Appendix 6.7-1: Preliminary Geotechnical Report

TECHNICAL MEMORANDUM

To: Amanda Acuna and Lisa Kranitz, City of Gardena

From: Rita Garcia, Kimley-Horn

Date: January 24, 2024

Subject: **Preliminary Geotechnical Investigation Report for Feasibility Purposes, 1610 W. Artesia Boulevard, Gardena, California Peer Review**

Kimley-Horn conducted a third-party peer review of the Project's Preliminary Geotechnical Investigation Report for Feasibility Purposes (Kling Consulting Group, Inc., October 2022) on behalf of the City of Gardena and determined that the analysis meets the applicable provisions of CEQA and the State CEQA Guidelines and is adequate for inclusion in the Project SCEA.

Please do not hesitate to contact Rita Garcia at 714.939.1030 or Rita.Garcia@kimley-horn.com with any questions.

Preliminary Geotechnical Investigation Report for Feasibility Purposes, 1610 W. Artesia Boulevard, Gardena, California 90248.

PN 22027-00
October 31, 2022

KCG KLING Consulting Group, Inc.

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October 31, 2022 **PN 22027-00**

Mr. Satish Lion
The Picerne Group
5000 Birch St., Suite 600
Newport Beach, California 92660

Subject: Preliminary Geotechnical Investigation Report for Feasibility Purposes, 1610 W. Artesia Boulevard, Gardena, California 90248

Dear Mr. Lion,

At your request and authorization, Kling Consulting Group, Inc. (KCG) has performed a preliminary geotechnical investigation report for feasibility purposes at the subject property located at 1610 W. Artesia Boulevard, Gardena, California (**see Figure 1 - Site Location Map**). The purpose of our evaluation is to review site geologic/geotechnical conditions and assess constraints for the development of the site. Subsurface field exploration consisting of four Cone Penetrometer (CPT) soundings and one Hollow-Stem Auger (HSA) boring, was completed to characterize the site conditions, determine engineering properties and develop feasibility-level geotechnical conclusions and recommendations. We expect our findings, opinions and recommendations would assist in formulating preliminary costs and budgets for the project.

We appreciate this opportunity to be of continued service and to work with you on this project. Should you have any questions regarding this report, please do not hesitate to call.

Respectfully,

KLING CONSULTING GROUP

John Holder

John C. Holder
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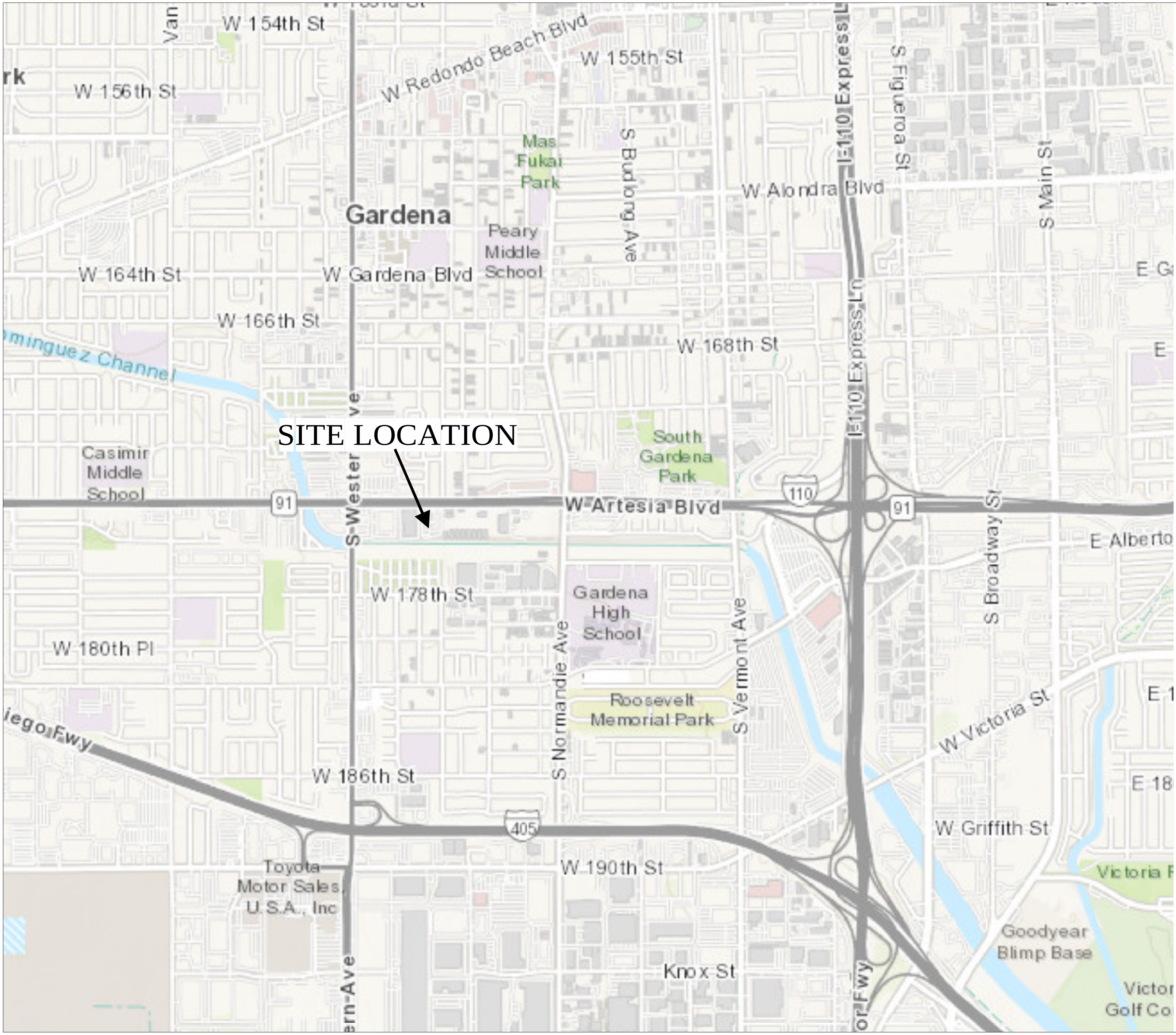
Dist: (3) one electronic PDF



Notes:

Scale: 1": 1850'

0 925 ft 1850 ft

KCG KLING Consulting Group, Inc.

Client:
Picerne Group

Address:
1610 W. Artesia Boulevard,
Gardena, CA 90248

Site Location Map

Drawn: J.H.	**Date:** 10/31/2022
P/N: 22027-00	**Figure:** 1

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1.0 INTRODUCTION

1.1 Purpose and Scope

The purpose of our preliminary geotechnical investigation has been to evaluate subsurface conditions at the site relative to the proposed development and provide feasibility level geotechnical recommendations to aid in project planning. Our subsurface exploration consisted of four Cone-Penetrometer Soundings (CPTs) and one Hollow-Stem Auger (HSA) boring located within the vicinity of the proposed development. The boring and CPT tests locations are shown on **Figure 2 – Geotechnical Map**.

1.2 Site Description

The subject property is located at 1610 W. Artesia Boulevard in Gardena, California. The site location (Longitude -118.305367°, Latitude 33.872132°) and surrounding area are presented on Figure 1. The Los Angeles County Office of the Assessor identifies the site as Assessor’s ID Number 6106-013-049.

The subject site is currently occupied by two commercial buildings and is approximately 3.8-acres in size. Existing residential and commercial properties surround the site. The site is bordered on the north by Artesia Boulevard, east and west by residential and commercial buildings, and south by the Dominguez Channel. According to the United States Geological Survey (USGS) 7.5-Minute Torrance Quadrangle (USGS, 2021), the site surface is generally flat. The approximate elevation on the site is 25 feet above mean sea level.

Based on a review of historic aerial photos (NETR, 2022) dating back to 1952, it appears the site was originally used for agricultural purposes before being developed sometime between 1972 and 1980. The commercial developments established to the east and west of the site appear to have been built in this same time period. The Dominguez Channel appears to have been constructed prior to the exitising commercial developments between 1952 and 1963.

1.3 Proposed Development

Our understanding of the project is based on reviewing the TPG Stein Yield Study prepared by TCA Architects. The proposed development comprises a five story residential structure (podium) with one subterranean level planned. No other specific information is available regarding the proposed development at this time.

Notes:

⊕ - Boring Hole Location

▲ - Cone Penetration Testing Location

0.94" - Amount of Vertical Liquefaction Settlement

Scale: 1": 60'

0 30 ft 60 ft

KCG KLING Consulting Group, Inc.

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Address:

1610 W. Artesia Boulevard,
Gardena, CA 90248

Geotechnical Map

Drawn: J.H.

Date: 10/31/2022

P/N: 22027-00

Figure: 2

2.0 GEOLOGIC CONDITIONS

2.1 Regional Geologic Setting

The subject site is located within the Los Angeles Basin in Gardena, California. This area resides on the northwestern margin of the Peninsular Range Geomorphic Province. The Los Angeles Basin terminates abruptly, forming coastal hills and mesas associated with the Newport-Inglewood Uplift. The dominant geologic structures of the province, near the subject site, include the Newport-Inglewood-Rose Canyon fault zone to the northeast.

Geological mapping of the area indicates near-surface native soil deposits consist of Pleistocene aged alluvial sediments comprised of varying sediments of sand and silt of valley deposits.

2.2 Site Geologic Units

The native soils underlying the surface of the subject site consist of Old Alluvial Valley Deposits of late Quaternary age. A general description of these alluvial deposits is presented as follows:

Old Alluvial Valley Deposits (Qoa): The Pleistocene age alluvial deposits in the vicinity of the site are mapped as anticipated to consist of predominantly dense to very dense silty sand.

2.3 Subsurface Conditions

2.3.1 Asphalt and Base

The site is mantled by asphalt concrete and aggregate base to a depths of between 2 – 4 inches from the existing ground in the vicinity of borehole KHSA-1.

2.3.2 Artifical Fill (Af)

The site is underlain by artificial fill consisting of clayey sand and silty clay to a depth of 10 feet below the ground surface within the vicinity of borehole KHSA-1, and CPT-1, CPT-2, CPT-3 and CPT-4.

The silty clay and clayey sand are dark brown, moist and fine to medium grained. Concrete and brick debris of up to 1 foot in diameter were observed within the vicinity of KHSA-1 at a depth of 5 feet below ground surface.

2.3.3 Old Alluvial Valley Deposits (Qoa)

The site is underlain by Old Alluvial Valley Deposits of Quaternary age which was encountered during our subsurface exploration between depths of 10 to 50 feet below the ground surface.

The late to middle Pleistocene age alluvial deposits comprised primarily clayey sand and silty clay. The clayey sand and silty clay were generally brown, fine grained, and moist to saturated. The clayey sand ranged from loose to medium dense and the silty clay is stiff in nature.

2.4 Groundwater

Groundwater was encountered within the single hollow stem boring at a depth of 21.5 feet below ground surface and in all CPT soundings based on pore water dissipation readings at depths between approximately 19 and 23 feet below the existing ground surface. The Los Angeles County Department of Public Works established Groundwater Level Data web application, indicates the nearest groundwater well in the vicinity of the subject site's highest ever recorded depth to water table surface was 16 feet below ground surface (bgs) recorded in April 1978.

According to the Seismic Hazard Zone Report for the Torrance 7.5-Minute Quadrangle, the historically highest groundwater level mapped for the subject site is 10 feet below ground surface (bgs).

3.0 GEOTECHNICAL ENGINEERING

3.1 Expansive Soil Characteristics

Expansion Index (EI) laboratory testing on a shallow soil sample from KB-1 resulted in an Expansion Index of 57, which is considered "medium" expansion potential (EI 51-90) according to the CBC.

3.2 Sulfate Content

Sulfate testing was performed on representative samples of the soil. The soils tested during this investigation indicated a class "S0" sulfate per ACI-318 (Reference 2), with a soluble sulfate content of 147 ppm or 0.0147%.

3.3 Moisture and Density

Samples were retrieved at various depths below the ground surface from the hollow-stem boring location and used to determine in-place dry density and moisture content. Moisture results indicate the sampled soils have a moisture content of ranging from 14.3 to 30.6 percent and a dry density ranging from 94.1 to 113.4 pcf. Laboratory test results of dry density and moisture content are recorded on the boring log in Appendix B.

3.4 Surface Fault Rupture

The subject site is not located within the State of California designated Fault-Rupture Hazard Zone (formerly known as Alquist-Priolo Zones), where a site-specific investigation to determine the locations of any active faults would be required.

However, the Southern California region is seismically active. Active and potentially active faults within Southern California can produce seismic shaking at the site. It is anticipated that the site will periodically experience ground acceleration due to exposure to moderate to large magnitude earthquakes occurring on distant faults. However, no active faults are known to exist at the site, and the risk of surface fault rupture is considered low. The closest active fault zone to the subject site is the Newport-Inglewood-Rose Canyon Fault Zone, located approximately 2.5 miles to the northeast.

3.5 Seismic Design Parameters

Presented below are the site seismic parameters utilizing generic geologic, seismic, and geotechnical data gathered for the site and the SEAC Seismic Design Tool (Reference 14). All structures should be designed for earthquake-induced strong ground motions in accordance with the 2019 CBC procedures utilizing the following parameters:

2019 CBC Seismic Design Parameters

Site Class (Soil Profile)	D
Latitude	33.872132
Longitude	-118.305367
Short Period Spectral Acceleration, Ss:	1.771
1-Second Period Spectral Acceleration, S1:	0.63
Site Coefficient, Fa:	1.0
Site Coefficient, Fv:	1.7
Maximum Considered Earthquake Spectral Response Acceleration, SMS:	1.771
Maximum Considered Earthquake Spectral Response Acceleration, SM1:	1.071
Design Spectral Response Acceleration, SDS:	1.181
Design Spectral Response Acceleration, SD1:	0.714
Site modified peak ground acceleration PGA_M	0.845
Seismic Design Category	D

Note: A site-specific ground motion analysis was not included in the scope of this investigation. Per ASCE 7-16, 11.4.8, structures on Site Class D with S_1 greater than or equal to 0.2 may require Site-Specific Ground Motion Analysis. However, a site-specific ground motion analysis may not be required based on exceptions listed in ASCE 7-16, 11.4.8. The project structural engineer should verify whether exceptions are valid for this site and if a Site-Specific Ground Motion Analysis is required.

3.6 *Liquefaction Potential*

Based on our review of published geologic data, subsurface data, the presence of a shallow static groundwater table, and the overall relatively loose nature of shallower on-site soils, it is our opinion that the site is susceptible to liquefaction. The state of California has also established a seismic hazard zone for liquefaction at the site.

Liquefaction was evaluated in accordance with California Geologic Survey *Guidelines for Evaluating and Mitigating Seismic Hazards in California*, 2008 (Reference 7) based on site peak ground acceleration, earthquake magnitude, and source characteristics relative to the mapped maximum considered geometric mean (MCEG) peak ground acceleration. The parameters used in our analysis included a probabilistic 2,475-year modal earthquake of 7.3 magnitude and a corresponding peak ground acceleration adjusted for site class effects of 0.85 g. Our analysis was performed utilizing the software program “CLiq v.1.7” by GeoLogismiki (Reference 9). The results of our analysis are presented below in Section 3.6, and a summary of the liquefaction analysis is presented in **Appendix C**- Liquefaction and Seismic Settlement Analysis.

The liquefaction analysis was performed utilizing a historic high groundwater level at 10-feet as presented in *The Seismic Hazard Zone Report for the Torrance 7.5-Minute Quadrangle, Los Angeles County, California* (Appendix A).

In addition, the analysis included the following parameters and assumptions:

- Factor of Safety = 1.3 (Chapter 6 California Geologic Survey *Guidelines for Evaluating and Mitigating Seismic Hazards in California*)
- “Dry” seismic settlements calculated (Section 3.5.5 Los Angeles Department of Public Works *Manual for Preparation of Geotechnical Reports)*
- Soil Behavior Type Index (Ic) = 2.60[18].
- Weighting factor for volumetric strain applied[11].
- Cn limit value applied.

3.7 *Seismically-Induced Settlement*

The liquefaction analyses results for seismically induced vertical ground settlement is presented below. The analysis was based on both existing conditions and with 10-foot basement excavation and assumed high ground water level of 10 feet below ground surface (bgs) .

CPT	Settlement Without Basement (Inches)	Settlement With Basement (Inches)
1	1.30	1.0
2	0.20	0.90
3	1.50	1.40
4	1.80	1.40

The overall vertical settlement calculations include seismically induced “dry” settlements.

Based on this analysis, the seismic induced settlements range from approximately 0.2 inches to 1.8 inches for existing conditions. It should be noted the majority of the vertical ground settlement (>1 inch) and up to approximately 1.6 inches occurs in the upper 20 feet of the soil column. Vertical ground settlements at depths between 22 and 50 feet are less than 0.2 inches. Additionally, seismically induced differential settlement is variable across the site, with an estimated differential settlement of 1.3-inches over a horizontal distance of 170 feet (between CPT-2 and CPT-3). When seismic settlement is analyzed assuming the upper ten feet is excavated for the proposed basement, the calculated seismic settlement ranged from 0.9 inches to 1.4 inches between CPT-2 and CPT-3 with a differential of approximately 0.50 inches over 170 feet horizontally which is equivalent to approximately 0.3 inches over 100 feet.

3.8 Seismically-Induced Lateral Displacements

Lateral spreading, a phenomenon associated with seismically induced soil liquefaction, is the lateral displacement of soils due to inertial motion and lack of lateral support during or post liquefaction. Lateral spreading generally occurs on gently sloping ground or level ground with nearby free surface faces such as a drainage or stream channel. Dominguez Channel is considered a “free surface” in the vicinity of the site. As such, seismically induced lateral spreading was evaluated as part of the liquefaction assessment.

In consideration of the close proximity to the concrete-lined Domingquez Channel and liquefaction settlement, the potential for lateral spreading to occur exists at the site. However, the exact amount of lateral spreading requires additional data and analysis beyond the scope of this preliminary investigation. Nonetheless, we believe the impact to the proposed apartment development would be mostly limited to surface ground improvements. The magnitude of horizontal displacement from spreading would decrease at further distances from the channel. The proposed podium structure with one level of basement would likely resist lateral movement due to its structural integrity. More specific estimates of lateral spreading would be evaluated in the final (Supplemental) investigation.

3.9 Seismically-Induced Landsliding

The State of California Seismic Hazard Zone Map for the Torrance Quadrangle has not designated the subject site for landsliding hazard potential. The potential for seismically-induced landsliding to occur at the site is considered very low due to the relatively flat topography and absence of significant slopes on or adjacent to the site. Slopes planned as part of the development should be engineered and constructed at a gradient of 2:1 (horizontal: vertical) or flatter.

4.0 CONCLUSIONS

The following preliminary conclusions are based upon our analysis and data review obtained during our subsurface field investigation. It is our opinion that the subject site is considered geotechnically suitable for the proposed development discussed above, provided the recommendations presented herein are implemented during design and construction. Additional subsurface exploration, laboratory testing and geotechnical analysis should be performed to confirm site conditions and to finalize the geotechnical investigation report.

- Based upon our review of the site, the underlying soils on-site are considered to have sufficient bearing capacity to support the proposed development, provided the preliminary recommendations herein are implemented.

- Geroundwater was encountered in our Boring B-1 at a depth of approximately 21.5 feet belwo the exsiting ground surface. Apparent groundwater recorded with pore water dissipation measurements in the CPT Soundings was encountered in all of our tests at depths of between approximately 19 and 23 feet below the existing ground surface during our subsurface exploration.

- Our geotechnical evaluation indicates that the upper 20 feet of the alluvial deposits that underlie the site are susceptible to liquefaction and seismic induced settlement due to a design-level earthquake incorporating the historical high groundwater level of 10 feet below existing grades (CGS, 1998). We estimate that liquefaction-induced vertical settlement for the subject apartment site would range from approximately 0.2 to 1.8 inches, with approximately 1.6 inches of estimated differential settlement over 350 feet. However, the seismic settlement analyzed beneath the proposed basement ranged from 0.9 inches to 1.4 inches resulting in differential settlement of 0.3 inches over 100 feet. This differential settlement of 0.3 inches over 100 feet should be incorporated into the overall design.

- KCG's professional opinion is that seismic and liquefaction-induced ground displacements can be mitigated by incorporating the differential settlement into the structural design of the building and employing a mat foundation system in the basement to support the proposed structure.

- Seismically induced lateral spreading is likely to occur at the site during significant seismic events; however, the spreading would likely affect surface improvements more than the proposed podium structure. Further analysis during the supplemental investigation should better predict the actual magnitude and extent of spreading

- Preliminarily, the soils underlying the site should be considered to have moderate expansion potential.

- No active fault is known to exist at the site, and the risk of surface fault rupture is considered to be very low.

- The proposed development should not adversely affect neighboring properties if proper care is taken during the construction of proposed improvements.

5.0 PRELIMINARY RECOMMENDATIONS

Preliminary recommendations presented below are based on information obtained from the client, and the preliminary geotechnical information gathered and analyzed to date.

5.1 Supplemental Subsurface Exploration

During this preliminary investigation phase, our CPT Soundings were primarily utilized to analyze the susceptibility of the underlying soil to seismic induced settlement and liquefaction potential. Due to existing buildings and improvements, CPT and boring locations were limited to readily accessible areas. We recommend that a supplemental geotechnical investigation be performed that includes both additional CPT soundings and soil borings to further characterize subsurface conditions, confirm groundwater levels and perform additional laboratory testing on obtained soil samples collected. The supplemental investigation would further refine our conclusions and recommendations and to comply with the Los Angeles Department of Public Works *Manual for Preparation of Geotechnical Reports*.

5.2 Earthwork Specifications

All grading should be performed in accordance with the General Earthwork and Grading Specifications presented in Appendix E, unless specifically revised or amended below. Grading should also conform to all applicable governing agency requirements. Prior to the commencement of grading operations, all vegetation, organic topsoil, and man-made structures (i.e., tanks, pipes, fences, etc.) should be cleared and disposed of off-site. Any undocumented fill or backfill encountered should be removed and re-compacted. All areas receiving fill should be scarified to 6 inches and/or over-excavated, moisture-conditioned between optimum moisture and two to four percent above optimum moisture content, and re-compacted to a minimum of 90 percent relative compaction as determined by ASTM D1557. Soil material excavated from the site should be adequate for re-use as compacted fill provided it is free of oversize rock, trash, vegetation, and other deleterious material. All earthwork and grading operations should be performed under the observation and testing of the geotechnical consultant of record.

5.3 Preliminary Remedial Earthwork and Over-Excavation

To provide uniform soil support for the proposed structures and reduce the potential for liquefaction induced settlement and settlement due to underlying potentially compressible soils, we recommend that the underlying soils be mitigated through ground improvement methods in those areas to receive buildings or other settlement-sensitive improvements, where not removed by planned excavations. It is our understanding that the proposed podium apartment structure would be supported entirely on a one-level parking basement. No remedial grading is anticipated for soil exposed after basement excavation is performed.

Should any at-grade structures be planned, we preliminarily anticipate remedial earthwork would involve over-excavation of the upper soils to maintain a minimum thickness of at least five (5) feet of fill below finish grade elevation, or a minimum of two (2) feet below proposed footings, whichever is deeper. The removal depth may vary laterally. As such, the recommended excavation depth may vary; this will need to be observed during construction. At a minimum, the removals should extend laterally beyond the building footprint five feet, where practical. In proposed pavement or flatwork areas, the depth of the removals should extend at least 12-inches below existing grade, or 12-inches below finish subgrade (whichever is deeper).

5.4 Preliminary Proposed Building Foundations Options

All foundation criteria are considered minimum requirements that may be superseded by more stringent requirements from the architect, structural engineer, or governing agencies. The preliminary recommended geotechnical design parameters are being provided for conventional spread footings and reinforced mat slab foundation systems with remedial earthwork for the at-grade residential buildings, if any**.**

5.4.1 Residential Apartment Building

5.4.1.1 Conventional Foundations

The following preliminary geotechnical parameters are provided for design of proposed conventional foundations at one level subterreanean parking. In general, the insitu soil at one level deep should provide support for proposed foundations. An allowable bearing pressure of 4000 pounds per square foot for square pad and continuous footings may be assumed. The minimum width and depth for continuous and square pad footings should be 24 inches and 24 inches, respectively. The depth is relative to finish slab elevation. Bearing pressures may be increased by 250 pounds per square foot per additional foot of width or depth to a maximum allowable bearing pressure of 5000 pounds per square foot. A coefficient of friction of 0.38 may be used, along with a passive lateral resistance of 250 pounds per square foot per foot of embedment. Footings should bear on either approved natural ground or compacted fill in the event localized areas of soft or disturbed soil is exposed after excavation.

If normal code requirements are used for seismic design, the allowable bearing value and coefficient of friction may be increased by 1/3 for short duration loads, such as the effect of wind or seismic forces. Static settlement of foundations supporting the proposed one three story buildings is not expected to exceed one inch and ¼-inch over fifty horizontal feet.

If any utility lines are within a 1:1 (horizontal: vertical) projection from the bottom of a footing, they may be within the influence zone of the proposed footing load. If this condition exists, the proposed footing should be deepened so that the utility is outside the zone of influence; the utility line could also be relocated or encased with concrete slurry. These conditions should be evaluated on a case by case basis.

5.4.1.2 Mat Foundation

A rigid mat foundation may be used for upport of the building at one level of subterranean basement. In general, the insitu soil should provide adequate support for proposed mat foundation. The subgrade should be evaluated upon completion of basement excavation. Any localized areas of soft or disturbed soil should be removed and recompacted prior to foundation constructioin. Mat foundations should be properly reinforced to form a relatively rigid structural unit in accordance with the structural engineering design. For designing a mat foundation, we preliminarily recommend a modulus of subgrade reaction of 100 pounds per square inch per inch (pci). This value can be further refined as part of the supplemental investigation. A maximum bearing pressure of 3000 psf is also recommended. For localized areas of higher pressure (often required for seismic design) further evaluation is warranted to evaluate the increase in pressure and resulting settlement.

5.5 Settlement

Static settlement of proposed foundations is dependent on the actual foundation system selected and actual bearing pressures. For preliminary planning purposes foundation settlement is expected to not exceed one inch in total and one-half inch differential over 50 horizontal feet. Anticipated liquefaction and seismic-induced settlement for the overall site ranges froms 0.2 to 1.8 inches. However, after basement excavation and loading, the seismically induced settlement is expected on the order of 0.30 inches over 100 horizontal feet. This is considered minor settlement, however it should be refined and verified during the recommended supplemental investigation.

5.6 Footing Setbacks

All footings should maintain a minimum 7-foot horizontal setback from the base of the footing to any descending slope. This distance is measured from the outside footing face at the bearing elevation. Footings should maintain a minimum horizontal setback of H/3 (H=slope height) from the base of the footing to the descending slope face and should be no less than 7 feet, and it need not be greater than 40 feet.

5.7 Slab-On-Grade

These recommendations are considered minimum requirements that may be superseded by more stringent requirements from the architect, structural engineer, or governing agencies.

Concrete slabs should be at least 4-inches in thickness. Actual slab thickness and reinforcement should be determined by the structural engineer based on structural loads and soil interaction. Our recommendations should be superseded by the recommendations of the structural engineer or architect.

New slabs-on-grade should minimally conform to the design procedure contained in Section 1808 of the 2019 California Building Code. The project structural engineer should consider these recommendations as minimum requirements and modify these recommendations as appropriate.

Slab subgrade soil moisture should be at least optimum moisture prior to placement of concrete or vapor barrier. If the moisture content of the existing subgrade soil is less than optimum, pre-saturation may be required to achieve optimum prior to placing the capillary layer or Stego.

Interior concrete slab-on-grade floors (if any) should be at least 4-inches in thickness underlain by a minimum 4-inch capillary break using ½-inch open graded gravel or material approved by the geotechnical engineer. The 4-inch capillary layer should be underlain by a 15-mil Stego Wrap vapor retarder or equivalent product with a permeance rate of 0.012 perms (or less) and puncture resistance of Class “A” or “B” per ASTM E 1745-11. As per the manufacturer recommendations, all seams should overlap a minimum of 6 inches and should be sealed in accordance with the specifications provided by the vapor retarder manufacturer. All penetrations must be sealed using a combination of Stego Wrap, Stego Tape and/or Stego Mastic or approved equivalent. The vapor retarder should be lapped downward a minimum of 12 inches where the vapor retarder encounters an interior footing or exterior thickened edge or footing. The vapor retarder must be placed on top of the capillary layer if it is expected to become wet prior to the concrete pour. If the capillary layer can be kept dry before pouring concrete, the vapor retarder may be placed under the capillary layer. The water-cement ratio of structural concrete should be not greater than 0.50. The actual slab thickness and reinforcement should be determined by the project structural engineer.

If moisture-sensitive floor coverings are utilized, interior concrete slabs should be designed and constructed in accordance with the applicable floor manufacturer's specifications. The flooring installer should conduct all applicable testing to determine if concrete slabs have sufficiently cured to receive flooring materials.

The basement slab on grade, if used exclusively for vehicular parking, may not require a moisture retarder. However, an aggregate layer of some thickness could be considered to reduce moisture vapor accumulating in the basement.

5.8 Retaining Walls

General guidelines are provided below for retaining walls up to twelve feet in retained height. Please note that drainage recommendations are provided only as a means to create a drained condition behind proposed retaining walls. Surface drains should not be connected to retaining wall sub-drainage. These drains are not intended as a means of waterproofing. If moisture or salt deposition is not desired, or if stone facing, stucco, or paint is to be applied to the wall outer surface, the wall should be provided with suitable waterproofing. The waterproofing system for the wall should be designed by a qualified waterproofing consultant. Any waterproofing or drainage system damaged by soil placement and compaction efforts should be repaired prior to completion of backfilling.
Foundations for proposed retaining and perimeter (non-retaining) walls which are to be founded into compacted fill materials may be designed utilizing an allowable bearing pressure as presented above for conventional foundations.

Cantilevered retaining walls should be designed to resist equivalent fluid pressures as indicated in the tables below:

Case 1 – Select (Clean Sand) Backfill Condition[1]

Backfill Condition (Active)	**Equivalent Fluid Pressure (psf/ft)**
Level	35
2:1 Slope	55

[1] Assumes clean sand (Sand Equivalent >30) backfill see attached detail RW-1.

Case 2 – Native Backfill Condition[2]

Backfill Condition (Active)	**Equivalent Fluid Pressure (psf/ft)**
Level	55
2:1 Slope	65

[2] Assumes drained native soil backfill see attached detail RW-1.

Both the clean sand and native backfill conditions provided above assume a drained condition behind the proposed retaining wall. A backdrain consisting of 4-inch perforated plastic pipe SDR 35 or Schedule 40, encased in ¾-inch gravel wrapped in Mirafi 140N or equivalent filter fabric, and properly outletted. Details for retaining wall drainage are provided in our attached Retaining Wall Detail RW-1 (Appendix E). A seismic surcharge of

19H should be applied at mid-height of the wall, where H= the retained height of the wall greater than 6 feet.

Additional surcharge loading considerations are not incorporated into the above values. If the project structural engineer wishes to incorporate additional loading due to these factors, the additional loads should be added to the values provided above. Foundations for proposed retaining walls may be designed by utilizing the recommendations for conventional foundations. However, when combining both frictional and passive lateral resistance, one or the other should be reduced by one-half.

Active earth pressure can be assumed for temporary shoring systems such as H-beam and lagging that can safely deflect sufficiently to initiate an active pressure condition. More detailed recommendations and design parameters for shoring should be evaluated as part of the supplemental investigation based on selected shoring systems.

5.8.1 Basement Walls

Basement walls should be designed for at-rest earth pressure. For preliminary design purposes, an at-rest earth pressure should be assumed equal to 75 pounds per cubic foot. Basement walls should be provided with backdrains consisting of drainage composites or sand backfill in connection with an aggregate wrapped in filter fabric with 4-inch diameter perforated pipe. In general, the basement wall drainage system should be based on the recommendation for drains presented in the previous section.

5.9 Preliminary Pavement Design

Pavement section design is provided below based on anticipated near surface soil conditions encountered during our investigation and assumed traffic loading.

5.9.1 Asphalt Concrete Pavement

R value testing was not performed as part of this investigation and should be performed during the supplemental investigation. However, we are assuming an R-Value of 30 for preliminary design purposes.

Based on an assumed R-value of 30 the parameters below are provided for preliminary design purposes. Pavement sections were calculated for traffic indices of 4.0 and 5.5, which are commonly used for parking stalls and drive aisles subject to passenger vehicles and service trucks, respectively. However, the selection of actual traffic index should be the purview of the project civil or traffic engineer.

Pavement Section Design

Location	R-Value	Traffic Index	Multiple Layered	
			Asphalt Concrete (inches)	Aggregate Base* (inches)
Parking Stall	30	4.0	3.0	6.0
Drive Aisles	30	5.5	3.0	8.0

*Aggregate base material should consist of Class 2 aggregate base materials or Crushed Miscellaneous Base (CMB).

The upper 12 inches of the subgrade soils should be compacted to at least 90 percent of the laboratory maximum dry density (ASTM D1557). All base materials should be compacted to at least 95 percent of the laboratory maximum dry density (ASTM D1557).

5.9.2 Portland Cement Concrete Pavement

For preliminary design of concrete pavement, it is recommended that a concrete pavement section consisting of 6-inches of concrete underlain by at least 4-inches of either Class 2 aggregate base or crushed miscellaneous base (CMB) be used for preliminary design. Concrete Compressive strength should be 4000 psi or greater. Aggregate base material should be compacted to a minimum of 95 percent relative compaction as per ASTM D1557. Subgrade soil should be compacted to at least 90 percent of the laboratory maximum dry density in accordance with ASTM D1557. If concrete crack control is desired, the slabs should be minimally reinforced with No. 4 rebar, placed every 24 inches on center, both ways. A 10-foot square or less grid system should be used in the construction of continuous sections of concrete pavement or as recommended by the structural engineer.

For trash enclosures, concrete pavement should consist of a minimum 8-inch thick concrete slab placed over a minimum of 6-inches of either Class 2 or crushed miscellaneous base material, compacted to 95 percent relative compaction. Concrete should have a minimum strength of 4000 psi and be reinforced with a minimum of No. 4 bars placed at 24 inches on center, in each direction, positively supported (with concrete chairs or other devices) at mid-height in the slab. Crack control joints should be placed at a 10-foot maximum spacing in each direction in the slab or as recommended by the structural engineer. Concrete mix design should incorporate the recommendations presented in the slab on grade section of this report for improved geotechnical performance.

5.10 Exterior Flatwork

The following general recommendations may be considered for concrete hardscape including expansive soils mitigation and may be superseded by the requirements of Los Angeles County.

5.10.1 Sidewalk, Pedestrian Walkways

Expansion Potential	**Minimum Concrete Thickness**	**Subgrade Pre-Soaking Depth**	**Reinforcement**	**Joint * Spacing**
Medium	4 (Full)	120% of Optimum to 18”	#3 @ 18" OC, EW	4-5 Feet

* Joints at curves and angle points are recommended.

5.10.2 Driveways, Patios, Entryways

Expansion Potential	**Minimum Concrete Thickness (in)**	**Subgrade Pre-Soaking Depth**	**Reinforcement**	**Joint[3] Spacing (Max)**
Medium	General Flatwork 4 (Full) Driveways 6 (Full)	120% of Optimum to 18”	#3 @ 18" OC, EW	4-5 Feet

[3] Joints at curves and angle points are recommended.

The above recommendations may be superseded by the project architect, structural engineer or the governing agency’s requirements. These recommendations are not intended to mitigate cracking caused by shrinkage and temperature warping.

5.11 Drainage

Positive drainage should be maintained away from any building or graded slope face and directed to suitable areas via non-erosive devices, as designed by the project civil engineer. For drainage over soil and paved areas immediately adjacent to structures, please refer to Section 1804.4 of the 2019 CBC.

5.12 Geotechnical Observation and Testing

Geotechnical observation and testing should be conducted during the following stages of grading:

- During all phases of rough and precise grading, footing excavations, etc.
- During slab and flatwork subgrade pre-saturation and moisture conditioning.
- During shoring system installation.
- During utility trench excavation and compaction.
- During placement of retaining wall sub-drainage, backfill, and compaction.

For any unusual conditions encountered during grading.

6.0 PROFESSIONAL LIMITATIONS

Geotechnical services are provided by KCG in accordance with generally accepted professional engineering and geologic practice in the area where these services are to be rendered. Client acknowledges that the present standard in the engineering and geologic and environmental profession does not include a guarantee of perfection and, except as expressly set forth in the conditions above, no warranty, expressed or implied, is extended by KCG.

Geotechnical reports are based on the project description and proposed scope of work as described in the proposal. Our conclusions and recommendations are based on the results of the field, laboratory, and office studies, combined with an interpolation and extrapolation of soil conditions as described in the report. The results reflect our geotechnical interpretation of the limited direct evidence obtained. Our conclusions and recommendations are made contingent upon the opportunity for KCG to continue to provide geotechnical services beyond the scope in the proposal to include all geotechnical services. If parties other than KCG are engaged to provide such services, they must be notified that they will be required to assume complete responsibility for the geotechnical work of the project by concurring with the recommendations in our report or providing alternate recommendations.

It is the reader's responsibility to verify the correct interpretation and intention of the recommendations presented herein. KCG assumes no responsibility for misunderstandings or improper interpretations that result in unsatisfactory or unsafe work products. It is the reader's further responsibility to acquire copies of any supplemental reports, addenda, or responses to public agency reviews that may supersede recommendations in this report.

APPENDIX A

REFERENCES

APPENDIX A

REFERENCES

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APPENDIX A

REFERENCES
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APPENDIX B

CPT SOUNDINGS AND BORING LOGS

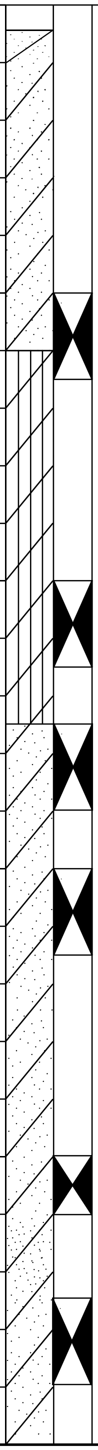
LOG OF EXPLORATORY BORING

Sheet **1** of **3**

Project: **1610 W. Artesia Blvd, Gardena, CA**
Project Number: **22027-00**
Date Drilled: **9/30/22**
Logged By: **J.H**

Boring No.: **KHSA-1**
Driller: **Bc2 Environmental**
Drill Type: **Hollow-Stem Auger**
Hammer Wt. / Drop: **140lb / 18in**
Ground Elev. [ft]: **---**

◩ Standard Split Spoon
■ Shelby Tube
∇ Water Level ATD
⧗ California
☒ Bulk Sample
▼ Static Water Table



Depth [ft]	Sample Type	Blows/6"	Moisture Content [%]	Dry Density, [pcf]	SOIL DESCRIPTION and CLASSIFICATION (USCS)	Pocket Pen. [tsf]	Lab Tests	Remarks
					@ **0 feet** - **Asphalt:** 3-4 inches thick			
					Artificial Fill (Af):			
					@ **0.5 feet** - **Clayey Sand (SC):** dark brown, medium grained, moist, medium dense.		EI SO4	
					@ **4.0 feet** - trash debris including concrete and brick, up to 1 foot diameter			
5	⧗	6 8 6			@ **6.0 feet** - **Silty Clay (CL):** dark brown, moist, fat.			No recovery.
10	⧗	5 7 13 [13]	19.2	111.2	@ **10.0 feet** - **Silty Clay (CL):** dark brown, moist, fat, stiff.	> 4.5		
					Old Alluvial Valley Deposits (Qoa):			
	⧗	6 14 16 [24]	18.1	113.4	@ **12.5 feet** - **Clayey Sand (SC):** brown, fine to medium grained, moist, medium dense.	> 4.5		
15	⧗	3 12 13 [18]	14.3	110.8	@ **15.0 feet** - **Clayey Sand (SC):** brown, fine to medium grained, moist, medium dense.	> 4.5	CN	
20	⧗		22.2	104.3	@ **20.0 feet** - **Clayey Sand (SC):** brown, fine to medium grained, moist/almost wet.	1.50		Blowcount N/A. ∇
	⧗	5 10 12 [13]	30.6	94.1	@ **22.5 feet** - **Clayey Sand (SC):** brown, fine to medium grained, wet, medium dense.	2.00	DS	

Blow count in bracket represents (N1)60 value.
LaCroix & Horn conversion factor of 0.64 used to convert California Sampler blow counts to SPT values.

LOG OF EXPLORATORY BORING

Sheet **2** of **3**

Project: **1610 W. Artesia Blvd, Gardena, CA**
Project Number: **22027-00**
Date Drilled: **9/30/22**
Logged By: **J.H**

Boring No.: **KHSA-1**
Driller: **Bc2 Environmental**
Drill Type: **Hollow-Stem Auger**
Hammer Wt. / Drop: **140lb / 18in**
Ground Elev. [ft]: **---**

◩ Standard Split Spoon
■ Shelby Tube
▽ Water Level ATD
⧗ California
☒ Bulk Sample
▼ Static Water Table

Depth [ft]	Graphic Log	Sample Type	Blows/6"	Moisture Content [%]	Dry Density, [pcf]	SOIL DESCRIPTION and CLASSIFICATION (USCS)	Pocket Pen. [tsf]	Lab Tests	Remarks
25		⧗		24.8	102.3	**Old Alluvial Valley Deposits (Qoa):** @ **25.0 feet - Clayey Sand (SC):** brown, fine to medium grained, wet.	1.25		Blowcount N/A.
30		⧗	6 7 9 [8]	24.2	102.9	@ **30.0 feet - Clayey Sand (SC):** brown, fine to medium grained, wet, medium dense.	1.50		
35		⧗	5 5 6 [4]	24.0	104.8	@ **35.0 feet - Clayey Sand (SC):** brown, fine to medium grained, wet, loose.	1.00		
40		⧗	4 5 6 [4]	23.8	101.8	@ **40.0 feet - Clayey Sand (SC):** brown, fine to medium grained, wet, loose.	0.50		
45		⧗	5 5 6 [4]	23.1	104.7	@ **45.0 feet - Clayey Sand (SC):** brown, fine to medium grained, wet, loose.	1.50		

Blow count in bracket represents (N1)60 value.
LaCroix & Horn conversion factor of 0.64 used to convert California Sampler blow counts to SPT values.

LOG OF EXPLORATORY BORING

Sheet **3** of **3**

Project:	**1610 W. Artesia Blvd, Gardena, CA**	Boring No.:	**KHSA-1**
Project Number:	**22027-00**	Driller:	**Bc2 Environmental**
Date Drilled:	**9/30/22**	Drill Type:	**Hollow-Stem Auger**
Logged By:	**J.H**	Hammer Wt. / Drop:	**140lb / 18in**
		Ground Elev. [ft]:	**---**

◪ Standard Split Spoon	■ Shelby Tube	∇ Water Level ATD
⧗ California	☒ Bulk Sample	▼ Static Water Table

Depth [ft]	Graphic Log	Sample Type	Blows/6"	Moisture Content [%]	Dry Density, [pcf]	SOIL DESCRIPTION and CLASSIFICATION (USCS)	Pocket Pen. [tsf]	Lab Tests	Remarks
50	▨	⧗		27.7	96.4	**@ 50.0 feet - <u>Clayey Sand (SC)</u>:** light gray, fine to medium grained, wet.	1.00		Blowcount N/A.
						End of Boring @ 51.5 ft below ground surface. Groundwater encountered @ 21.5 feet below ground surface. No Caving			

Blow count in bracket represents (N1)60 value.
LaCroix & Horn conversion factor of 0.64 used to convert California Sampler blow counts to SPT values.

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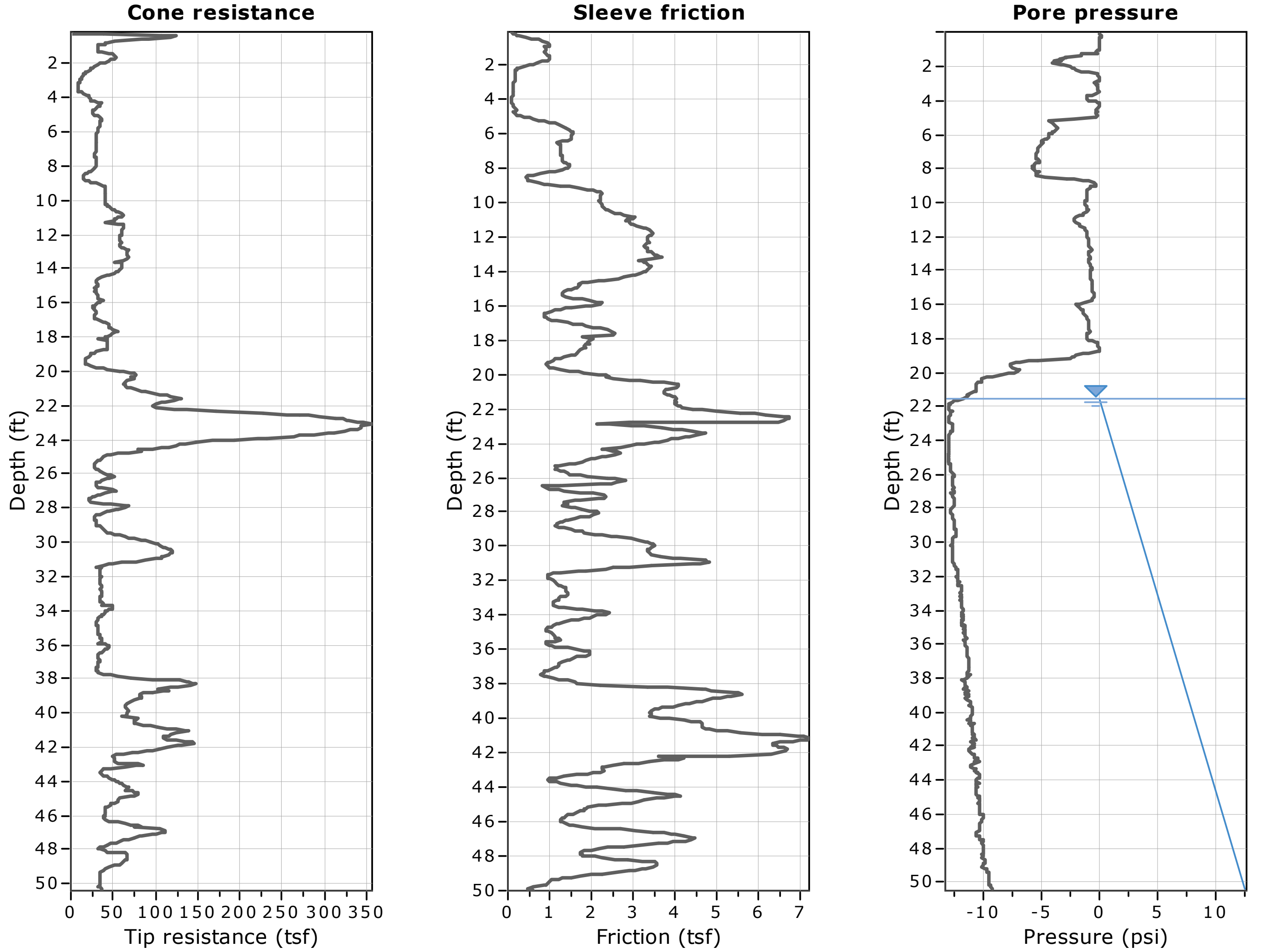
CPT: CPT-01
Total depth: 50.39 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

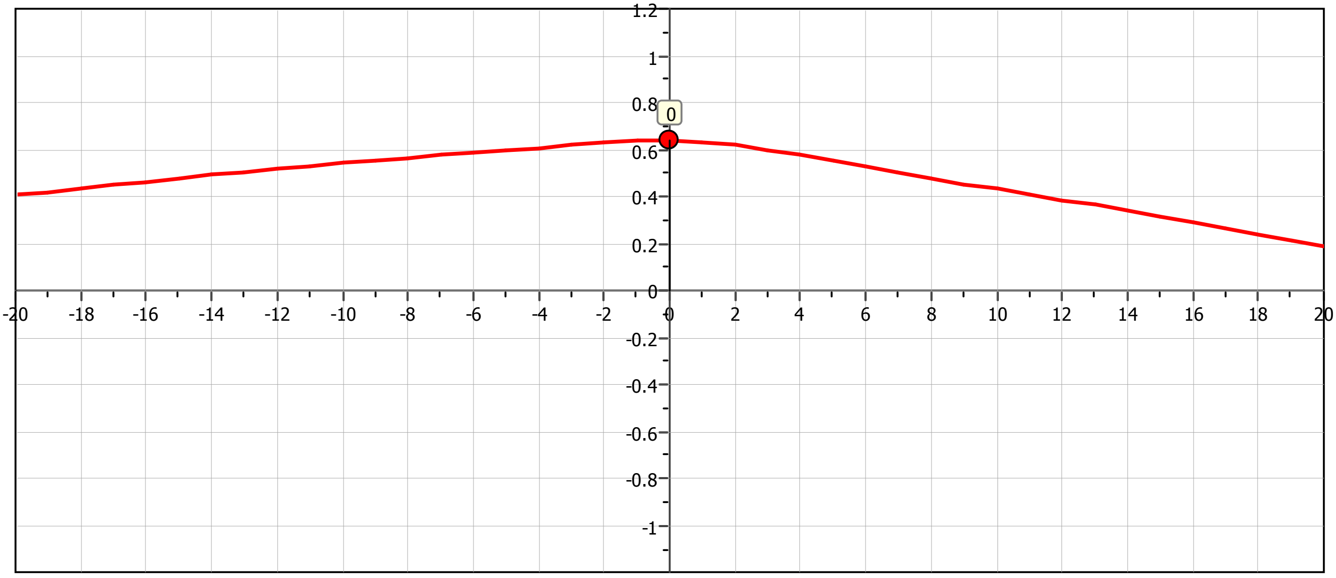


Cone resistance

Sleeve friction

Pore pressure

The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



Cross correlation between qc & fs

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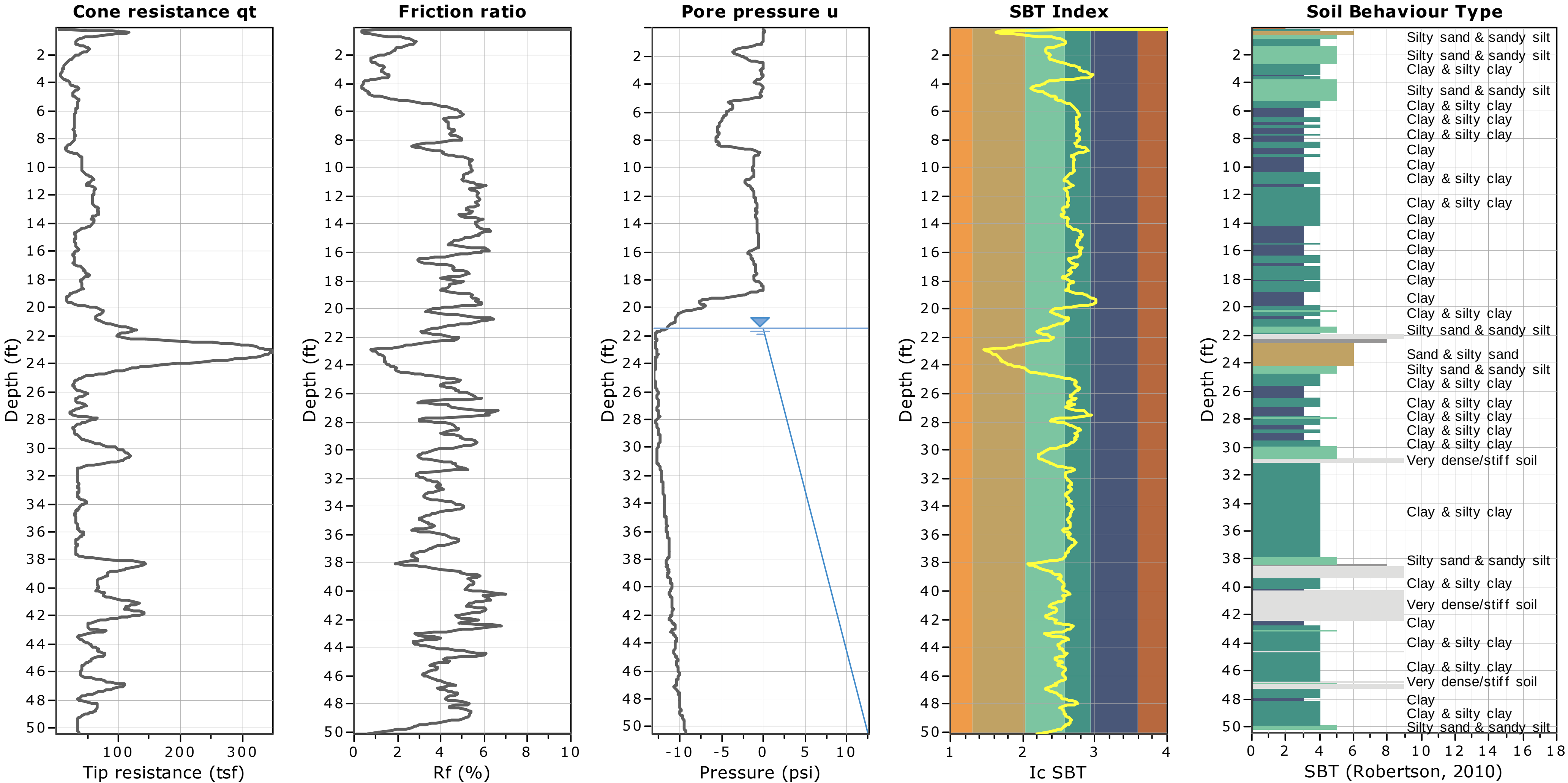
CPT: CPT-01
Total depth: 50.39 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



SBT legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

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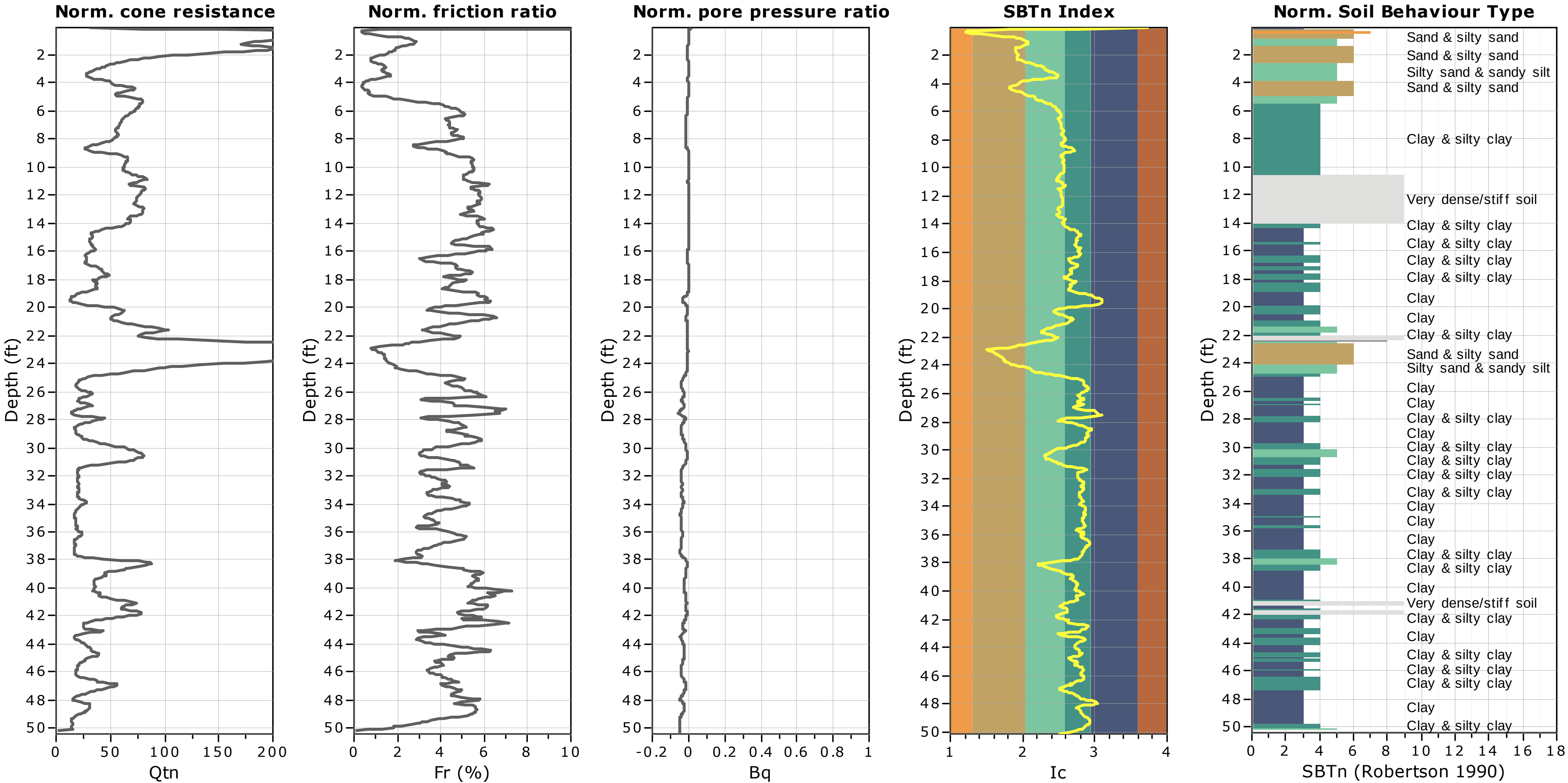
CPT: CPT-01
Total depth: 50.39 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

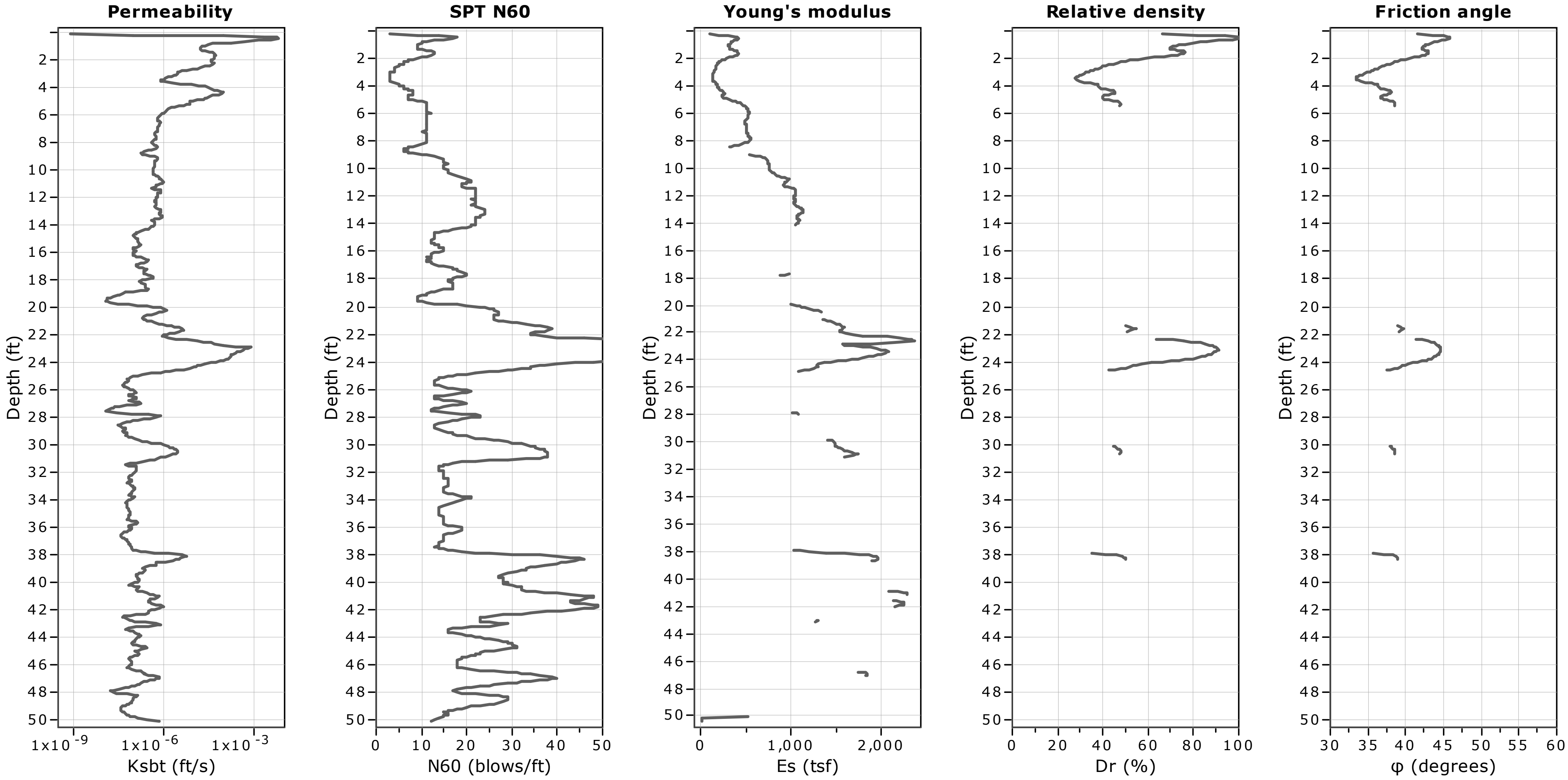


SBTn legend

🟥 1. Sensitive fine grained	🟩 4. Clayey silt to silty clay	🟧 7. Gravely sand to sand
🟫 2. Organic material	🟩 5. Silty sand to sandy silt	⬛ 8. Very stiff sand to clayey sand
🟦 3. Clay to silty clay	🟫 6. Clean sand to silty sand	⬜ 9. Very stiff fine grained

CPT: CPT-01
Total depth: 50.39 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

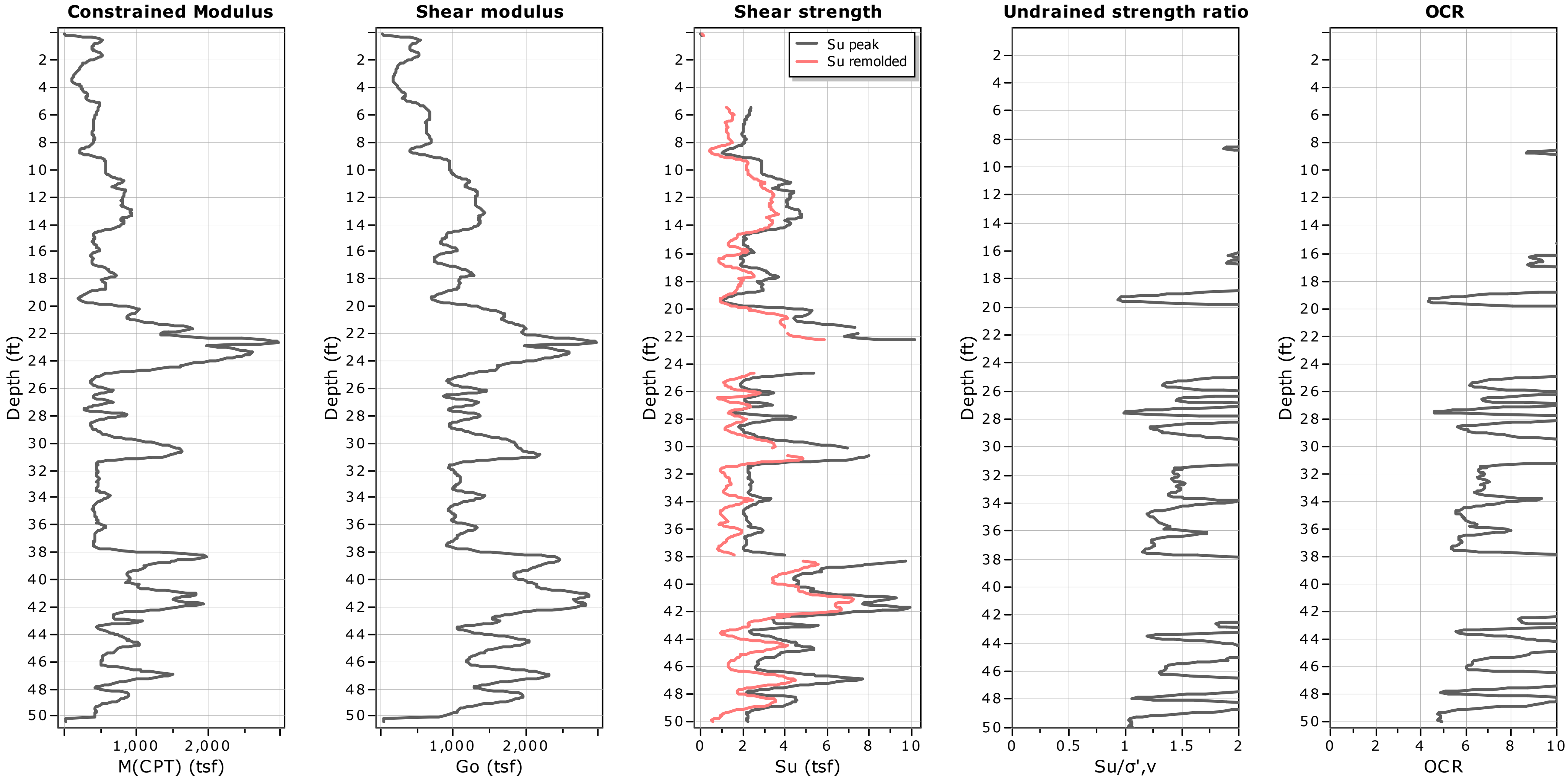
Project:
Location:



Calculation parameters
Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
—●— User defined estimation data

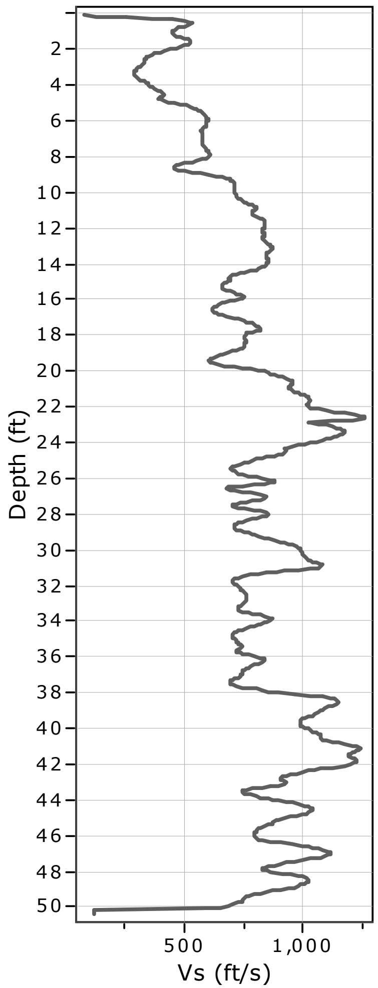
CPT: CPT-01
Total depth: 50.39 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



Calculation parameters
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
●— User defined estimation data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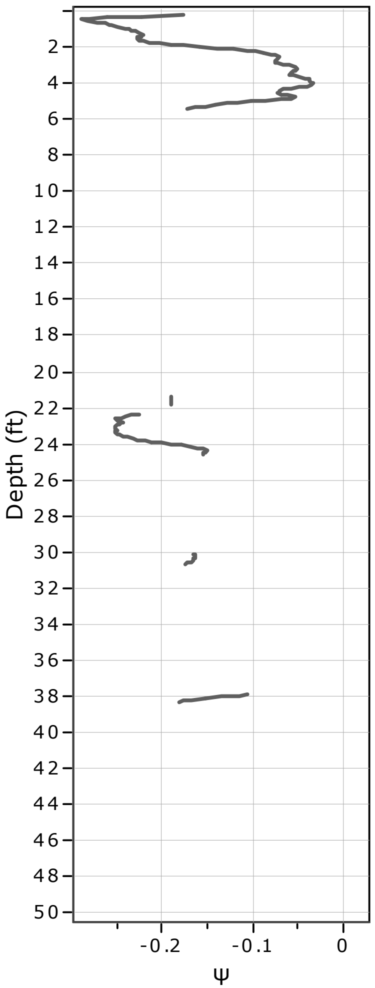
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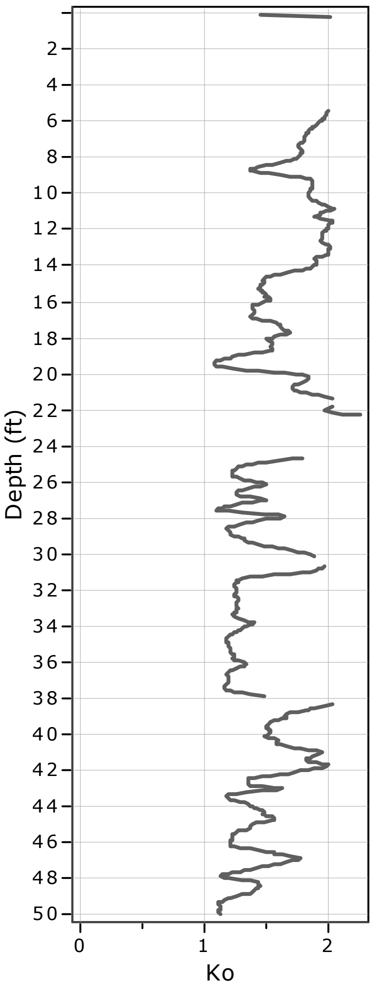
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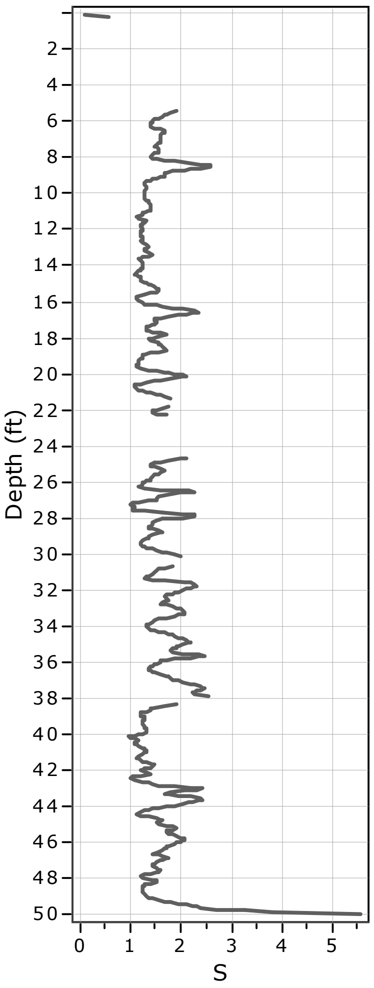
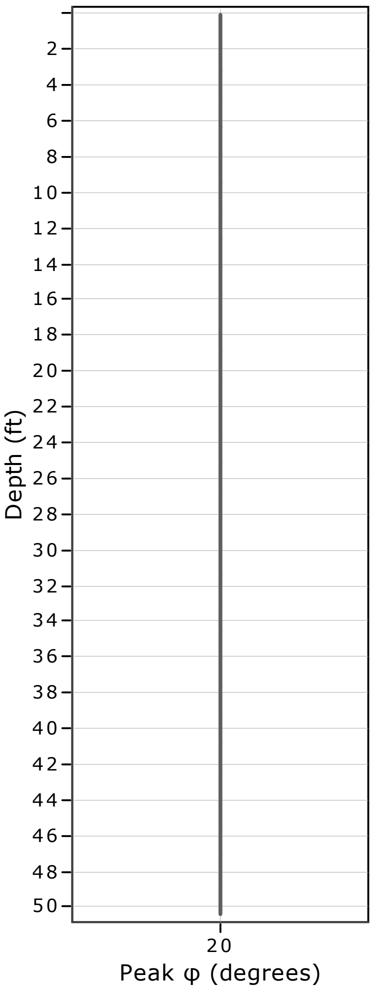

Soil sensitivity


Effective friction angle

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

● User defined estimation data

CPT: CPT-02
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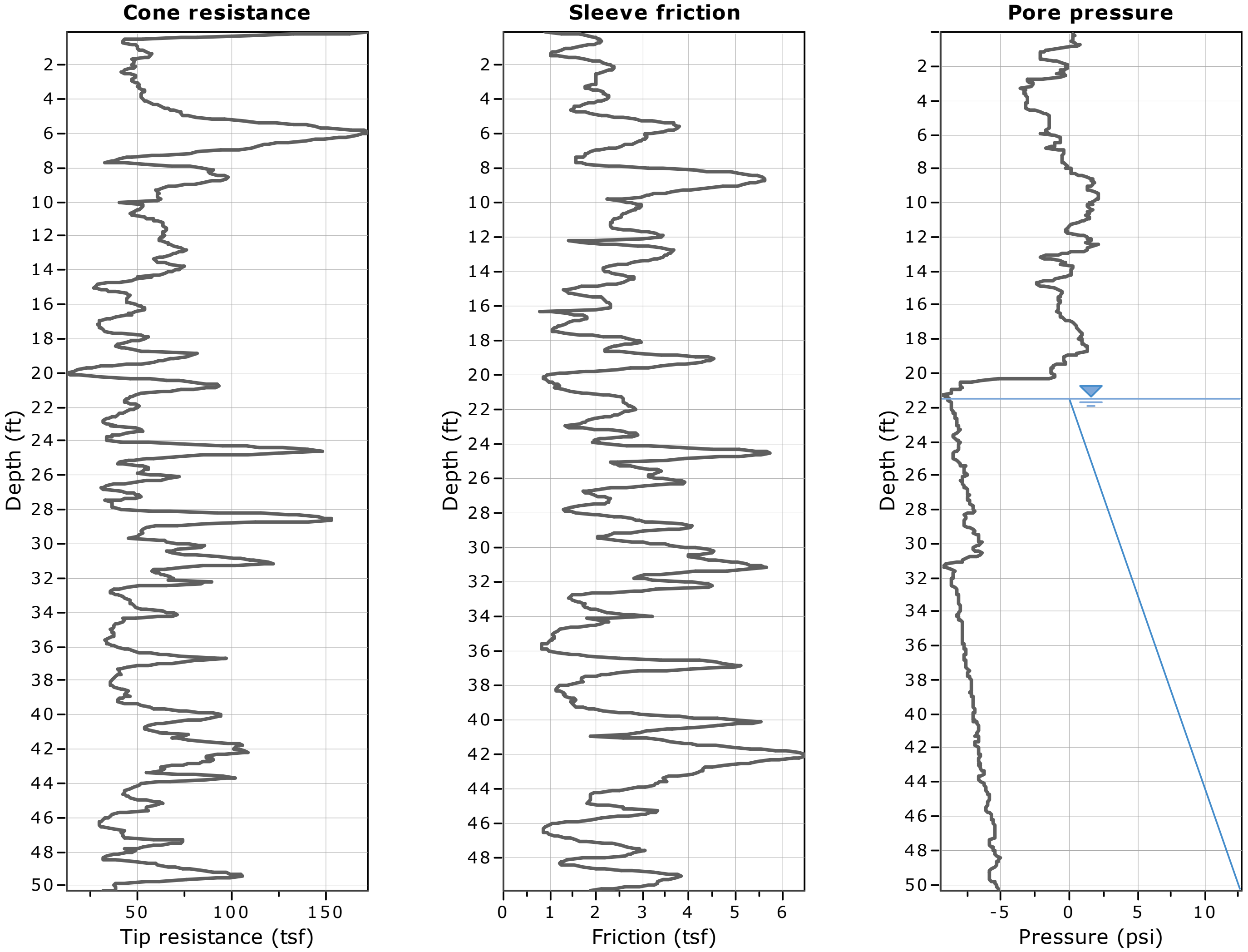
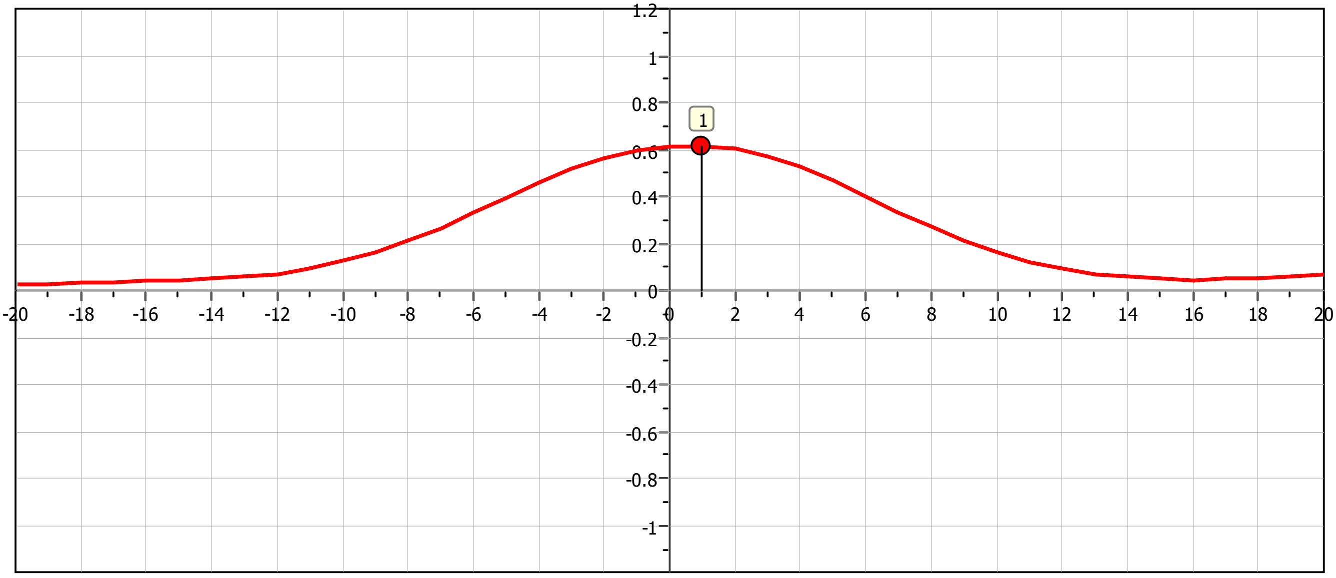
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).

Cross correlation between qc & fs



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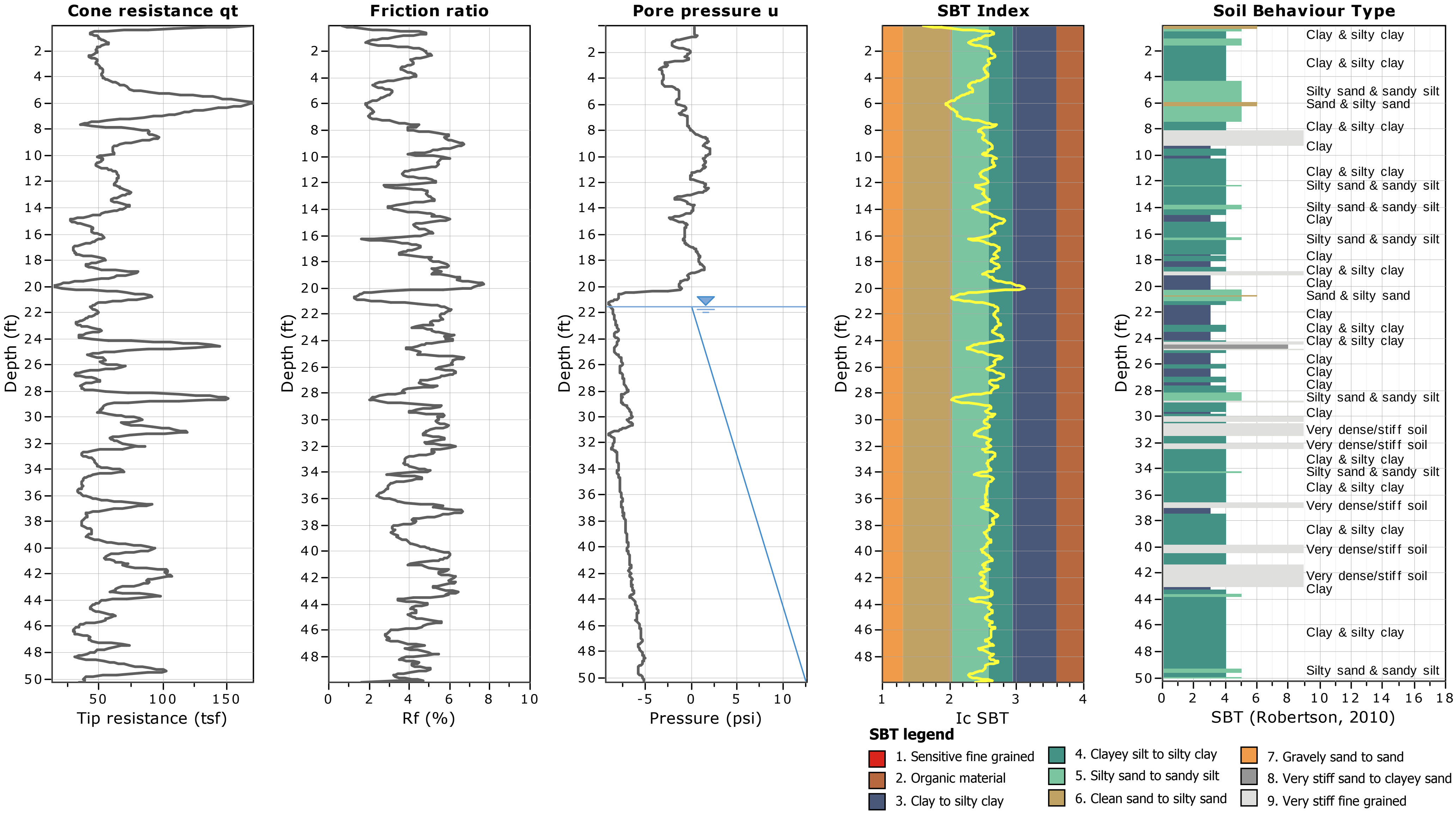
Cone Operator: Uknown

Project:
Location:



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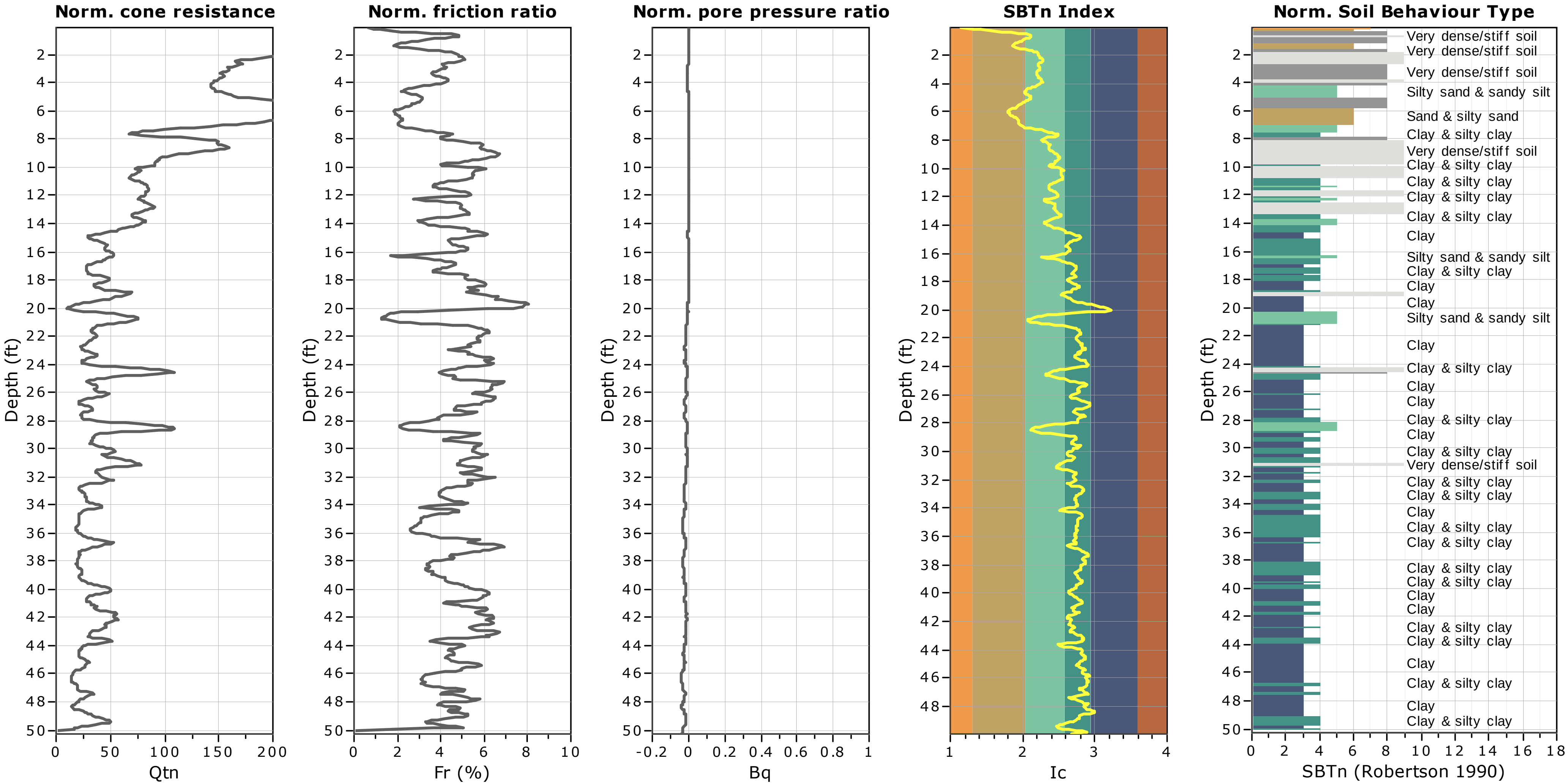
Cone Operator: Uknown

Project:
Location:



SBTn legend

- 🟥 1. Sensitive fine grained
- 🟫 2. Organic material
- 🟦 3. Clay to silty clay
- 🟩 4. Clayey silt to silty clay
- 🟩 5. Silty sand to sandy silt
- 🟨 6. Clean sand to silty sand
- 🟧 7. Gravely sand to sand
- ⬛ 8. Very stiff sand to clayey sand
- ⬜ 9. Very stiff fine grained

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Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

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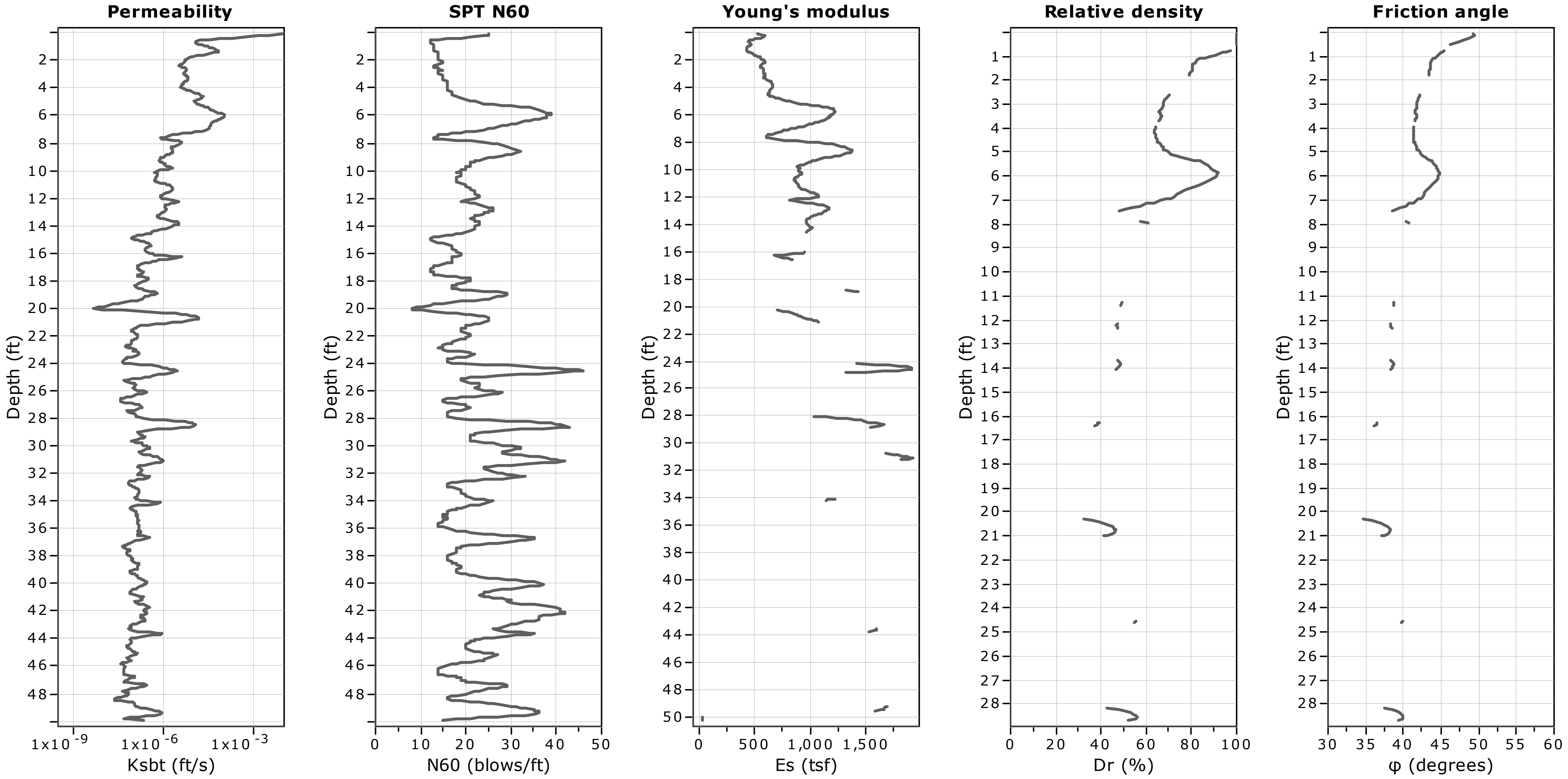
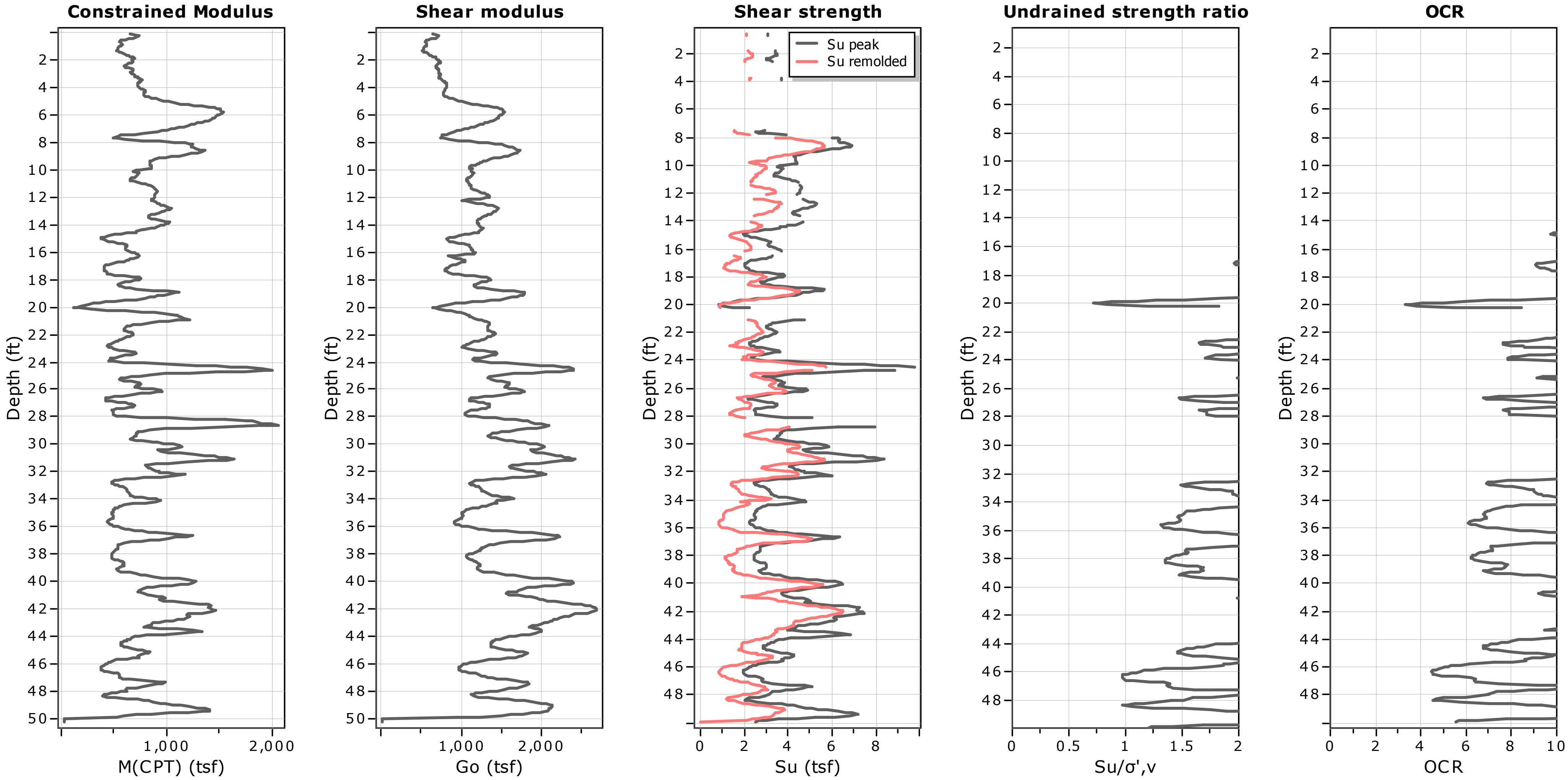


Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)
Relative desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
● User defined estimation data

CPT: CPT-02
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



Calculation parameters

Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
● User defined estimation data

CPT: CPT-02
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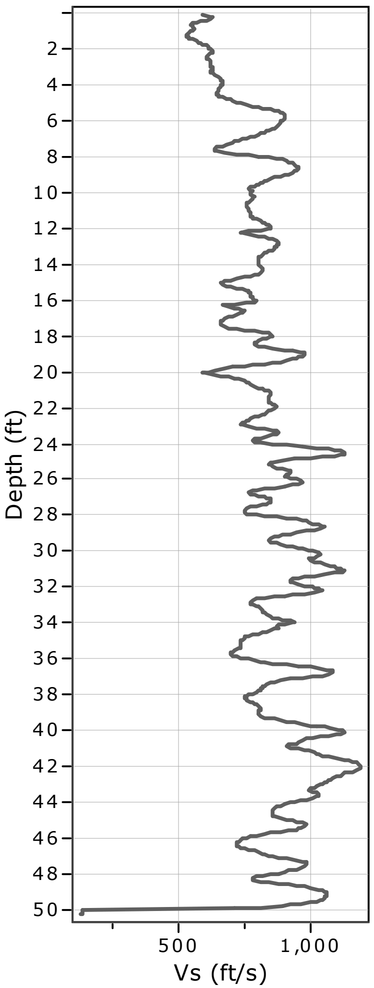
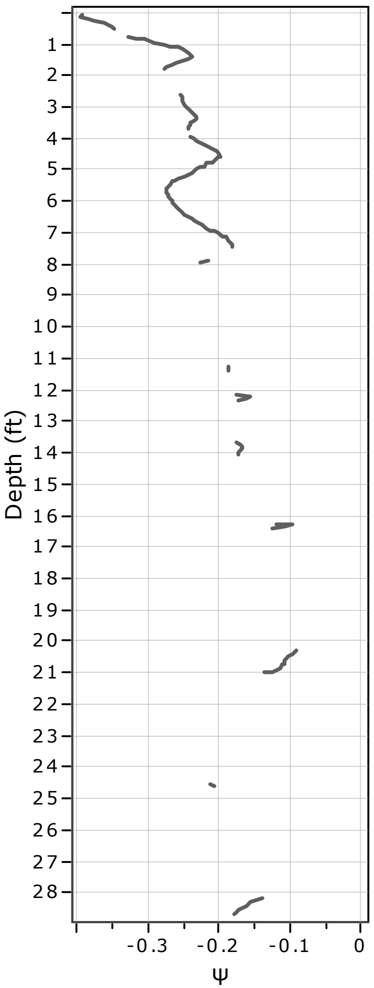
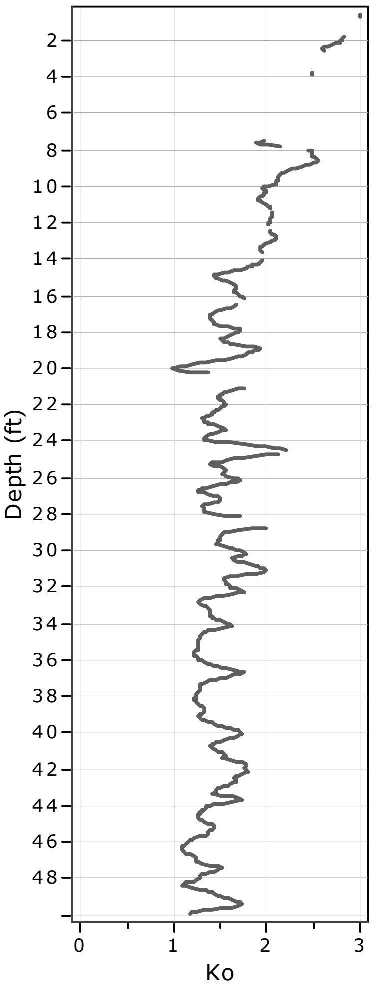
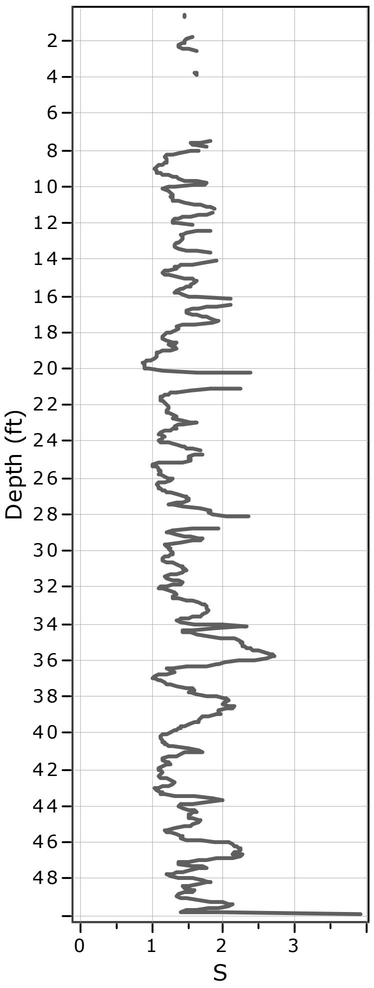
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

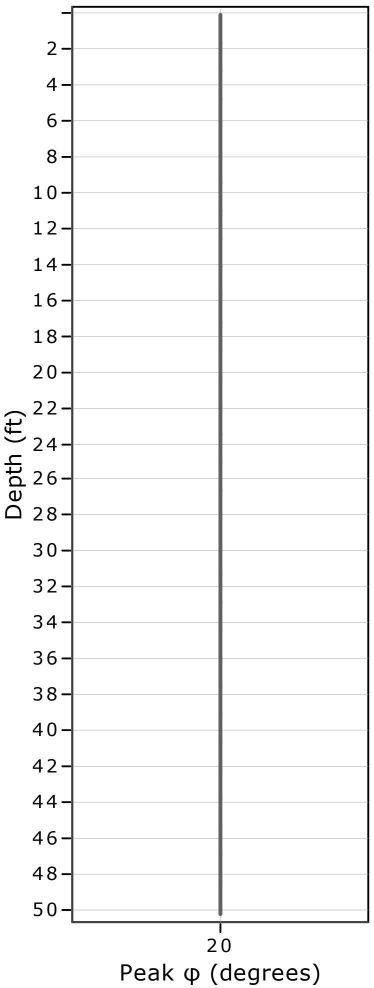
Project:
Location:


Shear Wave velocity


State parameter


In-situ stress ratio


Soil sensitivity

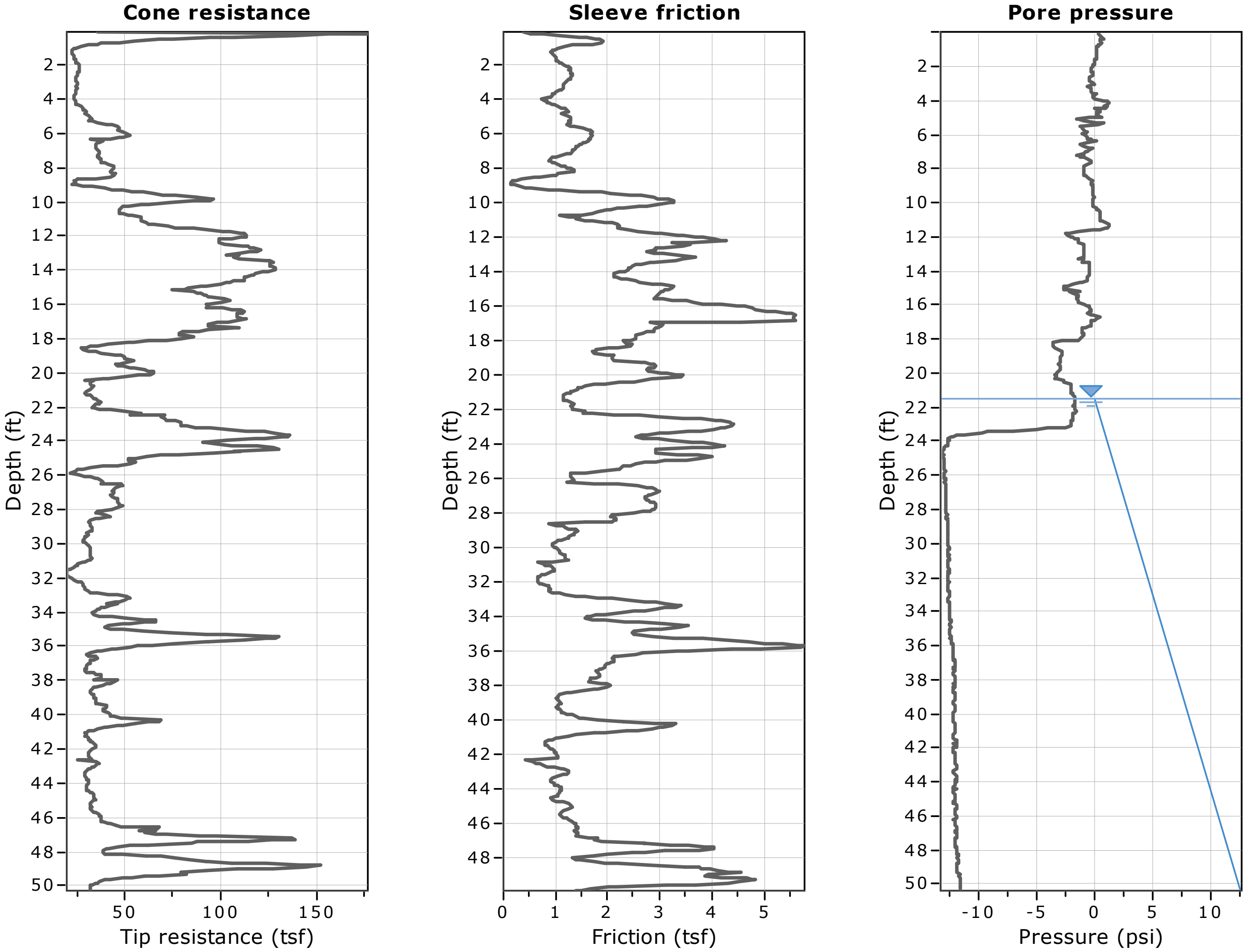

Effective friction angle

Calculation parameters

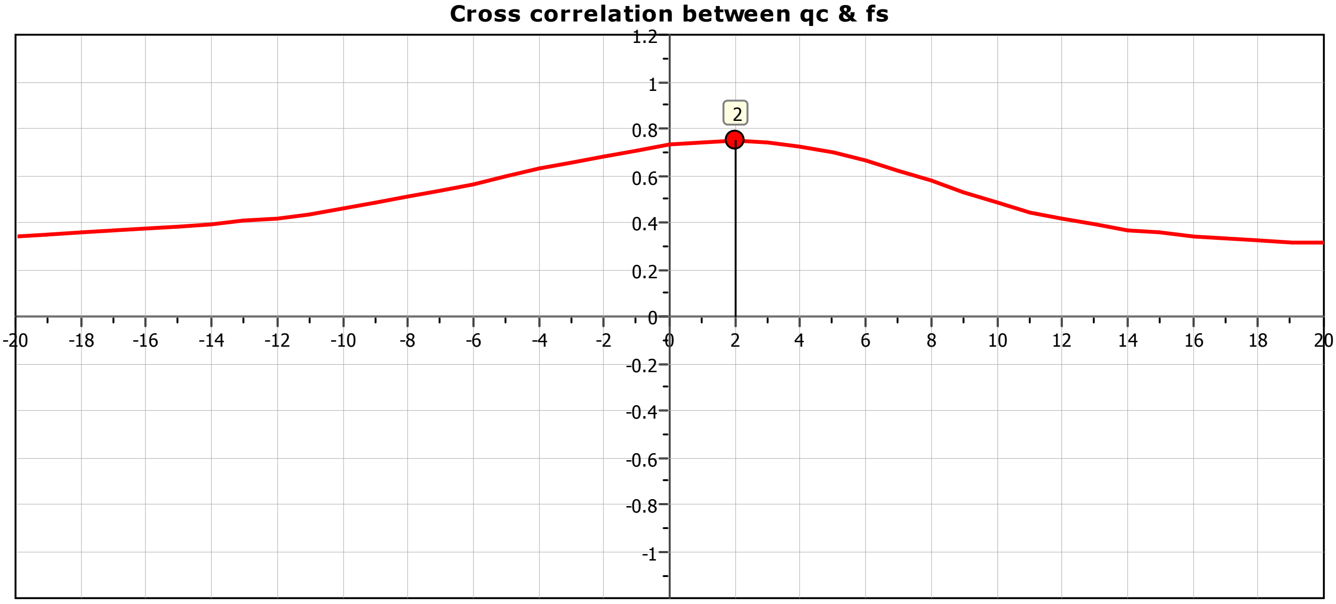
Soil Sensitivity factor, N_S: 7.00
—●— User defined estimation data

CPT: CPT-03
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



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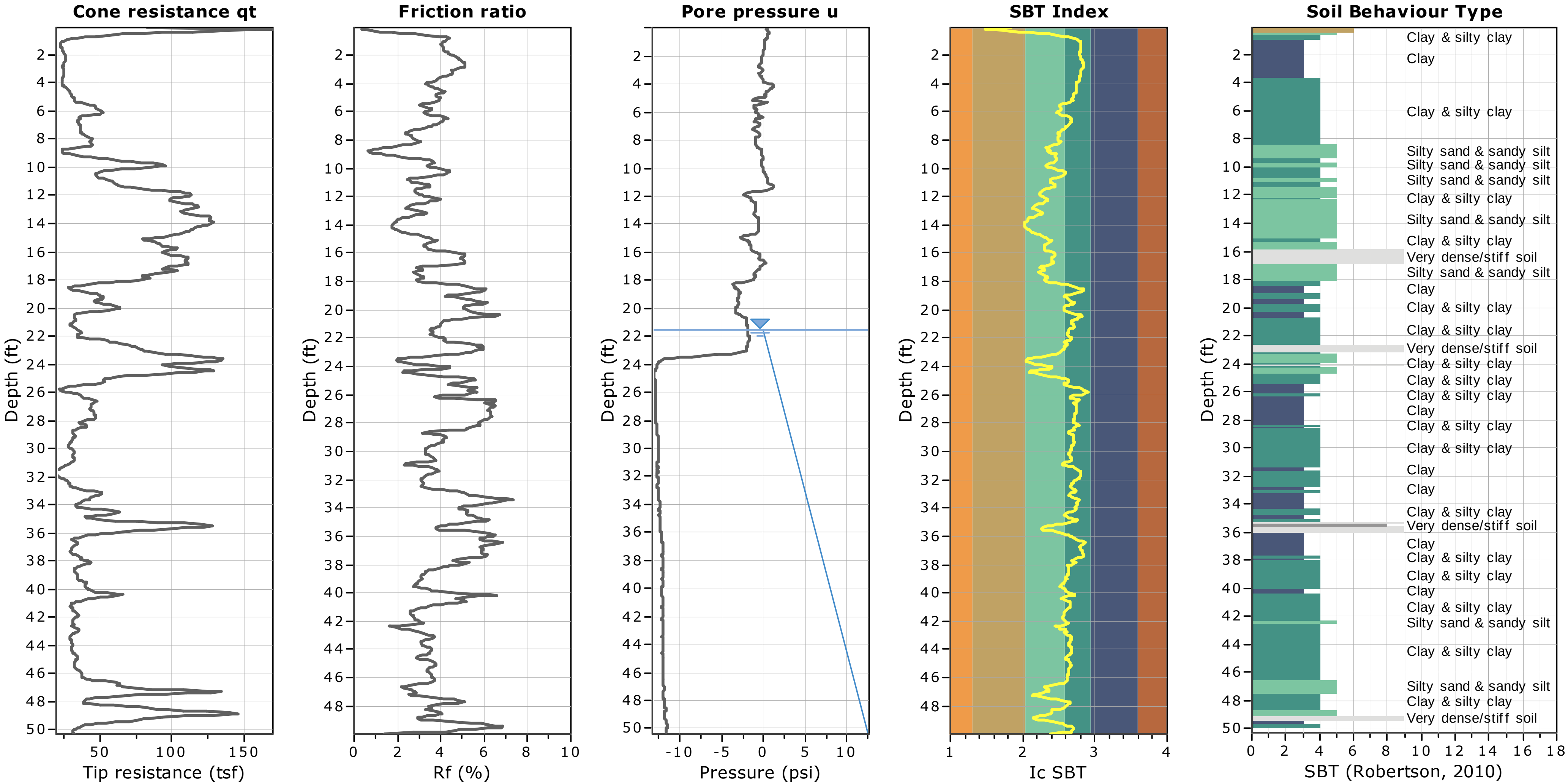
CPT: CPT-03
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:

Location:



SBT legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬜ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

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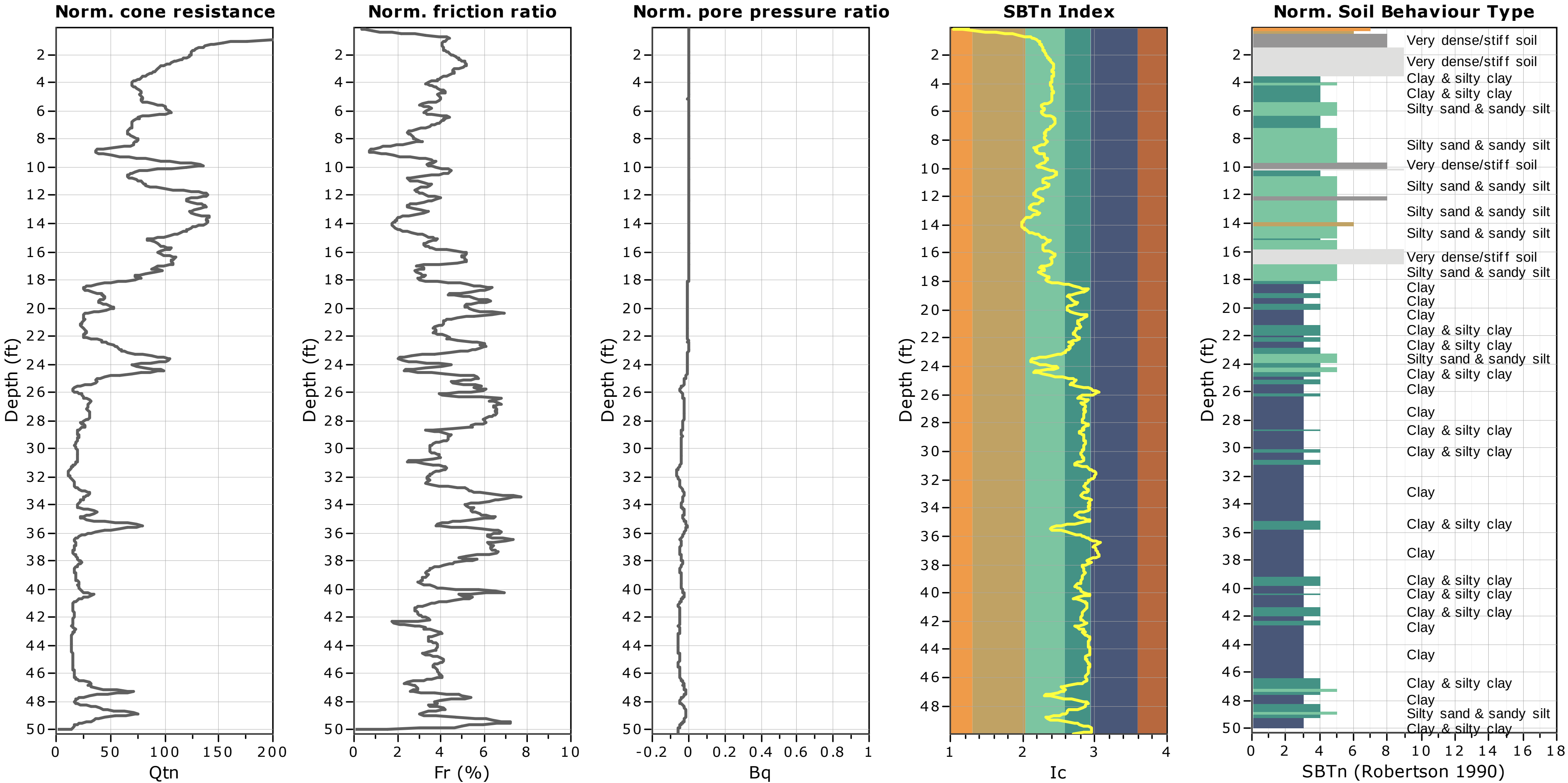
CPT: CPT-03
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

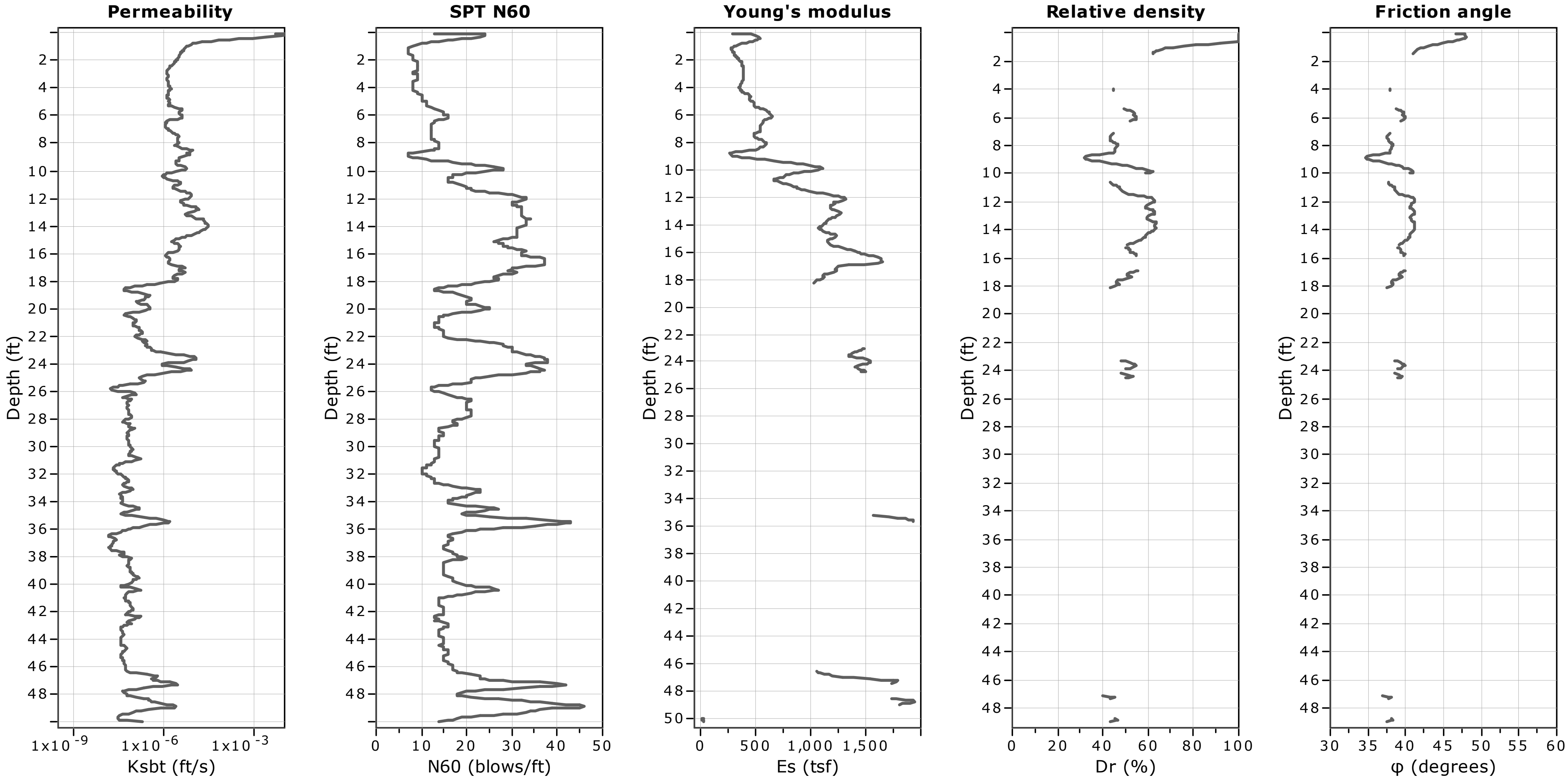


SBTn legend

🟥 1. Sensitive fine grained
🟫 2. Organic material
🟦 3. Clay to silty clay
🟩 4. Clayey silt to silty clay
🟩 5. Silty sand to sandy silt
🟨 6. Clean sand to silty sand
🟧 7. Gravely sand to sand
⬛ 8. Very stiff sand to clayey sand
⬜ 9. Very stiff fine grained

CPT: CPT-03
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

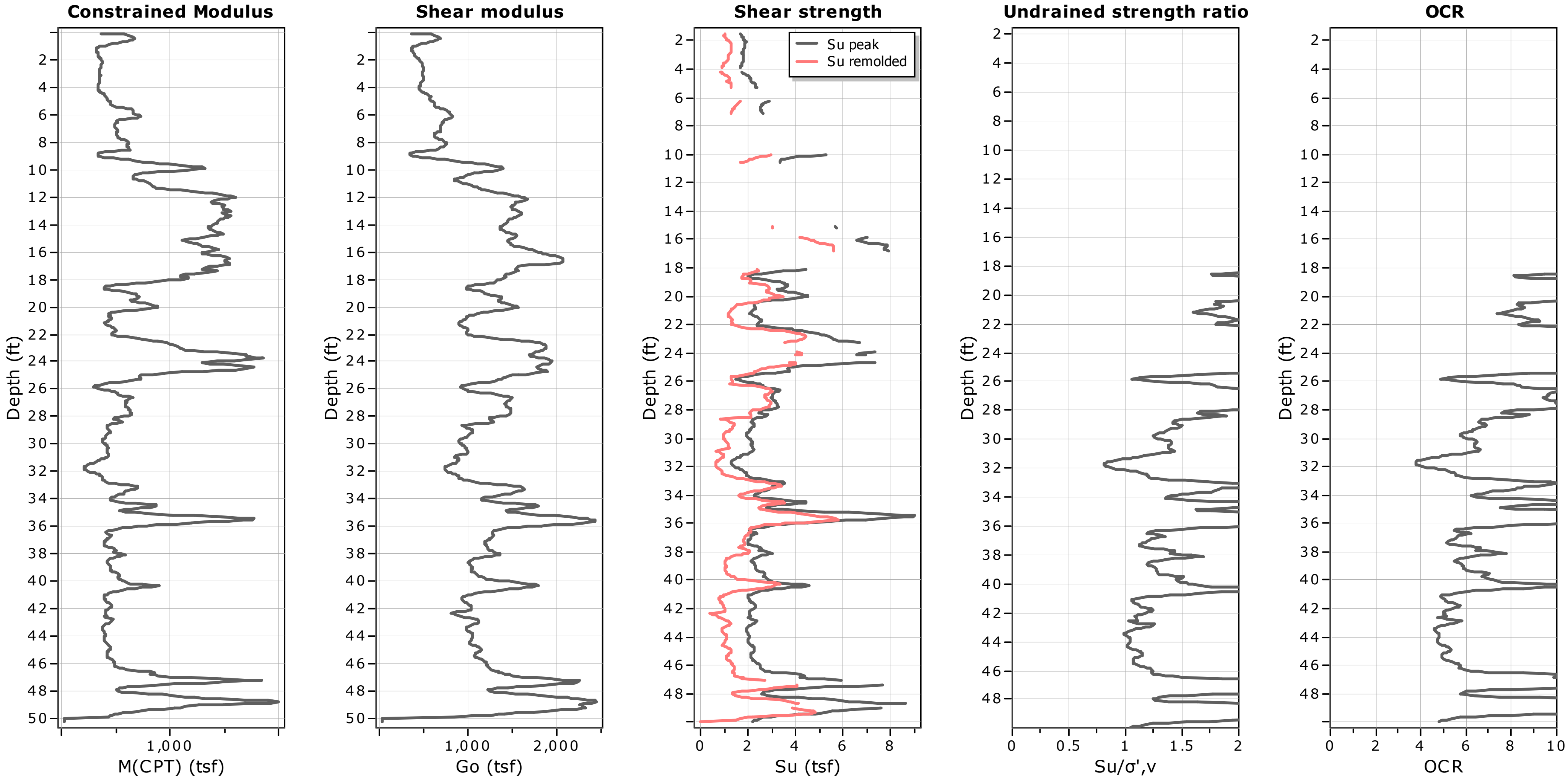


Calculation parameters

Permeability: Based on SBT$_n$
SPT N$_{60}$: Based on I$_c$ and q$_t$
Young's modulus: Based on variable alpha using I$_c$ (Robertson, 2009)
Relative desnisty constant, C$_{Dr}$: 350.0
Phi: Based on Kulhawy & Mayne (1990)
● User defined estimation data

CPT: CPT-03
Total depth: 50.27 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

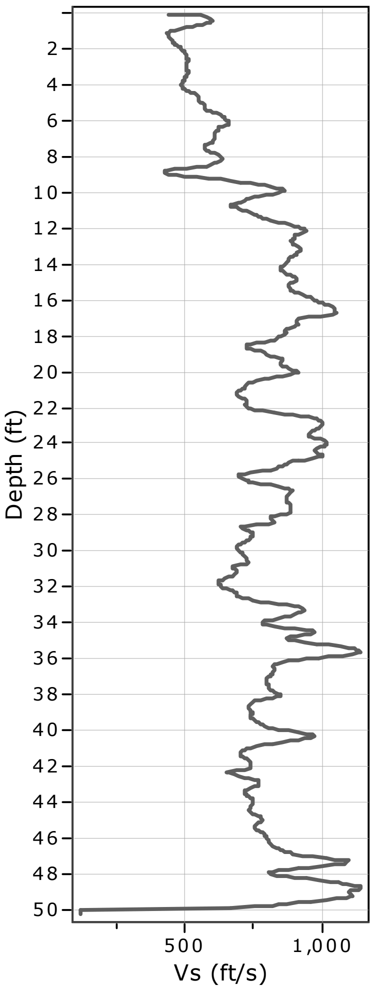
Project:
Location:



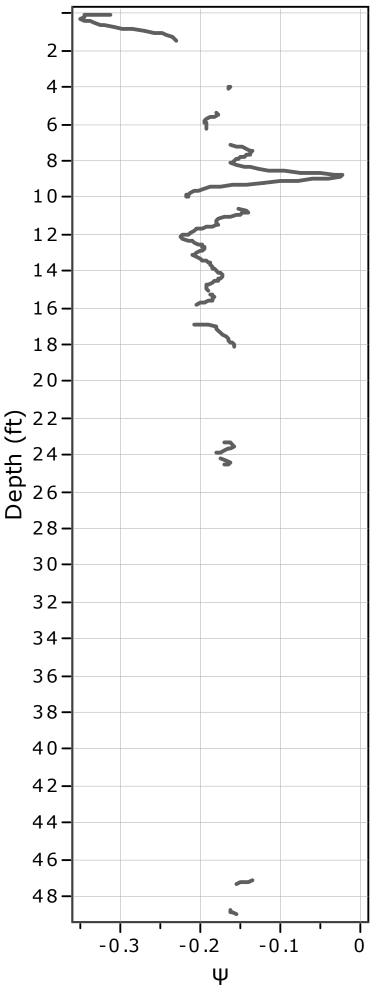
Calculation parameters
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

OCR factor for clays, N_{kt}: 0.33
●— User defined estimation data

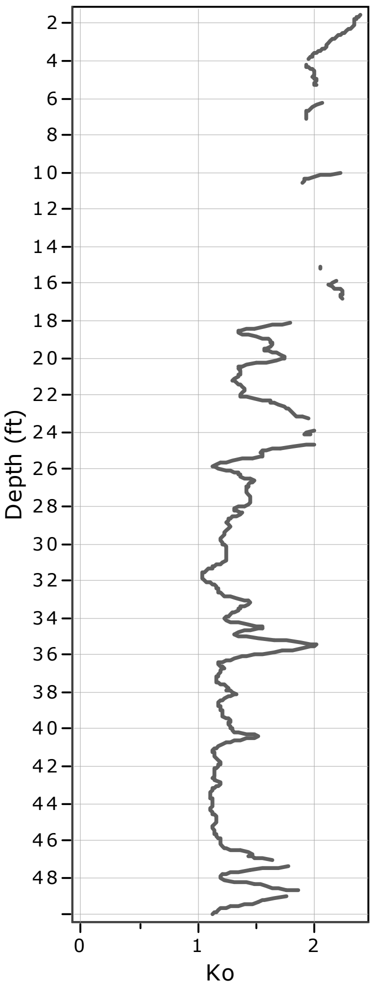
Shear Wave velocity



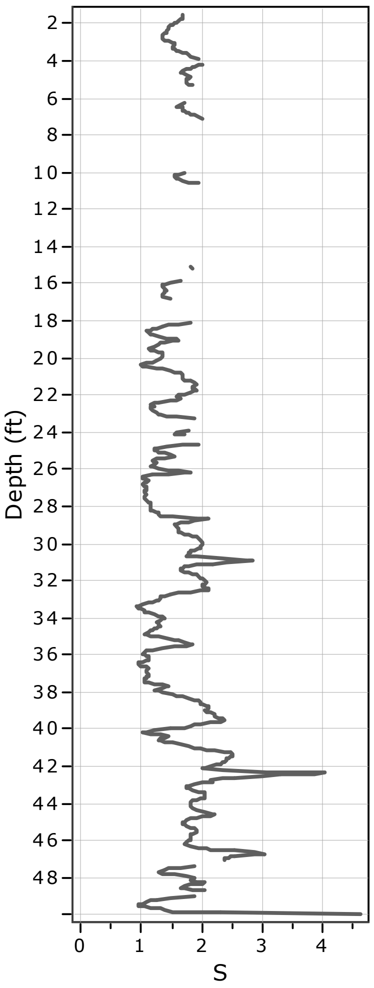
State parameter



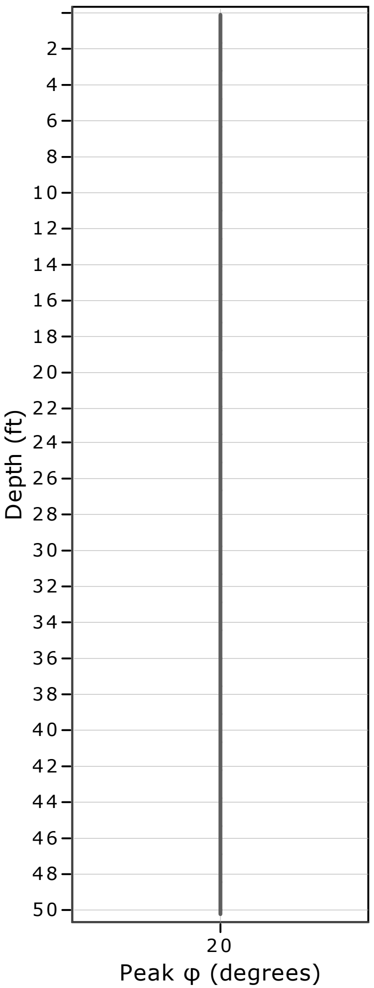
In-situ stress ratio



Soil sensitivity



Effective friction angle



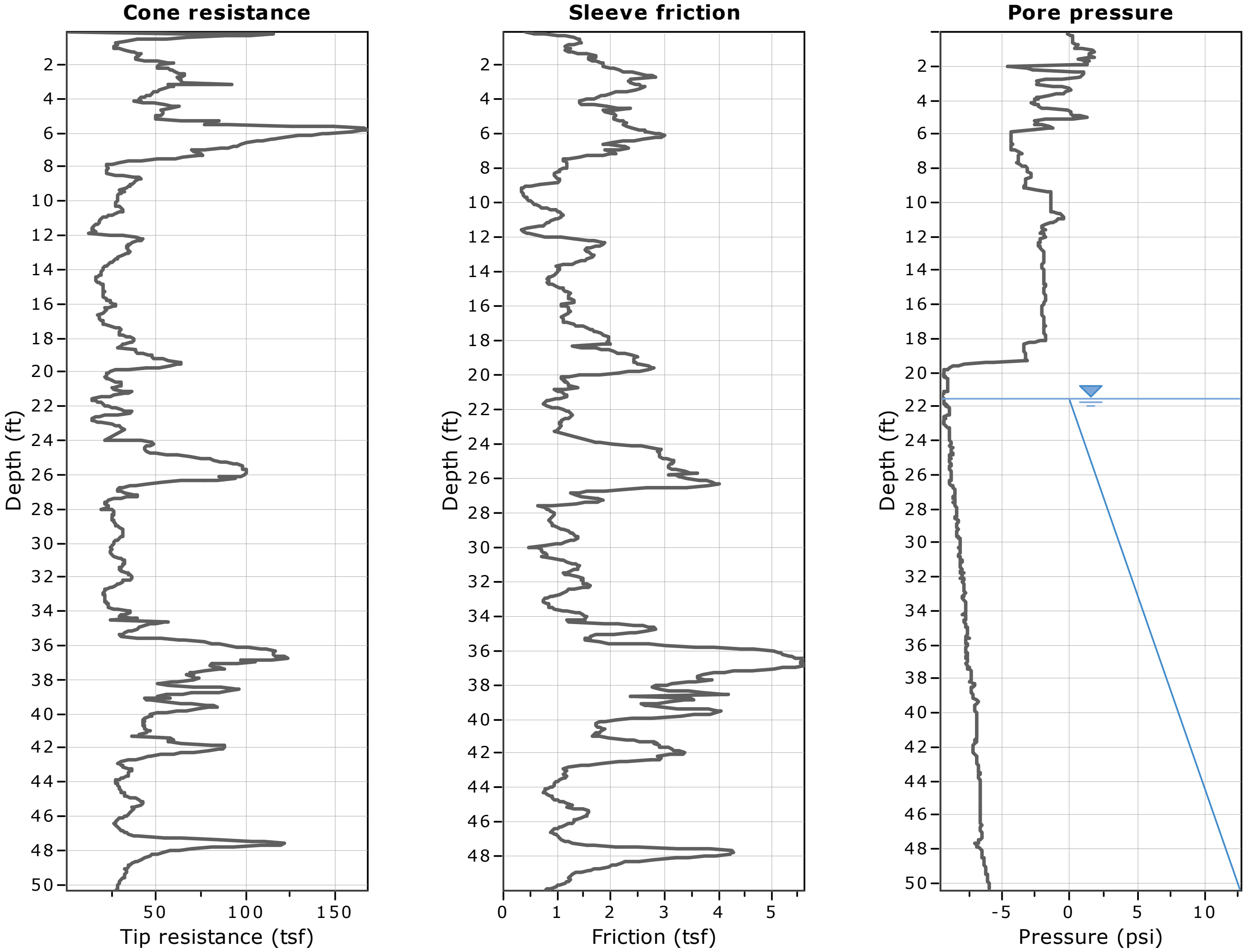
Calculation parameters

Soil Sensitivity factor, N_S: 7.00

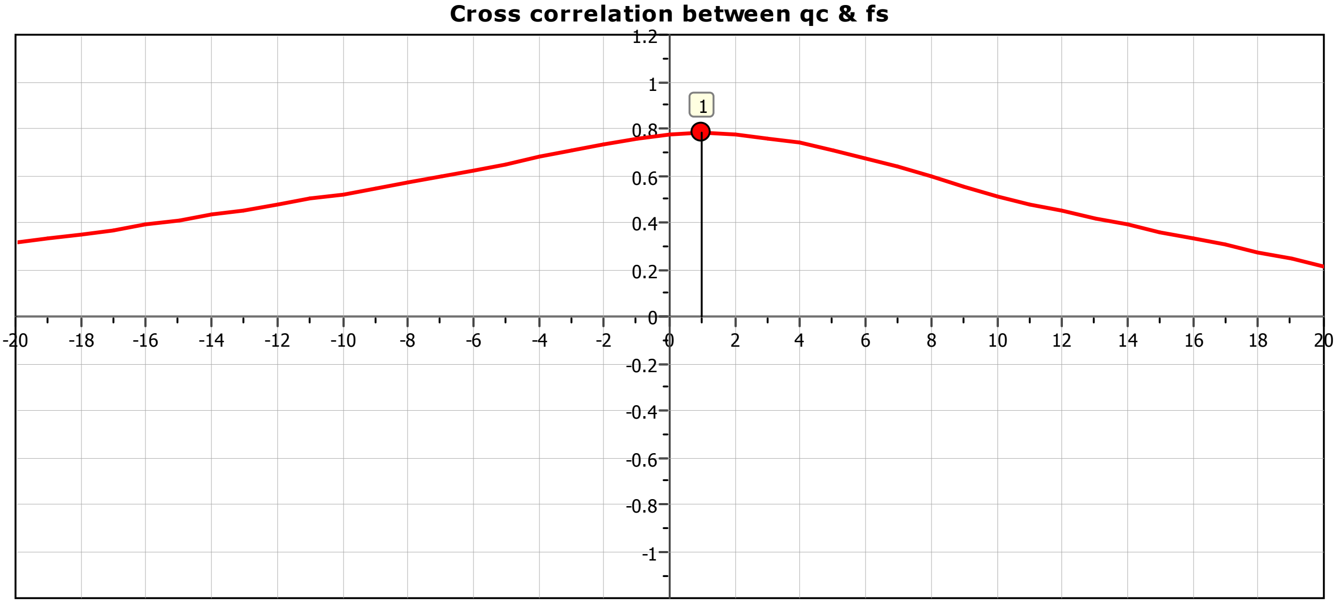
● User defined estimation data

CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:

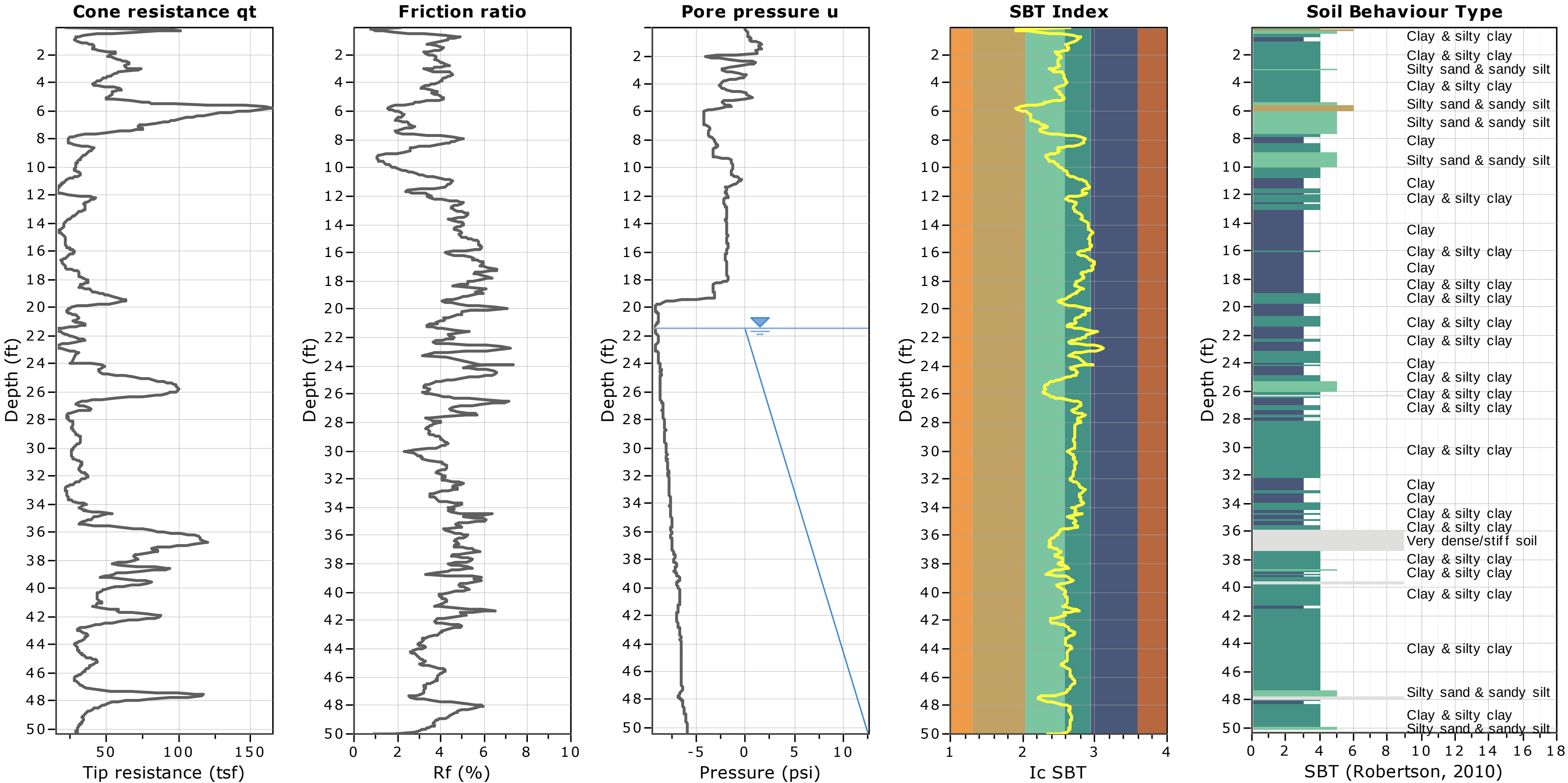


The plot below presents the cross correlation coeficient between the raw qc and fs values (as measured on the field). X axes presents the lag distance (one lag is the distance between two sucessive CPT measurements).



CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

Project:
Location:



SBT legend

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

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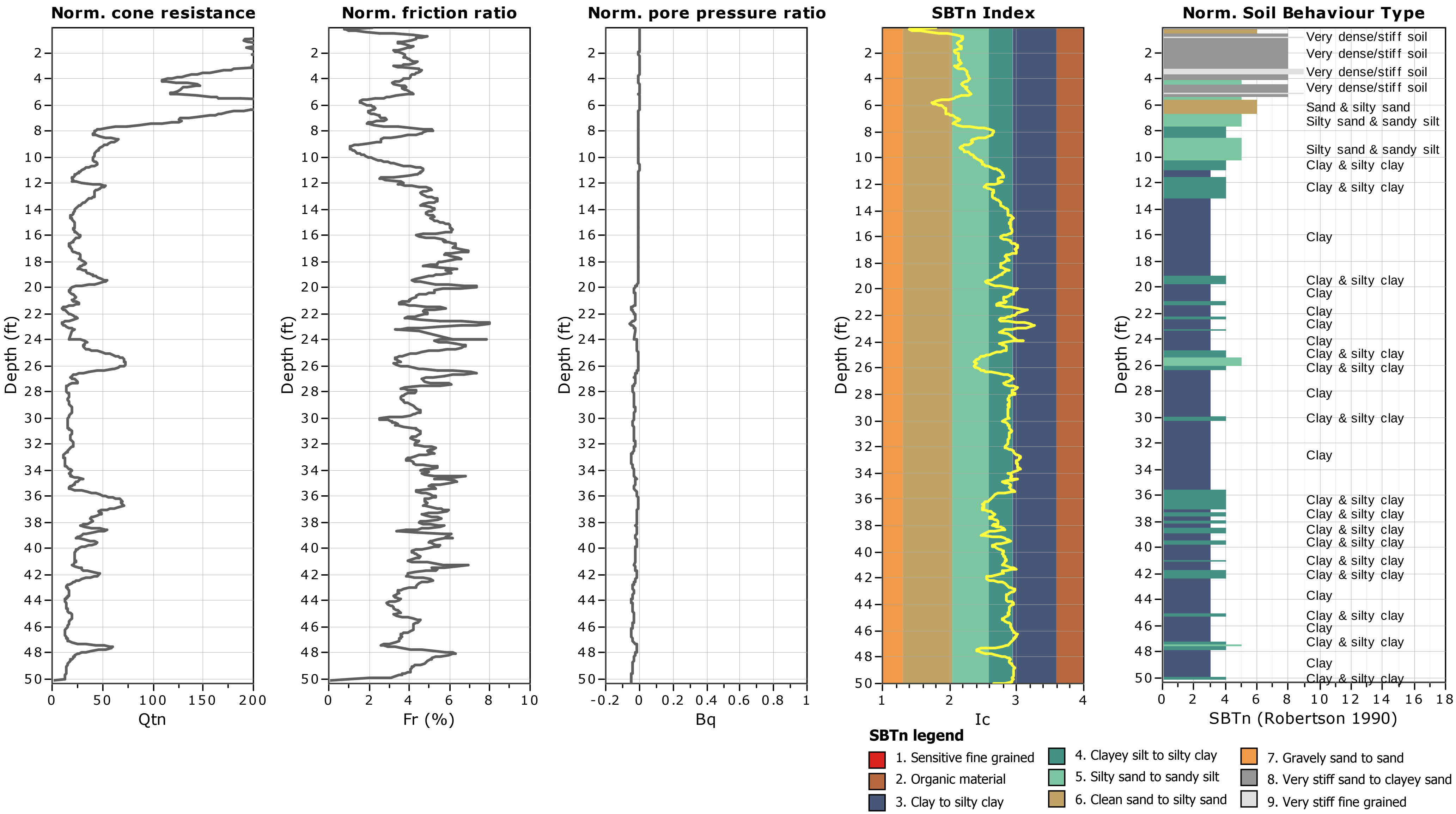
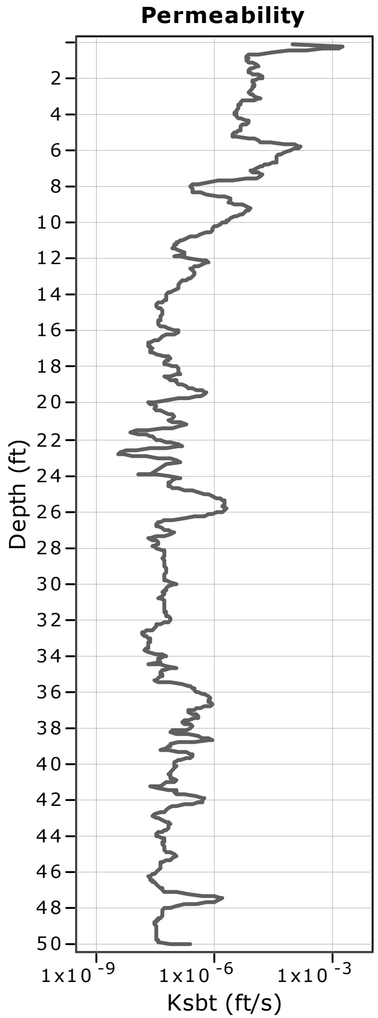
CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

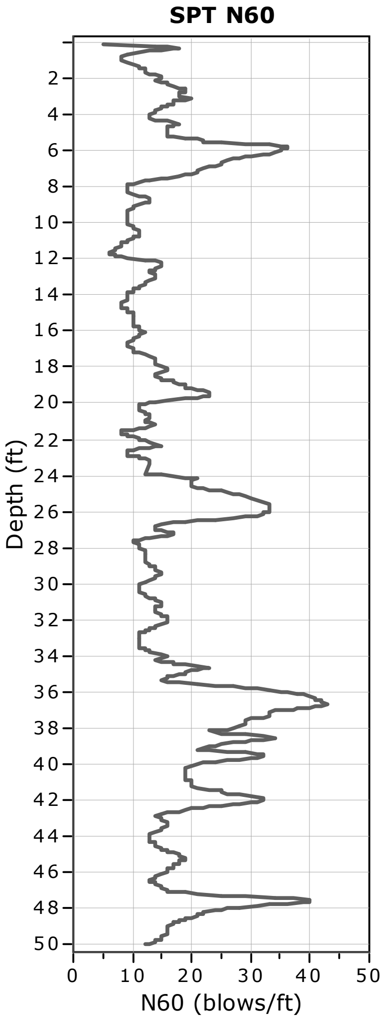
Project:
Location:

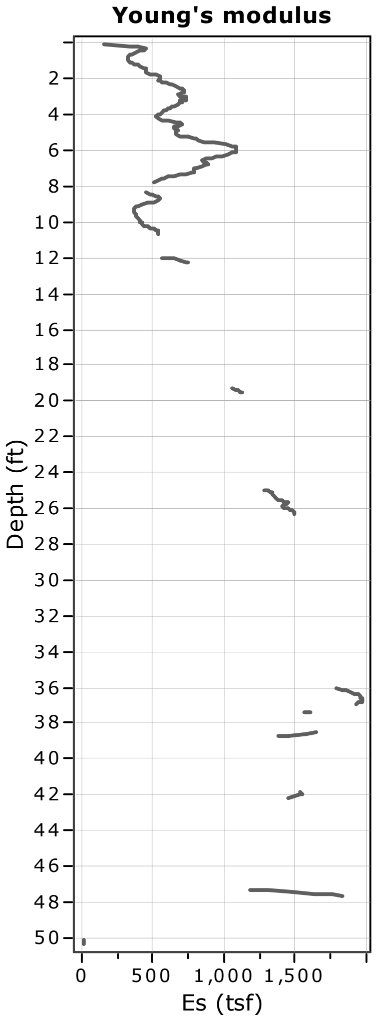


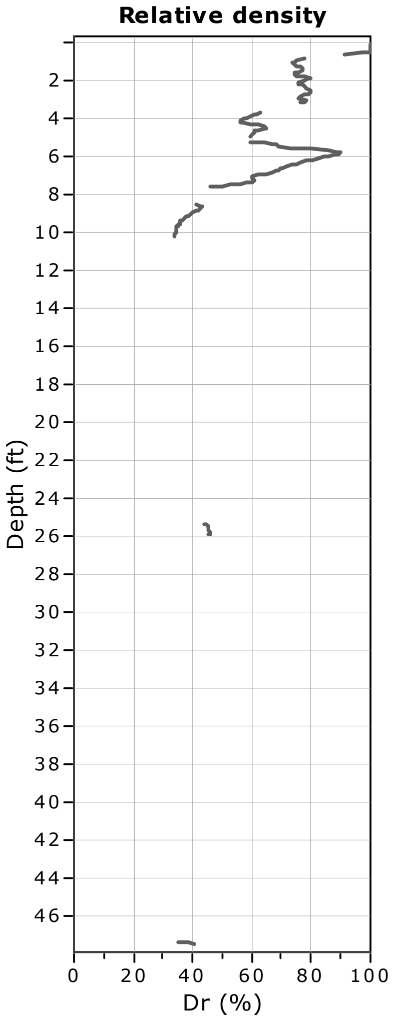
CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

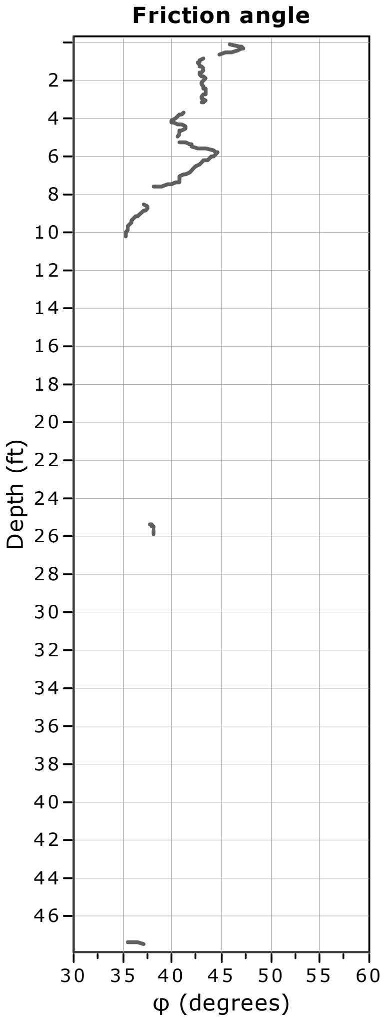
Project:
Location:











Calculation parameters

Permeability: Based on SBT_n
SPT N_{60}: Based on I_c and q_t
Young's modulus: Based on variable alpha using I_c (Robertson, 2009)

Relative desnisty constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)
—●— User defined estimation data

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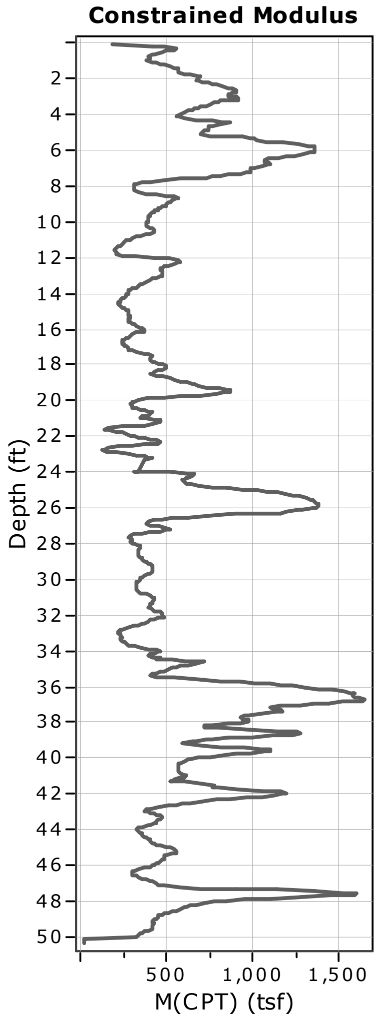
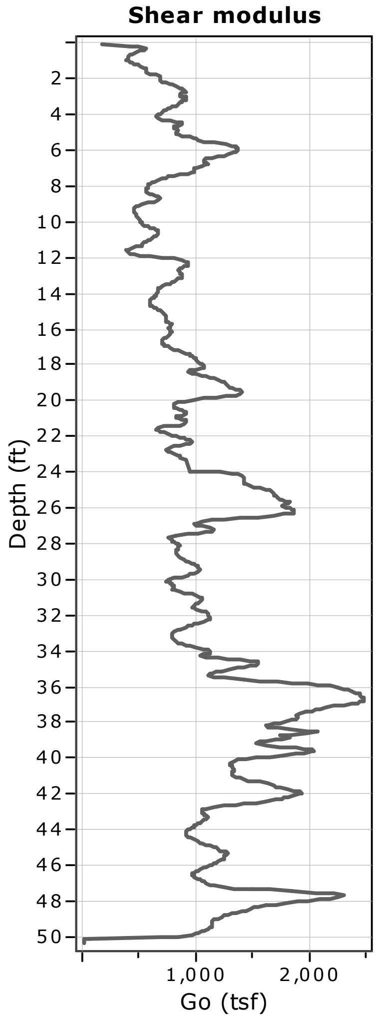
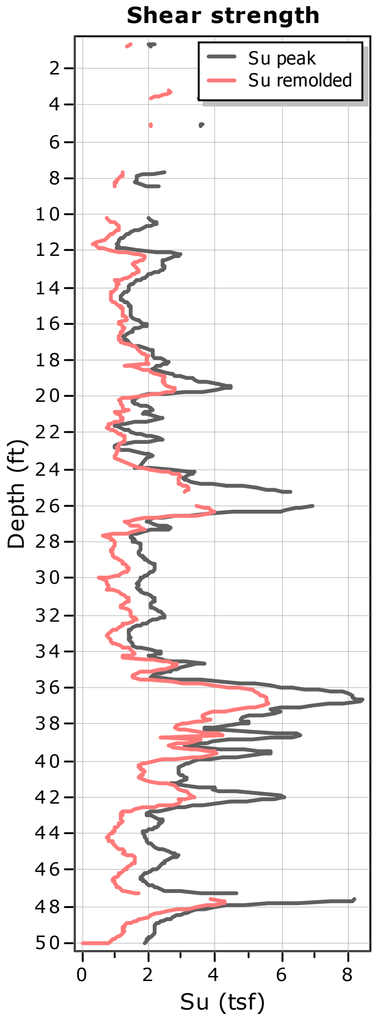
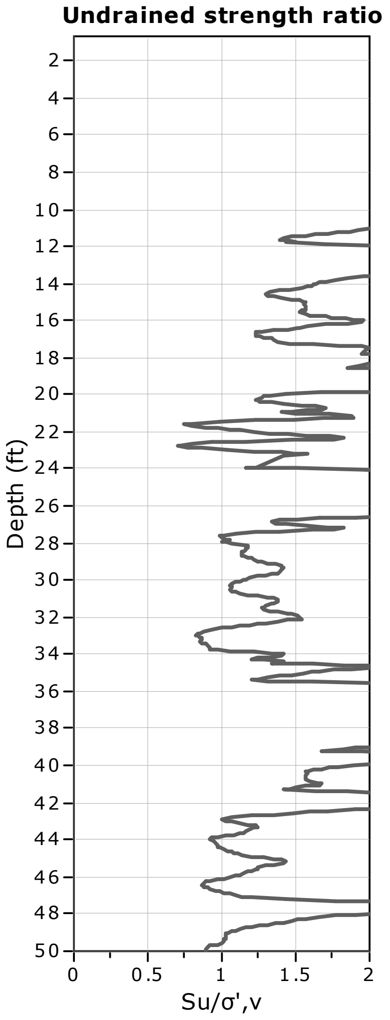
CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

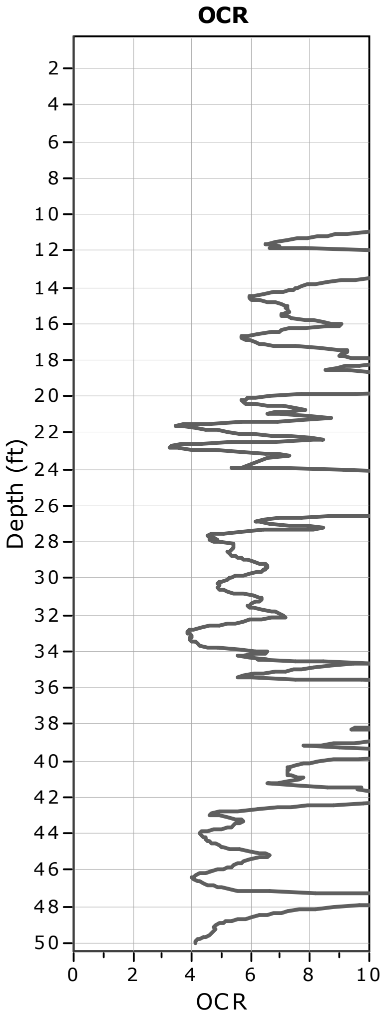
Project:
Location:











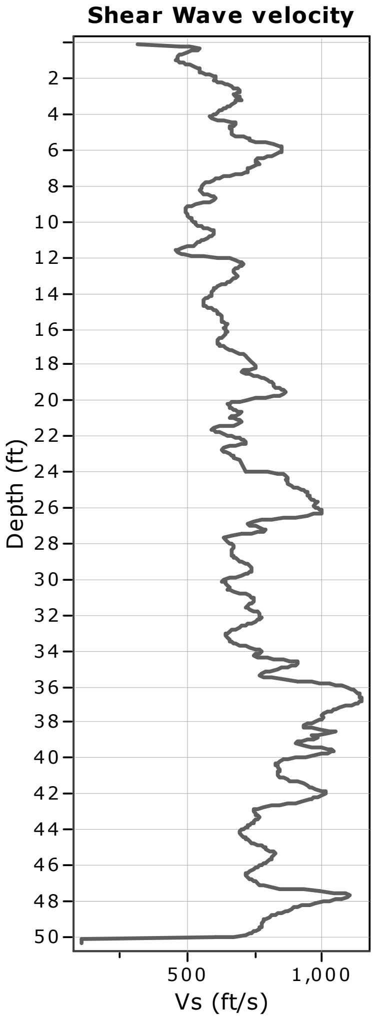
Calculation parameters

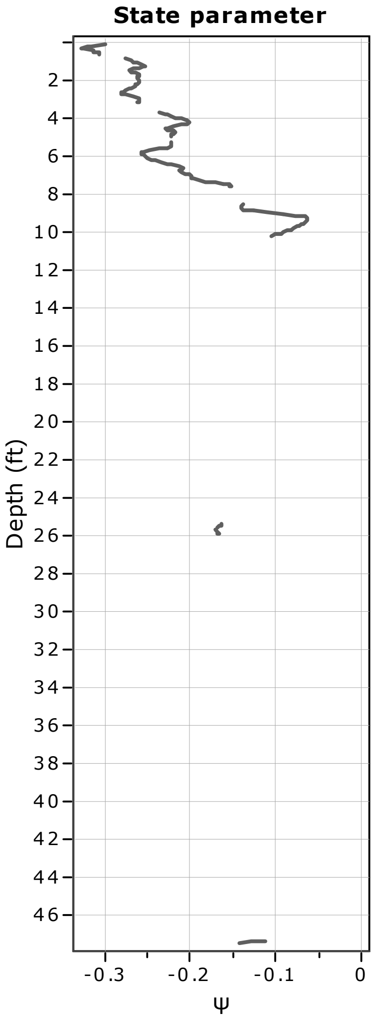
Constrained modulus: Based on variable *alpha* using I_c and Q_{tn} (Robertson, 2009)
Go: Based on variable *alpha* using I_c (Robertson, 2009)
Undrained shear strength cone factor for clays, N_{kt}: 14

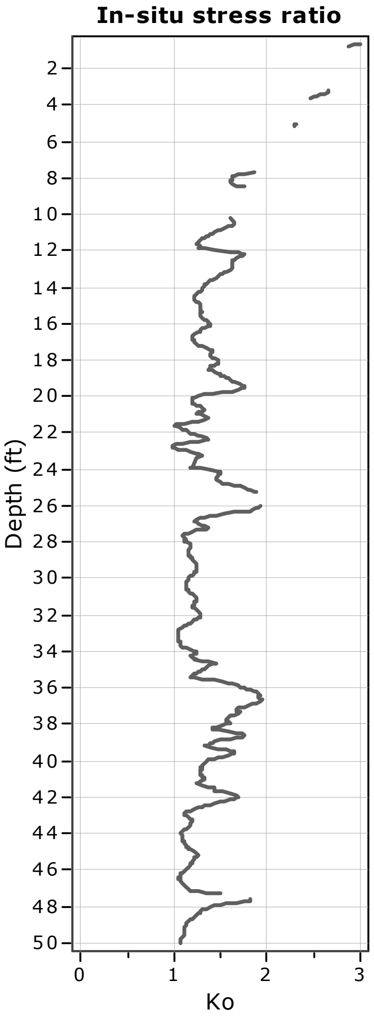
OCR factor for clays, N_{kt}: 0.33
—●— User defined estimation data

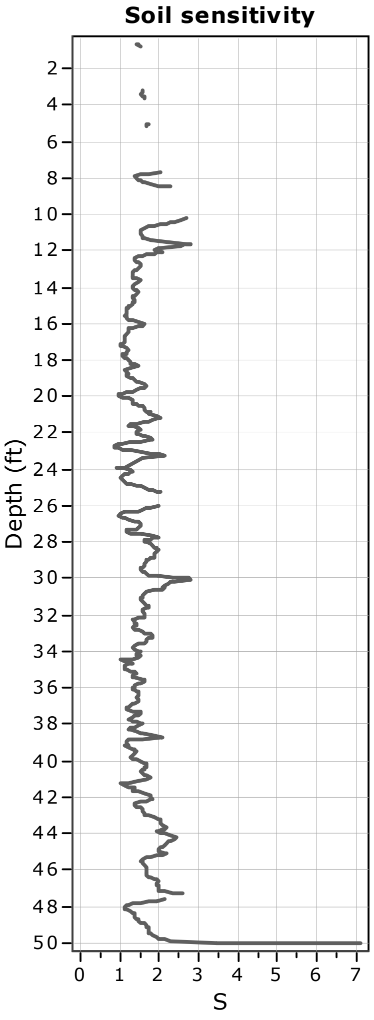
CPT: CPT-04
Total depth: 50.34 ft, Date: 10/31/2022
Surface Elevation: 0.00 ft
Coords: X:0.00, Y:0.00
Cone Type: Uknown
Cone Operator: Uknown

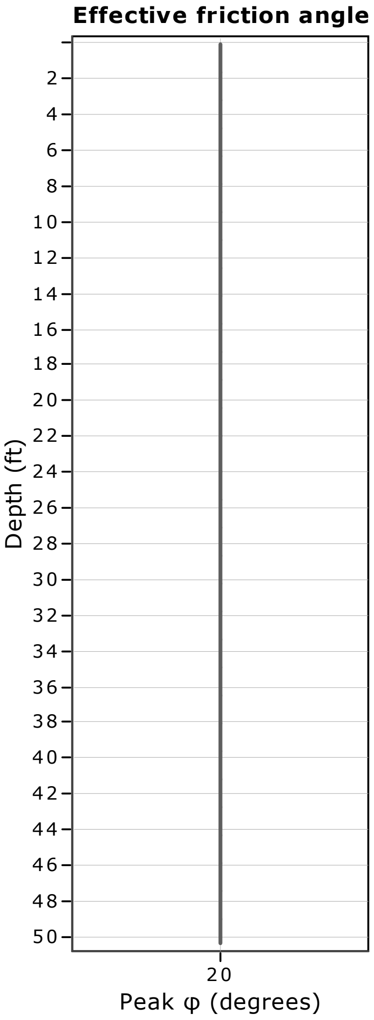
Project:
Location:











Calculation parameters

Soil Sensitivity factor, N_S: 7.00
● User defined estimation data

Presented below is a list of formulas used for the estimation of various soil properties. The formulas are presented in SI unit system and assume that all components are expressed in the same units.

:: Unit Weight, g (kN/m³) ::

$$g = g_w \cdot \left(0.27 \cdot \log(R_f) + 0.36 \cdot \log(\frac{q_t}{p_a}) + 1.236 \right)$$

where g_w = water unit weight

:: Permeability, k (m/s) ::

$I_c < 3.27$ and $I_c > 1.00$ then $k = 10^{0.952\text{-}3.04 \cdot I_c}$

$I_c \leq 4.00$ and $I_c > 3.27$ then $k = 10^{\text{-}4.52\text{-}1.37 \cdot I_c}$

:: N_{SPT} (blows per 30 cm) ::

$$N_{60} = \left(\frac{q_c}{P_a} \right) \cdot \frac{1}{10^{1.1268 - 0.2817 \cdot I_c}}$$

$$N_{1(60)} = Q_{tn} \cdot \frac{1}{10^{1.1268 - 0.2817 \cdot I_c}}$$

:: Young's Modulus, Es (MPa) ::

$$(q_t - \sigma_v) \cdot 0.015 \cdot 10^{0.55 \cdot I_c + 1.68}$$

(applicable only to $I_c < I_{c\_cutoff}$)

:: Relative Density, Dr (%) ::

$100 \cdot \sqrt{\frac{Q_{tn}}{k_{DR}}}$ (applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

:: State Parameter, ψ ::

$$\psi = 0.56 - 0.33 \cdot \log(Q_{tn,cs})$$

:: Peak drained friction angle, φ (°) ::

$$\varphi = 17.60 + 11 \cdot \log(Q_{tn})$$

(applicable only to SBT_n: 5, 6, 7 and 8)

:: 1-D constrained modulus, M (MPa) ::

If $I_c > 2.20$
$a = 14$ for $Q_{tn} > 14$
$a = Q_{tn}$ for $Q_{tn} \leq 14$
$M_{CPT} = a \cdot (q_t - \sigma_v)$

If $I_c \leq 2.20$
$M_{CPT} = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$

:: Small strain shear Modulus, Go (MPa) ::

$$G_0 = (q_t - \sigma_v) \cdot 0.0188 \cdot 10^{0.55 \cdot I_c + 1.68}$$

:: Shear Wave Velocity, Vs (m/s) ::

$$V_s = \left(\frac{G_0}{\rho} \right)^{0.50}$$

:: Undrained peak shear strength, Su (kPa) ::

$N_{kt} = 10.50 + 7 \cdot \log(F_r)$ or user defined

$$S_u = \frac{(q_t - \sigma_v)}{N_{kt}}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Remolded undrained shear strength, Su(rem) (kPa) ::

$S_{u(rem)} = f_s$ (applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Overconsolidation Ratio, OCR ::

$$k_{OCR} = \left[\frac{Q_{tn}^{0.20}}{0.25 \cdot (10.50 \cdot + 7 \cdot \log(F_r))} \right]^{1.25}$$ or user defined

$$OCR = k_{OCR} \cdot Q_{tn}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: In situ Stress Ratio, Ko ::

$$K_O = (1 - \sin\varphi') \cdot OCR^{\sin\varphi'}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Soil Sensitivity, S_t ::

$$S_t = \frac{N_S}{F_r}$$

(applicable only to SBT_n: 1, 2, 3, 4 and 9 or $I_c > I_{c\_cutoff}$)

:: Effective Stress Friction Angle, φ' (°) ::

$$\varphi' = 29.5° \cdot B_q^{0.121} \cdot (0.256 + 0.336 \cdot B_q + \log Q_t)$$

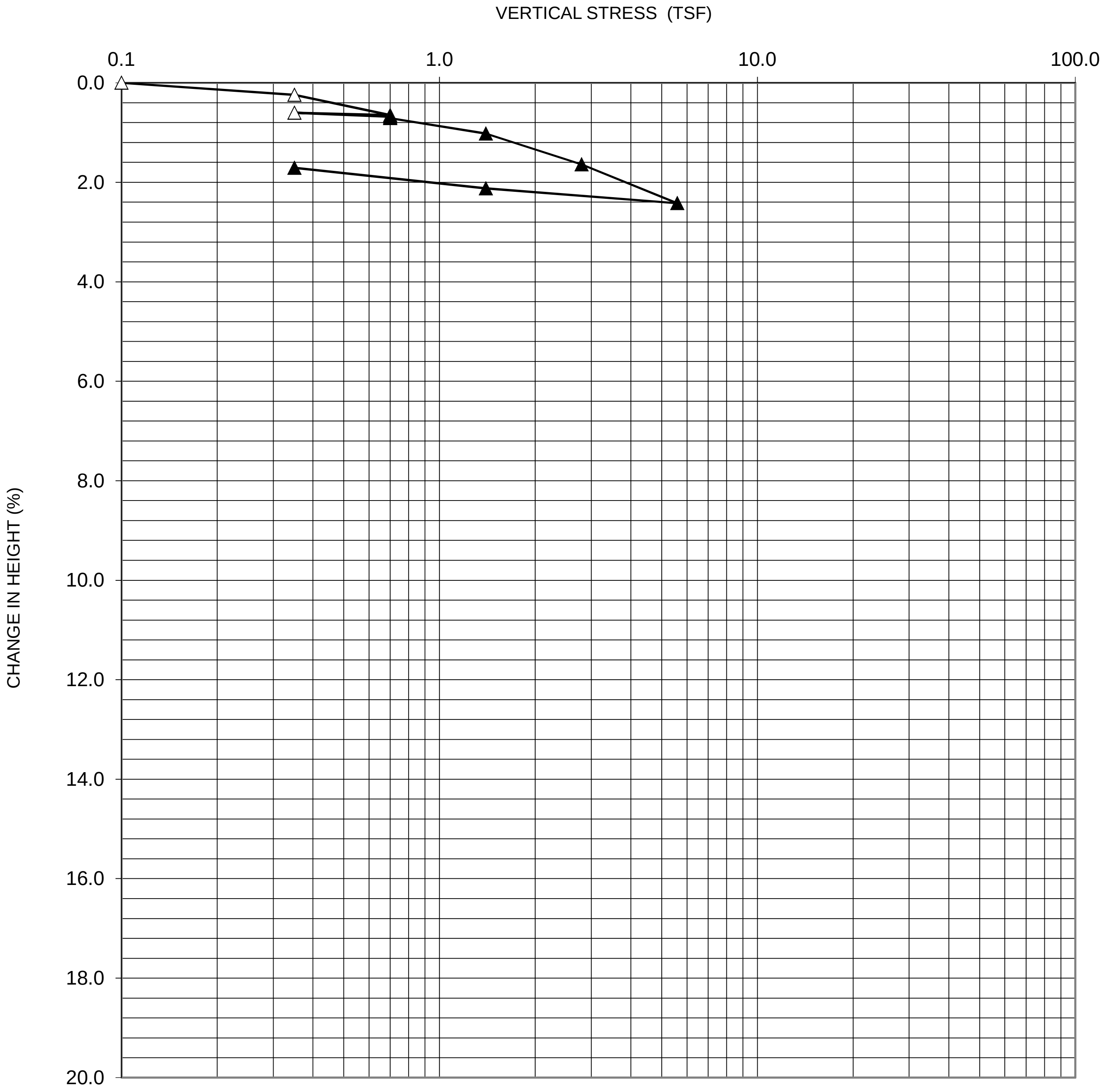
(applicable for $0.10 < B_q < 1.00$)

References

- Robertson, P.K., Cabal K.L., Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012
- Robertson, P.K., Interpretation of Cone Penetration Tests - a unified approach., Can. Geotech. J. 46(11): 1337–1355 (2009)

APPENDIX C

SUMMARY OF LABORATORY TEST RESULTS



PROJECT NO.: 22027-00

SOIL DESCRIPTIONS: DK. BR. SILTY FINE SAND W/ TRACE OF CLAY (SM)

BORING NO./LOCATION : KB - 1

DEPTH / ELEV. : 15'

LIQUID LIMIT : -

SPECIFIC GRAVITY : 2.68 (Assumed)

PLASTIC LIMIT: -

REMARKS :

	SPECIMEN HEIGHT (INCHES)	MOISTURE CONTENT (%)	DRY DENSITY (PCF)	SATURATION (%)	VOID RATIO
INITIAL	1.0000	15.3	112.7	85.0	0.484
FINAL	0.9829	16.7	114.6	97.3	0.459

CONSOLIDATION TEST CURVE

Project Name : PICERNE GARDENA
Project No. : 22027-00
Boring / Sample No : KB - 1
Depth : 22.5' (ft.)
Tested By : RB
Date: 7-Oct-22
Sample Descriptions / Classification : DK. BROWN SANDY CLAY (CL)

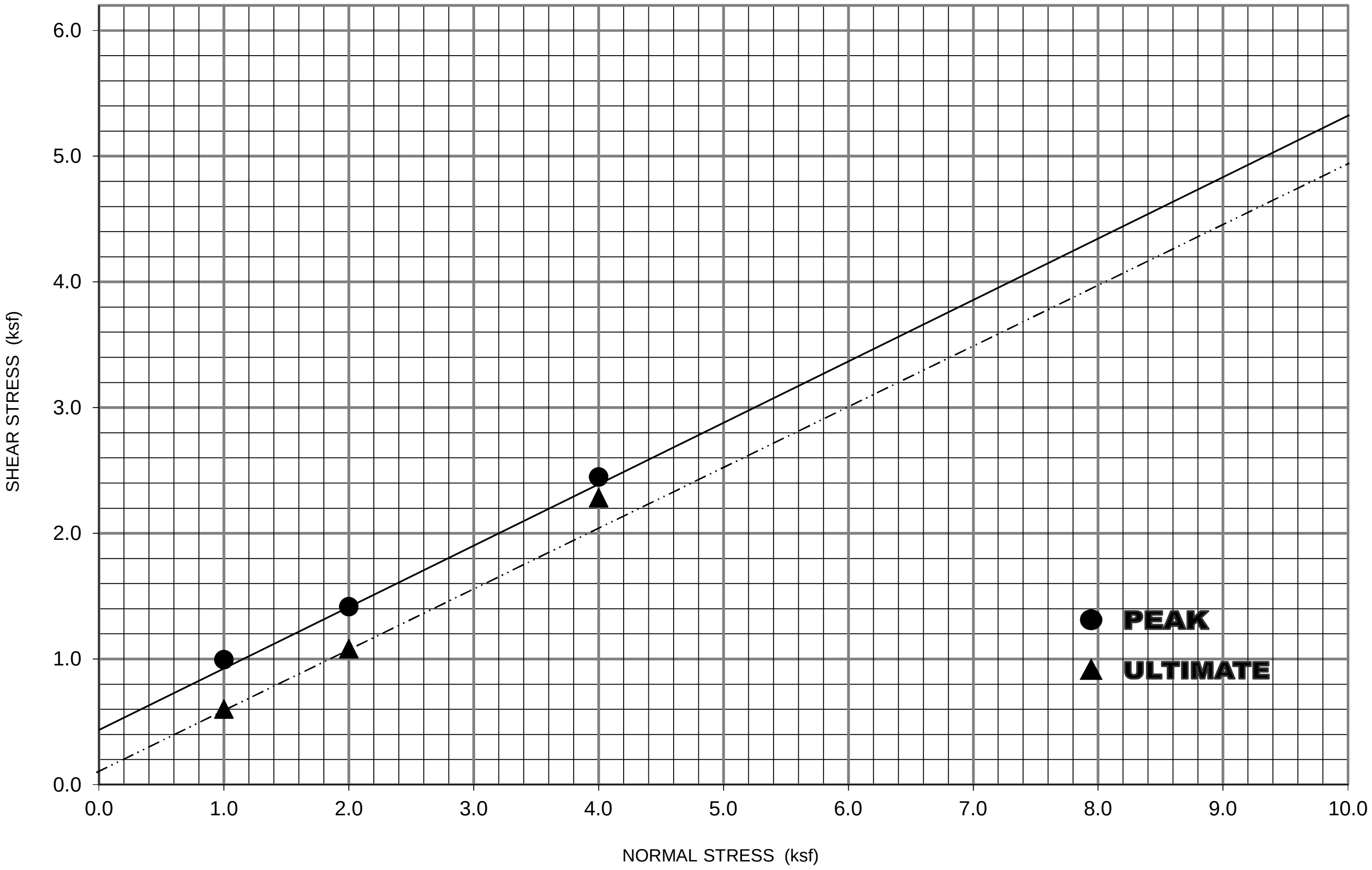
Applied Normal Load (ksf)	1.0		2.0		4.0	
Shear Stress,(Peak) (ksf)	0.996		1.416		2.448	
Shear Stress,(Ultimate) (ksf)	0.600		1.080		2.280	
Density and Saturation	Initial	Final	Initial	Final	Initial	Final
Wet Weight of Soil + Ring (gms)	186.93	186.77	189.19	188.86	194.16	193.3
Dry Weight of Soil + Ring (gms)		153.53		155.16		159.16
Weight of Water (gms)	-	46.54	-	47.28	-	45.81
Weight of Ring (gms)	-	44.36	-	43.93	-	44.78
Weight of Dry Soil (gms)	-	109.17	-	111.23	-	114.38
Moisture Content (%)	30.6	42.6	30.6	42.5	30.6	40.1
Wet Density (pcf)	119.0	118.9	121.3	121.0	124.7	124.0
Dry Density (pcf)	-	83.3	-	84.9	-	88.5
Specific Gravity,G_s (Assumed)	2.68					
Thickness of Specimen, (in.)	1.00					
Degree of Saturation, (%)	81.5	113.5	84.5	117.4	92.2	120.7
Void Ratio	-	1.007	-	0.970	-	0.889

Lateral Displacement, d_h 0.36 (in.)
Displacement Rate, d_r 0.05 (in./min.)
Elapsed Time of Test, t_e 7.20 (min.)

Specimen : Undisturbed : X
Remolded : -
Reconstituted : -

	PEAK	ULTIMATE
Cohesion,c (psf)	450	100
Friction Angle, ϕ	26	25

Remarks : LOAD 1000 & 2000 SANDY CLAY LOAD 4000 CLAYEY SAND



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Irvine, Ca. 92614
Tel: (949)797-6241 Fax: (949)797-6260

DIRECT SHEAR TEST
(ASTM D3080)

PROJECT NAME : PICERNE GARDENA

PROJECT NUMBER : 22027-00

TRACT NUMBER :

TESTED BY : RB DATE : 11-Oct-22

LOT NUMBER :

SAMPLED BY: JH DATE : 30-Sep-22

SAMPLE NO. :

LOCATION : KB - 1 @ 0 - 5'

SOIL DESCRIPTIONS / CLASSIFICATION : DK. BROWN CLAYEY SAND (SC)

TRIAL NUMBER		1	2	3	4
WET WT. OF SOIL + RING	(g)	592.63	604.39		
WEIGHT OF RING	(g)	204.36	204.36		
WET WEIGHT OF SOIL	(g)	388.27	400.03		
FACTOR		0.3030	0.3030		
WET DENSITY	(pcf)	117.6	121.2		
DRY DENSITY	(pcf)	108.3	110.7		
DEGREE OF SATURATION	(%)	#DIV/0!	#DIV/0!		

MOISTURE DETERMINATION

WET WEIGHT OF SOIL	(g)	319.52	307.42		
DRY WEIGHT OF SOIL	(g)	294.19	280.75		
MOISTURE CONTENT	(%)	8.6	9.5		

RACK NO. : 2

SURCHARGE : 144 psf

FINAL DENSITY & SATURATION

WET WT. + RING	(g)	
DRY WT. + RING	(g)	
MOISTURE CONTENT	(%)	
SAMPLE LENGTH	(cm)	
SAMPLE AREA	(cm^2)	
VOLUME	(cc)	
WT. OF RING	(g)	
DRY DENSITY	(pcf)	
SPEC.GRAVITY (assumed)		
SATURATION	(%)	#DIV/0!
% RETAINED ON #4 SIEVE		

DATE	TIME	ELAPSED TIME (min.)	DIAL READING (in.)	DEFLECTION (in.)
10-Oct	8:00		0.314	
10-Oct	11:00		0.369	
11-Oct	10:25		0.371	0.057

E. I. 57 SO_4 147 ppm

REMARKS :

EXPANSION INDEX

(UBC 18-2)

APPENDIX D

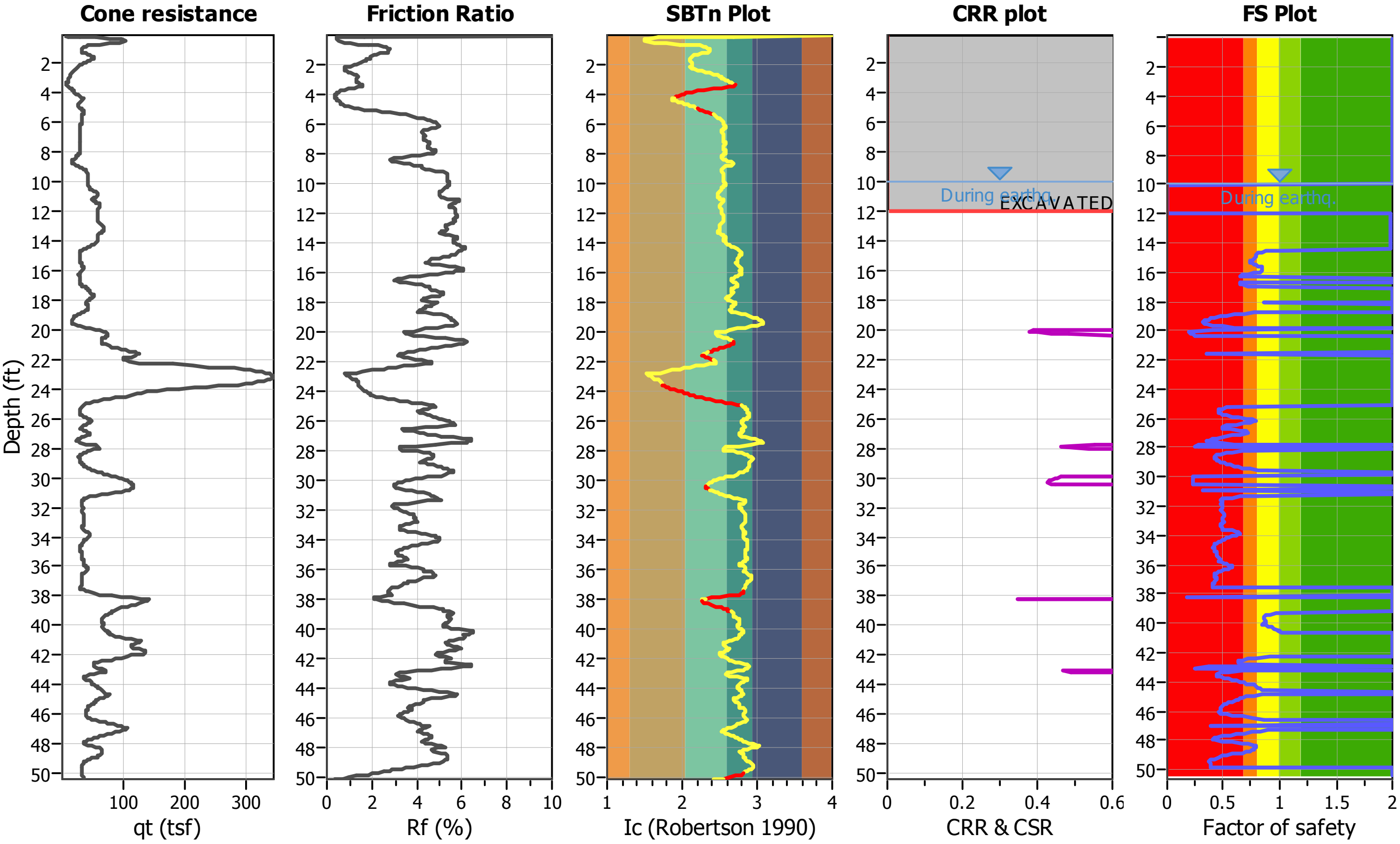
LIQUEFACTION AND SEISMIC SETTLEMENT ANALYSIS

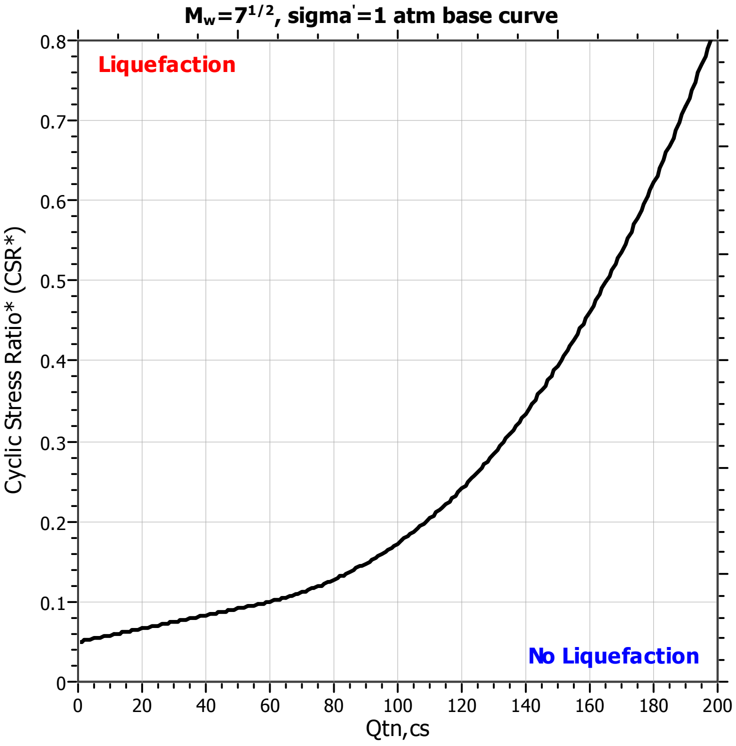
Project title : **Location :**

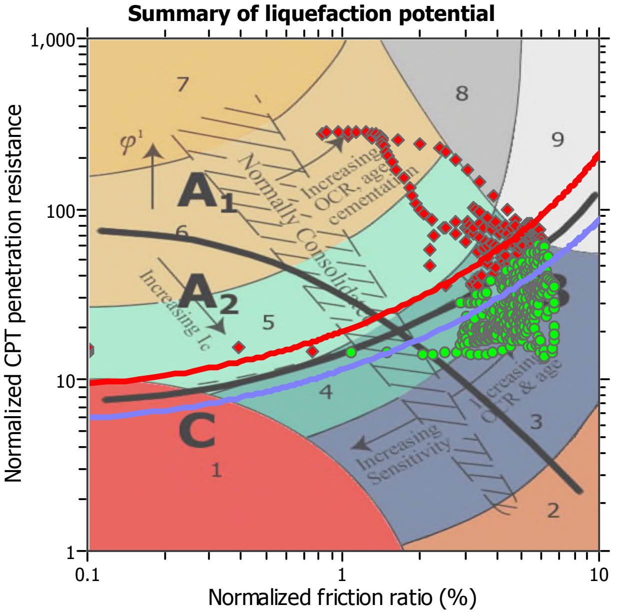
CPT file : CPT-1

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	21.50 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Excavation depth:	12.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	5	Footing load:	2.00 tsf	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

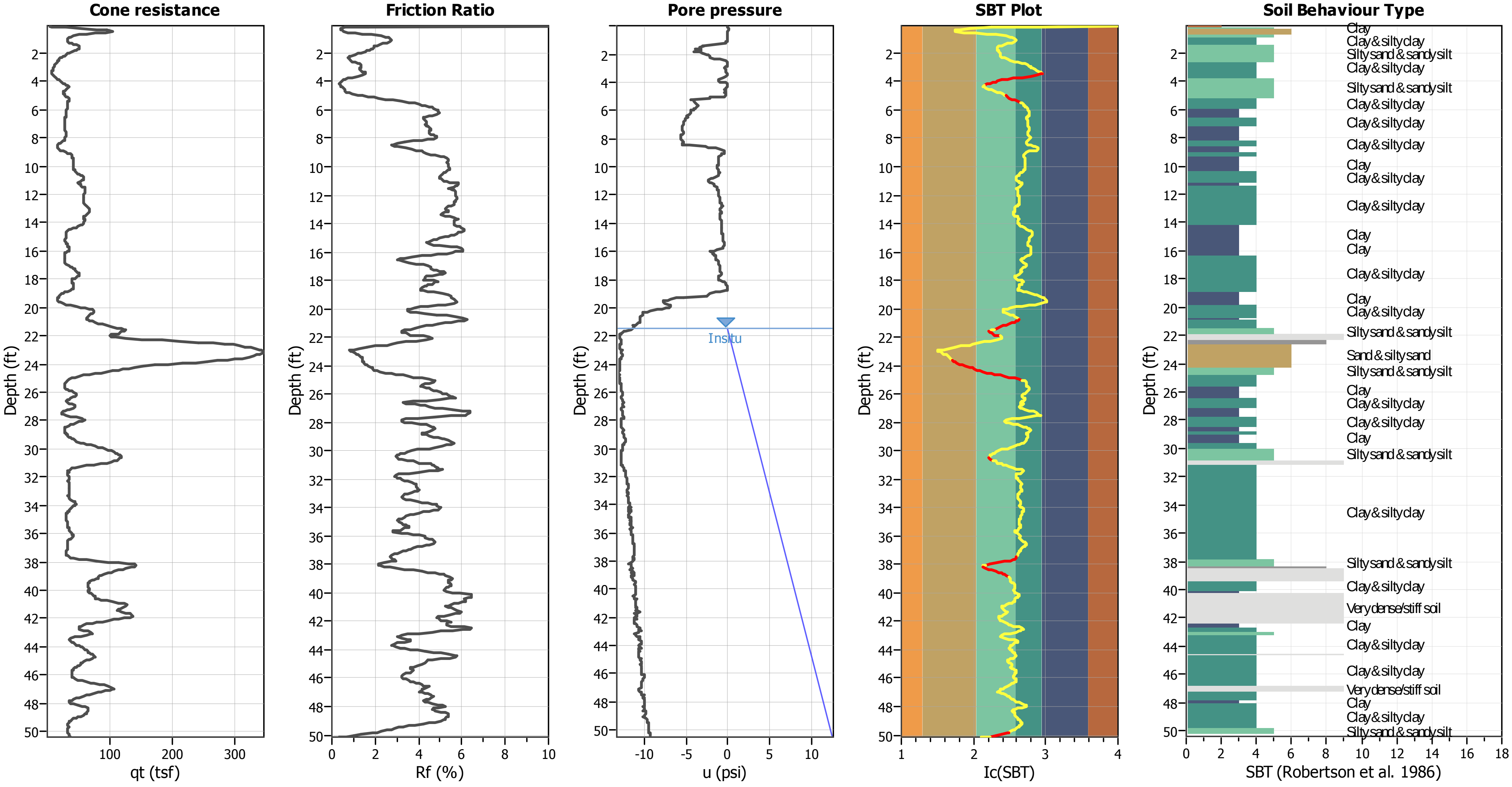






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: Robertson (2009)
Fines correction method: Robertson (2009)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.85
Depth to water table (insitu): 21.50 ft

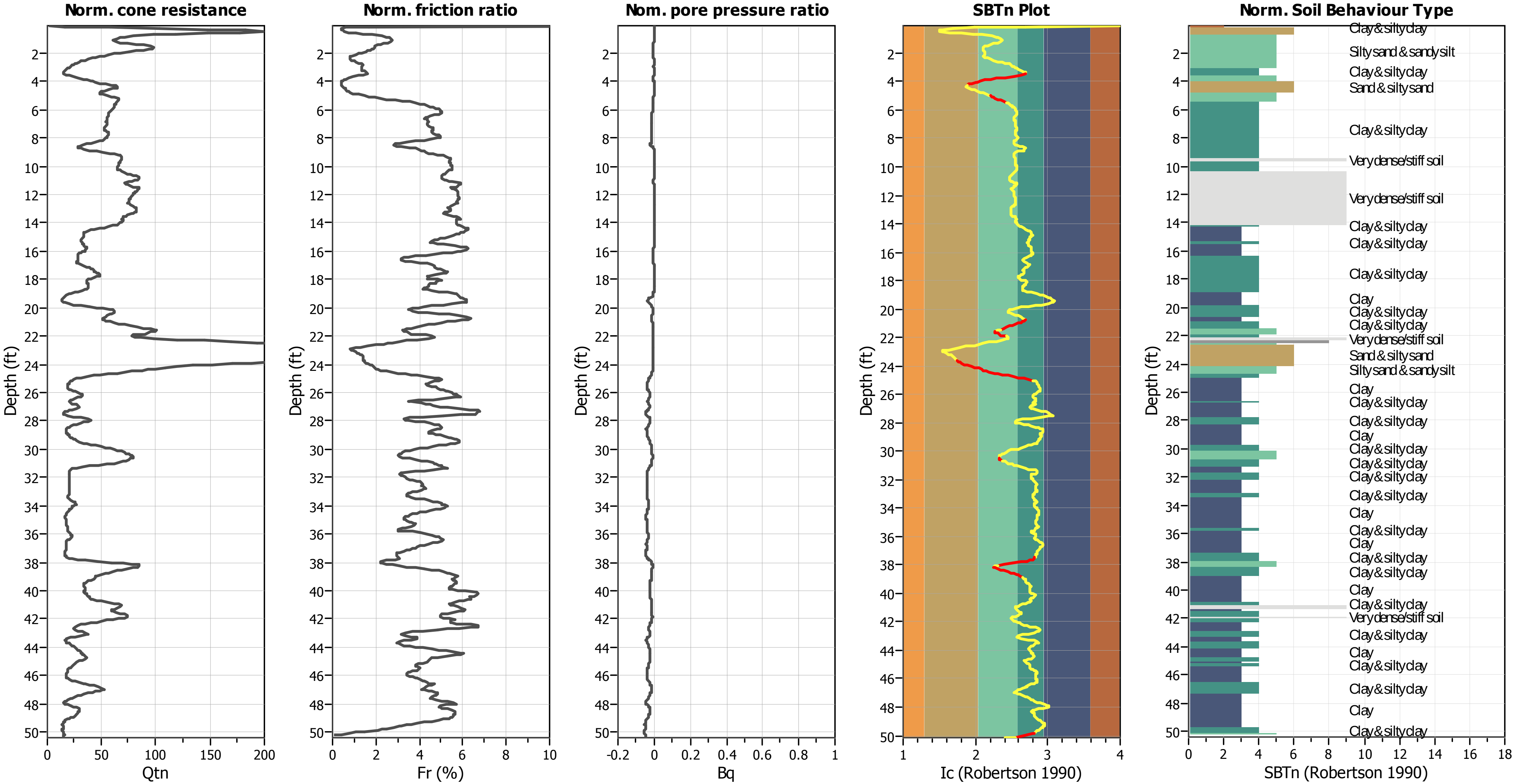
Depth to water table (erthq.): 10.00 ft
Average results interval: 5
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Excavation: Yes
Excavation depth: 12.00 ft

Footing load: 2.00 tsf
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: All soils
Limit depth applied: Yes
Limit depth: 50.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



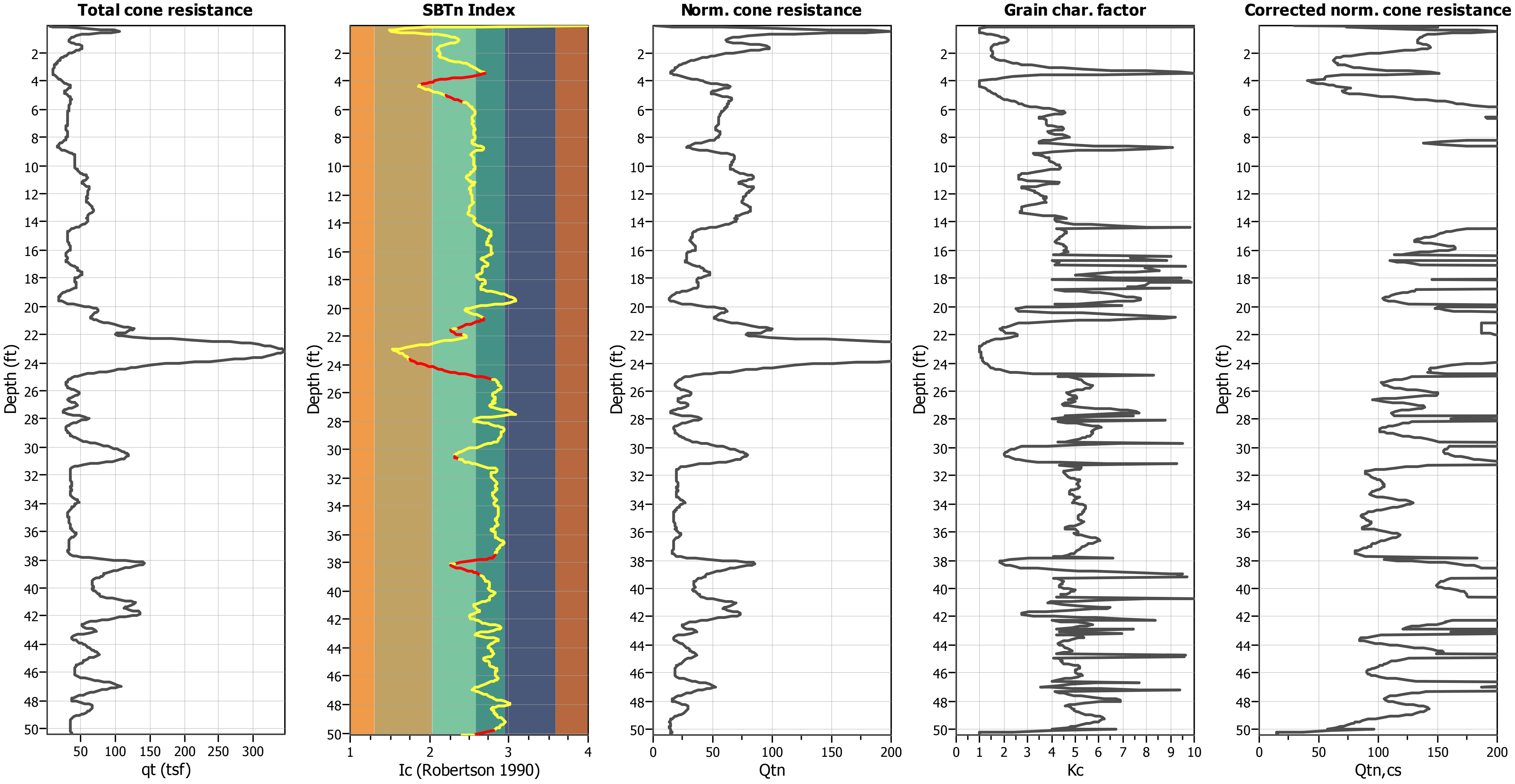
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

SBTn legend

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

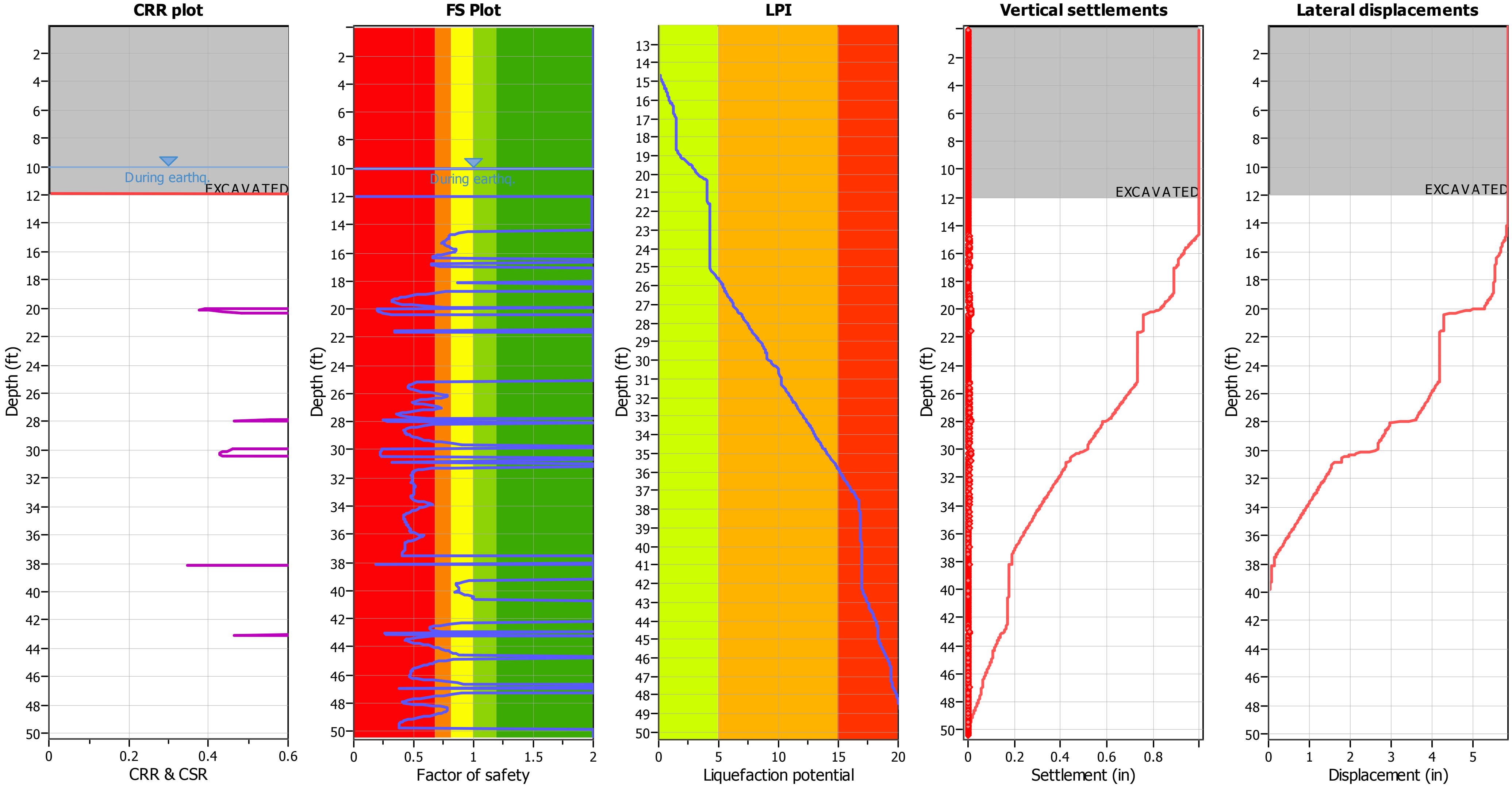
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 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

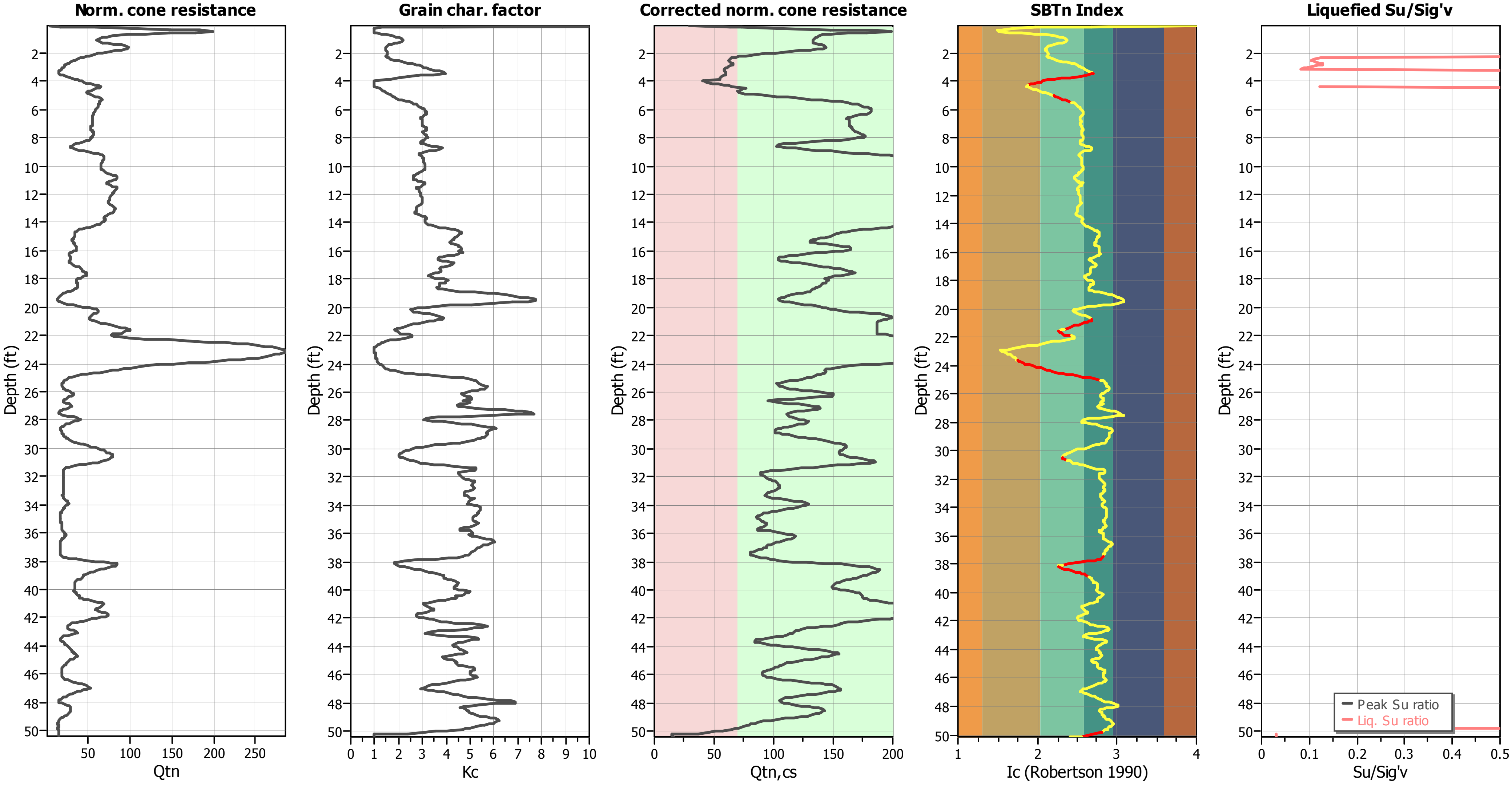
☐ Very high risk
☐ High risk
☐ Low risk

Liquefaction analysis summary plots

Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

:: Liquefaction Potential Index calculation data ::

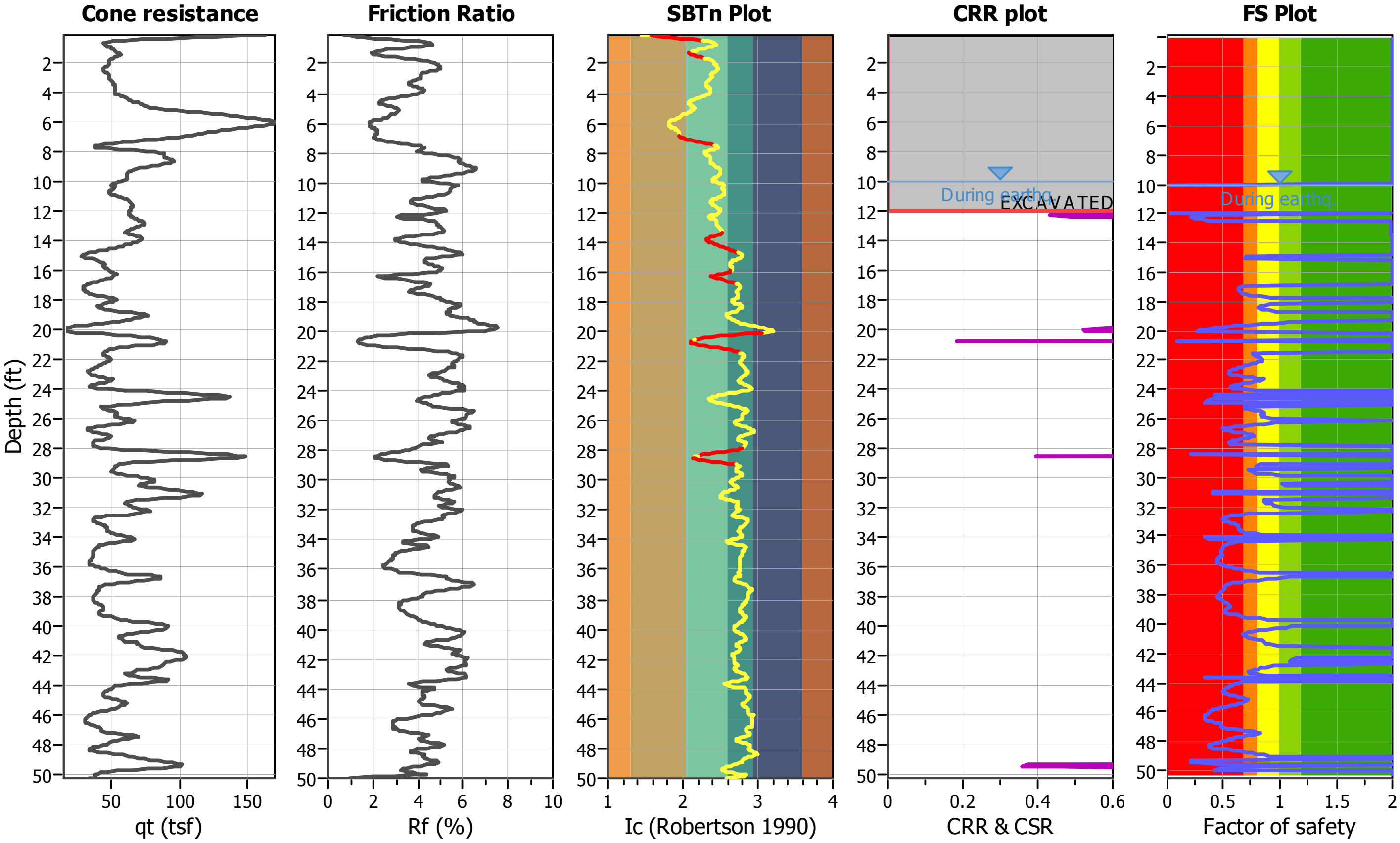
Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

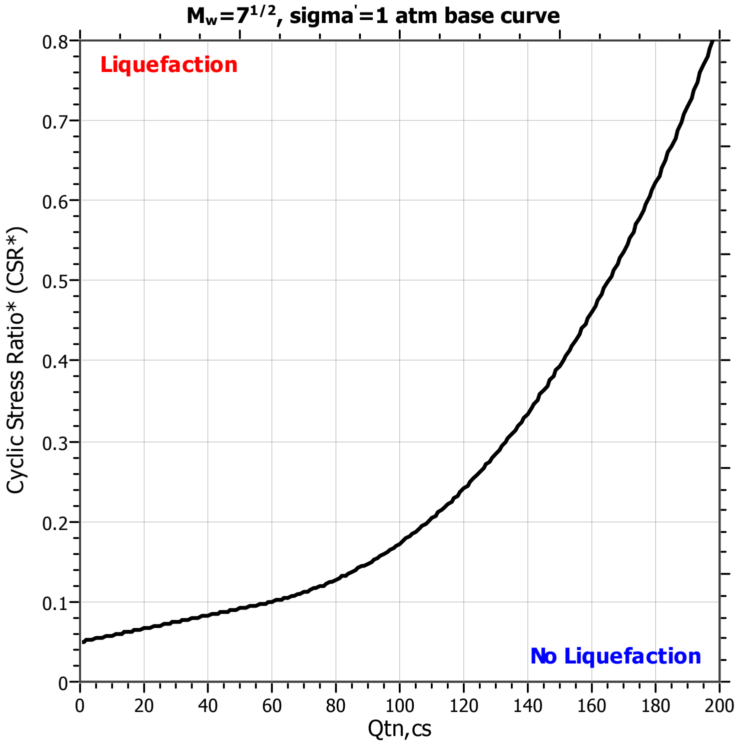
Project title : **Location :**

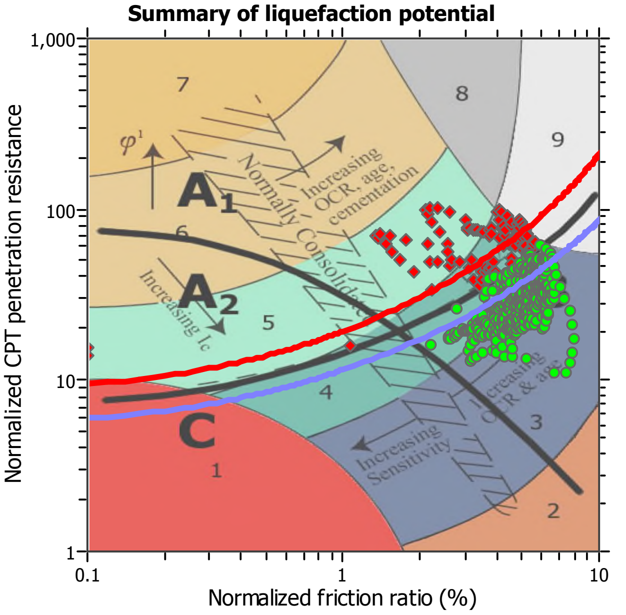
CPT file : CPT-2

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	21.50 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Excavation depth:	12.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	5	Footing load:	2.00 tsf	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

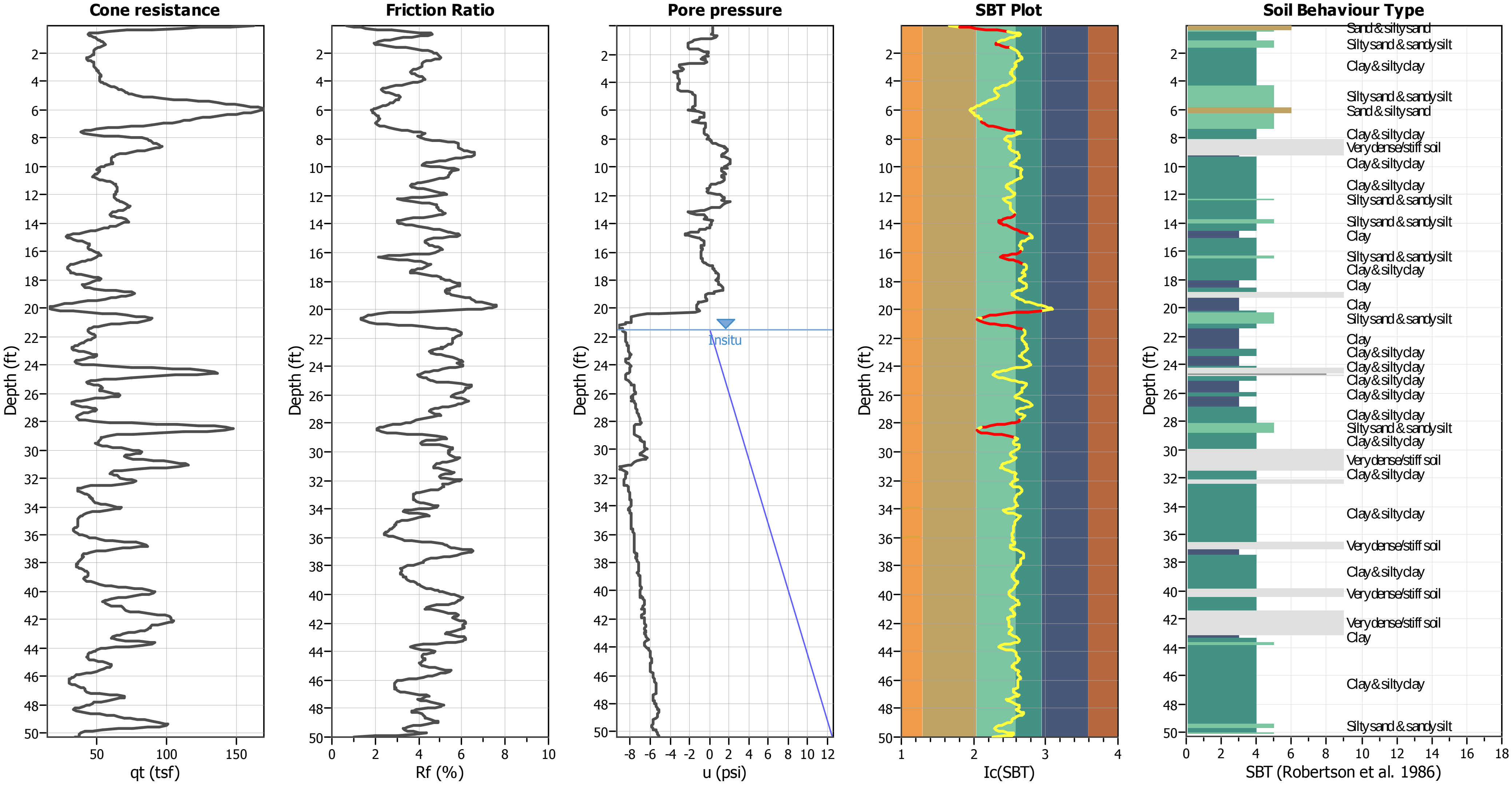






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: Robertson (2009)
Fines correction method: Robertson (2009)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.85
Depth to water table (insitu): 21.50 ft

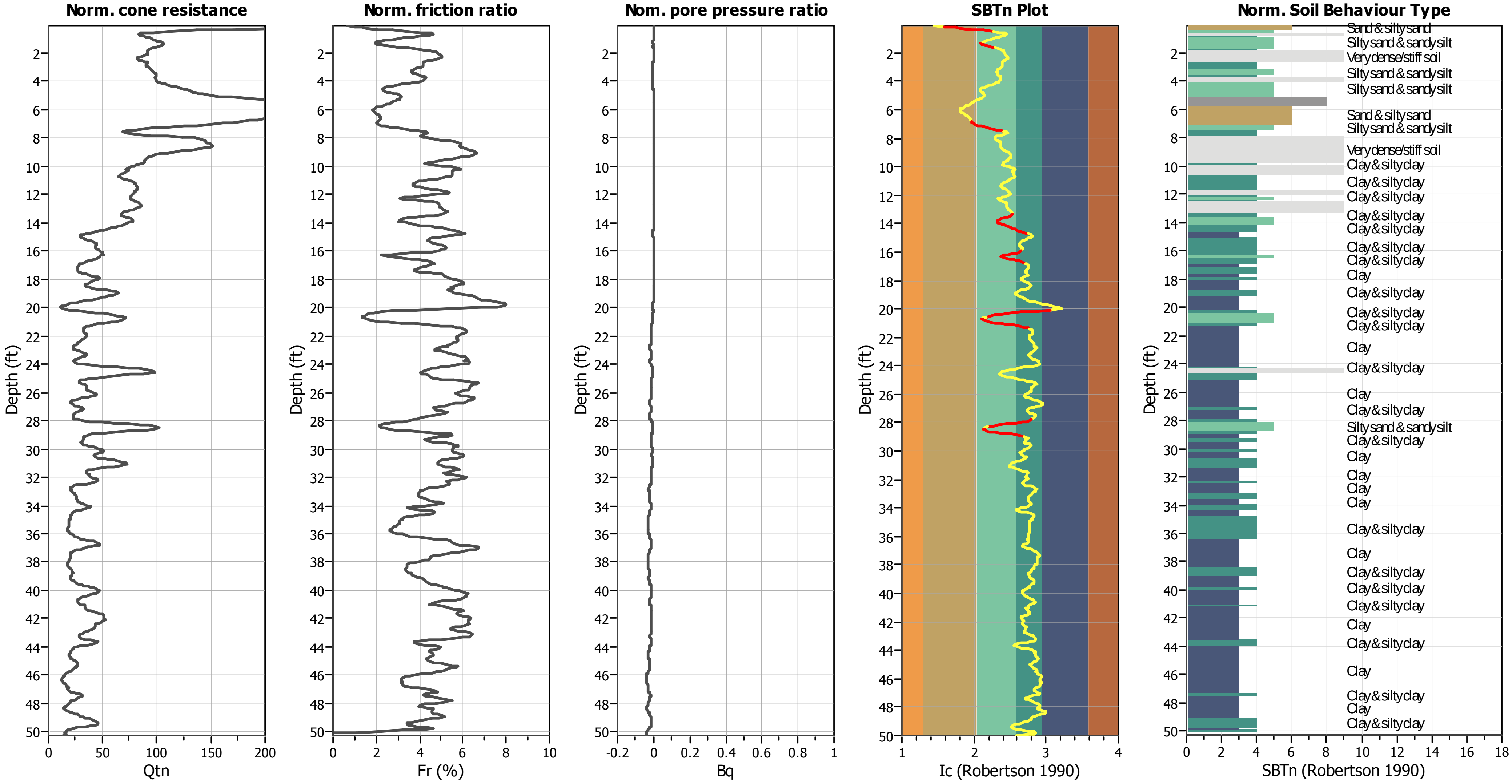
Depth to water table (erthq.): 10.00 ft
Average results interval: 5
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Excavation: Yes
Excavation depth: 12.00 ft

Footing load: 2.00 tsf
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: All soils
Limit depth applied: Yes
Limit depth: 50.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

SBTn legend

☐ 1. Sensitive fine grained
☐ 2. Organic material
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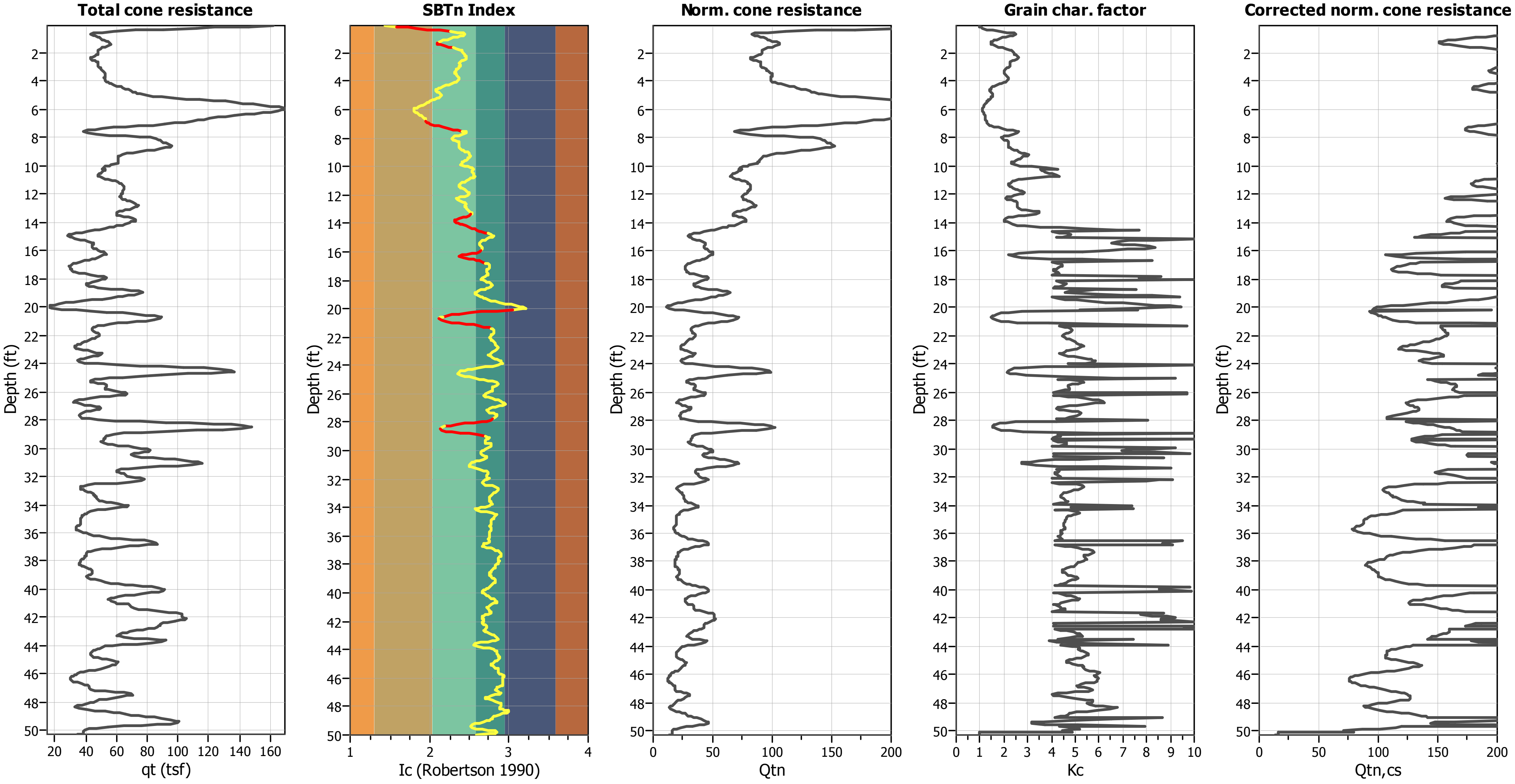
☐ 6. Clean sand to silty sand
☐ 7. Gravely sand to sand
☐ 8. Very stiff sand to
☐ 9. Very stiff fine grained

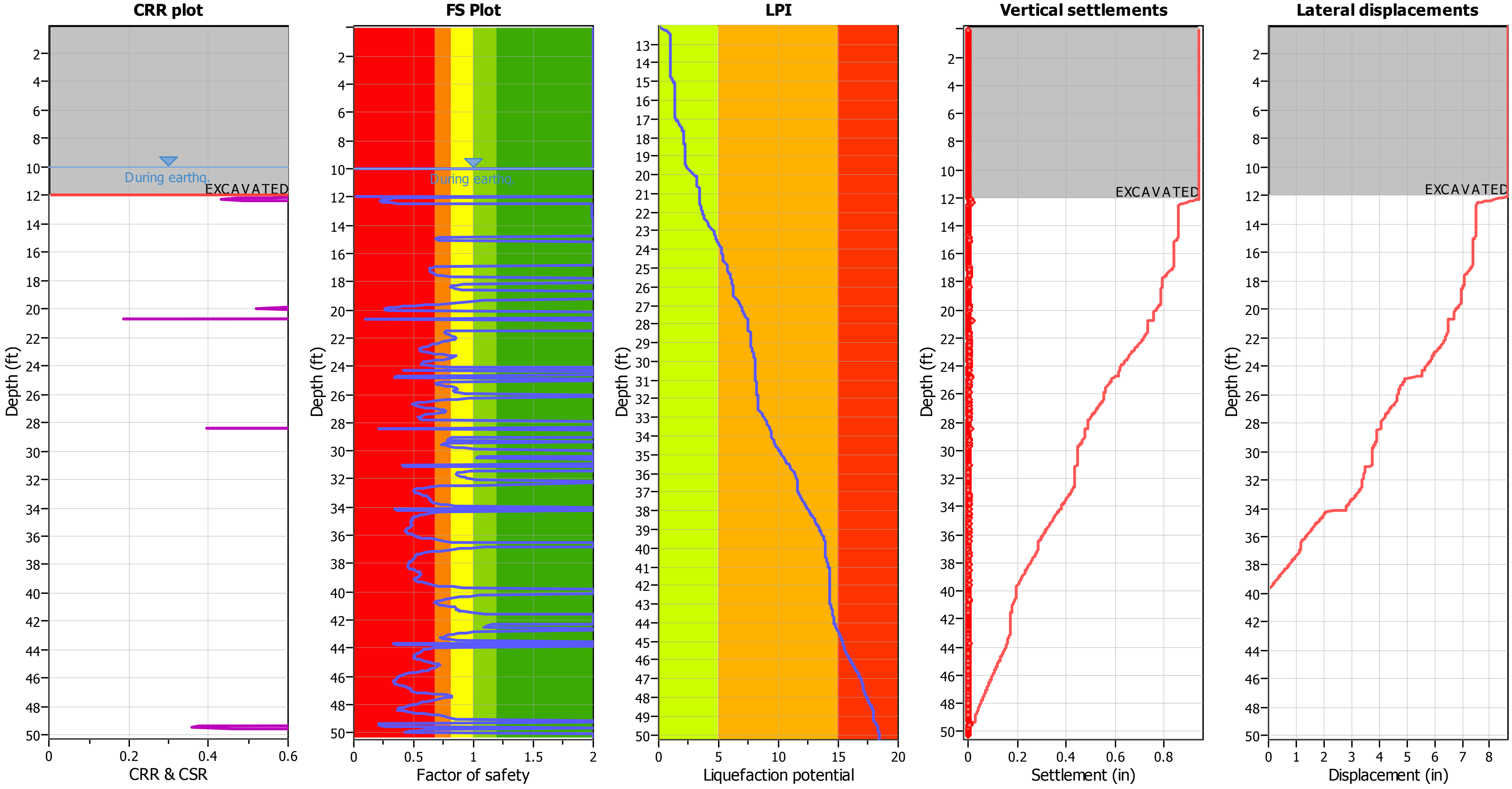
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: Robertson (2009)
Fines correction method: Robertson (2009)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.85
Depth to water table (insitu): 21.50 ft

Depth to water table (erthq.): 10.00 ft
Average results interval: 5
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Excavation: Yes
Excavation depth: 12.00 ft

Footing load: 2.00 tsf
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: All soils
Limit depth applied: Yes
Limit depth: 50.00 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

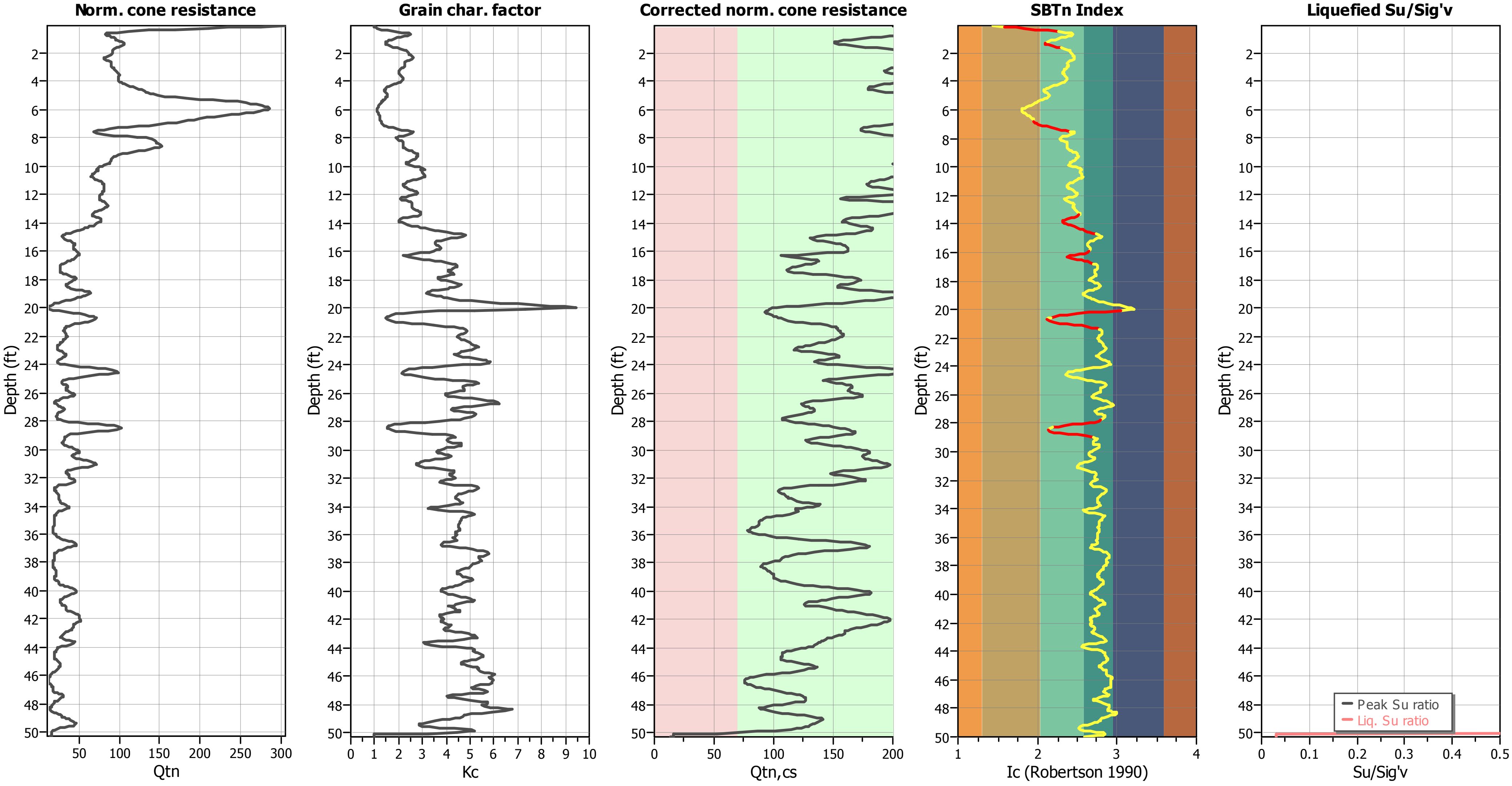
- ☐ Very high risk
- ☐ High risk
- ☐ Low risk

Liquefaction analysis summary plots

Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

:: Liquefaction Potential Index calculation data ::

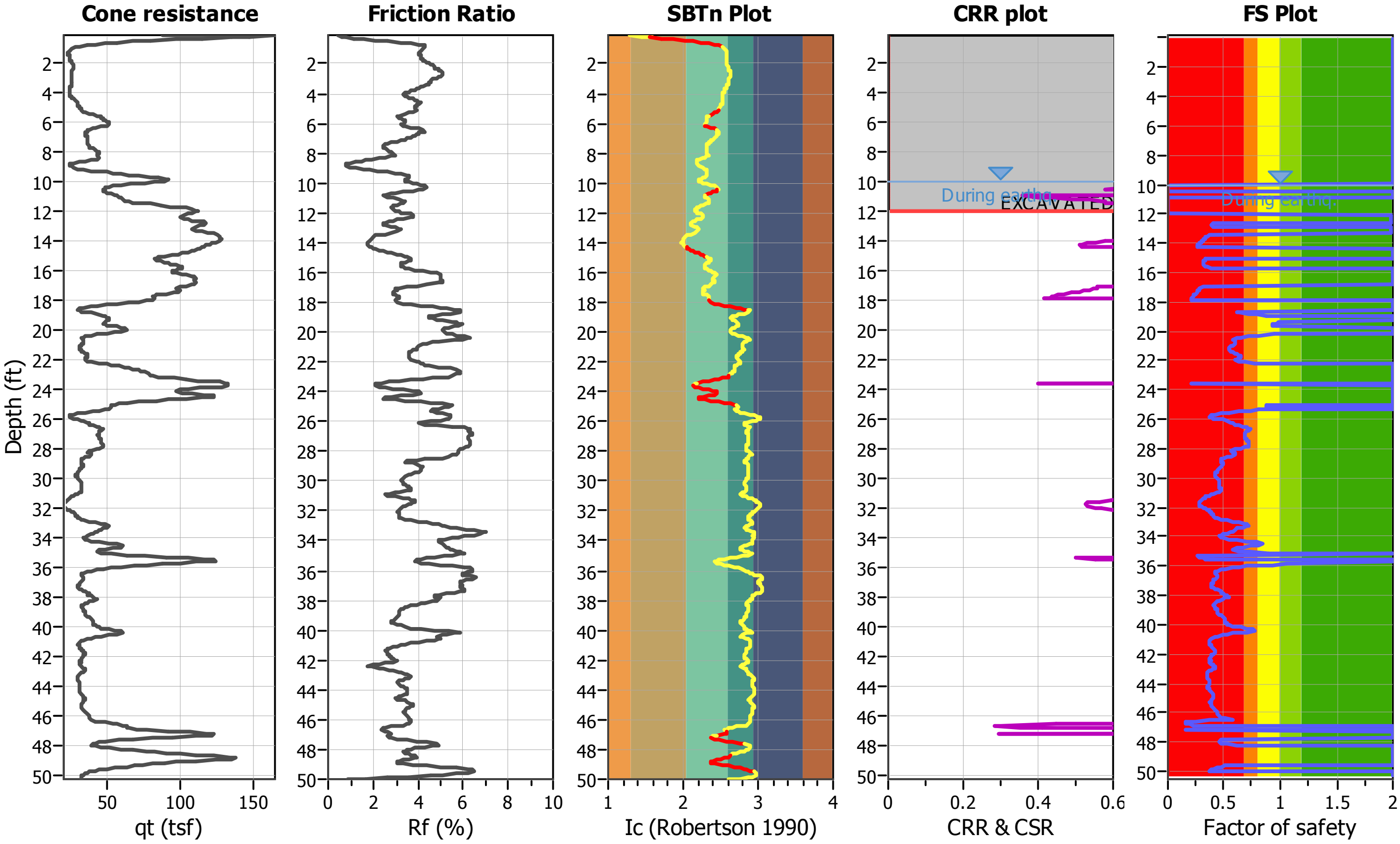
Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

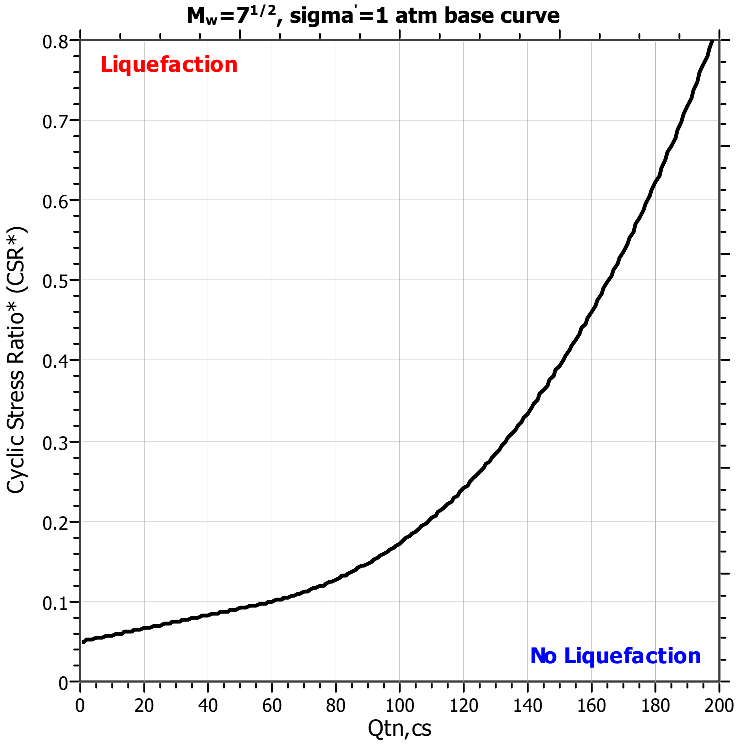
Project title : **Location :**

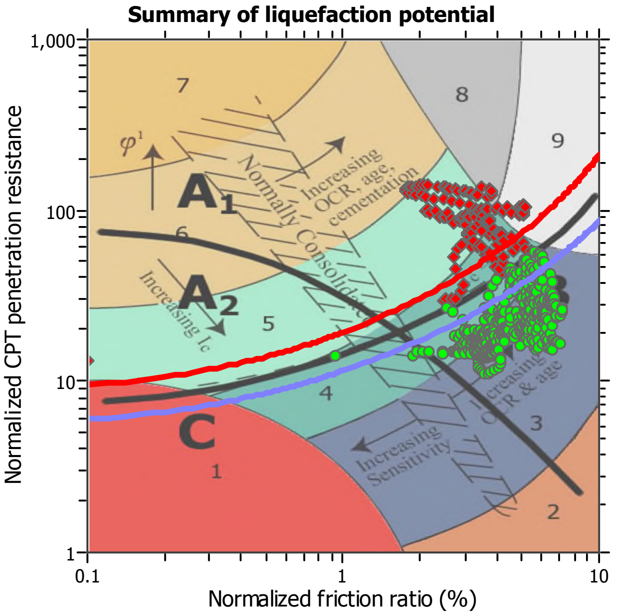
CPT file : CPT-3

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	21.50 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Excavation depth:	12.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	5	Footing load:	2.00 tsf	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

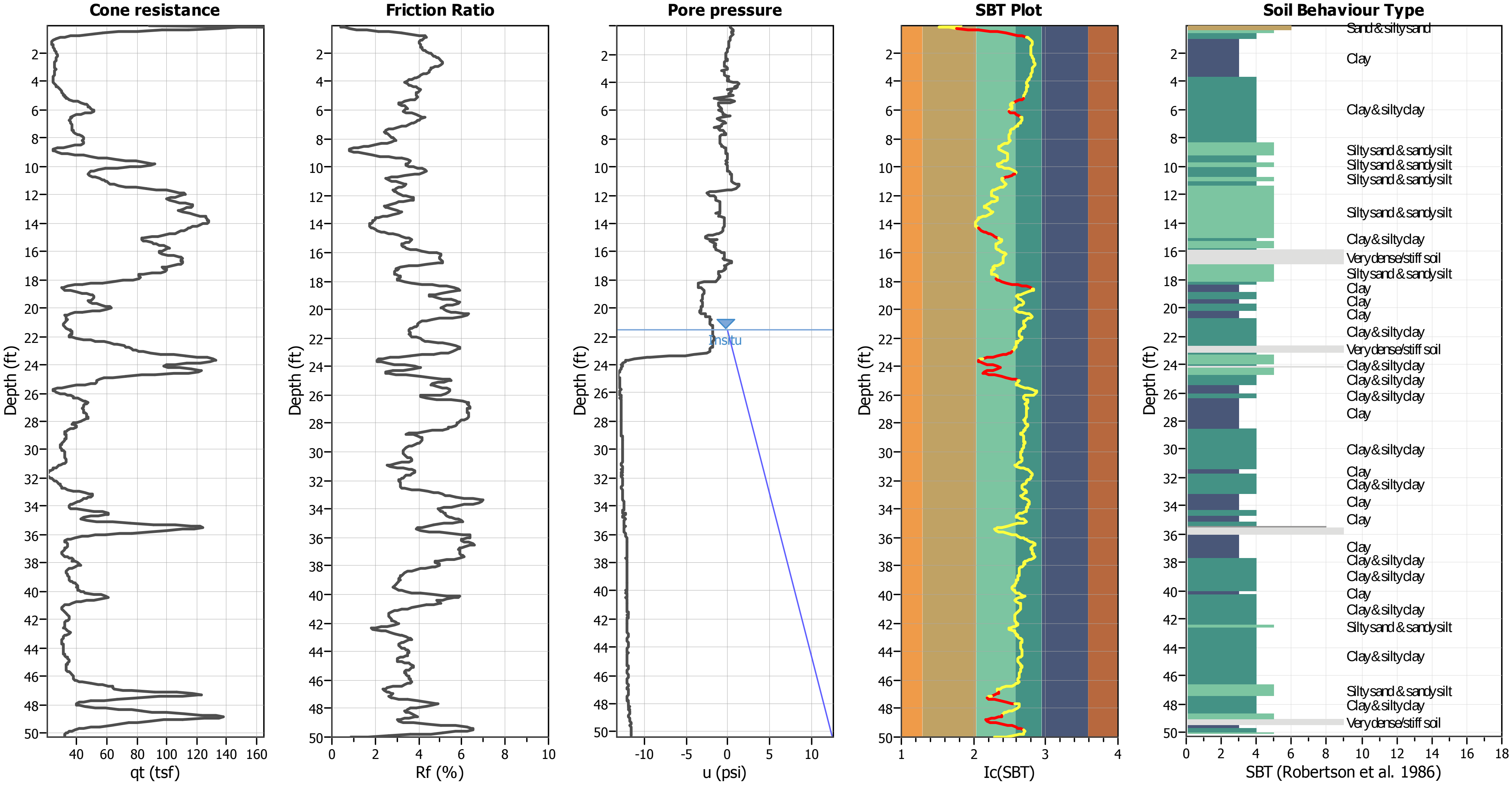






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



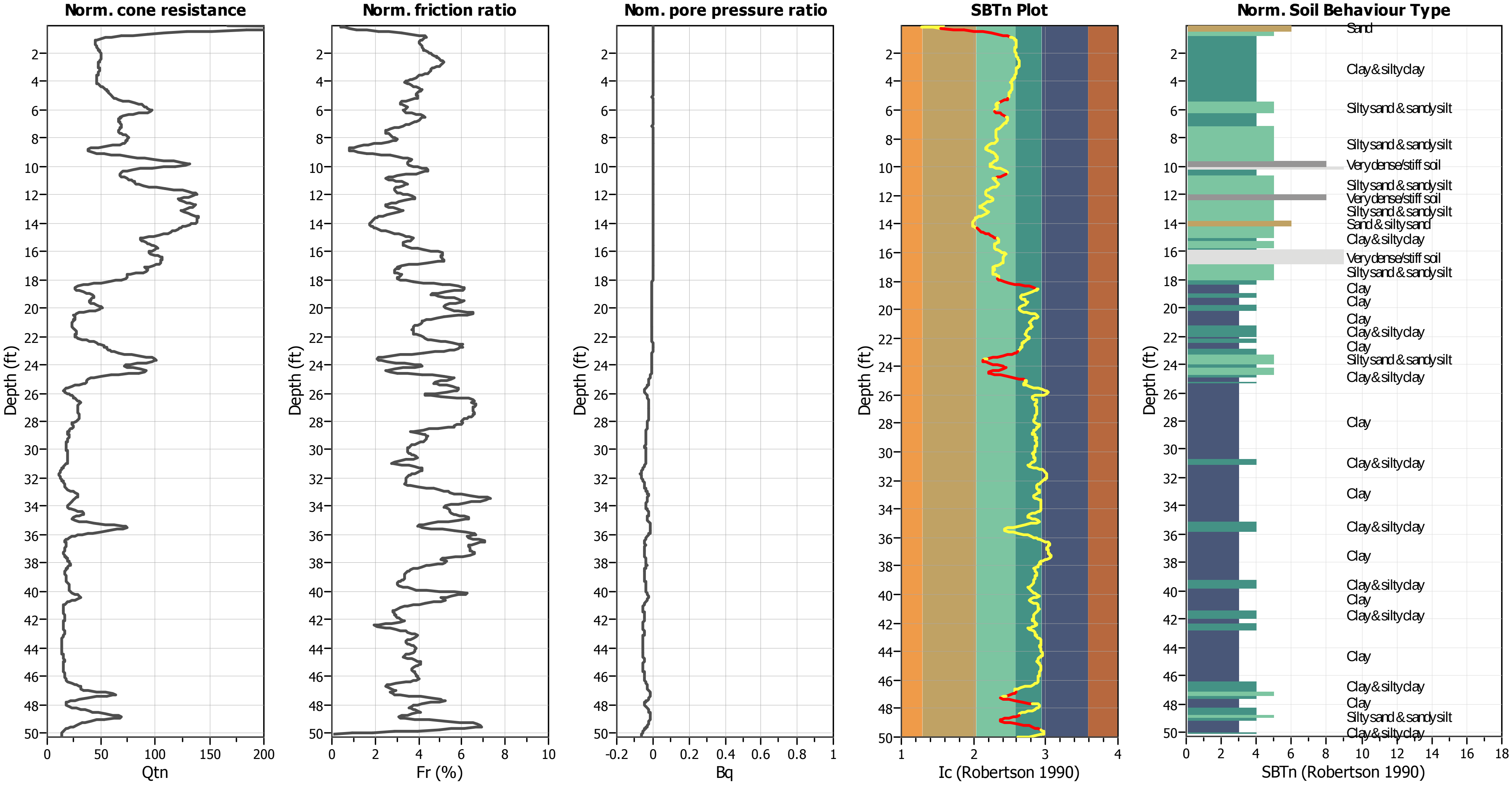
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



Input parameters and analysis data

Analysis method: Robertson (2009)
Fines correction method: Robertson (2009)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.85
Depth to water table (insitu): 21.50 ft

Depth to water table (erthq.): 10.00 ft
Average results interval: 5
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Excavation: Yes
Excavation depth: 12.00 ft

Footing load: 2.00 tsf
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: All soils
Limit depth applied: Yes
Limit depth: 50.00 ft

SBTn legend

- ☐ 1. Sensitive fine grained
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- ☐ 3. Clay to silty clay
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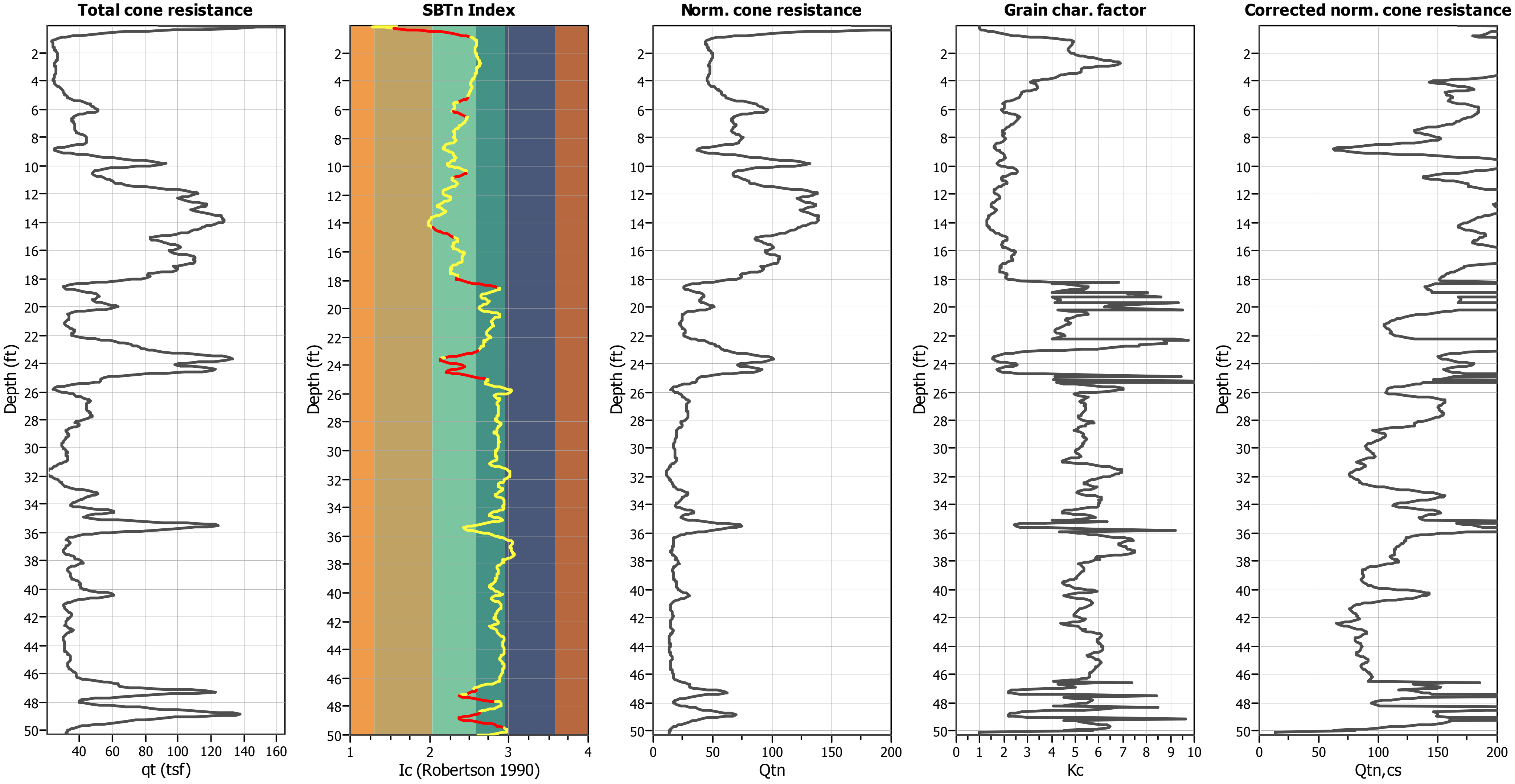
- ☐ 7. Gravely sand to sand
- ☐ 8. Very stiff sand to
- ☐ 9. Very stiff fine grained

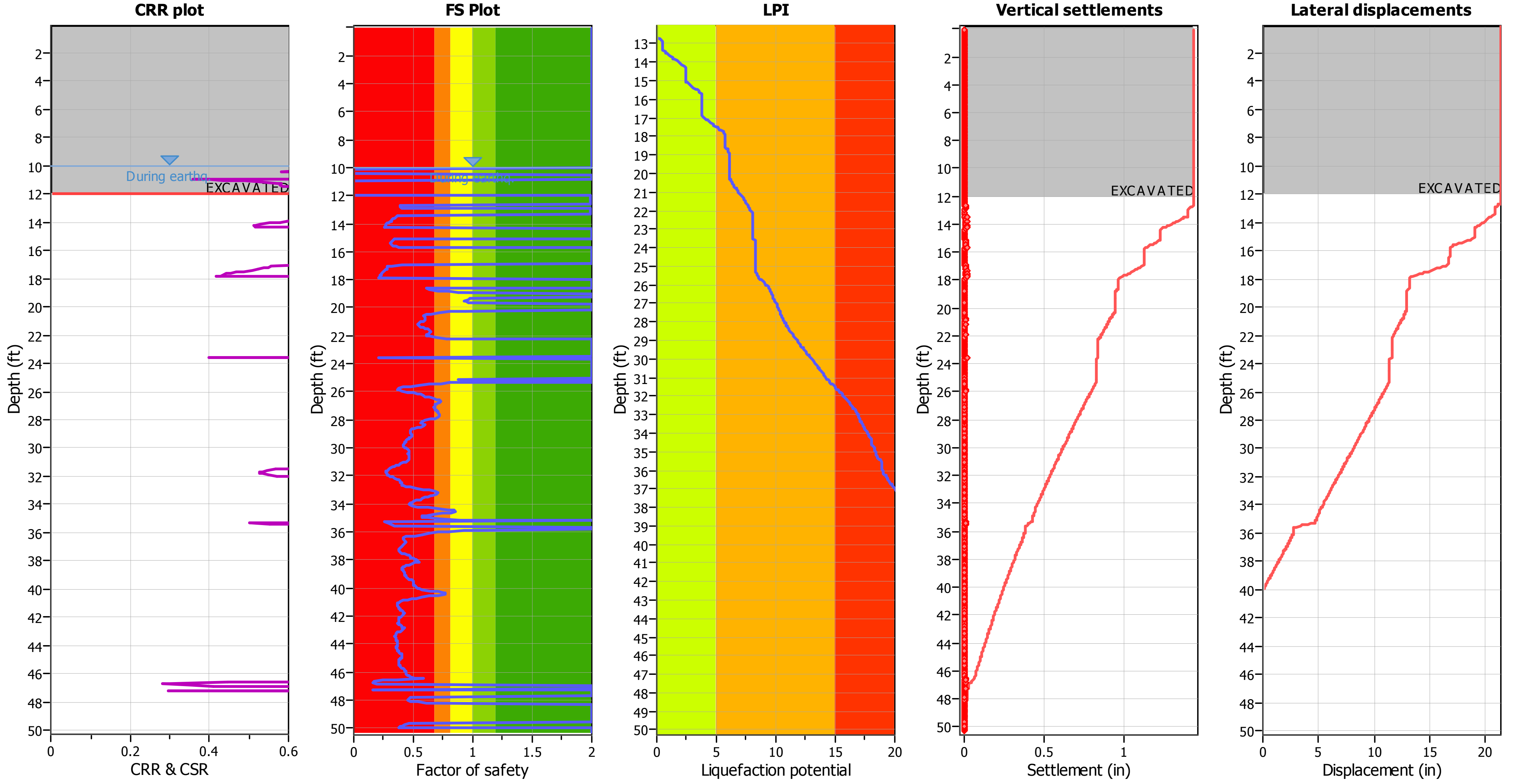
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 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

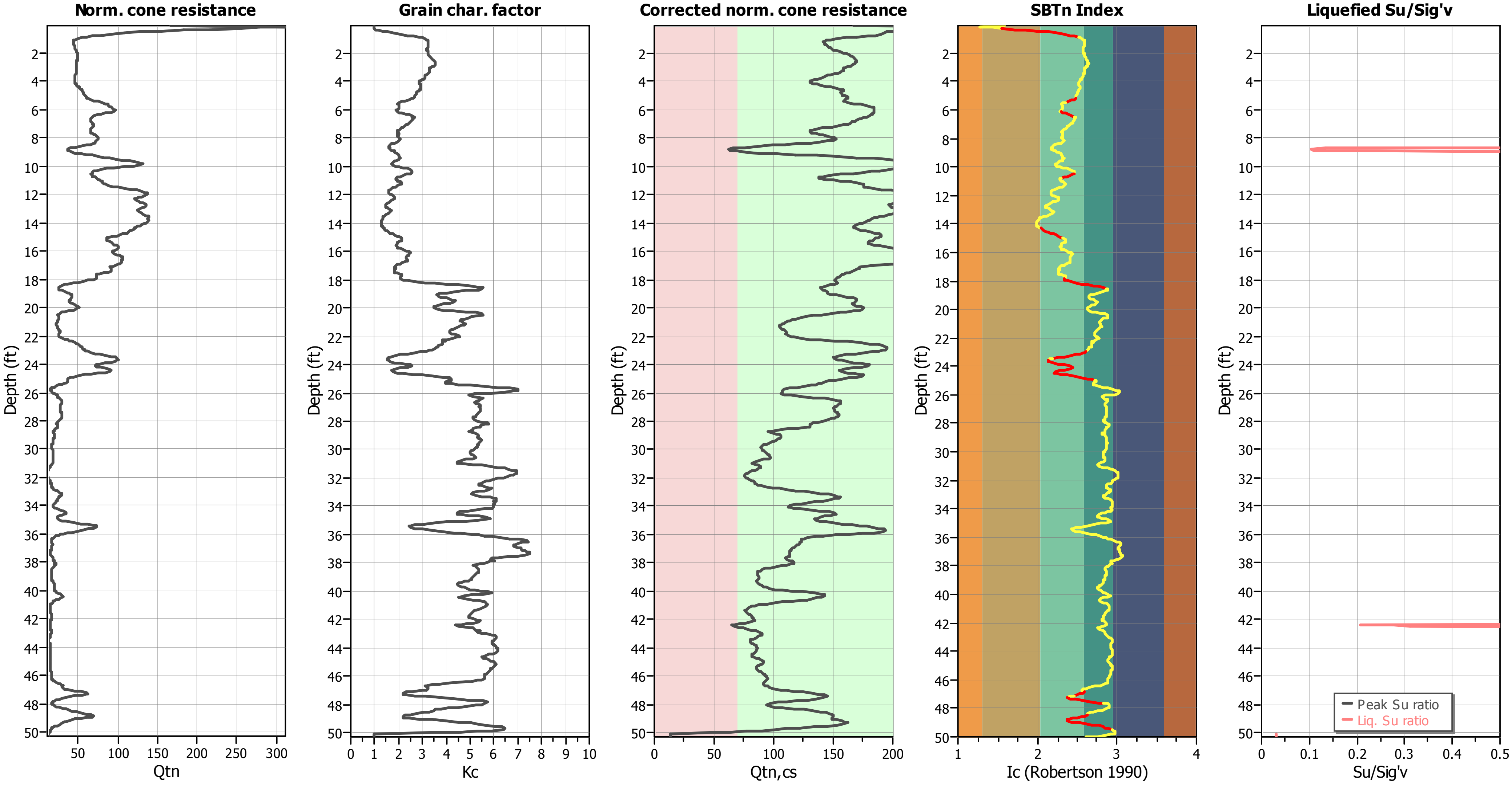
- ☐ Very high risk
- ☐ High risk
- ☐ Low risk

Liquefaction analysis summary plots

Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI

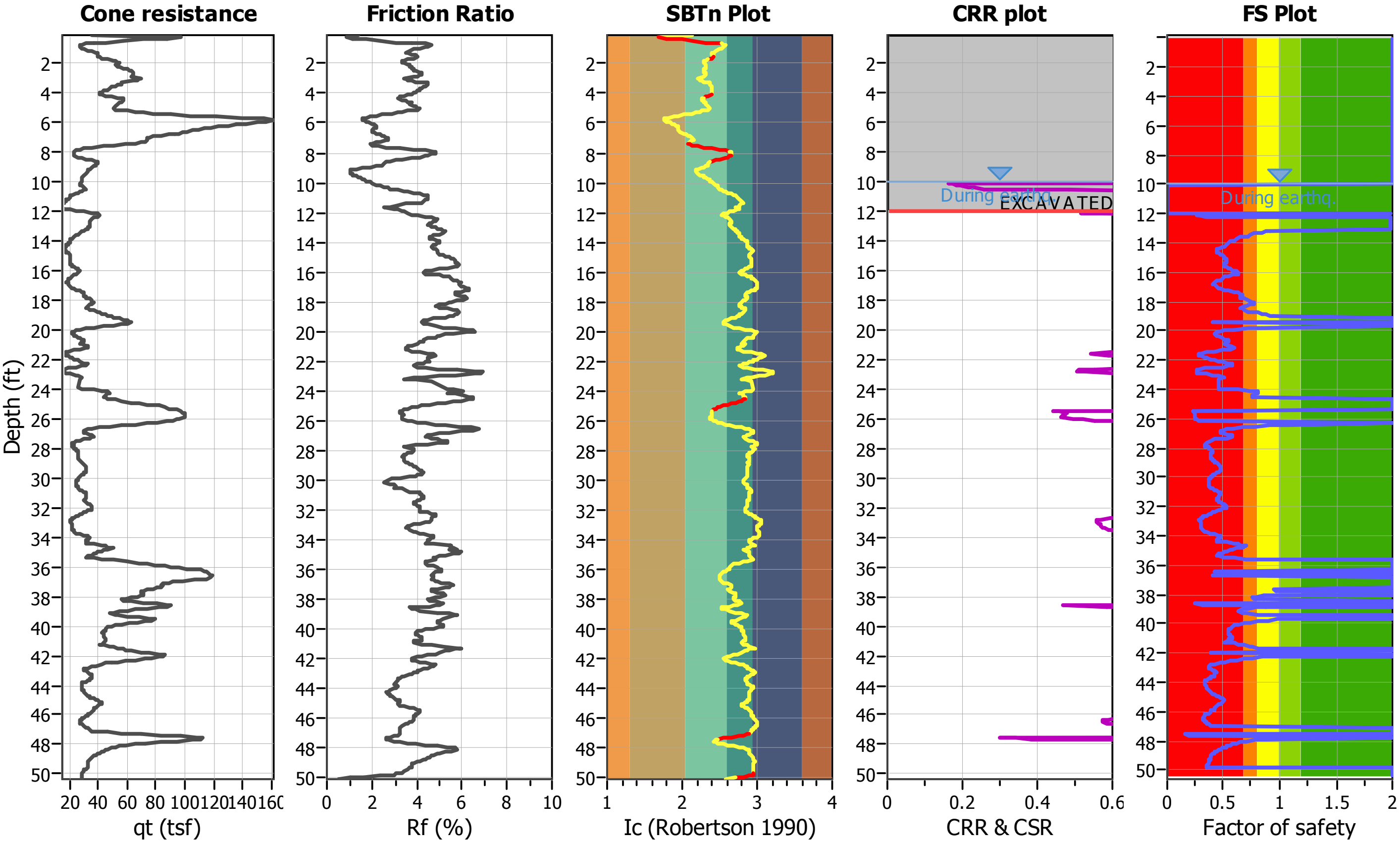
Kling Consulting Group, Inc.
18008 Sky Park Circle, Suite 250
Irvine, CA 92614
www.klingconsultinggroup.com

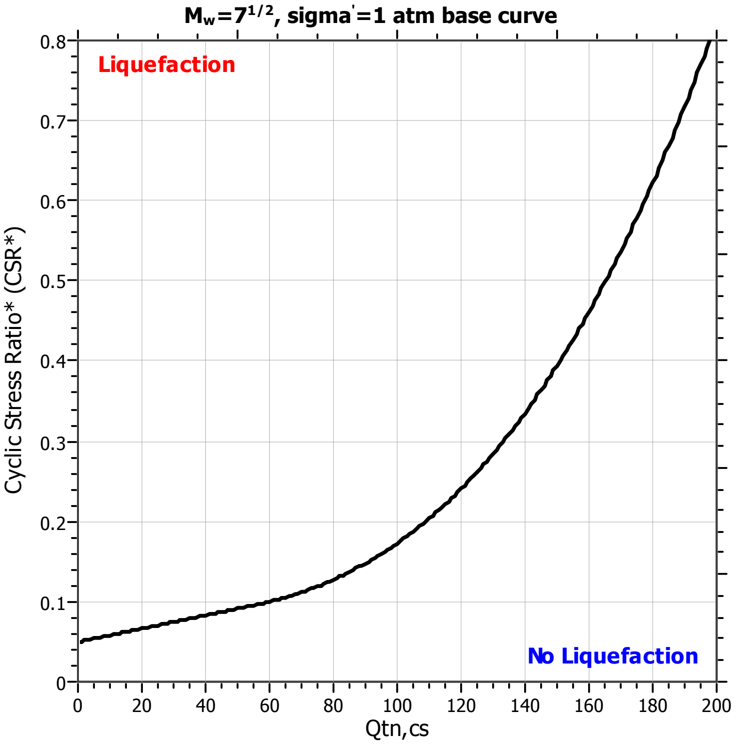
Project title : **Location :**

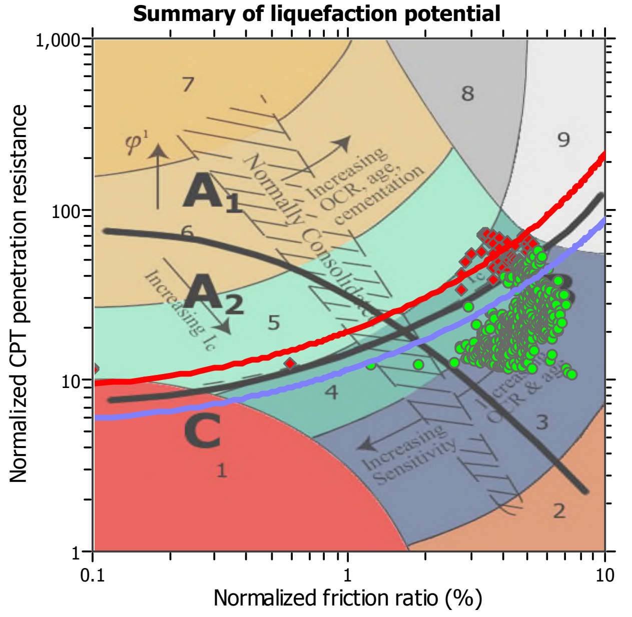
CPT file : CPT-4

Input parameters and analysis data

Analysis method:	Robertson (2009)	G.W.T. (in-situ):	21.50 ft	Excavation:	Yes	Clay like behavior applied:	All soils
Fines correction method:	Robertson (2009)	G.W.T. (earthq.):	10.00 ft	Excavation depth:	12.00 ft	Limit depth applied:	Yes
Points to test:	Based on Ic value	Average results interval:	5	Footing load:	2.00 tsf	Limit depth:	50.00 ft
Earthquake magnitude M_w:	7.30	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.85	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

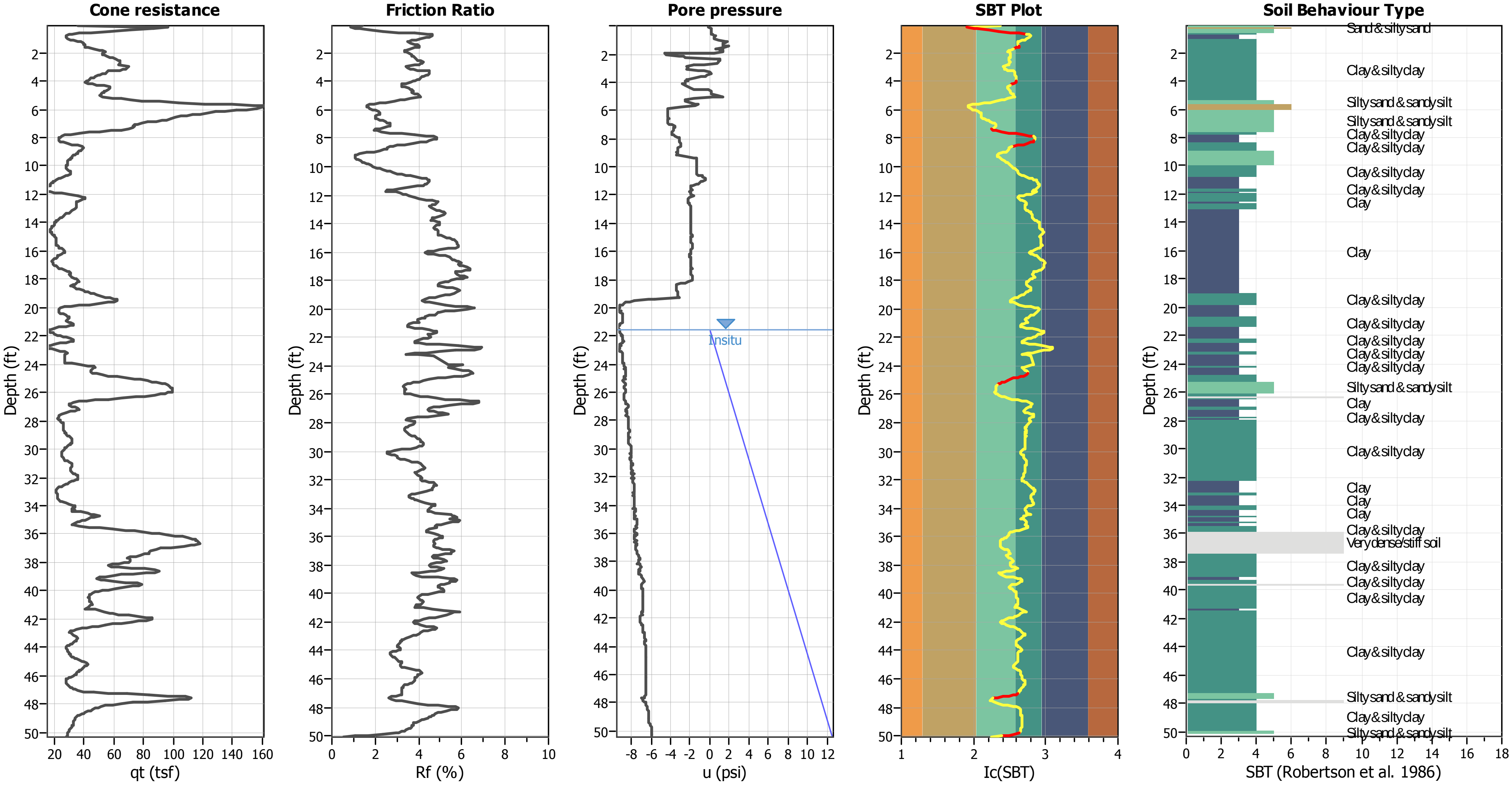






Zone A_1: Cyclic liquefaction likely depending on size and duration of cyclic loading
Zone A_2: Cyclic liquefaction and strength loss likely depending on loading and ground geometry
Zone B: Liquefaction and post-earthquake strength loss unlikely, check cyclic softening
Zone C: Cyclic liquefaction and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

CPT basic interpretation plots



Input parameters and analysis data

Analysis method: Robertson (2009)
Fines correction method: Robertson (2009)
Points to test: Based on Ic value
Earthquake magnitude M_w: 7.30
Peak ground acceleration: 0.85
Depth to water table (insitu): 21.50 ft

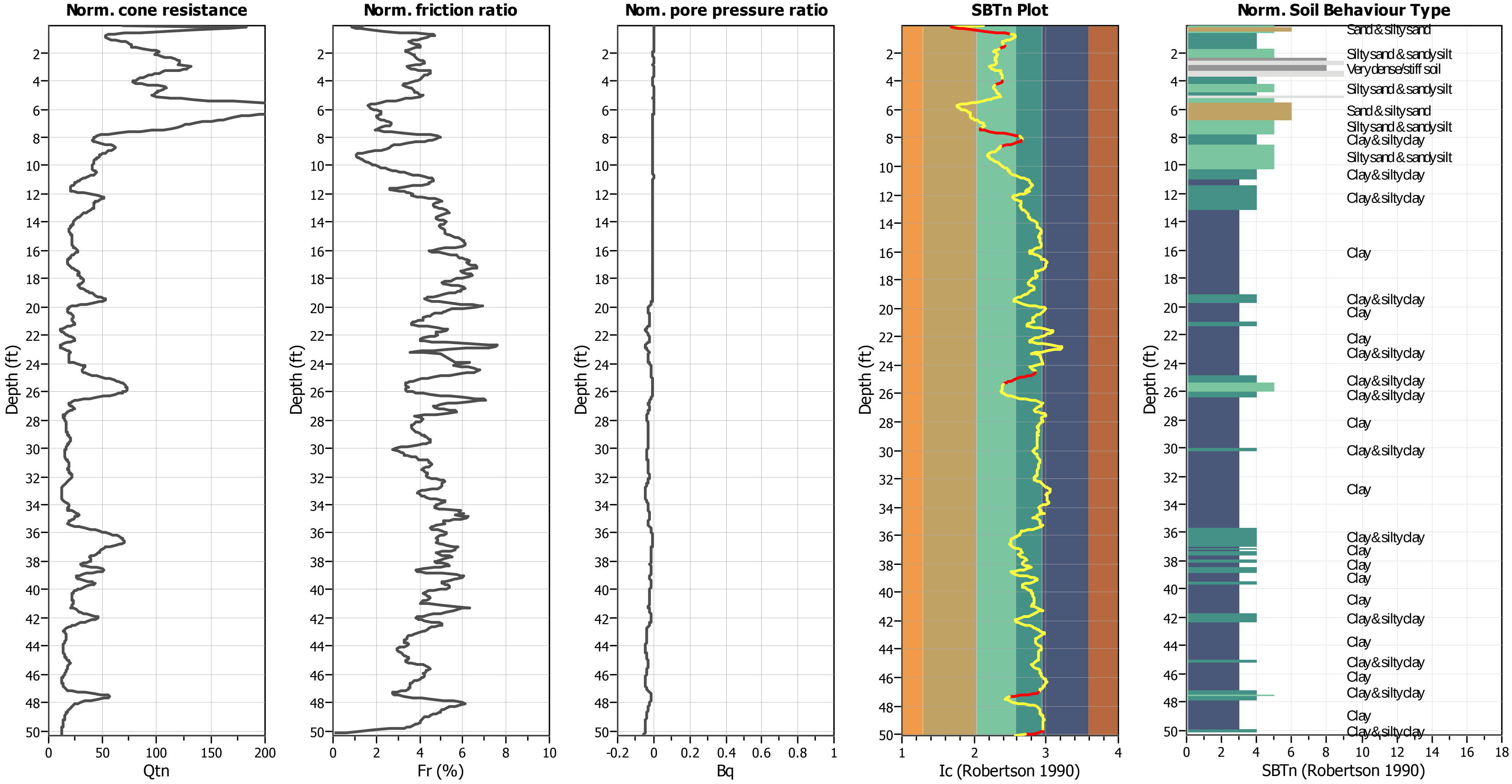
Depth to water table (erthq.): 10.00 ft
Average results interval: 5
Ic cut-off value: 2.60
Unit weight calculation: Based on SBT
Excavation: Yes
Excavation depth: 12.00 ft

Footing load: 2.00 tsf
Transition detect. applied: Yes
K_σ applied: Yes
Clay like behavior applied: All soils
Limit depth applied: Yes
Limit depth: 50.00 ft

SBT legend

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

CPT basic interpretation plots (normalized)



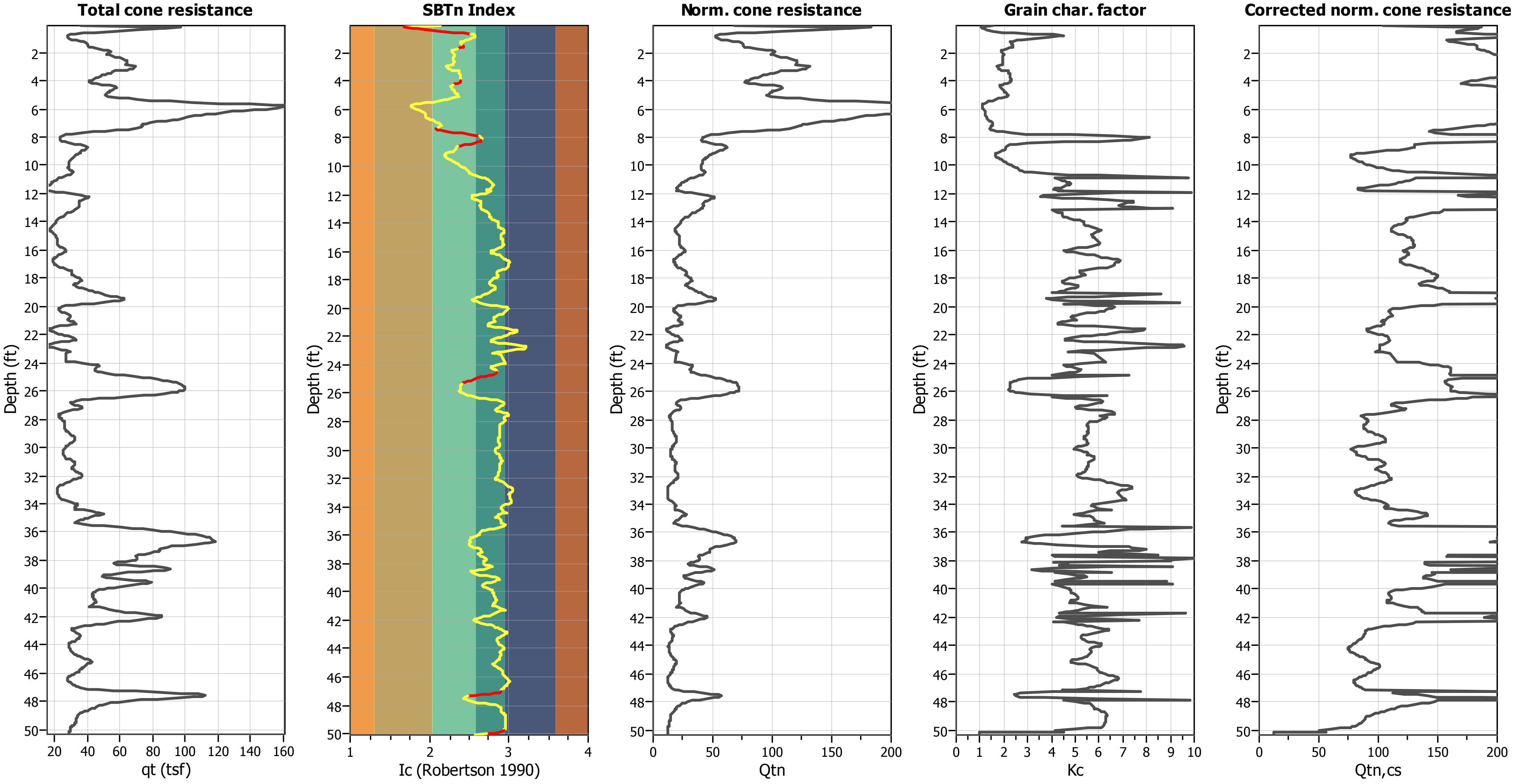
Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

SBTn legend

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

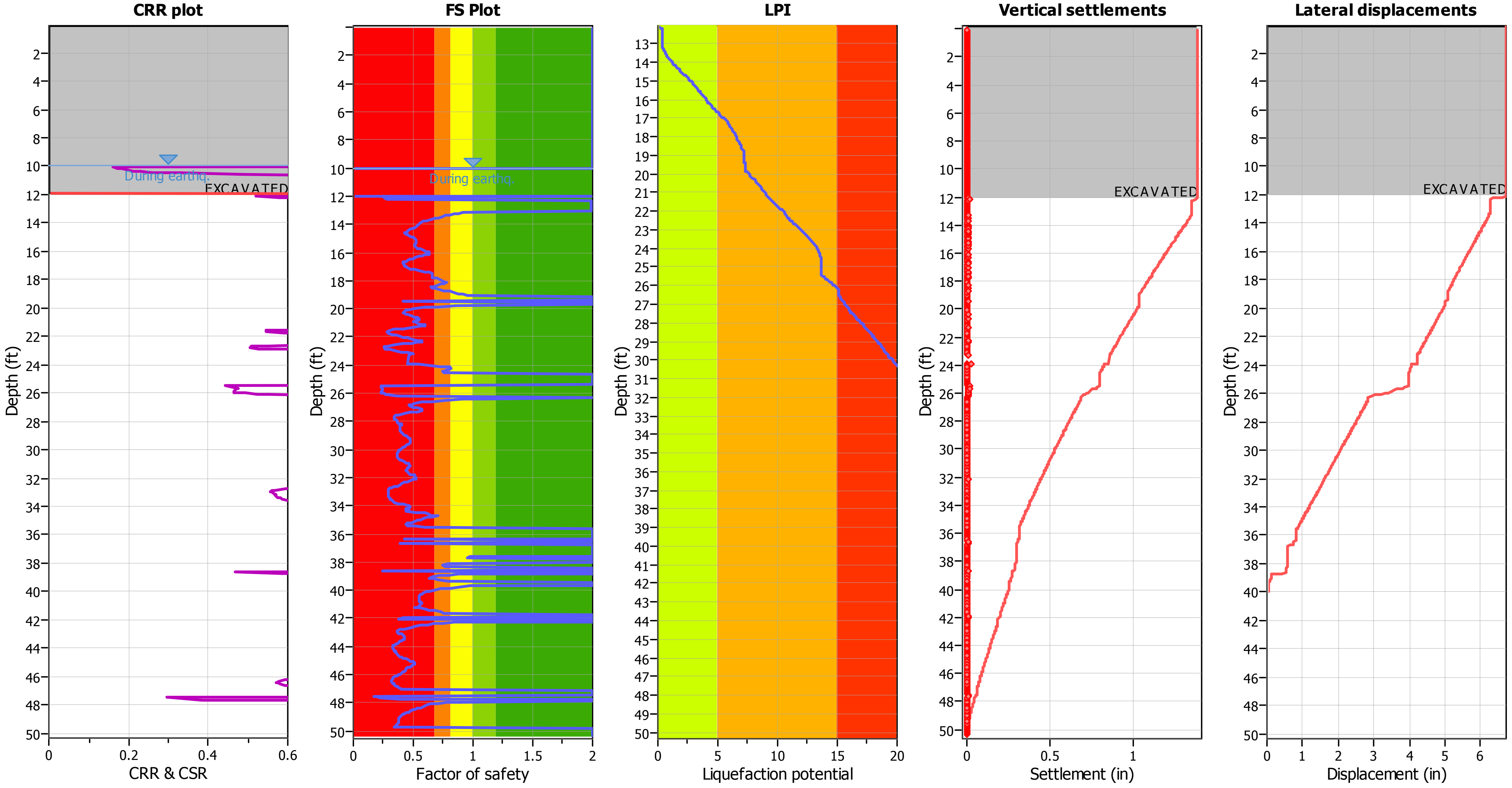
Liquefaction analysis overall plots (intermediate results)



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
Depth to water table (insitu):	21.50 ft	Excavation depth:	12.00 ft	Limit depth:	50.00 ft

F.S. color scheme

- ☐ Almost certain it will liquefy
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- ☐ Liquefaction and no liq. are equally likely
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LPI color scheme

- ☐ Very high risk
- ☐ High risk
- ☐ Low risk

Liquefaction analysis summary plots

Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	7.30	Unit weight calculation:	Based on SBT	Clay like behavior applied:	All soils
Peak ground acceleration:	0.85	Excavation:	Yes	Limit depth applied:	Yes
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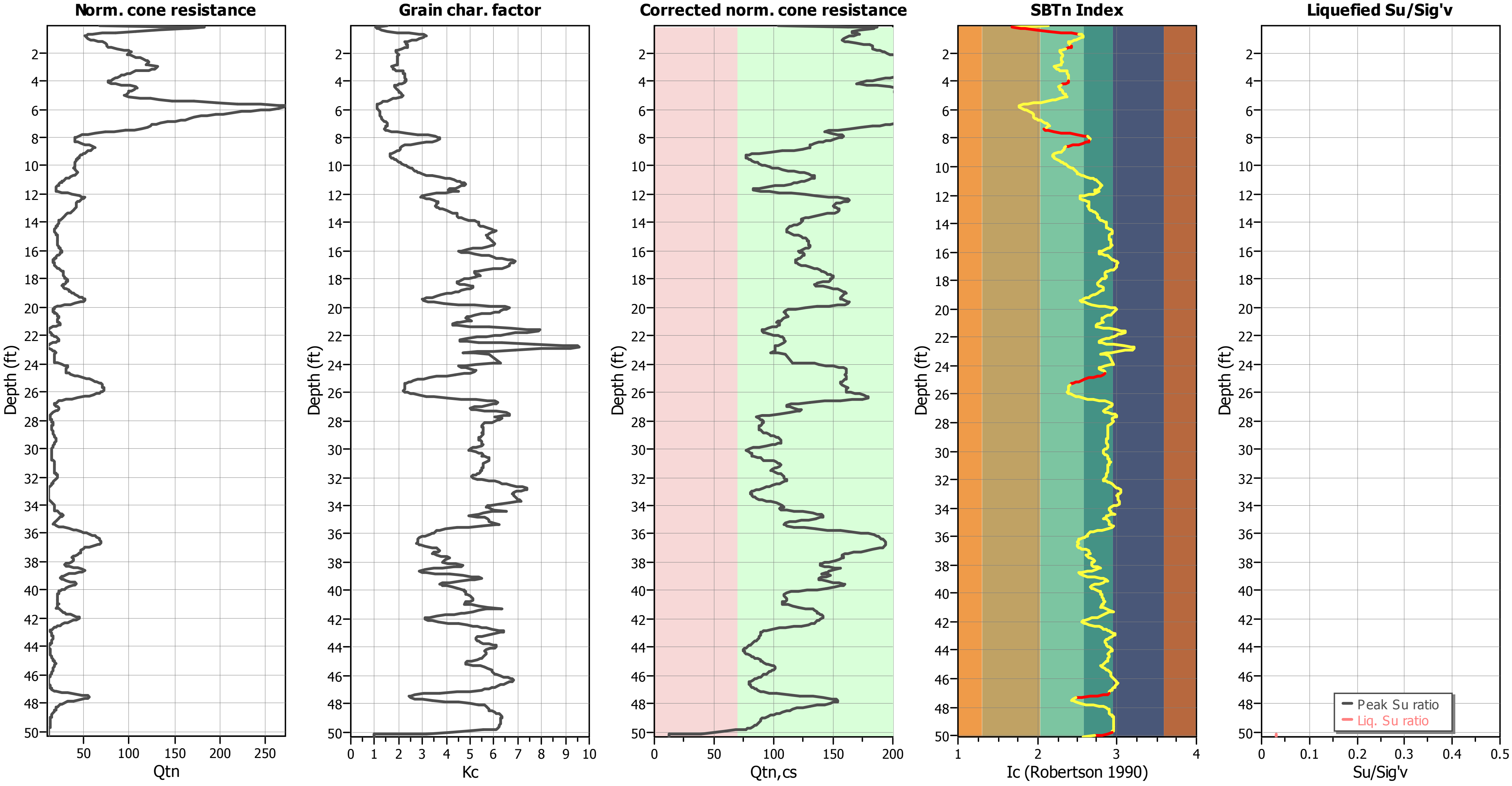
Check for strength loss plots (Robertson (2010))



Input parameters and analysis data

Analysis method:	Robertson (2009)	Depth to water table (erthq.):	10.00 ft	Footing load:	2.00 tsf
Fines correction method:	Robertson (2009)	Average results interval:	5	Transition detect. applied:	Yes
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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:: Liquefaction Potential Index calculation data ::

Depth (ft)	FS	F_L	w_z	d_z	LPI	Depth (ft)	FS	F_L	w_z	d_z	LPI