Government of Guyana

Guyana Energy Agency

Preparation of Detailed site investigation report Leguan Island Solar Photovoltaic Farm project site

Geotechnical Engineering Report

Report No. 1: CPT Method

INNOVATIVE ENGINEERING CONSULTANCY

Contents

1.0 Executive Summary

1.1 Background

Guyana is 96 percent dependent on imported fossil fuel for its electricity generation needs. The cost and reliability of electricity are recognized by the Government of the Cooperative Republic of Guyana as a major factor for profitability and efficiency in business operations, especially in energy-intensive industries such as manufacturing. Component 1 - Renewable energy solutions for the Hinterland under the Energy Matrix Diversification and Institutional Strengthening of the Department of Energy (EMISDE) Programme - is one of three components which will address the energy diversification policy goals of the Government of Guyana. It will finance the investment of solar technology in three townships and the Island of Leguan, by means of the installation of solar PV-tied mini-grid systems in Bartica (1.5 MW), Lethem (1.0 MW), Mahdia (0.65 MW) and Leguan (0.6 MW) totaling 3.75 MW, and the implementation of a storage capacity to manage intermittence of these sources. Overall, this Component will provide a reliable electricity source to the expanding needs of power supply in these communities, now relying on fossil fuel.

In accordance with the Inter - American Bank's Policy OP-703, this operation is classified as Category "B" and it is anticipated that the project will generate moderate impacts that could be easily moderated by the implementation of the required mitigation measures. The main impacts for Component 1 will be associated with land clearing (pre-construction) and erosion during both construction and operations. To meet the requirements of the IDB's Environmental and Social Safeguard Policies, the Government of Guyana will comply, to the satisfaction of the Bank, with the contractual terms and conditions set forth.

Energy Agency (GEA) awarded IECS Consulting Firm to offer consultancy services, in accordance with these Terms of Reference to complete detailed site investigation as it relates to the ground conditions of the proposed Leguan project site. This allows risks and liabilities to be minimized, while maximizing the potential for an economic and safe design to increase the likelihood of the project being completed on time and within budget. The proposed site investigations for the Leguan Solar Photovoltaic Project site will consist three (3) components as follows:

- Component 1: A Site (Land) Feature and Topographic Survey Report
- Component 2: A Geotechnical Engineering Report
- Component 3: A Flood Risk Report

1.2 INTRODUCTION

Innovative Engineering Consultancy Services was contracted by GEA to undertake soil testing services at Leguan, Region No. 3. The subsurface investigation at the proposed site consisted of one deep (25m) and five (8m) shallow explorations within the soil profile via cone penetration testing (CPT).

One key deliverable of CBA's contract is the draft soil testing report which is the subject of this report and constitutes an amalgamation of the results for the CPT data retrieved.

1.3 LOCAL GEOLOGICAL CONDITIONS

Guyana is dominated by plateau landforms. The western and southern parts of the country are relatively high in terrain and gently dips to the northeast. The Mesozoic and Cenozoic Paleogene-Neoprene alluvial formations are covered by the central and western regions.

The Coastal Plain, which lies near sea level, is underlain by clays of the Demerara Clay and Corpina Formations and crossed by old shorelines and sand ridges mostly parallel with the present shorelines. The sediments of the Coastal Plain together with those of the White Sand Series, referred to here as the Coastal Sediments, where their composition and configuration give rise to the artesian conditions on which the coastal water supply demands.

In the Leguan area, the conditions are vastly different in comparison to the Greater Georgetown area. Here the crystallines rise to within 300ft of the surface ridge or shelf. The upper members of the White Sand Series thin out as they approach it and there is evidence of gradual uplift. In this area, the Demerara Clay is completely absent as such and the presence of considerable bodies of lignite throughout the White Sand Series points to more terrestrial conditions.

1.4 LOCATION OF BOREHOLES

The site investigations were conducted in Leguan Island, Region No. 3 and the locations of the boreholes are shown in the Google Earth image below in Figure 1, with the coordinates listed in Table 1.

Table 1: Location of boreholes

Borehole Number	Latitude	Longitude
CPT#1	6°55'48.3"	58°22'11.0"
CPT#2	6°55'46.7"	58°22'12.4"
CPT#3	6°55'49.2"	58°22'10.3"
CPT#4	6°55'51.6"	58°22'11.9"
CPT#5	6°55'52.4"	58°22'10.9"
CPT#6	6°55'53.6"	58°22'9.6"

Figure 1: Borehole locations at the proposed Leguan site

1.5 SCOPE OF SUB-SURFACE INVESTIGATION

The objective of the soil testing investigations was to establish representative soil parameters, to be used in the foundation design of a solar photovoltaic farm at Leguan, Region No. 3. In accordance with the requirements of the contract, the services provided by IECS can be summarized as one (1) cone penetration testing to a maximum depth of 25m or refusal, whichever comes first and five (5) cone penetration testing to a maximum depth of 8m or refusal, whichever comes first. This draft soil testing report covers the results of the CPT investigations.

2.0 GENERAL APPROACH AND METHODOLOGY

The following section of the report details the methodological approach utilized to conduct the soil investigations. At the Leguan location, CPT#1, CPT#2 and CPT#3 were advanced on December 17, 2022 and CPT#4, CPT#5 and CPT#6 were advanced on December 18, 2022.

2.1 CPT OPERATION

The MC-23 Rotary Drill Rig (TMG, USA) was used as the primary field equipment to execute the CPT. Figure 2 shows the CPT operations being conducted. The MC-23 equipment is state-of-the-art, automated, and augmented with a software component that allows easy data collection and logging. The equipment provides a maximum push force of 20 tons for the advancement of the cones into the soil. In operation, the MC-23 measurements were made by driving a cone penetrometer attached to a series of rods into the ground at a constant speed. As the cone was driven into the ground, continuous measurement of the resistance penetration of the cone and the surface sleeve was recorded.

Figure 2: CPT operation at Leguan, Region No. 3

The refusal criteria for cone penetration testing are based on a combination of factors as detailed by the manufacturers of the MC-23 Rotary Drill Rig (TMG, USA) and refusal is accepted when one of the five criteria listed below is reached:

- The maximum tip resistance of 20 MPa is achieved; or
- The anchored Rig has uplifted and deviated beyond the safe limit from the ground surface reference level, due to a greater reaction force from the push rod-penetrometer tip string than the thrust force; or
- The tip's deviation from the vertical (15°) is reached; or
- Sixteen (16) metric tons thrust force; or
- The required depth for the boring, where possible, is achieved.

The cone penetrometer consists of a cone, filter, and friction sleeve as depicted in the schematic representation of Figure 3. The cone has a base section of 10cm2 and an angle of 60 degrees. The cone resistance is measured and logged by the equipment. The total force acting on the cone divided by the projected area of the cone produces the cone resistance.

Attached to the cone is the friction sleeve. The total force acting on the friction sleeve divided by the surface area of the friction sleeve produces the sleeve resistance. The local friction on the sleeve is measured by tension load cells embedded in the sleeve for a distance of 100mm behind the tip. As the probe is advanced through the soil, the average skin friction is measured.

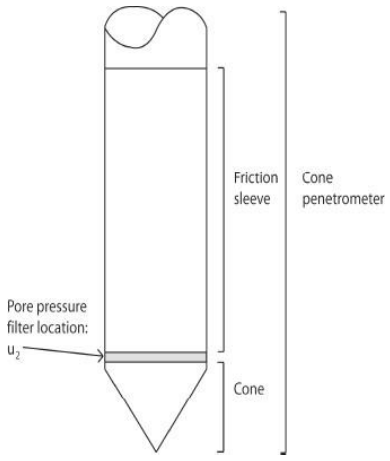


Figure 3: Cone Penetrometer

3.0 RESULTS

3.1 CPT PROFILING

The cone penetration test provides a guide to the mechanical characteristics, i.e. strength, stiffness, and compressibility, of the soil. For the cone penetration test conducted, Table 2 below details the depths the borings achieved.

Table 2: Achieved depths for CPTs conducted

CPT Number	Target Depth (m)	Depth Achieved (m)	Remarks
CPT #1	25.00	25.02	The required depth of boring was achieved.
CPT #2	8.00	8.04	The required depth of boring was achieved.
CPT #3	8.00	8.08	The required depth of boring was achieved.
CPT #4	8.00	8.04	The required depth of boring was achieved.
CPT #5	8.00	8.06	The required depth of boring was achieved.
CPT #6	8.00	8.04	The required depth of boring was achieved.

The raw data measurements from the CPTs were processed and interpreted. The data set for each borehole was filtered and analyzed using CPeT-IT (by GeoLogismiki), a recognized CPT interpretation software, which generates 1D, 2D, and tabular datasets for various engineering soil parameters. This prediction of soil type based on CPT is referred to as Soil Behavior Type (SBT).

The reports generated using the GeoLogismiki CPeT-IT software for each CPT conducted is attached in **Appendix A**. The report includes the Raw Data Plots along with Basic Plots, Normalized and SBT (Soil Behavior Type) plots. Included is a list of governing equations used in CPeT-IT for the estimation of the various soil parameters.

Raw Data Plots: These include plots of measured, cone tip resistance, qc, sleeve friction, fs, penetration pore pressure, u, and cross-correlation between qc and fs.

Basic Plots: These are plots of corrected, qt, friction ratio, Rf, penetration pore pressure, u (with reference hydrostatic profile based on user input GWL), normalized SBTn Ic, and non-normalized SBT.

Normalized Plots: These are plots of normalized CPT parameters, normalized tip resistance, Qtn, normalized friction ratio, Fr, normalized pore pressure parameter, Bq, normalized SBTn Ic, and normalized SBTn.

SBT plots: These plots display the CPT results on both the non-normalized and normalized CPT Soil Behaviour Type (SBT and SBTn) charts suggested by Robertson et al., 1986, and Robertson, 1990. The CPT data provides a guide to the mechanical characteristics (strength, stiffness, compressibility) of the soil, or the soil behavior type.

The tabulated parameter estimations for the CPT points are displayed in Appendix A. Also included are the profiles of the various soil layers for each CPT point as determined by the soil behavior type.

It is important to note that the CPeT-IT software only displays the plots for undrained shear strength against the depth of soils with SBTn values of 1, 2, 3, 4, and 9. No plots for shear strength of cohesionless soil (SBTn values of 5, 6, 7 & 8).

GENERAL COMMENTS

The analysis and findings presented in this report are based on the data obtained from the boring conducted at the indicated location at the site. Spatial variations that may occur between borings, or due to the modifying effects of construction or weather are not reflected in this report. In the event of any such variations, Innovative Engineering Consultancy Services should be immediately notified so that further evaluation and recommendations can be provided.

This report has been prepared for the exclusive use of our client, for specific application to the project highlighted, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the findings contained in this report shall not be considered valid unless Innovative Engineering Consultancy Services reviews the changes and either verifies or modifies the conclusions of this report in writing.

DISCLAIMER

The CPT tests and accompanying interpretation using CPeT-IT require experience and expert judgement in its use and it is recommended that careful consideration be taken in the use of the soil parameters presented herein Innovative Engineering Consultancy Services takes no responsibility for improper use of data and subsequent design.

REFERENCE

Robertson, P.K., Cabal K.L. Guide to Cone Penetration Testing for Geotechnical Engineering, Gregg Drilling & Testing, Inc., 5th Edition, November 2012

Robertson, Peter K. "Interpretation of cone penetration tests—a unified approach." Canadian geotechnical journal 46, no. 11 (2009): 1337-1355.

Barounis, N., and J. Philpot. "Estimation of in-situ water content and void ratio using CPT for saturated sands." In Cone Penetration Testing 2018: Proceedings of the 4th International Symposium on Cone Penetration Testing (CPT'18), 21-22 June, 2018, Delft, The Netherlands, p. 129. CRC Press, 2018.

United States. Bureau of Reclamation. Engineering geology field manual. US Department of the Interior, Bureau of Reclamation, 1991.

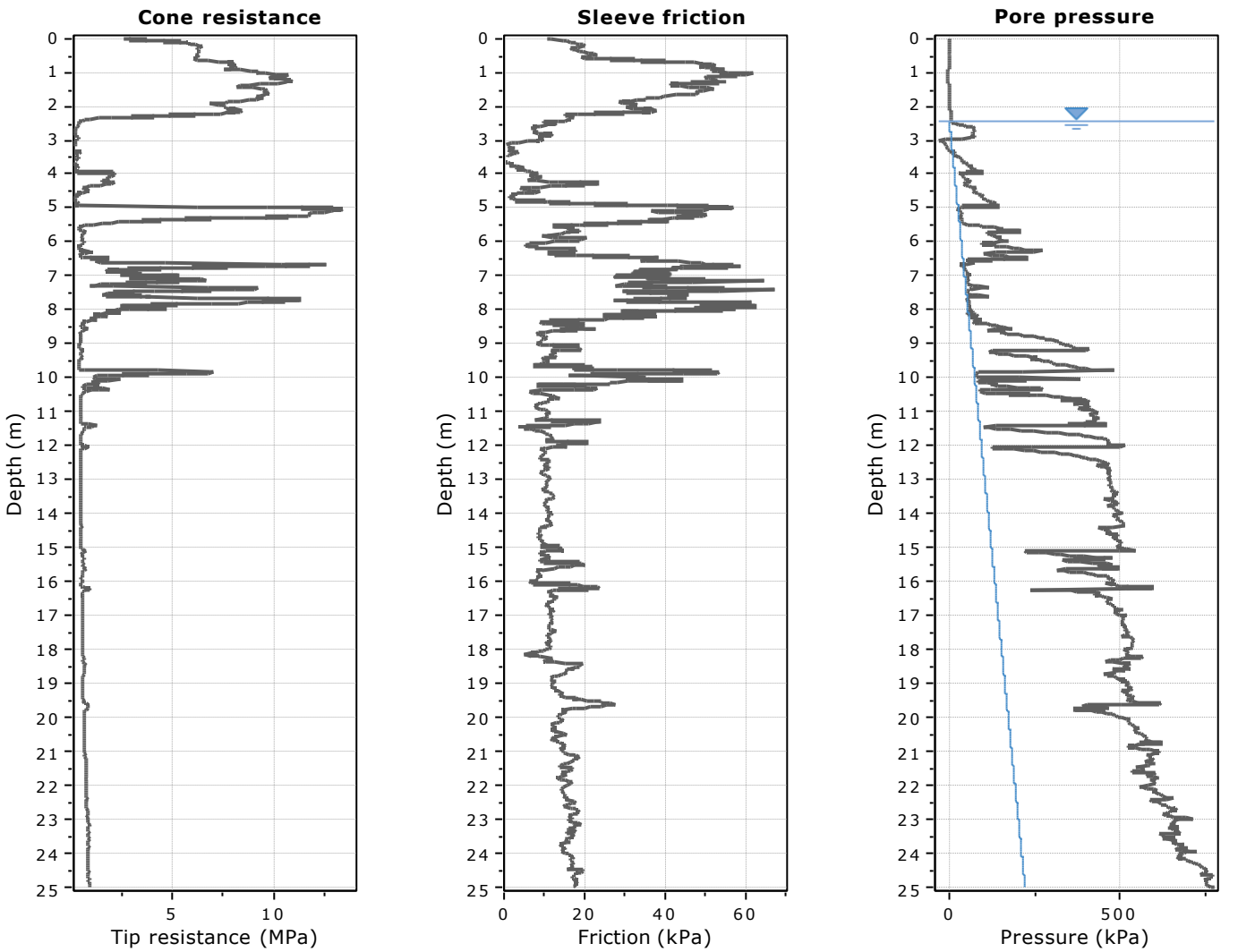
APPENDIX A – CPT Results

CPT#1

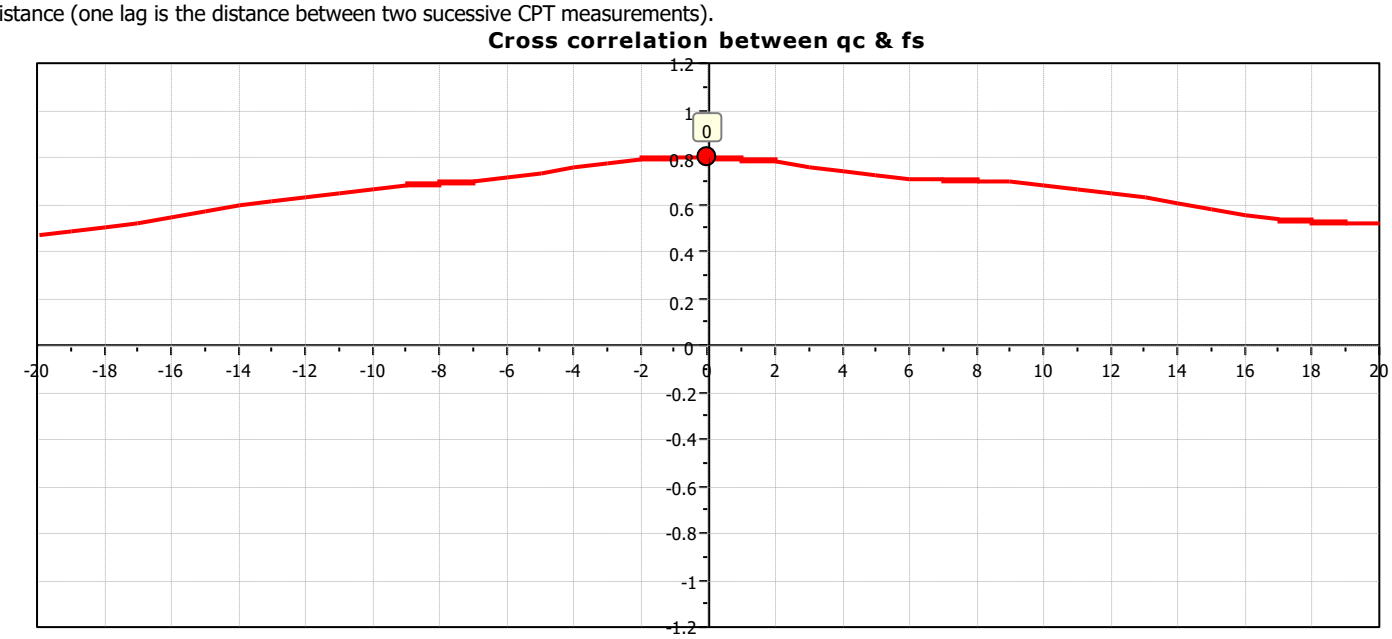
Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

CPT: #1
Total depth: 25.02 m, Date: 12/17/2022
Coords: 6°55'48.3" N 58°22'11" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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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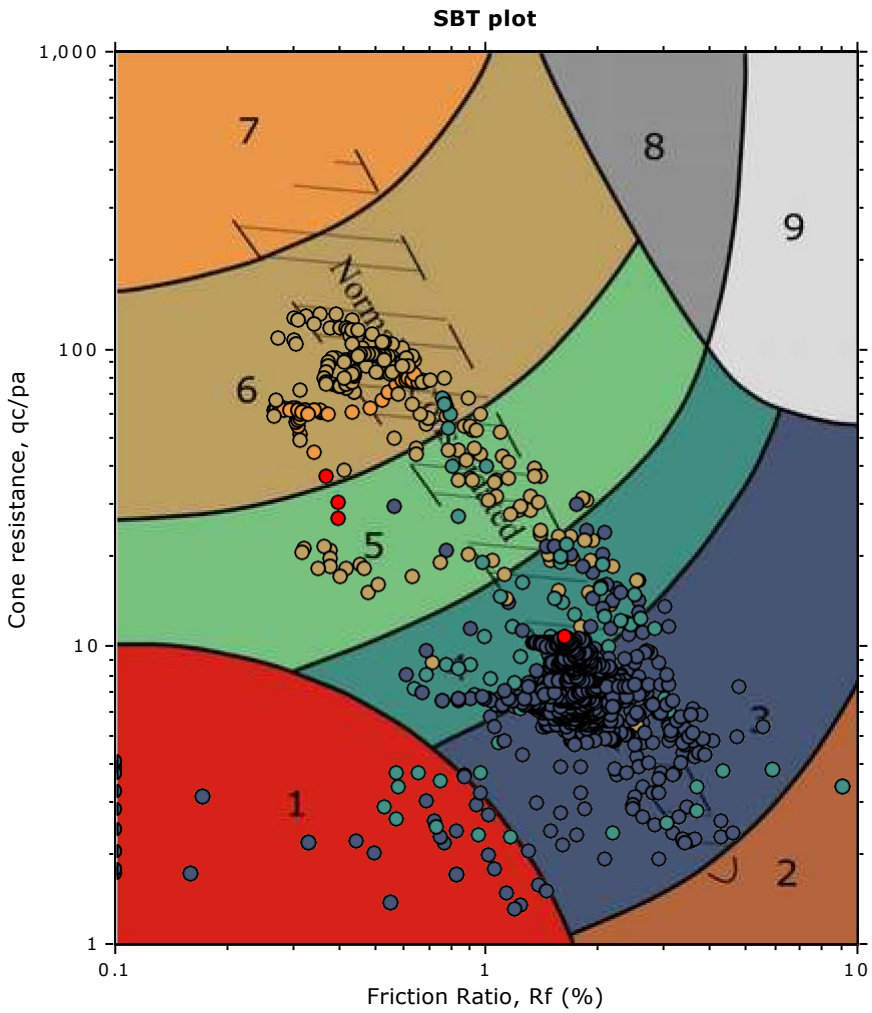
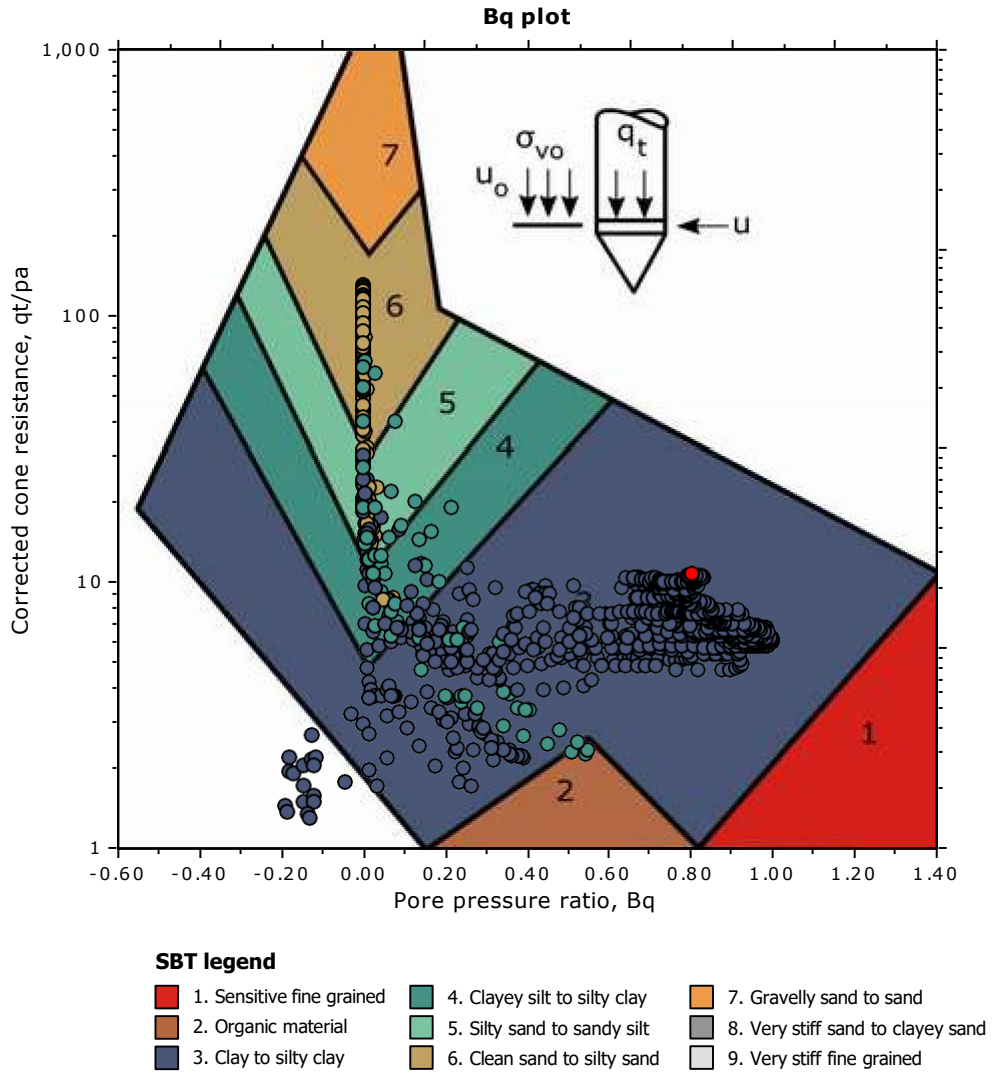
CPT: #1
Total depth: 25.02 m, Date: 12/17/2022
Coords: 6°55'48.3" N 58°22'11" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

SBT - Bq plots





SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly 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

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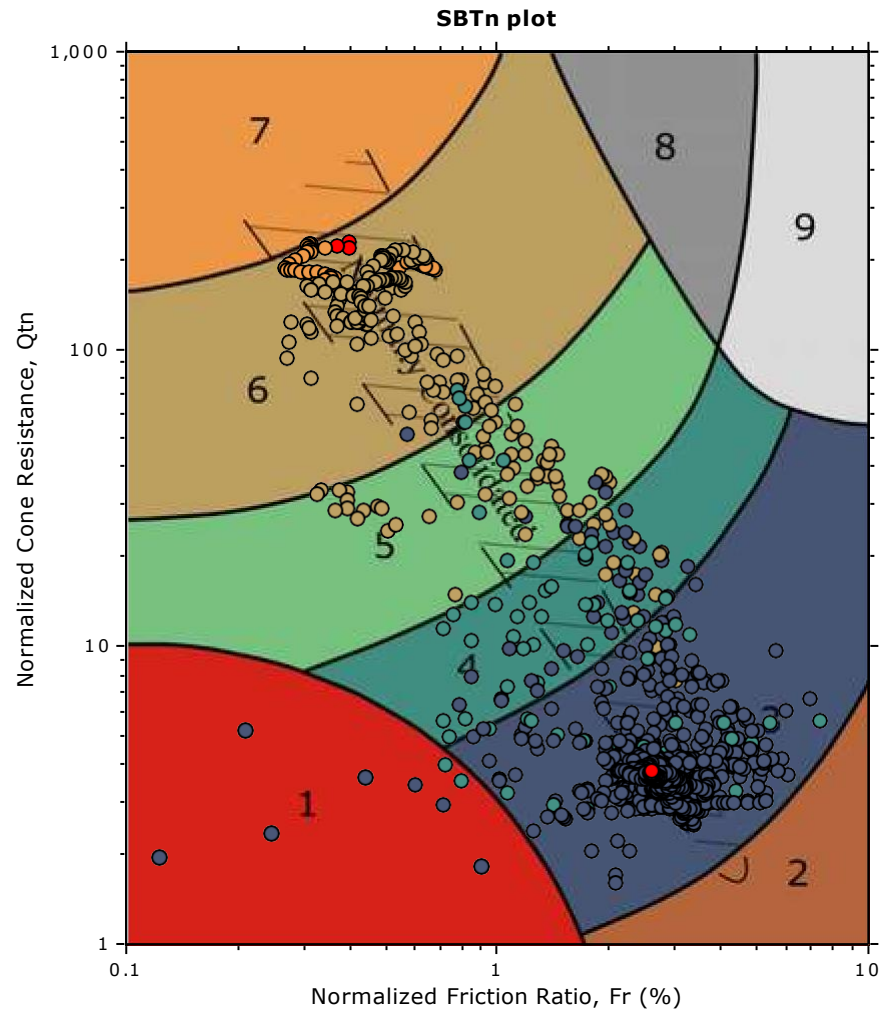
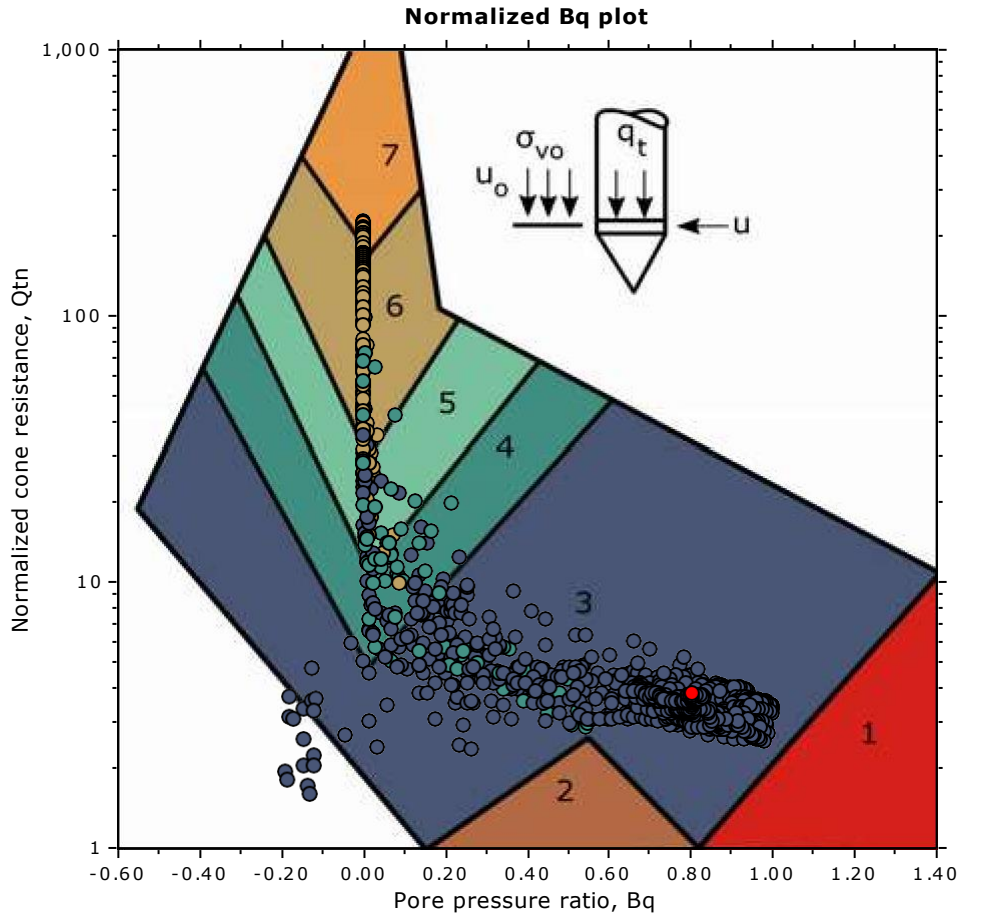
SBT - Bq plots (normalized)





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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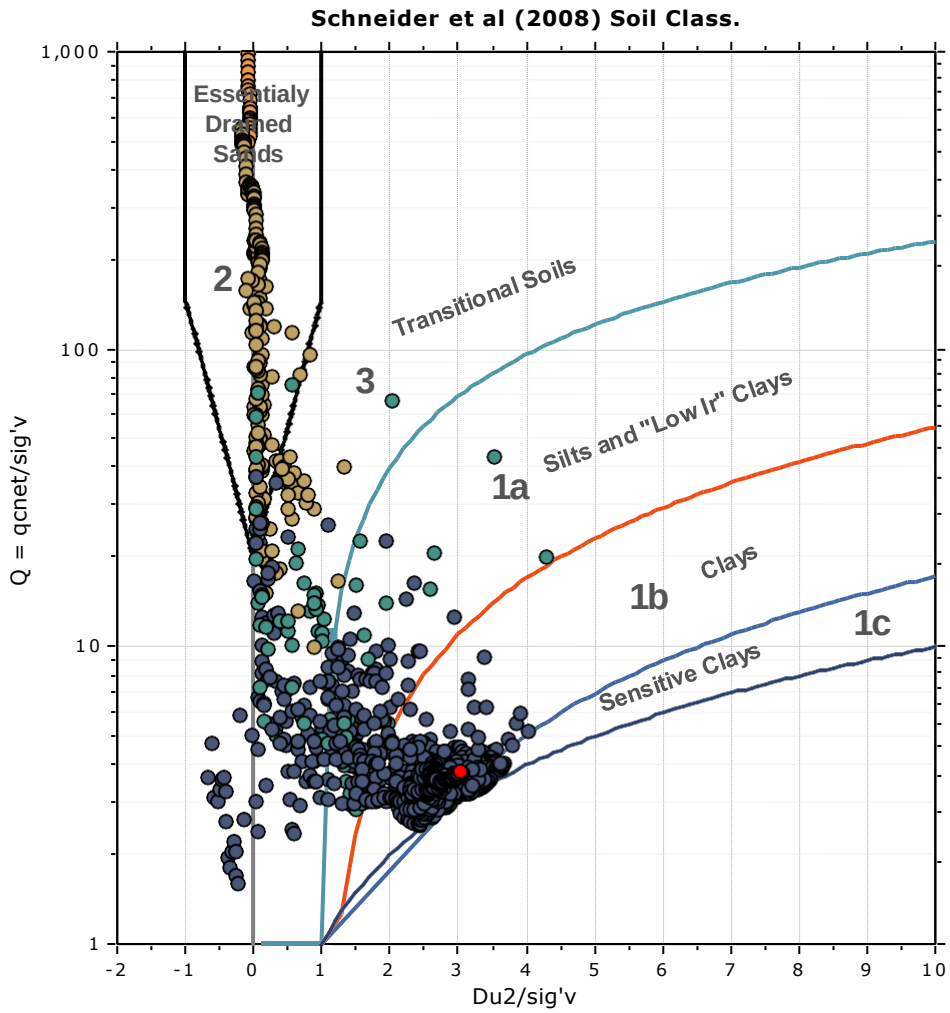
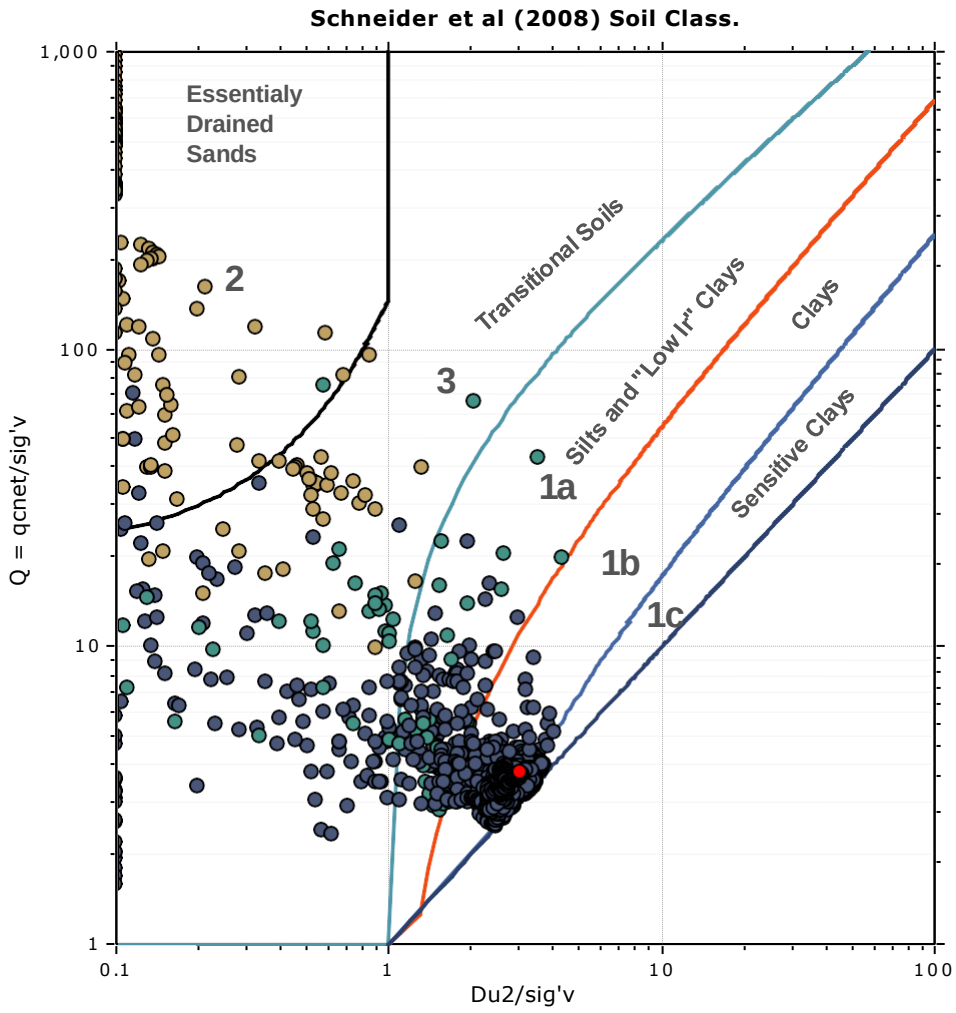
Bq plots (Schneider)





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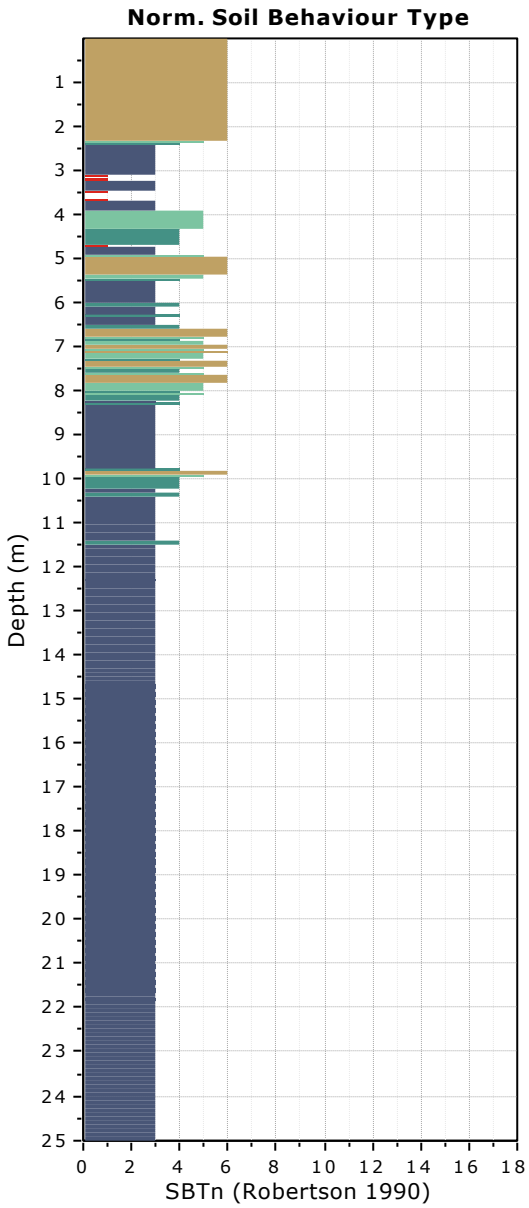

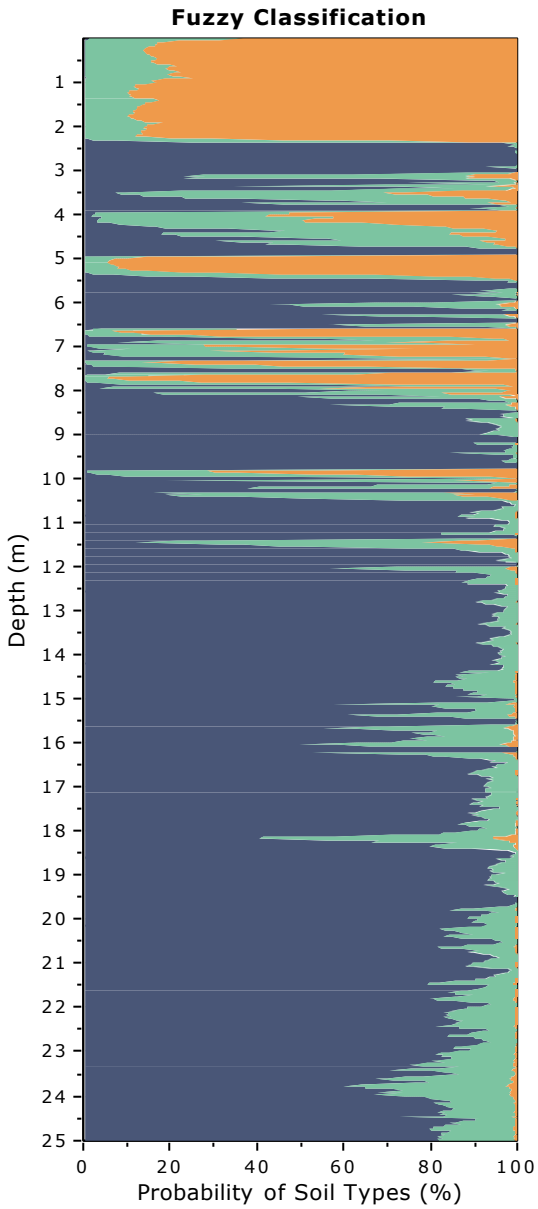

Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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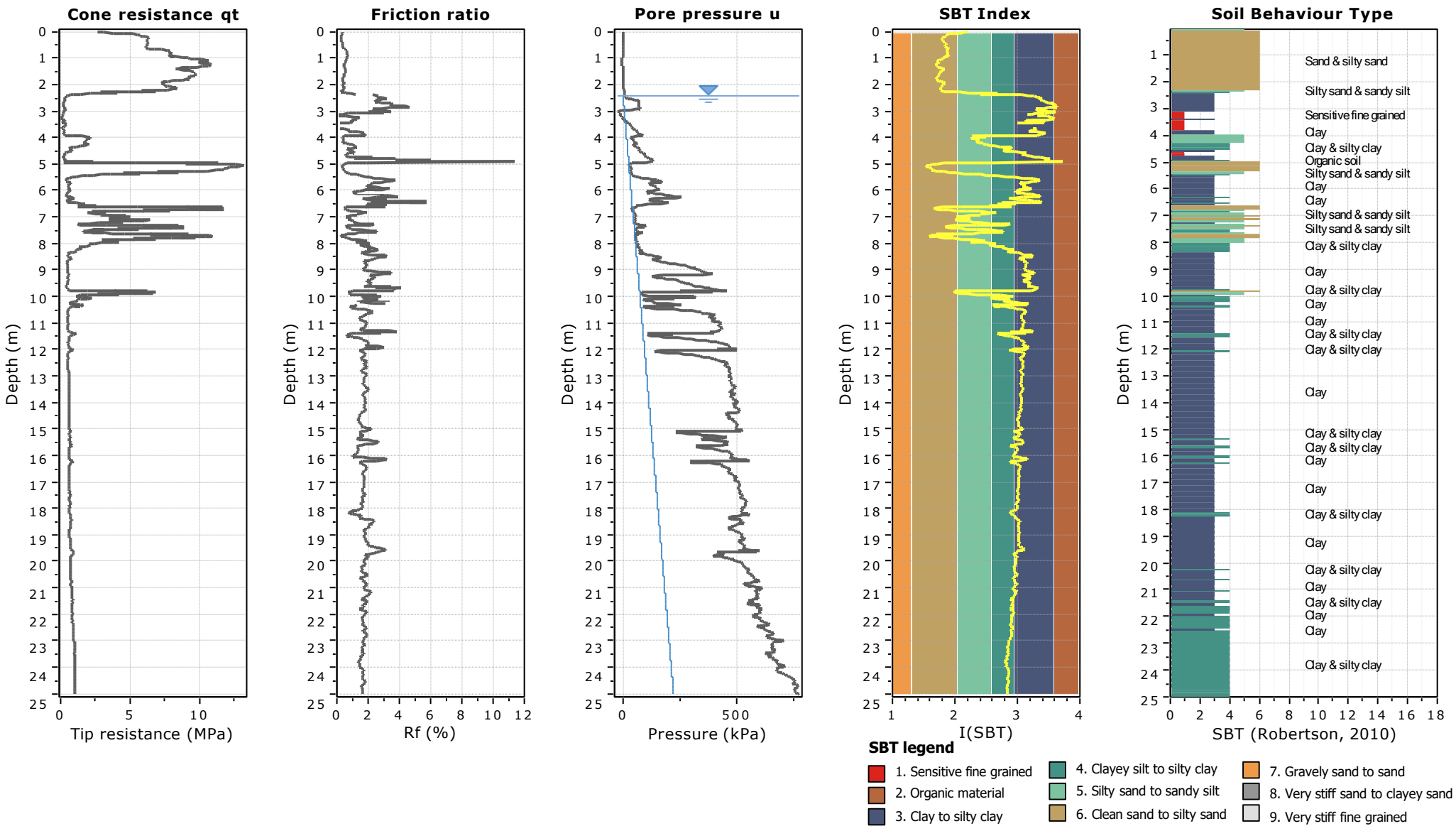

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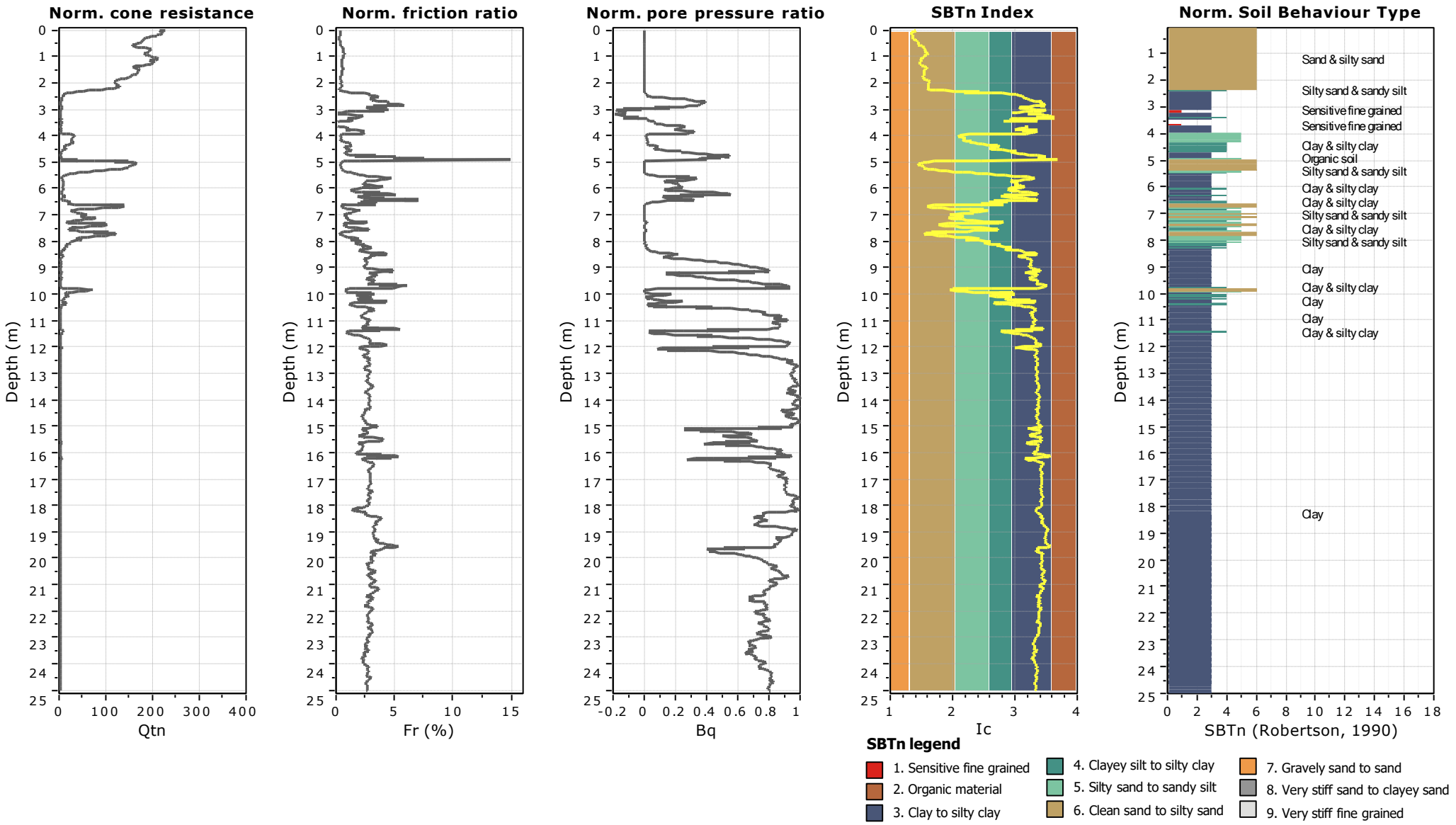

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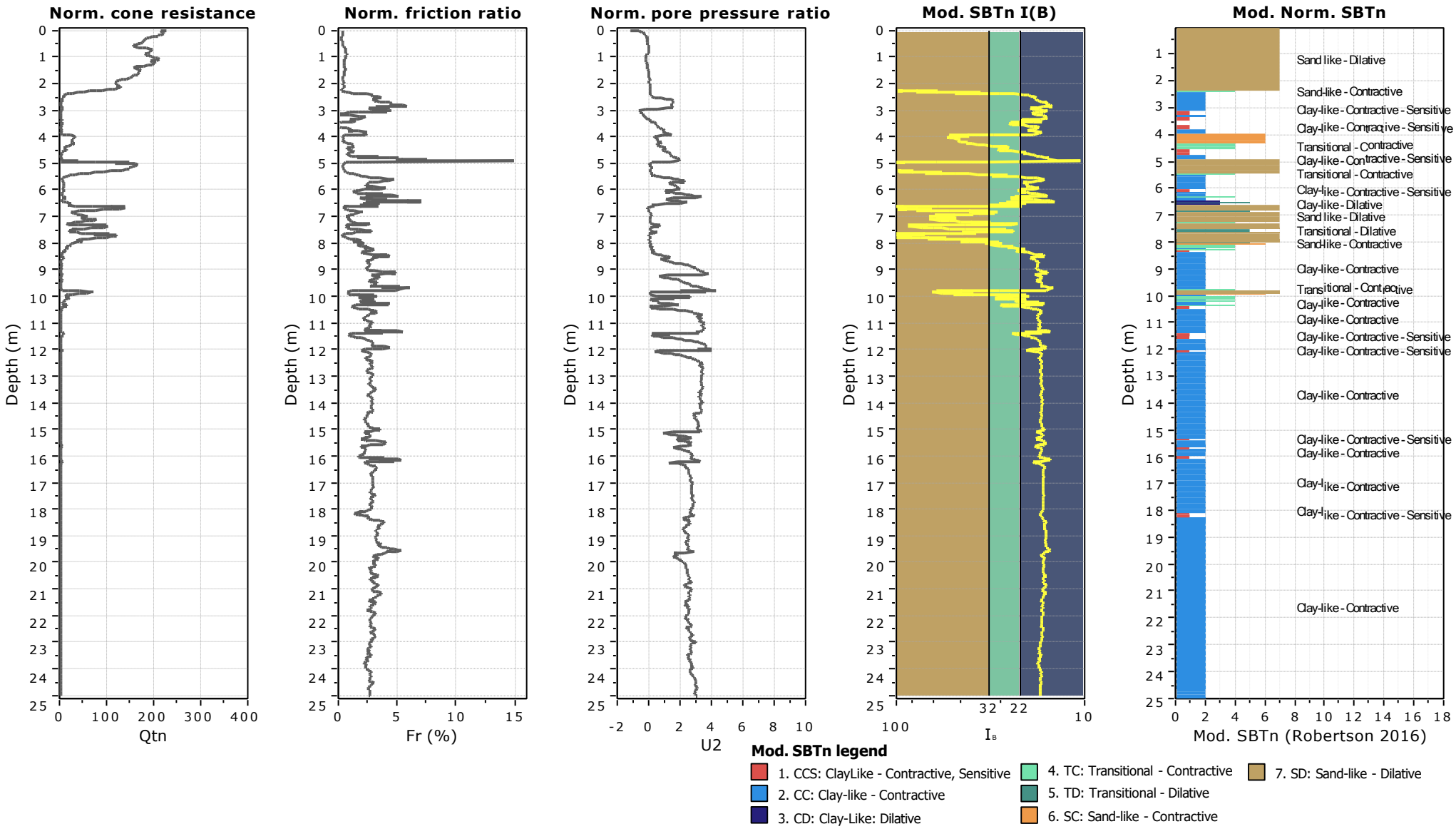

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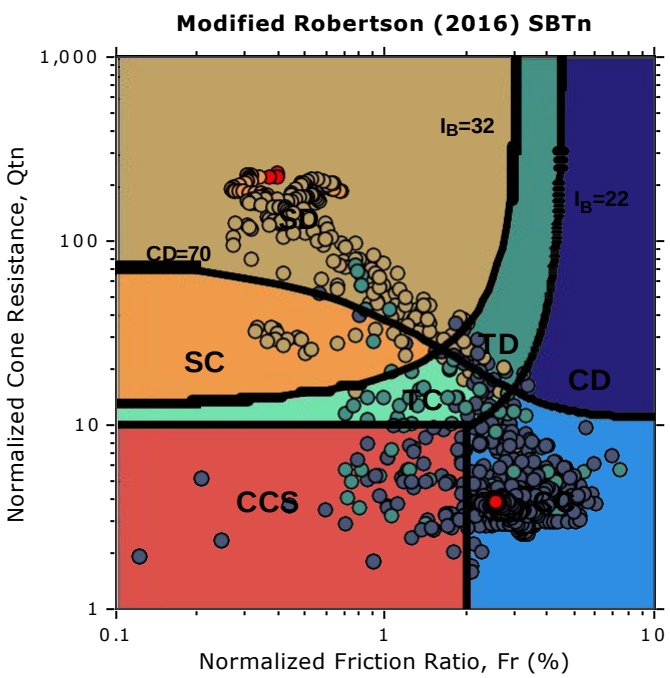
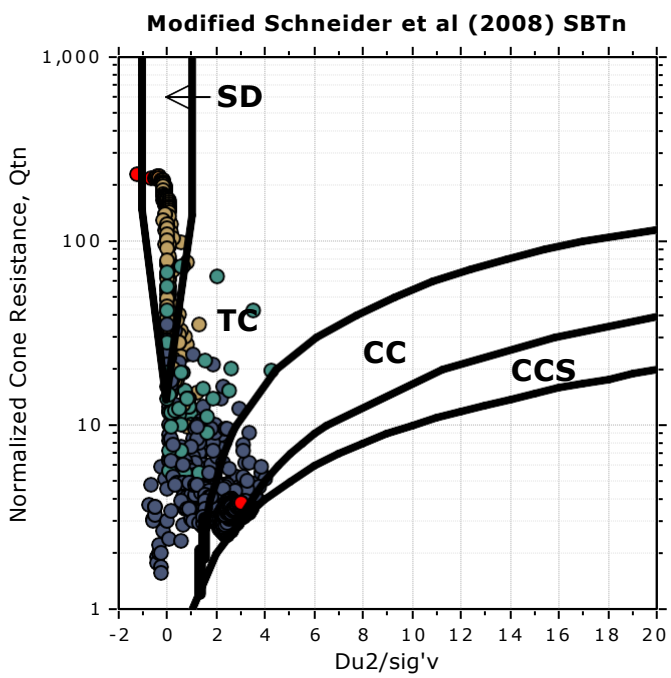
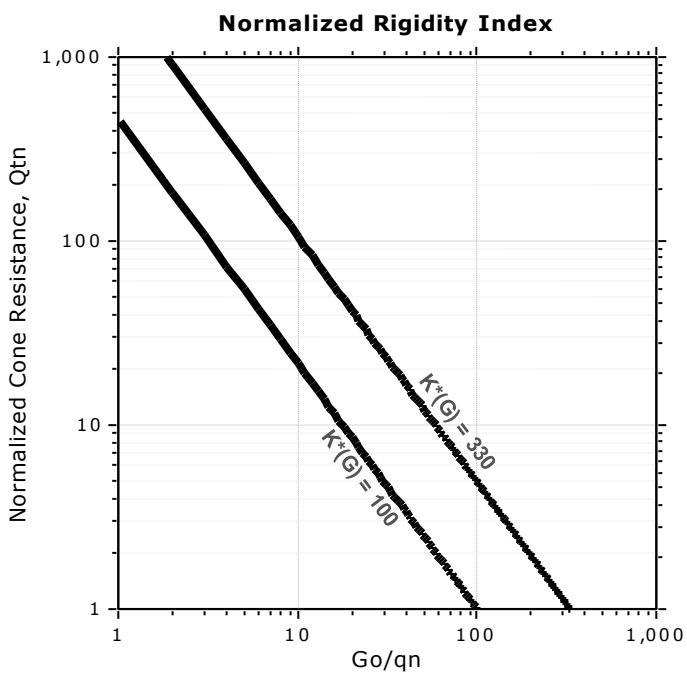
Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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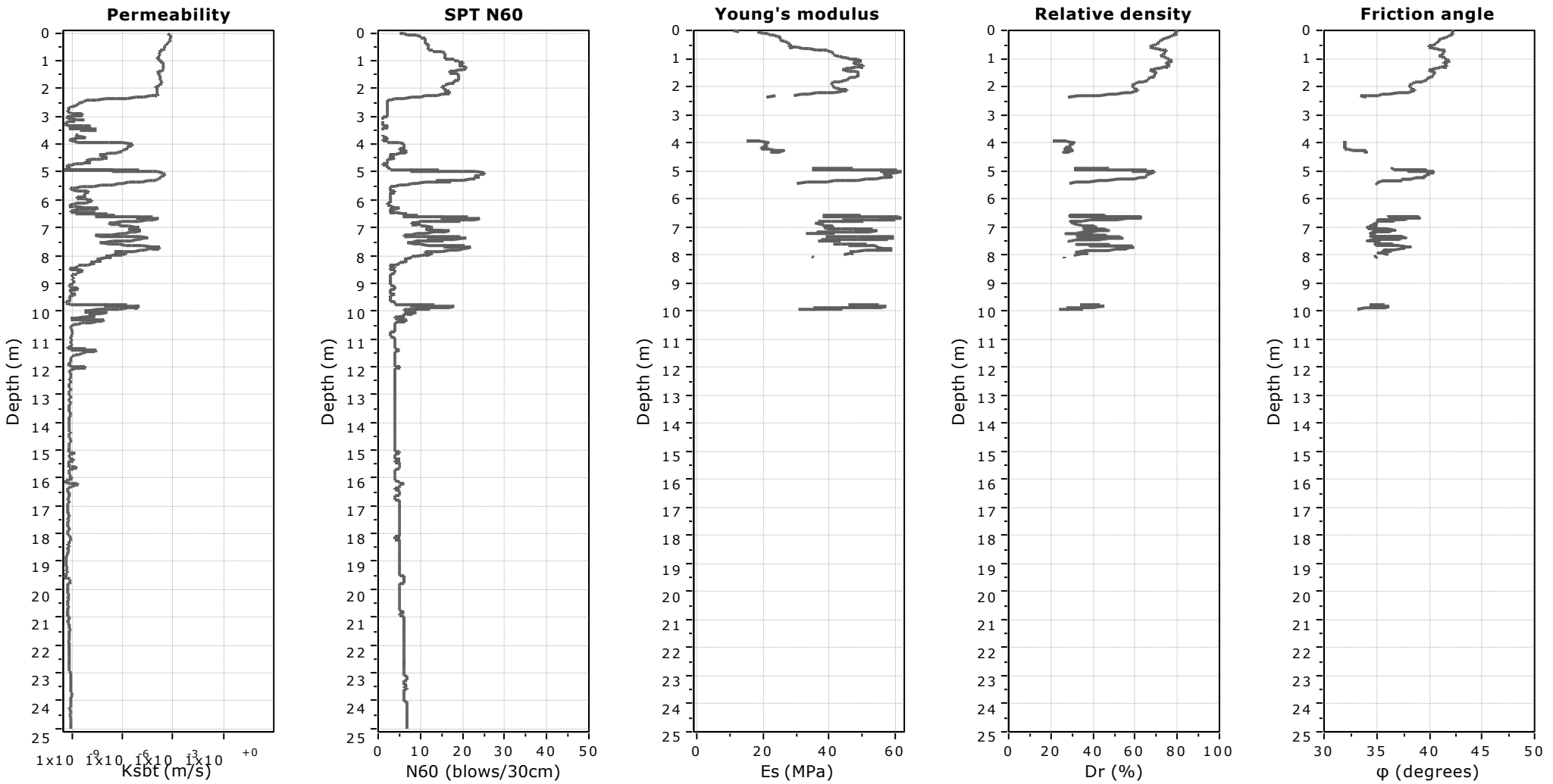

Calculation parameters

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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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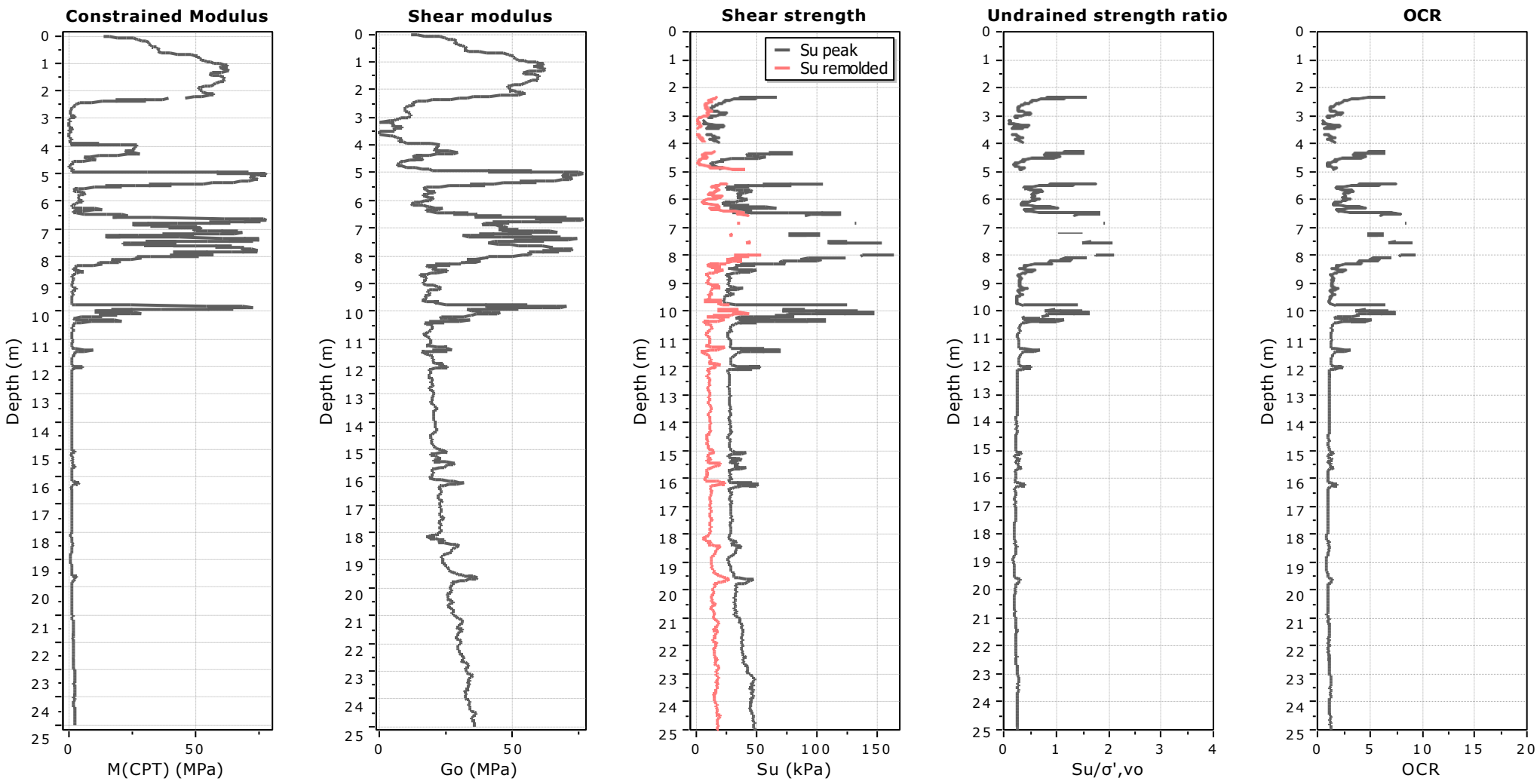

Calculation parameters

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
Flat Dilatometer Test data

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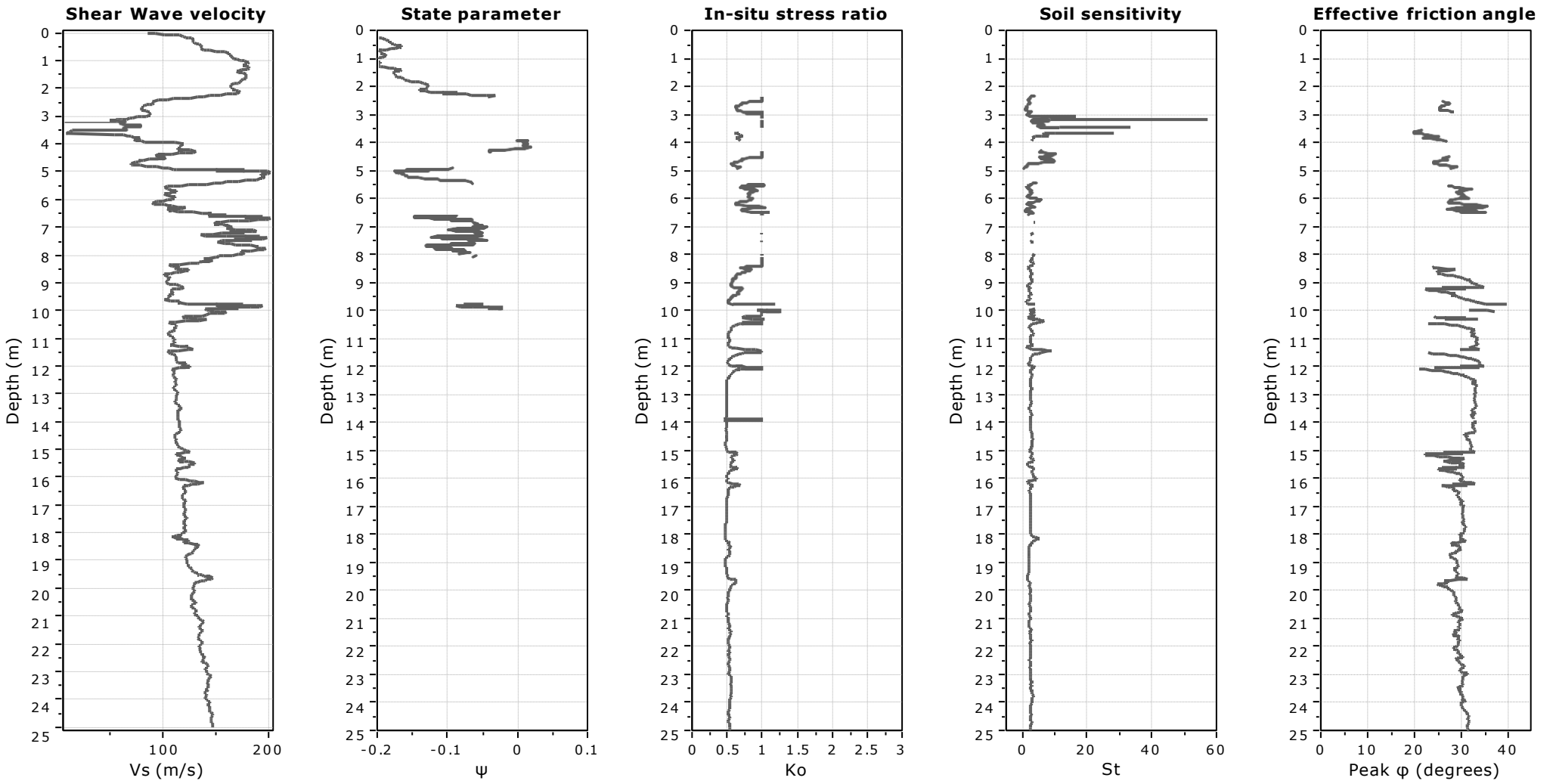

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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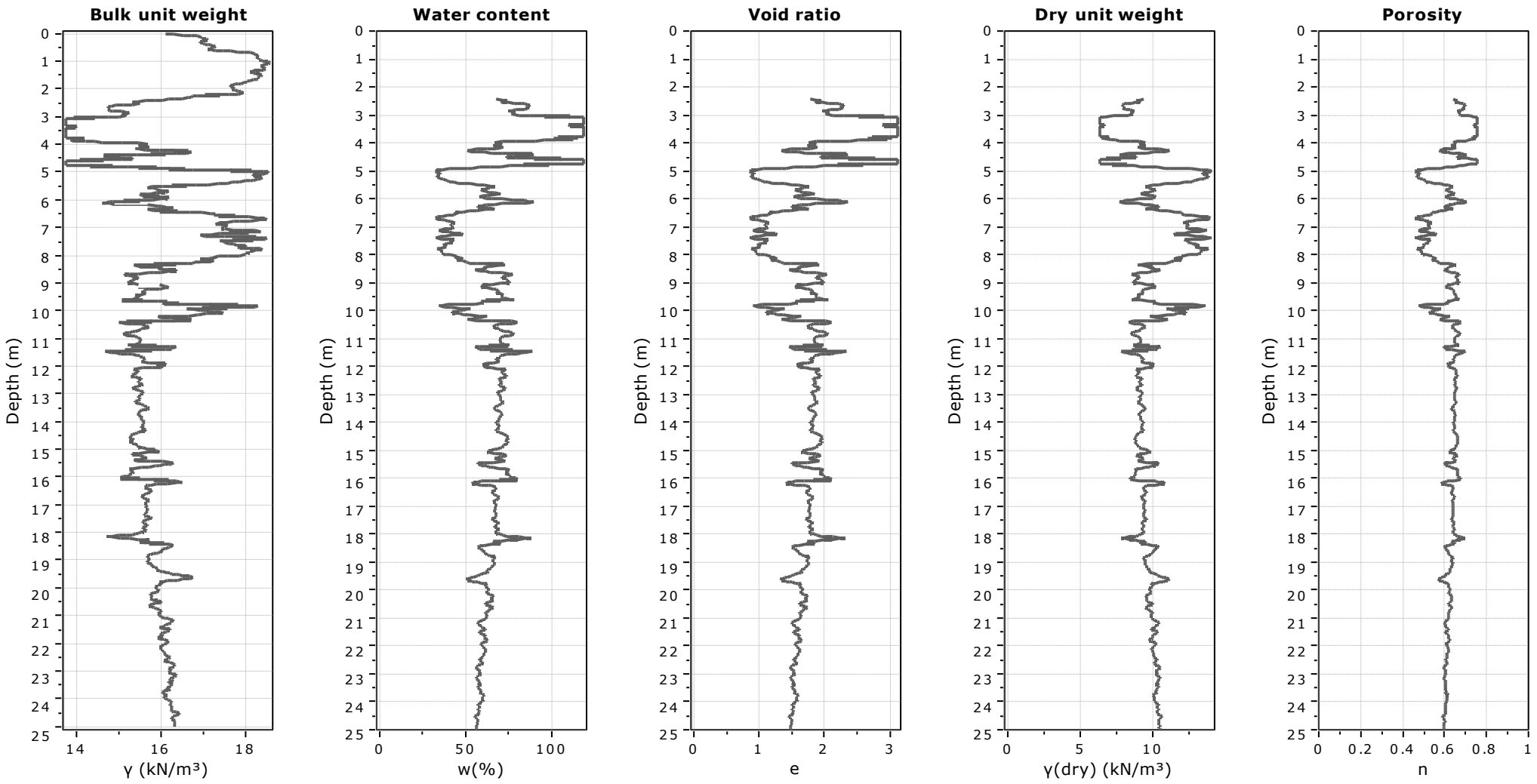

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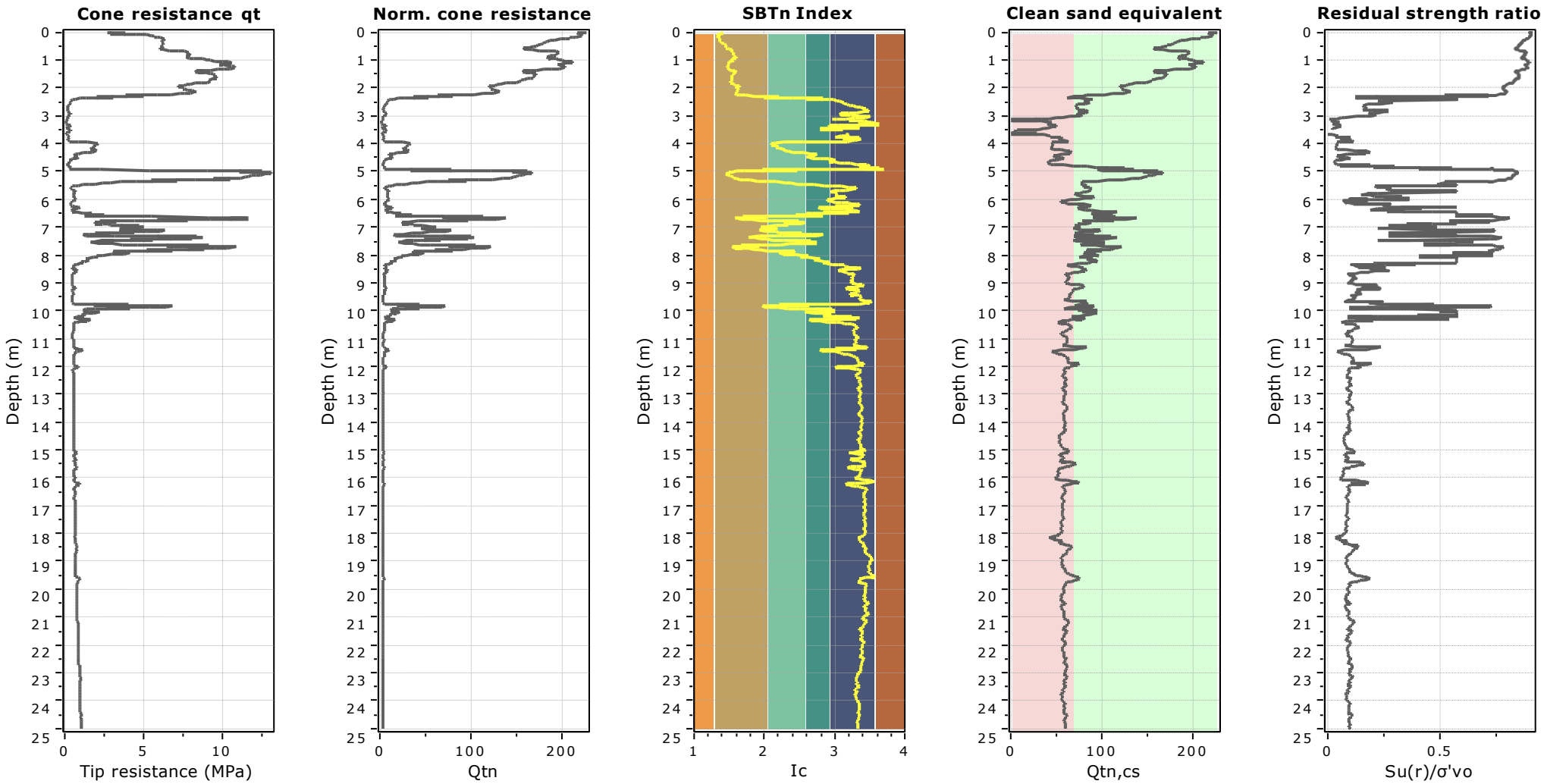

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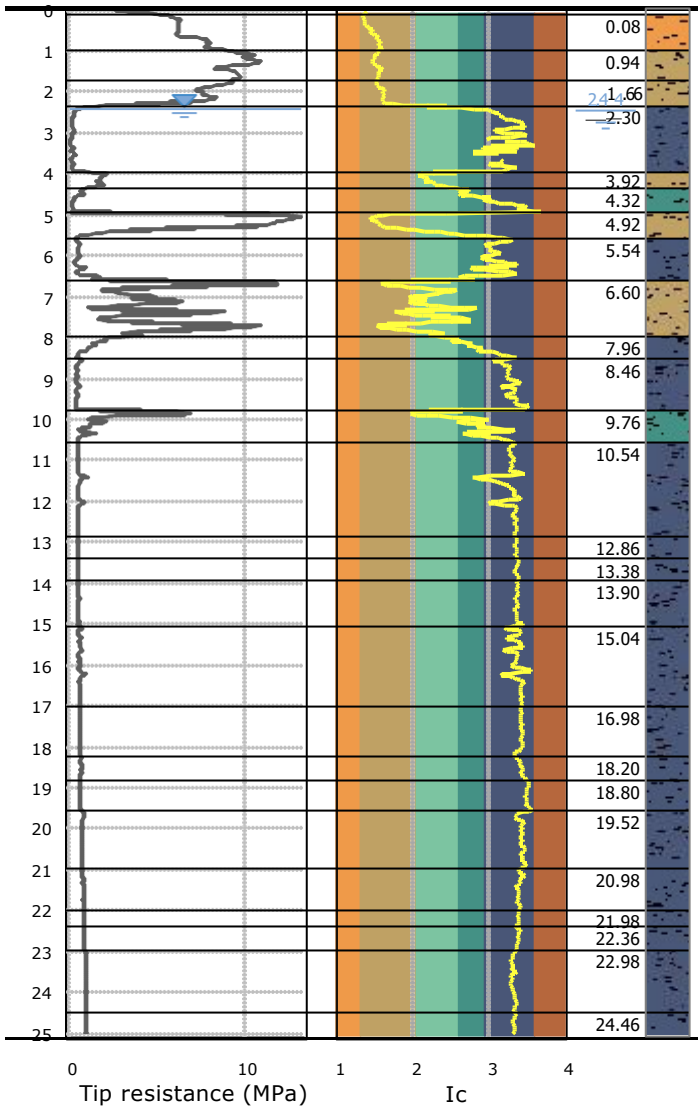
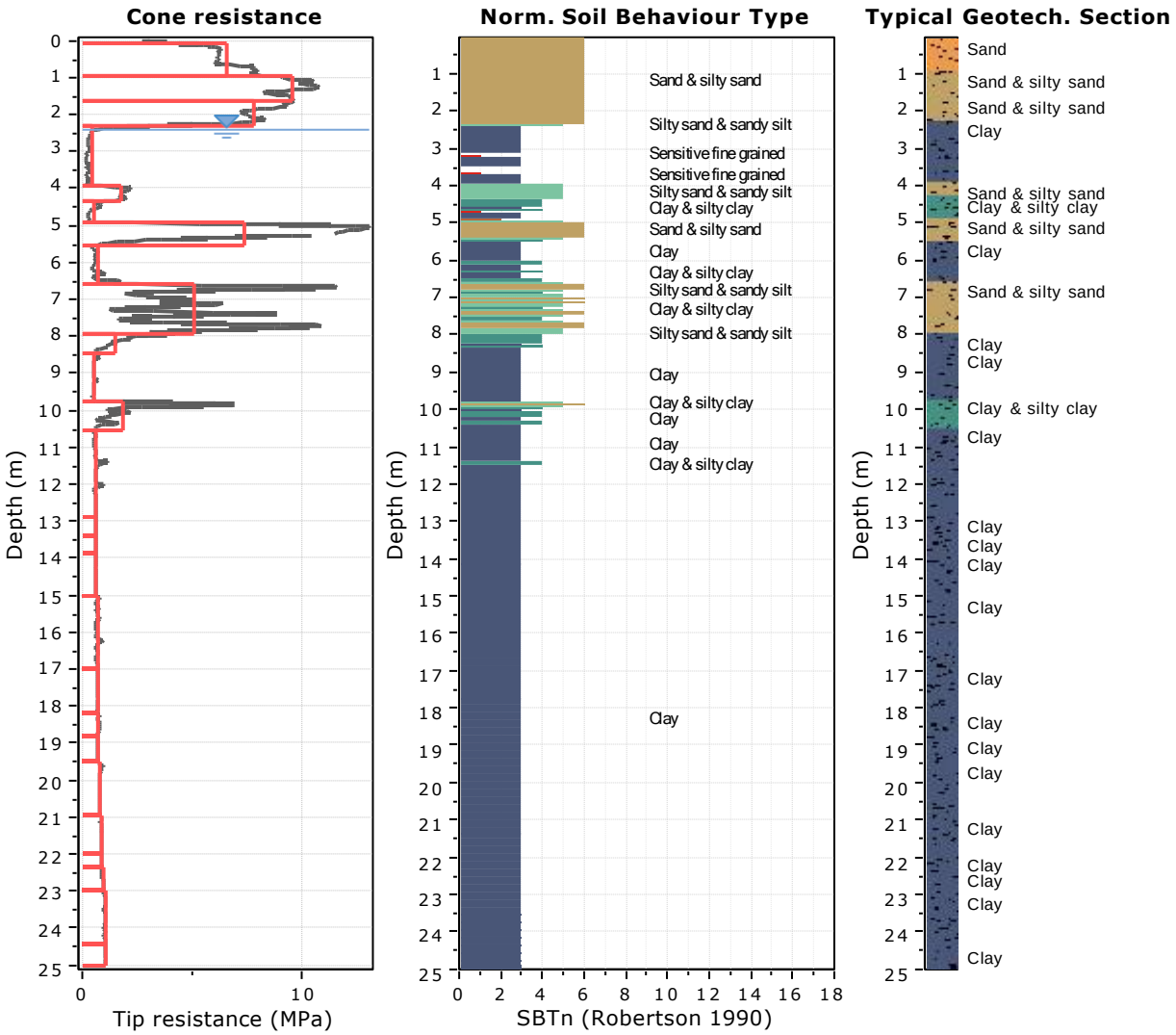
CPT: #1
Total depth: 25.02 m, Date: 12/17/2022
Coords: 6°55'48.3" N 58°22'11" W



Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.08	Sand	6.6	3.89E-4	12.7	30.9	73.1	41.1	38.7	36.5	-	-	-	17.5
0.94	Sand & silty sand	9.6	2.06E-4	19.1	47.8	72.6	41.0	59.9	58.9	-	-	-	18.4
1.66	Sand & silty sand	7.9	1.34E-4	16.2	42.2	60.3	38.4	52.9	50.2	-	-	-	17.7
2.30	Clay	0.4	4.06E-7	2.0	-	-	-	2.7	9.0	16.7	0.4	1.7	14.5
3.92	Sand & silty sand	1.7	1.70E-6	5.6	21.3	28.4	32.4	23.0	22.1	-	-	-	15.7
4.32	Clay & silty clay	0.5	3.82E-8	2.5	-	-	-	4.6	13.1	30.3	0.5	2.5	14.9
4.92	Sand & silty sand	7.4	1.07E-4	16.1	51.6	55.8	38.2	53.0	55.5	-	-	-	17.8
5.54	Clay	0.7	1.68E-8	3.6	-	-	-	6.3	20.8	42.1	0.7	3.0	16.0
6.60	Sand & silty sand	5.1	2.06E-5	13.7	47.8	42.6	36.1	52.1	55.2	-	-	-	17.9
7.96	Clay	1.5	1.01E-7	6.2	-	-	-	17.3	33.6	78.2	1.0	4.5	16.8
8.46	Clay	0.5	1.17E-9	3.3	-	-	-	1.9	19.2	28.2	0.3	1.5	15.6
9.76	Clay & silty clay	1.8	8.72E-7	7.1	-	-	-	19.9	34.8	68.8	0.7	3.5	16.6
10.54	Clay	0.6	1.89E-9	4.0	-	-	-	1.9	20.0	30.2	0.3	1.4	15.5
12.86	Clay	0.6	7.59E-10	4.0	-	-	-	1.4	20.1	27.4	0.3	1.2	15.5
13.38	Clay	0.6	7.24E-10	4.0	-	-	-	1.3	20.8	27.7	0.2	1.1	15.6
13.90	Clay	0.6	7.23E-10	4.0	-	-	-	1.3	20.7	27.7	0.2	1.1	15.5
15.04	Clay	0.7	7.83E-10	4.5	-	-	-	1.5	22.9	30.4	0.2	1.1	15.6
16.98	Clay	0.7	6.22E-10	4.9	-	-	-	1.2	22.7	28.4	0.2	1.0	15.6
18.20	Clay	0.7	6.26E-10	5.0	-	-	-	1.4	26.1	31.9	0.2	1.1	15.9
18.80	Clay	0.7	4.77E-10	5.0	-	-	-	1.1	25.3	28.0	0.2	0.9	15.8
19.52	Clay	0.8	5.92E-10	5.2	-	-	-	1.5	28.2	33.6	0.2	1.0	16.0
20.98	Clay	0.9	6.62E-10	6.0	-	-	-	1.7	30.1	37.4	0.2	1.1	16.1
21.98	Clay	0.9	6.83E-10	6.0	-	-	-	1.7	30.1	38.0	0.2	1.1	16.0
22.36	Clay	0.9	7.01E-10	6.0	-	-	-	2.0	32.2	40.7	0.2	1.1	16.2
22.98	Clay	1.0	8.44E-10	6.4	-	-	-	2.4	33.6	45.7	0.3	1.2	16.2
24.46	Clay	1.1	8.12E-10	7.0	-	-	-	2.5	35.6	47.3	0.3	1.2	16.3



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.08 (m), **End depth:** 0.94 (m)

Description: Sand

Basic results	**Estimation results**	
Total cone resistance: 6.63 ±0.89 MPa	Permeability: 3.89E-04 ±2.30E-04 m/s	Constrained Mod.: 38.67 ±9.35 MPa
Sleeve friction: 29.55 ±14.24 kPa	N_{60}: 12.70 ±2.39 blows	Go: 36.45 ±10.04 MPa
Ic: 1.46 ±0.09	Es: 30.85 ±7.46 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 73.12 ±3.40	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 41.10 ±0.64 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.49 ±0.56 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 0.94 (m), **End depth:** 1.66 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 9.63 ±0.73 MPa	Permeability: 2.06E-04 ±5.26E-05 m/s	Constrained Mod.: 59.91 ±2.41 MPa
Sleeve friction: 50.73 ±4.93 kPa	N_{60}: 19.05 ±1.05 blows	Go: 58.89 ±2.61 MPa
Ic: 1.53 ±0.04	Es: 47.80 ±1.92 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 72.60 ±3.45	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 41.00 ±0.66 °	O.C.R.: 0.00 ±0.00
	Unit weight: 18.37 ±0.12 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.66 (m), **End depth:** 2.30 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 7.87 ±1.24 MPa	Permeability: 1.34E-04 ±4.80E-05 m/s	Constrained Mod.: 52.88 ±5.34 MPa
Sleeve friction: 31.69 ±7.39 kPa	N_{60}: 16.18 ±2.02 blows	Go: 50.23 ±5.96 MPa
Ic: 1.60 ±0.07	Es: 42.19 ±4.26 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 60.26 ±5.54	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 38.44 ±1.19 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.71 ±0.37 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 2.30 (m), **End depth:** 3.92 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.40 ±0.56 MPa	Permeability: 4.06E-07 ±2.46E-06 m/s	Constrained Mod.: 2.74 ±6.66 MPa
Sleeve friction: 5.77 ±5.05 kPa	N_{60}: 2.00 ±1.47 blows	Go: 9.04 ±6.07 MPa
Ic: 2.81 ±1.04	Es: 0.00 ±0.00 MPa	Su: 16.71 ±9.60 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.36 ±0.21
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.68 ±0.99
	Unit weight: 14.49 ±0.84 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 3.92 (m), **End depth:** 4.32 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 1.75 ±0.44 MPa	Permeability: 1.70E-06 ±1.20E-06 m/s	Constrained Mod.: 23.05 ±6.17 MPa
Sleeve friction: 10.10 ±5.06 kPa	N_{60}: 5.57 ±1.16 blows	Go: 22.09 ±4.29 MPa
Ic: 2.29 ±0.24	Es: 21.35 ±2.56 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 28.39 ±2.33	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 32.41 ±0.74 °	O.C.R.: 0.00 ±0.00
	Unit weight: 15.74 ±0.53 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 4.32 (m), **End depth:** 4.92 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.53 ±0.31 MPa	Permeability: 3.82E-08 ±6.09E-08 m/s	Constrained Mod.: 4.63 ±5.06 MPa
Sleeve friction: 8.81 ±8.82 kPa	N_{60}: 2.55 ±1.03 blows	Go: 13.15 ±5.12 MPa
Ic: 3.02 ±0.36	Es: 0.00 ±0.00 MPa	Su: 30.31 ±18.64 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.54 ±0.32
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.51 ±1.48
	Unit weight: 14.88 ±0.96 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 4.92 (m), **End depth:** 5.54 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 7.38 ±4.77 MPa	Permeability: 1.07E-04 ±1.18E-04 m/s	Constrained Mod.: 53.02 ±25.61 MPa
Sleeve friction: 40.08 ±11.48 kPa	N_{60}: 16.13 ±8.15 blows	Go: 55.46 ±19.68 MPa
Ic: 1.99 ±0.59	Es: 51.62 ±9.74 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 55.84 ±13.59	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 38.20 ±1.88 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.79 ±0.79 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 5.54 (m), **End depth:** 6.60 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.72 ±0.40 MPa	Permeability: 1.68E-08 ±4.12E-08 m/s	Constrained Mod.: 6.29 ±6.56 MPa
Sleeve friction: 17.74 ±9.81 kPa	N_{60}: 3.65 ±1.40 blows	Go: 20.84 ±7.26 MPa
Ic: 3.05 ±0.21	Es: 0.00 ±0.00 MPa	Su: 42.10 ±23.09 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.65 ±0.32
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.01 ±1.50
	Unit weight: 15.99 ±0.71 kN/m³	

.:: Layer No: 9 ::.

Code: Layer_9 **Start depth:** 6.60 (m), **End depth:** 7.96 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 5.10 ±2.85 MPa	Permeability: 2.06E-05 ±4.11E-05 m/s	Constrained Mod.: 52.11 ±17.40 MPa
Sleeve friction: 42.98 ±10.75 kPa	N_{60}: 13.70 ±4.94 blows	Go: 55.21 ±11.99 MPa
Ic: 2.13 ±0.33	Es: 47.83 ±8.00 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 42.61 ±9.82	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 36.08 ±1.31 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.85 ±0.41 kN/m³	

.:: Layer No: 10 ::.

Code: Layer_10 **Start depth:** 7.96 (m), **End depth:** 8.46 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 1.47 ±0.80 MPa	Permeability: 1.01E-07 ±2.09E-07 m/s	Constrained Mod.: 17.29 ±12.56 MPa
Sleeve friction: 28.19 ±13.13 kPa	N_{60}: 6.23 ±2.30 blows	Go: 33.60 ±10.95 MPa
Ic: 2.81 ±0.26	Es: 0.00 ±0.00 MPa	Su: 78.16 ±38.83 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.97 ±0.48
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 4.48 ±2.22
	Unit weight: 16.79 ±0.77 kN/m³	

.:: Layer No: 11 ::.

Code: Layer_11 **Start depth:** 8.46 (m), **End depth:** 9.76 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.54 ±0.08 MPa	Permeability: 1.17E-09 ±7.54E-10 m/s	Constrained Mod.: 1.91 ±0.91 MPa
Sleeve friction: 12.81 ±4.11 kPa	N_{60}: 3.32 ±0.47 blows	Go: 19.18 ±2.62 MPa
Ic: 3.30 ±0.10	Es: 0.00 ±0.00 MPa	Su: 28.18 ±5.56 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.33 ±0.07
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.54 ±0.33
	Unit weight: 15.64 ±0.36 kN/m³	

.:: Layer No: 12 ::.

Code: Layer_12 **Start depth:** 9.76 (m), **End depth:** 10.54 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.84 ±1.69 MPa	Permeability: 8.72E-07 ±2.31E-06 m/s	Constrained Mod.: 19.86 ±20.92 MPa
Sleeve friction: 24.60 ±13.41 kPa	N_{60}: 7.08 ±3.91 blows	Go: 34.80 ±14.45 MPa
Ic: 2.80 ±0.39	Es: 0.00 ±0.00 MPa	Su: 68.84 ±34.33 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.75 ±0.38
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.45 ±1.73
	Unit weight: 16.62 ±0.90 kN/m³	

.:: Layer No: 13 ::.

Code: Layer_13 **Start depth:** 10.54 (m), **End depth:** 12.86 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.61 ±0.11 MPa	Permeability: 1.89E-09 ±4.13E-09 m/s	Constrained Mod.: 1.89 ±1.31 MPa
Sleeve friction: 10.85 ±3.11 kPa	N_{60}: 3.96 ±0.36 blows	Go: 19.96 ±2.22 MPa
Ic: 3.29 ±0.12	Es: 0.00 ±0.00 MPa	Su: 30.20 ±7.63 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.30 ±0.08
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.39 ±0.36
	Unit weight: 15.50 ±0.29 kN/m³	

.:: Layer No: 14 ::.

Code: Layer_14 **Start depth:** 12.86 (m), **End depth:** 13.38 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.60 ±0.00 MPa	Permeability: 7.59E-10 ±2.27E-11 m/s	Constrained Mod.: 1.36 ±0.03 MPa
Sleeve friction: 10.45 ±0.52 kPa	N_{60}: 4.00 ±0.00 blows	Go: 20.13 ±0.30 MPa
Ic: 3.36 ±0.01	Es: 0.00 ±0.00 MPa	Su: 27.44 ±0.28 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.25 ±0.00
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.17 ±0.02
	Unit weight: 15.49 ±0.05 kN/m³	

.:: Layer No: 15 ::.

Code: Layer_15 **Start depth:** 13.38 (m), **End depth:** 13.90 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.61 ±0.01 MPa	Permeability: 7.24E-10 ±4.24E-11 m/s	Constrained Mod.: 1.35 ±0.05 MPa
Sleeve friction: 10.99 ±0.83 kPa	N_{60}: 4.00 ±0.00 blows	Go: 20.80 ±0.48 MPa
Ic: 3.37 ±0.02	Es: 0.00 ±0.00 MPa	Su: 27.70 ±0.50 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.25 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.15 ±0.03
	Unit weight: 15.55 ±0.08 kN/m³	

.:: Layer No: 16 ::.

Code: Layer_16 **Start depth:** 13.90 (m), **End depth:** 15.04 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.62 ±0.01 MPa	Permeability: 7.23E-10 ±4.64E-11 m/s	Constrained Mod.: 1.29 ±0.08 MPa
Sleeve friction: 10.26 ±1.44 kPa	N_{60}: 4.00 ±0.00 blows	Go: 20.71 ±1.02 MPa
Ic: 3.37 ±0.02	Es: 0.00 ±0.00 MPa	Su: 27.67 ±0.82 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.24 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.10 ±0.04
	Unit weight: 15.47 ±0.15 kN/m³	

.:: Layer No: 17 ::.

Code: Layer_17 **Start depth:** 15.04 (m), **End depth:** 16.98 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.68 ±0.07 MPa	Permeability: 7.83E-10 ±3.35E-10 m/s	Constrained Mod.: 1.49 ±0.57 MPa
Sleeve friction: 11.78 ±3.59 kPa	N_{60}: 4.52 ±0.54 blows	Go: 22.95 ±2.74 MPa
Ic: 3.38 ±0.08	Es: 0.00 ±0.00 MPa	Su: 30.41 ±4.97 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.24 ±0.04
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.12 ±0.19
	Unit weight: 15.64 ±0.32 kN/m³	

.:: Layer No: 18 ::.

Code: Layer_18 **Start depth:** 16.98 (m), **End depth:** 18.20 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.68 ±0.01 MPa	Permeability: 6.22E-10 ±5.13E-11 m/s	Constrained Mod.: 1.18 ±0.07 MPa
Sleeve friction: 10.72 ±1.72 kPa	N_{60}: 4.90 ±0.30 blows	Go: 22.71 ±1.37 MPa
Ic: 3.42 ±0.02	Es: 0.00 ±0.00 MPa	Su: 28.39 ±0.75 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.21 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 0.98 ±0.04
	Unit weight: 15.55 ±0.23 kN/m³	

.:: Layer No: 19 ::.

Code: Layer_19 **Start depth:** 18.20 (m), **End depth:** 18.80 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.74 ±0.03 MPa	Permeability: 6.26E-10 ±8.18E-11 m/s	Constrained Mod.: 1.44 ±0.21 MPa
Sleeve friction: 13.96 ±3.42 kPa	N_{60}: 4.97 ±0.18 blows	Go: 26.06 ±2.69 MPa
Ic: 3.42 ±0.04	Es: 0.00 ±0.00 MPa	Su: 31.92 ±2.31 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.23 ±0.02
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.06 ±0.08
	Unit weight: 15.87 ±0.32 kN/m³	

.:: Layer No: 20 ::.

Code: Layer_20 **Start depth:** 18.80 (m), **End depth:** 19.52 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.70 ±0.03 MPa	Permeability: 4.77E-10 ±2.41E-11 m/s	Constrained Mod.: 1.07 ±0.12 MPa
Sleeve friction: 13.50 ±2.25 kPa	N_{60}: 5.00 ±0.00 blows	Go: 25.34 ±1.85 MPa
Ic: 3.51 ±0.02	Es: 0.00 ±0.00 MPa	Su: 28.01 ±1.65 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.19 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 0.90 ±0.05
	Unit weight: 15.83 ±0.18 kN/m³	

.:: Layer No: 21 ::.

Code: Layer_21 **Start depth:** 19.52 (m), **End depth:** 20.98 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.80 ±0.05 MPa	Permeability: 5.92E-10 ±7.93E-11 m/s	Constrained Mod.: 1.49 ±0.40 MPa
Sleeve friction: 15.15 ±3.93 kPa	N_{60}: 5.23 ±0.42 blows	Go: 28.17 ±2.83 MPa
Ic: 3.44 ±0.04	Es: 0.00 ±0.00 MPa	Su: 33.59 ±3.88 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.22 ±0.03
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.03 ±0.13
	Unit weight: 16.00 ±0.27 kN/m³	

.:: Layer No: 22 ::.

Code: Layer_22 **Start depth:** 20.98 (m), **End depth:** 21.98 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.87 ±0.02 MPa	Permeability: 6.62E-10 ±5.34E-11 m/s	Constrained Mod.: 1.73 ±0.09 MPa
Sleeve friction: 15.62 ±1.52 kPa	N_{60}: 6.00 ±0.00 blows	Go: 30.13 ±0.94 MPa
Ic: 3.40 ±0.03	Es: 0.00 ±0.00 MPa	Su: 37.37 ±1.11 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.24 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.09 ±0.03
	Unit weight: 16.09 ±0.10 kN/m³	

.:: Layer No: 23 ::.

Code: Layer_23 **Start depth:** 21.98 (m), **End depth:** 22.36 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.89 ±0.01 MPa	Permeability: 6.83E-10 ±1.30E-11 m/s	Constrained Mod.: 1.74 ±0.04 MPa
Sleeve friction: 14.77 ±0.65 kPa	N_{60}: 6.00 ±0.00 blows	Go: 30.10 ±0.47 MPa
Ic: 3.39 ±0.01	Es: 0.00 ±0.00 MPa	Su: 37.99 ±0.44 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.23 ±0.00
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.08 ±0.01
	Unit weight: 16.04 ±0.05 kN/m³	

.:: Layer No: 24 ::.

Code: Layer_24 **Start depth:** 22.36 (m), **End depth:** 22.98 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.93 ±0.02 MPa	Permeability: 7.01E-10 ±3.73E-11 m/s	Constrained Mod.: 1.96 ±0.14 MPa
Sleeve friction: 16.61 ±1.17 kPa	N_{60}: 6.00 ±0.00 blows	Go: 32.21 ±1.04 MPa
Ic: 3.38 ±0.02	Es: 0.00 ±0.00 MPa	Su: 40.68 ±1.56 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.25 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.13 ±0.04
	Unit weight: 16.19 ±0.08 kN/m³	

.:: Layer No: 25 ::.

Code: Layer_25 **Start depth:** 22.98 (m), **End depth:** 24.46 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 1.02 ±0.02 MPa	Permeability: 8.44E-10 ±6.01E-11 m/s	Constrained Mod.: 2.38 ±0.14 MPa
Sleeve friction: 16.26 ±1.12 kPa	N_{60}: 6.44 ±0.50 blows	Go: 33.61 ±0.75 MPa
Ic: 3.32 ±0.02	Es: 0.00 ±0.00 MPa	Su: 45.68 ±1.22 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.27 ±0.01
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.23 ±0.04
	Unit weight: 16.20 ±0.08 kN/m³	

.:: Layer No: 26 ::.

Code: Layer_26 **Start depth:** 24.46 (m), **End depth:** 25.00 (m)

Description: Clay

Basic results	**Estimation results**	
Total cone resistance: 1.06 ±0.01 MPa	Permeability: 8.12E-10 ±2.74E-11 m/s	Constrained Mod.: 2.46 ±0.05 MPa
Sleeve friction: 17.74 ±0.94 kPa	N_{60}: 7.00 ±0.00 blows	Go: 35.60 ±0.49 MPa
Ic: 3.34 ±0.01	Es: 0.00 ±0.00 MPa	Su: 47.33 ±0.58 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.26 ±0.00
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.22 ±0.01
	Unit weight: 16.32 ±0.05 kN/m³	

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.08	0.86	3.89E-04	12.7	30.9	73.1	41.1	38.7	36.5	0.0	0.0	0.0	17.5
0.94		(±2.30E-04)	(±2.4)	(±7.5)	(±3.4)	(±0.6)	(±9.4)	(±10.0)	(±0.0)	(±0.0)	(±0.0)	(±0.6)
0.94	0.72	2.06E-04	19.1	47.8	72.6	41.0	59.9	58.9	0.0	0.0	0.0	18.4
1.66		(±5.26E-05)	(±1.1)	(±1.9)	(±3.5)	(±0.7)	(±2.4)	(±2.6)	(±0.0)	(±0.0)	(±0.0)	(±0.1)
1.66	0.64	1.34E-04	16.2	42.2	60.3	38.4	52.9	50.2	0.0	0.0	0.0	17.7
2.30		(±4.80E-05)	(±2.0)	(±4.3)	(±5.5)	(±1.2)	(±5.3)	(±6.0)	(±0.0)	(±0.0)	(±0.0)	(±0.4)
2.30	1.62	4.06E-07	2.0	0.0	0.0	0.0	2.7	9.0	16.7	0.4	1.7	14.5
3.92		(±2.46E-06)	(±1.5)	(±0.0)	(±0.0)	(±0.0)	(±6.7)	(±6.1)	(±9.6)	(±0.2)	(±1.0)	(±0.8)
3.92	0.40	1.70E-06	5.6	21.3	28.4	32.4	23.0	22.1	0.0	0.0	0.0	15.7
4.32		(±1.20E-06)	(±1.2)	(±2.6)	(±2.3)	(±0.7)	(±6.2)	(±4.3)	(±0.0)	(±0.0)	(±0.0)	(±0.5)
4.32	0.60	3.82E-08	2.5	0.0	0.0	0.0	4.6	13.1	30.3	0.5	2.5	14.9
4.92		(±6.09E-08)	(±1.0)	(±0.0)	(±0.0)	(±0.0)	(±5.1)	(±5.1)	(±18.6)	(±0.3)	(±1.5)	(±1.0)
4.92	0.62	1.07E-04	16.1	51.6	55.8	38.2	53.0	55.5	0.0	0.0	0.0	17.8
5.54		(±1.18E-04)	(±8.2)	(±9.7)	(±13.6)	(±1.9)	(±25.6)	(±19.7)	(±0.0)	(±0.0)	(±0.0)	(±0.8)
5.54	1.06	1.68E-08	3.6	0.0	0.0	0.0	6.3	20.8	42.1	0.7	3.0	16.0
6.60		(±4.12E-08)	(±1.4)	(±0.0)	(±0.0)	(±0.0)	(±6.6)	(±7.3)	(±23.1)	(±0.3)	(±1.5)	(±0.7)
6.60	1.36	2.06E-05	13.7	47.8	42.6	36.1	52.1	55.2	0.0	0.0	0.0	17.9
7.96		(±4.11E-05)	(±4.9)	(±8.0)	(±9.8)	(±1.3)	(±17.4)	(±12.0)	(±0.0)	(±0.0)	(±0.0)	(±0.4)
7.96	0.50	1.01E-07	6.2	0.0	0.0	0.0	17.3	33.6	78.2	1.0	4.5	16.8
8.46		(±2.09E-07)	(±2.3)	(±0.0)	(±0.0)	(±0.0)	(±12.6)	(±10.9)	(±38.8)	(±0.5)	(±2.2)	(±0.8)
8.46	1.30	1.17E-09	3.3	0.0	0.0	0.0	1.9	19.2	28.2	0.3	1.5	15.6
9.76		(±7.54E-10)	(±0.5)	(±0.0)	(±0.0)	(±0.0)	(±0.9)	(±2.6)	(±5.6)	(±0.1)	(±0.3)	(±0.4)
9.76	0.78	8.72E-07	7.1	0.0	0.0	0.0	19.9	34.8	68.8	0.7	3.5	16.6
10.54		(±2.31E-06)	(±3.9)	(±0.0)	(±0.0)	(±0.0)	(±20.9)	(±14.4)	(±34.3)	(±0.4)	(±1.7)	(±0.9)

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
10.54 12.86	2.32	1.89E-09 (±4.13E-09)	4.0 (±0.4)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.9 (±1.3)	20.0 (±2.2)	30.2 (±7.6)	0.3 (±0.1)	1.4 (±0.4)	15.5 (±0.3)
12.86 13.38	0.52	7.59E-10 (±2.27E-11)	4.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.4 (±0.0)	20.1 (±0.3)	27.4 (±0.3)	0.3 (±0.0)	1.2 (±0.0)	15.5 (±0.1)
13.38 13.90	0.52	7.24E-10 (±4.24E-11)	4.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.3 (±0.1)	20.8 (±0.5)	27.7 (±0.5)	0.2 (±0.0)	1.1 (±0.0)	15.6 (±0.1)
13.90 15.04	1.14	7.23E-10 (±4.64E-11)	4.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.3 (±0.1)	20.7 (±1.0)	27.7 (±0.8)	0.2 (±0.0)	1.1 (±0.0)	15.5 (±0.2)
15.04 16.98	1.94	7.83E-10 (±3.35E-10)	4.5 (±0.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.5 (±0.6)	22.9 (±2.7)	30.4 (±5.0)	0.2 (±0.0)	1.1 (±0.2)	15.6 (±0.3)
16.98 18.20	1.22	6.22E-10 (±5.13E-11)	4.9 (±0.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.2 (±0.1)	22.7 (±1.4)	28.4 (±0.7)	0.2 (±0.0)	1.0 (±0.0)	15.6 (±0.2)
18.20 18.80	0.60	6.26E-10 (±8.18E-11)	5.0 (±0.2)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.4 (±0.2)	26.1 (±2.7)	31.9 (±2.3)	0.2 (±0.0)	1.1 (±0.1)	15.9 (±0.3)
18.80 19.52	0.72	4.77E-10 (±2.41E-11)	5.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.1 (±0.1)	25.3 (±1.8)	28.0 (±1.7)	0.2 (±0.0)	0.9 (±0.0)	15.8 (±0.2)
19.52 20.98	1.46	5.92E-10 (±7.93E-11)	5.2 (±0.4)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.5 (±0.4)	28.2 (±2.8)	33.6 (±3.9)	0.2 (±0.0)	1.0 (±0.1)	16.0 (±0.3)
20.98 21.98	1.00	6.62E-10 (±5.34E-11)	6.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.7 (±0.1)	30.1 (±0.9)	37.4 (±1.1)	0.2 (±0.0)	1.1 (±0.0)	16.1 (±0.1)
21.98 22.36	0.38	6.83E-10 (±1.30E-11)	6.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.7 (±0.0)	30.1 (±0.5)	38.0 (±0.4)	0.2 (±0.0)	1.1 (±0.0)	16.0 (±0.0)
22.36 22.98	0.62	7.01E-10 (±3.73E-11)	6.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.0 (±0.1)	32.2 (±1.0)	40.7 (±1.6)	0.2 (±0.0)	1.1 (±0.0)	16.2 (±0.1)

Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

Project: **Soil Testing Services for Solar Photovoltaic Farm**
Location: **Leguan, Region No. 3.**

CPT: #1
Total depth: 25.02 m, Date: 12/17/2022
Coords: 6°55'48.3" N 58°22'11" W

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_0 (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
22.98	1.48	8.44E-10	6.4	0.0	0.0	0.0	2.4	33.6	45.7	0.3	1.2	16.2
24.46		(±6.01E-11)	(±0.5)	(±0.0)	(±0.0)	(±0.0)	(±0.1)	(±0.8)	(±1.2)	(±0.0)	(±0.0)	(±0.1)
24.46	0.54	8.12E-10	7.0	0.0	0.0	0.0	2.5	35.6	47.3	0.3	1.2	16.3
25.00		(±2.74E-11)	(±0.0)	(±0.0)	(±0.0)	(±0.0)	(±0.1)	(±0.5)	(±0.6)	(±0.0)	(±0.0)	(±0.0)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(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)

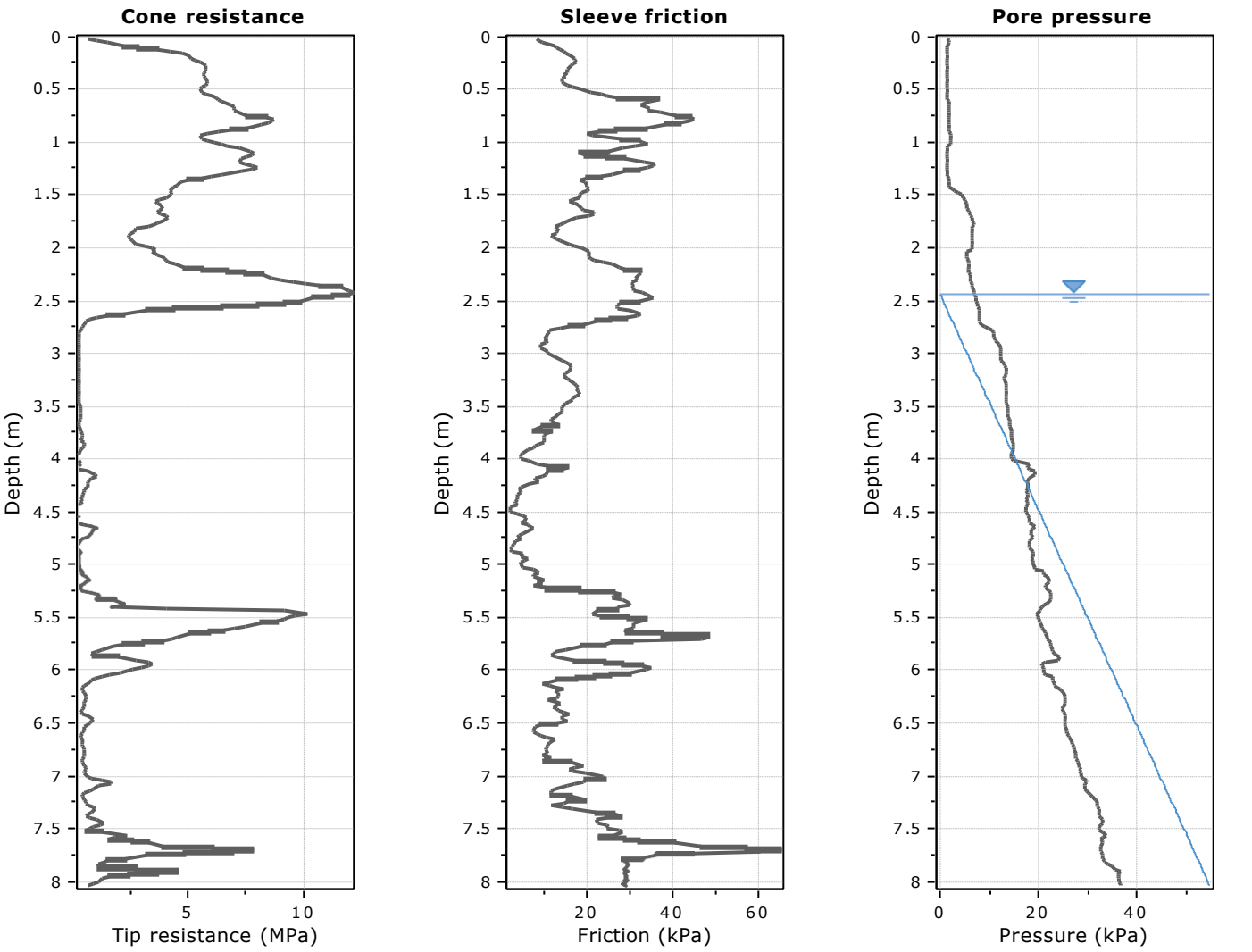
•N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

CPT#2

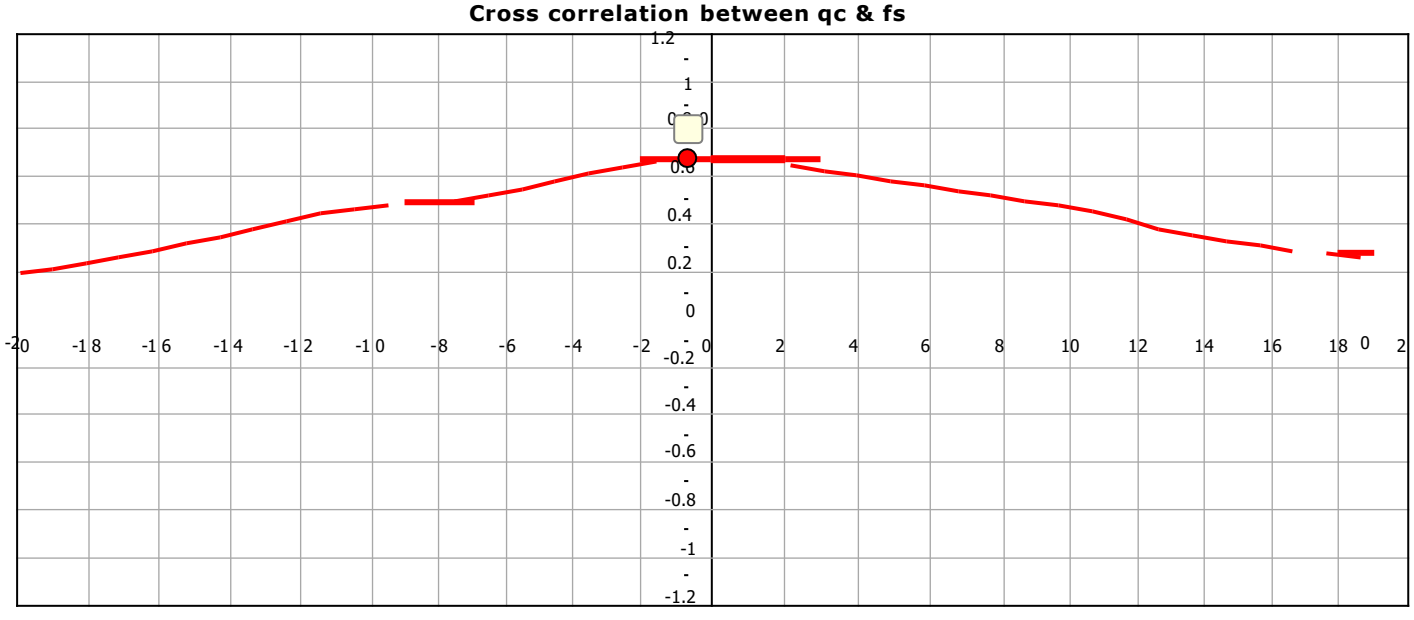
Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

CPT: #2
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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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Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

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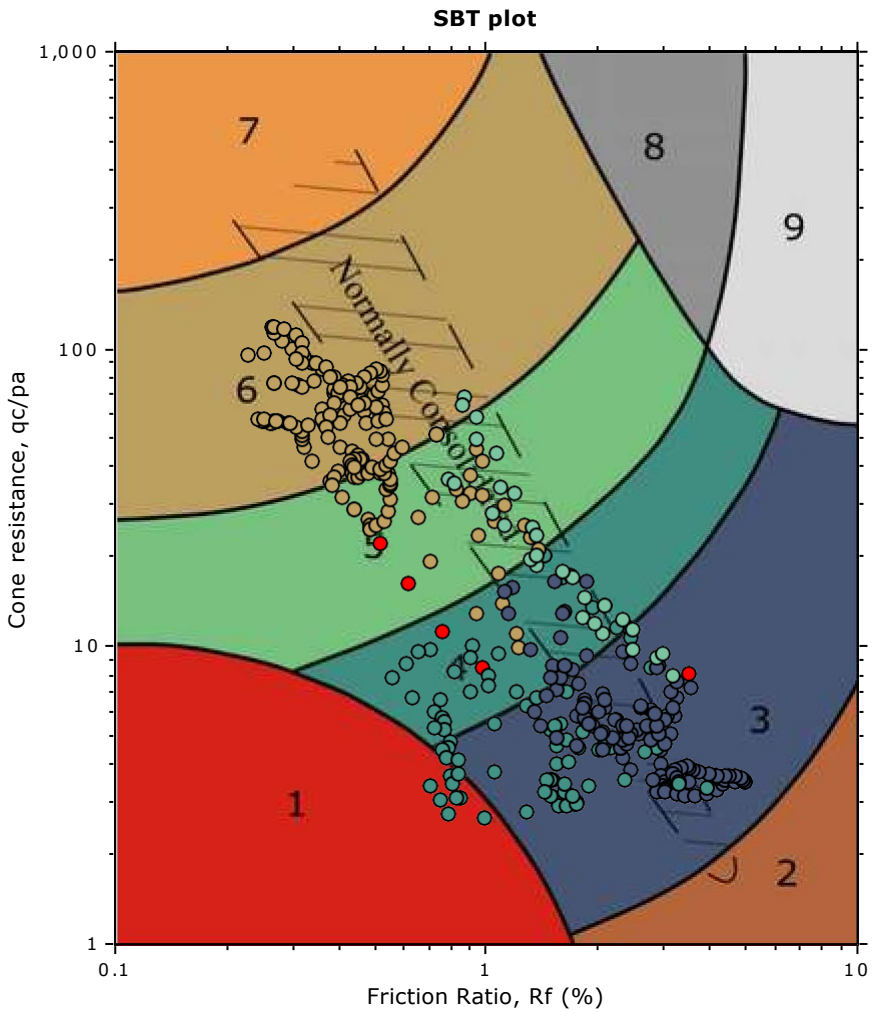
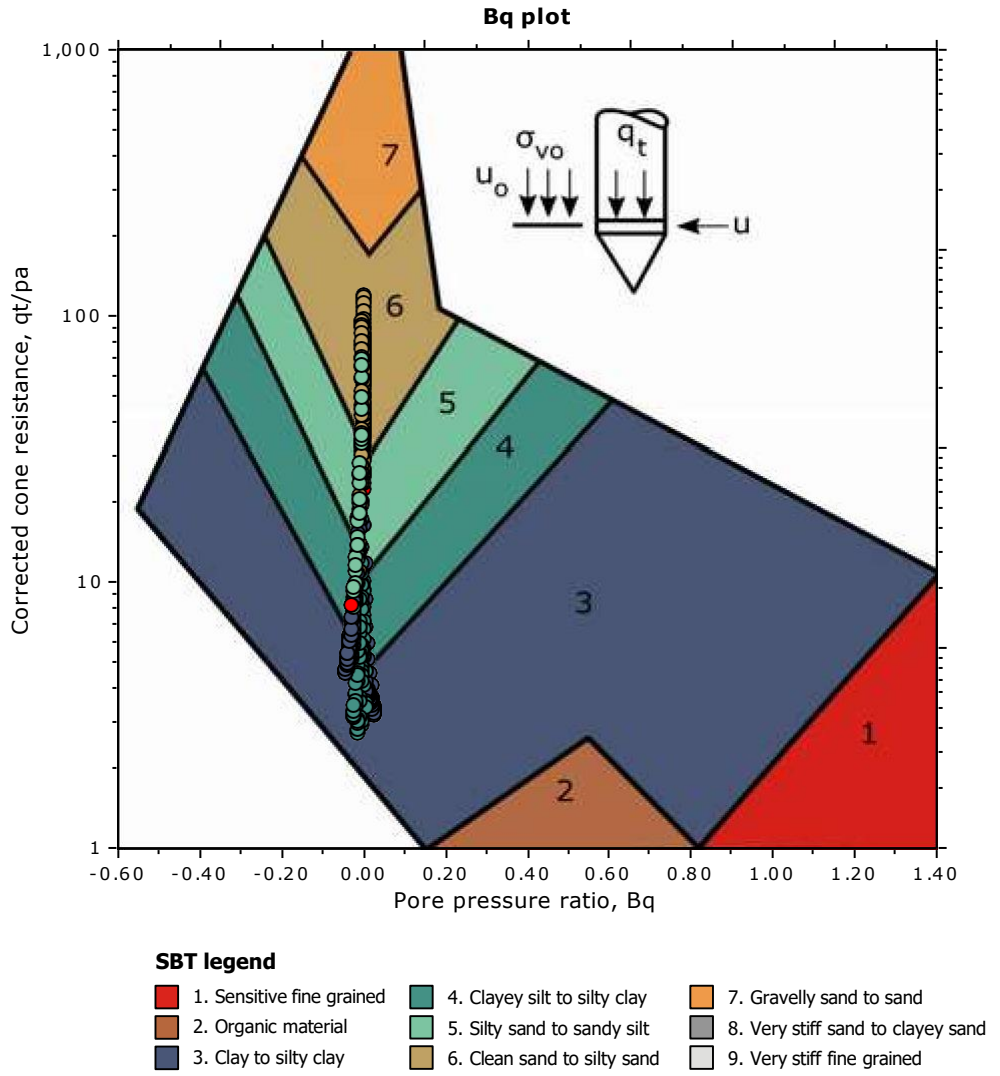
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

SBT - Bq plots





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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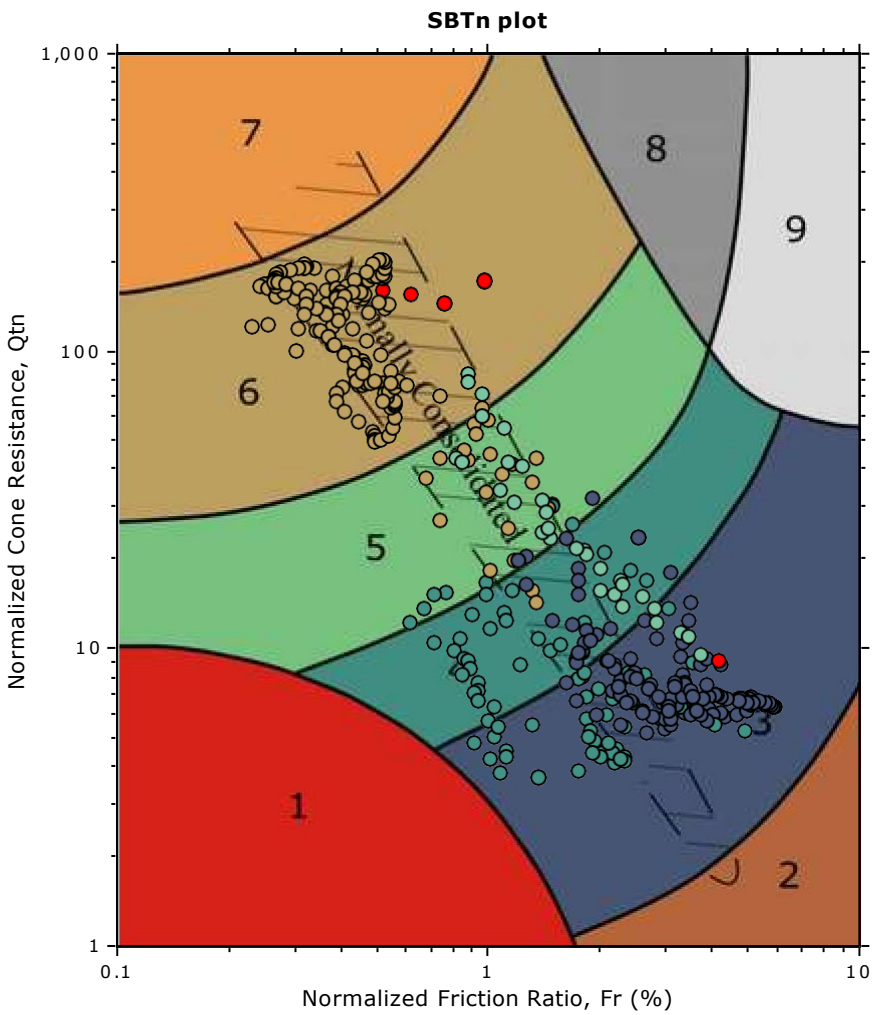
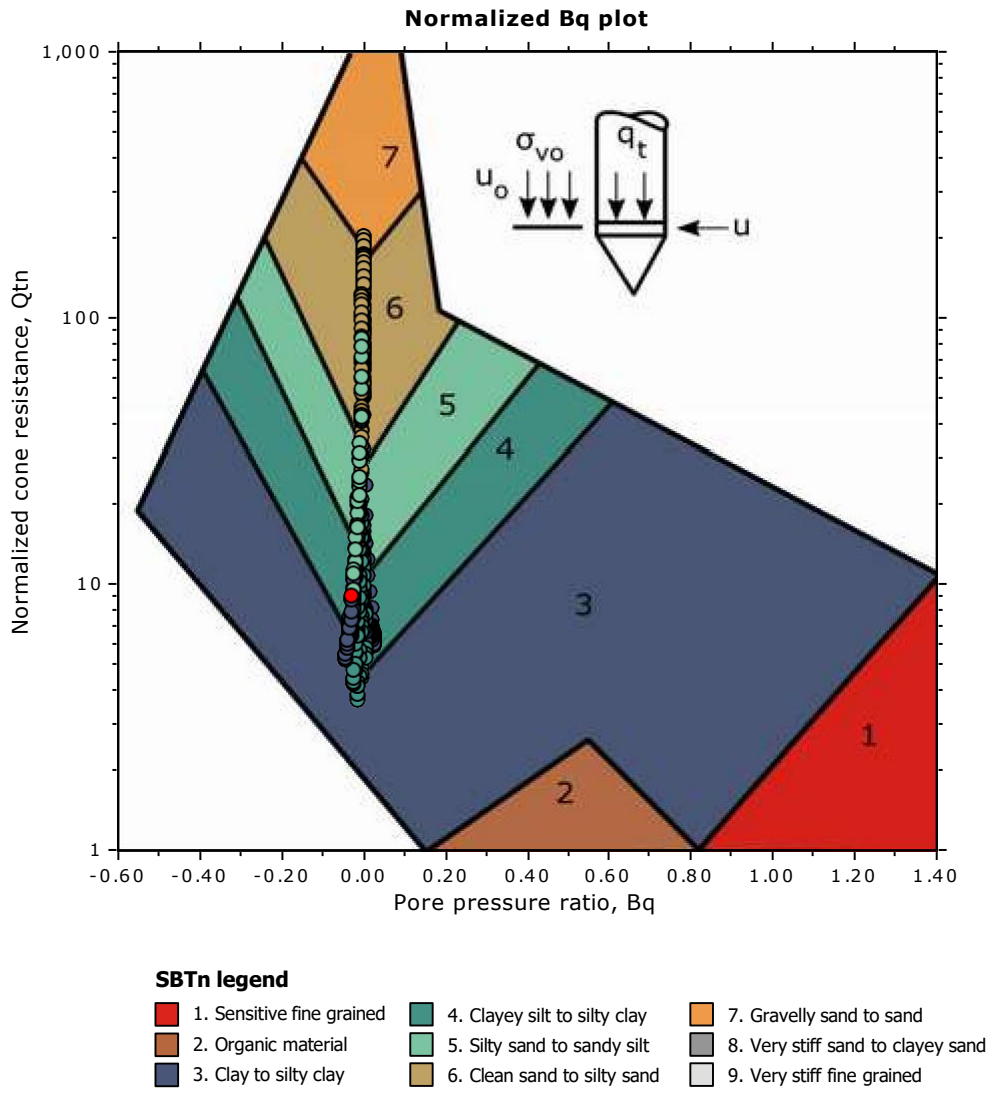
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #2
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

SBT - Bq plots (normalized)





SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly 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

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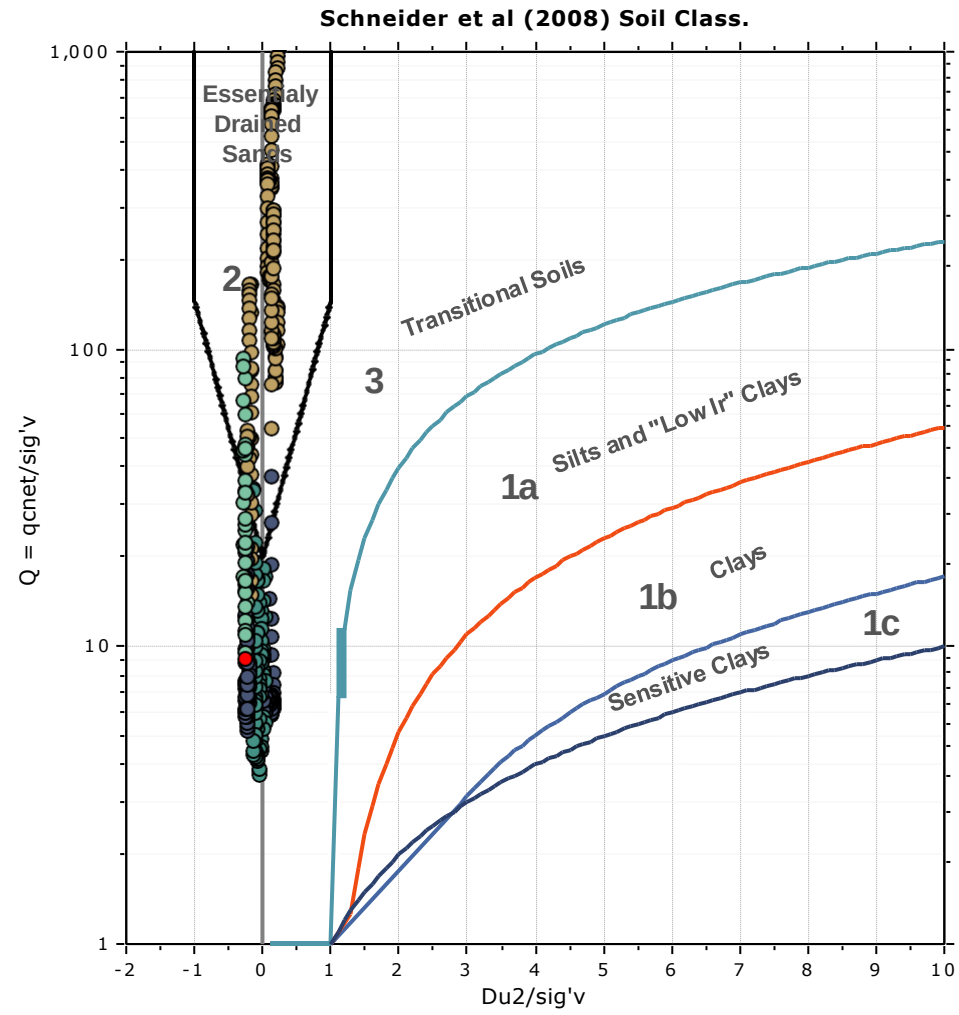
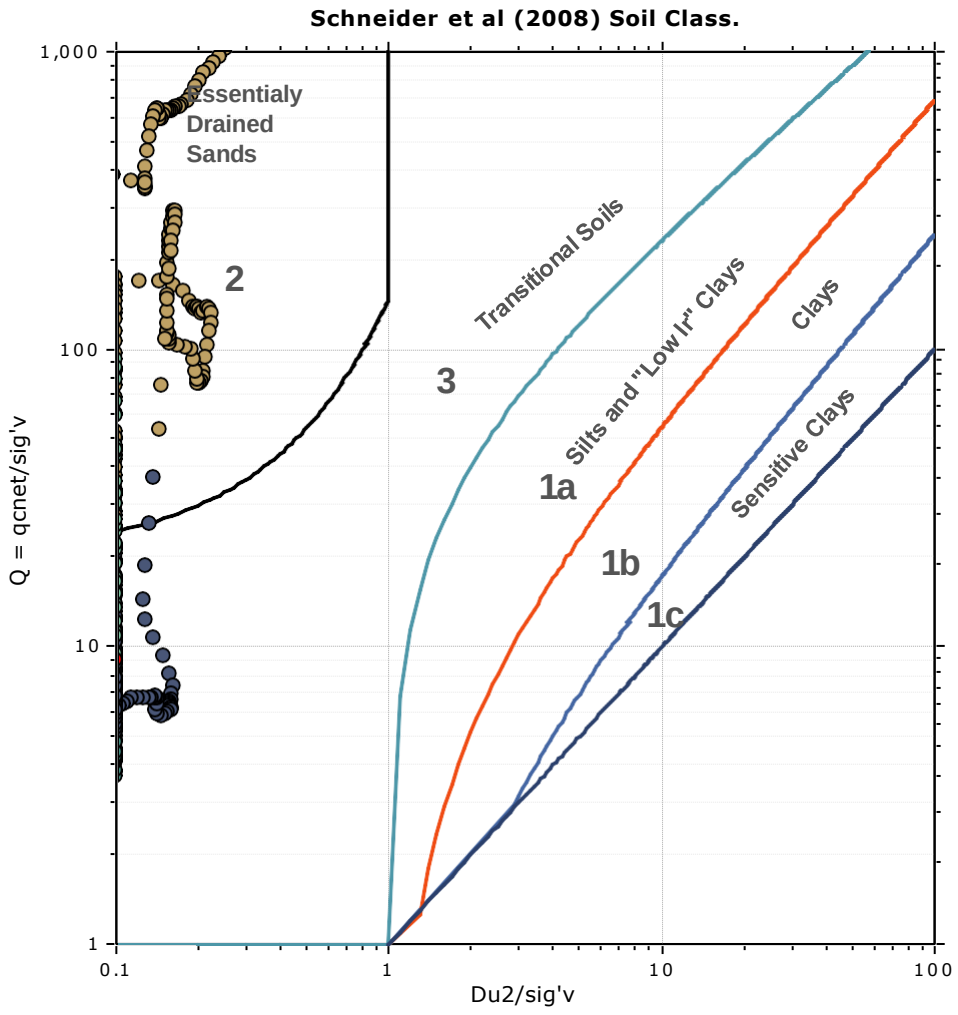
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #2
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

Bq plots (Schneider)





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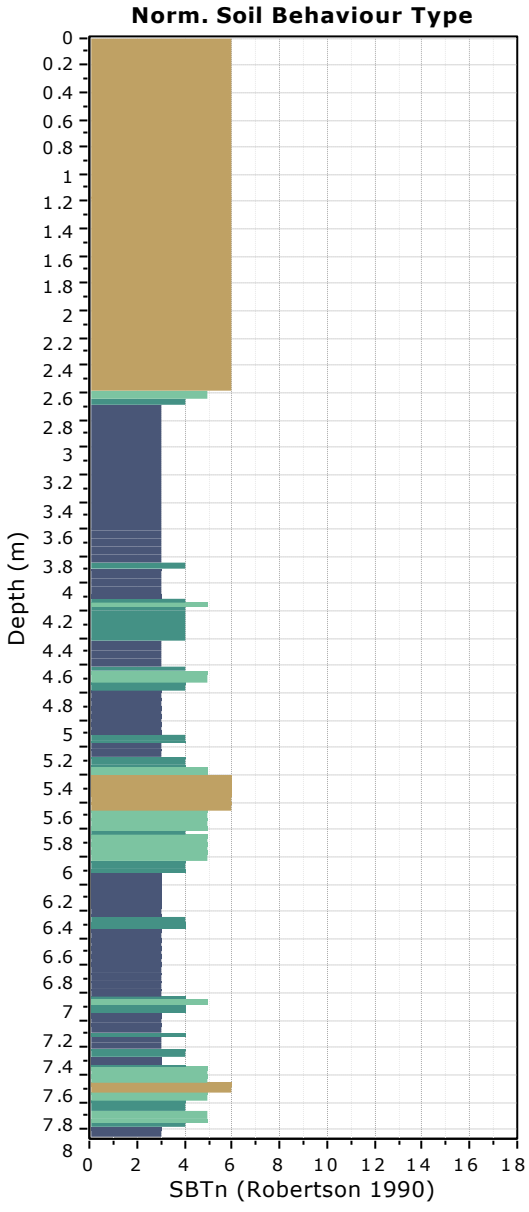
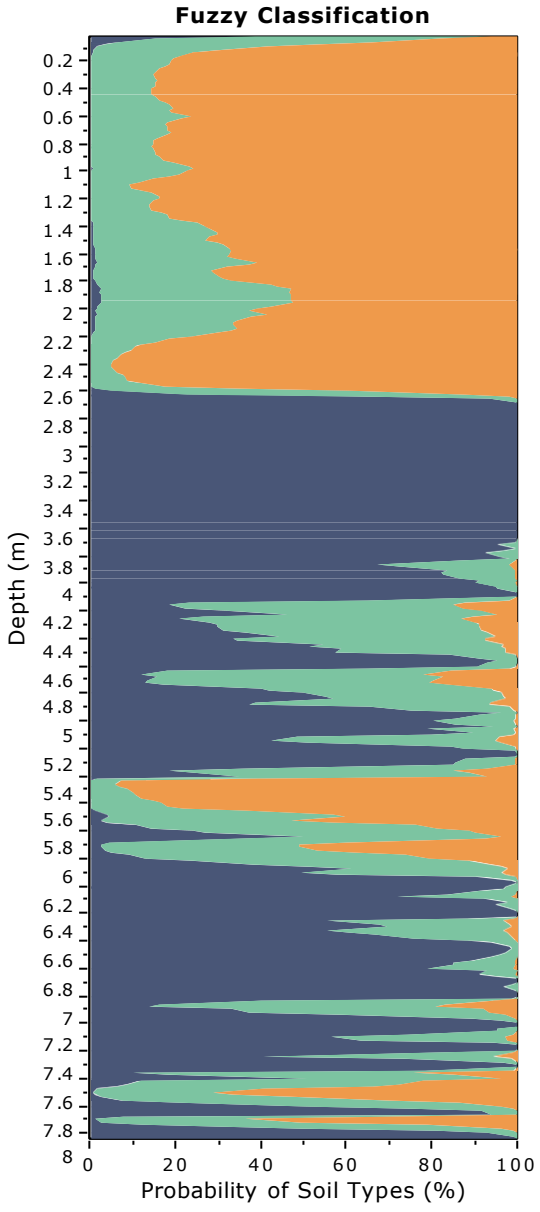
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #2
epth: 8.04 m, Date: 12/17/2022
ds: 6°55'46.7" N 58°22'12.4" W





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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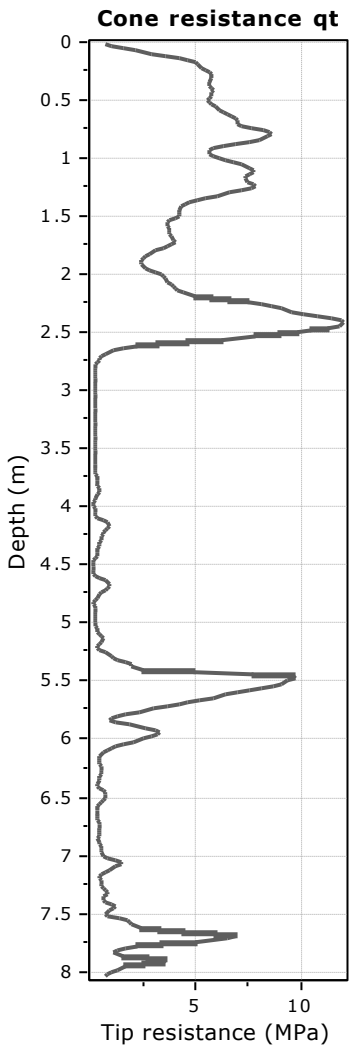
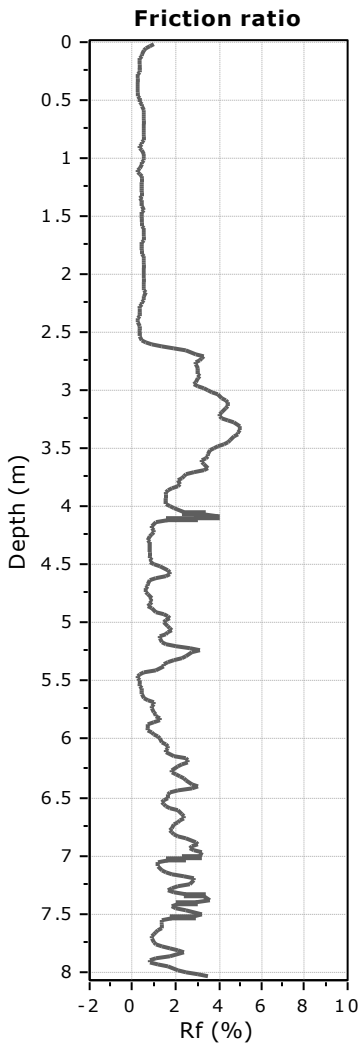
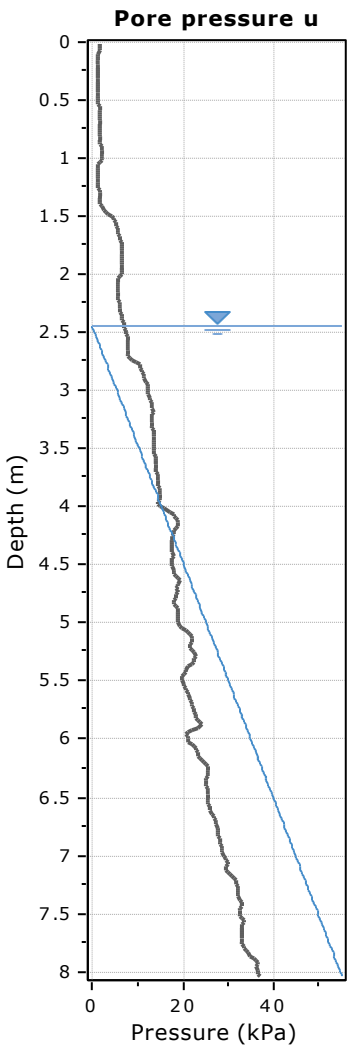
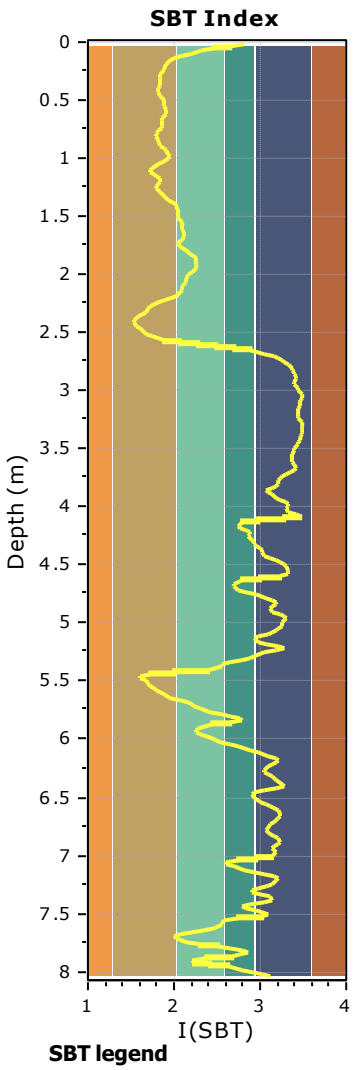
CPT: #2
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

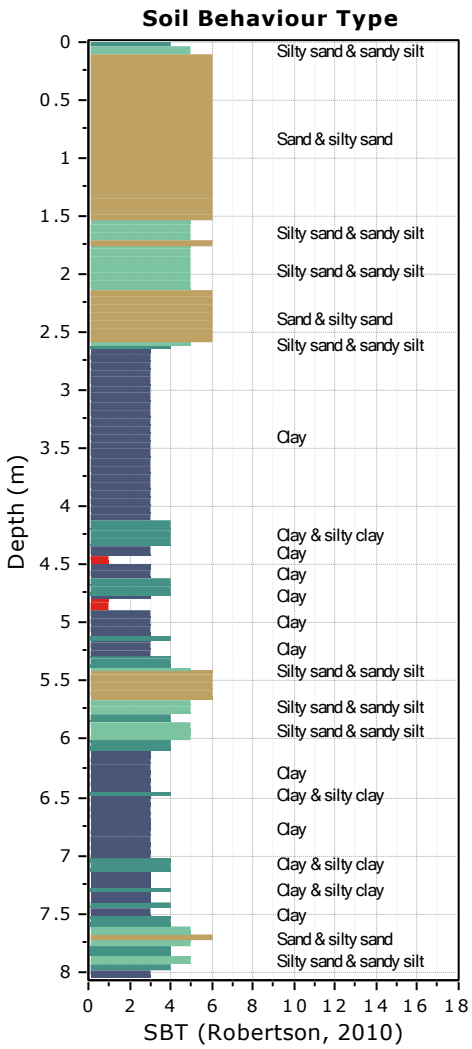
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.











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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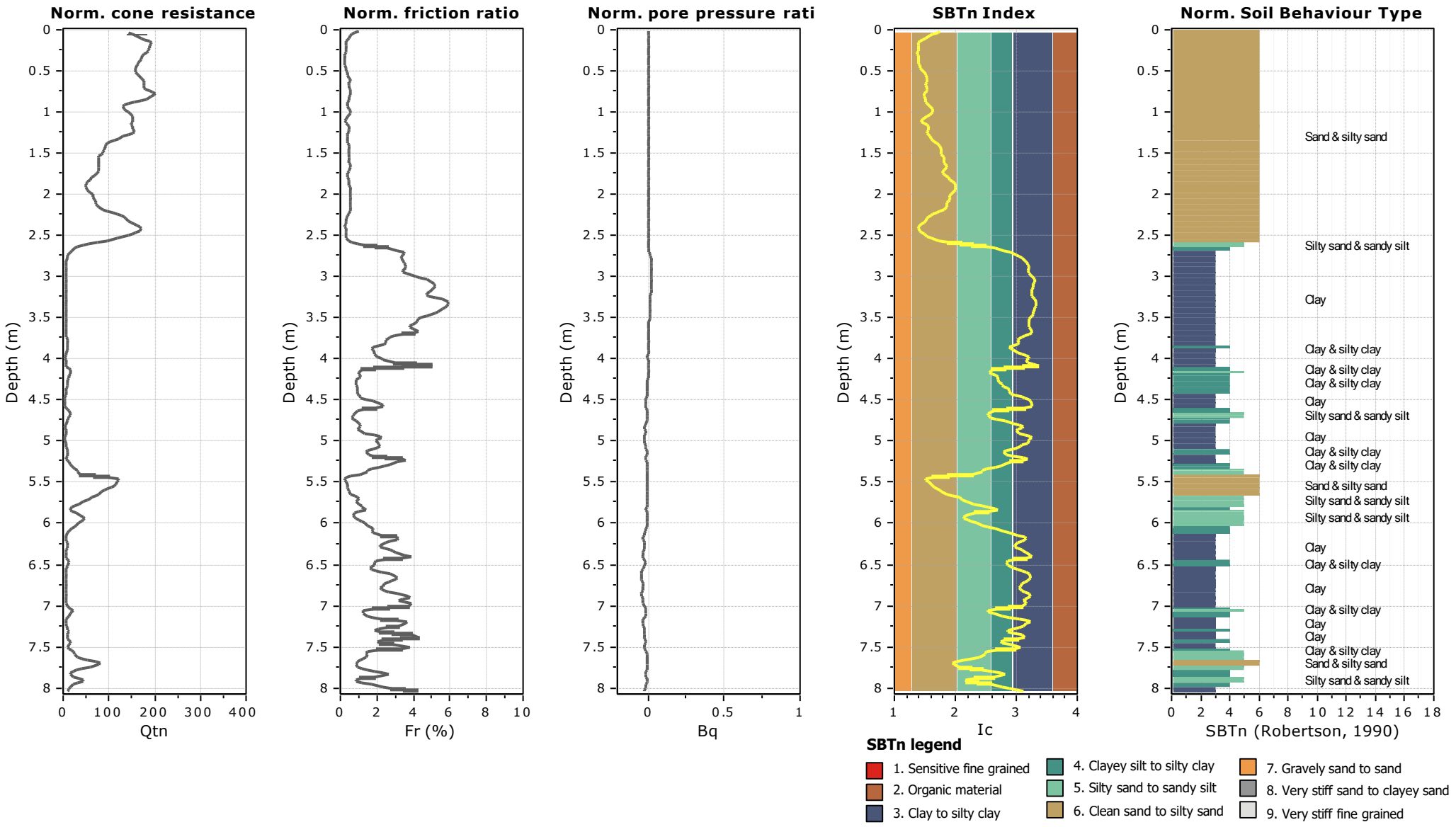
CPT: #2
Total depth: 8.04 m, Date: 12/17/2022
Coords: 6°55'46.7" N 58°22'12.4" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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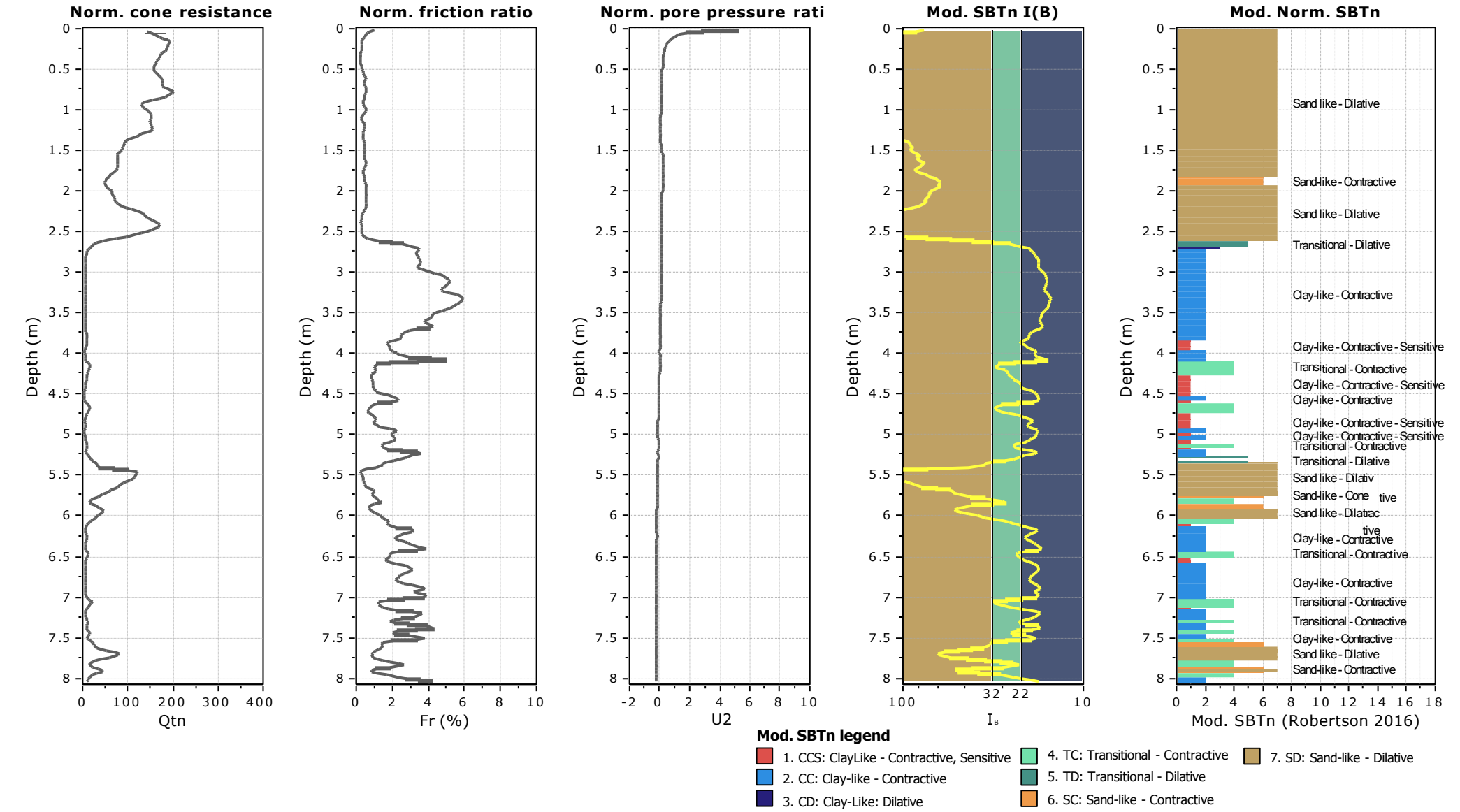

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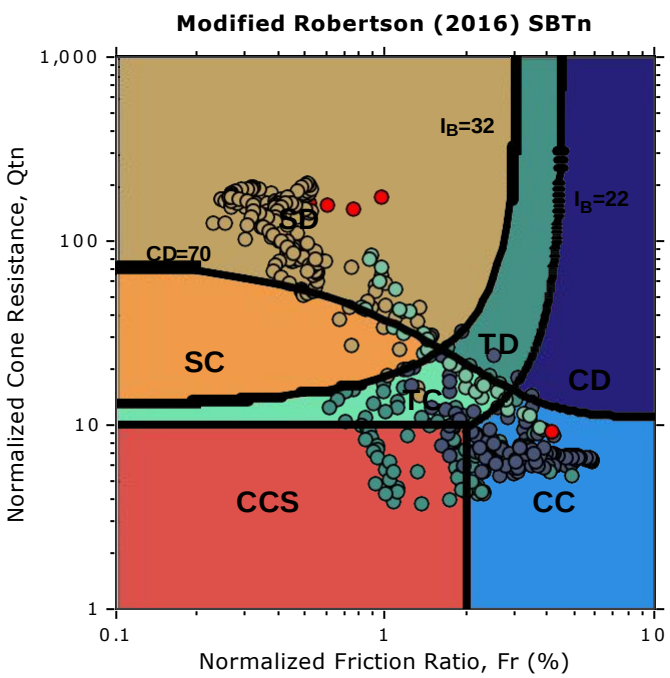
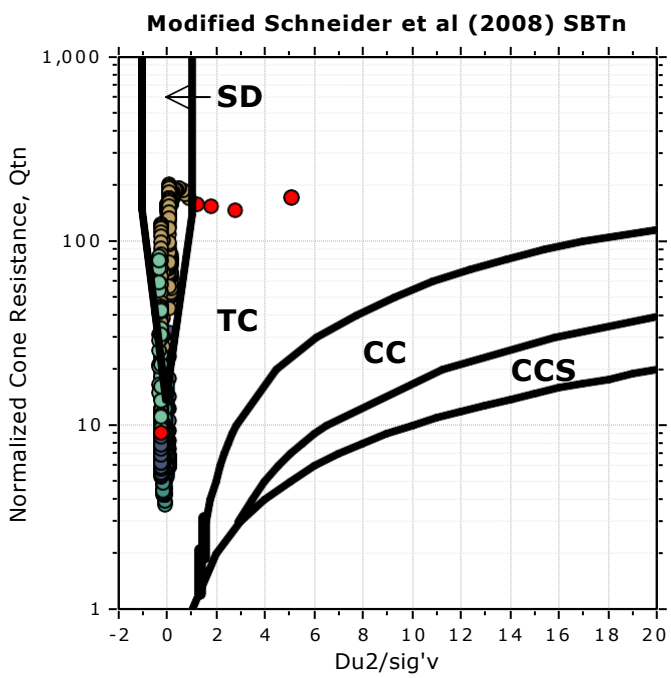
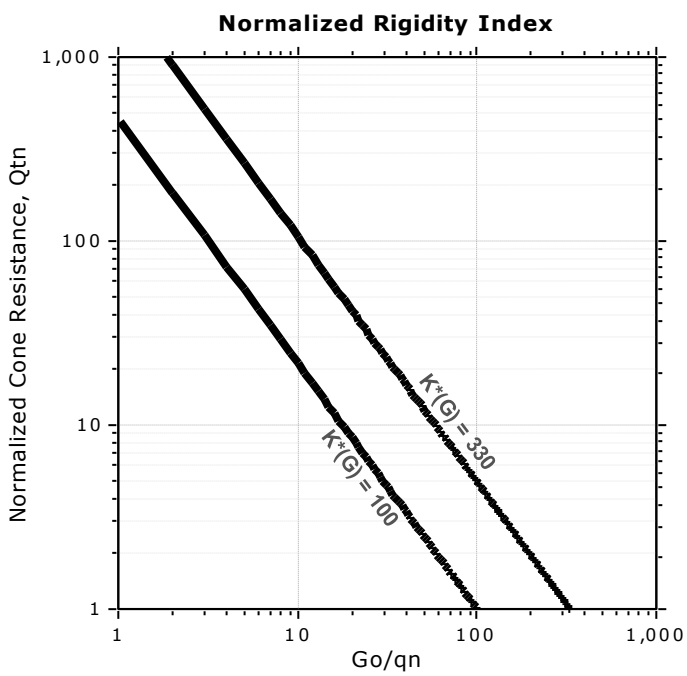
Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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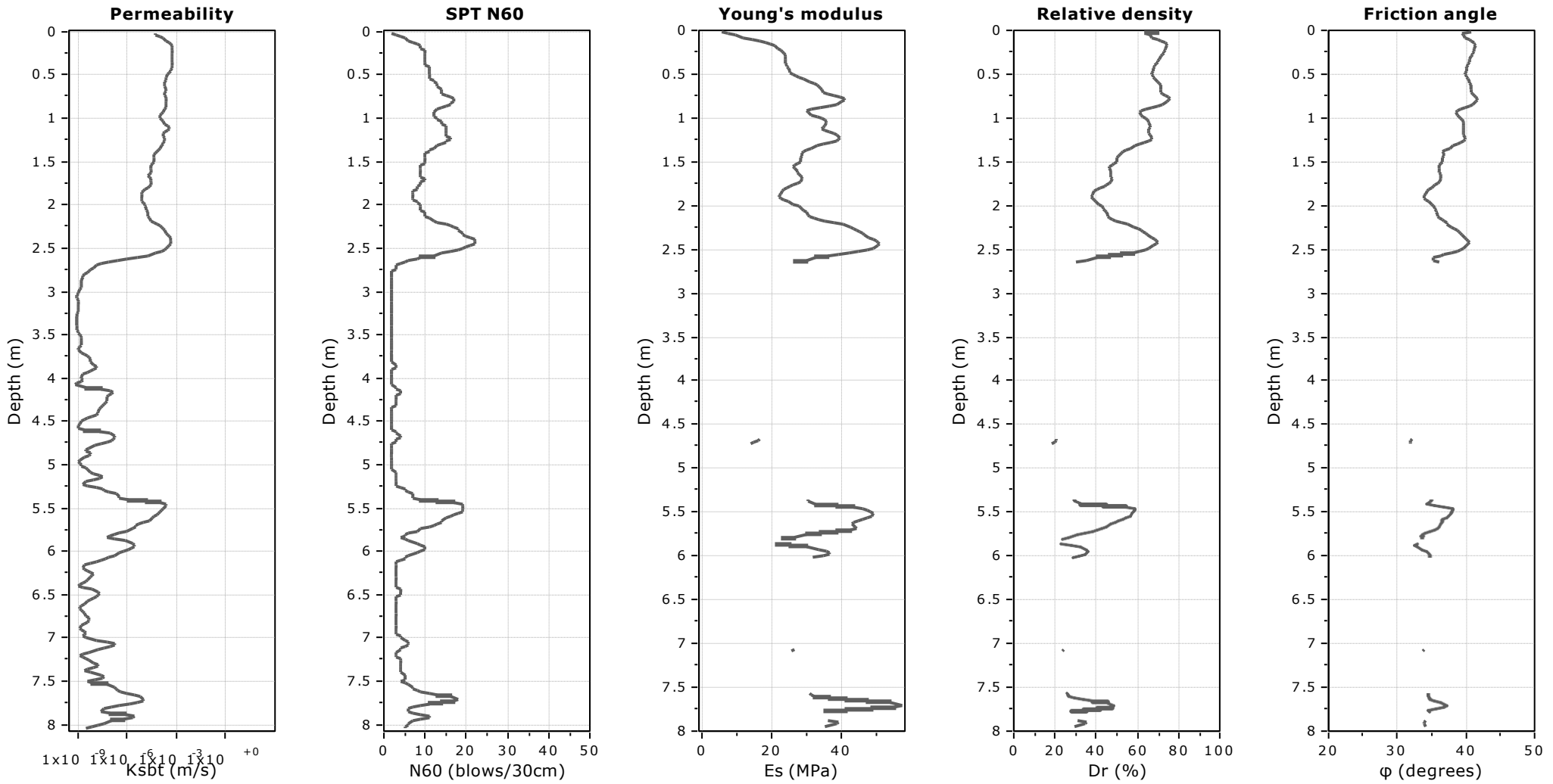

Calculation parameters

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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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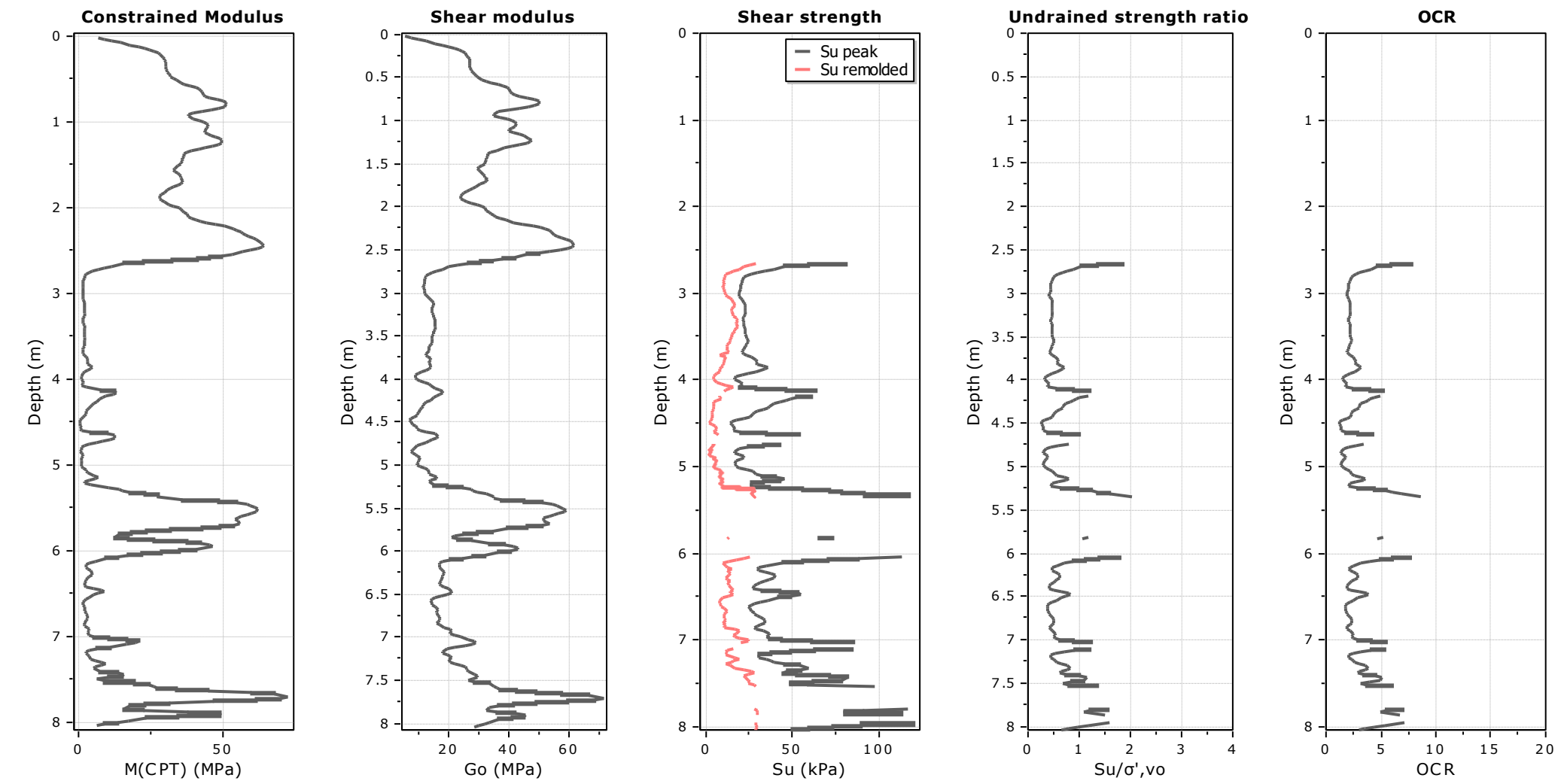

Calculation parameters

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
Flat Dilatometer Test data

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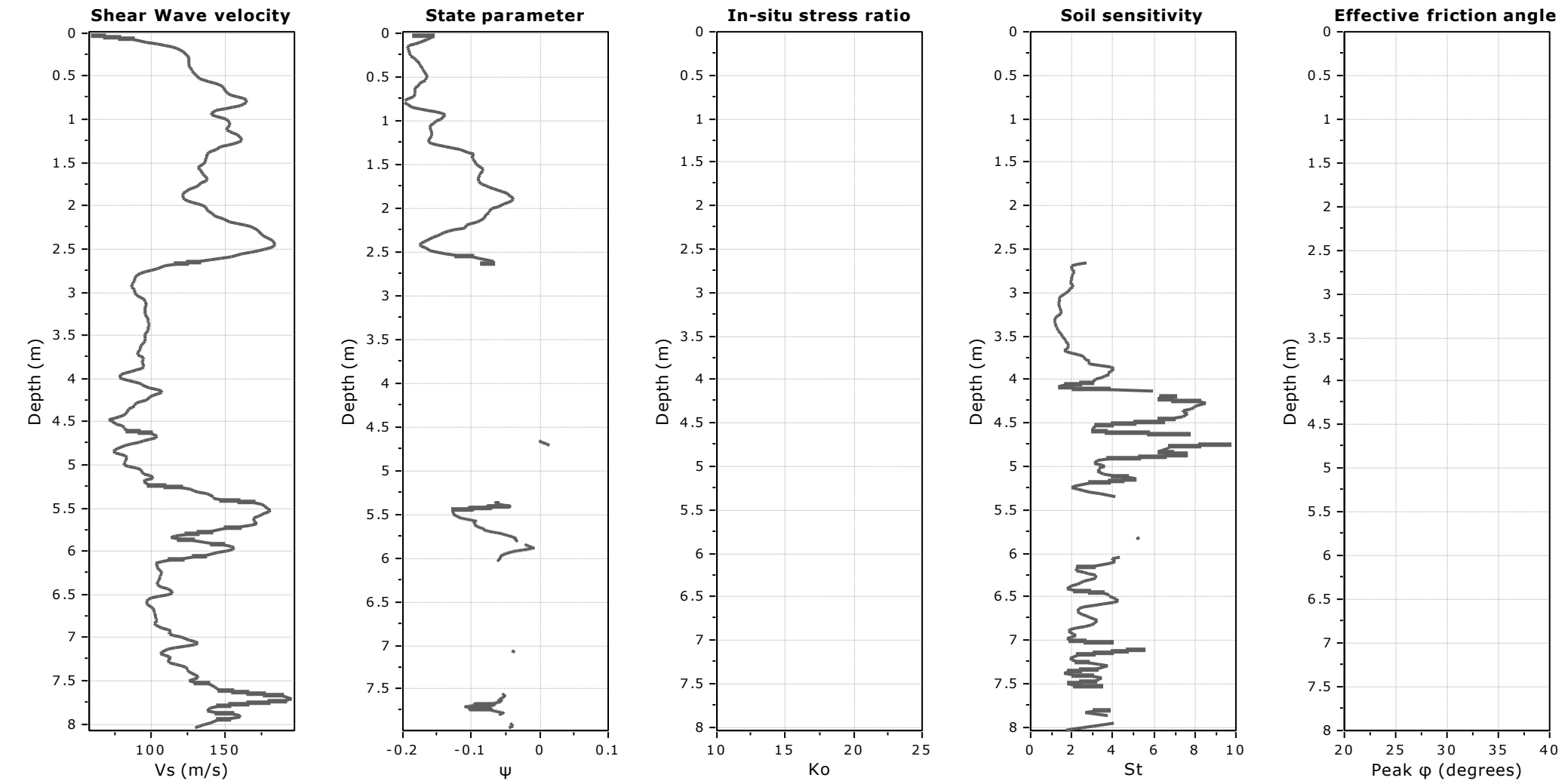

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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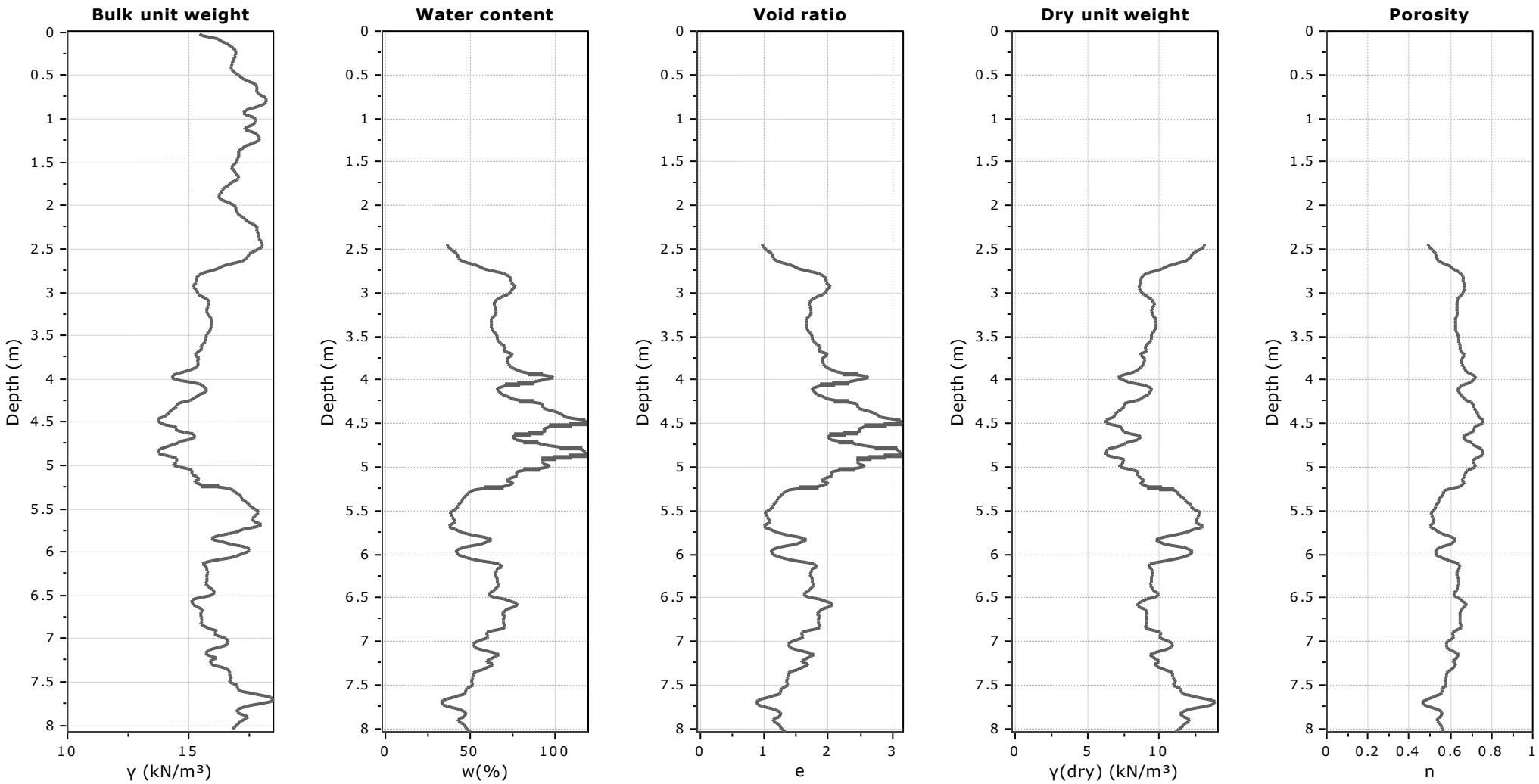

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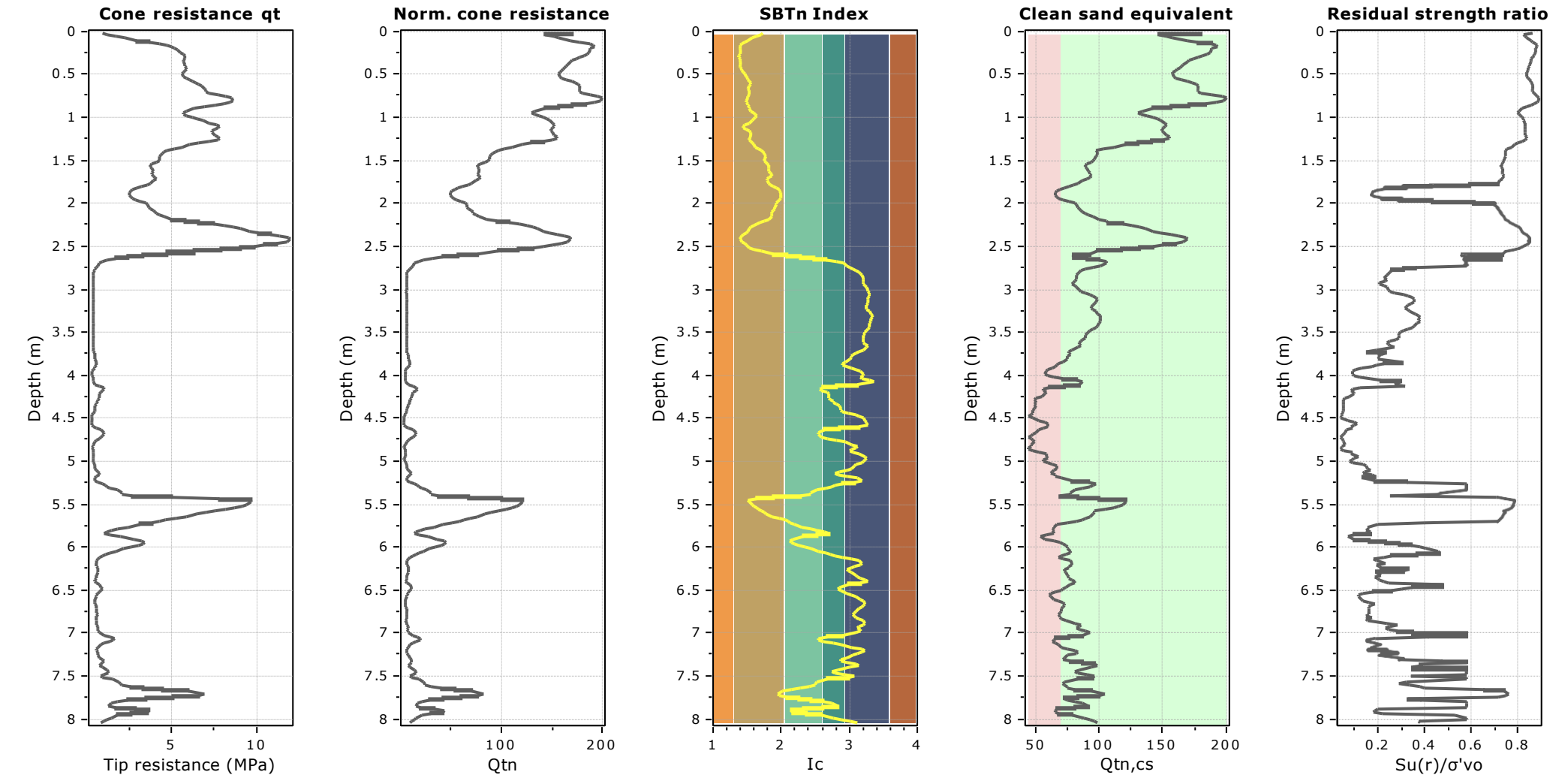

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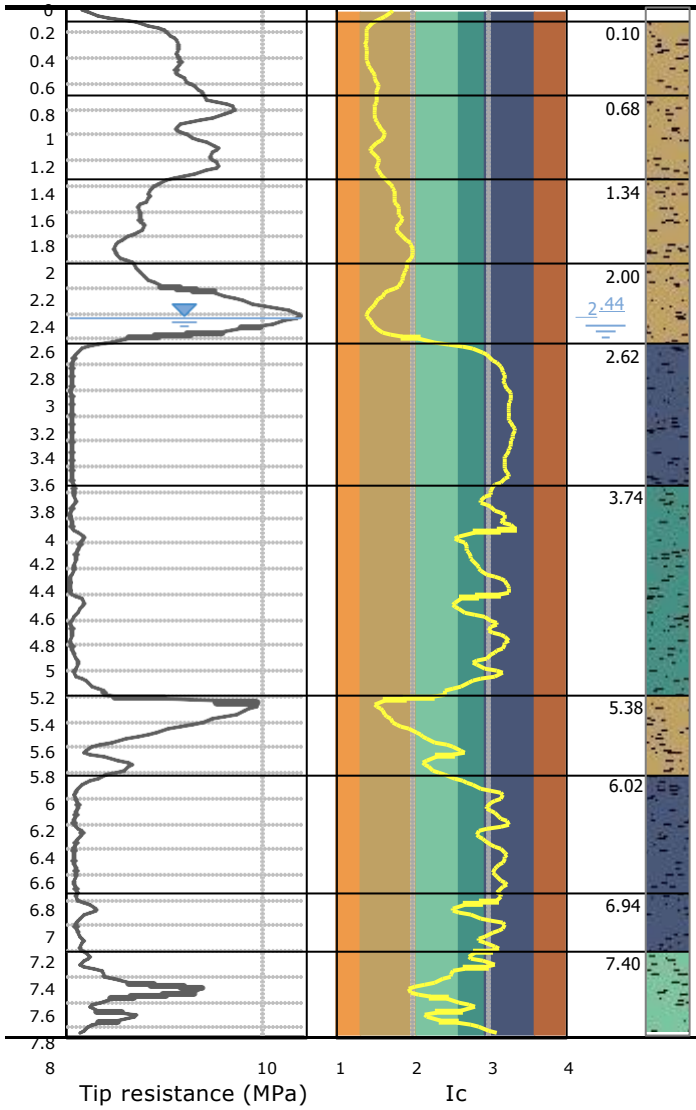
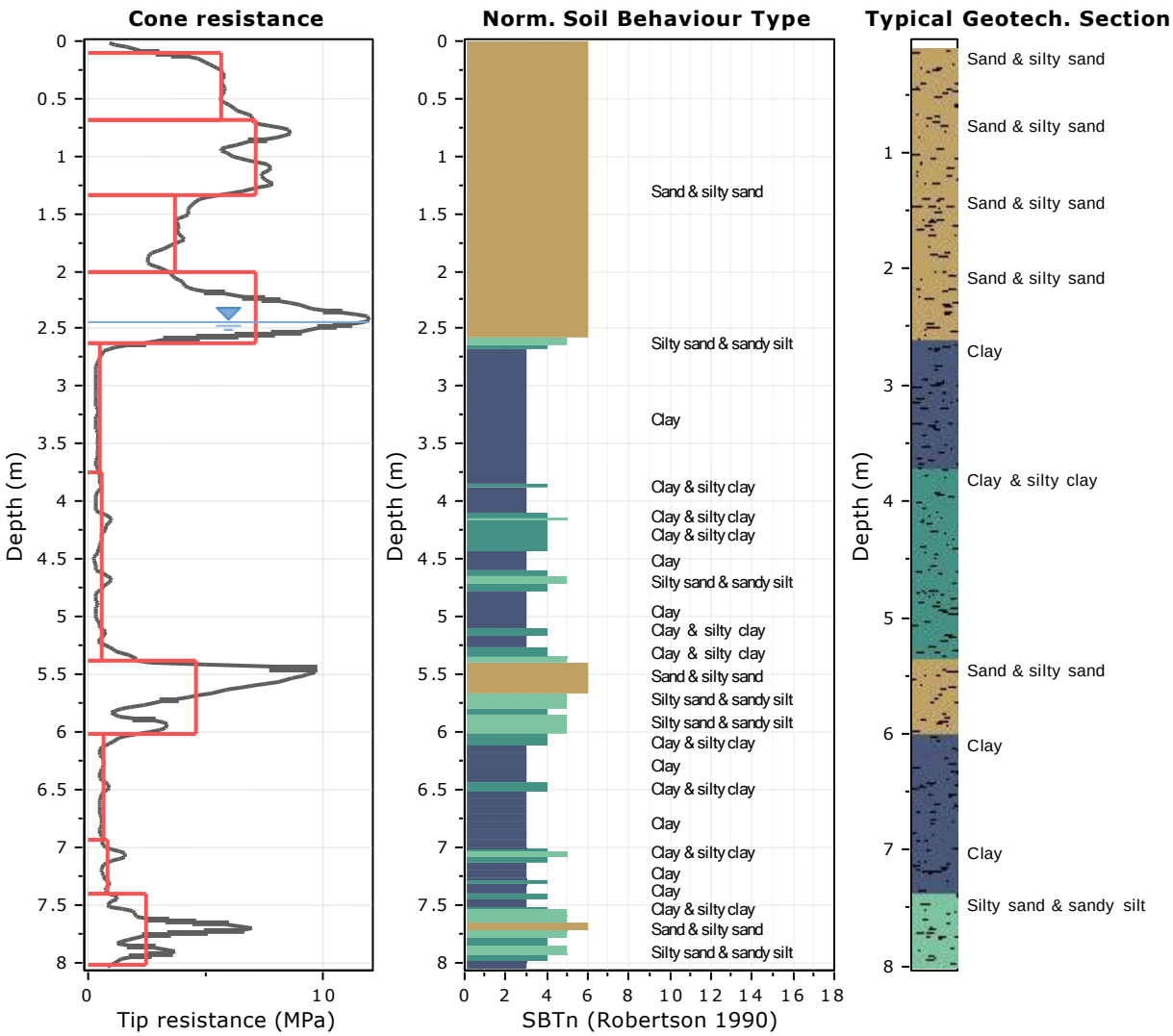


Depth (m)	Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.10	Sand & silty sand	5.6	3.92E-4	10.6	25.3	70.4	40.6	31.7	28.9	-	-	-	17.0
0.68	Sand & silty sand	7.1	1.97E-4	14.4	35.8	66.6	39.8	44.9	42.5	-	-	-	17.7
1.34	Sand & silty sand	3.7	2.92E-5	9.0	26.7	45.9	35.7	33.5	30.0	-	-	-	16.7
2.00	Sand & silty sand	7.1	1.51E-4	14.9	39.8	55.1	37.7	49.8	47.0	-	-	-	17.5
2.62	Clay	0.5	2.64E-8	2.3	-	-	-	3.6	15.3	24.7	0.5	2.4	15.7
3.74	Clay & silty clay	0.6	3.61E-8	2.8	-	-	-	5.2	13.8	32.0	0.6	2.7	14.9
5.38	Sand & silty sand	4.6	3.68E-5	11.6	38.1	41.0	35.4	43.1	43.1	-	-	-	17.2
6.02	Clay	0.7	1.90E-8	3.4	-	-	-	5.1	18.7	38.0	0.6	2.7	15.7
6.94	Clay	0.9	2.78E-8	4.1	-	-	-	7.9	23.2	48.1	0.7	3.2	16.2
7.40	Silty sand & sandy silt	2.5	1.38E-6	8.4	41.3	34.8	35.0	30.4	40.2	-	-	-	17.2



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.10 (m), **End depth:** 0.68 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 5.62 ±0.87 MPa	Permeability: 3.92E-04 ±1.43E-04 m/s	Constrained Mod.: 31.65 ±6.30 MPa
Sleeve friction: 19.80 ±7.36 kPa	N_{60}: 10.57 ±1.83 blows	Go: 28.95 ±6.47 MPa
Ic: 1.44 ±0.06	Es: 25.25 ±5.03 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 70.40 ±2.20	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 40.58 ±0.43 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.02 ±0.41 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 0.68 (m), **End depth:** 1.34 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 7.14 ±0.86 MPa	Permeability: 1.97E-04 ±6.67E-05 m/s	Constrained Mod.: 44.91 ±3.72 MPa
Sleeve friction: 31.04 ±7.45 kPa	N_{60}: 14.38 ±1.44 blows	Go: 42.50 ±4.14 MPa
Ic: 1.54 ±0.05	Es: 35.84 ±2.97 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 66.63 ±4.83	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 39.80 ±0.99 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.66 ±0.29 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.34 (m), **End depth:** 2.00 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 3.72 ±0.76 MPa	Permeability: 2.92E-05 ±2.08E-05 m/s	Constrained Mod.: 33.47 ±3.02 MPa
Sleeve friction: 17.06 ±3.00 kPa	N_{60}: 8.97 ±1.29 blows	Go: 30.01 ±3.17 MPa
Ic: 1.84 ±0.10	Es: 26.71 ±2.41 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 45.86 ±5.08	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.72 ±1.03 °	O.C.R.: 0.00 ±0.00
	Unit weight: 16.73 ±0.28 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 2.00 (m), **End depth:** 2.62 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 7.13 ±3.14 MPa	Permeability: 1.51E-04 ±1.60E-04 m/s	Constrained Mod.: 49.76 ±10.32 MPa
Sleeve friction: 28.12 ±4.92 kPa	N_{60}: 14.94 ±4.81 blows	Go: 46.98 ±10.38 MPa
Ic: 1.69 ±0.23	Es: 39.82 ±8.04 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 55.13 ±10.36	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 37.69 ±1.83 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.52 ±0.37 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 2.62 (m), **End depth:** 3.74 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.46 ±0.33 MPa	Permeability: 2.64E-08 ±1.41E-07 m/s	Constrained Mod.: 3.60 ±5.29 MPa
Sleeve friction: 15.01 ±5.06 kPa	N_{60}: 2.32 ±1.05 blows	Go: 15.27 ±4.19 MPa
Ic: 3.18 ±0.20	Es: 0.00 ±0.00 MPa	Su: 24.75 ±10.08 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.53 ±0.22
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.45 ±1.00
	Unit weight: 15.71 ±0.45 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 3.74 (m), **End depth:** 5.38 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.58 ±0.35 MPa	Permeability: 3.61E-08 ±6.78E-08 m/s	Constrained Mod.: 5.16 ±5.67 MPa
Sleeve friction: 8.36 ±6.68 kPa	N_{60}: 2.76 ±1.16 blows	Go: 13.81 ±5.88 MPa
Ic: 2.94 ±0.23	Es: 0.00 ±0.00 MPa	Su: 31.97 ±18.39 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.58 ±0.30
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.66 ±1.36
	Unit weight: 14.94 ±0.83 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 5.38 (m), **End depth:** 6.02 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 4.58 ±2.82 MPa	Permeability: 3.68E-05 ±6.29E-05 m/s	Constrained Mod.: 43.15 ±15.30 MPa
Sleeve friction: 27.11 ±8.84 kPa	N_{60}: 11.61 ±4.89 blows	Go: 43.07 ±11.58 MPa
Ic: 2.07 ±0.35	Es: 38.08 ±8.18 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 40.98 ±11.45	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.39 ±1.62 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.23 ±0.59 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 6.02 (m), **End depth:** 6.94 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.67 ±0.31 MPa	Permeability: 1.90E-08 ±5.73E-08 m/s	Constrained Mod.: 5.09 ±5.28 MPa
Sleeve friction: 13.13 ±4.30 kPa	N_{60}: 3.36 ±0.94 blows	Go: 18.71 ±4.19 MPa
Ic: 3.04 ±0.18	Es: 0.00 ±0.00 MPa	Su: 37.96 ±16.50 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.57 ±0.25
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.65 ±1.13
	Unit weight: 15.73 ±0.41 kN/m³	

.:: Layer No: 9 ::.

Code: Layer_9 **Start depth:** 6.94 (m), **End depth:** 7.40 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.86 ±0.30 MPa	Permeability: 2.78E-08 ±4.96E-08 m/s	Constrained Mod.: 7.89 ±5.43 MPa
Sleeve friction: 17.84 ±4.89 kPa	N_{60}: 4.08 ±0.93 blows	Go: 23.19 ±3.40 MPa
Ic: 2.96 ±0.21	Es: 0.00 ±0.00 MPa	Su: 48.14 ±15.26 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.68 ±0.21
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.15 ±0.96
	Unit weight: 16.19 ±0.32 kN/m³	

.:: Layer No: 10 ::.

Code: Layer_10 **Start depth:** 7.40 (m), **End depth:** 8.02 (m)

Description: Silty sand & sandy silt

Basic results	**Estimation results**	
Total cone resistance: 2.48 ±1.70 MPa	Permeability: 1.38E-06 ±2.72E-06 m/s	Constrained Mod.: 30.43 ±19.64 MPa
Sleeve friction: 32.54 ±10.84 kPa	N_{60}: 8.41 ±3.82 blows	Go: 40.22 ±12.37 MPa
Ic: 2.53 ±0.33	Es: 41.35 ±8.67 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 34.81 ±7.43	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 35.01 ±0.99 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.22 ±0.52 kN/m³	

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Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.10	0.58	3.92E-04	10.6	25.3	70.4	40.6	31.7	28.9	0.0	0.0	0.0	17.0
0.68		(±1.43E-04)	(±1.8)	(±5.0)	(±2.2)	(±0.4)	(±6.3)	(±6.5)	(±0.0)	(±0.0)	(±0.0)	(±0.4)
0.68	0.66	1.97E-04	14.4	35.8	66.6	39.8	44.9	42.5	0.0	0.0	0.0	17.7
1.34		(±6.67E-05)	(±1.4)	(±3.0)	(±4.8)	(±1.0)	(±3.7)	(±4.1)	(±0.0)	(±0.0)	(±0.0)	(±0.3)
1.34	0.66	2.92E-05	9.0	26.7	45.9	35.7	33.5	30.0	0.0	0.0	0.0	16.7
2.00		(±2.08E-05)	(±1.3)	(±2.4)	(±5.1)	(±1.0)	(±3.0)	(±3.2)	(±0.0)	(±0.0)	(±0.0)	(±0.3)
2.00	0.62	1.51E-04	14.9	39.8	55.1	37.7	49.8	47.0	0.0	0.0	0.0	17.5
2.62		(±1.60E-04)	(±4.8)	(±8.0)	(±10.4)	(±1.8)	(±10.3)	(±10.4)	(±0.0)	(±0.0)	(±0.0)	(±0.4)
2.62	1.12	2.64E-08	2.3	0.0	0.0	0.0	3.6	15.3	24.7	0.5	2.4	15.7
3.74		(±1.41E-07)	(±1.1)	(±0.0)	(±0.0)	(±0.0)	(±5.3)	(±4.2)	(±10.1)	(±0.2)	(±1.0)	(±0.4)
3.74	1.64	3.61E-08	2.8	0.0	0.0	0.0	5.2	13.8	32.0	0.6	2.7	14.9
5.38		(±6.78E-08)	(±1.2)	(±0.0)	(±0.0)	(±0.0)	(±5.7)	(±5.9)	(±18.4)	(±0.3)	(±1.4)	(±0.8)
5.38	0.64	3.68E-05	11.6	38.1	41.0	35.4	43.1	43.1	0.0	0.0	0.0	17.2
6.02		(±6.29E-05)	(±4.9)	(±8.2)	(±11.5)	(±1.6)	(±15.3)	(±11.6)	(±0.0)	(±0.0)	(±0.0)	(±0.6)
6.02	0.92	1.90E-08	3.4	0.0	0.0	0.0	5.1	18.7	38.0	0.6	2.7	15.7
6.94		(±5.73E-08)	(±0.9)	(±0.0)	(±0.0)	(±0.0)	(±5.3)	(±4.2)	(±16.5)	(±0.2)	(±1.1)	(±0.4)
6.94	0.46	2.78E-08	4.1	0.0	0.0	0.0	7.9	23.2	48.1	0.7	3.2	16.2
7.40		(±4.96E-08)	(±0.9)	(±0.0)	(±0.0)	(±0.0)	(±5.4)	(±3.4)	(±15.3)	(±0.2)	(±1.0)	(±0.3)
7.40	0.62	1.38E-06	8.4	41.3	34.8	35.0	30.4	40.2	0.0	0.0	0.0	17.2
8.02		(±2.72E-06)	(±3.8)	(±8.7)	(±7.4)	(±1.0)	(±19.6)	(±12.4)	(±0.0)	(±0.0)	(±0.0)	(±0.5)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(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)

•N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

CPT#3

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Lot 6 Onion Field LBI, Guyana.
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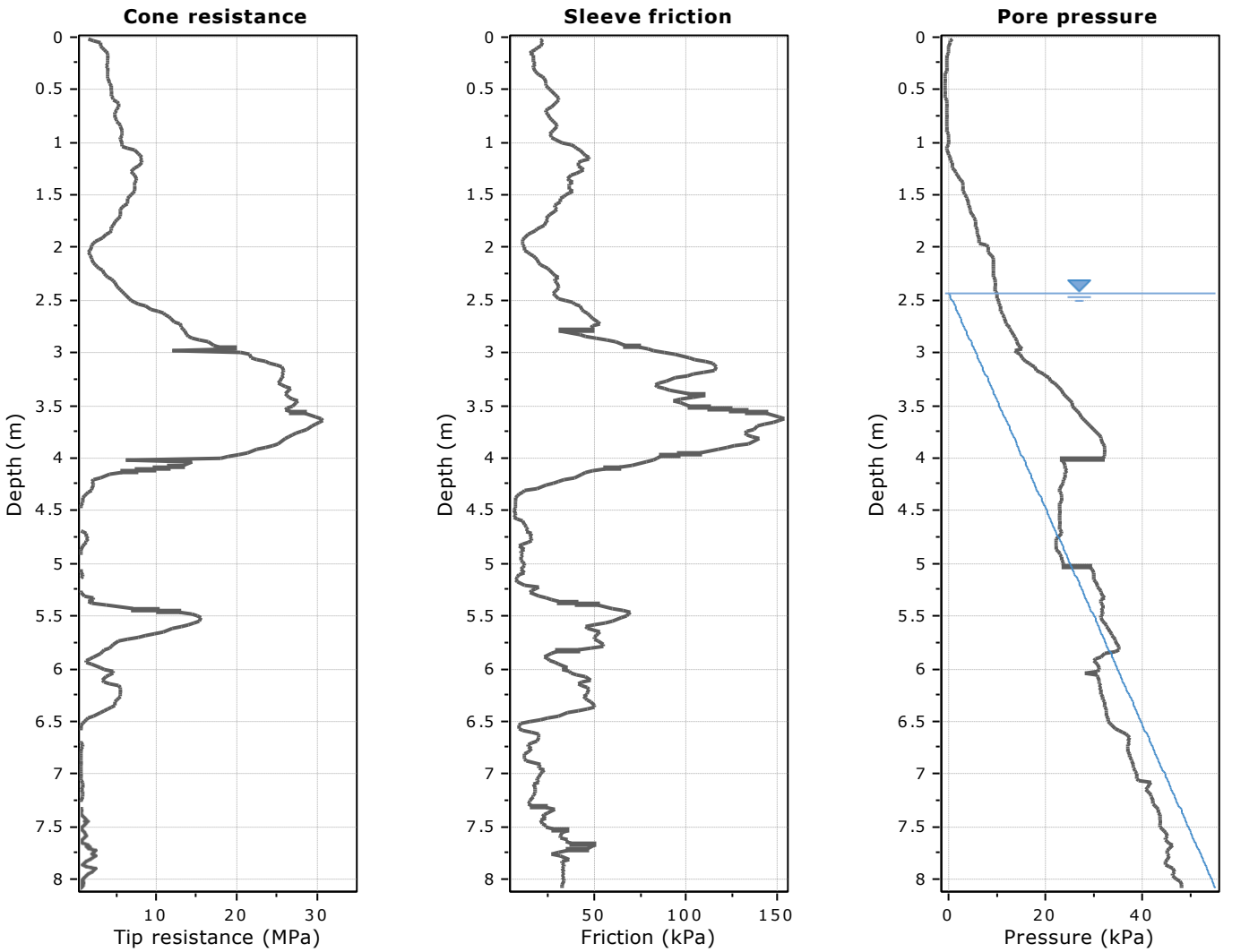
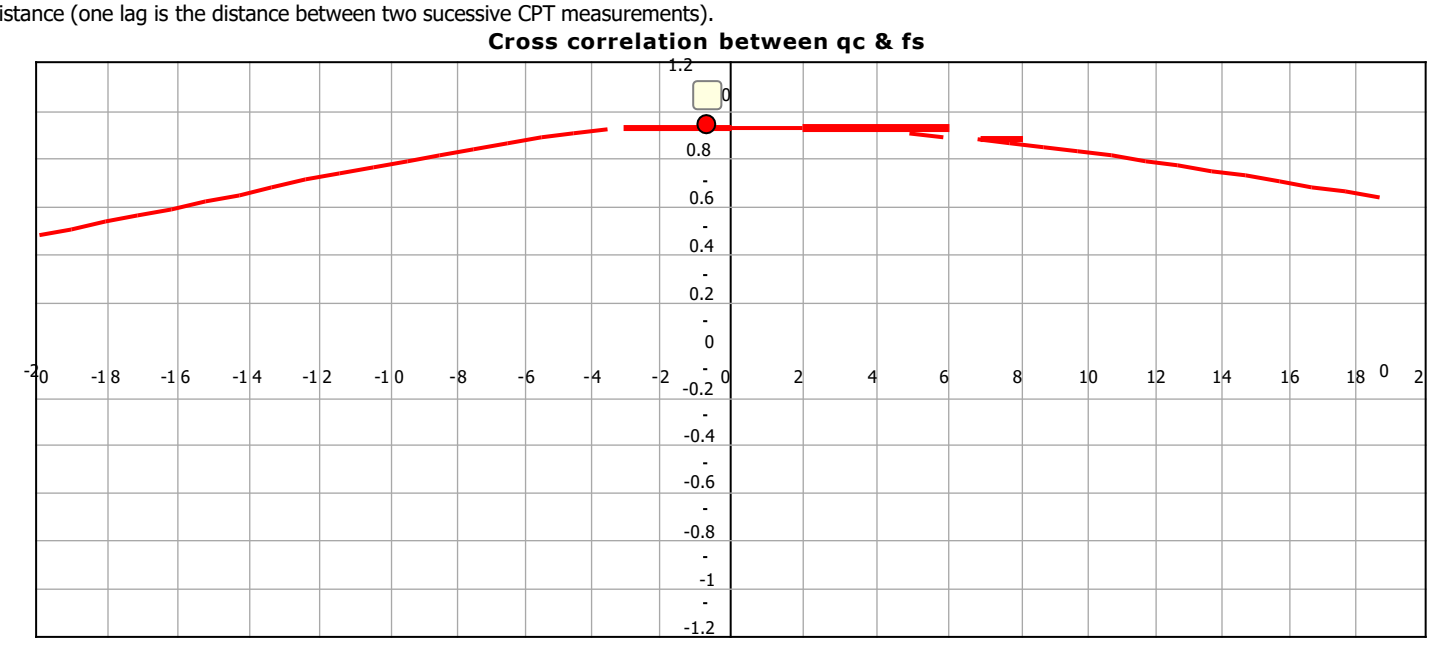
CPT: #3

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

epth: 8.08 m, Date: 12/17/2022
ds: 6°55'49.2" N 58°22'10.3" W



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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Project: Soil Testing Services for Solar Photovoltaic Farm
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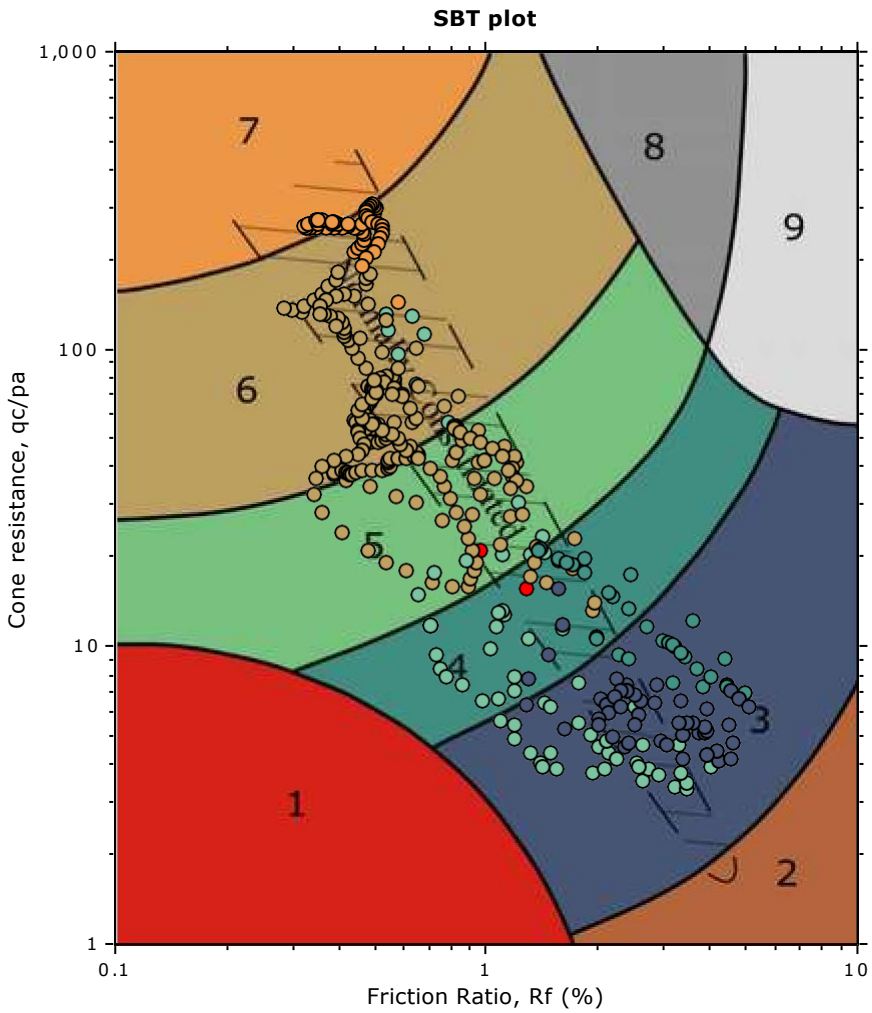
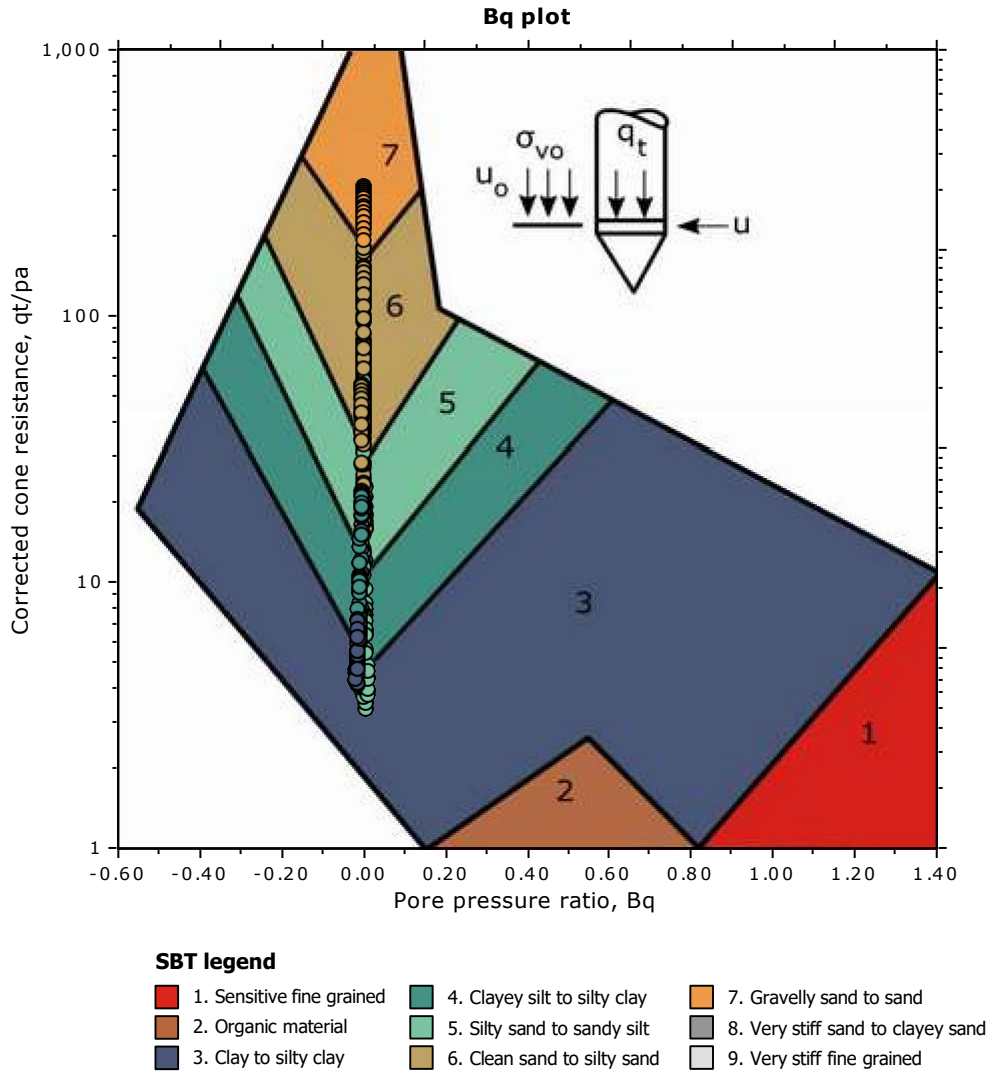
CPT: #3
Total depth: 8.08 m, Date: 12/17/2022
Coords: 6°55'49.2" N 58°22'10.3" W

SBT - Bq plots





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. Gravelly sand to sand
8. Very stiff sand to clayey sand
9. Very stiff fine grained

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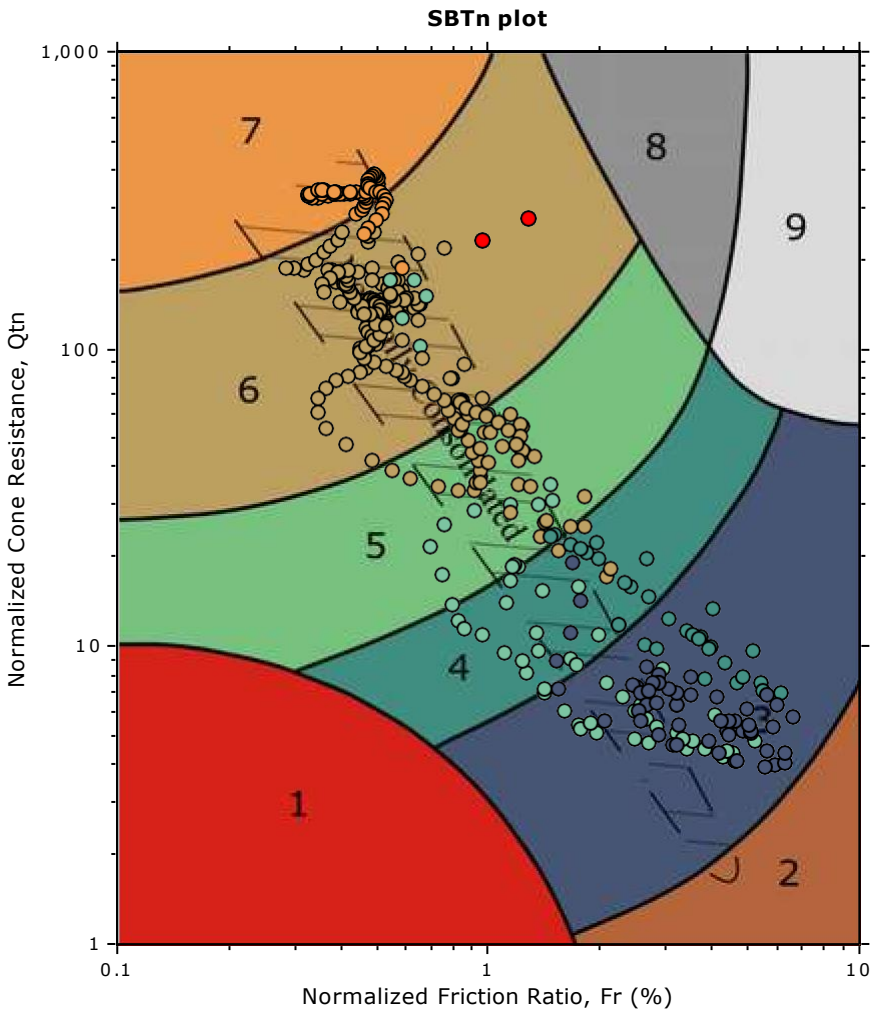
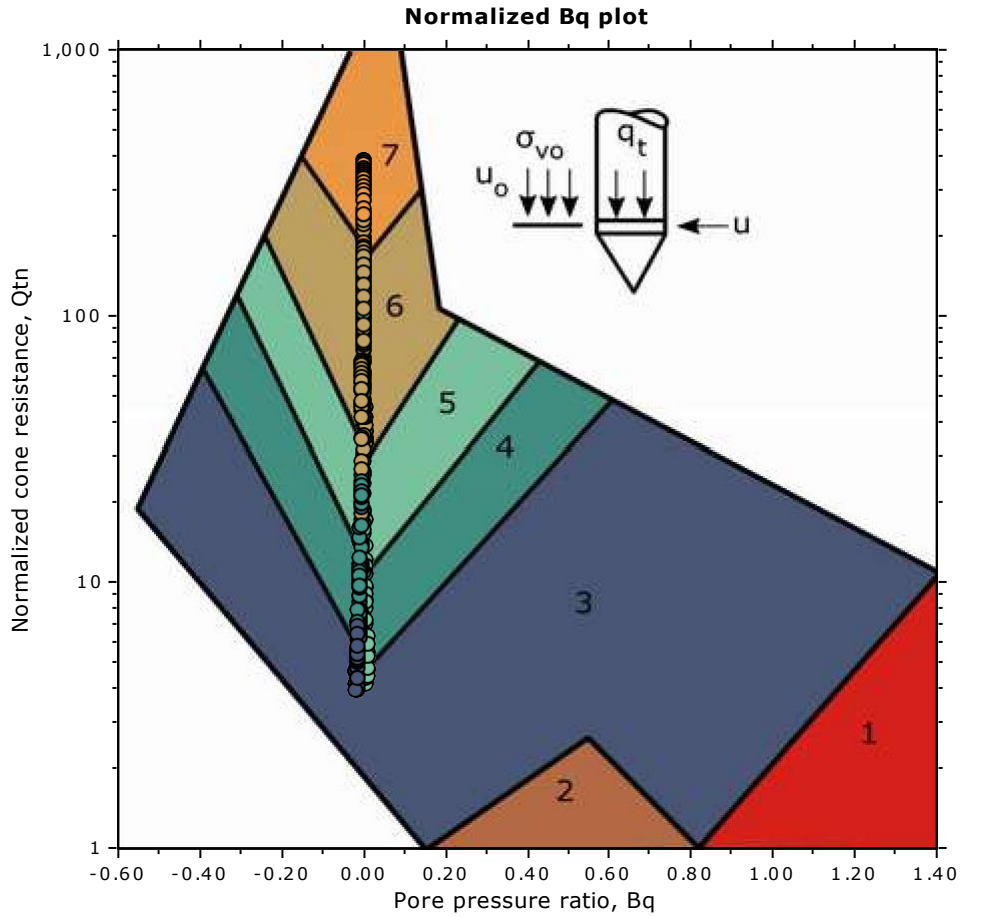
SBT - Bq plots (normalized)





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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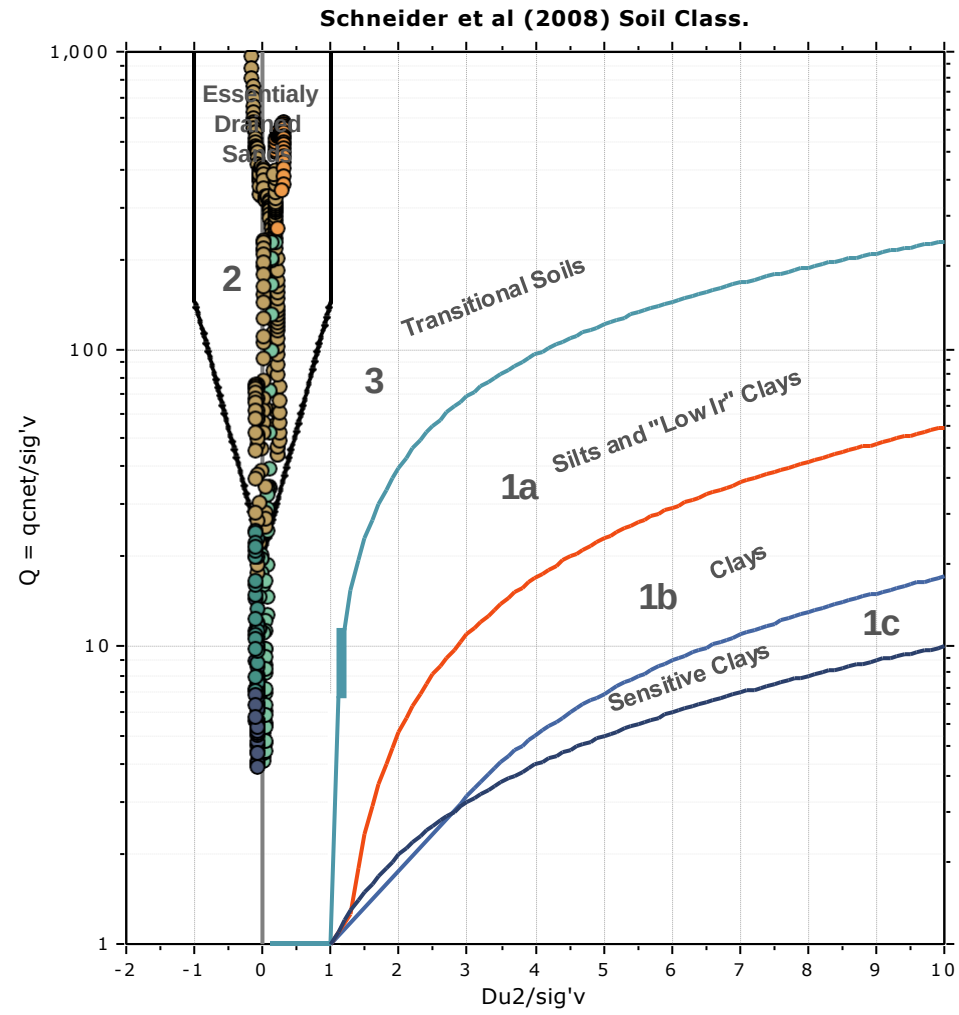
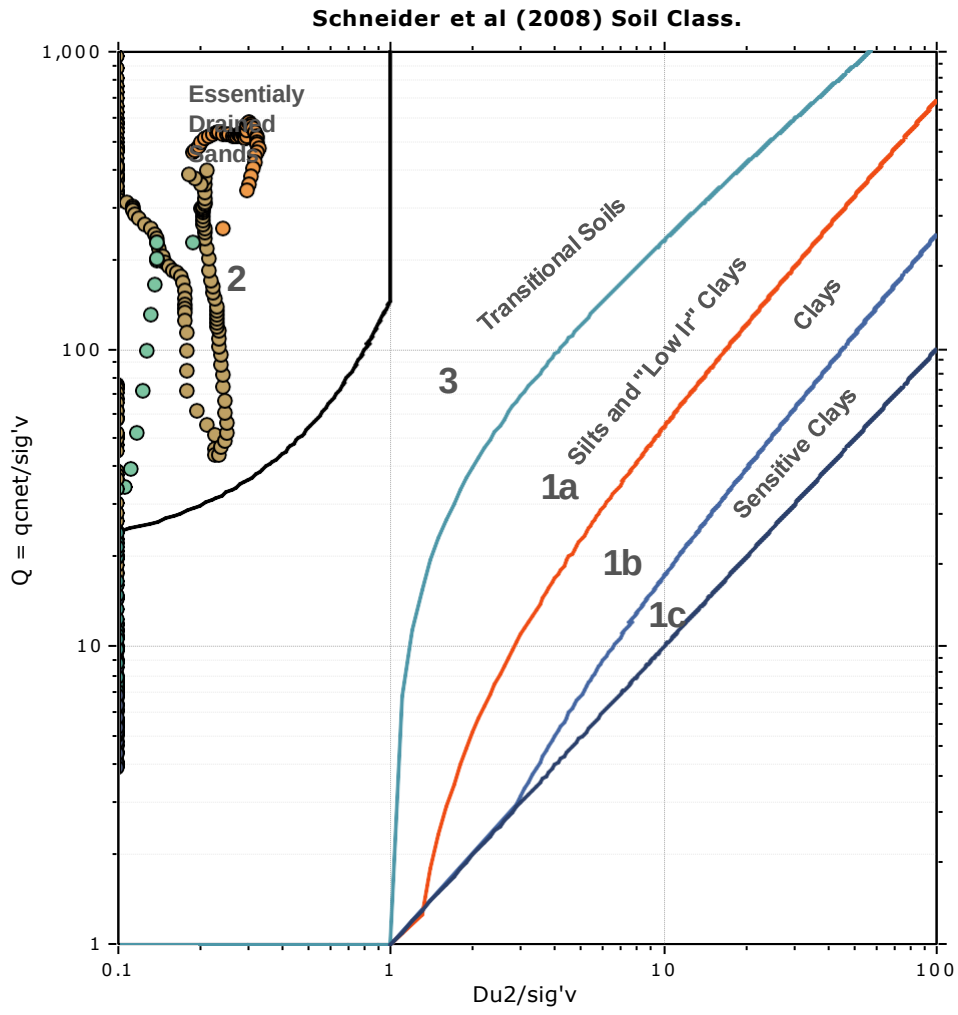
Bq plots (Schneider)





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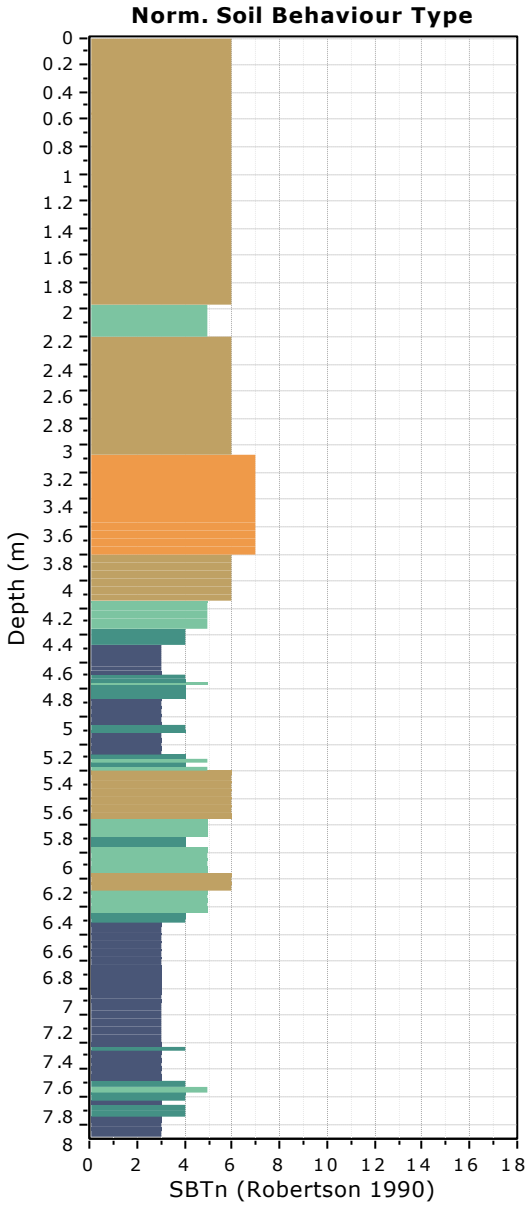

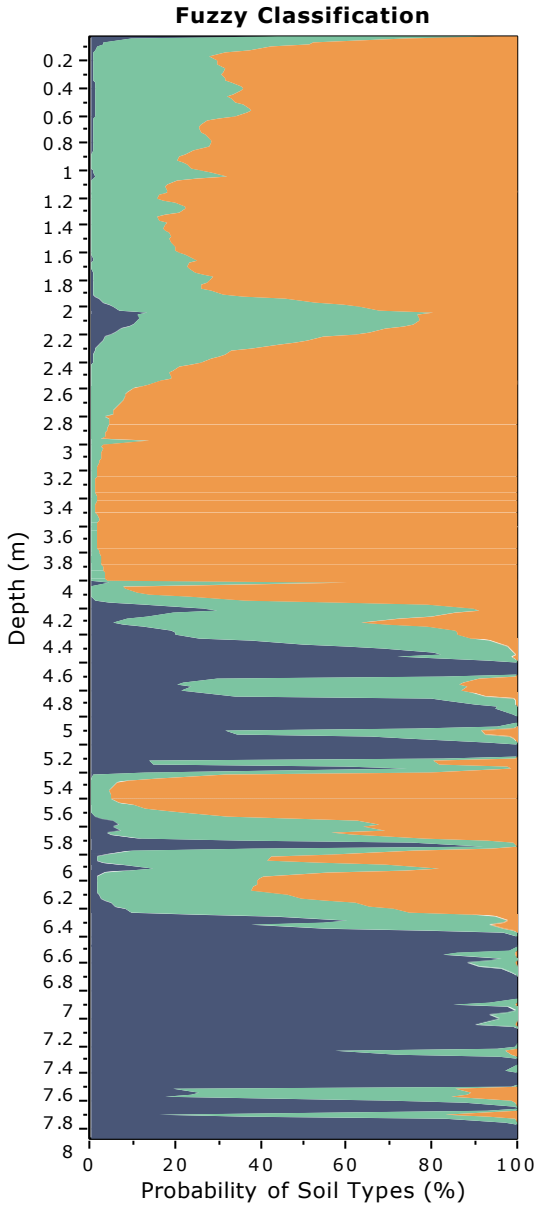

Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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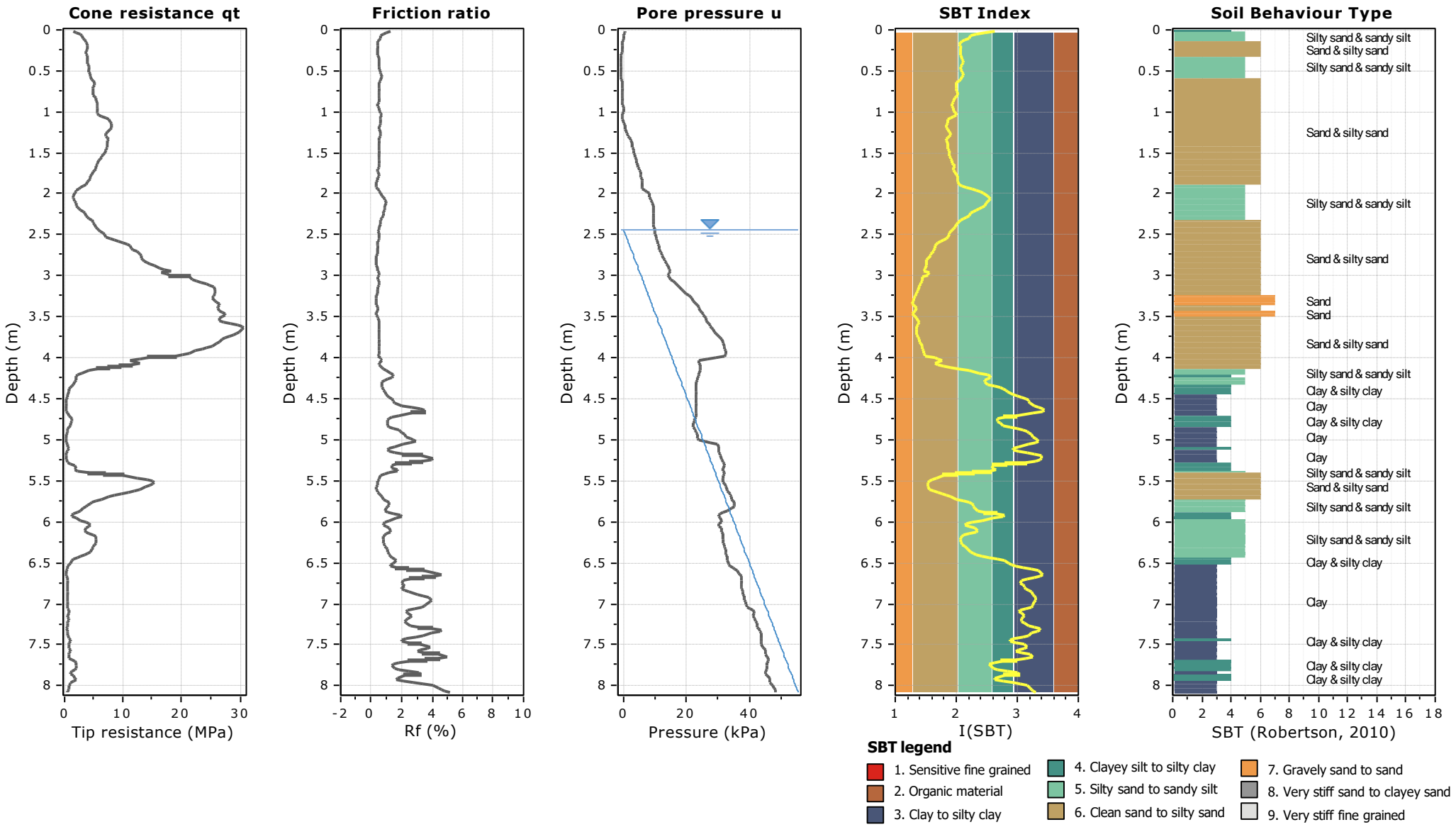

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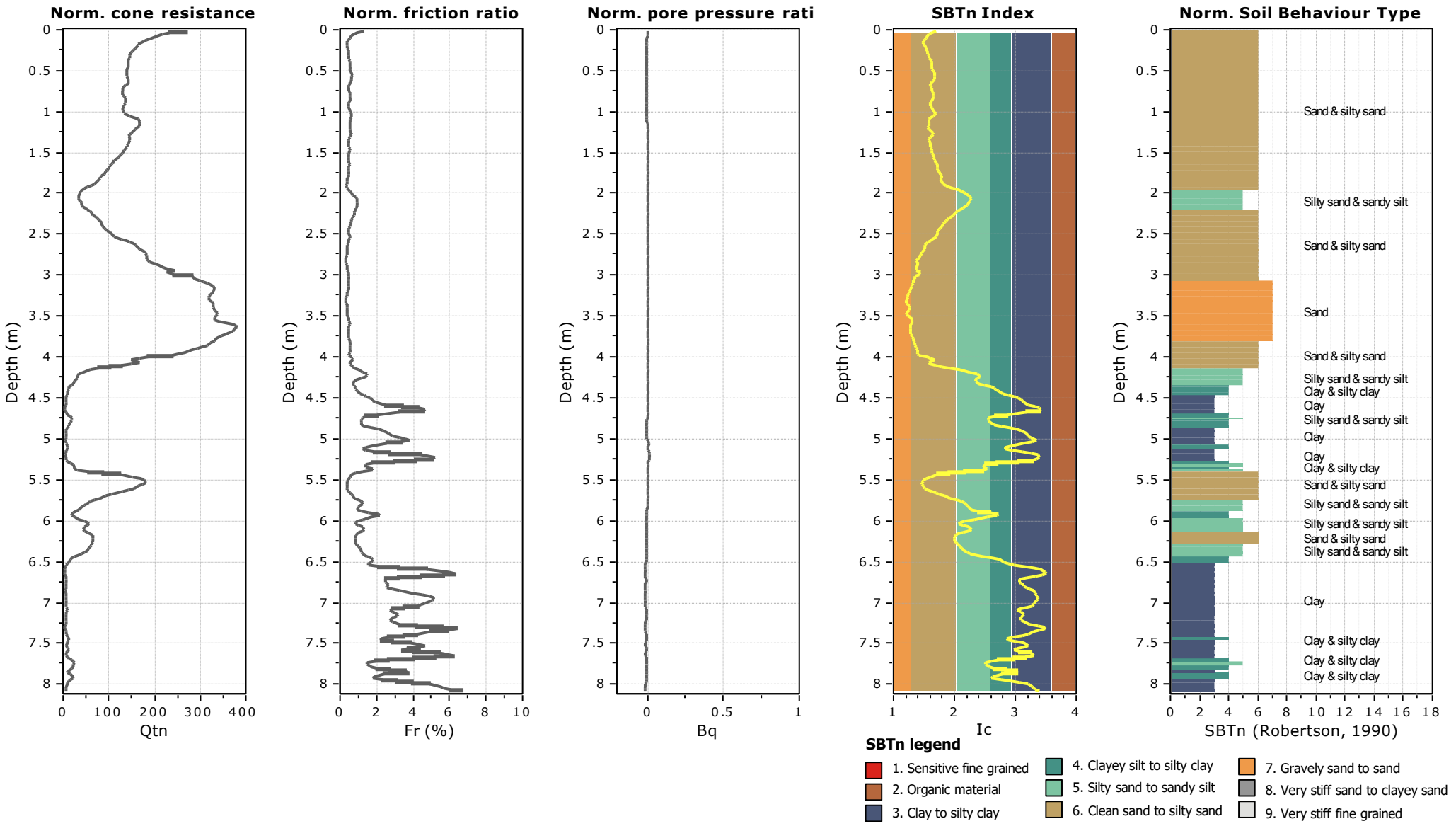

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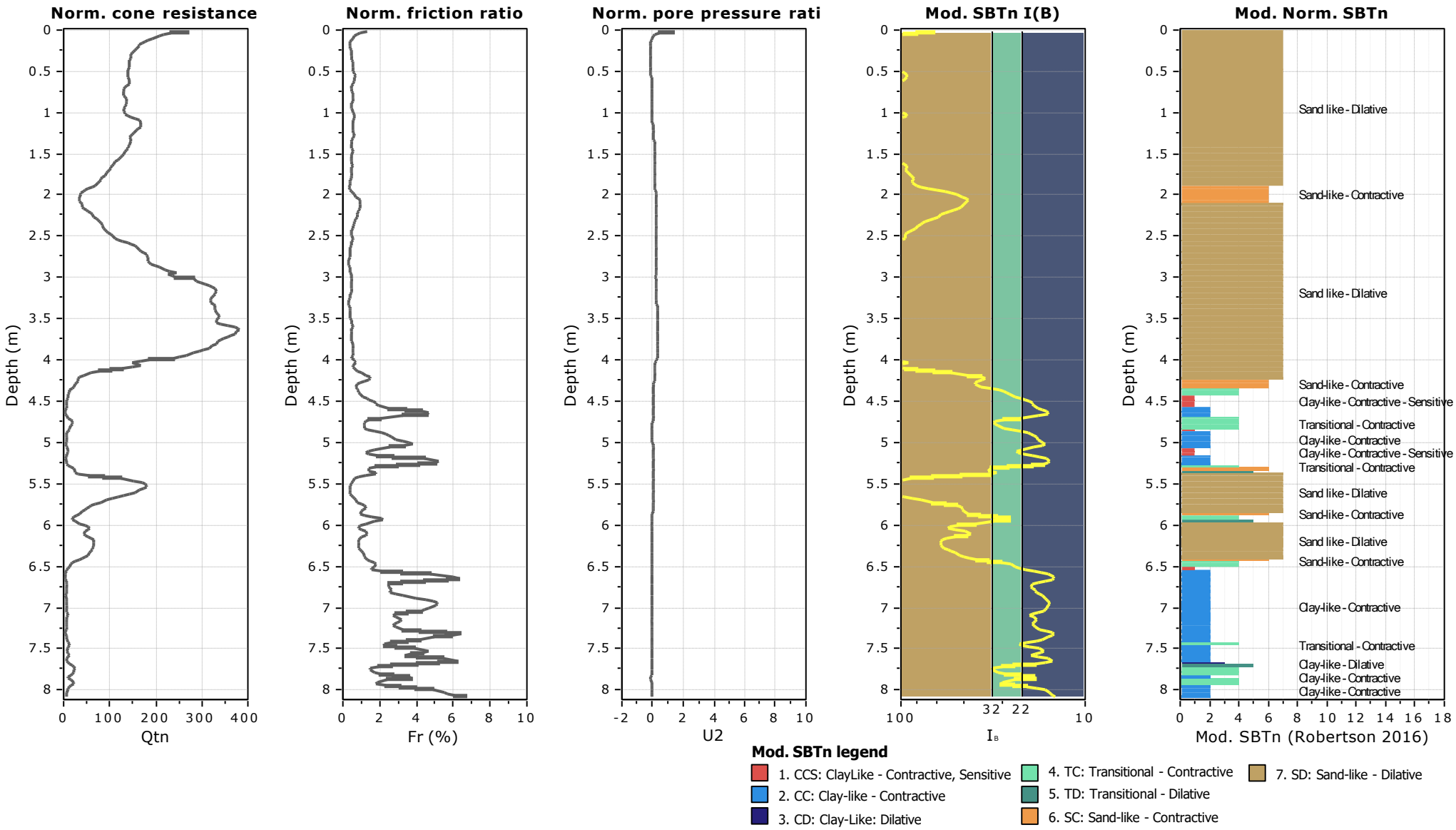

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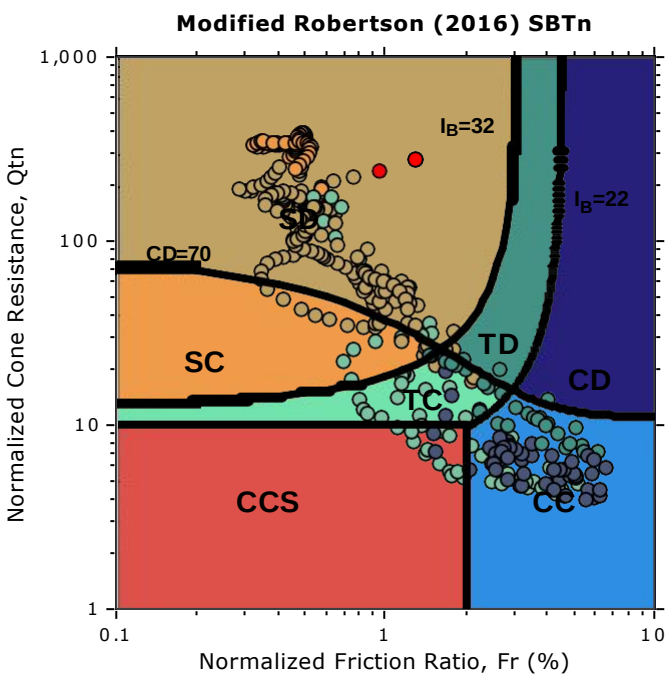
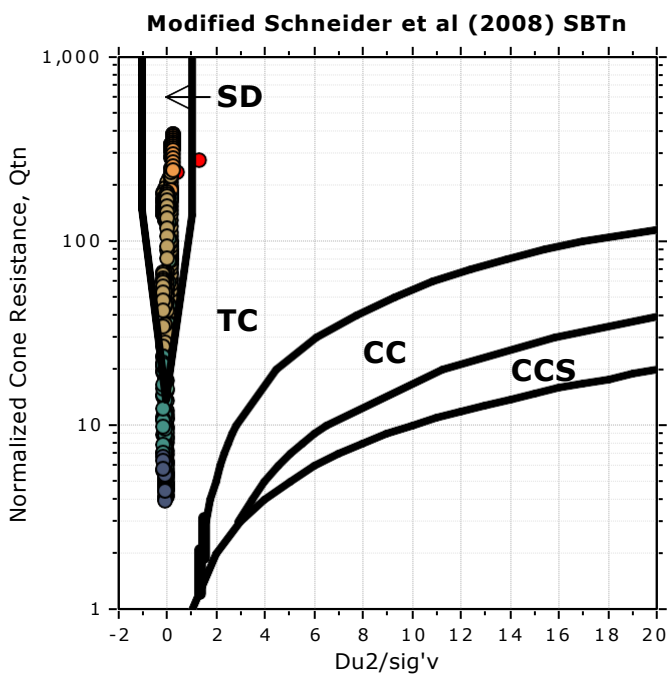
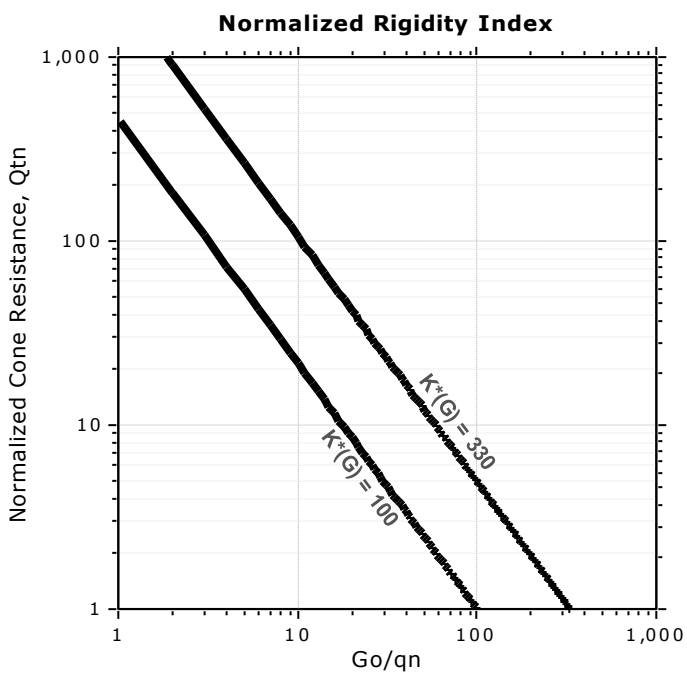
Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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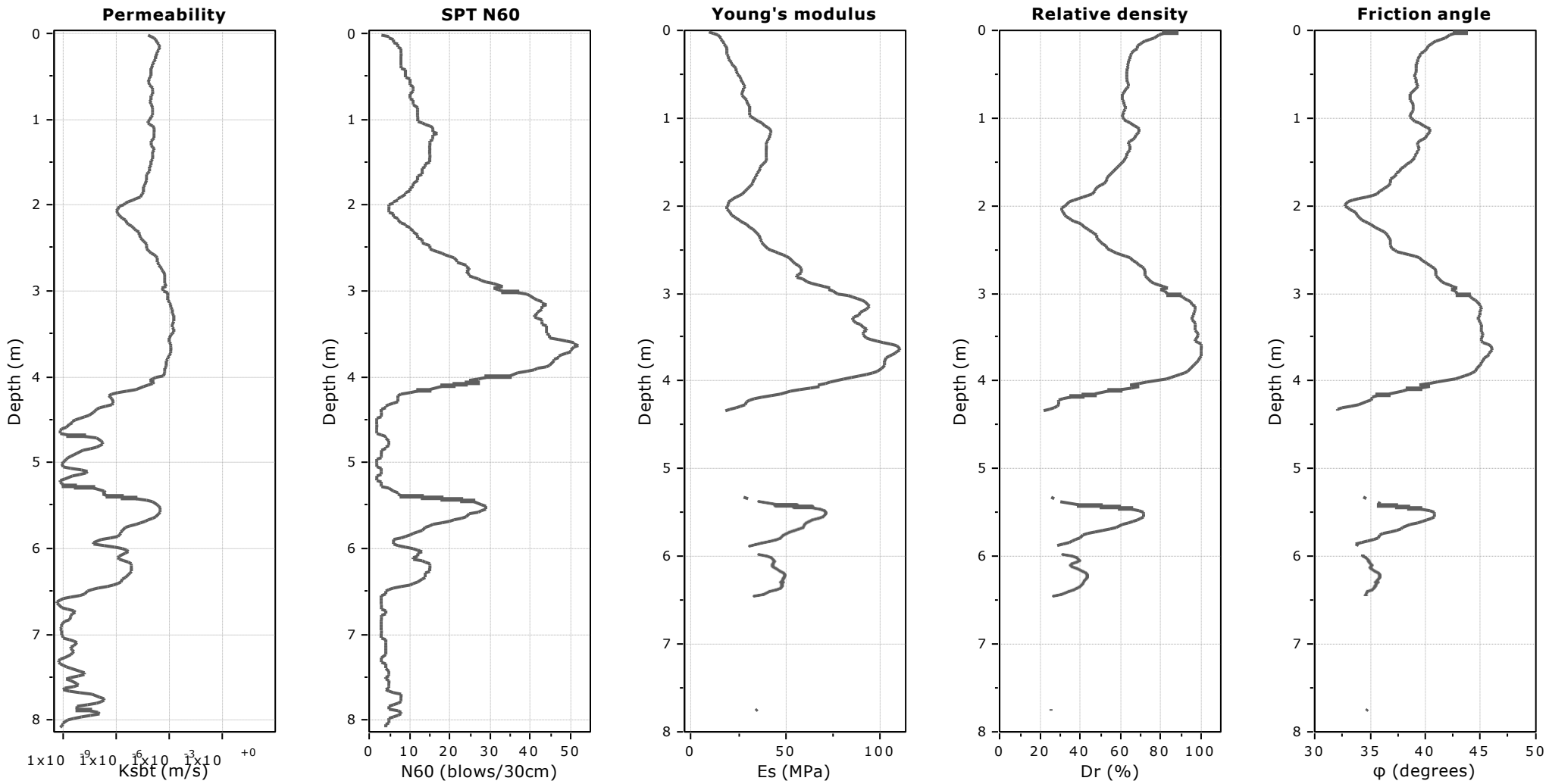

Calculation parameters

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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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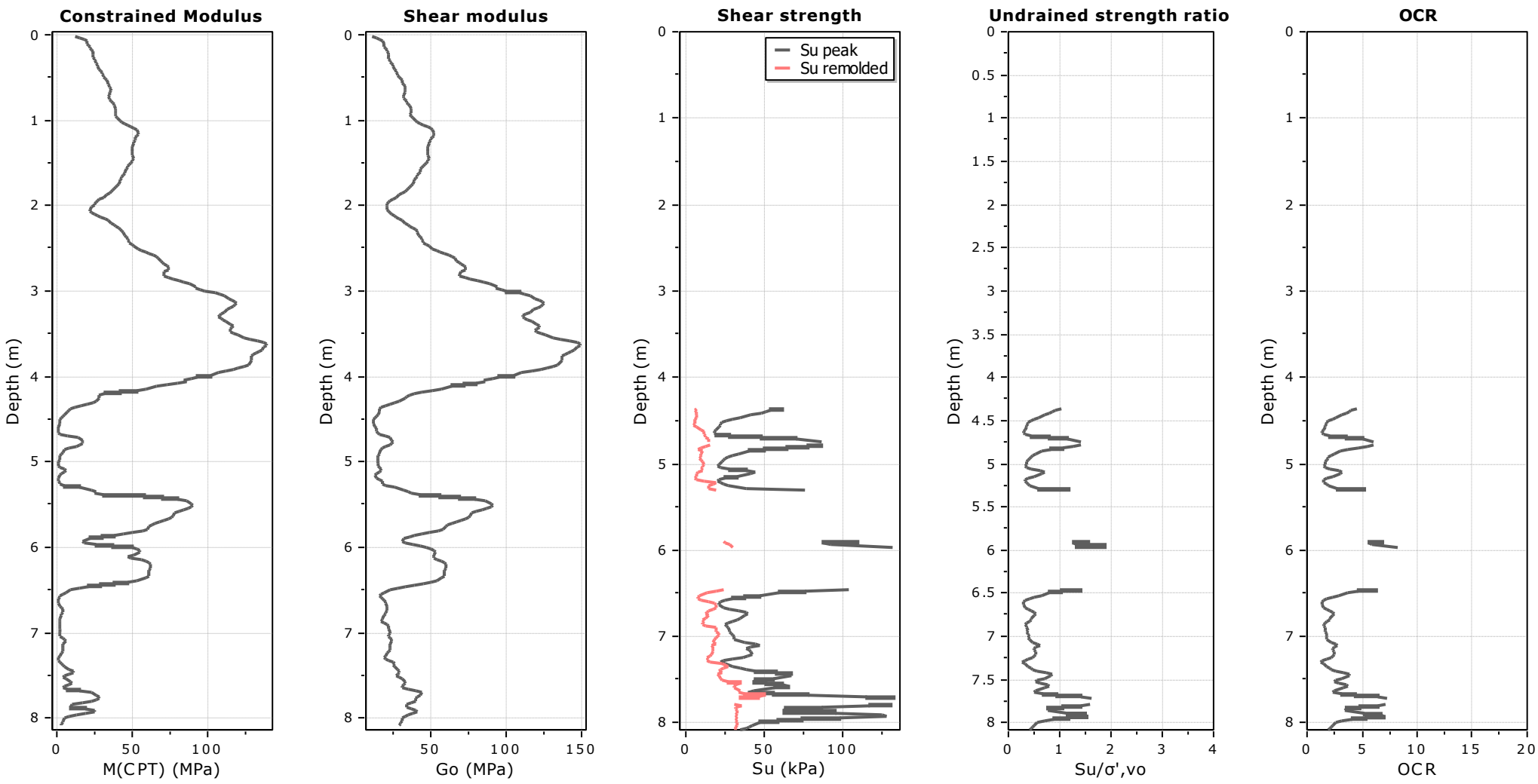

Calculation parameters

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
Flat Dilatometer Test data

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CPT: #3
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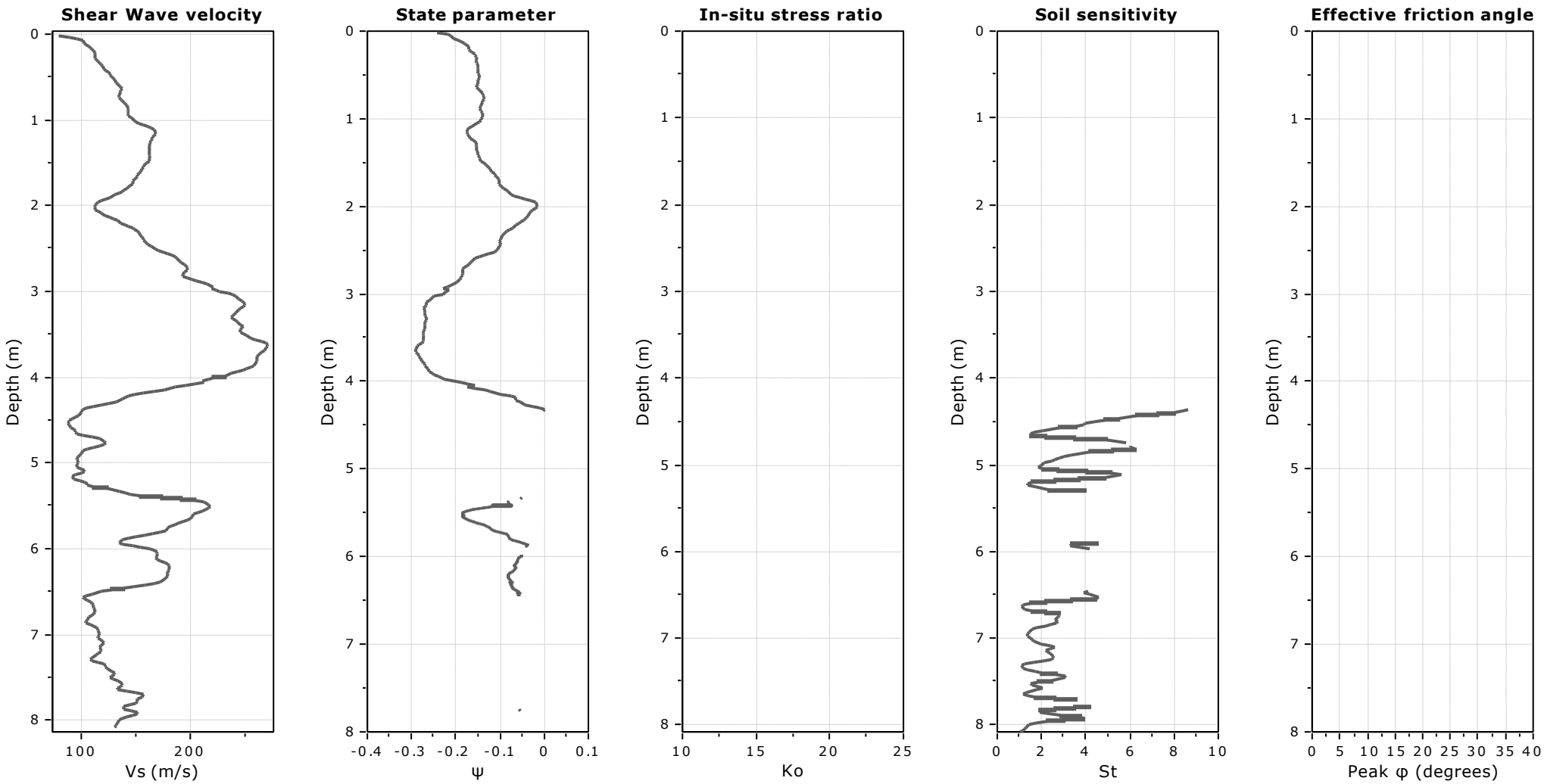

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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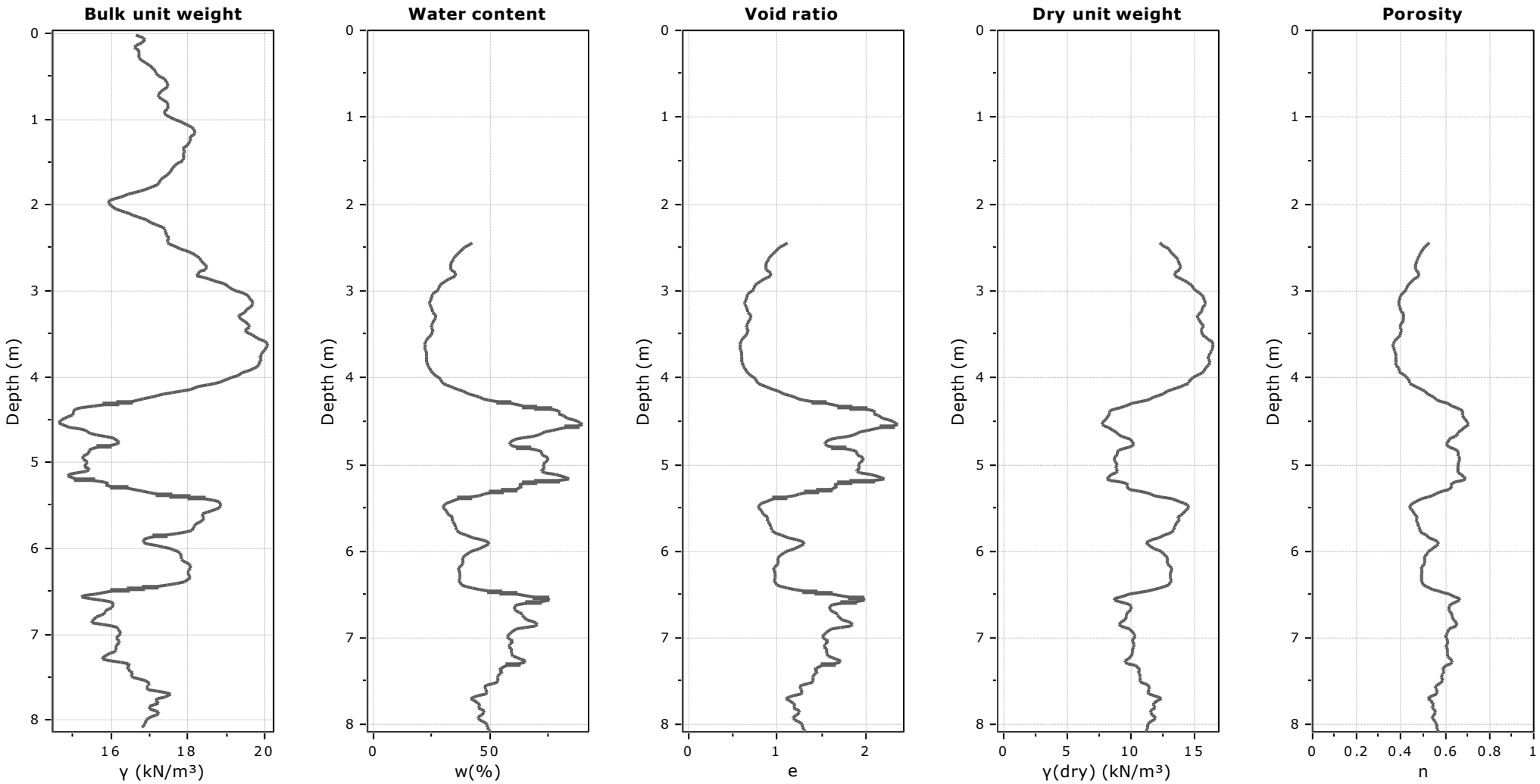

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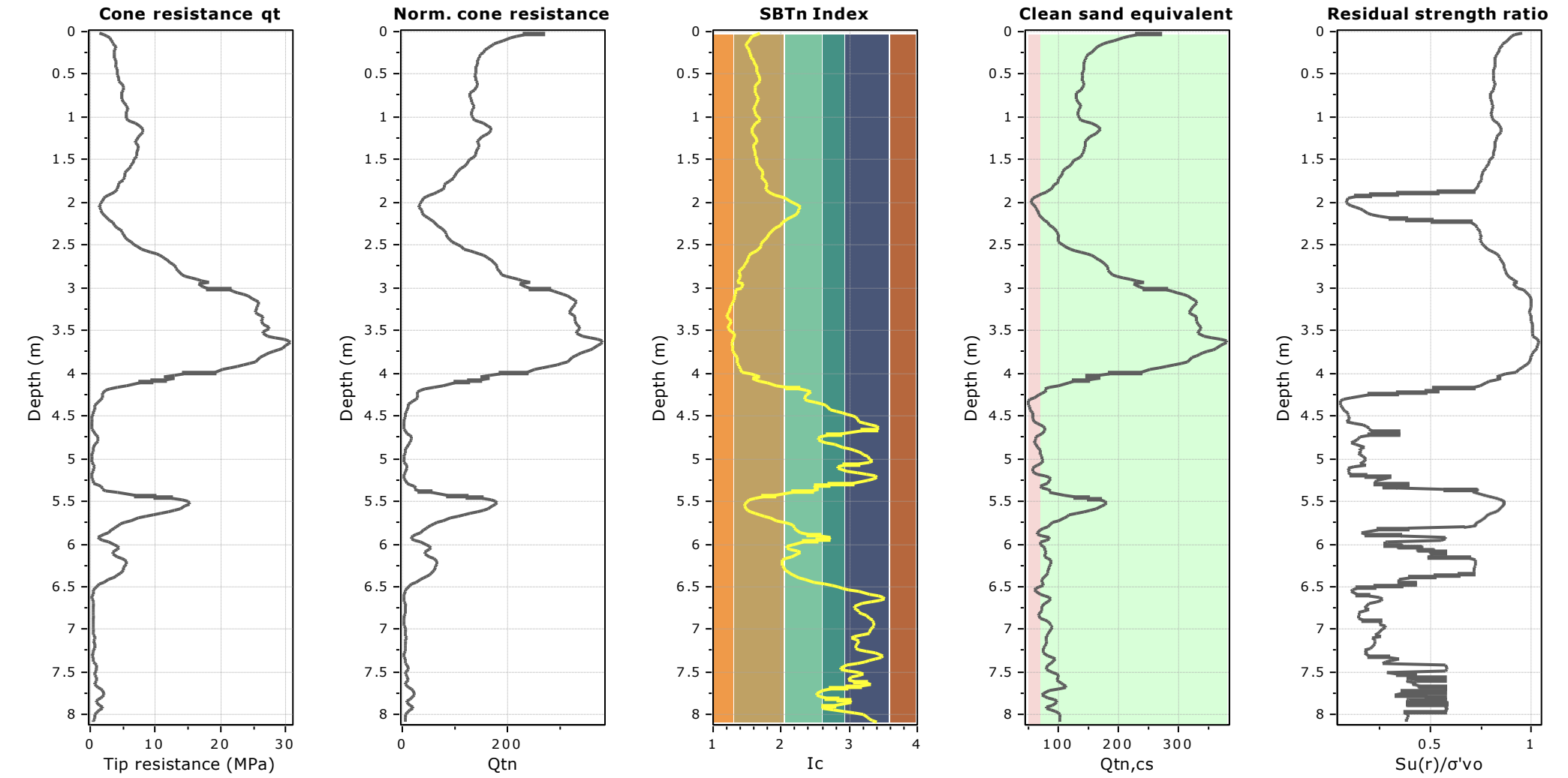

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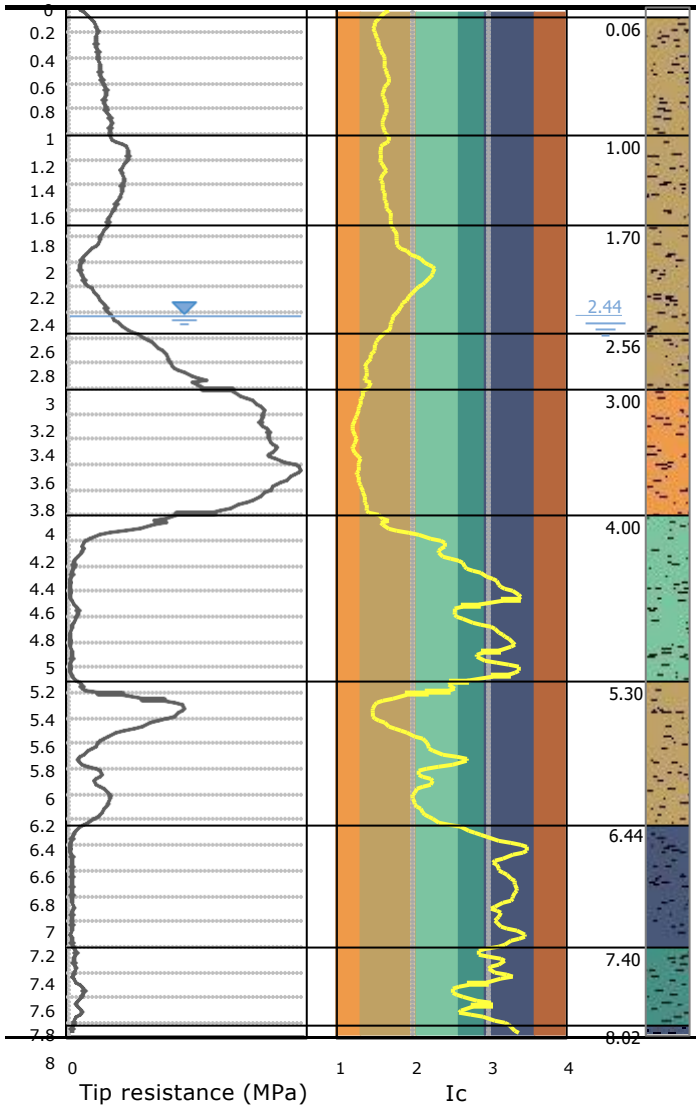
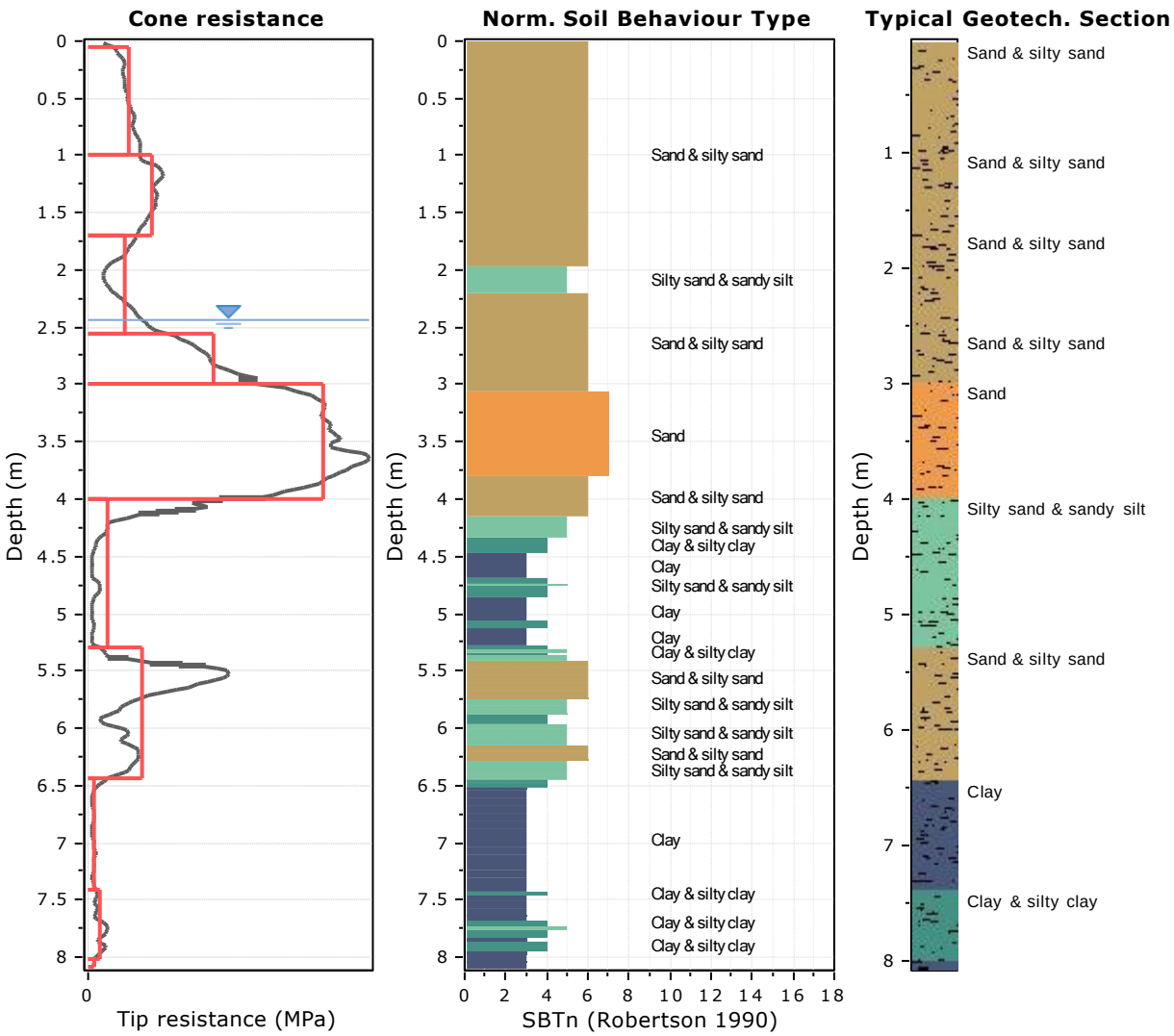


Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Sand & silty sand	4.5	1.28E-4	9.4	24.7	64.7	39.4	31.0	28.5	-	-	-	17.1
Sand & silty sand	6.8	1.00E-4	14.4	38.6	62.7	39.0	48.4	46.3	-	-	-	17.8
Sand & silty sand	4.1	2.48E-5	9.9	30.5	44.1	35.5	37.9	35.1	-	-	-	17.0
Sand & silty sand	13.6	3.76E-4	25.5	60.6	73.0	41.0	76.0	75.6	-	-	-	18.5
Sand	25.5	1.10E-3	43.6	94.3	95.3	44.8	118.1	124.4	-	-	-	19.7
Silty sand & sandy silt	2.1	1.11E-5	6.1	-	-	-	17.7	26.3	36.8	0.6	2.7	16.0
Sand & silty sand	5.8	4.46E-5	14.7	49.1	45.0	36.4	55.3	56.8	-	-	-	17.9
Clay	0.7	1.09E-8	3.6	-	-	-	4.1	21.6	35.8	0.5	2.1	16.0
Clay & silty clay	1.2	3.61E-8	5.8	-	-	-	13.2	34.1	73.8	0.9	4.1	17.0
Clay	0.7	9.08E-10	4.3	-	-	-	3.8	30.1	40.5	0.5	2.2	16.9



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.06 (m), **End depth:** 1.00 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 4.48 ±0.78 MPa	Permeability: 1.28E-04 ±5.52E-05 m/s	Constrained Mod.: 30.96 ±6.54 MPa
Sleeve friction: 23.07 ±4.87 kPa	N_{60}: 9.42 ±1.85 blows	Go: 28.50 ±6.46 MPa
Ic: 1.60 ±0.05	Es: 24.70 ±5.22 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 64.66 ±4.09	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 39.39 ±0.83 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.14 ±0.31 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 1.00 (m), **End depth:** 1.70 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 6.84 ±0.85 MPa	Permeability: 1.00E-04 ±2.99E-05 m/s	Constrained Mod.: 48.42 ±3.48 MPa
Sleeve friction: 36.34 ±6.06 kPa	N_{60}: 14.44 ±1.40 blows	Go: 46.26 ±3.87 MPa
Ic: 1.64 ±0.05	Es: 38.63 ±2.78 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 62.66 ±4.66	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 38.97 ±1.00 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.84 ±0.24 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.70 (m), **End depth:** 2.56 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 4.05 ±1.82 MPa	Permeability: 2.48E-05 ±2.31E-05 m/s	Constrained Mod.: 37.89 ±10.42 MPa
Sleeve friction: 22.29 ±8.27 kPa	N_{60}: 9.86 ±3.47 blows	Go: 35.07 ±10.27 MPa
Ic: 1.92 ±0.20	Es: 30.54 ±7.91 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 44.12 ±8.42	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.53 ±1.56 °	O.C.R.: 0.00 ±0.00
	Unit weight: 16.97 ±0.61 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 2.56 (m), **End depth:** 3.00 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 13.57 ±2.77 MPa	Permeability: 3.76E-04 ±1.63E-04 m/s	Constrained Mod.: 76.00 ±10.26 MPa
Sleeve friction: 54.05 ±14.66 kPa	N_{60}: 25.52 ±4.39 blows	Go: 75.56 ±11.70 MPa
Ic: 1.46 ±0.08	Es: 60.64 ±8.19 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 72.99 ±6.47	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 41.03 ±1.23 °	O.C.R.: 0.00 ±0.00
	Unit weight: 18.54 ±0.34 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 3.00 (m), **End depth:** 4.00 (m)

Description: Sand

Basic results	Estimation results	
Total cone resistance: 25.52 ±3.21 MPa	Permeability: 1.10E-03 ±4.30E-04 m/s	Constrained Mod.: 118.15 ±10.91 MPa
Sleeve friction: 113.86 ±21.19 kPa	N_{60}: 43.56 ±4.59 blows	Go: 124.40 ±13.01 MPa
Ic: 1.30 ±0.07	Es: 94.27 ±8.70 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 7	Dr (%): 95.27 ±5.34	Su ratio: 0.00 ±0.00
SBTn description: Sand	φ (degrees): 44.79 ±0.89 °	O.C.R.: 0.00 ±0.00
	Unit weight: 19.65 ±0.24 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 4.00 (m), **End depth:** 5.30 (m)

Description: Silty sand & sandy silt

Basic results	Estimation results	
Total cone resistance: 2.09 ±3.45 MPa	Permeability: 1.11E-05 ±3.46E-05 m/s	Constrained Mod.: 17.72 ±25.29 MPa
Sleeve friction: 19.01 ±19.71 kPa	N_{60}: 6.06 ±6.91 blows	Go: 26.35 ±21.41 MPa
Ic: 2.75 ±0.53	Es: 0.00 ±0.00 MPa	Su: 36.79 ±19.13 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.58 ±0.29
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.68 ±1.32
	Unit weight: 15.99 ±1.23 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 5.30 (m), **End depth:** 6.44 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 5.84 ±4.09 MPa	Permeability: 4.46E-05 ±9.01E-05 m/s	Constrained Mod.: 55.26 ±20.02 MPa
Sleeve friction: 43.70 ±12.23 kPa	N_{60}: 14.66 ±6.77 blows	Go: 56.77 ±16.50 MPa
Ic: 2.08 ±0.34	Es: 49.08 ±11.08 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 44.99 ±13.34	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 36.40 ±2.07 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.88 ±0.58 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 6.44 (m), **End depth:** 7.40 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.65 ±0.30 MPa	Permeability: 1.09E-08 ±4.13E-08 m/s	Constrained Mod.: 4.13 ±4.91 MPa
Sleeve friction: 16.83 ±4.81 kPa	N_{60}: 3.59 ±0.91 blows	Go: 21.64 ±3.94 MPa
Ic: 3.19 ±0.22	Es: 0.00 ±0.00 MPa	Su: 35.75 ±14.34 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.46 ±0.19
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.15 ±0.87
	Unit weight: 16.01 ±0.37 kN/m³	

.:: Layer No: 9 ::.

Code: Layer_9 **Start depth:** 7.40 (m), **End depth:** 8.02 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.23 ±0.47 MPa	Permeability: 3.61E-08 ±5.52E-08 m/s	Constrained Mod.: 13.23 ±8.17 MPa
Sleeve friction: 31.23 ±6.37 kPa	N_{60}: 5.81 ±1.40 blows	Go: 34.06 ±5.10 MPa
Ic: 2.93 ±0.24	Es: 0.00 ±0.00 MPa	Su: 73.83 ±30.09 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.89 ±0.35
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 4.11 ±1.60
	Unit weight: 16.98 ±0.29 kN/m³	

.:: Layer No: 10 ::.

Code: Layer_10 **Start depth:** 8.02 (m), **End depth:** 8.08 (m)

Description: Clay

Basic results	**Estimation results**	
Total cone resistance: 0.71 ±0.03 MPa	Permeability: 9.08E-10 ±8.82E-11 m/s	Constrained Mod.: 3.81 ±0.40 MPa
Sleeve friction: 32.49 ±0.43 kPa	N_{60}: 4.33 ±0.58 blows	Go: 30.08 ±0.43 MPa
Ic: 3.30 ±0.03	Es: 0.00 ±0.00 MPa	Su: 40.49 ±2.12 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.48 ±0.03
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.22 ±0.12
	Unit weight: 16.86 ±0.02 kN/m³	

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.06	0.94	1.28E-04	9.4	24.7	64.7	39.4	31.0	28.5	0.0	0.0	0.0	17.1
1.00		(±5.52E-05)	(±1.9)	(±5.2)	(±4.1)	(±0.8)	(±6.5)	(±6.5)	(±0.0)	(±0.0)	(±0.0)	(±0.3)
1.00	0.70	1.00E-04	14.4	38.6	62.7	39.0	48.4	46.3	0.0	0.0	0.0	17.8
1.70		(±2.99E-05)	(±1.4)	(±2.8)	(±4.7)	(±1.0)	(±3.5)	(±3.9)	(±0.0)	(±0.0)	(±0.0)	(±0.2)
1.70	0.86	2.48E-05	9.9	30.5	44.1	35.5	37.9	35.1	0.0	0.0	0.0	17.0
2.56		(±2.31E-05)	(±3.5)	(±7.9)	(±8.4)	(±1.6)	(±10.4)	(±10.3)	(±0.0)	(±0.0)	(±0.0)	(±0.6)
2.56	0.44	3.76E-04	25.5	60.6	73.0	41.0	76.0	75.6	0.0	0.0	0.0	18.5
3.00		(±1.63E-04)	(±4.4)	(±8.2)	(±6.5)	(±1.2)	(±10.3)	(±11.7)	(±0.0)	(±0.0)	(±0.0)	(±0.3)
3.00	1.00	1.10E-03	43.6	94.3	95.3	44.8	118.1	124.4	0.0	0.0	0.0	19.7
4.00		(±4.30E-04)	(±4.6)	(±8.7)	(±5.3)	(±0.9)	(±10.9)	(±13.0)	(±0.0)	(±0.0)	(±0.0)	(±0.2)
4.00	1.30	1.11E-05	6.1	0.0	0.0	0.0	17.7	26.3	36.8	0.6	2.7	16.0
5.30		(±3.46E-05)	(±6.9)	(±0.0)	(±0.0)	(±0.0)	(±25.3)	(±21.4)	(±19.1)	(±0.3)	(±1.3)	(±1.2)
5.30	1.14	4.46E-05	14.7	49.1	45.0	36.4	55.3	56.8	0.0	0.0	0.0	17.9
6.44		(±9.01E-05)	(±6.8)	(±11.1)	(±13.3)	(±2.1)	(±20.0)	(±16.5)	(±0.0)	(±0.0)	(±0.0)	(±0.6)
6.44	0.96	1.09E-08	3.6	0.0	0.0	0.0	4.1	21.6	35.8	0.5	2.1	16.0
7.40		(±4.13E-08)	(±0.9)	(±0.0)	(±0.0)	(±0.0)	(±4.9)	(±3.9)	(±14.3)	(±0.2)	(±0.9)	(±0.4)
7.40	0.62	3.61E-08	5.8	0.0	0.0	0.0	13.2	34.1	73.8	0.9	4.1	17.0
8.02		(±5.52E-08)	(±1.4)	(±0.0)	(±0.0)	(±0.0)	(±8.2)	(±5.1)	(±30.1)	(±0.3)	(±1.6)	(±0.3)
8.02	0.06	9.08E-10	4.3	0.0	0.0	0.0	3.8	30.1	40.5	0.5	2.2	16.9
8.08		(±8.82E-11)	(±0.6)	(±0.0)	(±0.0)	(±0.0)	(±0.4)	(±0.4)	(±2.1)	(±0.0)	(±0.1)	(±0.0)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(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)

•N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

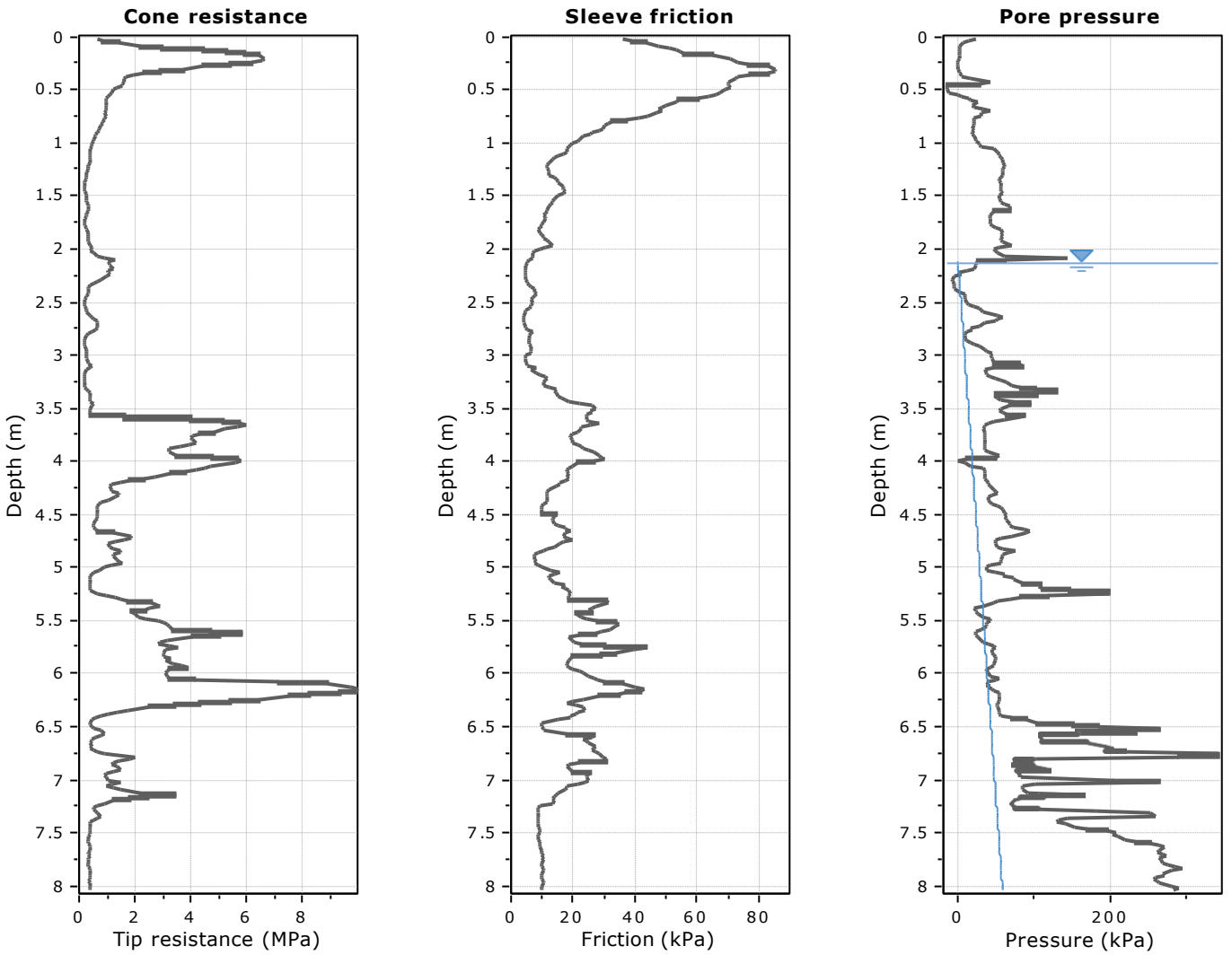
CPT#4

Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

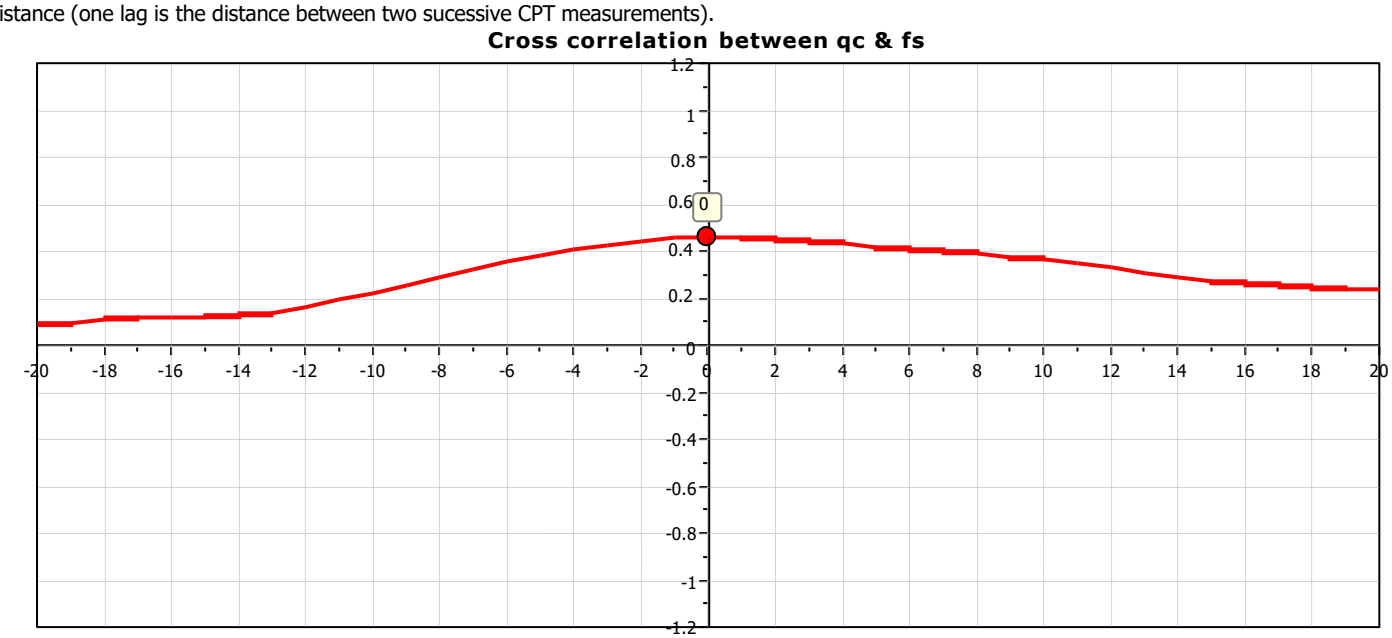
CPT: #4

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

epth: 8.04 m, Date: 12/18/2022
ds: 6°55'51.6" N 58°22'11.9" W



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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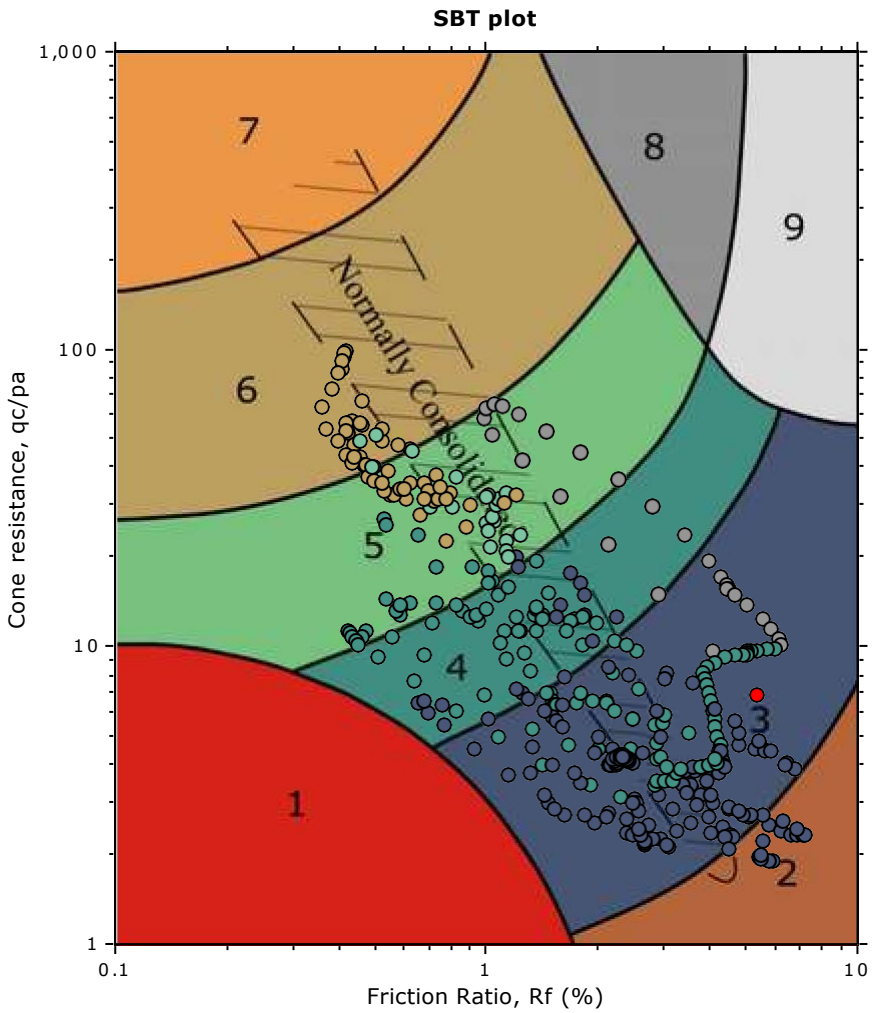
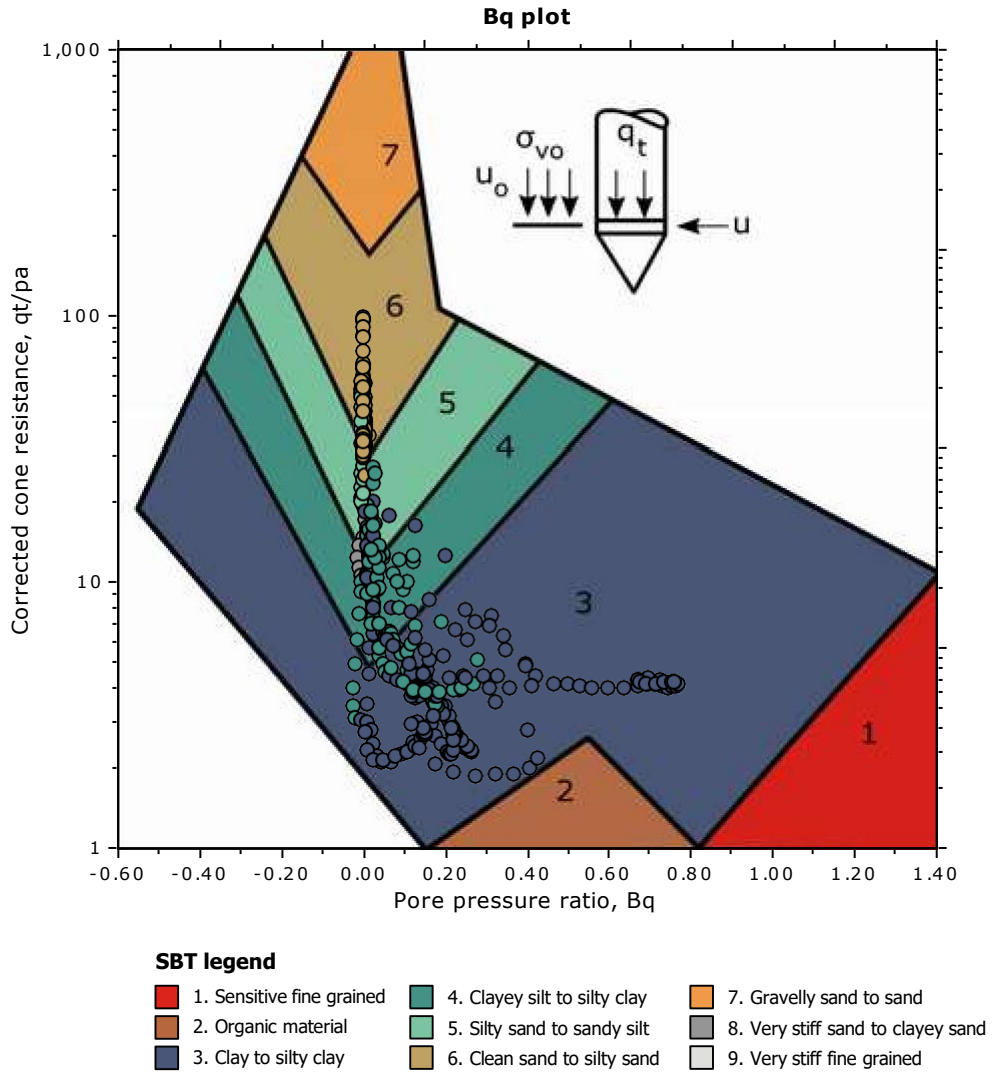
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

SBT - Bq plots





SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly 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

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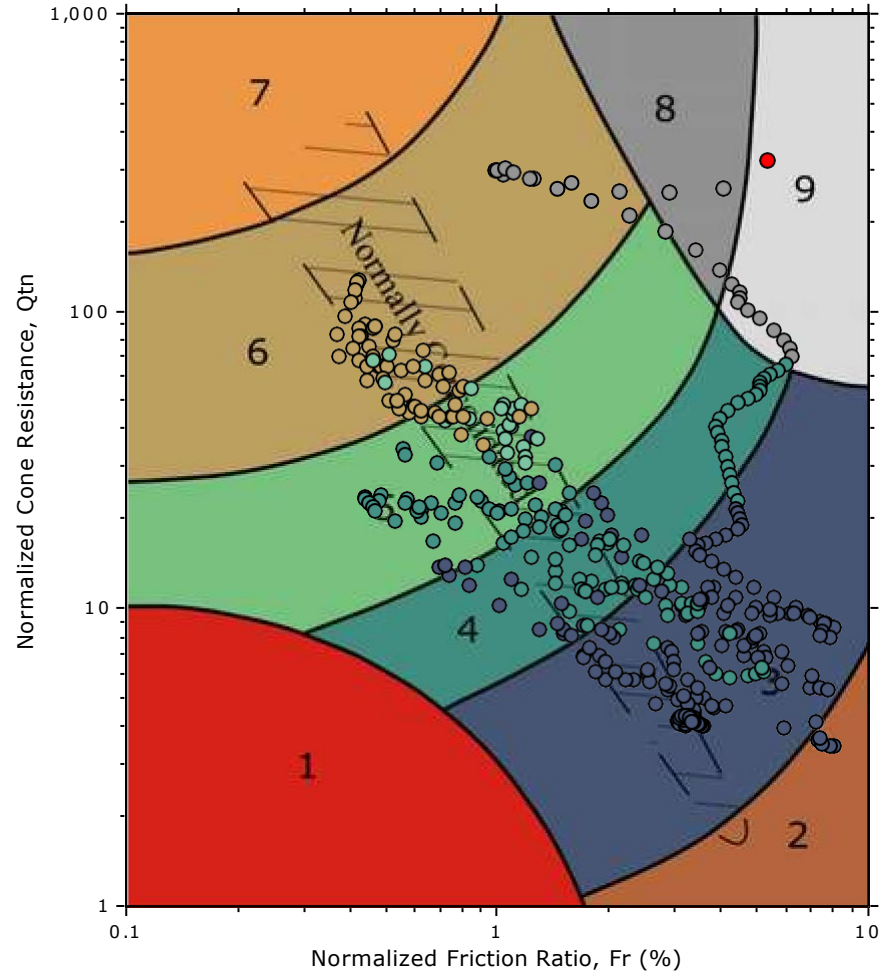
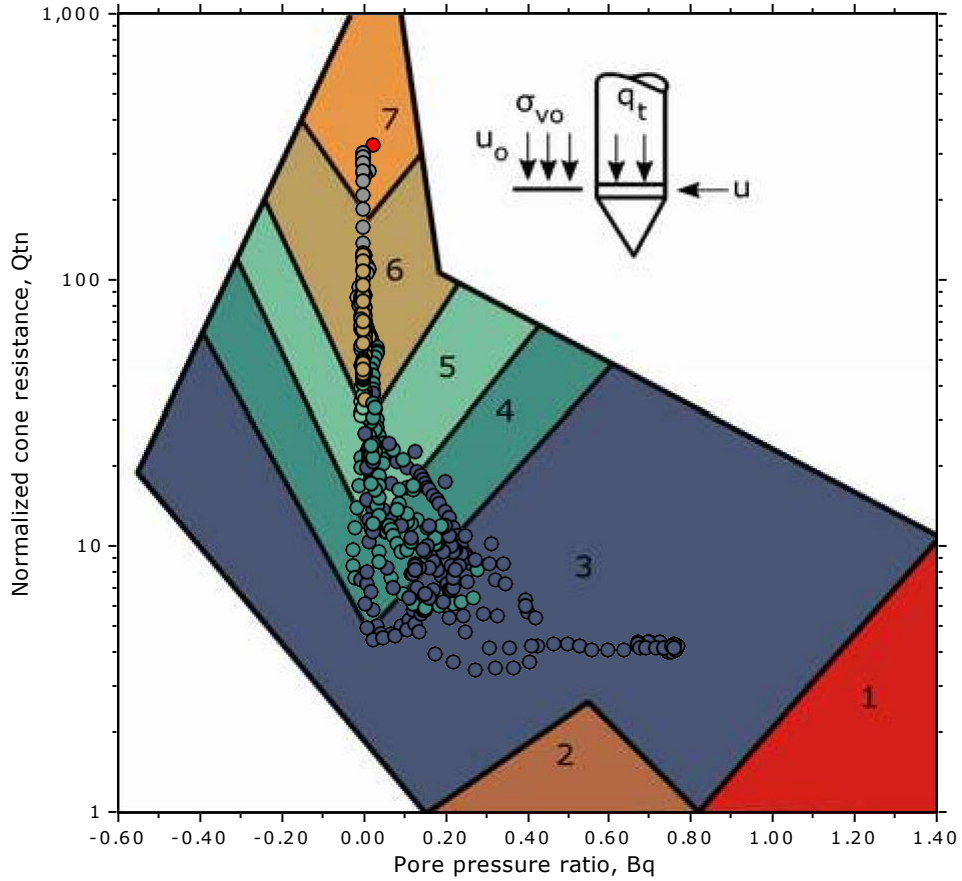
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

SBT - Bq plots (normalized)

SBTn plot



Normalized Bq plot



SBTn legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly 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

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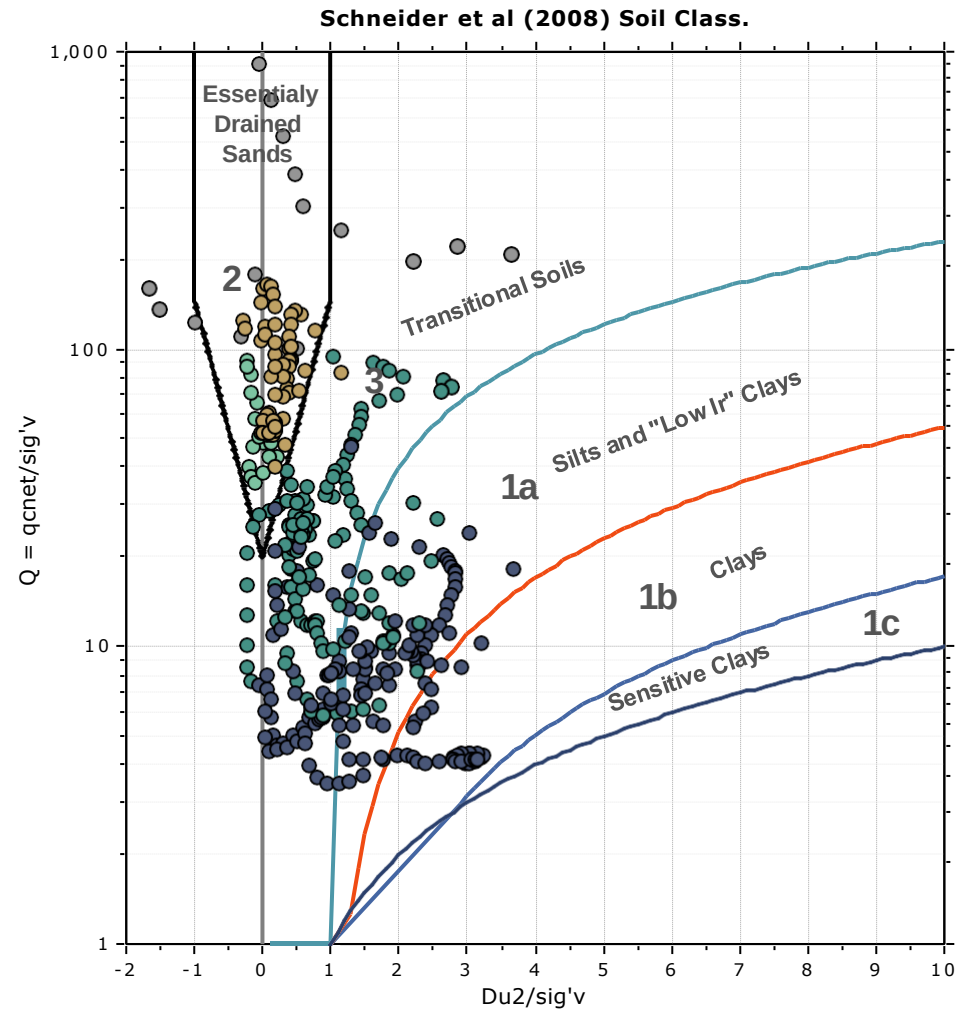
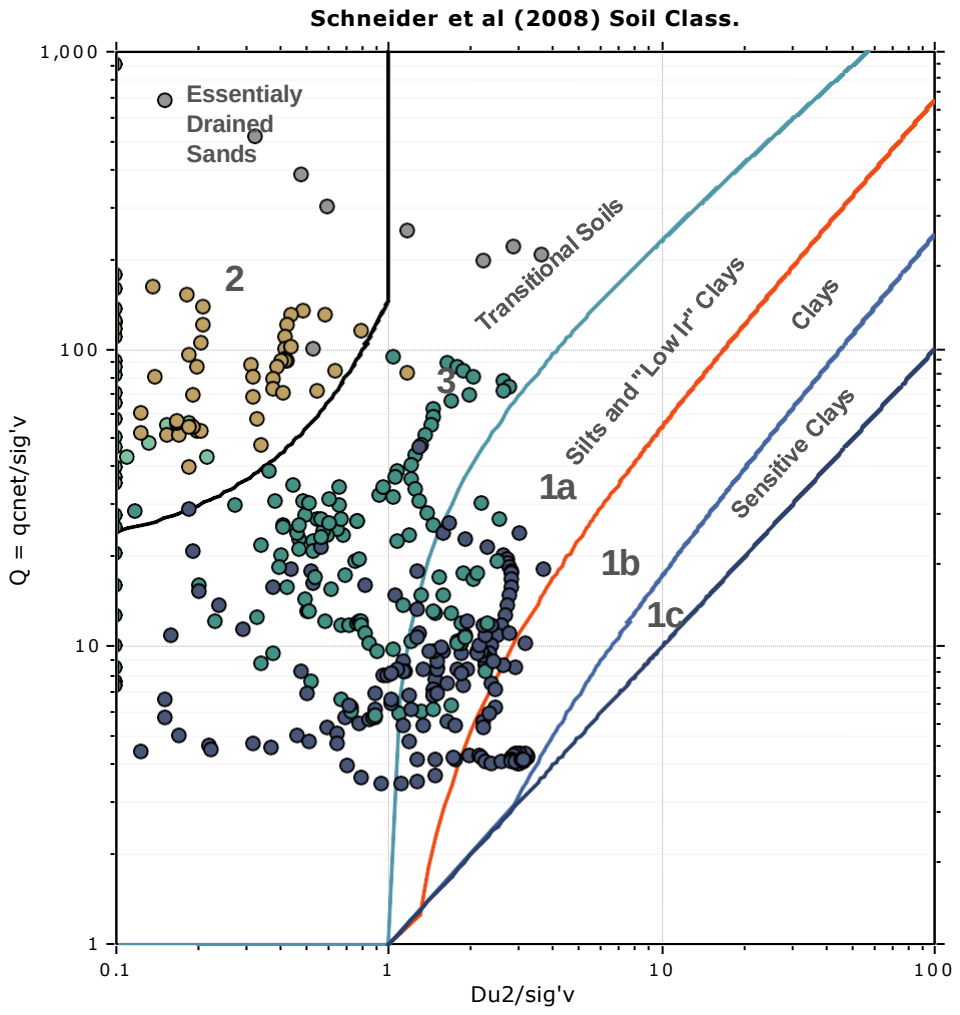
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Bq plots (Schneider)





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CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

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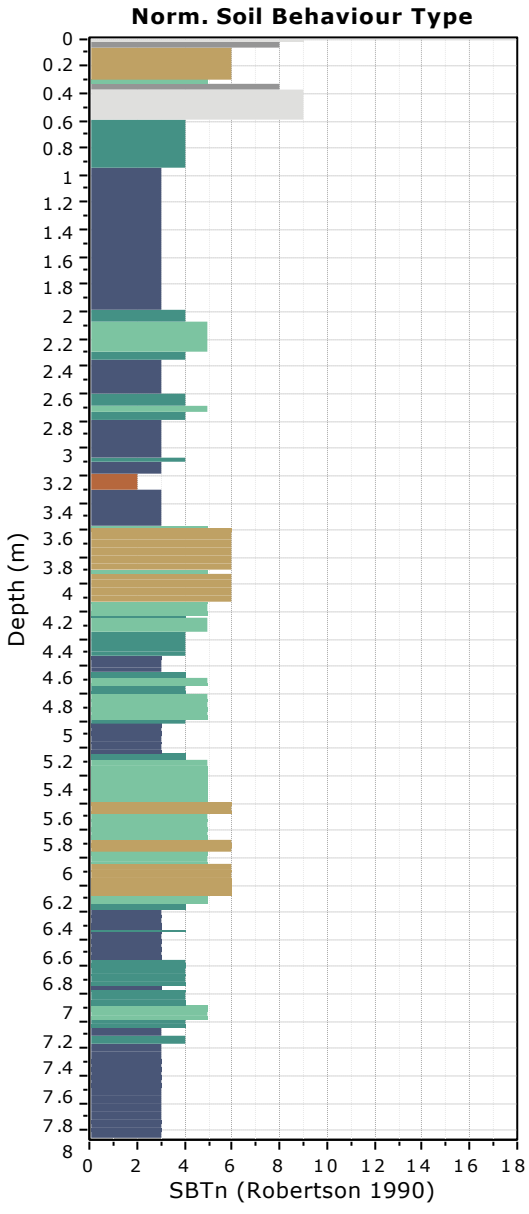
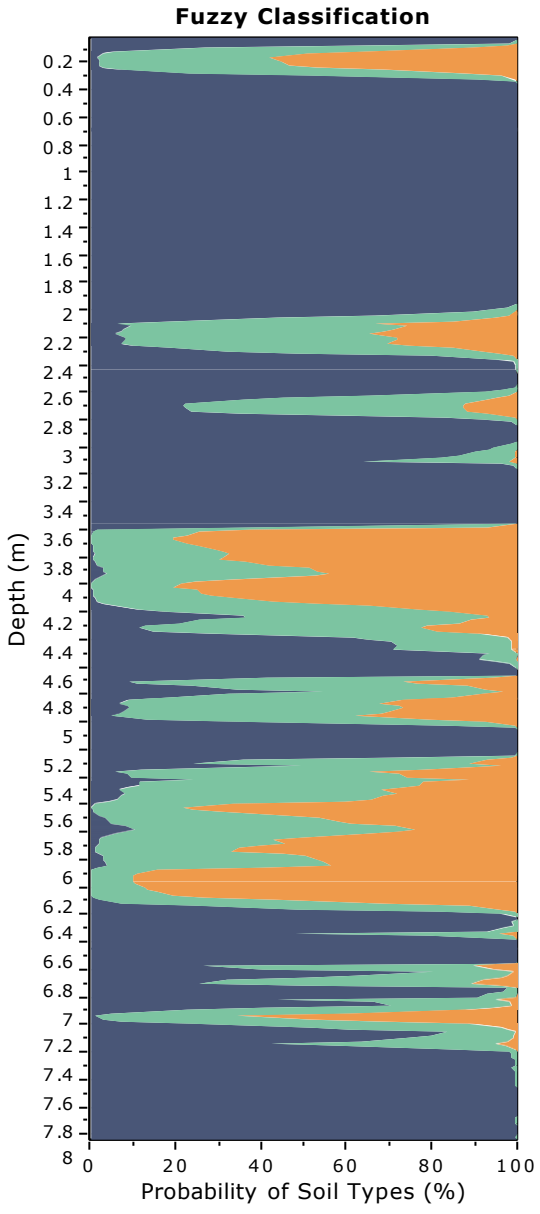
Location: Leguan, Region No. 3.





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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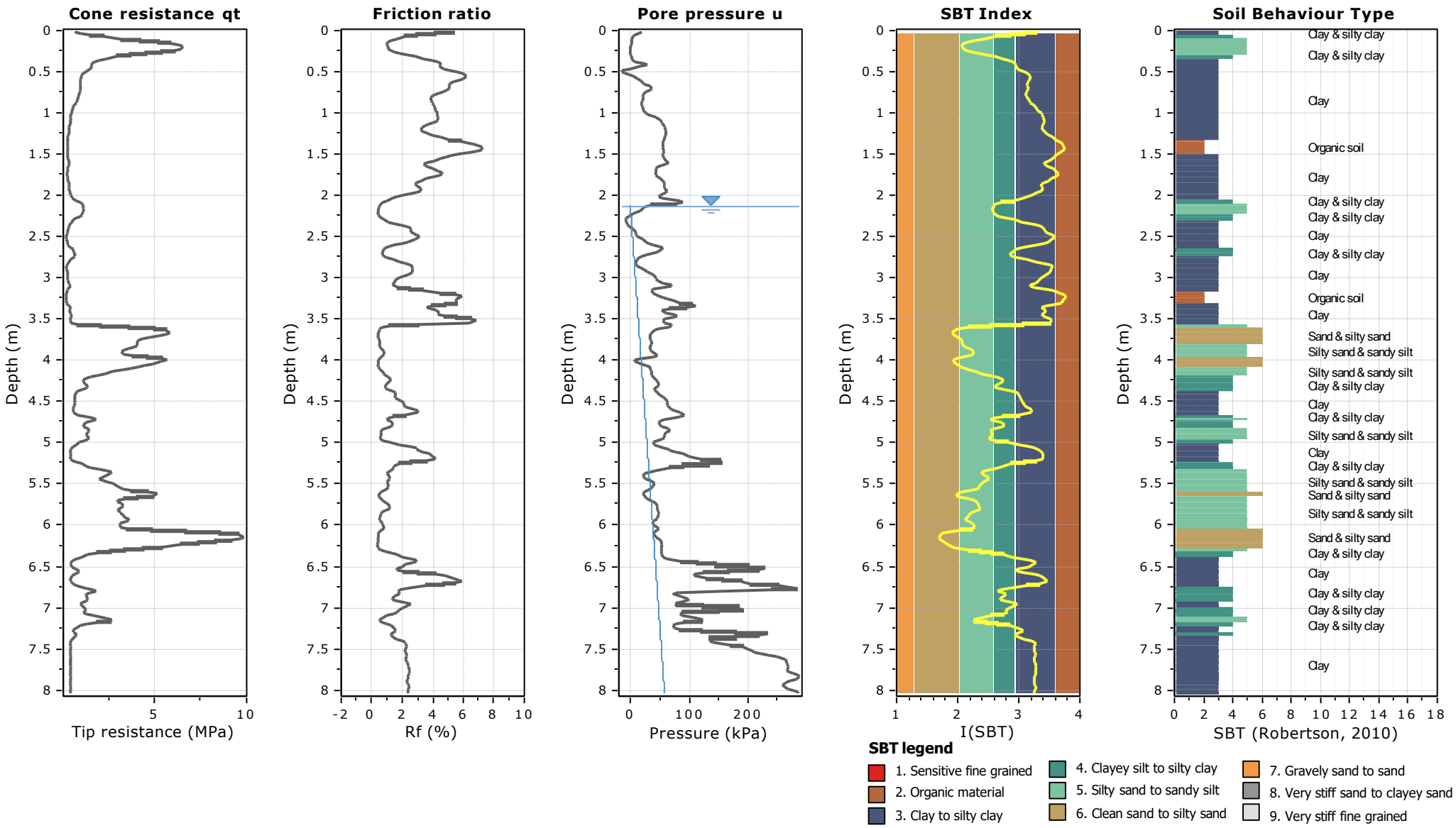
Location: Leguan, Region No. 3.



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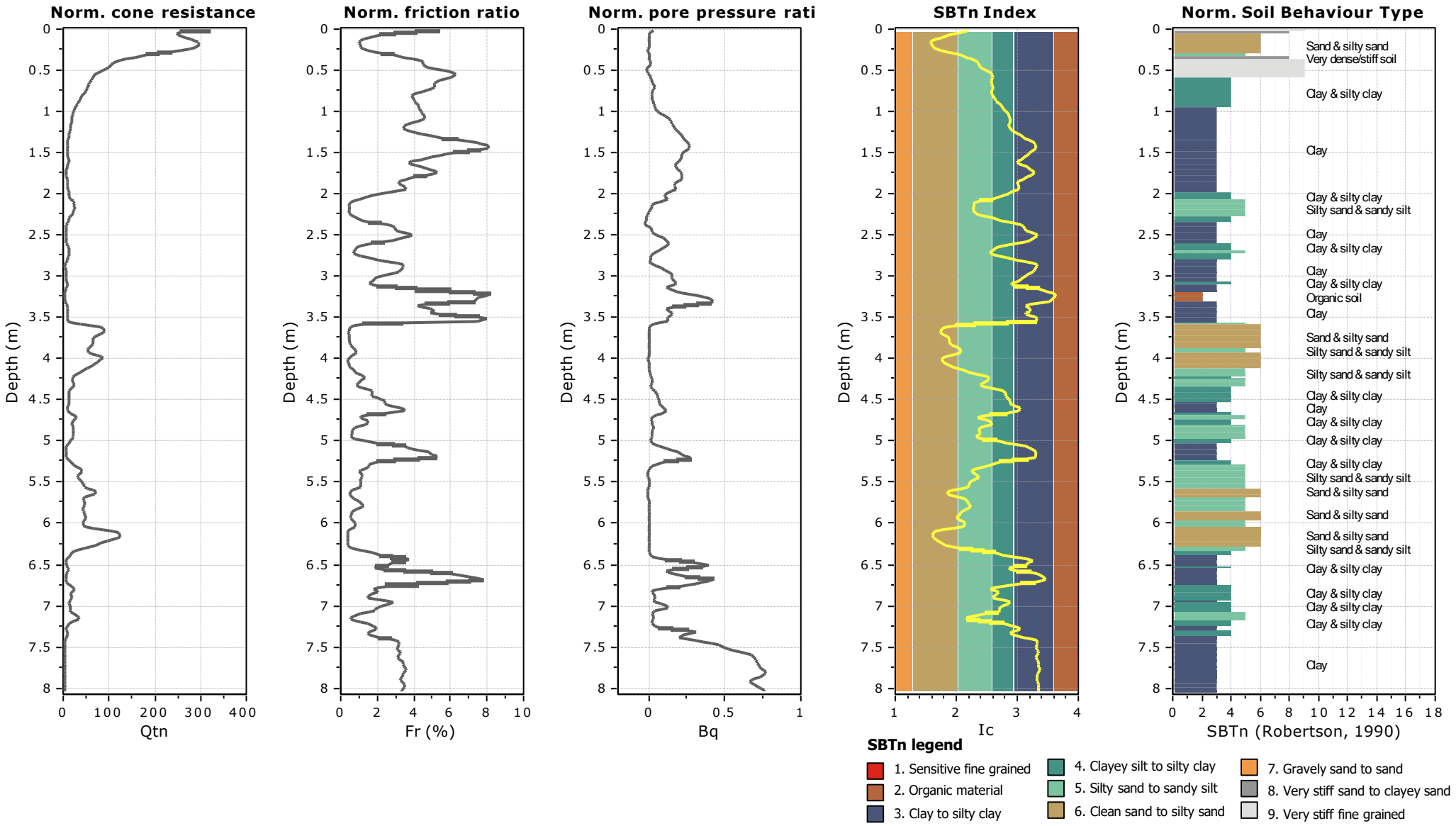
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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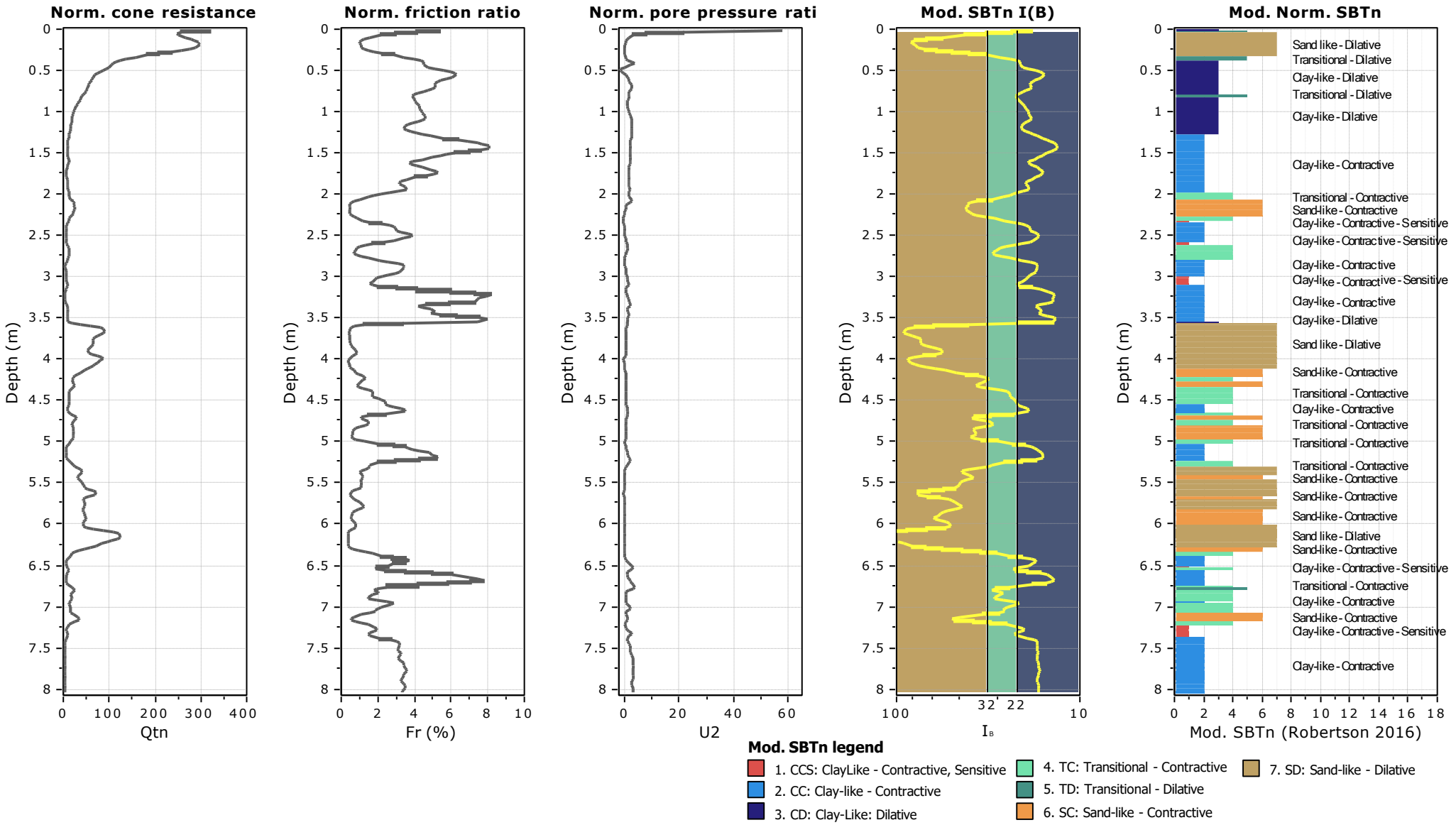
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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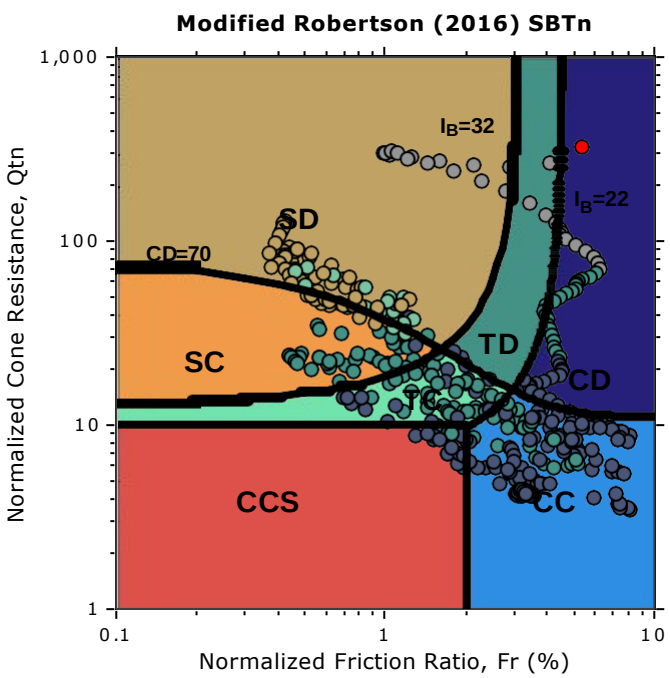
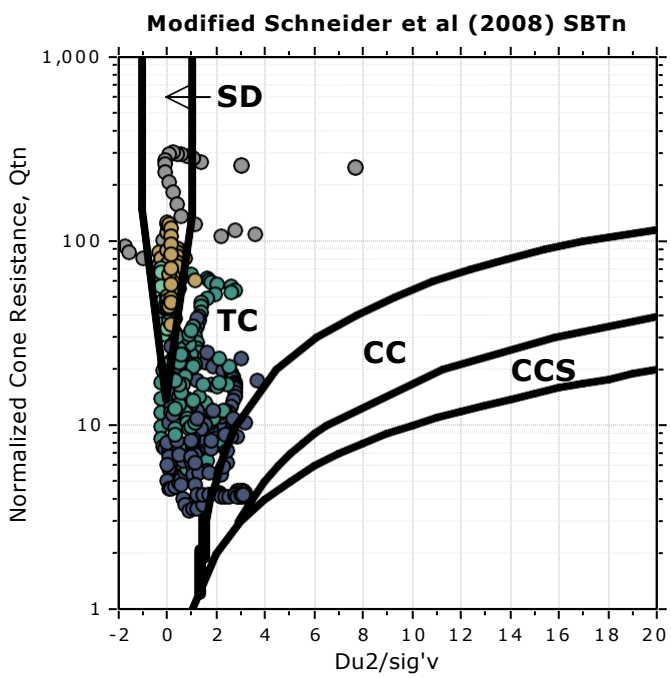
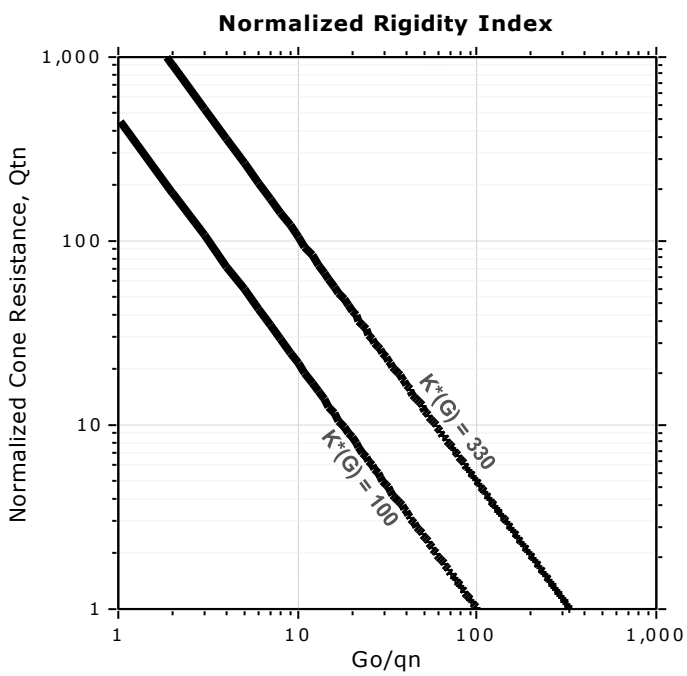
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Updated SBTn plots







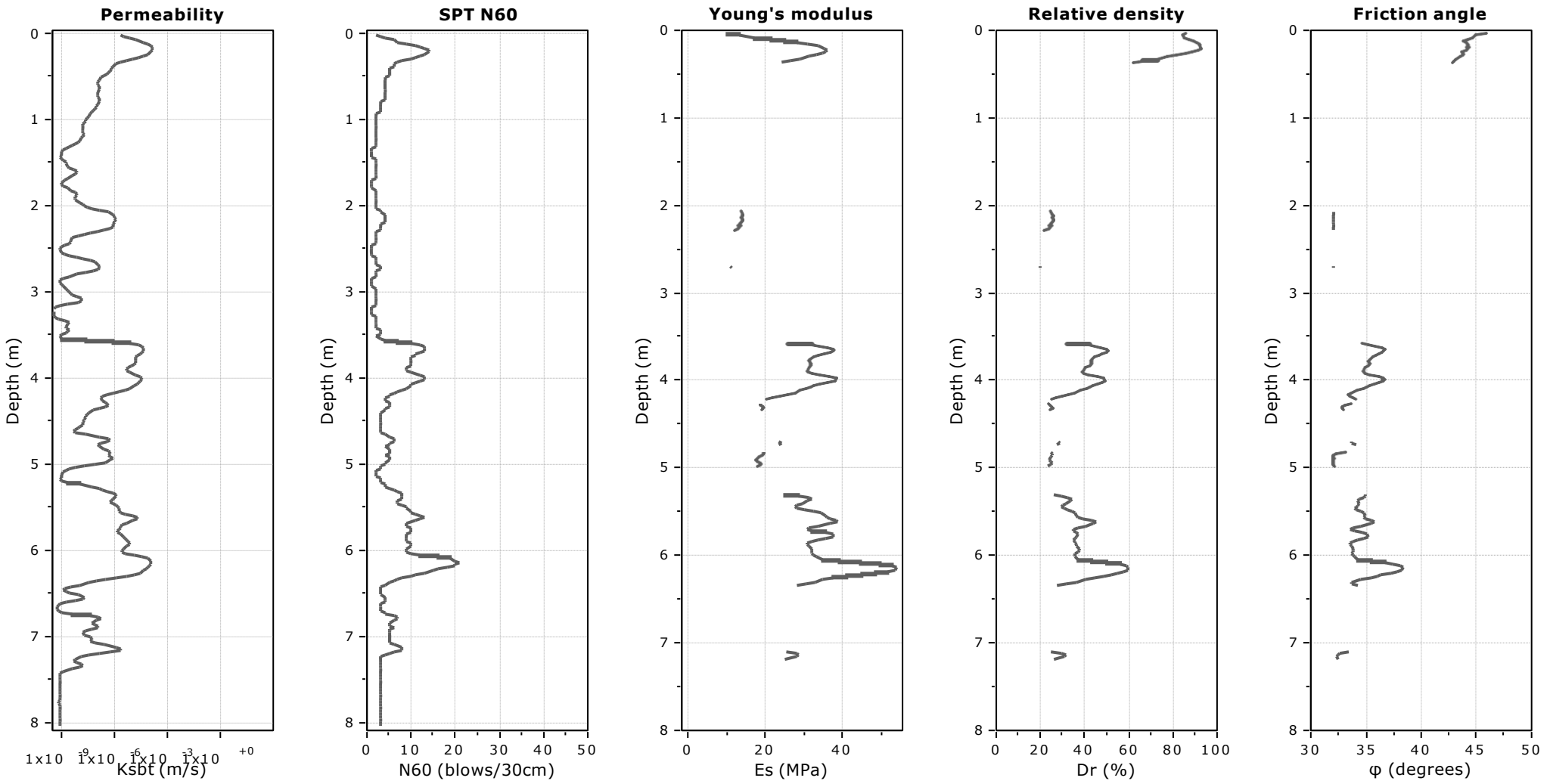
CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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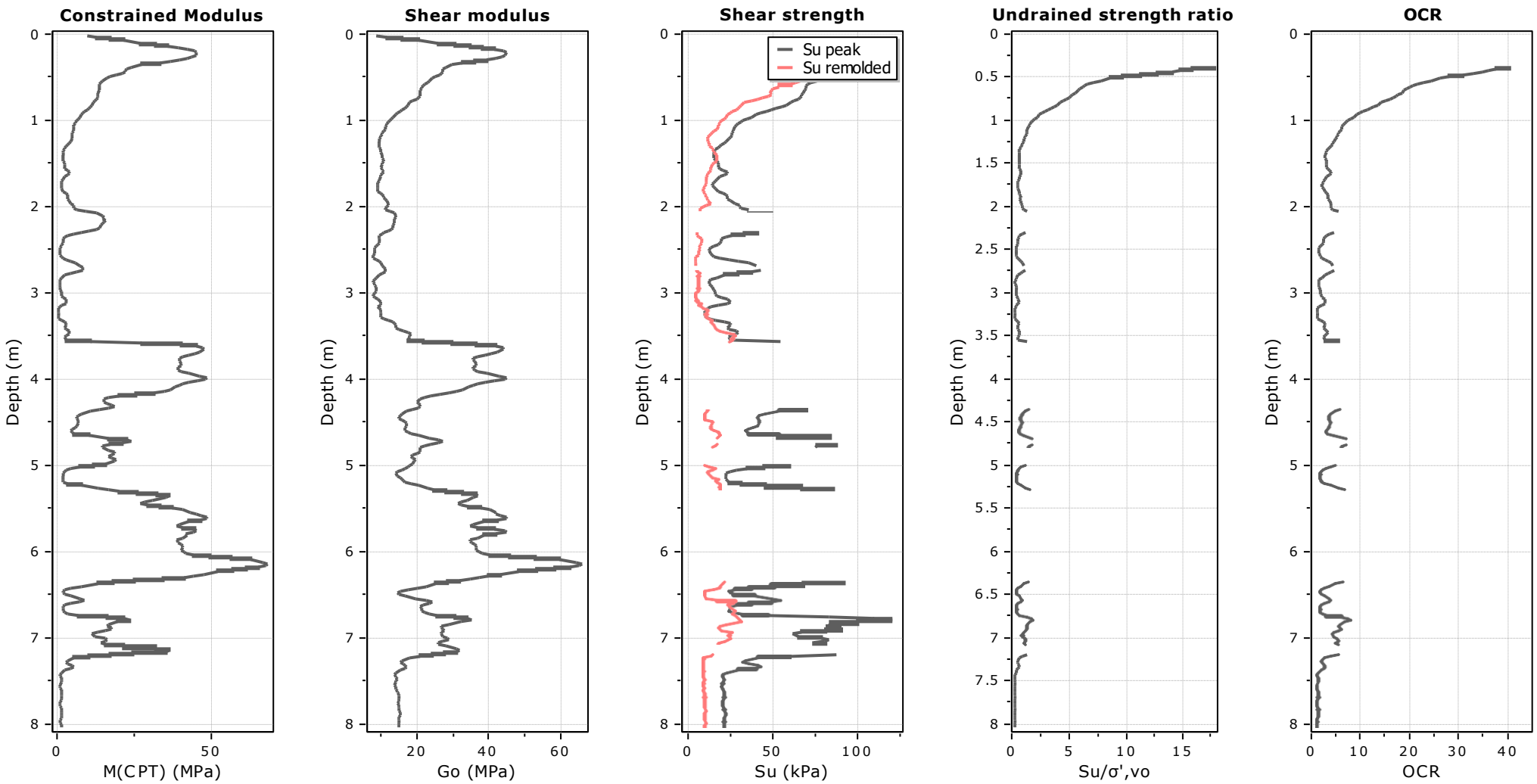
+592-220-1216

CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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
Flat Dilatometer Test data

Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
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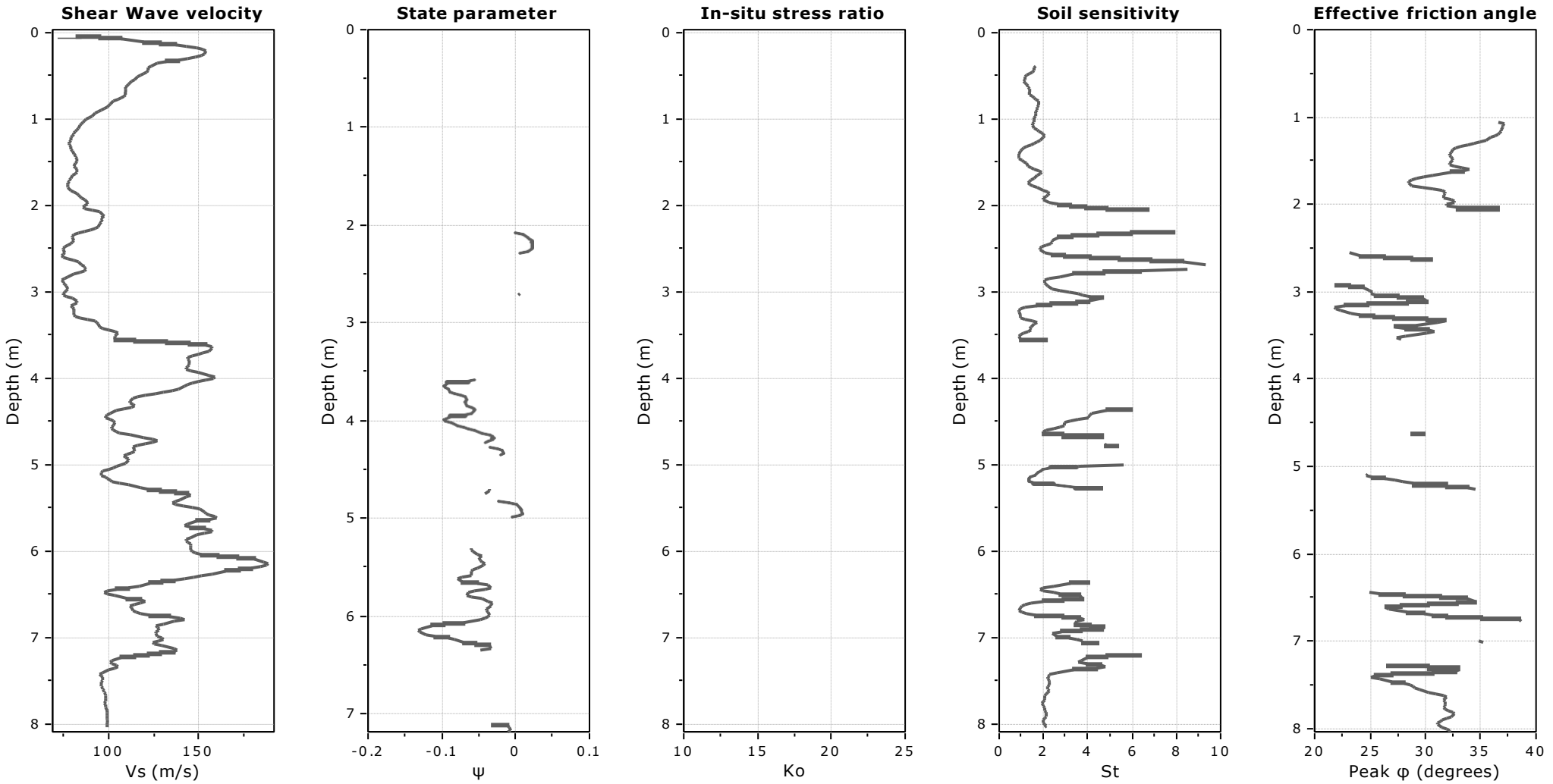
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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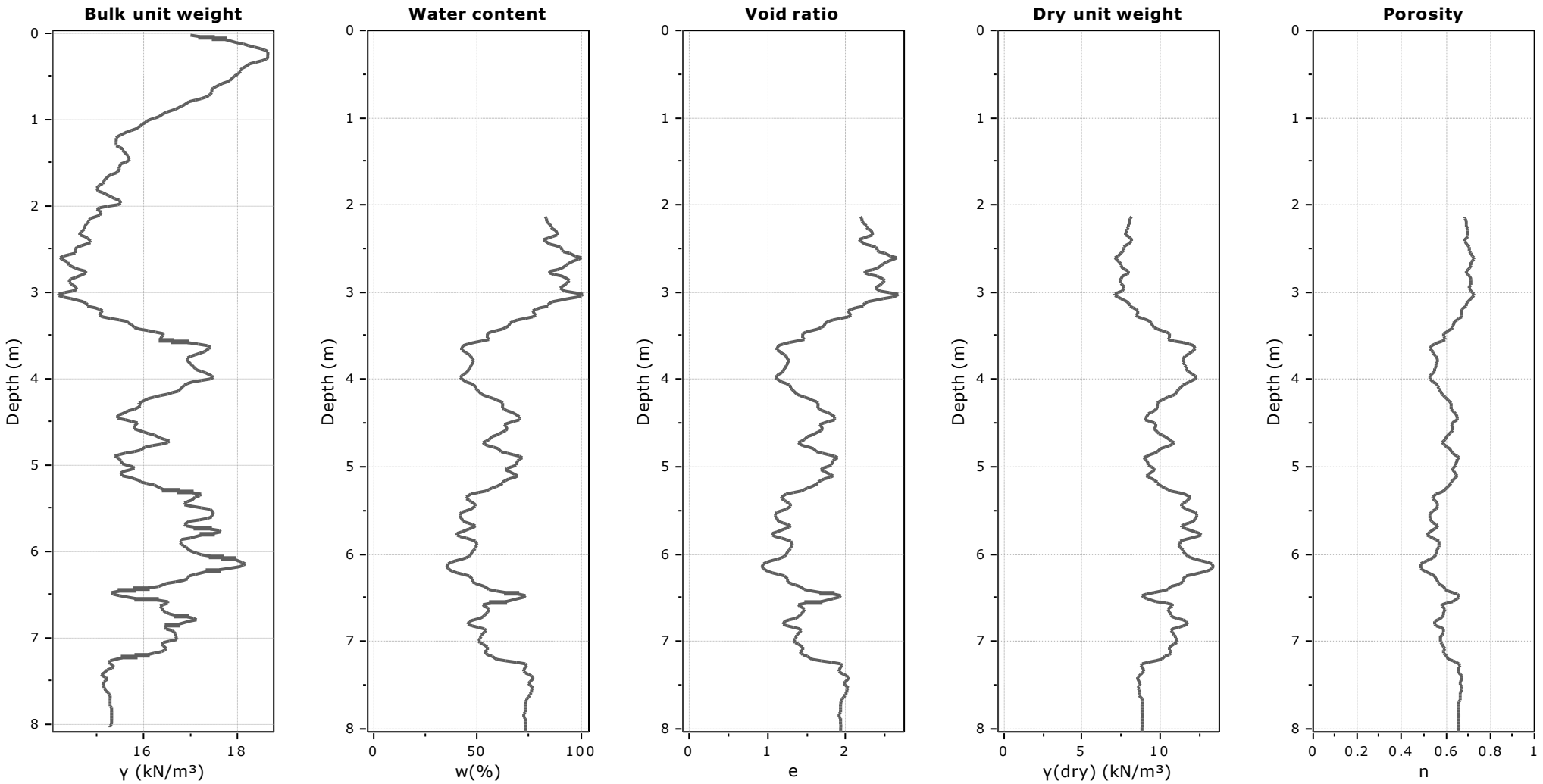
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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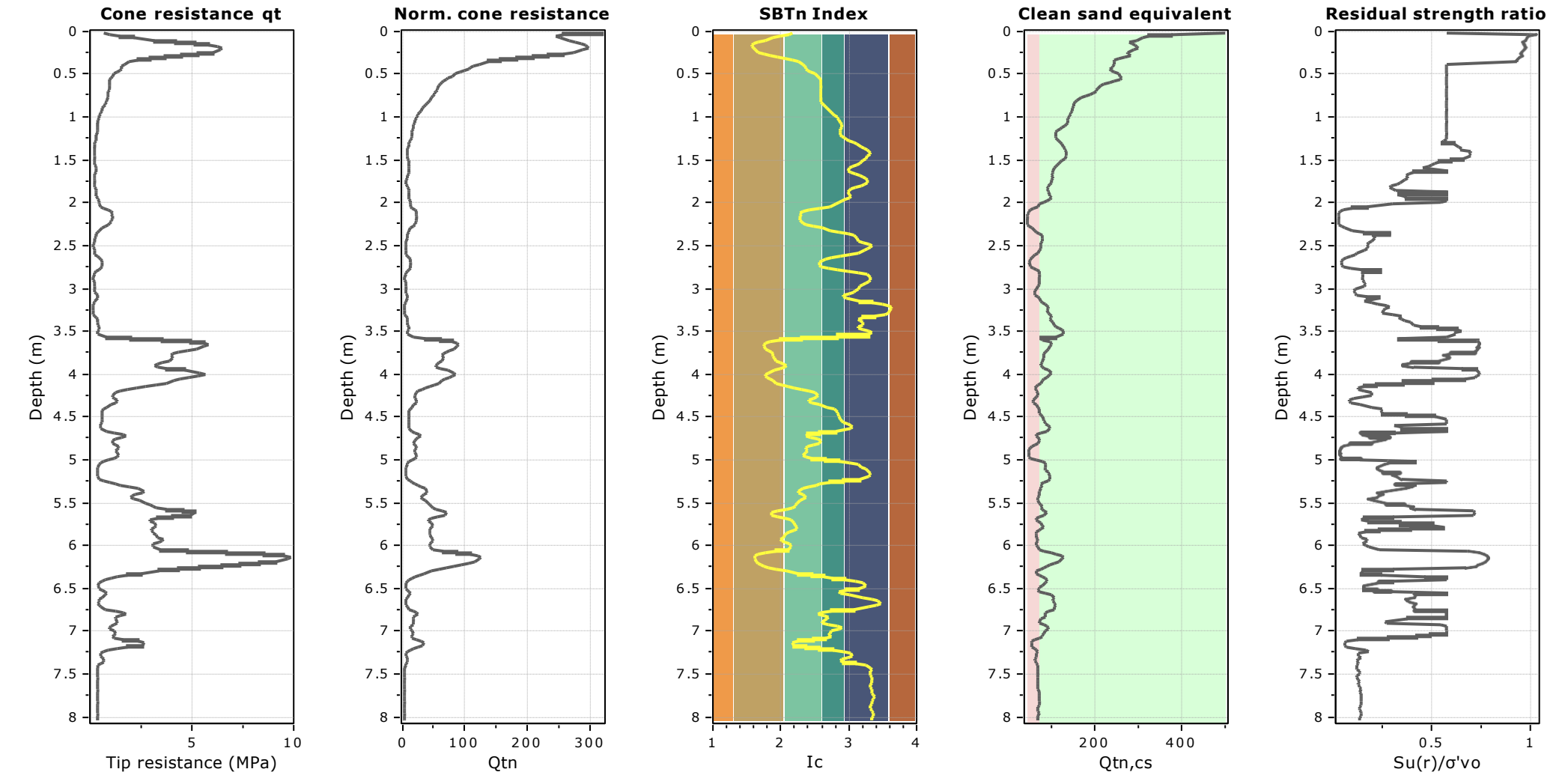
CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'51.6" N 58°22'11.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



Innovative Engineering Consultancy Services.
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

CPT: #4
Total depth: 8.04 m, Date: 12/18/2022
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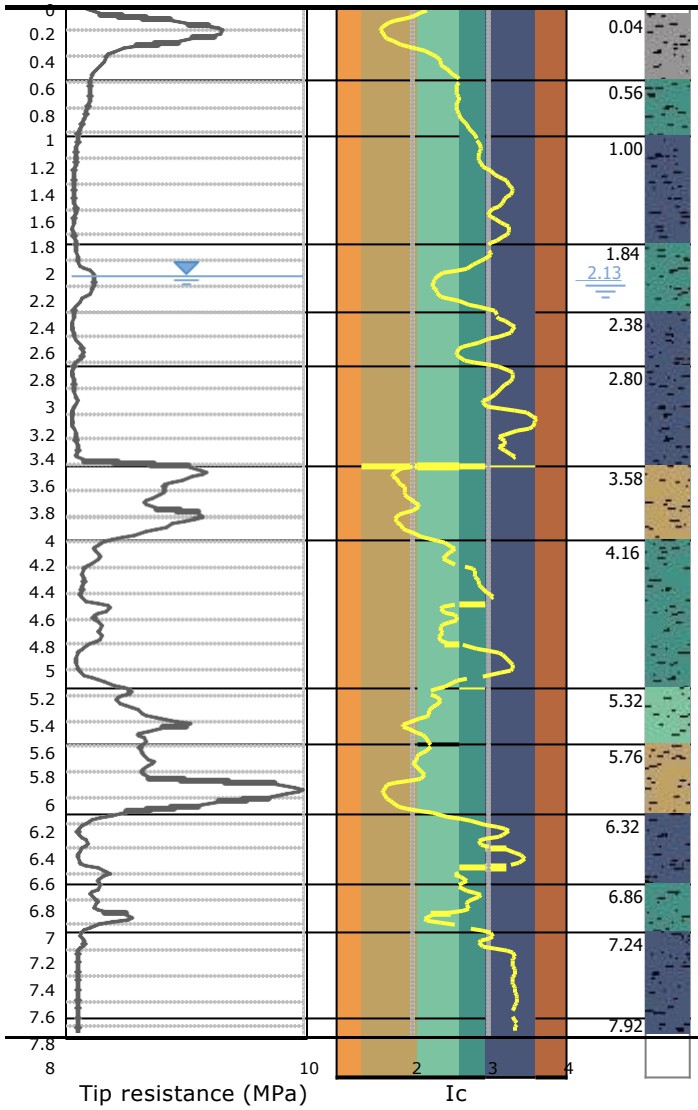
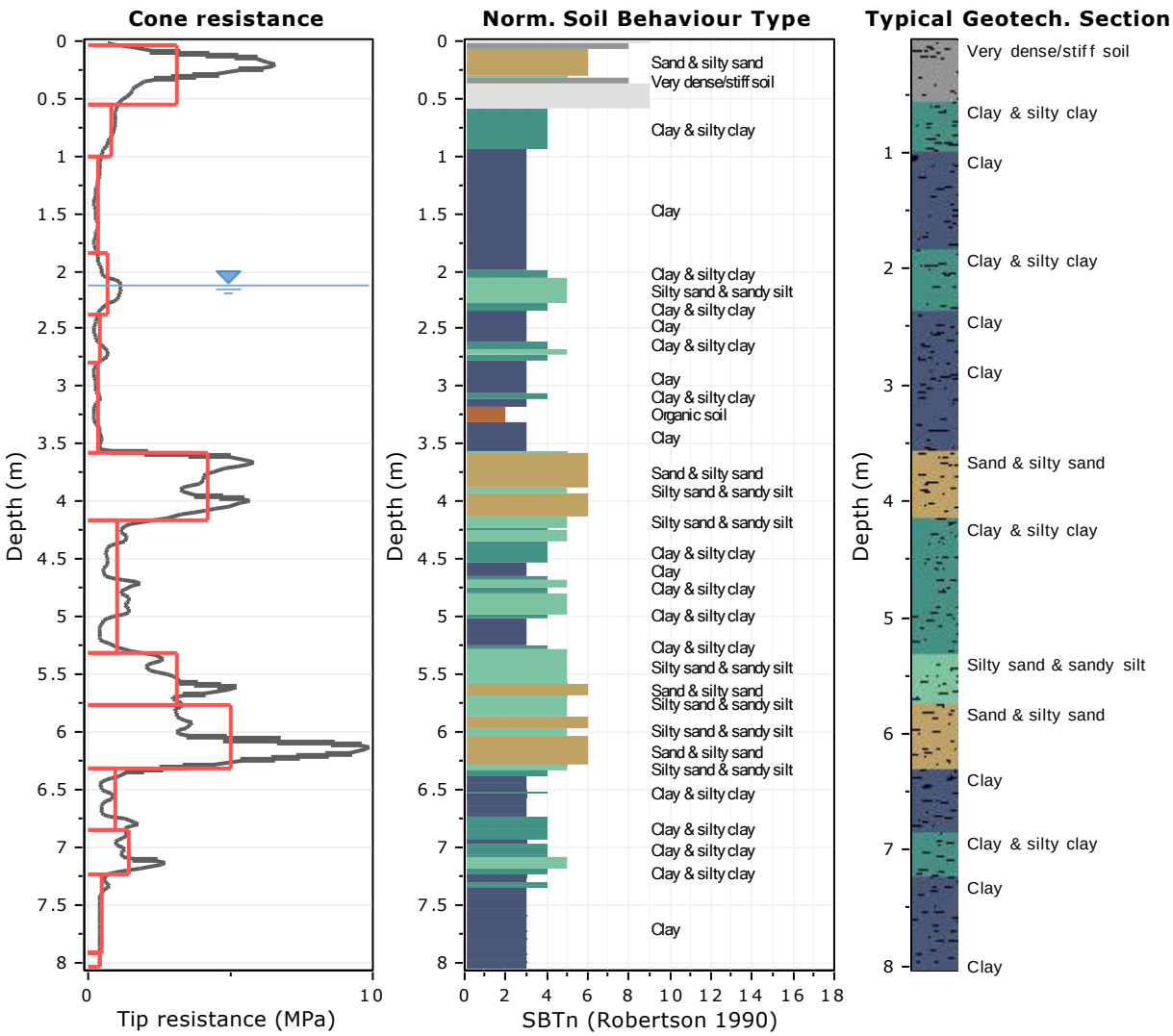


Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
0.04 Very dense/stiff soil	3.1	3.50E-5	7.7	27.5	83.7	44.0	28.7	31.0	-	-	-	18.2
0.56 Clay & silty clay	0.8	9.53E-8	3.3	-	-	-	11.2	18.4	57.3	3.2	14.9	17.0
1.00 Clay	0.3	7.01E-9	1.7	-	-	-	3.3	10.2	20.4	0.9	4.0	15.5
1.84 Clay & silty clay	0.7	3.30E-7	2.6	-	-	-	8.2	11.9	28.3	0.8	3.7	15.0
2.13												
2.38 Clay	0.4	3.46E-8	1.8	-	-	-	3.4	9.4	22.5	0.6	2.6	14.6
2.80 Clay	0.4	2.43E-8	2.0	-	-	-	2.6	11.9	19.1	0.5	2.2	15.2
3.58 Sand & silty sand	4.2	1.84E-5	10.6	32.9	43.3	35.4	41.0	37.8	-	-	-	17.1
4.16 Clay & silty clay	1.0	2.21E-7	4.1	-	-	-	12.3	19.8	45.7	0.9	4.0	15.9
5.32 Silty sand & sandy silt	3.1	3.98E-6	9.2	33.0	35.6	34.6	38.4	38.1	-	-	-	17.2
5.76 Sand & silty sand	5.0	2.89E-5	12.4	38.6	42.6	35.2	47.9	45.0	-	-	-	17.3
6.32 Clay	0.9	8.07E-8	4.4	-	-	-	9.9	24.2	52.4	0.8	3.7	16.4
6.86 Clay & silty clay	1.4	3.67E-7	5.5	-	-	-	18.1	27.0	74.7	1.1	5.1	16.4
7.24 Clay	0.5	2.74E-9	3.0	-	-	-	1.9	15.1	24.7	0.4	1.7	15.3
7.92 Clay	0.4	7.90E-10	3.0	-	-	-	1.2	15.2	21.2	0.3	1.4	15.3



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.04 (m), **End depth:** 0.56 (m)

Description: Very dense/stiff soil

Basic results	Estimation results	
Total cone resistance: 3.09 ±1.99 MPa	Permeability: 3.50E-05 ±5.00E-05 m/s	Constrained Mod.: 28.74 ±11.04 MPa
Sleeve friction: 67.08 ±12.41 kPa	N_{60}: 7.70 ±3.57 blows	Go: 30.96 ±9.06 MPa
Ic: 2.06 ±0.36	Es: 27.52 ±7.98 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 8	Dr (%): 83.71 ±8.91	Su ratio: 0.00 ±0.00
SBTn description: Very dense/stiff soil	φ (degrees): 44.02 ±0.71 °	O.C.R.: 0.00 ±0.00
	Unit weight: 18.16 ±0.37 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 0.56 (m), **End depth:** 1.00 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.82 ±0.18 MPa	Permeability: 9.53E-08 ±3.67E-08 m/s	Constrained Mod.: 11.24 ±2.54 MPa
Sleeve friction: 38.48 ±13.32 kPa	N_{60}: 3.35 ±0.78 blows	Go: 18.37 ±3.32 MPa
Ic: 2.64 ±0.08	Es: 0.00 ±0.00 MPa	Su: 57.33 ±12.97 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 3.22 ±1.01
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 14.89 ±4.68
	Unit weight: 17.03 ±0.50 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.00 (m), **End depth:** 1.84 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.31 ±0.07 MPa	Permeability: 7.01E-09 ±6.87E-09 m/s	Constrained Mod.: 3.25 ±1.51 MPa
Sleeve friction: 13.60 ±2.94 kPa	N_{60}: 1.72 ±0.45 blows	Go: 10.20 ±0.82 MPa
Ic: 3.08 ±0.16	Es: 0.00 ±0.00 MPa	Su: 20.38 ±5.05 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.86 ±0.32
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.98 ±1.46
	Unit weight: 15.51 ±0.28 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 1.84 (m), **End depth:** 2.38 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.67 ±0.32 MPa	Permeability: 3.30E-07 ±4.20E-07 m/s	Constrained Mod.: 8.24 ±5.00 MPa
Sleeve friction: 7.34 ±2.69 kPa	N_{60}: 2.64 ±0.83 blows	Go: 11.94 ±1.58 MPa
Ic: 2.67 ±0.31	Es: 0.00 ±0.00 MPa	Su: 28.30 ±7.55 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.80 ±0.15
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.70 ±0.70
	Unit weight: 15.02 ±0.27 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 2.38 (m), **End depth:** 2.80 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.38 ±0.16 MPa	Permeability: 3.46E-08 ±4.94E-08 m/s	Constrained Mod.: 3.40 ±2.76 MPa
Sleeve friction: 5.81 ±1.34 kPa	N_{60}: 1.82 ±0.66 blows	Go: 9.42 ±1.15 MPa
Ic: 2.97 ±0.27	Es: 0.00 ±0.00 MPa	Su: 22.51 ±9.90 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.57 ±0.21
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.64 ±0.97
	Unit weight: 14.58 ±0.20 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 2.80 (m), **End depth:** 3.58 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.36 ±0.29 MPa	Permeability: 2.43E-08 ±1.35E-07 m/s	Constrained Mod.: 2.63 ±4.41 MPa
Sleeve friction: 11.84 ±7.36 kPa	N_{60}: 2.02 ±1.07 blows	Go: 11.94 ±4.75 MPa
Ic: 3.22 ±0.25	Es: 0.00 ±0.00 MPa	Su: 19.08 ±8.30 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.47 ±0.19
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.17 ±0.86
	Unit weight: 15.19 ±0.78 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 3.58 (m), **End depth:** 4.16 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 4.21 ±1.01 MPa	Permeability: 1.84E-05 ±1.28E-05 m/s	Constrained Mod.: 41.02 ±4.73 MPa
Sleeve friction: 22.57 ±3.72 kPa	N_{60}: 10.57 ±1.76 blows	Go: 37.78 ±4.27 MPa
Ic: 1.92 ±0.14	Es: 32.91 ±3.33 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 43.34 ±4.79	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.42 ±0.85 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.10 ±0.23 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 4.16 (m), **End depth:** 5.32 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.01 ±0.46 MPa	Permeability: 2.21E-07 ±3.10E-07 m/s	Constrained Mod.: 12.28 ±7.38 MPa
Sleeve friction: 14.00 ±4.18 kPa	N_{60}: 4.08 ±1.25 blows	Go: 19.77 ±4.03 MPa
Ic: 2.71 ±0.32	Es: 0.00 ±0.00 MPa	Su: 45.74 ±19.79 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.86 ±0.34
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.99 ±1.57
	Unit weight: 15.94 ±0.37 kN/m³	

.:: Layer No: 9 ::.

Code: Layer_9 **Start depth:** 5.32 (m), **End depth:** 5.76 (m)

Description: Silty sand & sandy silt

Basic results	Estimation results	
Total cone resistance: 3.09 ±0.90 MPa	Permeability: 3.98E-06 ±5.46E-06 m/s	Constrained Mod.: 38.42 ±7.10 MPa
Sleeve friction: 27.38 ±5.94 kPa	N_{60}: 9.22 ±1.73 blows	Go: 38.11 ±4.46 MPa
Ic: 2.18 ±0.16	Es: 33.03 ±3.47 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 35.59 ±4.41	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 34.59 ±0.55 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.19 ±0.24 kN/m³	

.:: Layer No: 10 ::.

Code: Layer_10 **Start depth:** 5.76 (m), **End depth:** 6.32 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 5.02 ±2.49 MPa	Permeability: 2.89E-05 ±3.84E-05 m/s	Constrained Mod.: 47.85 ±10.22 MPa
Sleeve friction: 27.52 ±8.65 kPa	N_{60}: 12.45 ±4.29 blows	Go: 45.02 ±10.50 MPa
Ic: 1.96 ±0.22	Es: 38.55 ±7.92 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 42.64 ±9.22	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.18 ±1.65 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.33 ±0.45 kN/m³	

.:: Layer No: 11 ::.

Code: Layer_11 **Start depth:** 6.32 (m), **End depth:** 6.86 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.94 ±0.55 MPa	Permeability: 8.07E-08 ±2.32E-07 m/s	Constrained Mod.: 9.90 ±8.90 MPa
Sleeve friction: 21.60 ±6.69 kPa	N_{60}: 4.39 ±1.55 blows	Go: 24.19 ±6.01 MPa
Ic: 2.97 ±0.33	Es: 0.00 ±0.00 MPa	Su: 52.40 ±29.70 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.80 ±0.43
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.72 ±1.97
	Unit weight: 16.38 ±0.51 kN/m³	

.:: Layer No: 12 ::.

Code: Layer_12 **Start depth:** 6.86 (m), **End depth:** 7.24 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.43 ±0.55 MPa	Permeability: 3.67E-07 ±6.96E-07 m/s	Constrained Mod.: 18.13 ±8.07 MPa
Sleeve friction: 18.30 ±4.64 kPa	N_{60}: 5.45 ±1.28 blows	Go: 26.98 ±3.19 MPa
Ic: 2.62 ±0.22	Es: 0.00 ±0.00 MPa	Su: 74.68 ±13.32 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 1.10 ±0.19
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 5.06 ±0.86
	Unit weight: 16.41 ±0.30 kN/m³	

.:: Layer No: 13 ::.

Code: Layer_13 **Start depth:** 7.24 (m), **End depth:** 7.92 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.47 ±0.10 MPa	Permeability: 2.74E-09 ±4.11E-09 m/s	Constrained Mod.: 1.88 ±1.29 MPa
Sleeve friction: 9.42 ±0.61 kPa	N_{60}: 3.00 ±0.00 blows	Go: 15.08 ±0.93 MPa
Ic: 3.25 ±0.16	Es: 0.00 ±0.00 MPa	Su: 24.70 ±7.25 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.36 ±0.11
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.65 ±0.51
	Unit weight: 15.27 ±0.08 kN/m³	

.:: Layer No: 14 ::.

Code: Layer_14 **Start depth:** 7.92 (m), **End depth:** 8.04 (m)

Description: Clay

Basic results	**Estimation results**	
Total cone resistance: 0.43 ±0.00 MPa	Permeability: 7.90E-10 ±2.63E-11 m/s	Constrained Mod.: 1.24 ±0.04 MPa
Sleeve friction: 10.11 ±0.15 kPa	N_{60}: 3.00 ±0.00 blows	Go: 15.17 ±0.03 MPa
Ic: 3.35 ±0.01	Es: 0.00 ±0.00 MPa	Su: 21.25 ±0.32 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.30 ±0.00
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.38 ±0.02
	Unit weight: 15.32 ±0.01 kN/m³	

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_0 (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.04 0.56	0.52	3.50E-05 (±5.00E-05)	7.7 (±3.6)	27.5 (±8.0)	83.7 (±8.9)	44.0 (±0.7)	28.7 (±11.0)	31.0 (±9.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	18.2 (±0.4)
0.56 1.00	0.44	9.53E-08 (±3.67E-08)	3.3 (±0.8)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	11.2 (±2.5)	18.4 (±3.3)	57.3 (±13.0)	3.2 (±1.0)	14.9 (±4.7)	17.0 (±0.5)
1.00 1.84	0.84	7.01E-09 (±6.87E-09)	1.7 (±0.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	3.3 (±1.5)	10.2 (±0.8)	20.4 (±5.1)	0.9 (±0.3)	4.0 (±1.5)	15.5 (±0.3)
1.84 2.38	0.54	3.30E-07 (±4.20E-07)	2.6 (±0.8)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	8.2 (±5.0)	11.9 (±1.6)	28.3 (±7.6)	0.8 (±0.2)	3.7 (±0.7)	15.0 (±0.3)
2.38 2.80	0.42	3.46E-08 (±4.94E-08)	1.8 (±0.7)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	3.4 (±2.8)	9.4 (±1.1)	22.5 (±9.9)	0.6 (±0.2)	2.6 (±1.0)	14.6 (±0.2)
2.80 3.58	0.78	2.43E-08 (±1.35E-07)	2.0 (±1.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.6 (±4.4)	11.9 (±4.7)	19.1 (±8.3)	0.5 (±0.2)	2.2 (±0.9)	15.2 (±0.8)
3.58 4.16	0.58	1.84E-05 (±1.28E-05)	10.6 (±1.8)	32.9 (±3.3)	43.3 (±4.8)	35.4 (±0.8)	41.0 (±4.7)	37.8 (±4.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.1 (±0.2)
4.16 5.32	1.16	2.21E-07 (±3.10E-07)	4.1 (±1.2)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	12.3 (±7.4)	19.8 (±4.0)	45.7 (±19.8)	0.9 (±0.3)	4.0 (±1.6)	15.9 (±0.4)
5.32 5.76	0.44	3.98E-06 (±5.46E-06)	9.2 (±1.7)	33.0 (±3.5)	35.6 (±4.4)	34.6 (±0.6)	38.4 (±7.1)	38.1 (±4.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.2 (±0.2)
5.76 6.32	0.56	2.89E-05 (±3.84E-05)	12.4 (±4.3)	38.6 (±7.9)	42.6 (±9.2)	35.2 (±1.6)	47.9 (±10.2)	45.0 (±10.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.3 (±0.5)
6.32 6.86	0.54	8.07E-08 (±2.32E-07)	4.4 (±1.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	9.9 (±8.9)	24.2 (±6.0)	52.4 (±29.7)	0.8 (±0.4)	3.7 (±2.0)	16.4 (±0.5)
6.86 7.24	0.38	3.67E-07 (±6.96E-07)	5.5 (±1.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	18.1 (±8.1)	27.0 (±3.2)	74.7 (±13.3)	1.1 (±0.2)	5.1 (±0.9)	16.4 (±0.3)

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
7.24 7.92	0.68	2.74E-09 (±4.11E-09)	3.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.9 (±1.3)	15.1 (±0.9)	24.7 (±7.2)	0.4 (±0.1)	1.7 (±0.5)	15.3 (±0.1)
7.92 8.04	0.12	7.90E-10 (±2.63E-11)	3.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.2 (±0.0)	15.2 (±0.0)	21.2 (±0.3)	0.3 (±0.0)	1.4 (±0.0)	15.3 (±0.0)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(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)

•N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

CPT#5

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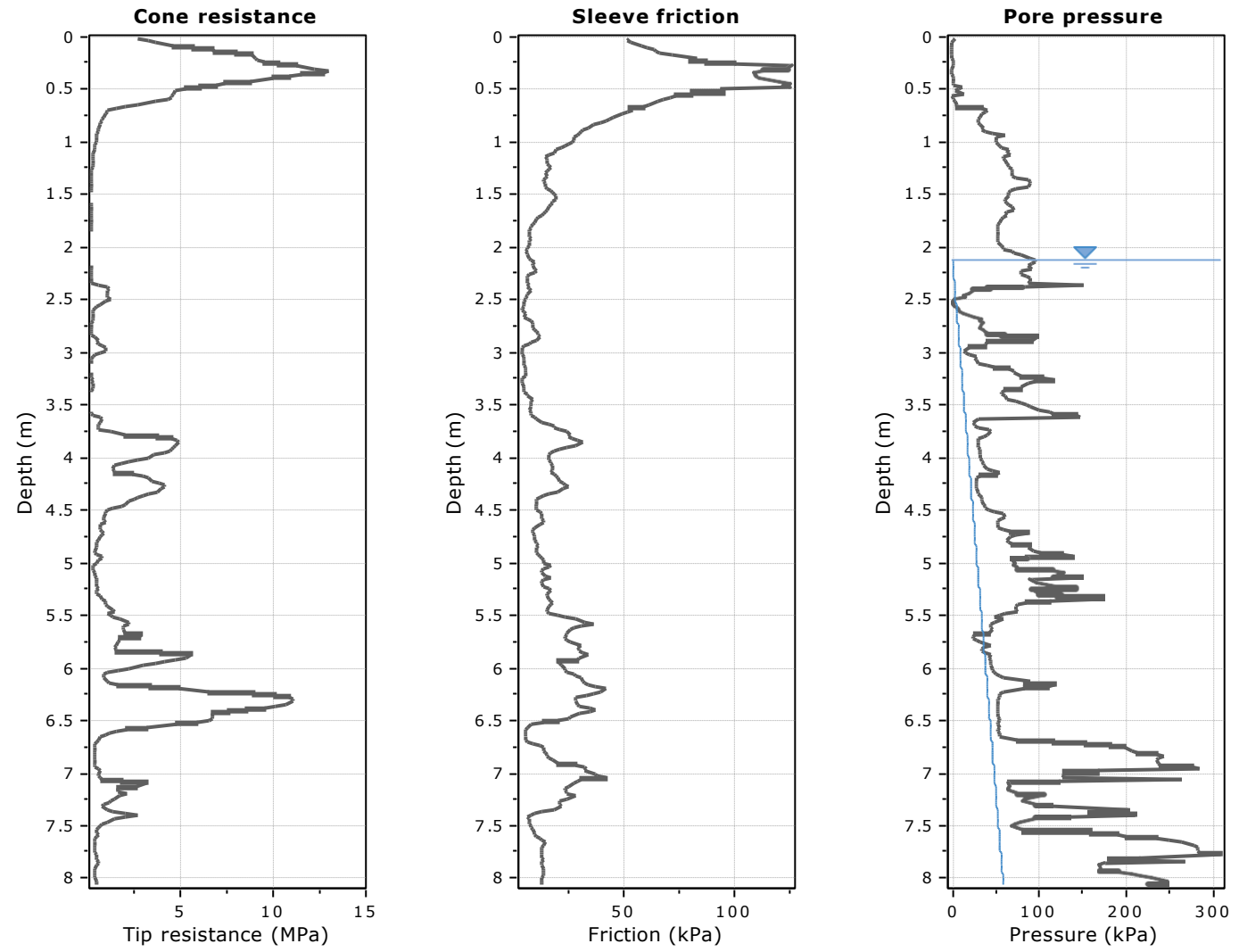
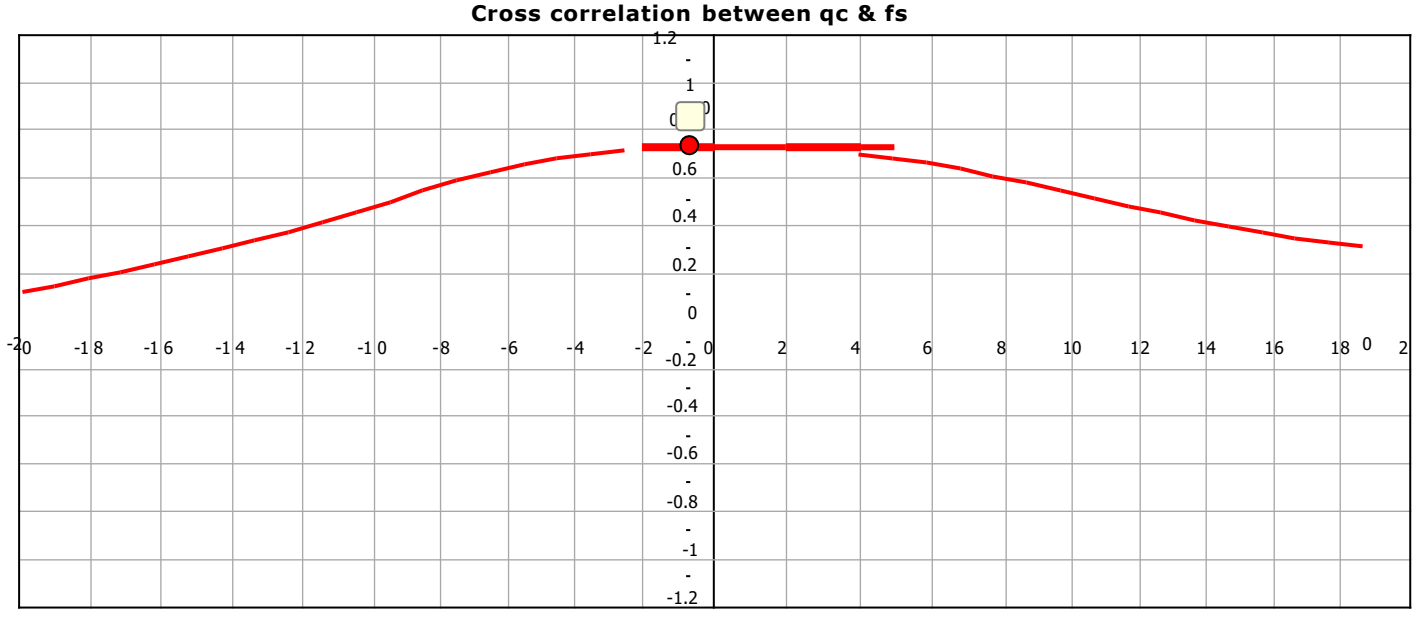
Lot 6 Onion Field LBI, Guyana.
+592-220-1216

CPT: #5
Total depth: 8.06 m, Date: 12/18/2022
Coords: 6°55'52.4" N 58°22'10.9" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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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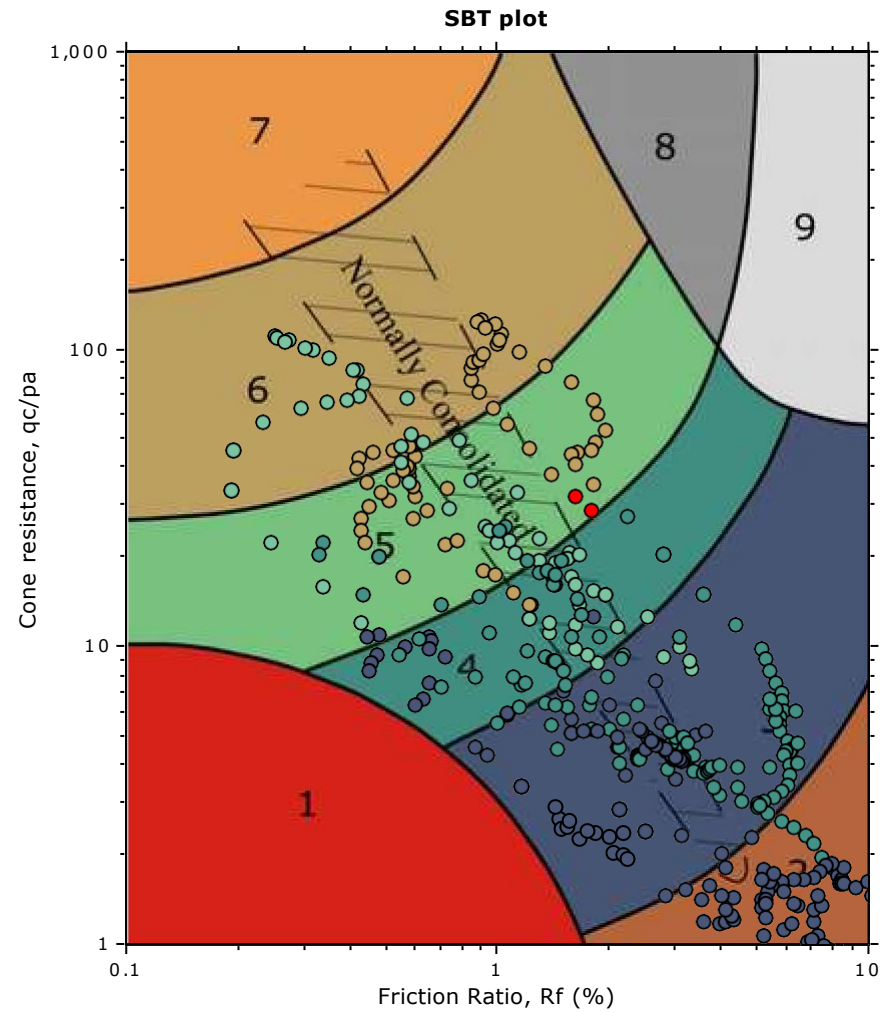
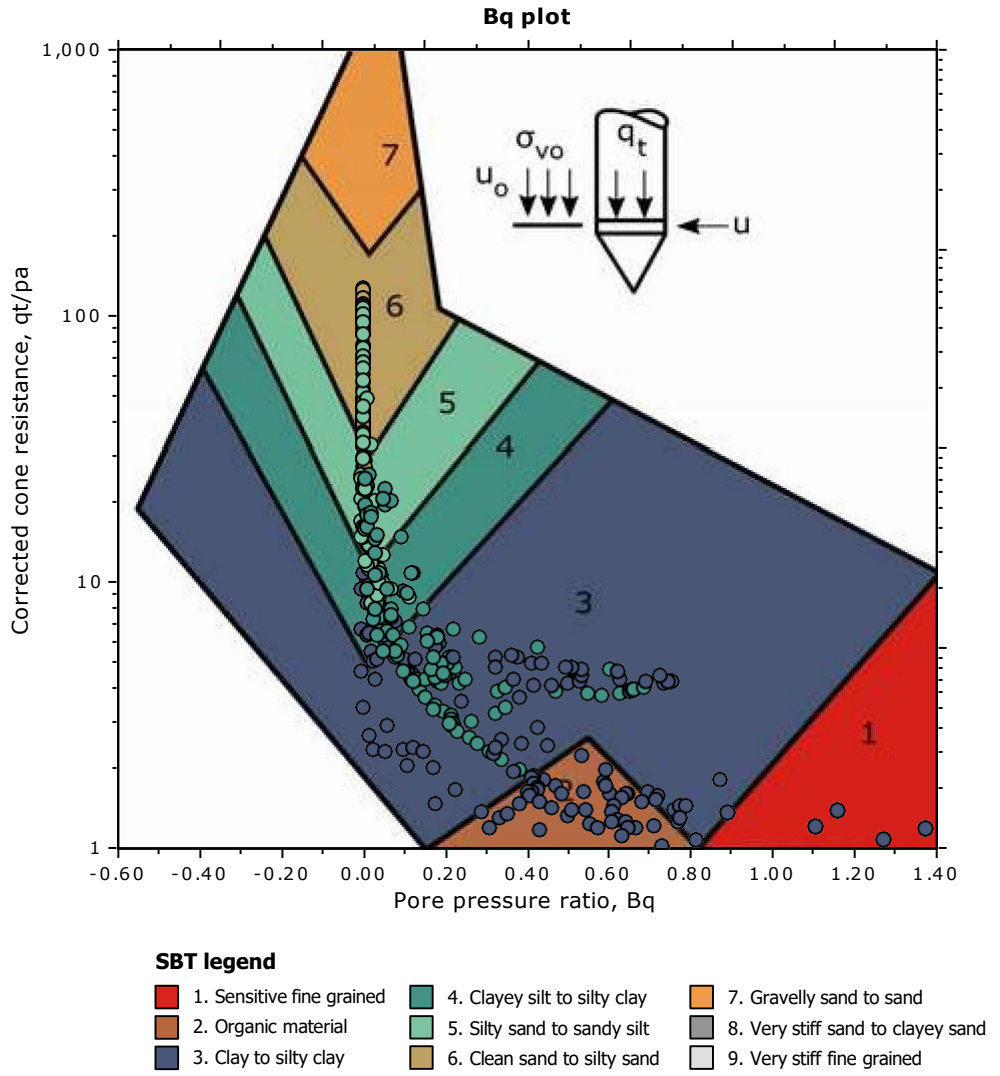
SBT - Bq plots





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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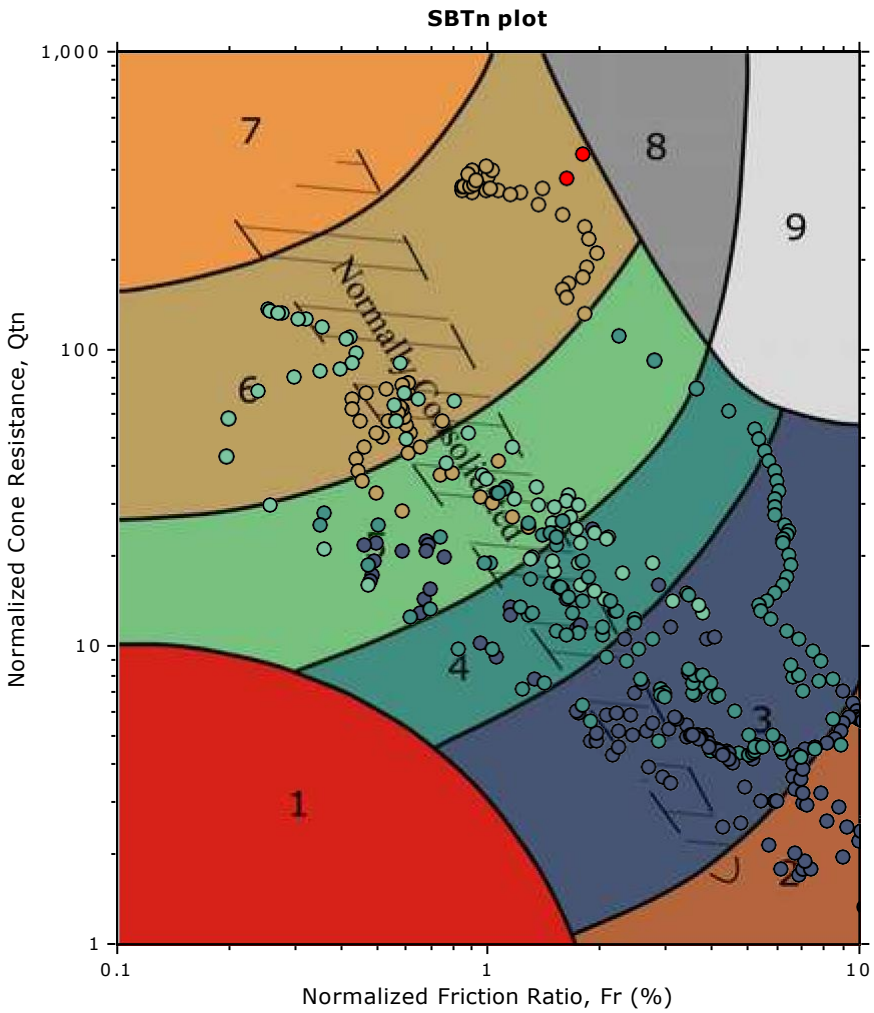
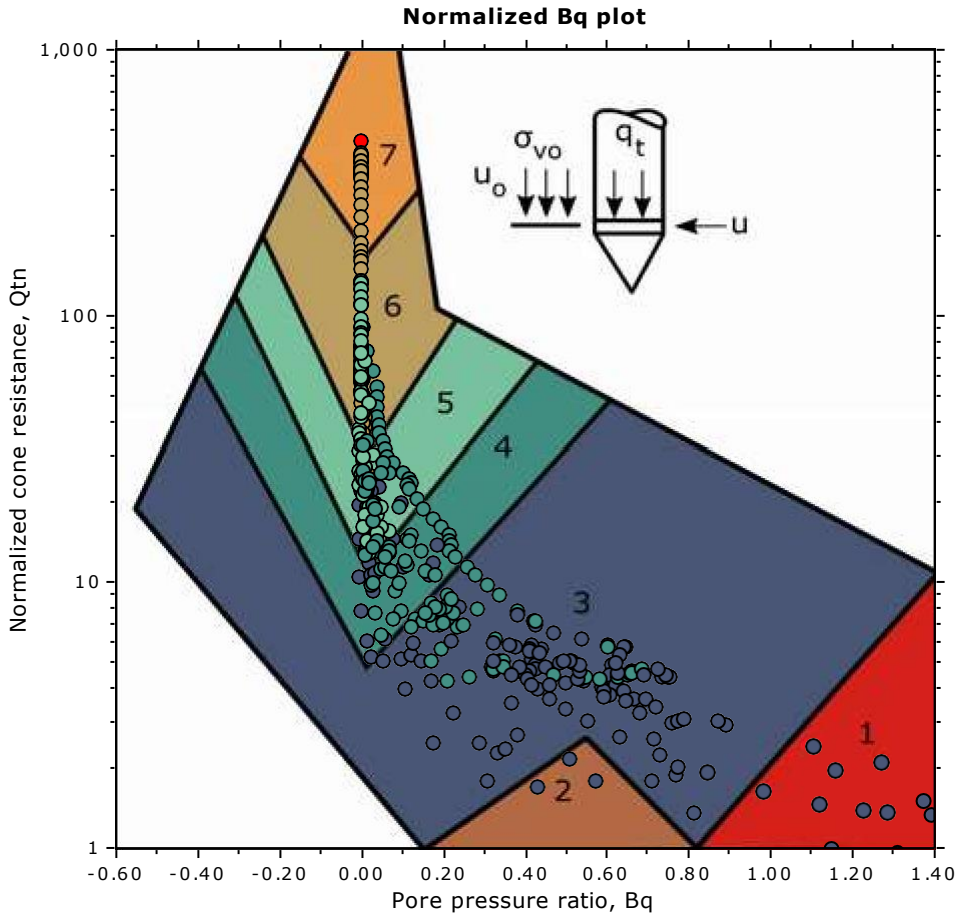
SBT - Bq plots (normalized)





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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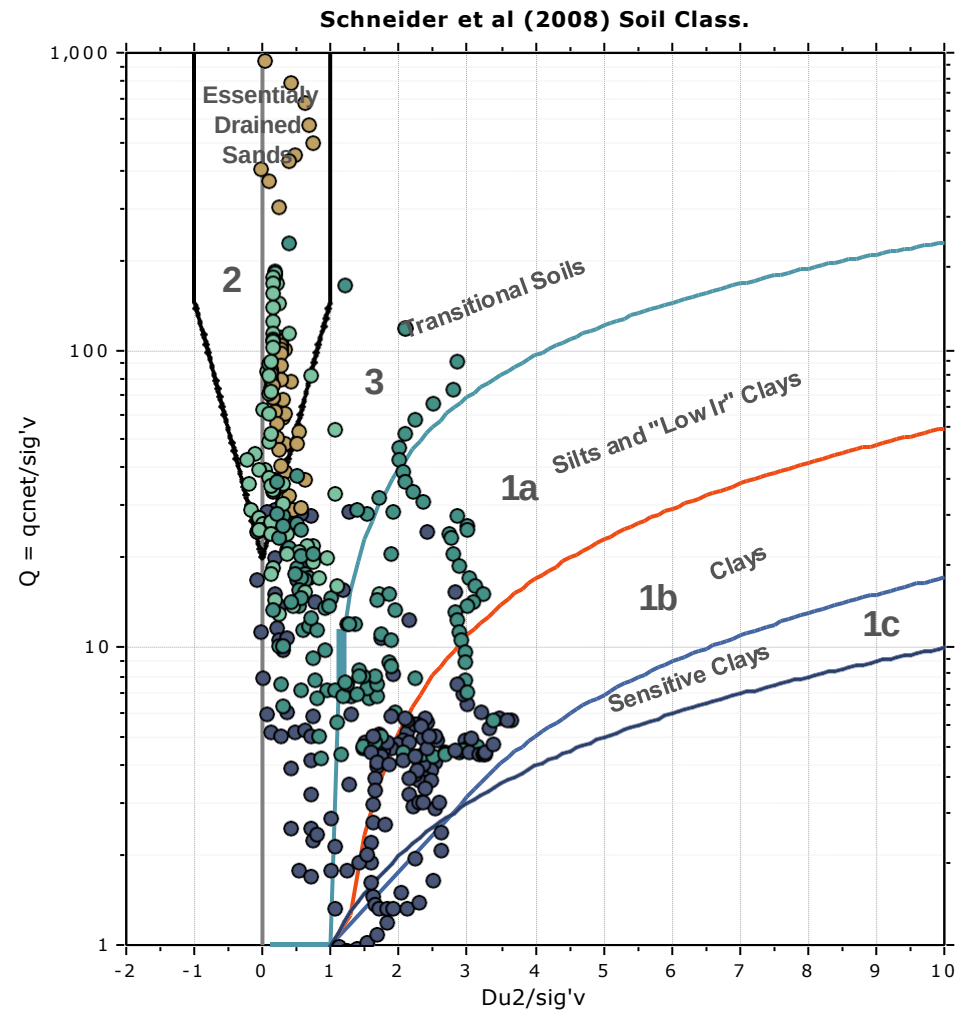
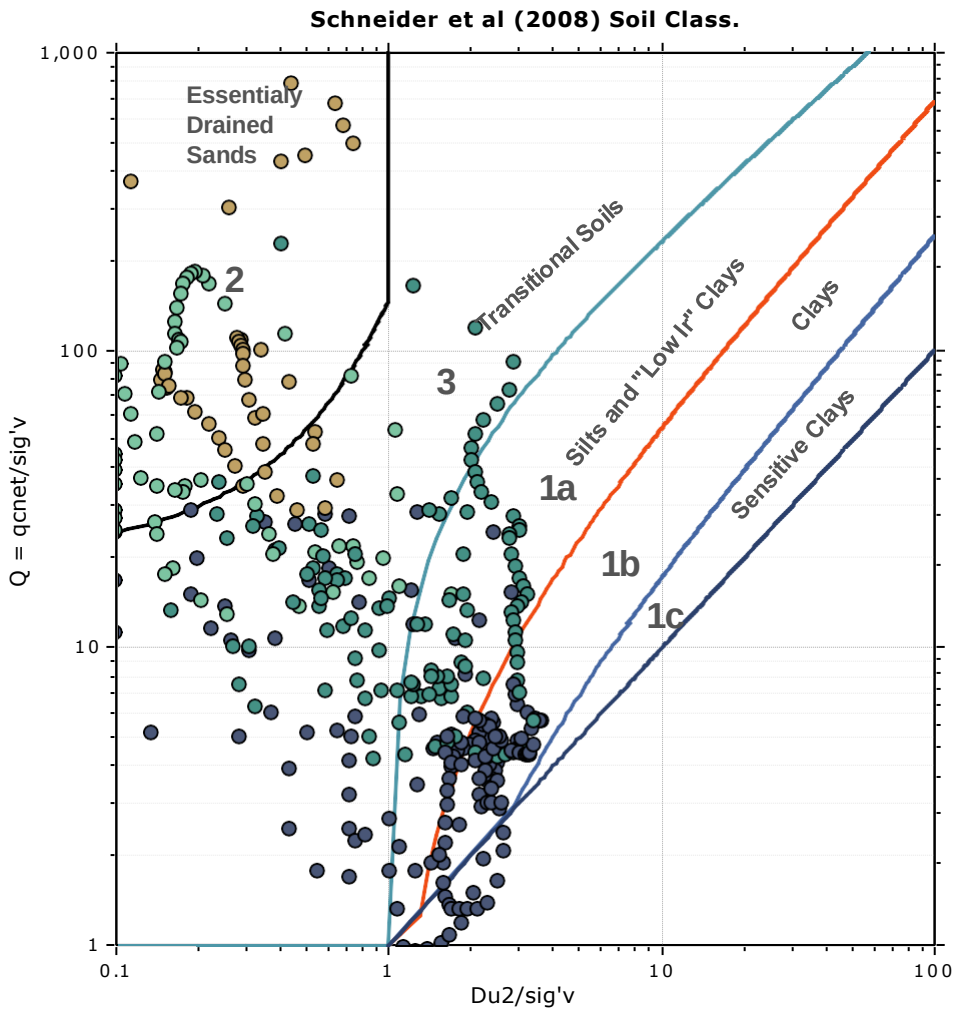
Bq plots (Schneider)





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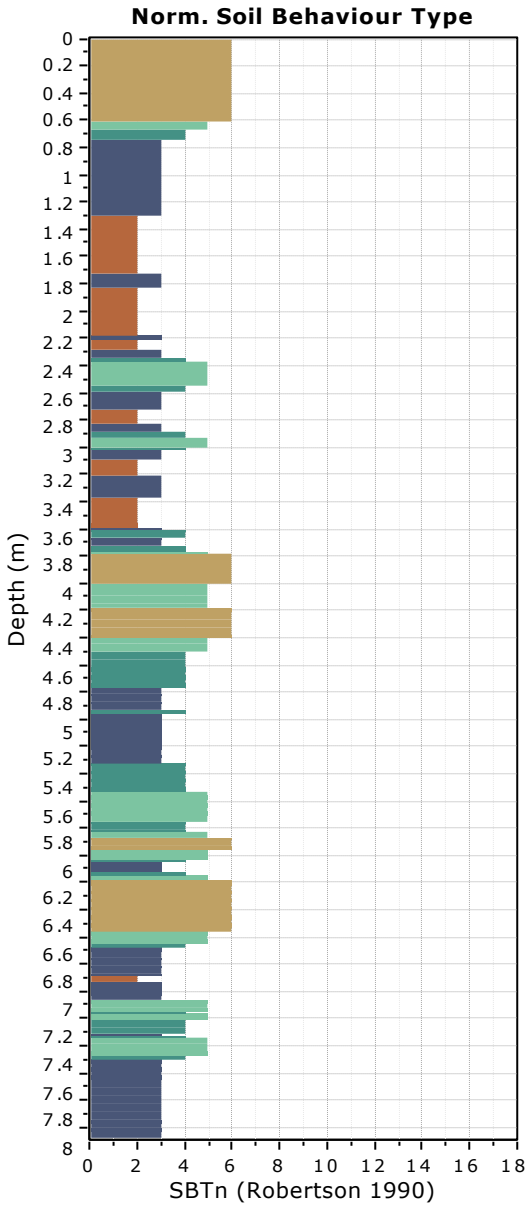

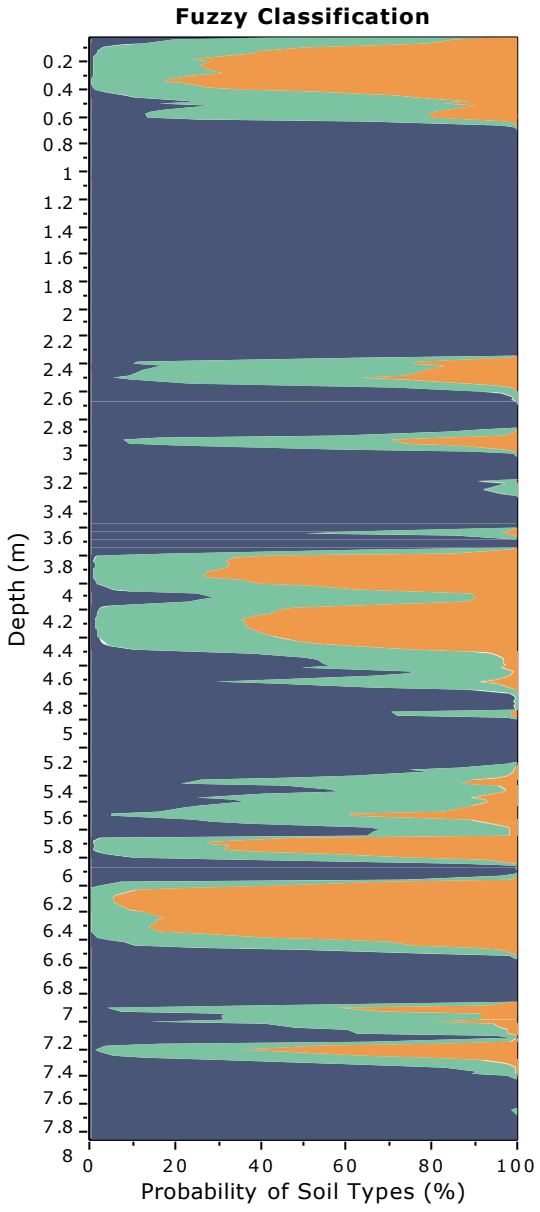

Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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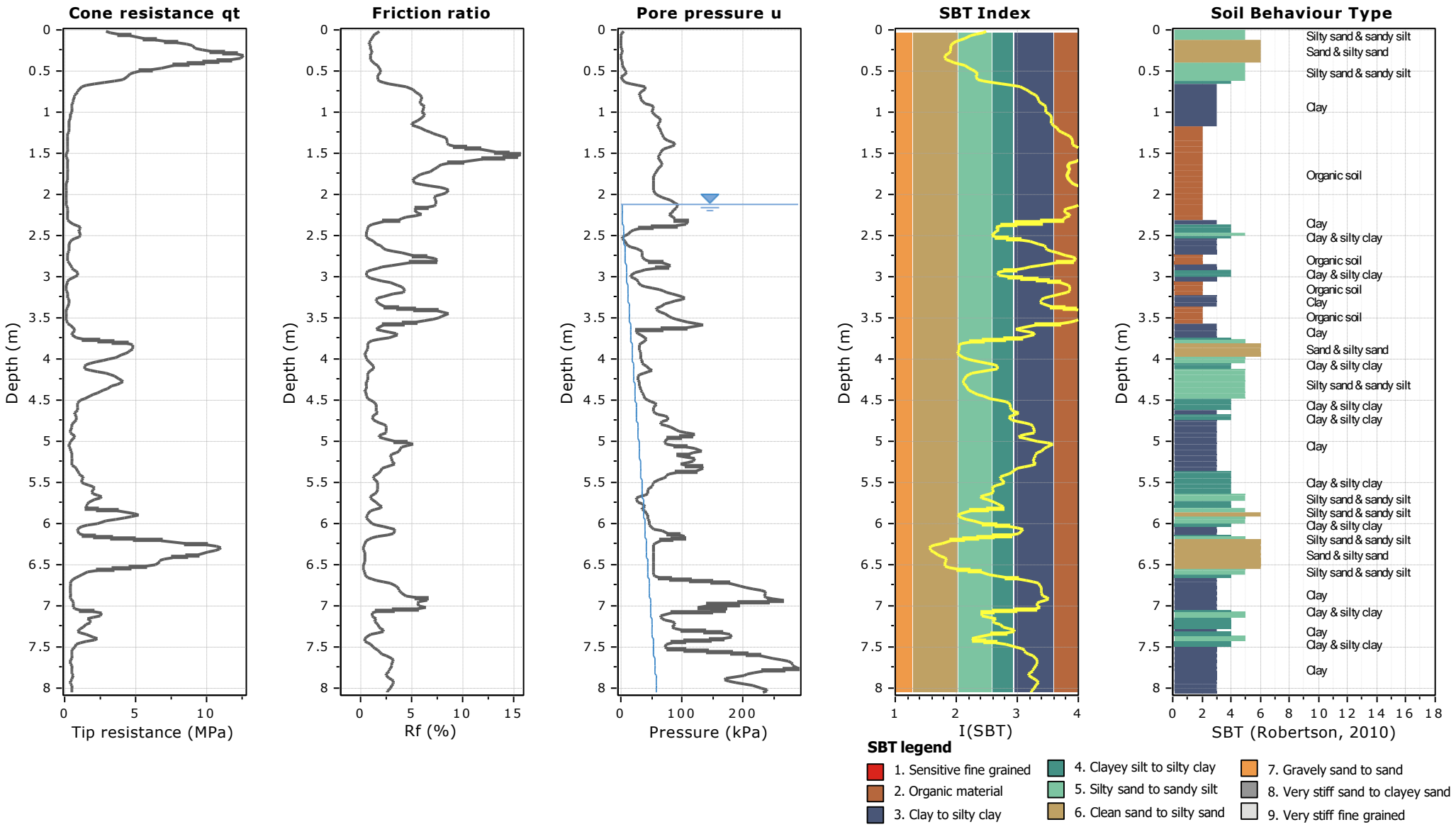

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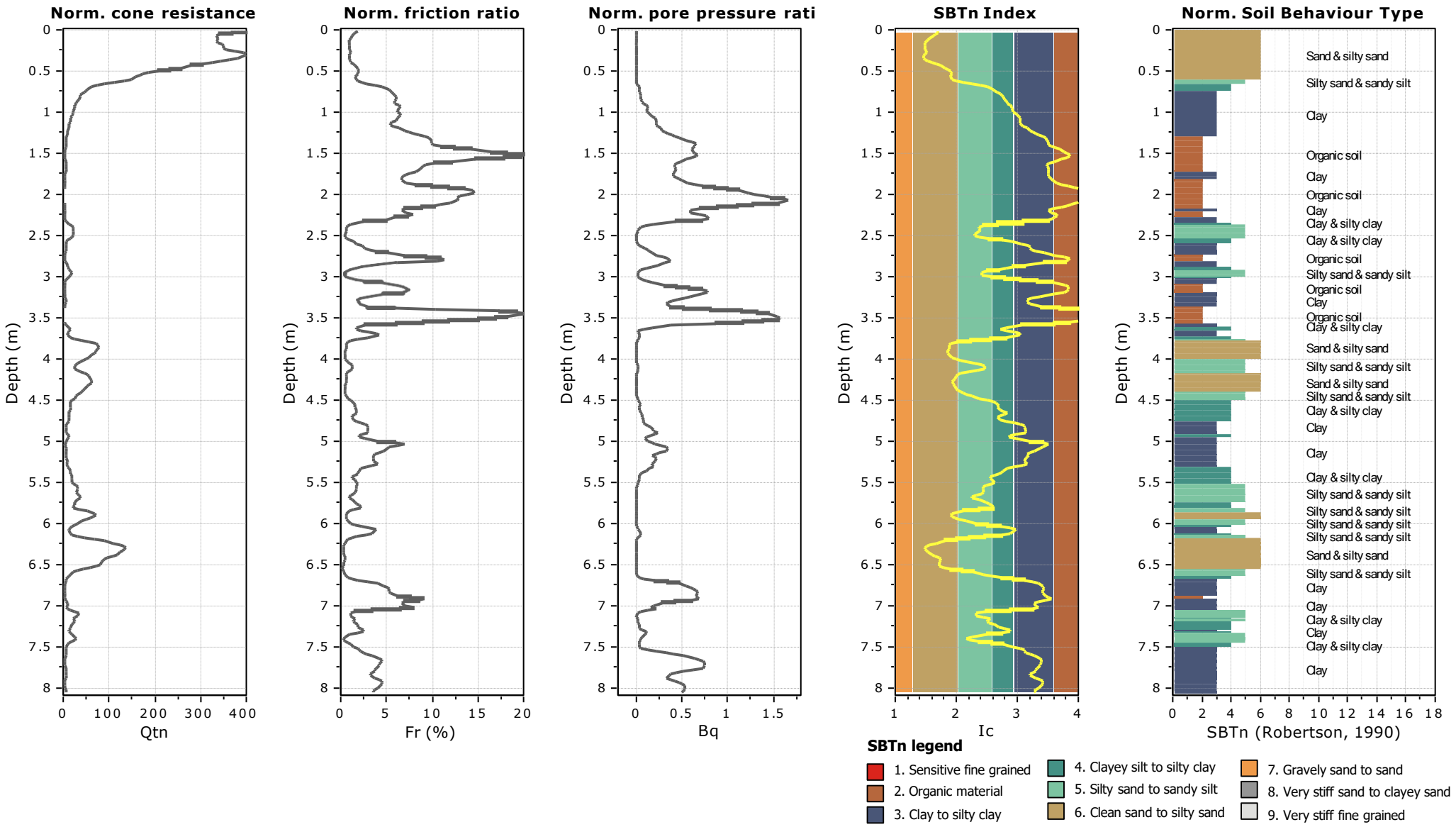

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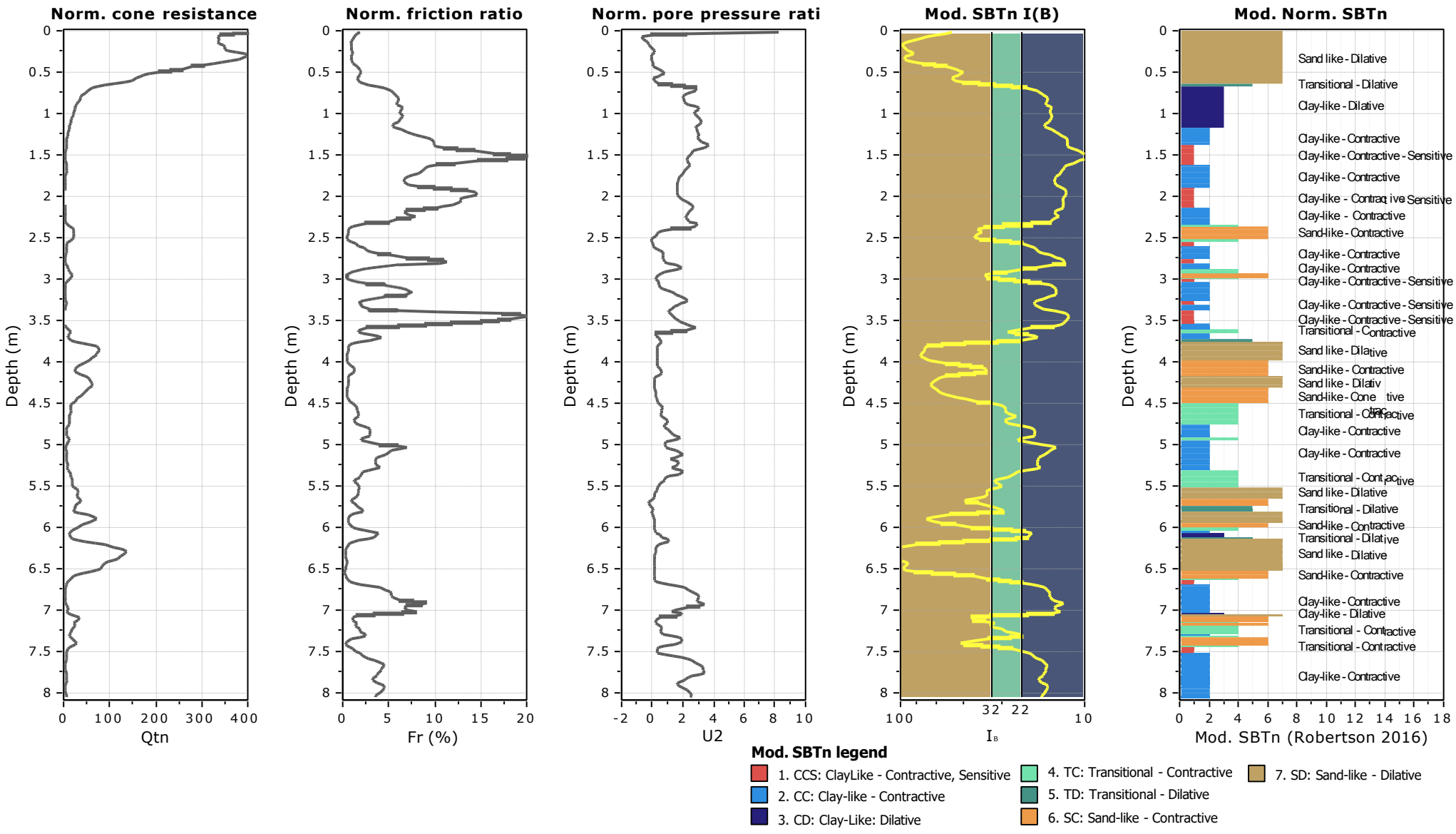

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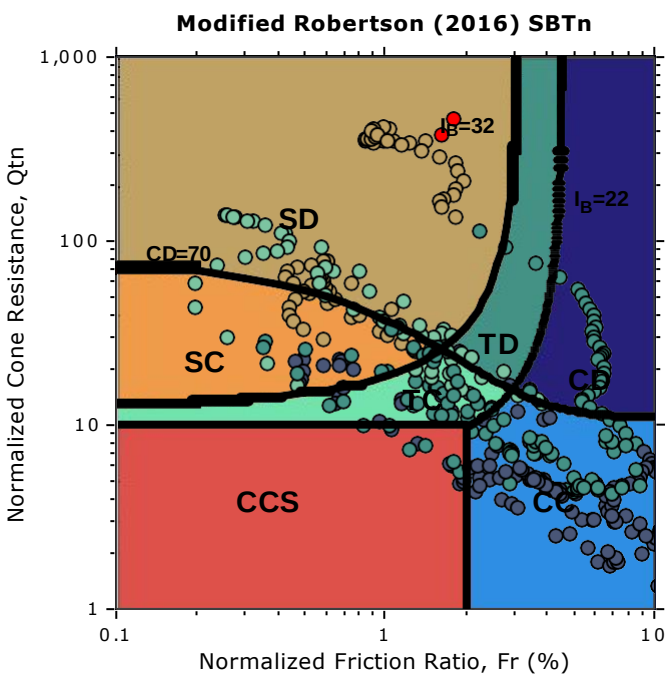
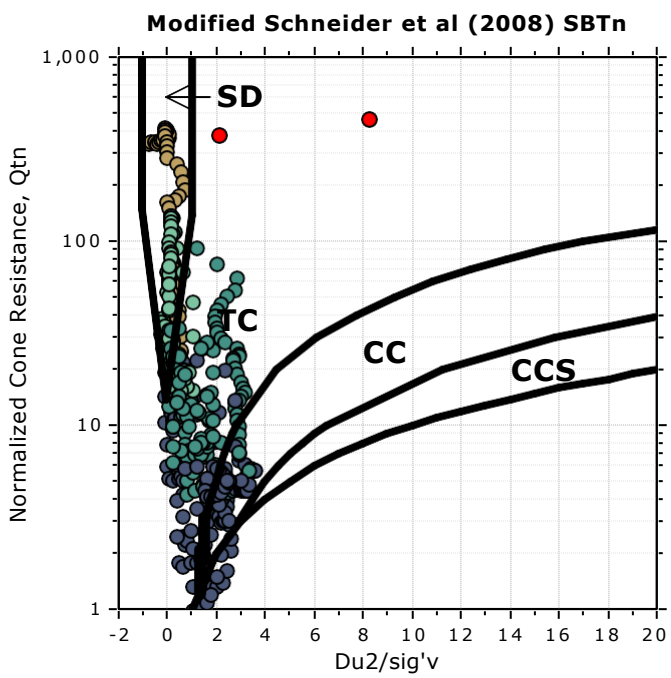
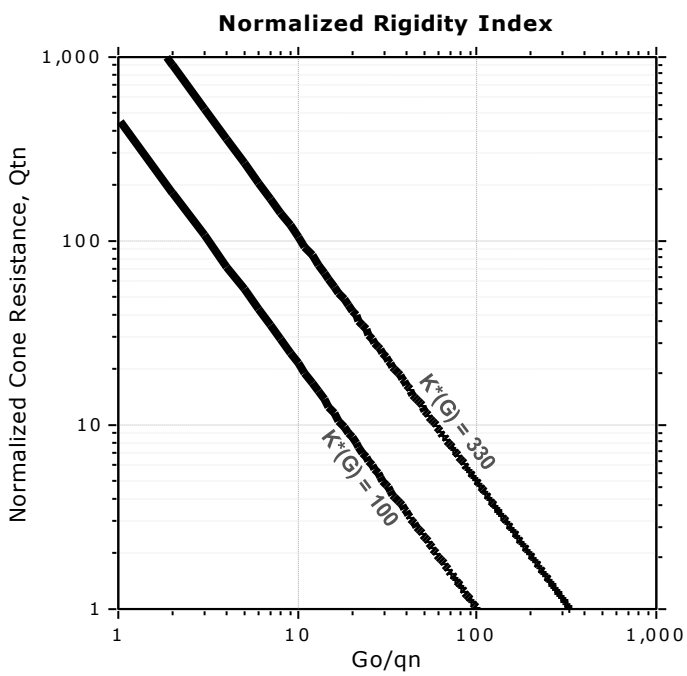
Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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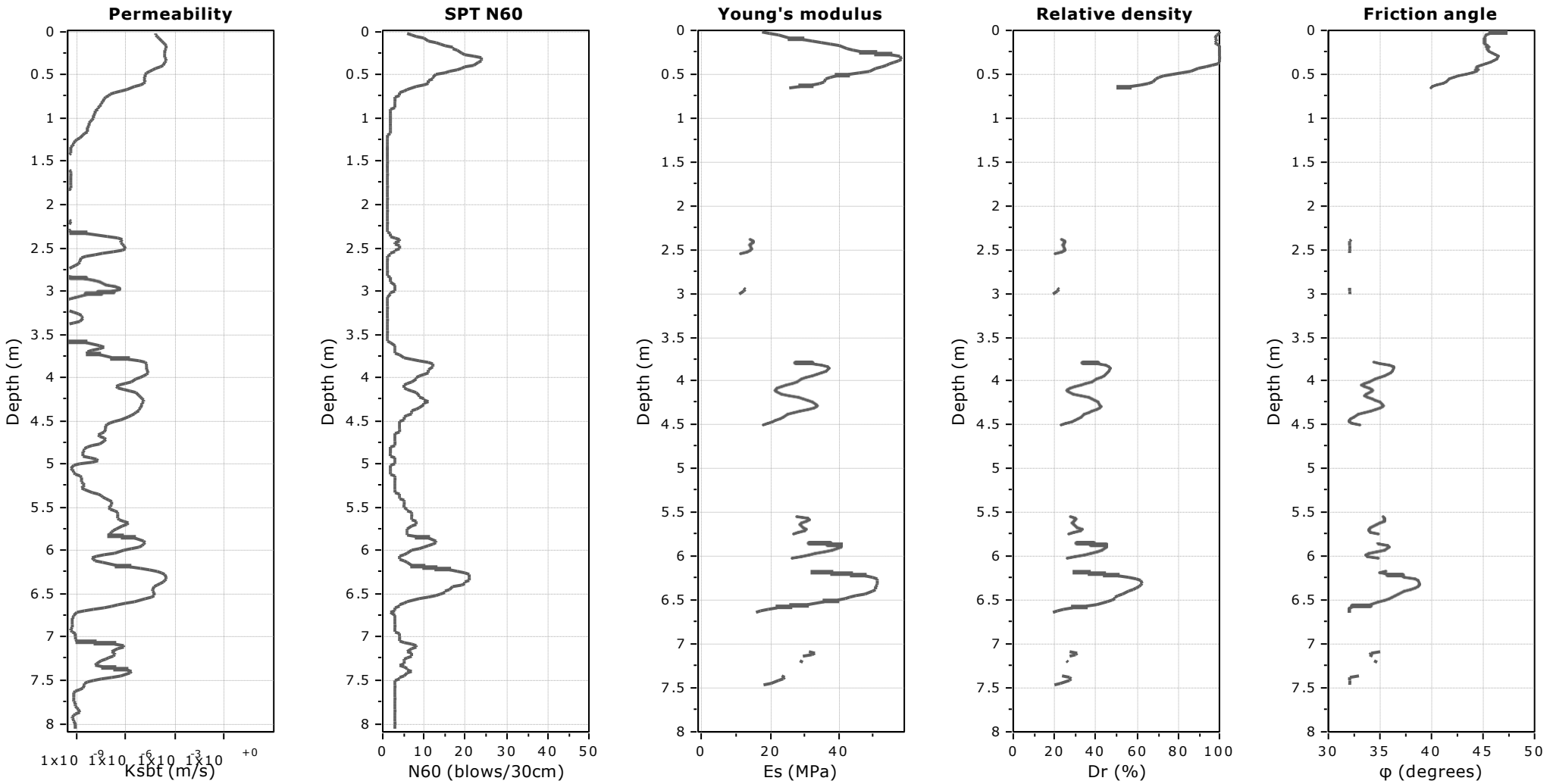

Calculation parameters

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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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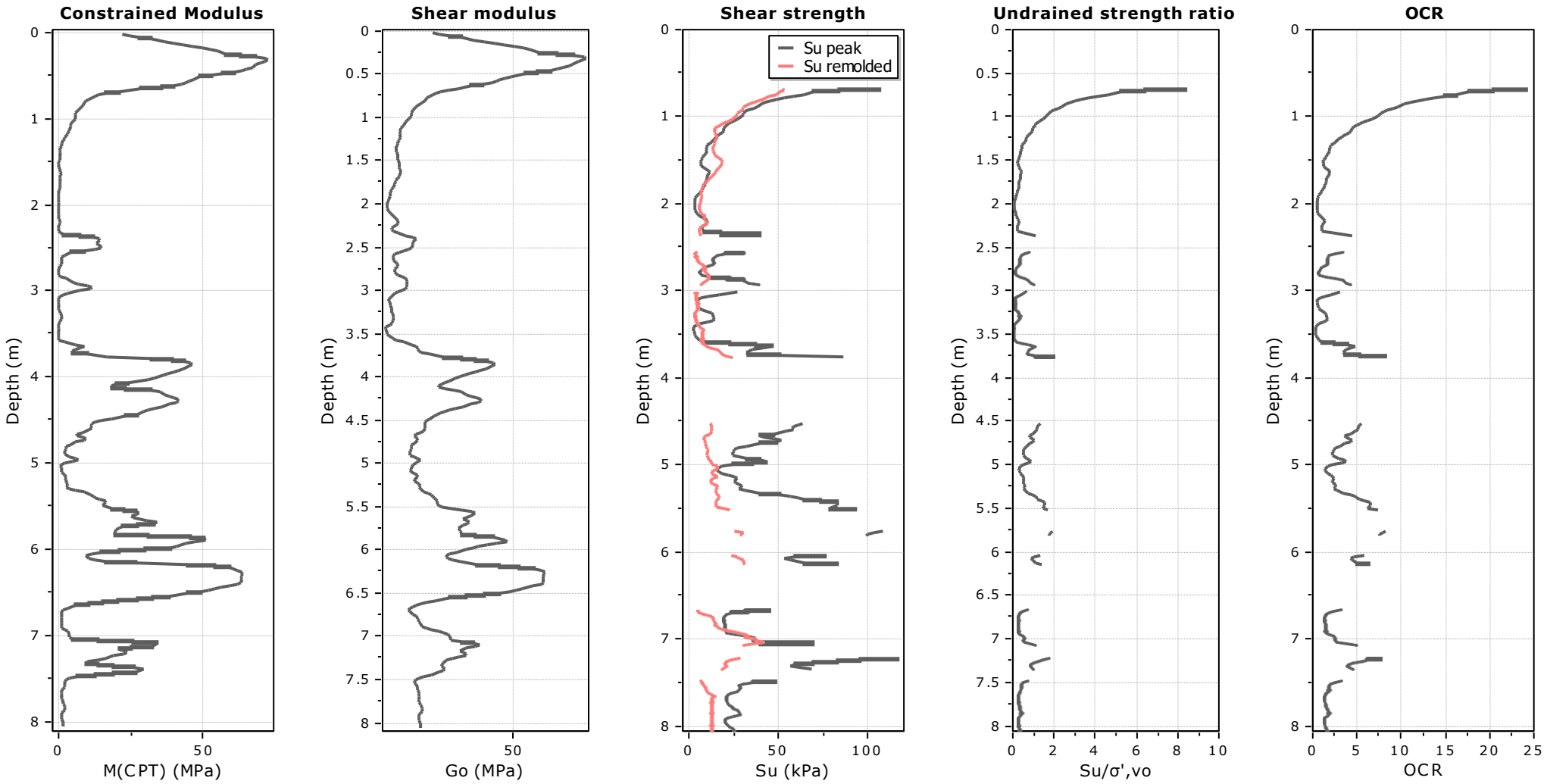

Calculation parameters

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
Flat Dilatometer Test data

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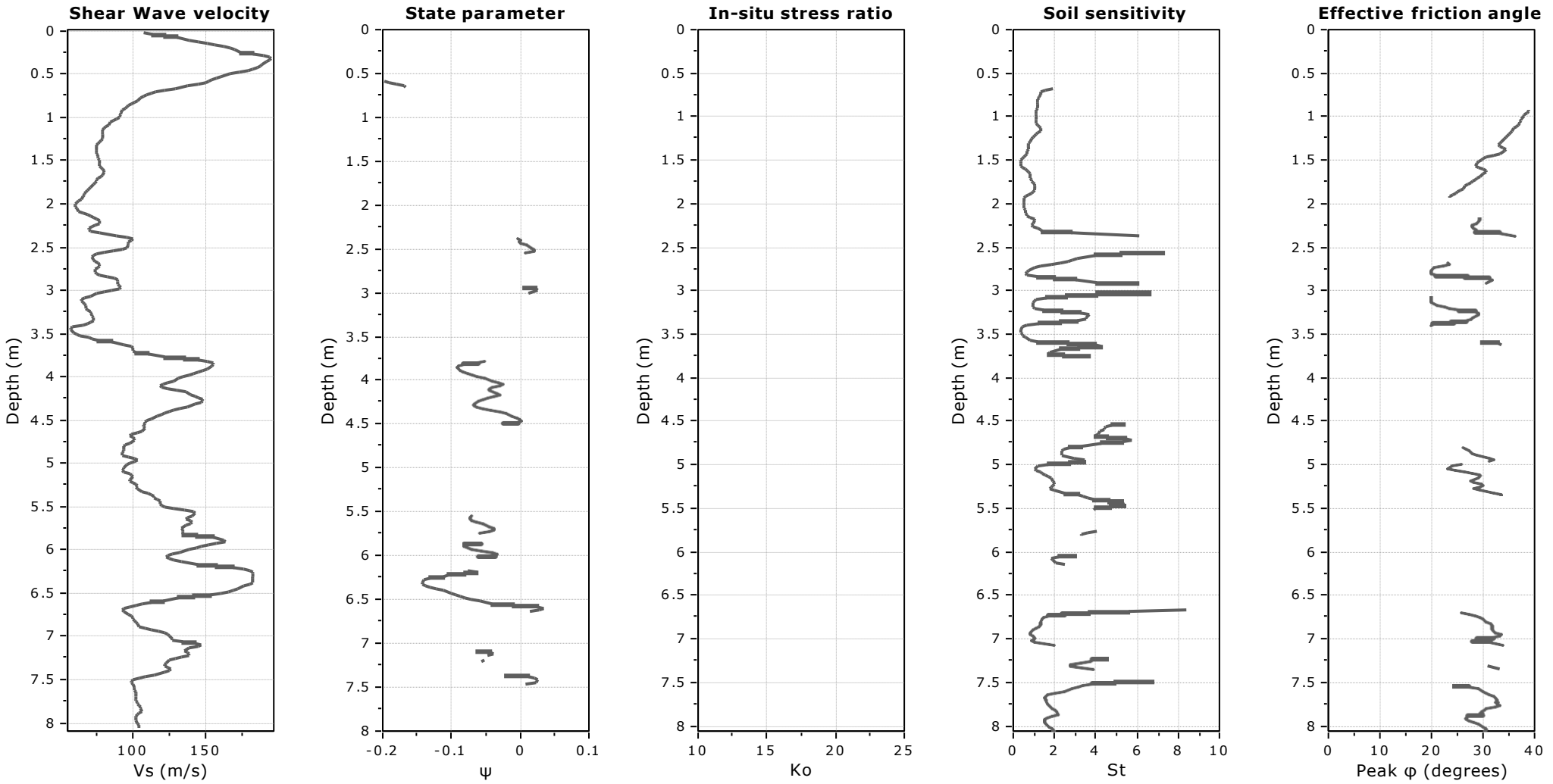

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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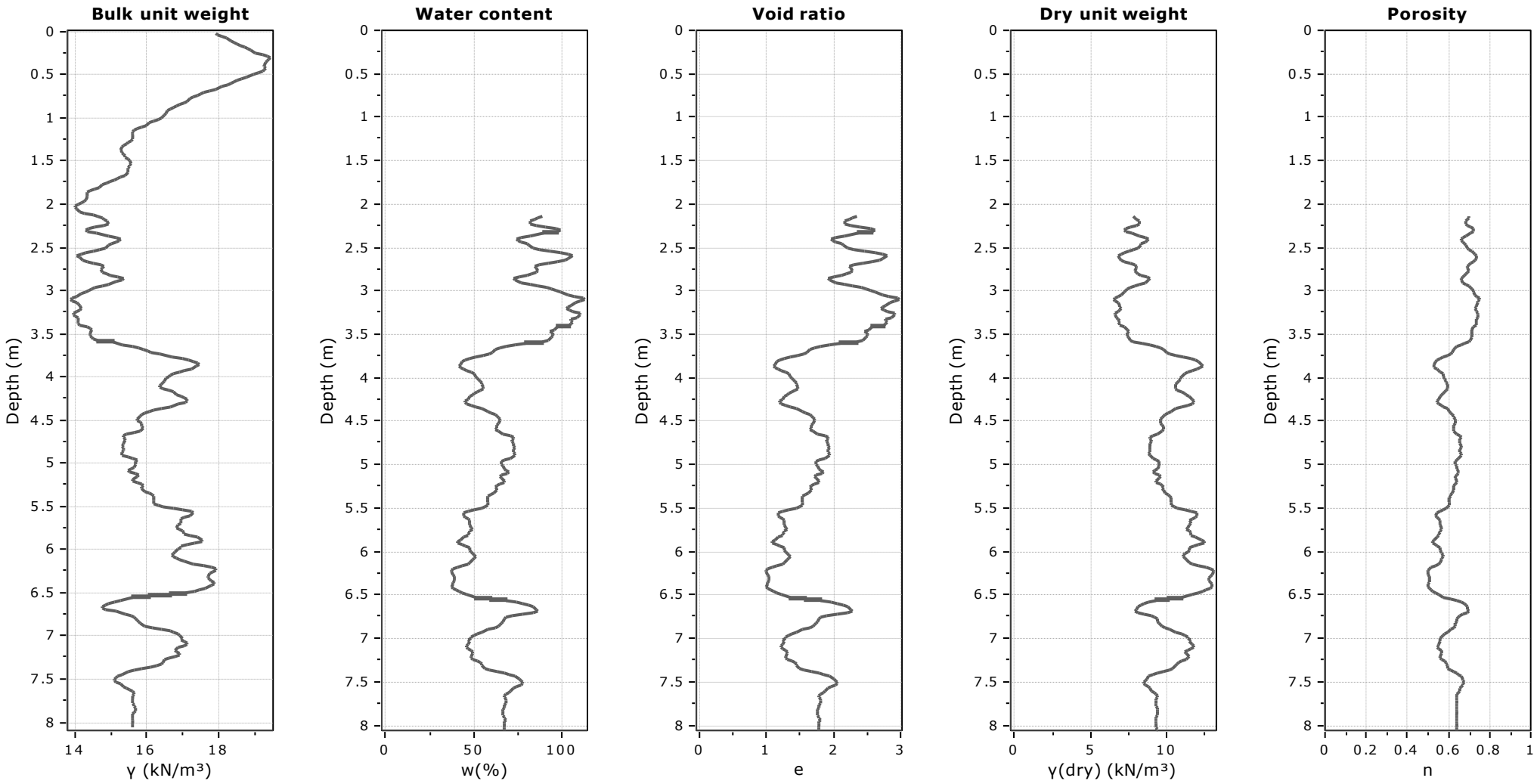

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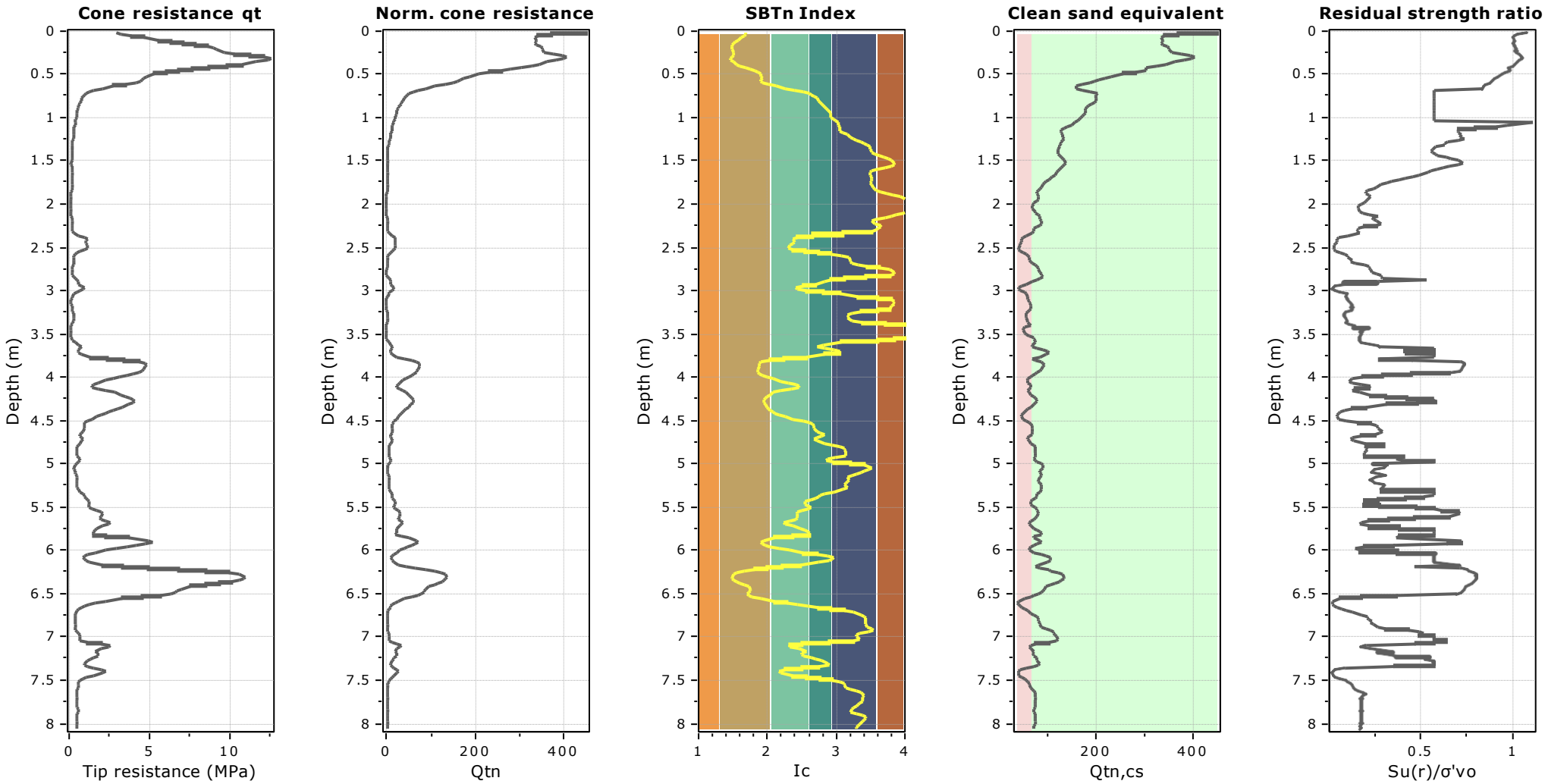

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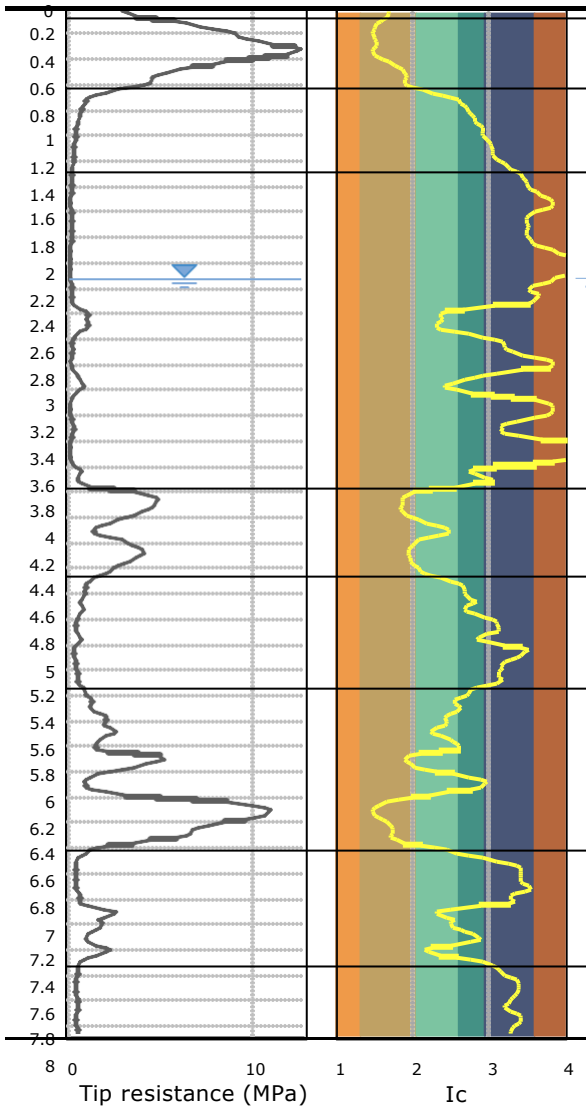
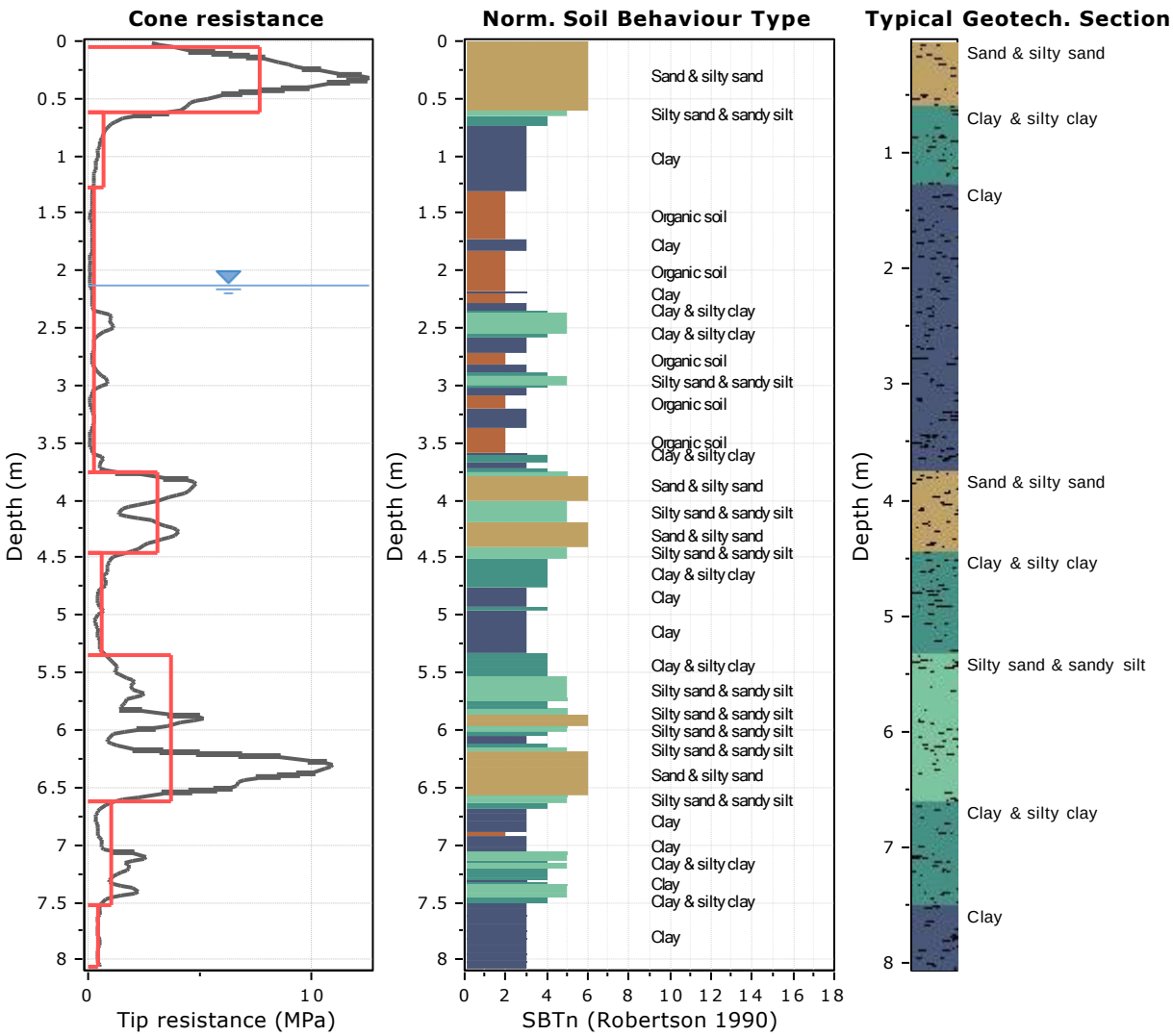


Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Sand & silty sand	7.7	1.46E-4	16.2	43.1	90.3	44.5	54.0	54.9	-	-	-	18.9
Clay & silty clay	0.7	3.79E-7	2.9	-	-	-	9.4	16.3	36.1	1.9	8.8	16.6
Clay	0.3	6.05E-8	1.5	-	-	-	2.5	9.0	12.6	0.3	1.6	14.8
Sand & silty sand	3.1	7.94E-6	8.4	28.5	37.5	34.3	34.1	32.0	-	-	-	16.7
Clay & silty clay	0.6	6.44E-8	3.0	-	-	-	6.1	16.1	35.3	0.7	3.1	15.6
Silty sand & sandy silt	3.7	3.27E-5	9.7	36.6	40.9	35.5	34.0	37.4	-	-	-	17.0
Clay & silty clay	1.0	2.16E-7	4.5	-	-	-	11.4	23.1	43.0	0.6	3.0	16.1
Clay	0.5	1.25E-9	3.0	-	-	-	1.7	16.5	24.3	0.4	1.6	15.6



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.06 (m), **End depth:** 0.62 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 7.70 ±2.89 MPa	Permeability: 1.46E-04 ±1.11E-04 m/s	Constrained Mod.: 54.01 ±12.85 MPa
Sleeve friction: 90.42 ±24.36 kPa	N_{60}: 16.17 ±4.87 blows	Go: 54.85 ±14.15 MPa
Ic: 1.66 ±0.18	Es: 43.09 ±10.25 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 90.28 ±13.11	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 44.48 ±1.64 °	O.C.R.: 0.00 ±0.00
	Unit weight: 18.88 ±0.43 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 0.62 (m), **End depth:** 1.28 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.72 ±0.73 MPa	Permeability: 3.79E-07 ±1.34E-06 m/s	Constrained Mod.: 9.36 ±9.22 MPa
Sleeve friction: 31.51 ±15.38 kPa	N_{60}: 2.85 ±1.94 blows	Go: 16.27 ±7.49 MPa
Ic: 2.85 ±0.31	Es: 0.00 ±0.00 MPa	Su: 36.09 ±22.13 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 1.91 ±1.18
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 8.80 ±5.44
	Unit weight: 16.58 ±0.83 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.28 (m), **End depth:** 3.76 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.29 ±0.28 MPa	Permeability: 6.05E-08 ±1.67E-07 m/s	Constrained Mod.: 2.49 ±4.14 MPa
Sleeve friction: 8.74 ±4.50 kPa	N_{60}: 1.50 ±0.92 blows	Go: 8.99 ±3.33 MPa
Ic: 3.41 ±0.50	Es: 0.00 ±0.00 MPa	Su: 12.62 ±12.35 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.34 ±0.27
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.58 ±1.23
	Unit weight: 14.75 ±0.59 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 3.76 (m), **End depth:** 4.46 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 3.09 ±1.10 MPa	Permeability: 7.94E-06 ±6.59E-06 m/s	Constrained Mod.: 34.13 ±8.29 MPa
Sleeve friction: 19.01 ±5.48 kPa	N_{60}: 8.42 ±2.23 blows	Go: 31.96 ±6.32 MPa
Ic: 2.07 ±0.19	Es: 28.53 ±4.89 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 37.53 ±6.16	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 34.34 ±1.20 °	O.C.R.: 0.00 ±0.00
	Unit weight: 16.73 ±0.44 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 4.46 (m), **End depth:** 5.34 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.63 ±0.29 MPa	Permeability: 6.44E-08 ±2.09E-07 m/s	Constrained Mod.: 6.06 ±4.96 MPa
Sleeve friction: 12.24 ±2.38 kPa	N_{60}: 3.00 ±0.80 blows	Go: 16.08 ±2.12 MPa
Ic: 2.97 ±0.29	Es: 0.00 ±0.00 MPa	Su: 35.29 ±13.73 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.68 ±0.26
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 3.13 ±1.18
	Unit weight: 15.64 ±0.21 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 5.34 (m), **End depth:** 6.62 (m)

Description: Silty sand & sandy silt

Basic results	Estimation results	
Total cone resistance: 3.71 ±3.10 MPa	Permeability: 3.27E-05 ±6.92E-05 m/s	Constrained Mod.: 34.01 ±18.19 MPa
Sleeve friction: 24.95 ±8.45 kPa	N_{60}: 9.68 ±5.43 blows	Go: 37.38 ±13.09 MPa
Ic: 2.23 ±0.43	Es: 36.59 ±9.68 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 40.93 ±12.21	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 35.47 ±1.83 °	O.C.R.: 0.00 ±0.00
	Unit weight: 16.97 ±0.69 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 6.62 (m), **End depth:** 7.52 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.04 ±0.65 MPa	Permeability: 2.16E-07 ±4.70E-07 m/s	Constrained Mod.: 11.44 ±10.33 MPa
Sleeve friction: 18.28 ±10.18 kPa	N_{60}: 4.52 ±1.63 blows	Go: 23.08 ±7.24 MPa
Ic: 2.90 ±0.43	Es: 0.00 ±0.00 MPa	Su: 43.02 ±27.63 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.64 ±0.39
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.98 ±1.79
	Unit weight: 16.07 ±0.78 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 7.52 (m), **End depth:** 8.06 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.47 ±0.04 MPa	Permeability: 1.25E-09 ±9.69E-10 m/s	Constrained Mod.: 1.70 ±0.45 MPa
Sleeve friction: 12.15 ±1.66 kPa	N_{60}: 3.00 ±0.00 blows	Go: 16.54 ±0.71 MPa
Ic: 3.30 ±0.10	Es: 0.00 ±0.00 MPa	Su: 24.32 ±3.08 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.35 ±0.05
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.62 ±0.22
	Unit weight: 15.55 ±0.15 kN/m³	

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Lot 6 Onion Field LBI, Guyana.
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Project: **Soil Testing Services for Solar Photovoltaic Farm**
Location: **Leguan, Region No. 3.**

CPT: #5
Total depth: 8.06 m, Date: 12/18/2022
Coords: 6°55'52.4" N 58°22'10.9" W

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_0 (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.06 0.62	0.56	1.46E-04 (±1.11E-04)	16.2 (±4.9)	43.1 (±10.2)	90.3 (±13.1)	44.5 (±1.6)	54.0 (±12.8)	54.9 (±14.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	18.9 (±0.4)
0.62 1.28	0.66	3.79E-07 (±1.34E-06)	2.9 (±1.9)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	9.4 (±9.2)	16.3 (±7.5)	36.1 (±22.1)	1.9 (±1.2)	8.8 (±5.4)	16.6 (±0.8)
1.28 3.76	2.48	6.05E-08 (±1.67E-07)	1.5 (±0.9)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.5 (±4.1)	9.0 (±3.3)	12.6 (±12.3)	0.3 (±0.3)	1.6 (±1.2)	14.8 (±0.6)
3.76 4.46	0.70	7.94E-06 (±6.59E-06)	8.4 (±2.2)	28.5 (±4.9)	37.5 (±6.2)	34.3 (±1.2)	34.1 (±8.3)	32.0 (±6.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	16.7 (±0.4)
4.46 5.34	0.88	6.44E-08 (±2.09E-07)	3.0 (±0.8)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	6.1 (±5.0)	16.1 (±2.1)	35.3 (±13.7)	0.7 (±0.3)	3.1 (±1.2)	15.6 (±0.2)
5.34 6.62	1.28	3.27E-05 (±6.92E-05)	9.7 (±5.4)	36.6 (±9.7)	40.9 (±12.2)	35.5 (±1.8)	34.0 (±18.2)	37.4 (±13.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.0 (±0.7)
6.62 7.52	0.90	2.16E-07 (±4.70E-07)	4.5 (±1.6)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	11.4 (±10.3)	23.1 (±7.2)	43.0 (±27.6)	0.6 (±0.4)	3.0 (±1.8)	16.1 (±0.8)
7.52 8.06	0.54	1.25E-09 (±9.69E-10)	3.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.7 (±0.4)	16.5 (±0.7)	24.3 (±3.1)	0.4 (±0.0)	1.6 (±0.2)	15.6 (±0.2)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(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)

•N Barounis, J Philpot, Estimation of in-situ water content, void ratio, dry unit weight and porosity using CPT for saturated sands, Proc. 20th NZGS Geotechnical Symposium

CPT#6

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Lot 6 Onion Field LBI, Guyana.
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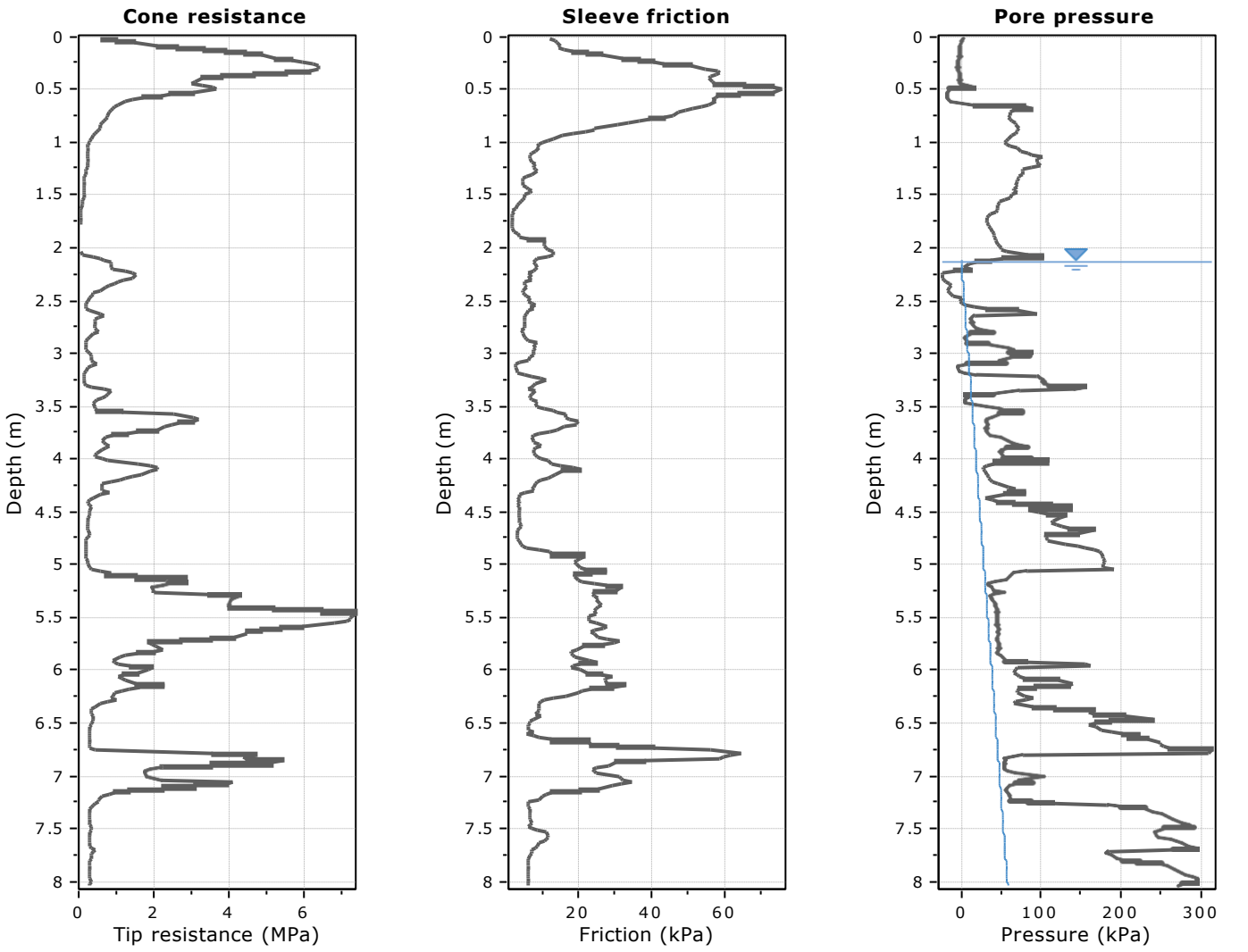
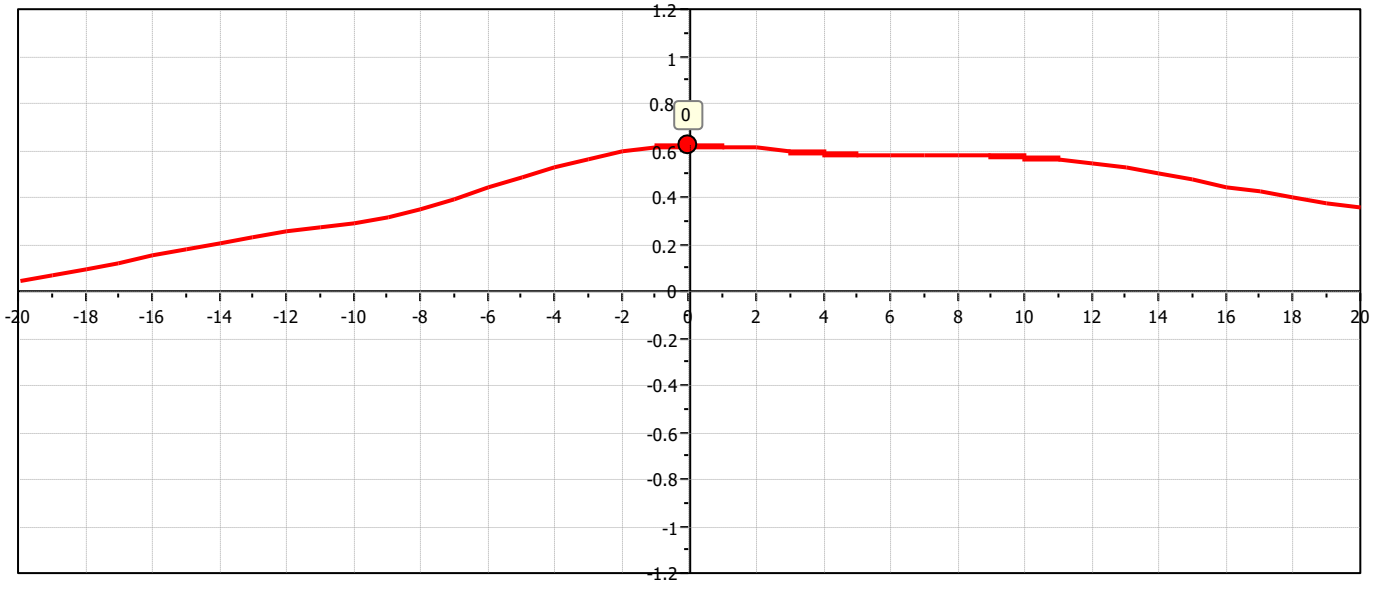
CPT: #6

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

epth: 8.04 m, Date: 12/18/2022
rds: 6°55'53.6" N 58°22'9.6" W



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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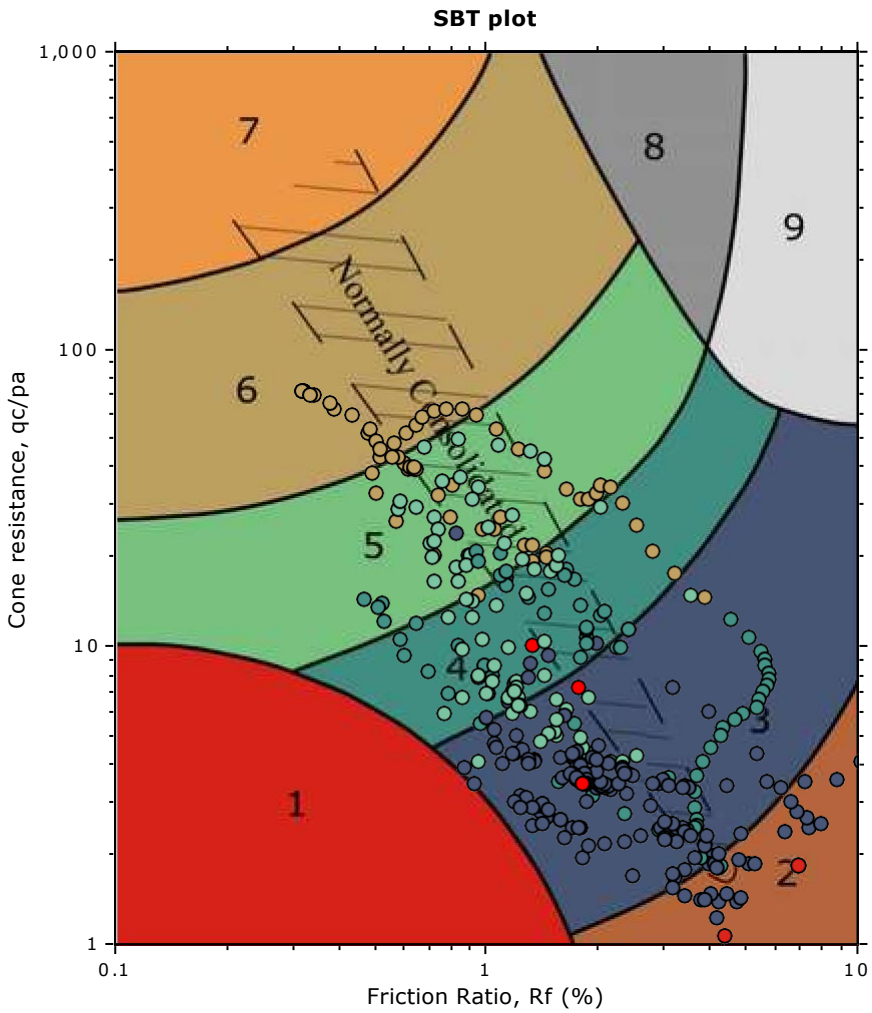
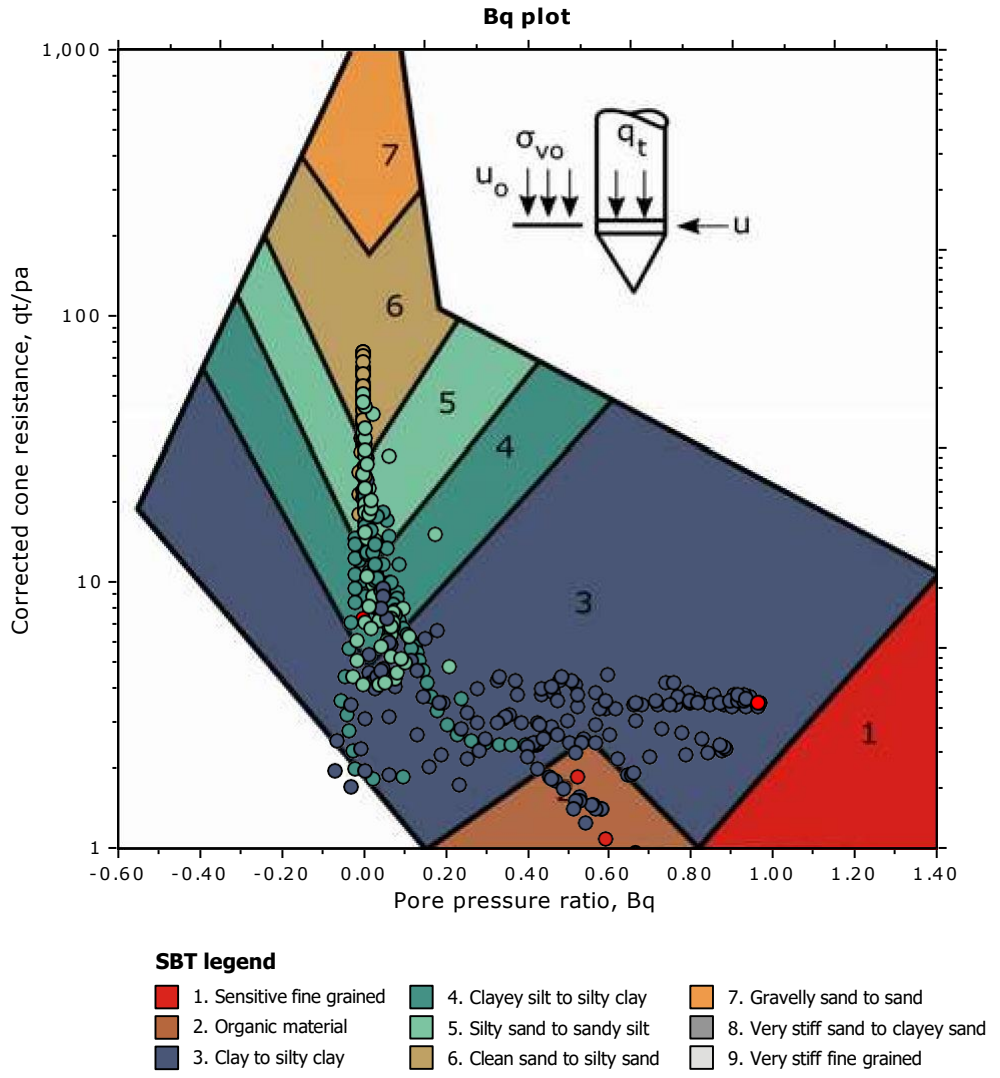
Project: **Soil Testing Services for Solar Photovoltaic Farm**
Location: **Leguan, Region No. 3.**

CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

SBT - Bq plots





SBT legend

1. Sensitive fine grained	4. Clayey silt to silty clay	7. Gravelly 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

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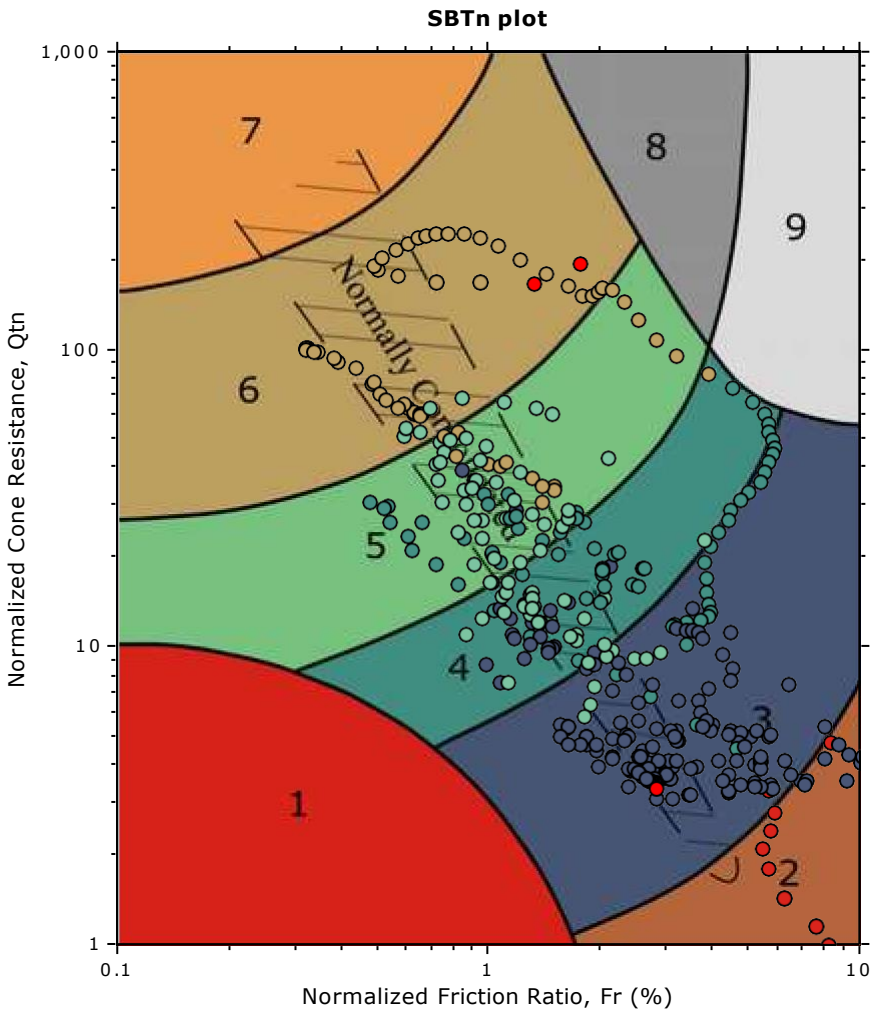
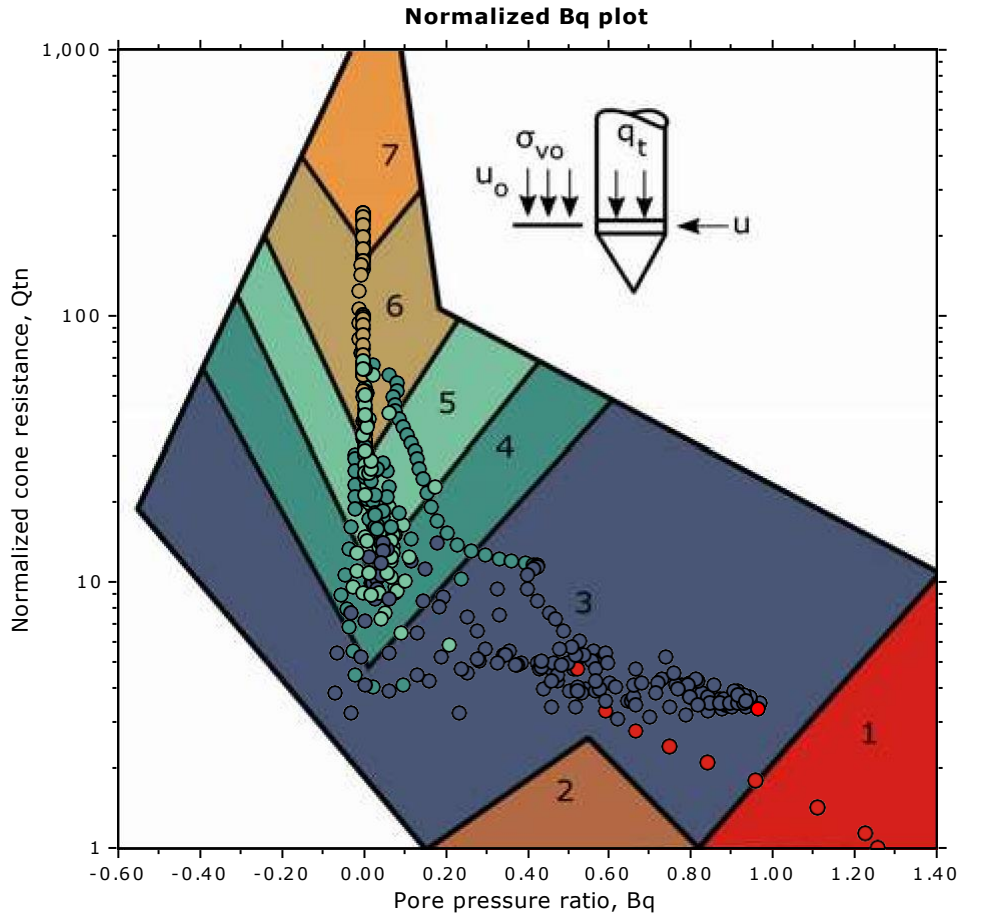
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

SBT - Bq plots (normalized)





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. Gravelly sand to sand
- 8. Very stiff sand to clayey sand
- 9. Very stiff fine grained

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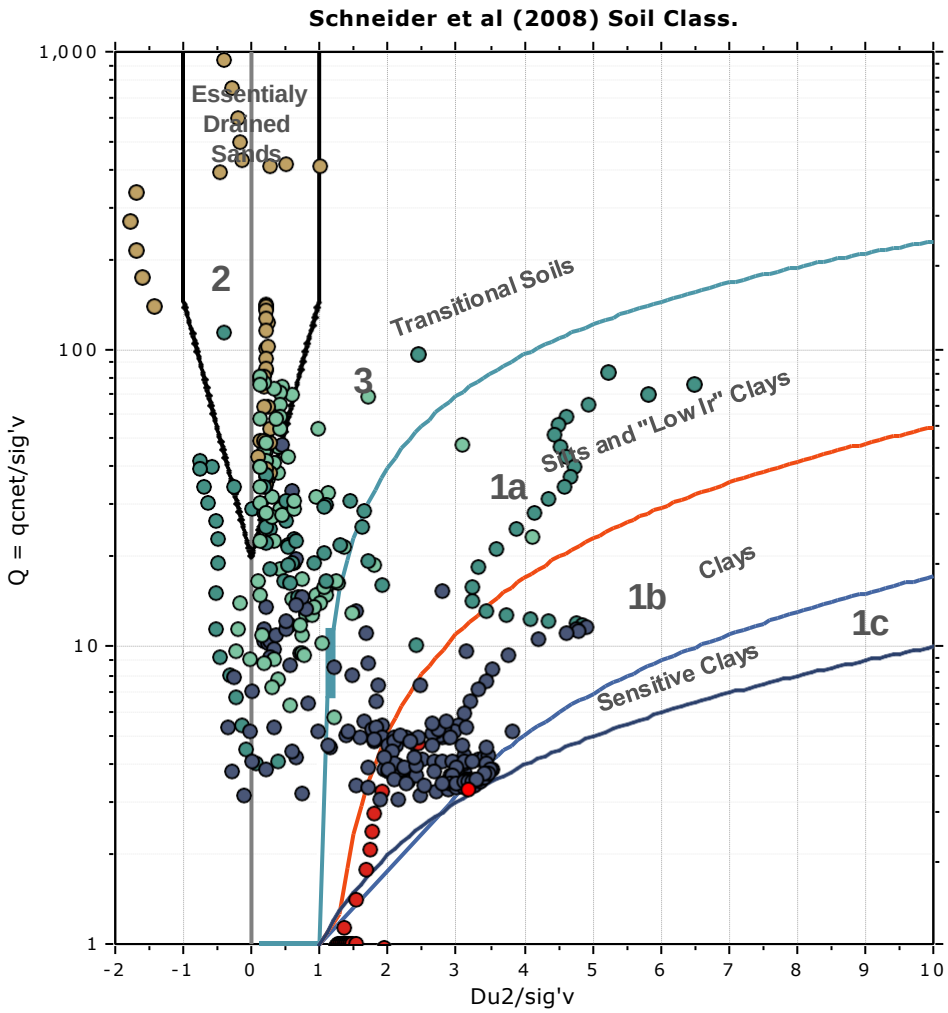
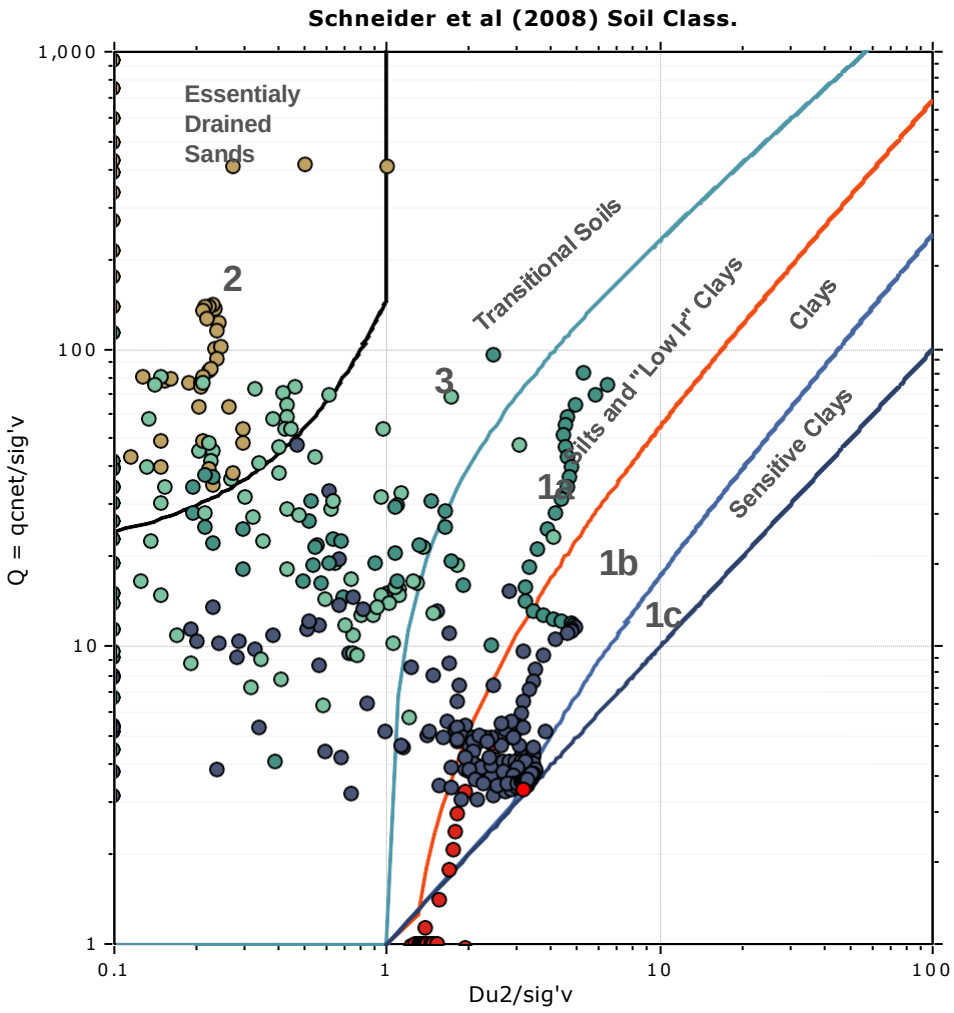
CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Bq plots (Schneider)





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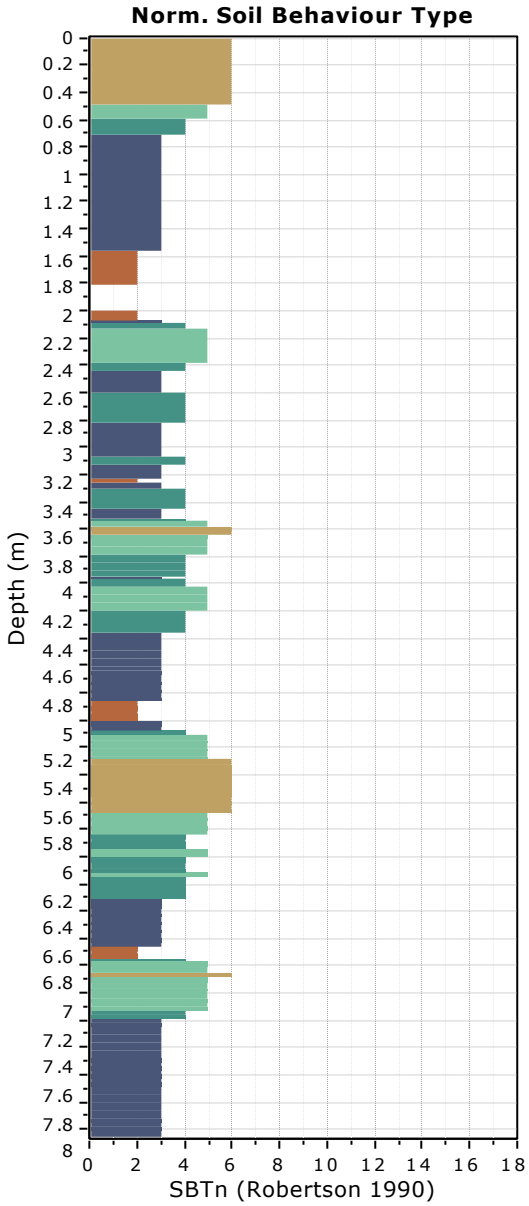
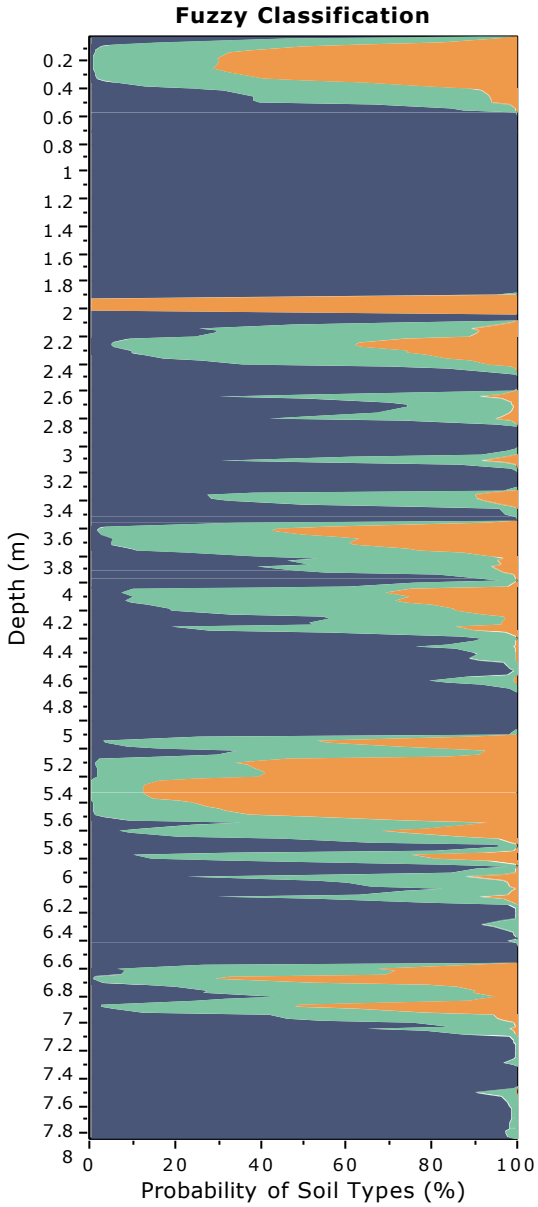
Project: **Soil Testing Services for Solar Photovoltaic Farm**
Location: **Leguan, Region No. 3.**

CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W





Fuzzy classifiaction legend

- Highly probable clayey soil
- Highly probable mixture soil
- Highly probable sandy soil

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CPT: #6
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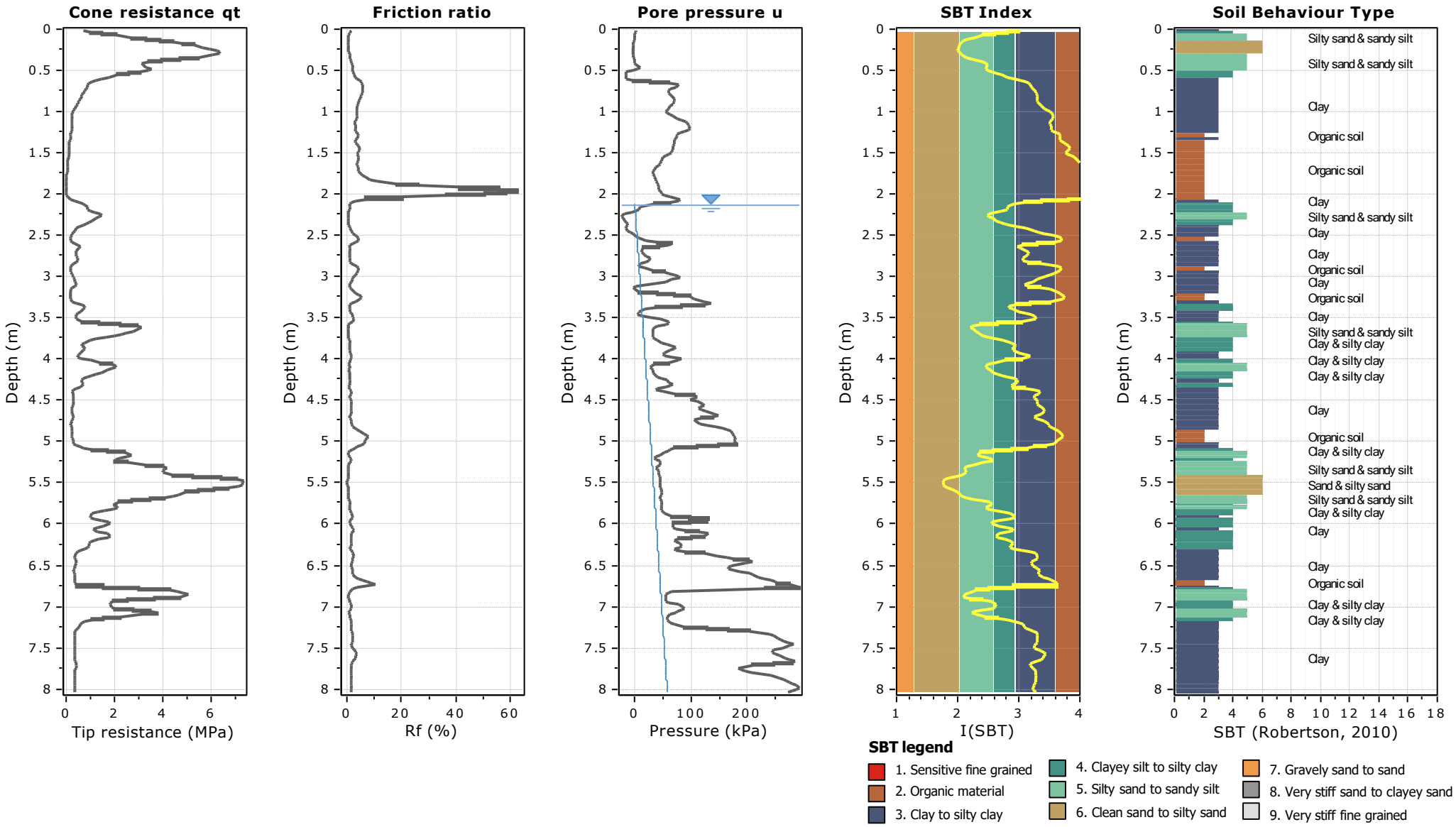
Coords: 6°55'53.6" N 58°22'9.6" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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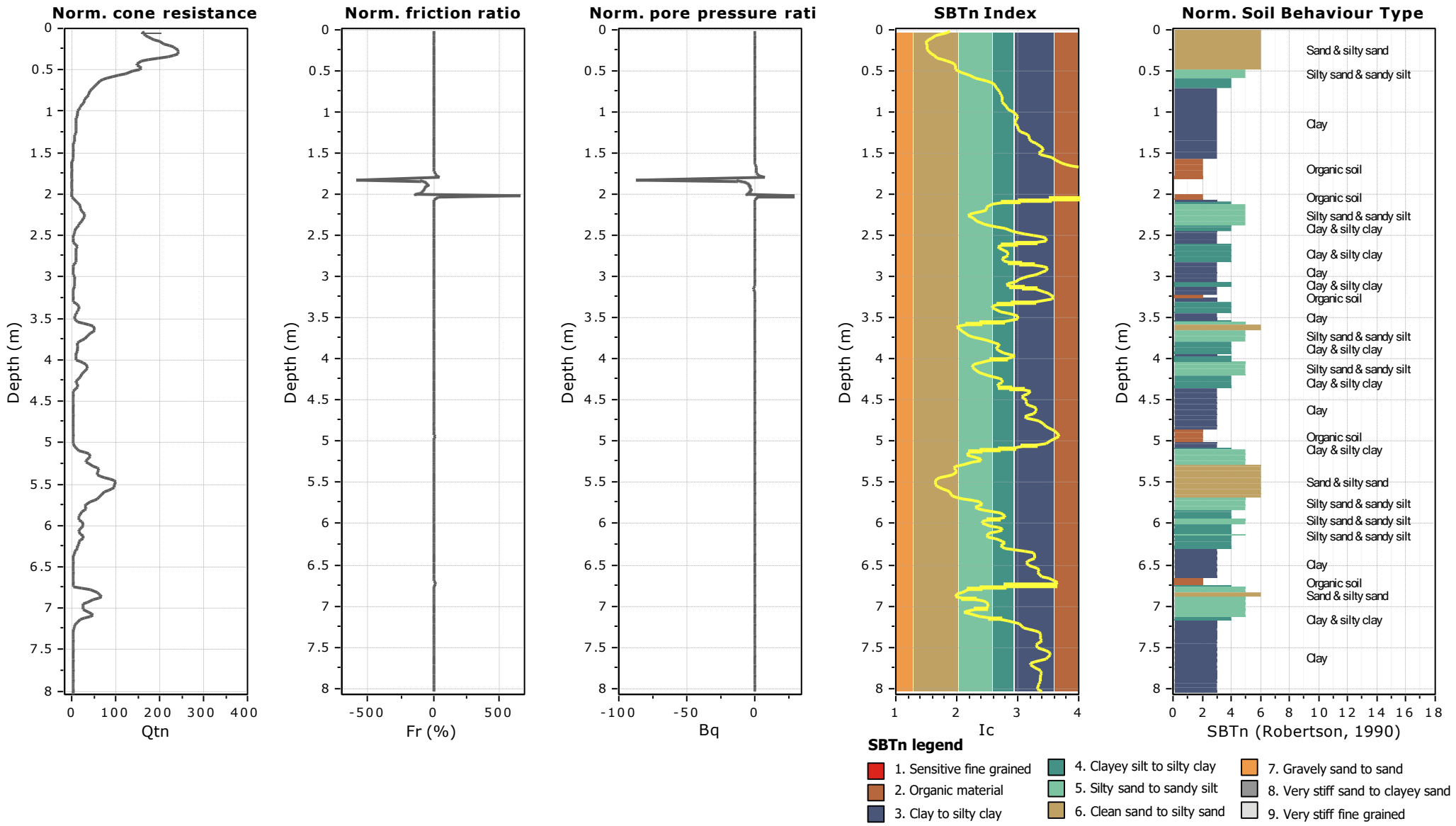
CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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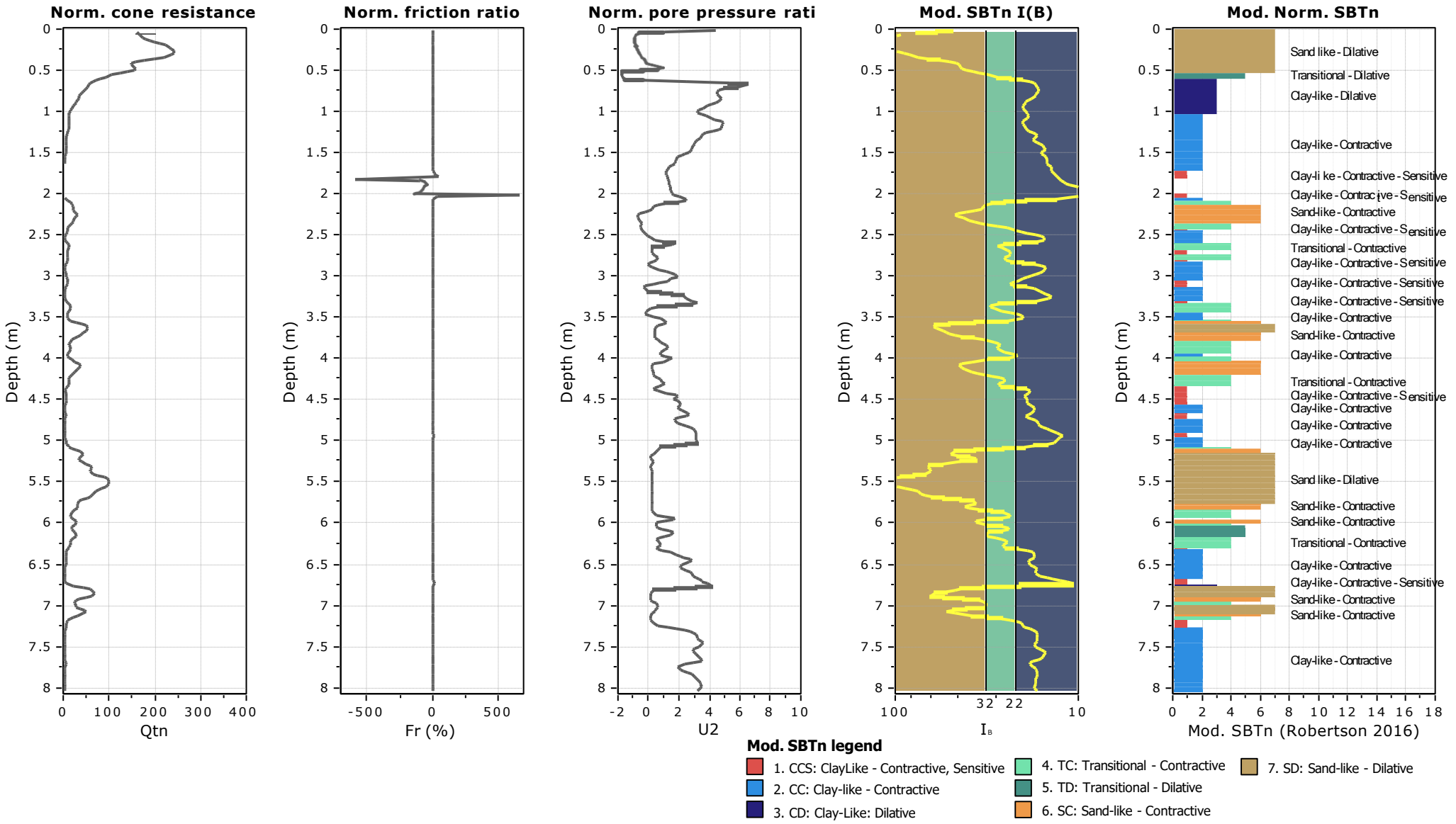
CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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Lot 6 Onion Field LBI, Guyana.
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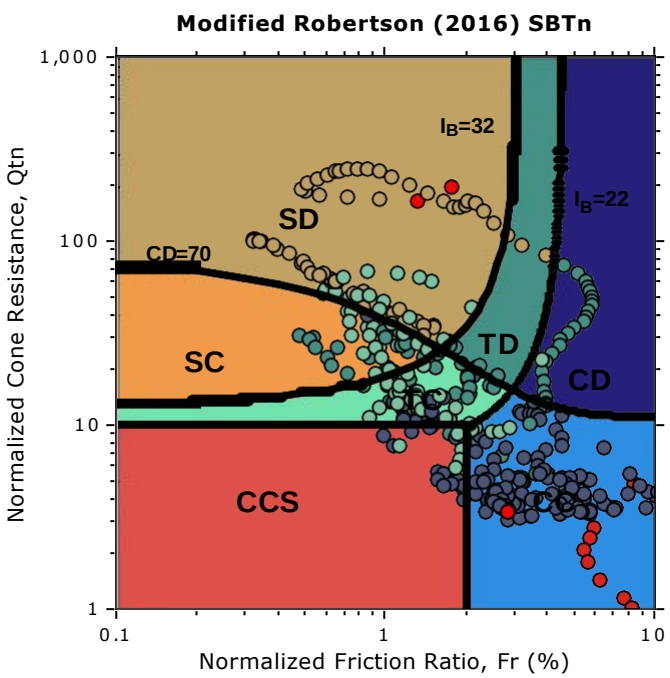
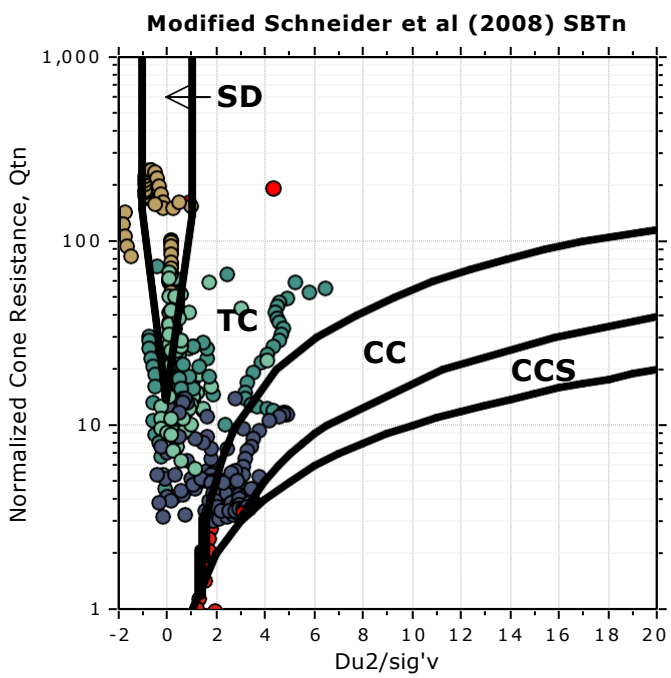
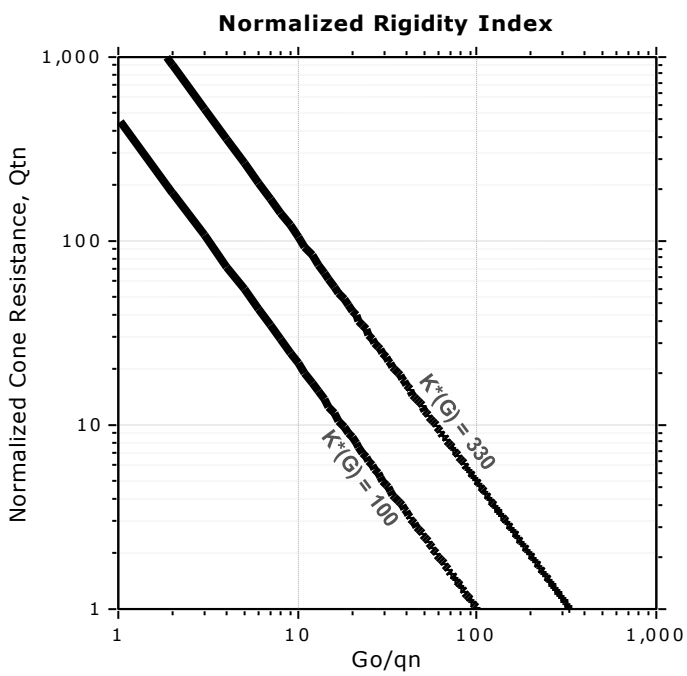
Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Updated SBTn plots







CCS: Clay-like - Contractive - Sensitive
CC: Clay-like - Contractive
CD: Clay-like - Dilative
TC: Transitional - Contractive
TD: Transitional - Dilative
SC: Sand-like - Contractive
SD: Sand-like - Dilative

K(G) > 330: Soils with significant microstructure (e.g. age/cementation)

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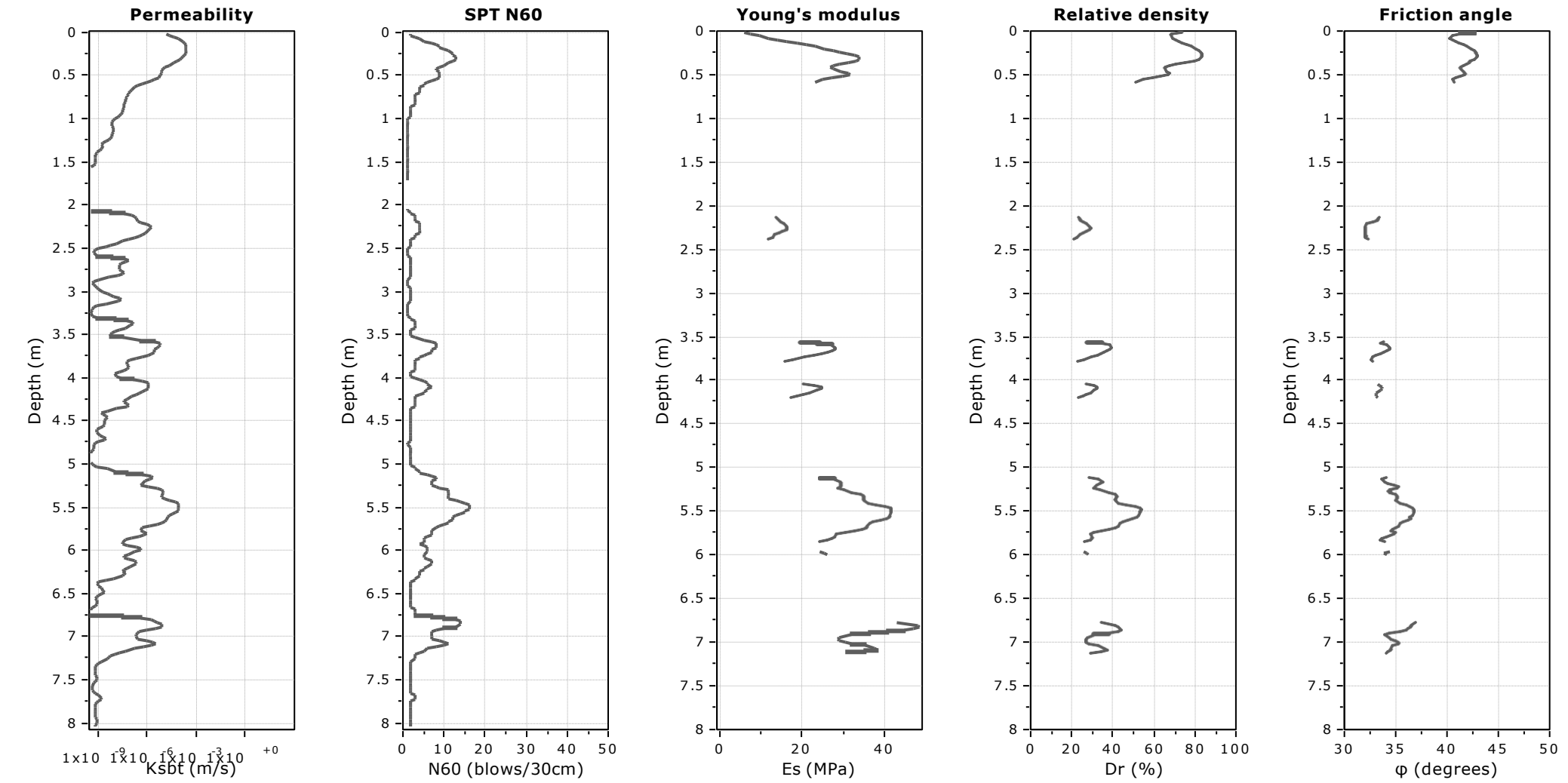
CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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 density constant, C_{Dr}: 350.0
Phi: Based on Kulhawy & Mayne (1990)

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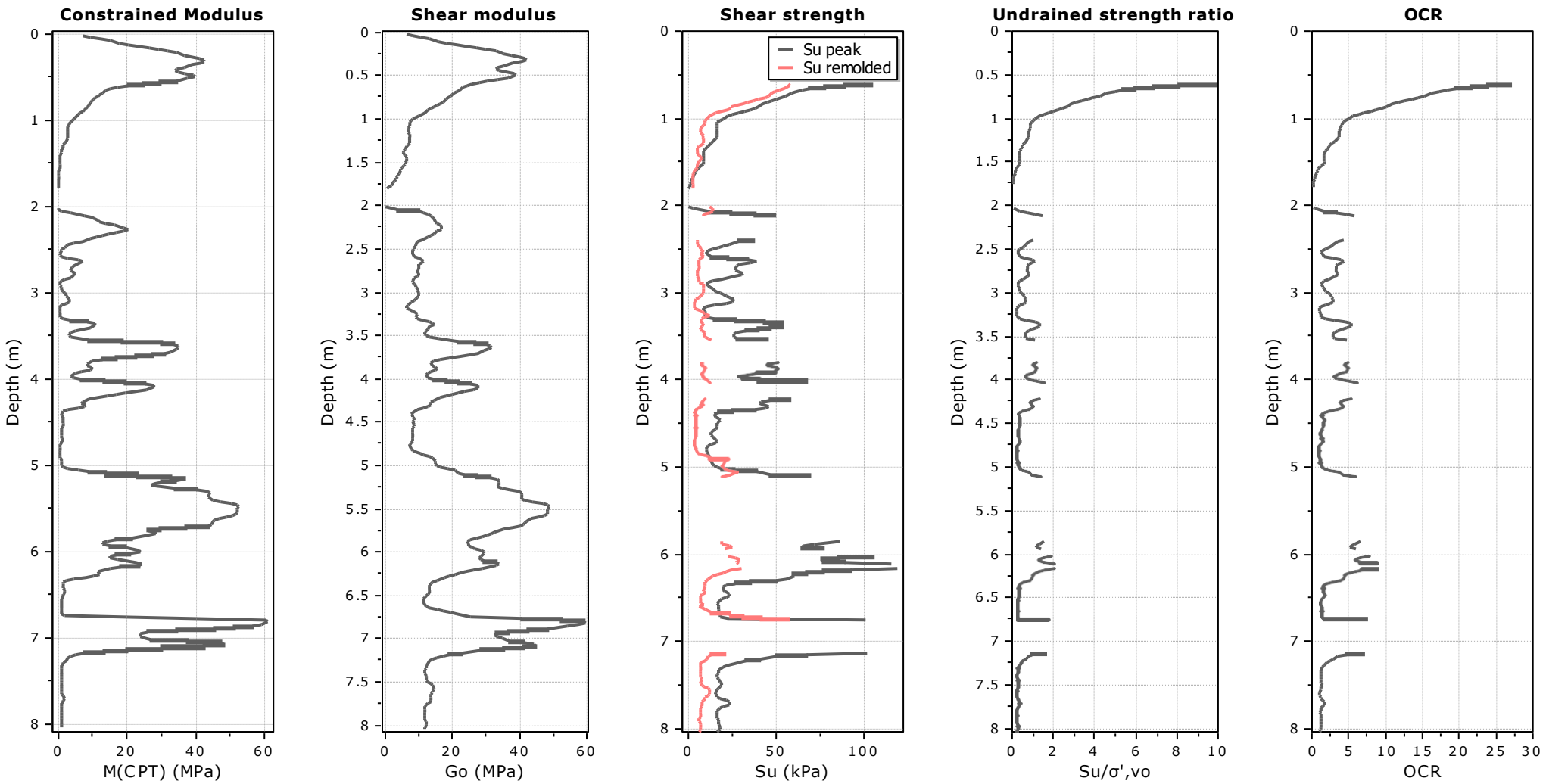
CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.



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
Flat Dilatometer Test data

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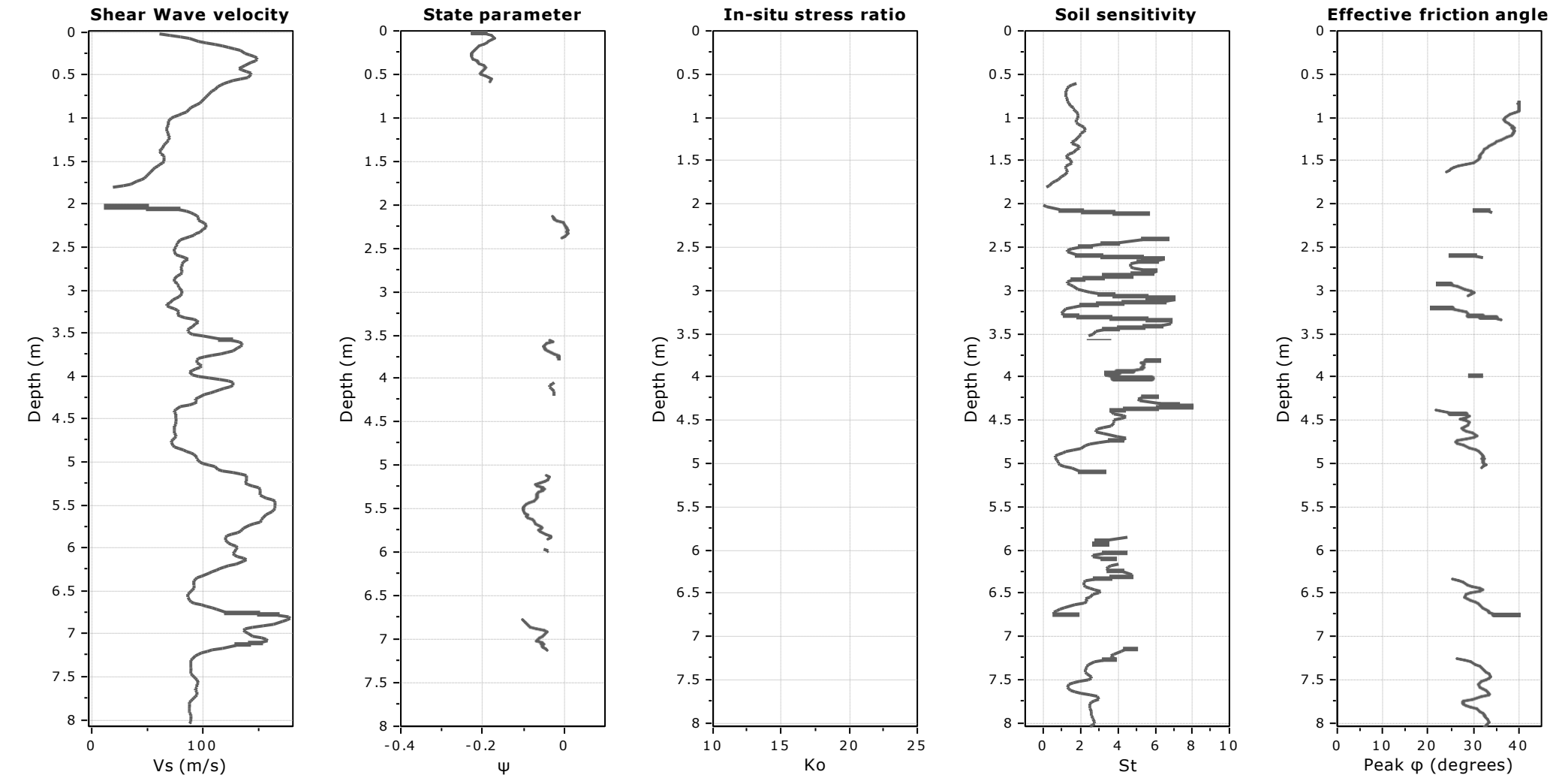

Calculation parameters

Soil Sensitivity factor, N_S: 7.00

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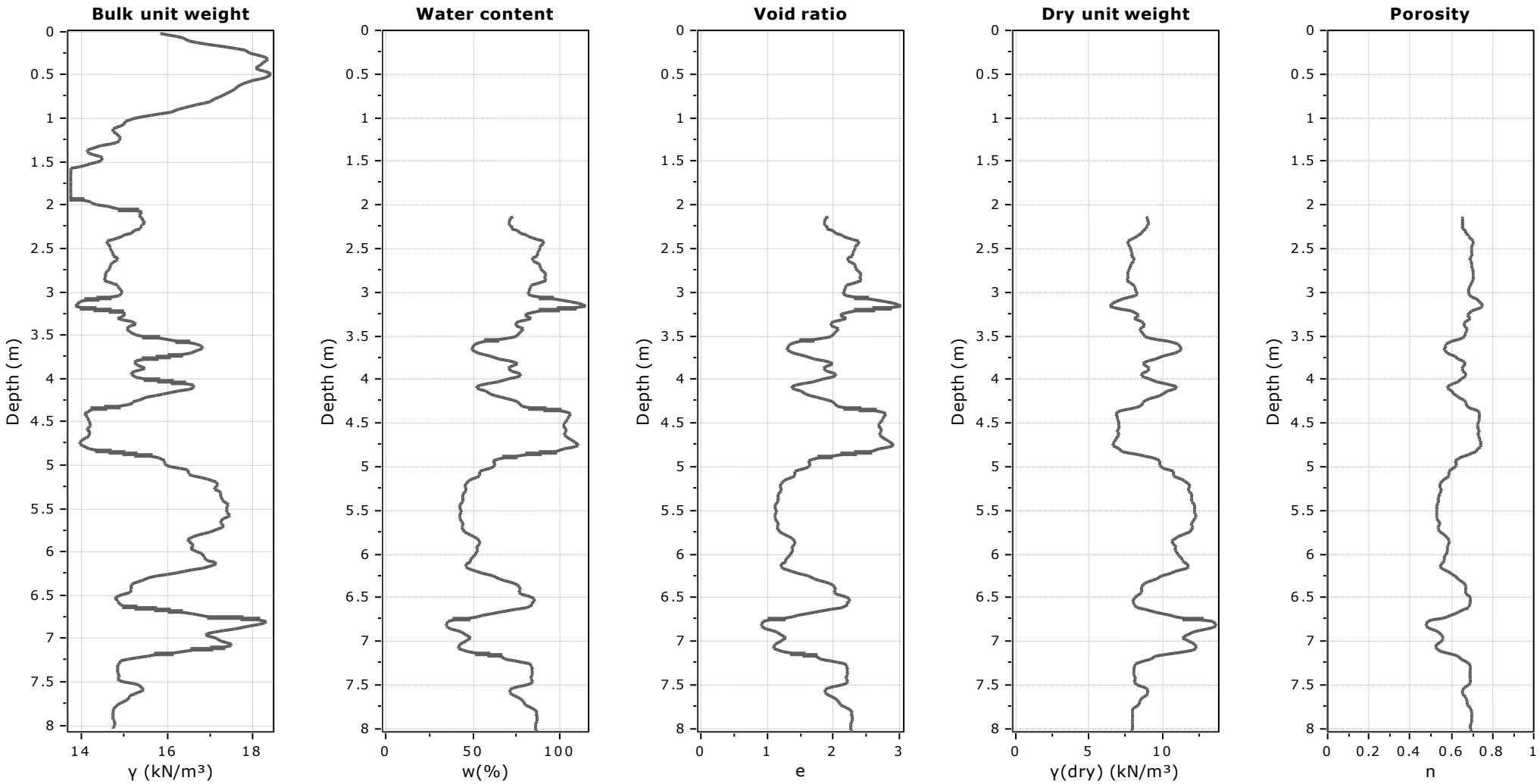

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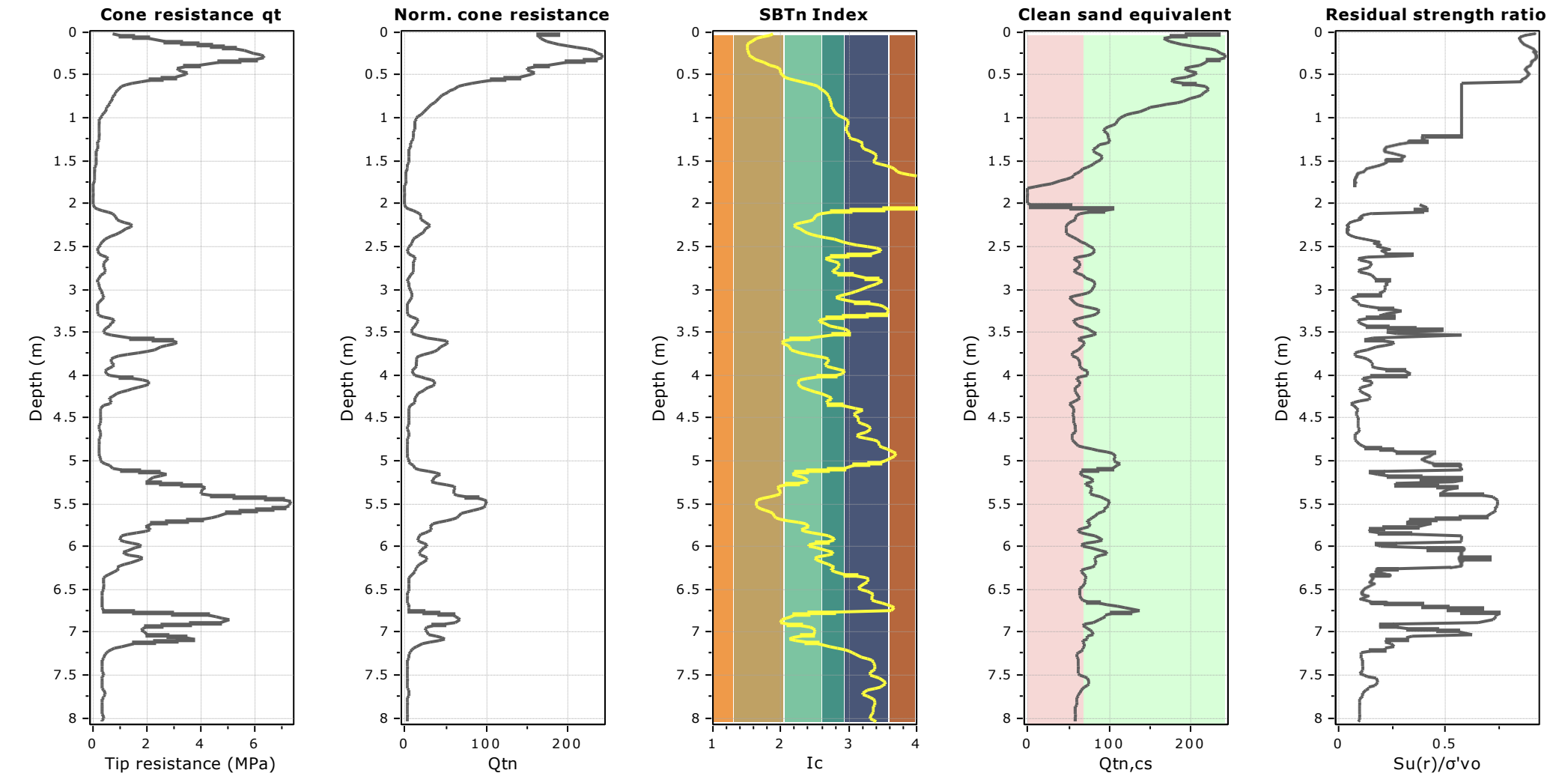

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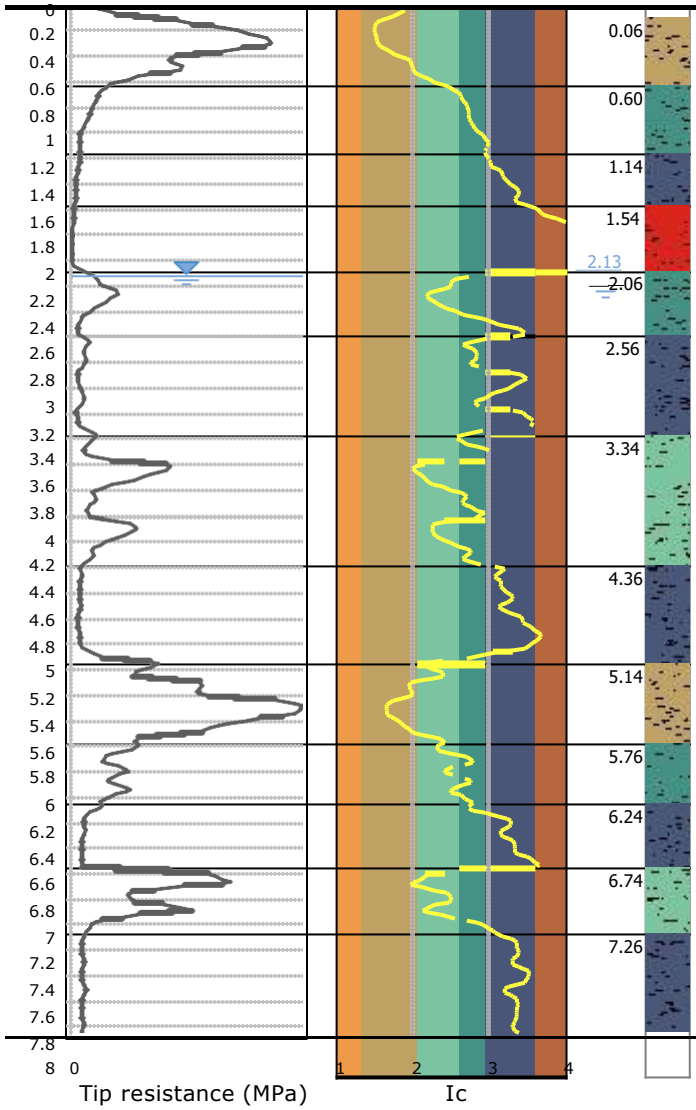
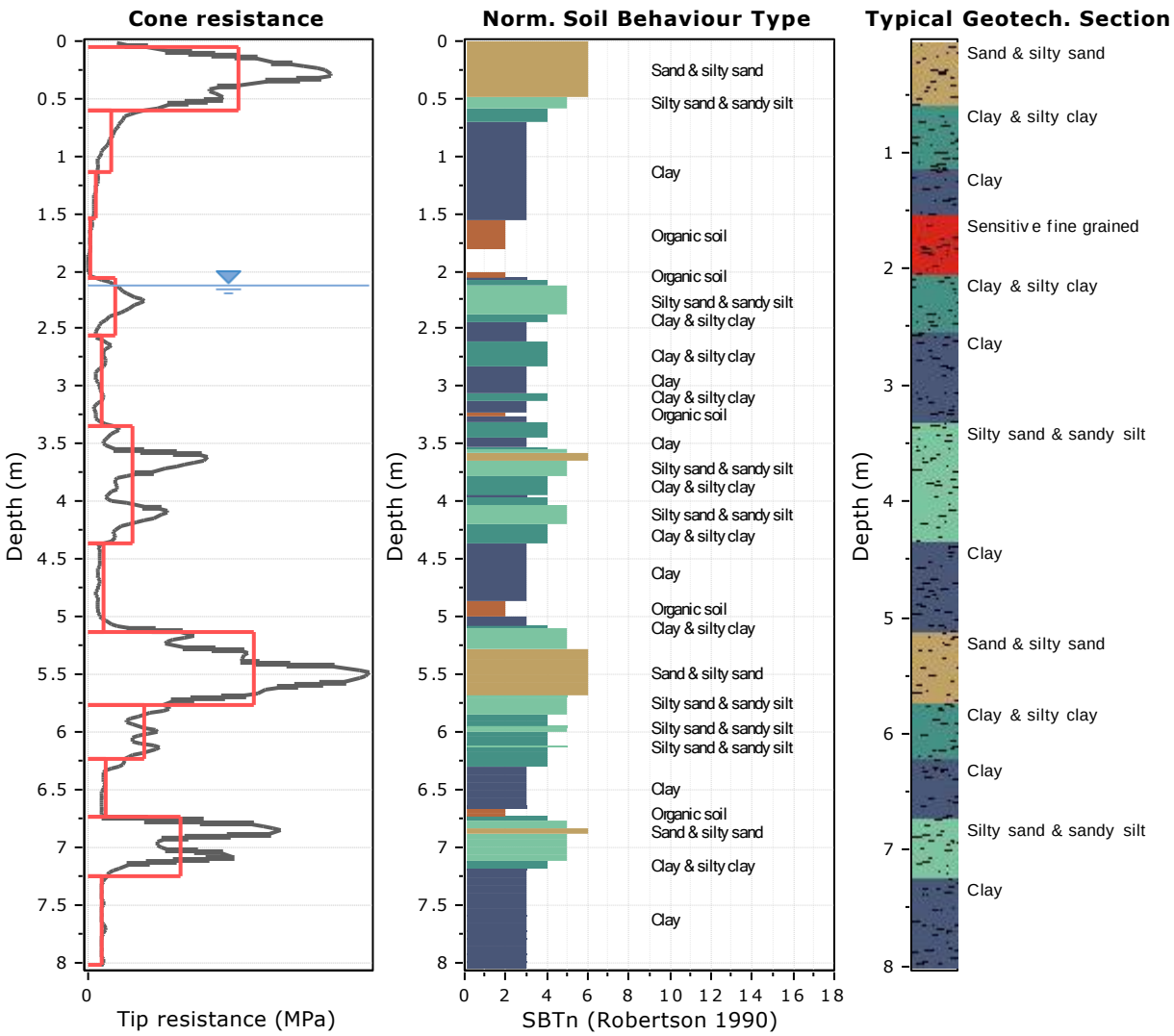


Description	qt (MPa)	Ksbt (m/s)	N60	Es (MPa)	Dr	Phi (°)	M (MPa)	Go (MPa)	Su (kPa)	Su ratio	OCR	Gamma (kN/m³)
Sand & silty sand	3.9	9.56E-5	8.9	26.0	71.6	41.7	31.9	31.1	-	-	-	17.8
Clay & silty clay	0.6	6.54E-8	2.5	-	-	-	8.1	14.3	41.8	2.4	11.1	16.3
Clay	0.2	2.92E-9	1.0	-	-	-	1.3	6.4	11.6	0.5	2.5	14.5
Sensitive fine grained	0.1	3.22E-10	1.0	-	-	-	0.2	3.5	3.2	0.1	0.5	14.0
Clay & silty clay	0.7	3.93E-7	2.6	-	-	-	8.8	12.3	22.5	0.6	2.8	15.1
Clay	0.3	1.40E-8	1.6	-	-	-	2.4	9.2	20.1	0.5	2.4	14.6
Silty sand & sandy silt	1.2	8.36E-7	4.1	22.6	31.1	33.5	14.5	18.1	-	-	-	15.7
Clay	0.4	5.83E-8	2.3	-	-	-	2.9	11.8	17.7	0.4	1.7	14.9
Sand & silty sand	4.3	2.30E-5	11.1	35.1	41.6	35.4	42.3	40.7	-	-	-	17.2
Clay & silty clay	1.5	2.19E-7	5.8	-	-	-	19.2	28.1	82.6	1.4	6.4	16.7
Clay	0.5	7.05E-9	2.5	-	-	-	2.8	15.2	25.9	0.4	2.0	15.4
Silty sand & sandy silt	2.4	1.46E-6	8.0	37.1	34.8	35.2	30.1	36.4	-	-	-	17.0
Clay	0.4	8.79E-10	2.1	-	-	-	1.0	12.6	18.0	0.3	1.3	14.9



Tabular results

.:: Layer No: 1 ::.

Code: Layer_1 **Start depth:** 0.06 (m), **End depth:** 0.60 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 3.90 ±1.54 MPa	Permeability: 9.56E-05 ±9.55E-05 m/s	Constrained Mod.: 31.92 ±8.71 MPa
Sleeve friction: 46.98 ±19.48 kPa	N_{60}: 8.89 ±2.71 blows	Go: 31.07 ±8.75 MPa
Ic: 1.79 ±0.27	Es: 25.99 ±6.74 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 71.64 ±8.72	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 41.68 ±0.79 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.77 ±0.66 kN/m³	

.:: Layer No: 2 ::.

Code: Layer_2 **Start depth:** 0.60 (m), **End depth:** 1.14 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.60 ±0.33 MPa	Permeability: 6.54E-08 ±9.77E-08 m/s	Constrained Mod.: 8.09 ±4.81 MPa
Sleeve friction: 28.70 ±18.40 kPa	N_{60}: 2.46 ±1.26 blows	Go: 14.33 ±6.16 MPa
Ic: 2.77 ±0.16	Es: 0.00 ±0.00 MPa	Su: 41.76 ±24.01 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 2.40 ±1.45
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 11.08 ±6.71
	Unit weight: 16.32 ±1.08 kN/m³	

.:: Layer No: 3 ::.

Code: Layer_3 **Start depth:** 1.14 (m), **End depth:** 1.54 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.18 ±0.05 MPa	Permeability: 2.92E-09 ±2.92E-09 m/s	Constrained Mod.: 1.33 ±0.85 MPa
Sleeve friction: 6.74 ±1.31 kPa	N_{60}: 1.00 ±0.00 blows	Go: 6.38 ±0.70 MPa
Ic: 3.21 ±0.17	Es: 0.00 ±0.00 MPa	Su: 11.56 ±3.38 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.53 ±0.20
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.46 ±0.90
	Unit weight: 14.50 ±0.29 kN/m³	

.:: Layer No: 4 ::.

Code: Layer_4 **Start depth:** 1.54 (m), **End depth:** 2.06 (m)

Description: Sensitive fine grained

Basic results	Estimation results	
Total cone resistance: 0.05 ±0.04 MPa	Permeability: 3.22E-10 ±1.32E-10 m/s	Constrained Mod.: 0.18 ±0.16 MPa
Sleeve friction: 5.48 ±4.03 kPa	N_{60}: 1.00 ±0.00 blows	Go: 3.47 ±2.21 MPa
Ic: 2.43 ±1.91	Es: 0.00 ±0.00 MPa	Su: 3.24 ±2.79 kPa
SBT_n: 1	Dr (%): 0.00 ±0.00	Su ratio: 0.12 ±0.10
SBTn description: Sensitive fine grained	φ (degrees): 0.00 ±0.00 °	O.C.R.: 0.54 ±0.45
	Unit weight: 13.95 ±0.40 kN/m³	

.:: Layer No: 5 ::.

Code: Layer_5 **Start depth:** 2.06 (m), **End depth:** 2.56 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 0.71 ±0.42 MPa	Permeability: 3.93E-07 ±5.72E-07 m/s	Constrained Mod.: 8.79 ±6.55 MPa
Sleeve friction: 7.48 ±1.94 kPa	N_{60}: 2.62 ±1.10 blows	Go: 12.31 ±3.04 MPa
Ic: 2.72 ±0.43	Es: 0.00 ±0.00 MPa	Su: 22.48 ±12.43 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 0.61 ±0.31
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.84 ±1.43
	Unit weight: 15.06 ±0.34 kN/m³	

.:: Layer No: 6 ::.

Code: Layer_6 **Start depth:** 2.56 (m), **End depth:** 3.34 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.33 ±0.13 MPa	Permeability: 1.40E-08 ±1.86E-08 m/s	Constrained Mod.: 2.43 ±2.02 MPa
Sleeve friction: 6.48 ±1.91 kPa	N_{60}: 1.65 ±0.53 blows	Go: 9.23 ±1.28 MPa
Ic: 3.11 ±0.30	Es: 0.00 ±0.00 MPa	Su: 20.13 ±9.27 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.52 ±0.22
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.39 ±1.03
	Unit weight: 14.64 ±0.32 kN/m³	

.:: Layer No: 7 ::.

Code: Layer_7 **Start depth:** 3.34 (m), **End depth:** 4.36 (m)

Description: Silty sand & sandy silt

Basic results	Estimation results	
Total cone resistance: 1.17 ±0.77 MPa	Permeability: 8.36E-07 ±1.59E-06 m/s	Constrained Mod.: 14.51 ±10.14 MPa
Sleeve friction: 11.08 ±4.37 kPa	N_{60}: 4.08 ±1.89 blows	Go: 18.11 ±6.42 MPa
Ic: 2.55 ±0.28	Es: 22.63 ±3.63 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 31.11 ±4.81	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 33.48 ±0.51 °	O.C.R.: 0.00 ±0.00
	Unit weight: 15.66 ±0.64 kN/m³	

.:: Layer No: 8 ::.

Code: Layer_8 **Start depth:** 4.36 (m), **End depth:** 5.14 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.41 ±0.42 MPa	Permeability: 5.83E-08 ±2.81E-07 m/s	Constrained Mod.: 2.94 ±6.39 MPa
Sleeve friction: 9.82 ±7.87 kPa	N_{60}: 2.33 ±1.12 blows	Go: 11.78 ±5.92 MPa
Ic: 3.24 ±0.32	Es: 0.00 ±0.00 MPa	Su: 17.69 ±11.14 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.37 ±0.21
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.71 ±0.98
	Unit weight: 14.85 ±0.99 kN/m³	

.:: Layer No: 9 ::.

Code: Layer_9 **Start depth:** 5.14 (m), **End depth:** 5.76 (m)

Description: Sand & silty sand

Basic results	Estimation results	
Total cone resistance: 4.33 ±1.79 MPa	Permeability: 2.30E-05 ±3.00E-05 m/s	Constrained Mod.: 42.28 ±8.30 MPa
Sleeve friction: 25.70 ±2.69 kPa	N_{60}: 11.06 ±2.98 blows	Go: 40.68 ±5.63 MPa
Ic: 2.00 ±0.25	Es: 35.14 ±4.60 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 6	Dr (%): 41.64 ±7.66	Su ratio: 0.00 ±0.00
SBTn description: Sand & silty sand	φ (degrees): 35.37 ±0.86 °	O.C.R.: 0.00 ±0.00
	Unit weight: 17.24 ±0.16 kN/m³	

.:: Layer No: 10 ::.

Code: Layer_10 **Start depth:** 5.76 (m), **End depth:** 6.24 (m)

Description: Clay & silty clay

Basic results	Estimation results	
Total cone resistance: 1.46 ±0.37 MPa	Permeability: 2.19E-07 ±2.32E-07 m/s	Constrained Mod.: 19.19 ±5.22 MPa
Sleeve friction: 23.06 ±4.45 kPa	N_{60}: 5.76 ±0.97 blows	Go: 28.13 ±3.13 MPa
Ic: 2.58 ±0.16	Es: 0.00 ±0.00 MPa	Su: 82.59 ±17.71 kPa
SBT_n: 4	Dr (%): 0.00 ±0.00	Su ratio: 1.38 ±0.26
SBTn description: Clay & silty clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 6.38 ±1.21
	Unit weight: 16.72 ±0.23 kN/m³	

.:: Layer No: 11 ::.

Code: Layer_11 **Start depth:** 6.24 (m), **End depth:** 6.74 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.46 ±0.19 MPa	Permeability: 7.05E-09 ±1.37E-08 m/s	Constrained Mod.: 2.82 ±3.43 MPa
Sleeve friction: 12.42 ±8.35 kPa	N_{60}: 2.54 ±0.76 blows	Go: 15.16 ±3.87 MPa
Ic: 3.24 ±0.27	Es: 0.00 ±0.00 MPa	Su: 25.89 ±13.90 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.44 ±0.23
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 2.02 ±1.07
	Unit weight: 15.42 ±0.60 kN/m³	

.:: Layer No: 12 ::.

Code: Layer_12 **Start depth:** 6.74 (m), **End depth:** 7.26 (m)

Description: Silty sand & sandy silt

Basic results	Estimation results	
Total cone resistance: 2.41 ±1.47 MPa	Permeability: 1.46E-06 ±2.19E-06 m/s	Constrained Mod.: 30.11 ±19.48 MPa
Sleeve friction: 30.88 ±17.02 kPa	N_{60}: 8.00 ±3.64 blows	Go: 36.40 ±13.85 MPa
Ic: 2.50 ±0.40	Es: 37.11 ±6.91 MPa	Su: 0.00 ±0.00 kPa
SBT_n: 5	Dr (%): 34.78 ±6.08	Su ratio: 0.00 ±0.00
SBTn description: Silty sand & sandy silt	φ (degrees): 35.15 ±0.91 °	O.C.R.: 0.00 ±0.00
	Unit weight: 16.98 ±0.97 kN/m³	

.:: Layer No: 13 ::.

Code: Layer_13 **Start depth:** 7.26 (m), **End depth:** 8.02 (m)

Description: Clay

Basic results	Estimation results	
Total cone resistance: 0.37 ±0.03 MPa	Permeability: 8.79E-10 ±5.30E-10 m/s	Constrained Mod.: 0.98 ±0.29 MPa
Sleeve friction: 7.67 ±1.72 kPa	N_{60}: 2.10 ±0.31 blows	Go: 12.58 ±0.88 MPa
Ic: 3.35 ±0.09	Es: 0.00 ±0.00 MPa	Su: 17.97 ±2.33 kPa
SBT_n: 3	Dr (%): 0.00 ±0.00	Su ratio: 0.27 ±0.04
SBTn description: Clay	φ (degrees): 0.00 ±0.00 °	O.C.R.: 1.26 ±0.17
	Unit weight: 14.93 ±0.21 kN/m³	

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Project: Soil Testing Services for Solar Photovoltaic Farm
Location: Leguan, Region No. 3.

CPT: #6
Total depth: 8.04 m, Date: 12/18/2022
Coords: 6°55'53.6" N 58°22'9.6" W

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_O (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m³)
0.06 0.60	0.54	9.56E-05 (±9.55E-05)	8.9 (±2.7)	26.0 (±6.7)	71.6 (±8.7)	41.7 (±0.8)	31.9 (±8.7)	31.1 (±8.7)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.8 (±0.7)
0.60 1.14	0.54	6.54E-08 (±9.77E-08)	2.5 (±1.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	8.1 (±4.8)	14.3 (±6.2)	41.8 (±24.0)	2.4 (±1.5)	11.1 (±6.7)	16.3 (±1.1)
1.14 1.54	0.40	2.92E-09 (±2.92E-09)	1.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.3 (±0.8)	6.4 (±0.7)	11.6 (±3.4)	0.5 (±0.2)	2.5 (±0.9)	14.5 (±0.3)
1.54 2.06	0.52	3.22E-10 (±1.32E-10)	1.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	0.2 (±0.2)	3.5 (±2.2)	3.2 (±2.8)	0.1 (±0.1)	0.5 (±0.4)	14.0 (±0.4)
2.06 2.56	0.50	3.93E-07 (±5.72E-07)	2.6 (±1.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	8.8 (±6.5)	12.3 (±3.0)	22.5 (±12.4)	0.6 (±0.3)	2.8 (±1.4)	15.1 (±0.3)
2.56 3.34	0.78	1.40E-08 (±1.86E-08)	1.6 (±0.5)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.4 (±2.0)	9.2 (±1.3)	20.1 (±9.3)	0.5 (±0.2)	2.4 (±1.0)	14.6 (±0.3)
3.34 4.36	1.02	8.36E-07 (±1.59E-06)	4.1 (±1.9)	22.6 (±3.6)	31.1 (±4.8)	33.5 (±0.5)	14.5 (±10.1)	18.1 (±6.4)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	15.7 (±0.6)
4.36 5.14	0.78	5.83E-08 (±2.81E-07)	2.3 (±1.1)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.9 (±6.4)	11.8 (±5.9)	17.7 (±11.1)	0.4 (±0.2)	1.7 (±1.0)	14.9 (±1.0)
5.14 5.76	0.62	2.30E-05 (±3.00E-05)	11.1 (±3.0)	35.1 (±4.6)	41.6 (±7.7)	35.4 (±0.9)	42.3 (±8.3)	40.7 (±5.6)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.2 (±0.2)
5.76 6.24	0.48	2.19E-07 (±2.32E-07)	5.8 (±1.0)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	19.2 (±5.2)	28.1 (±3.1)	82.6 (±17.7)	1.4 (±0.3)	6.4 (±1.2)	16.7 (±0.2)
6.24 6.74	0.50	7.05E-09 (±1.37E-08)	2.5 (±0.8)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	2.8 (±3.4)	15.2 (±3.9)	25.9 (±13.9)	0.4 (±0.2)	2.0 (±1.1)	15.4 (±0.6)
6.74 7.26	0.52	1.46E-06 (±2.19E-06)	8.0 (±3.6)	37.1 (±6.9)	34.8 (±6.1)	35.2 (±0.9)	30.1 (±19.5)	36.4 (±13.9)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	17.0 (±1.0)

Summary table of mean values

From depth To depth (m)	Thickness (m)	Permeability (m/s)	SPT_{N60} (blows/30cm)	E_s (MPa)	D_r (%)	Friction angle	Constrained modulus, M (MPa)	Shear modulus, G_0 (MPa)	Undrained strength, S_U (kPa)	Undrained strength ratio	OCR	Unit weight (kN/m^3)
7.26 8.02	0.76	8.79E-10 (±5.30E-10)	2.1 (±0.3)	0.0 (±0.0)	0.0 (±0.0)	0.0 (±0.0)	1.0 (±0.3)	12.6 (±0.9)	18.0 (±2.3)	0.3 (±0.0)	1.3 (±0.2)	14.9 (±0.2)

Depth values presented in this table are measured from free ground surface

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) ::

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

where g_w = water unit weight

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

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

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

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

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

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

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

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

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

:: Relative Density, Dr (%) ::

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

:: State Parameter, ψ ::

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

:: Drained Friction Angle, φ (°) ::

$$\varphi = \varphi'_{cv} + 15.94 \log(Q_{tn,cs}) - 26.88$$

(applicable only to SBT_n: 5, 6, 7 and 8 or $I_c < I_{c\_cutoff}$)

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

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

If $I_c \geq 2.20$

$$M_{CPT} = 0.03\ (q_t - \sigma_v)\ 10^{0.55 I_c + 1.68}$$

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

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

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

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

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

$N_{kt} = 10.50 + 7 \log(F_r)$ 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 ::

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

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

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

:: In situ Stress Ratio, Ko ::

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

(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 $I_c > I_{c\_cutoff}$)

:: Peak Friction Angle, φ' (°) ::

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

(applicable for $0.10 < B_q < 1.00$)

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