INITIA

GEOTECHNICAL SPECIALISTS

DEVELOPMENT NOUS

BROOKVALE RESIDENTIAL

GEOTECHNICAL ASSESSMENT REPORT

INITIA REF P-001006 REV A

FEBRUARY 2021

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1. Introduction

1.1 General

Initia Limited has been engaged by Development Nous Limited on behalf of Oderings Nurseries Christchurch Limited to provide geotechnical consultancy services in relation to the proposed residential subdivision development at a block of land, currently occupied by an Oderings Garden Centre, between Brookvale Road and Romanes Drive, Havelock North.

This Geotechnical Interpretative Report (GIR) provides geotechnical advice and recommendations to support design of the proposed development. It is considered suitable to support a Resource Consent application.

1.2 Scope of Works

The scope of works undertaken as part of the geotechnical assessment for the residential subdivision development includes the following:

- Geotechnical desk-study assessment including a review of the New Zealand Geotechnical Database (NZGD) to source any historical relevant geotechnical investigation data and a review of the published geological maps for the area.
- Site walkover/field mapping by a geotechnical specialist;
- Geotechnical field investigations comprising;
    - 3 No. machine drilled boreholes (BHs) extended to a depth of up to 8m.
    - 1 day of Static Cone Penetration tests (CPTs)
- Preparation of test logs and a field investigation location plan.
- Development of a subsurface model for the site;
- Liquefaction susceptibility analyses for SLS and ULS seismic events using the CPT and laboratory data;
- Preparation of test logs and a field investigation location plan.
- Development of a subsurface model for the site;
- Liquefaction susceptibility analyses for SLS and ULS seismic events using the CPT and laboratory data;
- Assessment of suitable foundation options derivation of design parameters;
- Preparation of a geotechnical report providing geotechnical advice to support earthworks and the Resource Consent for the development and future sections.

1.3 Proposed Development

The proposed development at 55 Brookvale Road is to be undertaken over an approximately 2 Ha site as shown on Figure 1006-001 in Appendix A. The development is to comprise predominantly residential dwellings between one and two storeys high with associated infrastructure.

2. Site Overview

2.1 Site Description

The site has been used as a garden centre with extensive glass houses and storage areas. Many of the glasshouses have now been removed, leaving the concrete slab exposed. This site is bounded by a drainage channel on the eastern and northern boundary. Playing fields are located to the west of the site and Brookvale Road is to the south of the site.

The site has a gentle slope with an elevation of RL 12.5 at the southern boundary, sloping down to the north at approximately RL 9 m.

2.2 Published Geology

The geological map of the area[1] indicates that the site is underlain by two different geological units. To the north west there is the recent Holocene river deposits including poorly consolidated alluvial gravel, sand and mud – shaded blue on the map below.

The rest of the site is underlain by Late Pleistocene river deposits comprising moderately weathered undifferentiated poorly sorted loess-covered alluvial gravel deposits – shaded orange (c. 6,500 to 3,000 year old) and yellow (> 14,000 years old)[2] on the map below.

Figure 2-1: Quaternary Geology of the Hawkes Bay area.

[1] Hawke's Bay Quaternary Geology, https://hbrcopendata-hbrc.opendata.arcgis.com/
[2] RDCL Report, Brookvale and Romanes Drive Subdivision Havelock North. Geotechnical Investigation. Ref: R_20029_02.

3. Geotechnical Investigation

3.1 Nearby Historical Investigations

A geotechnical investigation carried out from February to August 2020 was carried out by RDCL[2] for a proposed residential development to the north east, directly across Romanes Drive (approximately 100 m north east of the subject site). The development consists 105 lots approximately 550-600 m^2 each. The investigation comprised:

- 29 Test Pit excavations
- 26 Dynamic Cone Penetrometer tests
- 14 Cone Penetrometer Tests

With a second stage of investigation aimed to refine the risk of lateral spread along the northern boundary adjacent to a stormwater drain. This comprised:

- 8 Test Pits with 15 Shear Vane tests
- 7 Cone Penetrometer Tests
- 6 Soil samples laboratory tested for Atterberg's limit test, Particle size distribution and Linear shrinkage.

3.2 Initia Investigations

Geotechnical investigations for the proposed residential subdivision development took place over the 9th and 10th December 2020.

A summary of the investigations completed by Initia is provided in Table 3-1 below. The locations of all investigation points were surveyed using a handheld GPS unit and are presented on Figure 1006-001 in Appendix A.

3.2.1 Cone Penetration Tests

13 No. CPT's were undertaken by Geotech Drilling. All tests refused (tip resistance, q_c > 20 MPa) within the top 6 m. The CPTs were undertaken using a truck mounted CPT rig. The logs are presented in Appendix B.

3.2.2 Machine Boreholes

3 no. boreholes were drilled by Geotech drilling, all to a depth of 10.95 m. The boreholes were undertaken using a sonic drill rig. In situ Standard Penetration Tests (SPTs) were undertaken at 1.5 m intervals within the boreholes.

All boreholes were supervised by a qualified geologist/geotechnical engineer and all soils and rock encountered were logged in accordance with the New Zealand Geotechnical Society (NZGS) guidelines and are presented in Appendix B.

Table 3-1 Summary of investigations

Investigation Reference	Investigation Type	Coordinates (NZTM)		Elevation (mRL)	Depth (mBGL)
		Easting (m)	Northing (m)		
BH1	Machine Borehole	1933750	5602694	11.0	10.95
BH2	Machine Borehole	1933623	5602724	9.0	10.95
BH3	Machine Borehole	1933699	5602701	10.0	10.95
CPT01	Cone Penetration Test	1933677.55	5602609.03	11.7	3.5
CPT02	Cone Penetration Test	1933696.53	5602630.46	11.2	4.5
CPT03	Cone Penetration Test	1933745.91	5602698.40	10.7	4.6
CPT04	Cone Penetration Test	1933720.03	5602716.21	10.2	4.6
CPT05	Cone Penetration Test	1933695.28	5602720.62	9.5	4.9
CPT06	Cone Penetration Test	1933665.54	5602728.58	9.0	4.5
CPT07	Cone Penetration Test	1933633.12	5602734.44	9.0	5.9
CPT08	Cone Penetration Test	1933622.10	5602718.23	9.0	4.9
CPT09	Cone Penetration Test	1933661.95	5602705.38	9.5	4.6
CPT10	Cone Penetration Test	1933710.57	5602676.60	10.5	4.0
CPT11	Cone Penetration Test	1933677.86	5602675.76	11.8	4.6
CPT12	Cone Penetration Test	1933638.63	5602683.03	10.2	5.0
CPT13	Cone Penetration Test	1933659.92	5602638.72	11.0	3.5

3.3 Ground model

The results of machine boreholes and the CPT's carried out indicate the site is underlain by the following of geological units:

- Concrete overlying uncontrolled fill
- Holocene river deposits
- Pleistocene alluvium

A summary of the unit depths, thickness and in-situ strength testing is provided in Table 3-2, and geological sections are provided in Appendix A

Most of the site was covered by either concrete slabs from the demolished buildings or asphalt for Oderings carpark. Beneath this was up to 0.7 m of fill that generally consisted of loose, moist, brownish grey silty sandy fine to coarse gravels, with some cobbles. BH2 also had 200mm layer of fill comprising dark grey, medium dense, moist silty sand.

As illustrated in Figure 2-1, a geological boundary runs through the north west of the site. This separates the Holocene river deposits found in BH2, and the Pleistocene alluvium encountered in BH1 & BH3.

Both areas of the site had a similar stratigraphy of 4-5 m of clayey silts overlying 4.5 – 6.5 m of silty gravels. The in situ strength parameters outlined in Table 3-2 show that the geotechnical parameters of the two different units, and across the site are relatively consistent. The clayey silts are characterised by SPT values of 3 – 8 and CPT cone resistances of 1 – 16 MPa. The underlying gravels typically had SPT values of 50^{+}, and the CPT rig was Unable to Penetrate (UTP) this layer anywhere on the site.

Although geotechnically similar, the geological descriptions varied between the two units:

Holocene river deposits – North west corner (BH2)

Beneath the fill is an approximately 5 m thick layer of greenish grey/grey stiff, high plasticity, moist, clayey silts with a small silty sand layer.

Underlying this is a blueish grey medium dense, moist, silty sandy fine to coarse gravel, with trace cobbles. The base of this unit was unproven.

Pleistocene Alluvium – Rest of the site (BH1 & BH3)

Underlying the fill here is an approximately 4 m thick layer of greyish brown, stiff, high plasticity, moist clayey silt. This is above a brown and grey, medium dense to very dense, moist, silty fine to coarse gravel, with some clay, and a trace of sand and cobbles;

Table 3-2 Summary of geological units

Unit	Typical Description	Depth to top of unit (m)	Typical Layer Thickness (m)	In Situ Test Strength Parameters	
				SPT- N Value [blows/ 300] Range [Typical]	q_c, Cone resistance [MPa] Range [Typical]
Fill	Silty sandy GRAVEL, with some cobbles; brownish grey. Loose; moist; gravel, fine to coarse; sand, fine to coarse.	0.0	0.2 - 0.7	N/A	0.5 – 47
Holocene river deposits	Clayey SILTs and silty SANDs; greenish grey/grey. Stiff; high plasticity; moist.	0.2	~5.0	5 - 8	1 – 9 [1.5]
	Silty sandy GRAVEL, with trace cobbles; blueish grey. Medium dense; moist; gravel, fine to coarse, subrounded to subangular.	5.5	6.5(proved)	26 -50$^+$ [50$^+$]	25 – UTP [UTP]
Pleistocene Alluvium (c. 6,500 to 3,000 year old)	Clayey SILT; greyish brown. Stiff; high plasticity; moist.	0.9	~4.0	3 – 8 [3]	1 – 16 [1]
	Silty GRAVEL, with some clay, with trace sand and cobbles; brown and grey. Medium dense to very dense; moist; gravel, fine to coarse.	4.0 – 4.5	4.5 - 5.0	18 -50$^+$ [50$^+$]	25 – UTP UTP
	Clayey SILT; greyish brown. Stiff to very stiff; high plasticity; moist.	8.5 – 10.5	2.5(proved)	9 - 14	N/A

3.4 Groundwater

Water levels measured on the CPT's carried out on the 9th and 10th of December 2020 were between 2.10 and 3.80 m bgl.

Water levels were measured in the boreholes that were carried out concurrently with the CPT's. Ground water in BH1 measured at 2.3 m bgl approximately 3 hours after drilling. BH2 and BH3 both measured 1.8 m bgl directly after drilling. This level was likely elevated due to water introduced during the drilling process.

For the purposes of geotechnical analyses we have assumed a groundwater level 2.5m bgl.

4. Geotechnical Considerations

4.1 General

Geotechnical design and construction advice for the proposed development is presented in the following sub-sections, including:

1- Site Seismicity;
2- Liquefaction potential and consequences;
3- Consolidation Settlement;
4- Foundation options;
5- Earthworks considerations;
6- Construction and monitoring considerations.

4.2 Seismic Considerations

4.2.1 Seismic Subsoil Class

Given the seismic risk in the Hawkes Bay, any structures including foundations will need to be designed to comply with the NZ Building Code with consideration of seismic loading and effects.

In accordance with NZS 1170.5:2004 and the depth to inferred rock level (greater than 40m below existing ground level), it is recommended that the site subsoil Class D (deep soil) be utilised for the structural design of the proposed buildings.

For the purpose of geotechnical analysis, a Peak Ground Acceleration (PGA) of 0.34g with an earthquake magnitude of 6.9 has been derived for an Ultimate Limit State (ULS) earthquake event using the MBIE Guidelines, Module 1, based on assumed building importance level IL2 and a 50 year design life. A PGA of 0.08 should be used for the Serviceability Limit State (SLS) earthquake event, with an earthquake magnitude of 6.2.

We have also assessed the sensitivity of our analyses to the peak ground accelerations outlined in the GNS study[3] which captures an update to the New Zealand National Probabilistic Seismic Hazard Model. The GNS study recommends the following peak ground acceleration and earthquake magnitude pairings:

- SLS (1 in 25 year return period) 0.14g, Magnitude 6.2
- ULS (1 in 500 year return period, for IL2) 0.42, Magnitude 6.5

4.2.2 Liquefaction Potential and Effects on the development

The upper 4.0 to 6.5 m comprises stiff to hard cohesive material and is not considered susceptible to liquefaction.

Material beneath this, to depths of +8.5m comprises silty, sandy gravel and is considered susceptible to liquefaction.

Liquefaction triggering analyses have been carried out on material considered susceptible using the CLiq geotechnical analysis programme and in accordance with the Boulanger and Idriss (2014) method[4] with the SLS and ULS earthquake event parameters defined above using both CPT and SPT based methods.

[3] GNS (2015/186): Assessment of liquefaction risk in Hawke's Bay Volume : The liquefaction hazard model.
[4] Boulanger R.W., and Idriss I.M., 2014: CPT and SPT based Liquefaction Triggering Procedures. Centre for Geotechnical Modelling, Department of Civil & Environmental Engineering, College of Engineering, University of California at Davis.

The analyses indicate the following:

- under SLS levels of shaking, liquefaction is unlikely to be triggered;
- under ULS levels of shaking, layers within the profile are likely to liquefy. We note however, the layers are generally between 0.1 m and 0.5 m thick and generally non-continuous.

The Liquefaction Severity Number (LSN) index provides an indication of the likely effects of liquefaction at the ground surface and accordingly foundations.

LSN values range between 1 and 9 (on average 4) under ULS levels of shaking which suggests there will be little to no expression of liquefaction.

Our analyses indicate that liquefaction triggers at about 0.2 g (above SLS levels of shaking), and full liquefaction over the depths investigated is likely to be triggered at about 0.25 g as shown on Figure 4-1 below. This equivalent to about a 1 in 250 year event.

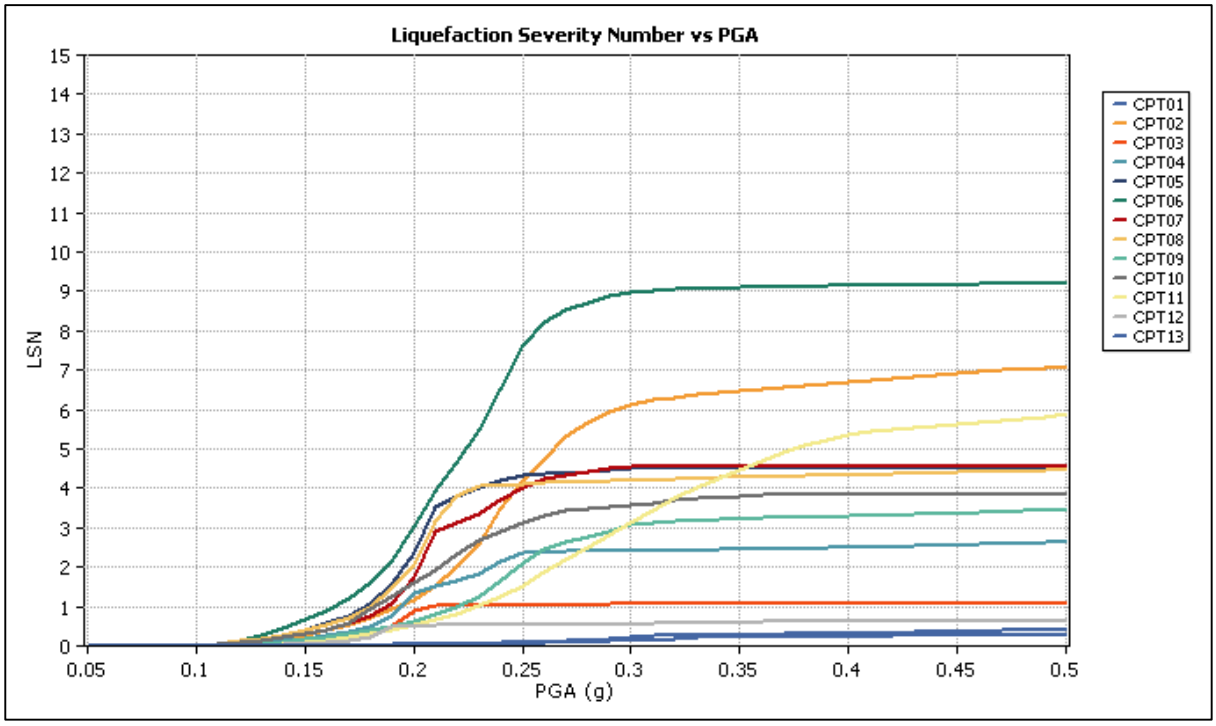

Figure 4-1: Sensitivity of LSN to PGA

The key consequences of liquefaction on the proposed development are:

- Vertical reconsolidation settlement; and
- Lateral spreading because of the presence of the drainage channel on the eastern and northern boundaries.

Reconsolidation Settlement

Under SLS levels of shaking, liquefaction induced free field settlement is expected to be less than 5mm.

Under ULS levels of shaking liquefaction induced free field settlement is expected to be less than 30 mm.

Lateral Spreading

Lateral spreading is generally defined as horizontal displacement of blocks of material towards an open slope face (e.g. stream banks) as a result of liquefaction on the underlying soils. The presence of a continuous liquefiable layer of reasonable thickness is required for significant spreading to occur.

Given the low liquefaction potential of the site subsoils over the depths investigated, the risk of lateral spreading is considered to minor.

While analyses indicate the risk of liquefaction and accordingly its effects are low, the foundations outlined in Section 4.4 are recommended to prevent structures from pulling apart during earthquake shaking. No ground improvements are considered necessary.

4.3 Consolidation Settlement

Due to the flat topography of the site, we do not expect a requirement for any major cut/fill works to be carried out. Given the stiff upper soils and relatively shallow very dense gravel bed across the site, we expect any consolidation settlement that may occur to be negligible (i.e. < 25 mm).

Should any fill material exceeding 0.5 m thickness need to be placed as part of the construction works, further analysis will need to be undertaken to reassess any consolidation settlement.

4.4 Foundation Considerations

To accommodate the anticipated levels of deformation outlined in Sections 4.2 and 4.3, raft type foundations are recommended for the proposed residential dwellings. The raft foundations can be constructed directly on the existing ground once the concrete slabs and any uncontrolled fill has been removed.

The following bearing pressures are considered suitable for use in preliminary design:

- Geotechnical Ultimate Capacity – 300 kPa;
- Ultimate Limit State – 150 kPa;
- Allowable bearing pressure – 100 kPa.

The values above are for the ‘ribs’ of the foundation.

During construction verification testing will need to be undertaken to confirm the in situ strengths are consistent with those assumed in design.

4.5 Services

Deformation from settlement and lateral spreading as a result of liquefaction under seismic loading is expected to be low, if any at all, however it is recommended that flexible materials and connections be used to allow efficient repair if damage was to occur.

4.6 Earthworks Considerations

Prior to construction the existing concrete slabs that cover a majority of the site will need to be demolished and removed. Site should be cleared of vegetation, and any surface topsoil or uncontrolled fill present stripped to natural ground. Should any deeper pockets of organic soils, uncontrolled fill or soft soils (undrained Shear Strength Su <80 kPa) be encountered below this, these soils must be removed/undercut and replaced with engineered fill.

5. Further Work

The following further work is recommended during design and construction of the proposed development.

Detailed Design

- Following removal of the remaining buildings and floor slabs, further investigation comprising test pits and laboratory testing to further characterise the site subsoils, especially fill depths across the site;
- Monitoring of groundwater levels;
- Assessment of suitable deformations for site services;
- Development of an earthworks specification.

Construction

- Observation of the site subgrade following removal of topsoil;
- Compaction testing and review of results;
- Settlement monitoring; and
- Observations of ground improvement work that may be required.

The observations will be required to certify the site suitable for construction of foundations.

6. Conclusions and Recommendations

On the basis of the subsurface information our conclusions and recommendations regarding the proposed development are as follows:

1. The site subsoils comprise clayey silts underlain by silty sandy gravels;
2. Based on the ground conditions encountered the key geotechnical hazards are liquefaction and consolidation settlement;
3. Liquefaction is not expected under Serviceability Limit State levels of shaking, however under Ultimate Limit State levels, non-continuous layers within the subsoil profile may liquefy;
4. The upper clayey silts are cohesive and considered not susceptible to liquefaction, and the underlying gravels are very dense, so liquefaction potential is low;
5. Consolidation settlements from the likely building loads are expected to be low (i.e. < 25 mm);
6. Engineered raft type foundations are recommended for the residential dwellings. Raft foundations can be constructed directly on the existing ground once the concrete slabs and any uncontrolled fill has been removed;
7. Flexible services and service connections are recommended.

7. Applicability

This report has been prepared for our client, Development Nous, with respect to the brief provided to us. The advice and recommendations presented in this report should not be applied to any other project or used in any other context without prior written approval from Initia Limited.

The liquefaction analyses outlined in this report are based on empirical methods derived from databased of various earthquakes. Earthquakes are unique and impose variable levels of shaking on different sites. Accordingly, it is important to understand that the actual performance may vary from that calculated.

During detailed design a review of the geotechnical aspects of the civil and structural design to ensure the considerations in this report have been adequately addressed.

During excavation and construction observations should be undertaken by a suitably qualified geotechnical engineer to confirm the exposed subsoils are compatible with the conditions on which this report has been based.

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Document control record

Report Title		Brookvale Residential Geotechnical Assessment Report			
Initia Project Reference		P-001006			
Client		Development Nous			
Revision	Date	Revision detail	Author	Reviewer	Approved by
-	02-02-21	First Issue	A. Klahn	N. Hickman	A. Pomfret
Current Revision		A			

Appendix A Figures

NOTES
1. ALL DIMENSIONS ARE IN METRES UNLESS NOTED OTHERWISE.
2. COORDINATE DATUM: HAWKES BAY 2000
3. AERIAL IMAGE, CONTOURS AND PROPERTY BOUNDARY TAKEN FROM LINZ DATA.

SCALE A1 1:500
SCALE A3 1:1000
0 5 10 15 20 25 30 35 40 45 50m

FOR INFORMATION

Rev	Revision Description	Designed	Drawn	Checked
A	FIRST ISSUE (13/01/2021)	AK	GG	AK

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DEVELOPMENT NOUS

ODERINGS GARDEN CENTRE, BROOKVALE RD, HAVELOCK

GEOTECHNICAL INVESTIGATION
LOCATION PLAN

Initia Project ref: P001006
Figure Number 1006-001
Revision A

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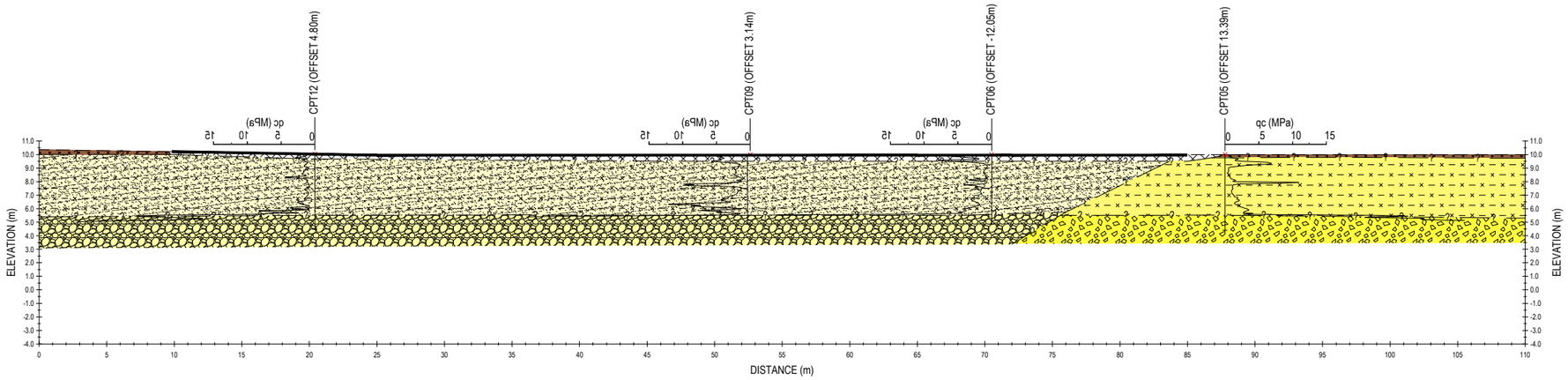
LEGEND

- EXISTING GROUND LEVEL
- INFERRED GEOLOGICAL UNIT BOUNDARY
- CONCRETE SLAB
- TOPSOIL
- FILL
- HOLCENE STIFF CLAYEY SILTS AND SILTY SANDS
- HOLCENE MEDIUM DENSE TO VERY DENSE GRAVELS
- PLEISTOCENE STIFF CLAYEY SILTS
- PLEISTOCENE MEDIUM DENSE TO VERY DENSE GRAVELS
- PLEISTOCENE VERY STIFF SILTS AND MEDIUM DENSE SANDS



1/001 SECTION 1
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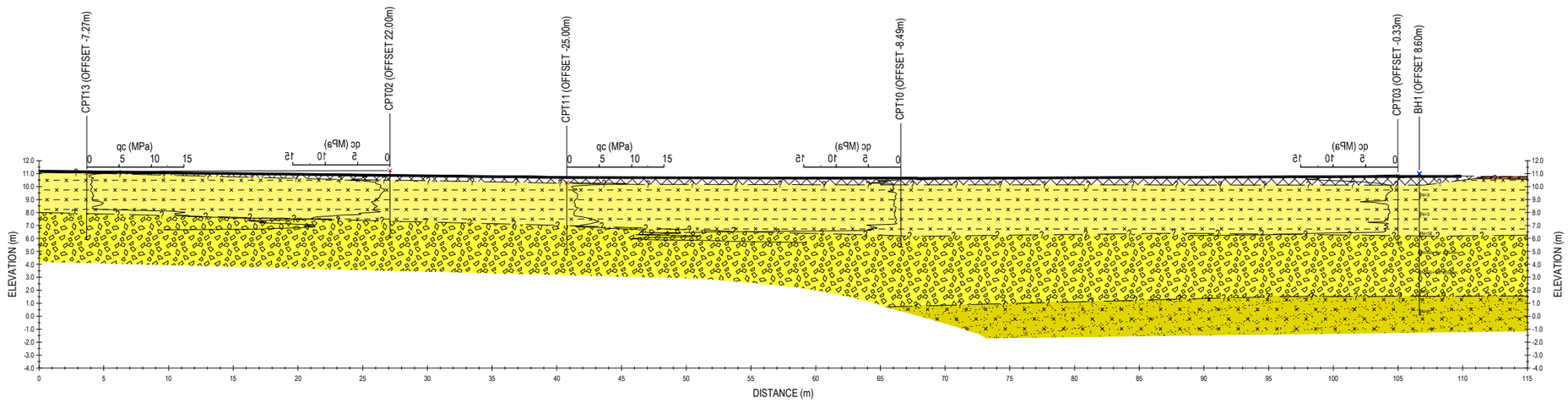

2/001 SECTION 2
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SCALE A1 1:200
SCALE A3 1:400
0 2 4 6 8 10 12 14 16 18 20m

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Rev	Revision Description	Designed	Drawn	Checked
A	FIRST ISSUE (14/01/2021)	AK	GG	AK

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ODERINGS GARDEN CENTRE, BROOKVALE RD, HAVELOCK

GEOTECHNICAL INVESTIGATION
GEOLOGICAL SECTION 1 & 2

Initia Project ref: P001006
Figure Number 1006-002
Revision A

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Appendix B Investigation Logs

BOREHOLE LOG

INITIA
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HOLE NO.: BH1

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North

Project Ref.: P-001006

CO-ORDINATES: 1933750.0mE, 5602694.0mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 11m
Datum: NAPIHT1962
Level method: GIS
CONTRACTOR: Geotech Driiling
RIG: Sonic Rig
DRILLER: Drew/Luke

START DATE: 09/12/2020
END DATE: 09/12/2020
LOGGED BY: APK
CHECKED BY: MDH

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Fill	Silty sandy GRAVEL, with some cobbles; brownish grey. Loose; moist; gravel, fine to coarse; sand, fine to coarse.	PQTT	100%									
Topsoil	SILT; dark brown. Very stiff; non-plastic; moist.											
	Silty sandy GRAVEL; greyish brown. Loose; moist; sand, fine to coarse.											
	Sandy SILT, with some clay; light brownish grey. Stiff; low plasticity; moist; sand, fine.			1.0	10.0			C 1.10 - 1.30m, 3				
		SPT	100%				0, 0 / 1, 1, 0, 1 N=3					
Holocene Alluvium/Beach Deposits	Clayey SILT, with trace gravel; greyish brown. Stiff; low plasticity; moist; gravel, fine, rounded.	PQTT	100%	2.0	9.0							
	SILT, with minor clay and sand; mottled green/brown. Stiff; low plasticity; moist; sand, fine.							C 2.40 - 2.60m, 1		09/12/2020		
	Clayey SILT, with trace sand and gravel; light brown. Stiff; low plasticity; moist; gravel, fine.			3.0	8.0							
		SPT	100%				1, 1 / 0, 1, 0, 2 N=3					
		PQTT	100%					C 3.60 - 3.80m, 2				
	Silty GRAVEL, with some clay and sand, with trace cobbles; brown. Medium dense; moist; gravel, fine to coarse, subangular to subround.			4.0	7.0							
		SPT	100%				3, 6 / 0, 3, 4, 11 N=18					
		PQTT	100%	5.0	6.0							
	6.00m: Grades to very dense	SPT	100%	6.0	5.0		6, 15 / 13, 20, 17 N=50+ for 225mm				Bentonite	
		PQTT	100%	7.0	4.0							
		SPT	100%				15, 16 / 18, 17, 15 for 55mm N=50+ for 205mm					
		PQTT	100%	8.0	3.0							
	SILT, with some clay; light brown. Stiff; low plasticity; moist.											
	SILT, with minor clay; grey. Stiff; low plasticity; moist.	SPT	100%	9.0			0, 0 / 0, 3, 3, 3 N=9					
	Clayey SILT; greyish brown. Stiff; high plasticity; moist.	PQTT	100%									

Box 1, 0.0-2.3m
Box 2, 2.3-5.0m
Box 3, 5.0-8.0m
Box 4, 8.0-11.0m

REMARKS

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BOREHOLE LOG

INITIA
GEOTECHNICAL SPECIALISTS

HOLE NO.: BH1

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North

Project Ref.: P-001006

CO-ORDINATES: 1933750.0mE, 5602694.0mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 11m
Datum: NAPIHT1962
Level method: GIS
CONTRACTOR: Geotech Driiling
RIG: Sonic Rig
DRILLER: Drew/Luke

START DATE: 09/12/2020
END DATE: 09/12/2020
LOGGED BY: APK
CHECKED BY: MDH

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Holocene Alluvium/Beach Deposits	[CONT] Clayey SILT; greyish brown. Stiff; high plasticity; moist.	PQTT	100%	11.0	0.0						Bentonite	Box 4, 8.0-11.0m
		SPT	100%				1, 2 / 1, 3, 2, 3 N=9				10.95m	
	EOH: 10.95m			12.0	-1.0							
				13.0	-2.0							
				14.0	-3.0							
				15.0	-4.0							
				16.0	-5.0							
				17.0	-6.0							
				18.0	-7.0							
				19.0	-8.0							

REMARKS

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CORE PHOTOS

HOLE No.: BH1
JOB No.: P-001006

Box 1, 0.0-2.3m

Box 2, 2.3-5.0m

Box 3, 5.0-8.0m

CORE PHOTOS

HOLE No.: BH1

JOB No.: P-001006

Box 4, 8.0-11.0m

BOREHOLE LOG

HOLE NO.: BH2

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North
Project Ref.: P-001006

CO-ORDINATES: 1933623.0mE, 5602724.0mN
ELEVATION: 9m
CONTRACTOR: Geotech Driiling
START DATE: 09/12/2020

Co-ordinate system: NZTM
Datum: NAPIHT1962
RIG: Sonic Rig
END DATE: 09/12/2020

Location method: GPSH
Level method: GIS
DRILLER: Drew/Luke
LOGGED BY: APK
CHECKED BY: MDH

INITIA
GEOTECHNICAL SPECIALISTS

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Fill	Silty SAND; dark grey. Medium dense; moist; sand, fine to medium.	PQTT	100%	0.0	9.0							
	SILT, with trace clay; dark brown grading to greyish brown. Stiff; moist. 0.30m - 0.35m: Silty PEAT (FIBROUS). 1.10m - 1.15m: Clayey silty GRAVEL. Medium dense; moist.											
	Clayey SILT; mottled grey/brownish grey. Stiff; low plasticity; moist.			1.0	8.0							
	Clayey SILT; greenish grey. Very stiff; high plasticity; moist.											
	Silty SAND, with trace shells and gravel; light grey. Loose; dilatant; wet; sand, fine; gravel, medium.	SPT	100%	2.0	7.0		2, 2 / 2, 2, 2, 2 N=8	C 1.95 - 2.15m, 5		▼ 09/12/2020		
	2.15m - 2.20m: 50 mm wood fragment	PQTT	100%									Box 1, 0.0-2.4m
	Clayey SILT, with some wood; brown. Stiff; low plasticity; moist.											
	Clayey SILT; greenish grey. Stiff; high plasticity; moist.			3.0	6.0							
		SPT	100%				0, 1 / 1, 1, 1, 2 N=5					
	Clayey gravelly SILT, with minor shells; greenish grey. Very stiff; low plasticity; moist.	PQTT	100%	4.0	5.0			C 3.80 - 4.00m, 4				
	Shelly silty sandy GRAVEL, with minor clay; light greenish grey. Dense; moist; gravel, fine to coarse.	SPT	100%				5, 8 / 5, 8, 8, 10 N=31					
		PQTT	100%	5.0	4.0						Bentonite	Box 2, 2.4-5.2m
	Silty sandy GRAVEL, with trace cobbles; blueish grey. Medium dense; moist; gravel, fine to coarse, subround to subangular.	SPT	100%	6.0	3.0		5, 6 / 7, 7, 5, 7 N=26					
Holocene Alluvium/Beach Deposits		PQTT	100%	7.0	2.0							
	7.50m: Grades to very dense	SPT	100%				16, 20 / 18, 18, 14 for 60mm N=50+ for 210mm					
		PQTT	100%	8.0	1.0							Box 3, 5.2-8.4m
		SPT	100%	9.0	0.0		24, 26 for 70mm N=50+					
		PQTT	100%									Box 4, 8.4-11.0m

REMARKS

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BOREHOLE LOG

INITIA
GEOTECHNICAL SPECIALISTS

HOLE NO.: BH2

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North

Project Ref.: P-001006

CO-ORDINATES: 1933623.0mE, 5602724.0mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 9m
Datum: NAPIHT1962
Level method: GIS
CONTRACTOR: Geotech Driiling
RIG: Sonic Rig
DRILLER: Drew/Luke

START DATE: 09/12/2020
END DATE: 09/12/2020
LOGGED BY: APK
CHECKED BY: MDH

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Holocene Alluvium/Beach Deposits	[CONT] Silty sandy GRAVEL, with trace cobbles; blueish grey. Medium dense; moist; gravel, fine to coarse, subround to subangular.	PQTT	100%								Bentonite 10.95m	Box 4, 8.4-11.0m
		SPT	100%				8, 17 / 17, 15, 14, 4 for 20mm N=50+ for 245mm					
	EOH: 10.95m			11.0	-2.0							
				12.0	-3.0							
				13.0	-4.0							
				14.0	-5.0							
				15.0	-6.0							
				16.0	-7.0							
				17.0	-8.0							
				18.0	-9.0							
				19.0	-10.0							

REMARKS

Initia Ltd.
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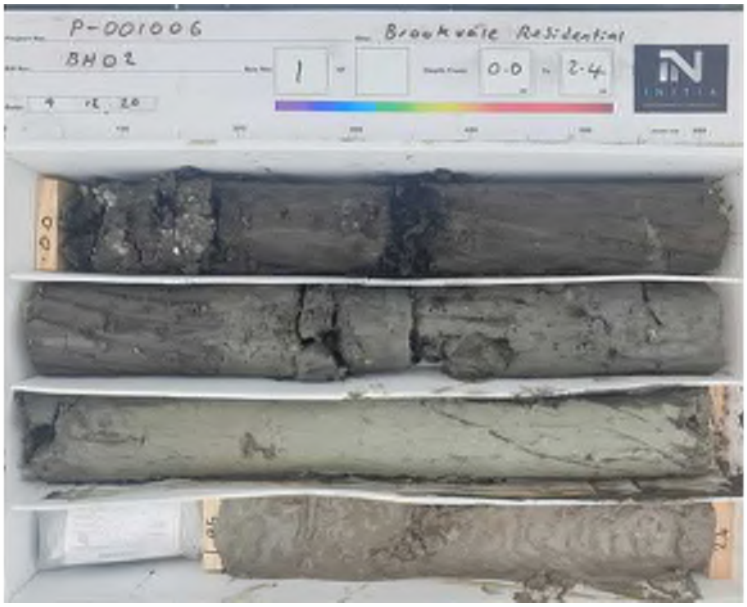
CORE PHOTOS

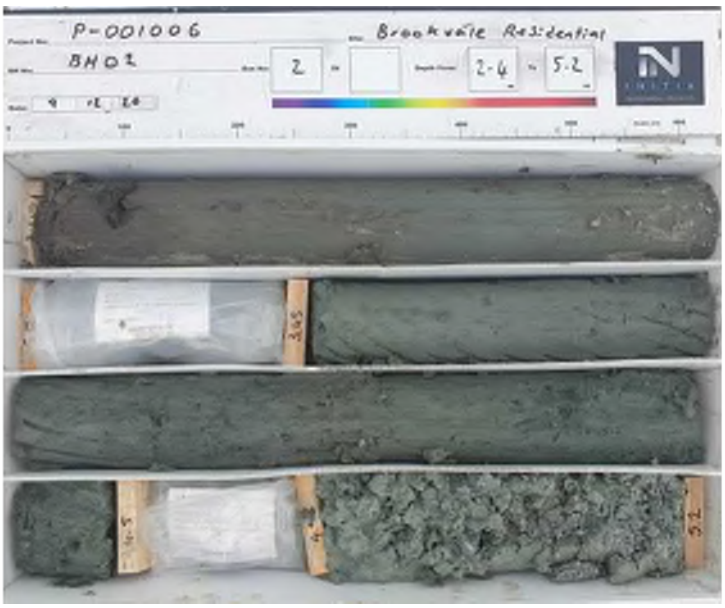
HOLE No.: BH2

JOB No.: P-001006

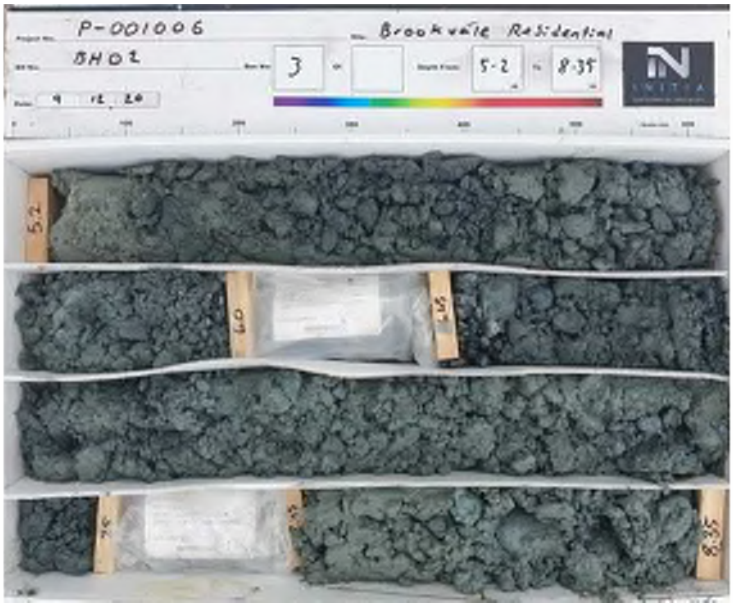
Box 1, 0.0-2.4m



Box 2, 2.4-5.2m



Box 3, 5.2-8.4m

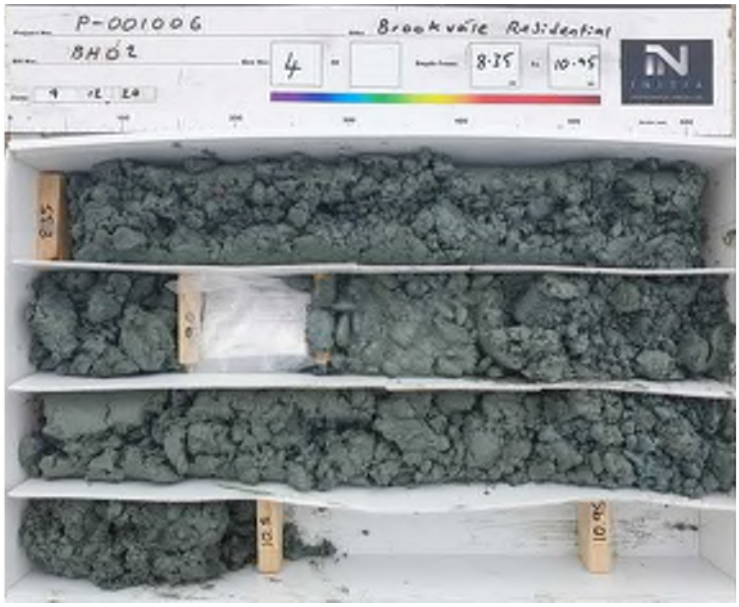


CORE PHOTOS

HOLE No.: BH2

JOB No.: P-001006

Box 4, 8.4-11.0m



BOREHOLE LOG

INITIA
GEOTECHNICAL SPECIALISTS

HOLE NO.: BH3

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North
Project Ref.: P-001006

CO-ORDINATES: 1933699.0mE, 5602701.0mN
Co-ordinate system: NZTM
Location method: GPSH
ELEVATION: 10m
Datum: NAPIHT1962
Level method: GIS
CONTRACTOR: Geotech Driiling
RIG: Sonic Rig
DRILLER: Drew/Luke
START DATE: 10/12/2020
END DATE: 10/12/2020
LOGGED BY: APK
CHECKED BY: MDH

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Fill	Silty GRAVEL, with some sand, with trace cobbles; grey and brown. Loose; moist; gravel, fine to coarse, subangular to subround.	PQTT	50%	0.0	10.0							
Fill	Gravelly SILT, with some sand; dark brown. Stiff; moist; gravel, fine to coarse.	PQTT	50%	0.0	10.0							
Fill	Core loss: 0.75 - 1.50 m	PQTT	50%	0.0	10.0							
Holocene Alluvium/Beach Deposits	Clayey SILT; greyish brown. Stiff; high plasticity; moist.	SPT	100%	1.0	9.0		0, 0 / 1, 1, 3, 3 N=8					
Holocene Alluvium/Beach Deposits	Silty GRAVEL, with some sand, with trace cobbles; greyish brown. Loose; moist; gravel, fine to coarse.	PQTT	100%	1.5	8.5							
Holocene Alluvium/Beach Deposits	Clayey SILT; greyish brown. Stiff; high plasticity; moist.	PQTT	100%	2.0	8.0					10/12/2020		
Holocene Alluvium/Beach Deposits		SPT	100%	3.0	7.0		1, 1 / 0, 1, 1, 1 N=3					Box 1, 0.0-3.5m
Holocene Alluvium/Beach Deposits	Clayey SILT, with trace sand; grey. Stiff; high plasticity; moist; sand, fine to medium.	PQTT	100%	3.5	6.5							
Holocene Alluvium/Beach Deposits	Clayey SILT, with some gravel, with trace sand; greyish brown. Stiff; high plasticity; moist; gravel, fine to medium.	PQTT	100%	4.0	6.0							
Holocene Alluvium/Beach Deposits	Silty GRAVEL, with some clay, with trace sand and cobbles; brown and grey. Dense; moist; gravel, fine to coarse.	SPT	100%	4.5	5.5		1, 7 / 10, 12, 10, 12 N=44					
Holocene Alluvium/Beach Deposits		PQTT	100%	5.0	5.0							
Holocene Alluvium/Beach Deposits		SPT	100%	6.0	4.0		8, 11 / 11, 10, 10, 15 N=46					Box 2, 3.5-5.9m
Holocene Alluvium/Beach Deposits		PQTT	100%	6.5	3.5							
Holocene Alluvium/Beach Deposits	7.50m: Grades to very dense	SPT	100%	7.0	3.0		8, 12 / 18, 15, 17 for 55mm N=50+ for 205mm					
Holocene Alluvium/Beach Deposits		PQTT	100%	7.5	2.5							
Holocene Alluvium/Beach Deposits		SPT	100%	8.0	2.0		9, 12 / 13, 11, 12, 14 N=50+					Box 3, 5.9-8.7m
Holocene Alluvium/Beach Deposits	SAND; brown. Medium dense; moist; sand, fine to medium.	PQTT	100%	8.5	1.5							
Holocene Alluvium/Beach Deposits				9.0	1.0							Box 4, 8.7-11.0m

Bentonite

REMARKS

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BOREHOLE LOG

HOLE NO.: BH3

CLIENT: Development Nous
PROJECT: Brookvale Residential
SITE LOCATION: 55 Brookvale Road, Havelock North
Project Ref.: P-001006

CO-ORDINATES: 1933699.0mE, 5602701.0mN
ELEVATION: 10m
CONTRACTOR: Geotech Driiling
START DATE: 10/12/2020

Co-ordinate system: NZTM
Datum: NAPIHT1962
RIG: Sonic Rig
END DATE: 10/12/2020

Location method: GPSH
Level method: GIS
DRILLER: Drew/Luke
LOGGED BY: APK
CHECKED BY: MDH

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	METHOD	TCR (%)	DEPTH	RL	GRAPHIC	INSITU TESTING (SPT 'N' / Vane shear strength)	SAMPLES	RQD (%)	WATER	INSTALLATION	CORE BOXES
Holocene Alluvium/Beach Deposits	[CONT] SAND; brown. Medium dense; moist; sand, fine to medium.	PQTT	100%									
	Clayey SILT; mottled dark brown/grey. Very stiff; high plasticity; moist.	SPT	100%				2, 2 / 2, 3, 4, 5 N=14				Bentonite 10.95m	Box 4, 8.7-11.0m
	EOH: 10.95m			11.0	-1.0							
				12.0	-2.0							
				13.0	-3.0							
				14.0	-4.0							
				15.0	-5.0							
				16.0	-6.0							
				17.0	-7.0							
				18.0	-8.0							
				19.0	-9.0							

REMARKS

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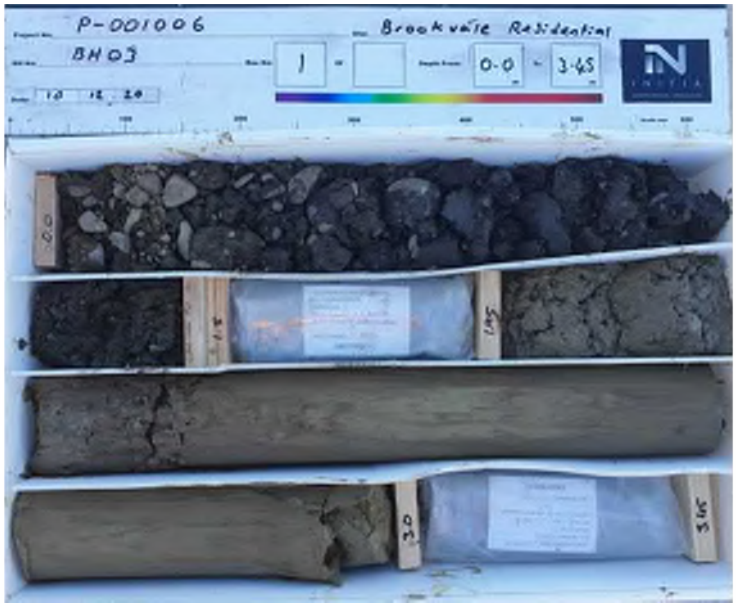
CORE PHOTOS

HOLE No.: BH3
JOB No.: P-001006

Box 1, 0.0-3.5m



Box 2, 3.5-5.9m

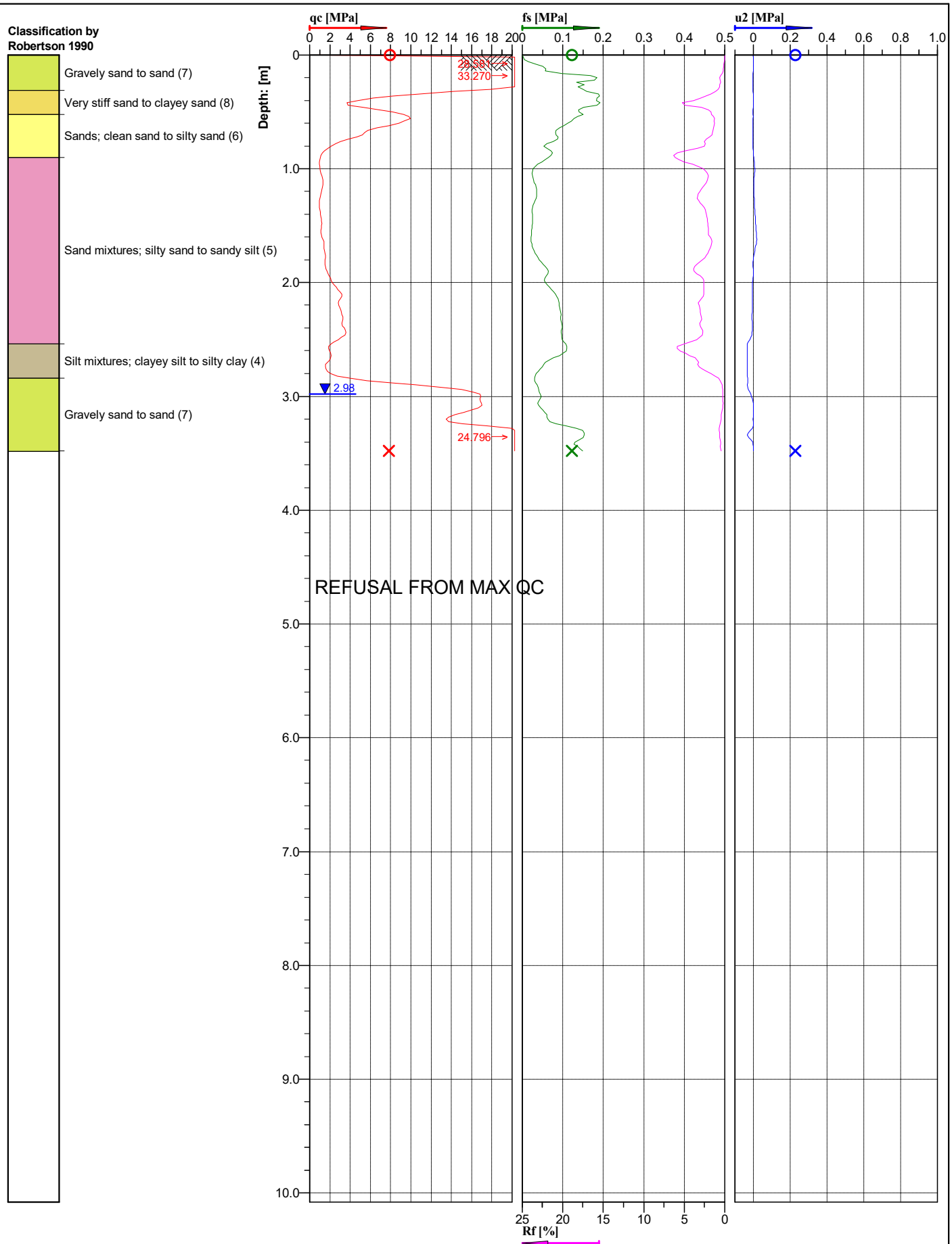
Box 3, 5.9-8.7m

CORE PHOTOS

HOLE No.: BH3

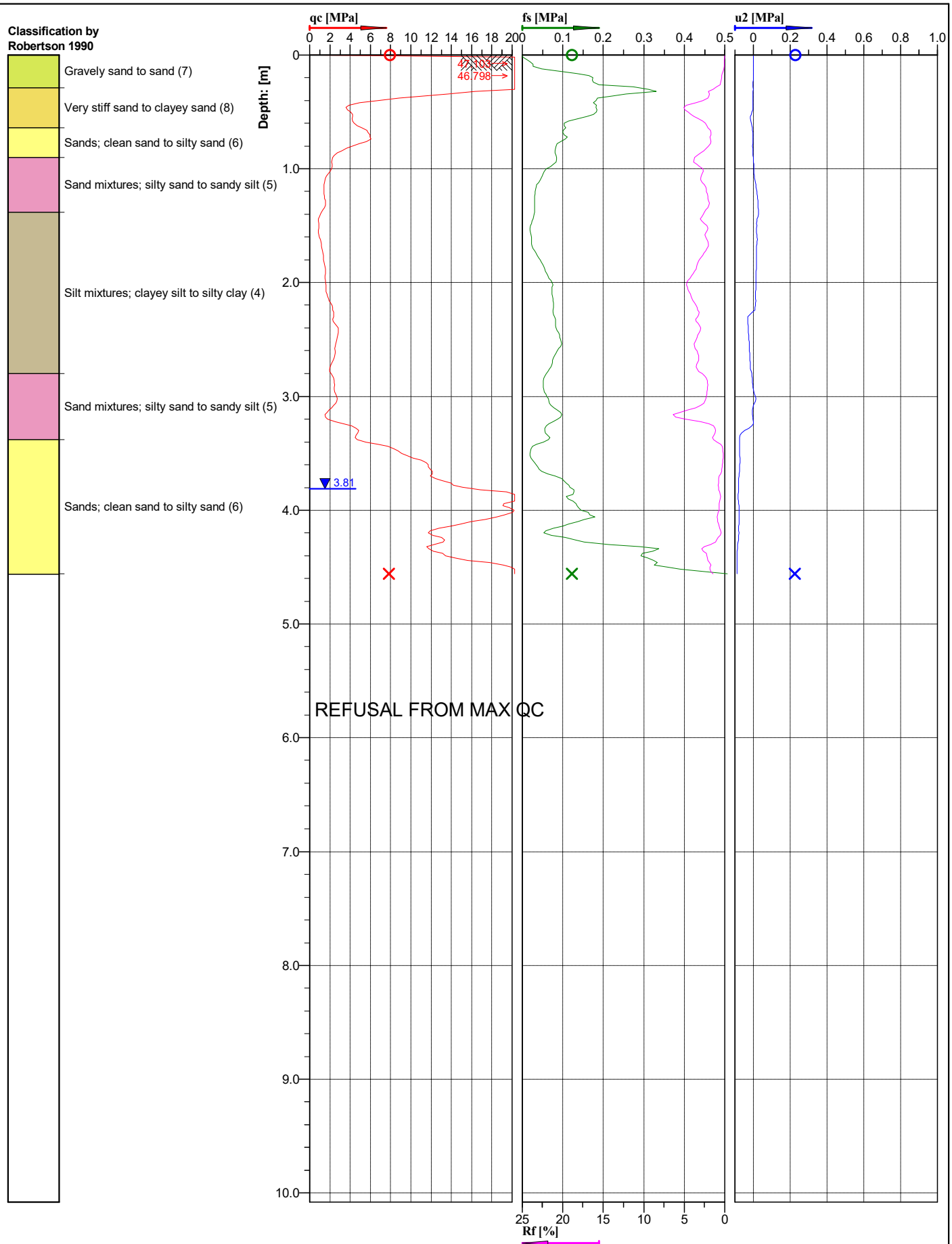
JOB No.: P-001006

Box 4, 8.7-11.0m



Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

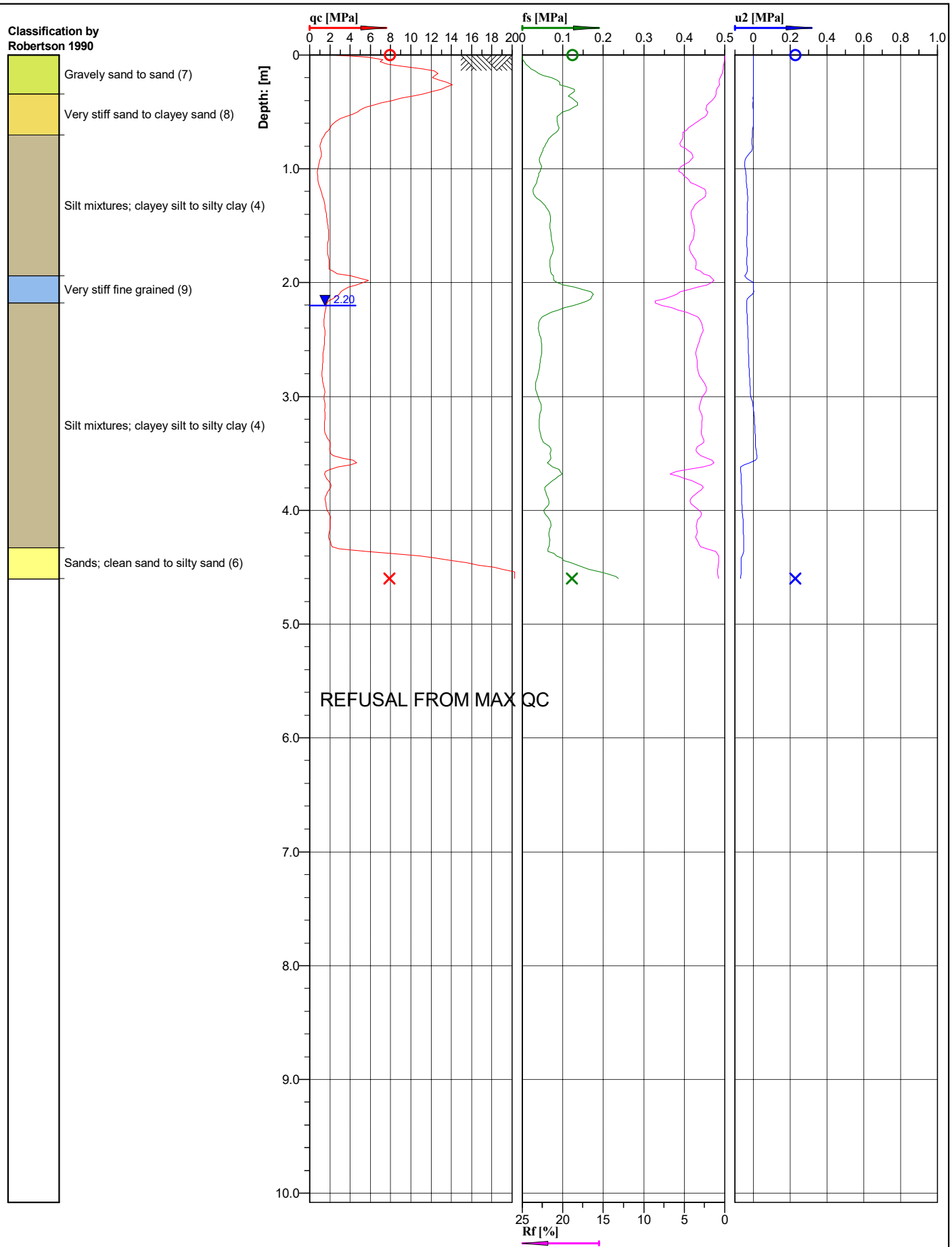
Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT01
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66121, E 176.88936		File: CPT01.cpt	



GEOTECH DRILLING

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT02
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66101, E 176.88957		File: CPT02.cpt	

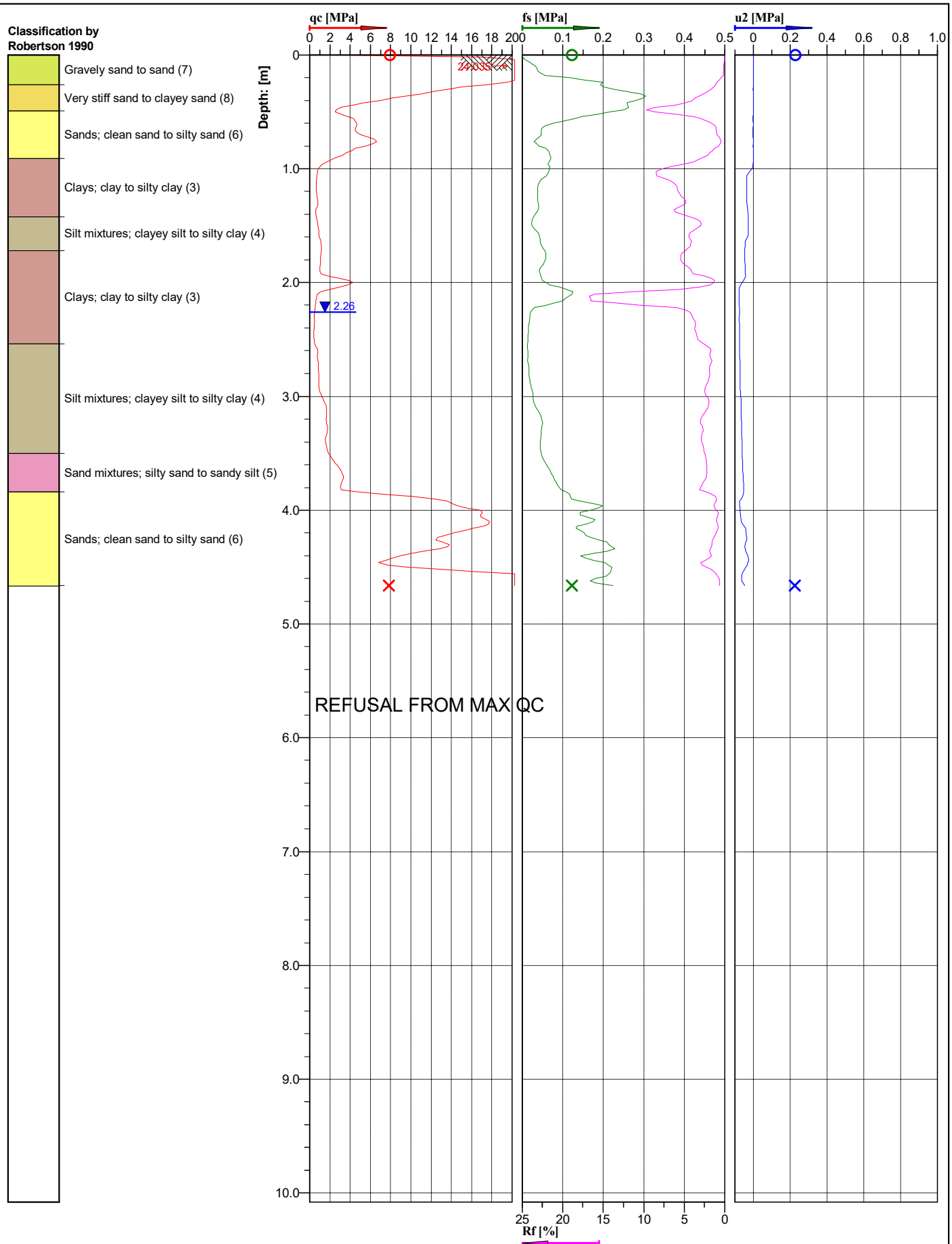


Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT03
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66038, E 176.89011		File: CPT03.cpt	

GEOTECH DRILLING

u2

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

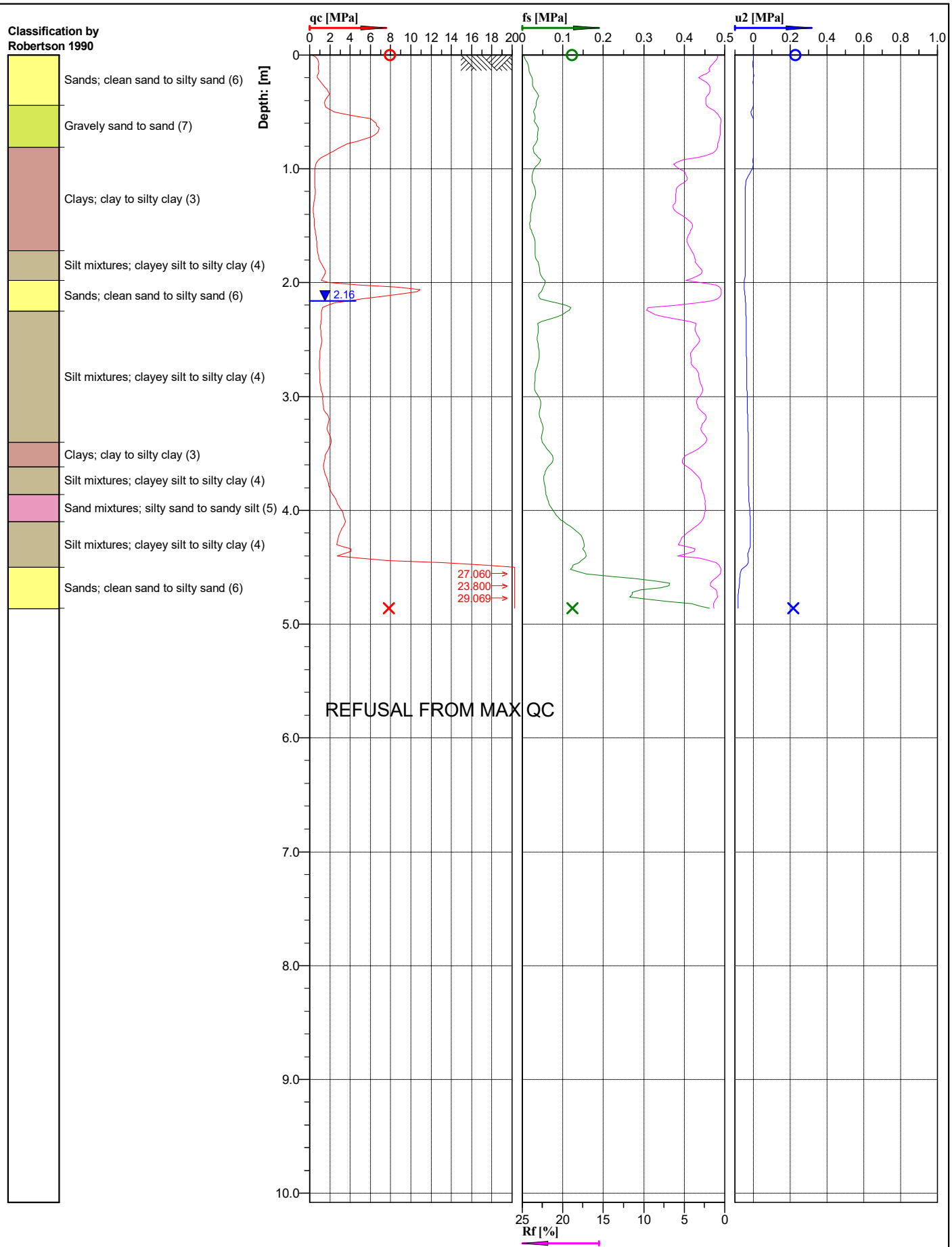


Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT04
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66023, E 176.88980		File: CPT04.cpt	

GEOTECH DRILLING

u2

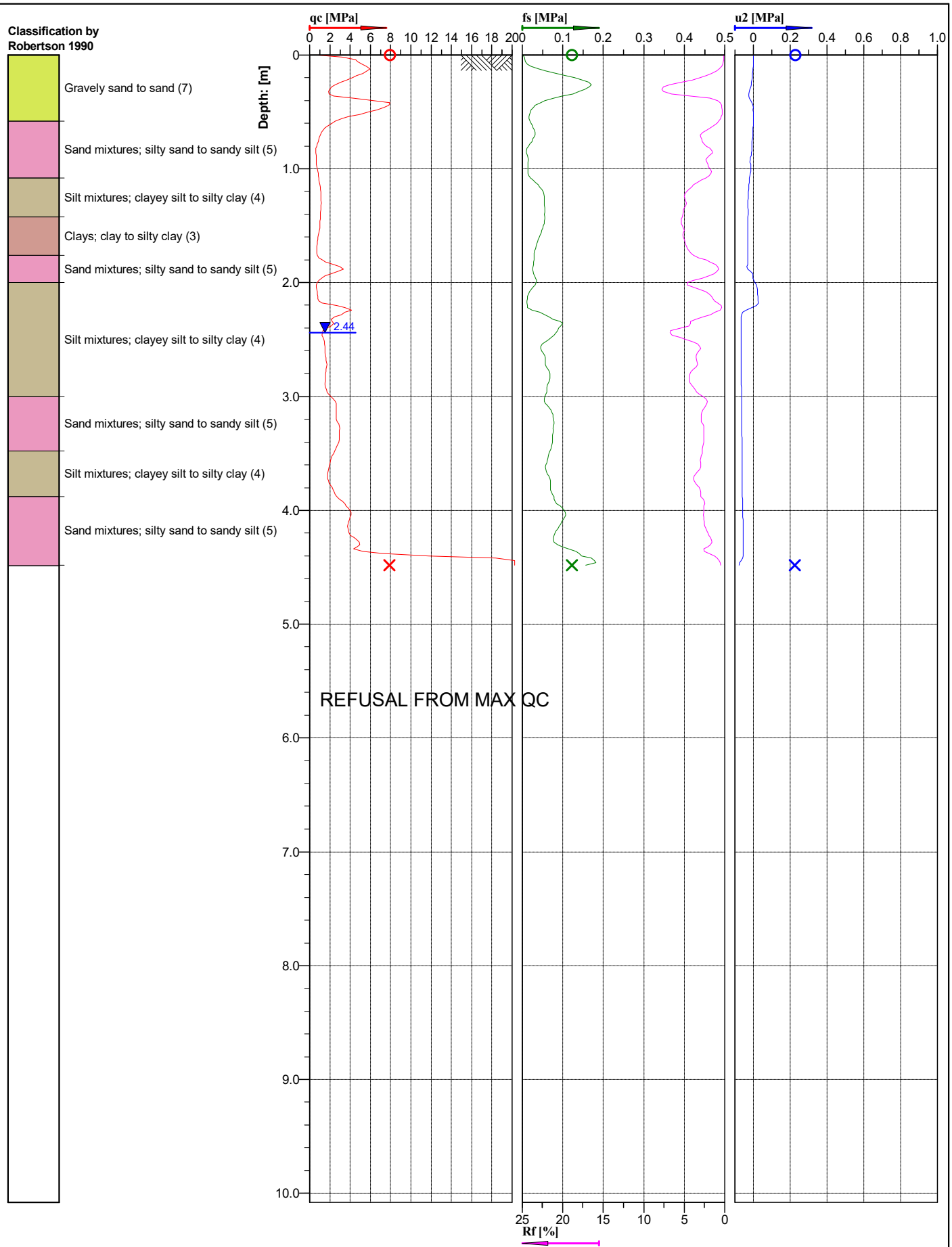
Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150



GEOTECH DRILLING

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66020, E 176.88951		File: CPT05.cpt	

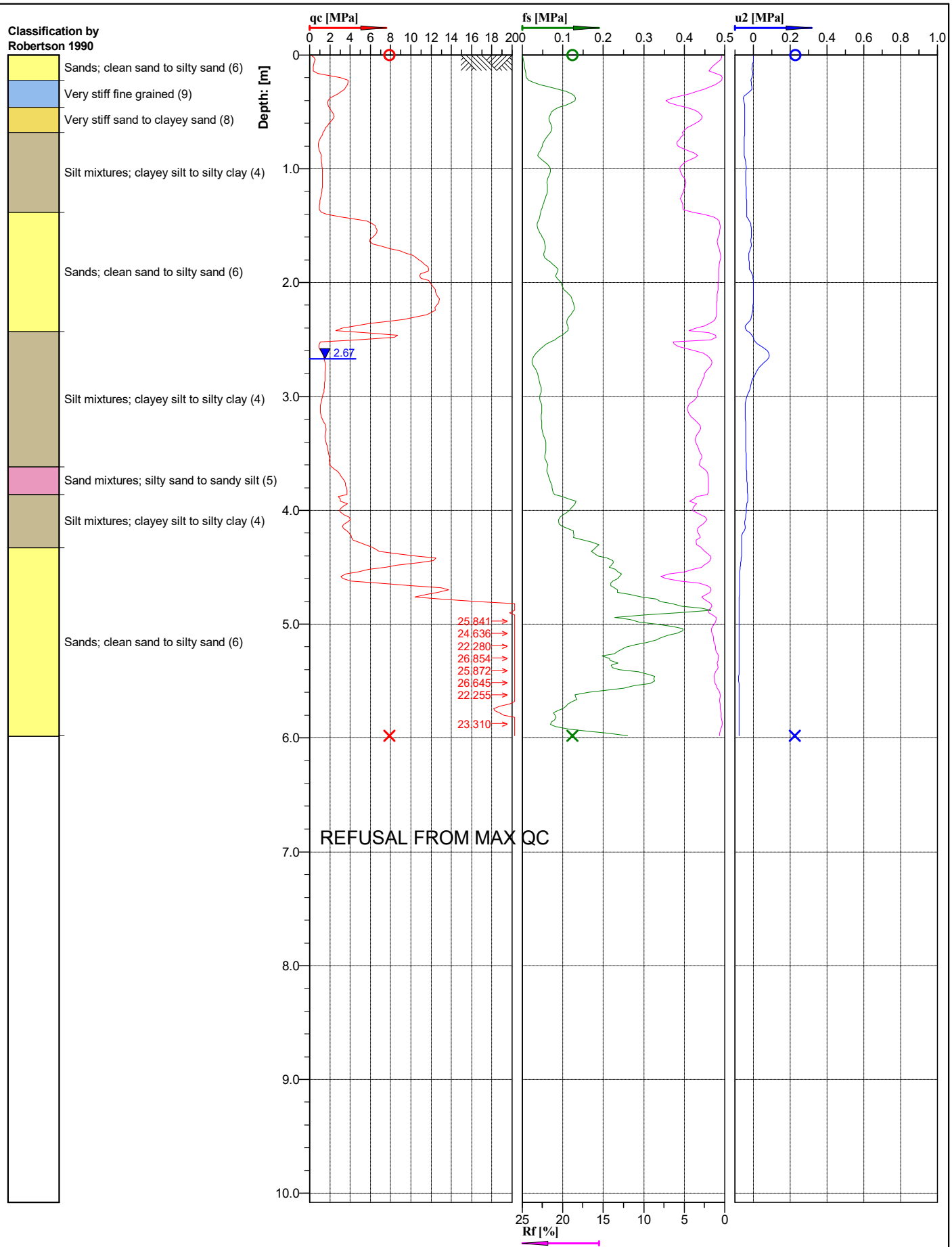


GEOTECH DRILLING

u2

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66014, E 176.88916		File: CPT06.cpt	

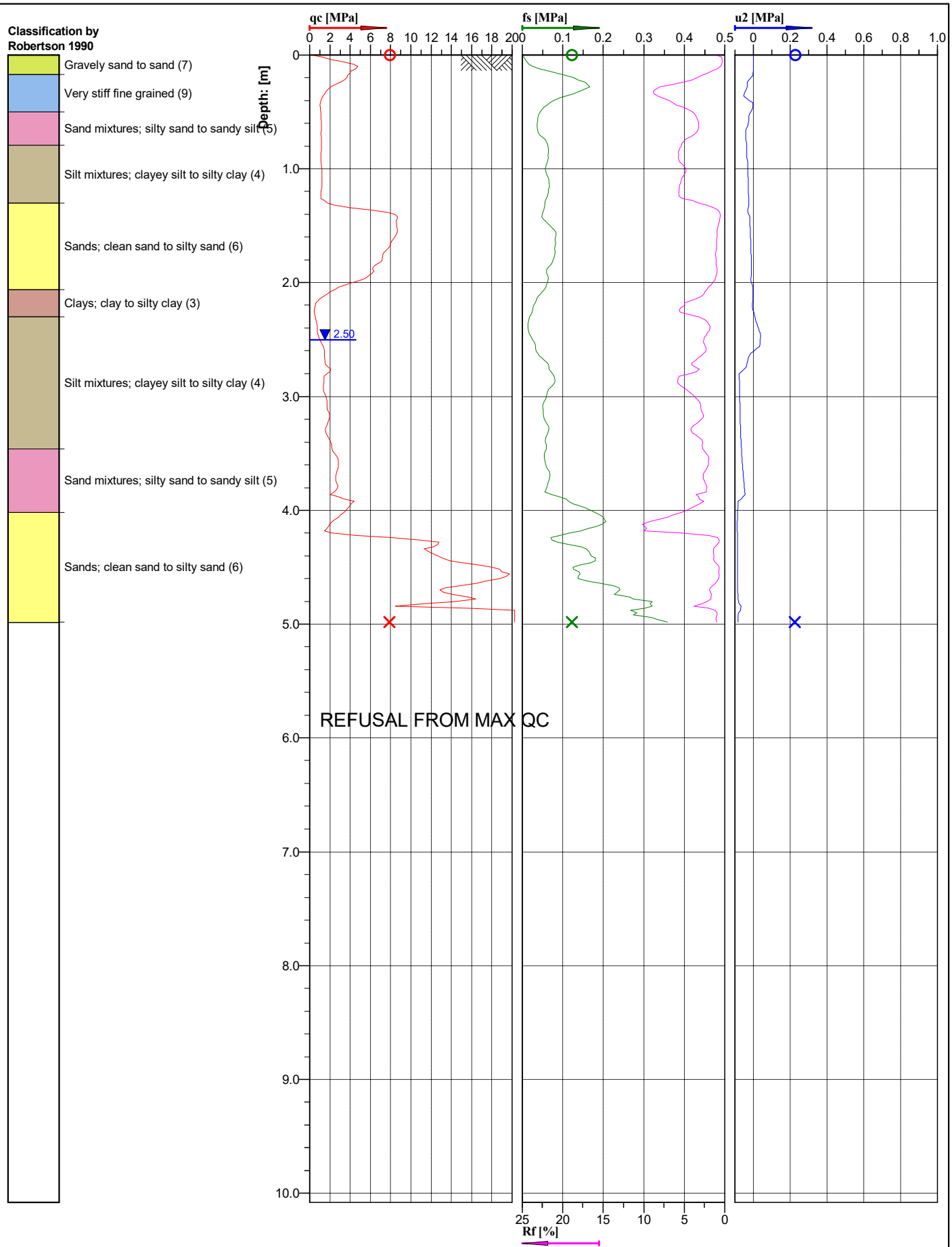


Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66010, E 176.88878		File: CPT07.cpt	

GEOTECH DRILLING

u2

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150



GEOTECH DRILLING

u2

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
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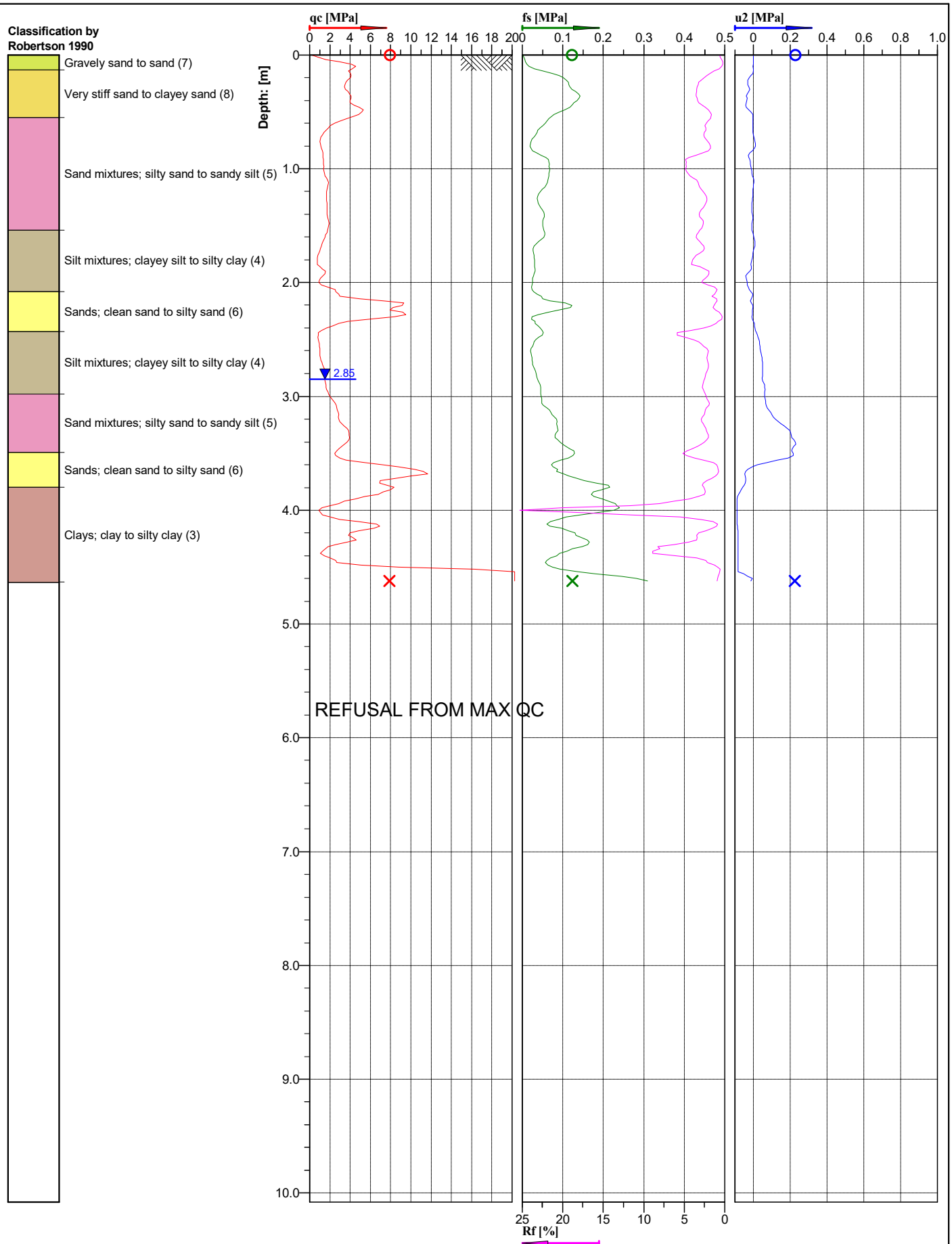
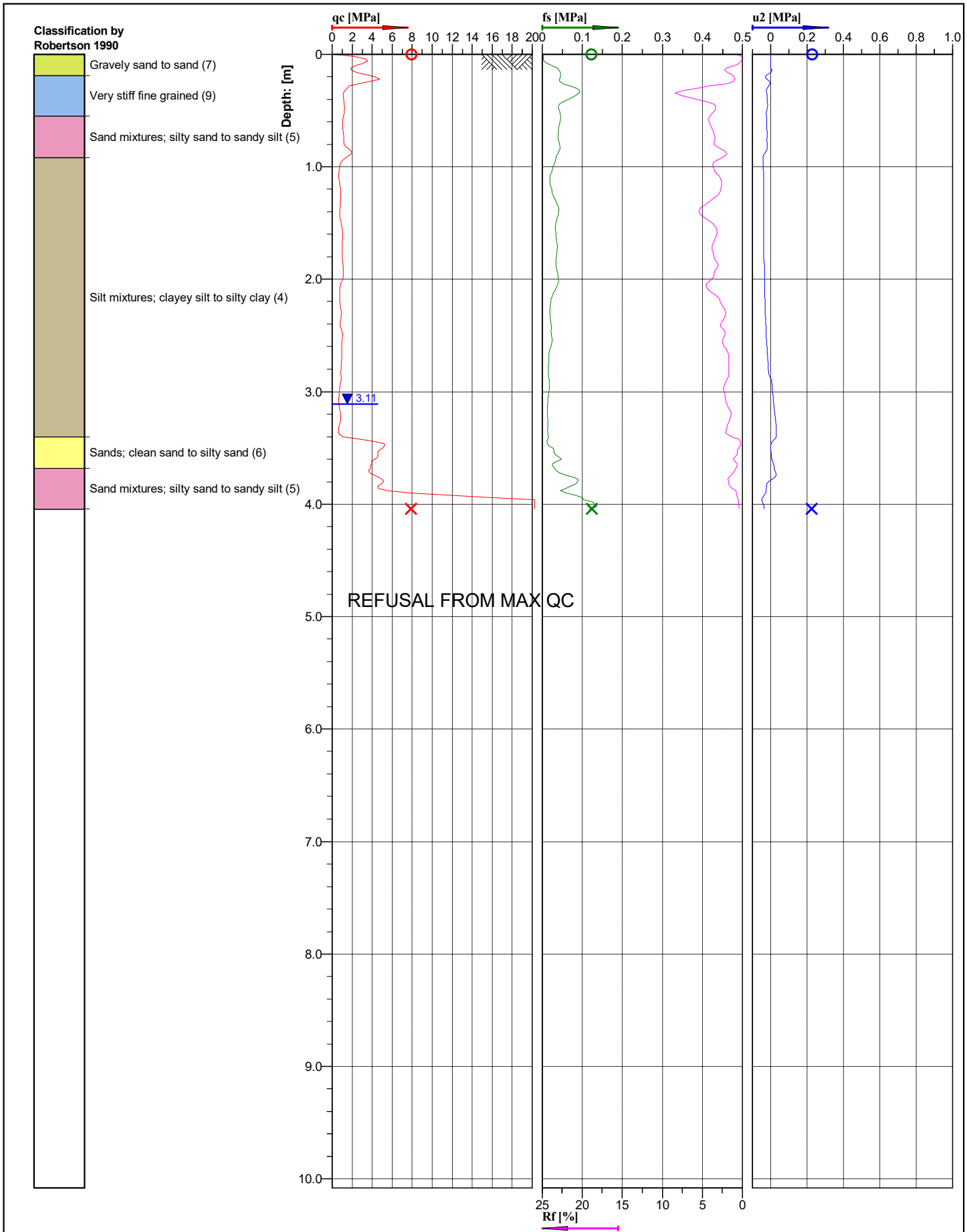


Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID:	Client: INTIIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66035, E 176.88913		File: CPT09.cpt	

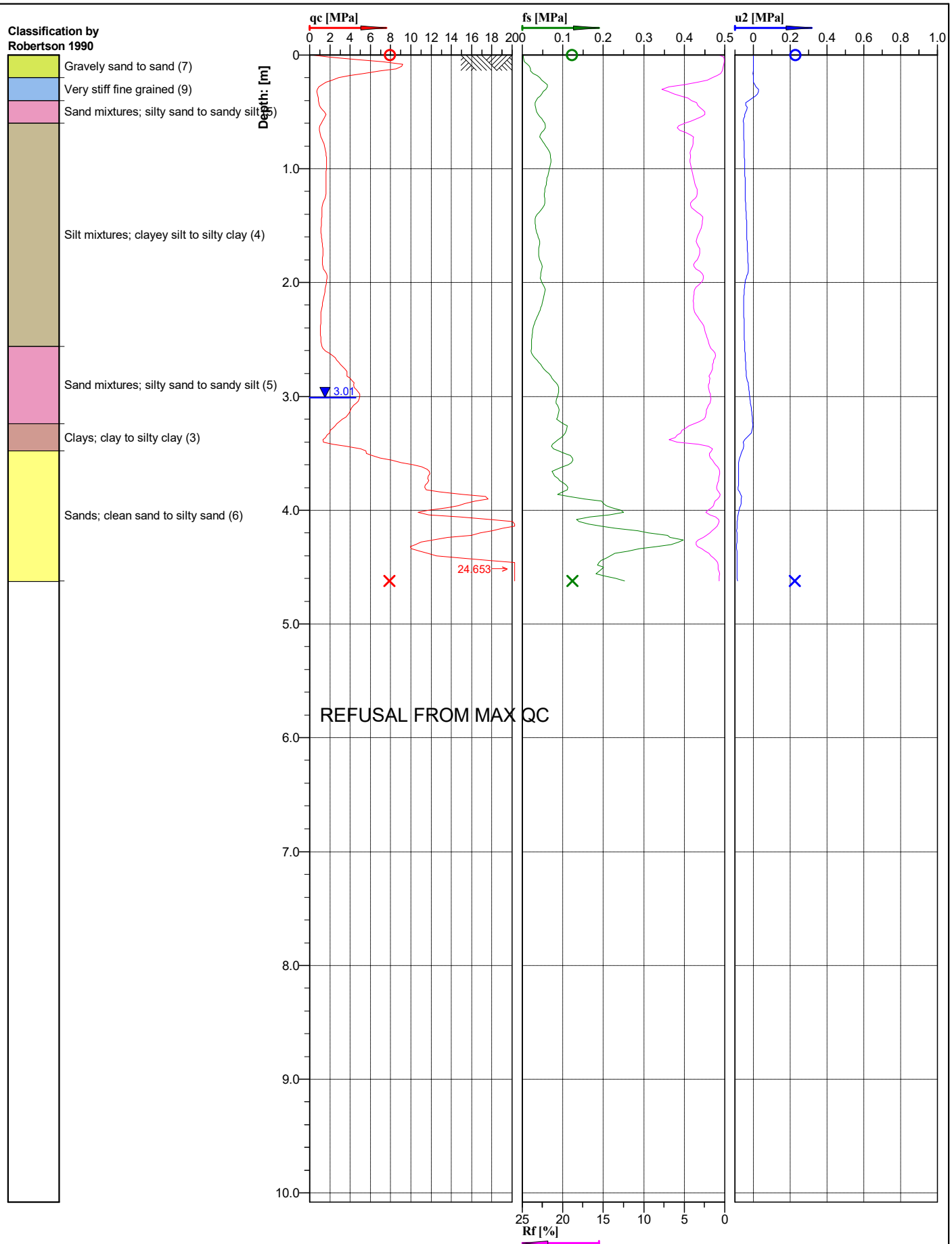


Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66059, E 176.88971		File: CPT10.cpt	

GEOTECH DRILLING

u2

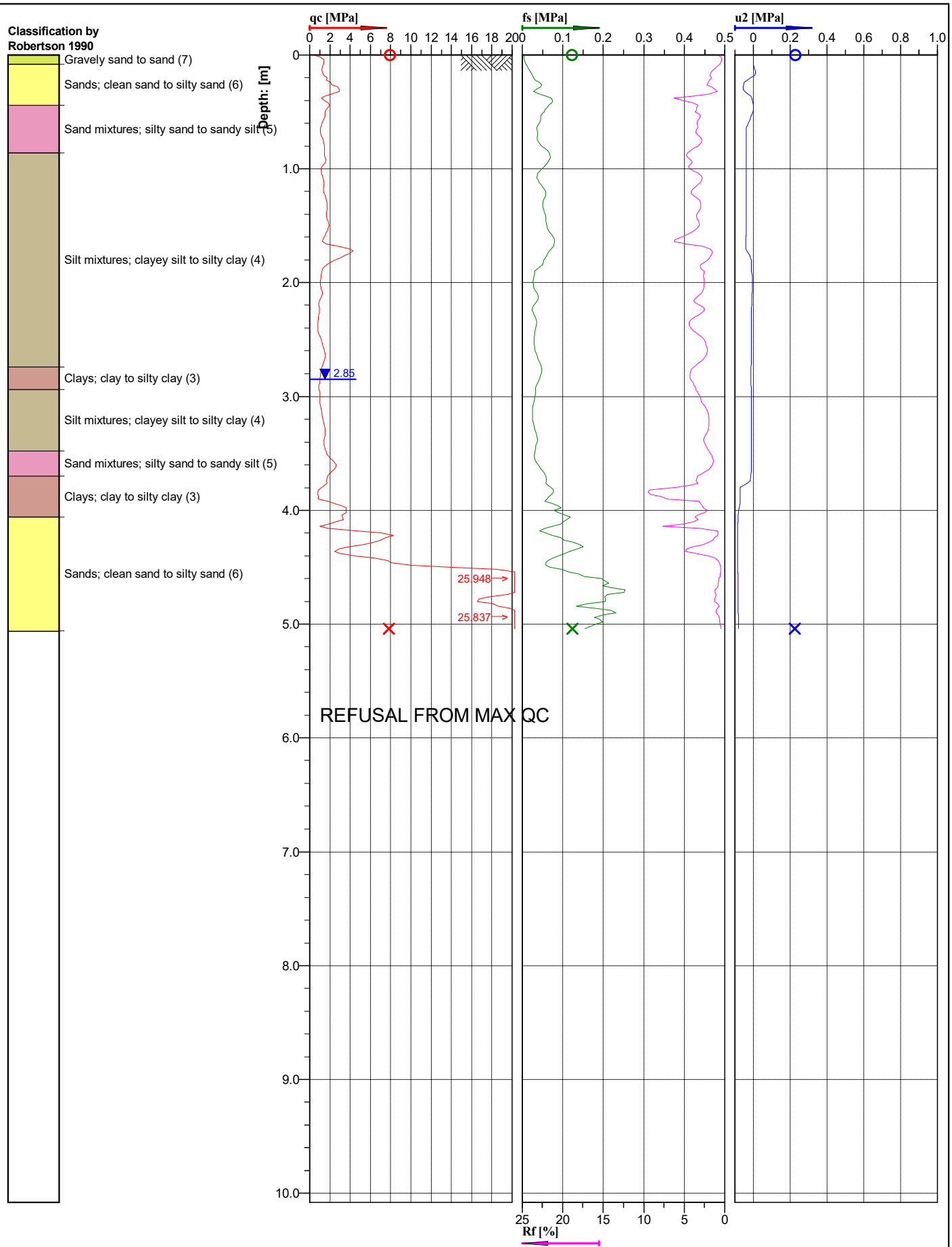
Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150



GEOTECH DRILLING

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66061, E 176.88933		File: CPT11.cpt	

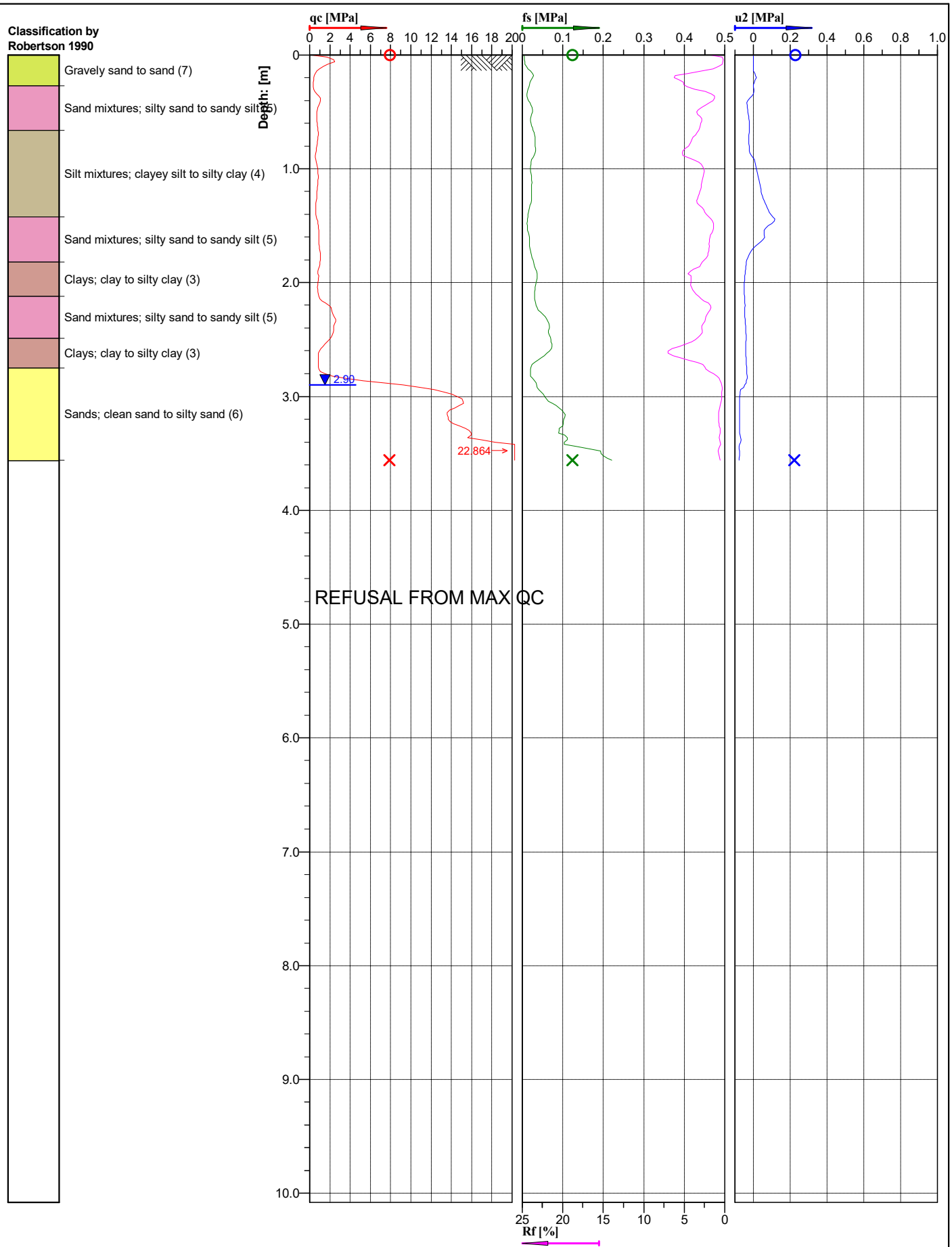


Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT12
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESEIDENTIAL		Page: 1/1	Fig.:
S 39.66056, E 176.88887		File: CPT12.cpt	

GEOTECH DRILLING

u2

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150



GEOTECH DRILLING

Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT13
Project ID:	Client: INITIA	Date: 10/12/2020	Scale: 1 : 45
Project: BROOKVALE RESIDENTIAL		Page: 1/1	Fig.:
S 39.66095, E 176.88914		File: CPT13.cpt	

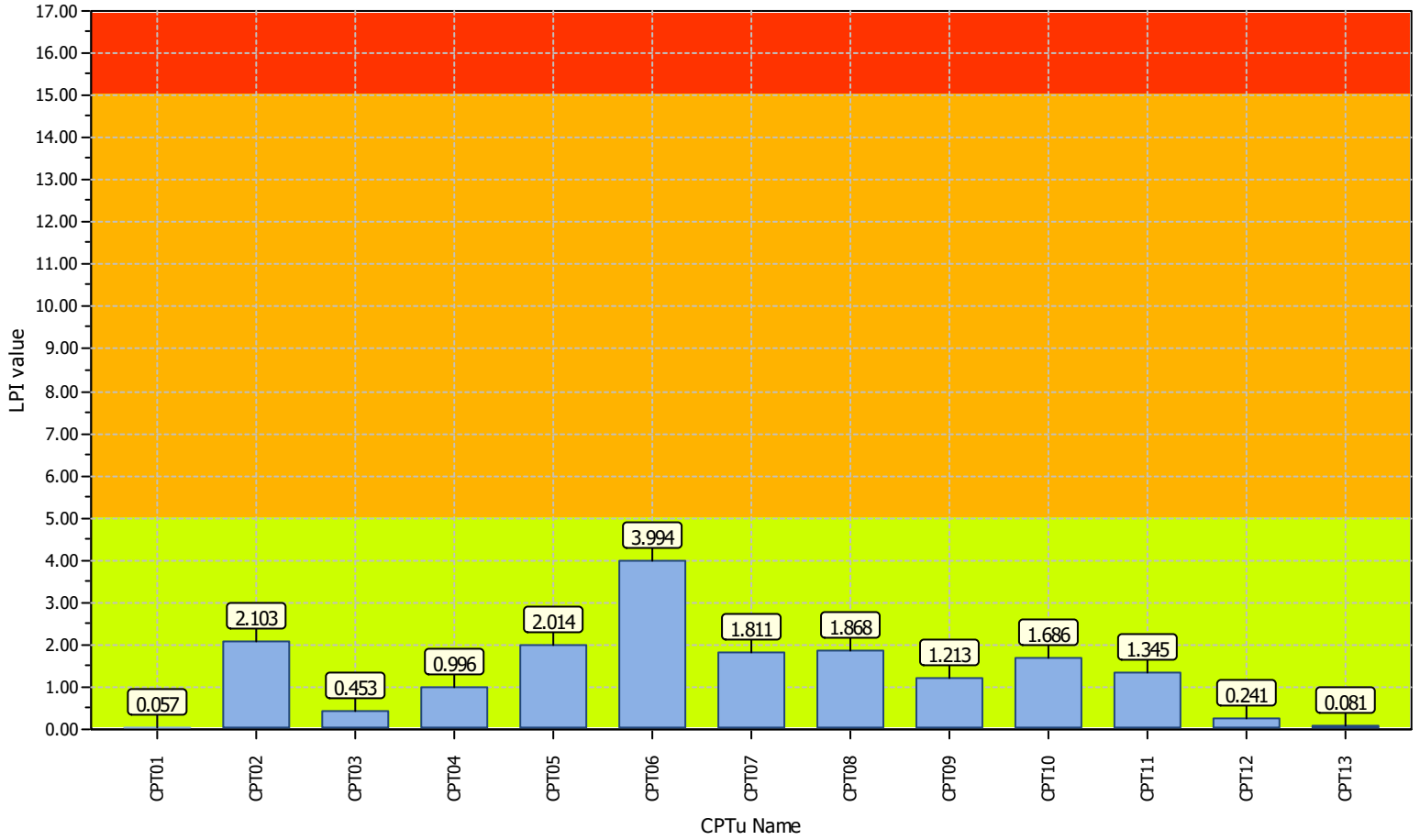
Appendix C Liquefaction Analysis

Initia Ltd
Geotechnical Specialists
114 St Georges Bay Road, Parnell, Auckland
www.initia.co.nz

Project title : Brookvale Residential

Location : 55 Brookvale Road, Havelock North

Overall Liquefaction Potential Index report



LPI color scheme

- Very high risk
- High risk
- Low risk

Basic statistics

Total CPT number: 13
100% low risk
0% high risk
0% very high risk

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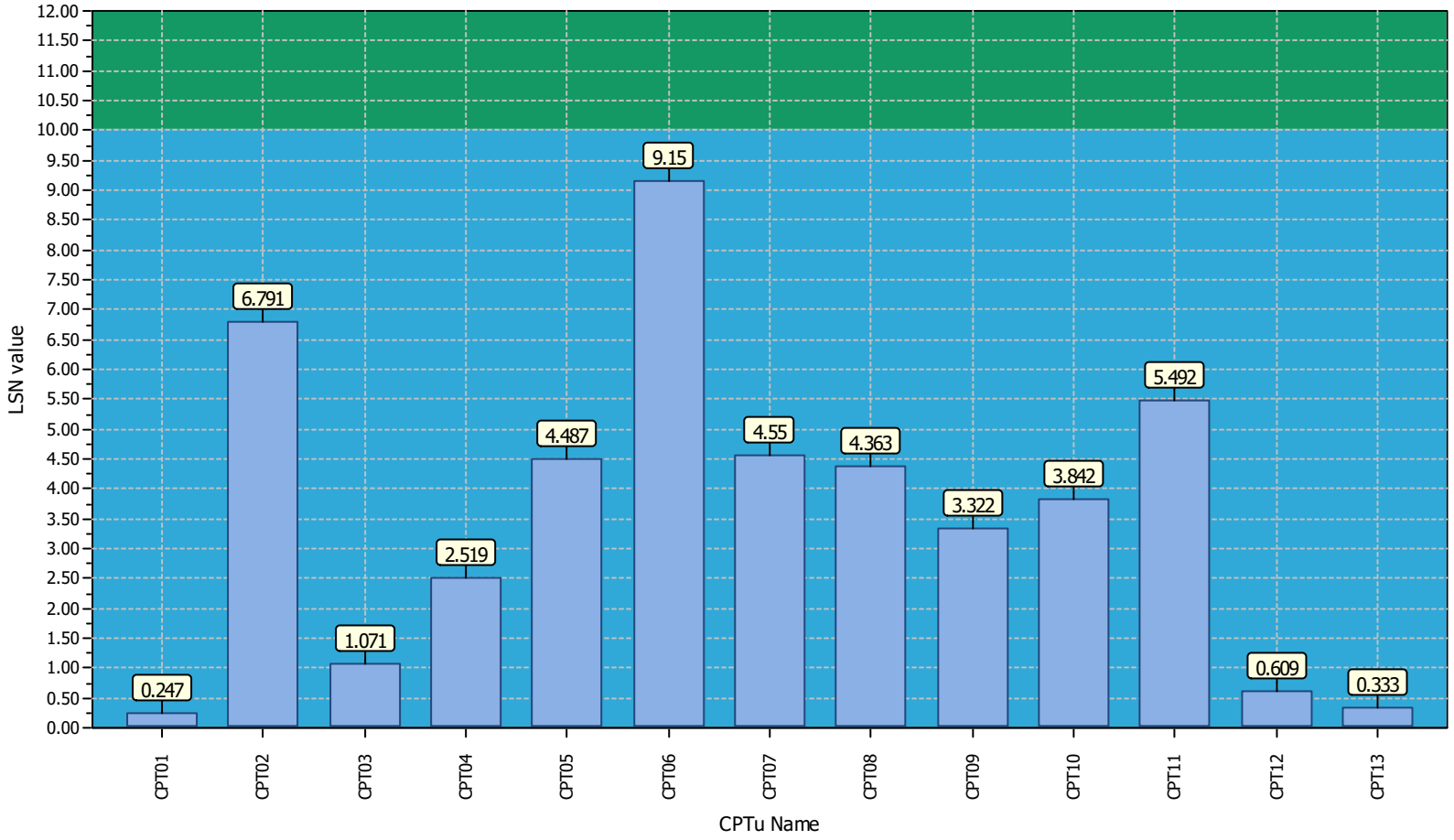
www.initia.co.nz

Project title : Brookvale Residential

Location : 55 Brookvale Road, Havelock North

Overall Liquefaction Severity Number report



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

Basic statistics

Total CPT number: 13

100% little liquefaction

0% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

Initia Ltd
Geotechnical Specialists
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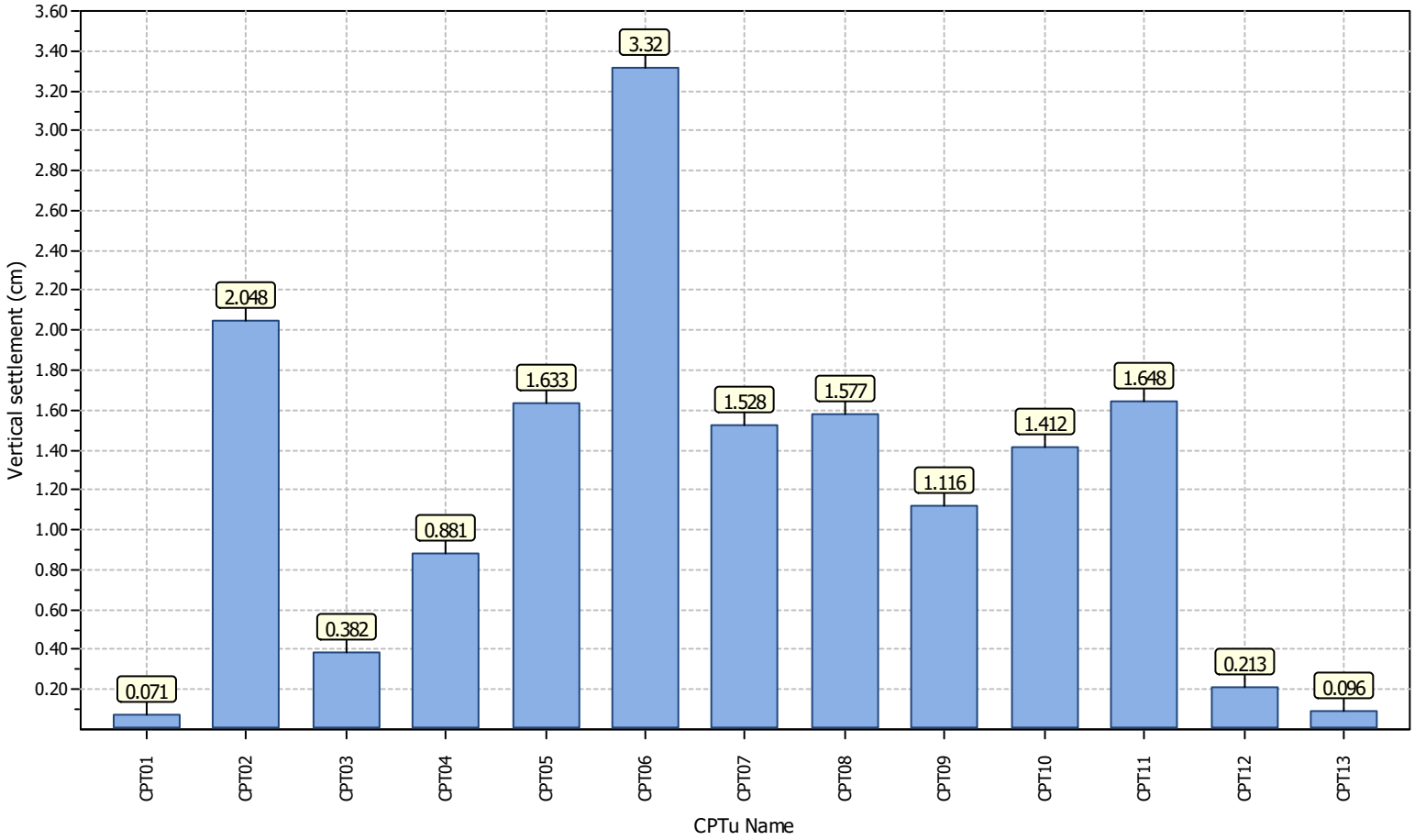
Project title : Brookvale Residential

Location : 55 Brookvale Road, Havelock North

Overall vertical settlements report



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114 St Georges Bay Road, Parnell, Auckland
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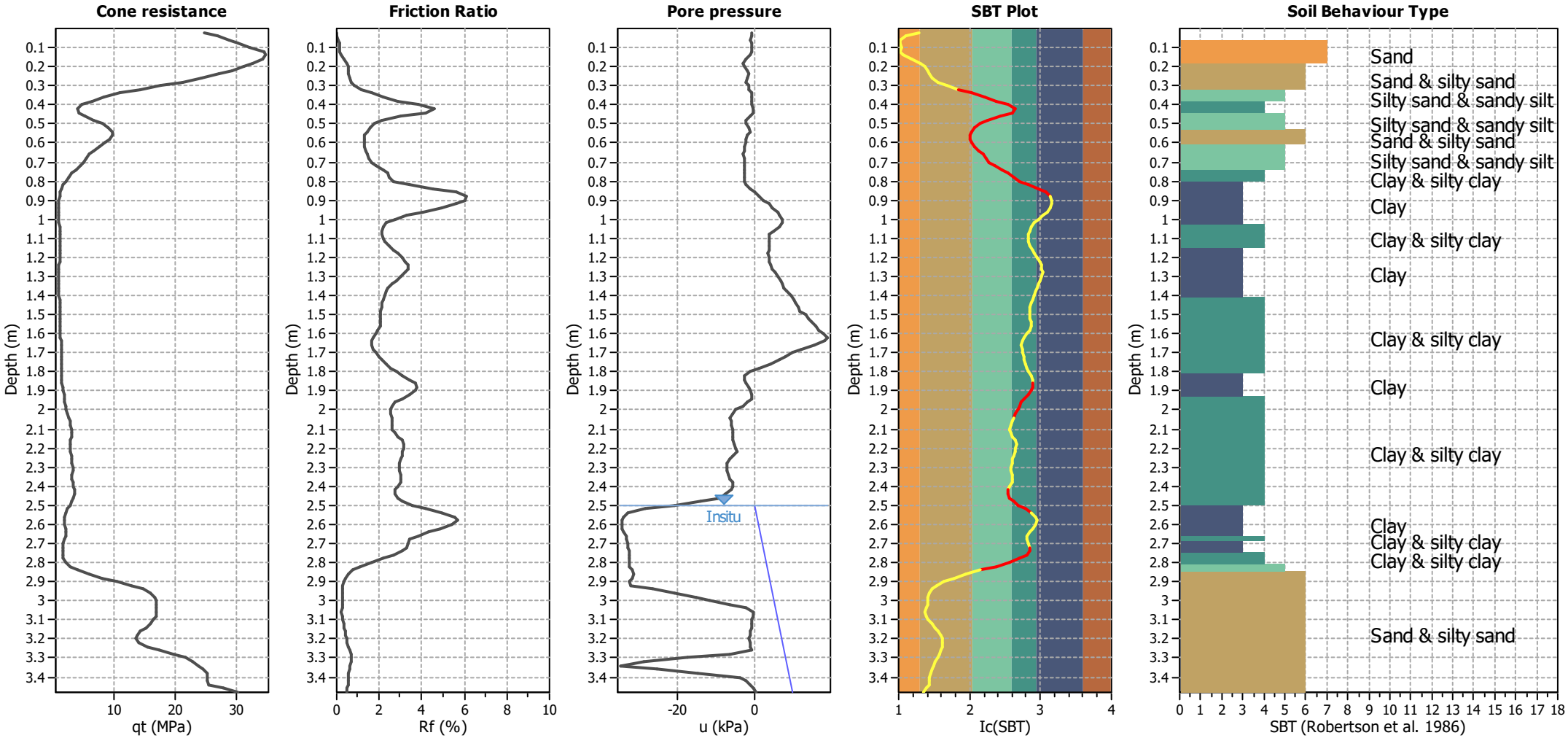
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT01
Total depth: 3.48 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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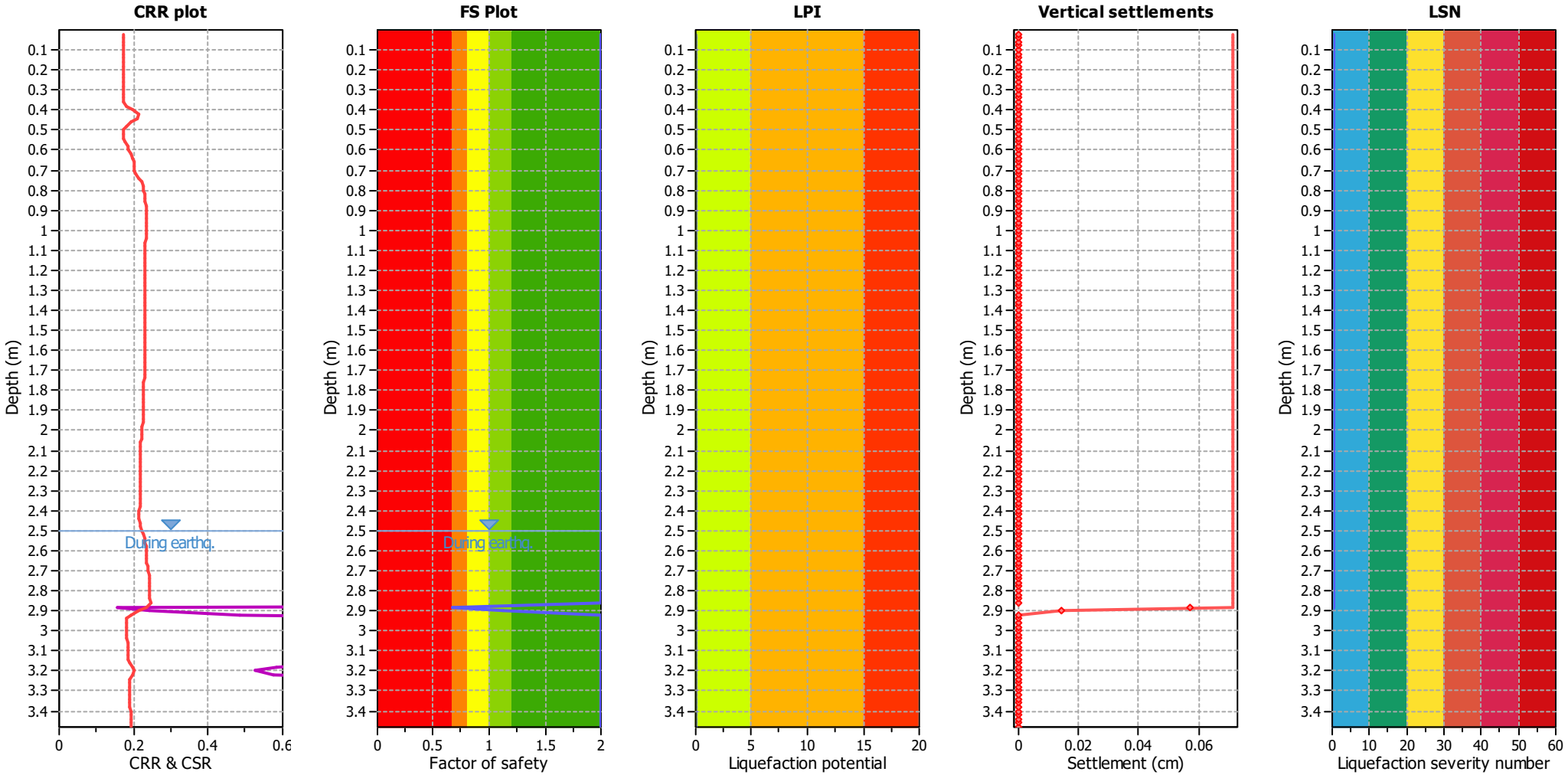
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT01
Total depth: 3.48 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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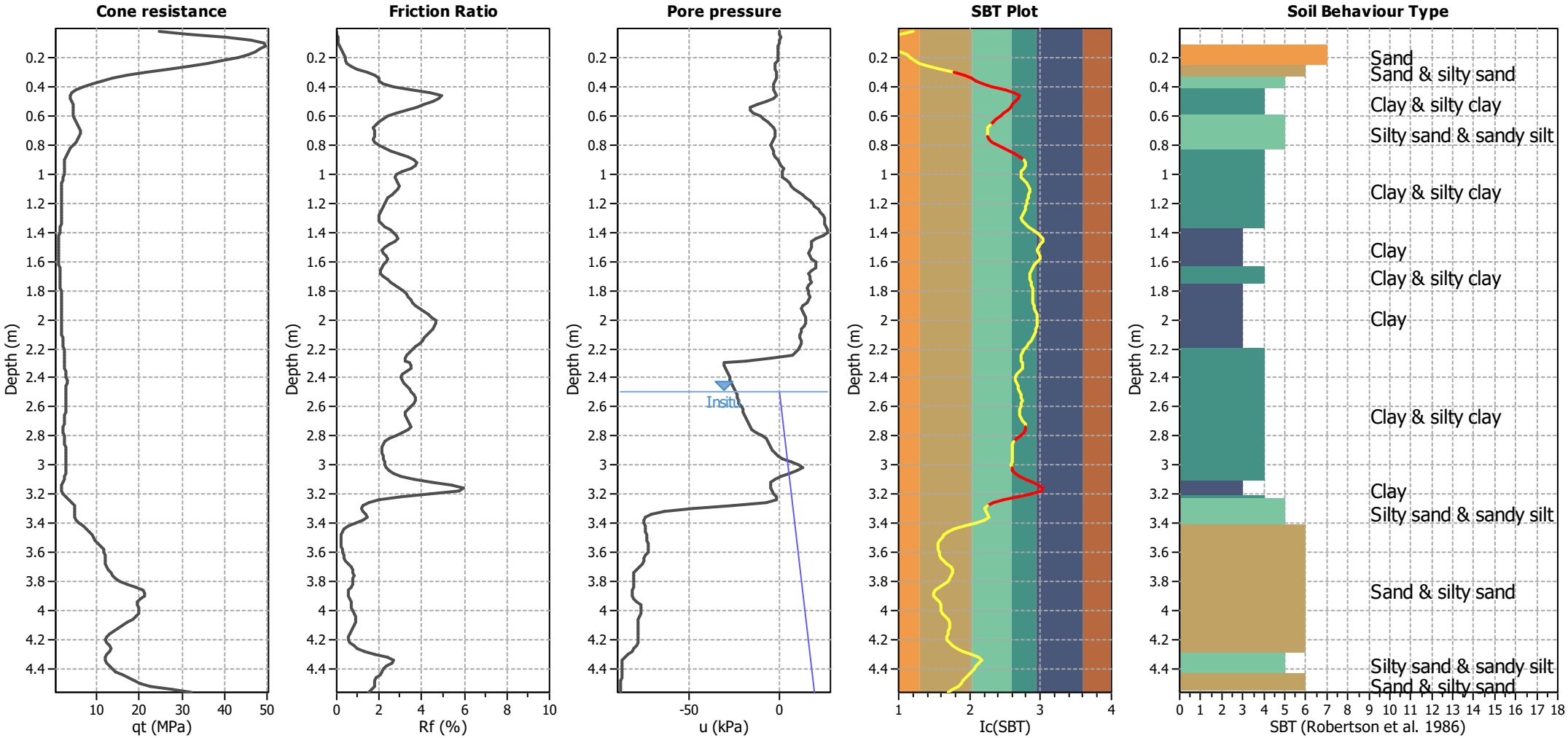
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT02
Total depth: 4.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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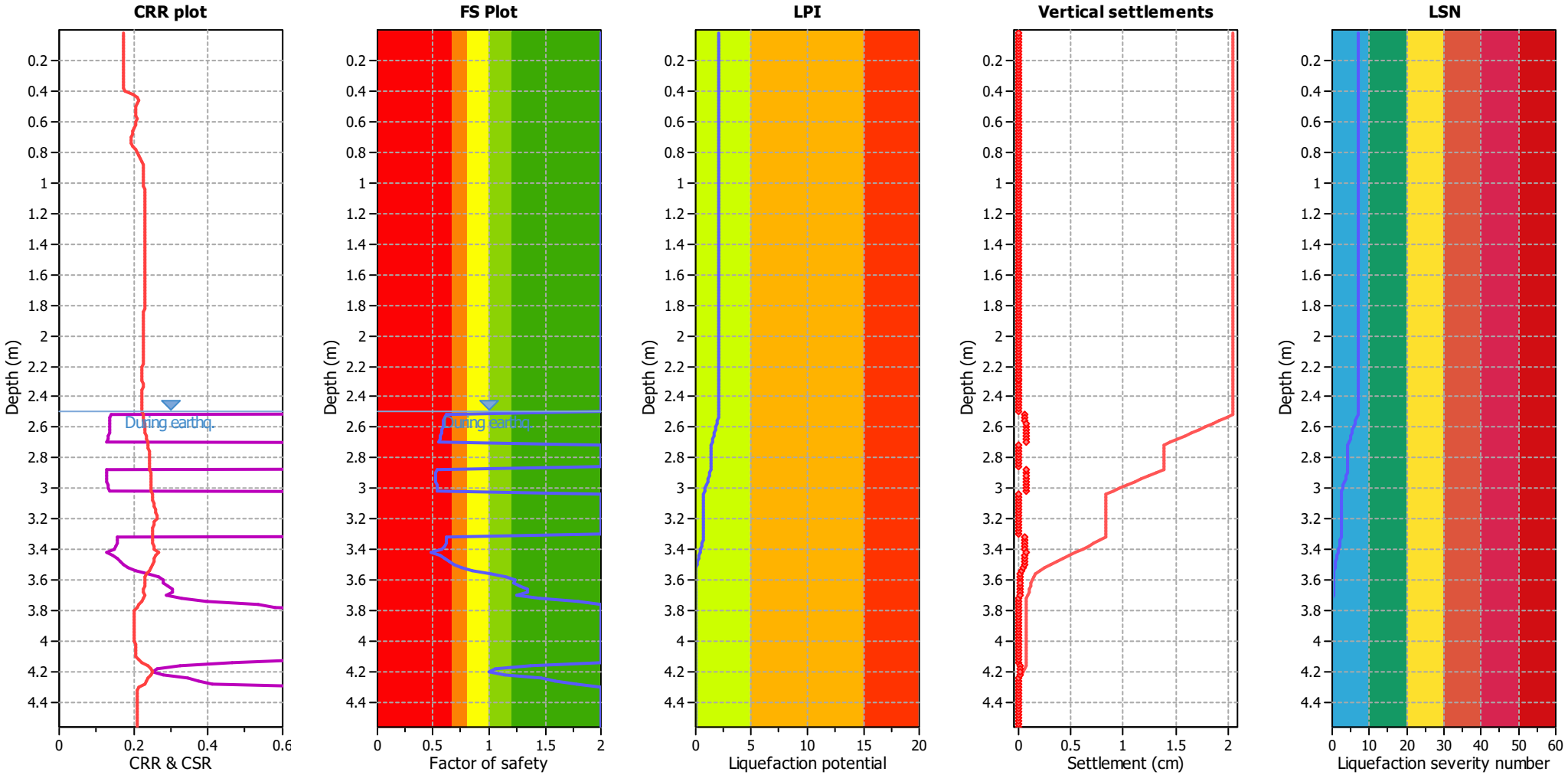
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT02
Total depth: 4.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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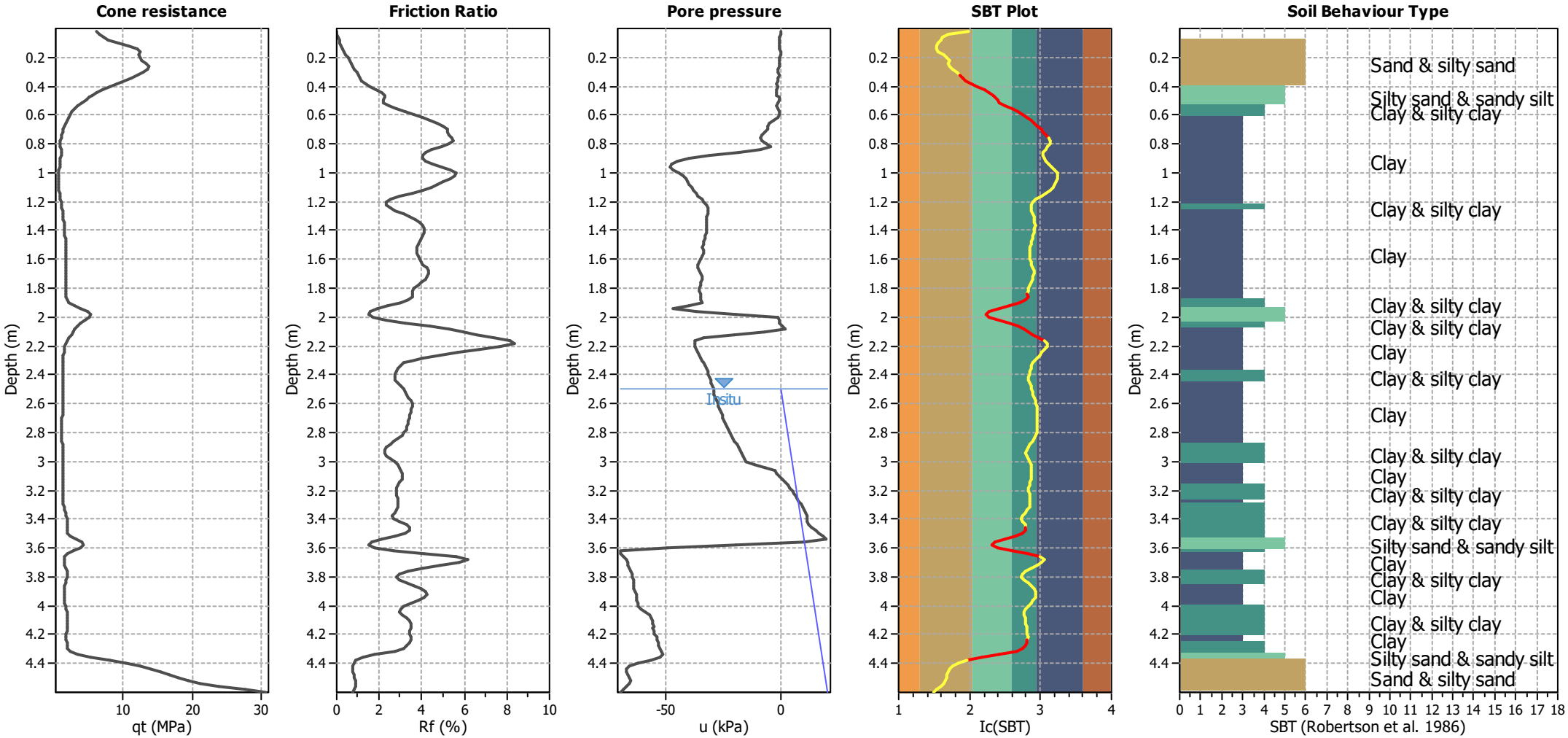
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT03
Total depth: 4.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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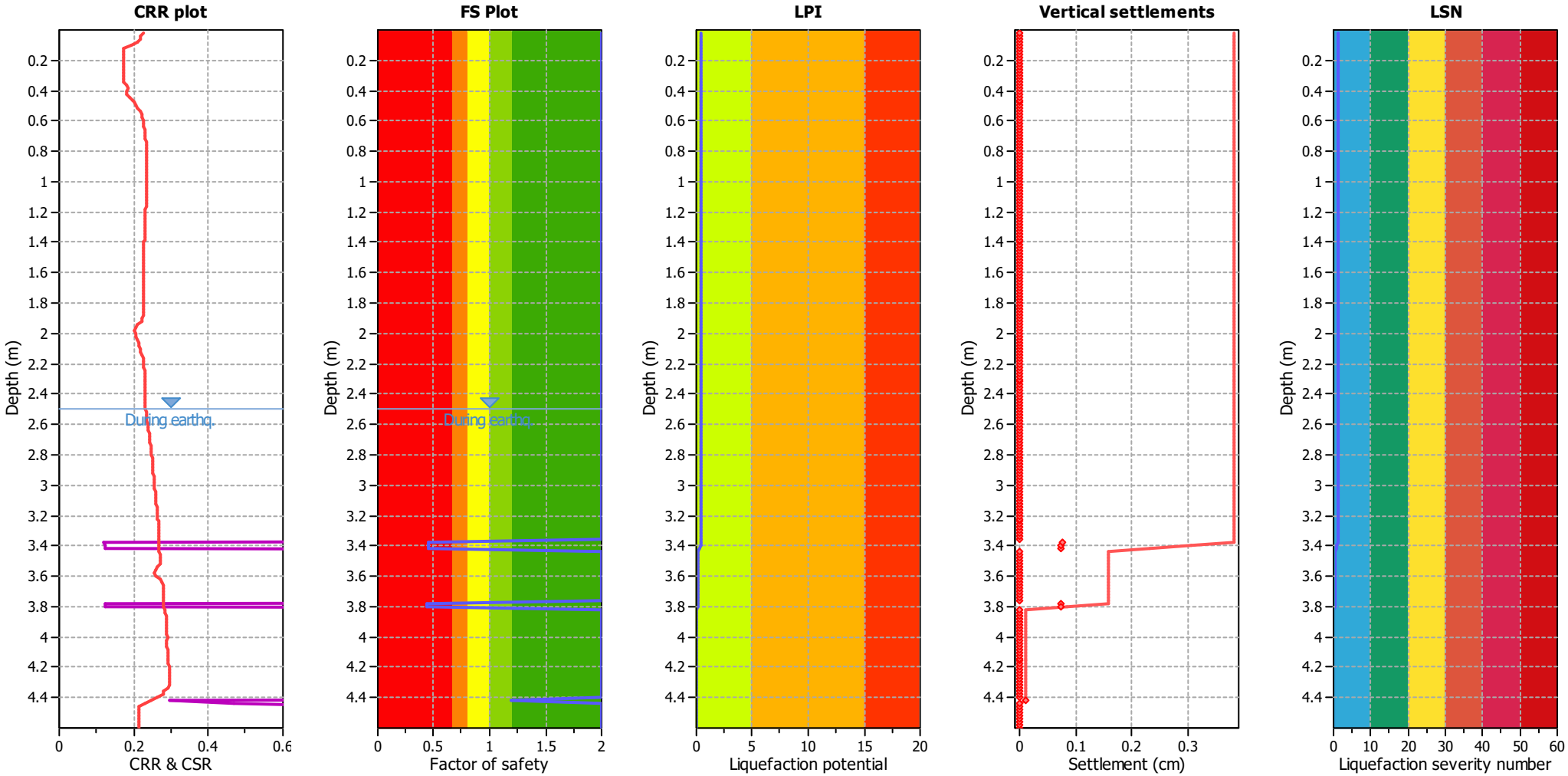
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT03
Total depth: 4.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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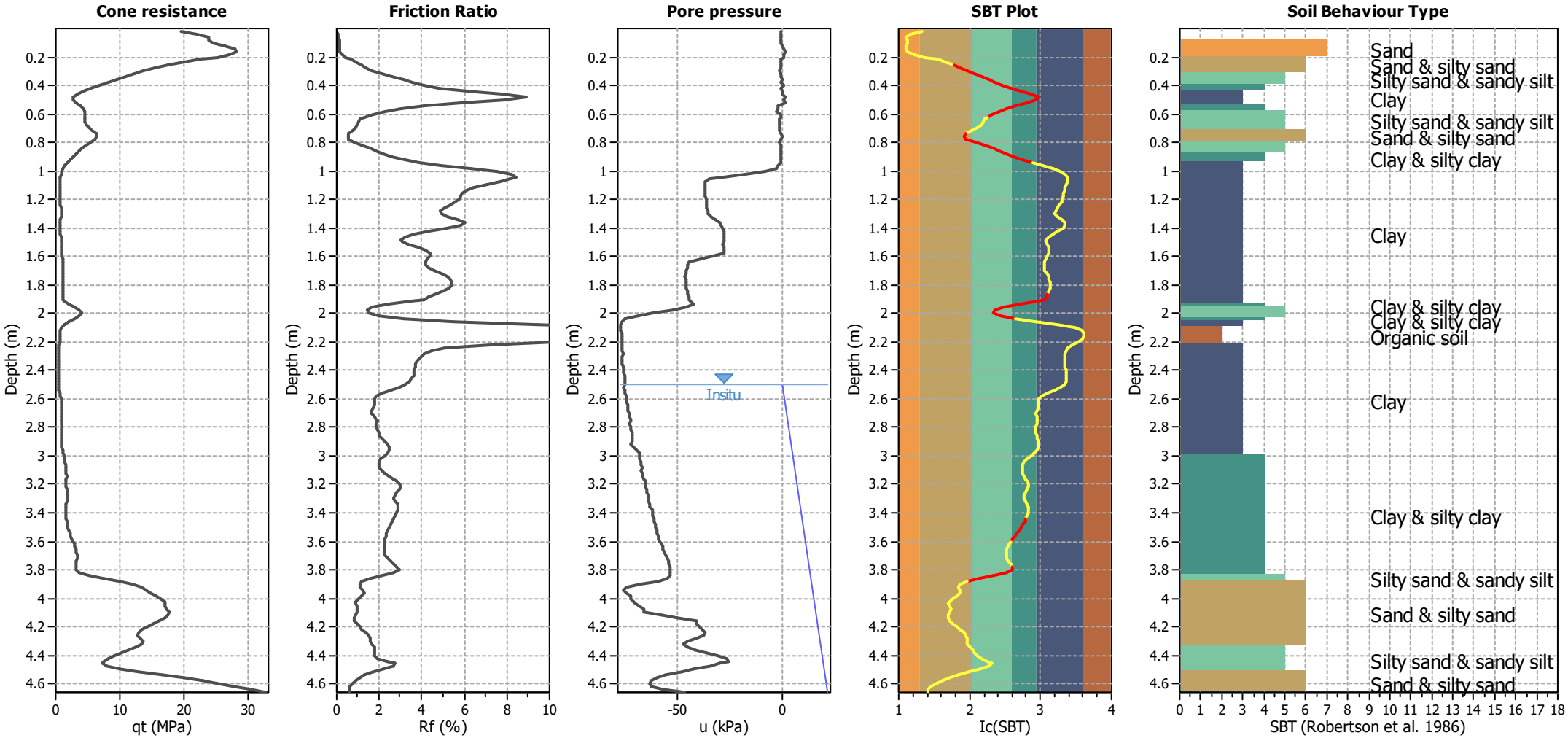
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT04
Total depth: 4.66 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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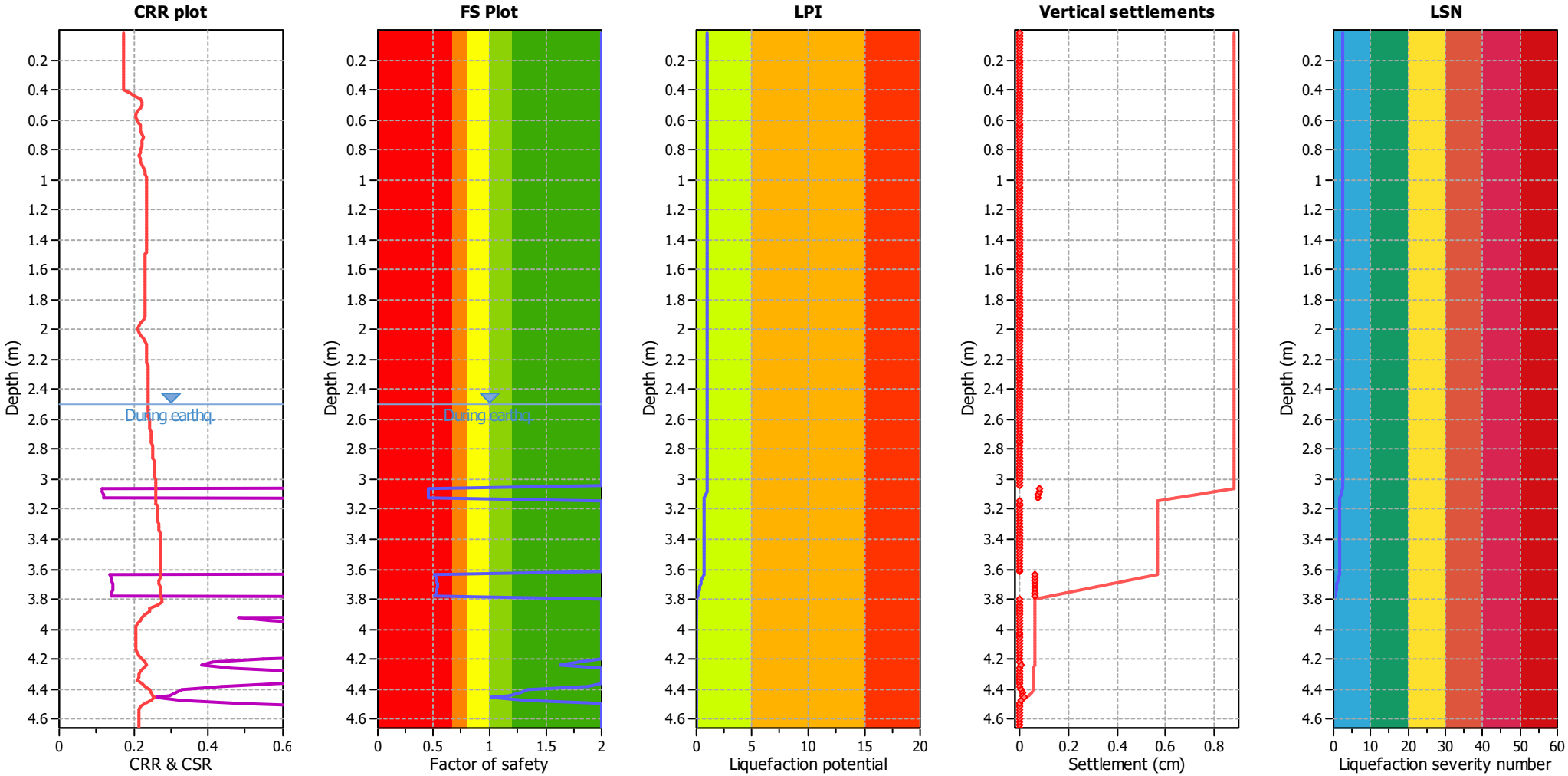
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT04
Total depth: 4.66 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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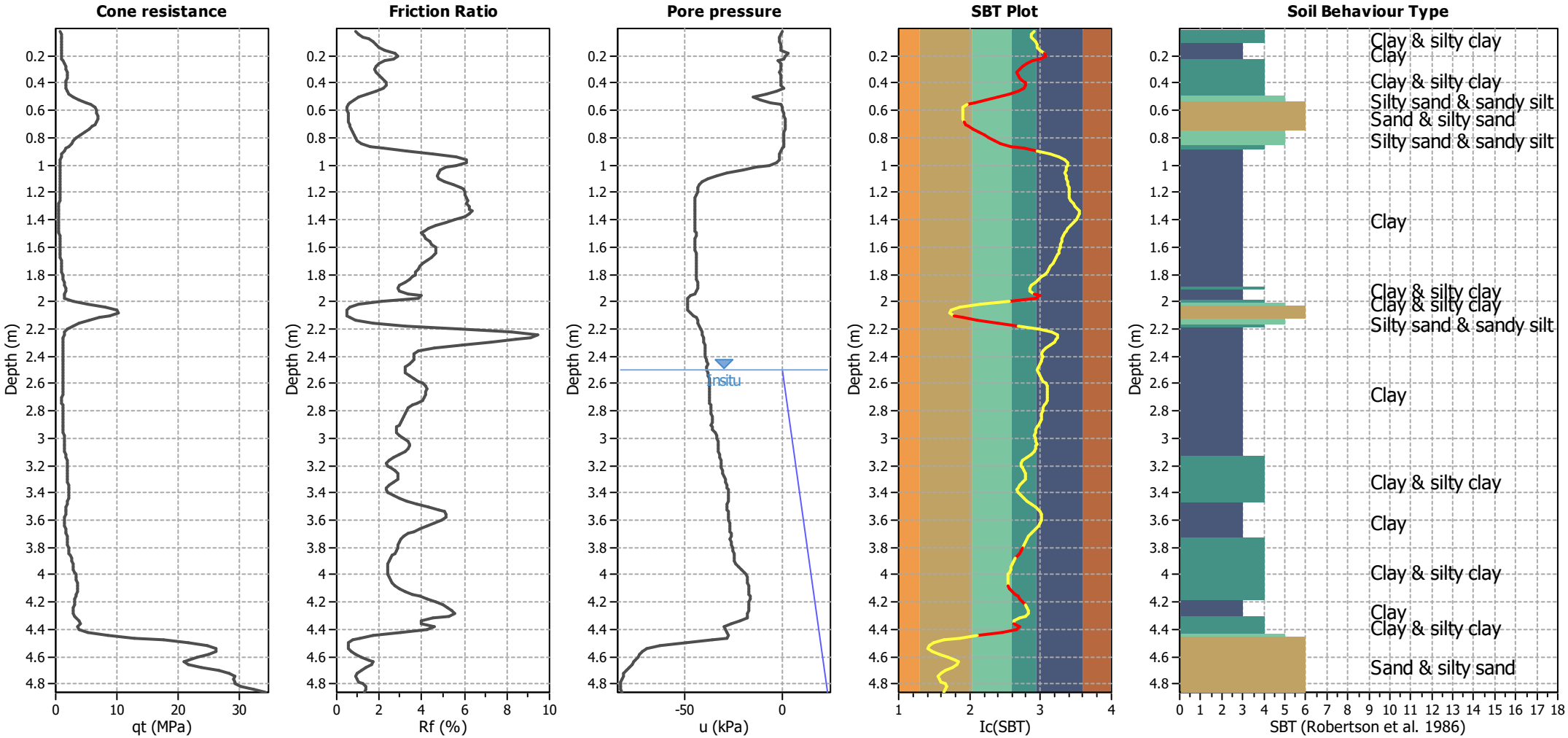
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT05
Total depth: 4.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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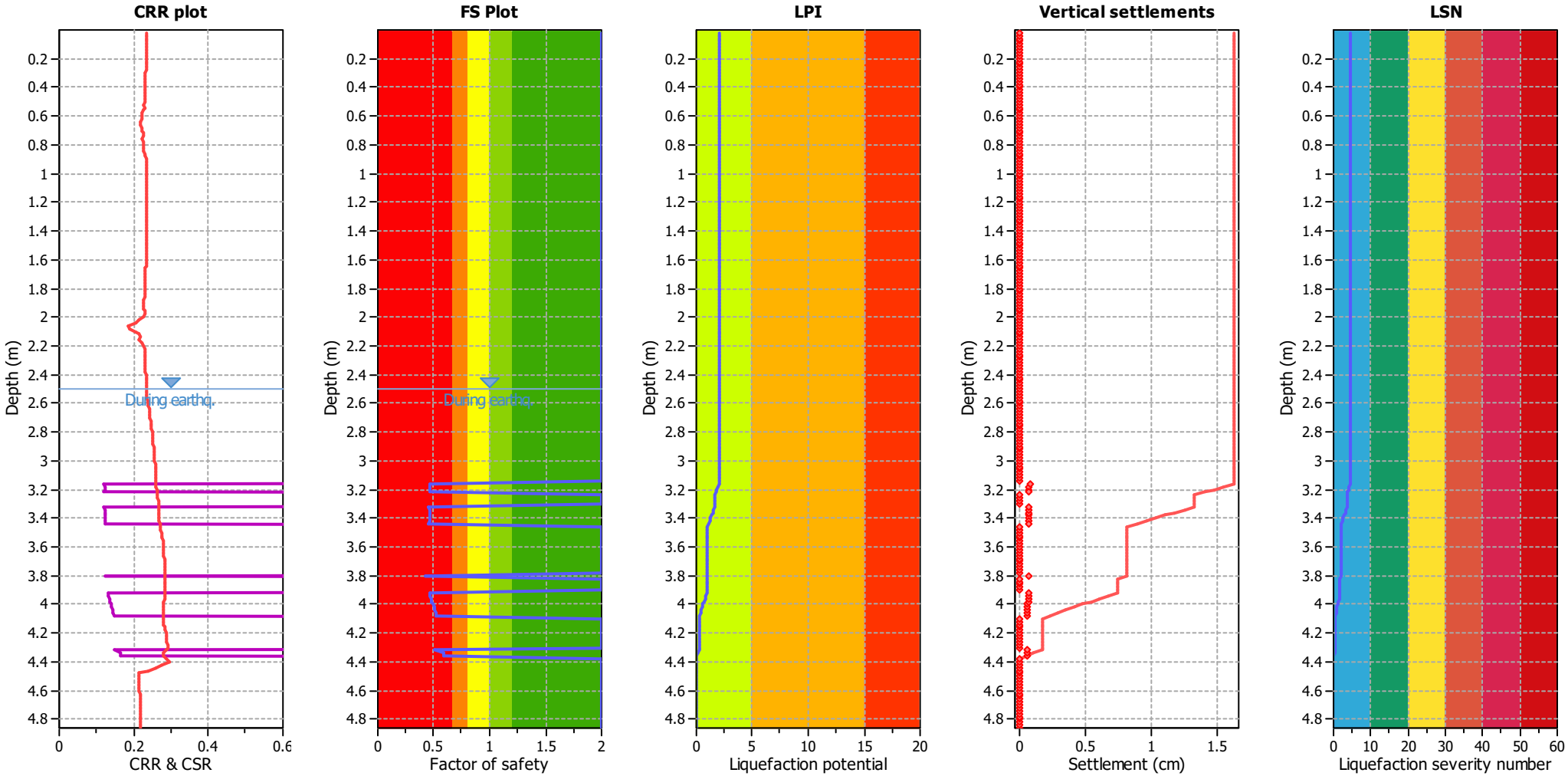
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT05
Total depth: 4.86 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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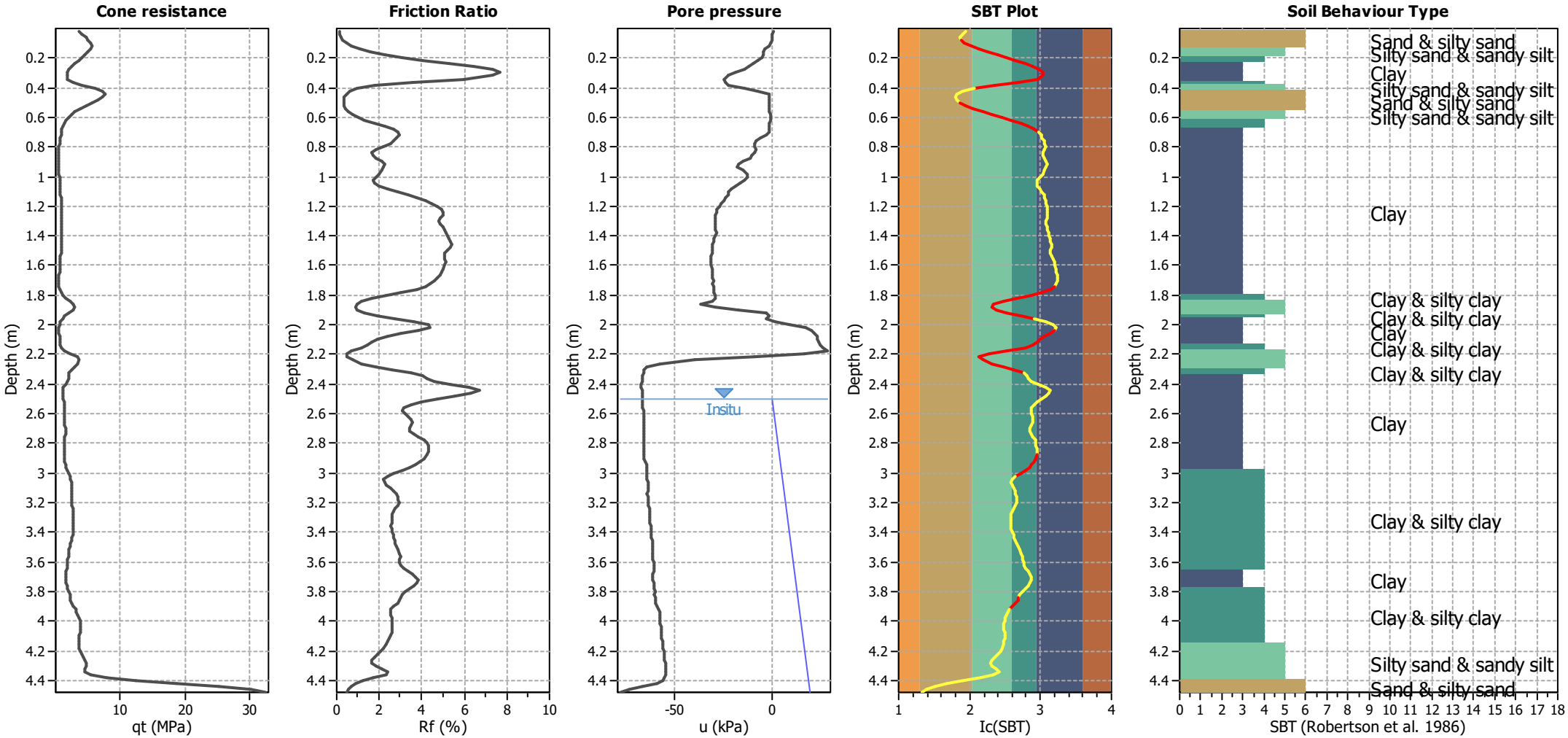
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT06
Total depth: 4.48 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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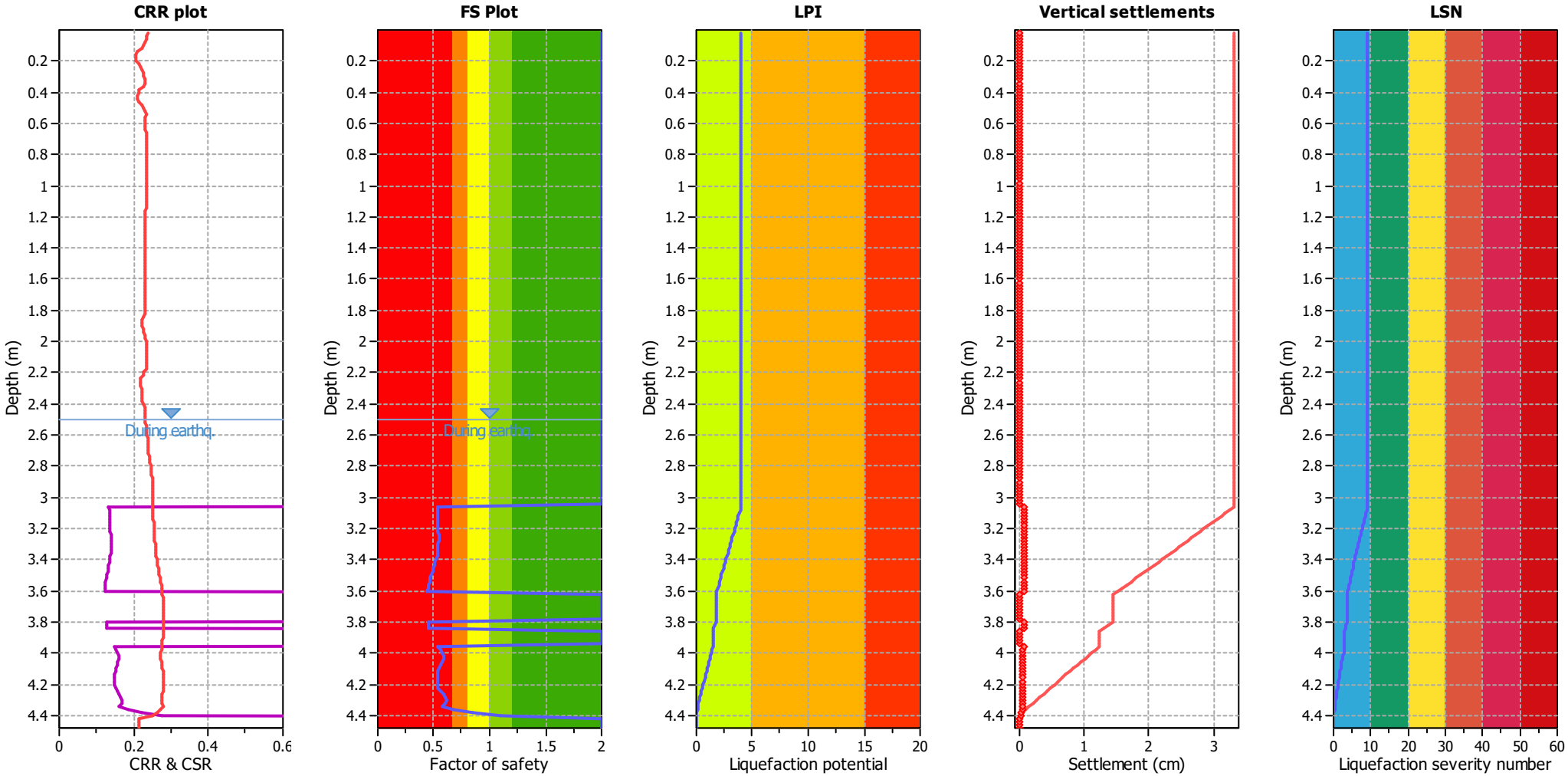
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT06
Total depth: 4.48 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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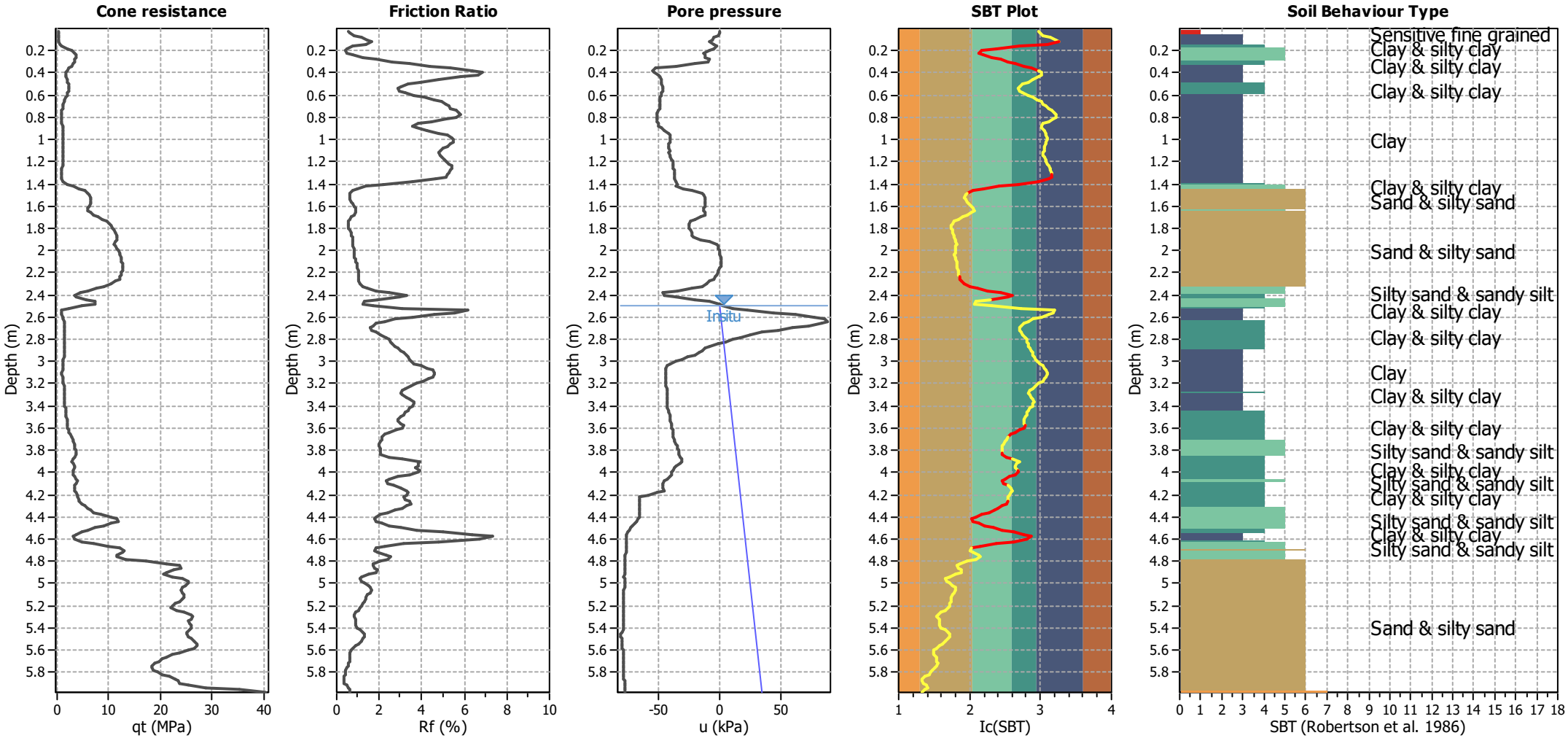
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT07
Total depth: 5.98 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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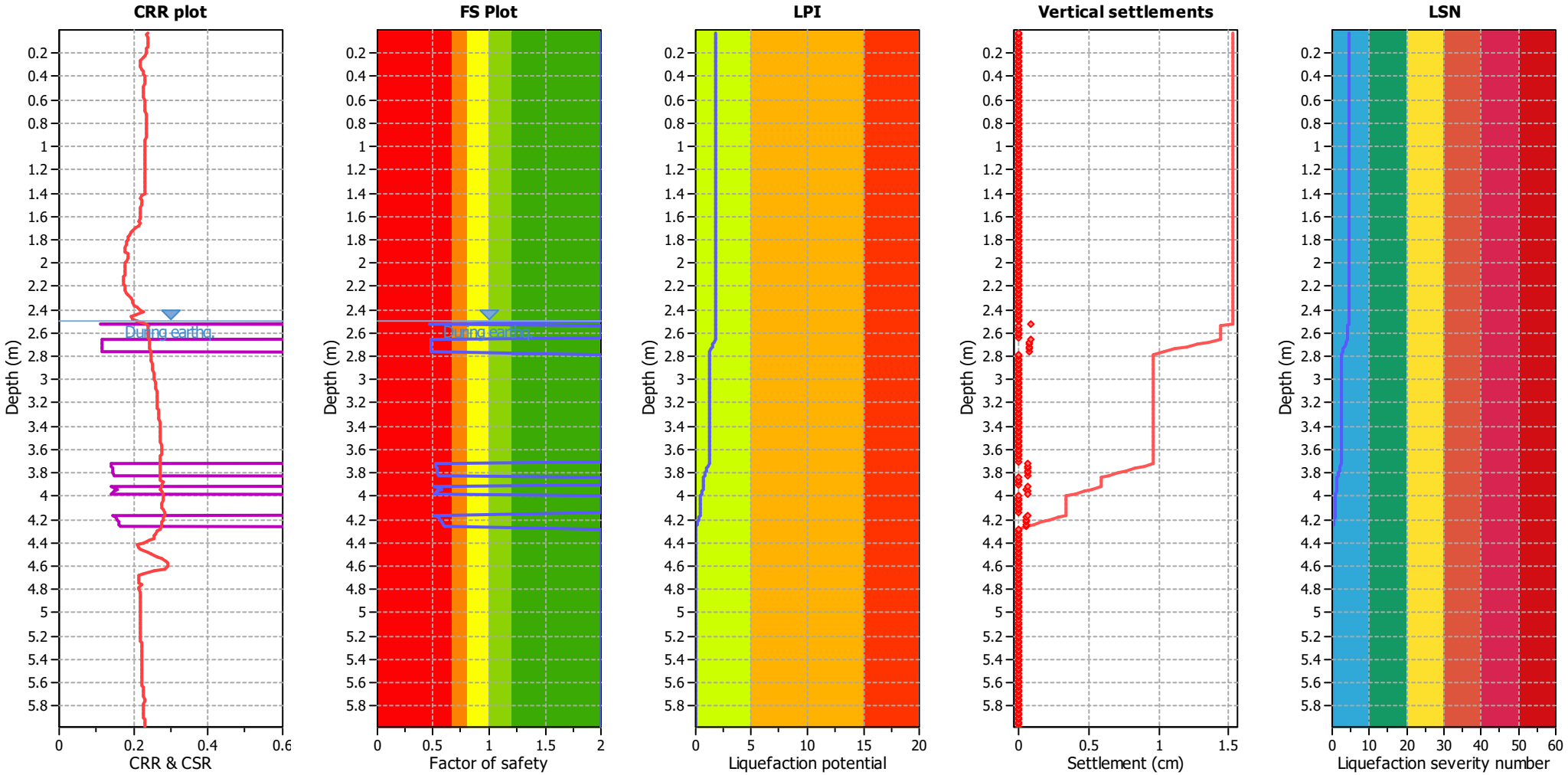
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT07
Total depth: 5.98 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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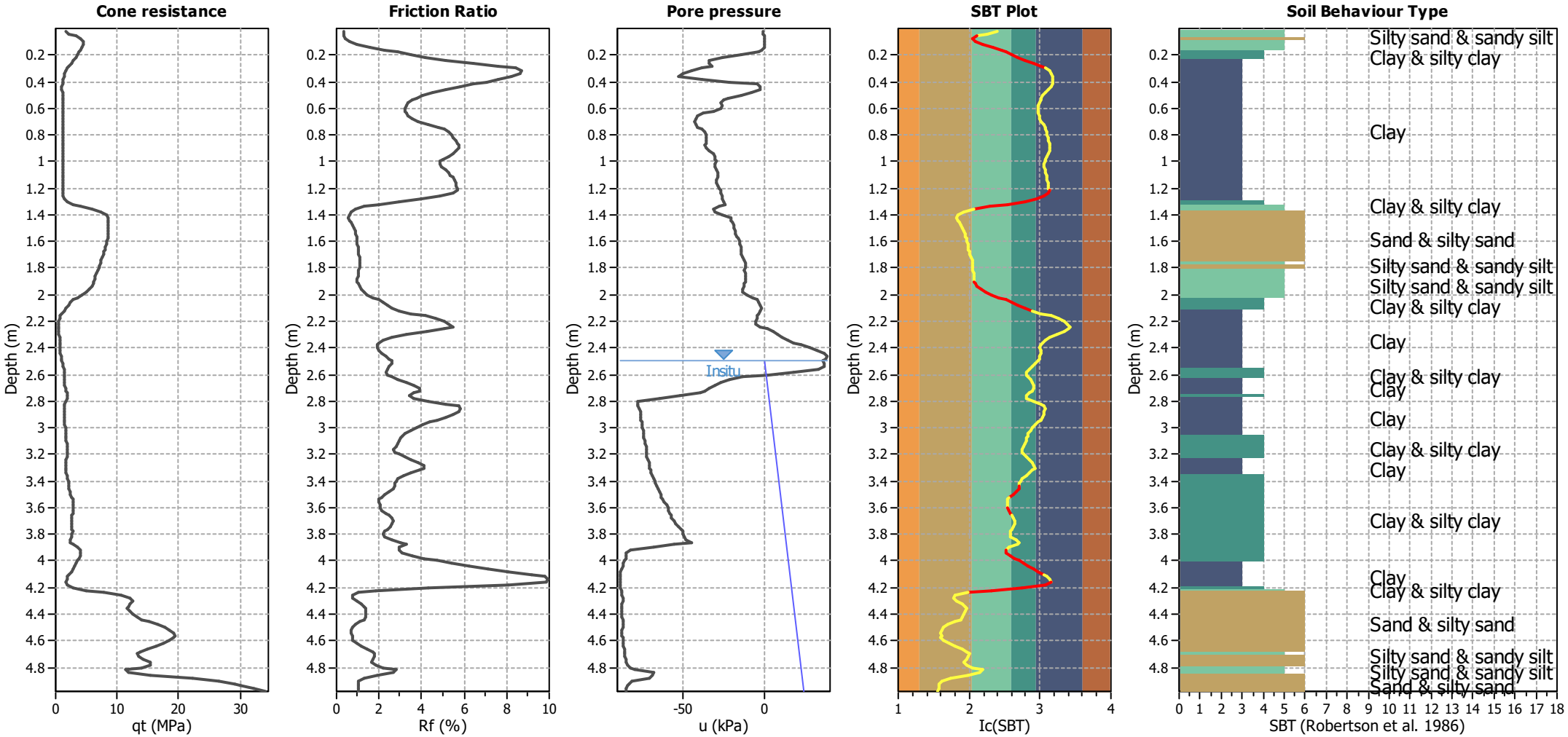
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT08
Total depth: 4.98 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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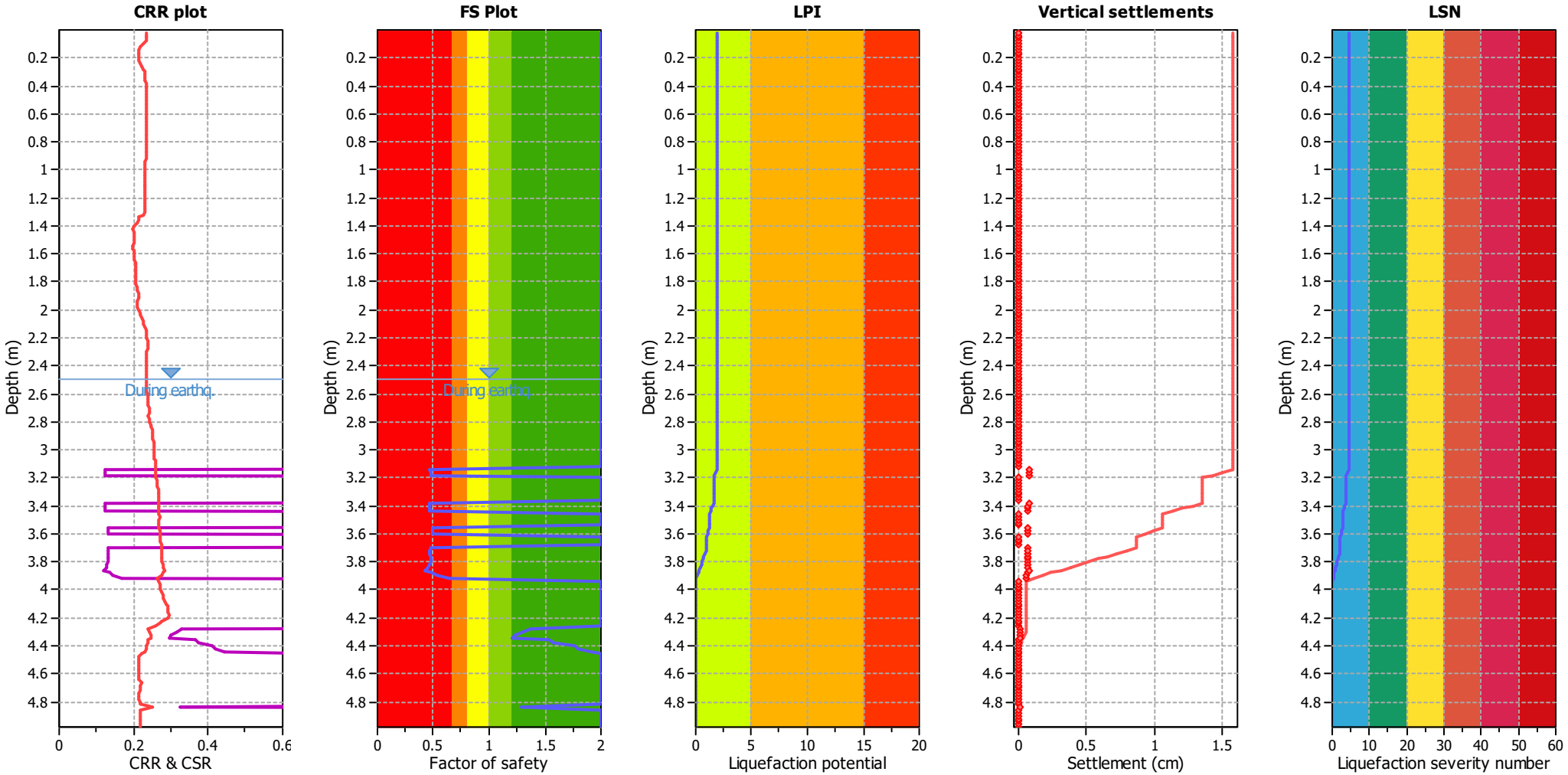
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT08
Total depth: 4.98 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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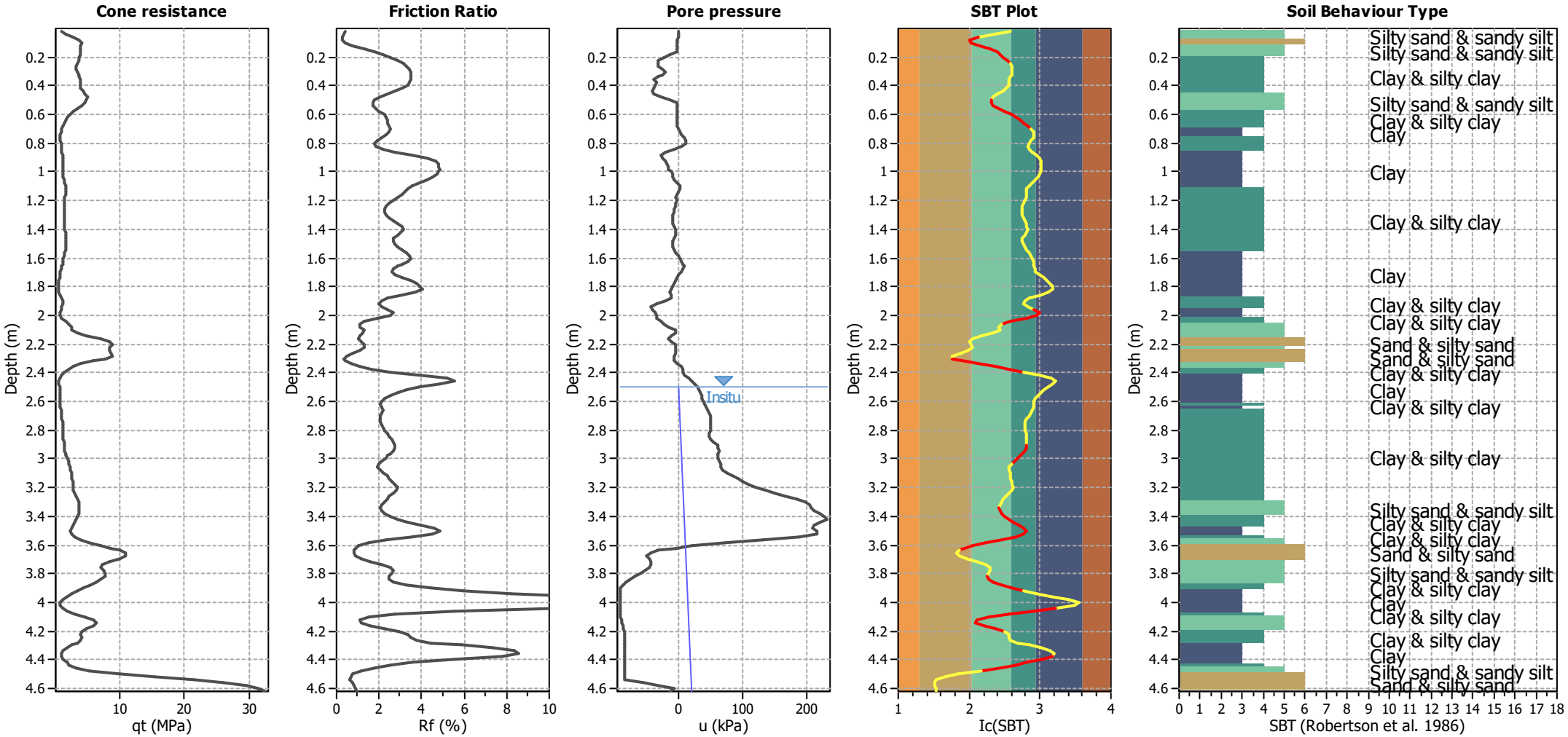
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT09
Total depth: 4.62 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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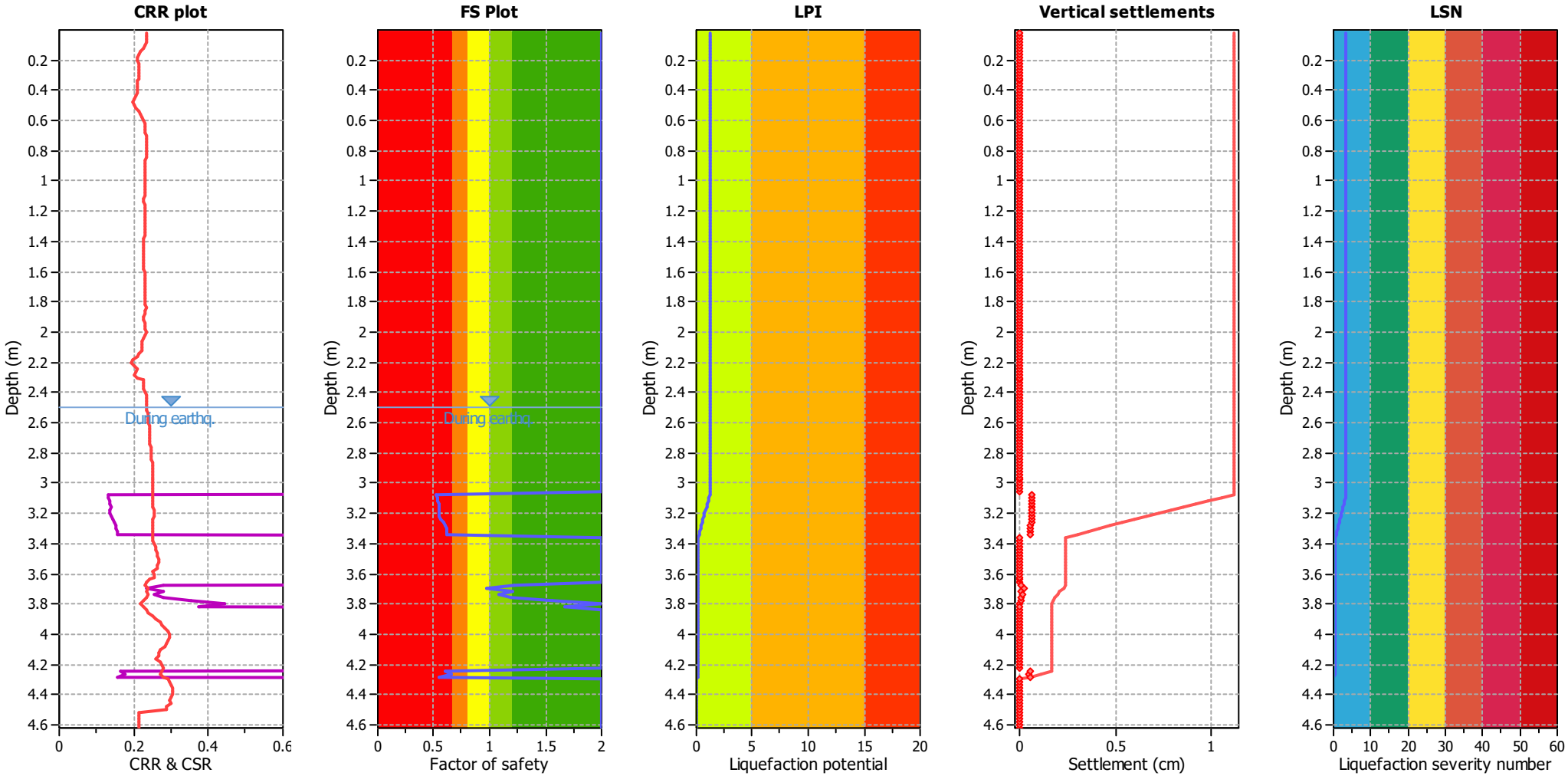
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT09
Total depth: 4.62 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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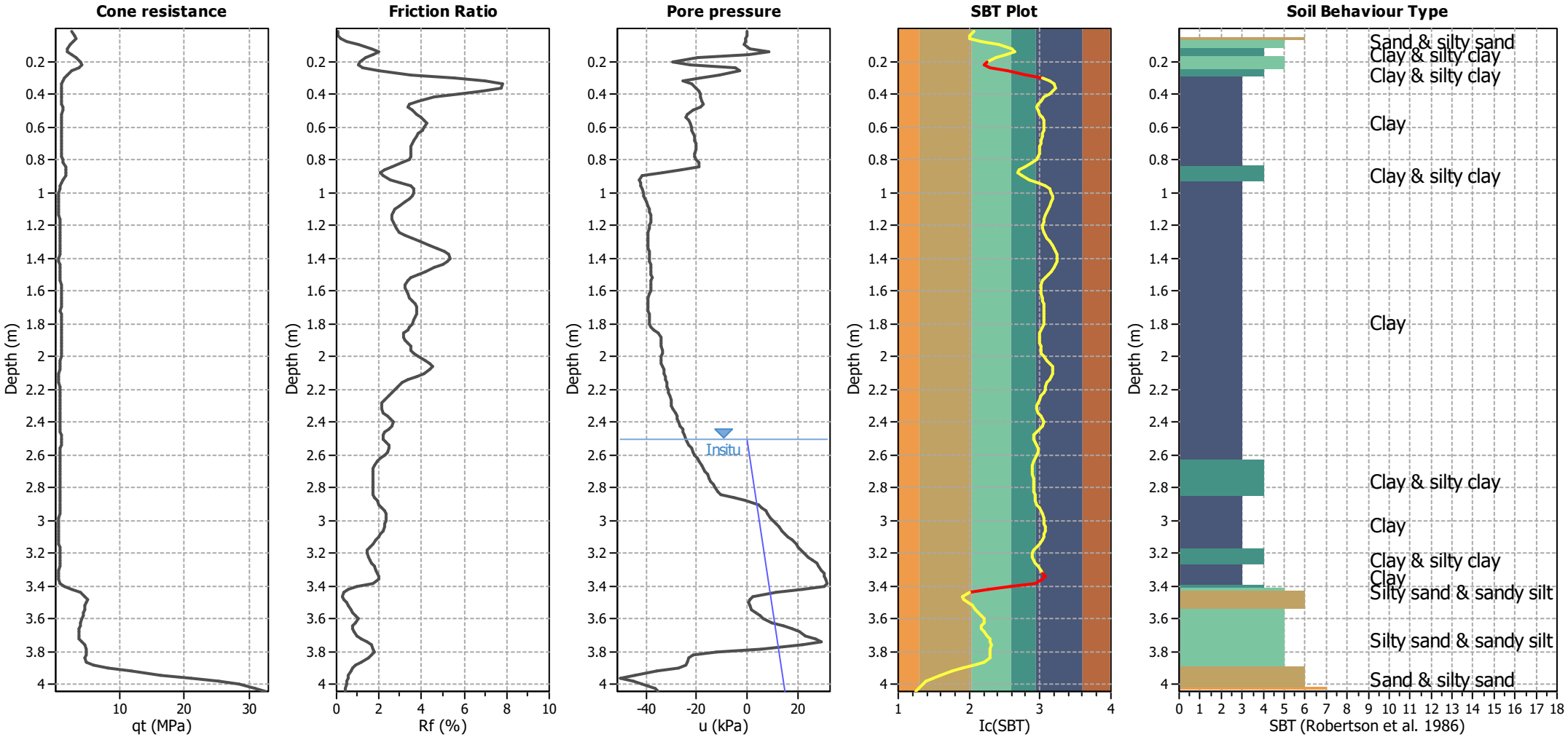
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT10
Total depth: 4.04 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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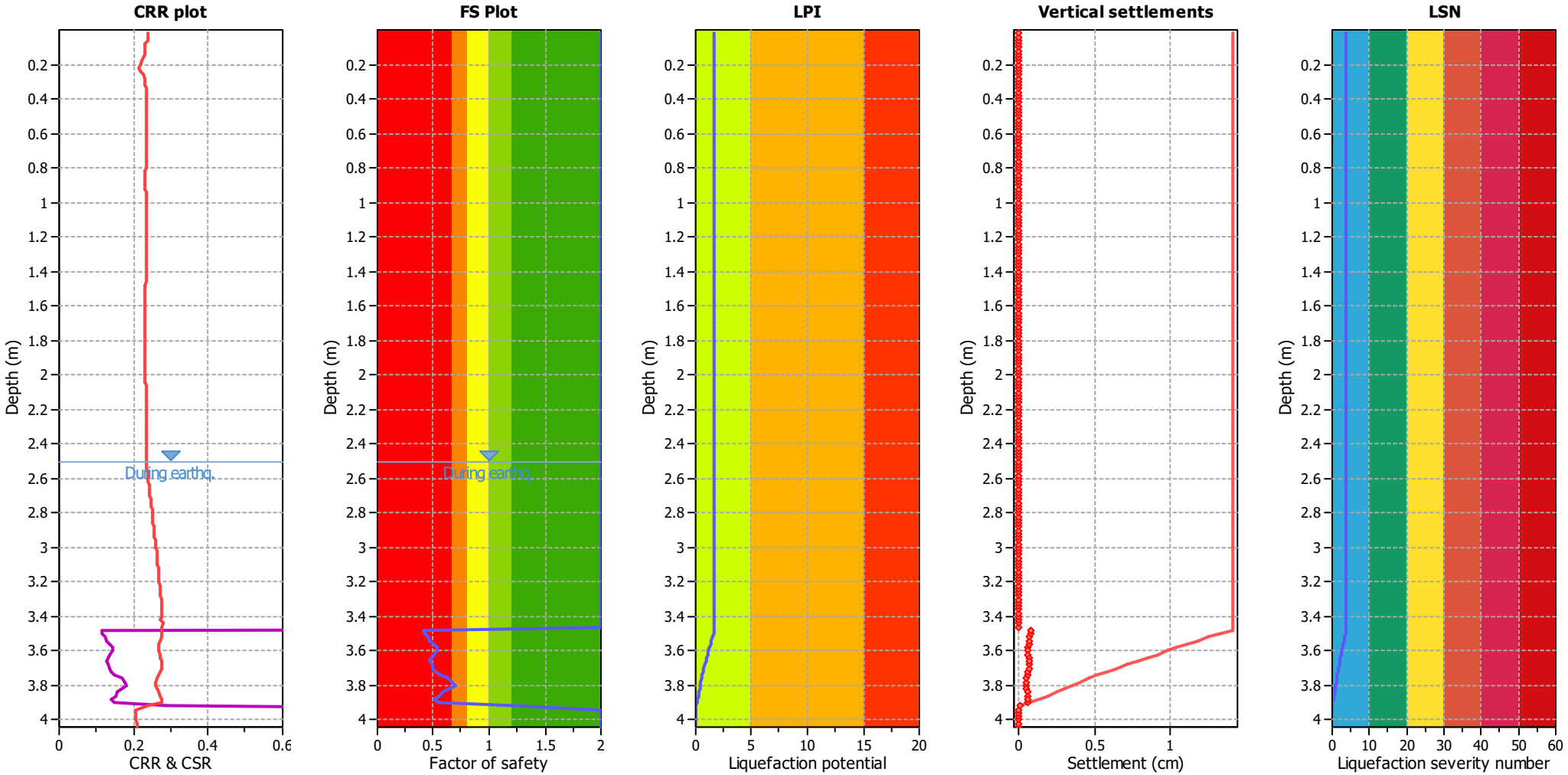
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT10
Total depth: 4.04 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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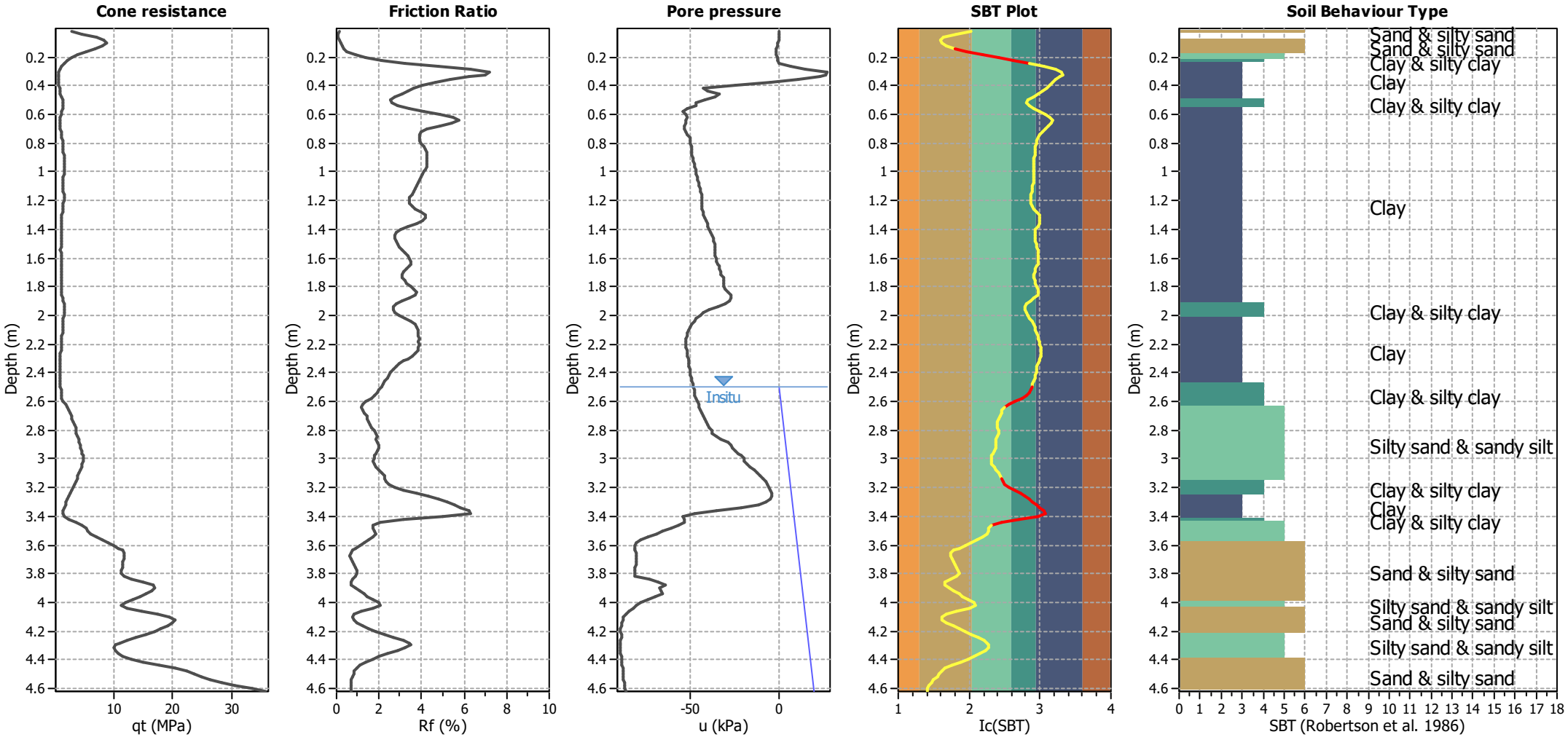
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT11
Total depth: 4.62 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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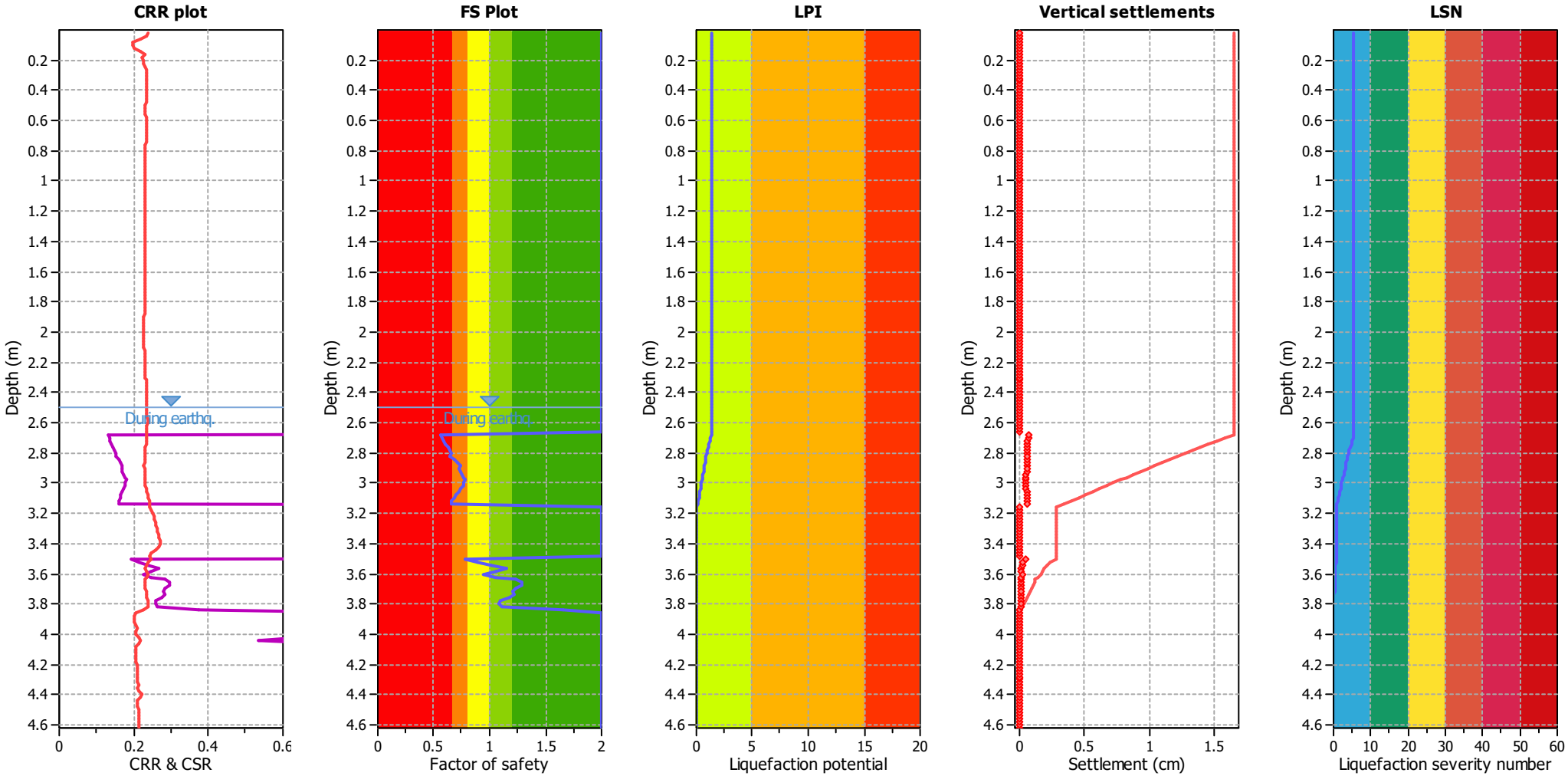
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT11
Total depth: 4.62 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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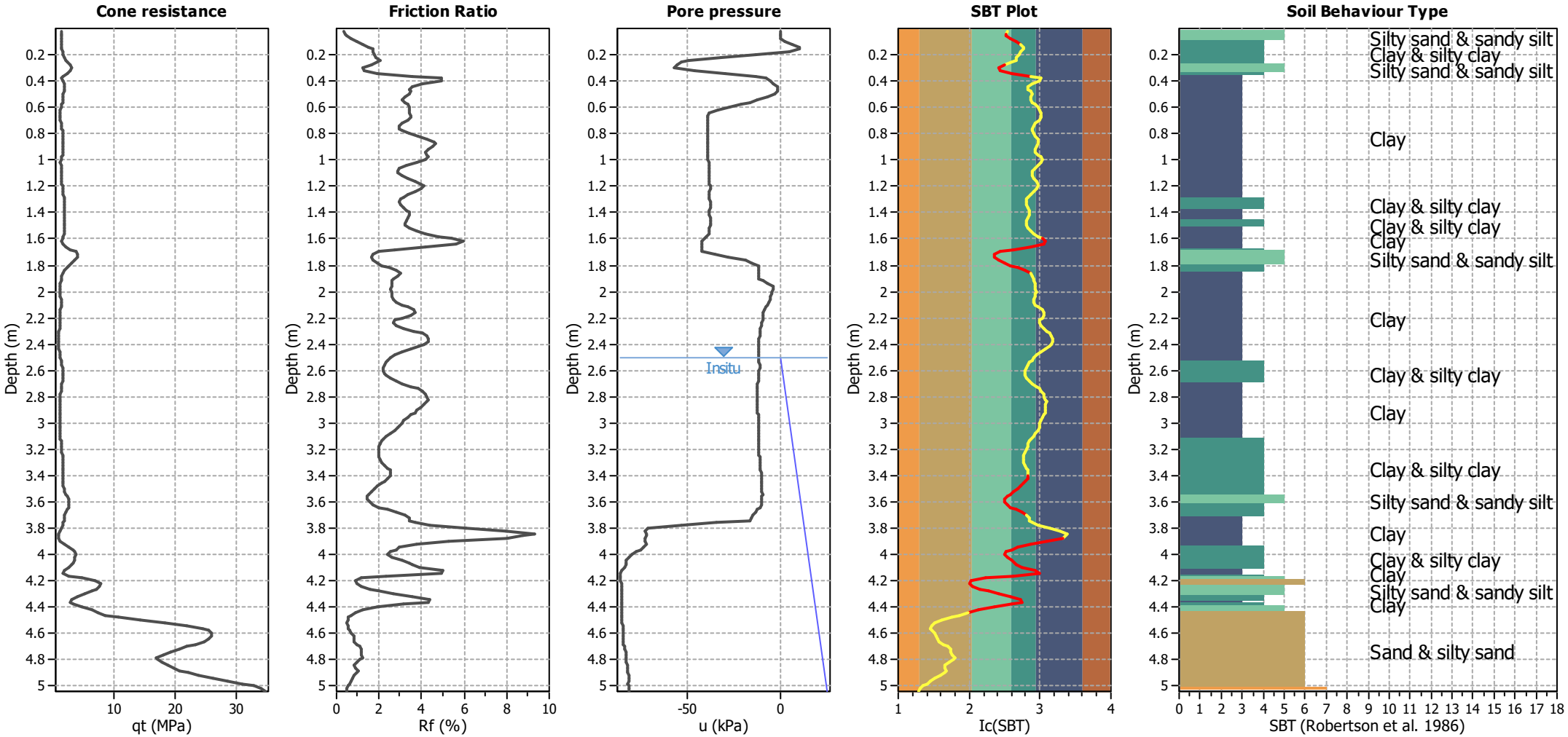
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT12
Total depth: 5.04 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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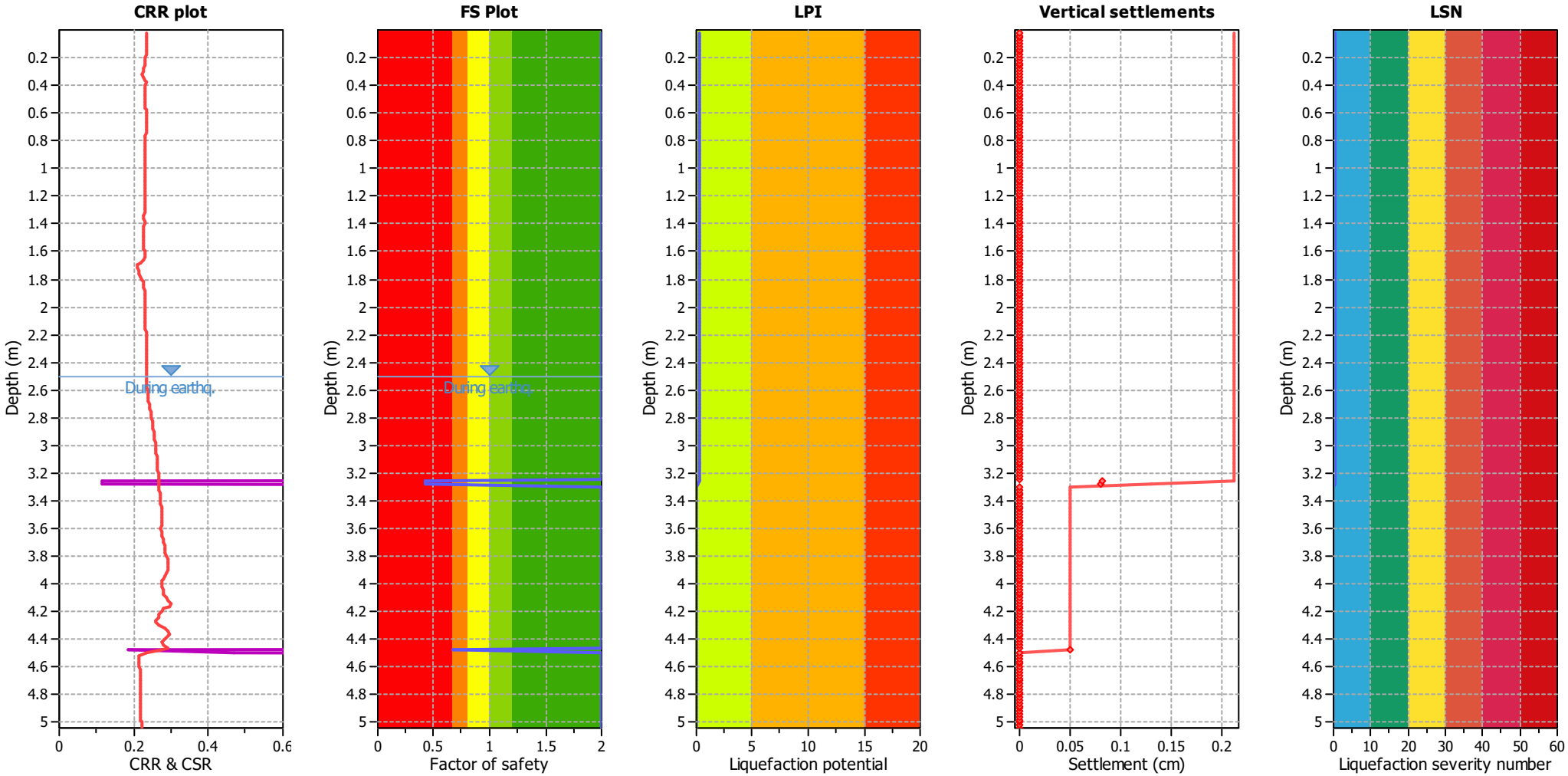
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT12
Total depth: 5.04 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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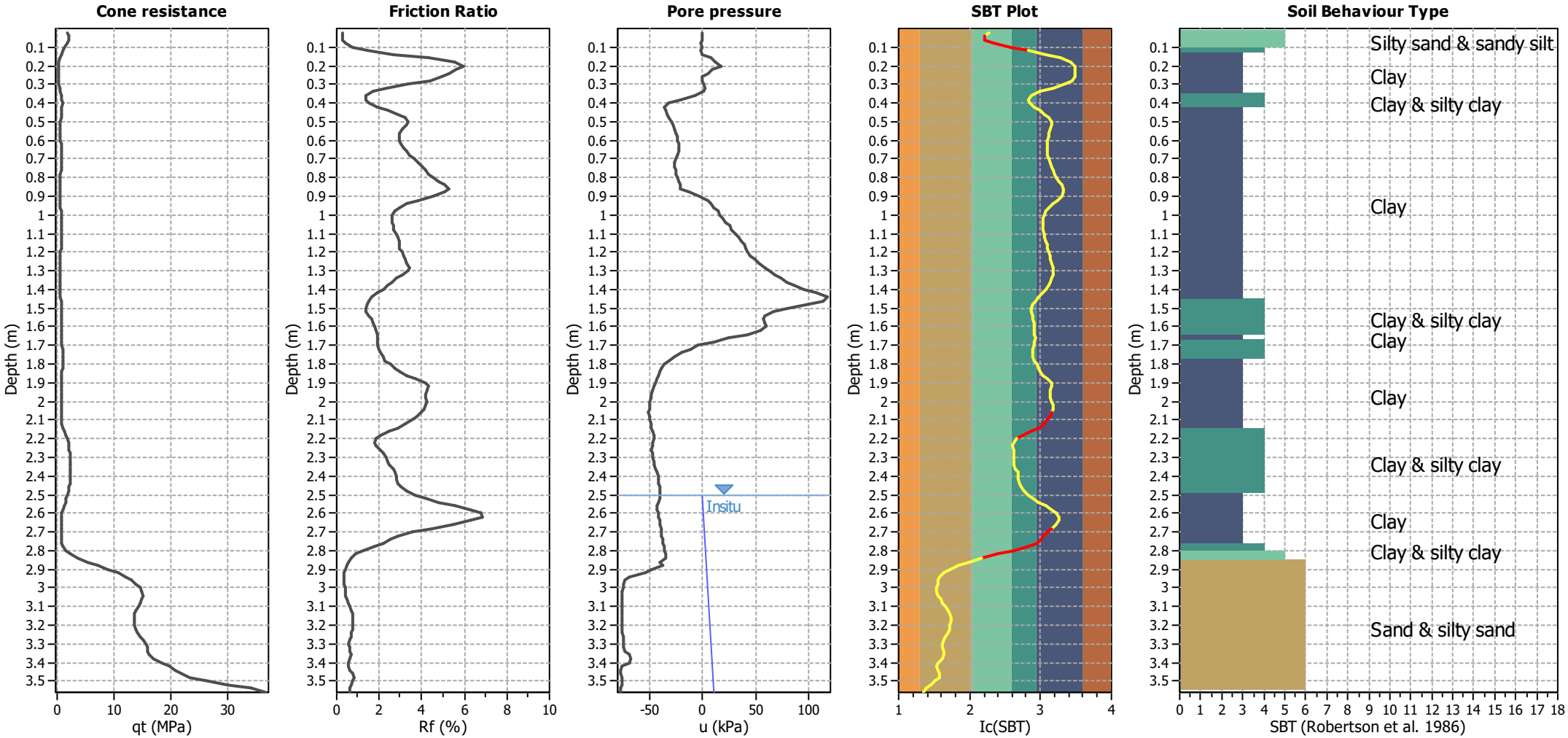
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT13
Total depth: 3.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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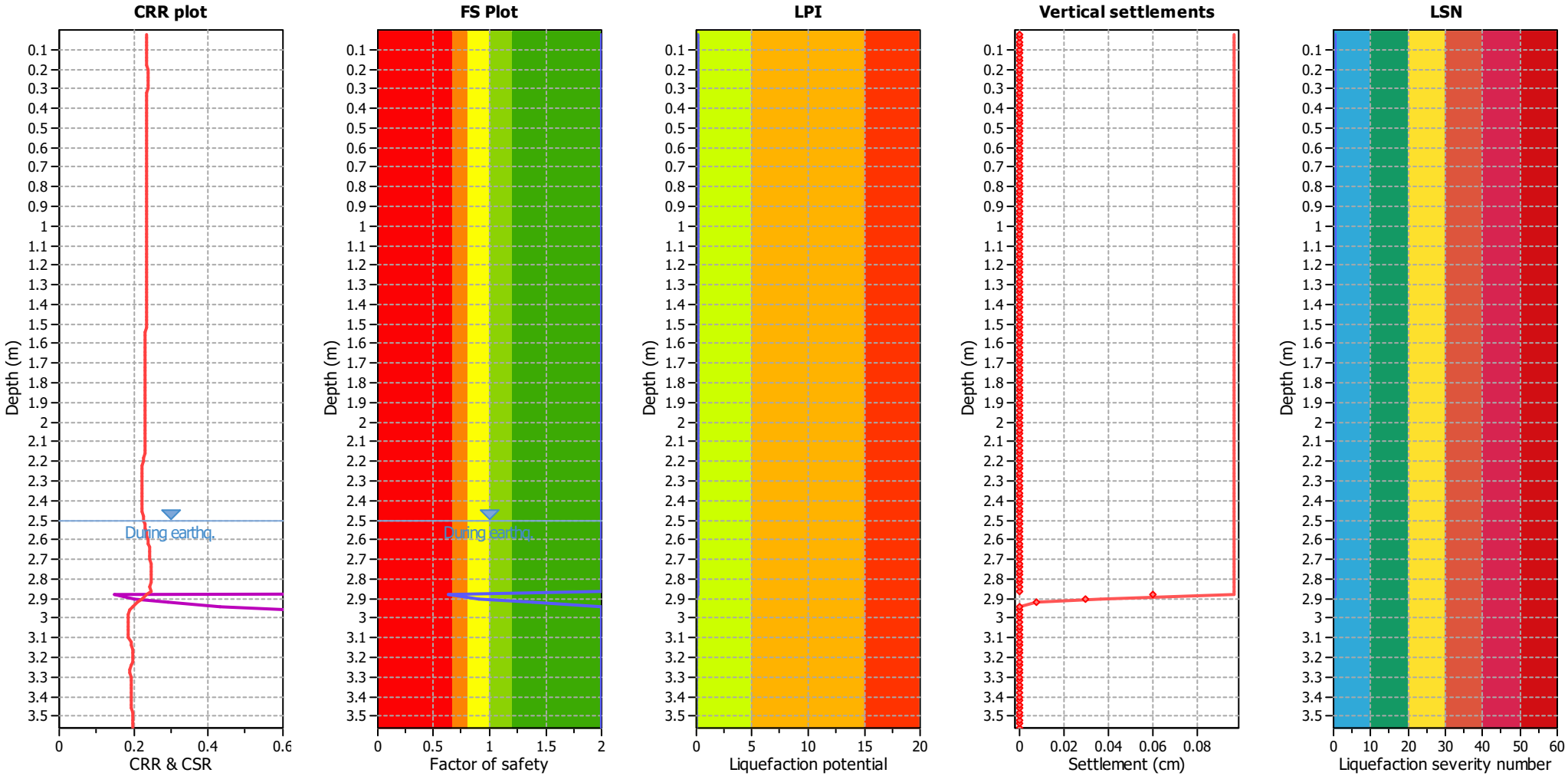
Project: **Brookvale Residential**
Location: **55 Brookvale Road, Havelock North**

CPT: CPT13
Total depth: 3.56 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	2.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	2.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.50	Ic cut-off value:	2.60	Trans. detect. applied:	Yes	MSF method:	Method based
Peak ground acceleration:	0.42	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		