25 January 2022

3463 OHAUPO ROAD, RUKUHIA

PRELIMINARY GEOTECHNICAL INVESTIGATION REPORT

McConnell Property

HAM2021-0073AC Rev 0

HAM2021-0073AC		
Date	**Revision**	**Comments**
25/01/2022	0	Issue to client

	Name	Signature	Position
Prepared by	Shane Forrest		Project Engineering Geologist
Reviewed by	Kori Lentfer		Principal Geotechnical Engineer
Authorised by	Andrew Linton		Principal Geotechnical Engineer

EXECUTIVE SUMMARY

This report presents the results of geotechnical investigations and a geohazards assessment to support a Private Plan Change (PPC) application to Waipa District Council and provides the basis for the Statement of Professional Opinion in ***Section 9.***

The subject site is 3463 Ohaupo Road, Rukuhia, where it is proposed to develop a commercial and industrial subdivision, with associated roading infrastructure and a stormwater soakage/detention basin. The site is underlain by Late Pleistocene aged river deposits comprising cross-bedded pumice sand, silt and gravel with interbedded peat of the Hinuera Formation.

The high point of the site is at ~RL52.0m approximately midway along the eastern boundary. South and southwest from this point, the topography is nearly level/ very gently sloping, with a low point of ~RL51.0m in the southwestern corner of the property. North and northwest of the high point, the land slopes very gently to the north, to low points of around RL48.5m on the northern boundary. The topography to the north comprises subtle erosional gully features created by overland flow paths extending to the north along the western boundary of the northern section and then extending to the north-east and along the northern boundary.

We consider that the site is suitable for the proposed level of development subject to our geohazards assessment and geotechnical recommendations summarised as follows:

- The depth of stormwater soakage basin excavations below existing levels should be limited wherever possible, to reduce the risk of lateral spreading during ULS earthquake conditions. Seismic slope stability analyses for the stormwater basins is recommended at detailed design stage to demonstrate compliance with the project design criteria.
- For large commercial / industrial buildings, preliminary estimates of static settlements for widespread floor loads of 35kPa are calculated to range from 10mm to 125mm (primary, over 6 months) and an additional 0 to 100mm (secondary, over design life of 50 years) for a floor size of 50m². The majority of the settlement appears to be occurring below 10m depth.
- The ULS liquefaction risk for this site is significant based on the liquefaction analysis results, without an ageing factor applied. Typically, shallow foundation types are considered feasible, subject to further assessment, and would need to comprise of stiffened raft type foundations, with subgrade soils comprising geogrid reinforced granular material (sand or gravel) placed to the engineered fill specification. Depending on the proposed building development and tolerance to settlement due to ULS earthquake shaking, deep ground improvement may be appropriate to limit settlements. Further site and laboratory testing is recommended to define an appropriate ageing factor for the site and provide a more accurate/reliable specific liquefaction analysis.
- For particularly heavy building loads ground improvement may be required to mitigate excessive settlement. Appropriate ground improvement options are discussed in ***Section 7.4***.
- A preliminary geotechnical ultimate bearing pressure of 300 kPa should be available for foundations in most areas. However reduced bearing pressures may be required where low shear strength/ density soils are exposed near finished levels. Improvement of near surface soil bearing capacity could be achieved with conventional compaction equipment.
- Trench collapse may pose problems where excavations are in loose soils or extend below the water table. Temporary dewatering and trench support or battering may be required.
- Hinuera Formation sands are considered suitable road subgrade materials. If loose sands are exposed, proof rolling is typically effective to increase CBR values. Where Hinuera Formation silts are present in road subgrades these may require undercutting and replacement with a subgrade improvement layer.
- The Hinuera Formation sandy soils at this site are considered suitable to provide a seepage function for the design of stormwater attenuation and soakage basins. The soakage test results indicate a range in K value of 6.11×10^{-6} m/sec to 2.71×10^{-4} m/sec.

Table of Contents

Appendices

1 INTRODUCTION

1.1 Project Brief

CMW Geosciences (CMW) was engaged by McConnell Property to provide a Geotechnical Interpretive Report for a site located at 3463 Ohaupo Road, Rukuhia, where it is proposed to develop a commercial and industrial subdivision, with associated roading infrastructure and a stormwater soakage/detention basin.

The scope of work and associated terms and conditions of our engagement were detailed in our services proposal referenced HAM2021-0073AA Rev.0 dated 16 August 2021.

This report is to support a Private Plan Change (PPC) application to Waipa District Council and provides the basis for the Statement of Professional Opinion in ***Section 9.***

1.2 Scope of Work

As detailed in our services proposal, the agreed scope of work to be conducted by CMW was defined as follows:

- Review of existing geotechnical information for the site (BECA Ltd Preliminary Geotechnical Assessment Report[1] & Geotechnical Interpretive Report)[2]
- Assessment of settlement and liquefaction risk in accordance with the MBIE / NZGS earthquake geotechnical engineering practice notes released in December 2021.
- General recommendations for future building foundation suitability and bearing capacity, static settlement, liquefaction and soakage assessments, and earthworks recommendations.
- Comment on the land suitability for commercial / industrial land development as presented on the current concept sketch received from the client.
- Provision of a preliminary Geotechnical Interpretive Report to support the PPC in accordance with current standards and engineering guidelines.

2 SITE DESCRIPTION

2.1 Site Location

The site is legally described as Part Allot 153 Te Rapa PSH DP 493079, comprises an area of approximately 19.8ha, and is located on the eastern side of Ohaupo Road and south-west of the southern end of Middle Road as shown on ***Figure 1*** below.

[1] "Genetic Waikato - Preliminary Geotechnical Assessment Report" BECA Report ref 2930986 dated 14 September 2012

[2] "Waikato Greenfield Development - Geotechnical Interpretive Report" BECA Report ref 2932830 dated 20 May 2015

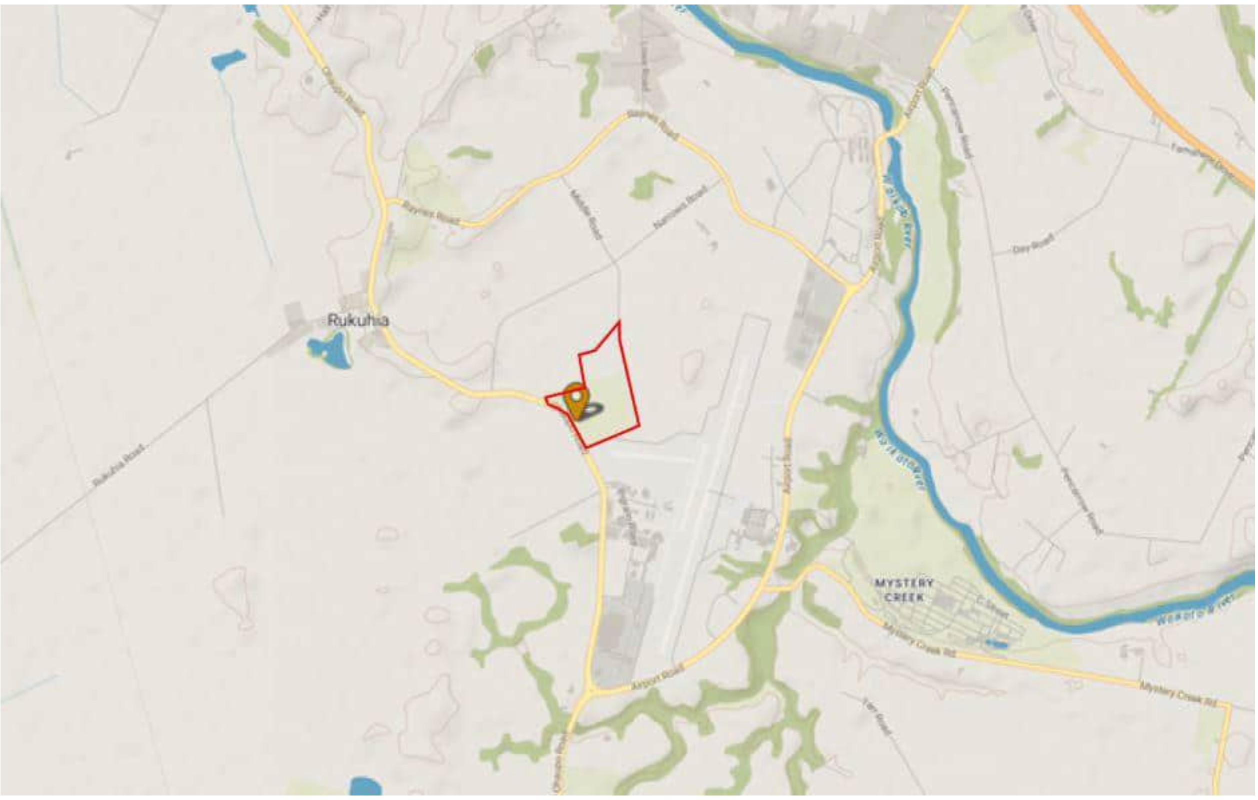

Figure 1: Site Location Plan (LINZ Maps). Site extent shown in red.

2.2 Landform

The current general landform, together with associated features located within and adjacent to the site is presented on the attached Site Investigation Plan (***Drawing 01***) in ***Appendix A*** and ***Figure 2*** below.

The site is bound to the west by State Highway 3 (SH3) and to the north, east and south by land parcels of similar topography.

The high point of the site is at ~RL52.0m approximately midway along the eastern boundary. South and southwest from this point, the topography is nearly level/ very gently sloping, with a low point of ~RL51.0m in the southwestern corner of the property. North and northwest of the high point, the land slopes very gently to the north, to low points of around RL48.5m on the northern boundary. The topography to the north includes subtle erosional gully features created by overland flow paths extending to the north along the western boundary of the northern portion and then extending to the north-east and along the northern boundary.

A few single-storey buildings are located on site, clustered in an area just to the east of the bend in Ohaupo Road (SH3).

Historical aerial photographs[3] show that the land has been farmed since prior to 1943 with little change since then.

[3] Retrolens website, Sourced from http://retrolens.nz and licensed by LINZ CC-BY 3.0

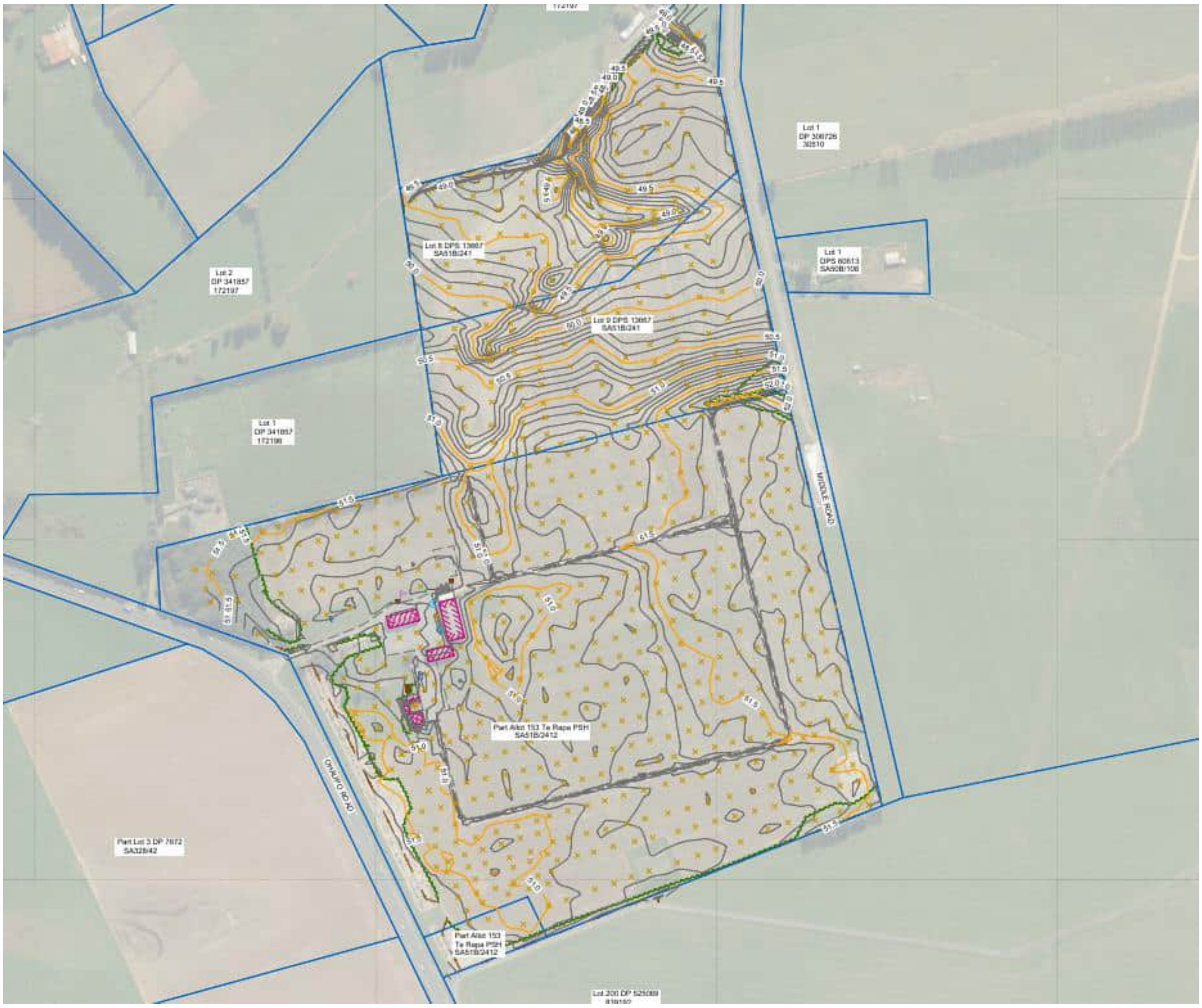

Figure 2: Topographical Survey Plan (BECA, July 2021, contours in 0.1m increments)

3 PROPOSED DEVELOPMENT

The current development proposal, as shown by the concept sketch provided by the client in ***Appendix B,*** and detailed in the McConnell Property email received on the 4th August 2021, is to create 43 industrial and commercial lots varying in size from around 2680m² to 1.3Ha with an access road stemming from a future roundabout on SH3 and connecting to future roads in the east. This development proposal is generally consistent with the land development proposed at the time of the earlier BECA Preliminary Geotechnical Assessment Report (2012) on the central and southern area, whereas no development was previously proposed on the northern area.

At the time of writing this report the project was still in the planning and preliminary urban design phase and no earthworks or engineering design drawings have yet been developed.

We have prepared this report on the basis that a future development will mostly comprise minor cuts and fills to form a near level site supporting commercial and industrial buildings with shallow strip and pad foundations and widespread floor loads of up to 35kPa.

A large stormwater basin/ wetland area is depicted at the north-eastern end of the property.

4 INVESTIGATION SCOPE

4.1 Desktop Study

CMW undertook a desktop study including review of geology maps, aerial photos, previous reports and information on the NZ Geotechnical Database.

4.2 Previous Field Investigation

The initial BECA field investigation for the southern portion of the site was carried out during November 2011 and comprised:

- Ten Cone Penetrometer Tests (CPTu), denoted CPT11-01 to CPT11-10, were pushed to depths of up to 29m to help define the ground model through the zone of influence of future building foundations and to provide preliminary indication of foundation requirements. Results of the CPT's are presented as traces of tip resistance (qc), friction resistance (fs) and friction ratio.
- Two hand auger boreholes, denoted HA11-02 and HA11-03, were drilled using a 50mm diameter auger to target depths of 1.5m below existing ground levels to visually observe the near surface soil profile and to facilitate shear vane testing.
- Three dynamic cone (Scala) penetrometer (DCP) tests were carried out adjacent to each hand auger borehole (presented on the hand auger borehole logs) and in an additional location to depths of up to 1.5m to provide soil density profiles for use as a comparison with the CPT data, and to provide a subgrade CBR value for pavement design purposes.

The second BECA field investigation was specifically for the development of the service centre in the area to the west near SH3. The investigation was carried out during October 2014 and comprised:

- Five Cone Penetrometer Tests (CPT), denoted CPT14-01 to CPT14-05, were pushed to depths of up to 20m to help define the ground model through the zone of influence of future building foundations and to provide preliminary indication of foundation requirements. Results of the CPT's are presented as traces of tip resistance (qc), friction resistance (fs) and friction ratio.
- One hand auger borehole, denoted HA014-01, was drilled using a 50mm diameter auger to a target depth of 3.0m below existing ground levels to visually observe the near surface soil profile and to facilitate shear vane testing.
- One machine auger hole denoted MA14-01, drilled to a target depth of 1.0m, to facilitate a falling head permeability test.
- Three dynamic cone (Scala) penetrometer (DCP) tests were carried out adjacent to the hand auger borehole (presented on the hand auger borehole logs) and in two additional locations (denoted SC14-01 and SC14-02) to depths of up to 3.0m to provide soil density profiles for use as a comparison with the CPT data, and to provide a subgrade CBR value for pavement design purposes.

4.3 Recent Field Investigation

Following a Dial Before You Dig search, the recent field investigation was carried out on 8th and 9th September 2021. All fieldwork was carried out under the direction of CMW Geosciences in general accordance with the NZGS specifications[4] and logged in accordance with NZGS guidance[5]. The approximate locations of the respective investigation sites referred to above were recorded using a hand-held GPS and are shown on the Site Investigation Plan in ***Appendix A***. Test location elevations were inferred from the provided Topographical Survey Plan.

[4] NZ Geotechnical Society (2017) NZ Ground Investigation Specification, Volume 1 – Master Specification
[5] NZ Geotechnical Society (2005), Field Description of Soil and Rock, Guideline for the field classification and description of soil and rock for engineering purposes.

The scope of fieldwork completed was as follows:

- Walkover survey of the site to assess the general landform, site conditions and the presence of adjacent structures / infrastructure.
- Six Cone Penetrometer Tests (CPT), denoted CPT21-01 to CPT21-06, were pushed to depths of up to 24m to help define the ground model through the zone of influence of future building foundations and to provide preliminary indication of foundation requirements. Results of the CPT's are presented as traces of tip resistance (qc), friction resistance (fs) and dynamic pore pressure (u2).
- Five hand auger boreholes, denoted HA21-01 to HA21-05, were drilled using a 50mm diameter auger to target depths of 5.0m below existing ground levels to visually observe the near surface soil profile and to facilitate vane shear strength testing. Dynamic cone penetrometer (DCP) tests were carried out adjacent to the auger hole to a depth of 5.0m. Engineering logs of the hand auger boreholes, together with peak and remoulded vane shear strengths and DCP blow counts per 100mm are presented in ***Appendix C***.
- Two shallow hand auger boreholes, denoted HAS21-01 and HAS21-02, were drilled using a 100mm diameter auger to depths of up to 2.3m to facilitate soakage tests and assess the strength and permeability of the near surface soils.

Copies of the recent CMW investigation & previous BECA's borehole logs, DCP tests, Soakage Test Results and the CPT traces are provided in ***Appendix C***.

The approximate locations of the respective boreholes and CPTs referred to above are shown on our Site Investigation Plan in ***Appendix A***.

5 GROUND MODEL

5.1 Published Geology

The published geological map[6] for the area indicates the site is underlain by Late Pleistocene aged river deposits comprising cross-bedded pumice sand, silt and gravel with interbedded peat of the Hinuera Formation as illustrated in ***Figure 3*** below.

The low hills to the east and west of the site are shown to be underlain by older volcanic silts and clays of the Walton Subgroup derived from insitu and fluvially reworked and weathered non-welded distal ignimbrites that are mantled with weathered volcanic ash.

The geologically older Walton Subgroup represents an older (1.2 million year old) landform that is present below the younger Hinuera Formation deposits.

[6] Waikato 1:250,000 Geological Map, No 4, Institute of Geological and Nuclear Sciences Limited, 2005.

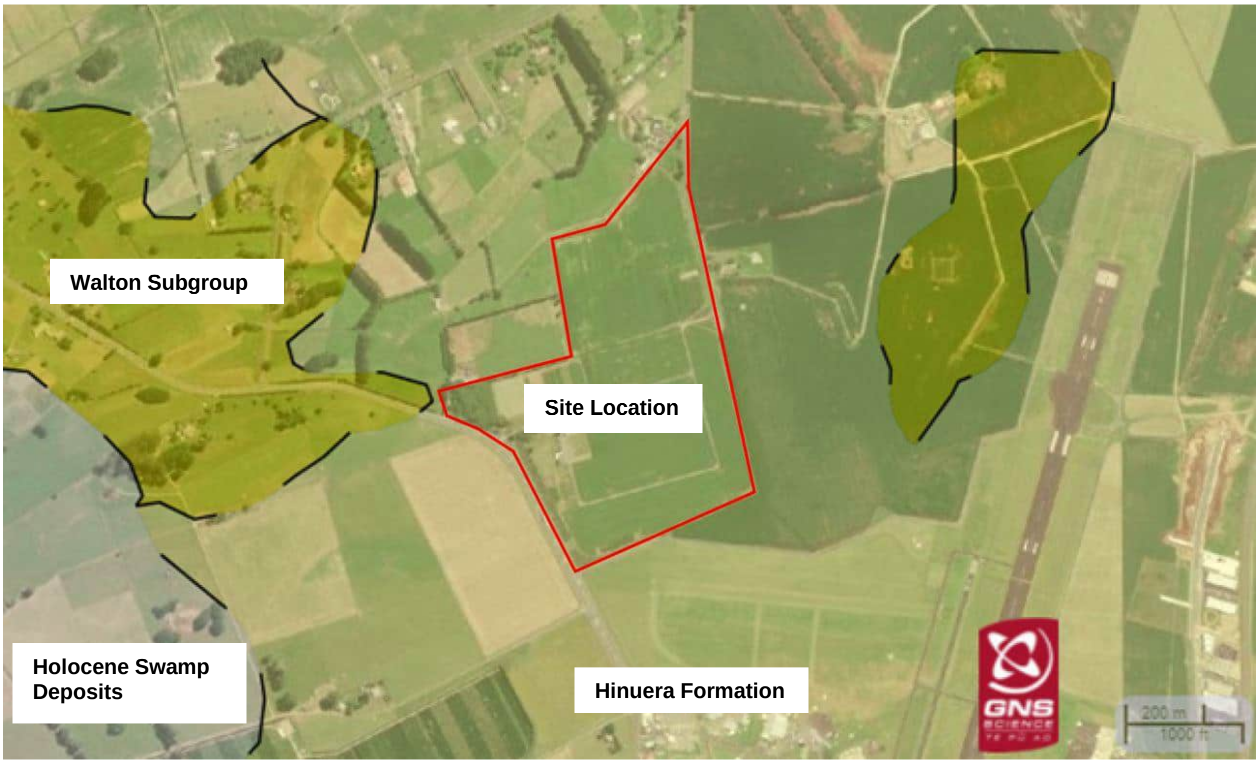

Figure 3: Regional Geology (QMap)

Based on the known history of the site, some superficial depths of fill are anticipated as a result of farming activities.

5.2 Stratigraphic Units

The ground conditions encountered and inferred from the historic and recent investigations are considered to be generally consistent with the published geology for the area and can be generalised according to the following subsurface sequences.

The distribution of the various units encountered is presented on Cross-section A-A in ***Appendix A.***

5.2.1 Topsoil / Fill

Topsoil was encountered in all boreholes with thicknesses of 0.2m to 0.3m, except for HA21-03, located in the invert of an overland flow path feature, which encountered topsoil to depth of 0.7m.

Uncontrolled fill was encountered to depths of 2.0m and 0.4m in HA21-01 and HA21-02 respectively. These materials typically consisted of very loose to medium dense Sandy organic SILT. Peak strength shear vane values recorded in this material ranged between 98kPa and 159kPa.

5.2.2 Hinuera Formation

Hinuera Formation deposits were encountered to be underlying the development area across the site. The soils can typically be grouped into five separate units, as depicted on the cross-section in ***Appendix A*** and as follows:

5.2.2.1 UNIT 1 – Very Loose to Loose Sand, Stiff to Very Stiff Silt

This material was encountered across the site, to depths of up to around 1.0m. DCP blows per 100mm generally ranged between 1 and 3. Cone tip resistance (qc) through this unit generally ranged between 0.4MPa and 2.0MPa. Peak strength shear vane values ranged between 94kPa and 191kPa. Silts are moderately sensitive to sensitive.

5.2.2.2 UNIT 2 – Medium Dense to Dense, Fine to Medium Sand

This material was encountered underlying Unit 1 on the higher flat portion, over approximately the southern half of the site. DCP blows per 100mm generally ranged between 3.5 and 10 . Cone tip resistance (qc) through this unit generally ranged between 2.0MPa and 8.0MPa.

5.2.2.3 UNIT 3 – Medium Dense to Dense, Fine to Medium Sand with Inter-bedded Lenses of Stiff Silt

This material was encountered underlying Unit 1 on the lower northern half of the site and underlying Unit 2 on the southern half of the site. CPTs estimated this sand to have a density of ~17kN/m^3 with the interbedded silts having a relatively low density of 15.0 – 16.0kN/m^3 (some organic content encountered in HA21-02). DCP blows per 100mm generally ranged between 3 and 16 in the sands, while in the silt layers, these ranged between 1 and 3. Cone tip resistance (qc) through the interbedded silts generally ranged between 0.2MPa and 0.65MPa, while through the sands the qc generally ranged between 2.0MPa and 8.0MPa with occasional lenses up to 17.0MPa.

5.2.2.4 UNIT 4 – Medium Dense to Dense, Sand – CPT Inferred

This material was encountered within the CPTs underlying Unit 3 across the whole site, being up to around 4m higher in the northern portion of the site. Cone tip resistance (qc) through this unit generally ranged between 4.0MPa and 20.0MPa.

5.2.3 Walton Subgroup

5.2.3.1 UNIT 5 – Stiff, Clayey Silt/ Silt – CPT Inferred

This material was encountered underlying Unit 4 across the whole site, being up to around 5m higher elevation in the northern-eastern portion of the site. Cone tip resistance (qc) through this unit generally ranged between 0.5MPa and 2.0MPa.

CPT21-05 and CPT21-06 refused at depths of approximately 23 metres which is inferred to be very dense sand / non-welded ignimbrite materials. Cone tip resistance (qc) in this unit reached up to 48.0MPa in CPT21-05 and 24.0MPa in CPT21-06 before the test was ended.

5.2.4 Summary

The distribution of these units is illustrated on Cross-section A in ***Appendix A*** and is summarised below in ***Table 1***.

Table 1: Summary of Strata Encountered

Unit / Strata	Top of Unit (mbgl)		Thickness (m)*	
	Min	Max	Min	Max
Topsoil	0.0	0.0	0.2	0.7
1 - Hinuera Formation – Very Loose to Loose Sand / Stiff to Very Stiff Silt	0.0	0.0	0.7	1.0
2 - Hinuera Formation – Medium Dense to Dense Sand	0.8	0.9	0.0	7.4**
3 - Hinuera Formation – Medium Dense to Dense Sand with Silt Interbeds	0.7	1.0	3.8**	8.0**
4 - Hinuera Formation – Medium Dense to Dense Sand	6.2**	12.4**	4.4**	7.6**

Table 1: Summary of Strata Encountered				
Unit / Strata	**Top of Unit (mbgl)**		**Thickness (m)***	
	Min	**Max**	**Min**	**Max**
5 – Walton Subgroup – Stiff Clayey Silt/Silt	10.6**	17.5**	-	-
Notes: *Thickness only recorded were base of strata has been confirmed. **Inferred from CPTs				

5.3 Groundwater

In ***Table 2*** we present the results of groundwater levels measured upon completion of testing, as recorded on the depicted investigation logs and CPT traces in ***Appendix C:***

Table 2: Groundwater Level Summary			
Investigation Location	**Groundwater Level**		**Comments**
	Depth Below Existing Ground Level (m)	**Date Measured**	
CPT11-01	3.2	25/11/2011	CPT11-01 – CPT11-10 undertaken across the higher southern portion of the site
CPT11-02	3.2	25/11/2011	
CPT11-03	2.9	25/11/2011	
CPT11-04	3.1	25/11/2011	
CPT11-05	3.6	25/11/2011	
CPT11-06	3.7	25/11/2011	
CPT11-07	2.9	25/11/2011	
CPT11-08	3.9	25/11/2011	
CPT11-09	3.8	25/11/2011	
CPT11-10	2.8	25/11/2011	
CPT14-03	3.5	10/10/2014	CPT14-03 & CPT14-04 undertaken in the western portion of site
CPT14-04	3.4	10/10/2014	
CPT21-01	3.5	09/09/2021	
CPT21-02	1.4	09/09/2021	Directly adjacent HA21-01
CPT21-03	0.4	09/09/2021	Directly adjacent HA21-02
CPT21-04	0.4	09/09/2021	Very close to HAS21-01
CPT21-05	1.0	09/09/2021	
CPT21-06	2.9	09/09/2021	Directly adjacent HA21-04

Table 2: Groundwater Level Summary			
Investigation Location	Groundwater Level		Comments
	Depth Below Existing Ground Level (m)	Date Measured	
HA21-01	1.0	08/09/2021	
HA21-02	1.1	08/09/2021	
HA21-03	0.1	08/09/2021	Borehole drilled in invert of OLFP
HA21-04	3.4	08/09/2021	
HAS21-01	0.8	08/09/2021	Borehole drilled near invert of OLFP
HAS21-02	0.8	08/09/2021	Borehole drilled near invert of OLFP
Notes: Investigation locations not listed did not encounter the groundwater table or it was not recorded OLFP = Over-land Flow Path			

From the results presented in ***Table 2***, it appears that the groundwater table in the higher southern and western areas varies from about 2.8m to 3.9m below existing ground level.

In the lower area to the north, especially near the overland flow path features, the groundwater table varies from near surface level to 1.4m below existing ground levels.

Seasonal fluctuation in groundwater levels is expected. Due to the limited groundwater monitoring, the magnitude of this variation is uncertain. However, from our experience in the area this variation may be in the order of around 1m.

5.4 Soakage Test Results

Falling head soakage (percolation) tests were carried out within the shallow hand auger borehole locations by lining the 100 mm diameter boreholes with perforated PVC pipe, filling the holes with water and monitoring the rate of water level fall over time.

The test results were used to calculate soil hydraulic conductivity in accordance with the analysis method of Hvorslev[7] and the CIRIA 113 method[8].

Analysis using the Hvorslev method considers soakage from both the base and sides of the test hole with no overlying restrictive layer.

Results of the analyses are presented in ***Table 3***.

Table 3: Soakage Test Results			
Location ID	Groundwater Depth (mBGL)	Hydraulic Conductivity, k	
		CIRIA 113	Hvorslev
HAS-01	0.8	2.71×10^{-4}	3.22×10^{-5}
HAS-02	0.8	5.18×10^{-5}	6.11×10^{-6}

[7] Hvorslev, M.J. (1951), Time Lag and Soil Permeability in Ground Water Observations. U.S. Army Corps of Engineers Waterway Experimentation Station, Bulletin 36
[8] Sommerville, S.H. (1986), REP R 113 Control of Groundwater for Temporary Works

Note: Hydraulic conductivities are taken as an average of the whole test curve. Designers must assess the permeability test results and select the most appropriate value.

6 GEOHAZARDS ASSESSMENT

6.1 Seismicity

A seismic assessment has been carried out in general accordance with NZGS guidance[9] to calculate the peak horizontal ground acceleration or PGA (a_{max}) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} x\ f\ x\ g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (refer Section 7.1 for subsoil class)

R = return period factor given in NZS1170.5, Table 3.5 (refer Section 7.1 for importance level)

f = site response factor subject to subsoil class (refer Section 7.1 for subsoil class)

g = acceleration due to gravity

The ULS PGA was calculated based on a 50-year design life in accordance with the New Zealand Building Code[10] and importance level (IL) 2 structures. The PGA for the serviceability limit state (SLS) and ultimate limit state (ULS) earthquake scenarios is as follows:

Table 4: Design Peak Ground Acceleration (PGA) for Various Limit States

Limit State	AEP	R	PGA(g)	$\text{Magnitude}_{\text{eff}}$
SLS	1/25	0.25	0.06	5.9
ULS	1/500	1.0	0.25	5.9

Note: SLS = serviceability limit state; ULS = ultimate limit state; AEP = annual exceedance probability

6.2 Fault Rupture

The nearest known active fault recorded in the GNS Active Faults Database[11] is the Kerepehi Fault, approximately 38km to the east of the site. The risk of fault rupture affecting the site is therefore considered low.

6.3 Liquefaction

6.3.1 General

Soil liquefaction is a process where typically saturated, granular soils develop excess pore water pressures during cyclic (earthquake) loading that exceed the effective stress of the soil. In loose soils, some dilation can occur during this process, which can lead to individual soil grains moving into suspension. Following the onset of liquefaction, the shear strength and stiffness of the liquefied soil is effectively lost causing excessive differential settlement of the ground surface, bearing capacity failure and collapse of structures and low-angle lateral spreading of slopes in liquefiable soils.

[9] NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2016)
[10] Ministry of Business, Innovation and Employment (1992) NZ Building Code Handbook, Third Edition, Amendment 13 (effective from 14 February 2014)
[11] https://data.gns.cri.nz/

In accordance with NZGS guidance[12] the liquefaction susceptibility of the soils at this site has been considered with respect to geological age, soil fabric and soil consistency / density.

6.3.2 Geological Age

The vast majority of case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills[13][14]. Pleistocene aged alluvium (>12,000 years) is considered to have a very low to low risk of liquefaction[14].

Hinuera Formation deposits are of mid to late Pleistocene geological age. These deposits are therefore significantly older than what case history data would suggest as being susceptible to liquefaction.

Notwithstanding this, age alone is often debated as being of insufficient evidence to discount liquefaction potential due to its qualitative nature. Consideration can therefore be given to applying an ageing factor

(K_{DR}) to site specific liquefaction analyses in accordance with methods described in Saftner et al[15] based on

$$K_{DR}=0.189 \cdot \log(t)+0.878$$

the following relationship (where t = time (years)):

The calculated aging factor for the Hinuera Formation is 1.65.

The method described by Saftner is based on Hayati and Andrus [16] but is updated following further studies and field trials. The basis for applying ageing factors to CPT-based liquefaction assessments is multi-faceted and discussed as follows:

- MBIE Module 3 states that liquefaction susceptibility of soils should be assessed with respect to geological criteria (age) and compositional criteria (soil fabric and consistency/density). The geological criteria for liquefaction susceptibility is outlined in Section 5.2.1 and states "The age of the deposit is an important factor to consider when assessing liquefaction susceptibility". However, it also notes that ageing effects can be difficult to quantify. Therefore CMW assessments do not rely on age alone to discount liquefaction. Geological age and compositional criteria are considered in conjunction when assessing liquefaction, as well as consideration of the geomorphology and topography of the area.
- Nearly all case history data compiled in empirical charts for liquefaction evaluation come from Holocene deposits or man-made fills (Seed & Idriss, 1971 and MBIE Module 3). Pleistocene aged alluvium (>12,000 years) is considered to have a very low to low risk of liquefaction (Youd & Perkins, 1978). Hinuera Formation deposits which underlie the site are Late Pleistocene alluvial deposits, with a geological age of 60 to 17 thousand years.
- MBIE Module 3 provides guidance for applying ageing factors which focus on a conservate approach unless supported by further site or laboratory testing. Uncertainties in effects of ageing on liquefaction resistance also should be incorporated. More accurate ageing factors can be derived from shear wave velocity testing (seismic CPT tests) and laboratory cyclic triaxial testing of the soils.

6.3.3 Soil Fabric

Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. Based on more recent case histories, there is general agreement that sands, non-plastic silts, gravels and

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[12] Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards", (May 2016)

[13] Seed, H.B. and Idriss, I.M. (1971) *A simplified procedure for evaluating soil liquefaction potential*, Earthquake Engineering Research Centre, Report No. EERC 70-9, University of California

[14] Youd, T.L. and Perkins, D.M. (1978) Mapping liquefaction-induced ground failure potential, *Journal of the Geotechnical Engineering Division,* ASCE, Vol. 104, No. GT4, Proc Paper 13659, p. 433-446

[15] Saftner, D.A.; Green, R.A.; Hryciw, R.D. (2015). Use of explosives to investigate liquefaction resistance of aged sand deposits, *Engineering Geology*, Vol 199, p.140-147.

[16] Hayati H, Andrus RD. (2009) Updated liquefaction resistance correction factors for aged sands Journal of Geotechnical and Geoenvironmental Engineering. 135: 1683-1692.

their mixtures form soils that are susceptible to liquefaction. Clays, although they may significantly soften under cyclic loading, do not exhibit liquefaction features, and therefore are not considered liquefiable. NZGS guidance[5] sets out the plasticity index (PI) criteria for liquefaction susceptibility as follows:

PI < 7: Susceptible to Liquefaction

7 ≤ PI ≥ 12: Potentially Susceptible to Liquefaction

PI ≥ 12: Not Susceptible to Liquefaction

The fines content of the sands beneath the site also has a significant impact on their liquefaction susceptibility.

Specific soil grading / plasticity index laboratory testing has not been undertaken to date. Further testing may be of value at building design stage if CPT based liquefaction assessment results are problematic and refinement of susceptibility is warranted.

6.3.4 Specific Analyses

Specific liquefaction analyses were based on the Boulanger and Idriss (2014) methods using the software package CLiq by comparing the cyclic stress ratio (CSR), being a function of the earthquake magnitude for the design return period event, to the cyclic resistance ratio (CRR), being a function of the CPT cone resistance (qc) and friction ratio.

Various ageing factors were applied to the CLiq models up to a maximum of the age specified in ***Section 6.3.2*** above. Results for the No Aging Factor analyses are presented in ***Appendix D.*** All ULS results are summarised in ***Table 5*** below:

Table 5: Liquefaction Analyses Results with Various Ageing Factors (Existing Ground Profile)

CPT No.	GW Level (m)	No Ageing Factor		1.3 Ageing Factor		1.65 Ageing Factor	
		ULS Settlement (mm)	Depth to Liquefied Layer (m) *	ULS Settlement (mm)	Depth to Liquefied Layer (m) *	ULS Settlement (mm)	Depth to Liquefied Layer (m) *
2021-01	3.5	95	4.0	55	4.2	17	4.5
2021-02	1.0	250	1.8	210	1.9	130	2.0
2021-03	0.4	190	0.8	170	1.0	140	1.5
2021-04	0.4	310	0.5	250	0.5	170	2.2
2021-05	1.0	170	1.0	130	1.2	70	2.0
2021-06	2.9	250	3.0	190	4.0	85	4.0
2014-01	3.0	90	3.0	60	3.2	22	6.8
2014-02	3.0	120	3.0	65	4.0	25	4.0
2014-03	3.0	190	3.0	115	4.2	40	4.2
2014-04	3.0	140	3.0	100	3.5	45	3.6
2014-05	3.0	200	3.0	110	3.0	38	3.6
2011-01	3.0	210	3.0	140	3.0	48	3.0
2011-02	3.0	280	3.0	200	3.2	90	4.3
2011-03	3.0	230	4.0	170	4.2	68	4.3
2011-04	3.0	170	3.0	110	3.0	35	3.0
2011-05	3.0	210	3.0	140	3.7	48	3.7

Table 5: Liquefaction Analyses Results with Various Ageing Factors (Existing Ground Profile)							
CPT No.	GW Level (m)	No Ageing Factor		1.3 Ageing Factor		1.65 Ageing Factor	
		ULS Settlement (mm)	Depth to Liquefied Layer (m) *	ULS Settlement (mm)	Depth to Liquefied Layer (m) *	ULS Settlement (mm)	Depth to Liquefied Layer (m) *
2011-06	3.0	280	3.0	215	3.0	90	3.2
2011-07	3.0	220	3.2	160	4.0	65	4.0
2011-08	3.0	190	4.0	120	5.0	45	5.0
2011-09	3.0	260	3.0	170	3.2	60	3.5
2011-10	3.0	160	3.0	105	3.0	40	4.8

No liquefaction is predicted under the SLS earthquake event and nil serviceability effect is expected on the proposed buildings, which meets the requirements of the New Zealand Building Code.

The design ULS earthquake induces liquefaction within all the CPT traces, and shows highly variable results across the site, with potential vertical liquefaction induced settlements of between 90mm and 310mm with no applied ageing factor versus 17mm to 170mm with an applied ageing factor of 1.65. It is recommended that Seismic Cone Penetration Testing (SCPT) is undertaken to define an appropriate site-specific ageing factor. Consideration will also be given to sampling and laboratory testing of liquefaction susceptible layers to further assess the risk of liquefaction. As a general rule, noticeable differential settlements may be assumed to be in the order of one half to two thirds of the total settlements reported above.

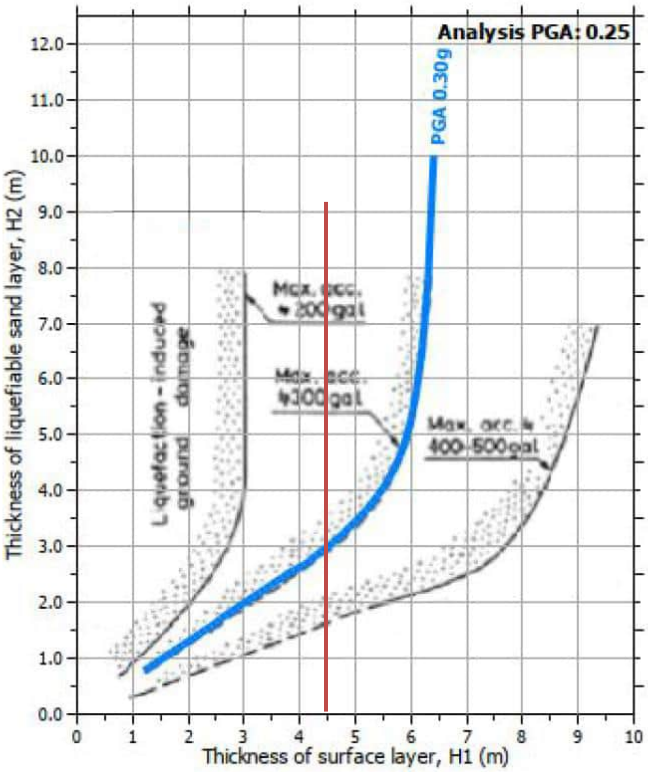


Figure 4: Figure 88 sourced from Ishihara (1985)[17]

Reference to Figure 88 (Figure 4 above), sourced from Ishihara (1985), was made with respect to assessing the contribution of a non-liquefiable crust over liquefiable sands with respect to the risk of surface manifestation.

As shown in the above figure, a 4.5m thick crust is required for the ULS scenario (0.25 pga) to prevent significant liquefaction induced ground damage where underlain by greater than 5m metres of underlying liquefiable ground. The specific analysis (without an ageing factor applied) typically showed that total thicknesses of liquefiable materials across the site are greater than 5m as depicted on Cross-section A in ***Appendix A***.

As shown in ***Table 5***, with no ageing factor applied, vertical settlements of up to 310mm are expected to occur during a ULS seismic event. Liquefiable layers are expected to be as shallow as 0.5m below existing ground level in the northern area of the site, while the liquefiable layers in the southern and western areas start generally at 3.0m depth.

With an ageing factor of 1.65 applied, the magnitude and extent of expected ULS settlement is reduced significantly to a maximum of 170mm (occurring in the northern portion of the site). Liquefiable layers are expected to be as shallow as 1.5m below existing ground level in the northern area of the site, while the liquefiable layers in the southern and western areas start generally at 3.0m depth, though the settlements in these areas are expected to be heavily reduced, with a maximum of 90mm.

The depth of the groundwater table is expected to be a key factor in determining the depth of non-liquefiable crust which in some locations may become thicker with the replacement and addition of engineered fill.

Under the ULS event, the NZ Building Code requires that buildings do not collapse and therefore preserve life but do not need to remain serviceable. The predicted settlements under the ULS earthquake event could lead to significant structural distortion or collapse, therefore specific structural design will be required.

6.4 Cyclic Softening

Although the fine-grained Walton Subgroup soils, are not considered liquefiable due to their high plasticity, they may still be susceptible to some strength loss, referred to as cyclic softening, during the ULS seismic event.

Cyclic softening analyses of those soils was carried out in accordance with Boulanger[18] and Idriss[19]. This correlates earthquake magnitude to the estimated number of equivalent stress cycles (***Figure 5*** below) and then correlates number of cycles to a cyclic shear strength ratio (***Figure 6*** below).

[17] Ishihara, K., (1985) "Stability of Natural Deposits During Earthquakes," Proc. Of the Eleventh International Conference on Soil Mechanics and Foundation Engineering, San Francisco, 12- 16th August 1985, Vol. 1, Theme Lectures Conferences, pp321- 376.
[18] Boulanger, R.W. and Idriss. I. M. (2007) Evaluation of Cyclic Softening in Silts and Clays, Journal of Geotechnical and Environmental Engineering, Vol 133, Issue 6.
[19] Idriss, I. M. and Boulanger, R. W. (2008) Soil Liquefaction During Earthquakes. Monograph 12, Earthquake Engineering Research Institute.

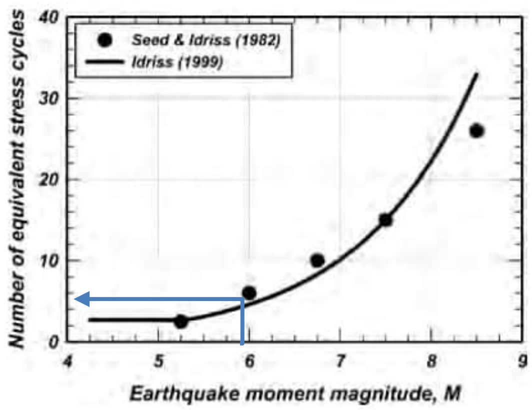


Figure 5: Relationship between earthquake magnitude and mean number of uniform stress cycles

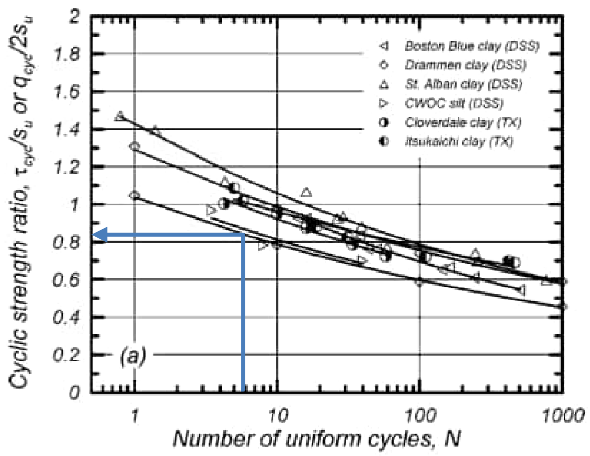


Figure 6: Relationship between cyclic strength ratio and number of uniform stress cycles

Based on the above assessment, 6 stress cycles are estimated during the ULS M5.9 earthquake resulting in an estimated cyclic shear strength of no more than 85% of the peak shear strength. Reduced peak shear strengths should be considered if any slope stability analyses are required e.g. for soakage basin detailed design.

6.5 Lateral Spread

Following the onset of liquefaction, the liquefied soils behave as a very weak undrained material, which can give rise to lateral spreading where a free face is present within the vicinity of the site.

Literature suggests that lateral spreading may occur if laterally persistent liquefied layers are present within a depth of 2 times the free face height. This risk should be assessed once earthworks plans have been formalised and soakage basin location and dimensions are known.

6.6 Soakage Basin Batters and Slope Stability

Detailed slope stability analyses are not warranted for the soakage basin at this early stage of the proposed development. An assessment should be completed as a part of the detailed earthworks design.

The existing landform shows no signs of slope instability and is assessed as very low risk.

6.7 Erosion

The predominantly sandy and silty nature of the natural soils, which will also generally be used as engineered fill, means that there is a risk of erosion if appropriate controls are not in place.

However, considering the relatively flat finished landform there will be a low risk of erosion across the site as a whole.

6.8 Load Induced Settlement

Although no earthworks plans are available at the time of this report preparation, it is anticipated that only minor fill placement will be undertaken, likely in the order of 1m thick across the lower lying portions of the site.

Proposed fill and future building loads may induce settlements within the underlying subsoils.

As the Hinuera Formation soils are sand dominated with lenses of fine grained silt, clay and localised organic silt and clay layers, load induced settlement is anticipated to be largely immediate.

6.8.1 Settlement Predictions

An assessment of static settlements was completed using CPT interpretation software CPeT-IT 3.6.1.5 for widespread commercial and industrial building loads of 35kPa across a footprint of 50m^2. Plots of cumulative settlement vs depth for each CPT test are included in ***Appendix E***.

Primary settlement was assessed over a period of 6 months with post-construction secondary creep settlements occurring over a design life of 50 years.

Estimated static settlements are summarised as follows in ***Table 6***:

Table 6: CPeT-IT Load Indued Settlement Analyses Results Summary		
CPT No.	35kPa Widespread Load	
	Primary Settlement (mm)	Secondary Settlement (mm)
CPT21-01	95	45
CPT21-02	40	15
CPT21-03	95	50
CPT21-04	45	25
CPT21-05	45	20
CPT21-06	115	100
CPT11-01	20	5
CPT11-02	50	40
CPT11-03	10	0
CPT11-04	15	0
CPT11-05	15	0
CPT11-06	15	0
CPT11-07	15	0
CPT11-08	15	5
CPT11-09	45	35
CPT11-10	40	15
CPT14-01	125	35
CPT14-02	120	65
CPT14-03	70	15
CPT14-04	95	50
CPT14-05	30	10

Fill loads have not been considered in the settlement estimates due to the primarily sandy nature of the Hinuera Formation soils beneath where fill will be placed. Associated settlements are anticipated to be immediate and largely resolved during earthworks construction.

For widespread floor loads of 35kPa, primary settlement magnitudes are calculated to range from 10mm to 125mm and additional secondary settlement magnitudes are calculated to range from 0mm to 100mm for a floor size of 50m². The majority of the settlement appears to be occurring below 10m depth.

6.9 Expansive Soils

National Standards exclude from the definition of ‘good ground’, soils with a liquid limit of more than 50% and a linear shrinkage of more than 15% due to their potential to shrink and swell as a result of seasonal fluctuations in water content.

The November 2019 update to the NZ Building Code, B1/AS1, includes significant detail on the assessment of expansive soil class and associated foundation design which may be relevant where clay soils are present.

Hinuera Formation silts and sands are not considered expansive.

7 GEOTECHNICAL RECOMMENDATIONS

7.1 Seismic Site Subsoil Category

The geological units encountered beneath the development area comprise soil strength materials, which with respect to the seismic site subsoil category defined in Section 3.1.3 of NZS1170.5, is defined as having a UCS < 1MPa therefore a seismic site subsoil class of D (deep or soft soil) is considered appropriate.

It is anticipated that future buildings will be considered Importance Level IL2 structures with respect to NZS1170.

7.2 Liquefaction / Lateral Spread Mitigation

With reference to the liquefaction, cyclic softening, and lateral spread assessment in ***Sections 6.3*** to ***6.5*** above, these geohazards are anticipated to be significant constraints for the proposed development with respect to the defined design criteria. Further site investigation and design is required to confirm the level of liquefaction hazard for the site.

We recommend that further sCPT possibly supported by laboratory testing of the soils should be undertaken to define an appropriate ageing factor for the site. Once this work has been undertaken, a more reliable specific liquefaction analysis can be done to assess vertical settlements under an ULS seismic event.

Referring to Figure 88 sourced from Ishihara (1985) (Figure 4 above), we expect that increasing the non-liquefiable crust thickness via the placement of engineered fills will be required to mitigate potential surface manifestation of the settlements during an ULS seismic event. The recommended thickness and extent of these fills will vary depending on the results of the tuned specific liquefaction analysis mentioned above, but generally could vary between 2.0m and 4.0m.

The installation of subsoil drains across the site is also expected to aid in thickening the non-liquefiable crust in the northern area where groundwater levels were recorded at up to 0.4m below the surface, as this is a key factor driving liquefaction under the ULS seismic event. General recommendations for subsoil drains are discussed below in ***Section 7.5.3***.

Based on the liquefaction analysis results without aging factor applied it is anticipated that shallow foundations would need to comprise of stiffened raft type foundations, with subgrade soils comprising geogrid reinforced granular material (sand or gravel) placed to the engineered fill specification.

Depending on the proposed building development and tolerance to settlement due to ULS earthquake shaking, deep ground improvement may be appropriate to limit settlements. This could take the form of the following options:

- Rammed Aggregate Piers (RAPs);
- CFA/DSM/Stone columns.

The depth of stormwater soakage basin excavations below existing levels should be limited wherever possible, to reduce the risk of lateral spreading during ULS earthquake conditions. Seismic slope stability analyses for the stormwater basins is recommended at detailed design stage to demonstrate compliance with design criteria above.

7.3 Soakage Basin Batter Stability

Based on our experience within similar soils as present at the site, a preliminary internal batter gradient of 1v:3h should be suitable assuming loose to medium dense sands.

Further slope stability analyses should be undertaken at the time of detailed design including assessment of soil types, variation of water levels, potential for scour/erosion and any surcharge loading.

A building restriction setback from the basins is expected and should be defined at the detailed design stage.

7.4 Static Settlement Management

7.4.1 General

Buildings should be designed to tolerate differential settlements of up to 1 in 240 (approximately 25mm over a 6-metre length of building) as required by the New Zealand Building Code.

Typically, shallow foundation types are considered feasible for lightweight industrial and commercial buildings subject to further geotechnical assessment at Building Consent stage.

Due to the inherent variability of the natural subsoils, foundation improvement works may be required. For any deeper or larger foundation dimensions, changes in stress conditions to the underlying variable strength natural subsoils are likely to result in increased settlements to those indicated in ***Section 6.8*** above.

7.4.2 Ground Improvement Options for Static Settlement

If particularly heavy building dead and live load combinations are proposed and specific geotechnical investigation and analysis indicates that settlement magnitudes are unacceptable, then to minimise post construction static ground settlements, a range and/or combination of options may be considered, including the following:

- Nominal 0.5 to 1m undercut of any low-strength/density near surface soils (such as Hinuera Formation very loose to loose silts or sands) and replacement with engineered fill (reused or imported sand, or hardfill), possibly with geogrid layers and possibly with stiffened raft foundations.
- Construction of a temporary surcharge or pre-load fill embankment above design finished level, to over-consolidate the compressible soils and minimise post construction embankment settlements. The settlement should be monitored for a period, with construction on hold until settlements have plateaued.
- Compensated foundation design using lightweight geofoam, such as EPS-block materials to keep pressures below pre-consolidation pressures within compressible soils thereby reducing consolidation settlements.
- Undertake deeper ground improvement beneath the building footprint, such as stone columns, soil mixed columns, CFA piles, Rammed Aggregate Piers (RAP's) or similar rigid inclusions to transfer loads from the structure to more competent underlying soils at depth.

7.5 Earthworks

7.5.1 General

All earthwork activities should be carried out in general accordance with the requirements of NZS 4431[20] and the general requirements of the Waikato Regional Infrastructure Technical Specifications (RITS) under the guidance of a Chartered Professional Geotechnical Engineer.

7.5.2 Subgrade Preparation

Preparation of the natural soil subgrade beneath proposed fill areas should comprise stripping of all vegetation, topsoil, any pre-existing fill materials or weak surficial alluvium. The subgrade should then be scarified and moisture conditioned where necessary and then proof rolled to verify the subgrade stiffness and consistency.

Where any particularly weak materials are encountered that weave excessively during the proof rolling process, they should be undercut and removed prior to placing engineered fill.

With the gully features, allowance should be made for excavating out all organic materials, cleaning out of all accumulated sediment, placement of drainage materials and bulk engineered fill above.

[20] Standards New Zealand (1989) Code of practice for earth fill for residential development, incorporating Amendment No. 1, NZS 4431:1989, NZ Standard

7.5.3 Subsoil Drainage

A network of subsoil drains will need to be installed across the northern part of the site within the shallow gully system that will manage near surface groundwater levels over the winter months.

At this early stage of the development, it is recommended that the new subsoil drain network cover this area with a nominal 30m spacing. The drain layout should be designed to discharge into the proposed stormwater basins.

Subsoil drains are anticipated to comprise a nominal 2m deep (from existing ground levels, underlying any fills) excavated trench with perforated draincoil, drainage aggregate and fully wrapped in a non-woven geotextile fabric. The geotextile wrapped drainage aggregate should be approximately 1m thick. The upper trench backfill should be compacted to engineer certifiable standard.

The function of subsoil drains and their outlets into proposed stormwater soakage basins will be protected using restrictions applied in a Geotechnical Completion Report following completion of earthworks. These may also include foundation piling requirements to prevent conflict with the drains.

7.5.4 Compaction

Earthfill must be placed, spread and compacted in controlled lifts under the direction of a geotechnical engineer. The fill is expected to comprise imported clay and silt or sand, free of any organics.

All earthfill must be placed to ensure adequate knitting of successive fill lifts by conditioning of any natural subgrade or fill surfaces that have become dry / wet prior to placing the following fill lift.

7.5.5 Quality Control

The source and / or type of material used for engineered fill will dictate the type of quality control testing undertaken.

For imported cohesive (clay/silt) materials test criteria using vane shear strength and air voids should be used. A representative suite of compaction curves with solid density and moisture content tests are recommended to confirm a project specific compaction specification.

For any imported granular (sand and gravel) fill materials, testing following compaction should be principally in terms of the maximum dry density within the appropriate water content range, which may be calibrated with a dynamic cone (Scala) penetrometer test that is then used as the primary testing measure. Where the source or quality of fill changes, re-calibration will be required.

The source of the fill should be discussed with and approved by the project geotechnical engineer to verify its appropriateness and quality control testing requirements.

7.6 Civil Works

7.6.1 Road Subgrades

The development masterplan indicates subdivision roading which will be constructed in primarily cut areas or where thin structural earthfill has been placed.

Hinuera silts are sensitive to disturbance and degrade rapidly with trafficking. Where traffic can be left off these materials, they are moisture conditioned, recompacted at optimum moisture contents and located at least 1m above the peak winter water table, there could be some opportunity to use them as a pavement subgrade material for minor roads. However, this is not considered practical for main collector-type roads and allowance should therefore be made to undercut these materials and replace with a subgrade improvement layer (SIL).

The thickness of the SIL should be determined by the pavement designer although a nominal thickness of 1m is envisaged to adequately dissipate traffic loads within the Hinuera Formation soils. From our experience a 1m thick sand SIL overlying high strength geotextile and geogrid may be appropriate. Specific consideration to construction methodologies, such as the use of long reach excavators, progressive excavation and SIL placement, along with use of geotextiles, etc, will also be required to avoid trafficking over sensitive silt subgrades.

It is envisioned that well-graded clean sand excavated during proposed stormwater basin construction would be suitable for use as SIL material.

Medium dense to dense Hinuera Formation sandy soils are generally suitable as road subgrade materials. Where loose Hinuera Formation sands are present at subgrade levels these may be conditioned by proof rolling to achieve suitable subgrade strengths.

7.6.2 Service Trenches

All of the materials to be exposed during the excavation of service trenches should be readily removed using an excavator.

Trench collapse is expected to pose problems in areas where groundwater is encountered, particular over winter months.

Installation of the proposed subsoil drainage network prior to service trenching is recommended. However for service lines deeper than the subsoil drains these should be installed first and are expected to require temporary construction dewatering in the form of regularly spaced sump pumps or well point dewatering spears.

Potential for dewatering induced settlements should be considered during detailed subdivision design and impact on adjacent roading and existing structures assessed.

It is anticipated that all trench backfill will be placed and compacted in accordance with RITS requirements.

7.6.3 Stormwater Soakage

The Hinuera Formation sandy soils at this site are considered suitable to provide a seepage function for the design of stormwater attenuation and soakage basins. The soakage test results indicate a range in K value of 6.11×10^{-6} m/sec to 2.71×10^{-4} m/sec.

Detailed soakage design is being undertaken by others. We recommend the design consider depth to groundwater table, potential for blinding of the base due to progressive fines build up, secondary overland flow paths and downstream effects.

There is a lot of variability in the soakage test results, and for preliminary design purposes conservatively using the lower value may be more appropriate than adopting an average. As such, further soakage testing in the location of the proposed soakage basins should provide greater confidence.

8 FOUNDATIONS

At the completion of earthworks, a Geotechnical Completion Report (GCR) will be prepared. The GCR will advise on anticipated foundation design parameters and any restrictions that require further engineering investigation and/ or design on individual lots to address any remaining natural hazards as described in Section 71(3) of the Building Act i.e., erosion, falling debris, subsidence, slippage, and inundation.

Restrictions that are expected to be applied in the GCR to protect the future buildings from natural hazards associated with static settlement and liquefaction, batters and drainage are outlined in the respective sections in this report.

On this site our provisional expectation is that, provided earthworks are completed in accordance with the standards and recommendations described herein, the following will apply:

- A preliminary geotechnical ultimate bearing pressure of 300kPa should be available for shallow strip and pad foundations constructed within both the natural cut ground and engineered fill areas, subject to the short axis of those footings measuring no greater than 1.5m in plan.

There may be areas where localised variations in shear strength/ density within the natural cut ground occur. Further confirmation of available bearing pressures will be addressed at the time of post earthworks soil testing.

- On the basis of soil descriptions and our experience, we have assessed the preliminary AS2870 Site Class for building platforms within the Hinuera Formation soils to be A (Stable). These recommendations should be subject to further review by a suitably qualified geotechnical engineer for specific building foundations.
- As required by section B1/VM4[21] of the New Zealand Building Code Handbook, a strength reduction factor of 0.5 and 0.8 must be applied to all recommended geotechnical ultimate soil capacities in conjunction with their use in factored design load cases for static and earthquake overload conditions respectively.

9 STATEMENT OF PROFESSIONAL OPINION

Based on the results of previous geotechnical investigations at the site and subject to the preliminary recommendations stated above, we consider that the site is suitable for the proposed level of development. The proposed Private Plan Change to enable commercial and industrial subdivision, with associated roading infrastructure and stormwater soakage/detention basin, is considered to be appropriate from a geotechnical perspective. This statement is dependent on further work as detailed in Section 10 below.

10 FURTHER WORK

Further geotechnical field investigation and design will be required to suitably mitigate the geotechnical risks identified in ***Section 6*** above.

Our recommendations for further work are as follows:

- Seismic Cone Penetration Testing, possibly in conjunction with laboratory testing, of potentially liquefiable soils should be undertaken to define an appropriate ageing factor for the site and provide a more accurate/reliable specific liquefaction analysis.
- Further slope stability analyses should be undertaken at the time of detailed design of the stormwater basins including assessment of soil types, variation of water levels, potential for scour/erosion and any surcharge loading. A building restriction setback from the basins should be confirmed at this time.
- Section 106 of the Resource Management Act22 (RMA) requires an assessment of the risk from natural hazards to be carried out when considering the granting of a subdivision consent. S106 RMA specifically states that the assessment must consider the combined effect of the natural hazard likelihood and material damage to land or structures (consequence). This is a requirement at Resource Consent application stage.
- Subsoil drainage design including drain layout and construction detailing.
- Earthworks material suitability assessment including sampling of proposed fill materials, laboratory testing and preparation of an project specific earthworks compaction control specification.
- Presentation of the above work in a Geotechnical Design Report suitable to support a Resource Consent application and / or detailed design as appropriate.

Proposed buildings should be subject to specific geotechnical site investigation, analyses and reporting at the time of Building Consent application.

[21] Ministry of Business, Innovation and Employment (2019) *Acceptable Solutions and Verification Methods for NZ Building Code Clause B1 Structure,* B1/VM4, Amendment 19
[22] Resource Management Act (1991), as at 29 October 2019

USE OF THIS REPORT

Site subsurface conditions cause more construction problems than any other factor and therefore are generally the largest technical risk to a project. These notes have been prepared to help you understand the limitations of your geotechnical report.

Your geotechnical report is based on project specific criteria

Your geotechnical report has been developed on the basis of our understanding of your project specific requirements and applies only to the site area investigated. Project requirements could include the general nature of the project; its size and configuration; the location of any structures on or around the site; and the presence of underground utilities. If there are any subsequent changes to your project you should seek geotechnical advice as to how such changes affect your report's recommendations. Your geotechnical report should not be applied to a different project given the inherent differences between projects and sites.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of subsurface investigation, the conditions may have changed, particularly when large periods of time have elapsed since the investigations were performed.

Interpretation of factual data

Site investigations identify actual subsurface conditions at points where samples are taken. Additional geotechnical information (e.g. literature and external data source review, laboratory testing on samples, etc) are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can exactly predict what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

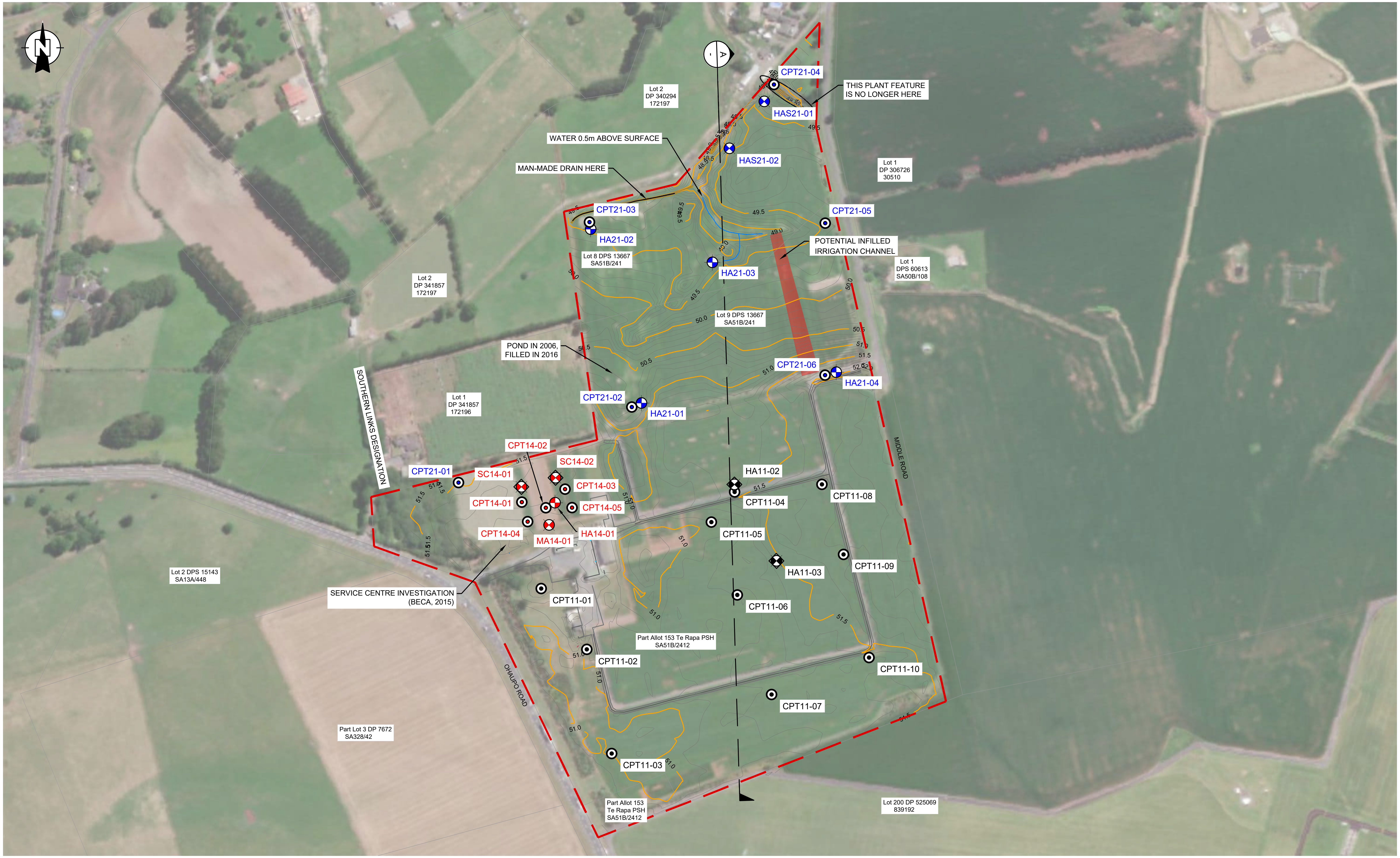
Your report's recommendations require confirmation during construction

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced. For this reason, you should retain geotechnical services throughout the construction stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site. A geotechnical designer, who is fully familiar with the background information, is able to assess whether the report's recommendations are valid and whether changes should be considered as the project develops. An unfamiliar party using this report increases the risk that the report will be misinterpreted.

Interpretation by other design professionals

Costly problems can occur when other design professionals develop their plans based on misinterpretations of a geotechnical report. Read all geotechnical documents closely and do not hesitate to ask any questions you may have. To help avoid misinterpretations, retain the assistance of geotechnical professionals familiar with the contents of the geotechnical report to work with other project design professionals who need to take account of the contents of the report. Have the report implications explained to design professionals who need to take account of them, and then have the design plans and specifications produced reviewed by a competent Geotechnical Engineer.

Appendix A: CMW Drawings



LEGEND:

HAS-01	CMW HA + SOAKAGE TEST LOCATION	HA11-01	BECA HAND AUGER SCALA
CPT21-01	CMW CPT LOCATION	HA14-01	BECA HAND AUGER
HA21-01	CMW HA LOCATION	CPT14-01	BECA CONE PENETROMETER TEST
		SC14-01	BECA SCALA
		MA14-01	BECA MACHINE AUGER/ TEST PIT
CPT11-01	BECA CONE PENETROMETER TEST		SITE BOUNDARY

NOTES:

1. CONTOURS TAKEN FROM TOPOGRAPHICAL SURVEY PLAN BY BECA (JULY 2021)

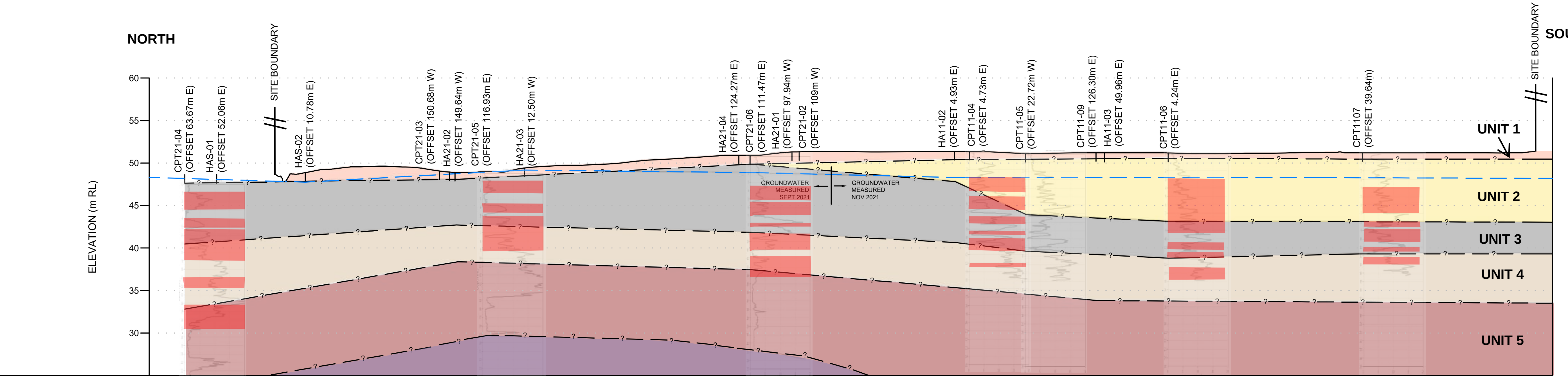
0 40 80 120 160 200 m

1:4000

CMW Geosciences

CLIENT: MCCONNELL PROPERTY		DRAWN: HV	PROJECT: HAM2021-0073
PROJECT: **3463 OHAUPO ROAD RUKUHIA**		CHECKED: SF	DRAWING: 01
		REVISION: 0	SCALE: 1:4000
TITLE: **SITE INVESTIGATION PLAN**		DATE: 28/09/2021	SHEET: A3 L

P:\HAM\2021\HAM2021-0073 3463 OHAUPO ROAD, RUKUHIA\DRAWINGS\HAM2021-0073 SITE INVESTIGATION PLAN.DWG



DISTANCE (m)	EXISTING GROUND (m RL)
10	
20	
30	
40	
50	
60	
70	
80	47.80
90	48.80
100	49.19
110	49.34
120	49.55
130	49.59
140	49.62
150	49.53
160	49.40
170	49.08
180	48.89
190	48.89
200	49.01
210	48.99
220	49.40
230	49.58
240	49.67
250	49.71
260	49.79
270	49.90
280	50.07
290	50.29
300	50.40
310	50.52
320	50.65
330	50.79
340	50.90
350	50.90
360	50.94
370	51.17
380	51.31
390	51.34
400	51.35
410	51.33
420	51.31
430	51.31
440	51.32
450	51.34
460	51.35
470	51.35
480	51.38
490	51.40
500	51.25
510	51.15
520	51.12
530	51.15
540	51.18
550	51.20
560	51.20
570	51.20
580	51.20
590	51.20
600	51.18
610	51.13
620	51.10
630	51.12
640	51.14
650	51.16
660	51.17
670	51.20
680	51.22
690	51.24
700	51.30
710	51.20
720	51.20
730	51.20
740	51.20
750	51.20
760	51.20
770	51.20
780	51.20
790	51.20
800	51.20
810	51.27
820	
825	

SECTION A (5x VERTICAL EXAGERATION)

LEGEND:

- EXISTING GROUND SURFACE
- INFERRED GEOLOGICAL BOUNDARY
- GROUNDWATER LEVEL
- (UNIT 1) VERY LOOSE TO LOOSE, SAND/SILT (~16.5-17.5 kN/m^3)
- (UNIT 2) MEDIUM DENSE TO DENSE, FINE TO MEDIUM SAND (~17.0 kN/m^3)
- (UNIT 3) MEDIUM DENSE TO DENSE, FINE TO MEDIUM SAND, (~17.0 kN/m^3) WITH INTER-BEDDED LENSES OF LOOSE SILT (~15.0-16.0 kN/m^3)
- (UNIT 4) CPT INFERRED MEDIUM DENSE TO DENSE, SAND (~18.0 kN/m^3)
- (UNIT 5) CPT INFERRED, STIFF, CLAYEY SILT/SILT (~16.0-17.0 kN/m^3)
- POSSIBLE VERY DENSE IGNIMBRITE (~18.0 kN/m^3)
- LIQUEFIABLE LAYER

Vertical 1:500 / Horizontal 1:2500 — 0 25 50 75 100 125 m

CMW Geosciences	CLIENT: MCCONNELL PROPERTY	DRAWN: HV	PROJECT: HAM2021-0073
	PROJECT: 3463 OHAUPO ROAD RUKUHIA	CHECKED: SF	DRAWING: 02
		REVISION: 0	SCALE: 1:2500
	TITLE: CROSS-SECTION A	DATE: 28/09/2021	SHEET: A3 L

P:\HAM\2021\HAM2021-0073 3463 OHAUPO ROAD, RUKUHIA\DRAWINGS\HAM2021-0073 SECTIONS.DWG

Appendix B: Provided Plans

Drawing Plotted: 12 Jul 2021 5:27 PM

SURVEY NOTES:
BECA REFERENCE: 4286308
SURVEY DATES: 5TH AND 6TH OF JULY 2021
SURVEYOR: AALIS DREWET AND JACK PRYDE

DATUM NOTE:
COORDINATES ARE IN TERMS OF NEW ZEALAND TRANSVERSE MERCATOR(NZTM). ORIGIN OF COORDINATES: DJF3 (LINZ GEODETIC DATABASE)
5807285.583MN 1804227.784ME

LEVELS ARE IN TERMS OF MOTURIKI 1953 VERTICAL DATUM.
ORIGIN OF LEVELS: AGFT (LINZ GEODETIC DATABASE) 51.4812 MRL

1.SURVEY CONTROL:
CONTROL HAS BEEN ESTABLISHED ON SITE WITH GNSS GPS WITH THE ABSOLUTE ACCURACY FOR POSITION AND LEVEL BEING ± 50MM.

2.SURVEY ACCURACY:
THIS SURVEY HAS BEEN CARRIED OUT TO TOPOGRAPHICAL STANDARDS RELATIVE TO THE SURVEY CONTROL. HARD FEATURES HAVE BEEN SURVEYED USING TOTAL STATION WITH THE RELATIVE ACCURACY FOR POSITION AND LEVEL BEING ± 20MM (2Σ). SOFT FEATURES HAVE BEEN SURVEYED USING GNSS GPS WITH THE RELATIVE ACCURACY FOR POSITION AND LEVEL BEING ± 50MM (2Σ). ALL LEVELS SHOWN ARE CORRECT AT THE TIME OF SURVEY. ANY CRITICAL DIMENSIONS AND LEVELS SHOULD BE VERIFIED.

3.FEATURES AND SERVICES:
EVERY EFFORT IS MADE TO IDENTIFY ALL VISIBLE ABOVE GROUND FEATURES. HOWEVER IT SHOULD BE NOTED THAT THERE MAY BE ITEMS OBSCURED AT THE TIME OF SURVEY. NO UNDERGROUND SERVICES HAVE BEEN INCLUDED IN THIS SURVEY.
FEATURES HAVE BEEN CODING USING THE BECA SURVEY CODING CONVENTION.

4.GROUND SURFACE MODEL:
CONTOURS SHOWN ON THIS PLAN HAVE BEEN ELECTRONICALLY COMPUTED FROM SPOT HEIGHT DETERMINATIONS USING A TIN GROUND SURFACE AND MAY NOT REPRESENT THE TRUE GROUND LEVELS. MINOR CONTOURS ARE AT 0.1M INTERVALS AND MAJOR CONTOURS ARE AT 0.5M INTERVALS.

5.BOUNDARIES:
BOUNDARIES SHOWN HAVE BEEN EXTRACTED FROM LANDONLINE AND HAVE NOT BEEN VERIFIED.

6.AERIAL IMAGERY:
AERIAL IMAGERY HAS BEEN DOWNLOADED FROM THE LINZ GIS DATABASE FOR INDICATIVE PURPOSES.
IT IS NOT TO SCALE AND HAS NOT BEEN VERIFIED IN THE FIELD.
IMAGERY IS FROM A DATASET DATED 2016-2019.

7.ADDITIONAL NOTES:
THIS SURVEY IS ISSUED FOR A SPECIFIC PROJECT AND MAY NOT BE ALTERED OR USED FOR ANY OTHER PURPOSE WITHOUT THE PRIOR WRITTEN CONSENT OF BECA.

LEGEND

- TOP OF BANK
- BOTTOM OF BANK
- BUILDING OUTLINE
- FENCE
- METAL TRACK
- EDGE OF VEGETATION
- LINZ BOUNDARY
- MINOR CONTOURS
- MAJOR CONTOURS
- WATER MANHOLE
- POWER POLE
- STORMWATER GRATE
- DRAIN INVERT
- SPOT HEIGHT

FOR INFORMATION
NOT FOR CONSTRUCTION

No.	Revision	By	Chk	Appd	Date
A	SURVEY TOPOGRAPHICAL INFORMATION	JP	MH	MH	12.07.21

Drawing Originator: Beca

Original Scale (A1) 1:2000
Reduced Scale (A3) 1:4000

Surveyed	AD JP	05.07.21	Approved For Issue*
Drawn	JP	08.07.21	
Verifier	MH	12.07.21	
Dwg Check	MH	12.07.21	Date N/A

* Refer to Revision 1 for Original Signature

Client: GENETIC TECHNOLOGIES LTD

Project: 3463 OHAUPO RD
GLENVIEW
HAMITLON 3282

Title: TOPOGRAPHICAL SURVEY

Discipline: SURVEY

Drawing No. 4286308-WS-001

Rev. A

Document No. 3320000-WS-0100

www.beca.com

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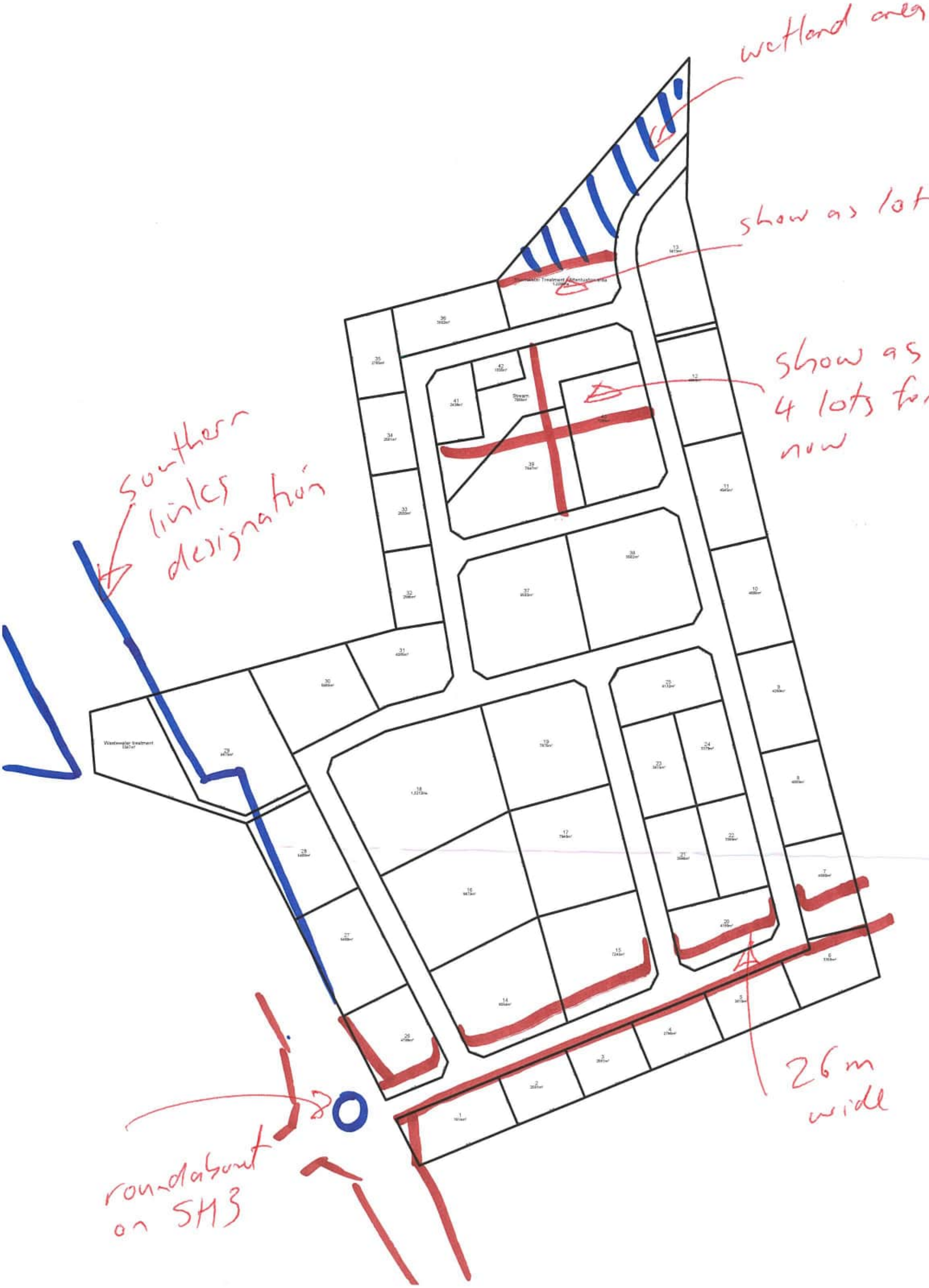
DO NOT SCALE

IF IN DOUBT ASK.


wetland area
show as lot
Stormwater Treatment / Attenuation area
Stream
show as 4 lots for now
southern links designation
Wastewater treatment
26m wide
roundabout on SH3
80

Appendix C: Field Investigation Results

HAND AUGER BOREHOLE LOG - HA21-01

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan — Logged by: NK — Checked by: DM — Scale: 1:25 — Sheet 1 of 1

Position: 449212.3mE; 691387.9mN — Projection: Mount Eden 2000
Datum: Moturiki — Survey Source: Hand Held GPS

Groundwater	Sample Depth	Type & Results	RL (m)	Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density
	0.2-0.3	B B		0.0–0.3	ML: SILT: No plasticity. (Topsoil)	M to W	
	0.6	Peak = 159kPa Residual = 51kPa		0.3–2.0	OL: Sandy Organic SILT: dark brown. Low plasticity, insensitive to moderately sensitive. (Uncontrolled Fill)		VSt
08-09-2021 (at 1.0 m)	0.9	Peak = 115kPa Residual = 41kPa					
	1.2	Peak = 98kPa Residual = 58kPa				S	
	1.5-1.6	B B					St
				2.0–3.2	SM: Silty Fine SAND: light grey. Poorly graded. (Hinuera Formation)		D
					... at 2.80m, Poor recovery		
					... at 3.10m, No recovery		MD
				3.2	Borehole terminated at 3.2 m		

Dynamic Cone Penetrometer (Blows/100mm), per 100 mm from surface:
1, 1, 2, 4, 5, 6, 4, 4, 4, 4, 4, 5, 3, 3, 3, 2, 2, 2, 3, 6, 9, 8, 11, 11, 11, 10, 10, 7, 6, 4, 2, 2, 2, 4, 5, 2, 2, 4, 4, 3, 5, 4, 6, 6, 6, 5, 4, 4, 4

Termination Reason: Hole collapse
Shear Vane No: 2087 — DCP No: 13
Remarks: Groundwater encountered at 1m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA21-02

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021

CMW Geosciences

Borehole Location: Refer to site plan | Logged by: NK | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

Position: 449162.9mE; 691588.5mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Depth (m)	Material Description	Moisture Condition	Consistency/ Relative Density
0.0–0.8	ML: SILT: with some clay; dark brown mottled orange white. (Uncontrolled Fill)	M	H
0.8–1.0	ML: SILT: with some clay; light grey. Low plasticity. (Hinuera Formation)	M (to 0.9); W to S (0.9–1.0)	H
1.0–1.7	SP: Silty Fine SAND: light grey. Poorly graded, rounded. (Hinuera Formation) ... *at 1.00m, Dilatent*	S	MD to D
1.7–2.0	SM: Silty Fine SAND: light grey. Poorly graded, rounded. (Hinuera Formation)	S	MD to D
2.0–2.2	ML: Sandy SILT: light grey. Low plasticity, sensitive. (Hinuera Formation)	S	VSt
2.2–3.2	SM: Silty Fine SAND: light grey. Poorly graded, rounded. (Hinuera Formation)	S	D (to 3.0); MD (3.0–3.2)
3.2–3.9	OL: Organic SILT: dark brown. Low plasticity. (Hinuera Formation) ... *from 3.20m to 3.80m, Poor recovery*	S	VS
3.9–5.0	SM: Silty Fine to medium SAND: brownish grey. Poorly graded, subrounded. (Hinuera Formation) ... *from 3.90m to 5.00m, Poor recovery*	S	D

Borehole terminated at 5.0 m

Groundwater: 08-09-2021 (at 1.1 m)

Samples & Insitu Tests

Depth	Type & Results
0.3	Peak = UTP
0.6	Peak = UTP
0.9	Peak = UTP
1.2	Peak = UTP
2.0	Peak = 163kPa Residual = 30kPa

Dynamic Cone Penetrometer (Blows/100mm)

Depth interval (m)	Blows
0.1–0.2	1
0.2–0.3	1
0.3–0.4	2
0.4–0.5	5
0.5–0.6	4
0.6–0.7	2
0.7–0.8	2
0.8–0.9	2
0.9–1.0	2
1.0–1.1	4
1.1–1.2	6
1.2–1.3	11
1.3–1.4	12
1.4–1.5	14
1.5–1.6	16
1.6–1.7	12
1.7–1.8	10
1.8–1.9	6
1.9–2.0	10
2.0–2.1	5
2.1–2.2	8
2.2–2.3	8
2.3–2.4	10
2.4–2.5	12
2.5–2.6	16
2.6–2.7	12
2.7–2.8	11
2.8–2.9	7
2.9–3.0	13
3.0–3.1	3
3.1–3.2	3
3.2–3.3	1
3.3–3.4	2
3.4–3.5	4
3.5–3.6	2
3.6–3.7	2
3.7–3.8	2
3.8–3.9	2
3.9–4.0	2
4.0–4.1	10
4.1–4.2	8
4.2–4.3	8
4.3–4.4	10
4.4–4.5	10
4.5–4.6	10
4.6–4.7	11
4.7–4.8	8
4.8–4.9	10
4.9–5.0	11

Termination Reason: Target depth
Shear Vane No: 2560 | DCP No: 13
Remarks: Groundwater encountered at 1.1m.

This report is based on the attached field description for soil and soil rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

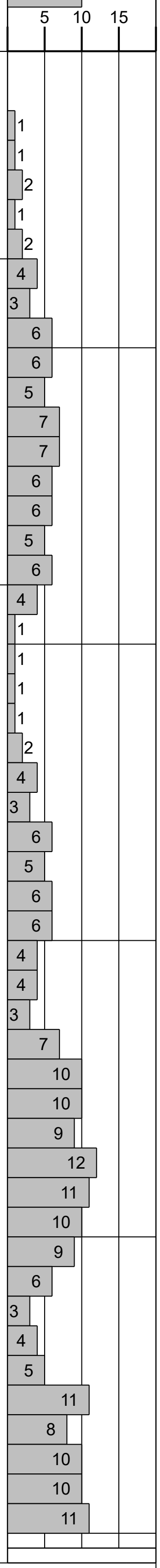
HAND AUGER BOREHOLE LOG - HA21-03

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan | Logged by: NK | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

Position: 449317.3mE; 691556.2mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density
08-09-2021						ML: SILT: dark brown. No plasticity. (Topsoil)	W to S	
	0.3	Peak = 146kPa Residual = 61kPa						
	0.6	Peak = 129kPa Residual = 47kPa						
						SM: Silty Fine to medium SAND: light grey mottled orange brown. Poorly graded. (Hinuera Formation)	S	
				1				
						SM: Silty Fine SAND: light grey. Poorly graded. (Hinuera Formation)		MD
						... at 1.20m, Poor recovery		
						... at 1.70m, No recovery		
						Borehole terminated at 1.8 m		
				2				
				3				
				4				
				5				

Dynamic Cone Penetrometer (Blows/100mm)



Termination Reason: Hole collapse
Shear Vane No: 2087 DCP No: 13
Remarks: Groundwater encountered from surface.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA21-04

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan | Logged by: NK | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

CMW Geosciences

Position: 449465.6mE; 691451.7mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density
				0.0–0.2		ML: SILT: dark brown. No plasticity. (Topsoil)	M to W	
	0.3	Peak = 125kPa Residual = 30kPa		0.2–0.8		SM: Silty Fine SAND: brown. Poorly graded. (Hinuera Formation)	M to W	VL to L
				0.8–2.0		SM: Silty Fine SAND: light brown. Poorly graded. (Hinuera Formation)	M to W	L to MD
08-09-2021 (at 3.4 m)				2.0–4.0		SM: Silty Fine SAND: light grey. Poorly graded. (Hinuera Formation) ... *at 3.40m, Poor recovery*	M to W (to 3.4 m); S (3.4–4.0 m)	L to MD
				4.0		Borehole terminated at 4.0 m		

Dynamic Cone Penetrometer (Blows/100mm), 0.0–5.0 m:
1, 1, 1, 2, 2, 1, 2, 1, 3, 3, 4, 3, 4, 4, 4, 3, 4, 3, 4, 4, 5, 5, 4, 6, 6, 7, 5, 5, 7, 5, 4, 4, 4, 7, 3, 5, 5, 4, 5, 3, 4, 5, 5, 6, 4, 4, 5, 5, 5

Termination Reason: Hole collapse
Shear Vane No: 2087 DCP No: 13
Remarks: Groundwater encountered at 3.4m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HA21-05

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan | Logged by: AC | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

Position: 449348.6mE; 691708.9mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
						SILT: dark brown. (Topsoil)			
						Clayey SILT: with some fine sand; light orange brown. Low plasticity. (Hinuera Formation)	S		
	0.4	Peak = UTP				SP: Silty Fine SAND: light brown. Poorly graded, rounded. (Hinuera Formation)			
						Borehole terminated at 0.6 m			
				1					
				2					
				3					
				4					
				5					

Termination Reason: Target Depth
Shear Vane No: 2327 | DCP No:
Remarks: Groundwater not encountered. Test hole to check why water ponding.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HAS01

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan | Logged by: AC | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

Position: 449172.5mE; 691604.5mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Material Description (Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit))	Moisture Condition	Consistency/ Relative Density
				0.0–0.2	SILT: with some rootlets; dark brown. (Topsoil)	M	
				0.2–0.5	SP: Fine SAND: with minor silt; light brown. Poorly graded, rounded. (Hinuera Formation)	M	VL to L
	0.6	Peak = 147kPa Residual = 27kPa		0.5–0.8	ML: Sandy SILT: fine sand; light grey streaked light orange brown. Low plasticity, sensitive. (Hinuera Formation)	M	VSt
▼	0.9	Peak = 123kPa Residual = 27kPa		0.8–1.0	ML: SILT: with minor clay; light grey. Low plasticity, sensitive. (Hinuera Formation)	M	VSt
				1.0–1.6	SM: Silty Fine SAND: light grey. Poorly graded, rounded. (Hinuera Formation)	W; W to S	MD to D
				1.6–2.0	SP: Fine to medium SAND: with minor silt; light grey. Poorly graded, rounded. (Hinuera Formation) ... *at 1.80m, Poor recovery*	S	MD to D
				2.0–2.3	SW: Fine to coarse SAND: dark grey. Well graded. (Hinuera Formation)	S	MD to D
				2.3	Borehole terminated at 2.3 m		

Dynamic Cone Penetrometer (Blows/100mm)

Depth (m)	0.0–0.1	0.1–0.2	0.2–0.3	0.3–0.4	0.4–0.5	0.5–0.6	0.6–0.7	0.7–0.8	0.8–0.9	0.9–1.0	1.0–1.1	1.1–1.2
Blows	1	2	2	2	2	1	1	2	2	3	4	4

Depth (m)	1.2–1.3	1.3–1.4	1.4–1.5	1.5–1.6	1.6–1.7	1.7–1.8	1.8–1.9	1.9–2.0	2.0–2.1	2.1–2.2	2.2–2.3	2.3–2.4
Blows	5	5	7	10	5	5	7	5	6	7	7	7

Termination Reason: Hole Collapse
Shear Vane No: 2560 | DCP No: 18
Remarks: Groundwater encountered at 0.8m.

This report is based on the attached field description for soil and rock, CMW Geosciences - Field Logging Guide, Revision 3 - April 2018.

HAND AUGER BOREHOLE LOG - HAS02

Client: McConnell Property
Project: Yates Development
Site Location: 3463 Ohaupo Road, Rukuhia, Hamilton
Project No.: HAM2021-0073
Date: 08/09/2021
Borehole Location: Refer to site plan | Logged by: AC | Checked by: DM | Scale: 1:25 | Sheet 1 of 1

Position: 449322.4mE; 691679.6mN | Projection: Mount Eden 2000
Datum: Moturiki | Survey Source: Hand Held GPS

Groundwater	Samples & Insitu Tests: Depth	Samples & Insitu Tests: Type & Results	RL (m)	Depth (m)	Graphic Log	Material Description Soil: Soil symbol; soil type; colour; structure; bedding; plasticity; sensitivity; additional comments. (origin/geological unit) Rock: Colour; fabric; rock name; additional comments. (origin/geological unit)	Moisture Condition	Consistency/ Relative Density	Dynamic Cone Penetrometer (Blows/100mm) 5 10 15
						SILT: with some rootlets; dark brown. (Topsoil)	M		1
	0.2	Peak = 191kPa Residual = 54kPa				ML: Clayey SILT: light orange brown. Low plasticity, moderately sensitive. (Hinuera Formation)		VSt	1
						SM: Silty Fine SAND: light brown. Poorly graded. (Hinuera Formation)		VL	2, 2
▼	0.6	Peak = 191kPa Residual = 57kPa				ML: SILT: with minor clay; light grey. Low plasticity, moderately sensitive. (Hinuera Formation)		L	2, 2, 3, 4
				1		SP: Silty Fine SAND: light grey. Poorly graded, rounded. (Hinuera Formation)	W	MD	7
						SM: Silty Fine to medium SAND: light grey. Poorly graded. (Hinuera Formation)	W to S / S		6, 7, 5, 5, 5, 5
						SW: Fine to coarse SAND: light grey to dark grey. Well graded, subrounded. (Hinuera Formation) *... at 1.70m, Poor recovery*	S		7, 6, 6, 6
				2		Borehole terminated at 1.9 m			
				3					
				4					
				5					

Termination Reason: Hole Collapse
Shear Vane No: 2560 | DCP No: 18
Remarks: Groundwater encountered at 0.8m.

CMW Geosciences			
CLIENT:	Phillip Yates Family Holdings Ltd	DESIGNER:	AMC
PROJECT:	3463 Ohaupo Road, Rukuhia, Hamilton	CHECKED:	DMM
		REVISION:	0
TITLE:	Falling Head Permeability Test - HAS01	DATE:	9/09/2021
		PROJECT:	HAM2021-0073

Specifications - Open-Ended Tube

Length L_1: 2.3 m

Diameter: 90 mm

Non-Perm L_2: m

Above Gnd L_3: 0 m

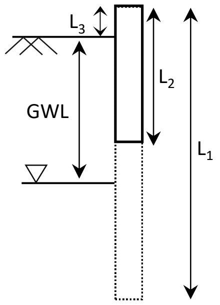
Ground Conditions

GWL: 0.8 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h / k_v}$

Bottom of Test Hole: 2.30 m BGL



Hydraulic Conductivity (k)

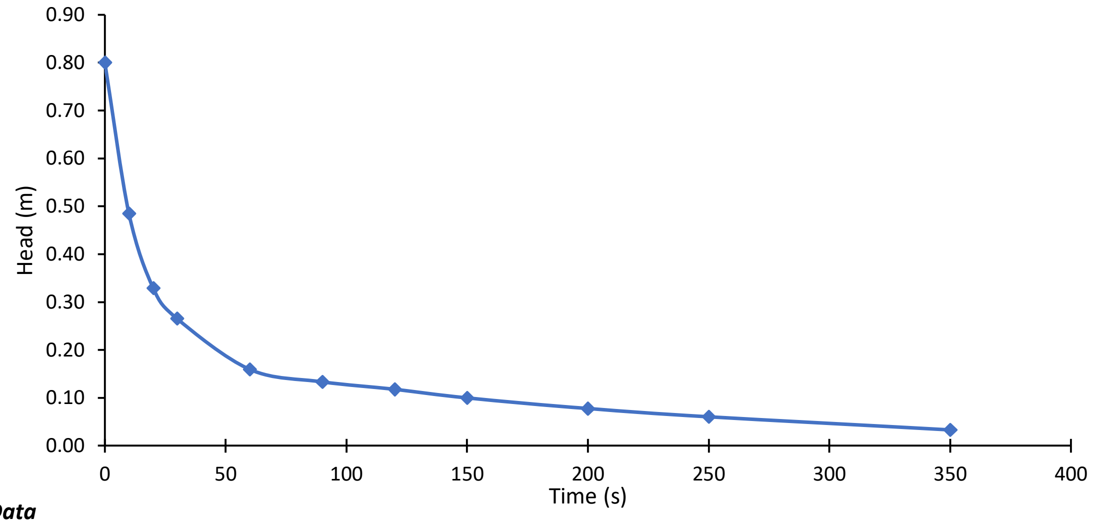
Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1+d}{2h_2+d}\right)\cdot\frac{(h_1+h_2)}{2(t_2-t_1)} =$$ 2.71E-04 ms^{-1} : 23.40 m/day

Hvorslev: Hvorslev (1951) *Time Lag and Soil Permeability in Ground-Water Observations* , Fig 18, p49

$$k = \frac{d^2\,ln\left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d}\right)^2 + 1}\right)}{8L(t_2-t_1)}\,ln\frac{H_1}{H_2} =$$ 3.22E-05 ms^{-1} : 2.78 m/day



STRATIGRAPHIC LOG

- SILT
- Silty sand
- SILT
- Silty sand
- Sand

EOH @ 2.3m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	0.000	0.800				
10	0.315	0.485	2.143		9.14E-05	9.49E-04
20	0.471	0.329	1.907		7.71E-05	6.97E-04
30	0.535	0.265	1.797		4.49E-05	3.69E-04
60	0.640	0.160	1.712		3.65E-05	2.82E-04
90	0.667	0.133	1.647		1.31E-05	8.90E-05
120	0.682	0.118	1.626		9.45E-06	6.09E-05
150	0.700	0.100	1.609		1.24E-05	7.63E-05
200	0.723	0.077	1.589		1.14E-05	6.57E-05
250	0.740	0.061	1.569		1.14E-05	5.89E-05
350	0.767	0.033	1.547		1.39E-05	6.12E-05

Note: Designer must select appropriate values and apply appropriate factors of safety

CMW Geosciences	CLIENT: Phillip Yates Family Holdings Ltd	DESIGNER:	AMC
	PROJECT: 3463 Ohaupo Road, Rukuhia, Hamilton	CHECKED:	DMM
		REVISION:	0
	TITLE: Falling Head Permeability Test - HAS02	DATE:	9/09/2021
		PROJECT:	HAM2021-0073

Specifications - Open-Ended Tube

Length L_1: 1.9 m

Diameter: 90 mm

Non-Perm L_2: m

Above Gnd L_3: 0 m

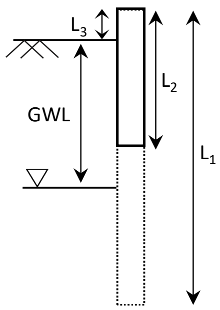
Ground Conditions

GWL: 0.8 m BGL (Blank = Bottom of hole)

Permeability Anisotropy

m: 1 $m = \sqrt{k_h / k_v}$

Bottom of Test Hole: 1.90 m BGL



Hydraulic Conductivity (k)

Note: CMW considers the CIRIA 113 value the most appropriate method for most purposes, but also provides the analysis method as outlined by Hvorslev if desired.

CIRIA 113: Somerville (1986), *Control of groundwater for temporary works,* CIRIA Report 113, Appendix 4

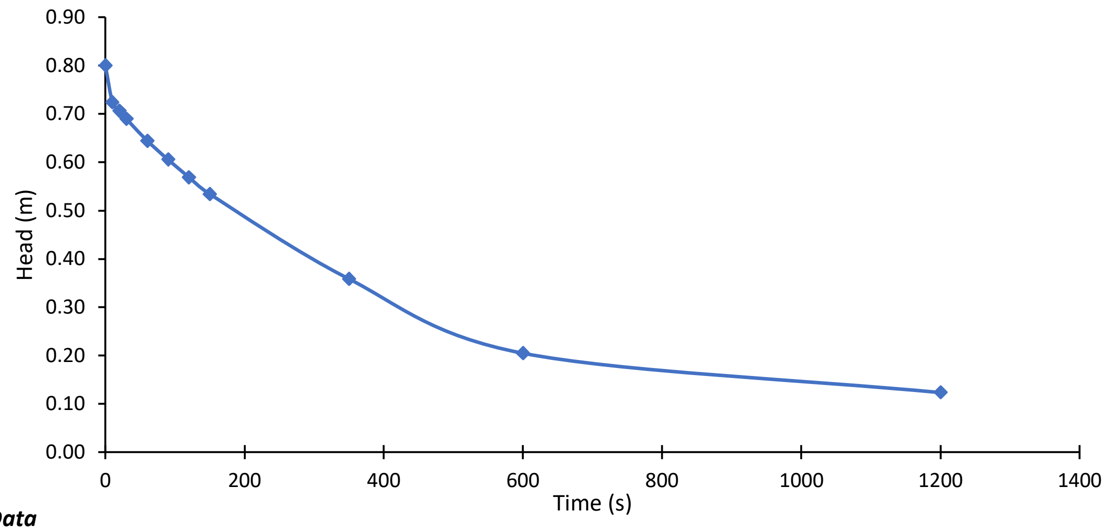
$$k = \left(log\frac{h_1}{h_2} - log\frac{2h_1 + d}{2h_2 + d} \right) \cdot \frac{(h_1 + h_2)}{2(t_2 - t_1)} =$$

5.18E-05 ms^{-1} = 4.47 m/day

Hvorslev: Hvorslev (1951) *Time Lag and Soil Permeability in Ground-Water Observations*, Fig 18, p49

$$k = \frac{d^2\, ln\left(\frac{mL}{d} + \sqrt{\left(\frac{mL}{d}\right)^2 + 1}\right)}{8L(t_2 - t_1)}\, ln\frac{H_1}{H_2} =$$

6.11E-06 ms^{-1} = 0.53 m/day



STRATIGRAPHIC LOG

SILT

Silty sand

SILT

Silty sand

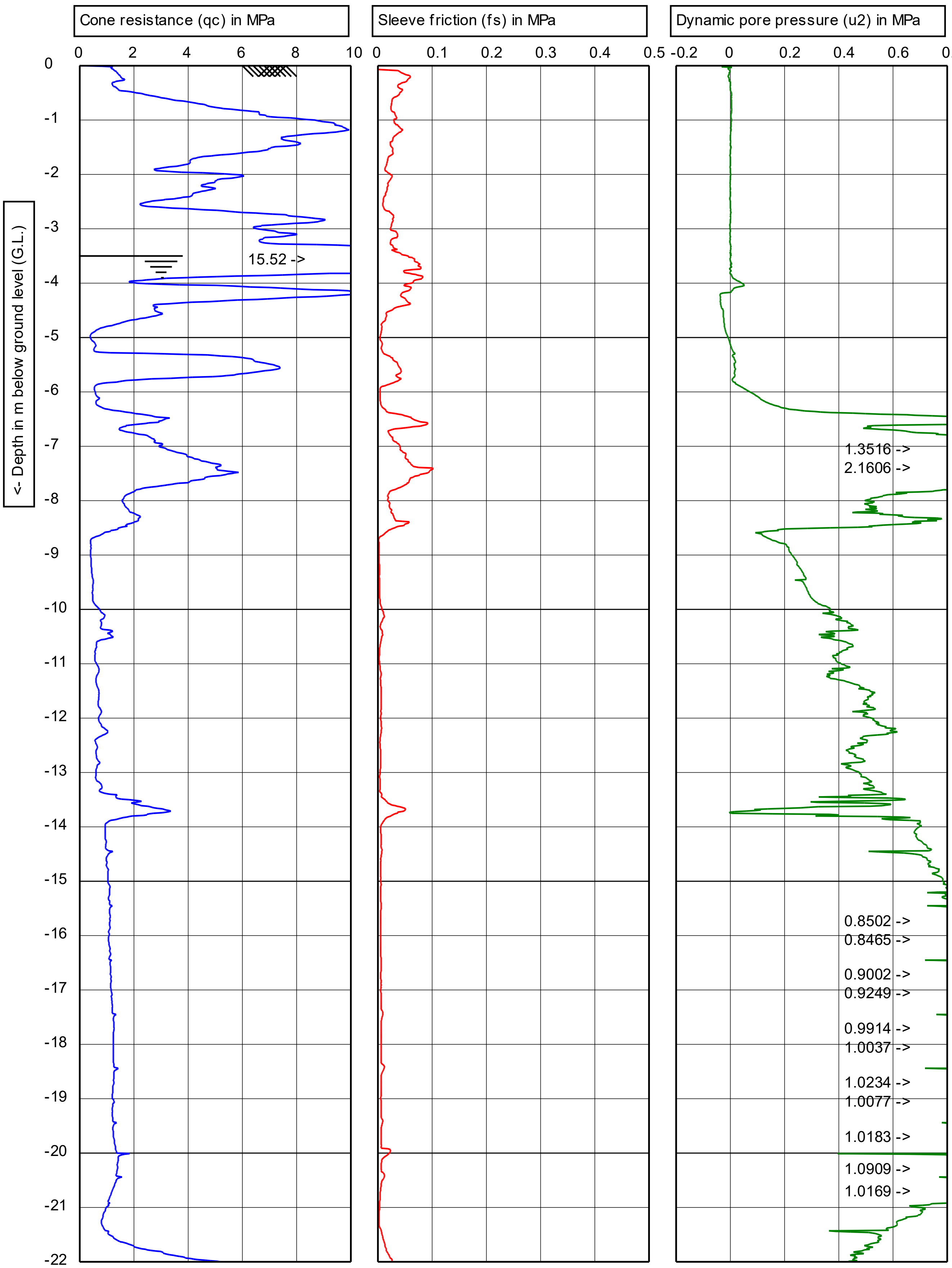
Sand

EOH @ 1.9m

Data

Time (s)	Tape Avg (m)	Head (m)	Perm. Length (m)		Hvorslev 'k' Case G (ms^{-1})	CIRIA 113 'k' (ms^{-1})
0	0.000	0.800				
10	0.076	0.724	1.862		2.02E-05	1.84E-04
20	0.094	0.706	1.815		5.16E-06	4.60E-05
30	0.110	0.690	1.798		4.91E-06	4.34E-05
60	0.156	0.644	1.767		4.76E-06	4.15E-05
90	0.194	0.606	1.725		4.42E-06	3.77E-05
120	0.231	0.569	1.687		4.56E-06	3.81E-05
150	0.266	0.534	1.651		4.64E-06	3.79E-05
350	0.442	0.358	1.546		4.63E-06	3.63E-05
600	0.595	0.205	1.381		5.62E-06	3.93E-05
1200	0.677	0.124	1.264		2.25E-06	1.33E-05

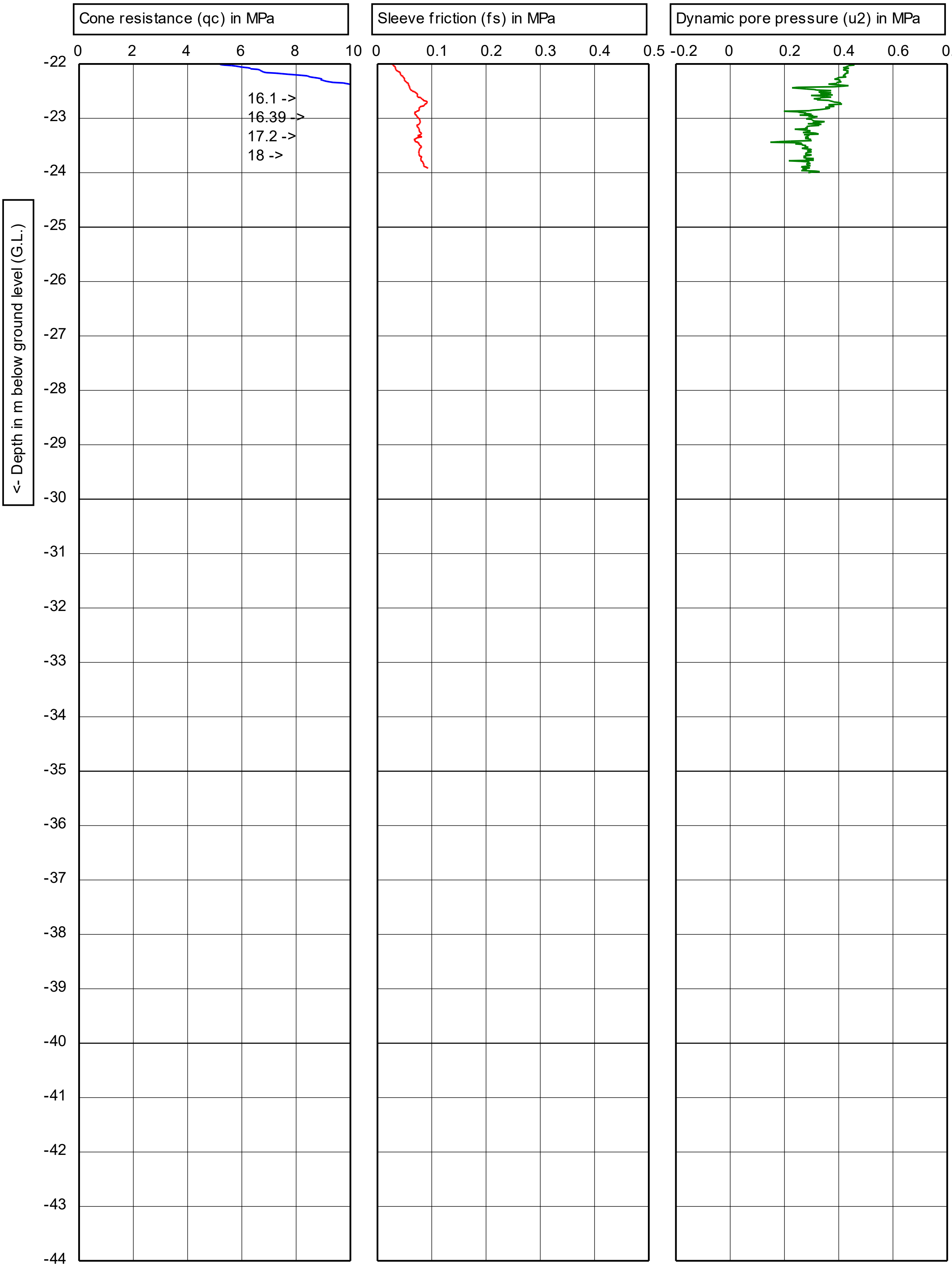
Note: Designer must select appropriate values and apply appropriate factors of safety



Test results indicated as not accredited are outside the scope of the laboratory's accreditation

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	**0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-3.50 m**	Date:	**9/09/2021**
	Project: **3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C19377**
	Location: **Hamilton**	Project no.:	**2-68014.00_HA7829**
	Position: **1804202, 5807398 NZTM**	CPT no.:	**21-01A** 1/12

1.47



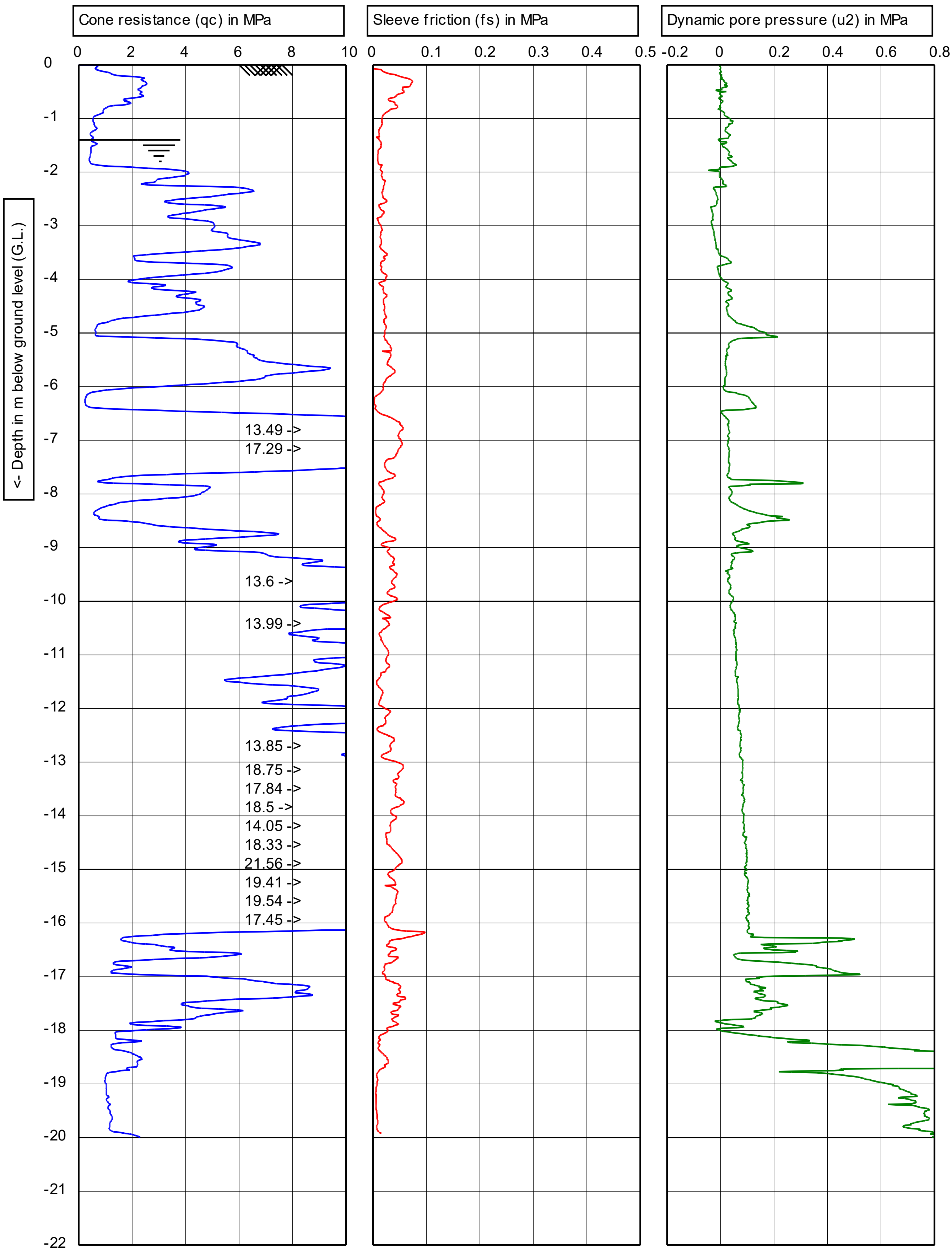
Target Depth

EOH - Dipped - GWL @ 3.5m

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	0.00 m Predrilled
	G.L.: **0.00 m MSL** W.L.: **-3.50 m**	Date:	**9/09/2021**
Project:	**3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C19377**
Location:	**Hamilton**	Project no.:	**2-68014.00_HA7829**
Position:	**1804202, 5807398 NZTM**	CPT no.:	**21-01A** 2/12

1.47



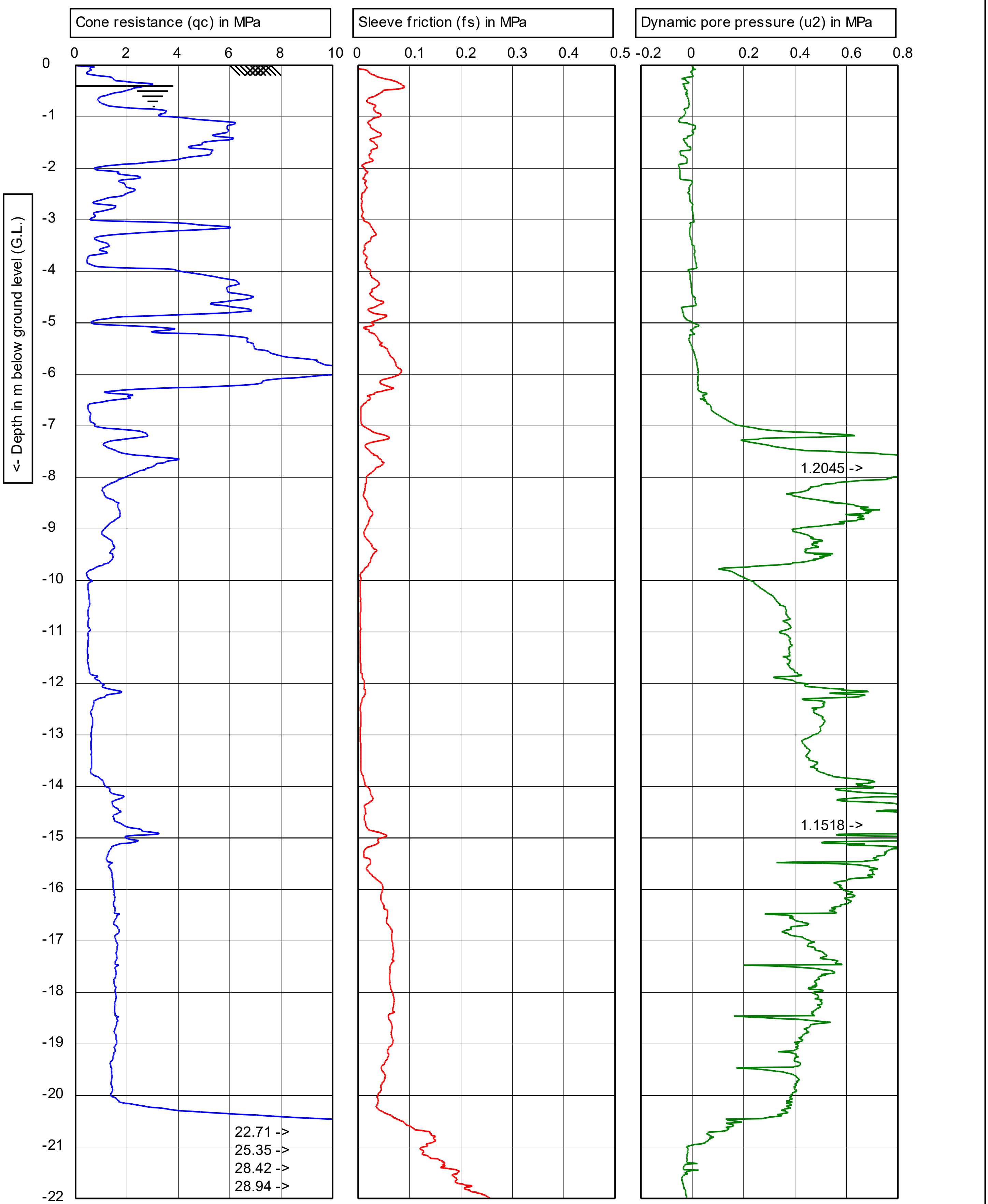
Target Depth

EOH - Dipped - GWL @ 1.4m

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	**0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-1.40 m**	Date:	**9/09/2021**
	Project: **3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C19377**
	Location: **Hamilton**	Project no.:	**2-68014.00_HA7829**
	Position: **1804396, 5807498 NZTM**	CPT no.:	**21-02A** 1/6

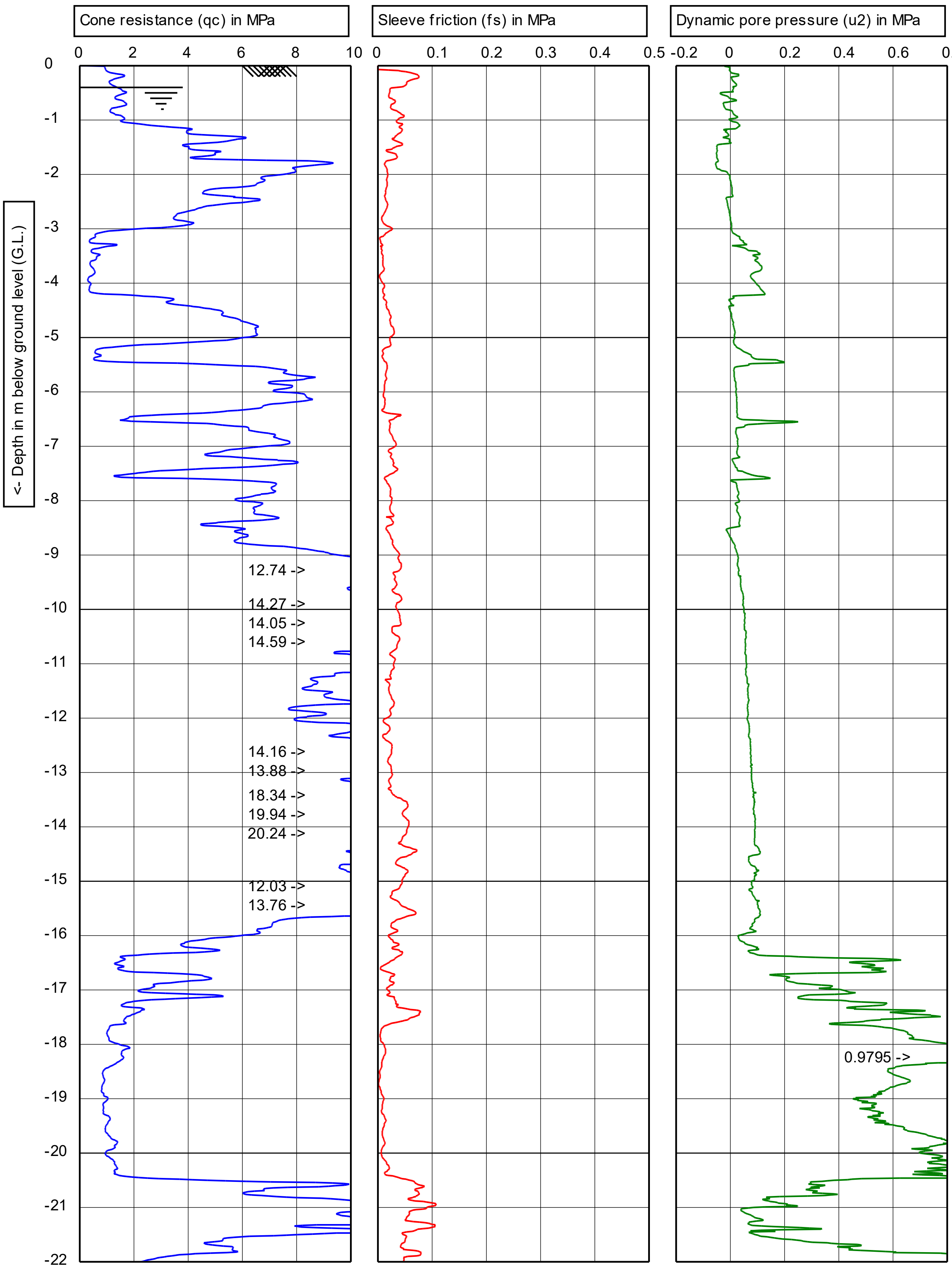
1.47



Test results indicated as not accredited are outside the scope of the laboratory's accreditation

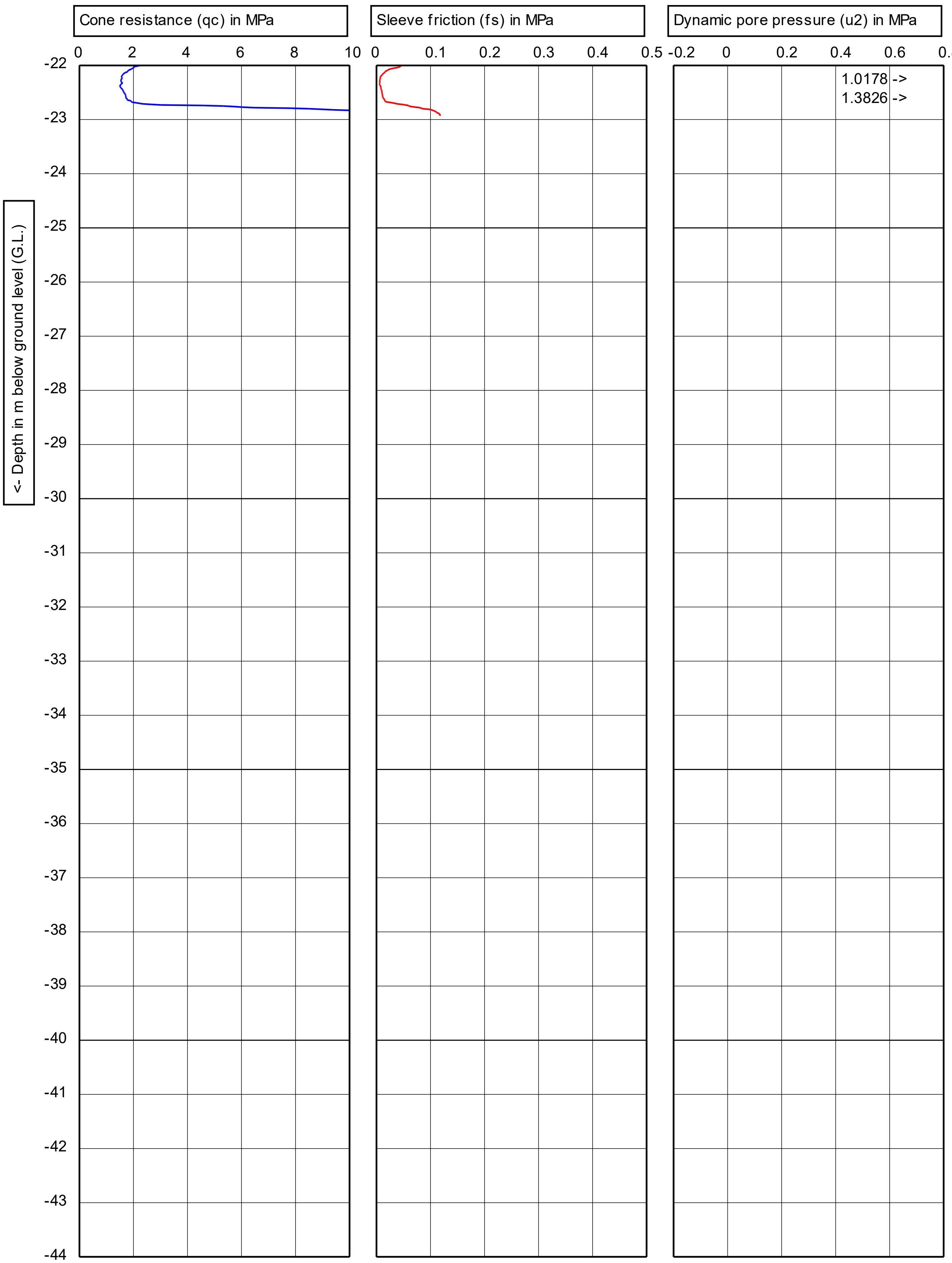
u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	**0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-0.40 m**	Date:	**9/09/2021**
	Project: **3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C14434**
	Location: **Hamilton**	Project no.:	**2-68014.00_HA7829**
	Position: **1804360, 5807694 NZTM**	CPT no.:	**21-03** 1/12

1.47



WSP	u2; 150 cm²; 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill: **0.00 m Predrilled**
		G.L.: **0.00 m MSL** W.L.: **-0.40 m**	Date: **9/09/2021**
IANZ Accredited Testing Laboratory. Test results indicated as not accredited are outside the scope of the laboratory's accreditation		Project: **3463 Ohaupo Rd**	Cone no.: **C10CFIIP.C19377**
		Location: **Hamilton**	Project no.: **2-68014.00_HA7829**
		Position: **1804559, 5807848 NZTM**	CPT no.: **21-04** **1/12**

1.47



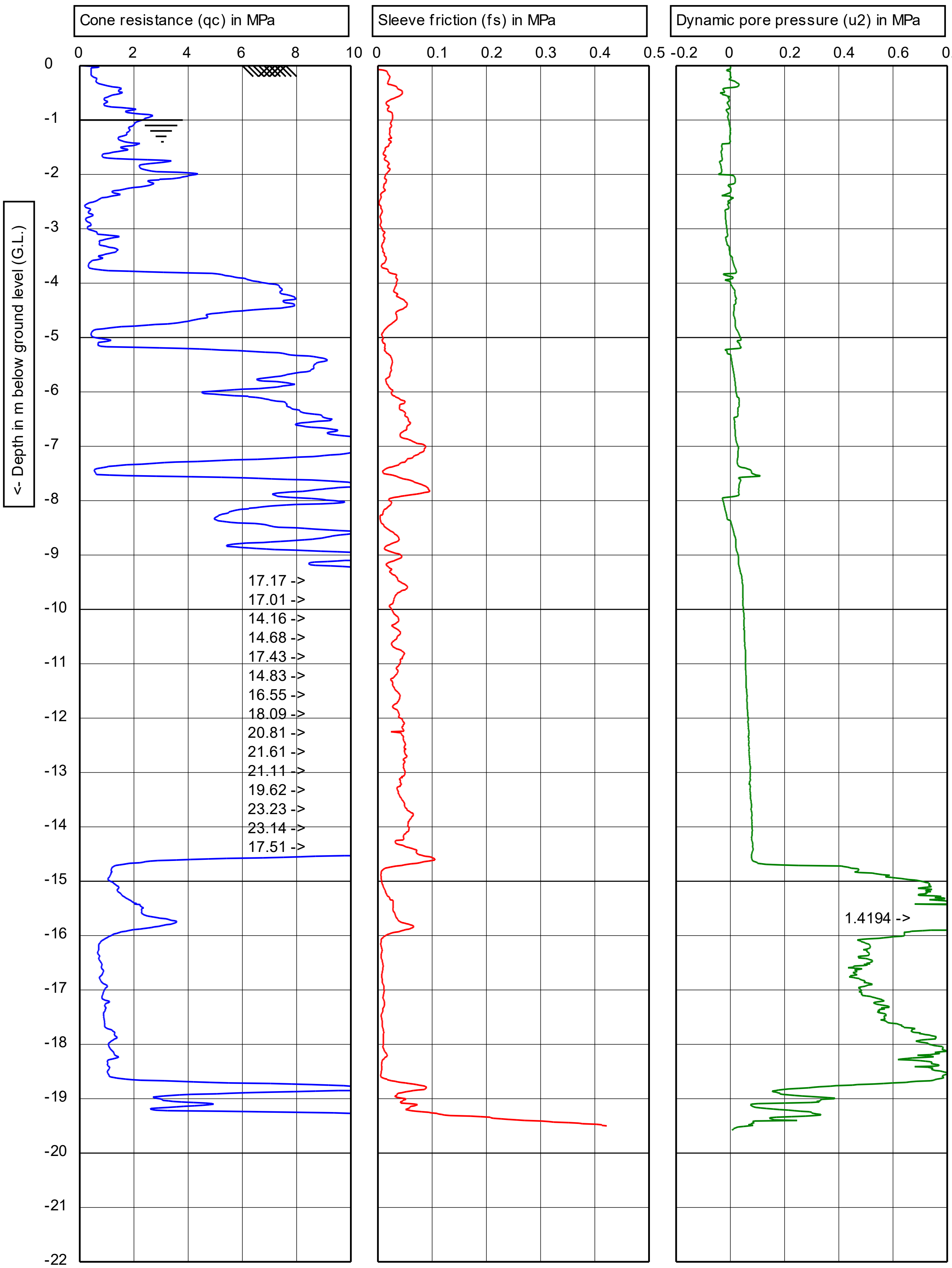
Target Depth

EOH - Dipped - GWL @ 0.4m

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill: **0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-0.40 m**	Date: **9/09/2021**
	Project: **3463 Ohaupo Rd**	Cone no.: **C10CFIIP.C19377**
	Location: **Hamilton**	Project no.: **2-68014.00_HA7829**
	Position: **1804559, 5807848 NZTM**	CPT no.: **21-04** 2/12

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

1.47



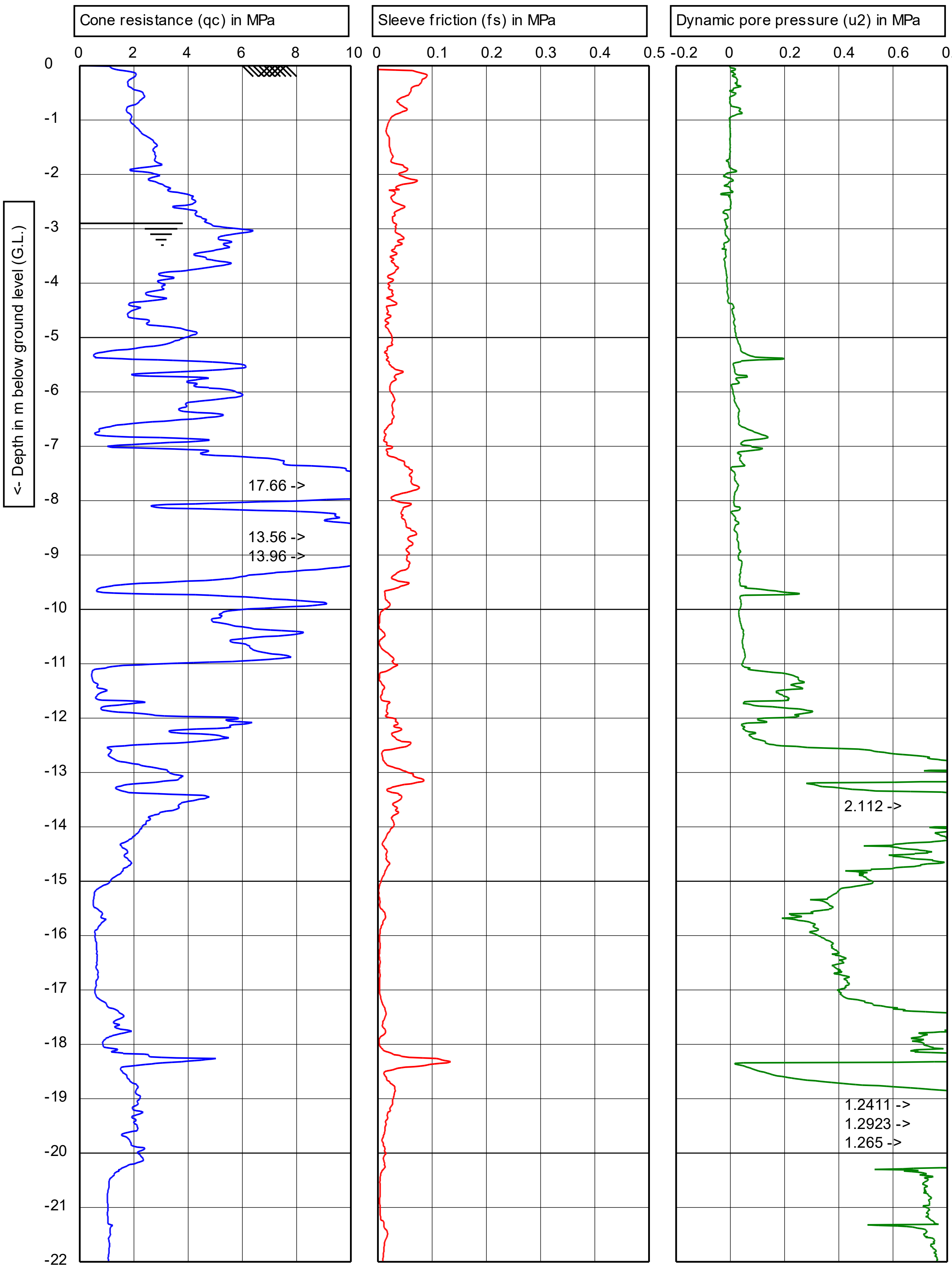
Refusal (qc 40+ MPa)

EOH - Dipped - GWL @ 1.0m

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012		Predrill: **0.00 m Predrilled**
	G.L.: **0.00 m MSL**	W.L.: **-1.00 m**	Date: **9/09/2021**
	Project: **3463 Ohaupo Rd**		Cone no.: **C10CFIIP.C14434**
	Location: **Hamilton**		Project no.: **2-68014.00_HA7829**
	Position: **1804631, 5807696 NZTM**		CPT no.: **21-05** 1/6

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

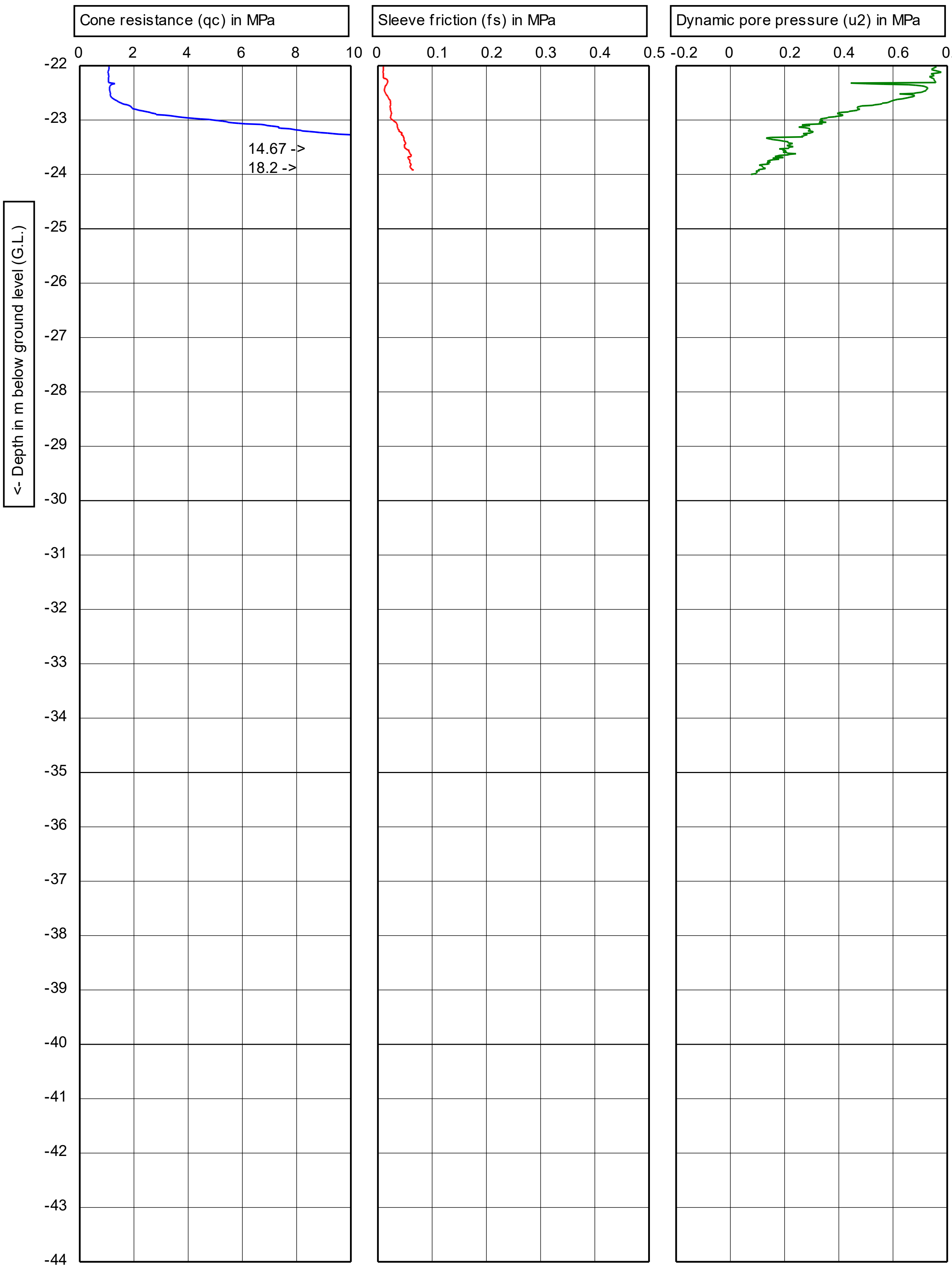
1.47



Test results indicated as not accredited are outside the scope of the laboratory's accreditation

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	**0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-2.90 m**	Date:	**9/09/2021**
	Project: **3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C19377**
	Location: **Hamilton**	Project no.:	**2-68014.00_HA7829**
	Position: **1804637, 5807537 NZTM**	CPT no.:	**21-06** 1/12

1.47



Target Depth

EOH - Dipped - GWL @ 2.9m

u2 150 cm² 10 cm²	Test according ASTM D5778:12 & ISO 22476-1:2012	Predrill:	**0.00 m Predrilled**
	G.L.: **0.00 m MSL** W.L.: **-2.90 m**	Date:	**9/09/2021**
Project:	**3463 Ohaupo Rd**	Cone no.:	**C10CFIIP.C19377**
Location:	**Hamilton**	Project no.:	**2-68014.00_HA7829**
Position:	**1804637, 5807537 NZTM**	CPT no.:	**21-06** 2/12

Test results indicated as not accredited are outside the scope of the laboratory's accreditation

1.47

HAND AUGER No: HA1

HAND AUGER LOG

PROJECT:	GTL Waikato Greenfield Development	JOB NUMBER:	2932830
SITE LOCATION:	3463 Ohaupo Road	CLIENT:	Genetics Waikato

CIRCUIT: NZTM
COORDINATES: N 5,807,358 m
E 1,804,284 m

AUGER LOCATION: Refer Geotechnical Layout Plan
R L: 60 m
DATUM: NZTM

DEPTH (m)	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	RL (m)
0.0–0.3	ML	M	'Firm' SILT, some organics, some fine to coarse sand, minor clay, trace fine gravel; dark brown; moist, low plasticity.**[Topsoil].**		0, 2, 1	
0.3–0.6	SM	M	Loose fine to coarse SAND, some silt, minor fine to medium gravel; orange brown; moist, low plasticity (fines). Gravel: subrounded to rounded, weak, pumice.	Hinuera Formation (Tauranga Group)	2, 3, 3	59.5 (0.5)
0.6–1.5	SW	M	Medium dense fine to coarse SAND, some fine to coarse gravel, minor silt; light brown and grey; moist, low plasticity (fines). Gravel: subrounded to rounded, weak, pumice. 1.0m, greyish brown. 1.25m, dense.	Hinuera Formation (Tauranga Group)	3, 4, 3, 3, 4, 5, 8, 7	59.0 (1.0)
1.5–2.0	SM	M	Medium dense fine to coarse SAND, some silt, some fine to coarse gravel; greyish brown; moist, low plasticity (fines). Gravel: subrounded to rounded, weak, pumice. 1.65m, loose.	Hinuera Formation (Tauranga Group)	6, 7, 3, 2, 7	58.5 (1.5)
2.0–2.1	SM	M	Dense silty, fine to coarse SAND, trace fine to medium gravel; light grey; moist, low plasticity (fines).	Hinuera Formation (Tauranga Group)	9	58.0 (2.0)
2.1–3.0	SM	M	Dense fine to coarse SAND, some silt, some fine to coarse gravel; greyish brown; moist, low plasticity (fines). Gravel: subrounded to rounded, weak, pumice. 2.5 to 2.6m, medium dense.	Hinuera Formation (Tauranga Group)	7, 7, 7, 8, 6, 4, 8, 7, 7	57.5 (2.5)
3.0			END OF LOG @ 3 m			57.0

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5; RL scale: 59.5, 59.0, 58.5, 58.0, 57.5, 57.0, 56.5, 56.0, 55.5

DATE AUGERED:	10/10/14	DIAMETER:	50
LOGGED BY:	CWP	METHOD:	Manual
SHEAR VANE No:	Geo 1249		

COMMENTS:
No groundwater was observed in this borehole. The borehole was terminated due to frequent hole collapse from 2.5m depth. Elevation and coordinates measured from hand held GPS with accuracy of 5m.

HAND AUGER No: SC1

HAND AUGER LOG

PROJECT: GTL Waikato Greenfield Development — JOB NUMBER: 2932830
SITE LOCATION: 3463 Ohaupo Road — CLIENT: Genetics Waikato

CIRCUIT: NZTM
COORDINATES: N 5,807,377 m
E 1,804,249 m

AUGER LOCATION: Refer Geotechnical Layout Plan
R L: 60 m
DATUM: NZTM

DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	SV	τ (kPa)	SAMPLES	R L (m)
							0				
							1				
							2				
							1				
0.5							2				59.5
							1				
							2				
							3				
							3				
1.0							5				59.0
							2				
							6				
							8				
							7				
1.5							7				58.5
							7				
							8				
							9				
							6				
2.0							8				58.0
							11				
							8				
							7				
							8				
2.5							8				57.5
							7				
							6				
							7				
							3				
3.0							6				57.0
							10				
							10				
							11				
							11				
3.5							9				56.5
							9				
							8				
							8				
							7				
4.0											56.0
4.5											55.5

DATE AUGERED: 10/10/14 — DIAMETER: 20
LOGGED BY: CWP — METHOD: Manual
SHEAR VANE No: Geo 1249

COMMENTS:
Scala advanced to 4.0m target depth. Elevation and coordinates measured from hand held GPS with accuracy of 5m.

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET — Revision 1

A4 Scale 1:25

HAND_AUGER P:\293\2932830\TGE - GEOTECH\INVESTIGATION\GENETICS WAIKATO.GPJ BECA.GDT 21/10/14

HAND AUGER No: **SC2**

HAND AUGER LOG

SHEET 1 of 1

PROJECT: GTL Waikato Greenfield Development	JOB NUMBER: 2932830
SITE LOCATION: 3463 Ohaupo Road	CLIENT: Genetics Waikato

CIRCUIT: NZTM
COORDINATES: N 5,807,390 m
E 1,804,304 m

AUGER LOCATION: Refer Geotechnical Layout Plan
R L: 60 m
DATUM: NZTM

DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	SV	τ (kPa)	SAMPLES	R L (m)
							0				
							2				
							1				
							1				
0.5							2				59.5
							4				
							4				
							3				
							3				
1.0							5				59.0
							5				
							5				
							5				
							5				
1.5							4				58.5
							4				
							6				
							8				
							6				
2.0							8				58.0
							10				
							10				
							8				
							8				
2.5							10				57.5
							10				
							8				
							6				
							3				
3.0							6				57.0
							6				
							6				
							7				
							6				
3.5							8				56.5
							7				
							7				
							6				
							7				
4.0											56.0
4.5											55.5

DATE AUGERED:	10/10/14	DIAMETER:	20
LOGGED BY:	CWP	METHOD:	Manual
SHEAR VANE No:	Geo 1249		

COMMENTS:
Scala advanced to 4.0m target depth. Elevation and coordinates measured from hand held GPS with accuracy of 5m.

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

Revision 1

A4 Scale 1:25

HAND_AUGER P:\293\2932830\TGE - GEOTECH\INVESTIGATION\GENETICS WAIKATO.GPJ BECA.GDT 21/10/14

Beca

TEST PIT No: MA1

TEST PIT LOG

SHEET 1 of 1

PROJECT: GTL Waikato Greenfield Development
JOB NUMBER: 2932830
SITE LOCATION: 3463 Ohaupo Road
CLIENT: Genetics Waikato

CIRCUIT: NZTM
COORDINATES: N 5,807,346 m
E 1,804,288 m
TEST PIT LOCATION: Refer Geotechnical Layout Plan
R L: 60 m
DATUM: NZTM

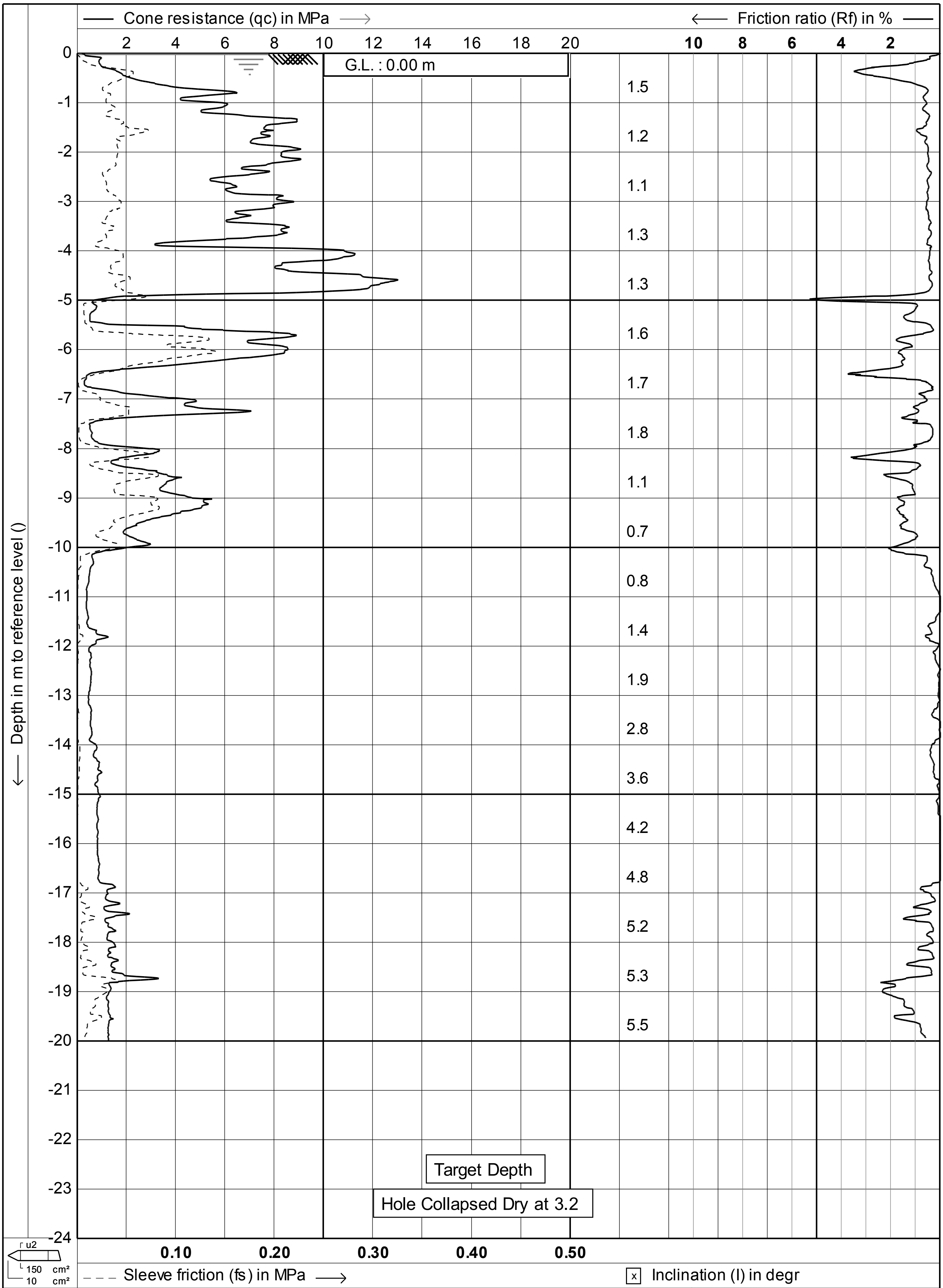
DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala	SV	τ (kPa)	SAMPLES	R L (m)
			ML	M	'Firm' SILT, some organics, some fine to coarse sand, minor clay, trace fine gravel; dark brown; moist, low plasticity.**[Topsoil].**	**Hinuera Formation (Tauranga Group)**					
			SM	M	'Very loose' fine to coarse SAND, some silt, minor fine to medium gravel; orange brown; moist, low plasticity (fines). Gravel: subrounded to rounded, weak, pumice.						
0.5			SW	M	'Loose' fine to coarse SAND, some fine to coarse gravel, minor silt; brownish grey; moist, low plasticity (fines). Gravel: subrounded to rounded, weak to moderately strong, pumice and sandstone. 0.85m, grey and light brown.						59.5
1.0					END OF LOG @ 1 m						59.0
1.5											58.5
2.0											58.0
2.5											57.5
3.0											57.0
3.5											56.5
4.0											56.0
4.5											55.5

DATE EXCAVATED: 10/10/14
CONTRACTOR: Beca
LOGGED BY: CWP
EQUIPMENT: Bobcat + 600 diameter auger
SHEAR VANE No: Geo 1249
METHOD: Machine drill

COMMENTS:
Test pit excavated to 1.0m depth to perform soakaway trial. Elevation and coordinates measured from hand held GPS with accuracy of 5m.

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET
Revision 1

A4 Scale 1:25



1.42

PERRY GEOTECH

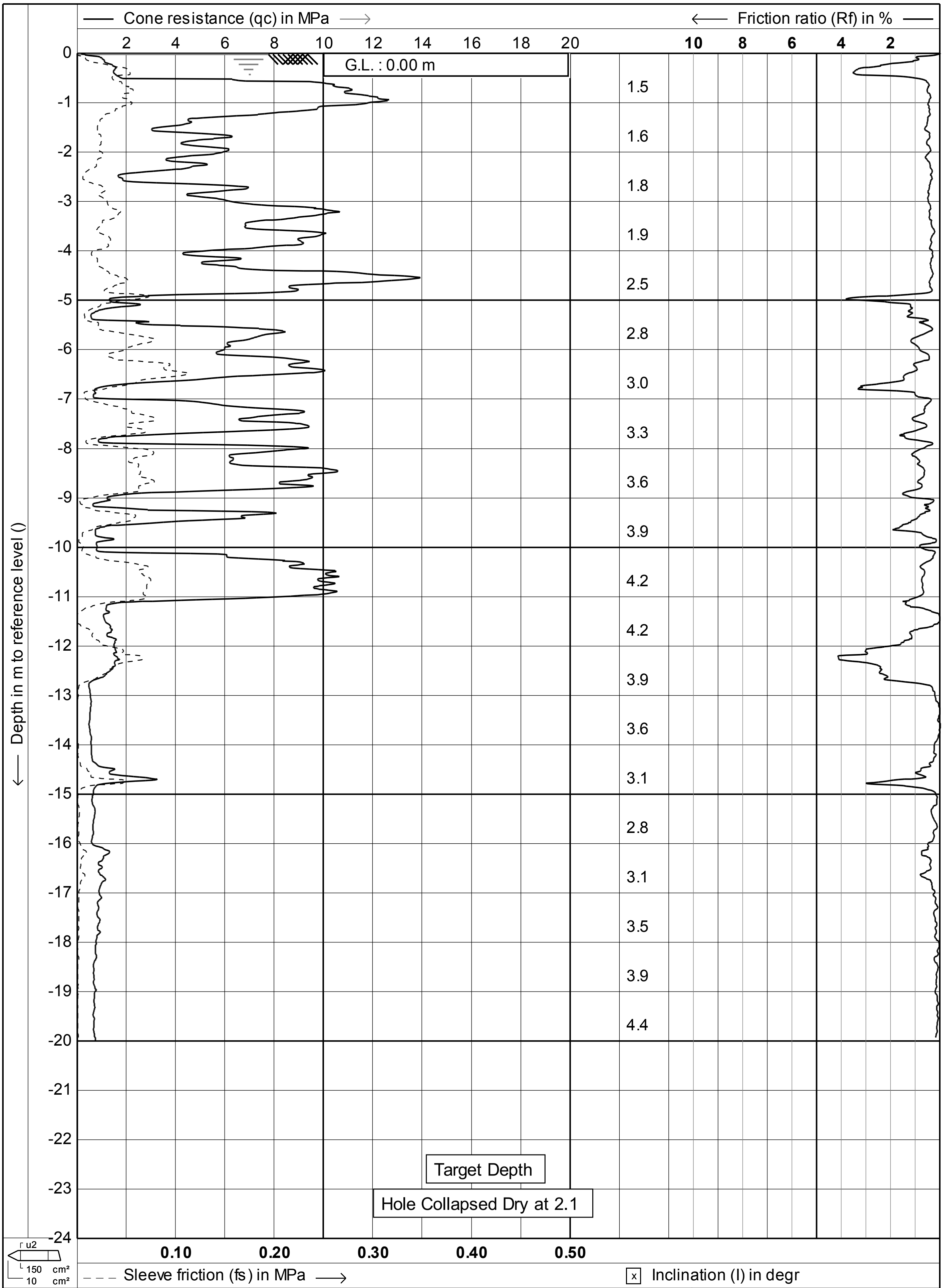
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **Waikato Greenfield Development**

Position: **0, 0**

Date	: **10-10-2014**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**01BC7**
CPT no.	: **01**



1.42

PERRY GEOTECH

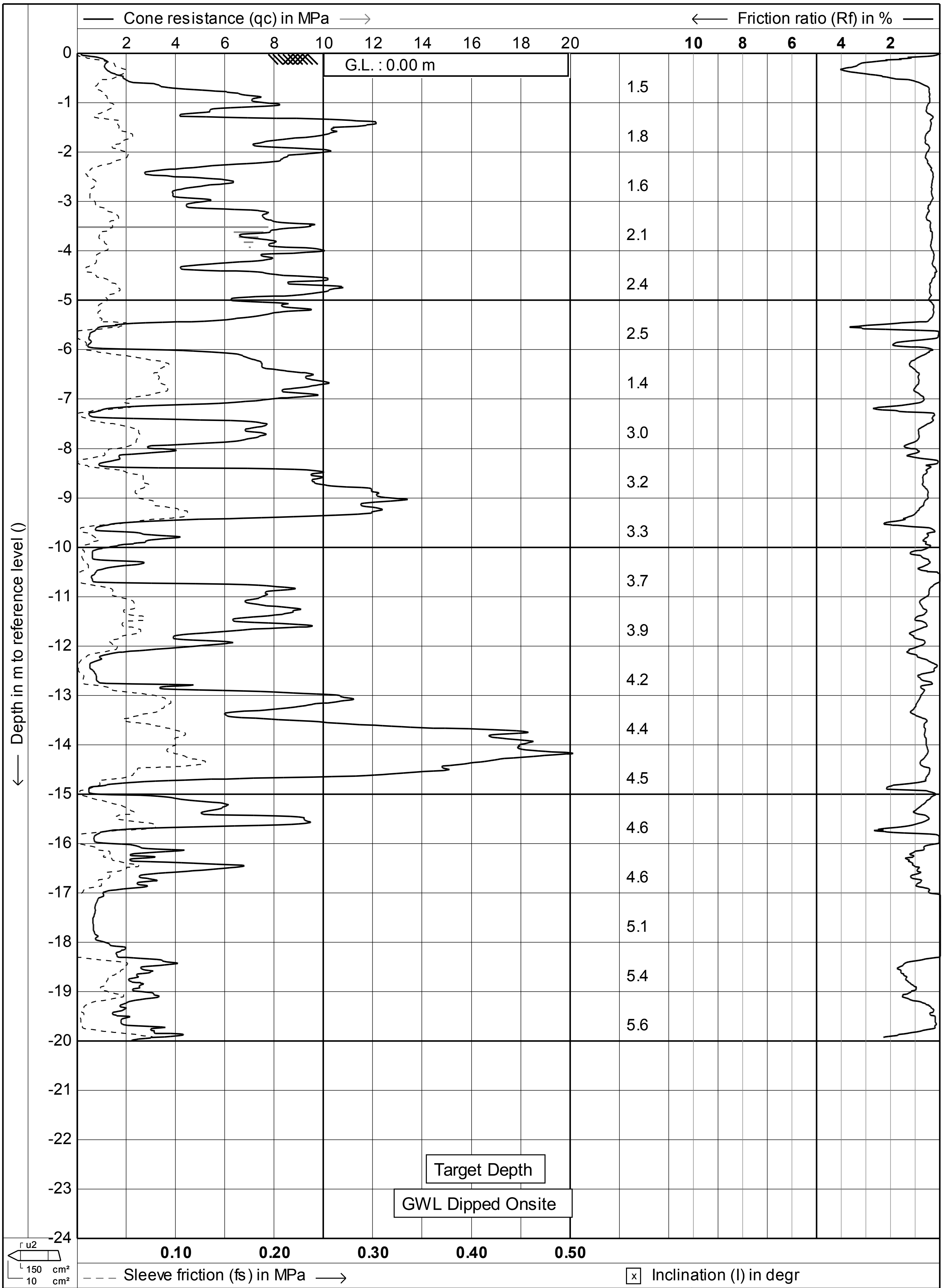
Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**

Location: **Waikato Greenfield Development**

Position: **0, 0**

Date	: **10-10-2014**
Cone no.	: **C10CFIIP.C10268**
Project no.	: **01BC7**
CPT no.	: **02** — **1/14**

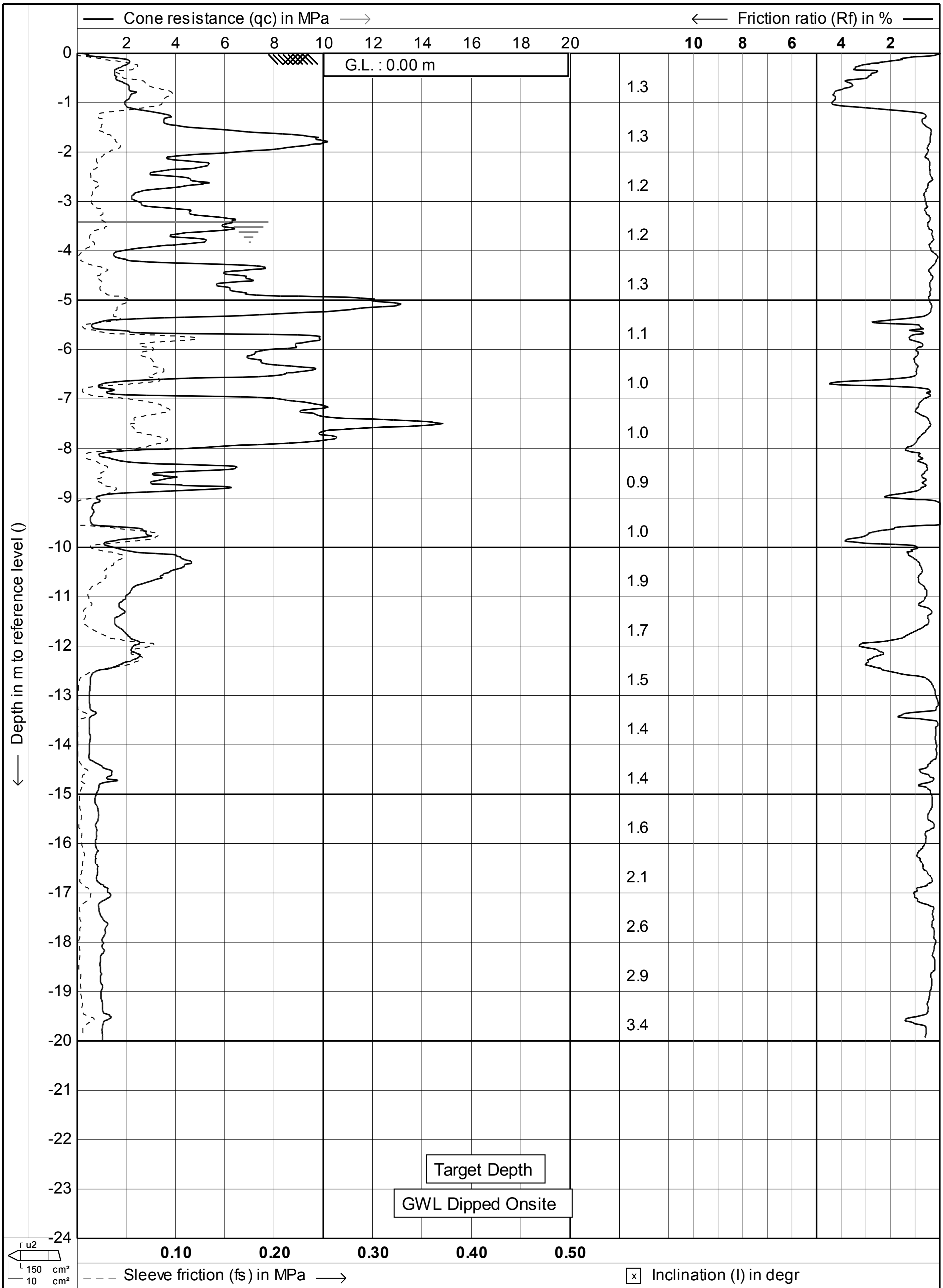


PERRY GEOTECH

Test according A.S.T.M Standard D 5778-12

Project : **Site Investigations**	Date	: **10-10-2014**	
Location: **Waikato Greenfield Development**	Cone no.	: **C10CFIIP.C10268**	
Position: **0, 0**	Project no. :	**01BC7**	
	CPT no.	: **03**	**1/14**

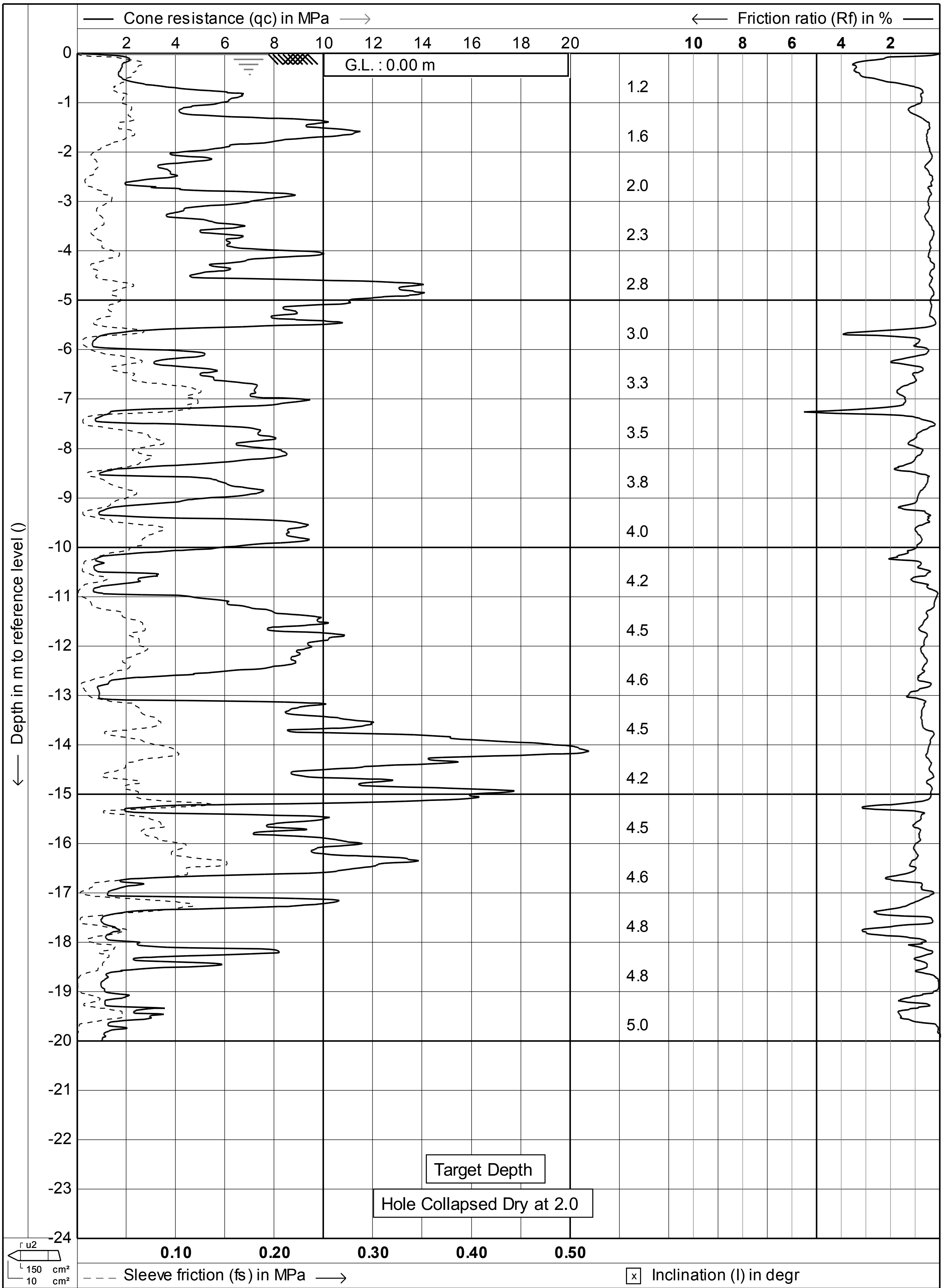
1.42



Test according A.S.T.M Standard D 5778-12	Date : **10-10-2014**
Project : **Site Investigations**	Cone no. : **C10CFIIP.C10268**
Location: **Waikato Greenfield Development**	Project no. : **01BC7**
Position: **0, 0**	CPT no. : **04** — **1/14**

PERRY GEOTECH

1.42



Test according A.S.T.M Standard D 5778-12	
Project : **Site Investigations**	Date : **10-10-2014**
Location: **Waikato Greenfield Development**	Cone no. : **C10CFIIP.C10268**
Position: **0, 0**	Project no. : **01BC7**
	CPT no. : **05** **1/14**

1.42

Beca

HAND AUGER No: **HA02**

HAND AUGER LOG

SHEET 1 of 1

PROJECT: Genetic Waikato Greenfield Study	JOB NUMBER: 2930986
SITE LOCATION: Genetic Greenfield Site - Rukuhia	CLIENT: Genetic Technologies Ltd

CIRCUIT: NZGD1949
COORDINATES: N 6,369,026 m
E 2,714,739 m

AUGER LOCATION: Refer to location plan
R L: 51 m
DATUM: Mean Sea Level

DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	SV	τ (kPa)	SAMPLES	R L (m)
0.0–0.2			OL	M	"Firm", clayey SILT, minor fine to medium sand, minor organics; brown; moist, non plastic. Organics: Rootlets. (TOPSOIL).		1, 2				
0.2–0.9			CL	M	Stiff, clayey SILT; orange brown; moist, non plastic.		2, 2, 2, 2, 3, 4	64/30	94/47		50.5
0.9–1.5			SP	M	Loose, fine to medium SAND, trace coarse sand; grey mottled orange, brown; moist. Sand: sub-angular - sub-rounded, slightly weathered.		6, 7, 7, 6, 6, 9, 10				50.0
1.5					END OF LOG @ 1.5 m						49.5

Depth scale: 0.5, 1.0, 1.5, 2.0, 2.5; RL scale: 50.5, 50.0, 49.5, 49.0, 48.5

DATE AUGERED: 25/11/11	DIAMETER: 50mm	COMMENTS:	
LOGGED BY: ST5	METHOD: Hand Auger	Co-ordiantes determined using a hand-held GPS unit with an accurary of ±2m.	
SHEAR VANE No: GEO1249			

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

Revision A

A4 Scale 1:15

HAND_AUGER P:\293\2930986\200 (2930986) GENETICS WAIKATO (2011)\TGE\GEOTECHNICAL INVESTIGATIONS\GINT\GENETIC WAIKATO GREENFIELD STUDY.GPJ BECA.GDT 10/1/12

HAND AUGER No: HA03

HAND AUGER LOG

PROJECT: Genetic Waikato Greenfield Study
JOB NUMBER: 2930986
SITE LOCATION: Genetic Greenfield Site - Rukuhia
CLIENT: Genetic Technologies Ltd

CIRCUIT: NZGD1949
COORDINATES: N 6,368,918 m
E 2,714,791 m
AUGER LOCATION: Refer to location plan
R L: 48 m
DATUM: Mean Sea Level

DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	SV	τ (kPa)	SAMPLES	R L (m)
0.0–0.3			OL	M	"Firm", clayey SILT, trace fine sand, minor organics; dark brown; moist, non plastic. Organics: Rootlets. (TOPSOIL).		2, 2.5				
0.3–0.8			ML	M	Very stiff, clayey SILT, minor fine to medium sand; orange brown; moist, non plastic.		2.5, 2, 2, 2, 2	78/24	113/39		47.5
0.8–1.5			SW	M	Loose, fine to medium SAND, minor coarse sand, trace fine gravel; brown; moist, non plastic. Sand: sub-angular - sub-rounded, slightly weathered. Gravel: sub-angular - sub-rounded, slightly weathered.		2, 3, 4, 4, 4, 6, 6, 10				47.0
1.5					END OF LOG @ 1.5 m						46.5
2.0											46.0
2.5											45.5

DATE AUGERED: 25/11/11
DIAMETER: 50mm
LOGGED BY: ST5
METHOD: Hand Auger
SHEAR VANE No: GEO1249

COMMENTS:
Co-ordiantes determined using a hand-held GPS unit with an accurary of ±2m.

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

Revision A

A4 Scale 1:15

HAND_AUGER P:\293\2930986\200 (2930986) GENETICS WAIKATO (2011)\TGE\GEOTECHNICAL INVESTIGATIONS\GINT\GENETIC WAIKATO GREENFIELD STUDY.GPJ BECA.GDT 10/1/12

Beca

HAND AUGER No: **SP01**

HAND AUGER LOG

PROJECT:	Genetic Waikato Greenfield Study	JOB NUMBER:	2930986
SITE LOCATION:	Genetic Greenfield Site - Rukuhia	CLIENT:	Genetic Technologies Ltd

CIRCUIT:	NZGD1949	AUGER LOCATION:	Refer to location plan
COORDINATES:	N 6,368,847 m	R L:	54 m
	E 2,714,587 m	DATUM:	Mean Sea Level

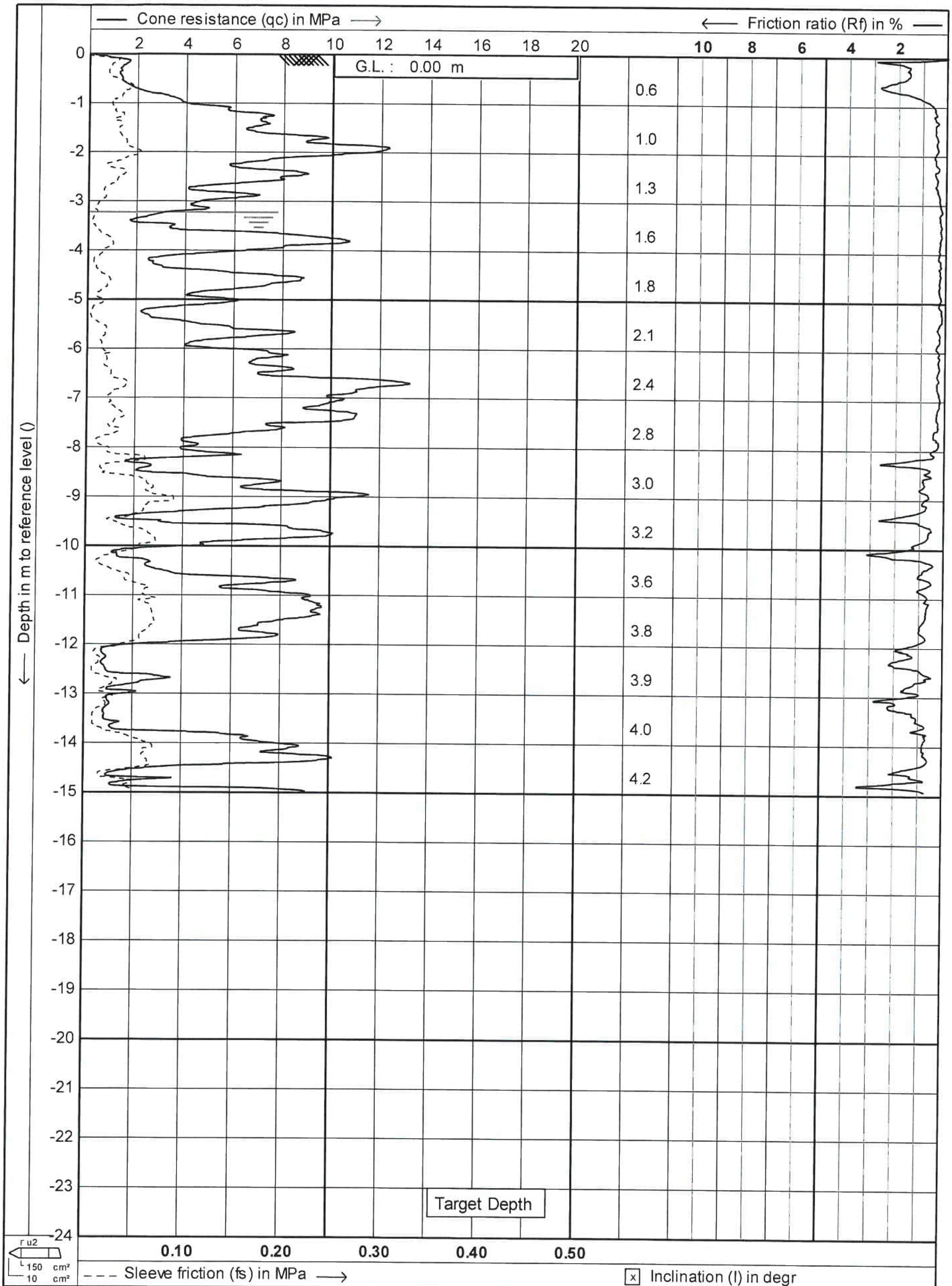
DEPTH (m)	WATER LEVEL	GRAPHIC LOG	USCS	MOISTURE	SOIL / ROCK DESCRIPTION	GEOLOGICAL UNIT	Scala (Blows/100mm)	SV	τ (kPa)	SAMPLES	R L (m)
							2				
							3				
							2				
							2				
0.5							2				53.5
							2				
							3				
							4				
							5				
1.0							6				53.0
							4				
							3.5				
							3.5				
							4				
1.5							4				52.5
2.0											52.0
2.5											51.5

DATE AUGERED:	25/11/11	DIAMETER:		COMMENTS:
LOGGED BY:	ST5	METHOD:	Scala Penetrometer	Co-ordiantes determined using a hand-held GPS unit with an accurary of ±2m.
SHEAR VANE No:	GEO1249			

FOR EXPLANATION OF SYMBOLS AND ABBREVIATIONS SEE KEY SHEET

Revision A

A4 Scale 1:15

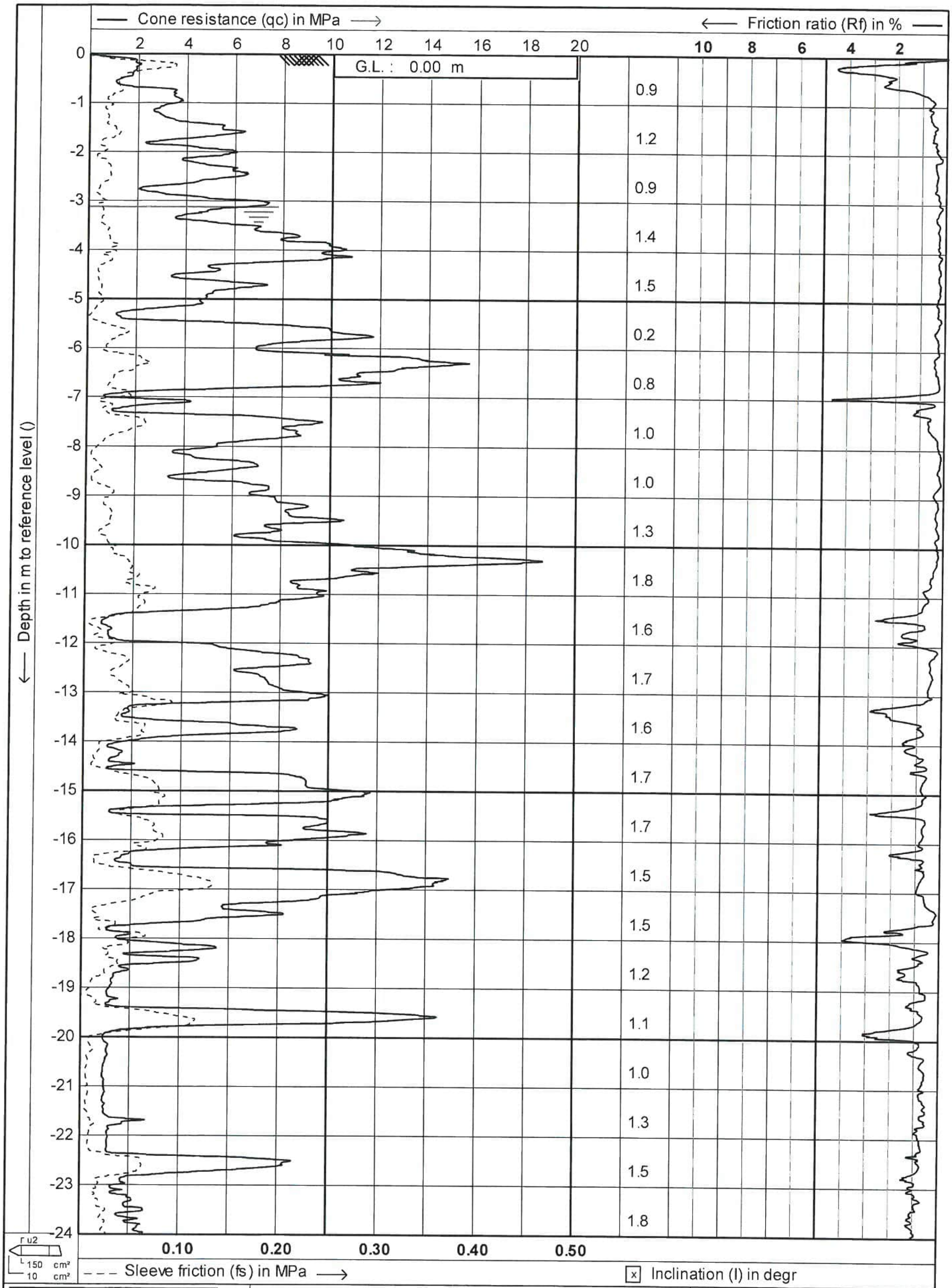


Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project :	**Generic Waikato Greenfields Study**
Location:	**3463 Ohaupo Rd - Rukuhia**
Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **1**
	1/14

CPTask V1.31



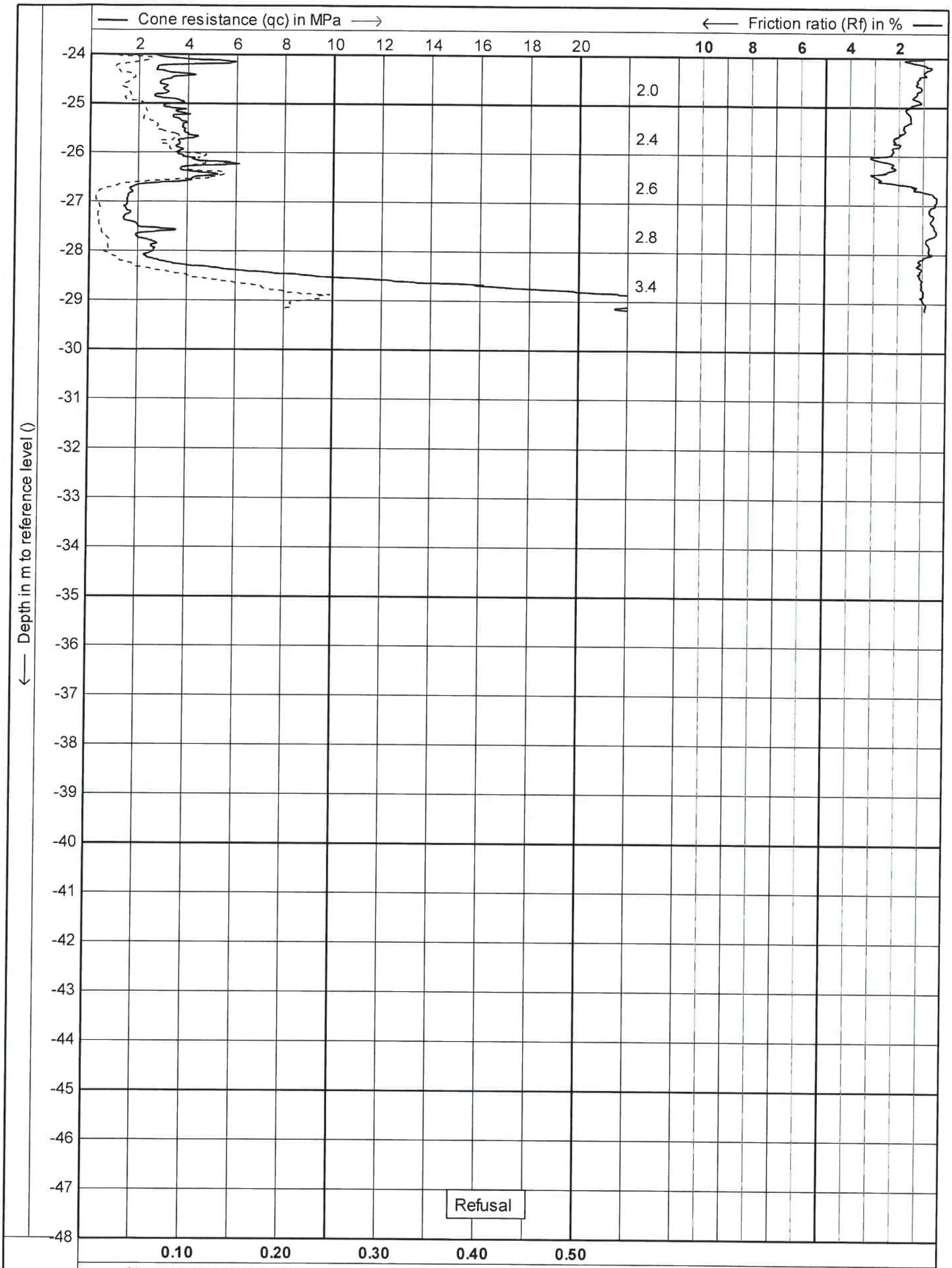
Perry Drilling GEO PROBE A division of Perry Environmental Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project :	Generic Waikato Greenfields Study	Date	: 25-11-2011
		Cone no.	: C10CFIIP.C10268
		Project no. :	02BC13
Location:	3463 Ohaupo Rd - Rukuhia	CPT no.	: 2

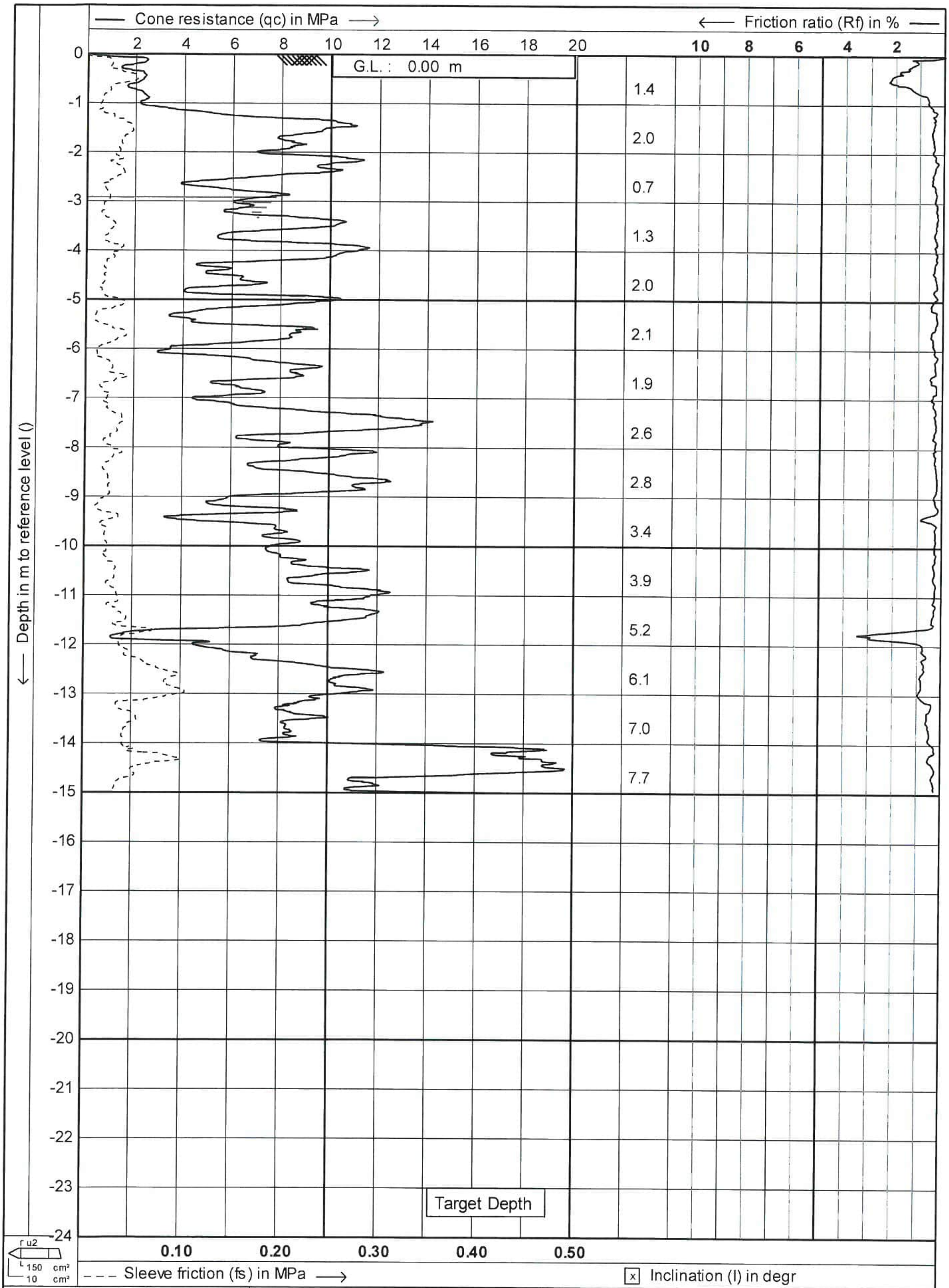
1/28

CPTask V1.31



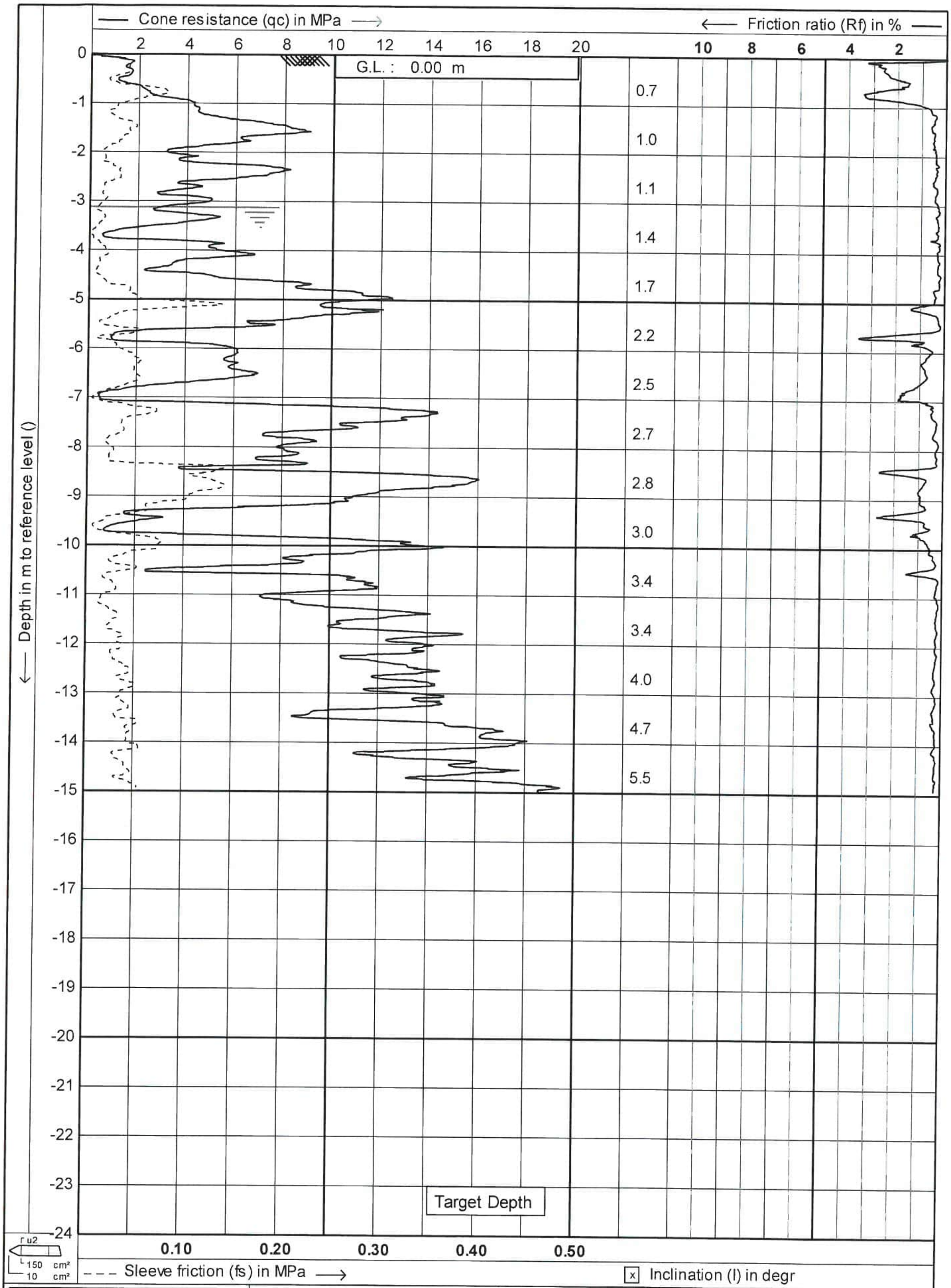
Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **25-11-2011**	
	Project : **Generic Waikato Greenfields Study**	Cone no. : **C10CFIIP.C10268**	
		Project no. : **02BC13**	
	Location: **3463 Ohaupo Rd - Rukuhia**	CPT no. : **2**	**2/28**

CPTask V1.31



Perry Drilling / Geo Probe — Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date	: **25-11-2011**
	Project : **Generic Waikato Greenfields Study**	Cone no.	: **C10CFIIP.C10268**
		Project no. :	**02BC13**
	Location: **3463 Ohaupo Rd - Rukuhia**	CPT no.	: **3** — **1/14**

CPTask V1.31



CPTask V1.31

Perry DRILLING GEO PROBE Ground Drilling and Environmental Specialists

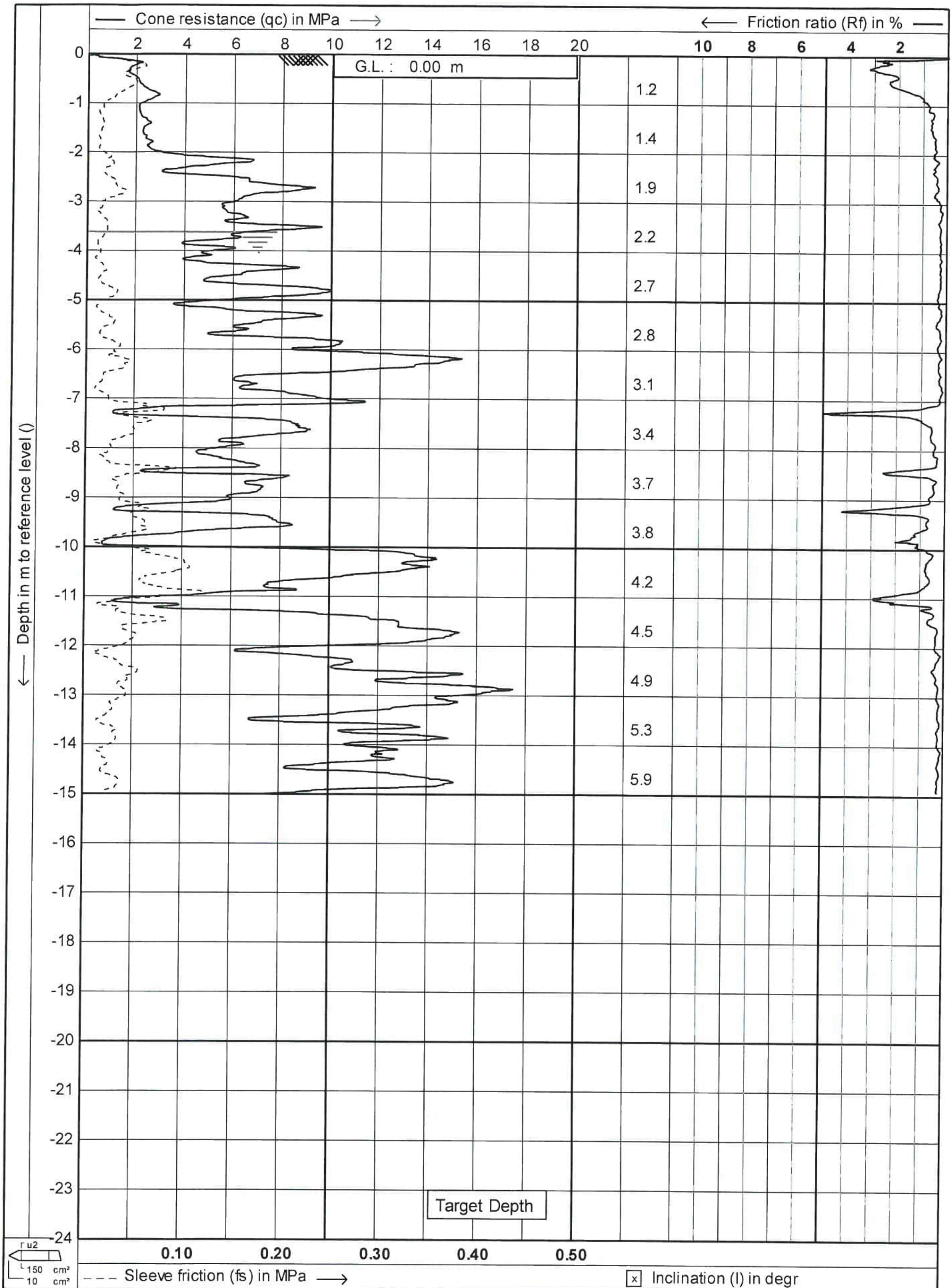
Test according A.S.T.M. Standard D 5778-07

Project : **Generic Waikato Greenfields Study**

Location: **3463 Ohaupo Rd - Rukuhia**

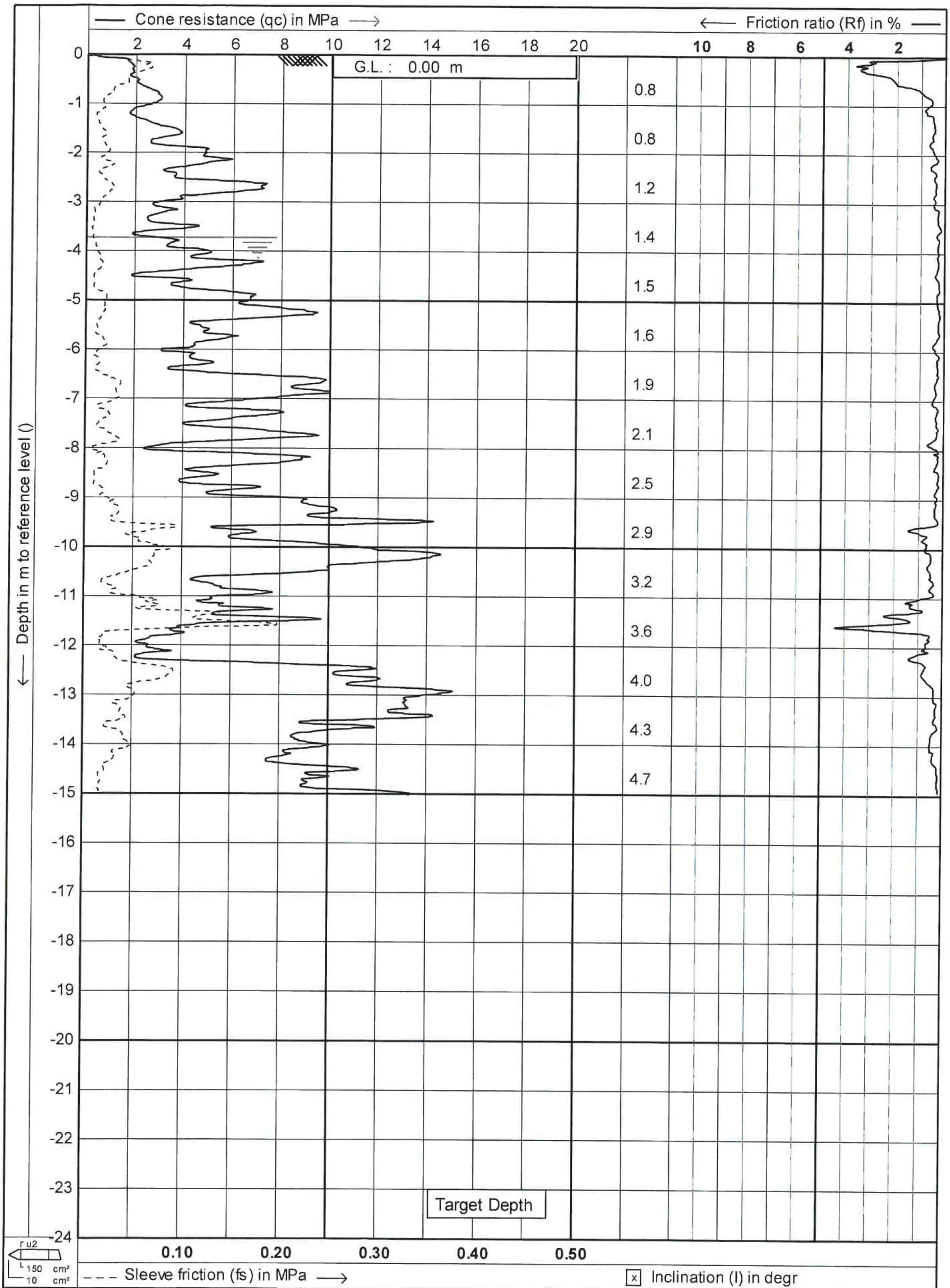
Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **4**

1/14



Test according A.S.T.M. Standard D 5778-07	Date	: **25-11-2011**
Project : **Generic Waikato Greenfields Study**	Cone no.	: **C10CFIIP.C10268**
	Project no.	: **02BC13**
Location: **3463 Ohaupo Rd - Rukuhia**	CPT no.	: **5** **1/14**

CPTask V1.31



Perry DRILLING GEO PROBE — Ground Drilling and Environmental Specialists

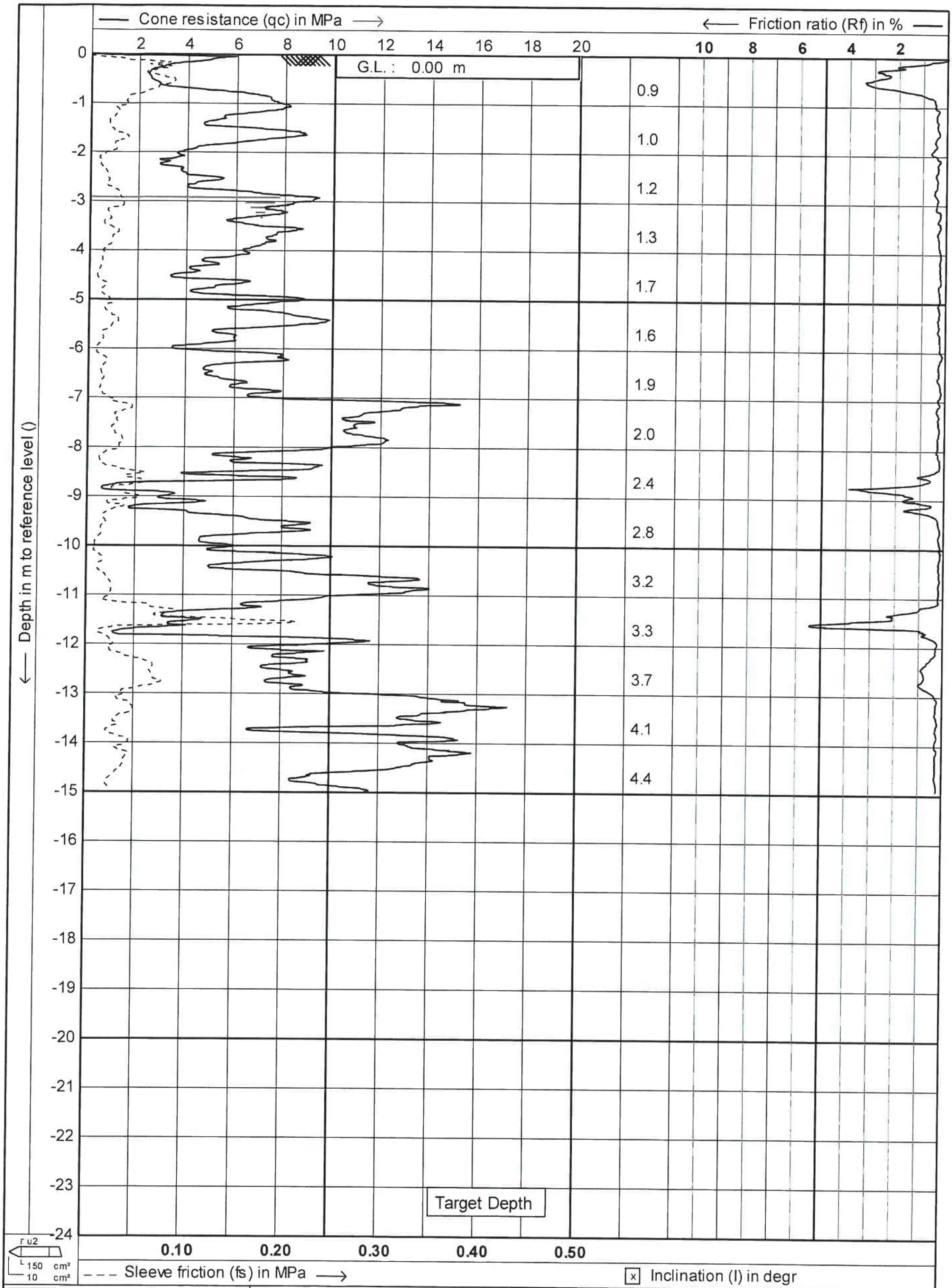
CPTask V1.31

Test according A.S.T.M. Standard D 5778-07

Project :	**Generic Waikato Greenfields Study**
Location:	**3463 Ohaupo Rd - Rukuhia**

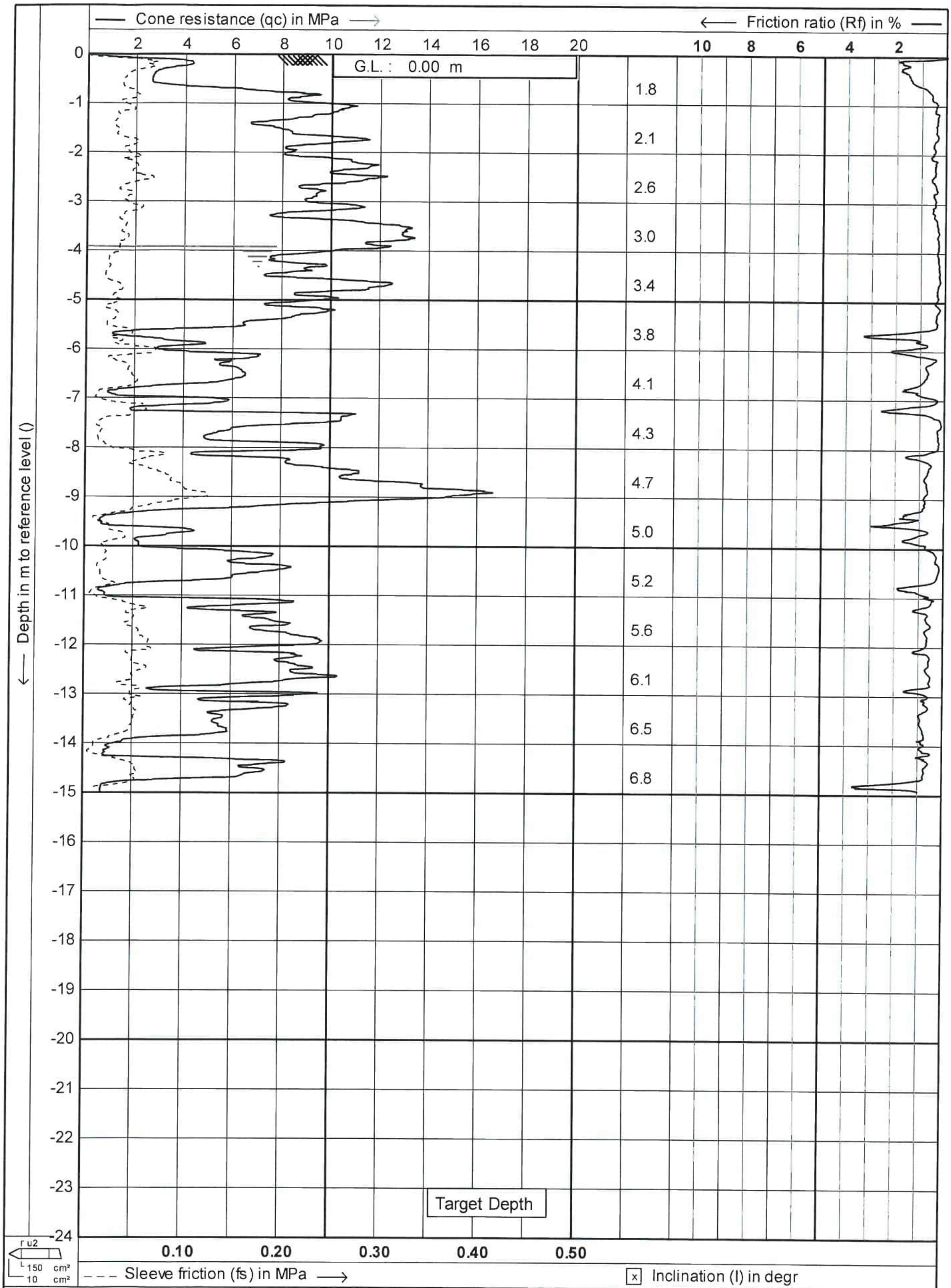
Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **6**

1/14



Perry Drilling Geo Probe Ground Drilling and Environmental Specialists	Test according A.S.T.M. Standard D 5778-07	Date : **25-11-2011**
	Project : **Generic Waikato Greenfields Study**	Cone no. : **C10CFIIP.C10268**
		Project no. : **02BC13**
	Location: **3463 Ohaupo Rd - Rukuhia**	CPT no. : **7** — **1/14**

CPTask V1.31



Test according A.S.T.M. Standard D 5778-07

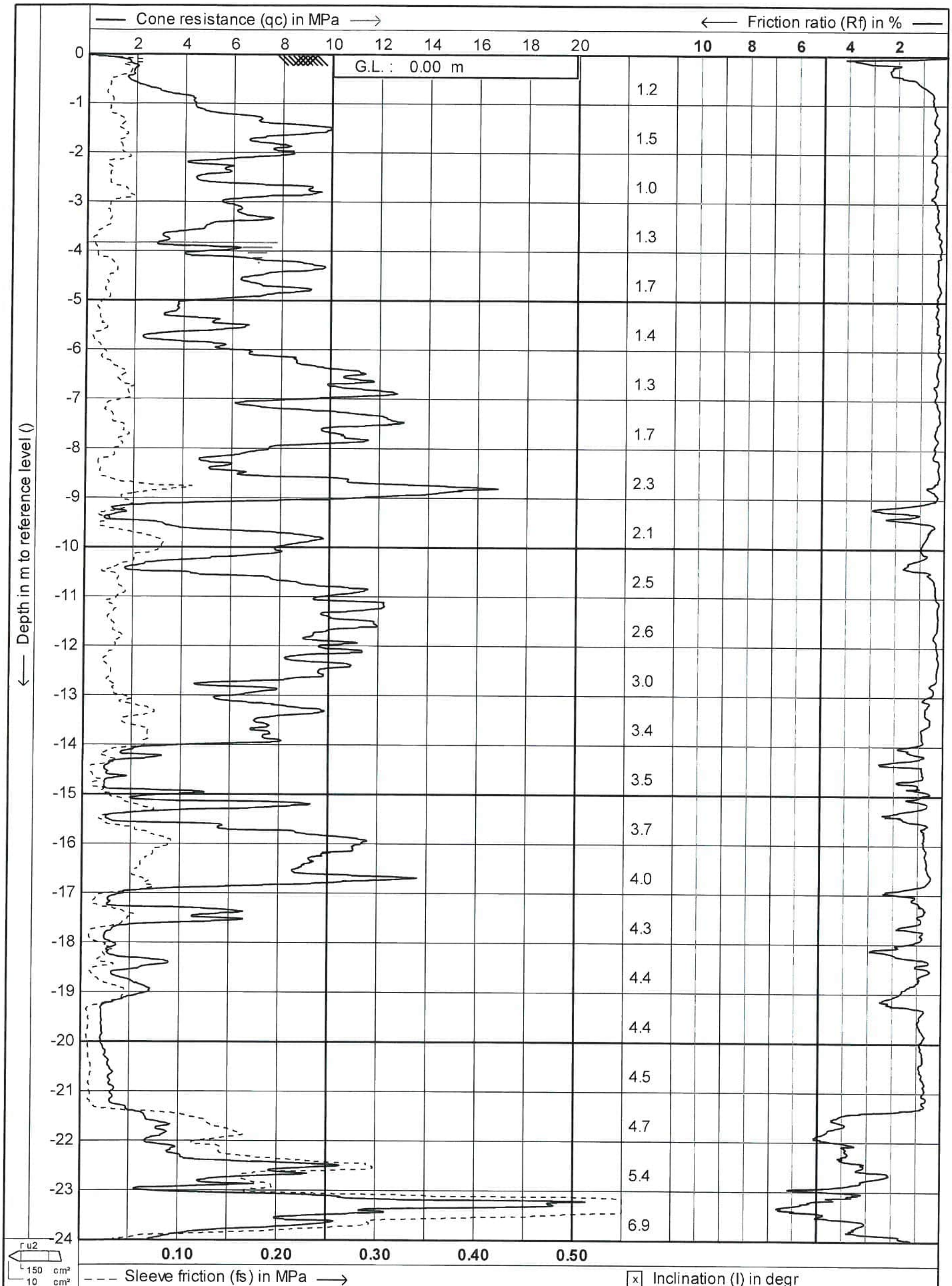
Project : **Generic Waikato Greenfields Study**

Location: **3463 Ohaupo Rd - Rukuhia**

Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **8**

1/14

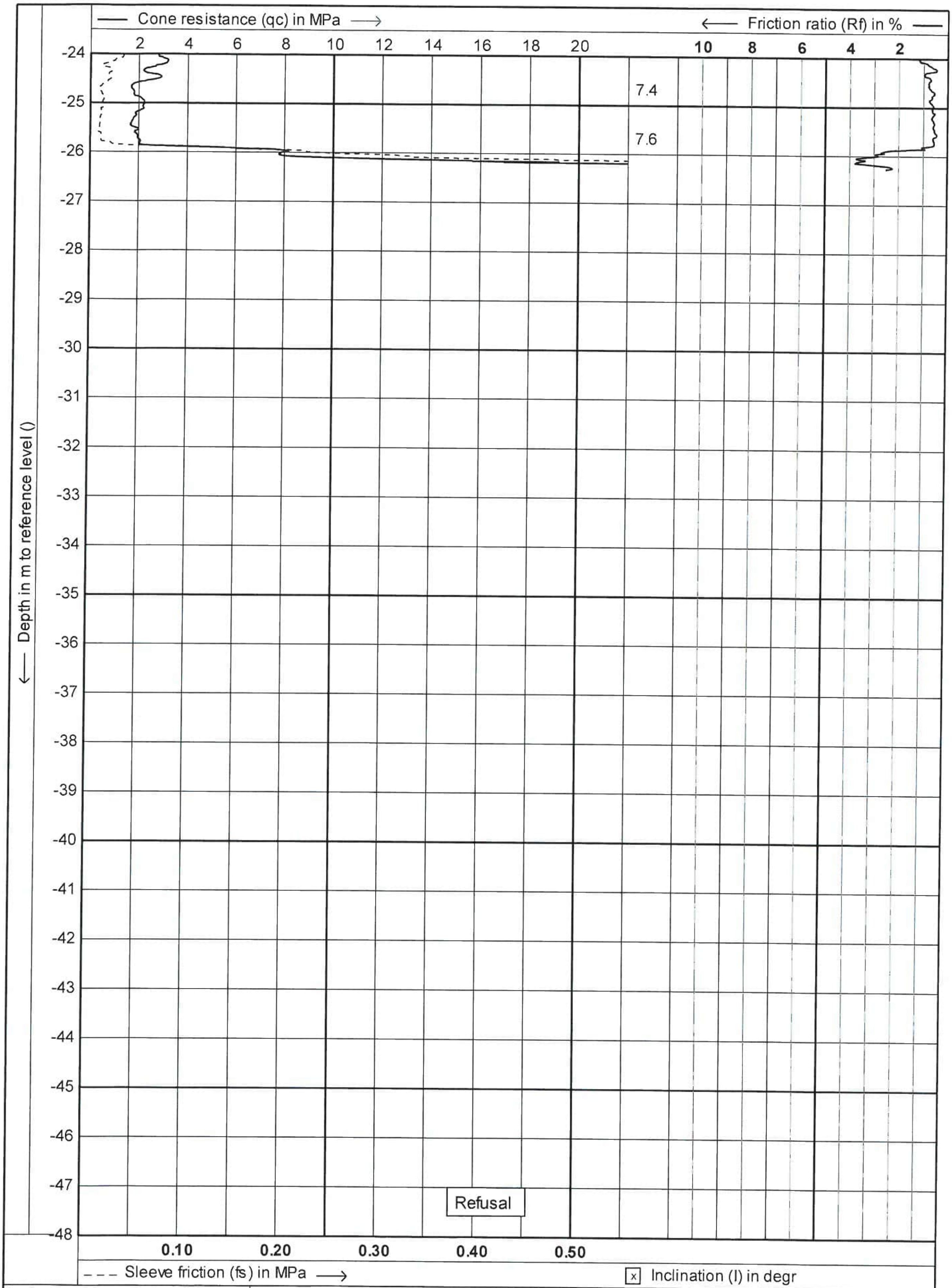
CPTask V1.31



CPTask V1.31

Test according A.S.T.M. Standard D 5778-07

Project :	**Generic Waikato Greenfields Study**	Date	: **25-11-2011**
		Cone no.	: **C10CFIIP.C10268**
		Project no. :	**02BC13**
Location:	**3463 Ohaupo Rd - Rukuhia**	CPT no.	: **9** **1/28**



CPTask V1.31

Perry Drilling GEO PROBE Ground Drilling and Environmental Specialists

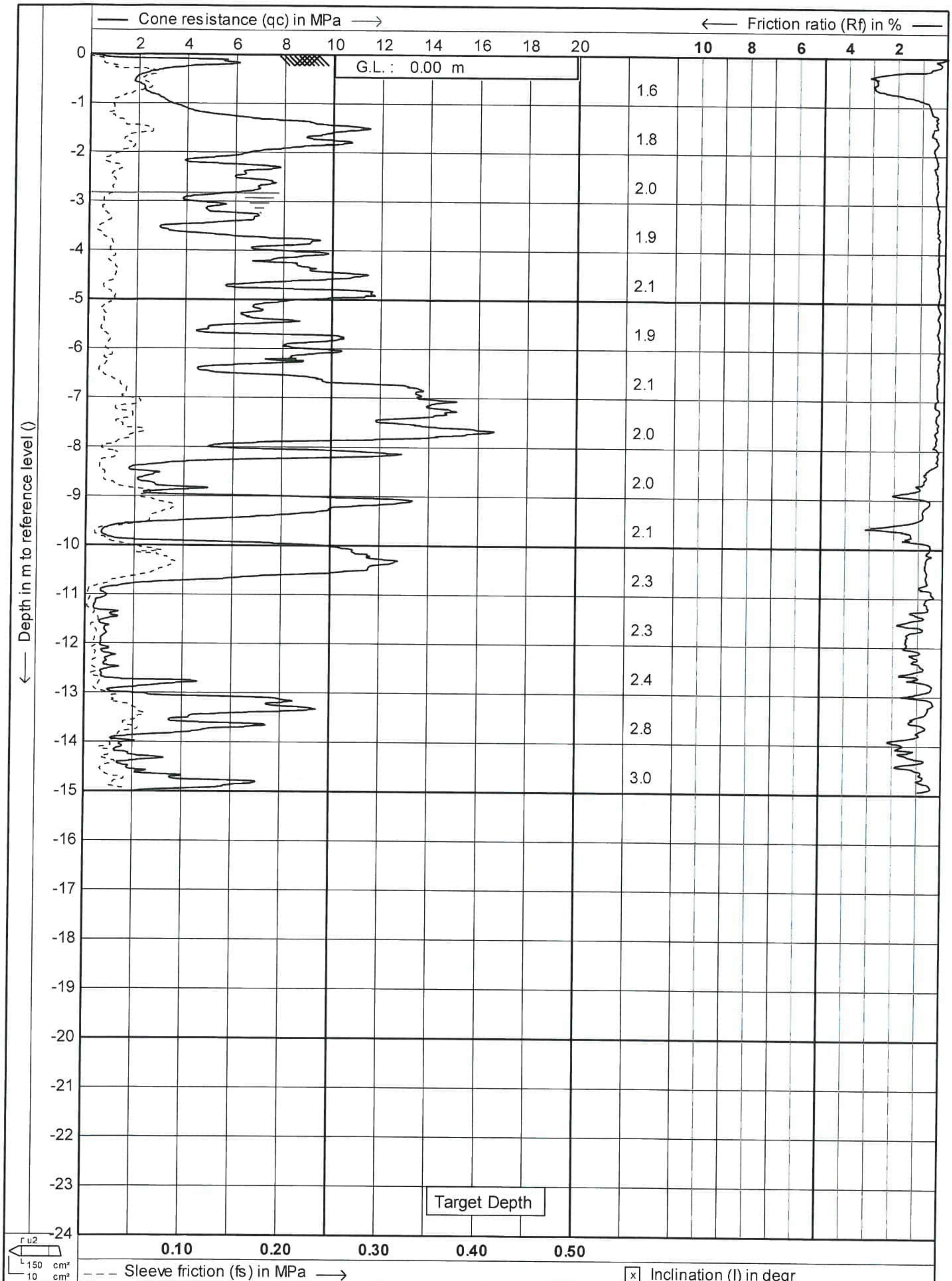
Test according A.S.T.M. Standard D 5778-07

Project : **Generic Waikato Greenfields Study**

Location: **3463 Ohaupo Rd - Rukuhia**

Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **9**

2/28



Perry DRILLING GEO PROBE A DIVISION OF
Ground Drilling and Environmental Specialists

Test according A.S.T.M. Standard D 5778-07

Project : **Generic Waikato Greenfields Study**

Location: **3463 Ohaupo Rd - Rukuhia**

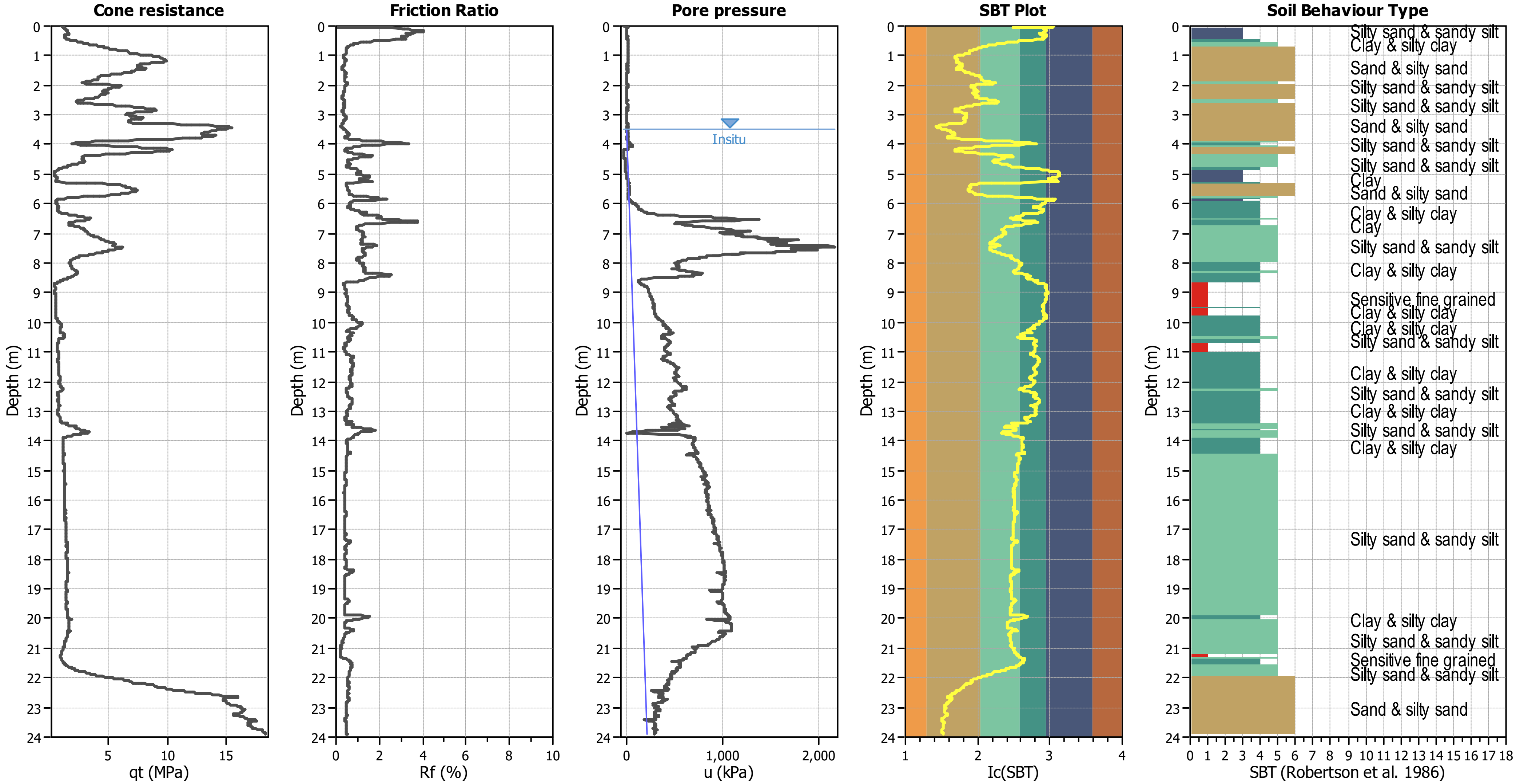
Date	: **25-11-2011**
Cone no.	: **C10CFIIP.C10268**
Project no. :	**02BC13**
CPT no.	: **10**

1/14

CPTask V1.31

Appendix D: Liquefaction Analysis Results

CPT basic interpretation plots



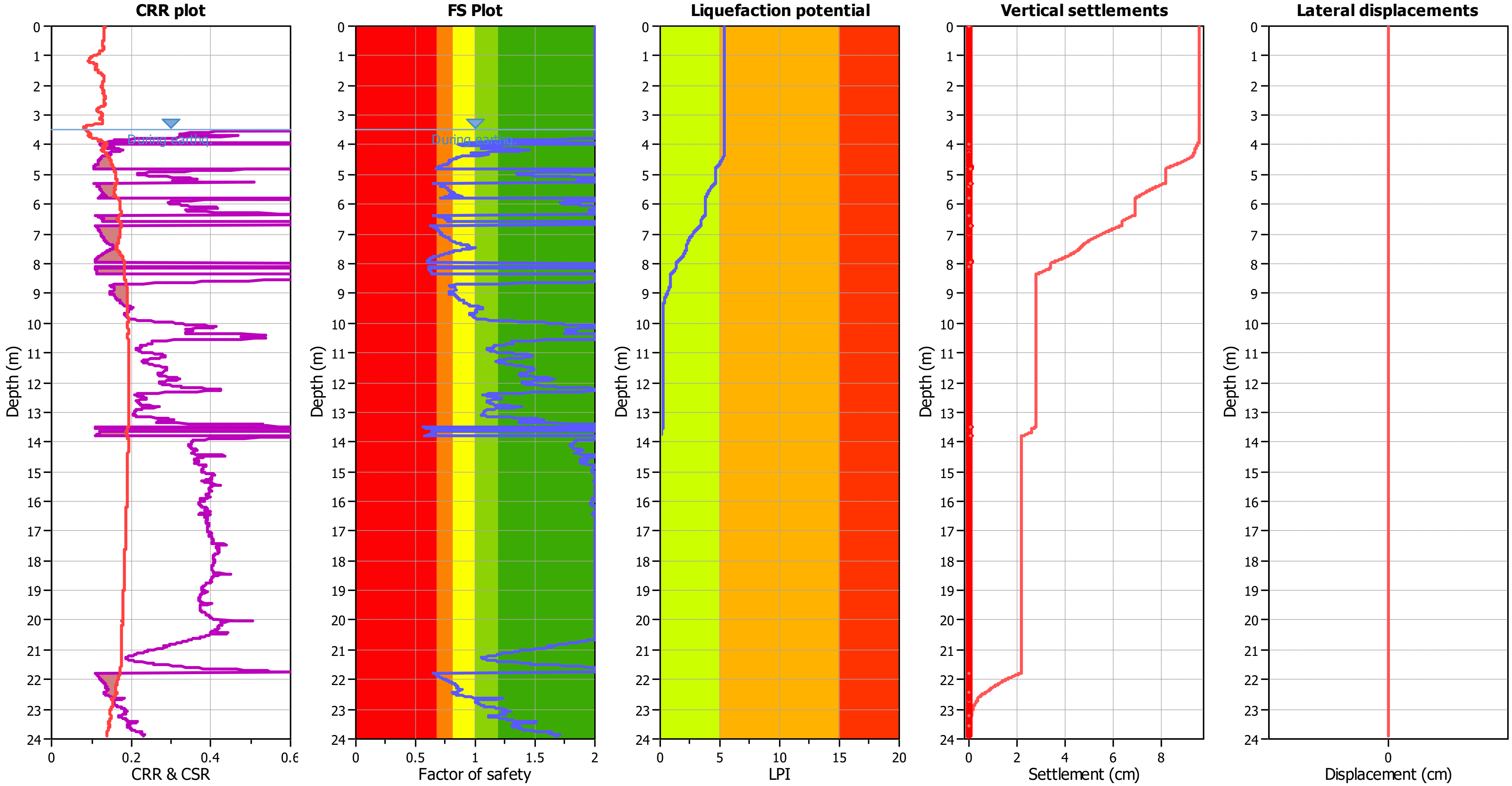
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

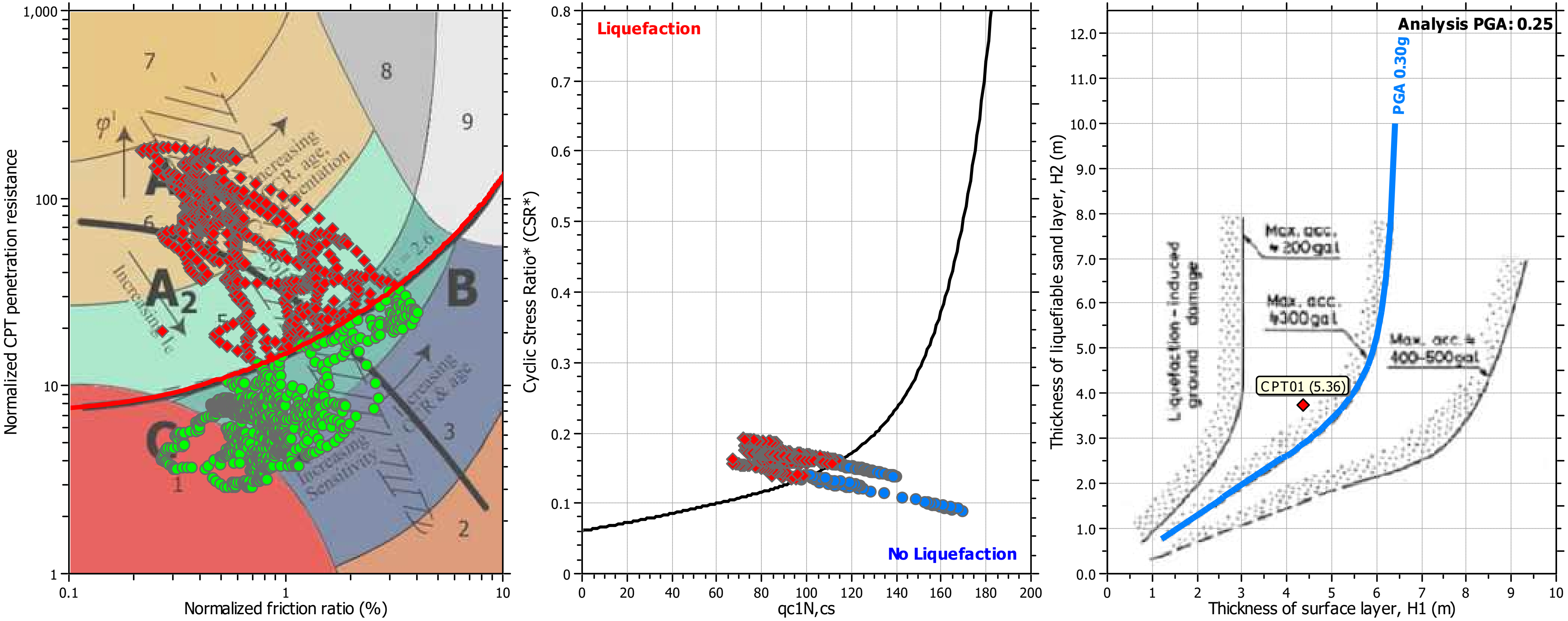
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

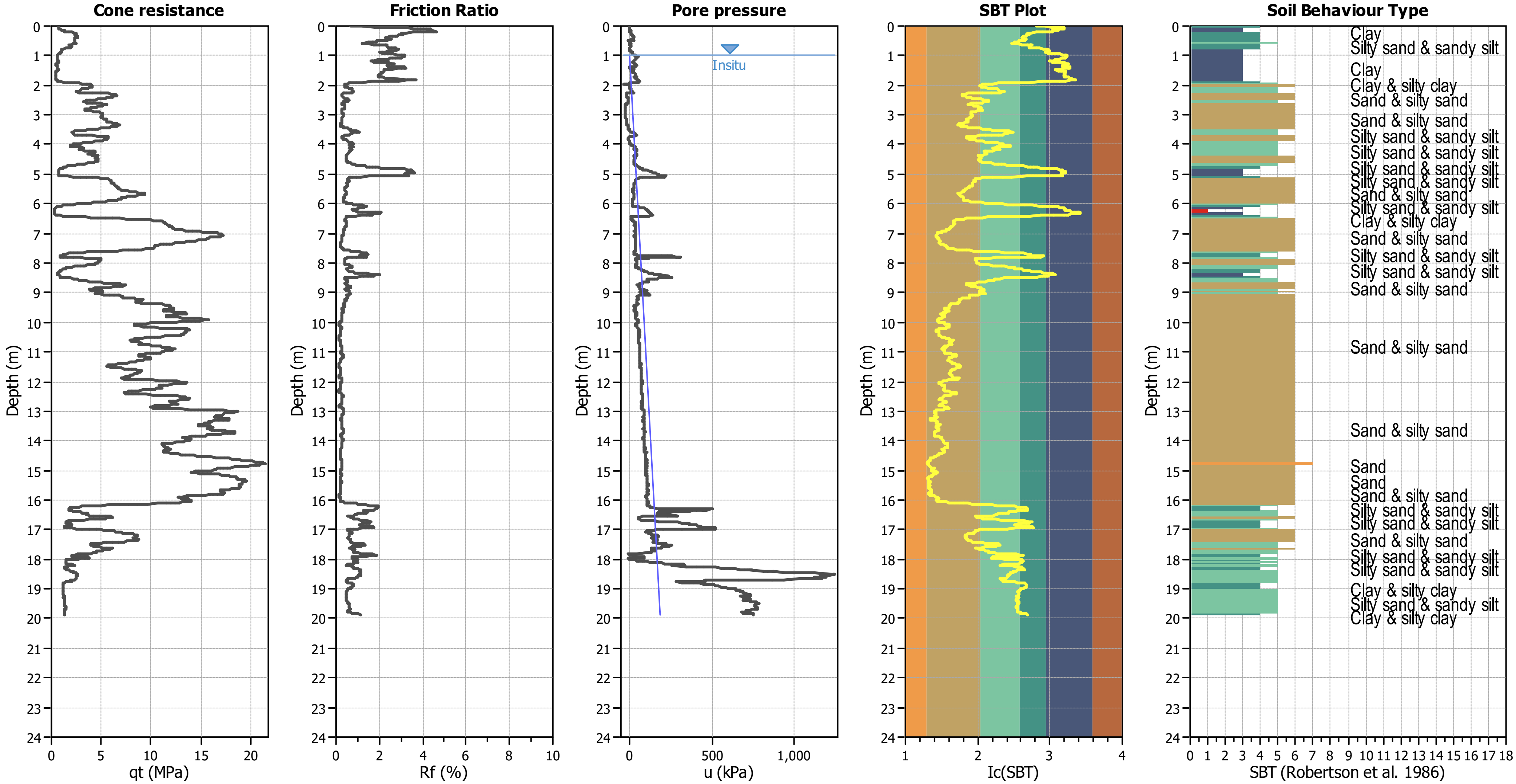
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



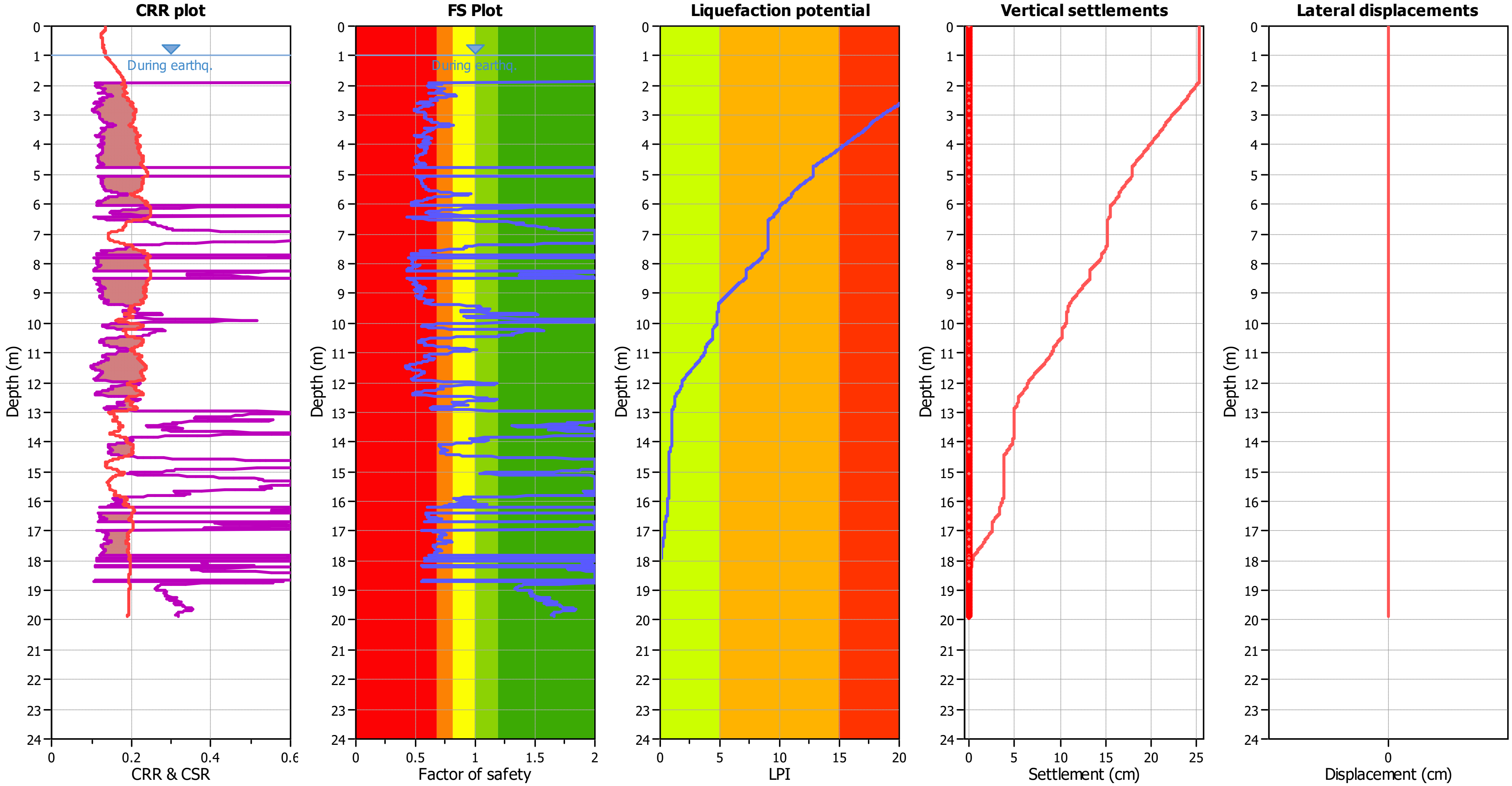
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

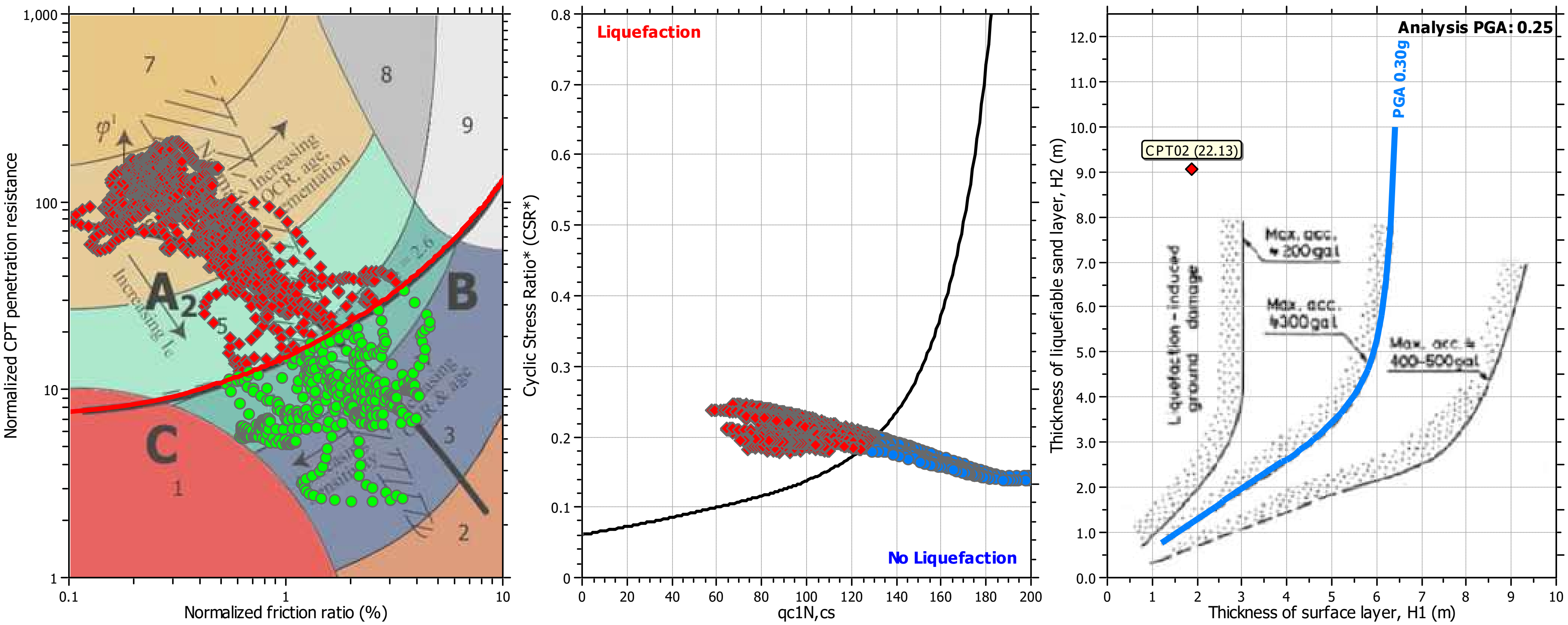
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

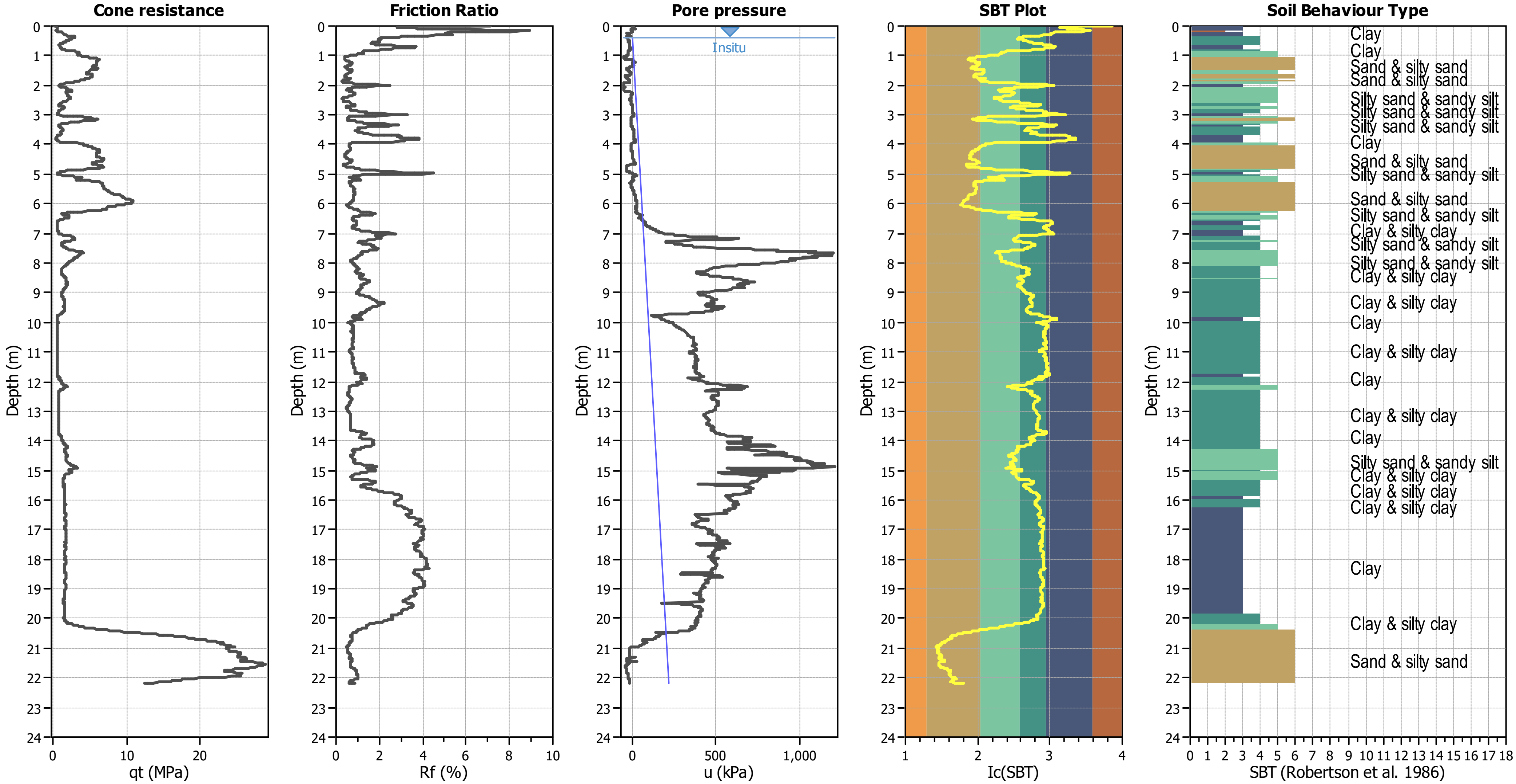
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



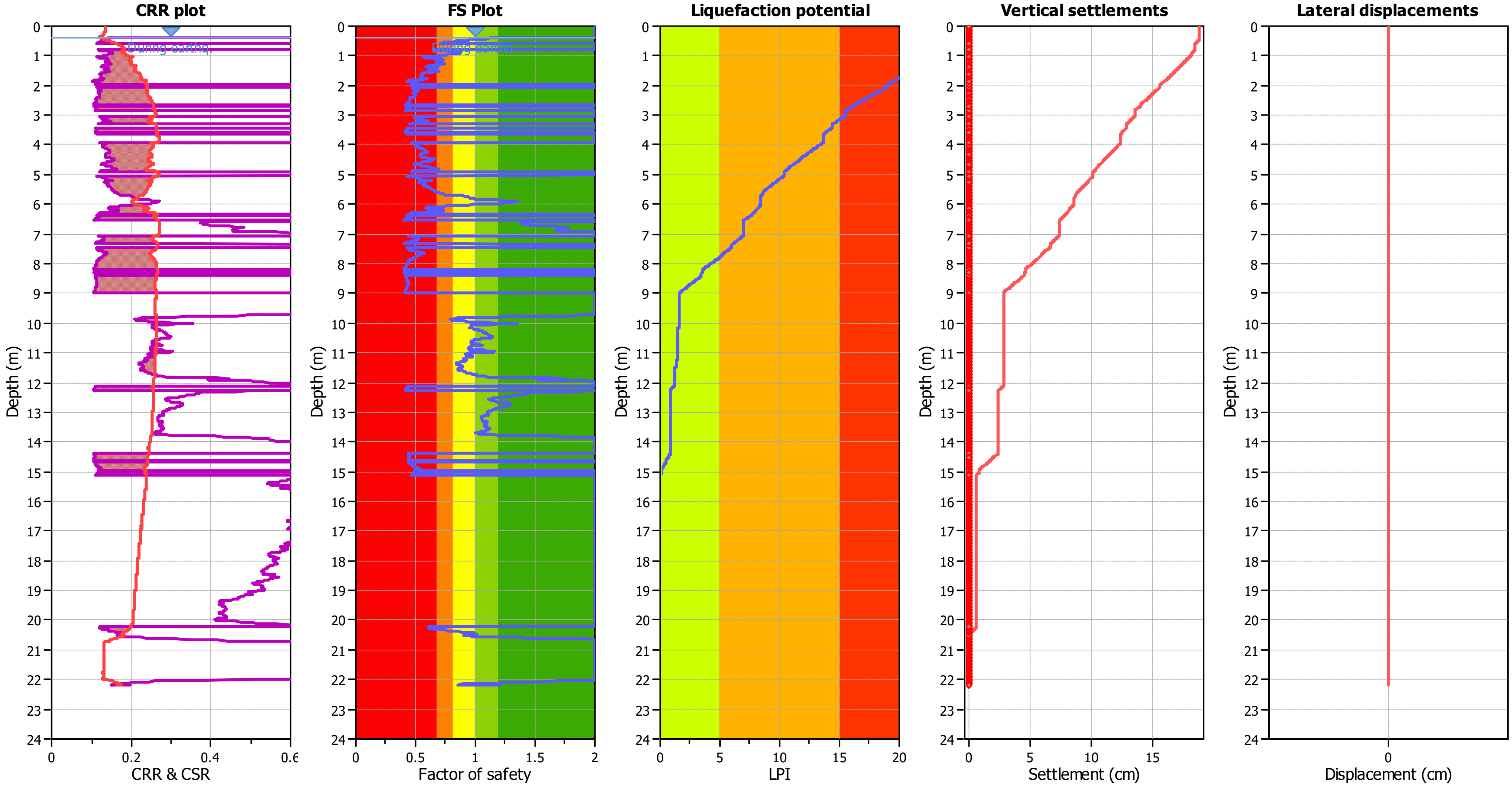
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

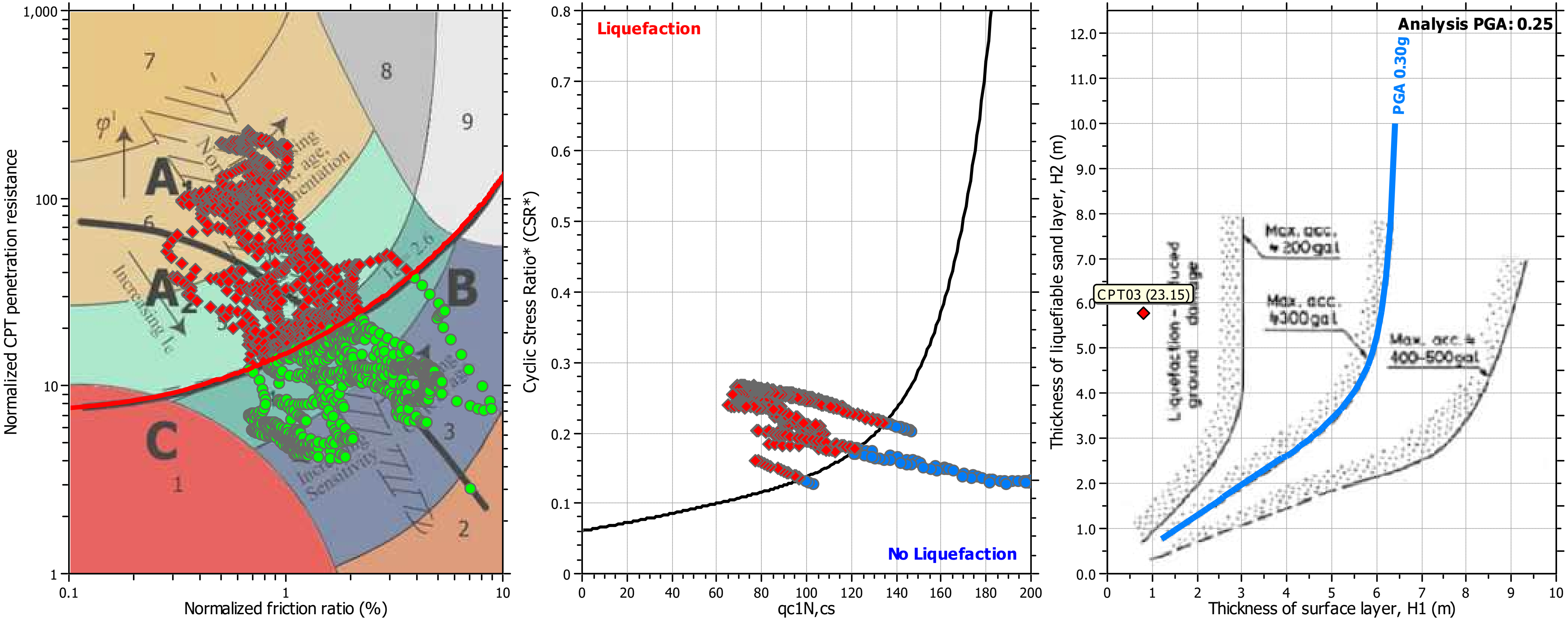
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

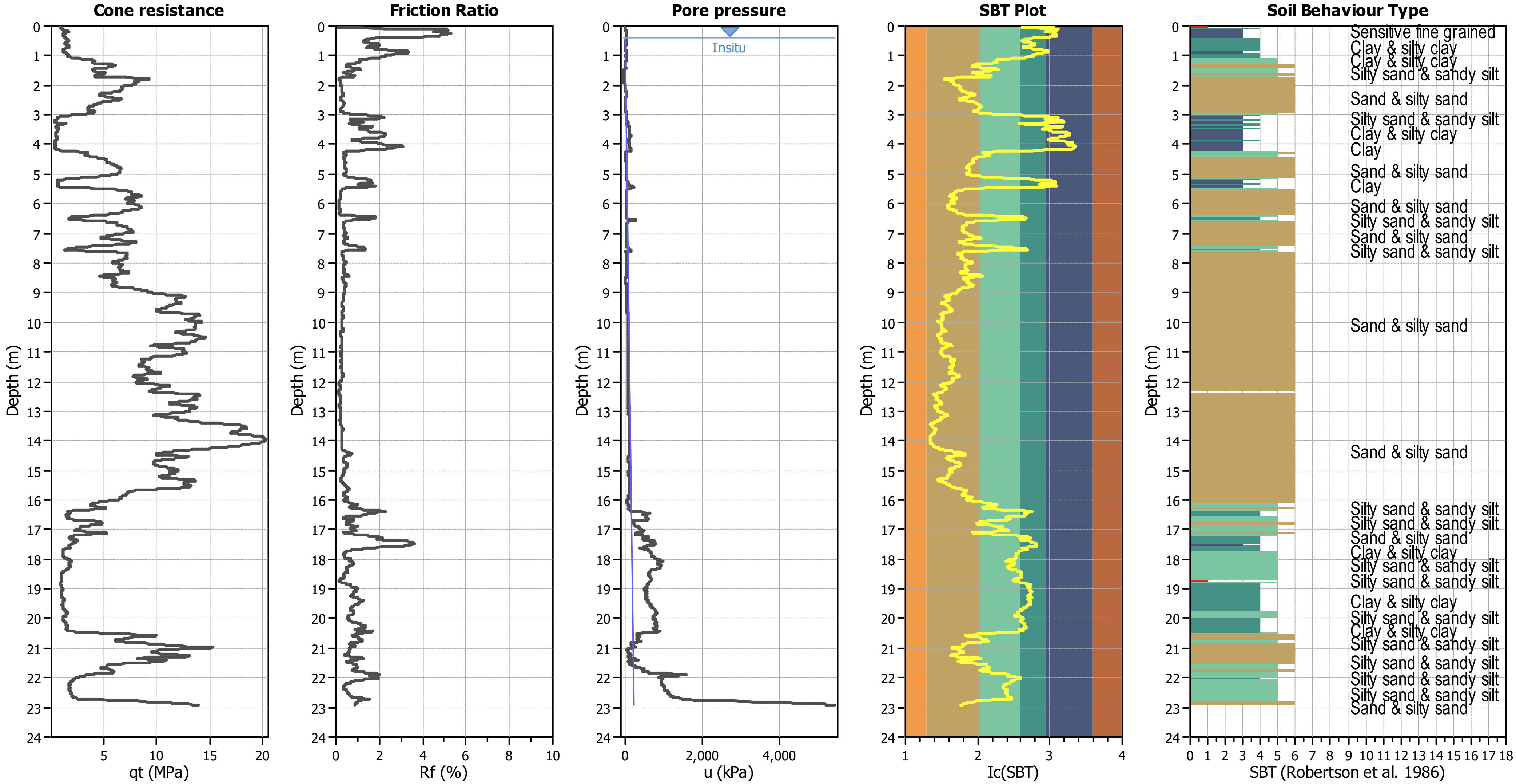
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



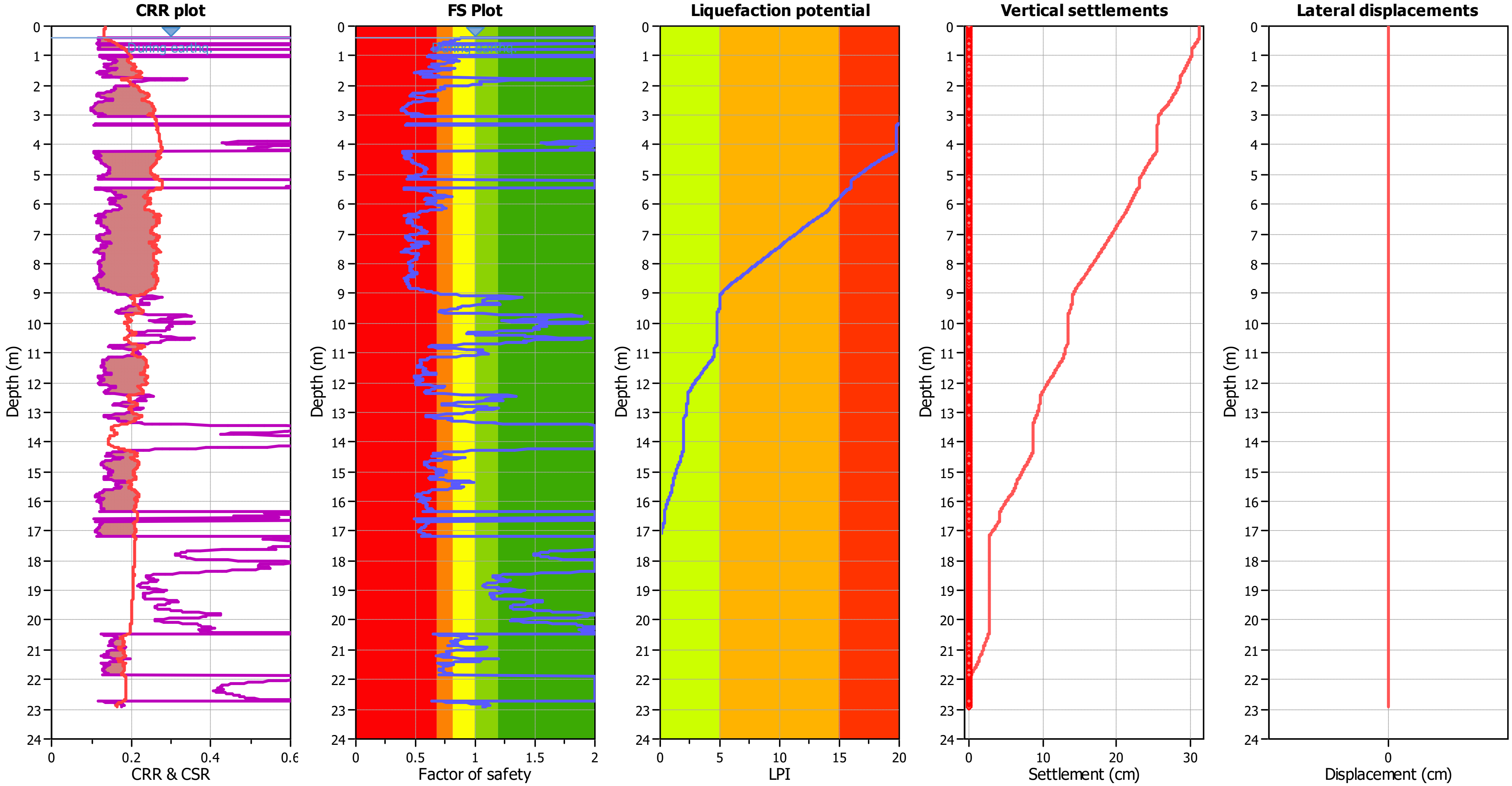
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

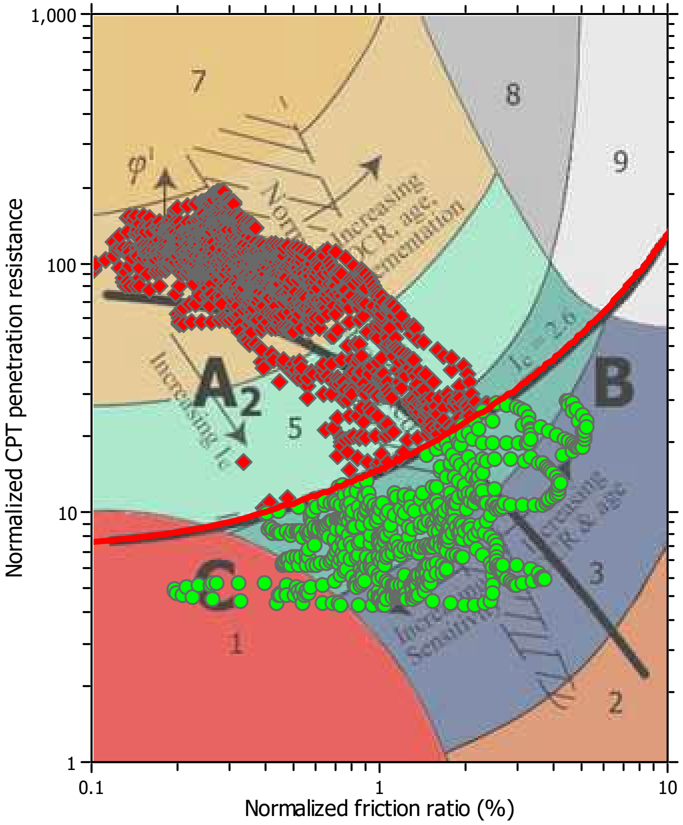
F.S. color scheme

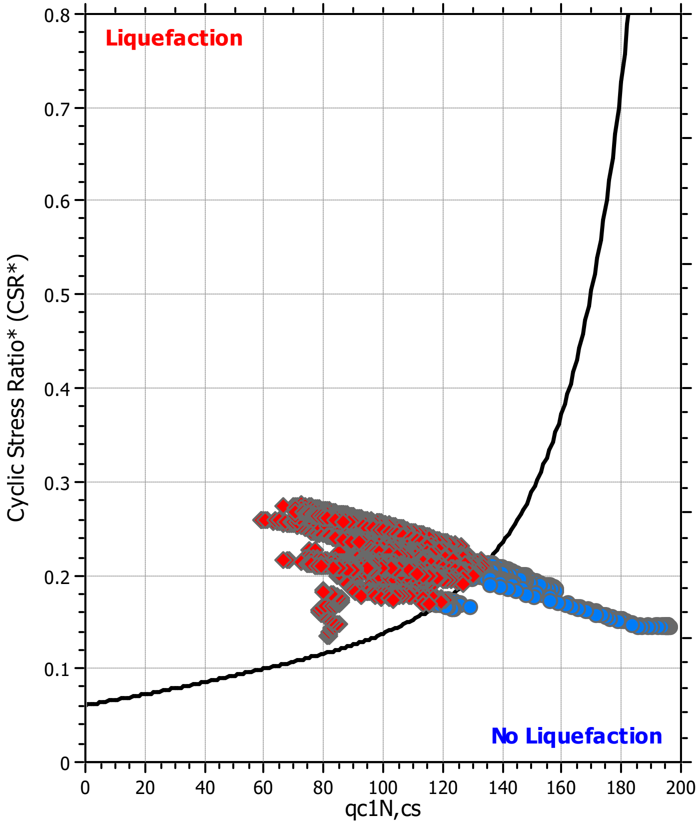
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

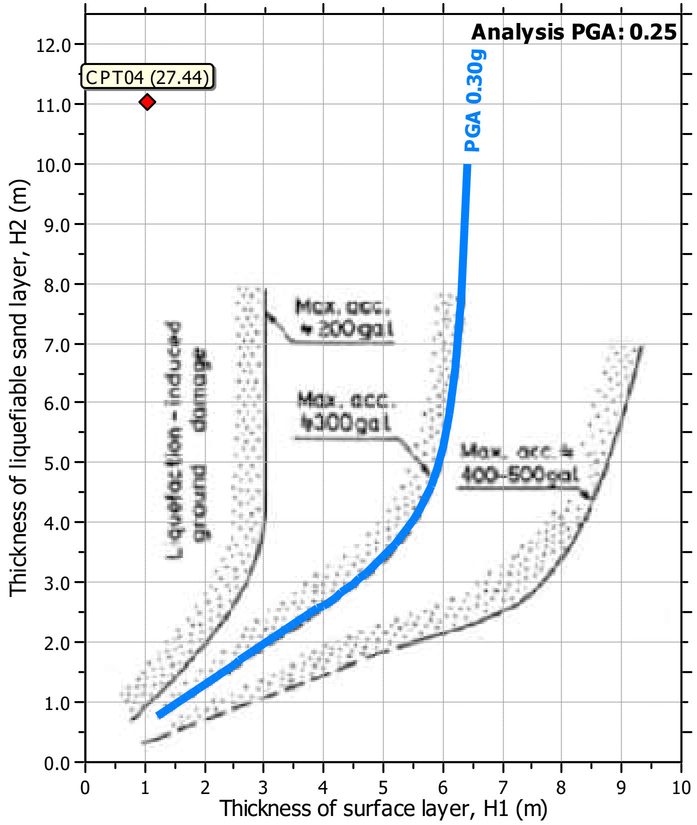
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



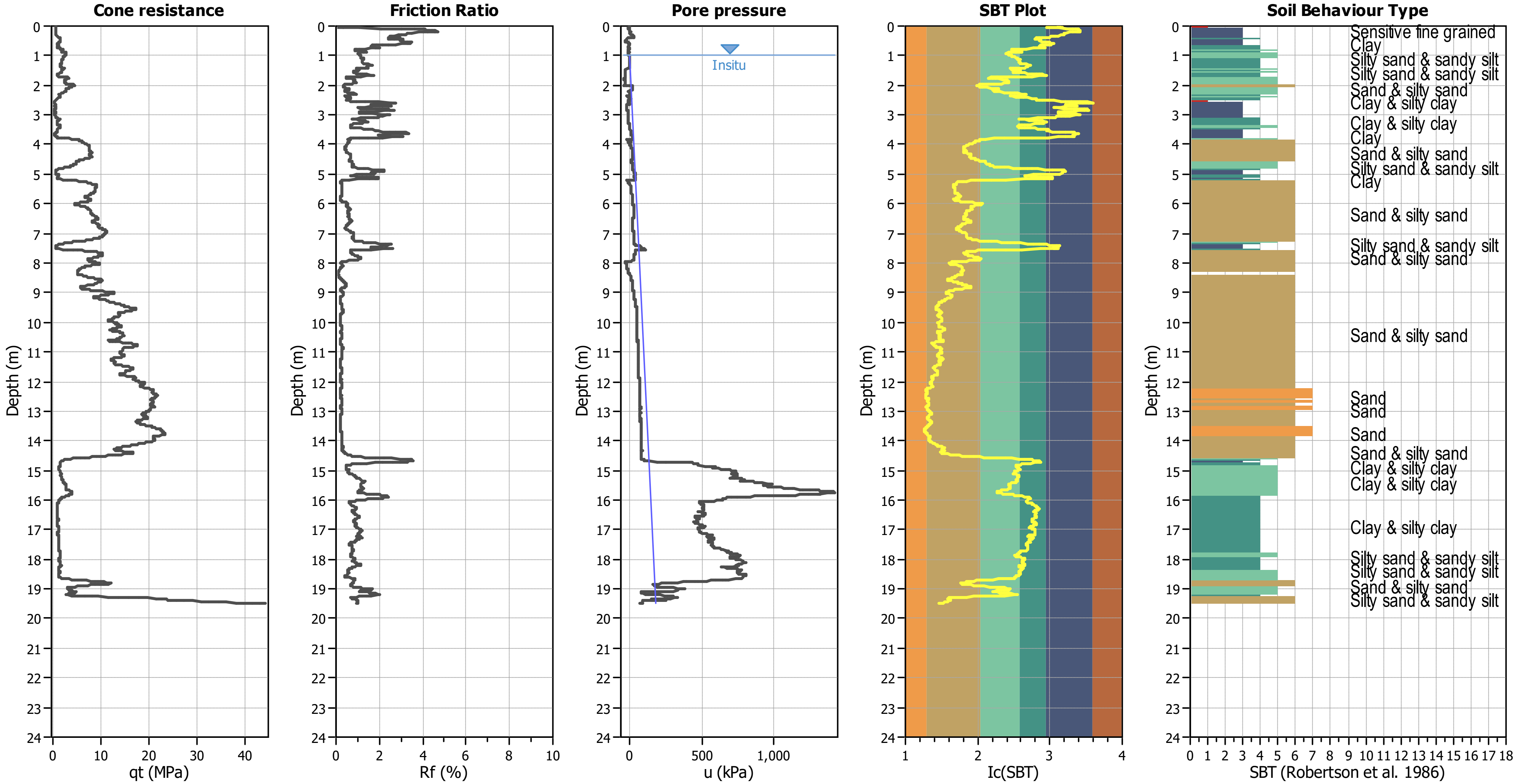




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



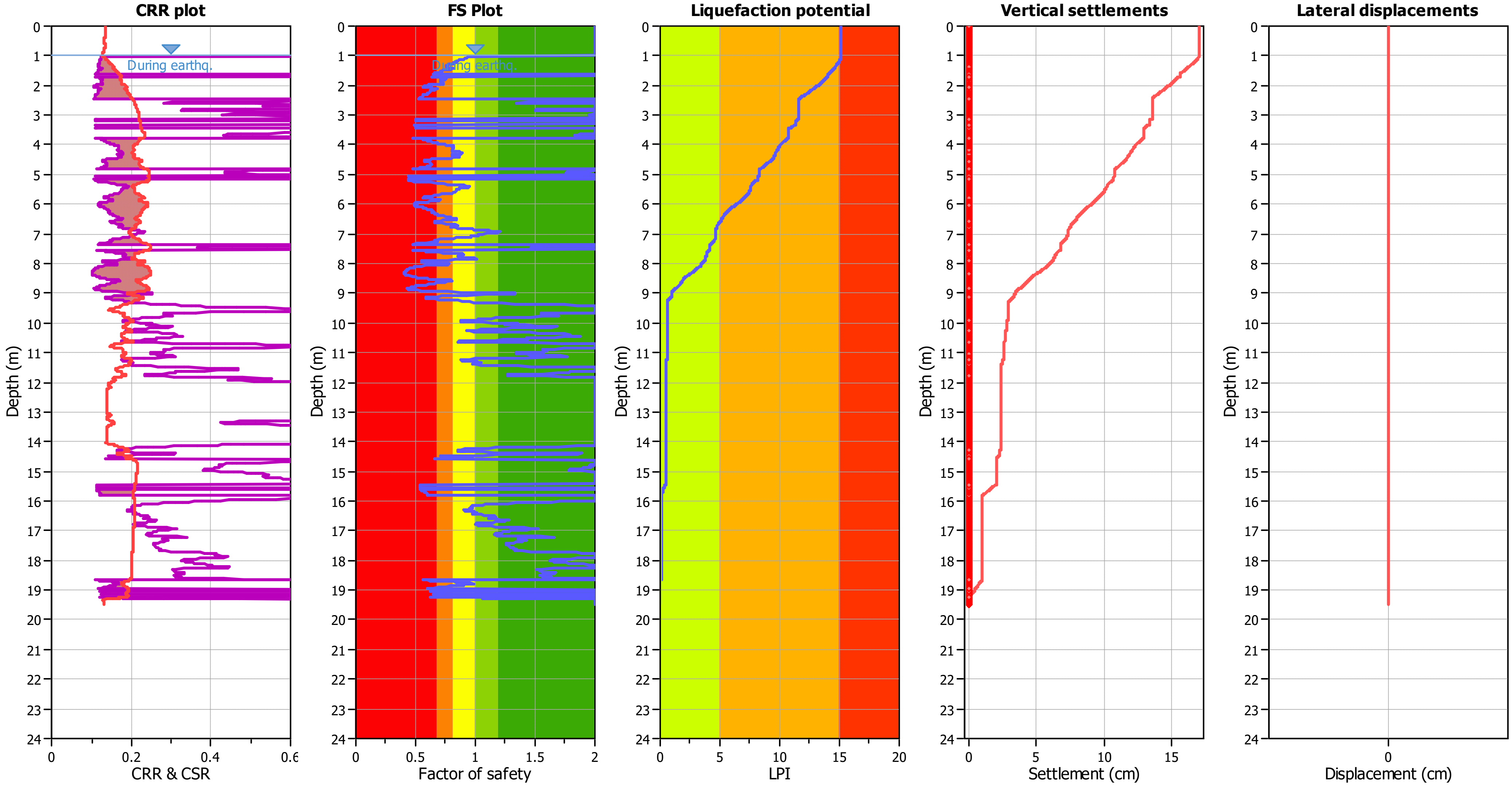
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

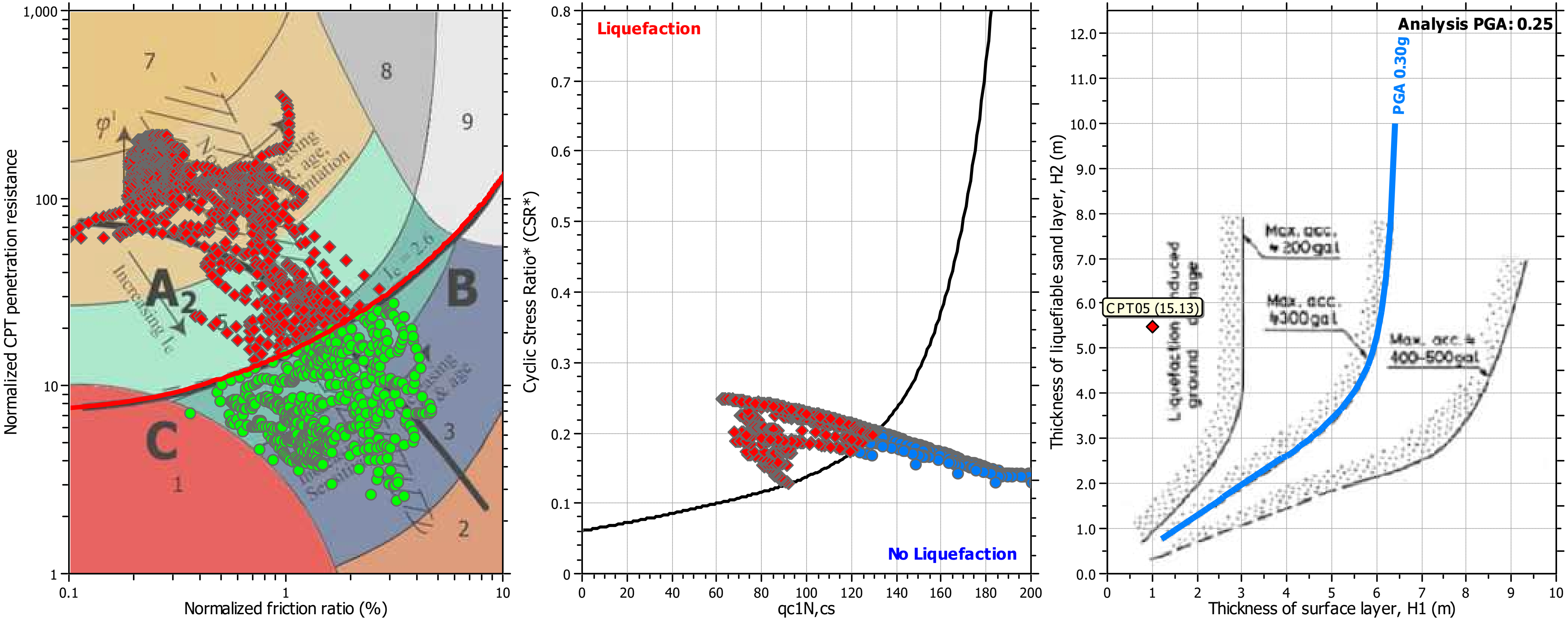
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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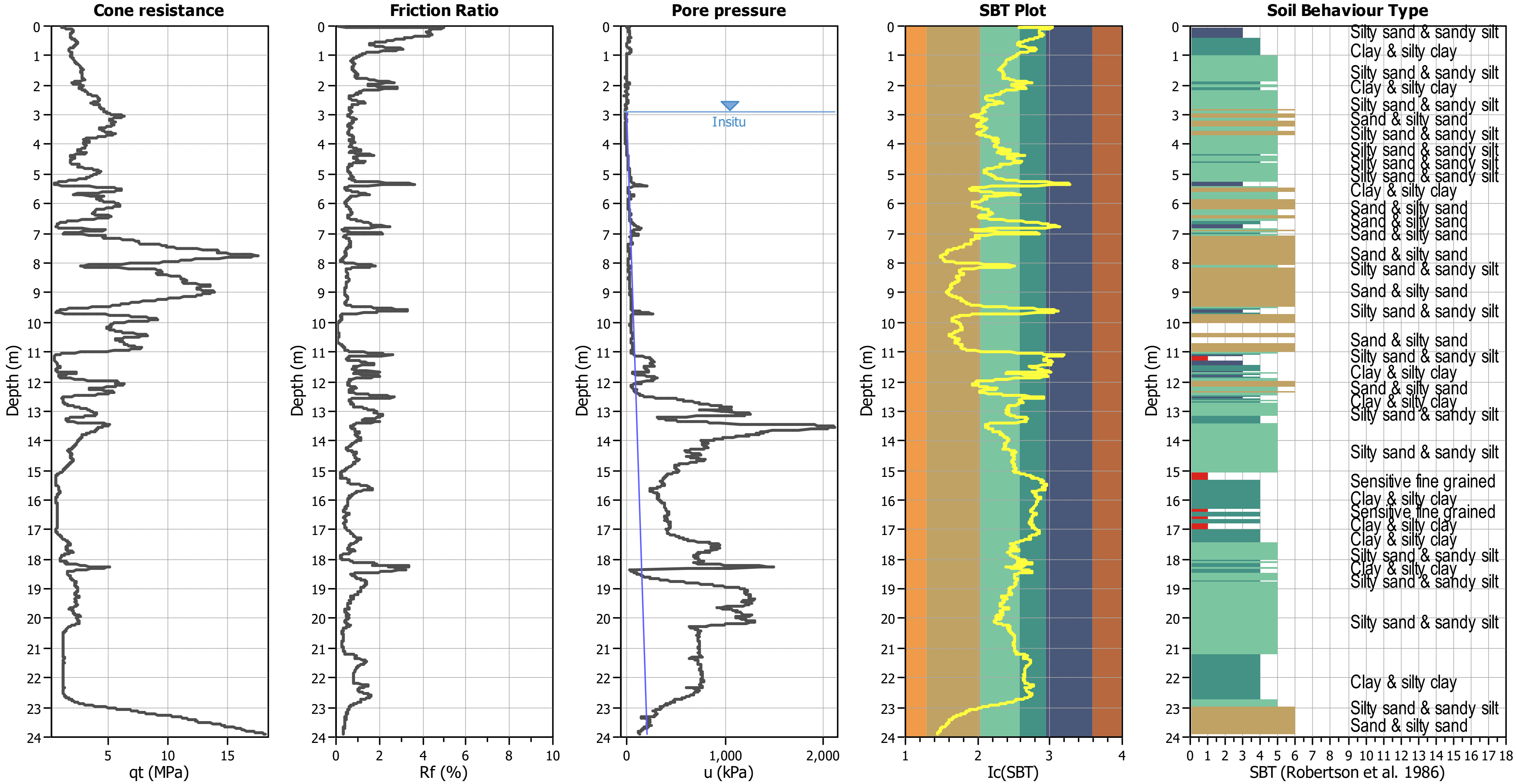
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



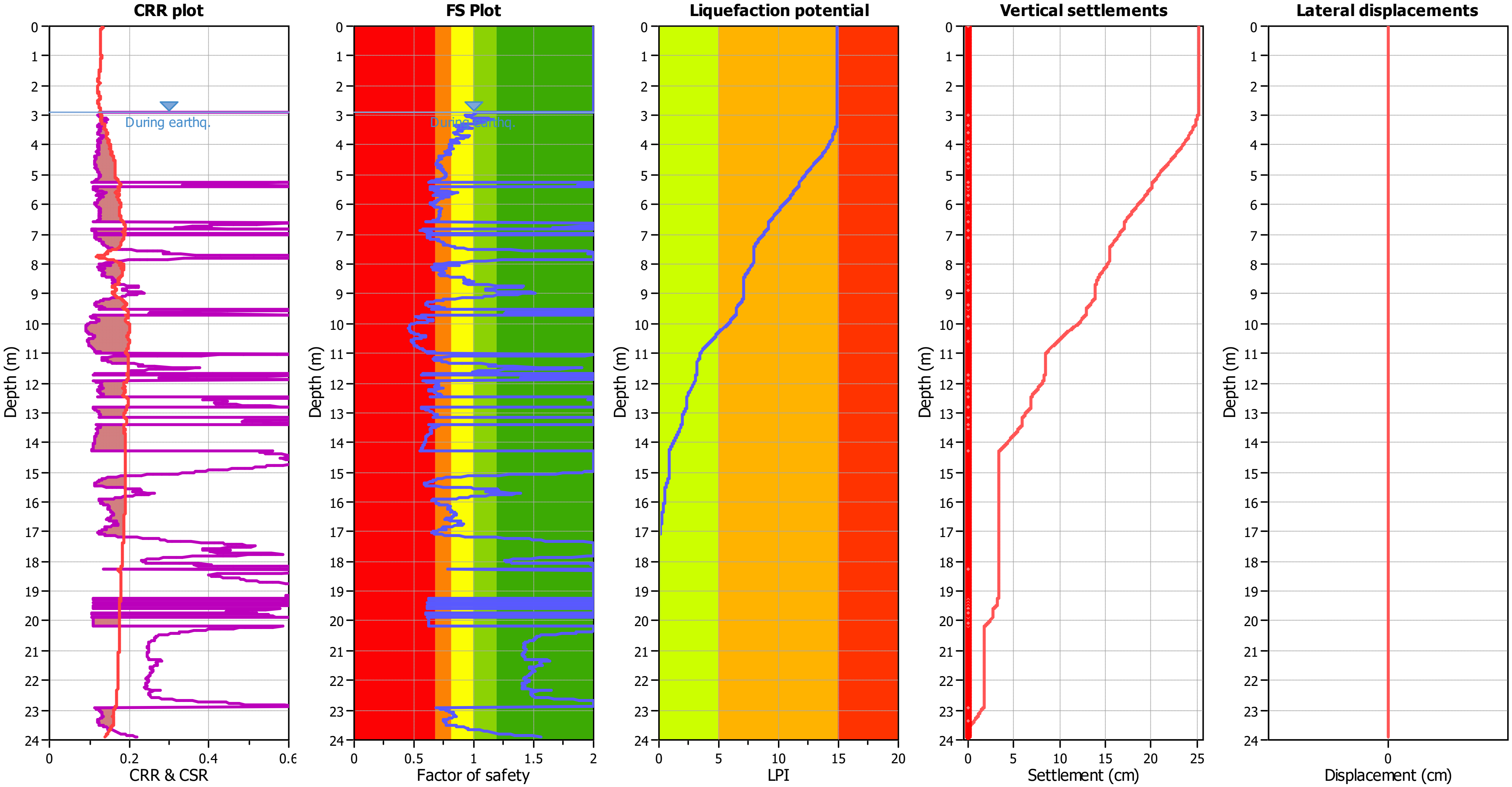
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	N/A

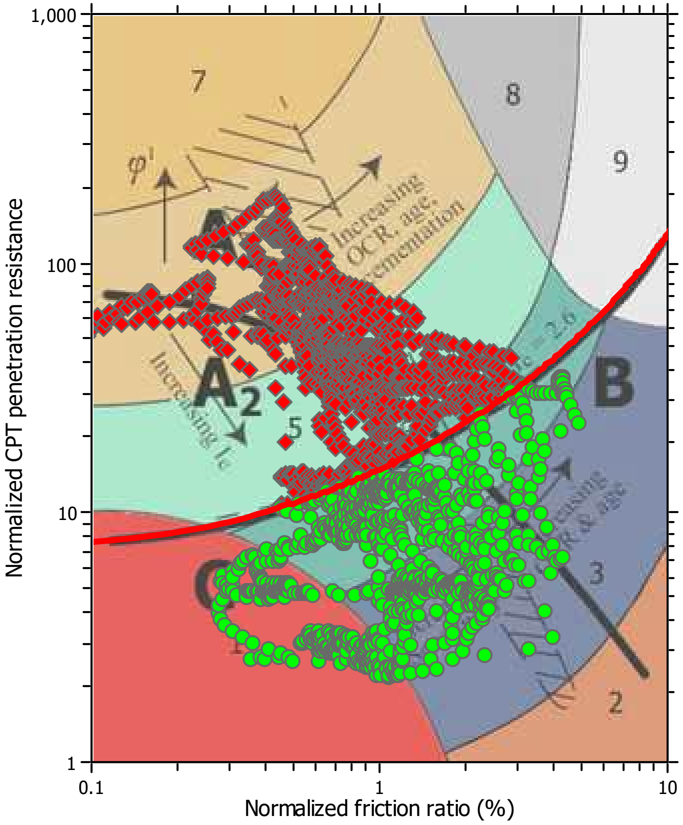
F.S. color scheme

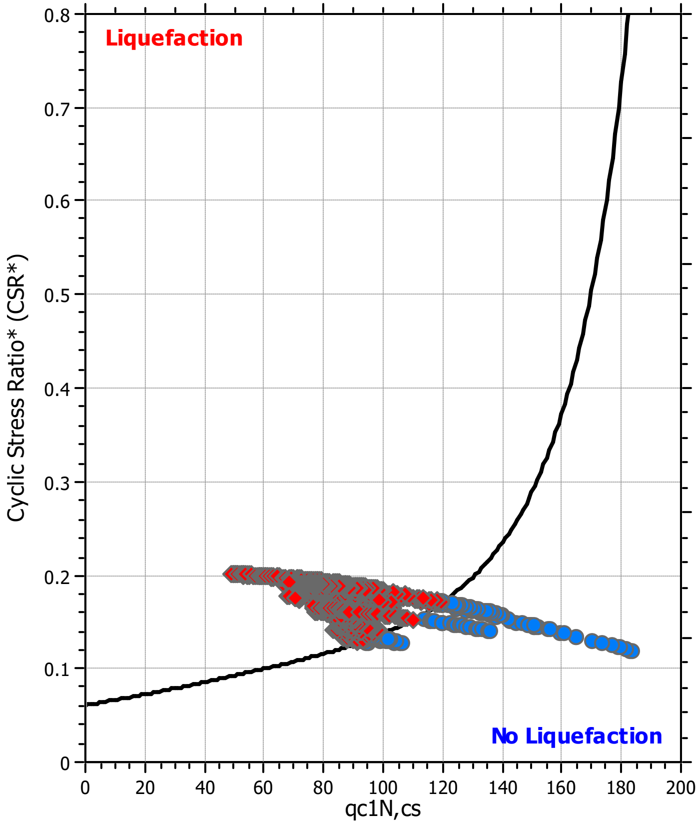
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

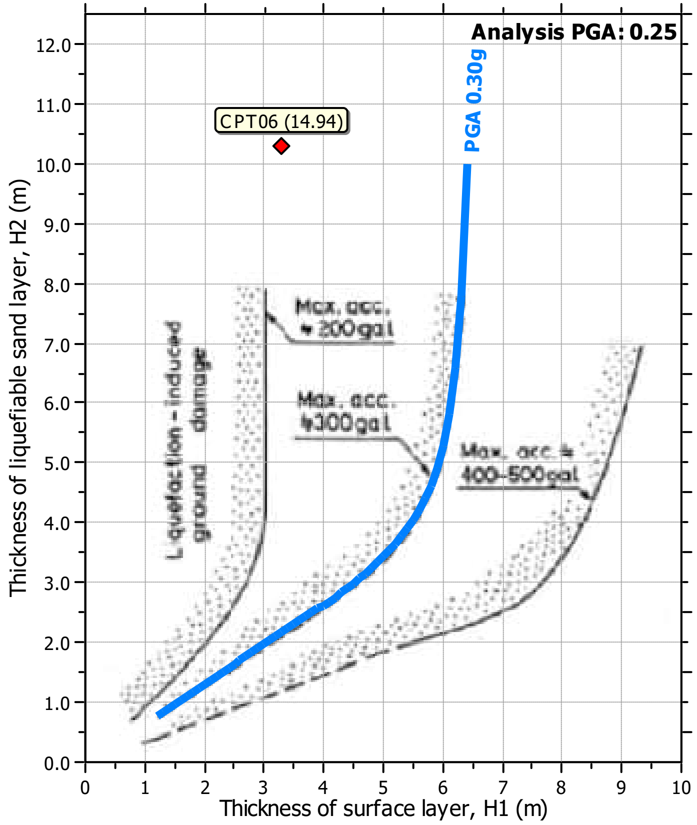
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



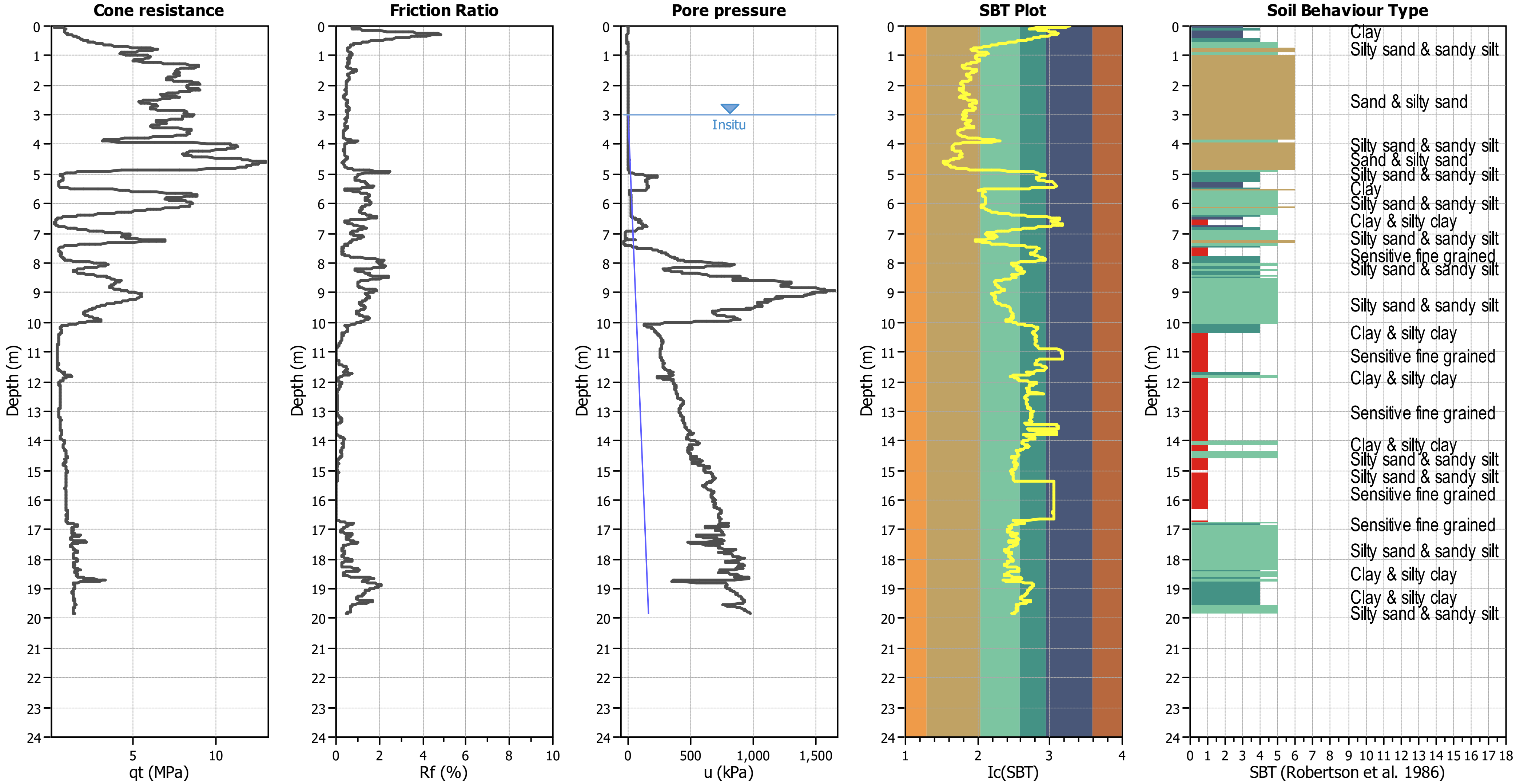




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



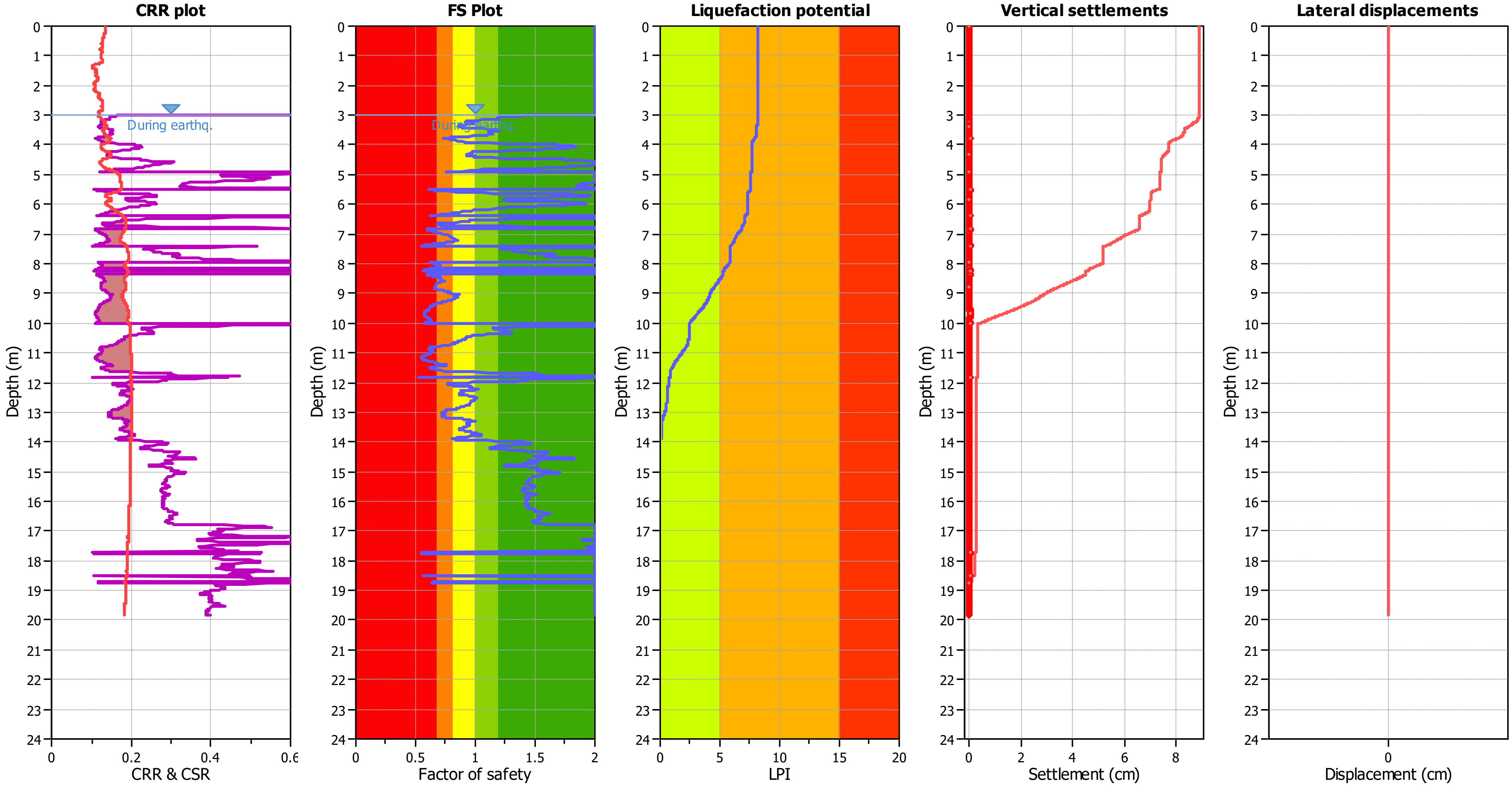
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

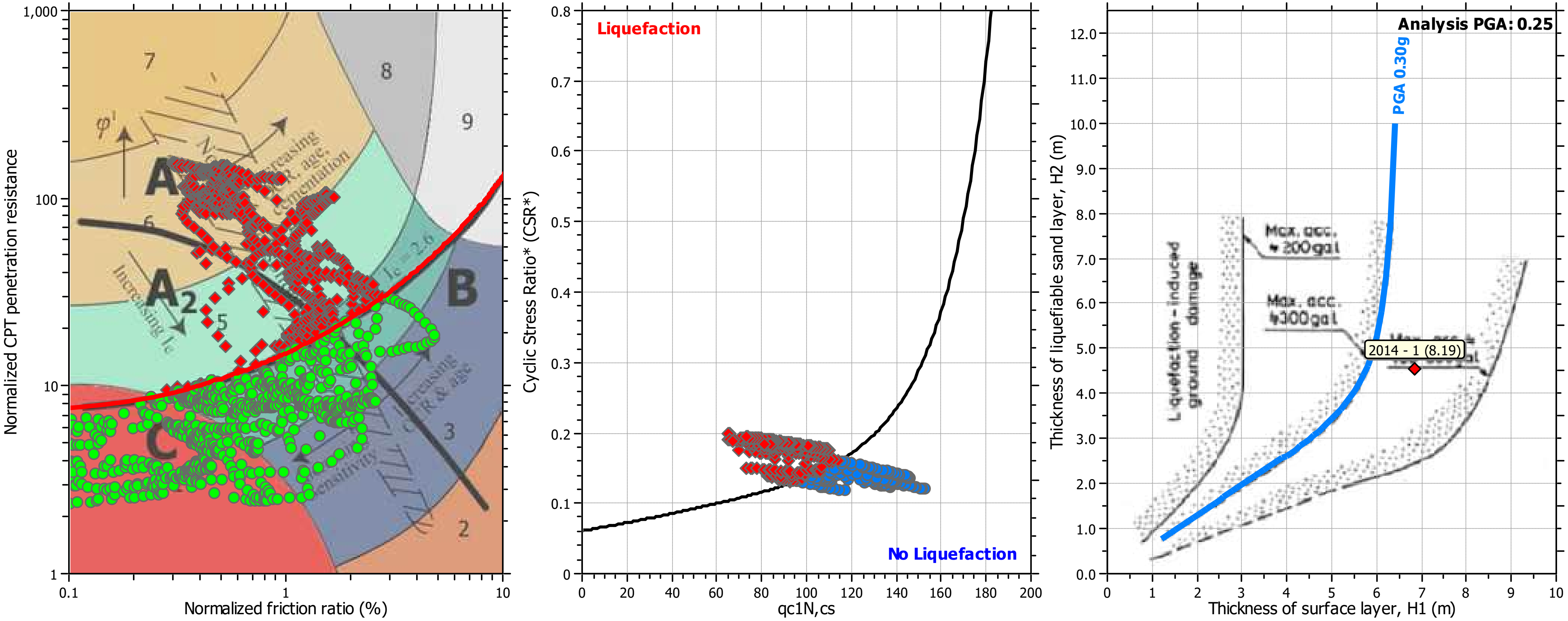
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

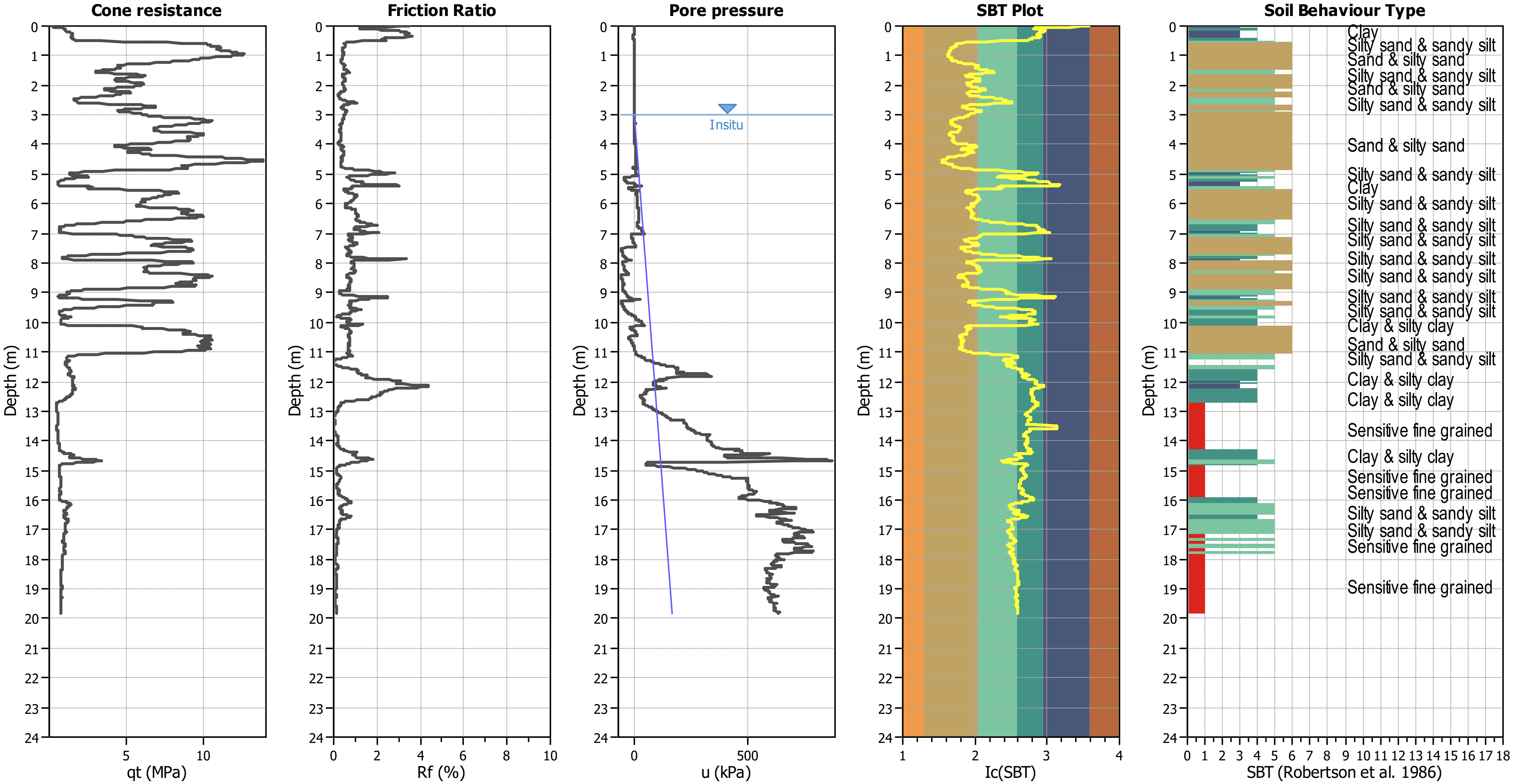
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



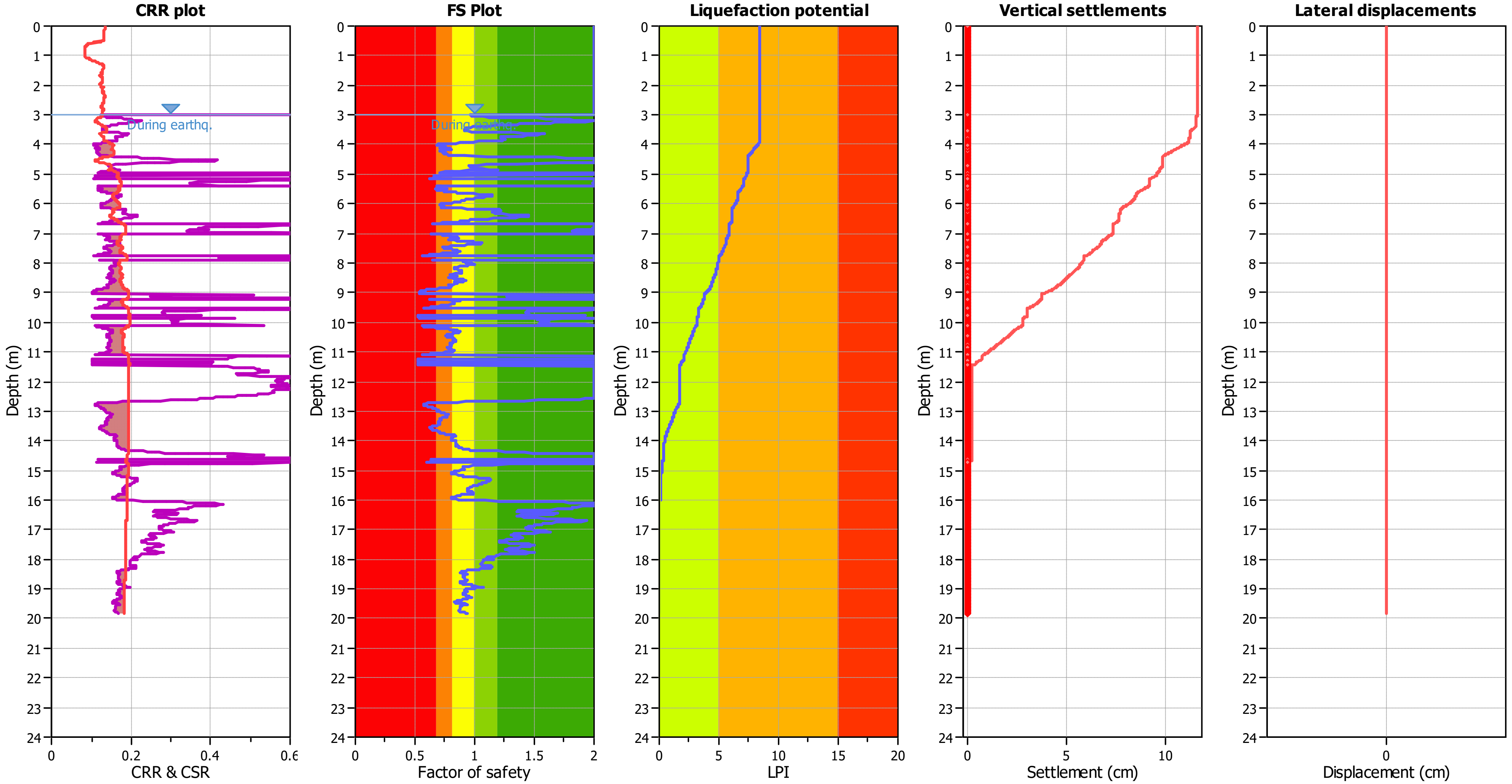
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

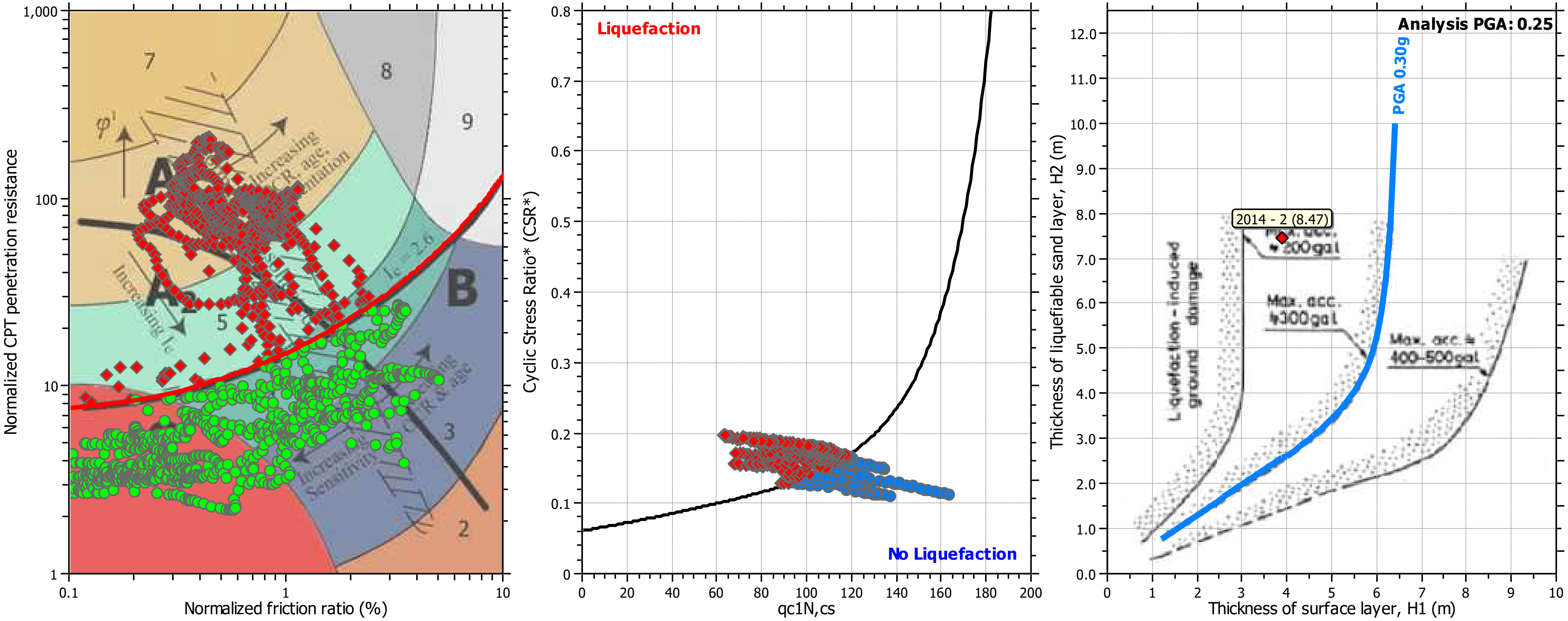
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

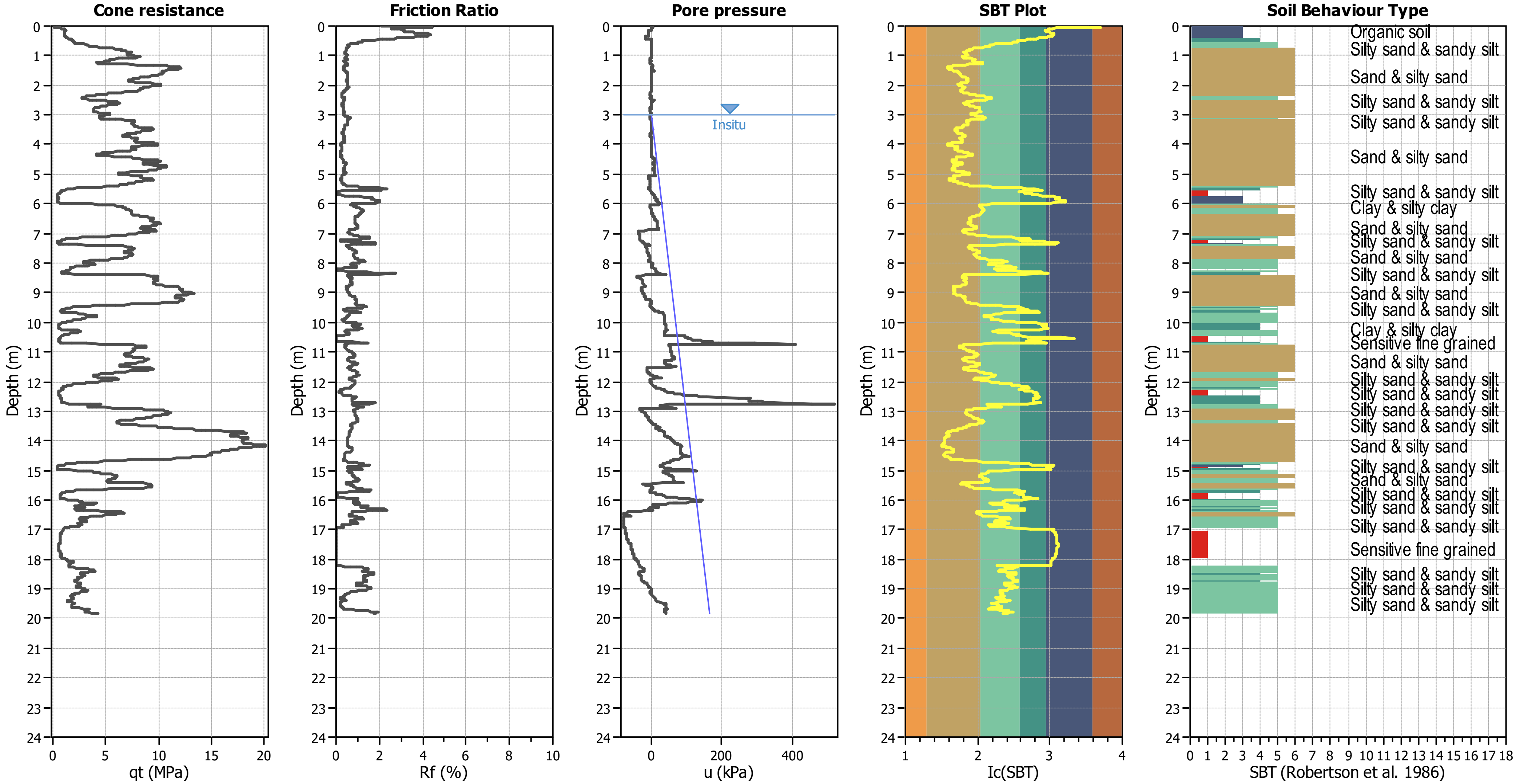
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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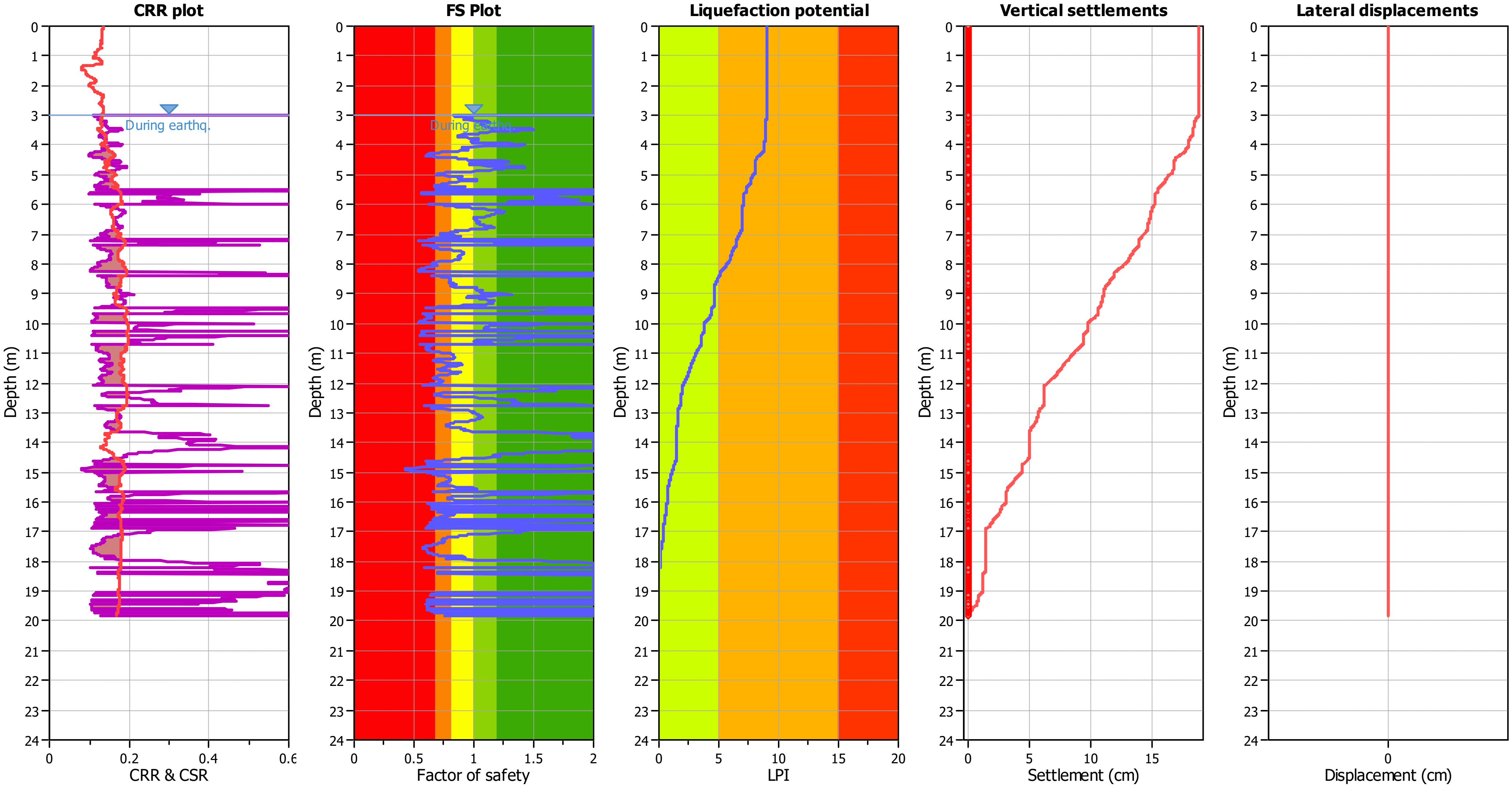
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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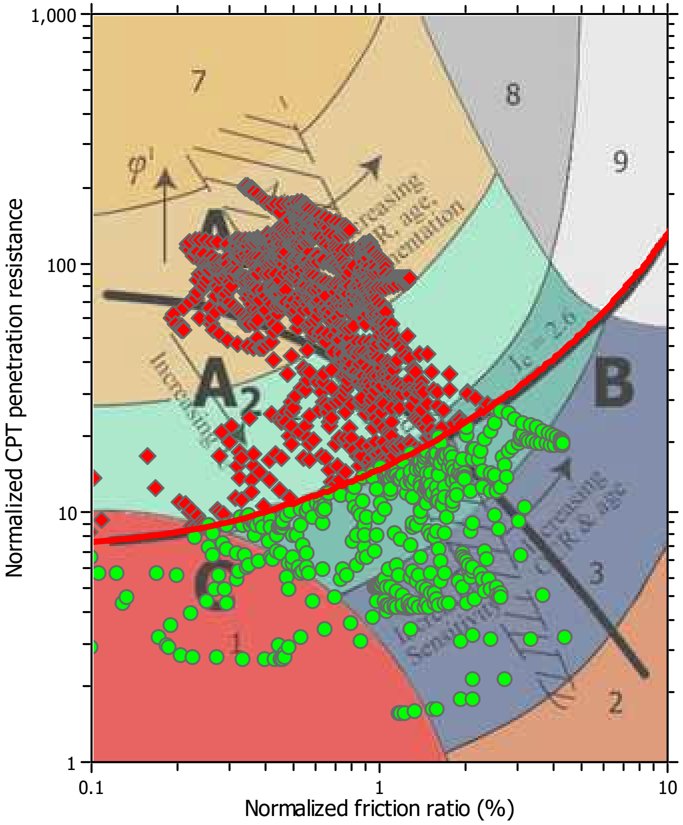
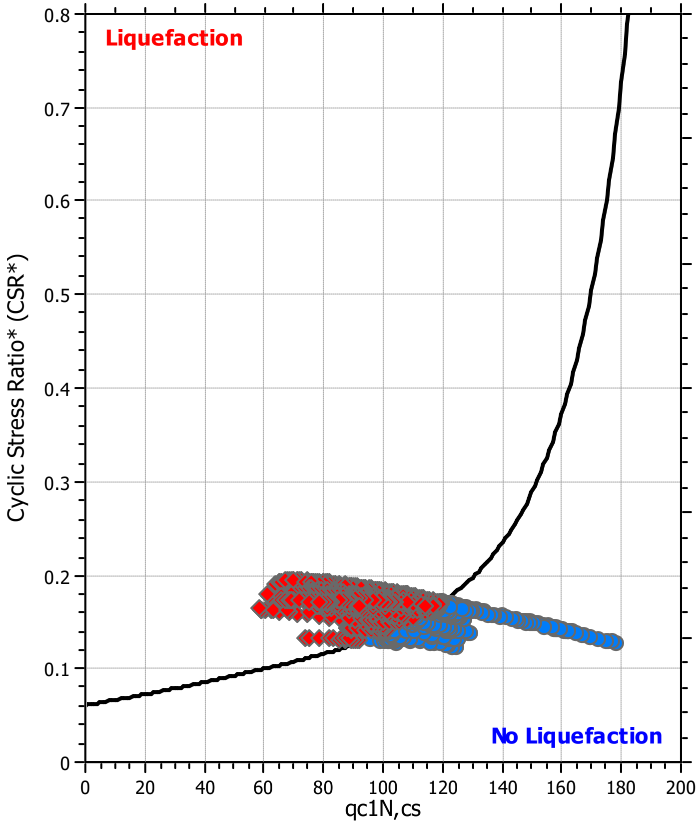
- Almost certain it will not liquefy

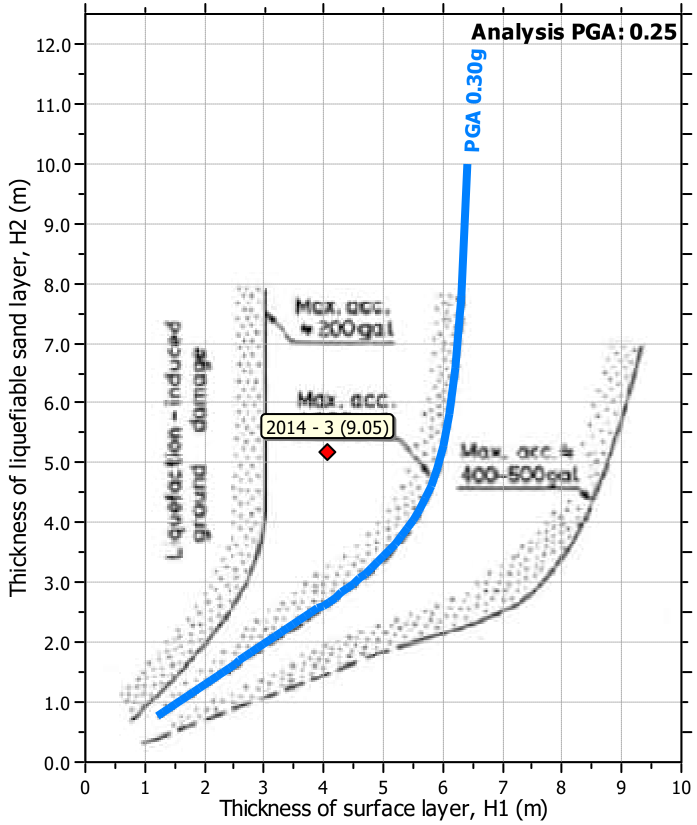
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



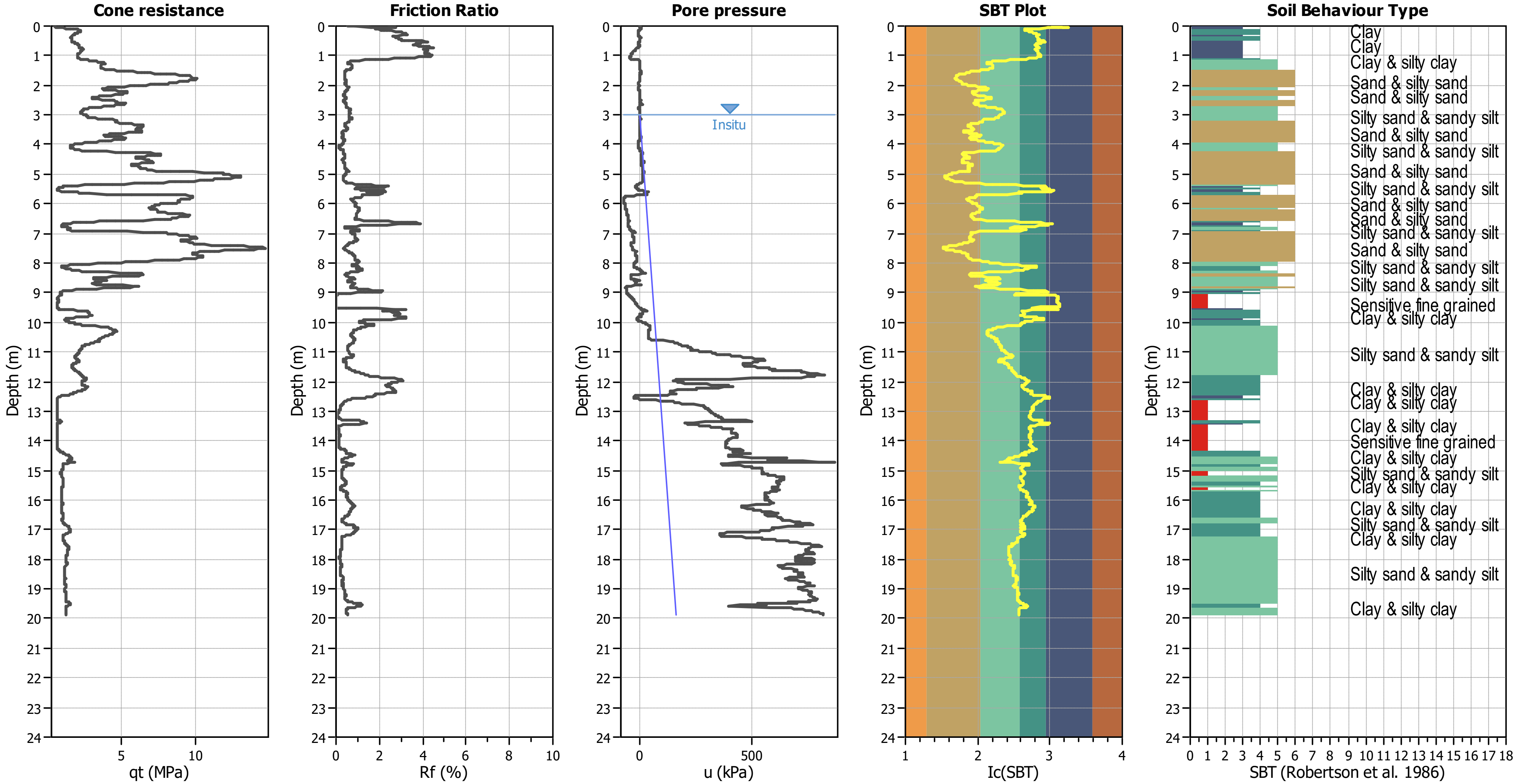




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
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Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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- 3. Clay to silty clay
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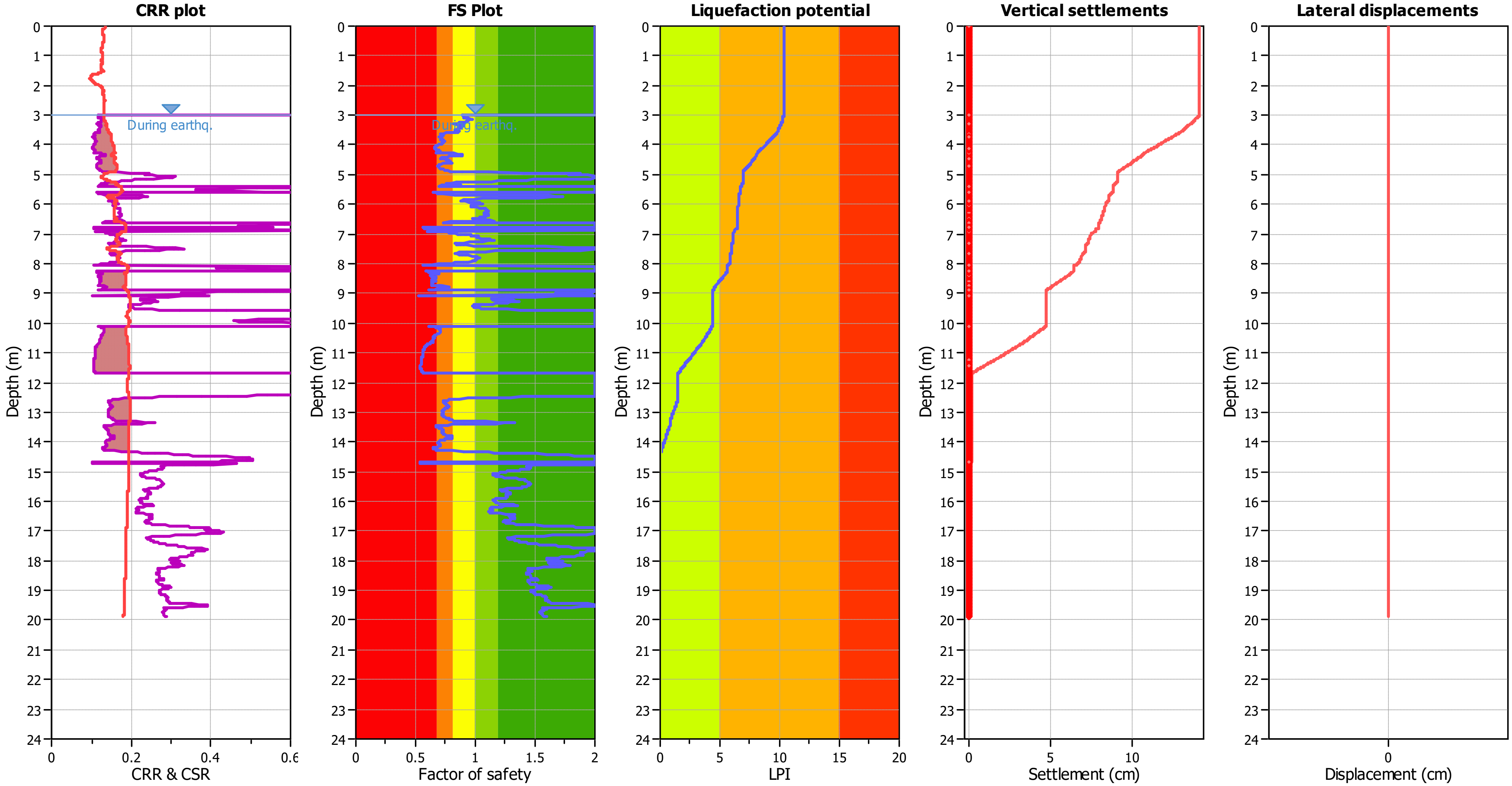
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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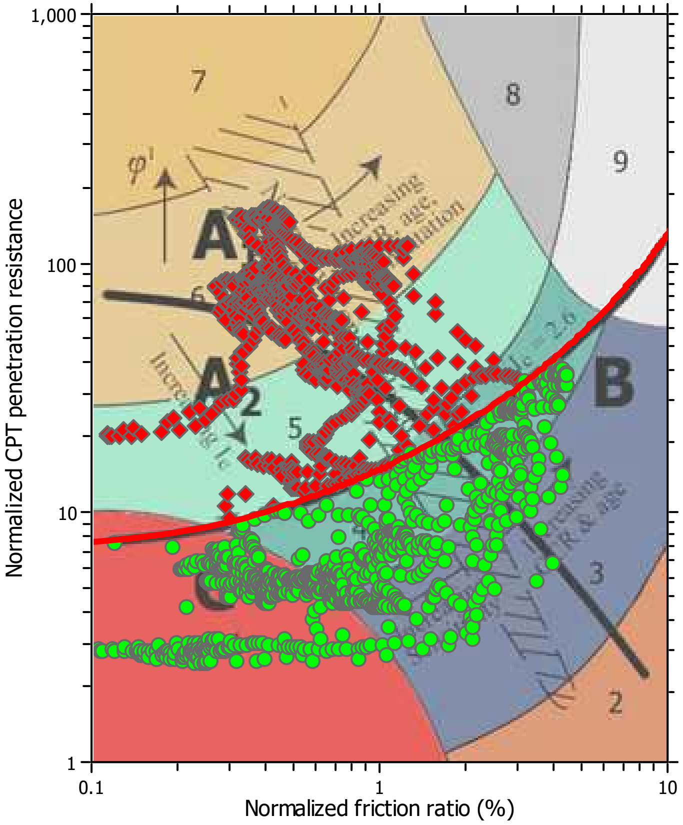
F.S. color scheme

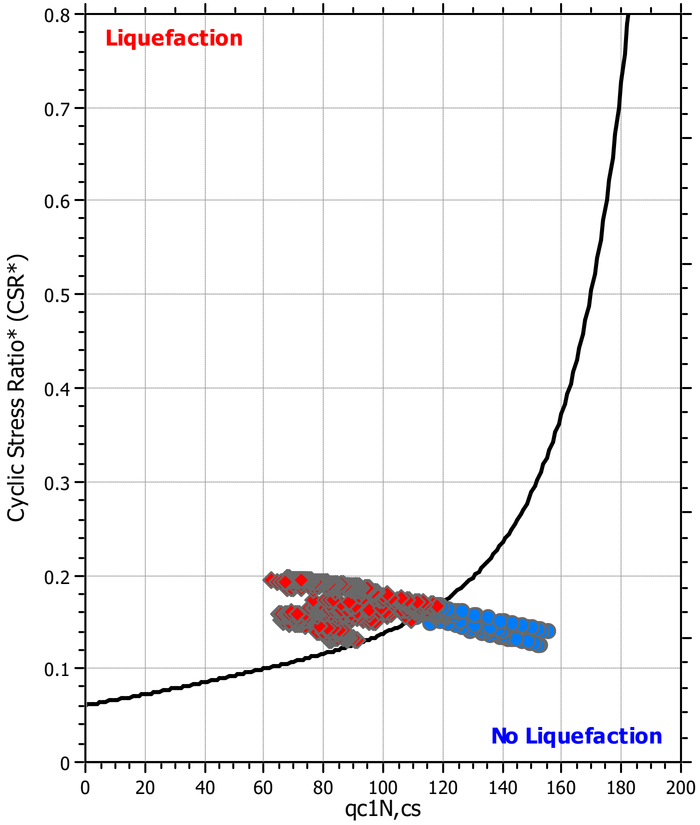
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

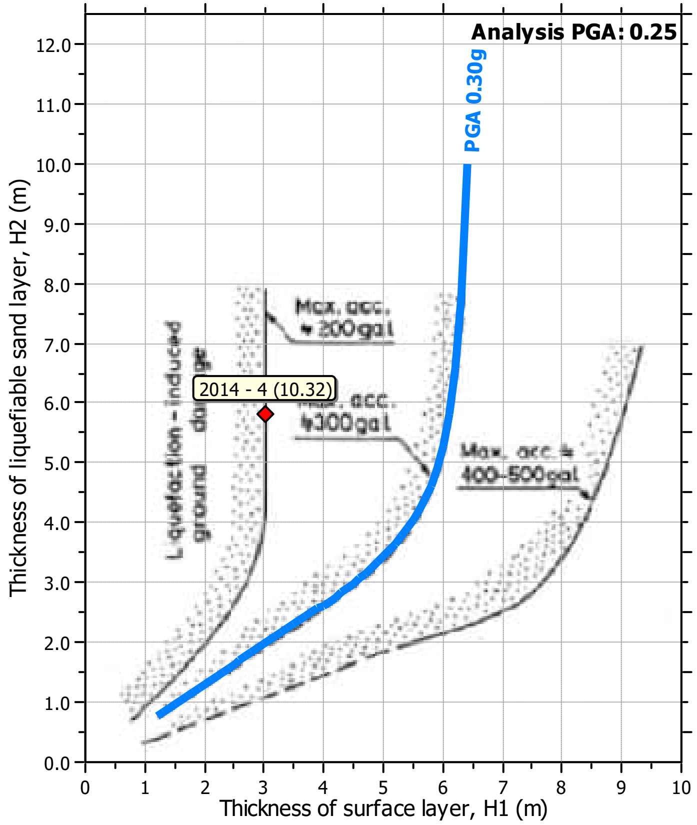
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



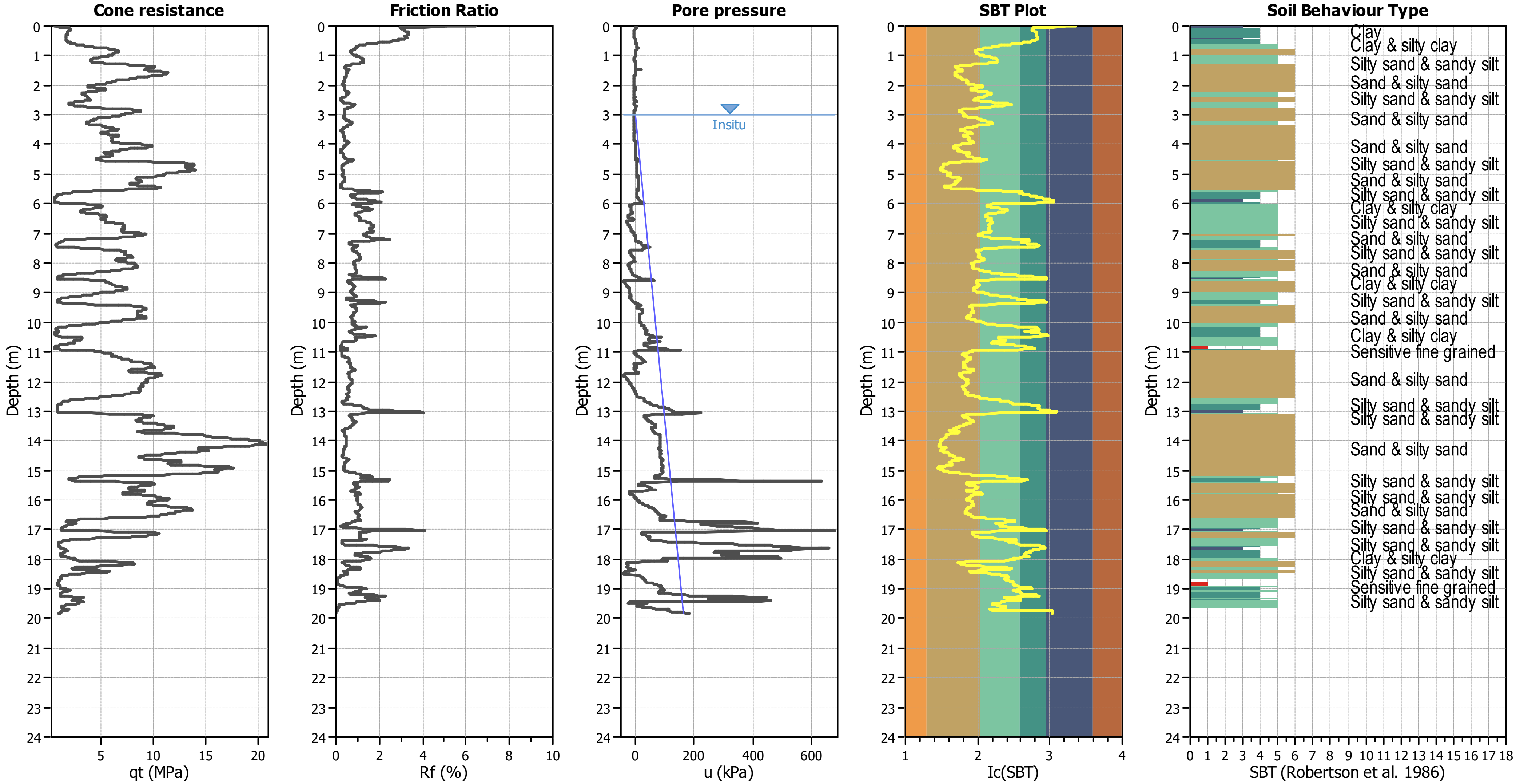




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



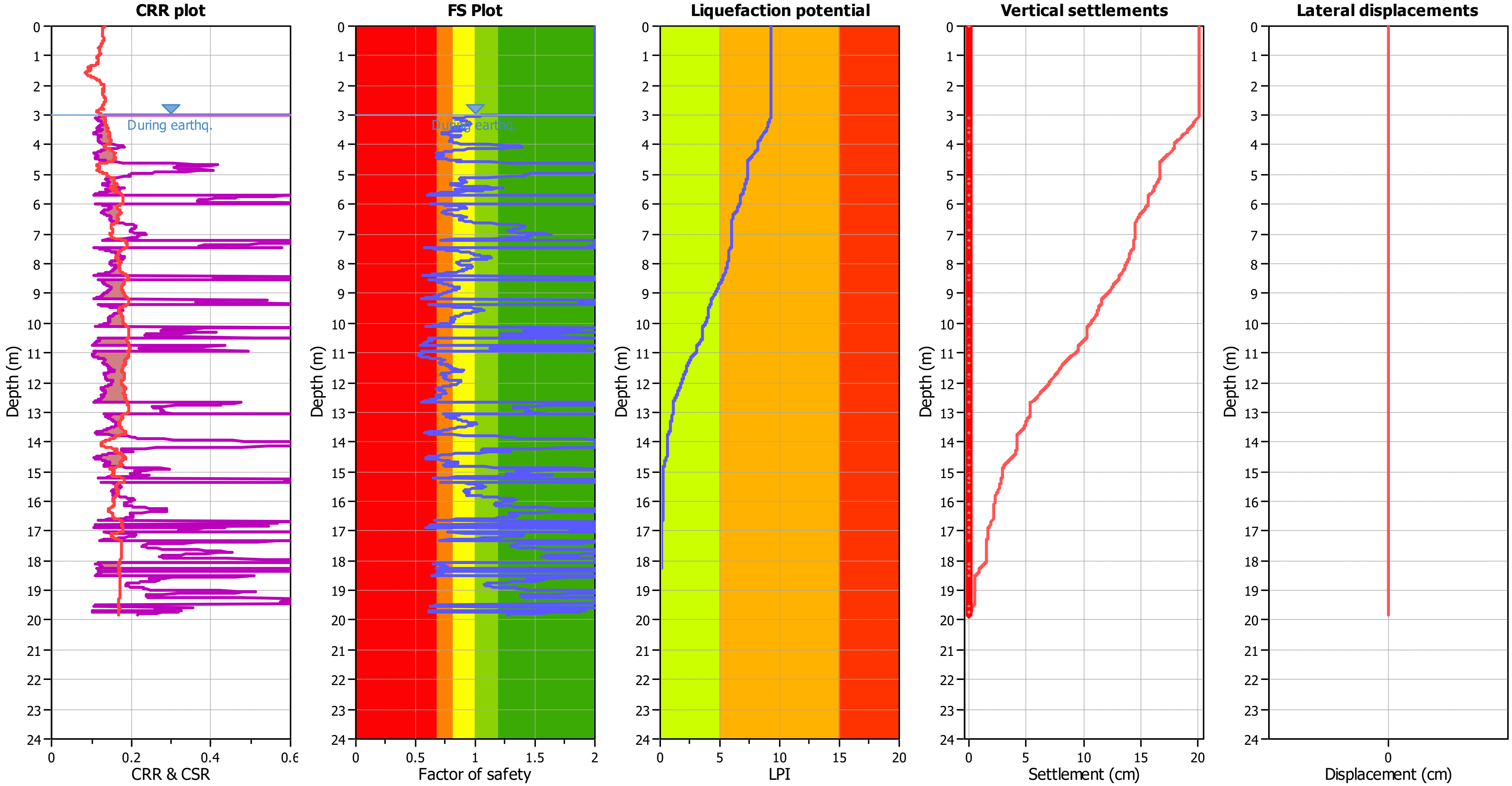
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

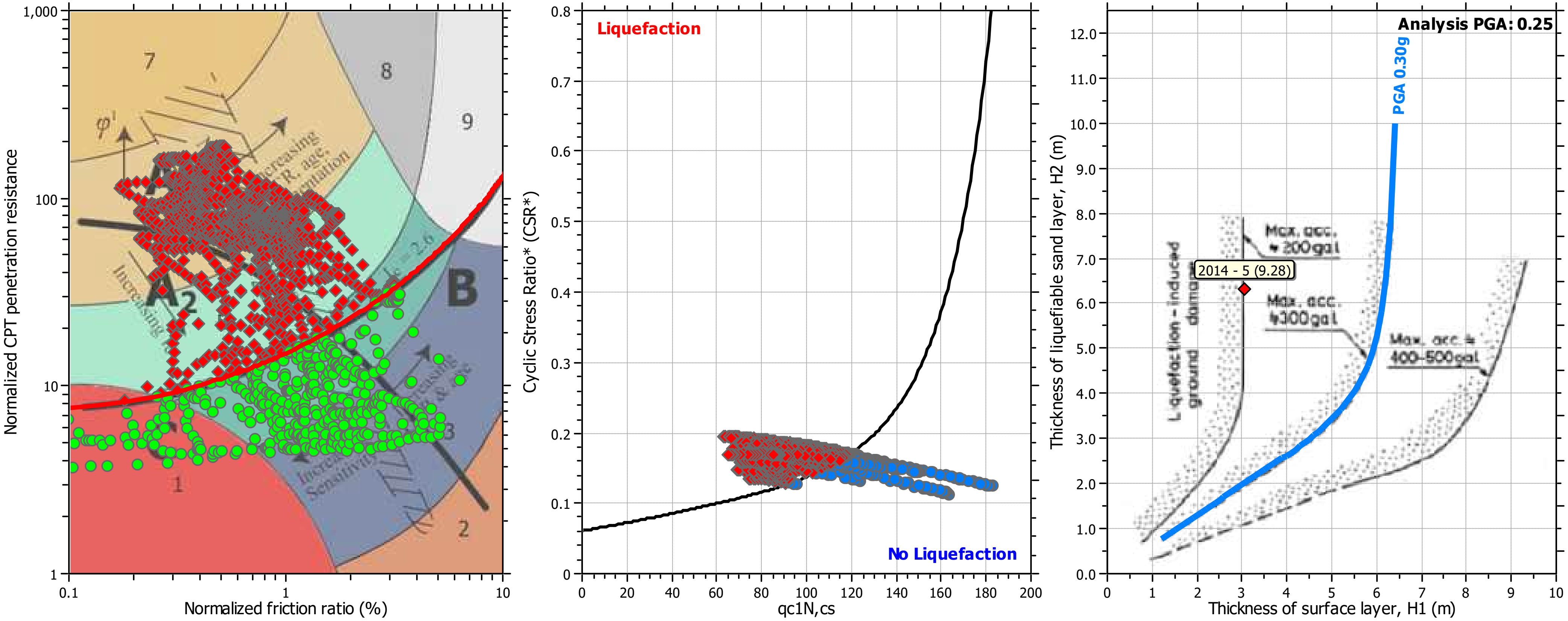
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

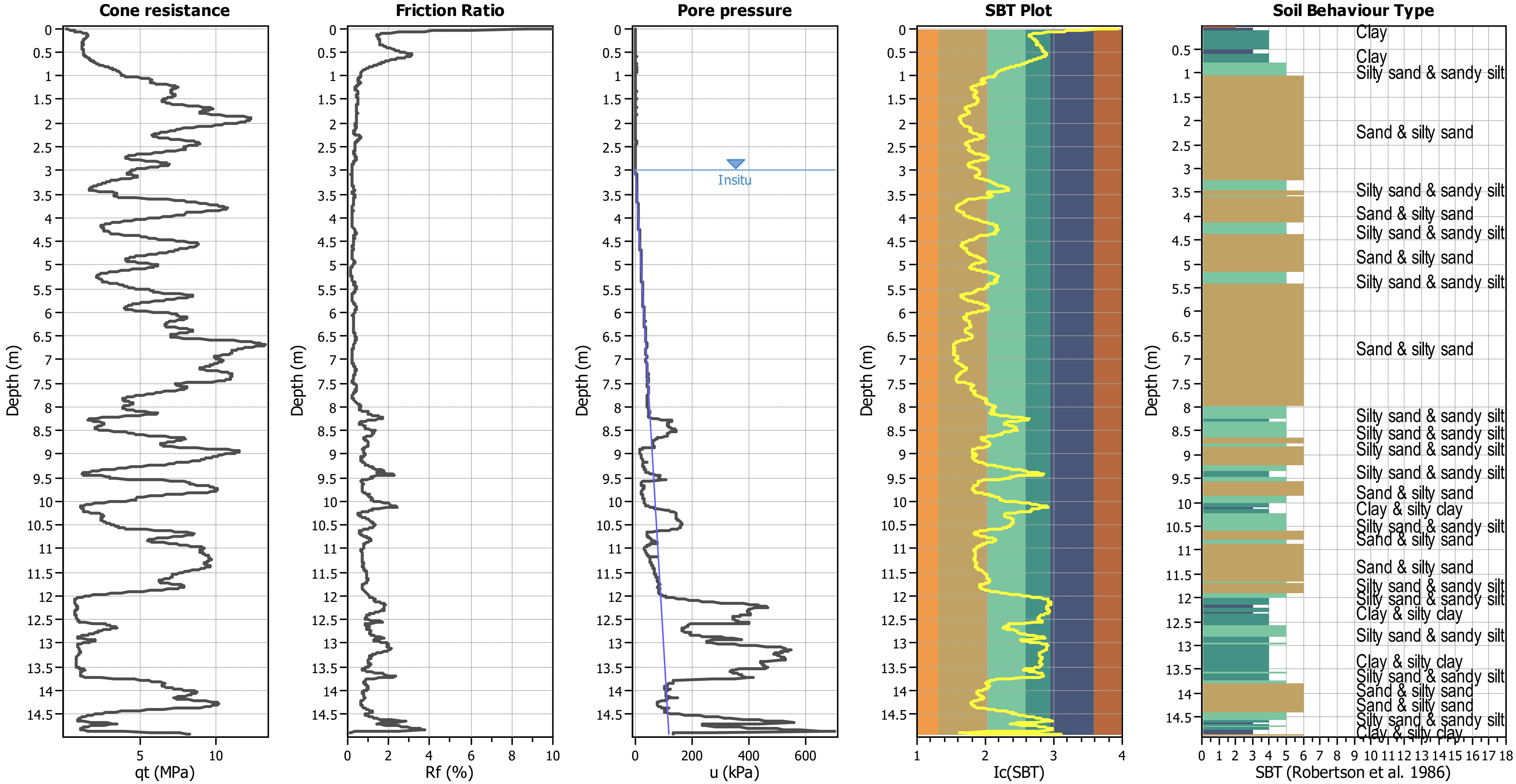
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



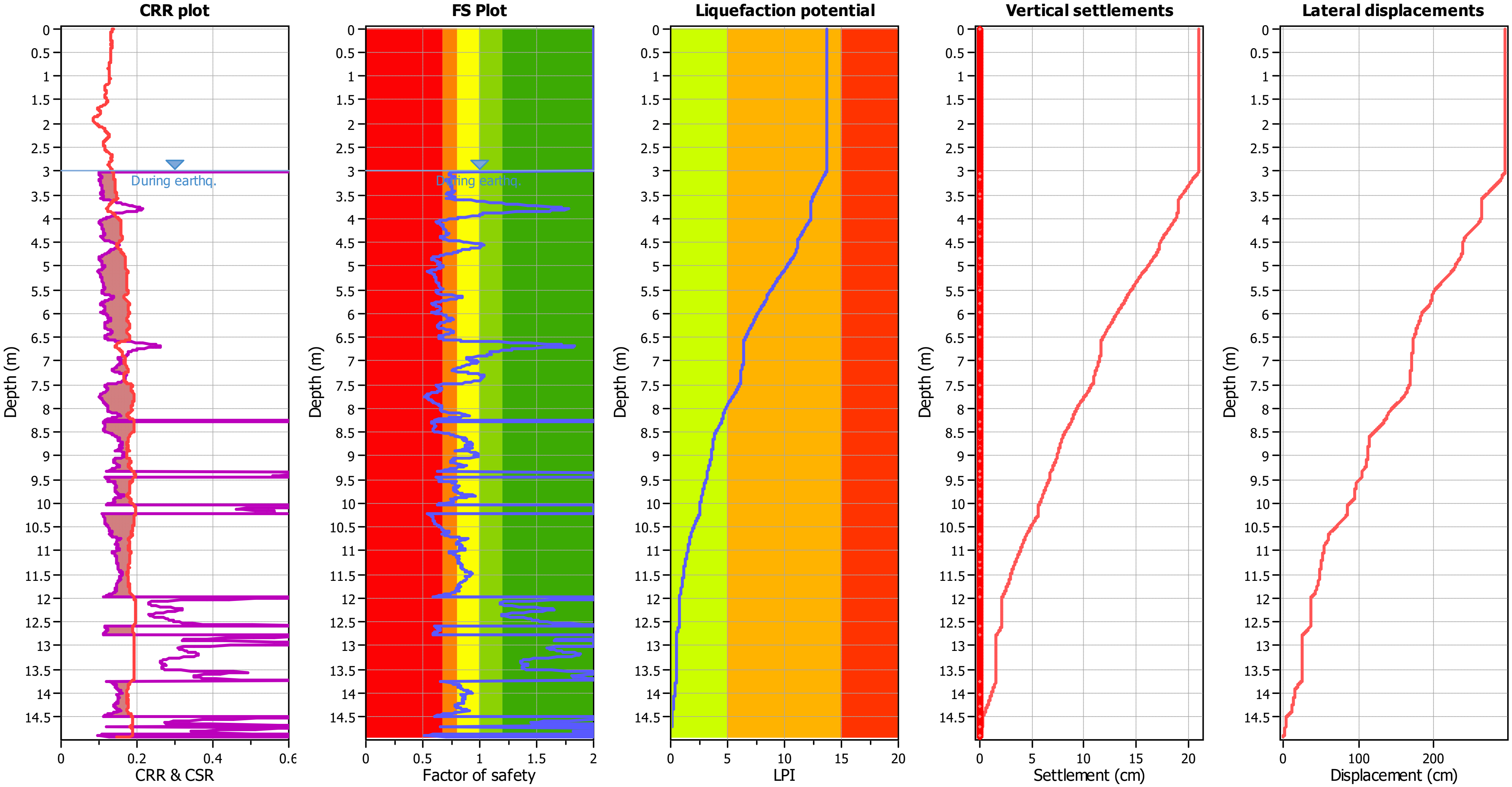
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

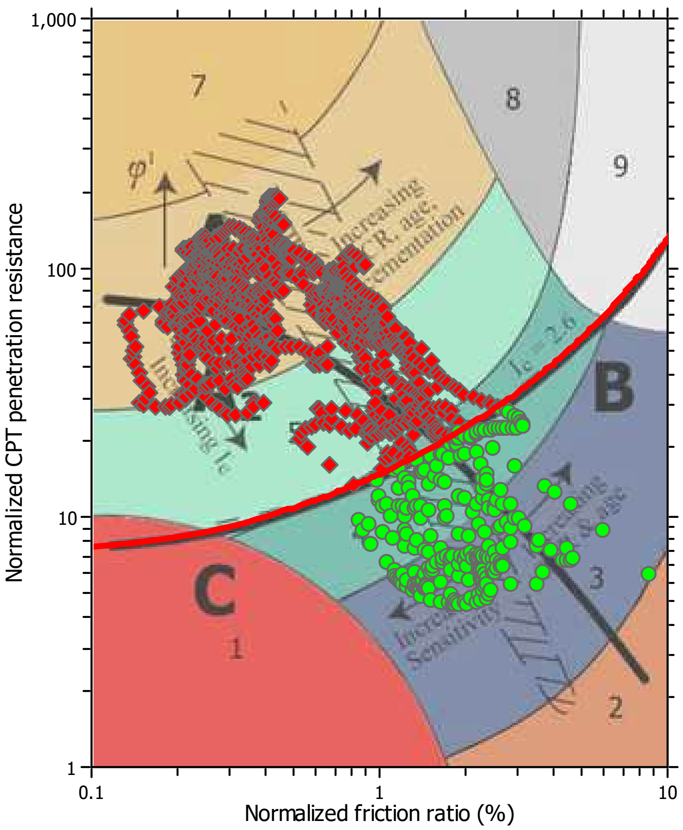
F.S. color scheme

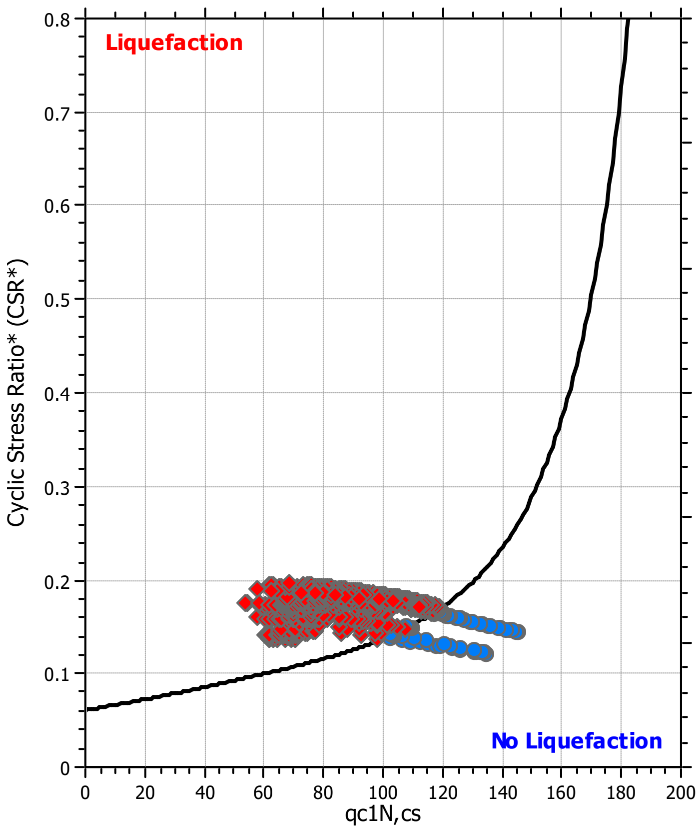
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

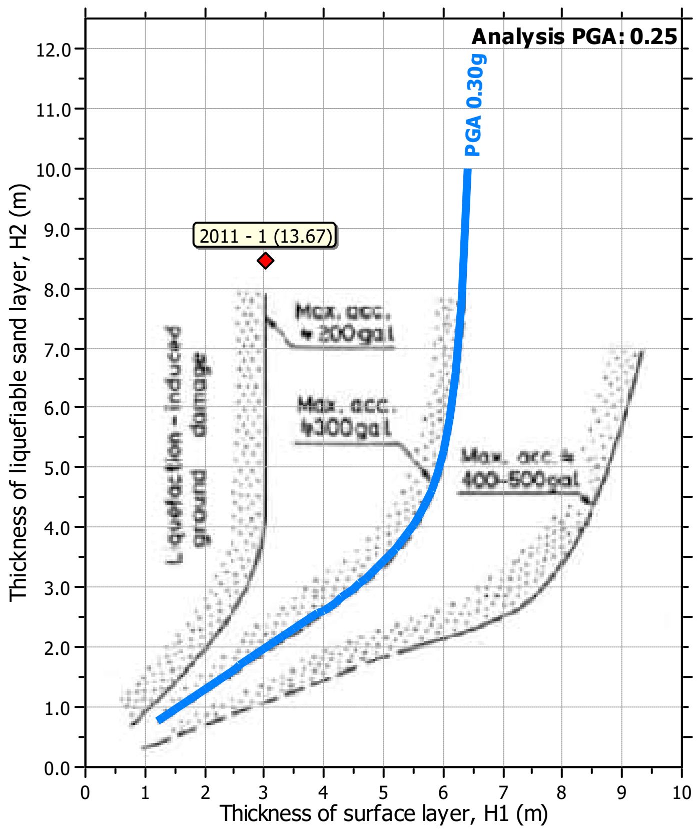
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



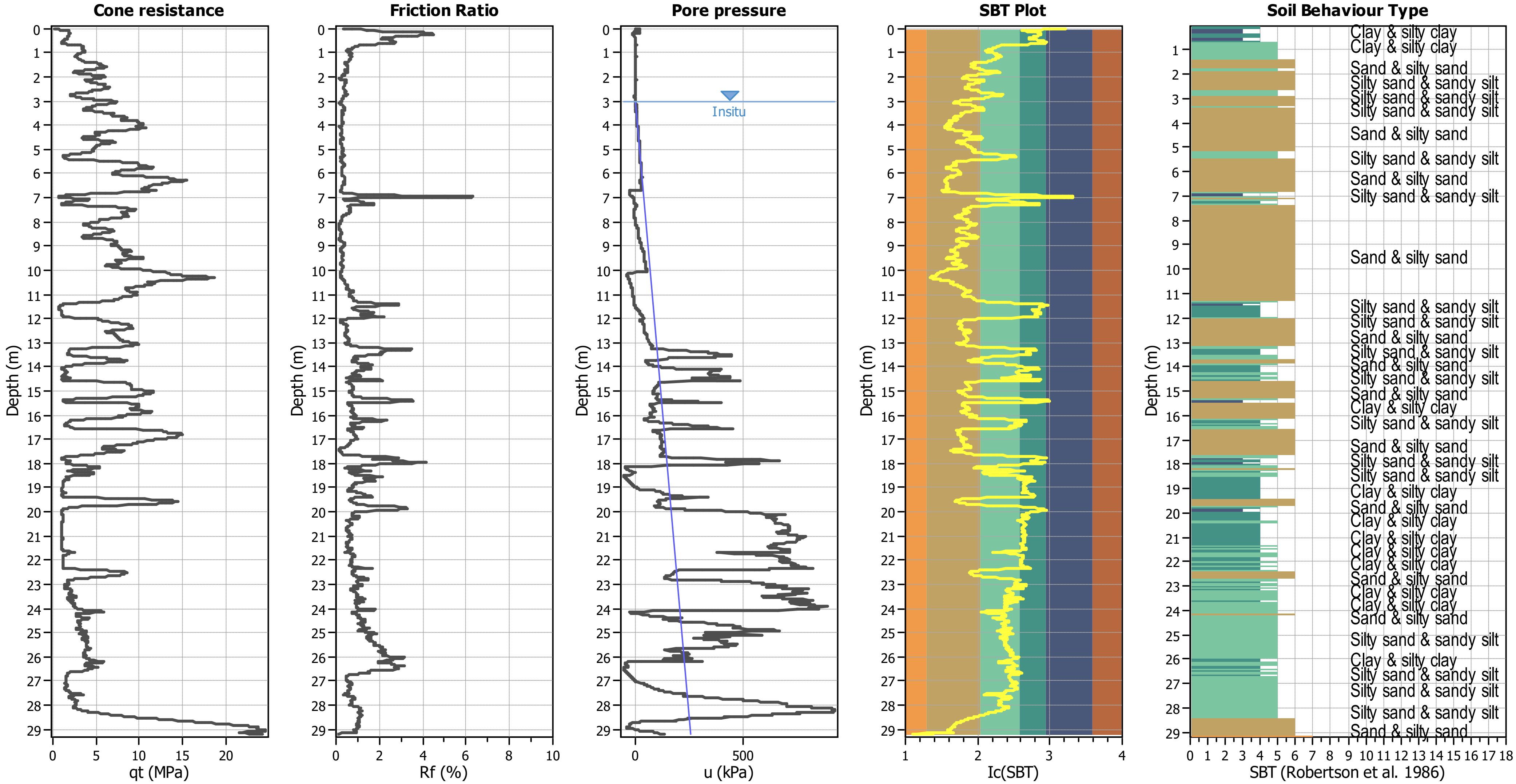




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



Input parameters and analysis data

Analysis method:	B&I (2014)
Fines correction method:	B&I (2014)
Points to test:	Based on Ic value
Earthquake magnitude M_w:	5.90
Peak ground acceleration:	0.25
Depth to water table (insitu):	3.00 m

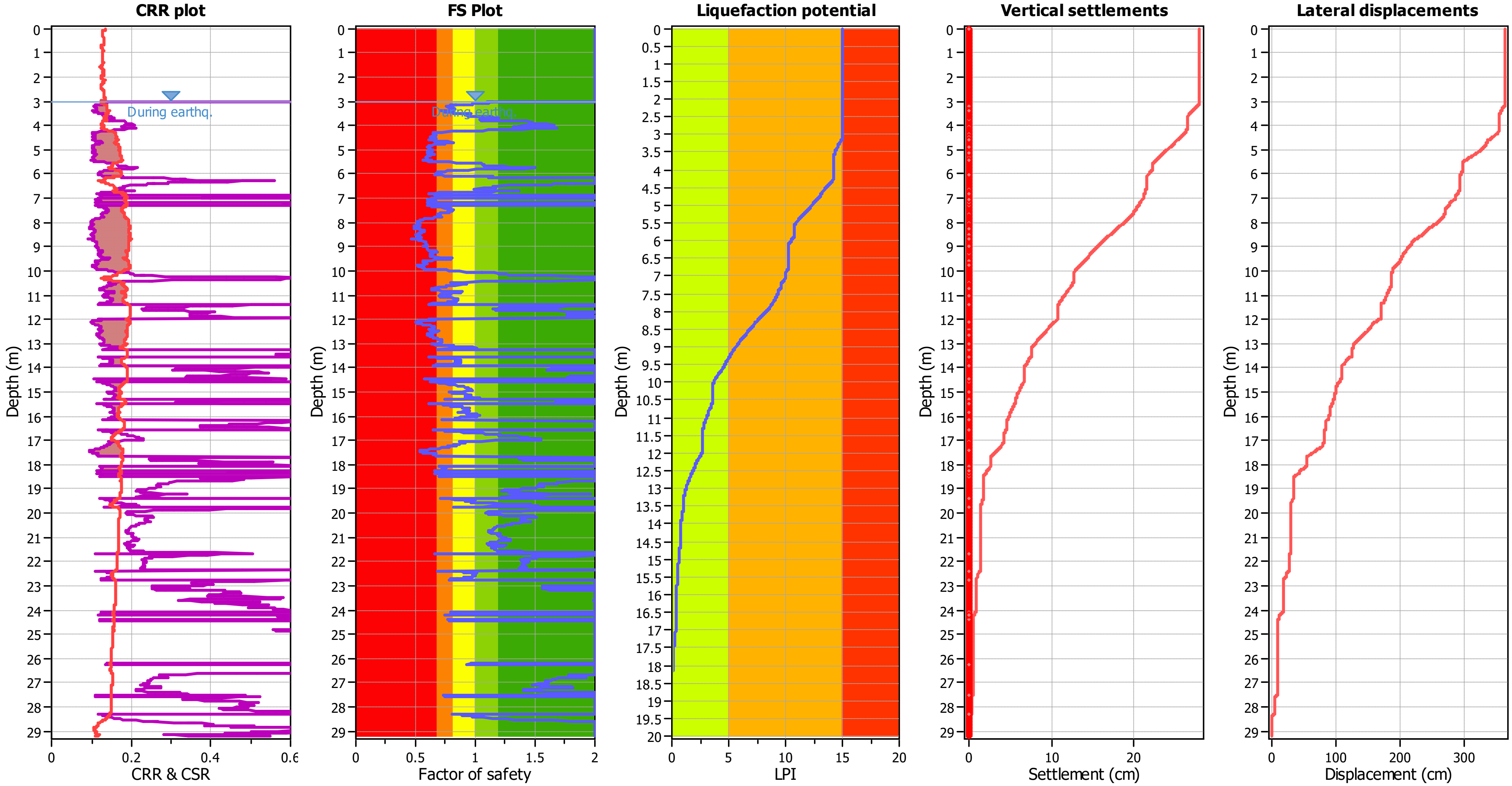
Depth to GWT (erthq.):	3.00 m
Average results interval:	3
Ic cut-off value:	2.60
Unit weight calculation:	Based on SBT
Use fill:	No
Fill height:	N/A

Fill weight:	N/A
Transition detect. applied:	No
K_σ applied:	Yes
Clay like behavior applied:	Sand & Clay
Limit depth applied:	No
Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

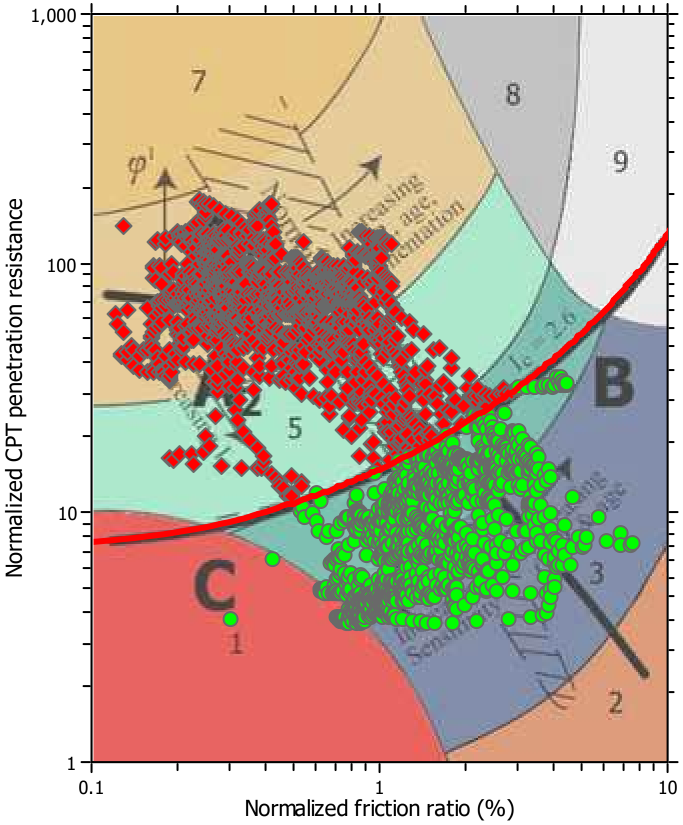
F.S. color scheme

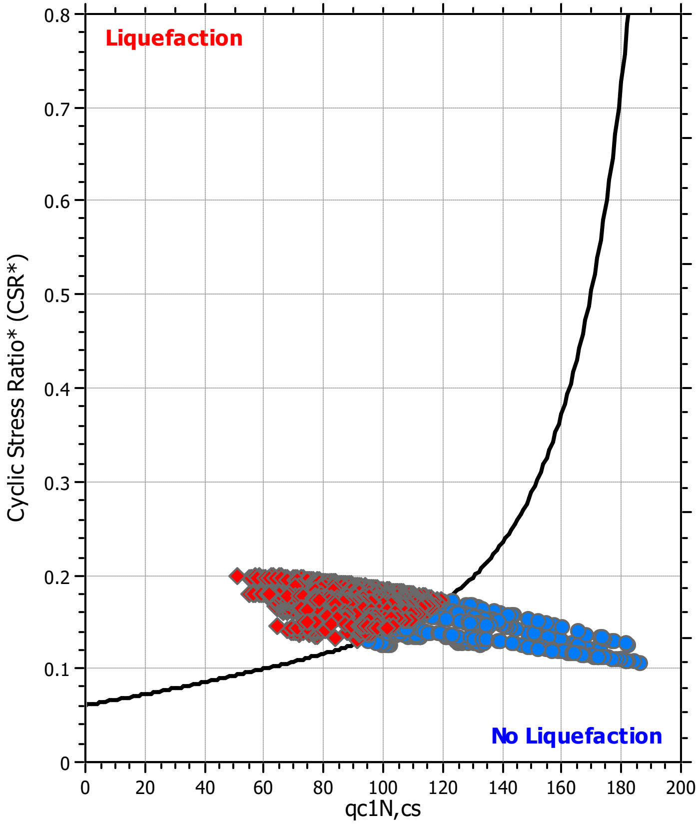
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

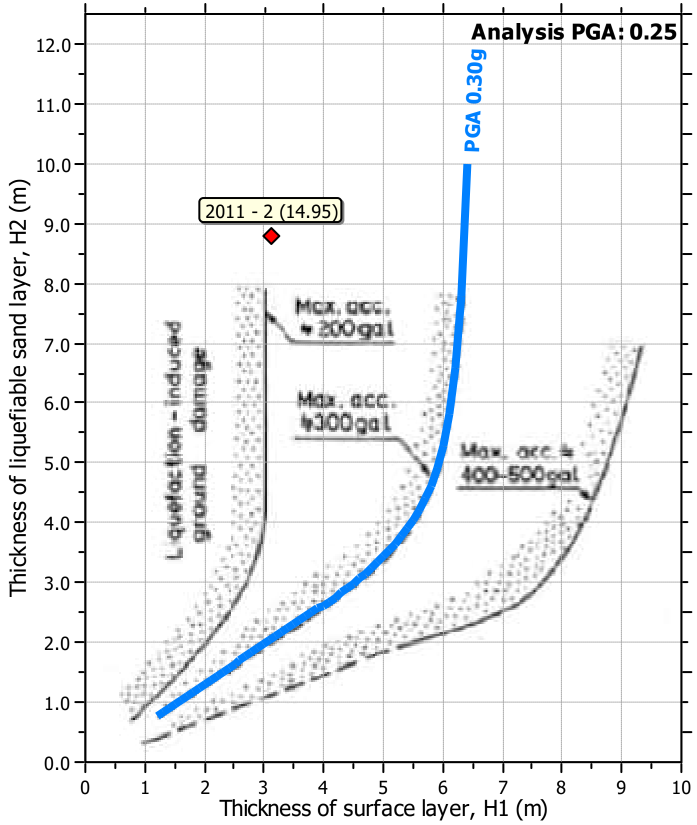
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



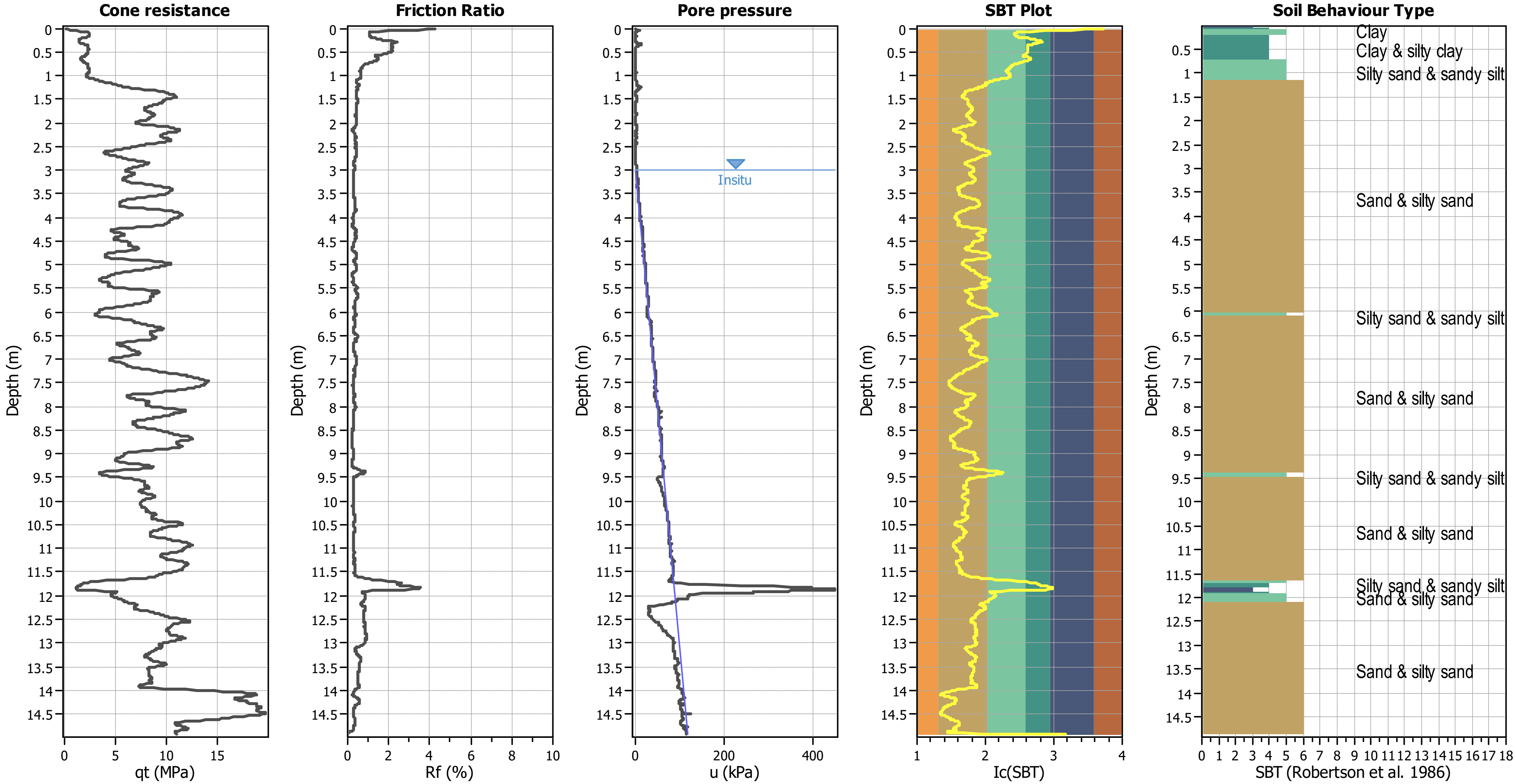




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



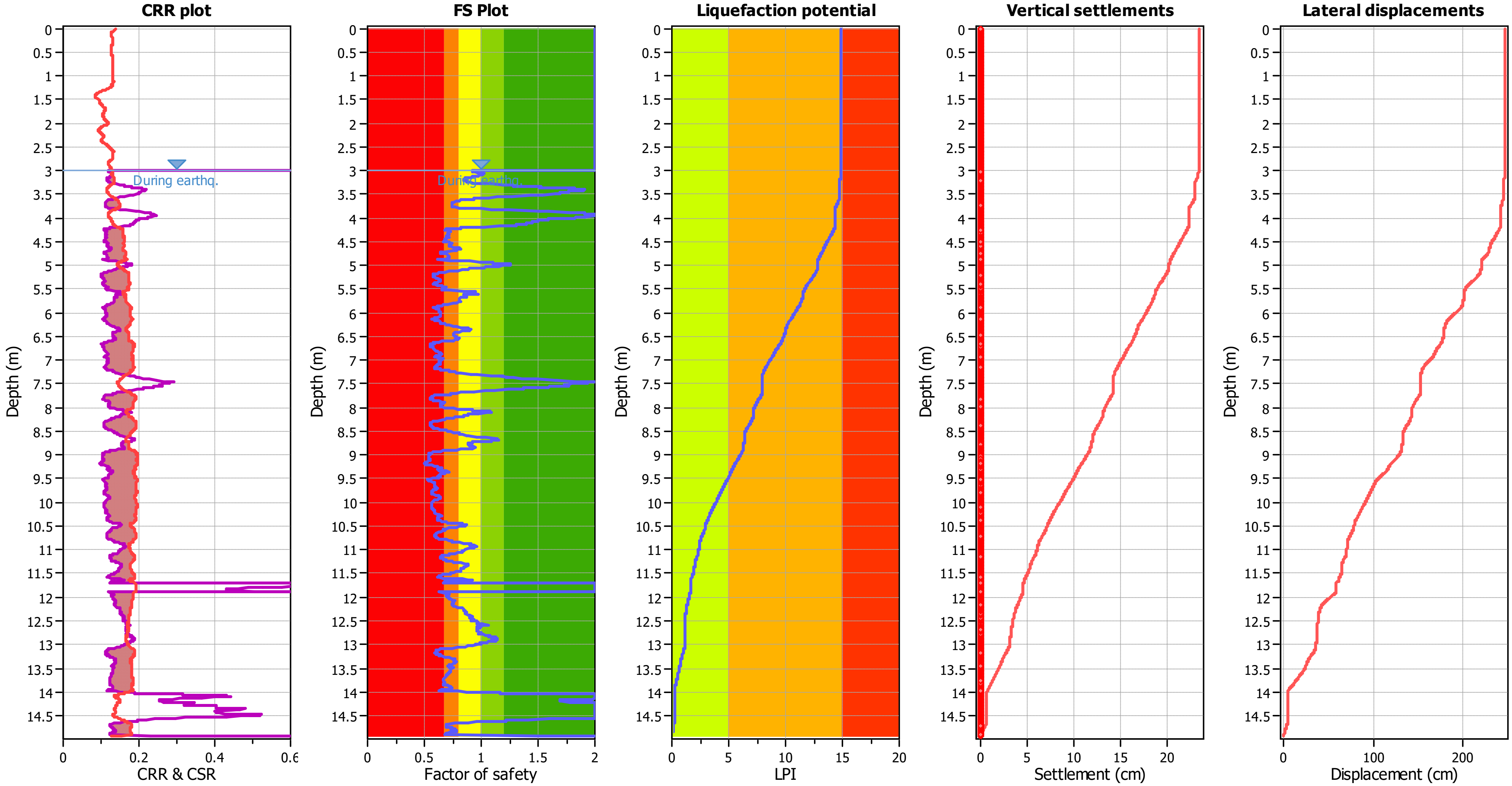
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

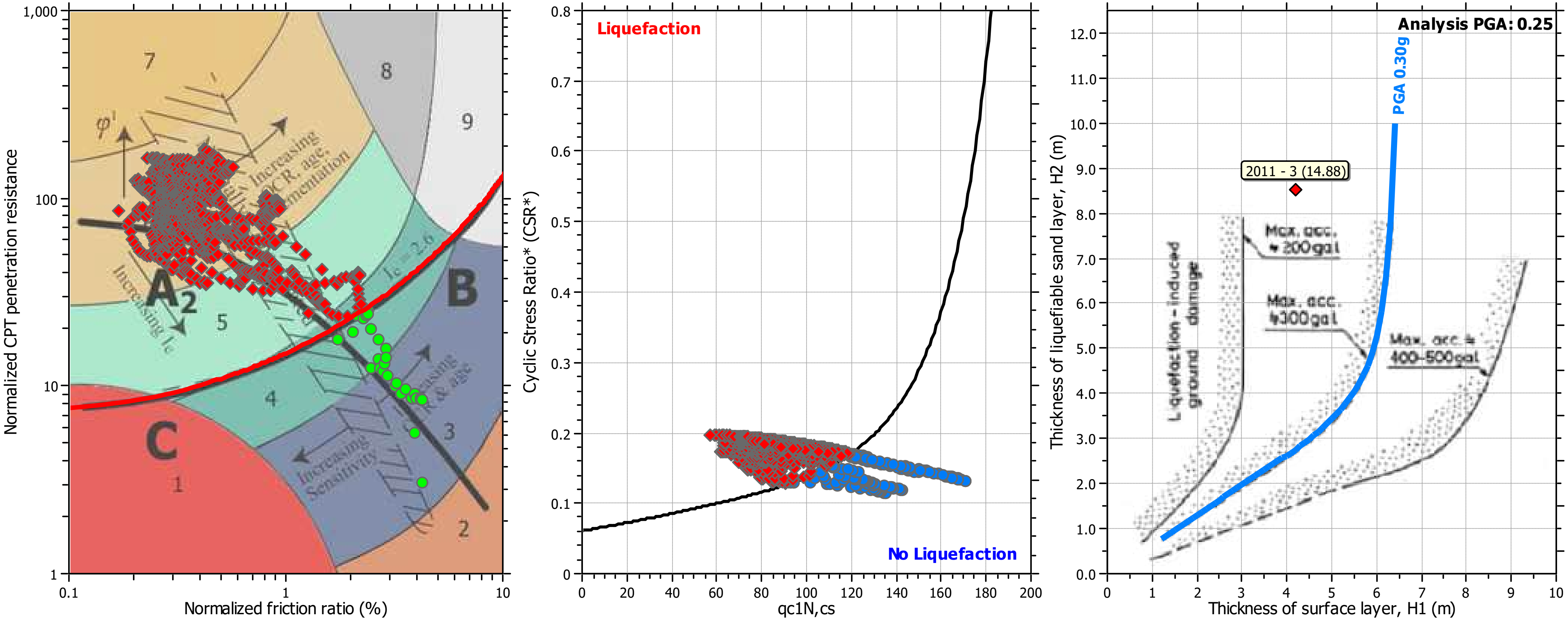
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

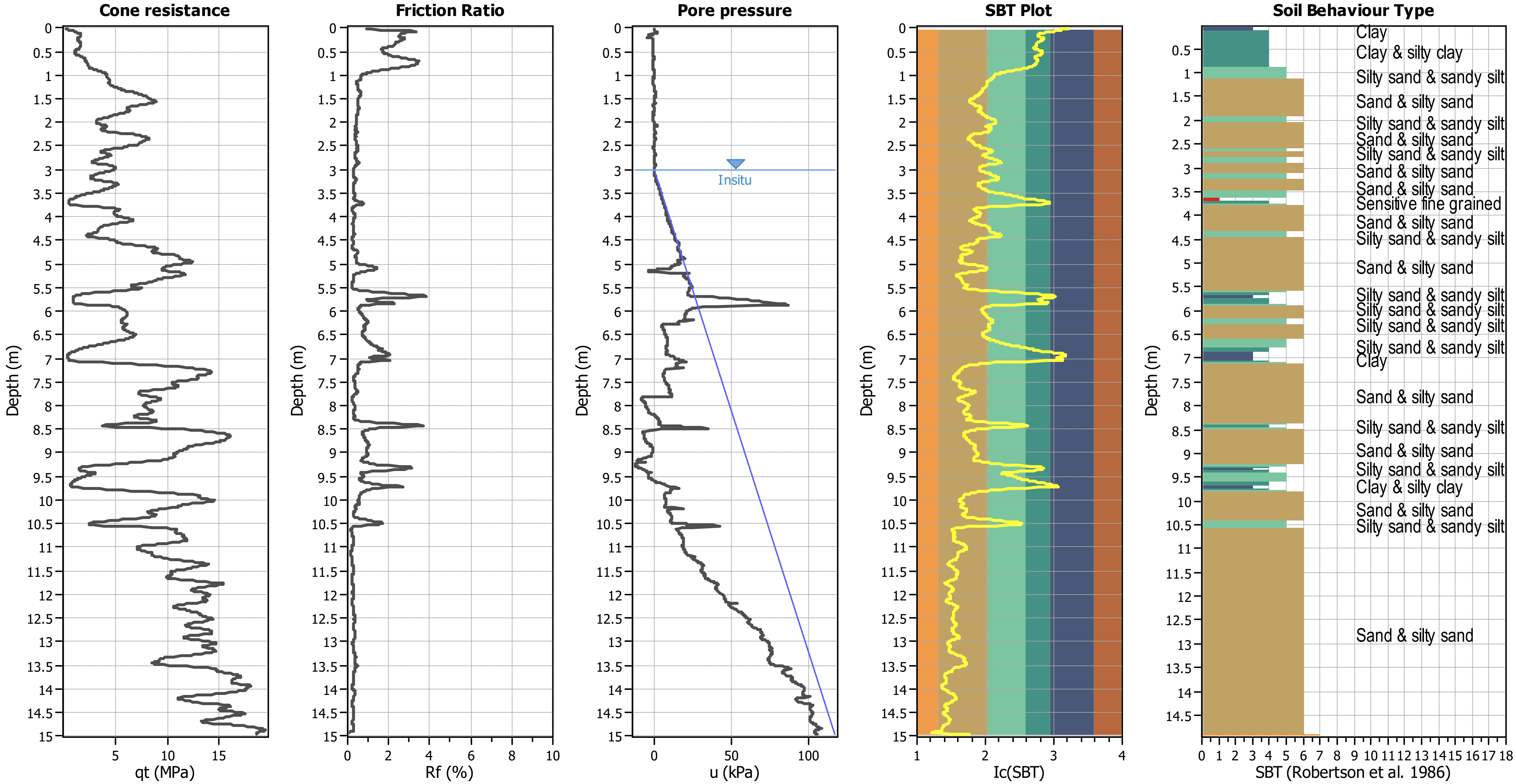
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



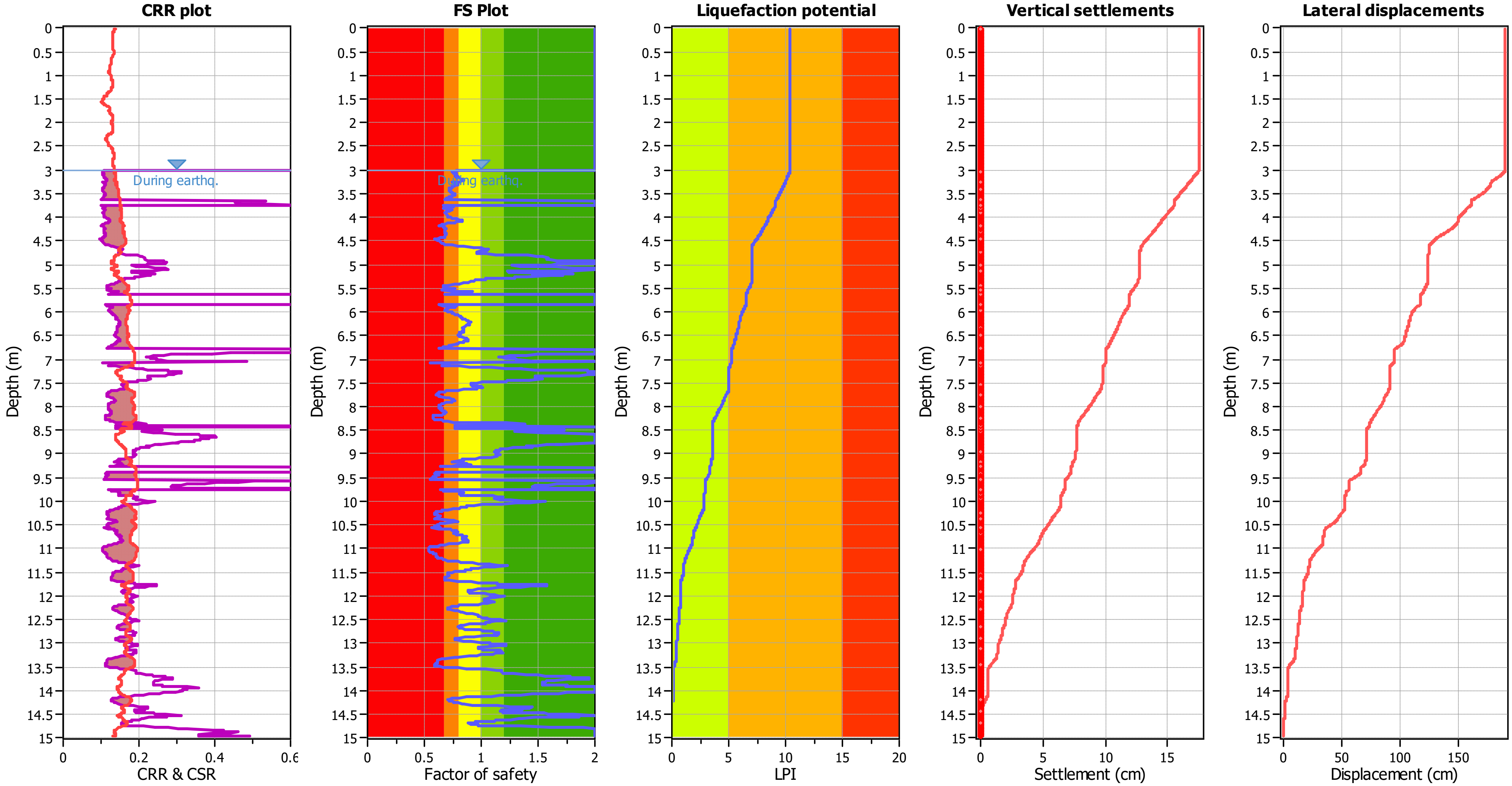
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

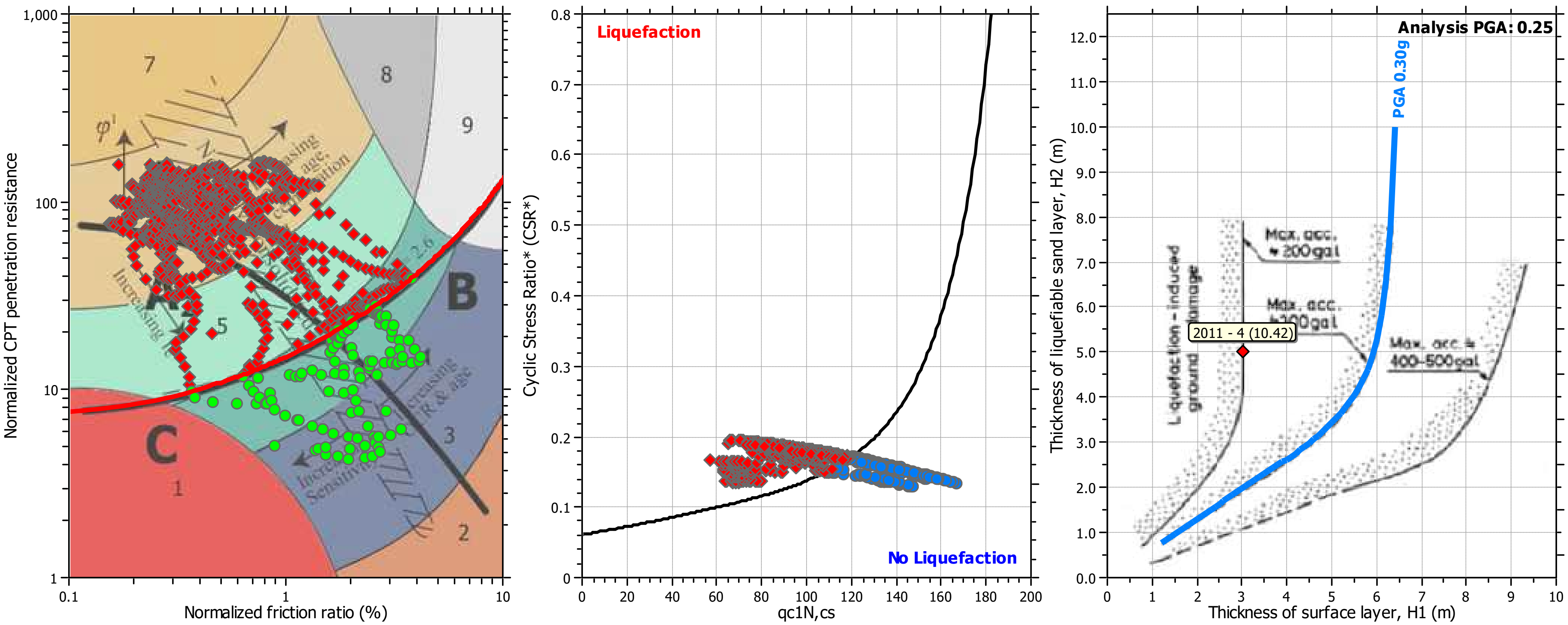
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
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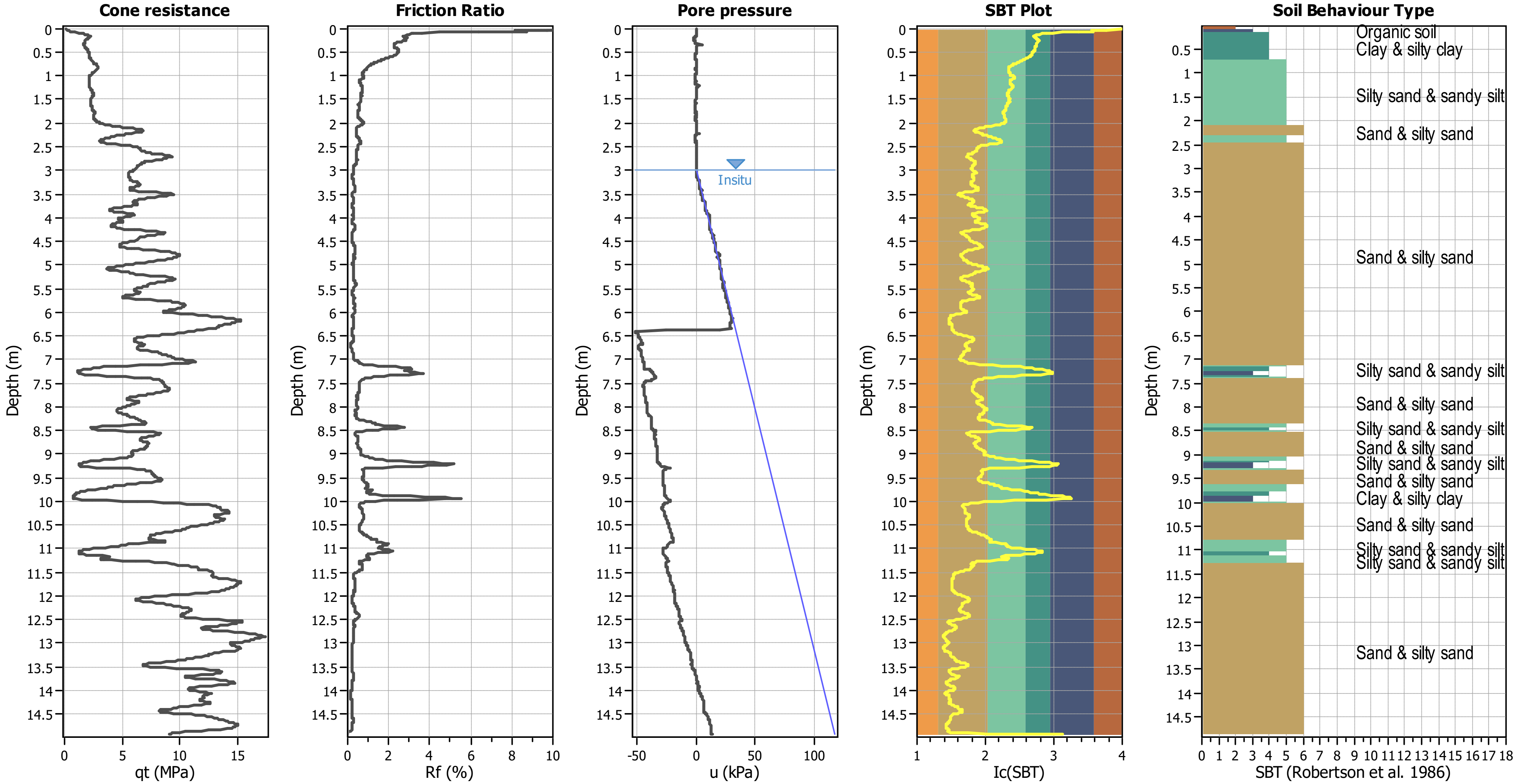
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



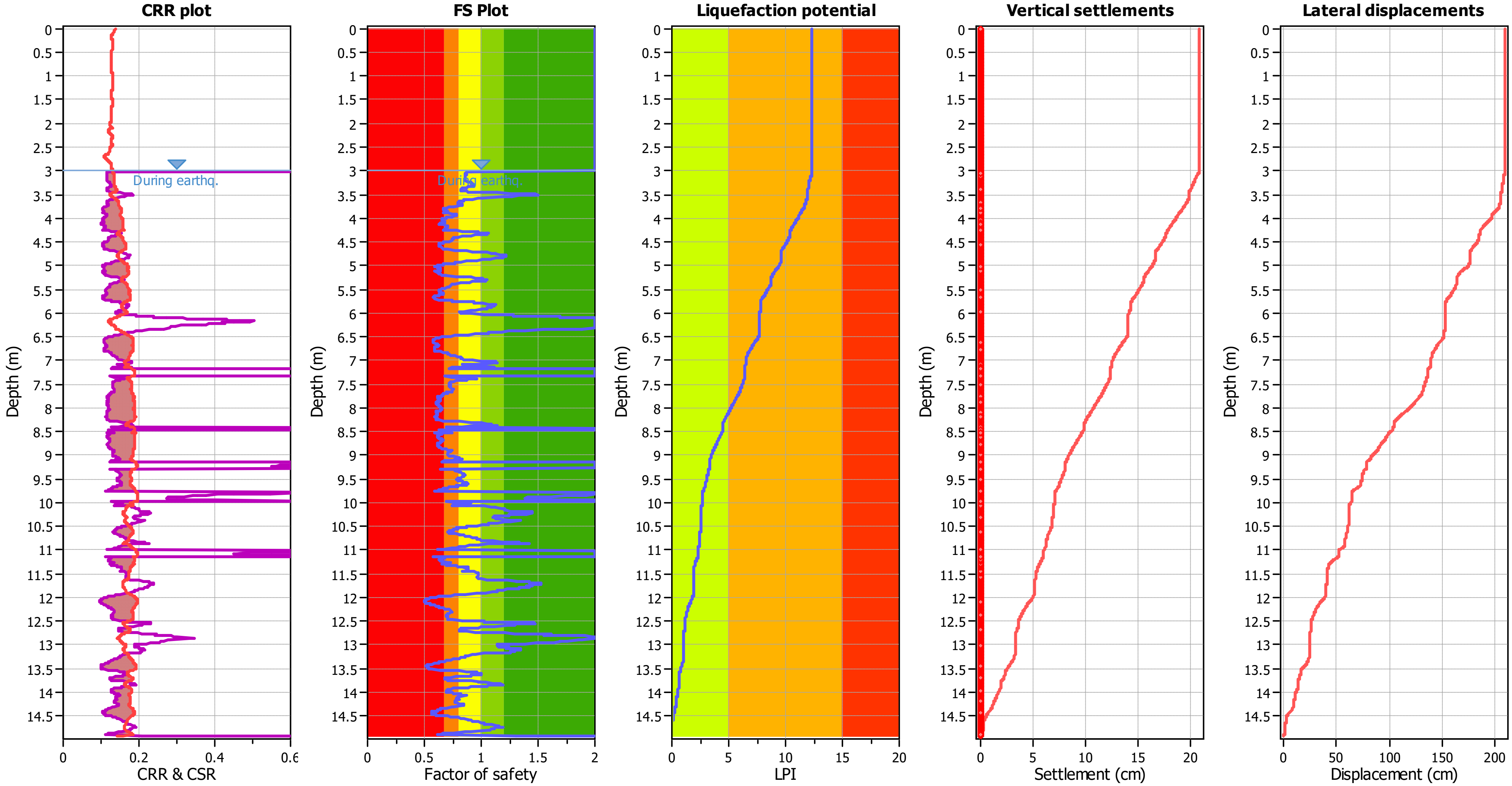
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

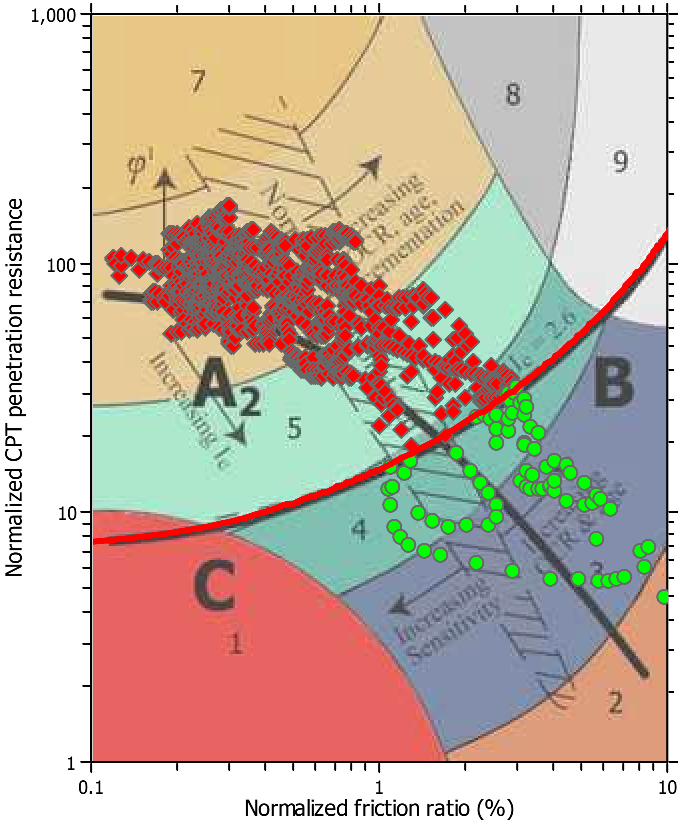
F.S. color scheme

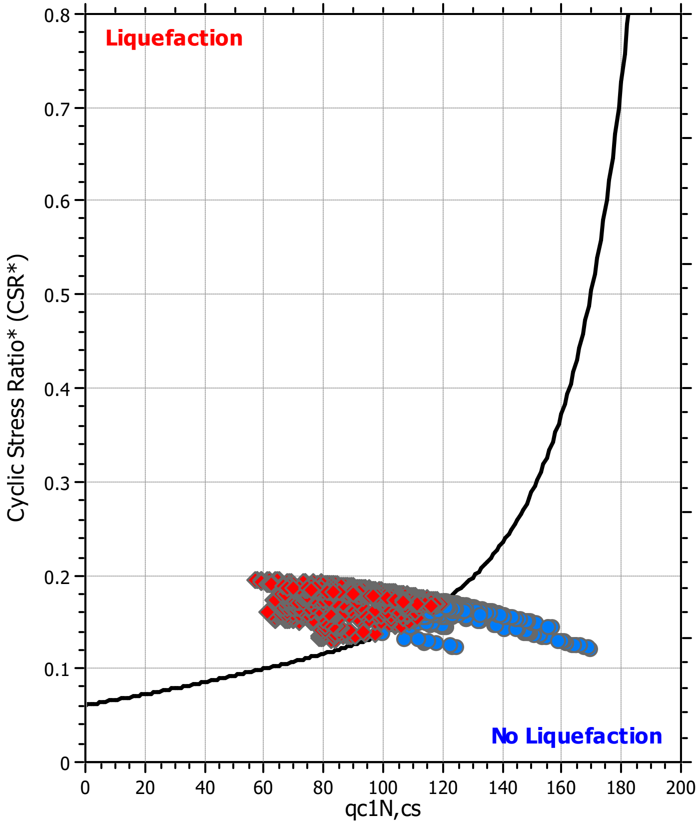
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

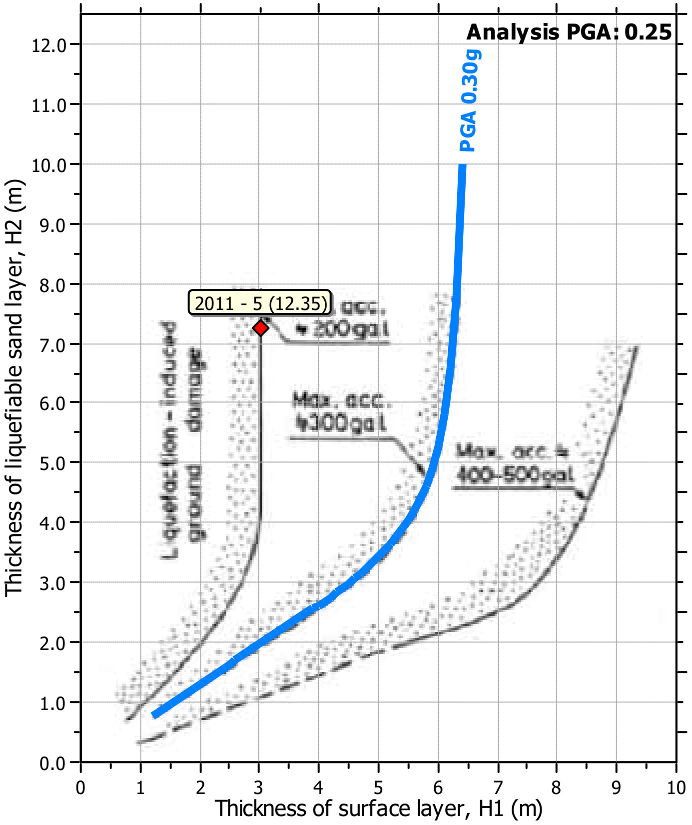
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



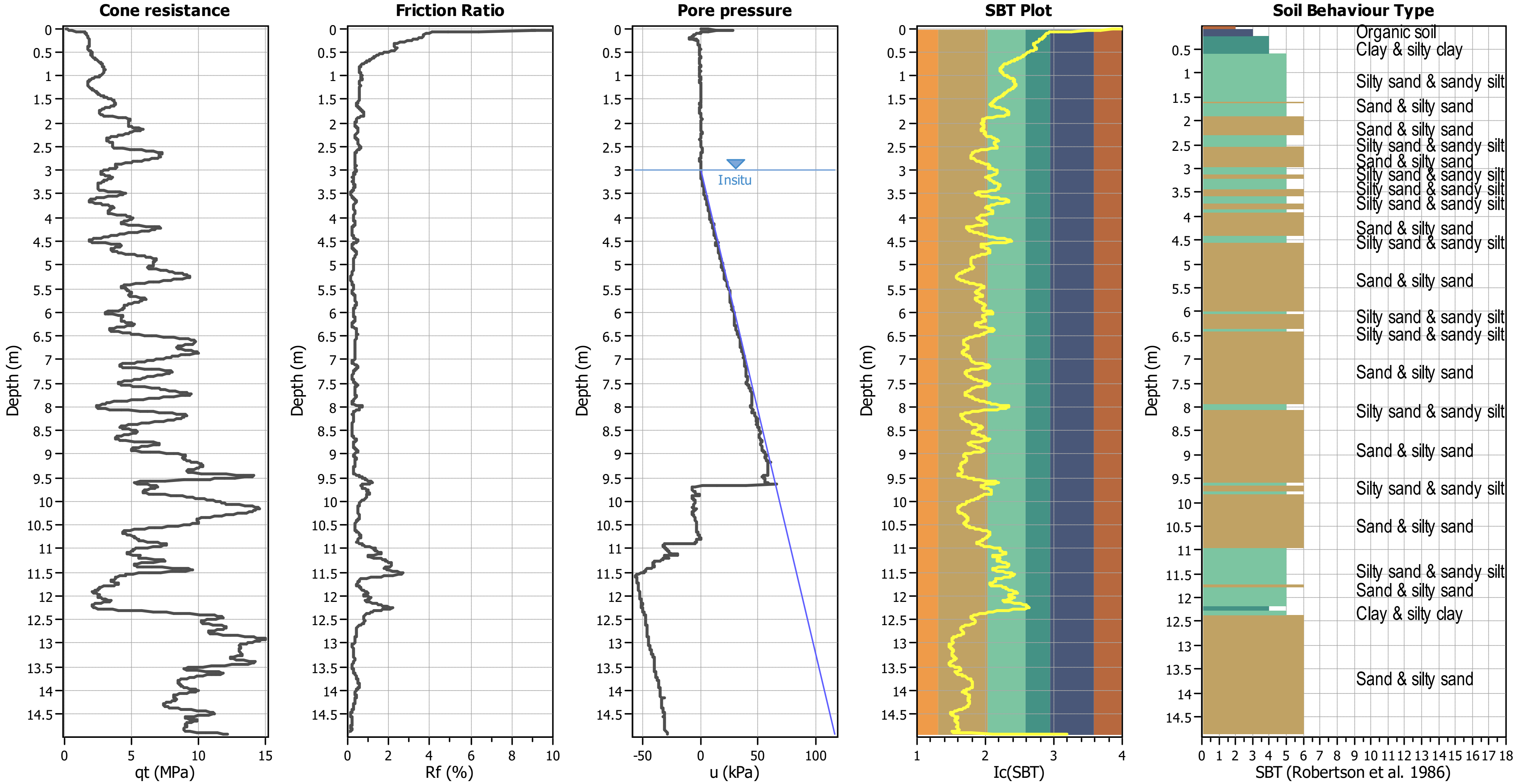




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



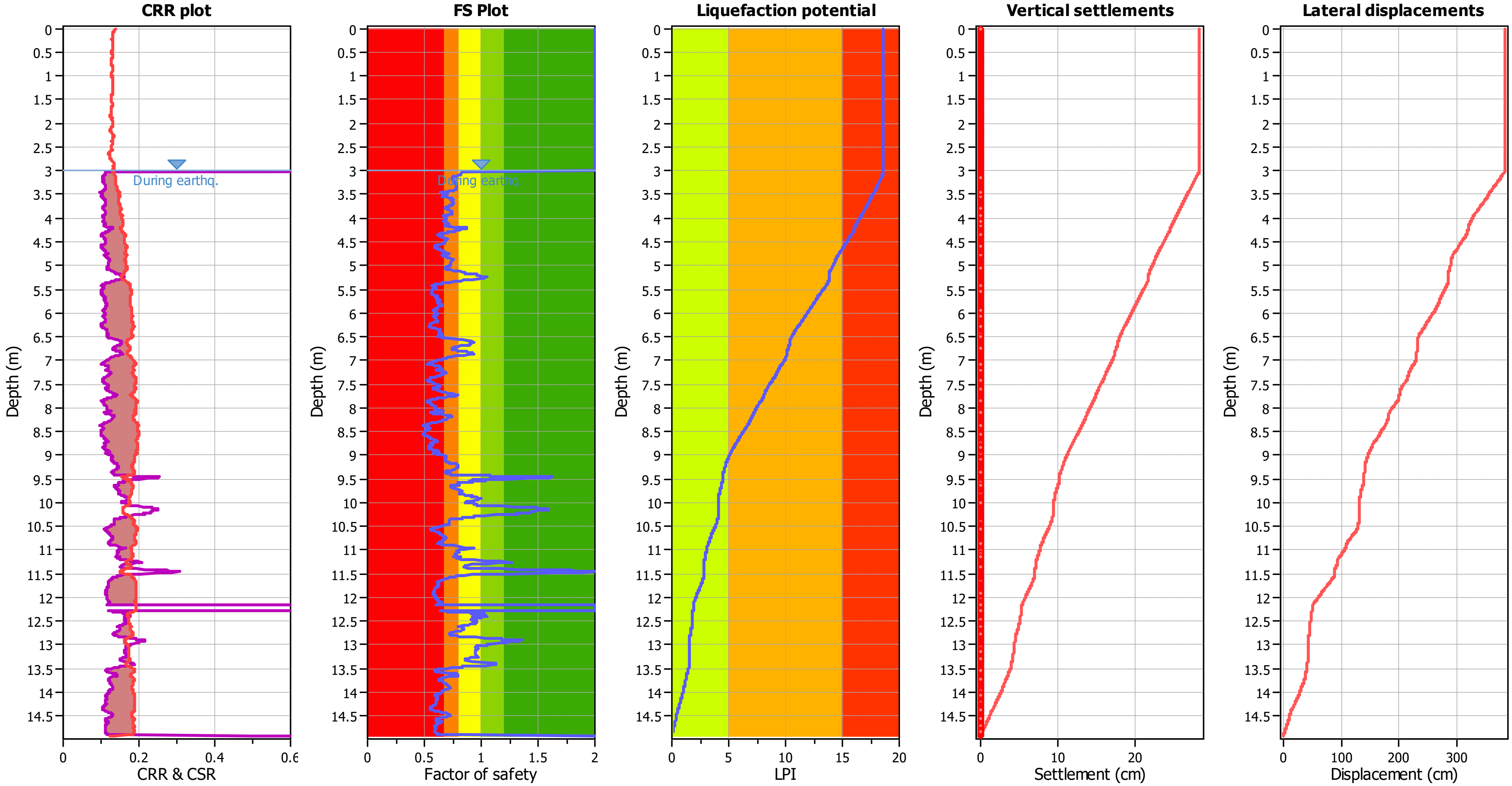
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

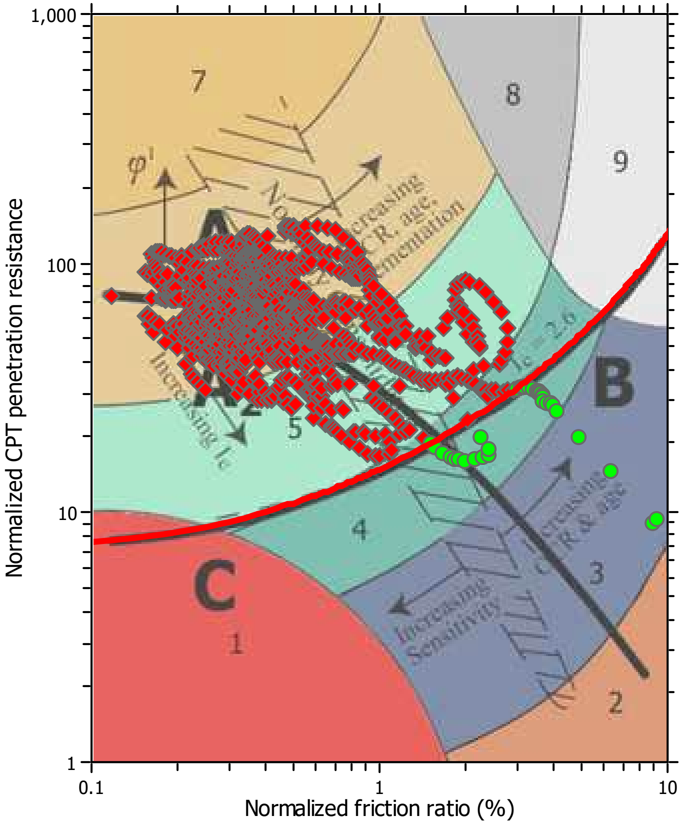
F.S. color scheme

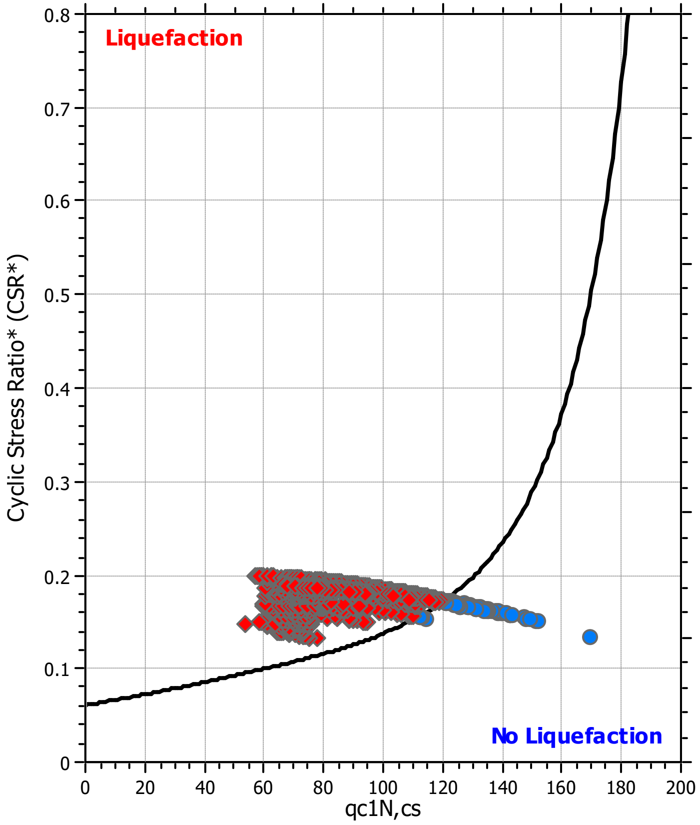
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

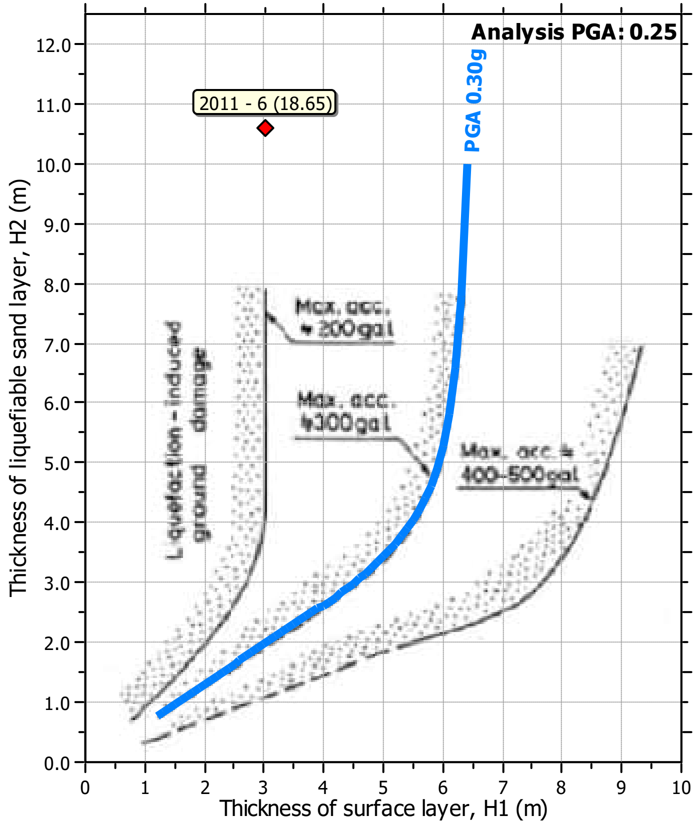
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



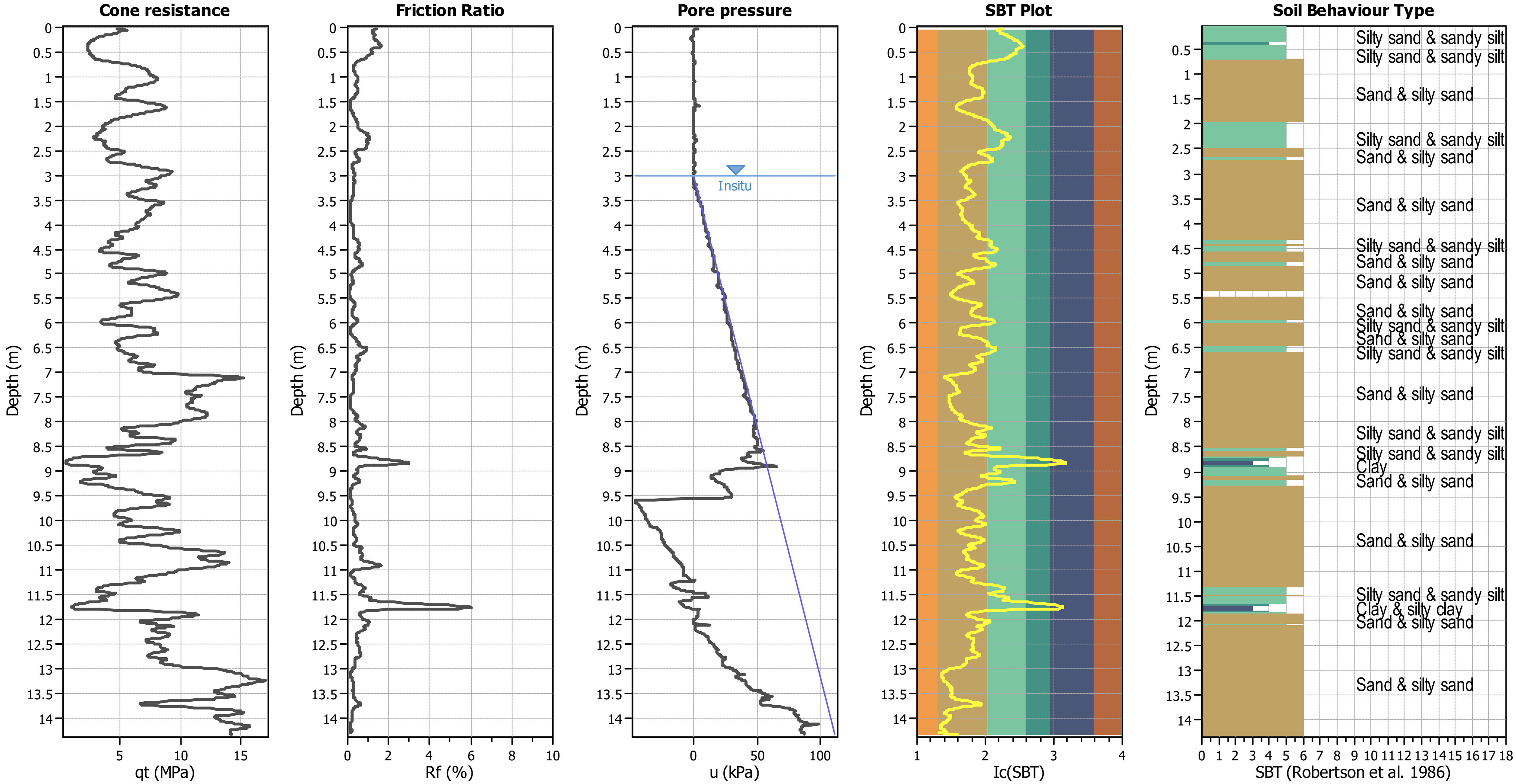




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



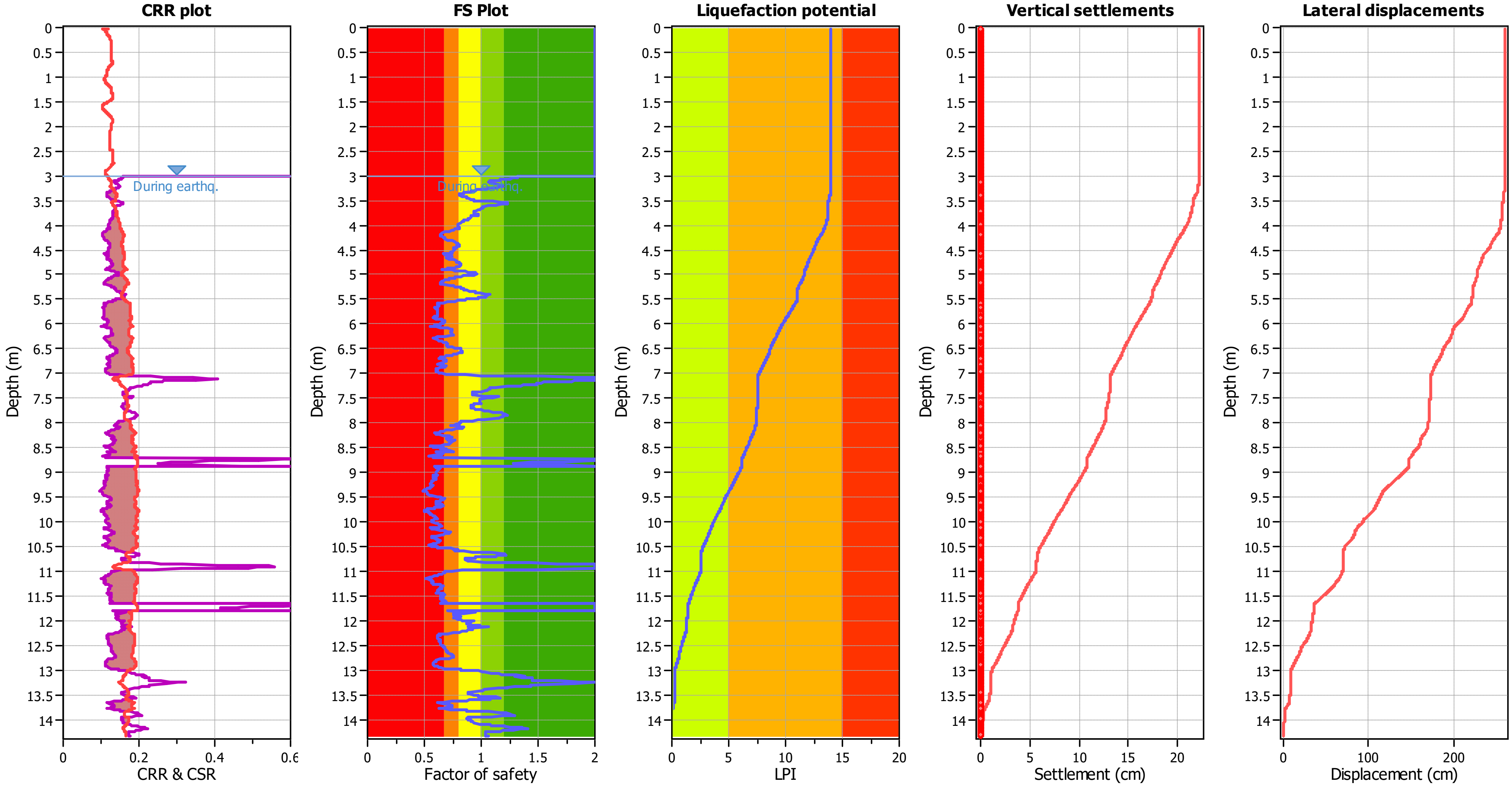
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

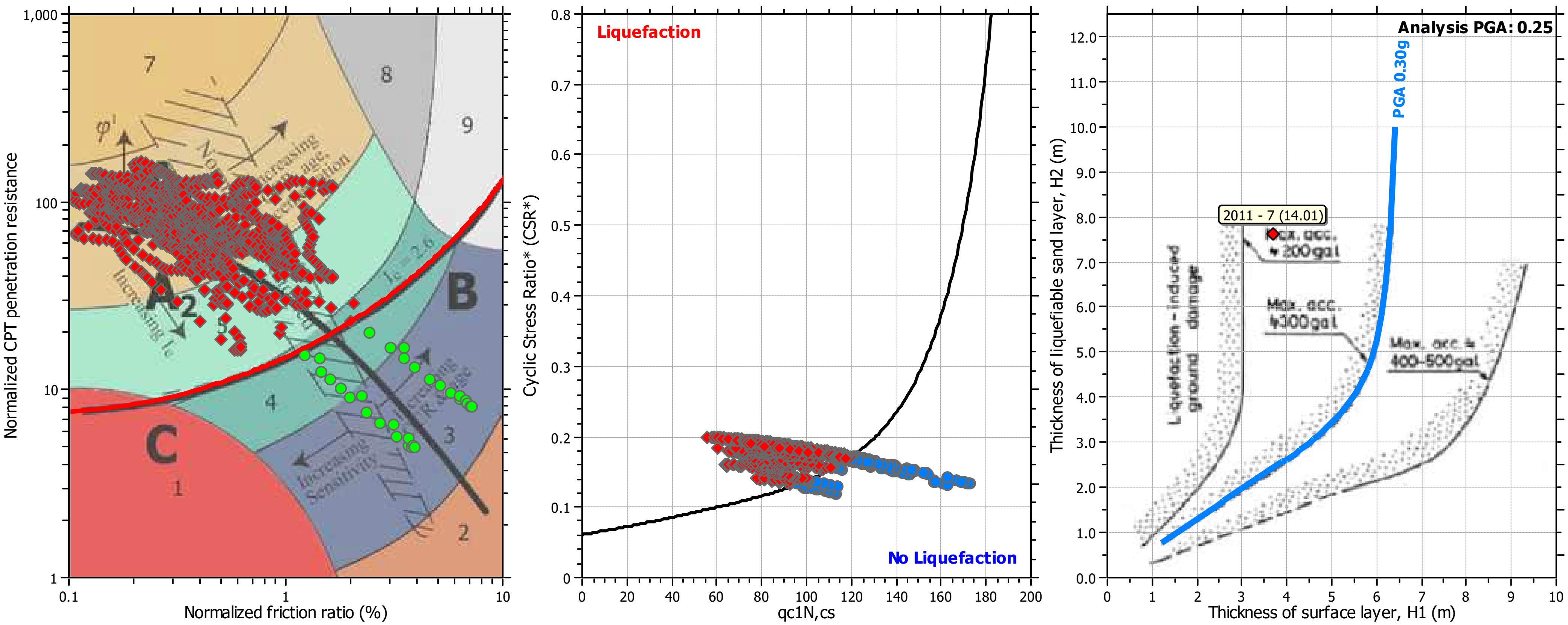
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

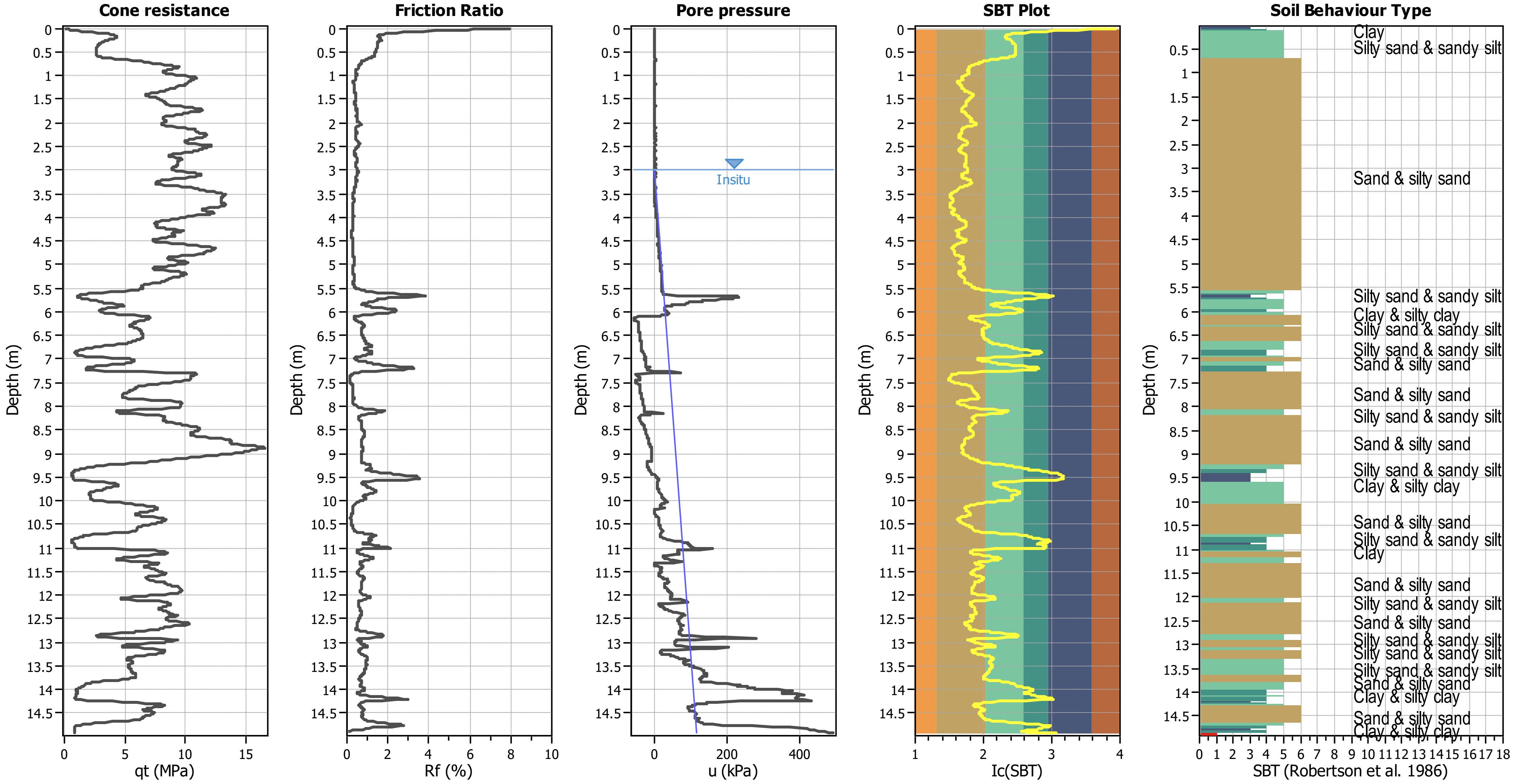
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



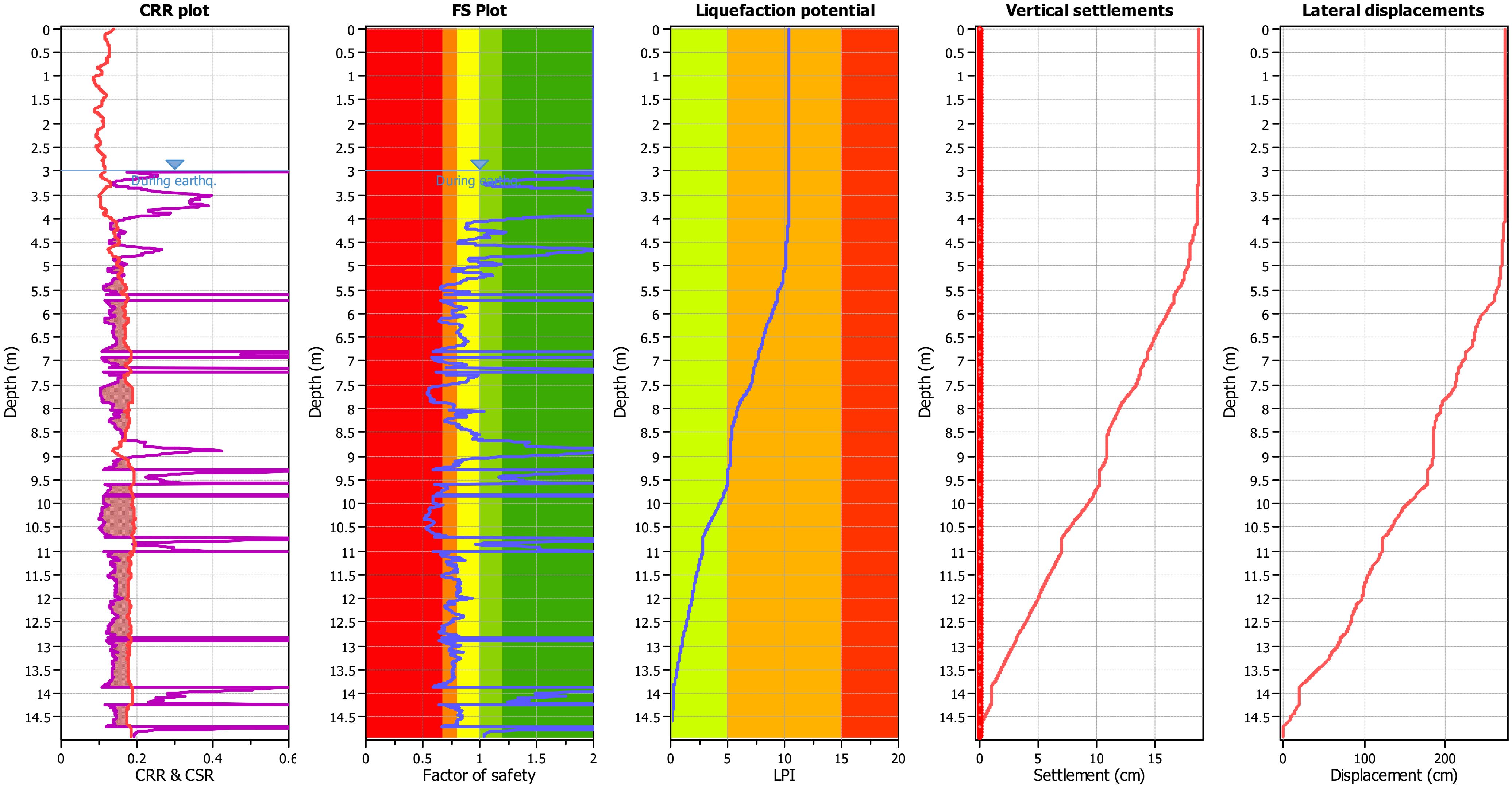
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

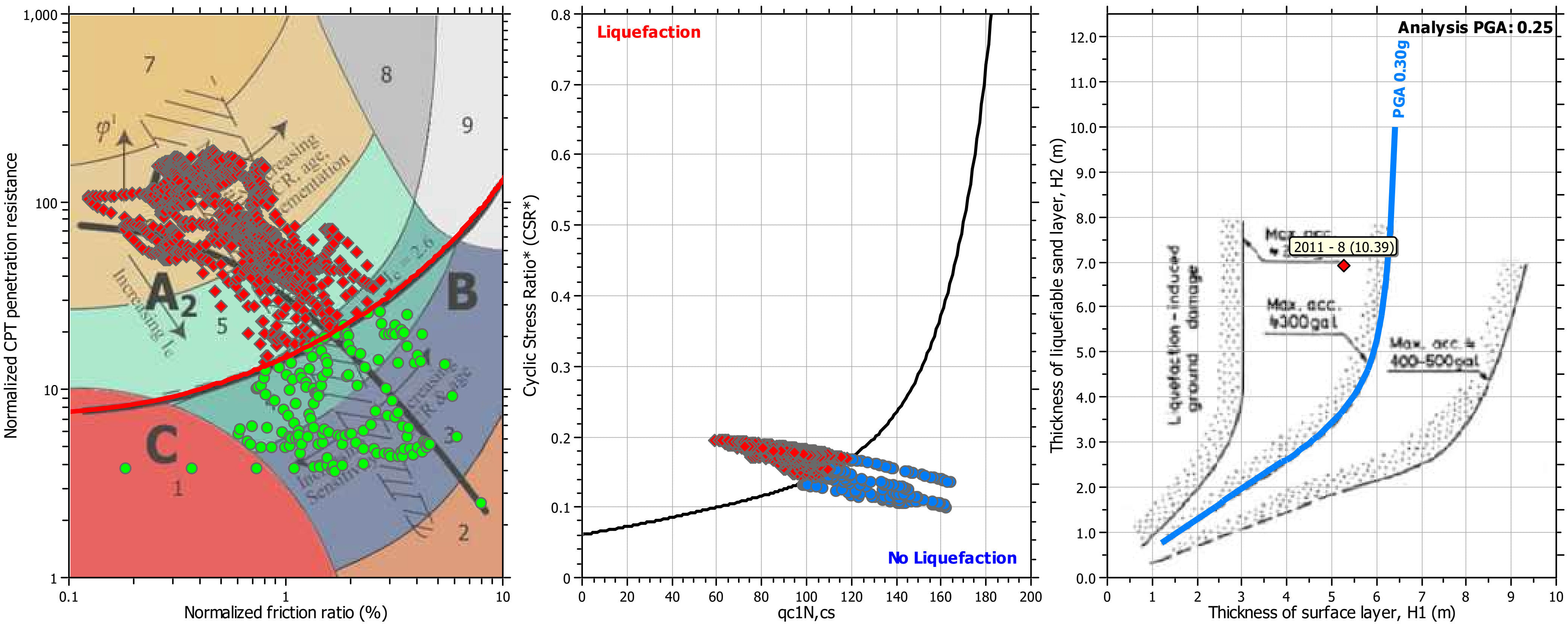
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

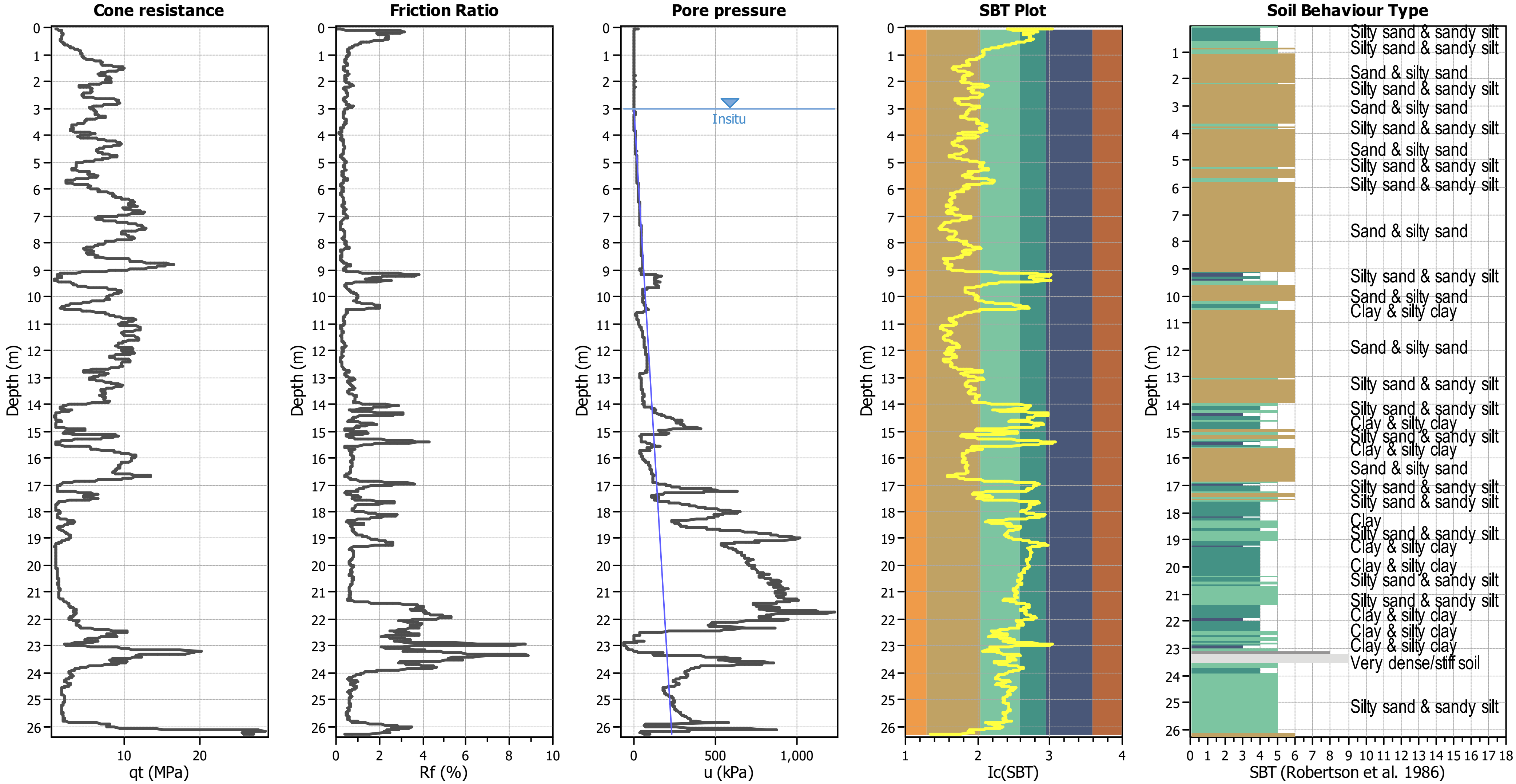
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



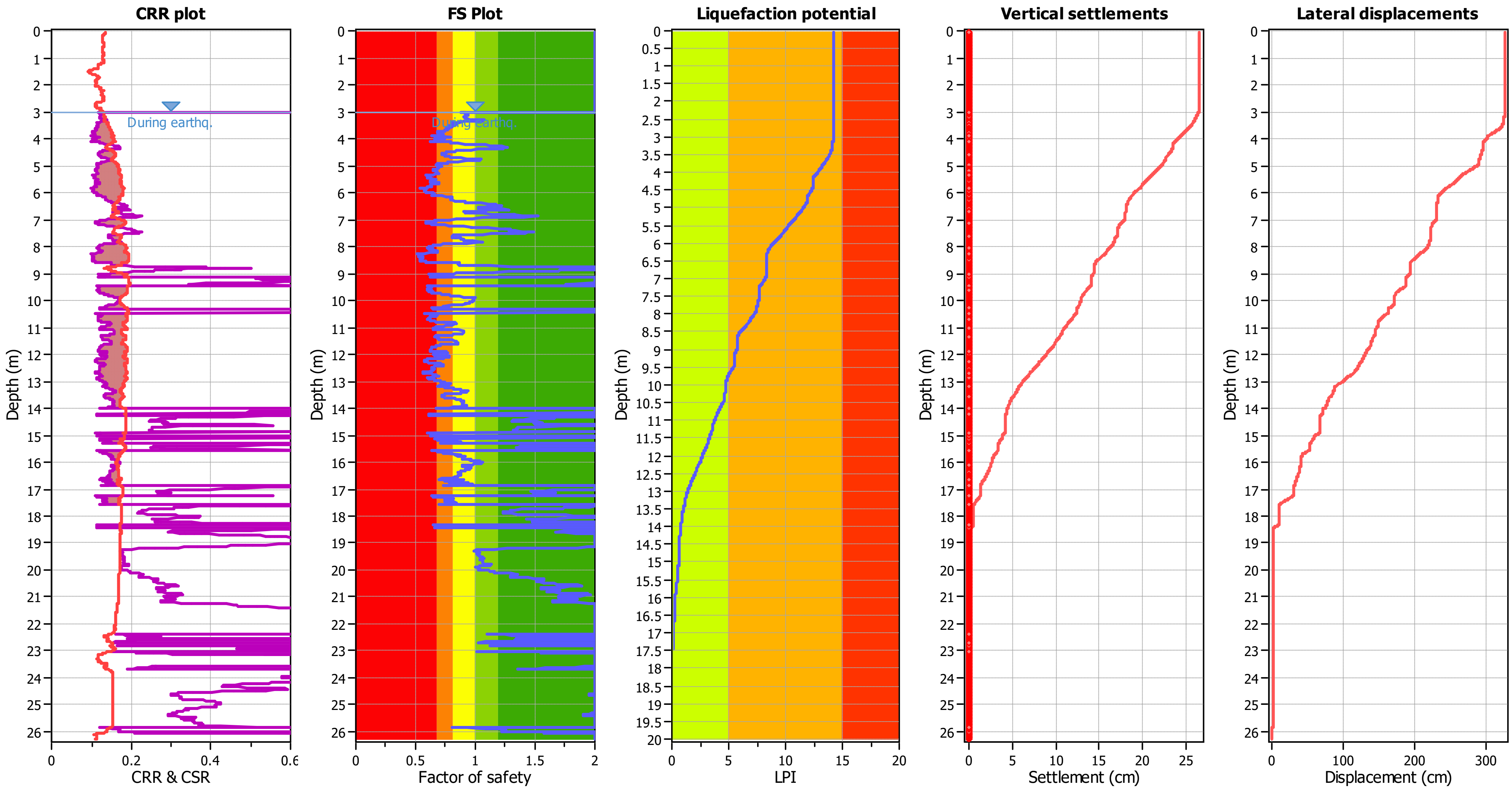
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

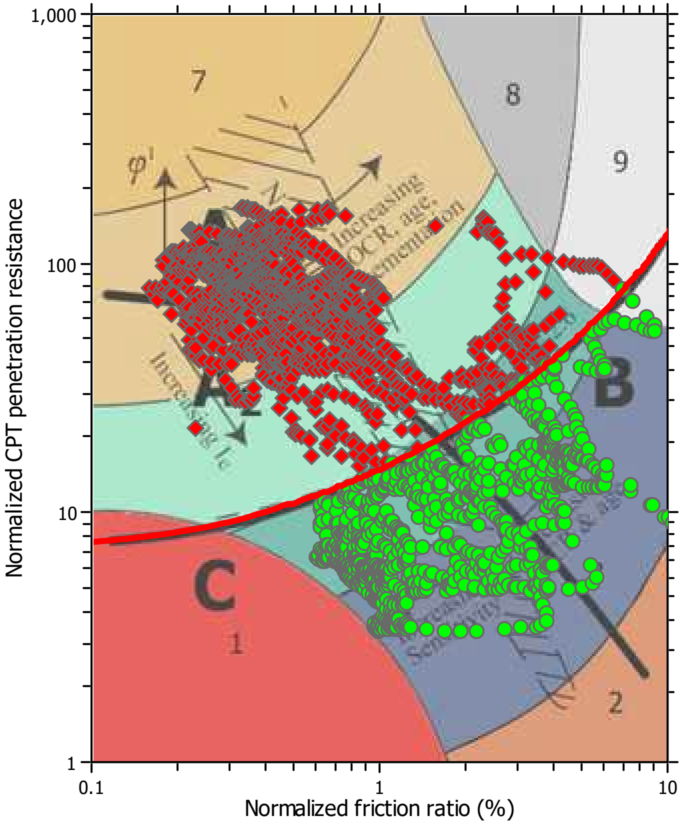
F.S. color scheme

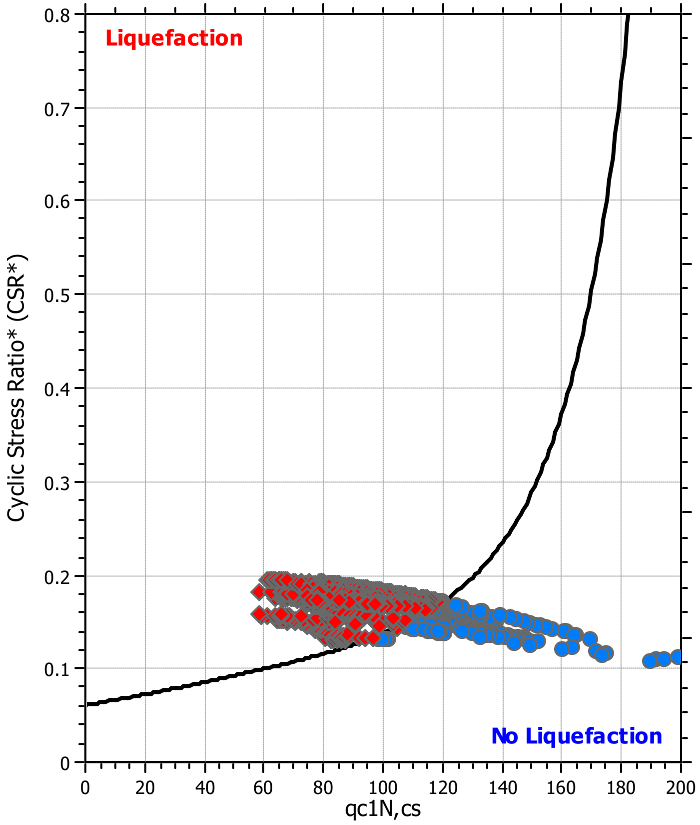
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

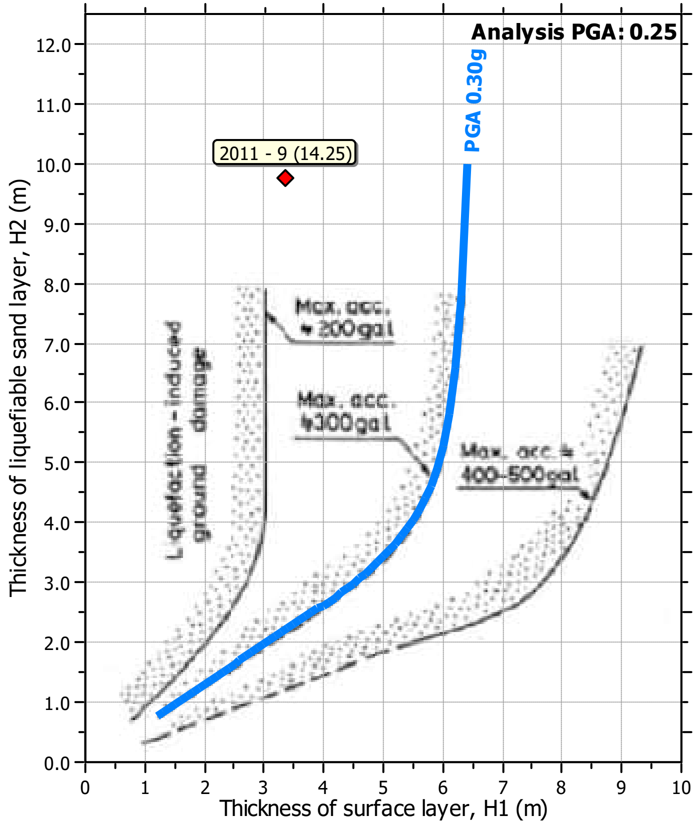
LPI color scheme

- Very high risk
- High risk
- Low risk

Liquefaction analysis summary plots



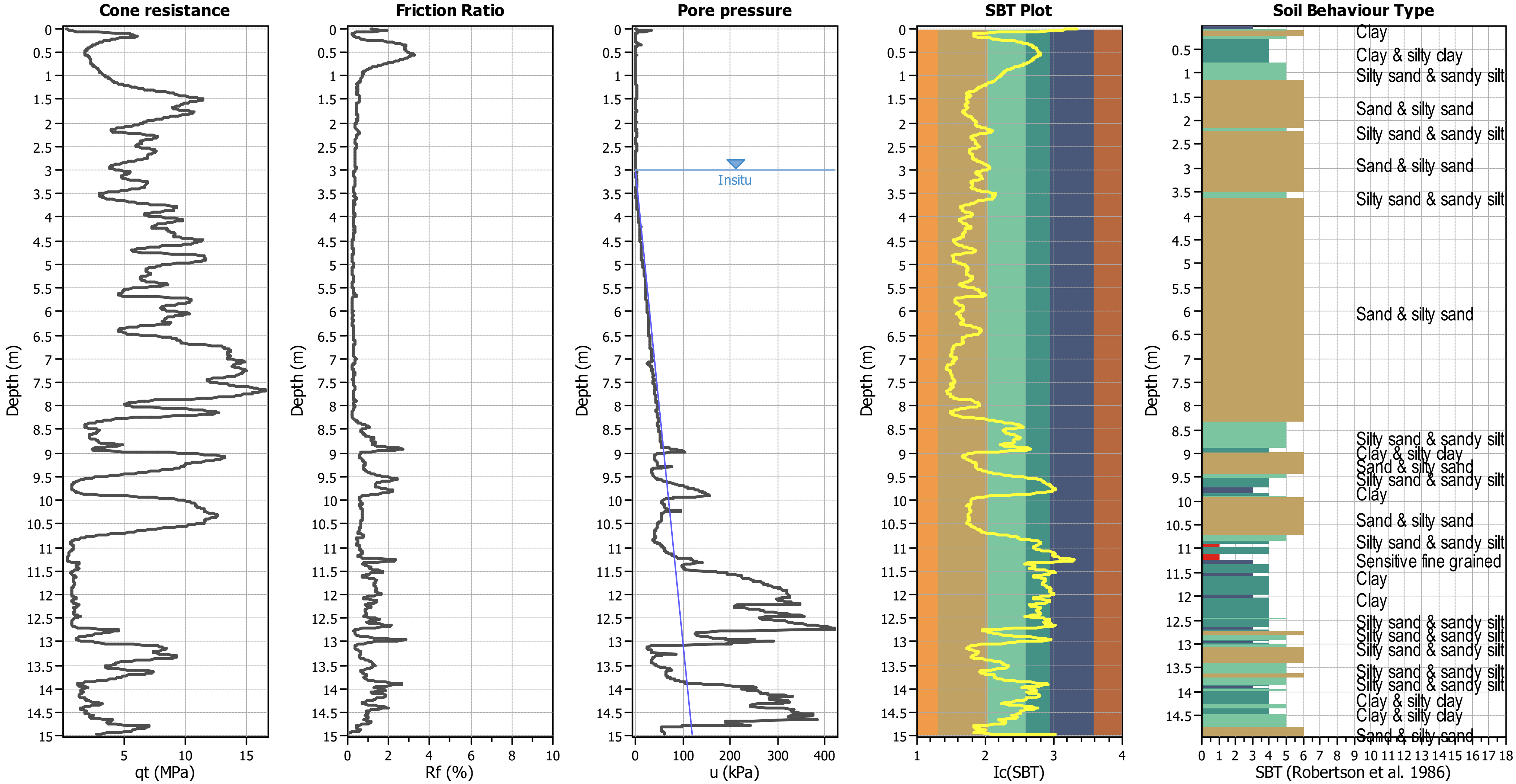




Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



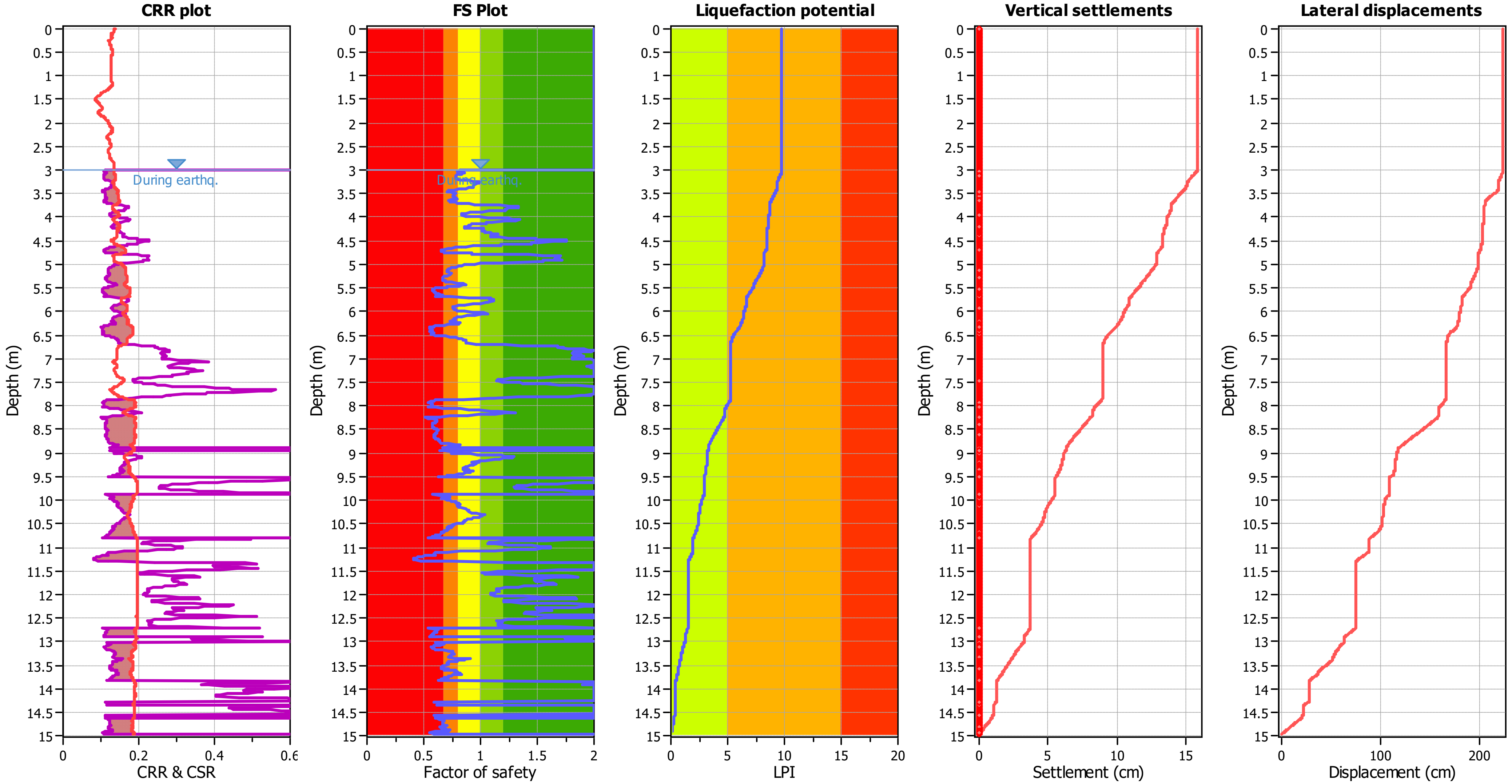
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

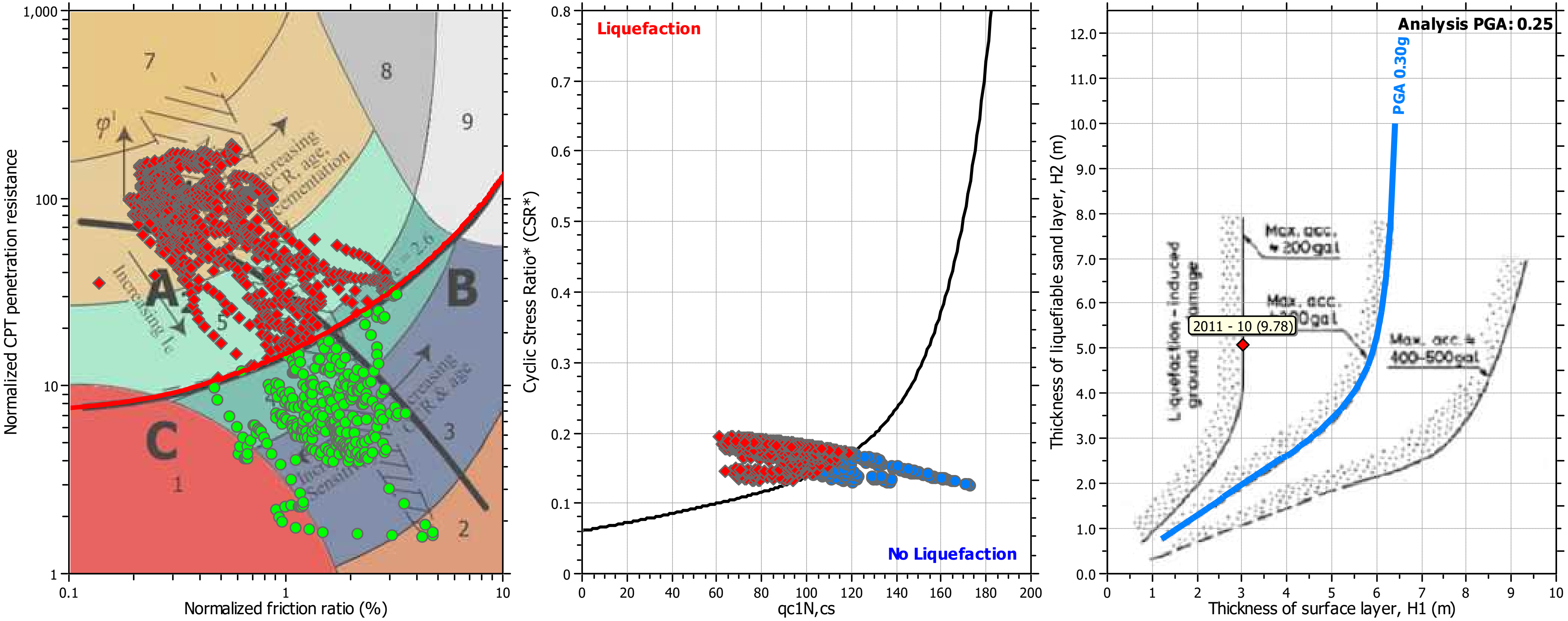
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

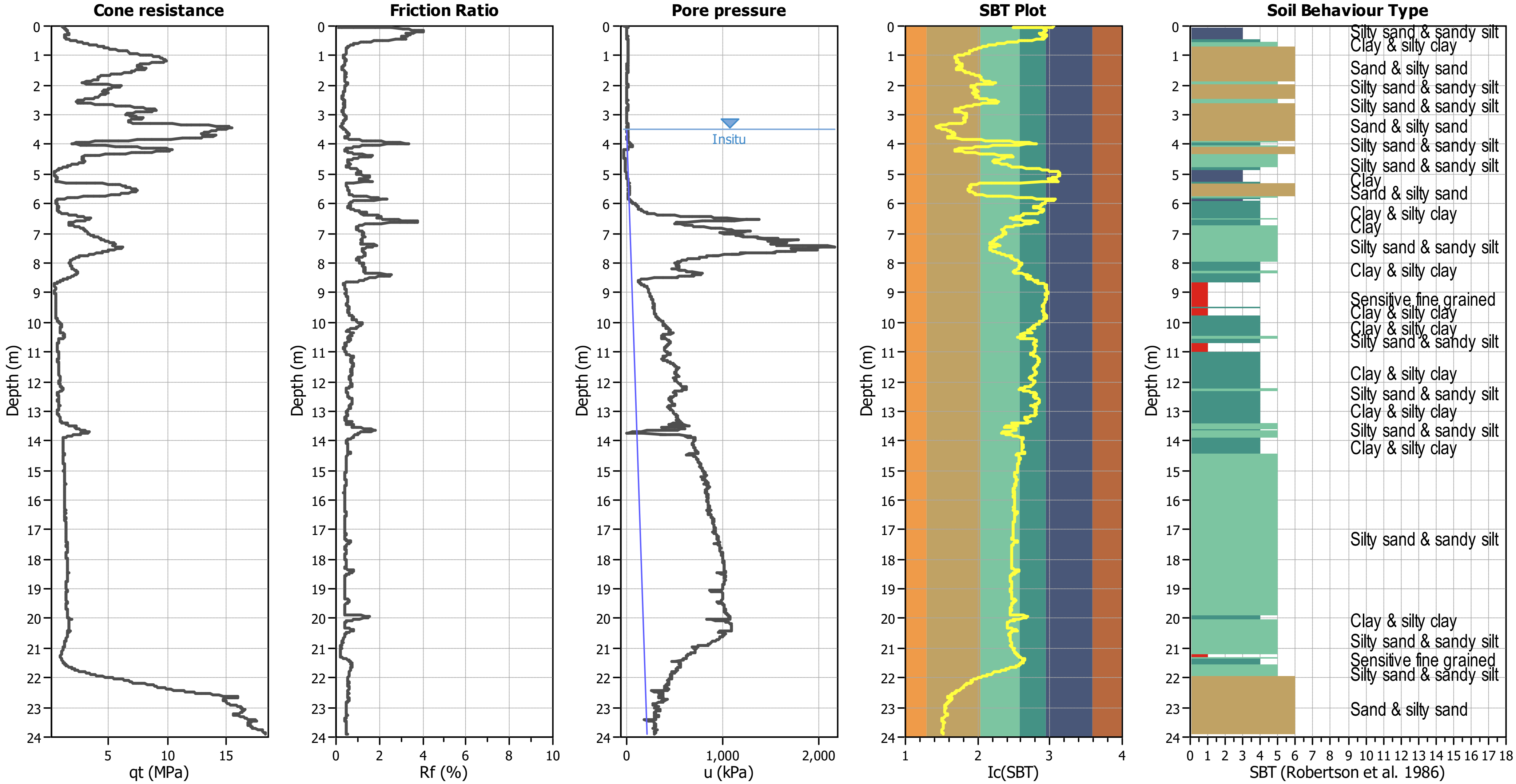
Liquefaction analysis summary plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.25	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

CPT basic interpretation plots



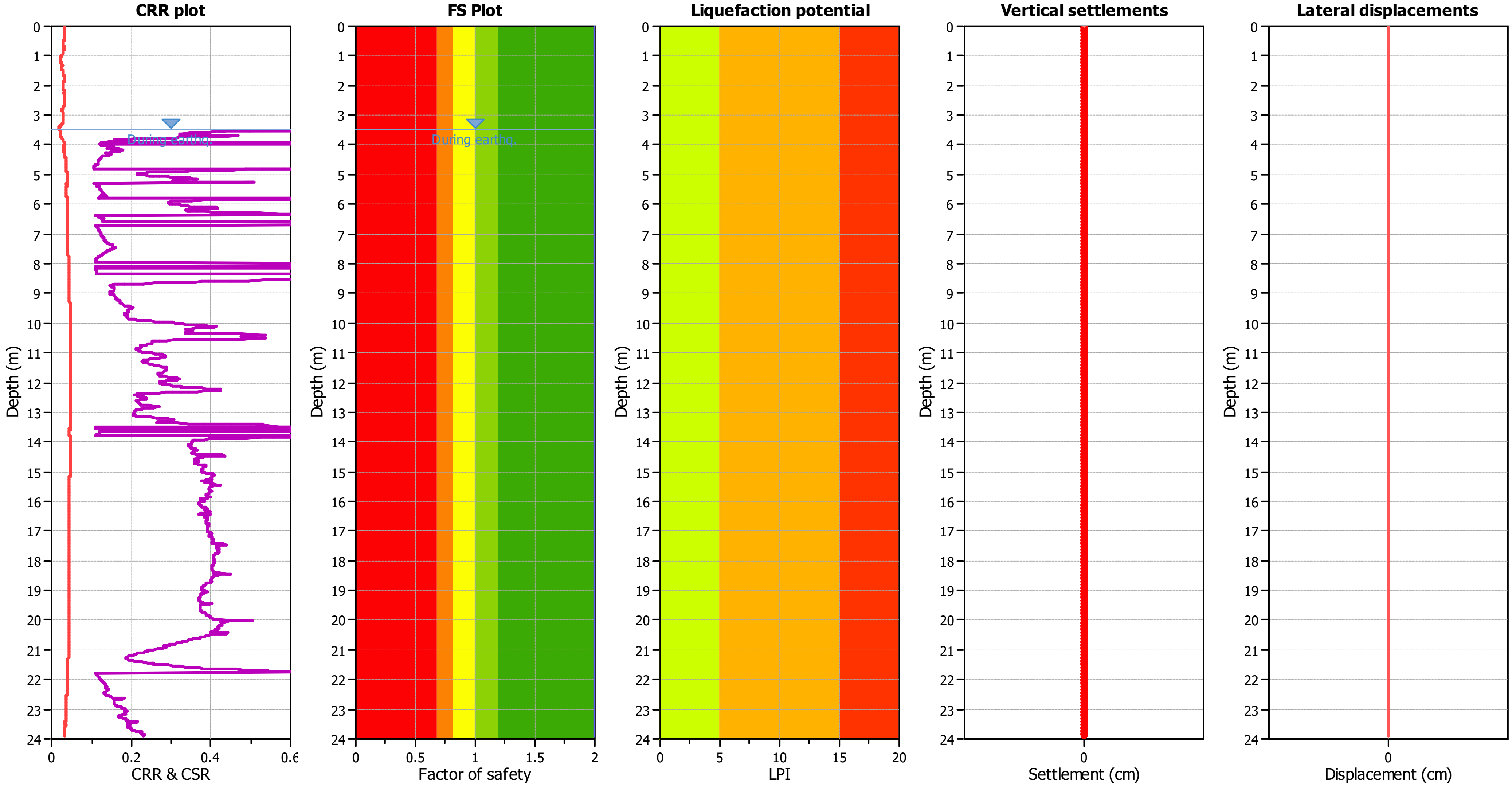
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.50 m	Fill height:	N/A	Limit depth:	N/A

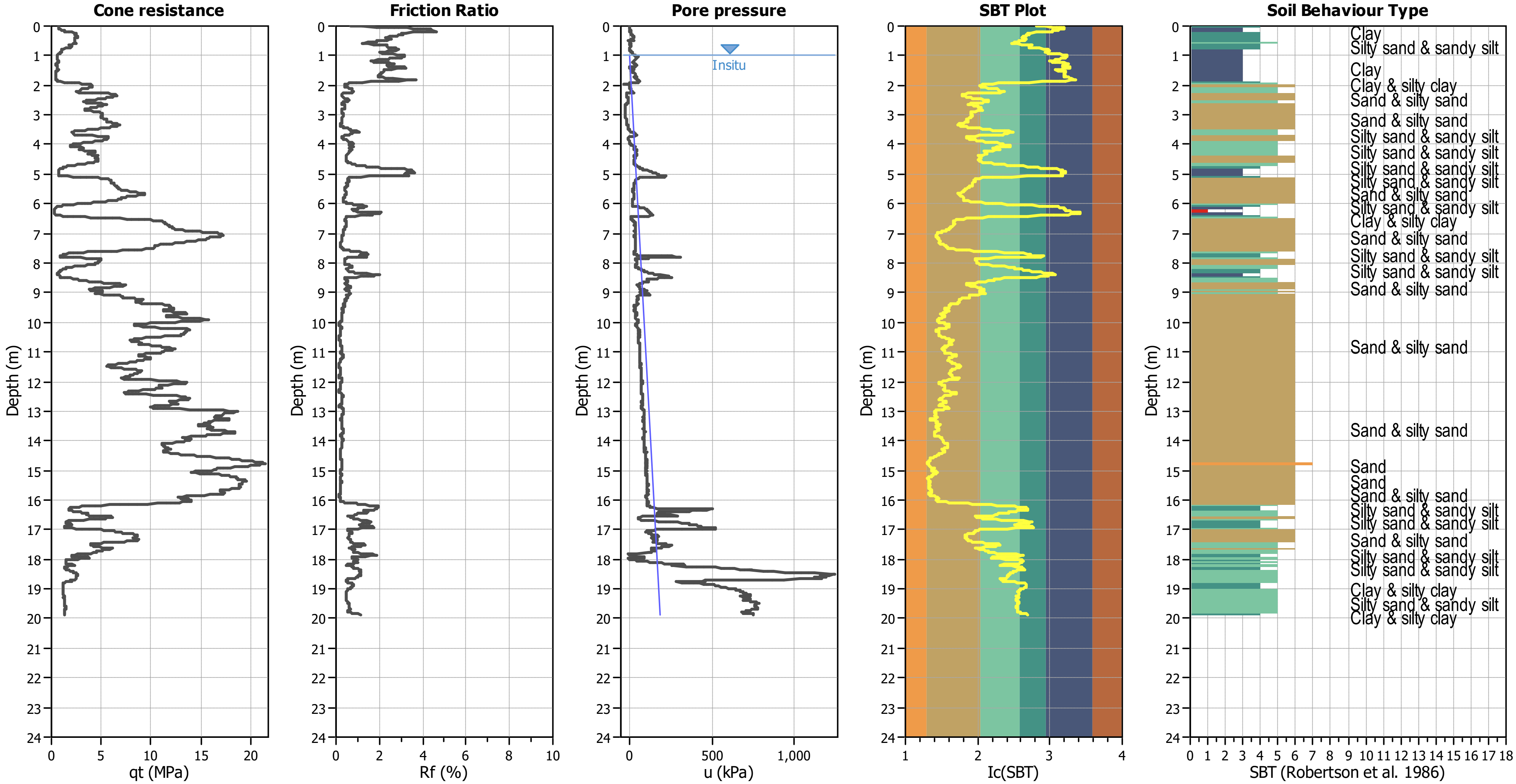
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



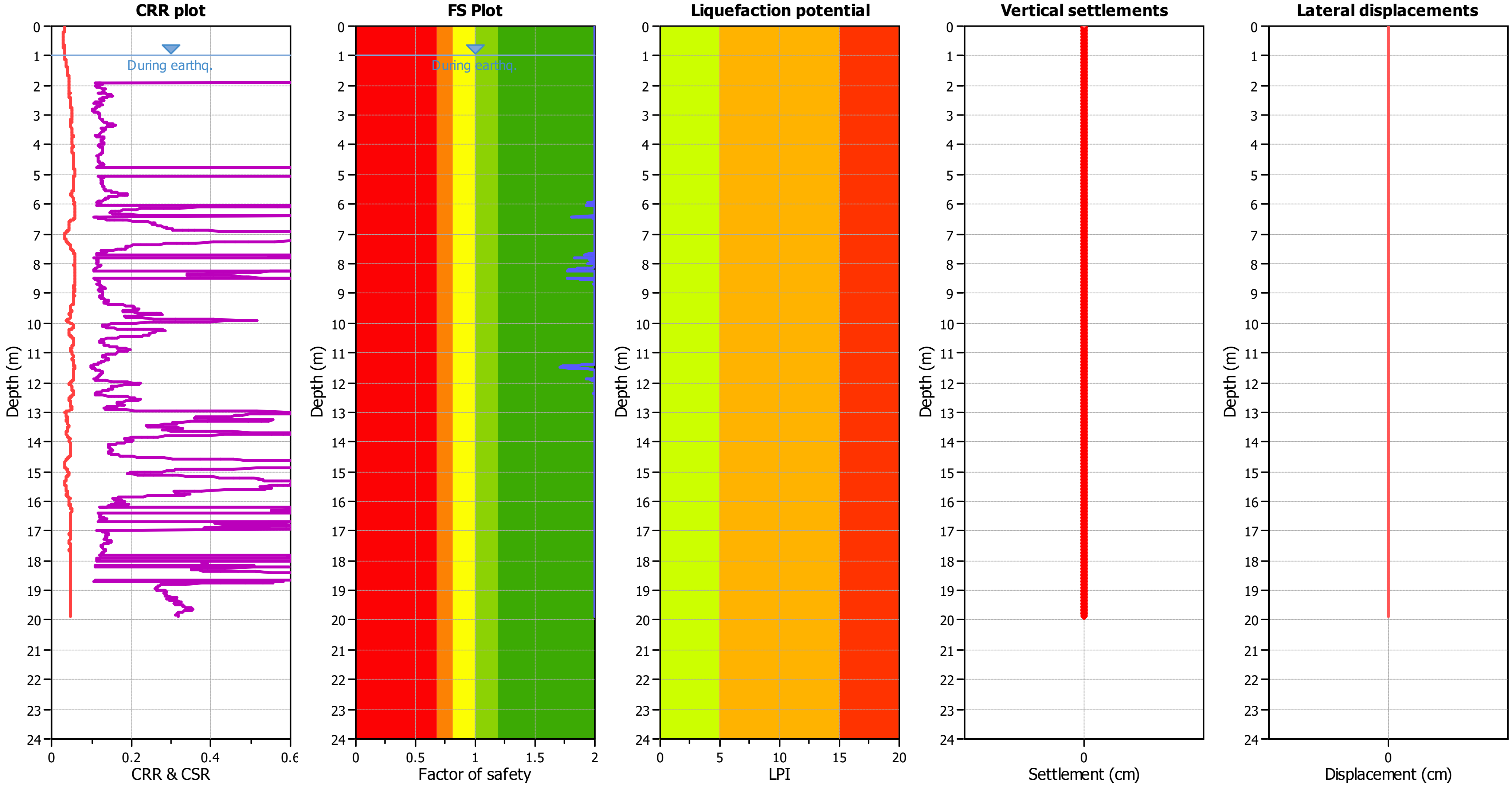
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

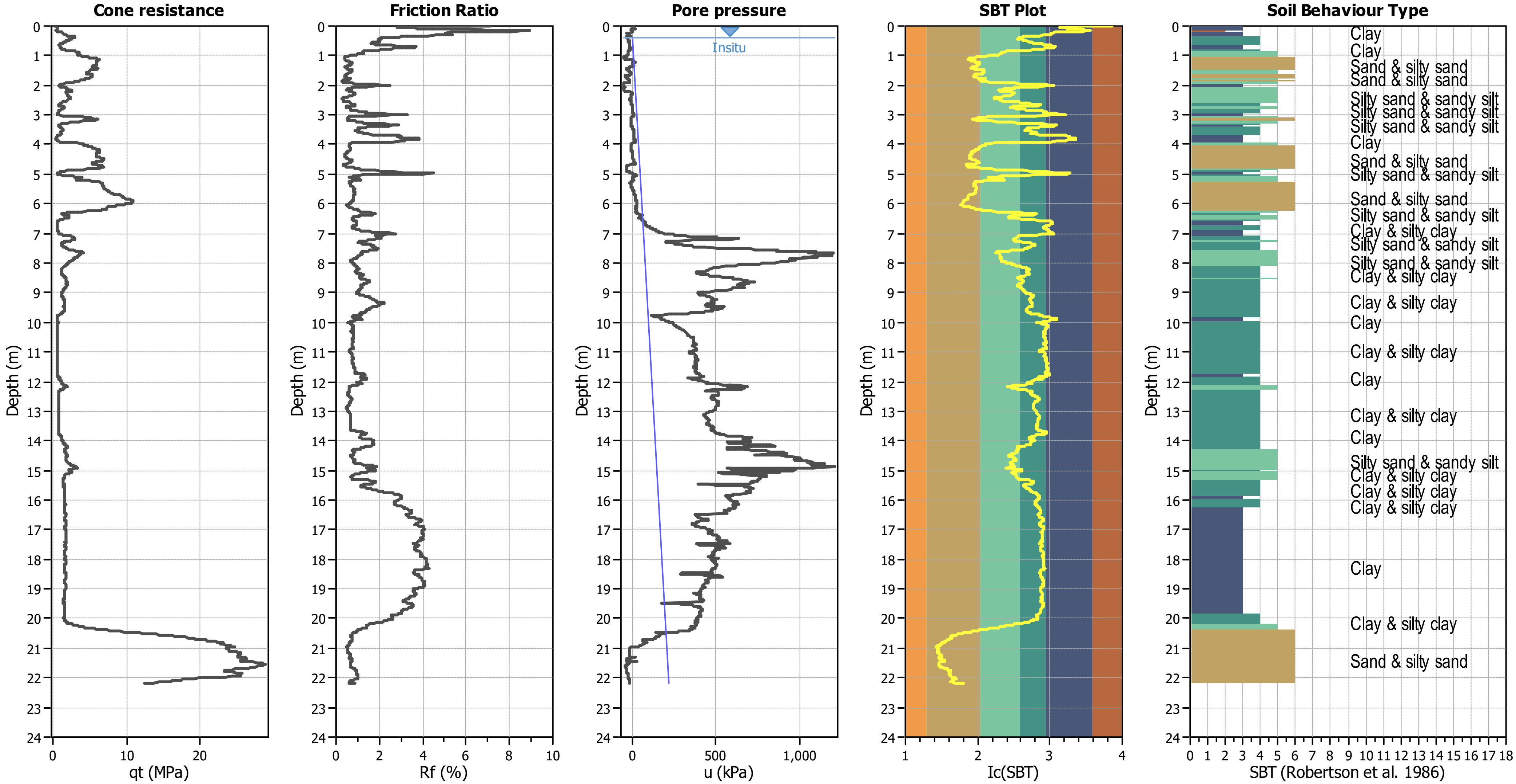
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



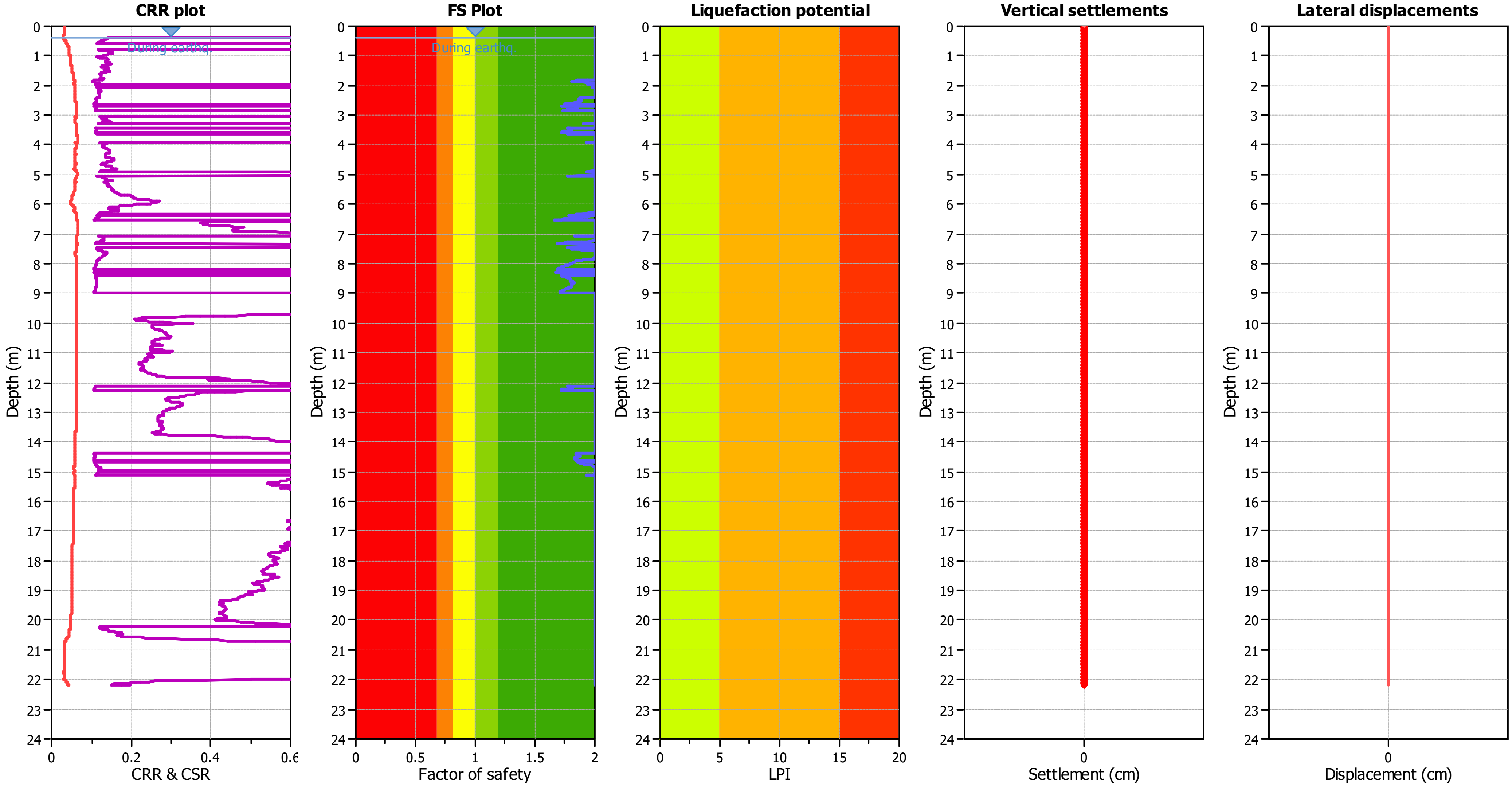
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

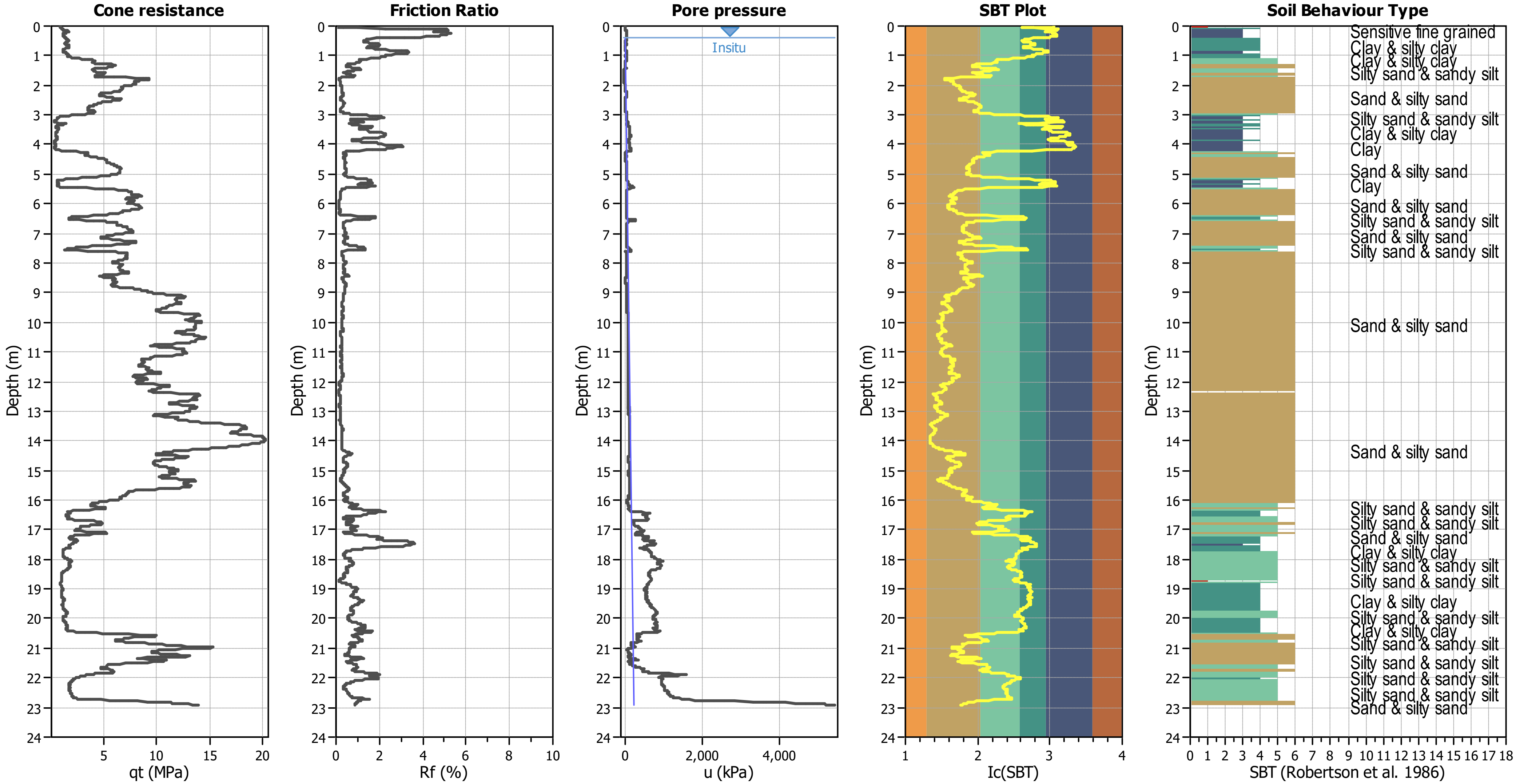
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



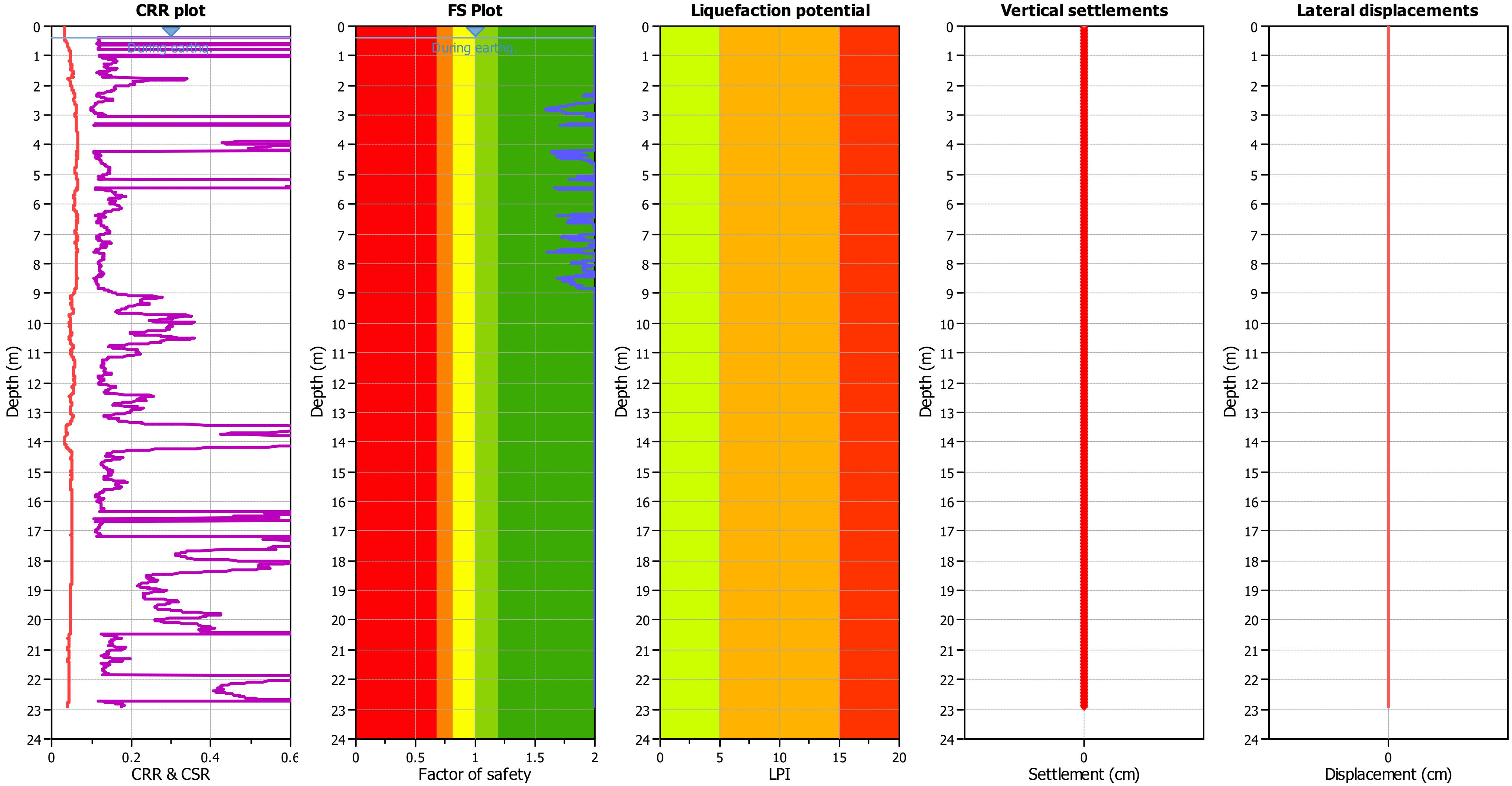
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	0.40 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	0.40 m	Fill height:	N/A	Limit depth:	N/A

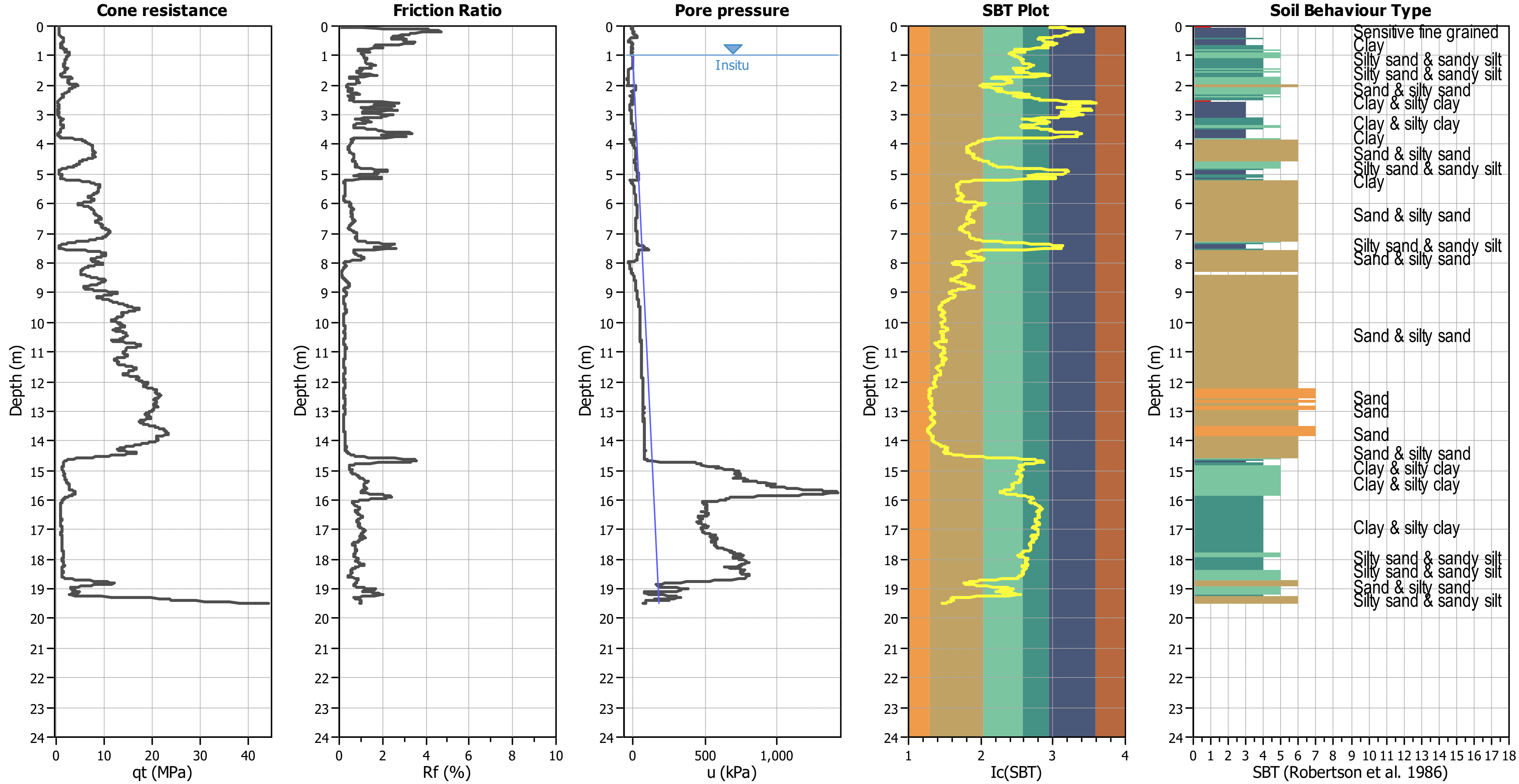
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



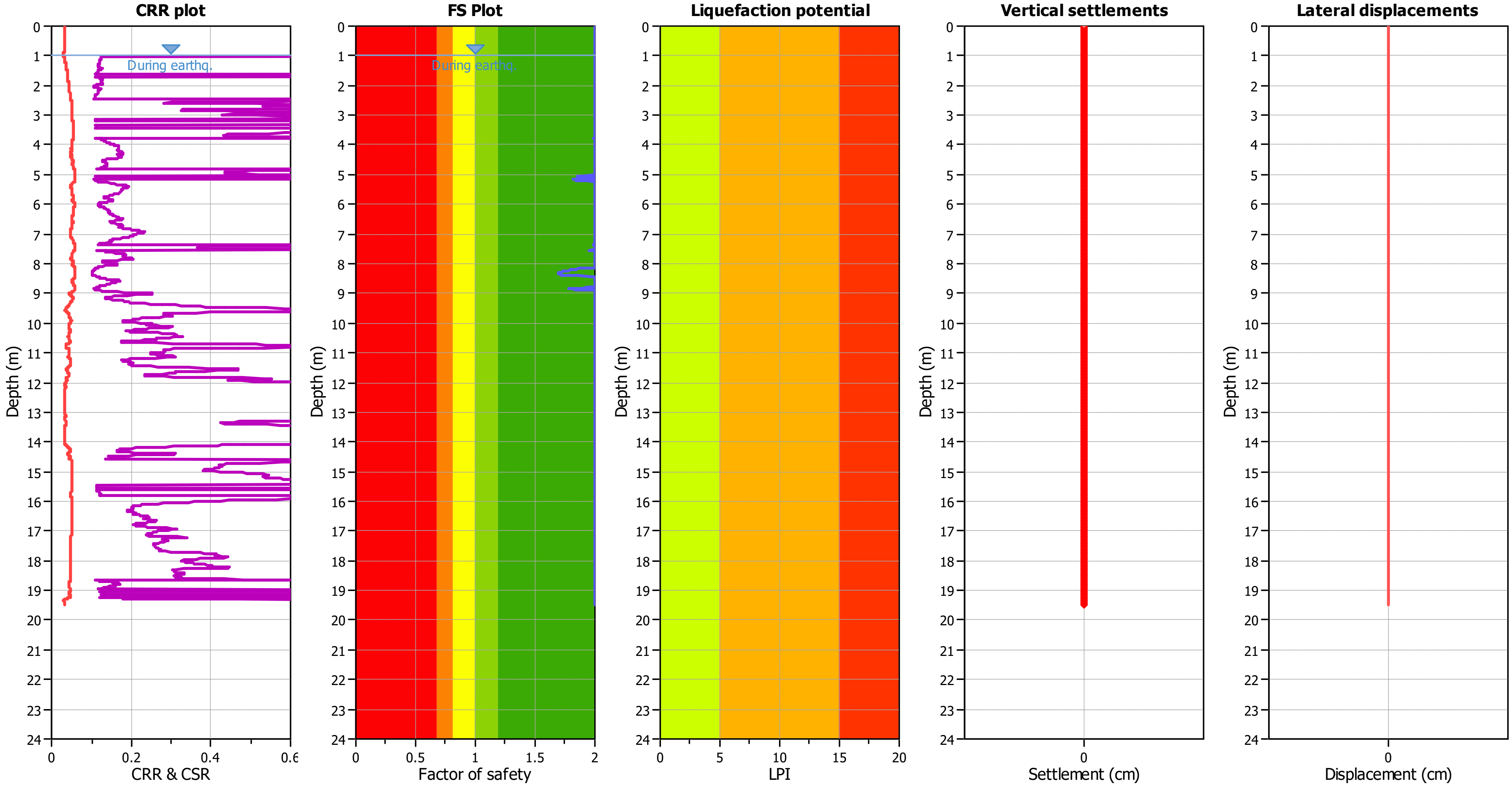
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	1.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	1.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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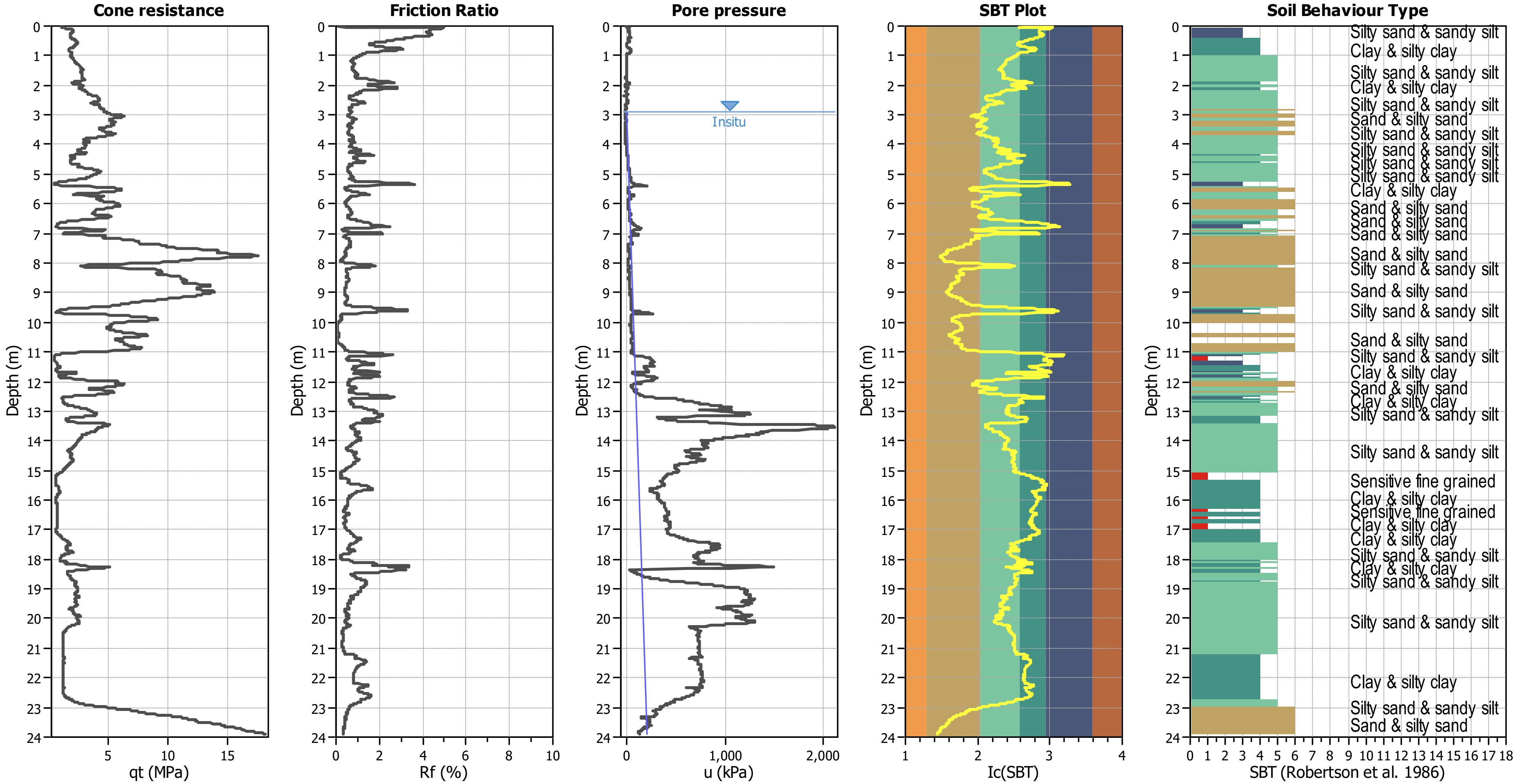
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



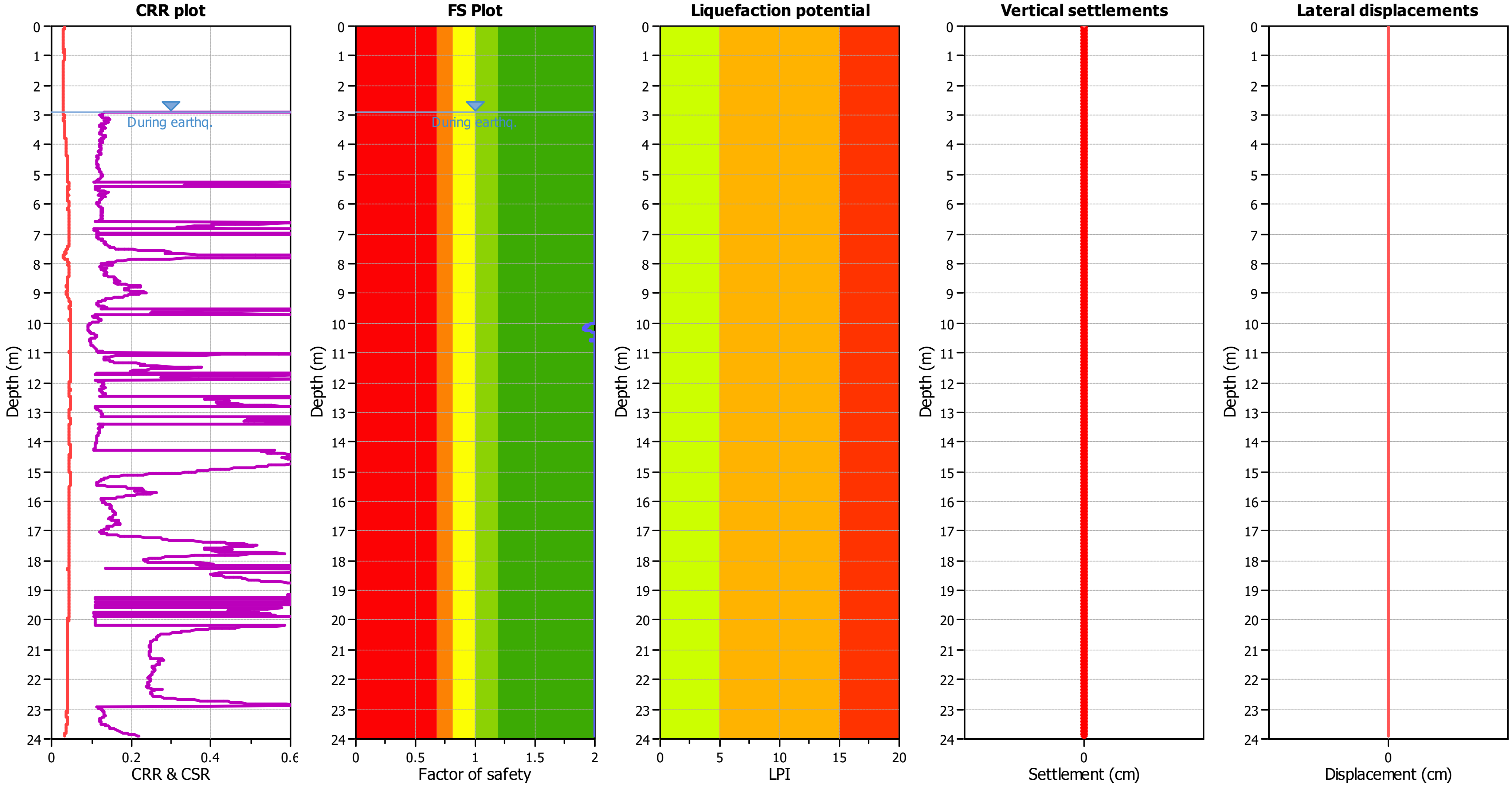
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.90 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	2.90 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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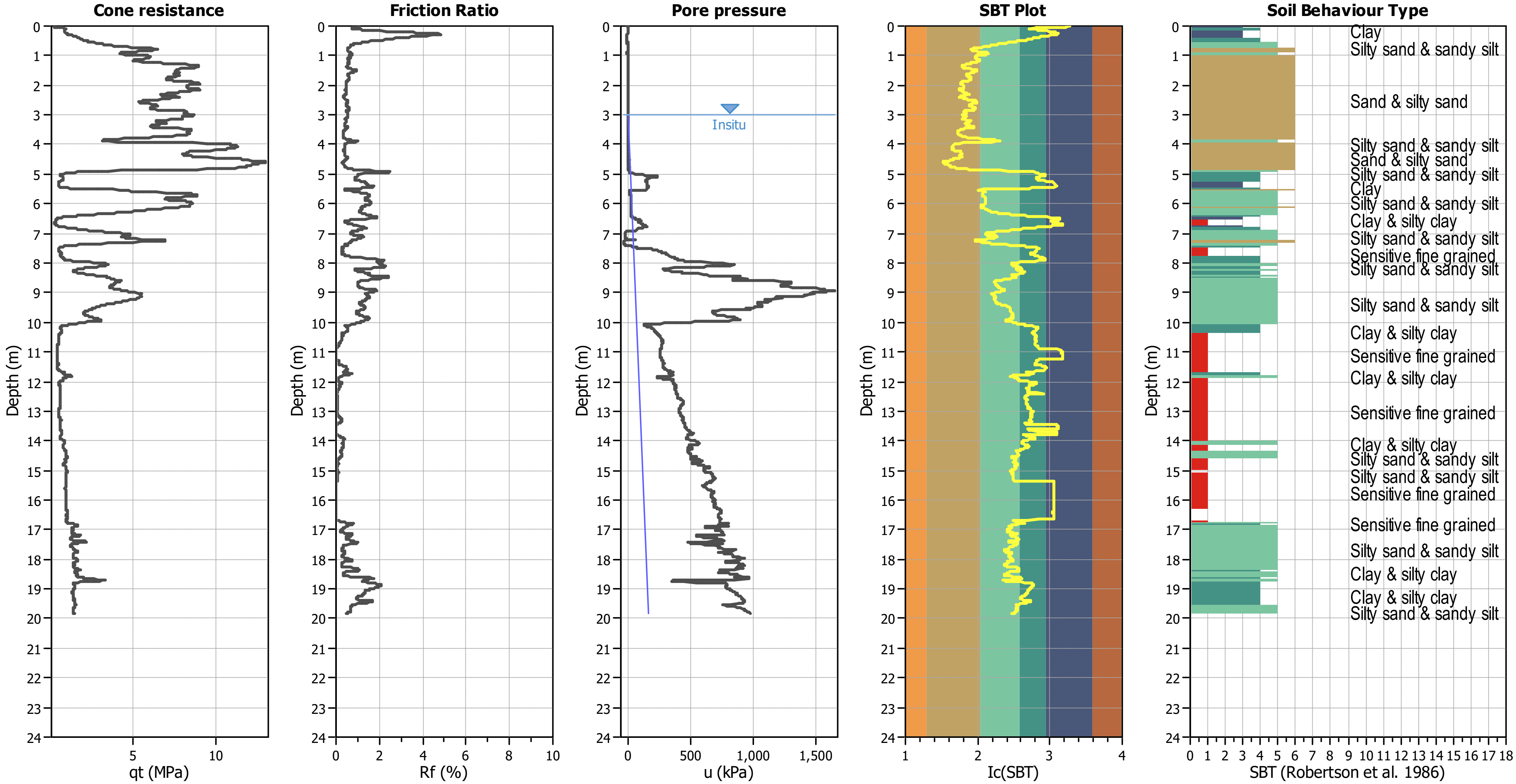
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



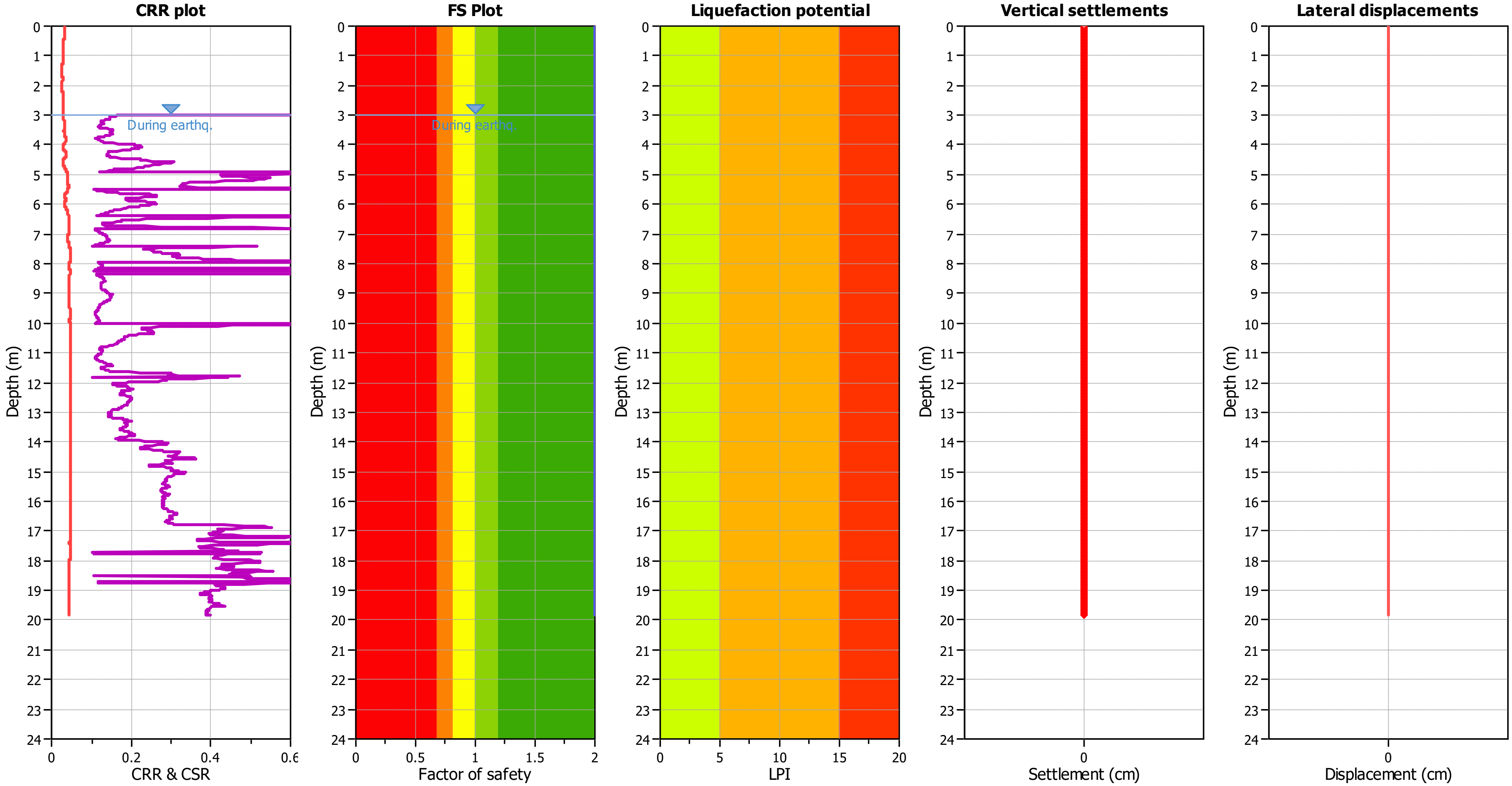
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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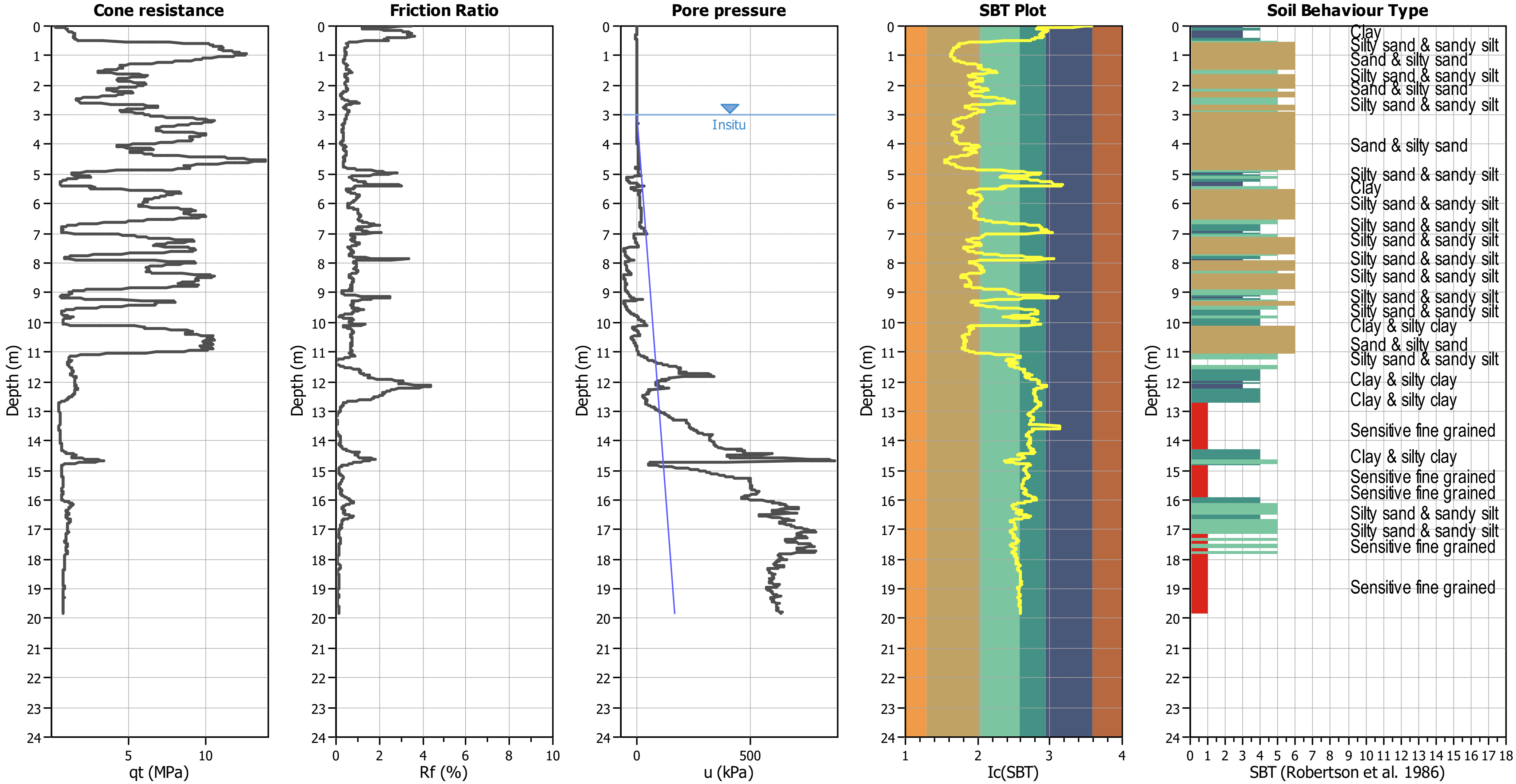
CPT basic interpretation plots



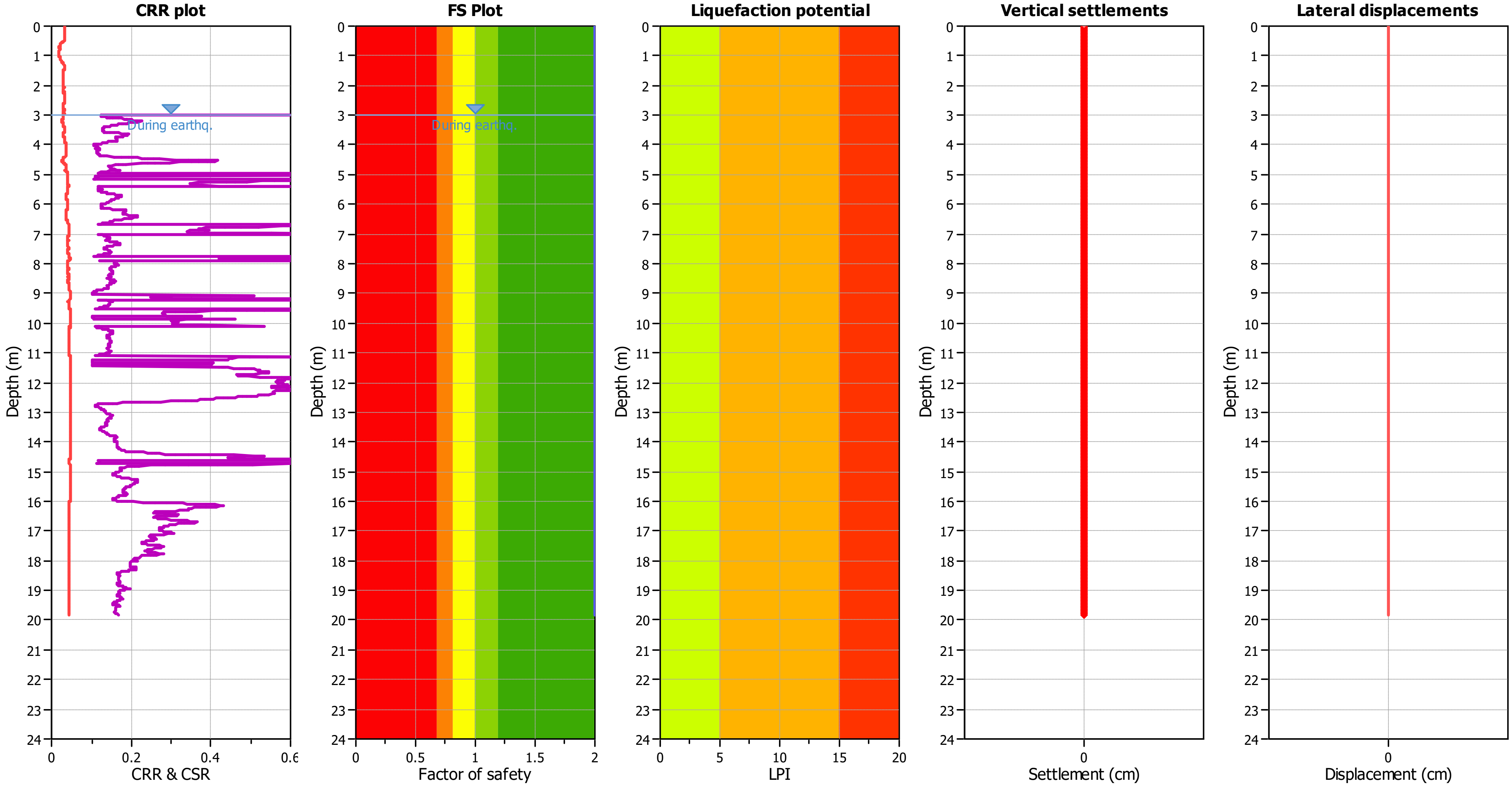
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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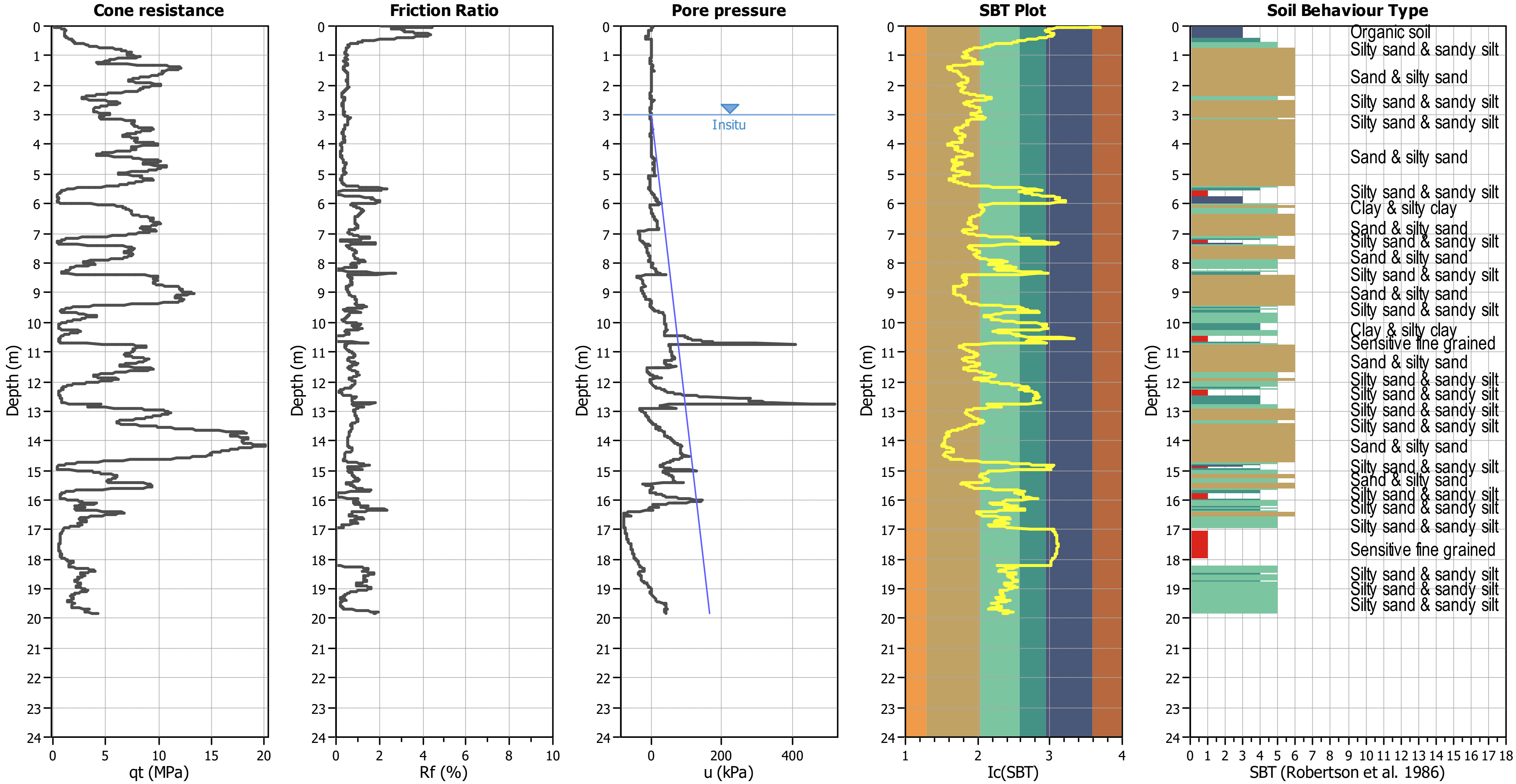
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



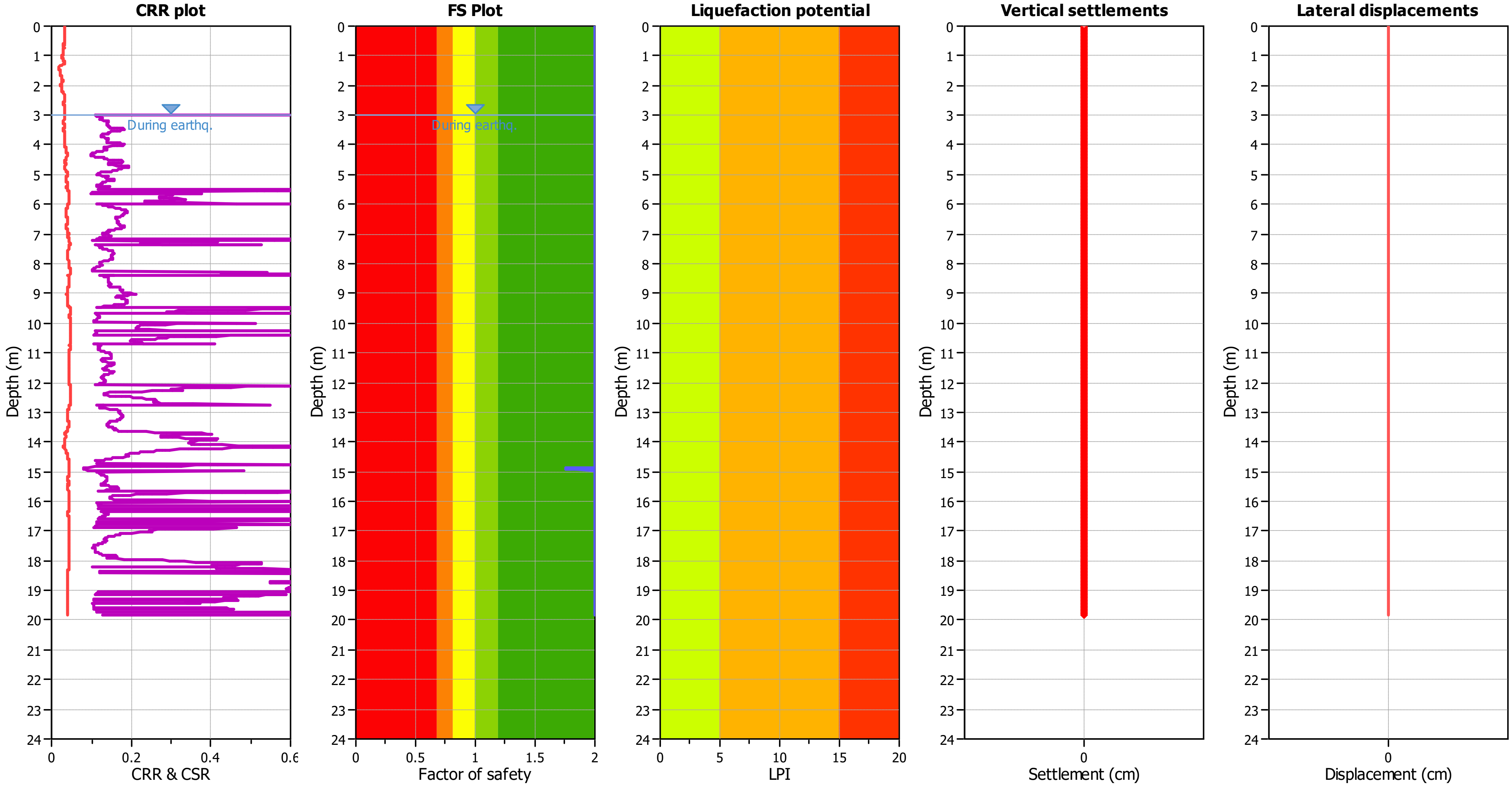
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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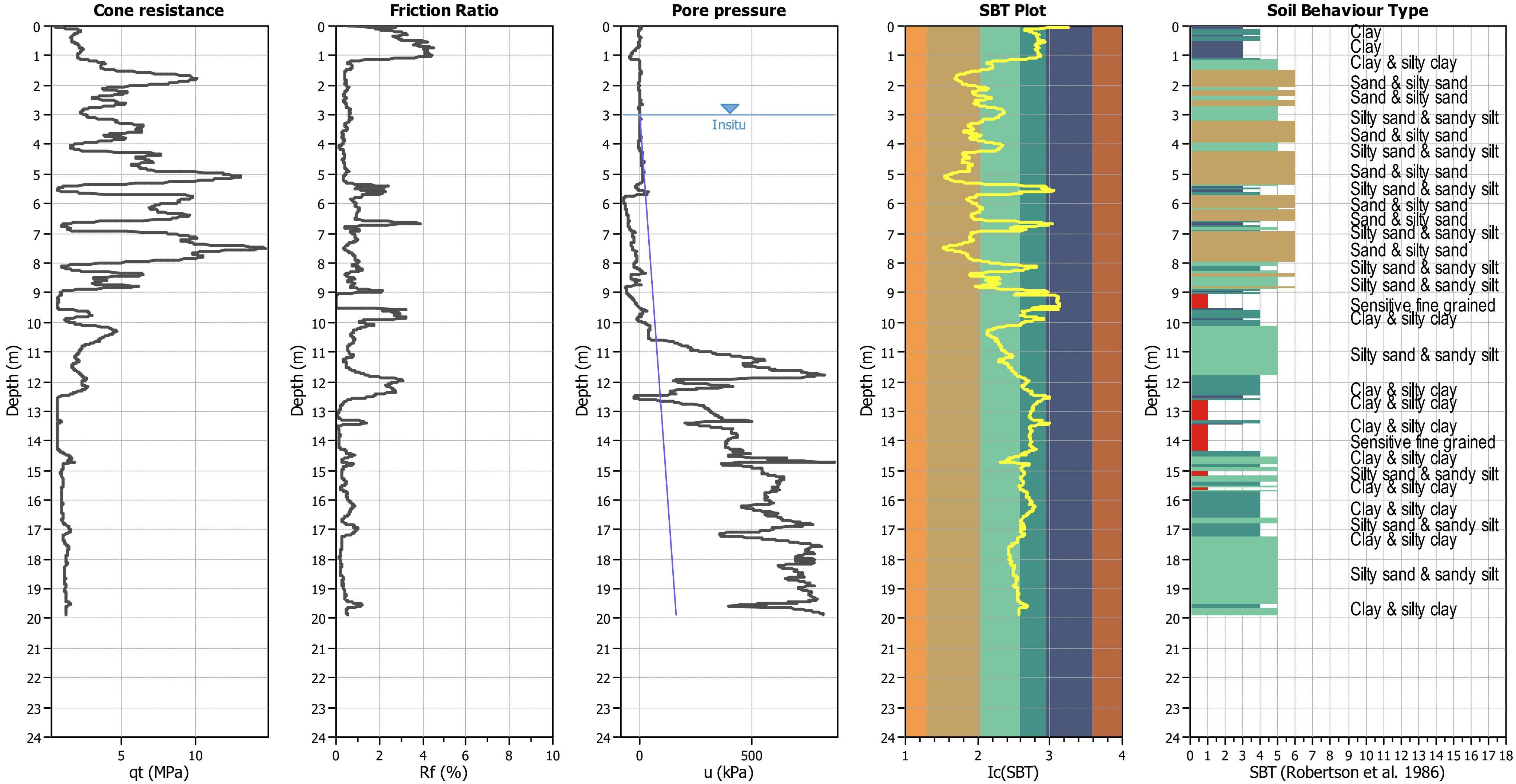
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



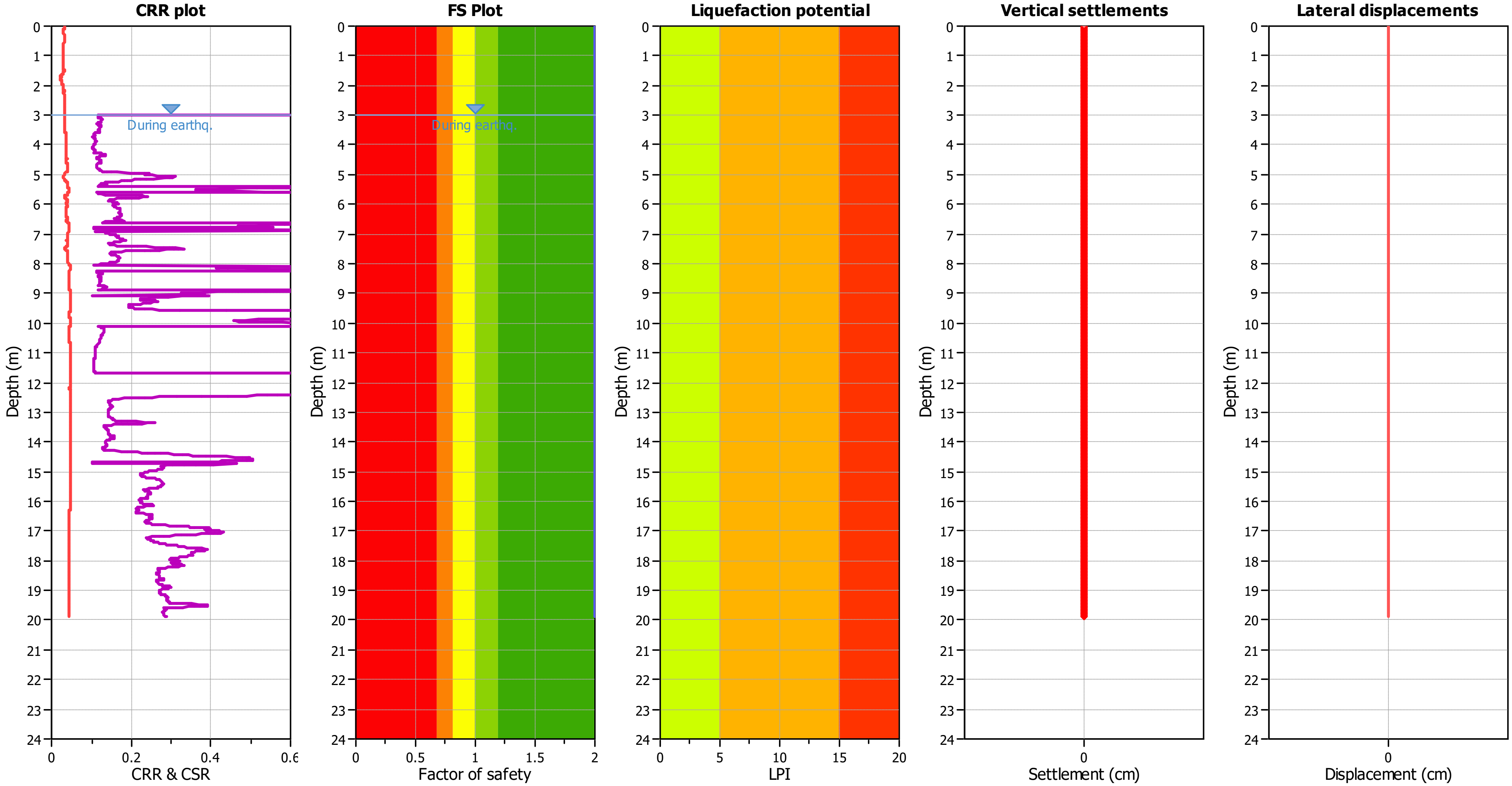
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

- Almost certain it will liquefy
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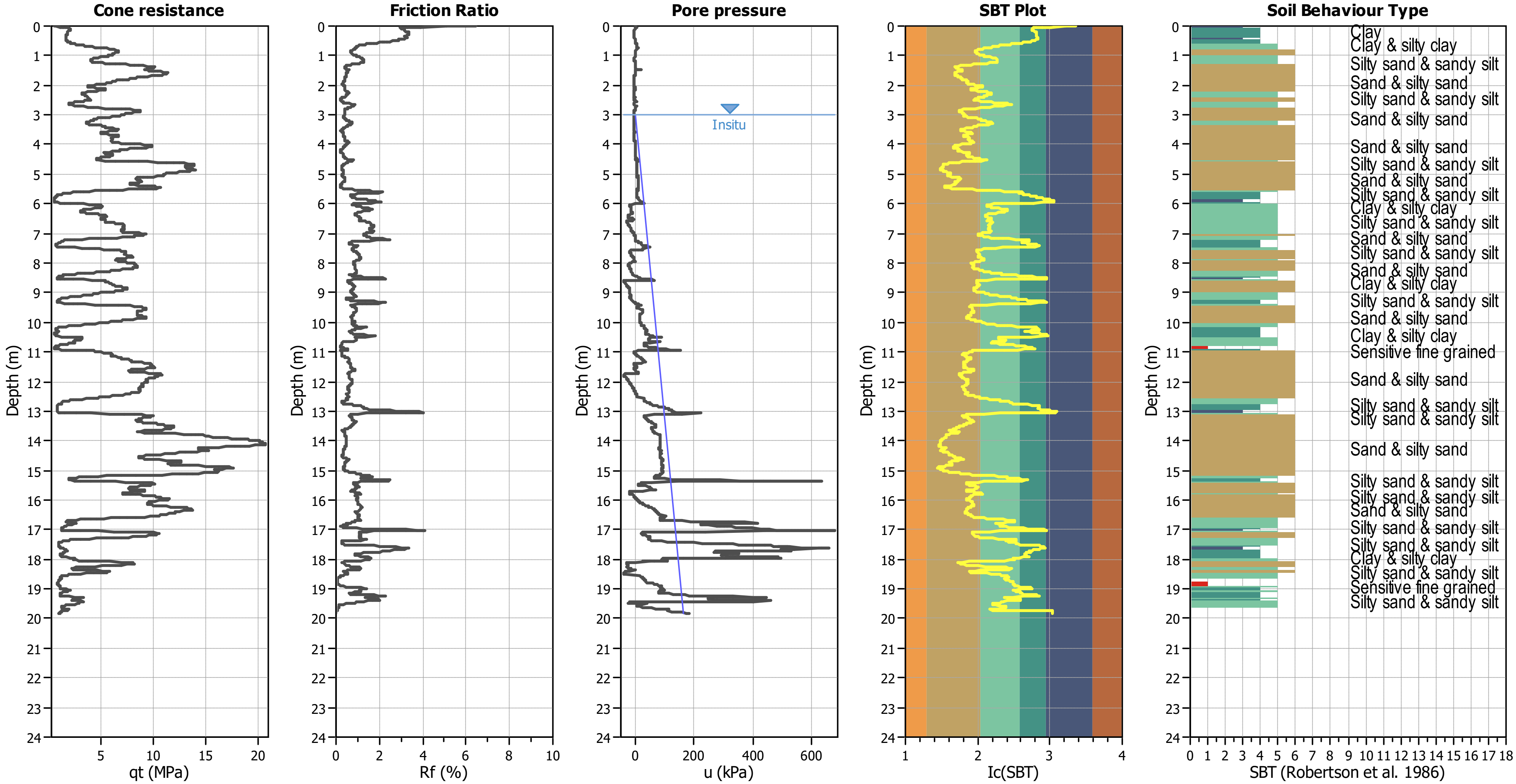
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



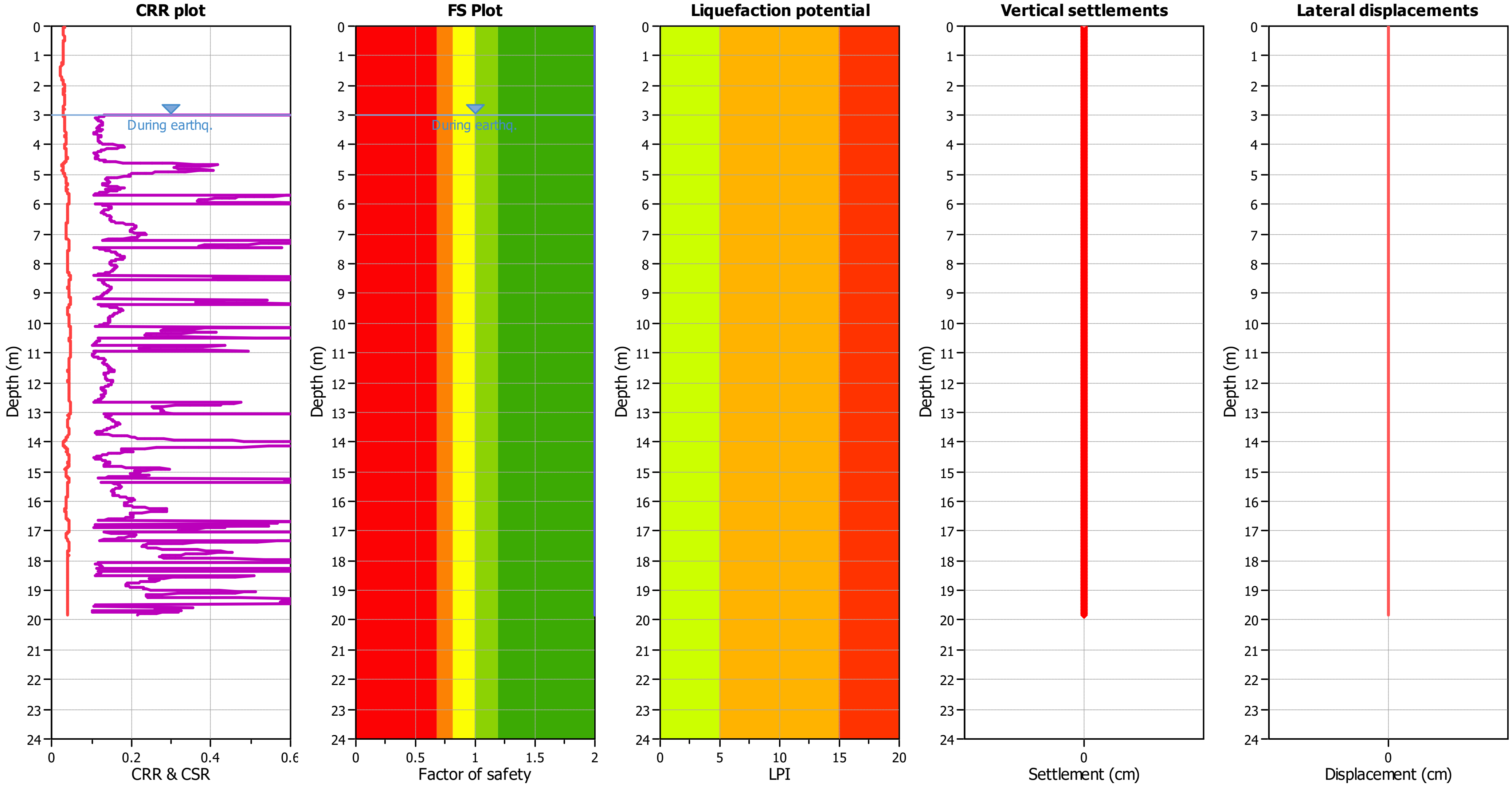
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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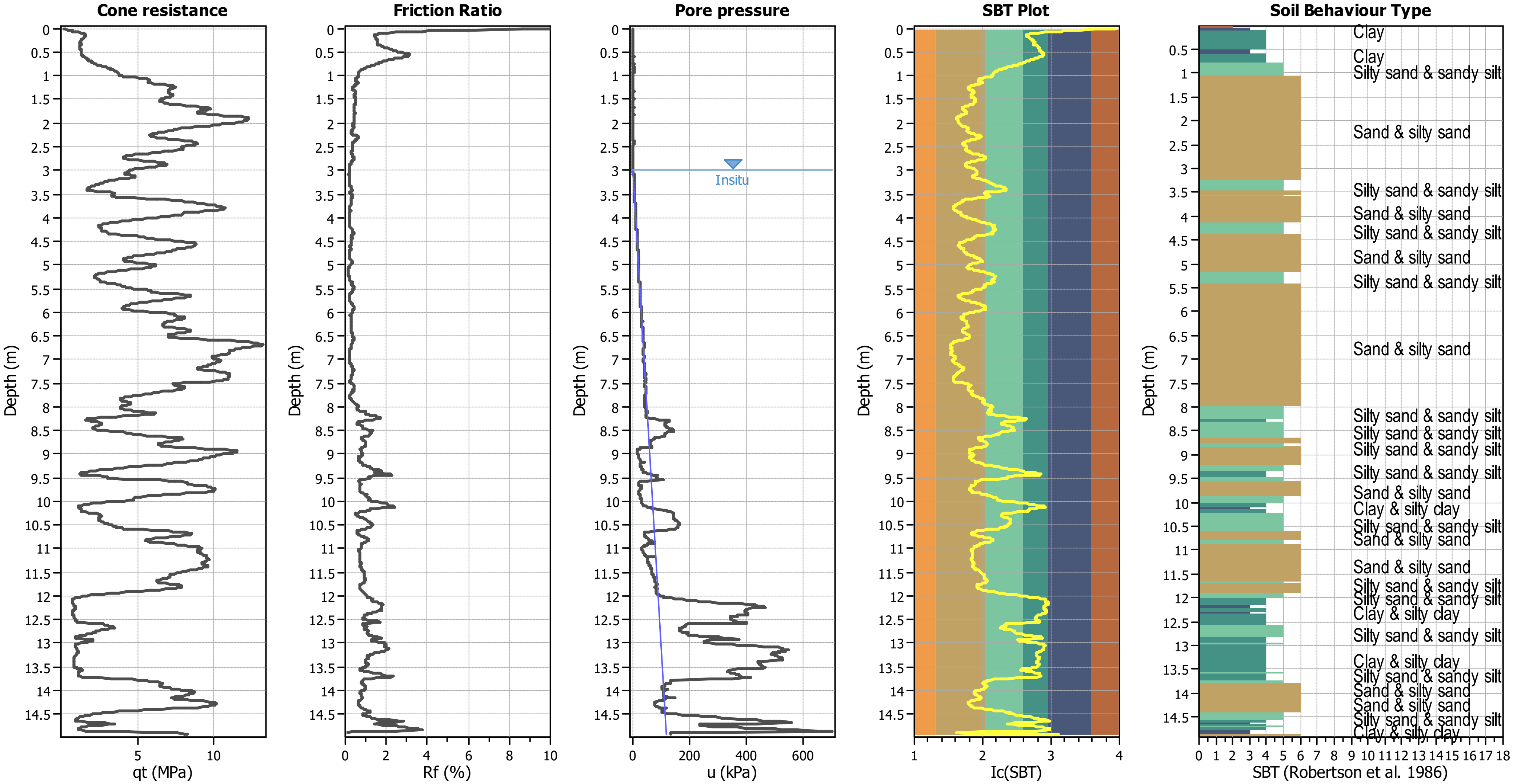
CPT basic interpretation plots



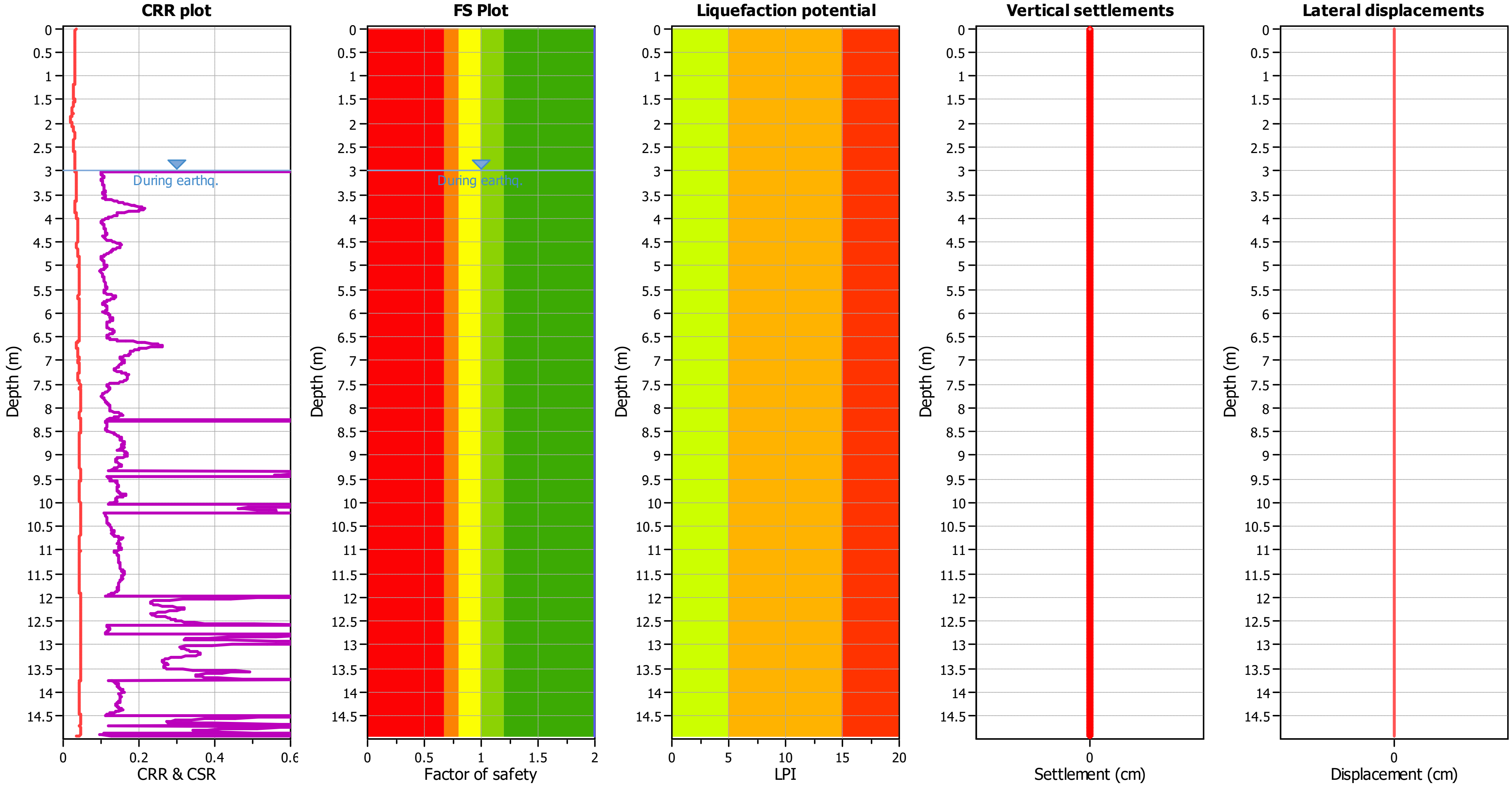
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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LPI color scheme

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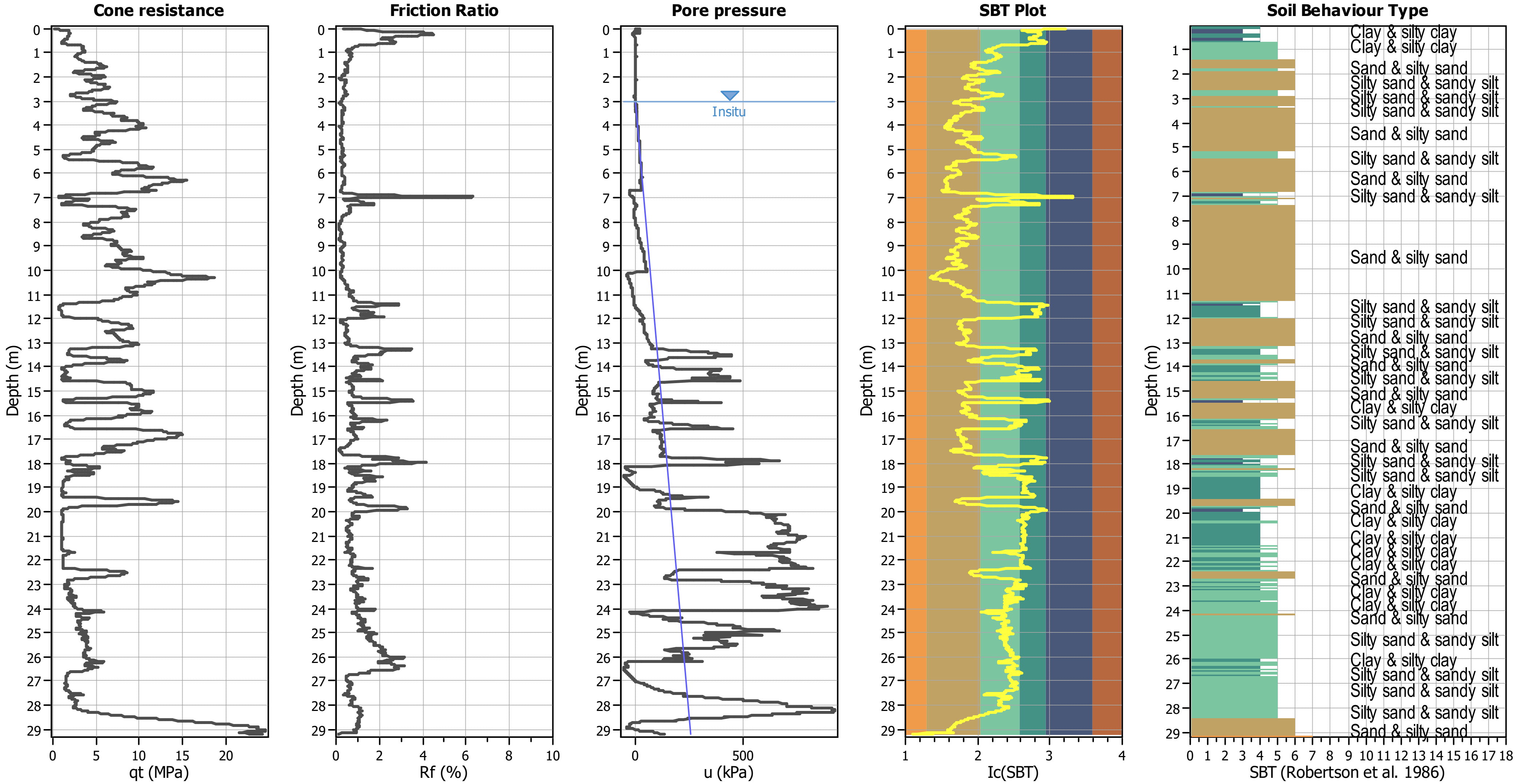
CPT basic interpretation plots



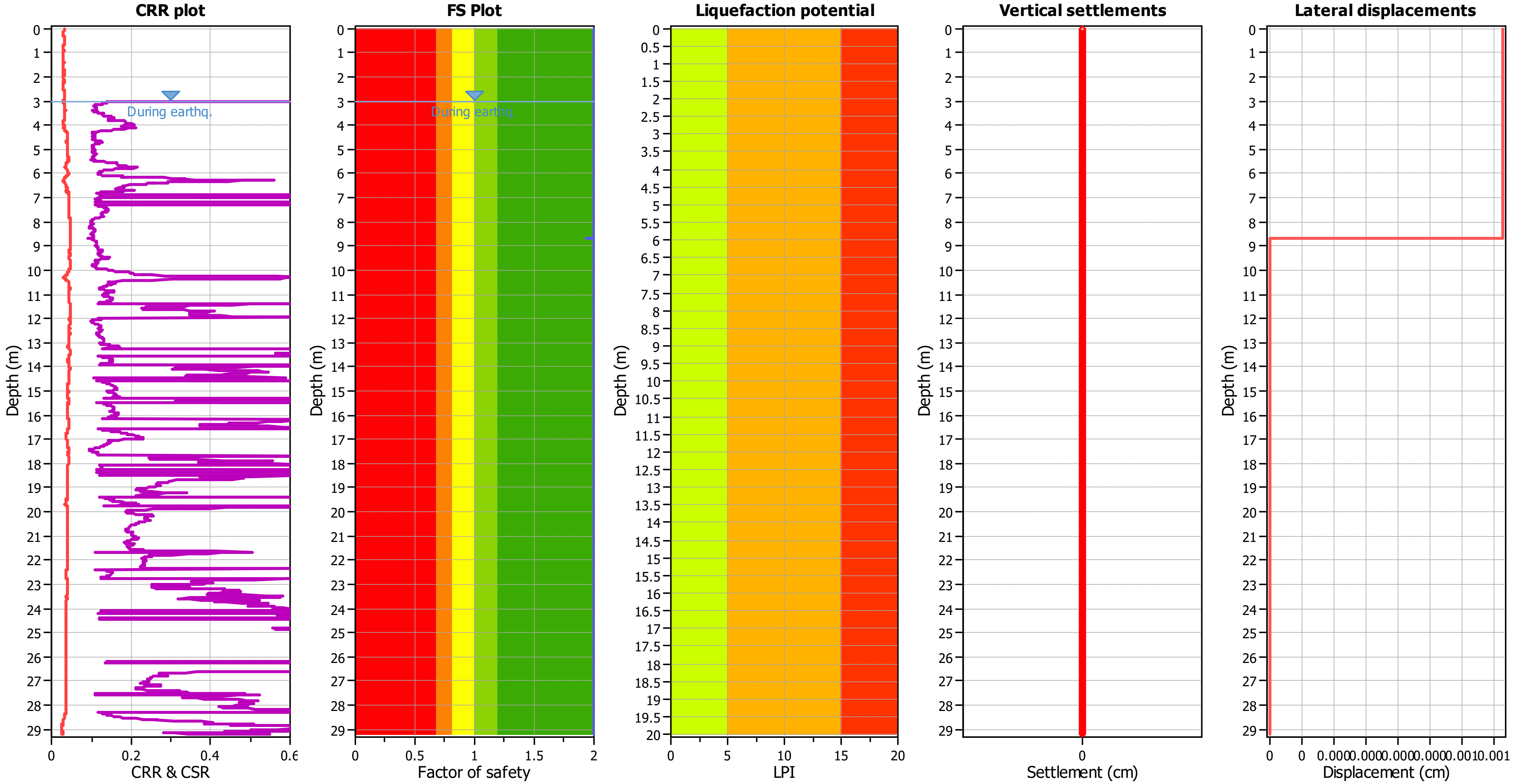
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

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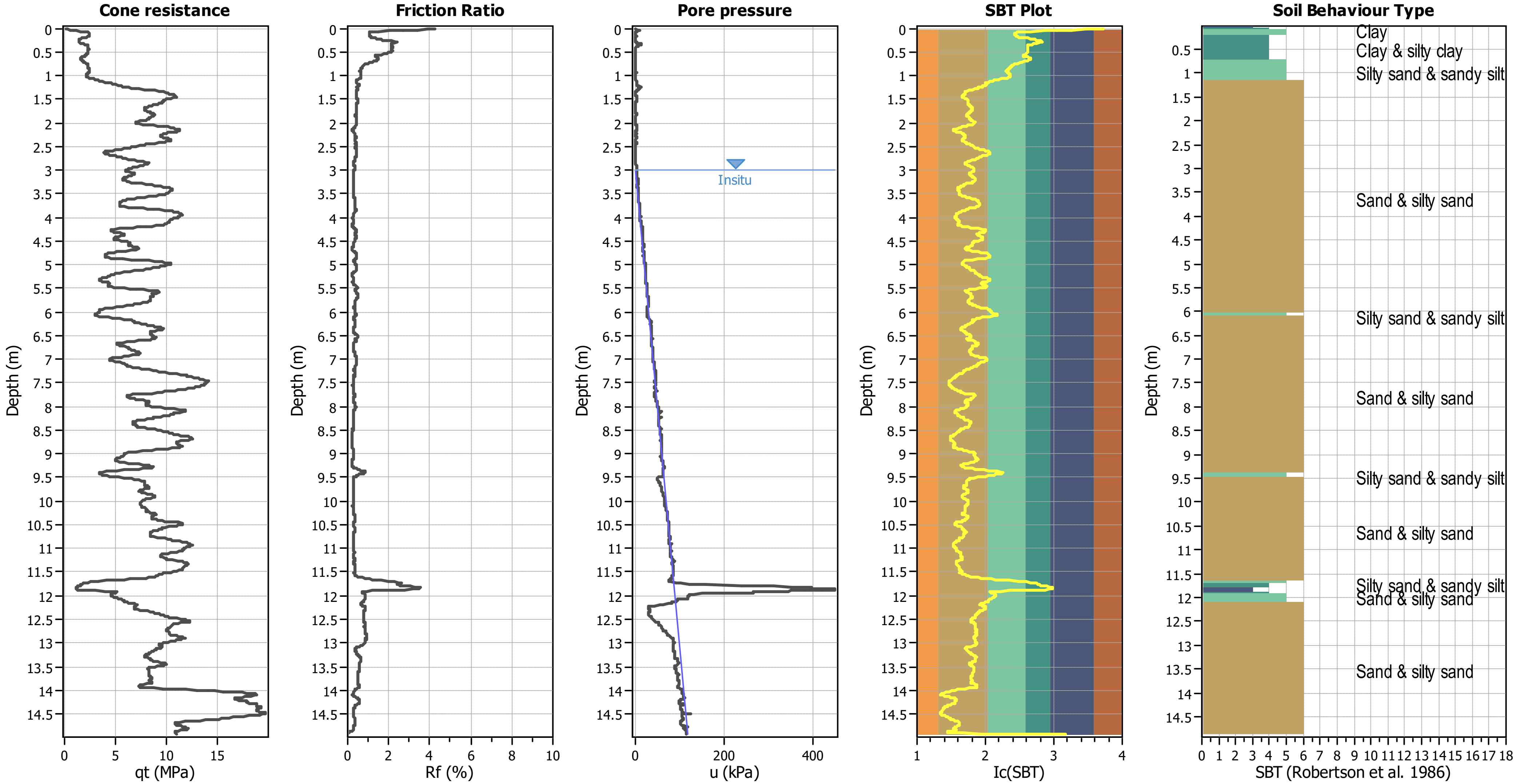
LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



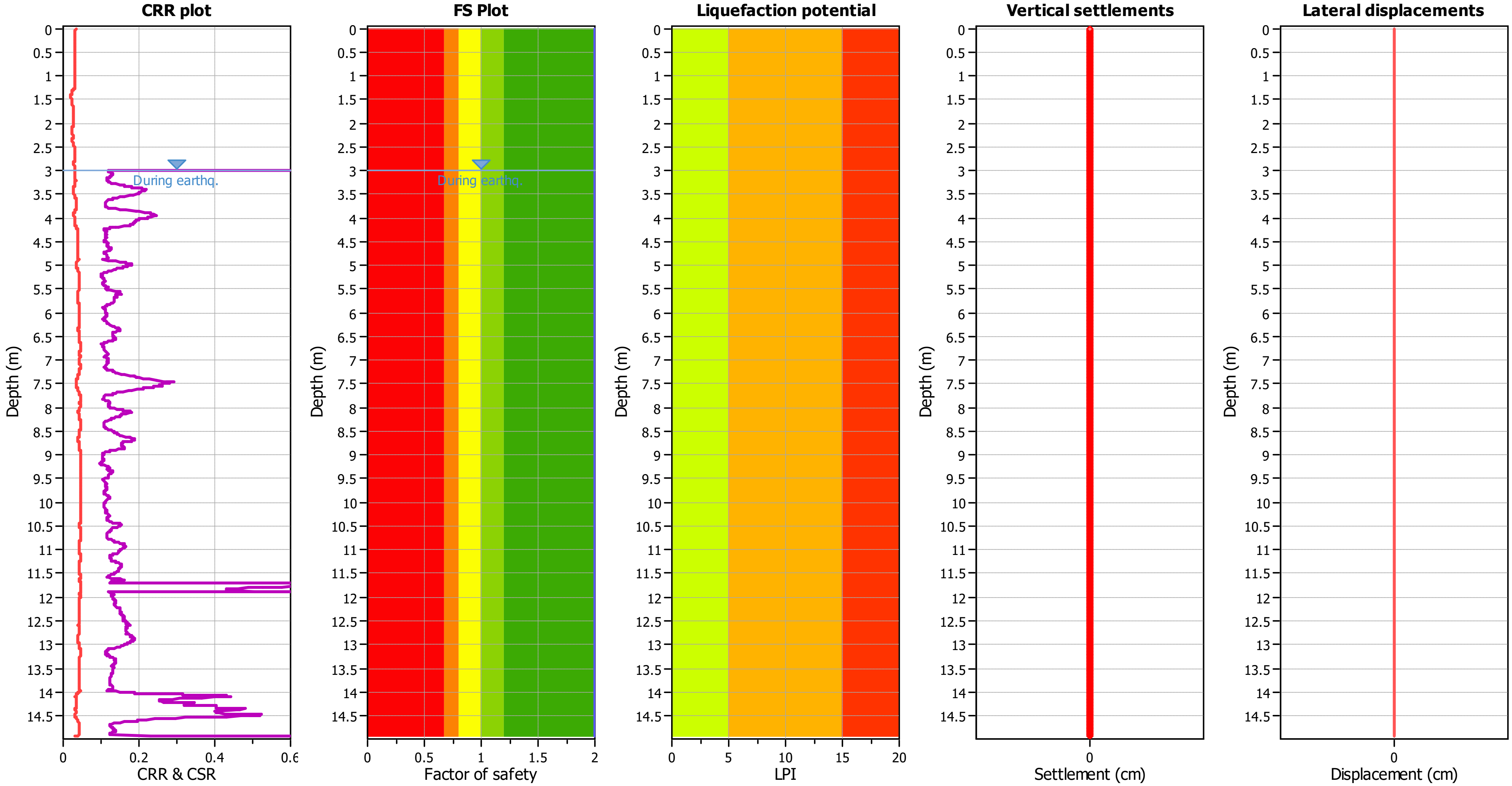
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_{σ} applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
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Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

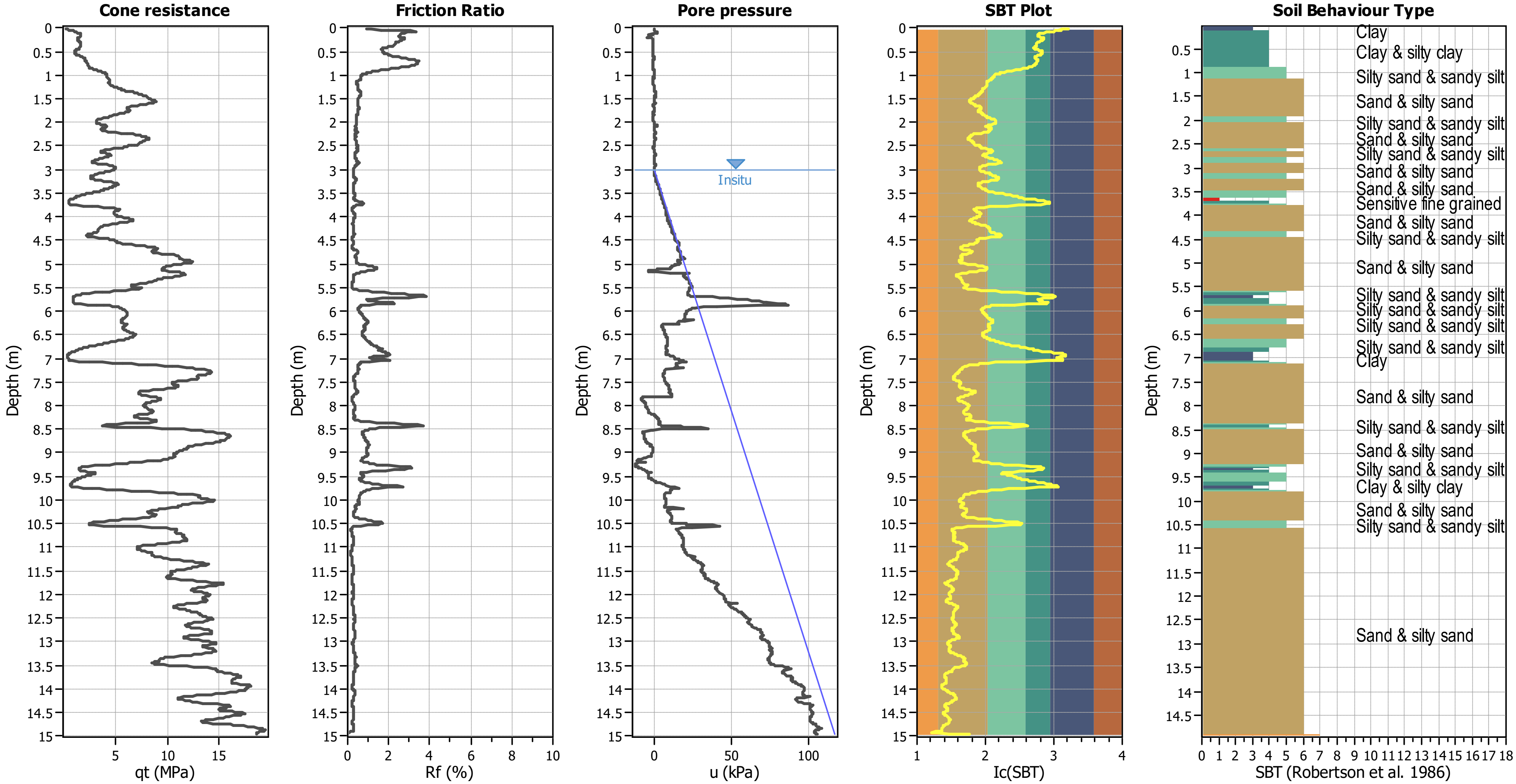
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



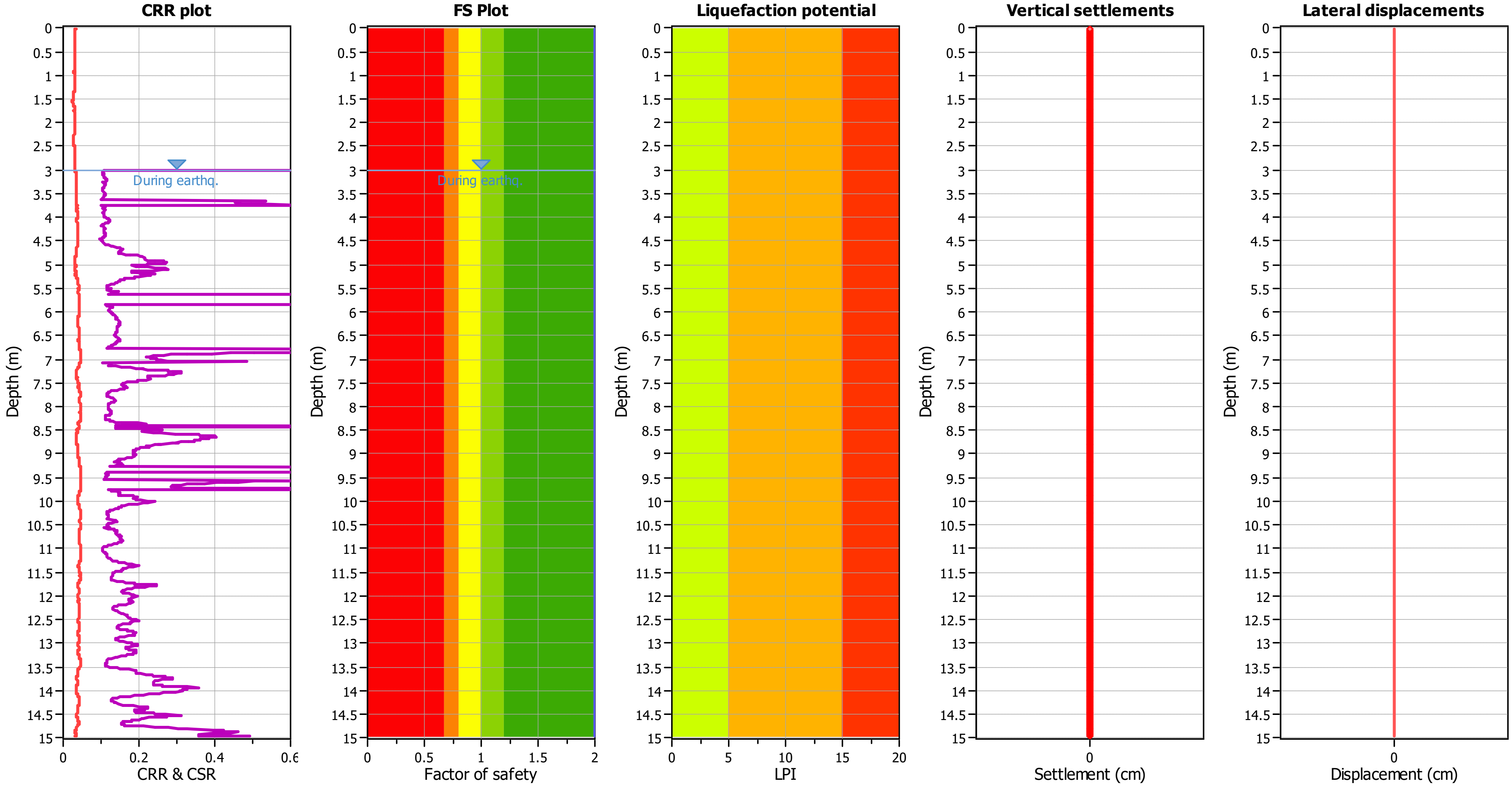
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

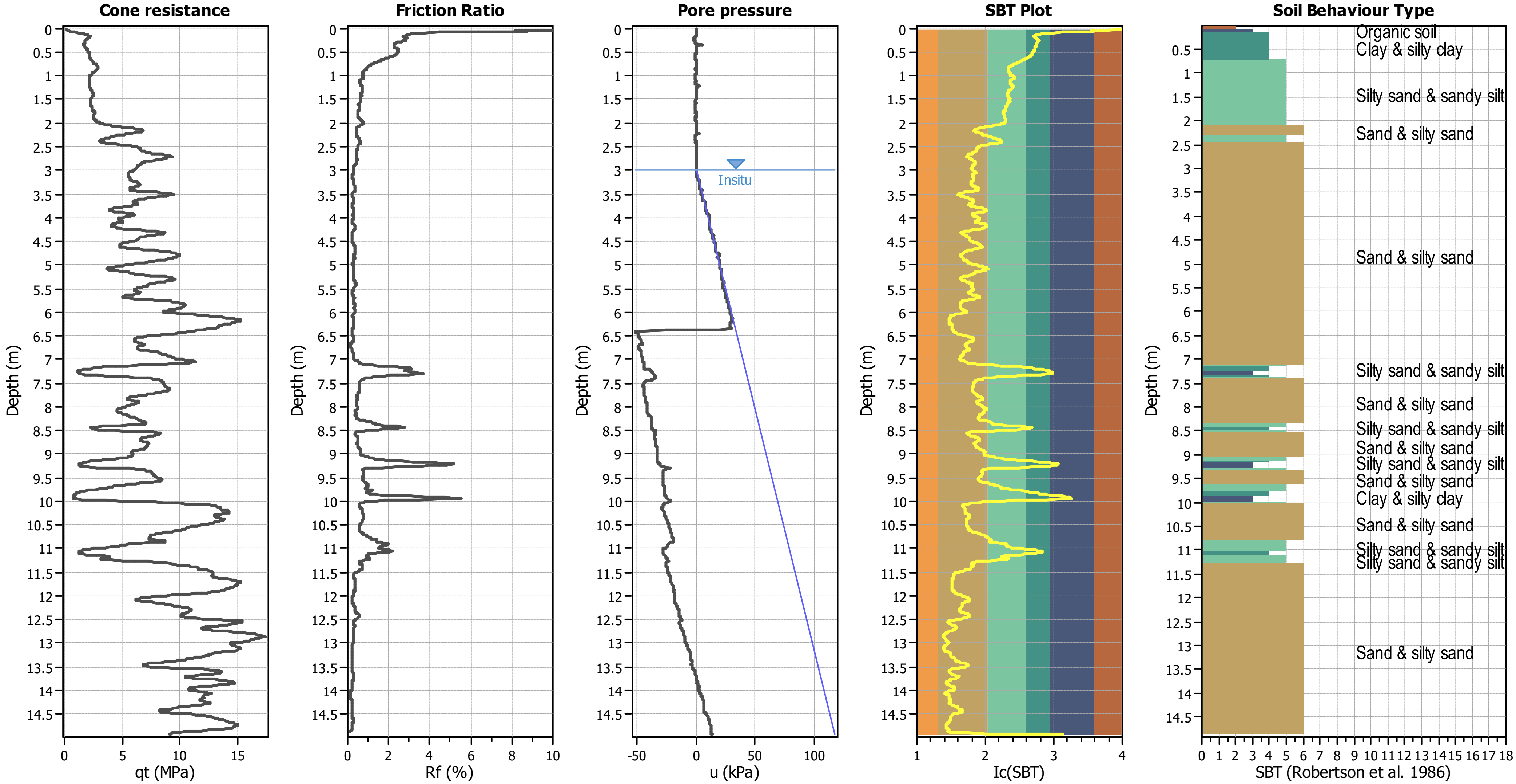
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



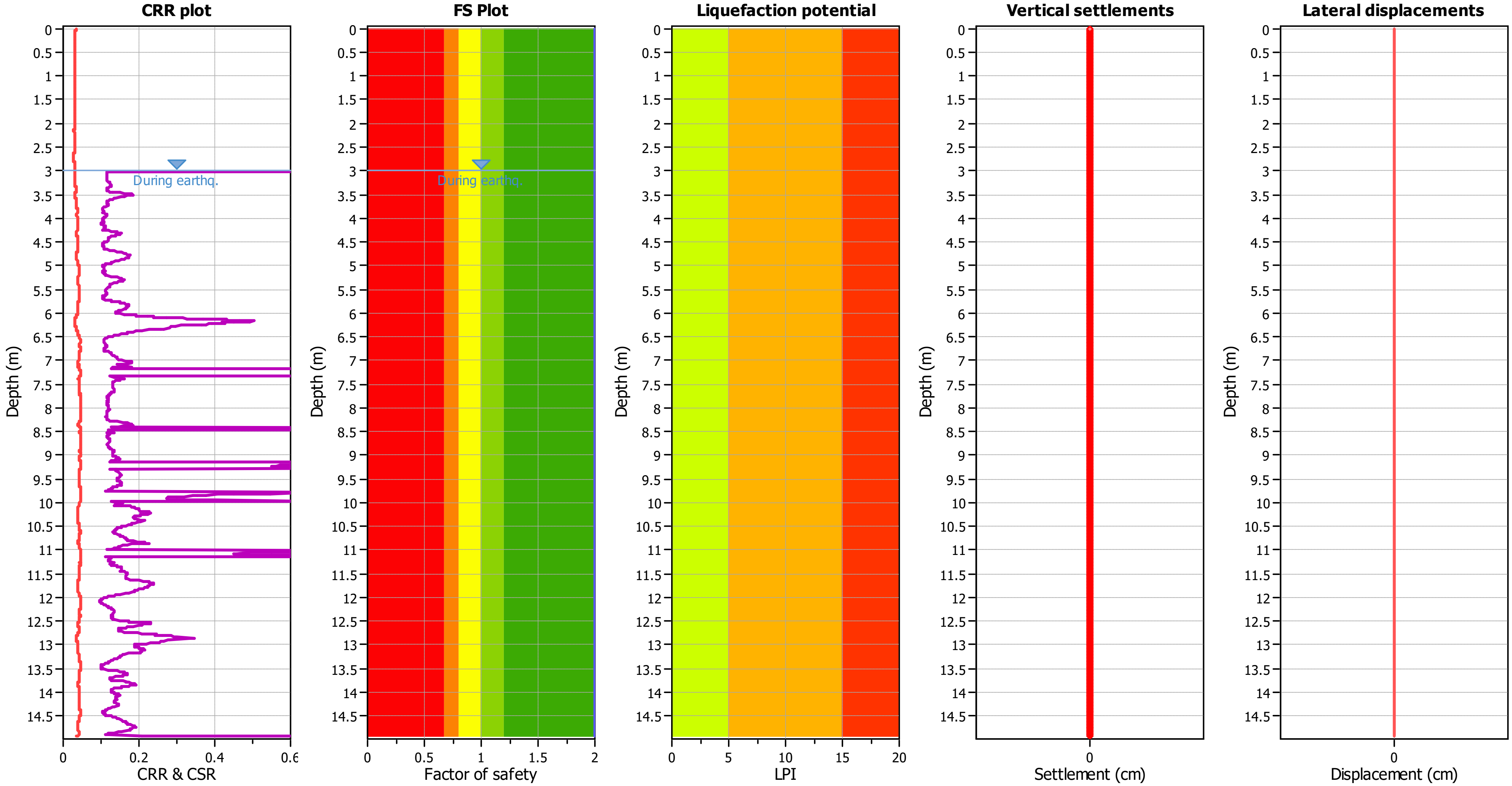
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

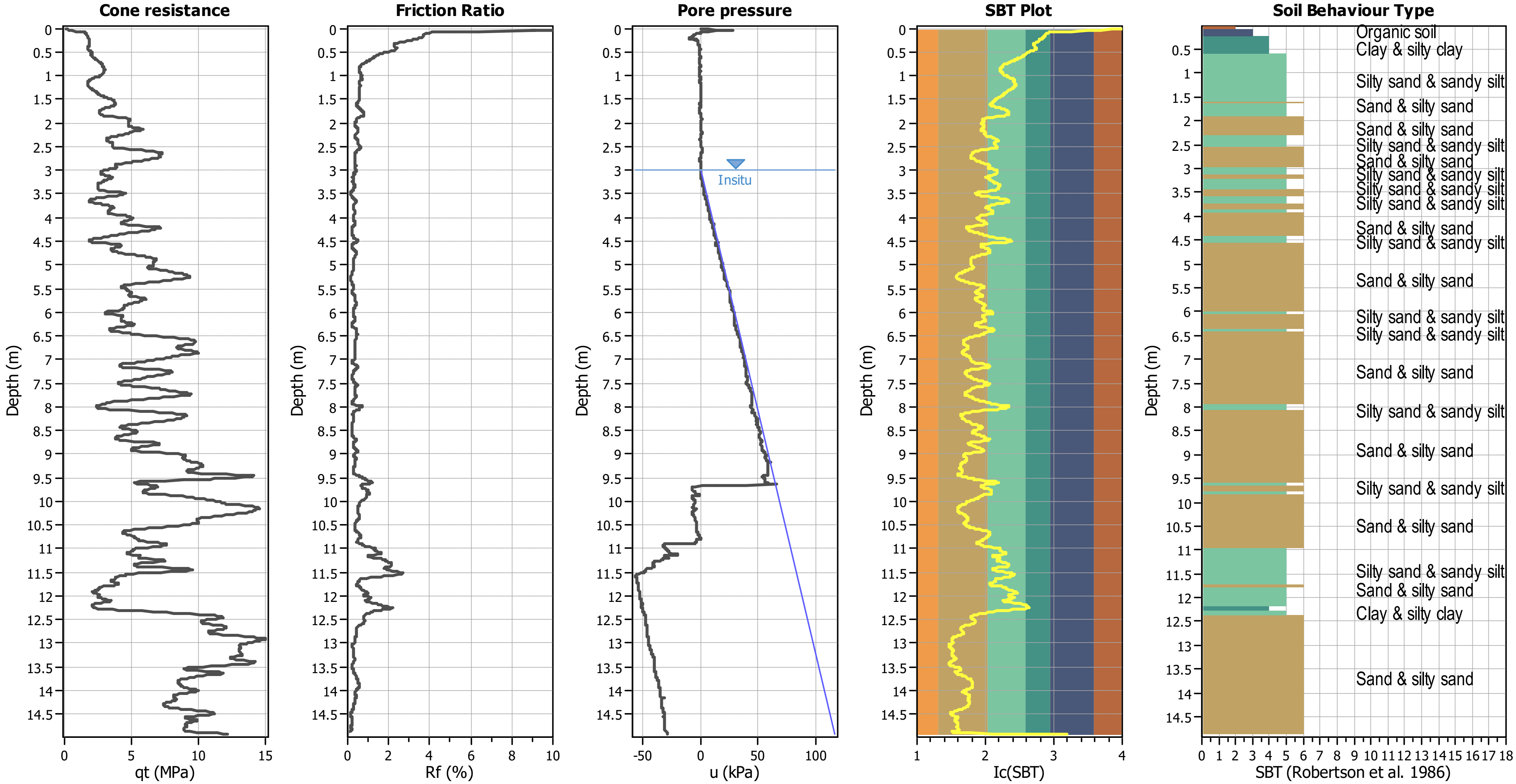
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



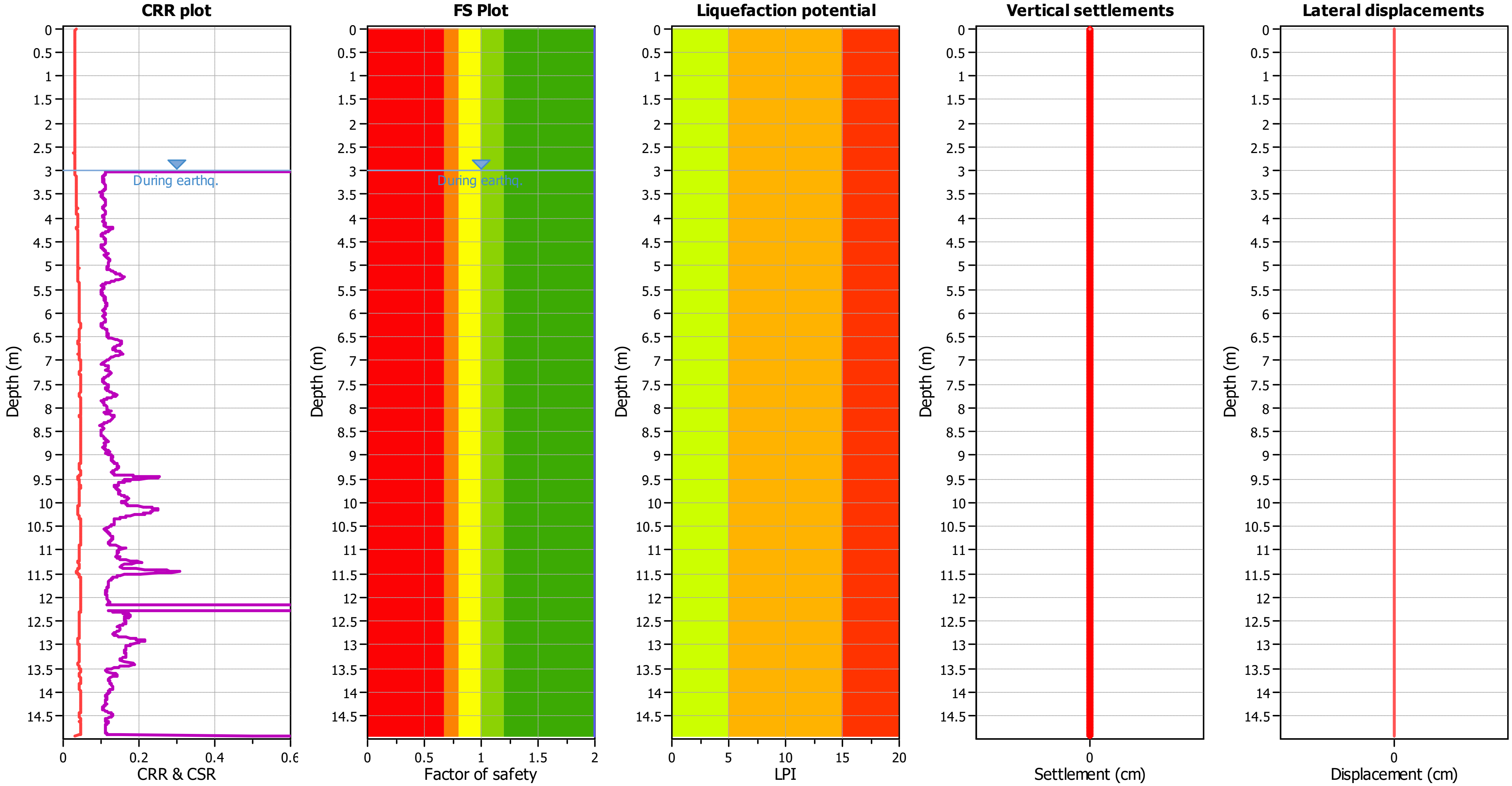
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

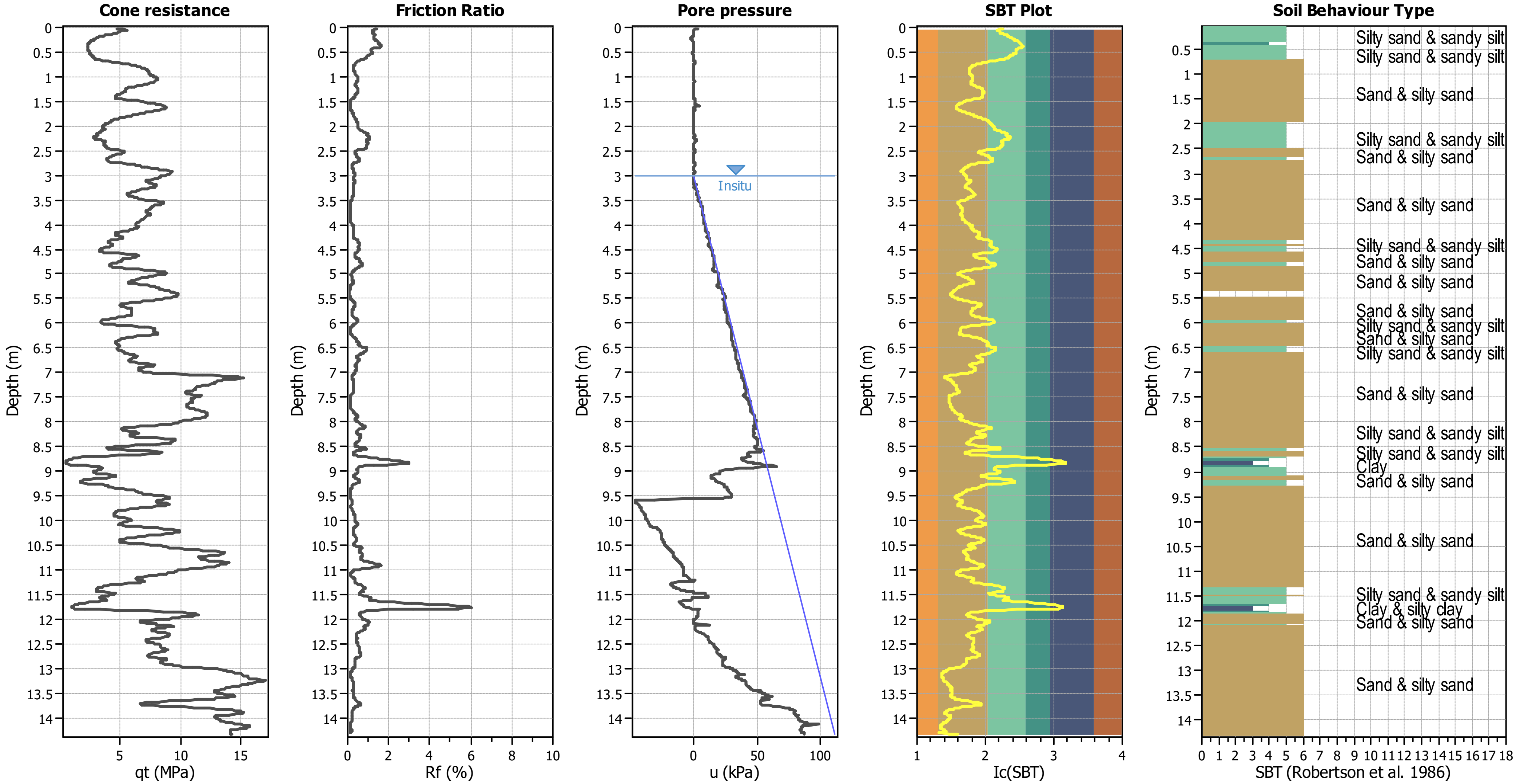
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



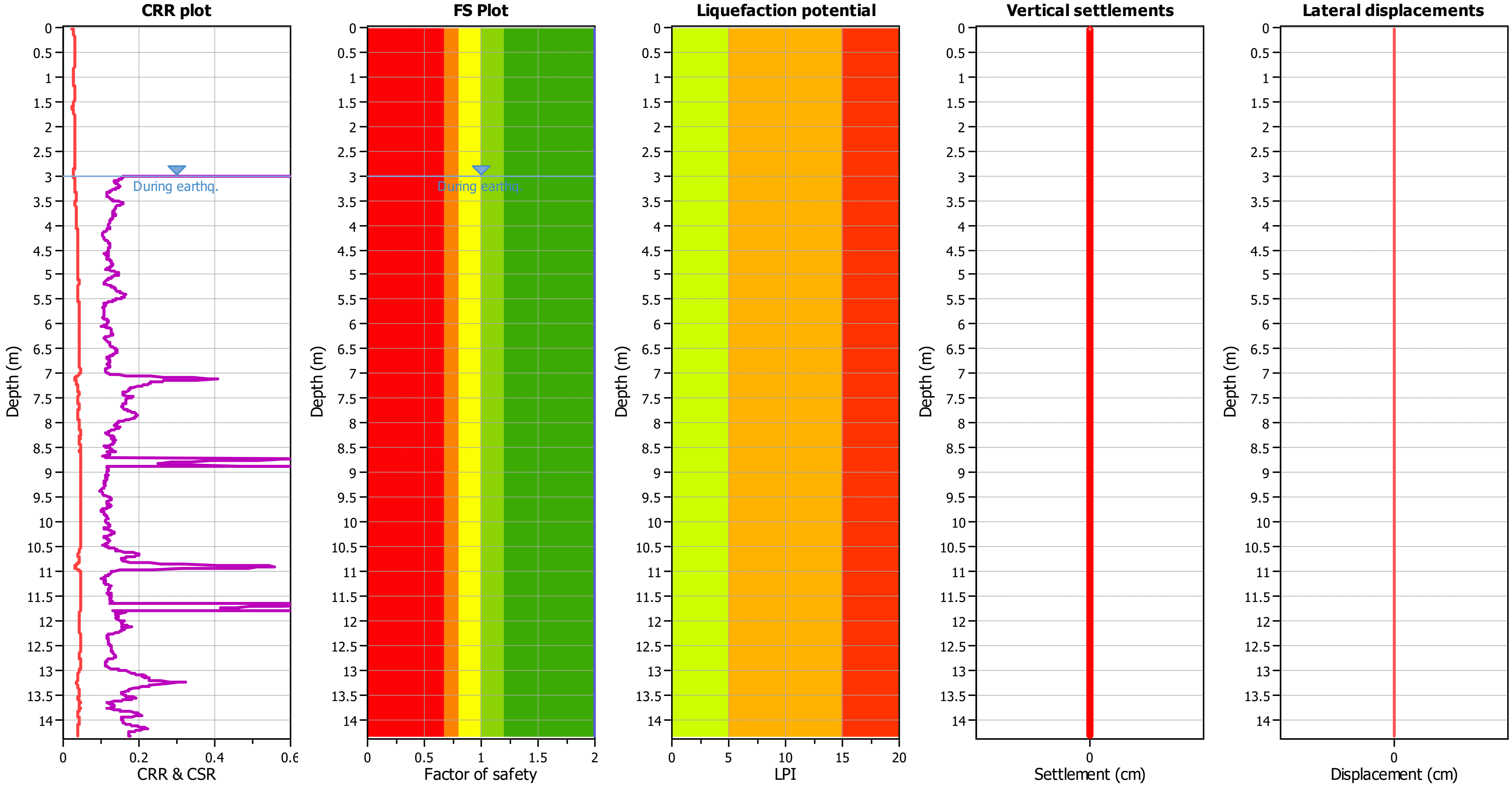
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

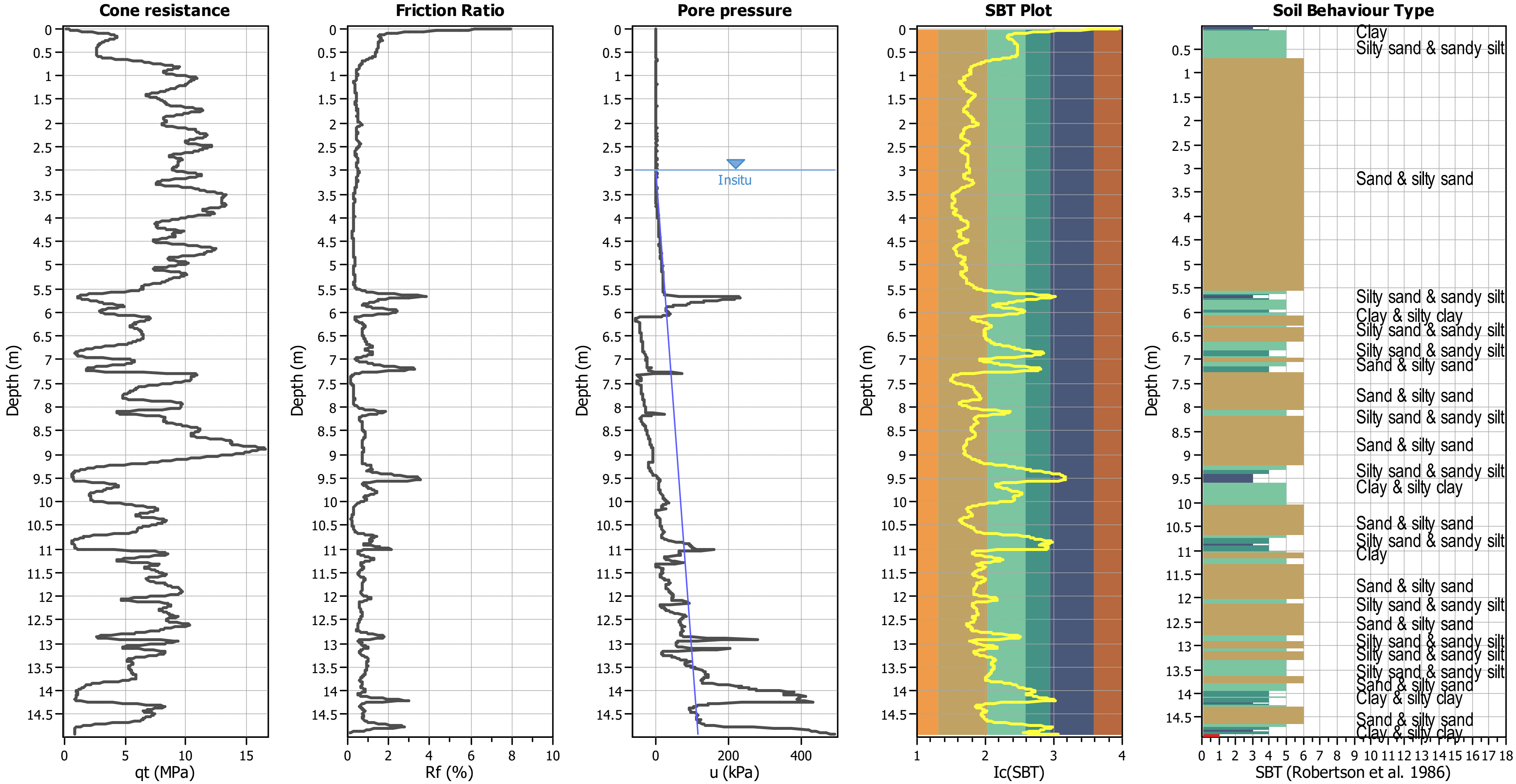
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



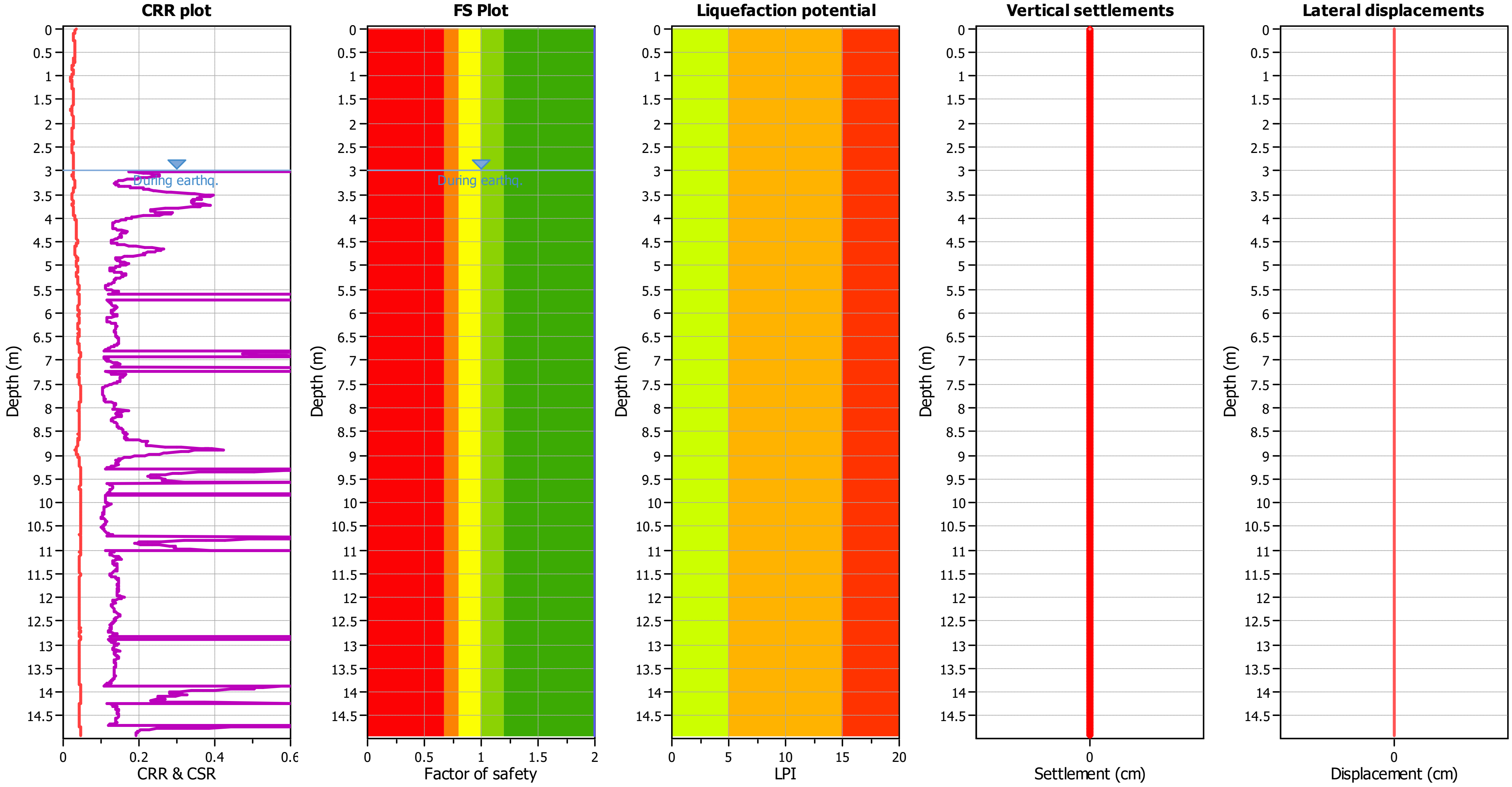
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

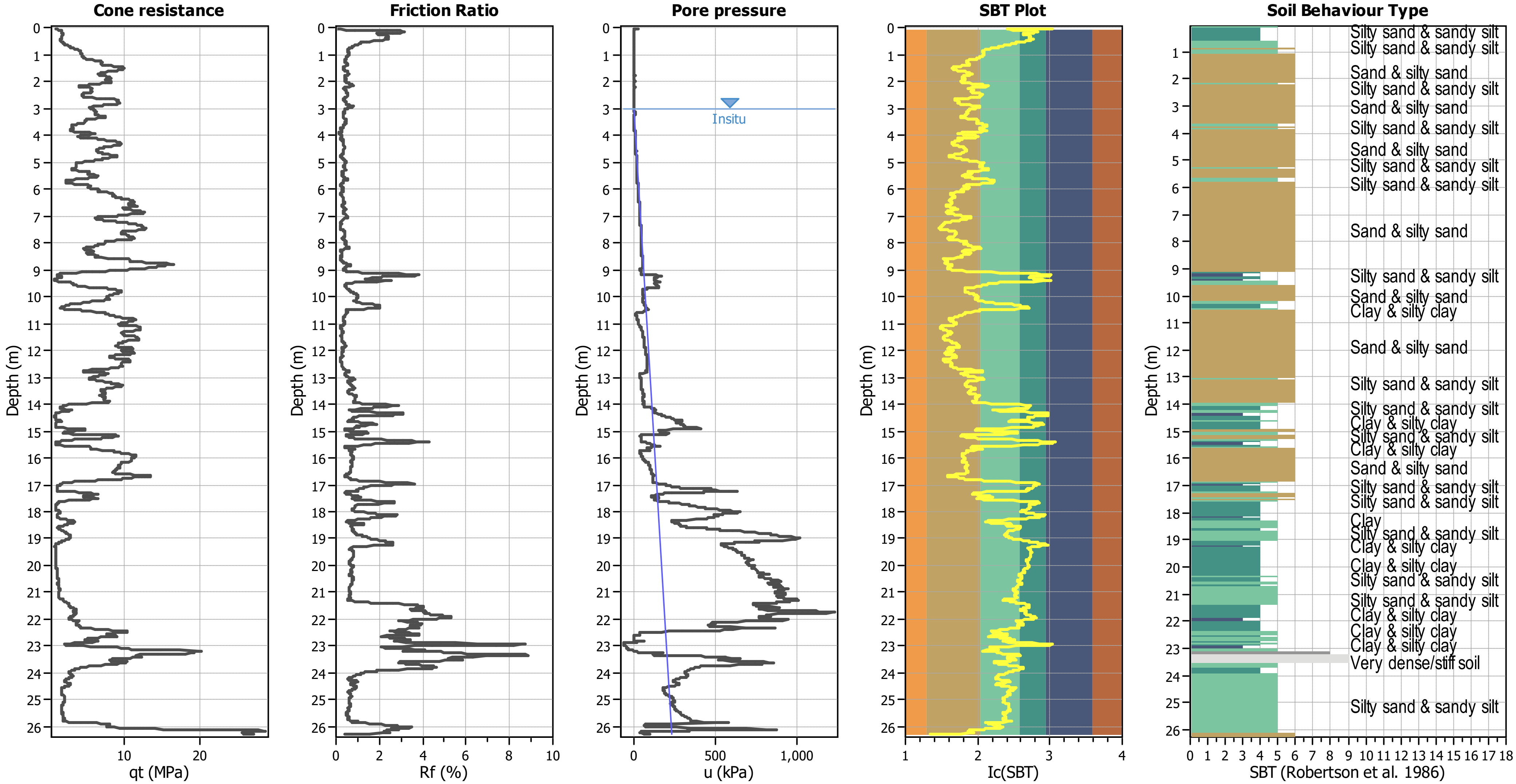
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



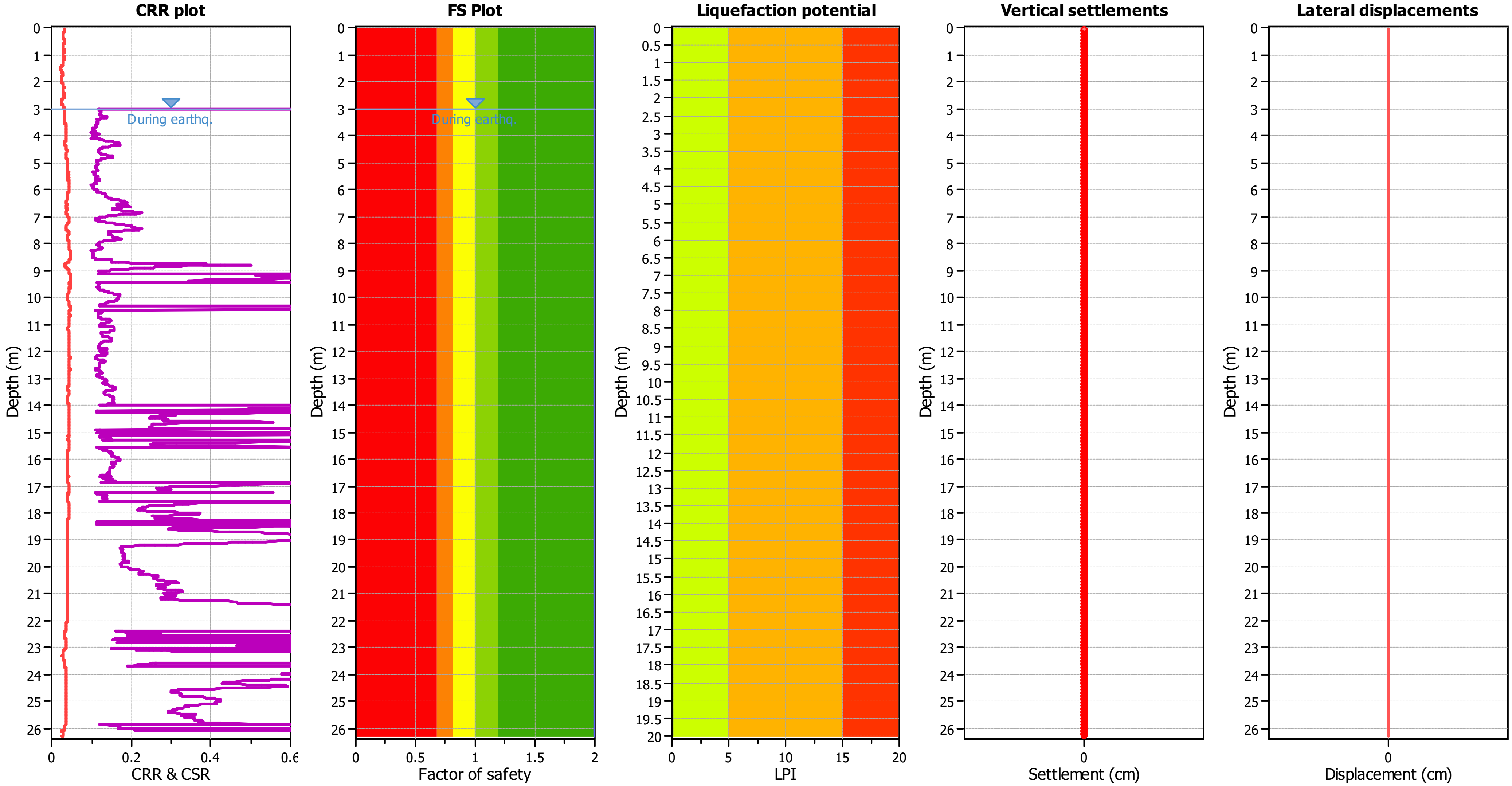
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

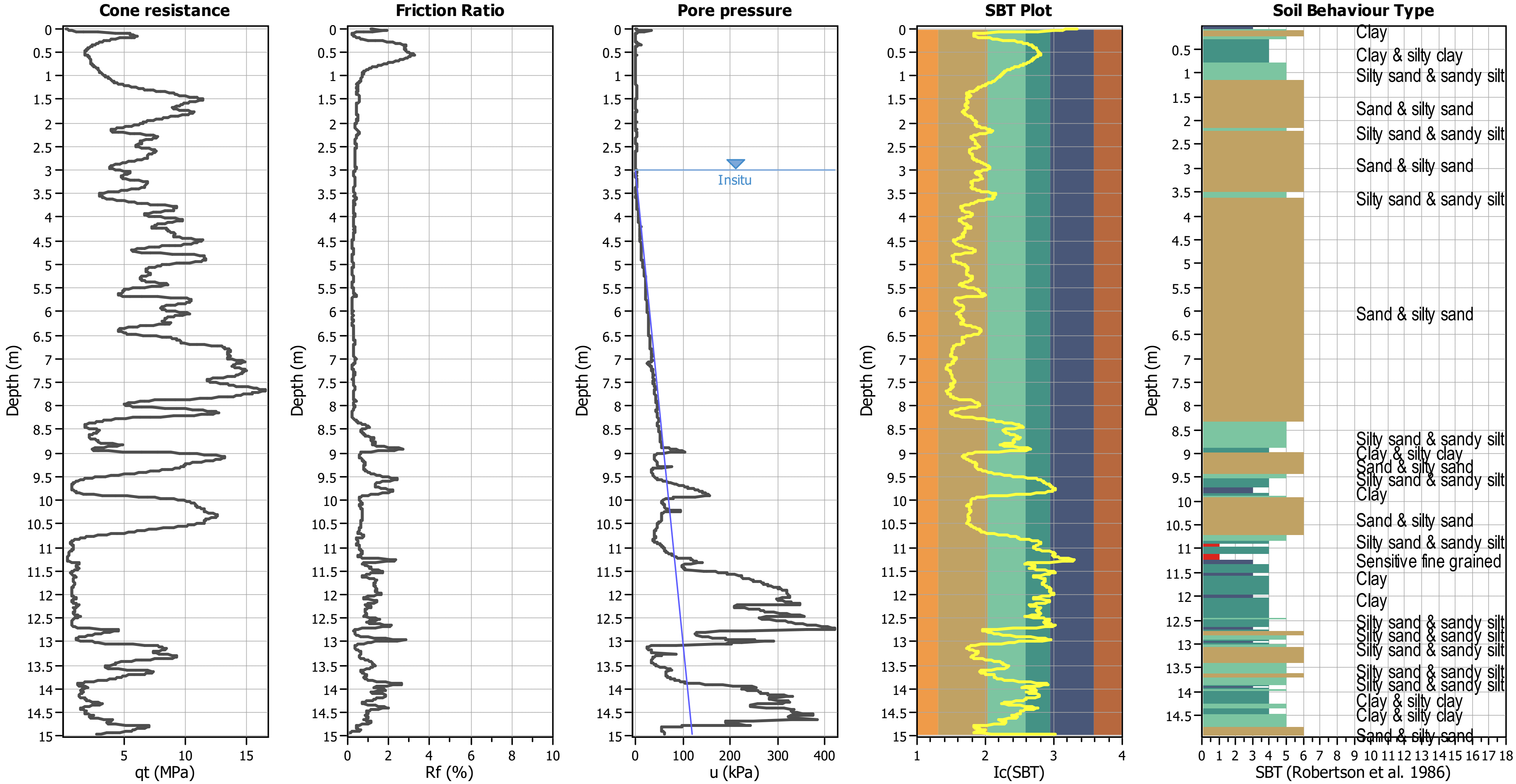
F.S. color scheme

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

LPI color scheme

- Very high risk
- High risk
- Low risk

CPT basic interpretation plots



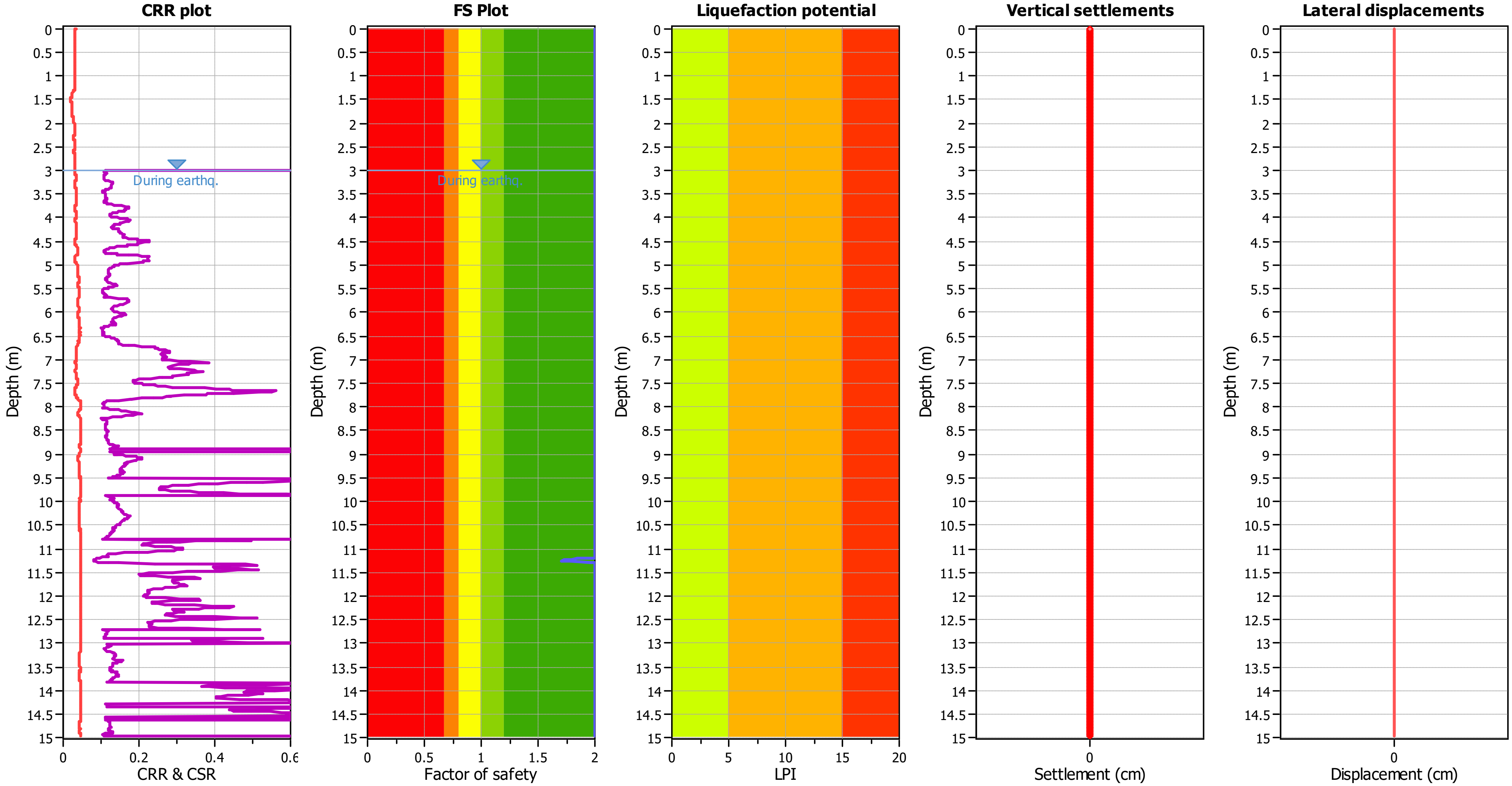
Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

SBT legend

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

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	3.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	5.90	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sand & Clay
Peak ground acceleration:	0.06	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	3.00 m	Fill height:	N/A	Limit depth:	N/A

F.S. color scheme

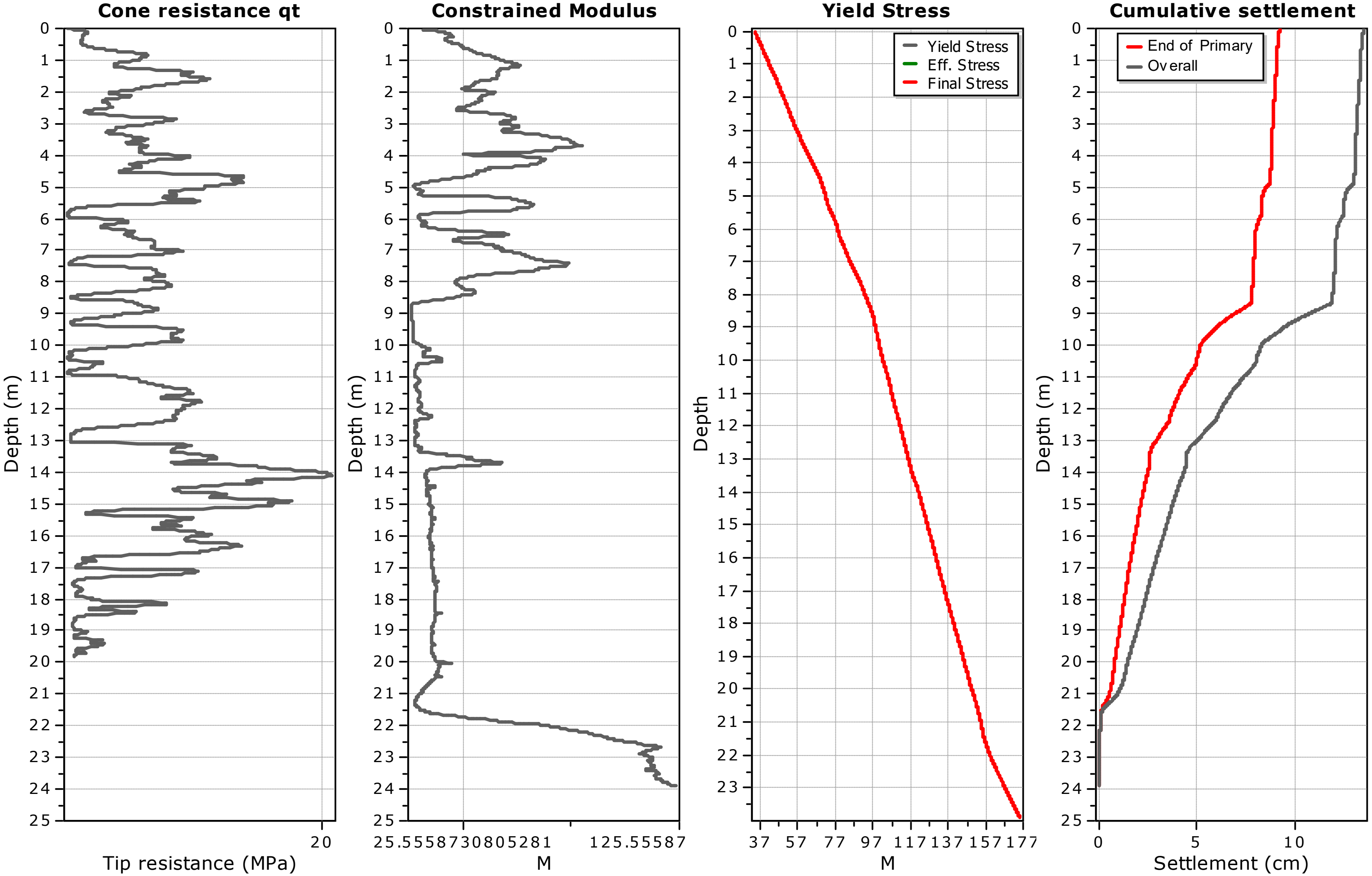
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LPI color scheme

- Very high risk
- High risk
- Low risk

Appendix E: Settlement Analysis Results

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

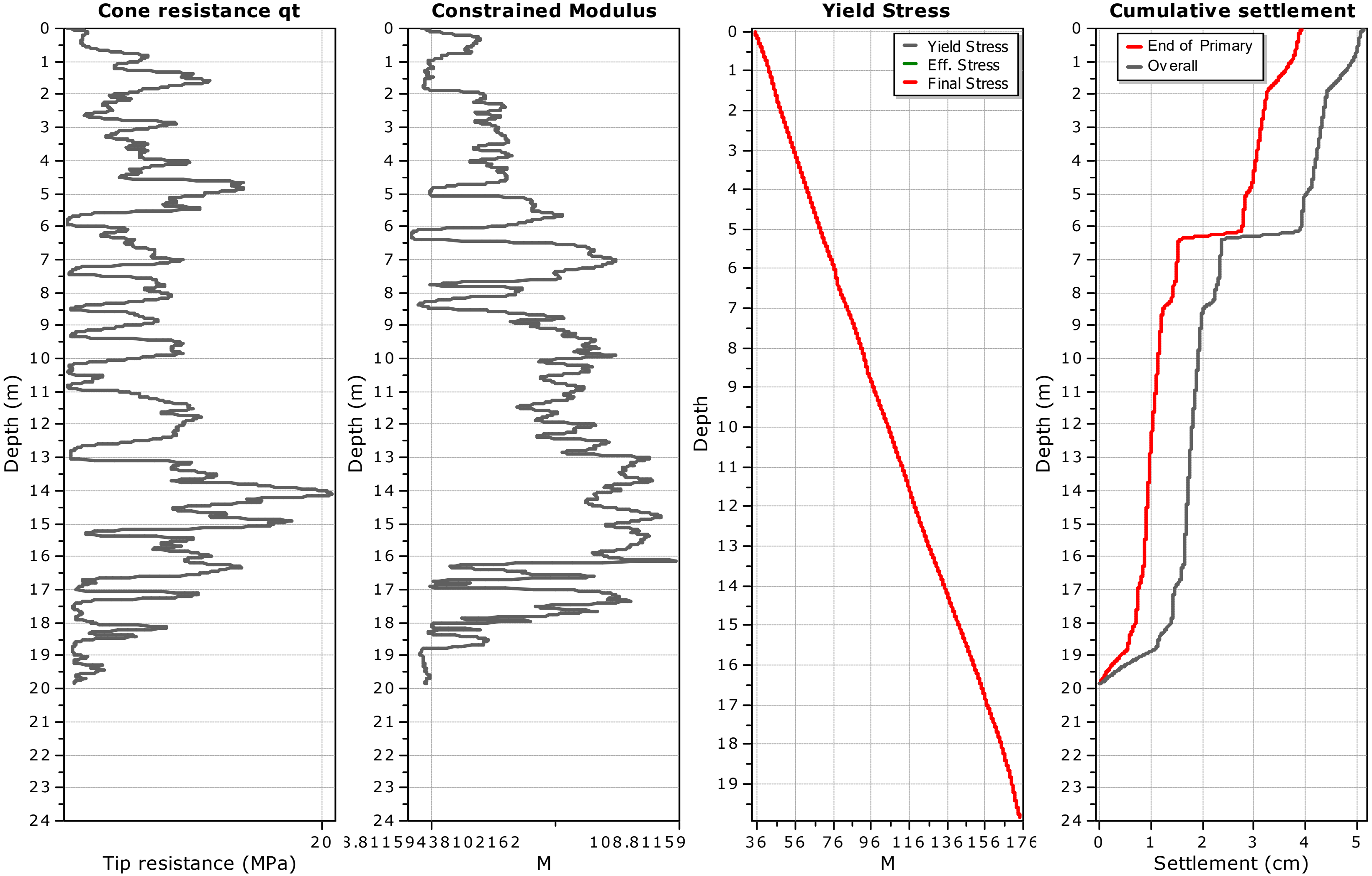
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

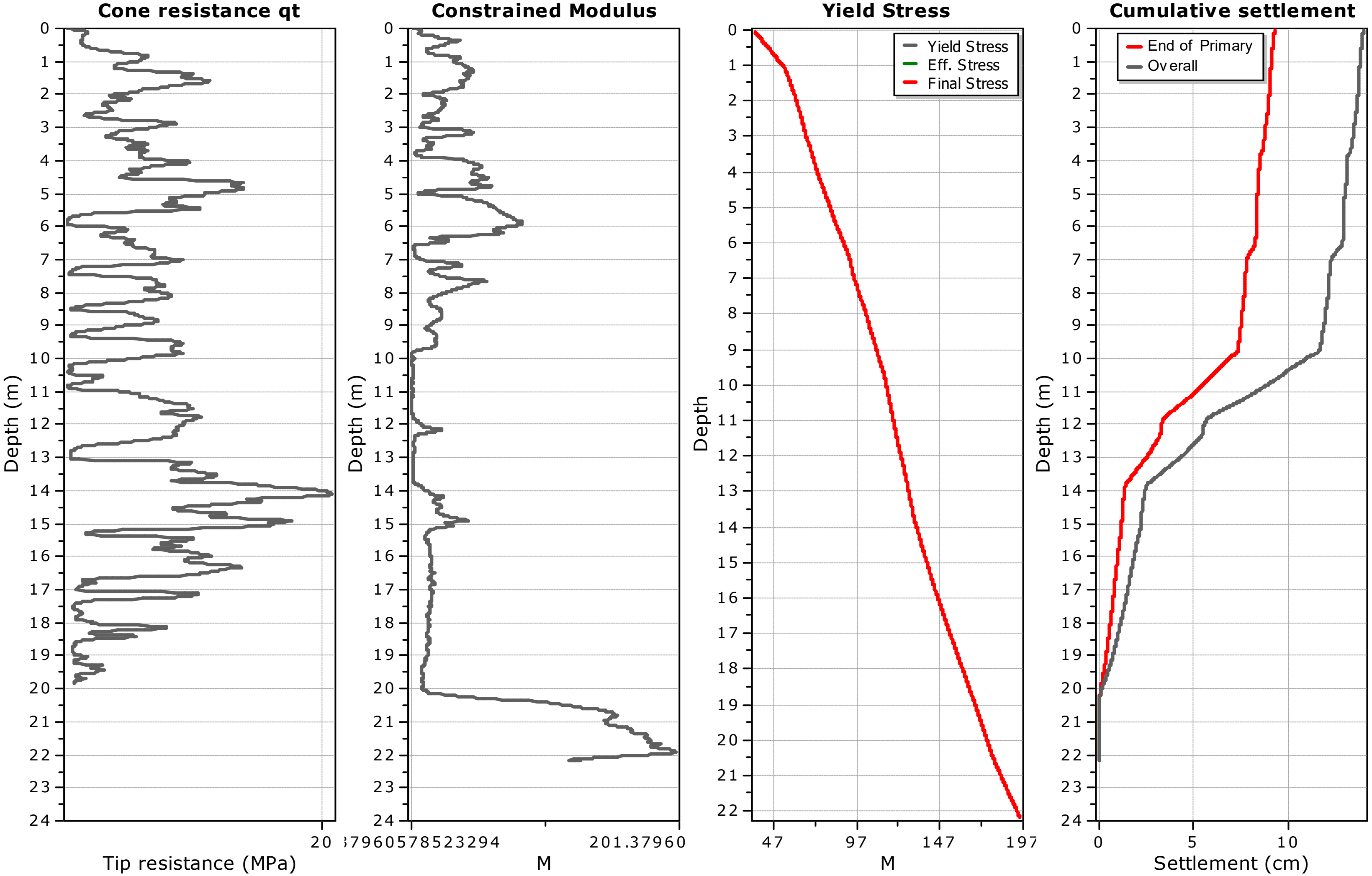
where t_p is the duration of primary consolidation

GeoLogismiki
Geotechnical Engineers
Merarhias 56
http://www.geologismiki.gr

CPT: CPT21-03
Total depth: 22.18 m, Date: 16/09/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.05 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

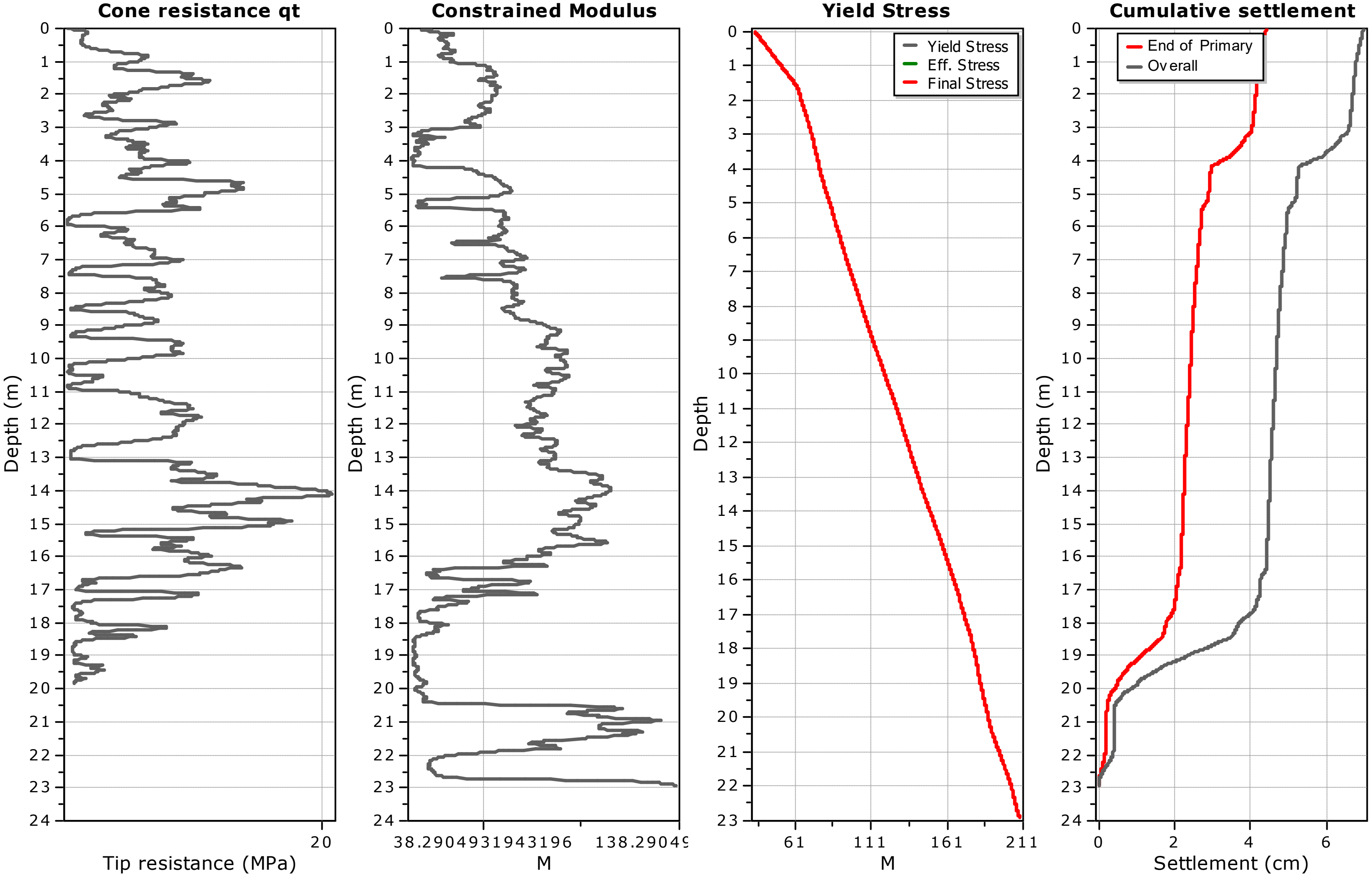
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

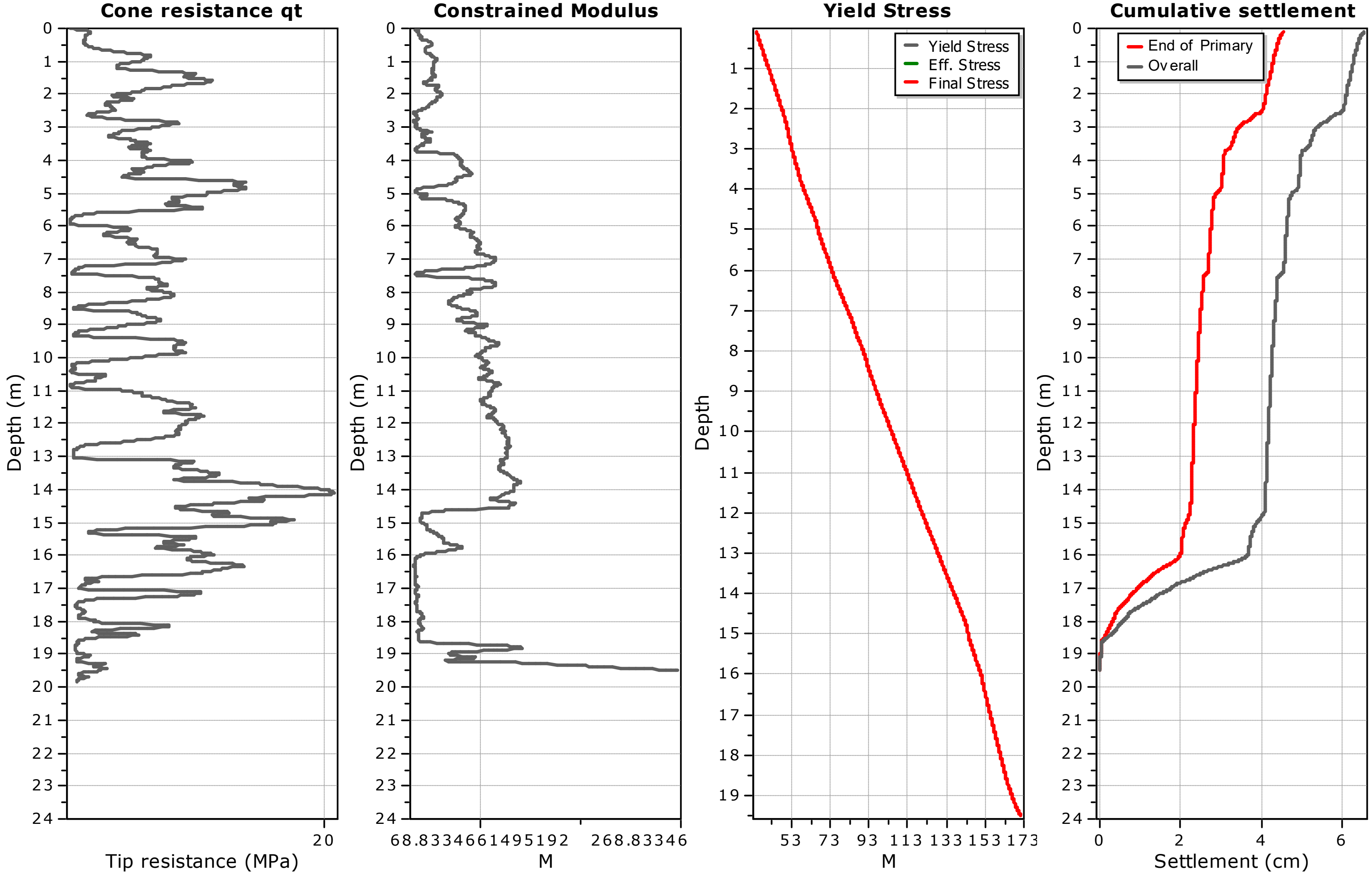
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

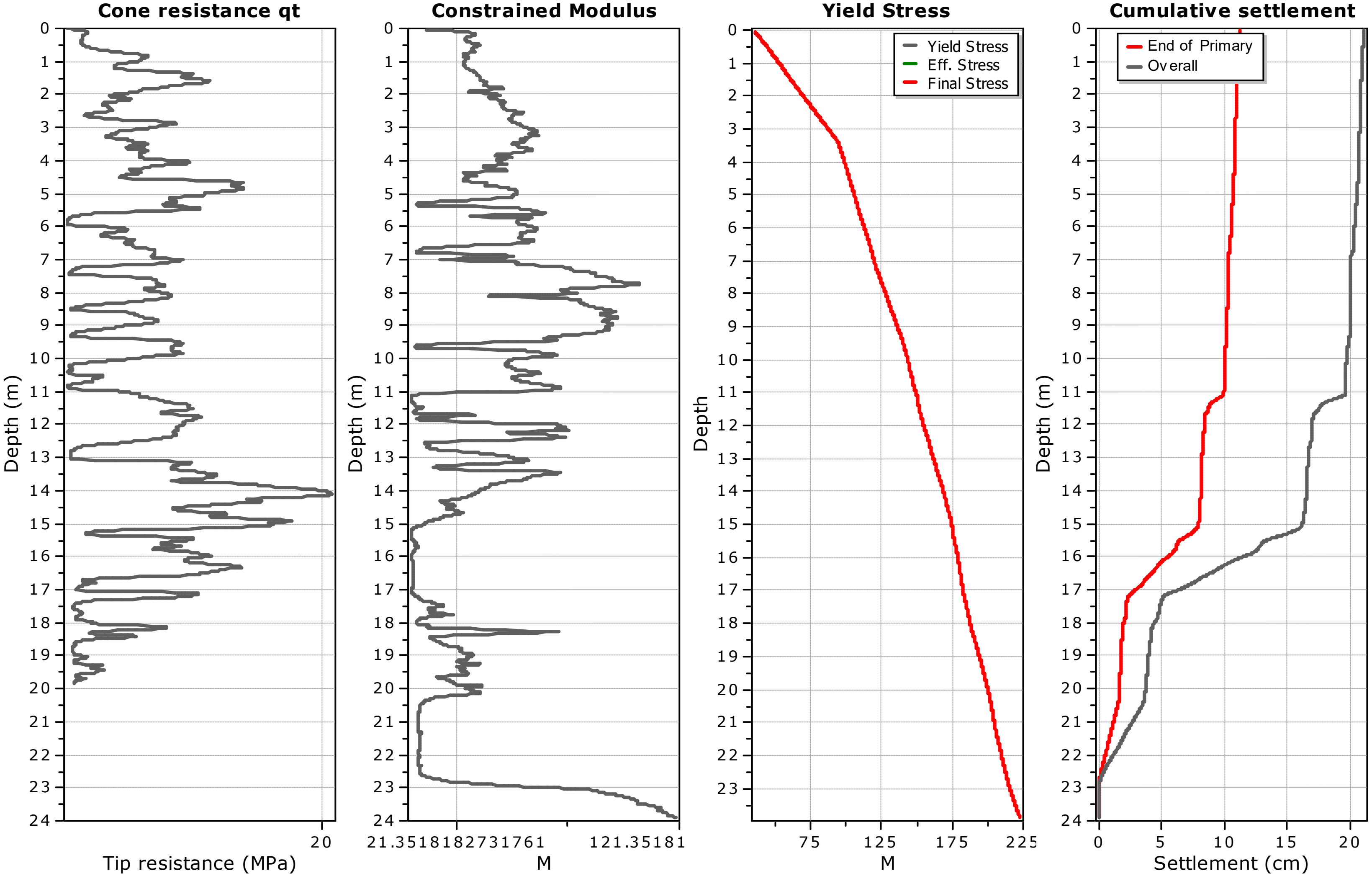
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.05 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

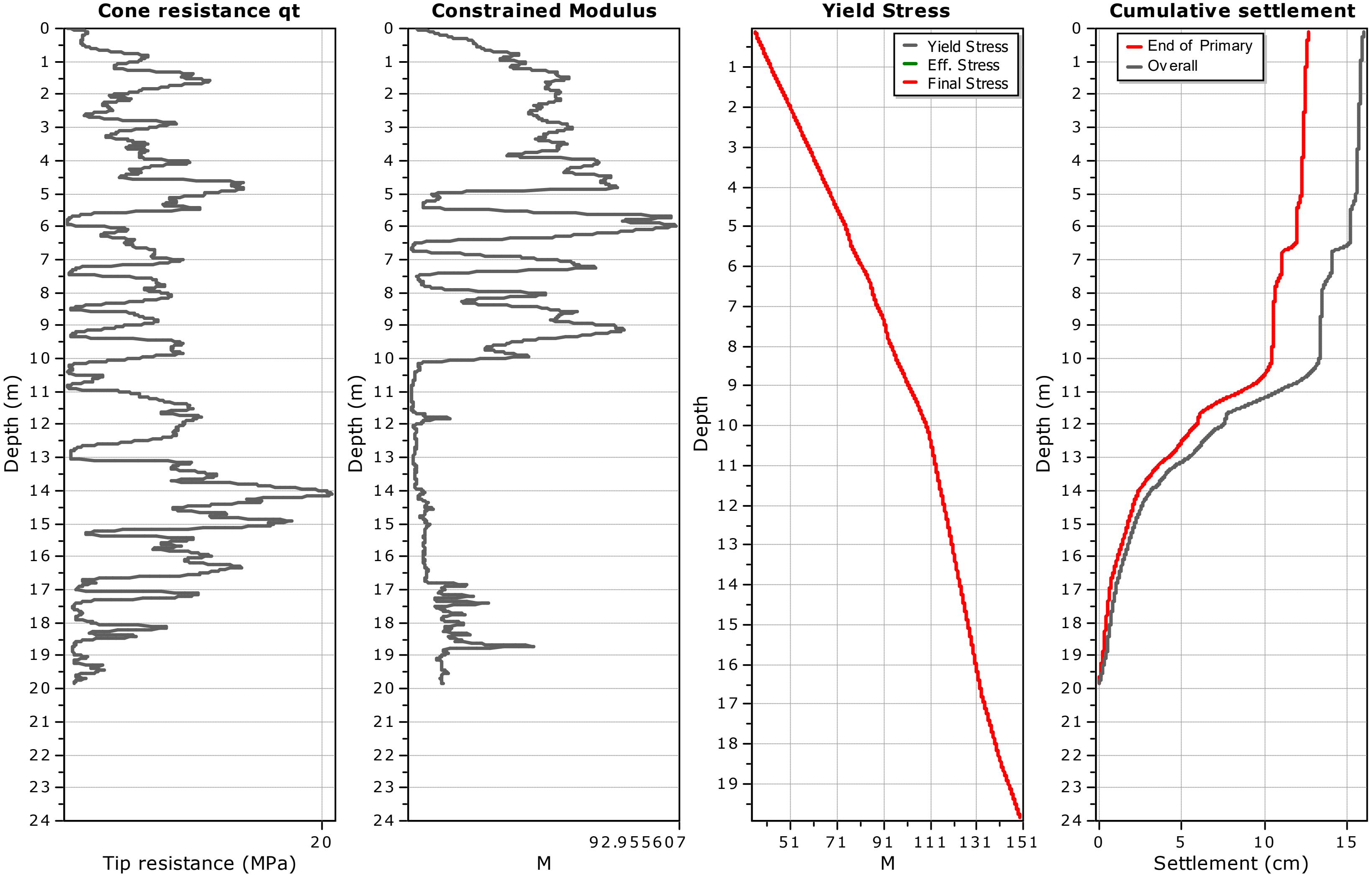
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

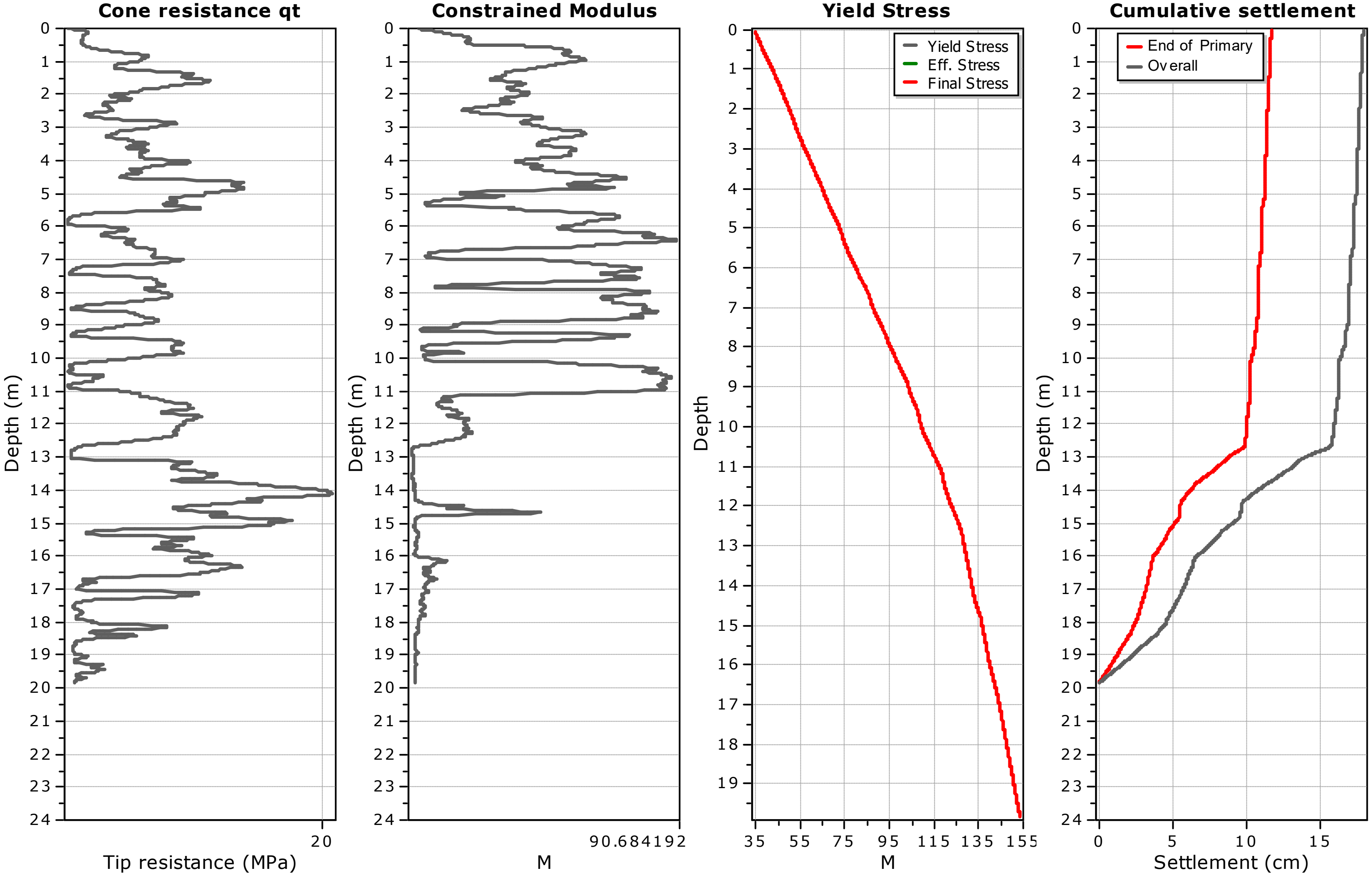
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

CPT: CPT14-02
Total depth: 19.83 m, Date: 16/09/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.05 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

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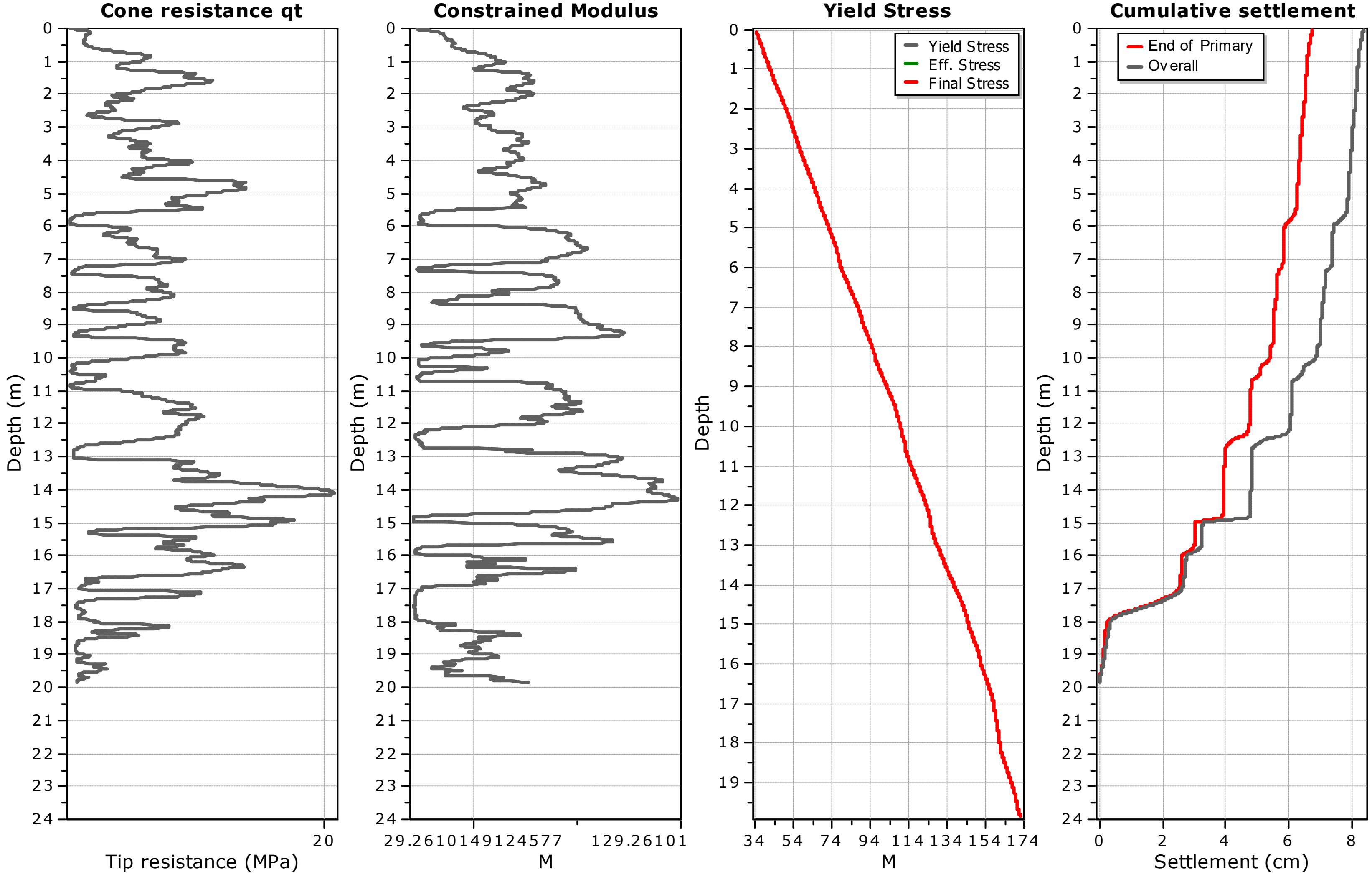
CPT: CPT14-03
Total depth: 19.84 m, Date: 16/09/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.05 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

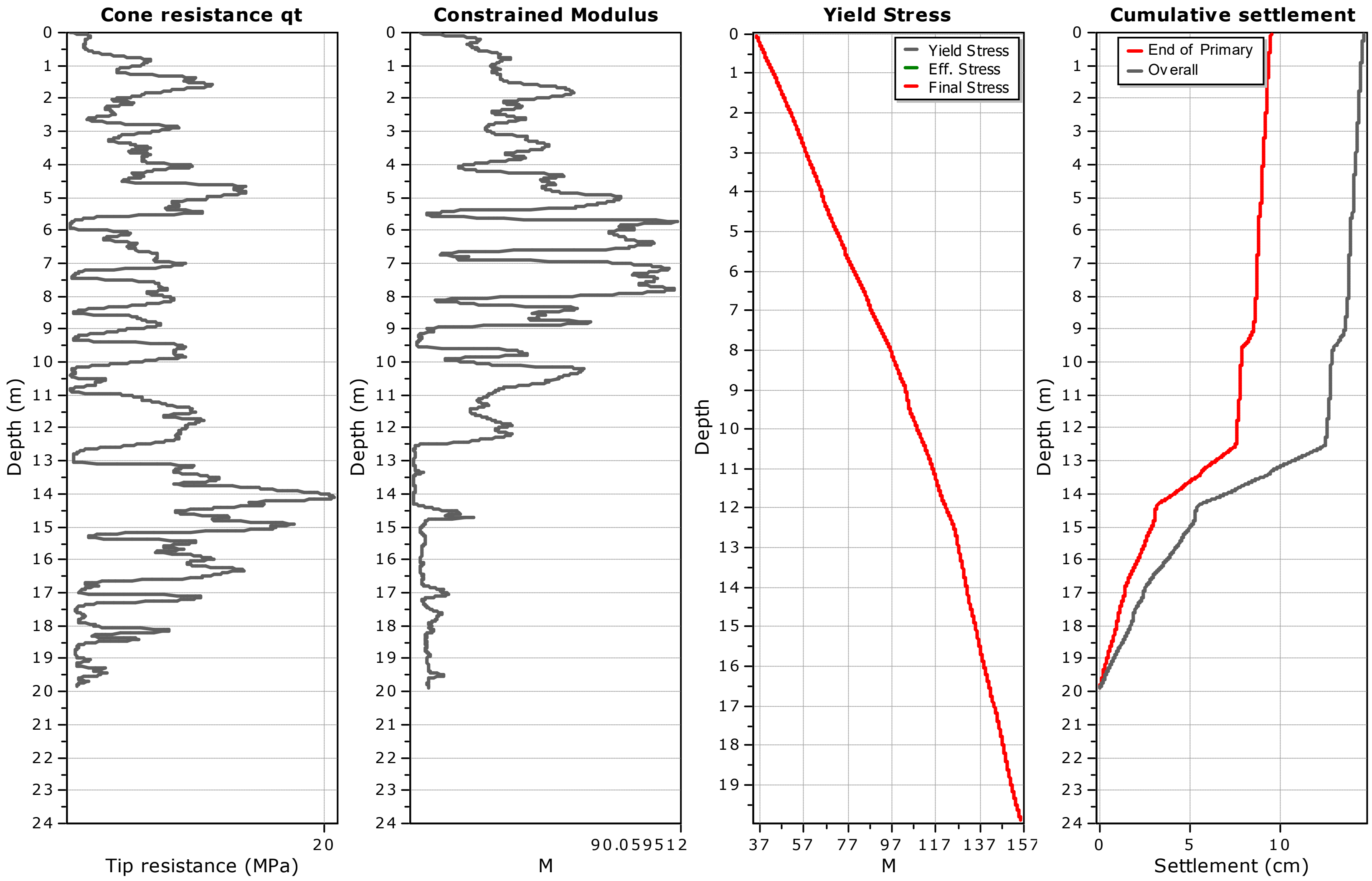
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.05 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

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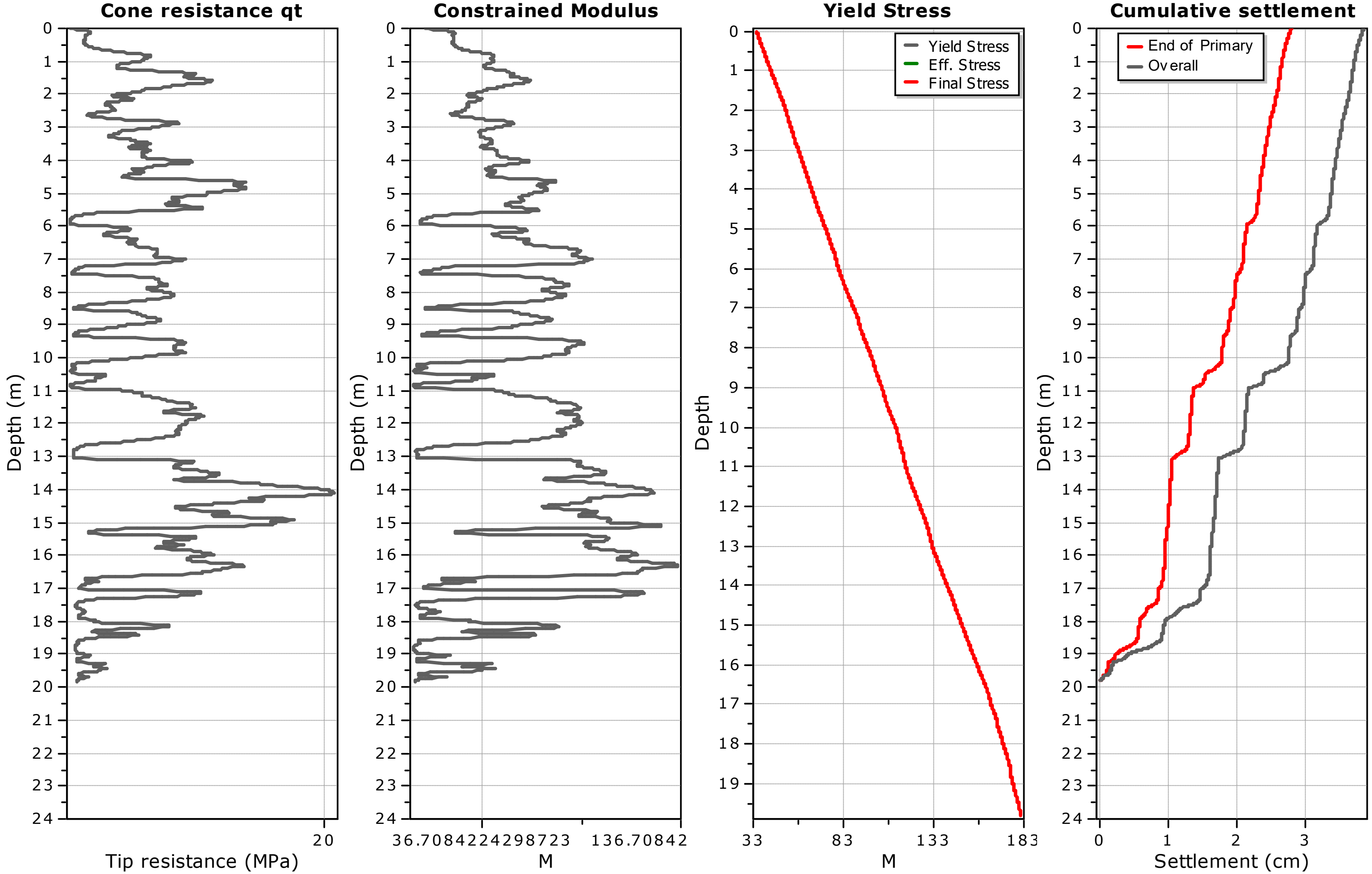
CPT: CPT14-05
Total depth: 19.82 m, Date: 16/09/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00

Project:
Location:

Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.00 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

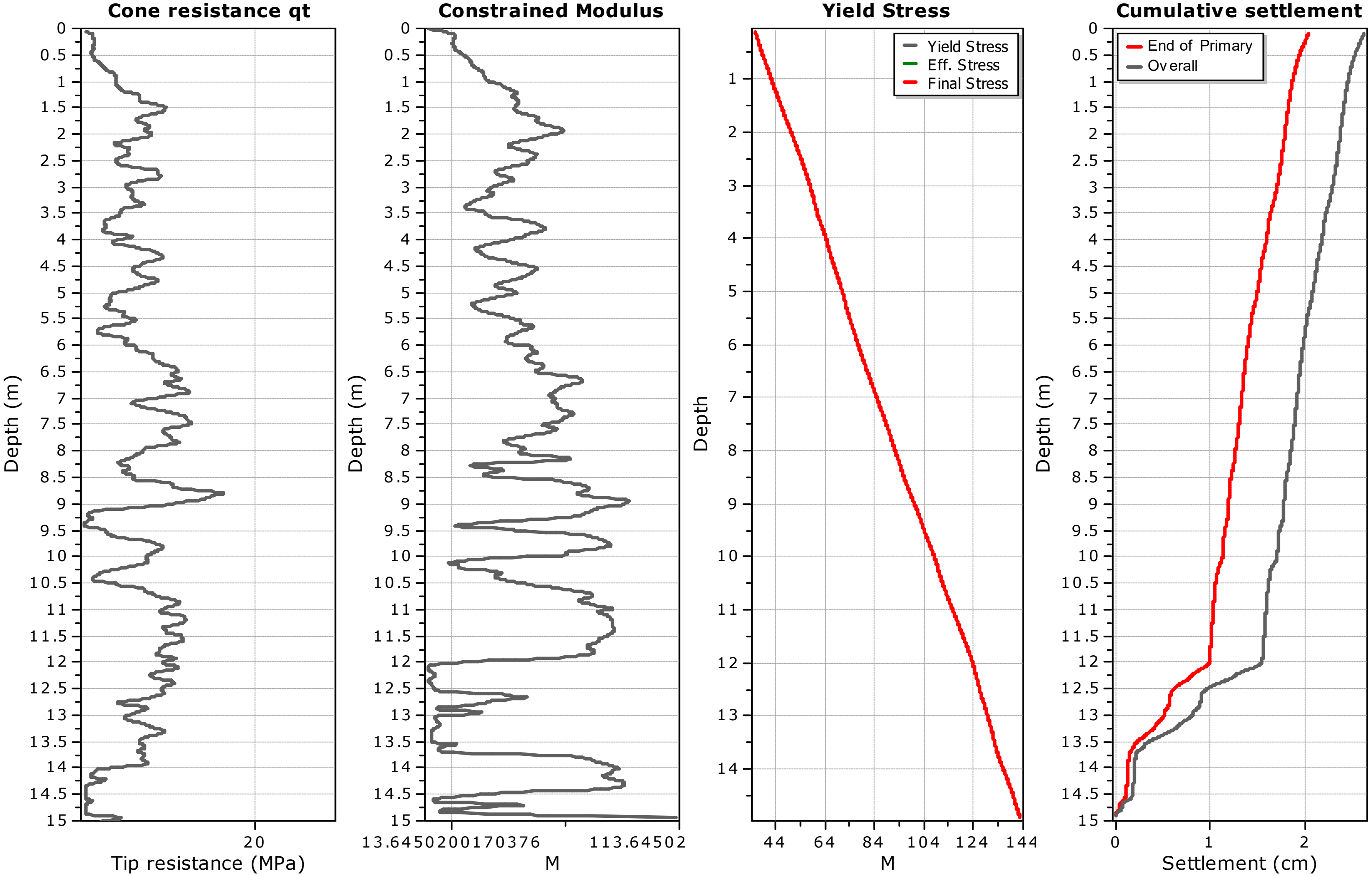
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

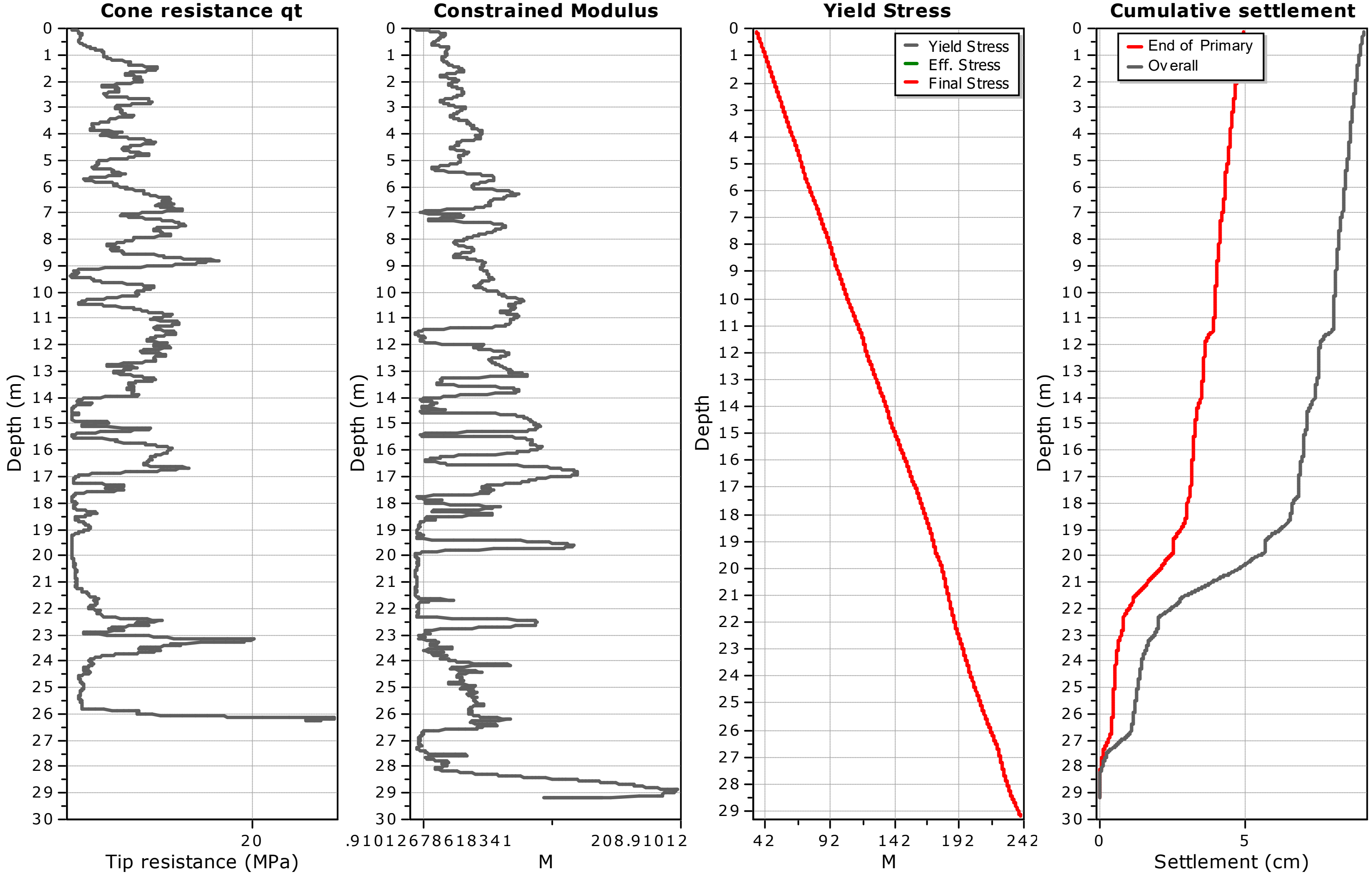
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

$$S = \sum \frac{\Delta \sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

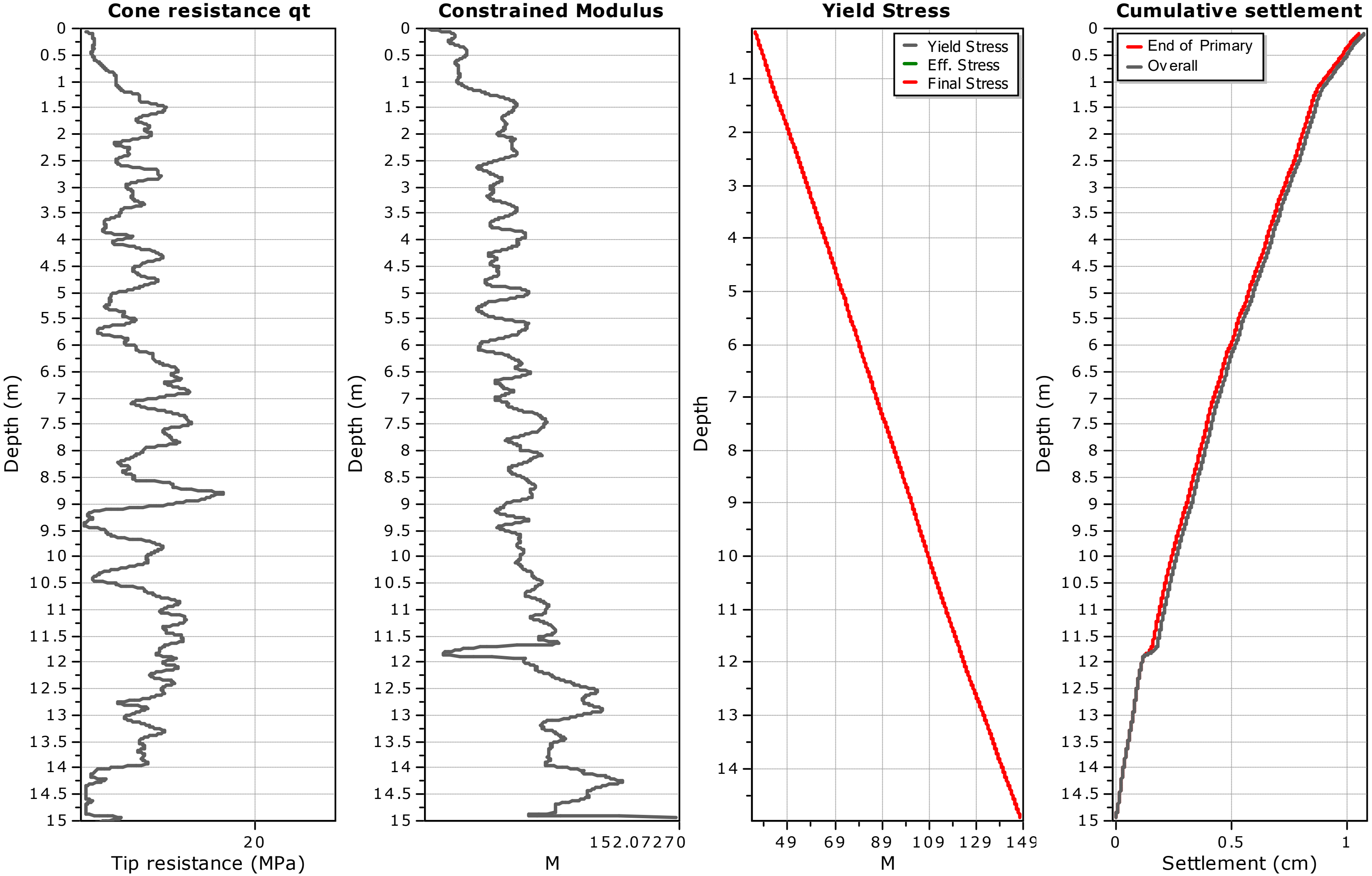
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

CPT: CPT11-03
Total depth: 14.93 m, Date: 20/09/2021
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Project:
Location:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

* Primary settlement calculation is performed according to the following formula:

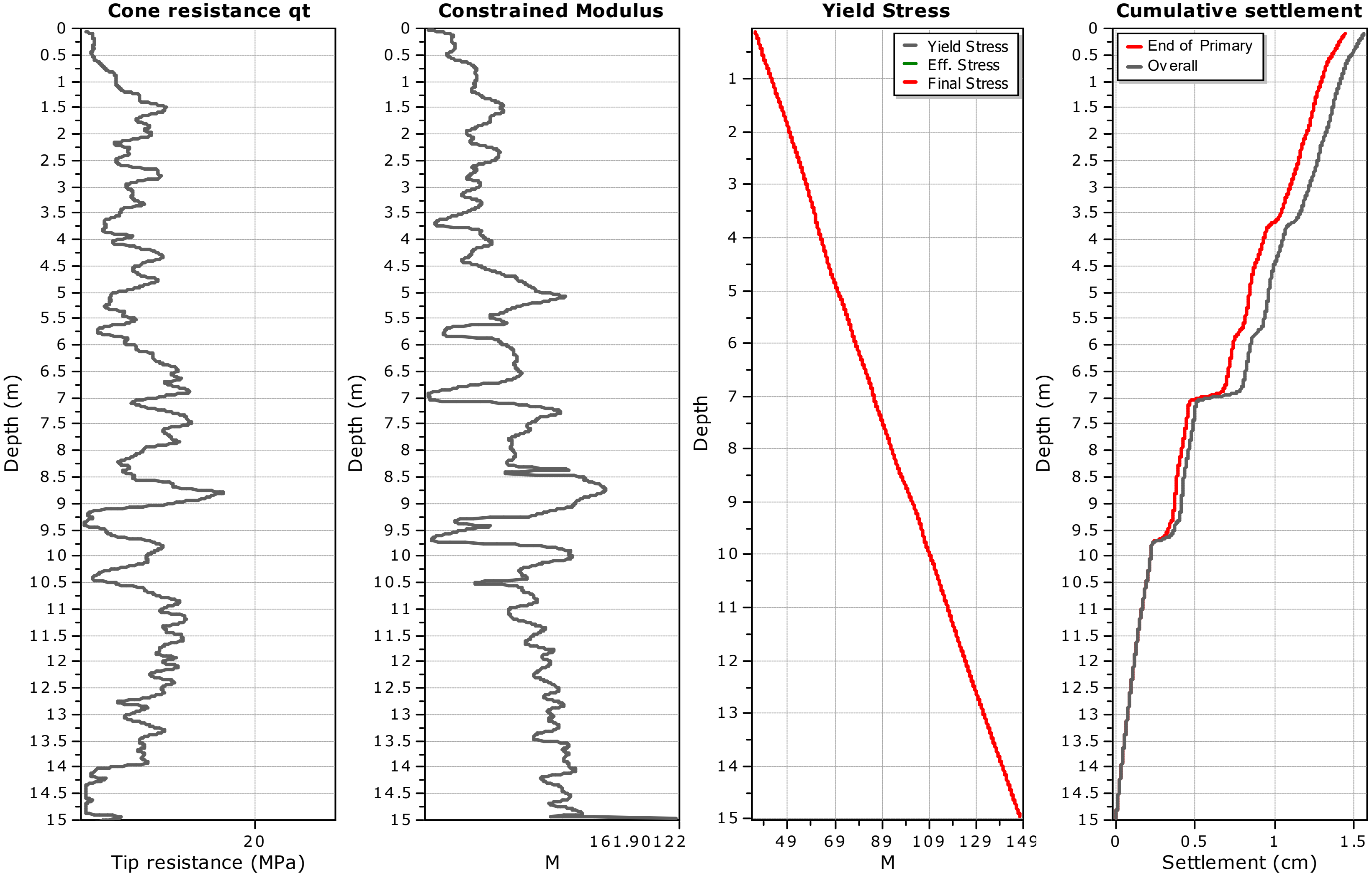
$$S = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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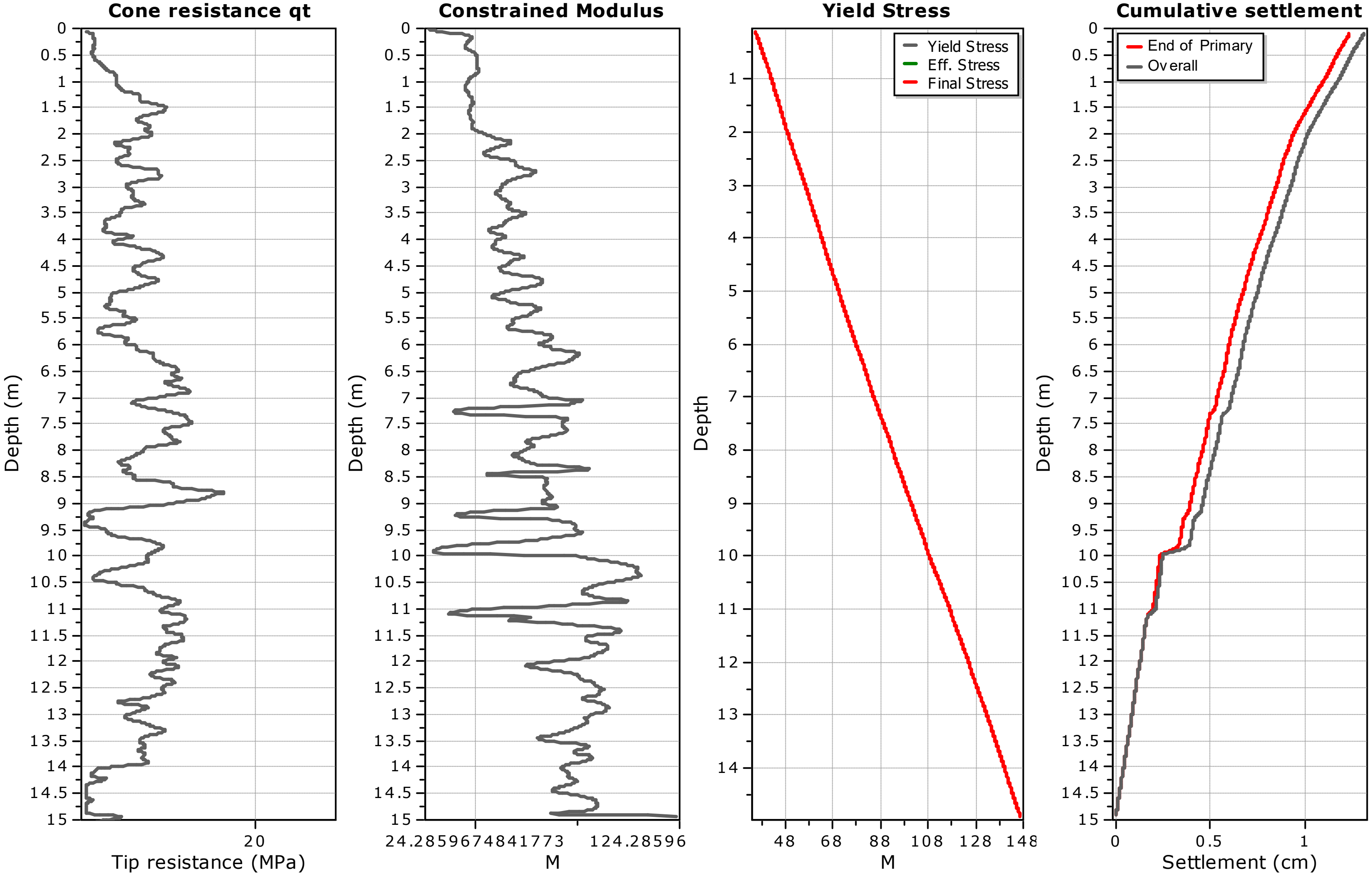
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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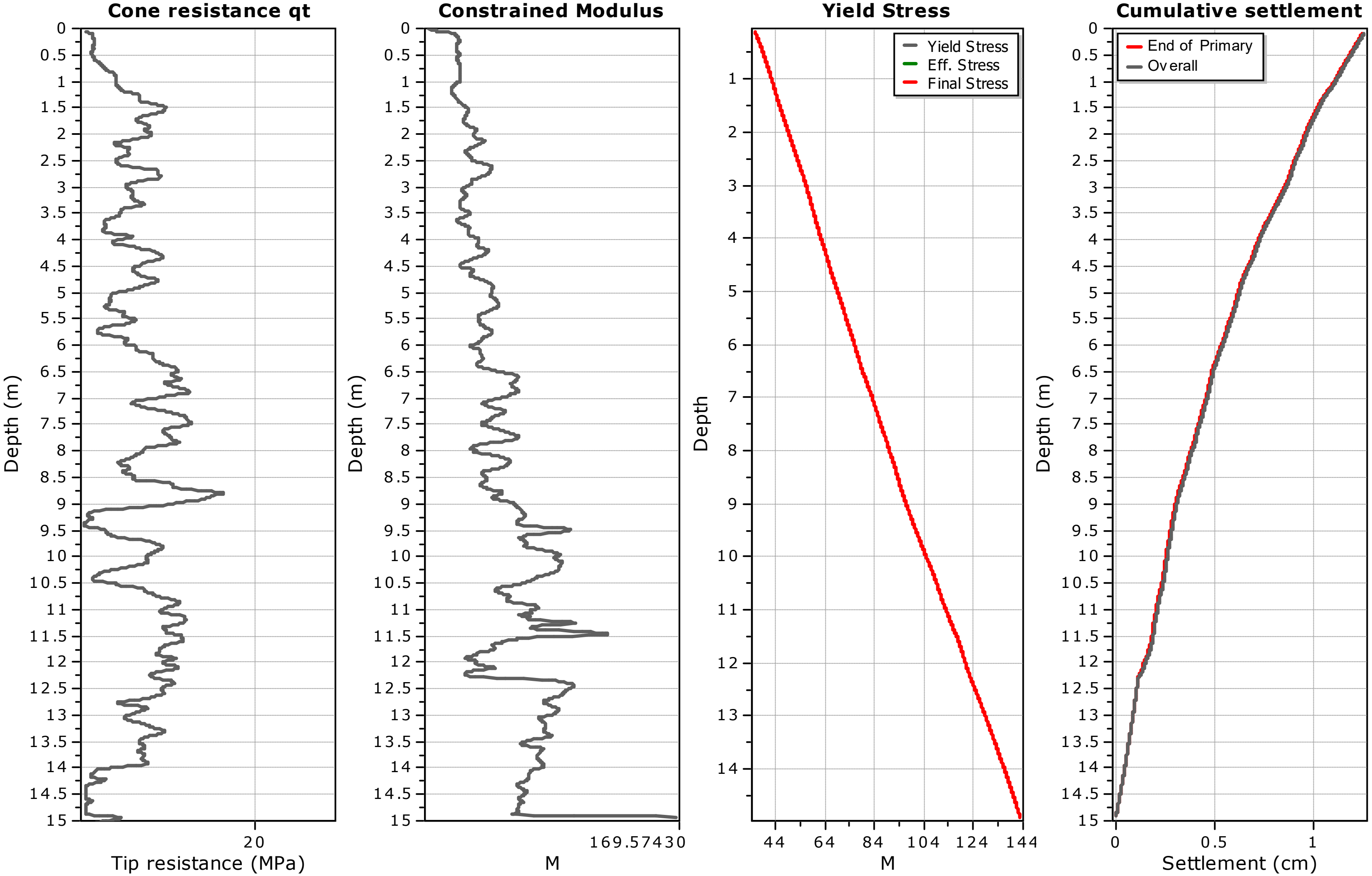
Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
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Apply 20% rule: No
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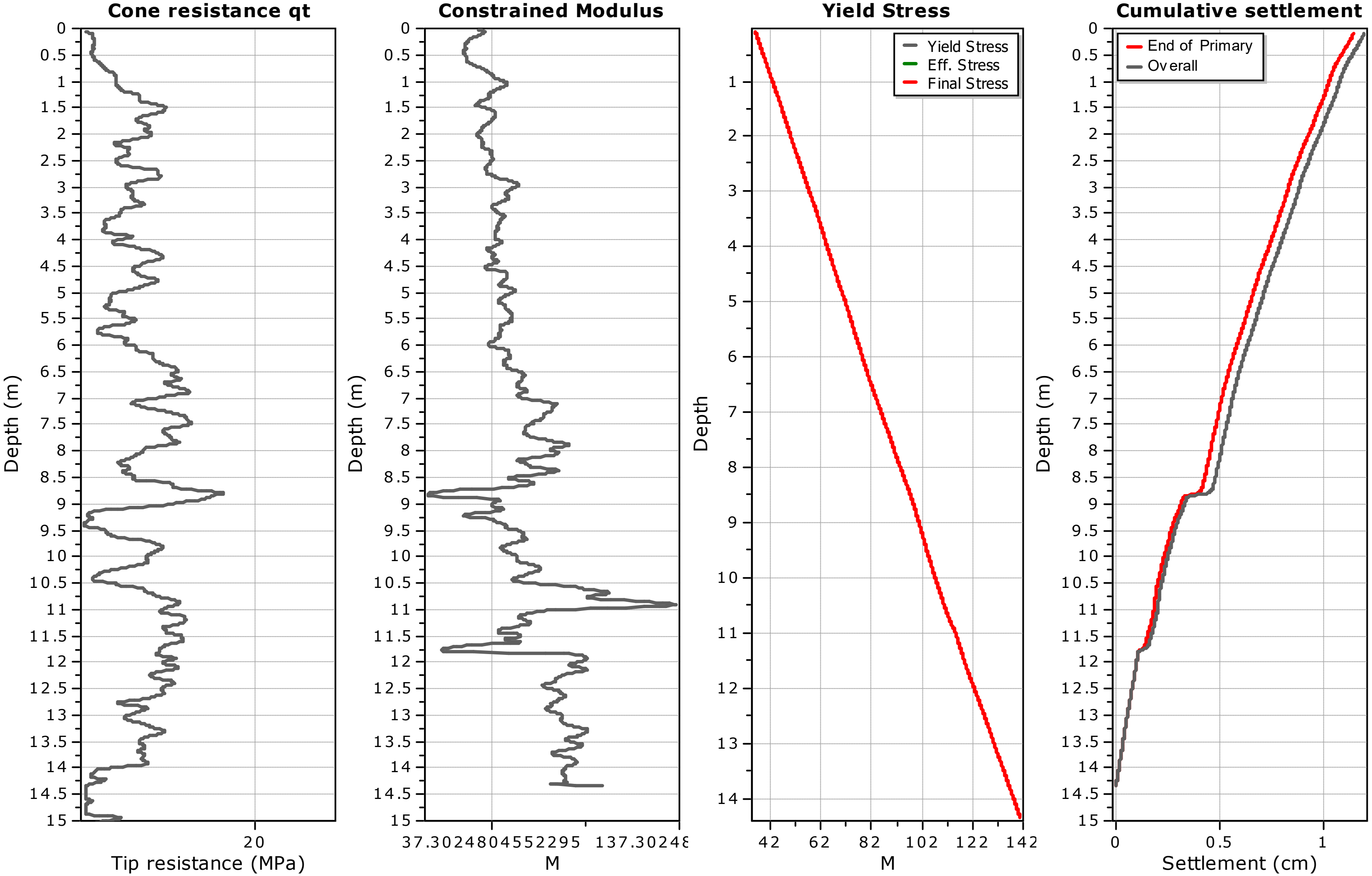
where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
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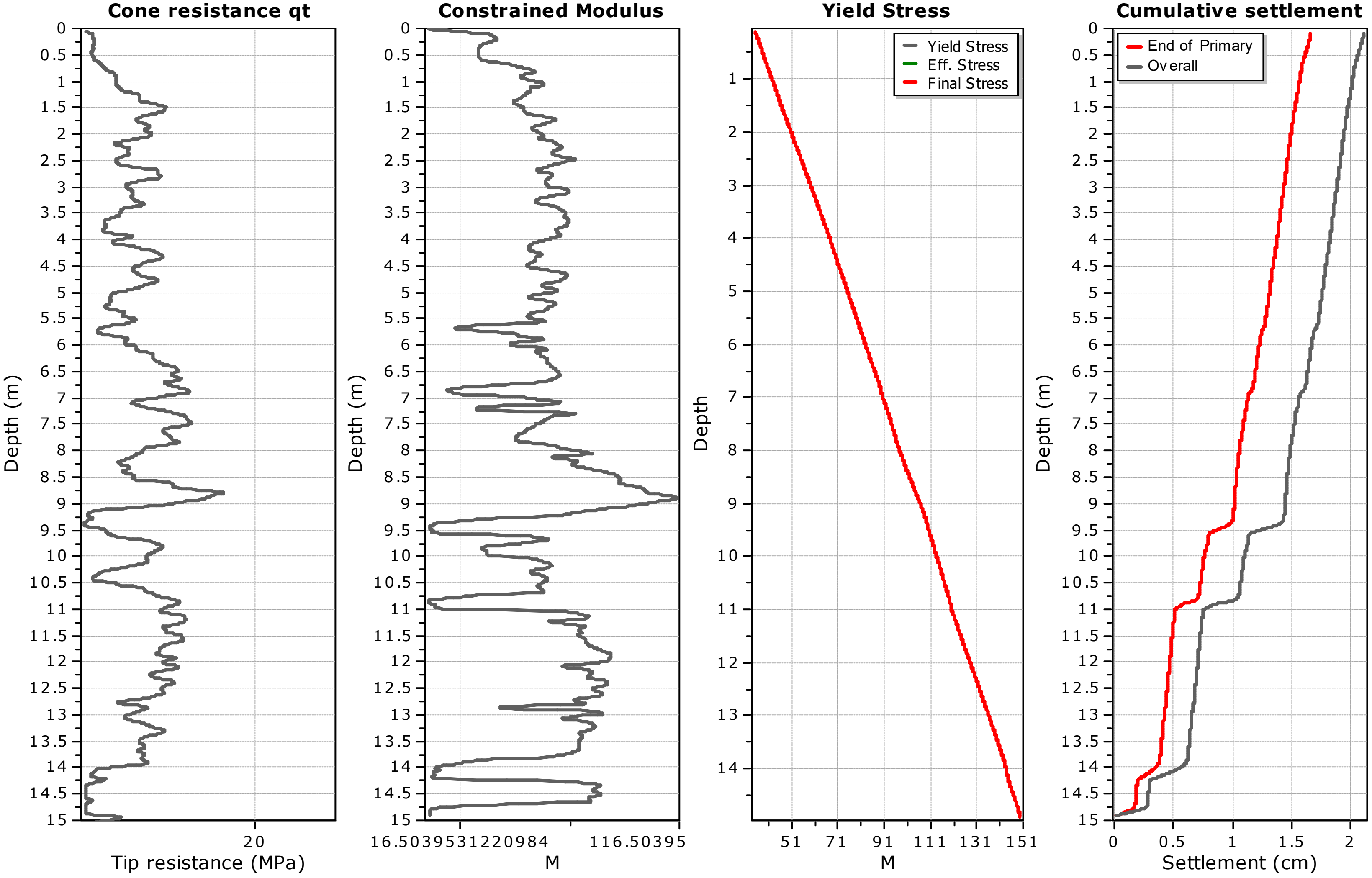
where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
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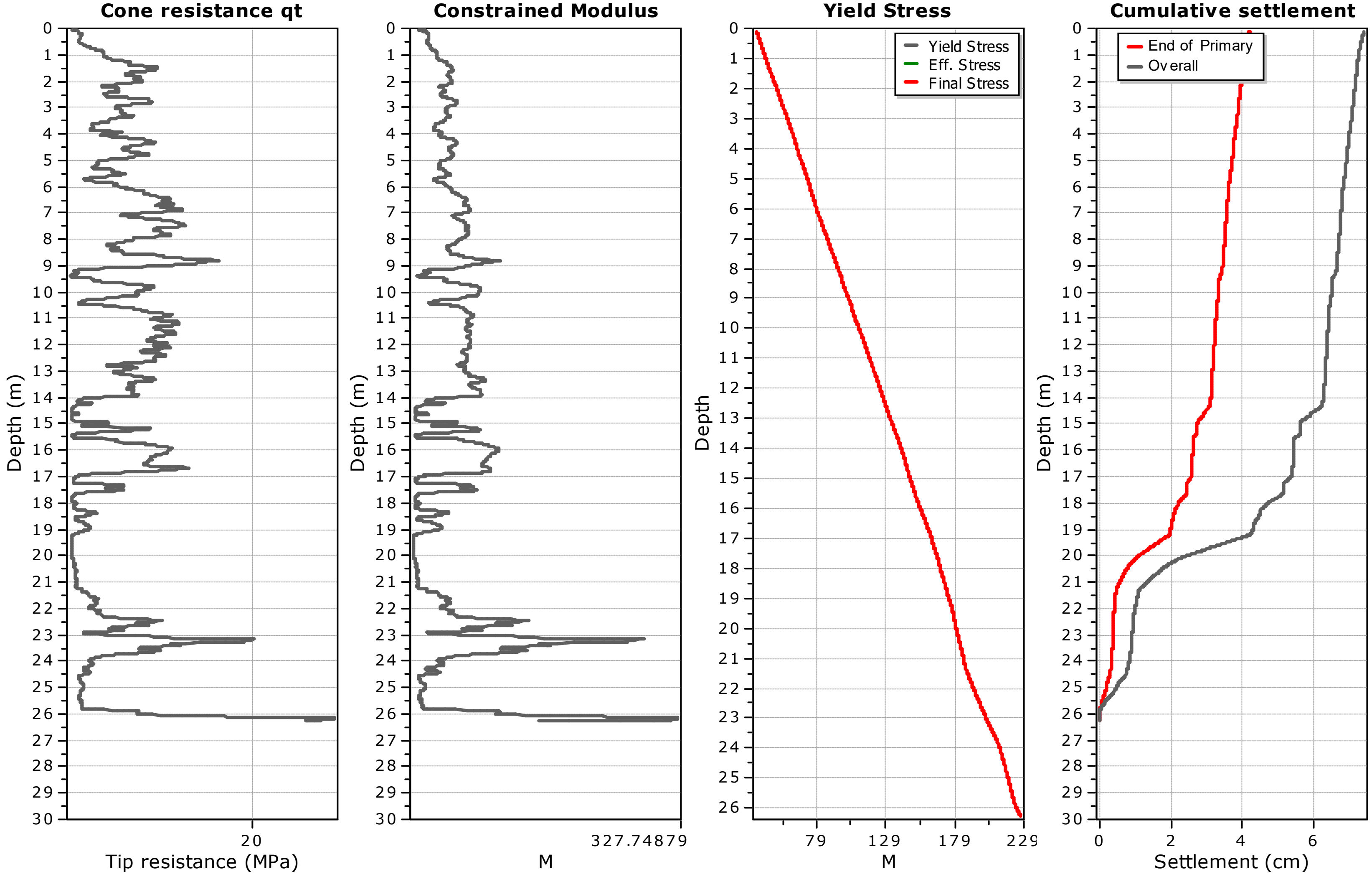
where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
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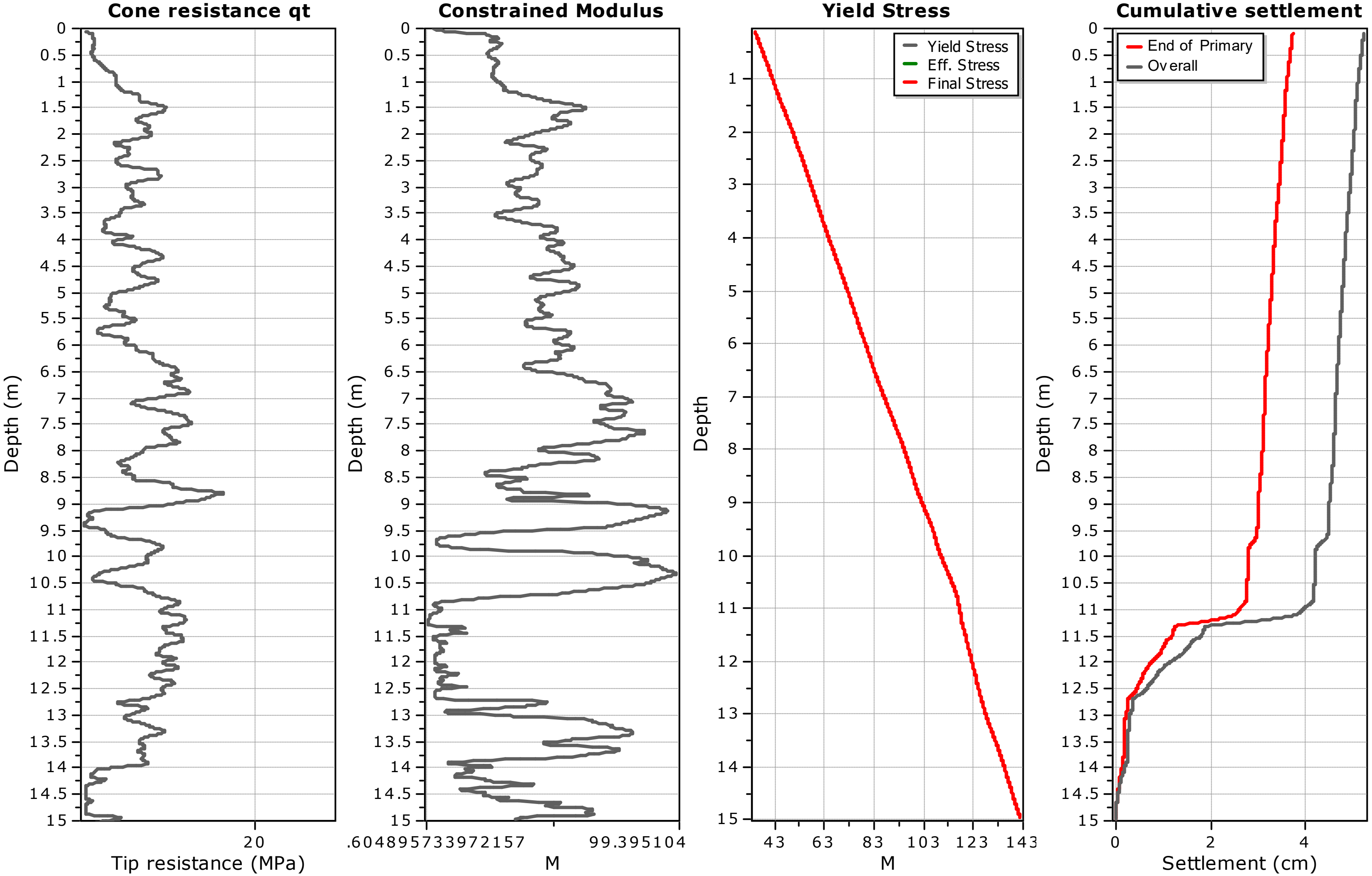
$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 50.00 (m)
L/B: 1.0
Footing pressure: 35.00 (kPa)
Embedment depth: 0.10 (m)
Footing is rigid: No
Remove excavation load: No
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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* Secondary (creep) settlement calculation is performed according to the following formula:

$$S = C_\alpha \cdot \Delta z \cdot \log(t/t_p)$$

where t_p is the duration of primary consolidation