



GEOTECHNICAL INVESTIGATION REPORT

FOR PROPOSED RESIDENTIAL SUBDIVISION

555 Birchs Road, Lincoln, Selwyn

Client: Urban Estates Limited

Project Reference: LTC24135

Revision: Rev A

Date: 14 June 2024

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Project Reference:	LTC24135	
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Executive Summary:

Project	Address	555 Birchs Road, Lincoln, Selwyn
	Consenting Authority	Selwyn District Council
	Proposed Development	Residential Subdivision
	MBIE Technical Category	N/A - Rural and Unmapped
	Mapped Liquefaction Vulnerability	Possible
Liquefaction Analysis	Modelled vertical land settlement (SLSA)	Up to 5mm (TC1)
	Modelled vertical land settlement (SLSB)	5mm to 25mm (TC2)
	Modelled vertical land settlement (ULS)	15mm to 110mm (TC2)
	Global lateral movement category	Minor
	Lateral stretch category	Minor
	Site Specific Technical Category and Liquefaction Vulnerability, as assessed via our investigation and analysis	TC2, Medium
Site Assessment	Site Subsoil Classification	Class D - Deep or Soft Soil Sites
	Static Settlement Assessment	2mm to 37mm
	Geotechnical Hazard Assessment	Portions of site within SDC mapped 200-year flooding areas
	Depth of unsuitable materials on site (Topsoil)	0.2m to 0.6m
	Groundwater Depth	Measured at 1.9m to 2.65
Foundation Assessment and Recommendations	Preliminary Bearing Capacity within underlying natural soils	200kPa
	Foundations	TC2 stiffened slab foundations, subject to lot specific shallow soil testing following subdivision earthworks
	Additional Geotechnical Input	- If required, subdivision earthworks monitoring to be undertaken by a geo-professional familiar with the findings in this report. - Lot specific shallow soil testing at foundation design / Building Consent stage to confirm foundation requirements per lot.

Figure 1: Aerial photograph of investigation site



(Source: Land Information New Zealand (LINZ) [image captured 5 June 2024](#))

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1.0 Introduction & Scope of Work

LandTech Consulting Limited (LandTech) were engaged by Urban Estates Limited (the Client) to carry out a geotechnical investigation at 555 Birchs Road, Lincoln, Selwyn. The geotechnical investigation is in relation to the proposed residential subdivision of the site.

This geotechnical report summarises the findings of our investigation and analysis as per the brief given to us by our Client, and which were carried out in accordance with the Earthquake geotechnical engineering practice modules produced by MBIE and NZGS¹. It includes evaluation of ground conditions, assessment of subdivision suitability and potential geohazards, and provision of preliminary foundation recommendations. This report may be relied upon by our Client's appointed consultants for design purposes and by the Selwyn District Council (SDC) for corresponding consent applications.

Our scope of works for the geotechnical investigation and reporting for the site included the following:

- Desktop study;
- Field investigation (i.e. site walkover, test pits, deep investigations and short-term groundwater monitoring);
- Liquefaction assessment of existing CPT data for the site; and
- Provision of this geotechnical report.

2.0 Site & Dwelling Description

The site is located at 555 Birchs Road, Lincoln, Selwyn, approximately 1.3km northeast of Lincoln town centre and is legally described as Lot 2 Deposited Plan 33959 BLK I Halswell SD, with a total area of 8.6ha according to LINZ². The site is shown on the LandTech *Test Location Plan*, Drawing No. LTC24135 / 1 (attached in Appendix A) and Figure 1 (above).

The near level to gently undulating site fronts Birchs Road to the west. Residential properties are located to the south and west of the site and similar rural properties are located to the north and east. Two dwellings are located close to the south property boundary near the centre of the site. The dwellings are accessed from Birchs Road by an approximately 200m long driveway located on the south property boundary. We understand from the client's engineers that the area around the existing dwellings and driveway are excluded from the plans to develop the proposed subdivision.

¹ *Earthquake geotechnical engineering practice modules*, MBIE and NZGS, (2021). Accessed via <https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/geotechnical-guidance/>

² <https://data.linz.govt.nz/>, accessed 5 June 2024

3.0 Proposed Development

We have not sighted any plans for the proposed subdivision. However, we understand from the client that the preliminary plan is to create approximately 90 residential lots on the site.

4.0 Area Geology

The geomorphological³ and geological^{4,5} map of the area geology has been reviewed. These sources indicate that the site is underlain by Late Pleistocene to Holocene aged River Deposits and Alluvial deposits. The characteristics of these deposits consist mostly of un-weathered, variably sorted gravel, sand and silt river deposits which have been transported downslope from the Southern Alps toward the east coast.

The characteristics of the River Deposits can vary widely over small distances. These variances include vertical and horizontal differences in both soil particle size distribution and consolidation. Due to potential variation within these geologic units, river deposits can be prone to differential settlement should horizons of soft, fine-grained and organic materials be present within the near surface soil profile. Similarly, they can also exhibit a potential for liquefaction during seismic events and lateral spreading near river systems in areas of high groundwater tables and where loose sandy soil types are present.

Alluvial Deposits generally comprise interbedded horizons of fine to coarse-grained sand and silt, as well as layers of cohesive clay and peat. Layers of rounded to sub-rounded, gravel to cobble sized greywacke particles can also be present. Due to their depositional environment the characteristics of Alluvial Deposits can vary widely over short distances. These variations can include vertical and/or horizontal differences in both soil and/or particle size distribution and degree of soil consolidation.

The geotechnical properties of Alluvial Deposits depend on a number of variable factors, including soil composition, level of consolidation, particle size distribution, and organic content. The presence or absence of groundwater can also affect local soil behaviour characteristics. Due to this variability, during seismic events alluvium can be prone to differential settlement, liquefaction and, near river systems, significant lateral spreading.

³ *Geomorphological Map of Christchurch and Eastern Canterbury*, Beeg, Junes & Barrell (2015). Accessed via Christchurch Liquefaction Viewer, <https://canterburymaps.govt.nz/map?webmap=ea5f9f0ad09b4192a481f2c76aa91907> on 6 June 2024.

⁴ *Geology of the Christchurch Urban Area*, Brown and Weeber (1992) Accessed via Canterbury Maps, <https://canterburymaps.govt.nz/> on 6 June 2024.

⁵ *GNS Geological Unit QMAP*, GNS Science. Accessed via New Zealand Geology Web Map, <https://data.gns.cri.nz/geology/> on 6 June 2024.

4.1 Faults in Canterbury

We have referred to a Selwyn District earthquake fault report compiled by GNS Science and Environment Canterbury (ECan) titled, *General distribution and characteristics of active faults and folds in the Selwyn District, North Canterbury*, dated July 2013.

The GNS report provides a general overview of the nature of geologically active areas within the Selwyn District. The report indicates that the site is located approximately 11 km southeast of the Greendale Fault, as shown in Figure 2 below (Canterbury Maps image).

The Greendale Fault and associated blind faults of the Darfield earthquake sequence have been defined by GNS Science via field inspection, aerial photography interpretation and geologic mapping. The GNS report indicates that these faults were unknown prior to 2010 and that the ages of previous ruptures therefore are also not known. This leaves the potential for further unmapped faults to exist within the locality of the investigation site. The report suggests that the magnitude of large earthquakes along Greendale Fault could be on the order of 7.0M, as observed during the CES. The estimated Recurrence Interval (RI) of the Greendale Fault is between 5,000 and 10,000 years (RI class IV).

Figure 2: Canterbury Maps image showing site in relation to the Greendale Fault



We sourced peak ground acceleration (PGA) data for the vicinity of the site during the September 2010 (M7.1) CES event, centred west of the site, from the United States Geological Survey⁶. Seismic recording stations located approximately 2.5km south and 2.7km west of the site recorded PGAs of

⁶ <https://earthquake.usgs.gov/earthquakes/eventpage/usp000huvq/map>

0.37 and 0.41, respectively. We expect that the site will have experienced shaking of similar intensity during the earthquake.

5.0 Geological Data Review

For the purpose of this data review, reference has been made to the following sources:

- The SDC District Plan⁷;
- The SDC flooding and coastal hazards mapping⁸;
- ECan map viewer⁹;
- The ECan Listed Land Use Register (LLUR)¹⁰; and
- The New Zealand Geotechnical Database (NZGD)¹¹.

The above websites were accessed on 6 June 2024. The following text summarises the findings of our data review, and the information reviewed has contributed to our geotechnical assessment, model, and recommendations for the site.

- Flood mapping for SDC accessed via Canterbury Maps⁷ shows that large portions of the site could experience surface flooding to depths between <0.2m and 01.0m during a 1-in-200-year flooding event. The deepest flooding is modelled as an approximately east-west channel-like feature across the centre of the site.
- Canterbury Maps⁷ places the site east of the *Eastern Canterbury liquefaction susceptibility line* (2012) and within the liquefaction vulnerability area of possible, where a “liquefaction assessment [is] required”.
- The *Selwyn liquefaction susceptibility map* (2006) accessed via Canterbury Maps⁶ shows the large majority of the site to be located within an area underlain by *river sediments >10,000 years old*, where there is considered to be “a small chance of liquefaction of small, isolated areas during strong earthquake shaking.” The northeast corner of the site is located within an area underlain by *river sediments <10,000 years old (active river beds & flood plains)*, where there is considered to be “a possibility of liquefaction of small, isolated areas during strong earthquake shaking.”
- The MBIE *Residential Foundation Technical Category Map* indicates the site is located within an area designated as N/A - Rural and Unmapped. This indicates that normal consenting procedures apply.

⁷ <https://www.selwyn.govt.nz/property-and-building/planning/strategies-and-plans/selwyn-district-plan>

⁸ <https://apps.canterburymaps.govt.nz/SelwynNaturalHazards/>

⁹ <http://canterburymaps.govt.nz/>

¹⁰ <https://llur.ecan.govt.nz/>

¹¹ <http://www.nzgd.org.nz/>

- The ECan LLUR, indicates no HAIL activities are recorded to have taken place at the site, according to the register. According to ECan, the site was included in a desktop review of the wider area completed in 2011. No areas of potential contamination were identified on the site as a result of the review. This does not confirm the site has no soil contamination, but only indicates the regional council does not have records of potentially hazardous activities taking place at the site that could lead to soil contamination.
- We have referred to online data to assess the surface expression of liquefaction and liquefaction-induced ground damage observed on and near the site during the Canterbury Earthquake Sequence (CES)¹². A review of aerial photography of rural Canterbury, including the area of the site, was completed by GNS following the September 2010 and February 2011 earthquake events. The mapped data from the GNS review (accessed via Canterbury Maps) indicates that flooding was identified in the centre of the site, within an apparent channel/swale feature following the September 2010 CES event.
- We have referred to historical aerial photography¹³, which shows the site was vacant farm/pastureland in the earliest available images (1940s) and has remained relatively unchanged since. Development of the dwellings within the wider property on the south boundary (excluded from this investigation) is shown having started by 2010. A linear channel or swale feature running approximately east-west across the centre of the site and joining with a channel feature near the northeast property boundary is visible on all available photographs – an example is shown in Figure 3 below.

Figure 3: Photo sourced from Canterbury Maps showing apparent drainage feature (arrows),



¹² GNS *Observed Liquefaction in Rural Areas*, accessed via Canterbury Maps

¹³ Accessed via Canterbury maps, <https://canterburymaps.govt.nz/map?webmap=7d0dc64208474b4c976b90ccc6ce9ae7>

- The *Piezometric Contours in the Canterbury Region* layer accessed via Canterbury Maps⁶ includes groundwater elevation data for the site and wider region, which indicates that the site is located between mapped piezometric lines (depth to groundwater) of 2.5m and 5.0m below ground surface.
- According to the NZGD, logs for boreholes BH_118128 and BH_118129 (drilled on 19 March 2018 and discussed further in Section 5.1 below) indicate groundwater was measured at 2.4m depth at each borehole location, assumed on the day of drilling.

5.1 NZGD Geotechnical Investigation Data

The *NZGD Geotechnical Investigation Data* map shows that there have been multiple machine boreholes drilled on the site. Deep testing (CPT), test pit and shallow soil testing data for the site are also available from the NZGD. We discuss this data in detail in Section 7.0 below.

The positions of the boreholes are marked on the LandTech *Test Location Plan*, Drawing No. LTC24135 / 1 (attached in Appendix A), and the details of the tests are as follows:

- Machine borehole (BH_118128 - total depth 10.64m), by McMillan Drilling for Davis Ogilvie on 19 March 2018, located within the northwest central portion of the site.
- Machine borehole (BH_118129 – total depth 10.64m), by McMillan Drilling for Davis Ogilvie on 19 March 2018, located within the southeast portion of the property.

The soils encountered in each borehole were similar, with the exception of an approximately 3.0m thick gravel layer encountered starting at 1.5m in BH_11128; sands and silts were encountered in this interval in BH_11129 approximately 210m to the southeast. Organic material was identified in both locations from between approximately 4.5m and 6.0m depth. Gravel was encountered in both boreholes from approximately 6.0m to the termination depths at 10.64m. A summary of the soils and raw field N values of each borehole are summarised below, and copies of the logs are included within Appendix C.

BH_11128

- 0.0m to 1.5m; silt
- 1.5m to 4.3m; fine to coarse gravel, N=39, N=27,
- 4.3m to 6.1m; clay with wood pieces from 4.6m to 6.0m,
- 6.1m to 10.64m; fine to coarse gravel and sandy gravel, minor sand layer from 7.7m to 8.1m, N=25, N=29, N=16.

BH_11129

- 0.0m to 4.7m; sand and silt,
- 4.7m to 6.1m; organic silty clay,
- 6.1m to 10.64m; fine to coarse gravel and sandy gravel, N=41, N=52, N=29.

Groundwater was recorded at 2.4m depth in both machine borehole logs.

6.0 Field Investigation

Our field investigation for the site took place on 6 June 2024 and comprised the following components:

- Detailed site inspection,
- Excavation of two test pits with associated in-situ soil testing carried out at the base of the excavation,
- Installation of piezometers in each test pit, and
- Two Dynamic Probe (Super Heavy) (DPSH) tests.

The approximate test positions¹⁴ are indicated on the LandTech *Test Location Plan*, Drawing No. LTC24135 / 1, (attached in Appendix A).

The soil conditions encountered within the test pits were logged by LandTech technical staff¹⁵. The test pit logs are attached in Appendix B, together with the results of the various tests undertaken, including the groundwater conditions determined during the site investigation.

Dynamic Cone (Scala) Penetrometer testing was carried out next to the test pit locations to determine a density profile with depth¹⁶.

DPSH tests were carried out by LandTech technical staff using a Pagani TG63-150 CPT rig. The results of this testing are attached in Appendix C and are discussed in Section 7.4, below.

Groundwater measurements were made within the piezometers on the day of installation upon completion of the fieldwork and again after 4 days as indicated on the attached logs.

¹⁴ Field tests and sections were located using a hand-held GPS unit and a measuring tape without survey control and are therefore approximate only.

¹⁵ Soil was logged in accordance with New Zealand Geotechnical Society *Guideline for the Description of Soil and Rock for Engineering Purposes* (2005).

¹⁶ In accordance with NZS 4402:1988, Test 6.5.2, *Dynamic Cone Penetrometer*.

7.0 Subsurface Conditions

The subsurface conditions encountered during our field investigation and recorded in Hand Auger, Scala penetrometer test, and Test Pit logs sourced from the NZGD comprised a surface layer of topsoil and fill overlying Alluvial and River Deposits consistent with the mapped geology. A summary of the subsurface conditions, including data sourced from NZGD logs, is given below in Table 2 and Table 3. A general description of the main soil units follows. Detailed descriptions are given in the test logs attached in Appendix B and D. The shallow (HA-DCP) test locations are shown on our attached Site Plan in Appendix A.

Table 2: Shallow Testing Summary

Test ID	Test Depth	Depth of Topsoil	Groundwater Level	Scala Depth
TP01#	3.0	0.3	1.9 to 2.0	2.6
TP02#	3.7	0.3	NE to 2.65	3.9
HA-DCP_118145*	1.9	0.3	NE	2.0
HA-DCP_118241*	2.2	0.3	NE	2.6
HA-DCP_118252*	1.7	0.2	NE	1.9
HA-DCP_118132*	1.5	0.3	NE	1.6
HA-DCP_118131*	1.6	0.3	1.4	1.7
HA-DCP_118242*	Scala only	Scala only	Scala only	2.3
HA-DCP_118130*	1.5	0.3	1.4	2.1
HA-DCP_118253*	1.8	0.4	NE	2.2
HA-DCP_118244*	1.8	0.3	1.6	1.8
HA-DCP_118246*	1.7	0.3	1.2	2.2
HA-DCP_118251*	Scala only	Scala only	Scala only	3.6
HA-DCP_118254*	3.0	0.4	2.4	3.6
HA-DCP_118247*	3.0	0.2	2.4	3.0
HA-DCP_118255*	3.0	0.4	2.6	3.0
HA-DCP_118256*	3.0	0.3	2.7	3.0
HA-DCP_118250*	Scala only	Scala only	Scala only	3.0
HA-DCP_118249*	3.0	0.3	2.7	3.0

Table Notes: Measurements are in metres (m) below present ground level (bpgl)

See also Table 3

* Sourced from NZGD

NE = Not Encountered

Table 3: Test Pit Summary

Test Pit ID	Excavation Depth	Depth of Topsoil	Depth to gravel	Groundwater Level	
				6/6/24	6/10/24
TP01#	3.0	0.3	2.2	2.0	1.9
TP02#	3.7	0.3	NE	NE	2.65
TP_118262*	3.3	0.4	2.5	2.7	
TP_118261*	2.6	0.4	1.6	2.2	
TP_118264*	2.4	0.4	2.2	2.3	
TP_118260*	2.1	0.3	1.5	1.5	
TP_118265*	2.1	0.4	1.8	1.8	
TP_118268*	3.7	0.6	NE	2.6	
TP_118267*	3.3	0.3	NE	PC	
TP_118266*	3.4	0.3	NE	PC	

Table Notes: Measurements are in metres (m) below present ground level (bpgl)
 # See also Table 2
 * Sourced from NZGD
 NE = Not Encountered
 PC = Pit Collapse, "water encountered" at base of test pit per test pit log

7.1 Topsoil and Fill

Topsoil and fill were encountered/recorded from the existing ground surface to depths between 0.2m and 0.6m. Due to the organic content of the topsoil, these materials are not considered suitable for permanent support of foundations due to the potential for differential settlement.

The shallow test data was collected/mapped in discrete locations across the site; therefore, ground conditions could vary away from the individual test positions. This bears the potential for greater depths of unsuitable topsoil than those encountered within our testing and as recorded in the NZGD-sourced test logs, which should be taken into account during earthworks and foundation excavations.

7.2 River and Alluvial Deposits

Alluvial soils and River Deposits were encountered from below the topsoil to the termination of our own and the NZGD-sourced test pits and hand augers. In the northwest half of the site, soils encountered generally comprised interbedded silts and sands (a minor organic peat layer was encountered in TP01), overlying encountered and inferred gravel beginning at between approximately 1.6m to 2.6m depth. This relatively shallow gravel layer was not encountered in tests undertaken in the remainder (southeast half) of the site, i.e. where alluvial soils continue uninterrupted to the base of shallow testing between 3.3m and 3.7m depth. Based on the locations and results of the test pit, hand auger and scala tests above, the southeastern extent of the upper, relatively shallow gravel layer is roughly defined by the natural drainage feature near the centre of the site noted in Section 5.0 above. The NZGD machine borehole data discussed above indicates that the shallow gravel layer is approximately 2m thick and is underlain by weaker and organic soil/materials; thickness of the layer is expected to vary away from the borehole location. A deeper gravel layer, starting at approximately 6.0m depth is identified in both

NZGD boreholes (located north and south of the central drainage feature); the layer extends to at least 10.6m depth based on the borehole data logs (Appendix C).

7.3 Scala Penetrometer Tests and Shear Vane Tests

Scala Penetrometer testing of ours and sourced from the NZGD returned results ranging between 0.5 and 40+ blows per 100mm. Below topsoil/fill the results ranged from 2 to 12 blows per 100mm within sand and silt material (loose to dense material) before increasing to 30+ blows (dense to very dense) near refusal on or within identified and inferred gravel, where encountered. The depths of our and the NZGD Scala testing (listed in Table 2 above and included in Appendix B and C) were greater south of the central drainage feature discussed in Section 5.0. Scala testing north of the drainage generally refused on shallow logged and inferred gravel starting at 1.6m to 2.7m below ground surface; testing south of the drainage extended to target depths of between 3.0m and 3.9m below ground surface.

Undrained shear strength measured via shear vane testing within the fine-grained material logged in TP01 ranged between 87kPa (in a minor peat layer), and +250kPa (in silt) generally comprising 'soft' to 'hard' consistency.

7.4 CPT and DPSH Tests

The reviewed NZGD-sourced CPT data (listed in Table 4 below and detailed in Appendix C) were generally consistent with the shallow and deep testing discussed in the sections above. Generally, the testing identified a shallow layer of 5MPa to 10MPa soil from ground surface to ~1.0m depth, overlying weaker (less than 5MPa) soil overlying a dense gravel layer (generally between 30MPa and 50MPa) starting at between 6.0m and 7.0m depth. The CPT tests north of the central drainage feature discussed in Section 5.0 also identified a shallow (1.5m to 2.0m thick) gravel layer starting at between approximately 2.0m and 3.5m depth. Very weak material (less than 3MPa) is identified across the testing (north and south of the drainage) between approximately 4.5m depth and the inferred deeper gravel layer at approximately 7.0m depth. The depths of this weaker/organic material and the deeper gravel identified north and south of the drainage feature is consistent with the organic material and wood identified (between approximately 4.5 and 6.1m depth) and deeper gravel (between approximately 6.1m and the termination depths of 10.6m) identified in BH_118128 and BH_118129, discussed above. South of the drainage, the CPTs identify only sands, silts and weak organic material from ground surface to the inferred gravel layer at approximately 6.0m-7.0m depth. A single CPT (CPT_118117) extended below the deeper inferred gravel layer starting at 7.0m and identified a weaker layer (less than 5MPa) between approximately 9.5m and 10.5m depth before terminating on very dense (greater than 50MPa) material. The NZGD deep test locations are shown on our attached Site Plan in Appendix A.

The results of our own DPSH testing (listed in Table 4 below and detailed in Appendix D) were also consistent with the testing data discussed above. Test DPSH01 in the northwest end of the site returned blow counts of 2 to 6 blows per 100mm starting from ground surface to 1.4m depth before

increasing rapidly to 38 blows per 100mm above shallow refusal at 1.7m depth on inferred very dense gravel. Test DPSH02 in the southeast part of the site returned blows largely between 1 and 2 blows per 100mm from ground surface to approximately 2.0m depth. Below this, from 2.0m to 3.9m depth, blow counts increased to between 6 and 15 blows per 100mm. Below this, a very weak layer was encountered (blow counts between 0.5 and 2 blows per 100mm) from 4.0m to 5.6m depth. Blow counts then increased to between 2 and 6 blows per 100mm from 5.6m to 6.9m depth before increasing rapidly to 30 and 40 blows per 100mm from 6.9m to effective refusal at 7.1m depth. The DPSH test locations are shown on our attached Site Plan in Appendix A.

Table 4: CPT-DPSH Summary

Test ID	Depth of Test	Groundwater Level
DPSH01	1.7	NE
DPSH02	7.1	HC
CPT_118009*	2.1	1.95
CPT_118112*	7.02	1.7
CPT_117991*	2.2	2.1
CPT_118001*	2.0	1.5
CPT_118114*	6.96	1.7
CPT_117989*	5.82	1.4
CPT_117988*	3.63	1.3
CPT_118116*	7.14	1.7
CPT_118127*	6.64	2.1
CPT_87812*	6.99	3.1
CPT_118125*	7.0	2.5
CPT_118117*	11.89	1.8
CPT_118120*	8.12	1.2
CPT_118121*	7.6	2.4
CPT_118123*	7.08	2.4

Table Notes: Measurements are in metres (m) below present ground level (bpgl)

* Sourced from NZGD

NE = Not Encountered

HC = Hole Collapse

Based on the testing data above, the generalised soil profiles north and south of the central drainage feature are as follows.

North

- 0.0m to 2.0m: Sand and silt material, with Q_c values consistently between 2MPa and 10MPa.
- 2.0m to 3.5m: Gravel material; Q_c values rapidly increase to between 25MPa and greater than 50MPa (and effective refusal); this indicates a depositional environment in transition.
- 3.5m to between 5.5m and 7.0m: Weak silt and clay-like materials encountered, with Q_c values generally less than 3MPa.

- 5.5m to 7.0m; Gravel material; Q_c values increase rapidly to greater than 50MPa, resulting in effective test refusal at between 6.0m and 7.0m.

South

- 0.0m to 4.5m: This layer comprises sand and silt-like material, with Q_c values consistently between 2MPa and 10MPa.
- 4.5m to 6.5m: Weak clay-like and organic materials encountered, with Q_c values generally less than 3MPa.
- 6.5m to 9.0m: Dense gravels with minor (up to 0.5m thick) sandy layers; Q_c values increase rapidly to between 30MPa and greater than 50MPa. All but one test refuses at or above 9.0m
- 9.0m to 12.0m (CPT_118117 only): Q_c values decrease steadily to less than 3MPa at 10.0m depth before increasing to greater than 50MPa and effective refusal at 11.89m depth.

7.5 Groundwater

Groundwater was measured within our installed piezometers on the day of installation at depth of 2.0m within TP01; groundwater was not encountered in TP02 on the same day. Depths measured on 10 June 2024 (4 days later) were 1.9m (TP01) and 2.65m (TP02).

As discussed above, groundwater was recorded on the NZGD logs at depths between 1.5m and 2.7m depth below ground surface. Regional groundwater mapping indicates groundwater levels between 2.5m and 5.0m depth below ground surface. Groundwater levels are also expected to fluctuate seasonally and with rainfall over shorter timeframes. It may be possible that shallow, short-term perched water tables or ground seeps could exist in the shallow organic materials above the shallow gravel layer north of the central drainage feature noted above. It may also be possible that the shallow gravels are either permanently or temporarily (i.e. seasonally or after rain events) water bearing.

7.6 Site Seismicity

For the purpose of applying the requirements of NZS 1170.5:2004 the site subsoil is considered Class D - Deep or Soft Soil Sites. This classification is based on the depth of soils estimated to exceed those given in table 3.2 of the standard.

8.0 Liquefaction Assessment

We have analysed CPTs sourced from the NZGD listed above for liquefaction in Model Earthquake Events. We have used only the CPTs which reached depths of greater than 5.0m depth. This is because the shallow gravel and deep groundwater levels (relative to the shallower testing depths) expected in the locations of the remaining CPTs would not produce useful estimations of liquefaction damage. The analysis has been carried out using proprietary software¹⁷ Geologismiki CLiq Version 3. Liquefaction settlement and land damage potential has been calculated for the three model earthquake events specified in MBIE/NZGS Module 1 - Earthquake geotechnical engineering practice (November 2021)¹⁸, based on a methodology adapted from the same. Analysis was carried out using groundwater conditions based on the groundwater depths measured on site as listed below.

The model conditions are given below:

- *Service Limit State A* (SLSA); where $M_w = 7.5$ and $PGA = 0.13g$;
- *Service Limit State B* (SLSB); where $M_w = 6.0$ and $PGA = 0.19g$;
- *Ultimate Limit State* (ULS); where $M_w = 7.5$ and $PGA = 0.35g$; and
- Groundwater Level during all modelled events are set at 2.0m.

We note that the results obtained by using the model earthquake events exceeded the liquefaction and settlement observed on site during the CES. In our initial analysis we used a Probability Function of $PL = 16\%$ and a $C(fc) = 0.0$, which we consider contributed to the overpredictions when compared to the actual/mapped land damage. To account for a likely discrepancy, we carried out a second analysis using a revised Probability Factor of $PL = 50\%$ and a $C(fc) = 0.2$ to calibrate the model, which resulted in a more realistic representation of the actual site performance during the CES. Our revised calculation was conducted in accordance with Clarification 51 of the MBIE Guidelines (October 2014).

Table 1 below shows the results of these analyses (using $PL=50\%$ and $C(fc) = 0.2$), with outputs attached in Appendix E.

¹⁷ Geologismiki Geotechnical Software, CLiq v.3.3.1.14 – CPT Liquefaction Assessment Software

¹⁸ *Earthquake geotechnical engineering practice Module 1: Overview of the Geotechnical Guidelines*, MBIE and NZGS, (2021). Accessed via <https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/module-1-overview-guidelines/>

Table 1: Liquefaction Analysis Results

Test ID	Result	SLSA	SLSB	ULS
CPT_118114	Index Settlement (10.0m)	<5mm	5mm	20mm
	Liquefaction Severity Number	1	1	5
	Ground Damage Category	Little to none	Little to none	Little to none
CPT_117989	Index Settlement (10.0m)	<5mm	5mm	15mm
	Liquefaction Severity Number	1	1	3
	Ground Damage Category	Little to none	Little to none	Little to none
CPT_118112	Index Settlement (10.0m)	5mm	20mm	50mm
	Liquefaction Severity Number	1	3	12
	Ground Damage Category	Little to none	Little to none	Minor
CPT_118127	Index Settlement (10.0m)	5mm	25mm	80mm
	Liquefaction Severity Number	1	6	22
	Ground Damage Category	Little to none	Little to none	Moderate
CPT_118116	Index Settlement (10.0m)	<5mm	10mm	35mm
	Liquefaction Severity Number	1	2	8
	Ground Damage Category	Little to none	Little to none	Little to none
CPT_87812	Index Settlement (10.0m)	<5mm	10mm	110mm
	Liquefaction Severity Number	1	2	17
	Ground Damage Category	Little to none	Little to none	Minor
CPT_118125	Index Settlement (10.0m)	<5mm	10mm	80mm
	Liquefaction Severity Number	1	3	21
	Ground Damage Category	Little to none	Little to none	Moderate
CPT_118117	Index Settlement (10.0m)	15mm	50mm	90mm
	Liquefaction Severity Number	2	8	22
	Ground Damage Category	Little to none	Little to none	Moderate
CPT_118120	Index Settlement (10.0m)	<5mm	10mm	70mm
	Liquefaction Severity Number	1	3	25
	Ground Damage Category	Little to none	Little to none	Moderate
CPT_118121	Index Settlement (10.0m)	5mm	25mm	80mm
	Liquefaction Severity Number	1	5	19
	Ground Damage Category	Little to none	Little to none	Minor
CPT_118123	Index Settlement (10.0m)	5mm	20mm	65mm
	Liquefaction Severity Number	1	4	20
	Ground Damage Category	Little to none	Little to none	Moderate

The settlements presented in Table 1 above are to the nearest 5mm. Due to the inherent uncertainty in calculating liquefaction induced settlement, the calculated free field settlements (land settlement) are indicative only. Actual settlements on site may vary from those above and do not take into account foundation influences; volume loss from surface expression, loss in bearing strength and influences from lateral spreading.

Based on the results of our quantitative liquefaction assessment of the site's model earthquake performance, up to moderate liquefaction induced land damage is considered possible during future ULS earthquakes and little to no land damage is modelled at SLS. This indicates that a liquefaction vulnerability category of medium would be applicable for the site. Differential settlement resulting from our analysis is estimated to be approximately 25mm for an SLS event and less than 100mm for a ULS event, based on half the magnitude of estimated settlement.

Based on the results of the model liquefaction analysis the site would be considered TC2, with index settlements being less than or equal to 50mm at SLS for the upper 10m, and less than or (in one test) near 100mm at ULS.

As discussed in Section 4.1, the site likely experienced shaking on the order of 0.4 PGA during the M7.1 September 2010 earthquake event. Based on this, we consider that the site has likely been well tested to SLS and near to ULS levels of shaking. As discussed in Section 5.0, GNS identified potential earthquake-related flooding within the central portion of the site following the September 2010 earthquake. Data relating to changes in ground surface levels, ground cracking or localised liquefaction ejecta is otherwise unavailable for the site. Based on this we consider that a TC2 categorisation for the site is a conservative assessment for the entirety of the site, noting lesser liquefaction potential is likely in areas with shallow gravel.

Based on the removed location from any major watercourses and our liquefaction analysis above, the site is considered to fall within the minor category of both Global Lateral Movement (0mm to 100mm at ULS) and Lateral Stretch (0mm to 100mm at ULS).

9.0 Static Settlement

We have performed numerical static settlement assessment using the CPT data acquired on site using Geologismiki CPeT-IT¹⁹. We performed the analysis on a generic 0.3m wide strip footing with an applied load of 50kPa over a 100-year period. Structural loads should be confirmed by the Structural Engineer and reassessed by us during the detailed design phase.

The results indicate that the total predicted settlement ranges between 2mm and 37mm, with the majority of the settlement being associated with soil creep. Creep settlements are estimated using a simplified approach suggested by Messi (1994) using CPeT-IT, taking into account the layering of the substrata and overburden applied. Outputs are presented in Appendix F.

¹⁹ Geologismiki Geotechnical Software, CPeT-IT v.3.5.3.3 – CPT Interpretation Software

Table 2: Summary of Static Settlement Calculation

Test ID	Primary (6 months) (mm)	Secondary (100 Years) (mm)	Total (mm)
CPT_117989	1	3	4
CPT_118112	2	4	6
CPT_118127	2	3	5
CPT_118116	1	1	2
CPT_87812	1	7	8
CPT_118125	2	16	18
CPT_118117	1	4	5
CPT_118120	1	2	3
CPT_118121	5	32	37
CPT_118123	3	27	30

It should be noted that the method used above to calculate settlement has limitations. The calculations carried out do not account for the presence of non-engineered fill, the breakdown of organic soils and peats, large fluctuations in the groundwater table, construction tolerance issues, or structural deterioration of building elements. Therefore, due to the presence of peat/organic deposits and the considerations given above, static settlements of conventional foundations may be in excess of those presented above. Earthworks and foundations designed and constructed in accordance with our following recommendations are expected to mitigate the static settlement risk from the presence of the soft and organic soils encountered throughout this site at variable depths and locations.

10.0 Geotechnical Hazard Evaluation

Section 106 of the Resource Management Act 1991 outlines hazards that must be assessed when a territorial authority considers a Subdivision Consent application. This section outlines our evaluation of possible geotechnical hazards associated with the site.

10.1 Erosion

The site is not considered to be subject to active erosion, and is unlikely to accelerate, worsen, or result in erosion over a 100 year timeline.

10.2 Falling Debris

No elevated land exists in close proximity to the site; therefore, the risk of falling debris from upslope rock fall or land slippage is considered negligible.

10.3 Subsidence

The TC2 site is considered prone to liquefaction-induced subsidence. Due to the presence of organic material and peat in the subsurface, and the calculated static settlements discussed above, conventional shallow foundations constructed on the site would be considered at risk from soil consolidation and creep settlements. Foundations designed in accordance with Section 11.0 of this report are considered likely to mitigate the subsidence/creep risk.

10.4 Slippage

The TC2 site is considered prone to lateral spreading (i.e., slippage). Foundations designed in accordance with Section 11.0 of this report are considered likely to mitigate the slippage risk.

10.5 Inundation

According to the Selwyn District Council, the site is prone to flooding during 200-year modelled flooding events.

Additionally, based on our liquefaction analysis above, the site is considered likely to be inundated with up to moderate quantities of liquefaction ejecta following future large earthquake events.

11.0 Preliminary Geotechnical Recommendations

Based on the findings of our investigation and natural hazard assessment, we consider the proposed subdivision is suitable from a geotechnical perspective. As such we have attached a Statement of Professional Opinion in Appendix G.

11.1 Preliminary Foundation Recommendations

Based on the results of our assessments herein, future new housing within the subdivision will need to be supported with TC2 type foundations from the MBIE Canterbury Rebuild Guidelines (December

2012). The use of TC2 stiffened slab foundations is also considered suitable to mitigate the static settlement potential identified as part of our herein assessment.

The bearing capacity for design purposes should be confirmed following any subdivision earthworks via lot-specific shallow soil testing.

11.2 Earthworks and Retaining

All earthworks to be carried out on the site are to be in accordance with the requirements of NZS 4431:2022 *Engineered fill construction for lightweight structures*. All unsuitable materials (i.e. non-engineered fill, vegetation, tree roots/stumps, topsoil, organics, detritus material, demolished building foundations, and decommissioned services and their associated backfilled trenches) are to be stripped away from areas of earthworks and stockpiled clear of the operational area or carted off-site. The site is to be inspected by an experienced Geo-professional to ensure all unsuitable materials have been removed prior to fill placement.

Temporary excavations of up to 0.5m in depth may generally be cut vertically, while deeper excavations may require temporary support and/or battering to maintain stability during construction. These recommendations are provided for situations where excavations are clear of site boundaries, and surcharges from existing pavements / buildings. In these situations, staged excavations or top down constructed temporary retaining may be required. It must be understood, maintenance of excavation stability is the responsibility of the contractor, and these recommendations are provided as guidance only. Prior to commencing earthworks, a sediment control system should be constructed to ensure that the Council requirements are met, particularly with respect to wind erosion of exposed and stockpiled soil materials.

Fill should be kept to no more than 600mm above current ground level without referring the matter back to us. Fill should comprise materials approved by the Geo-professional and be compacted in 200mm layers to reach no less than 95% maximum dry density. Nuclear densometer testing is to be conducted on every third layer of fill, to be approved by the Geo-professional. The edges of any fill should be either battered at 5H: 1V or be suitably retained. Retaining of granular fill can be designed utilising a friction angle of 35° and unit weight of 22kN/m³ to determine active earth pressures, while lateral load resistance should be calculated for embedment into suitable natural soils using a friction angle of 28° and unit weight of 17kN/m³, and in accordance with Module 6 of the MBIE/NZGS Earthquake Geotechnical Practice guidelines.

11.3 Pavements

We recommend a preliminary design CBR value of 2% for flexible or rigid pavements at the site, based on Scala blow counts within the natural soils and reference to NZS4404:2010. The thickness of the basecourse would depend on the final CBR used for the subgrade and the anticipated loading. The compaction of the basecourse should be carried out with a non-vibratory roller of appropriate static weight and energy. We recommend the placement of geotextile between the subgrade and basecourse (i.e. Bidim A19 or equivalent). This is to reduce the mixing of the natural soil with the engineered fill and will increase the performance of the basecourse.

Any vegetation, organic or deleterious material, including topsoil and non-engineered fill may require removal from under pavement areas prior to aggregate placement. The subgrade should be subject to inspection by an experienced Geo-professional who is familiar with the findings of this report, with Scala testing of the prepared subgrade surface carried out to confirm the design CBR value has been achieved.

12.0 Stormwater Control & Underground Services

Concentrated stormwater flows from all impermeable areas must be collected and disposed in a council approved method. Any uncontrolled stormwater must not be allowed to saturate the ground as this will be potentially affect the foundation performance of buildings and pavements. If the disposal of stormwater is to be carried out via soakage pit or any other subsoil drains Council Consent must be obtained.

Underground services may need to be underlain by a bedding of ballast depending on the depth of the services and available bearing capacity during construction. Based on the lateral spreading categorisation for the site and as a preliminary assessment, we consider the site to be consistent with Medium liquefaction vulnerability. Regardless, the design of the horizontal infrastructure should be carried out in accordance with the CCC Infrastructure Design Standard (IDS) - Part 4 to 6. Service trenches deeper than 2.0m may require temporary shoring and dewatering, which may require a dewatering permit from Ecan and further geotechnical assessment to evaluate settlements on neighbouring properties.

Service trenches should be suitably treated when crossing from natural ground to improved ground to provide adequate support and flexibility to remain usable following future large earthquakes. Similarly, flexible connections are required between the ground improvement and house foundations.

Should service lines and buried infrastructure require excavations below the depth of groundwater on site, groundwater draw-down and corresponding settlement analysis to be carried out, and a permit from ECan for dewatering may be required. We recommend that excavations be undertaken in late summer / early autumn when groundwater levels are generally at their seasonal lowest levels. Shoring required to ensure the stability of such excavations is to be designed and supervised by a suitable qualified Geo-professional familiar with this report.

13.0 Future Geotechnical Involvement

13.1 Shallow Soil Testing

Each individual lot should be subject to shallow soil testing to support the detailed design and Building Consent applications for future housing. The results of the shallow soil testing may supersede the findings of our area-wide investigations and preliminary foundation recommendations supplied herein.

13.2 Construction Observations

Should extensive subdivision-wide earthworks take place, a Geo-professional familiar with the findings of this report should be engaged to carry out observations during earthworks and any corresponding subdivision construction with geotechnical implications to confirm our above recommendations are being wholly followed. Of note is that, if LandTech is to be engaged to complete the work:

- Inspections will not be carried out prior to the issue of Council Resource and/or Building Consents; unconsented works will not be inspected.
- We recommend that once received, the Consent be forwarded and reviewed by us. Following the Consent review a schedule of inspections can be issued to the Client.
- Without sufficient observations during the foundation construction phases, LandTech will not be in a position to provide engineering certification (i.e. Producer Statement PS4).

14.0 Limitations

This geotechnical report has been prepared for our Client, Urban Estates Limited, for the purposes of supporting their proposed residential development. This report may be used by our Client's appointed consultants for design purposes, and for supporting Consent applications to Christchurch City Council. This report shall not be extrapolated for other nearby sites or used for any other purposes without the express approval of LandTech and their Client.

This report has been based on the results of tests at point locations; therefore, subsurface conditions could vary away from the assumed geotechnical model. Should exposed soil conditions vary from those described herein we request to be informed to determine the continued applicability of our recommendations. We have attempted to conduct a thorough investigation of soil types across the site, within the agreed scope of works. However, variations still may exist as soils can vary naturally and due to previous human activities, which LandTech have no control over and should not be held accountable for.

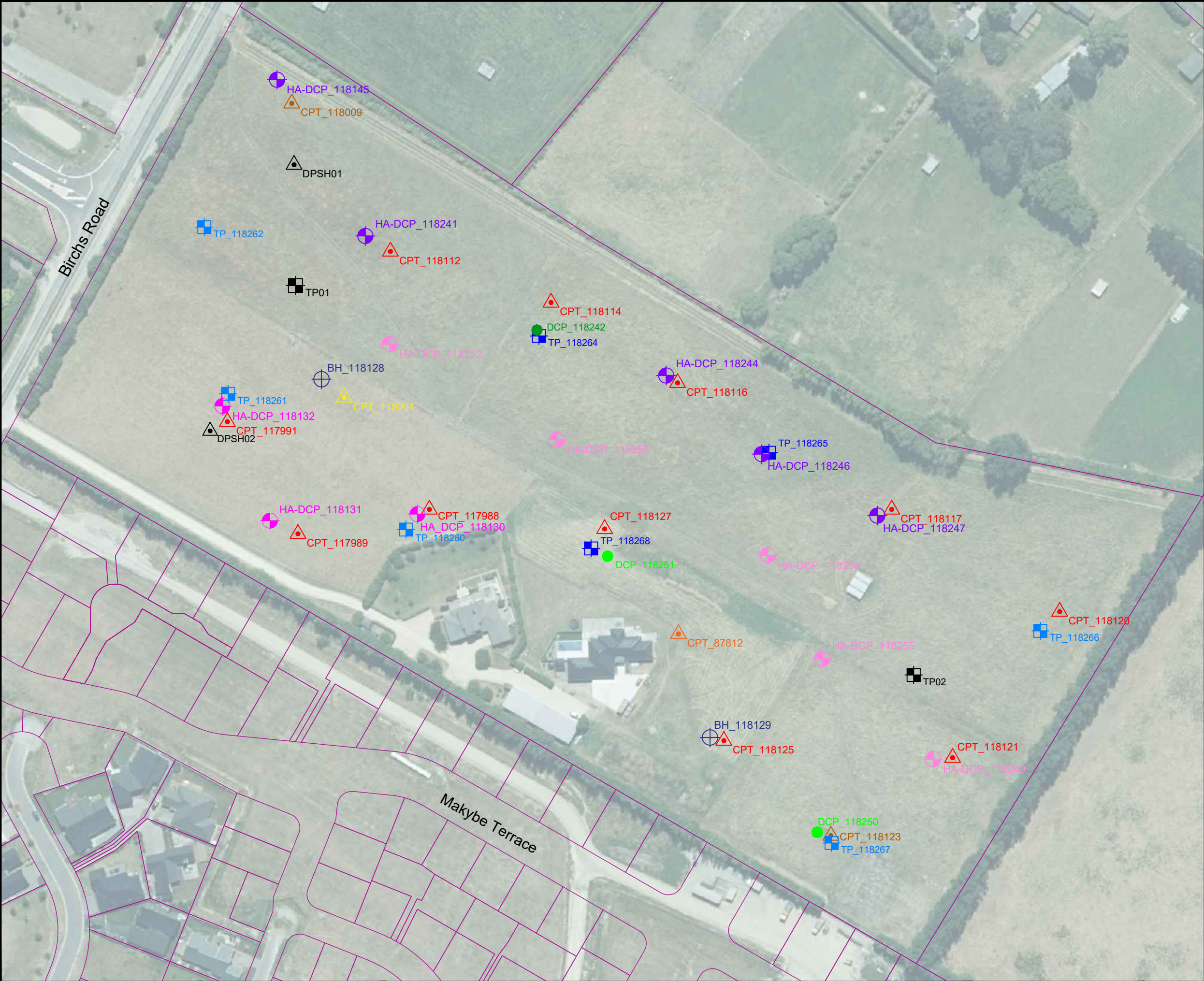
The geotechnical investigation was confined to geotechnical aspects of the site only and did not involve the assessment for environmental contaminants. In addition, our investigation and analyses have also not considered possible fault rupture that may cause deformations and displacements of the ground directly below the site. This type of assessment is outside of the scope of our geotechnical engagement.

END OF REPORT

APPENDIX A

LandTech Drawings





KEY:

TP01

LandTech Consulting Ltd. testpit locations, tested 06/06/2024

DPSH01

LandTech Consulting Ltd. CPT test locations, tested 06/06/2024

CPT_

McNeil Drilling CPT test locations, tested 18/12/2017

CPT_

McNeil Drilling. CPT test locations, tested 18/12/2018

CPT_118001

DCN Drilling Ltd. CPT test locations, tested 18/12/2017

CPT_87812

Ground investigations Ltd. CPT test locations, tested 27/10/2016

BH_

Davis Ogilvie. machine borehole location, drilled 19/03/2023

TP_

Davis Ogilvie. testpit locations, tested 18/12/2017

TP_

Davis Ogilvie. testpit locations, tested 18/12/2018

HA-DCP_

Davis Ogilvie. augerhole locations, drilled 01/03/2018

HA-DCP_

Davis Ogilvie. augerhole locations, drilled 02/03/2018

HA-DCP_

Davis Ogilvie. augerhole locations, drilled 08/03/2018

DCP_118242

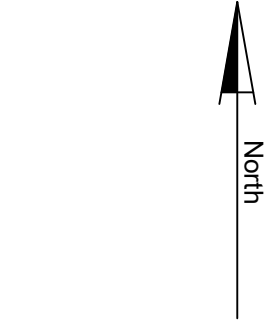
Davis Ogilvie. DCP test location, tested 02/03/2018

DCP_

Davis Ogilvie. DCP test location, tested 08/03/2018



Existing boundary



NOTES:

Locations of features approximate only

Original sheet size A3

Boundary information on this *Test Location Plan* adapted from LINZ website: www.data.linz.govt.nz (05/06/2024)

Drawing No:
LTC24135/ 1

Scale:
1: 1,500 (A3)

Filename: LTC24135 - Drawings.dwg

Drawn by:
SW

Checked by:
KP

Date:
06/06/2024

Revision:
A

AMENDMENTS		
DATE	REV	DESCRIPTION
06/06/2024	A	Report Issue

Check all dimensions and levels on site before commencing construction.
This drawing and design remains the property of LandTech Consulting Ltd. and may not be reproduced without approval and permission from LandTech Consulting Ltd.

Test Location Plan

555 Birchs Road
LINCOLN



Christchurch Office:
3/16 Leslie Hills Drive, Riccarton, Christchurch 8011

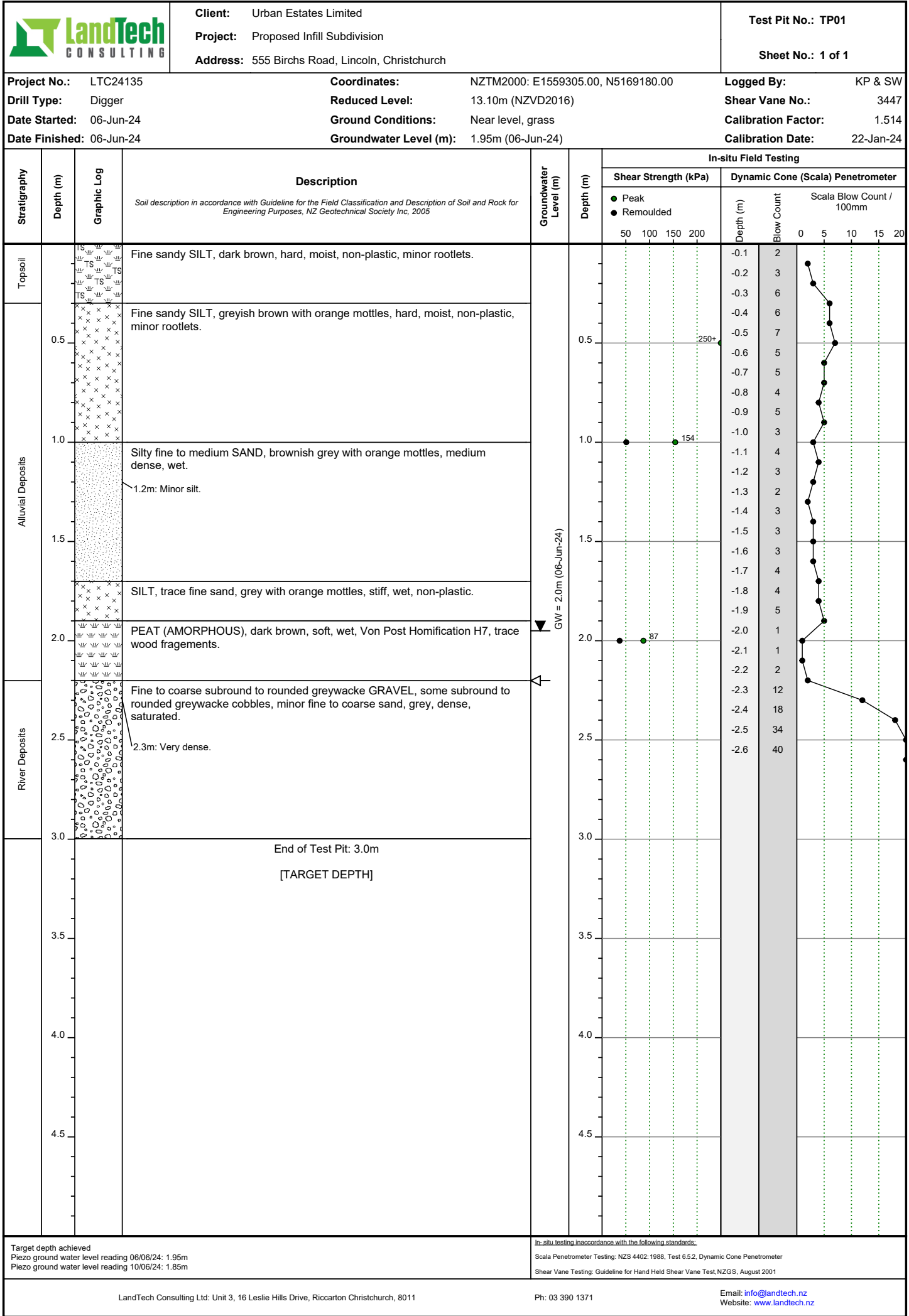
Auckland Office:
15C Paramount Drive, Henderson, Auckland 0610

Postal Address:
PO Box 119, Christchurch 8013

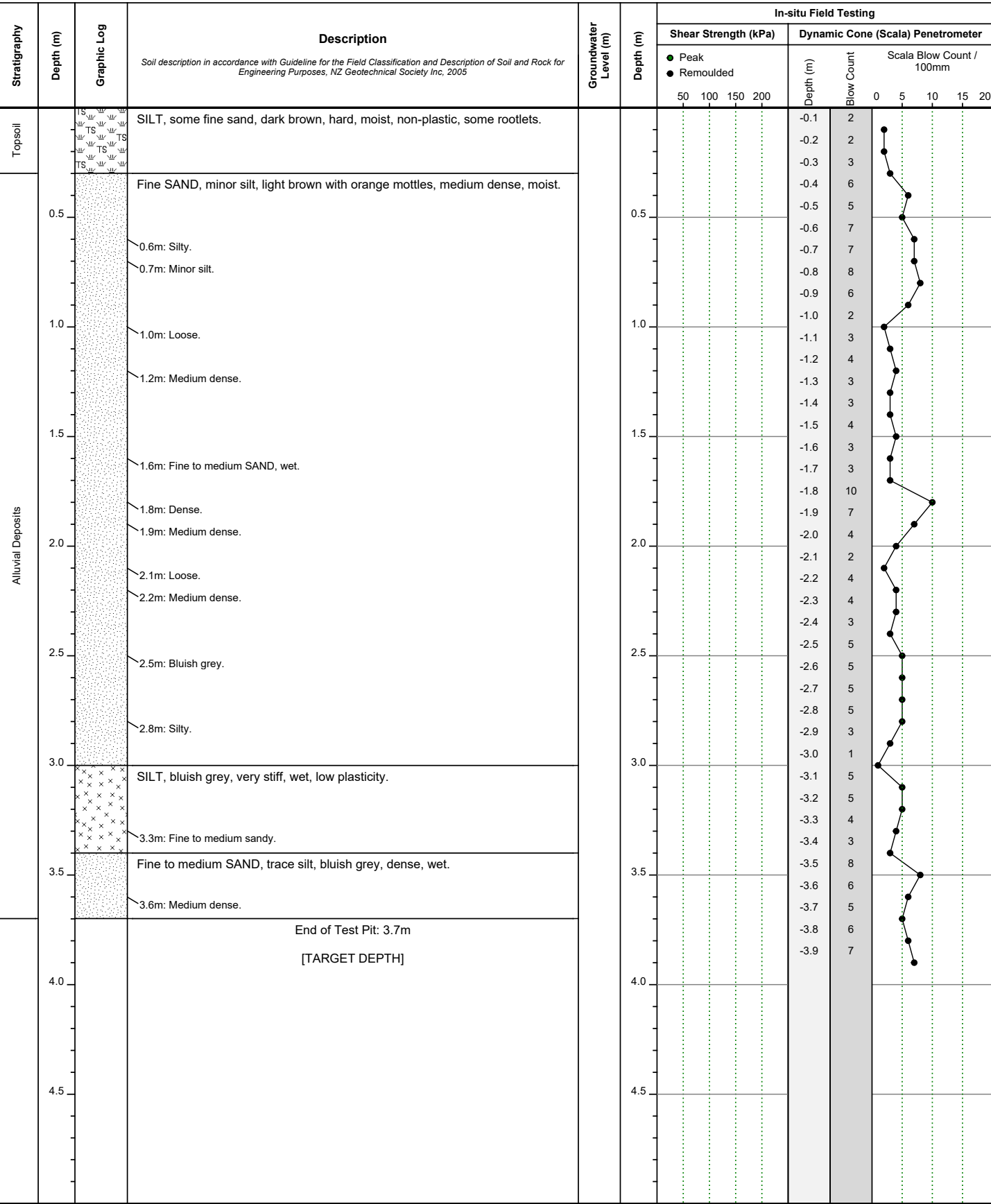
Website: www.landtech.nz Email: info@landtech.nz

APPENDIX B

LandTech Field Logs



Project No.: LTC24135 Coordinates: NZTM2000: E1559559.00, N5169020.00 Logged By: KP & SW
Drill Type: Digger Reduced Level: 12.50m (NZVD2016) Shear Vane No.:
Date Started: 06-Jun-24 Ground Conditions: Near level, grass Calibration Factor:
Date Finished: 06-Jun-24 Groundwater Level (m): Not Encountered Calibration Date:



Target depth Achieved
Piezo ground water level reading 06/06/24: n/a piezo was dry
Piezo ground water level reading 10/06/24: 2.65m

In-situ testing in accordance with the following standards:
Scala Penetrometer Testing: NZS 4402:1988, Test 6.5.2, Dynamic Cone Penetrometer
Shear Vane Testing: Guideline for Hand Held Shear Vane Test, NZGS, August 2001

APPENDIX C

LandTech and NZGD Deep Test Results

LandTech CONSULTING DYNAMIC PROBE - SUPER HEAVY LOG										HOLE NO.: DPSH01																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				
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SITE LOCATION: 555 Birchs Road, Lincoln, Christchurch CO-ORDINATES: 5169136.00mE, 5169136.00mN (NZTM2000)										OPERATOR: JM ELEVATION: 13.1m (NZVD2016)		START DATE: 06/06/2024 END DATE: 06/06/2024																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
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NOTES:



DYNAMIC PROBE - SUPER HEAVY LOG

HOLE NO.:
DPSH02

CLIENT: Urban Estates Limited
PROJECT: Proposed Infill Subdivision

JOB NO.:
LTC24135

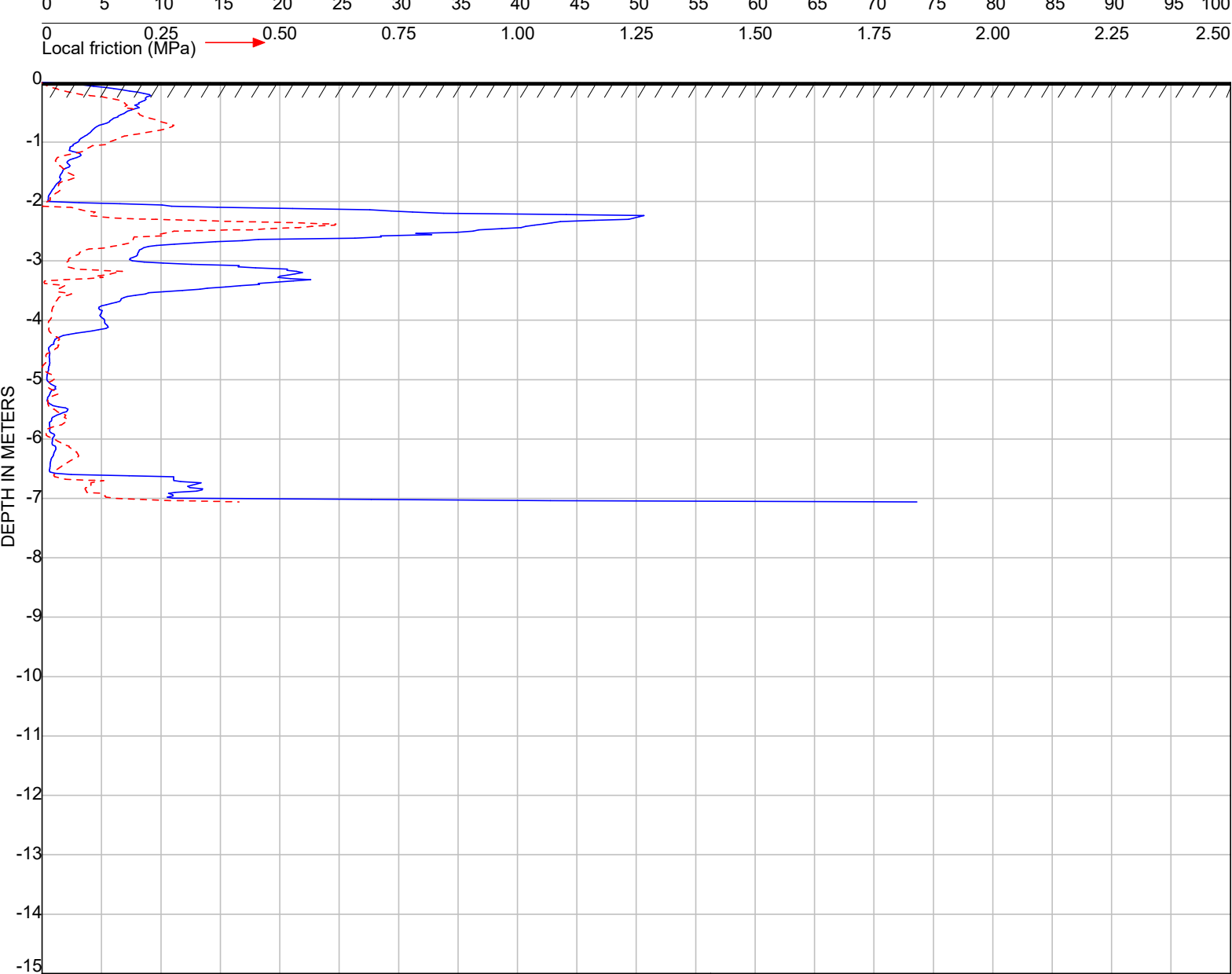
SITE LOCATION: 555 Birchs Road, Lincoln, Christchurch
CO-ORDINATES:

OPERATOR: JM
ELEVATION: 12.5m (NZVD2016)

START DATE: 06/06/2024
END DATE: 06/06/2024

DEPTH (m)	DATA	(Blows / 100mm)															(Torque / 100Nm)										WATER	DEPTH (m)			
		4	8	12	16	20	24	28	32	36	10	20	30	40	50	60	70	80	90												
6	1																											6			
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	1																														
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7	5																											7			
	4																														
	6																														
	30																														
	40																														
	EOH: 7.1m Termination Reason: DPSH refusal																													8	
9																													9		

Remarks:		TEST DETAILS:	
Groundwater not measured due to hole collapse at 1.6m Coordinates from handheld GPS accurate to +/-4m Pagani TG63-150 Rig, 10 cm² piezocone		Weight	63.5 kg
		Rod Mass	6.2 kg
		Drop Height	750 mm
		Cone Area Ratio	0.002
		Predrill	0.1
		Termination	DPSH refusal



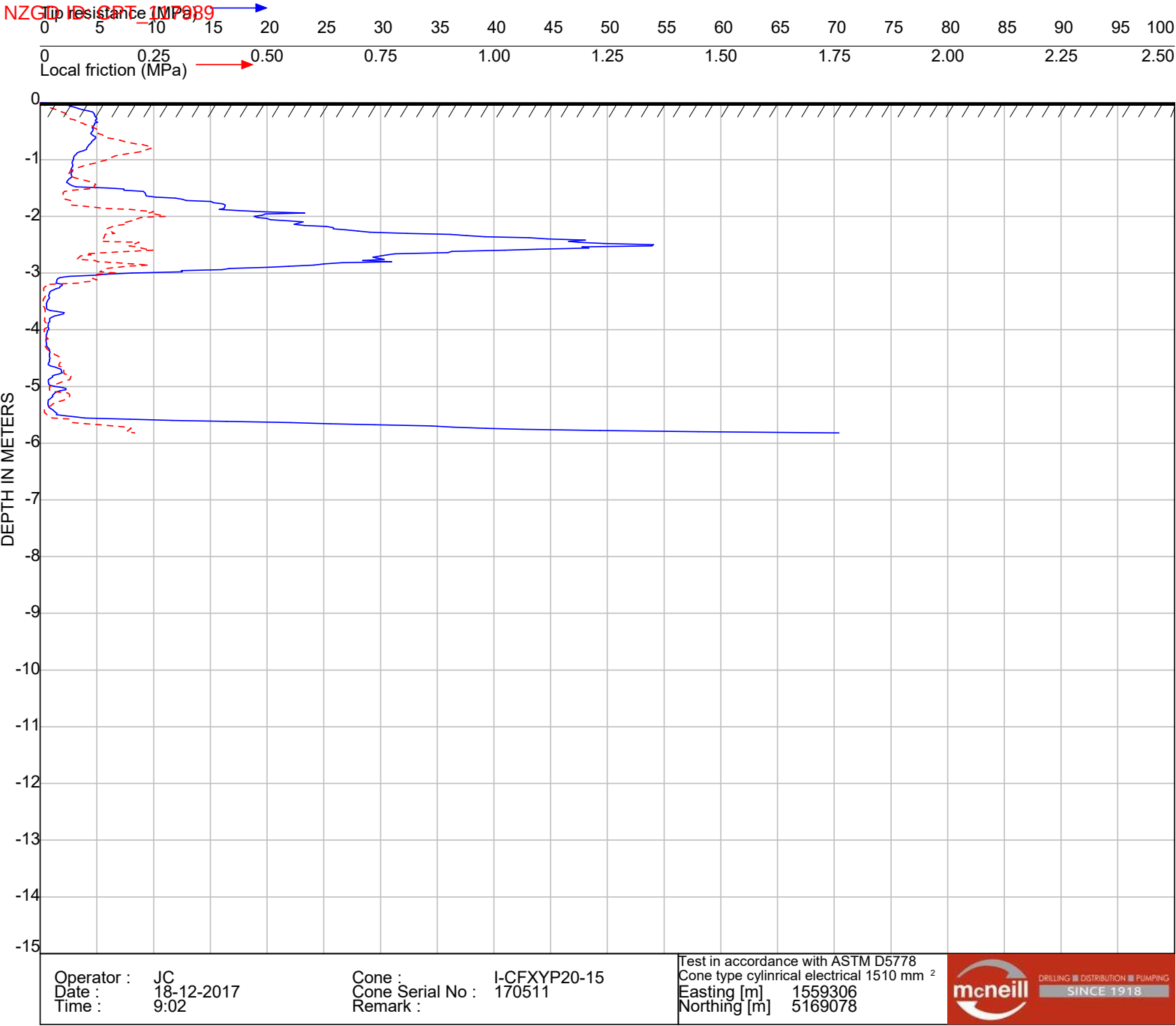
Operator : JC	Cone : I-CFYYP20-15	Test in accordance with ASTM D5778
Date : 18-12-2017	Cone Serial No : 170511	Cone type cylindrical electrical 1510 mm ²
Time : 11:48	Remark :	Easting [m] 1559410
		Northing [m] 5169173



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

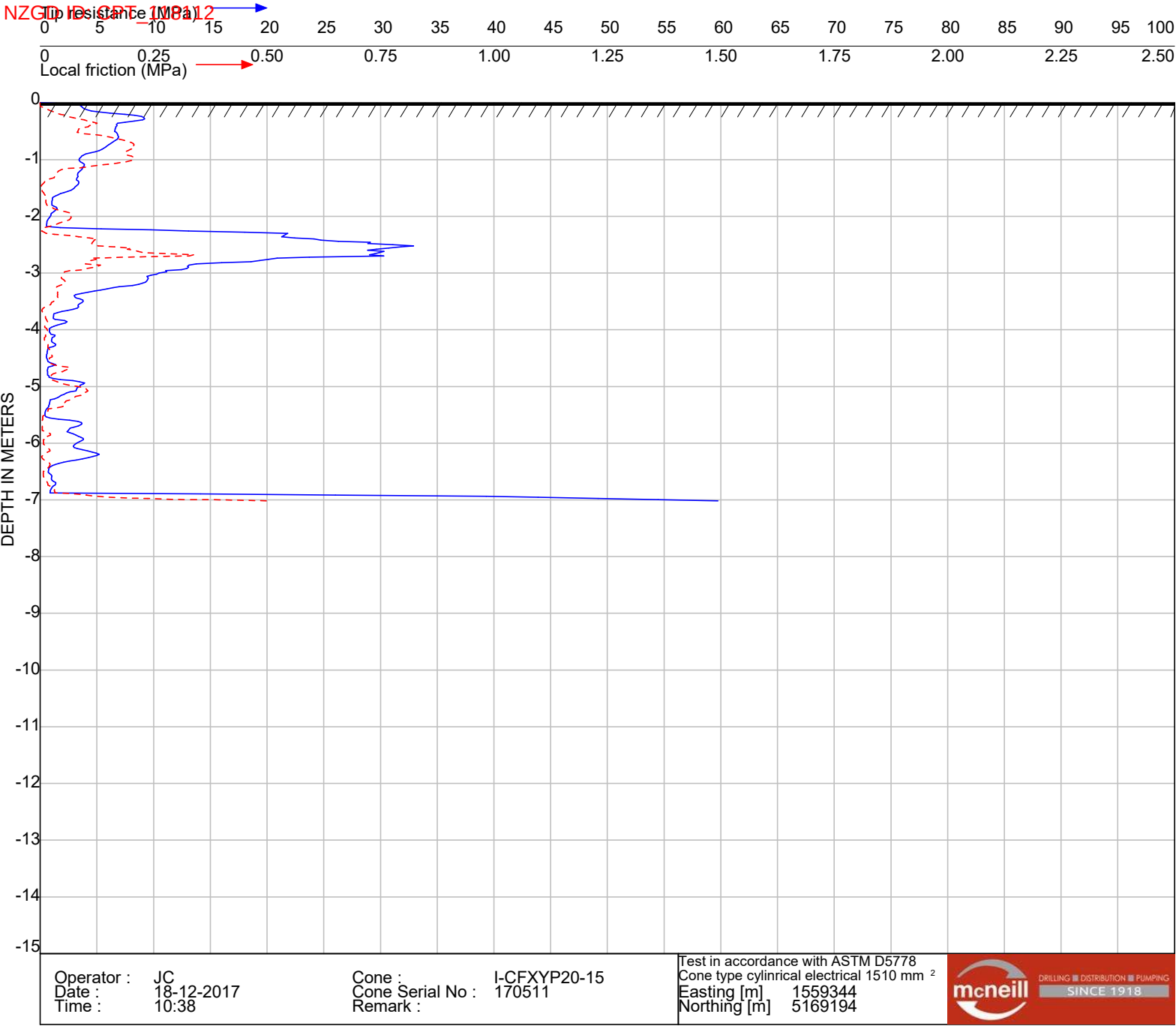
Project No : 4748
Location : CPT8



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

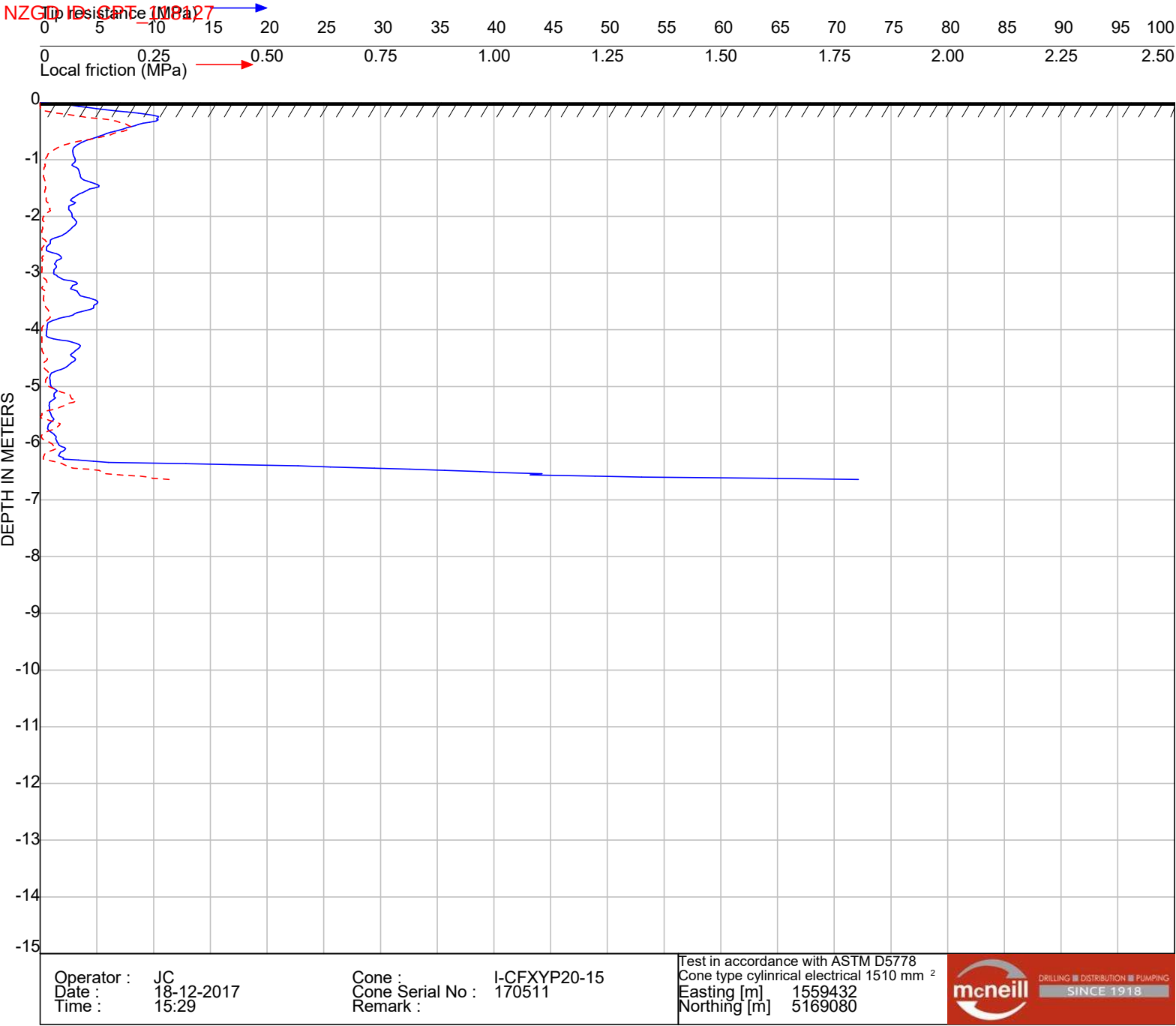
Project No : 4748
Location : CPT2



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

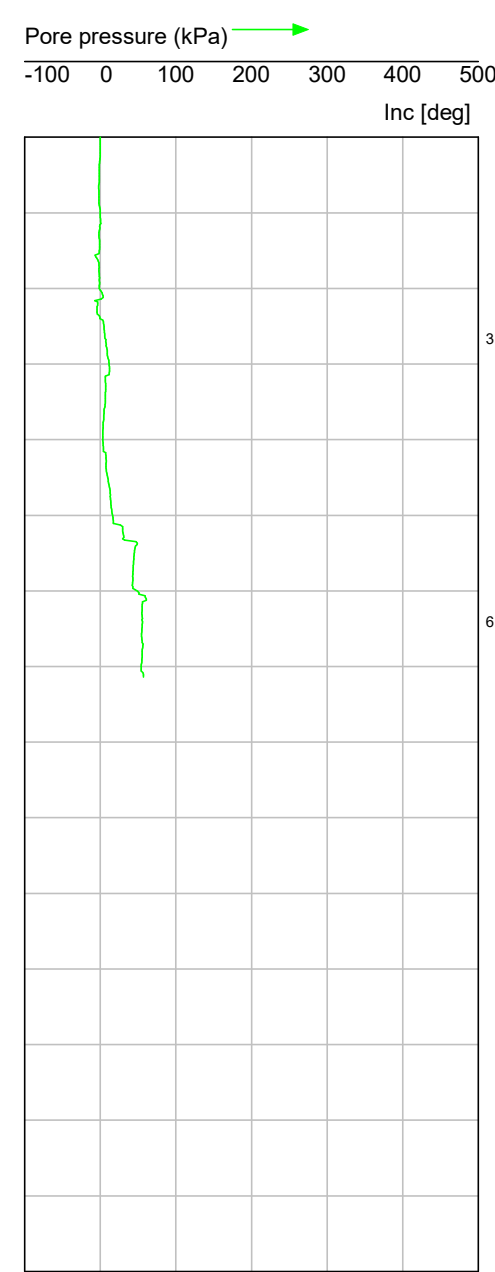
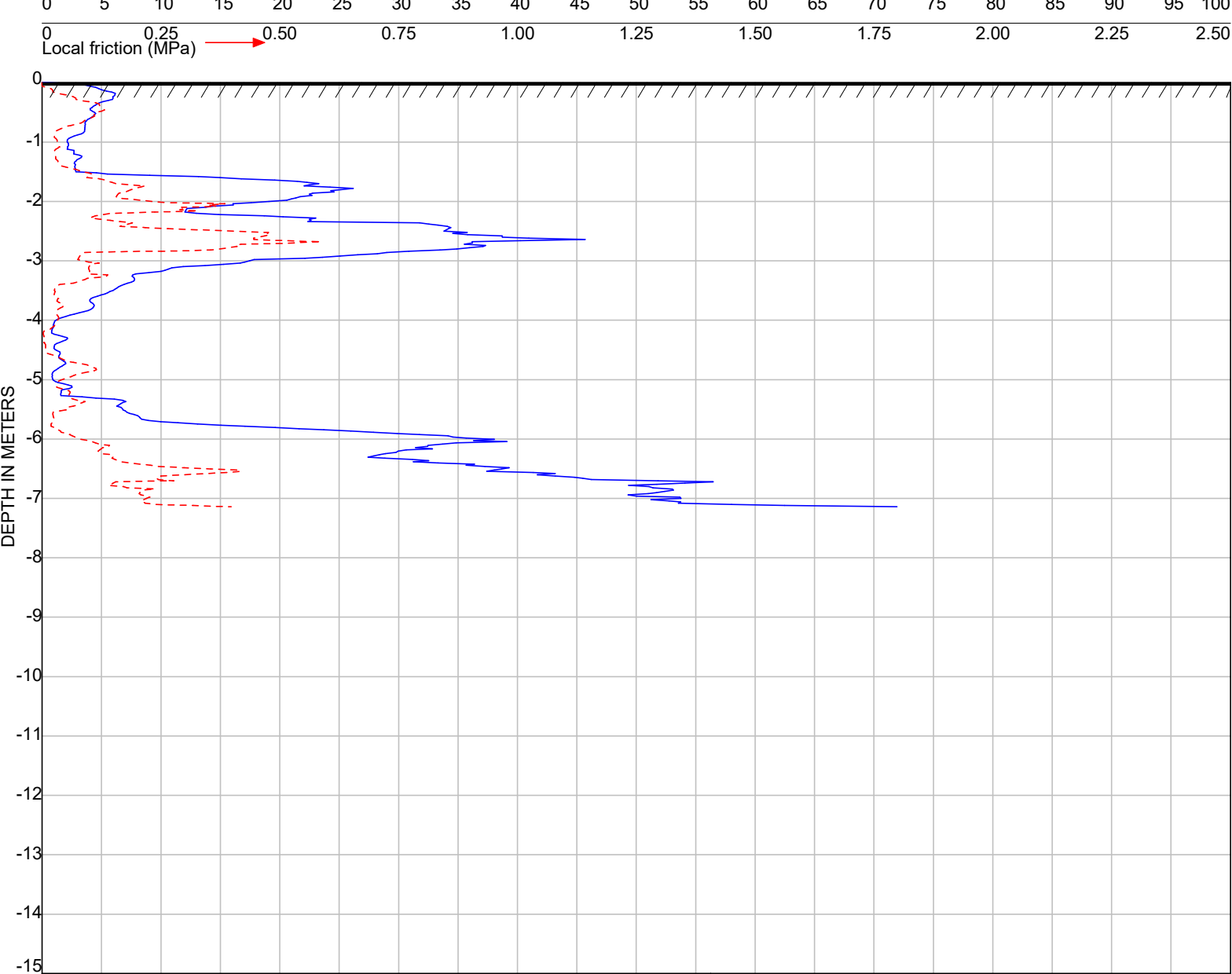
Project No : 4748
Location : CPT7



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

Project No : 4748
Location : CPT16



Operator : JC	Cone : I-CFXYP20-15	Test in accordance with ASTM D5778
Date : 18-12-2017	Cone Serial No : 170511	Cone type cylindrical electrical 1510 mm ²
Time : 12:09	Remark :	Easting [m] 1559462
		Northing [m] 5169140

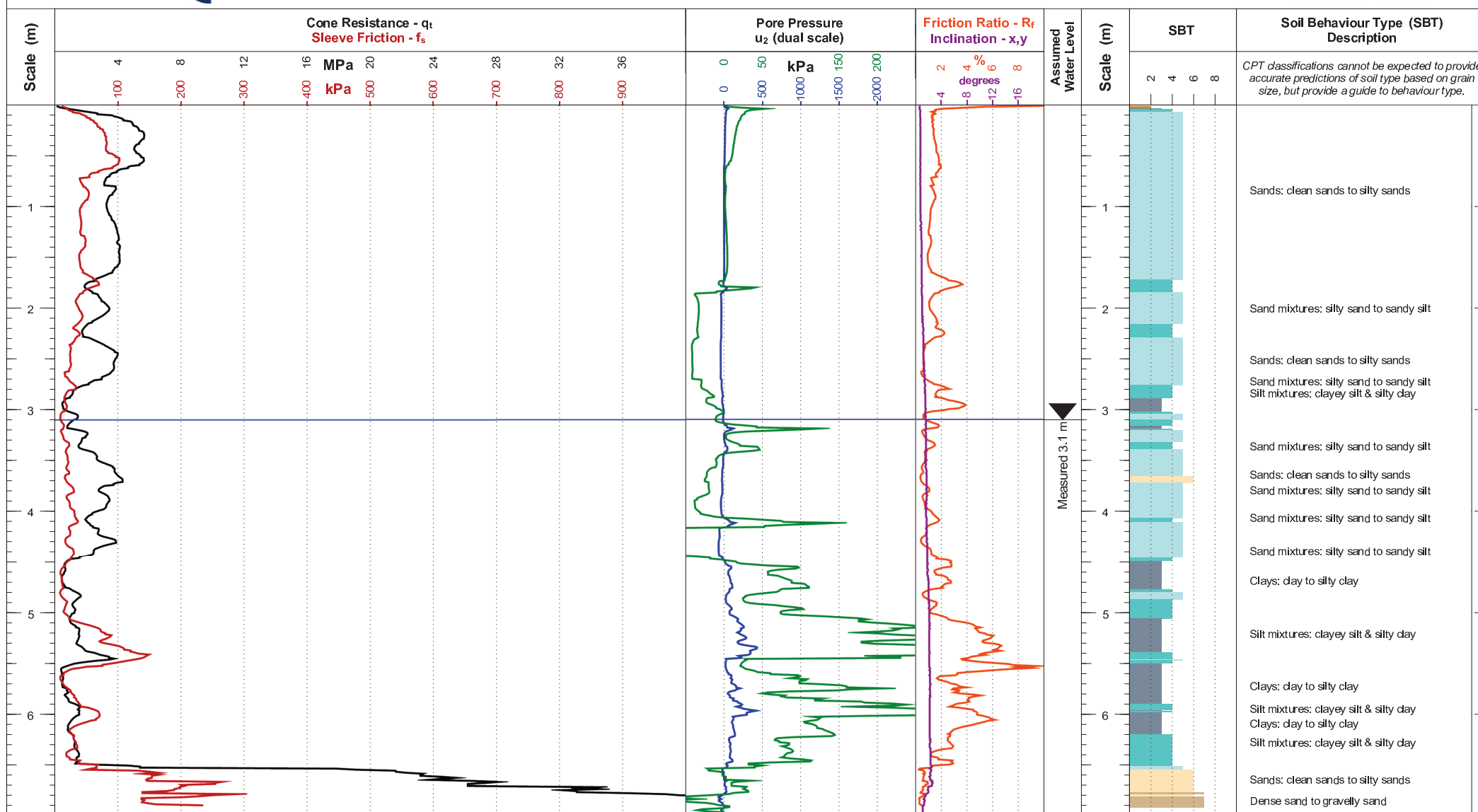


PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

Project No : 4748
Location : CPT9

CONE PENETRATION TEST (CPT) LOG



Client: Geoconsult
Project Name: Lots 3 & 5 - 555 Birches Road
Location: Lincoln, Canterbury
Project Engineer: Warren Sillitoe
Contractor: Ground Investigation Ltd.

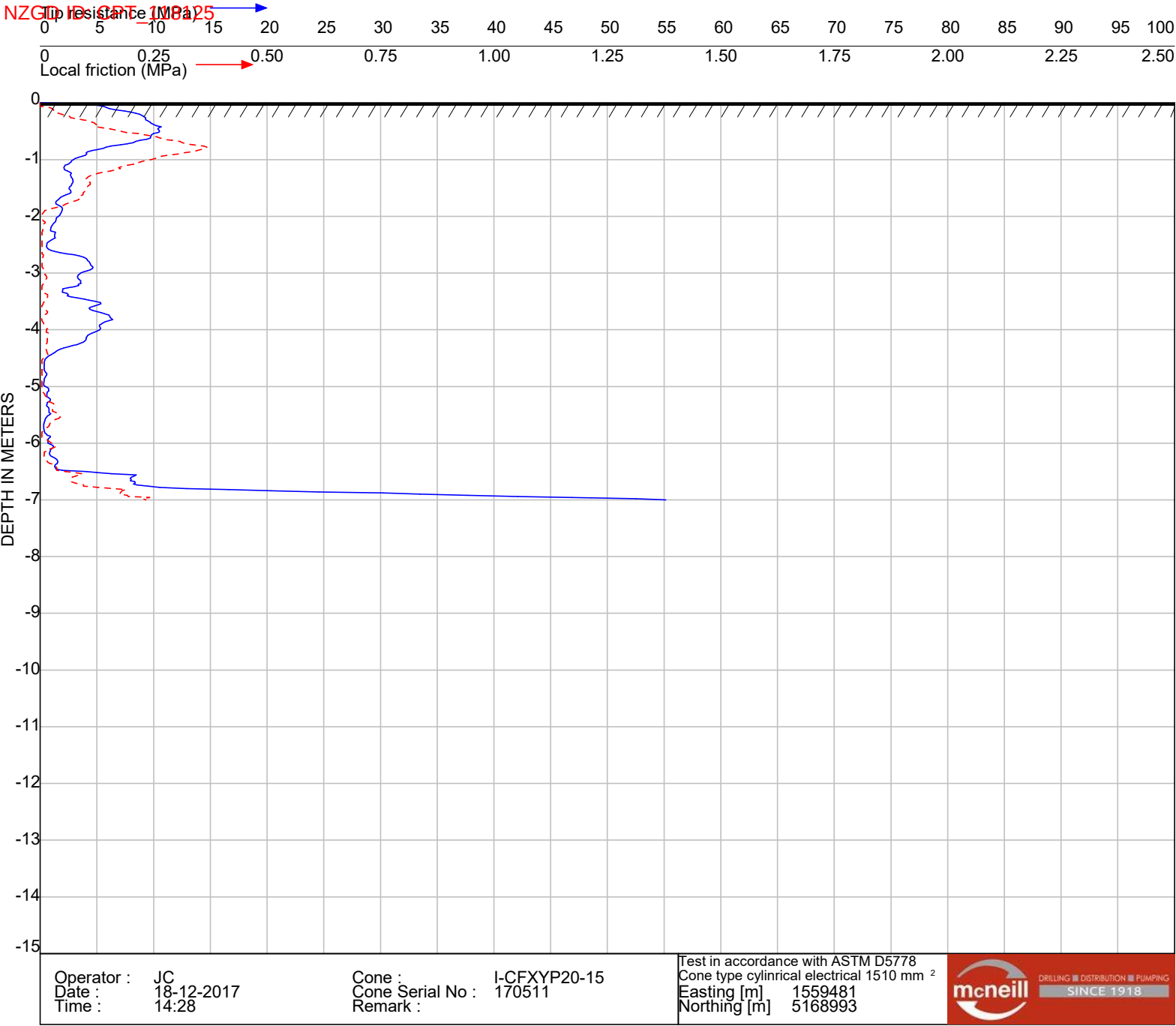
North (m): 5169039.86
East (m): 1559461.90
Elevation (m): -
Location Method: Handheld GPS
Hole Depth (m): 6.99

Remarks:
Stopped due to high cone end resistance. Continued with DPSH.

Operator: Ben Ellis
Cone Number: MKJ309

Cone Area Ratio: 0.8
Sleeve Offset (m): 0.08

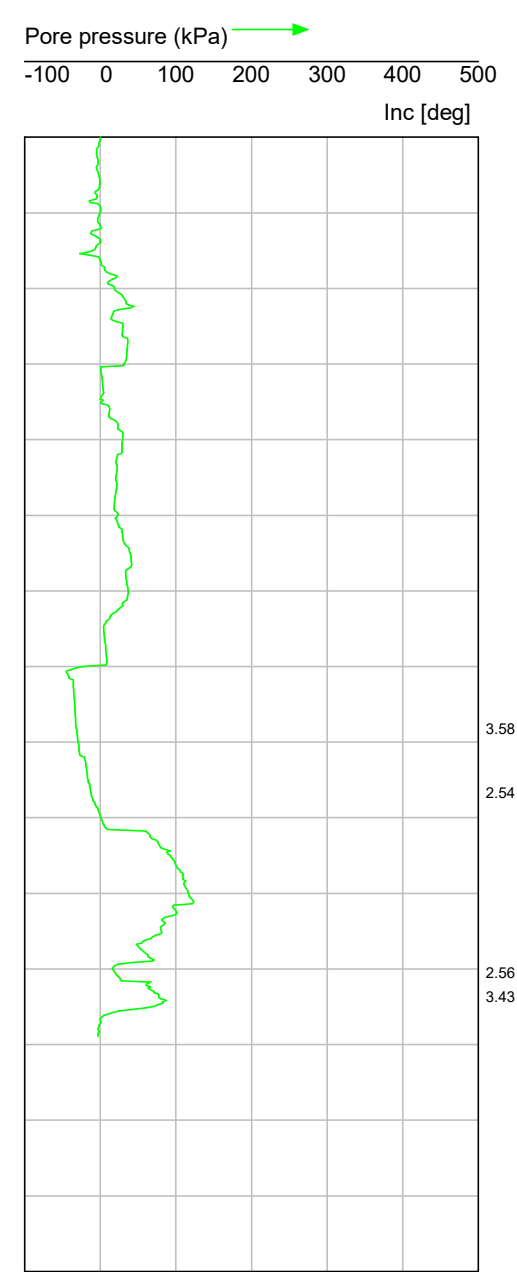
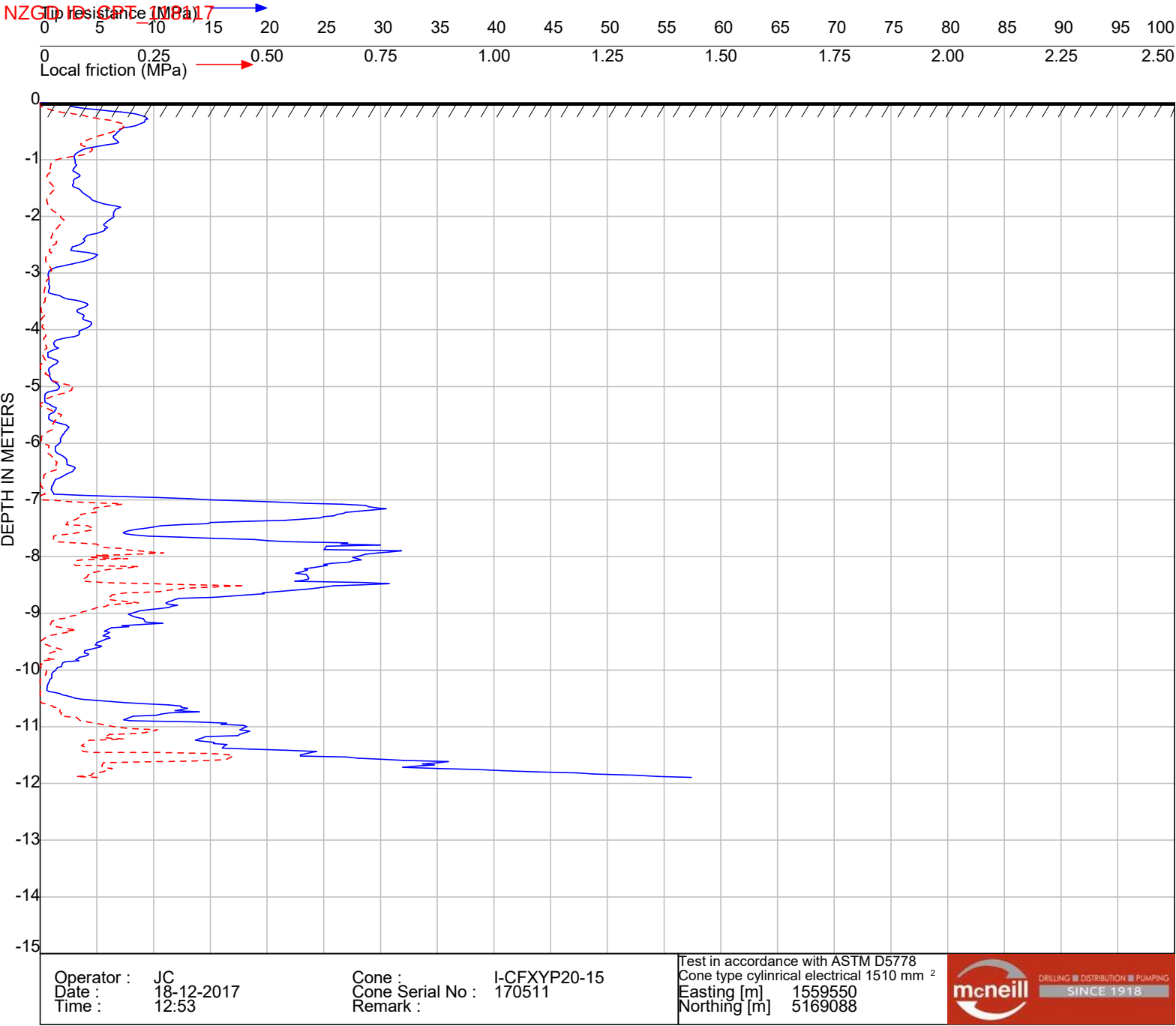
Client Job Number:	
CPT Number:	CPT-01
G.I. Job Number:	16-652
Date: 27/10/2016	Page 1 of 1



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

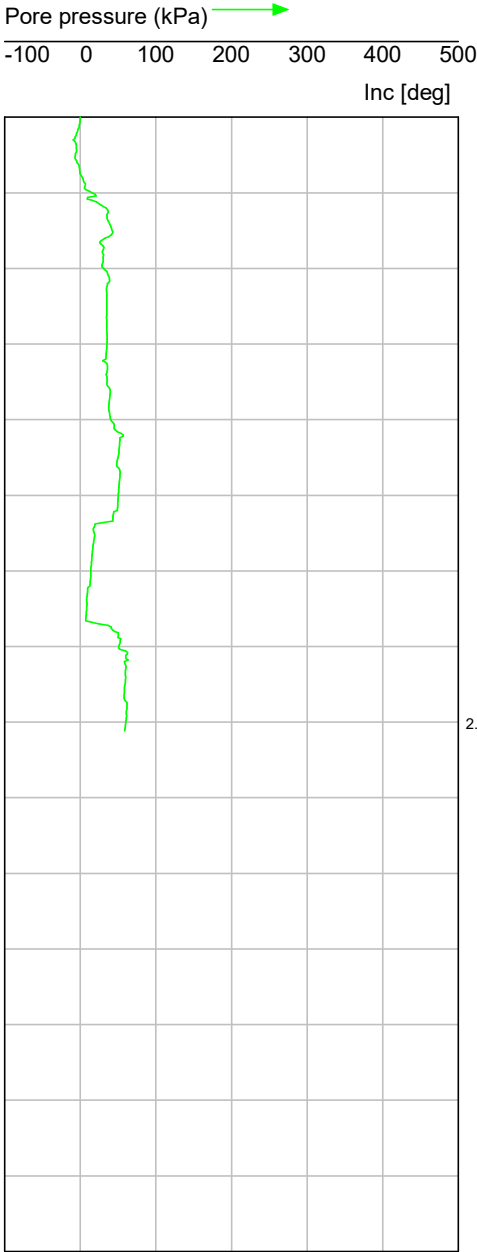
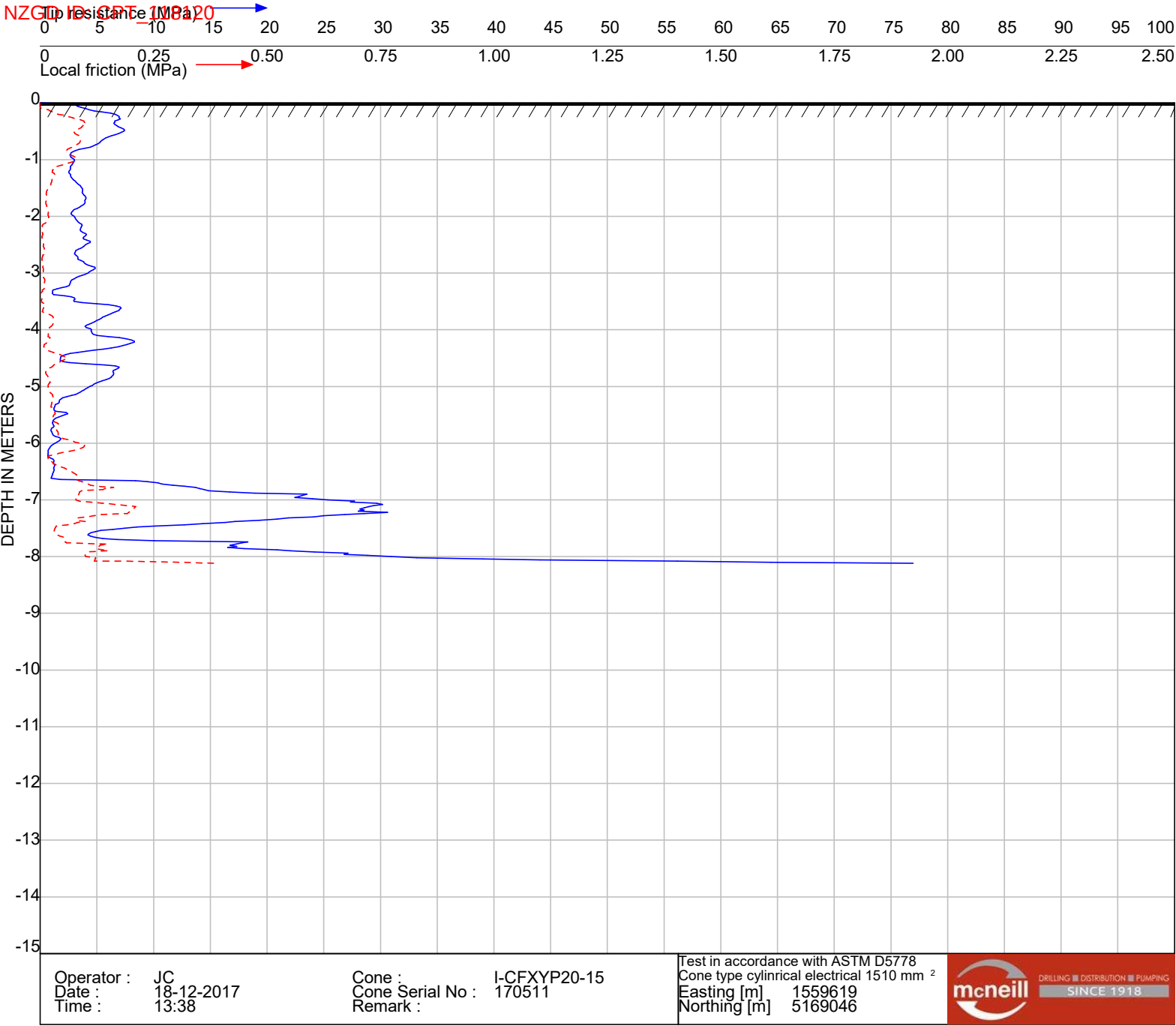
Project No : 4748
Location : CPT15



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

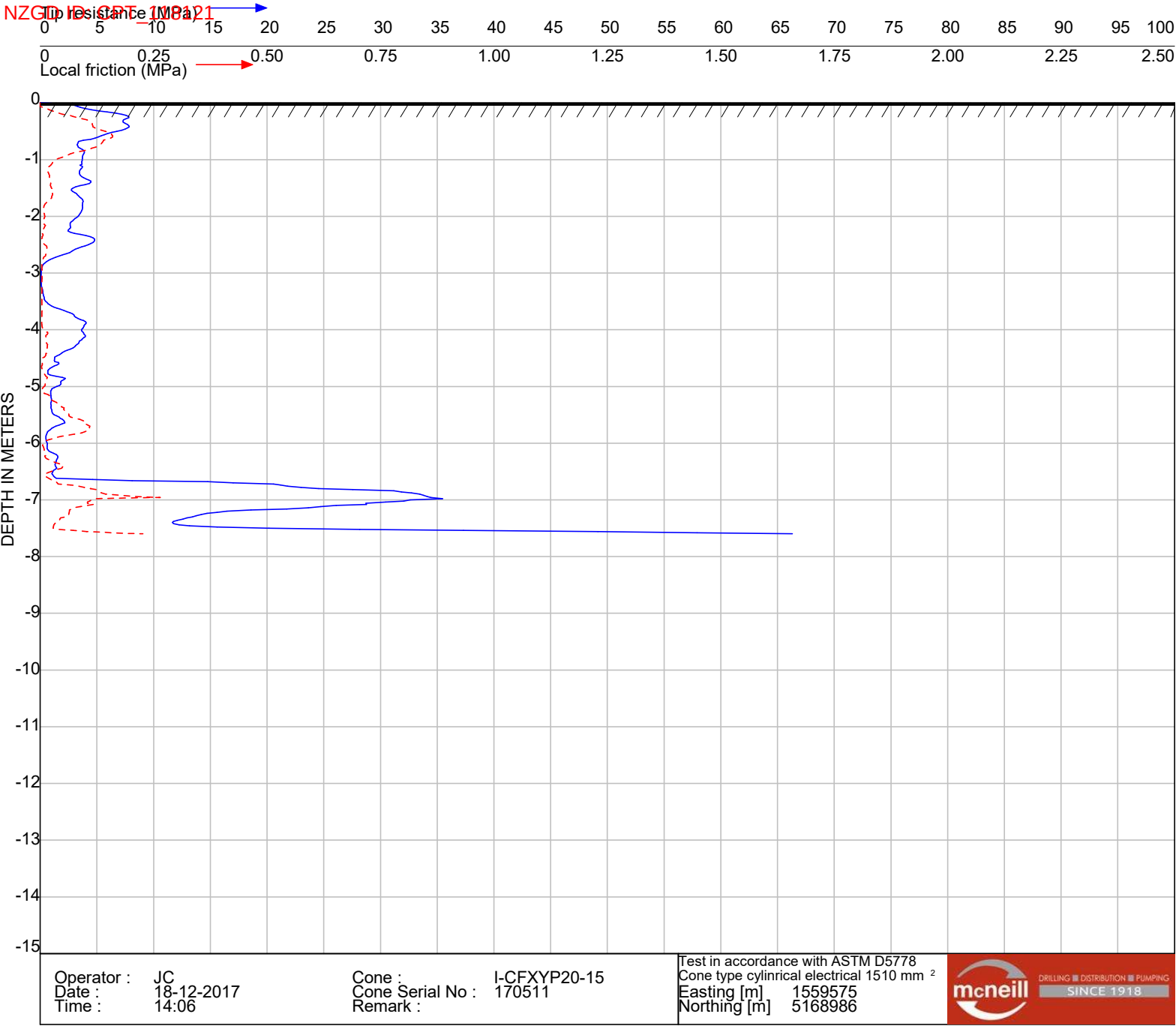
Project No : 4748
Location : CPT11



PIEZO CONE PENETRATION TEST

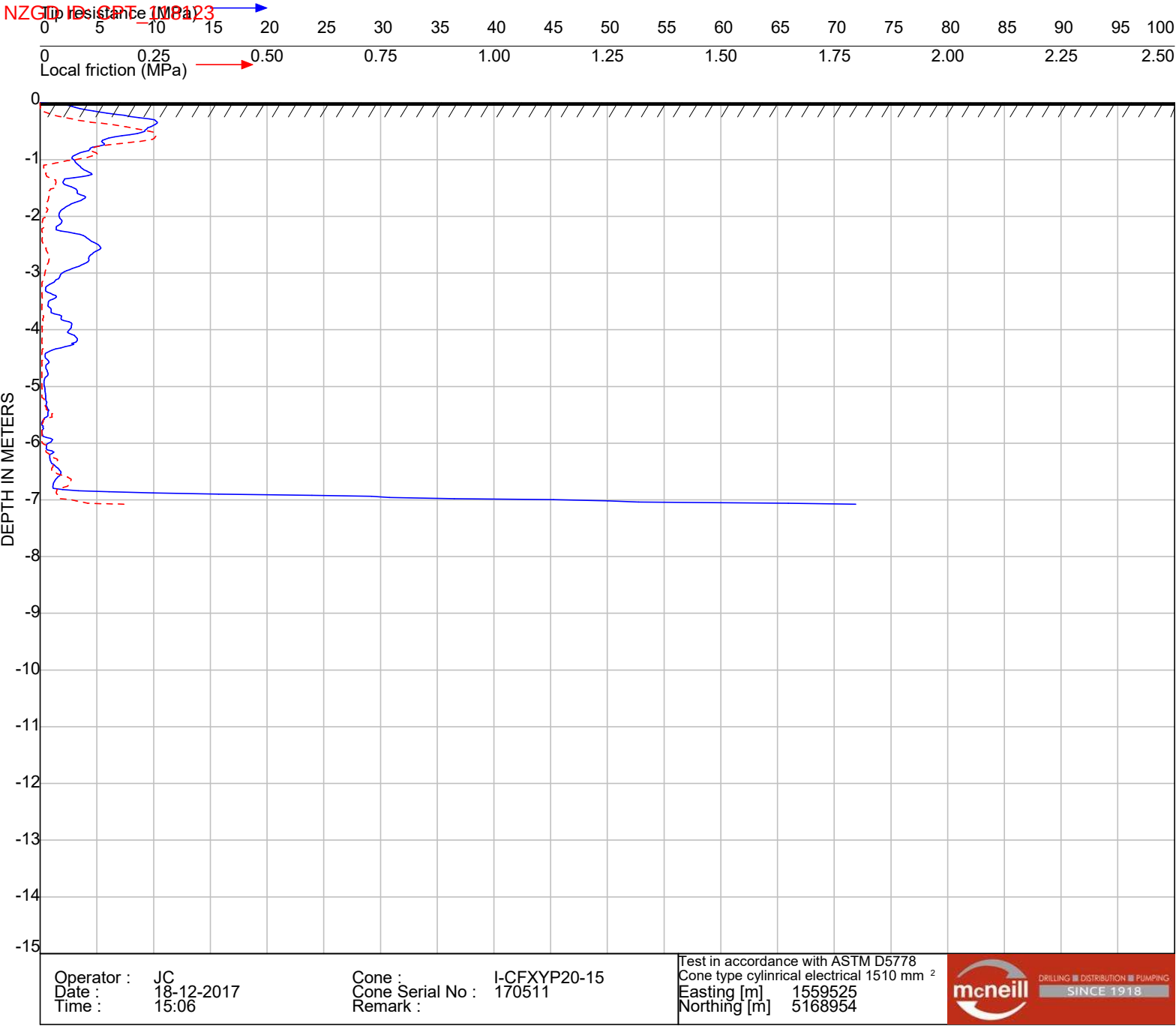
Client : Davis Ogilvie
Project : 555 Birchs Road

Project No : 4748
Location : CPT12



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road



PIEZO CONE PENETRATION TEST

Client : Davis Ogilvie
Project : 555 Birchs Road

Project No : 4748
Location : CPT14

doDAVIS OGILVIE			Davis Ogilvie & Partners Limited Level 1, 24 Moorhouse Avenue, Addington, Christchurch 8140 Office 0800 999 333 Email hello@do.nz www.do.nz			DEEP INVESTIGATION RESULTS							
PROJECT: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)						Date: 19/03/18							
CLIENT: Lincoln Developments Limited						Time: 9:00 a.m.							
LOCATION: Refer to Geotechnical Site Plan G01A						Excavation Method:							
COORDINATES:			RL GROUND:			INCLINATION: Vertical							
GRID: NZTM			DATUM:			ORIENTATION: HOLE DEPTH: 10.6m							
Ground Water	USCS	Description	Weathering		Graphic Log	Depth (m)	TCR (%)			SPT N-value (Uncorrected)	Sample	Backfill & Installation	
			SW	CW			25	50	75			10	20
	CH	Silty CLAY with trace organics; bluish grey. Firm, wet, high plasticity. Organic content is roots and rootlets preserved in clay matrix.					50						
	CH	Fine sandy CLAY with some silt; bluish grey. Soft, saturated, high plasticity.											
	GW	Fine to medium sandy, fine to coarse GRAVEL with some silt; bluish grey. Dense, saturated, gravel is well graded, sub-rounded to sub-angular greywacke. 6.2m: Becomes light orangey brown. 6.5m: Cobbles encountered				6.50							
	GW	7.0m: Cobbles encountered 7.1m: Reduction in SILT				7.00	100						
	GW	7.3m: Becomes fine to coarse sandy.				7.50							
	GW	Fine to coarse GRAVEL; bluish grey. Dense, saturated, gravel is well graded. No sand recovered.									4, 4 / 4, 4, 6, 11 N = 25		
	SW	Fine to medium gravelly, fine to coarse SAND; greyish brown. Medium dense, saturated, gravel is well graded.				8.00							
	SP	Medium and coarse SAND; greyish brown. Medium dense, saturated, uniformly graded.											
	GW	Medium and coarse sandy, fine to coarse GRAVEL; greyish brown. Dense, saturated, gravel well graded, sub-rounded greywacke.				8.50	80						
	GW	Fine to coarse GARVEL; bluish grey. Very dense, saturated, gravel is well rounded, sub-rounded to sub-angular greywacke.				9.00							
	GW					9.50					8, 9 / 9, 6, 6, 8 N = 29		
	GW					10.00	50						
		EOH: 10.64m				10.50							
											9, 6 / 5, 4, 3, 4 N = 16		
Logged By: HC+AB		Start Date: 19/03/2018		Remarks TCR value derived from McMillan logs.									
Plotted By: KL		End Date:											
Checked By: MS		Driller: McMillan Drilling											

Page 2 of 2

doDAVIS OGILVIE			Davis Ogilvie & Partners Limited Level 1, 24 Moorhouse Avenue, Addington, Christchurch 8140 Office 0800 999 333 Email hello@do.nz www.do.nz			DEEP INVESTIGATION RESULTS									
PROJECT: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)						Date: 19/03/18									
CLIENT: Lincoln Developments Limited						Time: 12:00 p.m.									
LOCATION: Refer to Geotechnical Site Plan G01A						Excavation Method:									
COORDINATES:			RL GROUND:			INCLINATION: Vertical									
GRID: NZTM			DATUM:			ORIENTATION: HOLE DEPTH: 10.6m									
Ground Water	USCS	Description	Weathering		Graphic Log	Depth (m)	TCR (%)		SPT N-value (Uncorrected)		Sample	Backfill & Installation			
			SW	CW			25	50	75	10		20	30	40	50
▼	TS	SILT with some clay; dark brown. Moist, rootlets (TOPSOIL).				0.00 - 0.50						Bentonite			
	ML	SILT with some clay; grey with orange mottles. Hard, moist, low plasticity, limonite nodules (coarse sand sized), trace rootlets. 1.0m: Becomes hard with increased orange mottling.				0.50 - 1.00									
	SM	Silty fine SAND; light grey with orange mottling. Medium dense, wet, uniformly graded.				1.00 - 1.50								C 1.32m, 1, Core sample (general)	
	ML	Fine sandy SILT; light greyish brown with orange mottling. Firm, wet, non-cohesive, dark red iron band at 2.3 m. 2.4m: Becomes saturated. Water dipped here.				1.50 - 2.50									
	SP	Fine SAND with minor silt; orangey brown. Loose, saturated, uniformly graded.				2.50 - 3.00								C 2.44m, 2, Core sample (general)	
	SM	Silty fine SAND; light grey with orange mottling. Medium dense, wet, uniformly graded. 2.6m: Becomes bluish grey.				3.00 - 3.50								C 3.04m, 3, Core sample (general)	
	SP	Fine and medium SAND with minor silt; greyish brown. Medium dense, saturated, uniformly graded. 3.2m: Becomes medium SAND.				3.50 - 4.00									
		3.5m: Becomes silty fine SAND interbedded with layers of fine SAND.				4.00 - 4.50									
		3.9m: Becomes fine and medium SAND.				4.50 - 5.00									
		4.6m - 4.6m: Becomes silty fine SAND and fine sandy SILT; grey.				5.00 - 5.50									
CH	4.7m - 4.8m: Layer of organic silty CLAY; dark brown. Comprised of amorphous rootlets and organics.				5.50 - 6.00						C 4.36m, 4, Core sample (general)	Surrounding ground collapse			
	Organic silty CLAY; grey. Soft, saturated, moderate to high plasticity, organic odour.				6.00 - 6.50										
	5.0m - 5.1m: Layer of organic silty CLAY; dark brown. Comprised of amorphous rootlets and organics. 5.2m - 5.2m: Layer of amorphous organic silty CLAY; grey and dark brown. 5.3m: Layer of silty fine SAND.				6.50 - 7.00									C 5.48m, 5, Core sample (general)	
	5.3m - 5.4m: PEAT; medium to dark brown. Comprised of amorphous remains, some rootlets and twigs.				7.00 - 7.50										
CH	Organic silty CLAY; dark brown. Soft, wet, high plasticity rootlets, minor fibrous organics.				7.50 - 8.00										
Logged By:		Start Date:		Remarks TCR value derived from McMillian logs.											
HC+AB		19/03/2018													
Plotted By:		End Date:													
KL															
Checked By:		Driller:													
MS		McMillan Drilling													

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APPENDIX D

NZGD Shallow Test Results

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 02/03/18

Time: 10:00 a.m.

Excavation Method: DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)	
					DCP 6																			
					1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8		9
	Auger at DCP 6				Groundwater Not Encountered																			
	SILT, dark brown. Moist, rootlets, moderately organic (TOPSOIL). [0.30m]	TS																						
	SILT with some clay, yellow brown mottled grey. Stiff, moist, low plasticity. [0.20m]	ML																						
0.5	SILT with some fine sand, mottled grey and orange. Stiff, moist, non plastic. [0.20m]	ML																						0.5
	Fine SAND, mottled grey and orange. Medium dense, moist, non plastic. [0.40m]	SP																						
1.0	Silty fine SAND, orange and grey mottled. Medium dense, moist. [0.10m]	SM																						1.0
	Fine SAND with some silt, orange mottled grey. Medium dense, moist. [0.30m]	SP																						
1.5	Fine sandy SILT, orange mottled grey. Firm to stiff, moist. [0.10m]	ML																						1.5
	Clayey SILT, grey mottled with orange. Firm to stiff, wet. [0.20m]	ML																						
	Medium SAND and fine GRAVEL, grey. Very dense, wet to saturated. [0.10m]	GP																						
	Auger terminated at 2.00m -																							
2.0																							2.0	

Logged By: HC+CG

Plotted By: KL

Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

NZGD ID: HA-DCP_118241

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 08/03/18

Time: 10:00 a.m.

Excavation Method: HA+DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					DCP 17																		
					1	2	3	4	5	6	7	8	9										
	SILT; dark brown. Moist, rootlets (TOPSOIL) [0.20m]	TS		Groundwater Not Encountered																			
	SILT with some fine sand and minor clay; mottled orange and grey. Firm to very stiff, moist, low plasticity. [0.60m] 0.4m: SV= 230/NA (kPa)	ML																					
0.5																							0.5
	Silty fine SAND; grey. Loose to medium dense, moist. [0.60m] 1.0m - 1.1m: silty fine SAND with orange mottling interbedded units.	SM																					
1.0																							1.0
	Clayey SILT; mottled orange and grey. Soft, moist, moderate plasticity. [0.20m]	CL																					
1.5																							1.5
	Fine to medium GRAVEL; Grey. Very Dense, dry. (recovered) [0.05m] Auger terminated at 1.70m - Refusal on gravel.	GP																					
2.0																							2.0
2.5																						2.5	
3.0																						3.0	

Produced with Core-GS by Geroc

Logged By: HC+AB
Plotted By: KL
Checked By: MS

Notes: SV= Shear Vane
kPa (Undisturbed / Remoulded)

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Logged By: HC+AB

Plotted By: KL

Checked By: MS

Notes: SV= Shear Vane
kPa (Undisturbed / Remoulded)

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

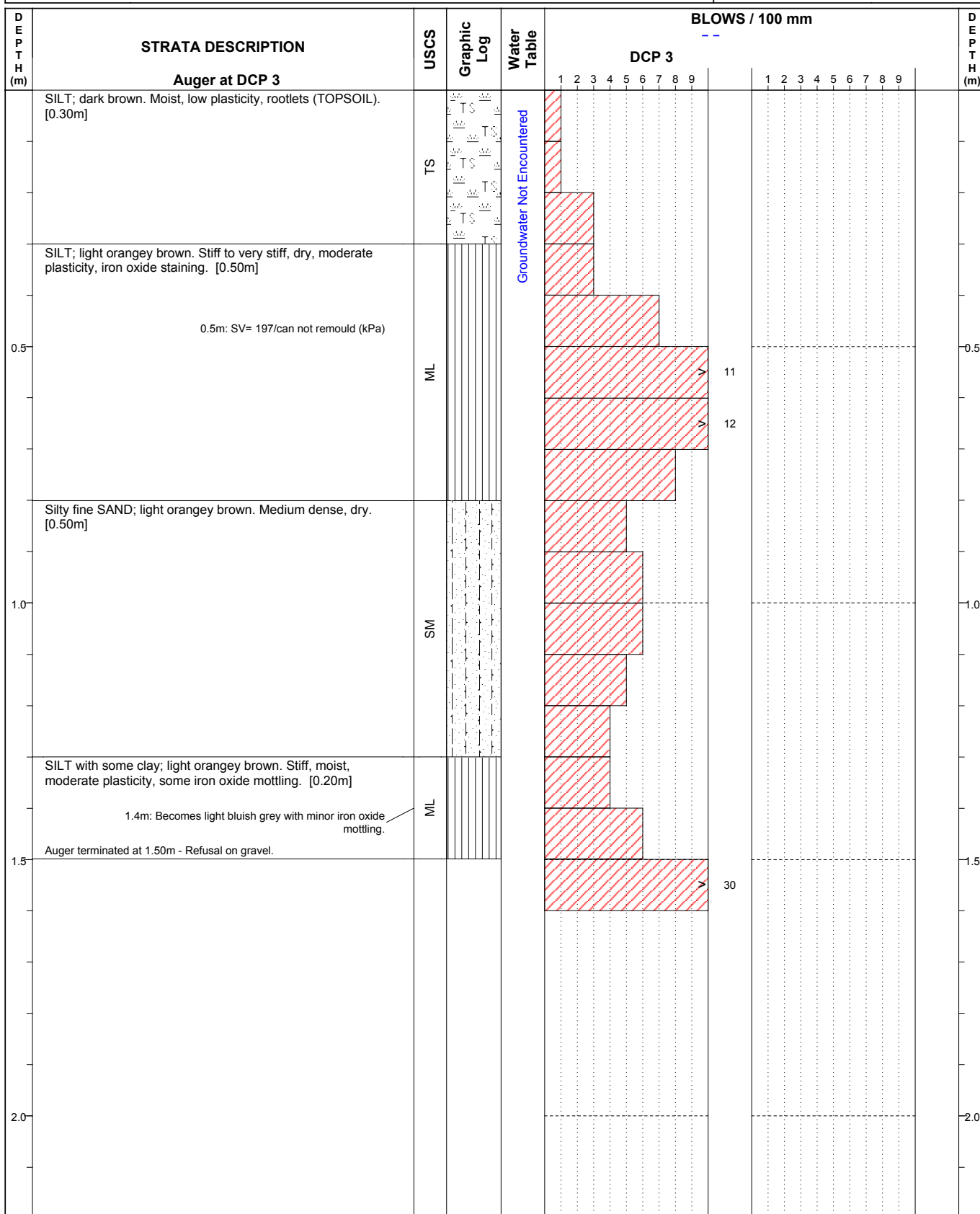
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (G01a).

Date: 01/03/18

Time: 11:30 a.m.

Excavation Method: HA+DCP





Davis Ogilvie & Partners Limited
 Level 1, 24 Moorhouse Avenue, Addington, Christchurch 8140
Office 0800 999 333 **Email** hello@do.nz
www.do.nz

SHALLOW INVESTIGATION RESULTS

Job N^o /37071_North Block

Test N^o /DCP 2 + HA

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

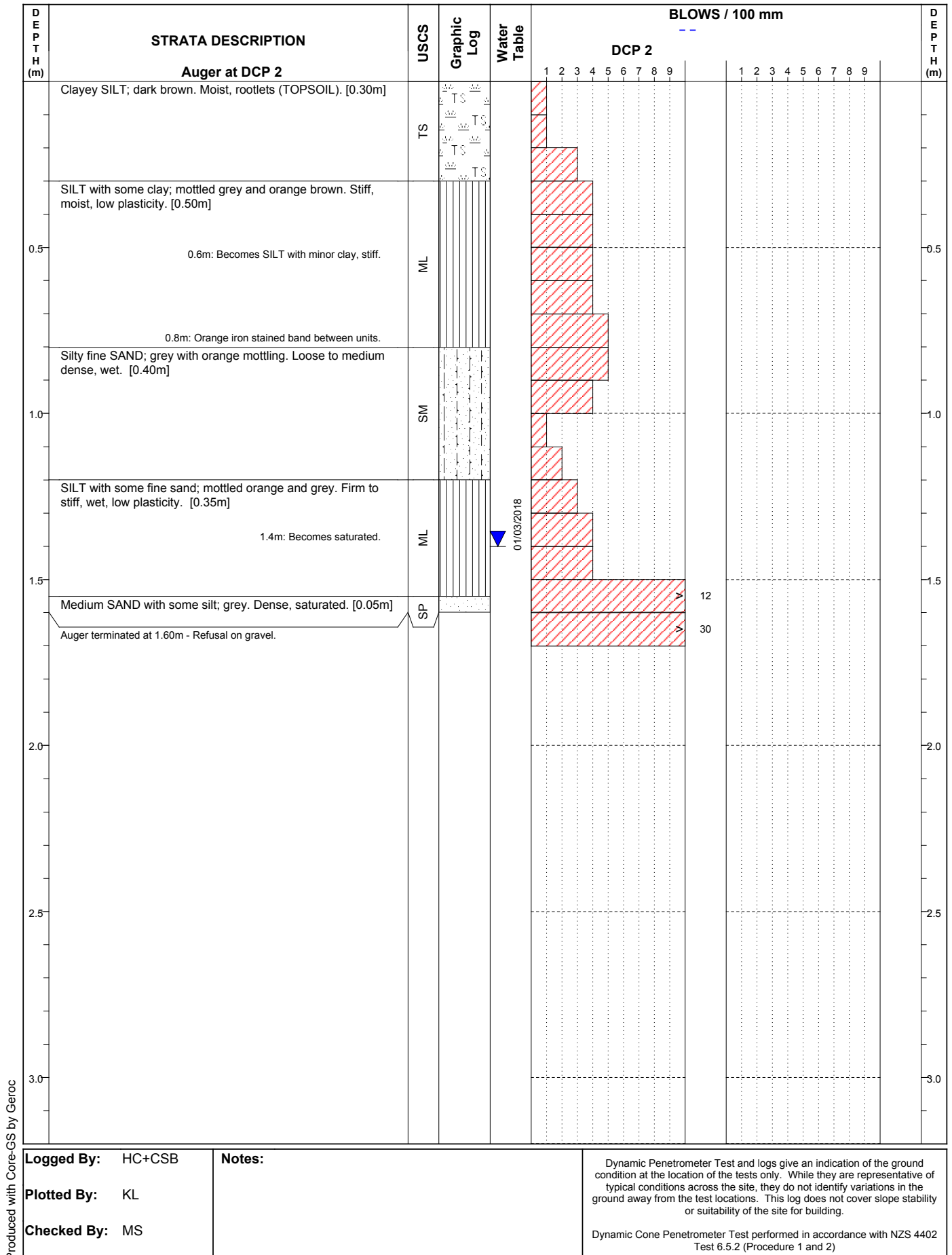
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (G01a).

Date: 01/03/18

Time: 10:30 a.m.

Excavation Method: HA+DCP



Project: 555 Birches Road, Lincoln (Lot 2 DP 33959) Client: Lincoln Developments Limited Test Location: Refer to attached Geotechnical Site Plan (GO1a).	Date: 02/03/18 Time: 9:30 a.m. Excavation Method: DCP
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[illegible]

Produced with Core-GS by Geroc

Logged By: HC+CG Plotted By: KL Checked By: MS	Notes: Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building. Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)
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Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 01/03/18

Time: 10:00 a.m.

Excavation Method: HA+DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)		
					DCP 1																				
					1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8		9	
	SILT; dark brown. Moist, low plasticity, rootlets (TOPSOIL). [0.30m]	TS		01/03/2018																					
	0.4m: SV=142/28 kPa																								
0.5	SILT with trace clay; light grey, mottled orange brown. Stiff, moist, low plasticity, iron oxide staining. [0.80m]		ML																						
	0.7m: SV=197/NA kPa																								
	0.9m: Stronger iron oxide staining, orange colour.																								
1.0																									
	SILT with some fine sand; orangey brown. Stiff, moist, low plasticity, iron oxide staining. [0.10m]	ML																							
	SILT with some clay. Stiff, wet, moderate plasticity no iron oxide staining. [0.20m] 1.3m: Becomes saturated.	ML																							
1.5	Silty sandy fine to coarse GRAVEL with some clay; grey. Very stiff, saturated, sand is fine to coarse grained, gravel is sub-angular to angular up to 10mm. [0.10m] Auger terminated at 1.50m - Refusal on gravel.	GM													11										
															20										
															23										
															24										
															20										
															19										
2.0															30										

Produced with Core-GS by Geroc

Logged By: HC+CSB

Plotted By: KL

Checked By: MS

Notes: SV=Shear Vane
kPa (undisturbed / remoulded)
Ground water rise from 1.4 m

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 02/03/18

Time: 10:00 a.m.

Excavation Method: HA+DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					DCP 18																		
					1	2	3	4	5	6	7	8	9										
	SILT; dark brown. Moist, rootlets (TOPSOIL). [0.40m]	TS		Groundwater Not Encountered																			
0.5	SILT with some clay; light orangey brown. Stiff to very stiff, dry, iron oxide mottling. [0.50m]	ML																					
1.0	Fine sandy SILT; light blue grey with orange mottling. Stiff, moist. [0.40m]	ML																					
1.5	Clayey SILT; light blue grey. Firm to very stiff, moist. [0.50m]	ML																					
	Auger terminated at 1.80m - Refusal on gravel.																						
2.0																							
2.5																							
3.0																							

Produced with Core-GS by Geroc

Logged By: CSB+CG

Plotted By: KL

Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Produced with Core-GS by Geroc

Logged By: CSB+CG

Plotted By: KL

Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Logged By: CSB+CG Plotted By: KL Checked By: MS	Notes: SV= Shear Vane kPa (Undisturbed / Remoulded)	Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building. Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)
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Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

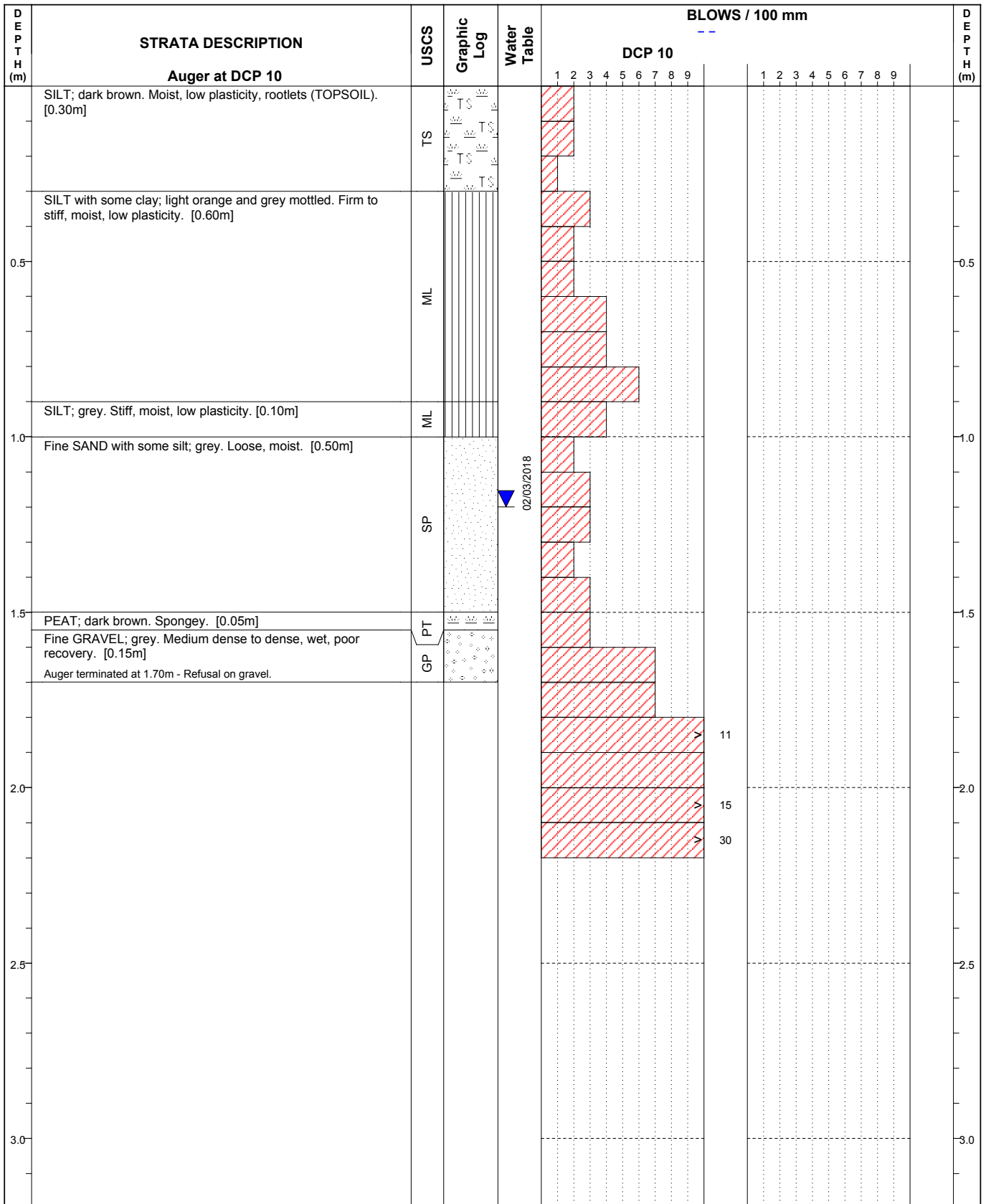
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 02/03/18

Time: 11:30 a.m.

Excavation Method: HA+DCP



Logged By: HC+CG

Plotted By: KL

Checked By: MS

Notes: Pre-augured to 1.0m.
Water rose to 1.2 post auger.

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959) Client: Lincoln Developments Limited Test Location: Refer to attached Geotechnical Site Plan (GO1a).	Date: 08/03/18 Time: 10:30 a.m. Excavation Method: DCP
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DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					DCP 16																		
					1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9	
	No Associated Log			Groundwater Not Encountered																			

Produced with Core-GS by Geroc

Logged By: HC+AB	Notes: Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building. Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)
Plotted By: KL	
Checked By: MS	

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

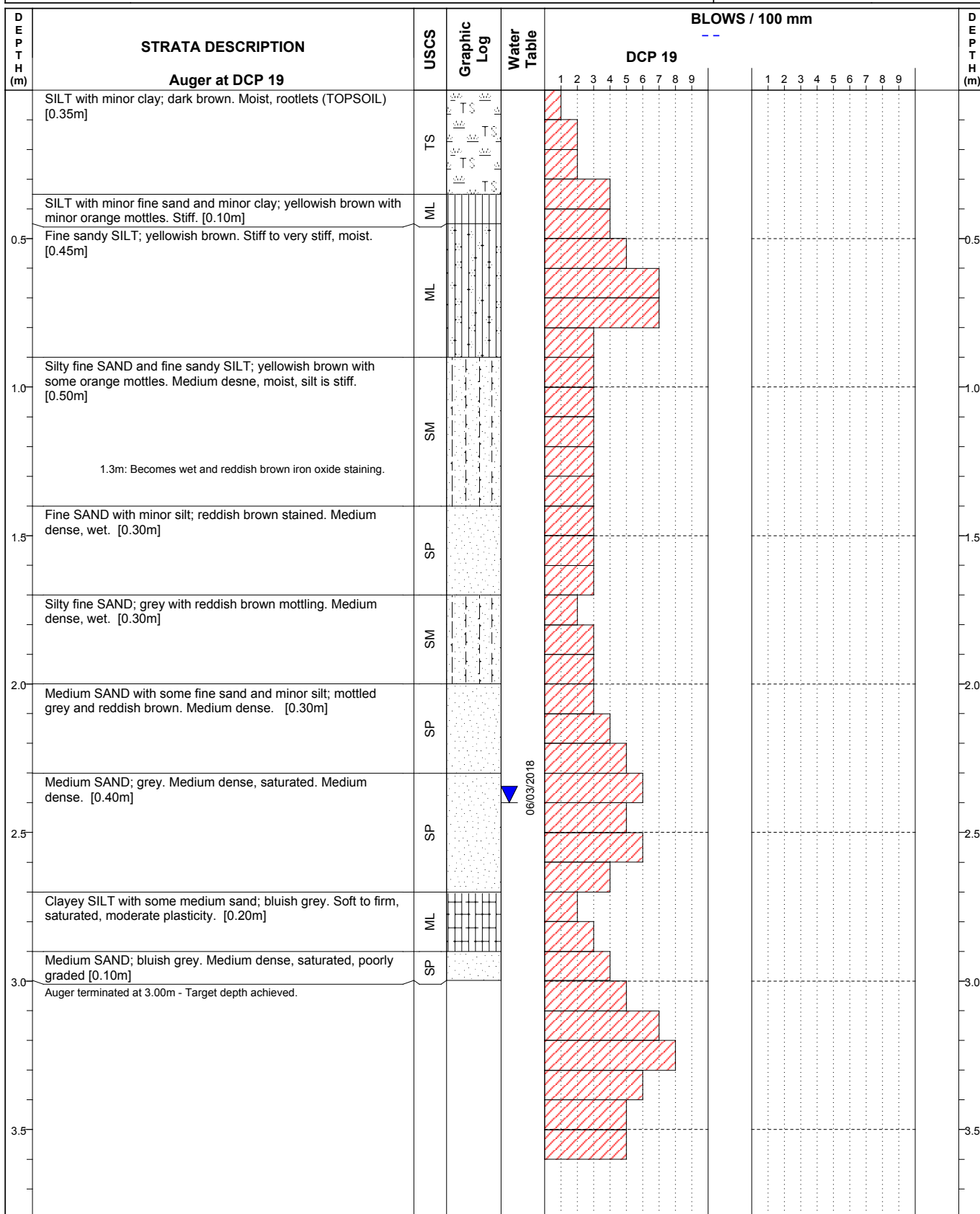
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 06/03/18

Time: 11:00 a.m.

Excavation Method: HA+DCP



Logged By: HC+AB

Plotted By: KL

Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

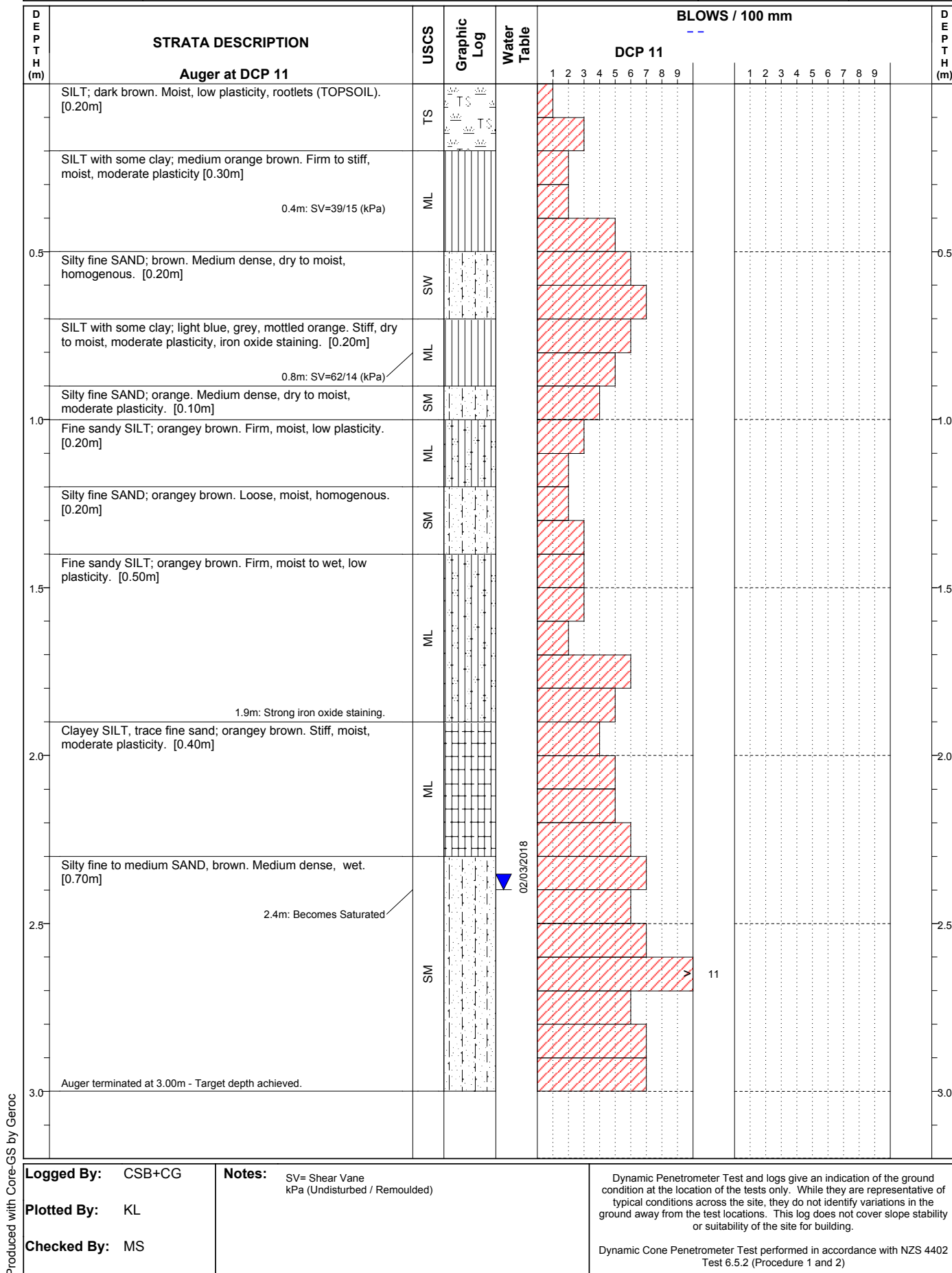
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 02/03/18

Time: 11:00 a.m.

Excavation Method: HA+DCP



Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 08/03/18

Time: 11:30 a.m.

Excavation Method: HA+DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					DCP 20																		
					1	2	3	4	5	6	7	8	9										
	SILT; dark brown. Moist, rootlets (TOPSOIL) [0.35m]	TS																					
0.5	SILT with some clay; yellowish brown with orange mottles. Stiff to very stiff, moist, low plasticity. [0.35m]	ML																				0.5	
	Clayey SILT; bluish grey with orange mottling. Stiff to very stiff, moist, low plasticity. [0.30m]	ML																					
1.0	Silty fine SAND; grey with dark reddish mottling. Loose to medium dense, moist. [0.40m]	SM																				1.0	
	1.4m: Becomes wet.																						
1.5	Fine sandy SILT with some silt; dark reddish brown. Medium dense, wet. [0.50m]	SP																				1.5	
	Silty fine SAND; grey. Medium dense, wet to saturated. [0.60m]	SM																				2.0	
2.5	Fine SAND with some silt; grey with reddish iron staining. Dense, saturated, poorly graded. [0.20m]	SP																				2.5	
	Medium SAND; blue. Dense, saturated. [0.30m]	SP																					
	2.9m: Becomes silty fine SAND.																						
3.0	Auger terminated at 3.00m - Target depth achieved.																					3.0	

Produced with Core-GS by Geroc

Logged By: HC+AB
Plotted By: KL
Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Produced with Core-GS by Geroc

Logged By: HC+AB

Plotted By: KL

Checked By: MS

Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

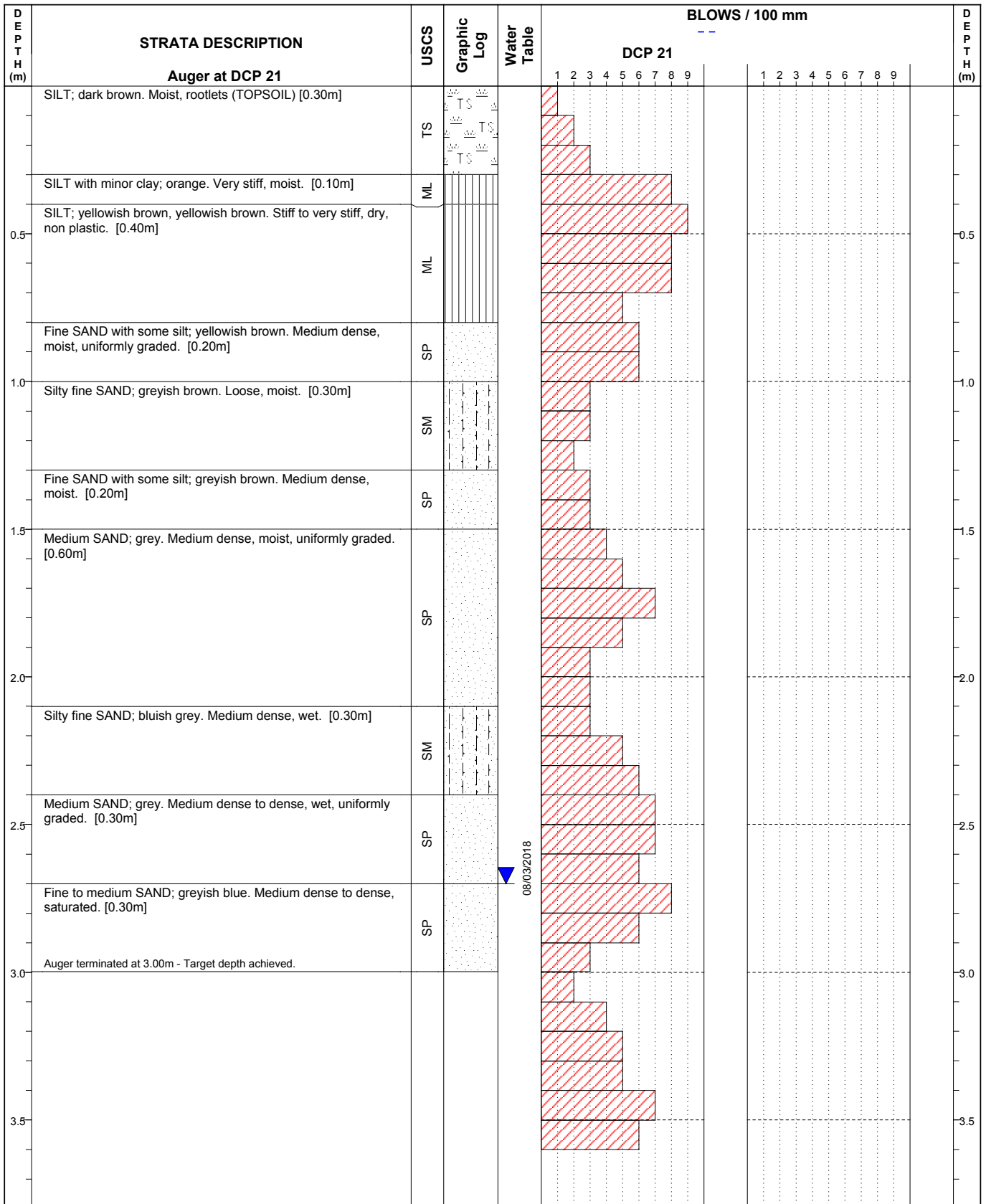
Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 08/03/18

Time: 2:00 p.m.

Excavation Method: HA+DCP

Logged By: HC+AB

Plotted By: KL

Checked By:
Notes:

Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)



Davis Ogilvie & Partners Limited

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www.do.nz

SHALLOW INVESTIGATION RESULTS

Job N^o /37071_North Block

Test N^o / DCP 14

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)	Date: 08/03/18
Client: Lincoln Developments Limited	Time: 1:20 p.m.
Test Location: Refer to attached Geotechnical Site Plan (GO1a).	Excavation Method: DCP

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
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Logged By: DCP	Notes: Dynamic Penetrometer Test and logs give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This log does not cover slope stability or suitability of the site for building. Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)
Plotted By: HC+AB	
Checked By: MS	

Produced with Core-GS by Geroc

Project: 555 Birches Road, Lincoln (Lot 2 DP 33959)

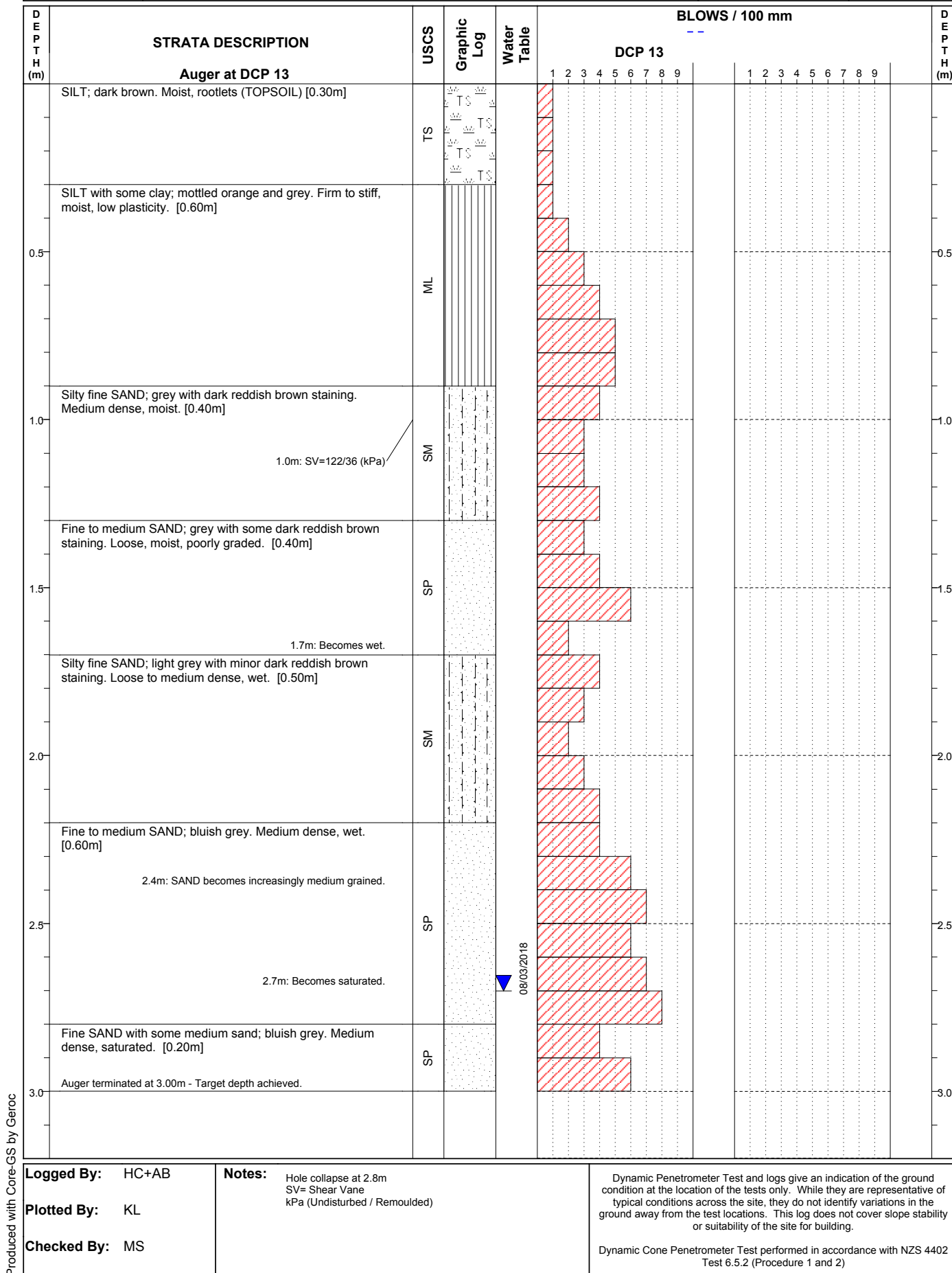
Client: Lincoln Developments Limited

Test Location: Refer to attached Geotechnical Site Plan (GO1a).

Date: 08/03/18

Time: 12:30 p.m.

Excavation Method: HA+DCP



Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT5																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.40m]	TS																					
0.5	Fine sandy SILT; light grey with orange mottles. Stiff to firm, dry, rootlets and minor oxidised fine organics. [0.50m]	ML																				0.5	
1.0	Fine SAND; yellowish brown with reddish brown. Medium dense, moist, uniformly graded, moderate iron oxide staining. [0.70m]	SP																				1.0	
1.5	1.6m: Iron oxide band																					1.5	
2.0	Fine sandy SILT with some organics; blue. Soft, wet, low plasticity. [0.70m]	ML																				2.0	
	2.2m - 2.3m: Unit contains pockets and bands of dark brown amorphous and fibrous peat, and undecomposed wood.																						
2.5	Fine to medium SAND; blue. Medium dense, wet, uniformly graded. [0.20m]	SP																				2.5	
	2.5m: Pit collapse.																						
	Medium to coarse sandy fine to coarse GRAVEL with minor cobbles and organics; bluish grey. Very dense, saturated, well graded. Contains fibrous logs 200-300 mm diameter. Gravel is subrounded greywacke. [0.80m]	GW		 18/12/2017																			
3.0																						3.0	
	Test Pit terminated at 3.30m - water encountered / test pit collapse																						
3.5																						3.5	

18/12/2017

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT3																						
	Fine sandy SILT, greyish brown. Dry, rootlets. (TOPSOIL) [0.40m]	TS																					
0.5	Fine sandy SILT, mottled grey and yellowish orange. Stiff, dry, rootlets. [0.50m]	ML																				0.5	
1.0	Fine SAND with some silt, yellowish brown with orange mottles. Loose, moist, uniformly graded. [0.70m]	SP																				1.0	
1.5																						1.5	
2.0	Medium to coarse sandy fine to coarse GRAVEL with minor cobbles trace boulders; bluish grey. Very dense, wet to saturated, well graded. Gravel is subrounded greywacke. [1.00m]	GW																				2.0	
2.5																						2.5	
	Test Pit terminated at 2.60m - water encountered / test pit collapse																						
3.0																						3.0	
3.5																						3.5	

18/12/2017

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT8																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.40m]	ML																					
0.5	Fine sandy SILT; yellow mottled orange-brown. Stiff-firm, dry. [0.60m]	ML																				0.5	
	0.9m: becomes moist																						
1.0	Fine sandy SILT; bluish grey with orange mottling. Soft, wet, non-plastic. [0.20m]	ML																				1.0	
1.5	Fine and medium SAND; orangey brown. Wet, uniformly graded, heavy iron oxide staining, iron nodules. [0.50m]	SP																				1.5	
2.0	Clayey SILT; bluish grey to greyish brown. Soft, wet, high plasticity. [0.40m]	MH																				2.0	
	1.9m: below are increasing pockets of dark brown amorphous peat																						
	PEAT; dark brown. Amorphous, with some fibrous wood. [0.10m]	PT																					
	Medium to coarse sandy fine to coarse GRAVEL with minor cobbles and organics; bluish grey. Very dense, saturated, well graded. Contains fibrous wood 200-300 mm diameter. Gravel is subrounded greywacke. [0.20m]	GW																					
2.5	Test Pit terminated at 2.40m - water encountered / test pit collapse																					2.5	
3.0																						3.0	
3.5																						3.5	

18/12/2017

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT1																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.30m]	TS																					
0.5	Fine sandy SILT; mottled grey and yellowish orange. Stiff, dry, rootlets. [0.40m]	ML																				0.5	
	Silty fine SAND; mottled bluish grey and orange. Medium dense, moist, uniformly graded. [0.30m] 0.9m: iron staining below	SM																					
1.0	Fine sandy SILT with some clay; blue mottled orange. Firm, wet. [0.50m]	ML																				1.0	
1.5	Medium to coarse sandy fine to coarse GRAVEL; bluish grey. Very dense, wet to saturated, well graded. Gravel is subrounded greywacke. [0.60m]	GW		18/12/2017																		1.5	
2.0	Test Pit terminated at 2.10m - water encountered / test pit collapse																					2.0	
2.5																						2.5	
3.0																						3.0	
3.5																						3.5	

Logged By: HC
Plotted By: HC
Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT10																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.40m]	TS																					
0.5	Fine sandy SILT; mottled greyish brown and orange. Stiff, dry. [0.30m]	ML																				0.5	
	SILT with some fine sand; orange. Firm, wet, low plasticity. [0.30m]	ML																					
1.0	Silty fine to medium SAND; bluish grey with orange mottles. Medium dense, wet. [0.40m]	SM																				1.0	
1.5	Fine sandy SILT; bluish grey with orange mottles. Firm, wet. [0.30m]	ML																				1.5	
	PEAT; dark brown. Amorphous, with some fibrous wood. [0.10m]	PT																					
2.0	Medium to coarse sandy fine to coarse GRAVEL with minor cobbles and organics; bluish grey. Very dense, saturated, well graded. Contains fibrous wood 200-300 mm diameter. Gravel is subrounded greywacke. [0.30m]	GW		18/12/2017																		2.0	
	Test Pit terminated at 2.10m - water encountered / test pit collapse																						
2.5																						2.5	
3.0																						3.0	
3.5																						3.5	

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)
Client: Lincoln Developments Limited
Test Location: Refer to Site Plan (G01A)

Date: 18/12/18
Time: 9:00 AM
Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
0.5	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.60m]	TS																					0.5
	Fine sandy SILT; light yellowish brown with orange mottles. Firm, dry, rootlets. [0.20m] 0.7m: becomes moist	ML																					
1.0	Fine and medium SAND with some silt; greyish brown mottled reddish brown. Loose-medium dense, moist, uniformly graded. [1.80m] 1.0m: becomes wet	SP																					1.0
1.5	1.2m: Colour change to light yellowish brown.																						1.5
2.0	2.0m - 2.6m: Iron oxide staining.																						2.0
2.5																							2.5
3.0	Interlayered clayey SILT with some organics & medium SAND; blue. Wet to saturated. Silt is high plasticity, organic material consists of roots, twigs, branches and trunks. [1.10m] 3.0m: fibrous wood encountered	ML																					3.0
3.5	Test Pit terminated at 3.70m - Extent of excavation.																						3.5

Produced with Core-GS by Geroc

Logged By: HC
Plotted By: HC
Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)

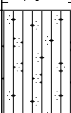
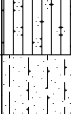
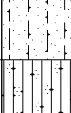
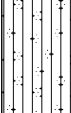
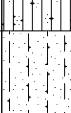
Client: Lincoln Developments Limited

Test Location: Refer to Site Plan (G01A)

Date: 18/12/18

Time: 9:00 AM

Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1	2	3	4	5	6	7	8	9		1	2	3	4	5	6	7	8	9
	Test Pit at CPT14																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.30m]	TS																					
0.5	Fine sandy SILT; yellowish brown. Stiff, dry. [0.40m]	ML																					
1.0	Silty fine SAND: yellowish brown with orange mottling. Loose-medium dense, moist. [0.30m] 0.9m: Becomes medium dense	SP																					
1.5	Fine sandy SILT; mottled grey and orange. Soft, wet. [0.50m]	ML																					
2.0	Silty fine SAND with minor organics; light grey with orange iron staining. Medium dense, wet, organics are fine short twigs or roots with iron staining halos. [0.70m]	SM																					
2.5	Interbedded: organic silty fine SAND / fine to medium SAND / clayey SILT; blue. Sands are medium dense, wet. Silt is soft, saturated, and moderate plasticity. Organic content is fibrous branches and twigs. [1.10m]	SM																					
3.0	Test Pit terminated at 3.30m - water encountered / test pit collapse																						
3.5																							

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

Project: Flemington North Block - 555 Birchs Road, Lincoln (Lot 2 DP 33959)

Client: Lincoln Developments Limited

Test Location: Refer to Site Plan (G01A)

Date: 18/12/18

Time: 9:00 AM

Excavation Method: 20T Excavator

DEPTH (m)	STRATA DESCRIPTION	USCS	Graphic Log	Water Table	BLOWS / 100 mm																		DEPTH (m)
					1 2 3 4 5 6 7 8 9									1 2 3 4 5 6 7 8 9									
	Test Pit at CPT12																						
	Fine sandy SILT; greyish brown. Dry, rootlets. (TOPSOIL) [0.30m]	TS																					
0.5	Fine sandy SILT; orange-brown. Stiff, dry. [0.30m]	ML																			0.5		
	Fine SAND; light greyish brown. Medium dense, dry. [0.40m]	SP																					
1.0	Fine sandy SILT; mottled grey and orange. Firm, moist, low plasticity, iron staining. [0.30m] 1.1m: becomes wet	ML																			1.0		
1.5	Interbedded silty fine SAND & fine sandy SILT; mottled light greyish blue and orangey brown. Medium dense / firm, wet, poorly graded. [1.20m]	SM																			1.5		
2.0																					2.0		
2.5	2.5m: Collapse in sand unit																				2.5		
	Fine to medium SAND with some silt; greyish blue. Medium dense, wet, poorly graded. [0.90m]	SP																					
3.0																					3.0		
3.5	Test Pit terminated at 3.40m - water encountered / test pit collapse																				3.5		

Produced with Core-GS by Geroc

Logged By: HC

Plotted By: HC

Checked By: KT

Notes:

Dynamic Penetrometer and Test Bore log tests give an indication of the ground condition at the location of the tests only. While they are representative of typical conditions across the site, they do not identify variations in the ground away from the test locations. This report does not cover slope stability or suitability of the site for building.

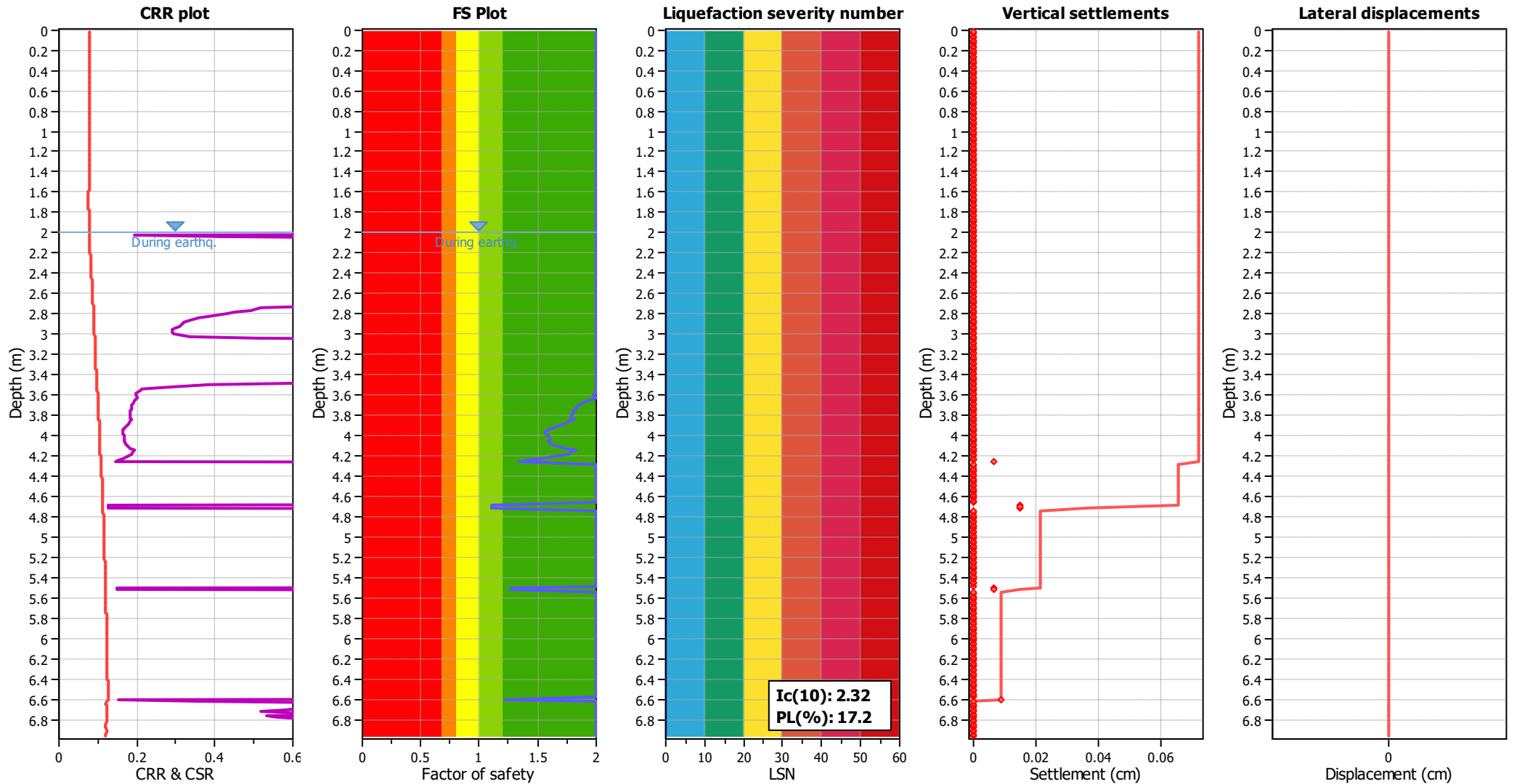
Dynamic Cone Penetrometer Test performed in accordance with NZS 4402 Test 6.5.2 (Procedure 1 and 2)

APPENDIX E

Model Earthquake Liquefaction Analysis Outputs



Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

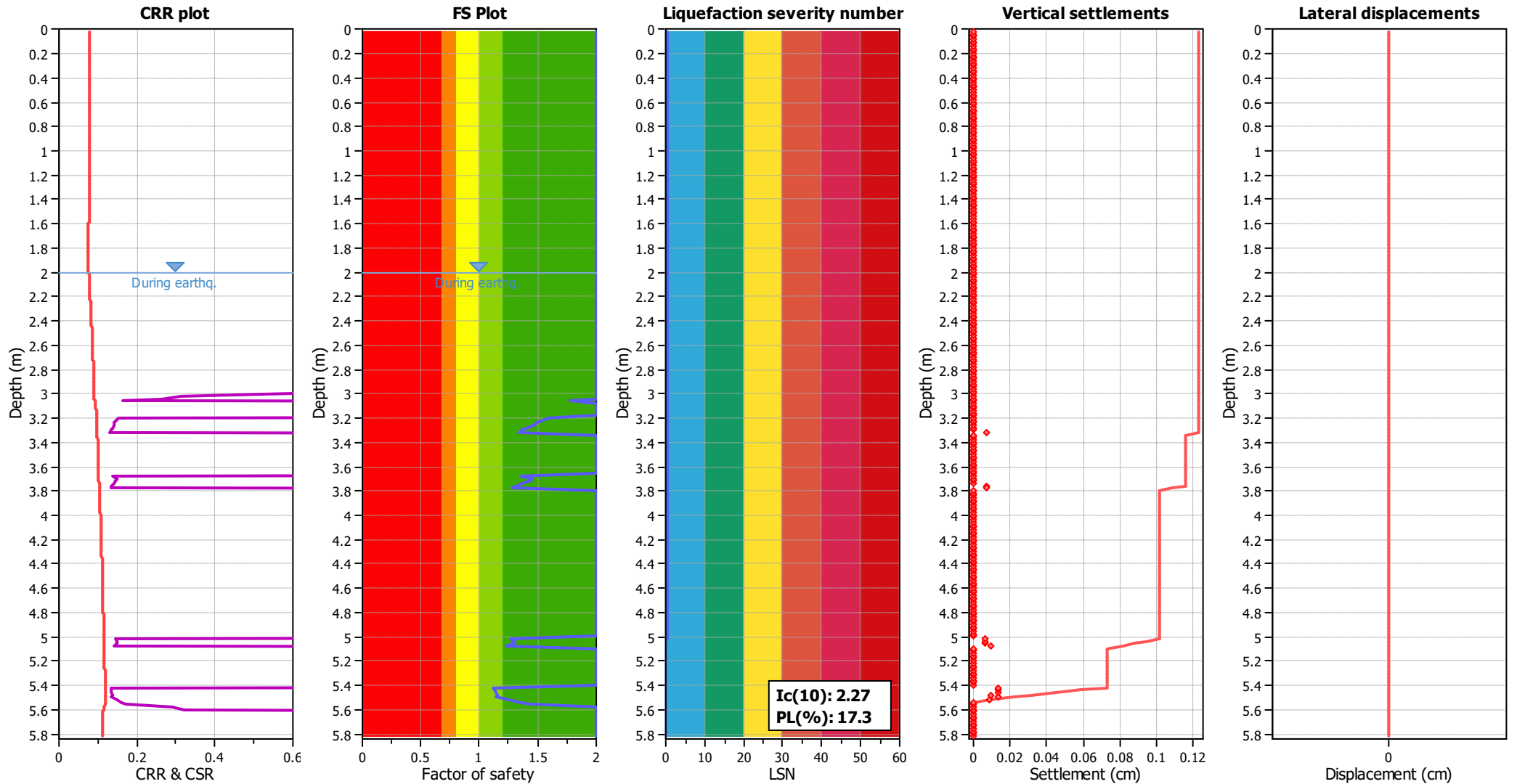
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

Red	Severe damage
Dark Red	Major expression of liquefaction
Orange	Moderate to severe exp. of liquefaction
Yellow	Moderate expression of liquefaction
Light Green	Minor expression of liquefaction
Dark Green	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

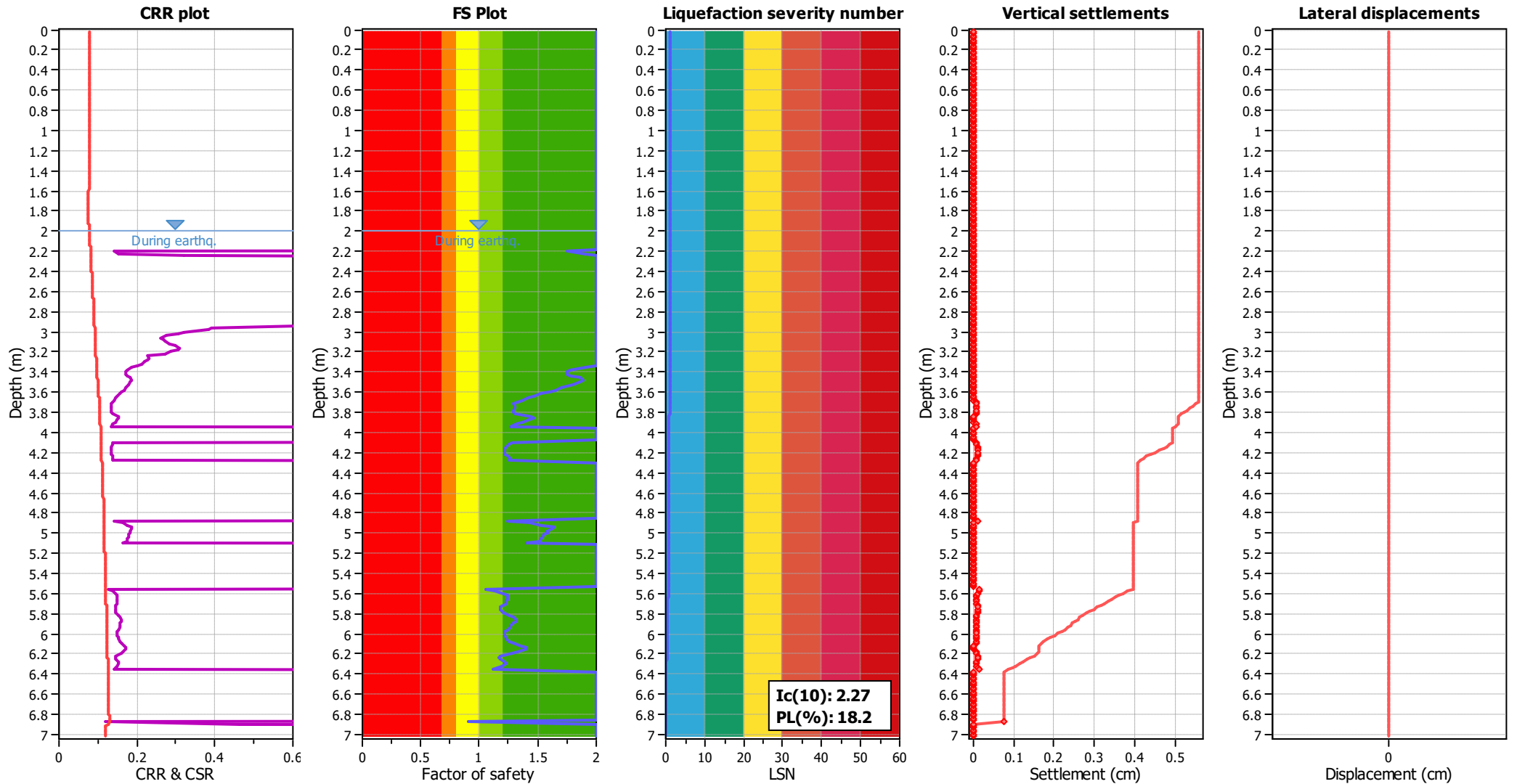
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

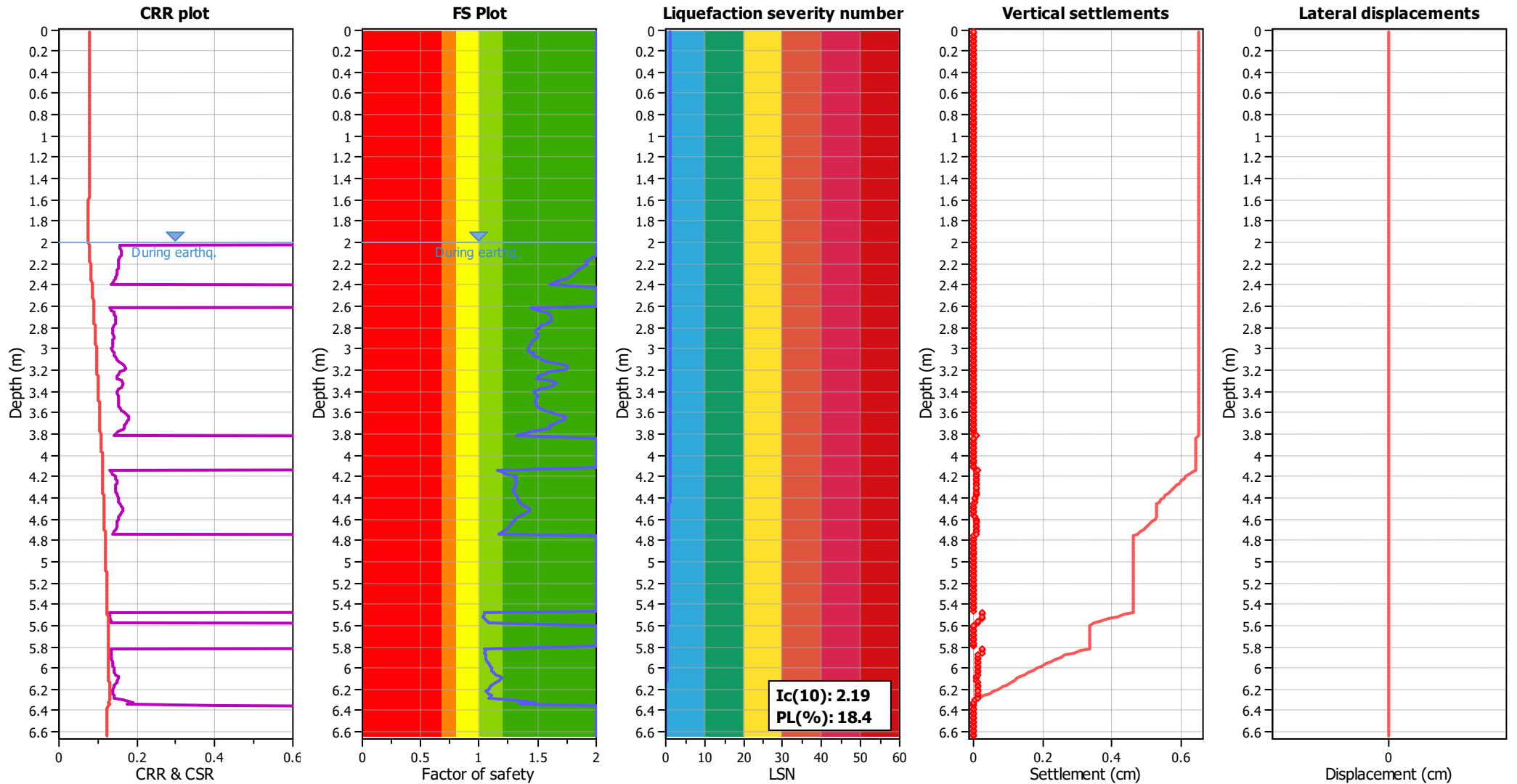
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Yellow	Moderate expression of liquefaction
Light Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

Liquefaction analysis overall plots



Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

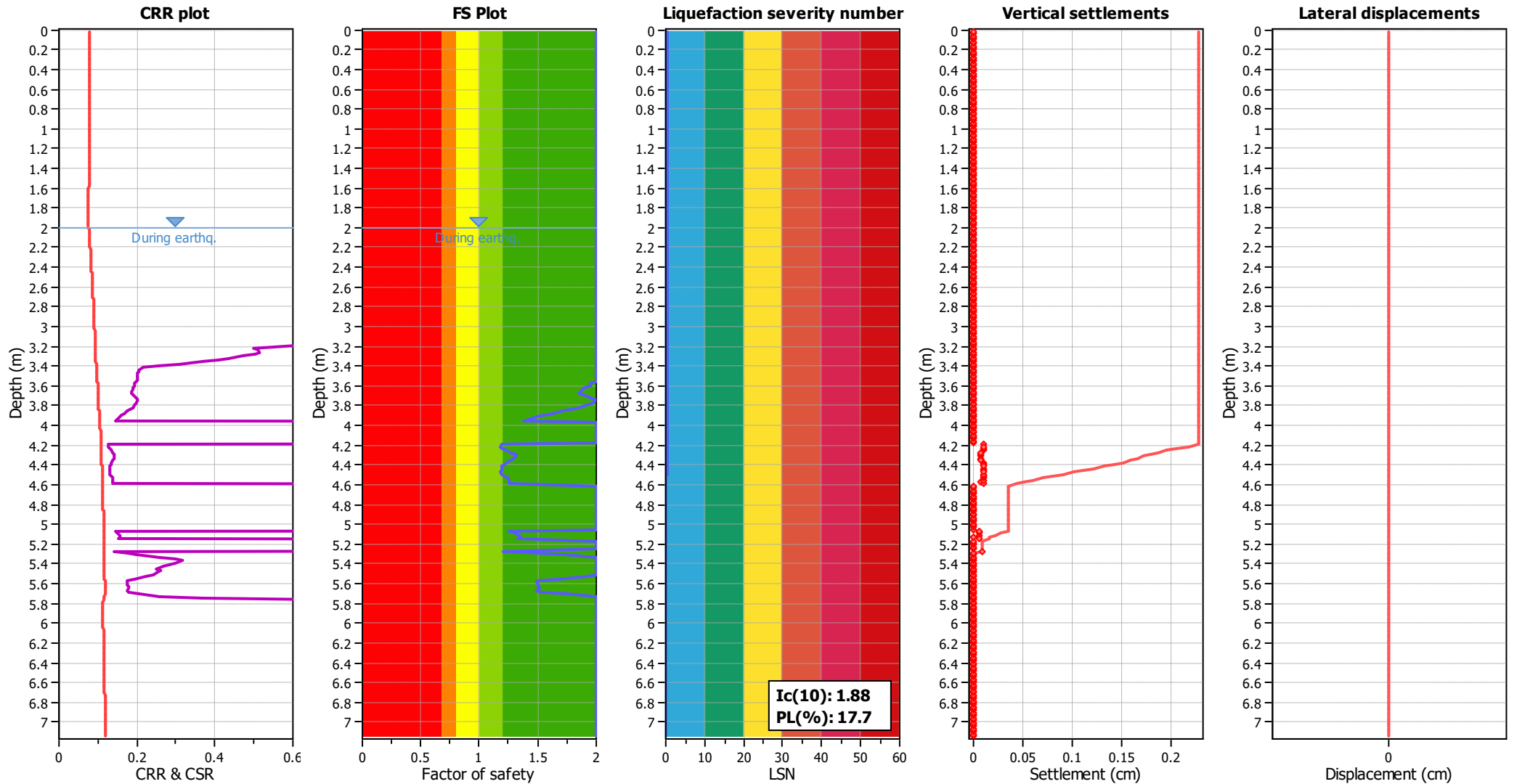
F.S. color scheme

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

LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
Moderate expression of liquefaction
Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

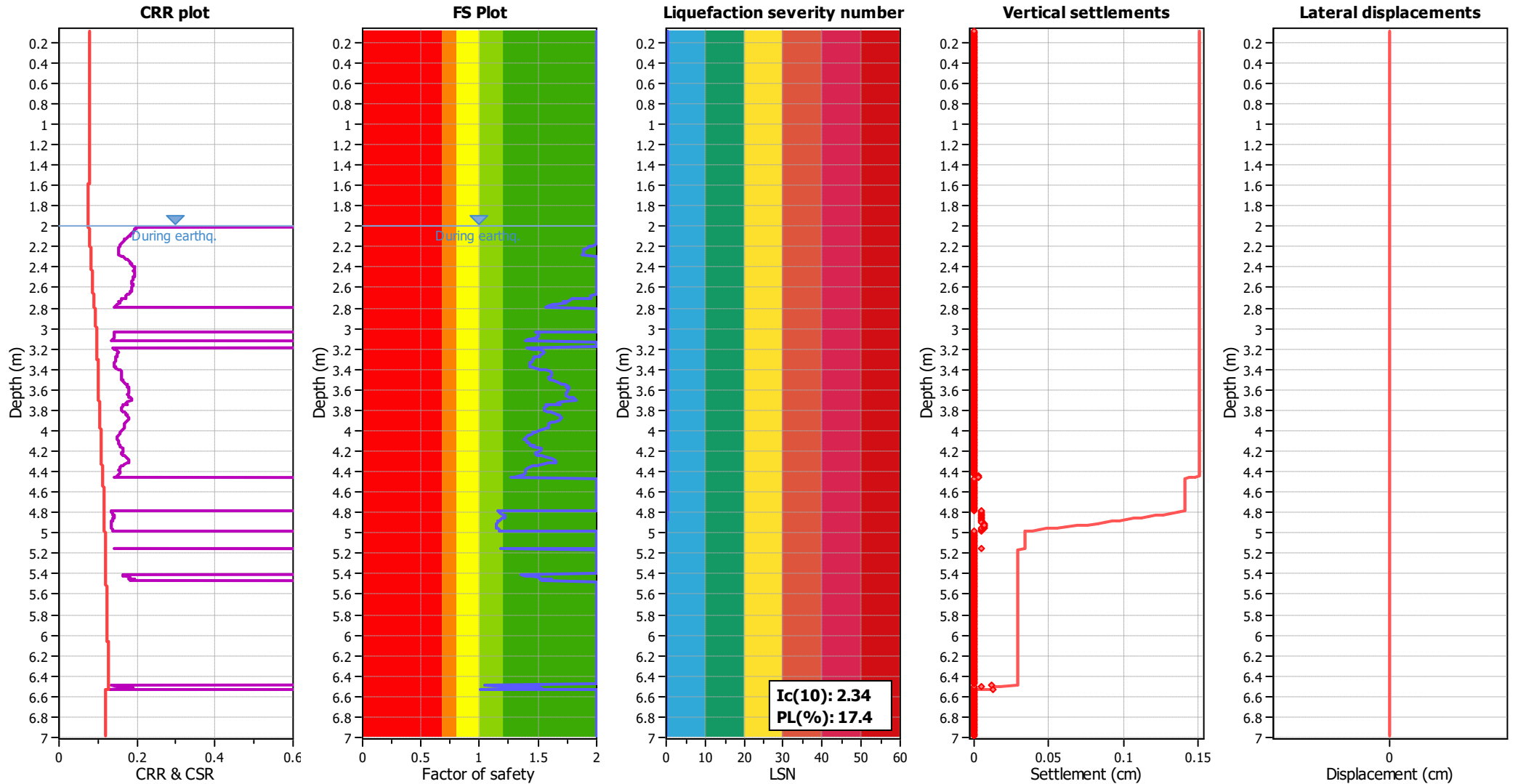
F.S. color scheme

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

LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
Moderate expression of liquefaction
Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

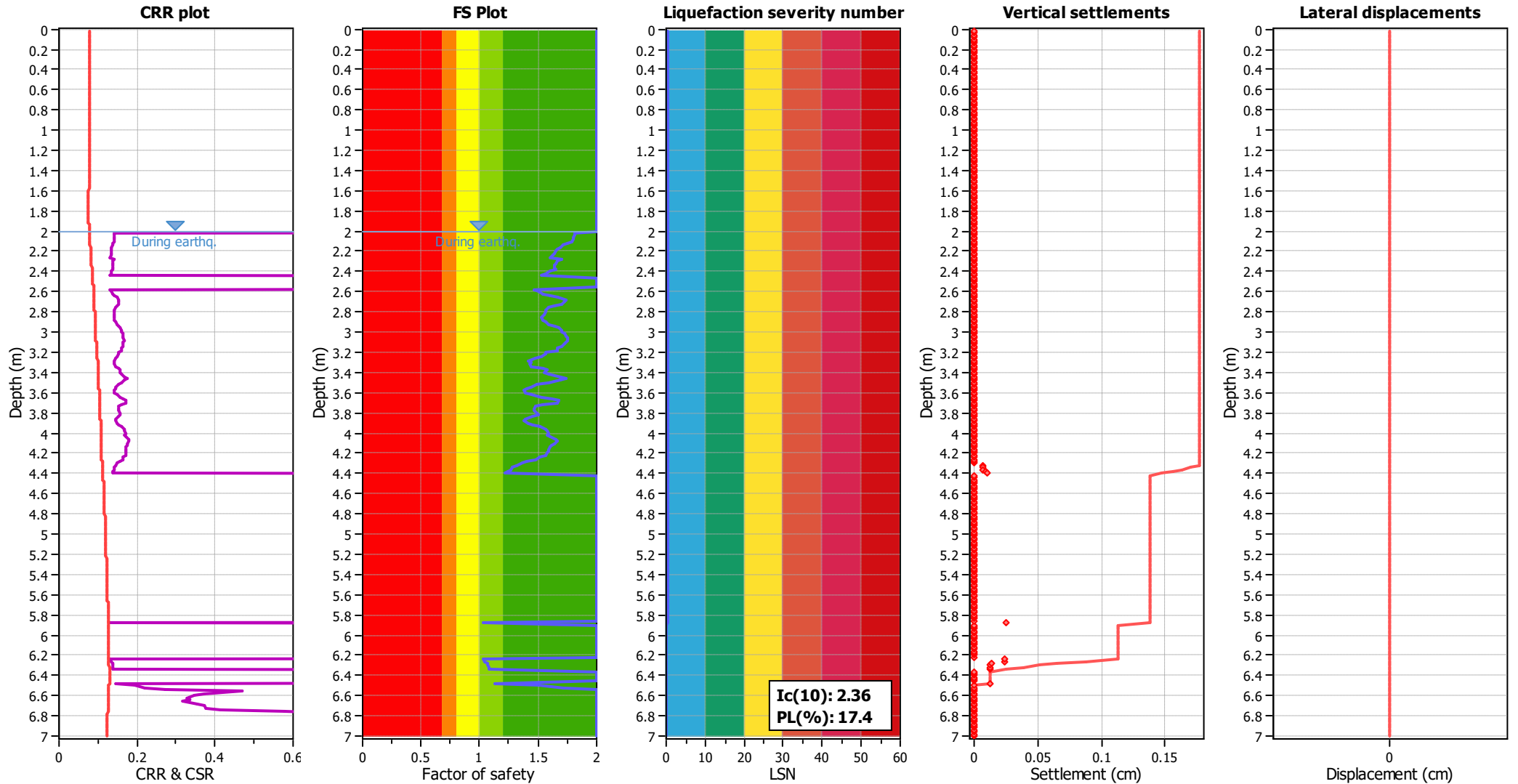
F.S. color scheme

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

LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
Moderate expression of liquefaction
Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	2.00 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 :	1.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

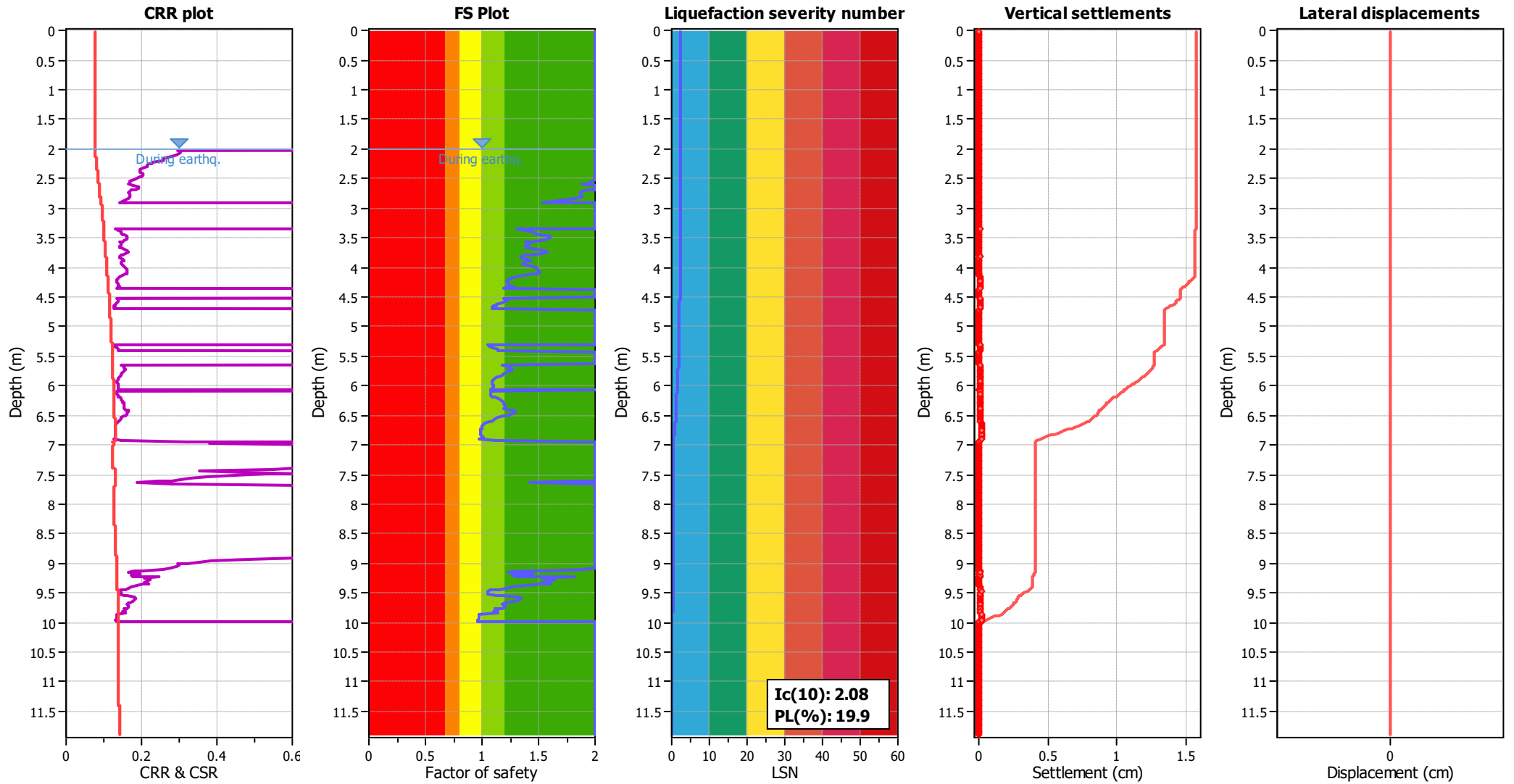
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

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Dark Red	Major expression of liquefaction
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

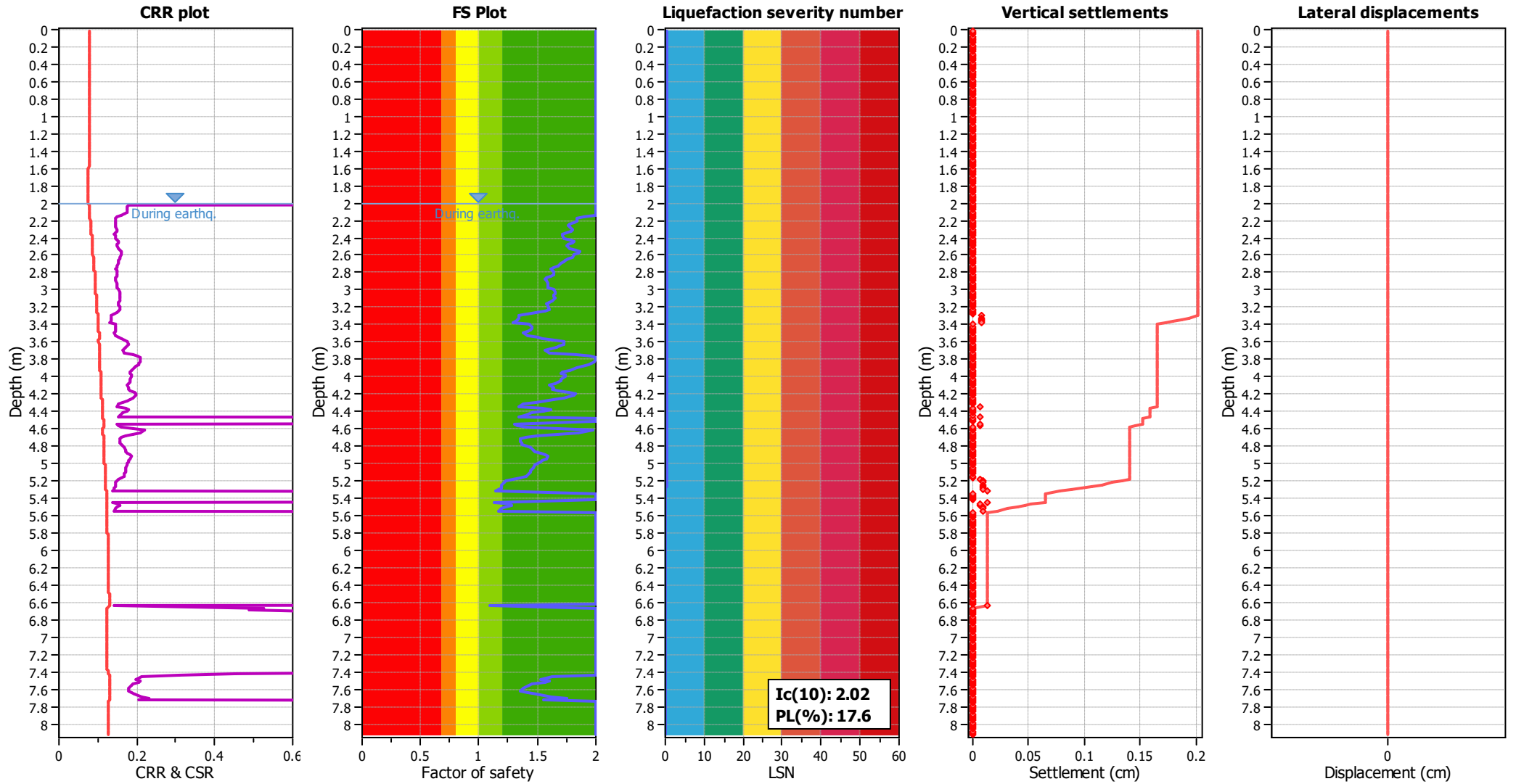
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on I_c value	I_c cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

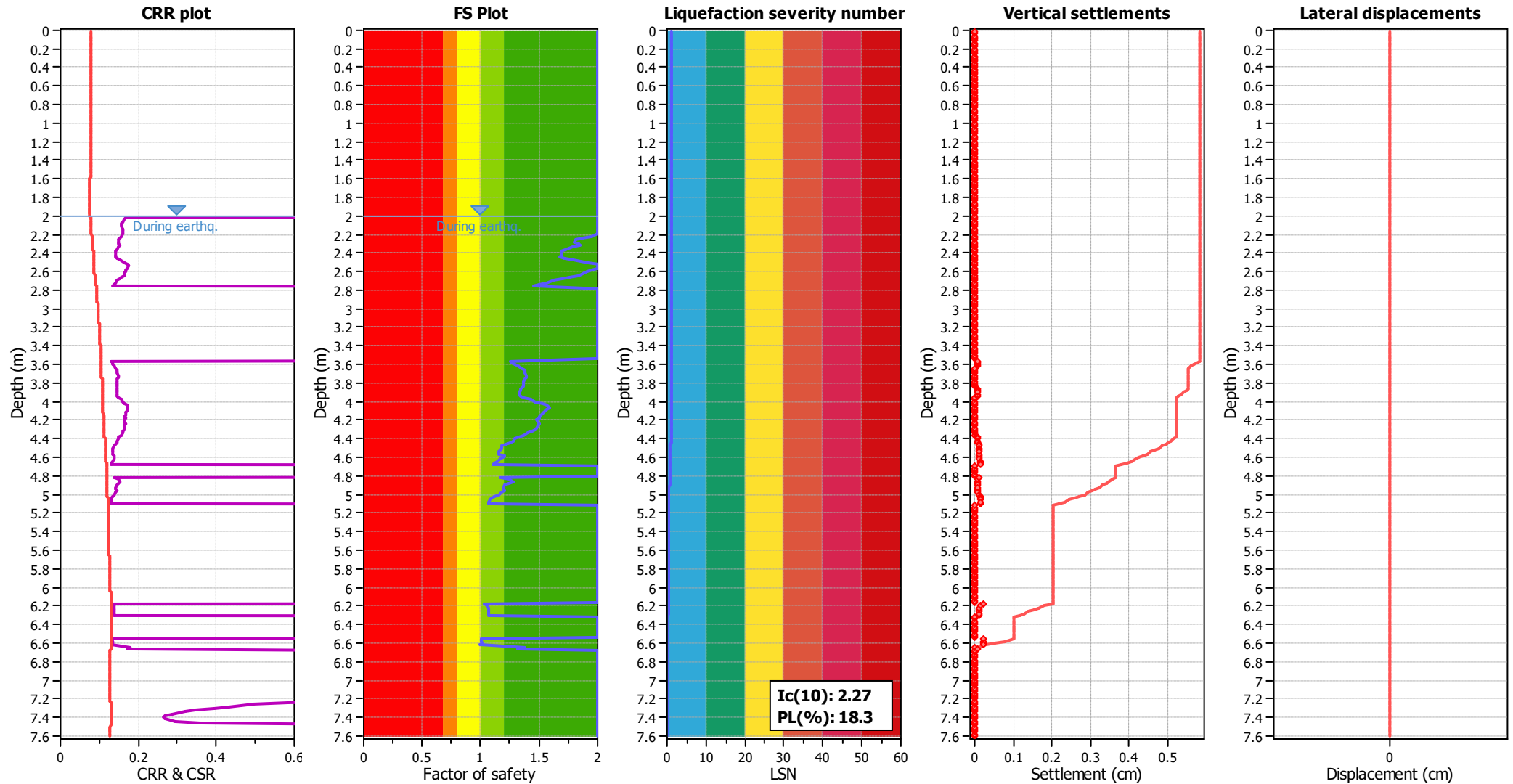
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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_f applied:	Yes
Earthquake magnitude M_w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

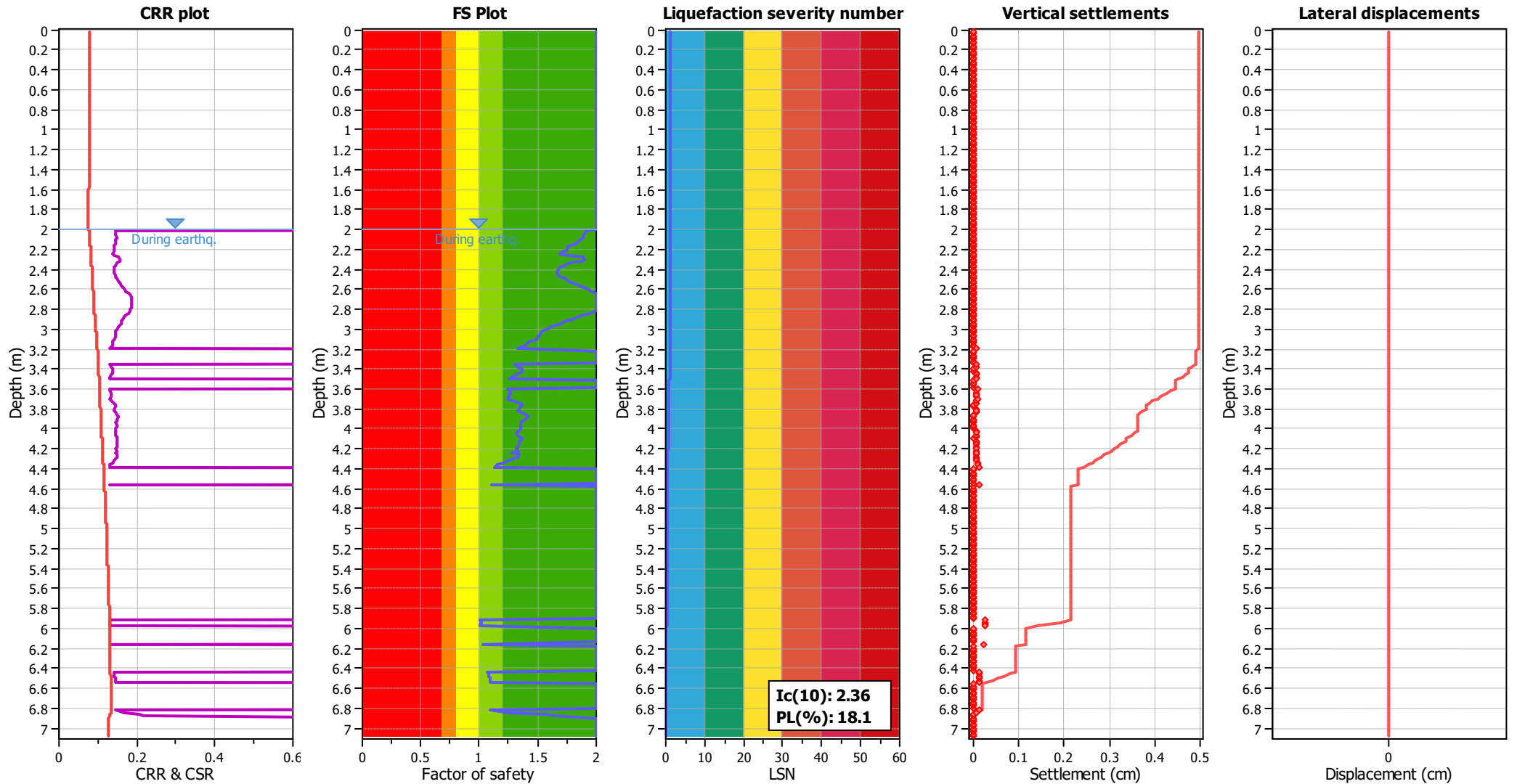
F.S. color scheme

■	Almost certain it will liquefy
■	Very likely to liquefy
■	Liquefaction and no liq. are equally likely
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LSN color scheme

■	Severe damage
■	Major expression of liquefaction
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■	Moderate expression of liquefaction
■	Minor expression of liquefaction
■	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.13	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

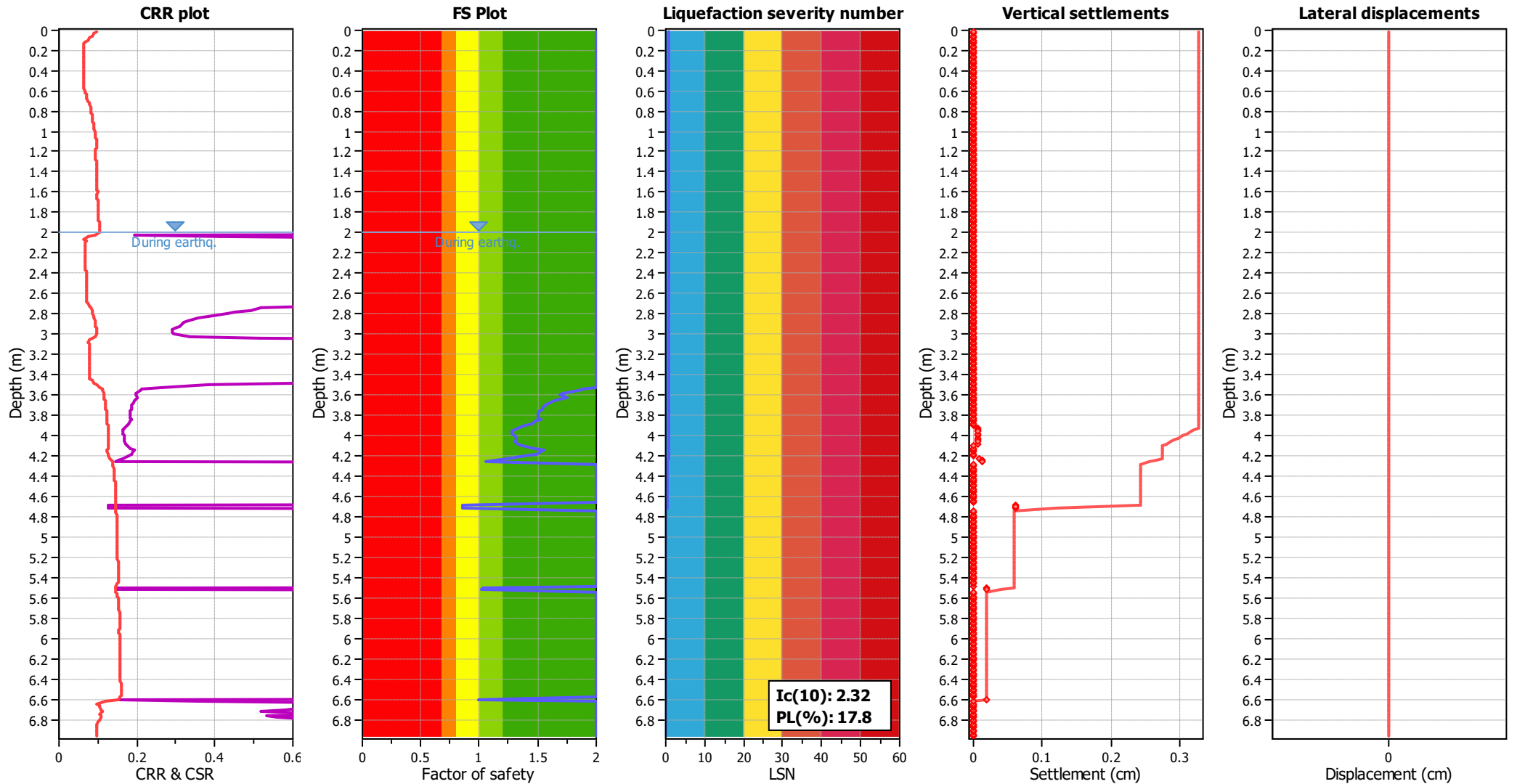
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

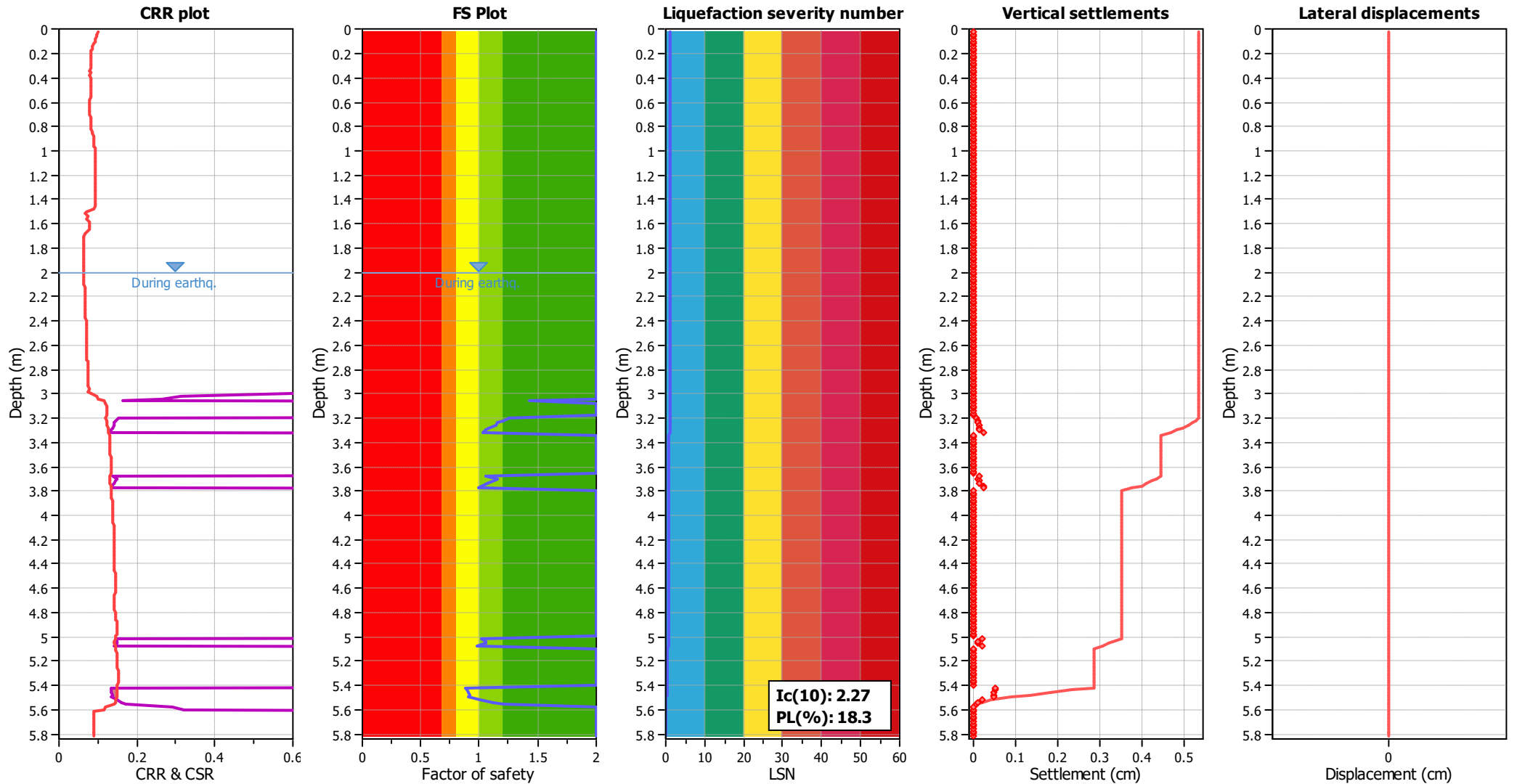
F.S. color scheme

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Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

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Orange	Moderate to severe exp. of liquefaction
Yellow	Moderate expression of liquefaction
Light Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

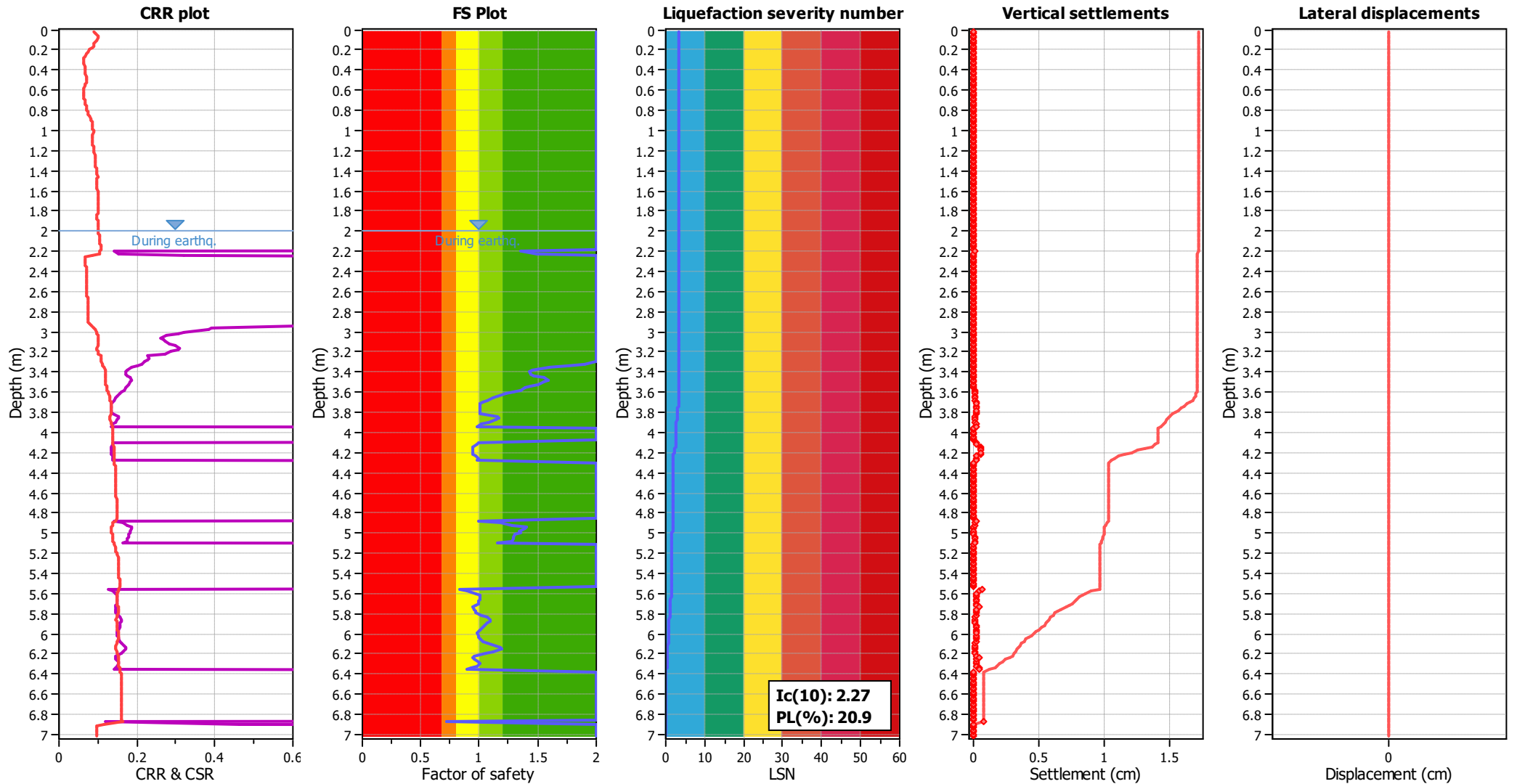
F.S. color scheme

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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

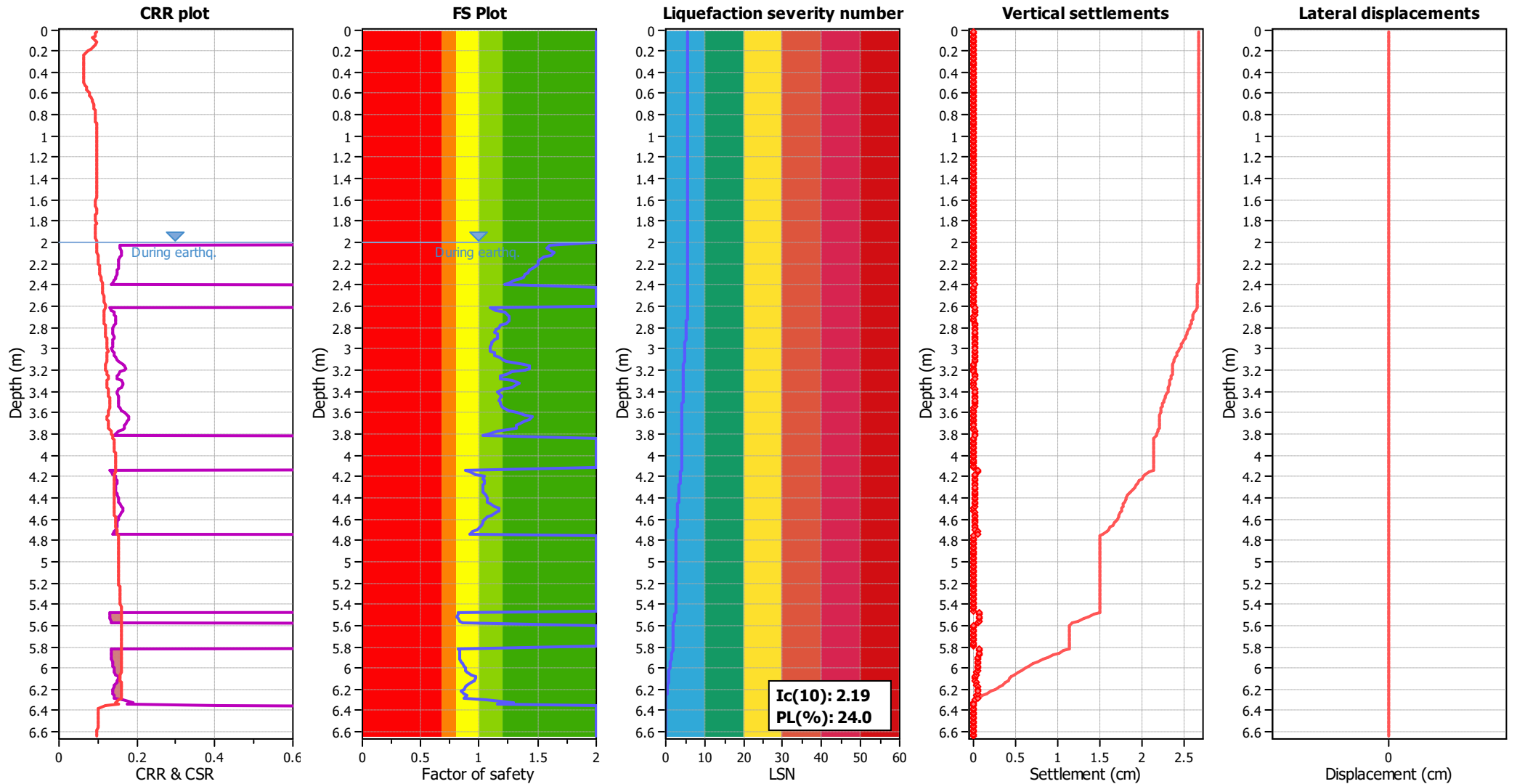
F.S. color scheme

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

LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
Moderate expression of liquefaction
Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

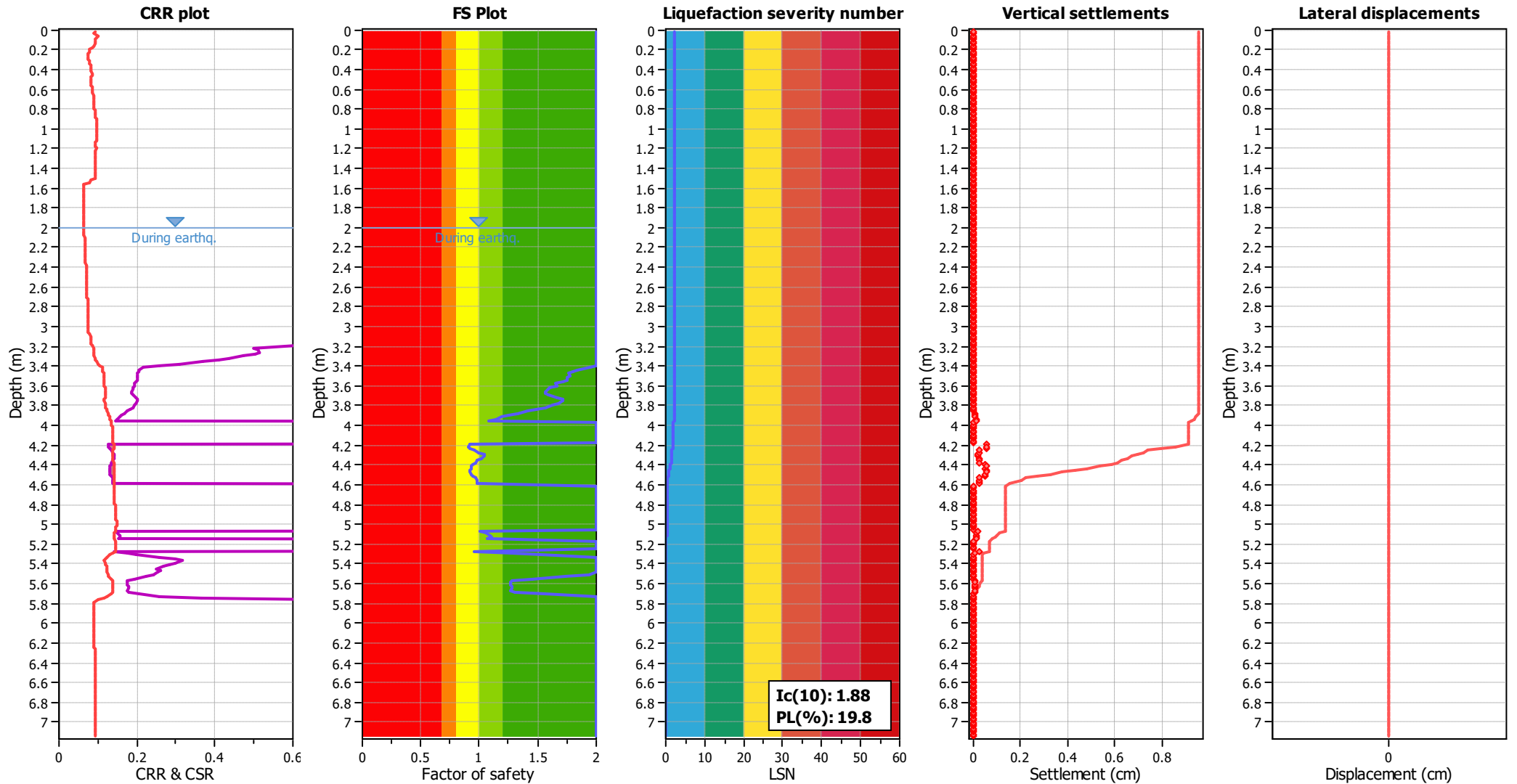
F.S. color scheme

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

LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
Moderate expression of liquefaction
Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

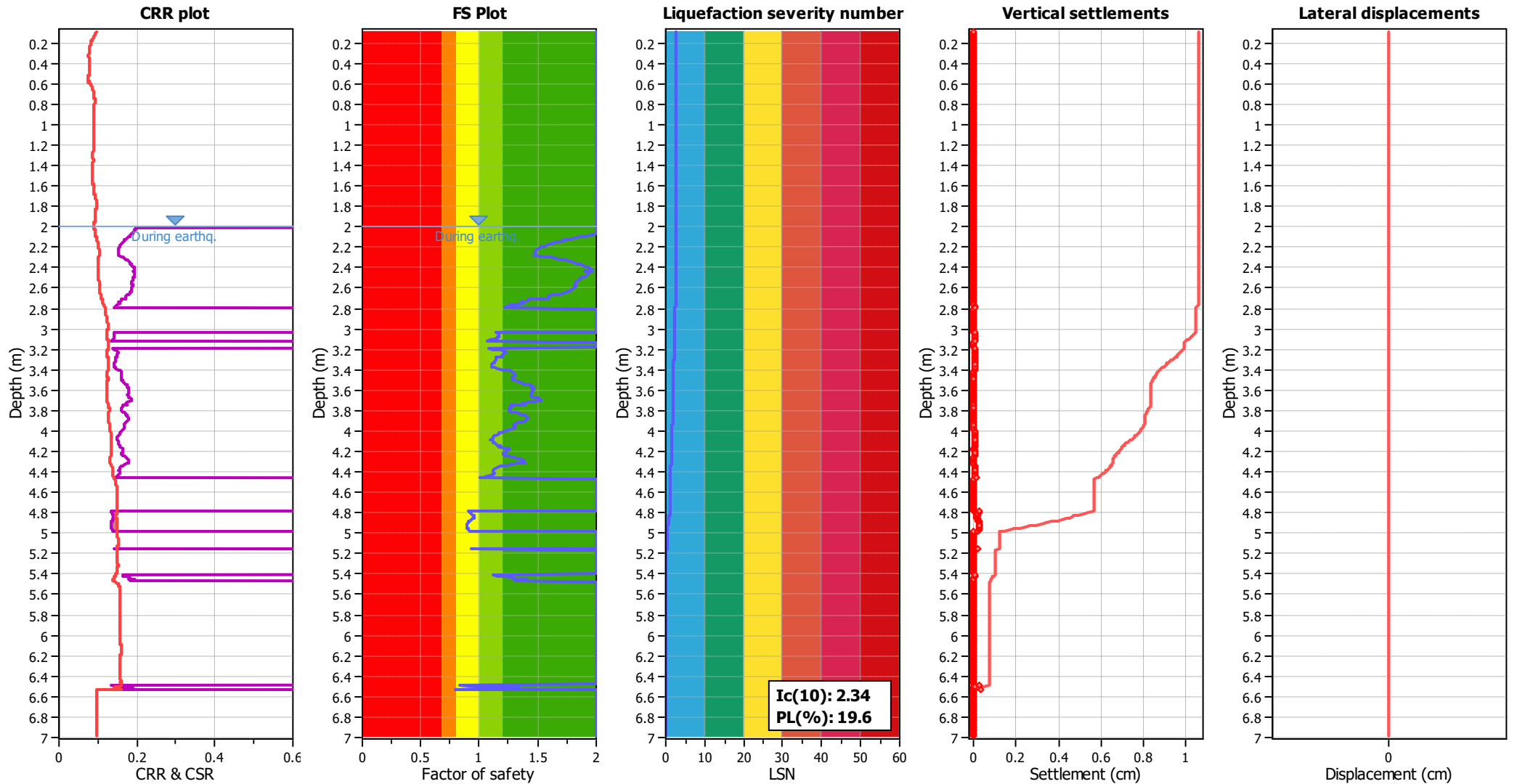
F.S. color scheme

Red	Almost certain it will liquefy
Orange	Very likely to liquefy
Yellow	Liquefaction and no liq. are equally likely
Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

Red	Severe damage
Orange	Major expression of liquefaction
Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _s applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

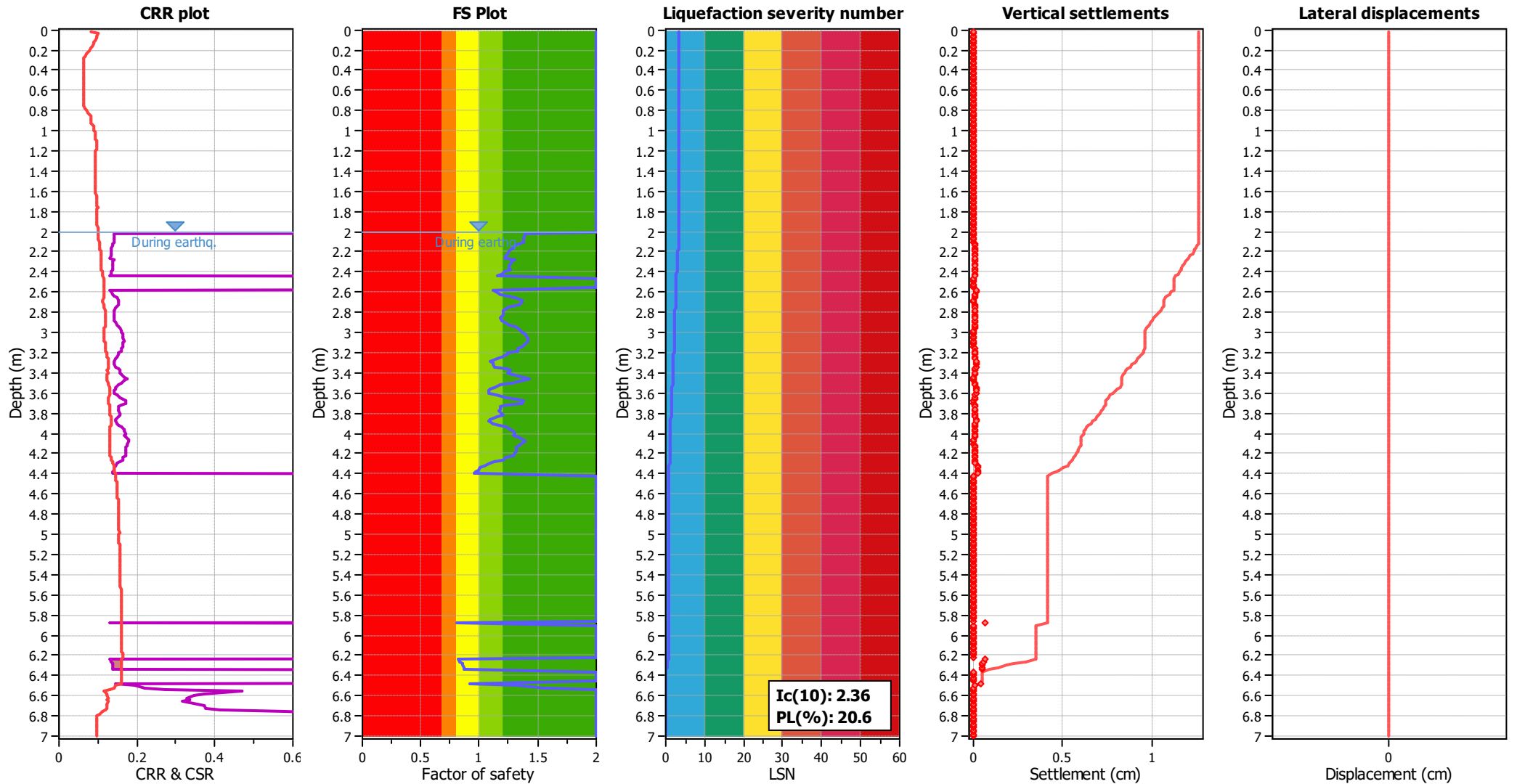
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LSN color scheme

Severe damage
Major expression of liquefaction
Moderate to severe exp. of liquefaction
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Minor expression of liquefaction
Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

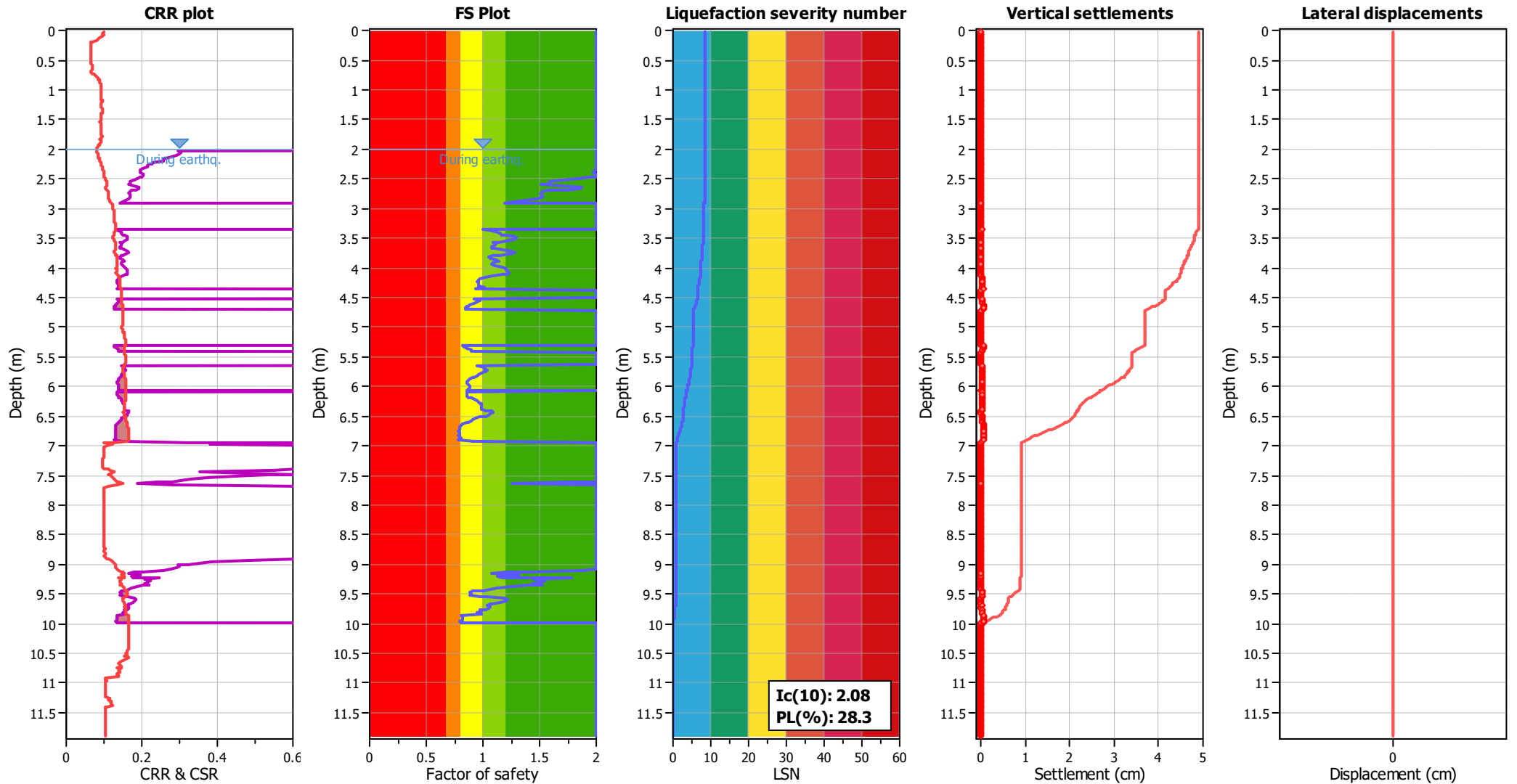
F.S. color scheme

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Almost certain it will not liquefy

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Major expression of liquefaction
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Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 m	Fill weight:	N/A
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K ₀ applied:	Yes
Earthquake magnitude M _w :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

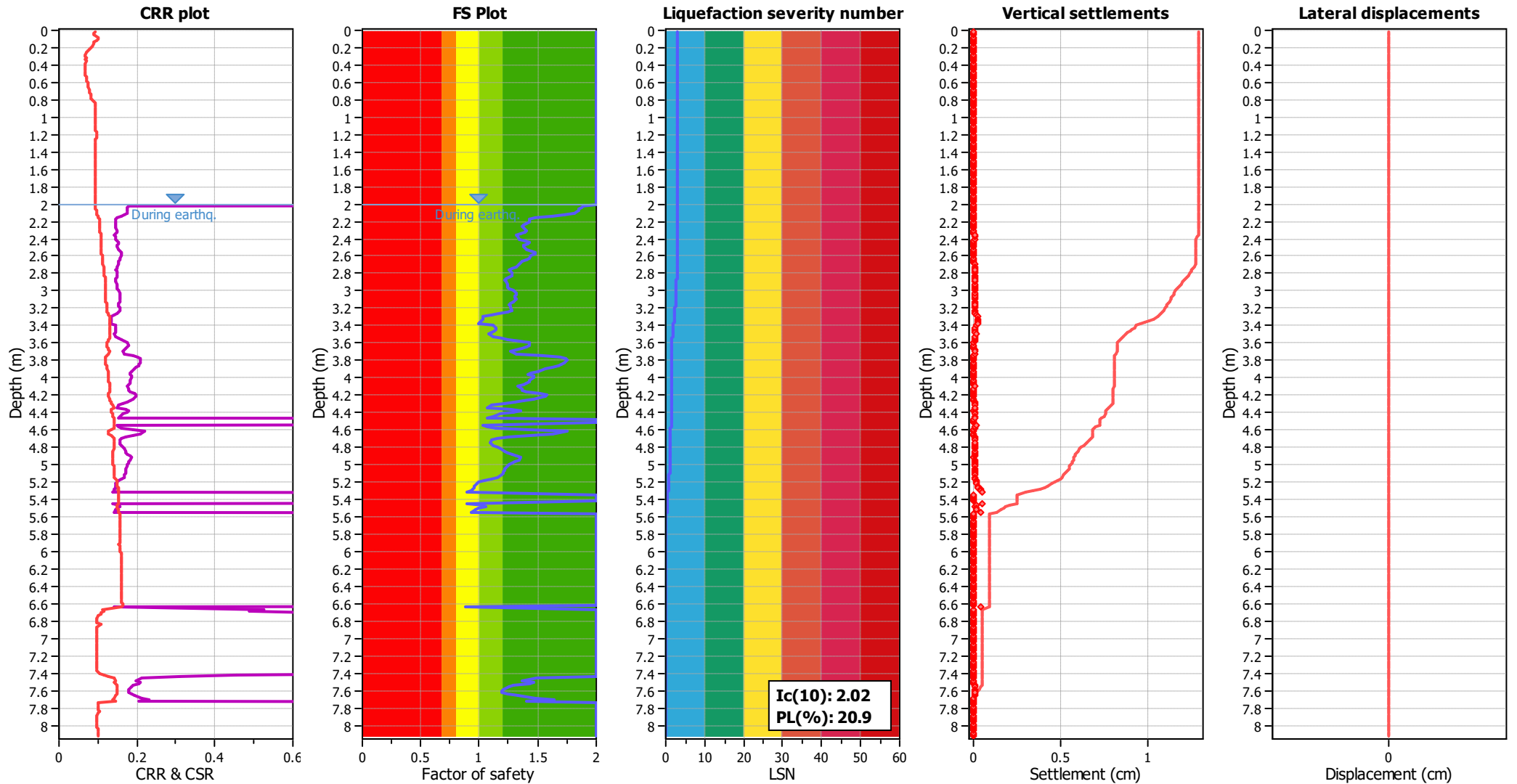
F.S. color scheme

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Light Green	Unlike to liquefy
Dark Green	Almost certain it will not liquefy

LSN color scheme

Red	Severe damage
Dark Red	Major expression of liquefaction
Orange	Moderate to severe exp. of liquefaction
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Light Green	Minor expression of liquefaction
Dark Green	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 m	Fill weight:	N/A
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Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

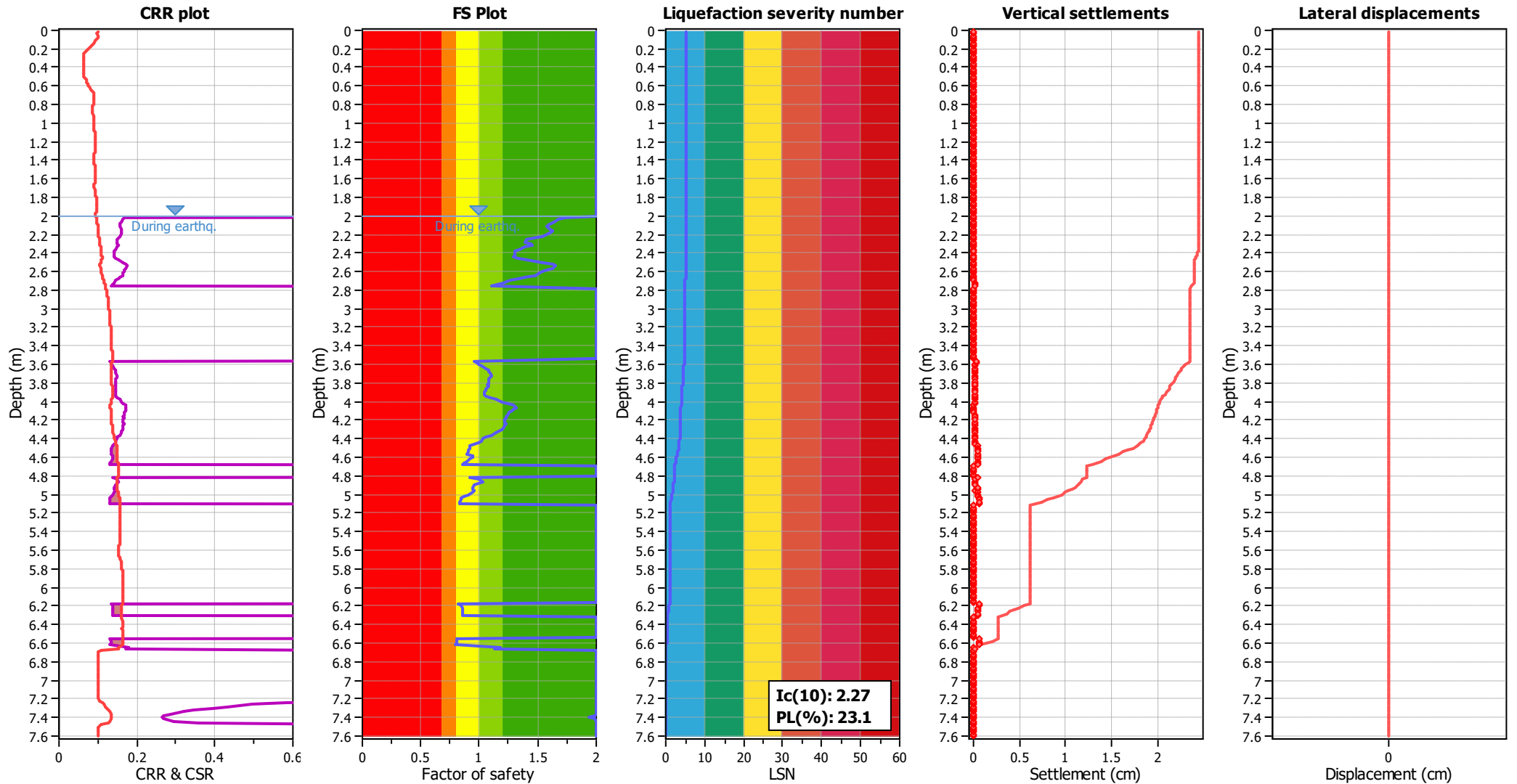
F.S. color scheme

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

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Moderate to severe exp. of liquefaction
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

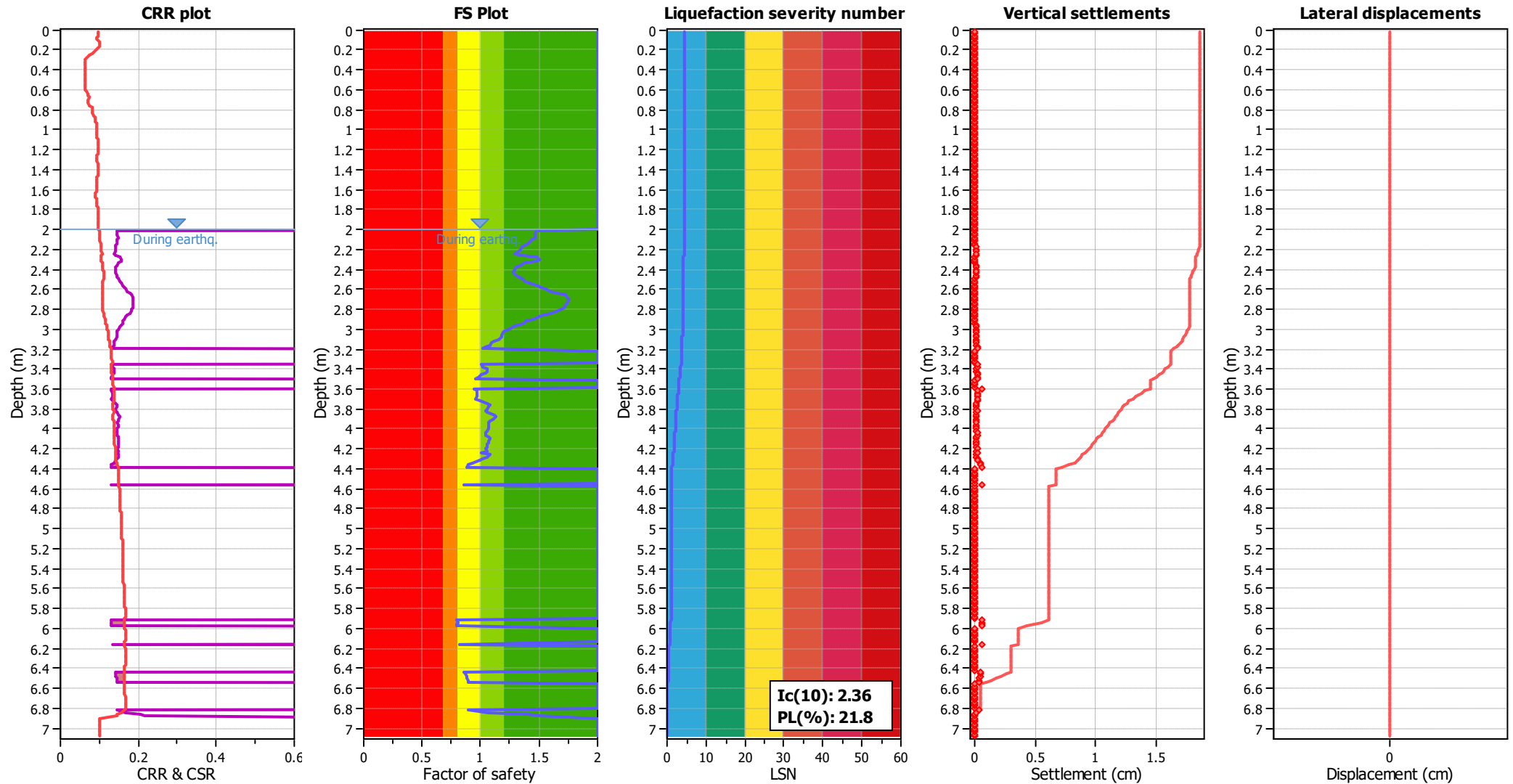
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.19	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

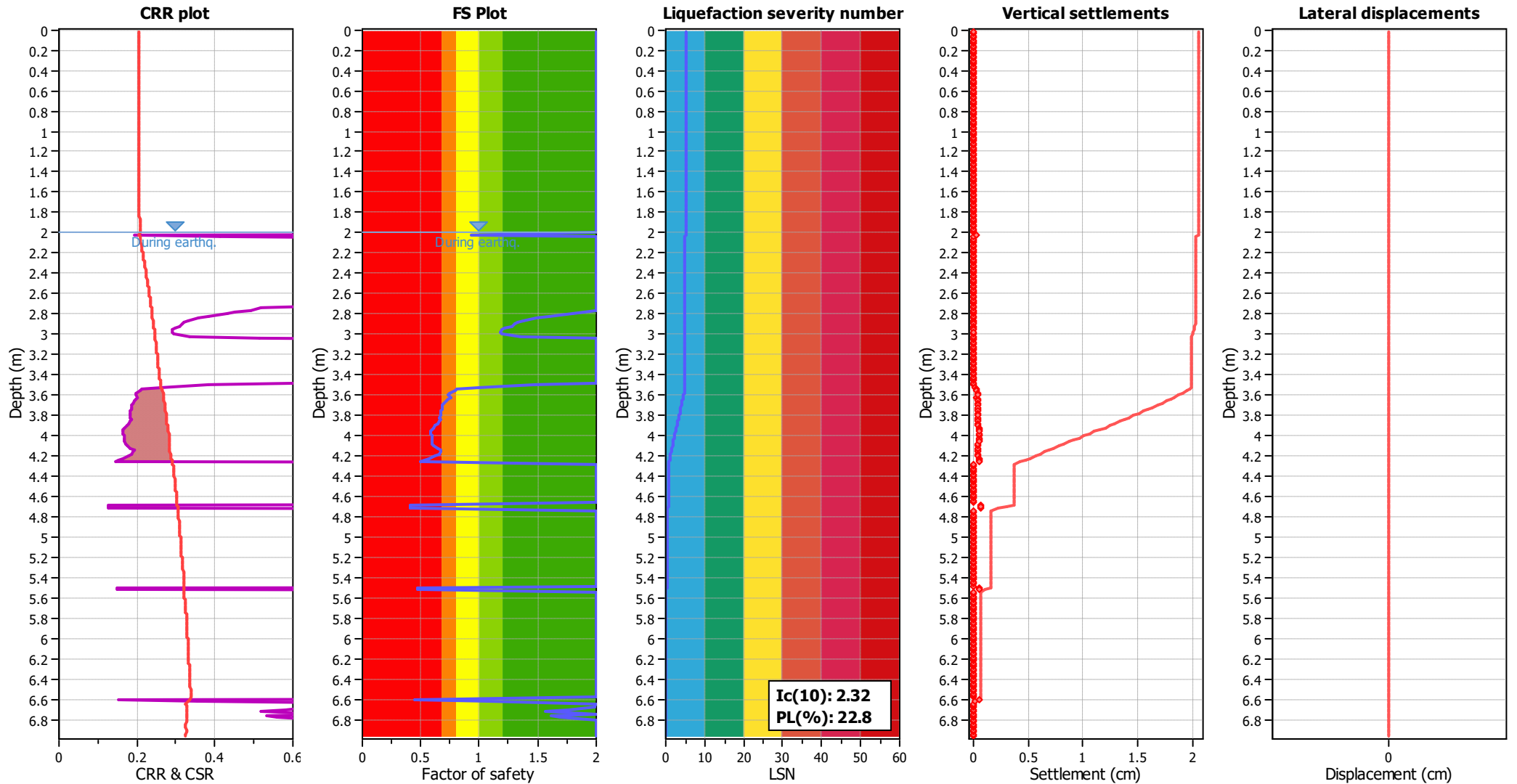
F.S. color scheme

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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 ₀ applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

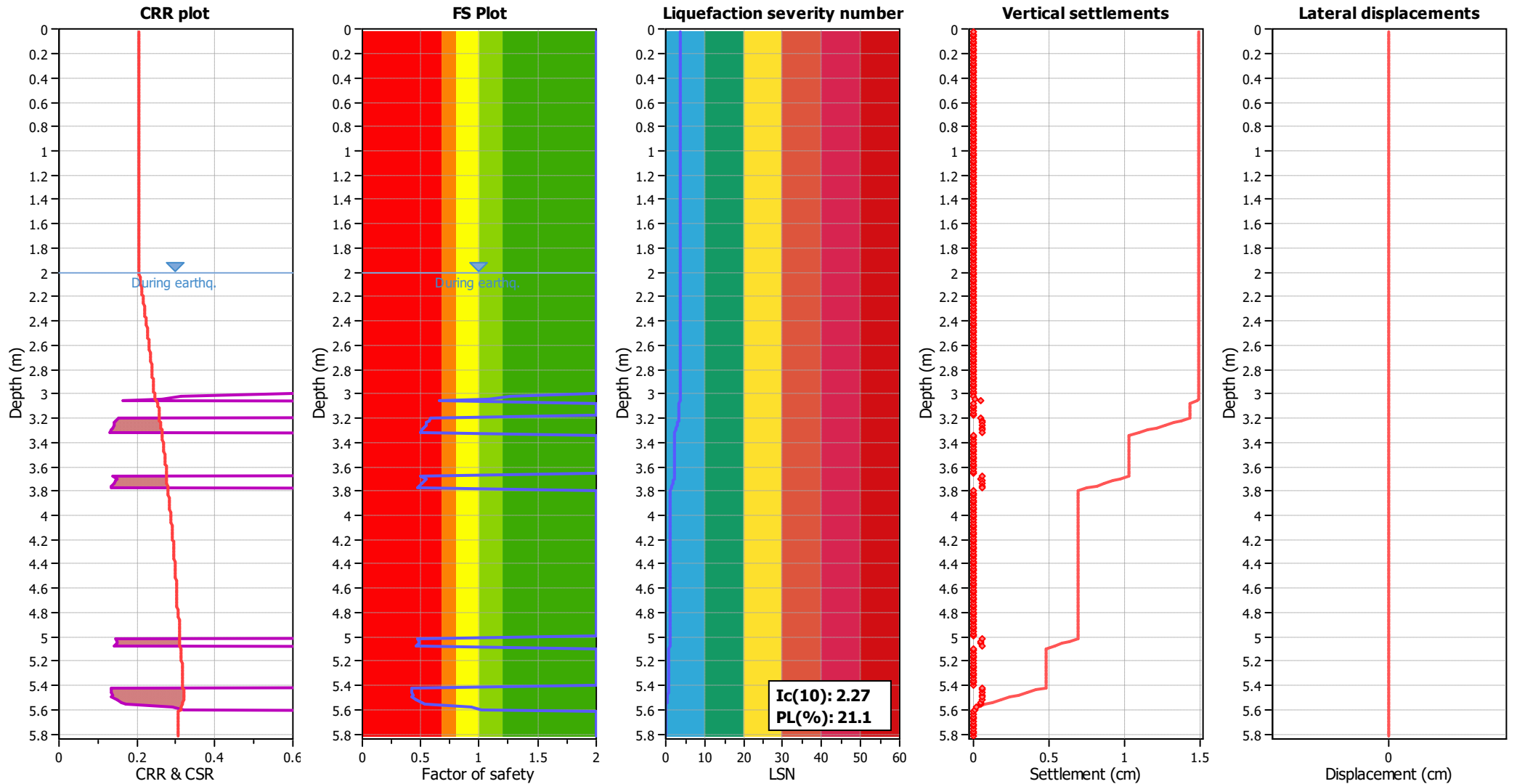
F.S. color scheme

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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

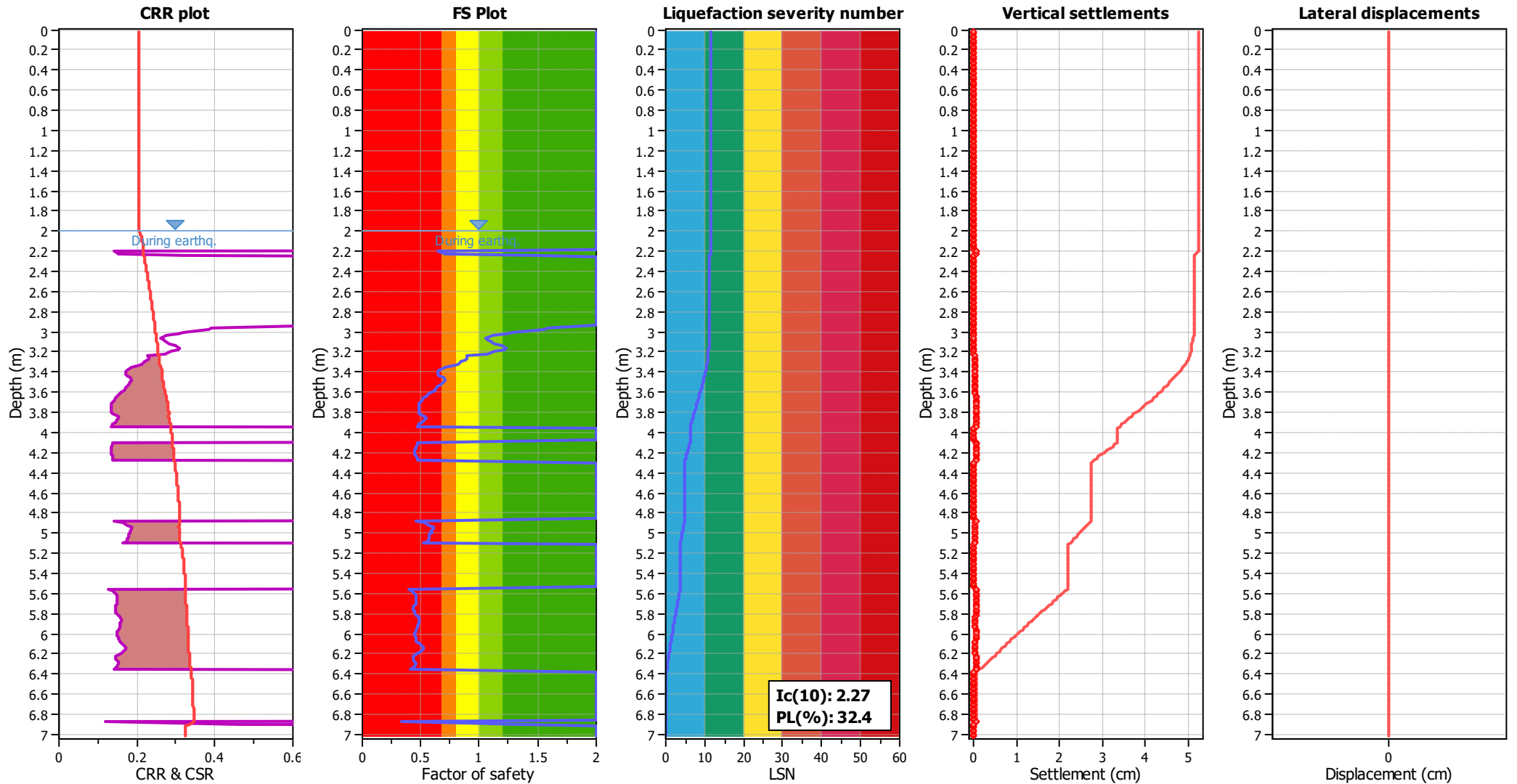
F.S. color scheme

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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

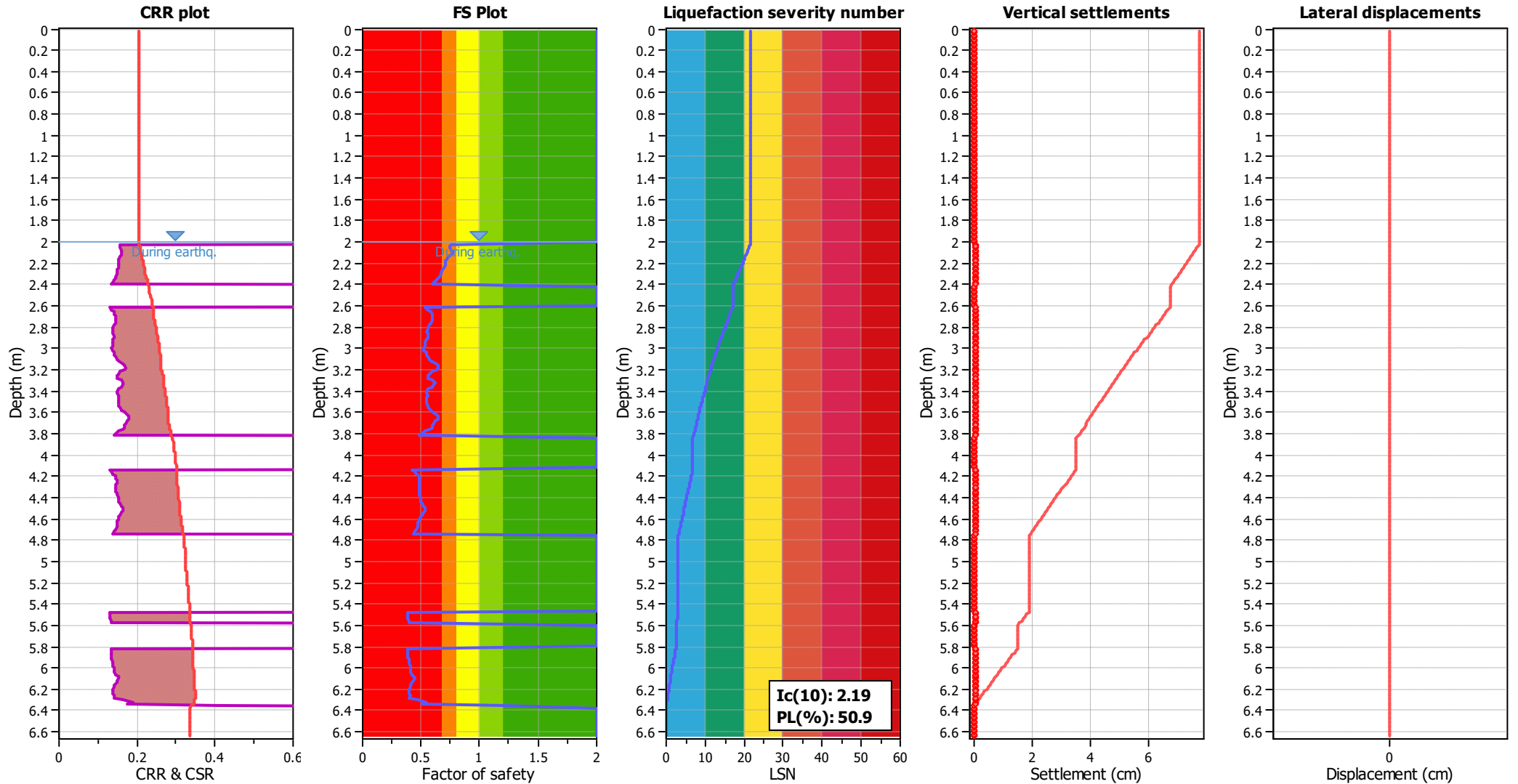
F.S. color scheme

Red	Almost certain it will liquefy
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Yellow	Moderate to severe exp. of liquefaction
Light Green	Moderate expression of liquefaction
Dark Green	Minor expression of liquefaction
Blue	Little to no expression of liquefaction

Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method: B&I (2014)
Fines correction method: B&I (2014)
Points to test: Based on I_c value
Earthquake magnitude M_w : 7.50
Peak ground acceleration: 0.35
Depth to water table (insitu): 1.95 m

Depth to GWT (earthq.): 2.00 m
Average results interval: 3
 I_c cut-off value: 2.60
Unit weight calculation: Based on SBT
Use fill: No
Fill height: N/A

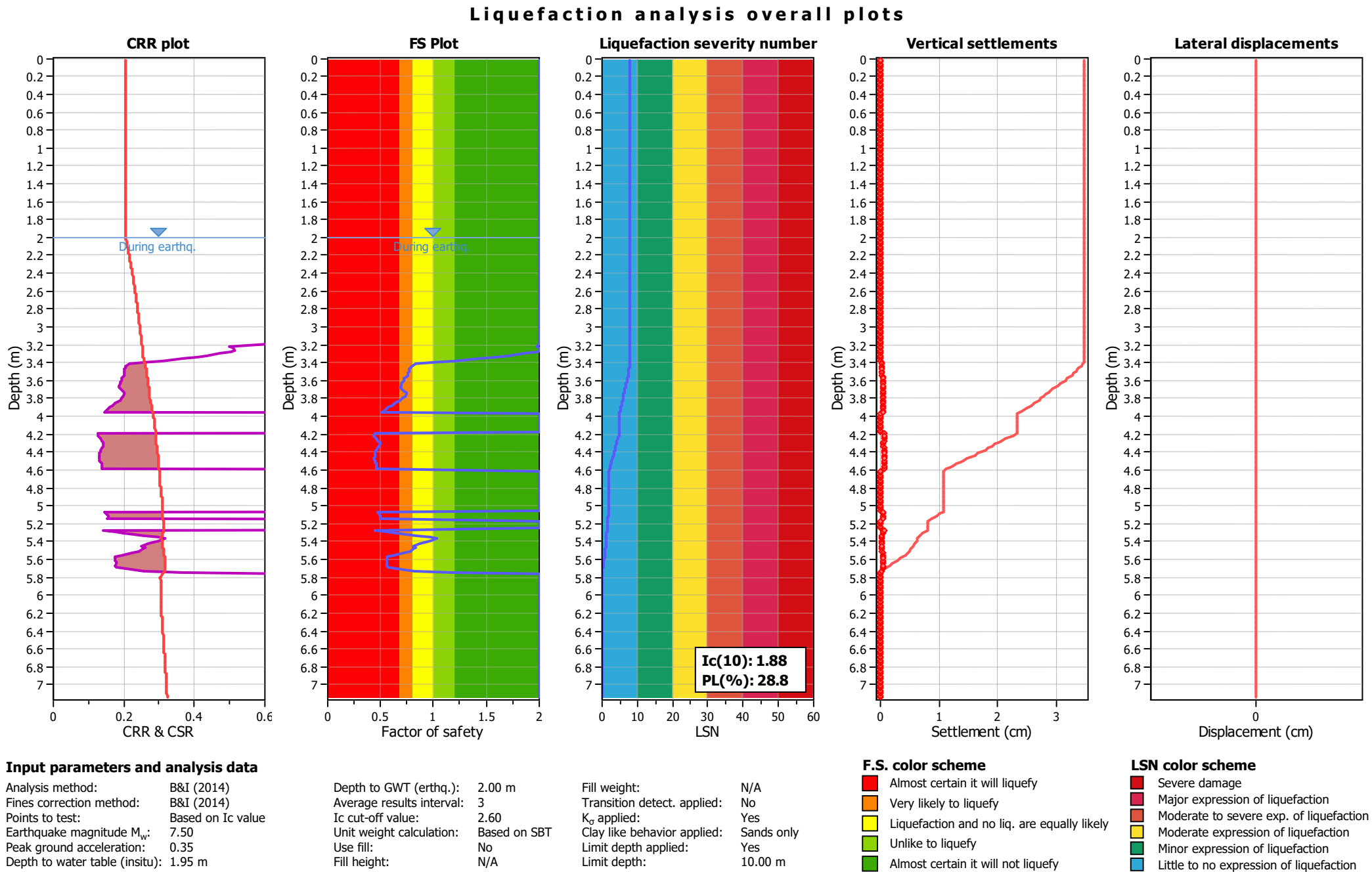
Fill weight: N/A
Transition detect. applied: No
 K_σ applied: Yes
Clay like behavior applied: Sands only
Limit depth applied: Yes
Limit depth: 10.00 m

F.S. color scheme

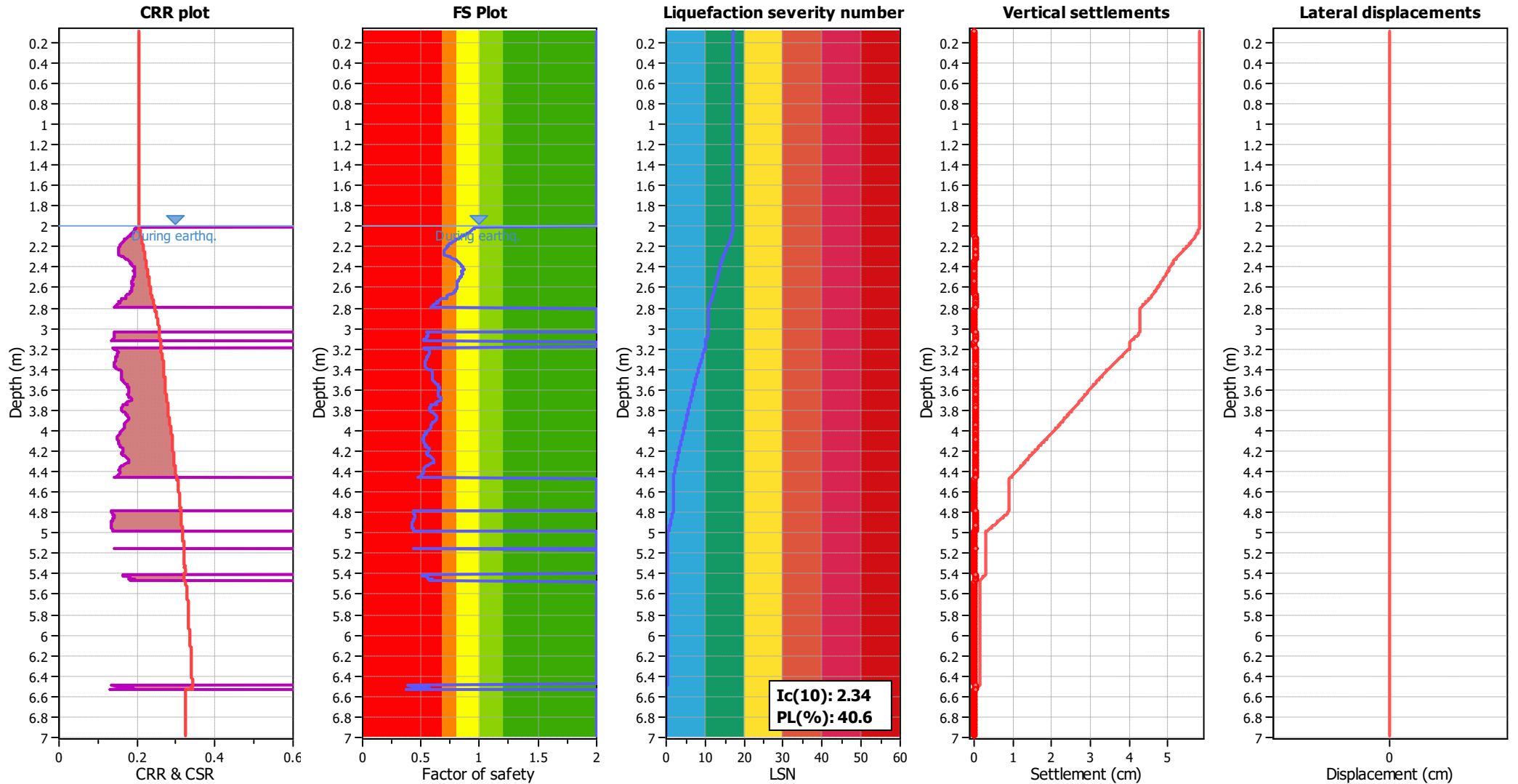
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

LSN color scheme

- Severe damage
- Major expression of liquefaction
- Moderate to severe exp. of liquefaction
- Moderate expression of liquefaction
- Minor expression of liquefaction
- Little to no expression of liquefaction



Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

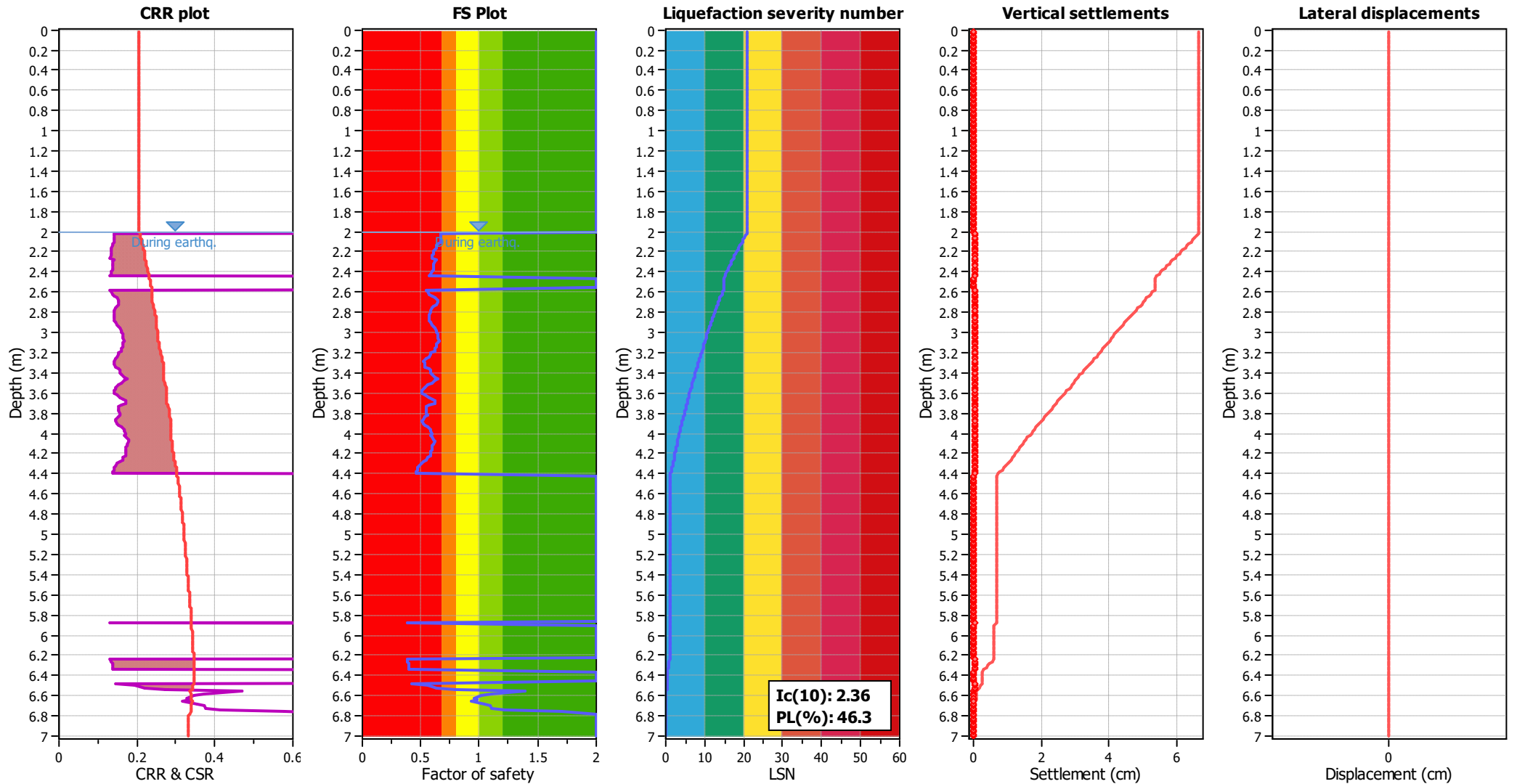
F.S. color scheme

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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 _g applied:	Yes
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Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

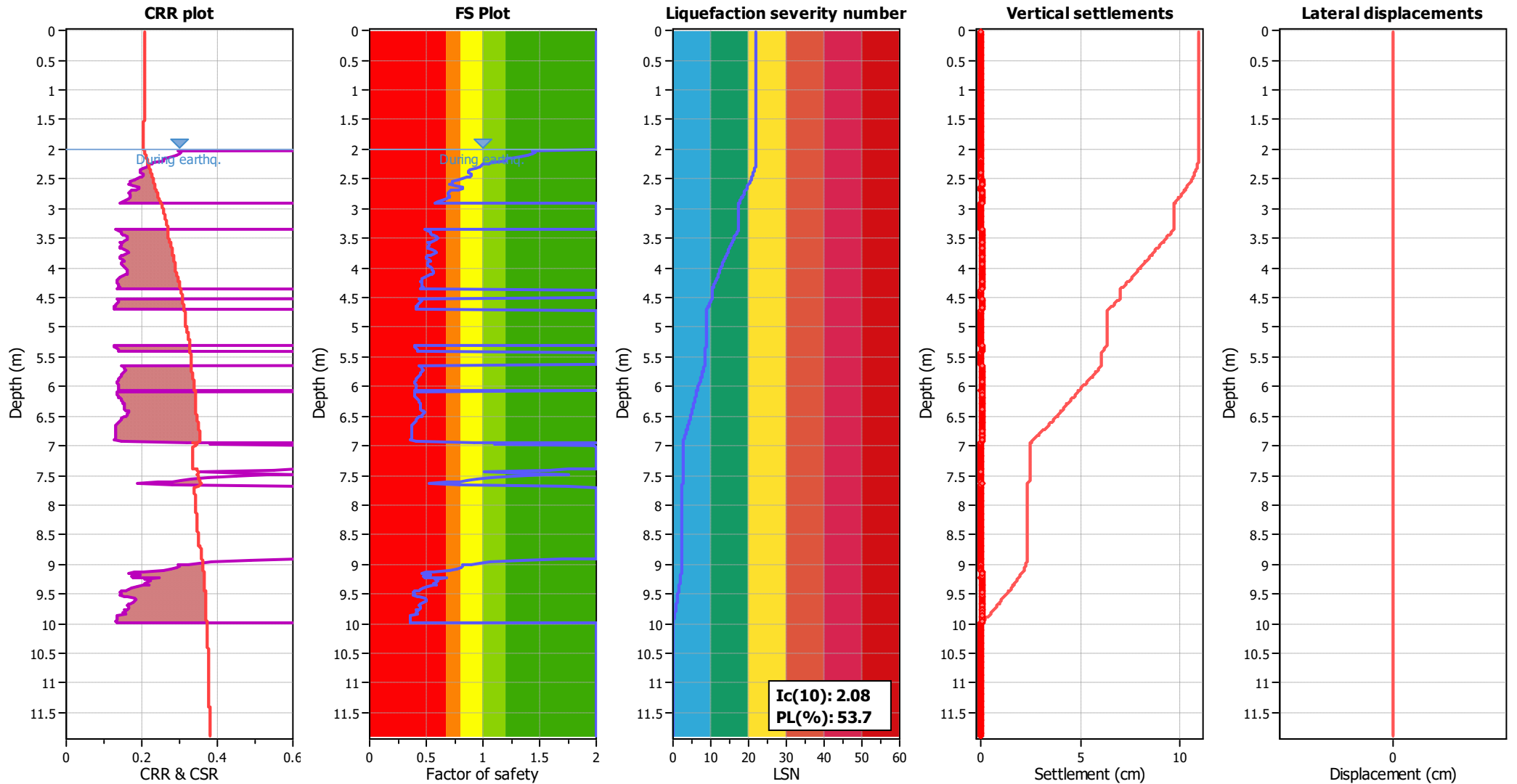
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Liquefaction analysis overall plots



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Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 m	Fill weight:	N/A
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Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

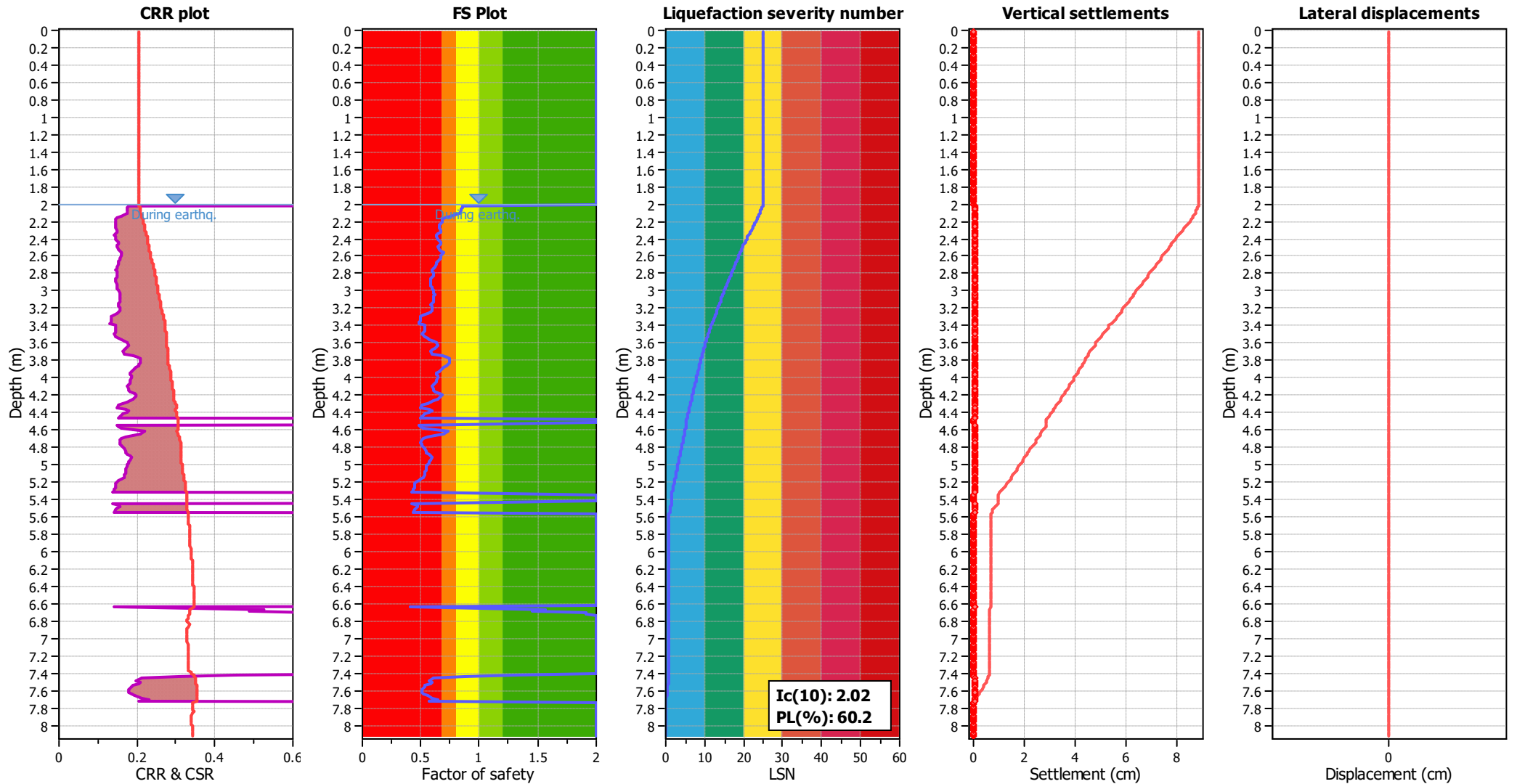
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Liquefaction analysis overall plots



Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (earthq.):	2.00 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 :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

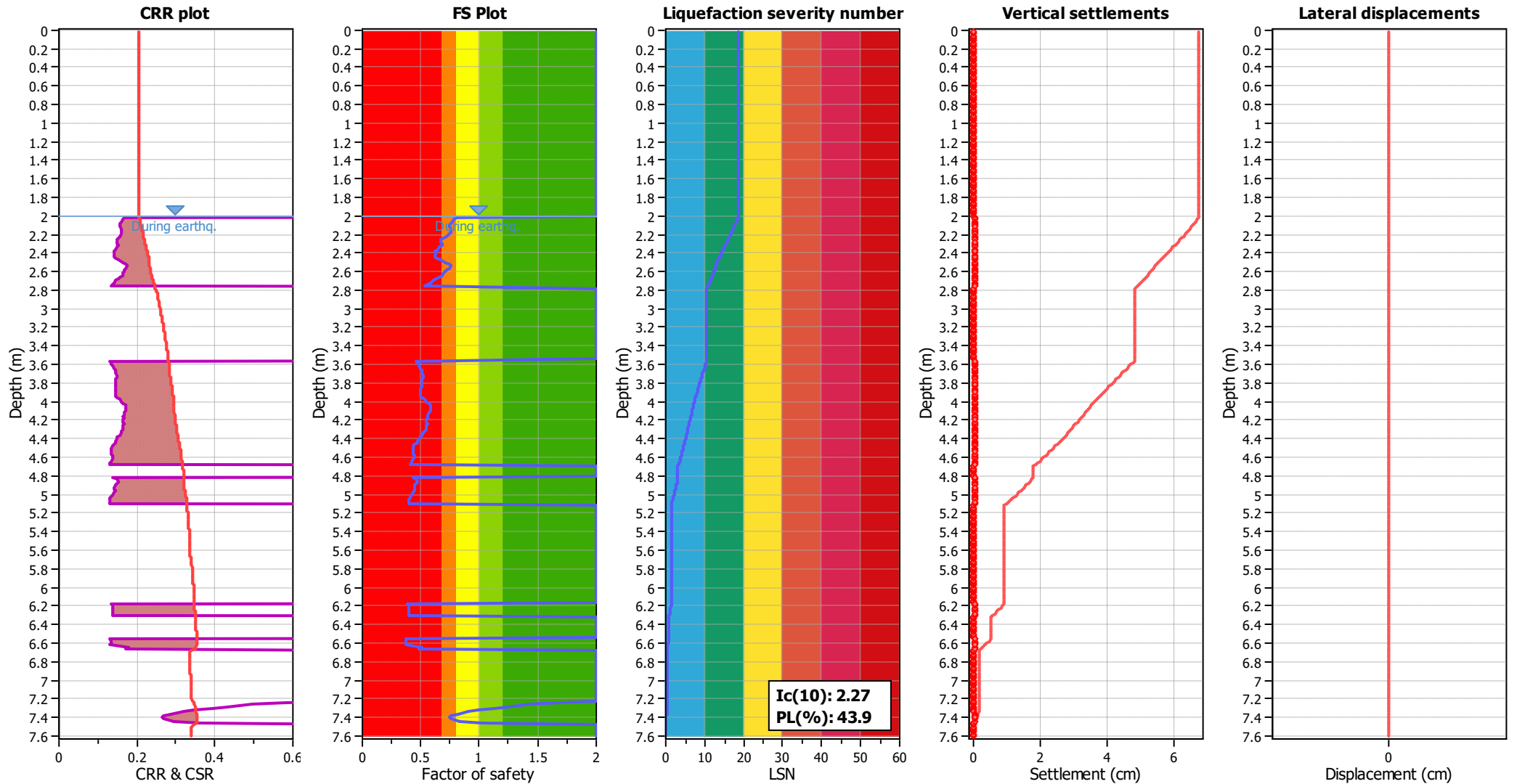
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Liquefaction analysis overall plots



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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 _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
Depth to water table (insitu):	1.95 m	Fill height:	N/A	Limit depth:	10.00 m

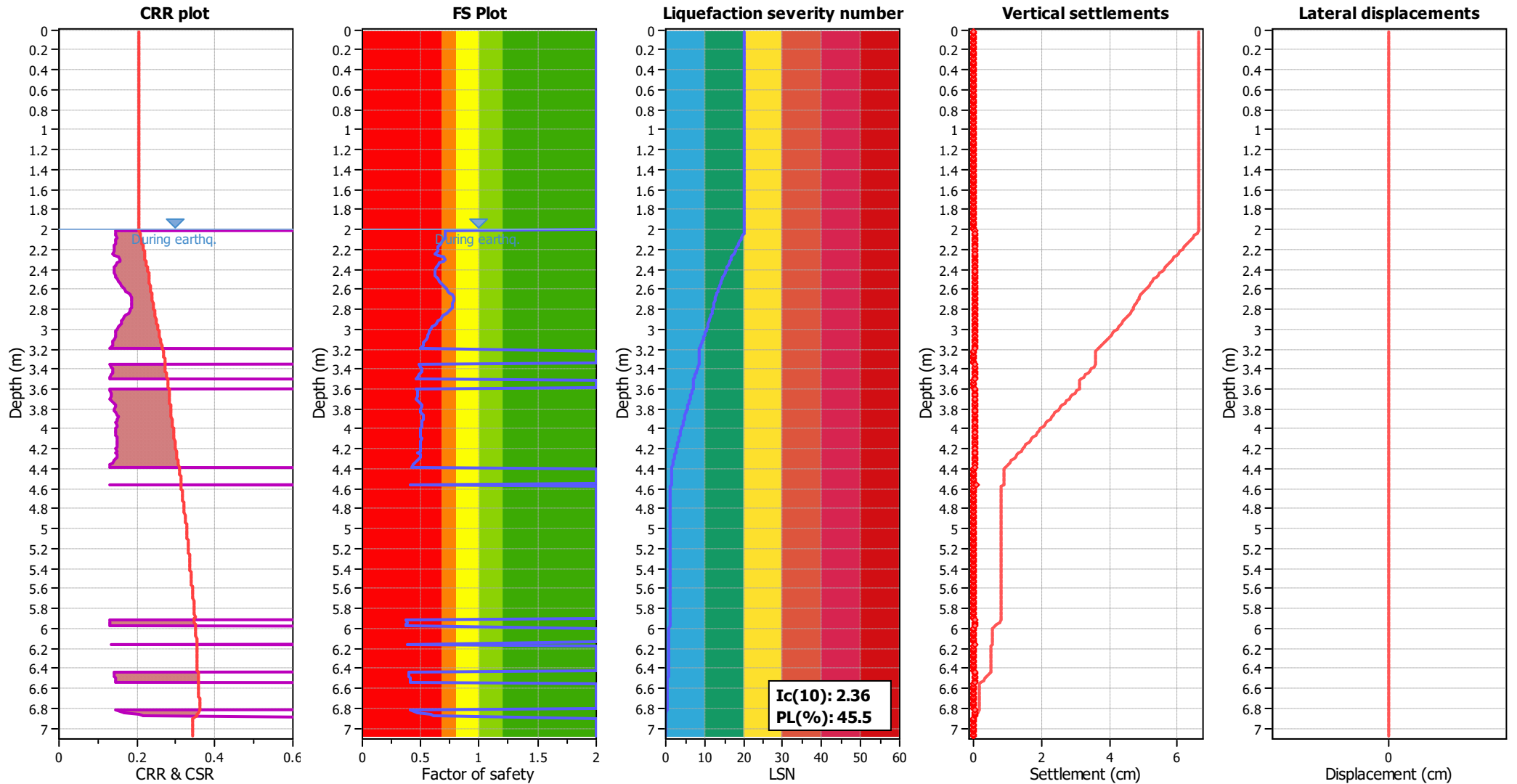
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Points to test:	Based on Ic value	Ic cut-off value:	2.60	K _g applied:	Yes
Earthquake magnitude M _w :	7.50	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.35	Use fill:	No	Limit depth applied:	Yes
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APPENDIX F

Static Settlement Analysis Outputs



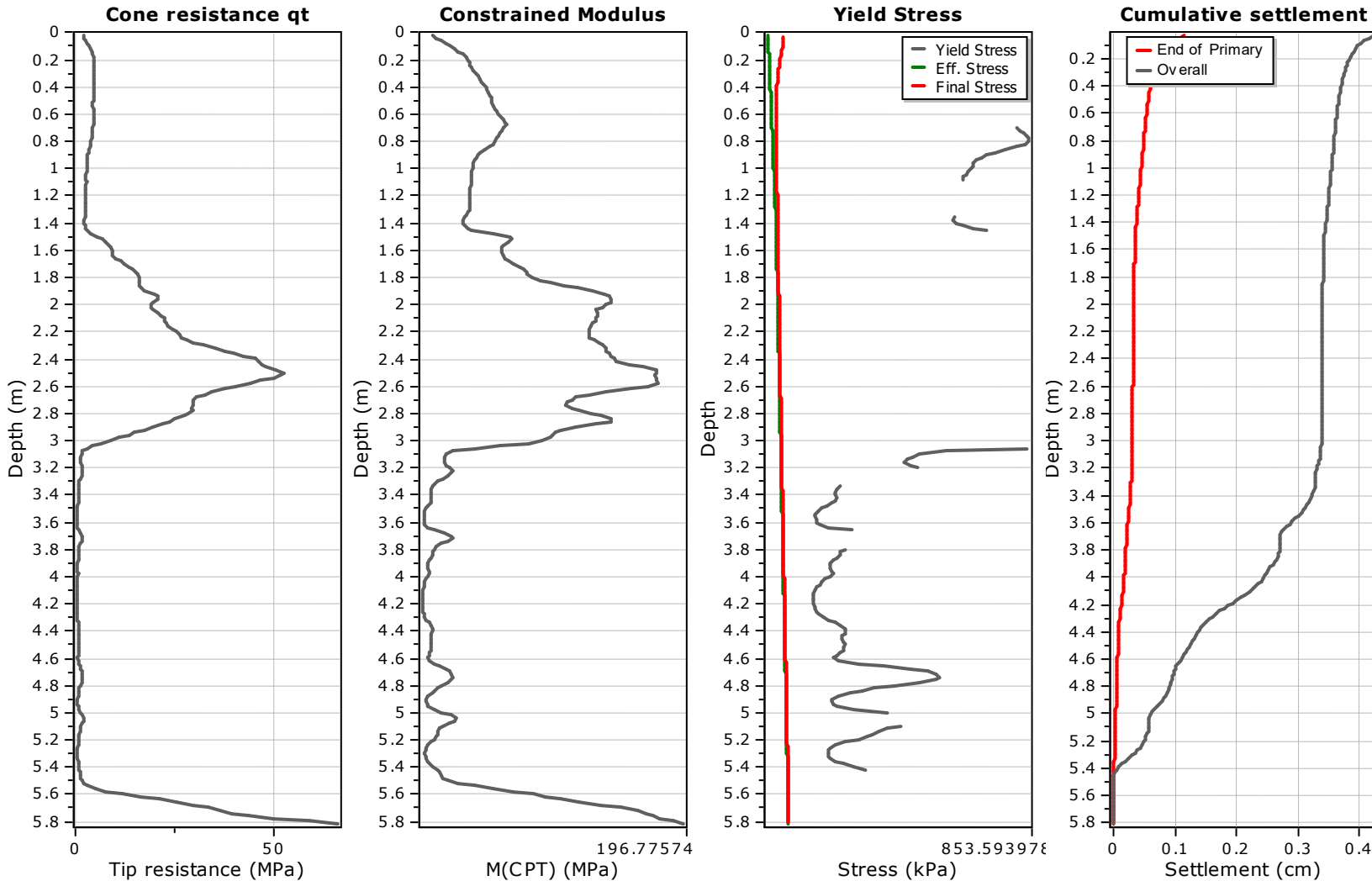
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
www.landtech.nz

Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_117989

Total depth: 5.82 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



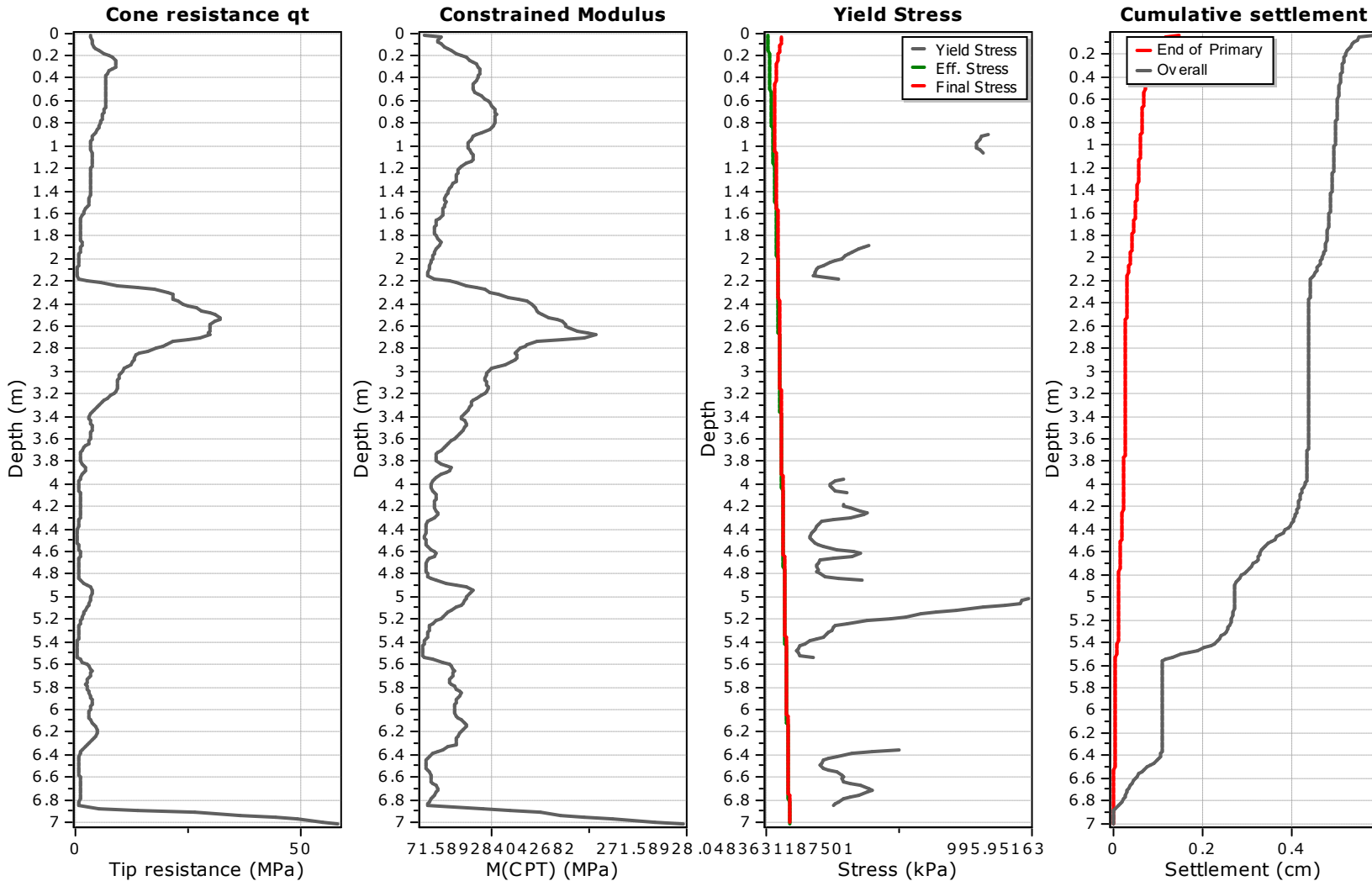
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
www.landtech.nz

Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118112

Total depth: 7.02 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



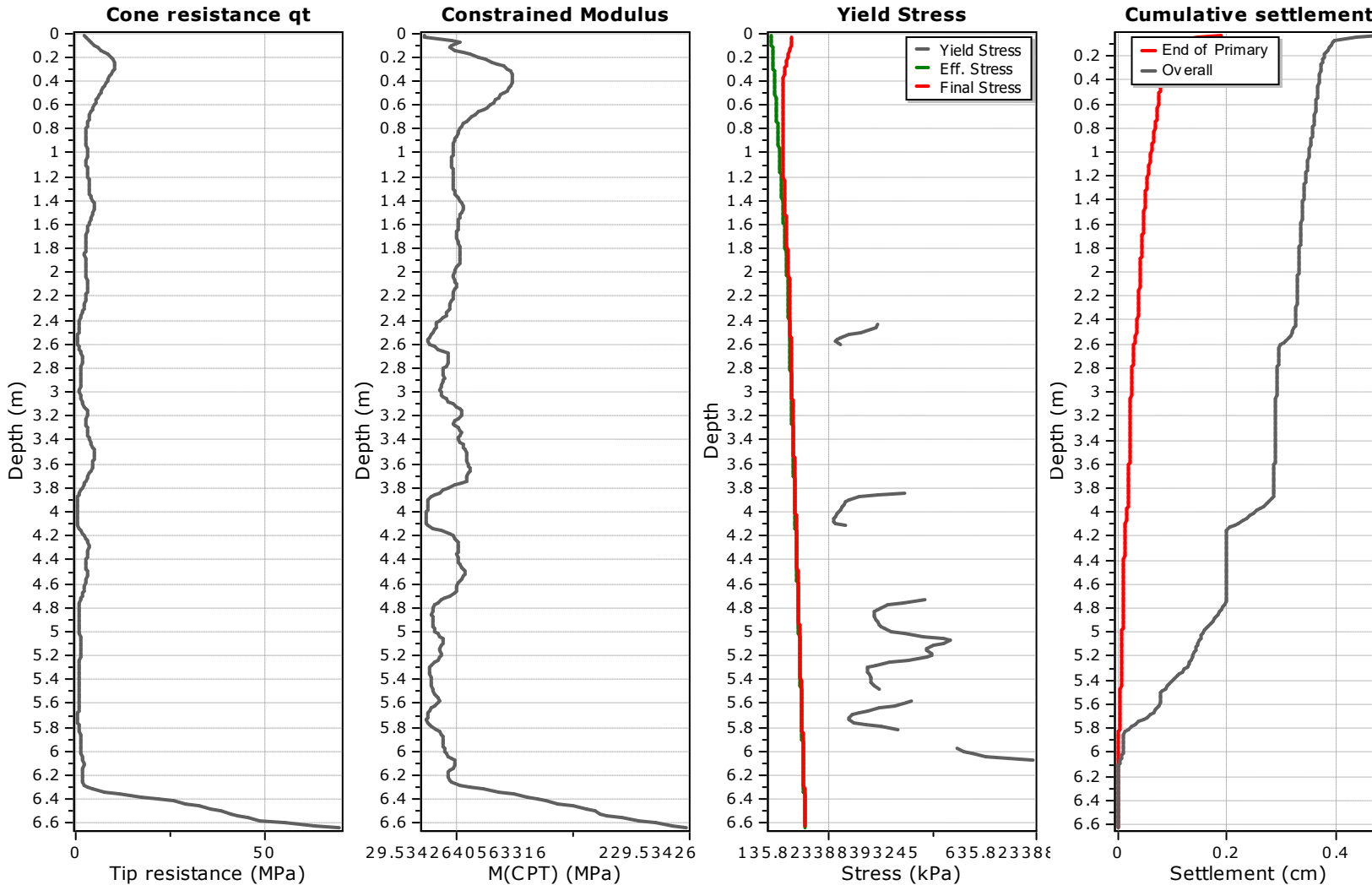
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
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Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118127

Total depth: 6.64 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



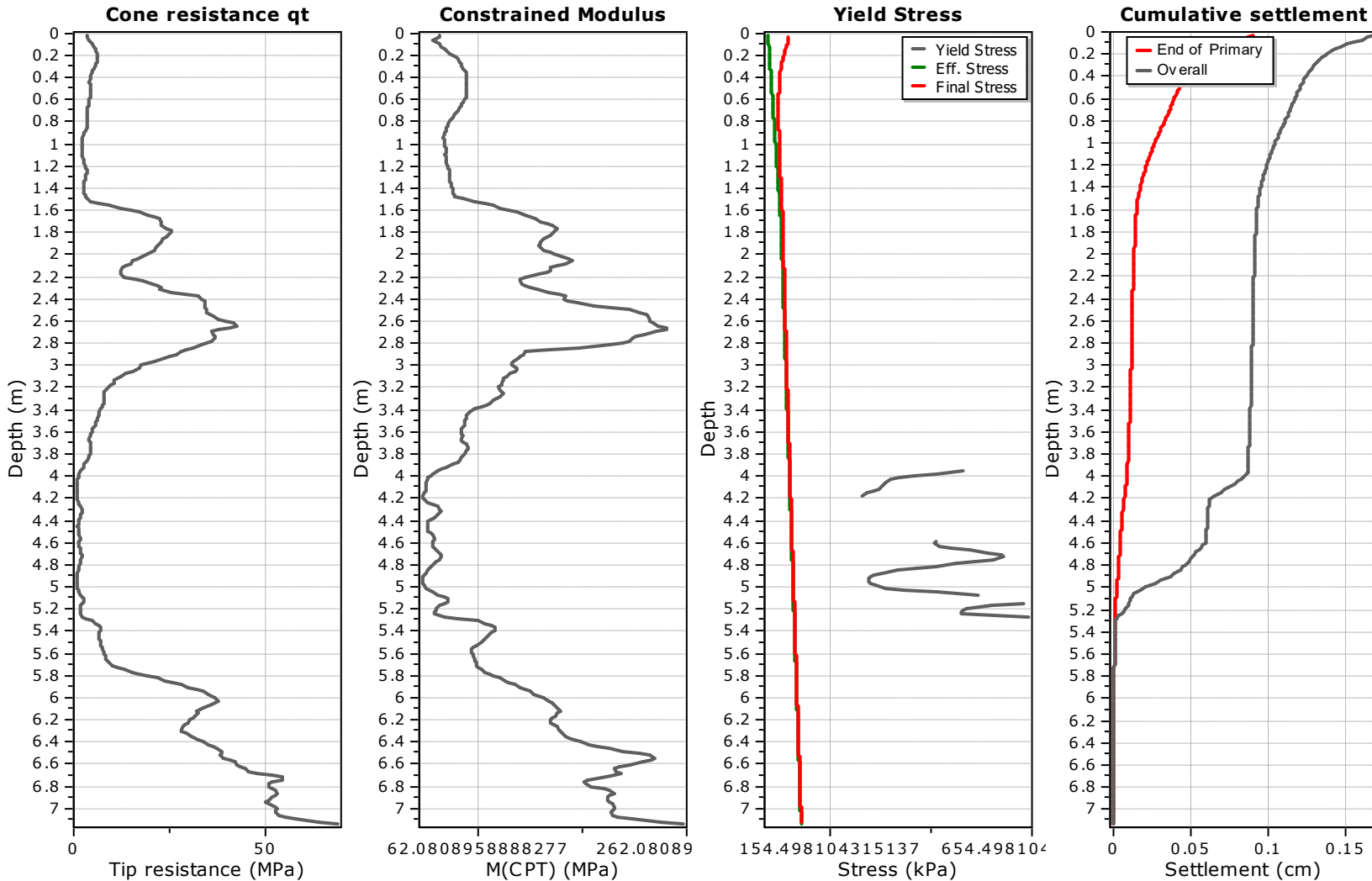
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
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Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118116

Total depth: 7.14 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



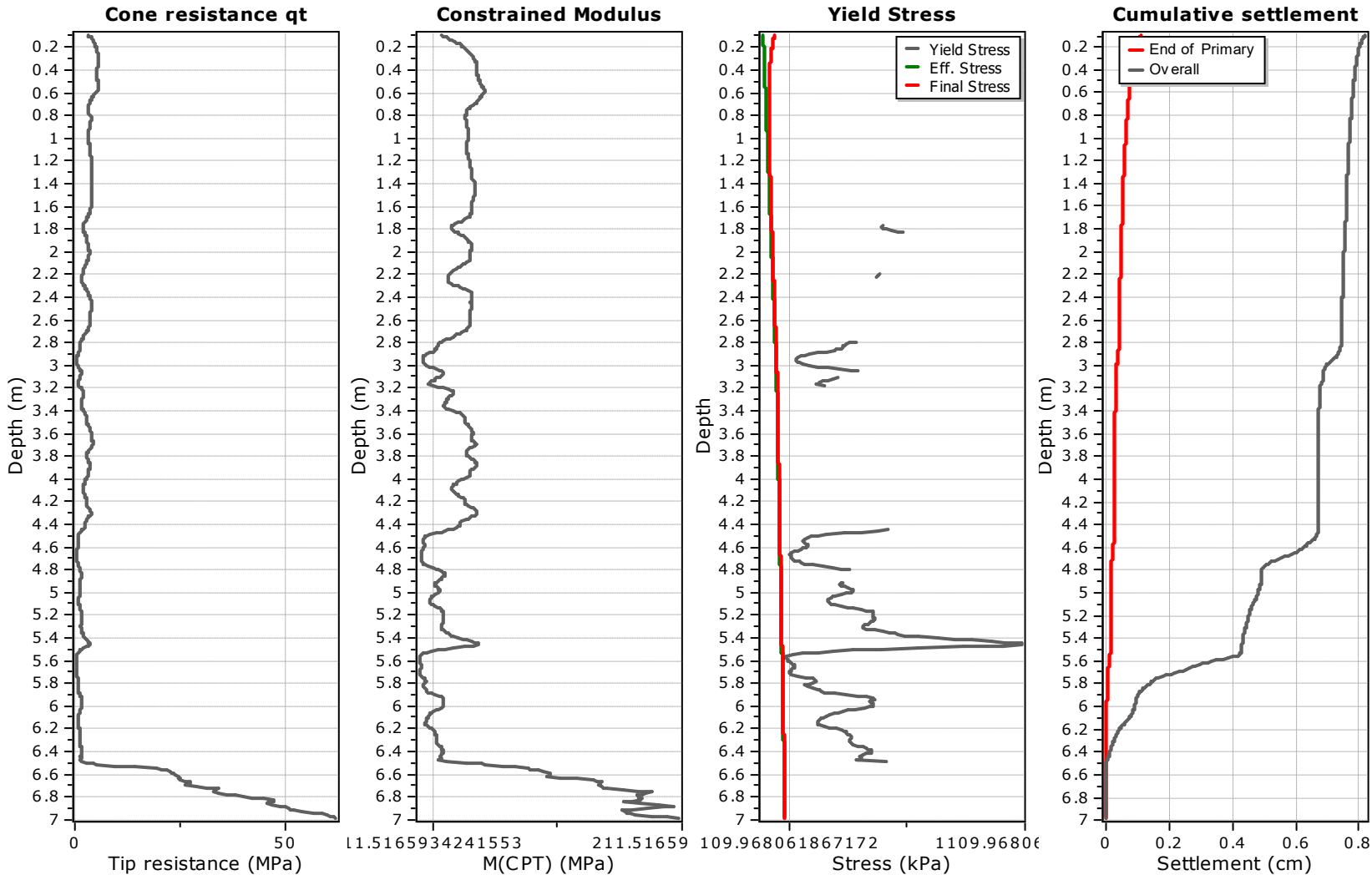
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
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Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_87812

Total depth: 6.99 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



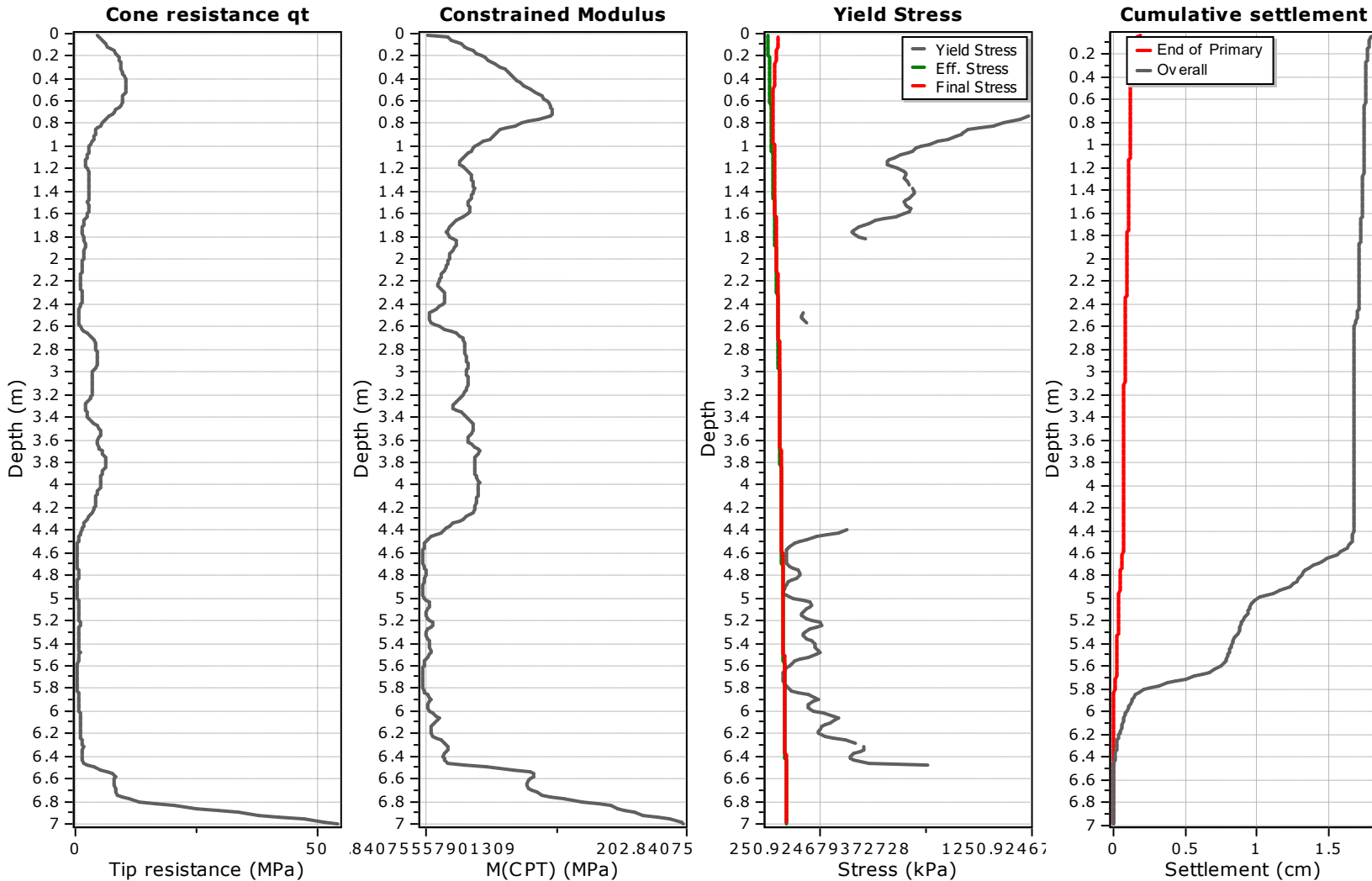
LandTech Consulting Ltd
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Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118125

Total depth: 7.00 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



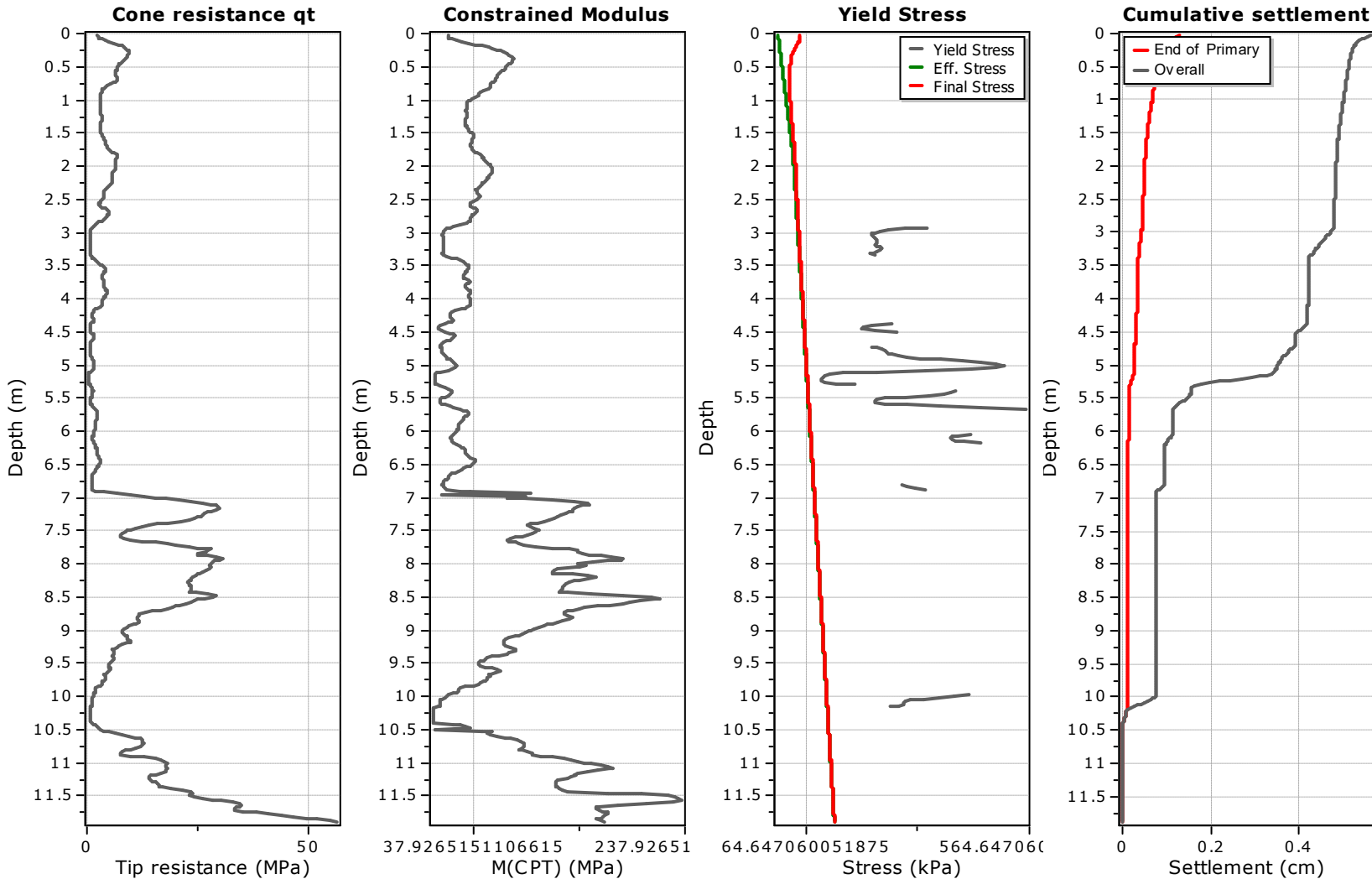
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Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
www.landtech.nz

Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118117

Total depth: 11.89 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



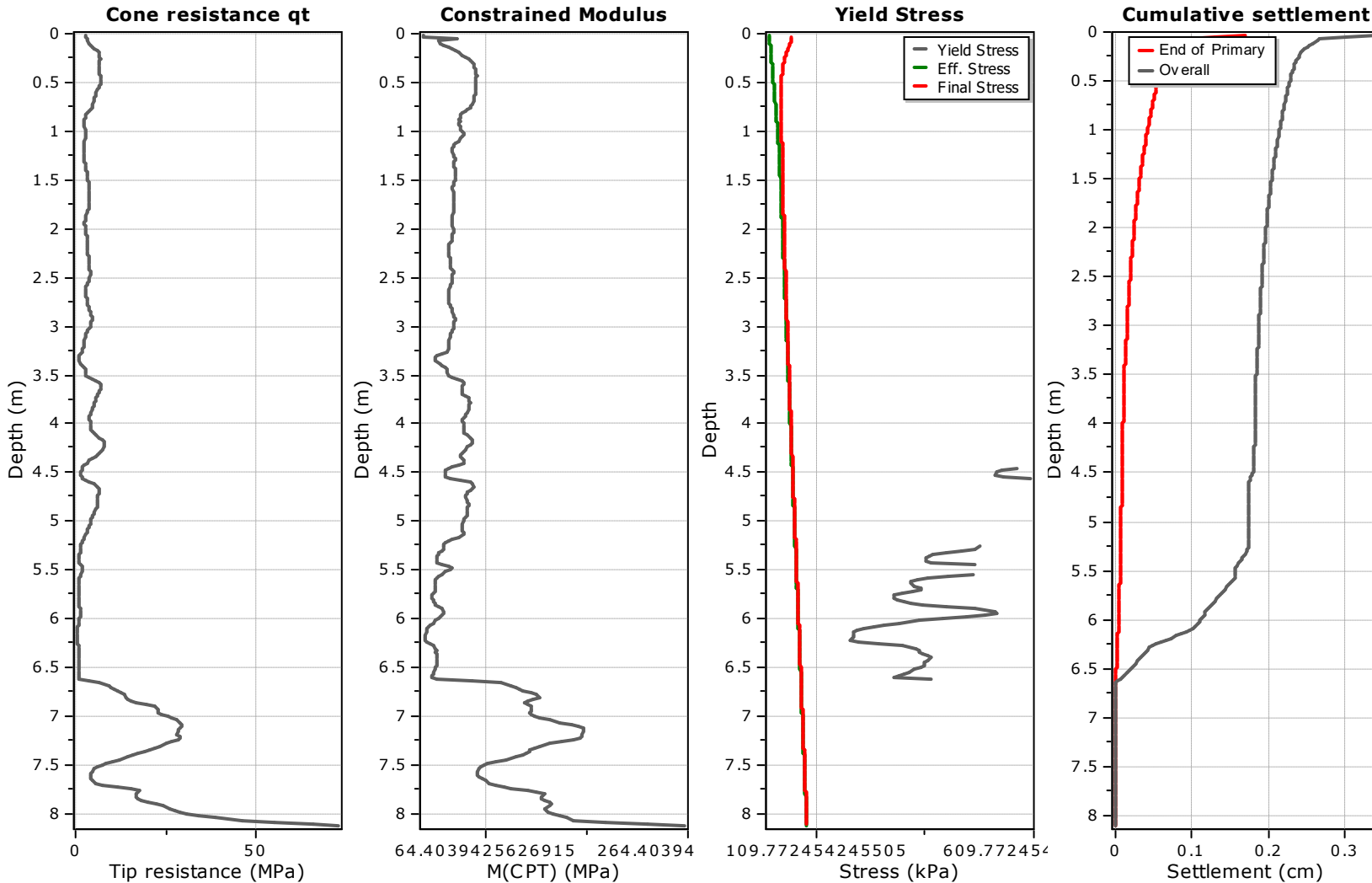
LandTech Consulting Ltd
Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
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Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118120

Total depth: 8.12 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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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Project: 555 Birchs Road, Lincoln, Selwyn

Location: 555 Birchs Road, Lincoln

CPT: CPT_118121

Total depth: 7.60 m, Date: 5/06/2024

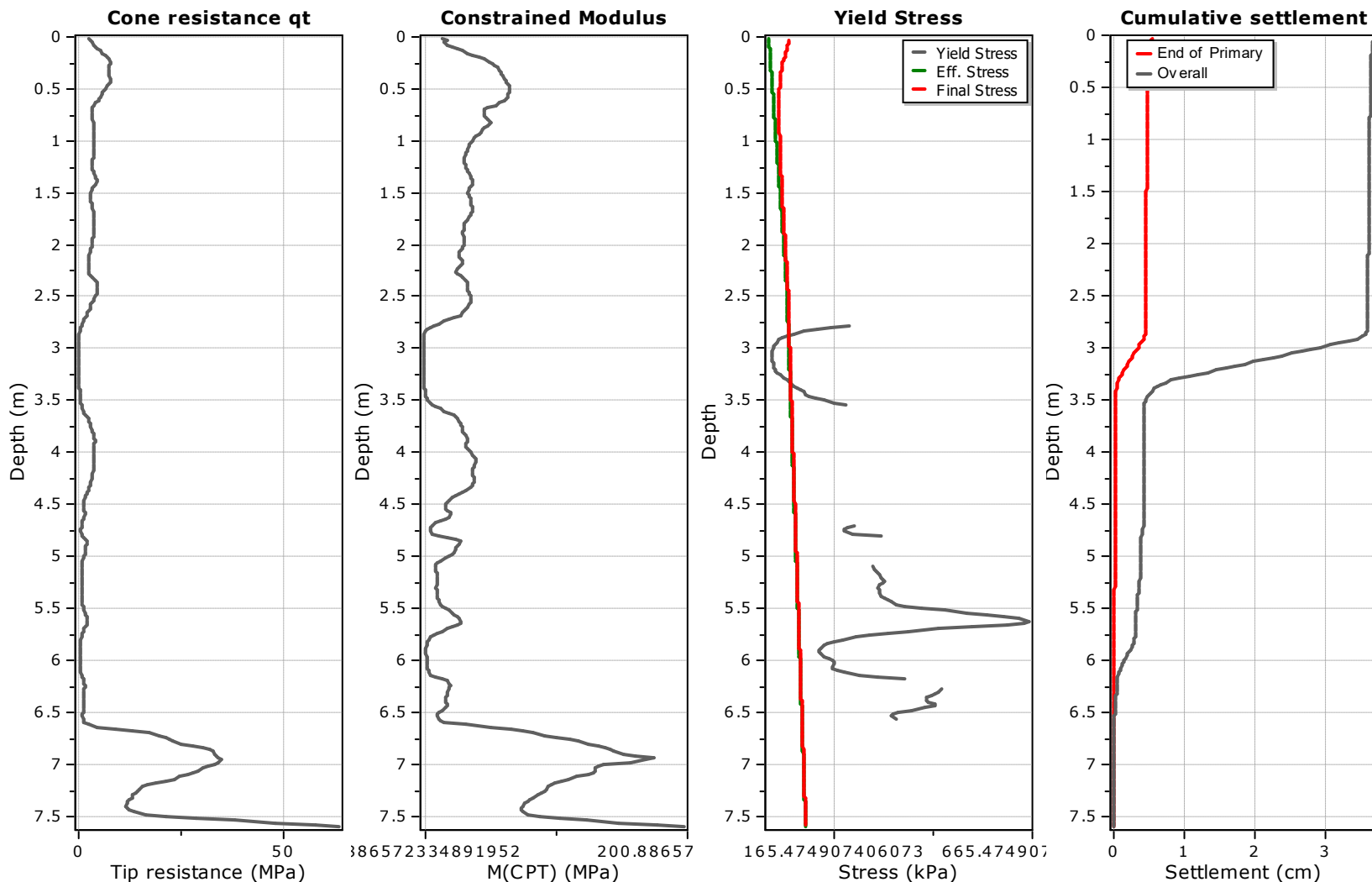
Surface Elevation: 0.00 m

Coords: X:0.00, Y:0.00

Cone Type:

Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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



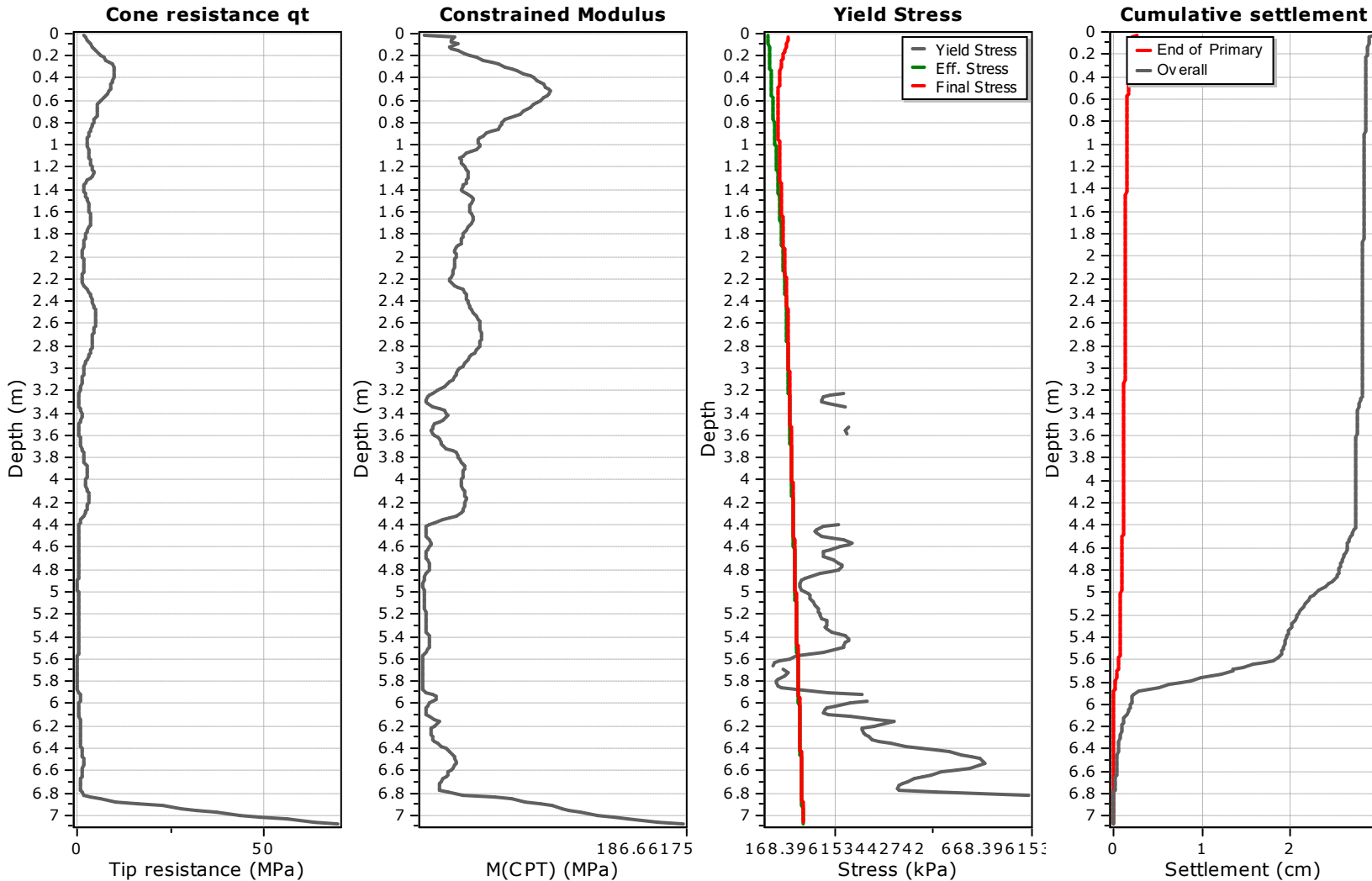
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Unit 3 | 16 Leslie Hills Drive
Riccarton, Christchurch
www.landtech.nz

Project: 555 Birchs Road, Lincoln, Selwyn
Location: 555 Birchs Road, Lincoln

CPT: CPT_118123

Total depth: 7.08 m, Date: 5/06/2024
Surface Elevation: 0.00 m
Coords: X:0.00, Y:0.00
Cone Type:
Cone Operator:

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 0.30 (m)
L/B: 10.0
Footing pressure: 50.00 (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: 1200 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

APPENDIX G

Statement of Professional Opinion

Statement of Professional Opinion on the Suitability of Land for Subdivision

Issued by: *Landtech Consulting Ltd*
(*Geotechnical engineering firm or suitably qualified engineer*)

To: *Urban Estates Ltd*
(*Owner/Developer*)

To be supplied to: *Selwyn District Council*
(*Territorial authority*)

In respect of: *Proposed Subdivision*
(*Description of proposed infrastructure/land development*)

At: *Lot 2 Deposited Plan 33959 BLK I Halswell SD*
(*Address*)

I (*Geotechnical engineer*) *Dwayne Wilson* on behalf of (*Geotechnical engineering firm*) *Landtech Consulting Ltd*

hereby confirm:

1. I am a suitably qualified and experienced geotechnical engineer and was retained by the owner/developer as the geotechnical engineer on the above proposed development.
2. My/the geotechnical assessment report, dated *13 June 2024* has been carried out in accordance with the Department of Building and Housing *Guidelines for geotechnical investigation and assessment of subdivisions* and includes:
 - (i) Details of and the results of my/the site investigations.
 - (ii) A liquefaction assessment.
 - (iii) An assessment of rockfall and slippage, including hazards resulting from seismic activity.
 - (iv) An assessment of the slope stability and ground bearing capacity confirming the location and appropriateness of building sites.
 - (v) Recommendations proposing measures to avoid, remedy or mitigate any potential hazards on the land subject to the application, in accordance with the provisions of Section 106 of the Resource Management Act 1991.
3. In my professional opinion, I consider that Council is justified in granting consent incorporating the following conditions:

Geotechnical recommendations as per our attached geotechnical report
4. This professional opinion is furnished to the territorial authority and the owner/developer for their purposes alone, on the express condition that it will not be relied upon by any other person and does not remove the necessity for the normal inspection of foundation conditions at the time of erection of any building.
5. This certificate shall be read in conjunction with my/the geotechnical report referred to in Clause 2 above, and shall not be copied or reproduced except in conjunction with the full geotechnical completion report.
6. The geotechnical engineering firm issuing this statement holds a current policy of professional indemnity insurance of no less than \$ 2,000,000.00

(Minimum amount of insurance shall be commensurate with the current amounts recommended by IPENZ, ACENZ, TNZ, INGENIUM.)



.....
(Signature of Engineer)

Date: 13 June 2024

Qualifications and experience: *BEngTech (Civil), MEngSt (Geotechnical), CMEngNZ, CPEng*