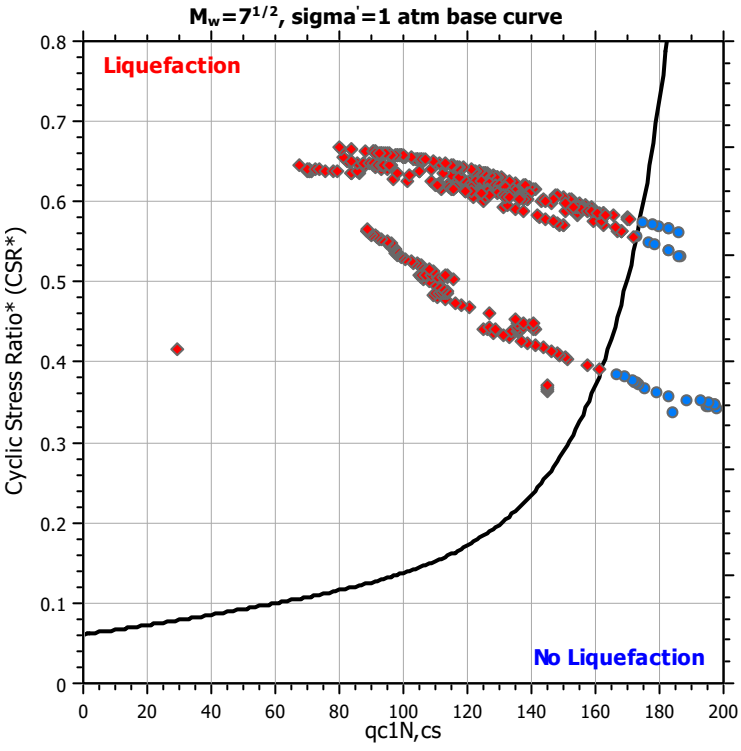
Location : North Harbor Drive and Liberator Way, San Diego, CA

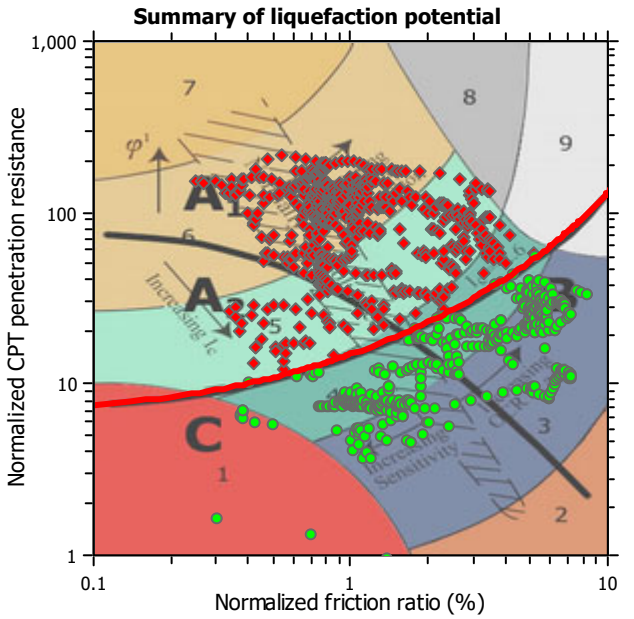
CPT file : CPT-16 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.93 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.62 ft	Fill height:	3.69 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

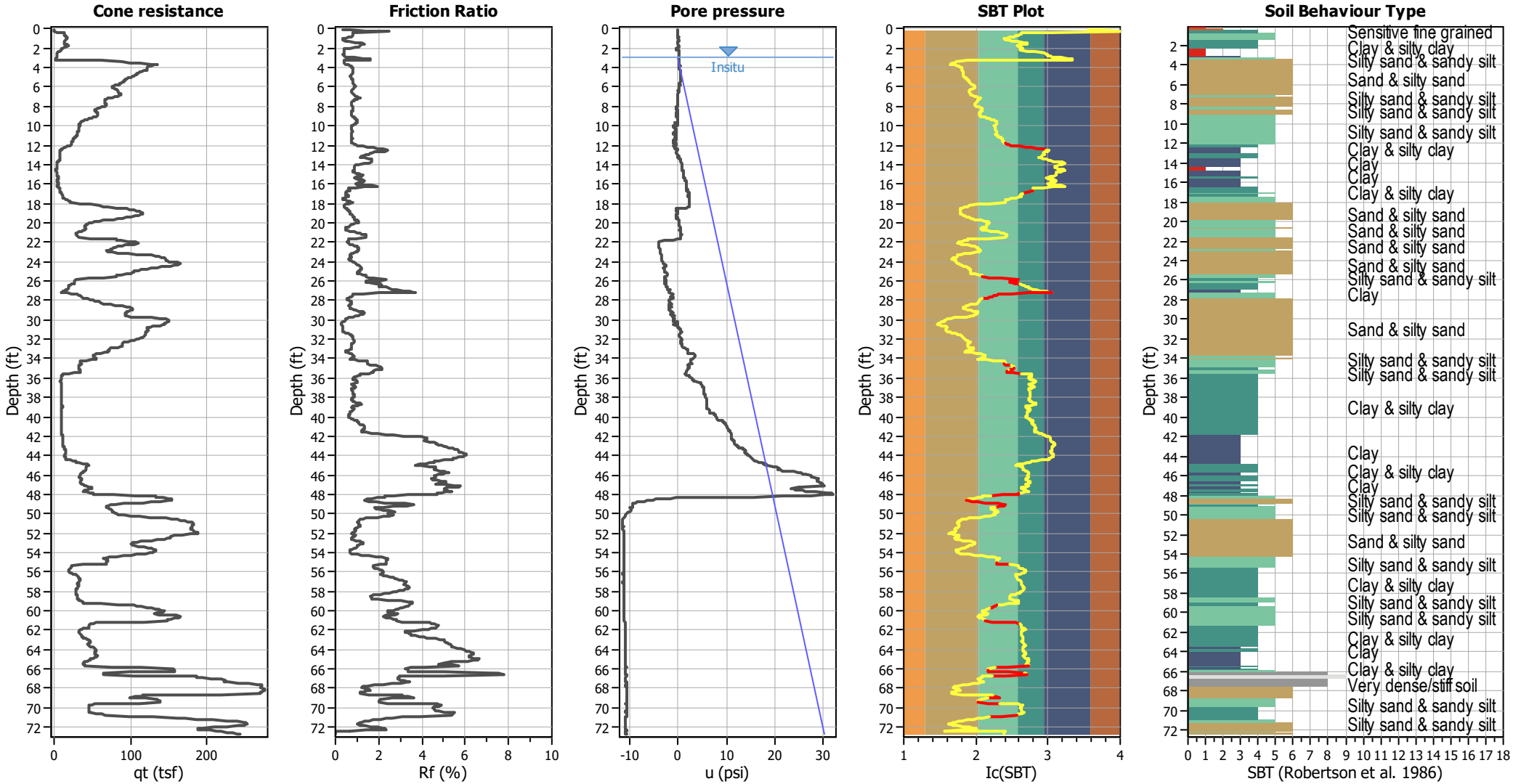






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



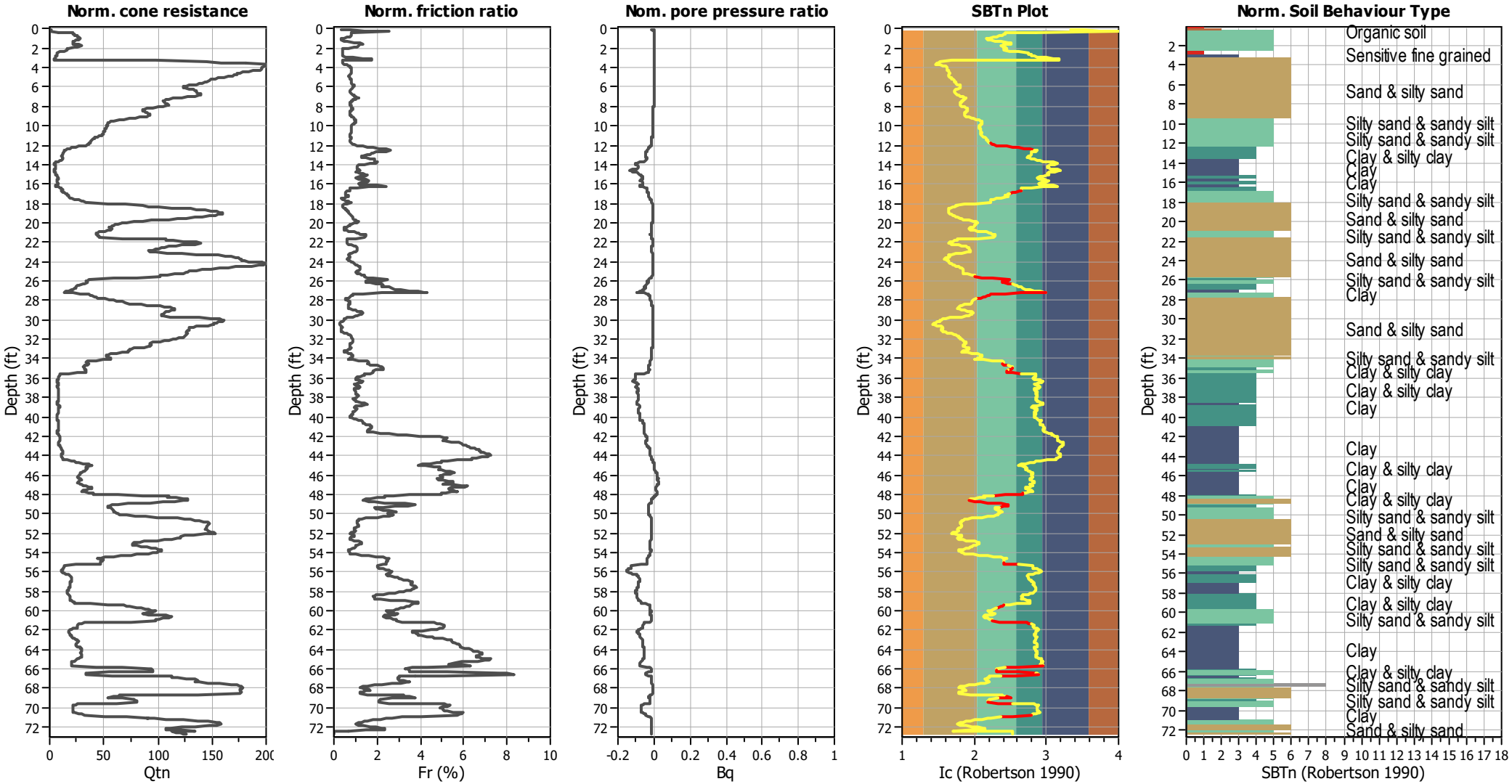
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 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)



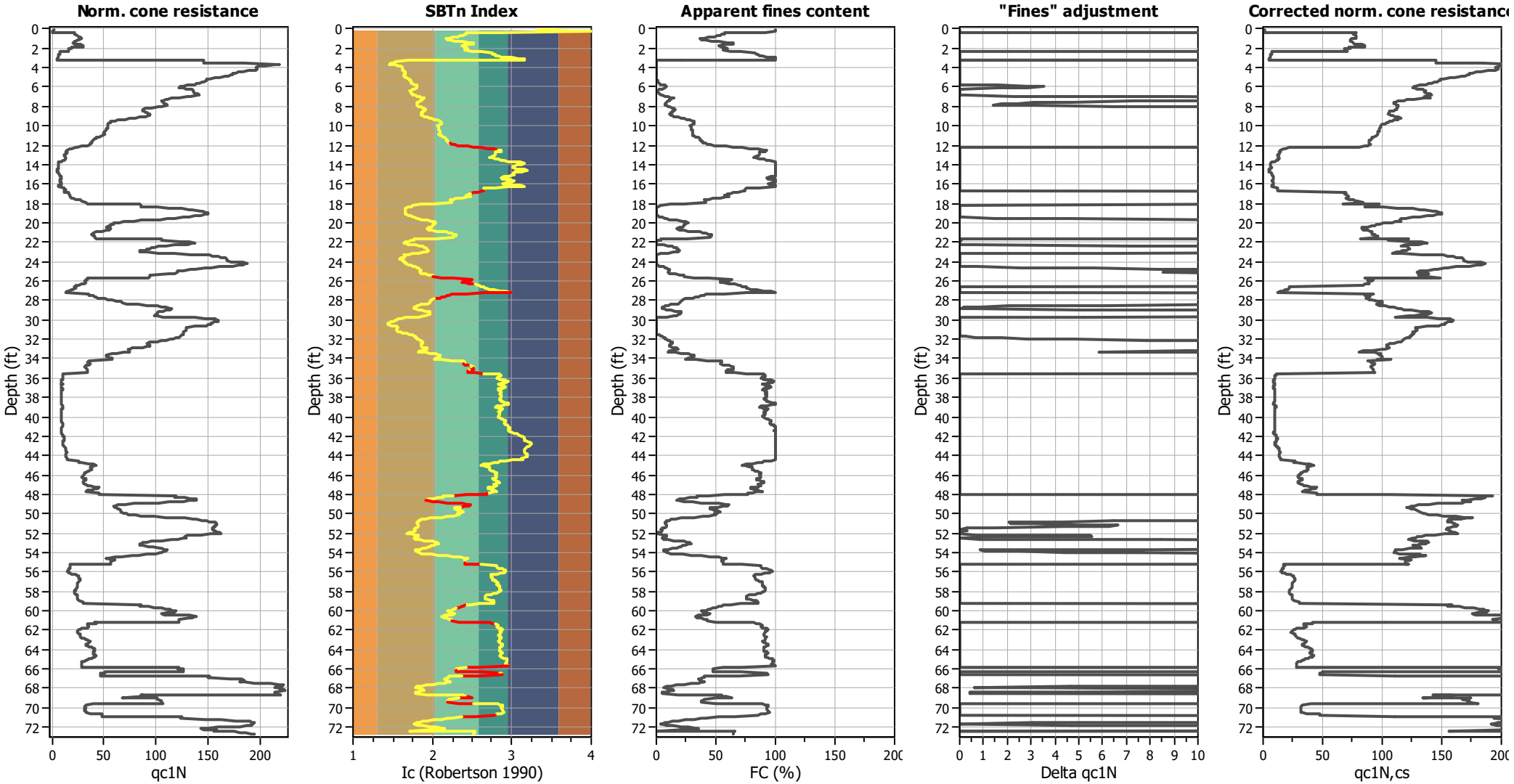
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 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

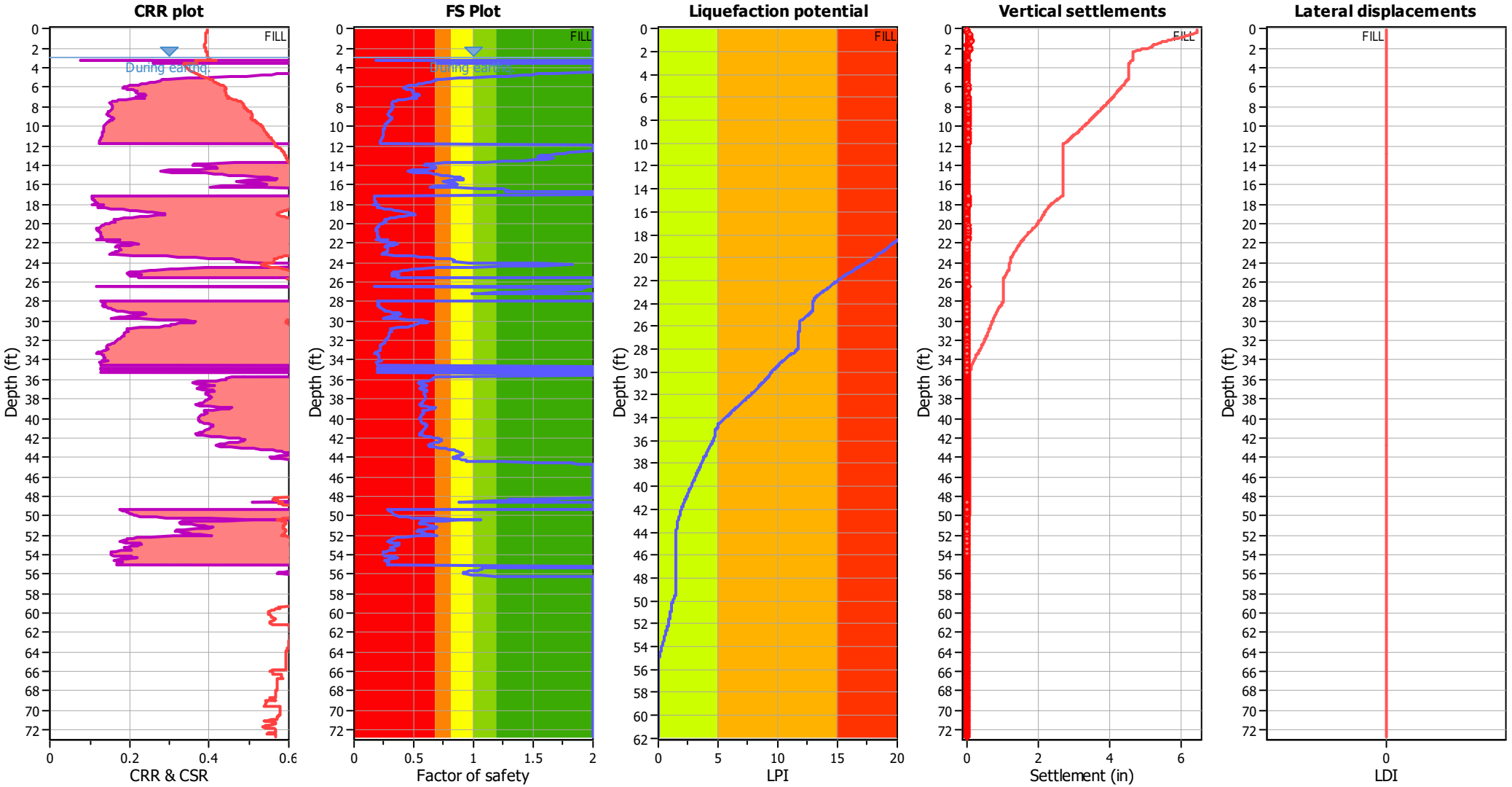
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 ft	Limit depth:	60.00 ft

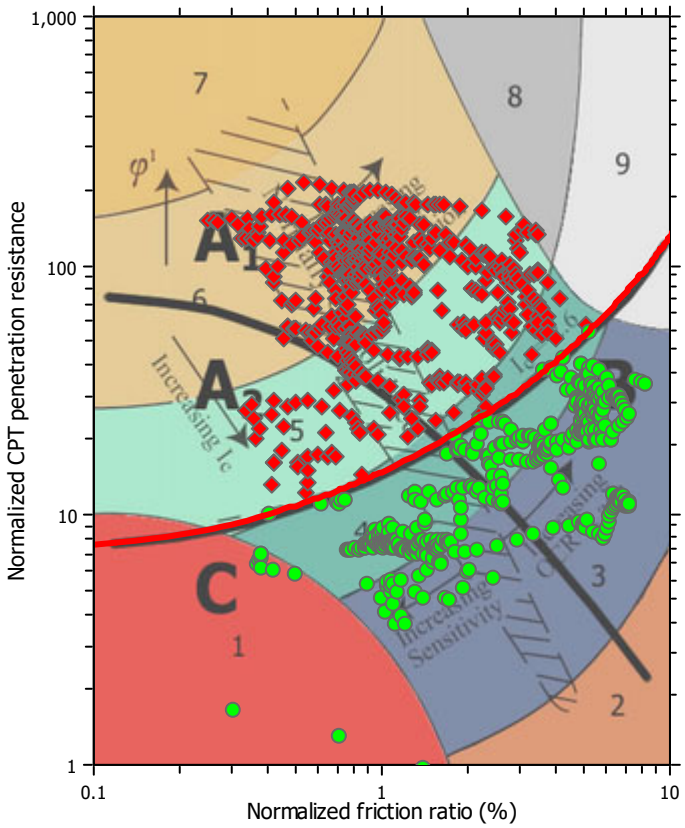
F.S. color scheme

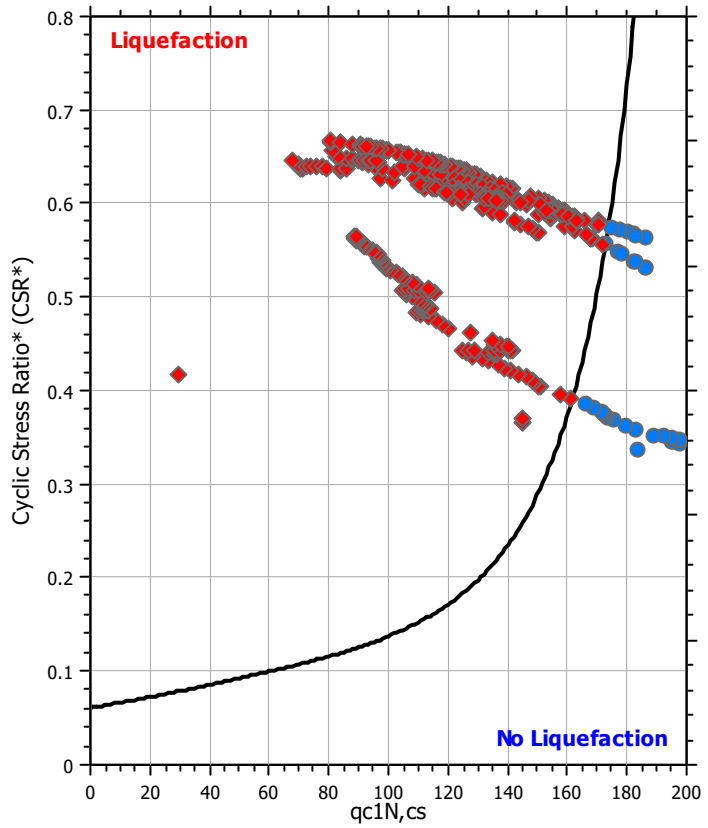
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

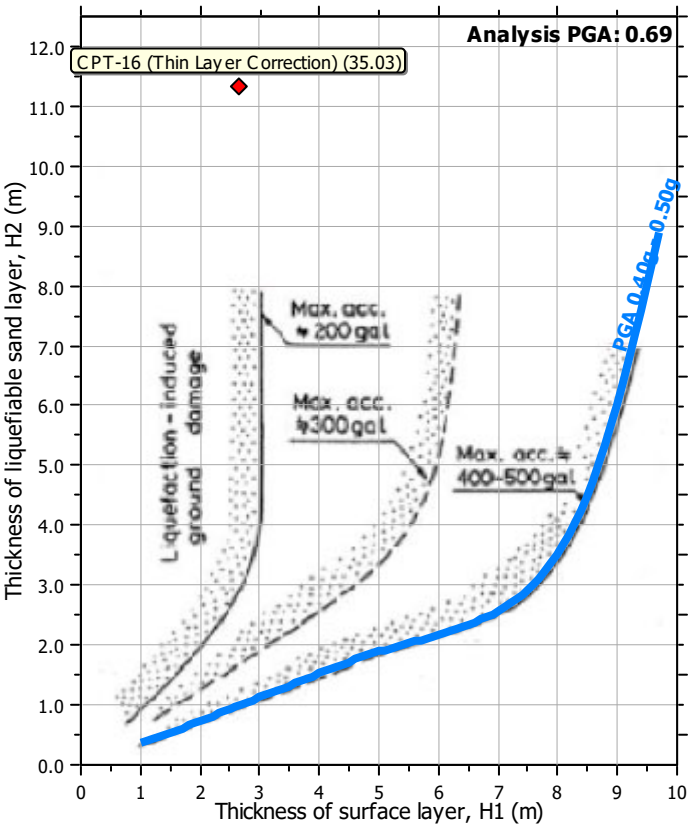
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



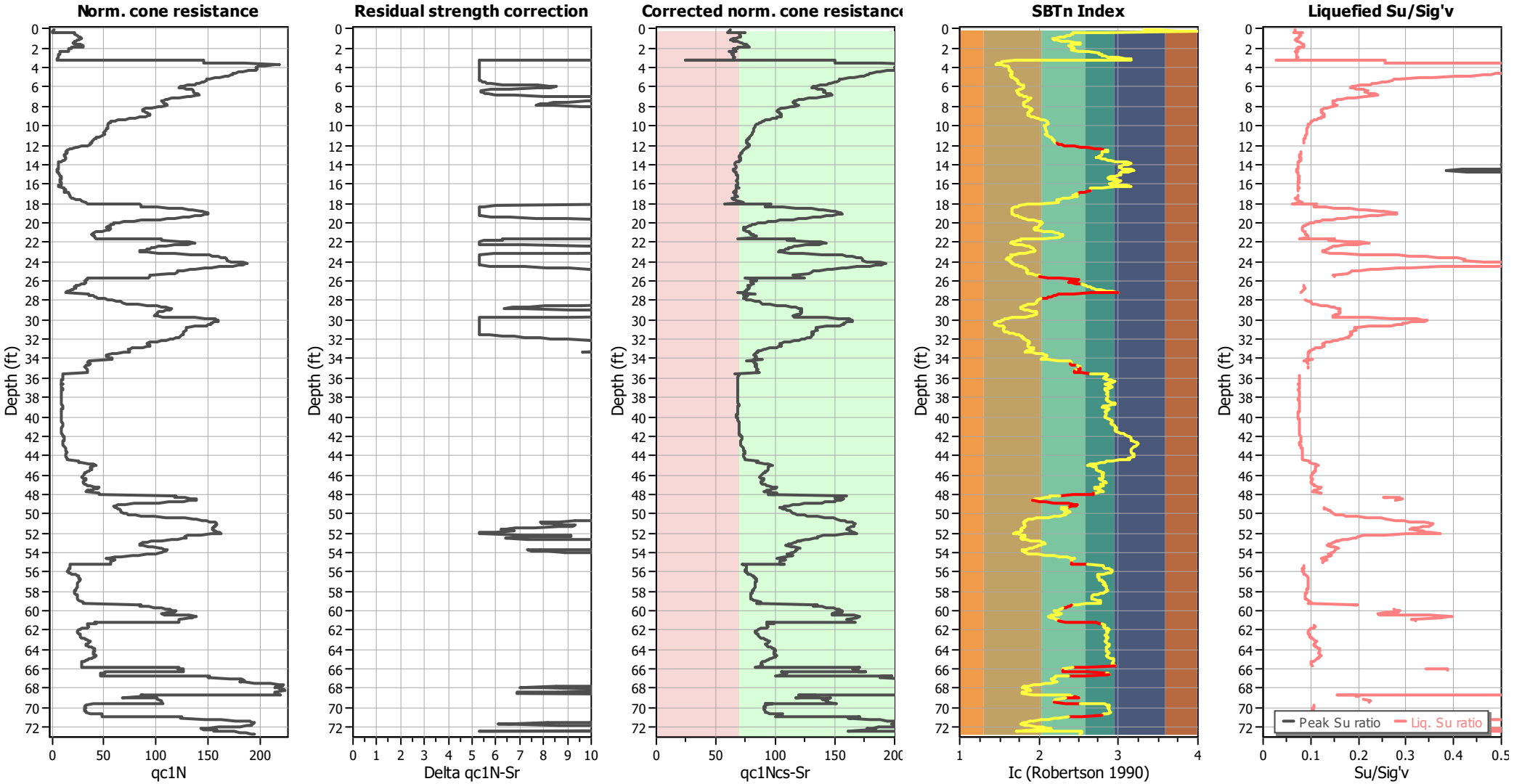




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

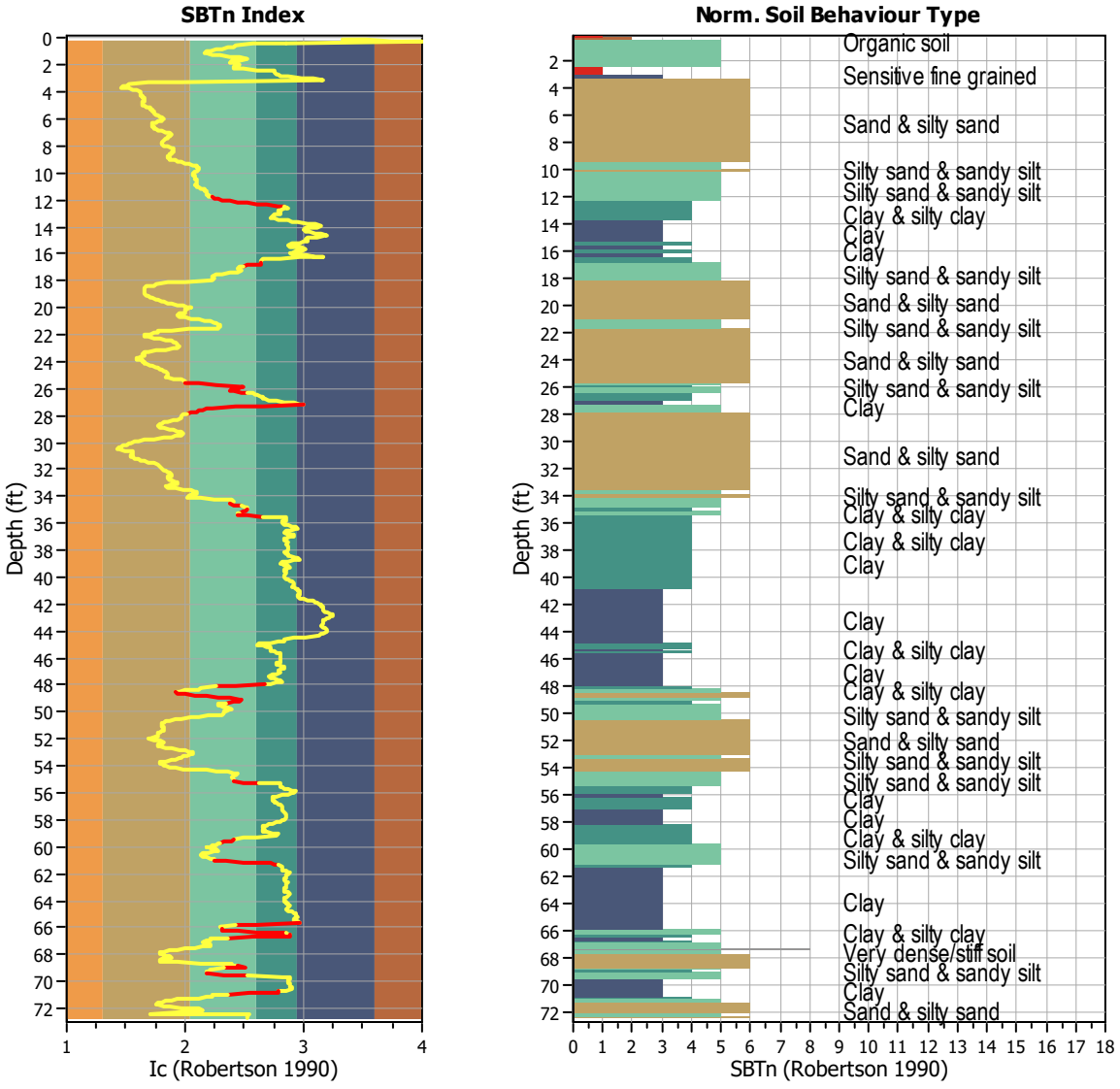
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.93 ft	Fill height:	3.69 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

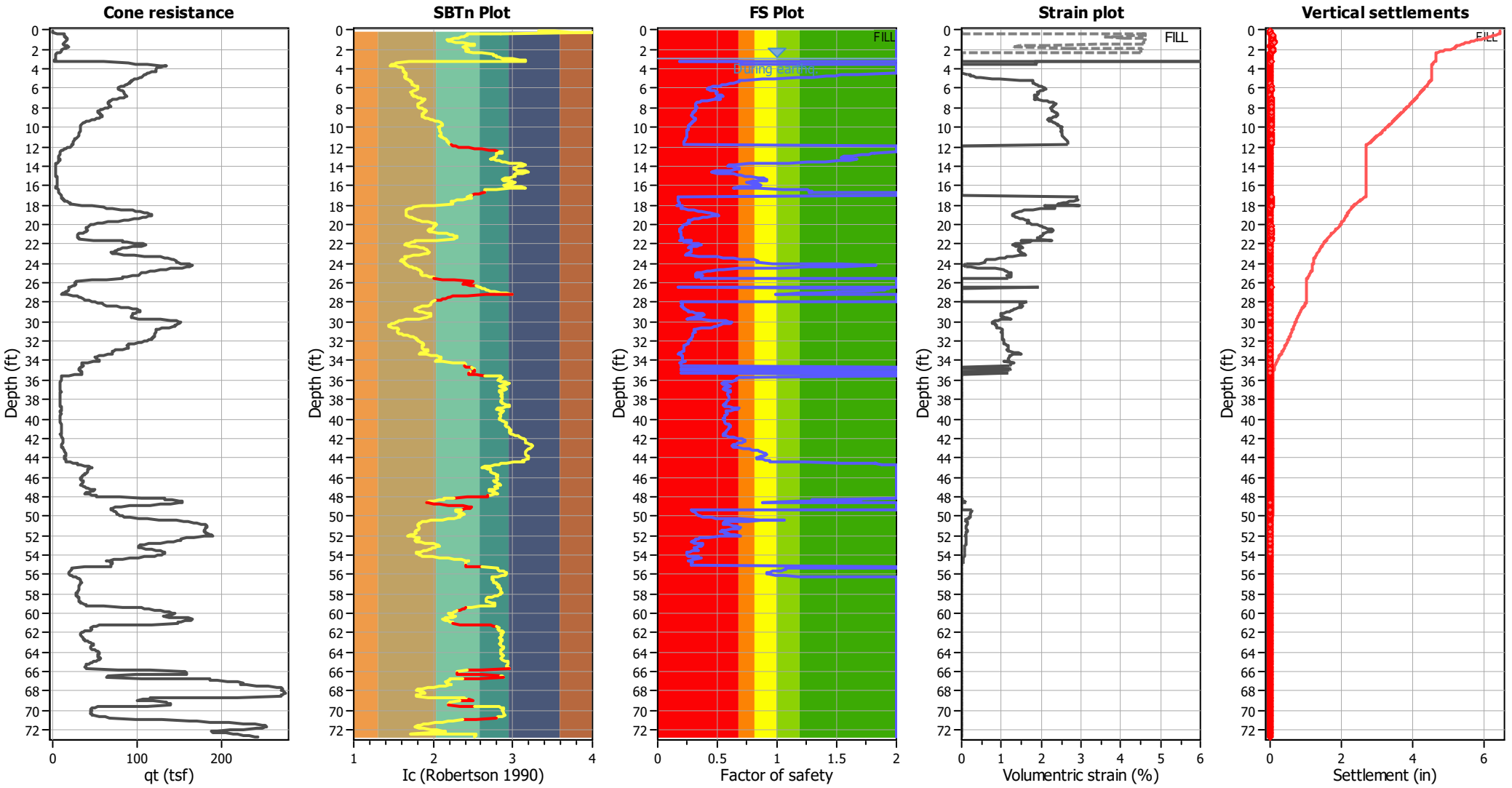
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	109
I_c change ratio value:	0.0250	Exclusion percentage:	9.84%
Minimum number of points in layer:	4	Number of layers detected:	21

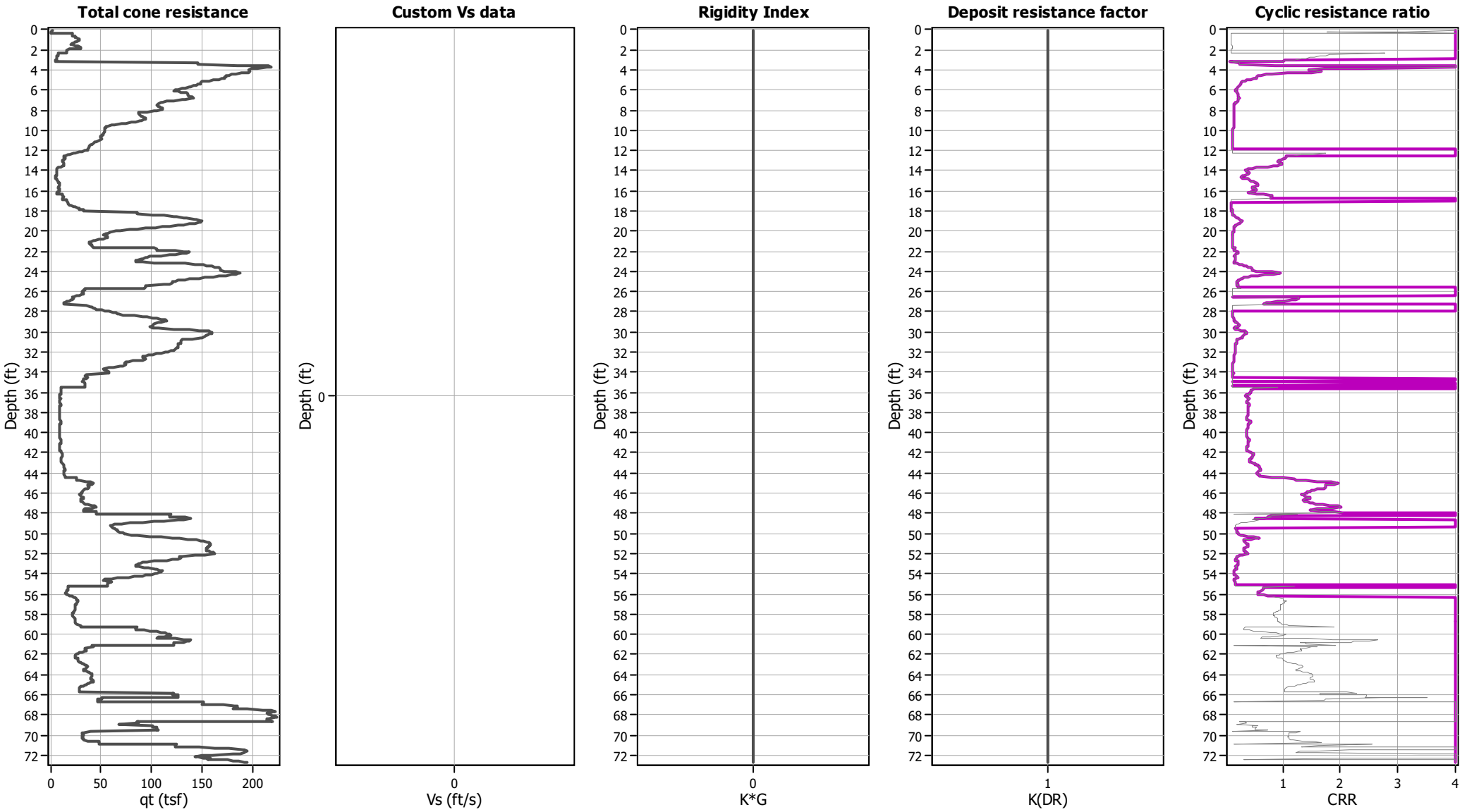
Estimation of post-earthquake settlements



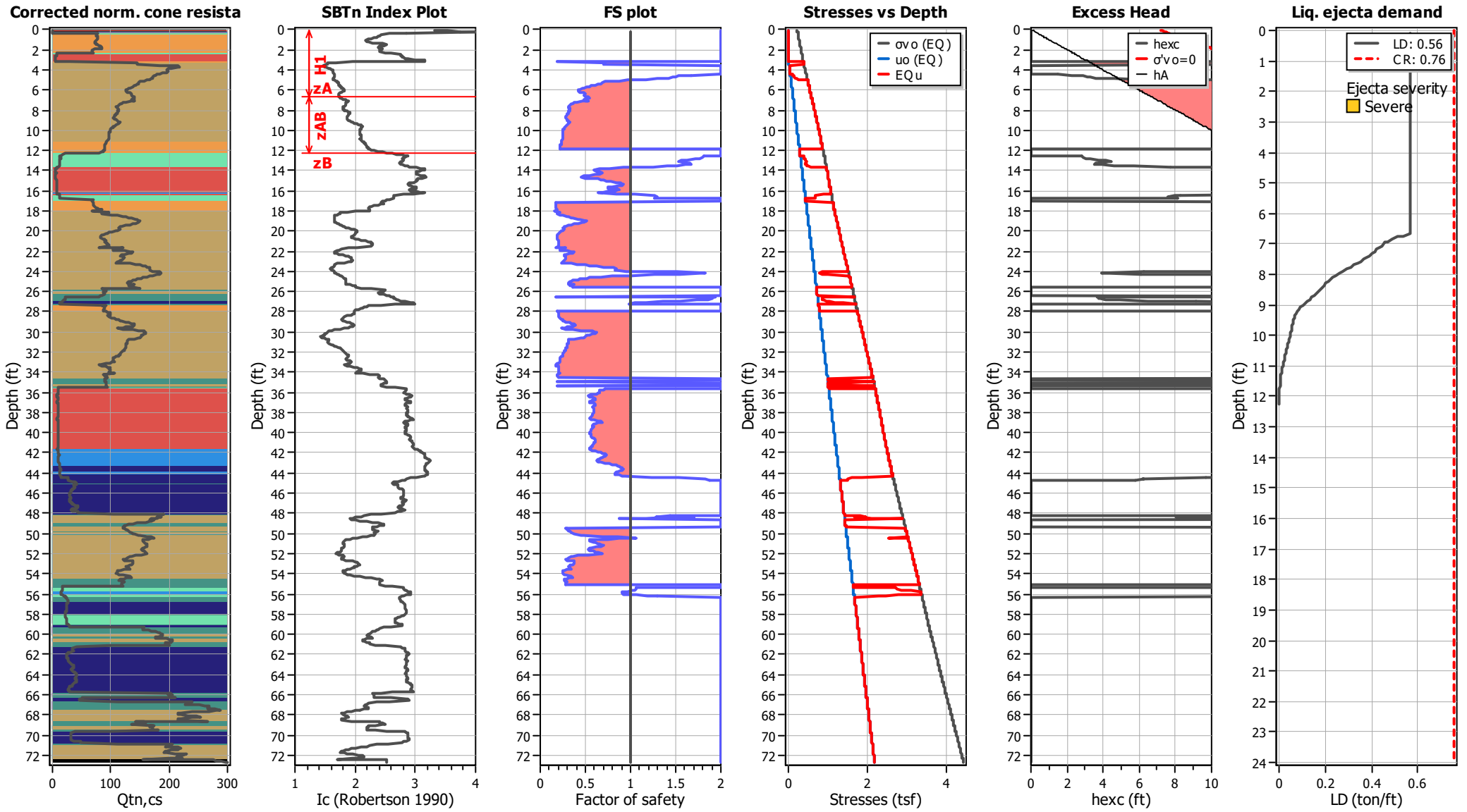
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

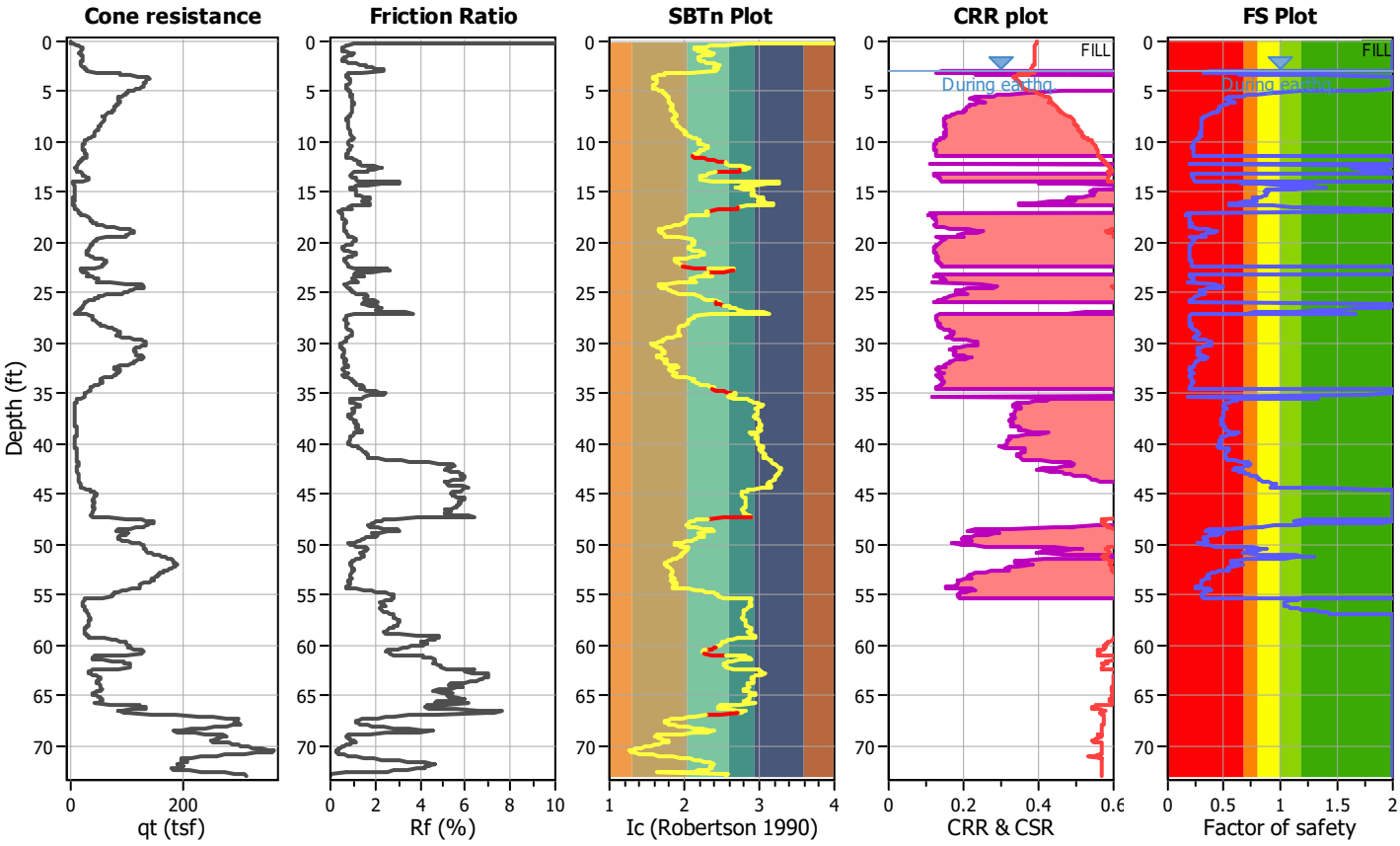
Project title : Topgolf Harbor Island

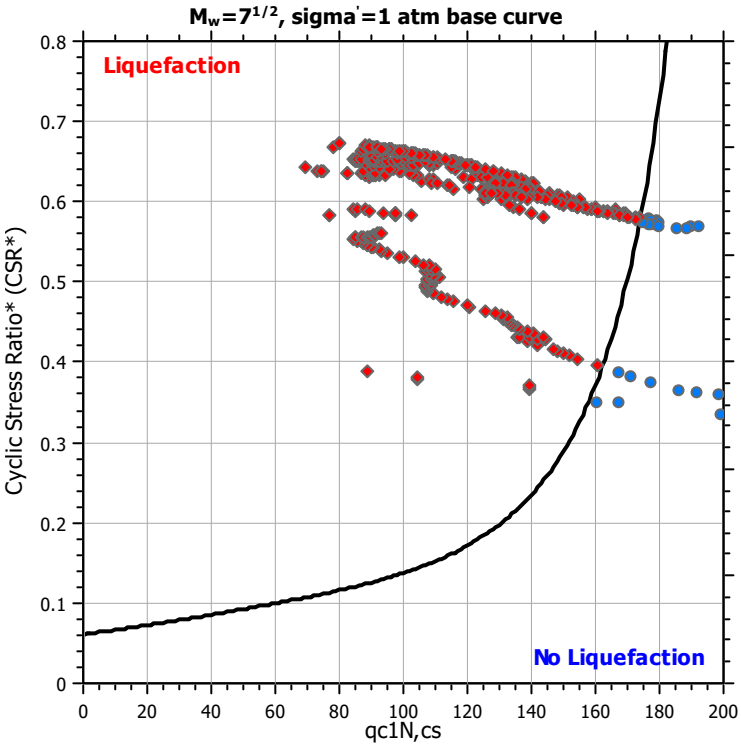
Location : North Harbor Drive and Liberator Way, San Diego, CA

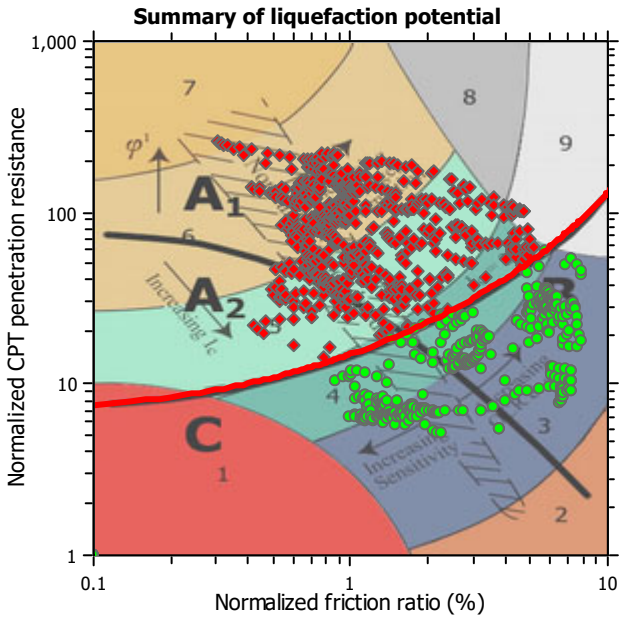
CPT file : CPT-17 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.03 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.12 ft	Fill height:	3.09 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

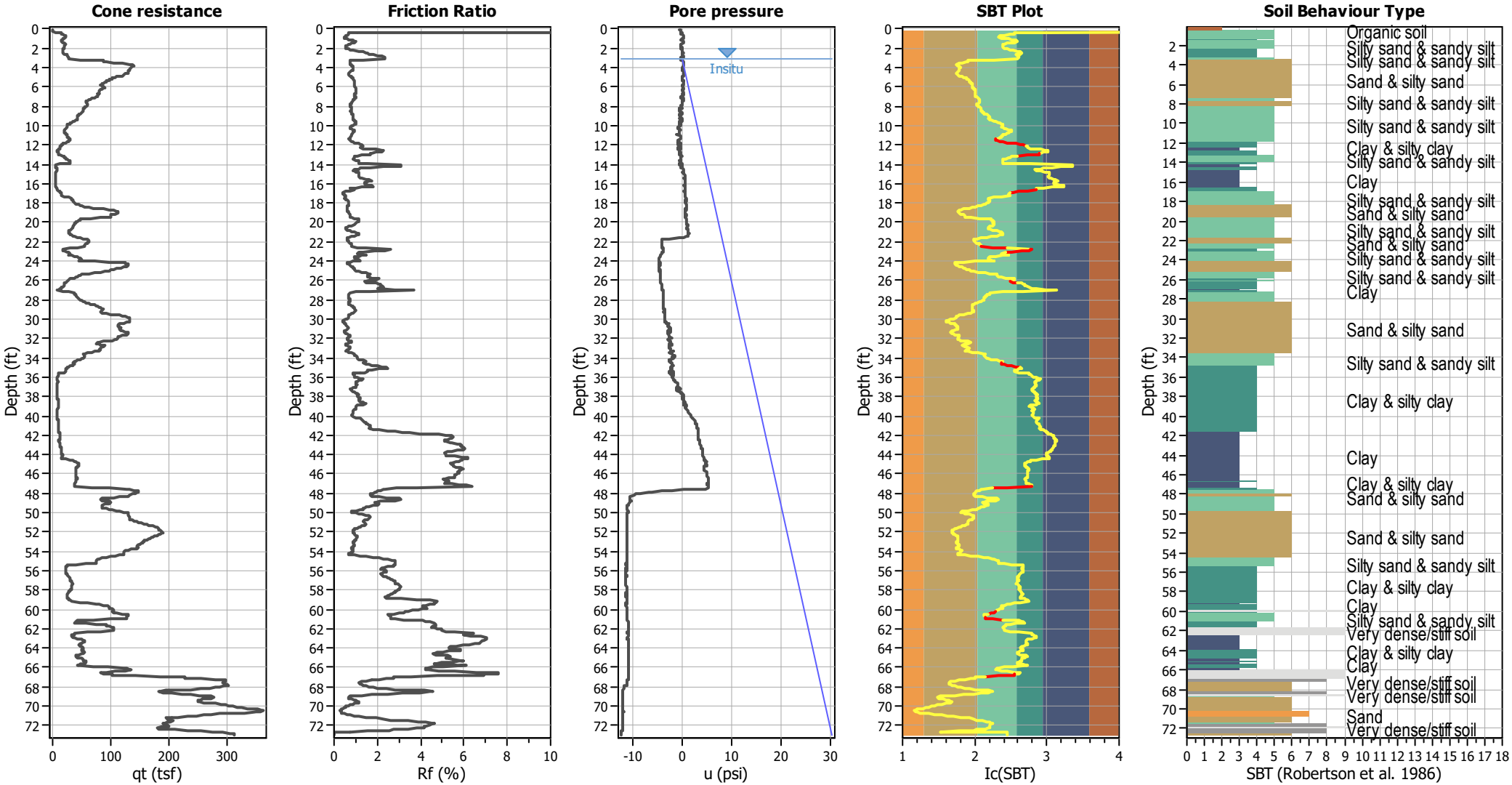






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



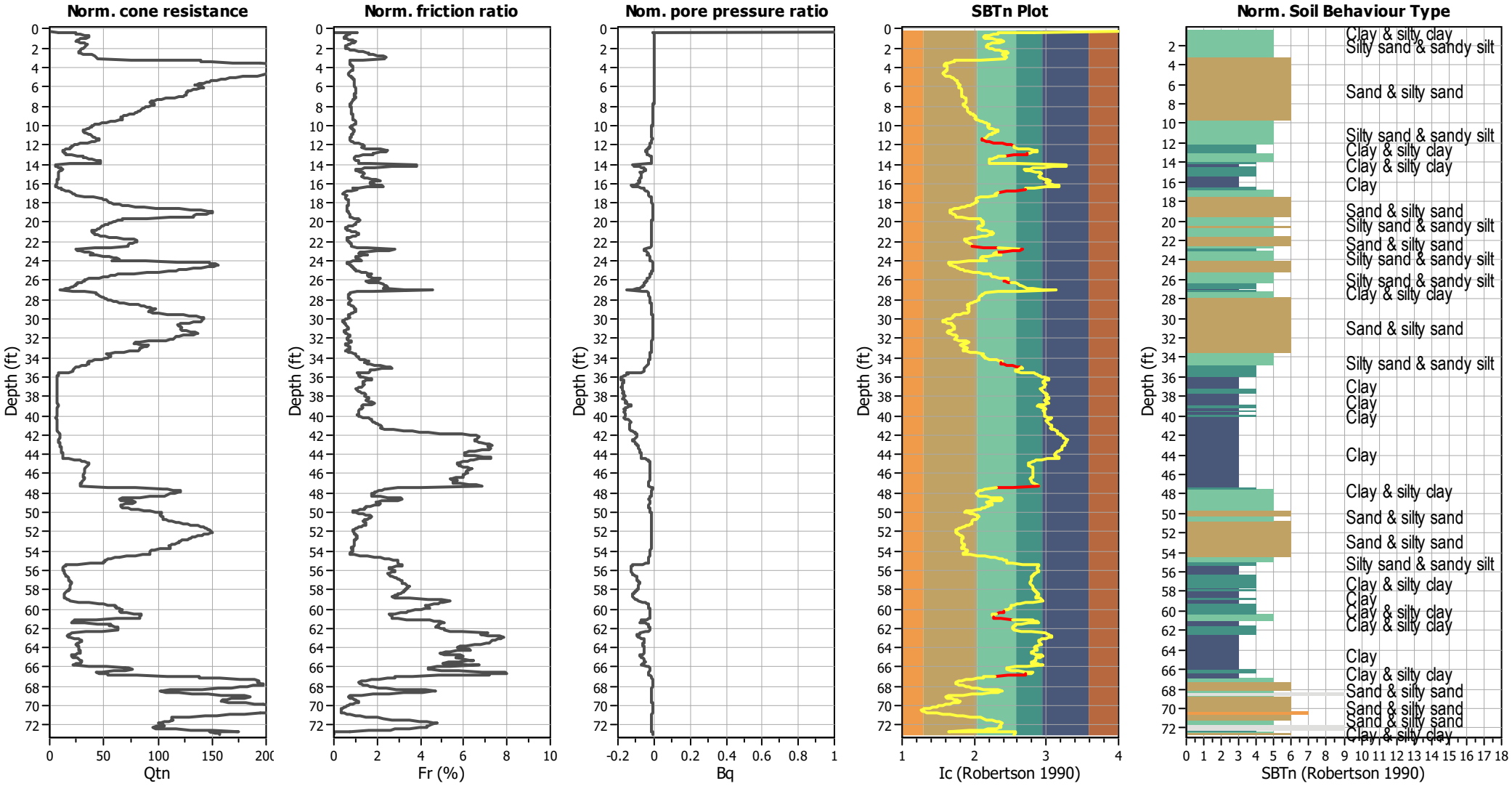
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 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)



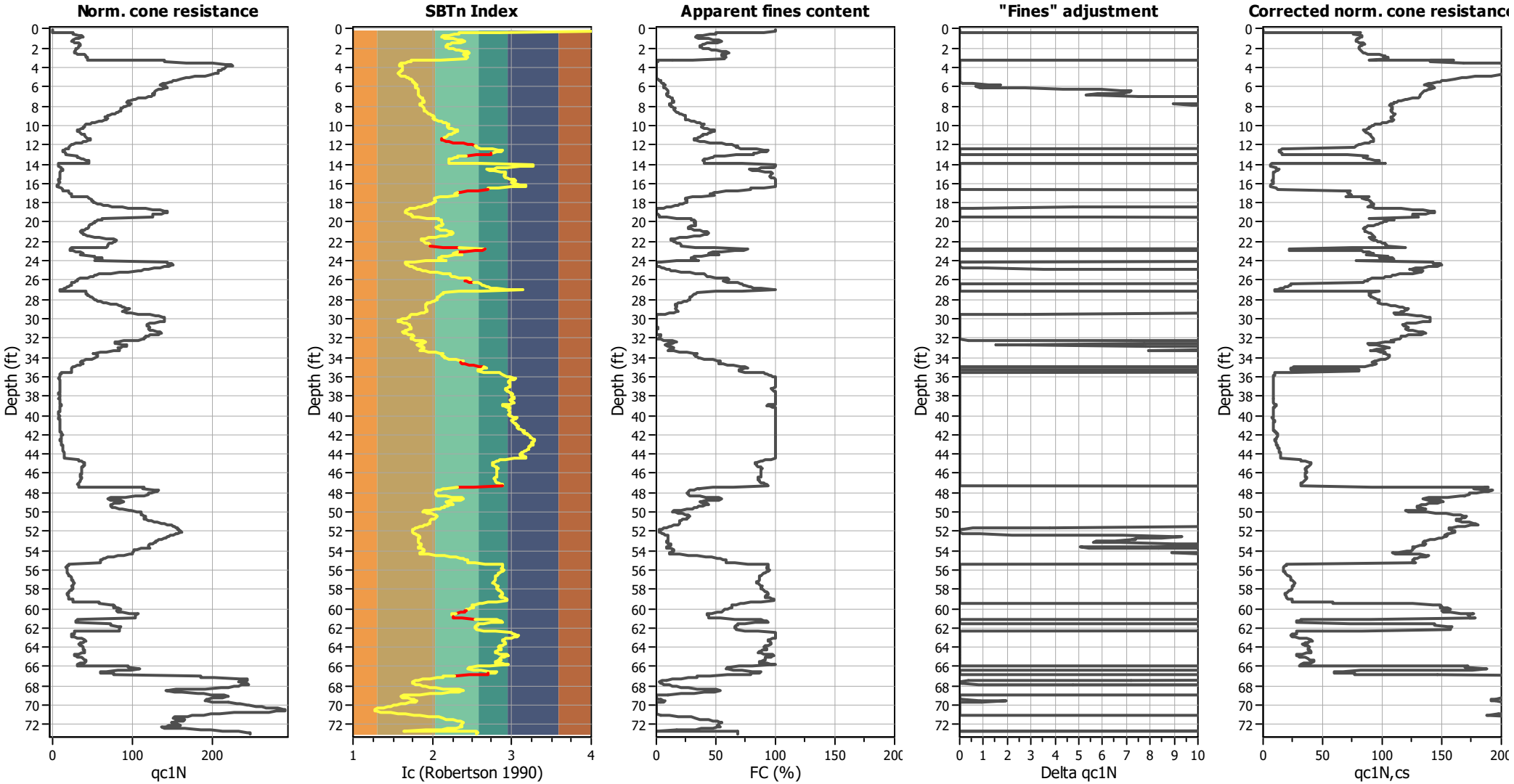
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 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

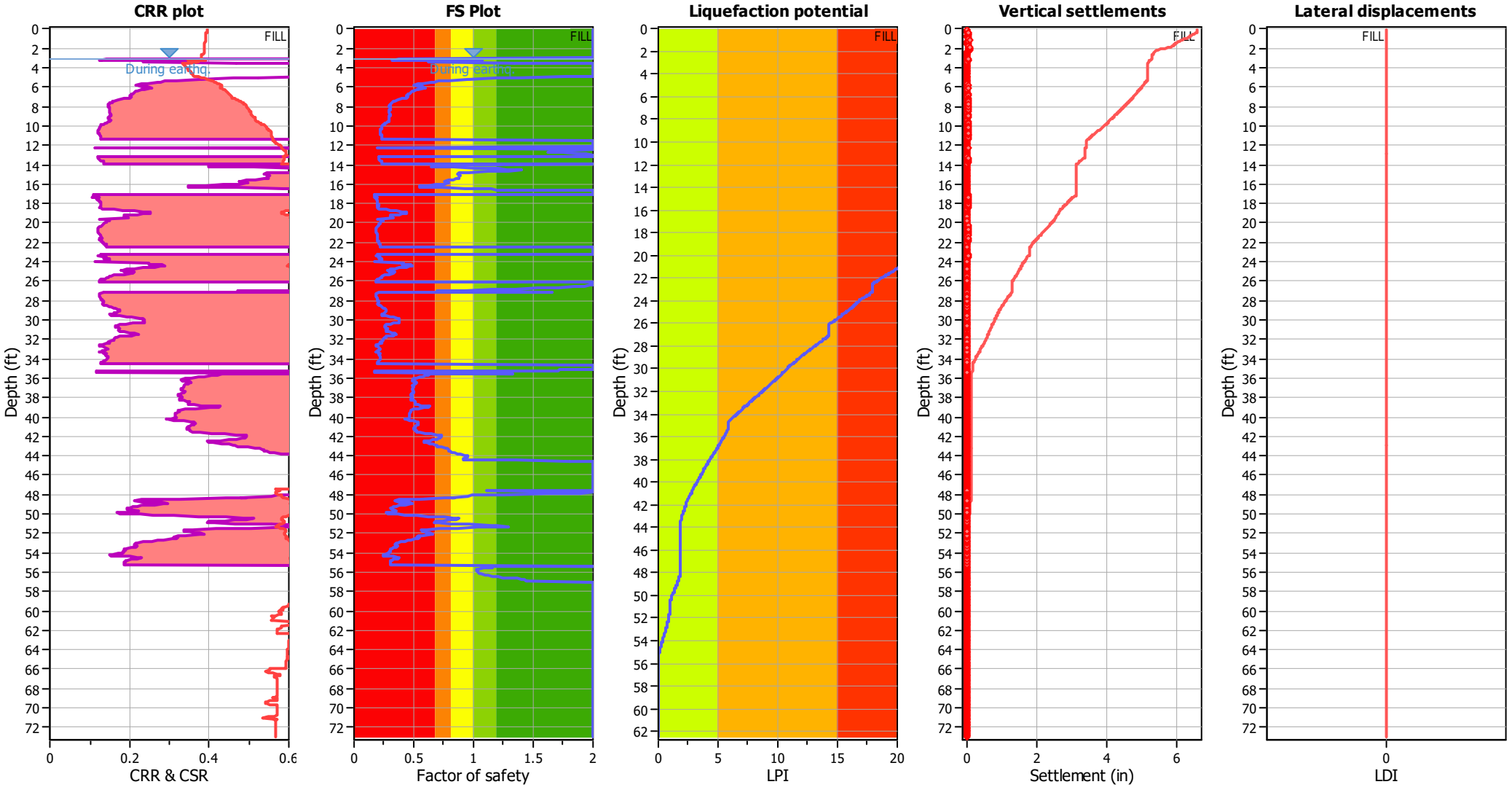
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 ft	Limit depth:	60.00 ft

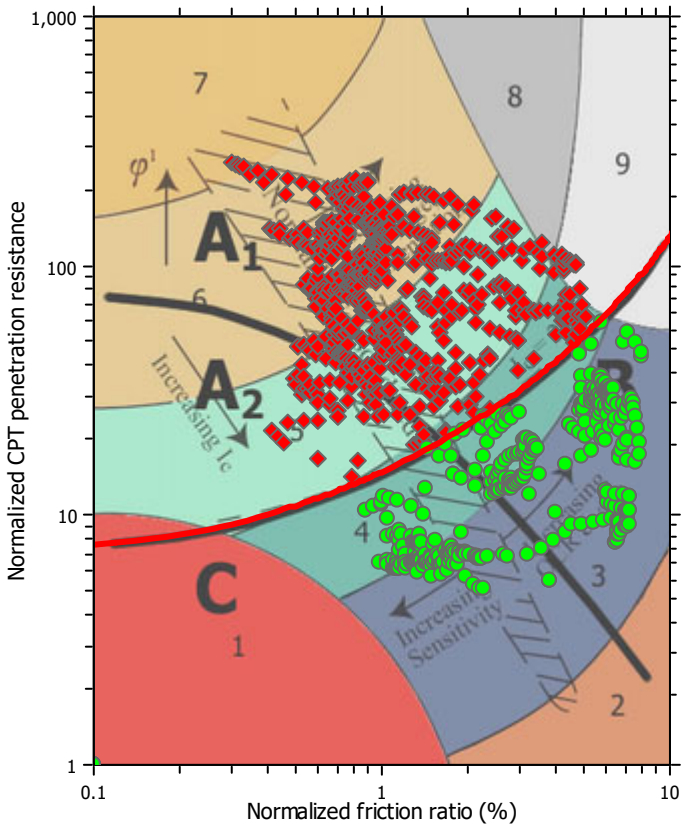
F.S. color scheme

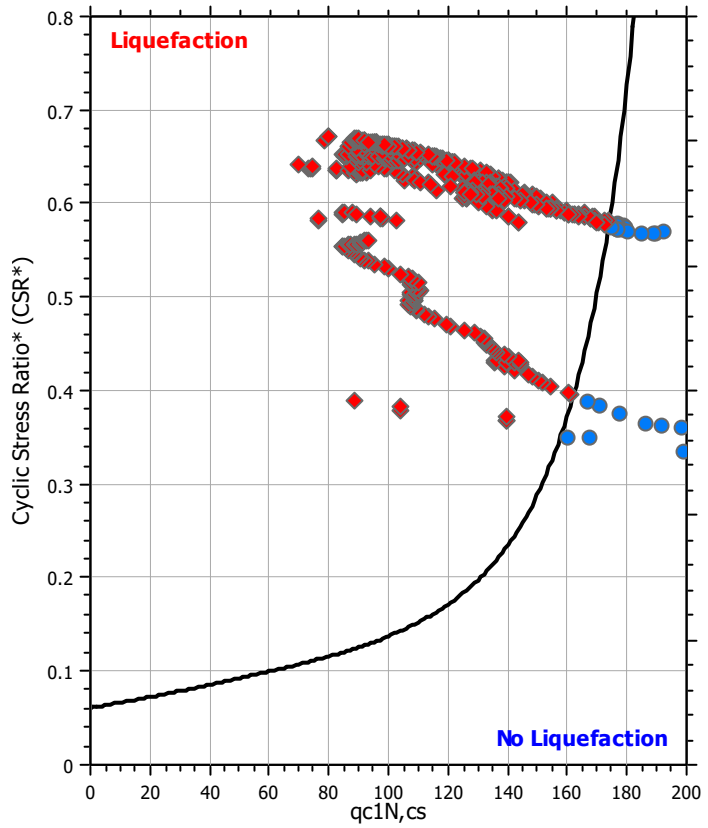
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

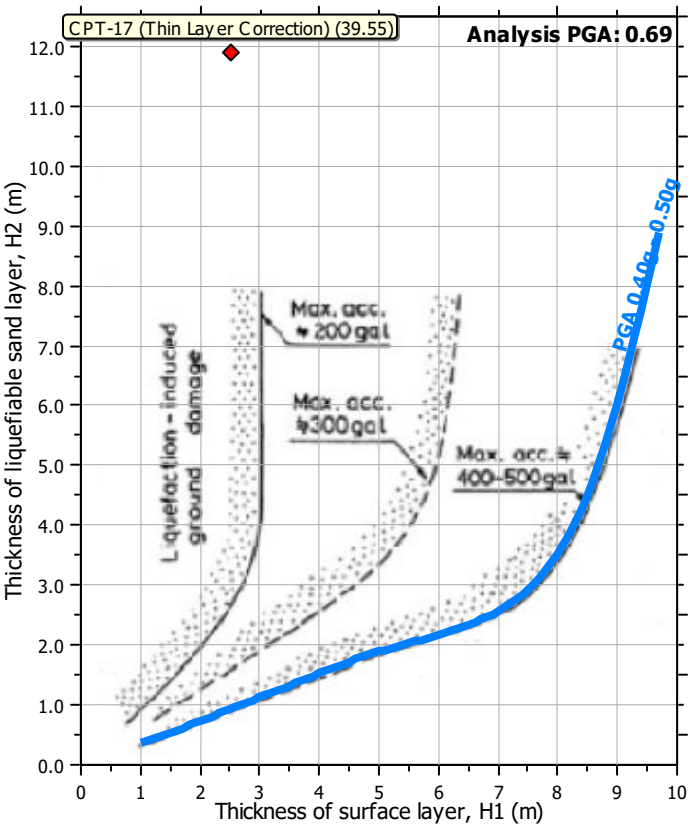
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



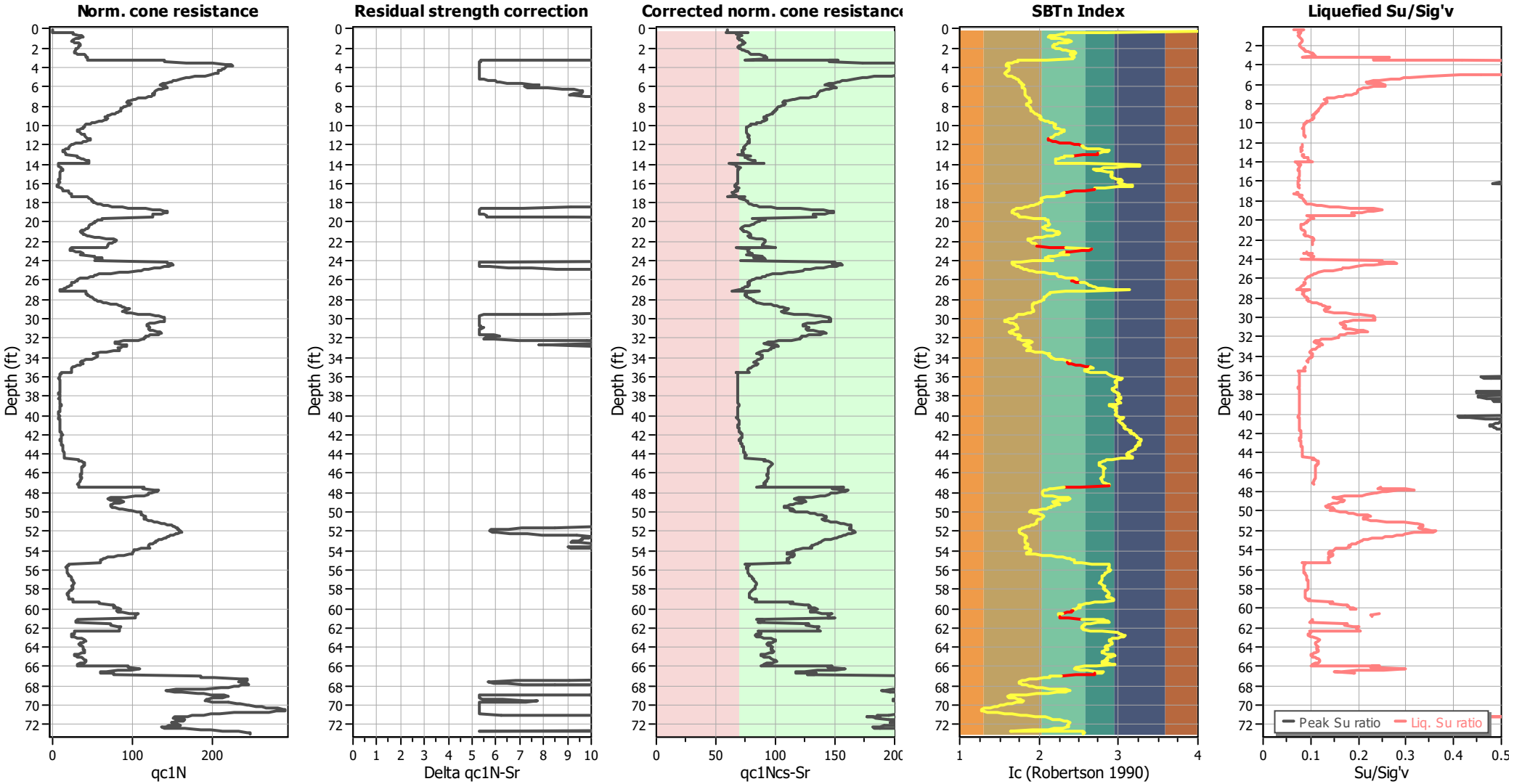




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

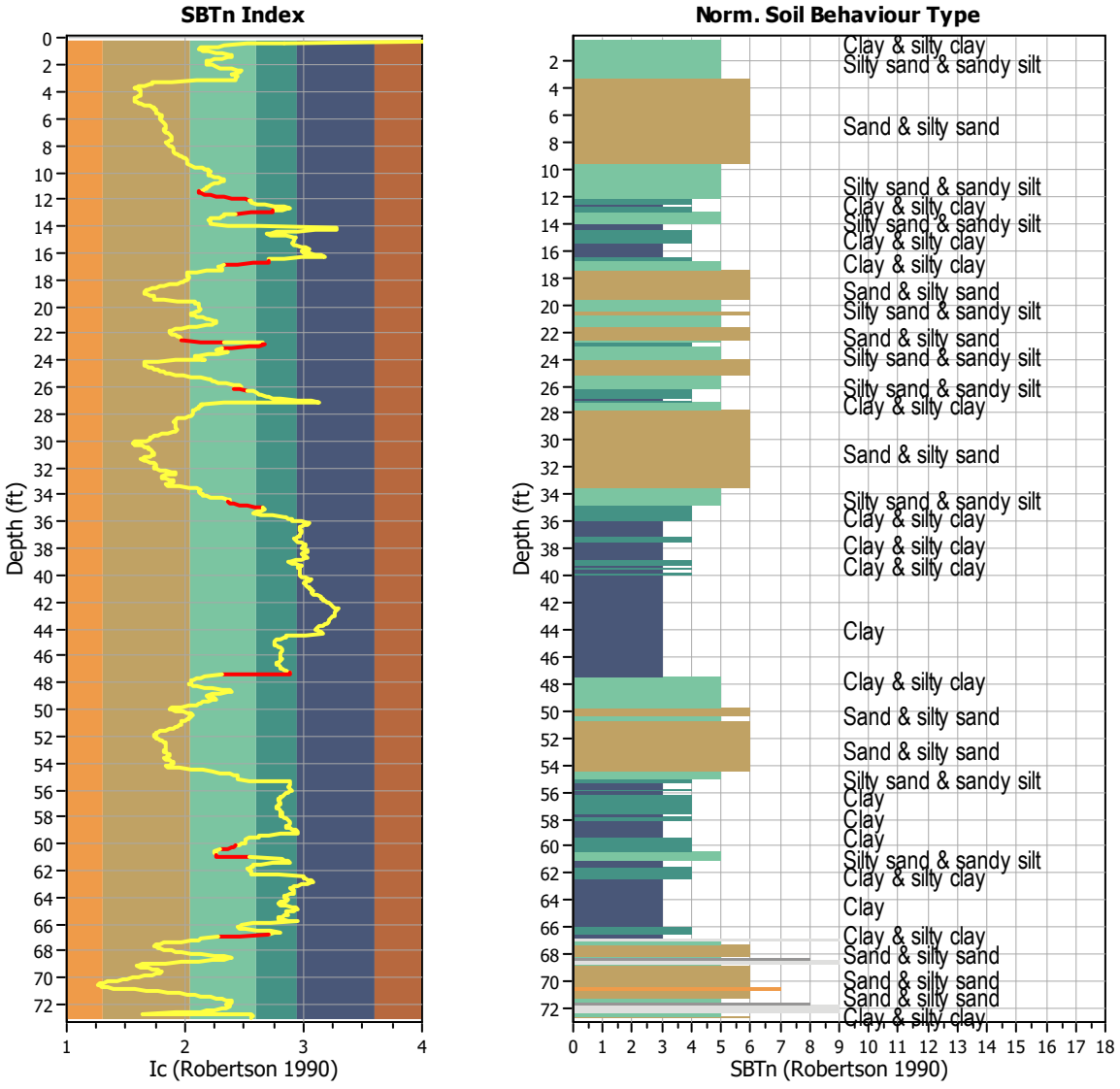
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.03 ft	Fill height:	3.09 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

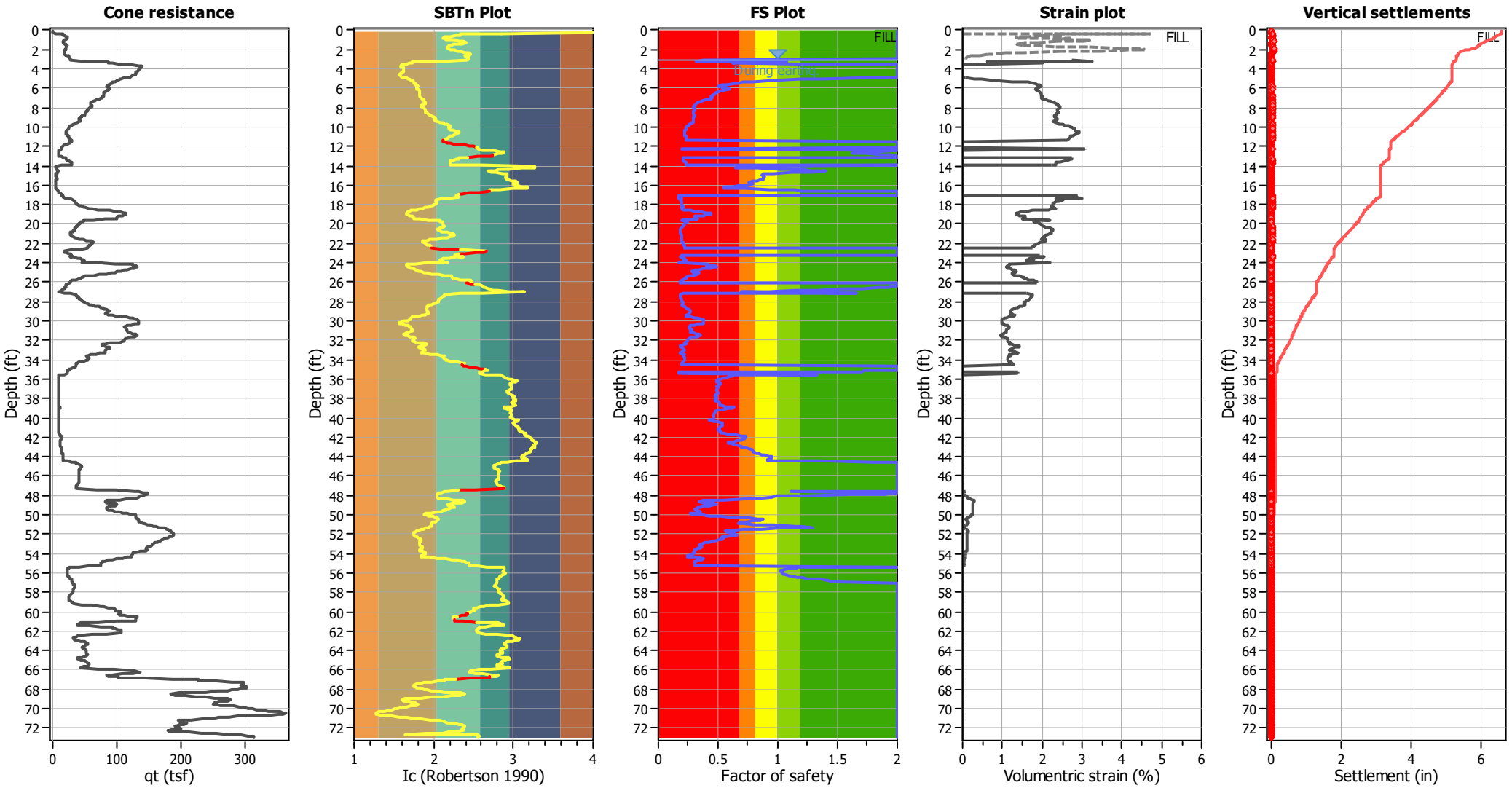
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1111
I_c maximum check value:	3.00	Total points excluded:	59
I_c change ratio value:	0.0250	Exclusion percentage:	5.31%
Minimum number of points in layer:	4	Number of layers detected:	11

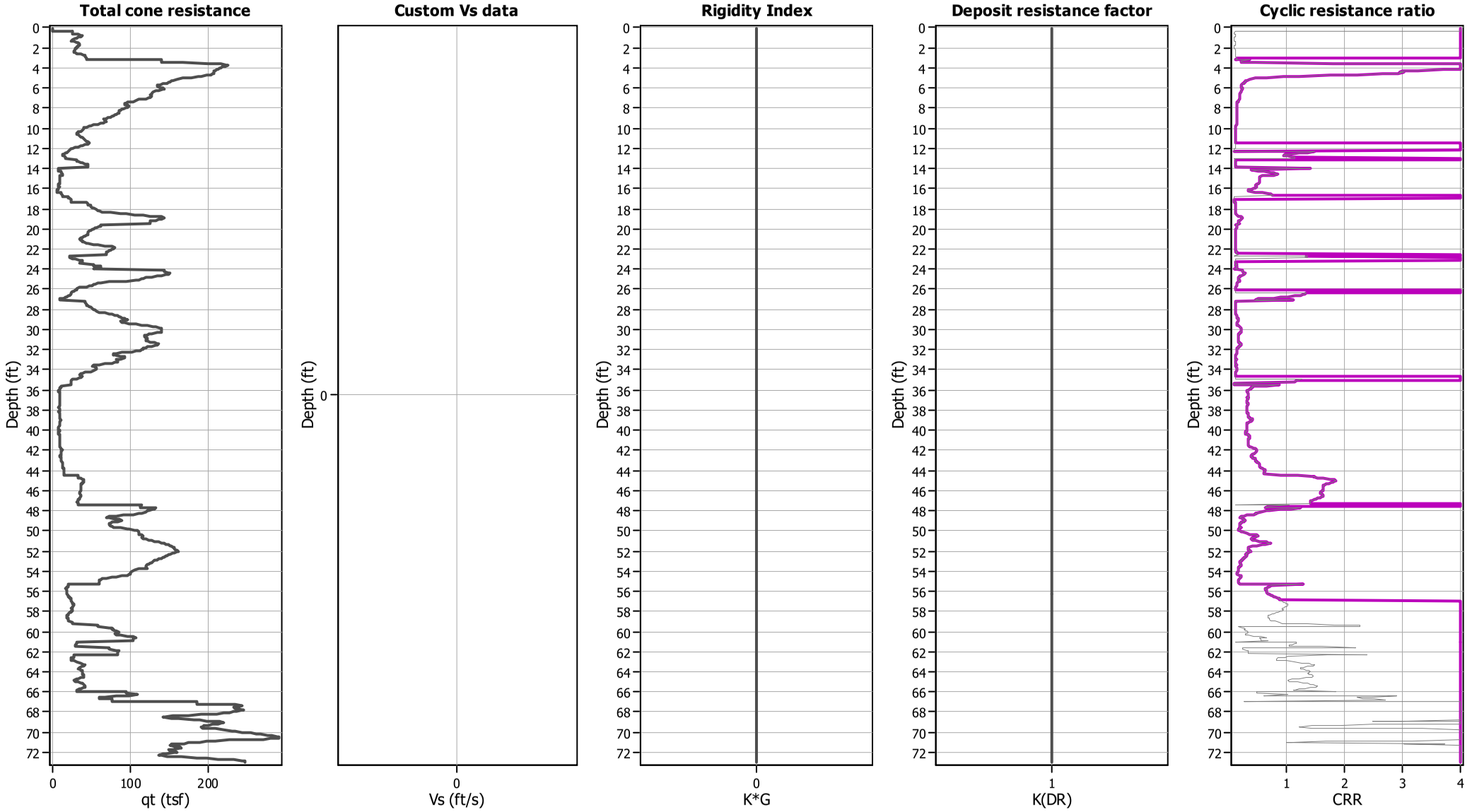
Estimation of post-earthquake settlements



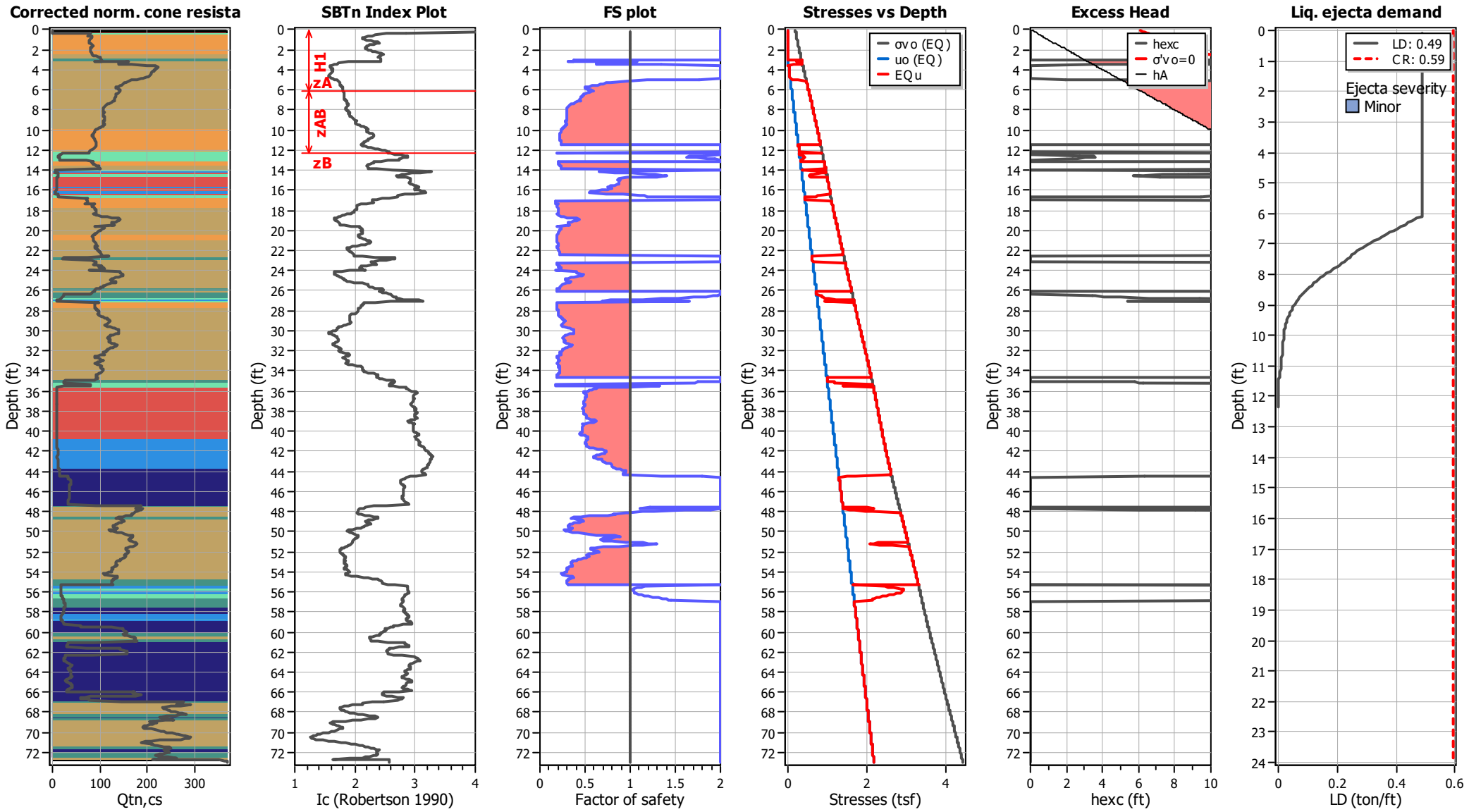
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

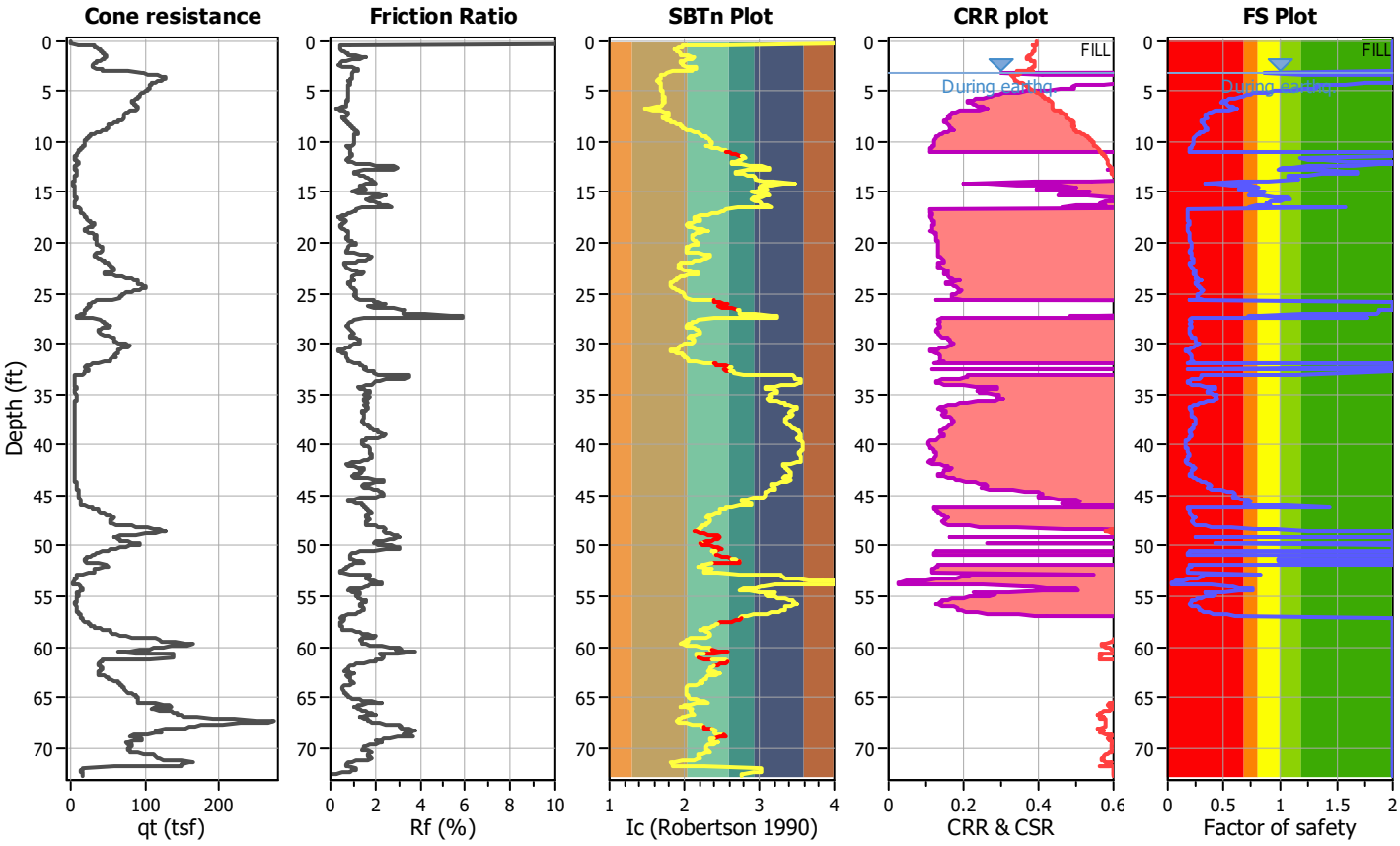
Project title : Topgolf Harbor Island

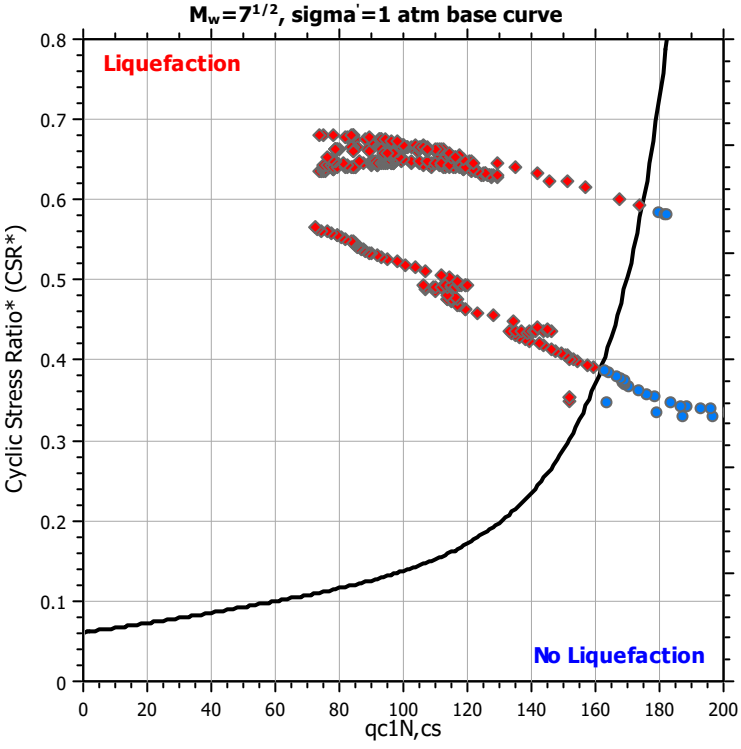
Location : North Harbor Drive and Liberator Way, San Diego, CA

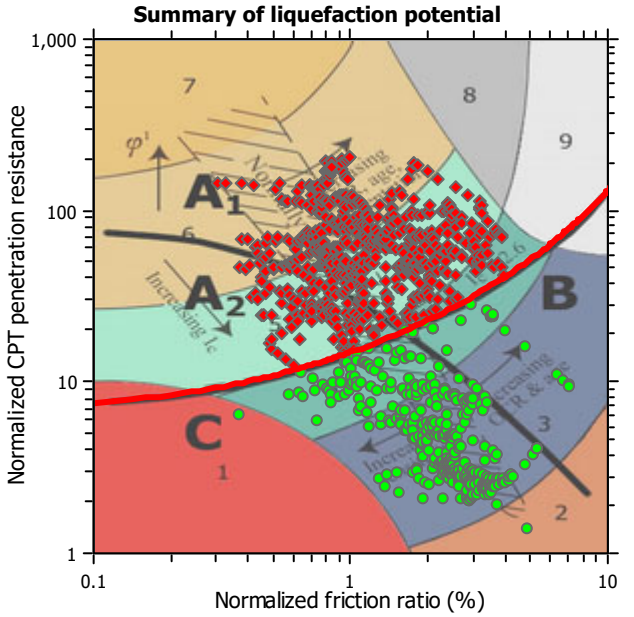
CPT file : CPT-18 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.16 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.12 ft	Fill height:	2.96 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

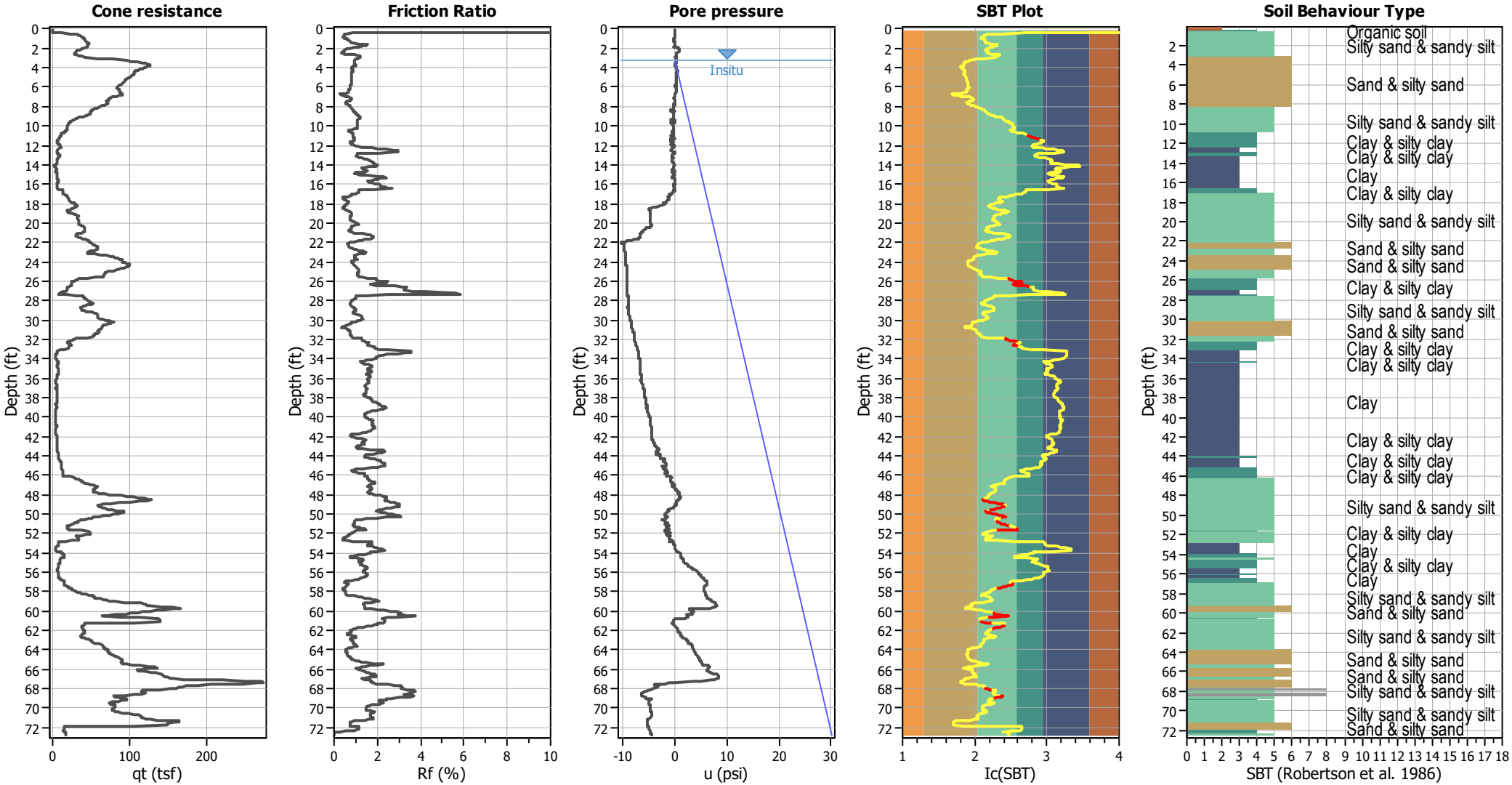






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



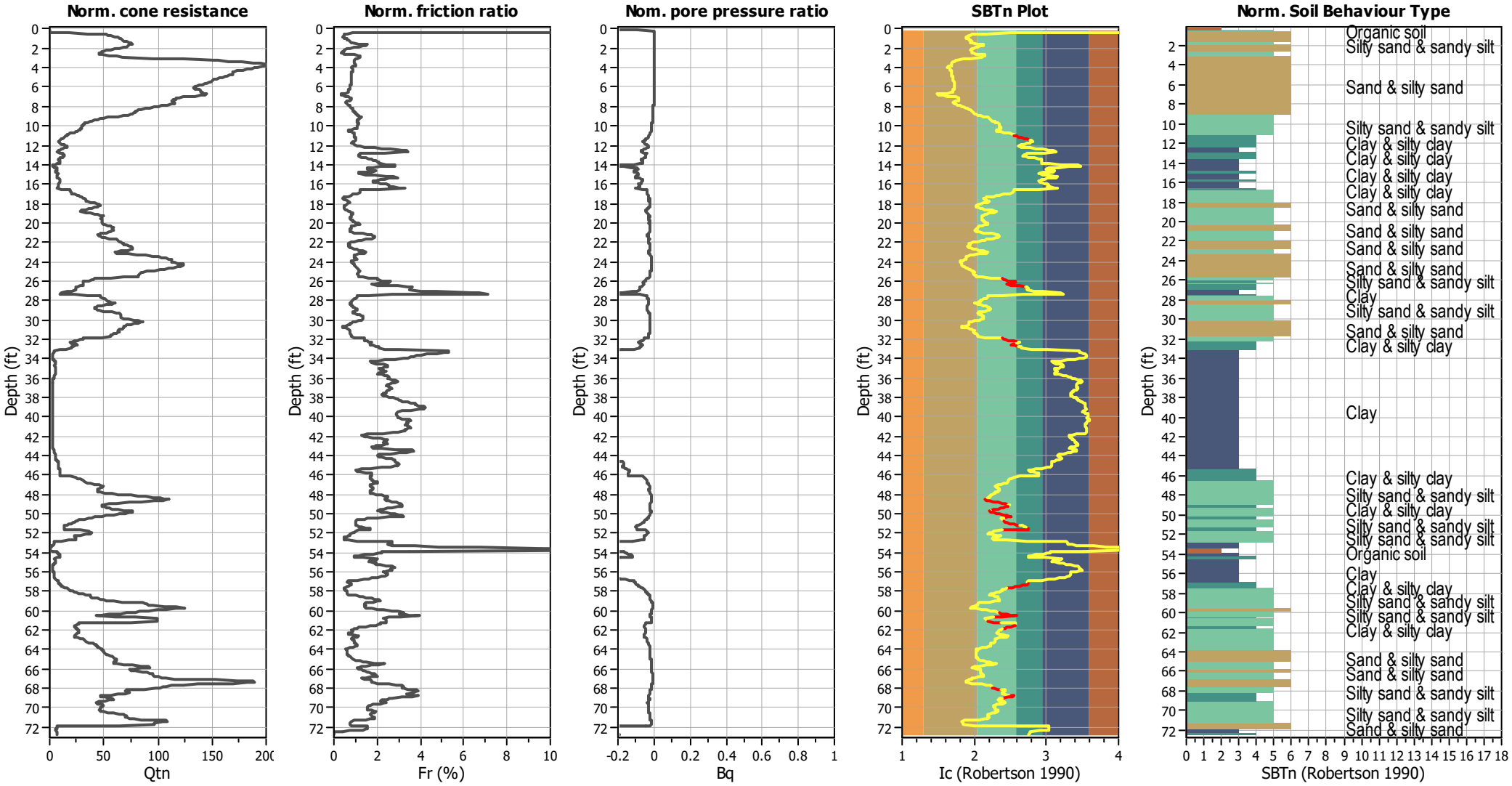
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 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)



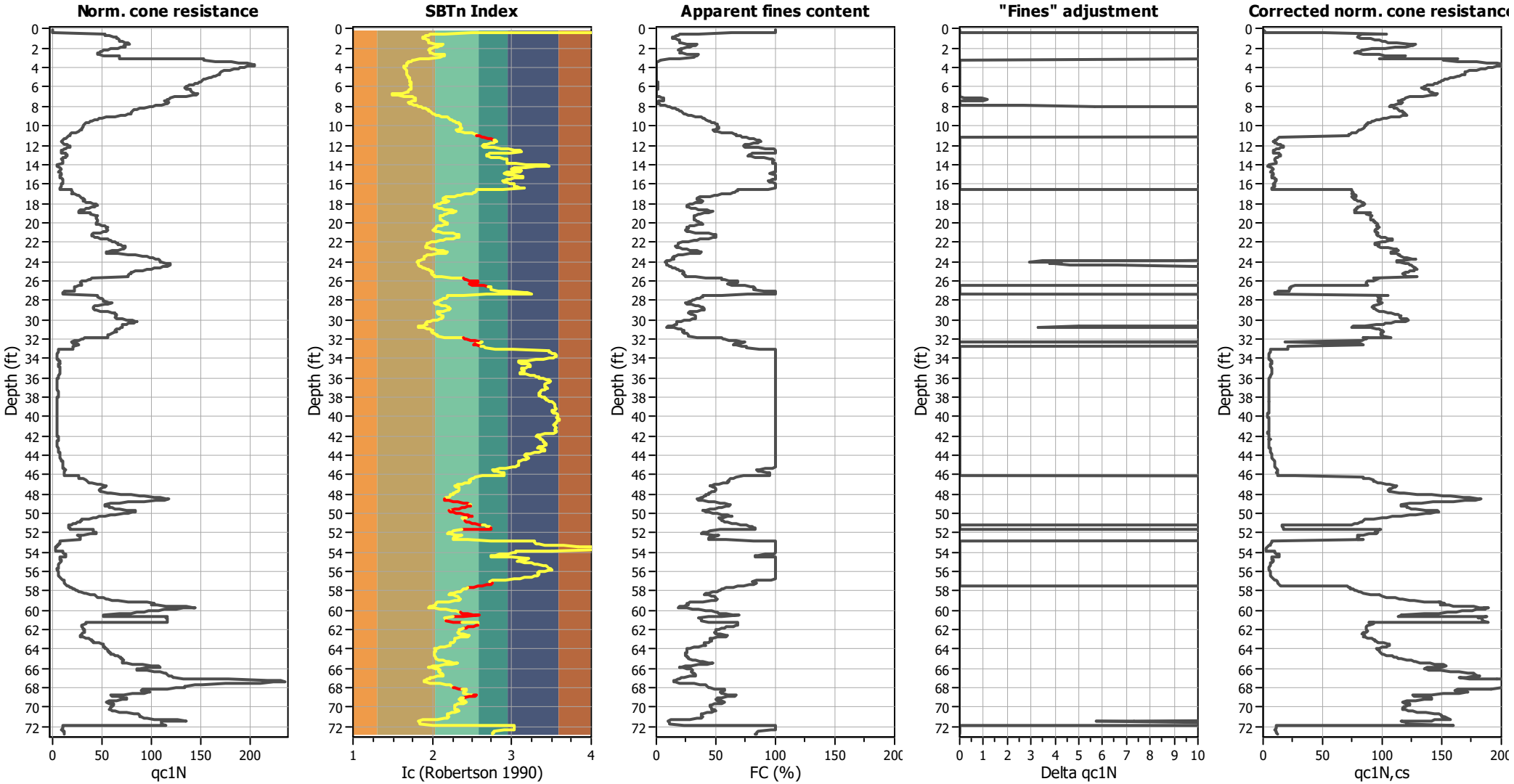
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 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

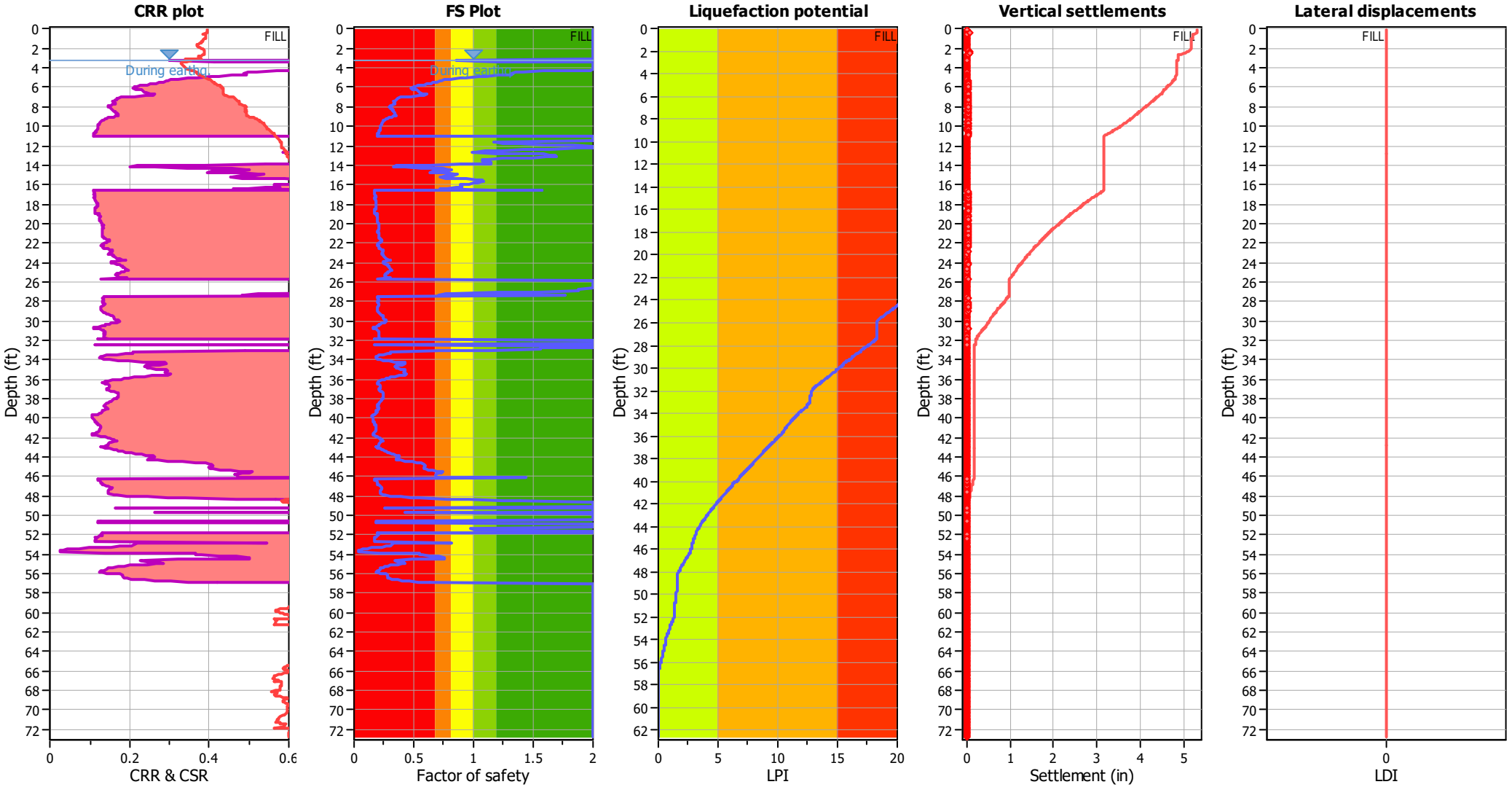
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 ft	Limit depth:	60.00 ft

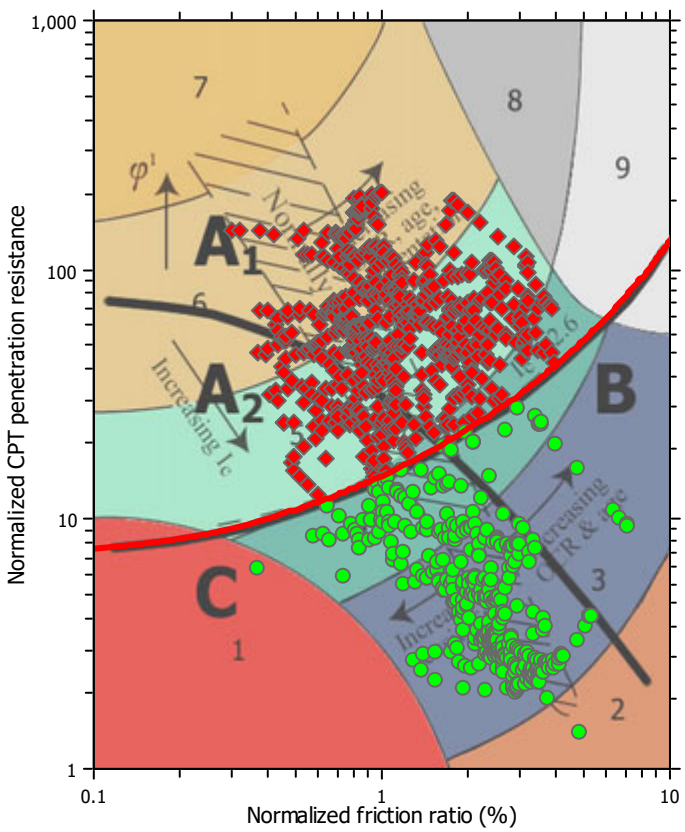
F.S. color scheme

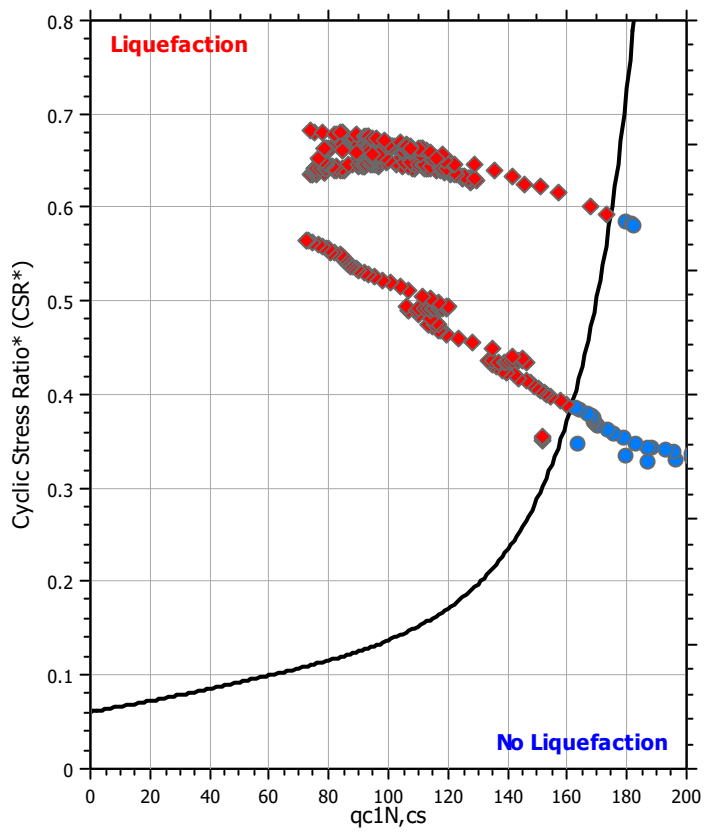
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

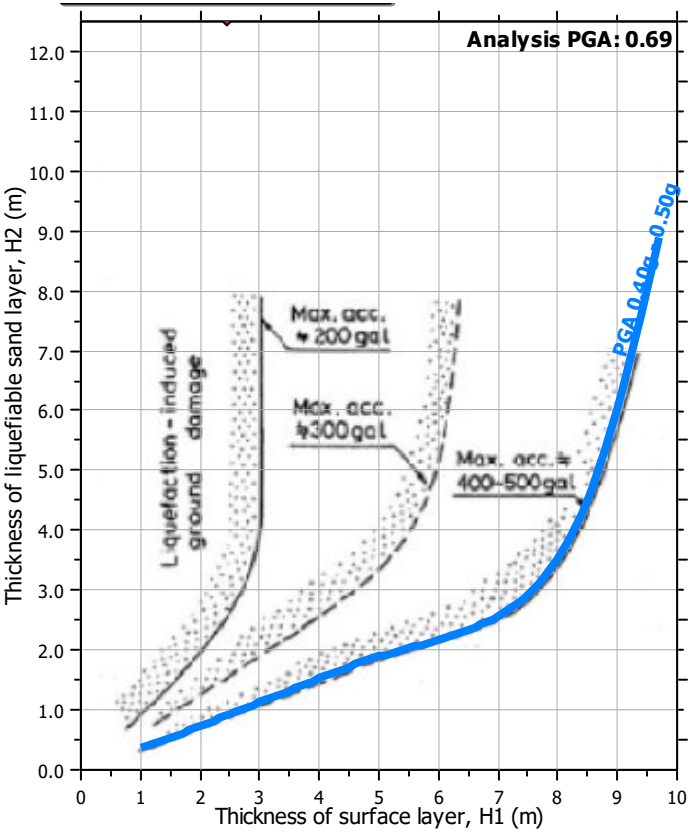
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



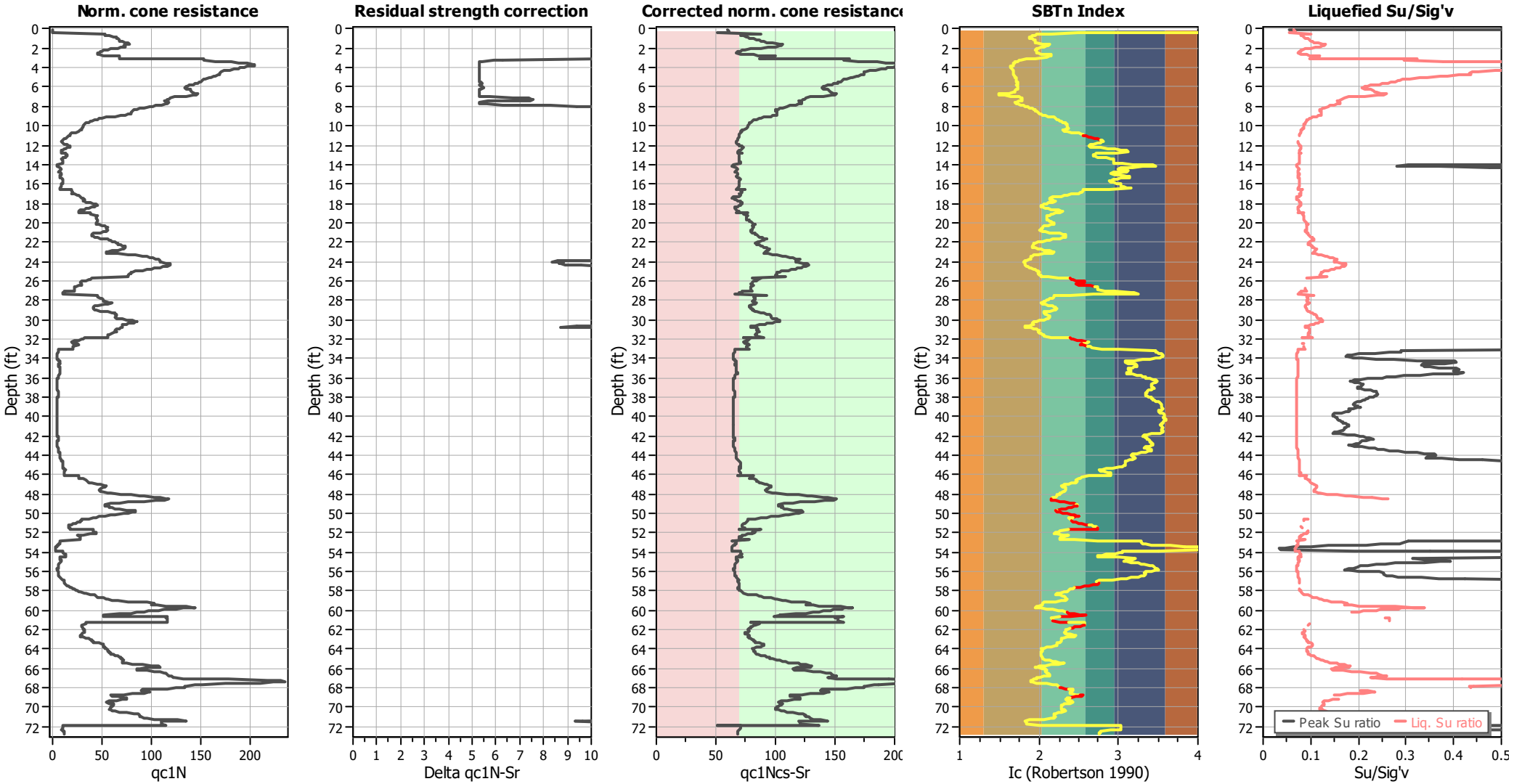




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

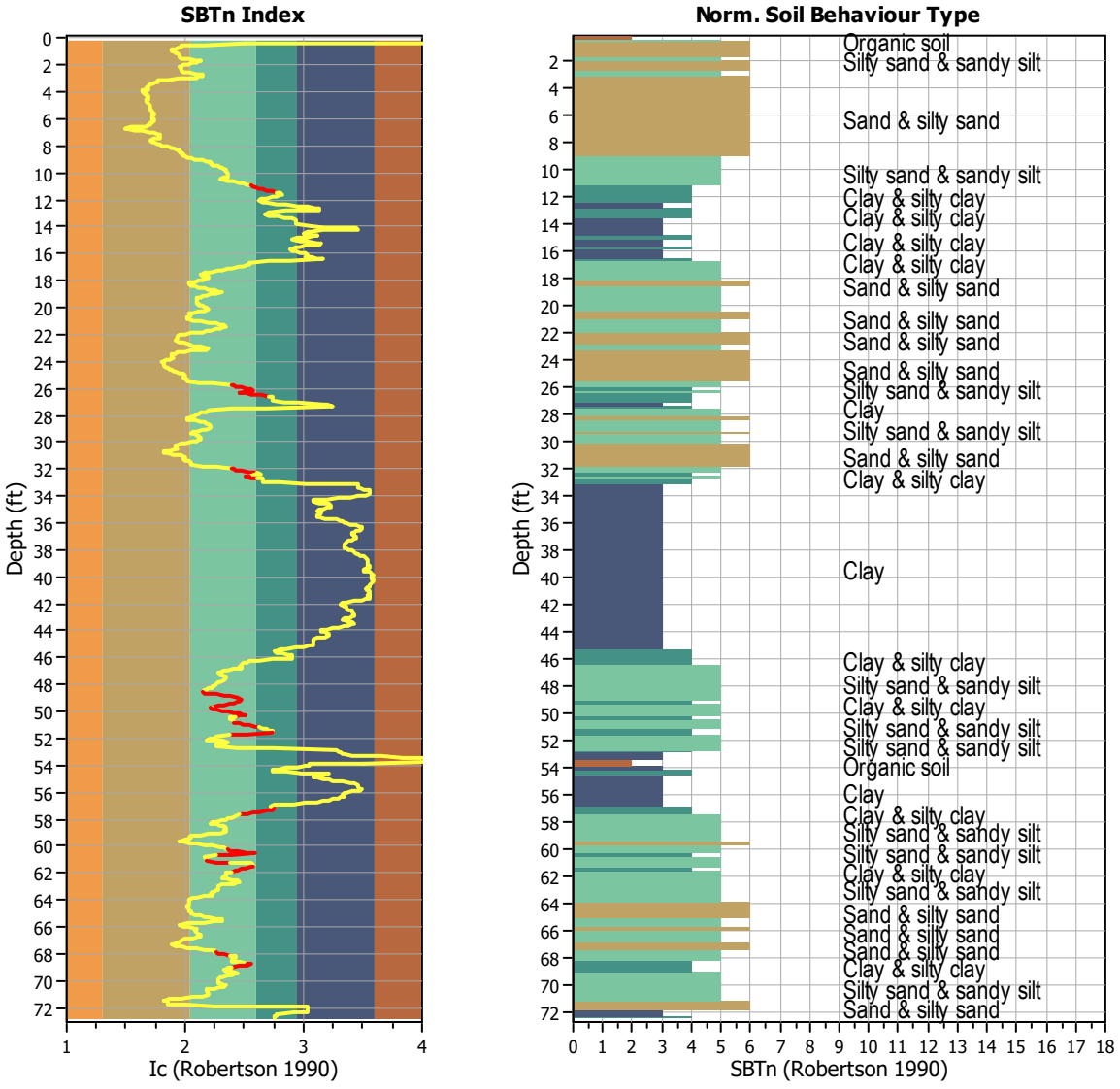
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.16 ft	Fill height:	2.96 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

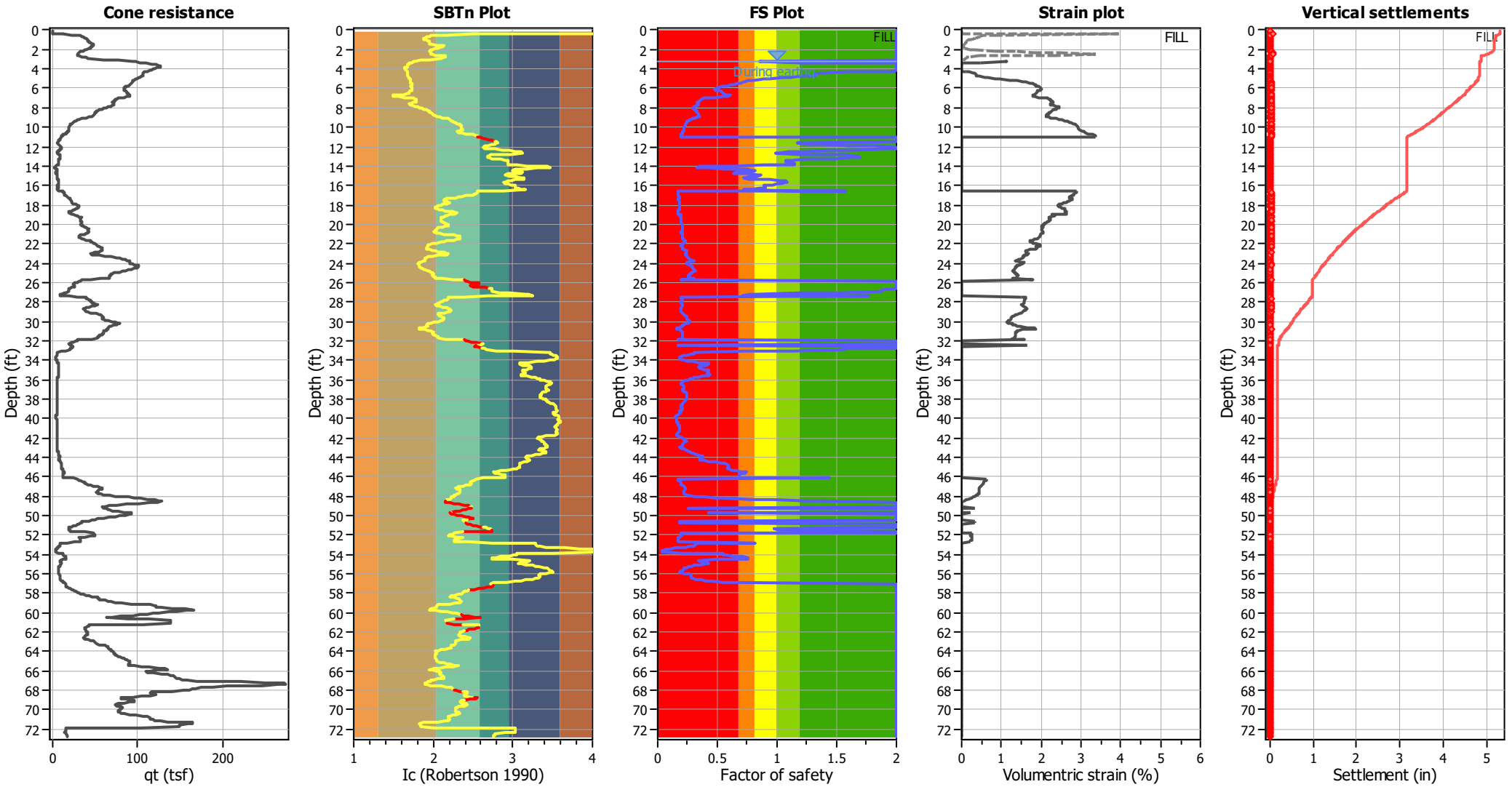
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	108
I_c change ratio value:	0.0250	Exclusion percentage:	9.75%
Minimum number of points in layer:	4	Number of layers detected:	19

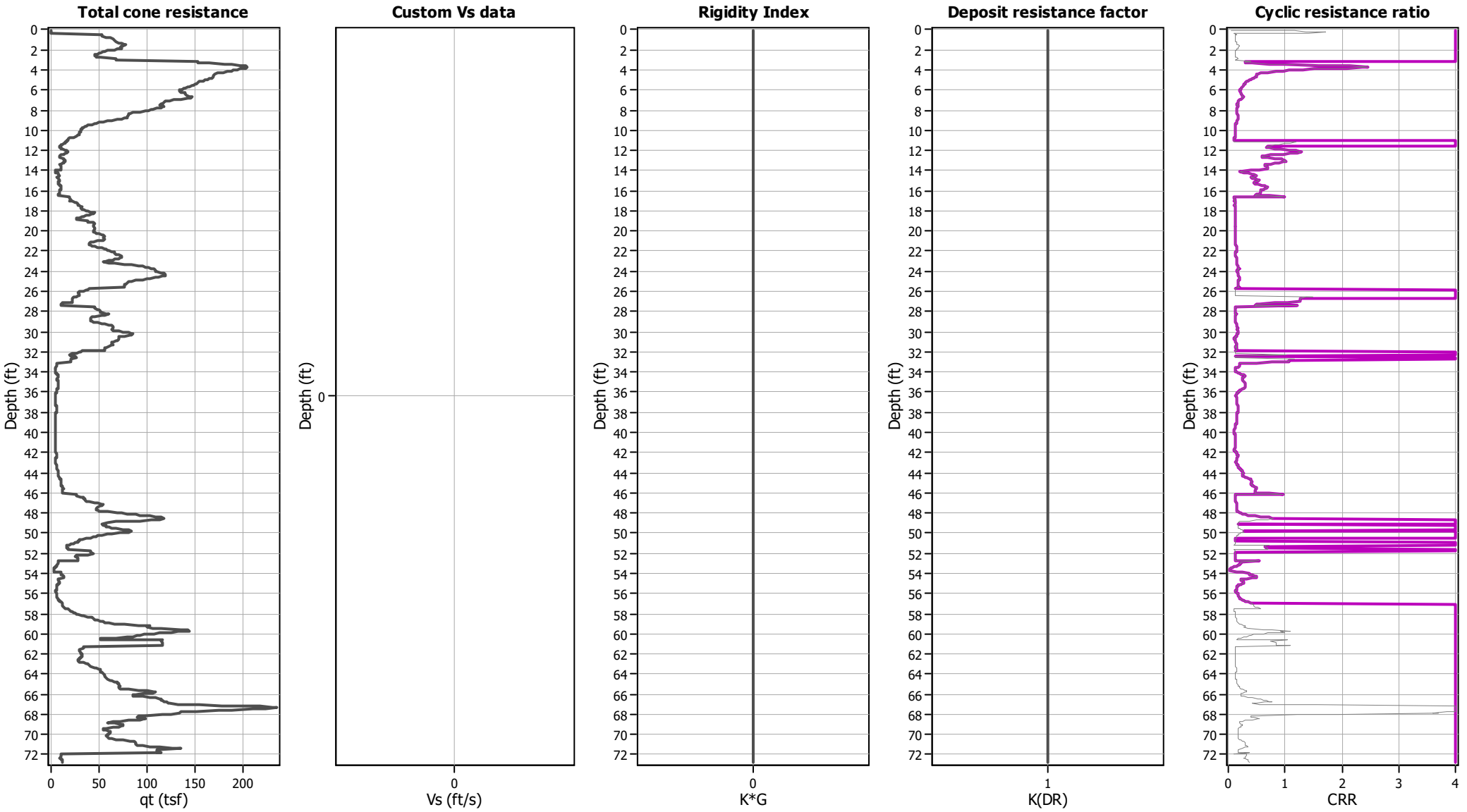
Estimation of post-earthquake settlements



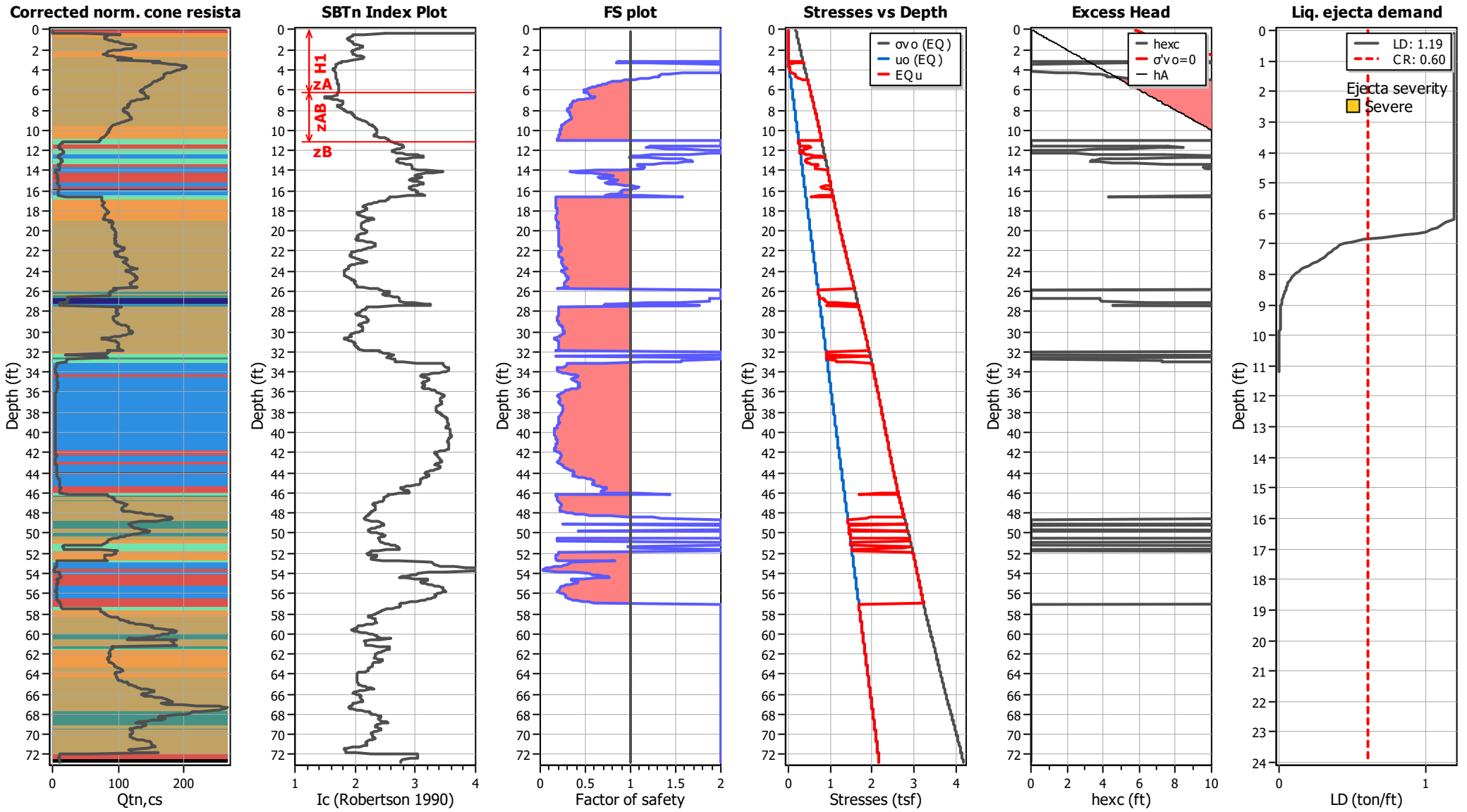
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

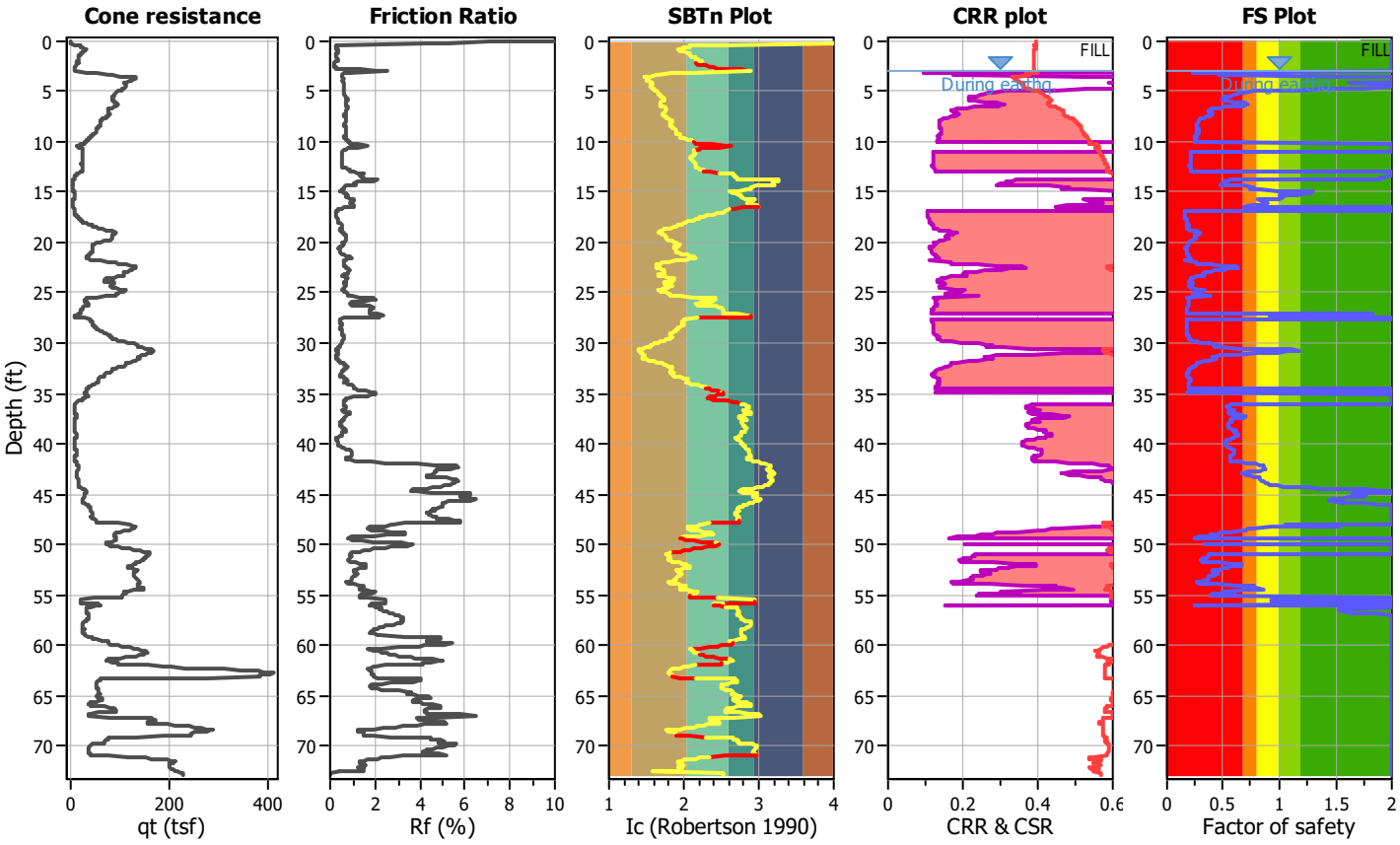
Project title : Topgolf Harbor Island

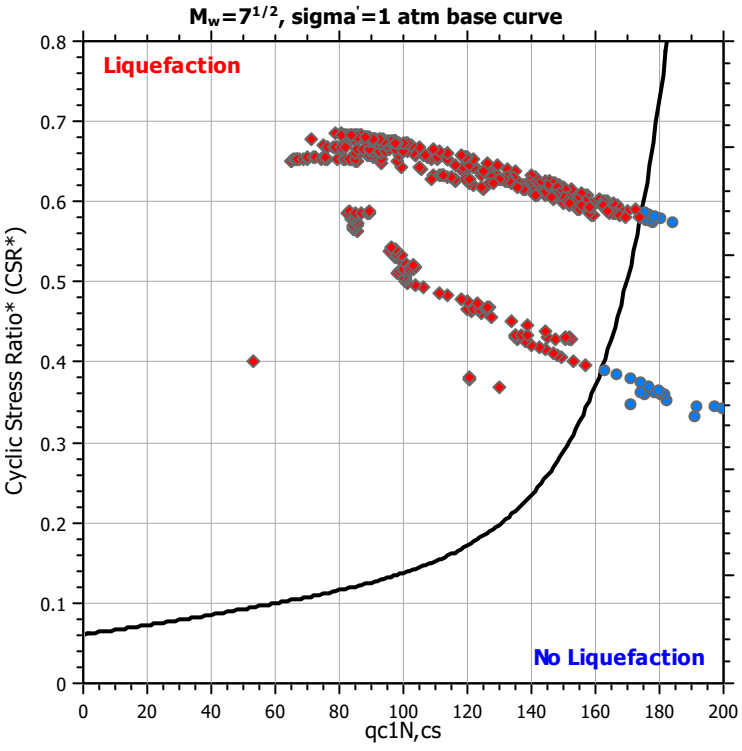
Location : North Harbor Drive and Liberator Way, San Diego, CA

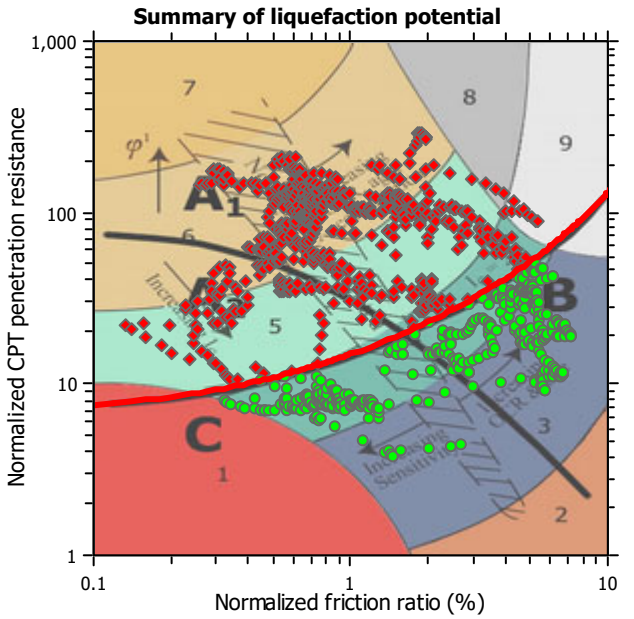
CPT file : CPT-19 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.10 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.12 ft	Fill height:	3.02 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

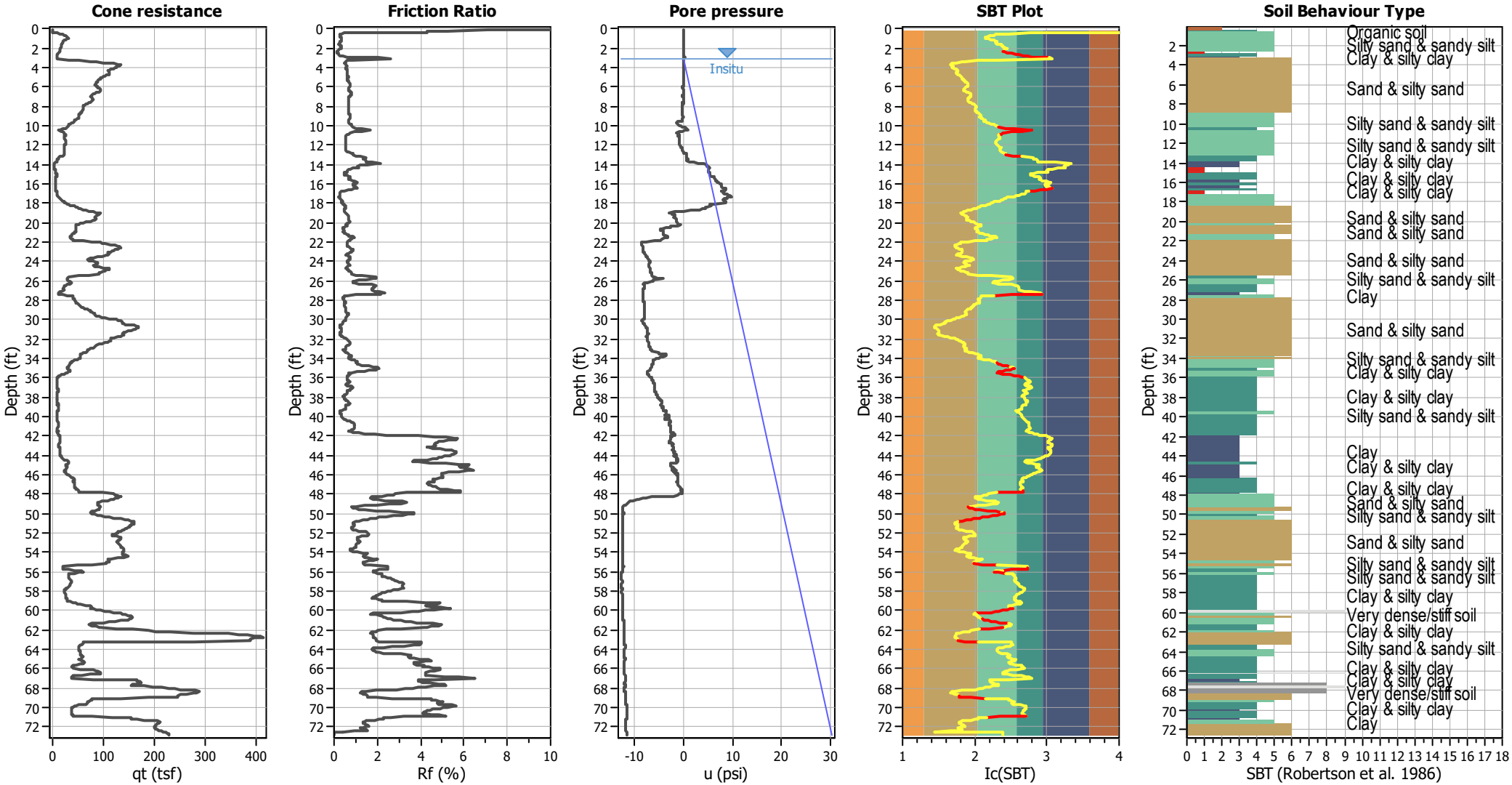






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



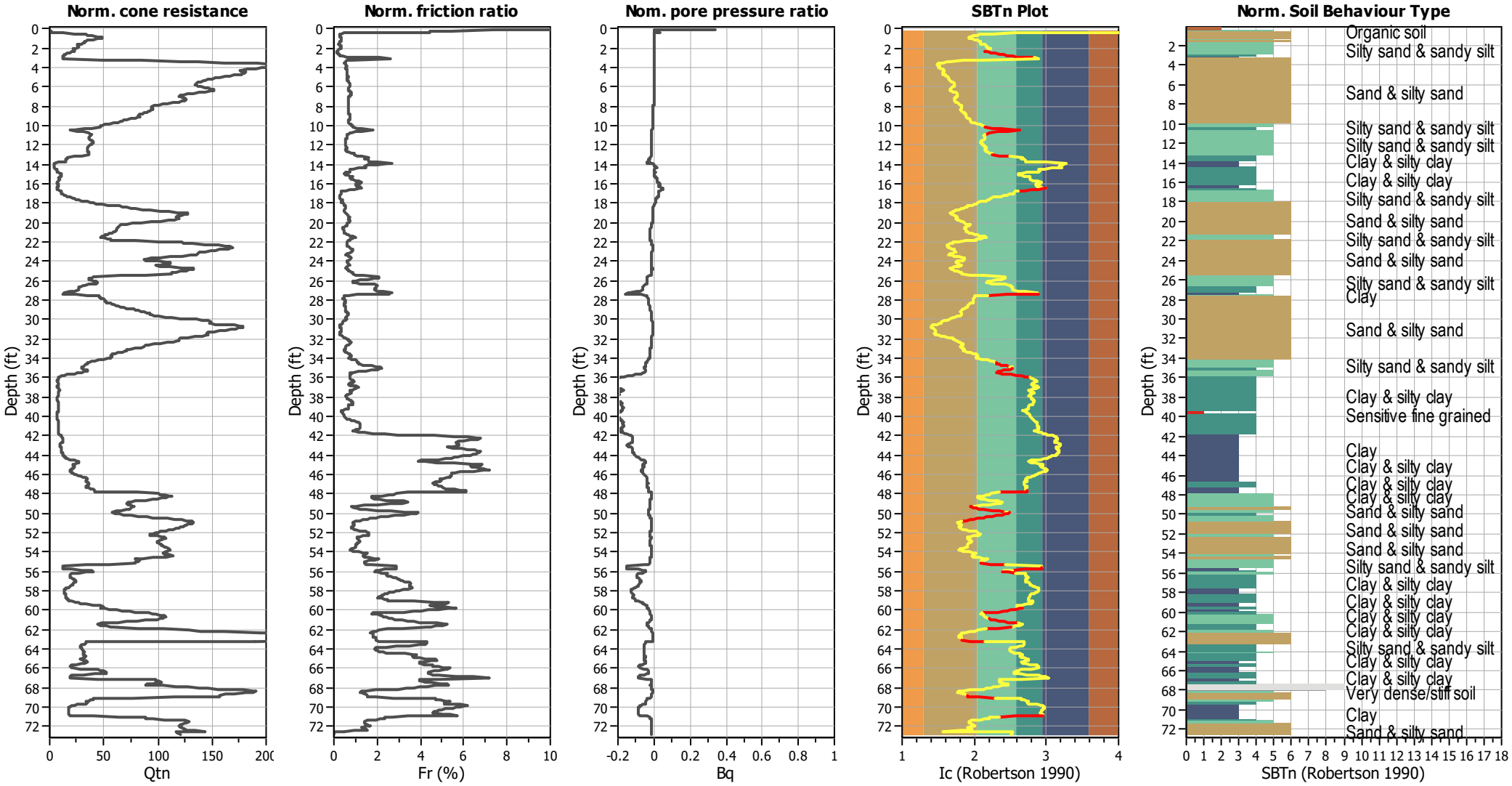
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 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)



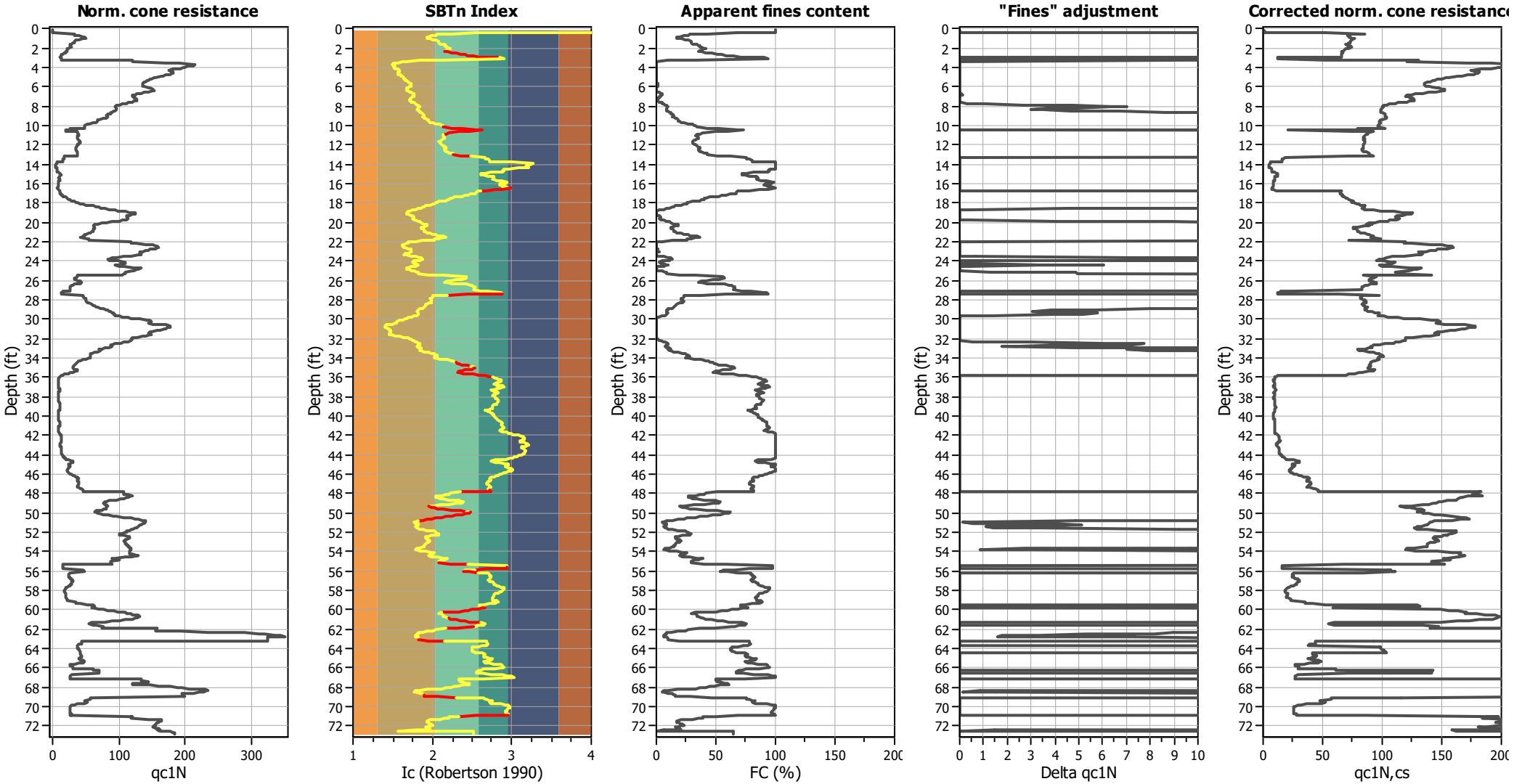
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 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

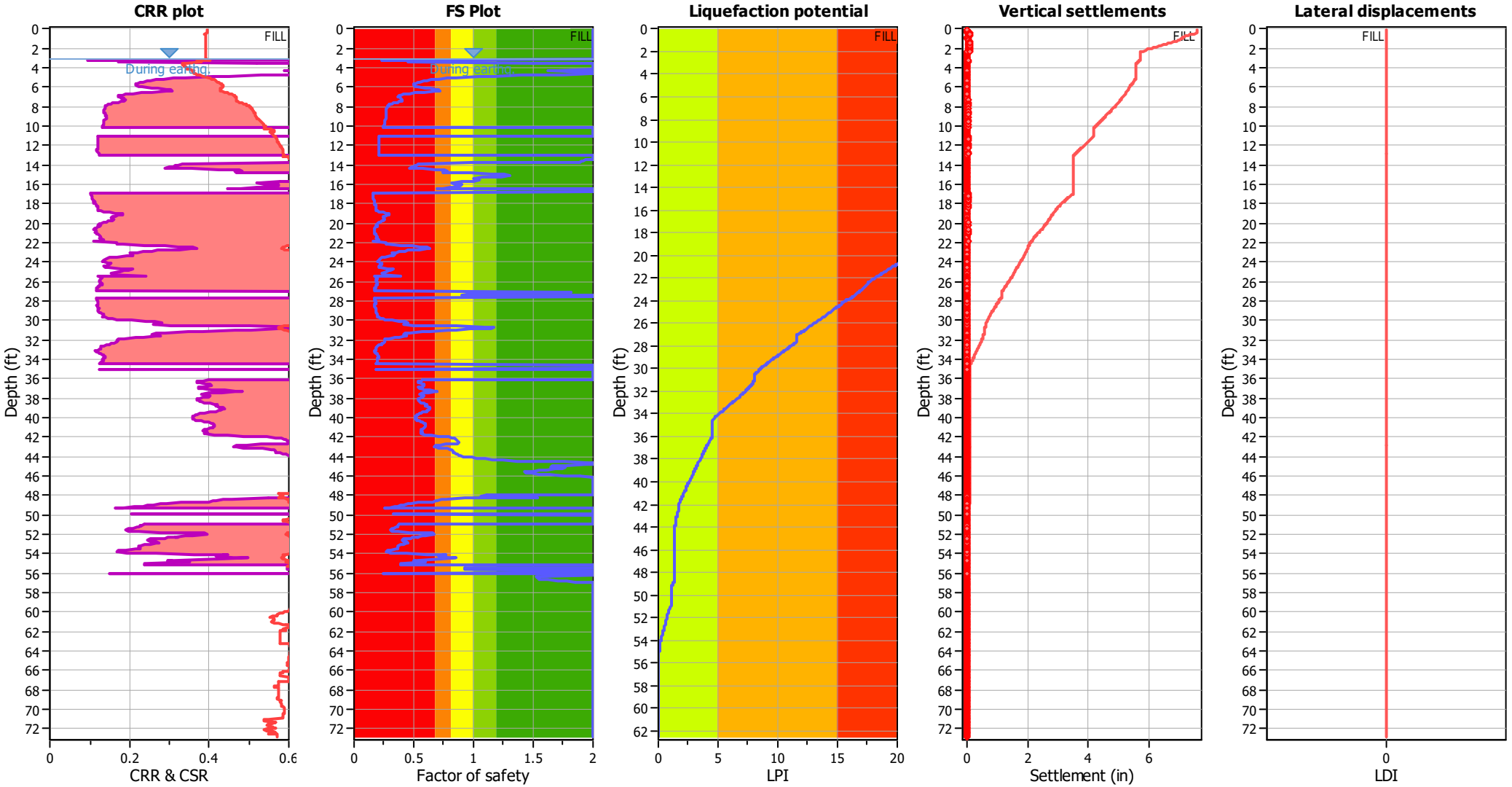
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

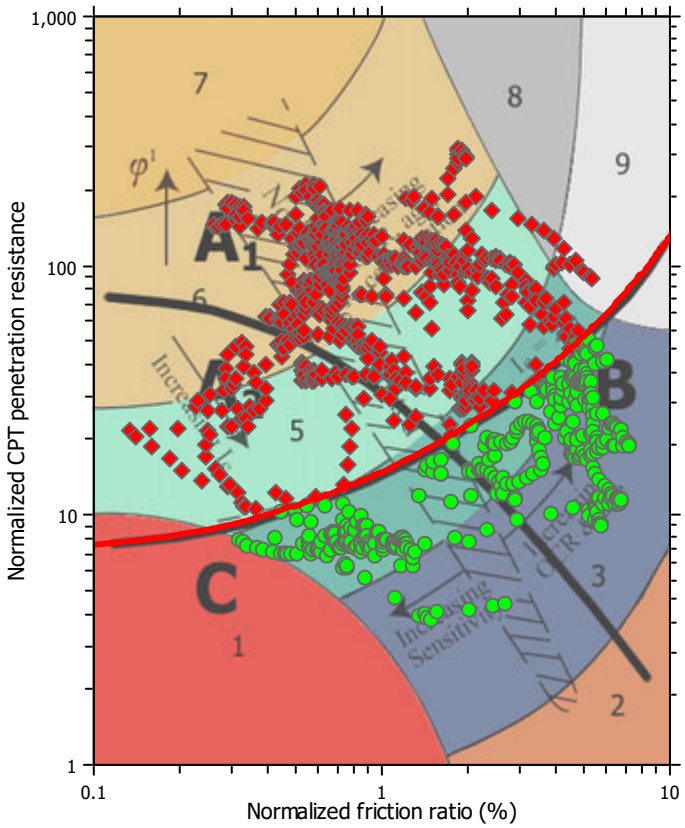
F.S. color scheme

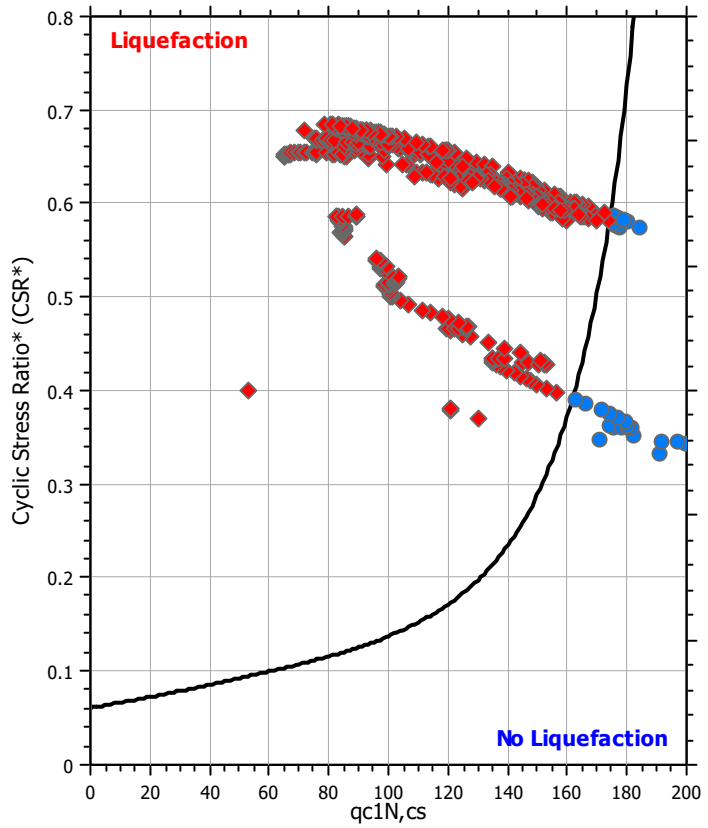
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

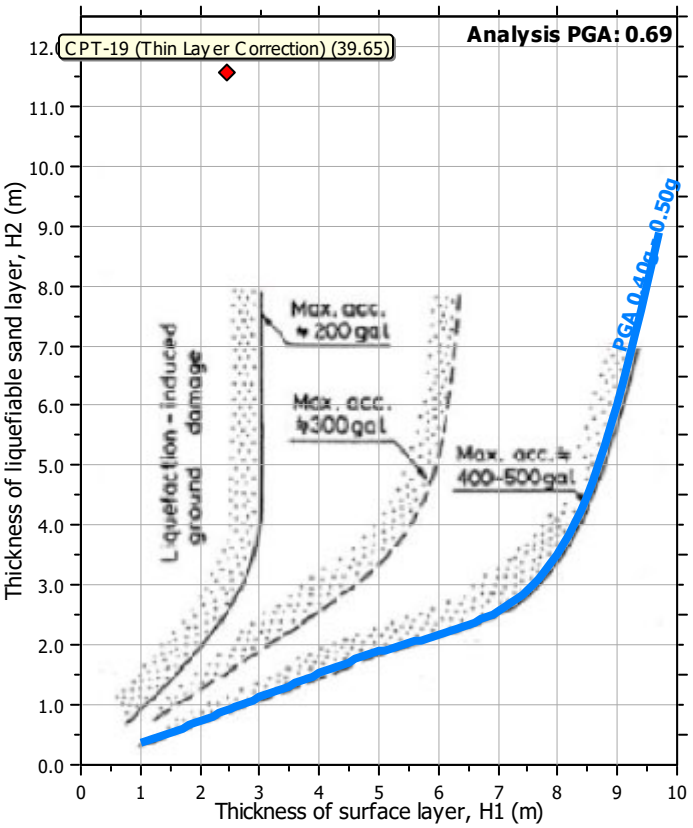
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



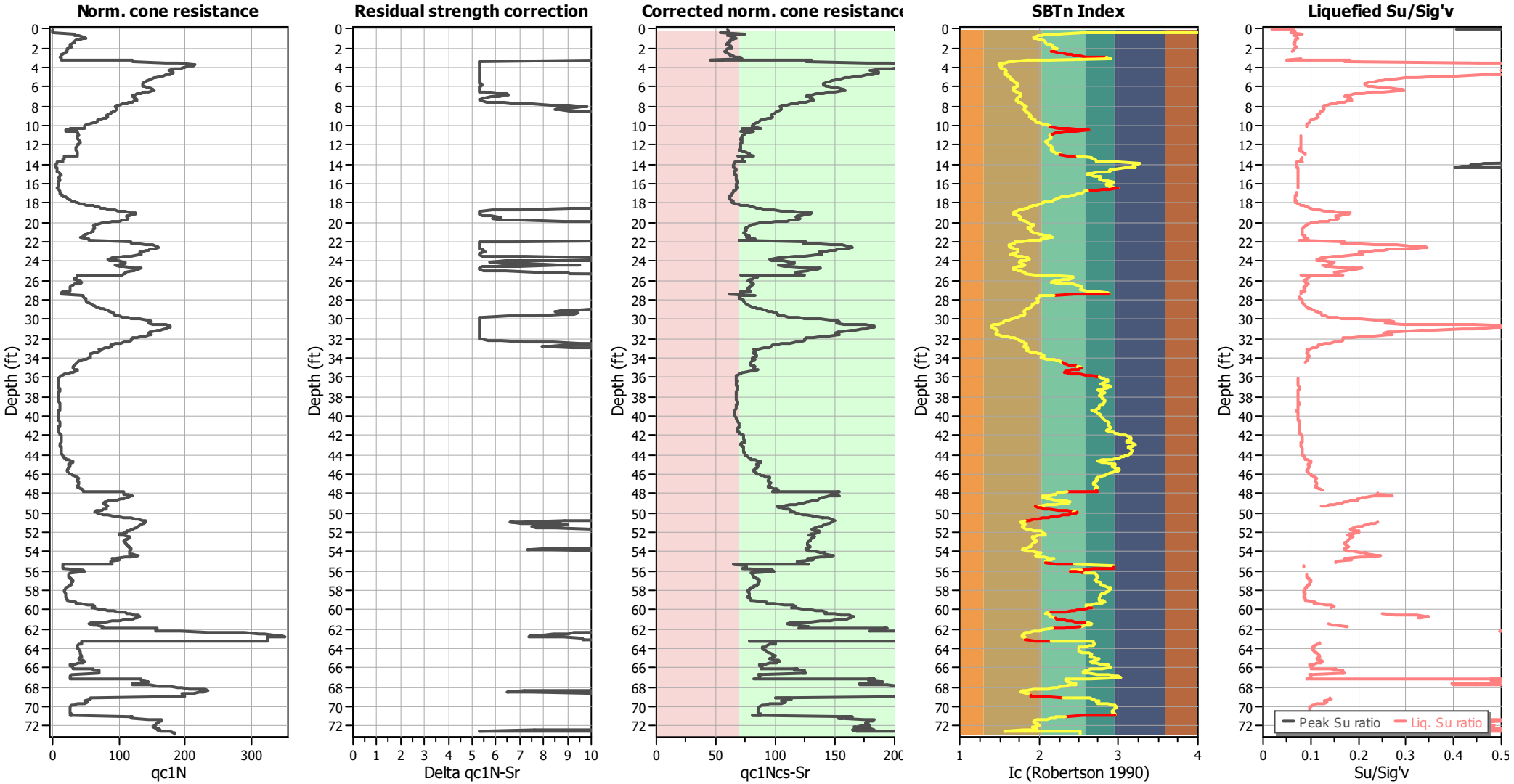




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

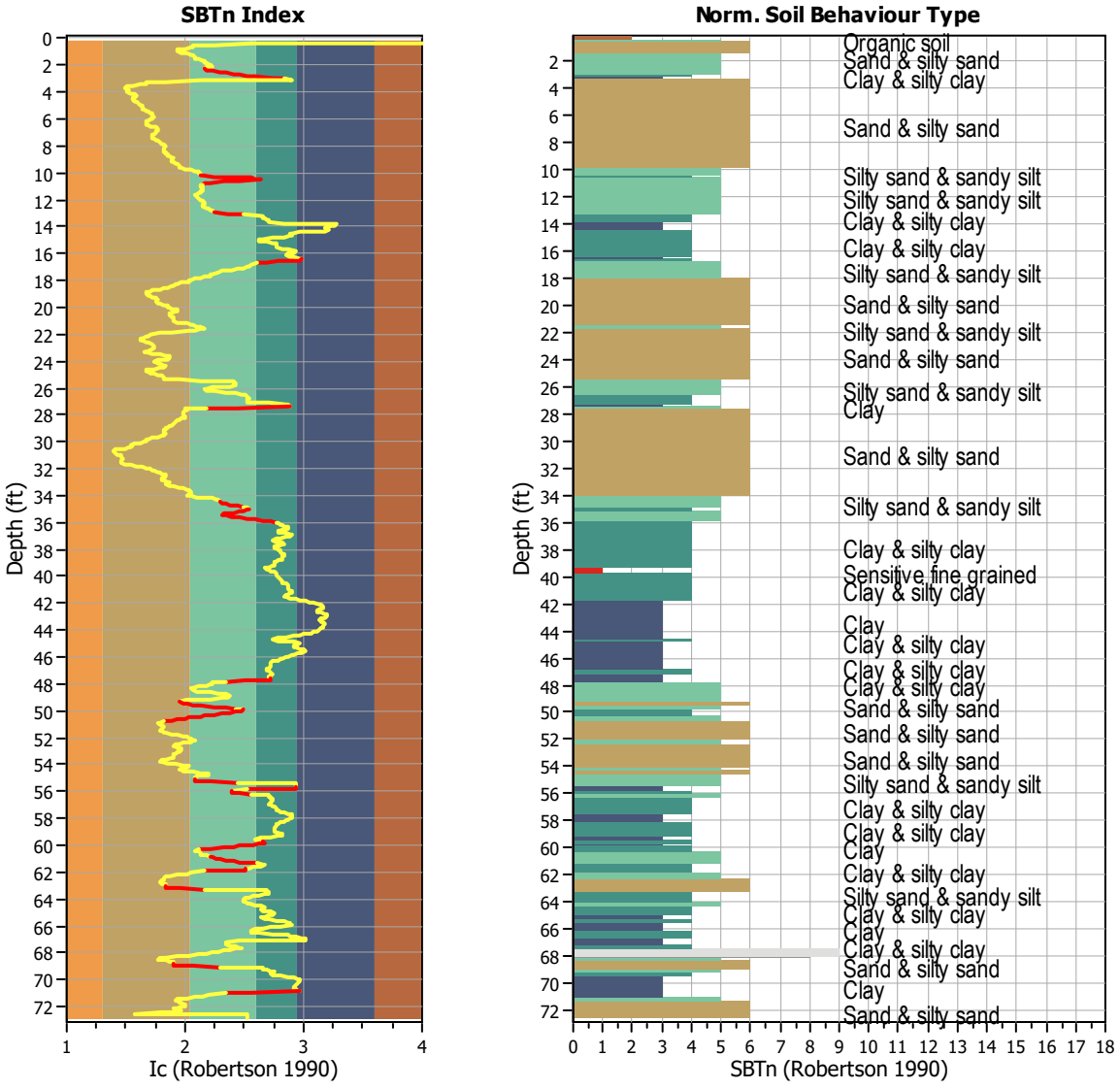
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

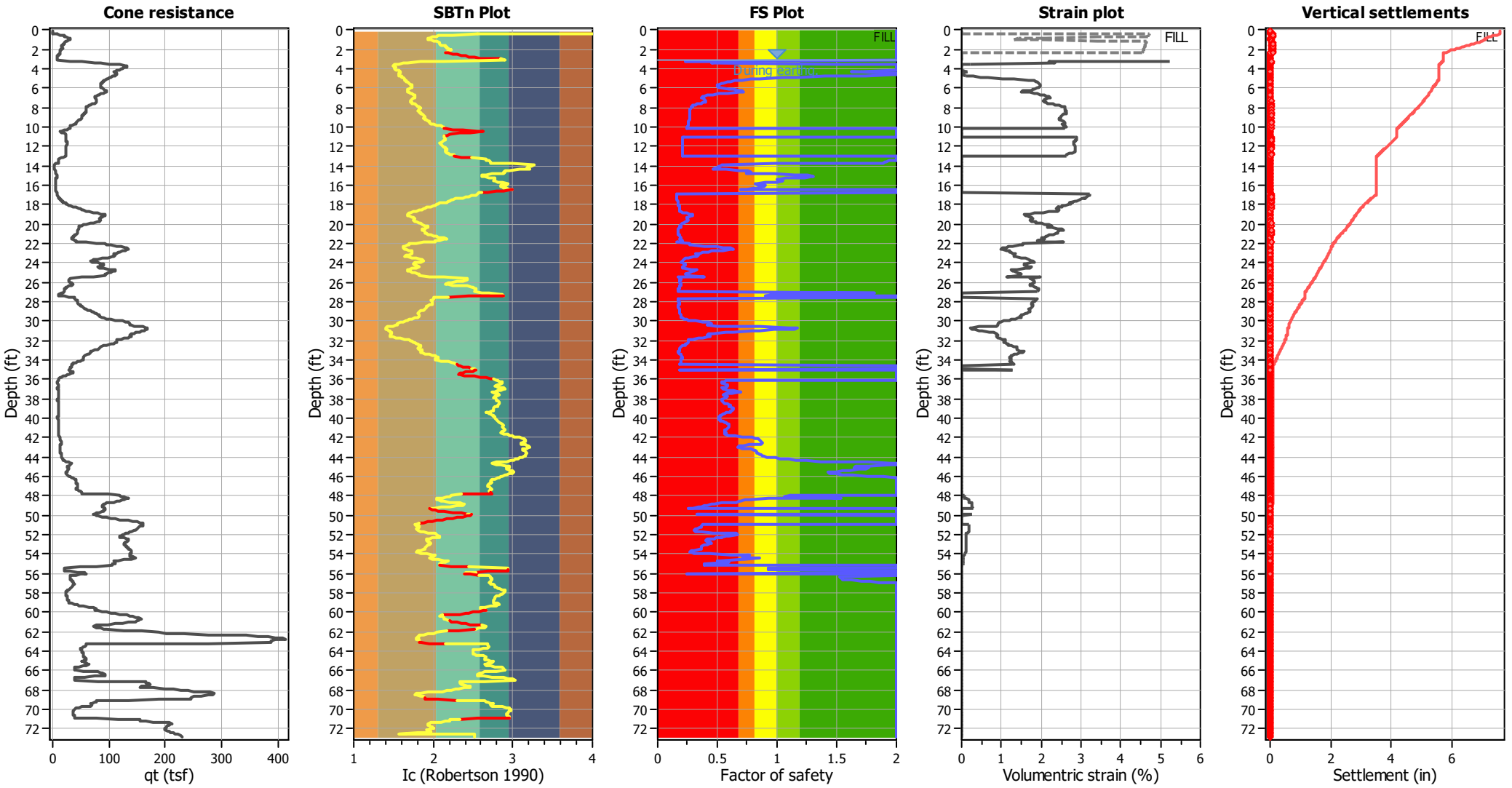
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1109
I_c maximum check value:	3.00	Total points excluded:	137
I_c change ratio value:	0.0250	Exclusion percentage:	12.35%
Minimum number of points in layer:	4	Number of layers detected:	21

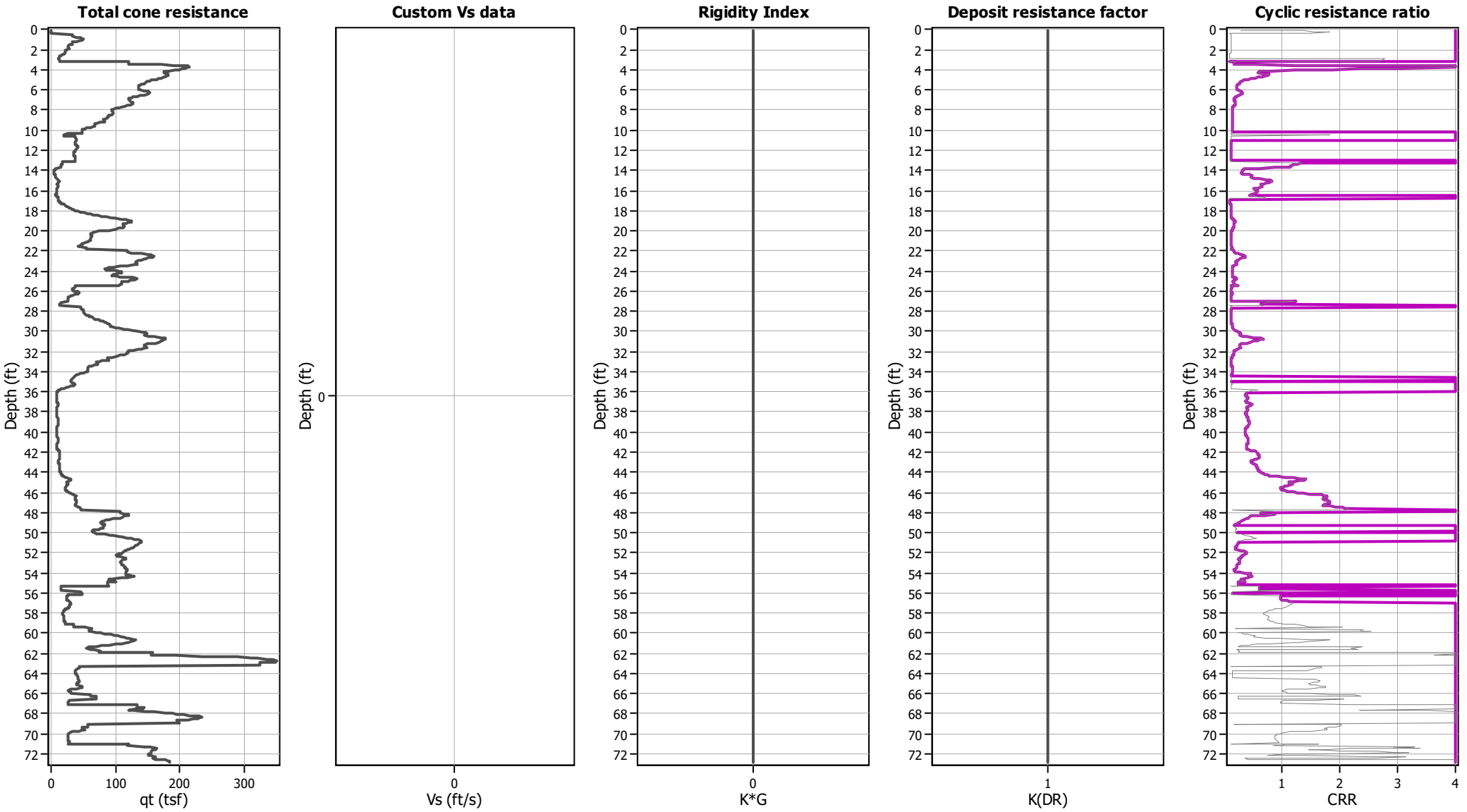
Estimation of post-earthquake settlements



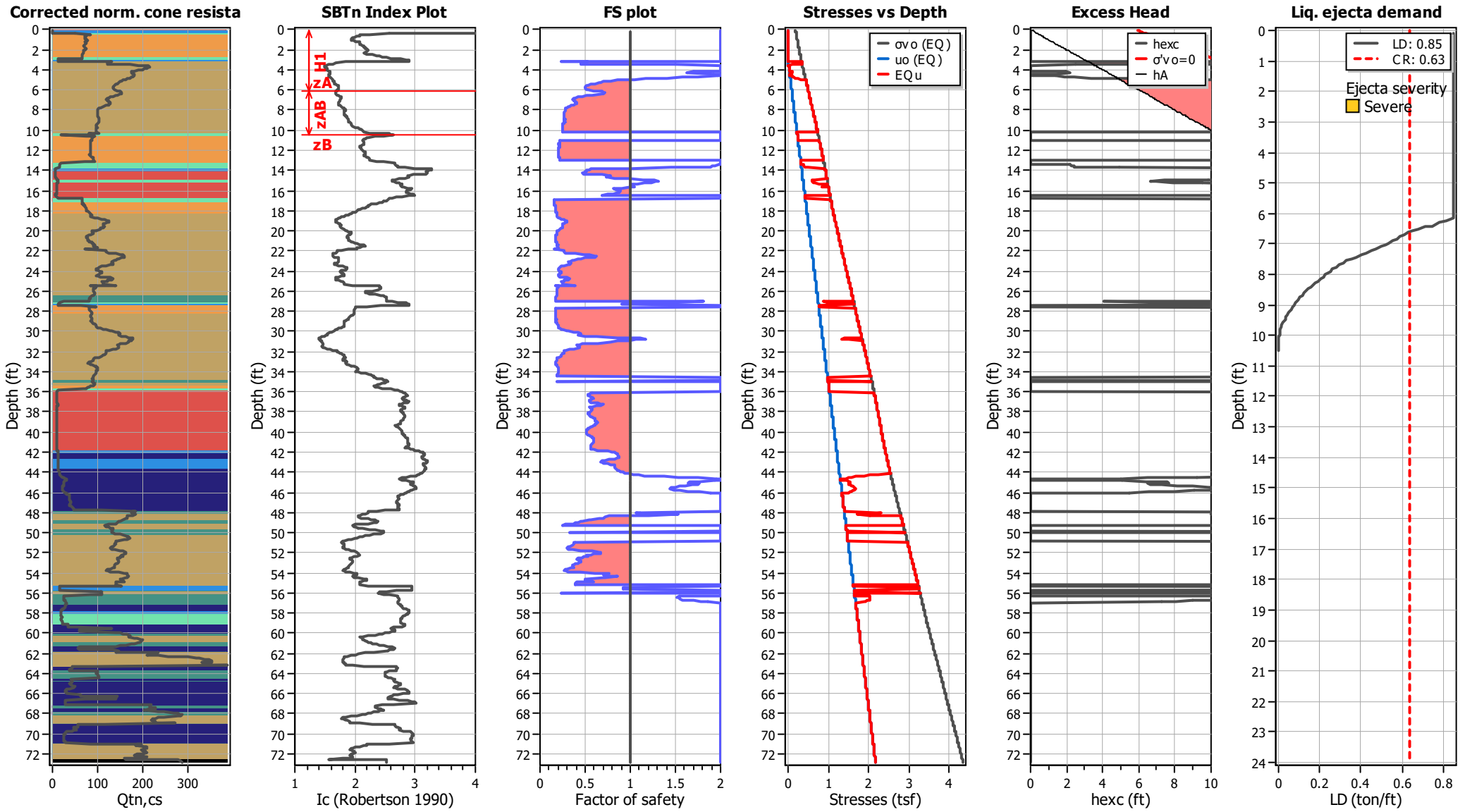
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

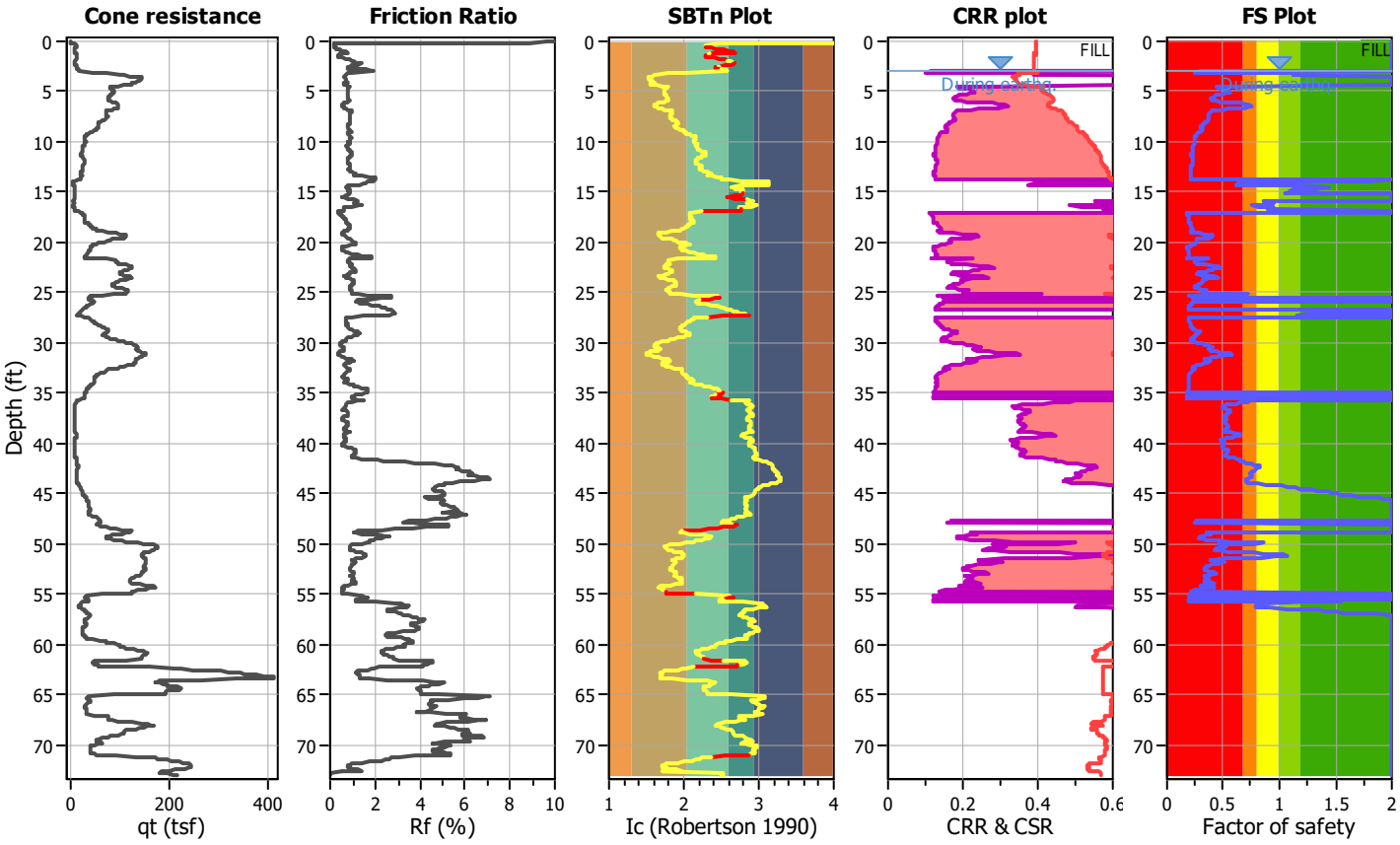
Project title : Topgolf Harbor Island

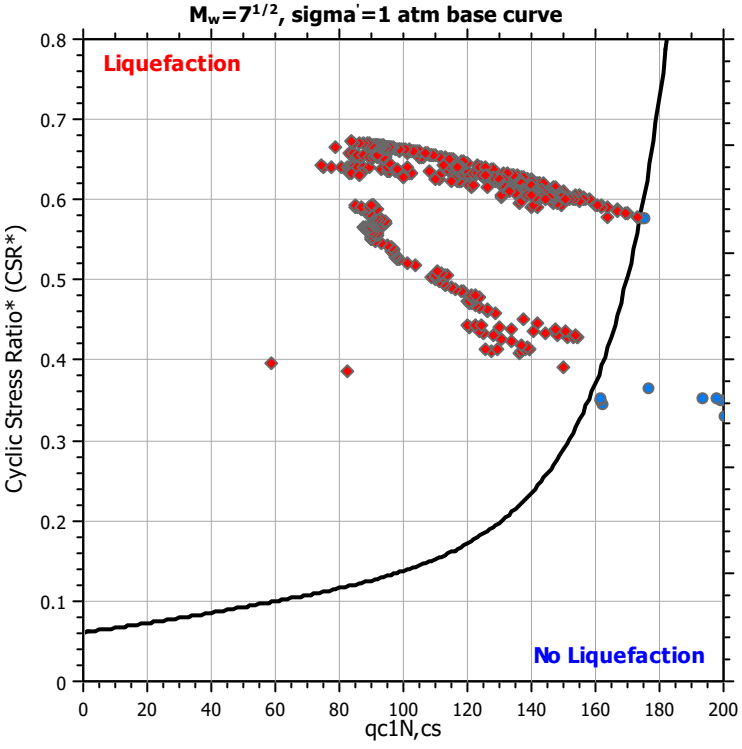
Location : North Harbor Drive and Liberator Way, San Diego, CA

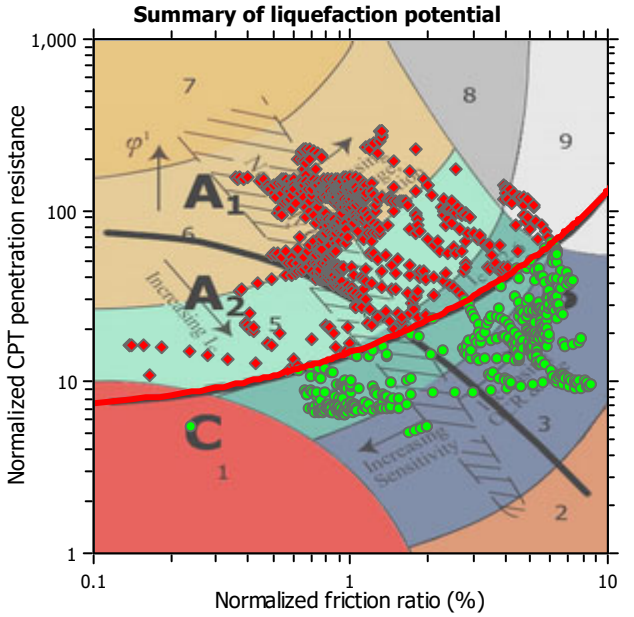
CPT file : CPT-20 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.10 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	6.12 ft	Fill height:	3.02 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

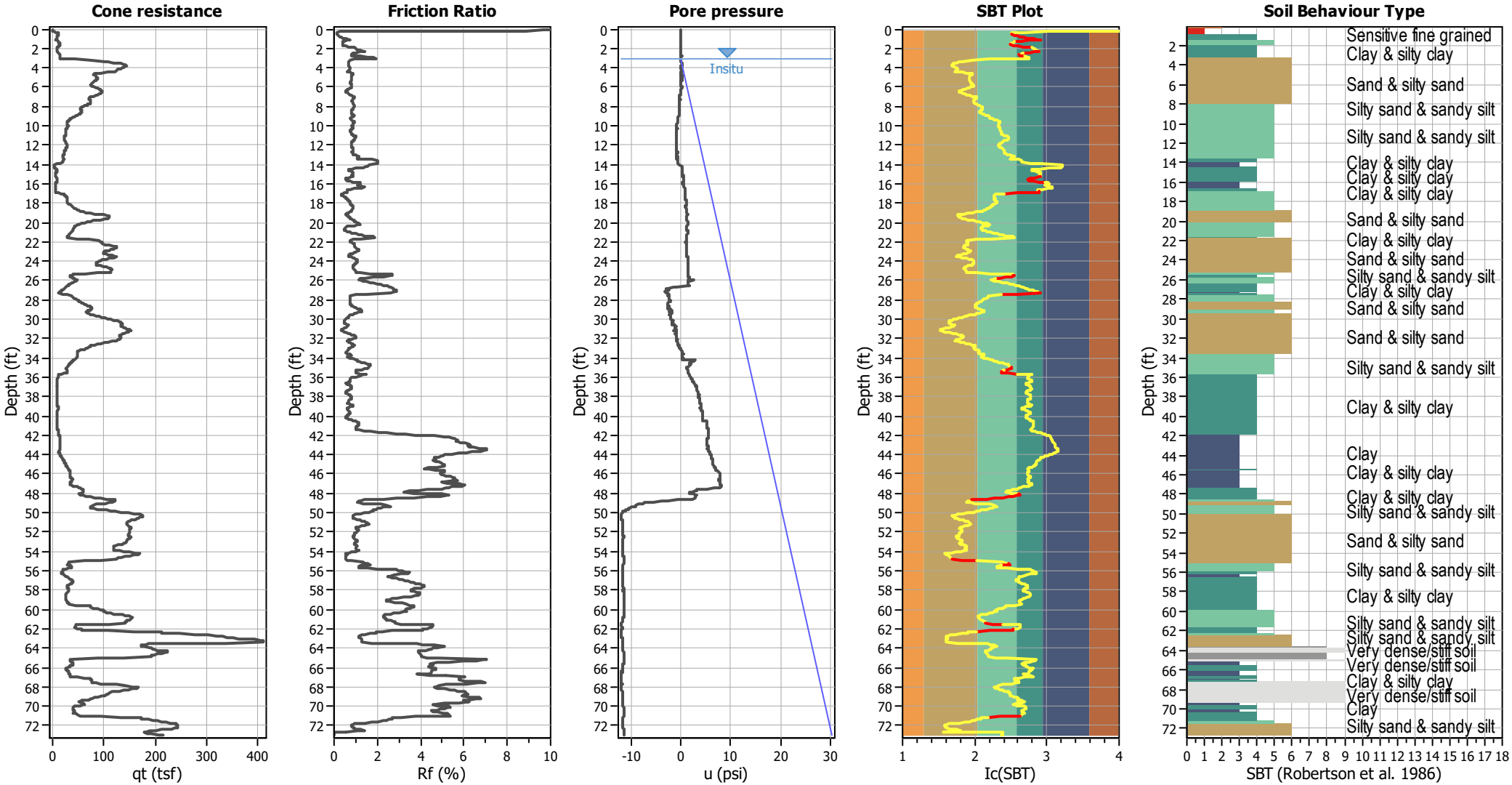






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



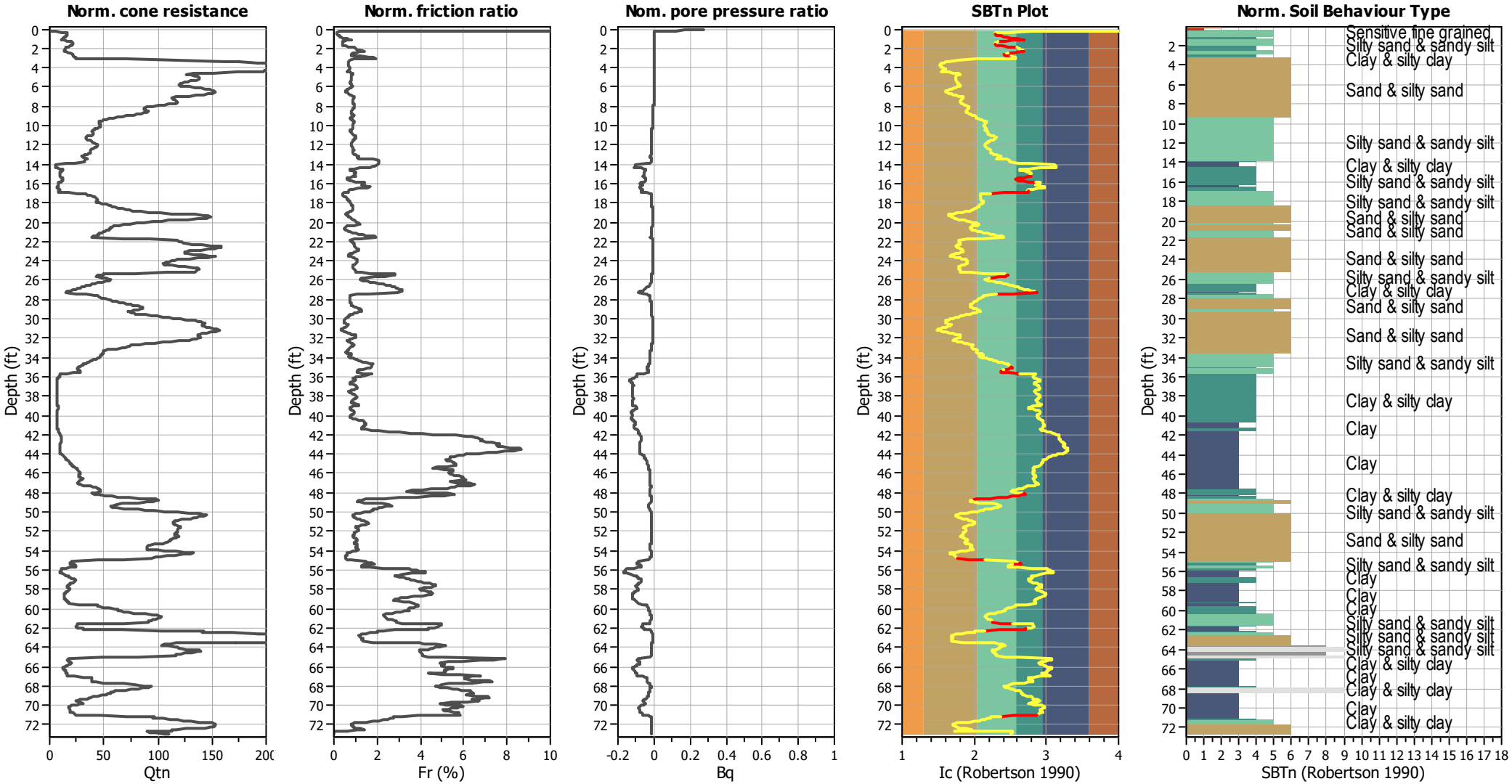
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 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)



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Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

SBTn legend

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5. Silty sand to sandy silt
6. Clean sand to silty sand
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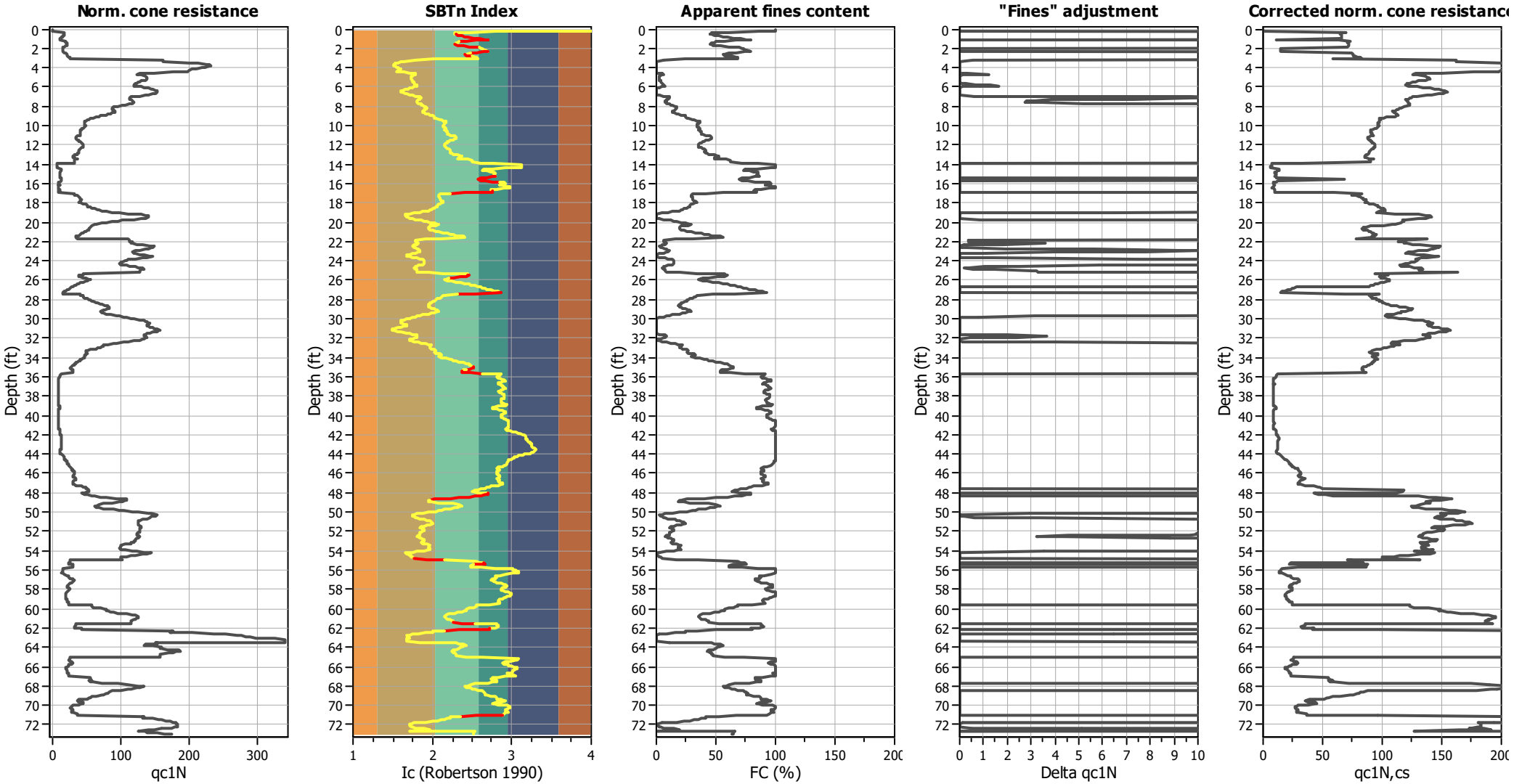
8. Very stiff sand to
9. Very stiff fine grained

Liquefaction analysis overall plots (intermediate results)



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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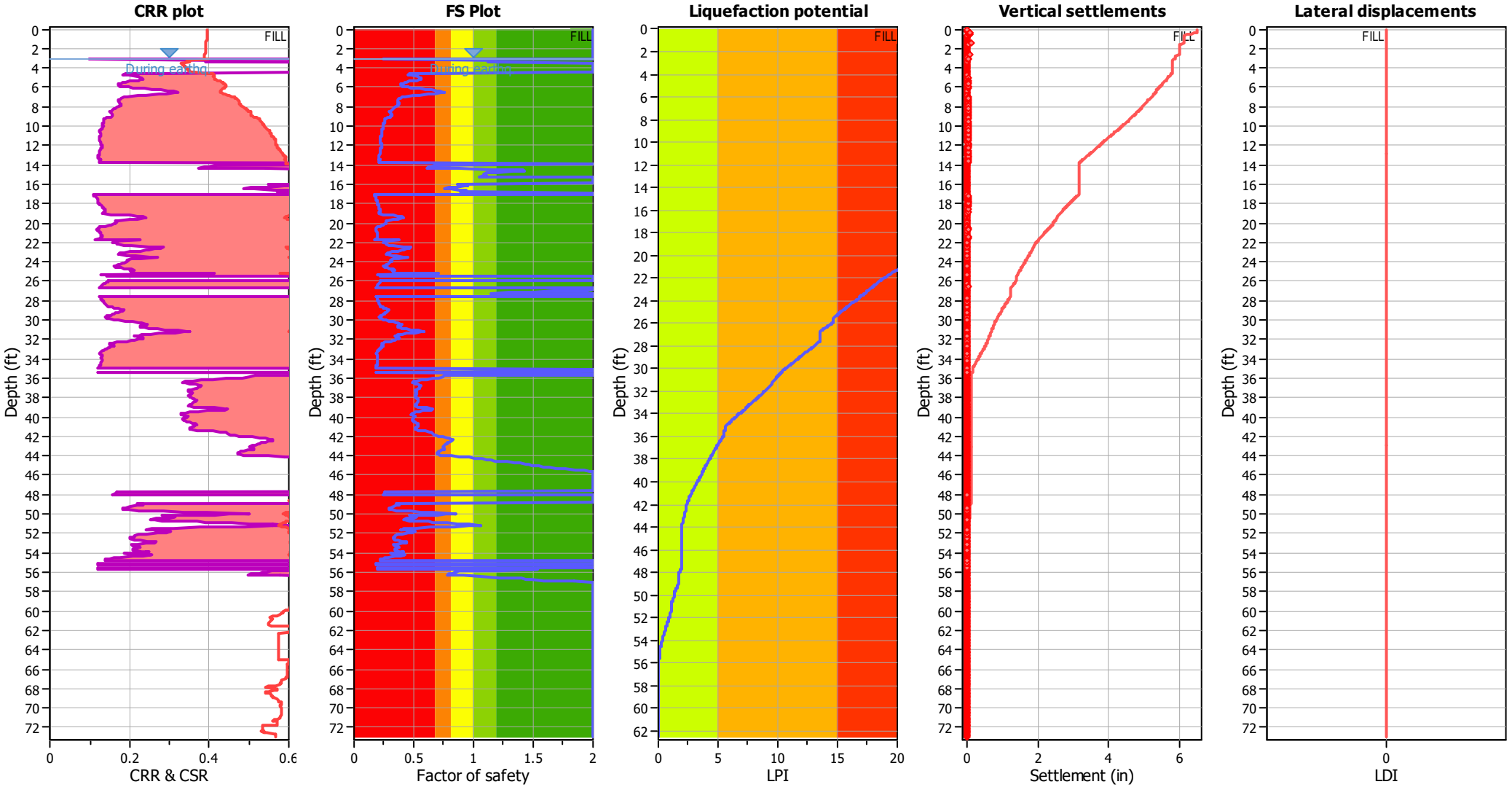
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



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Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

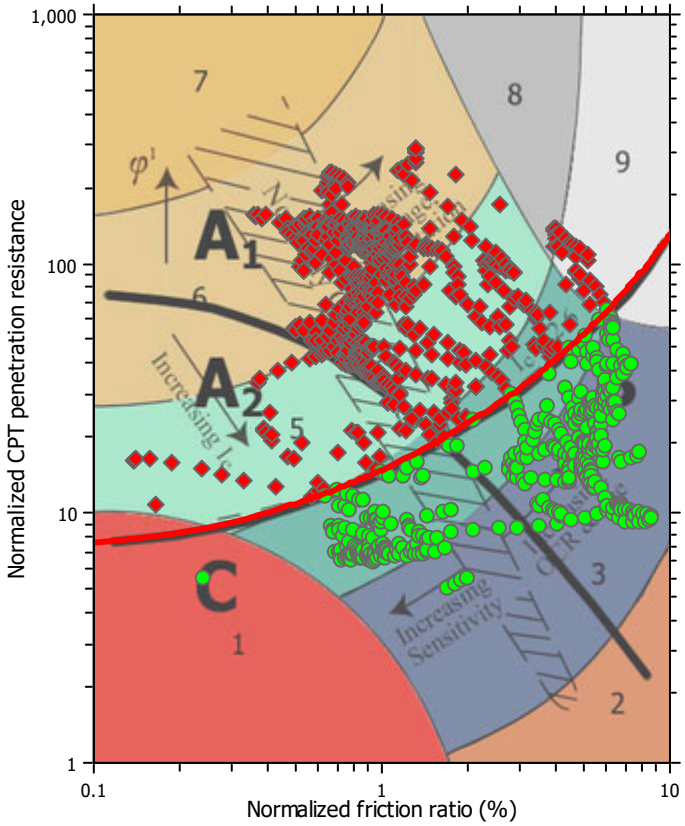
F.S. color scheme

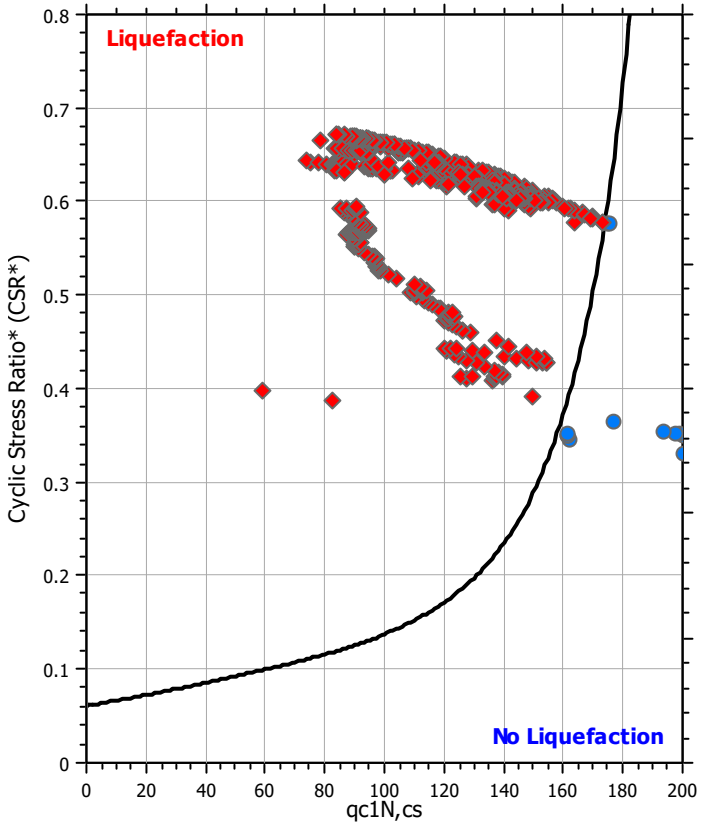
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

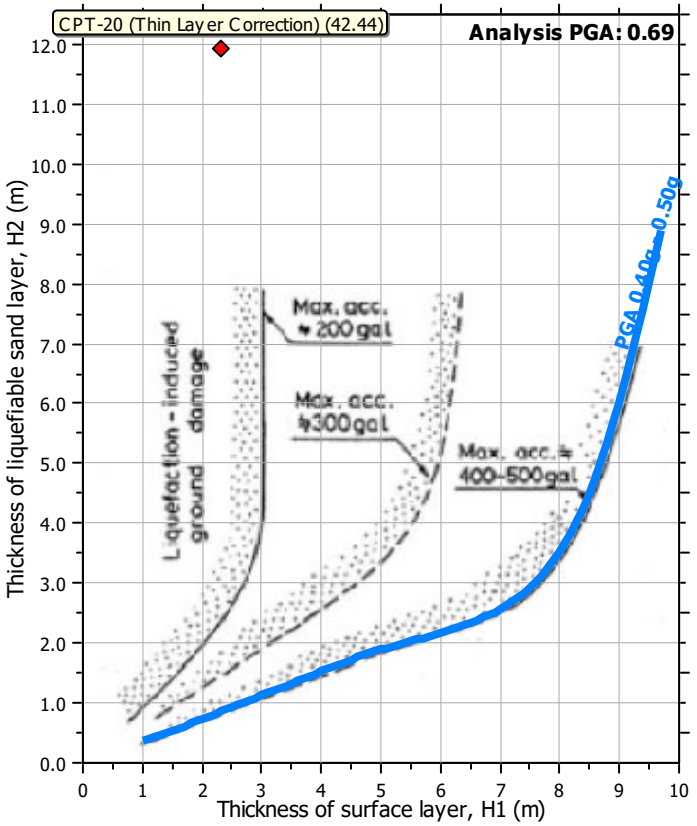
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



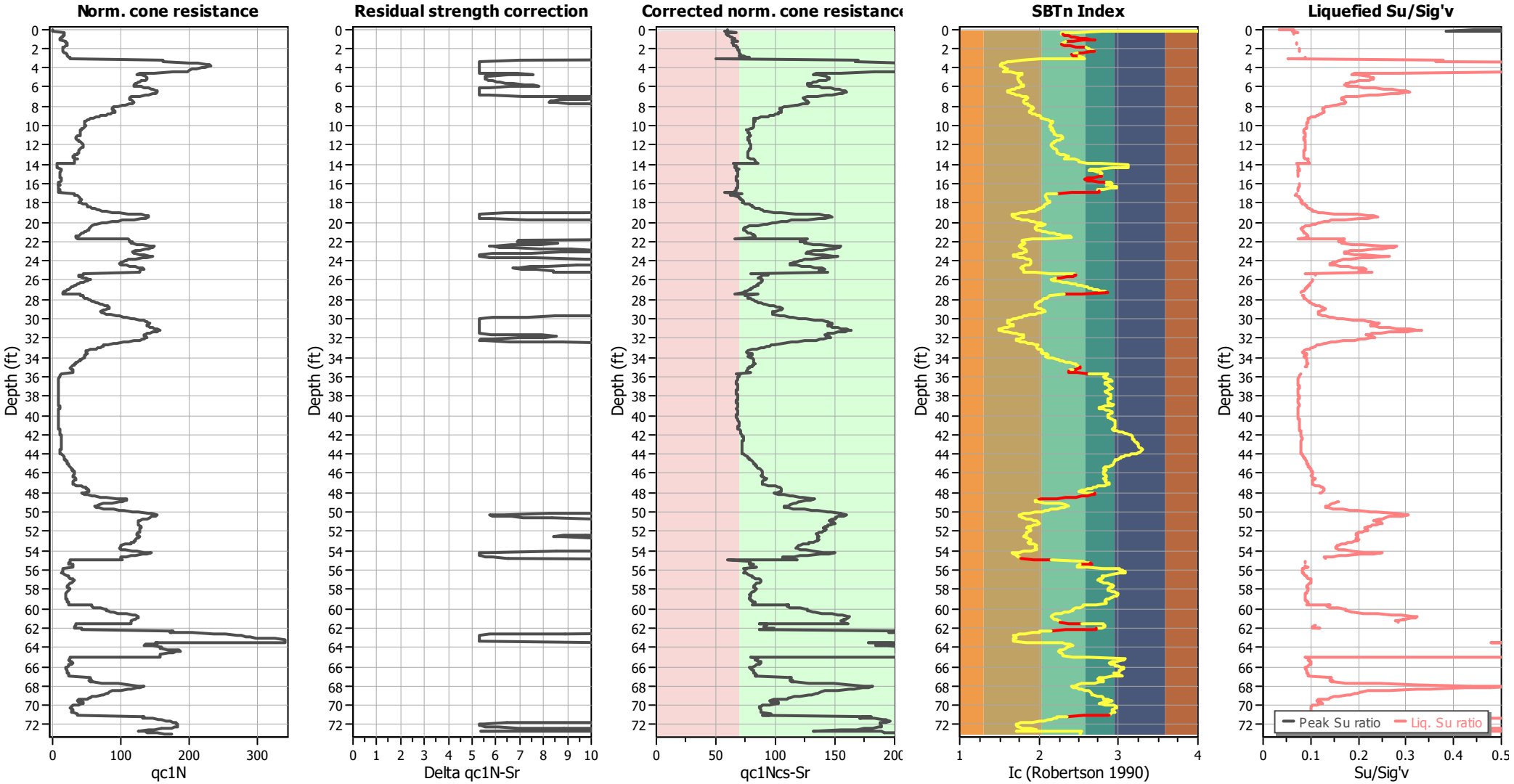




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

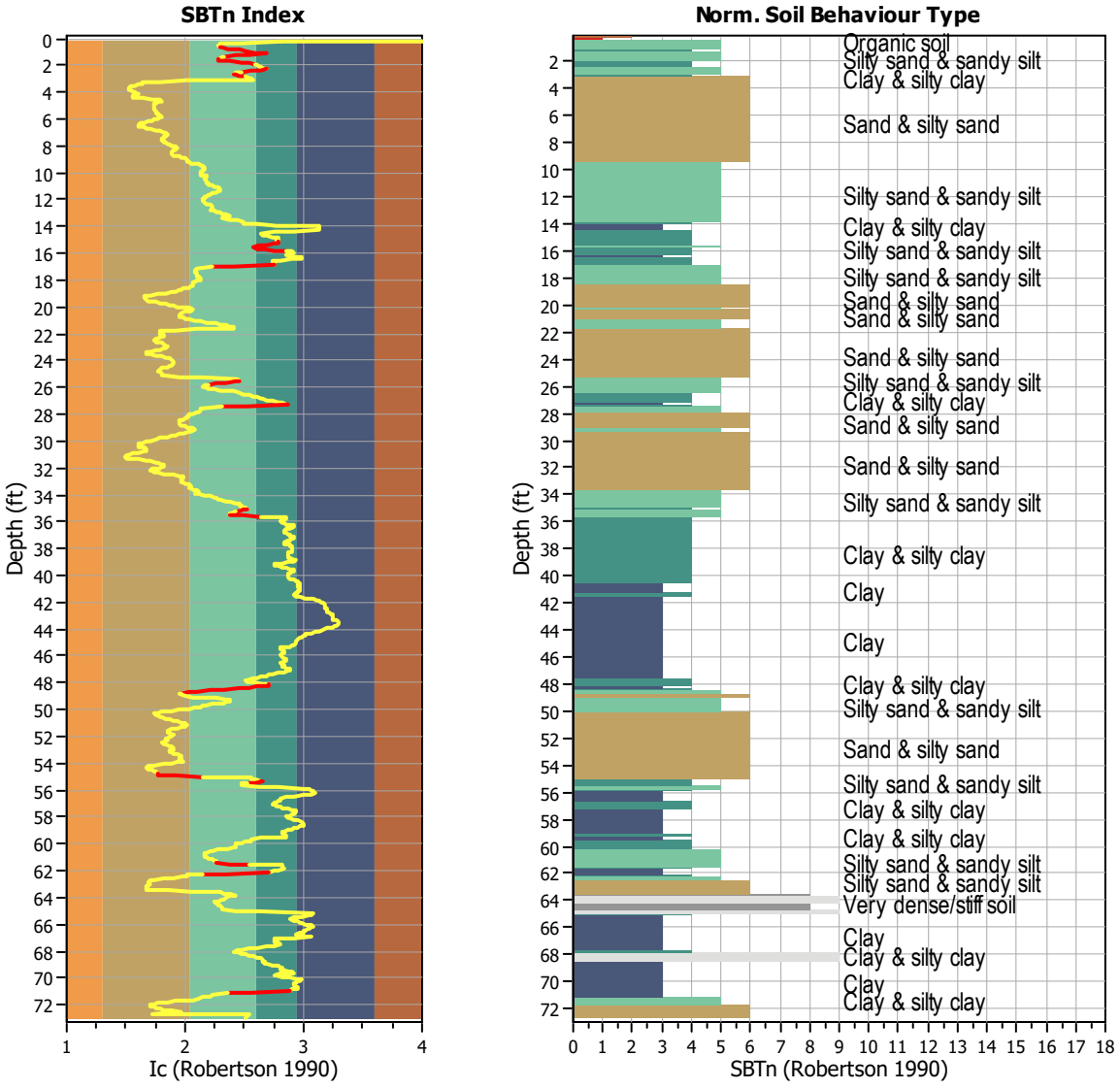
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	6.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.10 ft	Fill height:	3.02 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

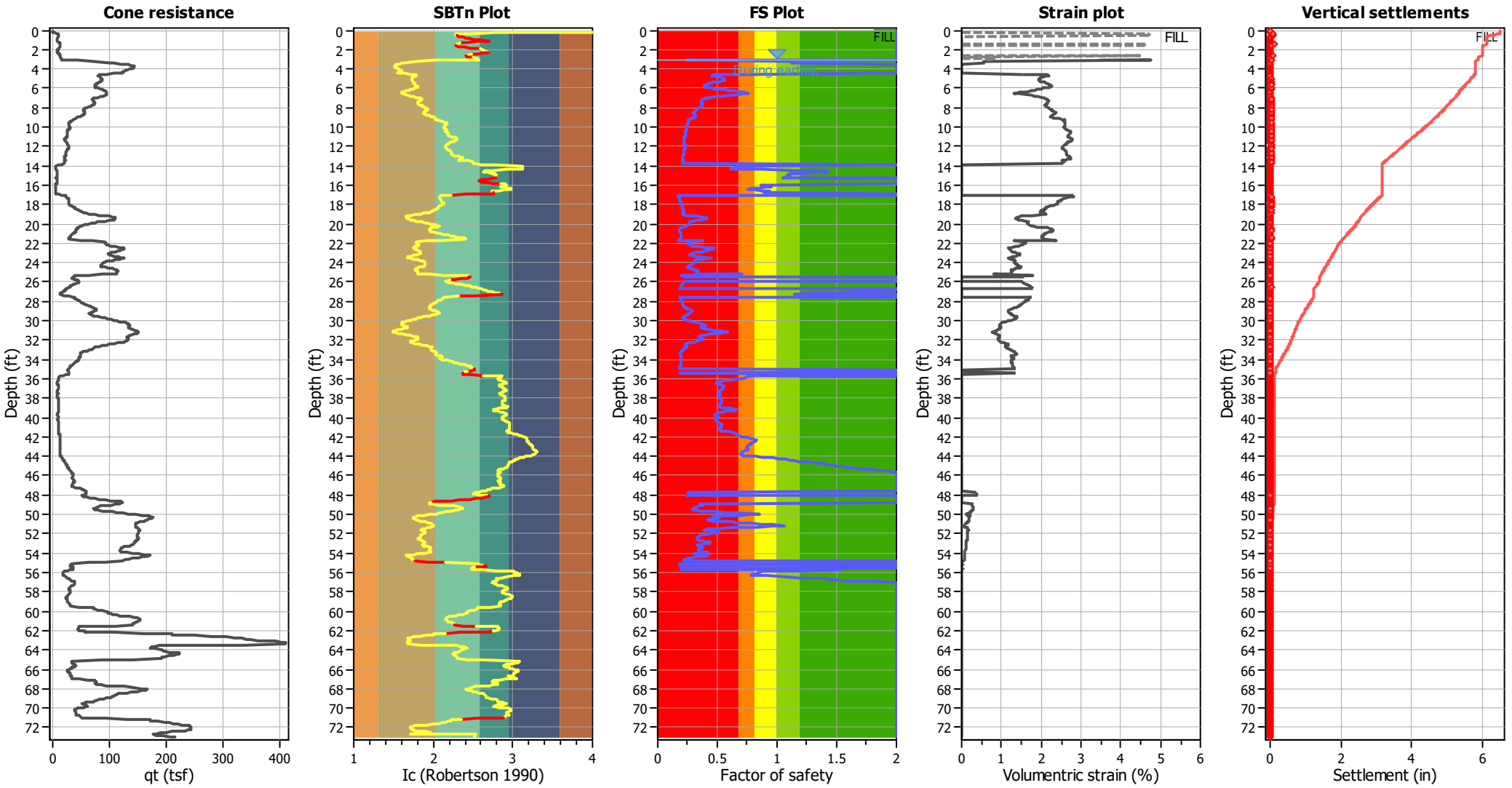
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1112
I_c maximum check value:	3.00	Total points excluded:	94
I_c change ratio value:	0.0250	Exclusion percentage:	8.45%
Minimum number of points in layer:	4	Number of layers detected:	18

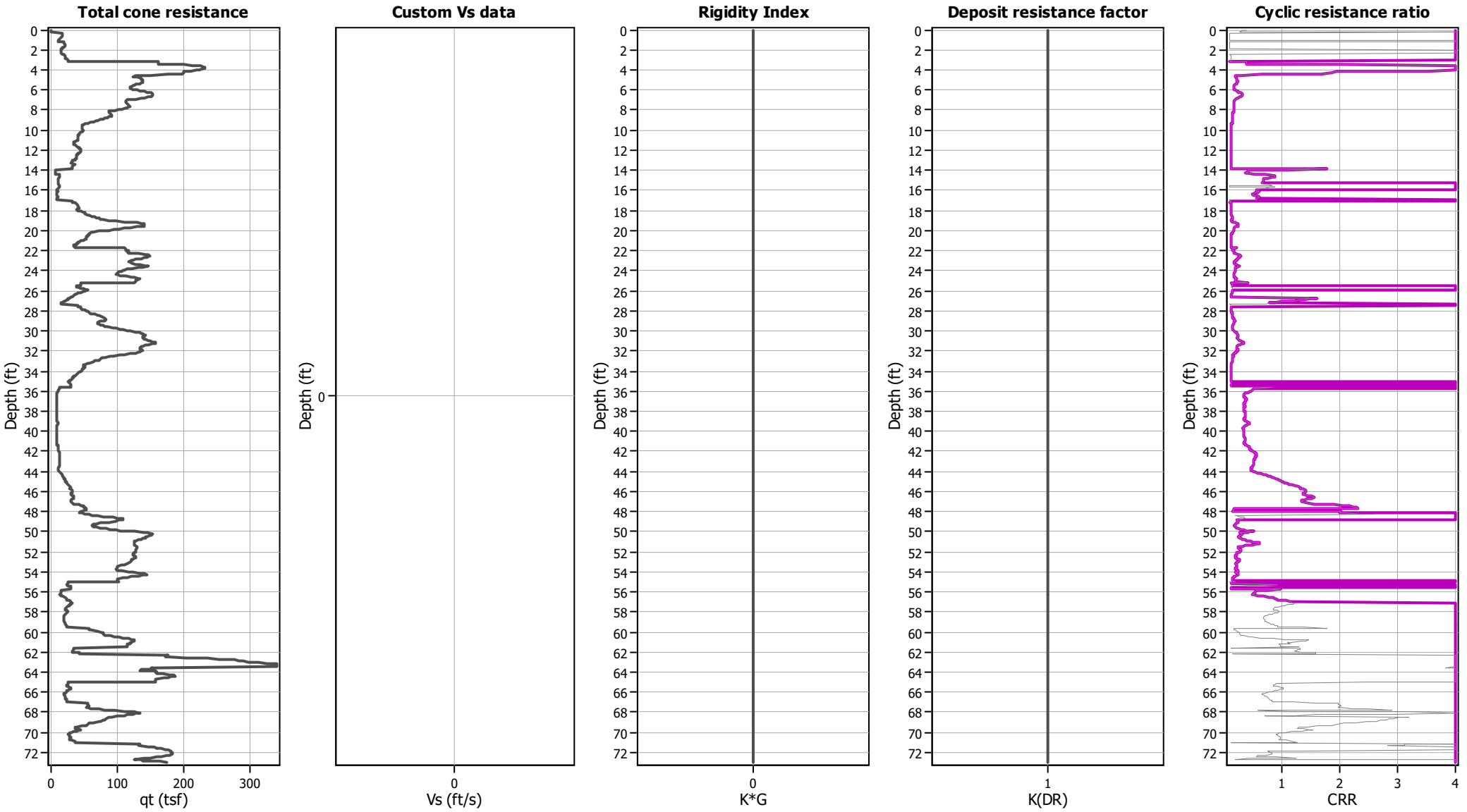
Estimation of post-earthquake settlements



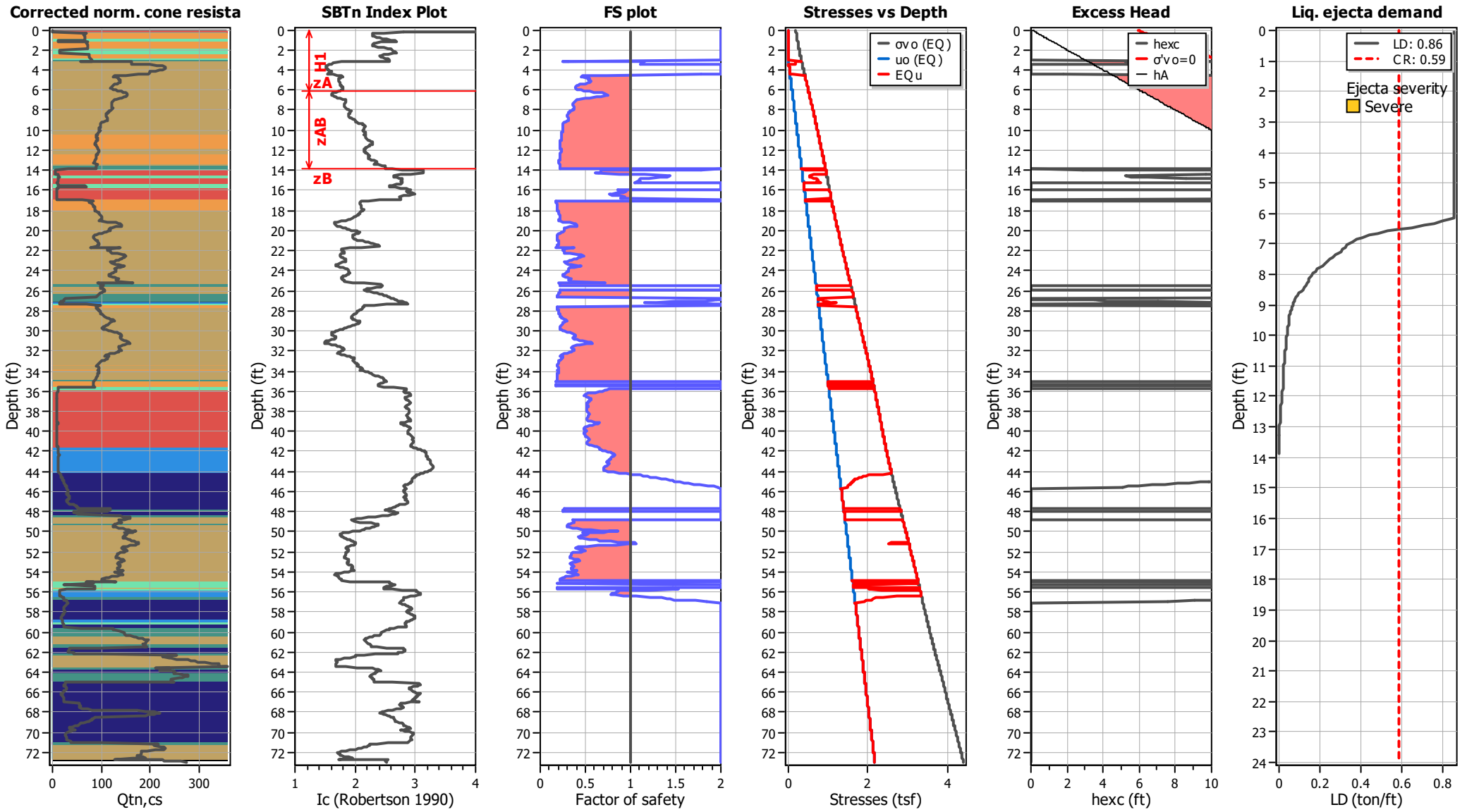
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

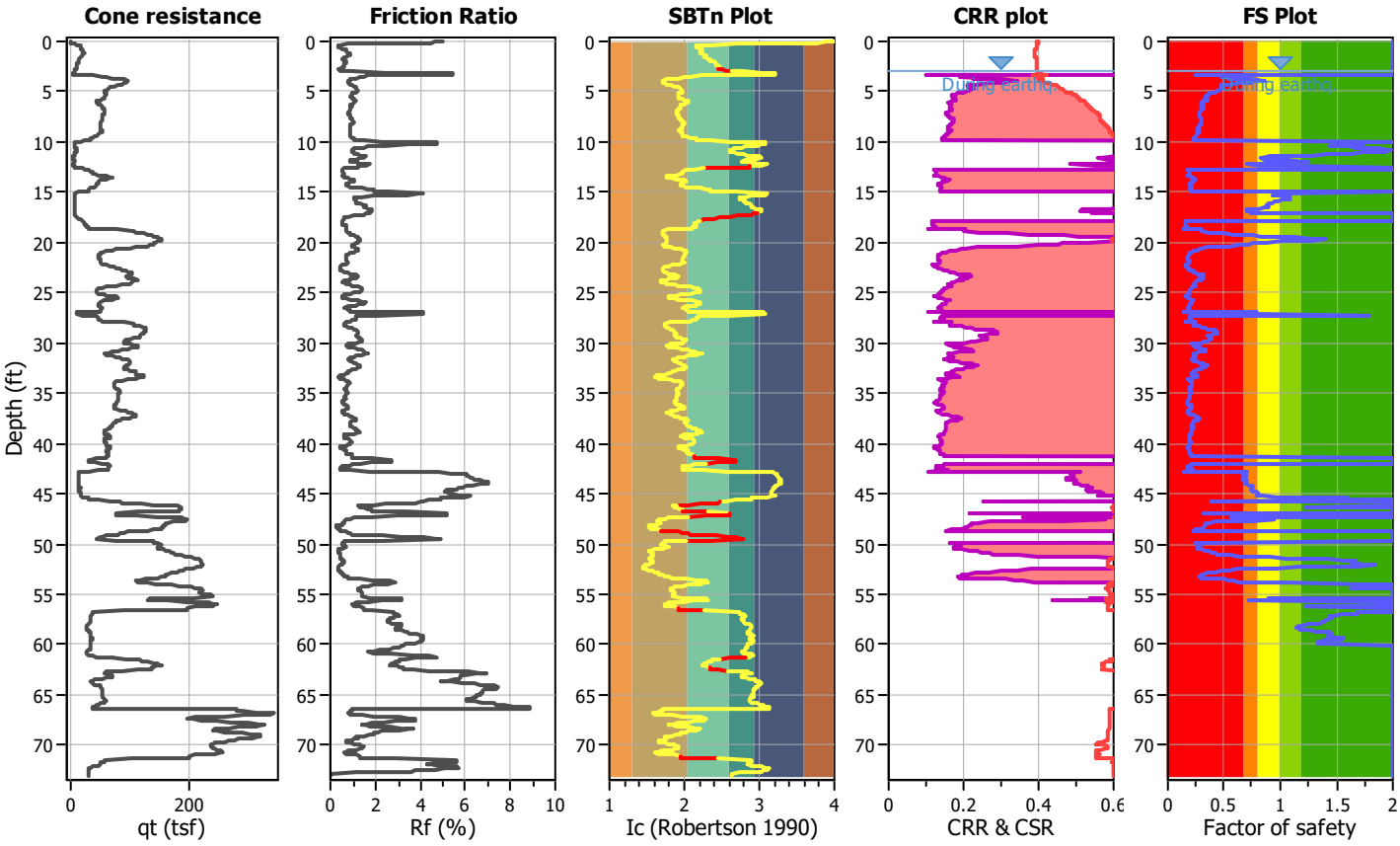
Project title : Topgolf Harbor Island

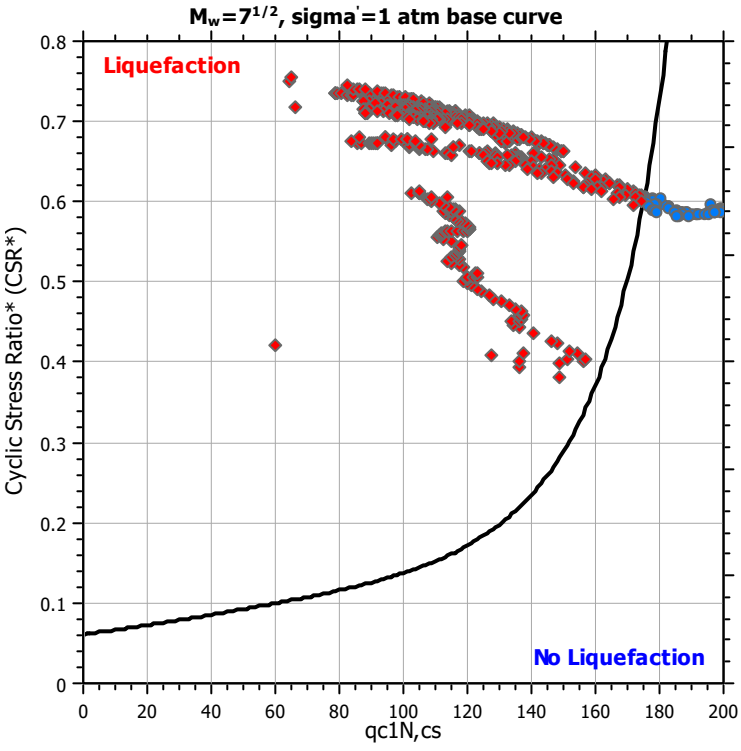
Location : North Harbor Drive and Liberator Way, San Diego, CA

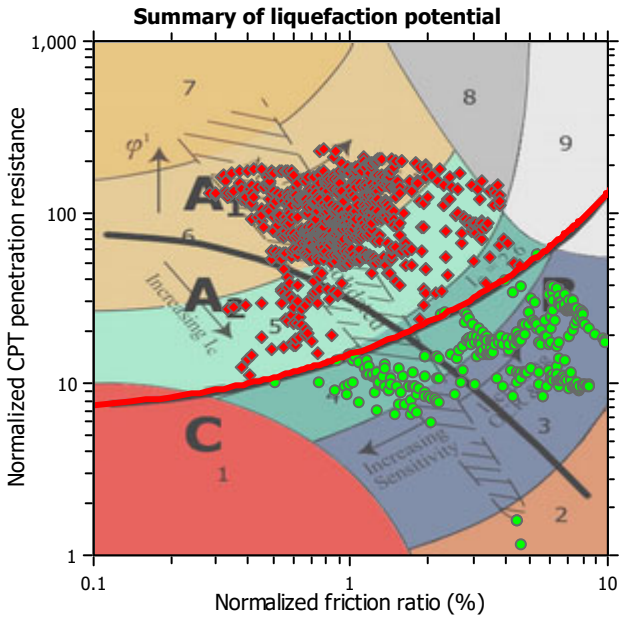
CPT file : CPT-21 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

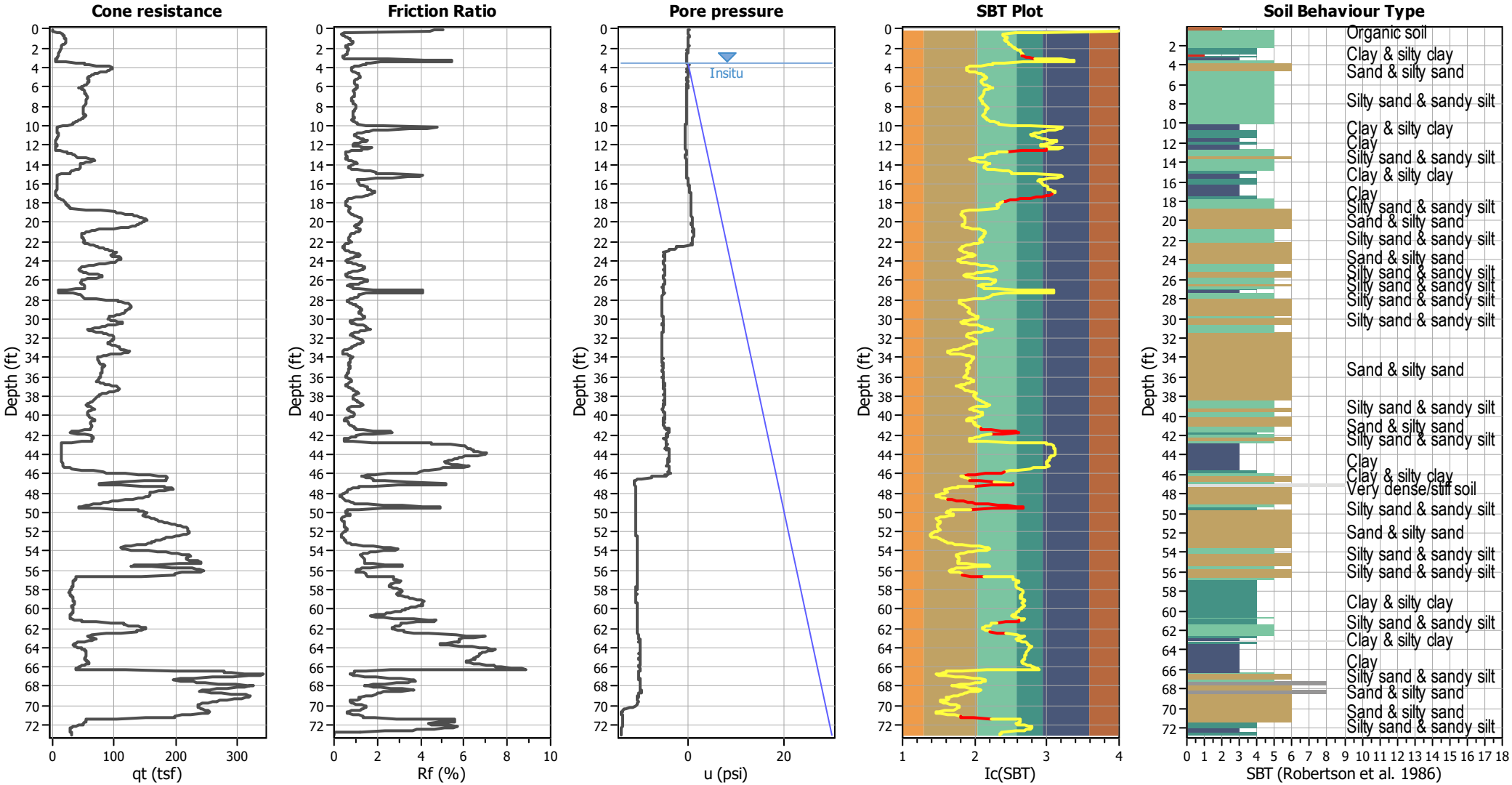






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



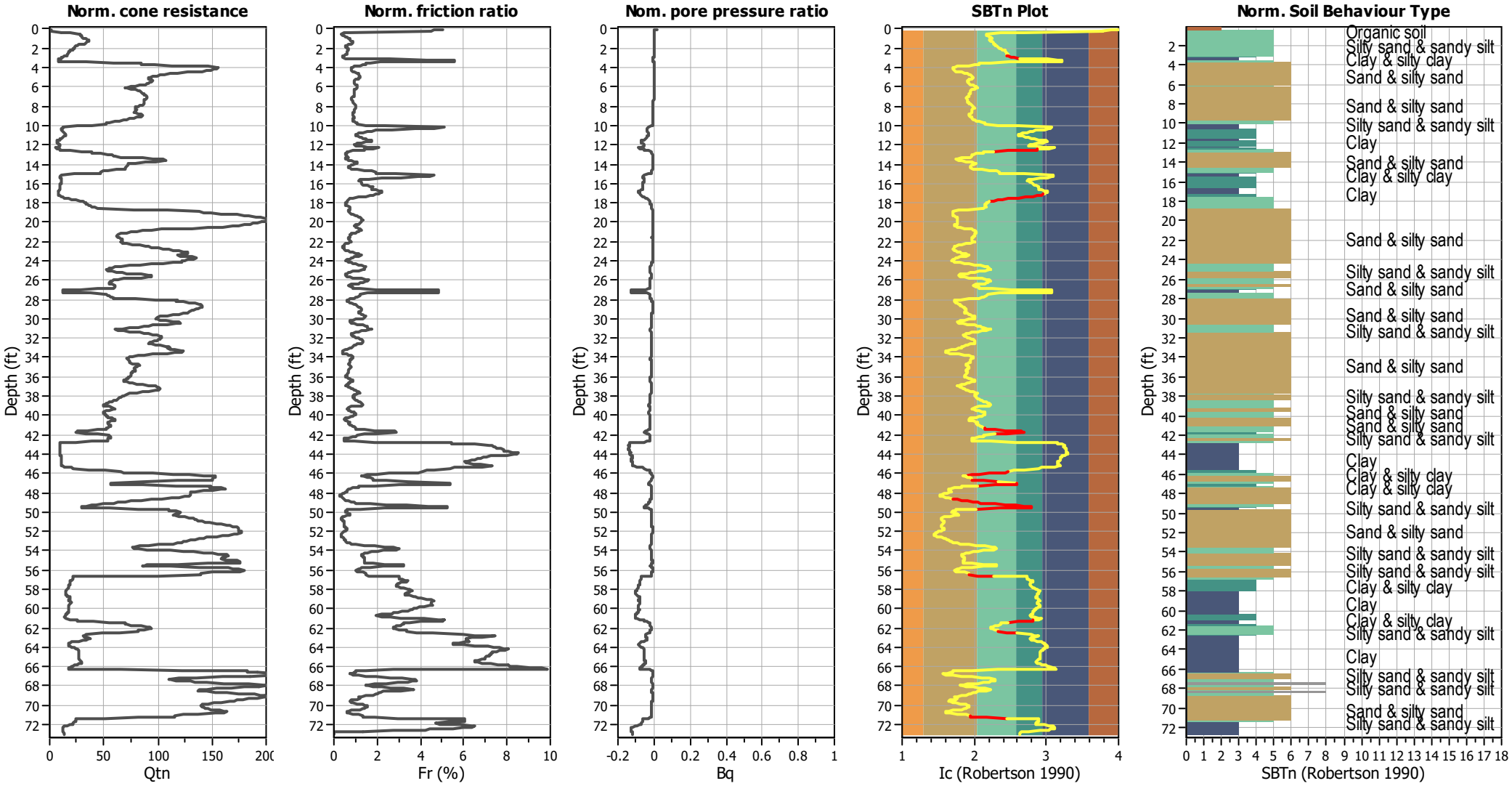
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	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)



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
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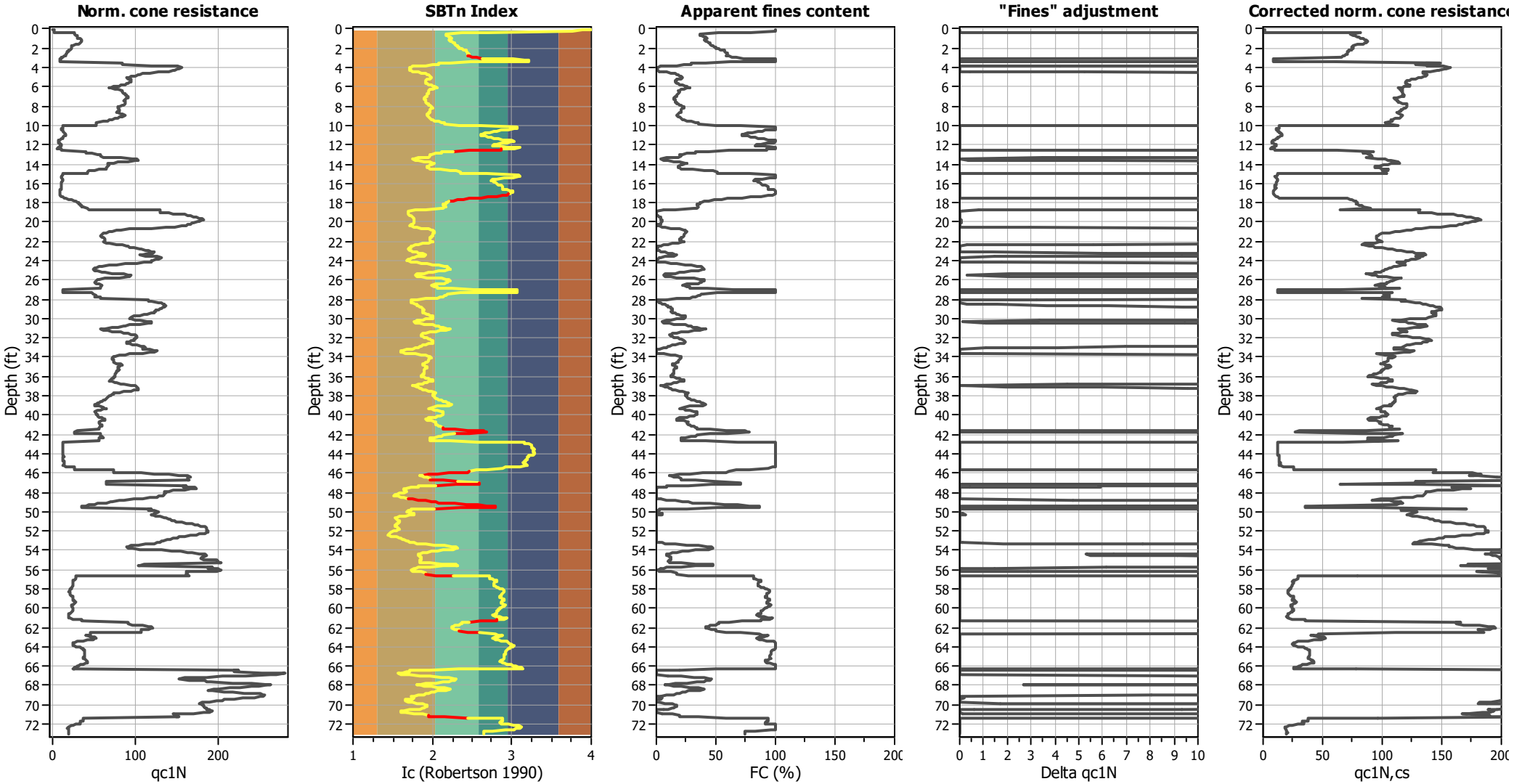
Liquefaction analysis overall plots (intermediate results)



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Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
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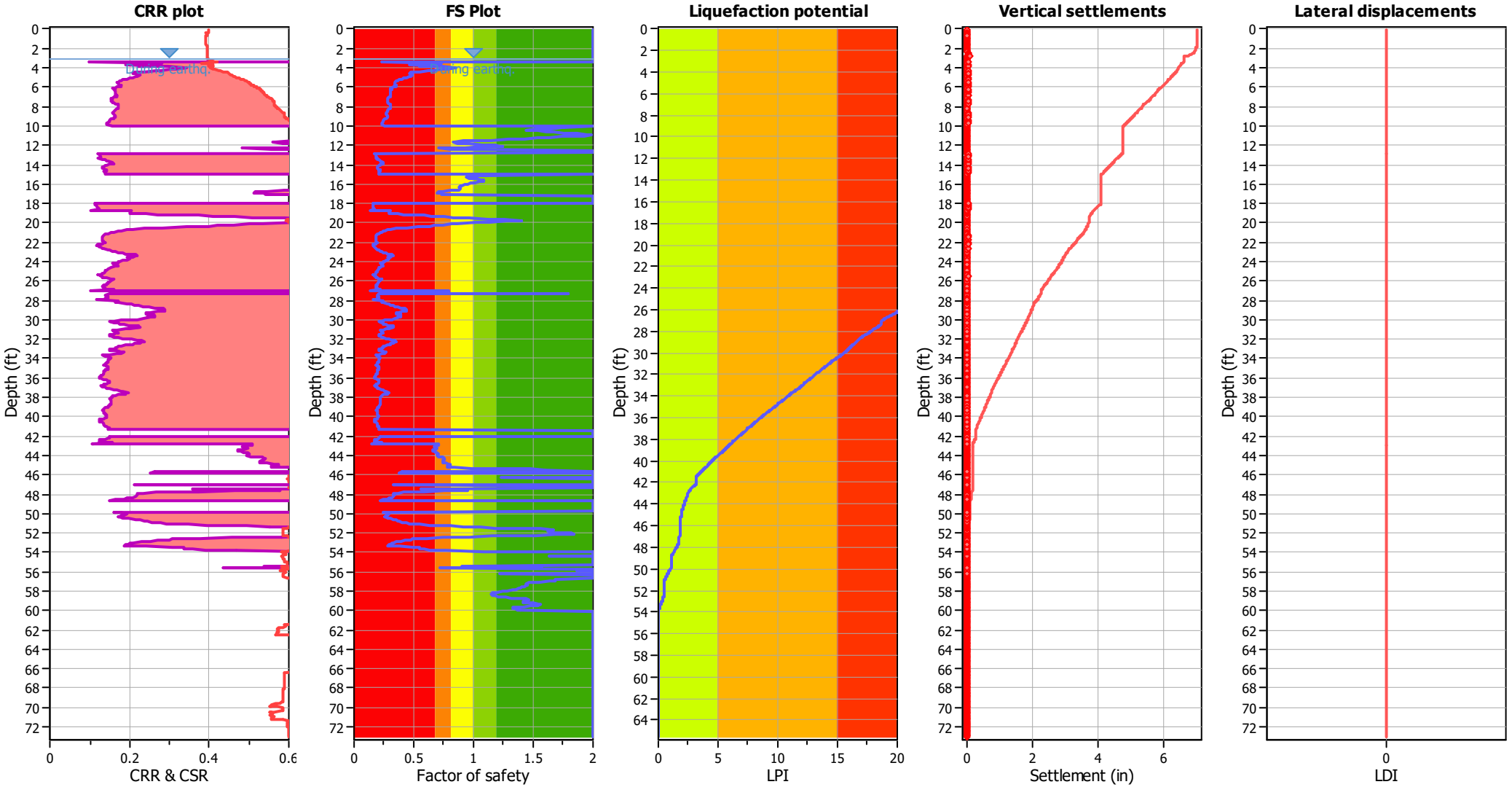
Liquefaction analysis overall plots



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Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	60.00 ft

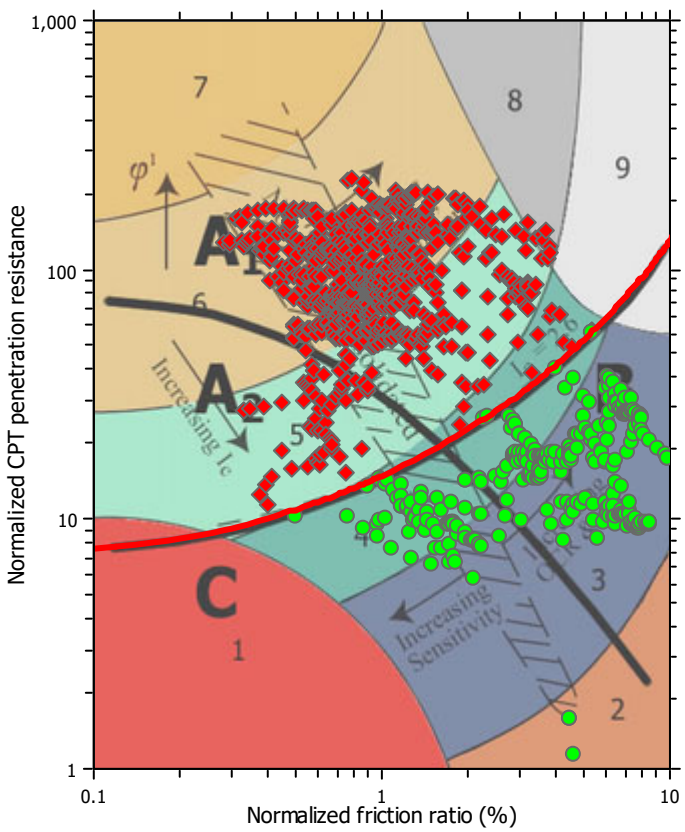
F.S. color scheme

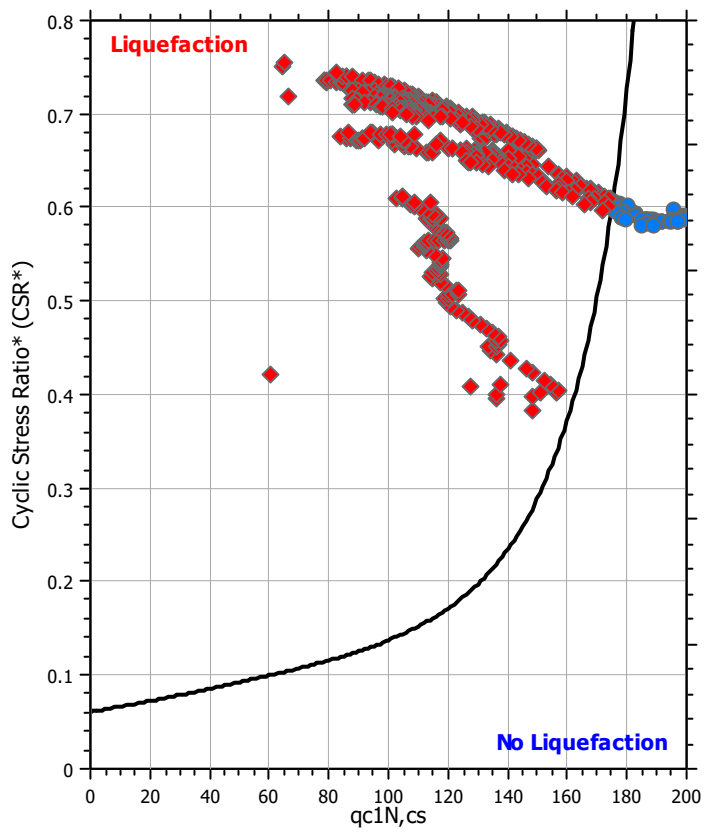
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

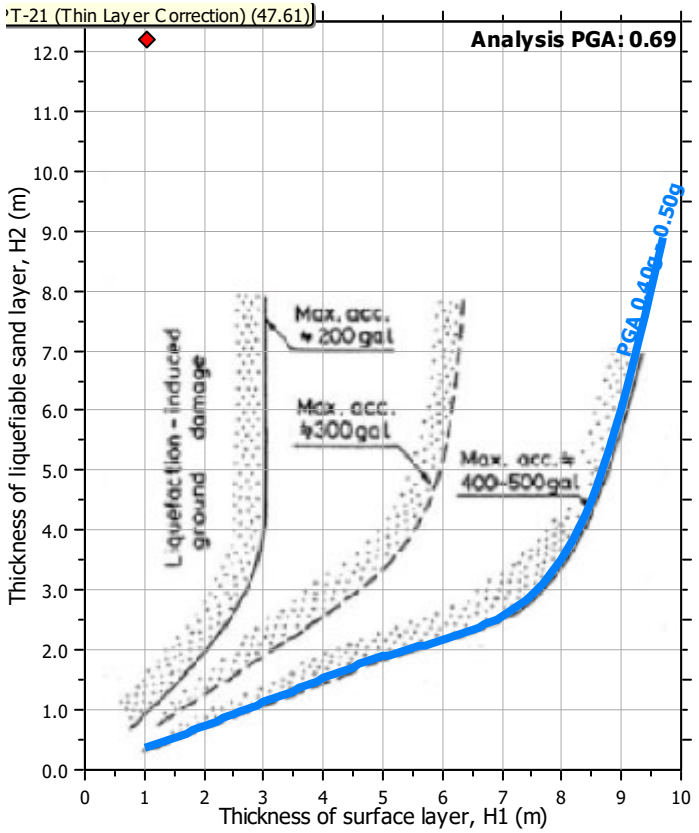
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







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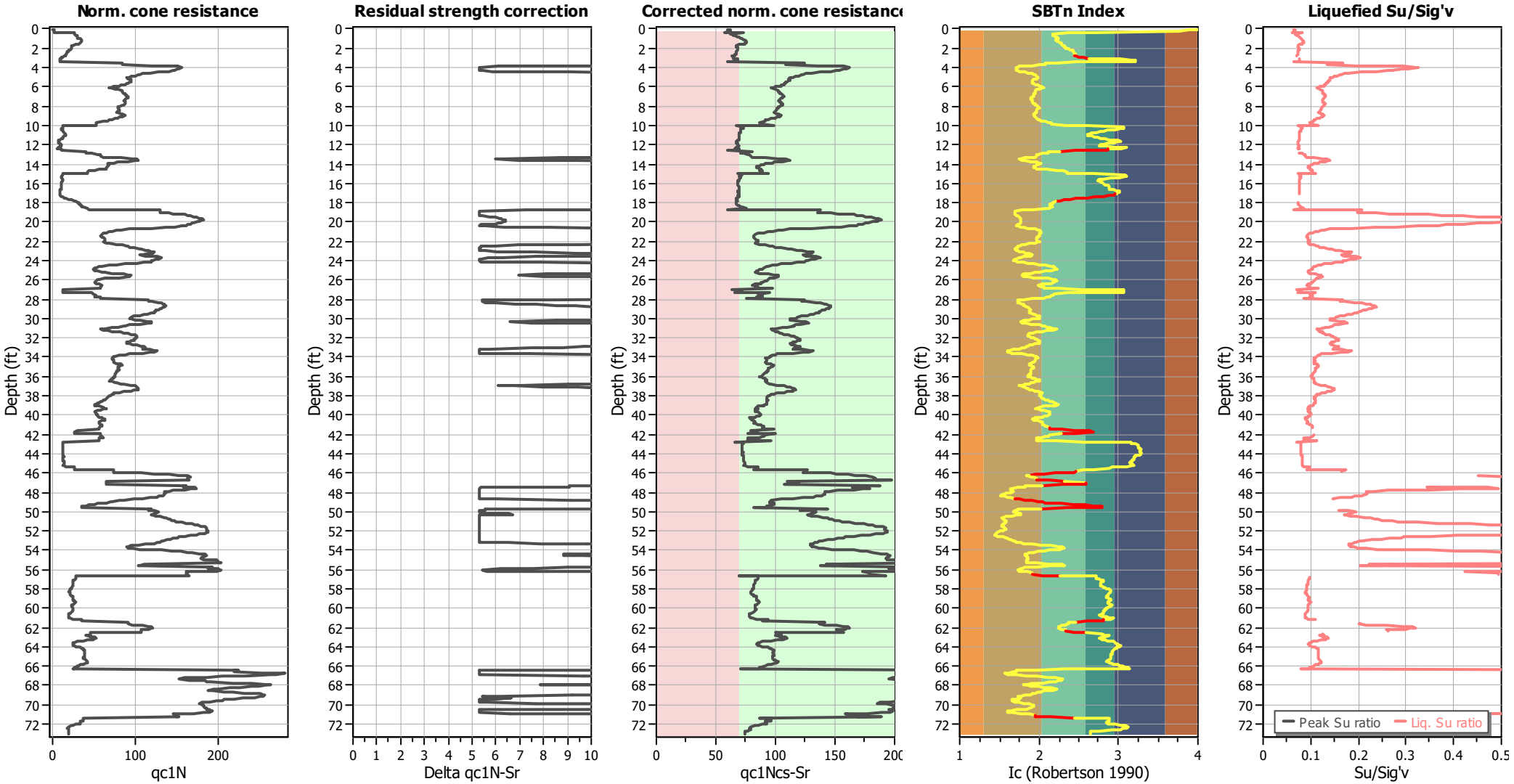
Depth to water table (insitu):	3.50 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



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Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
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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).

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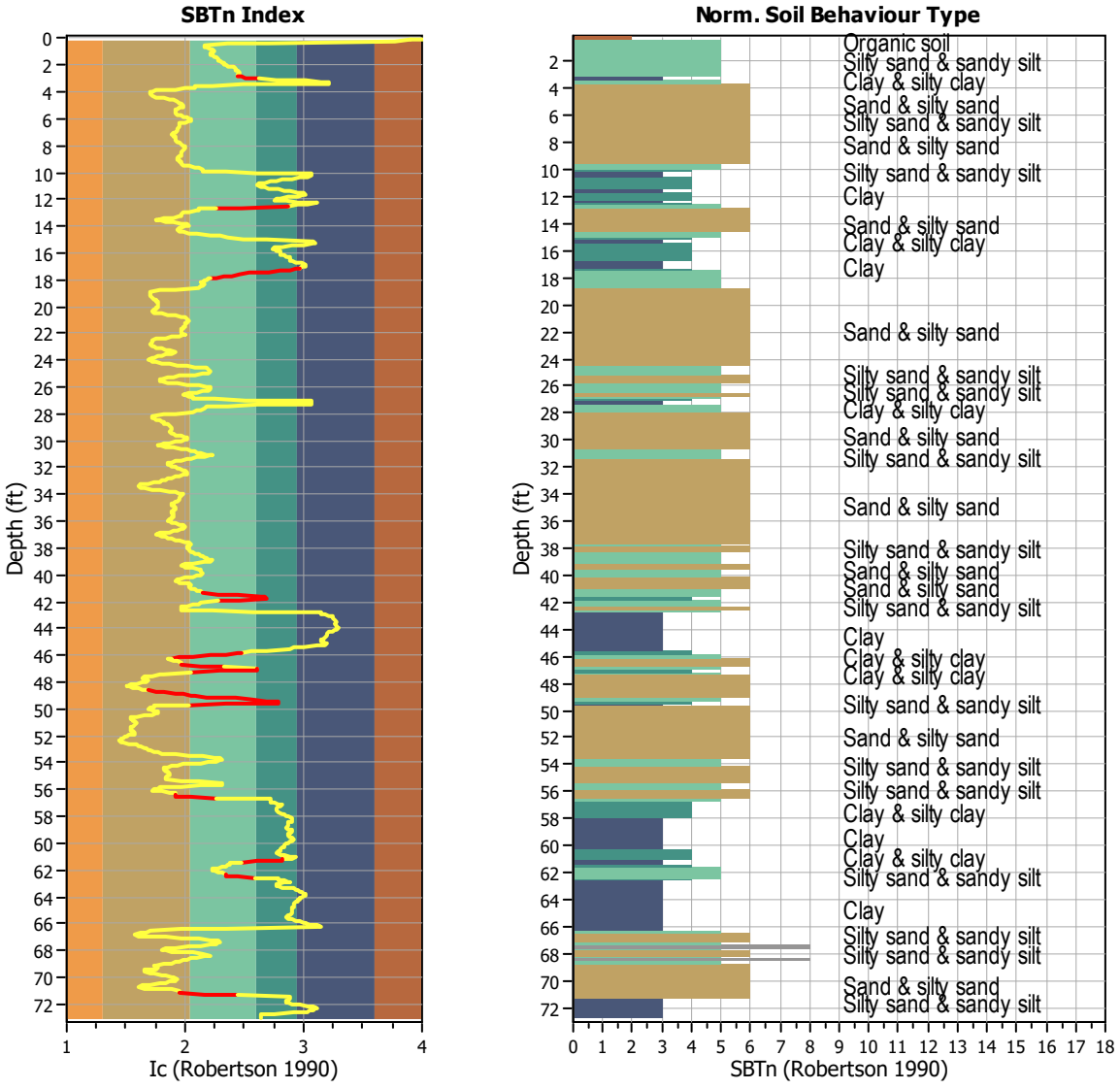
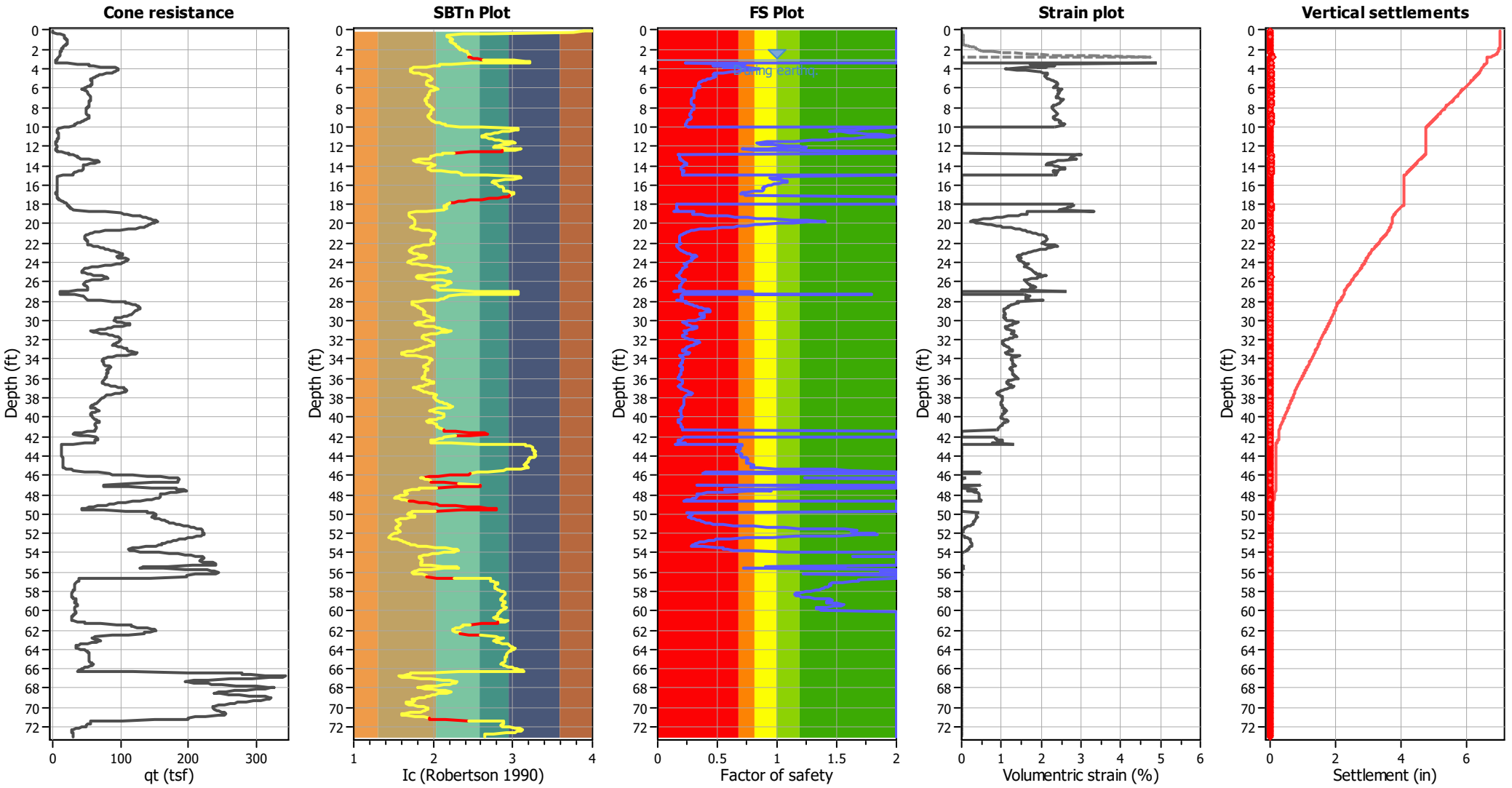


Transition layer algorithm properties		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	1113
I_c maximum check value:	3.00	Total points excluded:	80
I_c change ratio value:	0.0250	Exclusion percentage:	7.19%
Minimum number of points in layer:	4	Number of layers detected:	14

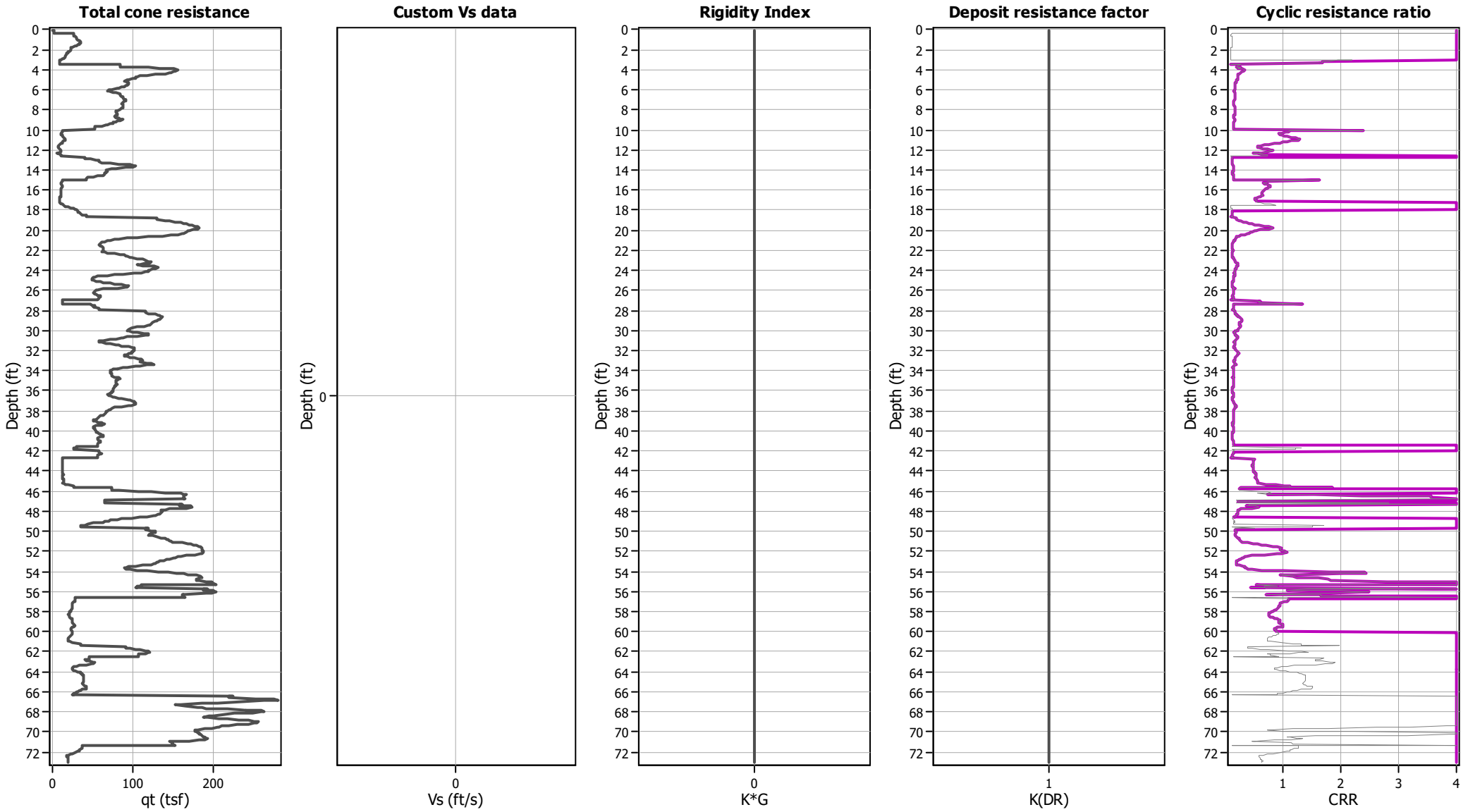
Estimation of post-earthquake settlements



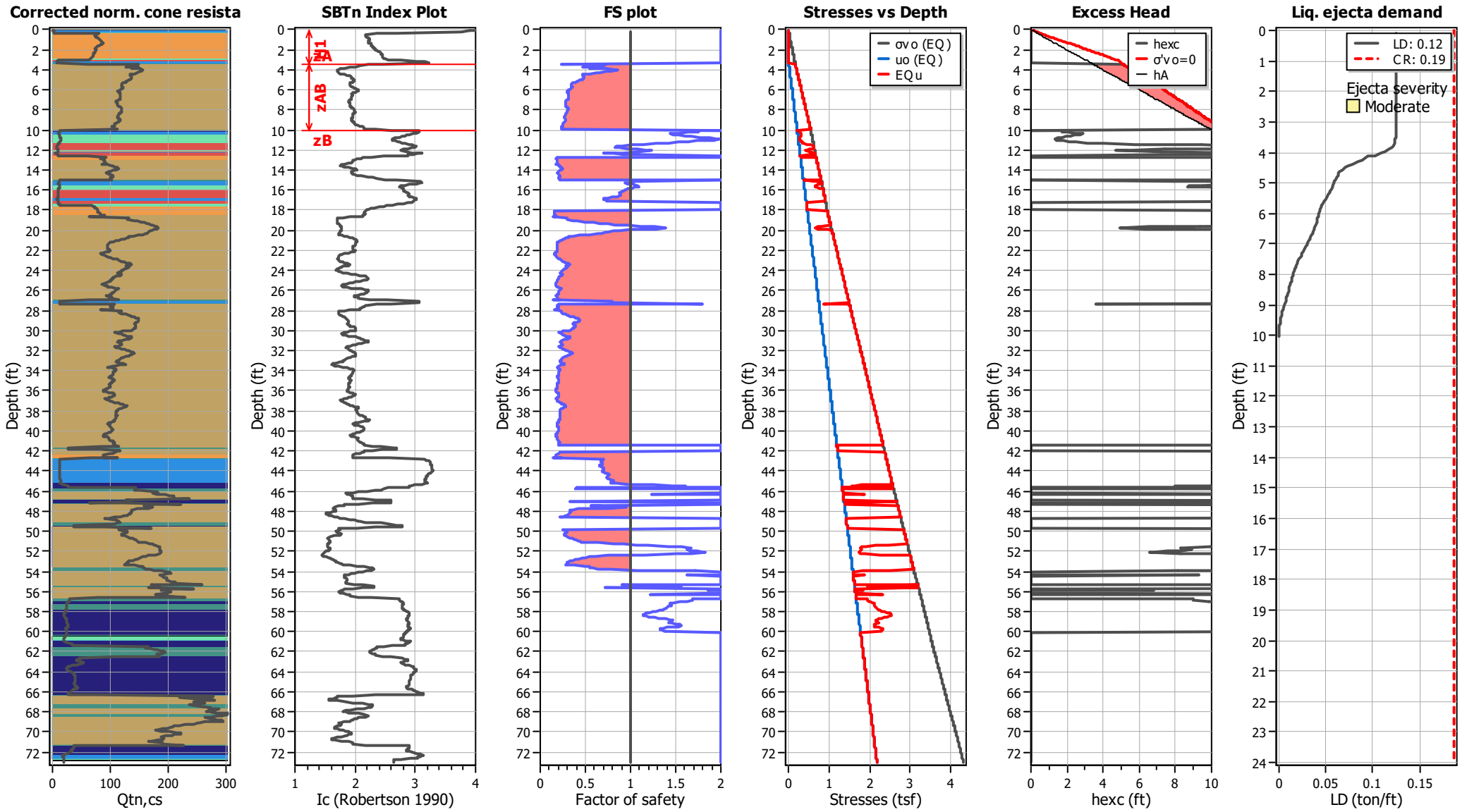
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

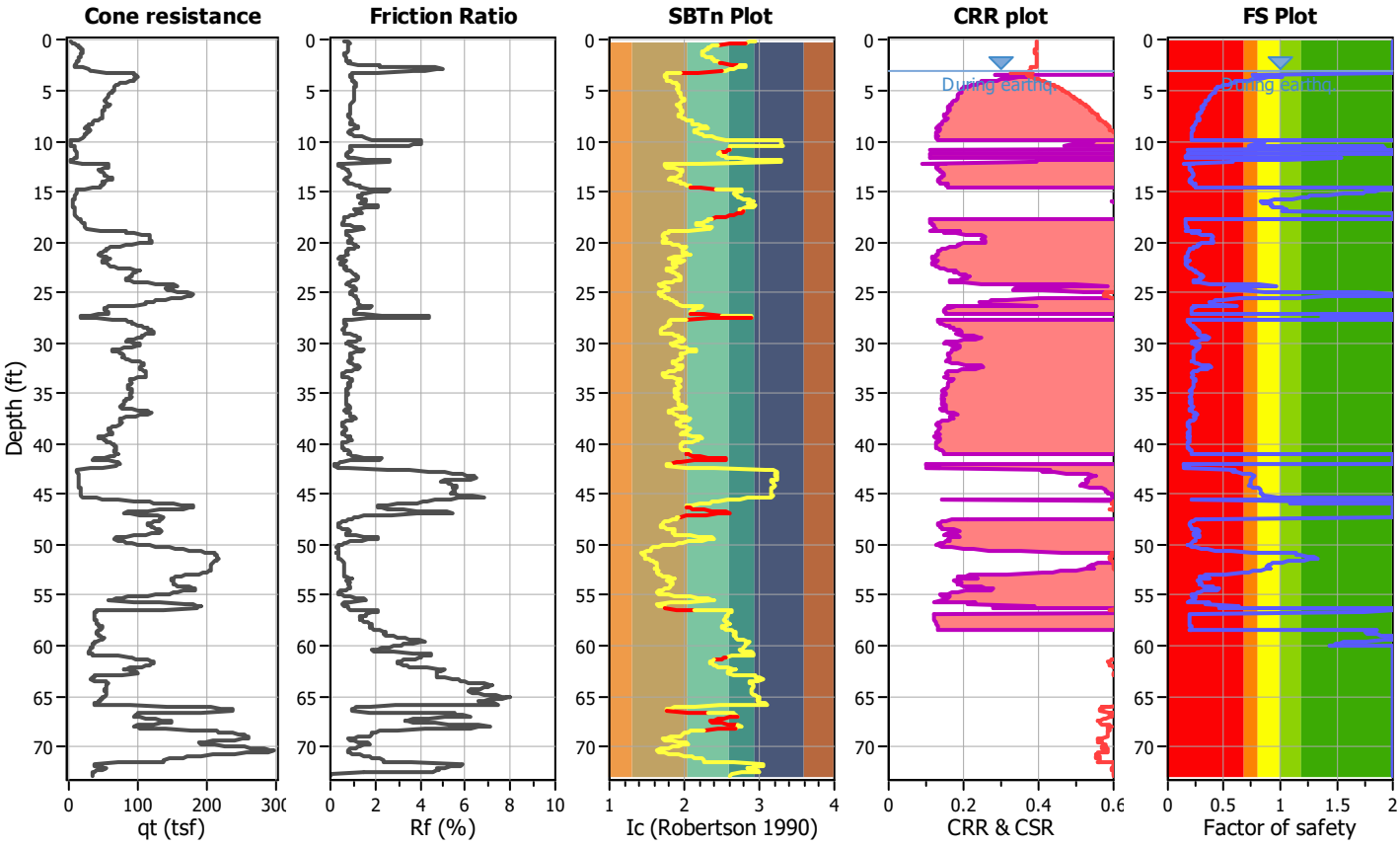
Project title : Topgolf Harbor Island

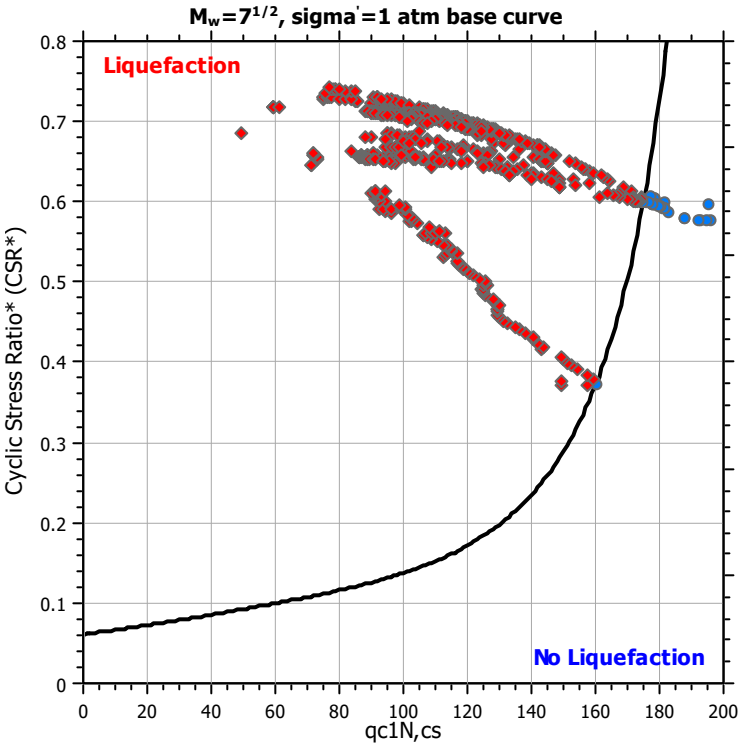
Location : North Harbor Drive and Liberator Way, San Diego, CA

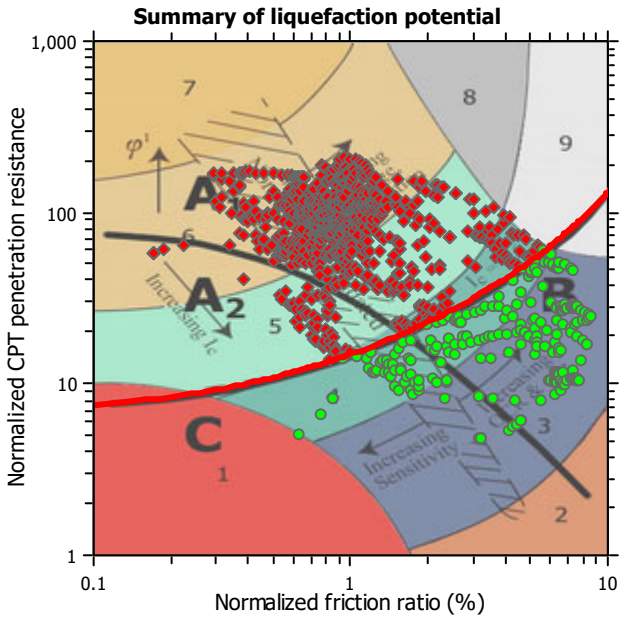
CPT file : CPT-22 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.58 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

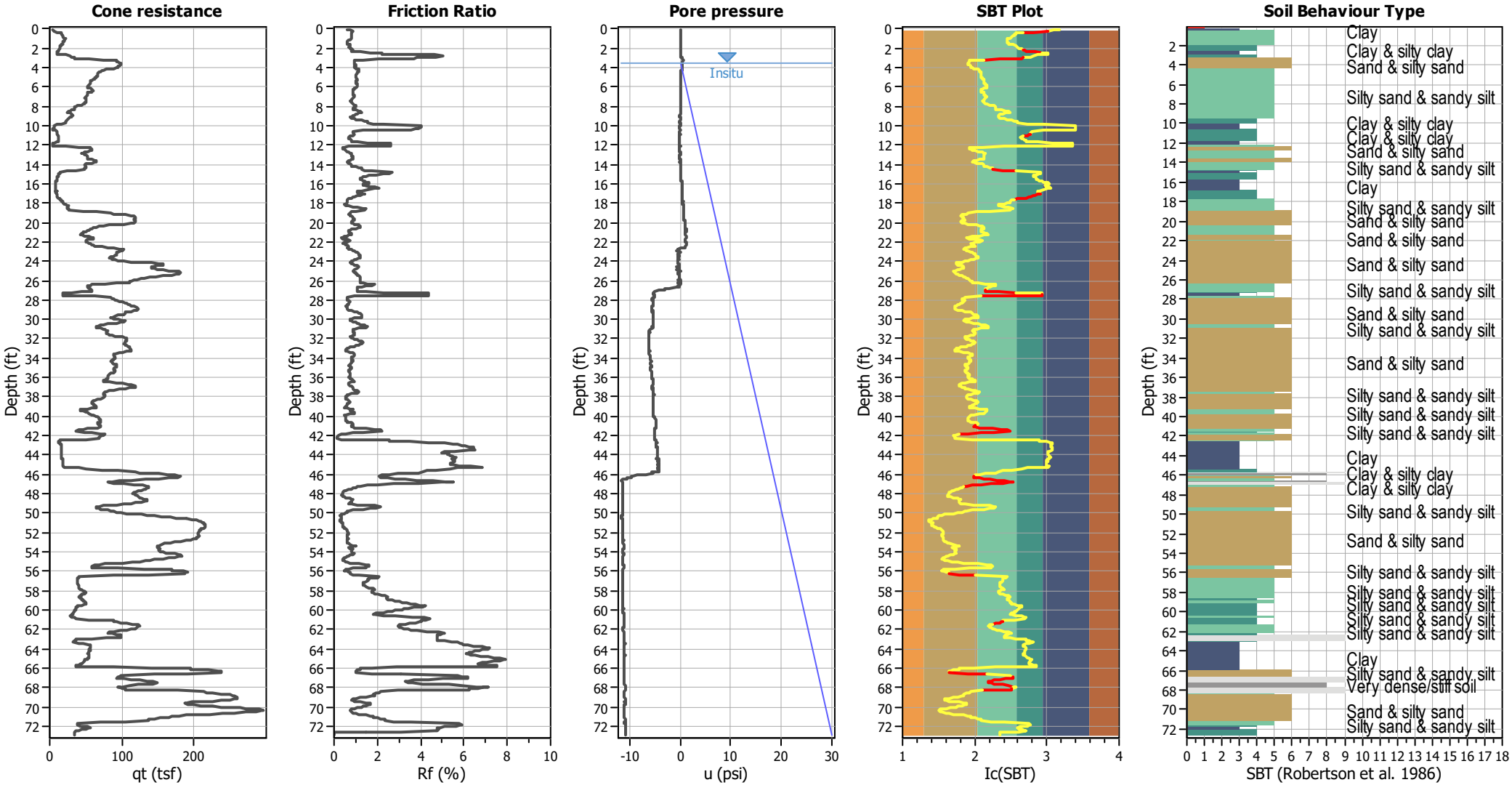






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



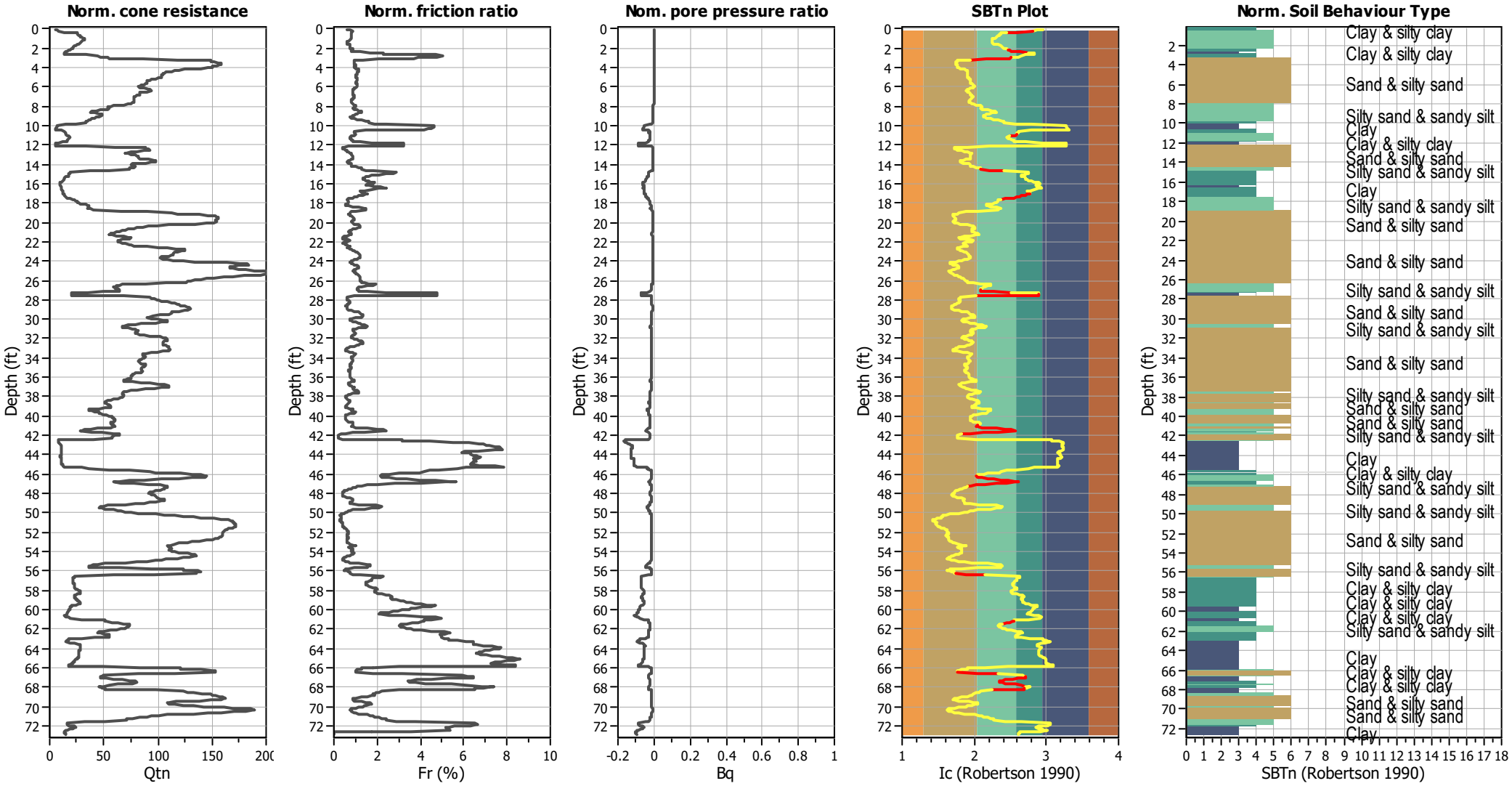
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	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)



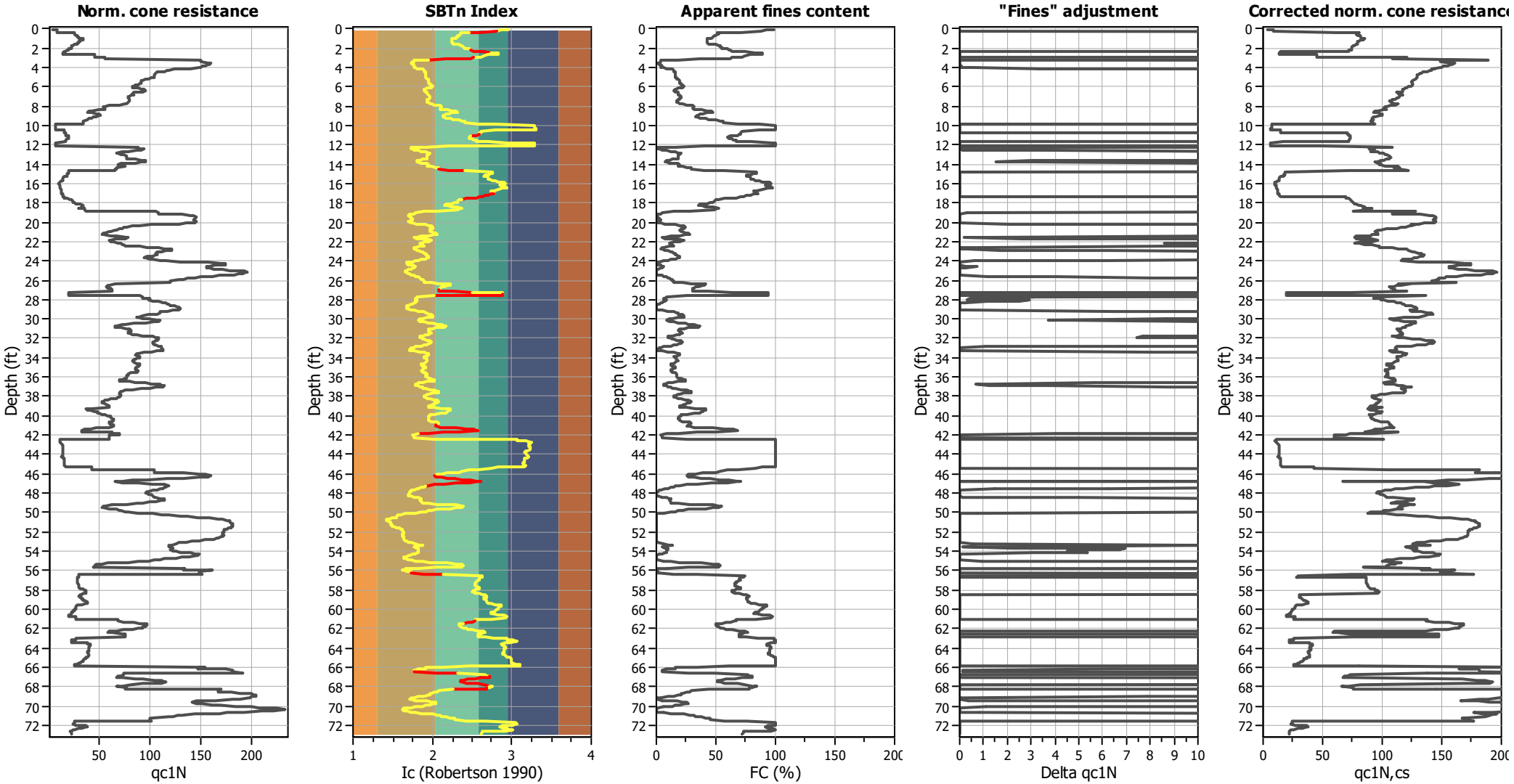
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	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

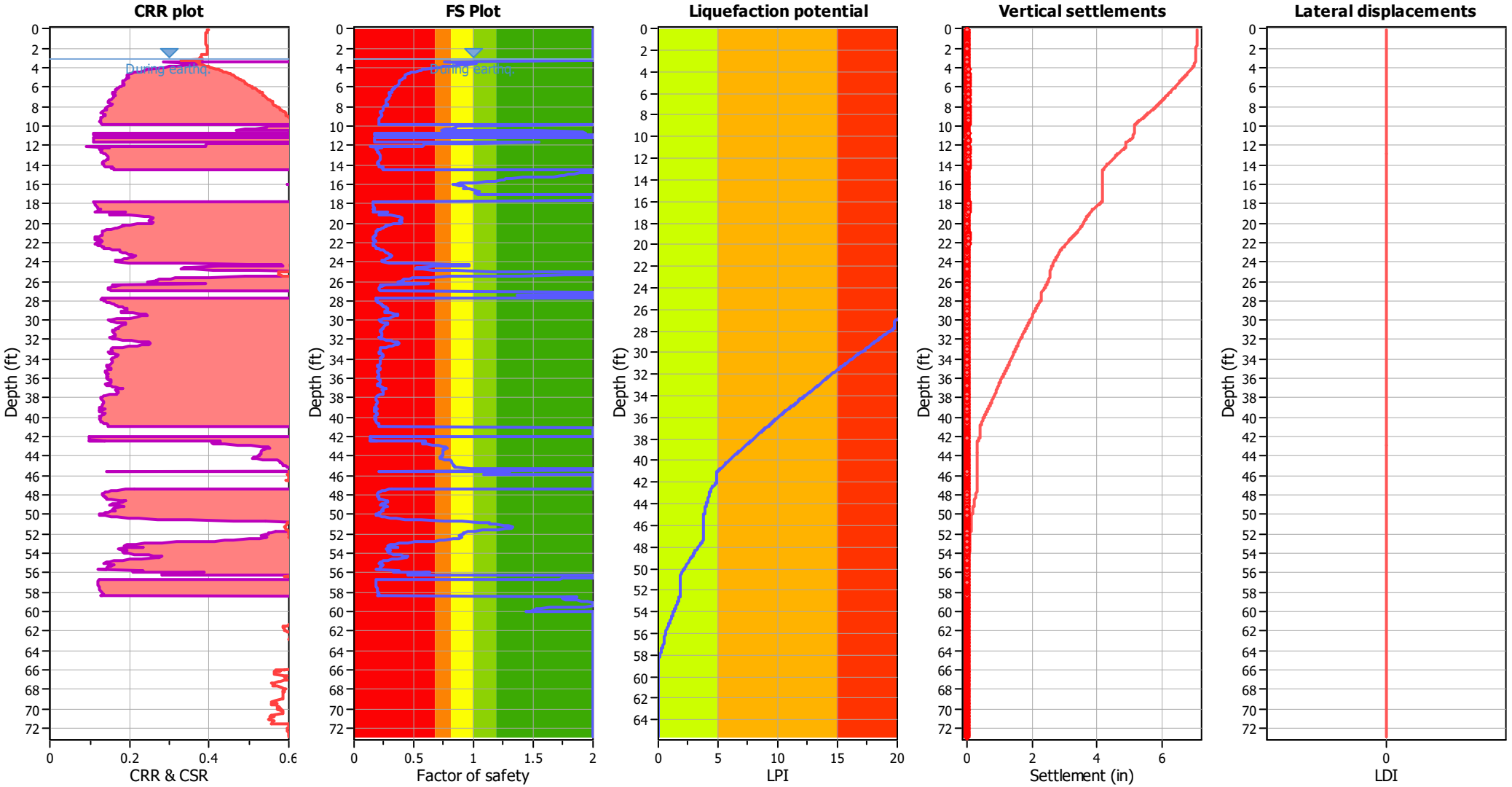
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	Limit depth:	60.00 ft

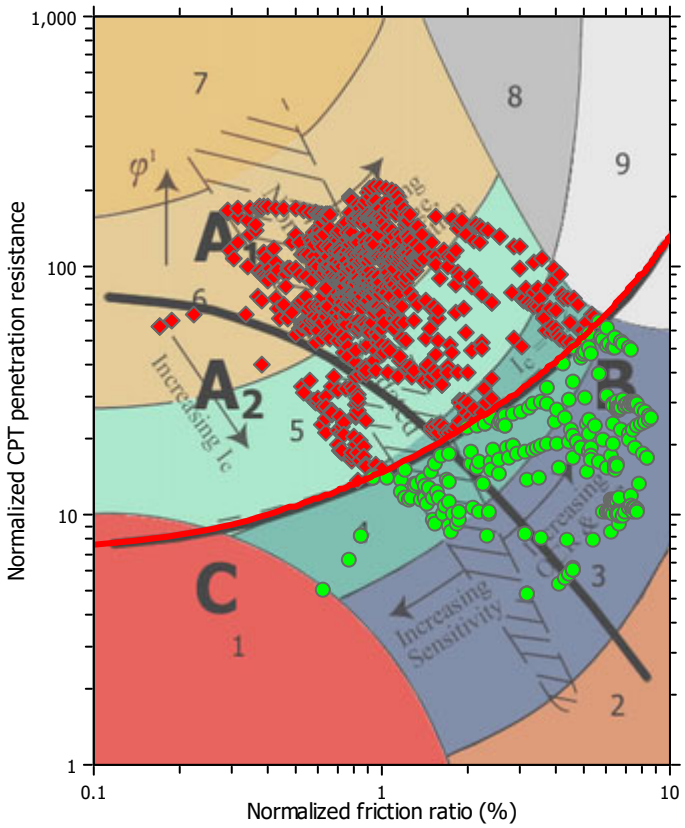
F.S. color scheme

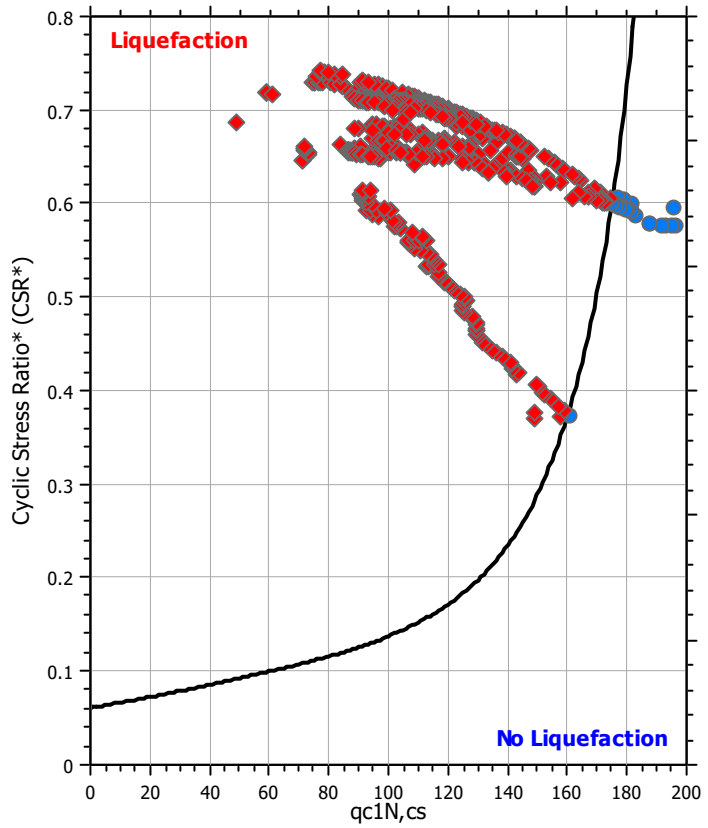
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

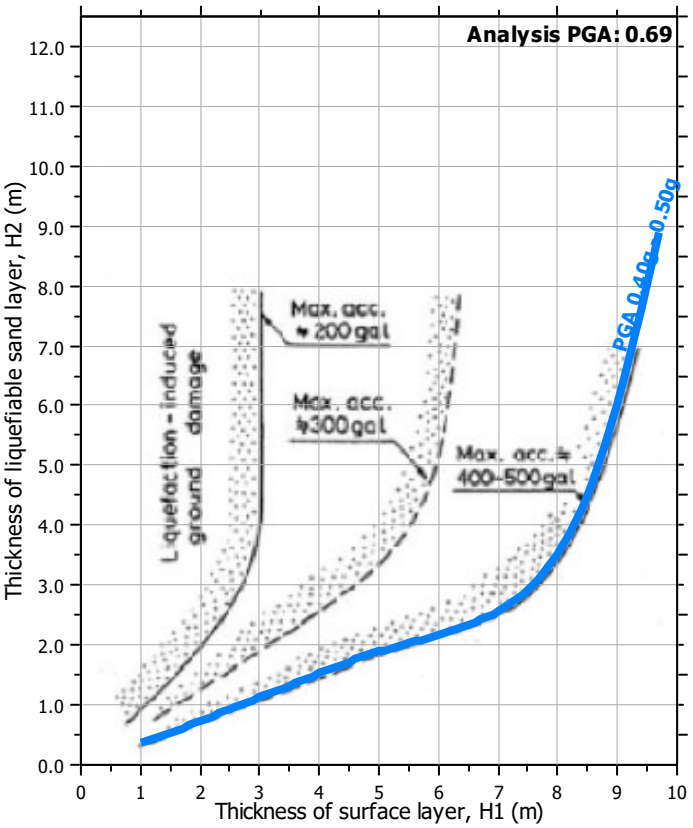
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



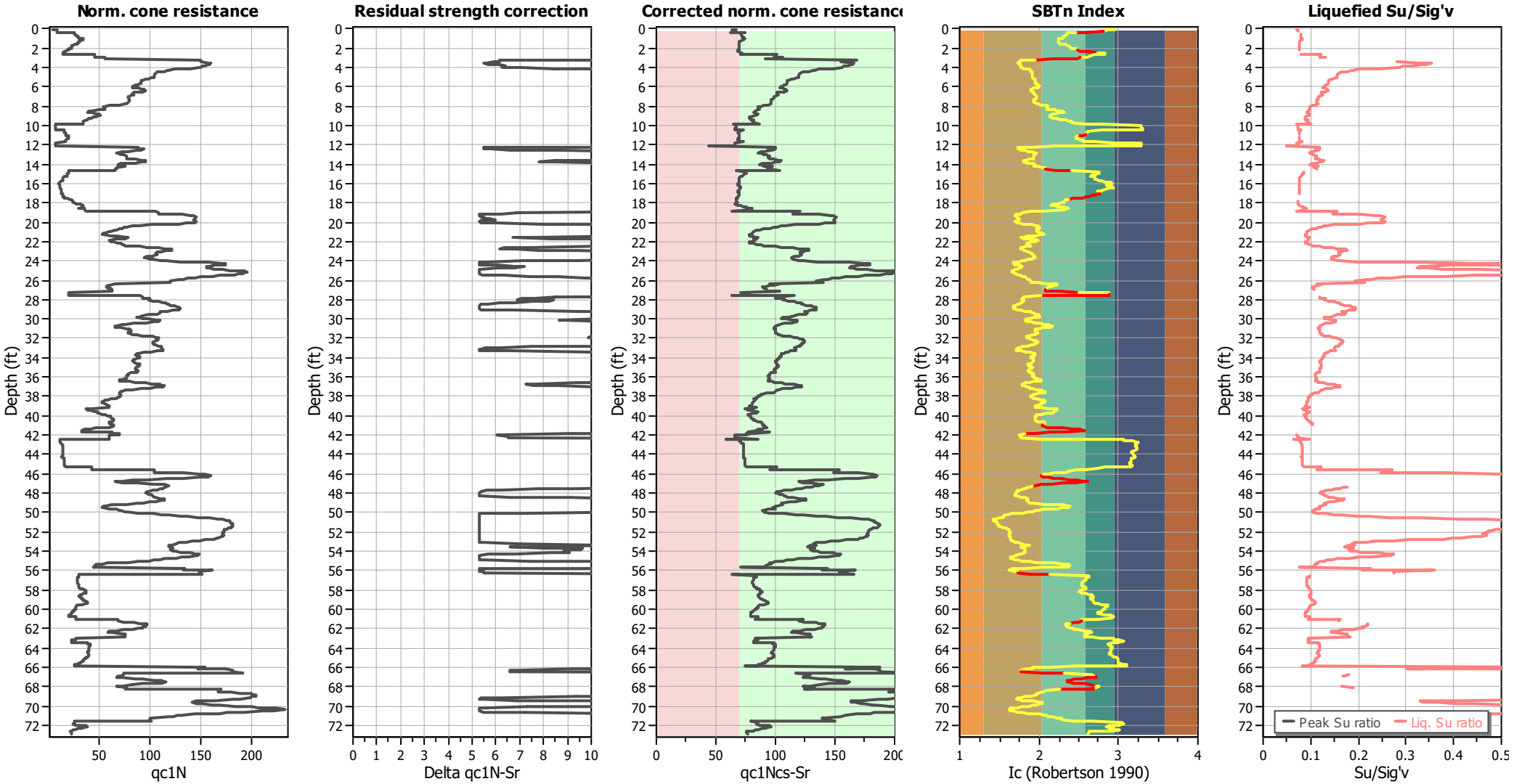




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

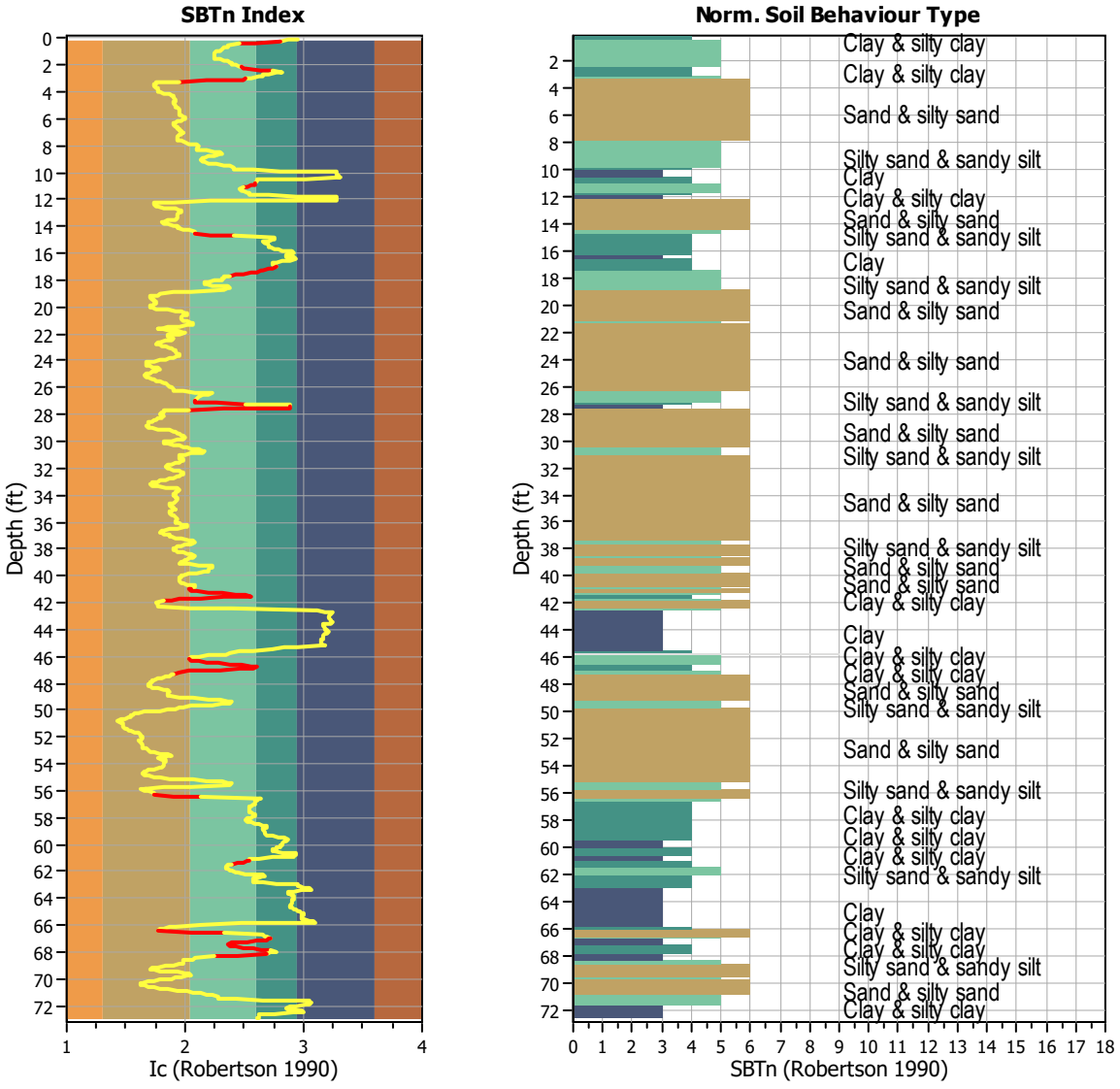
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.58 ft	Fill height:	N/A	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

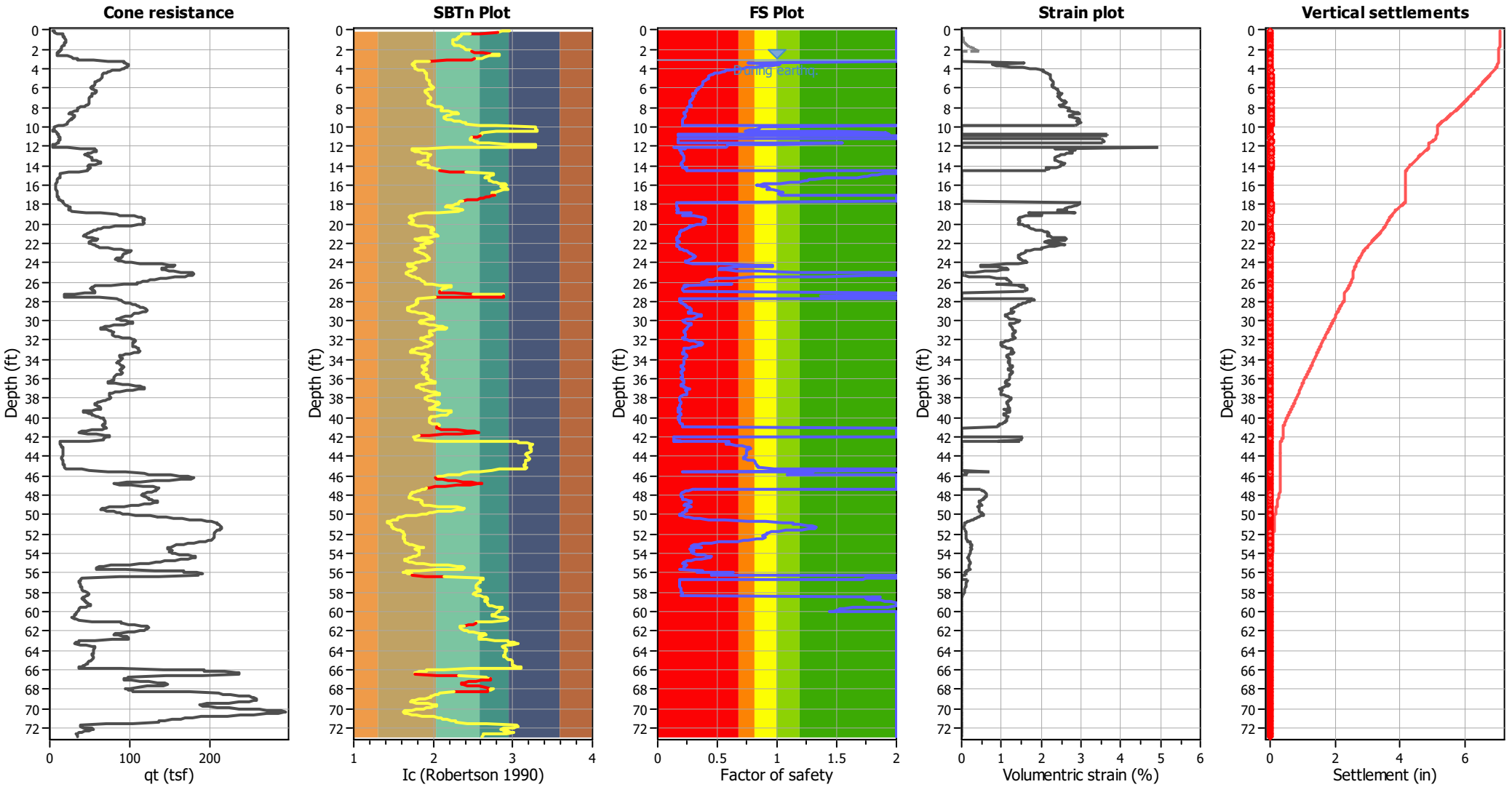
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1111
I_c maximum check value:	3.00	Total points excluded:	106
I_c change ratio value:	0.0250	Exclusion percentage:	9.54%
Minimum number of points in layer:	4	Number of layers detected:	18

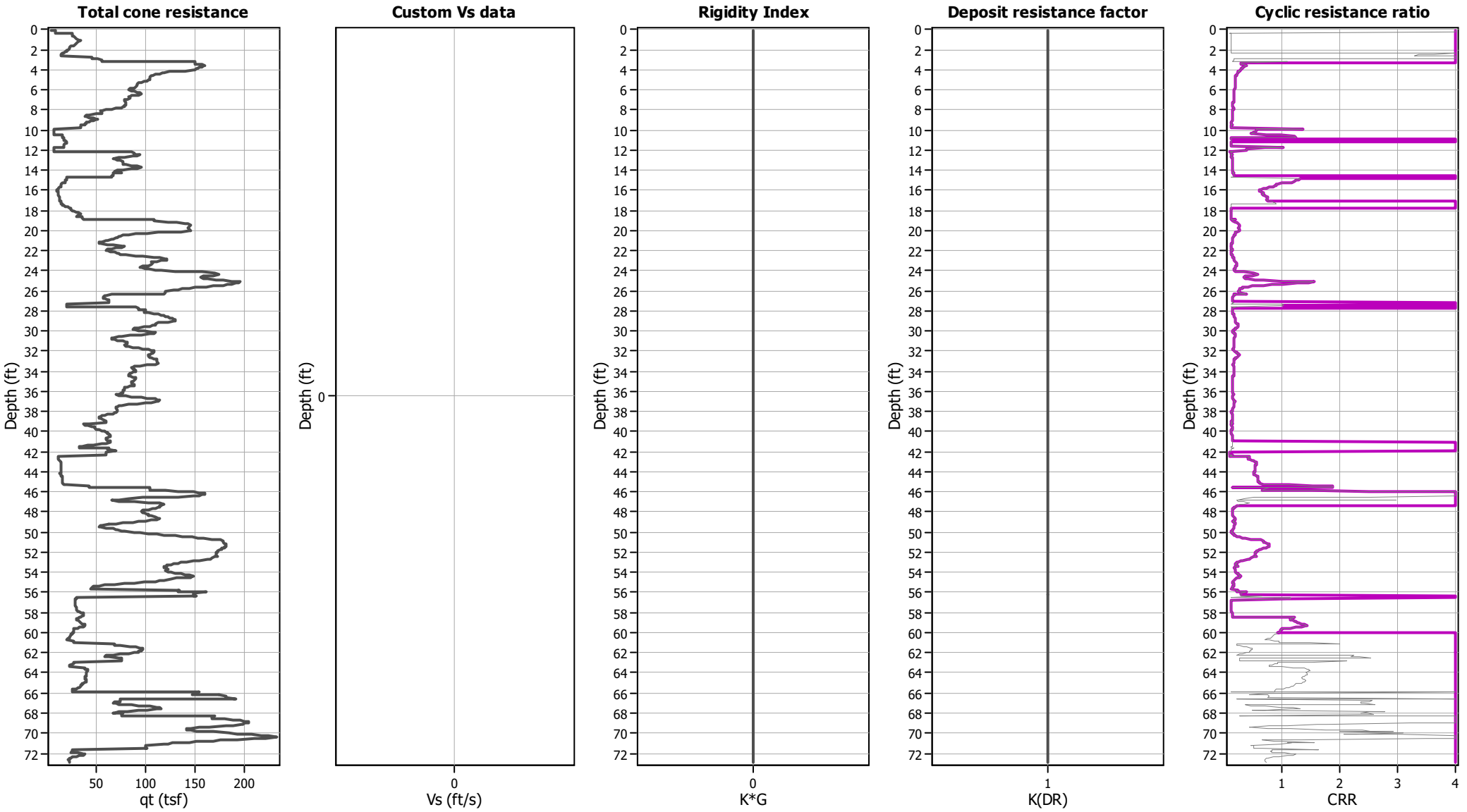
Estimation of post-earthquake settlements



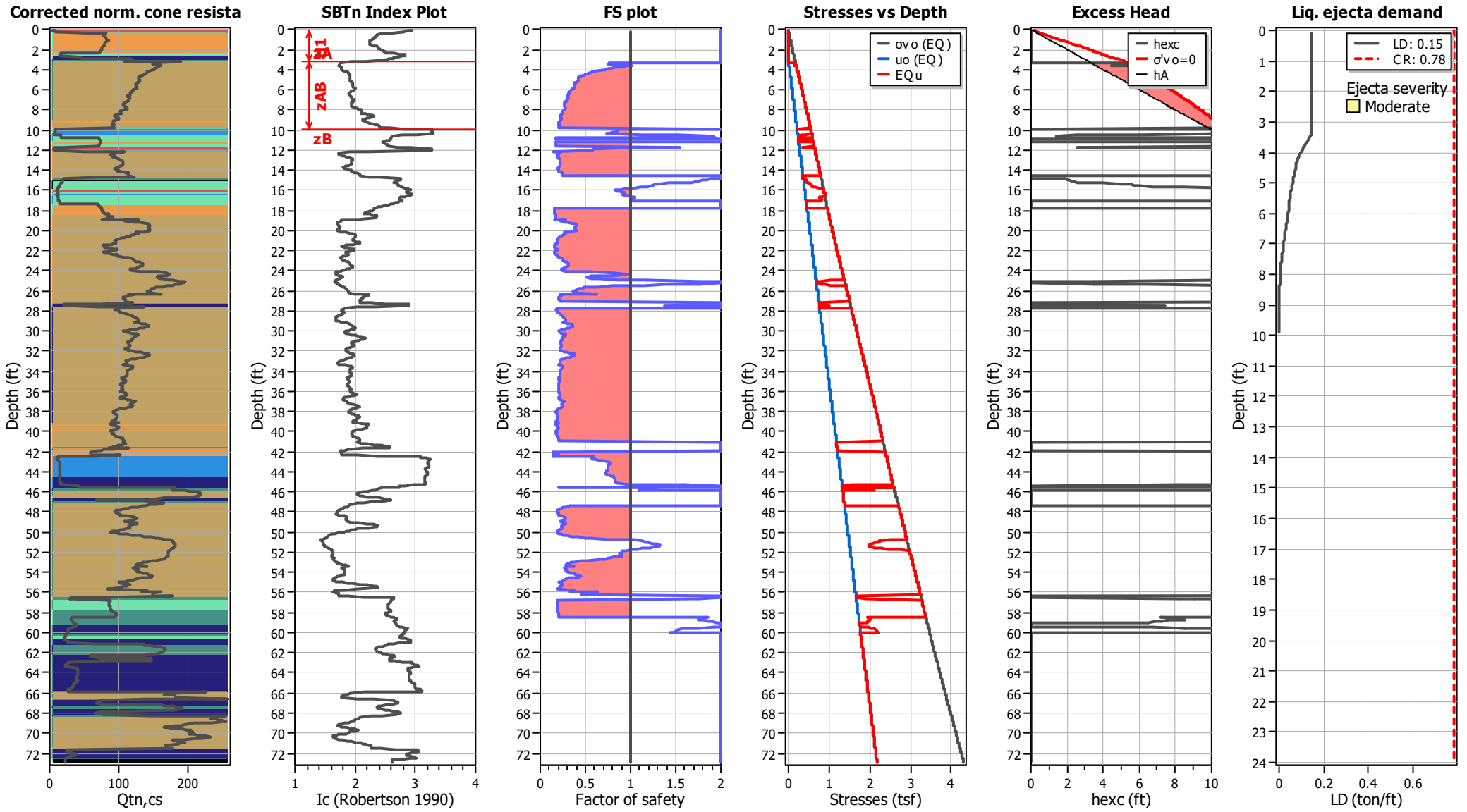
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

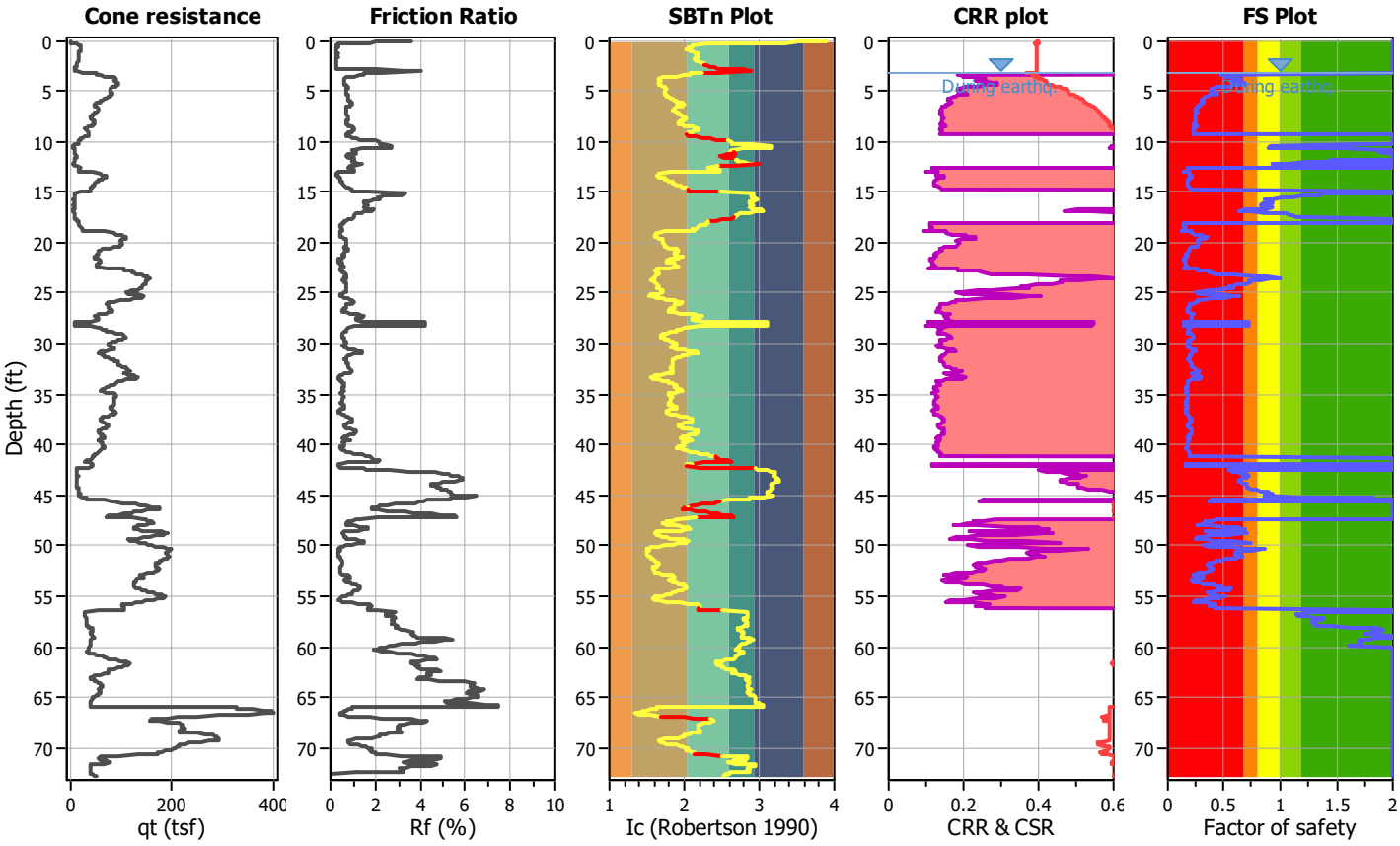
Project title : Topgolf Harbor Island

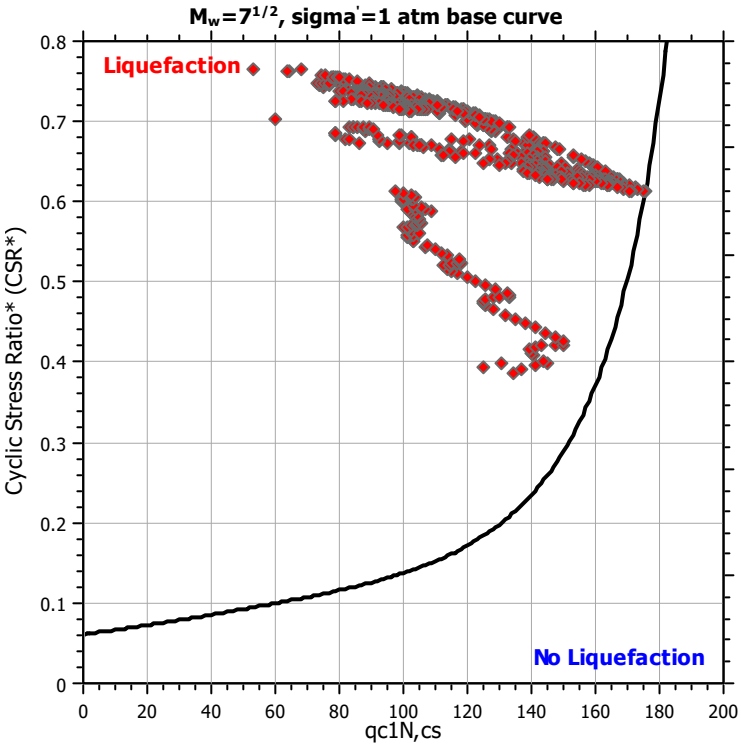
Location : North Harbor Drive and Liberator Way, San Diego, CA

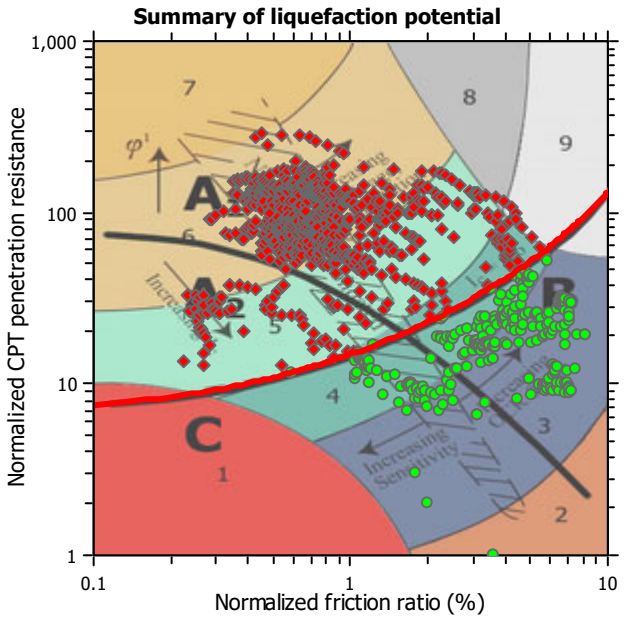
CPT file : CPT-23 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.67 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

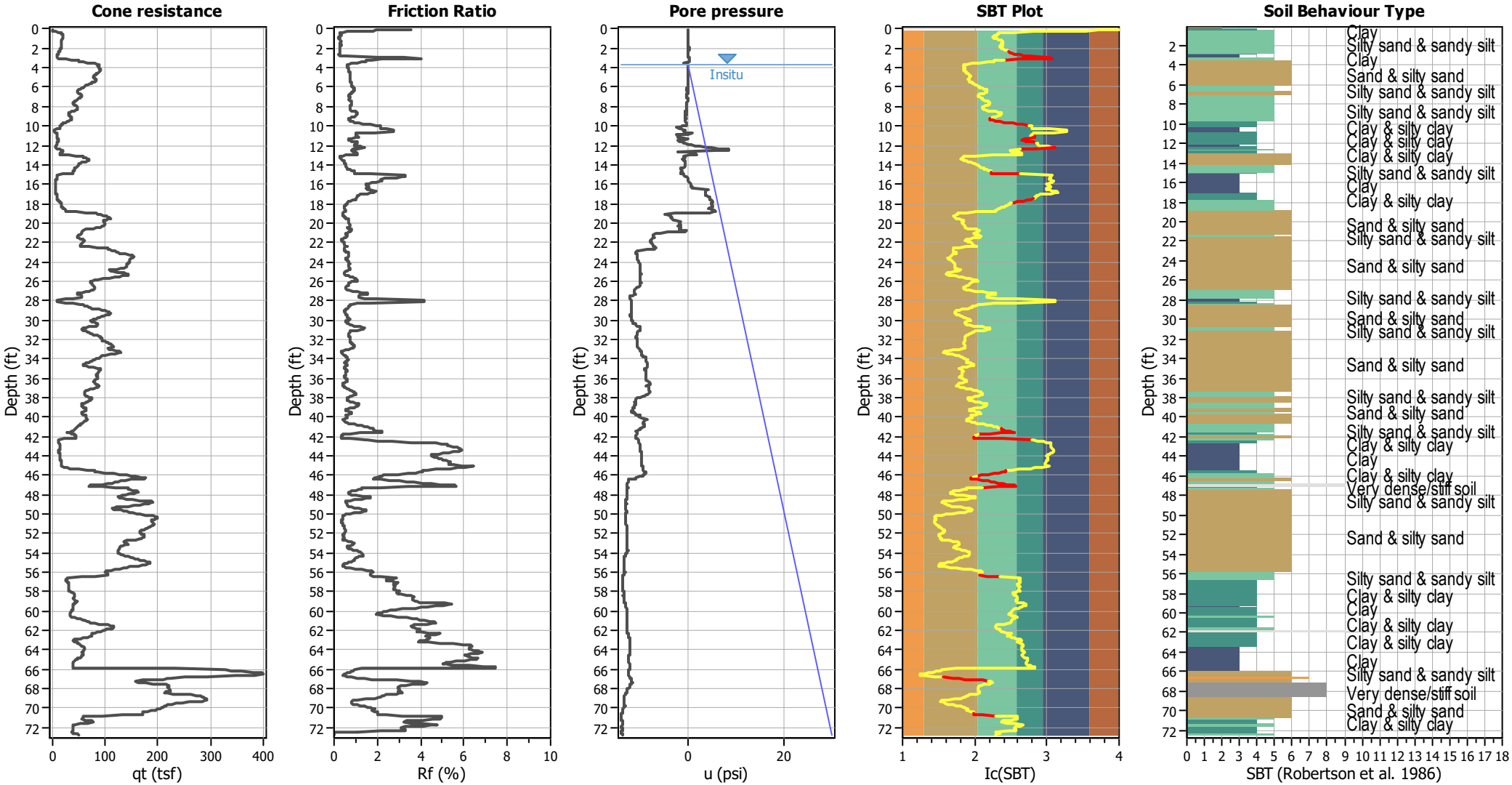






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



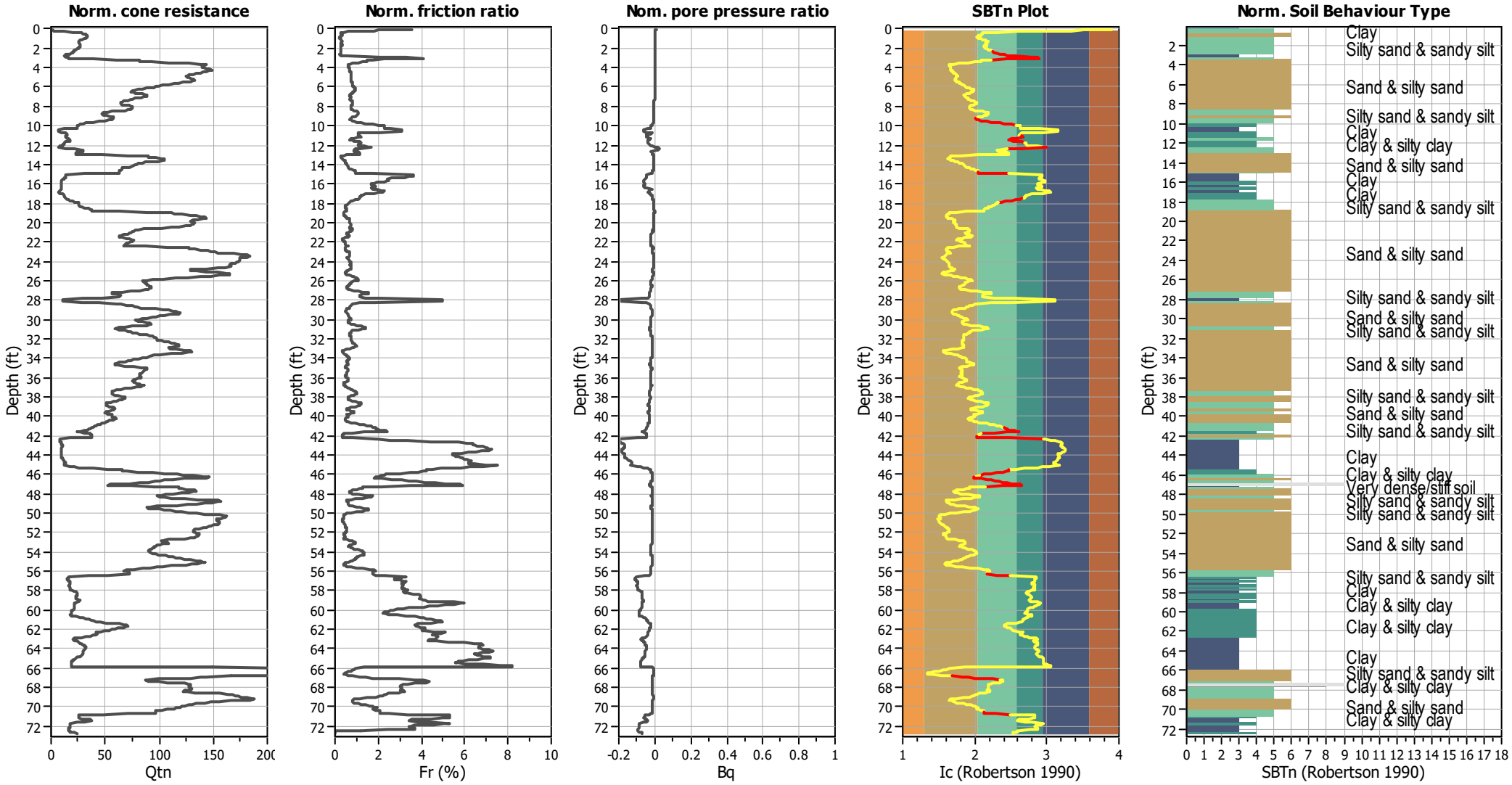
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	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)



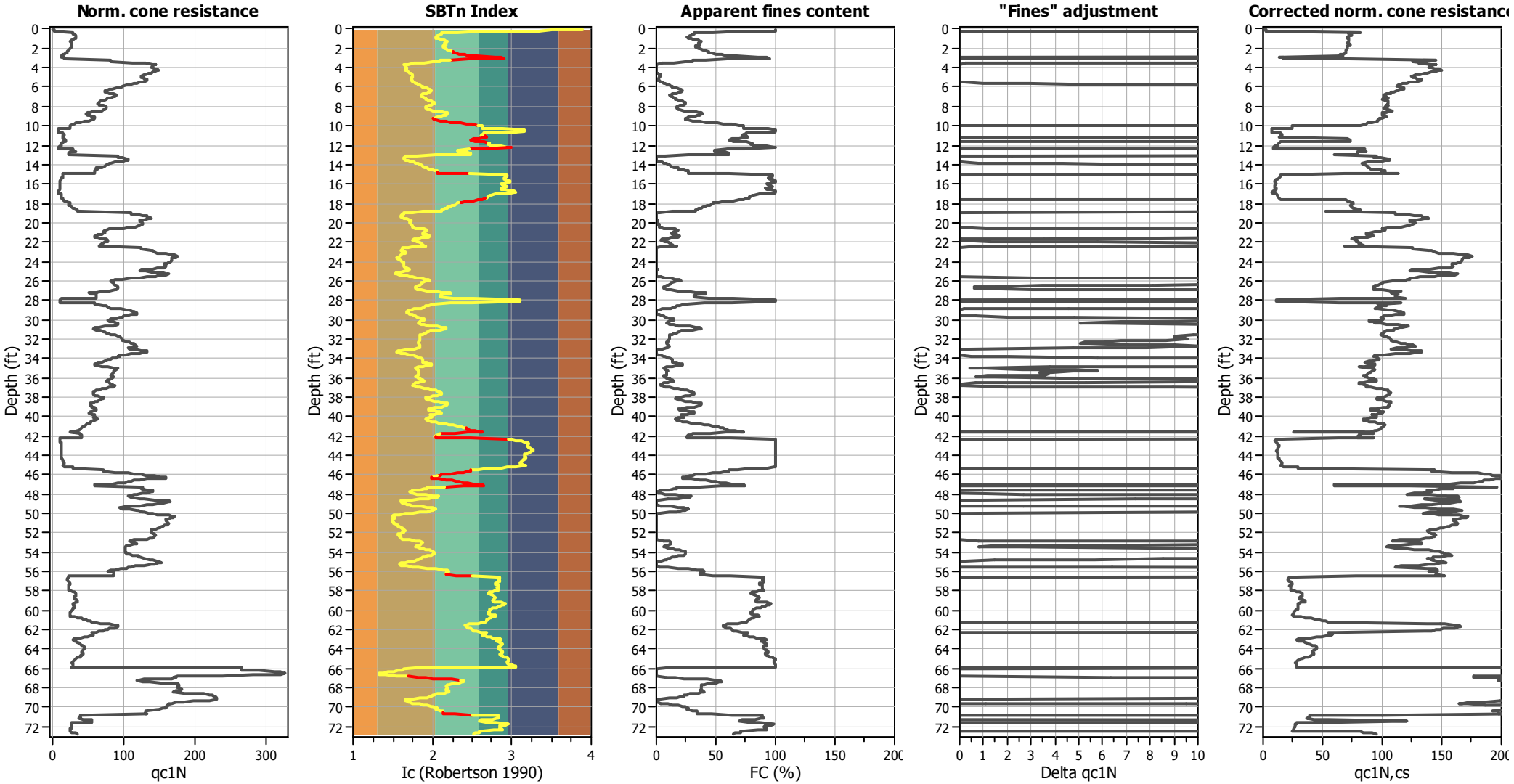
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	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

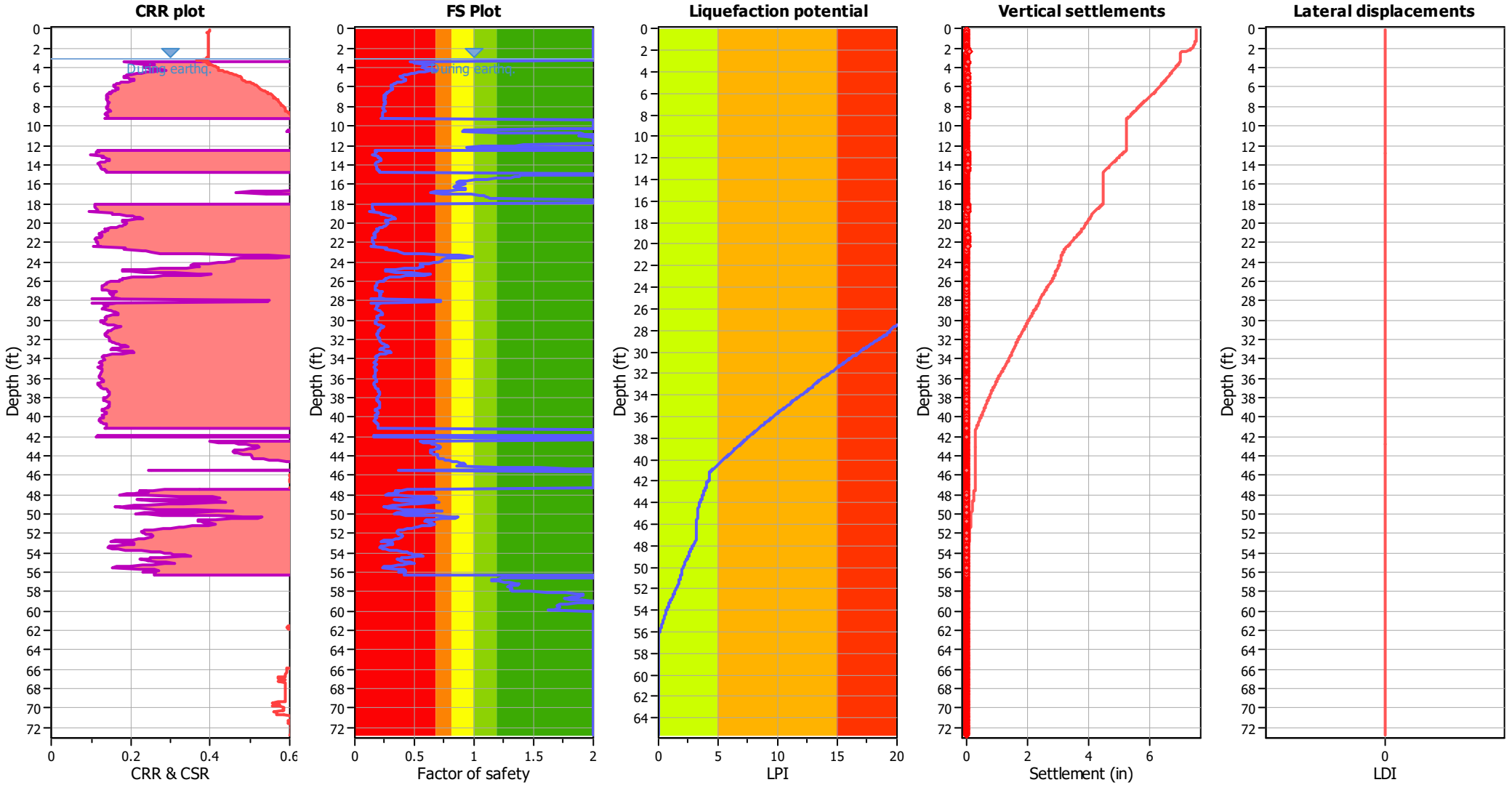
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	Limit depth:	60.00 ft

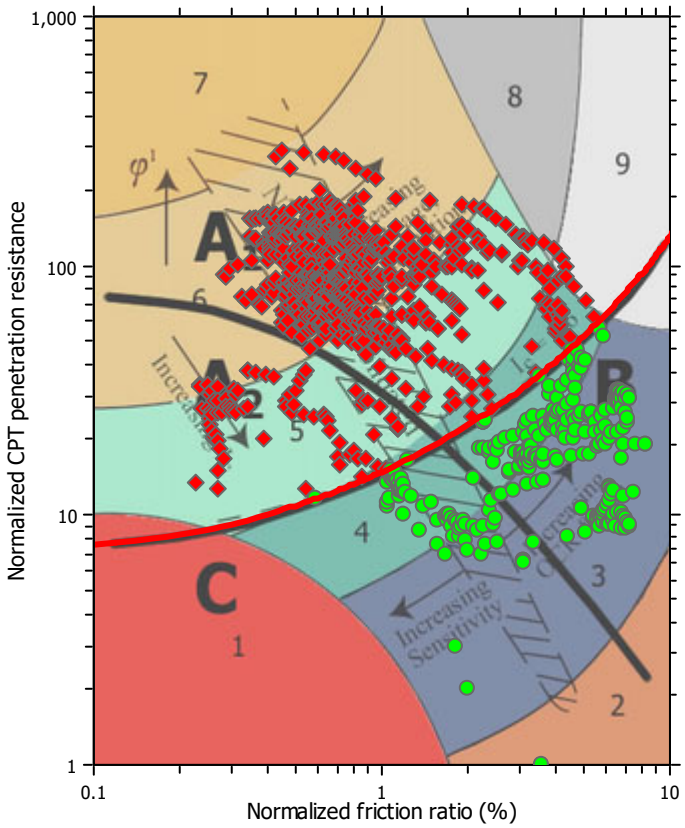
F.S. color scheme

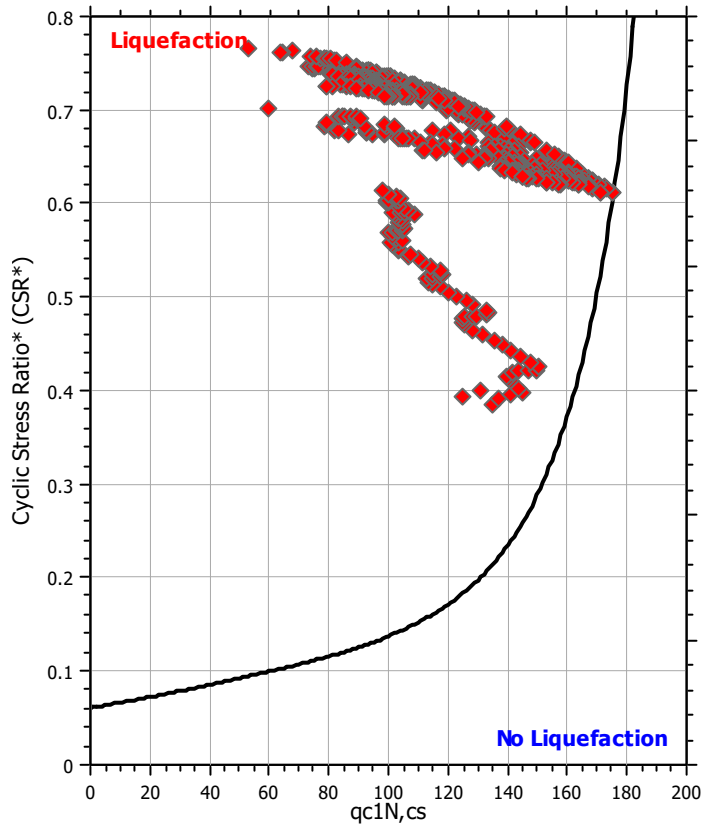
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

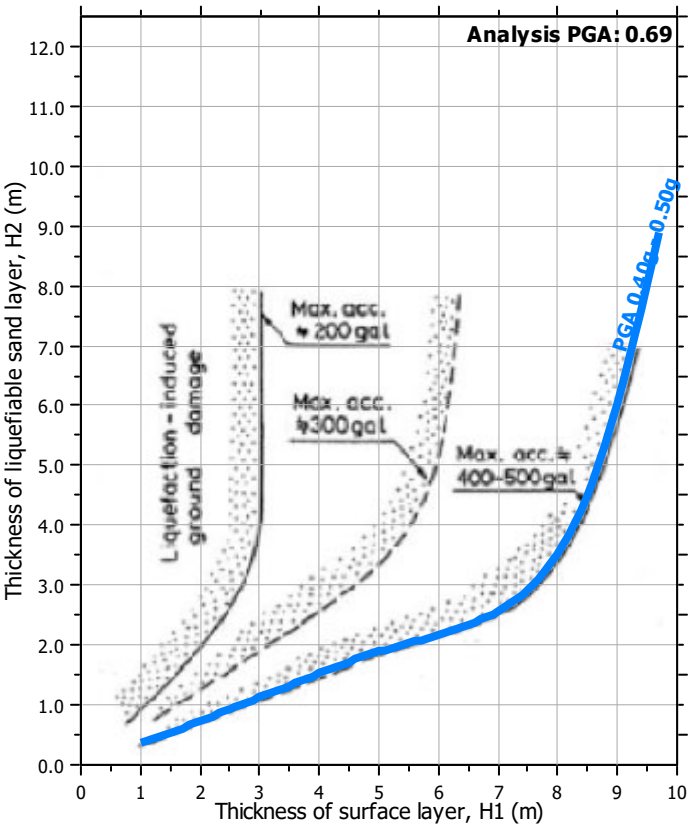
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



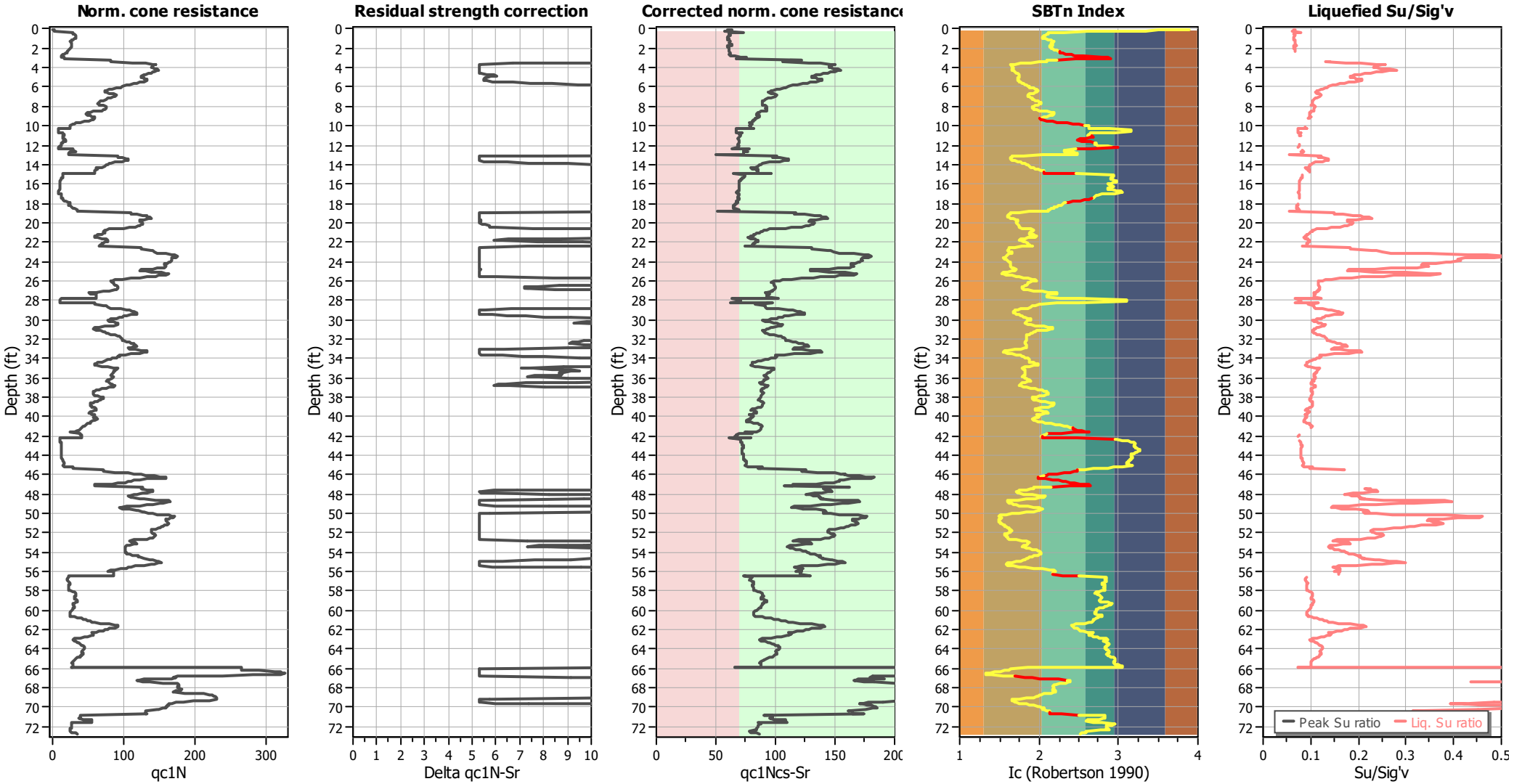




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

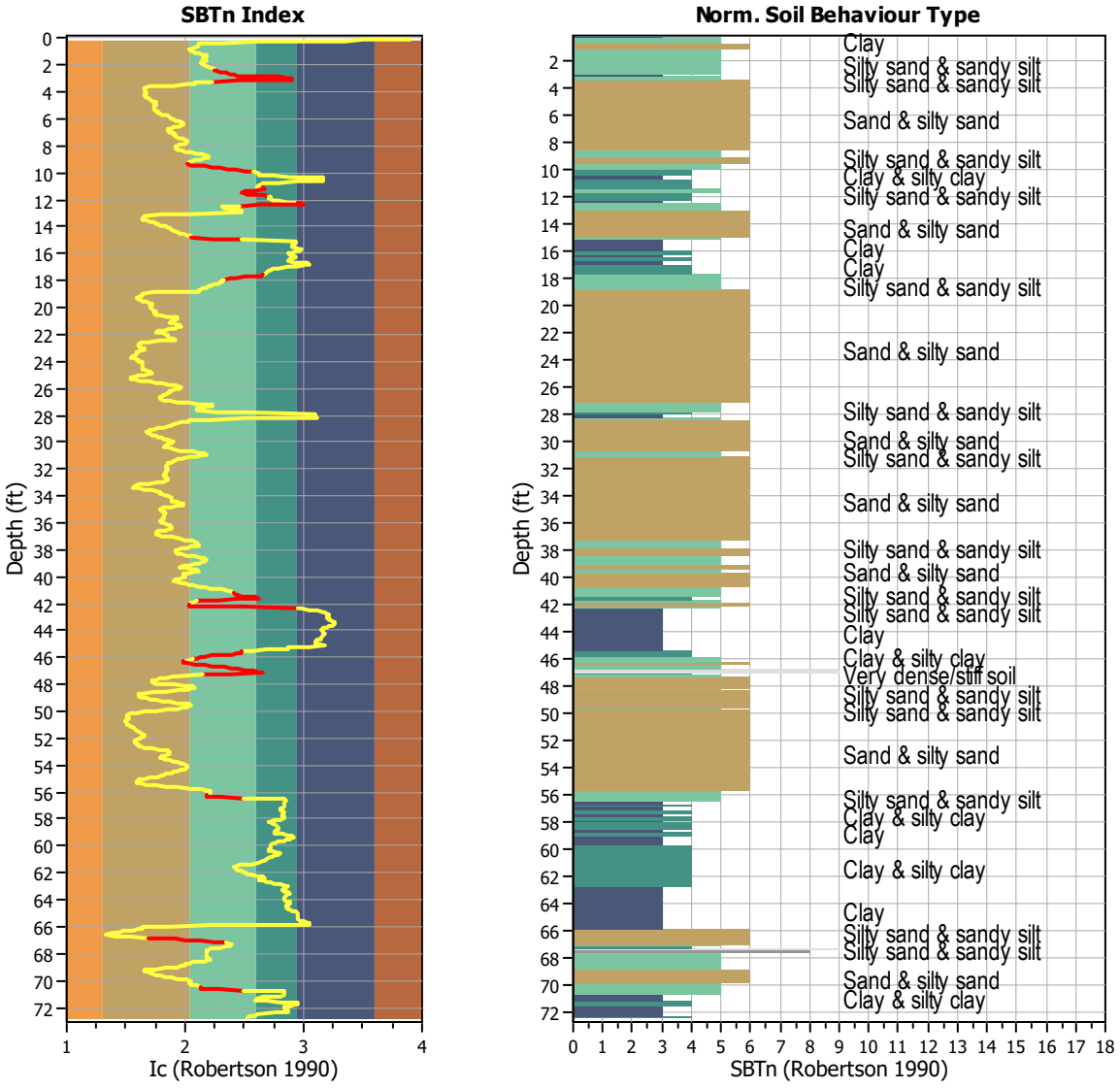
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.67 ft	Fill height:	N/A	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).

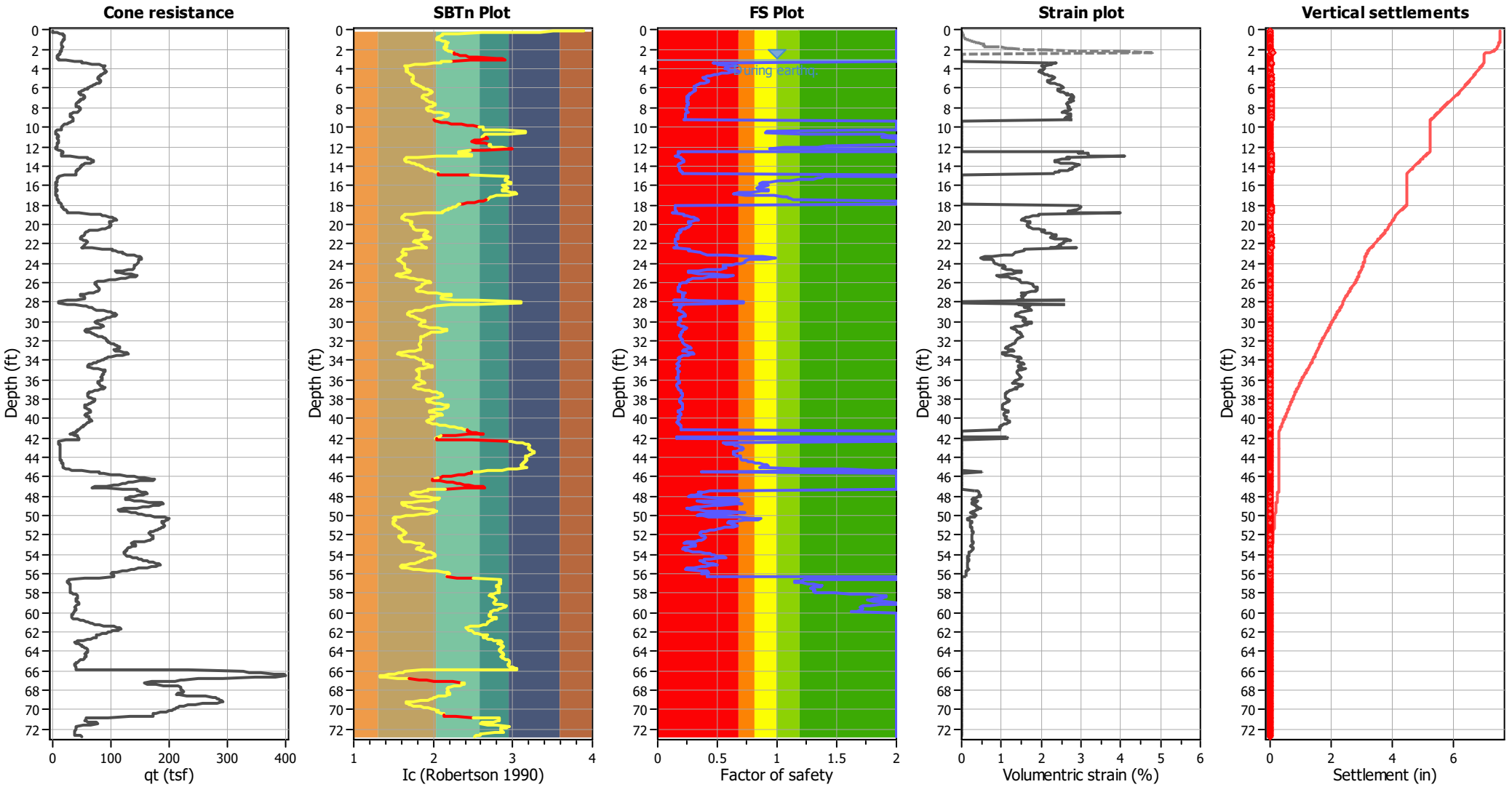
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



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:	1106
Total points excluded:	109
Exclusion percentage:	9.86%
Number of layers detected:	17

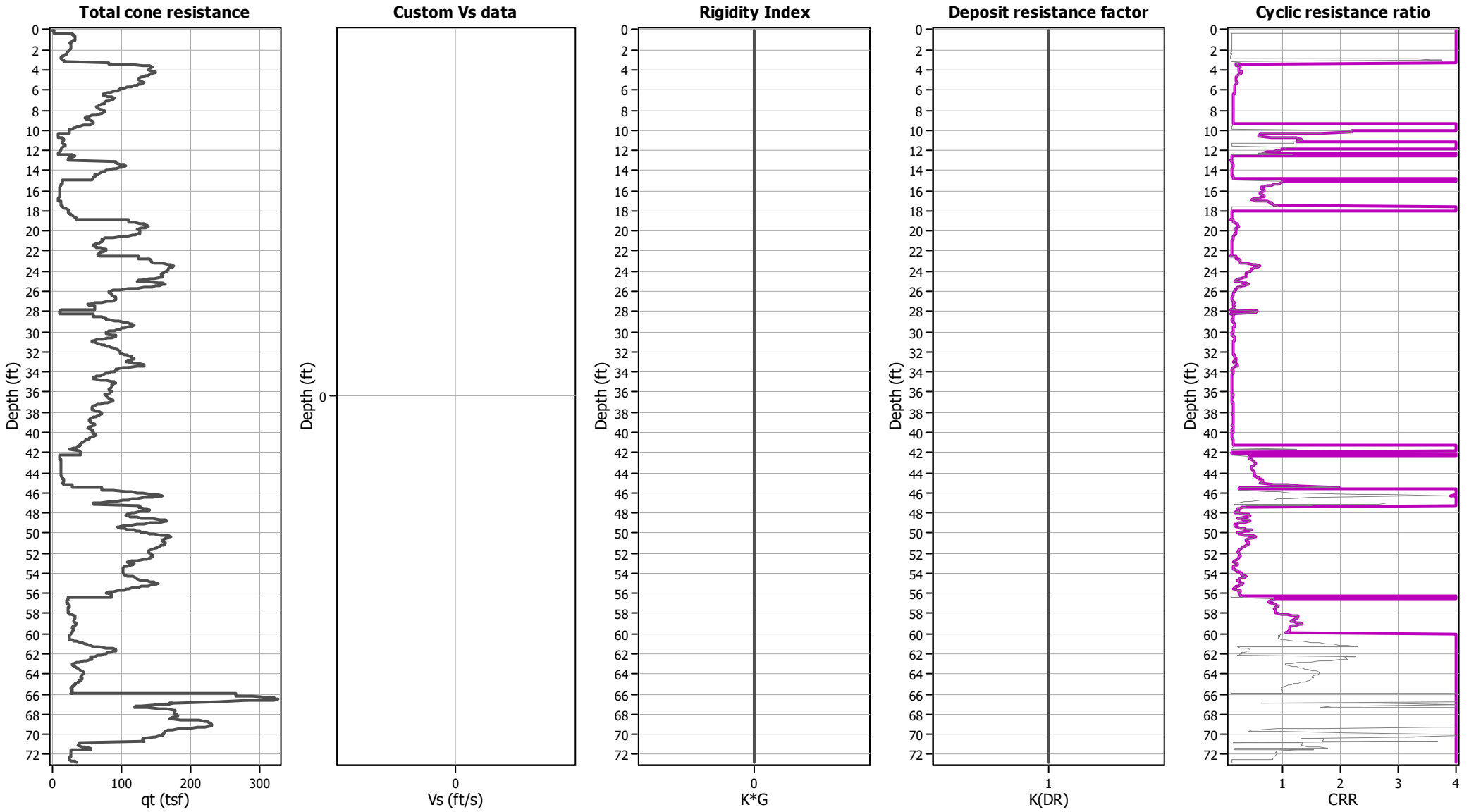
Estimation of post-earthquake settlements



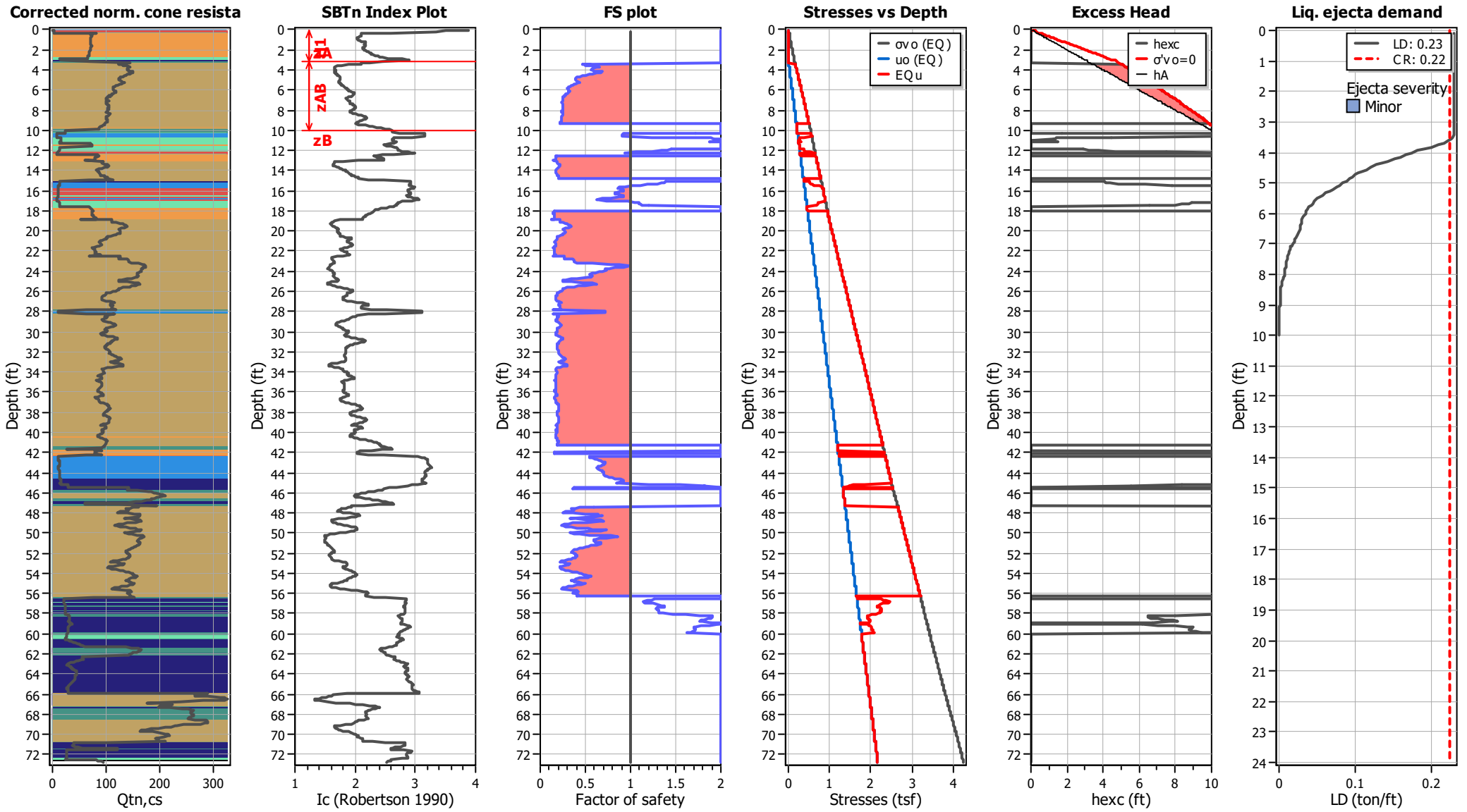
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

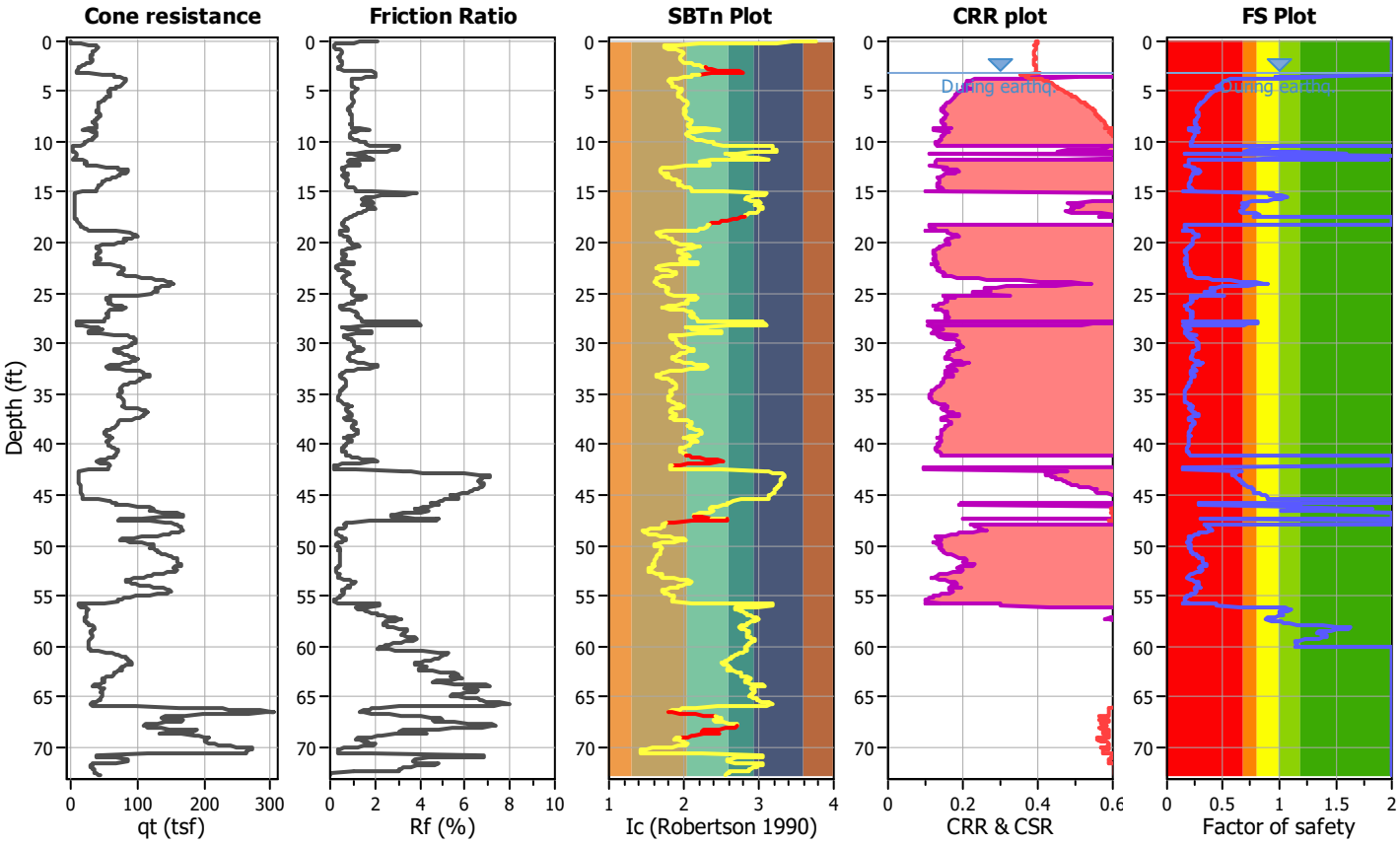
Project title : Topgolf Harbor Island

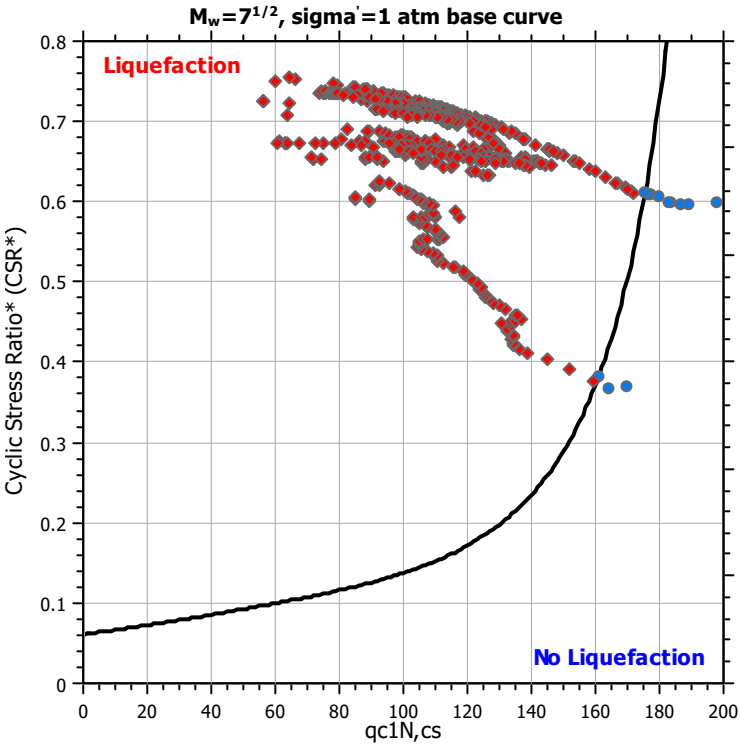
Location : North Harbor Drive and Liberator Way, San Diego, CA

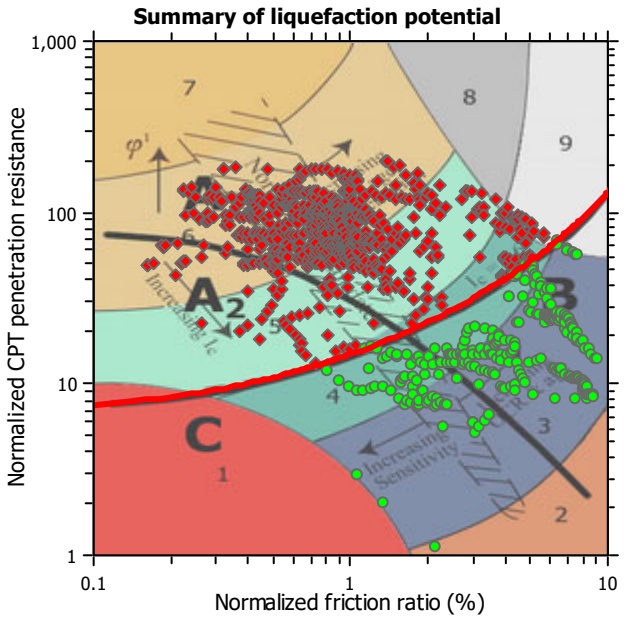
CPT file : CPT-24 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.61 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

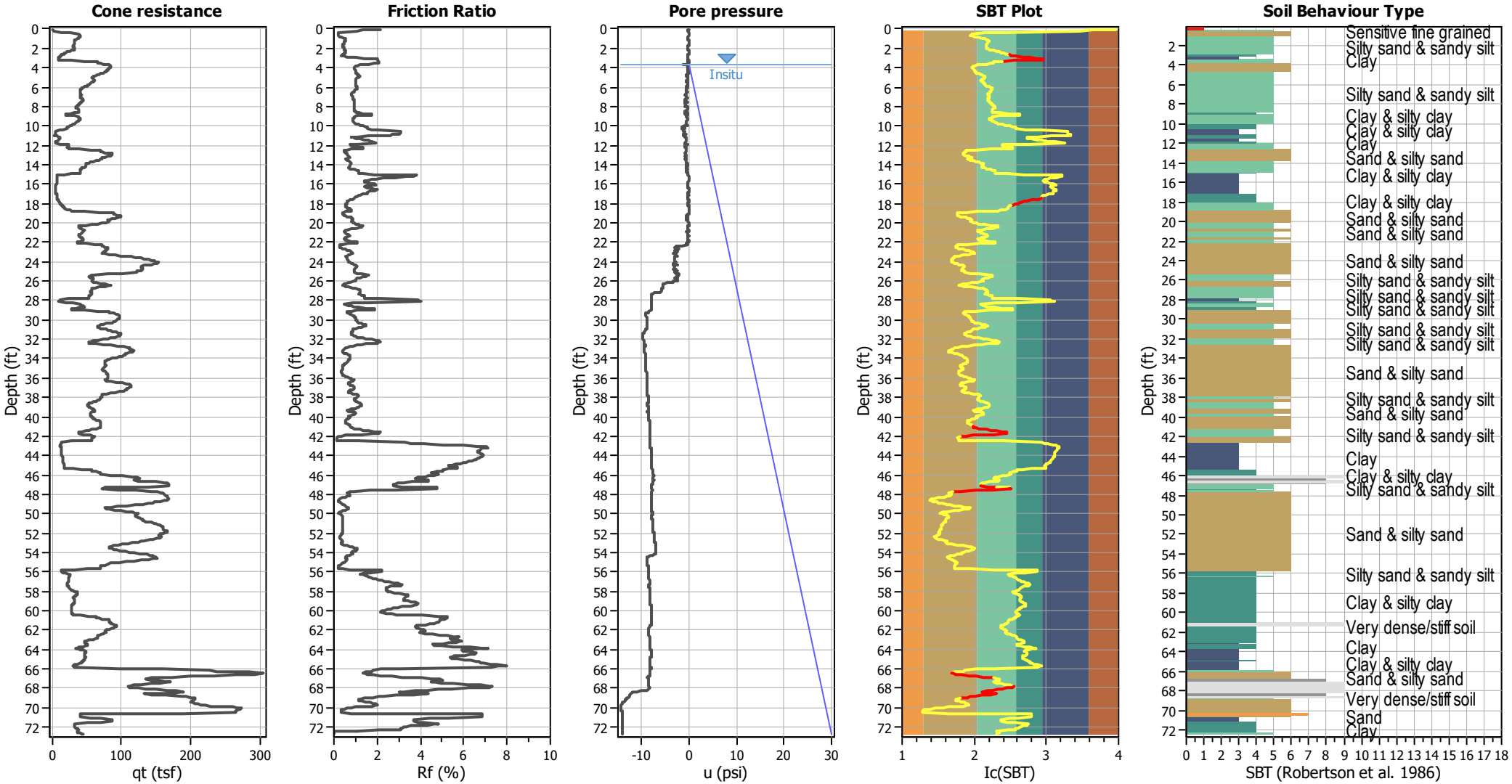






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



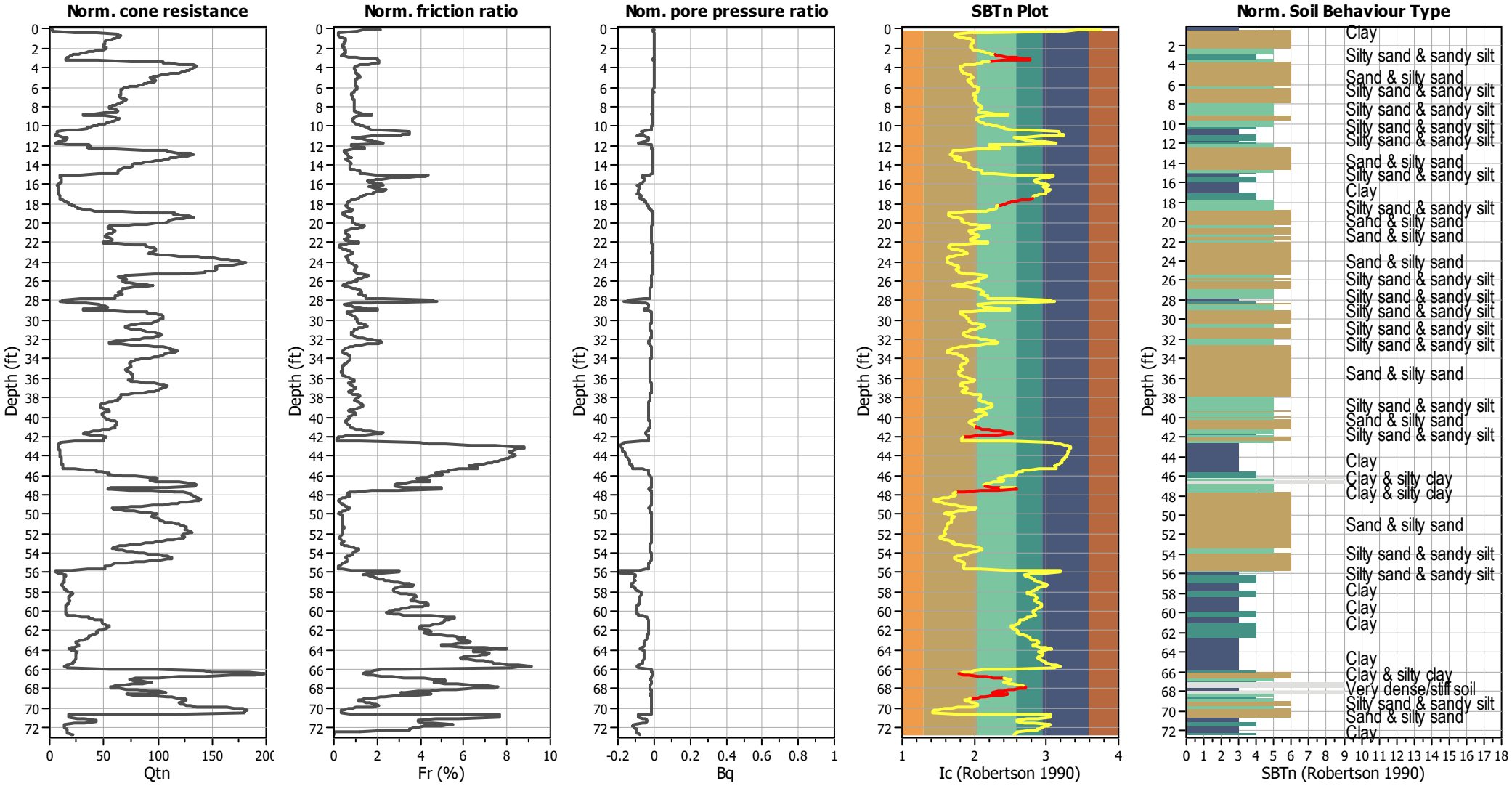
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	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)



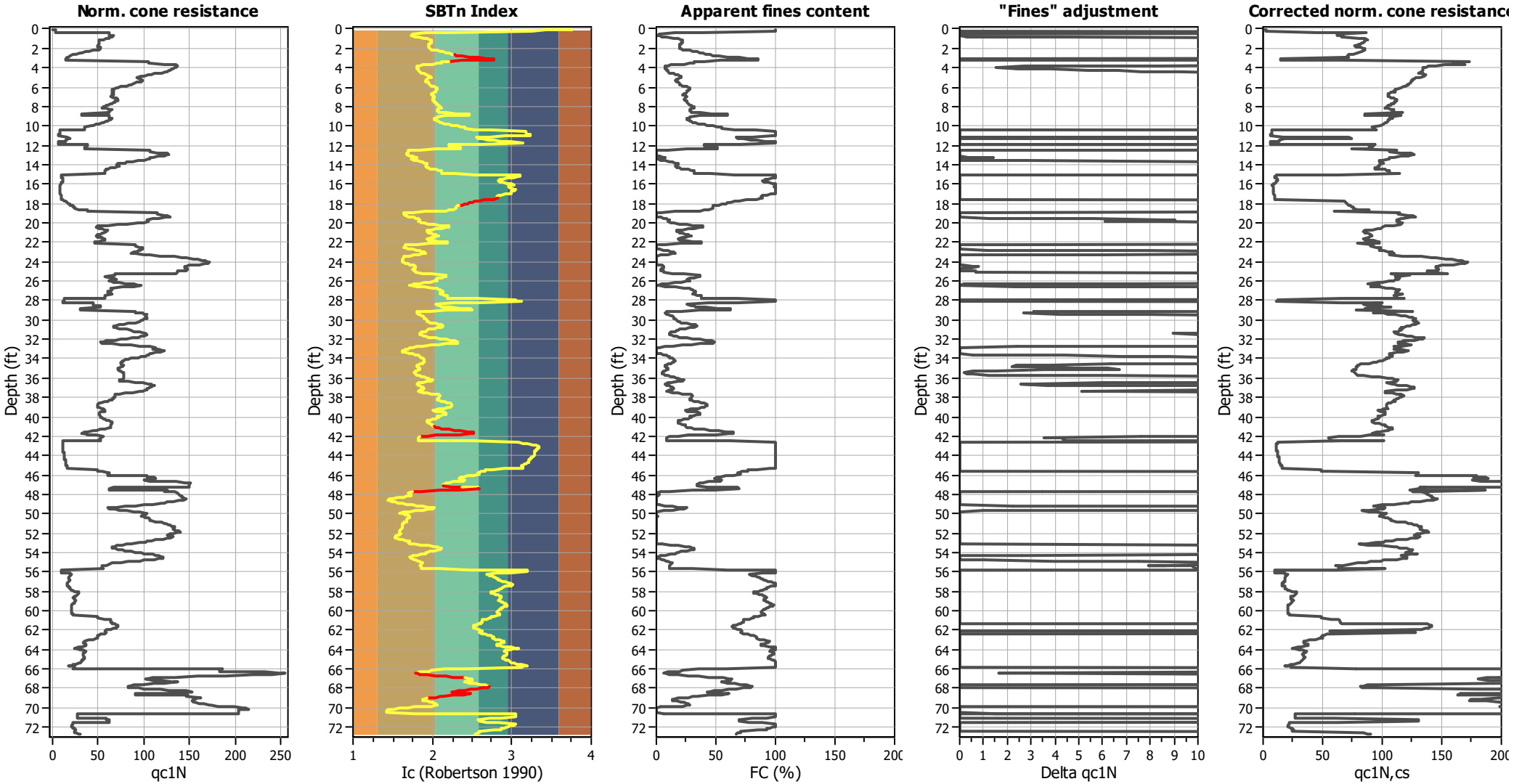
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	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

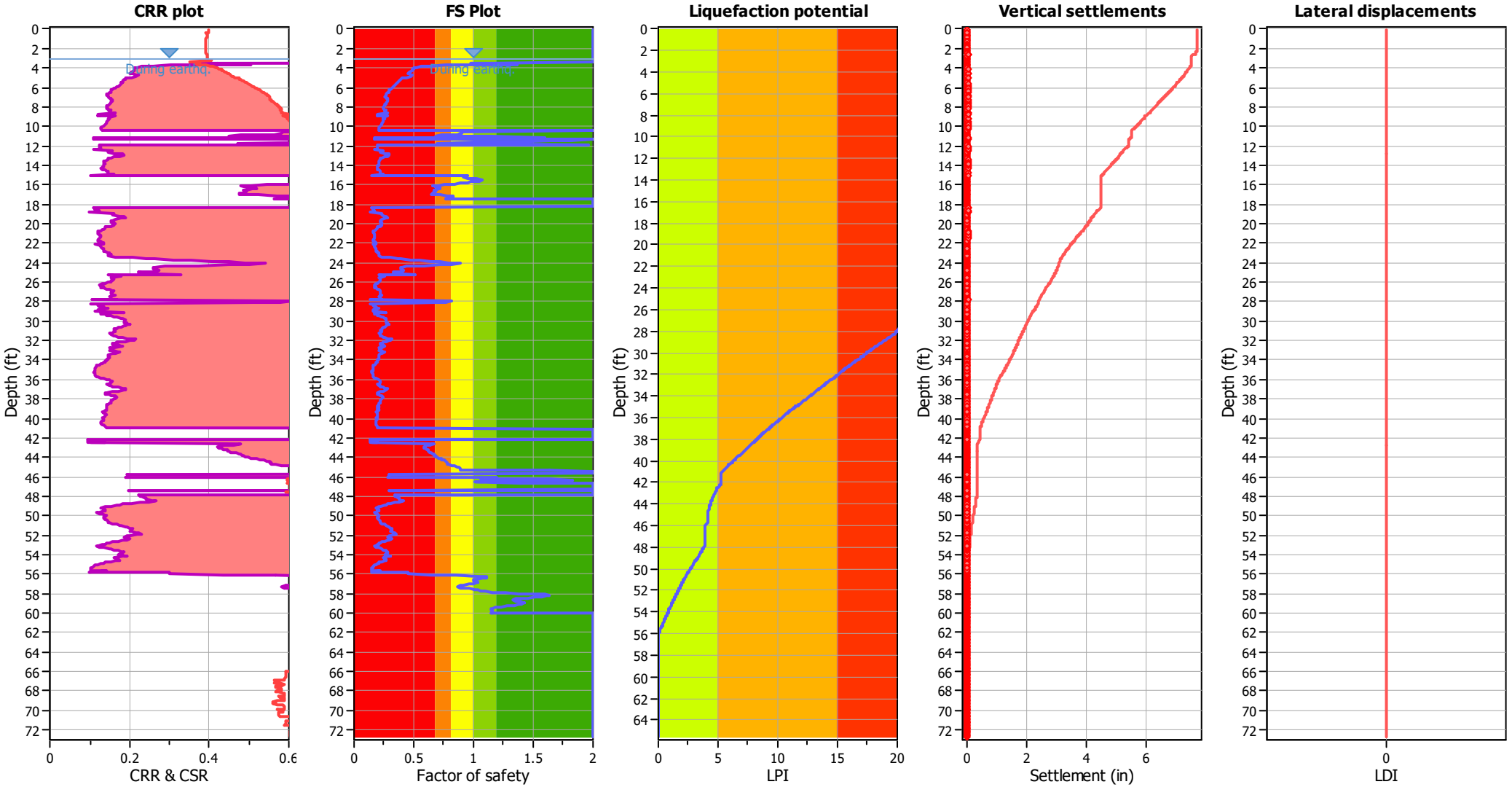
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	Limit depth:	60.00 ft

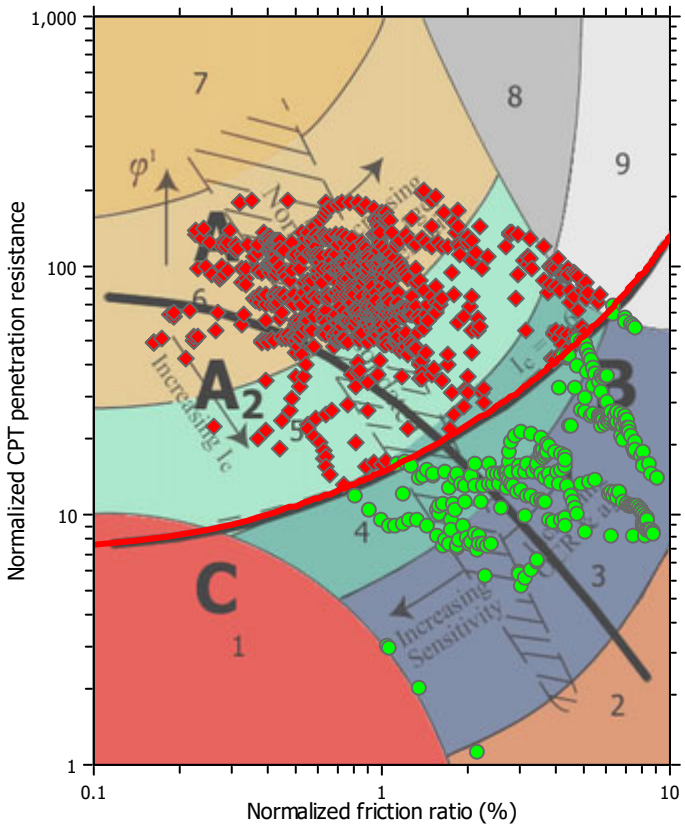
F.S. color scheme

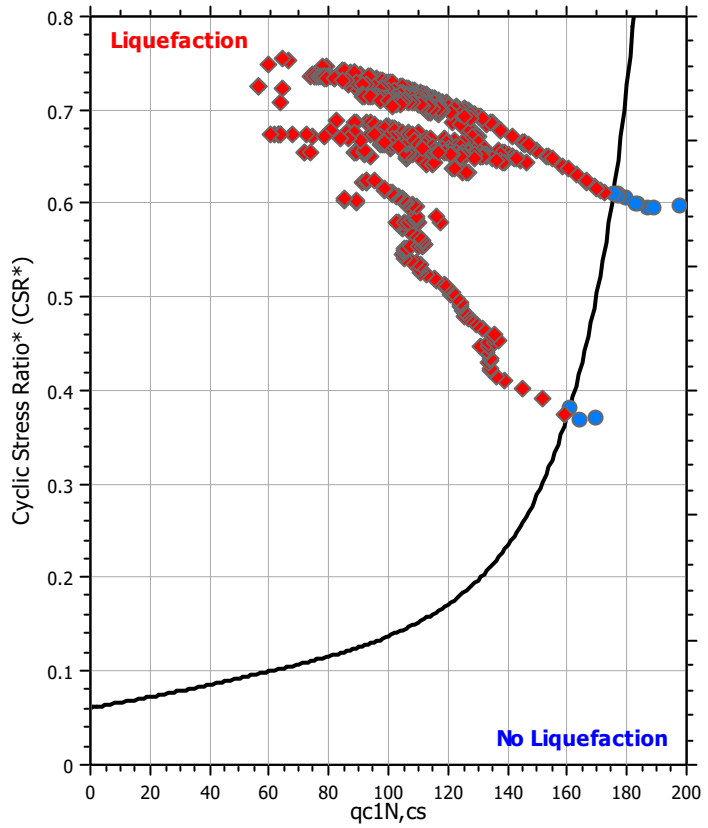
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

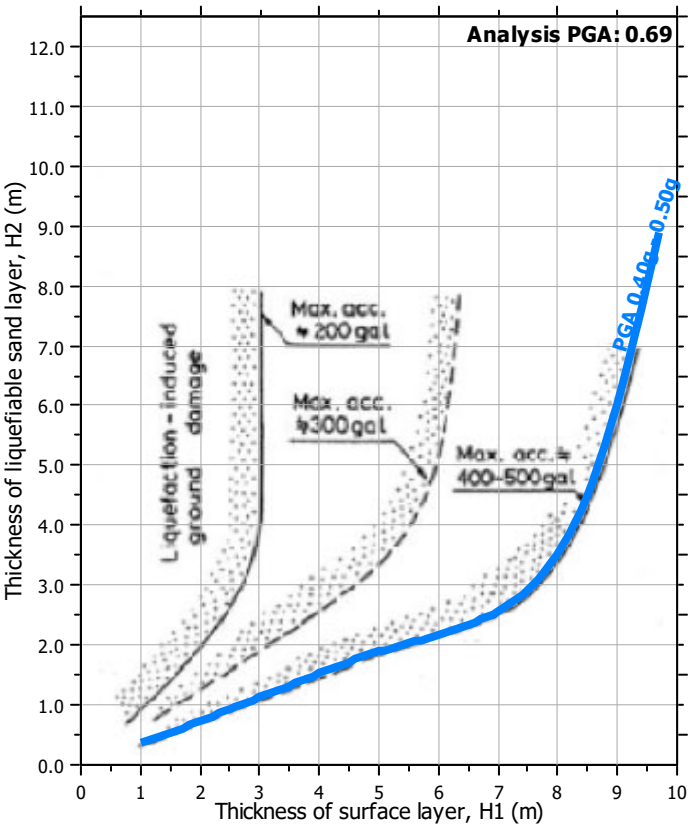
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



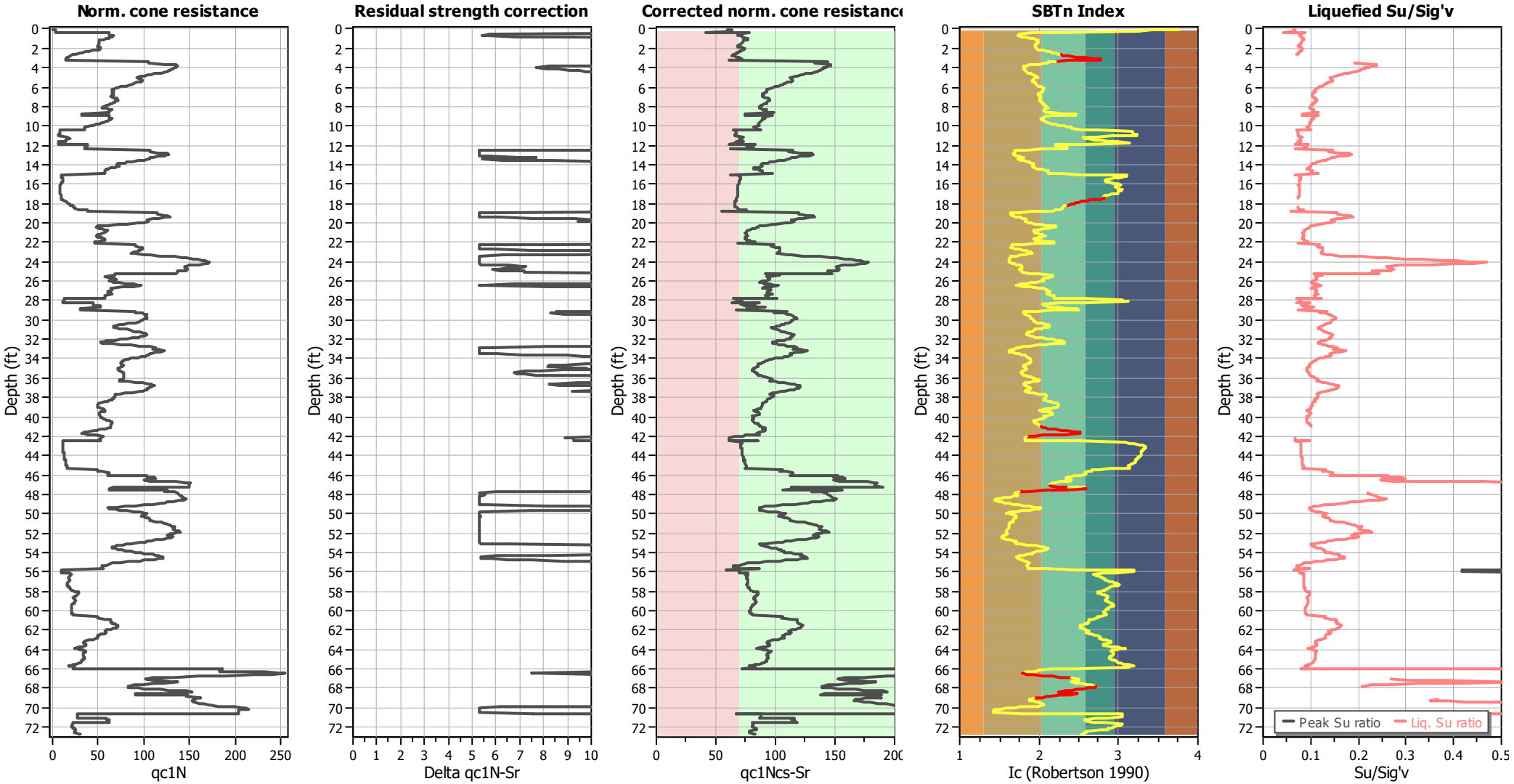




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

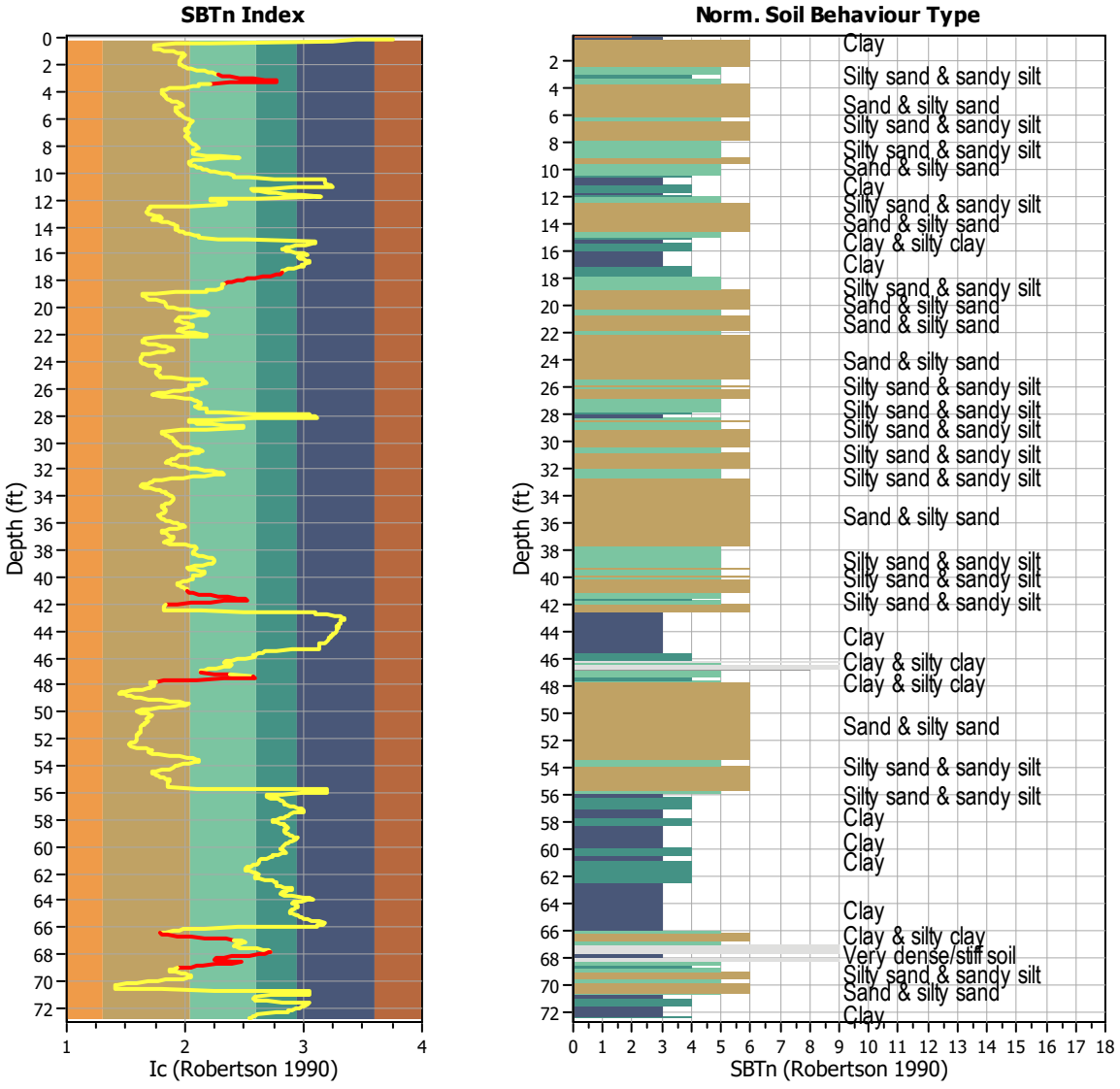
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.61 ft	Fill height:	N/A	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).

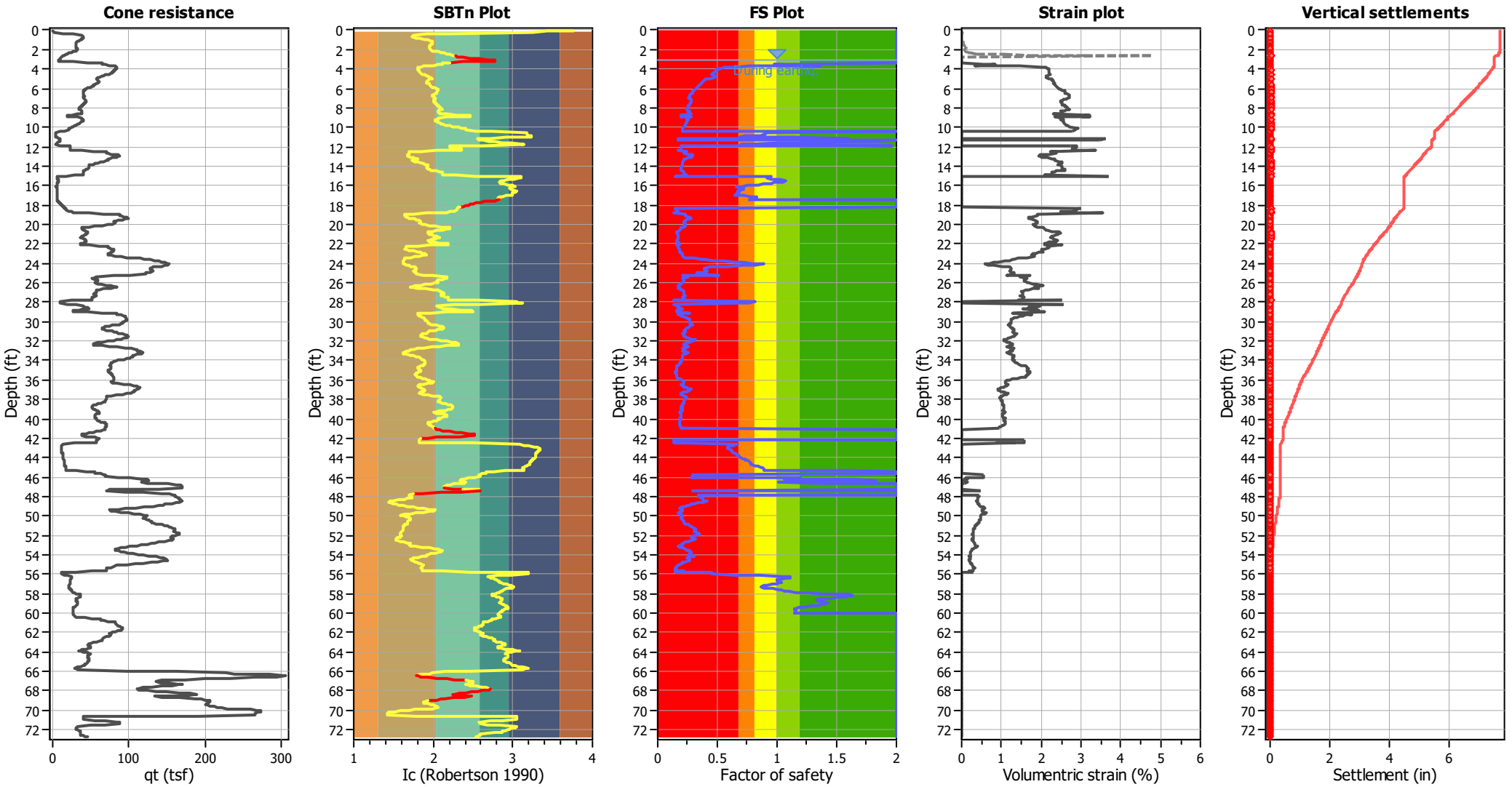
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



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:	1108
Total points excluded:	82
Exclusion percentage:	7.40%
Number of layers detected:	11

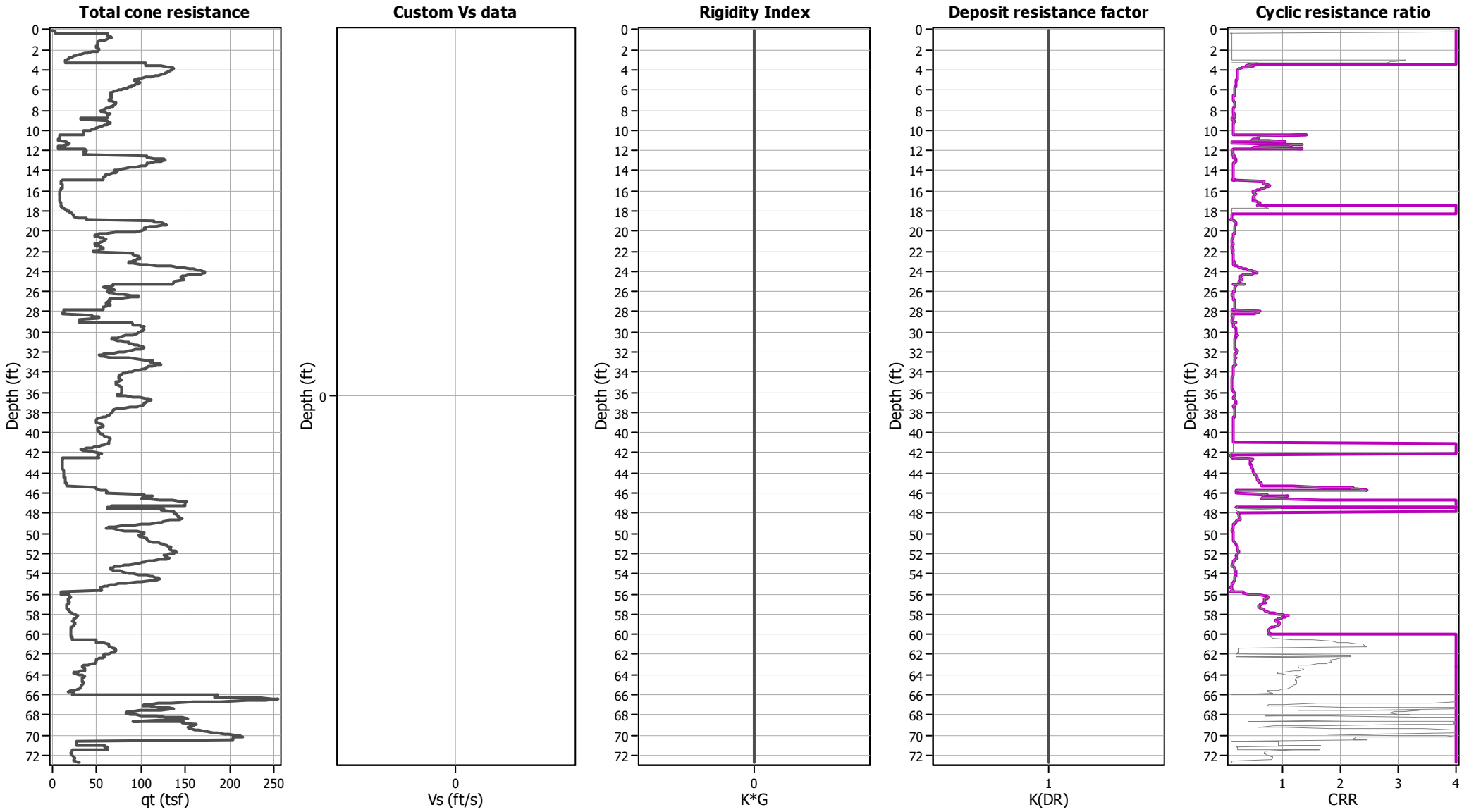
Estimation of post-earthquake settlements



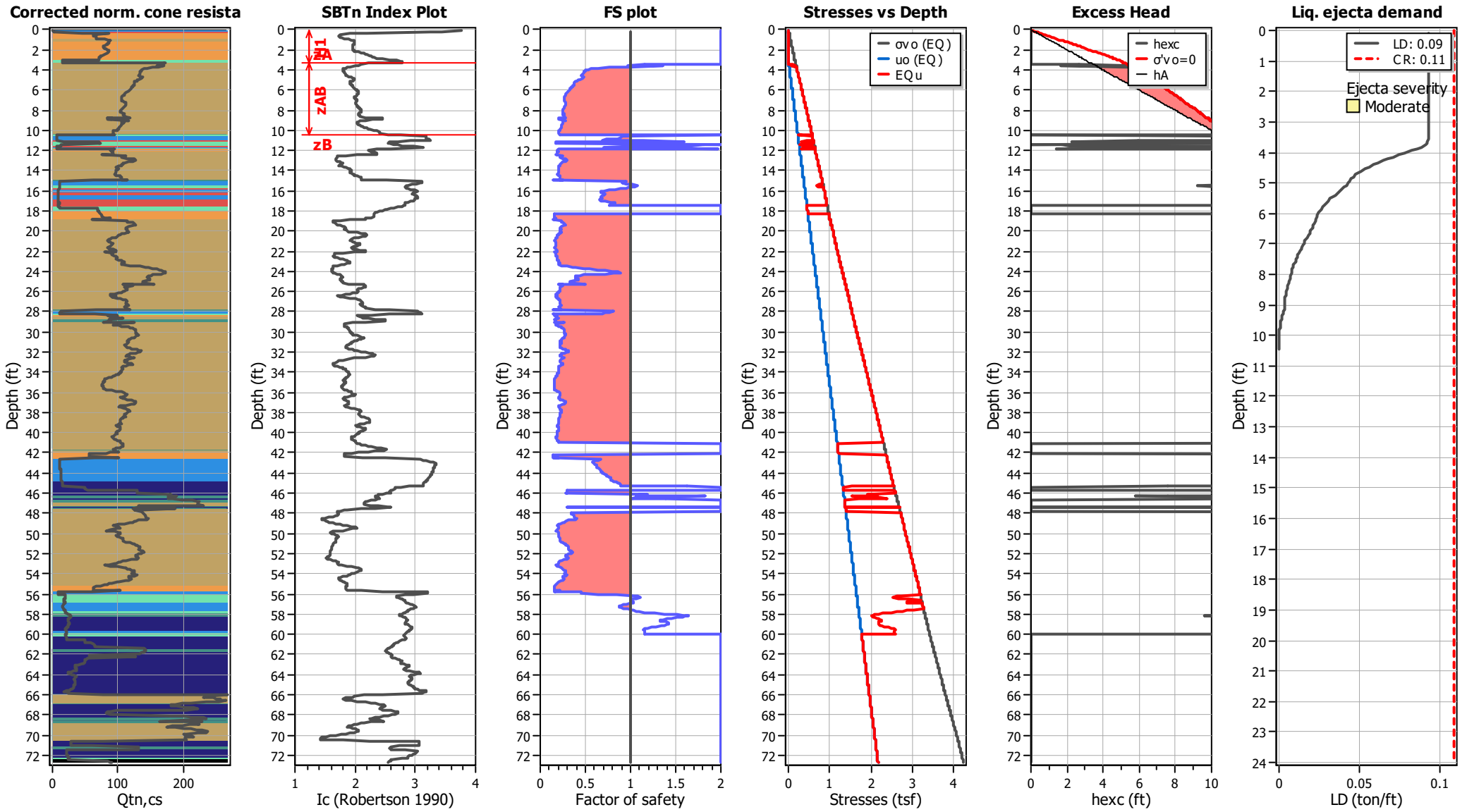
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

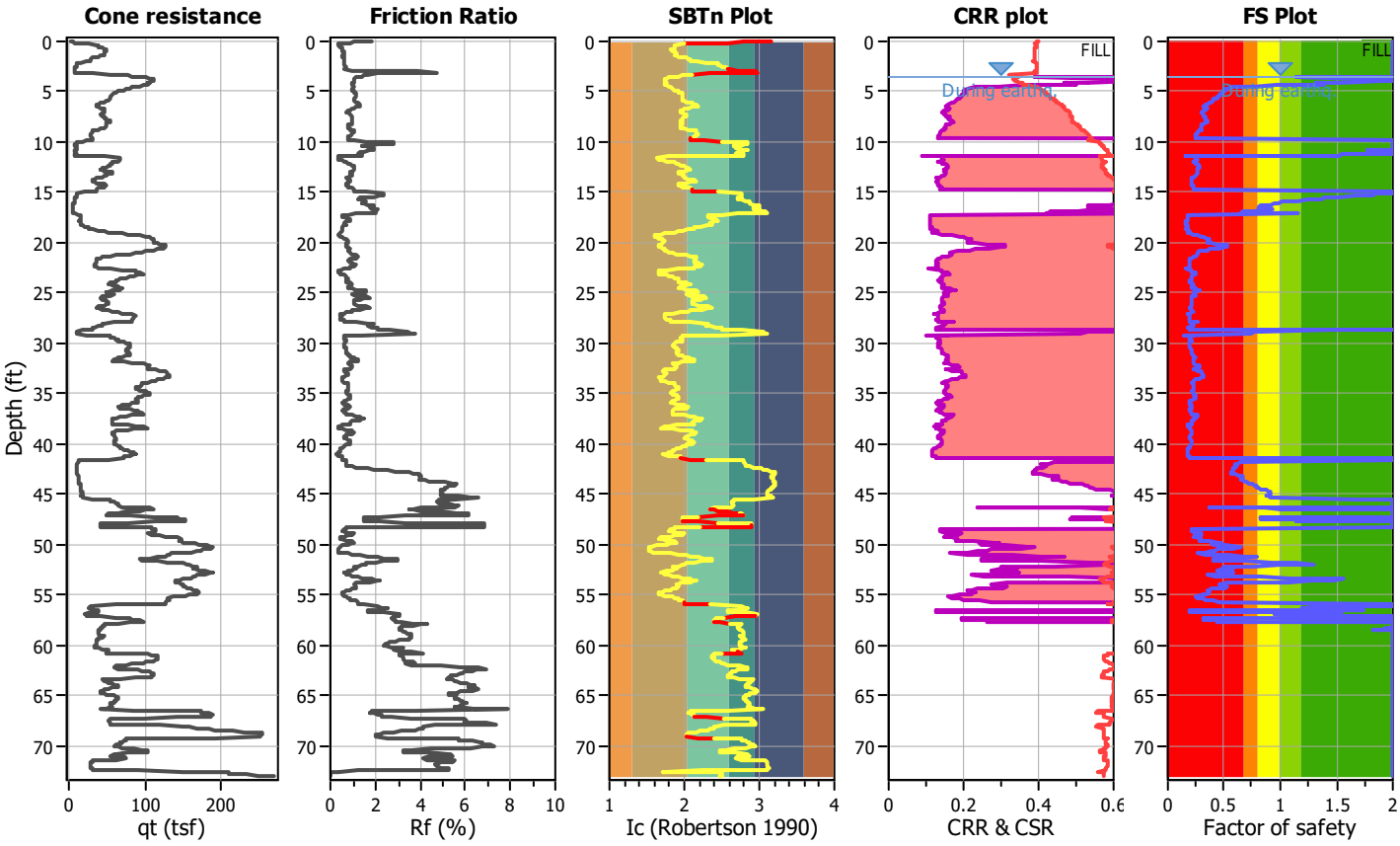
Project title : Topgolf Harbor Island

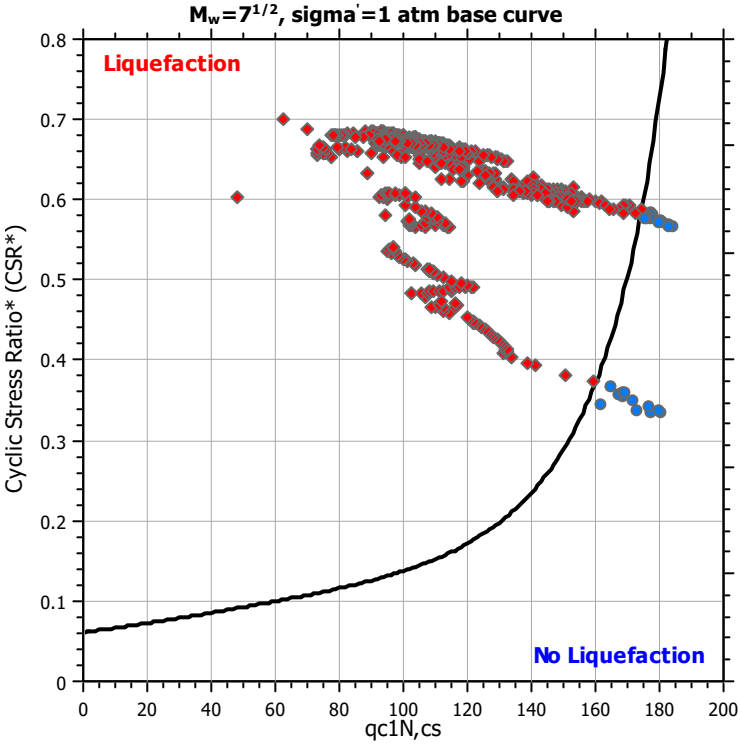
Location : North Harbor Drive and Liberator Way, San Diego, CA

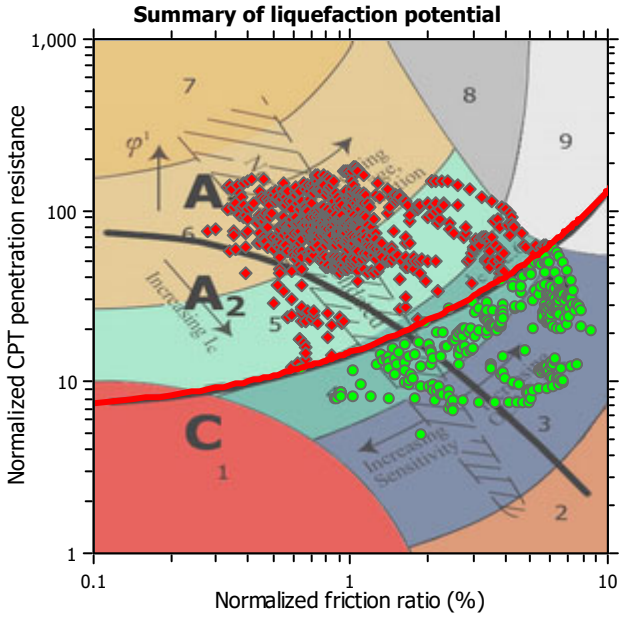
CPT file : CPT-27 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.65 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.47 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

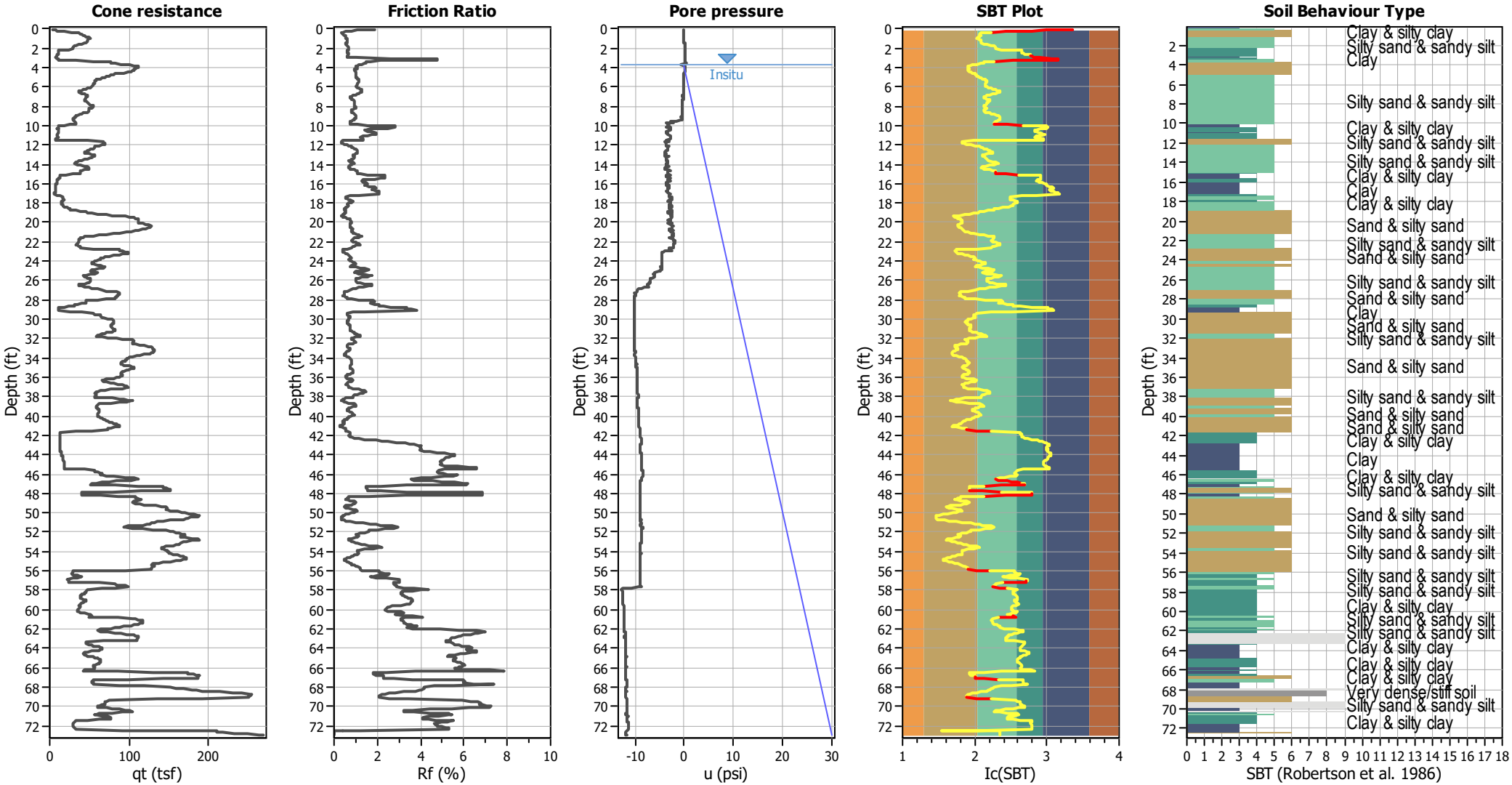






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



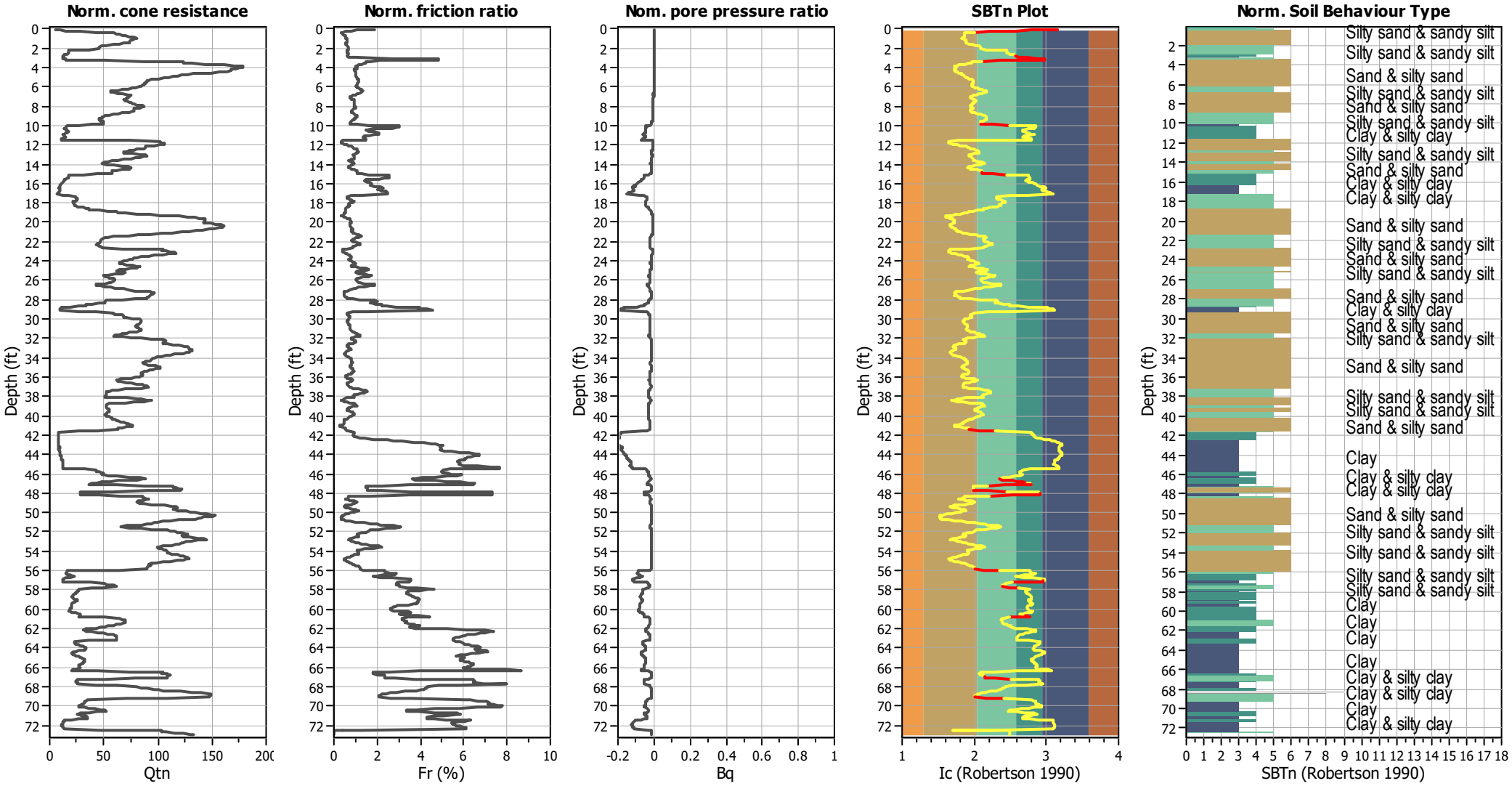
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 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)



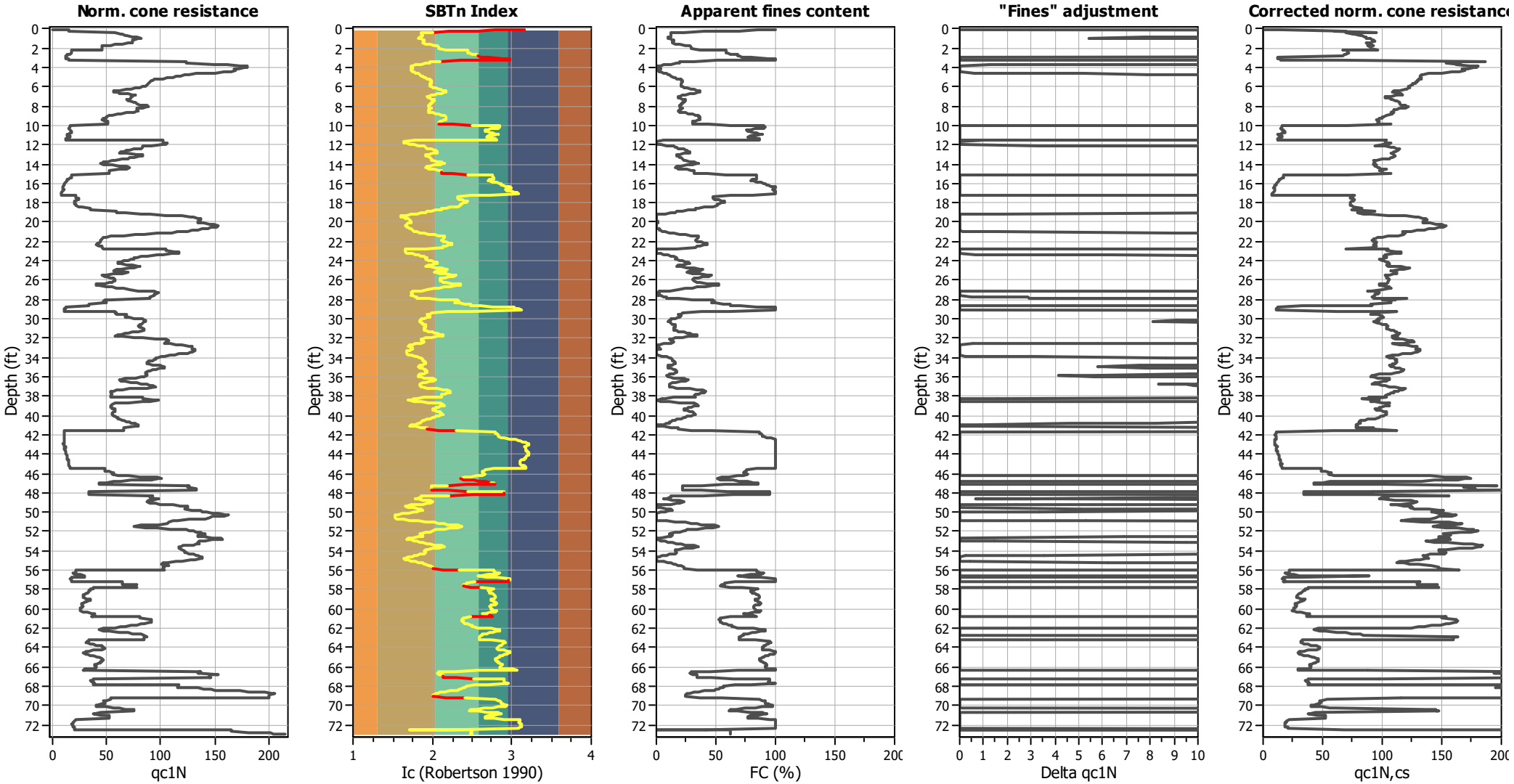
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 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

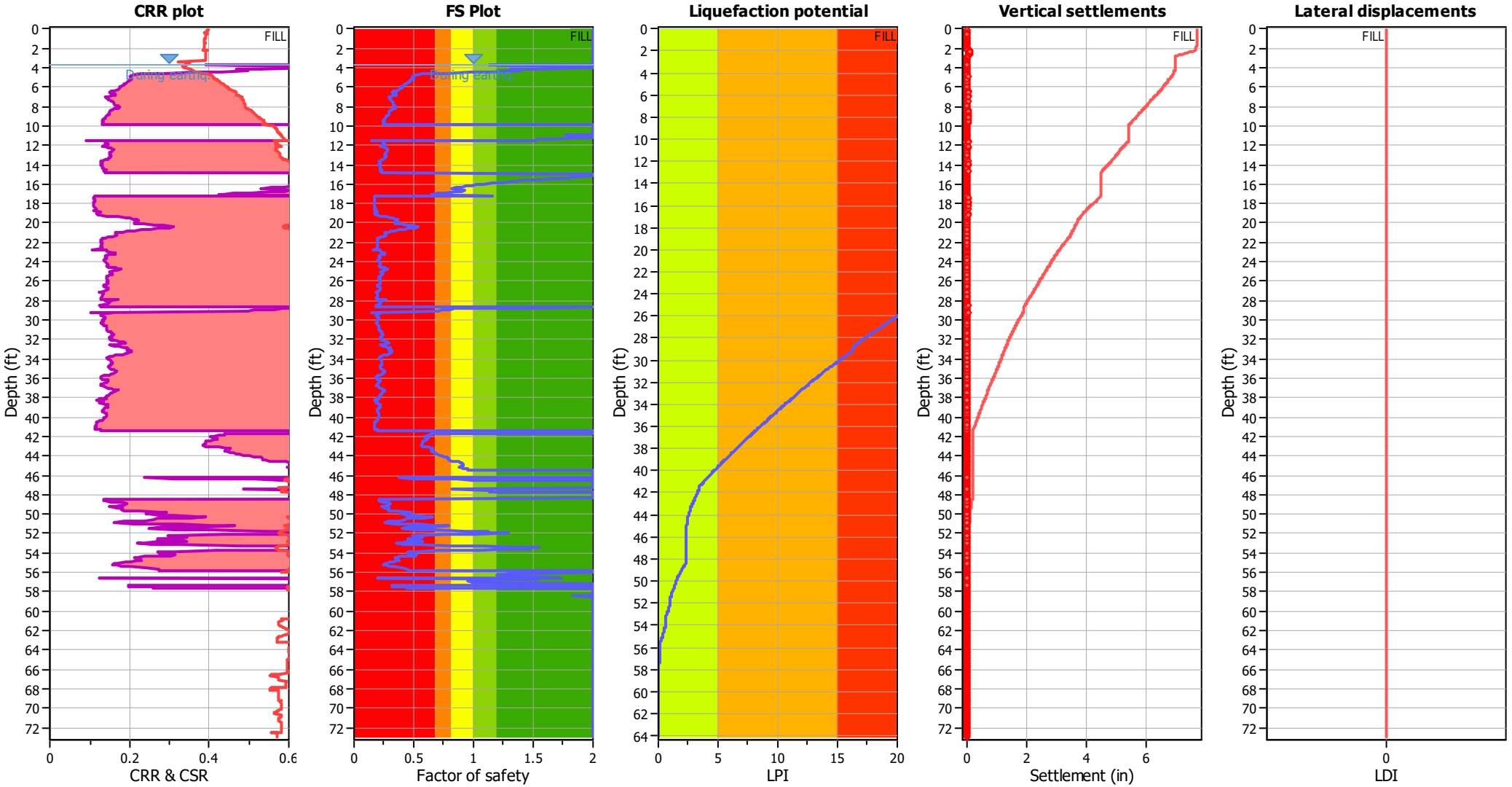
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 ft	Limit depth:	60.00 ft

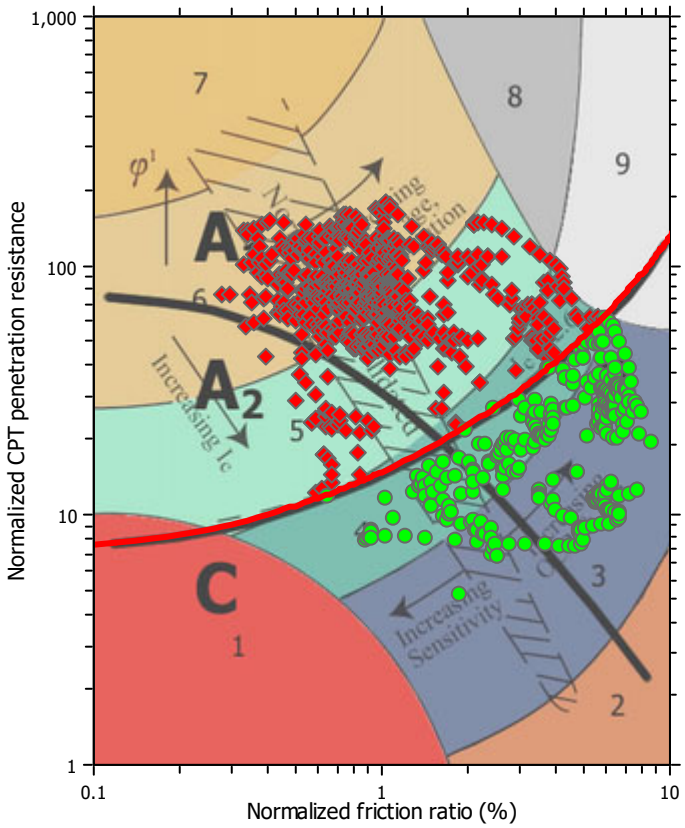
F.S. color scheme

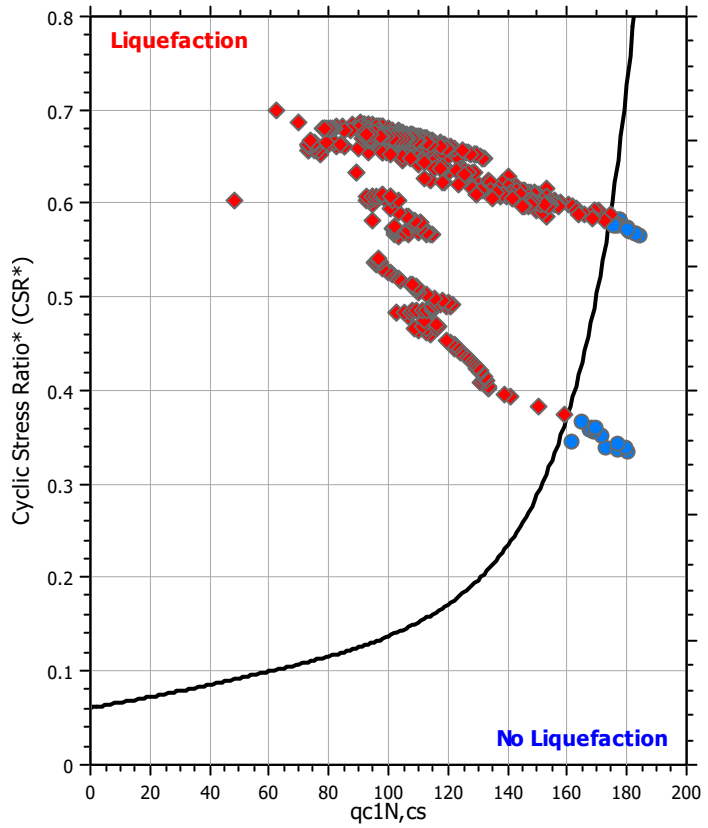
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

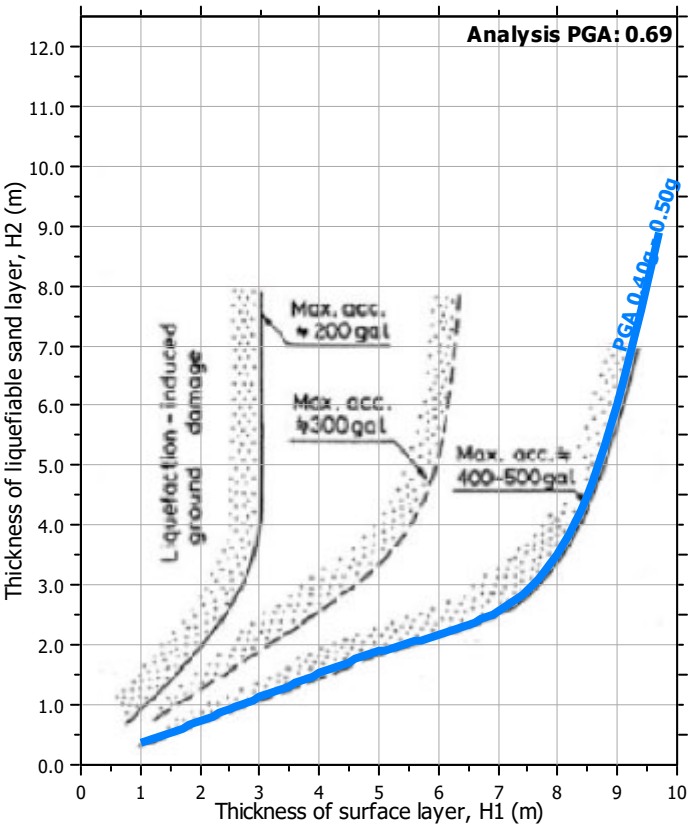
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



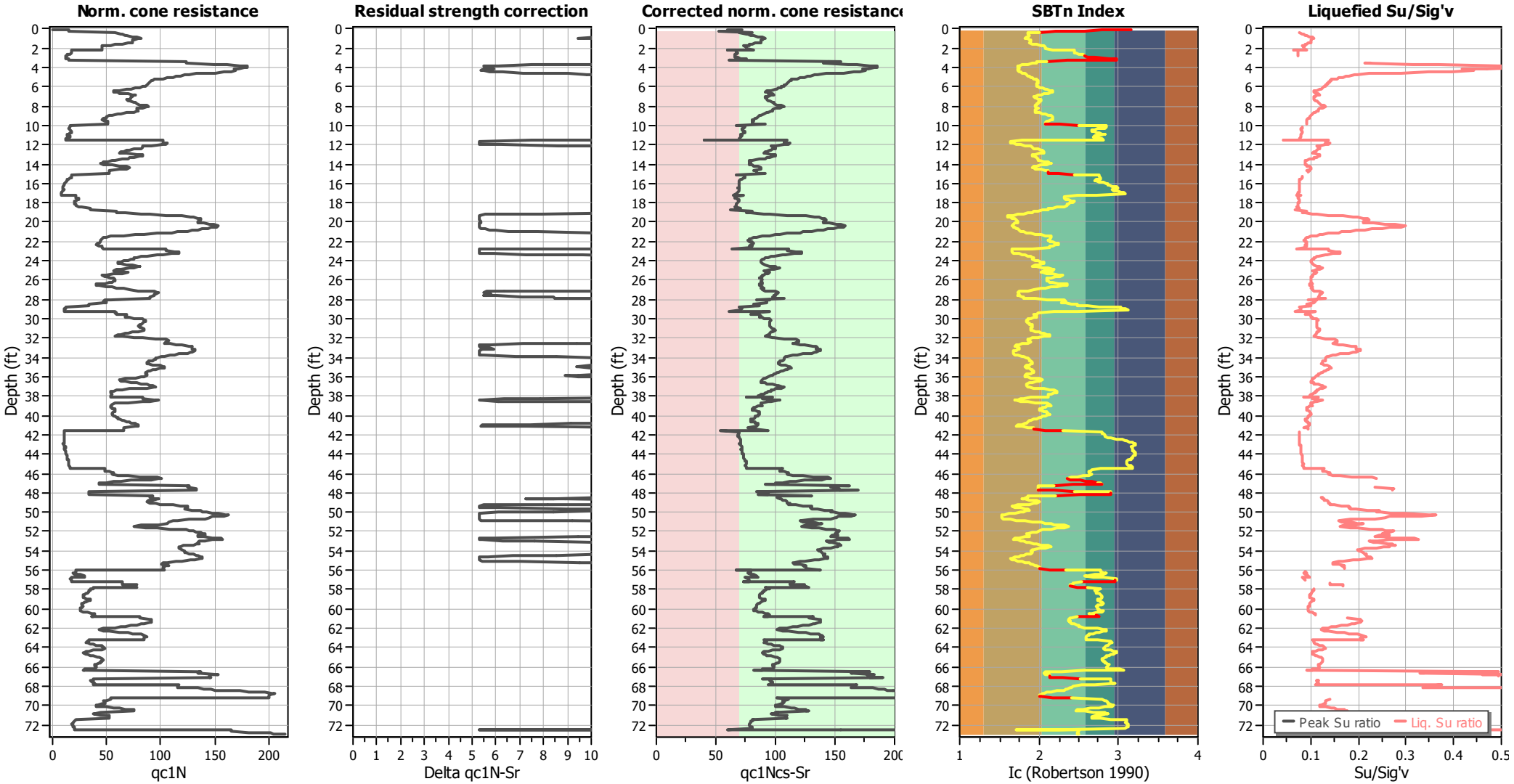




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

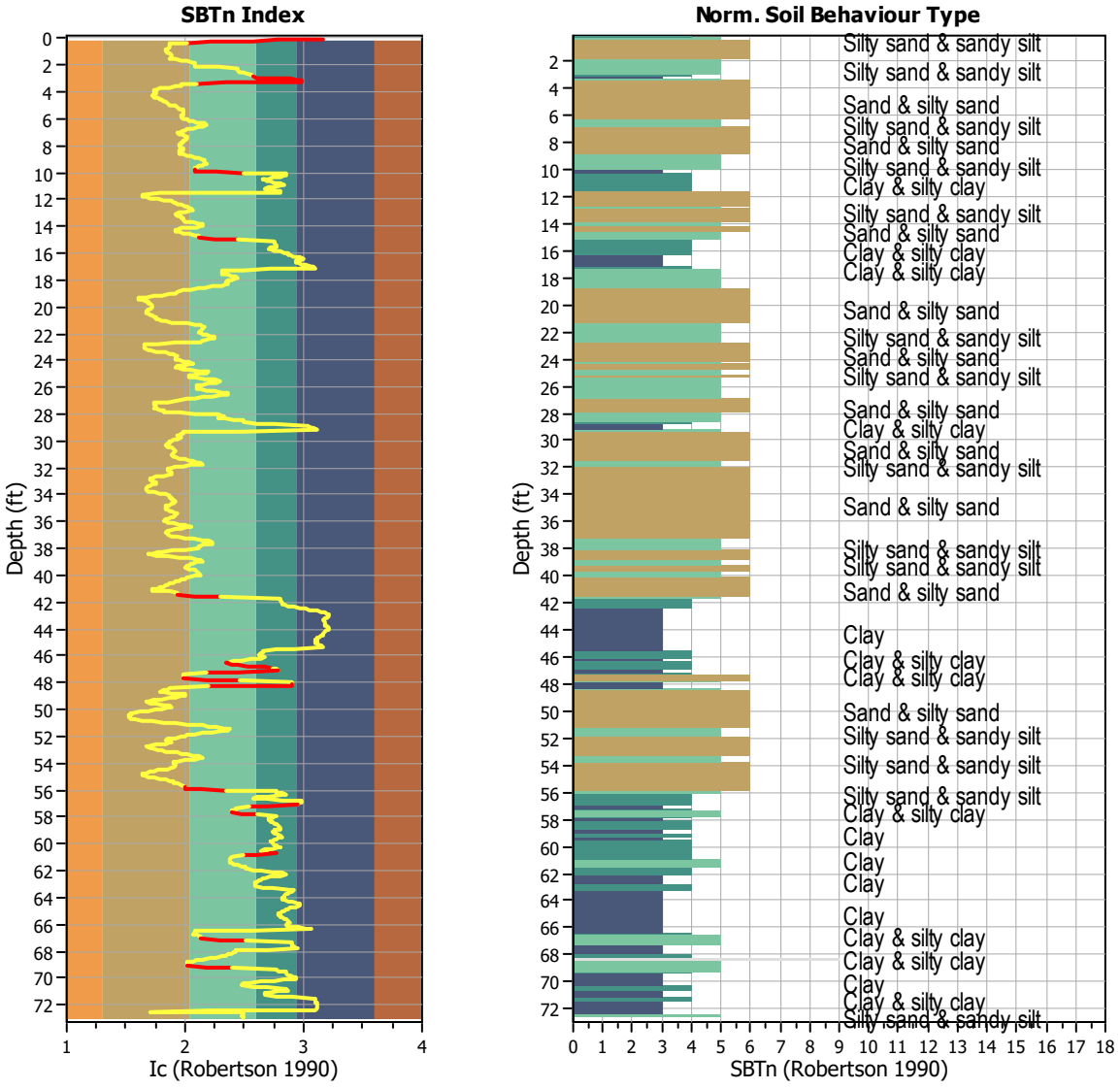
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.65 ft	Fill height:	1.47 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

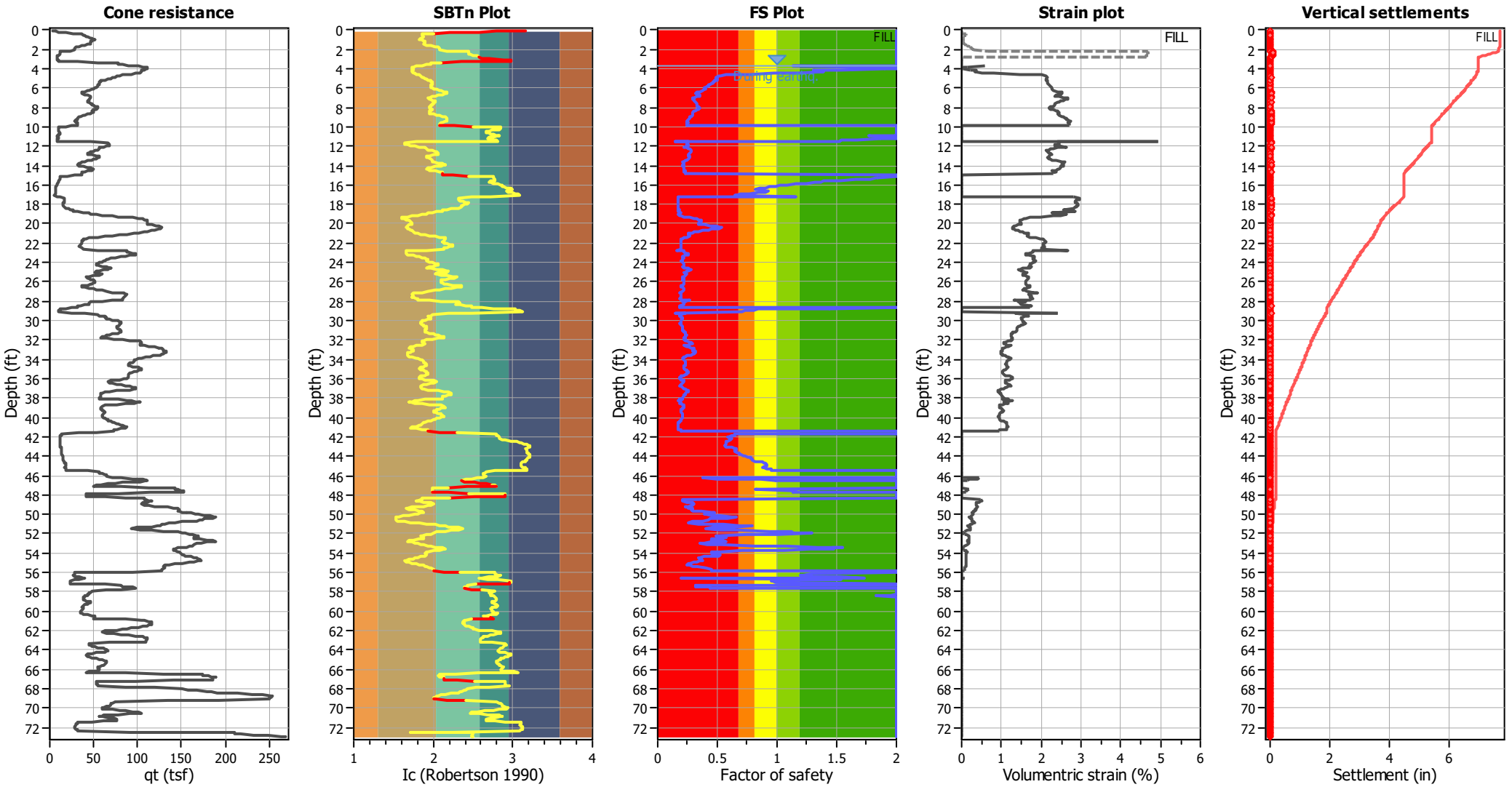
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1111
I_c maximum check value:	3.00	Total points excluded:	71
I_c change ratio value:	0.0250	Exclusion percentage:	6.39%
Minimum number of points in layer:	4	Number of layers detected:	16

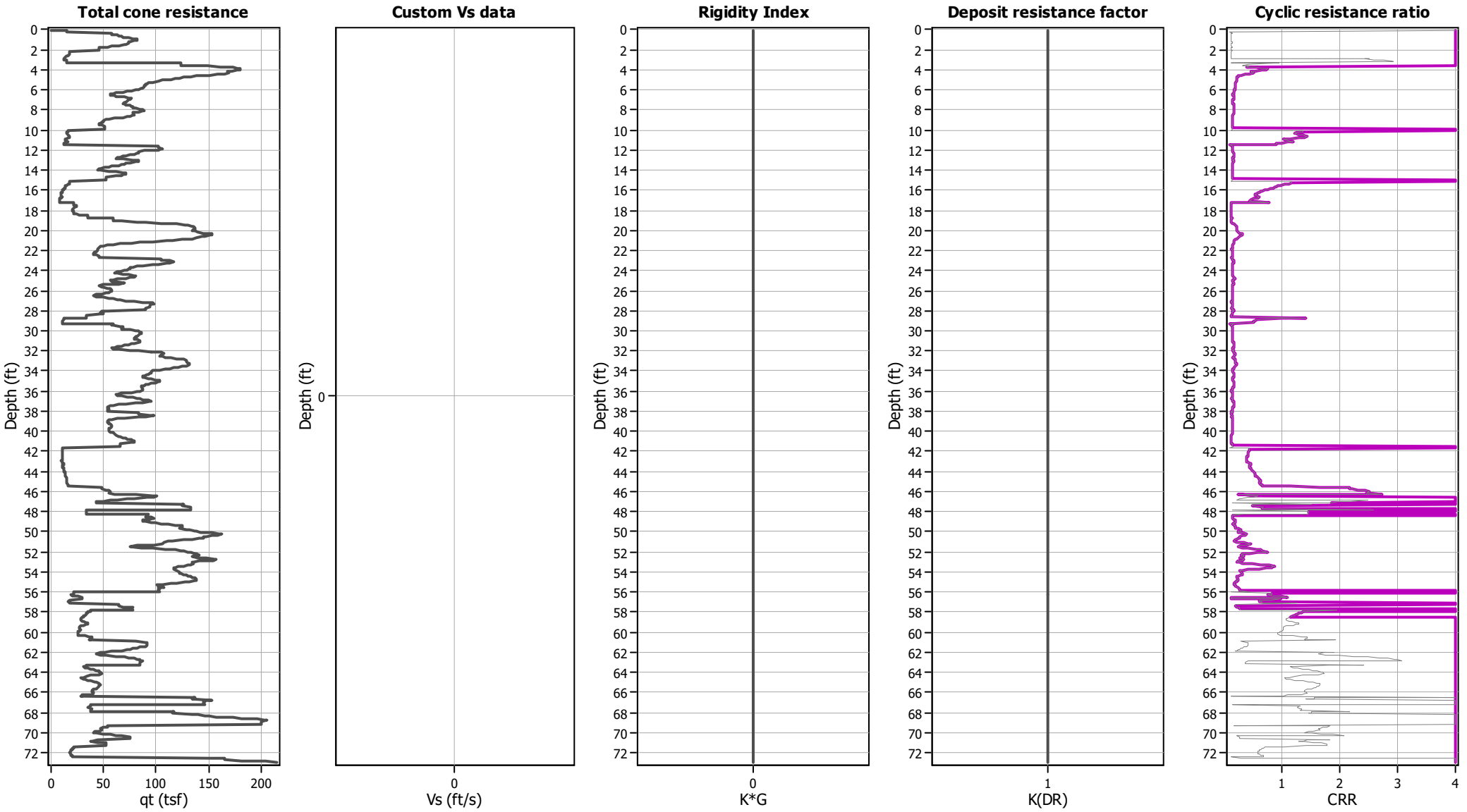
Estimation of post-earthquake settlements



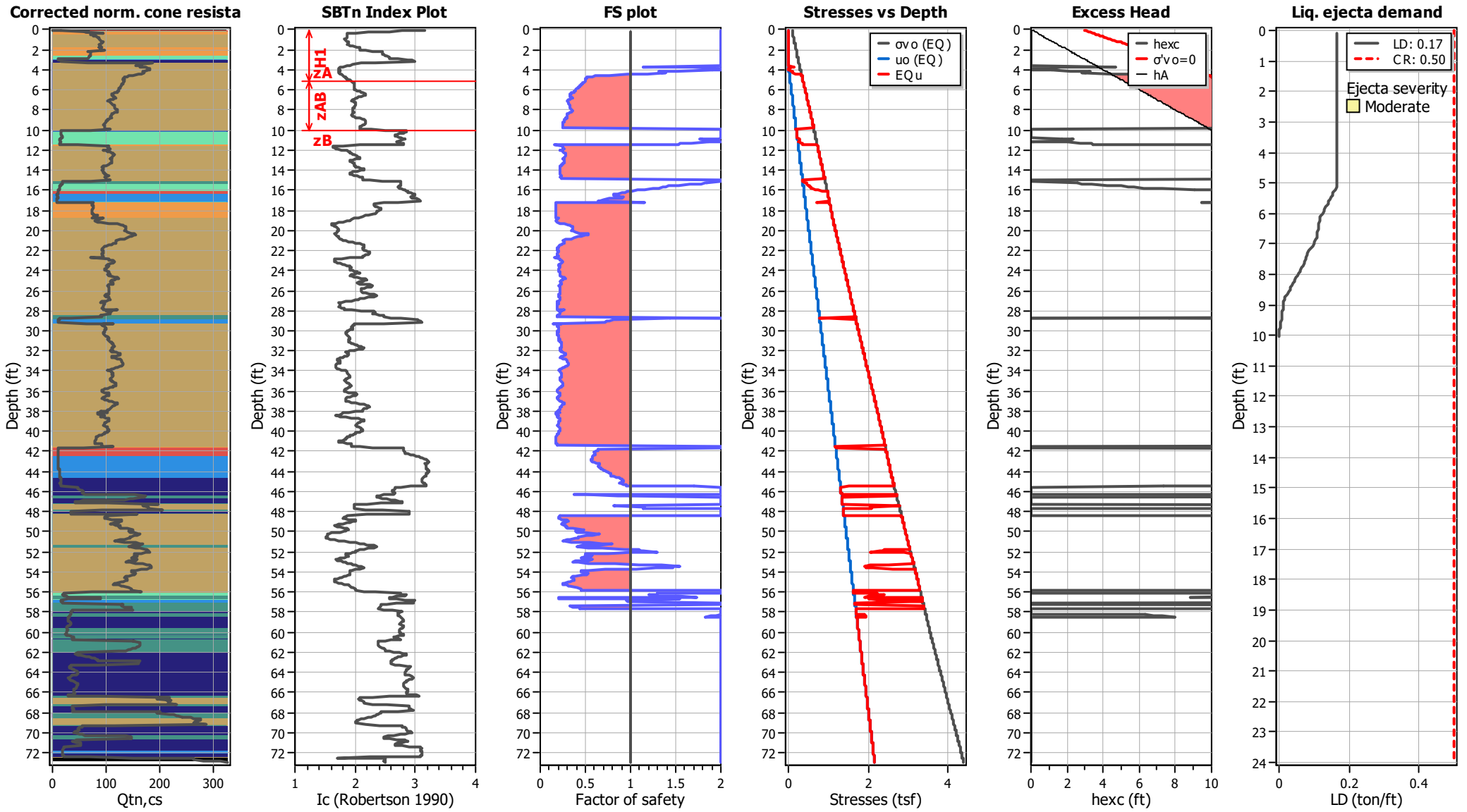
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

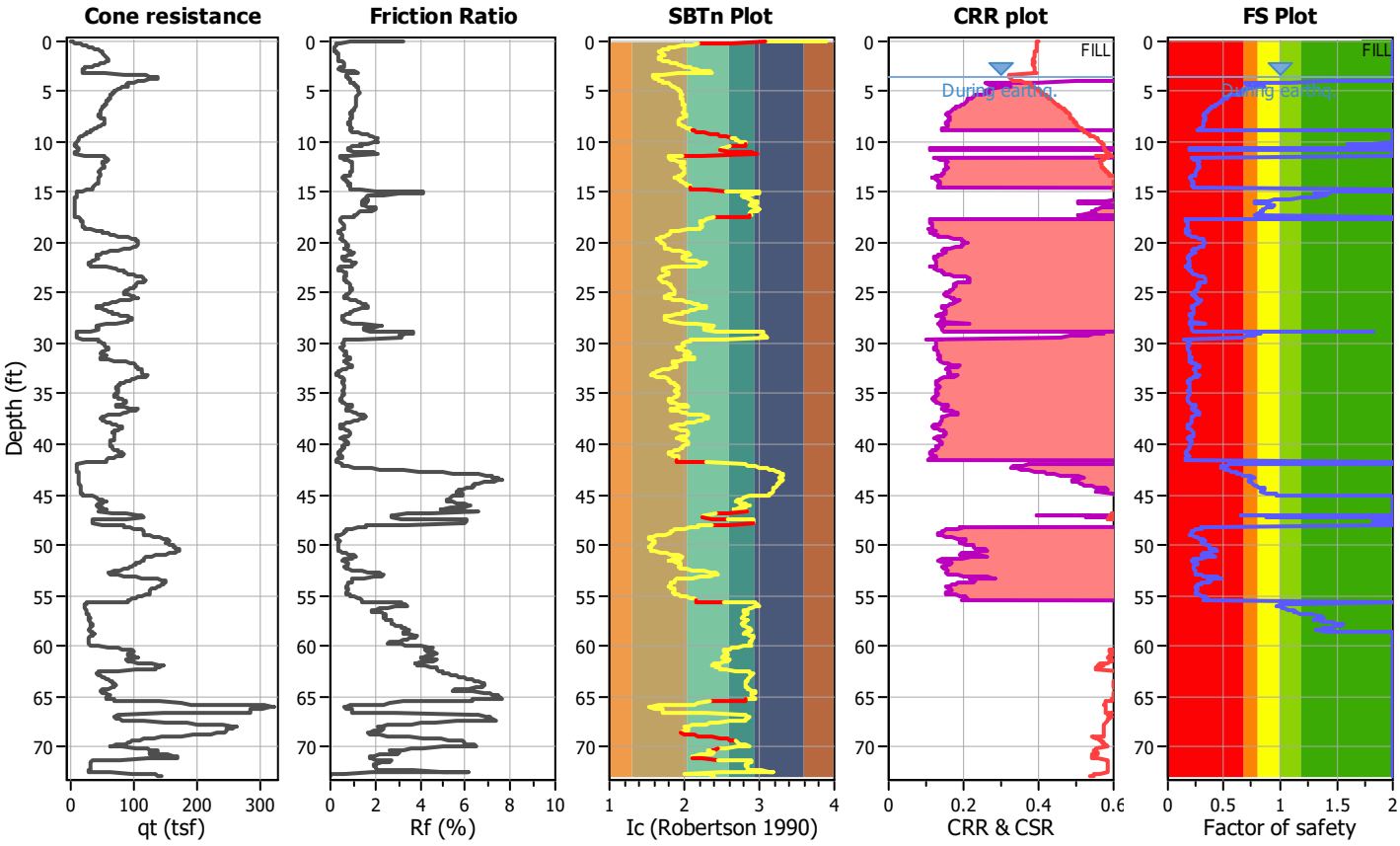
Project title : Topgolf Harbor Island

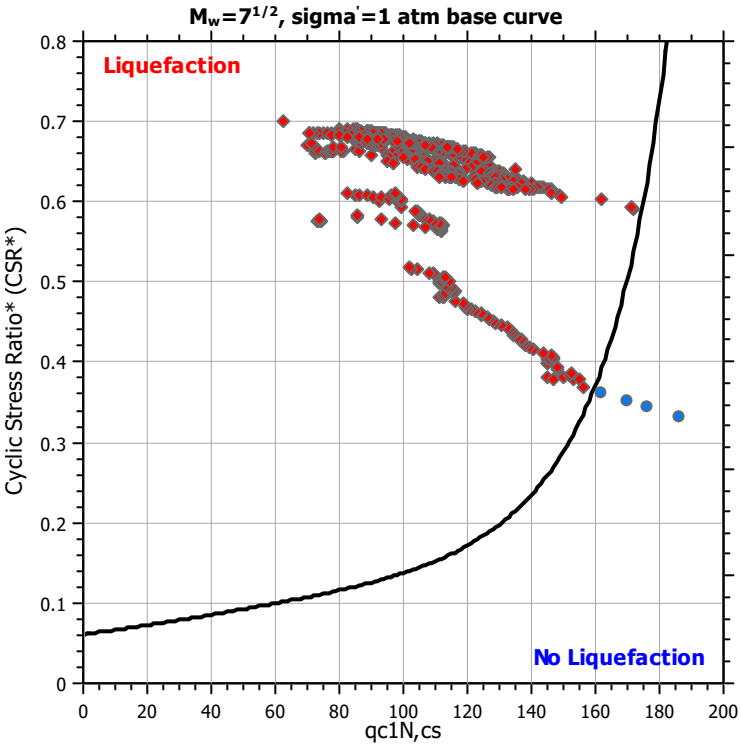
Location : North Harbor Drive and Liberator Way, San Diego, CA

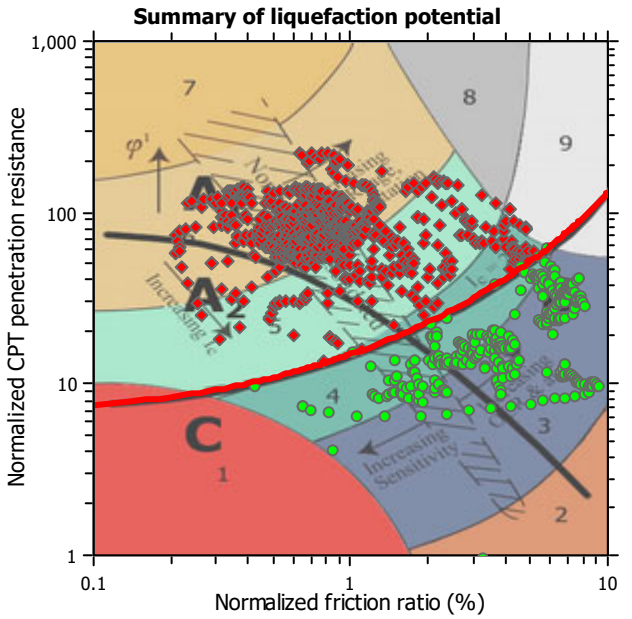
CPT file : CPT-28 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.63 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.49 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

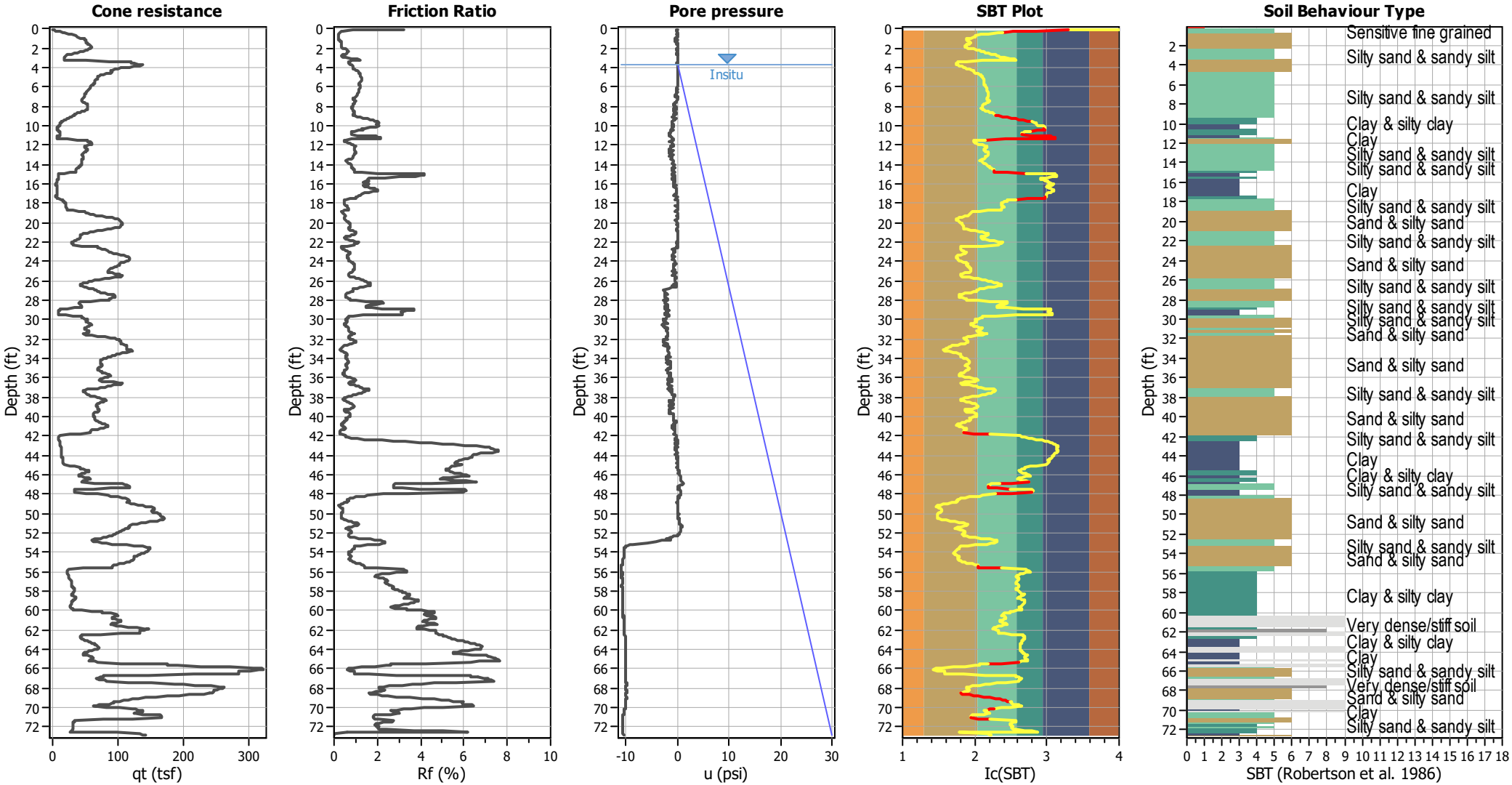






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



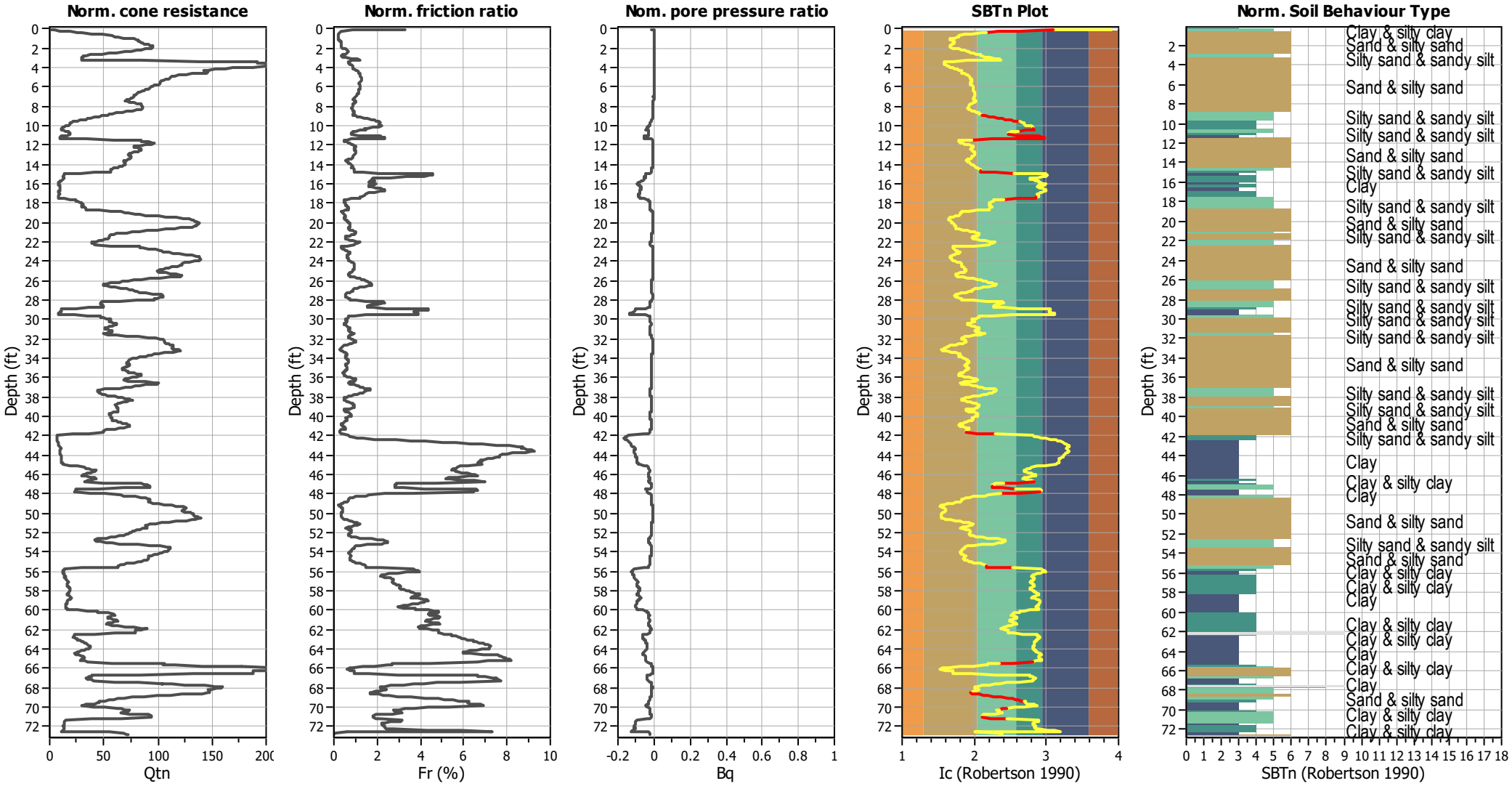
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 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)



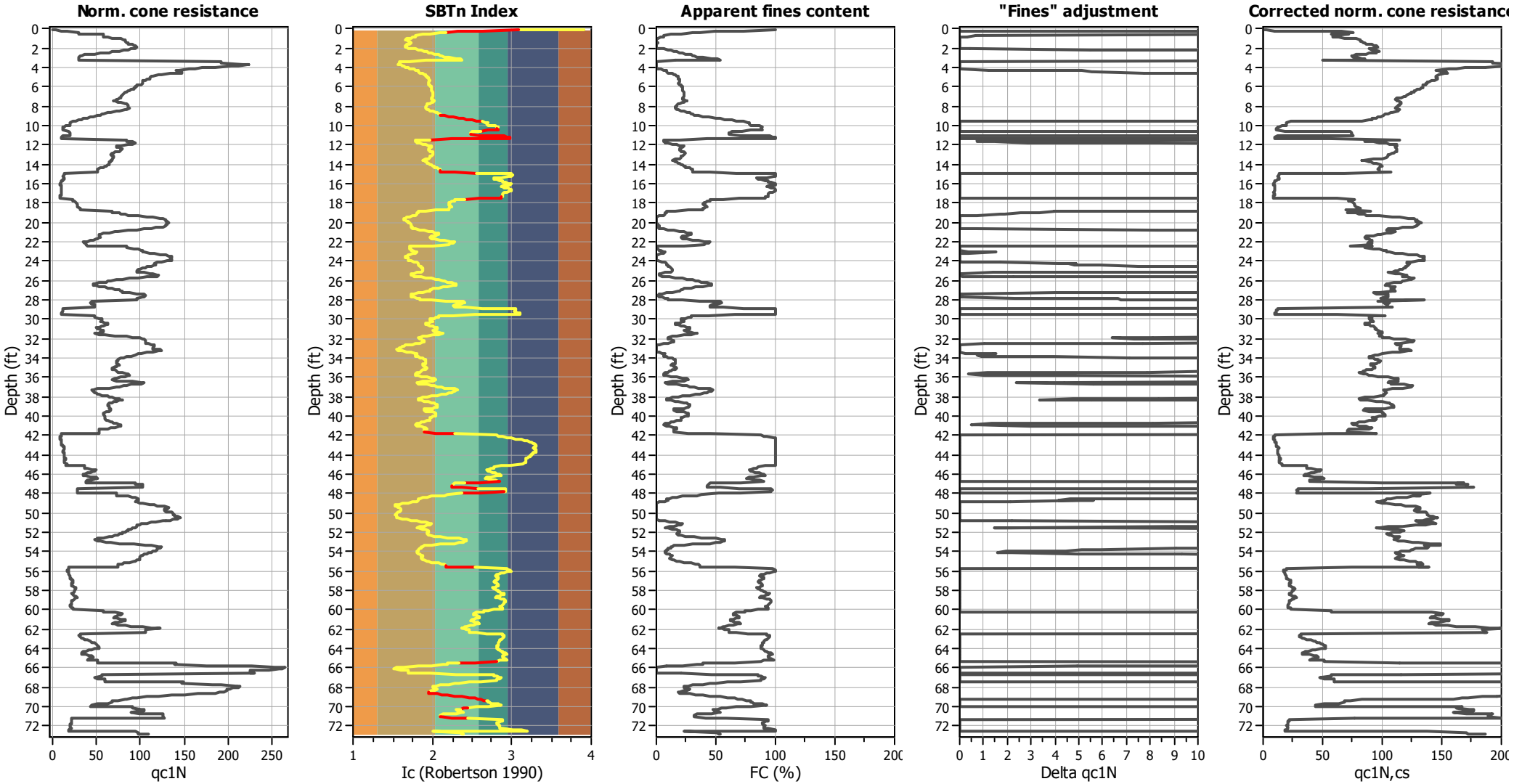
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 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

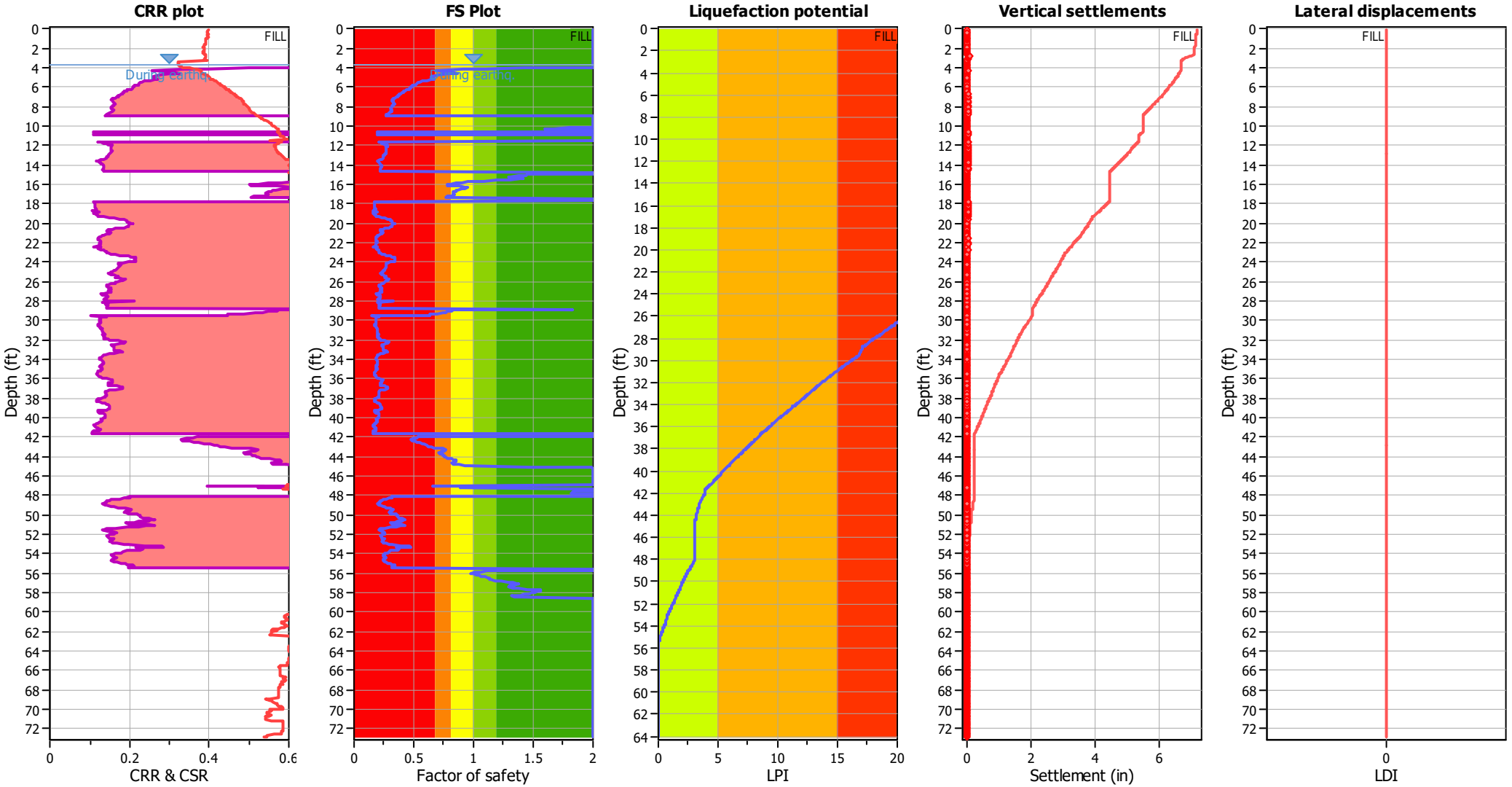
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 ft	Limit depth:	60.00 ft

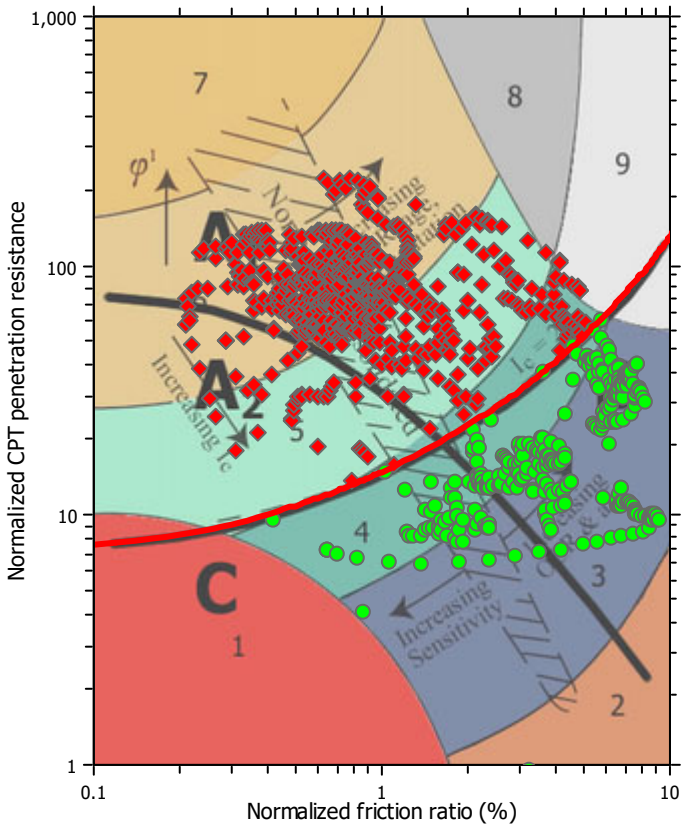
F.S. color scheme

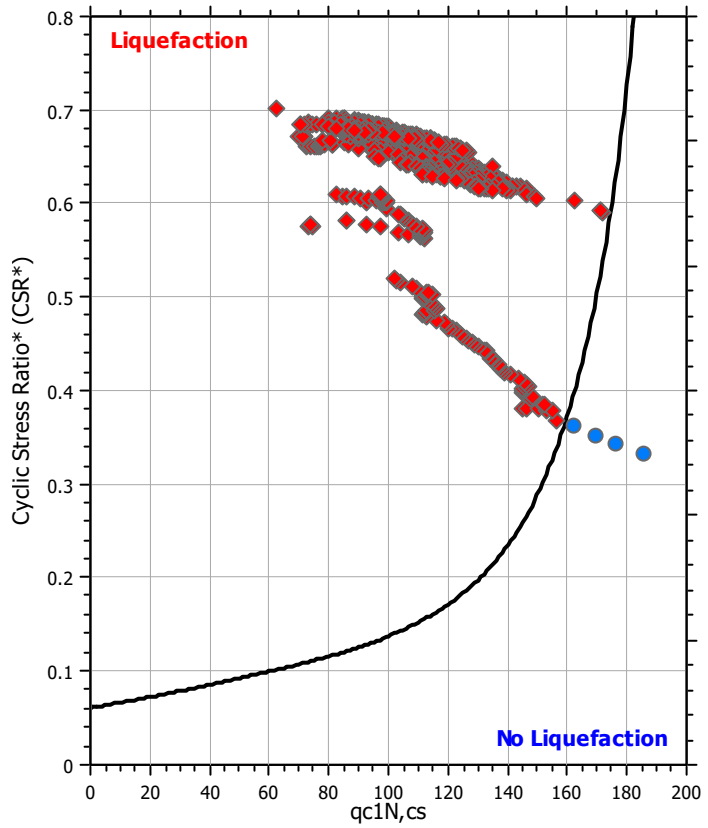
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

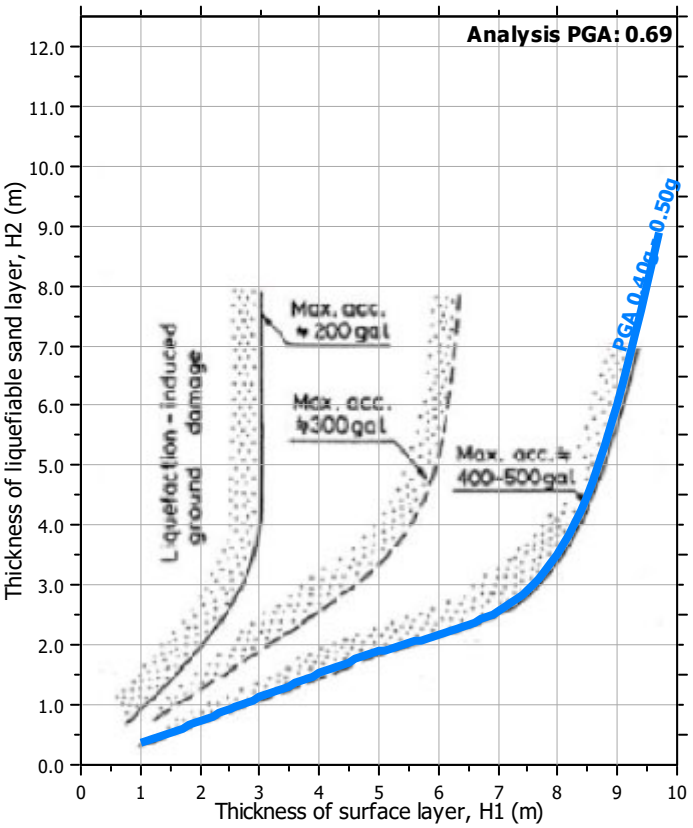
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



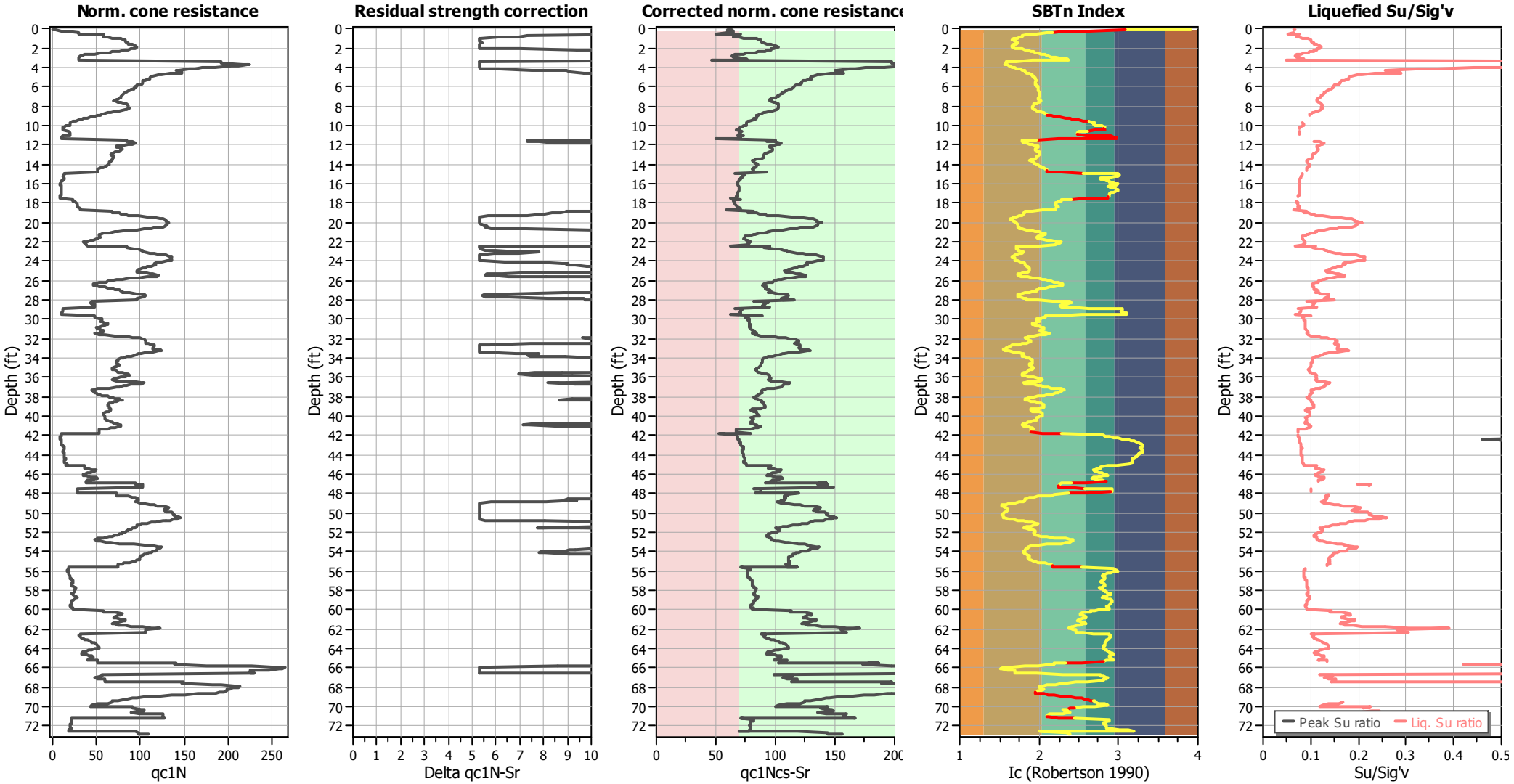




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

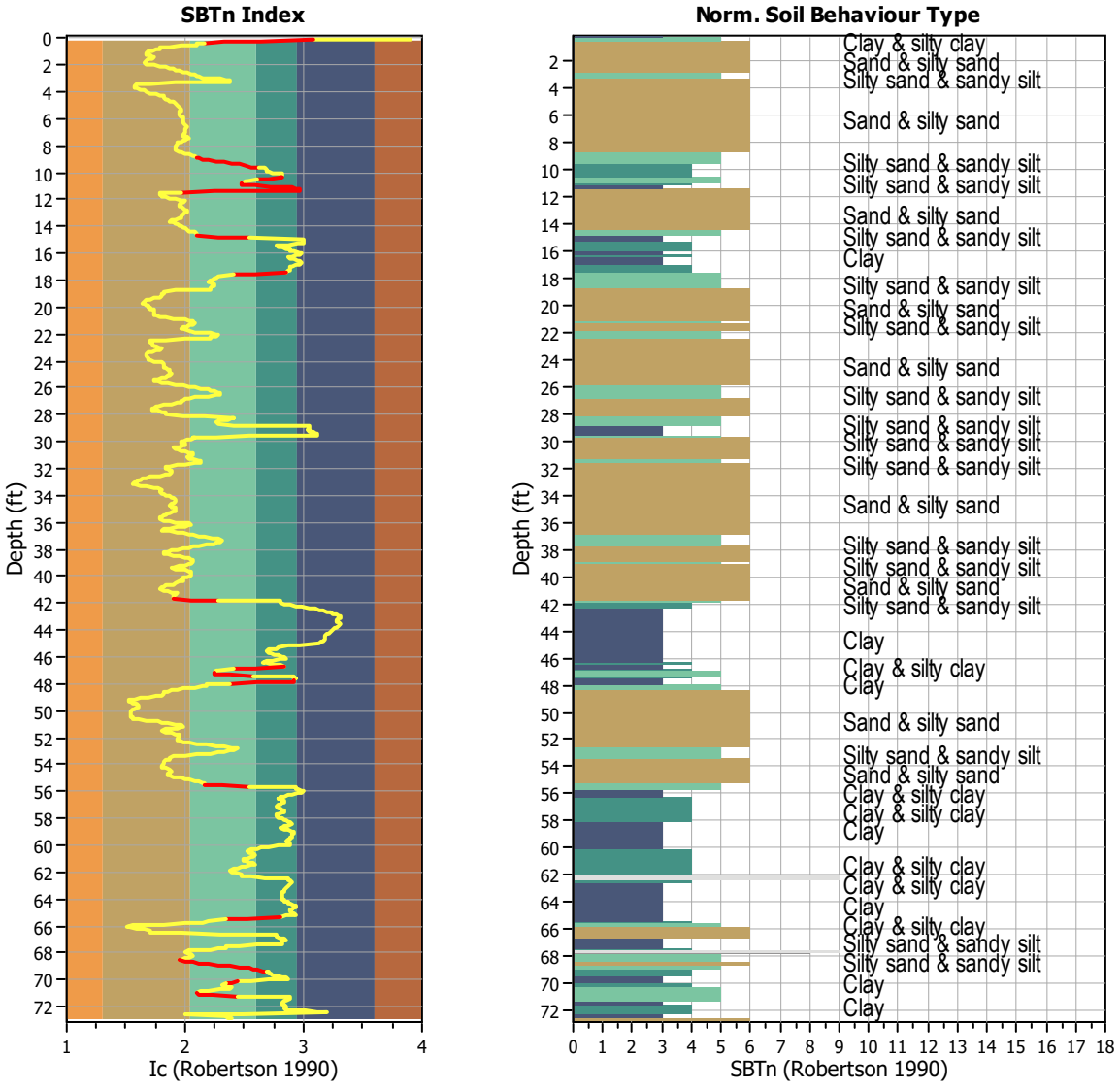
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.63 ft	Fill height:	1.49 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.



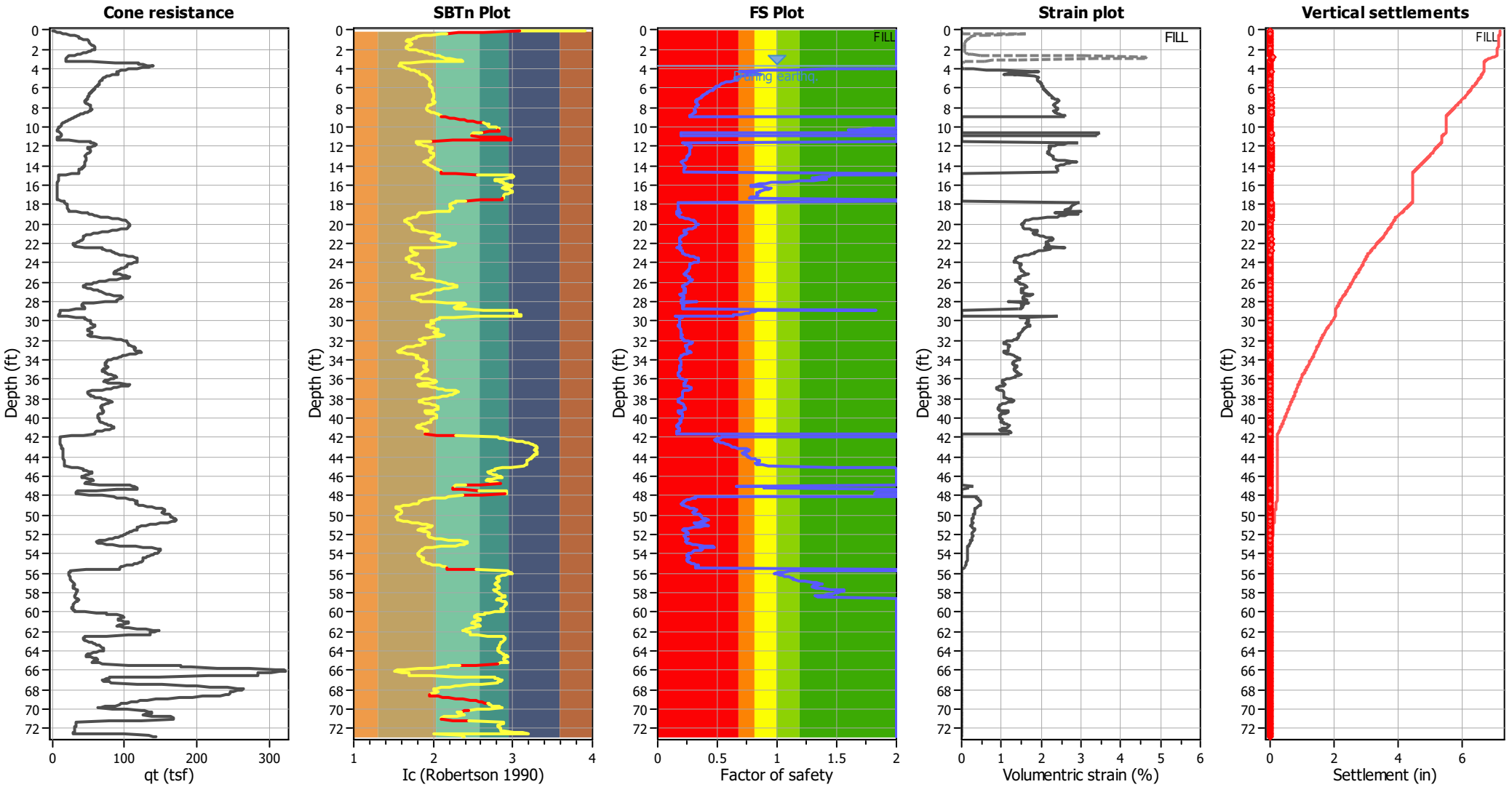
Transition layer algorithm properties

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:	1110
Total points excluded:	84
Exclusion percentage:	7.57%
Number of layers detected:	16

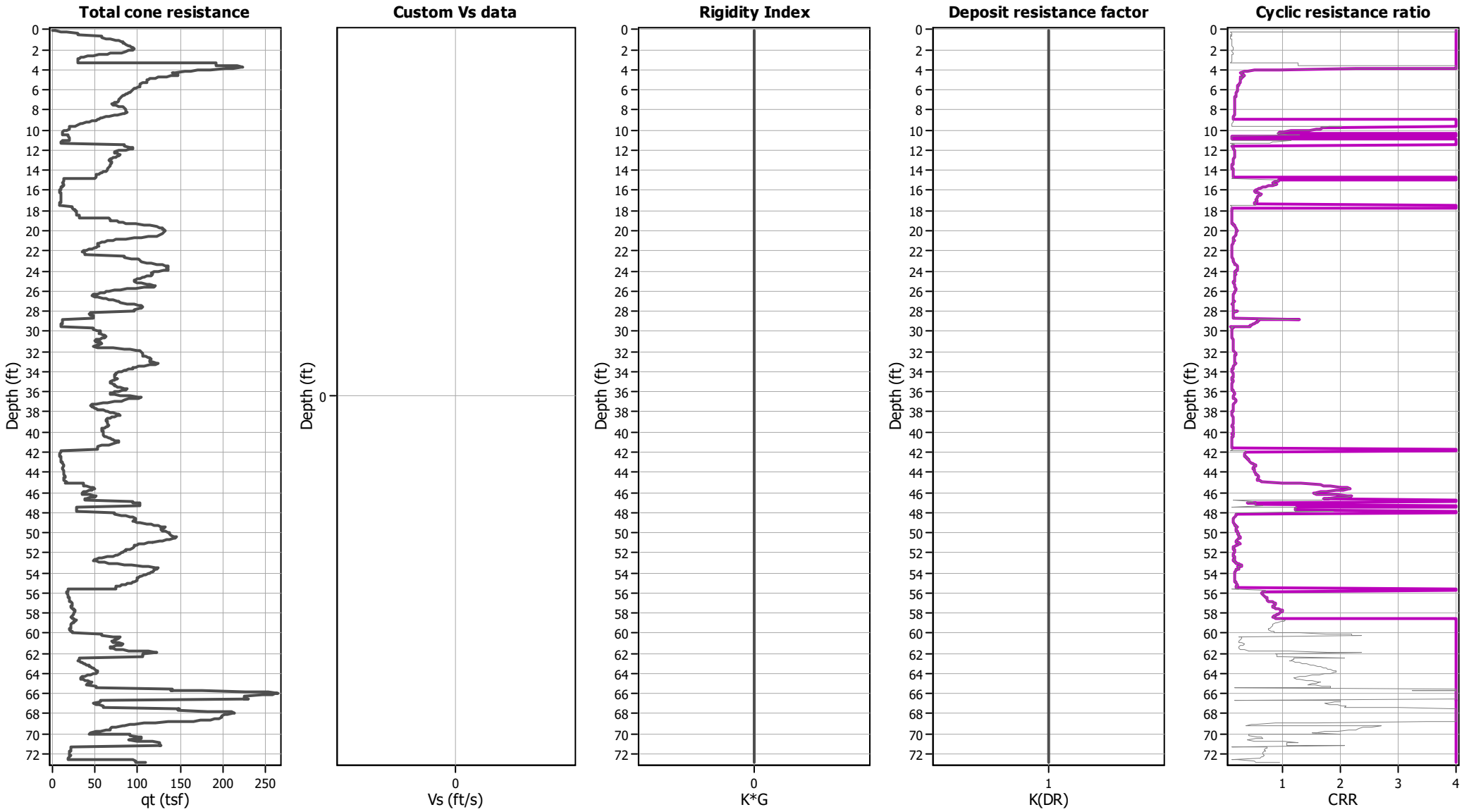
Estimation of post-earthquake settlements



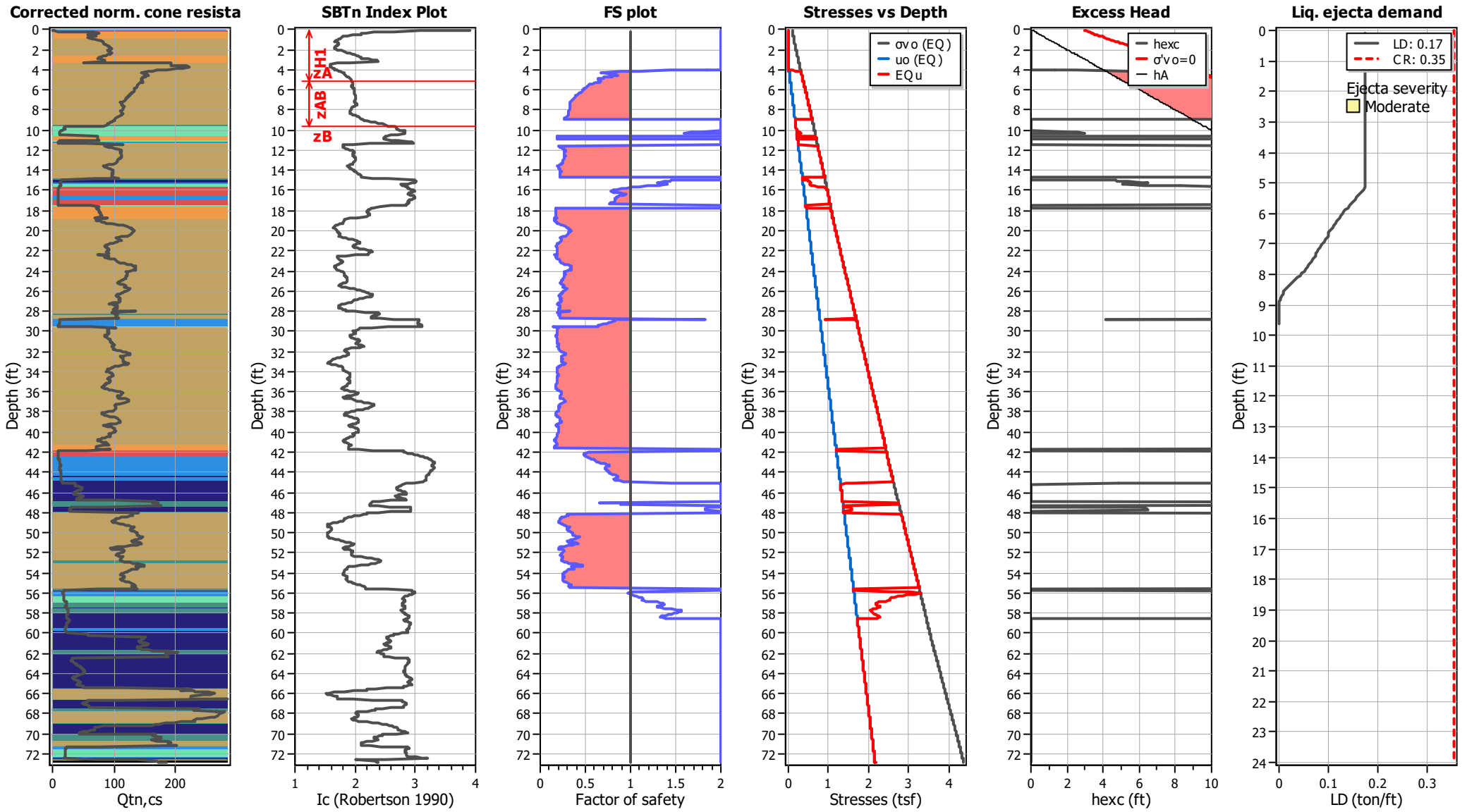
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

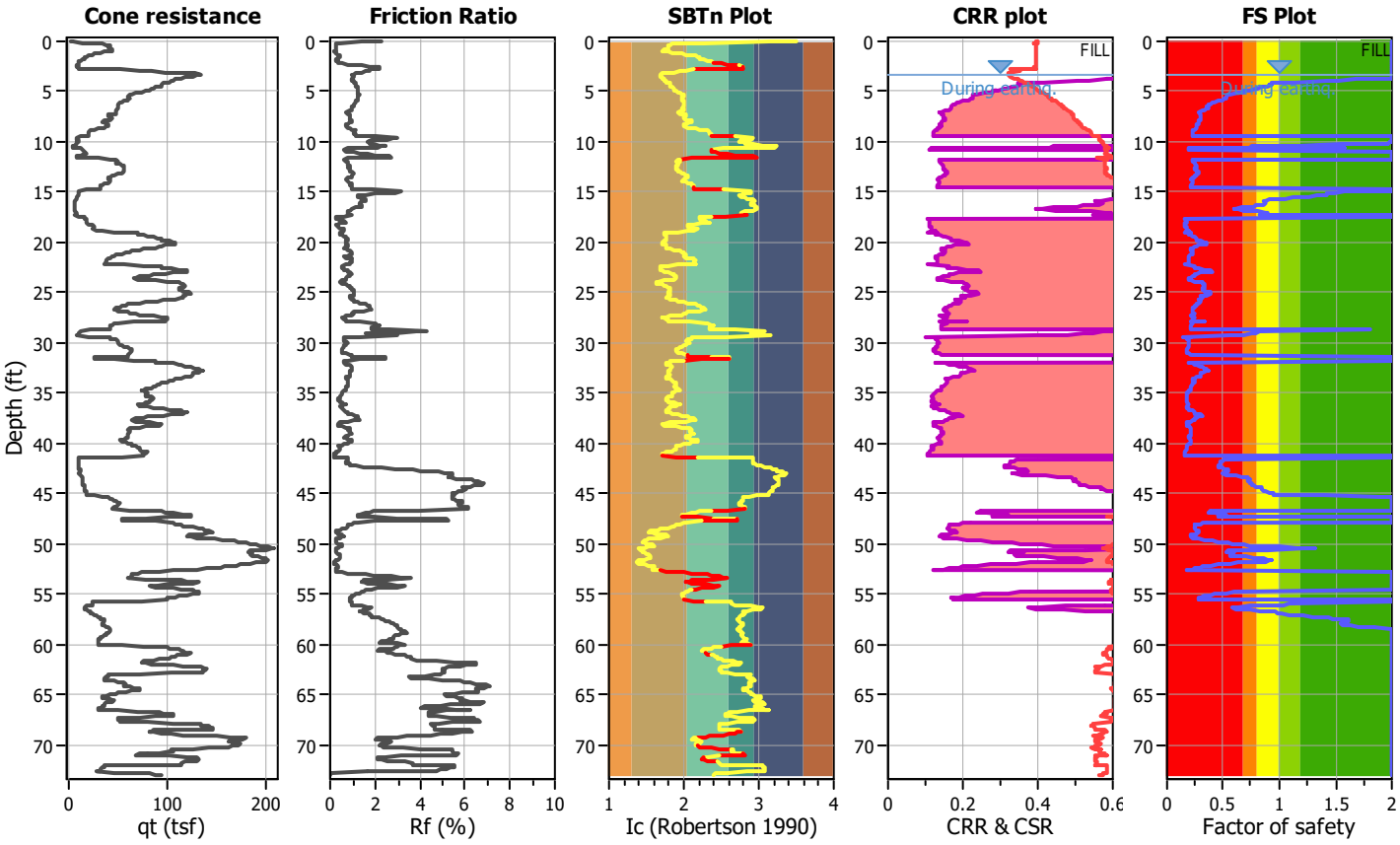
Project title : Topgolf Harbor Island

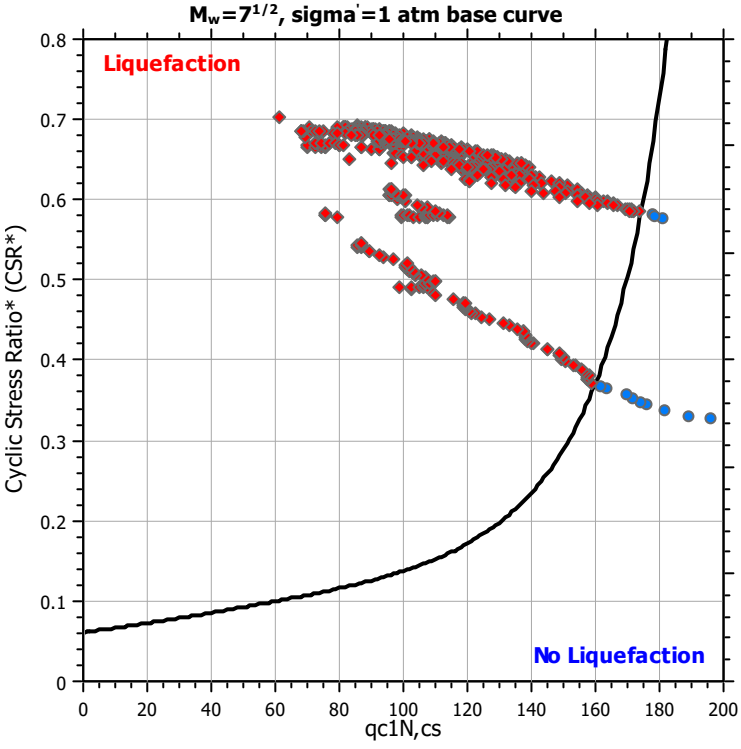
Location : North Harbor Drive and Liberator Way, San Diego, CA

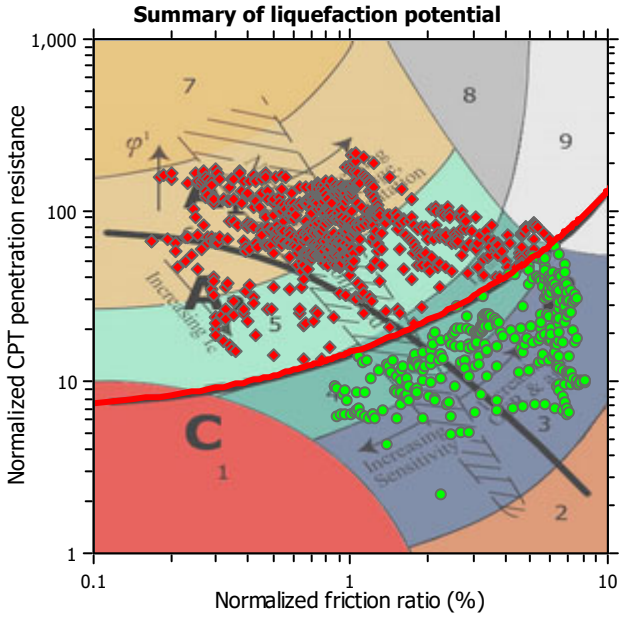
CPT file : CPT-29 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.44 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.68 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

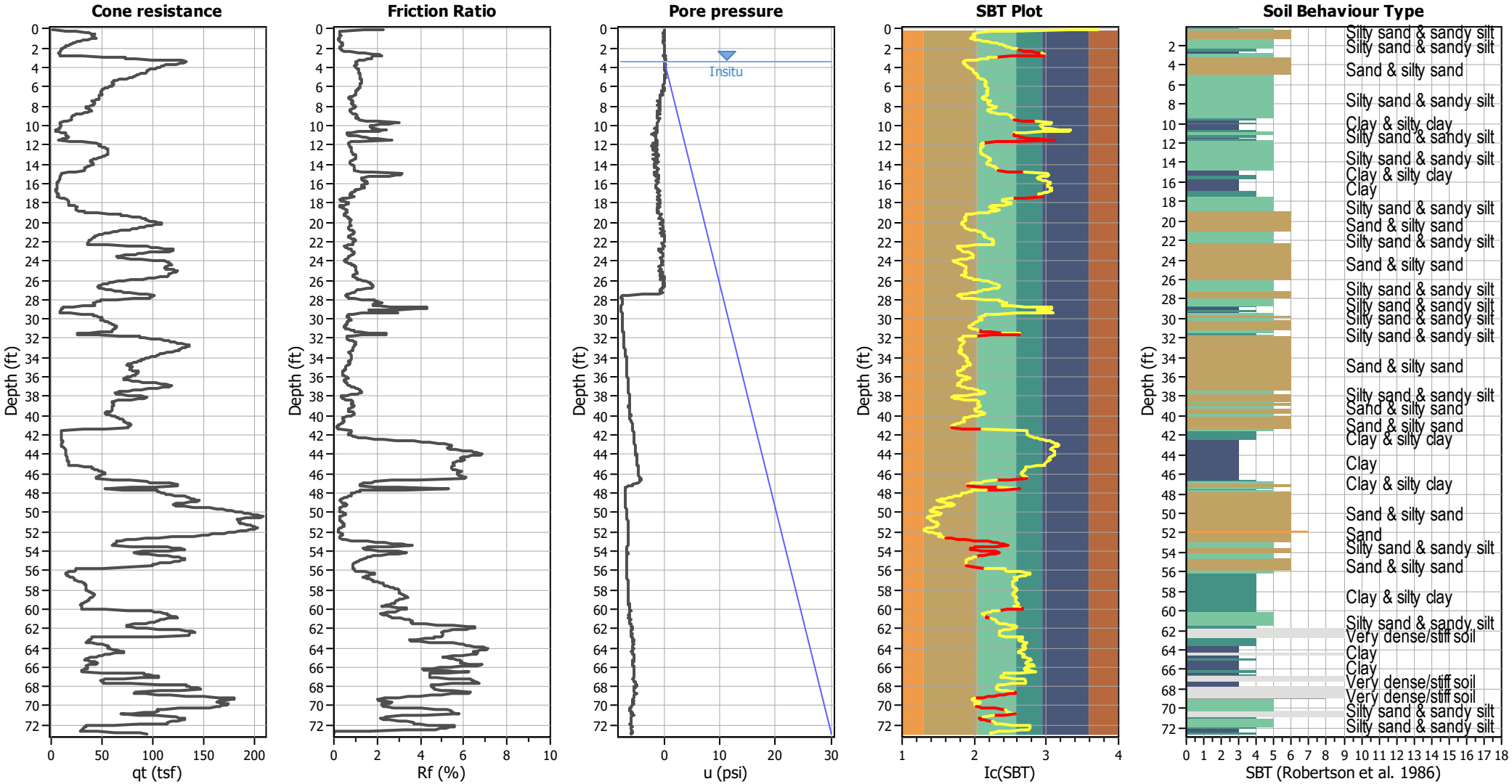






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



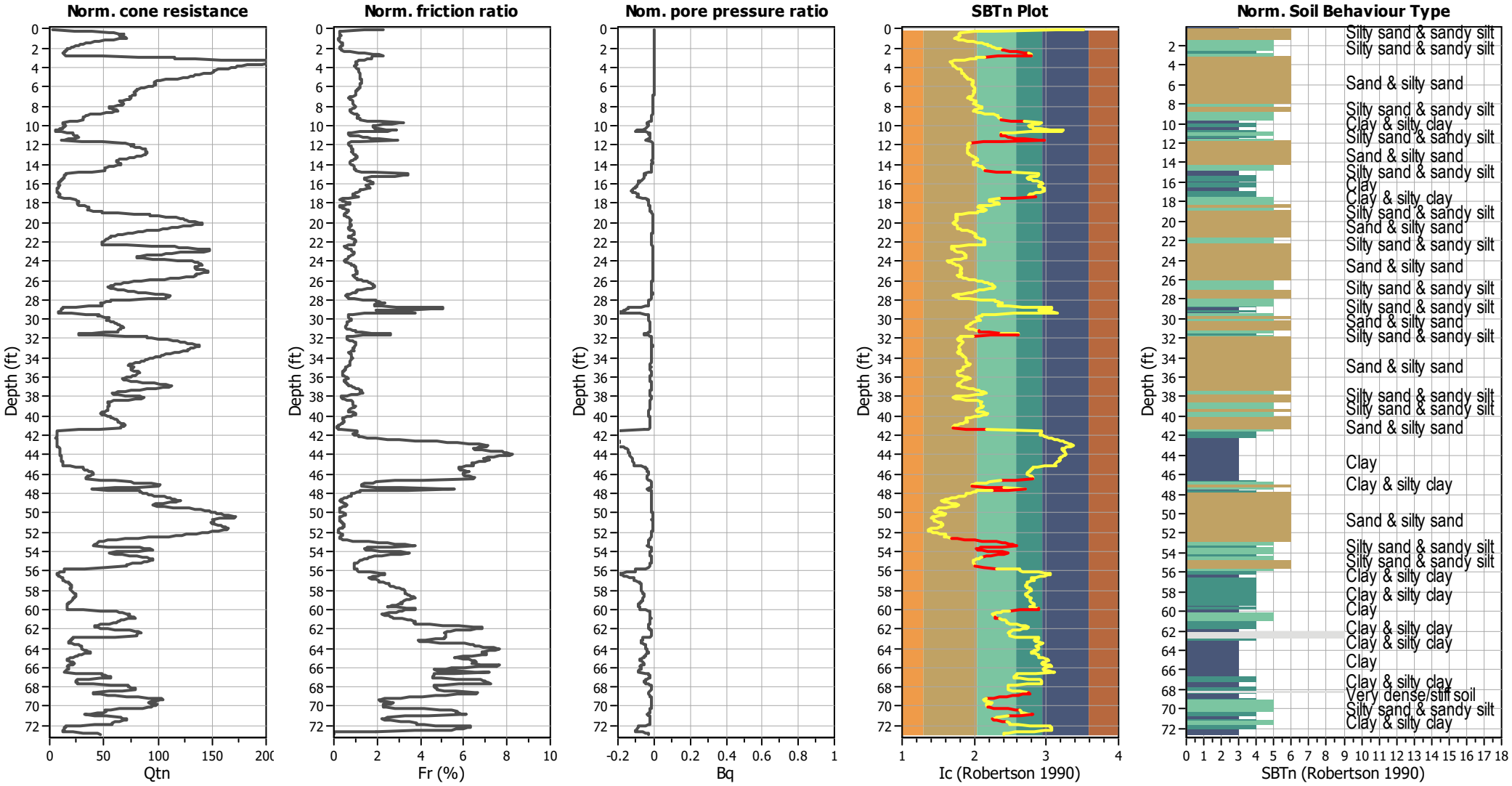
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 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)



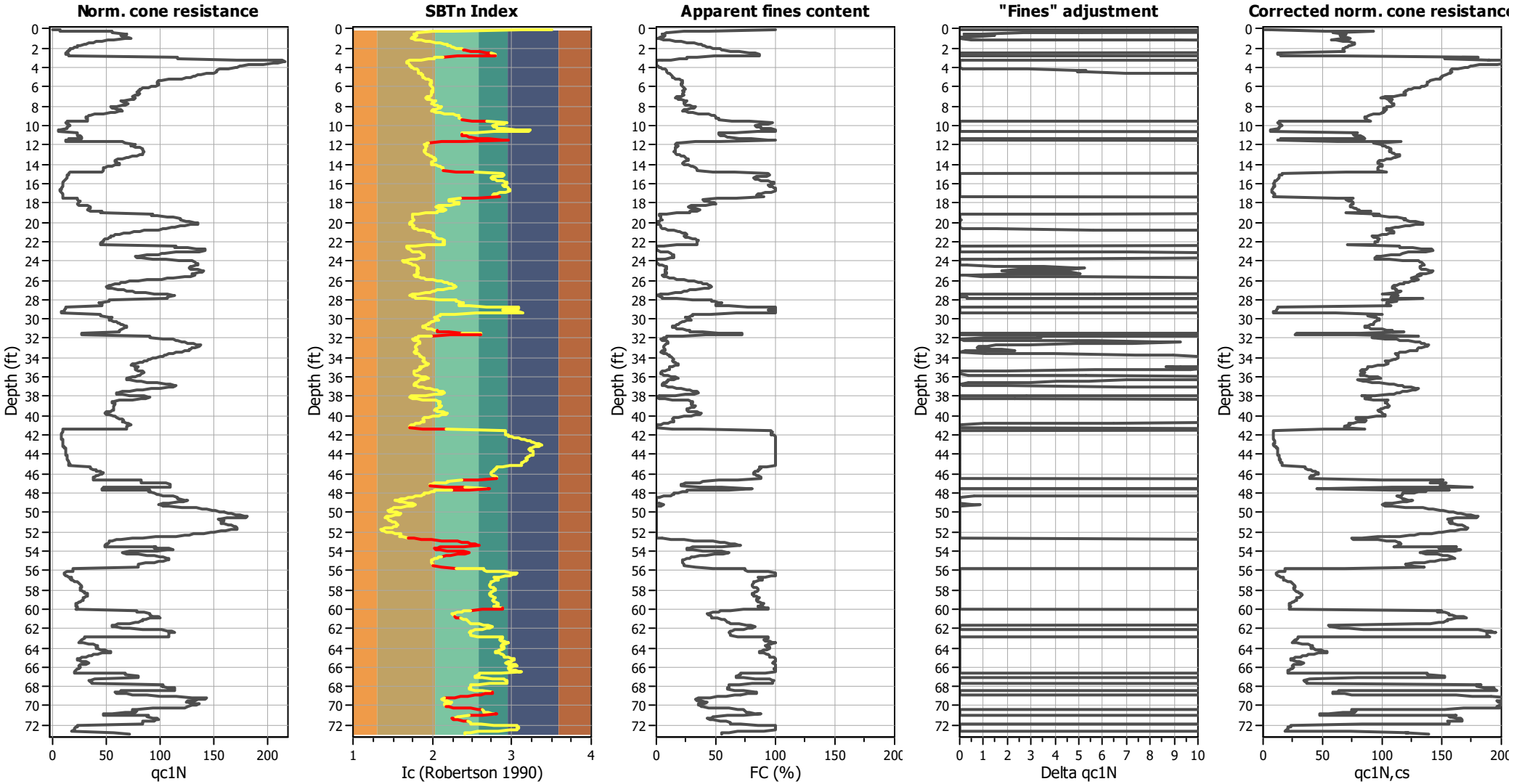
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 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

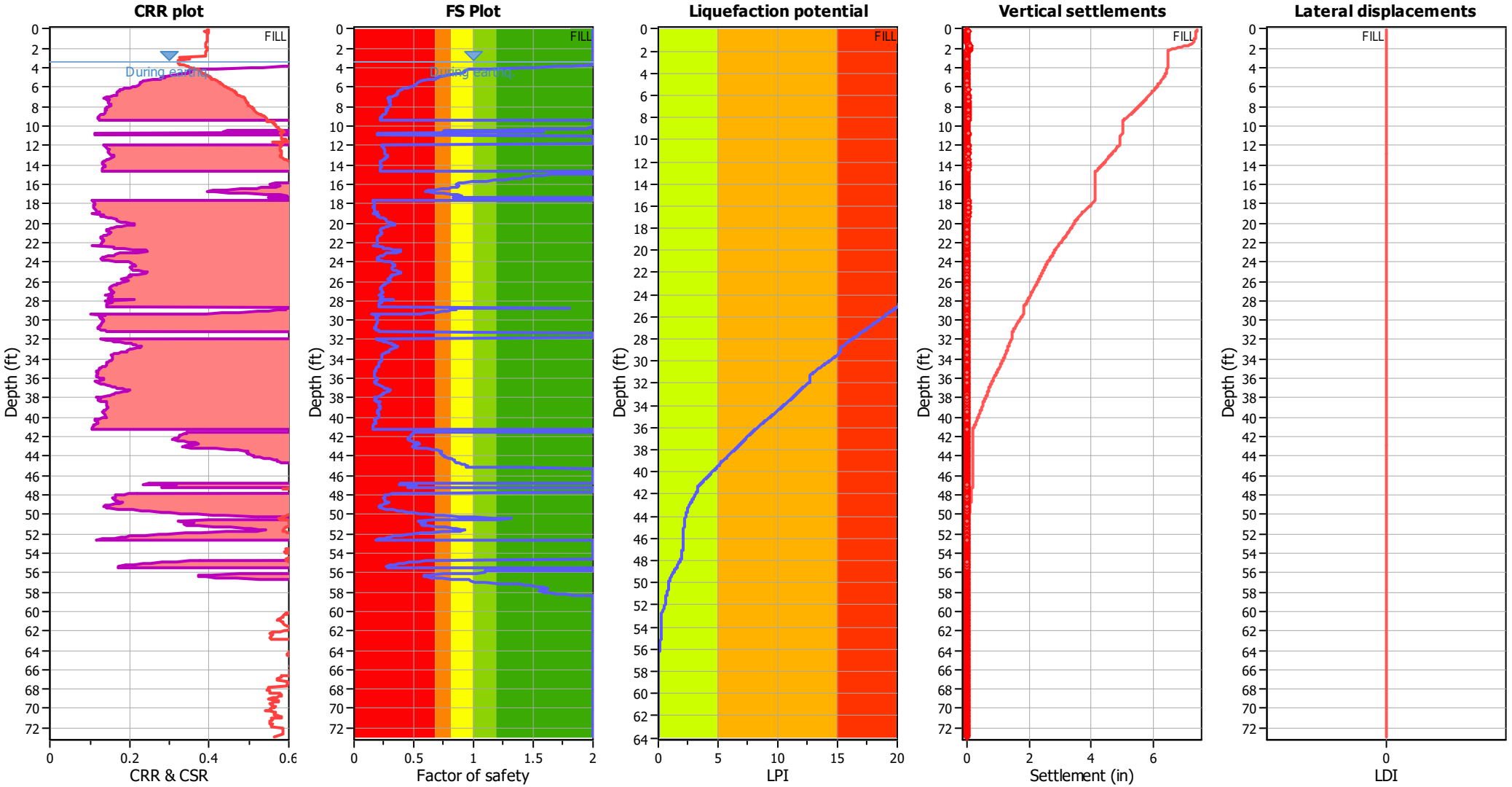
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 ft	Limit depth:	60.00 ft

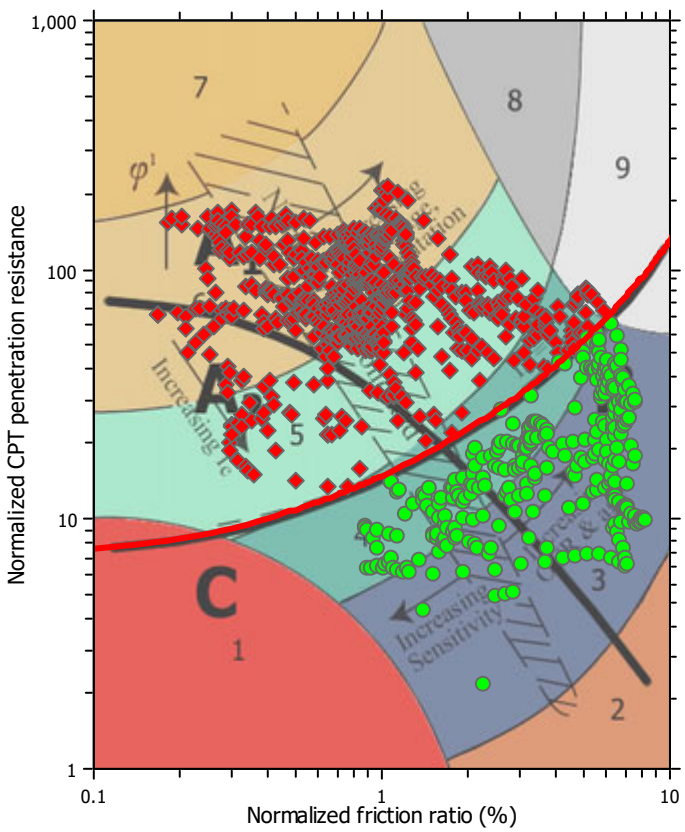
F.S. color scheme

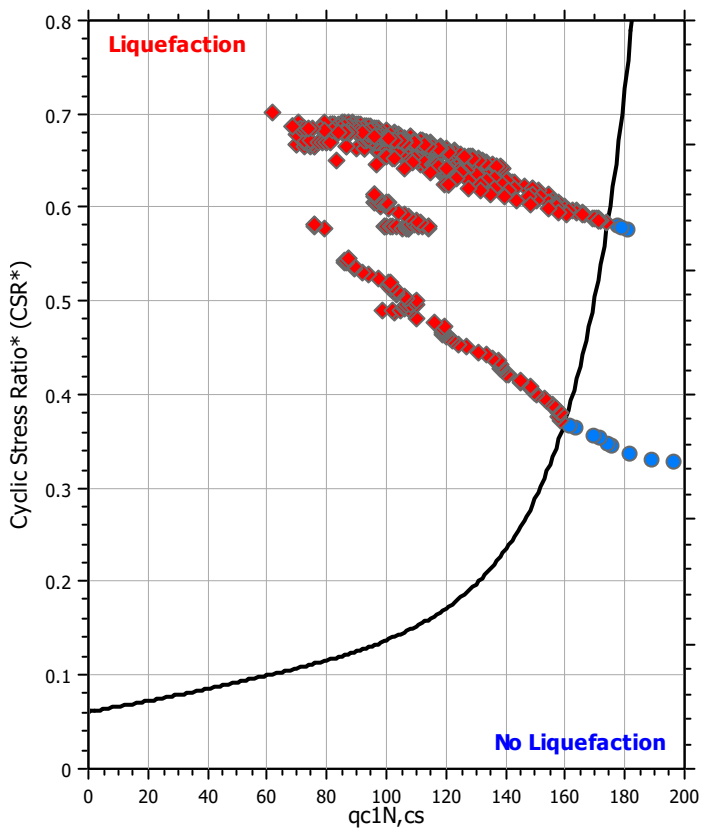
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

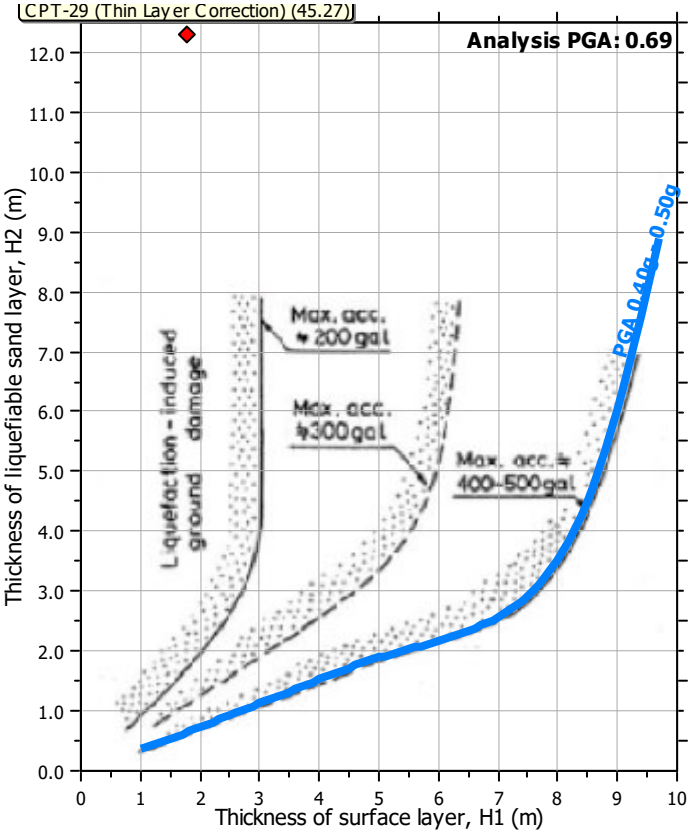
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



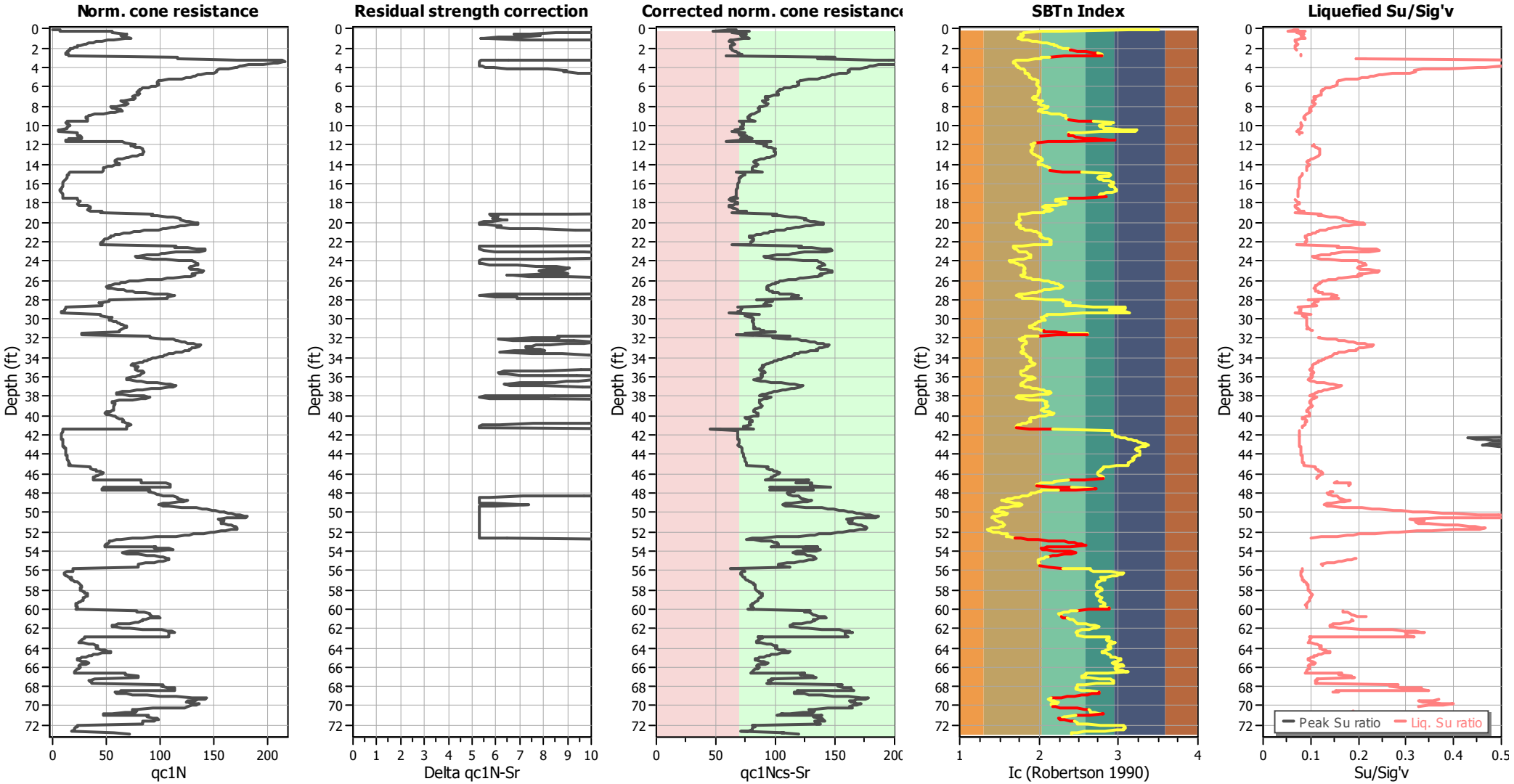




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

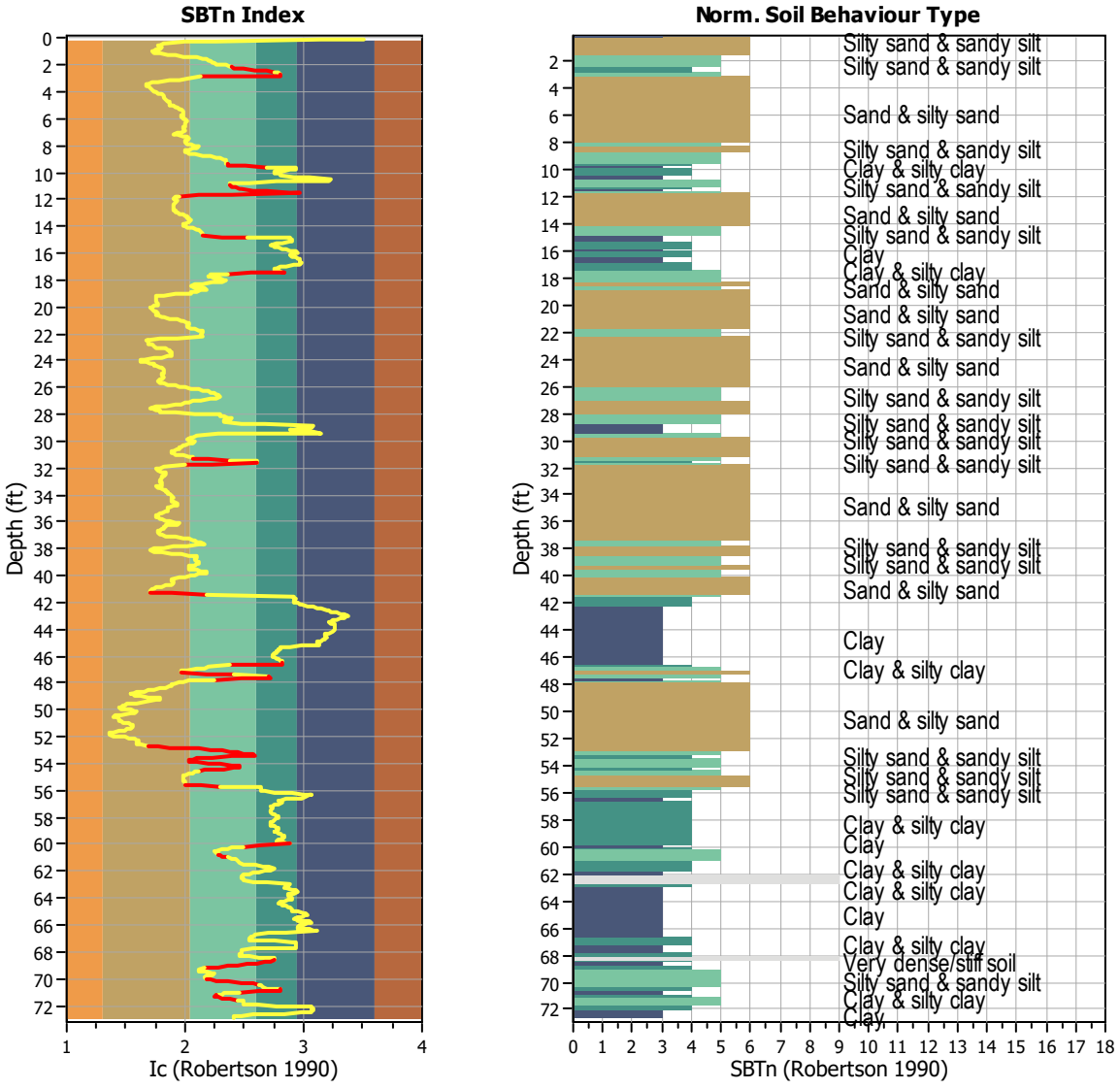
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.44 ft	Fill height:	1.68 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

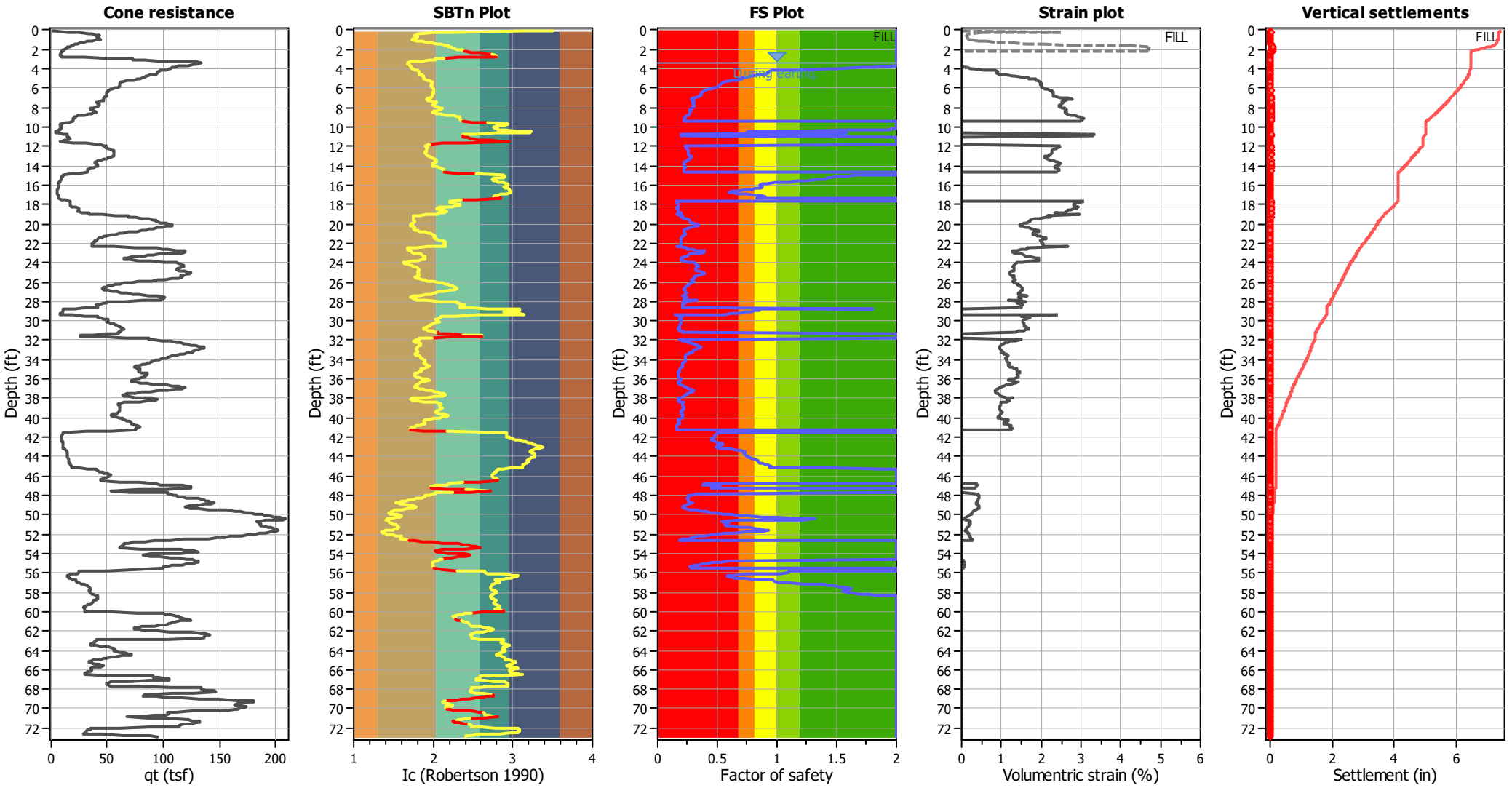
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1110
I_c maximum check value:	3.00	Total points excluded:	131
I_c change ratio value:	0.0250	Exclusion percentage:	11.80%
Minimum number of points in layer:	4	Number of layers detected:	24

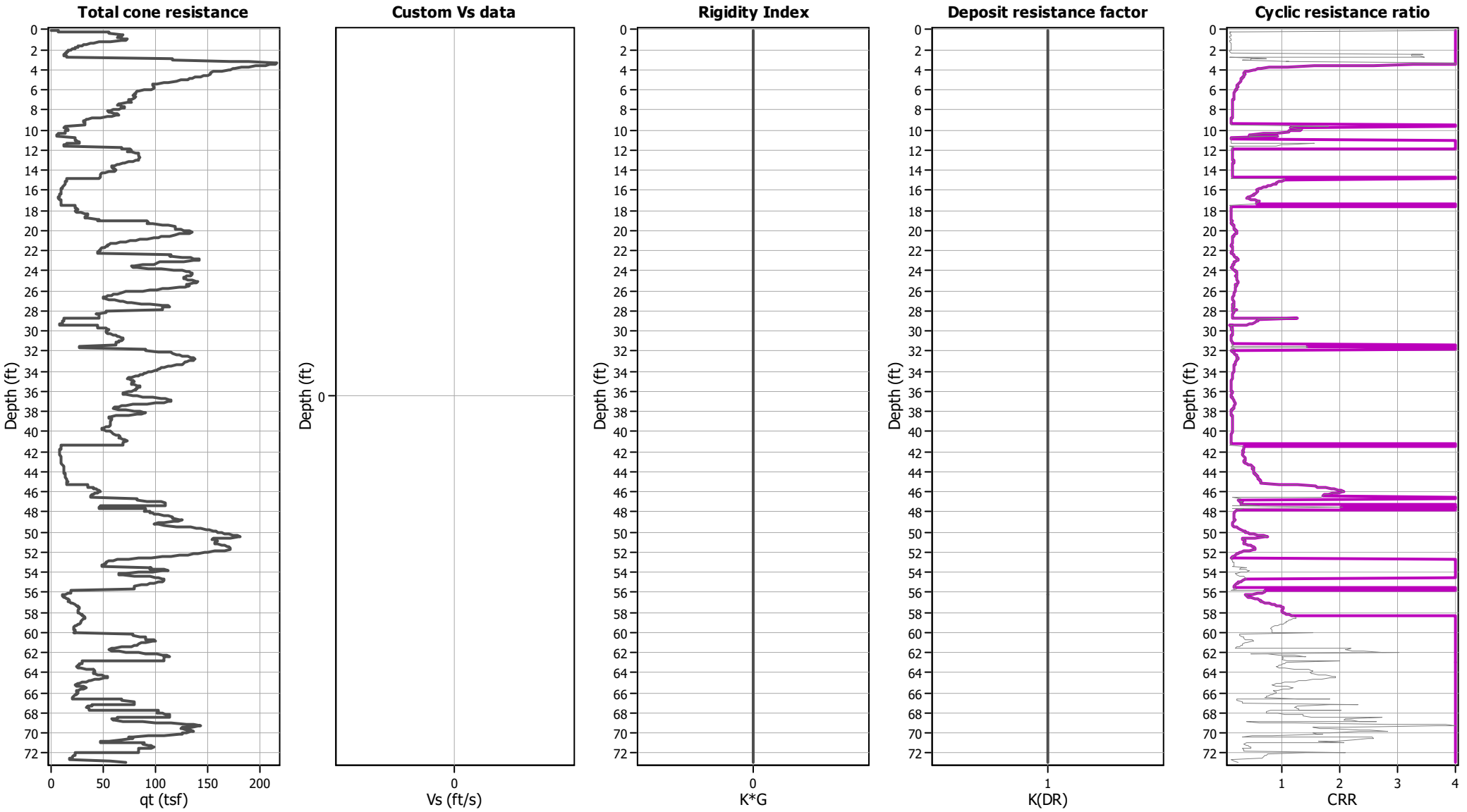
Estimation of post-earthquake settlements



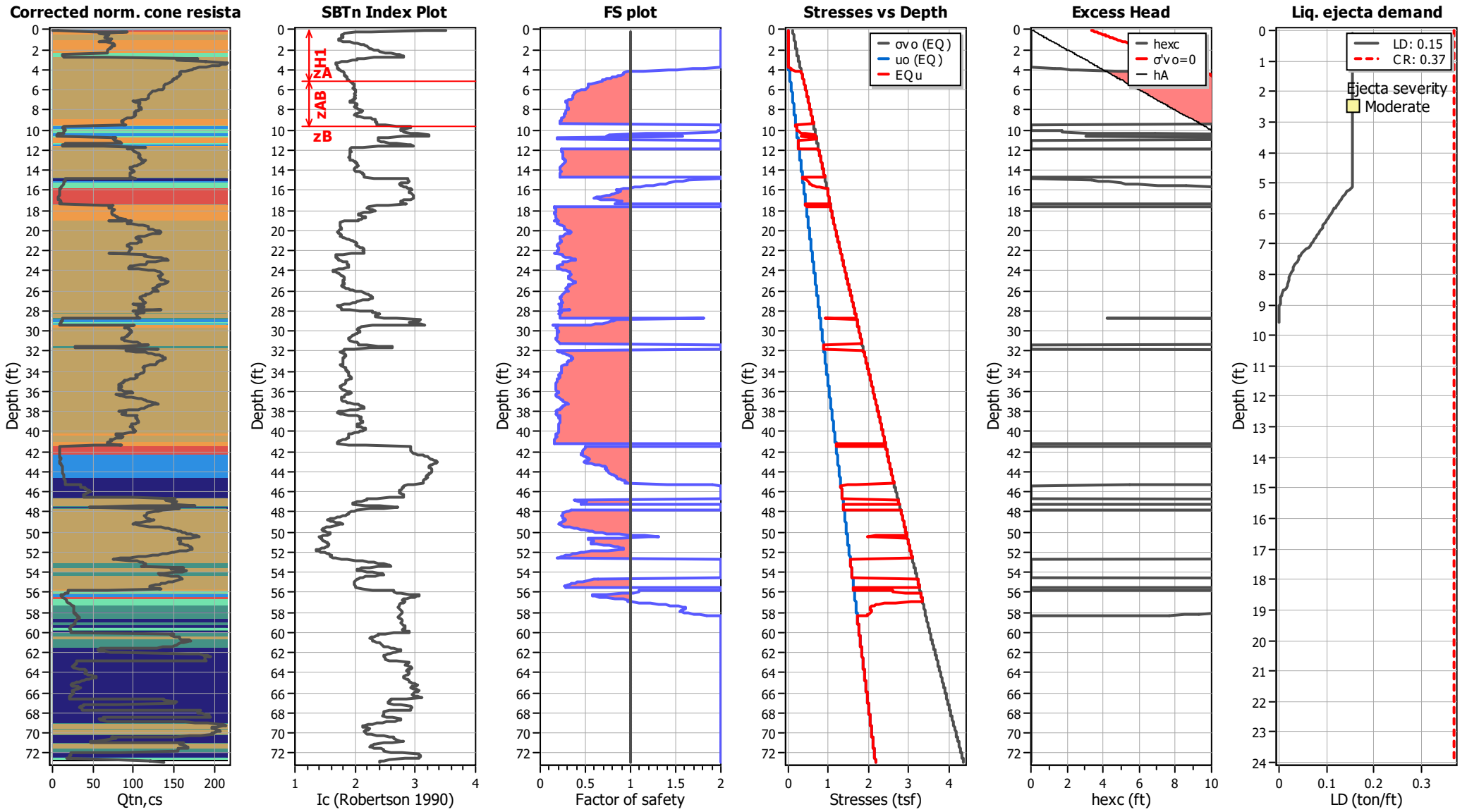
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

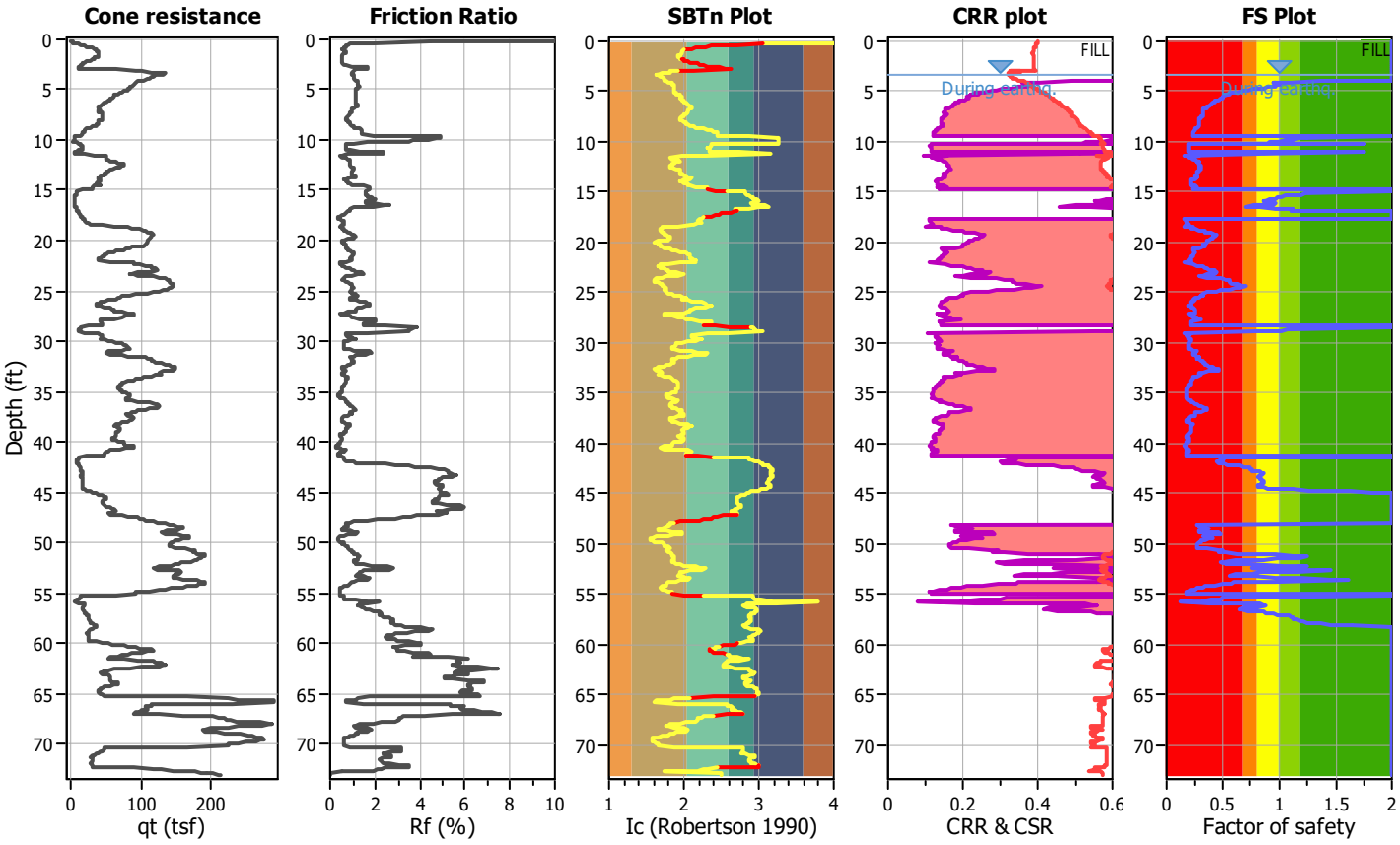
Project title : Topgolf Harbor Island

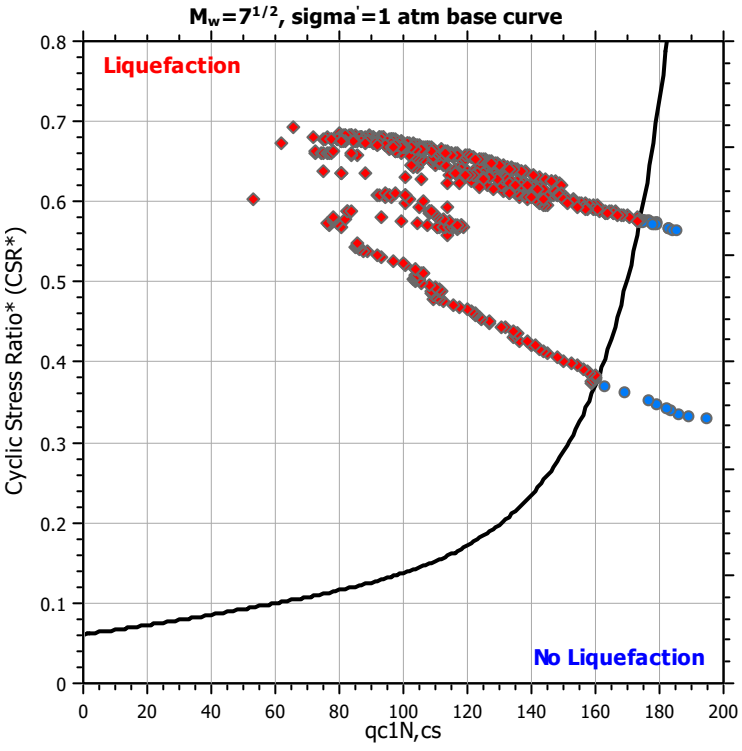
Location : North Harbor Drive and Liberator Way, San Diego, CA

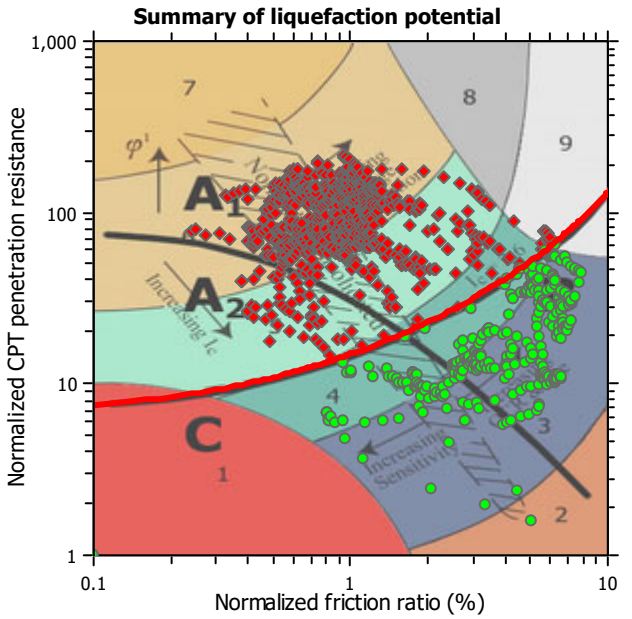
CPT file : CPT-30 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.35 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	5.12 ft	Fill height:	1.77 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

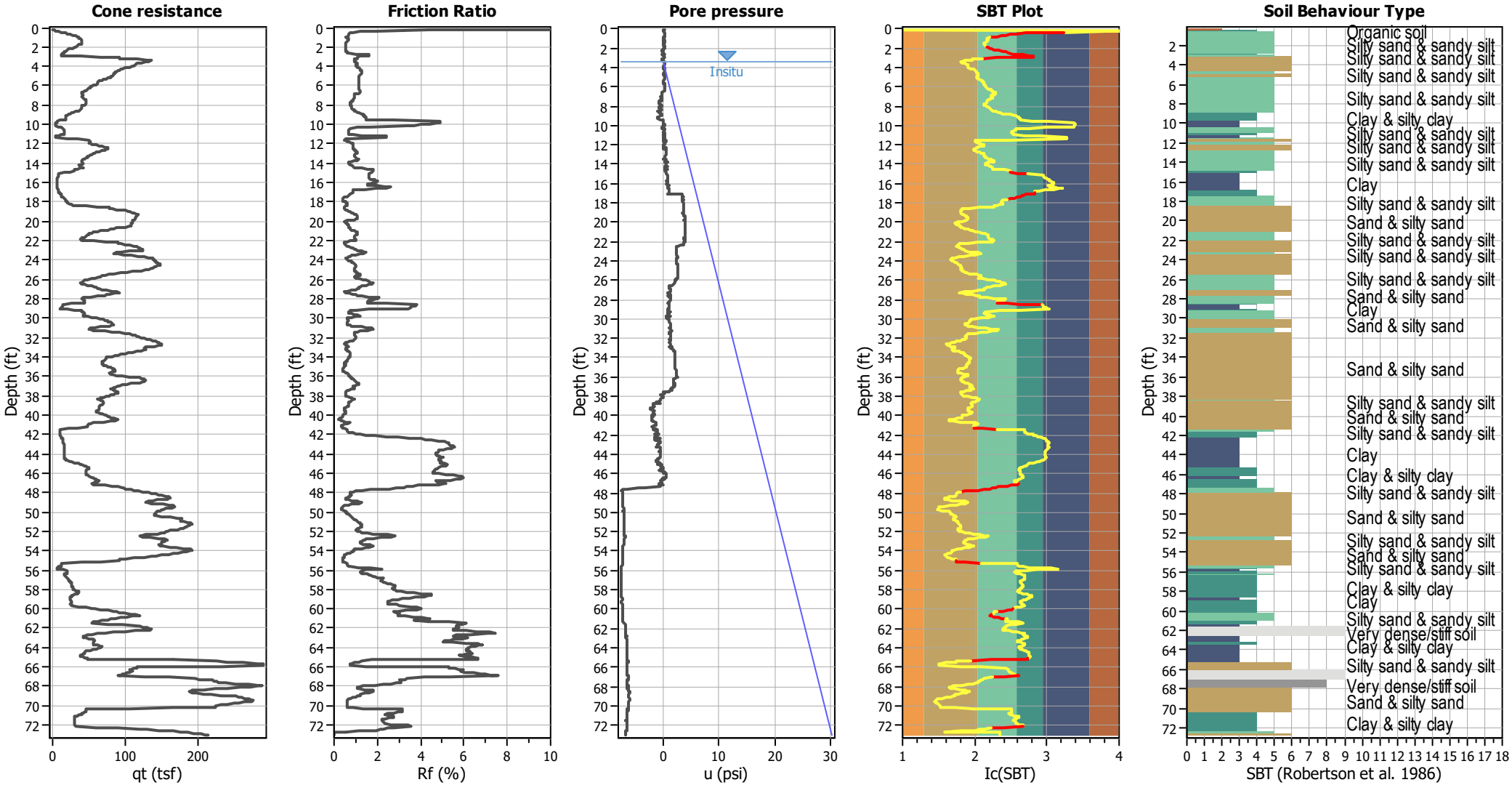






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



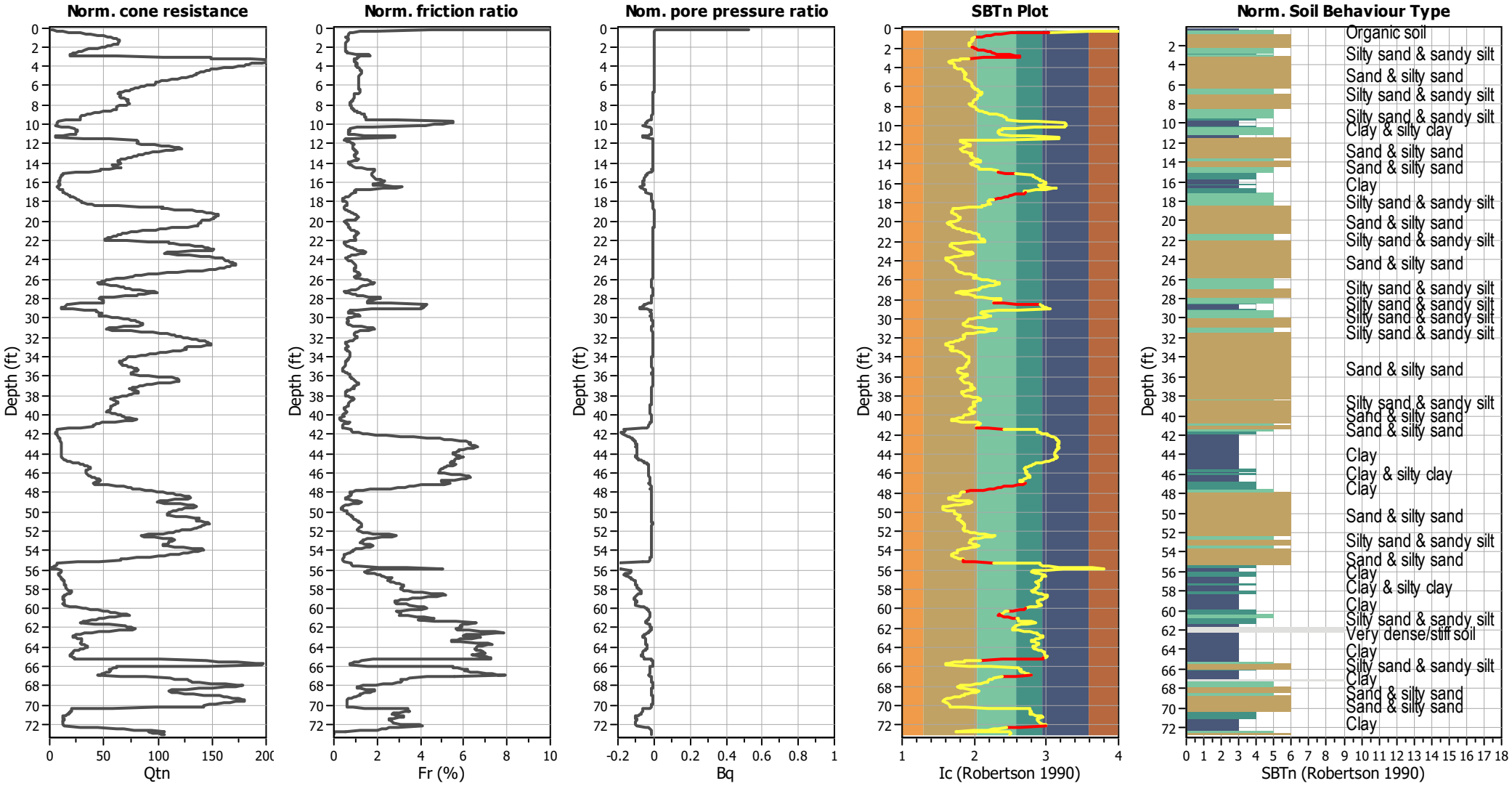
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 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)



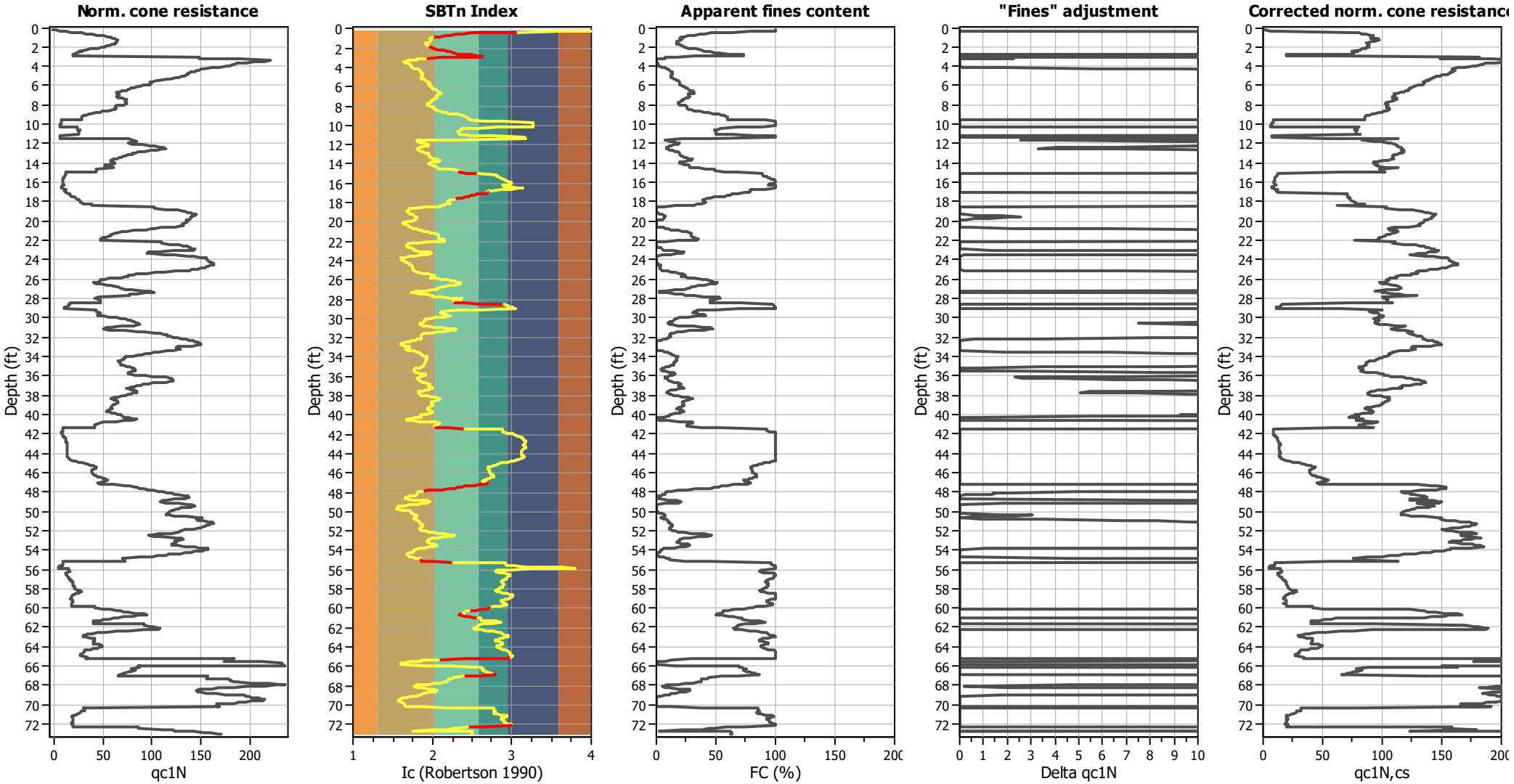
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 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

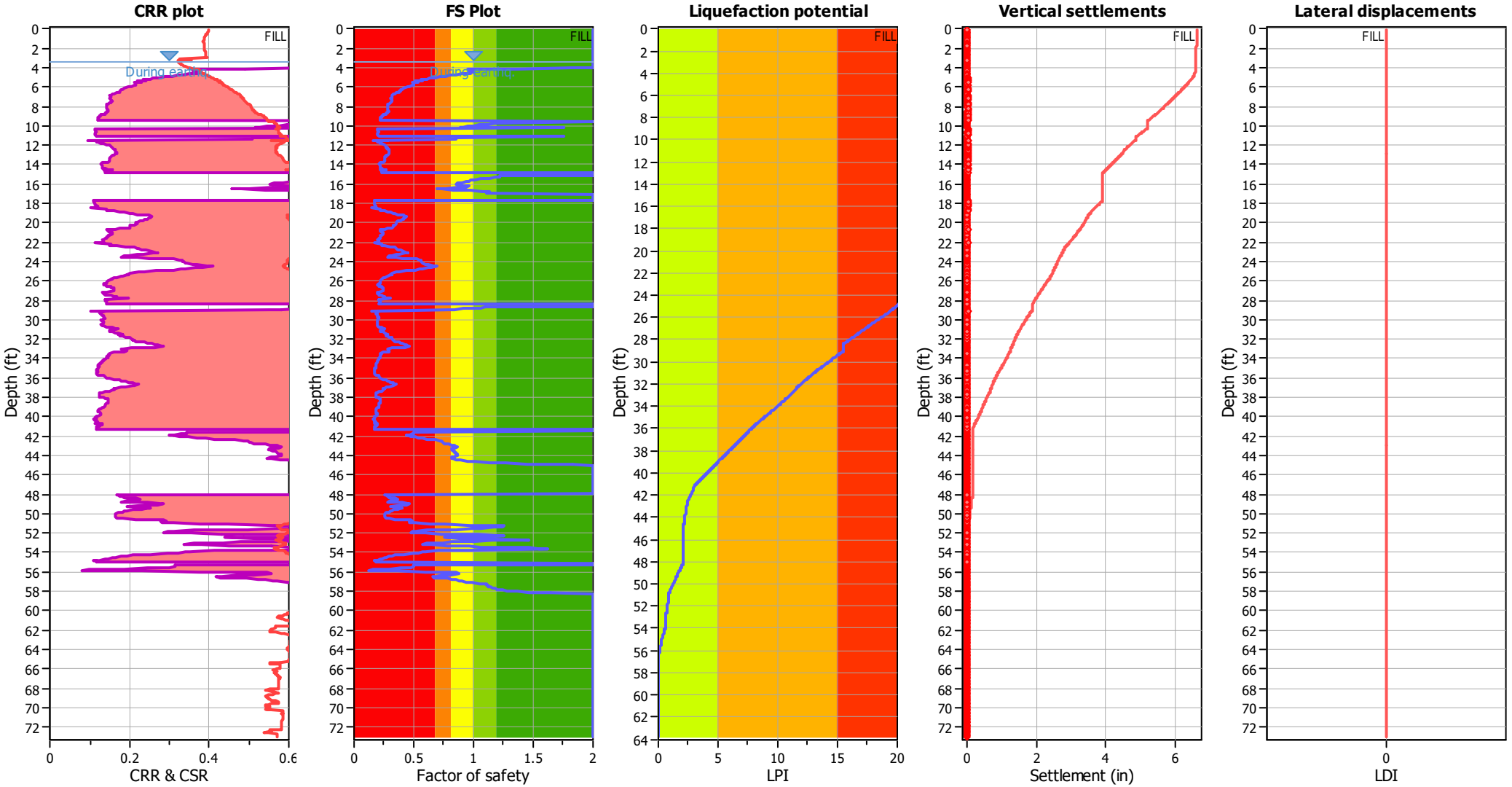
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 ft	Limit depth:	60.00 ft

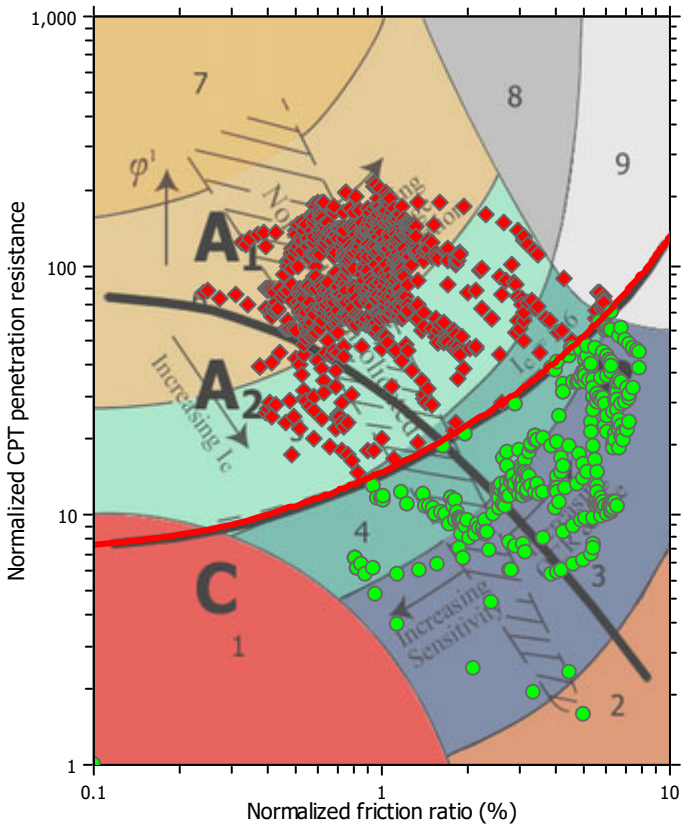
F.S. color scheme

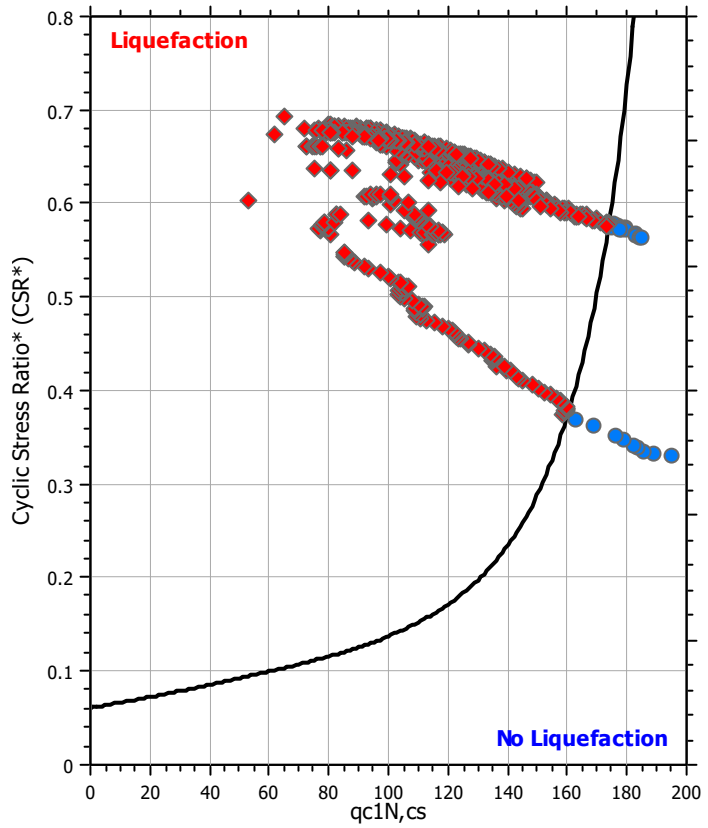
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

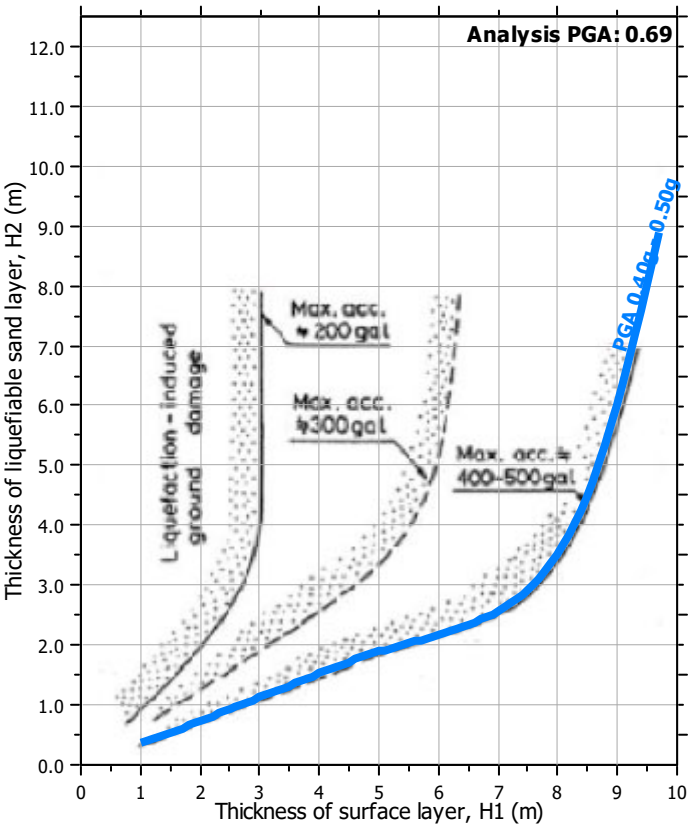
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



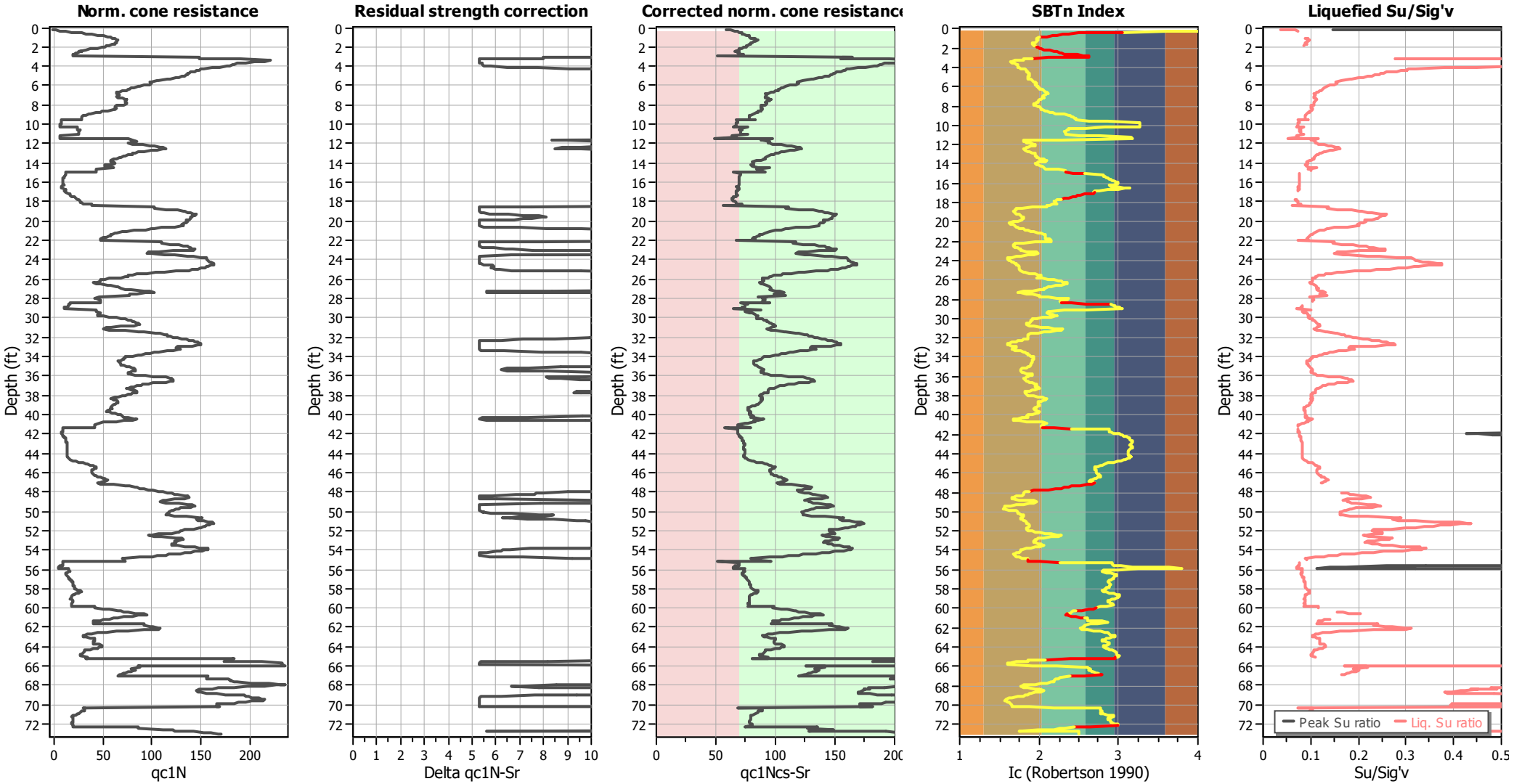




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

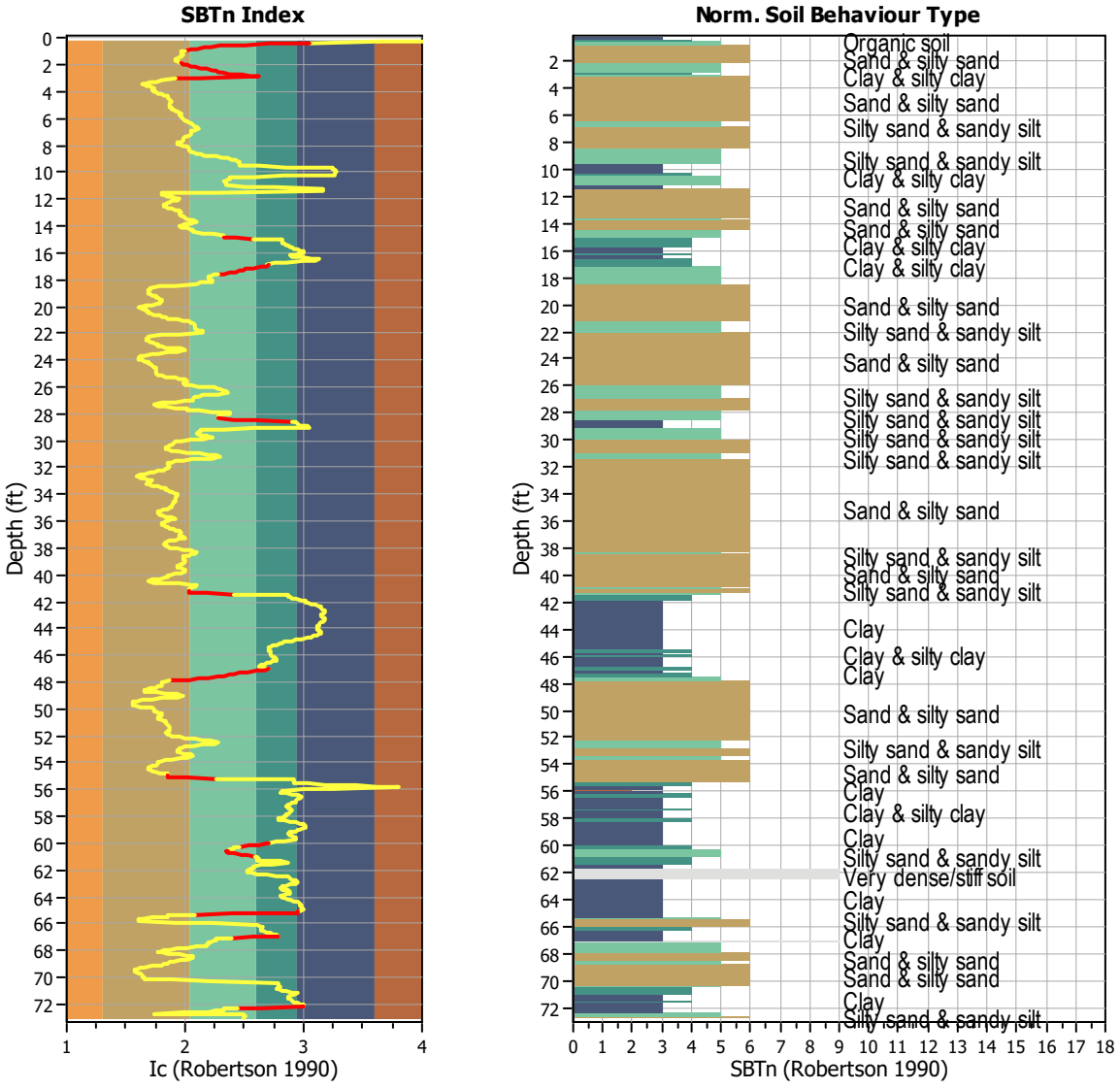
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	5.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.35 ft	Fill height:	1.77 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

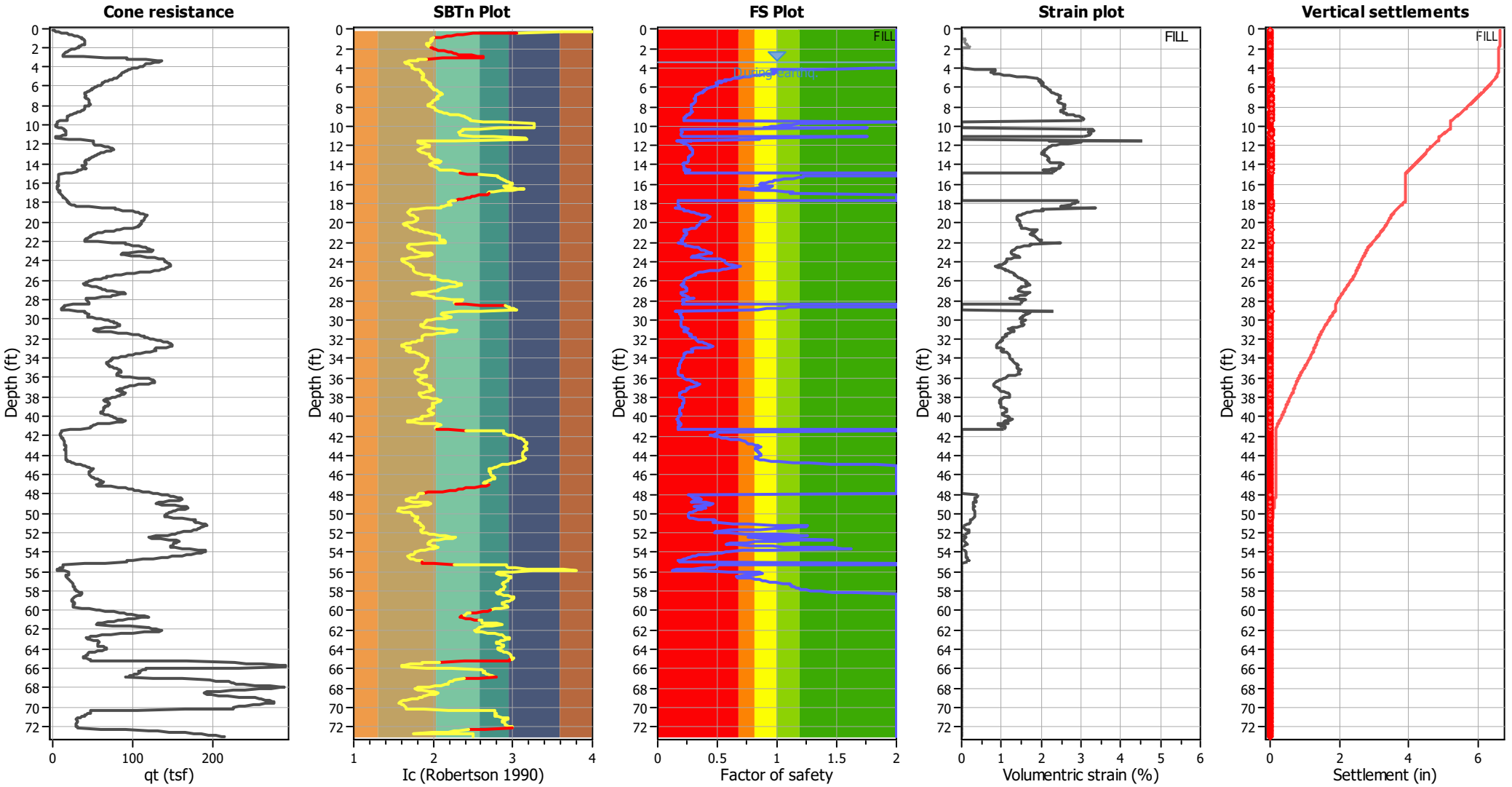
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1112
I_c maximum check value:	3.00	Total points excluded:	96
I_c change ratio value:	0.0250	Exclusion percentage:	8.63%
Minimum number of points in layer:	4	Number of layers detected:	14

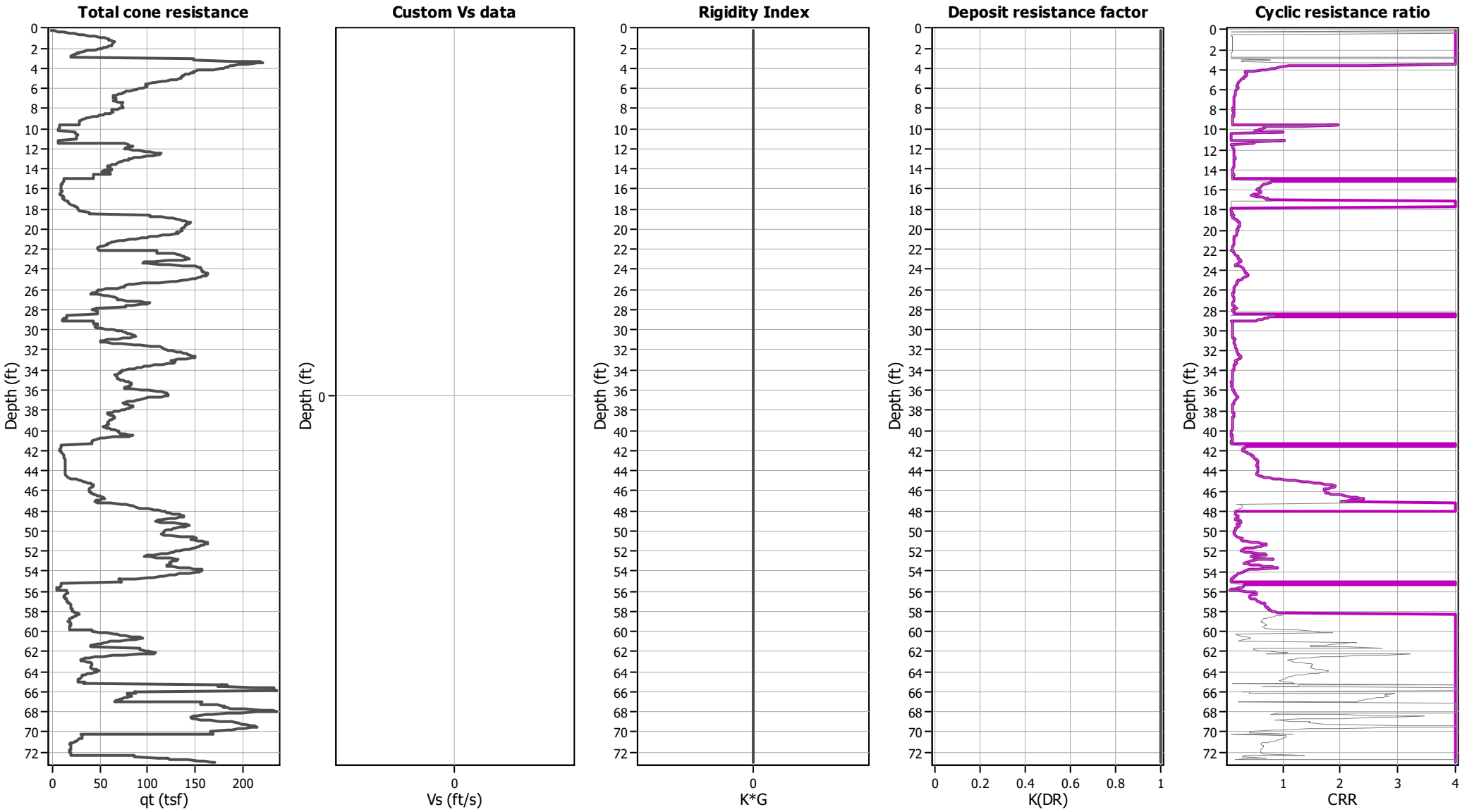
Estimation of post-earthquake settlements



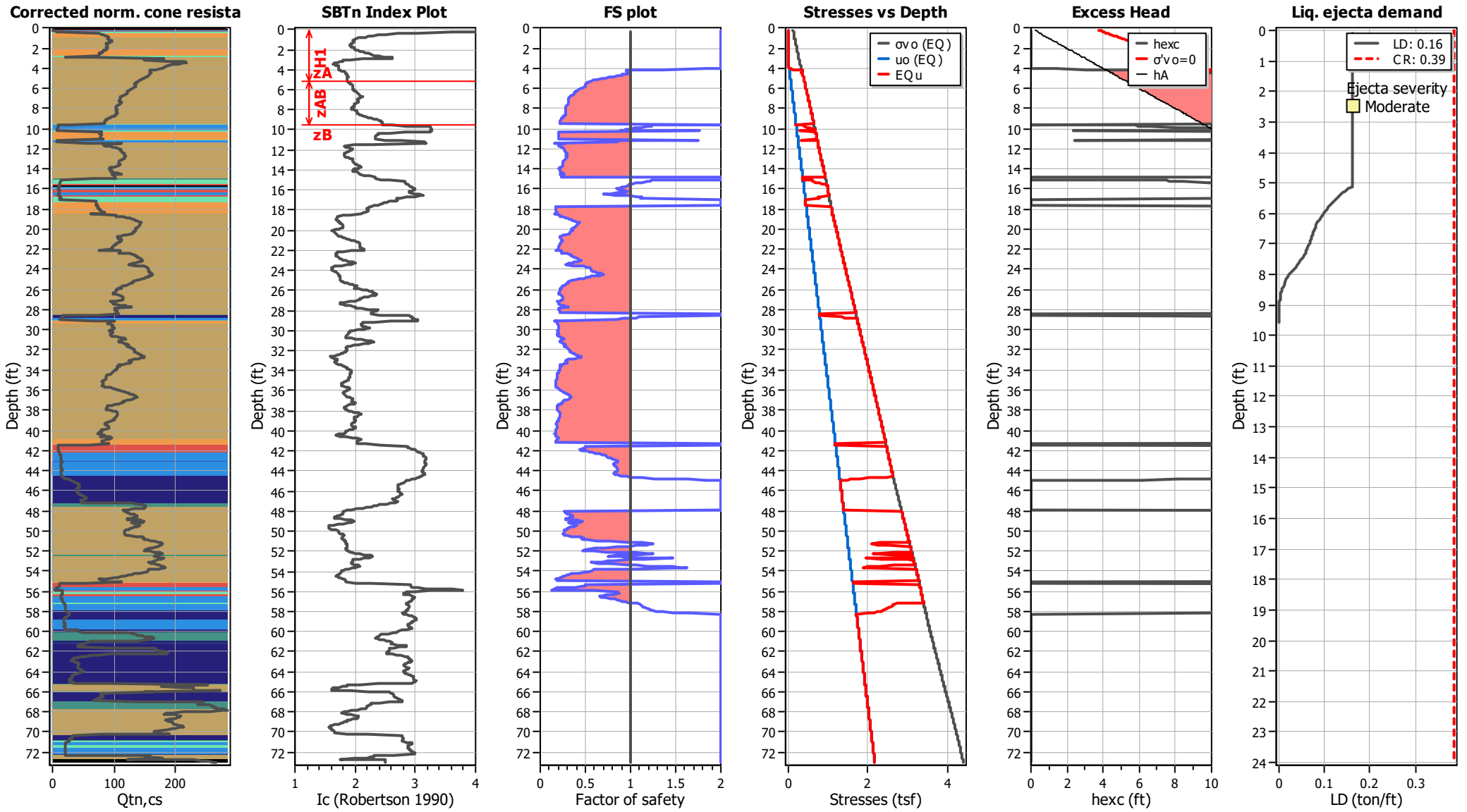
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

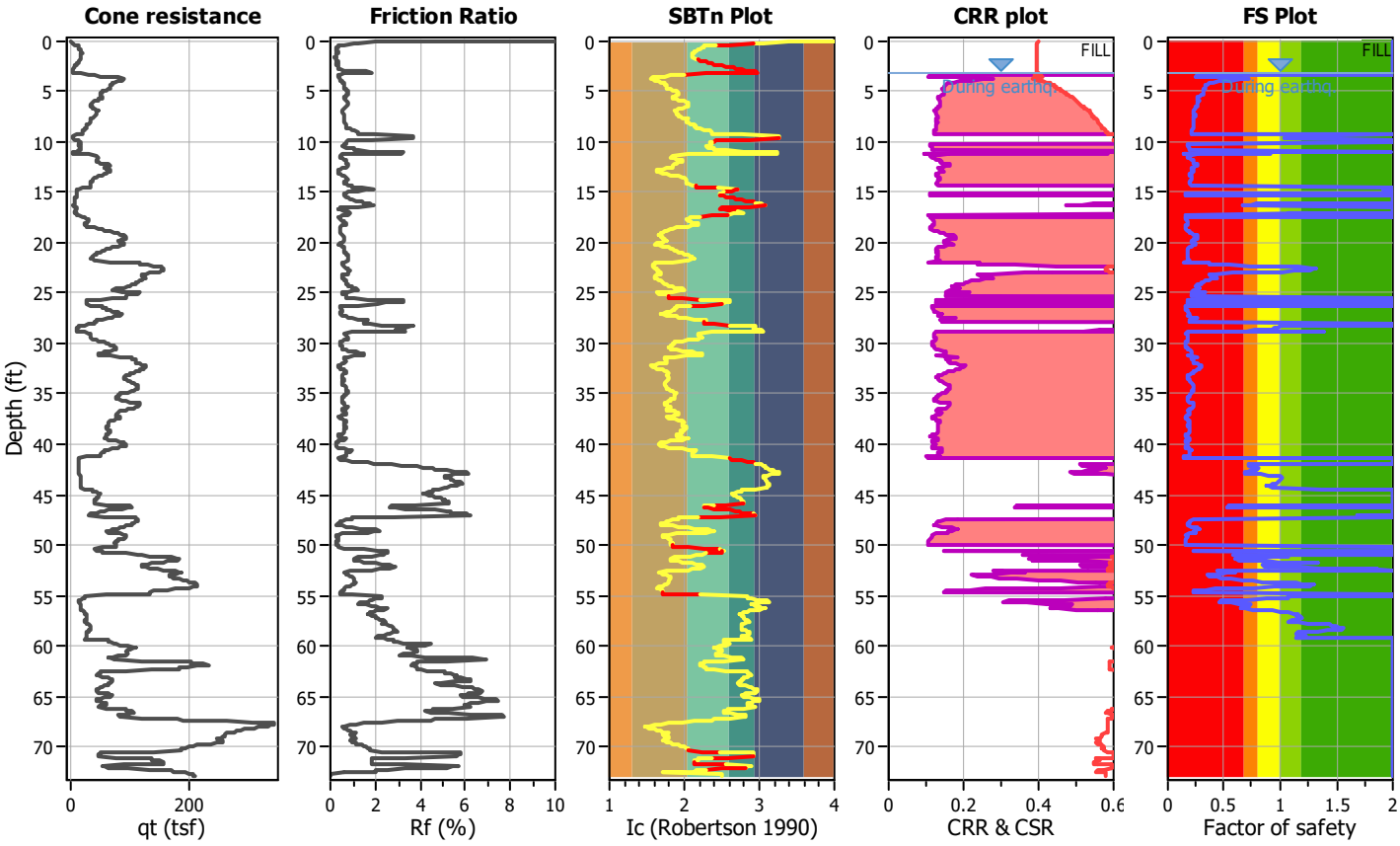
Project title : Topgolf Harbor Island

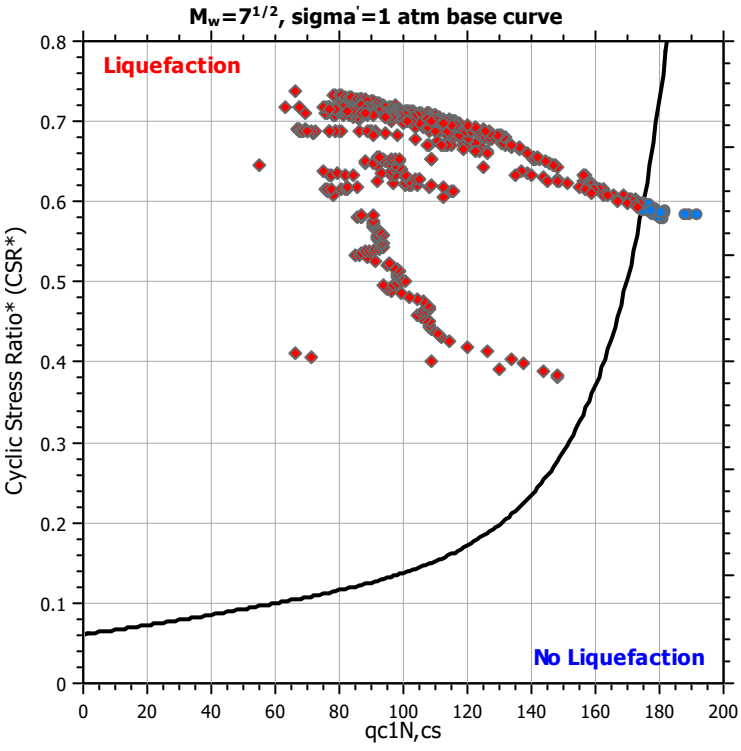
Location : North Harbor Drive and Liberator Way, San Diego, CA

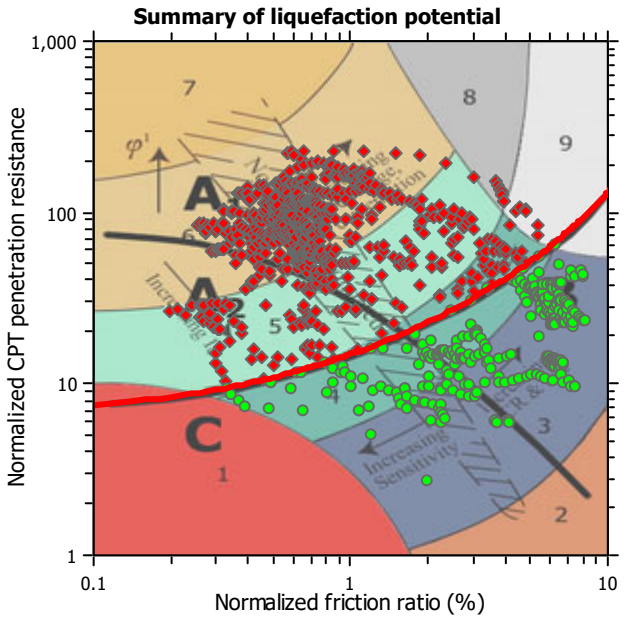
CPT file : CPT-31 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.25 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	0.87 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

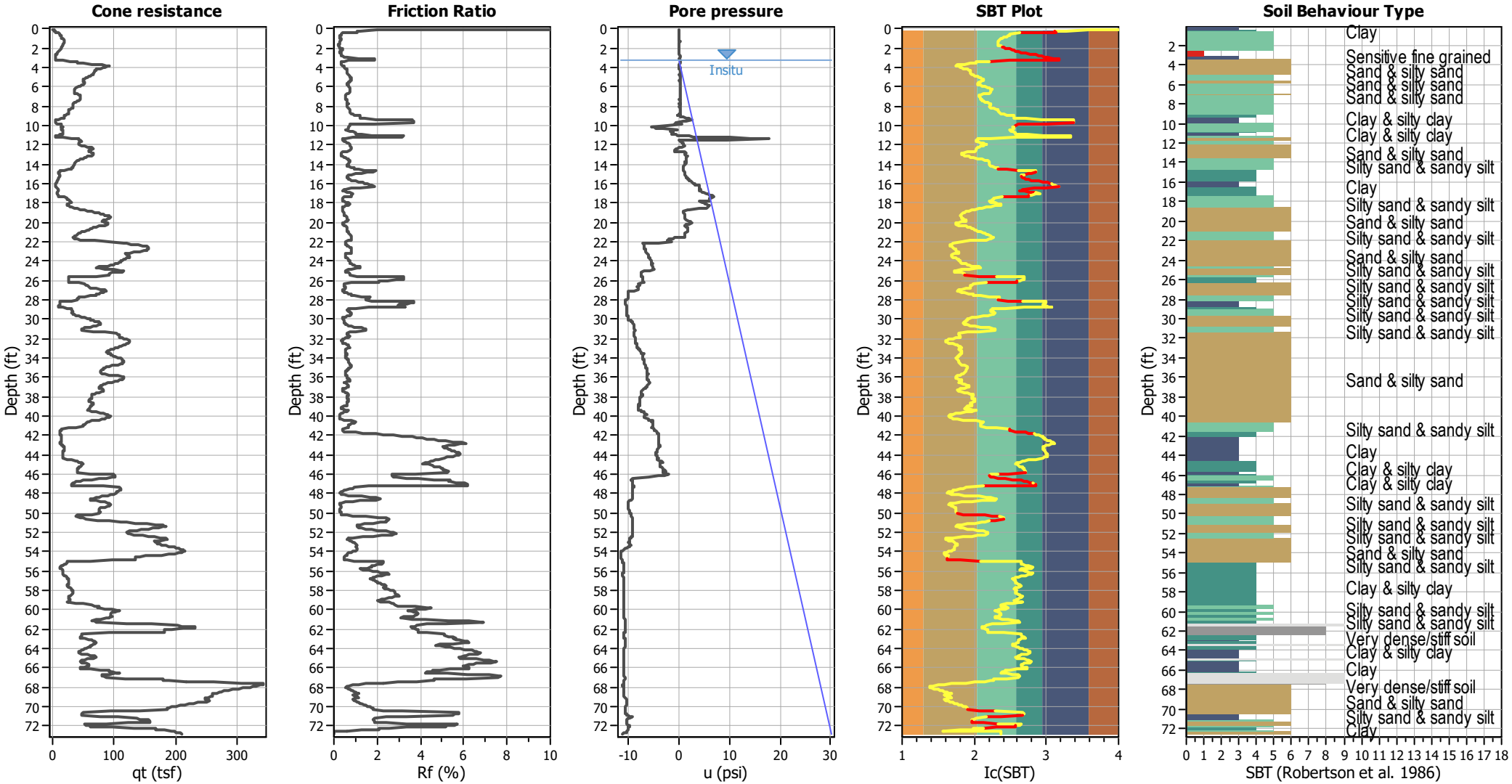






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



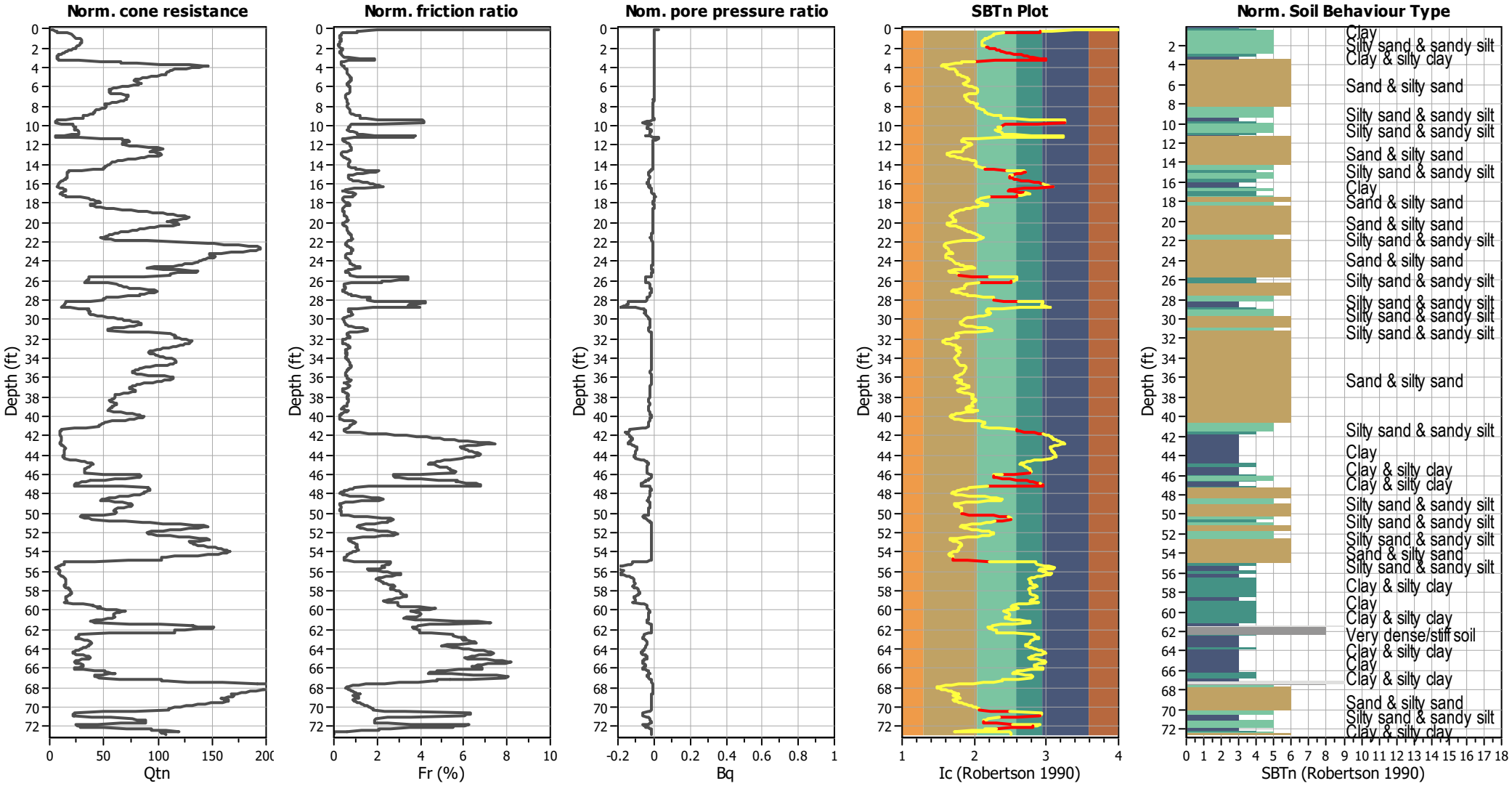
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 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)



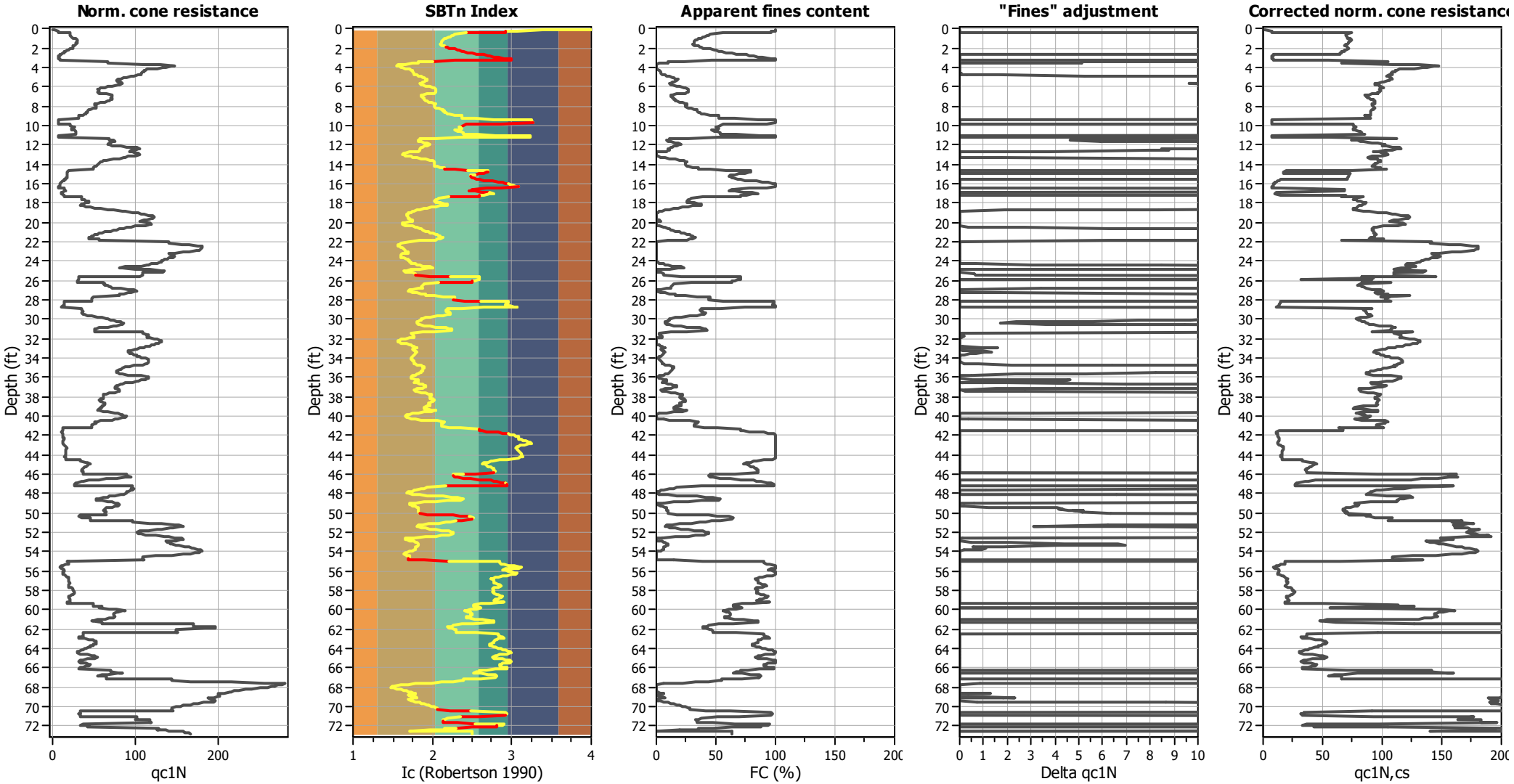
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 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

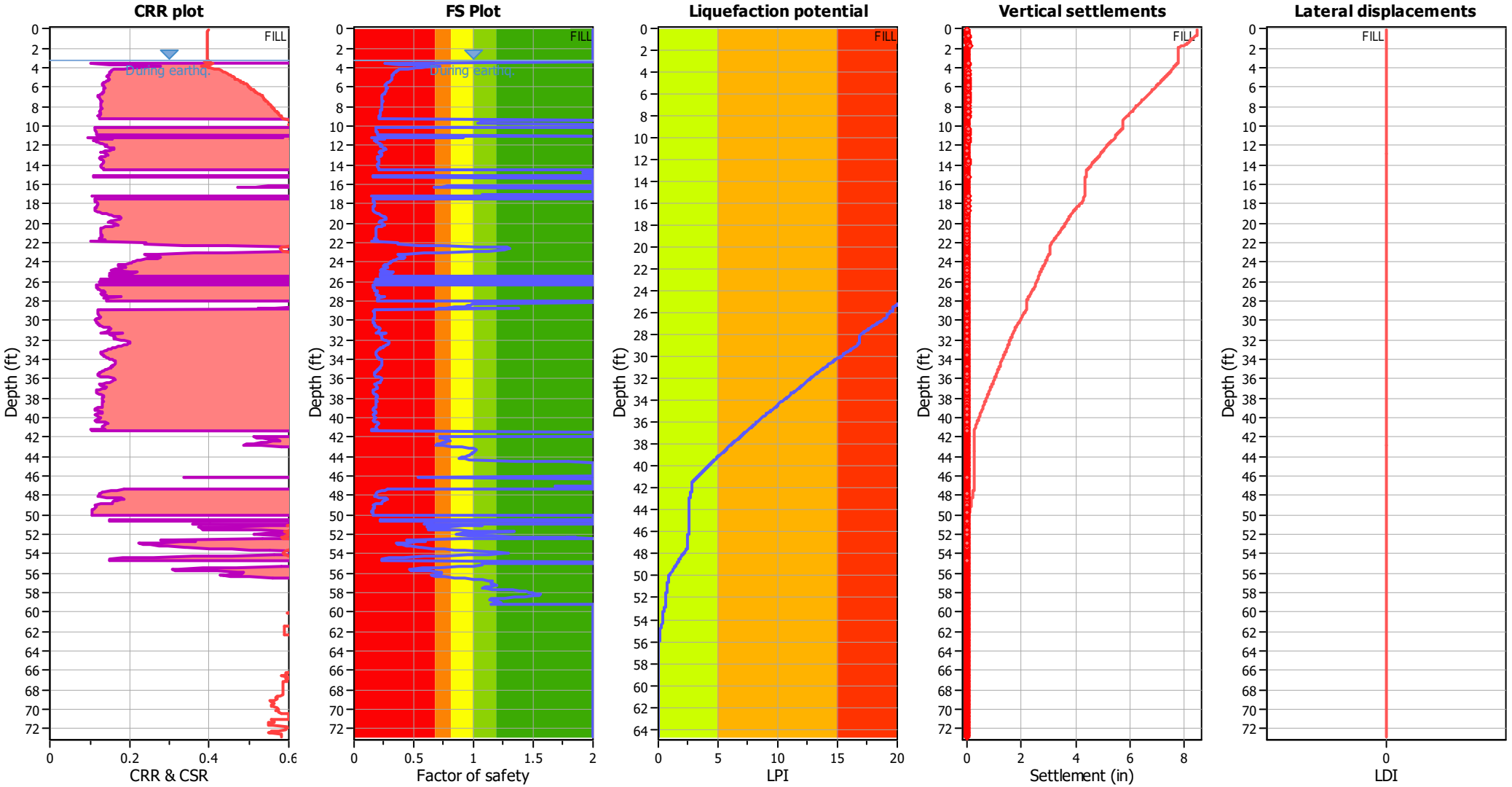
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 ft	Limit depth:	60.00 ft

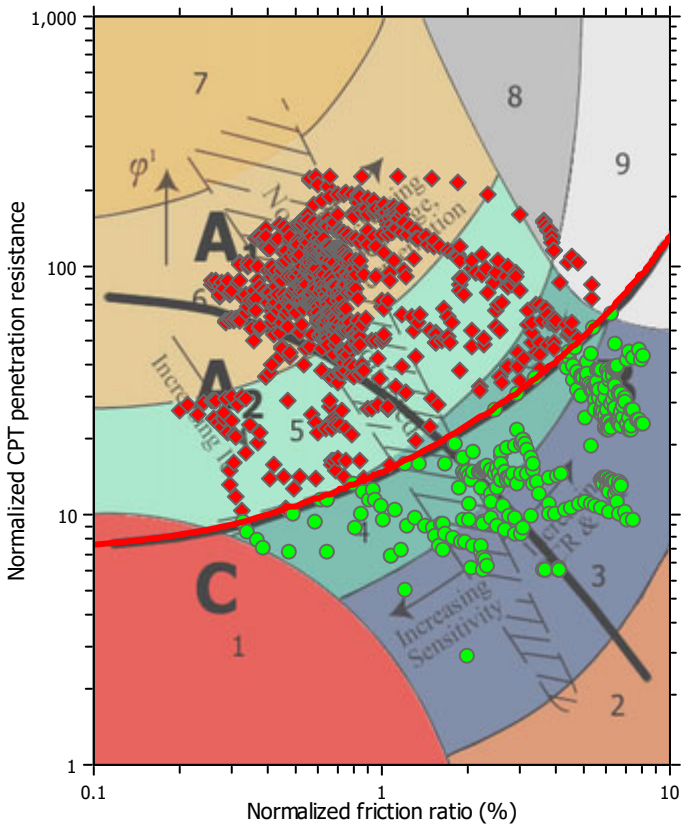
F.S. color scheme

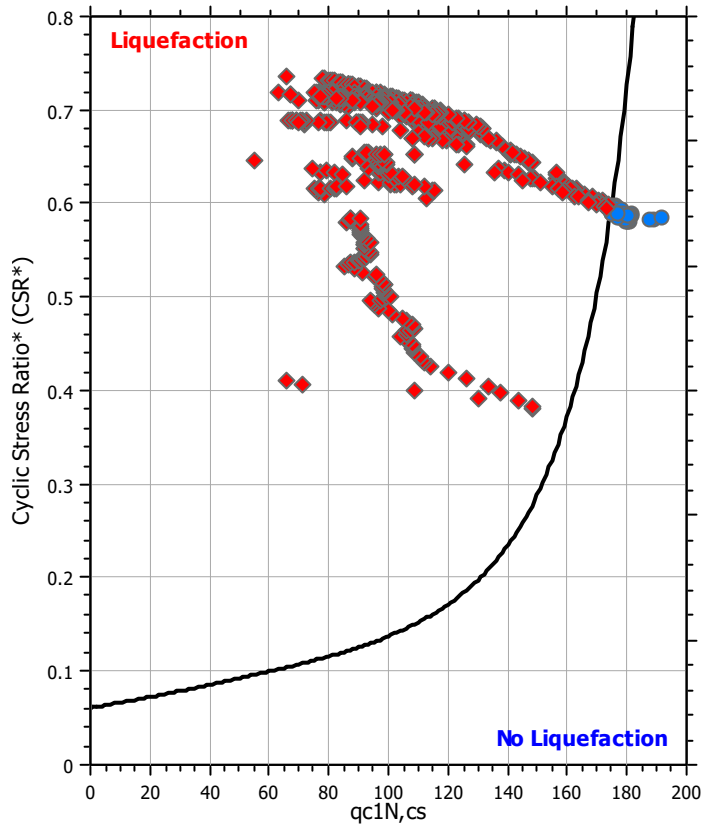
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

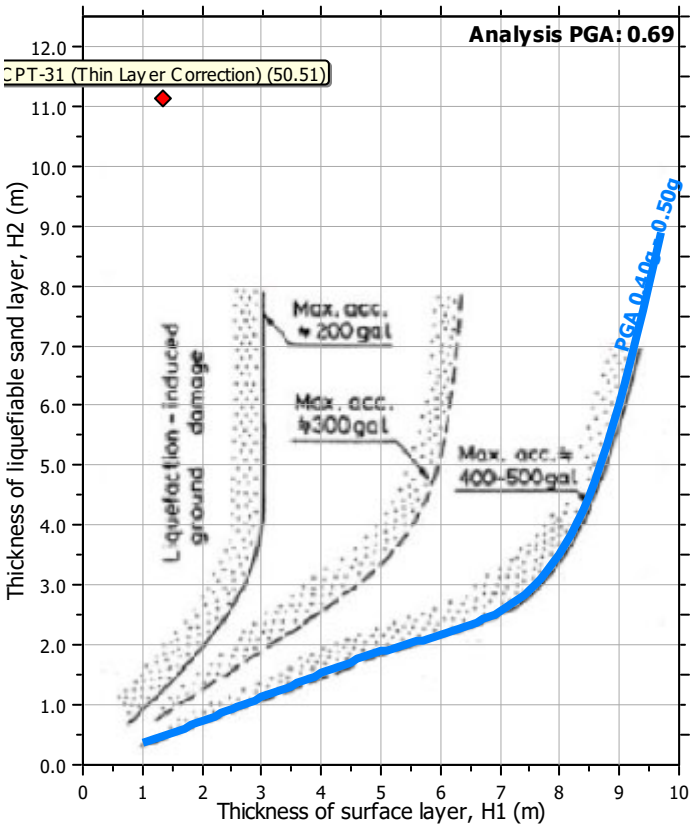
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



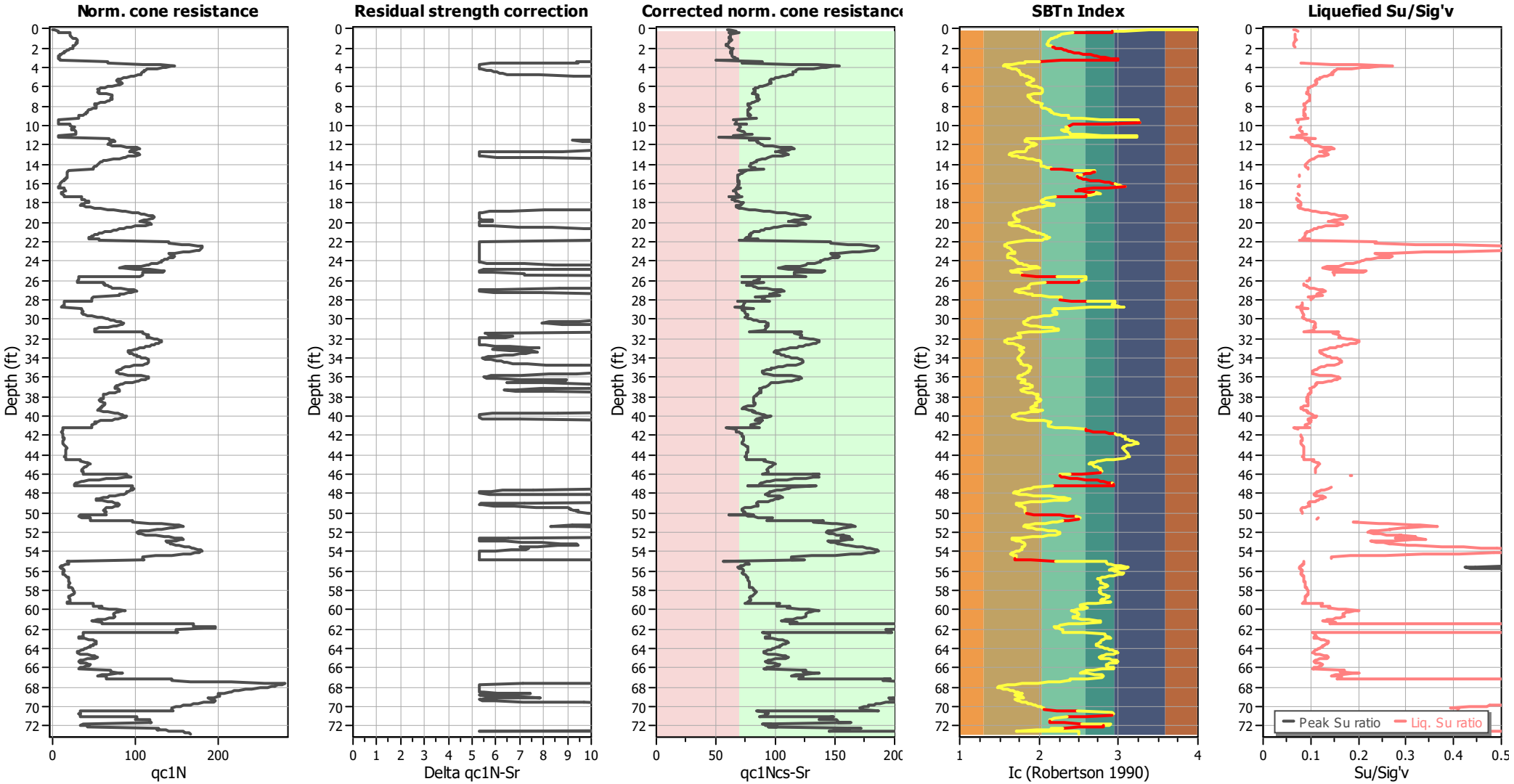




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

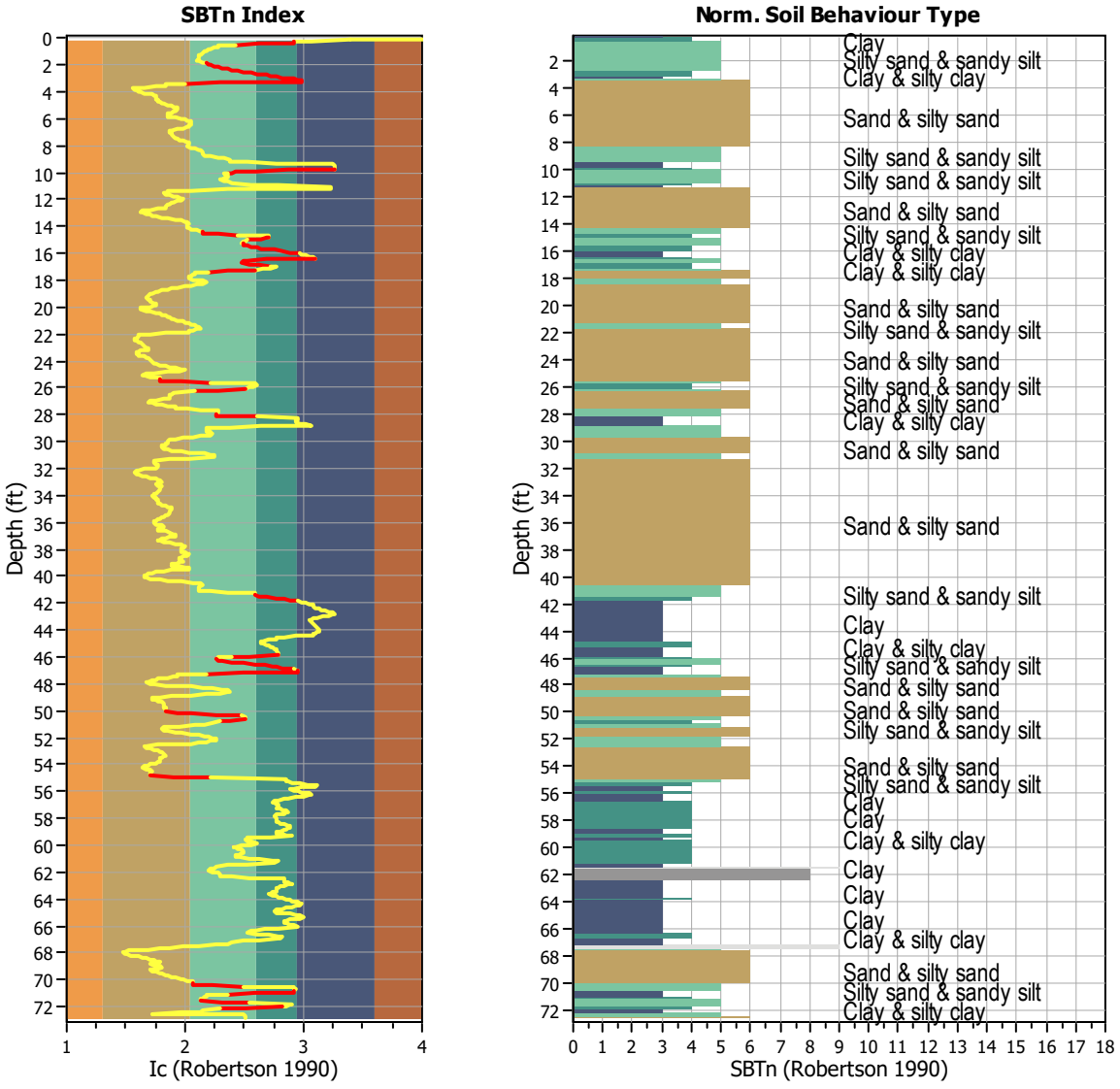
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.25 ft	Fill height:	0.87 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.



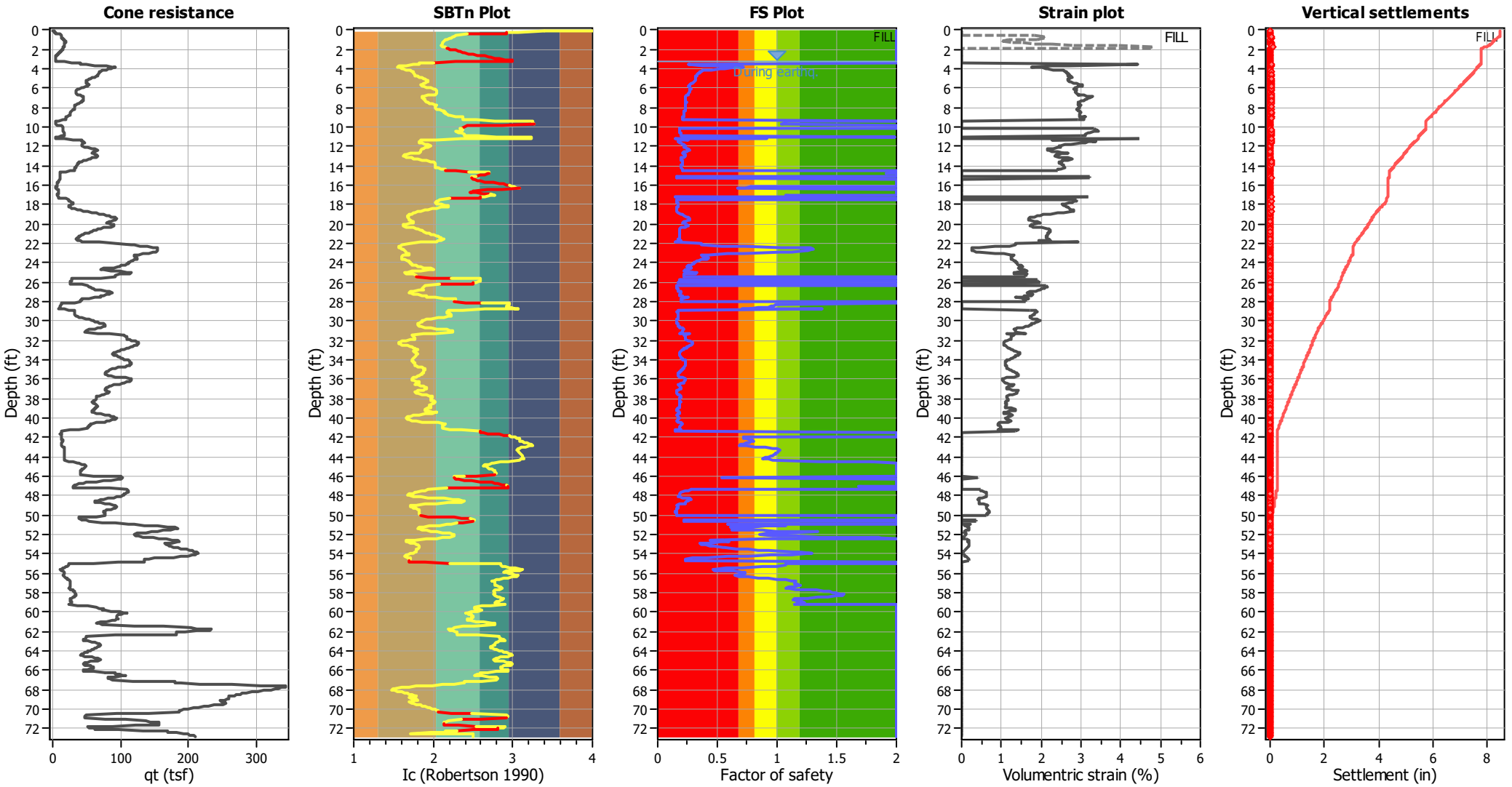
Transition layer algorithm properties

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:	1110
Total points excluded:	141
Exclusion percentage:	12.70%
Number of layers detected:	24

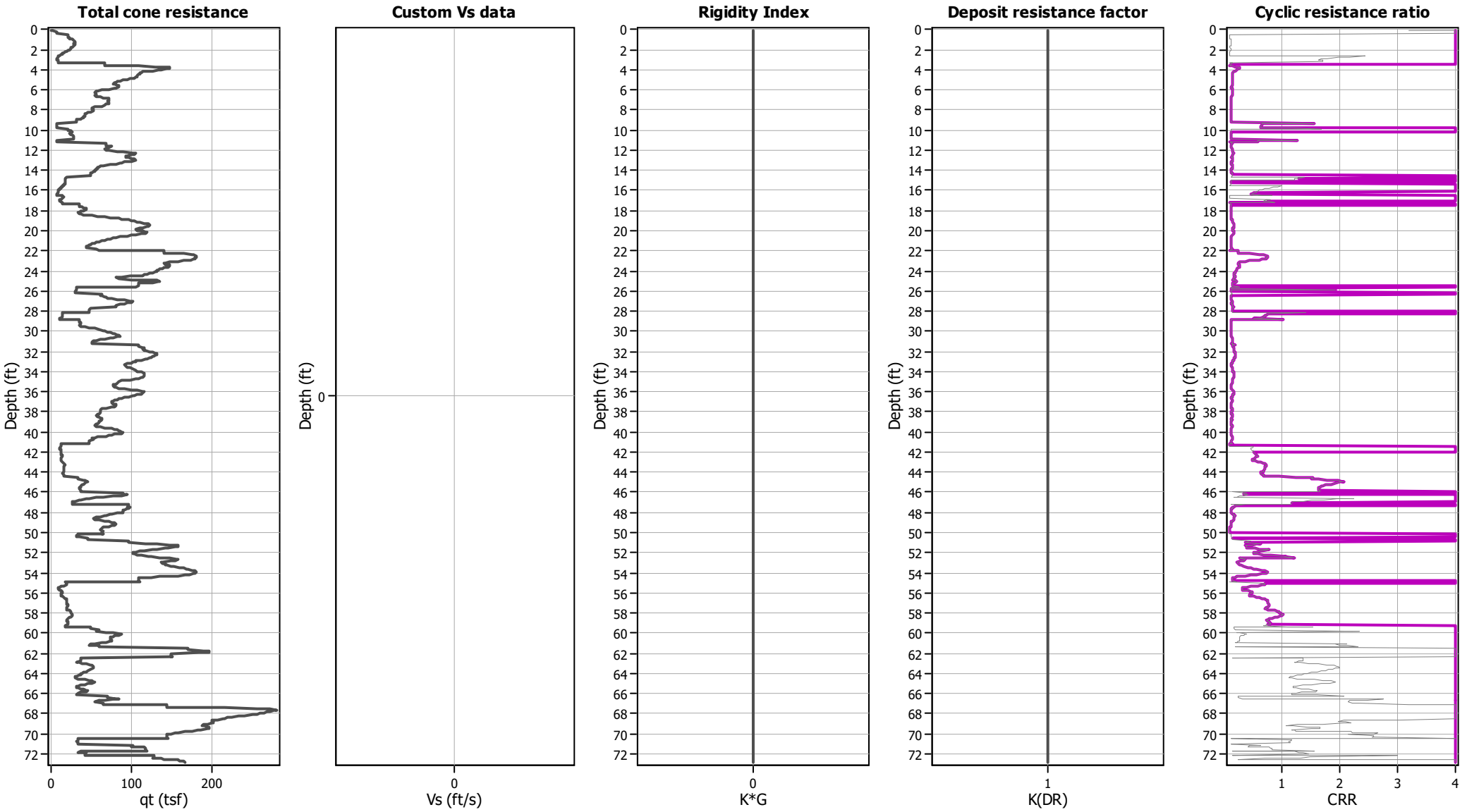
Estimation of post-earthquake settlements



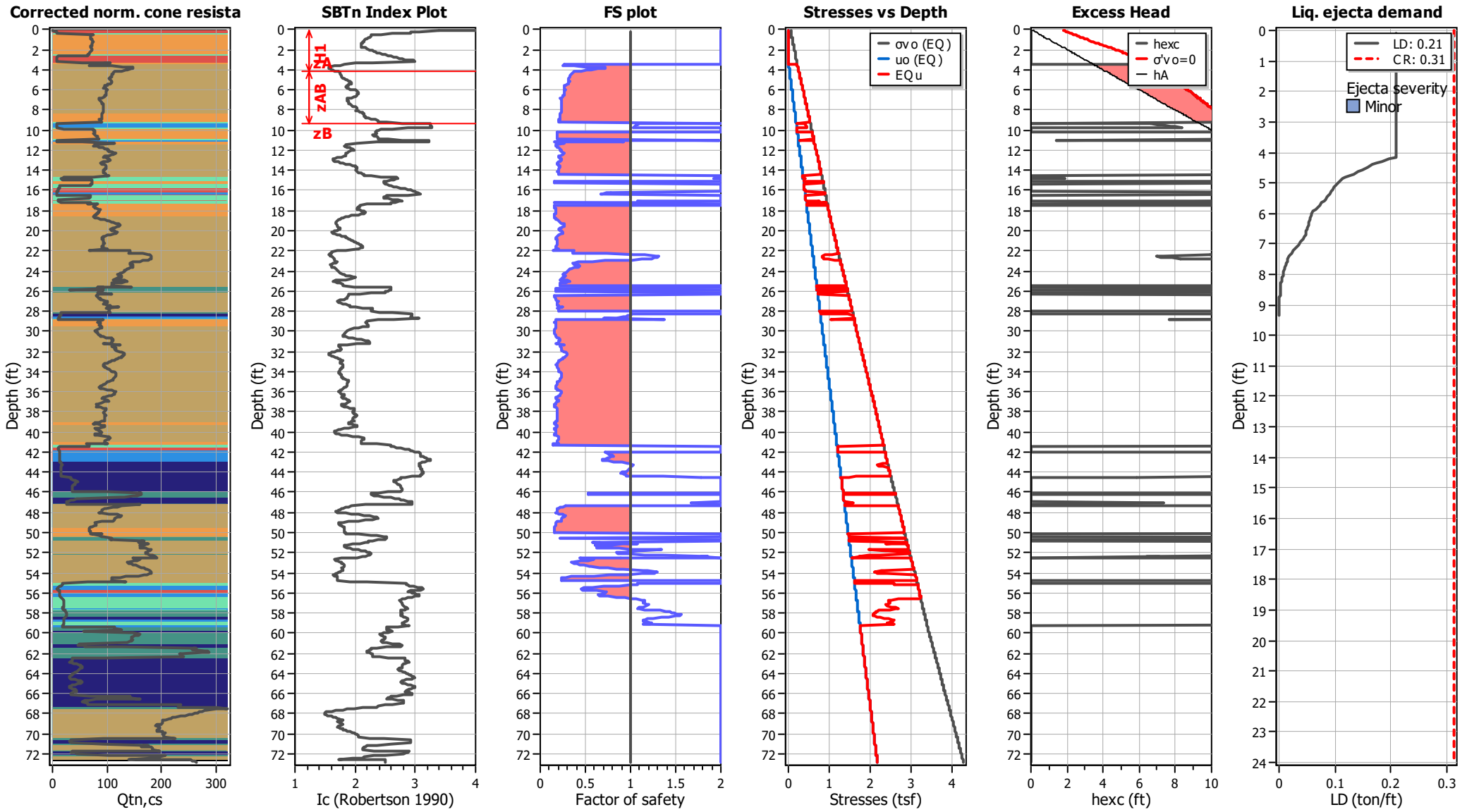
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

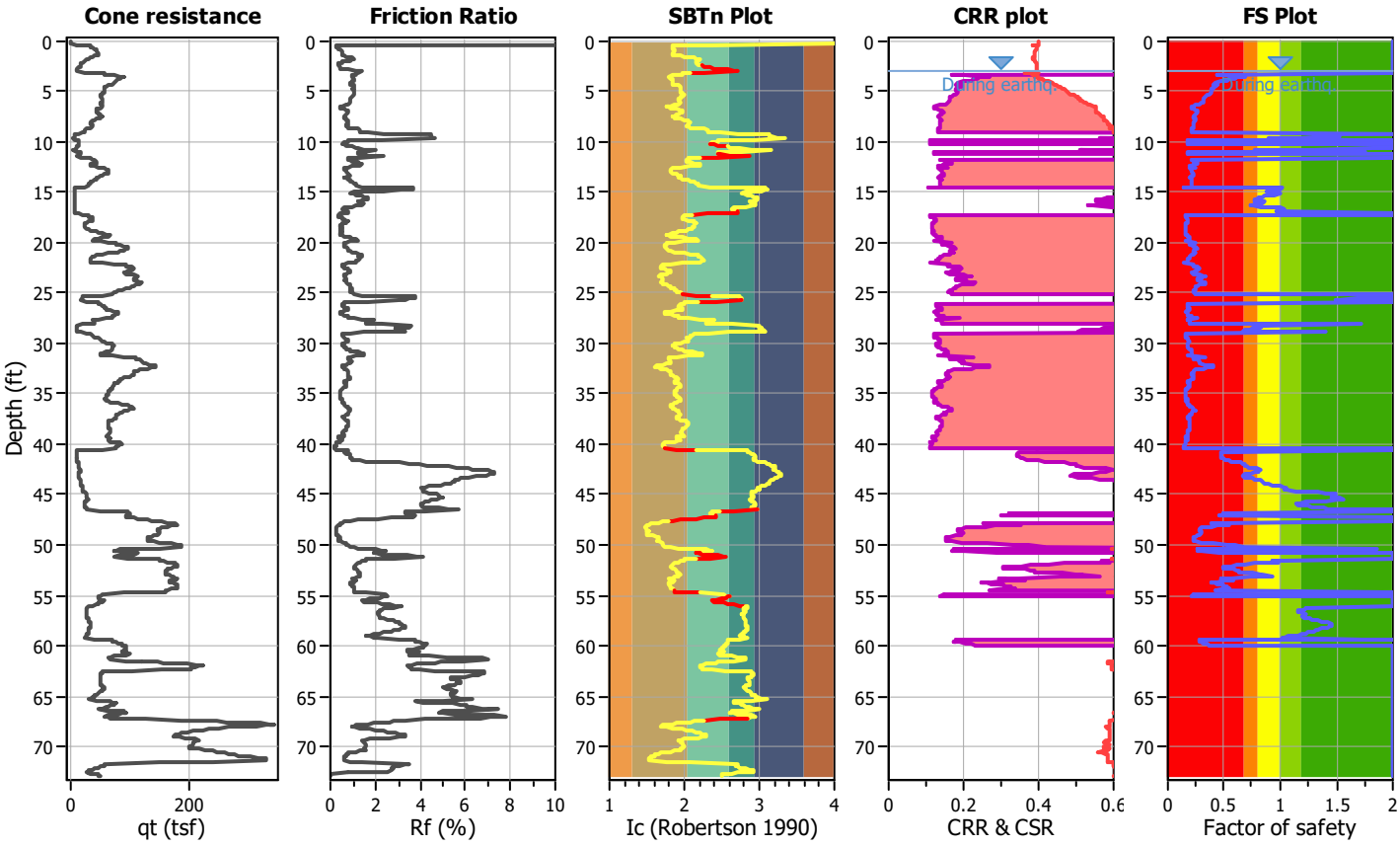
Project title : Topgolf Harbor Island

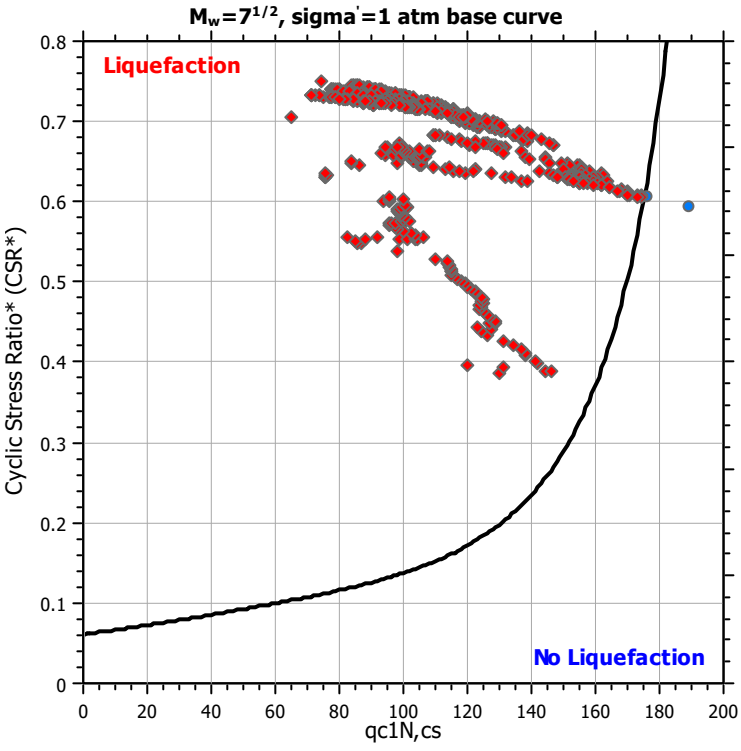
Location : North Harbor Drive and Liberator Way, San Diego, CA

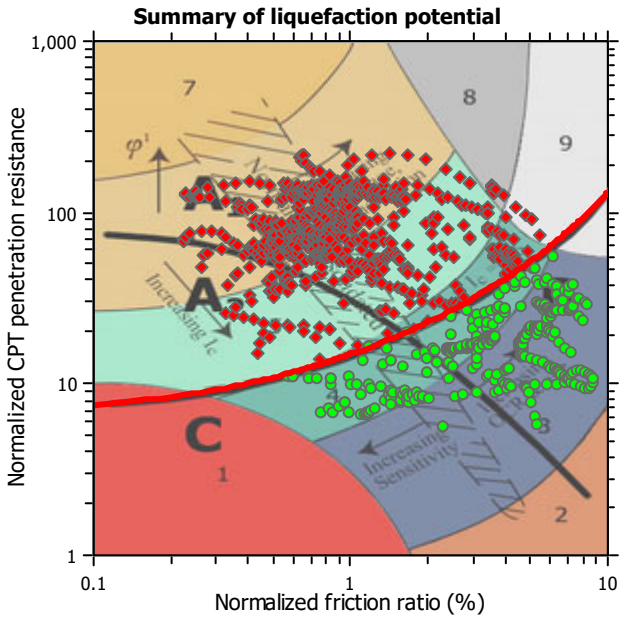
CPT file : CPT-32 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.13 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

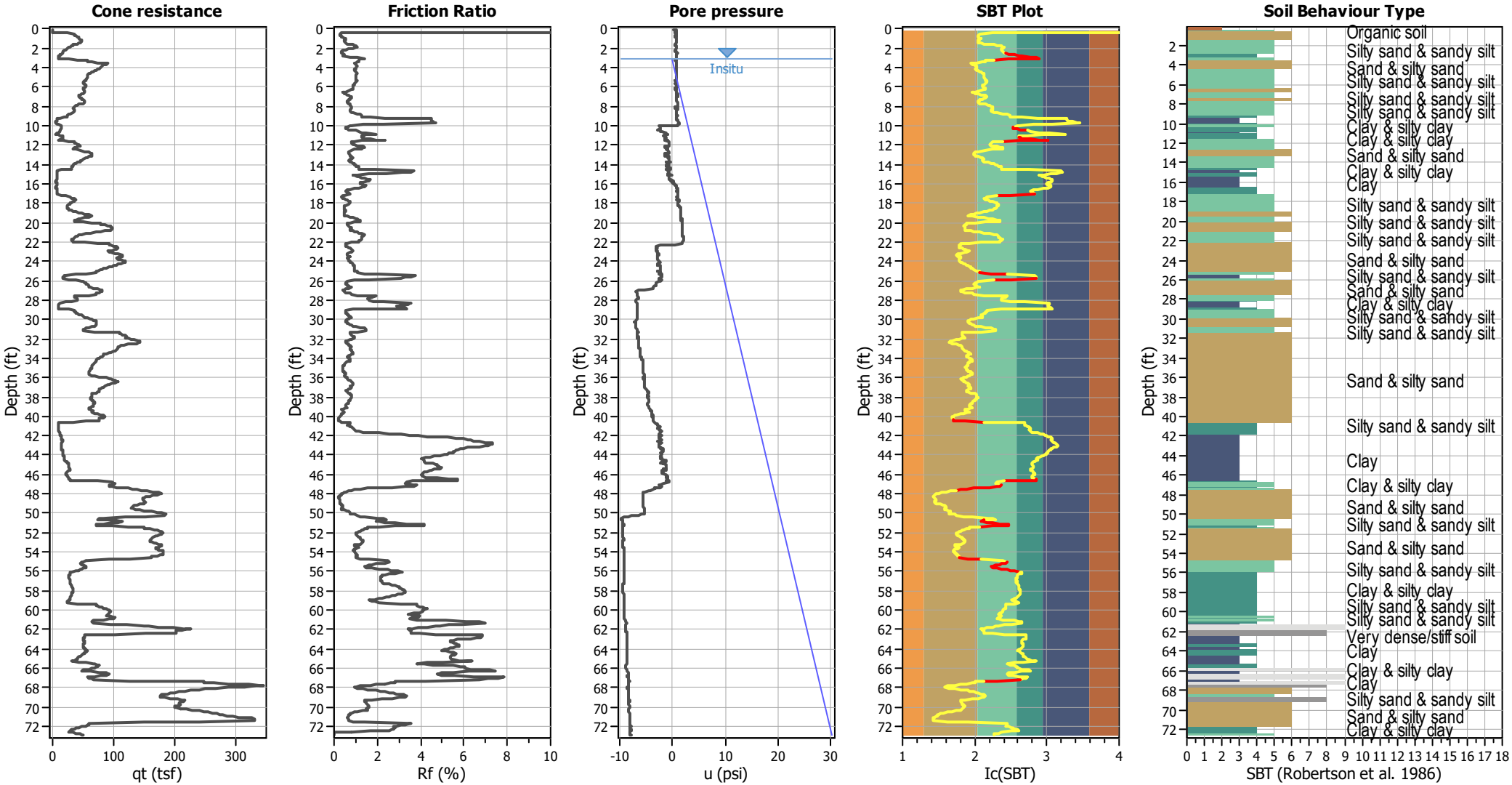






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



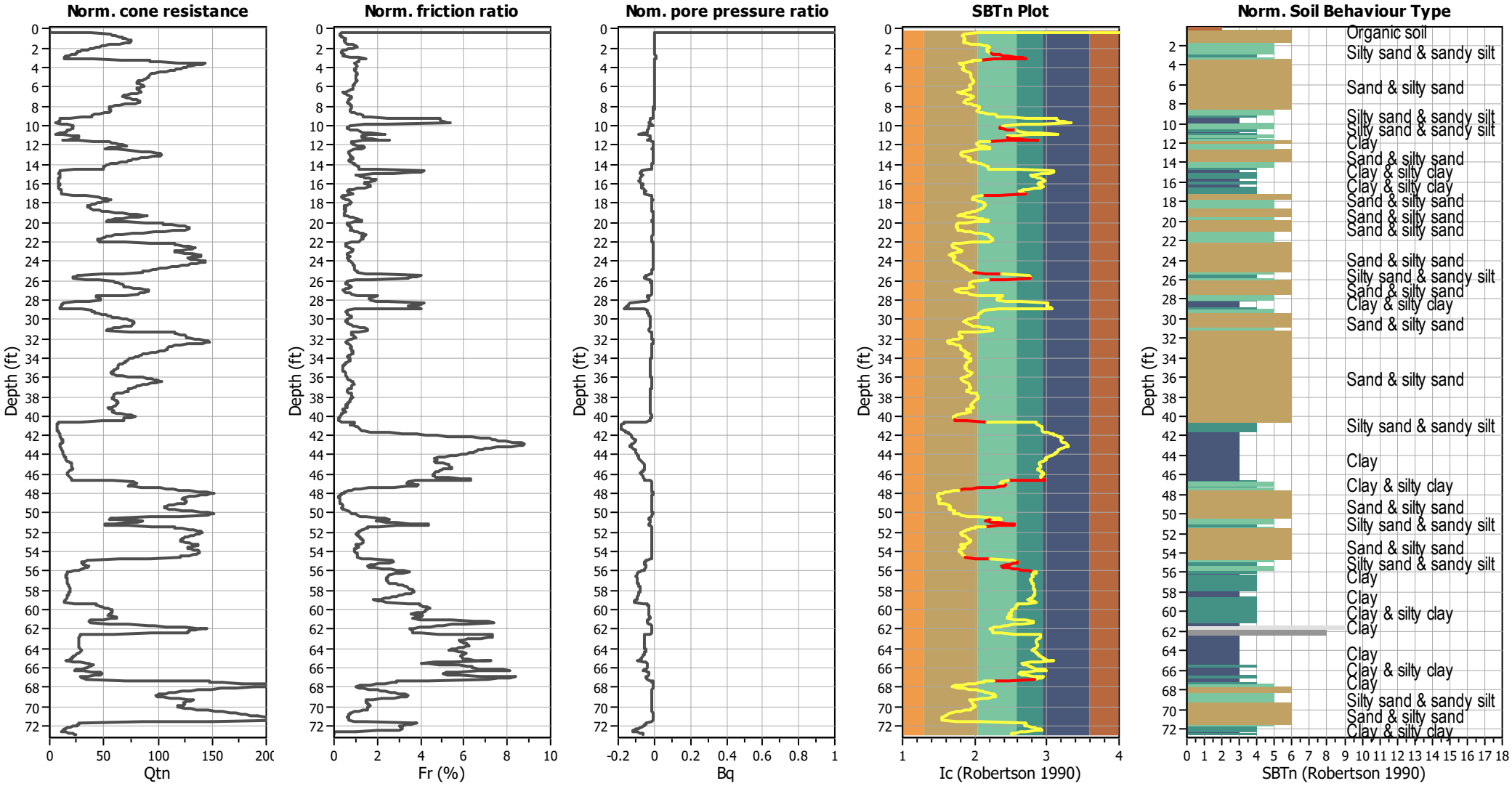
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	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)



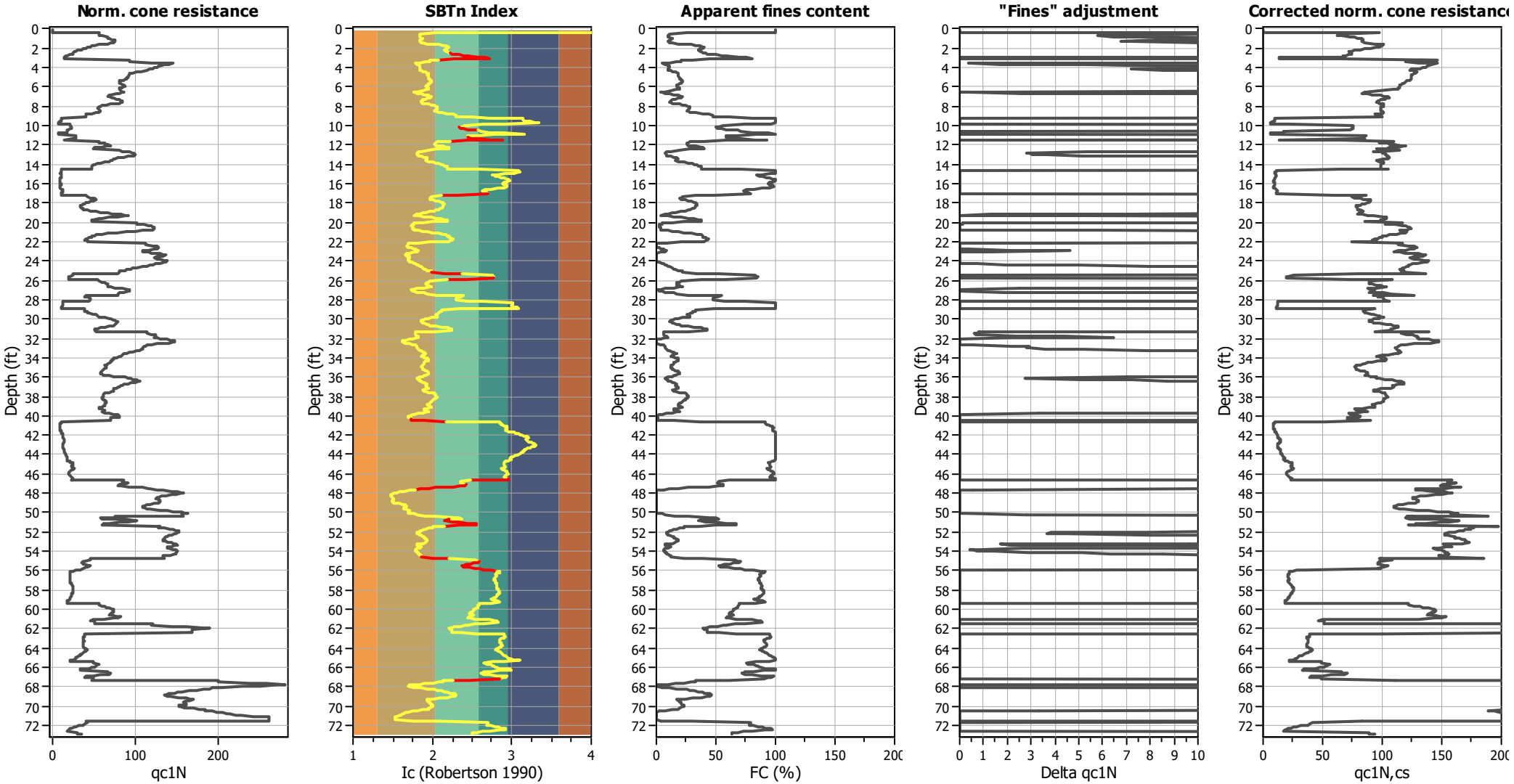
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	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

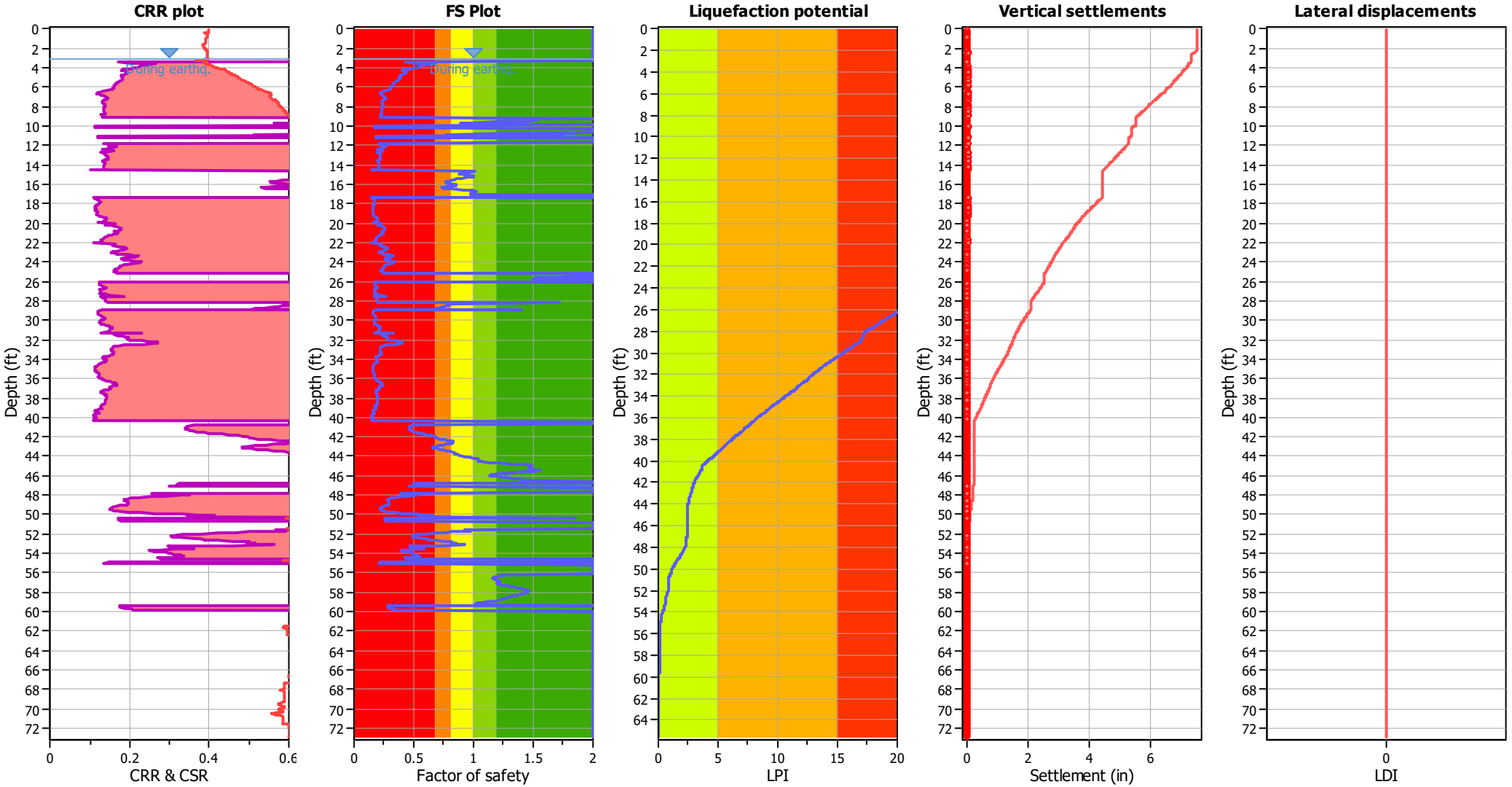
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	Limit depth:	60.00 ft

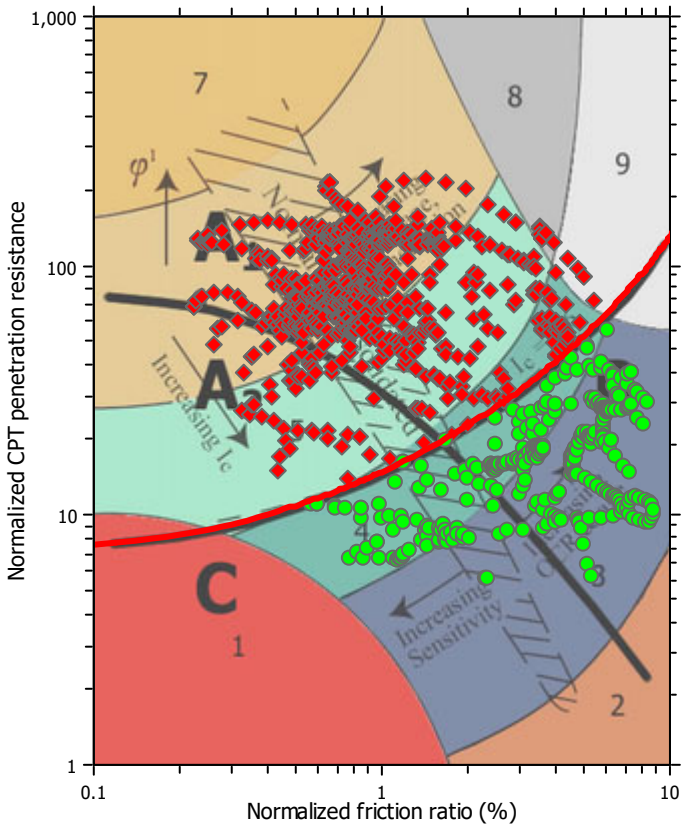
F.S. color scheme

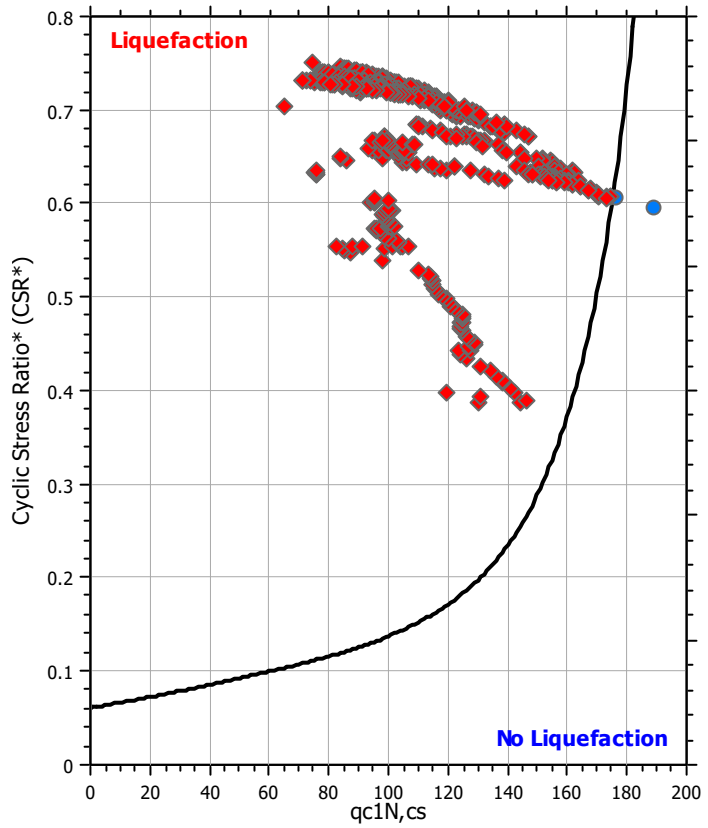
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

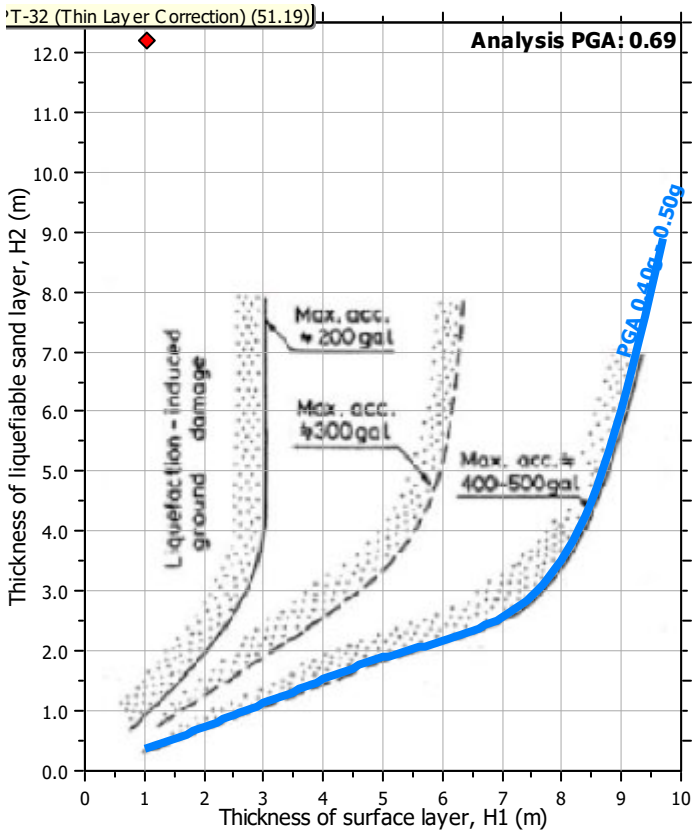
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



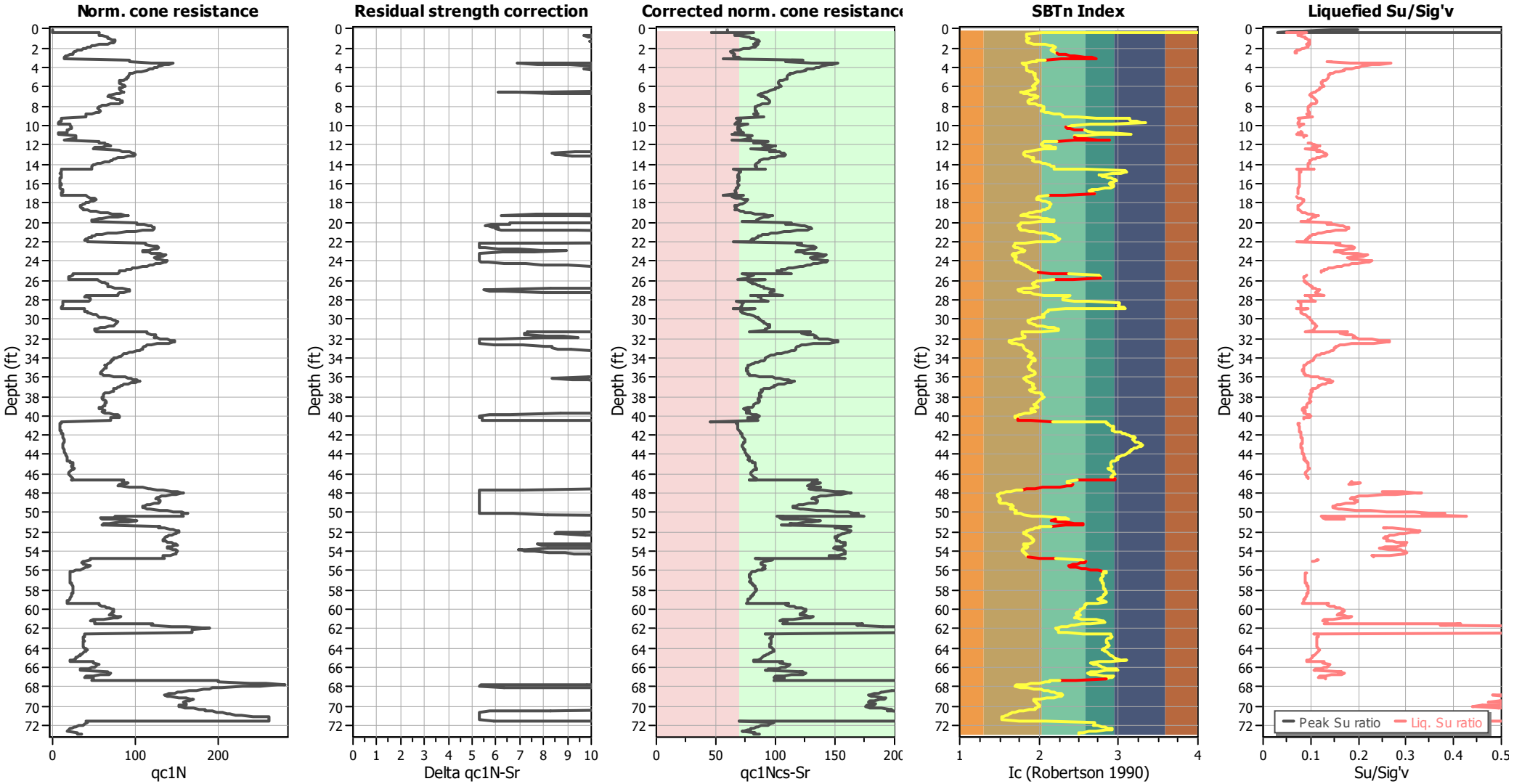




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

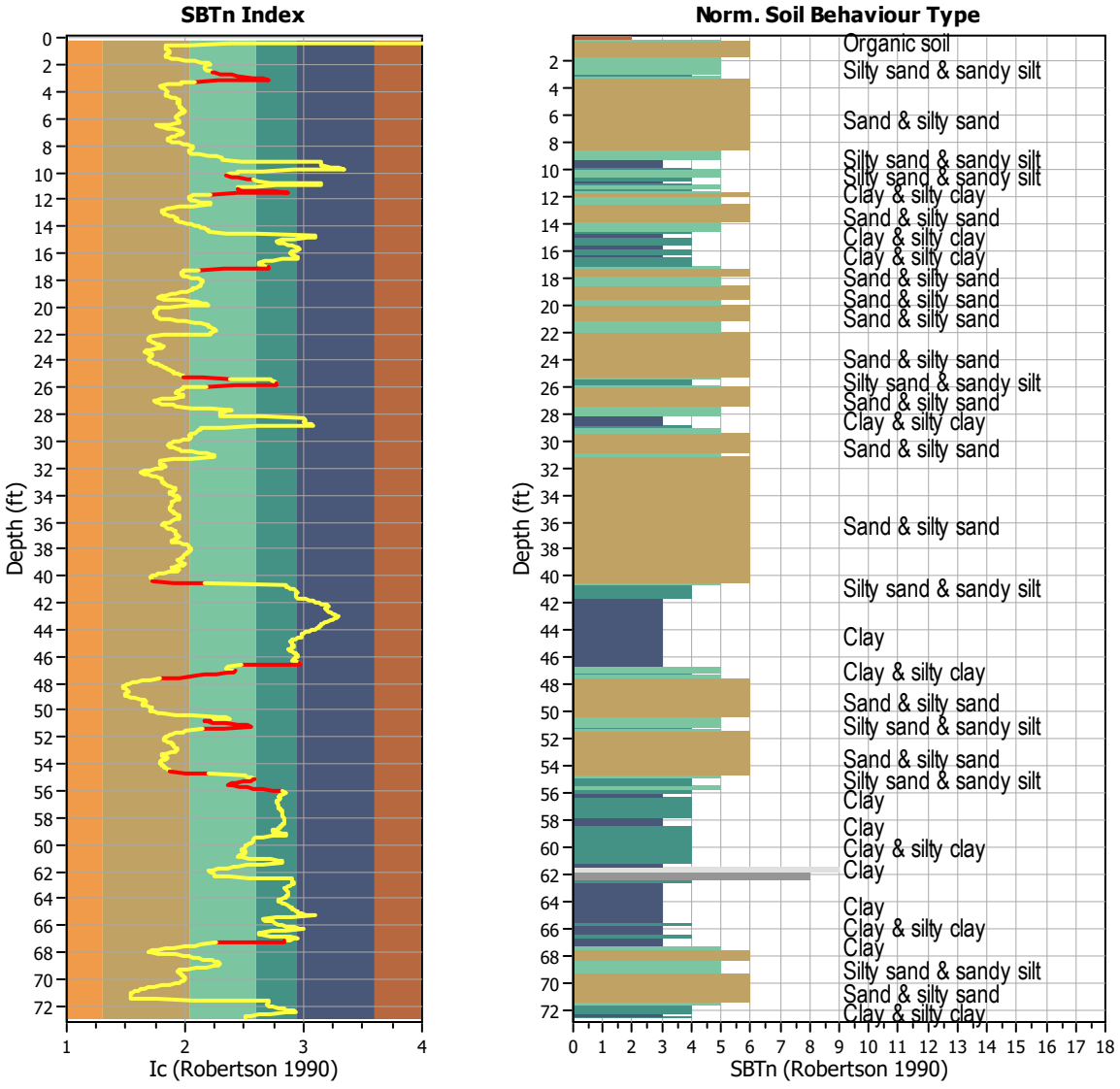
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.13 ft	Fill height:	N/A	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

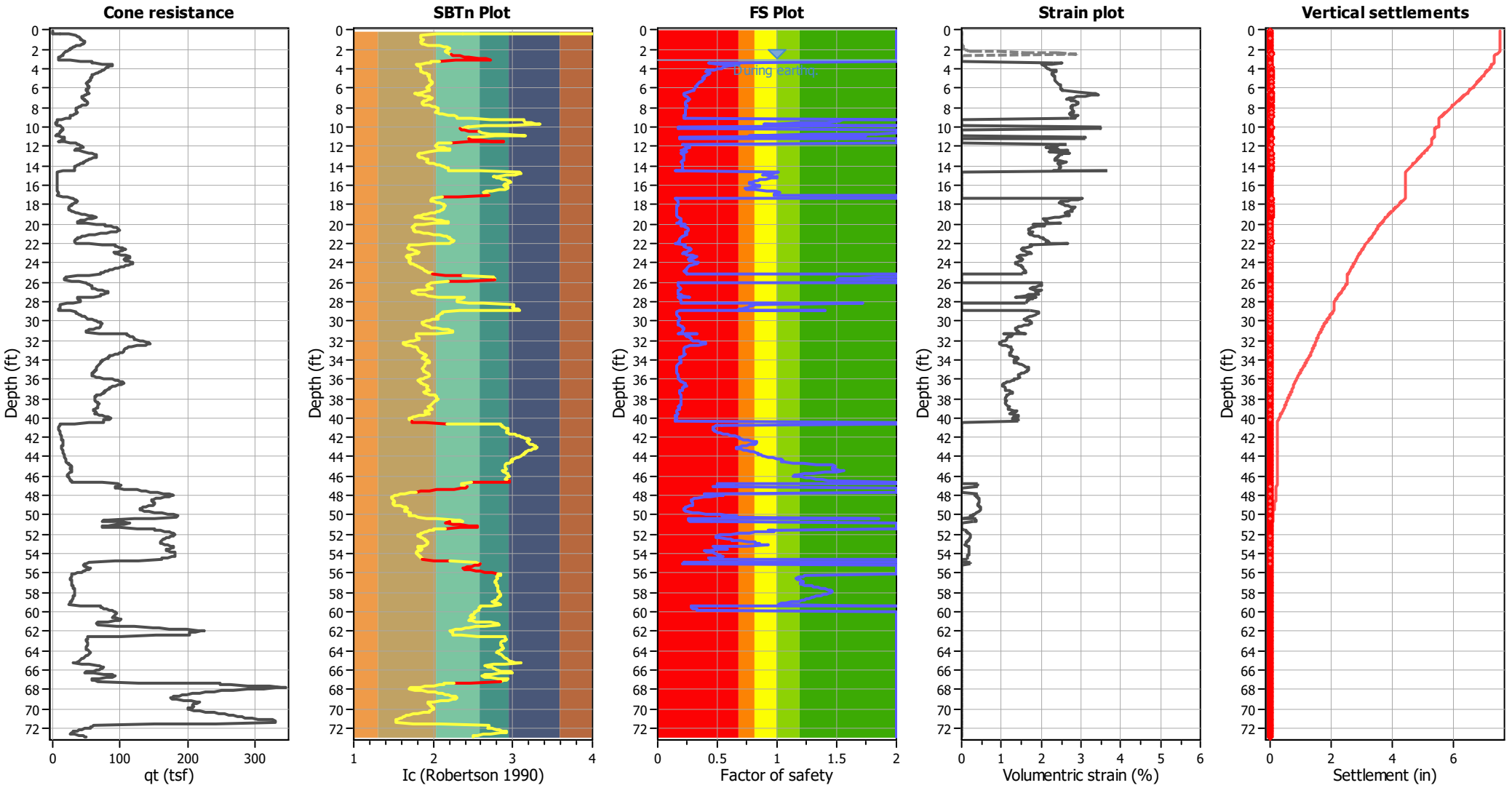
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1111
I_c maximum check value:	3.00	Total points excluded:	91
I_c change ratio value:	0.0250	Exclusion percentage:	8.19%
Minimum number of points in layer:	4	Number of layers detected:	17

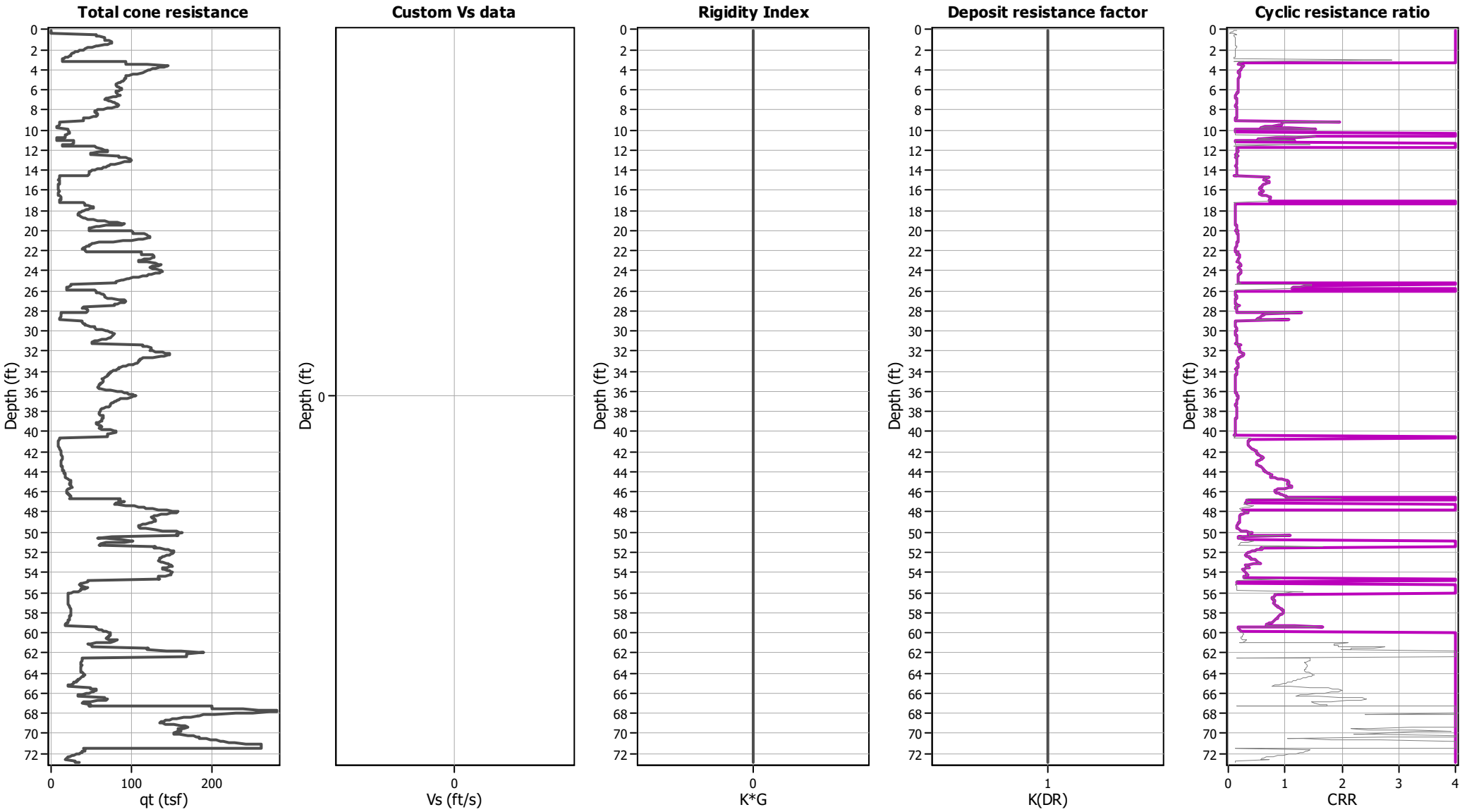
Estimation of post-earthquake settlements



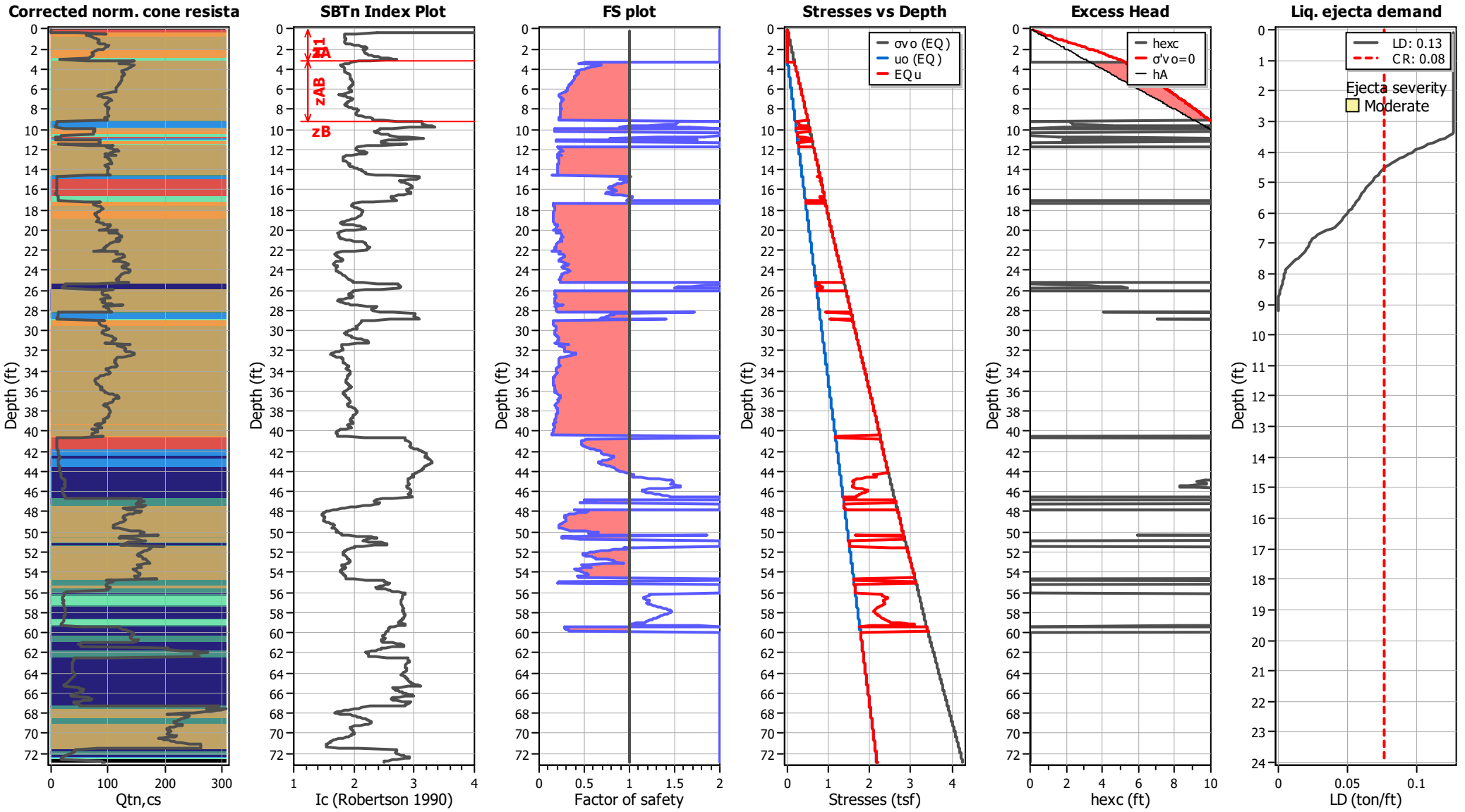
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



NOVA Services, Inc.

LIQUEFACTION ANALYSIS REPORT

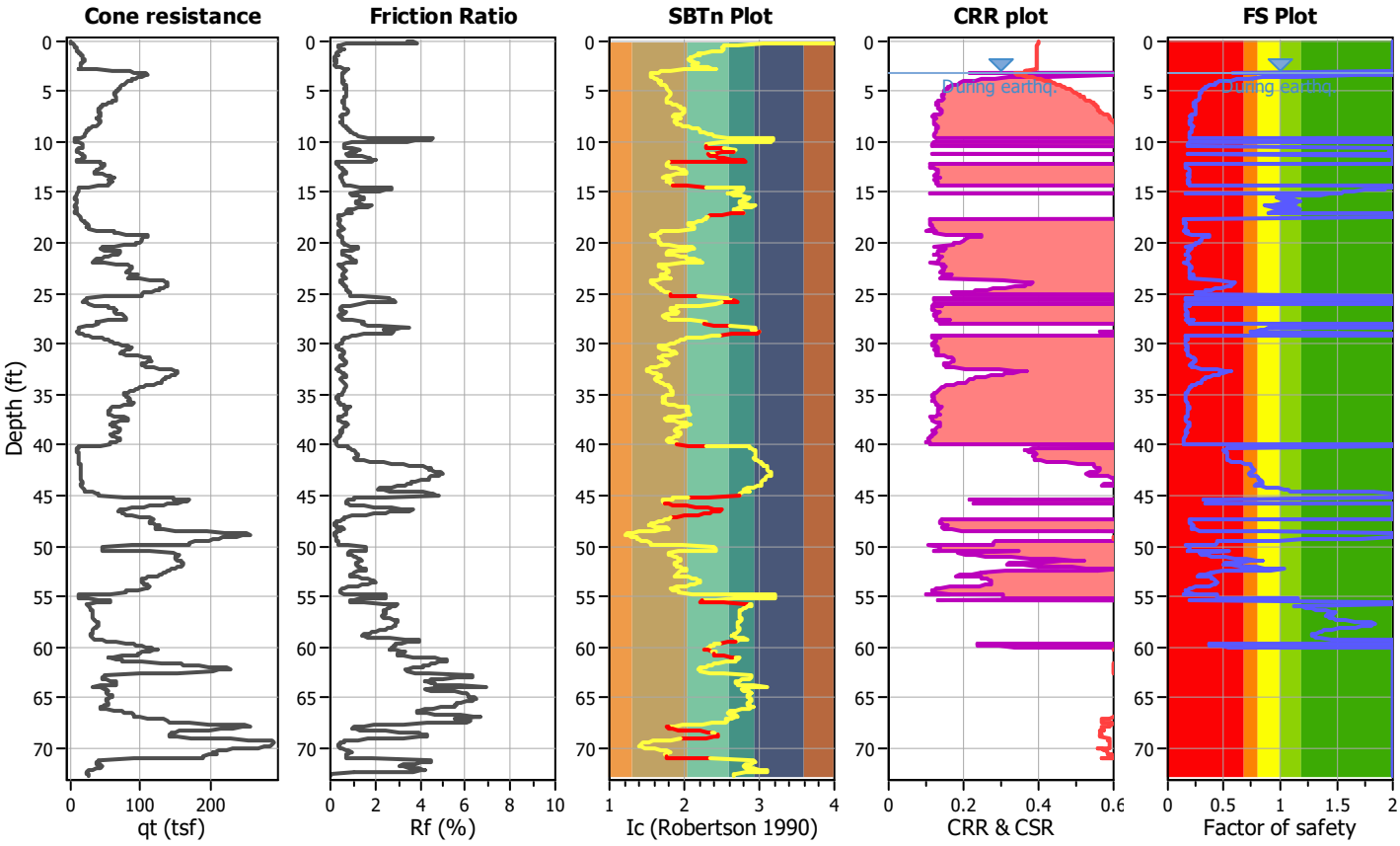
Project title : Topgolf Harbor Island

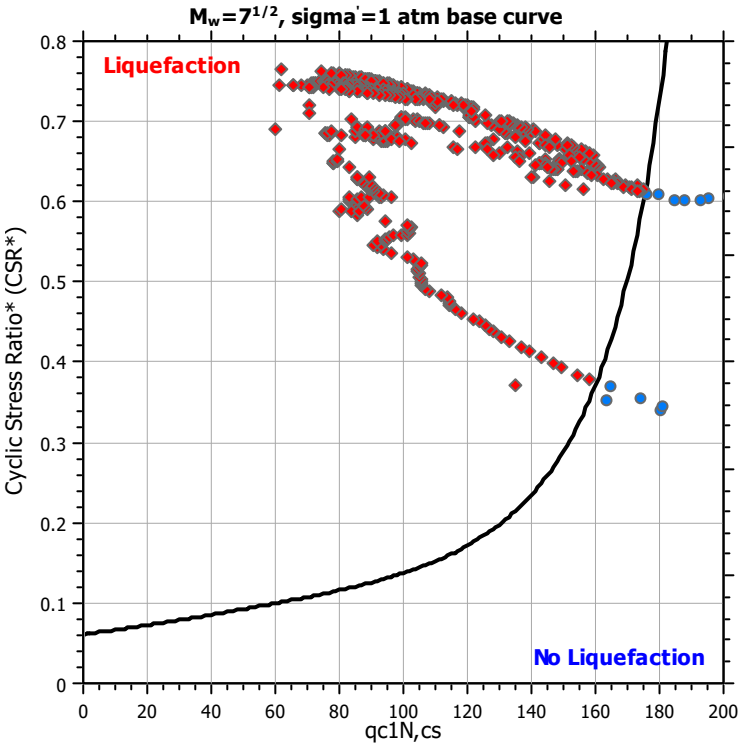
Location : North Harbor Drive and Liberator Way, San Diego, CA

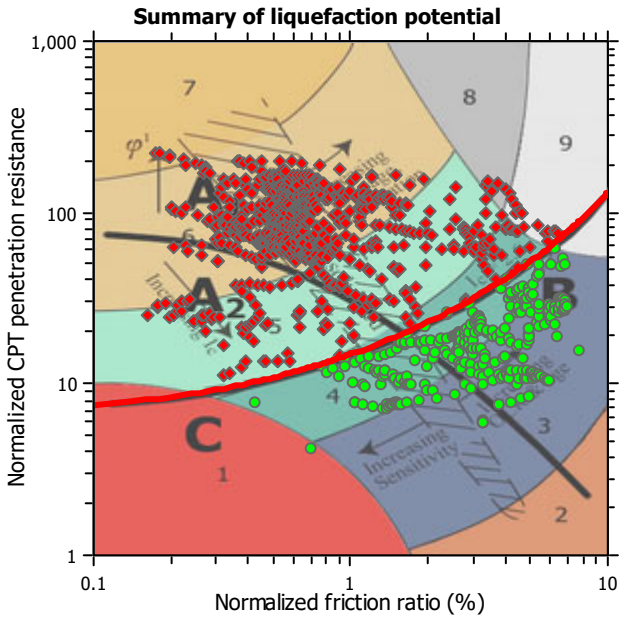
CPT file : CPT-33 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.33 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

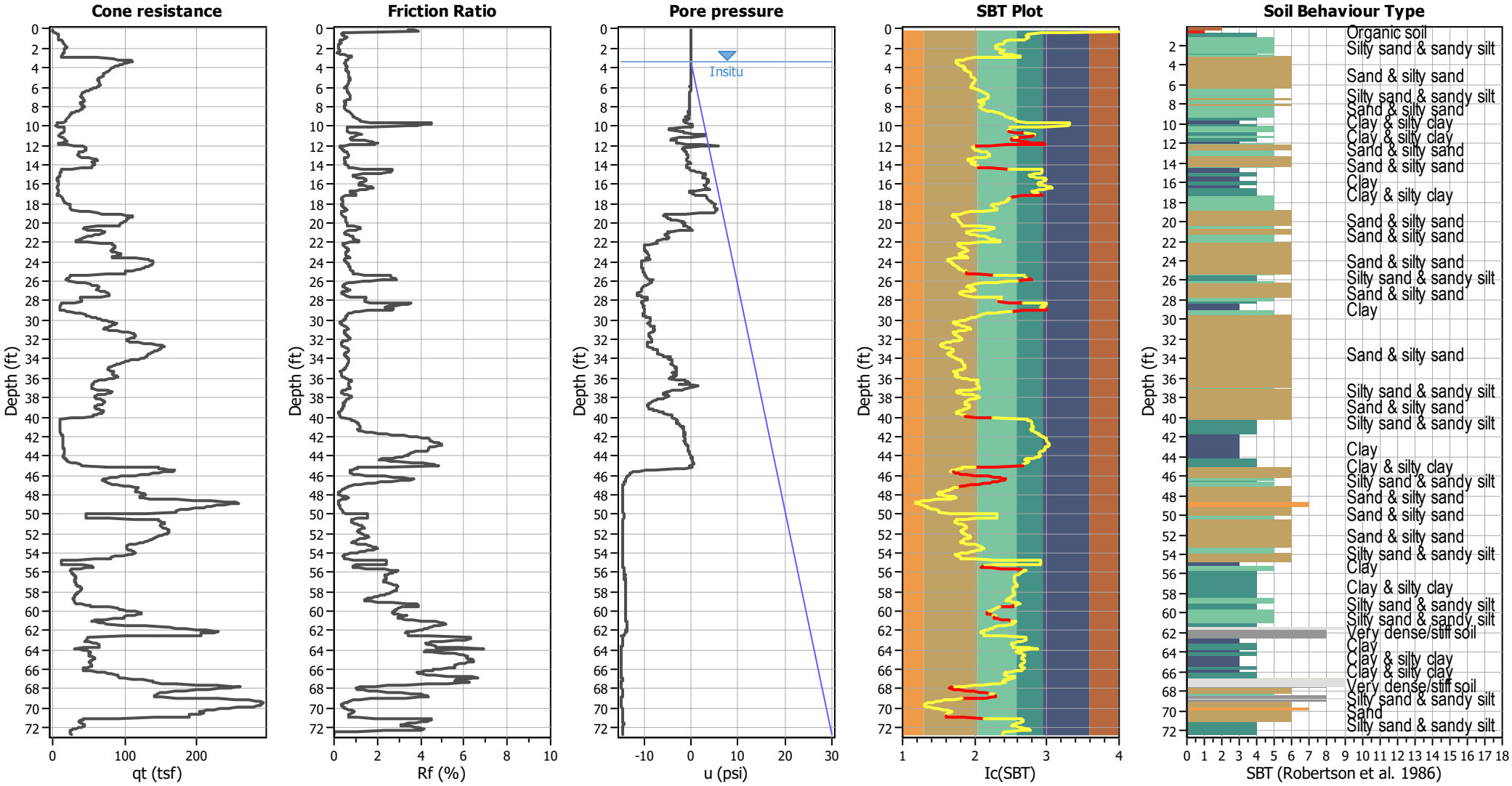






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



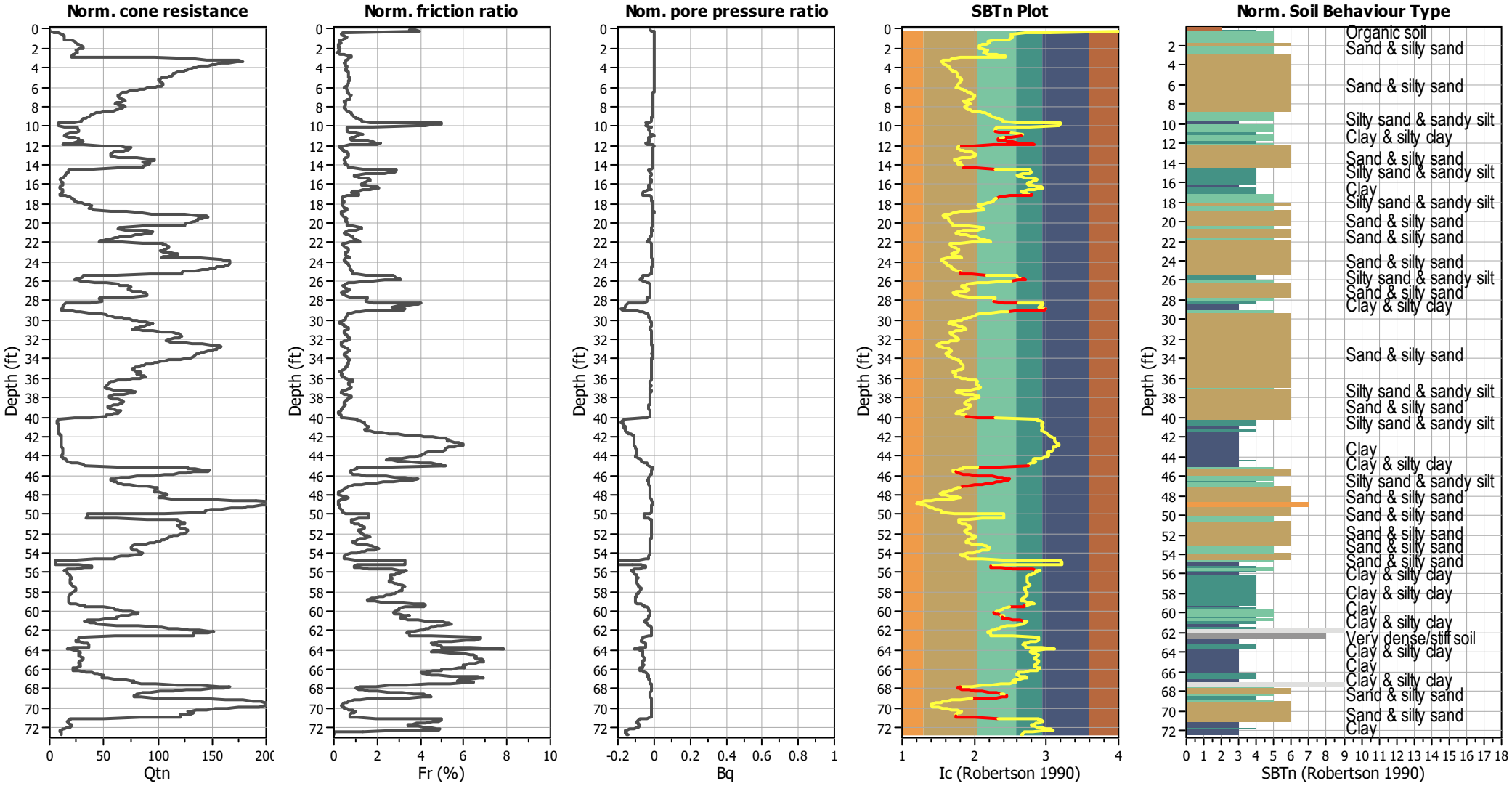
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	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)



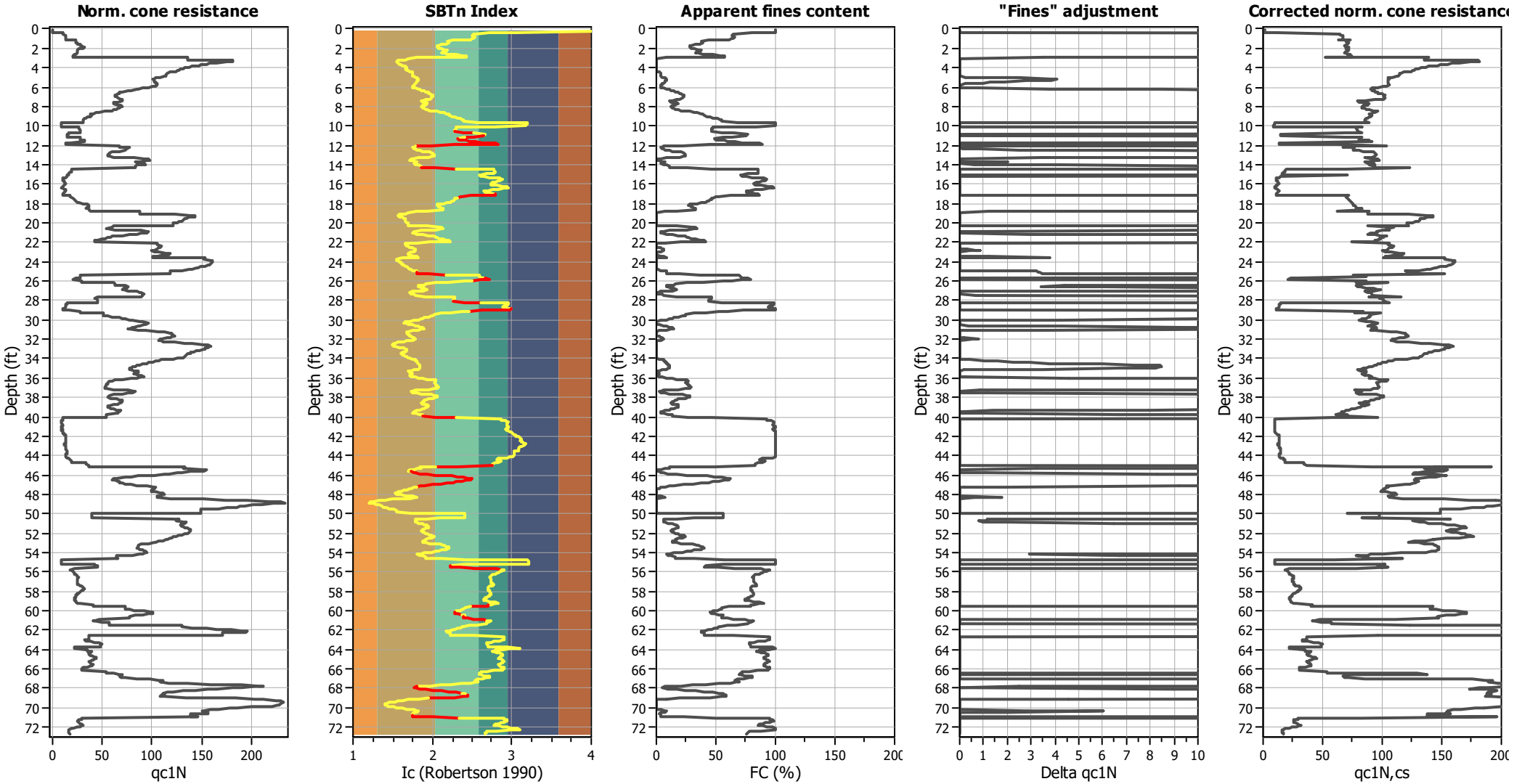
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	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

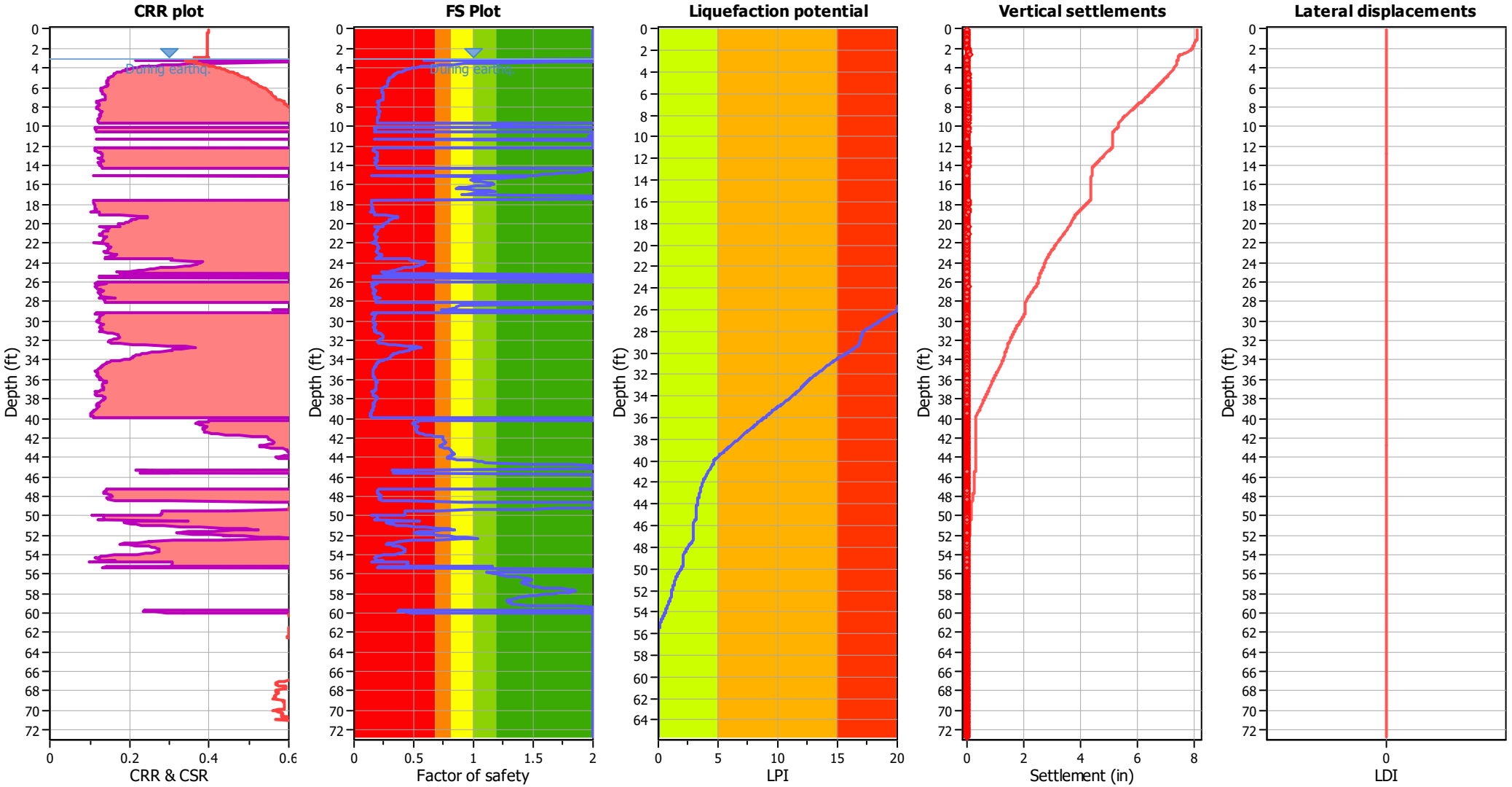
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	Limit depth:	60.00 ft

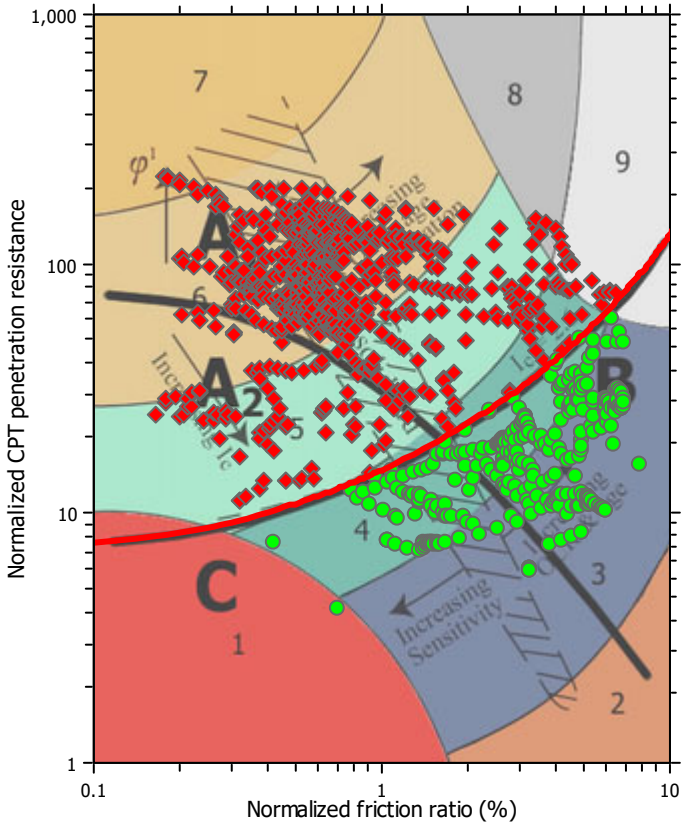
F.S. color scheme

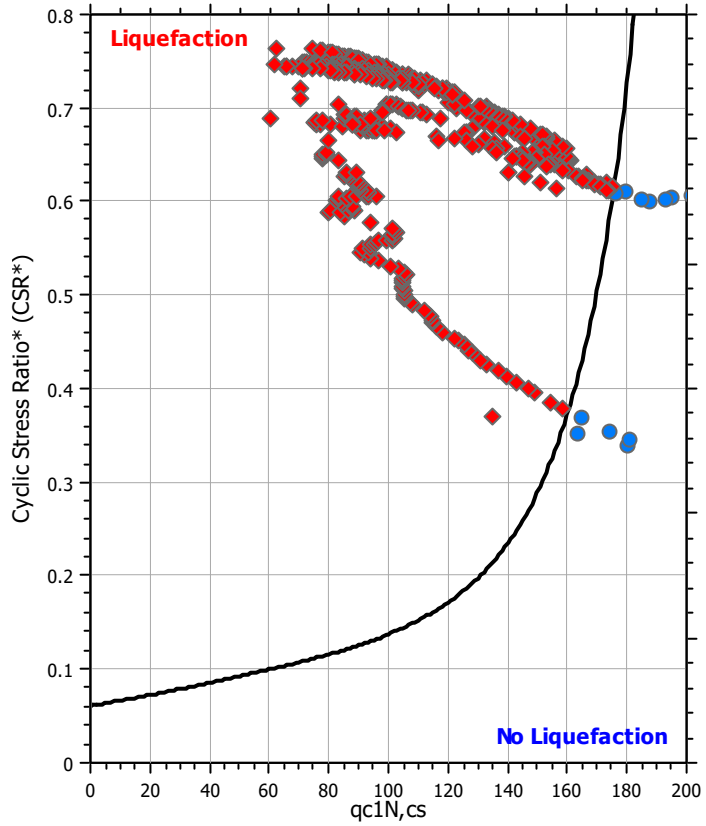
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

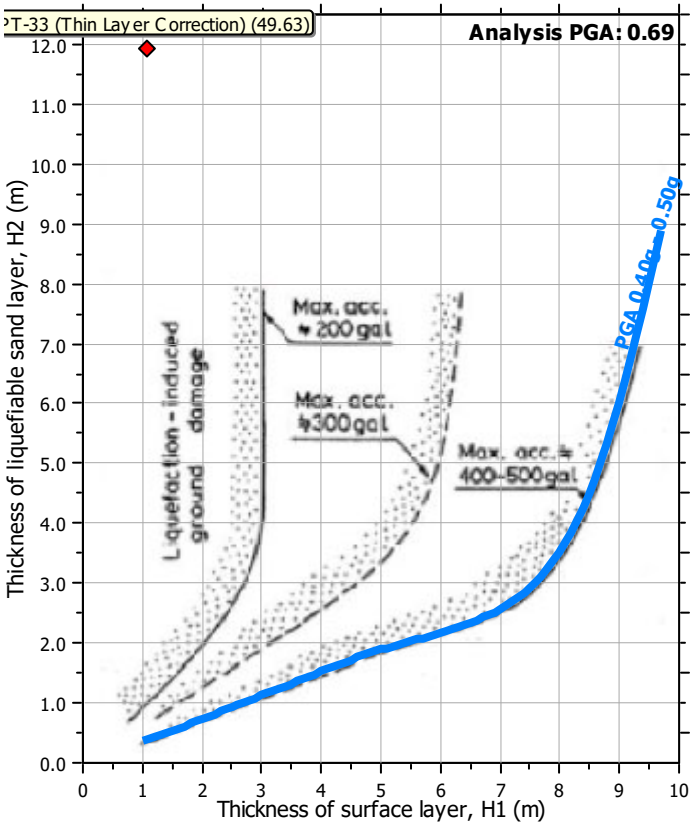
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



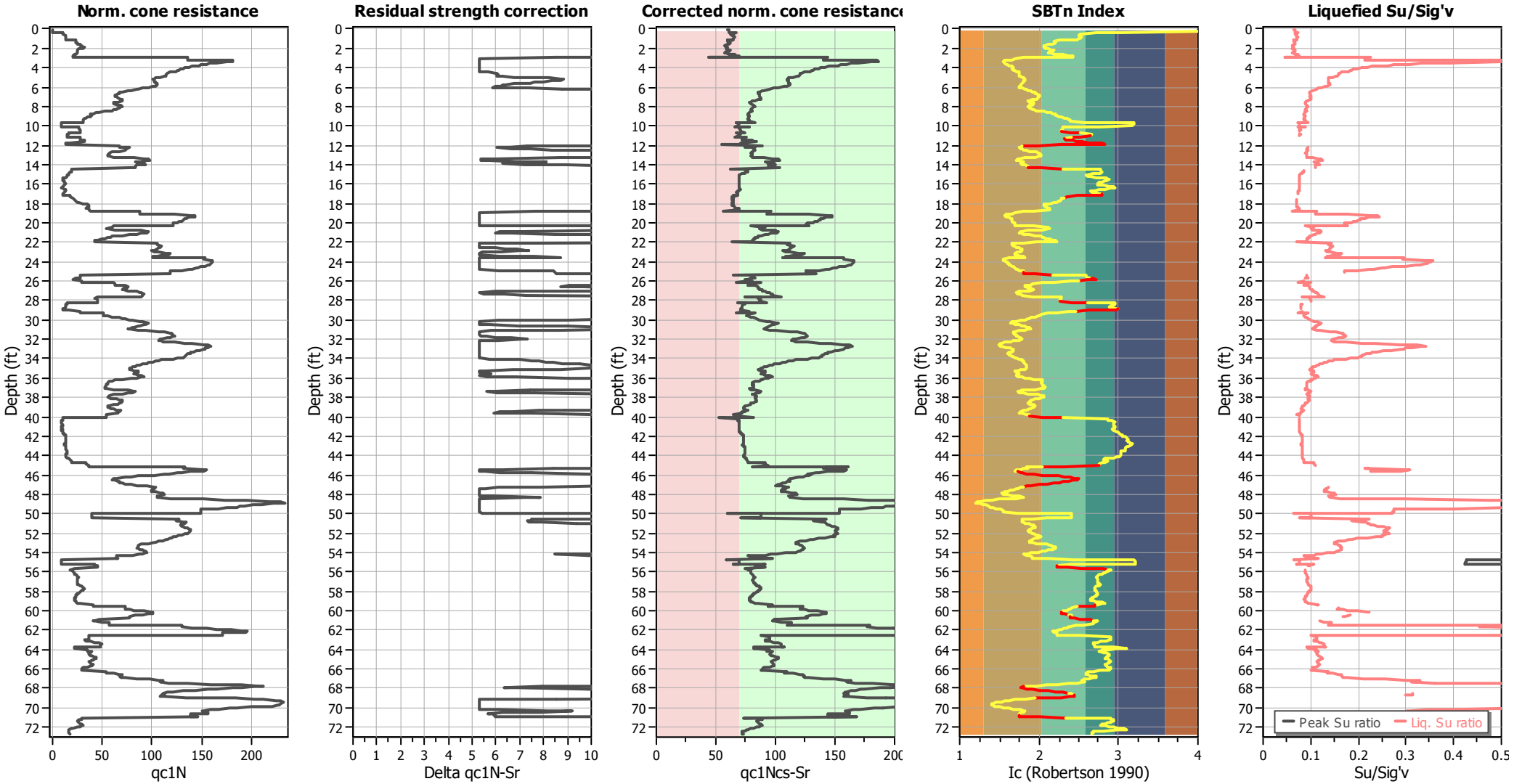




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

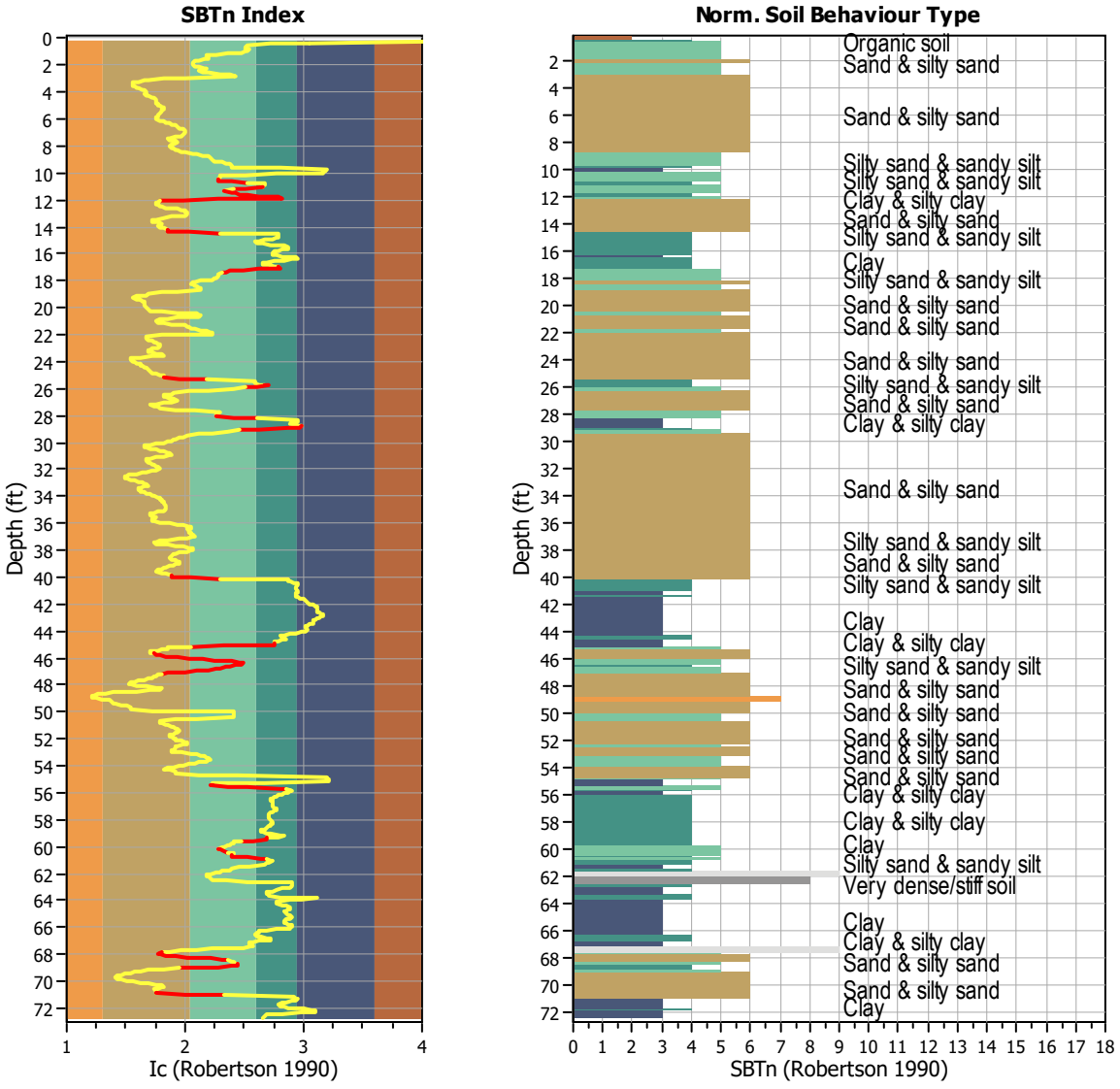
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.33 ft	Fill height:	N/A	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

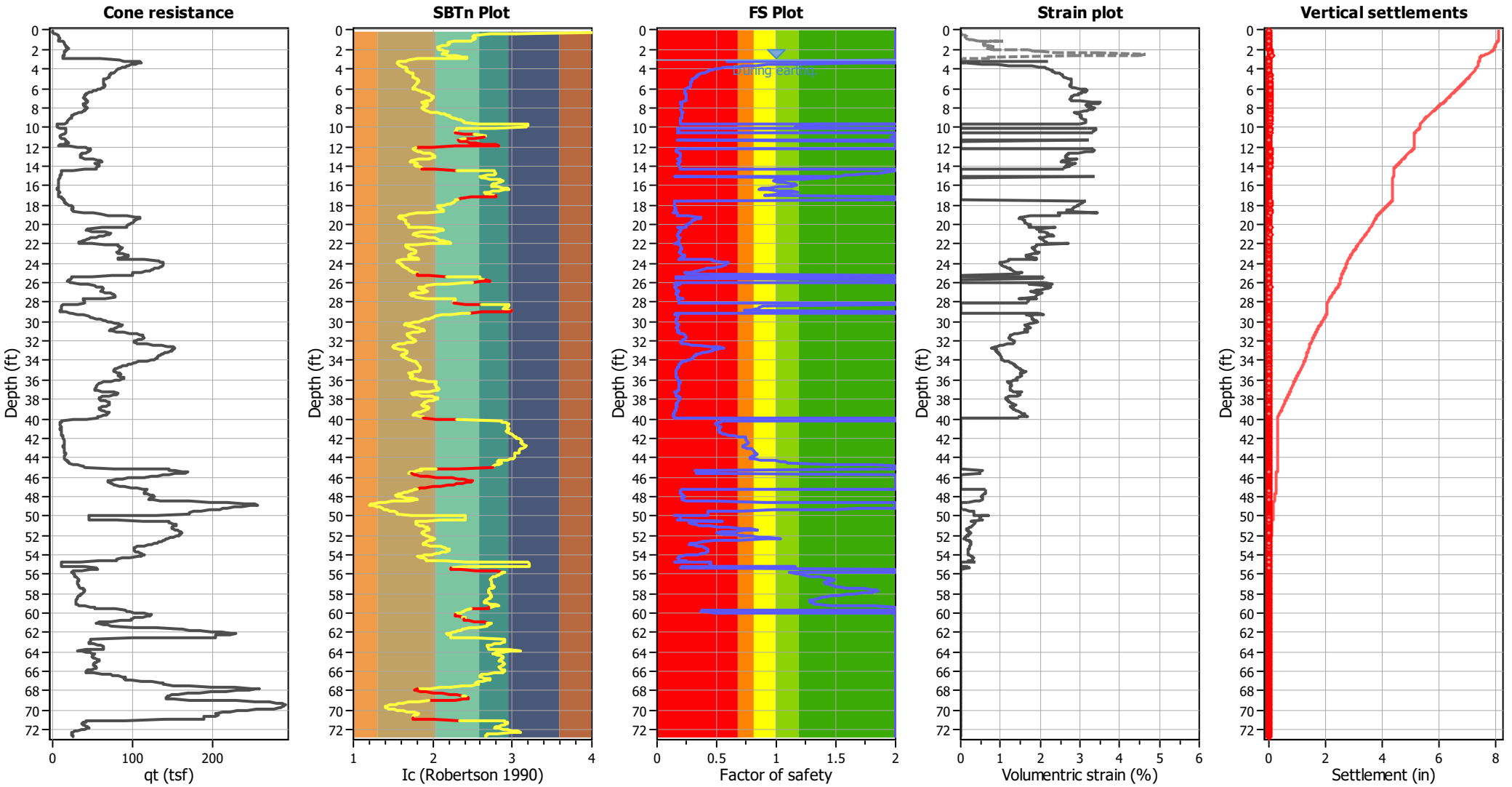
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	122
I_c change ratio value:	0.0250	Exclusion percentage:	11.01%
Minimum number of points in layer:	4	Number of layers detected:	21

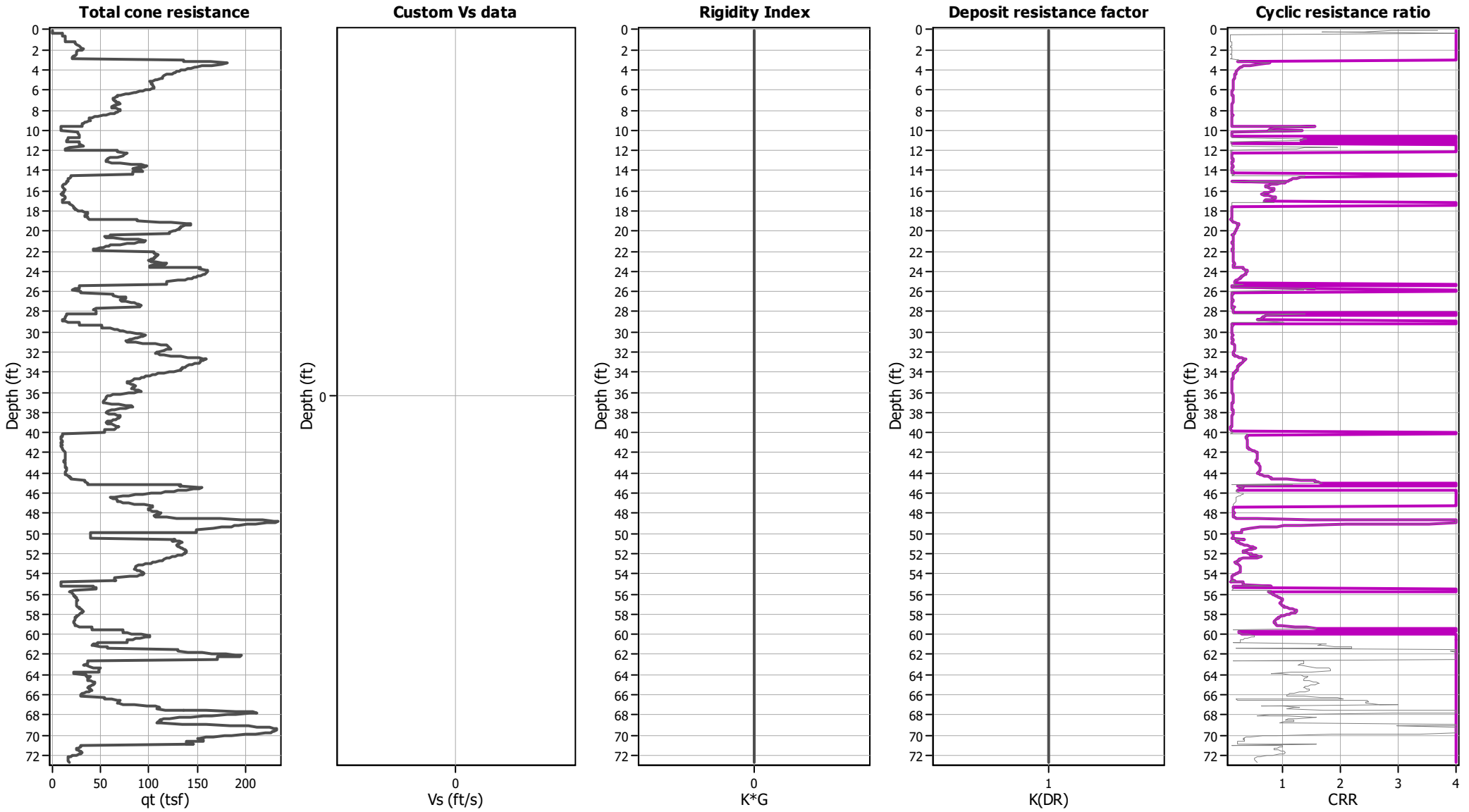
Estimation of post-earthquake settlements



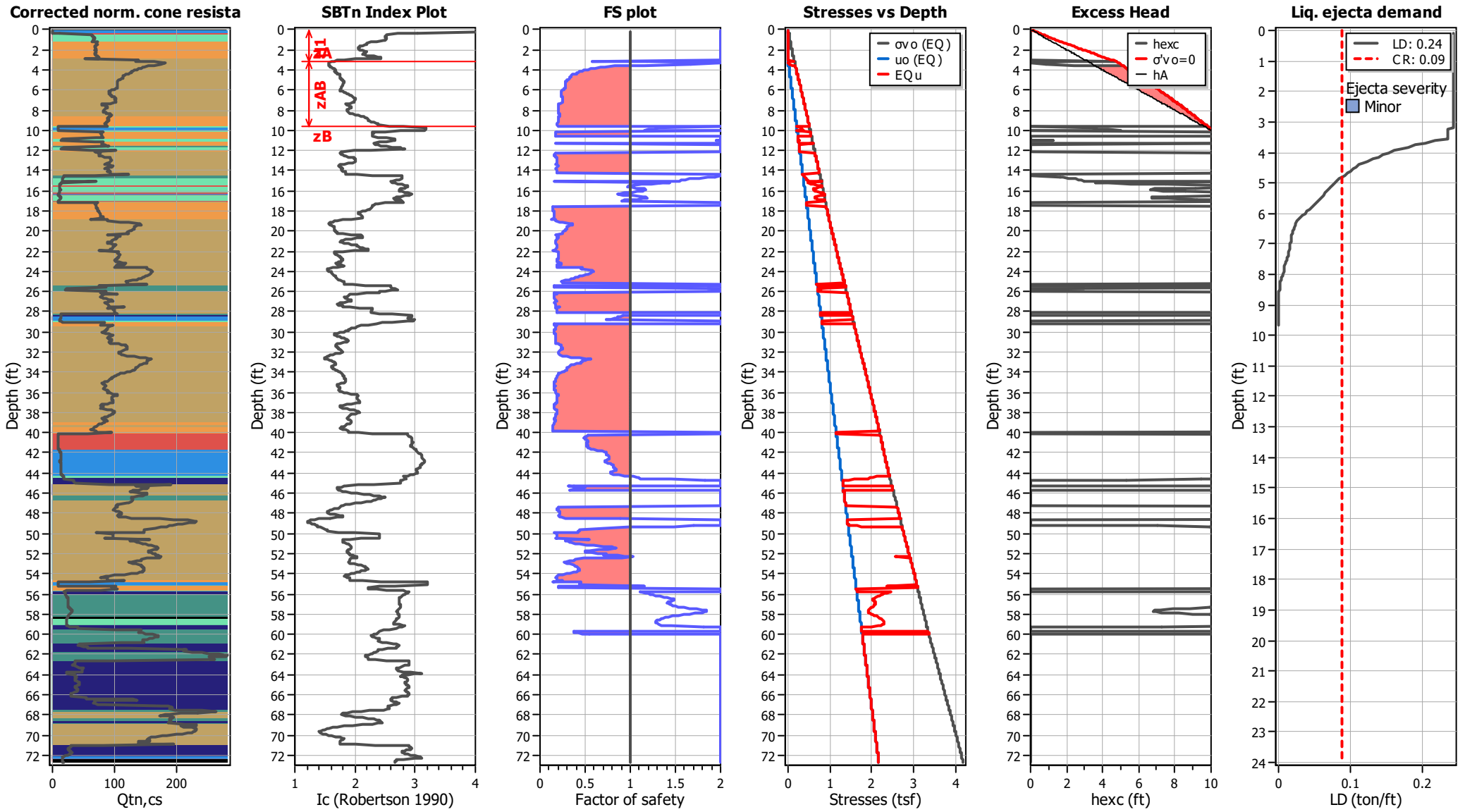
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

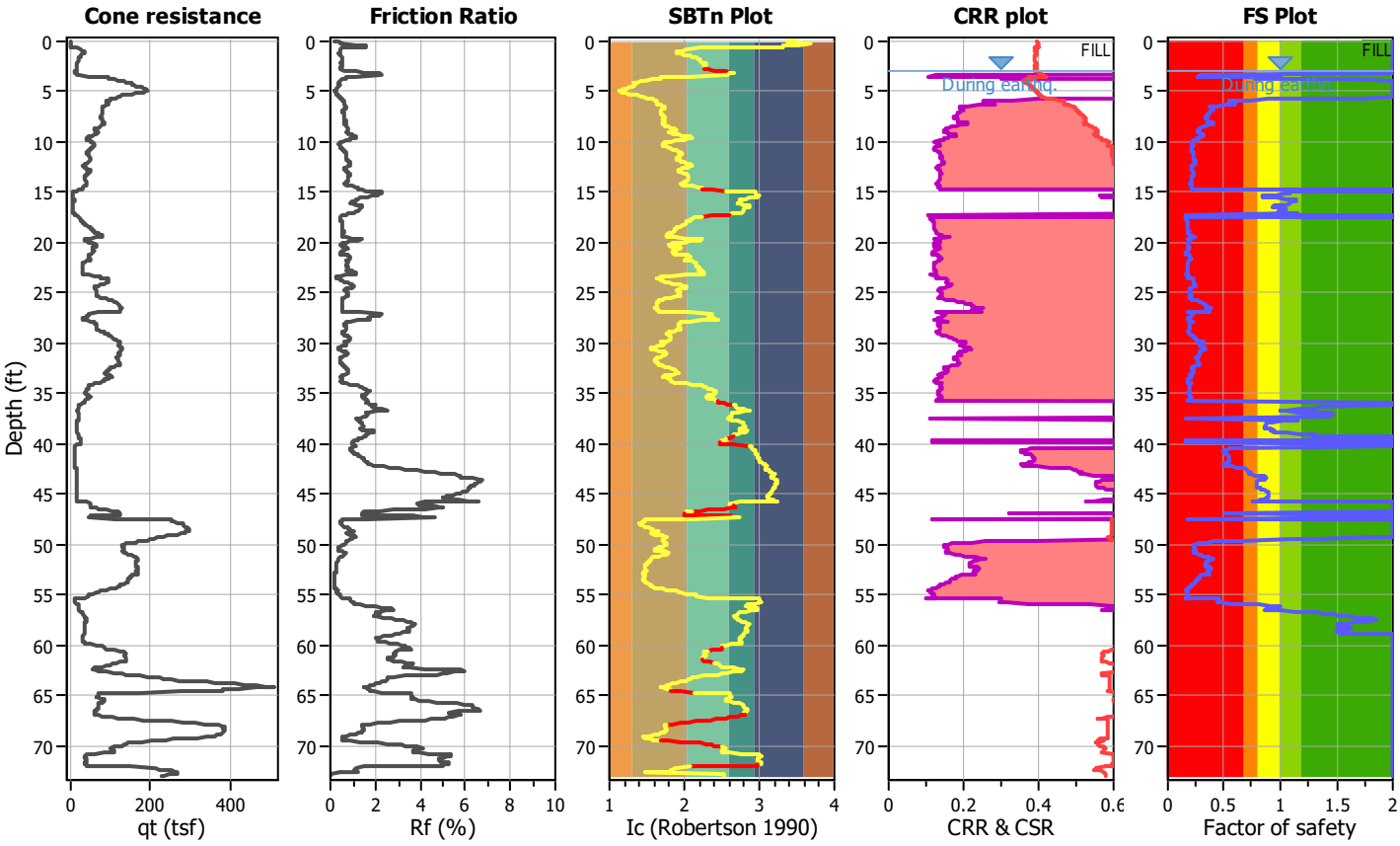
Project title : Topgolf Harbor Island

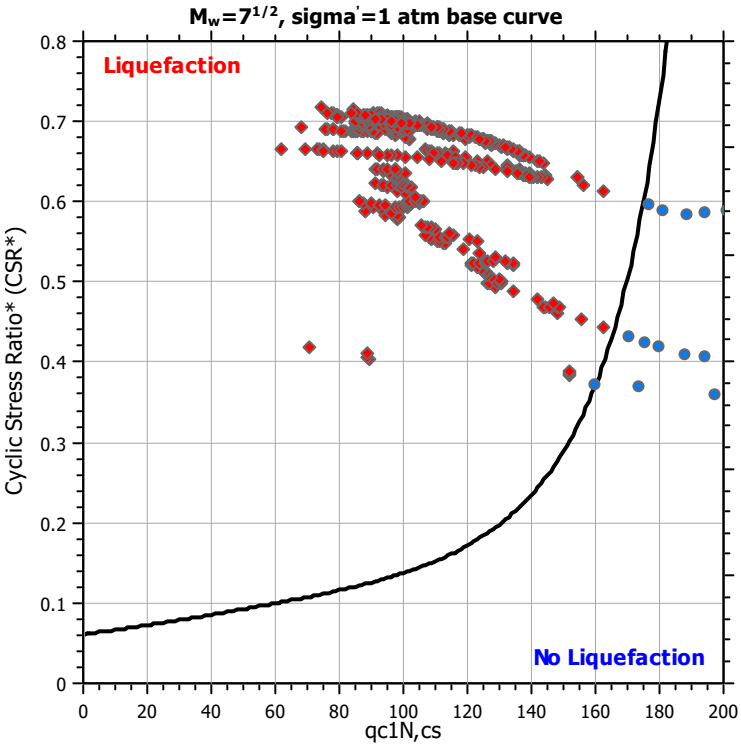
Location : North Harbor Drive and Liberator Way, San Diego, CA

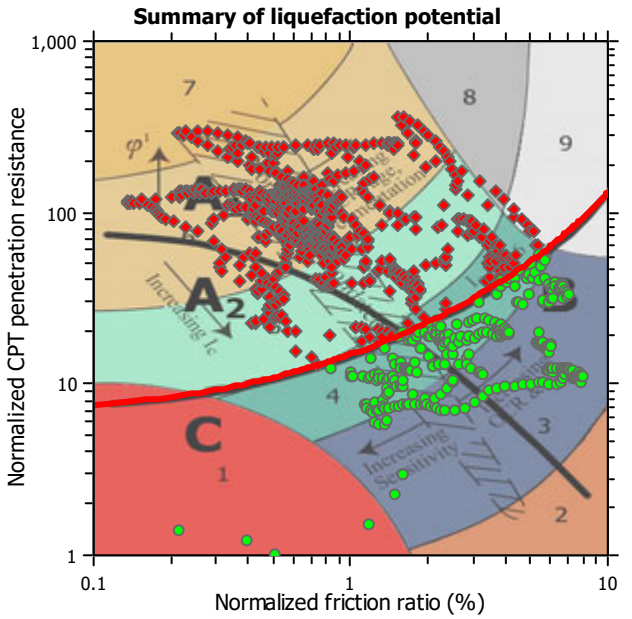
CPT file : CPT-35 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.04 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	1.08 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

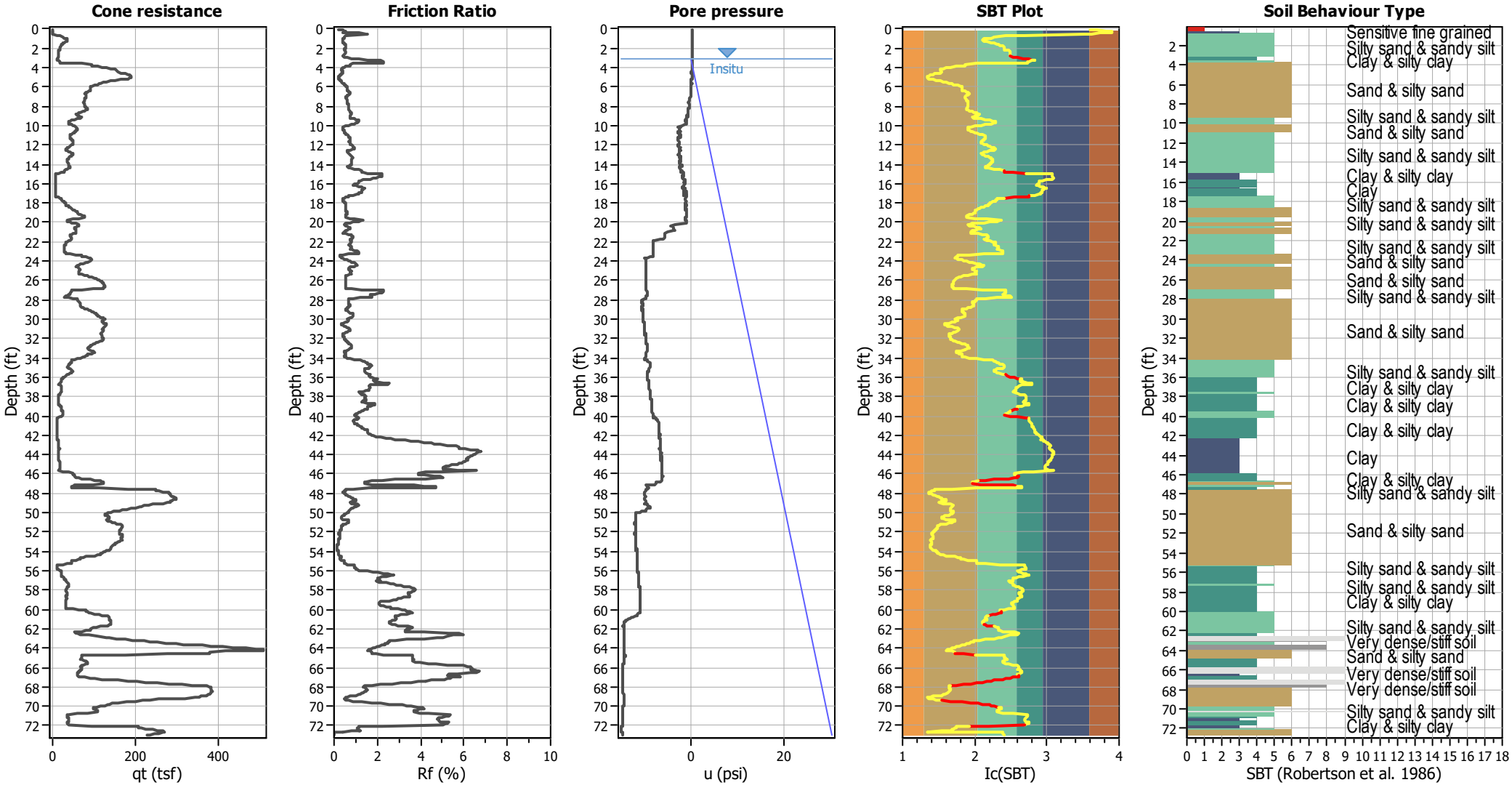






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



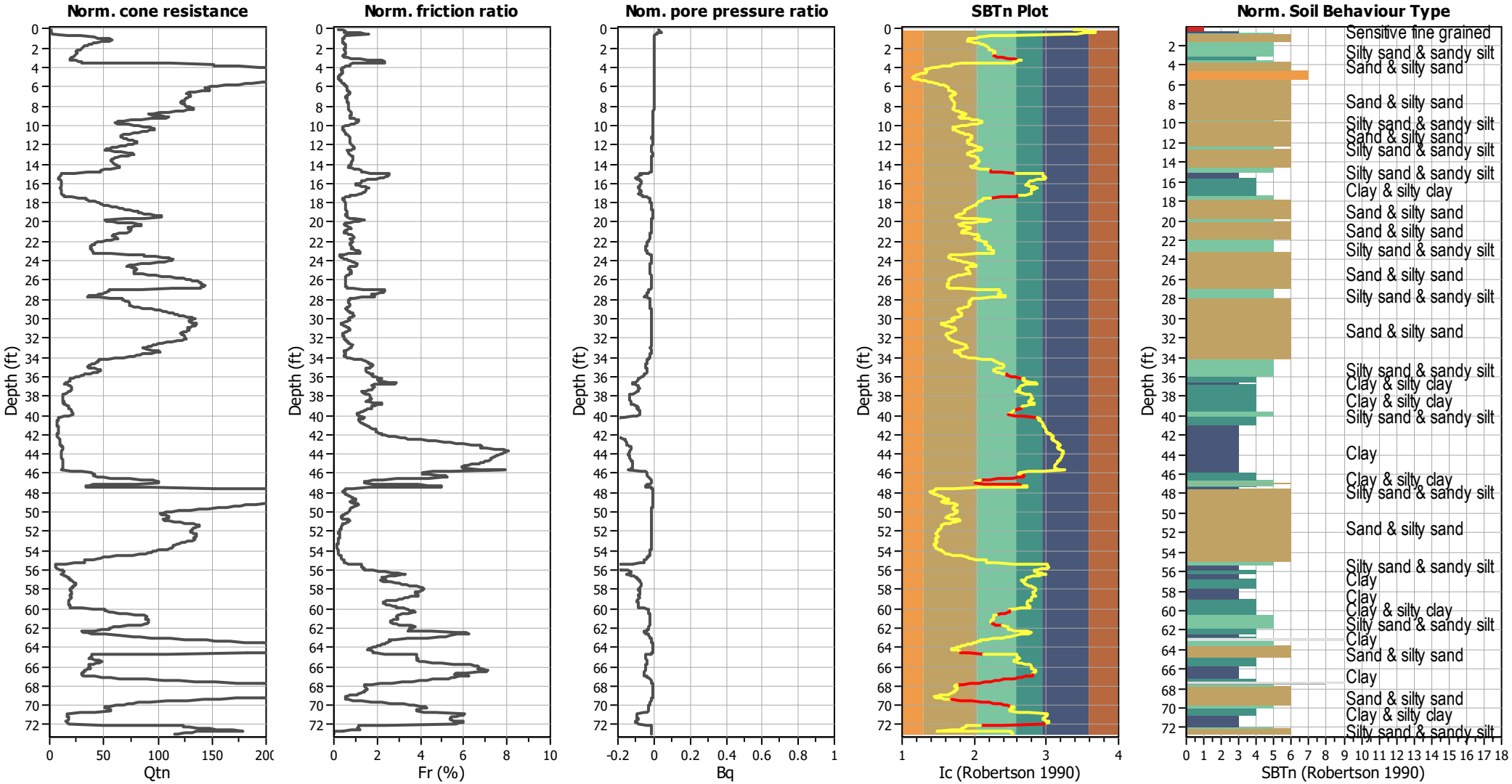
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 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)



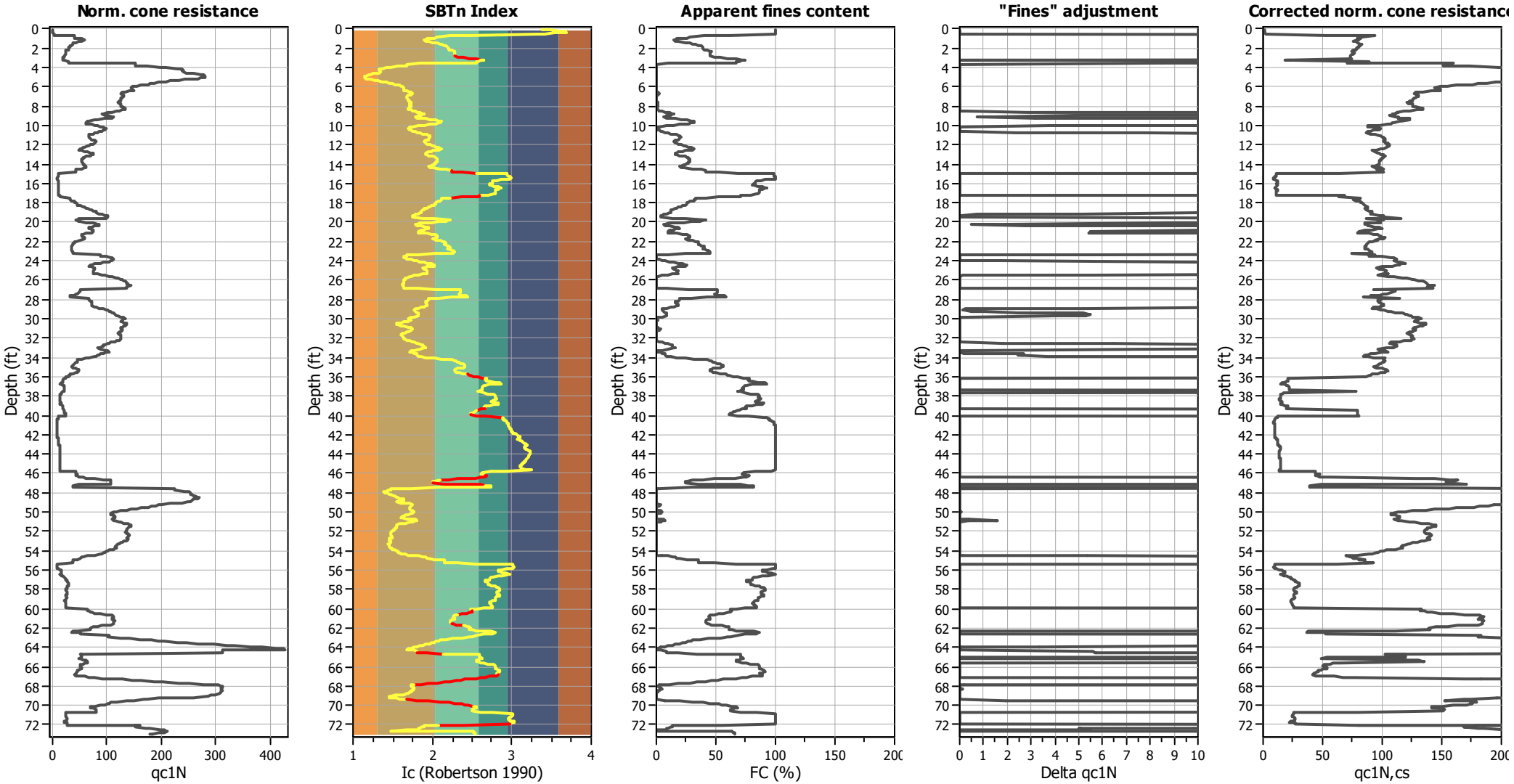
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 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

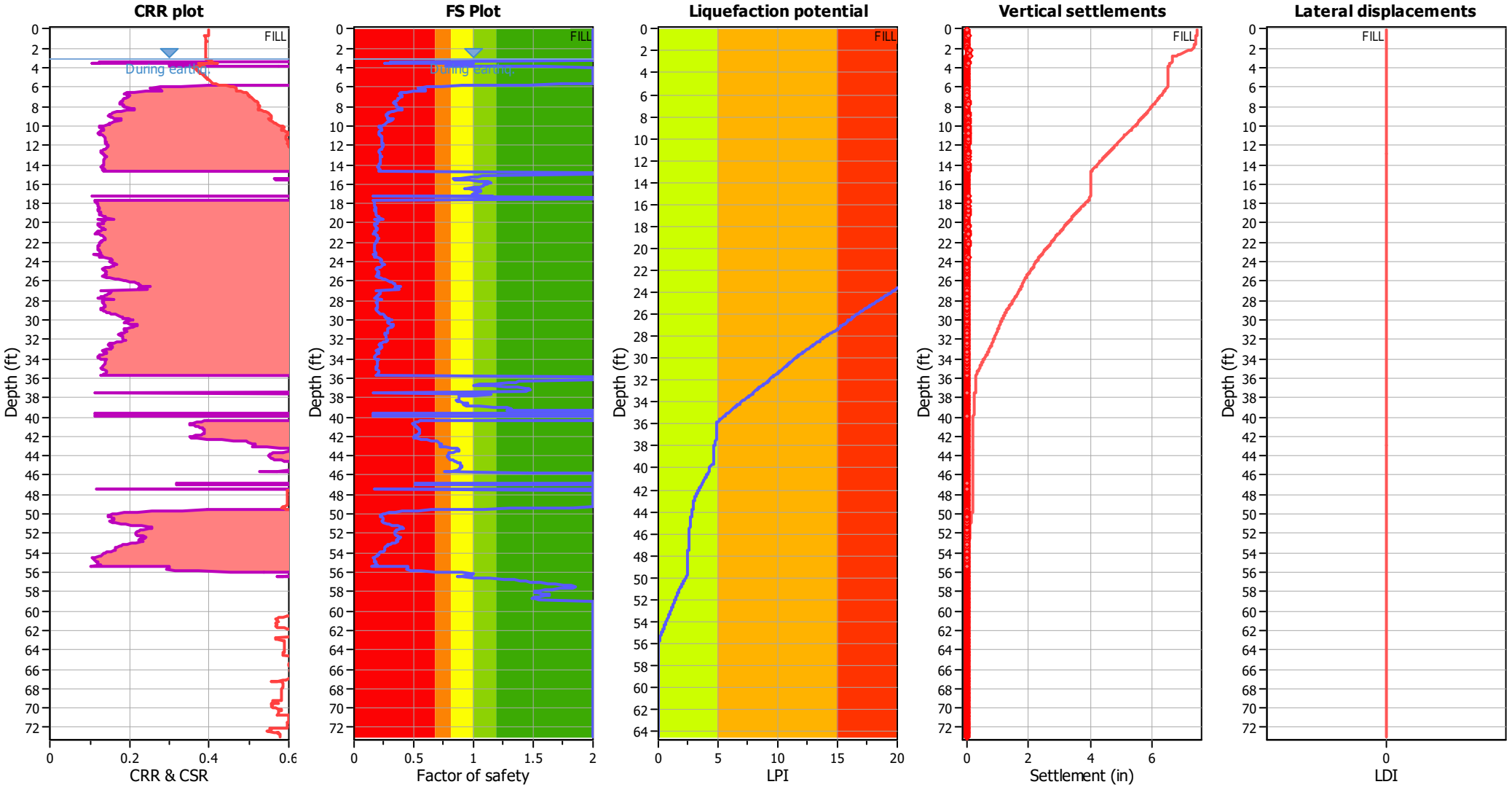
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 ft	Limit depth:	60.00 ft

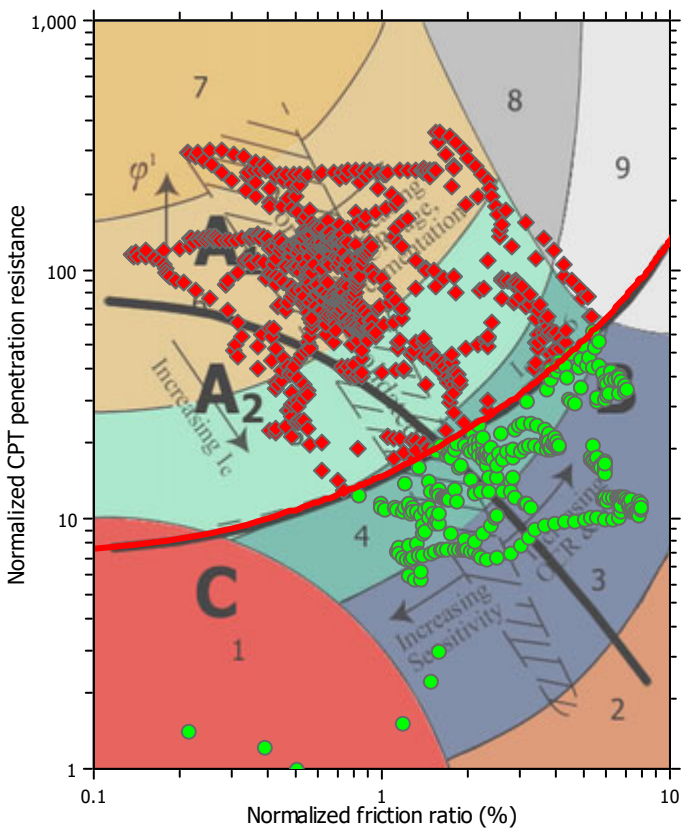
F.S. color scheme

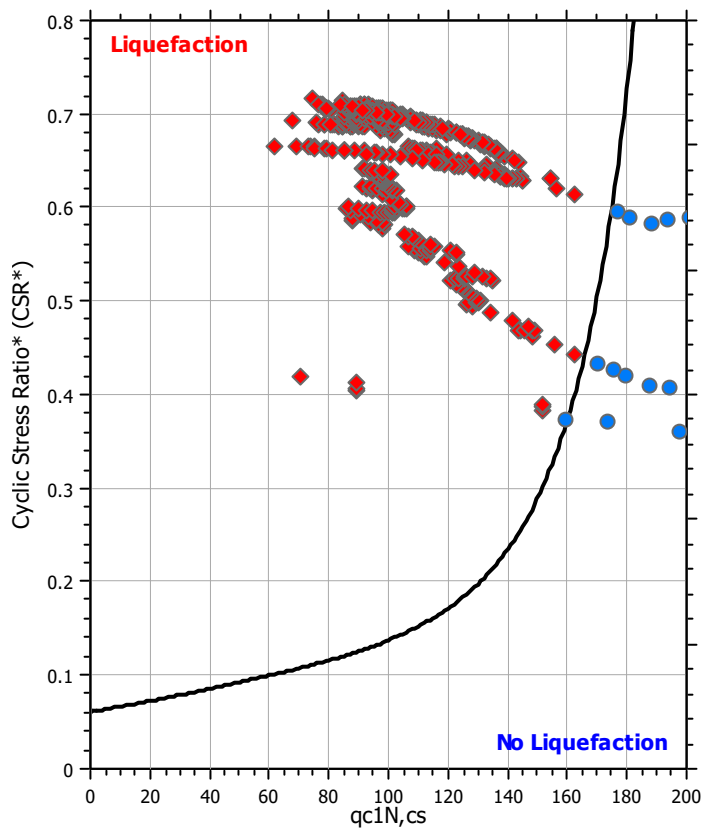
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

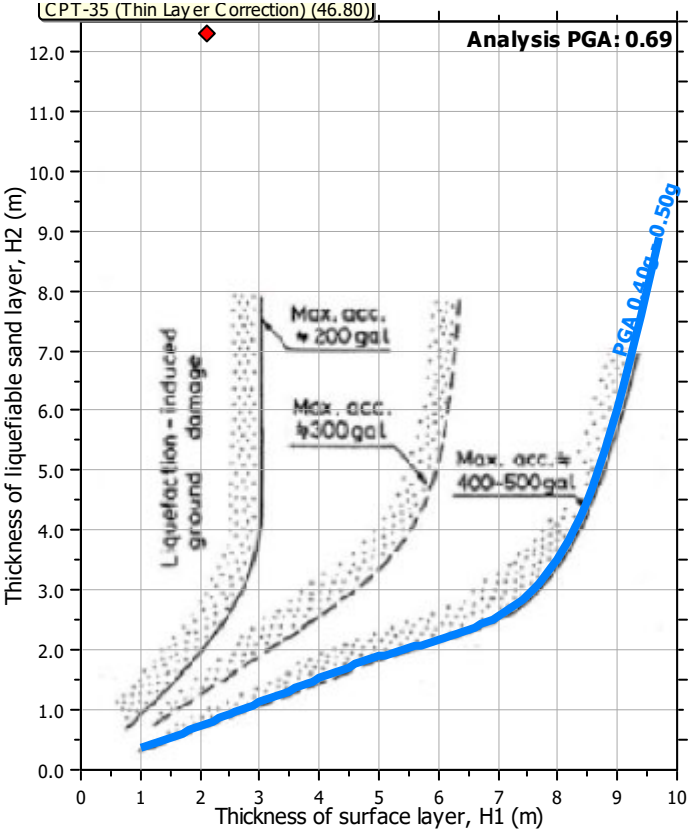
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



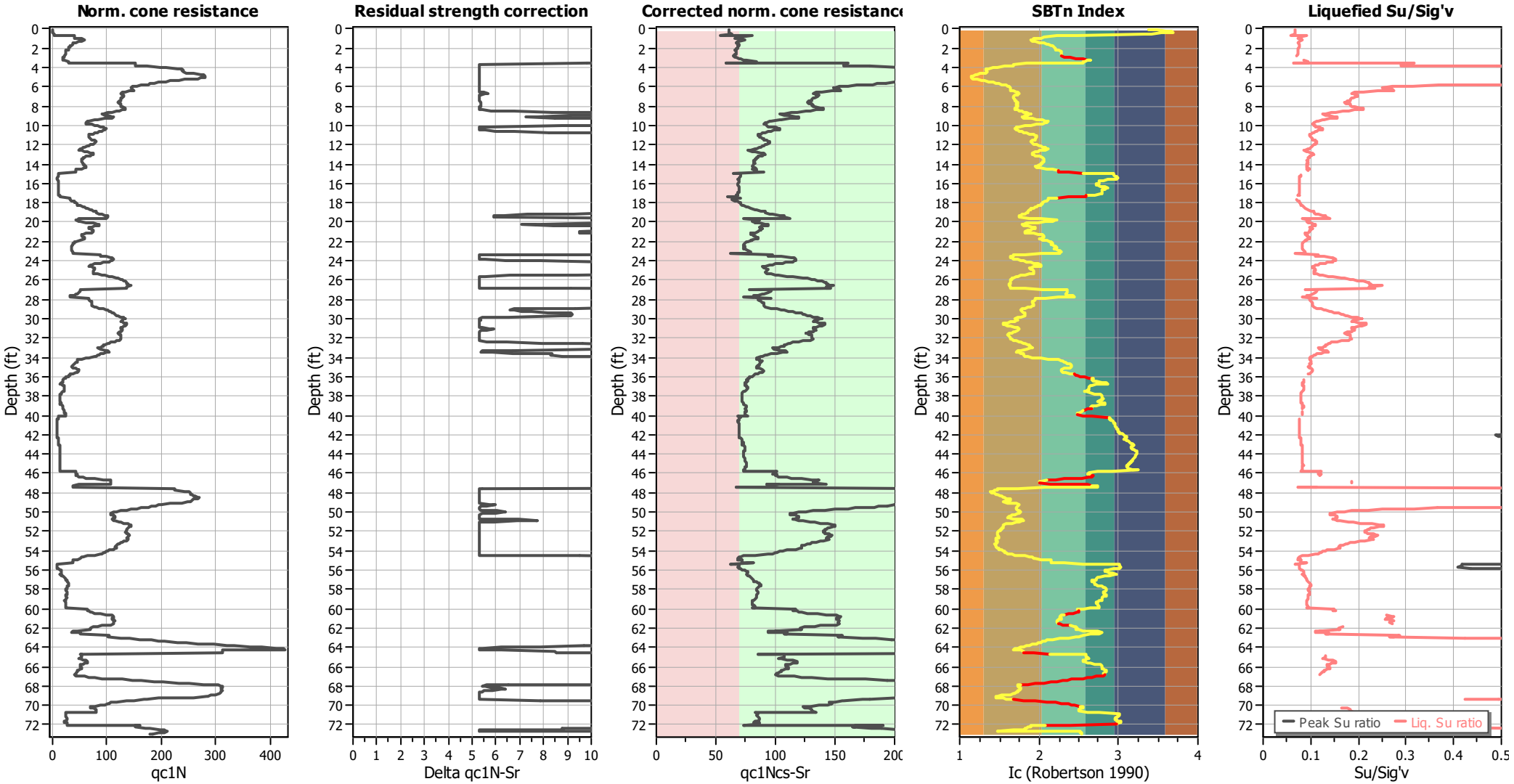




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

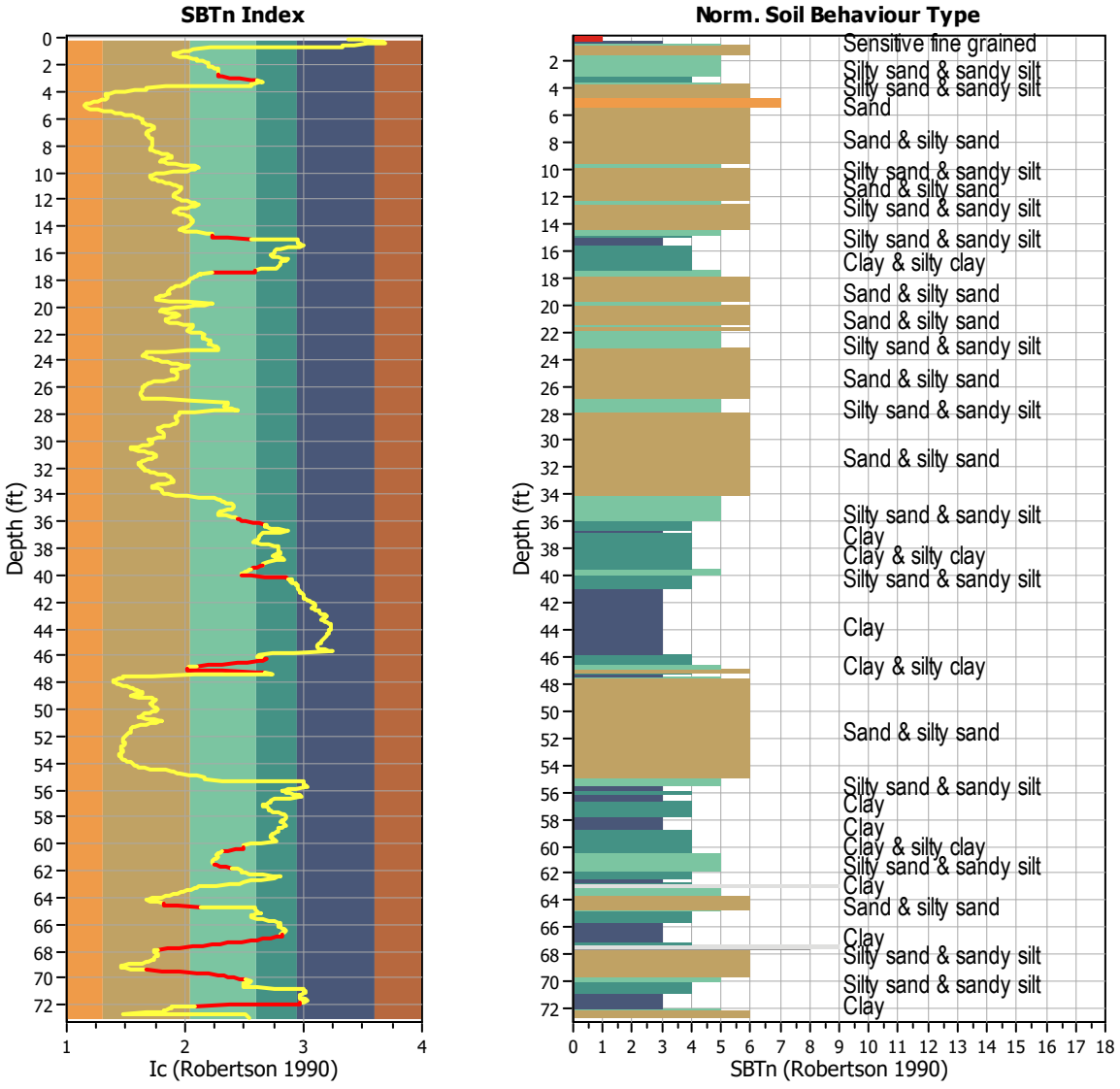
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.04 ft	Fill height:	1.08 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

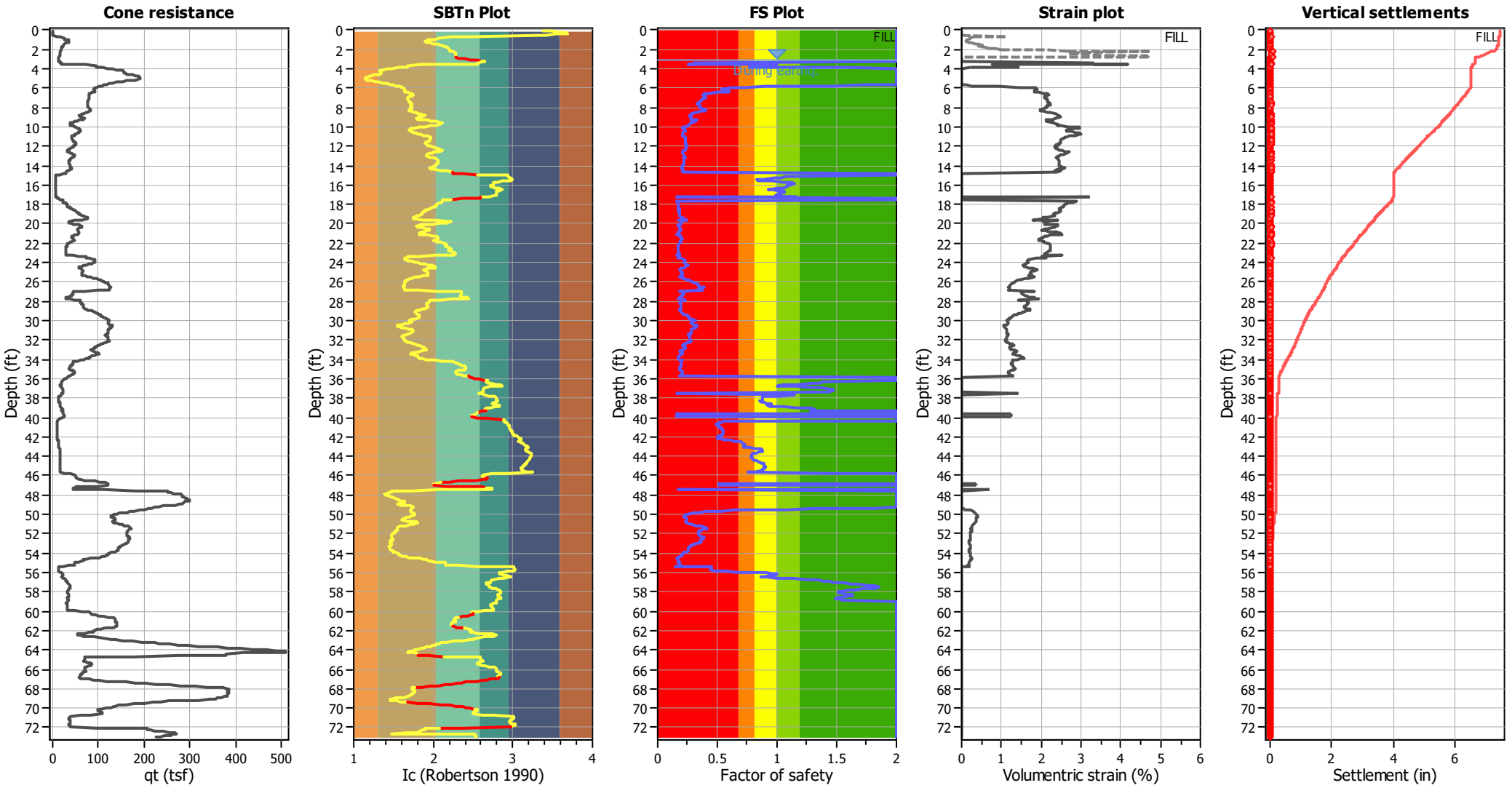
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1110
I_c maximum check value:	3.00	Total points excluded:	95
I_c change ratio value:	0.0250	Exclusion percentage:	8.56%
Minimum number of points in layer:	4	Number of layers detected:	14

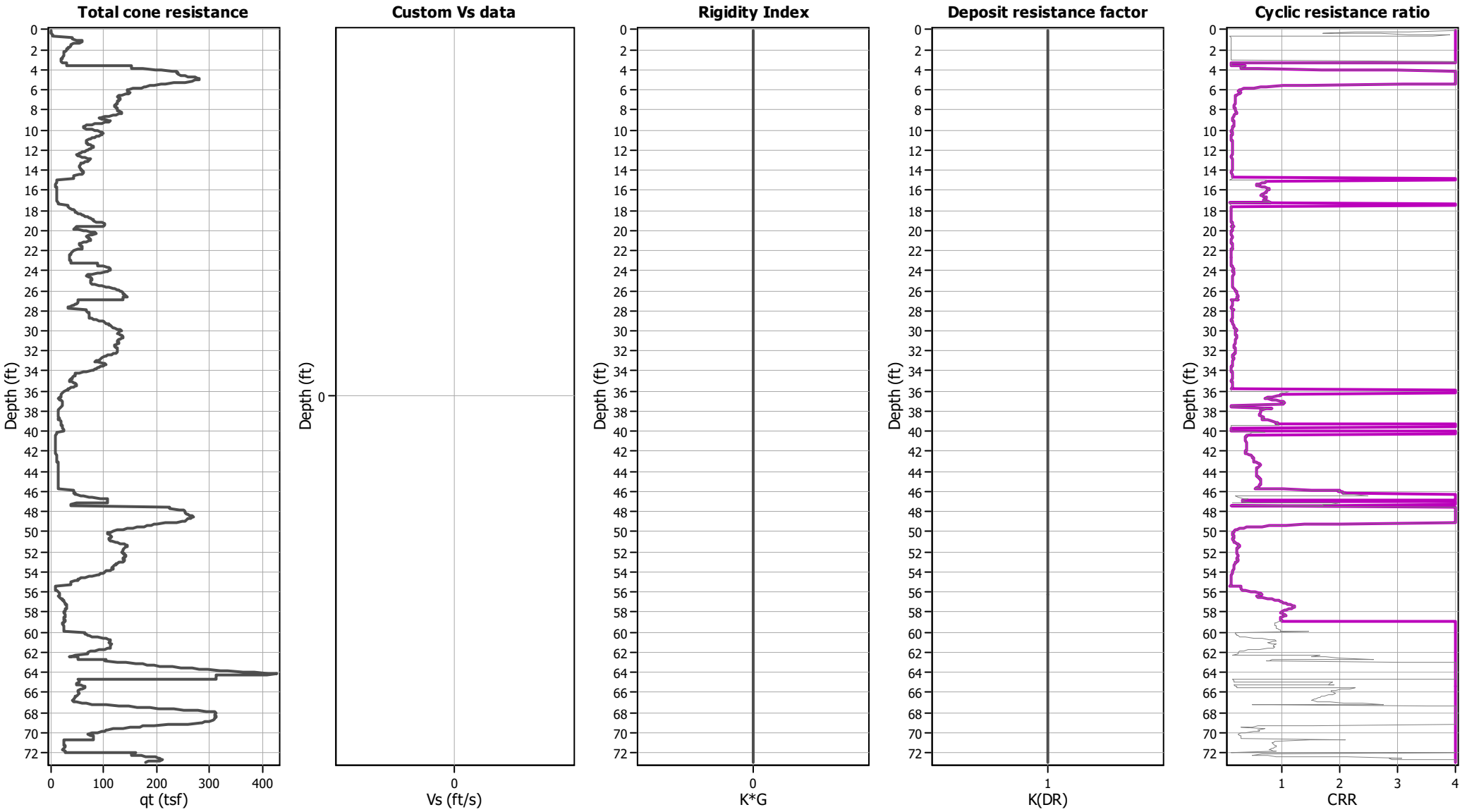
Estimation of post-earthquake settlements



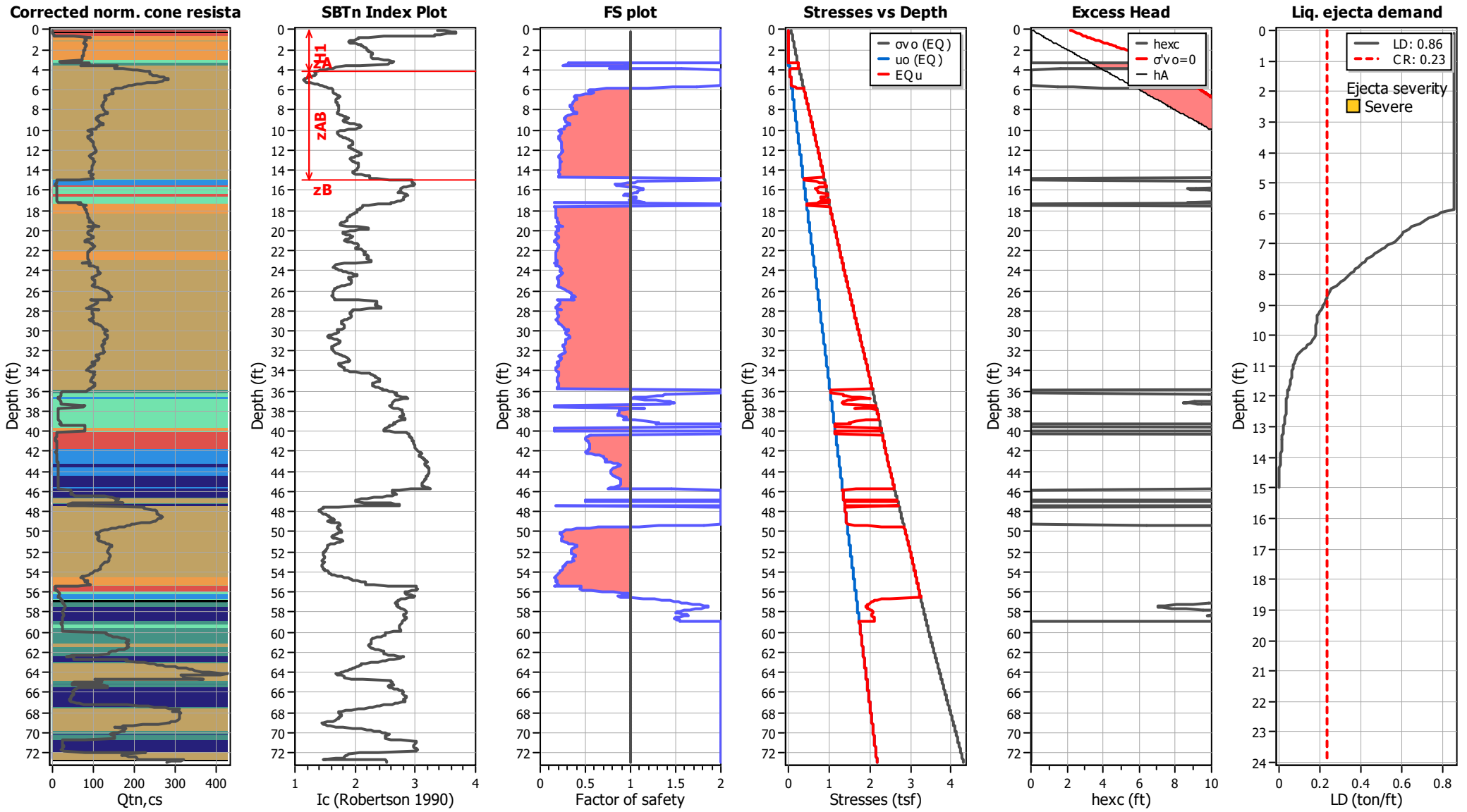
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

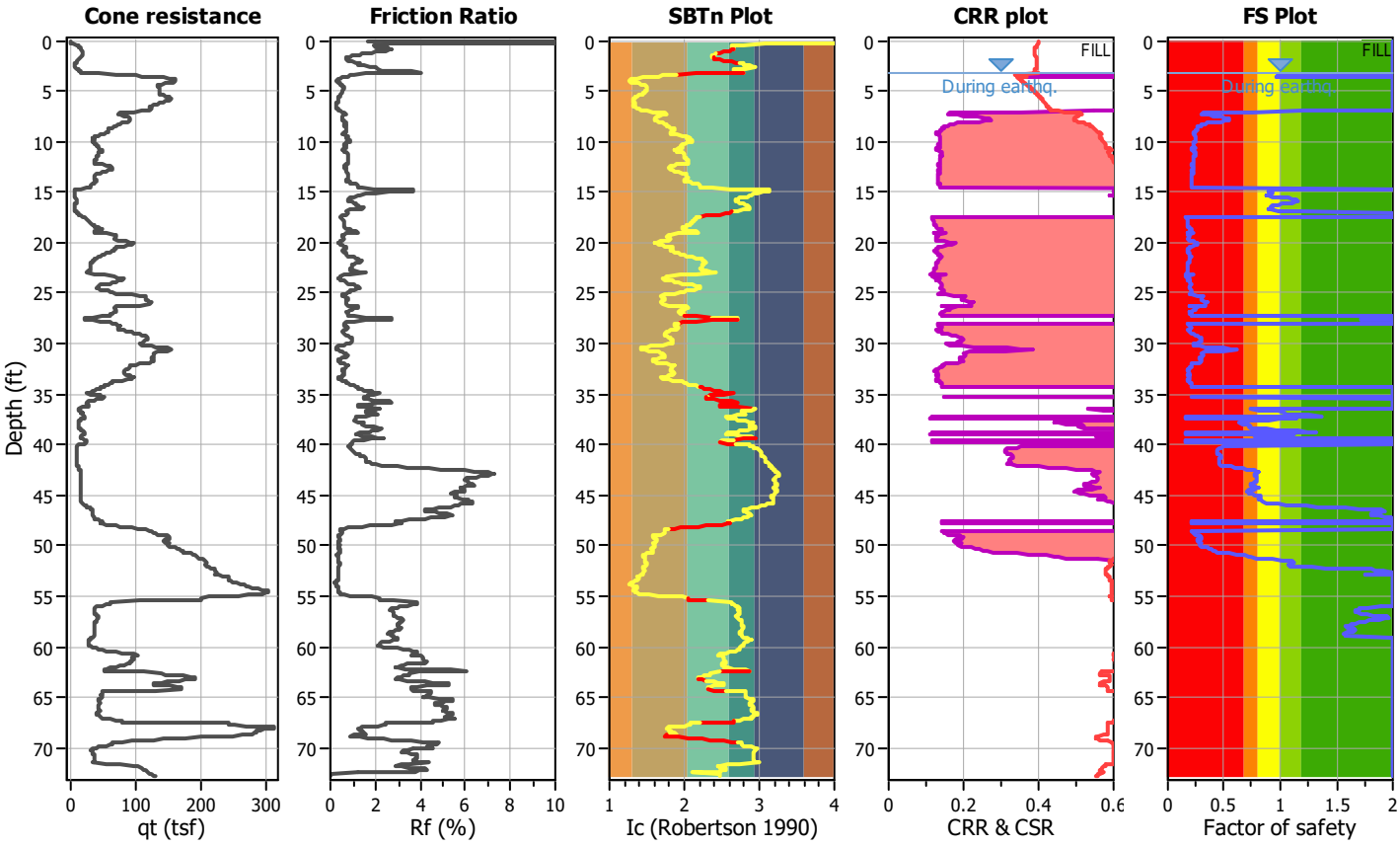
Project title : Topgolf Harbor Island

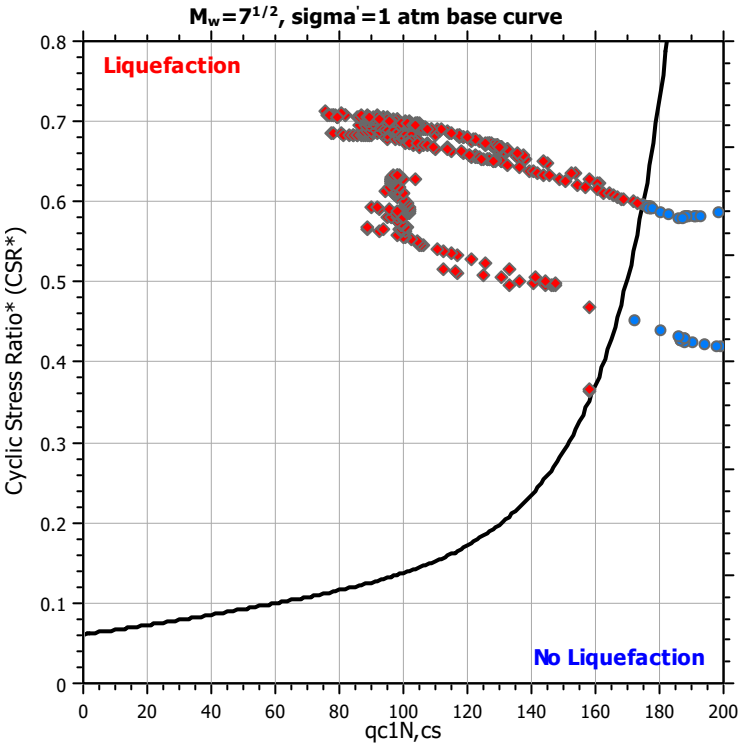
Location : North Harbor Drive and Liberator Way, San Diego, CA

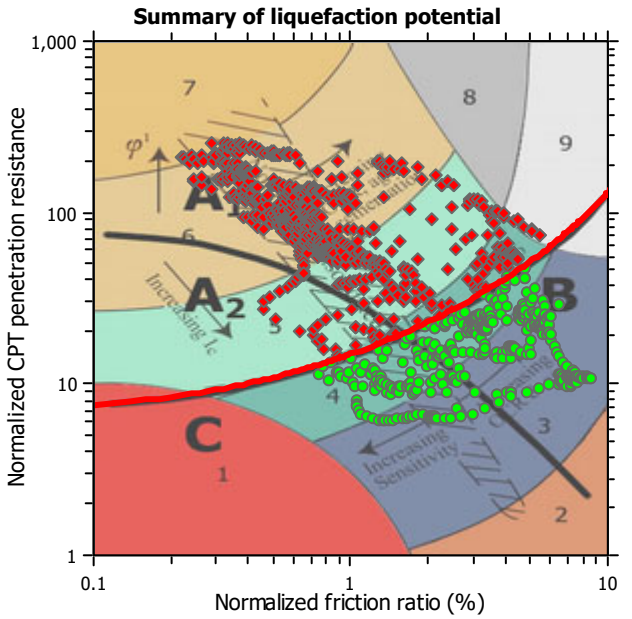
CPT file : CPT-37 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.12 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

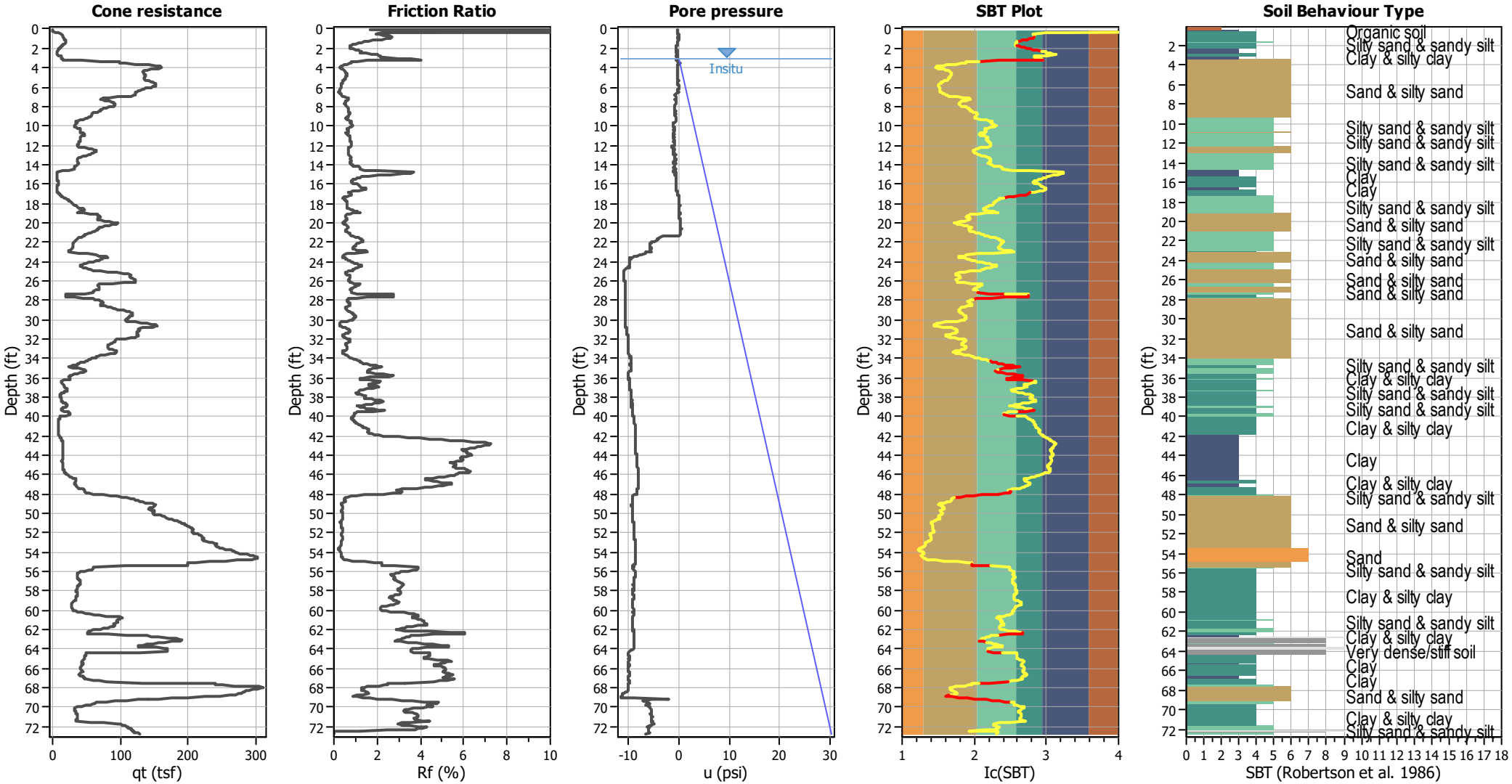






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



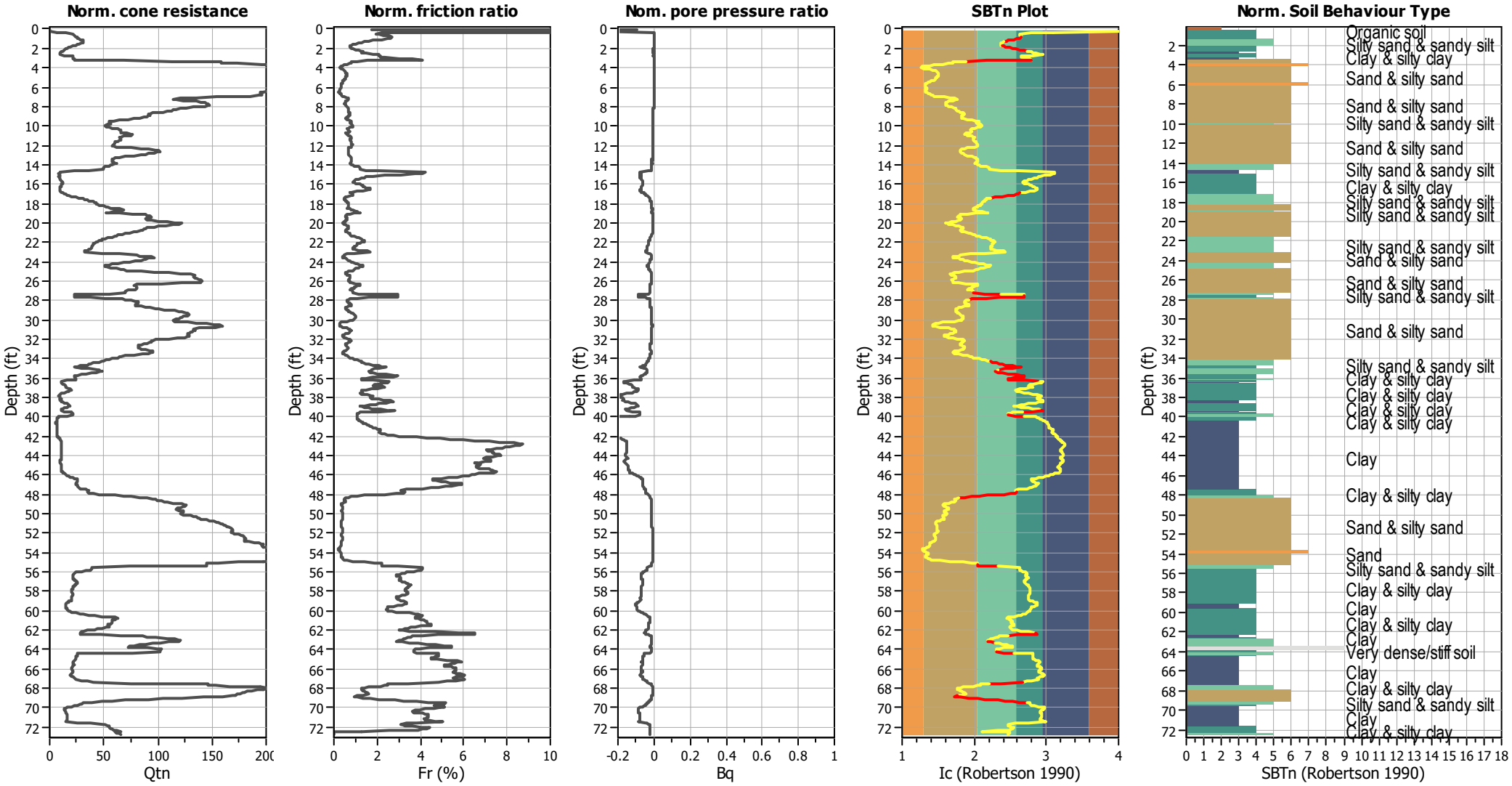
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.00 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)



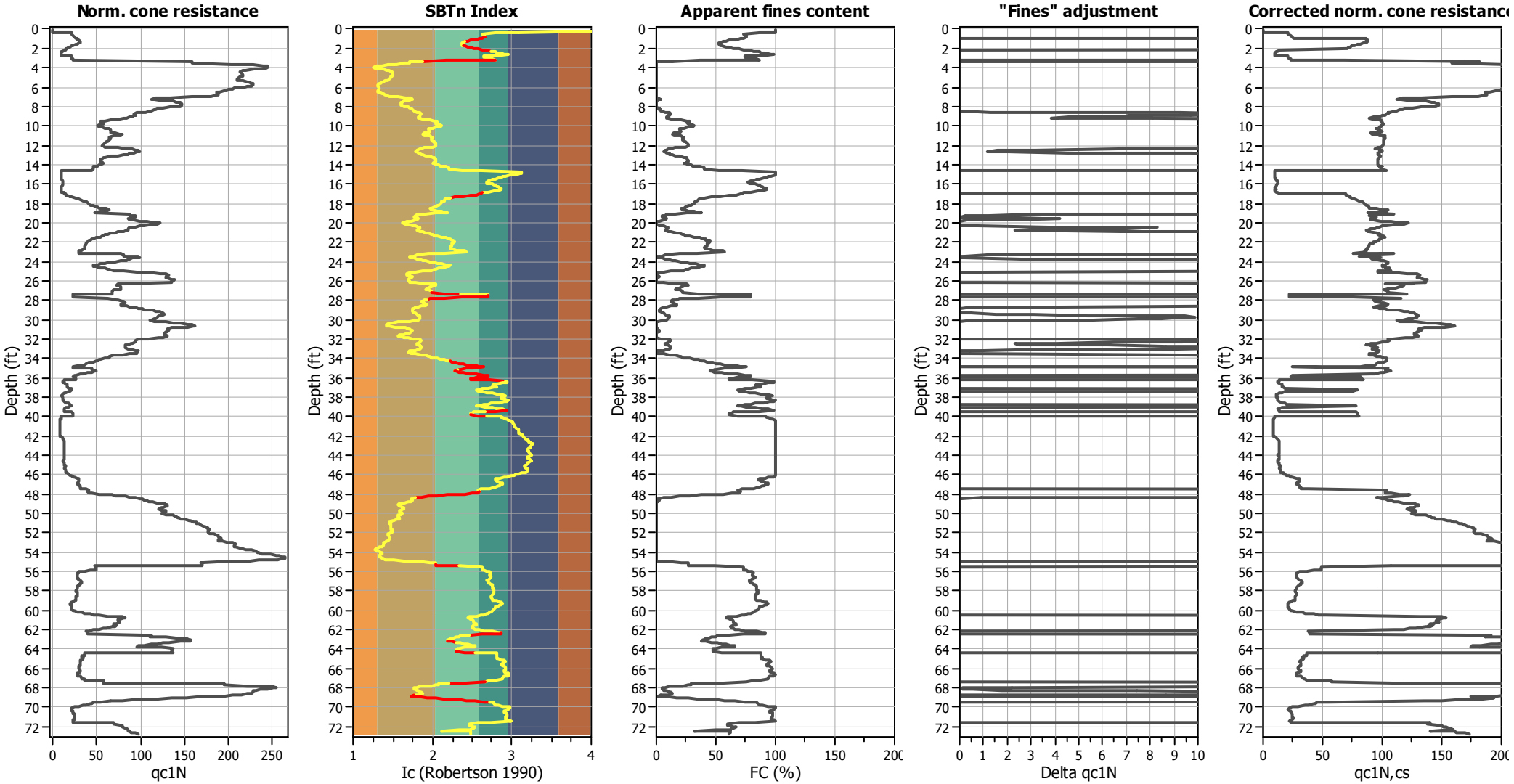
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 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
7. Gravely sand to sand
8. Very stiff sand to
9. Very stiff fine grained

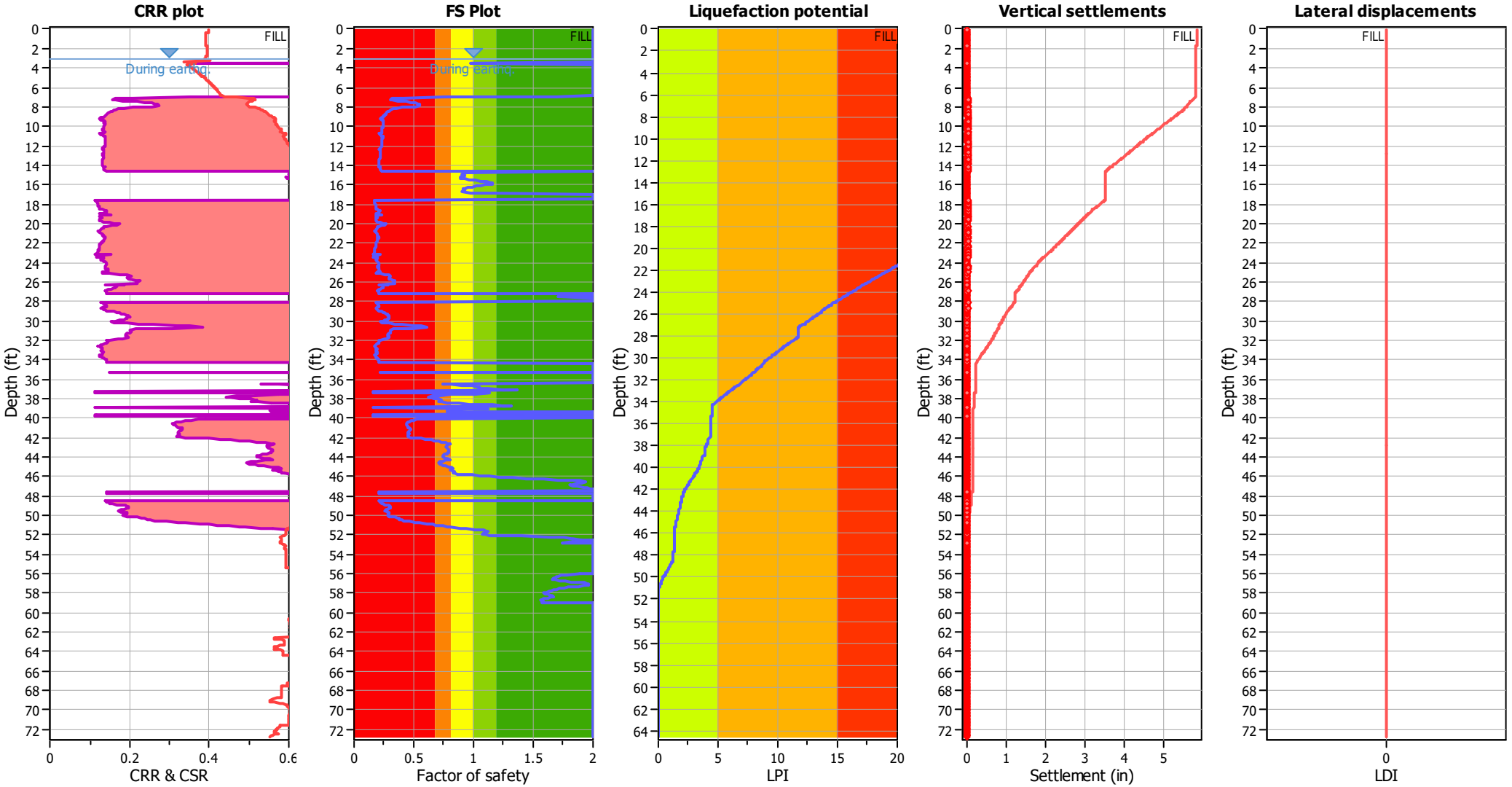
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

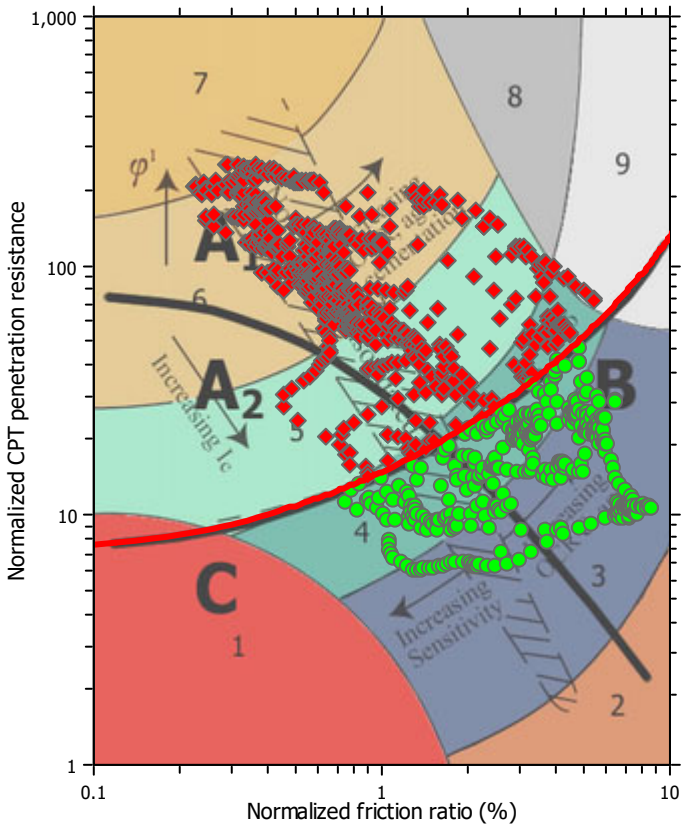
F.S. color scheme

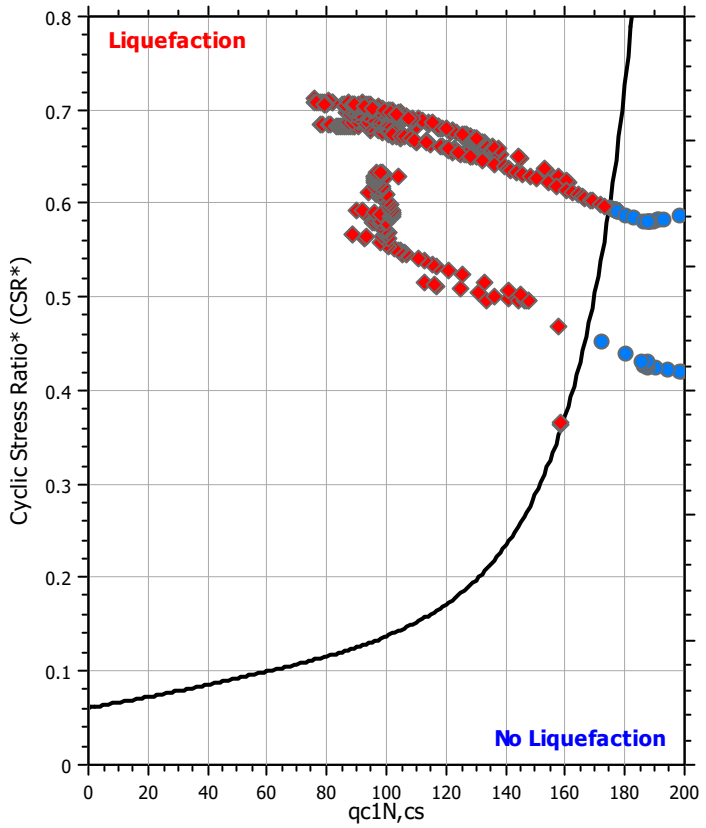
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

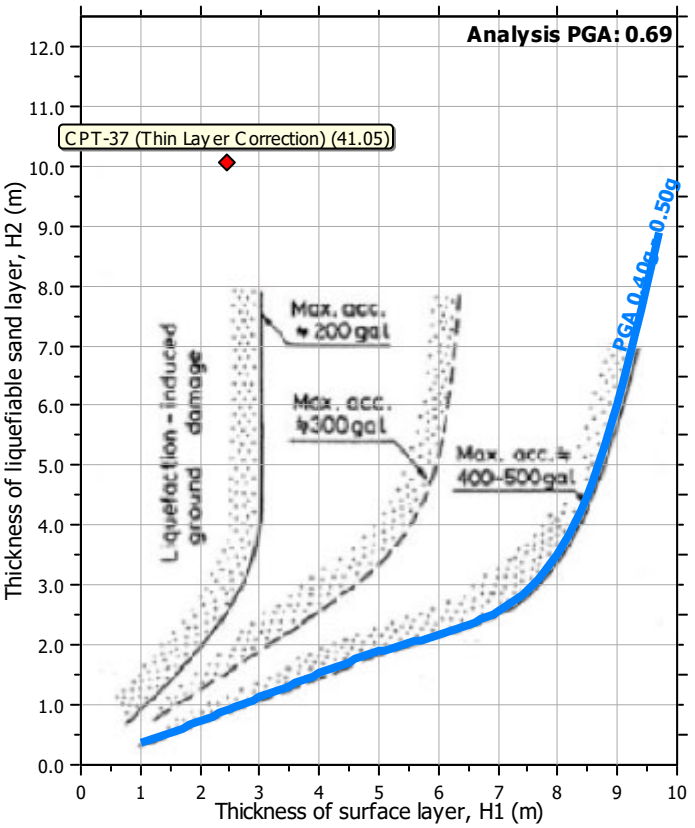
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



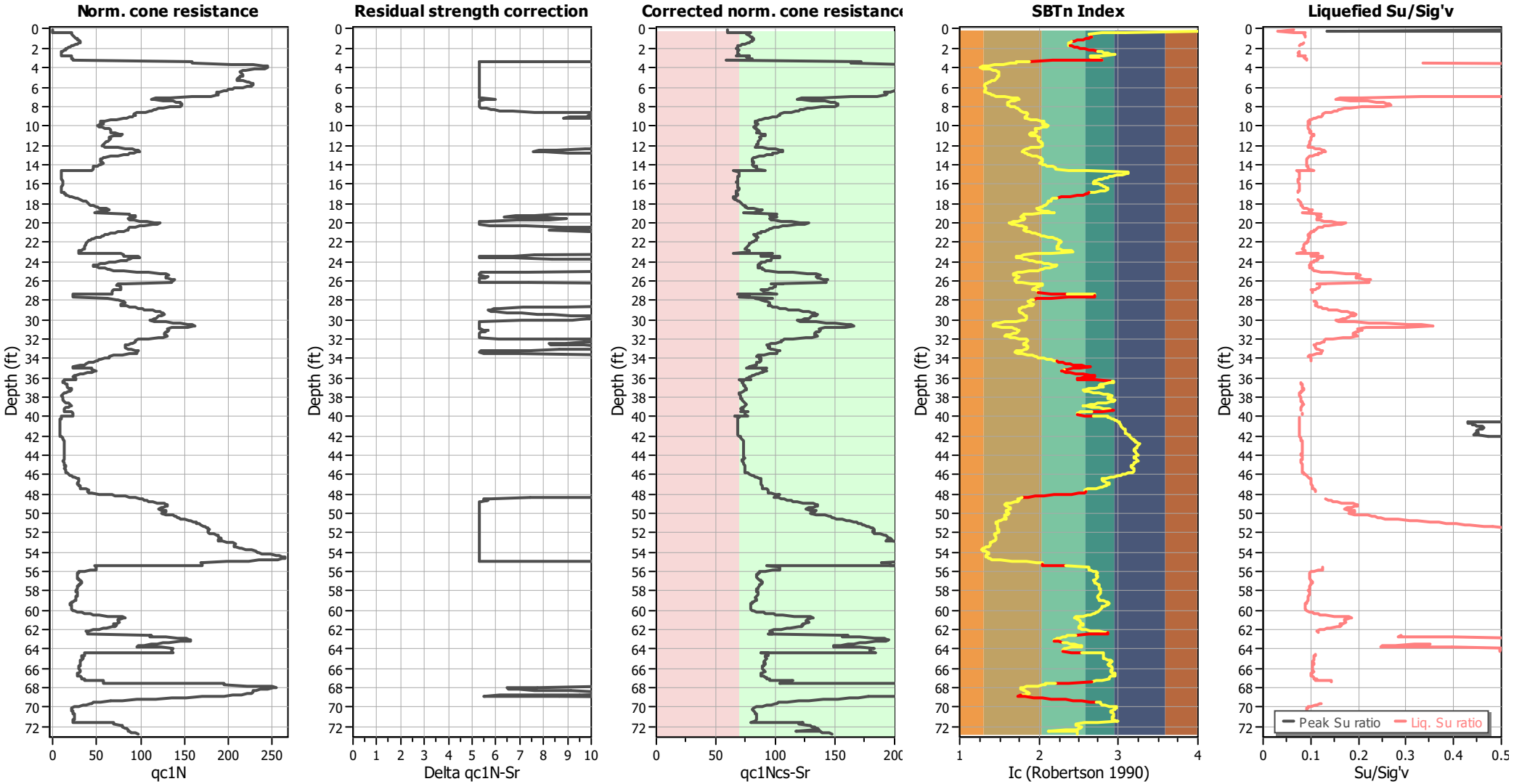




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

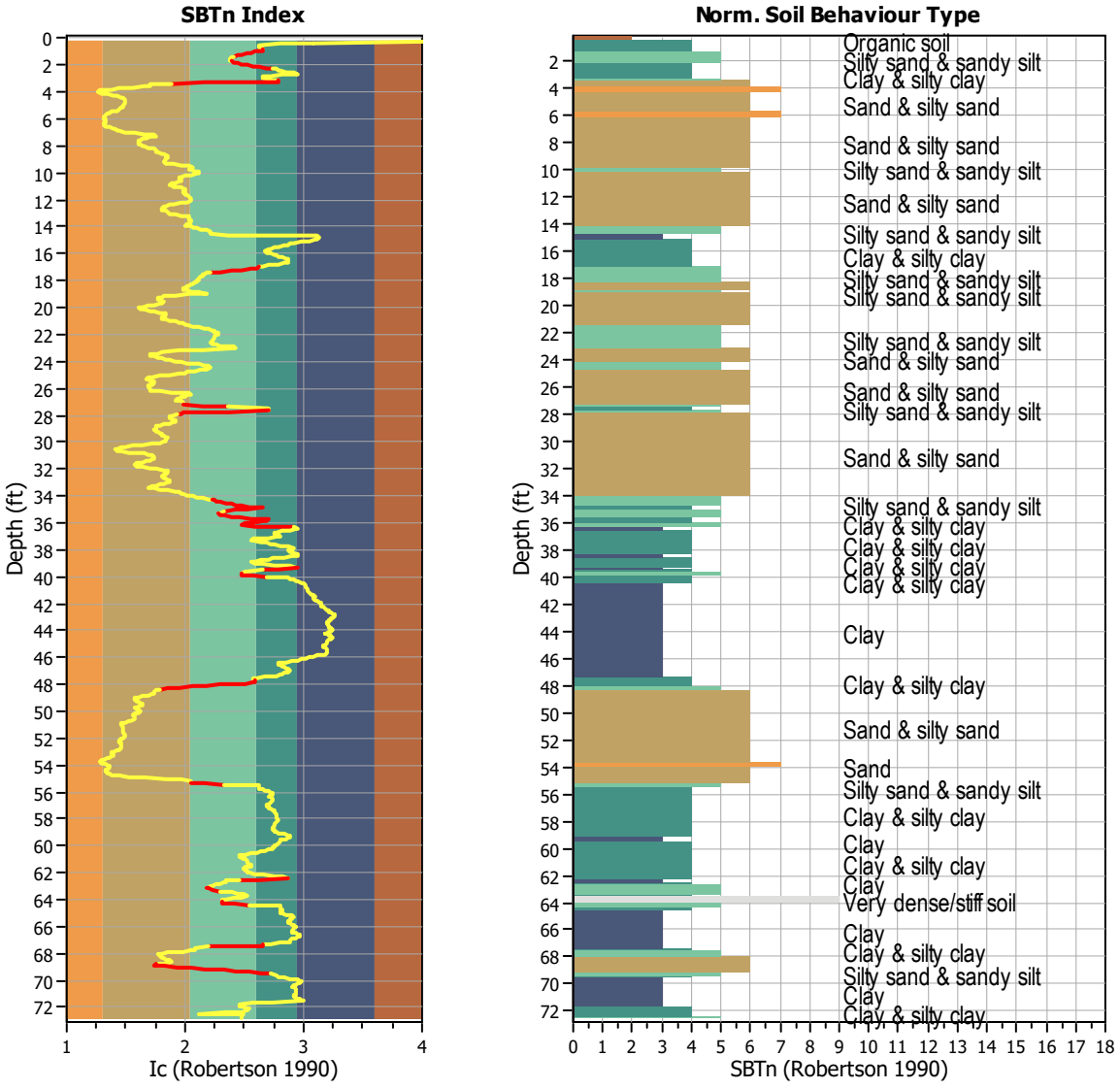
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

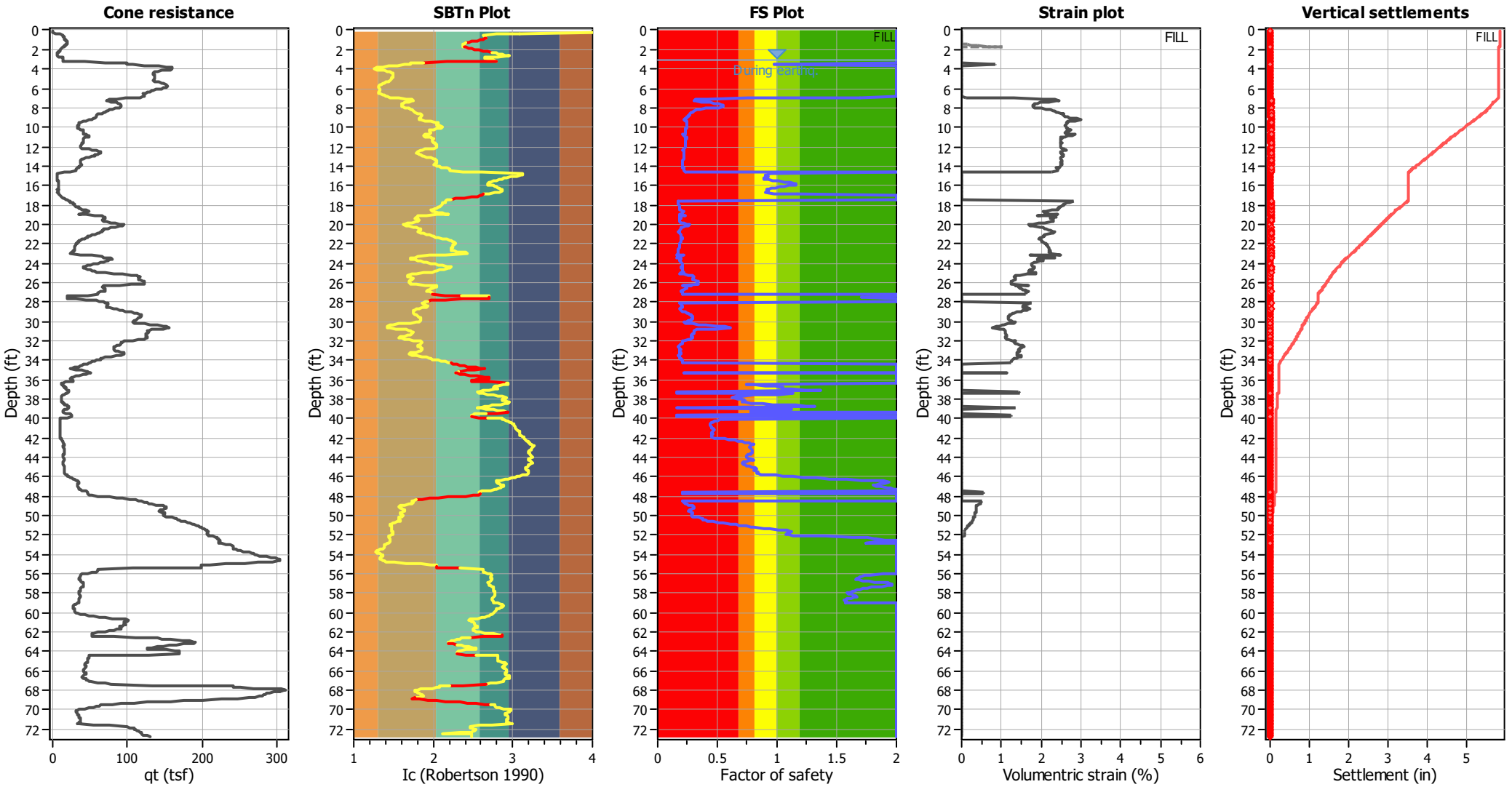
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	1109
I_c maximum check value:	3.00	Total points excluded:	125
I_c change ratio value:	0.0250	Exclusion percentage:	11.27%
Minimum number of points in layer:	4	Number of layers detected:	20

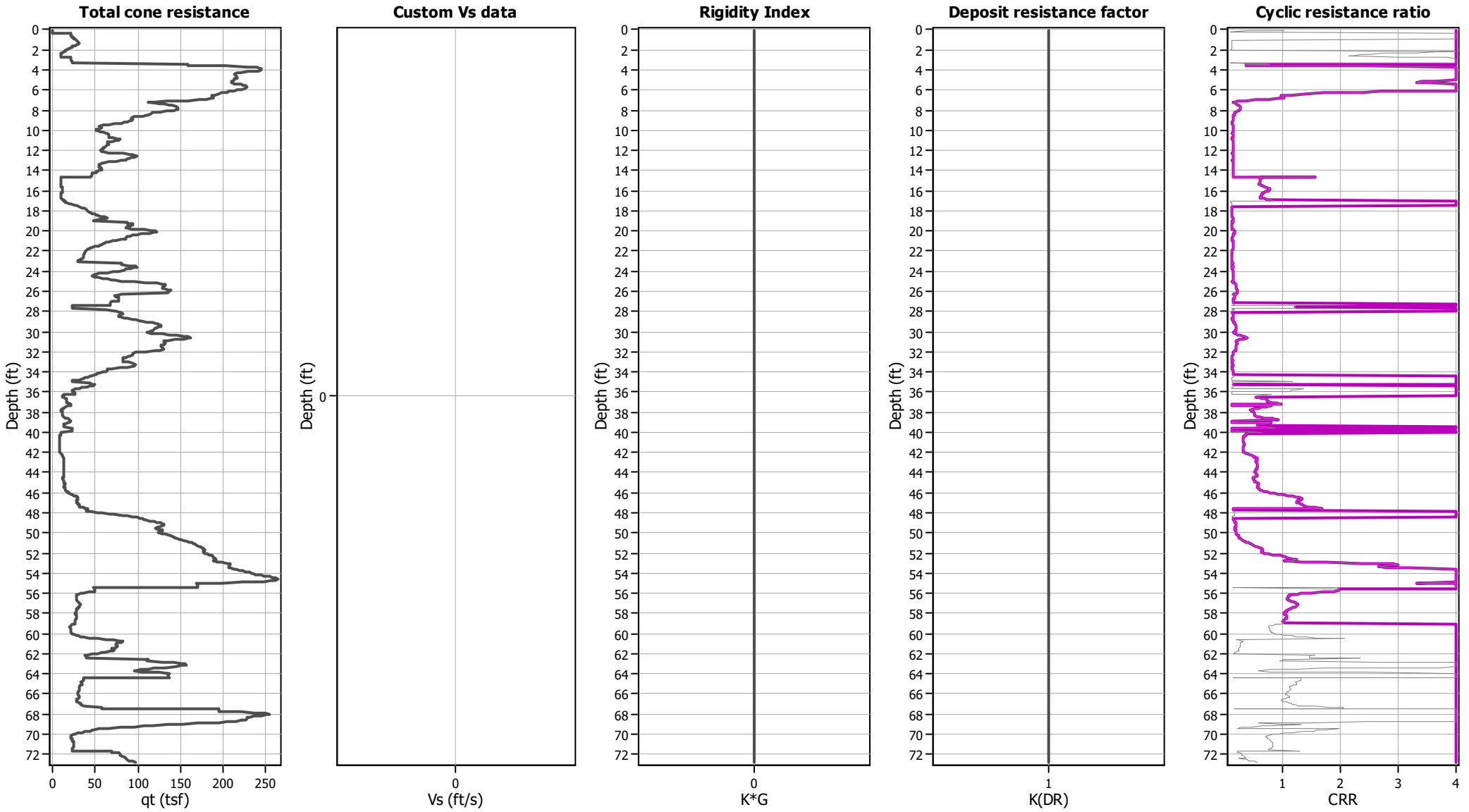
Estimation of post-earthquake settlements



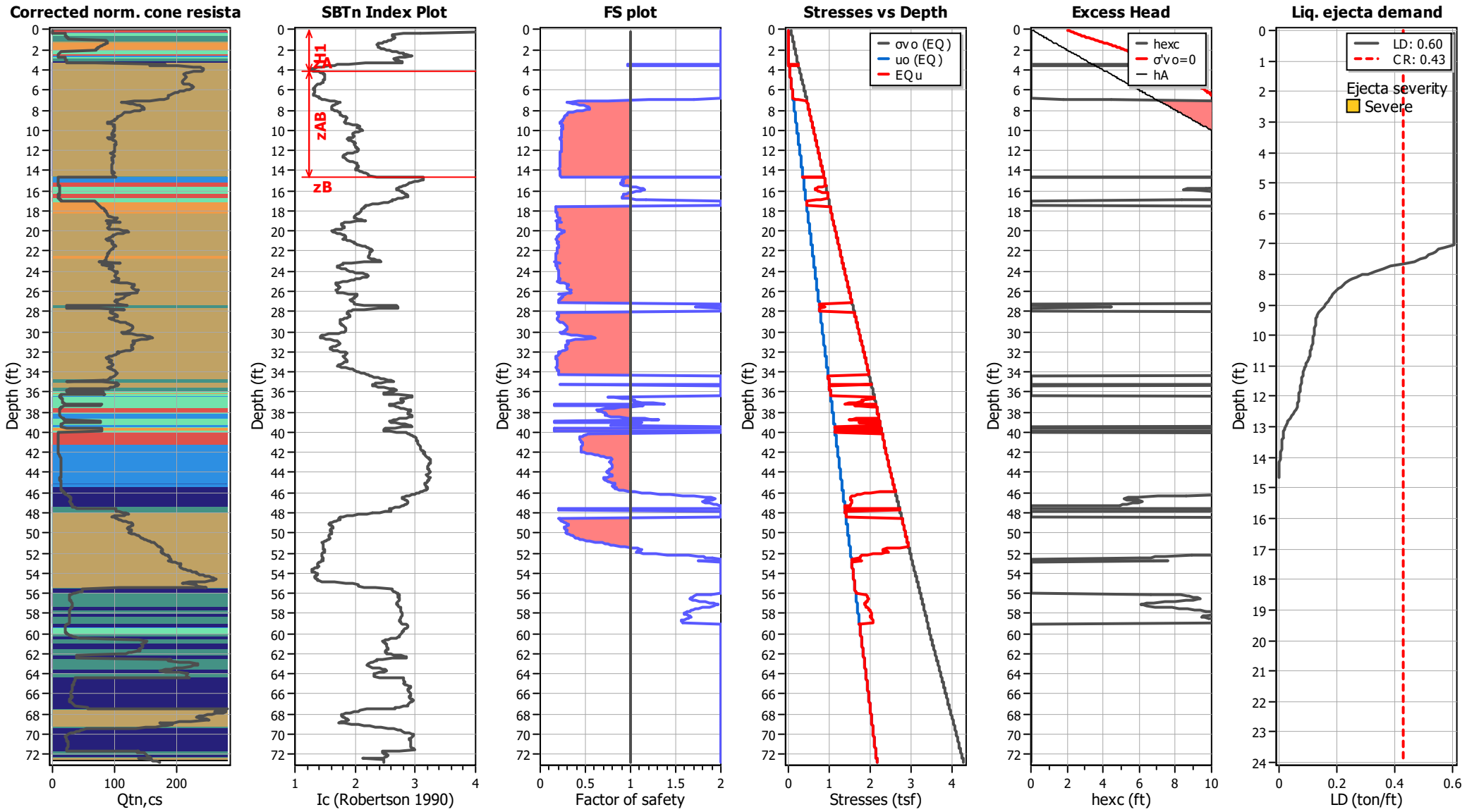
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

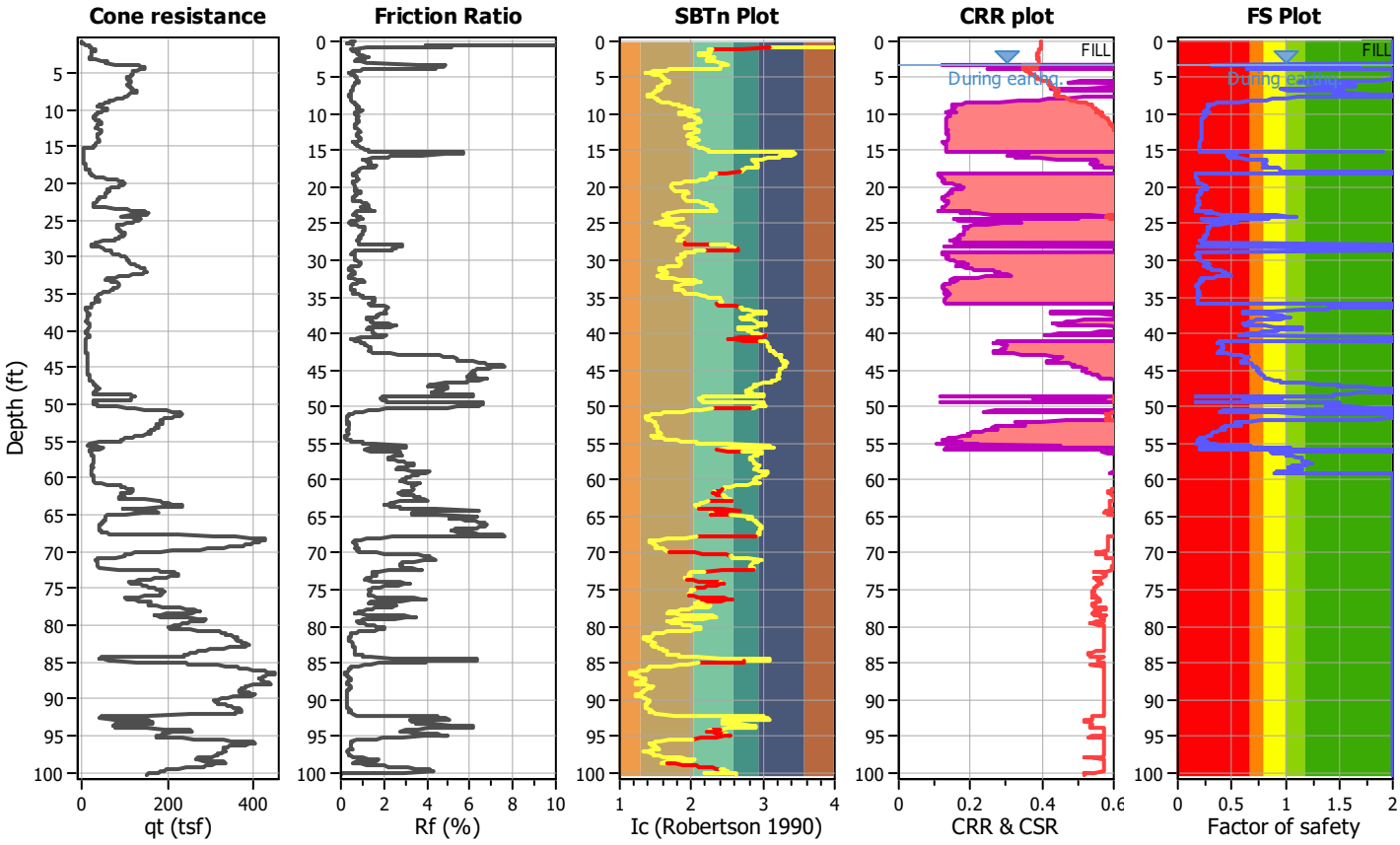
Project title : Topgolf Harbor Island

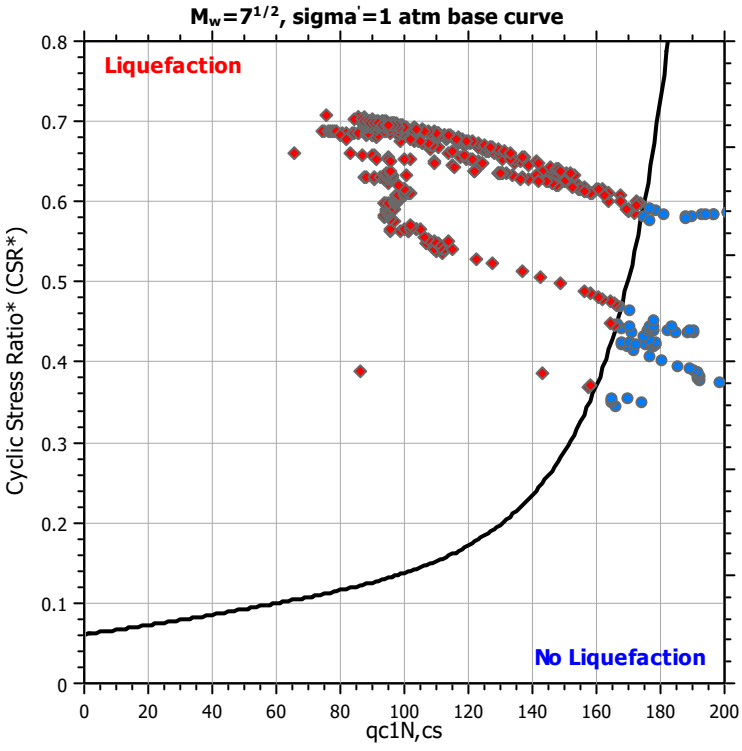
Location : North Harbor Drive and Liberator Way, San Diego, CA

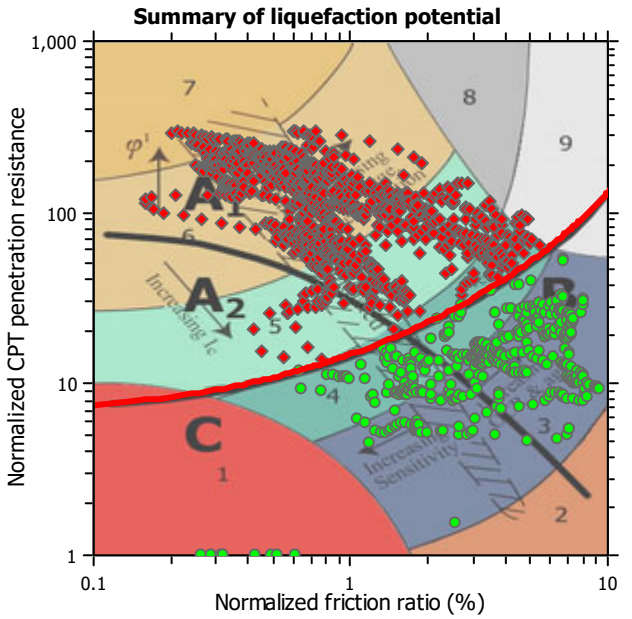
CPT file : CPT-38 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.20 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	0.92 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

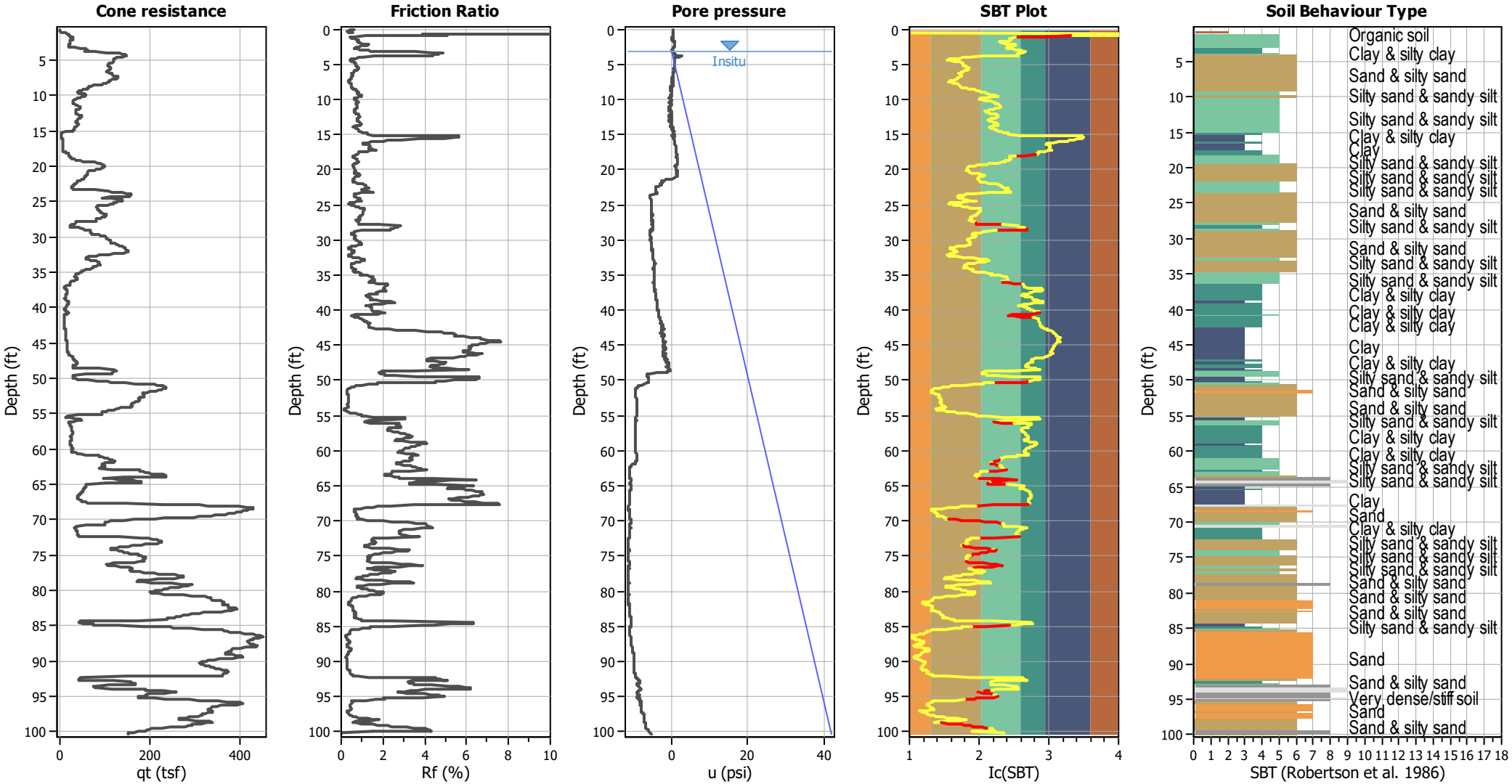






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



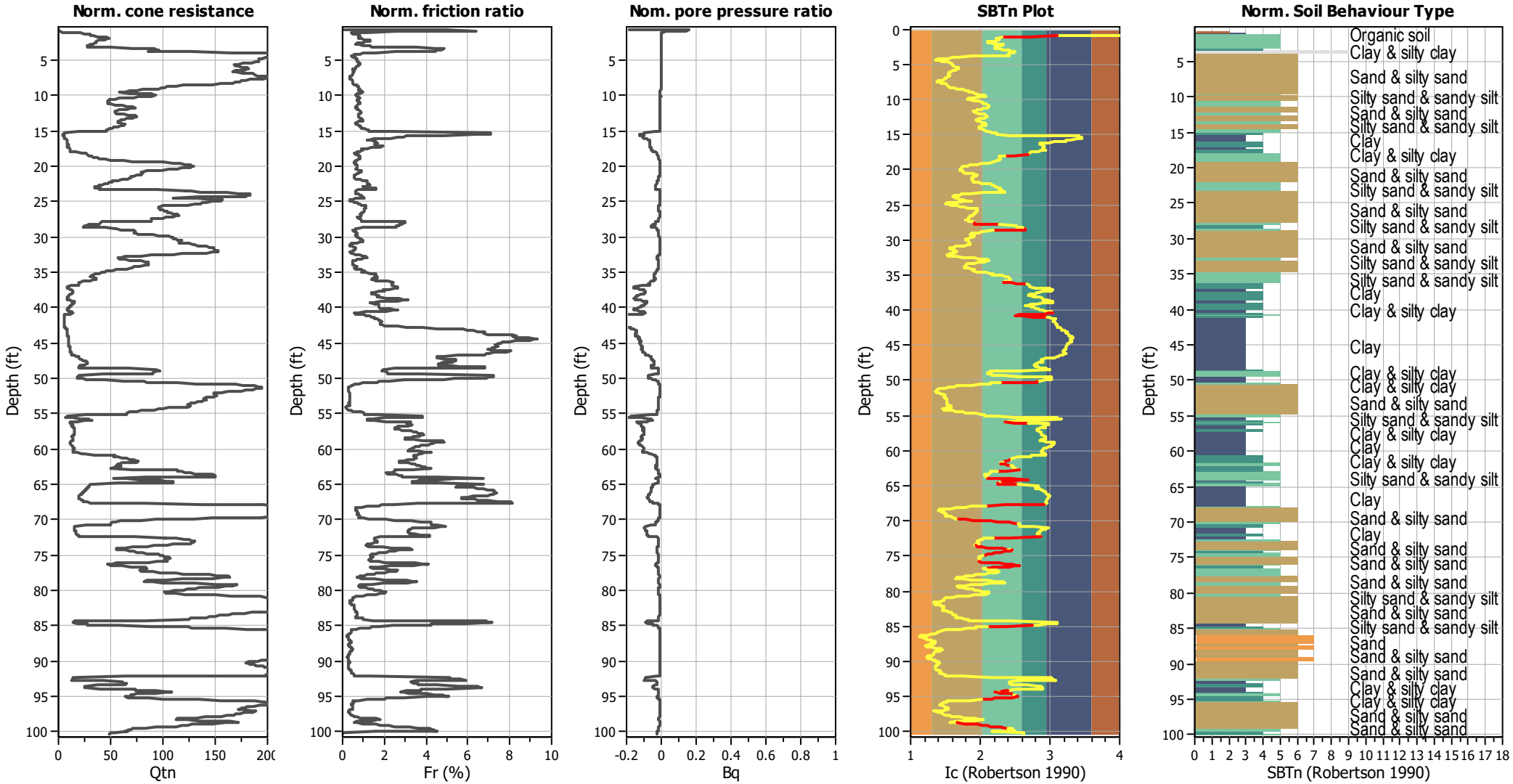
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 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)



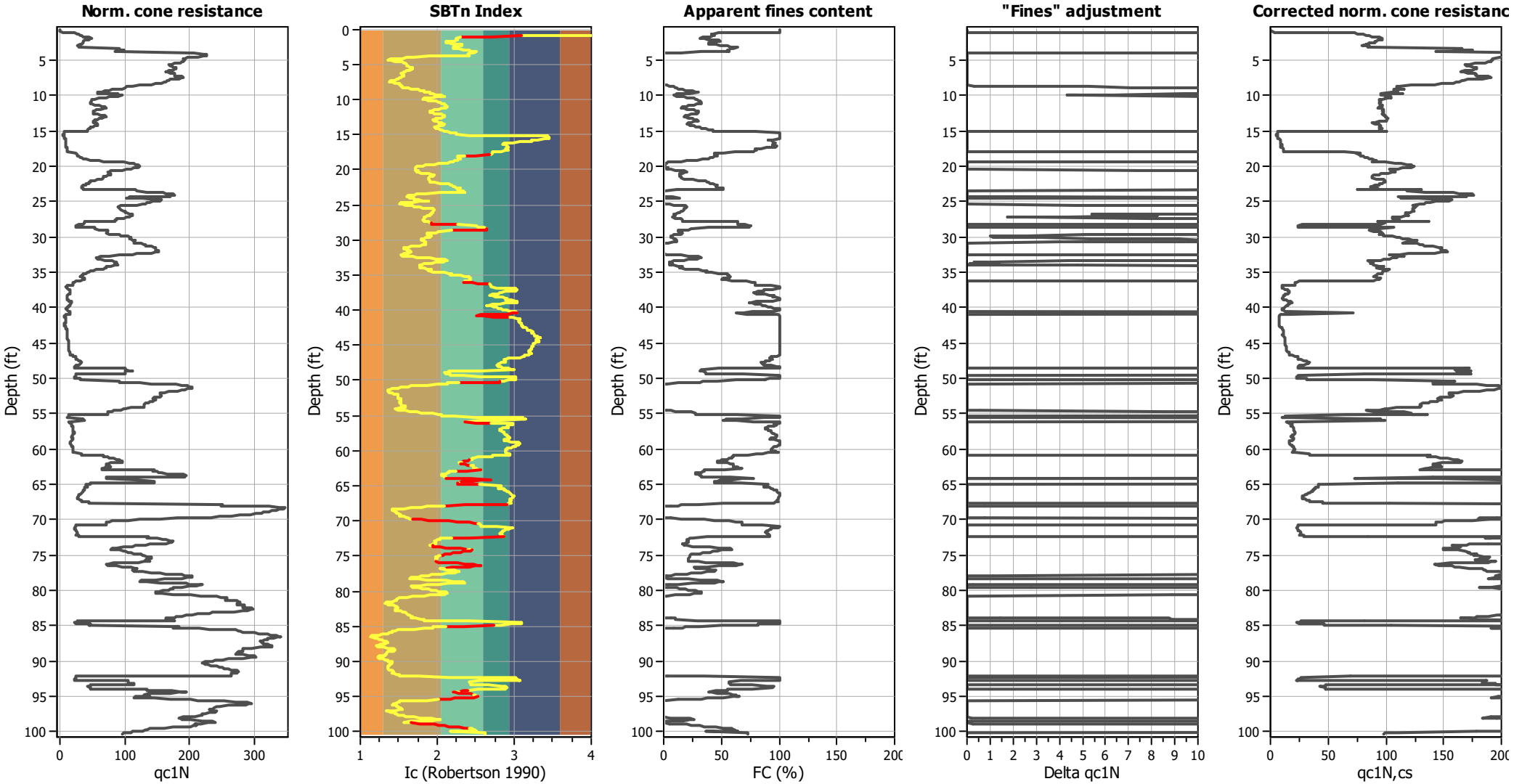
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 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

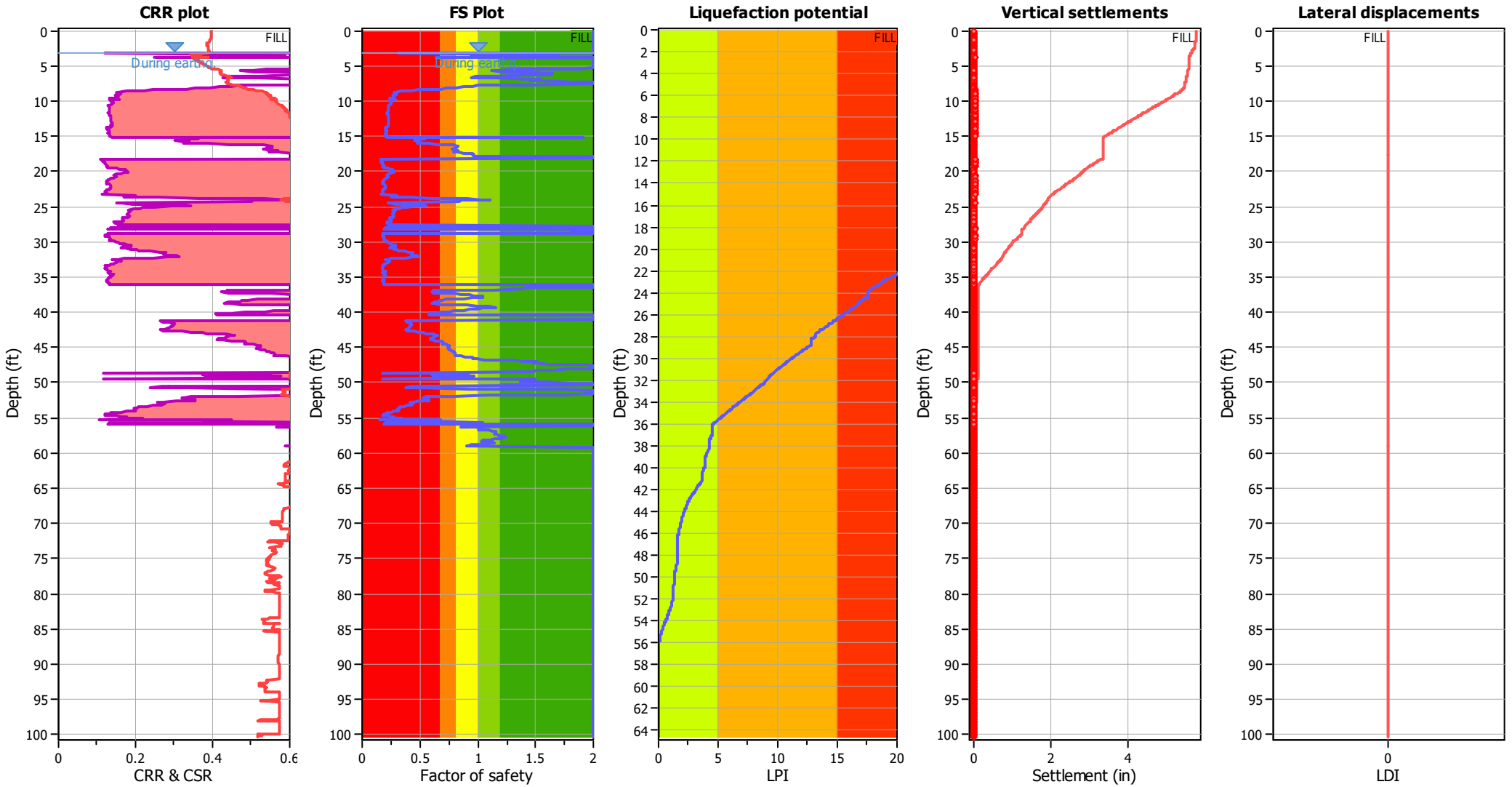
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 ft	Limit depth:	60.00 ft

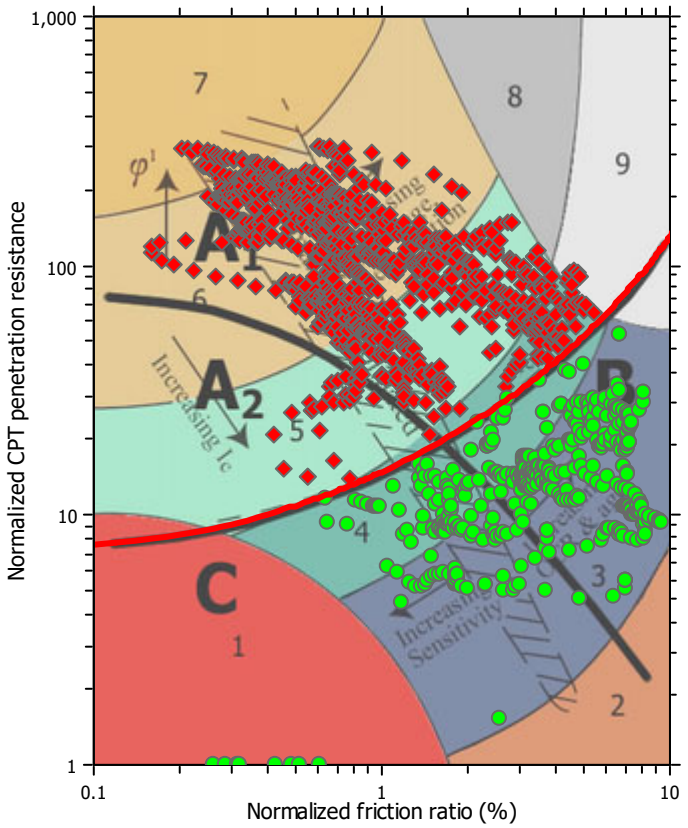
F.S. color scheme

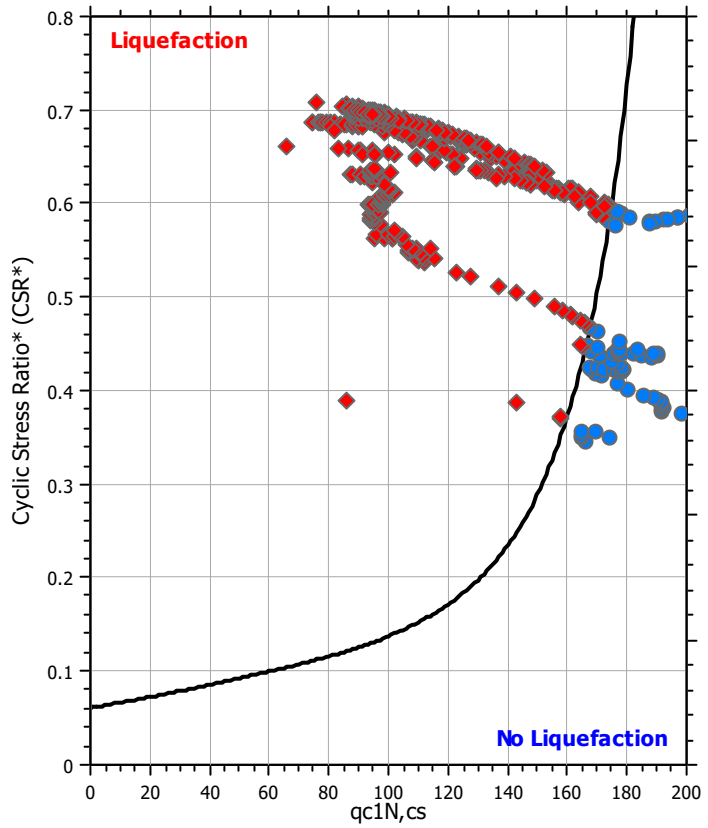
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

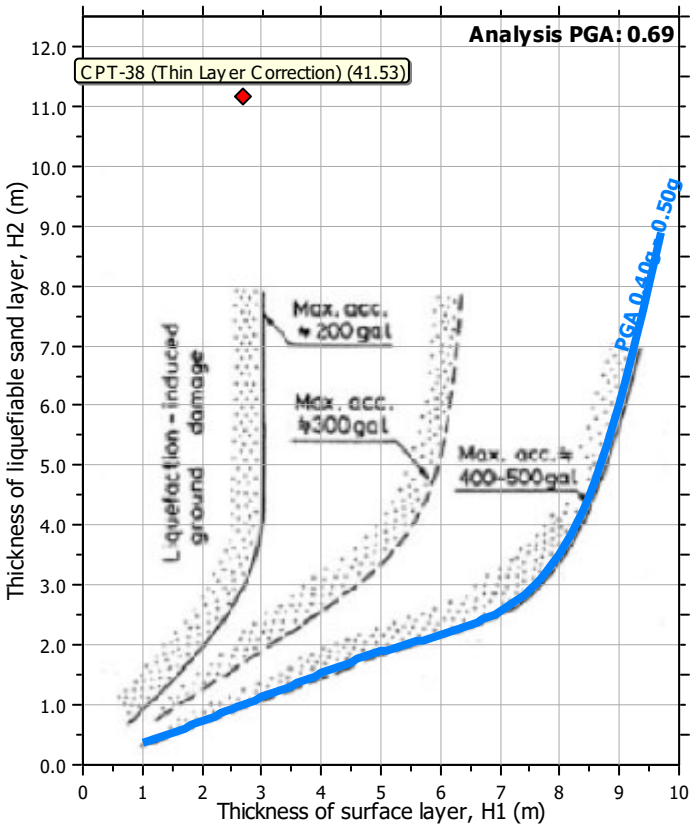
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



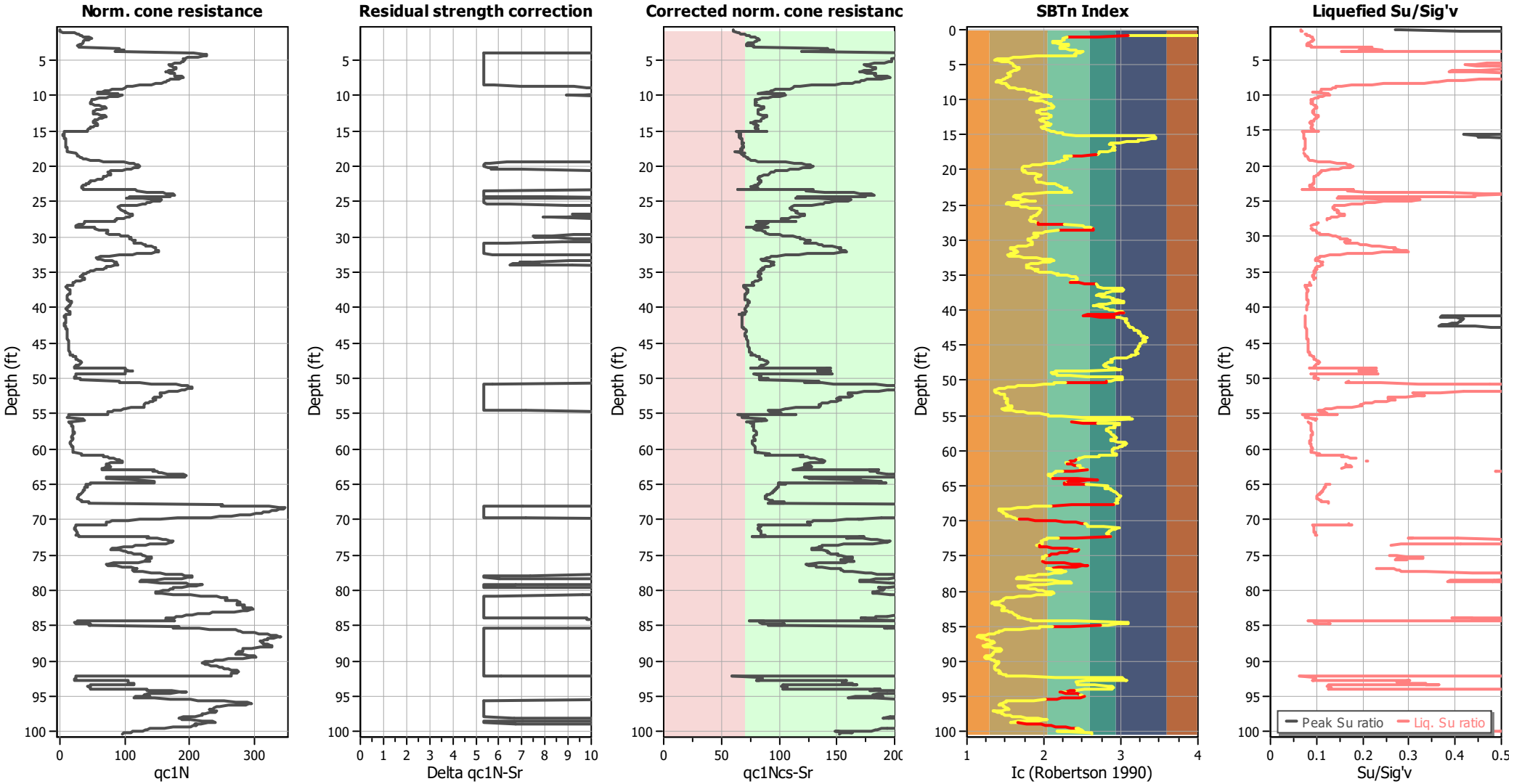




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

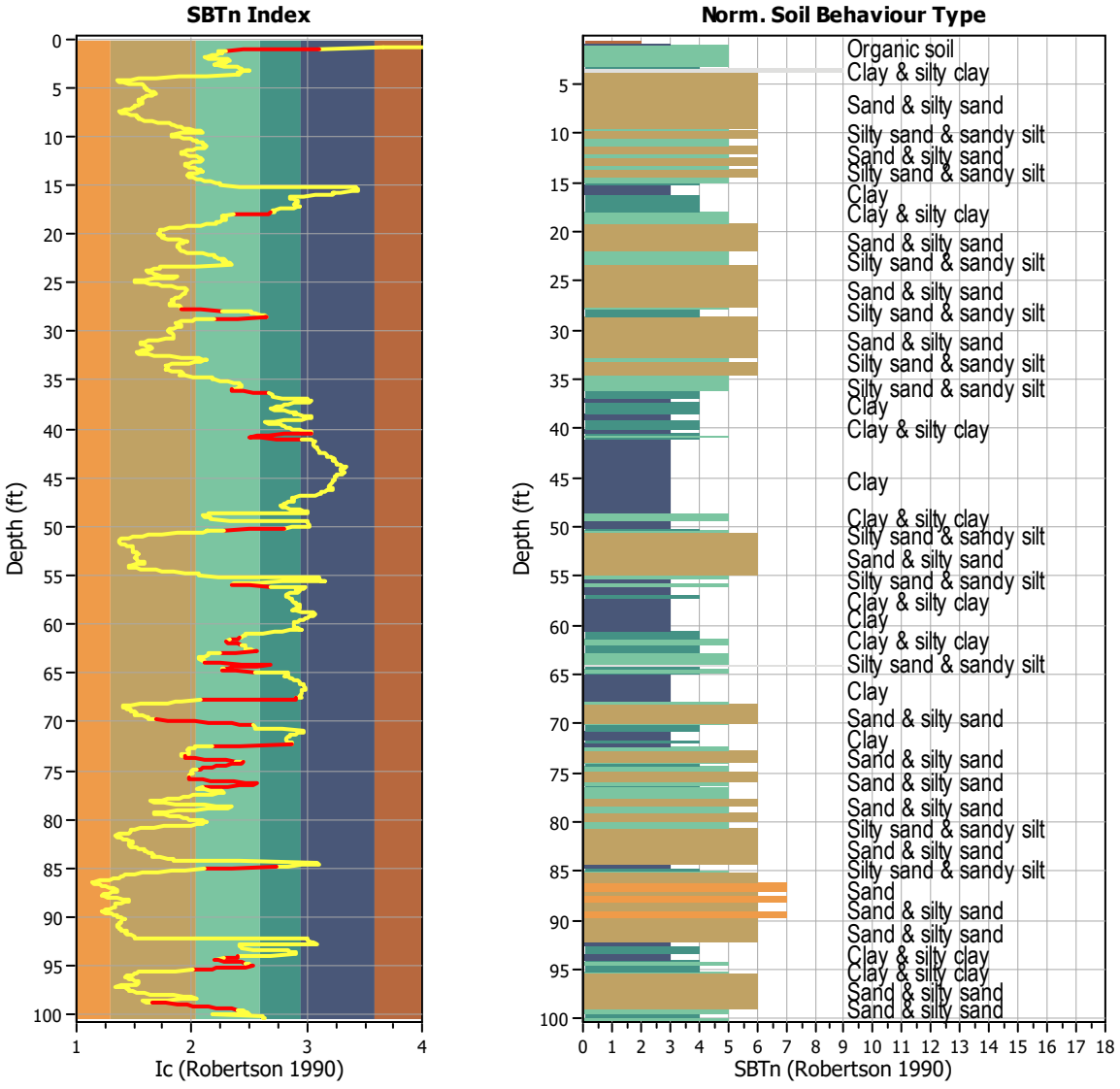
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.20 ft	Fill height:	0.92 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

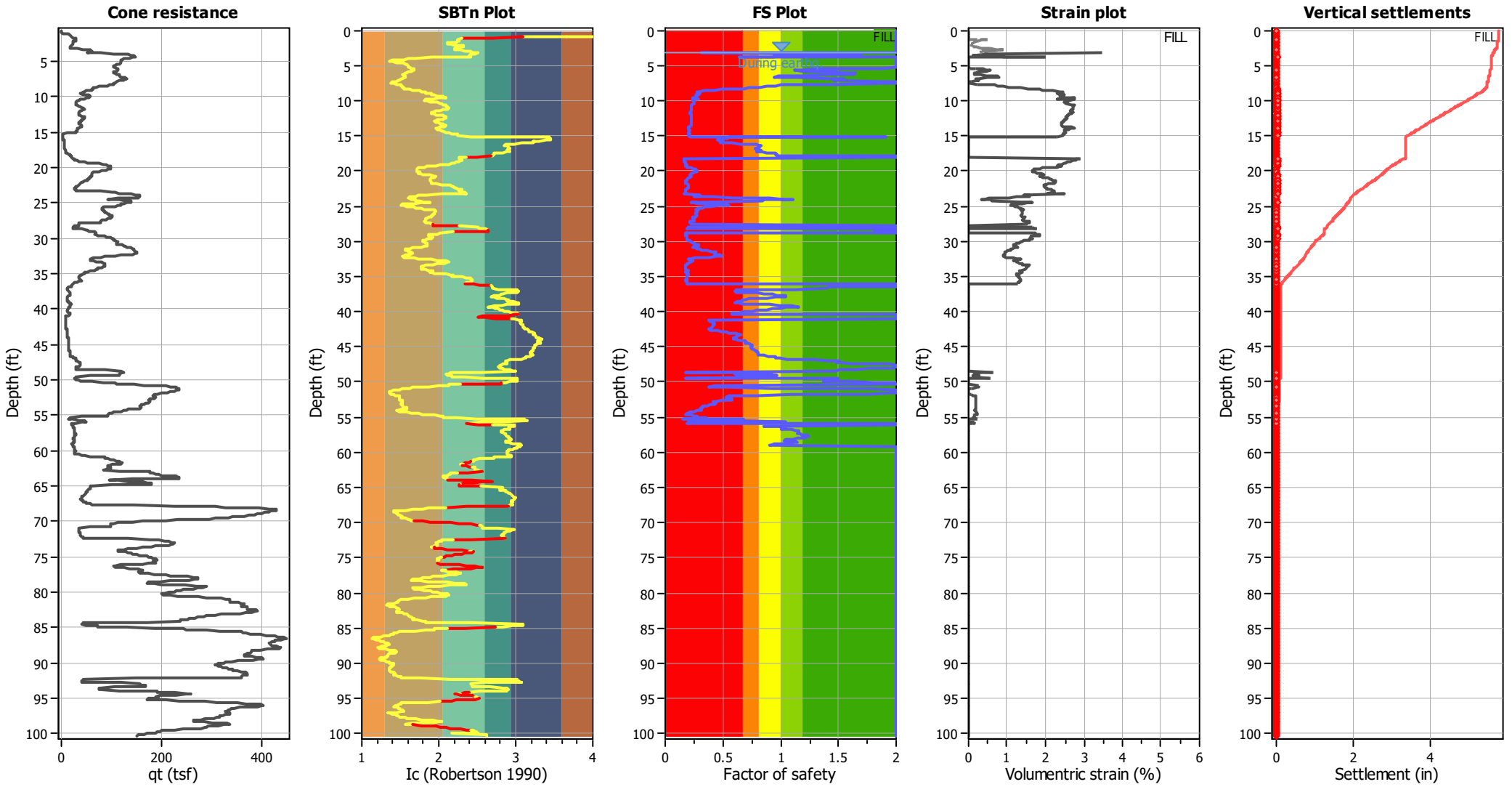
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1528
I_c maximum check value:	3.00	Total points excluded:	160
I_c change ratio value:	0.0250	Exclusion percentage:	10.47%
Minimum number of points in layer:	4	Number of layers detected:	27

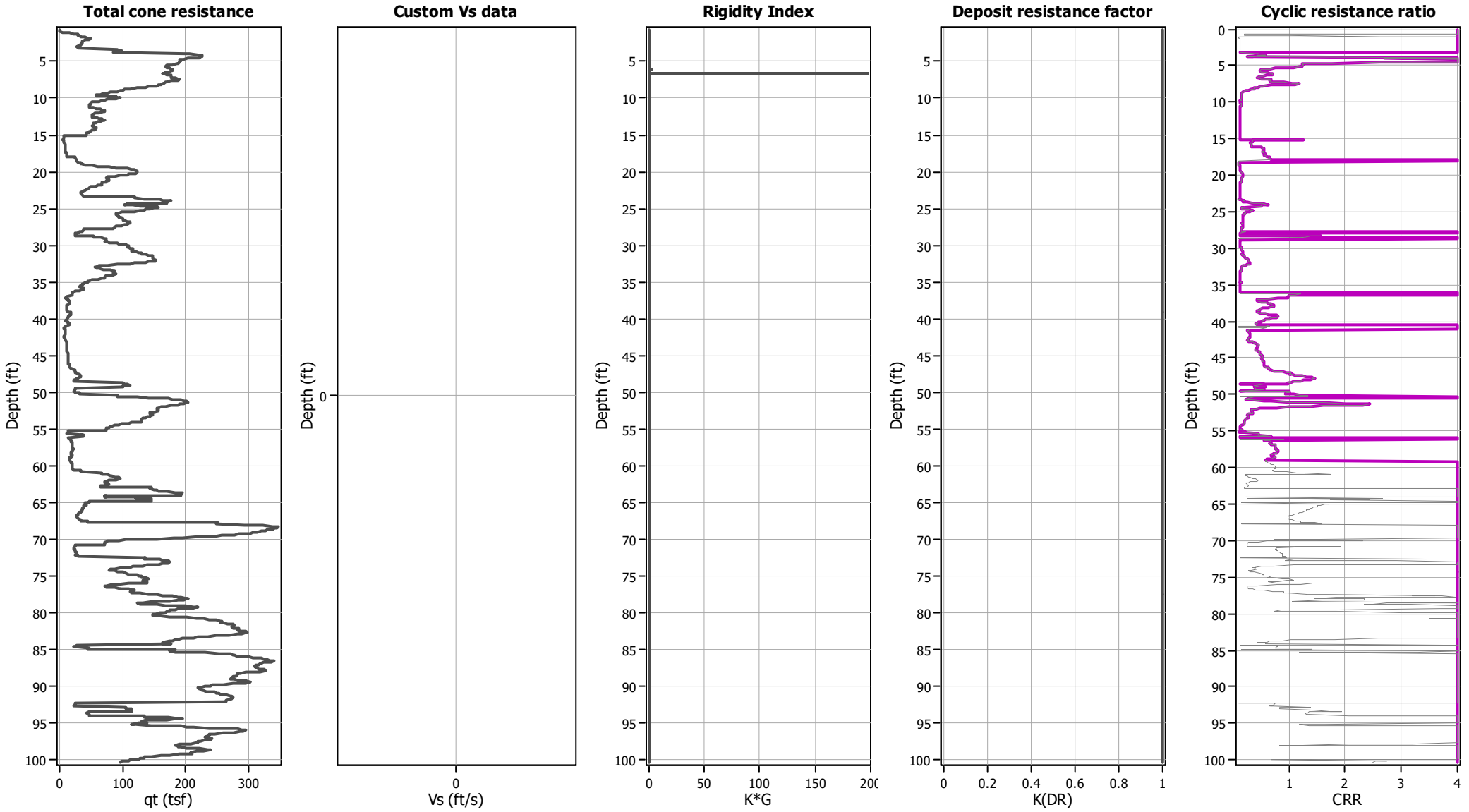
Estimation of post-earthquake settlements



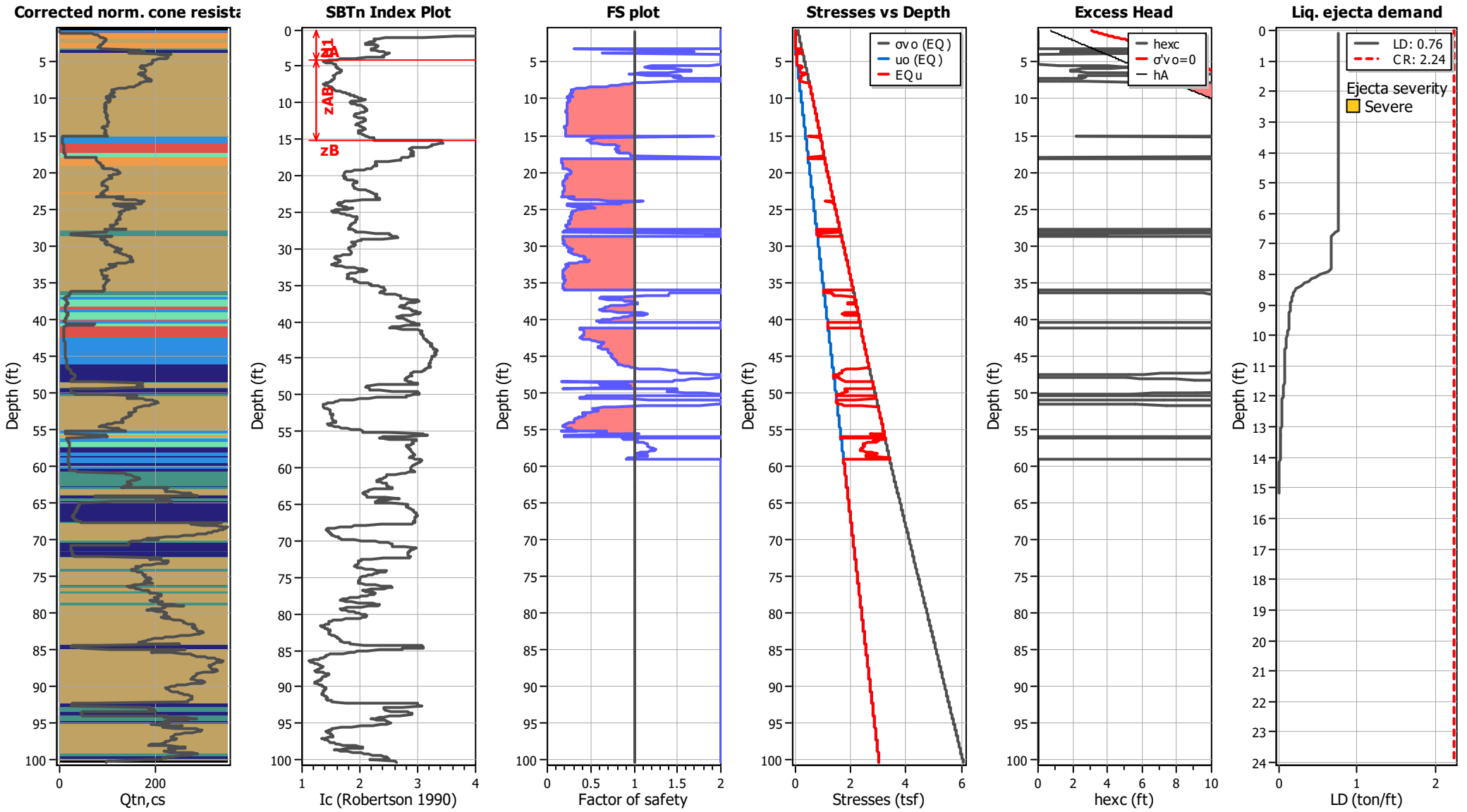
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

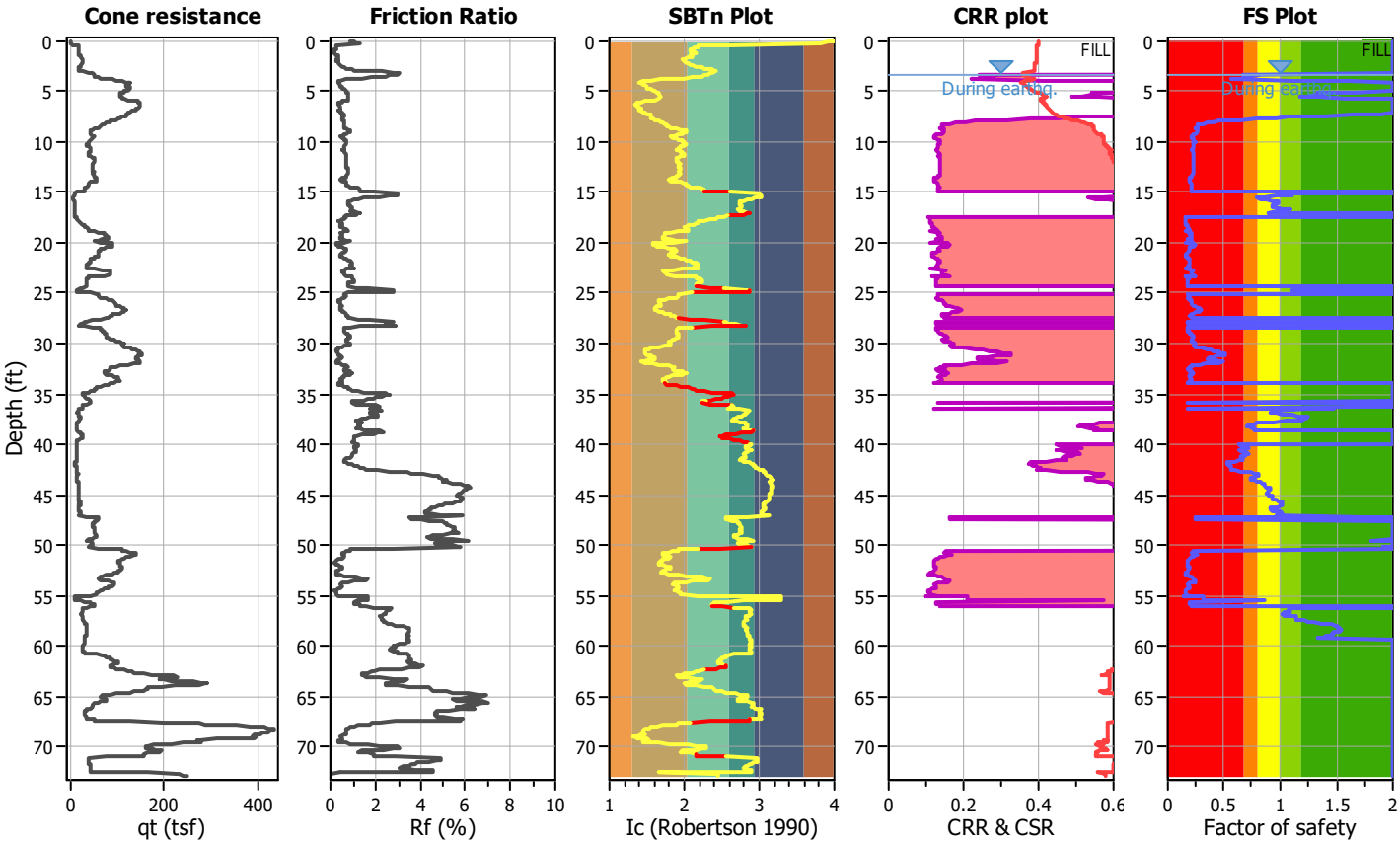
Project title : Topgolf Harbor Island

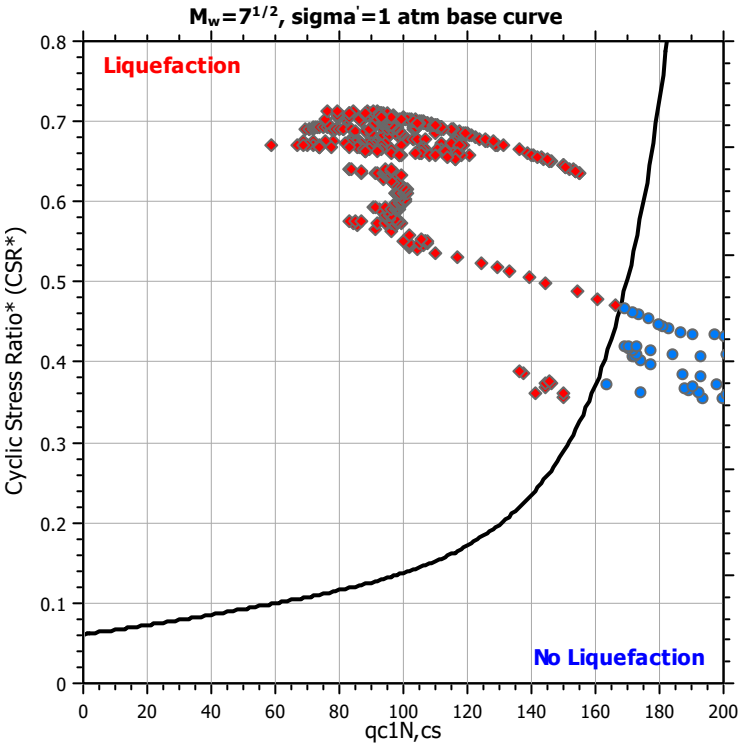
Location : North Harbor Drive and Liberator Way, San Diego, CA

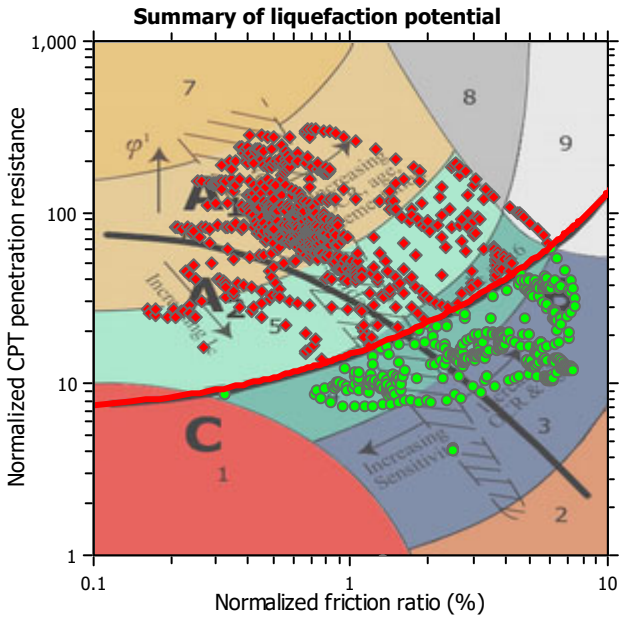
CPT file : CPT-39 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.34 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	0.78 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

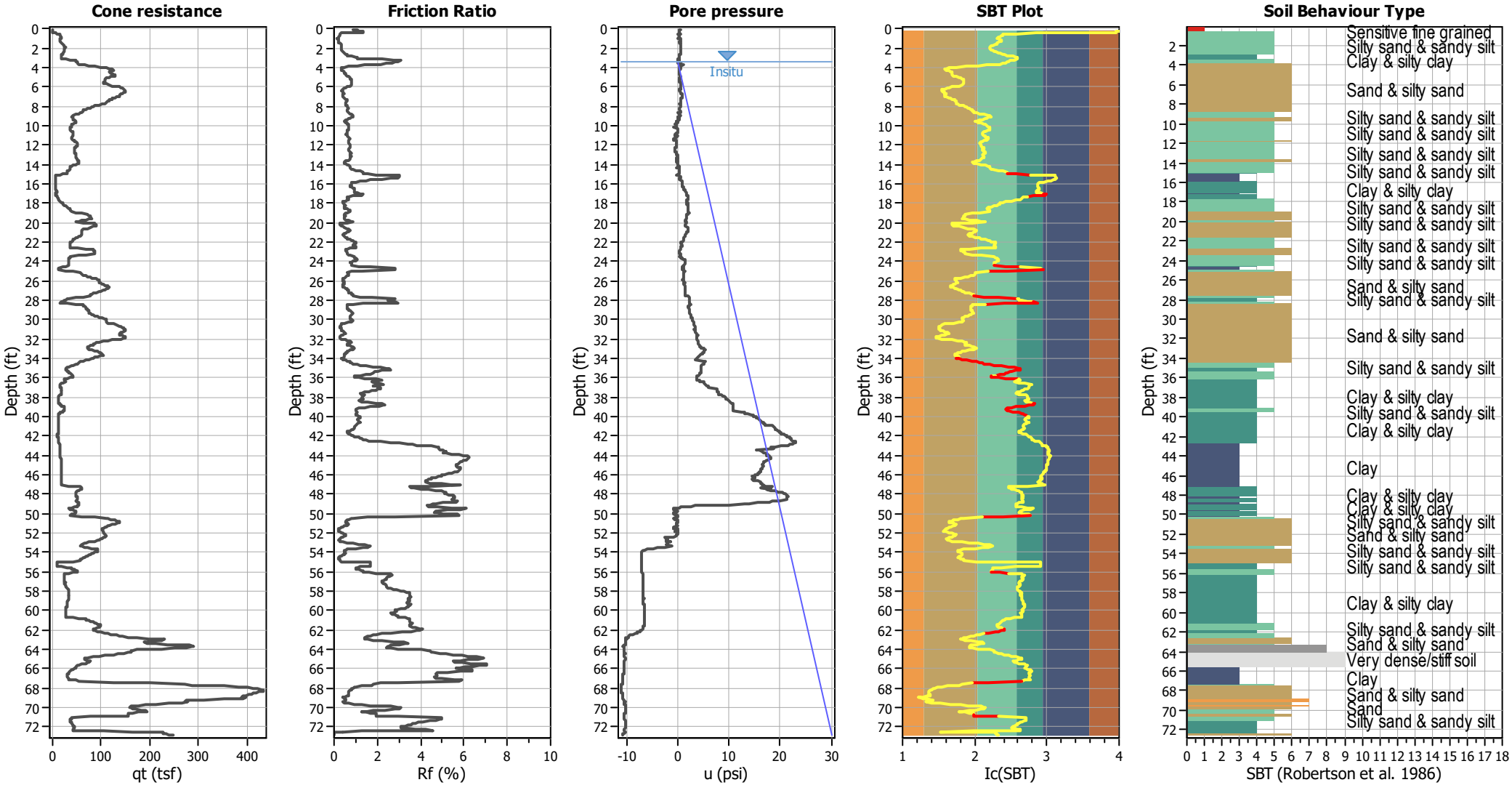






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



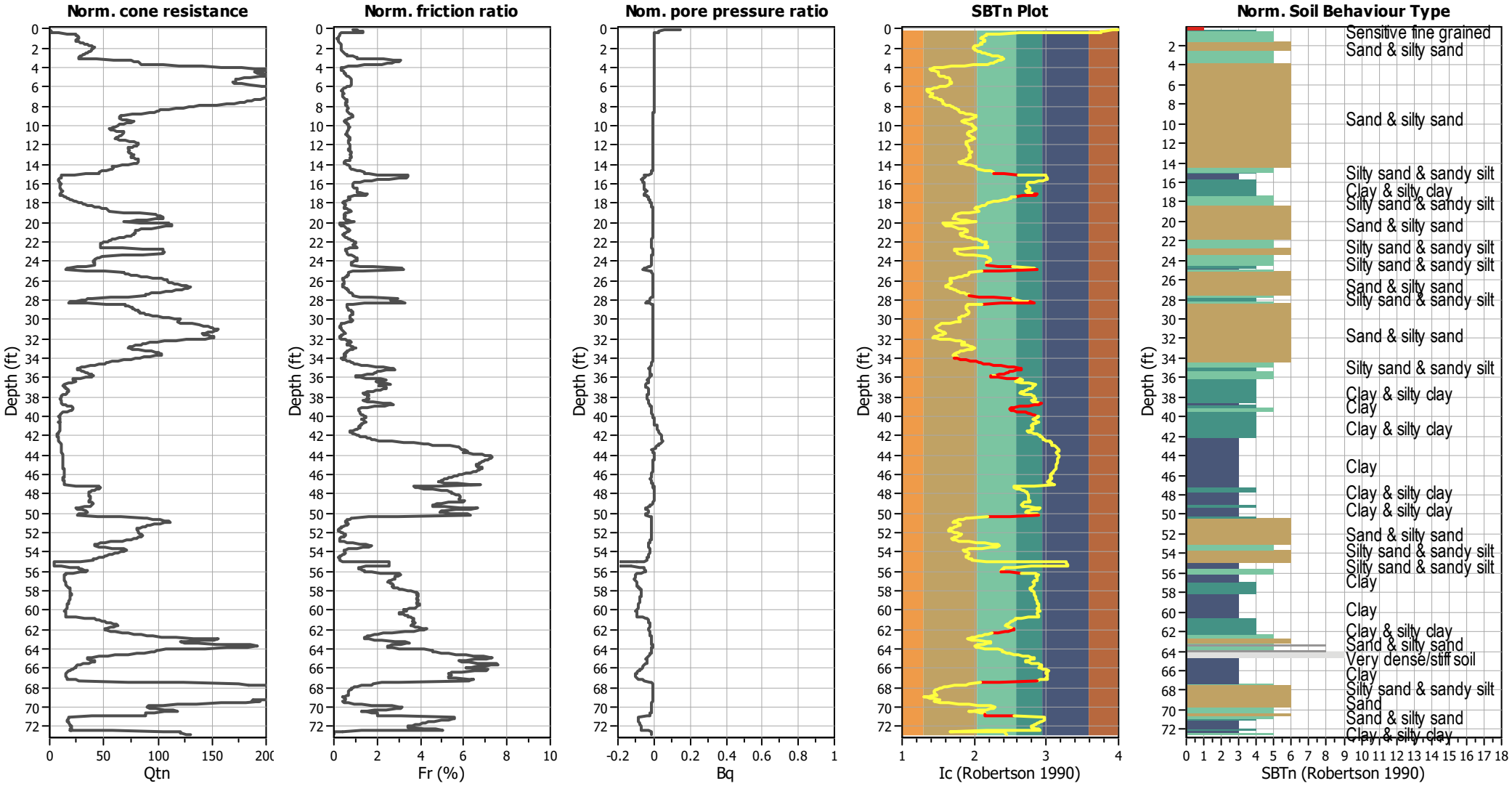
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 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)



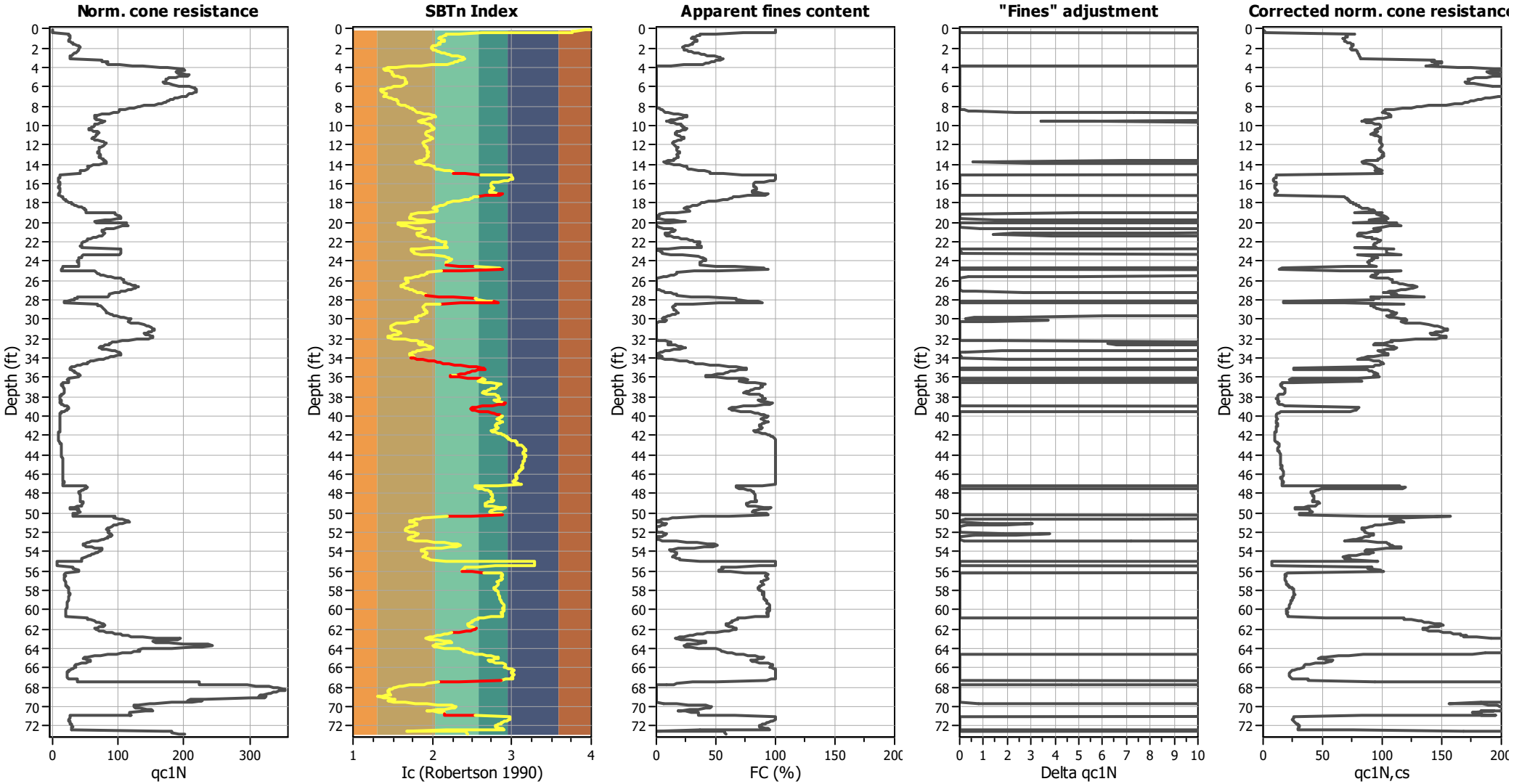
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 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

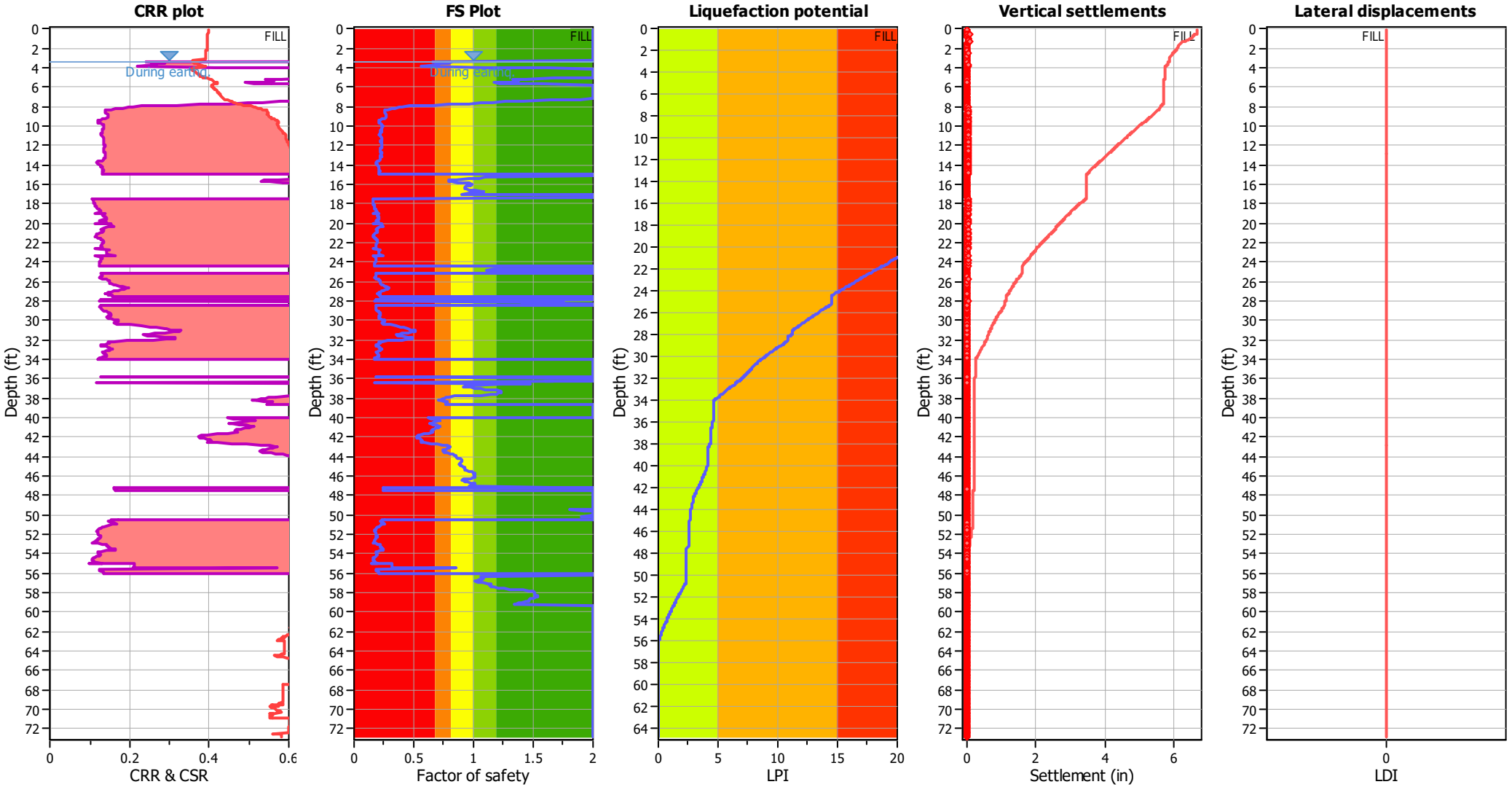
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 ft	Limit depth:	60.00 ft

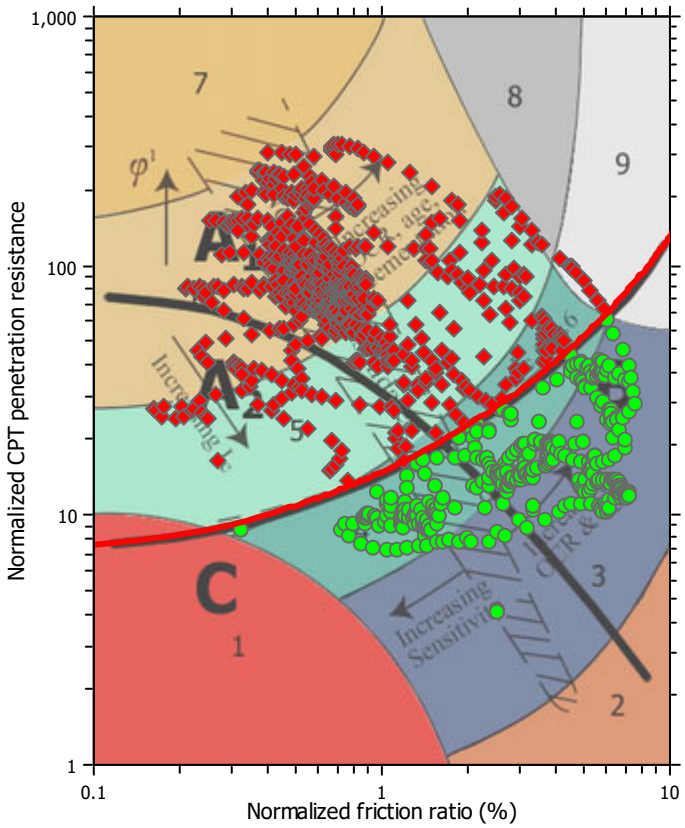
F.S. color scheme

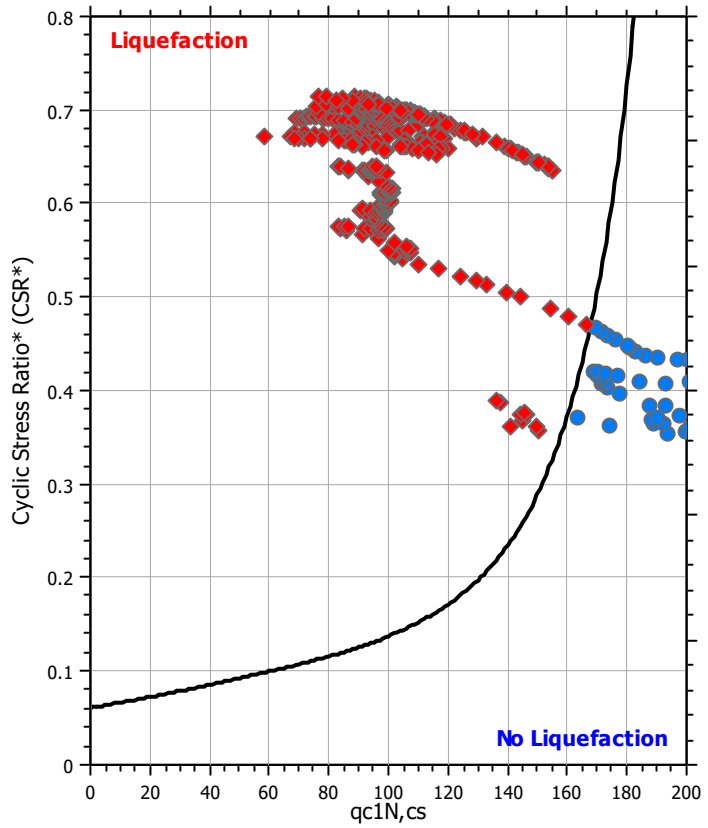
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

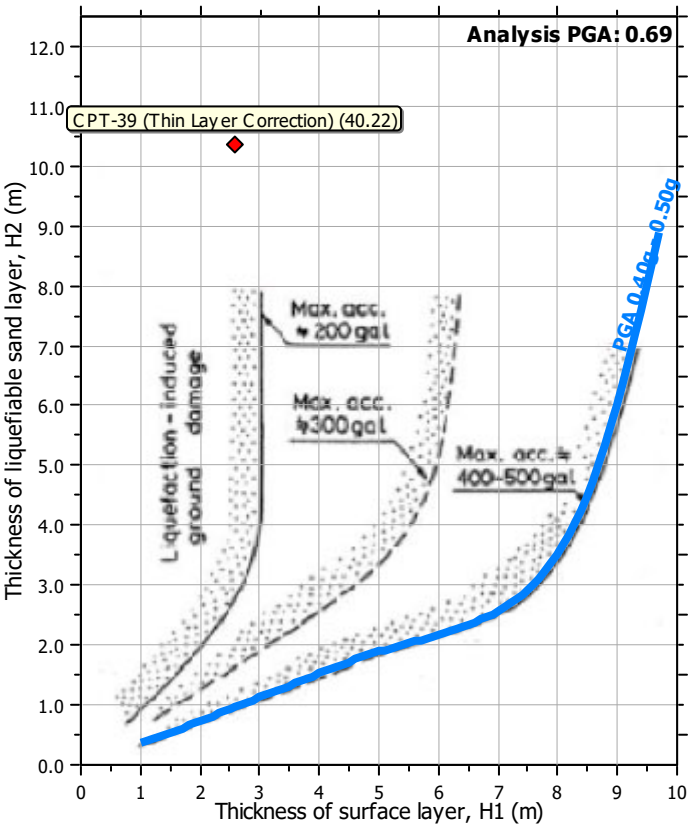
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



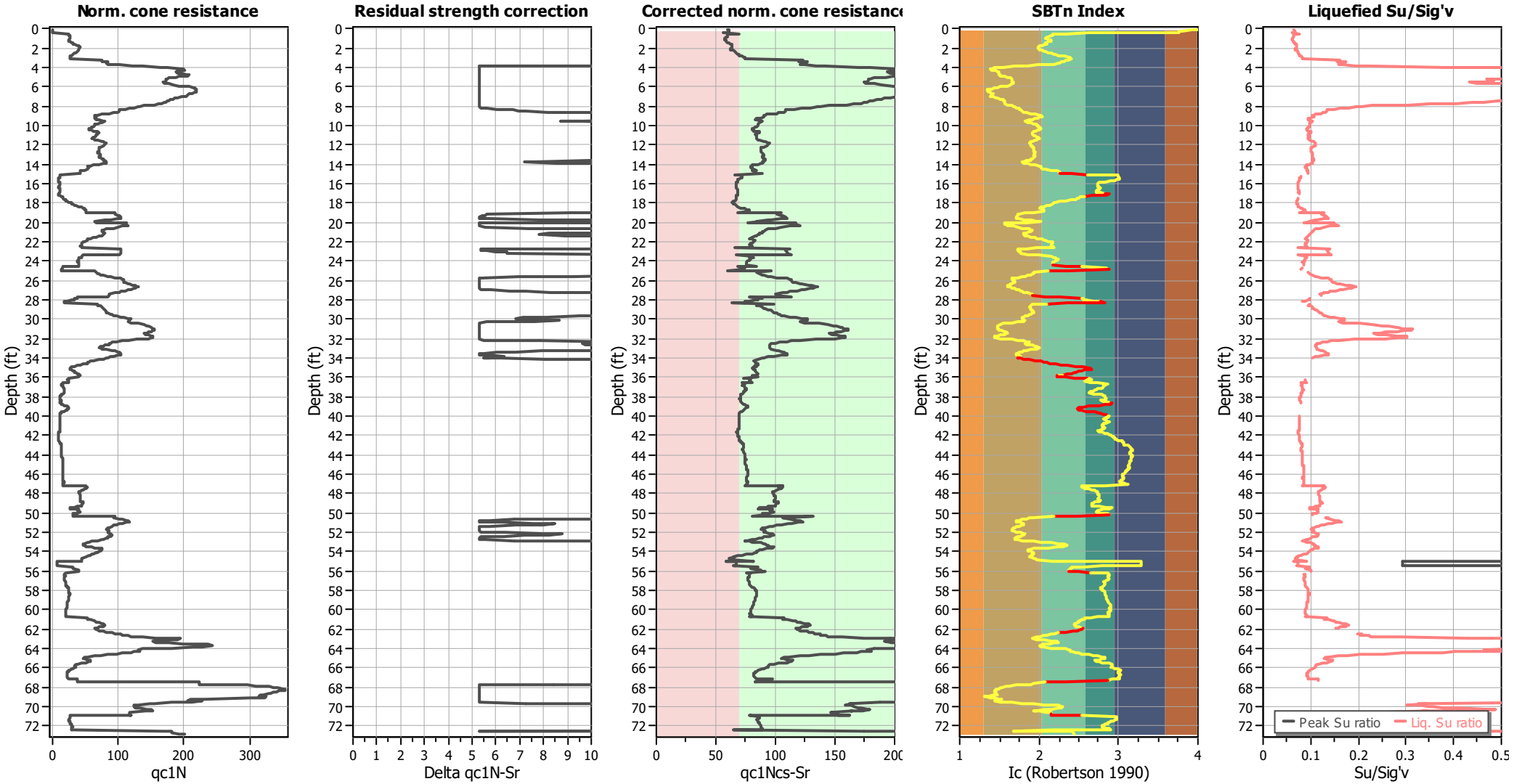




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

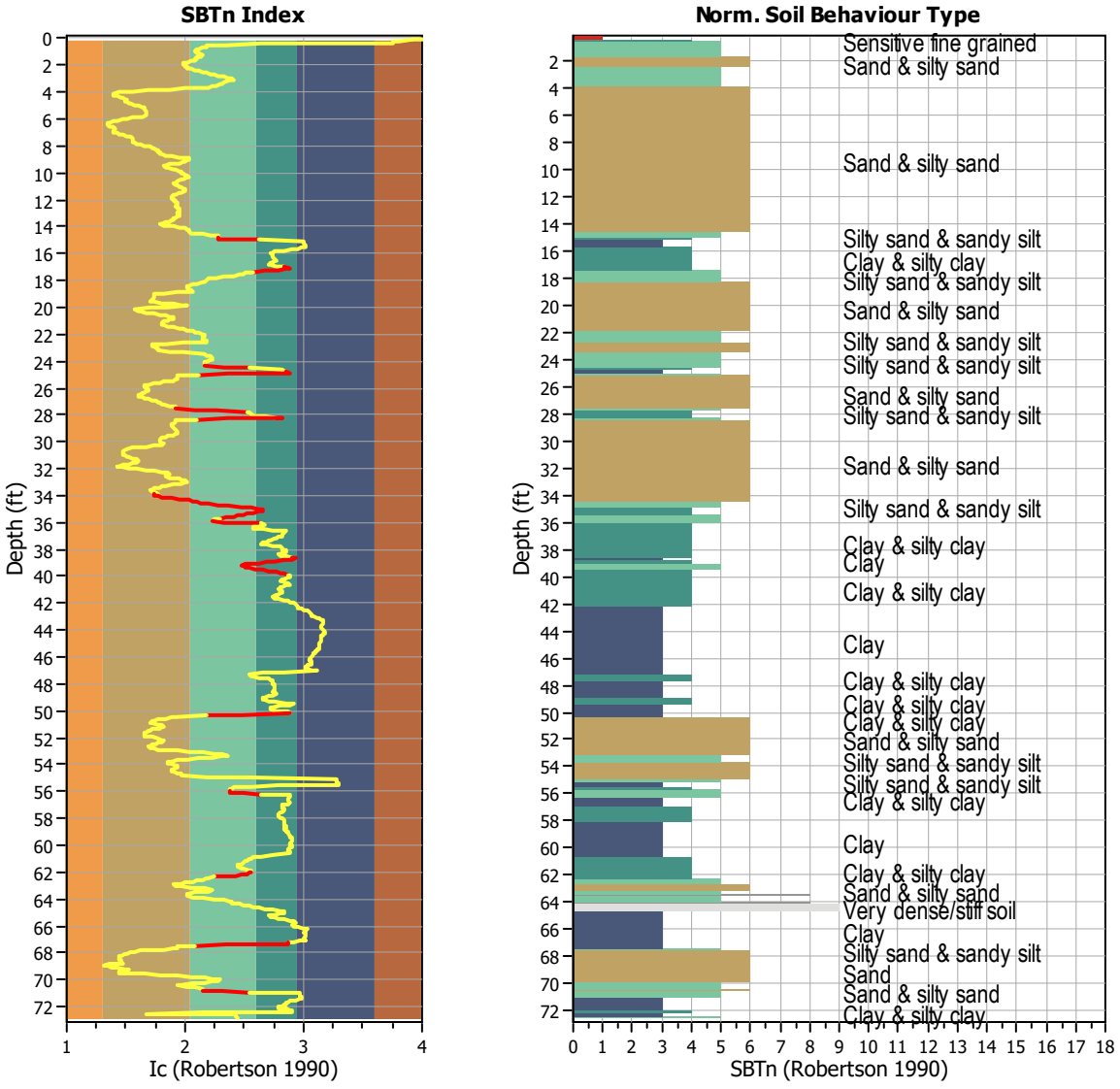
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.34 ft	Fill height:	0.78 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

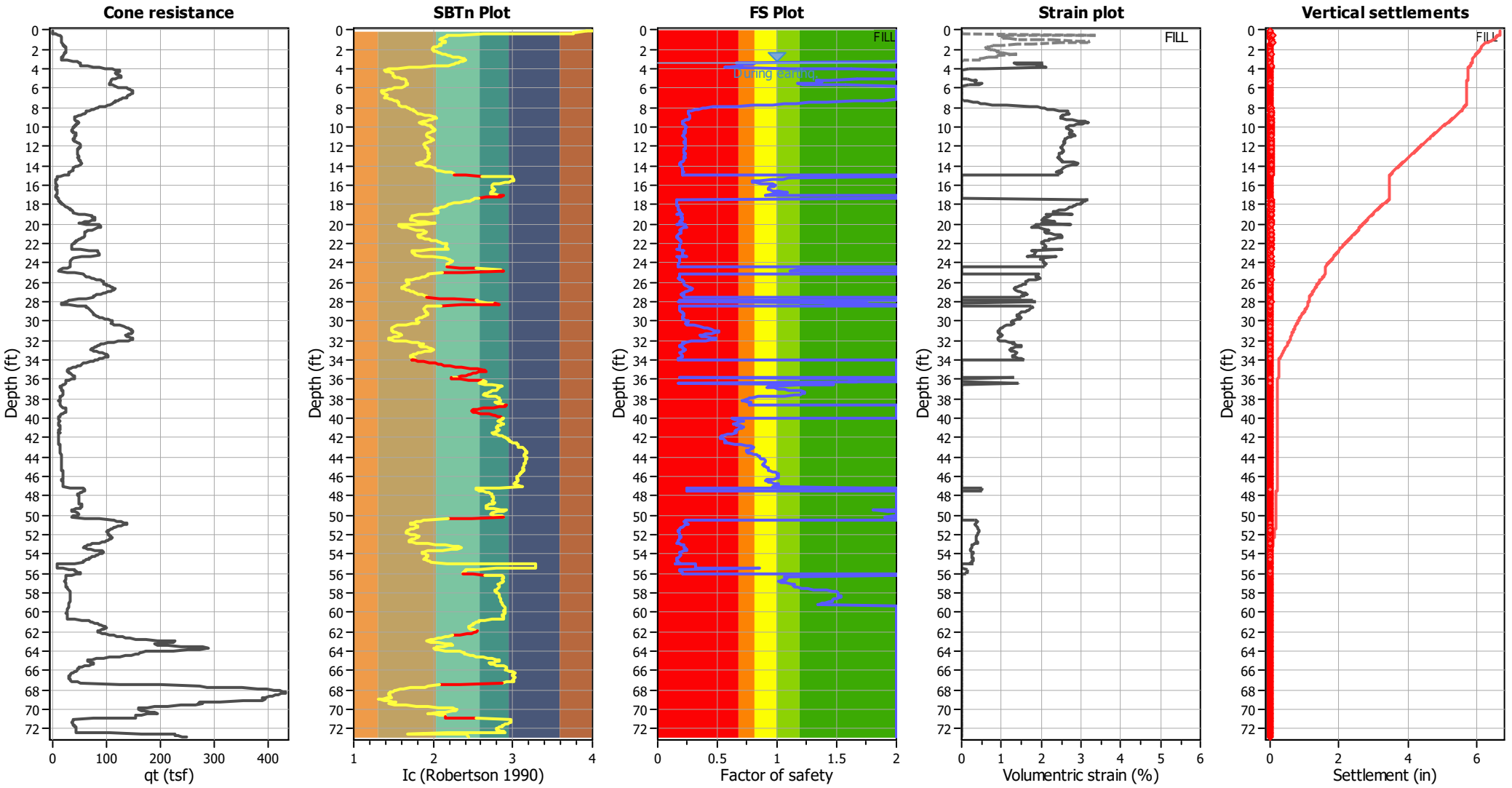
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between 1.80 < I_c < 3.0) and a rate of change of I_c. Transitions typically occur 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:	1108
I_c maximum check value:	3.00	Total points excluded:	104
I_c change ratio value:	0.0250	Exclusion percentage:	9.39%
Minimum number of points in layer:	4	Number of layers detected:	16

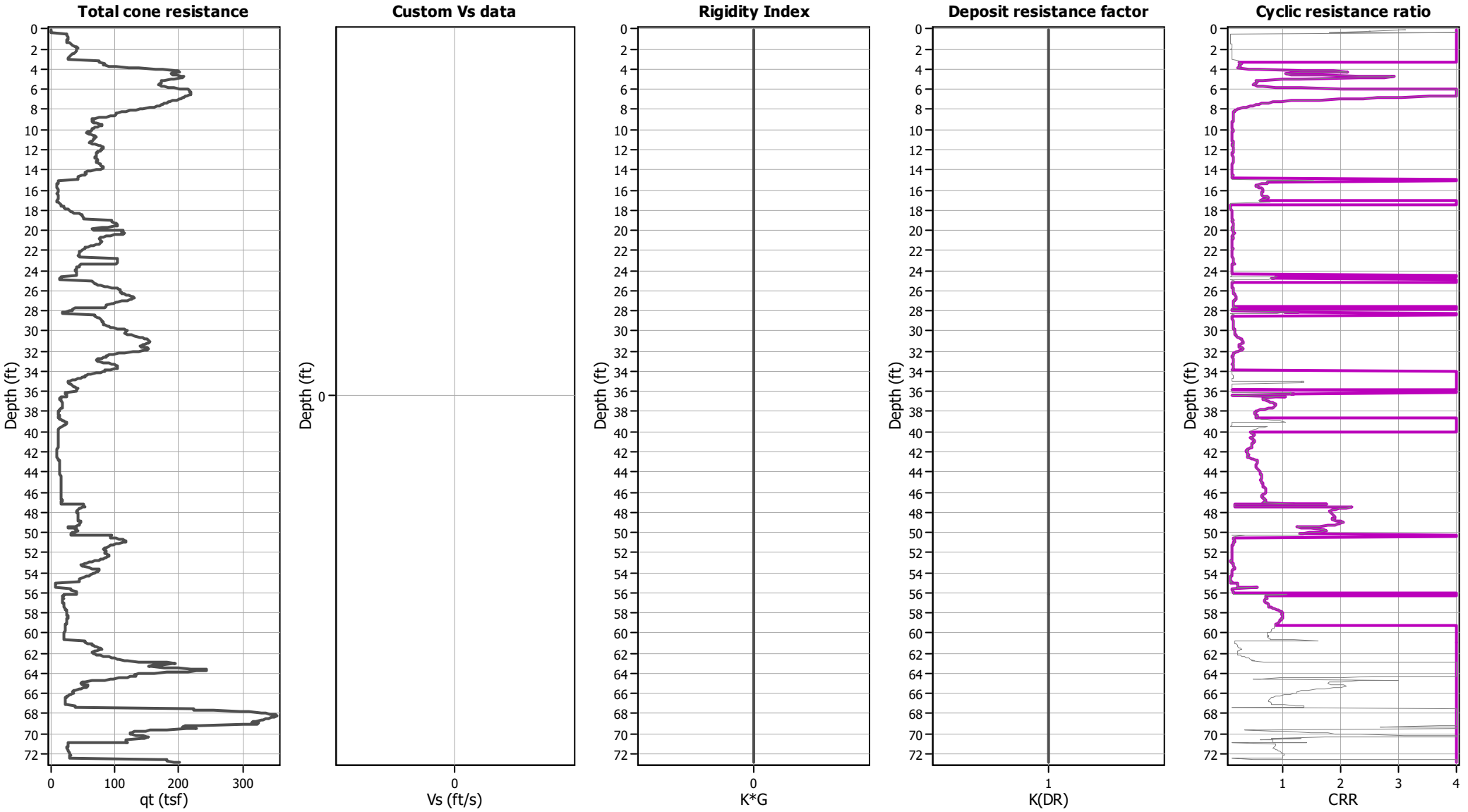
Estimation of post-earthquake settlements



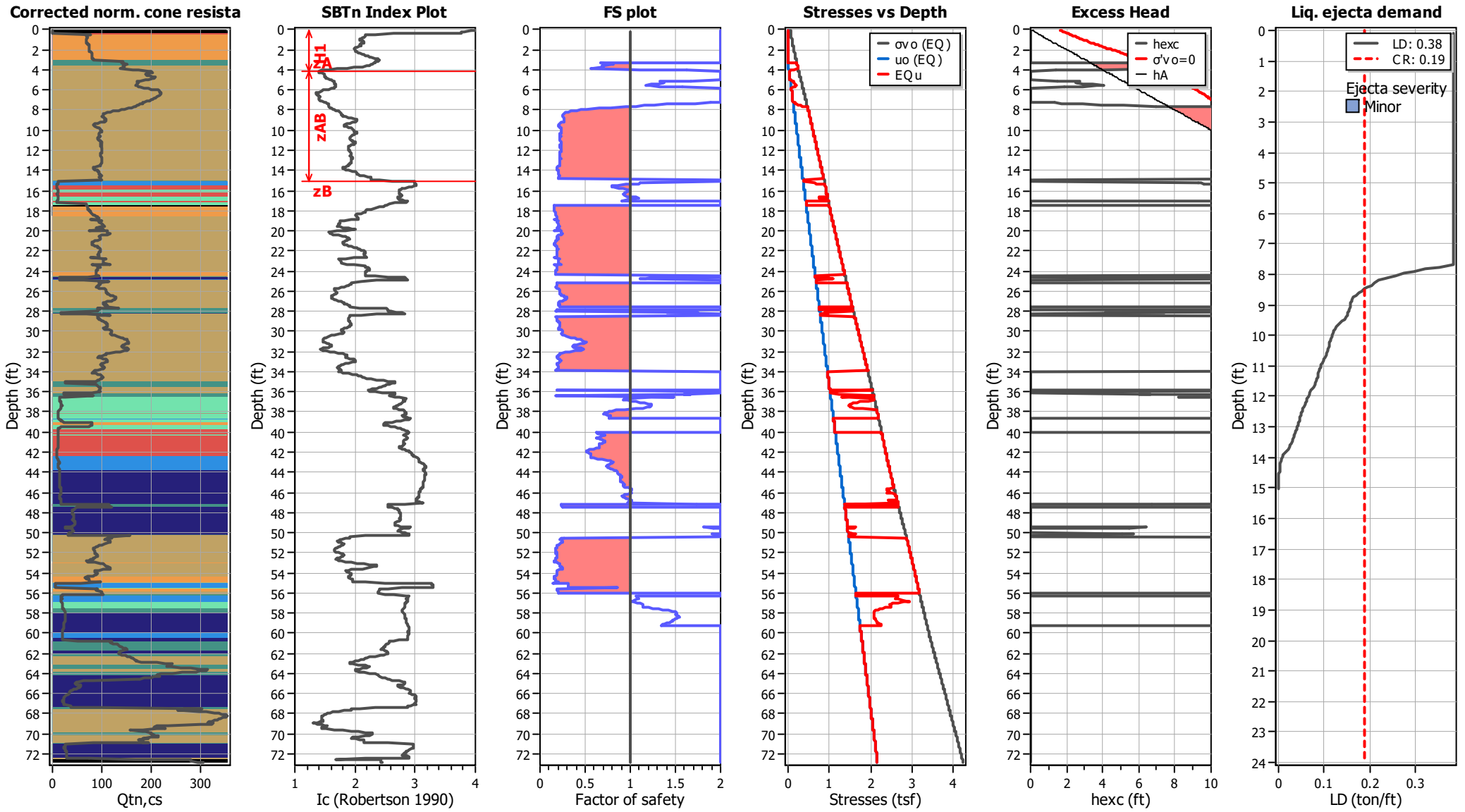
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

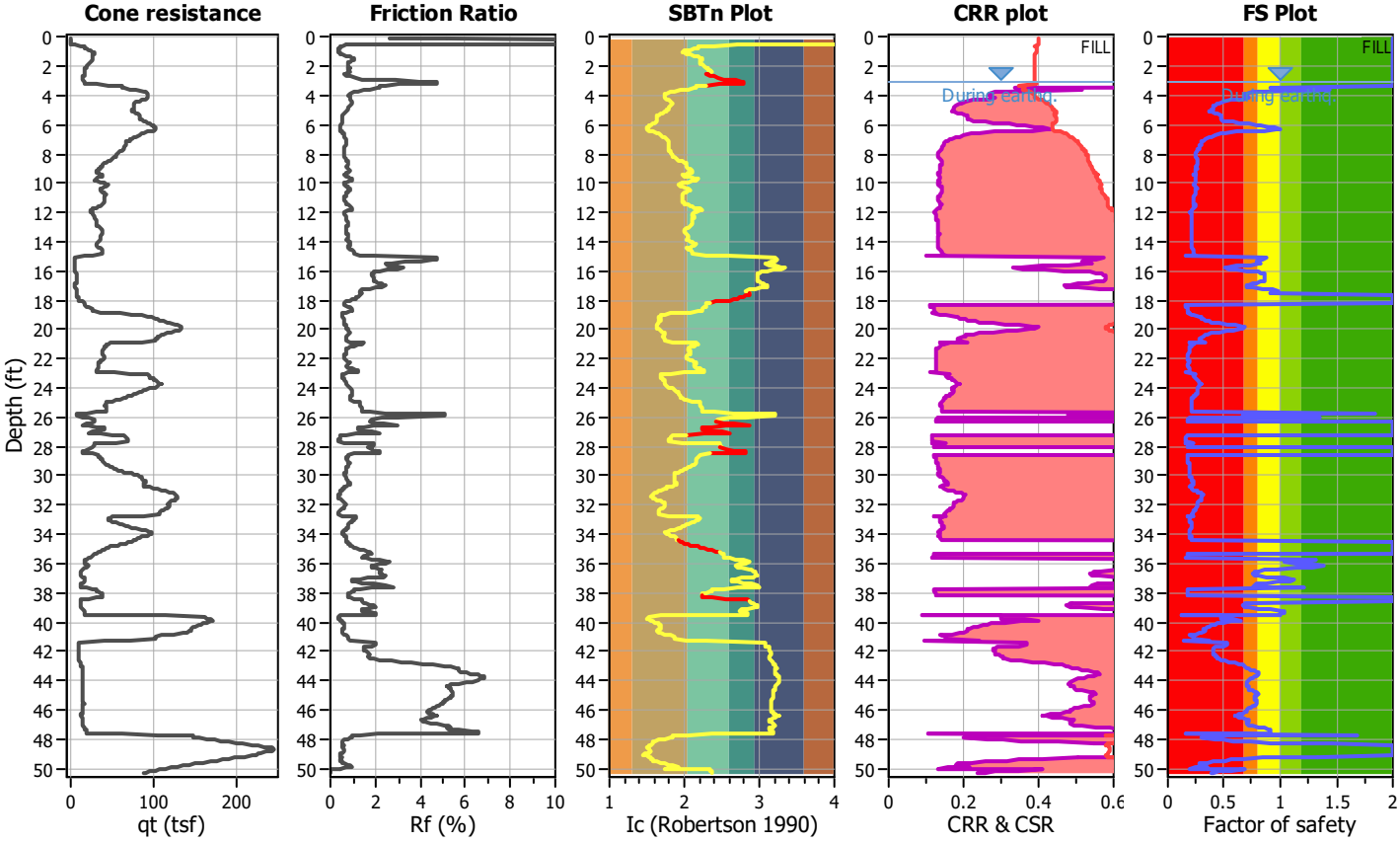
Project title : Topgolf Harbor Island

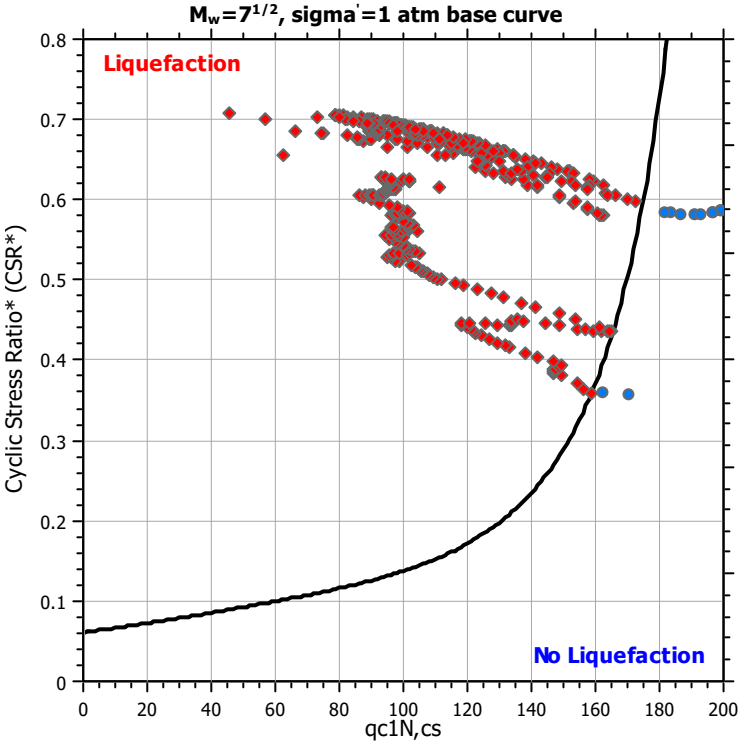
Location : North Harbor Drive and Liberator Way, San Diego, CA

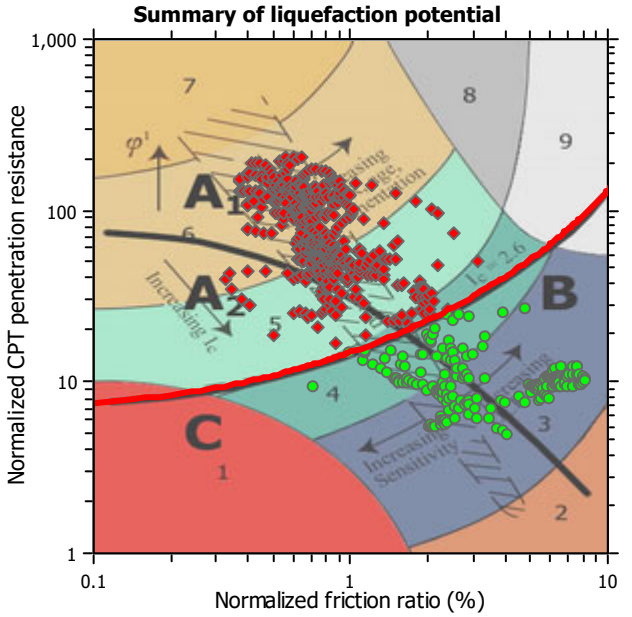
CPT file : CPT-40 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.12 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.50 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

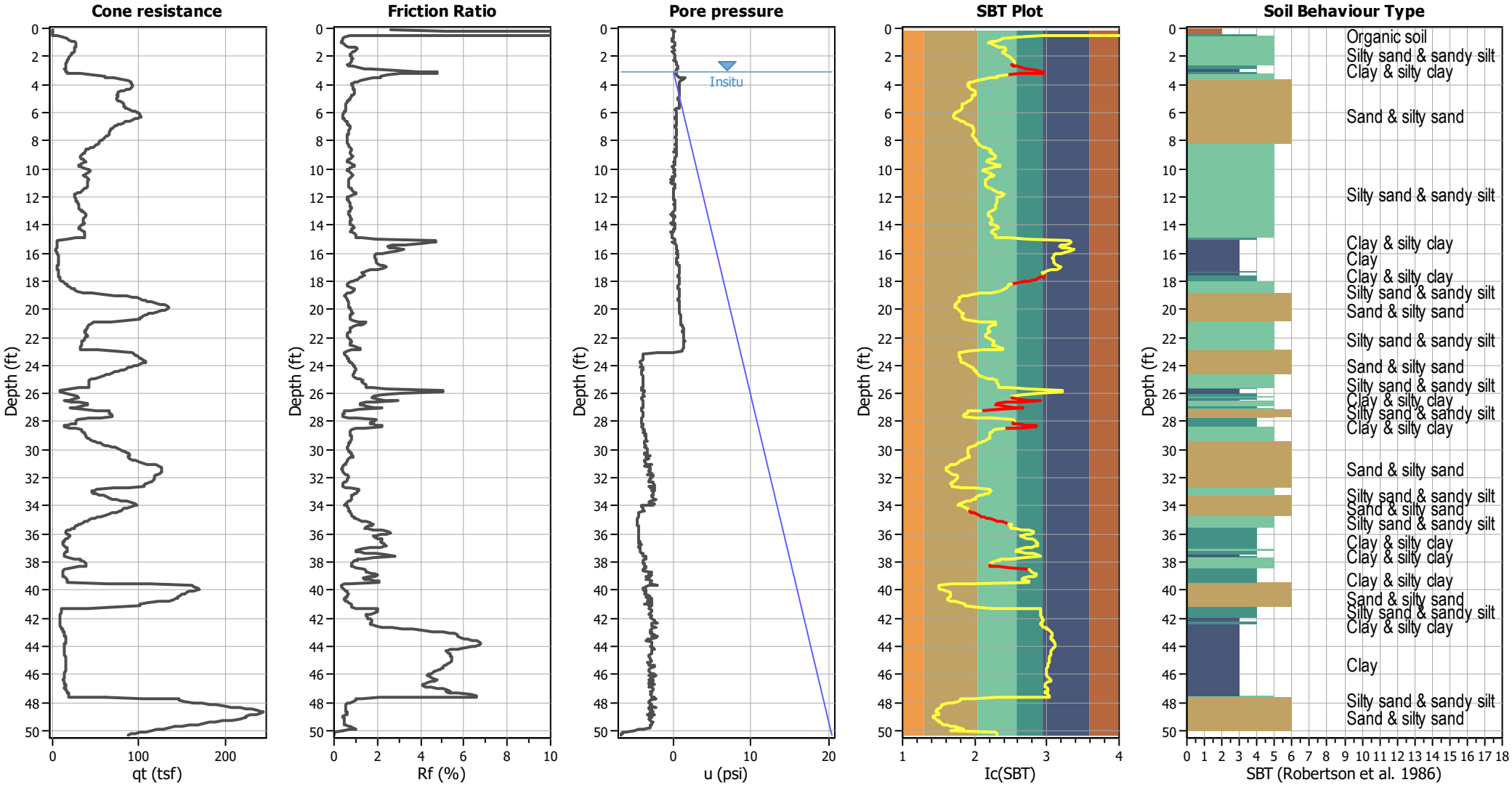






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



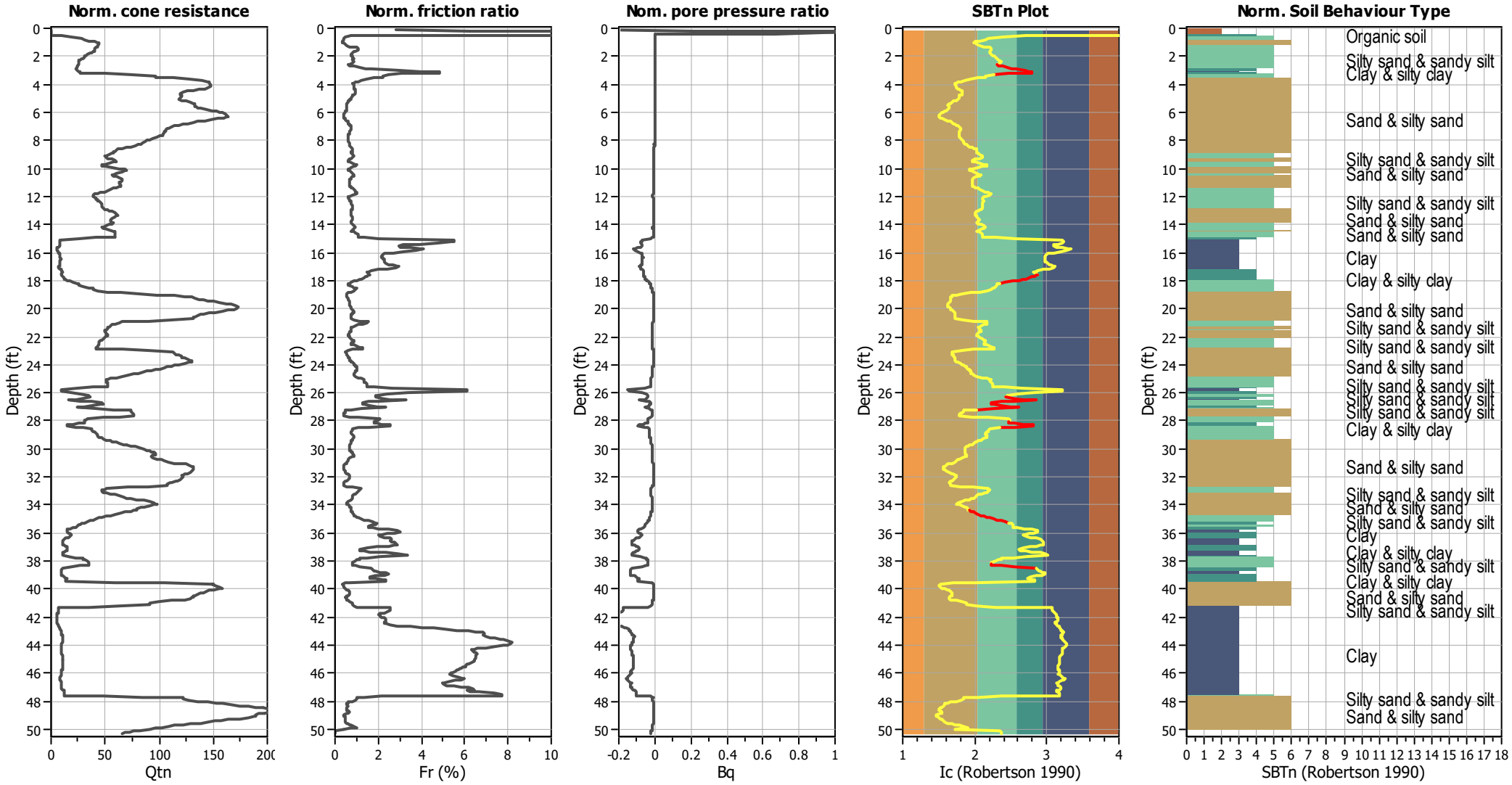
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 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)



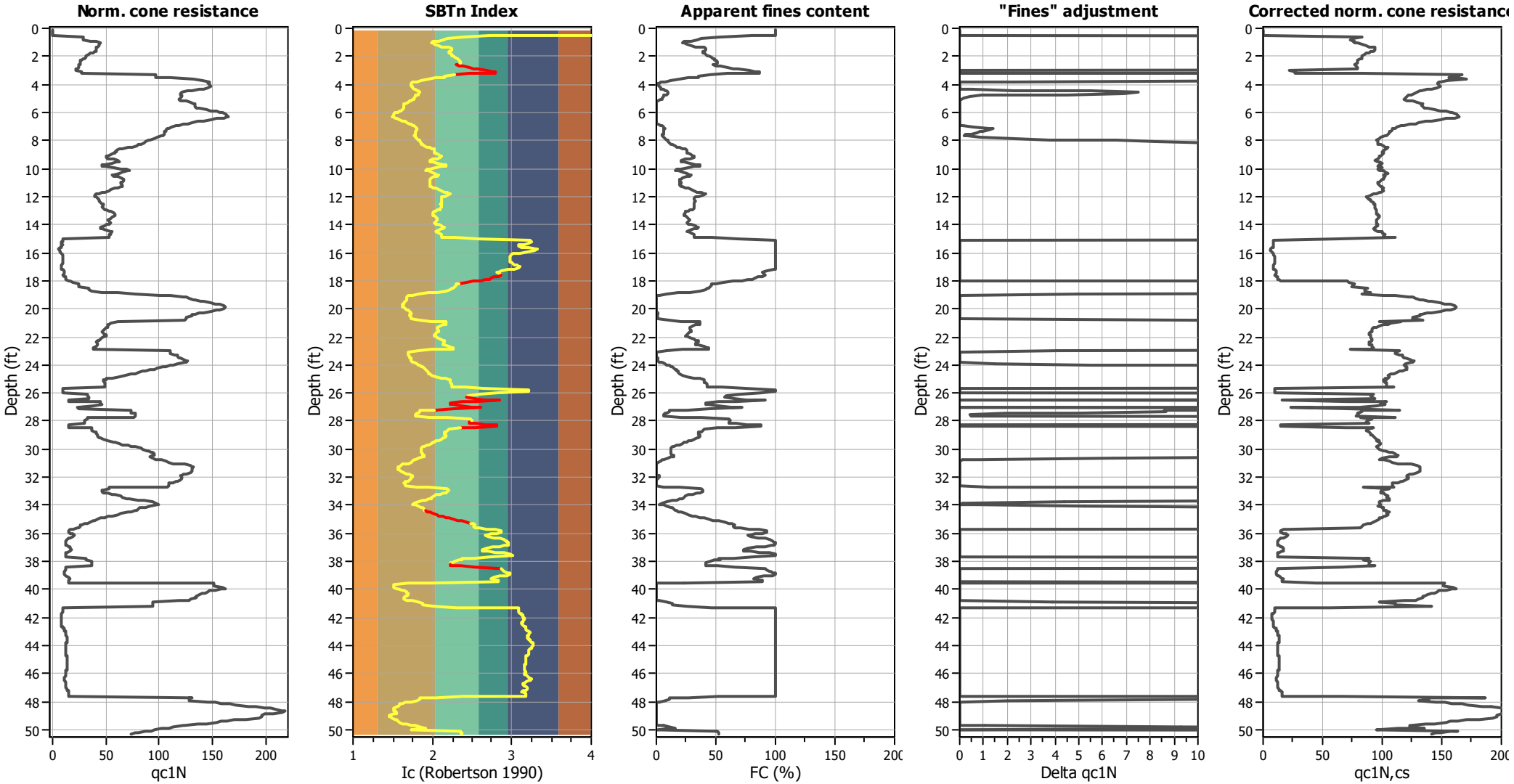
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 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

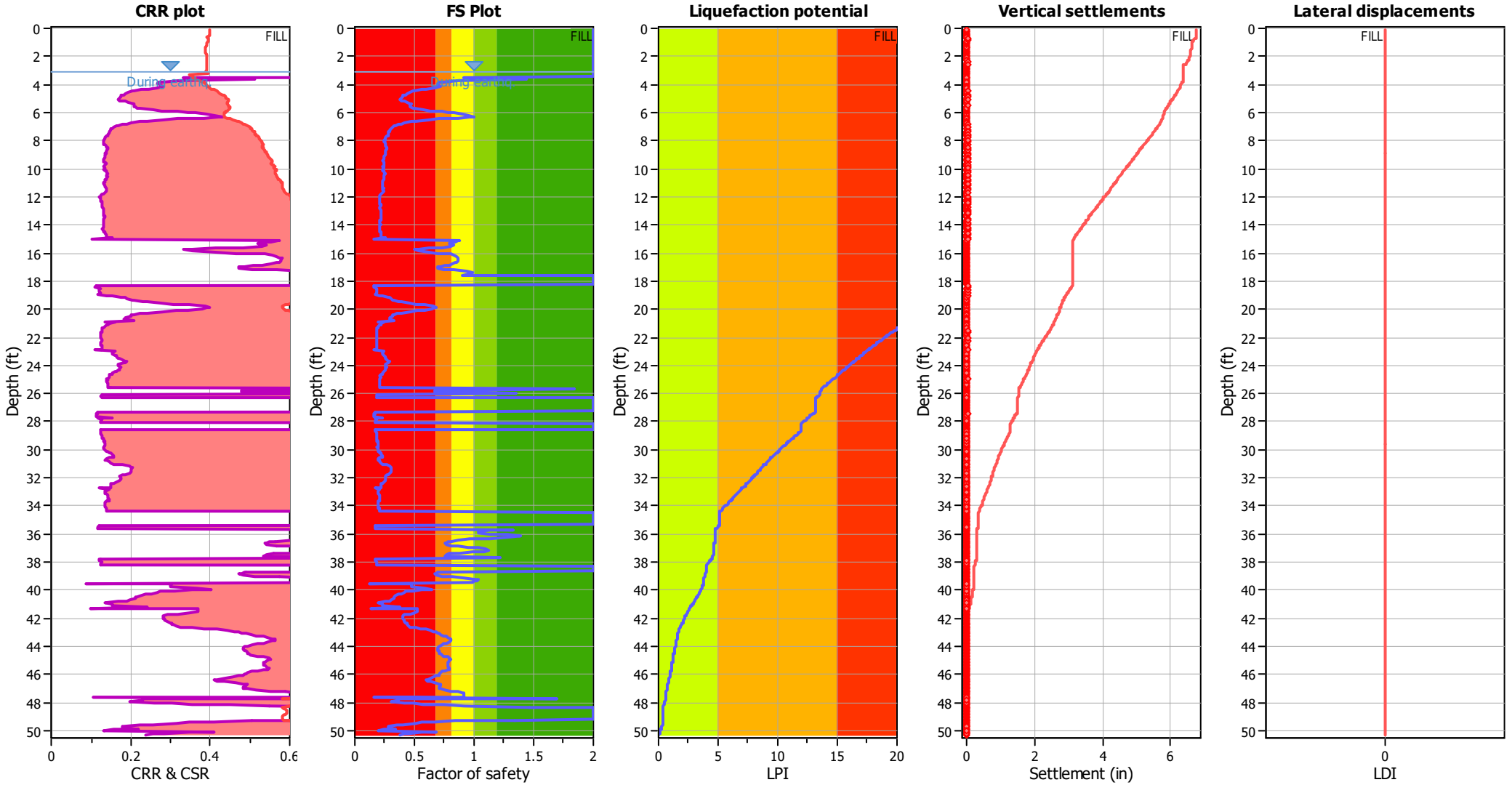
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

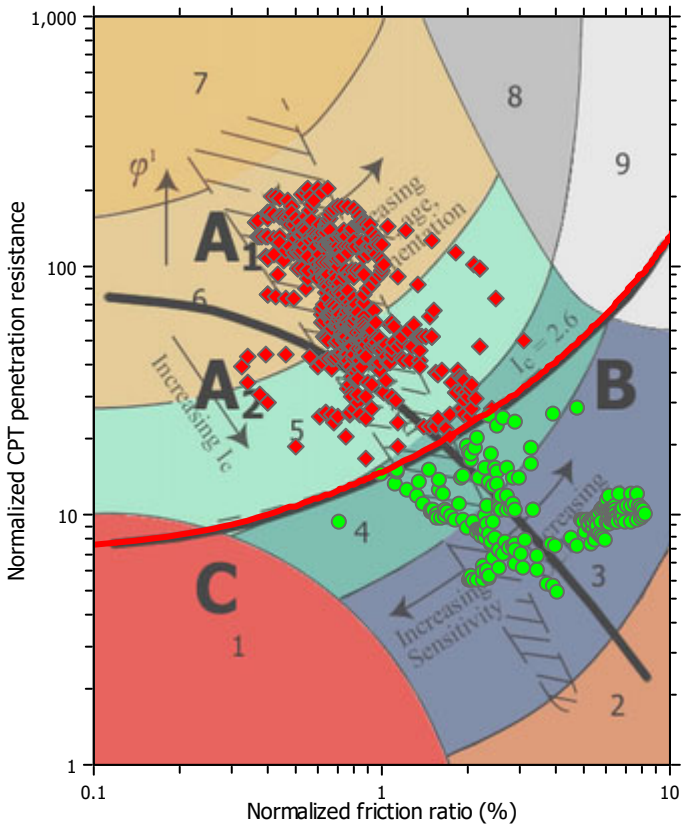
F.S. color scheme

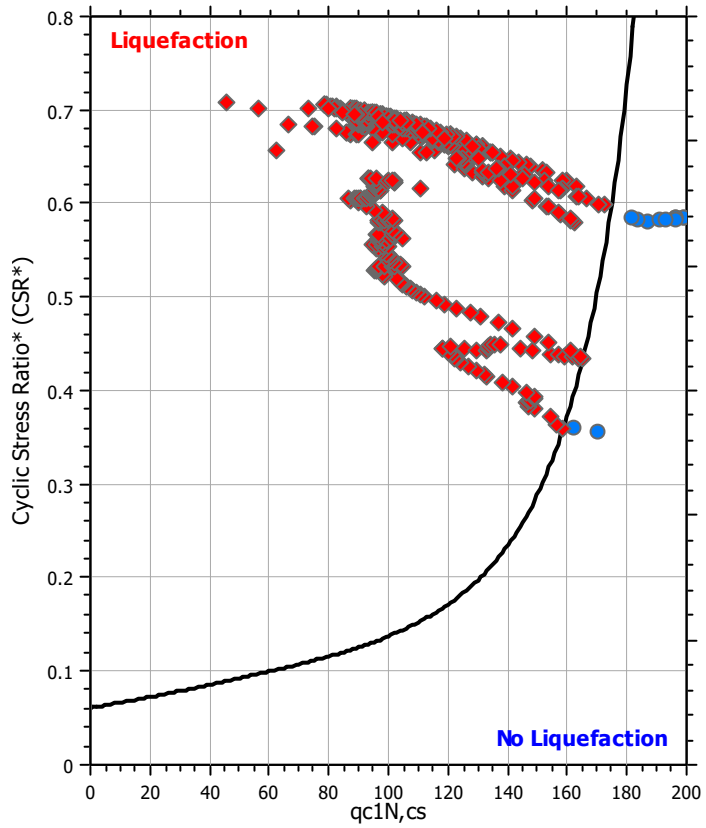
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

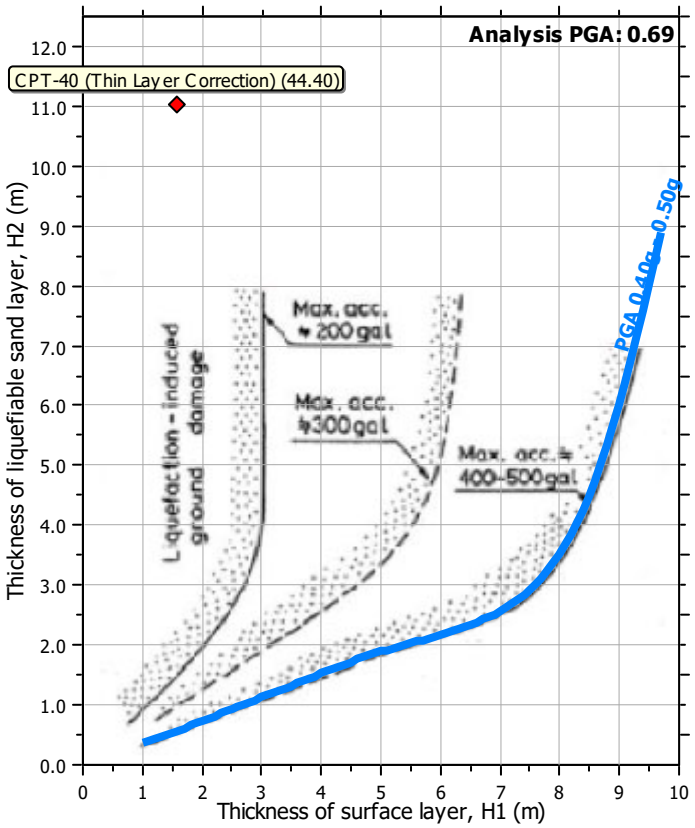
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



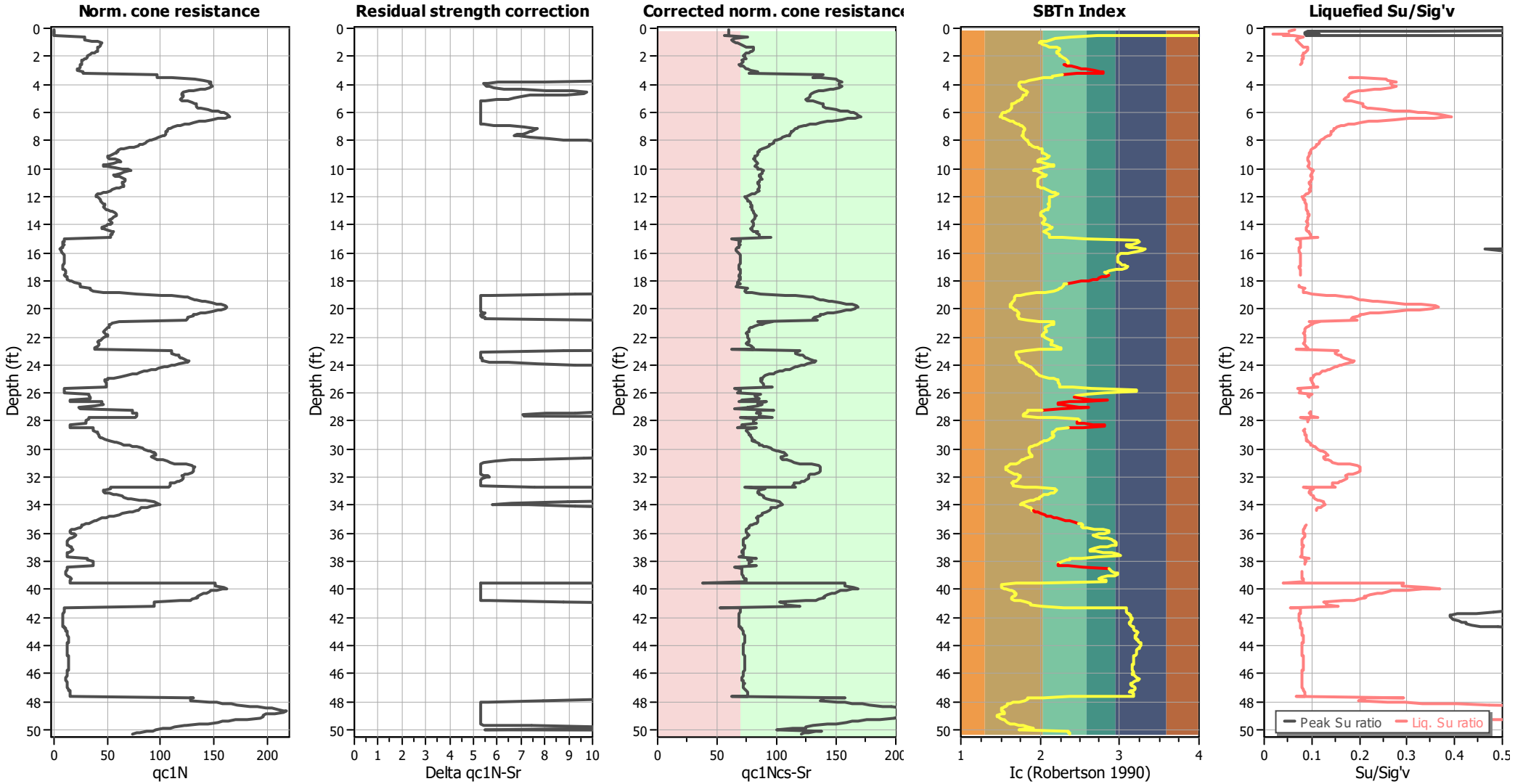




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

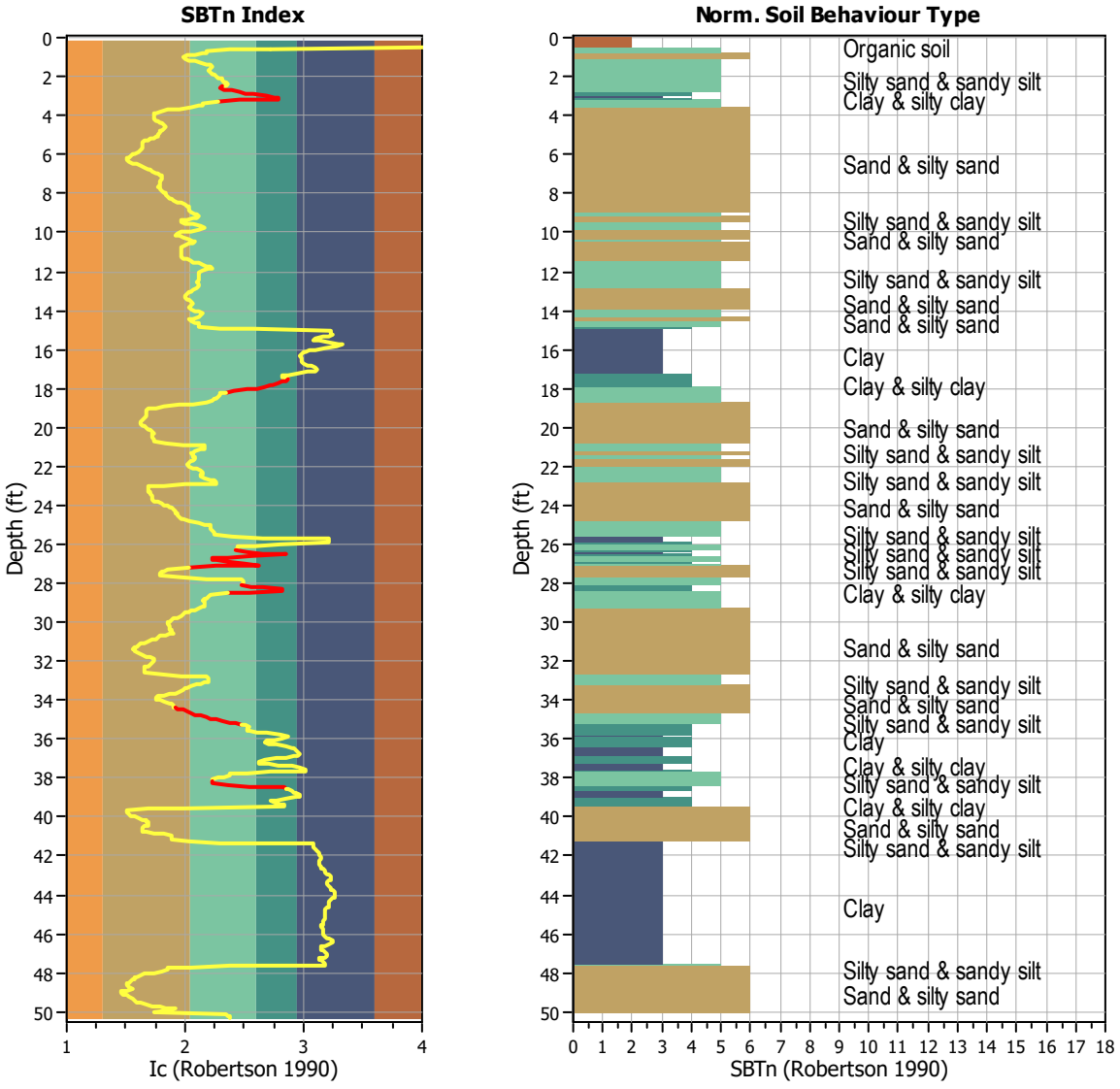
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

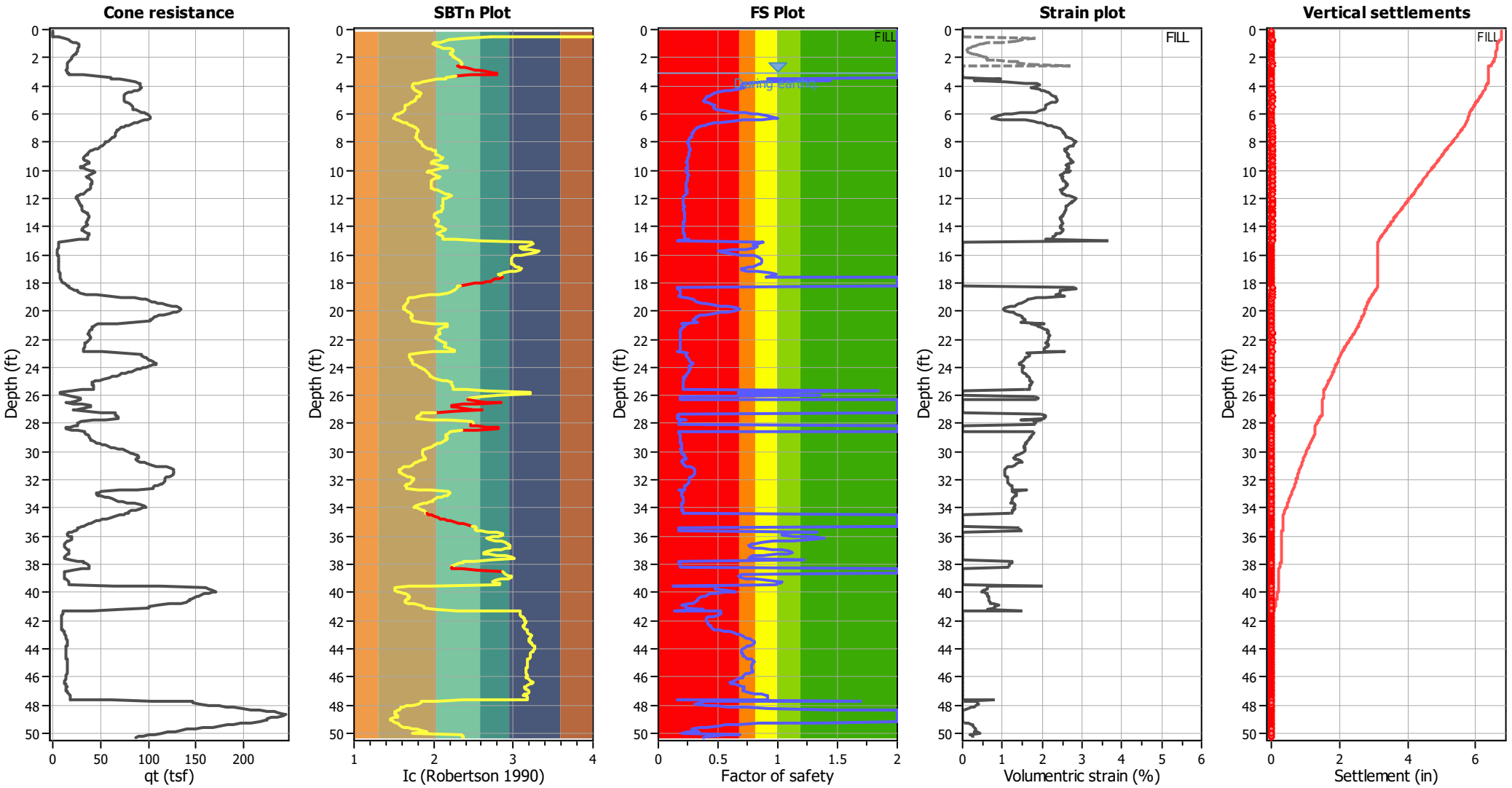
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	767
I_c maximum check value:	3.00	Total points excluded:	69
I_c change ratio value:	0.0250	Exclusion percentage:	9.00%
Minimum number of points in layer:	4	Number of layers detected:	11

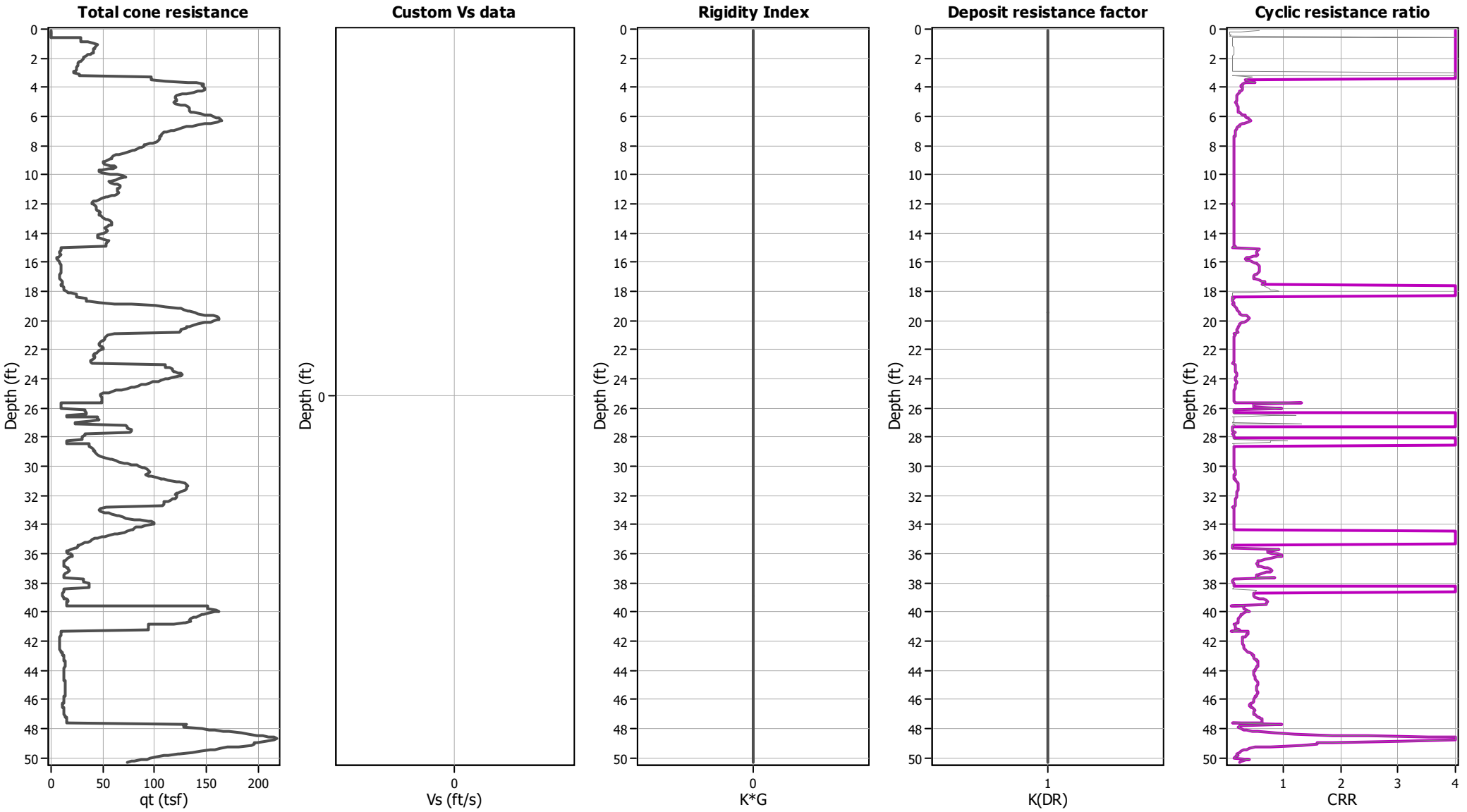
Estimation of post-earthquake settlements



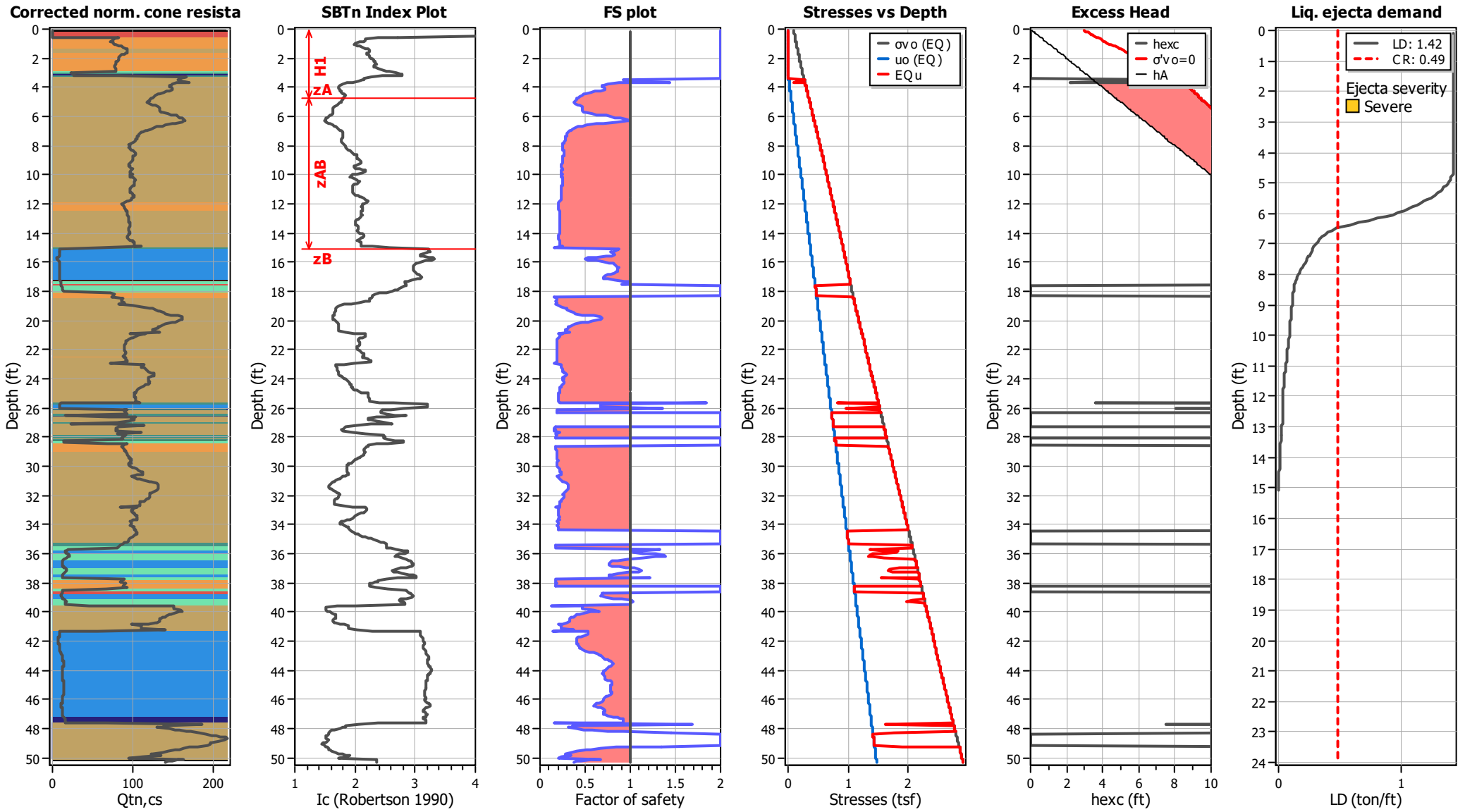
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

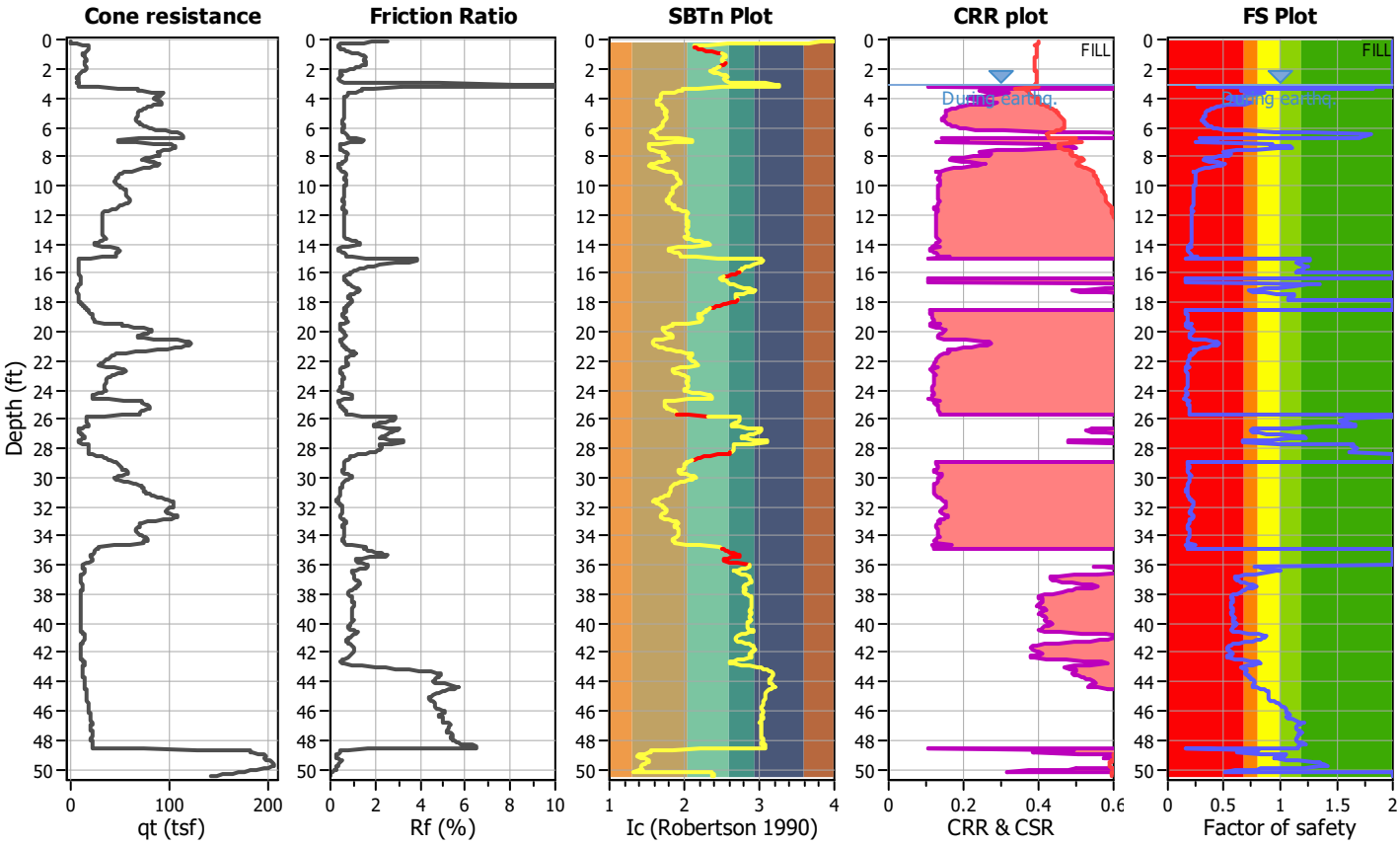
Project title : Topgolf Harbor Island

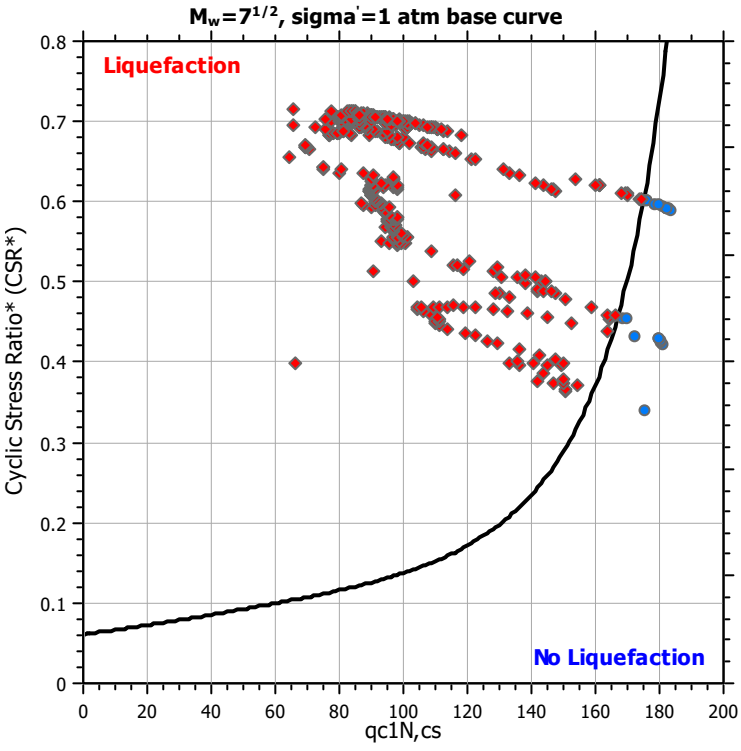
Location : North Harbor Drive and Liberator Way, San Diego, CA

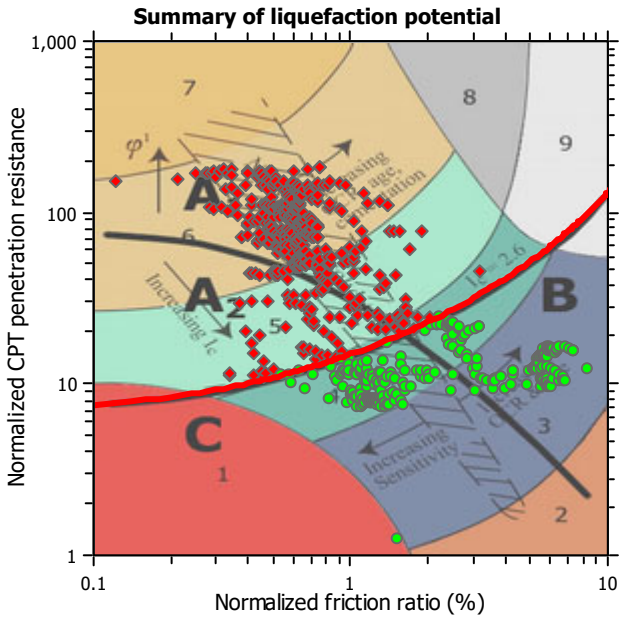
CPT file : CPT-41 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.12 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	1.50 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

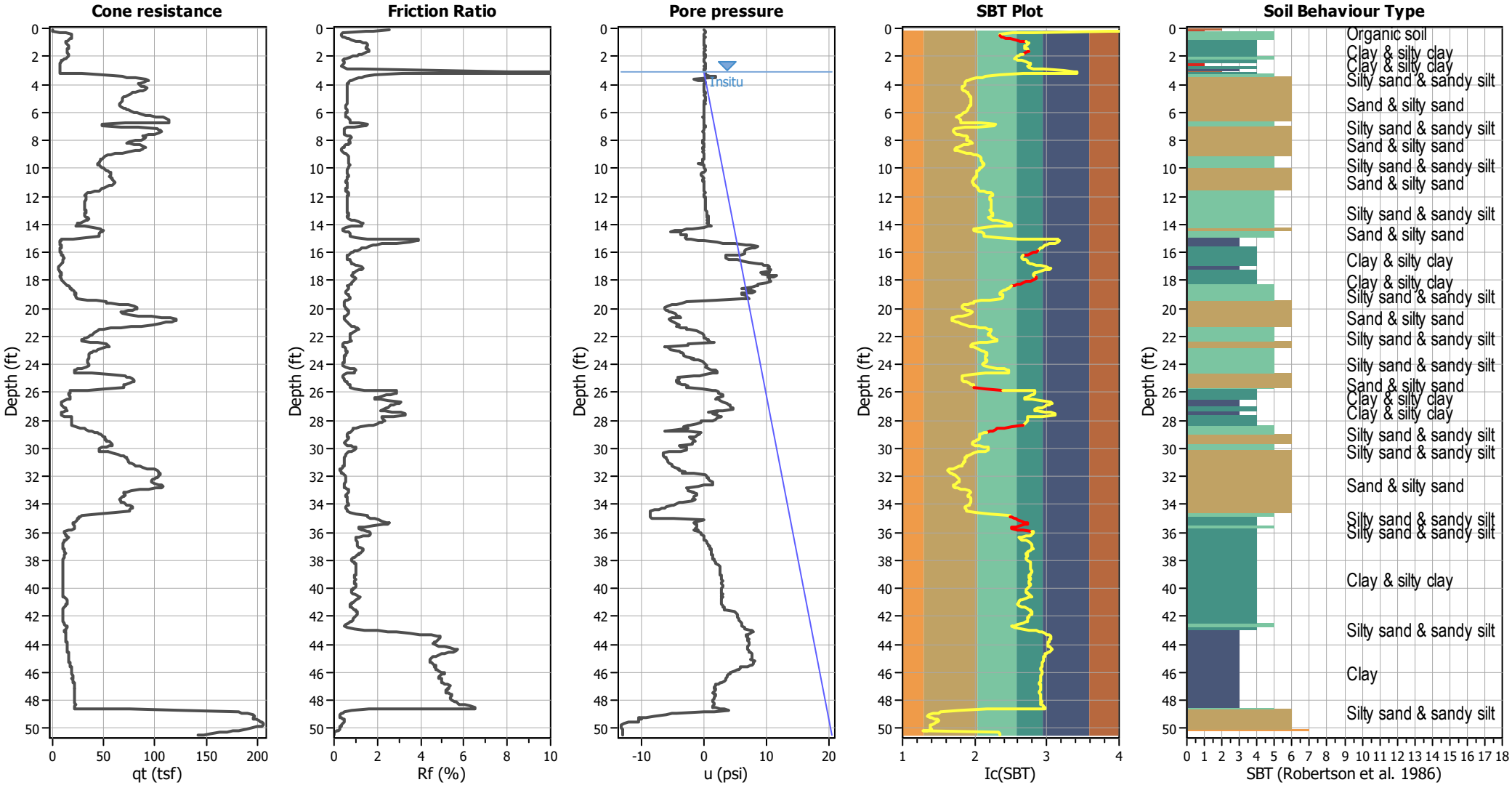






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



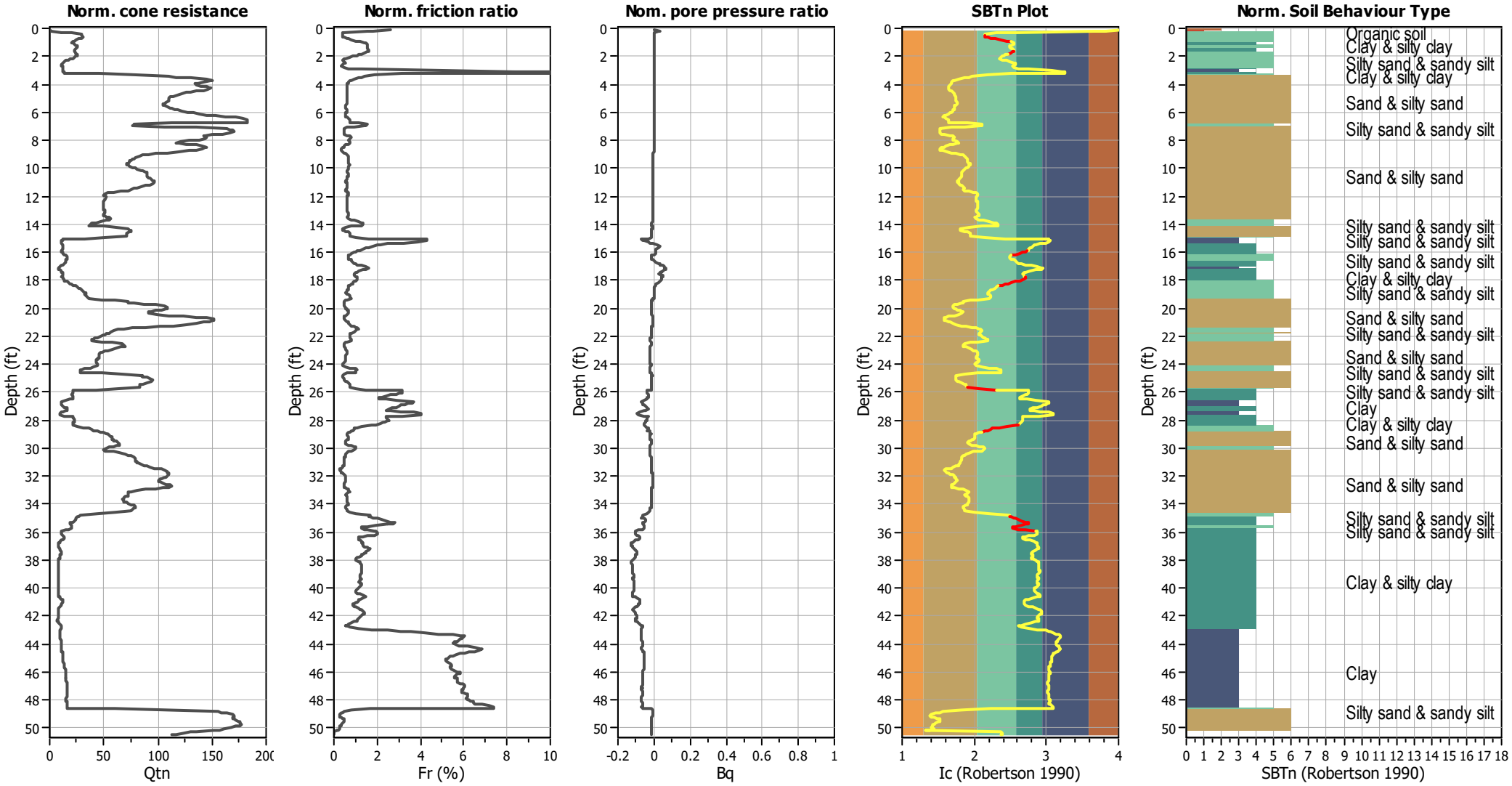
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 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)



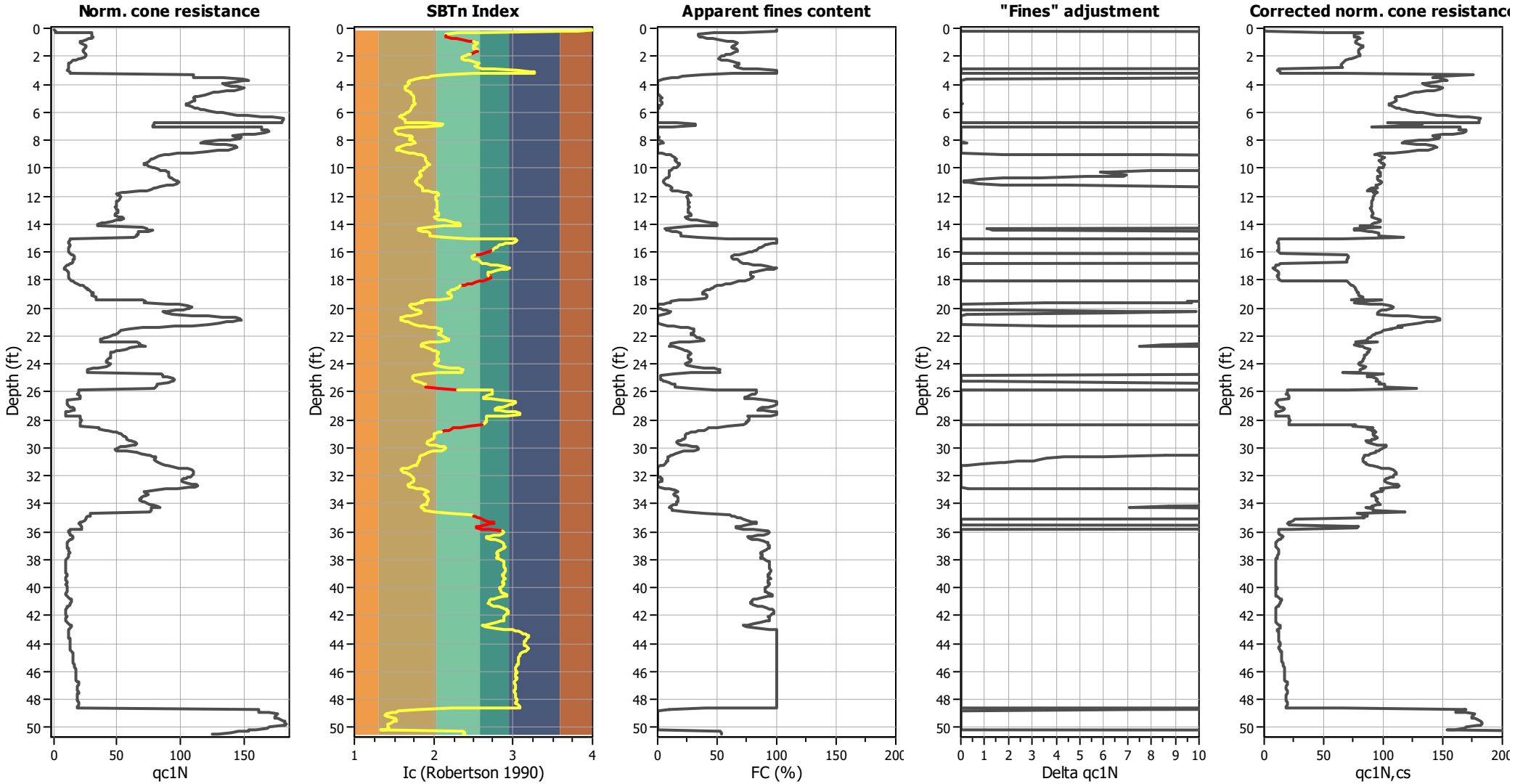
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 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

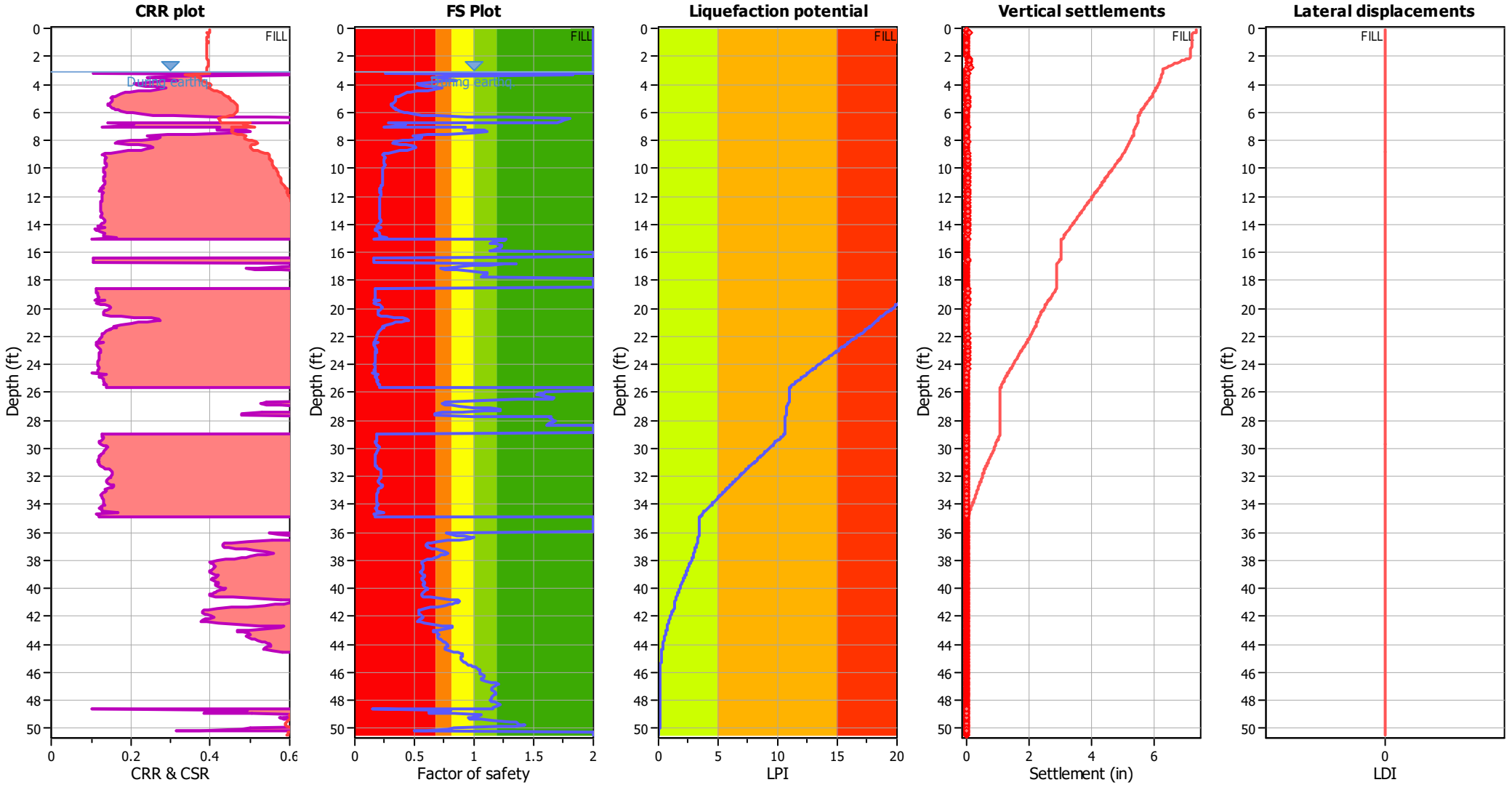
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

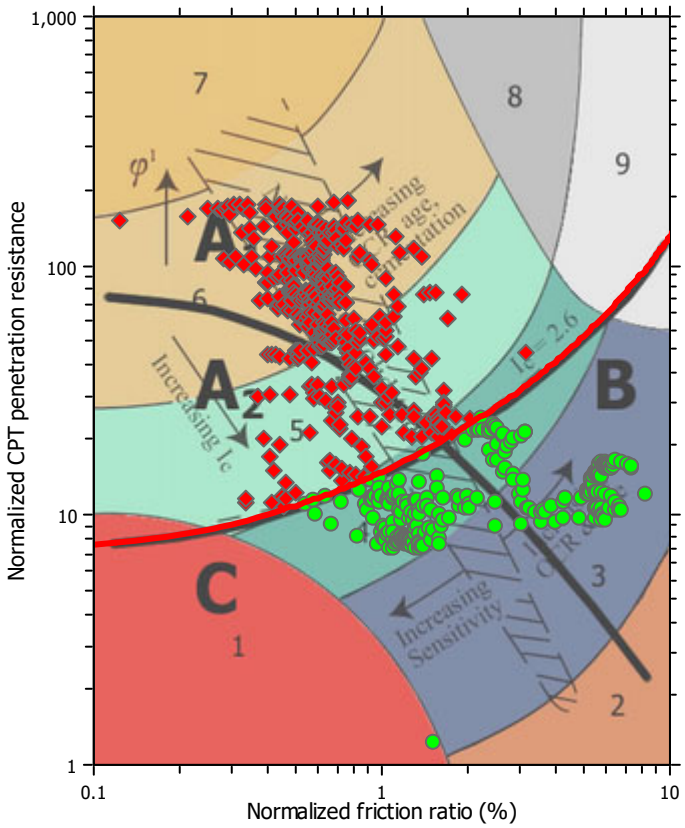
F.S. color scheme

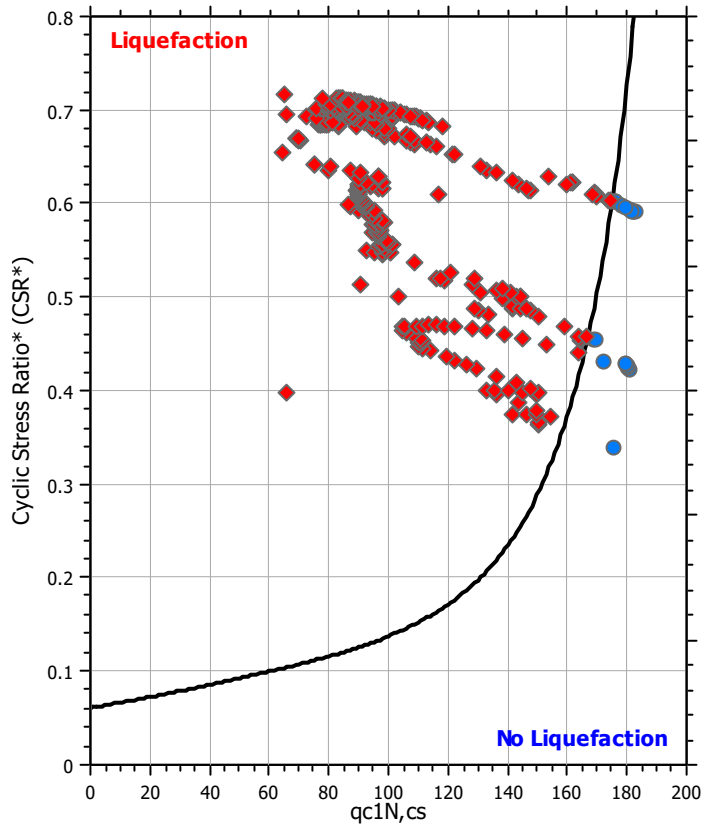
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

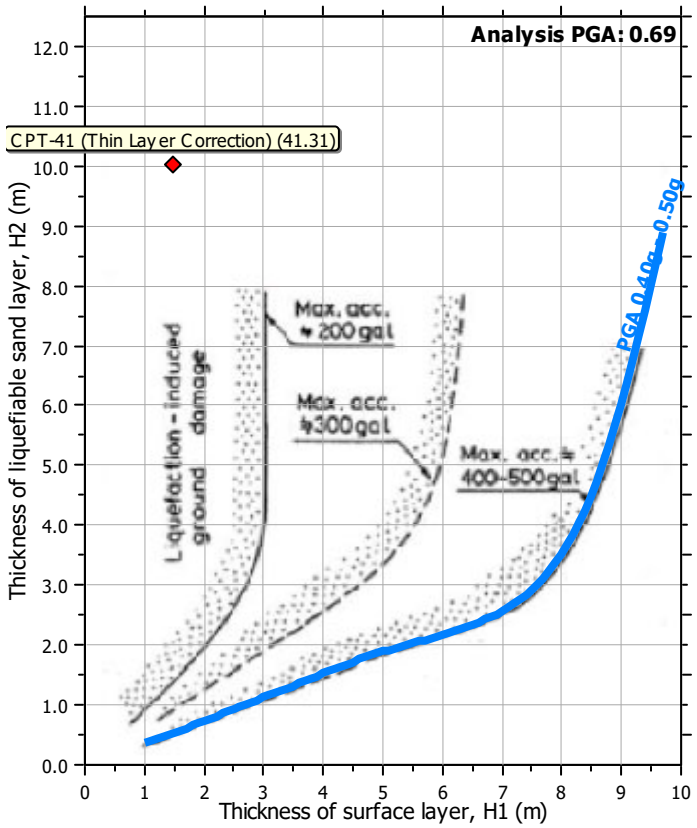
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



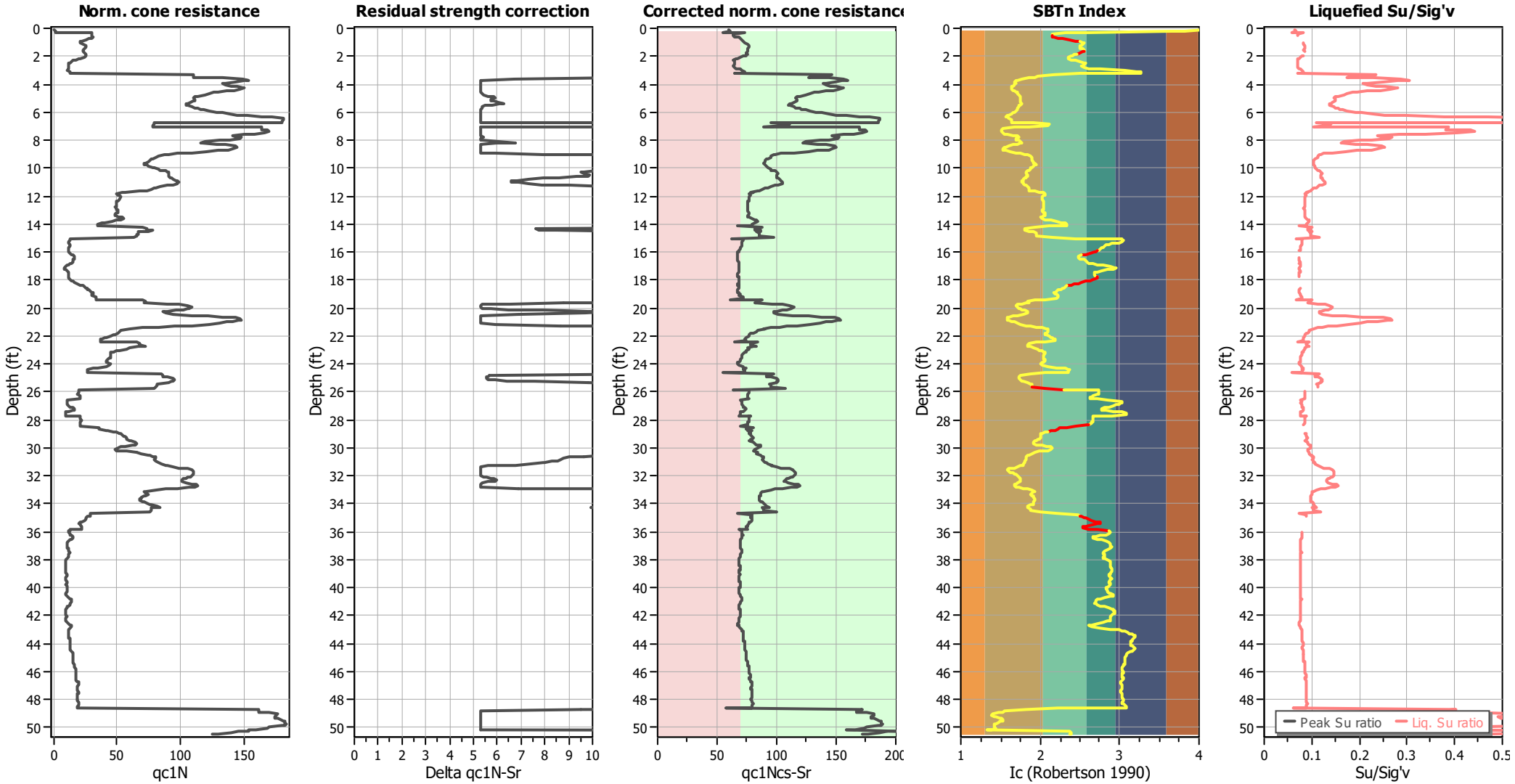




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

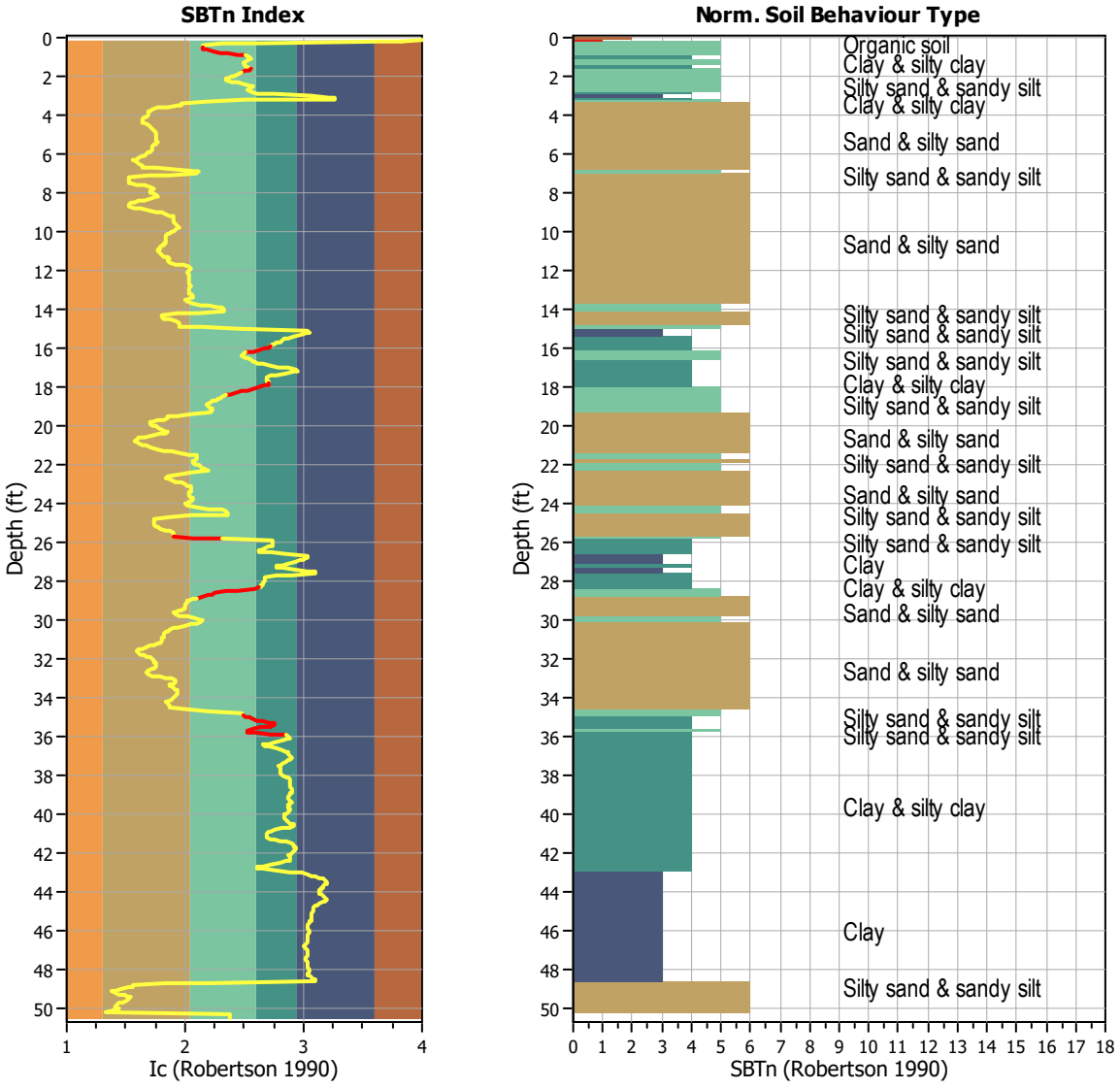
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

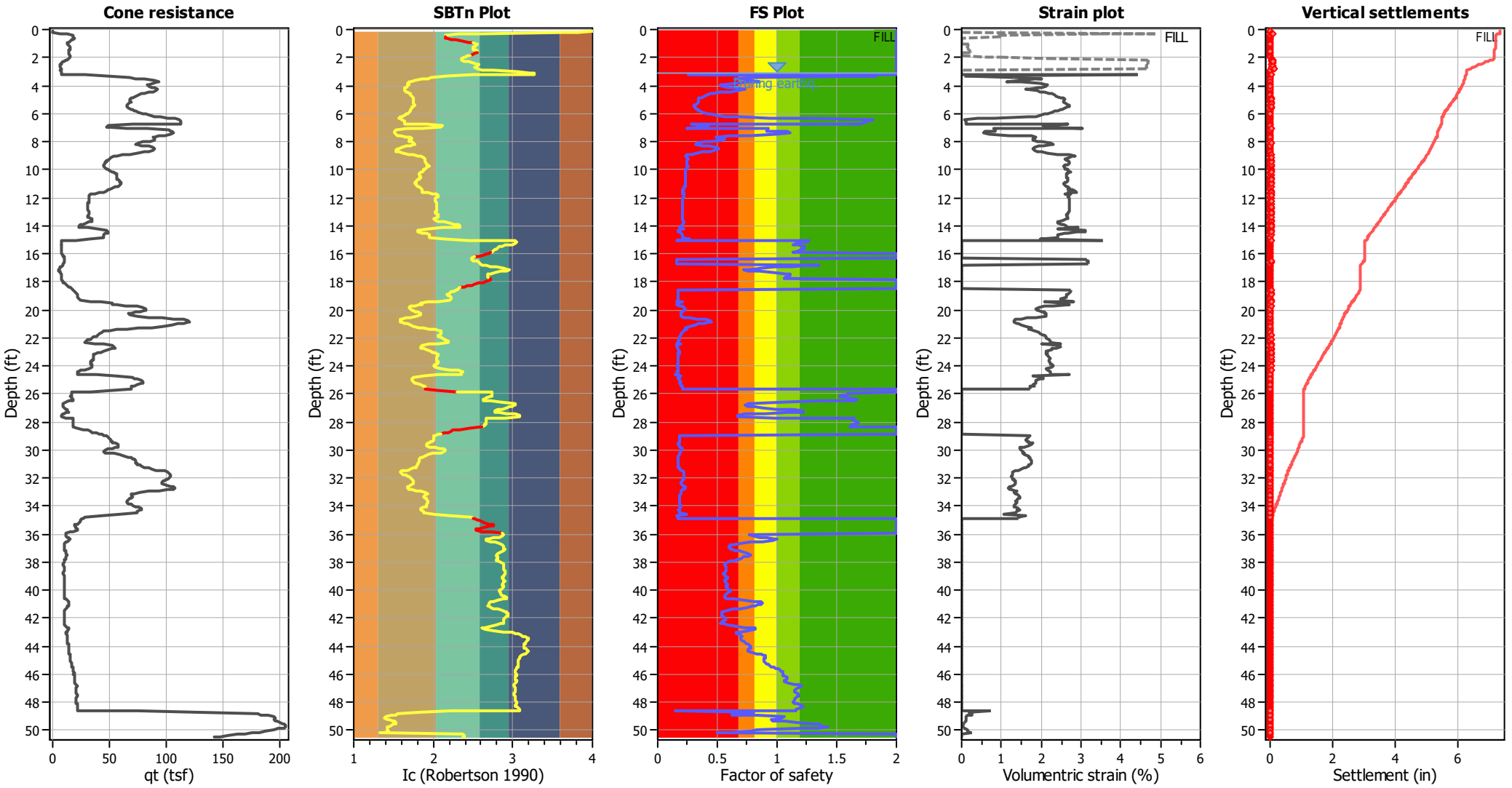
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	769
I_c maximum check value:	3.00	Total points excluded:	58
I_c change ratio value:	0.0250	Exclusion percentage:	7.54%
Minimum number of points in layer:	4	Number of layers detected:	9

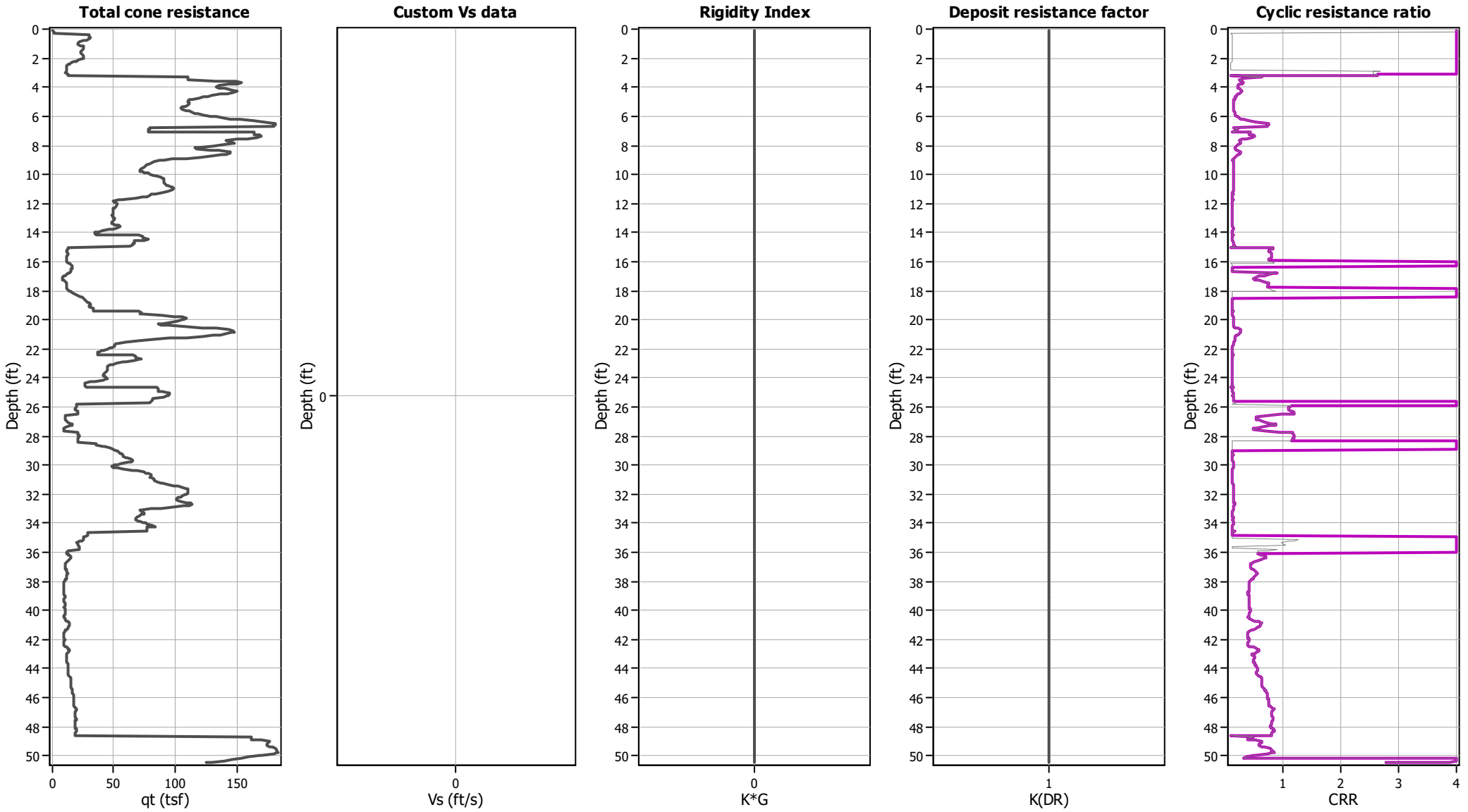
Estimation of post-earthquake settlements



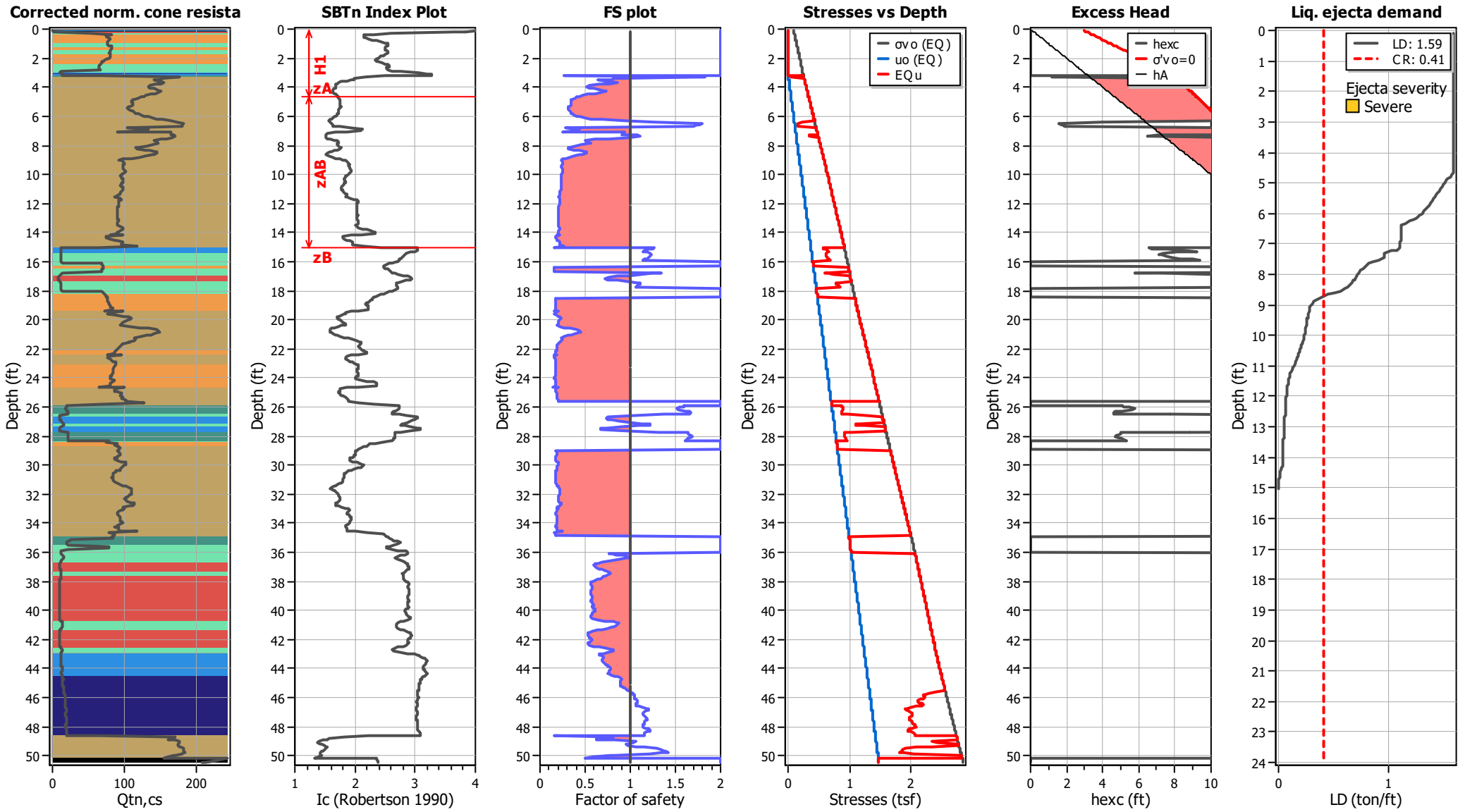
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



NOVA Services, Inc.

LIQUEFACTION ANALYSIS REPORT

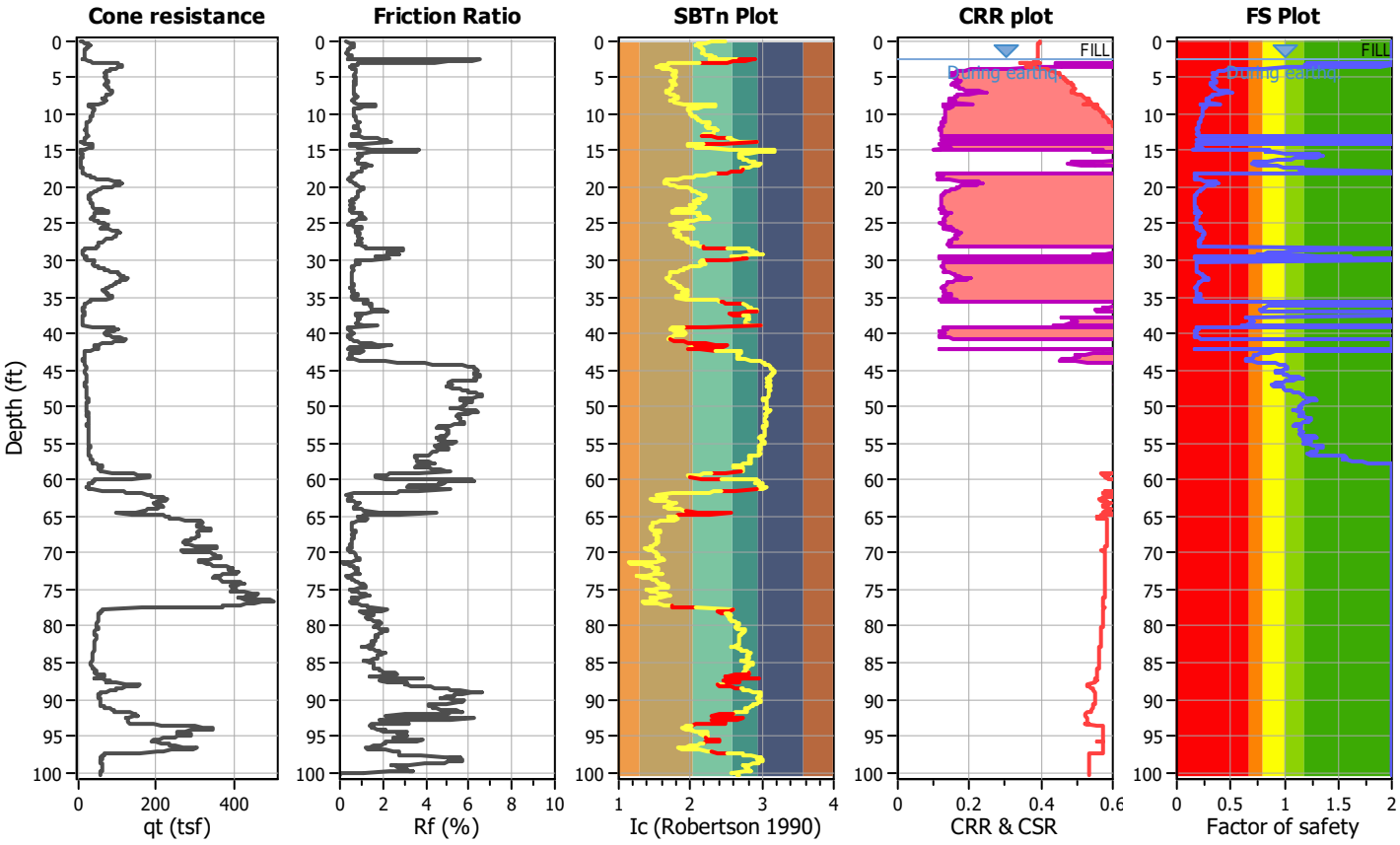
Project title : Topgolf Harbor Island

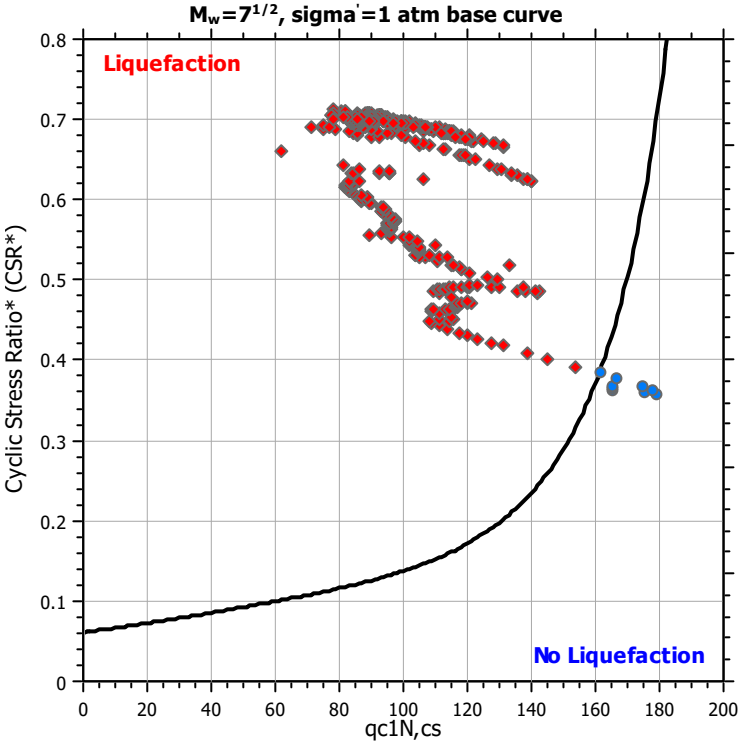
Location : North Harbor Drive and Liberator Way, San Diego, CA

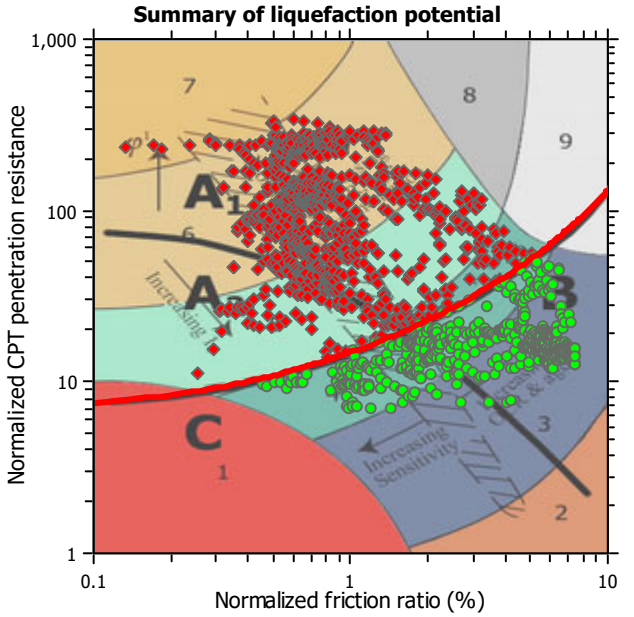
CPT file : CPT-42 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.62 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.62 ft	Fill height:	2.00 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

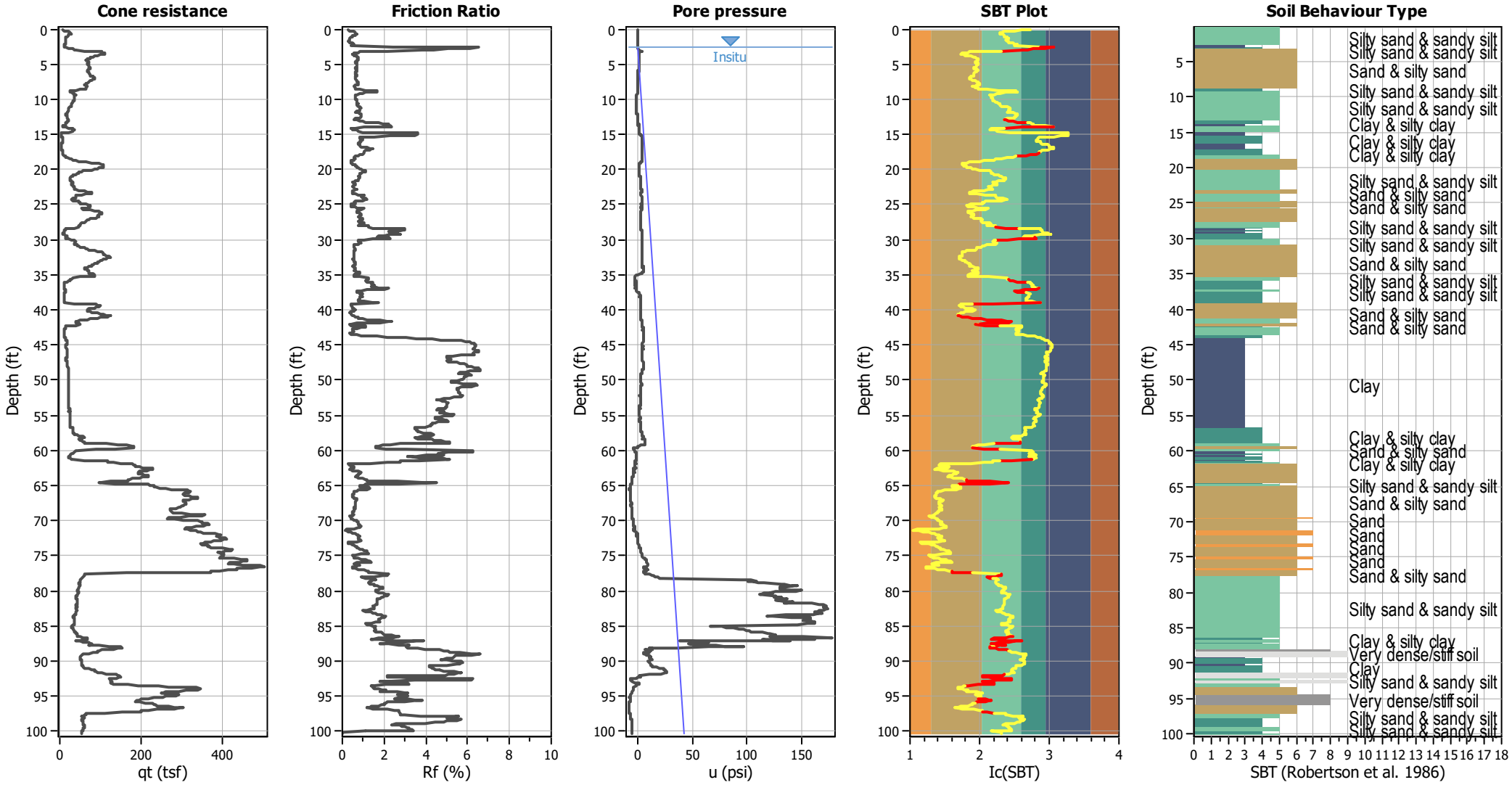






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



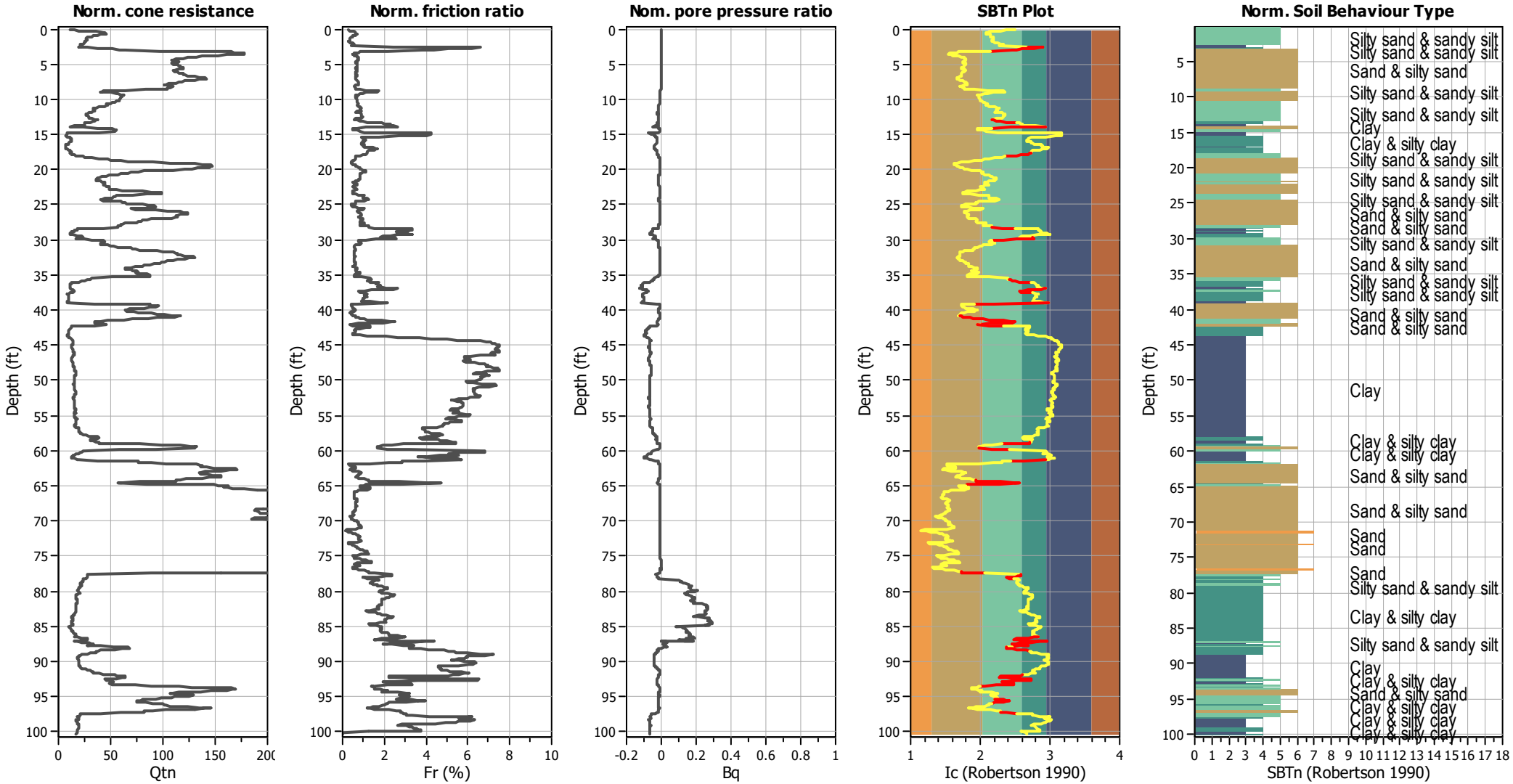
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 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)



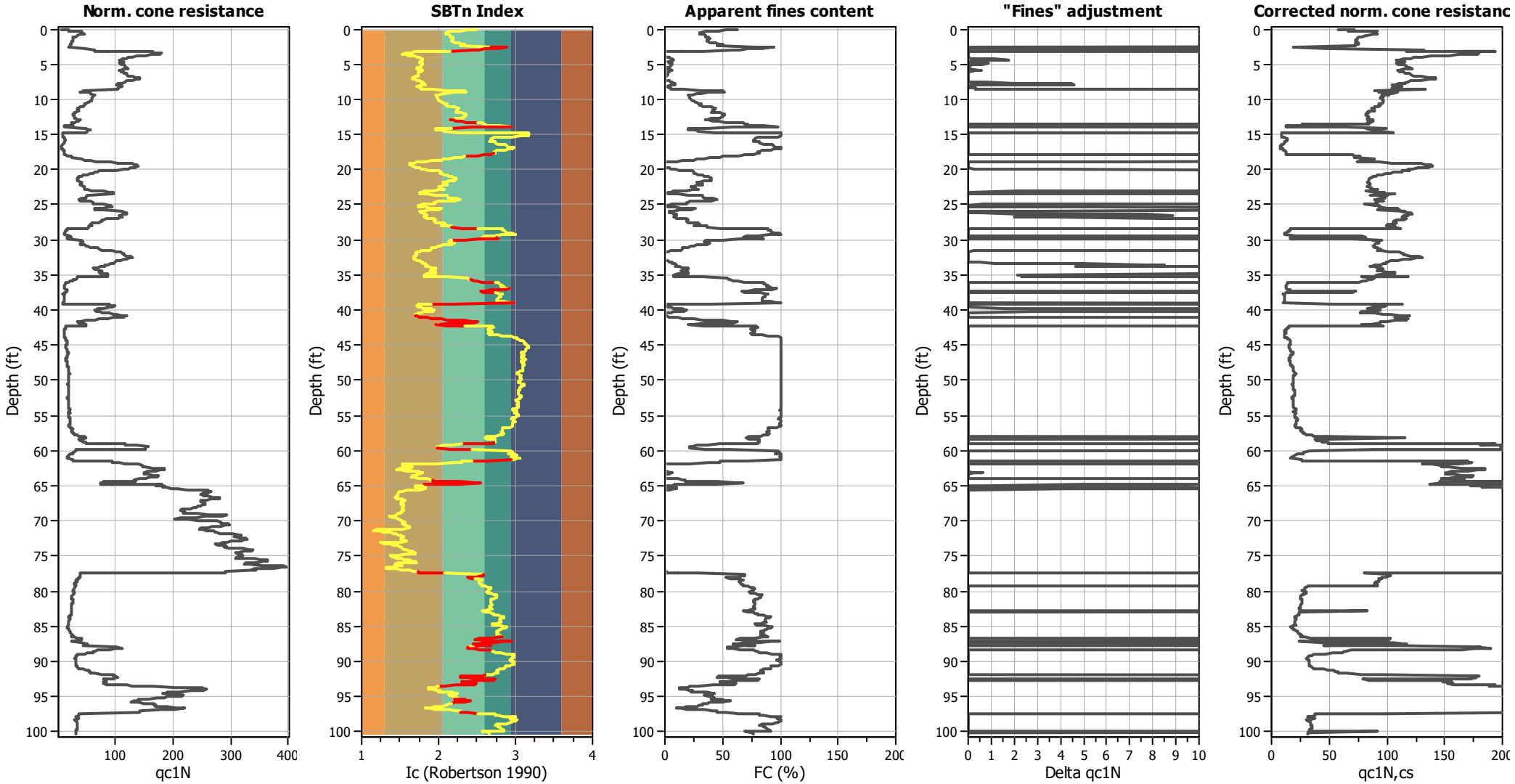
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 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

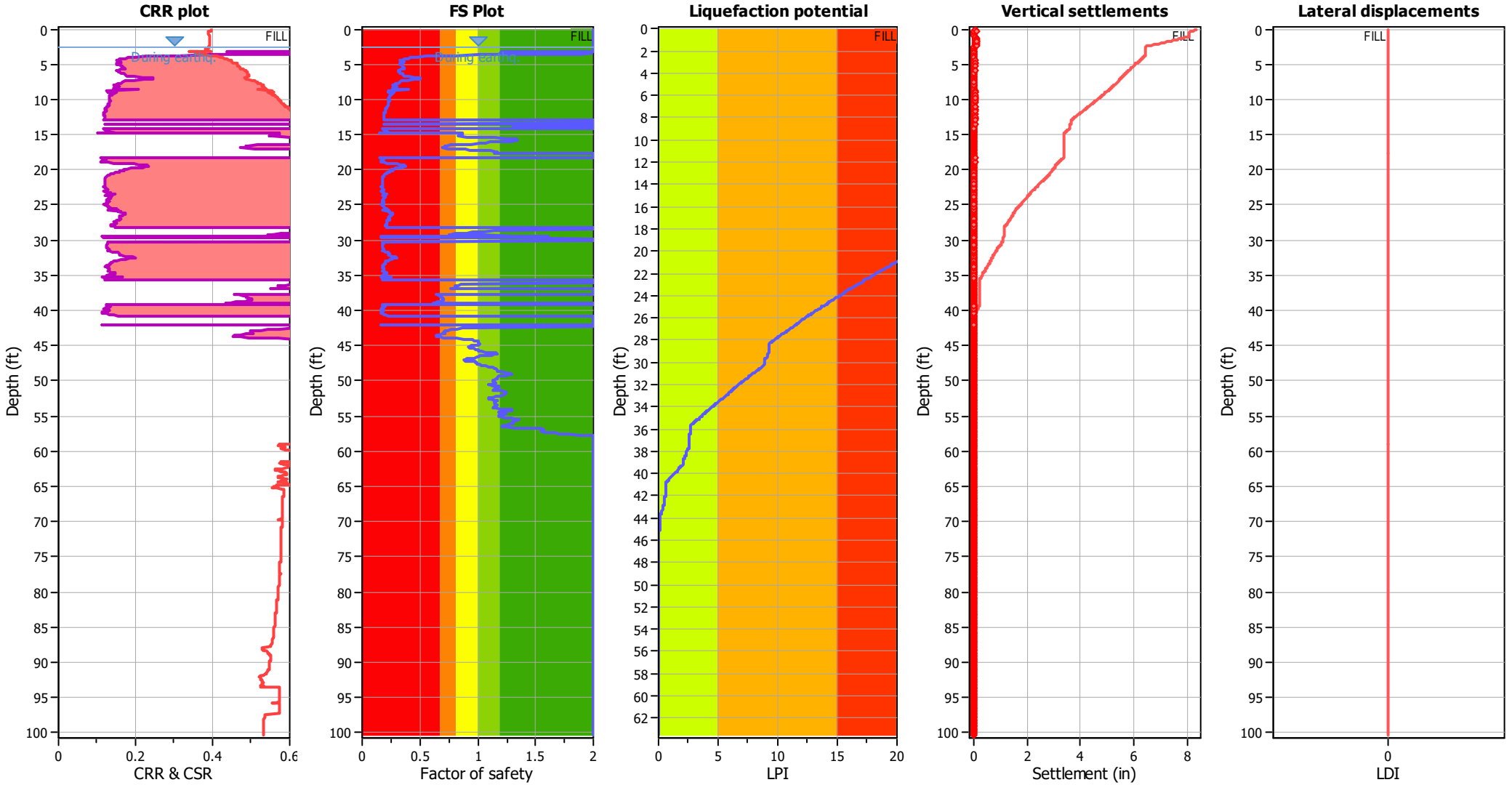
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 ft	Limit depth:	60.00 ft

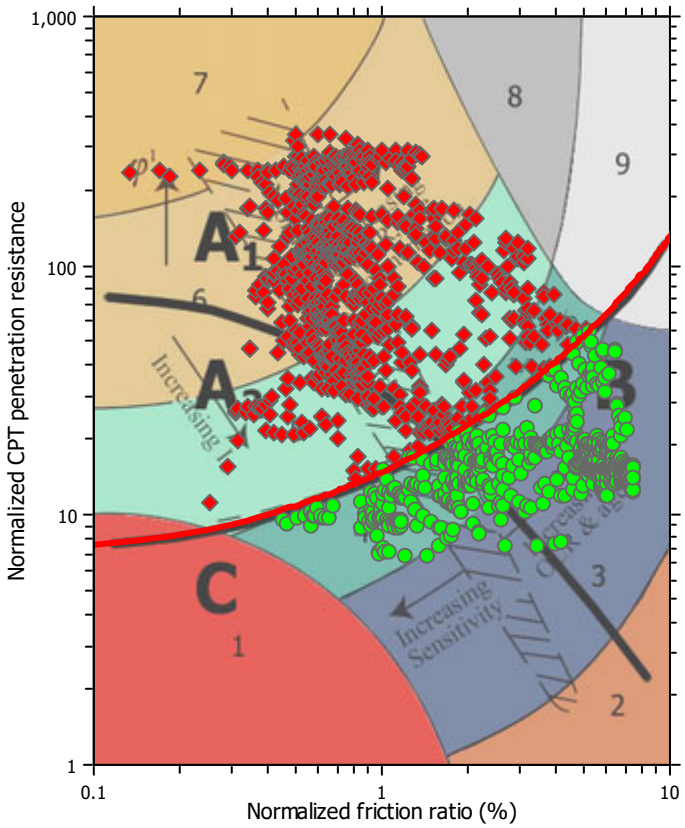
F.S. color scheme

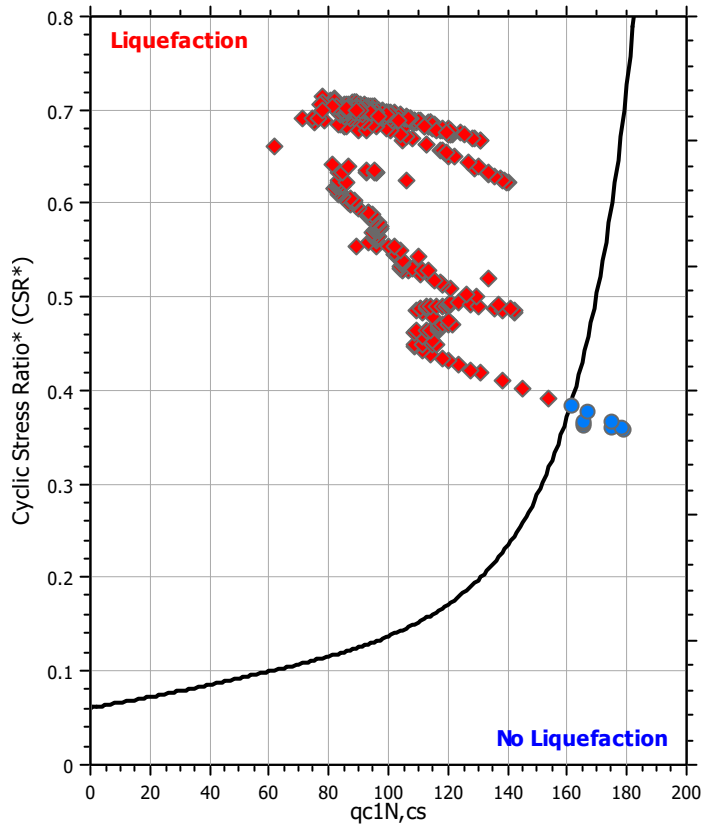
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

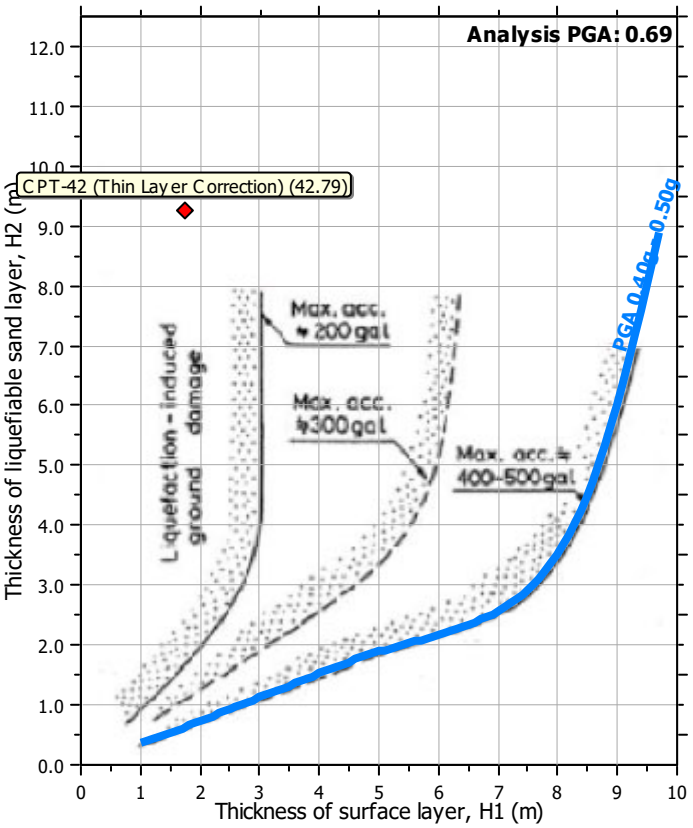
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



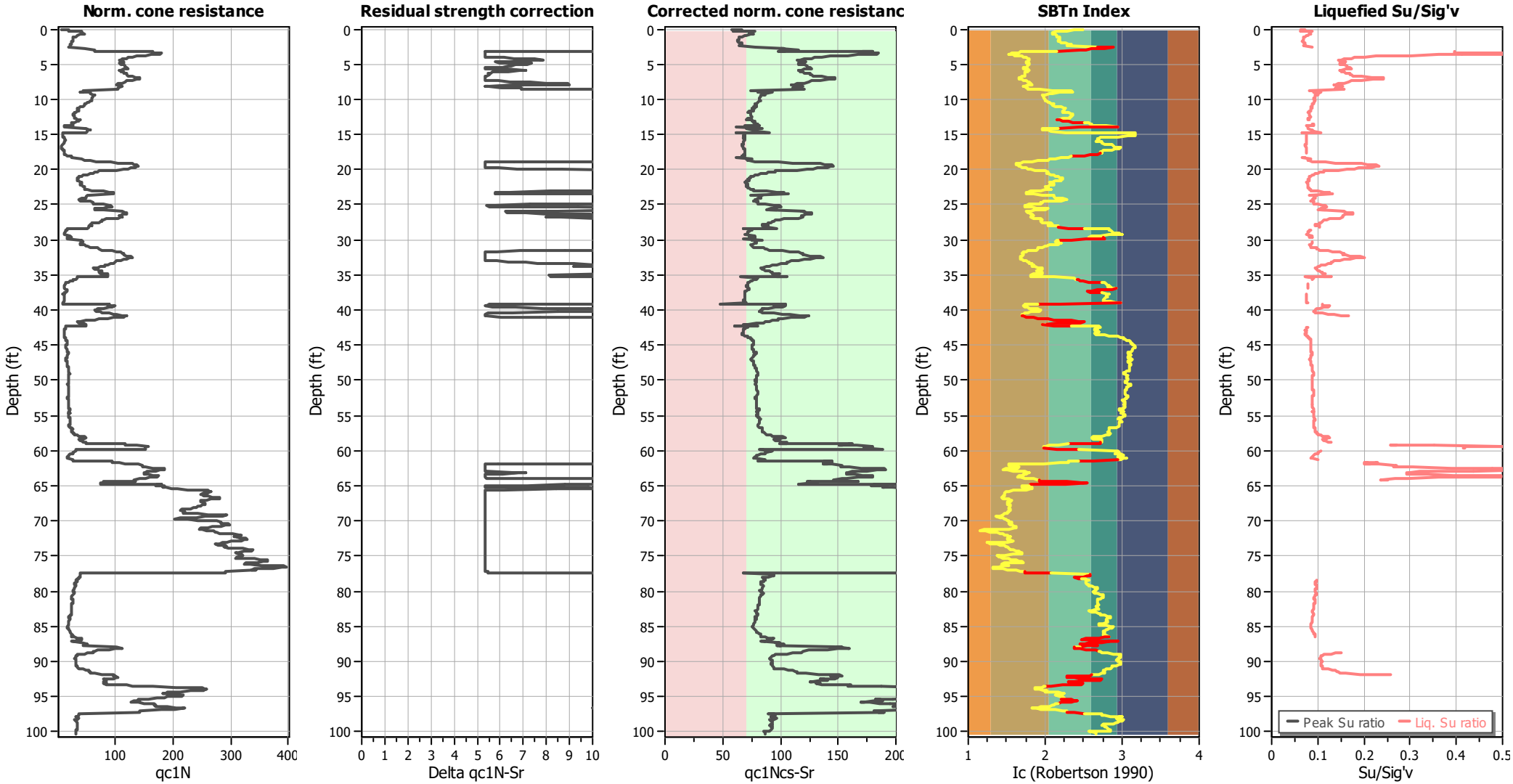




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

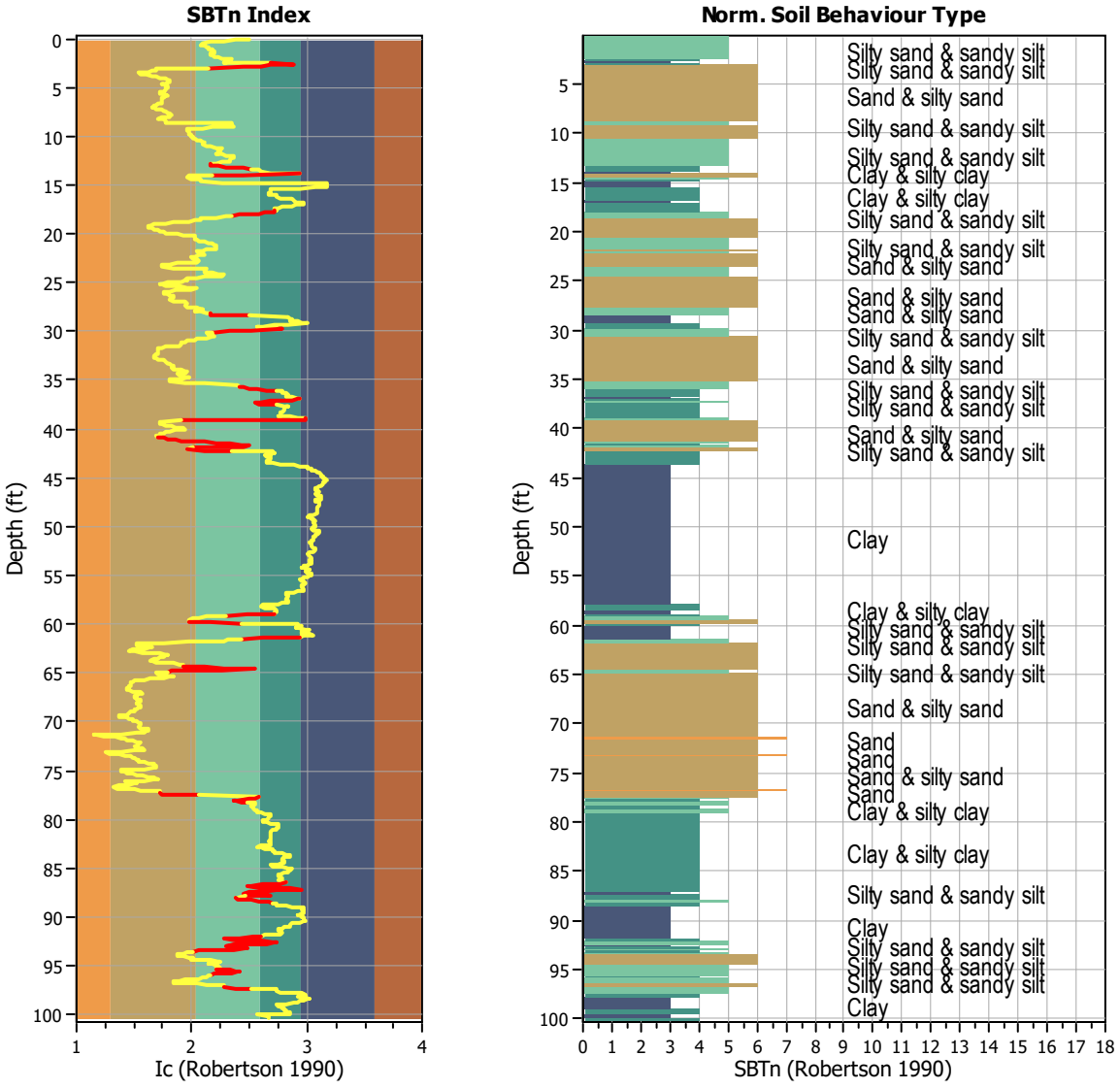
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.62 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	2.00 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

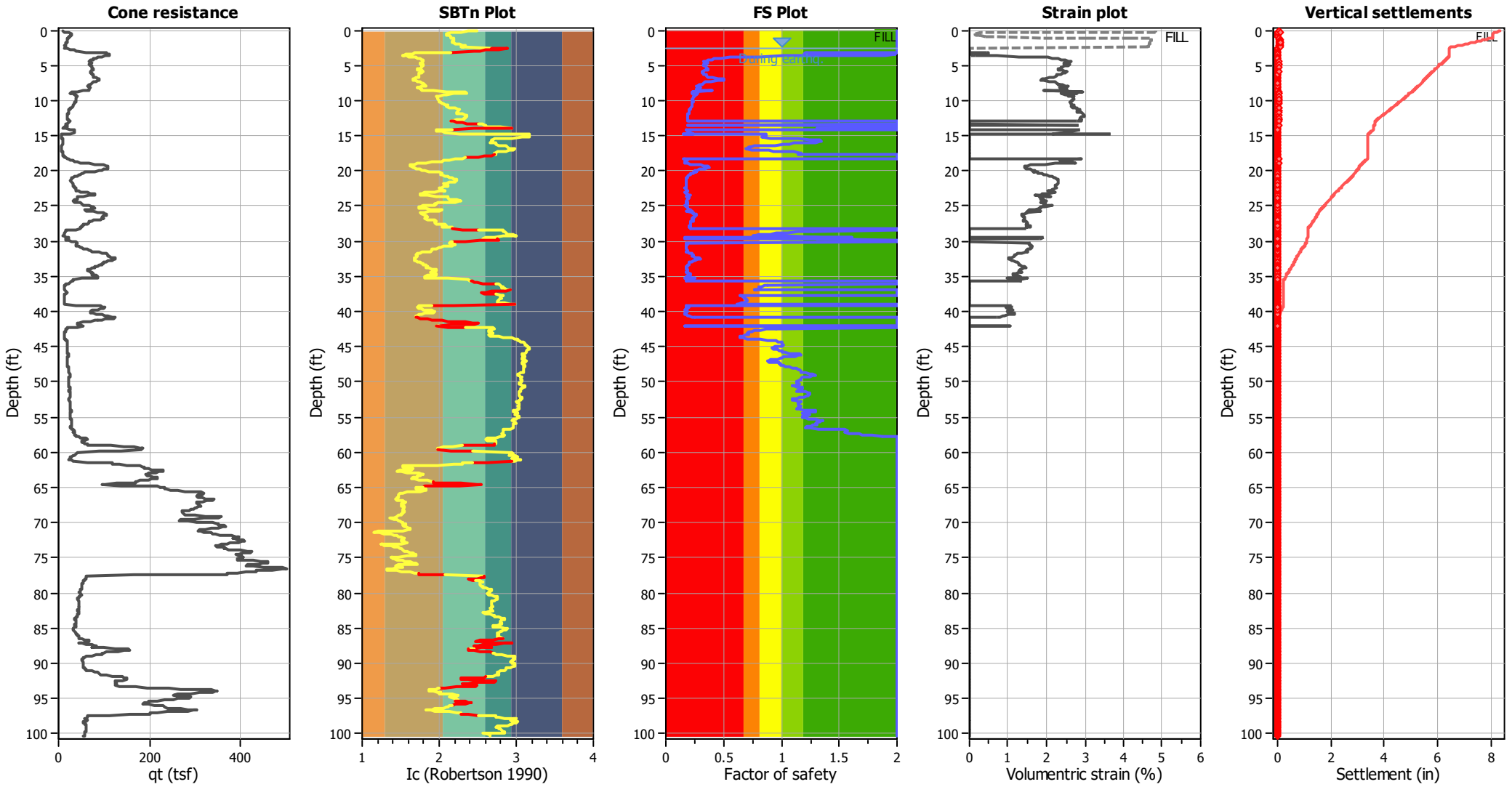
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	1524
I_c maximum check value:	3.00	Total points excluded:	196
I_c change ratio value:	0.0250	Exclusion percentage:	12.86%
Minimum number of points in layer:	4	Number of layers detected:	35

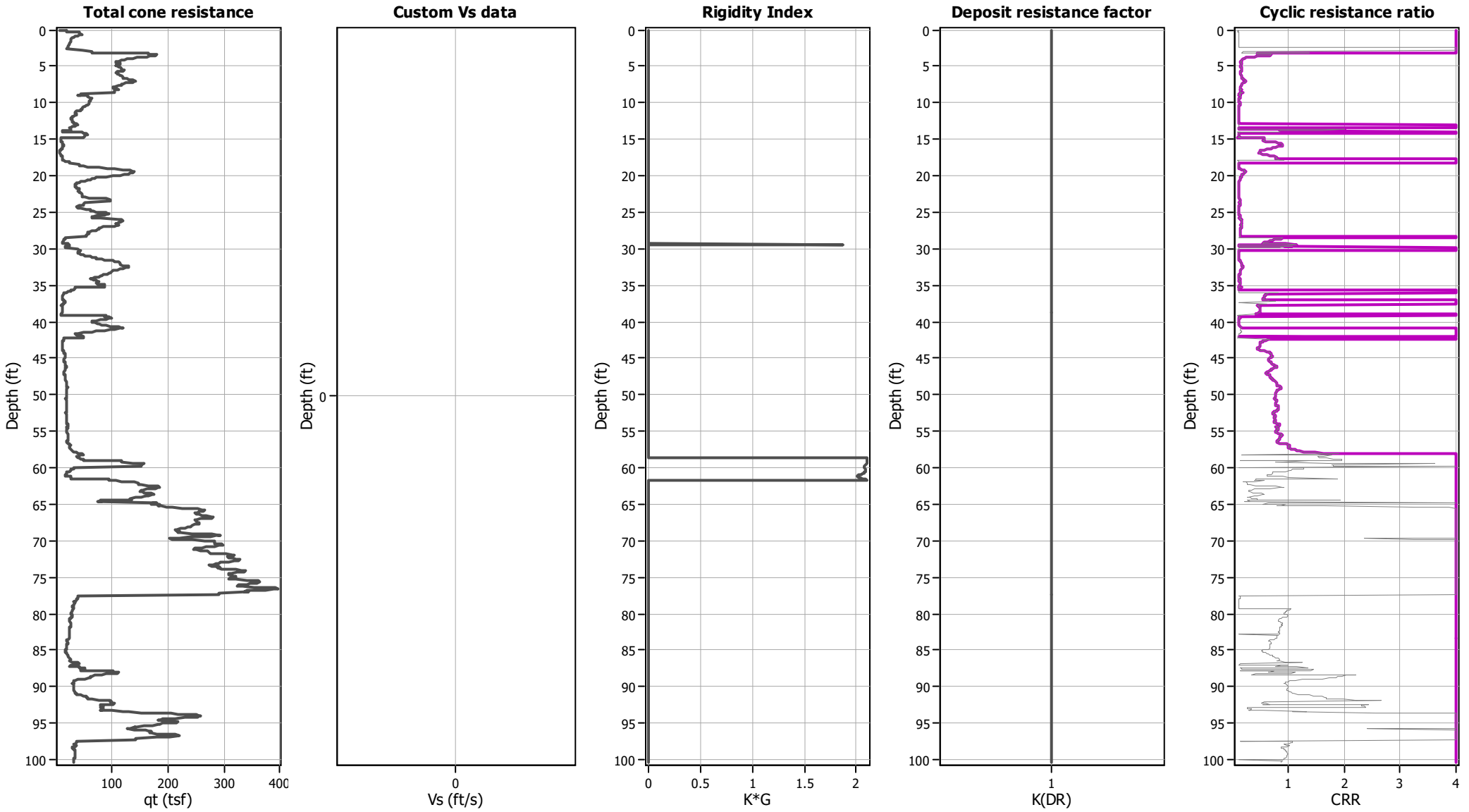
Estimation of post-earthquake settlements



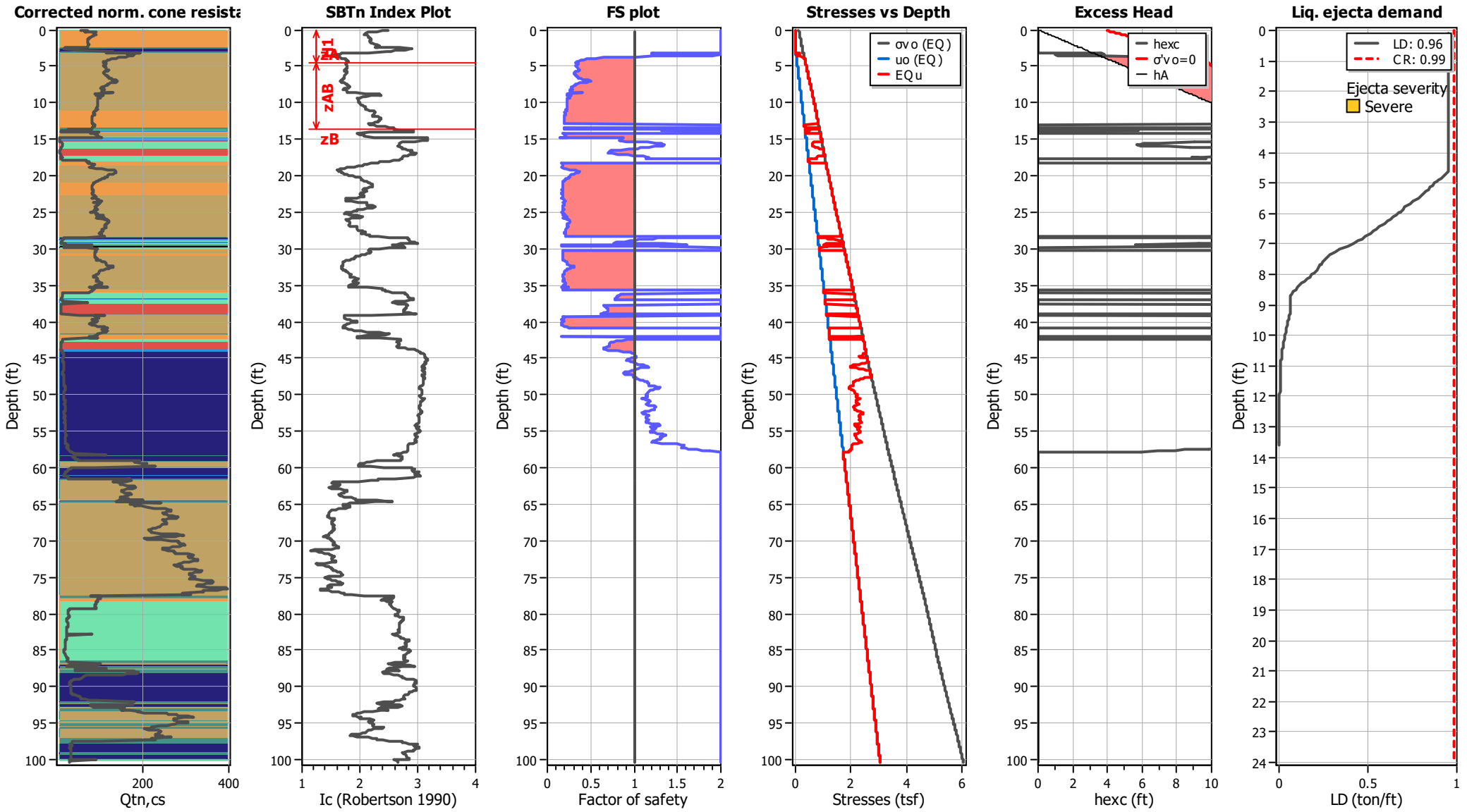
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

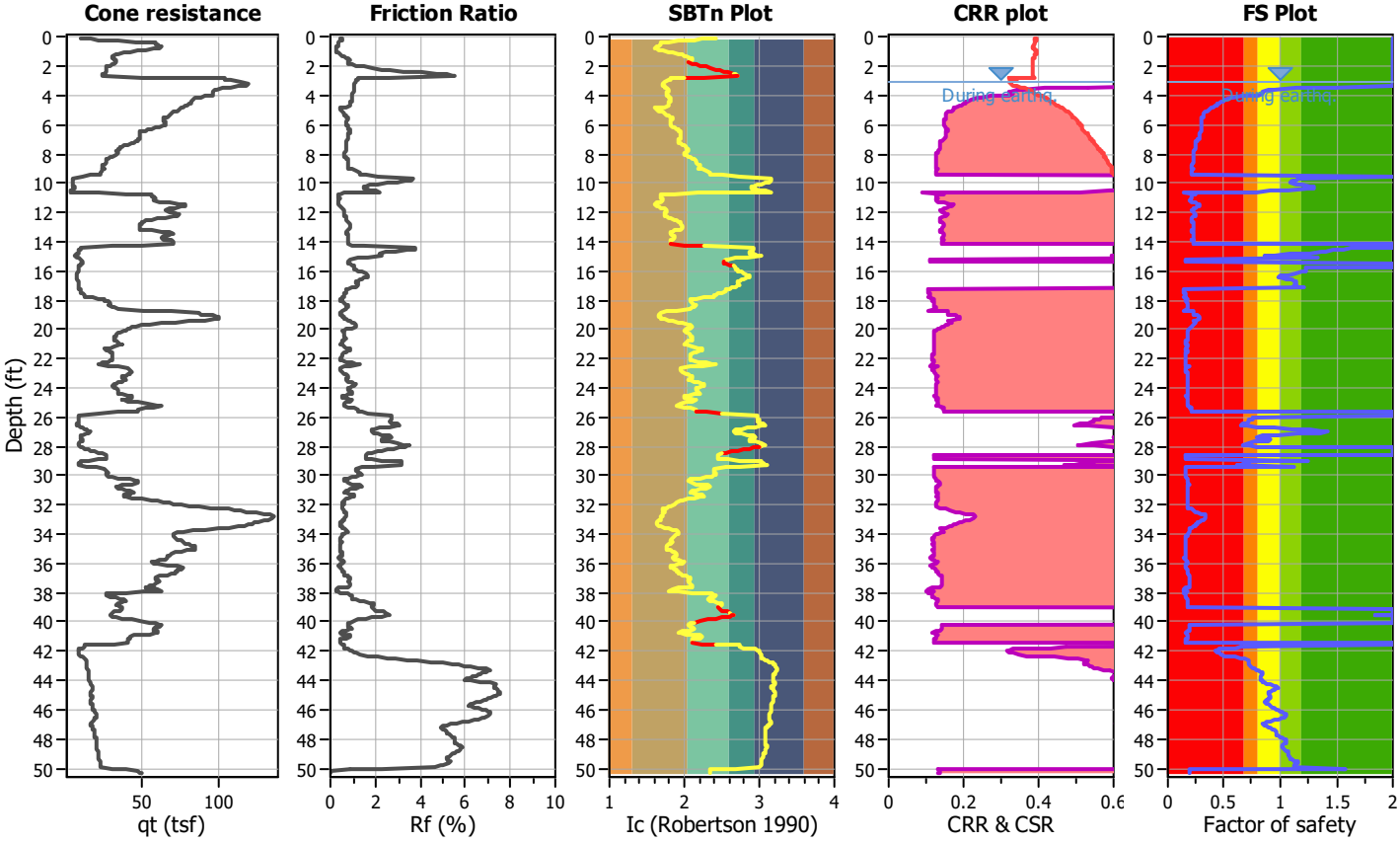
Project title : Topgolf Harbor Island

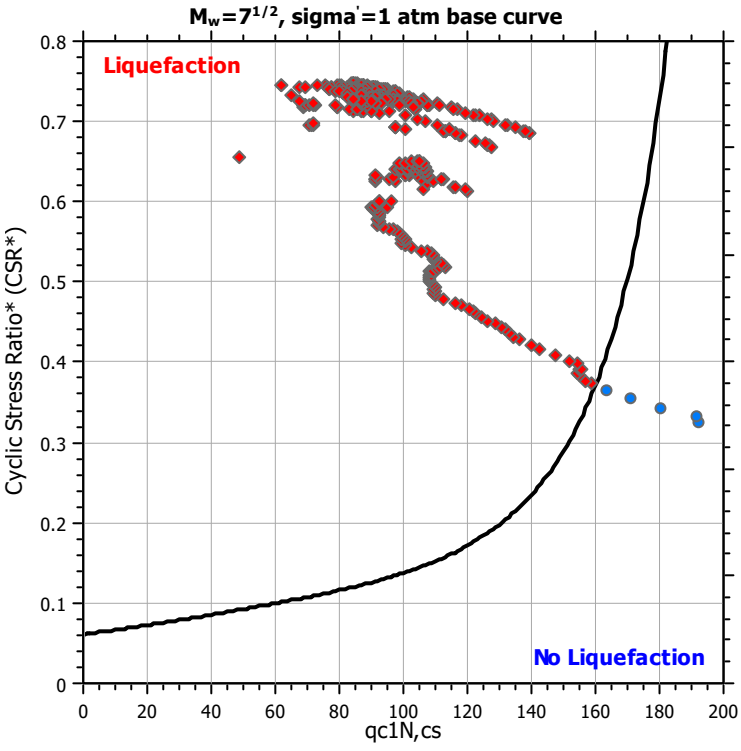
Location : North Harbor Drive and Liberator Way, San Diego, CA

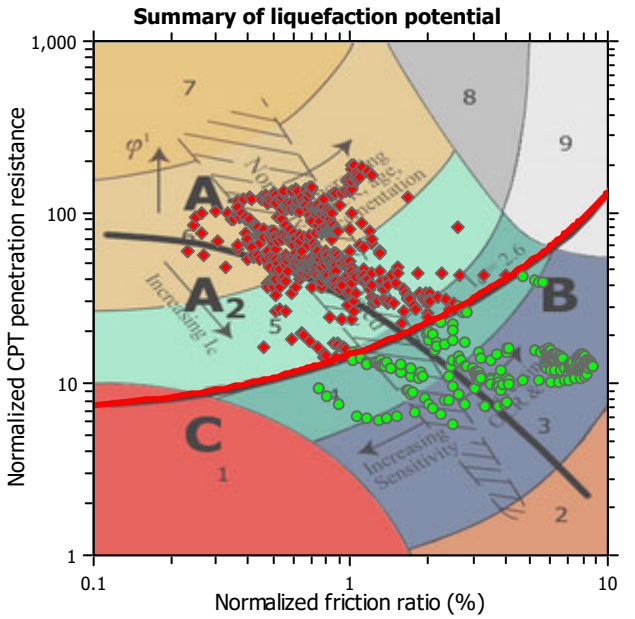
CPT file : CPT-43 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.12 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

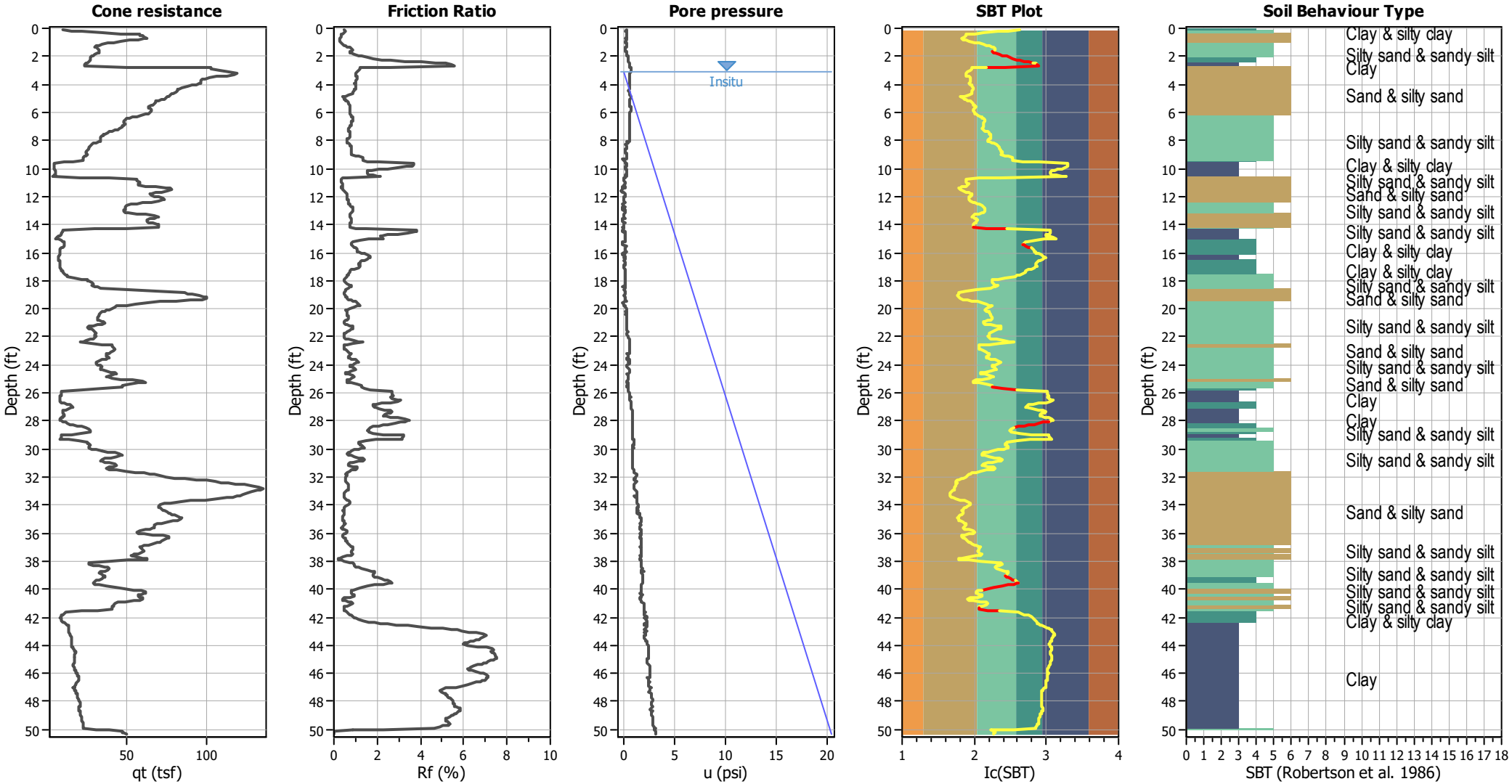






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



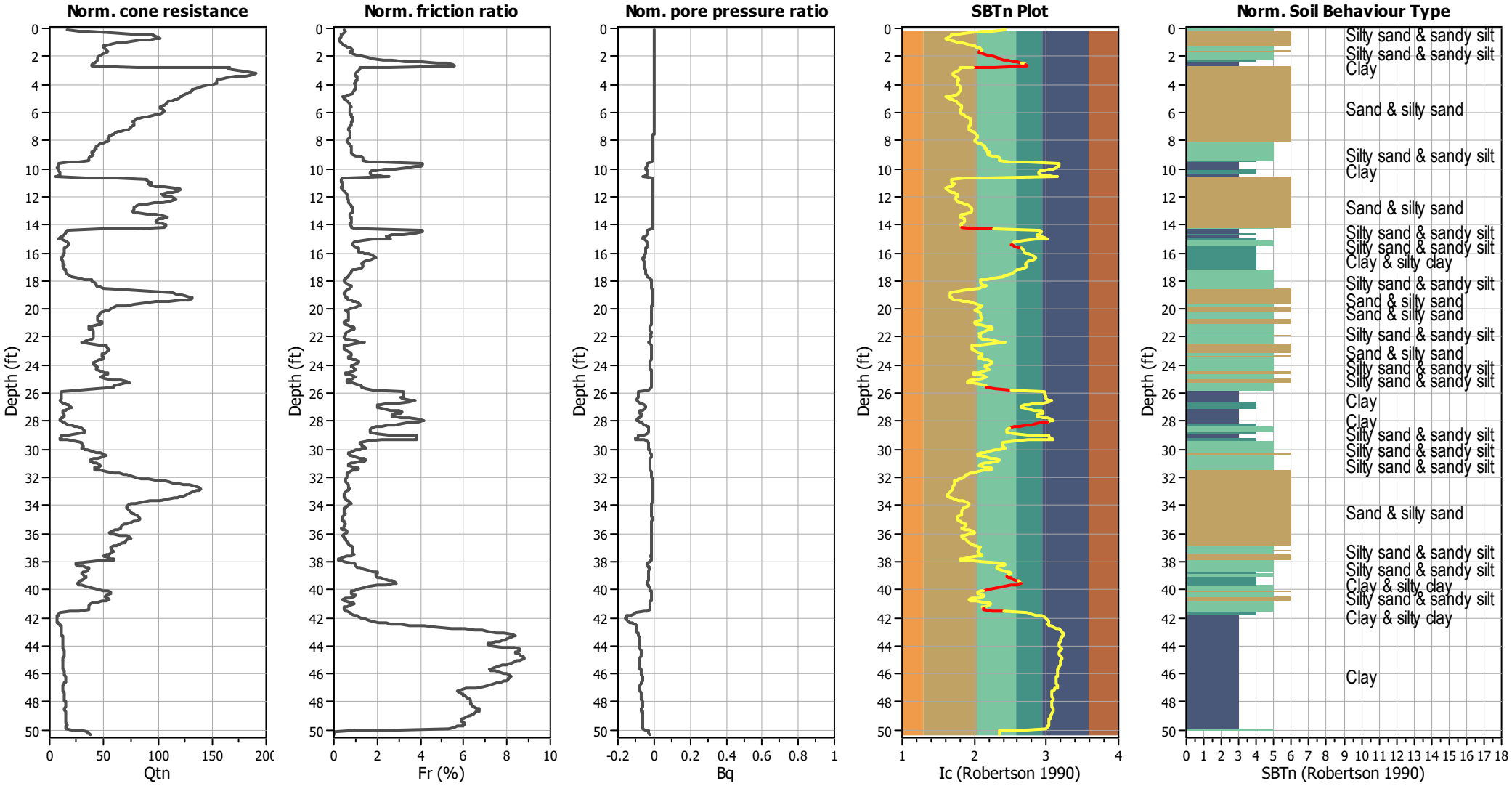
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	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)



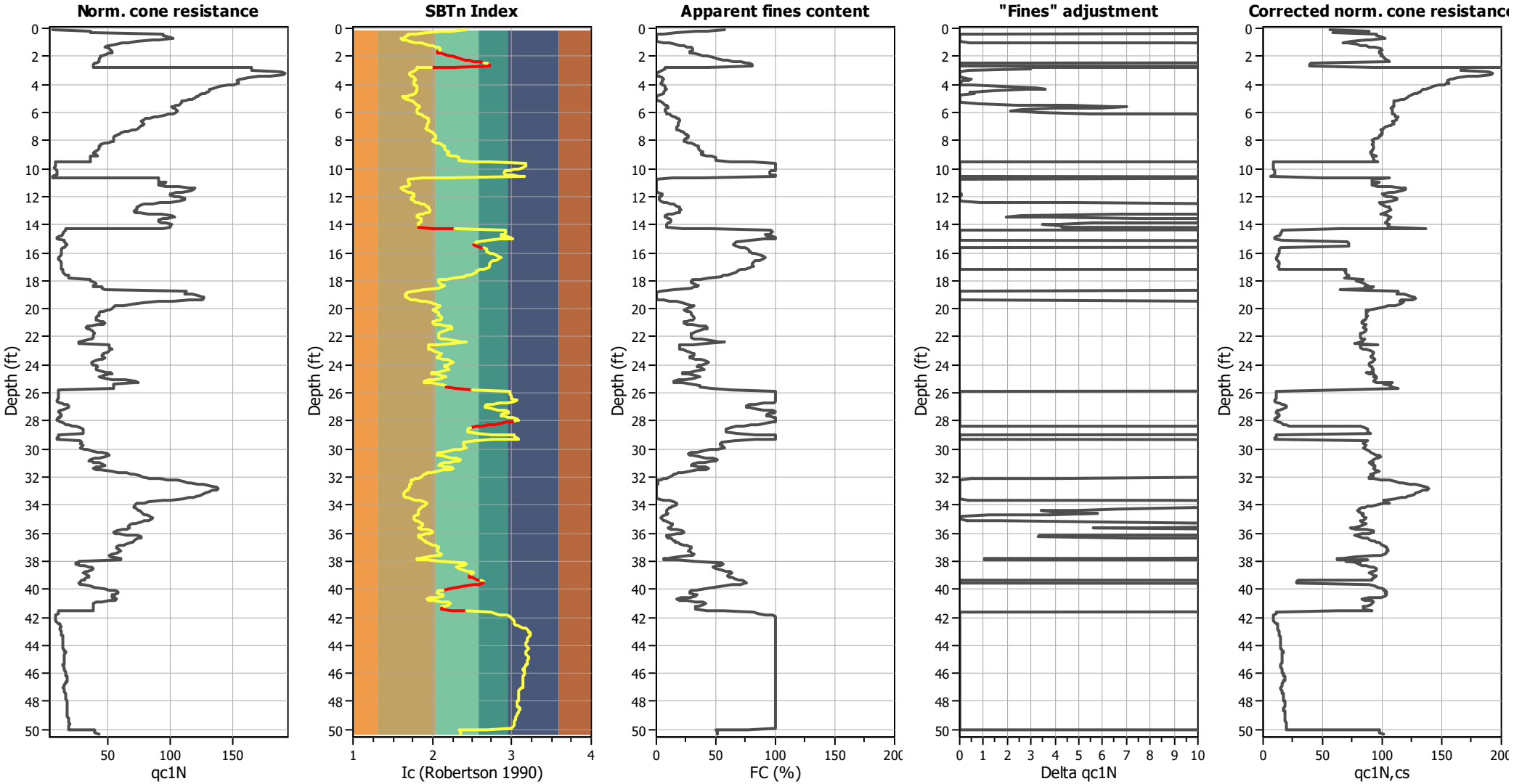
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	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

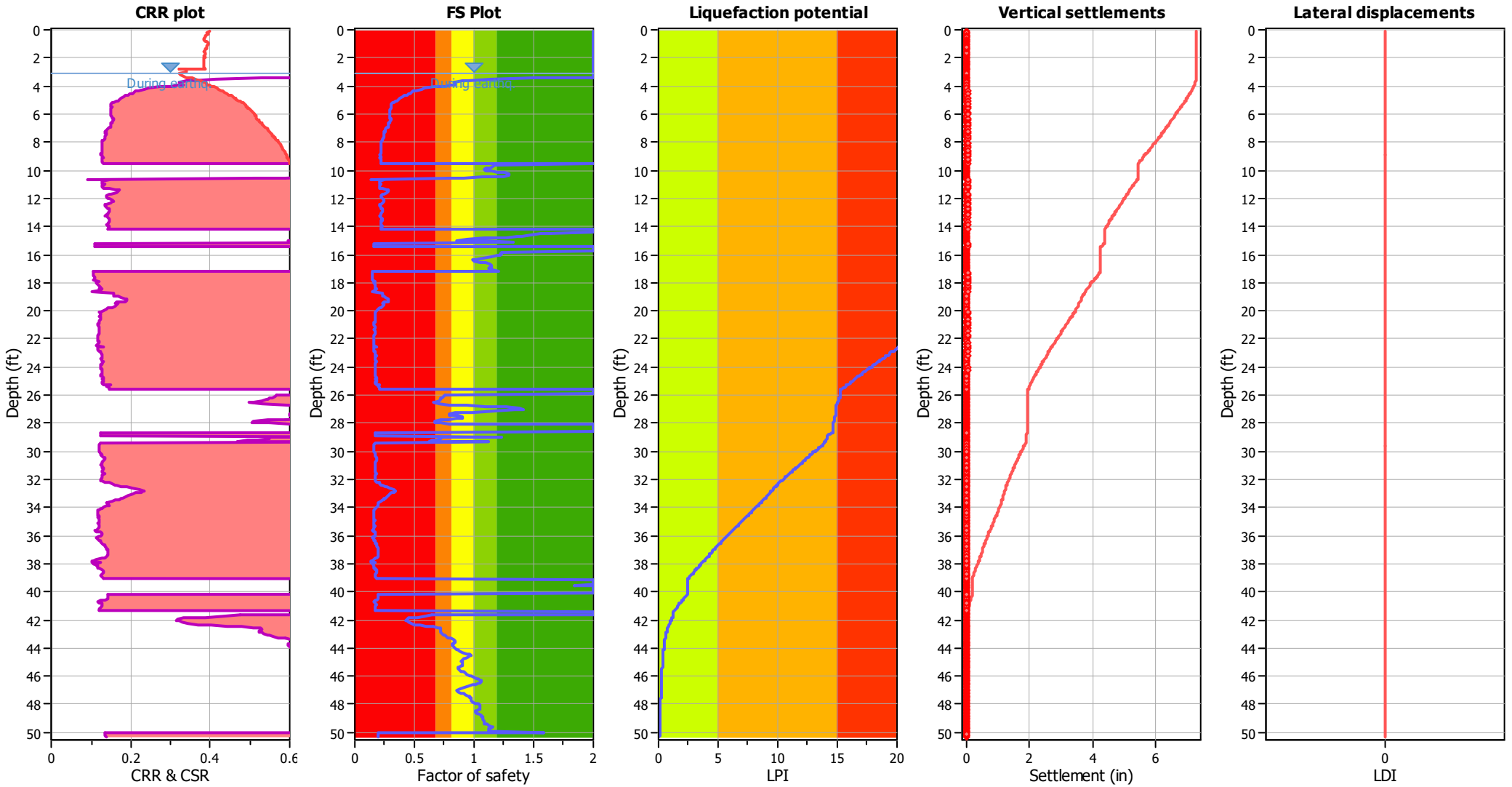
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

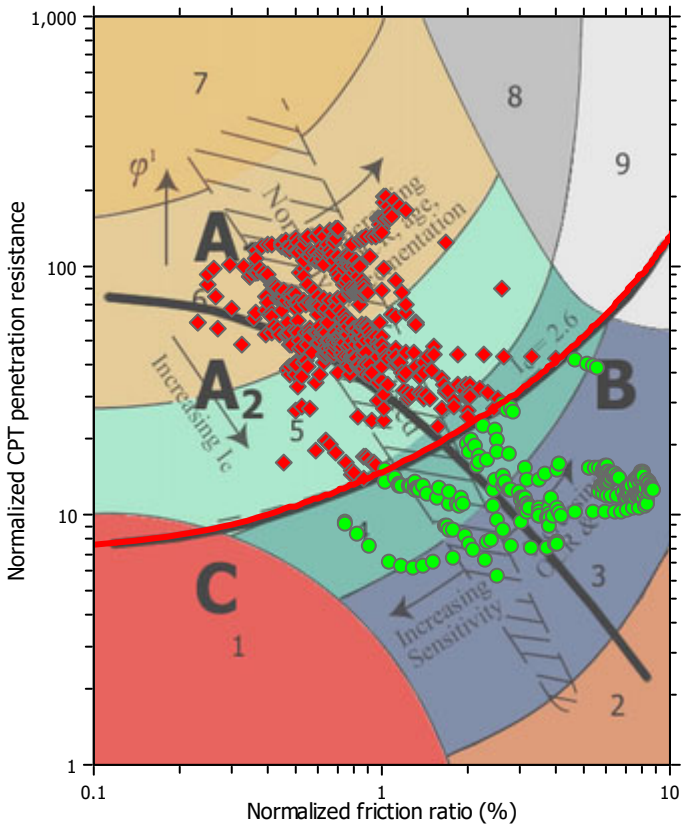
F.S. color scheme

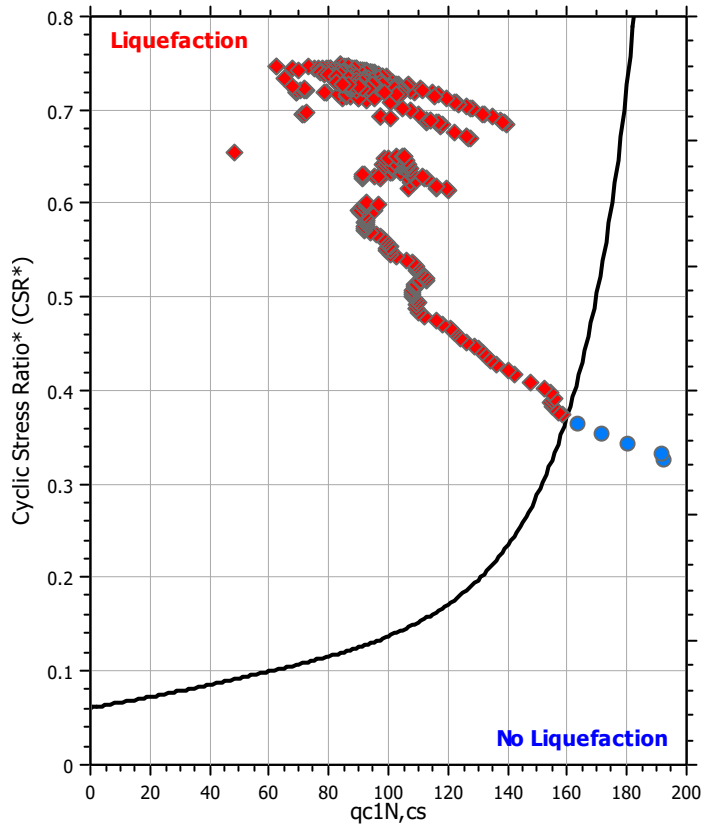
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

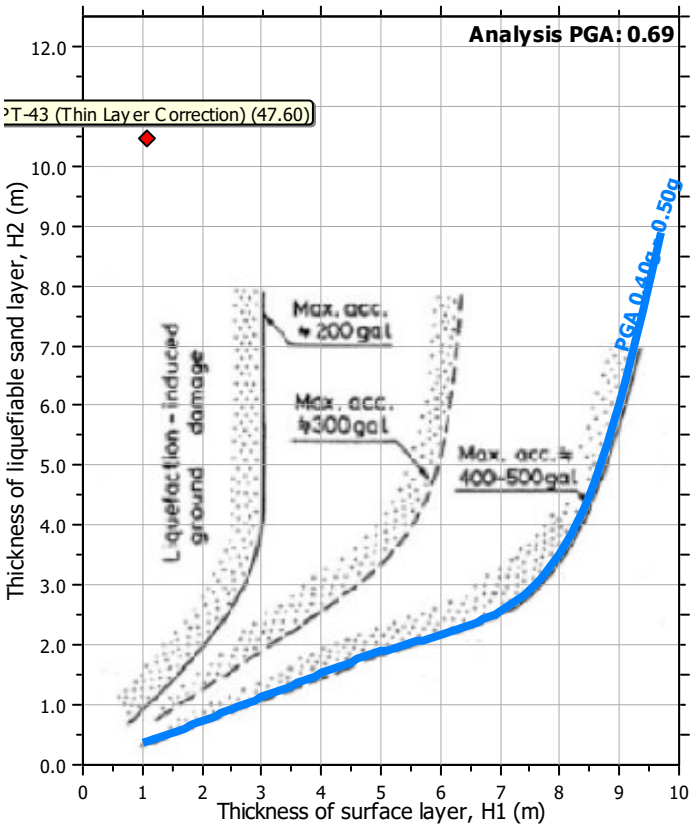
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



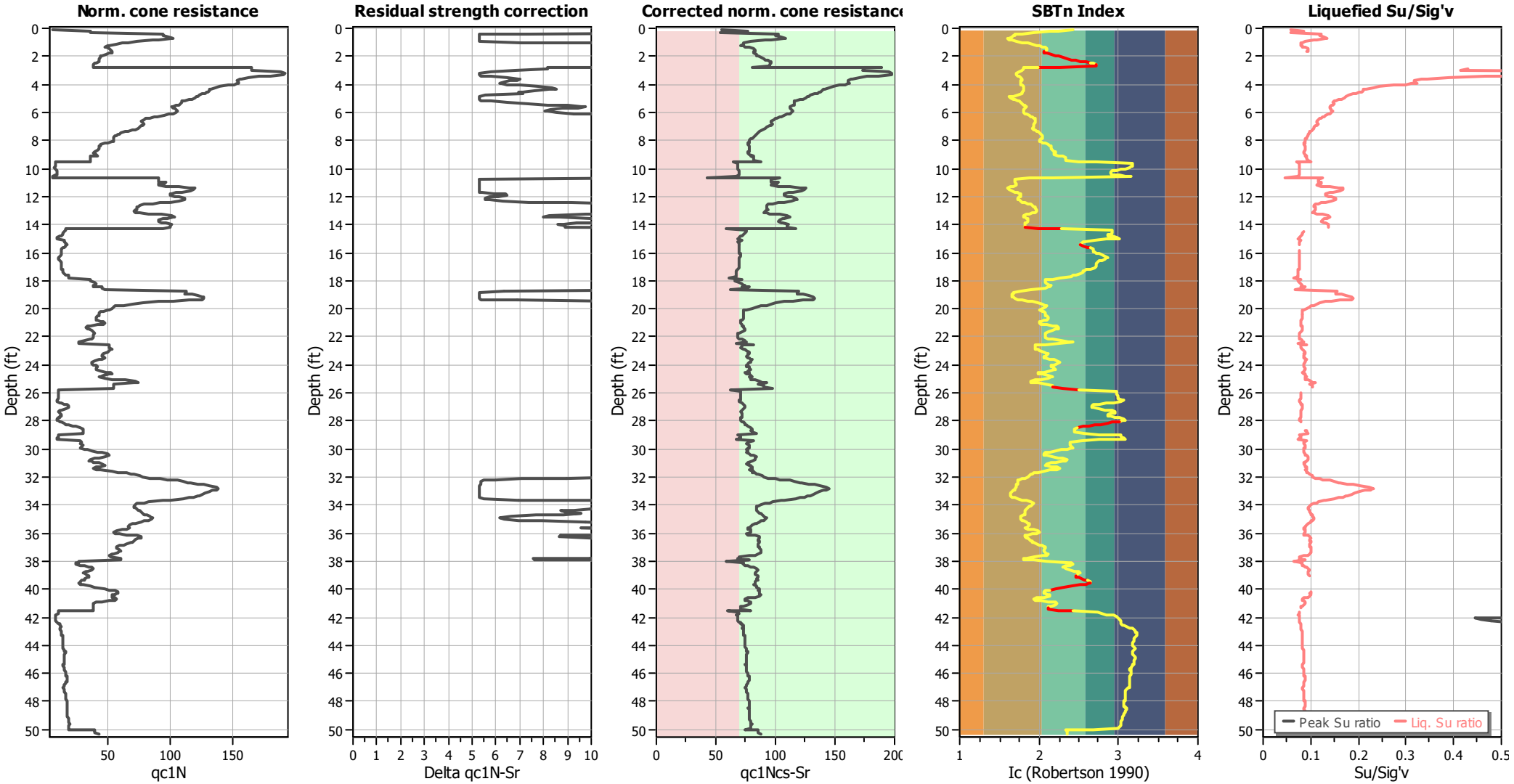




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

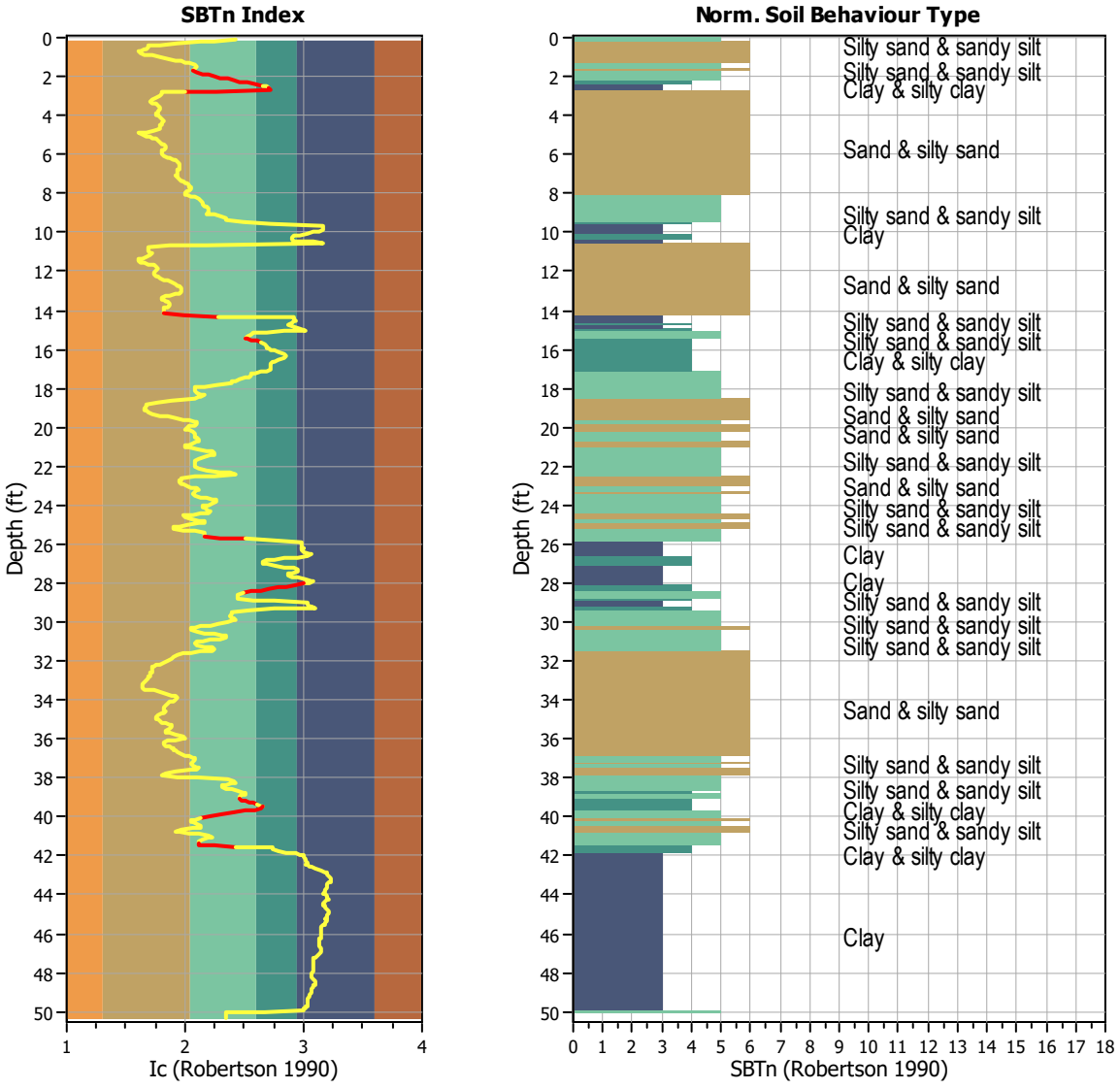
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

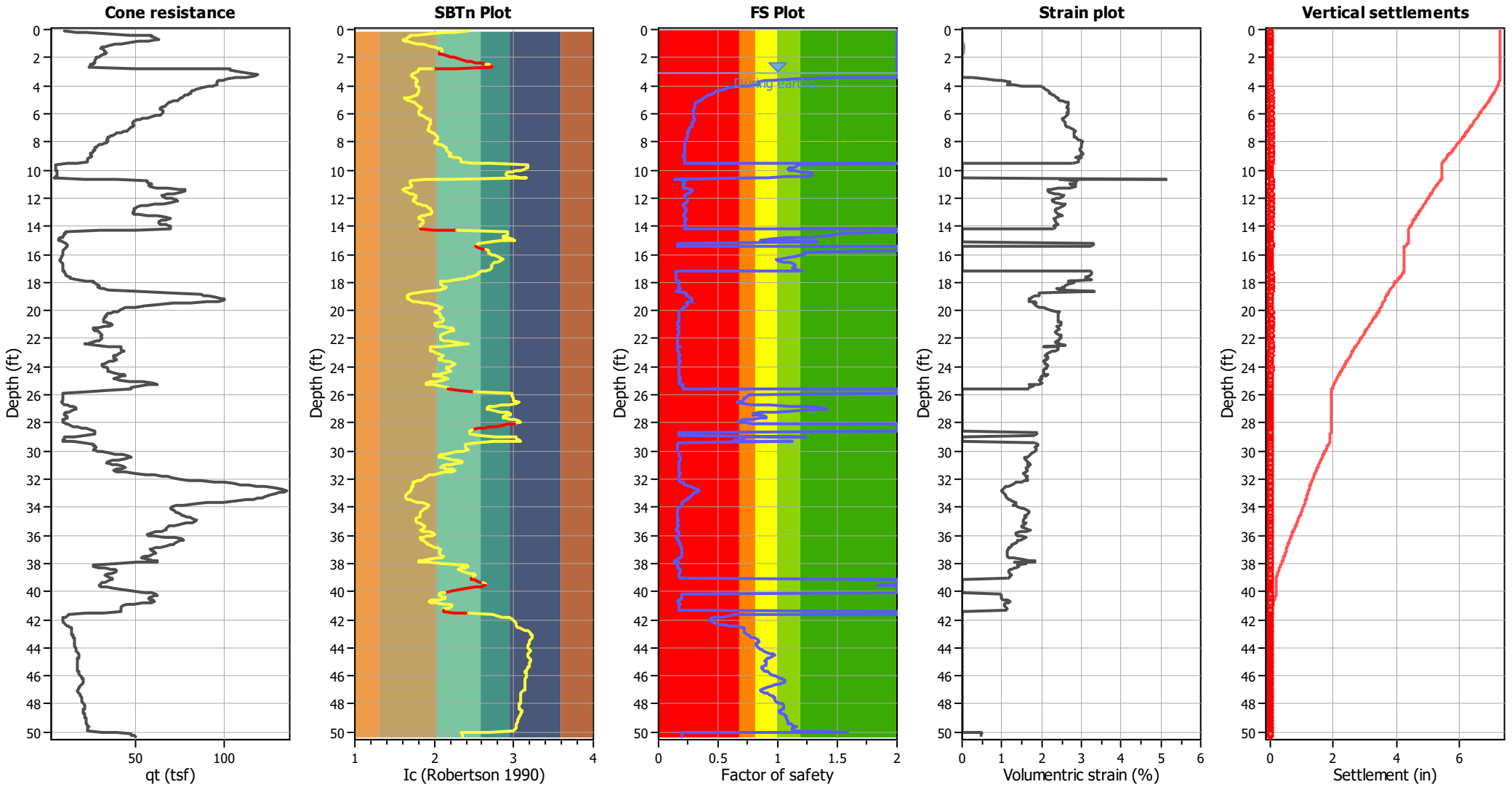
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	759
I_c maximum check value:	3.00	Total points excluded:	56
I_c change ratio value:	0.0250	Exclusion percentage:	7.38%
Minimum number of points in layer:	4	Number of layers detected:	9

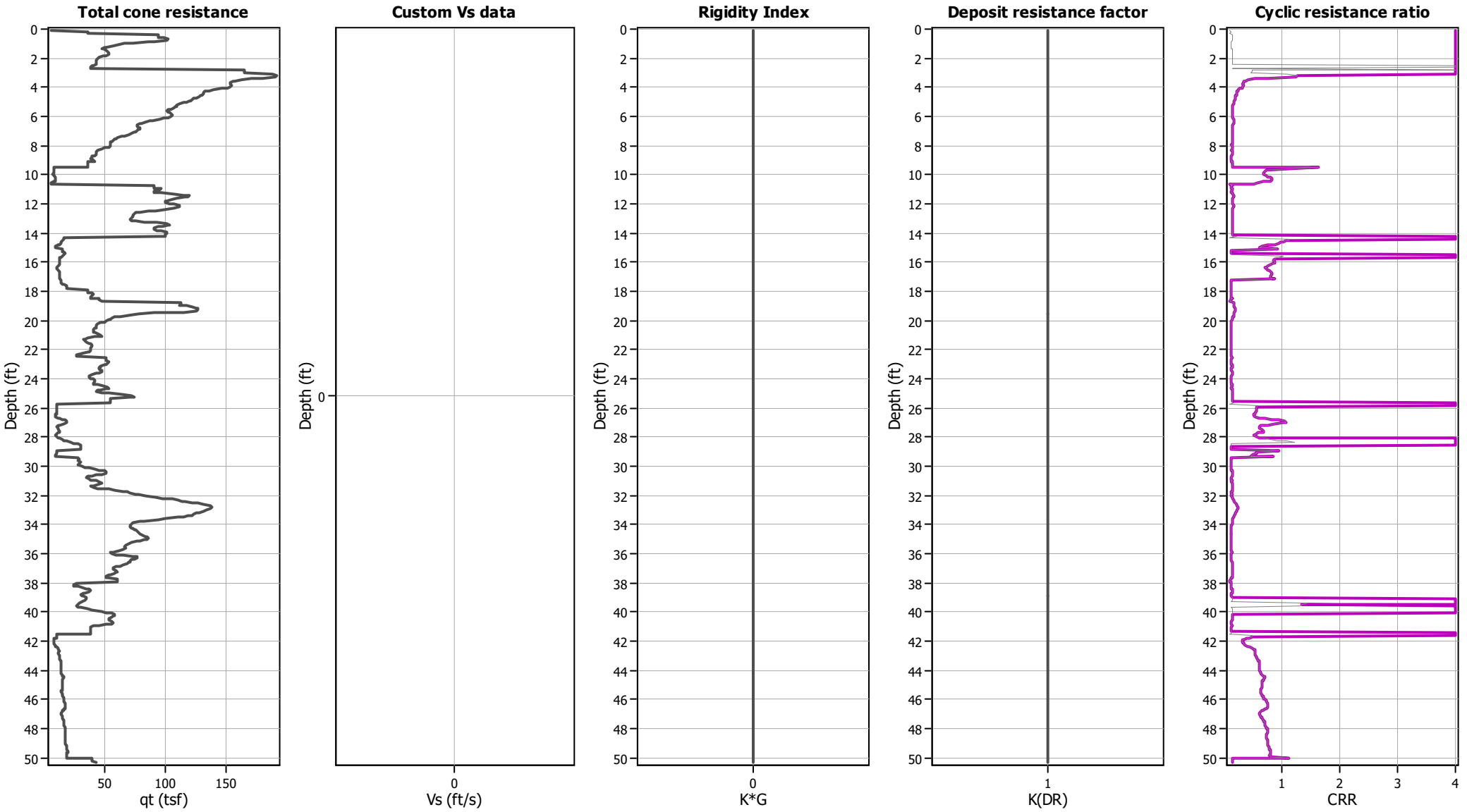
Estimation of post-earthquake settlements



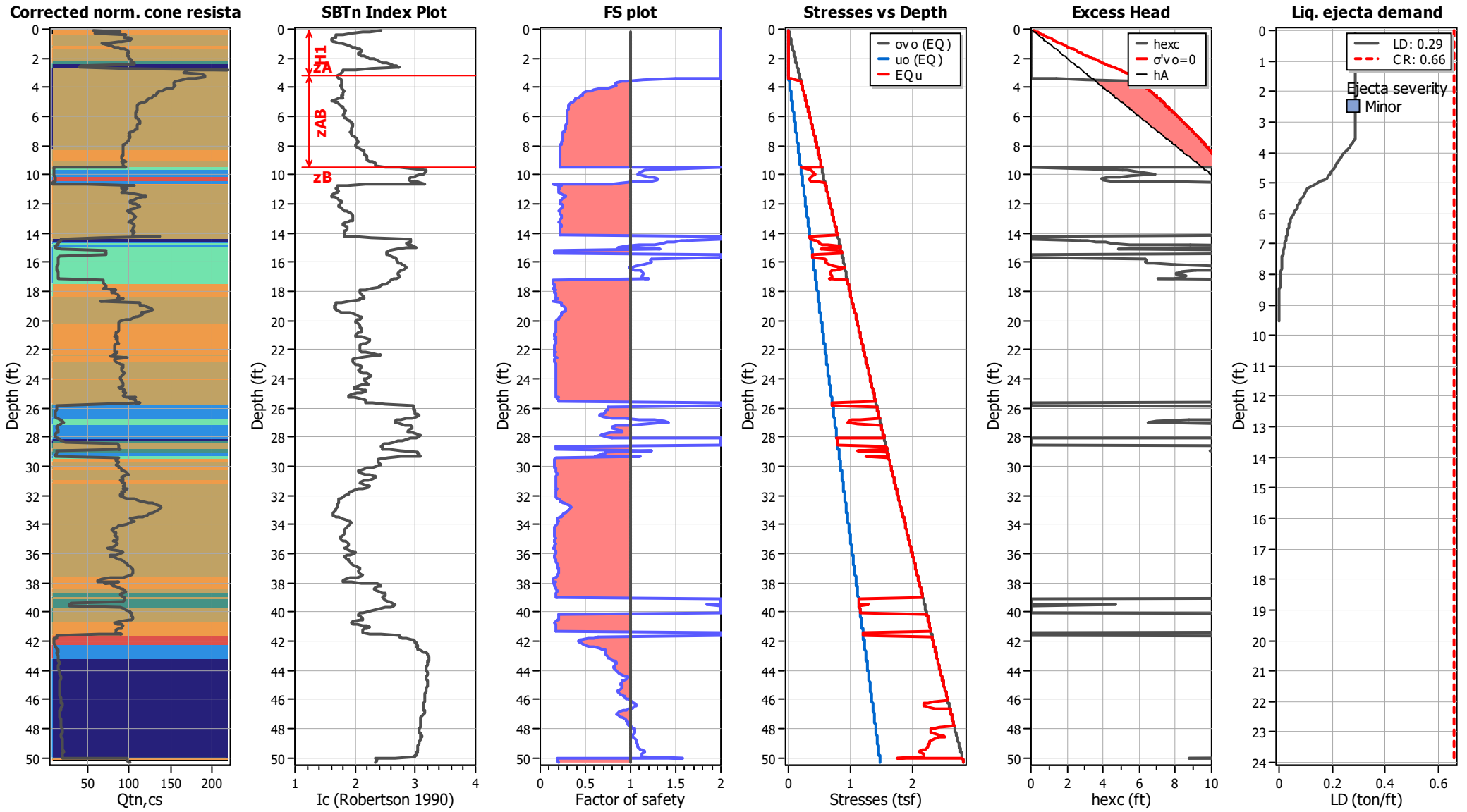
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

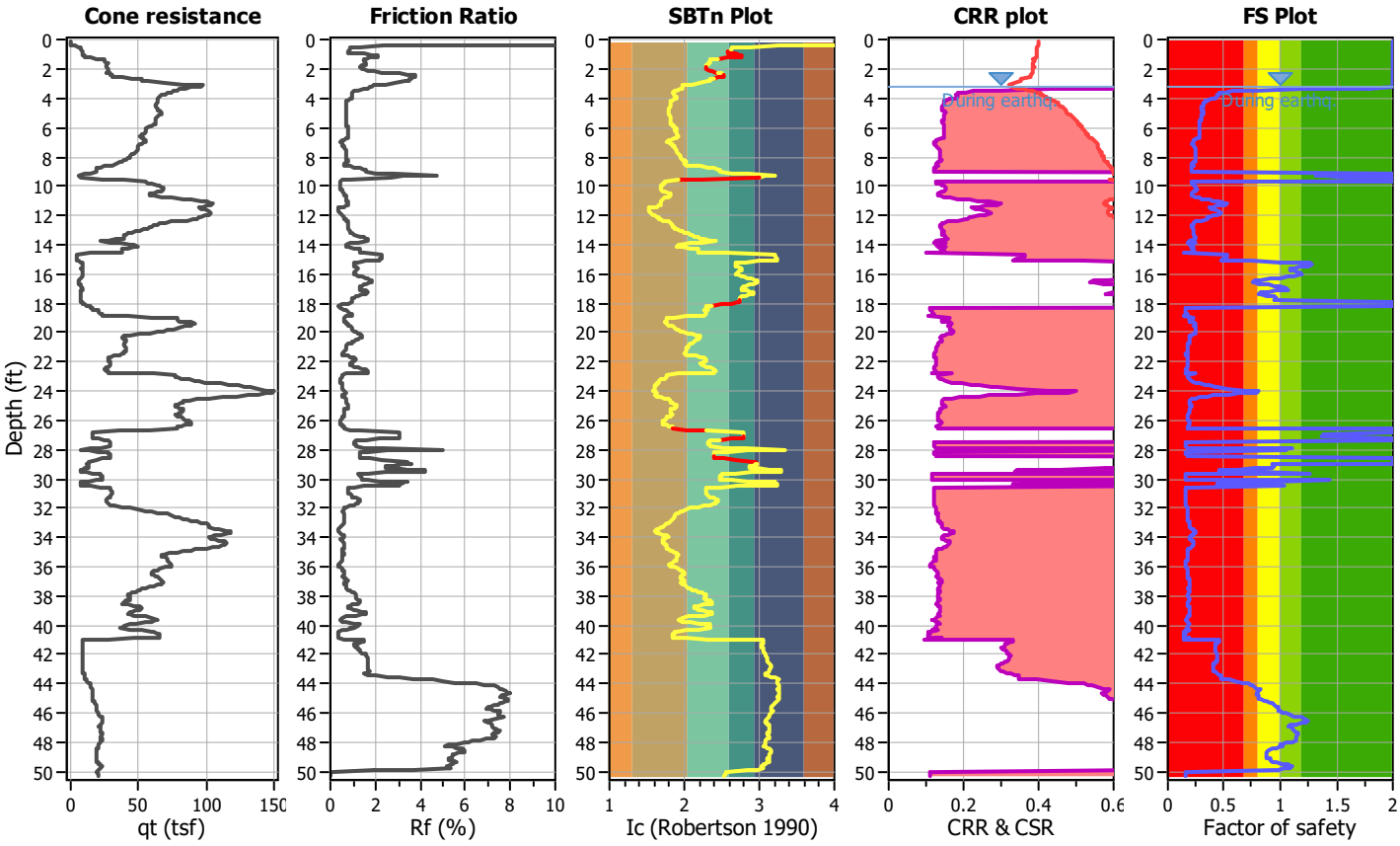
Project title : Topgolf Harbor Island

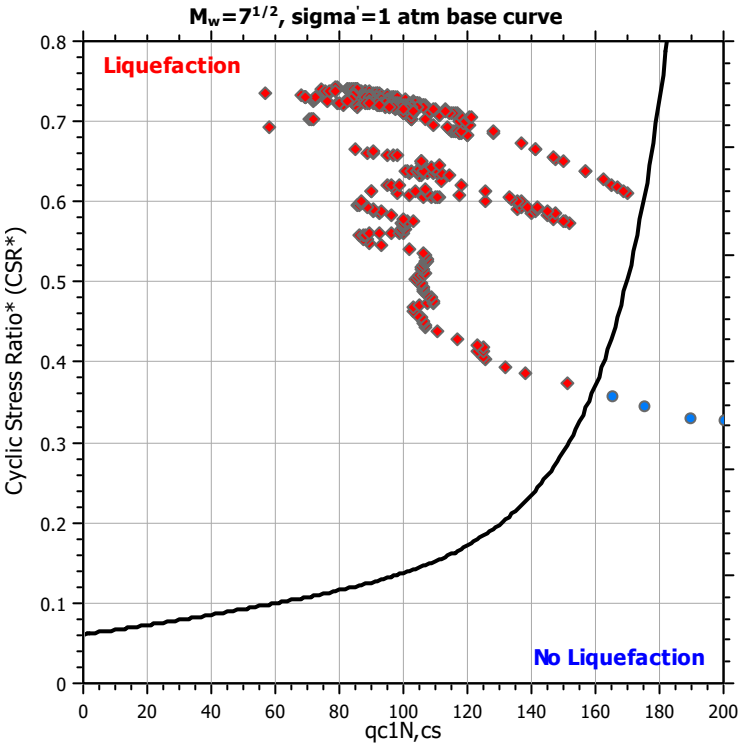
Location : North Harbor Drive and Liberator Way, San Diego, CA

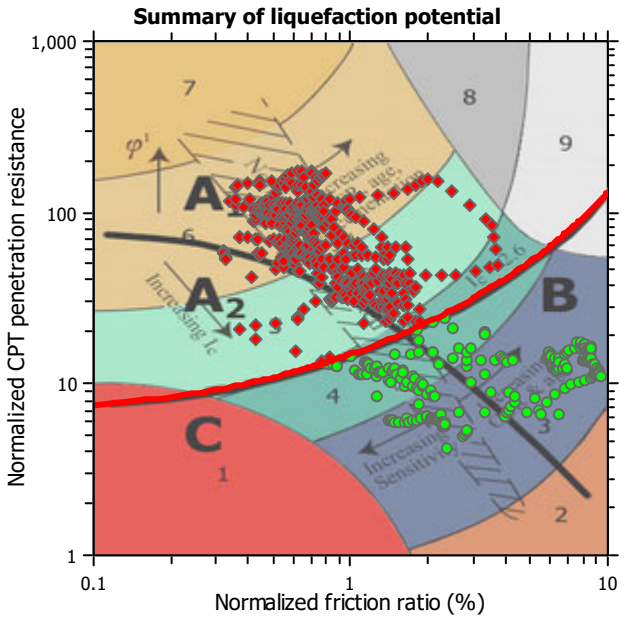
CPT file : CPT-44 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.12 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

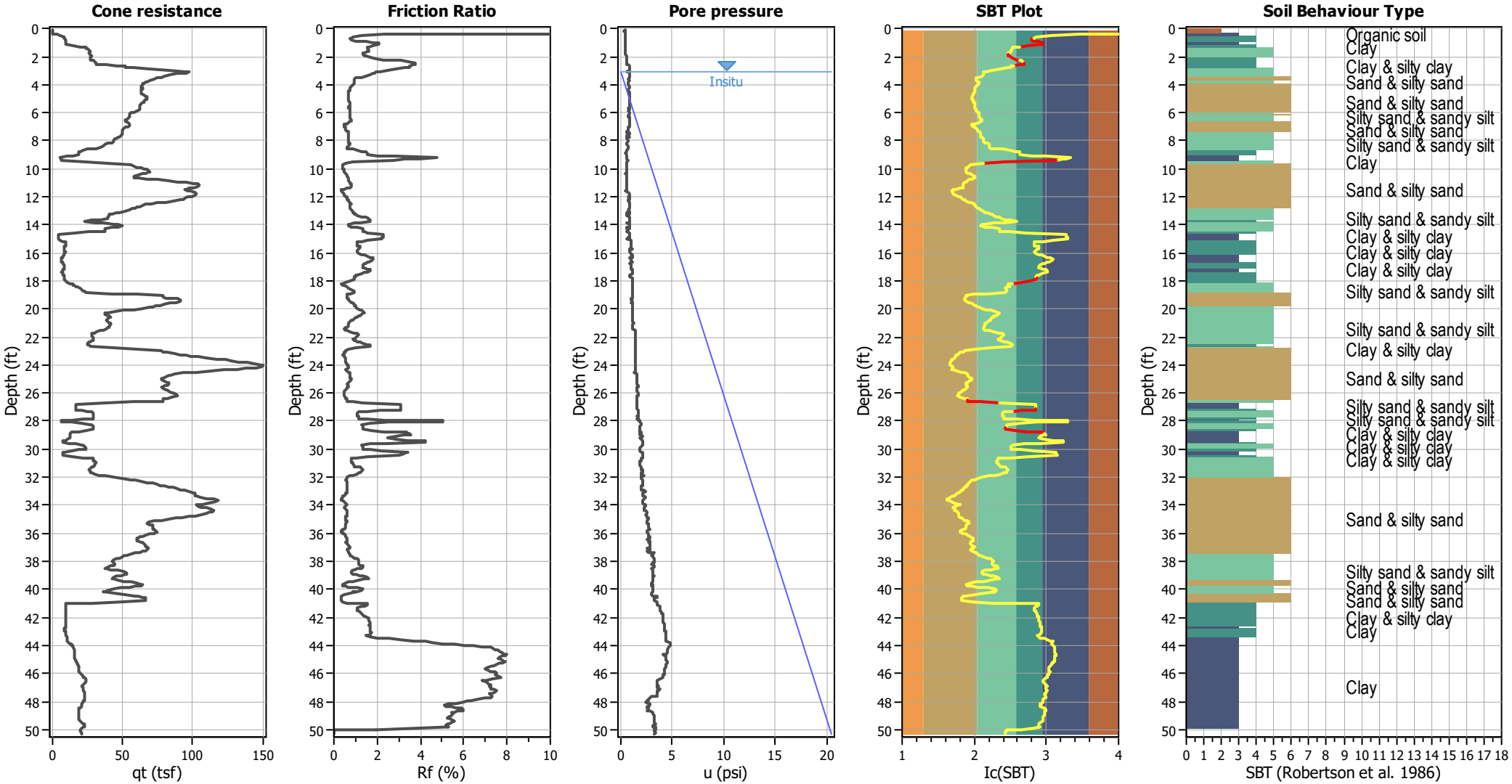






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



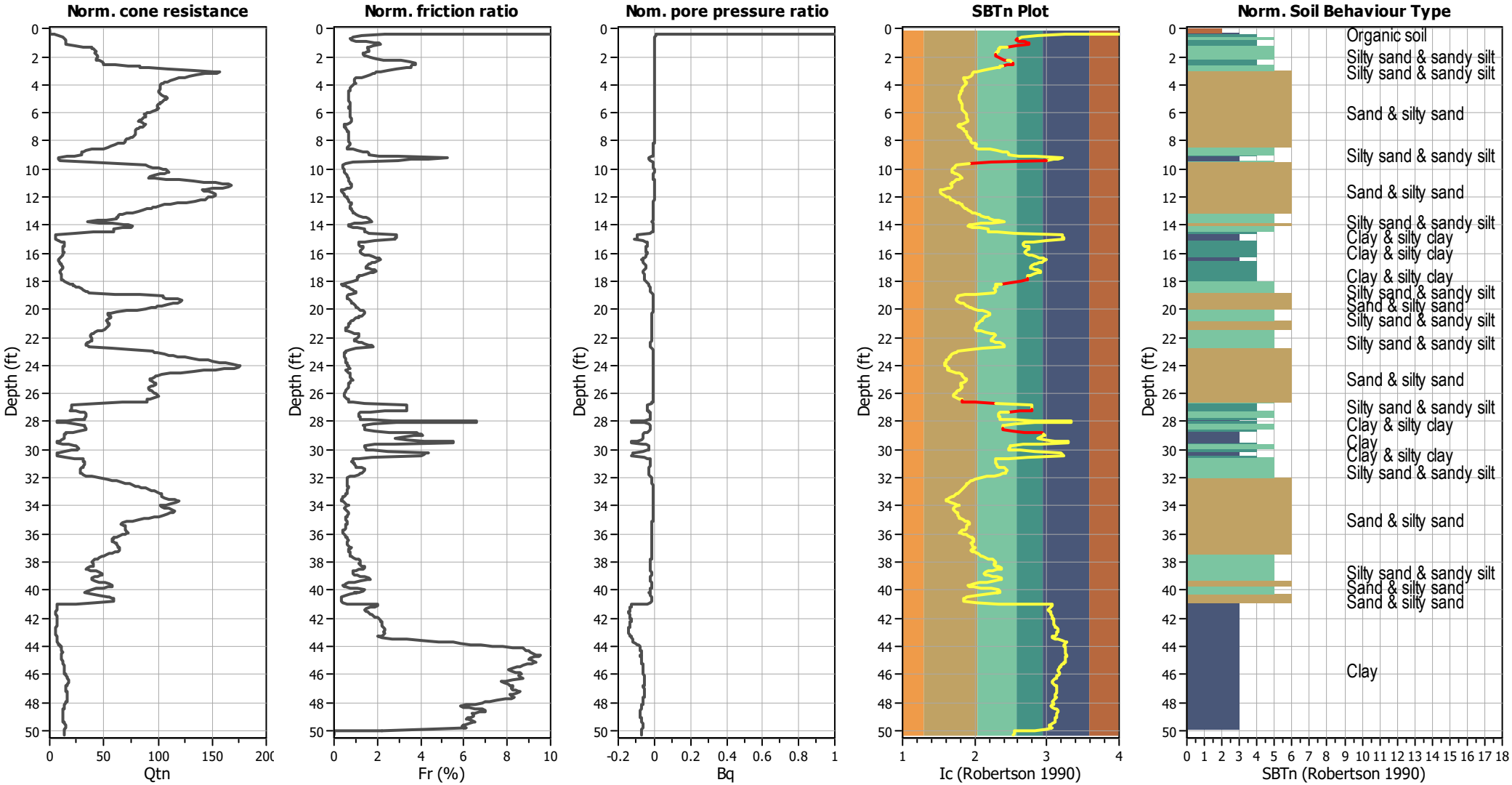
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	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)



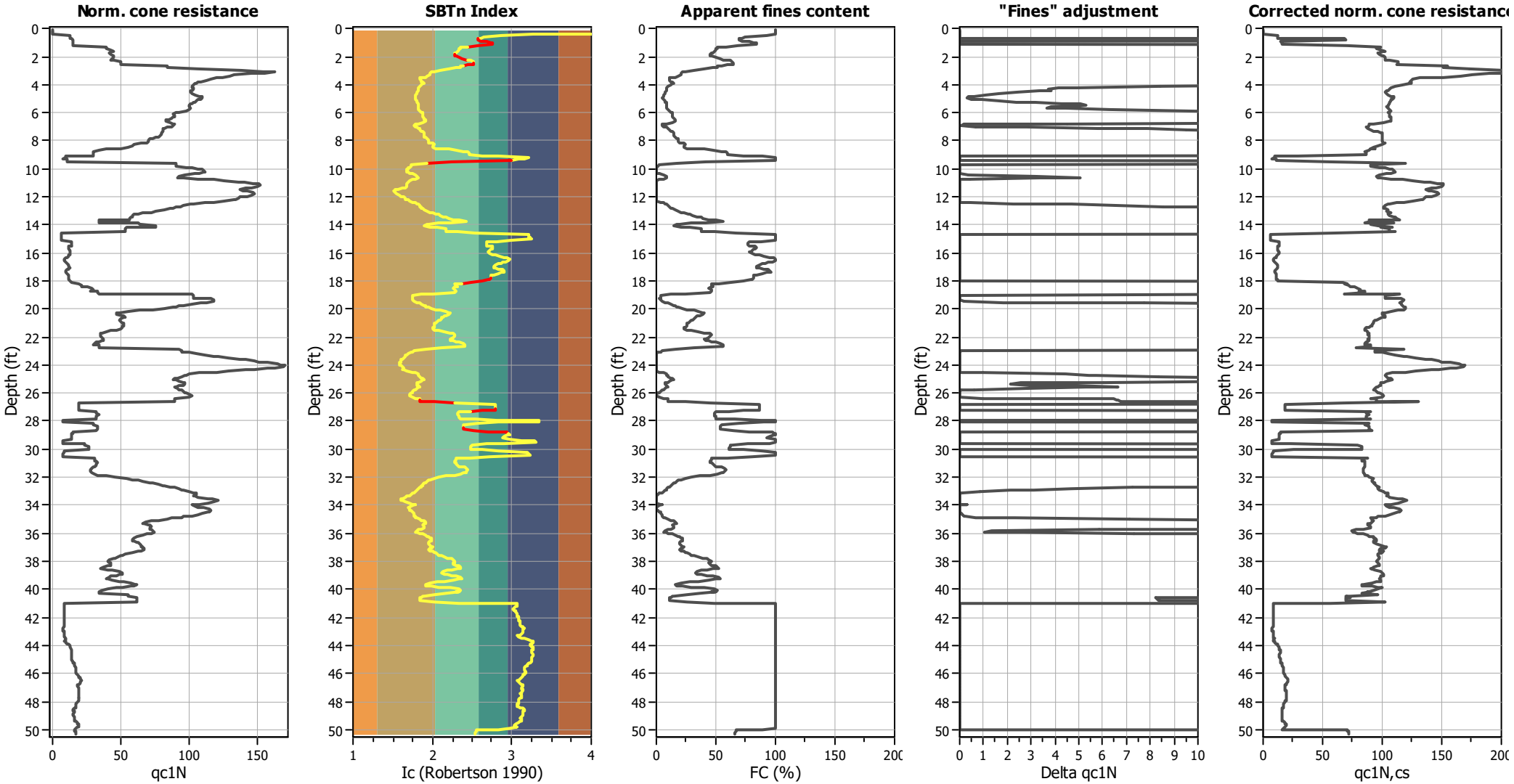
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	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

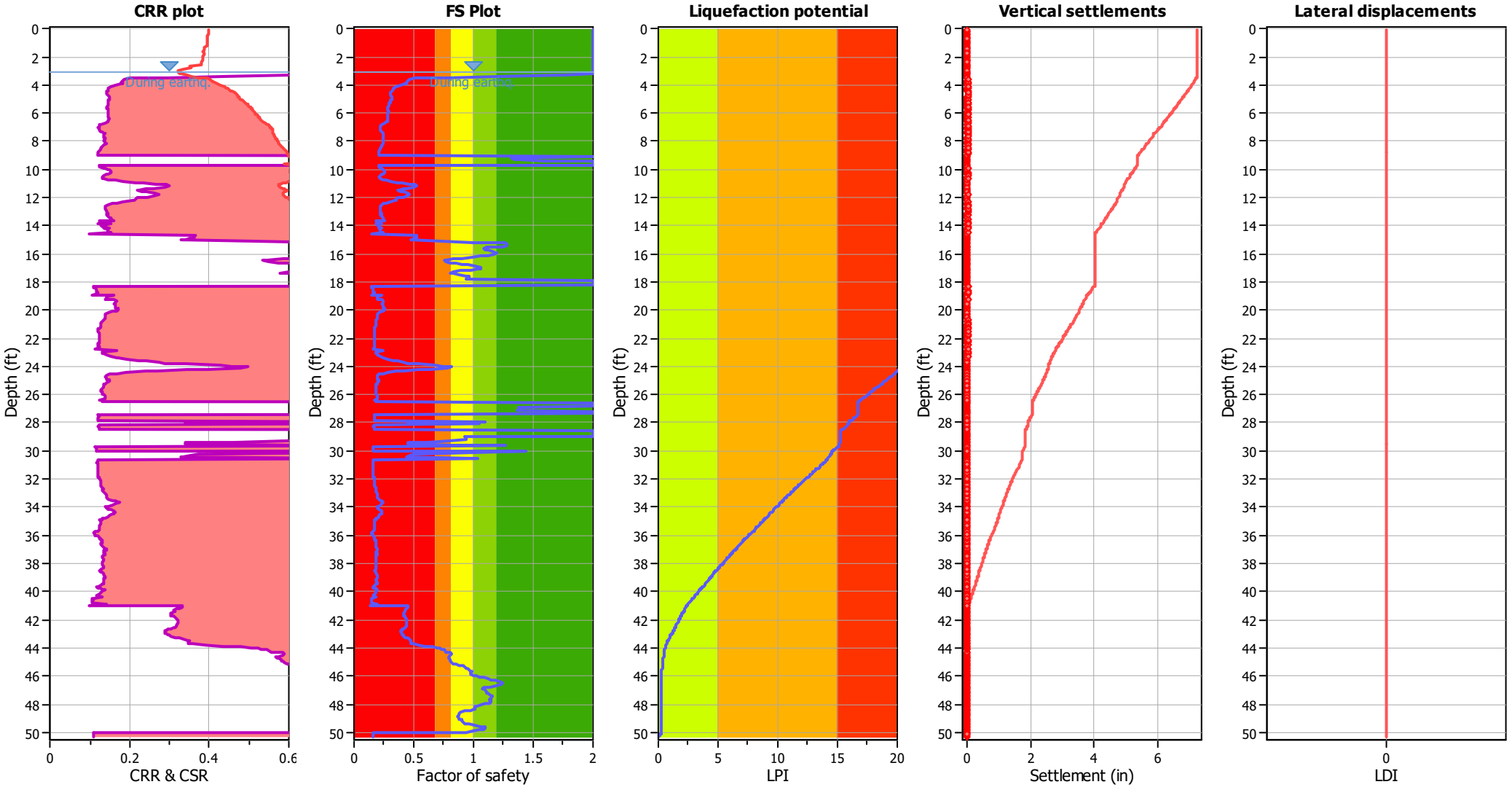
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

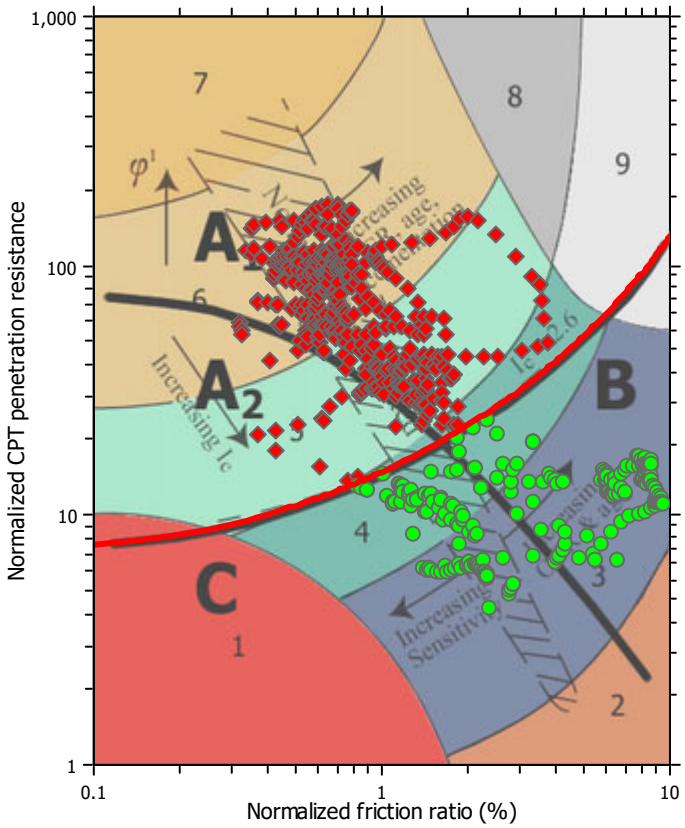
F.S. color scheme

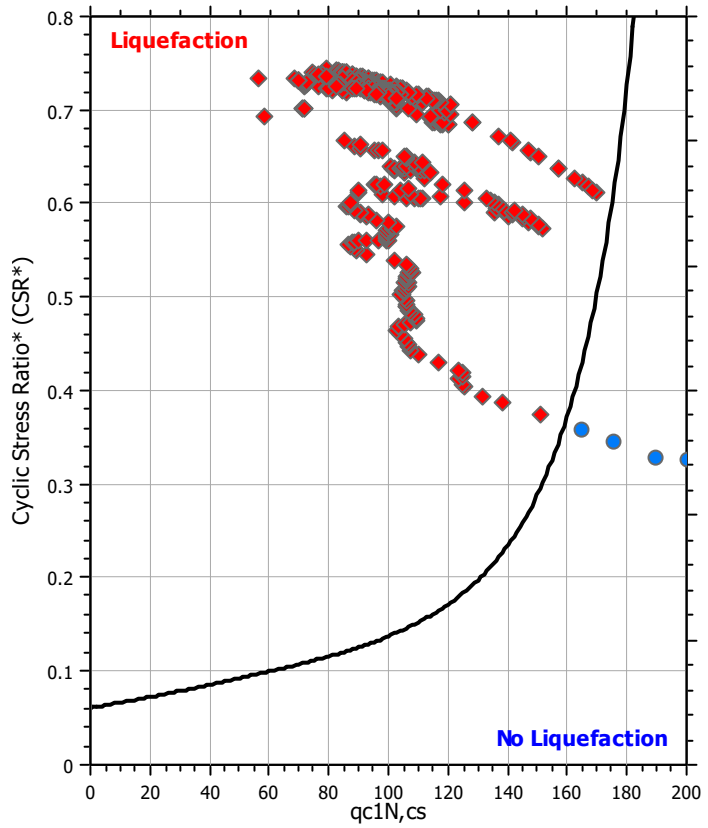
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

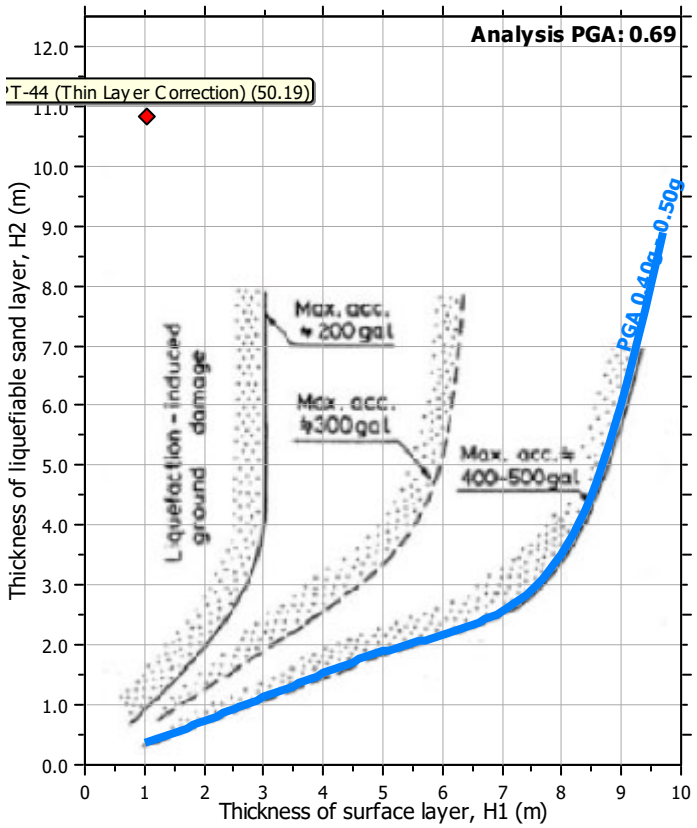
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



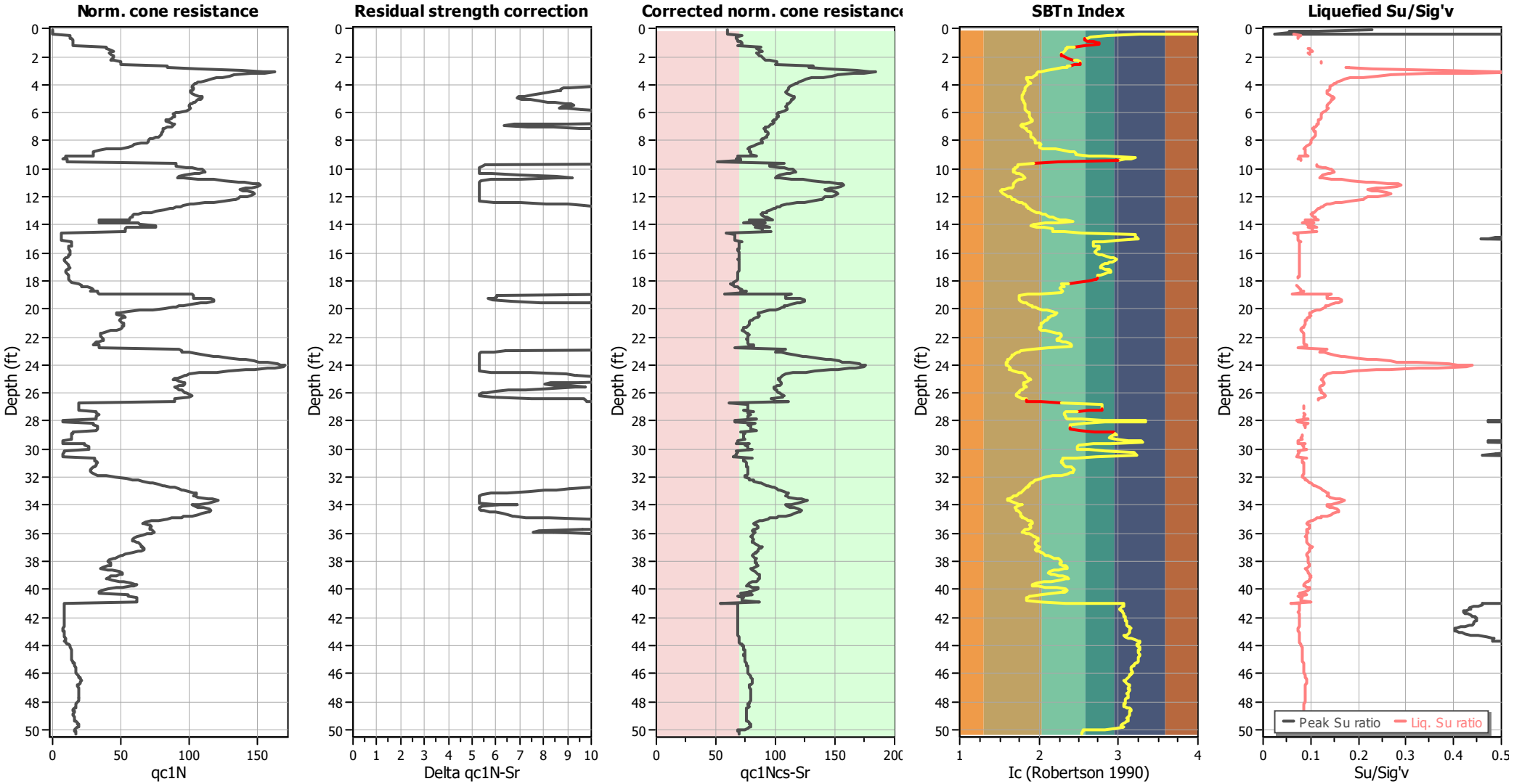




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

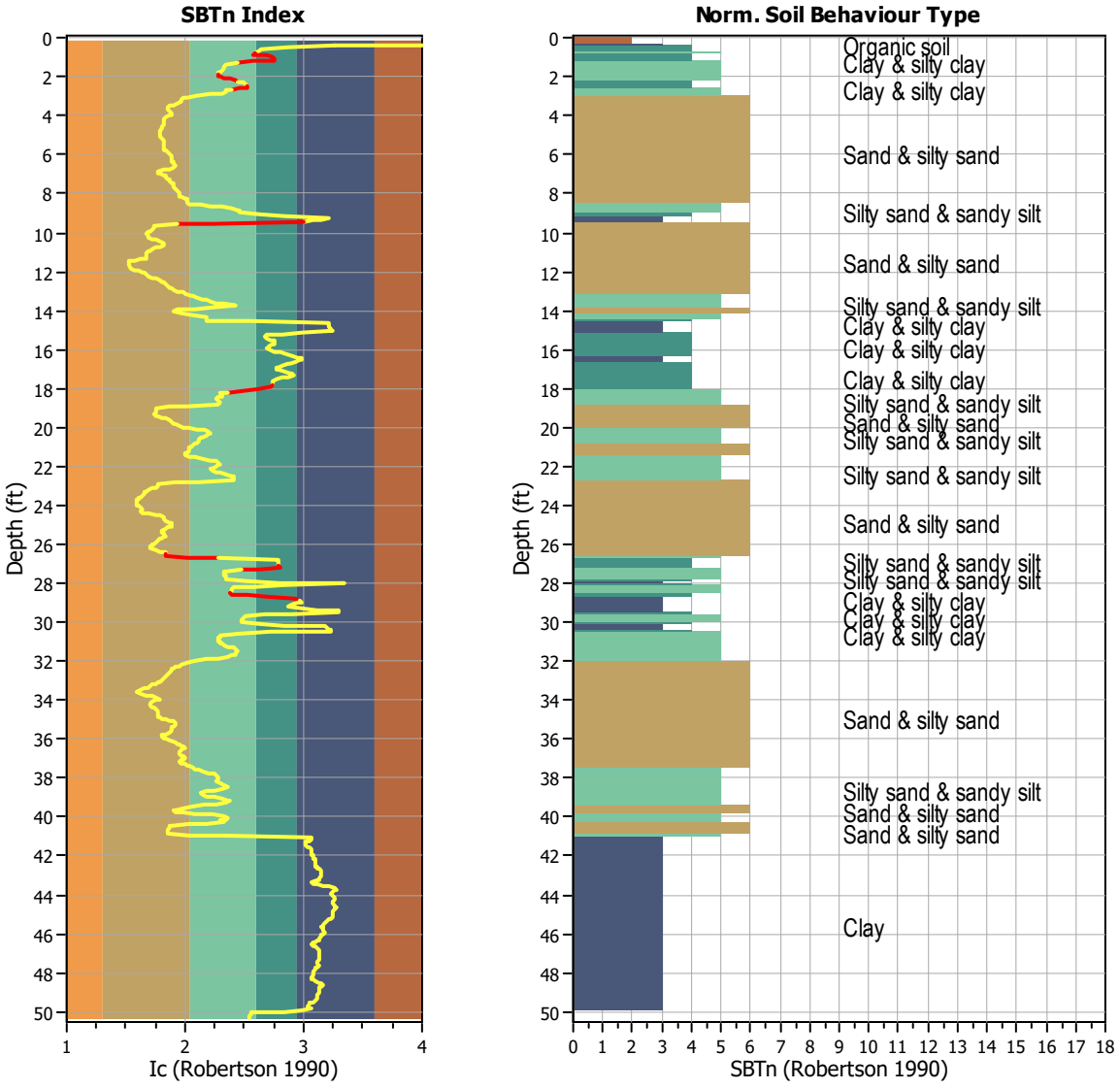
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.12 ft	Fill height:	N/A	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.



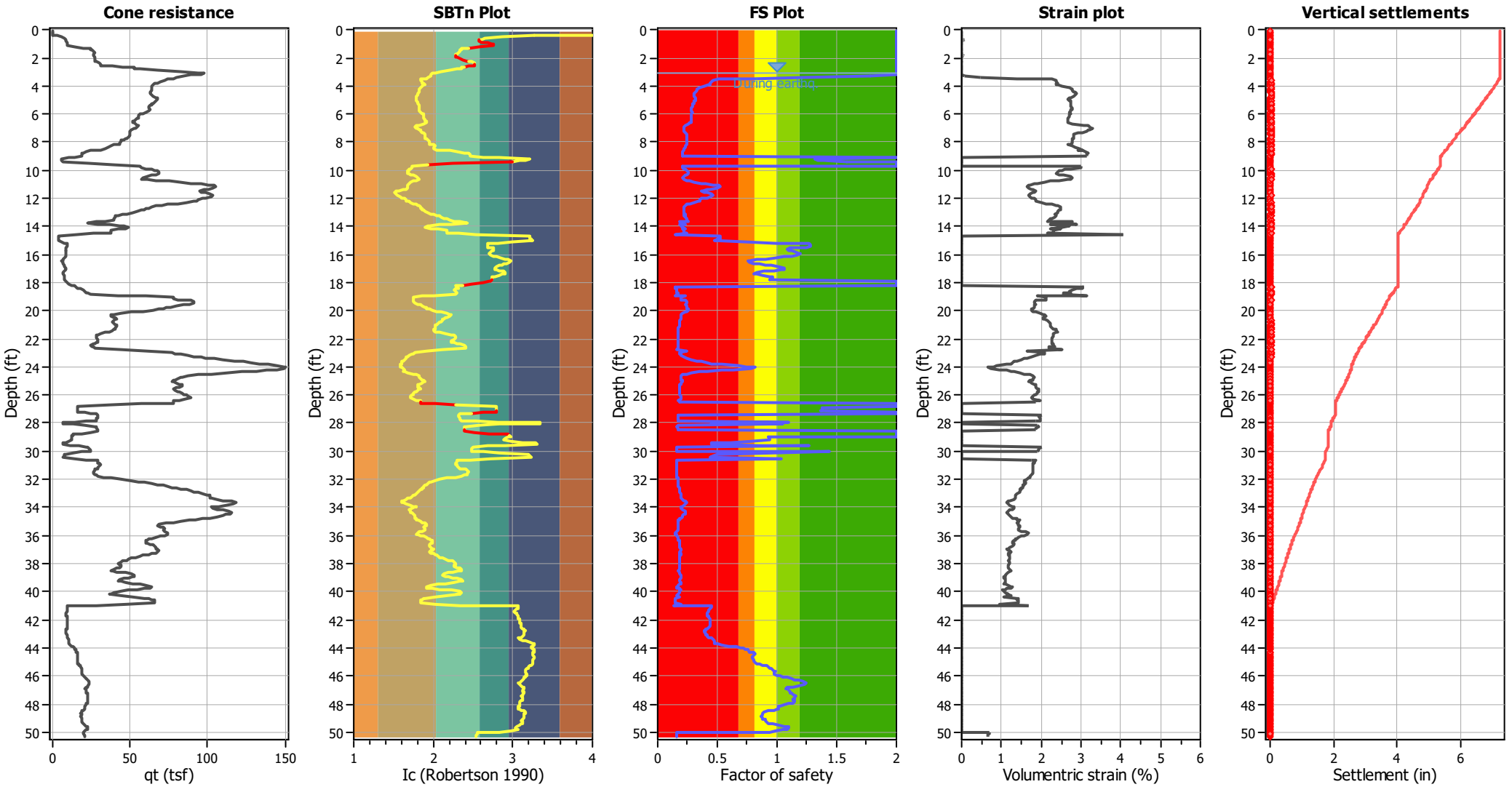
Transition layer algorithm properties

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:	762
Total points excluded:	45
Exclusion percentage:	5.91%
Number of layers detected:	9

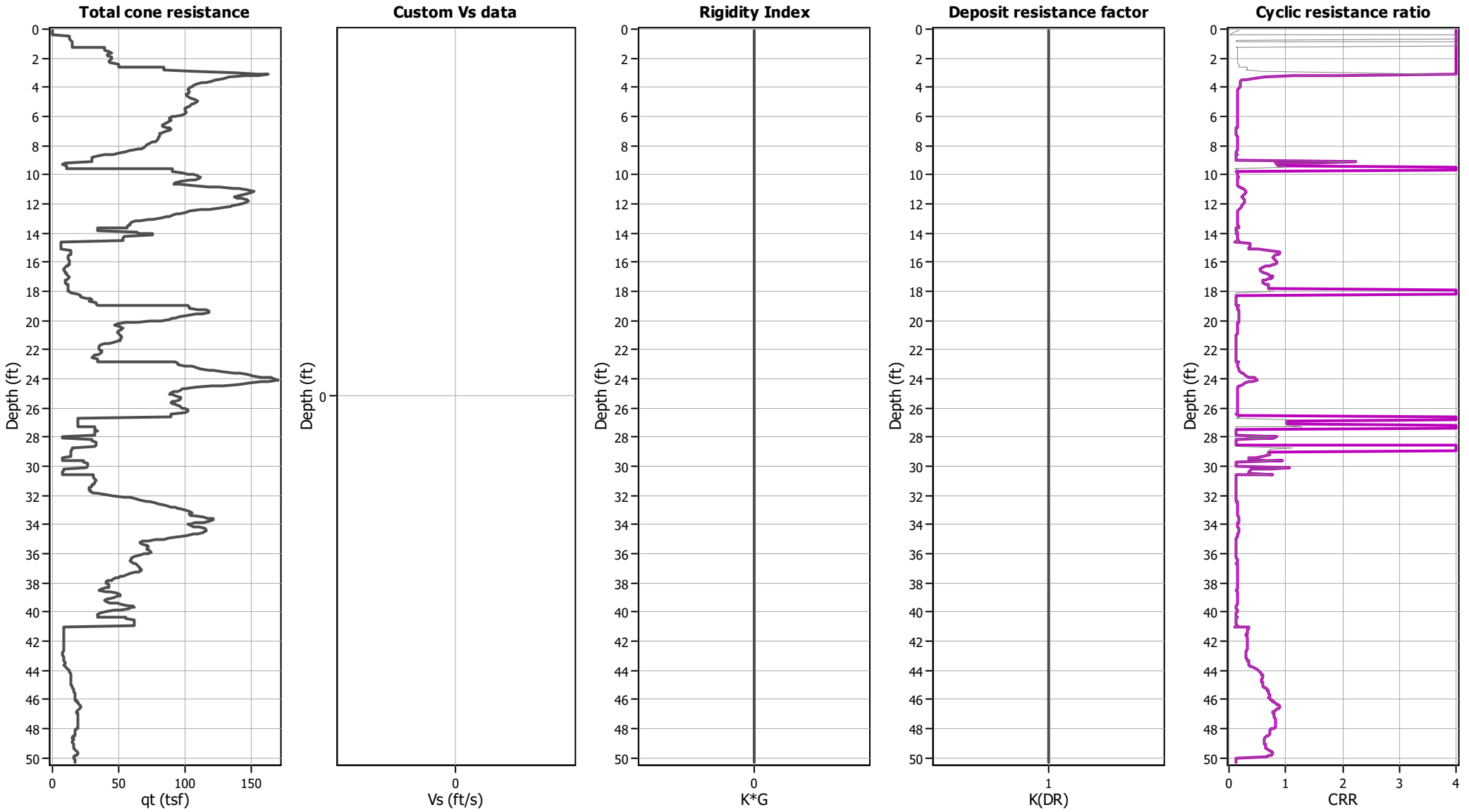
Estimation of post-earthquake settlements



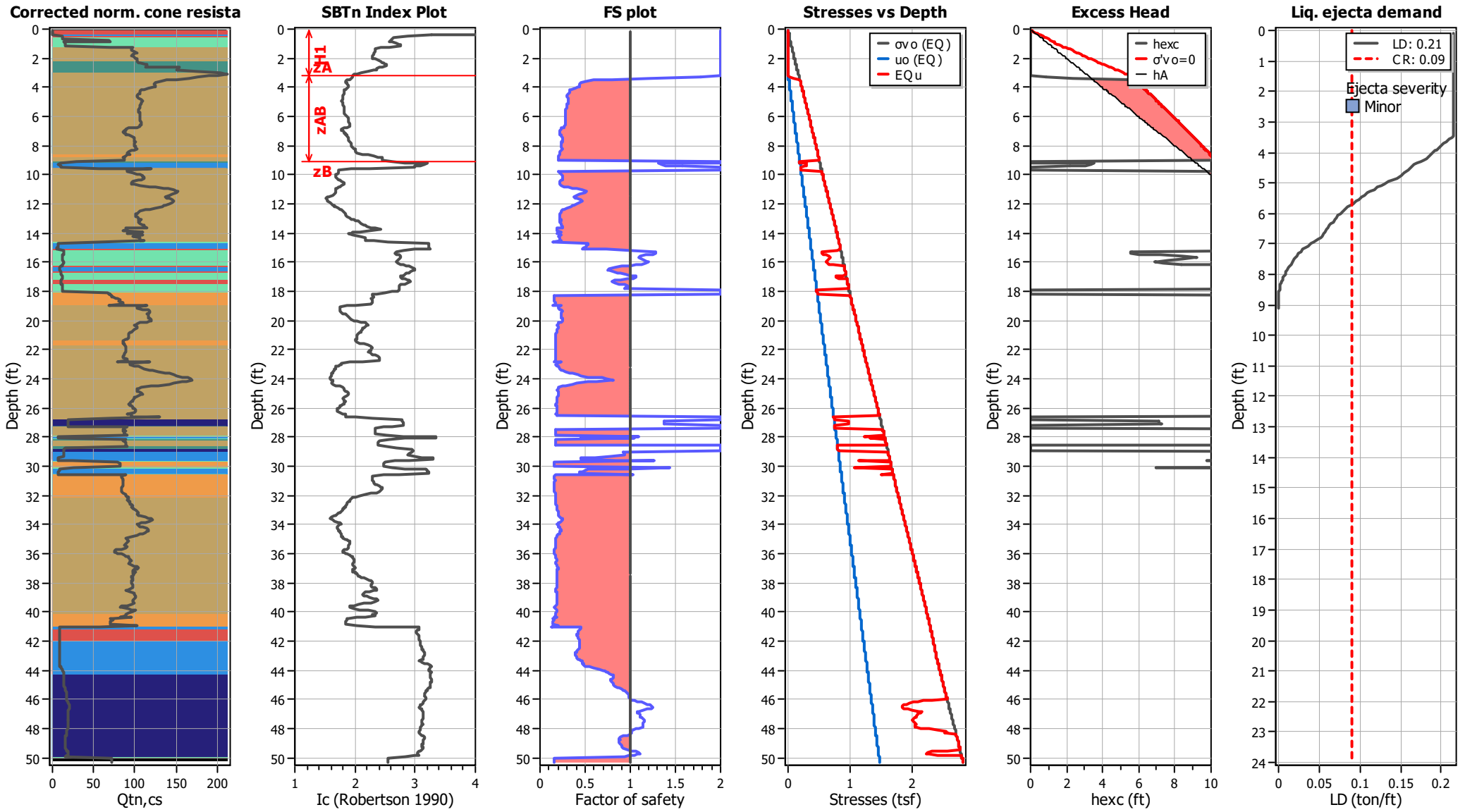
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



NOVA Services, Inc.

LIQUEFACTION ANALYSIS REPORT

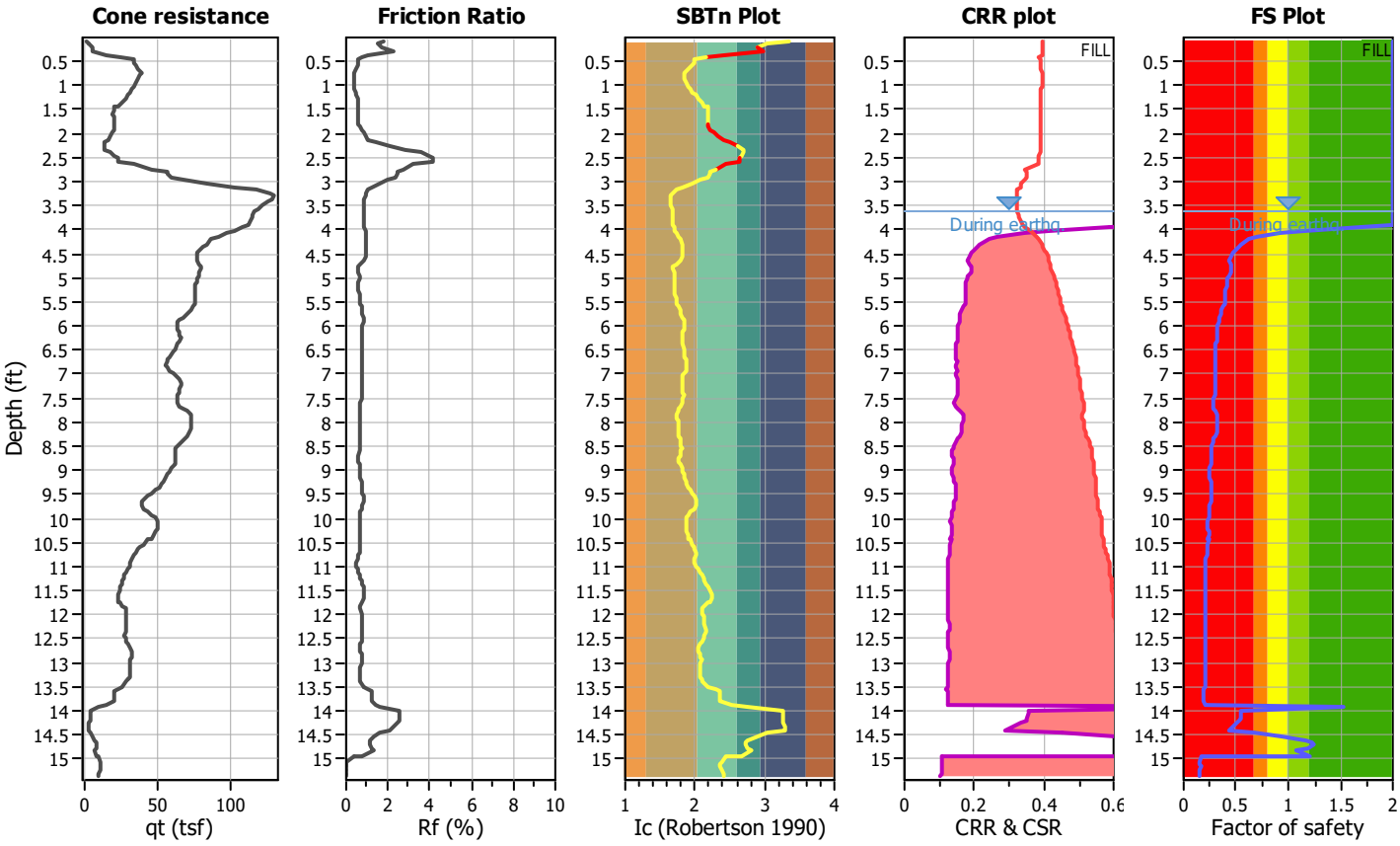
Project title : Topgolf Harbor Island

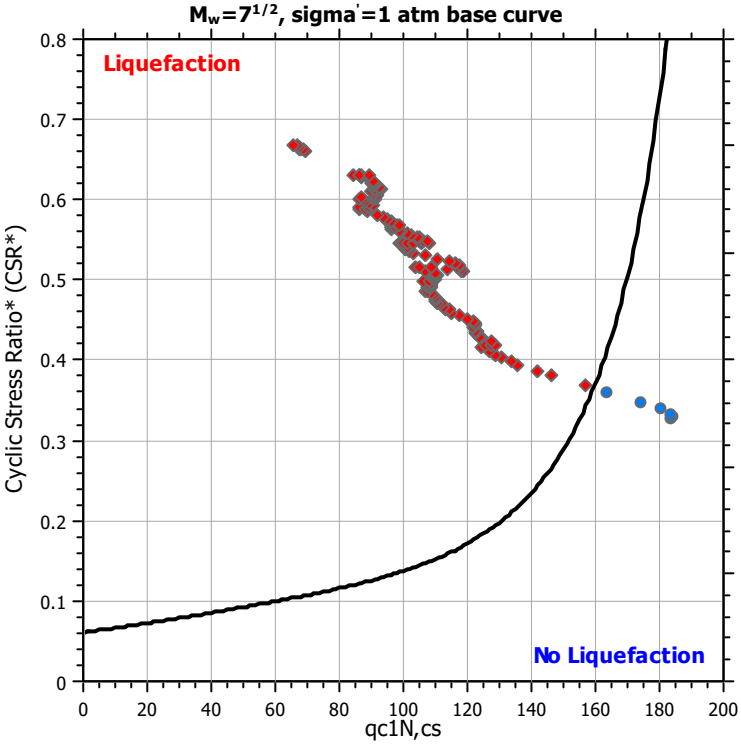
Location : North Harbor Drive and Liberator Way, San Diego, CA

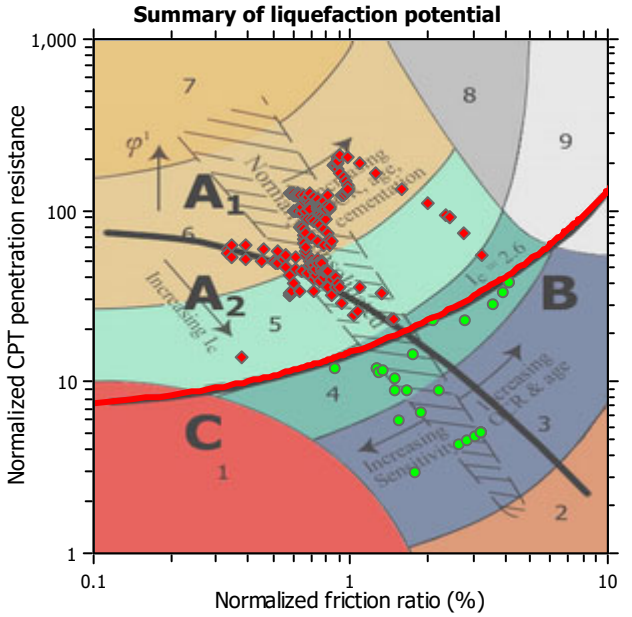
CPT file : CPT-45 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.62 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	0.50 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

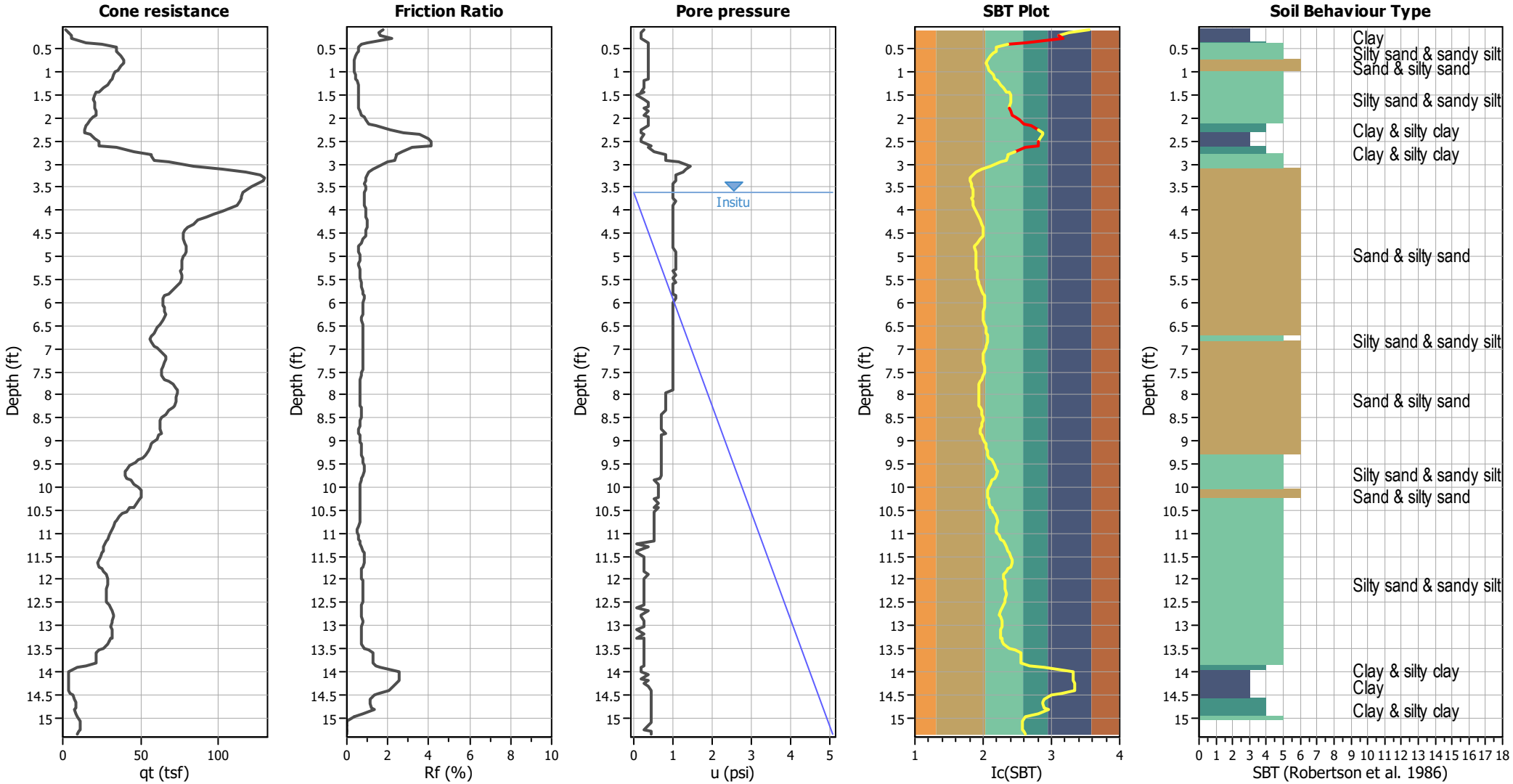






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



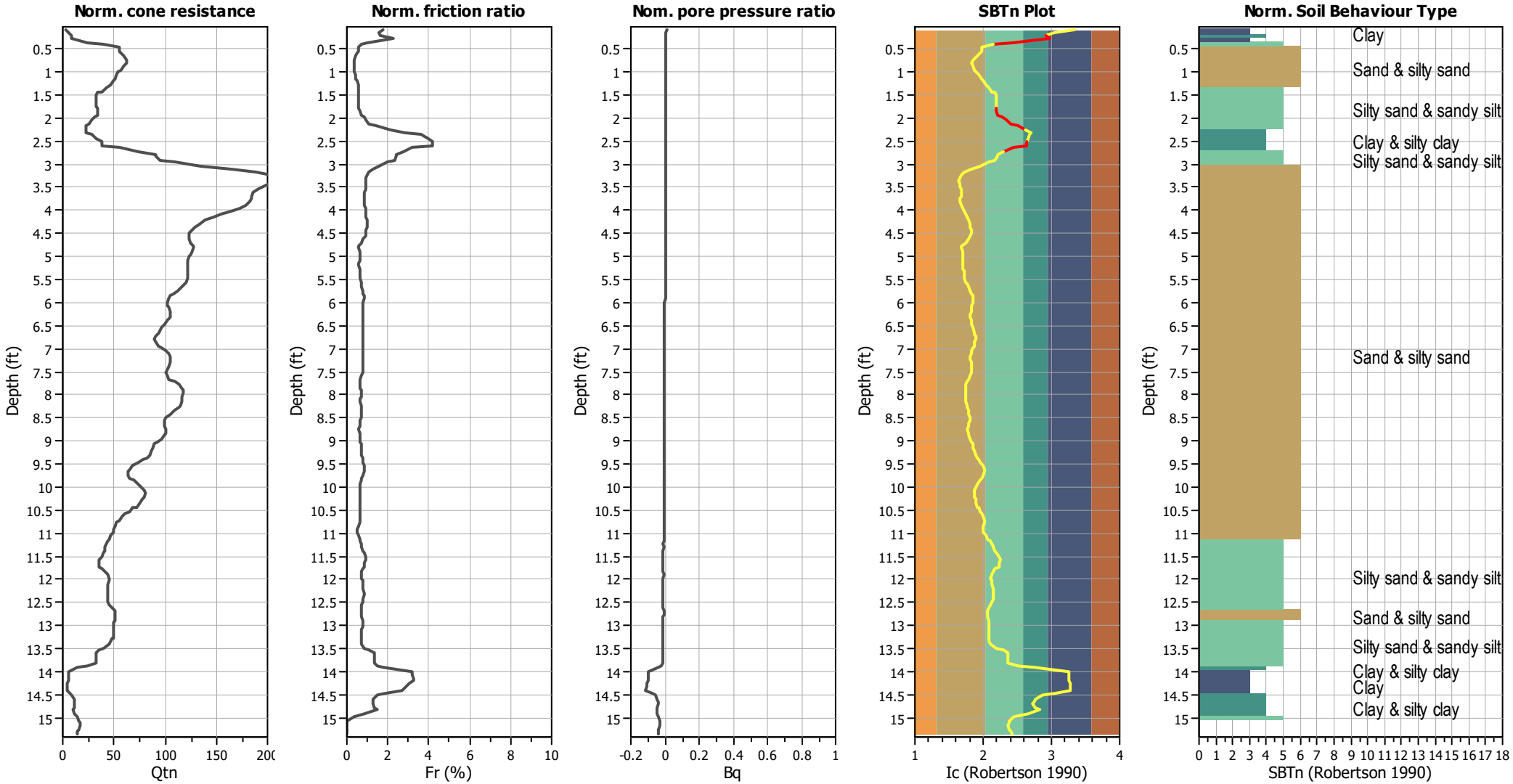
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 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)



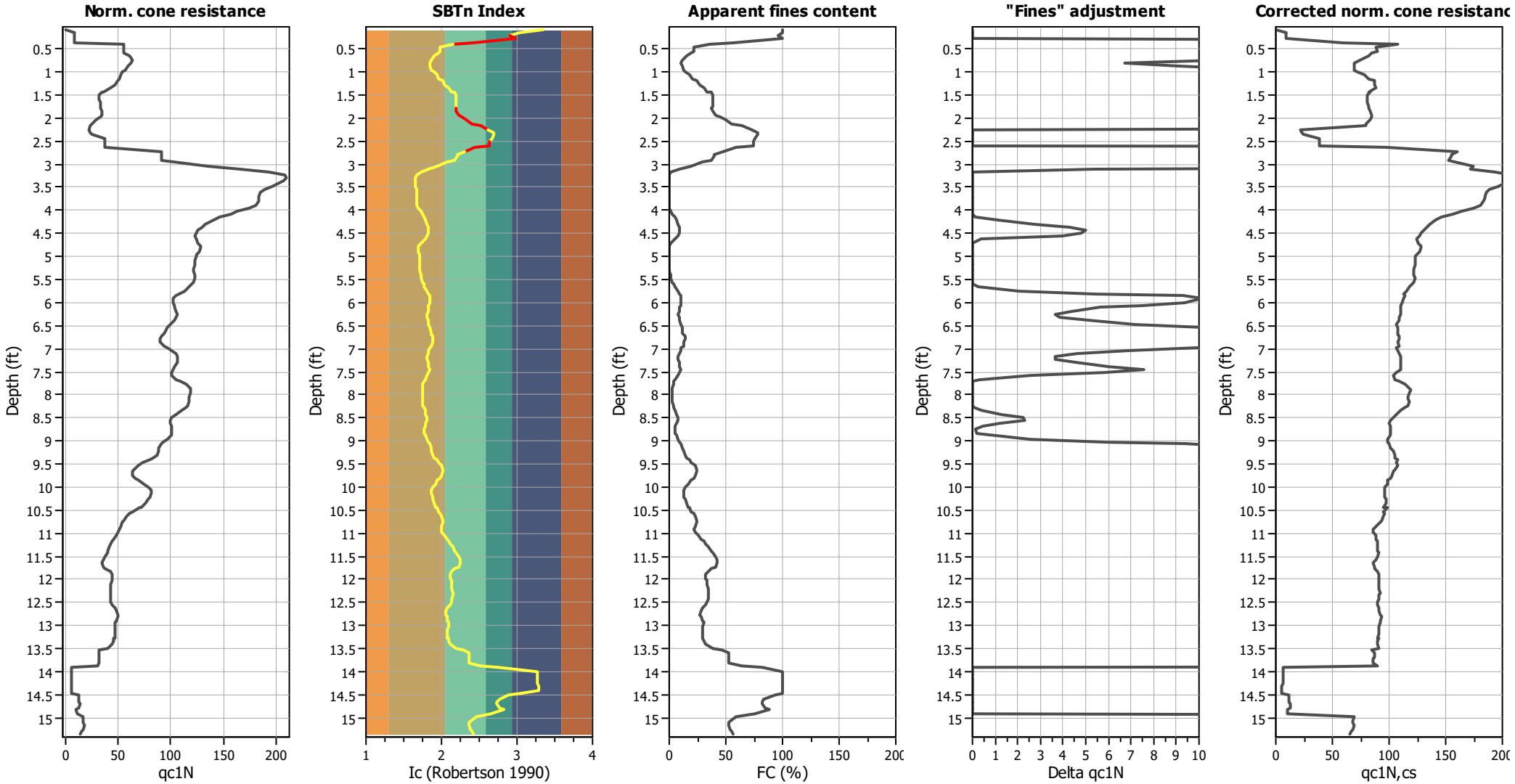
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 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

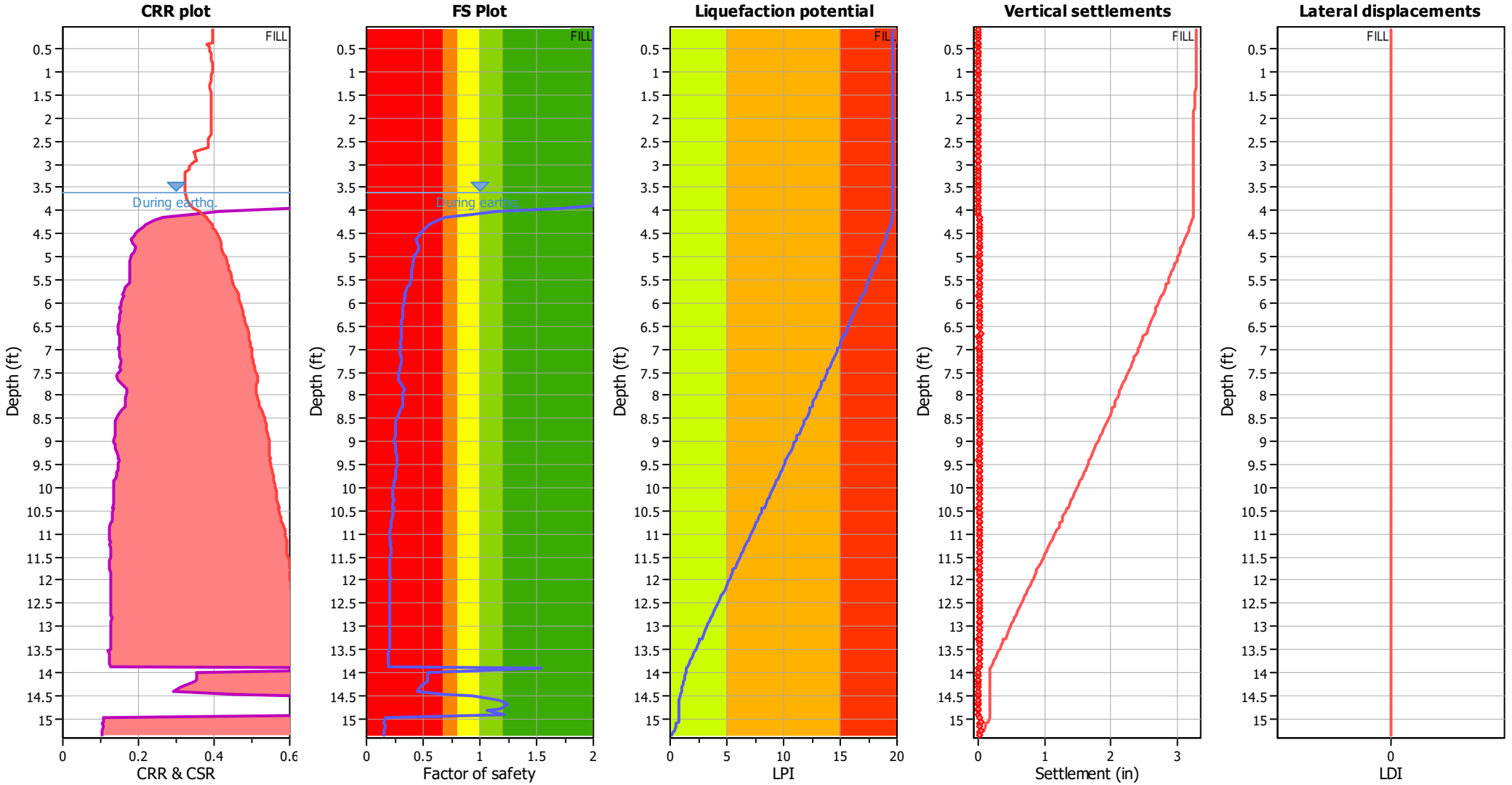
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

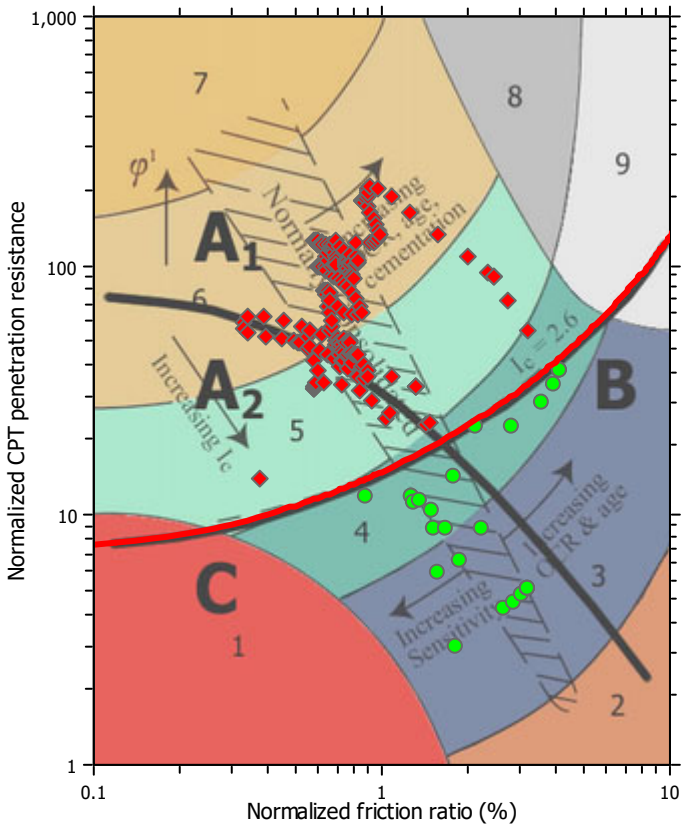
F.S. color scheme

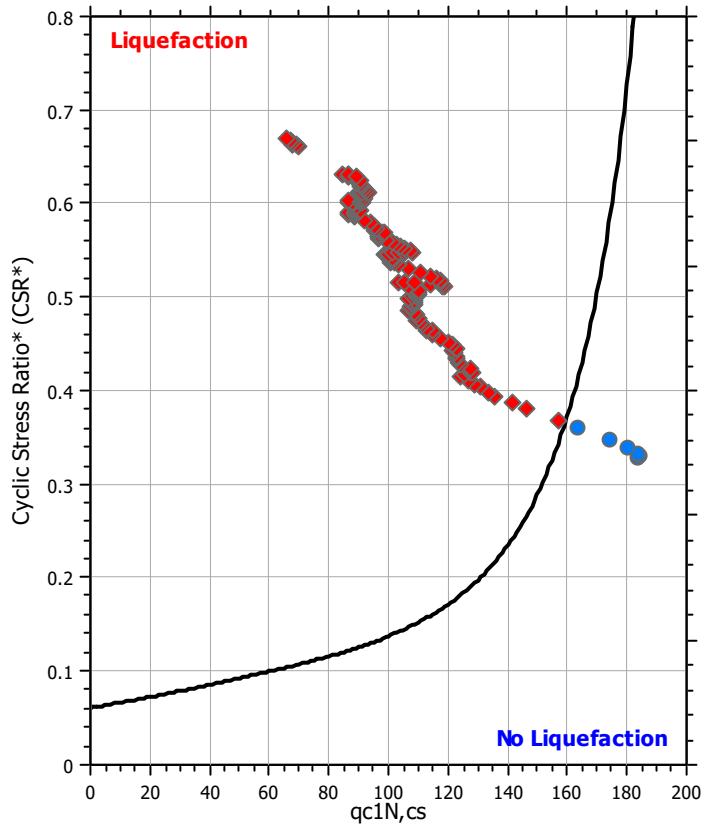
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

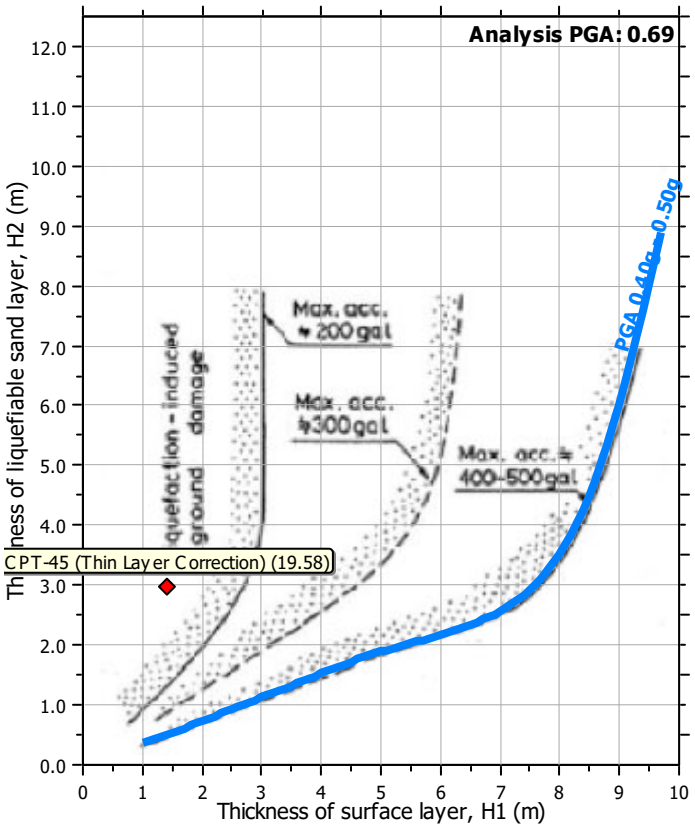
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



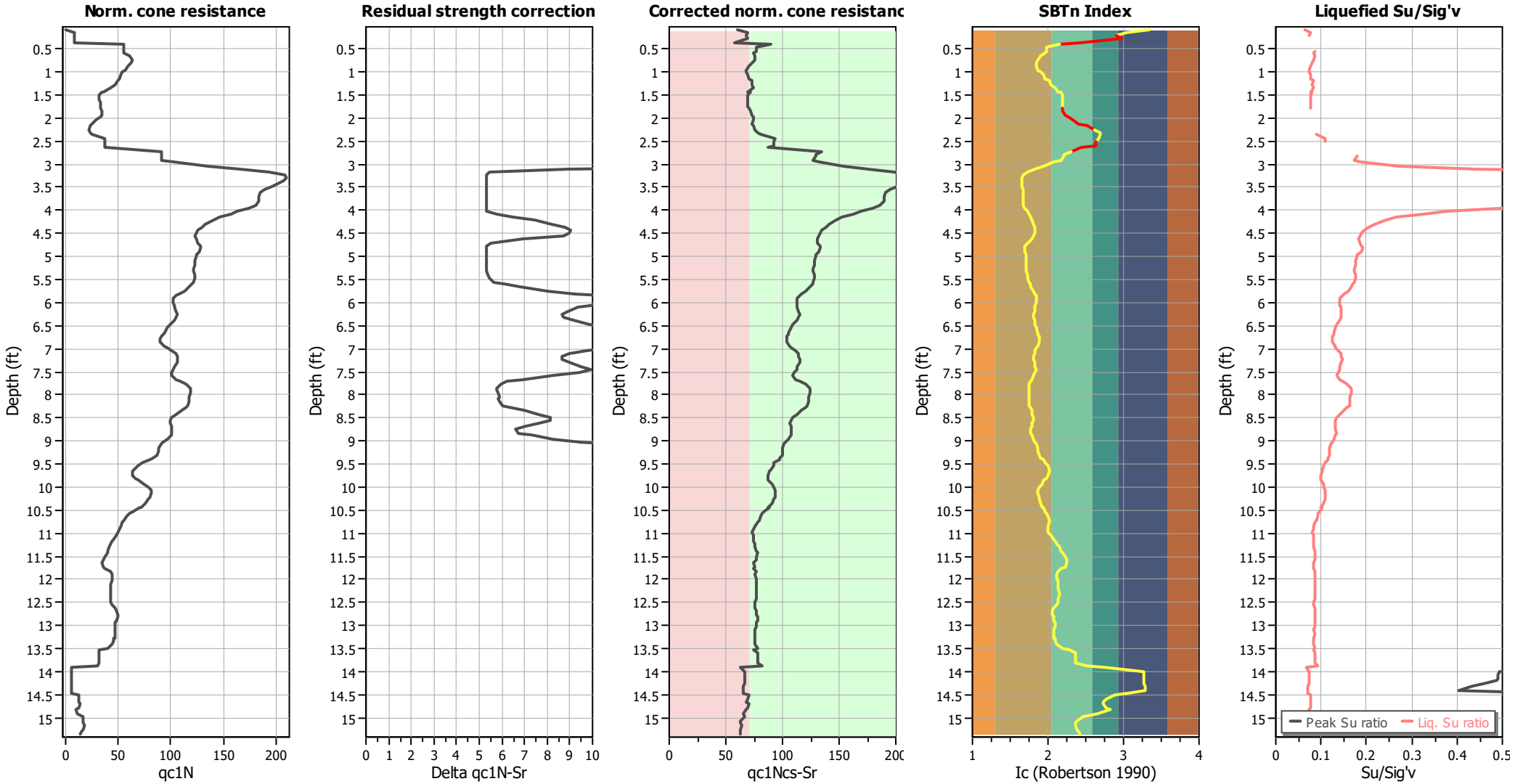




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

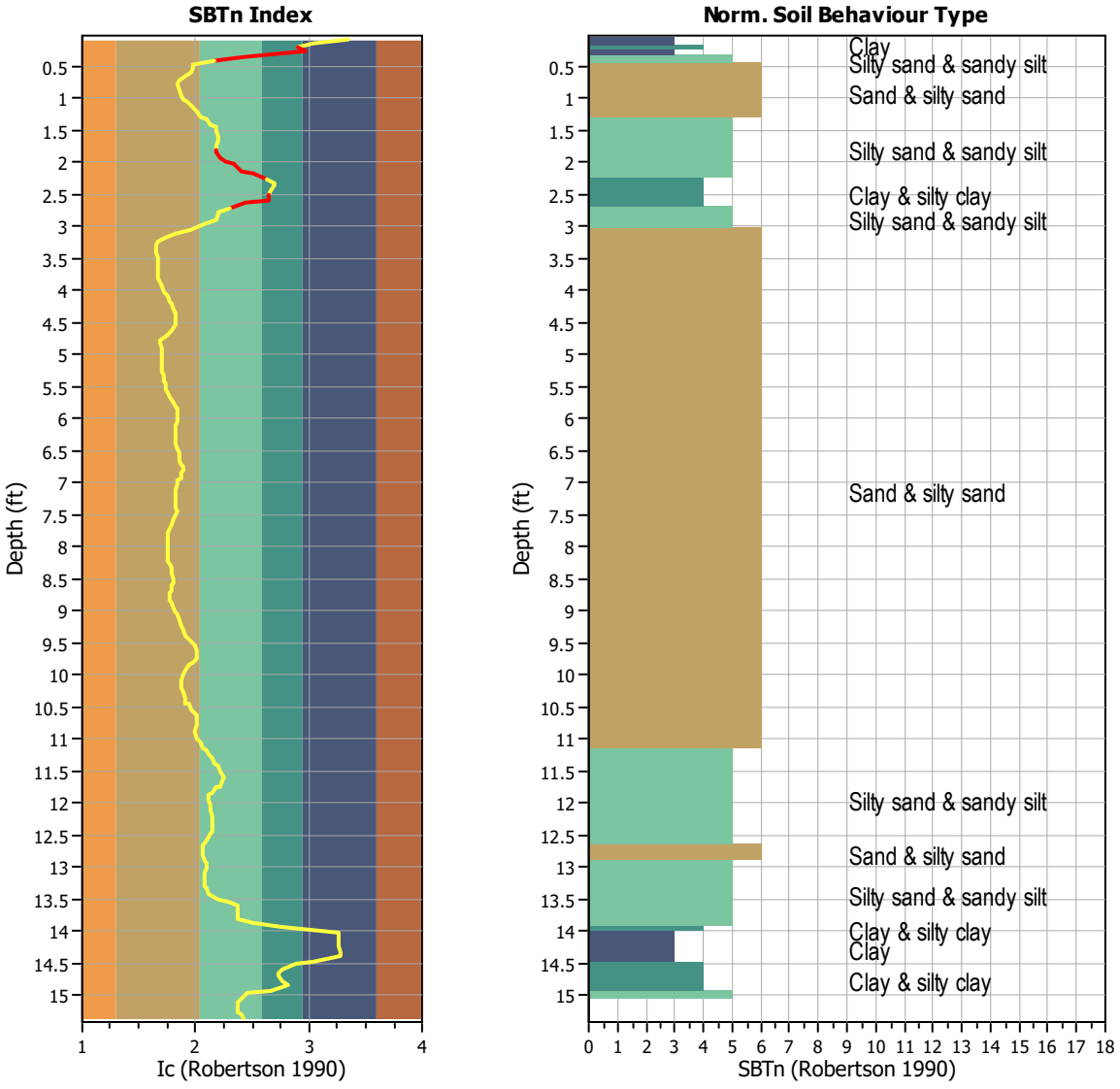
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

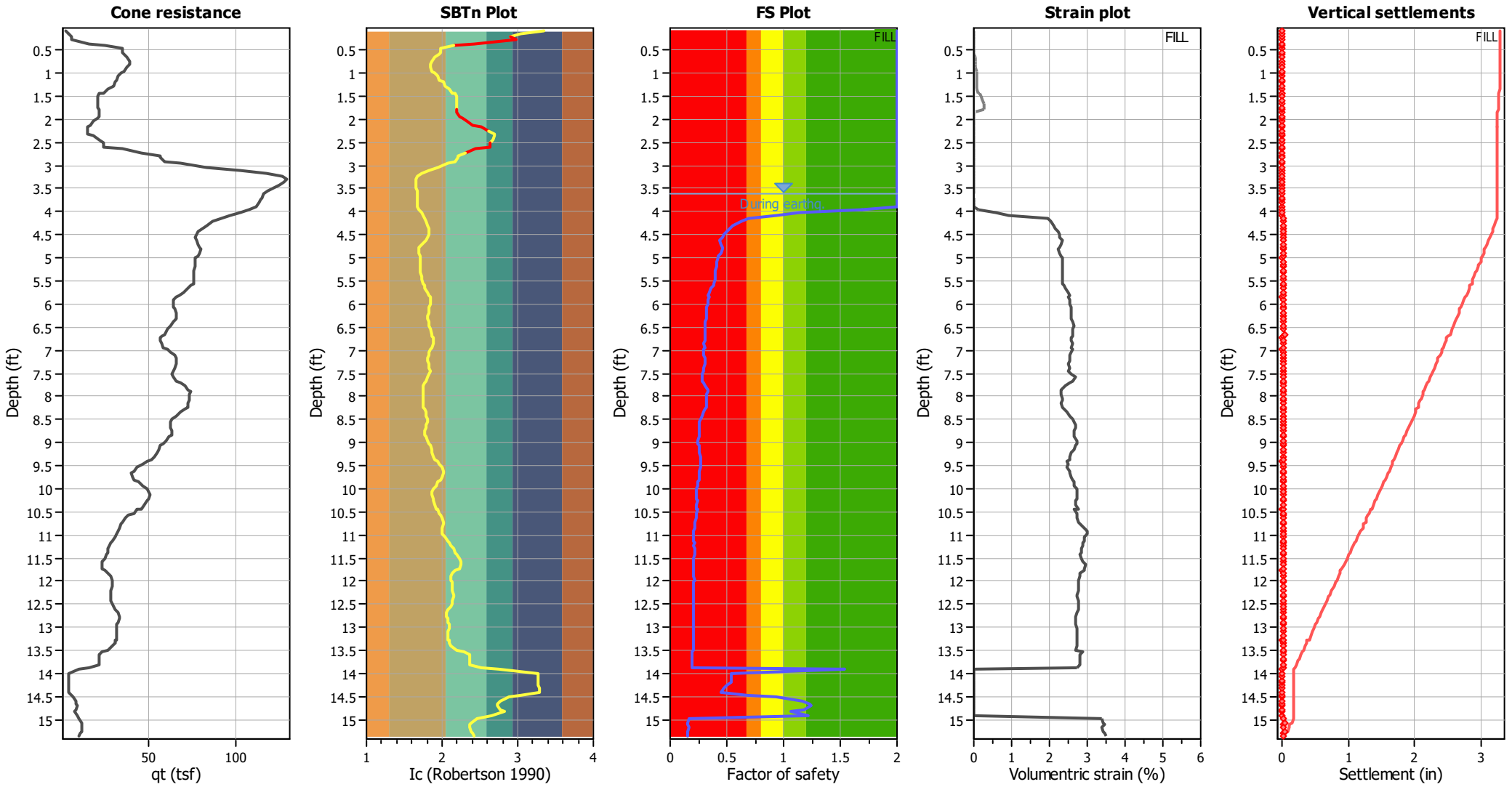
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	233
I_c maximum check value:	3.00	Total points excluded:	16
I_c change ratio value:	0.0250	Exclusion percentage:	6.87%
Minimum number of points in layer:	4	Number of layers detected:	3

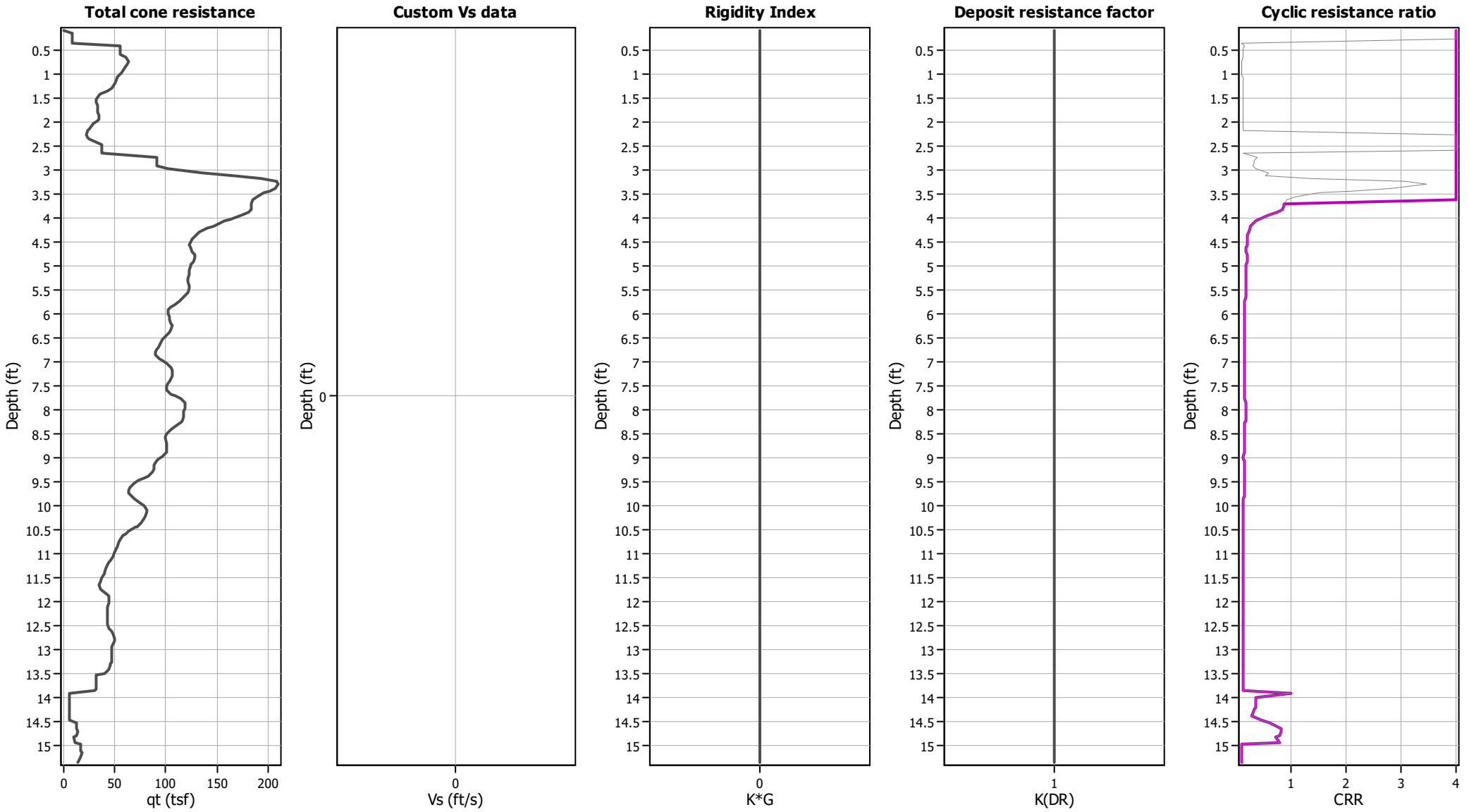
Estimation of post-earthquake settlements



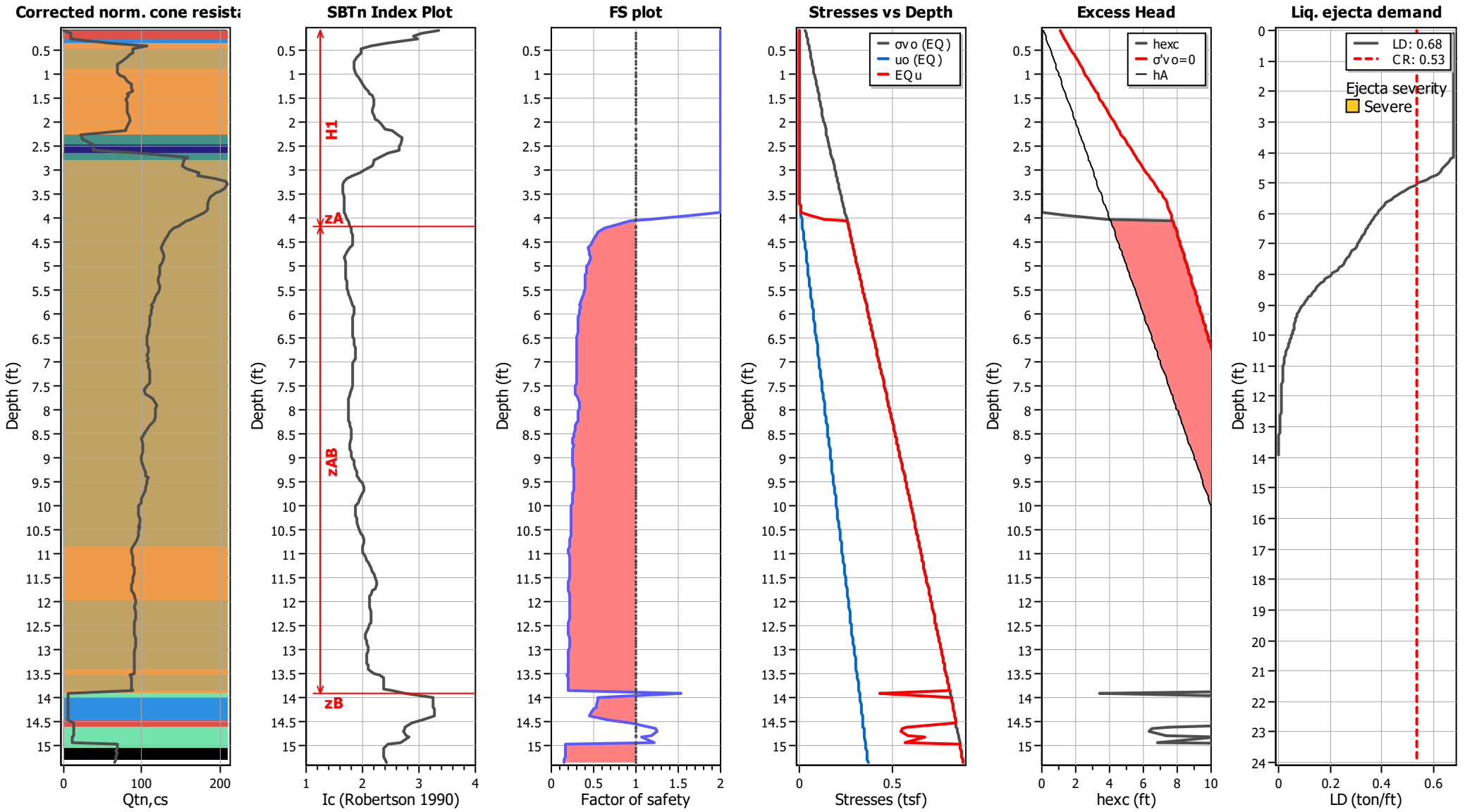
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

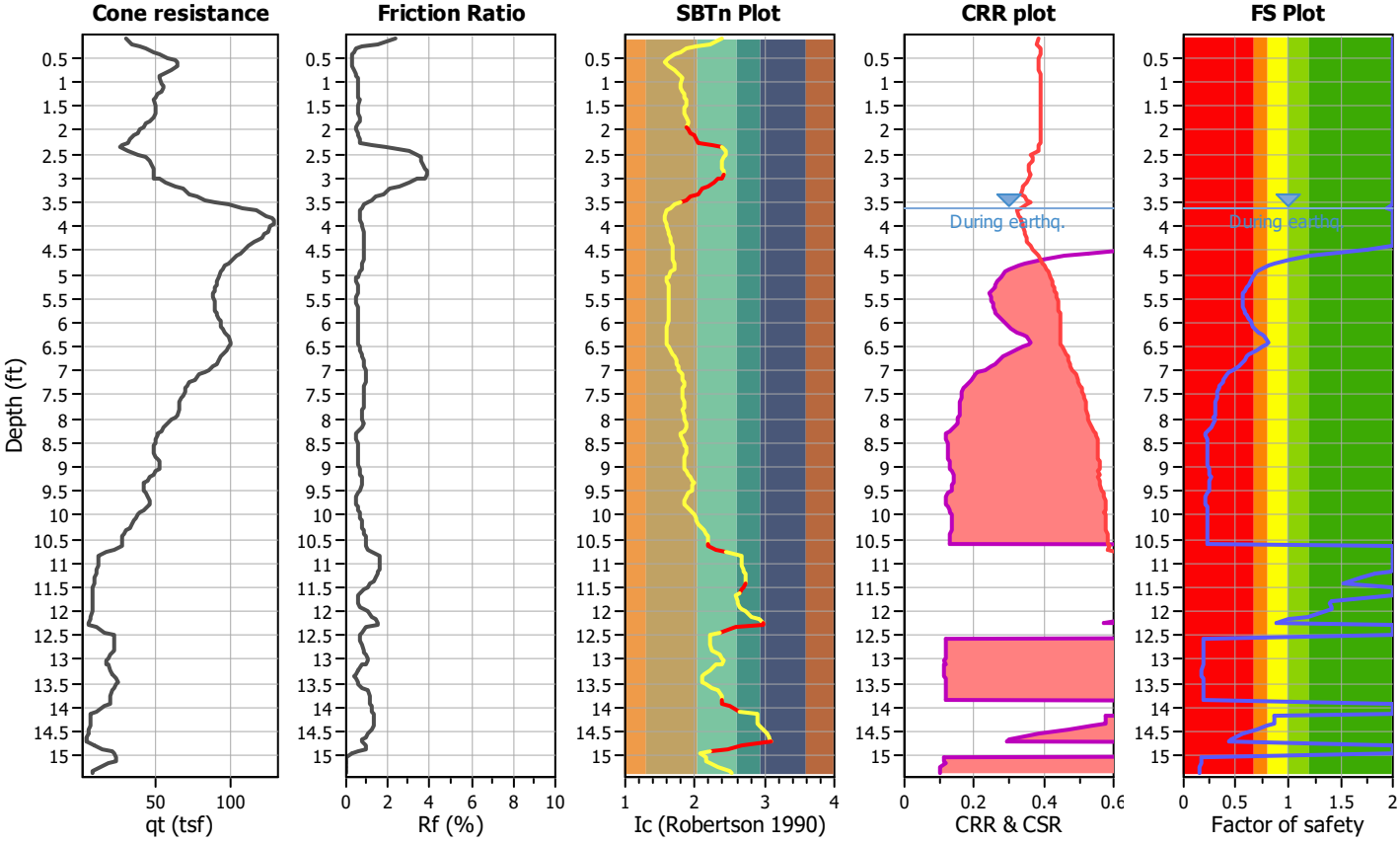
Project title : Topgolf Harbor Island

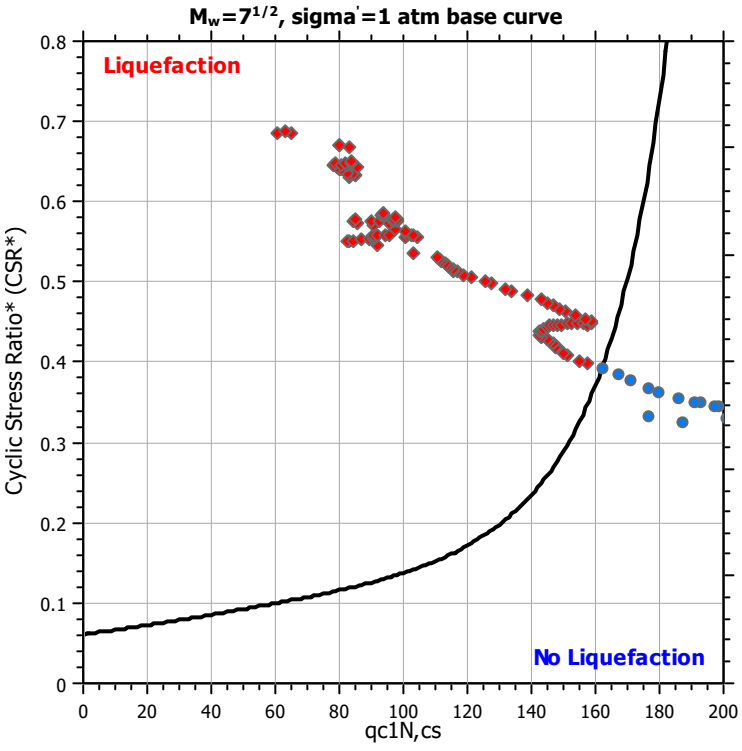
Location : North Harbor Drive and Liberator Way, San Diego, CA

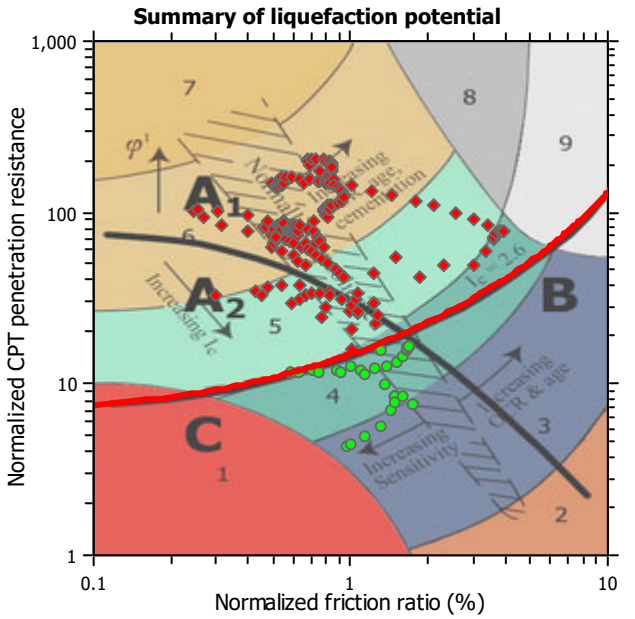
CPT file : CPT-46 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.62 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.62 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

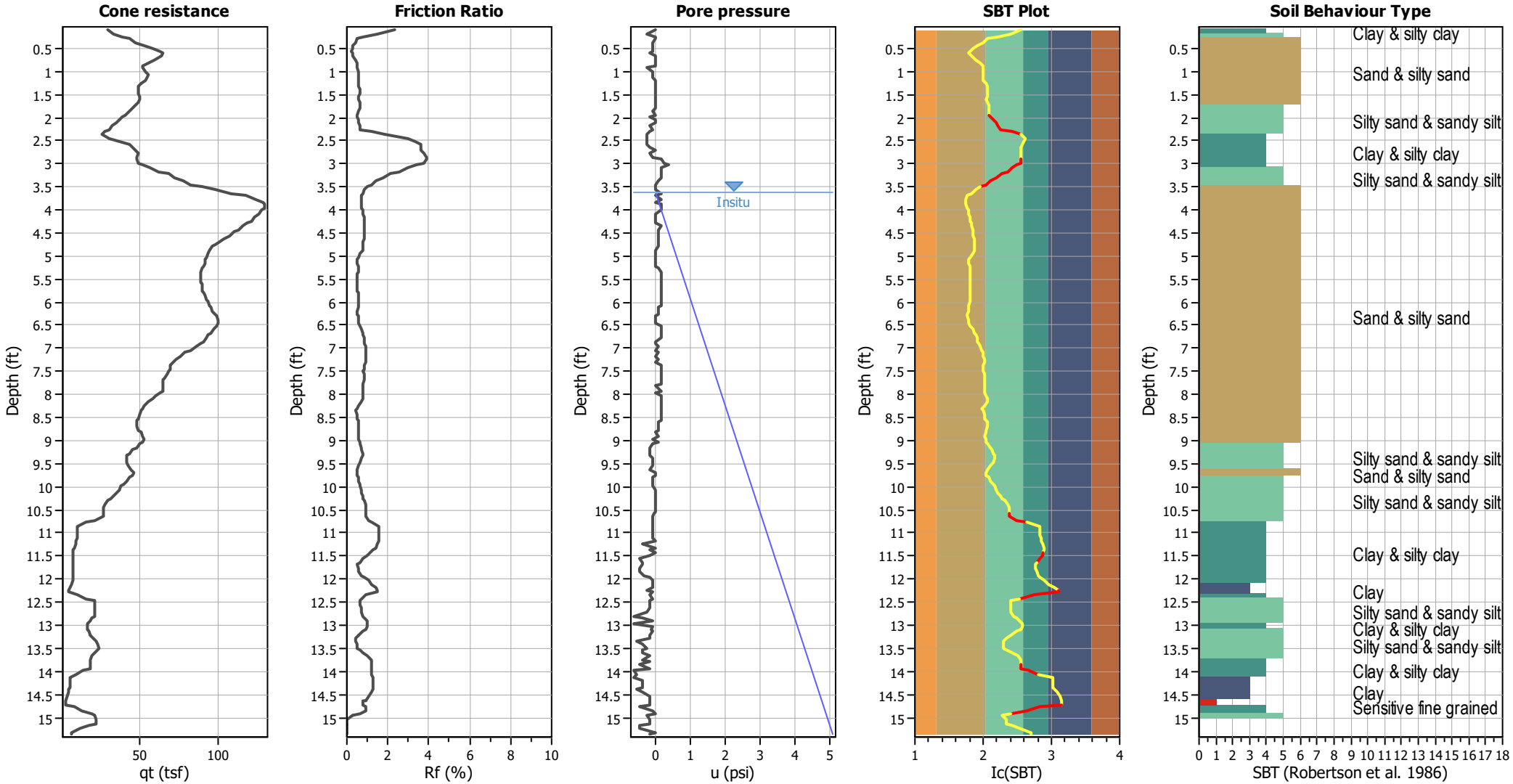






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



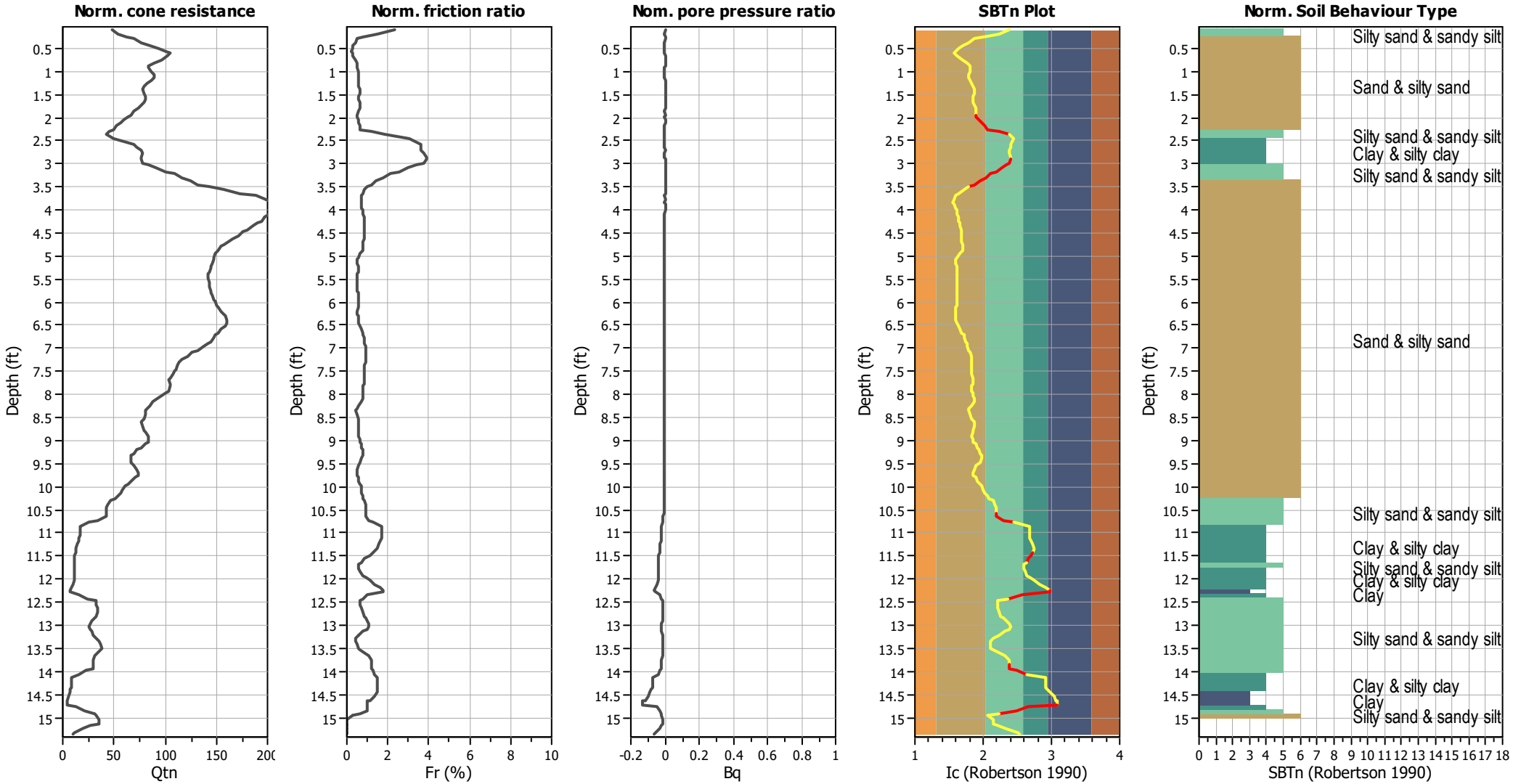
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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)



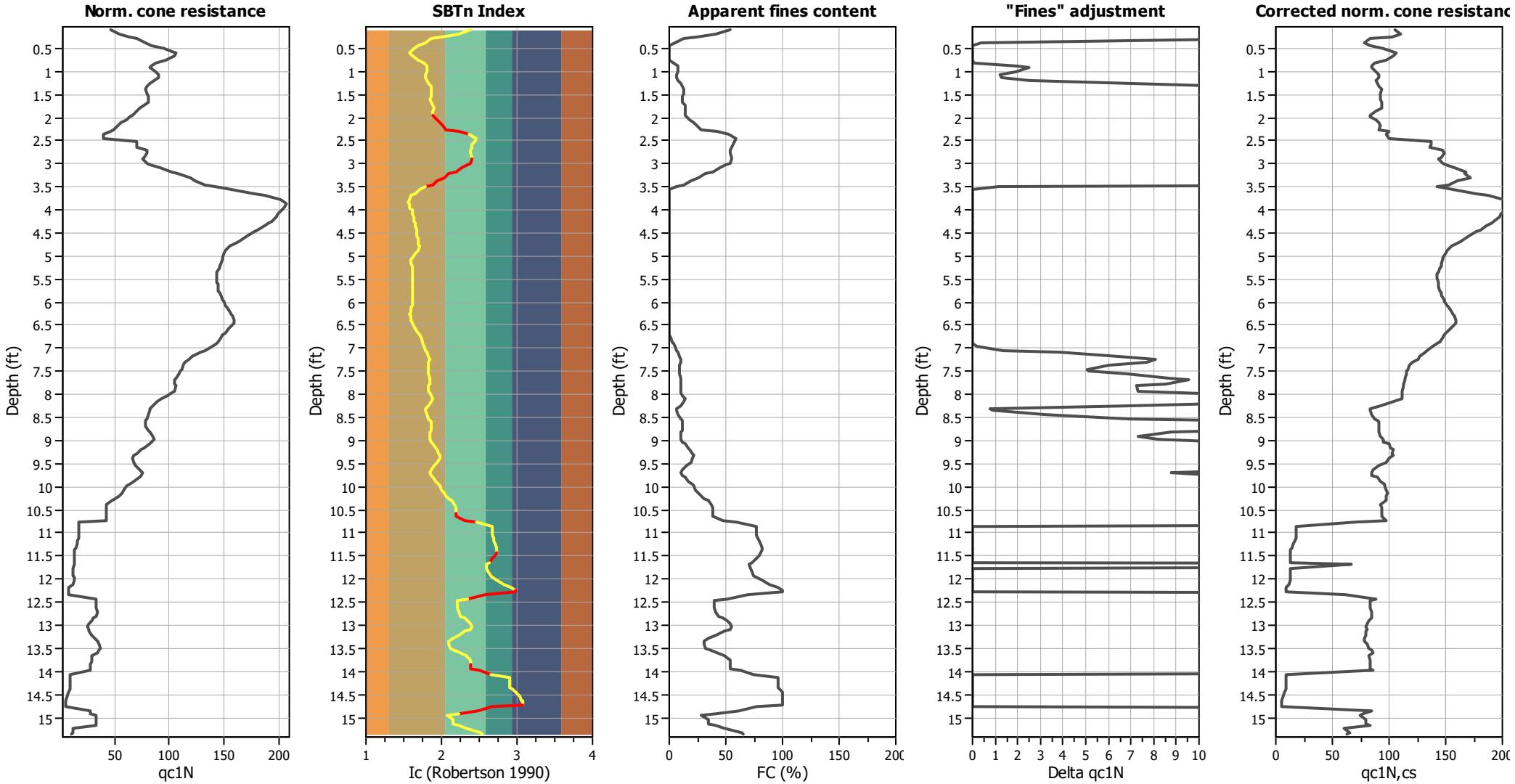
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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

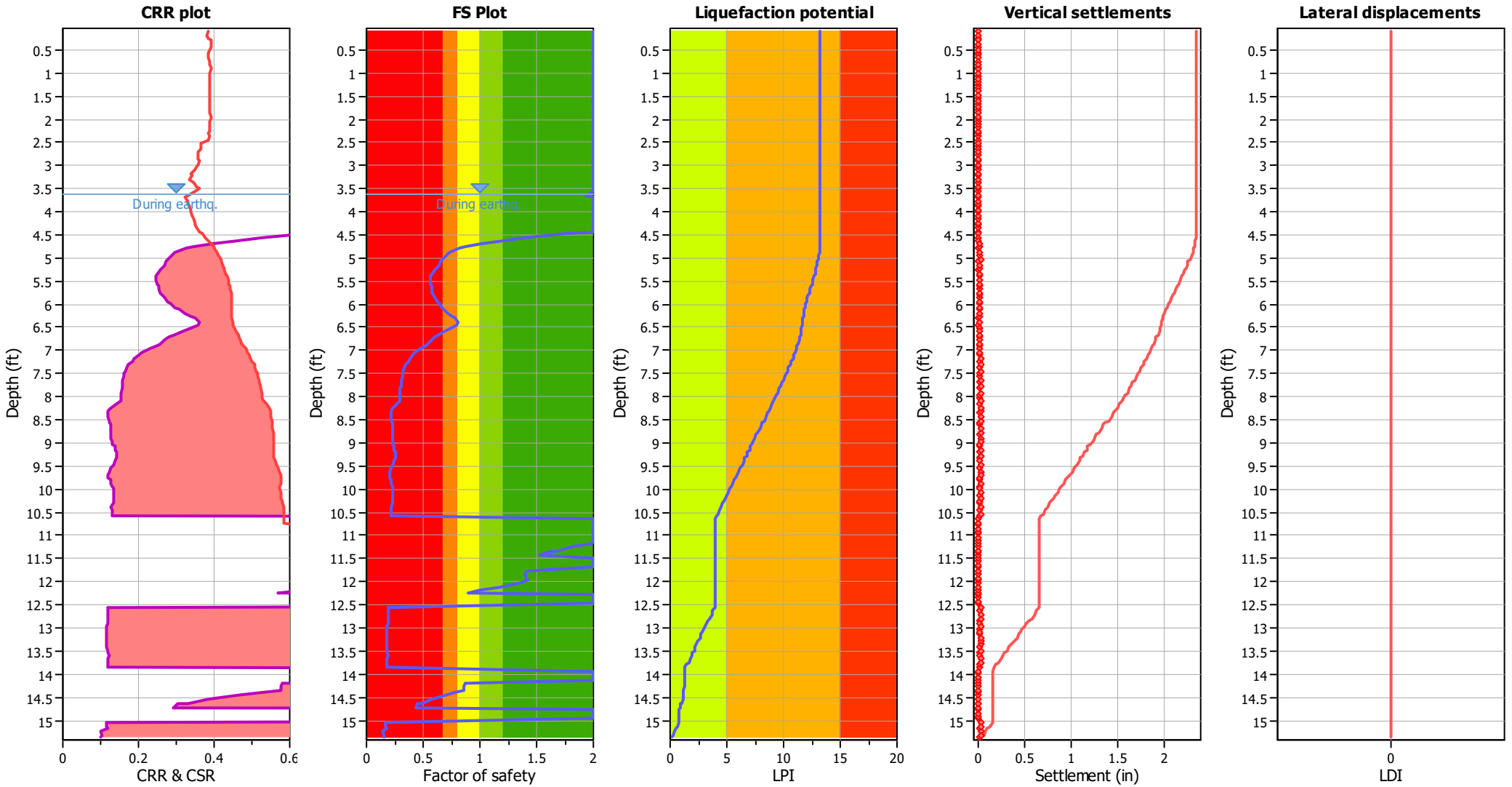
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

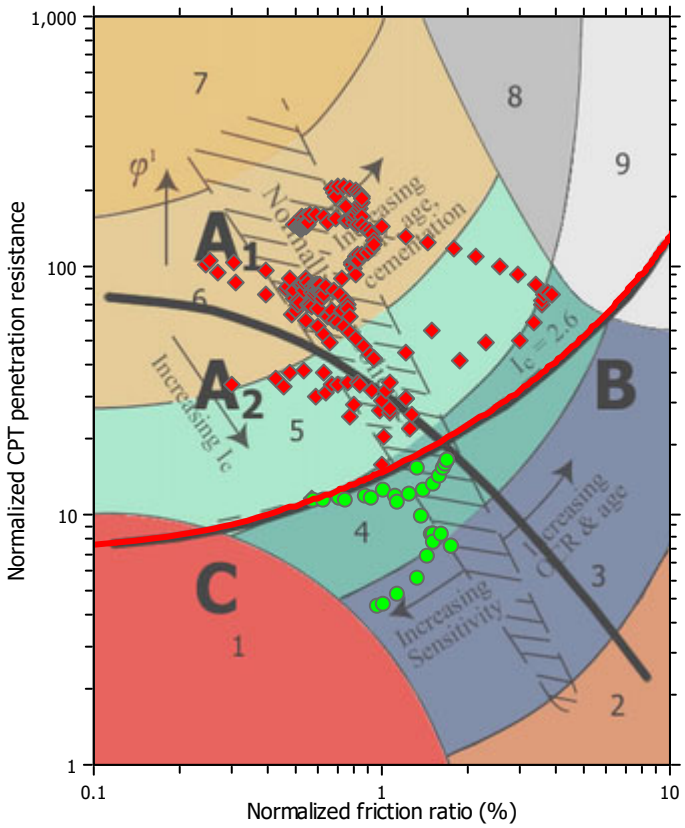
F.S. color scheme

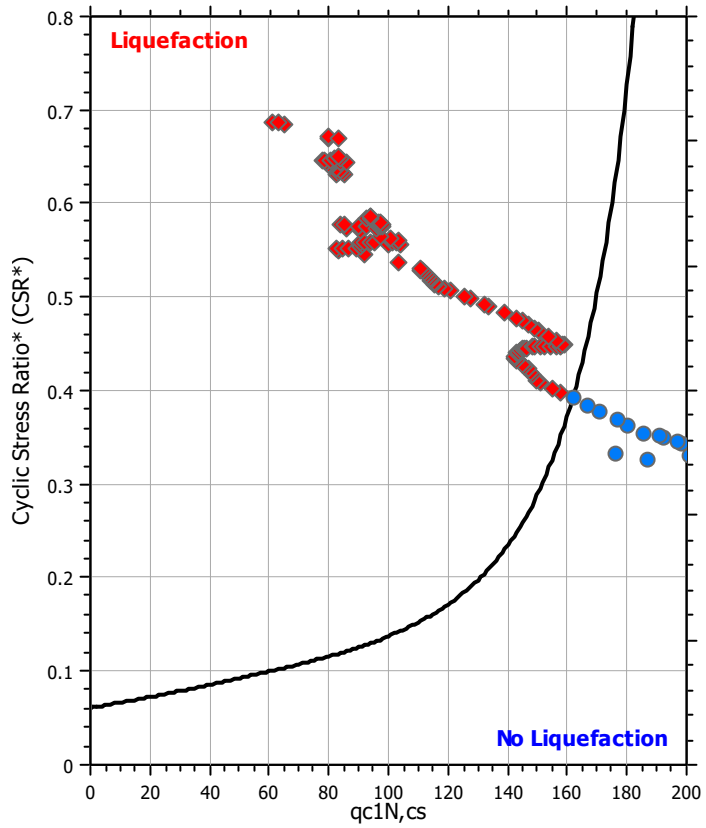
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

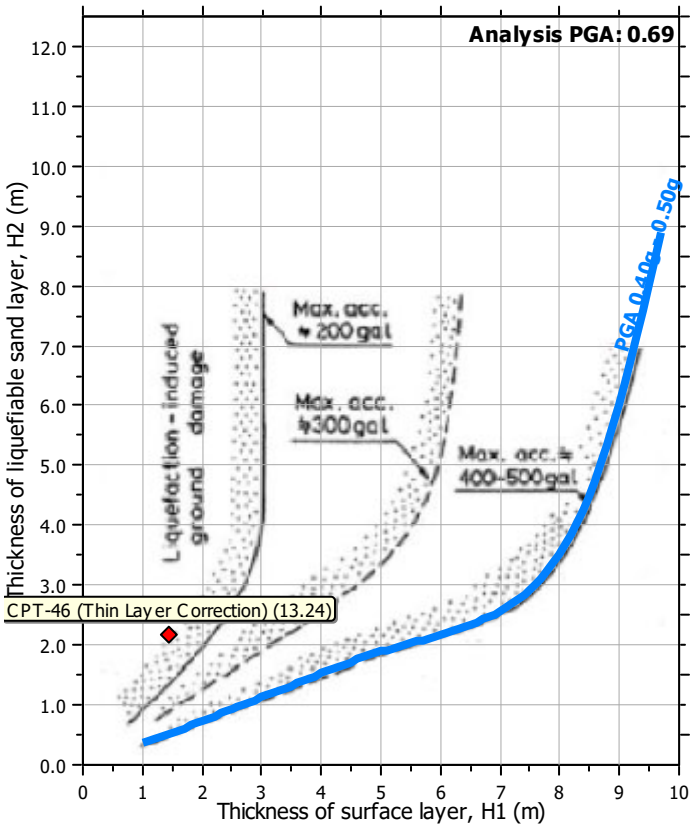
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



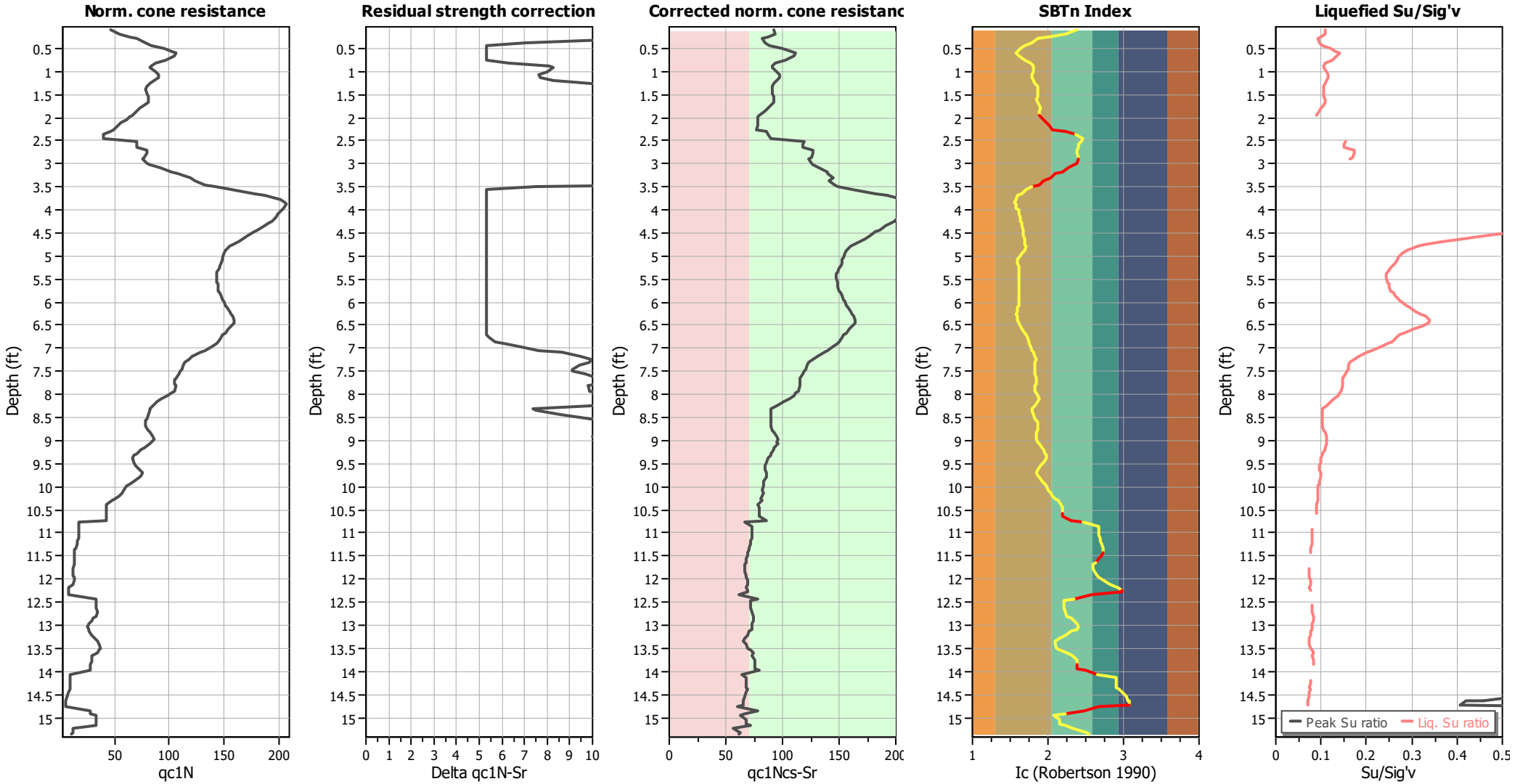




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

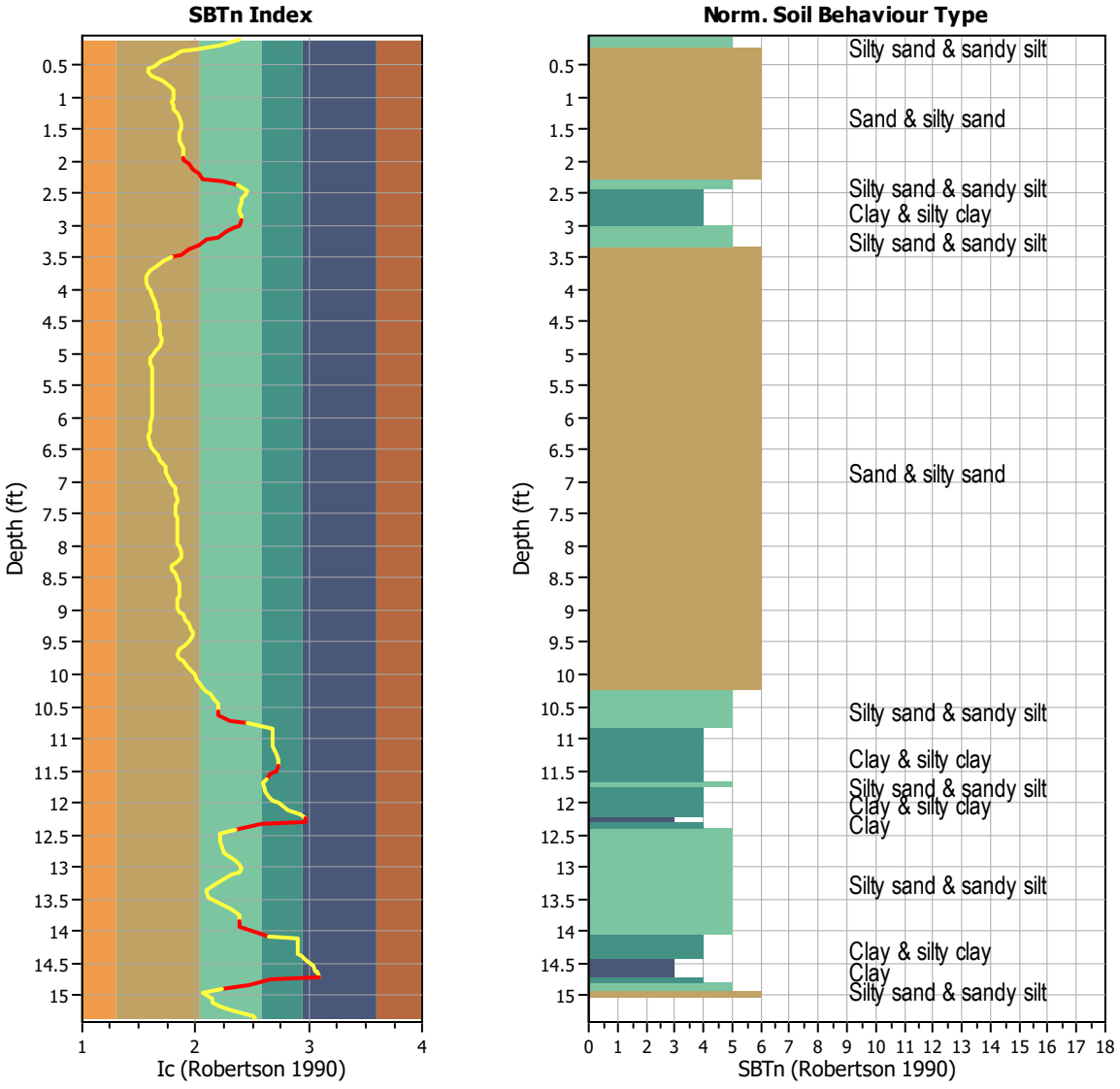
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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.



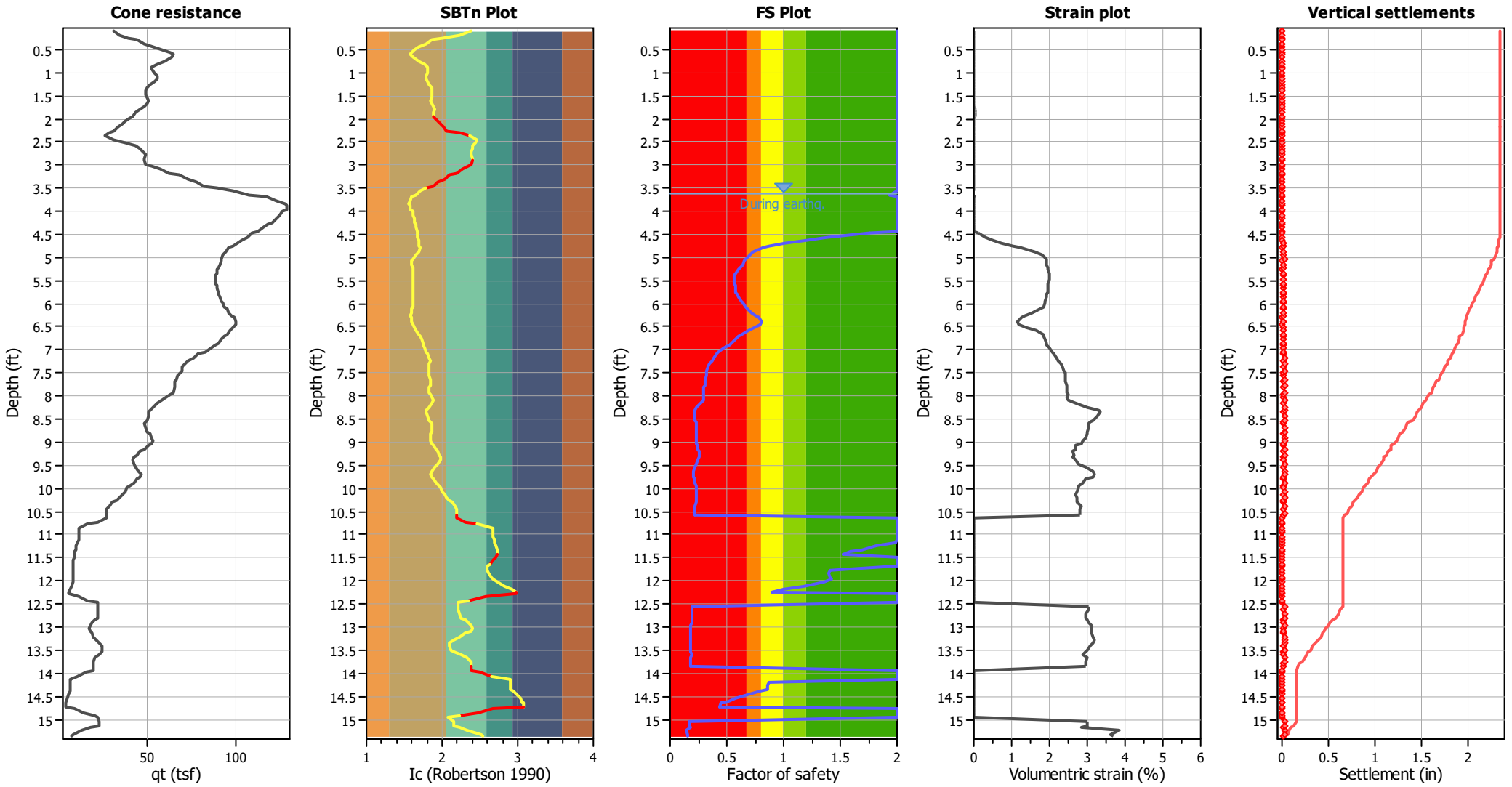
Transition layer algorithm properties

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:	234
Total points excluded:	38
Exclusion percentage:	16.24%
Number of layers detected:	7

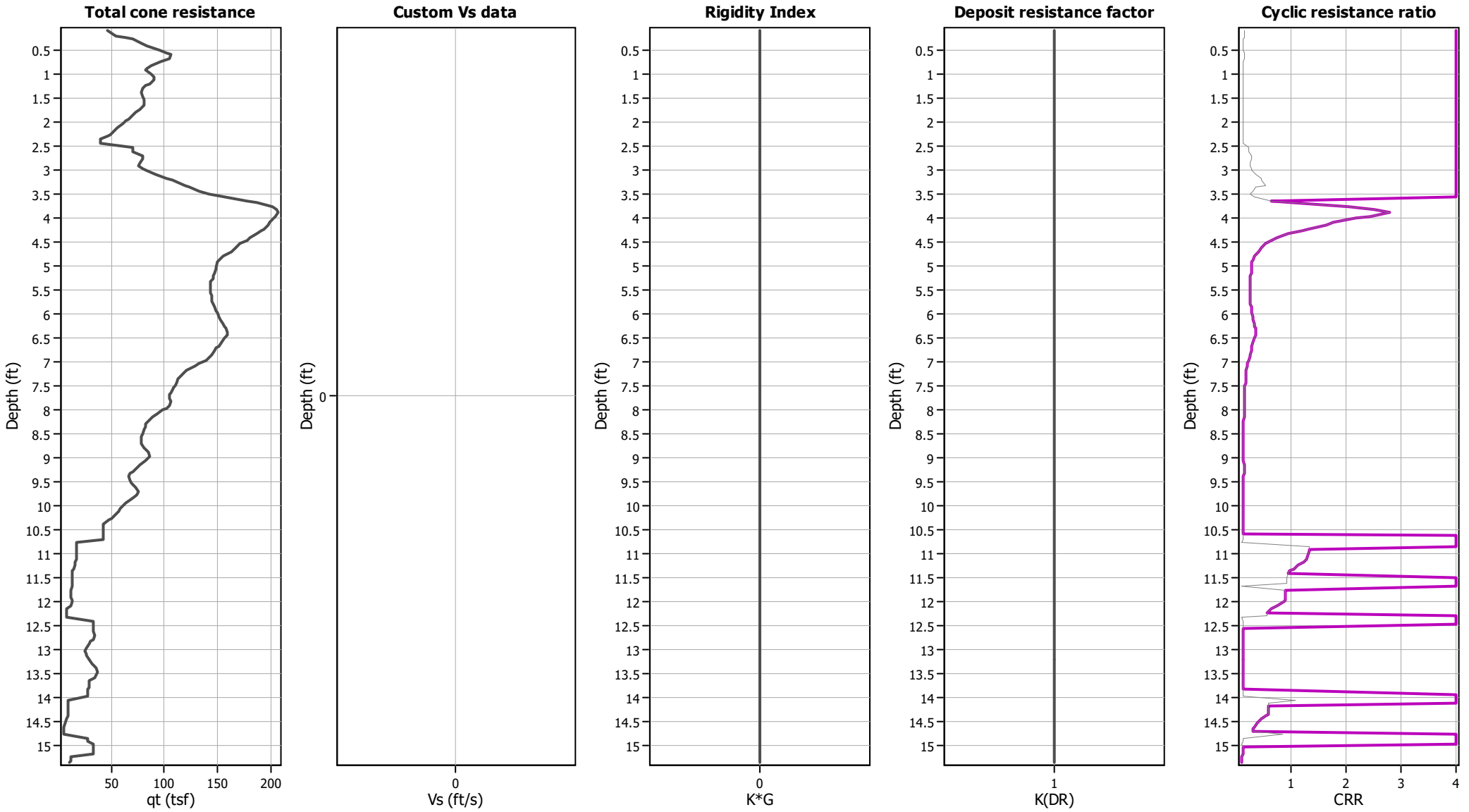
Estimation of post-earthquake settlements



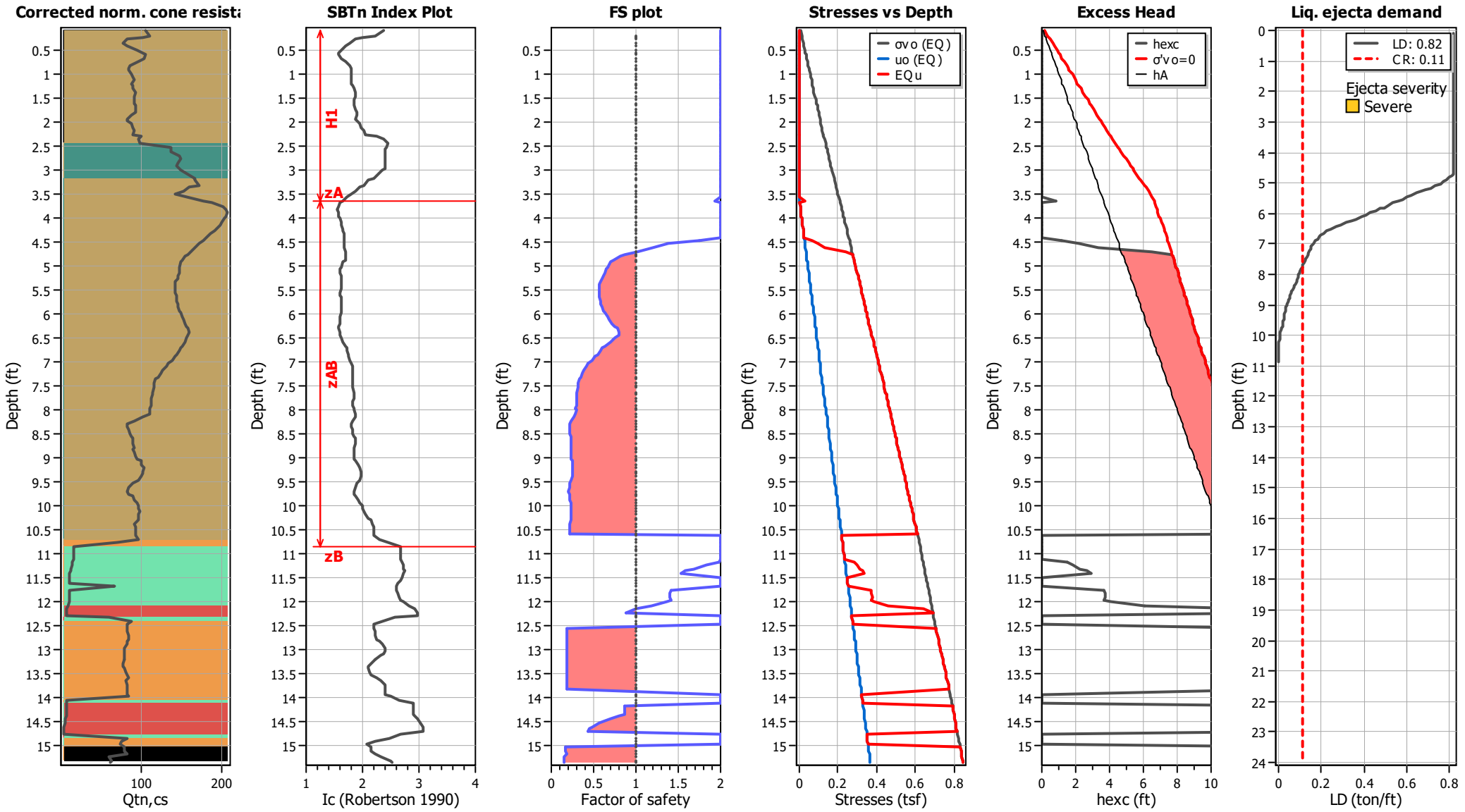
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

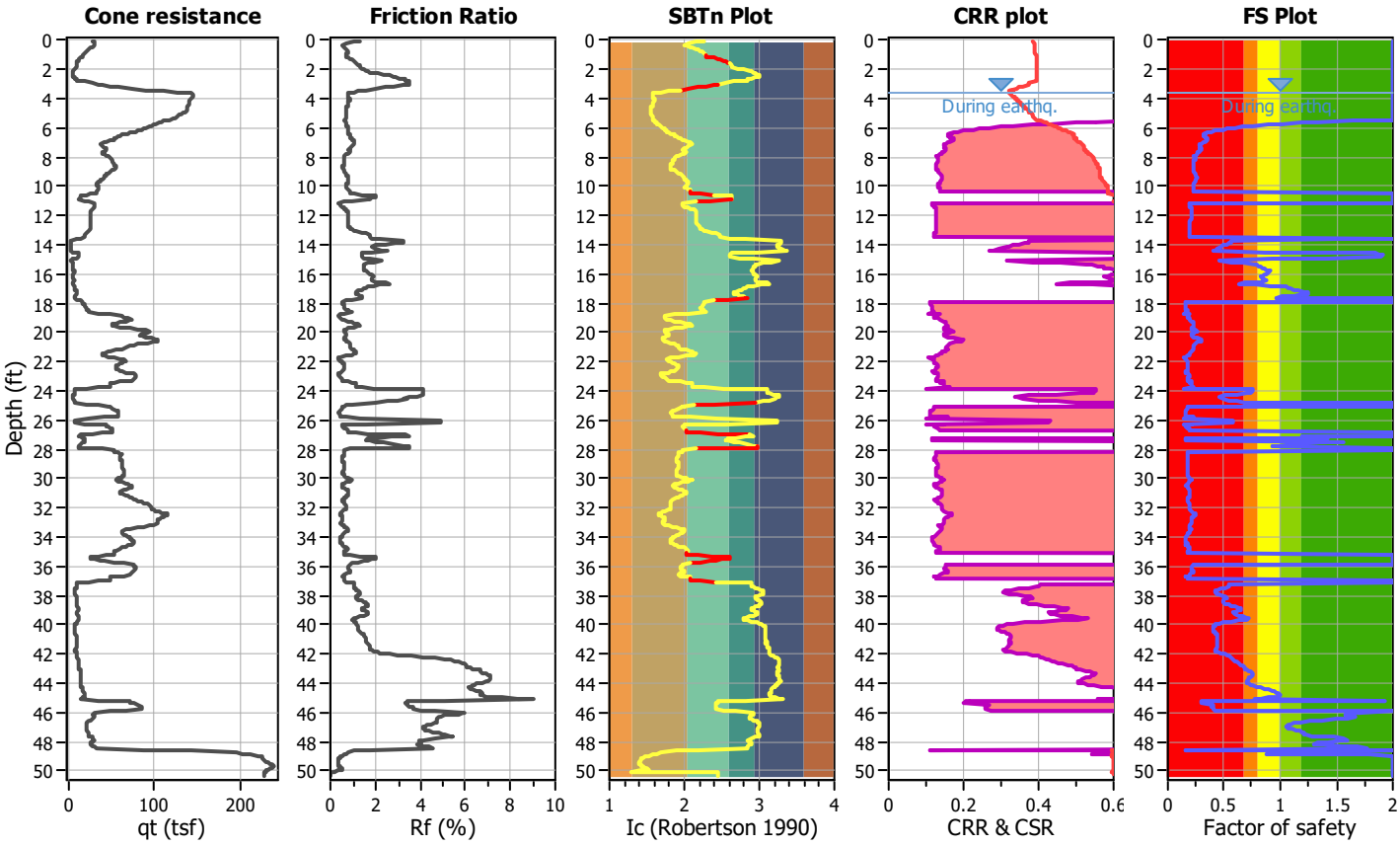
Project title : Topgolf Harbor Island

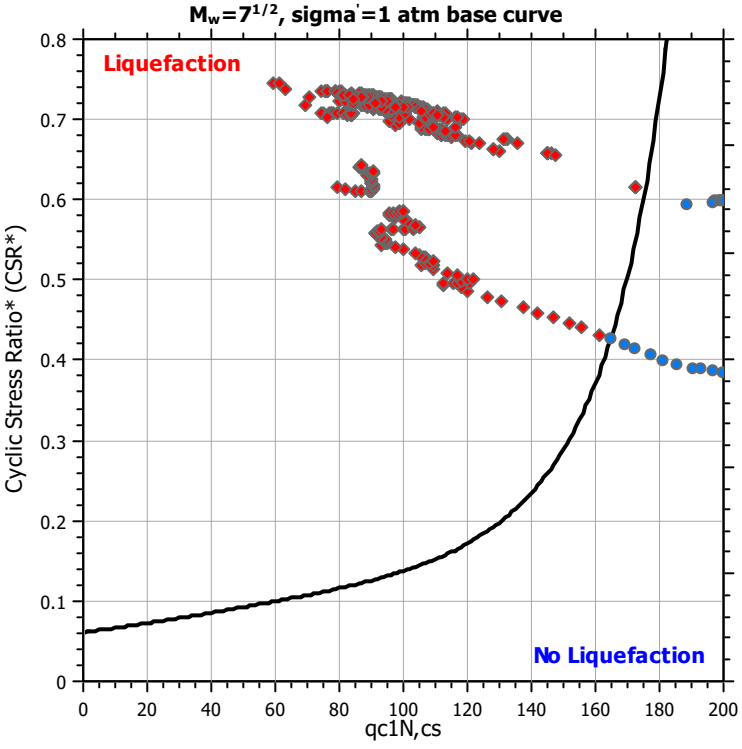
Location : North Harbor Drive and Liberator Way, San Diego, CA

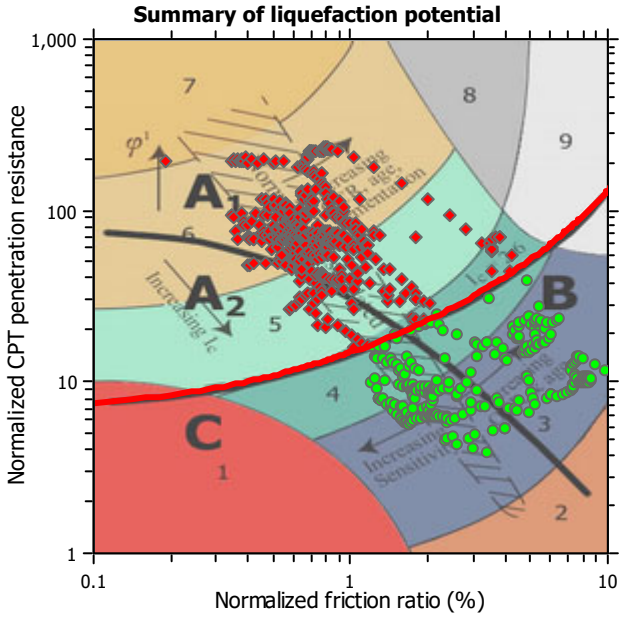
CPT file : CPT-47 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.62 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.62 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

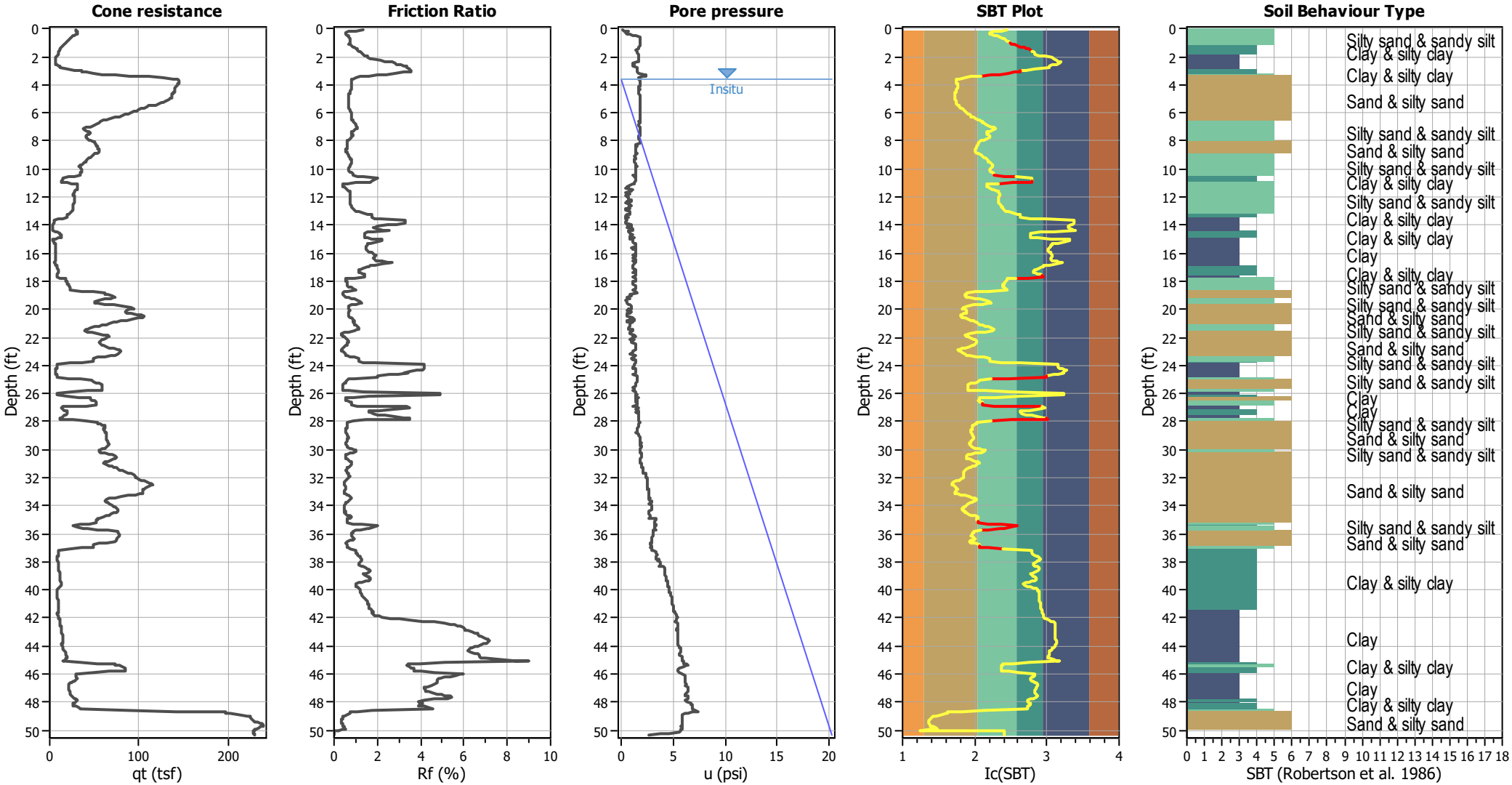






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



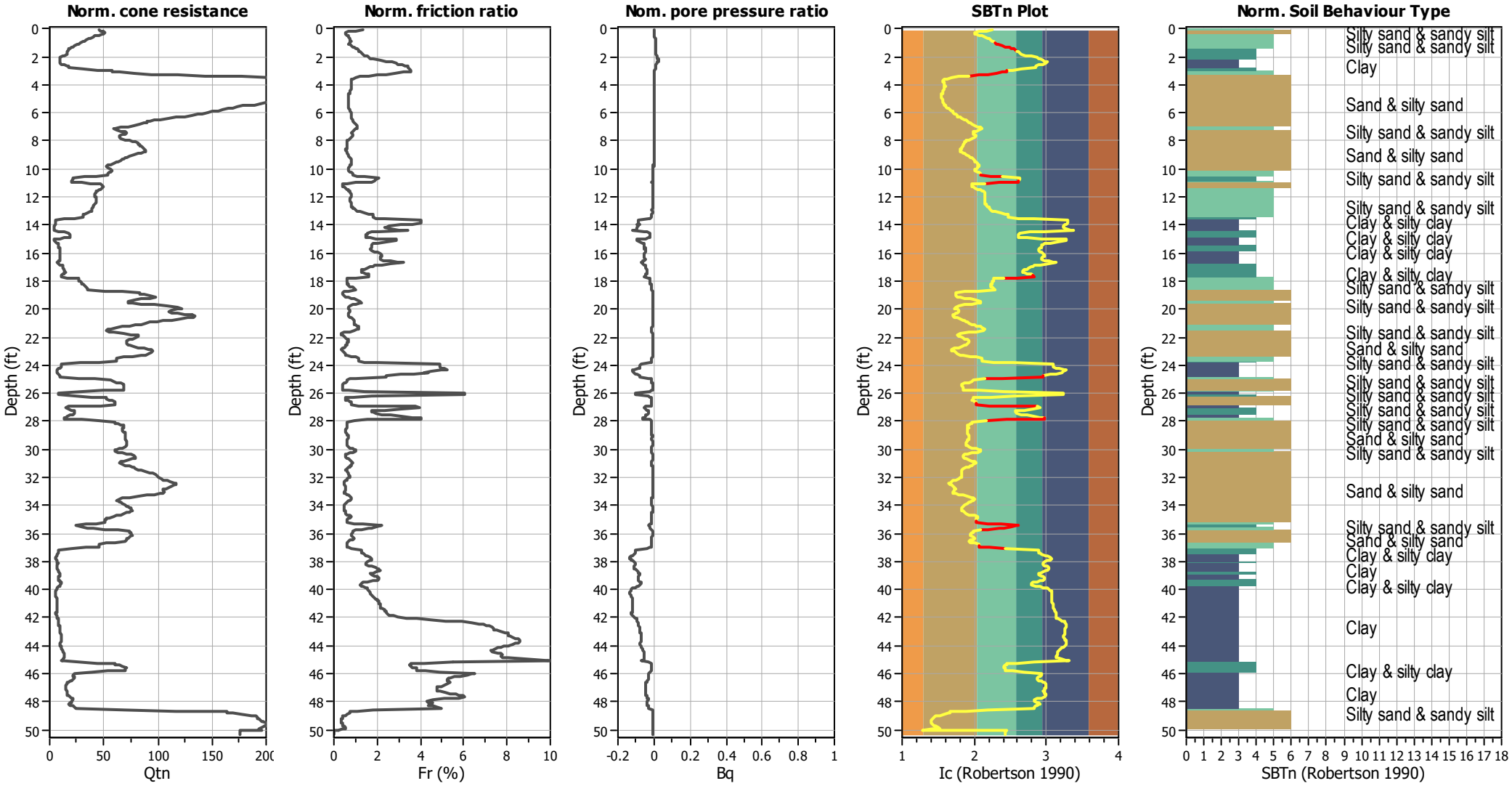
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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)



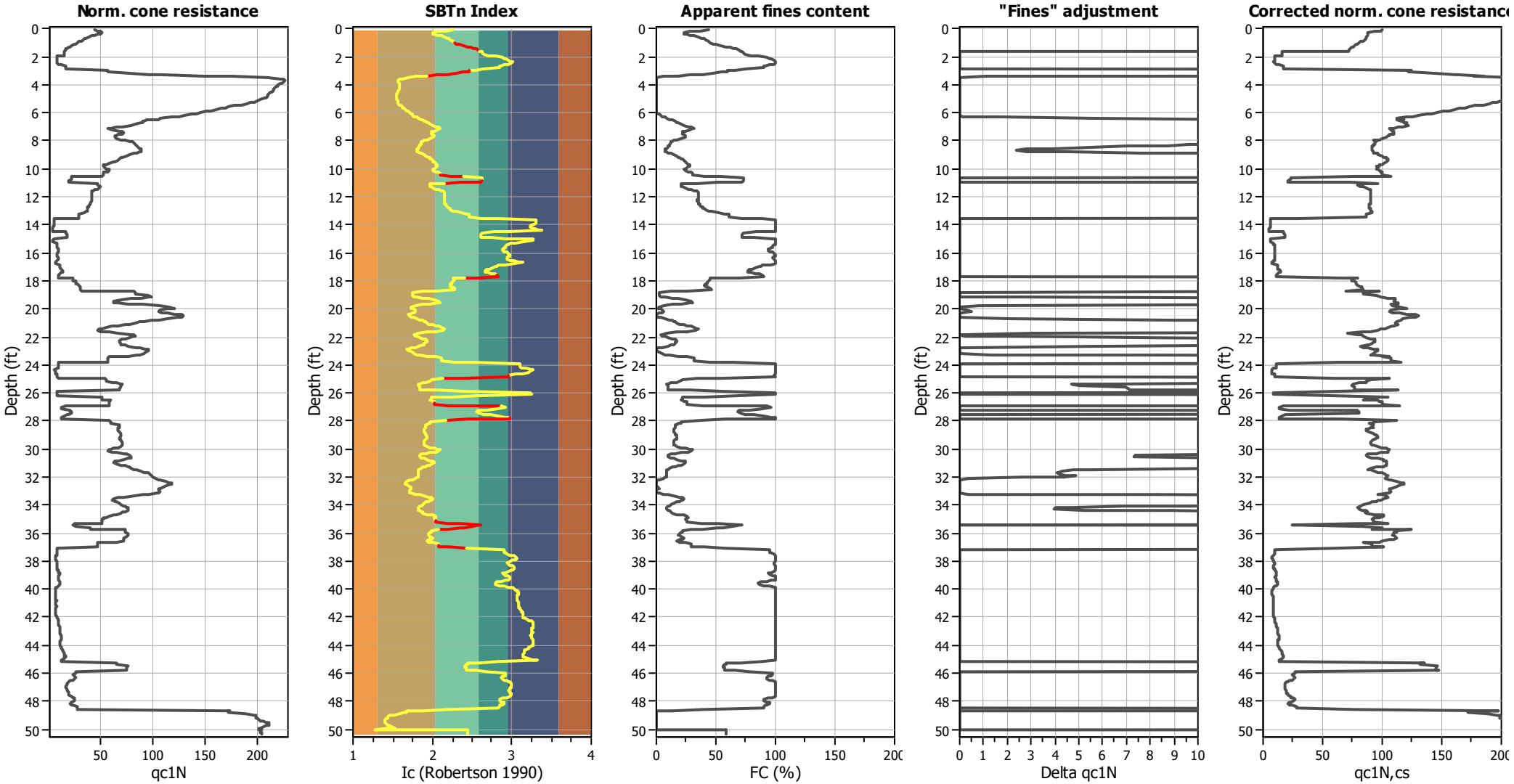
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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

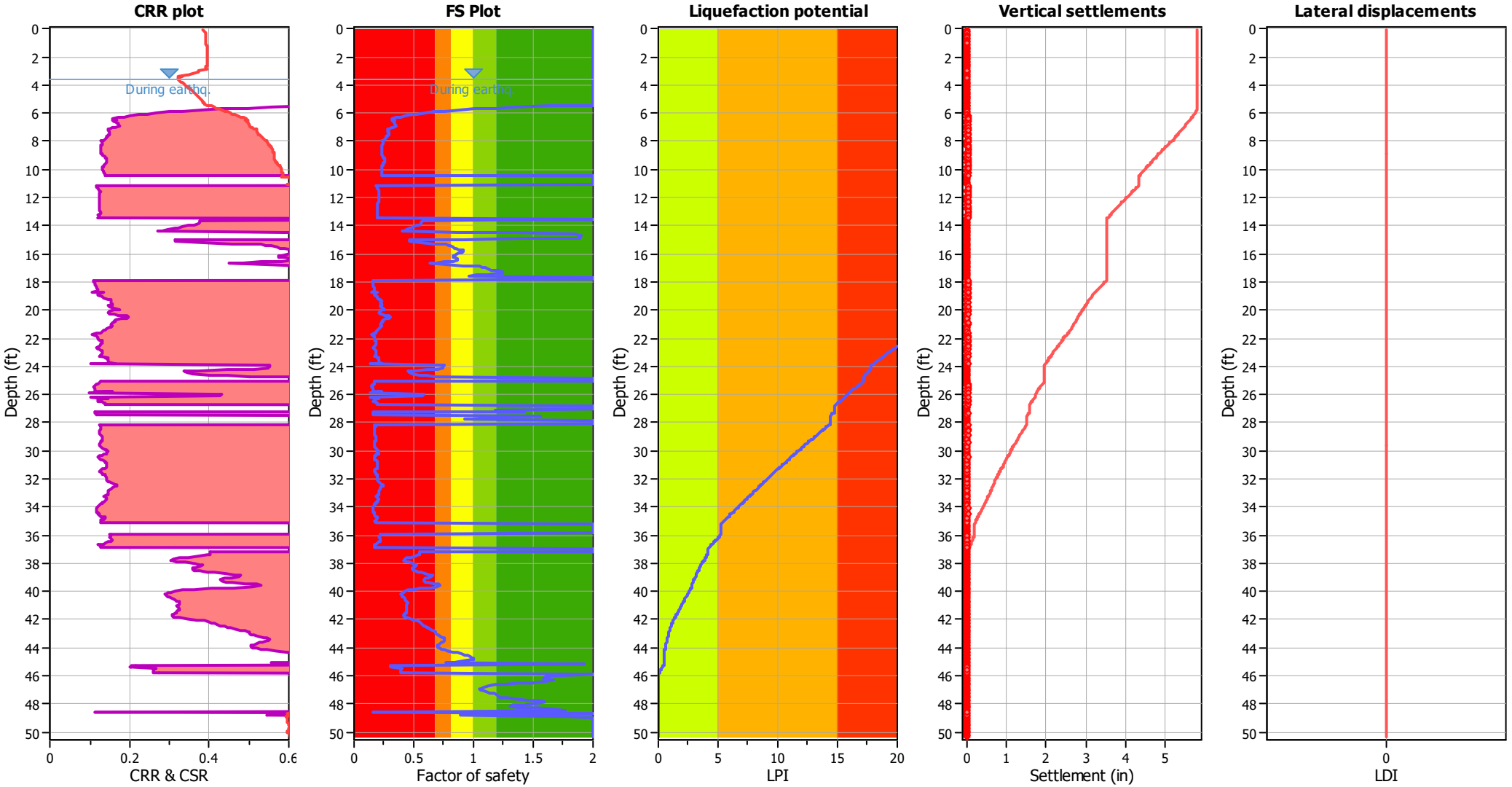
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

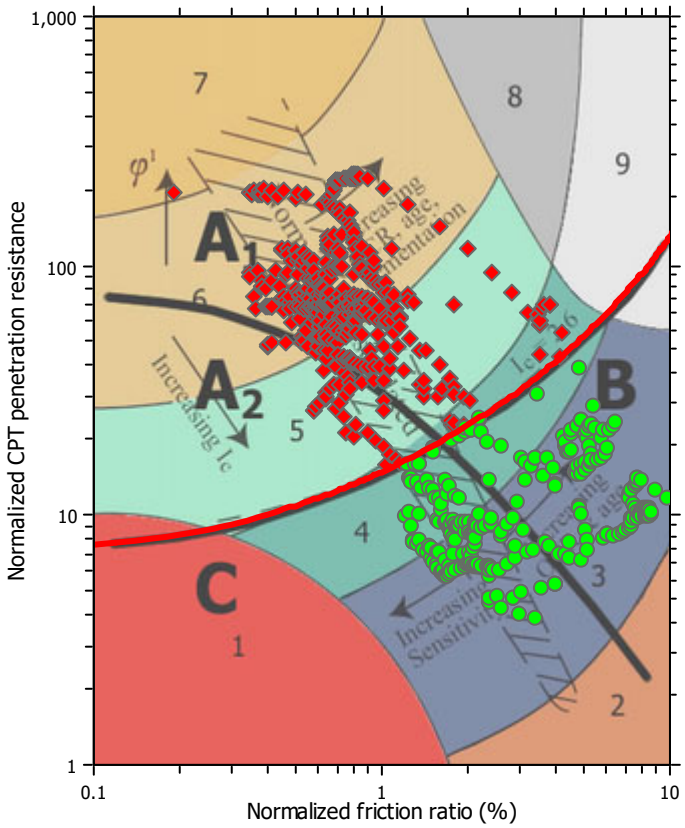
F.S. color scheme

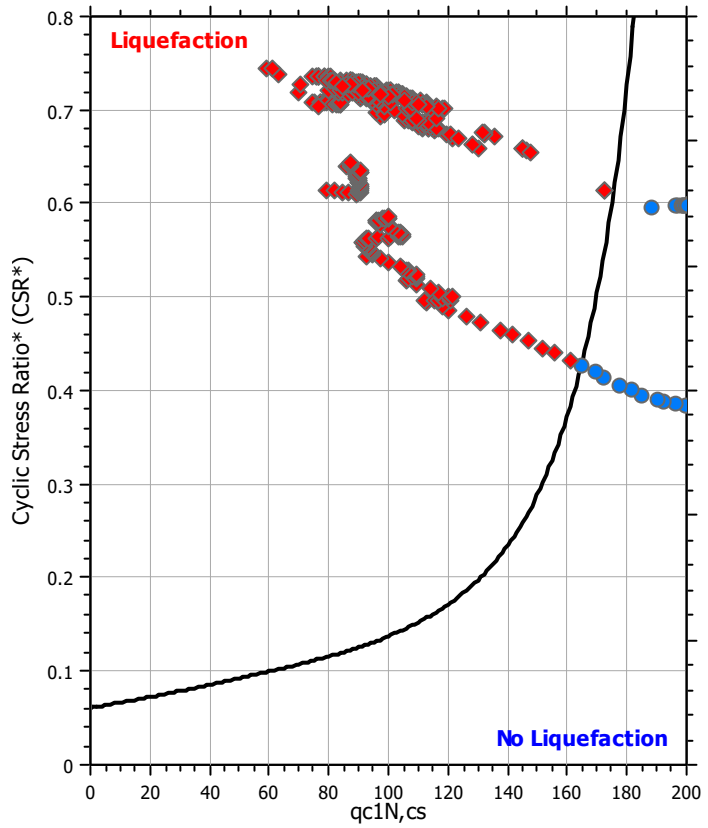
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

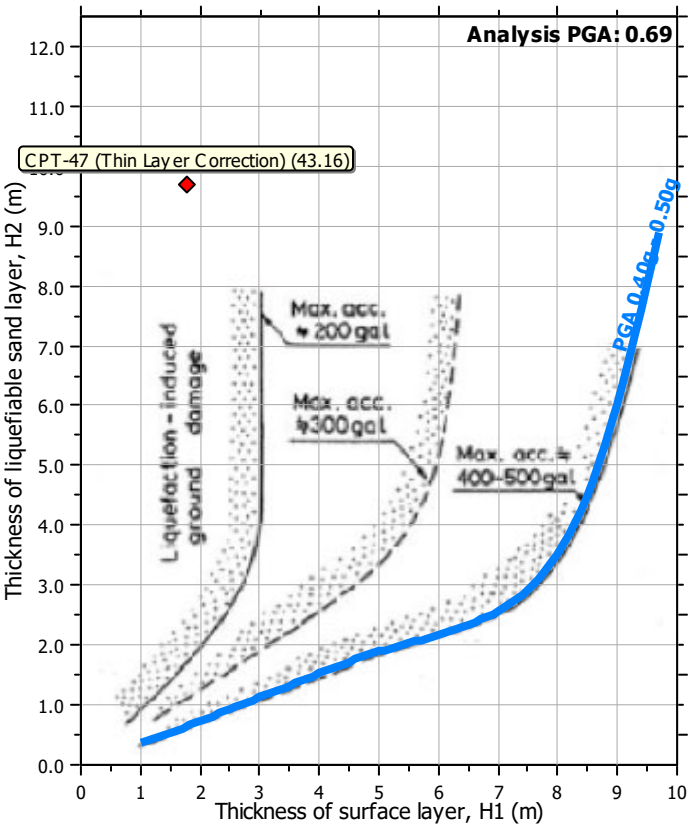
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



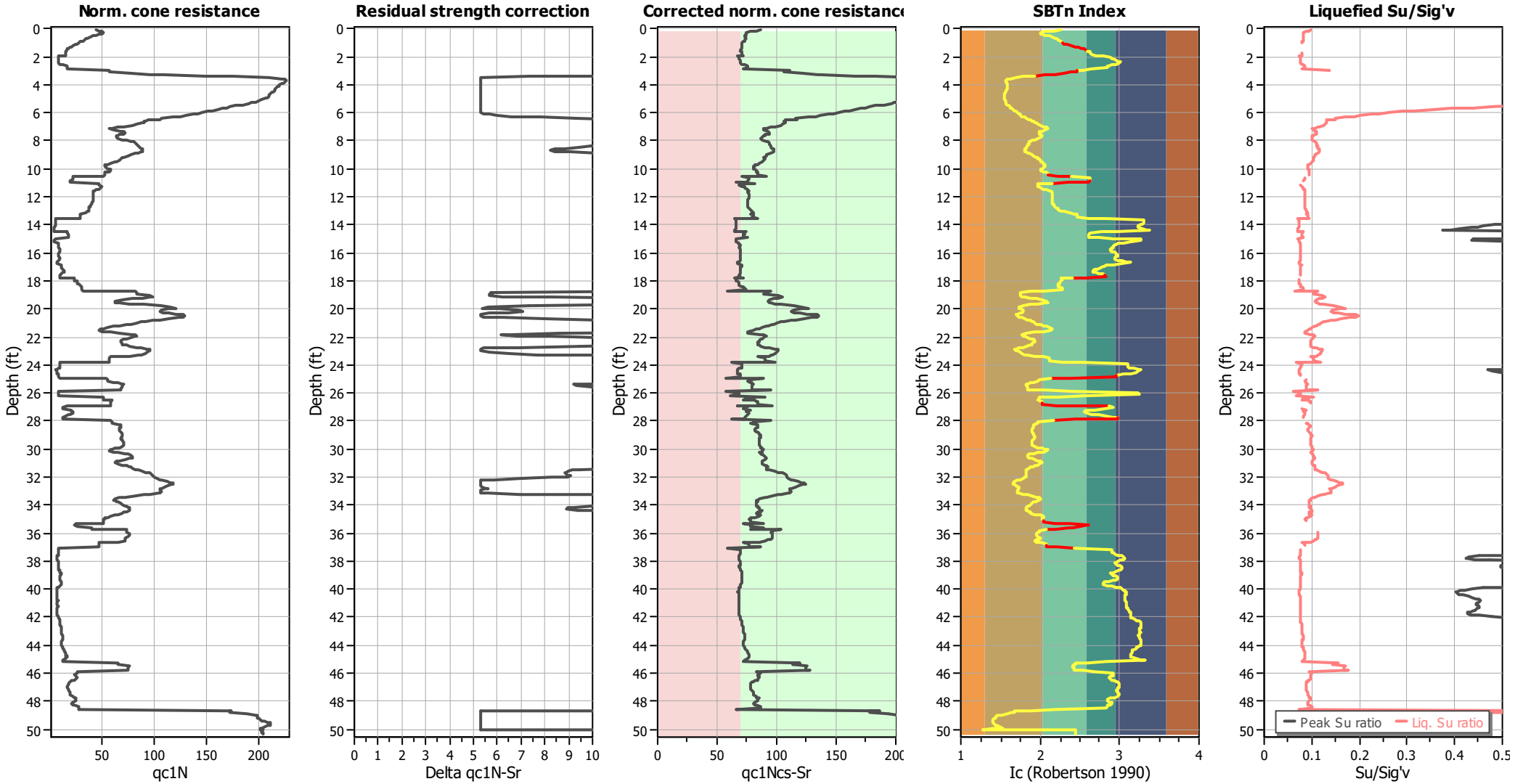




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

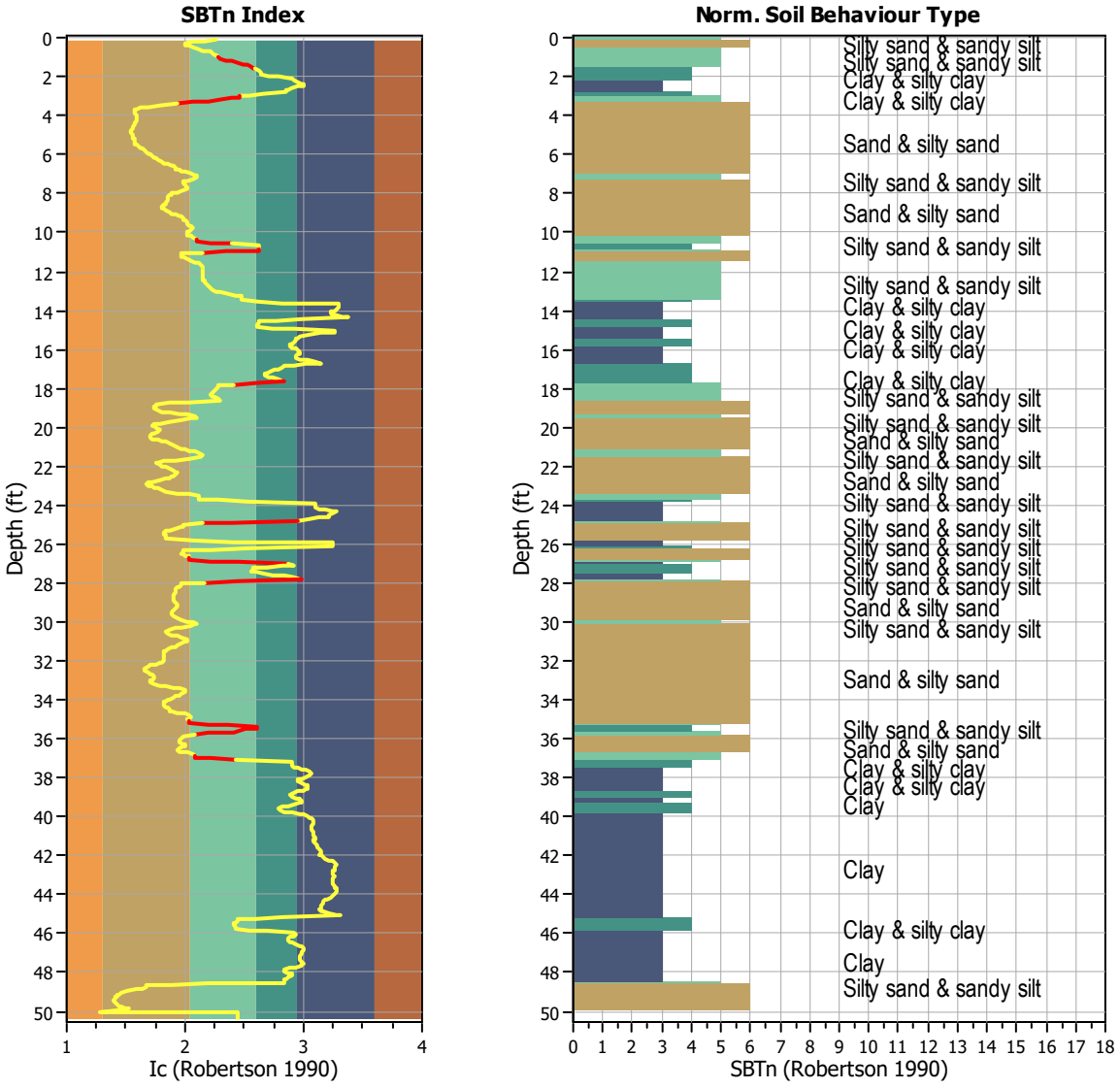
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

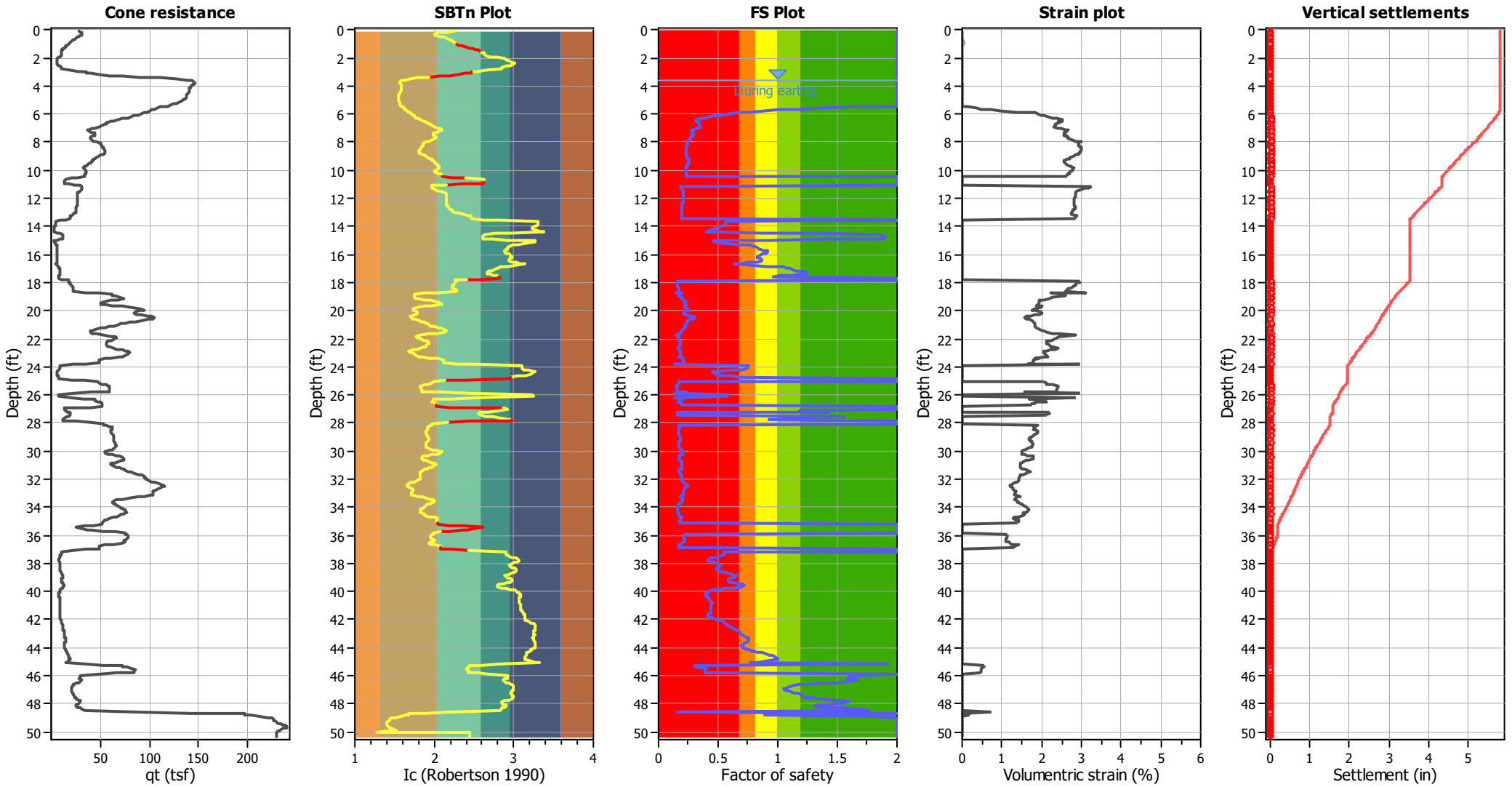
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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:	767
I_c maximum check value:	3.00	Total points excluded:	57
I_c change ratio value:	0.0250	Exclusion percentage:	7.43%
Minimum number of points in layer:	4	Number of layers detected:	11

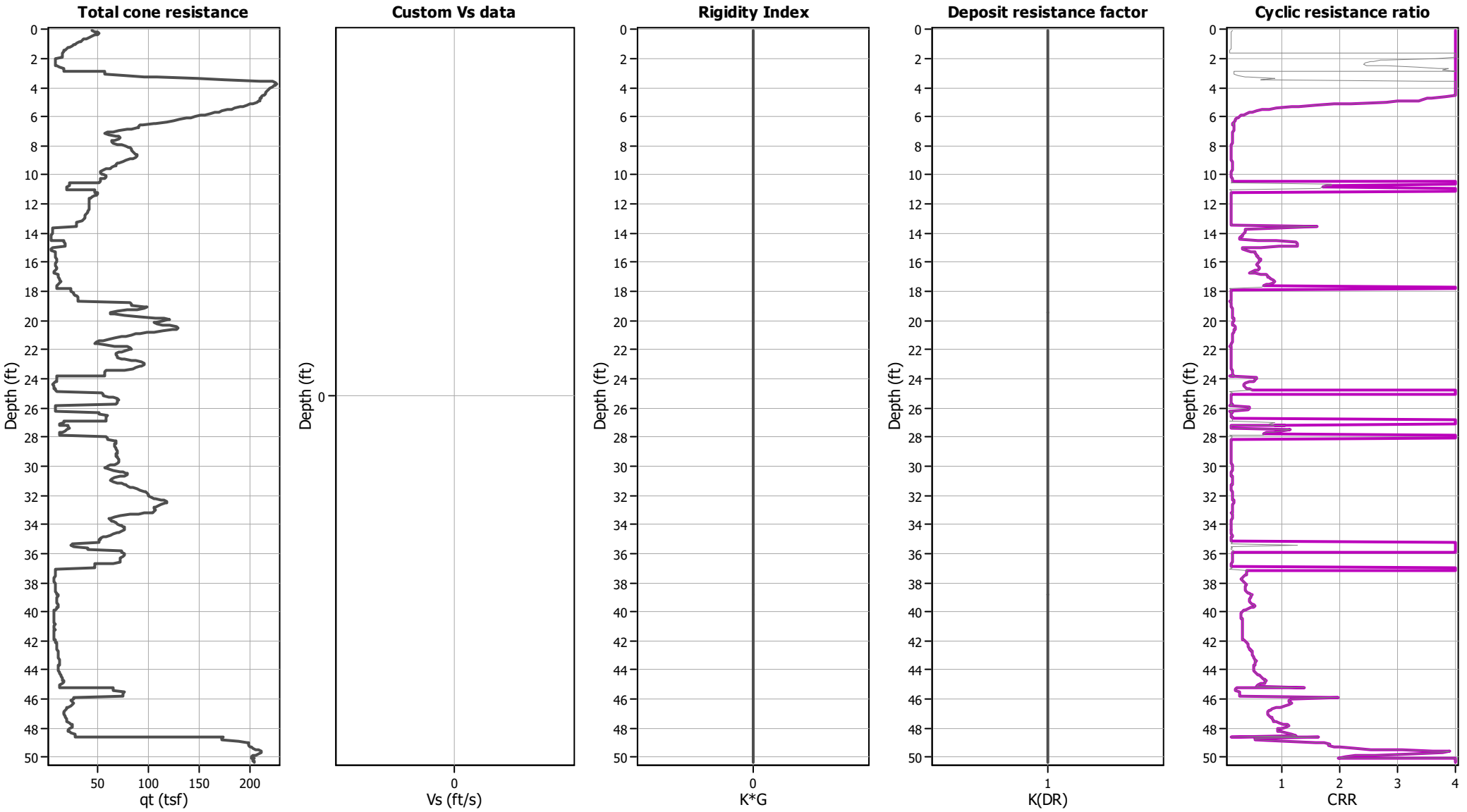
Estimation of post-earthquake settlements



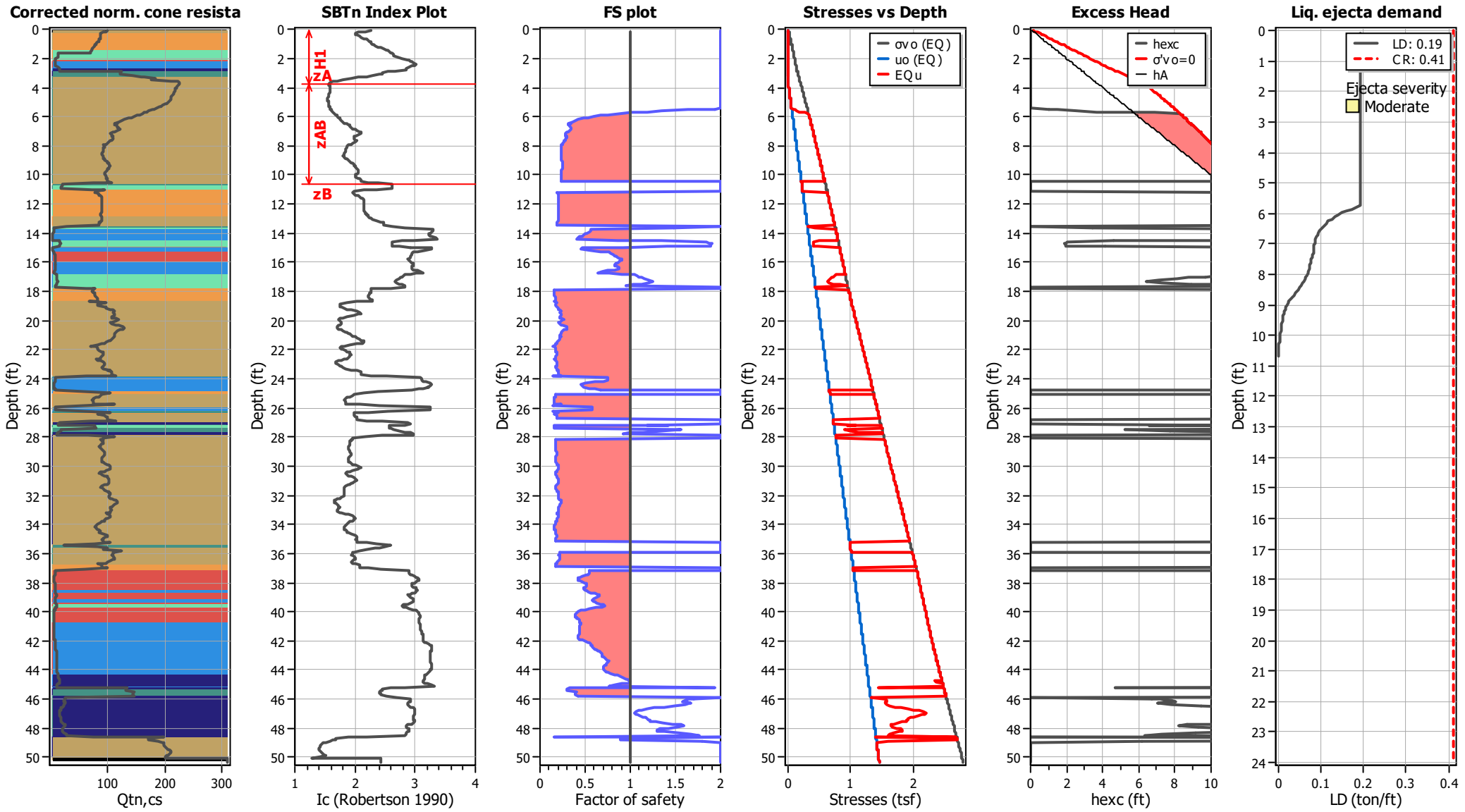
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

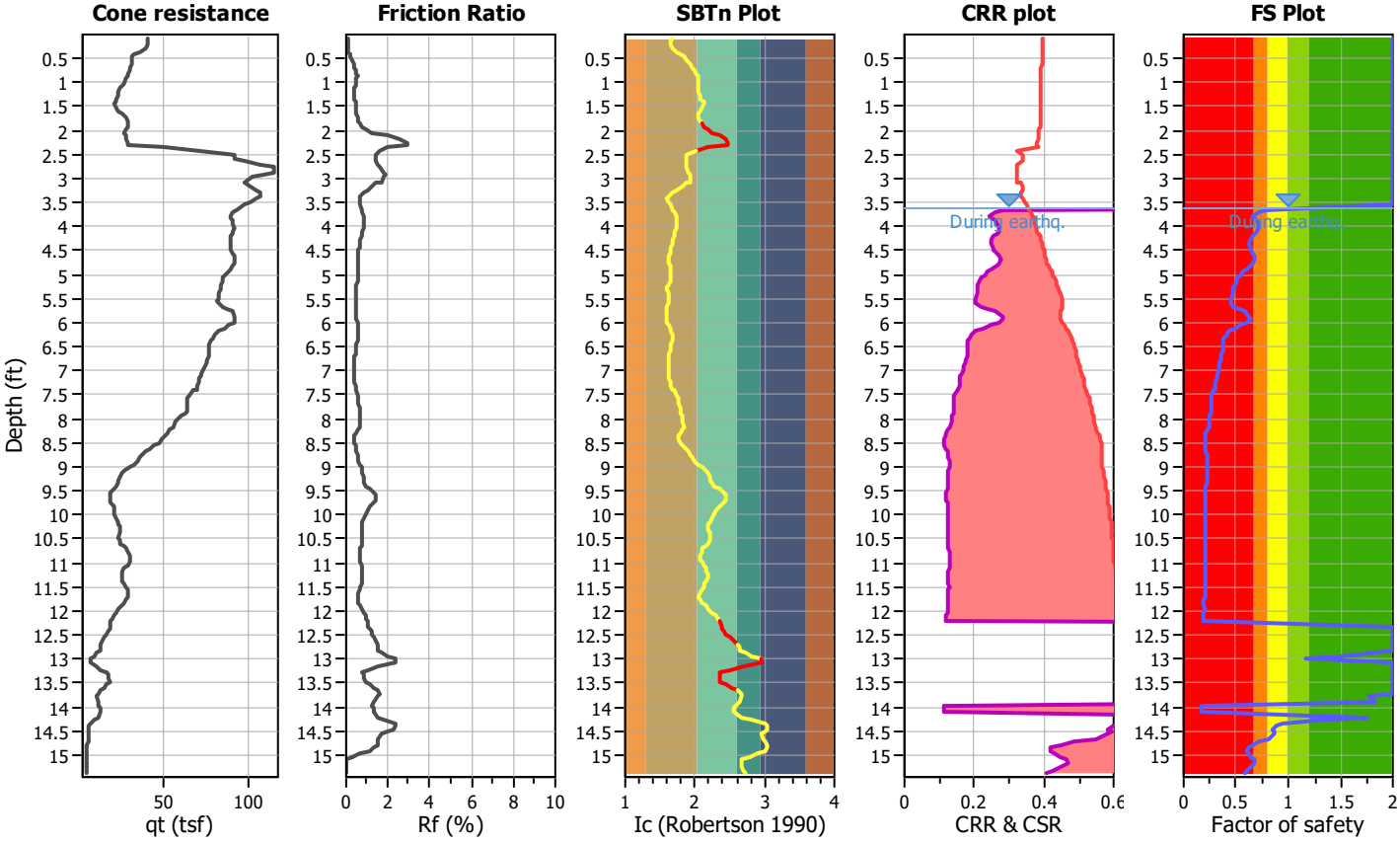
Project title : Topgolf Harbor Island

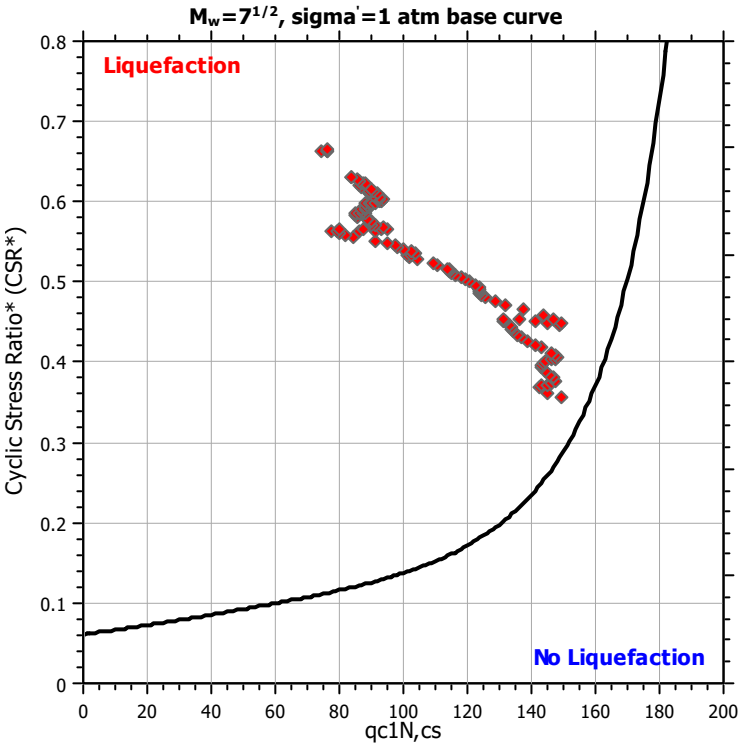
Location : North Harbor Drive and Liberator Way, San Diego, CA

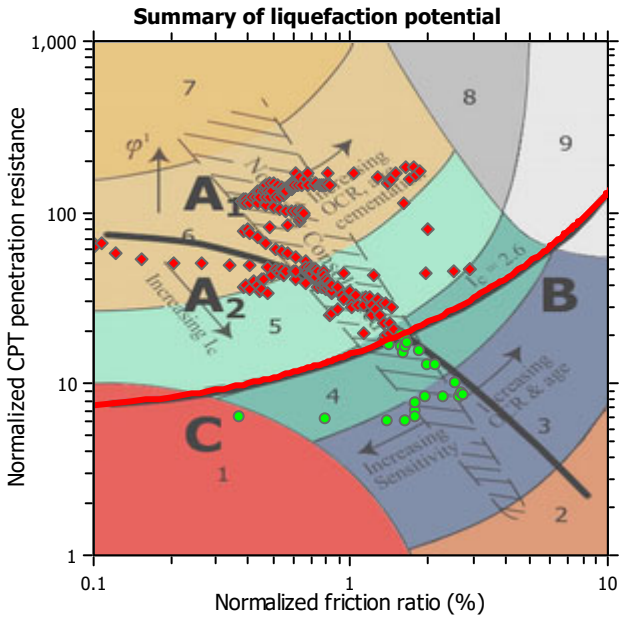
CPT file : CPT-48 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.62 ft	Use fill:	No	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.62 ft	Fill height:	N/A	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	60.00 ft
Earthquake magnitude M_w:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

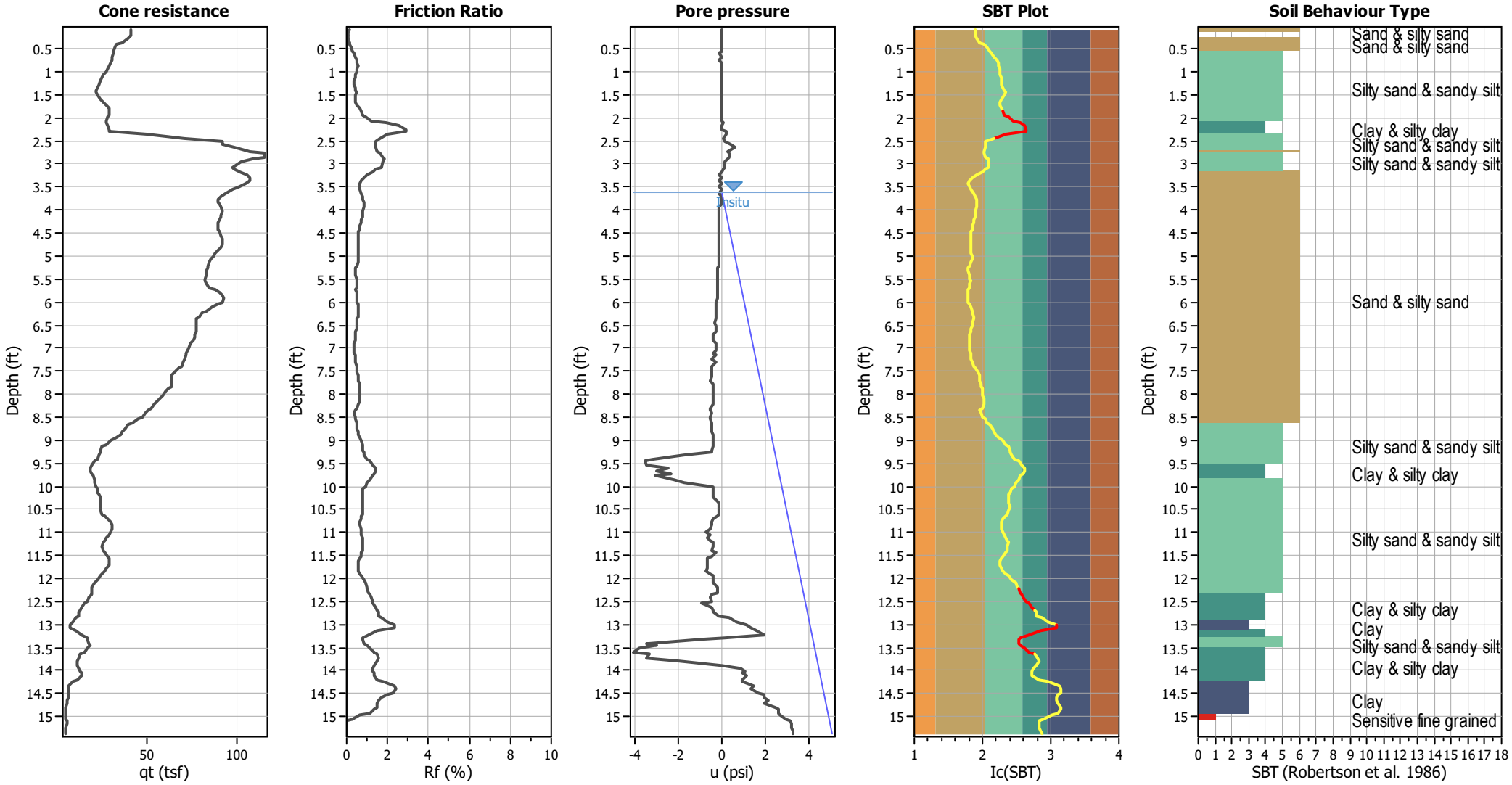






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



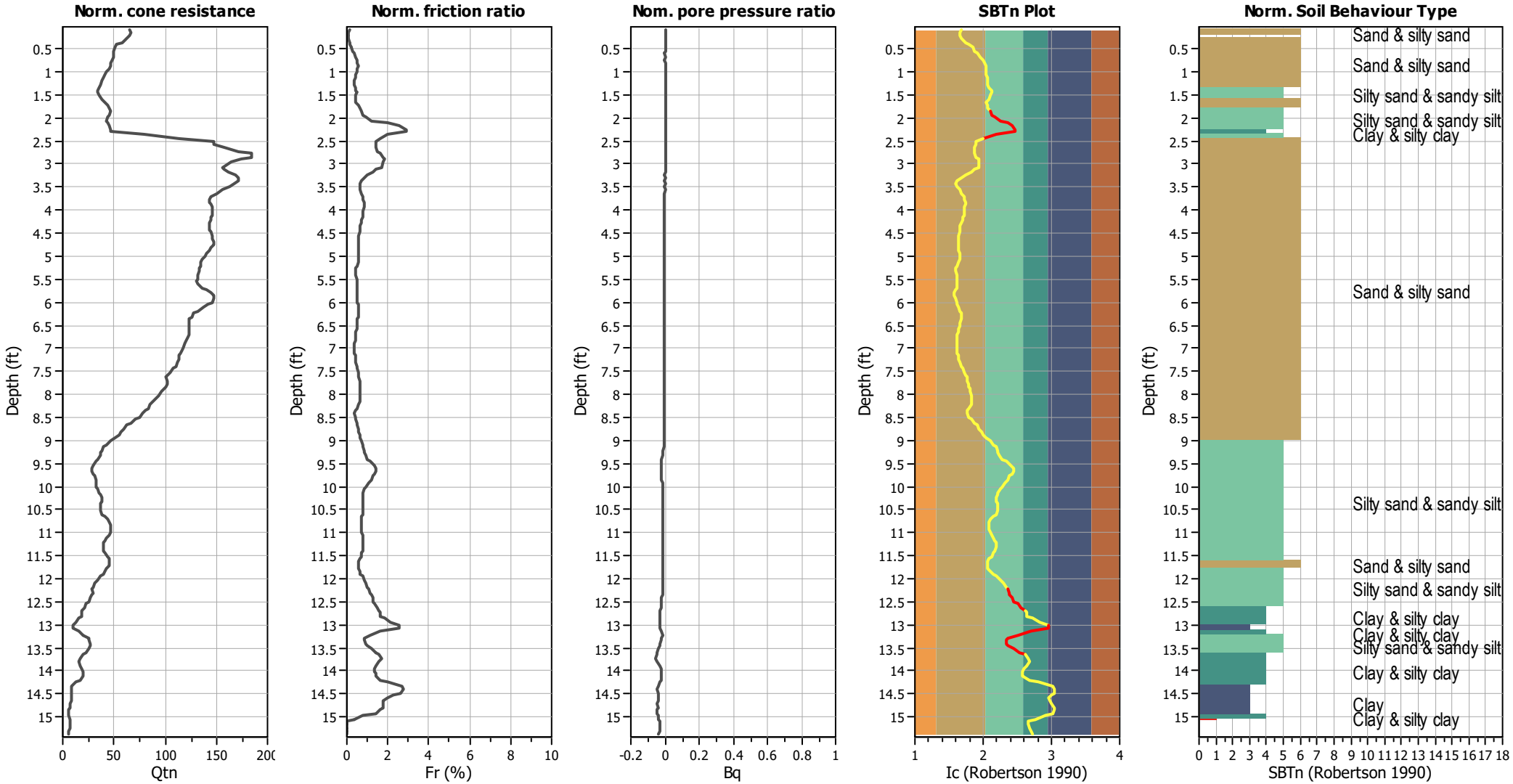
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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)



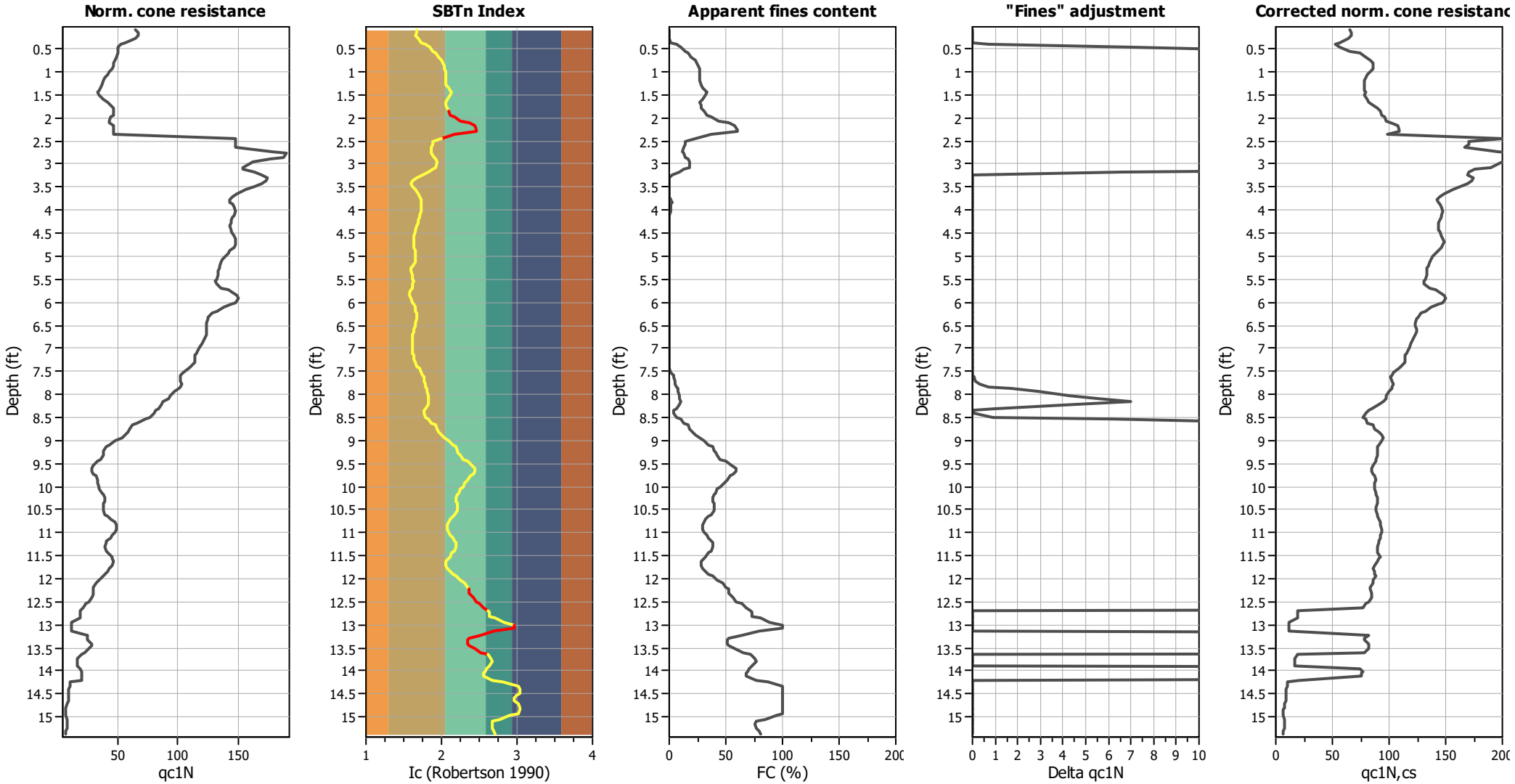
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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

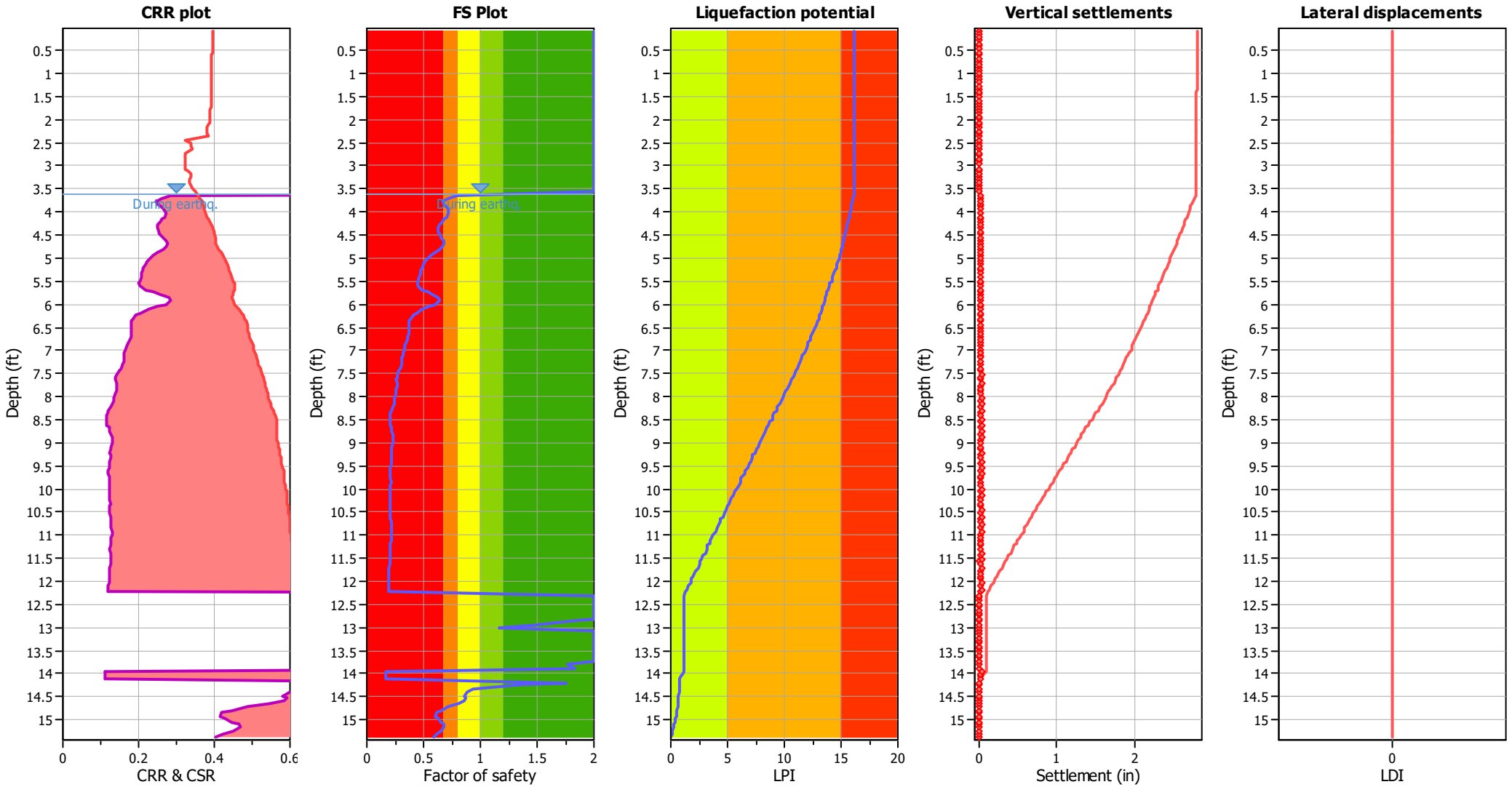
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

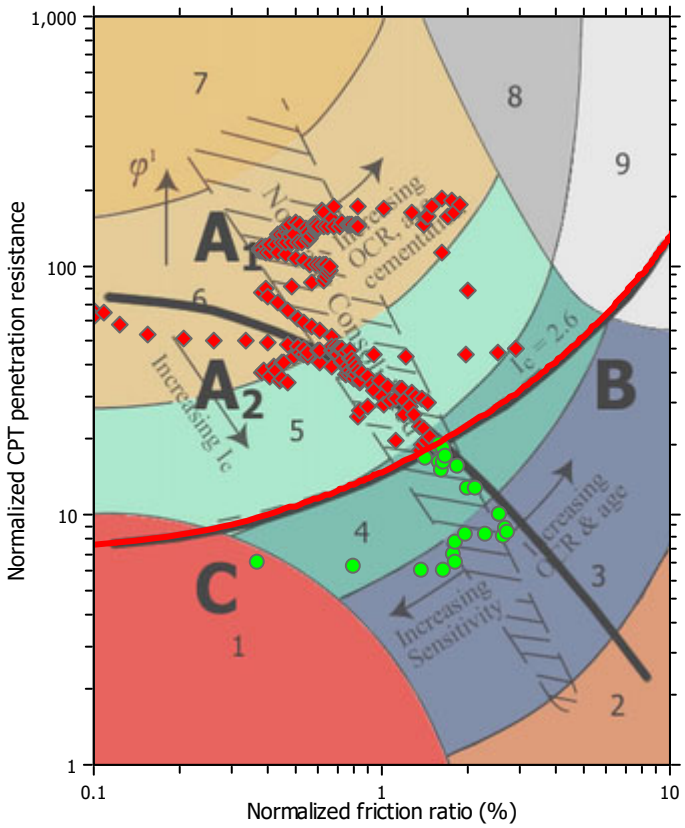
F.S. color scheme

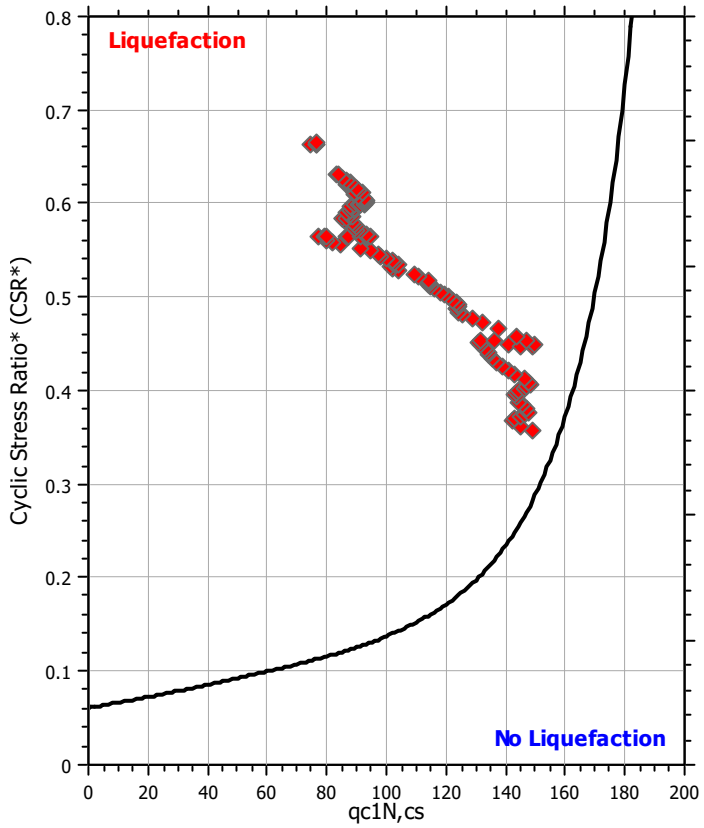
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

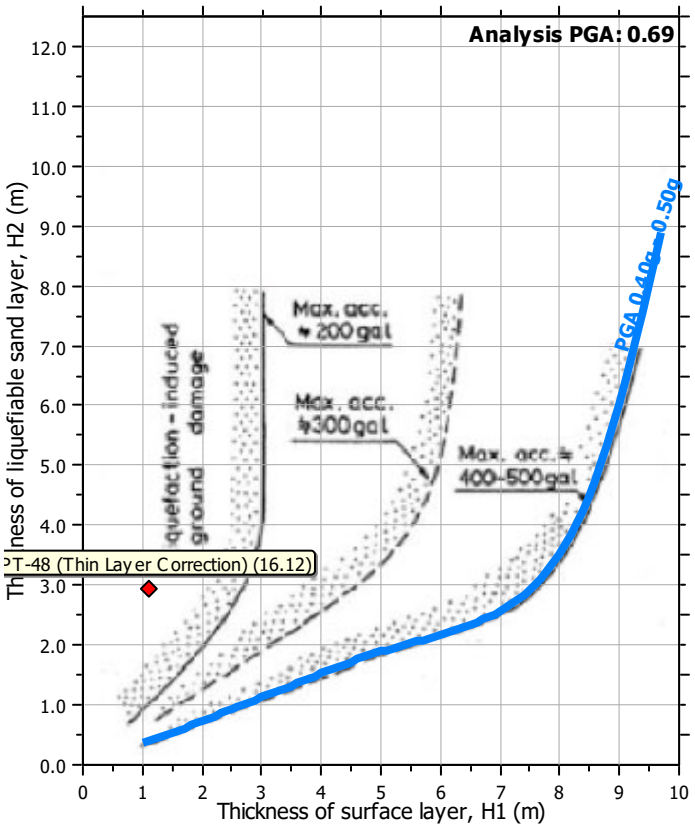
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



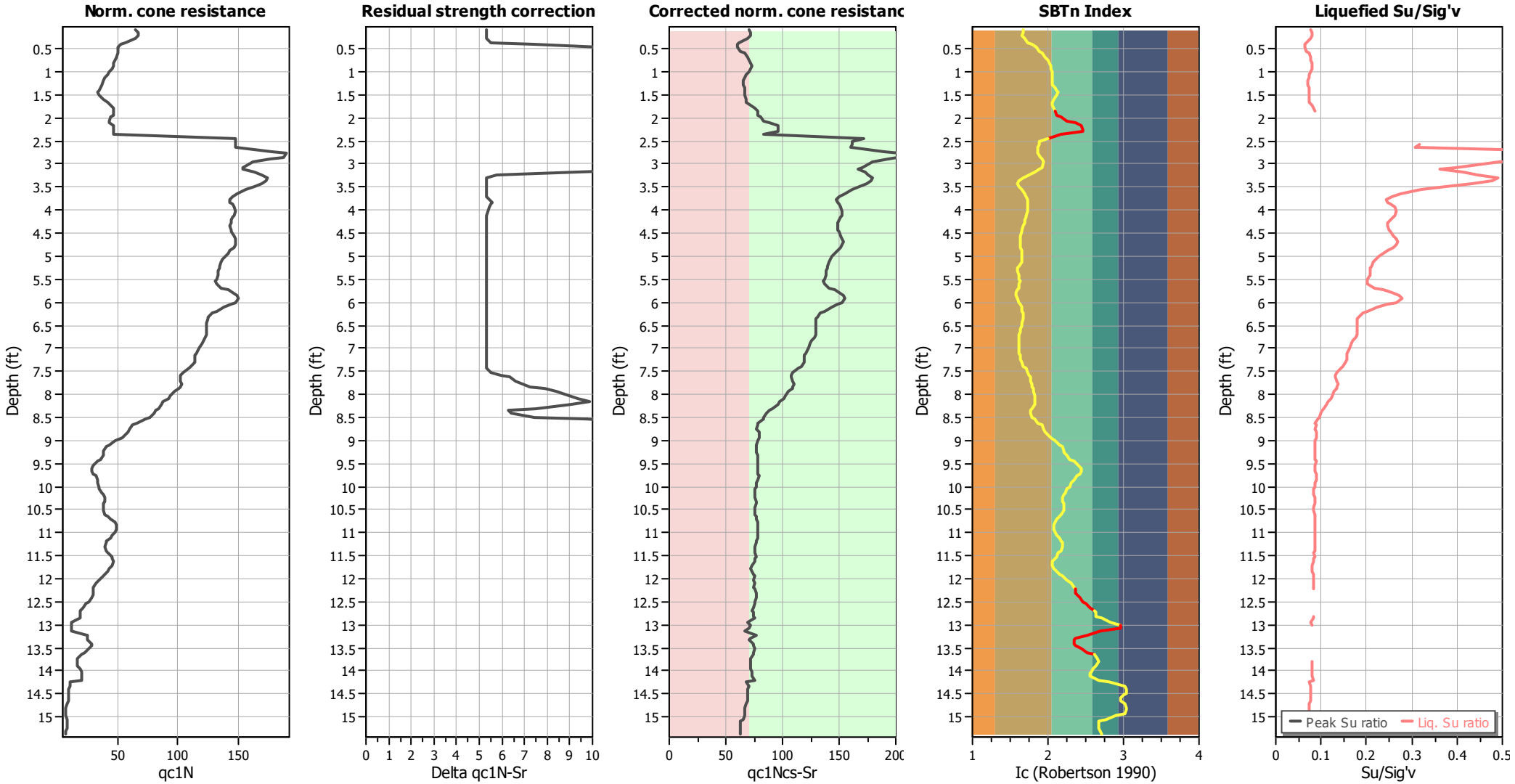




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

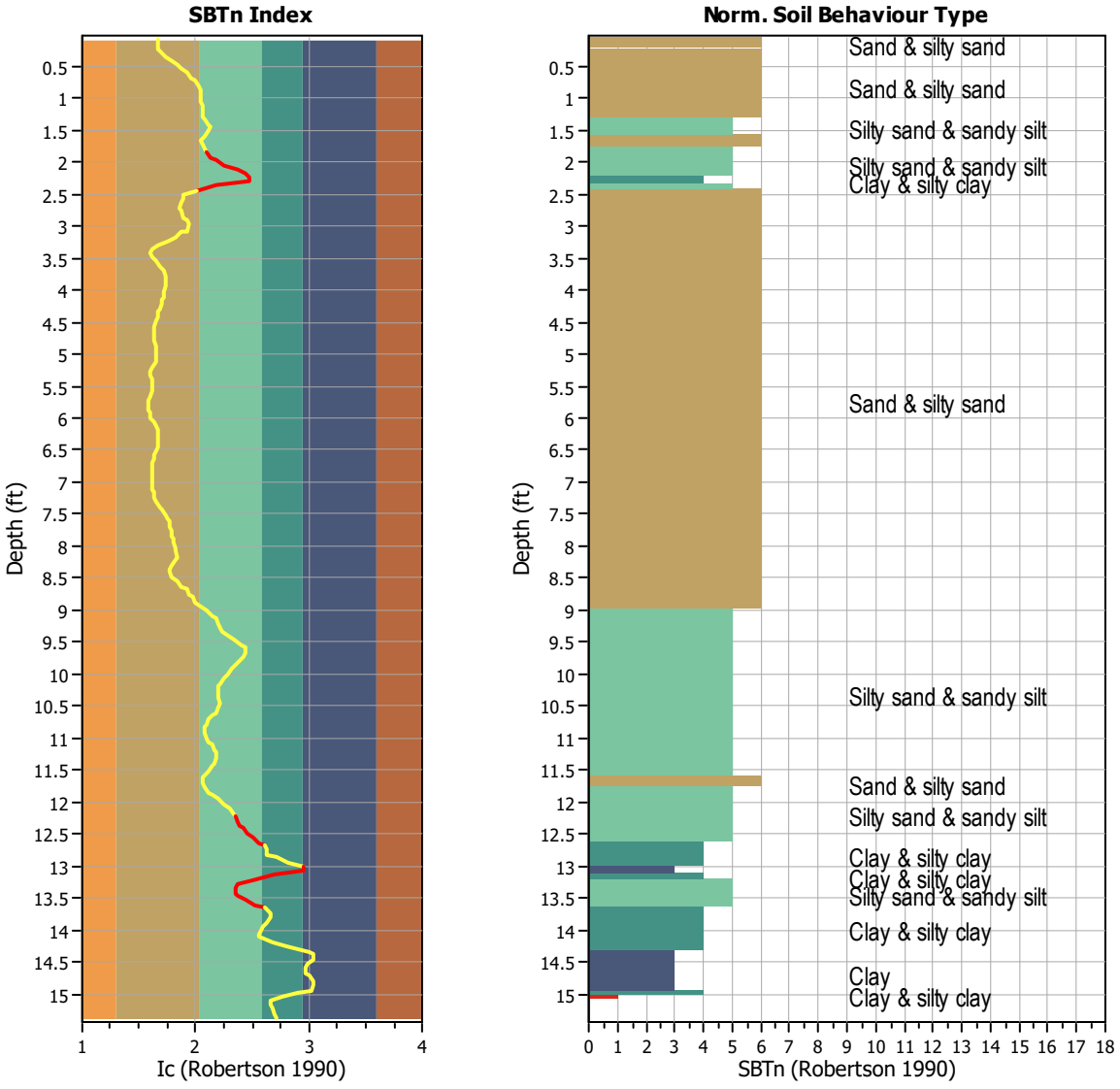
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.62 ft	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	3.62 ft	Fill height:	N/A	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).

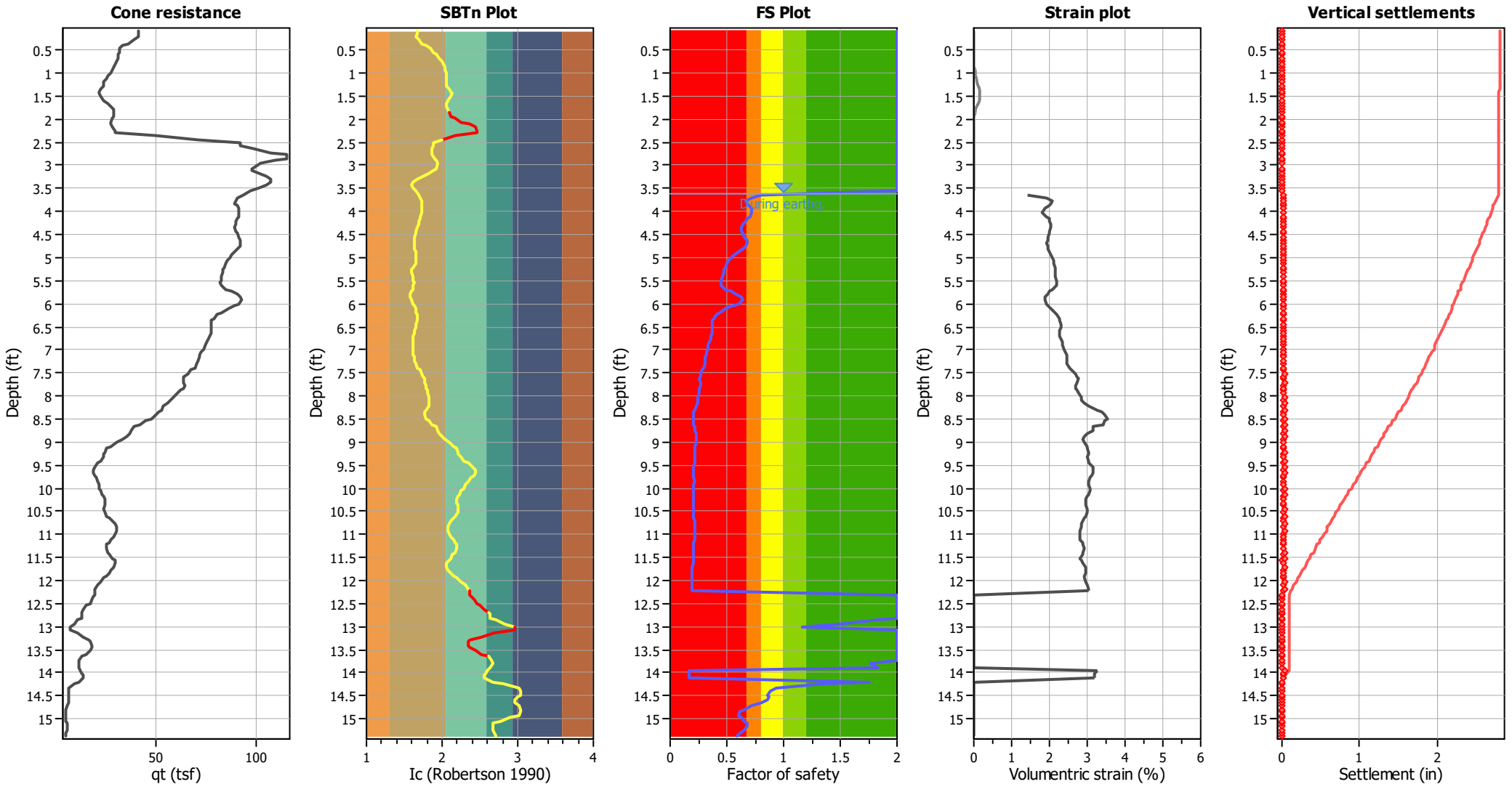
The SBT_n plot below, displays in red the detected transition layers based on the parameters listed below the graphs.



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:	234
Total points excluded:	29
Exclusion percentage:	12.39%
Number of layers detected:	5

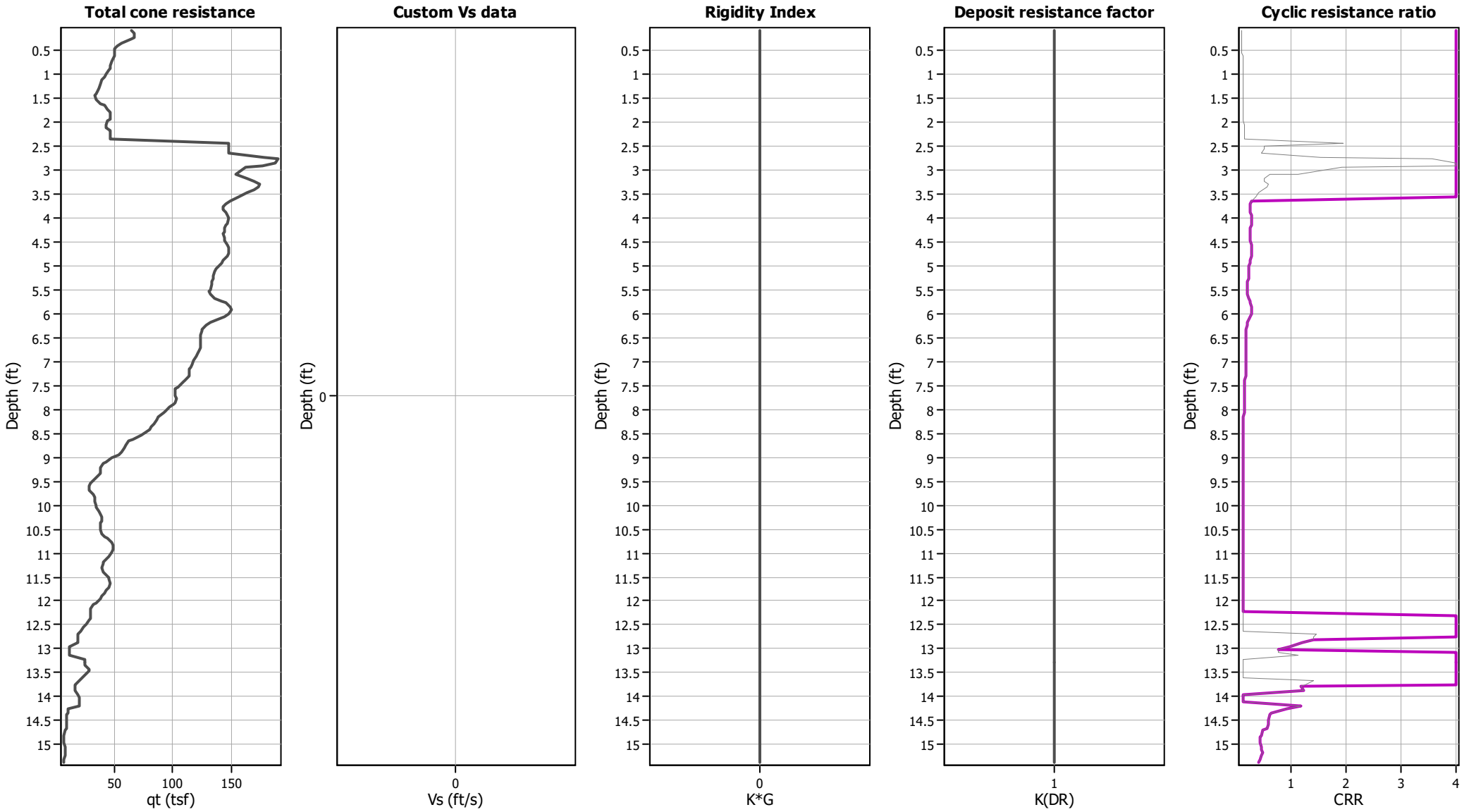
Estimation of post-earthquake settlements



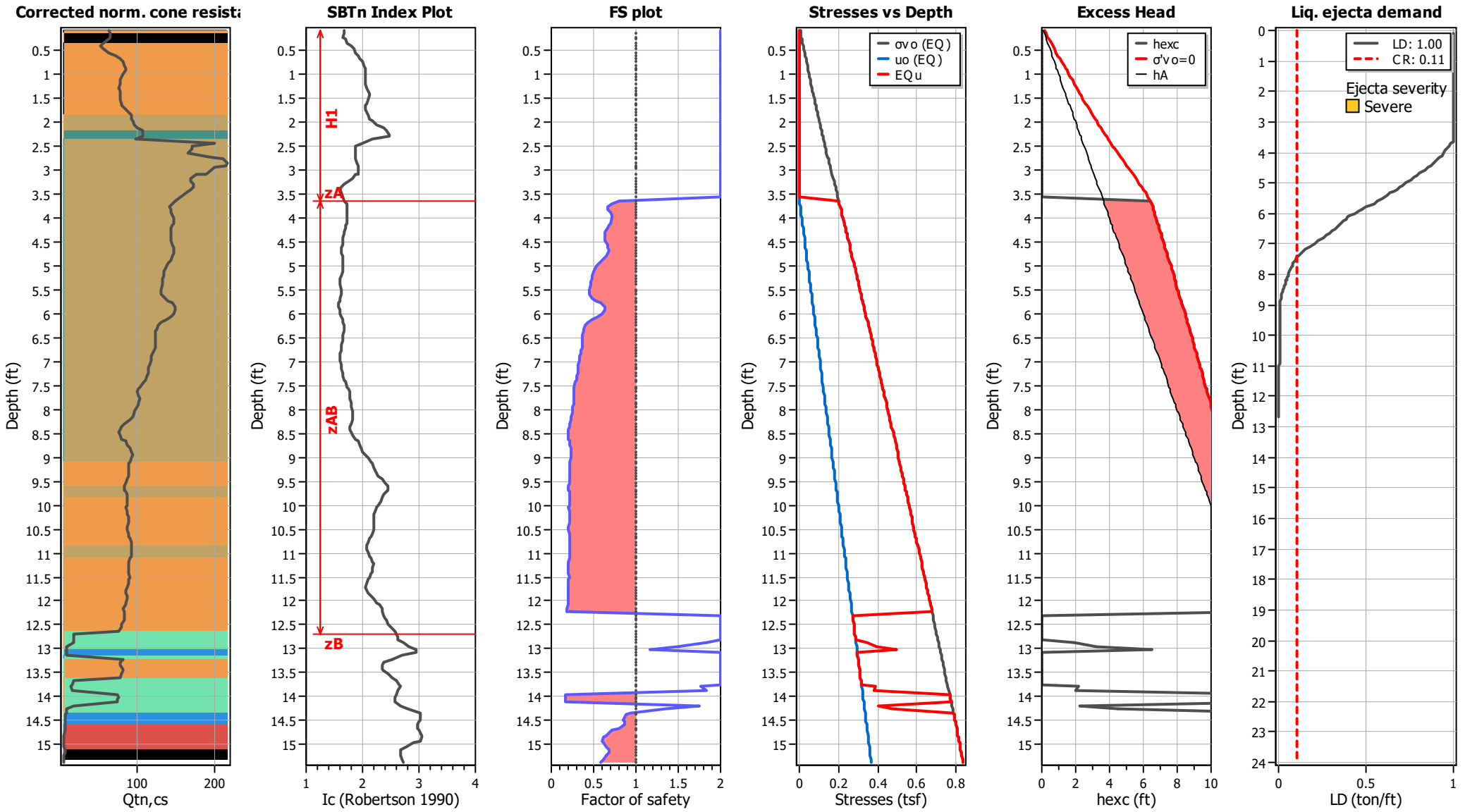
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



NOVA Services, Inc.

LIQUEFACTION ANALYSIS REPORT

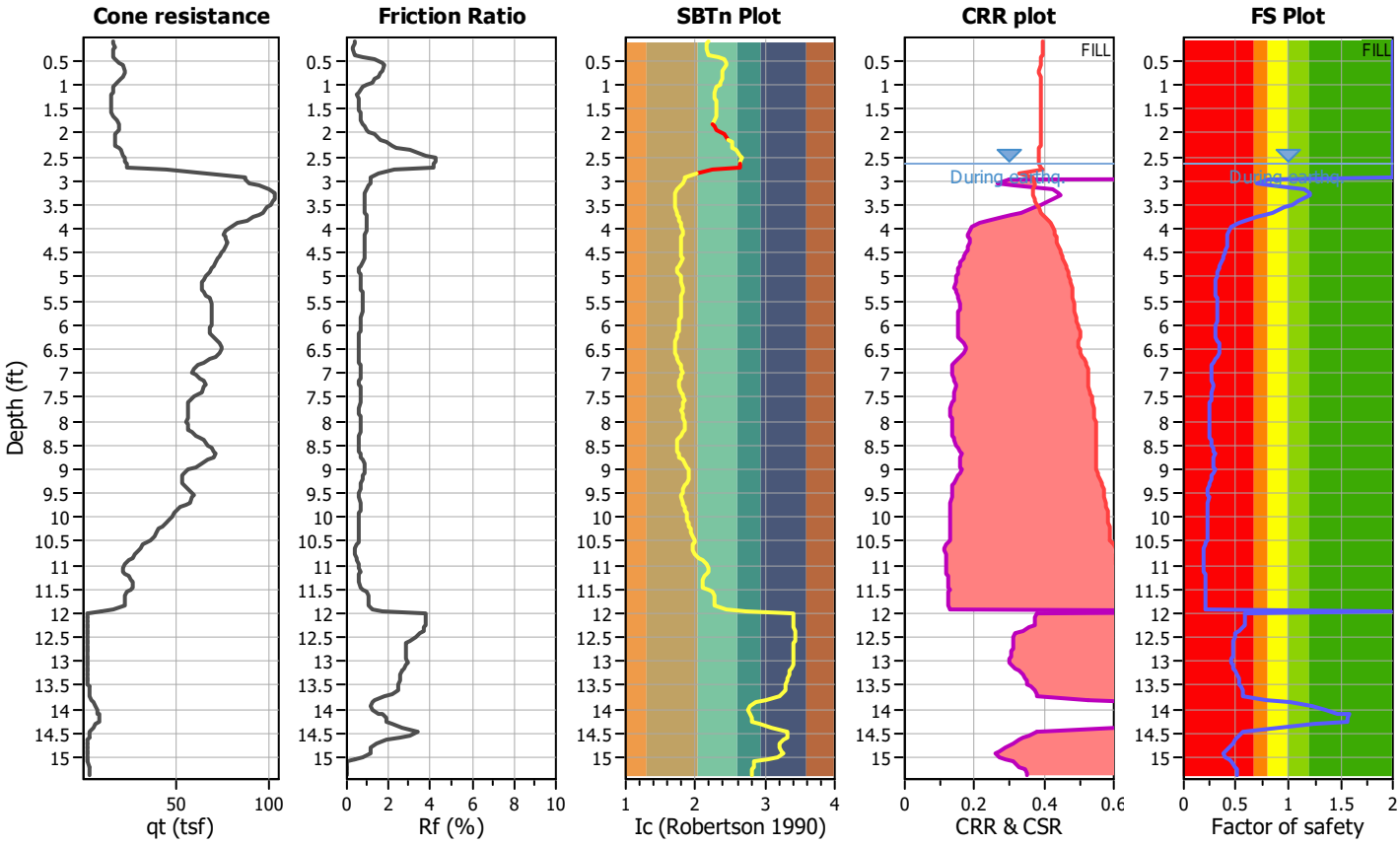
Project title : Topgolf Harbor Island

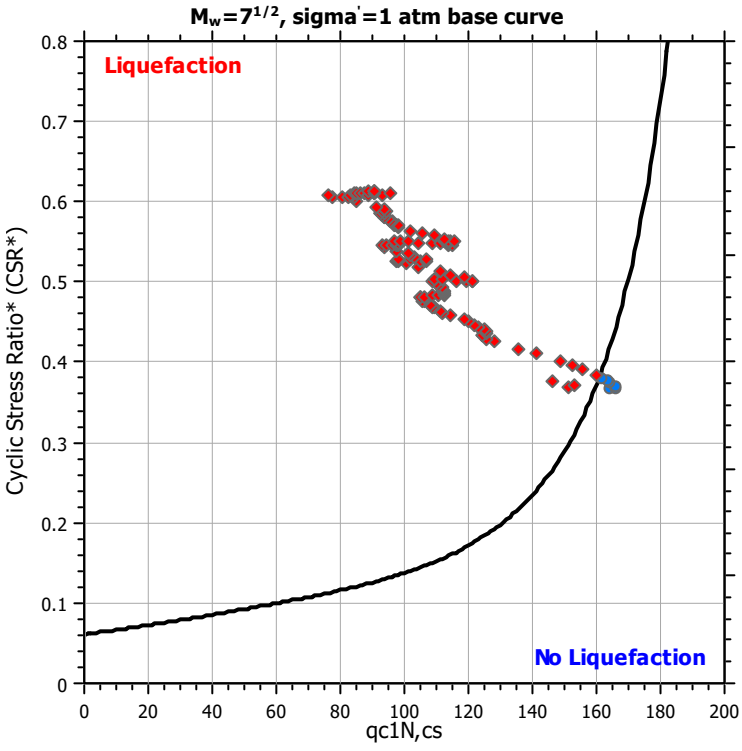
Location : North Harbor Drive and Liberator Way, San Diego, CA

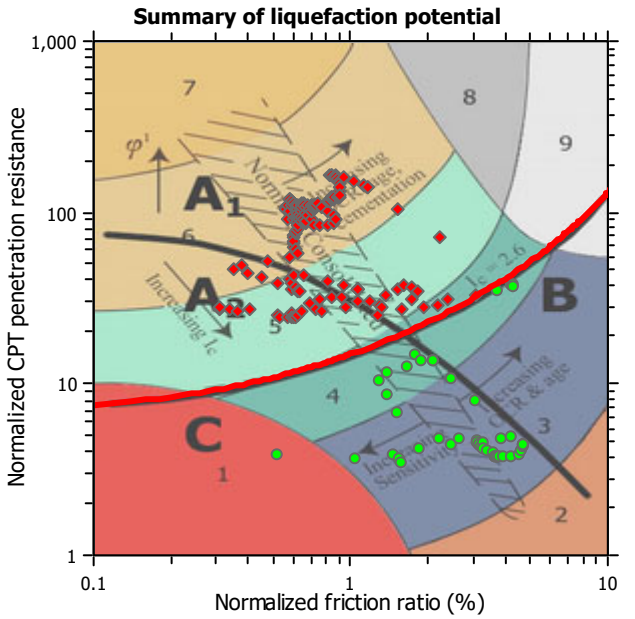
CPT file : CPT-49 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.62 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.12 ft	Fill height:	1.50 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

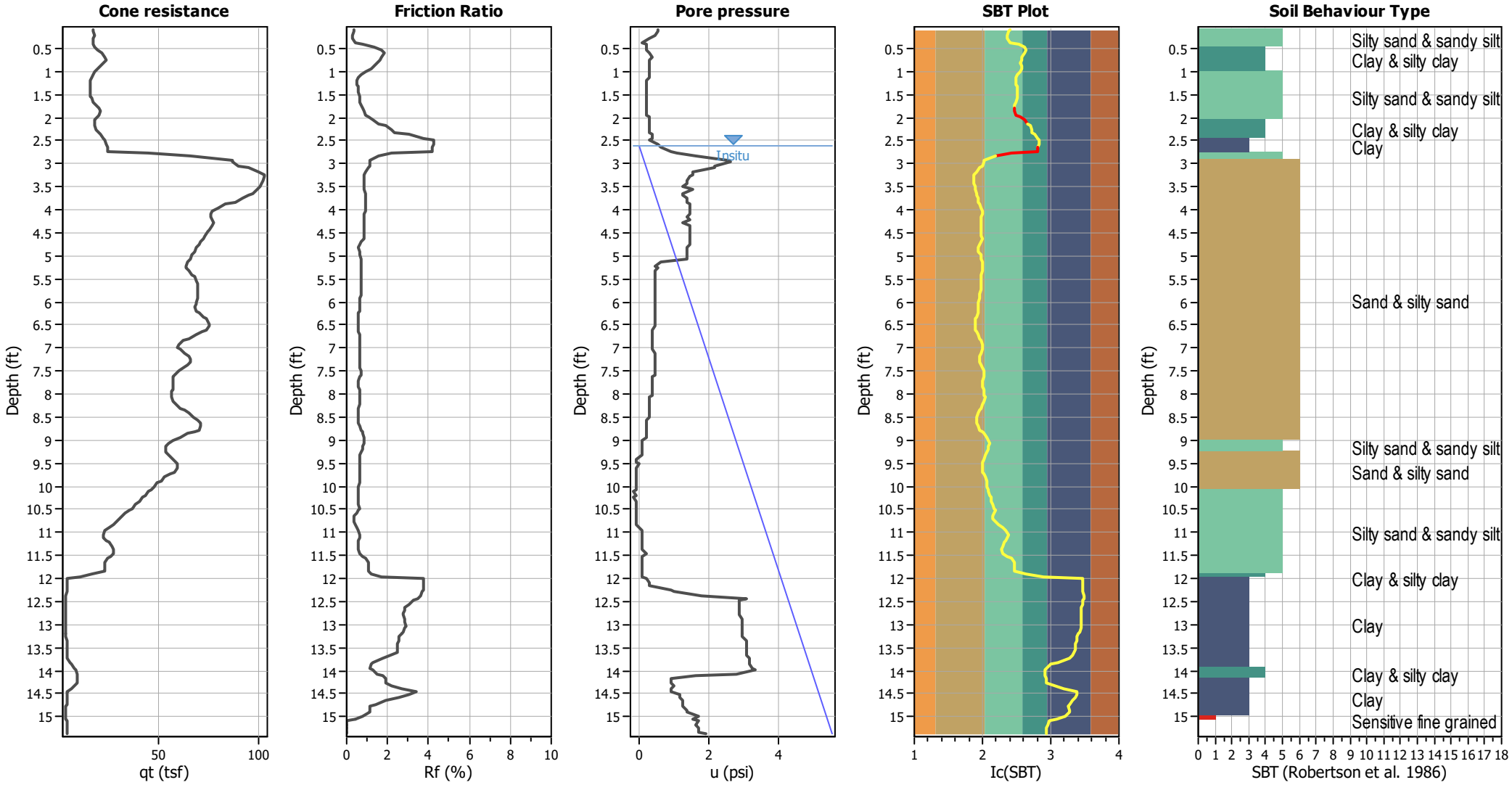






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



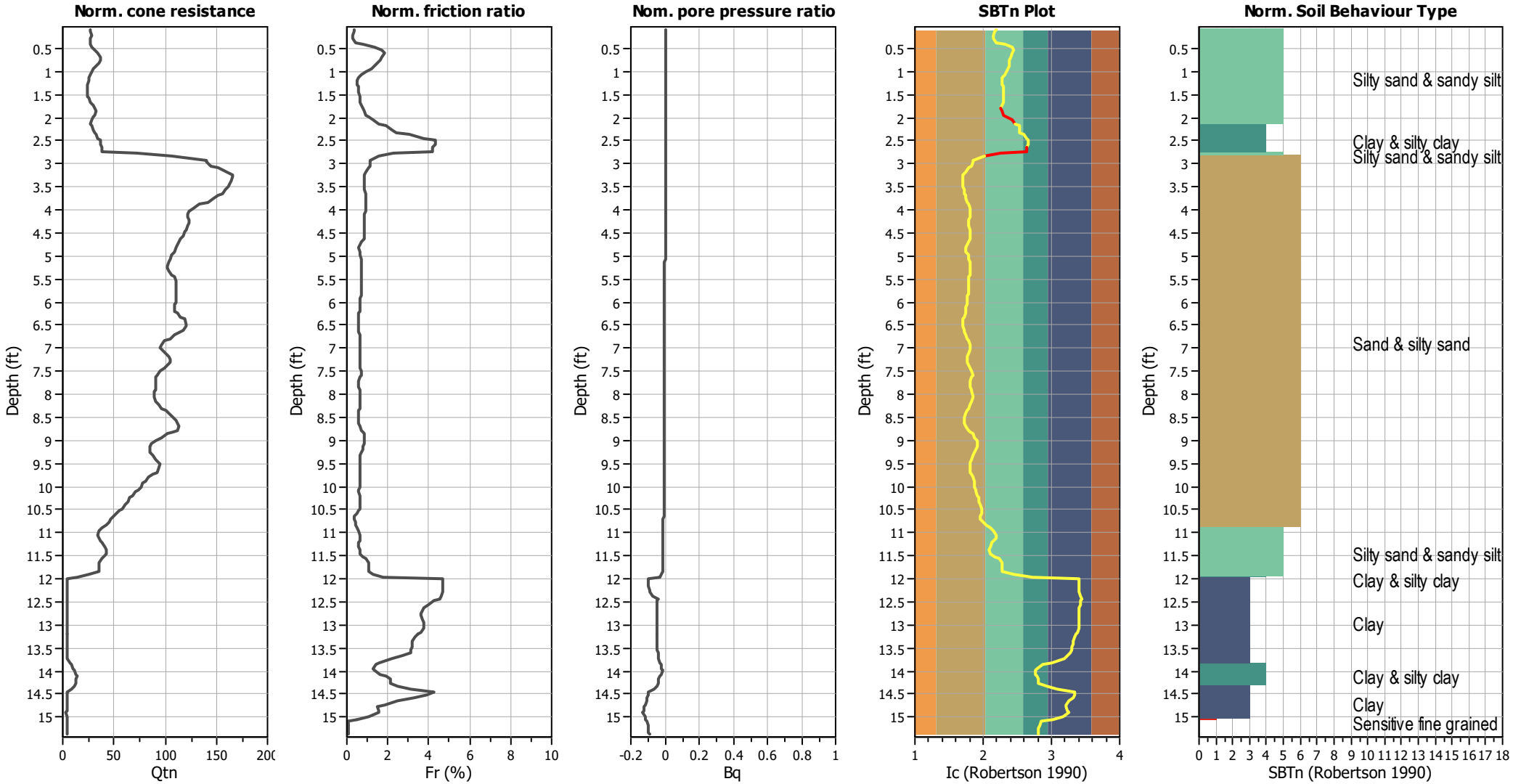
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 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:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

SBTn legend

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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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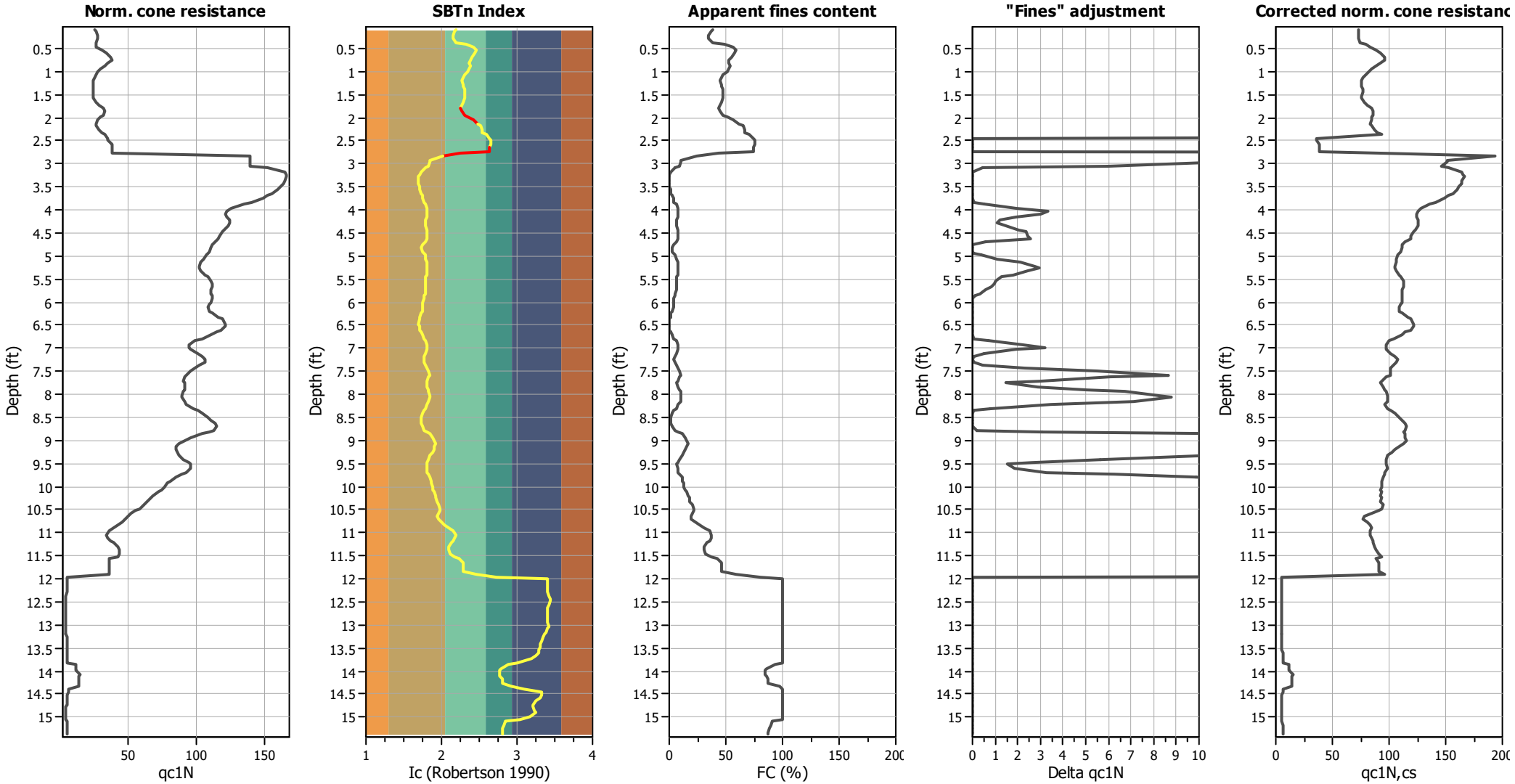
8. Very stiff sand to
9. Very stiff fine grained

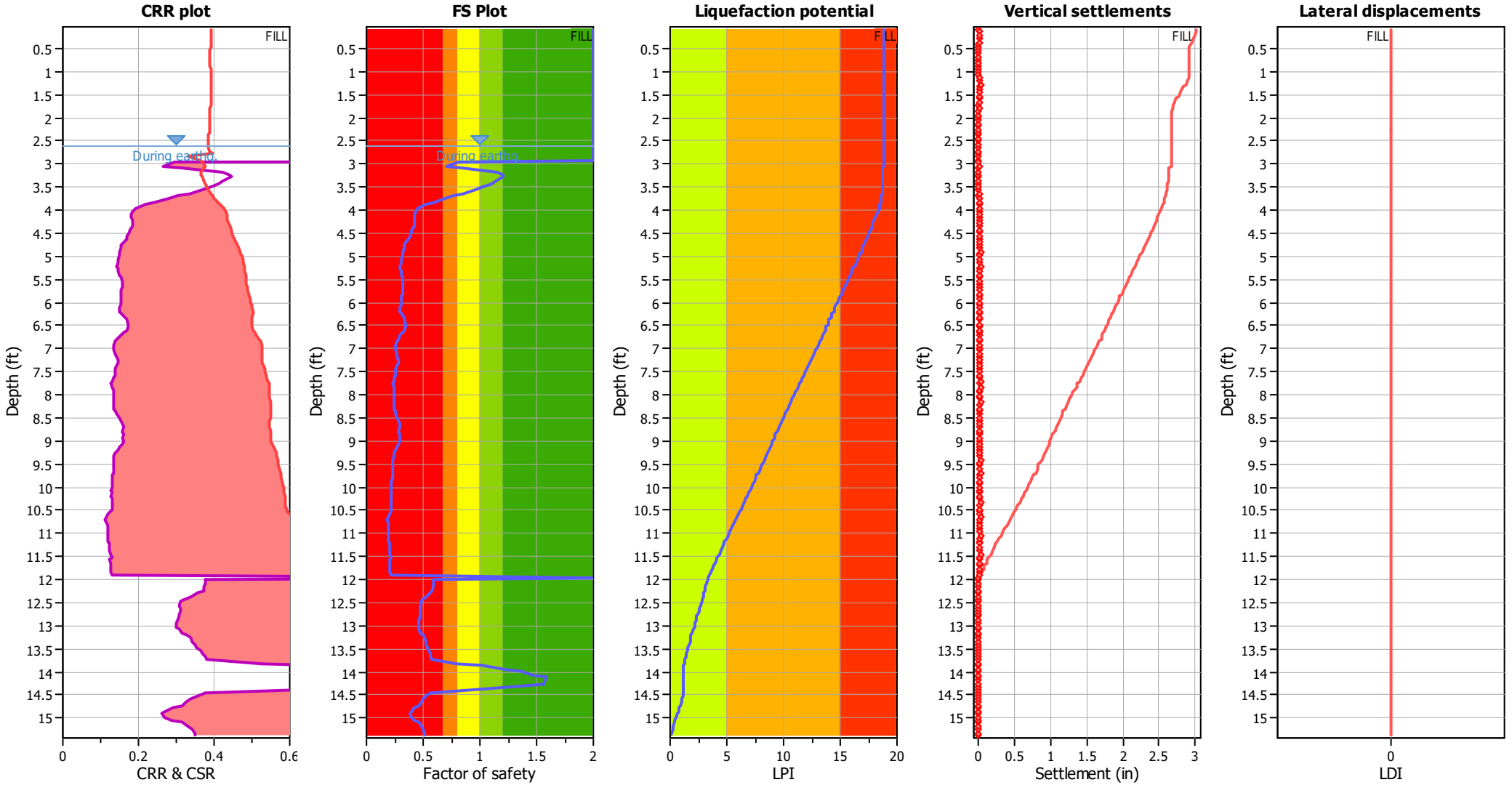
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

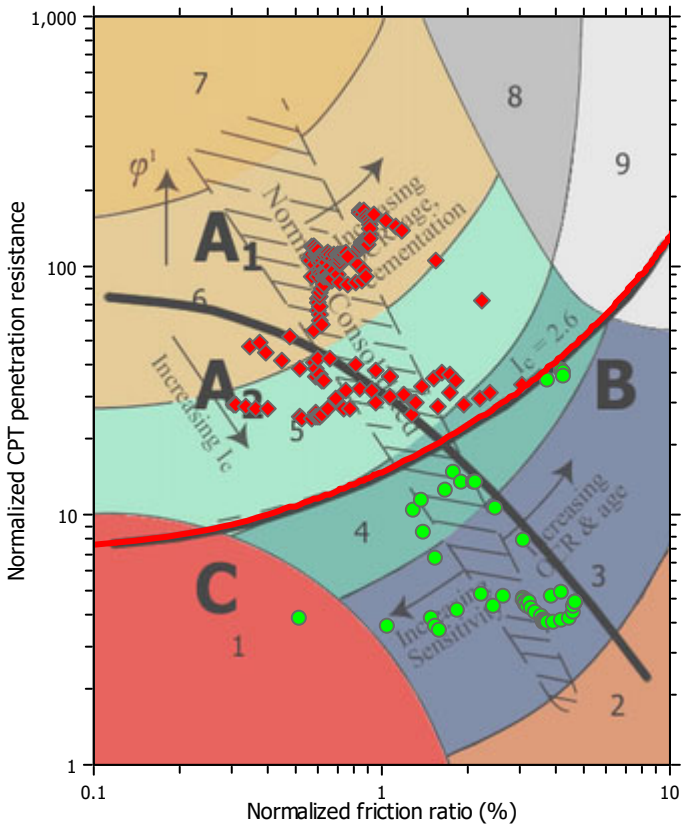
F.S. color scheme

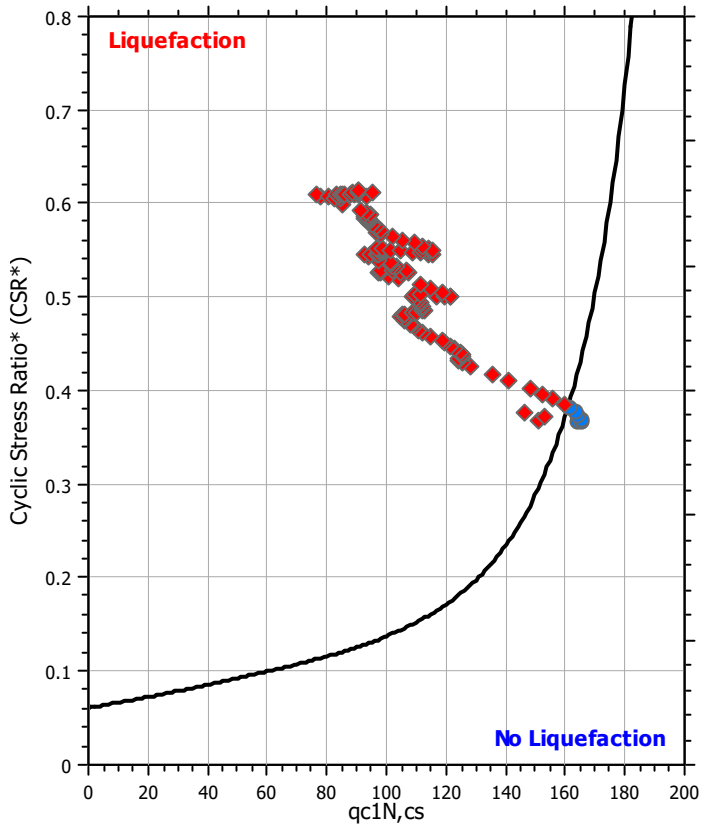
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

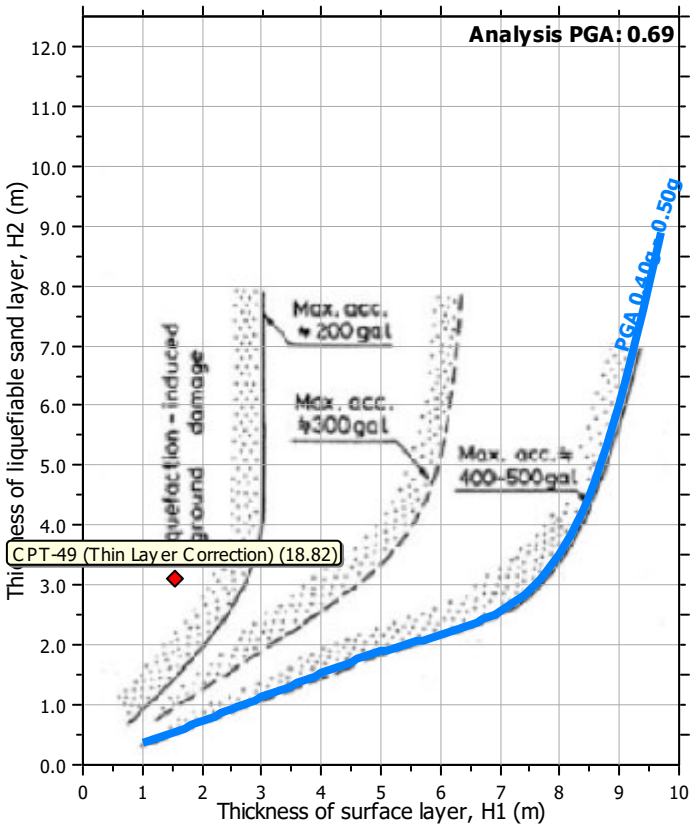
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



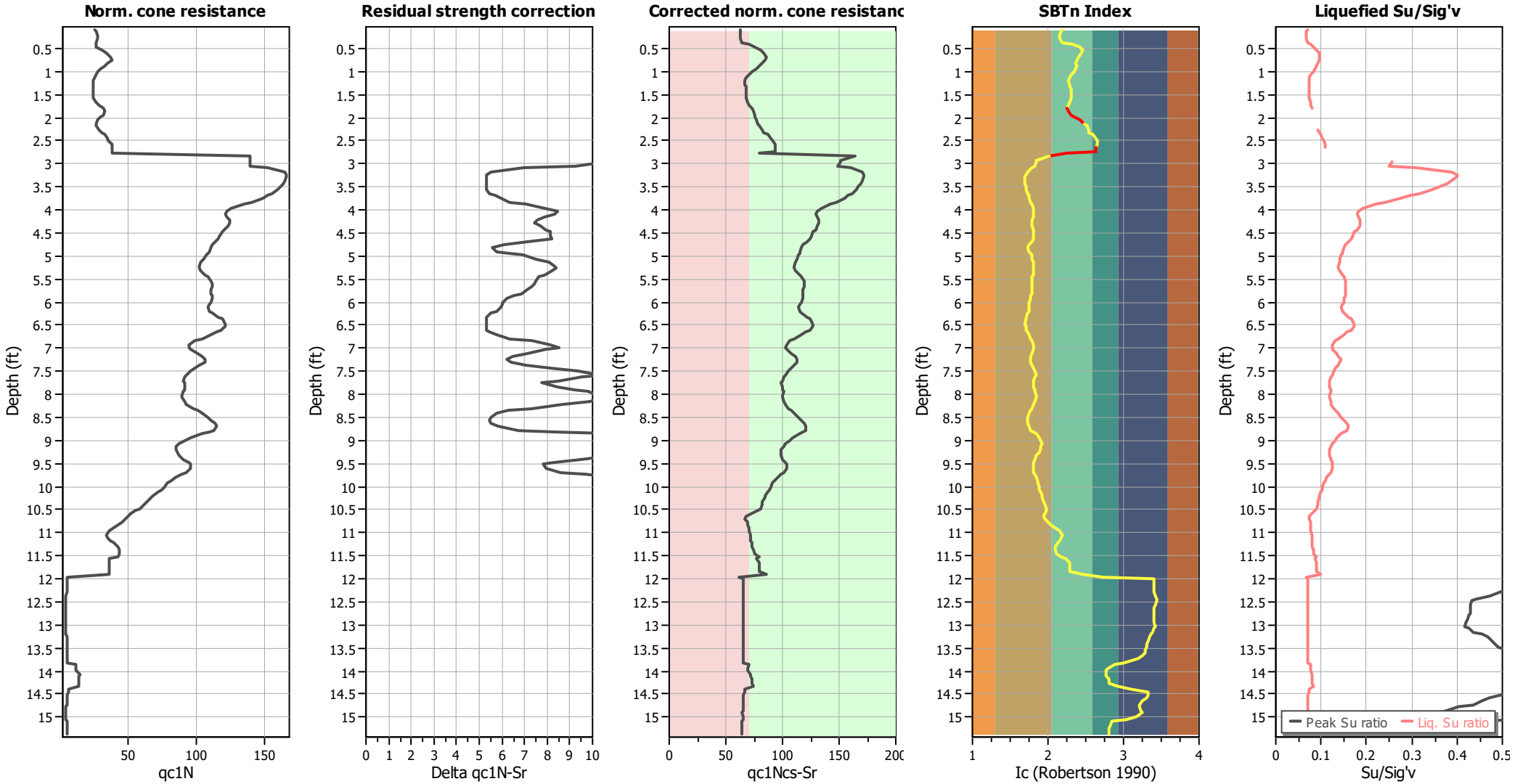




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

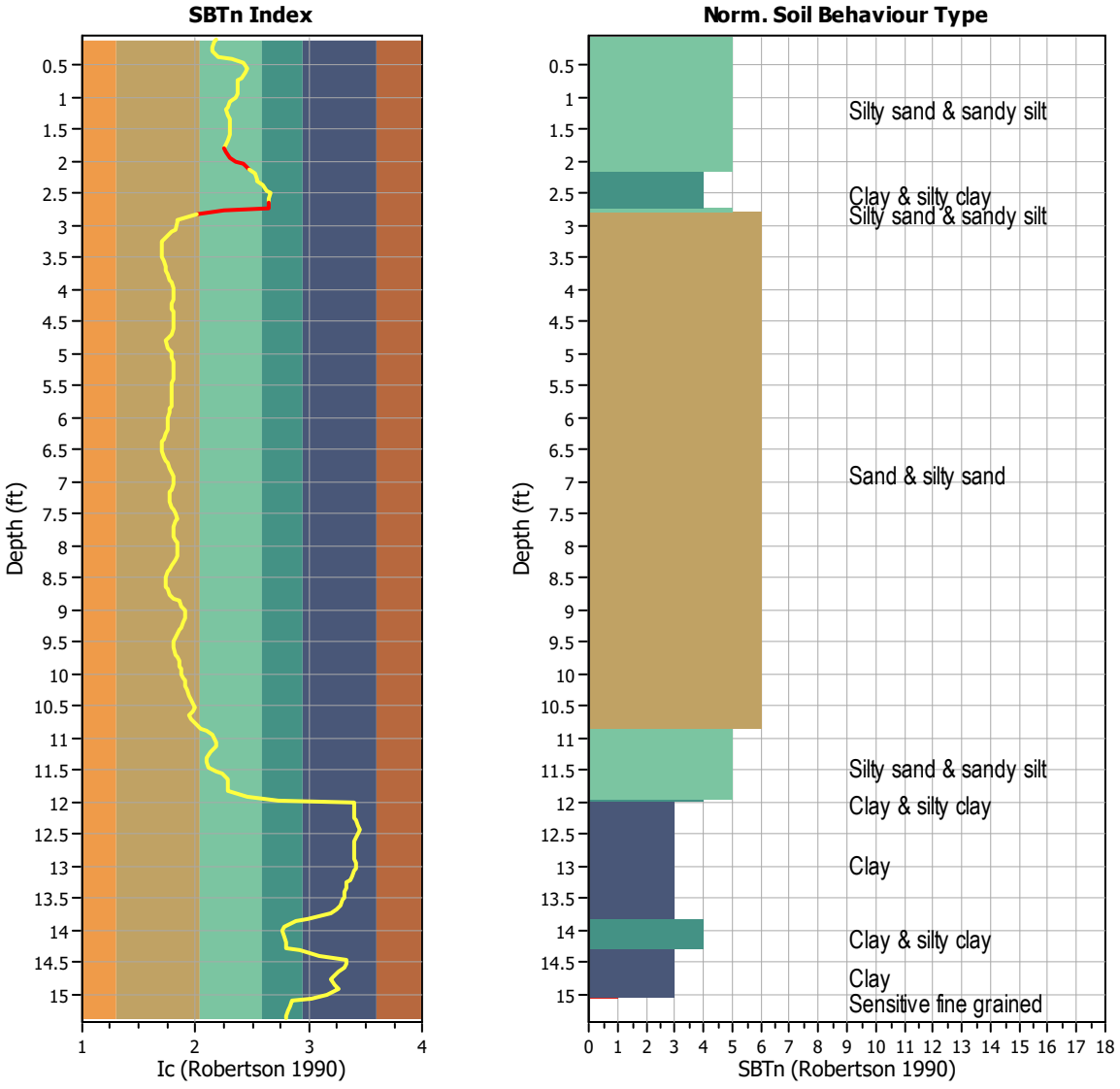
Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	1.50 ft	Limit depth:	60.00 ft

TRANSITION LAYER DETECTION ALGORITHM REPORT
Summary Details & Plots

Short description

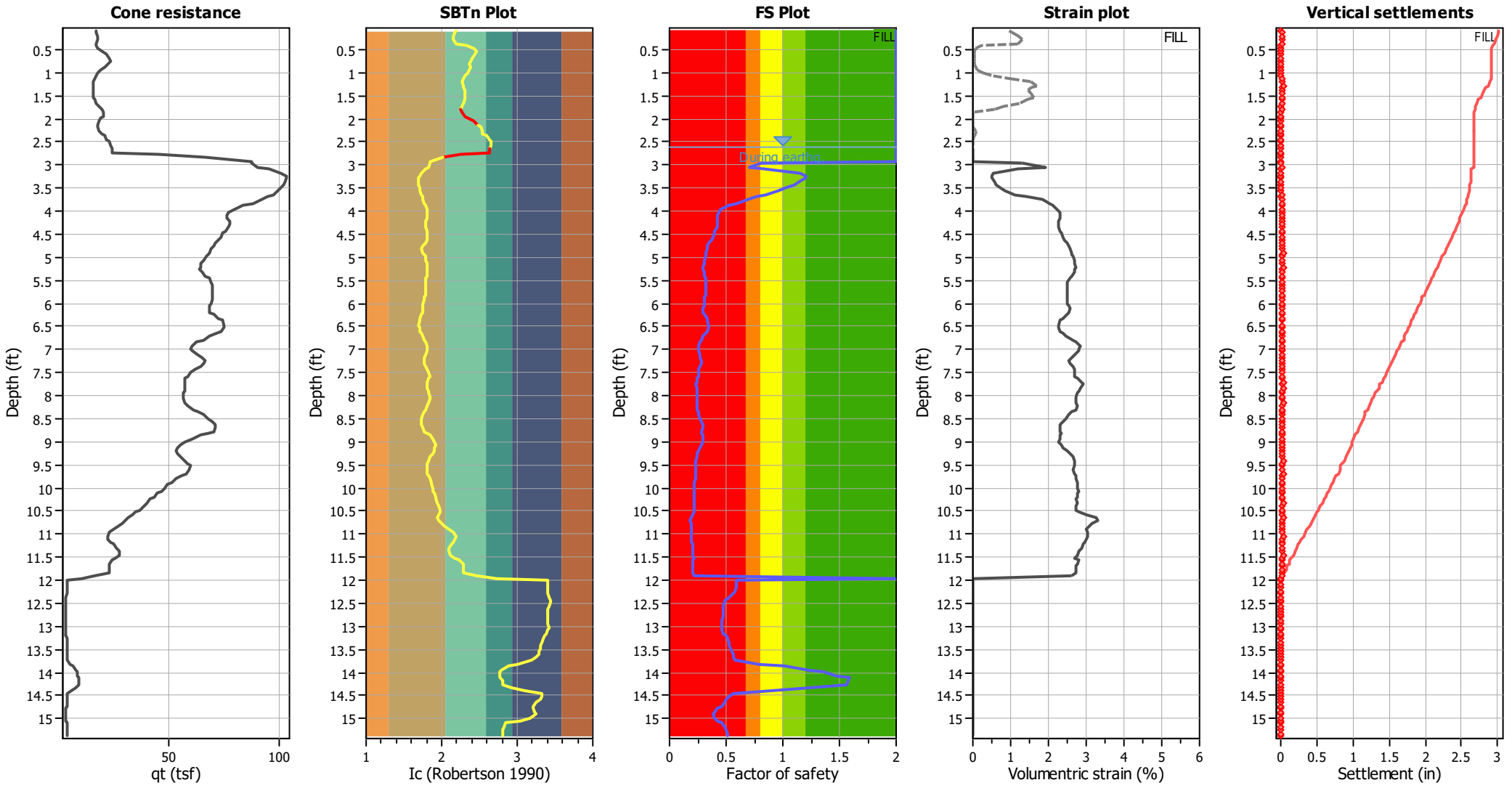
The software will delete data when the cone is in transition from either clay to sand or vise-versa. To do this the software requires a range of I_c values over which the transition will be defined (typically somewhere between $1.80 < I_c < 3.0$) and a rate of change of I_c. Transitions typically occur 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		General statistics	
I_c minimum check value:	1.70	Total points in CPT file:	234
I_c maximum check value:	3.00	Total points excluded:	10
I_c change ratio value:	0.0250	Exclusion percentage:	4.27%
Minimum number of points in layer:	4	Number of layers detected:	2

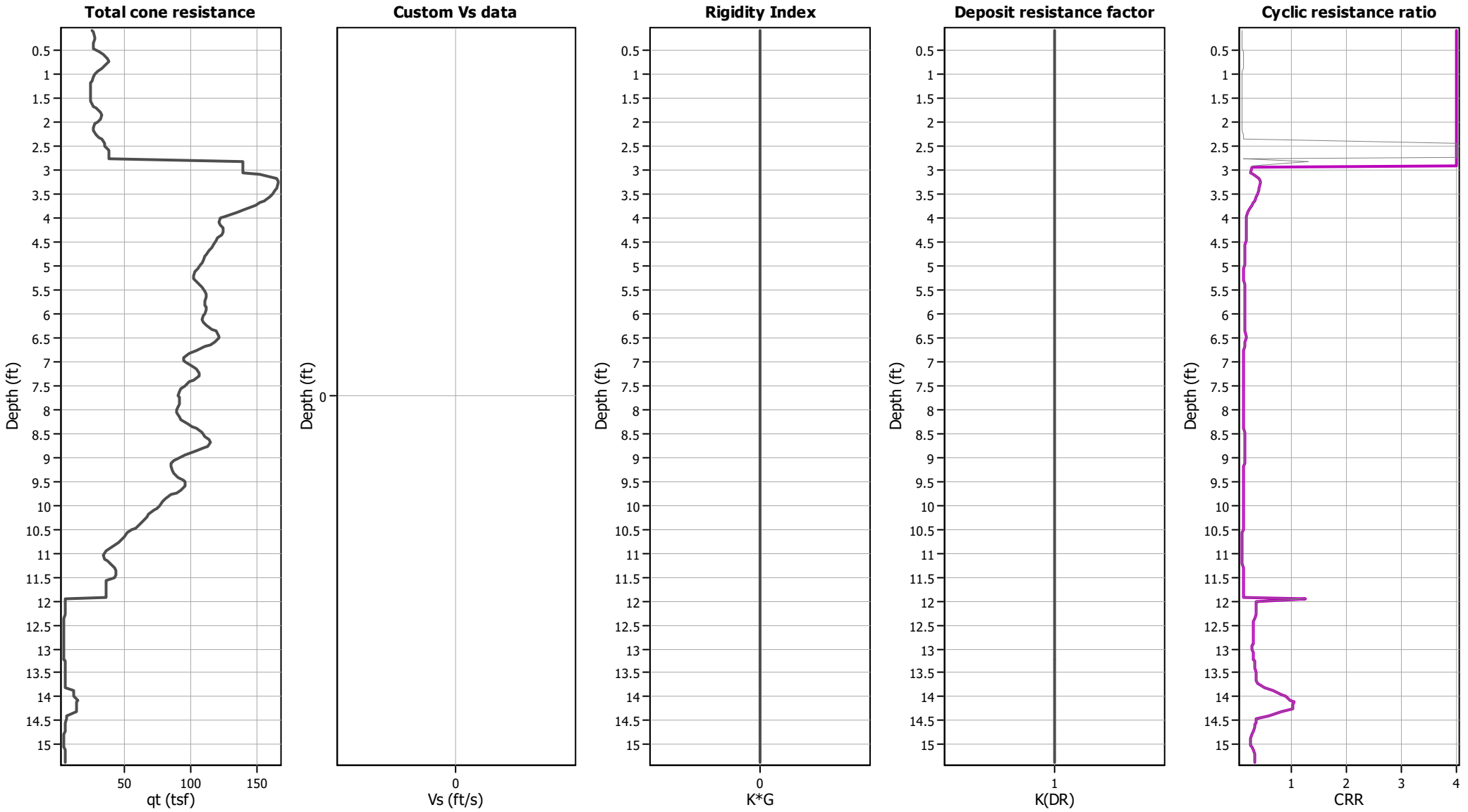
Estimation of post-earthquake settlements



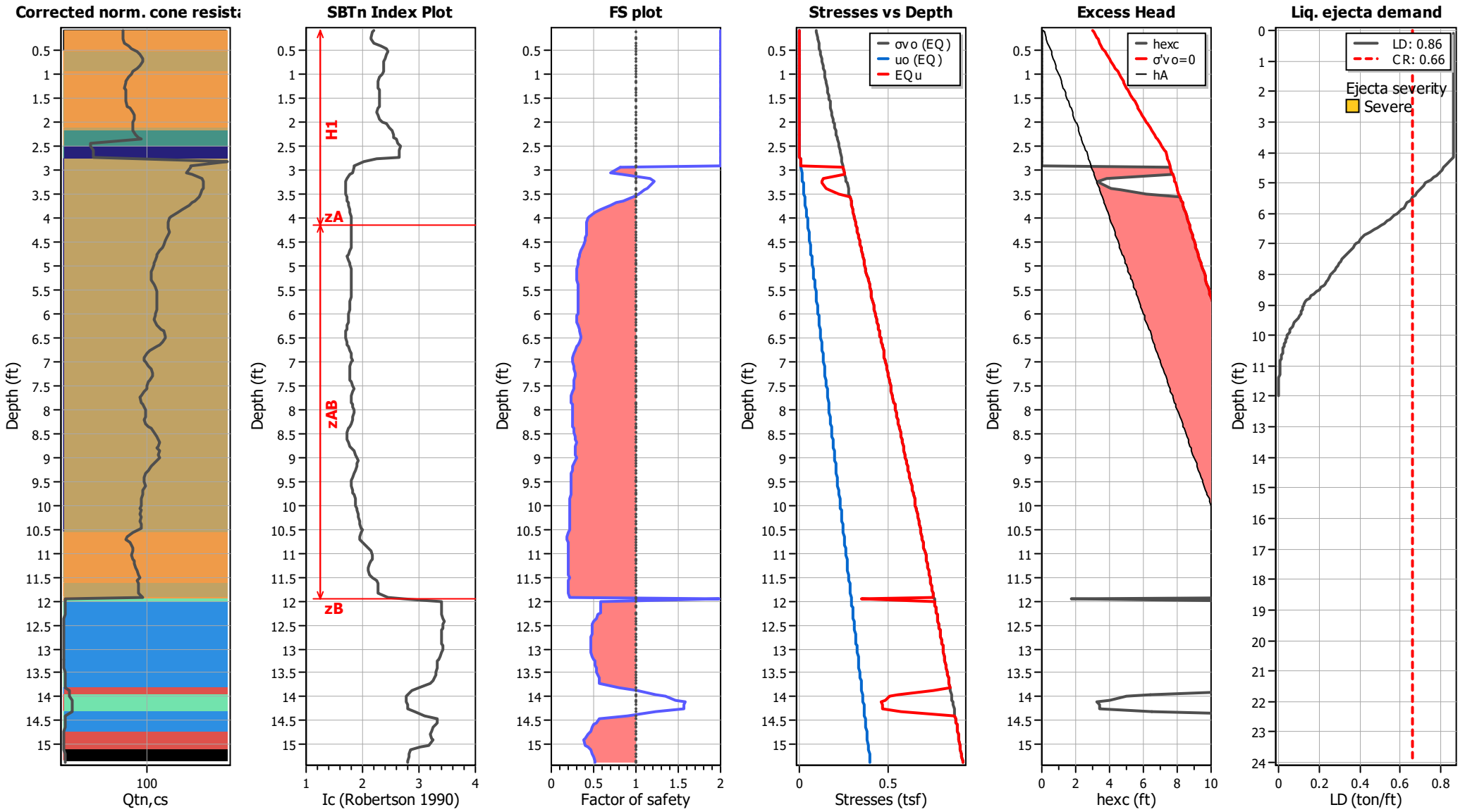
Abbreviations

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

Aging Calculation Estimation



Ejecta Severity Estimation



LIQUEFACTION ANALYSIS REPORT

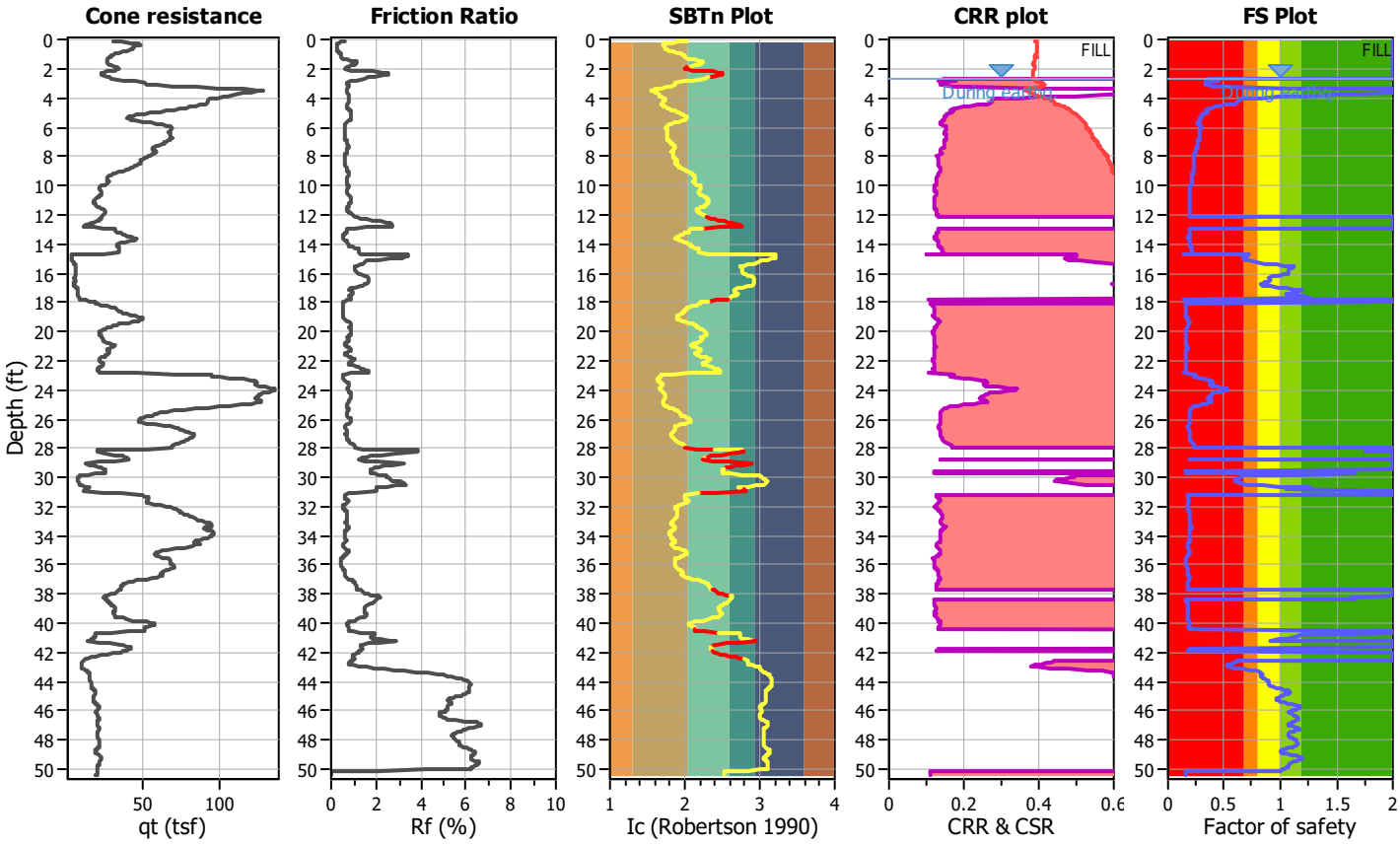
Project title : Topgolf Harbor Island

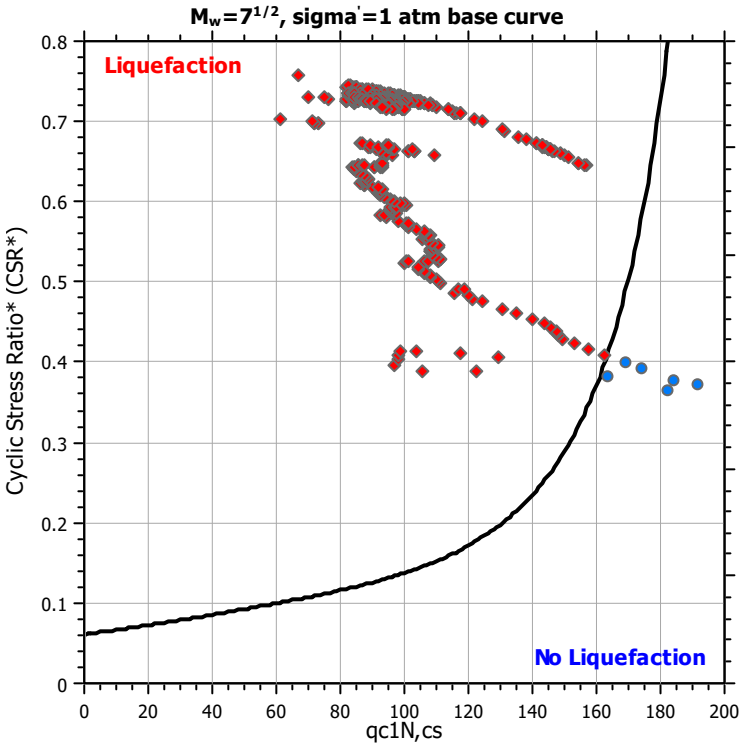
Location : North Harbor Drive and Liberator Way, San Diego, CA

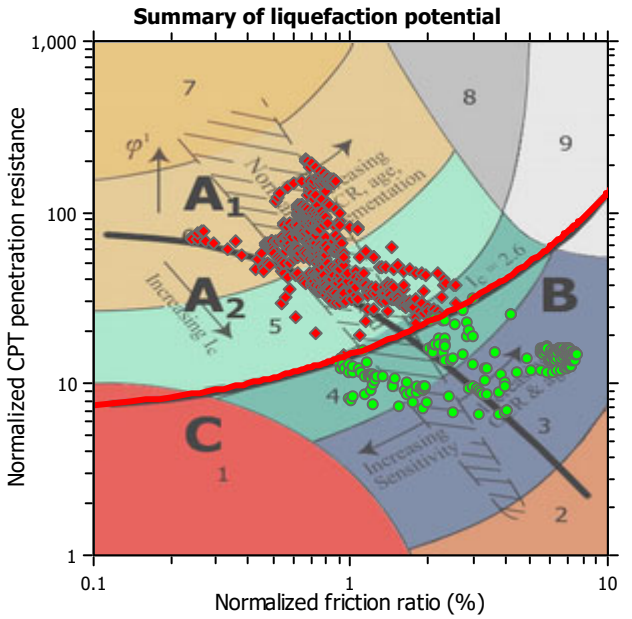
CPT file : CPT-50 (Thin Layer Correction)

Input parameters and analysis data

Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.62 ft	Use fill:	Yes	Clay like behavior applied:	Sand & Clay
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.12 ft	Fill height:	0.50 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:	6.89	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method
Peak ground acceleration:	0.69	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

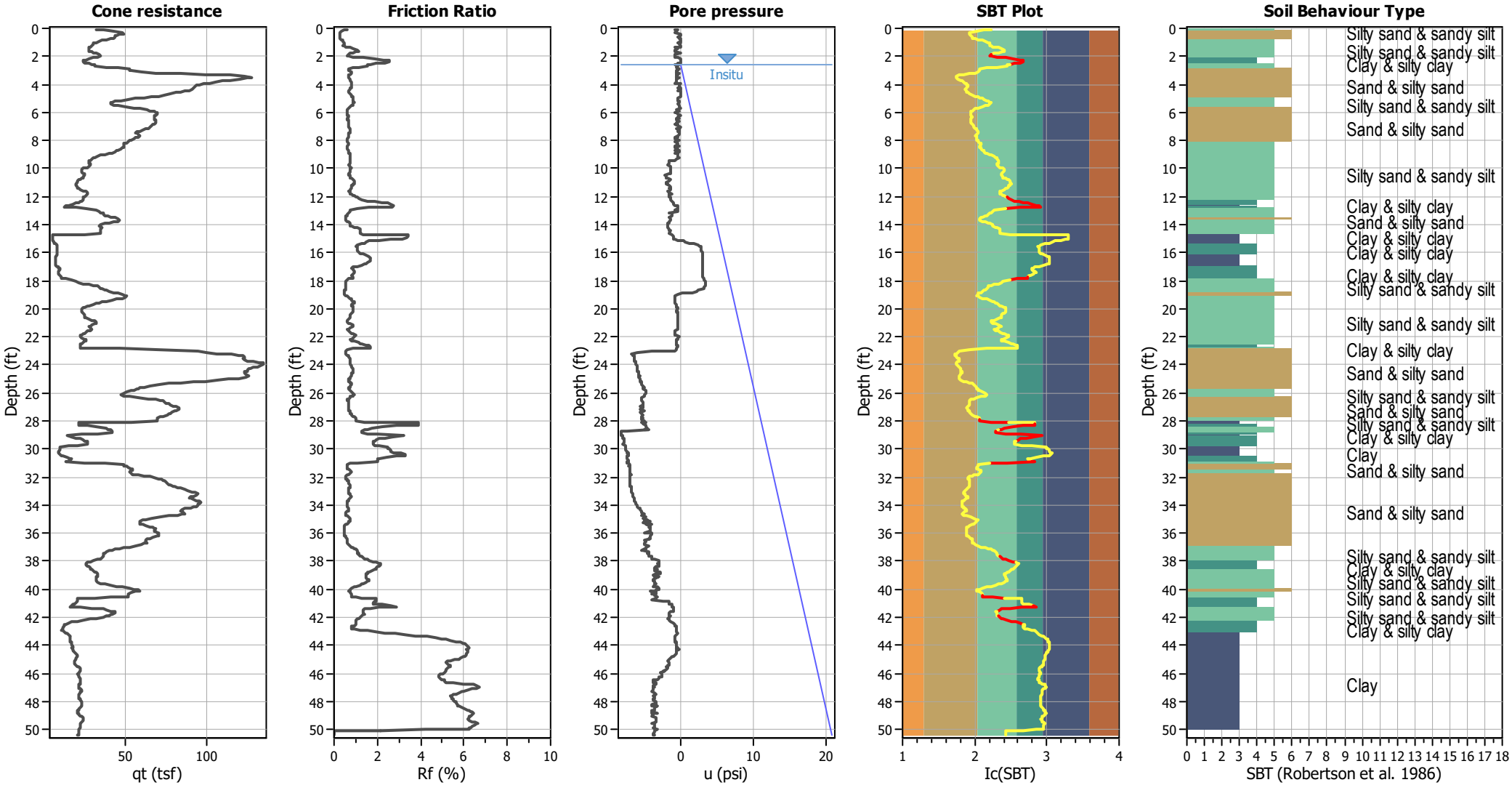






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



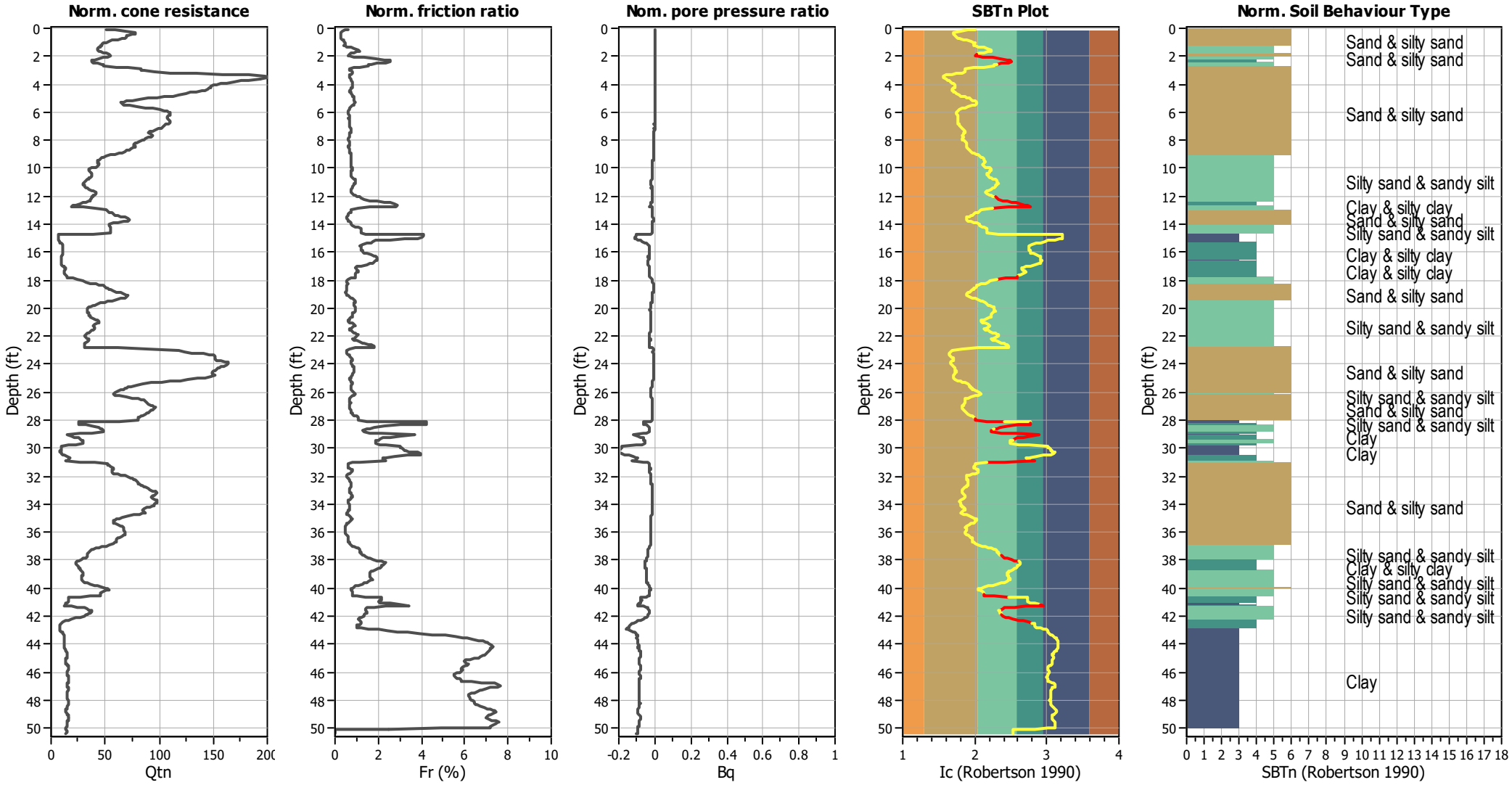
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	0.50 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:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

SBTn legend

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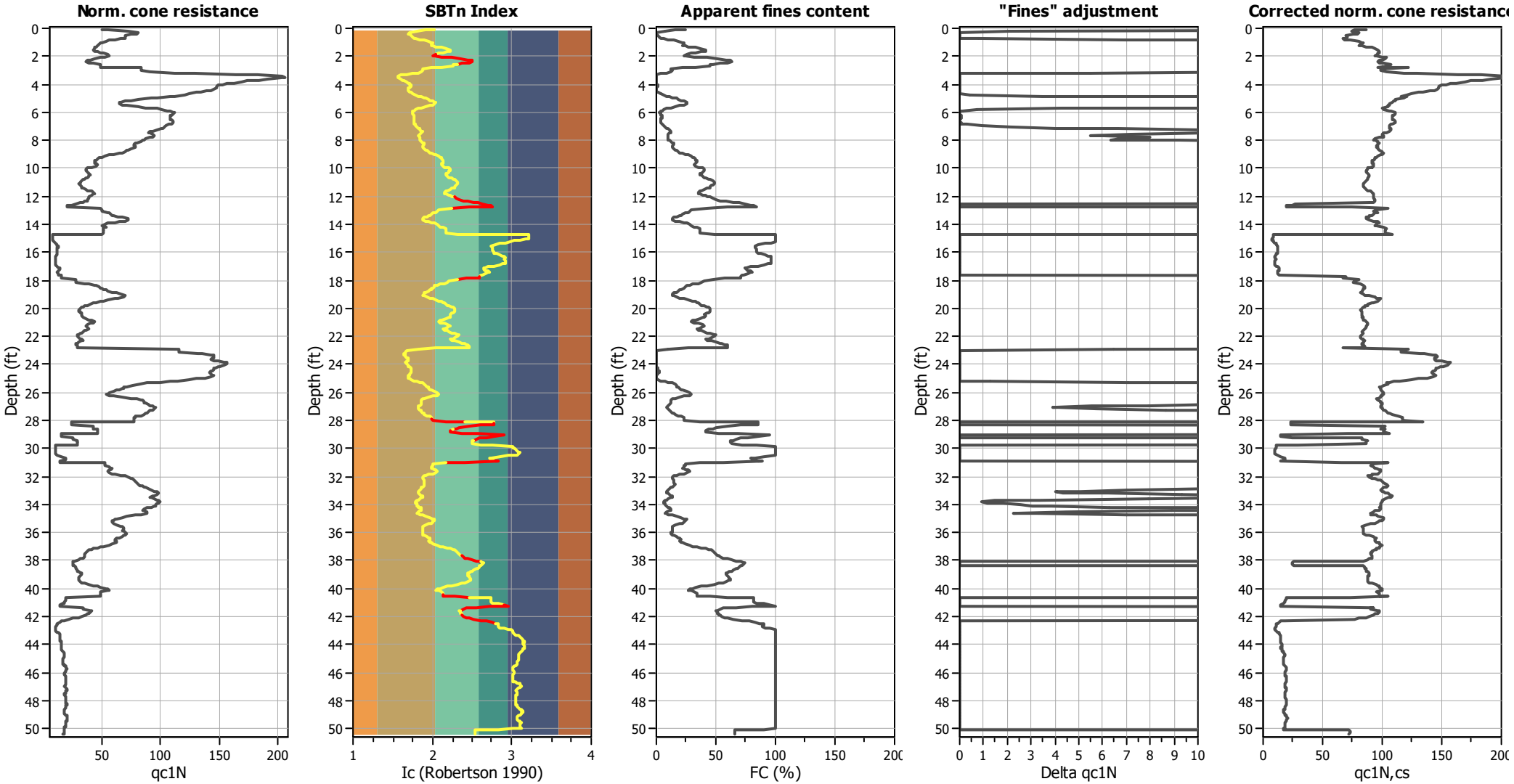
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	120.00 lb/ft^3
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.89	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
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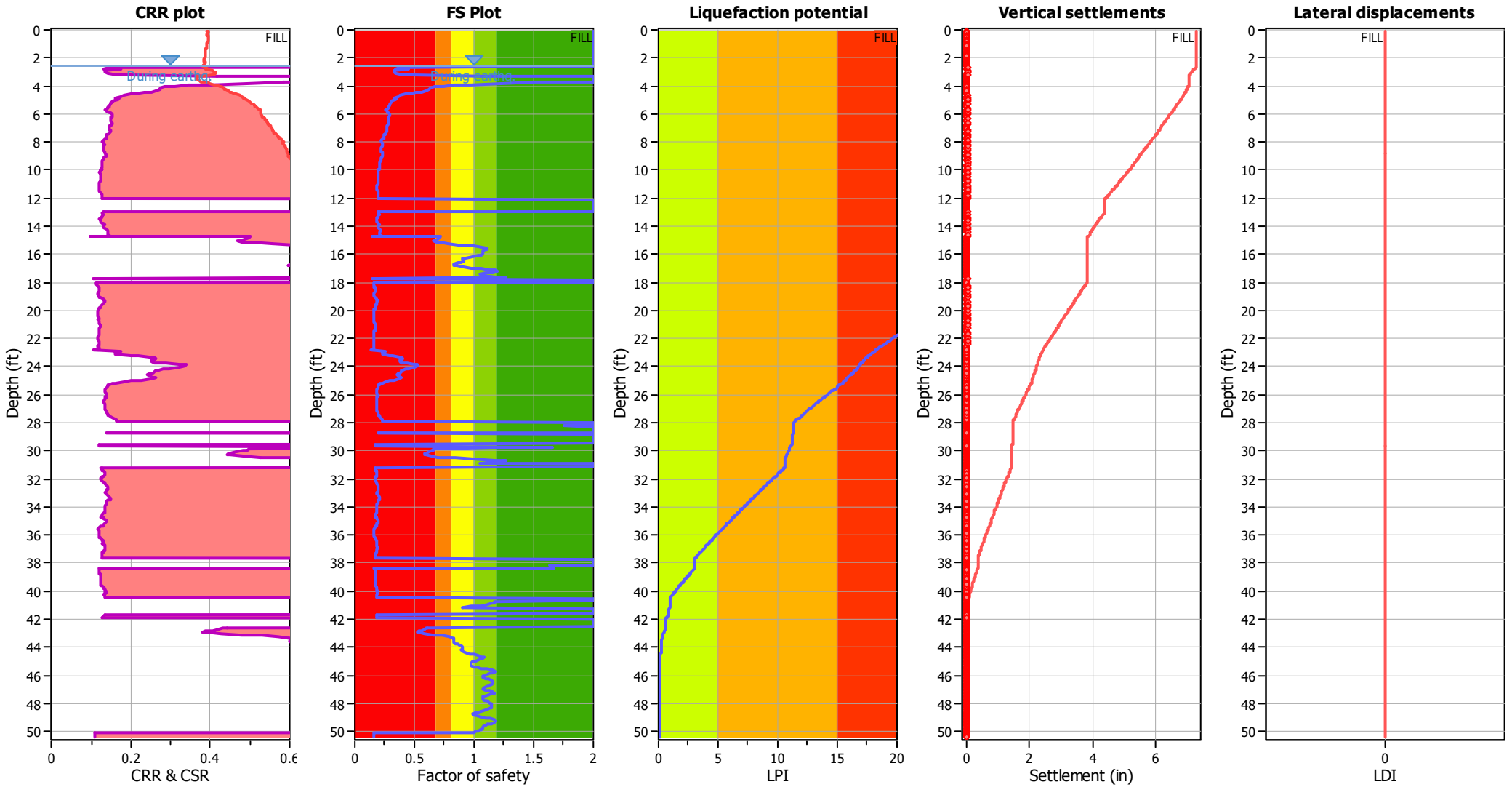
Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	120.00 lb/ft³
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Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
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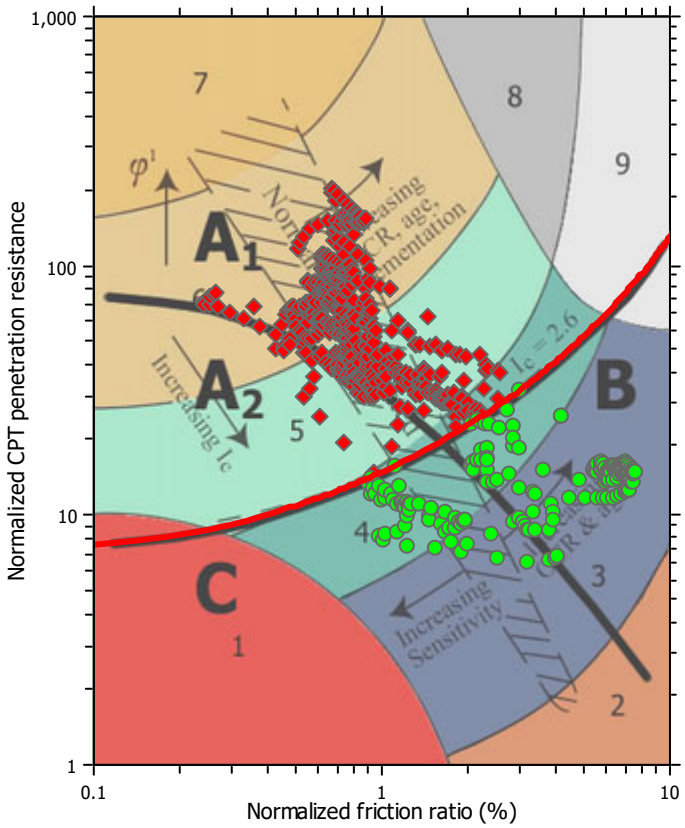
F.S. color scheme

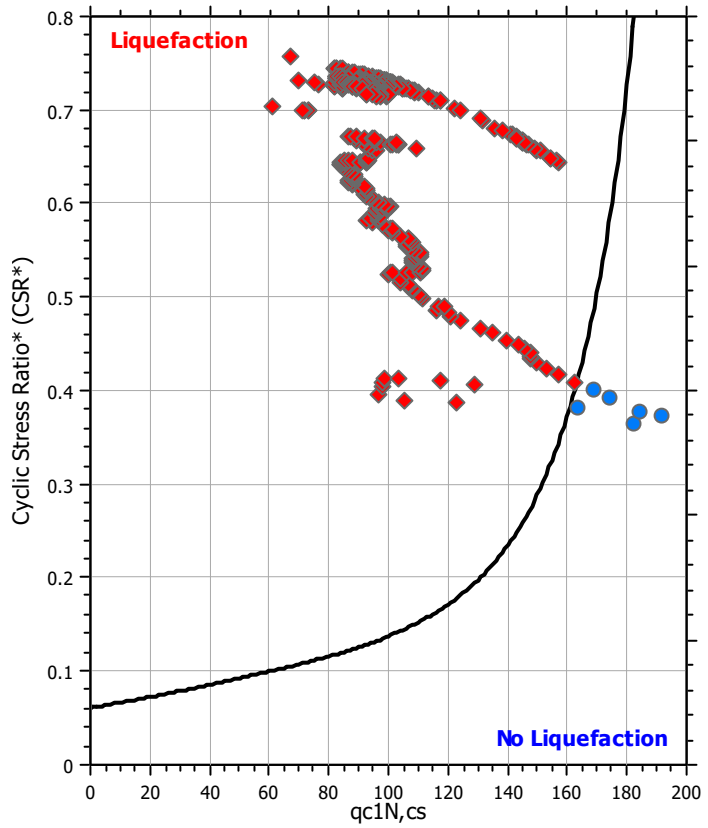
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

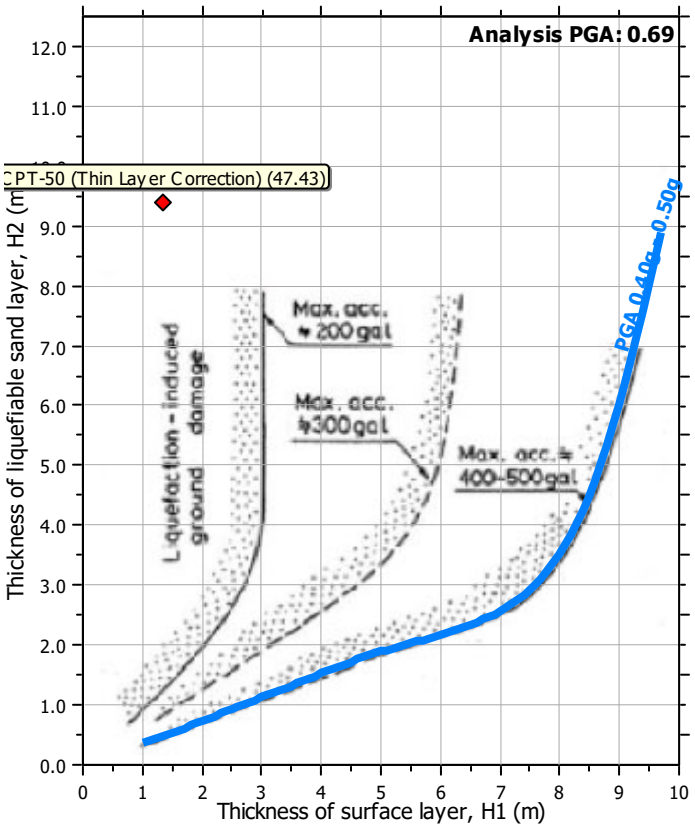
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots







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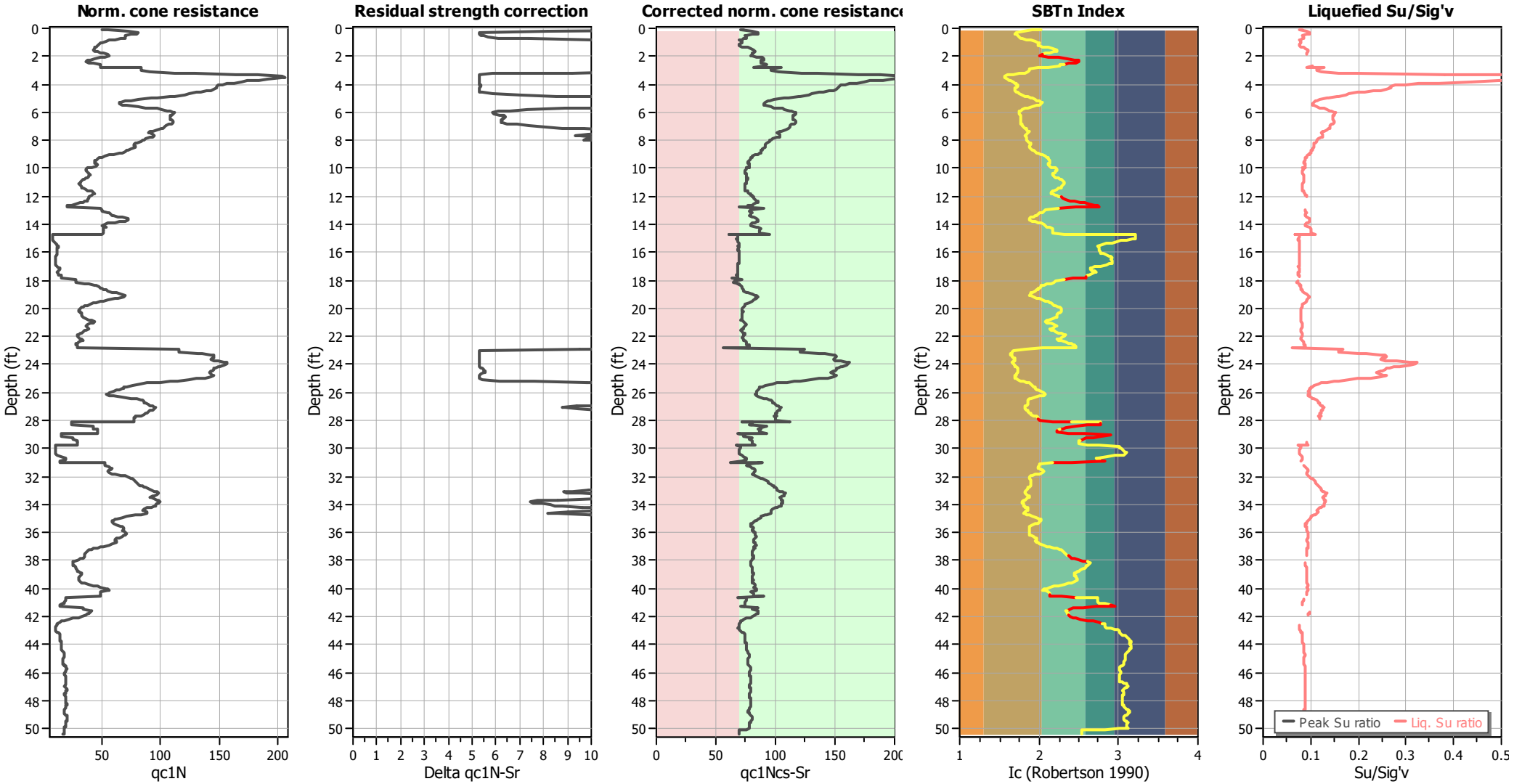
Peak ground acceleration:	0.69	Use fill:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	2.62 ft	Fill height:	0.50 ft	Limit depth:	60.00 ft

Check for strength loss plots (Idriss & Boulanger (2008))



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.12 ft	Fill weight:	120.00 lb/ft³
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	Yes
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Depth to water table (insitu):	2.62 ft	Fill height:	0.50 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).

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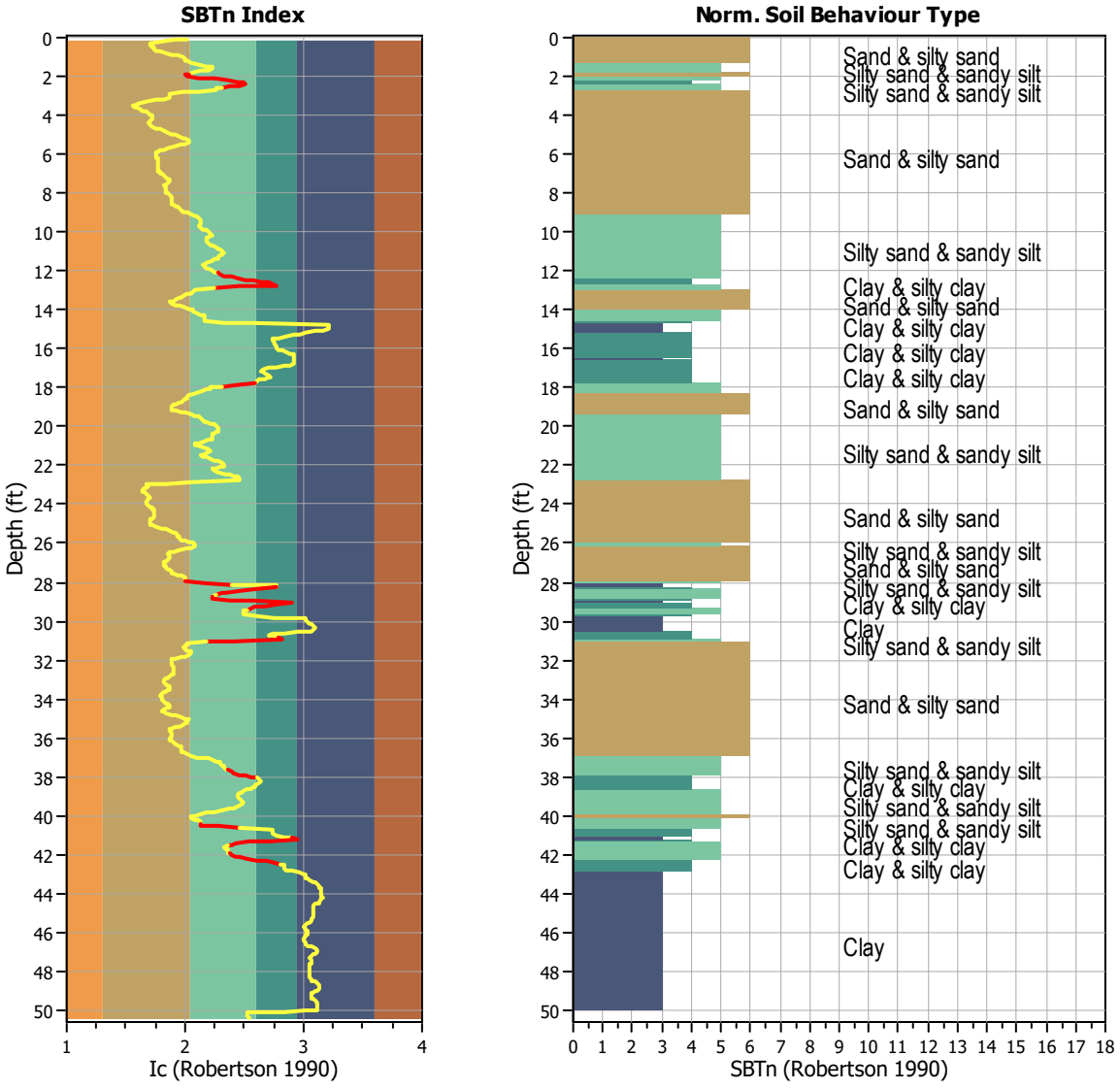
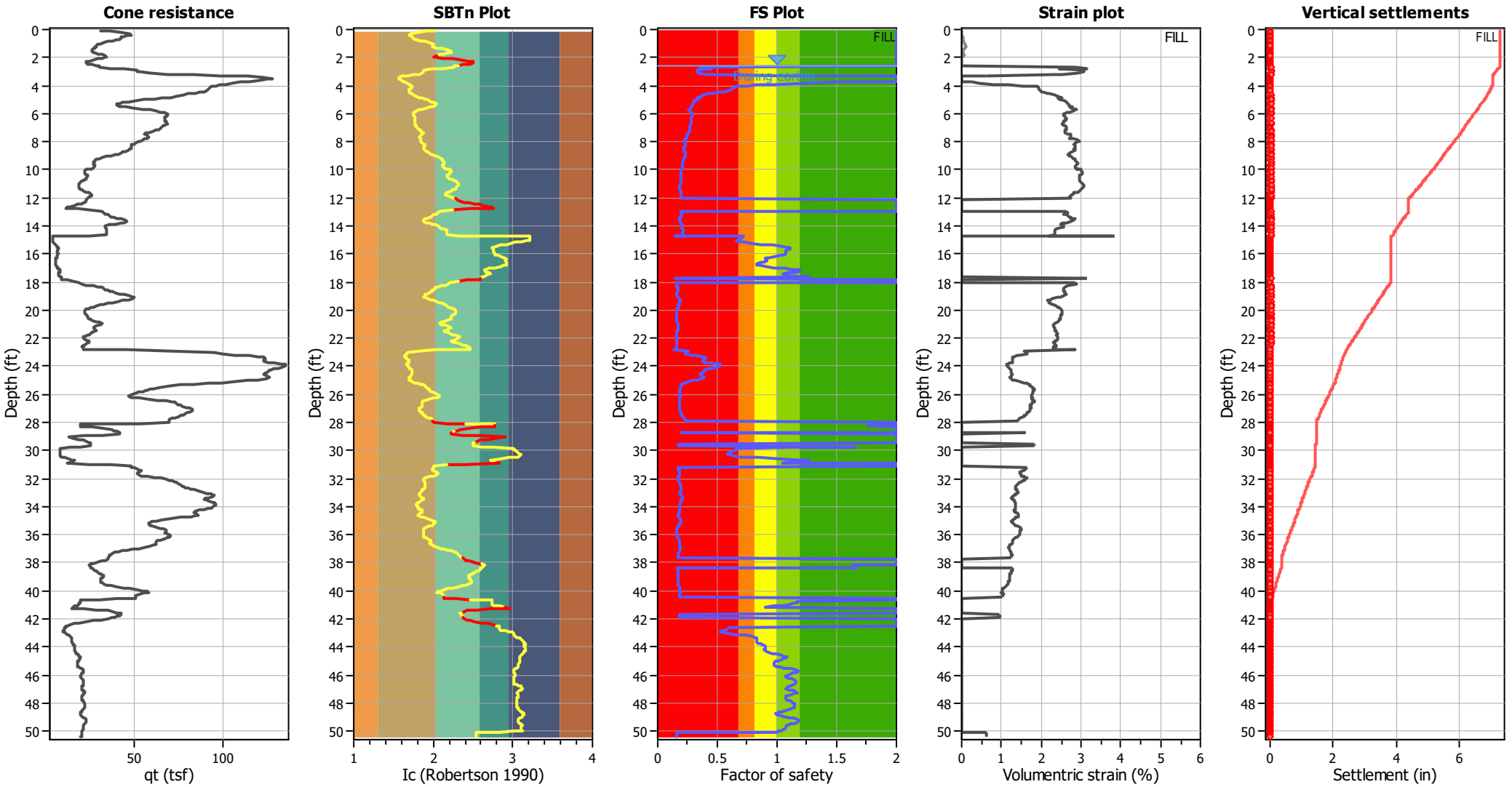


Transition layer algorithm properties	
I_c minimum check value:	1.70
I_c maximum check value:	3.00
I_c change ratio value:	0.0250
Minimum number of points in layer:	4

General statistics	
Total points in CPT file:	767
Total points excluded:	83
Exclusion percentage:	10.82%
Number of layers detected:	14

Estimation of post-earthquake settlements



Abbreviations

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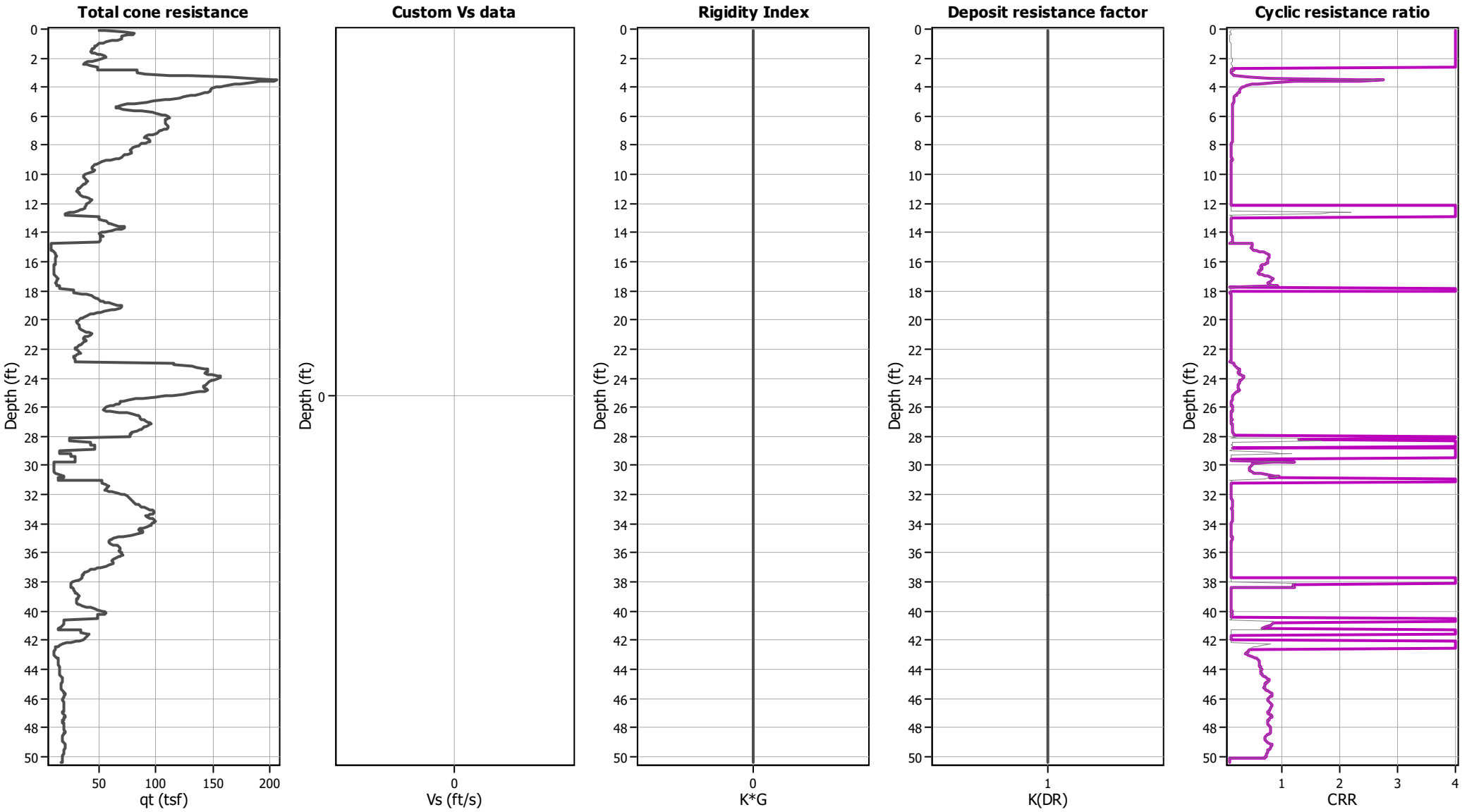
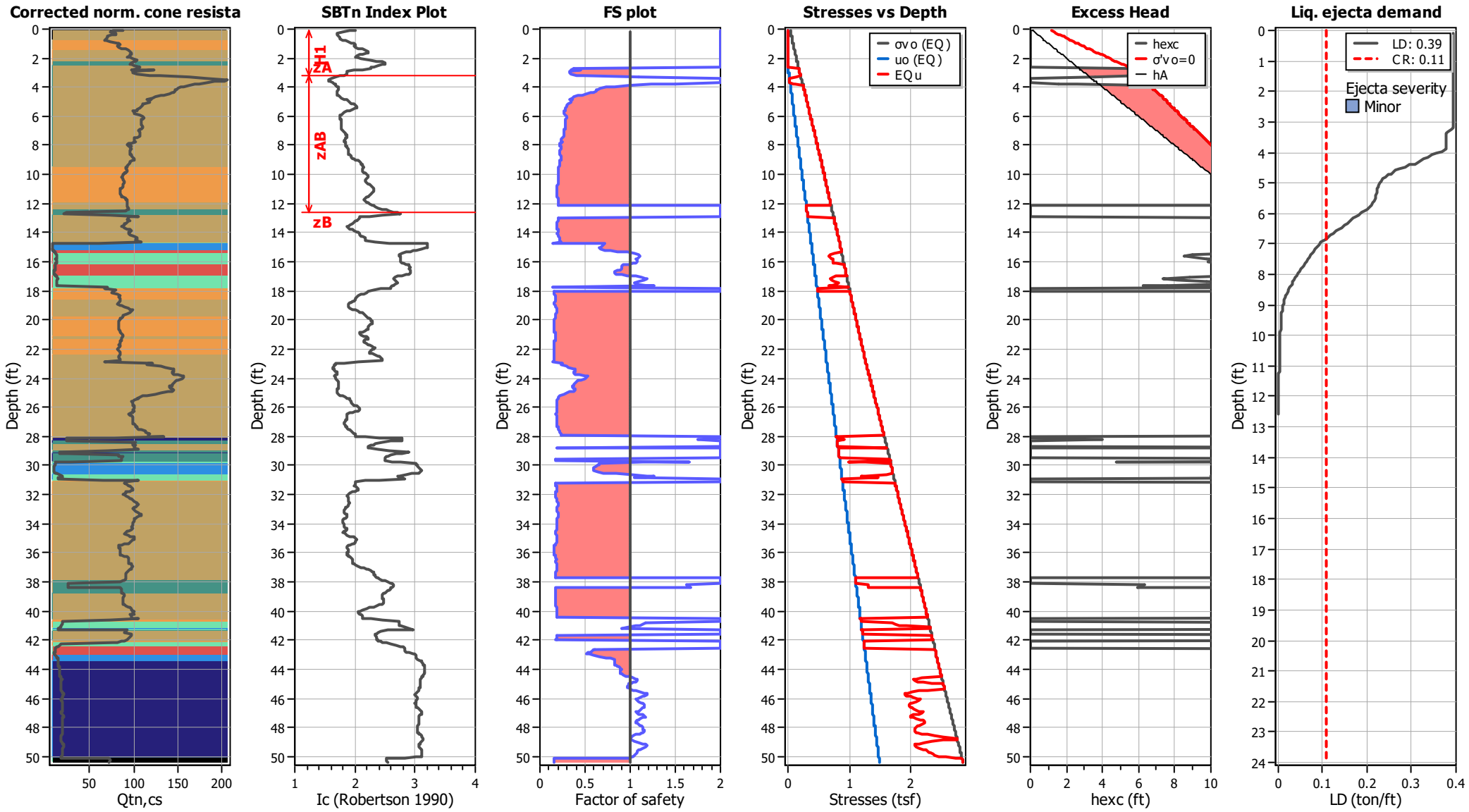
I_c:	Soil Behaviour Type Index
FS:	Calculated Factor of Safety against liquefaction
Volumentric strain:	Post-liquefaction volumentric strain

Aging Calculation Estimation

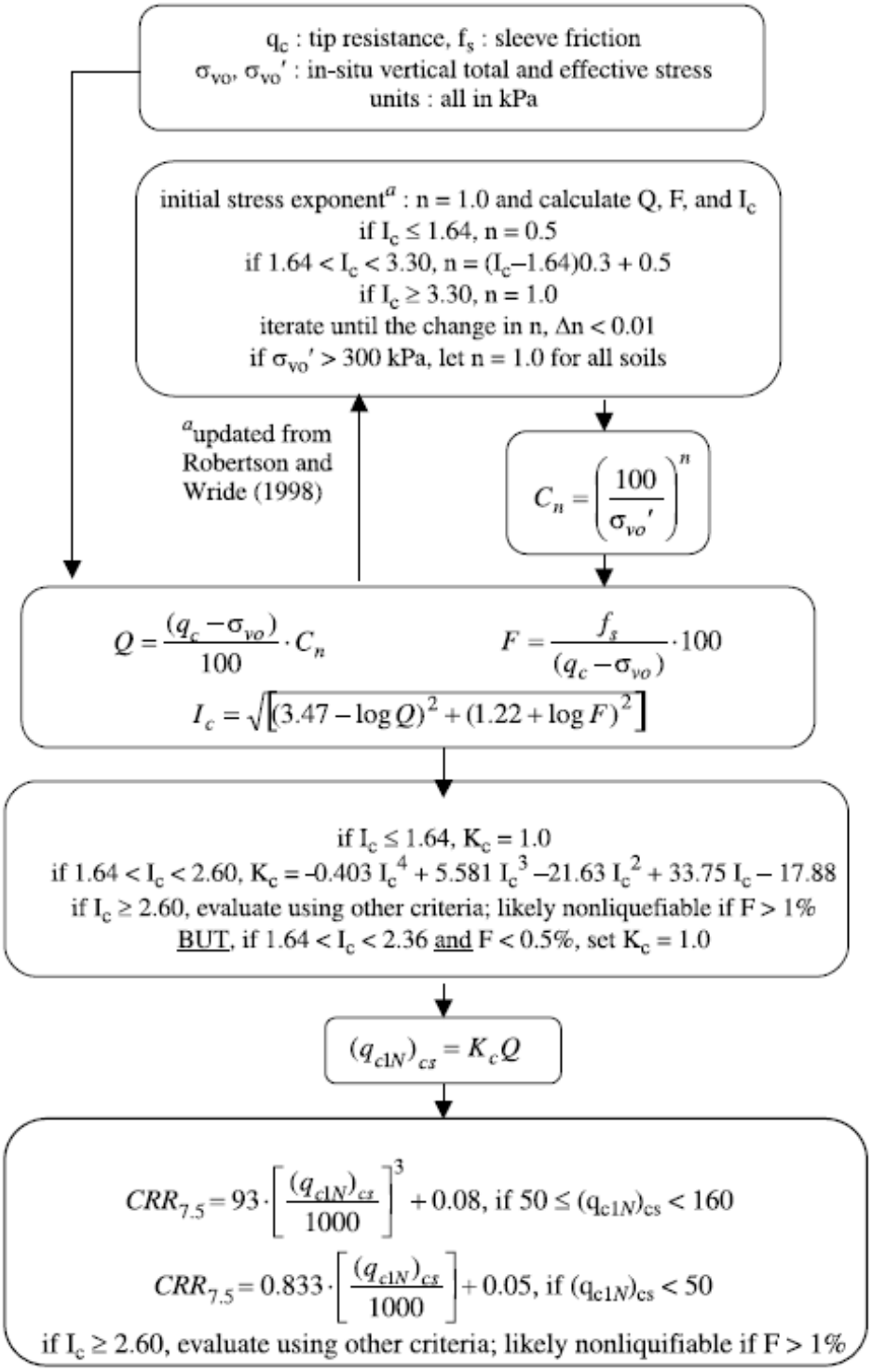


Ejecta Severity Estimation



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

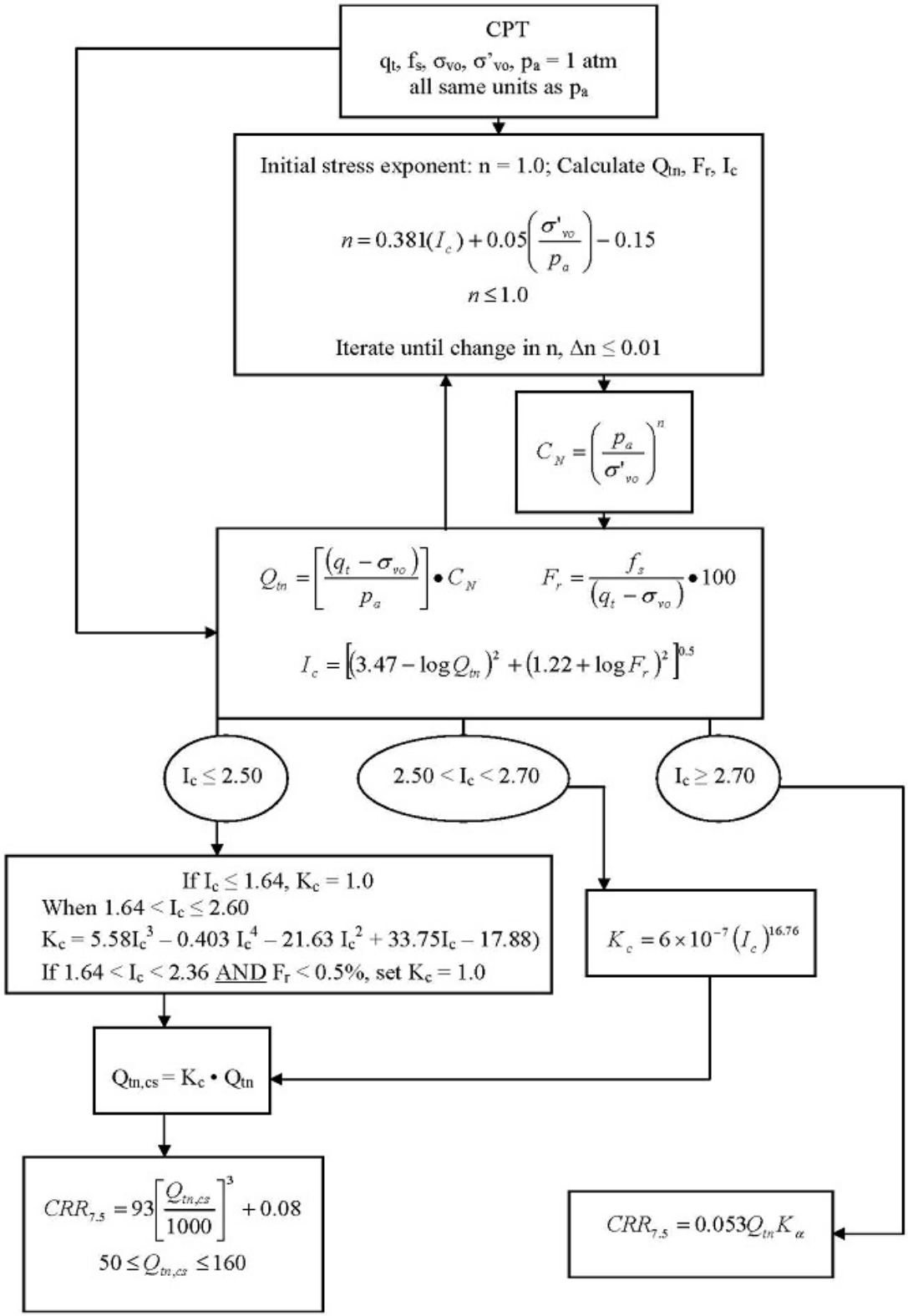
Calculation of soil resistance against liquefaction is performed according to the Robertson & Wride (1998) procedure. The procedure used in the software, slightly differs from the one originally published in NCEER-97-0022 (Proceedings of the NCEER Workshop on Evaluation of Liquefaction Resistance of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



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

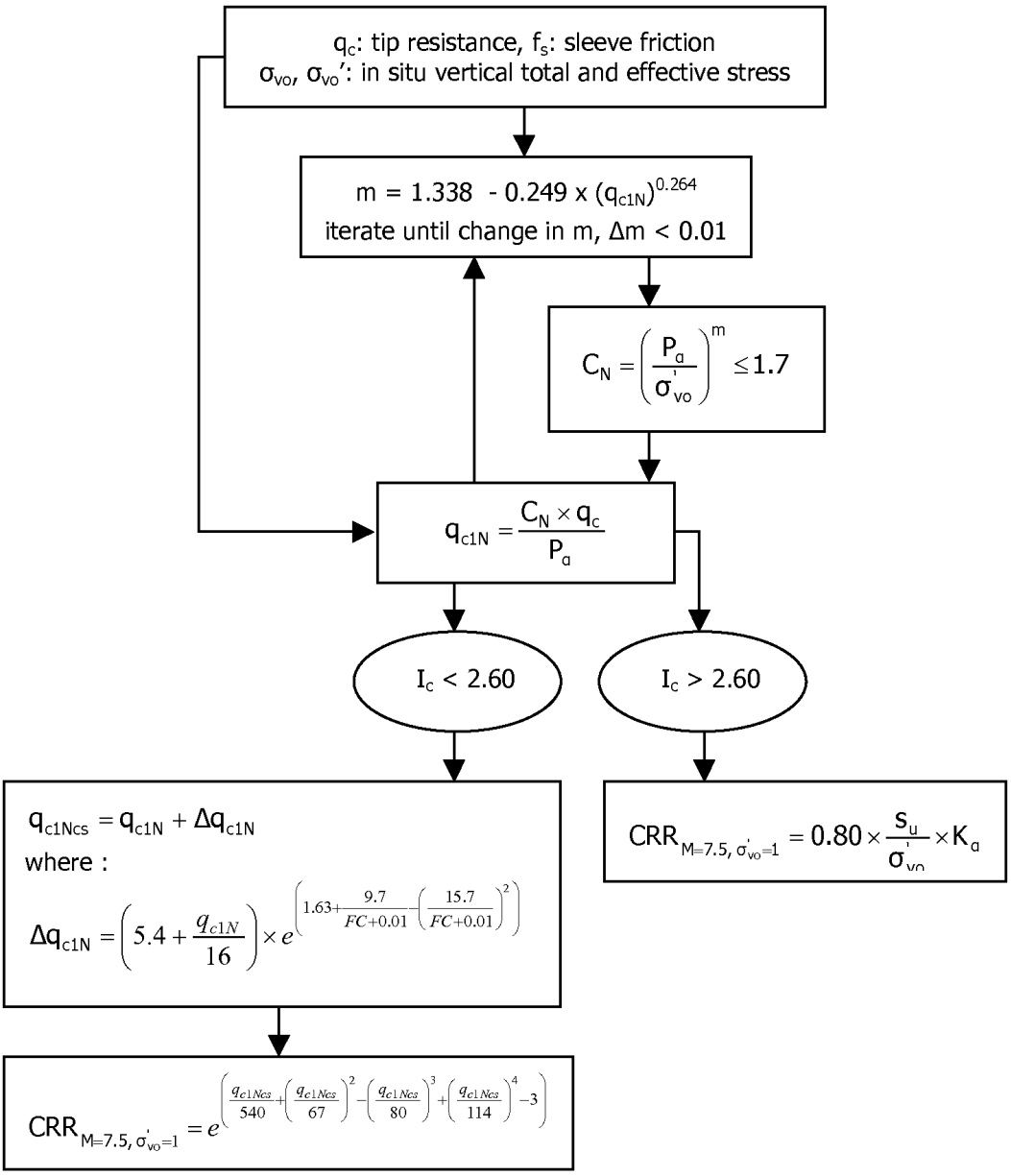
Procedure for the evaluation of soil liquefaction resistance (all soils), Robertson (2010)

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

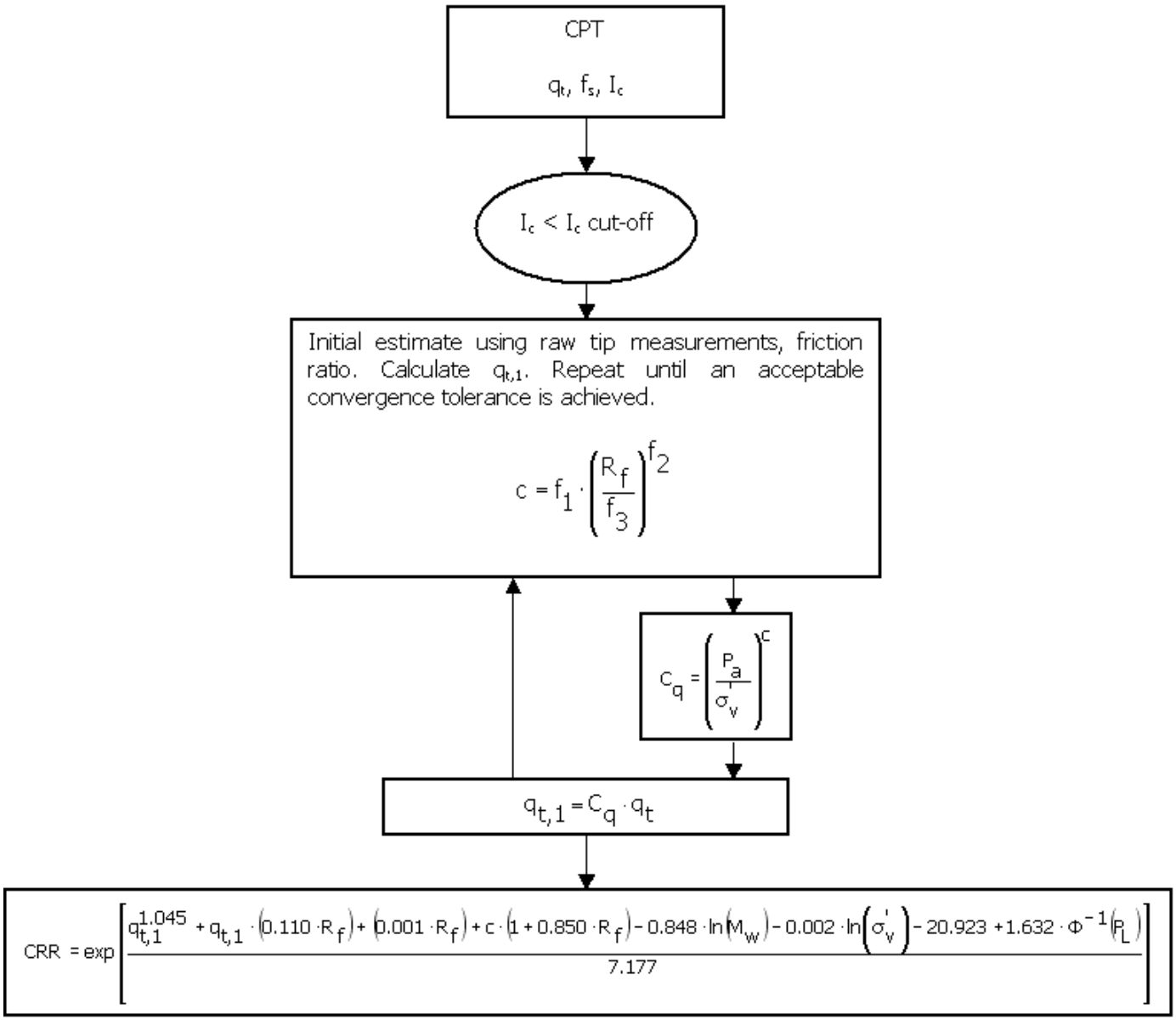


[1] P.K. Robertson, 2009. "Performance based earthquake design using the CPT", Keynote Lecture, International Conference on Performance-based Design in Earthquake Geotechnical Engineering – from case history to practice, IS-Tokyo, June 2009

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



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



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

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

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

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

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

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

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

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

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

$$MSF_{max} = 1.09 + \left(\frac{q_{C1Ncs}}{180}\right)^3 \le 2.2$$

σ'_v *and* σ_v *at start of earthquake shaking*

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

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

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

$$q_{c1N} = C_{Ne} \frac{q_c}{P_a}$$

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

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

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

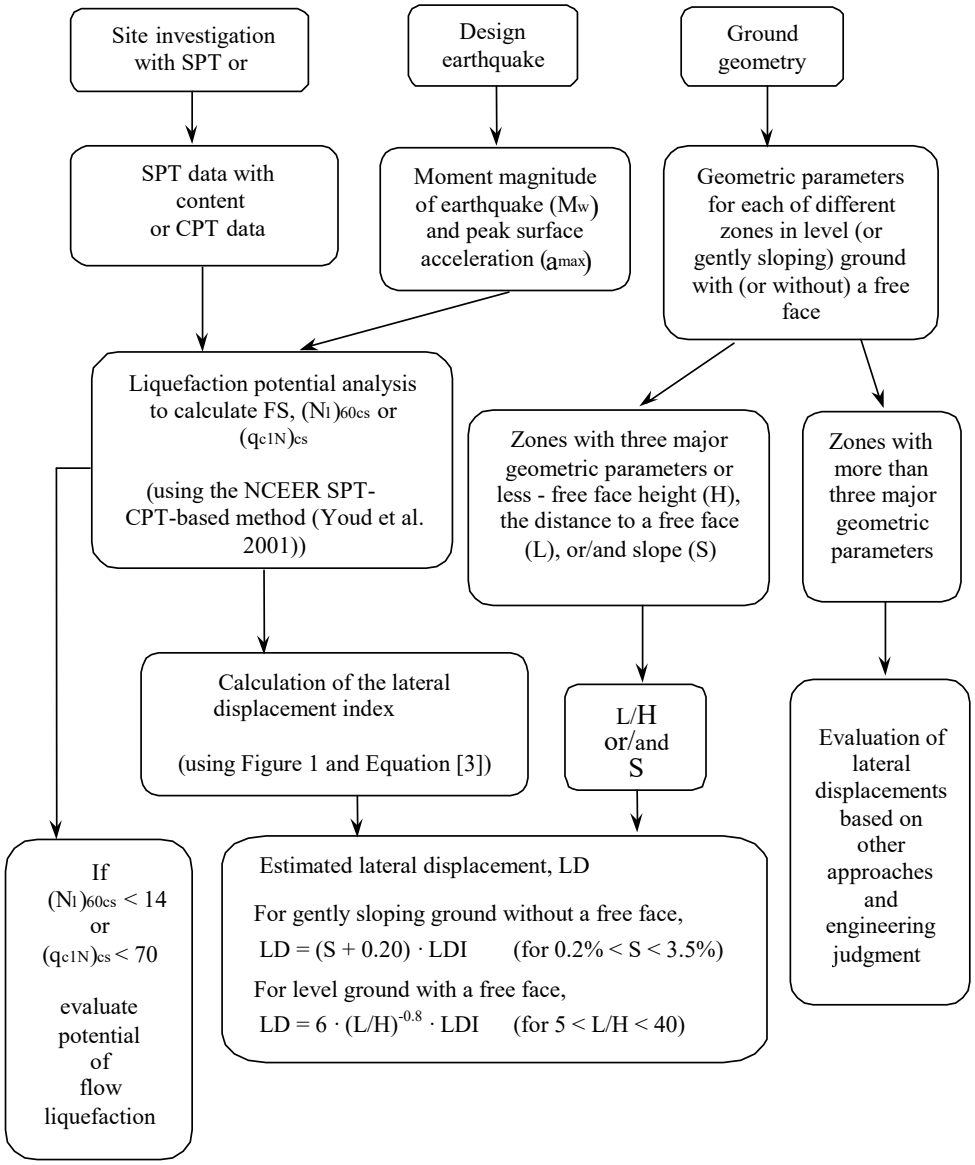
$$I_c = \left[\left(3.47 - \log\left(Q\right)\right)^2 + \left(1.22 + \log\left(F\right)\right)^2\right]^{0.5}$$

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

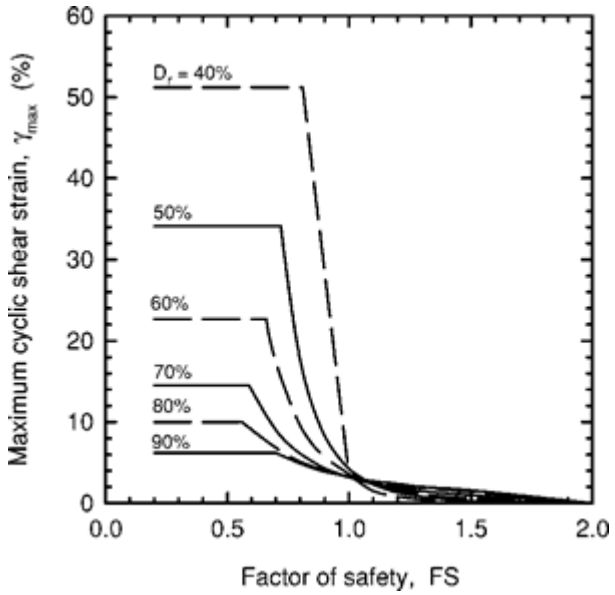
$$F = \left(\frac{f_s}{q_c - \sigma_{vc}}\right) \cdot 100\%$$

σ'_v *at time of CPT sounding*

Procedure for the evaluation of liquefaction-induced lateral spreading displacements



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



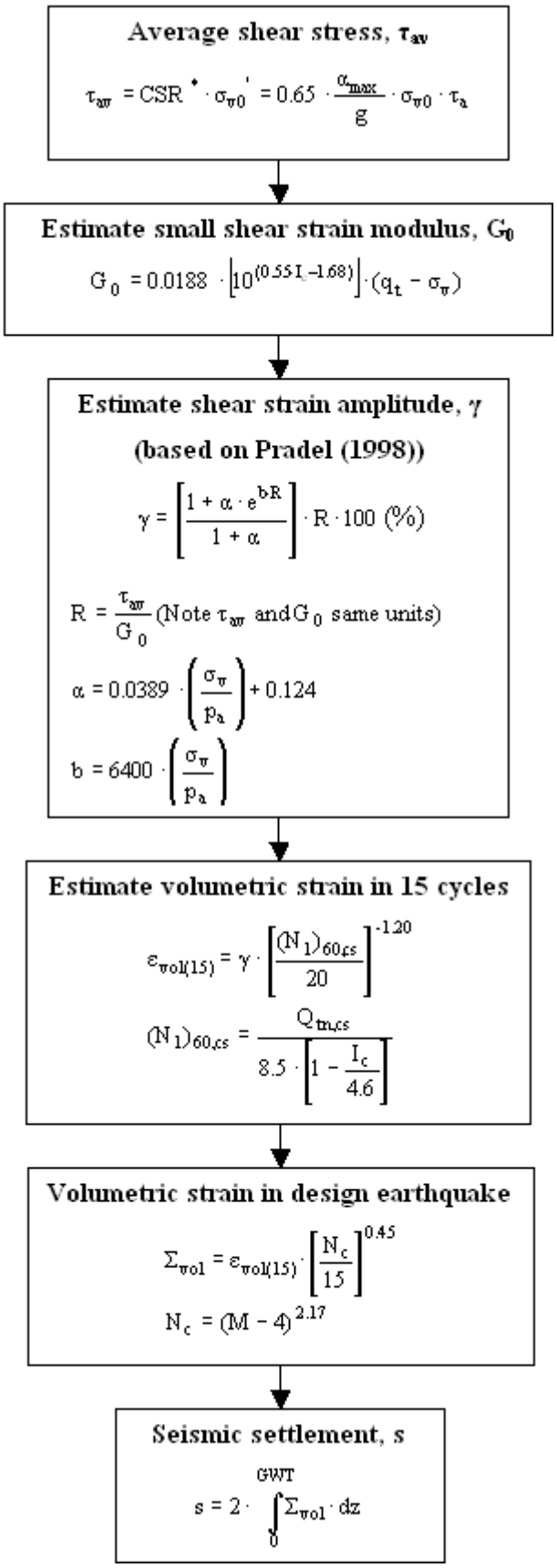
[1] Figure 1

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

[1] Equation [3]

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

Procedure for the estimation of seismic induced settlements in dry sands



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.

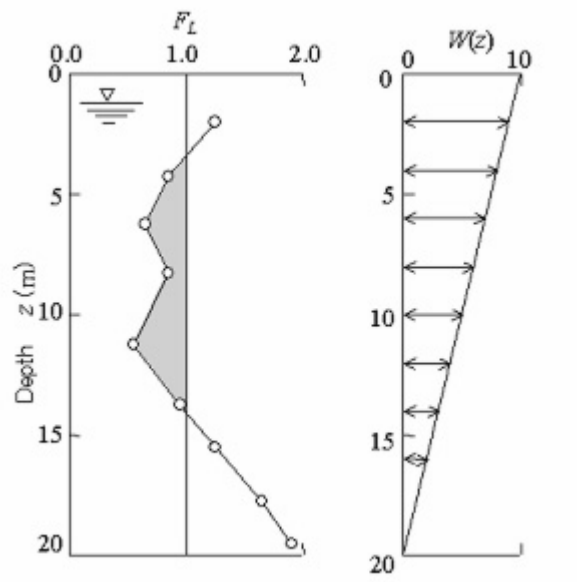
To estimate the severity of liquefaction extent at a given site, LPI is calculated based on the following equation:

$$\mathbf{LPI} = \int_0^{20} (10 - 0{,}5z) \times F_L \times dz$$

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

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

- LPI = 0 : Liquefaction risk is very low
- 0 < LPI <= 5 : Liquefaction risk is low
- 5 < LPI <= 15 : Liquefaction risk is high
- LPI > 15 : Liquefaction risk is very high



Graphical presentation of the LPI calculation procedure

Shear-Induced Building Settlement (Ds) calculation procedure

The shear-induced building settlement (Ds) due to liquefaction below the building can be estimated using the relationship developed by Bray and Macedo (2017):

$$Ln(Ds) = c1 + c2 * LBS + 0.58 * Ln\left(Tanh\left(\frac{HL}{6}\right)\right) + 4.59 * Ln(Q) - 0.42 * Ln(Q)^2 - 0.02 * B + 0.84 * Ln(CAVdp) + 0.41 * Ln(Sa1) + \varepsilon$$

where Ds is in the units of mm, c1= -8.35 and c2= 0.072 for LBS ≤ 16, and c1= -7.48 and c2= 0.014 otherwise. Q is the building contact pressure in units of kPa, HL is the cumulative thickness of the liquefiable layers in the units of m, B is the building width in the units of m, CAVdp is a standardized version of the cumulative absolute velocity in the units of g-s, Sa1 is 5%-damped pseudo-acceleration response spectral value at a period of 1 s in the units of g, and ε is a normal random variable with zero mean and 0.50 standard deviation in Ln units. The liquefaction-induced building settlement index (LBS) is:

$$LBS = \sum W * \frac{\varepsilon_{shear}}{z} dz$$

where z (m) is the depth measured from the ground surface > 0, W is a foundation-weighting factor wherein W = 0.0 for z less than Df, which is the embedment depth of the foundation, and W = 1.0 otherwise. The shear strain parameter (ε_shear) is the liquefaction-induced free-field shear strain (in %) estimated using Zhang et al. (2004). It is calculated based on the estimated Dr of the liquefied soil layer and the calculated safety factor against liquefaction triggering (FSL).

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APPENDIX D
LABORATORY TESTING

Laboratory tests were performed in accordance with the generally accepted American Society for Testing and Materials (ASTM) test methods or suggested procedures. Brief descriptions of the tests performed are presented below:

- **CLASSIFICATION:** *Field classifications were verified in the laboratory by visual examination. The final soil classifications are in accordance with the Unified Soils Classification System and are presented on the exploration logs in Appendix B.*

- **PARTICLE-SIZE DISTRIBUTION (GRADATION) OF SOILS (ASTM D6913):** *The gradation of representative soil samples were evaluated in general accordance with ASTM D6913.*

- **ATTERBERG LIMITS (ASTM D4318):** *The liquid limit, plastic limit, and plasticity index of soils were determined in general accordance with ASTM D4318. These test results were utilized to evaluate the soil classification in accordance with the Unified Soil Classification System.*

- **EXPANSION INDEX (ASTM D4829):** *The expansion index of selected materials were evaluated in general accordance with ASTM D4829. The specimens were molded under a specified compactive energy at approximately 50 percent saturation (plus or minus 1 percent). The prepared 1-inch thick by 4-inch diameter specimens were loaded with a surcharge of 144 pounds per square foot and were inundated with distilled water. Readings of volumetric swell were made for a period of 24 hours.*

- **CORROSIVITY TEST (CAL. TEST METHOD 417, 422, 643):** *Soil pH and minimum resistivity tests were performed on representative soil samples in general accordance with test method CT 643. The sulfate and chloride contents of the selected samples were evaluated in general accordance with CT 417 and CT 422, respectively.*

Soil samples not tested are now stored in our laboratory for future reference and evaluation, if needed. Unless notified to the contrary, samples will be disposed of 60 days from the date of this report.

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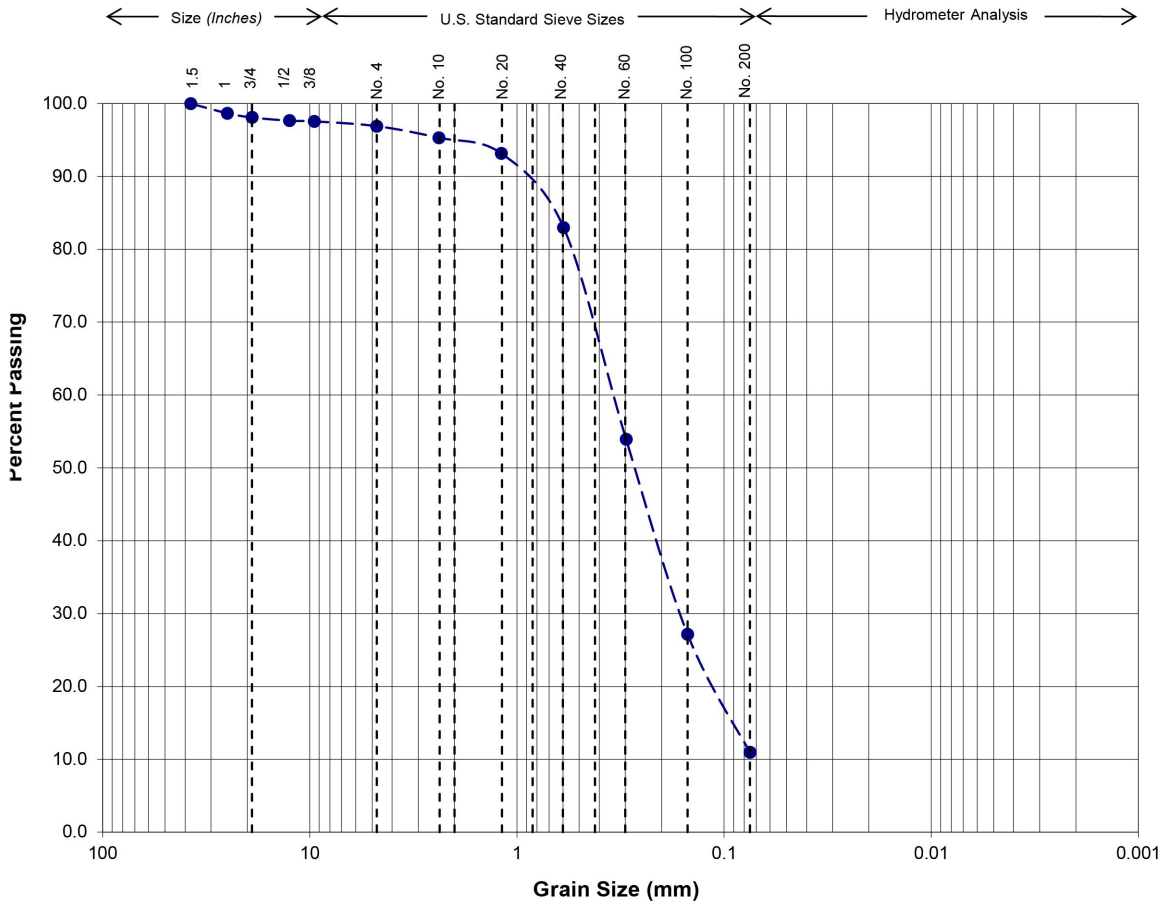
LAB TEST SUMMARY

TOPGOLF HARBOR ISLAND
NORTH HARBOR DRIVE AND LIBERATOR WAY
SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.1



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location:	B-4	Atterberg Limits (ASTM D4318):	
Depth (ft):	½ - 5	Liquid Limit, LL:	NP
USCS Soil Type:	SP-SM	Plastic Limit, PL:	NP
Passing No. 200 (%):	11	Plasticity Index, PI:	NP

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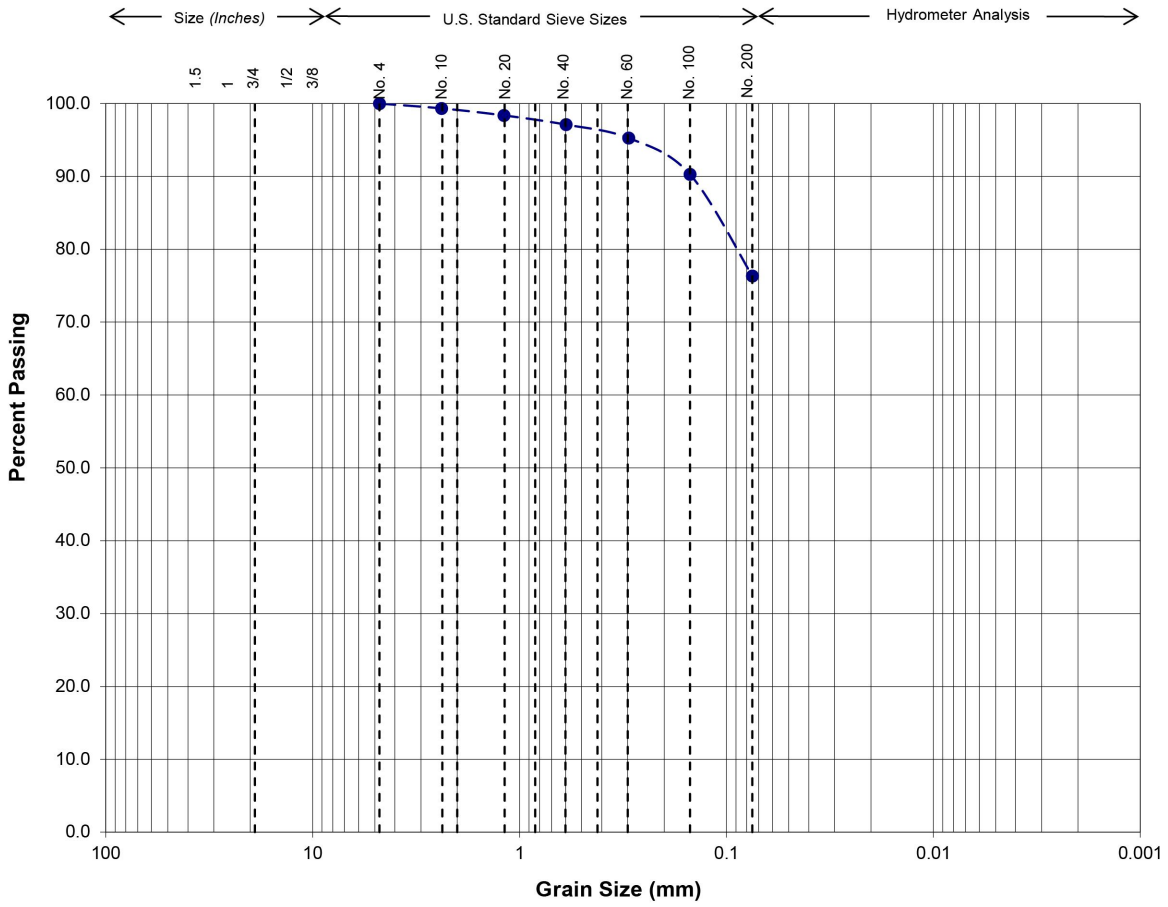
CLASSIFICATION TEST RESULTS

TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.2



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location:	B-5	Atterberg Limits (ASTM D4318):	
Depth (ft):	40 - 43	Liquid Limit, LL:	57
USCS Soil Type:	CH	Plastic Limit, PL:	19
Passing No. 200 (%):	76	Plasticity Index, PI:	38

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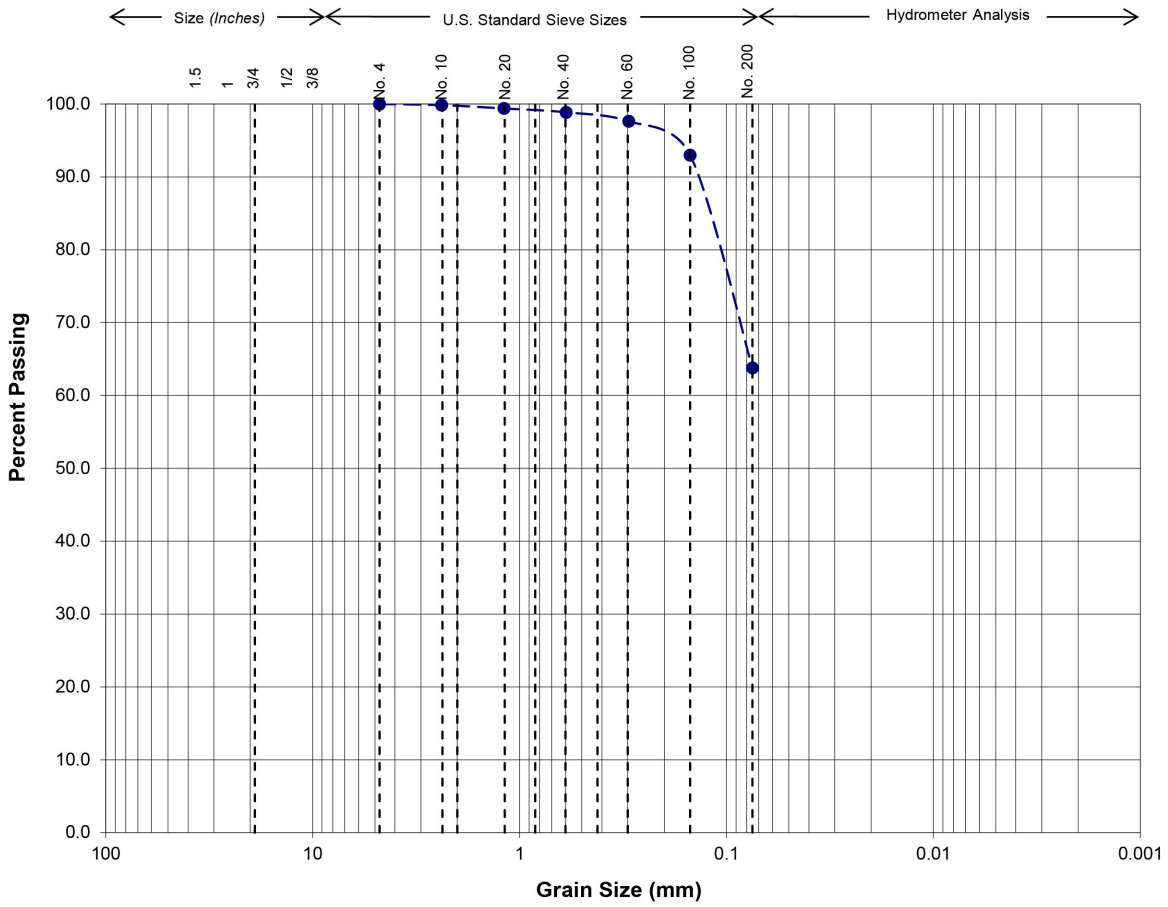
CLASSIFICATION TEST RESULTS

TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.3



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location: B-6

Depth (ft): 10 - 11½

USCS Soil Type: ML

Passing No. 200 (%): 64

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CLASSIFICATION TEST RESULTS

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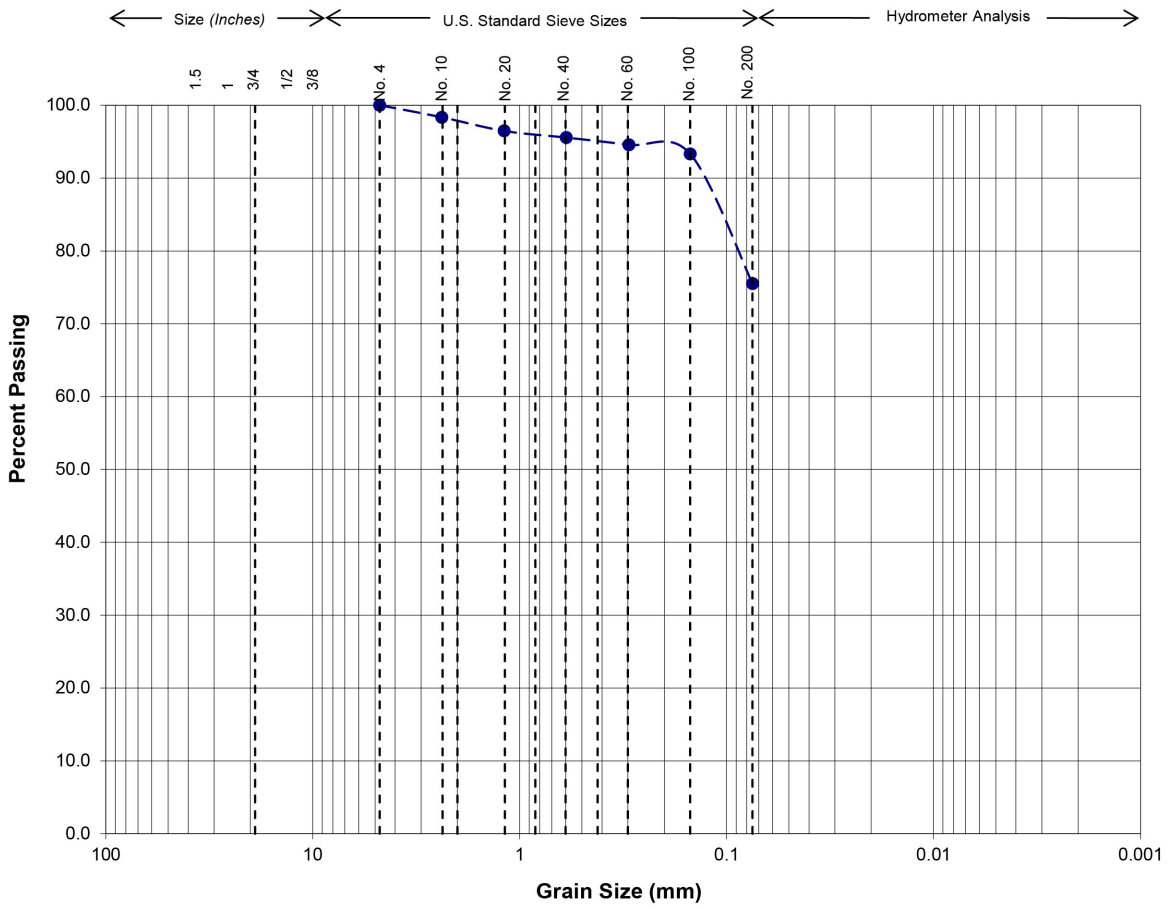
BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.4



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location: B-7

Depth (ft): 30 - 31½

USCS Soil Type: ML

Passing No. 200 (%): 76

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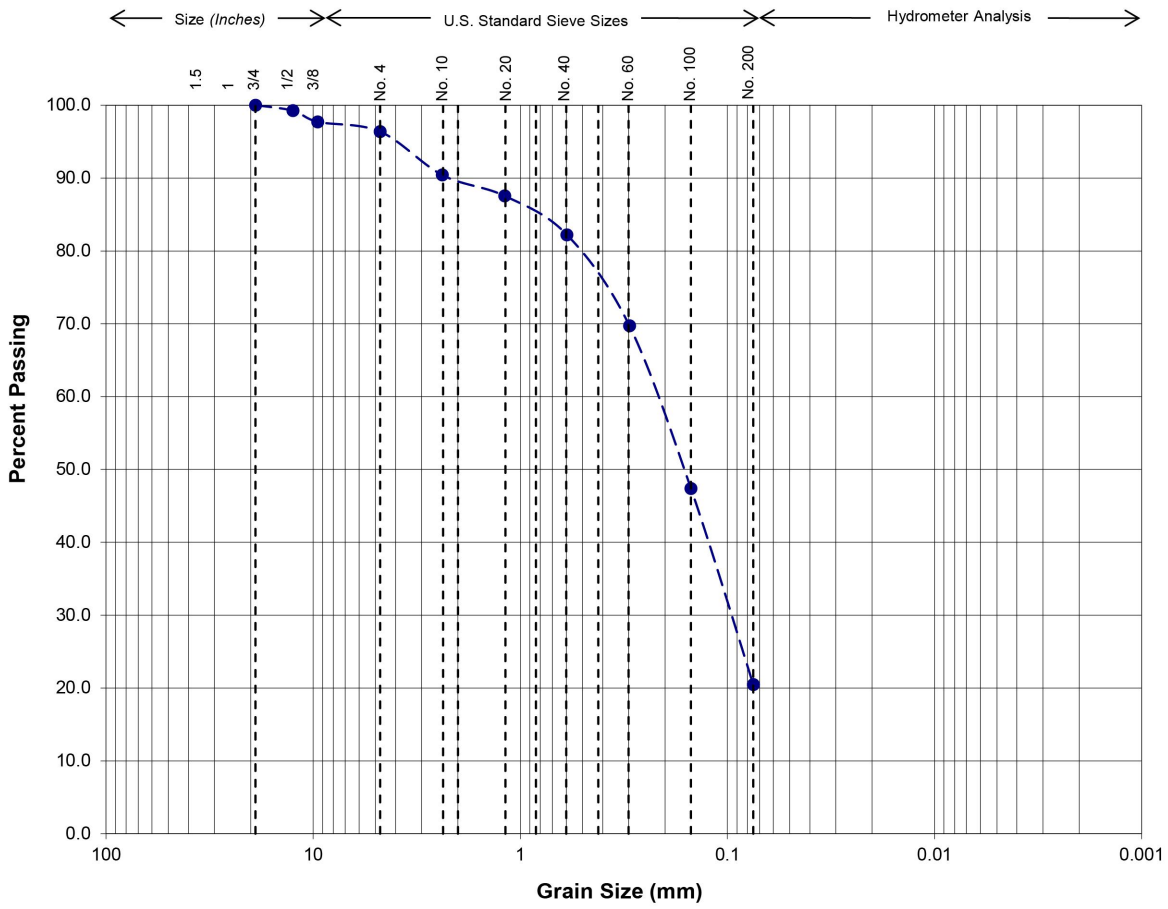
TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.5



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location: B-8

Depth (ft): 1 - 5

USCS Soil Type: SM

Passing No. 200 (%): 21

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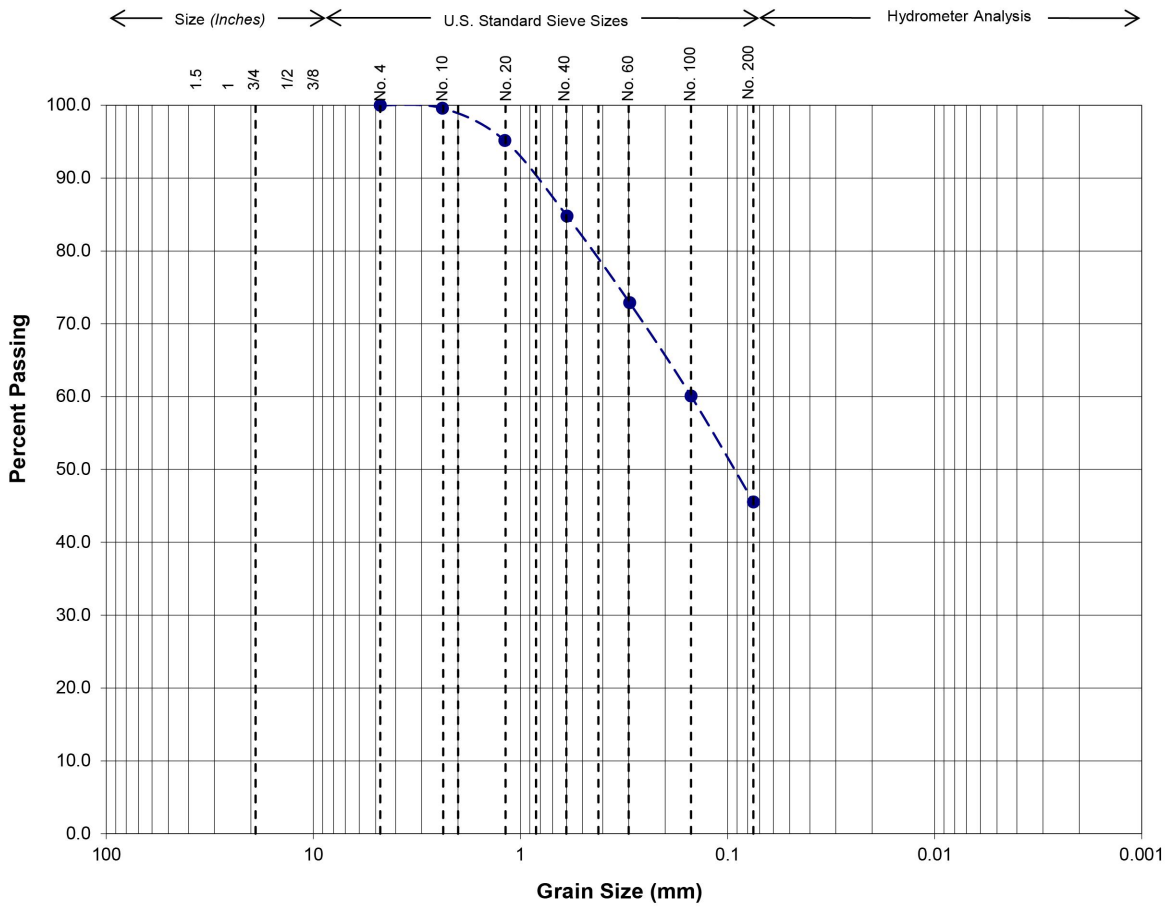
CLASSIFICATION TEST RESULTS

TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.6



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location: B-8

Depth (ft): 55 - 56½

USCS Soil Type: SC

Passing No. 200 (%): 46

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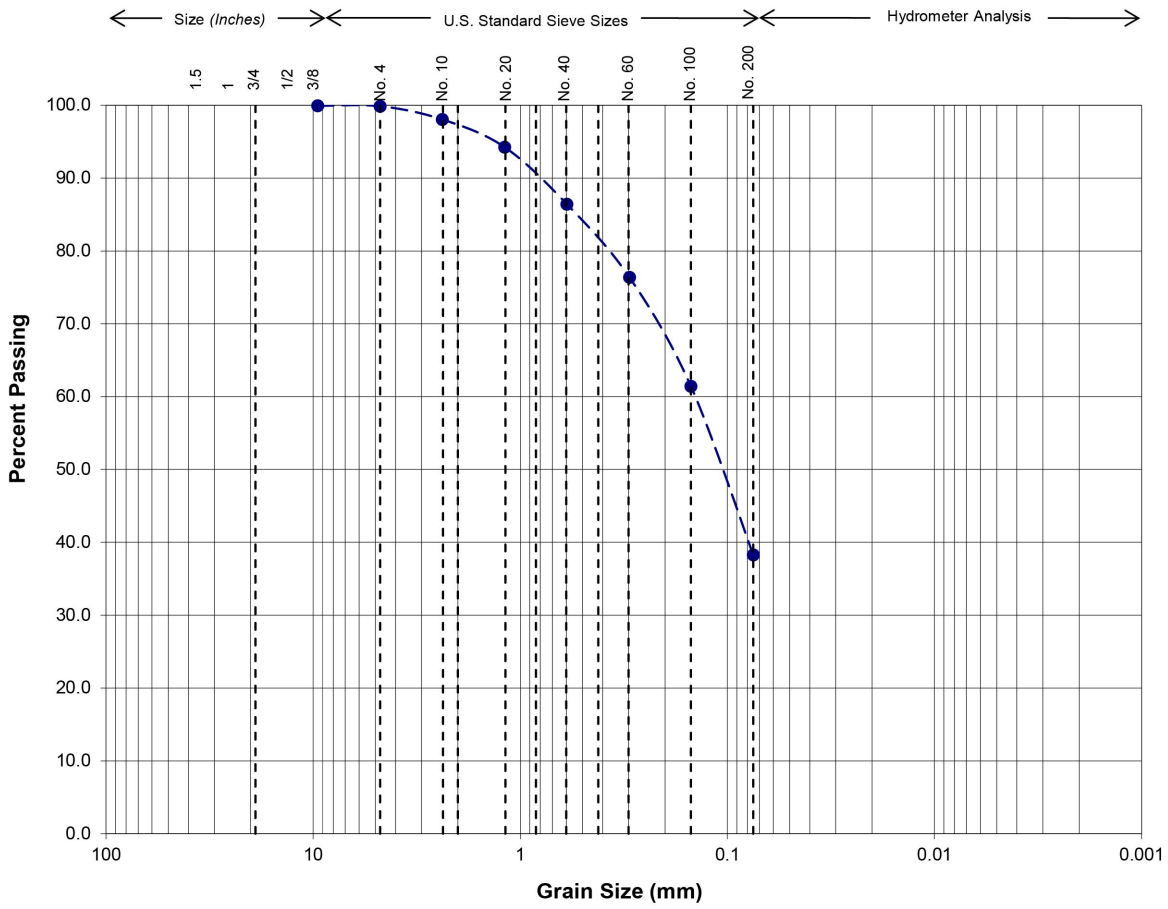
CLASSIFICATION TEST RESULTS

TOPGOLF HARBOR ISLAND

NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.7



Gravel		Sand			Silt or Clay
Coarse	Fine	Coarse	Medium	Fine	

Sample Location:	B-9	Atterberg Limits (ASTM D4318):	
Depth (ft):	½ - 2½	Liquid Limit, LL:	NP
USCS Soil Type:	SM	Plastic Limit, PL:	NP
Passing No. 200 (%):	38	Plasticity Index, PI:	NP

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NORTH HARBOR DRIVE AND LIBERATOR WAY

SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.8

Expansion Index (ASTM D4829)

Sample Location	Sample Depth (ft.)	Expansion Index	Expansion Potential
B-4	½ - 5	0	Very Low
B-9	½ - 2½	6	Very Low

Classification of Expansive Soil (ASTM D4829)

Expansion Index	Expansion Potential
0-20	Very Low
21-50	Low
51-90	Medium
91-130	High
>130	Very High

Corrosivity (Cal. Test Method 417,422,643)

Sample Location	Sample Depth (ft.)	pH	Resistivity (Ohm-cm)	Sulfate Content (ppm)	Sulfate Content (%)	Chloride Content (ppm)	Chloride Content (%)
B-5	40 - 43	7.6	60	390	0.039	30000	3.000
B-7	10 - 11½ and 15 - 16½	7.7	1169	60	0.006	89	0.009
B-8	20 - 21½ and 25 - 26½	8.4	558	39	0.004	816	0.082

Water-Soluble Sulfate Exposure (ACI 318 Table 19.3.1.1 and Table 19.3.2.1)

Water-Soluble Sulfate (SO_4) in Soil (% by Weight)	Exposure Severity	Exposure Class	Cement Type (ASTM C150)	Max. W/C	Min. f_c' (psi)
$SO_4 < 0.10$	N/A	S0	No type restriction	N/A	2,500
$0.10 \le SO_4 < 0.20$	Moderate	S1	II	0.50	4,000
$0.20 \le SO_4 \le 2.00$	Severe	S2	V	0.45	4,500
$SO_4 > 2.00$	Very Severe	S3	V plus pozzolan or slag cement	0.45	4,500

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LAB TEST RESULTS

TOPGOLF HARBOR ISLAND
NORTH HARBOR DRIVE AND LIBERATOR WAY
SAN DIEGO, CALIFORNIA

BY: GN	REVIEWED BY: GD/AN	PROJECT: 2024034	FIGURE: D.9

APPENDIX E
SITE-SPECIFIC GROUND MOTION HAZARD ANALYSIS

SITE-SPECIFIC GROUND MOTION ANALYSIS (ASCE 7-16)

Project: Topgolf Harbor Island
Client: McCarthy Building Companies
Job No: 2024034

Latitude: 32.72814 deg
Longitude: -117.19062 deg
Vs_{30}: 220.3 m/s (Measured)

Calculated By: GD
Date: 5/9/24

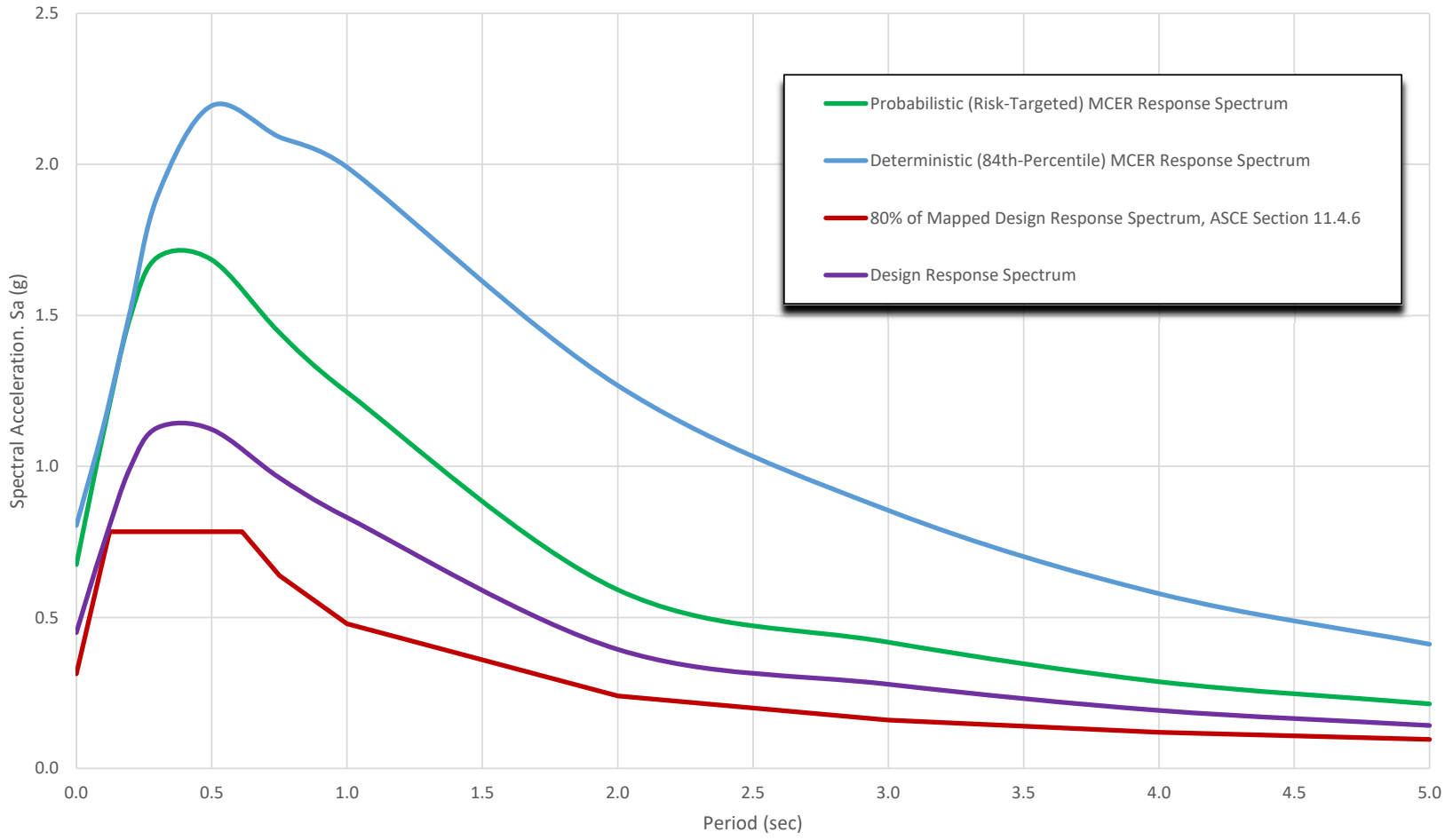
Period T (sec)	PROBABILISTIC (RISK-TARGETED) GROUND MOTION ANALYSIS				DETERMINISTIC (84TH-PERCENTILE) GROUND MOTION ANALYSIS			CODE-BASED (LOWER LIMIT) ASCE 7-16 SECTION 11.4.6		SITE-SPECIFIC DESIGN RESPONSE		
	Uniform Hazard Ground Motion (g)	Risk Targeted Ground Motion (g)	Maximum Direction Scale Factor	Maximum Directional Probabilistic Sa (g)	84th Percentile Spectral Accelaration (g)	Maximum Direction Scale Factor	Maximum Directional Deterministic Sa (g)	Code Based S_a (g)	80% of Code Based S_a (g)	Design S_{aM} (g)	Design S_a (g)	T x S_a (T>1s)
PGA	0.692	0.613	1.1	0.674	0.731	1.1	0.804	0.392	0.313	0.674	0.450	---
0.10	1.111	1.009	1.1	1.110	1.030	1.1	1.133	0.872	0.697	1.110	0.740	---
0.20	1.513	1.360	1.1	1.496	1.379	1.1	1.517	0.979	0.783	1.496	0.997	---
0.30	1.684	1.504	1.125	1.692	1.684	1.125	1.895	0.979	0.783	1.692	1.128	---
0.50	1.621	1.433	1.175	1.684	1.867	1.175	2.194	0.979	0.783	1.684	1.123	---
0.75	1.324	1.166	1.2375	1.443	1.689	1.2375	2.090	0.799	0.639	1.443	0.962	---
1.00	1.087	0.958	1.3	1.245	1.531	1.3	1.990	0.599	0.479	1.245	0.830	0.830
2.00	0.542	0.438	1.35	0.591	0.939	1.35	1.268	0.300	0.240	0.591	0.394	0.788
3.00	0.333	0.298	1.4	0.417	0.610	1.4	0.854	0.200	0.160	0.417	0.278	0.834
4.00	0.221	0.198	1.45	0.287	0.399	1.45	0.579	0.150	0.120	0.287	0.191	0.766
5.00	0.158	0.142	1.5	0.213	0.274	1.5	0.411	0.120	0.096	0.213	0.142	0.710

INPUT PARAMETERS - SEAOC (https://seismicmaps.org/)

Site Class=	D	
F_a=	1.000	Short Period Site Coefficient
S_S=	1.468	Mapped MCE_R, 5% Damped at T=0.2s
S_1=	0.499	Mapped MCE_R, 5% Damped at T=1s
S_{DS}=	0.979	Design, 5% Damped at Short Periods
S_{MS}=	1.468	The MCE_R, 5% Damped at Short Periods
T_L (sec)=	8.0	Long Period Transition (Sect 11.4.6)
F_{PGA} (g)=	1.1	Site Coefficient for PGA
PGA_M (g)=	0.733	
F_v=	1.801	Used Only for Calculation of T_o and T_s
S_{M1}=	0.899	
S_{D1}=	0.599	Design, 5% Damped at T=1s
T_o (sec)=	0.122	Defined in ASE 7-16 Sect 11.4.6
T_S (sec)=	0.612	Defined in ASE 7-16 Sect 11.4.6

SITE-SPECIFIC DESIGN PARAMETERS

S_{DS}=	**1.015**	90% of max S_a (ASE 7-16 Sect 21.4)
S_{MS}=	**1.523**	MCE_R, 5% Damped, adjusted for Site Class
S_{D1}=	**0.834**	Design, 5% Damped, at T=1s (Sect 11.4.5)
S_{M1}=	**1.252**	MCE_R, 5% Damped, at T=1s, adjusted for Site
F_a=	**1.000**	Short Period Site Coefficient
F_v=	**1.801**	Long Period Site Coefficient (7-16 Sect 21.3)
S_S=	**1.523**	MCE_R, 5% Damped at T=0.2s
S_1=	**0.695**	MCE_R, 5% Damped at T=1s
$PGA_{Probabilistic}$ (g)=	**0.692**	Peak Ground Acceleration, Probabilistic
$PGA_{Deterministic}$ (g)=	**0.731**	Peak Ground Acceleration, Deterministic
F_{PGA} (g)=	**1.1**	Site Coefficient for PGA
0.5*F_{PGA} (g)=	**0.550**	OK (Check $PGA_{Deterministic}$ > 0.5 x F_{PGA})
0.8*PGA_M (g)=	**0.586**	PGA_M (g) (Determined from ASCE 7-16 Eq. 11.8-1)
Site Specific PGA_M (g) =	**0.692**	(Check $PGA_{Site\ Specific}$> 0.8 x PGA_M)



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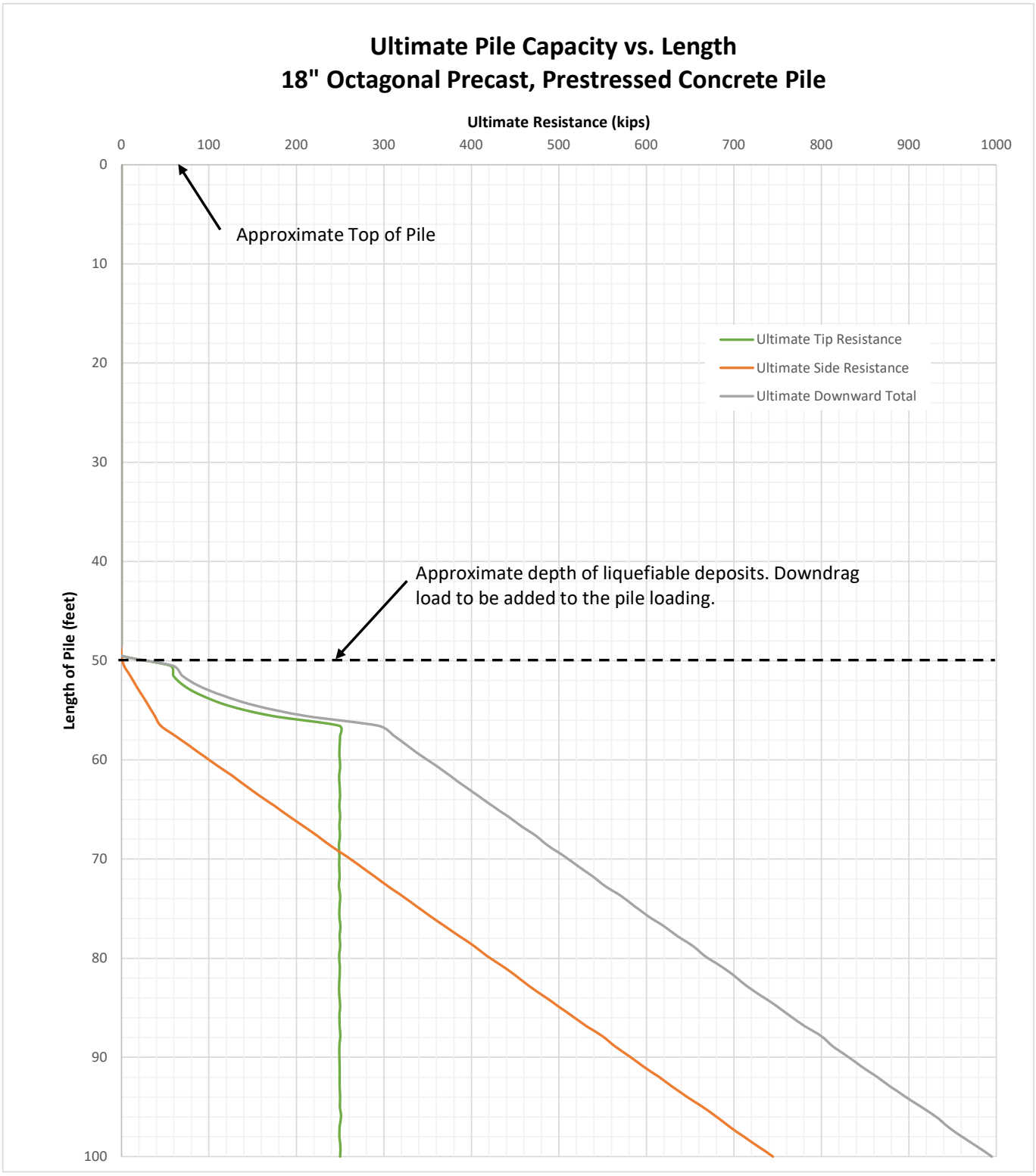
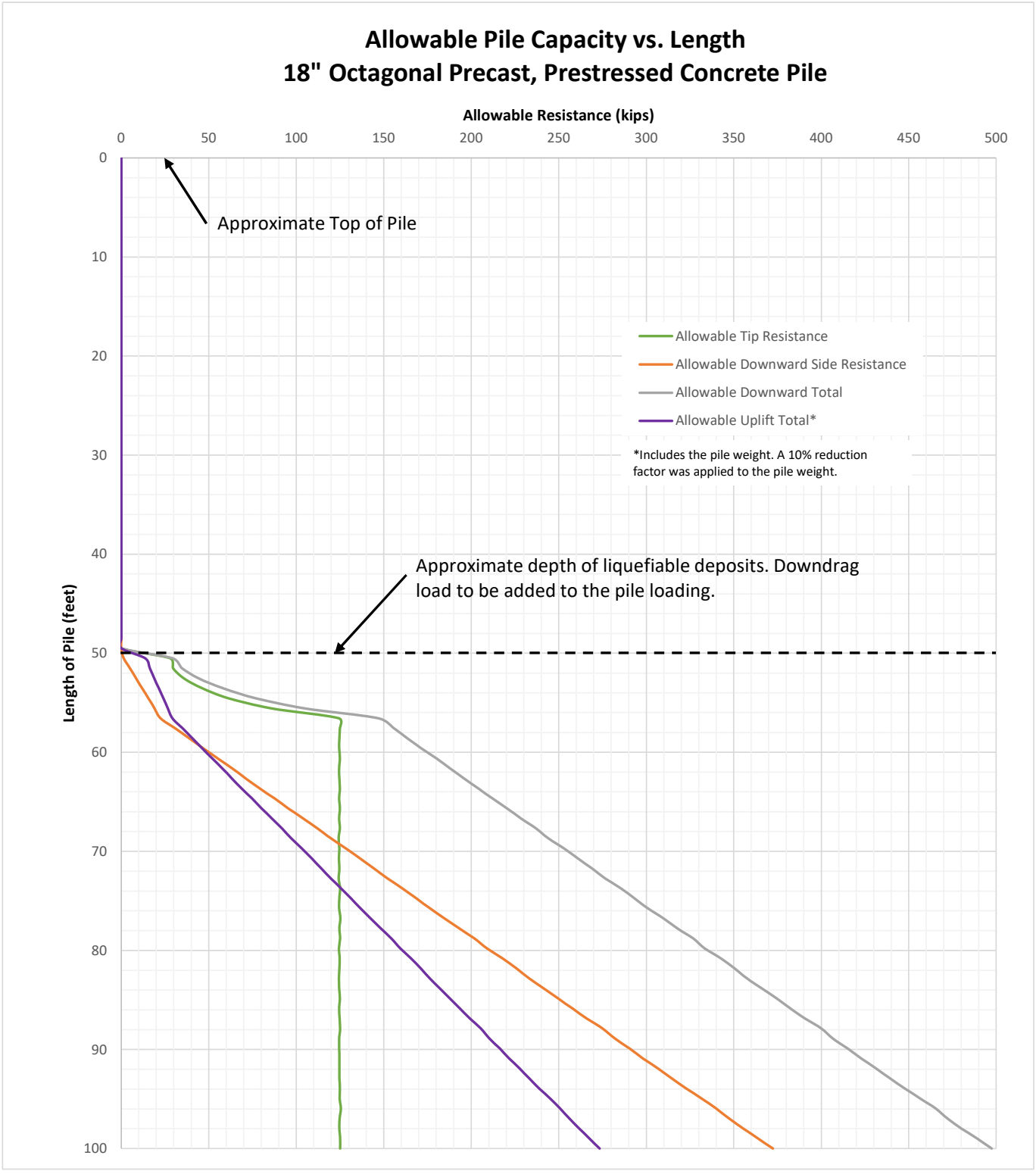
Topgolf Harbor Island
North Harbor Drive & Liberator Way, San Diego, California

By:	GCD	Date:	October 2024
Job Number:	2024034	Figure:	E.2

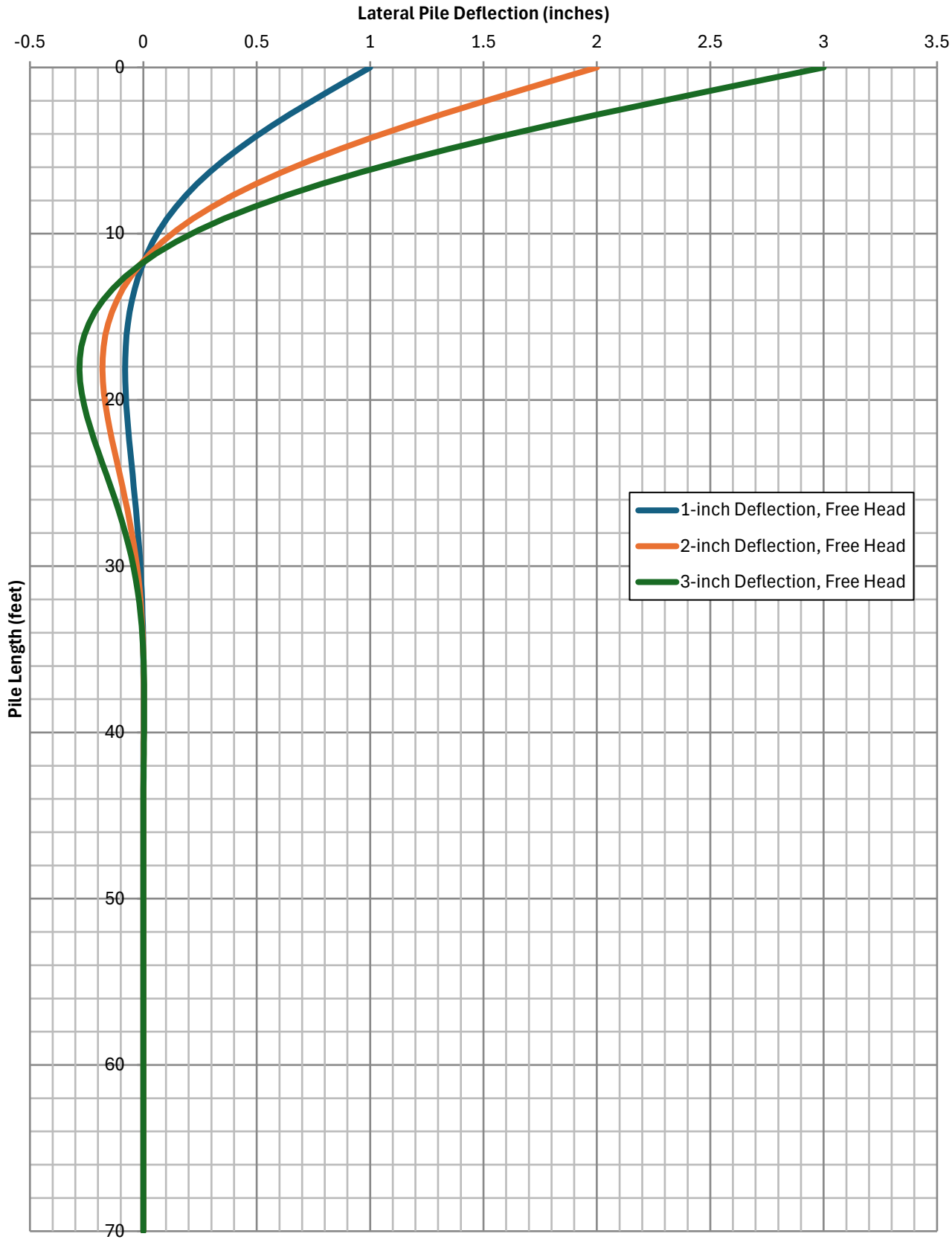
APPENDIX F
AXIAL PILE CAPACITIES


Ultimate Pile Capacity vs. Length
18" Octagonal Precast, Prestressed Concrete Pile
Ultimate Resistance (kips)
0
100
200
300
400
500
600
700
800
900
1000
Length of Pile (feet)
0
10
20
30
40
50
60
70
80
90
100
Approximate Top of Pile
Approximate depth of liquefiable deposits. Downdrag load to be added to the pile loading.
Ultimate Tip Resistance
Ultimate Side Resistance
Ultimate Downward Total

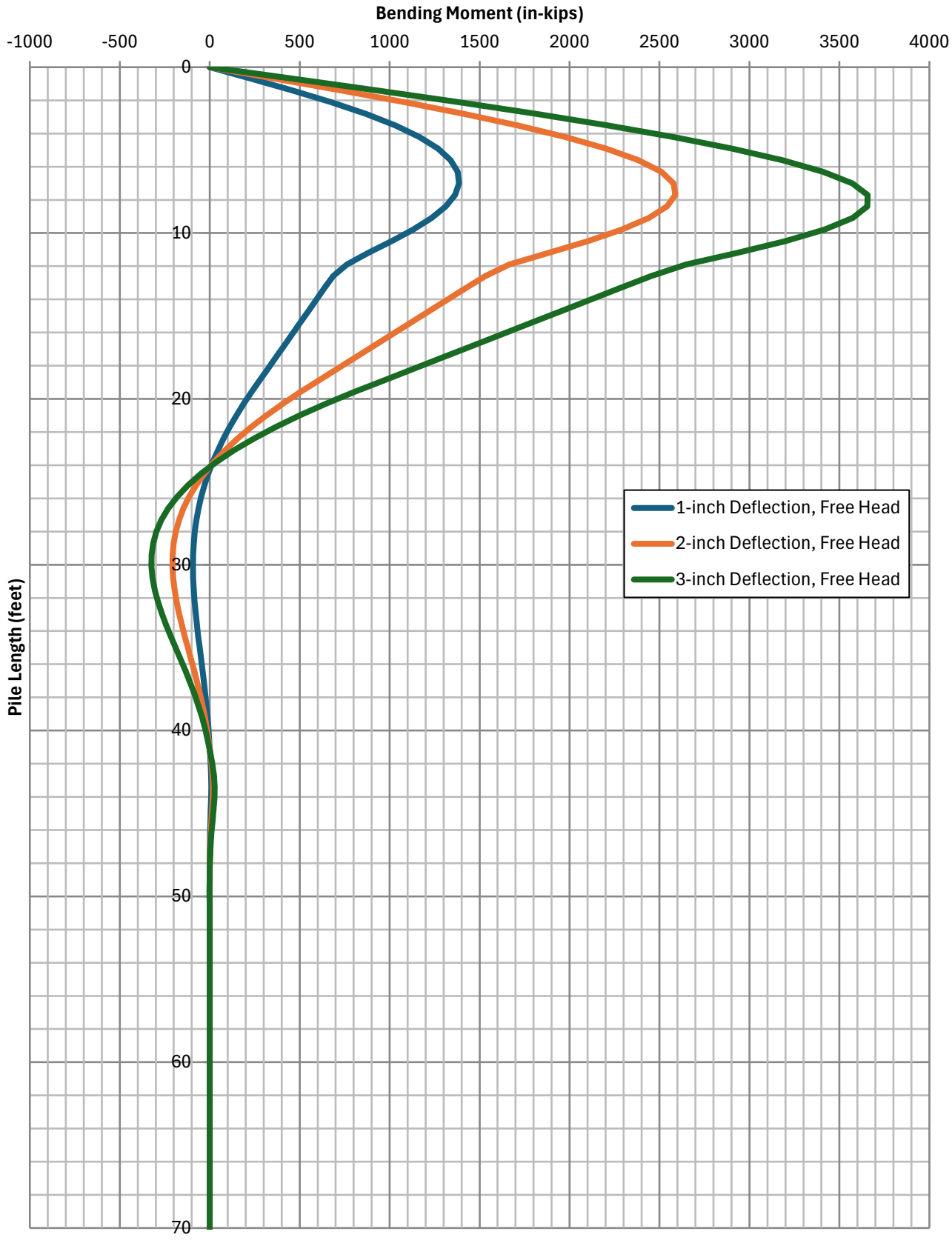

Allowable Pile Capacity vs. Length
18" Octagonal Precast, Prestressed Concrete Pile
Allowable Resistance (kips)
0
50
100
150
200
250
300
350
400
450
500
Length of Pile (feet)
0
10
20
30
40
50
60
70
80
90
100
Approximate Top of Pile
Approximate depth of liquefiable deposits. Downdrag load to be added to the pile loading.
Allowable Tip Resistance
Allowable Downward Side Resistance
Allowable Downward Total
Allowable Uplift Total*
*Includes the pile weight. A 10% reduction factor was applied to the pile weight.

APPENDIX G
LATERAL PILE CAPACITIES

18" Octagonal Precast, Prestressed Concrete Pile



18" Octagonal Precast, Prestressed Concrete Pile



18" Octagonal Precast, Prestressed Concrete Pile

