HAWKE'S BAY GEOTECH

Ed Sundstrum C/o Vermont Street Partners No. 4 Limited

GEOTECHNICAL ASSESSMENT REPORT

PROPOSED PLAN CHANGE

174 & 176 Brookvale Road, Havelock North

Prepared & authorized by:

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Project Number:	*25030*
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Client:	*Ed Sundstrum C/o Vermont Street Partners No. 4 Limited*
Project Address:	*174 & 176 Brookvale Road, Havelock North*
Site Legal Description:	*Lot 2 DP 529421, Lot 2 DP 7771, and Lots 1 & 2 DP 16311*

Executive Summary

Hawke's Bay Geotech Limited (HB Geotech) were engaged to undertake preliminary geotechnical investigations and assessments for a proposed Plan Change to residential use, for the parcels of land located at 174 & 176 Brookvale Road, Havelock North (legally described as Lot 2 DP 529421, Lot 2 DP 7771, and Lots 1 & 2 DP 16311). The proposed / conceptual development plans indicate the development may involve the formation of up to 195 Residential lots and may involve significant earthworks including large areas of filling of between 1.0m to 4.0m as well as the re-alignment of an existing ephemeral stream in the east.

Site investigations encountered some areas of weak and / or organic fills as well as some areas of natural organic soils. These were typically in infilled old stream channels and where fill earthworks have been undertaken to form level platforms. Fill depths typically did not exceed 3.0m where investigations were undertaken. Below any topsoil, organics or fill, the natural soils encountered comprise of good strength fine-grained (predominantly silt) alluvial units at surface. These soils were typically underlain by gravels (within 1.0m to 4.0m), however in a localized areas around the centre-south of the site and in the eastern stream channel, finer grained units (expected to comprise of Sandy SILT to Silty SAND) were encountered in CPTs to significant depths (12m-13m).

The preliminary liquefaction analysis indicates that the liquefaction risk within the site is likely to range from low to high and that the site is likely comprise of portions of land which can be considered TC1, TC2 and Hybrid TC2/3. The highest risk appears to be within the localized area where Sandy SILTS to Silty SANDs appear to make up the majority of the soil profile. Further investigations and analysis will be required at later stages to better delineate areas of liquefaction risk however this preliminary analysis is suitable to evaluate the potential risk as being within the typical limits of engineering mitigation measures and residential foundations.

The preliminary static settlement check indicates that the significant depth of fill proposed over the site may lead to excessive settlements (i.e. > 25mm) in areas where the proposed fill depth is greater than ~1.5m. Therefore further analysis and monitoring of areas where there is significant fill (or static settlement potential) will need be undertaken to ensure the majority of settlements have completed before construction of buildings on the lots can begin.

There are several existing cut and fill slopes on the site, some of which have been cut at steep angles and are unlikely to have adequate factors of safety for residential purposes. The proposed plan has taken steps to remediate this by proposing buttress filling with gentle slopes up against the steeper slopes to improve stability. In general the proposed cut and fill earthworks appear to be at suitably shallow gradients and whilst confirmation through additional investigations and analysis will be required at later stages, the risk is considered adequately low at this stage. Any potential risks can be mitigated through typical engineering measures such as retaining walls and alterations to slope configurations etc.

All other geotechnical risks at the site were considered suitably low and can be mitigated through typical engineering measures. Based on our preliminary assessment of the geotechnical hazards affecting the site, and our experience in subdivision earthworks and mitigating engineering measures, we consider that the ground conditions within the proposed Plan Change area for 174 & 176 Brookvale Road, Havelock North are geotechnically suitable for the proposed residential land use as indicated in the Vermont Street Partners Conceptual Masterplan (Draft Rev. 3 – April 2006) and Maven Associates Limited Proposed Earthworks Plans ref. Project No. 135041, Rev A.

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APPENDICES

1 INTRODUCTION

Hawke's Bay Geotech Limited (HB Geotech) were engaged by Ed Sundstrum C/o Vermont Street Partners No. 4 Limited to undertake preliminary geotechnical investigations and assessment for a proposed Plan Change for the parcels of land located at 174 & 176 Brookvale Road, Havelock North (legally described as Lot 2 DP 529421, Lot 2 DP 7771, and Lots 1 & 2 DP 16311). The site location is shown in a local site setting in Figure 1 and in a site-specific setting in Figure 2.

The purpose of this report is to summarise the ground conditions beneath the site, assess the geotechnical risks present, provide our professional opinion as to the suitability of land for residential use, and to provide preliminary geotechnical recommendations pertaining to risk mitigation and development of the site. This report is intended to accompany a Plan Change application to the relevant councils.

Figure 1: Site location in a local setting (HDC Intramaps)

Figure 2: Site location in a site-specific setting (HDC Intramaps)

2 Proposed Development

Based on our review of the Vermont Street Partners (VSP) Conceptual Masterplan (Draft Rev. 3 – April 2006) and Maven Associates Limited (Maven) Proposed Earthworks Plans ref. Project No. 135041, Rev A (excerpts included in Figures 3 & 4) we understand that the proposed development involves:

- Development of up to 195 residential building lots and associated services.
- Cut earthworks of typically between 0.5m to 1.0m to from level platforms, however up to 2.5m of cut is proposed in localised elevated areas along the western site boundary and to form stormwater ponds. Approximately 40,000m^3 of topsoil stripping and 40,000m^3 of in-situ cut material.
- Fill earthworks typically ranging between 0.5m to 2.5m but up to 4.0m in a localised area in the west of the site. Approximately 148,000m^3 of fill.
- Re-alignment of the existing ephemeral stream in the eastern portion of the site involving cut earthworks in the order of 2.5m and filling of up to 4.0m.

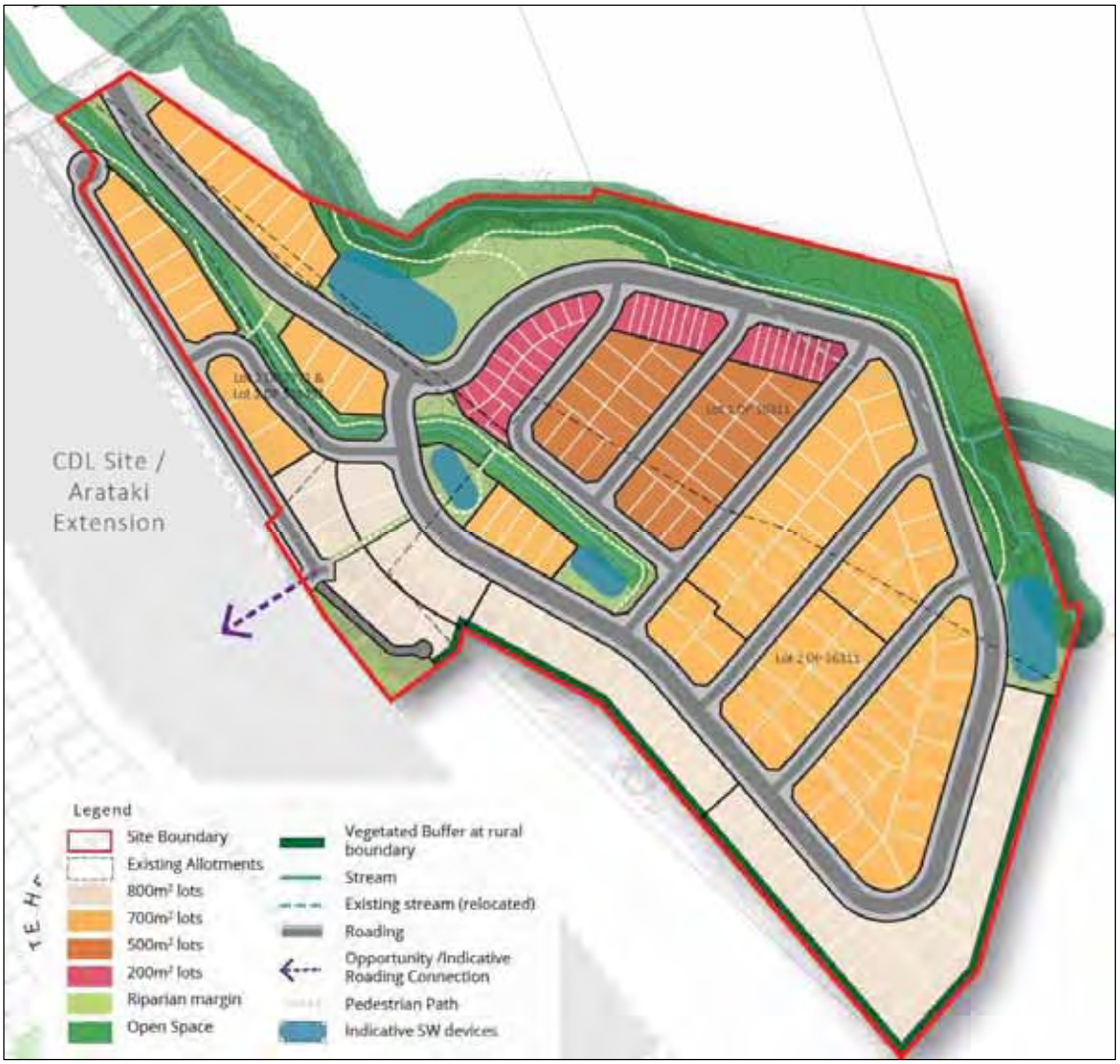

Figure 3: Excerpt from VSP Conceptual Masterplan

Figure 4: Excerpt from Maven Associates – Proposed Cut/Fill Plan

3 Site Study

3.1 Site Setting

The site is located within Havelock on relatively flat ground which has formed from the deposition of river transported materials, predominantly from the Tukituki River which is located about 1.2km east of the site.

The ground level generally rises gently across the site from ~RL10 (NZVD 2016) in north to around RL15 in the south-east of the site. Along the western site boundary there is significant sloping ground which leads up to the higher elevated alluvial terrace to the west. Some of the slopes have been cut back at steep angles (i.e. >35°) and the natural slopes are typically moderate (i.e. between 20° to 30°). There is an ephemeral stream which runs through the eastern portion of the site and the invert of the channel is approximately 3m below the surrounding land. To the east of the site, the ground levels are similar or slightly lower where a younger river terrace is located.

The site is currently used for commercial and agricultural purposes with several businesses operating out of the existing buildings on site and most of the undeveloped land being used for growing young trees. There is significant existing infrastructure on site including:

- Multiple large sheds and many smaller commercial sheds.
- Existing treatment ponds,
- A residential dwelling / office,
- Several overland stormwater drains – conveying overland flows to the eastern ephemeral stream.

Figure 5 includes recent aerial imagery of the site indicating the existing infrastructure. Figure 6 includes an excerpt from the Maven Associates - Preliminary Infrastructure Report which indicates the location of historical channels on site as well as the locations of current natural and artificial channels.

Figure 5: Aerial Imagery acquired April 2023 indicating the current commercial infrastructure on site.

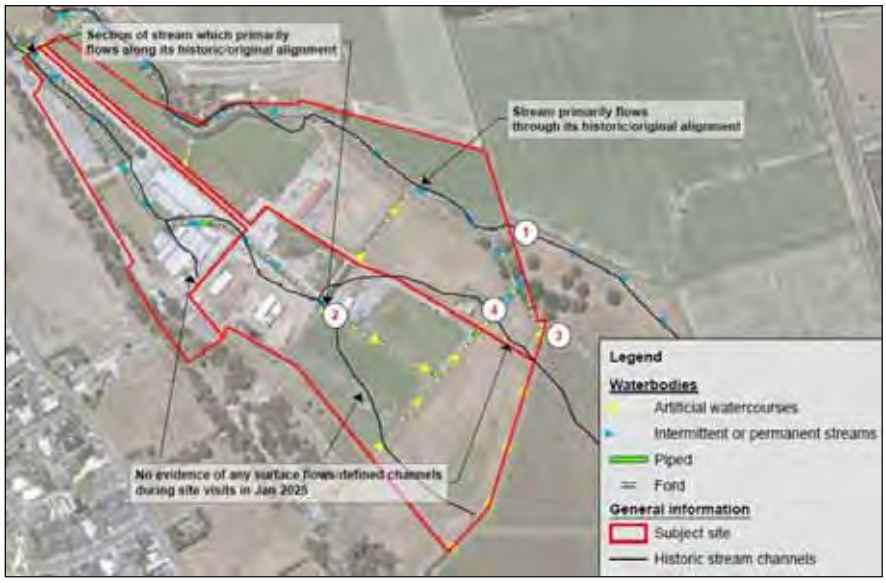

Figure 6: Excerpt from the Maven Associates - Preliminary Infrastructure Report indicating historical & current natural and artificial overland flow channels.

Recent site photos of some key areas of the site are included in Figures 7-21.

Figure 7: Photo from the elevated south-western platform.

Figure 8: Photo of the central area of the site - viewing east from the elevated south-western platform.

Figure 9: Photo of the southern portion of the site – viewing south-east from the elevated south-western platform.

Figure 10: Photo of the north-western elevated platform – Note the steep cuts in the bank.

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Figure 13: Photo of the south-western elevated platform and steep cut slopes in the bank.

Figure 14: Photo of the south-western slopes.

Figure 15: Photo of an existing treatment pond in the centre west of the site.

Figure 16: Photo of the southern portion of the site – viewing south-west.

Figure 17: Photo of the south-eastern portion of the site.

Figure 18: Photo of the eastern ephemeral stream which is proposed to be diverted and infilled in this area.

Figure 19: Photo of the north-eastern portion of the site – viewing south-east.

Figure 20: Photo of the Northern portion of the site – viewing south-west.

Figure 21: Photo of the site entrance and western stream where it leaves the site and crosses beneath Brookvale Road.

3.2 Previous Reports

As part of our assessment we have reviewed the following reports which should be read in conjunction with this report. The reports are included in Appendix A.

- Tonkin & Taylor (T&T) Geotechnical Investigation Reports for Commercial Developments at Te Mata Mushroom Farm, Havelock North, dated June 2013 & July 2020, referenced 29272 & 1014649.V1 respectively.
- Land Water People (LWP) Site Investigation Report ref. HBT021, dated 10 November 2022 which refers to the investigations and assessment for an application for earthworks consent with respect to a now infilled stormwater pond.

The T&T geotechnical investigation data and assessments have been used to assist the assessment of the site and therefore, have been indicated alongside our test locations in the Test Location Plan. The investigation results however are only included in the appended reports to avoid double ups and to ensure results are kept with the relevant reports.

The information included in the LWP investigation has also been used in this report to identify the location of the infilled stormwater pond as well as to assess the potential uncertified fill depths within the area, and the natural soils expected below.

3.3 Published Geology and Geotechnical Hazards

The Hawke's Bay Regional Council Hazards Portal, GNS Active Faults Database and GNS Geological Maps were reviewed as a part of this desktop study.

The hazard portal indicates that the primary geological hazard associated with the site is liquefaction, with the site mapped within a 'medium' vulnerability zone.

The GNS online maps vary:

- The 1:250,000 scale online web maps indicate the southern half of the site is underlain by Middle Pleistocene to Late Pleistocene River deposits (comprising of moderately weathered undifferentiated poorly sorted loess-covered alluvial gravel deposits), and the north of the site by more recent Holocene River deposits comprising predominantly of poorly consolidated alluvial gravel, sand, and mud.
- The most recent (2020) geological maps (1:75,000, GNS Science geological map[1]) indicates that the site is entirely within the Middle to Late Pleistocene River deposits (am) comprising of gravel, sand, and silt.

Given the scale of the mapping and our site observations, we consider that the more recent (1:75,000 scale) maps are likely more accurate as to the deposits in the area.

No active faults are mapped within or within close proximity to the site.

[1] Lee, JM, Begg JG, Bland KJ 2020. Geological map of the Napier-Hastings urban area: scale 1:75,000, GNS Science geological map 7a.

3.4 HISTORICAL AERIAL IMAGERY

A review of the Crown Historical aerial imagery archive was undertaken through the HDC Intramaps and Retrolens along with more recent imagery via Google Earth Pro and Land Information NZ (LINZ).

The earliest available imagery from Retrolens was acquired in 1950 (Figure 22) and indicates that the site was used for predominantly pastural purposes at this time. The north-western and south-western elevated platforms appear to have not been constructed at this stage. Cut and fill earthworks were likely undertaken at later stages in this area.

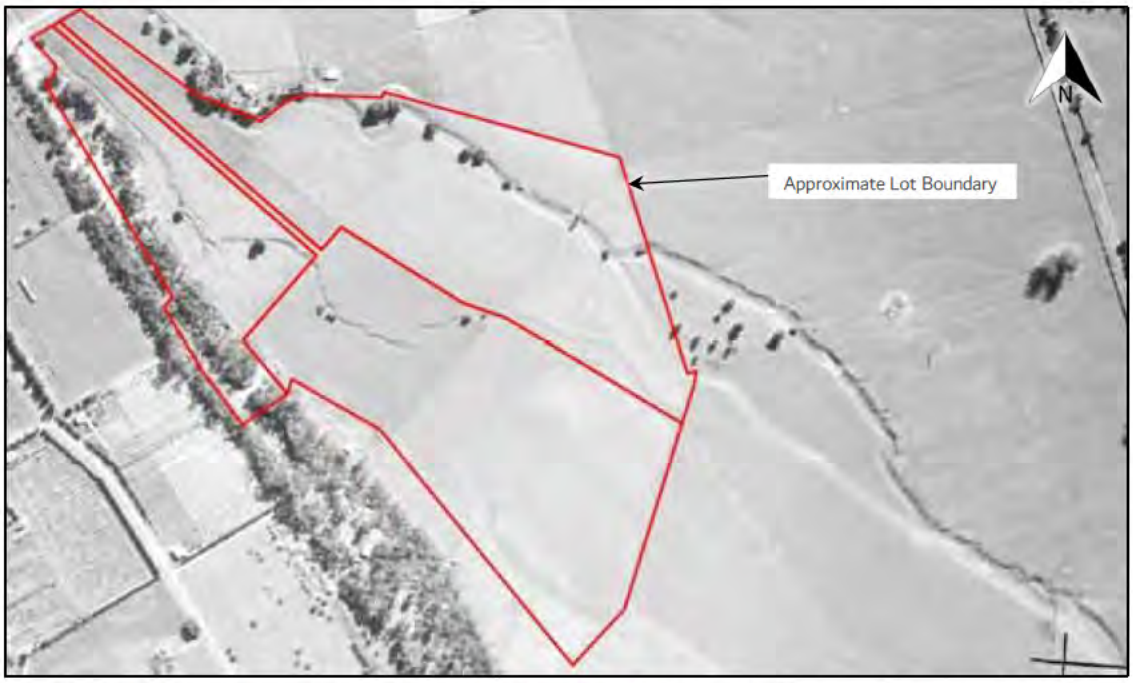

Figure 22: Historical aerial image of the site (1950) – Maven Associates (Preliminary Infrastructure Report)

No significant changes were noted until around 1980 when development of commercial buildings began, and a small dam was constructed on one of the contributing overland flow paths which leads to the eastern ephemeral stream. Aerial Imagery indicating the small dam from 1980 is included in Figure 23.

Figure 23: Historical aerial image of the site (1980) – Maven Associates (Preliminary Infrastructure Report)

Further review of historical imagery indicates that further commercial development occurred within 174 Brookvale Road over the 1980's and much of the pastural land, predominantly 176 Brookvale Road, was converted to horticultural use.

A review of more recent aerial imagery (post 2009) via Google Earth Pro has identified the following features which are indicated in Figure 24 and in further detail in Figures 25 & 26.

- North-eastern elevated platform - There has been some cut and fill earthworks in this area to form the current platform.
- Central Commercial Area – Infilling of the old stream channel (as indicated in Figure 25).
- Central North – Potential for shallow fill in this area from stockpiles laid out over the area.
- North-eastern Fill – Infilling of the old ephemeral eastern stream channel where and oxbow had formed (refer to Figure 26).
- Some ponding of water (in image post Cyclone Gabrielle) in the south-west of the site where an old channel is located.

Figure 24: Recent aerial imagery with the locations of historical filling or potential filling, and ponding.

Figure 25: Recent aerial imagery indicating historical infilling of the channel in the centre of the site.

Figure 26: Recent aerial imagery indicating historical infilling of an old oxbow in the eastern ephemeral stream.

4 Site Investigations

4.1 Available Deep Information

It is noted that there are a significant number of Wells across and close to the site which have been logged during drilling. The logs are typical suitable to identify fine-grained soils, sand and gravels at approximate depths. The well logs have been reviewed and interpreted in order to gain a preliminary understanding of the deeper soil profile and to supplement the two 10m deep boreholes, CPT test, and the 6m deep test pit which have been undertaken on the site. The well log locations are indicated in Figure 27 and include a brief summary of the soils logged. The complete Well Logs are included in Appendix B along with our test information.

Figure 27: Recent Well Log Locations and Log Summaries.

4.2 Previous Site Investigations

Previous site investigations have been undertaken by T&T for the site and are indicated alongside our testing in the Test Location Plan (Figure 28). T&T Site investigations were undertaken in June 2013 & July 2020, and included:

- 2 Machine Boreholes (BH) undertaken to depths of ~9.2m with SPT tests at 1.5m intervals.
- 4 Cone Penetration Tests (CPT) undertaken to depths of between 2.4m to 4.6m due to refusal in dense gravel units.
- 8 Test Pits (TP) to between 3.8 to 4.0 m below ground level.
- 6 Scala Penetrometer Test (S), undertaken to depths of between 1.7m to 4.4m below the current ground level, refusing in very dense soils (with the exception of Test S6 which refused at shallow 0.35m).

The site investigation logs for the T&T investigations are included with the relevant reports (referenced 29272 & 1014649.V1) in Appendix A.

4.3 Current Site Investigations

Site investigations were undertaken by HB Geotech between the 21st to the 27th of May 2025 in overcast conditions following some rainfall the days prior.

Field investigations included:

- A site walkover assessment of the immediate surrounding area and setting out of the test locations using approximately georeferenced plans and a hand-held GPS.
- 6 Cone Penetration Tests (CPT) were undertaken to a maximum depth of 13.1m or refusal. A Dynamic Super Heavy Penetrometer (DPSH) tests was undertaken in CPTs 9, 10 & 11 which refused at shallow depths (i.e. < 5.5m). The DPSH test typically refused within 1.0m of the depth at which the CPTs refused.
- 9 Augered boreholes (HA), undertaken using a 50mm hand auger. HA08 comprises of a combination of face logs and sampling with the hand auger. HA02 - HA06 also had Scala Penetrometers tests undertaken either adjacent to, or in the base, of the hand augers.
- 7 Test pits were undertaken typically to depths of 4-5m, however at TP12 a deep pit was attempted which achieved a depth of 6.0m.

The test locations for the HB Geotech investigations are indicated in Figure 28 along with the locations of the Wells on site and our cross-section locations. The HB Geotech site investigation & CPT logs are included in Appendix B.

As discussed in the previous section, the test locations of the T&T investigations are also included in the Test Location plan (Figure 28) and the investigation logs are included in the Appendix A along with the relevant reports (referenced 29272 & 1014649.V1).

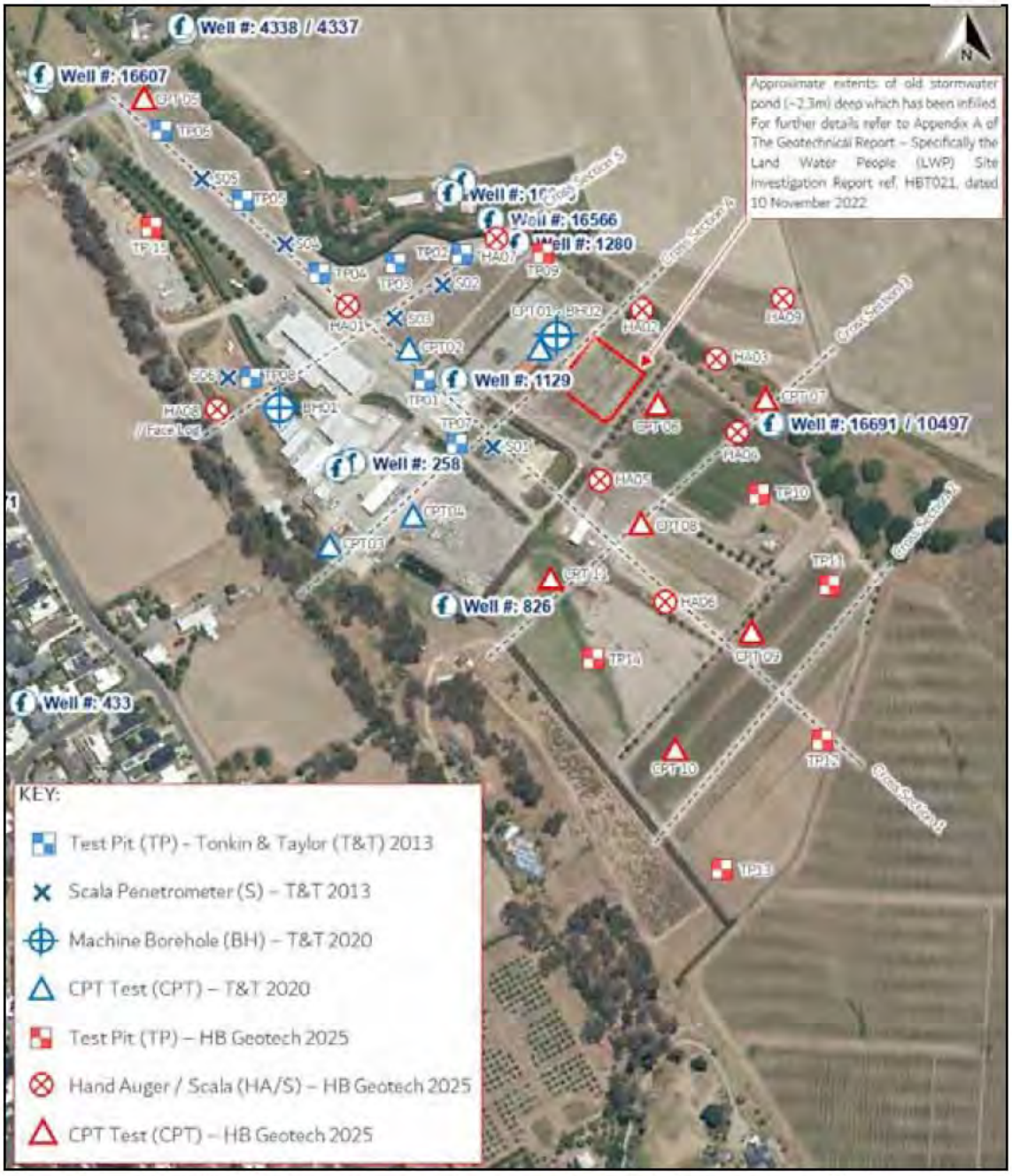

Figure 28: Test Location Plan – Including previous Tonkin & Taylor Investigations (blue)

5 GROUND CONDITIONS

Our interpretation of the ground conditions beneath the site are summarised in this section. The ground model is preliminary only and has been based on available information and subsurface data obtained at discrete locations at a particular time. It should be noted that due to the often complex and variable nature of the ground and groundwater, conditions between the investigation points may vary from those inferred in this report. All depths are below the current site level at the time of investigations unless otherwise stated.

5.1 GROUNDWATER

Groundwater levels varied across the site but generally were in the order of ~2.0m below ground near the entrance from Brookvale Road (Land RL ~9.5) and increased in depth to around ~4.0m in the centre of the site (Land RL ~11.5) and again increased in depth to ~6.0m at the southern end of the site Land RL ~14-15). Given the change in elevation of the land, the groundwater appears to typically lie around RL7.5 to RL8.5. There were some localized areas which had higher levels, in particular in the south-west of the site where there appears to have been an old stream channel. Groundwater here was logged in TP14 at -2.0m correlating to ~RL10.5 and in CPT11 at -0.9m correlating to ~RL11. The higher groundwater in the west may also indicate groundwater recharge coming from the more elevated river terraces to the west of the site.

Groundwater levels in the eastern ephemeral stream are expected to typically be between 1.0m to 2.0m below the invert of the channel under prevailing conditions. The stream is only expected to flow during significant rainfall events with high intensities (similar to Cyclone Gabrielle) or following significant wet weather events with long durations where elevated groundwater levels may occur.

5.2 SITE STRATIGRAPHY

Five preliminary ground models have been developed for the site based on the information available at this point. The ground models are included in Appendix C of this report and are also discussed briefly in the following section.

Topsoil, Fill & Shallow Organic Soils:

Topsoil

Topsoil was encountered across the majority of the undeveloped portion of the site and in the more developed areas, has typically been replaced with gravel fills and hardstand areas.

Uncertified Fill

Uncertified fill including organic fill was encountered in several areas across the sites and are discussed briefly below.

- North-eastern elevated platform – Cut and fill earthworks have been undertaken with the eastern portion of the platform comprising of fill. TP15 (Appendix B) was undertaken in this location and encountered poorly compacted fill and organics to ~3.0m depth. The fill depth is likely to vary in depth and composition across the area. Fill image included in Figure 29.
- Central Commercial Area – Infilling of the old stream channel (as indicated in Figure 25 – Section 3.4). This area was not tested but is expected to comprise of poor-quality uncertified fill.
- Central North – Potential for shallow fill in this area from stockpiles laid out over the area based on historical imagery (refer to Section 3.4 for indicative locations).
- North-eastern Fill – Infilling of the old Ephemeral eastern stream channel where and old oxbow had formed (refer to Figure 26 – Section 3.4). HA07 (Appendix B) was undertaken in this location and encountered very weak organic fill to around 2.4m which was underlain by firm organic silty soils to ~3.0m where gravels caused refusal of the test. Fill image included in Figure 30.

Figure 29: Site photo of uncertified fill – TP15 - North-eastern elevated platform.

Figure 30: Site photo of uncertified fill – HA07 – In-filled Old Eastern Stream Channel.

Natural Soils:

The natural soils covering the site comprise of alluvial deposits which tend to vary in thickness across the site. The units appear to generally be continuous, however some fine-grained units were encountered in the south-central portion of the site (CPTs 07, 08 & 09) and these deposits appear to be more localized. The Alluvial soils encountered typically comprise of the following:

Shallow Organic Soils

Natural organic soils were typically only encountered in the base of the ephemeral stream but may still be present elsewhere on site, particularly where old channels were present or have been infilled.

The organic soils typically are blackish brown to dark grey and generally comprise of silts which have an organic odour (but little observable plant matter). There were also some shallow weak gravel layers with organic silts present. The organic soils were present to depths of between 0.8m to 1.7m in the ephemeral stream base.

Very Stiff to Hard Fine-grained Units – Typically Sandy SILT to Clayey SILT.

This unit is generally encountered across the site beneath any topsoil, fill or shallow organics. The unit is typically thickest in the centre of the site (up to 4.0m) and is thinner towards the north (near Brookvale Road) where it was around 1.5m-2.0. This unit becomes very thin in the southern third of the site (Test Pits 11-14) where it was typically less than 1.0m thick. The thickness of the unit is more consistent across the site (west to east). This unit is typically yellowish brown to light greyish brown and often has minor to slight orangish brown mottling. Undrained shear strengths in this unit were consistently in excess of 100kPa, generally 150kPa or more, and often greater than 200kPa.

GRAVEL Units

This unit is generally encountered below the fine-grained units discussed above at depths ranging from ~0.5m to just over 4.0m. The upper 1-2 meters of the gravels tend to comprise of a Sandy GRAVEL with minor silt and minor to trace clay. With depth the gravels typically become coarser and have minor sand, silt and sometimes trace clay. Given the difficulty in advancing testing through this unit and limitations of reach for test pits, we have had to rely on the available borehole data primarily as the Well Logs typically only indicate whether the soils are gravel or not (with very little detail).

The GRAVELs extend for a significant depth below the site and typically make up the majority of the soil profile. At depth they are typically interrupted by 1-2 relatively thin, finer-grained units (silt and/or clay), however in the south-centre of the site (Cross Section 03) finer-grained units such as Sandy SILT or Silty SAND are much more prevalent (making up the majority of the upper 10m of the soil profile). The gravel units in this location are thinner and more interbedded with the finer units. We recommend that the reader refer to the ground models included in Appendix C for further detail.

Saturated, Finer-Grained Soils (Potentially Localized)

As discussed briefly above, several layers of a finer-grained (Sandy SILT or Silty SAND) soil were encountered in CPTs 07, 08 & 09. It should be noted that only CPT data is available for this unit and therefore the soil types are inferred from the recorded properties. Confirmation of the soils type will assist in developing ground models at later project stages.

At this point these units are considered to be localized (north to south) as indicated in Cross Section 01, but appear to be laterally continuous across the site (west to east) as indicated in Cross Section 03. It should be noted that the lateral extents are vaguely understood due to other CPT tests refusing at shallow depths in the gravels (which may be underlain by a continuation of this unit), however the available Well Logs and previous T&T Machine Boreholes to the north, indicate these units are unlikely to continue further north than the centre of the site (approximately the location of Cross Section 4). The extents of the units further south are unknown due to the lack of deeper information in the area (refer to Cross Section 01), however if present, this unit must continue at a significantly deeper depth given that TP12 (near the southern boundary) encountered gravel units to >6.0m depth.

Deep Fine-grained Soils

As discussed briefly within the GRAVEL unit description, there are some deep fine-grained soils (clay and/or silt) which are interbedded with the GRAVEL unit. These are typically present below 10m and therefore are based on the Well Logs. For this reason there is little data on the soil properties. Given these soils have been logged during drilling of wells, we consider they are only suitable to indicate the presence of fine-grained units and are not suitable to differentiate between clays and silts. For the depth and distribution of these units we recommend the reader refer to the ground models in Appendix C.

5.3 Site Soil Class

Based on available information, the geological setting, and out preliminary assessment, we consider the site is most appropriately designated a Class D “Deep Soil” site as defined by NZS 1170.5 (2004) “Structural Design Actions: Part 5: Earthquake actions – New Zealand”.

6 HAZARD ASSESSMENT

The following section summarises our assessment of the geotechnical hazards considered to be affecting the subject site and the potential risk that these present to the proposed development with respect to ground deformation and land stability.

6.1 SEISMICITY

The Ministry of Business Innovation & Environment (MBIE) Guidelines for Earthquake Geotechnical Engineering Practice in New Zealand Module 1, November 2021, provides guidance on estimating magnitudes and peak ground acceleration (PGA) in accordance with the Building Act.

For seismic analysis in this report, we have adopted Method 1 from the MBIE Module 1, which recommends the use of estimated parameters from the National Seismic Hazard Model (NZHM). The ground motion values adopted are provided in Table 1 and are based on the return periods provided in Table 3.3 of 1170.0:2002 (Structural Design Actions) assuming an Importance Level 2 (IL2) structure with a 50-year design life. An Intermediate Limit State (ILS) corresponding to a return period of 1/100-years has also been included to assist in understanding the potential effects of liquefaction for lower magnitude but higher probability events.

Table 1: Adopted Ground Motion Parameters for Liquefaction Analysis

Limit State	Return Period	Annual Exceedance Probability	Peak Ground Acceleration (PGA)	Magnitude
Serviceability Limit State 1 (SLS1)	1/25 year	4%	0.12g	6.4
Intermediate Limit State (ILS)	1/100 year	1%	0.26g	6.7
Ultimate Limit State (ULS)	1/500 year	0.2%	0.58g	7.1

6.2 LIQUEFACTION

A preliminary liquefaction assessment has been carried out by reviewing the T&T 2020 Geotechnical Report (Appendix A) and by analyzing the HB Geotech CPT data recorded from site with the simplified method based on Boulanger and Idriss (2014), in accordance with the recommendations set out in the MBIE Earthquake Geotechnical Engineering Practice – Module 3, November 2021.

Proprietary geotechnical software (CLiq) was used for the calculations and the peak ground accelerations and magnitudes provided in Section 6.1 were adopted. The default soil behavior type index (Ic) cut-off of 2.6 was adopted and soil unit weights were automatically calculated based on SBT values. Liquefaction-induced free-field vertical volumetric strains were estimated based on Zhang et al. (2002). A lateral spreading assessment was not considered necessary given the sites geographical location and topography.

Site-specific fines testing was not undertaken but investigations typically encountered fine grained units. The fines fitting parameter C(FC) was set to zero for initial analysis and a sensitivity check was undertaken by adjusting the C(FC) value to 0.2. No corrections were made to the input data with respect to transition effects as the soil layers typically transitioned between liquefiable units and as such, care is

required in applying the transition effects in order to not exclude units that may liquefy from the assessment.

The groundwater levels encountered on site were adopted as the prevailing level and are expected to be typical or slightly higher than typical given on the time of year and the rainfall in the month prior to fieldwork. We appreciate that at times groundwater may rise above this level, however we consider that this would only result from storm events with their own annual exceedance probability which should not be considered in conjunction with another exceedance probability (i.e. seismic events) as the probability of such events occurring simultaneously is considered highly unlikely. As some elevated levels were noted around CPT08 and the groundwater level here was not measured, a sensitivity check was undertaken assuming an elevated groundwater level of 2.0m.

6.2.1 Liquefaction Results & Discussion

The results of the preliminary liquefaction analysis are included in Appendix D and discussed below. It should be noted that *some* results may be low due to the CPT's being unable to advance through the shallow gravel layers (i.e. beyond 4-5m). In general, we consider that the results for CPTs 06, 09, 10 & 11 may not be indicative of potential liquefaction effects as these test sites may be underlain by liquefiable units at depth. Further investigations and analysis will be required at later stages to better delineate areas of liquefaction risk however, this preliminary analysis is considered suitable to assess whether the risk is within the limits of typical engineering mitigation measures.

Serviceability Limit State

Results indicate that negligible to very low liquefaction triggering is expected under the SLS (1:25yr) case with no SLS settlements exceeding the limits of a TC1 Site.

Intermediate Limit State

- Northern half of the site - Analysis indicate that negligible to very low liquefaction is expected (likely a TC1 Class area).
- South-centre and old stream channel (Cross Section 03 / CPT08 & CPT07) - Analysis indicates that significant liquefaction may trigger in the Sandy SILT to Silty SAND units which at CPT07 & 08, makes up the majority of the soil profile to ~12m below ground. For CPTs 07 & 08 respectively, the LSN Values are 25 & 18, and settlements are estimated to be 170mm – 150mm (or 120mm – 90mm when indexed / limited to 10m depth).
- Southern portion of the site – Analysis indicates little to no potential in the upper 5-6m of the soil profile but the soils below this depth are unknown and liquefiable units may be present. However, the upper 5m of the profile in this area typically comprises gravel and any liquefaction effects in the deeper soils are highly unlikely to cause effects greater than those identified in the south-centre of the site (Cross Section 03 location).

Ultimate Limit State

Under Ultimate Limit State conditions the effects of liquefaction are slightly greater but remain localized to the south-central area, eastern stream channel and *potentially* the southern portion of the site (as discussed above). For CPTs 07 & 08 respectively, the LSN Values are 35 & 25, and settlements are estimated to be 200mm – 185mm (or 150mm – 120mm when indexed / limited to 10m depth). Hybrid TC2/3 site conditions

The sensitivity analysis where the C(FC) value was adjusted to 0.2 indicated a reduction in free-field volumetric settlements with ULS indexed values (limited to 10m depth) being between 140mm (CPT07) to 115mm (CPT08). We consider that these values are likely more indicative of actual effects based on available information including typical C(FC) values for Christchurch and the fines content of the soils encountered, however detailed site-specific investigations would be required to confirm what C(FC) value is suitable.

The sensitivity analysis where the groundwater level in CPT08 was increased to 2.0m indicated a slight increase in free-field settlements (~15mm) and increase in LSN to 31 (from 25), however the results did not affect the likely Technical Class (TC) for this area which is still within a Hybrid TC2/3 class.

A check for the effect of filling on the potential liquefaction effects was also undertaken and indicates that the addition of the fill will only have negligible beneficial effects, however it is noted that the analysis does not account for any improvement in the soils from consolidation due to the fill. It should be noted that an obvious benefit of the fill would be that it provides greater separation between foundations and liquefiable units / increases the thickness of the non-liquefiable raft.

6.2.2 Liquefaction Risk Summary

The preliminary analysis indicates that the liquefaction risk within the site is likely to range from low to high and that the site is likely comprise of portions of land which can be considered TC1, TC2 and Hybrid TC2/3. Further investigations and analysis will be required at later stages to better delineate areas of liquefaction risk however this preliminary analysis is suitable to evaluate the potential risk as being within the typical limits of engineering mitigation measures and residential foundations.

6.3 Cyclic Failure

Based on our preliminary assessment and available data, the risk from cyclic failure is considered to be low. The saturated soils within the upper 10m of the profile typically comprise of either gravels or liquefiable units with little to no sensitive clay-like soils expected.

Under ULS conditions there may be some minor cyclic softening in deeper clay layers (beyond the depth of CPT testing), but these units are well below the depth where we would expect any significant influence at surface other than negligible additional free-field settlements.

Further assessment will be required at later stages as more information / data becomes available however the risk is considered adequately low that no further assessment is required at this stage.

6.4 Compressible Soils & Static Settlements

Compressible soils are those that will undergo a reduction in volume under an imposed load, such as the weight of fill or a structure. This generally occurs as a result of the expulsion of air and water from the soil void spaces, which causes restructure of the soil particles.

As part of any earthworks we would anticipate that any shallow organic soils and uncertified fill would be removed prior to placing any fill, therefore we have excluded any preliminary assessment of static settlements in these soils.

The underlying soils typically have good strengths but under significant loading will undergo some consolidation. In addition, some deeper units with lower strengths may also undergo consolidation should the load be large enough and span a significant area.

The proposed development plans referenced in Section 2 of this report indicate that the proposed fill depths may range from the following:

- Fill of up to ~0.5m in the north (CPT05 location).
- Fill of ~1.5m to ~2.5m in the centre of the site (CPT08 location).
- Fill of up to ~4.0m in the eastern stream channel (CPT07 location).
- Fill of up to ~4.0m in the west (Tonkin & Taylor CPT03 location).

Given the proposed development involves significant filling over a large area, we have undertaken a preliminary check for static settlements to assess the potential magnitude of settlements which may occur as a result of the proposed fill earthworks. The analysis has been undertaken for CPTs 5, 7 & 8 as these are located in areas where significant filling is proposed and these CPTs also achieved the greatest depths and had the most prone soils encountered. The preliminary analysis has assumed the following:

- 100m x 100m overall fill footprint with a soil unit weight of 22kN/m^3
- The following distributed loads were applied at 0.5m below ground level for the following CPTs (The excavation load was removed and 0.5m of fill added to load calculations).
    - CPT05 = 25kPa
    - CPT07 = 110kPa
    - CPT08 = 80kPa

The preliminary analysis results are included in Appendix E and indicate the following:

- Northern Area (CPT05) - Settlements are unlikely to exceed 15mm and ~50% of the settlements are expected to occur within a short period (i.e. 6-8 months).
- Eastern Channel Infill (CPT07) - Settlements are unlikely to exceed 35mm and almost all of the settlements will occur within a short period (i.e. 6-8 months).
- South-Central Fill Area (CPT08) - Settlements are unlikely to exceed 25mm and almost all of the settlements will occur within a short period (i.e. 6-8 months).

Based on the preliminary analysis, the proposed filling is unlikely to result in excessive ongoing (long duration / creep) settlements but may result in some significant settlements (in excess of 25mm) where filling of 1.5m or greater is proposed. It is noted that in these areas, over 90% of the settlements are expected to occur over a relatively short time-frame (i.e. 6-8 months). Further assessment will be required at later stages as more information / data becomes available however based on the preliminary assessment, the risk is considered adequately low that no further assessment is required at this stage.

Mitigation options are likely to involve further investigations and analysis to identify the most at risk areas for fill induced settlements and installing monitoring pins below these prior to filling to allow ongoing settlement monitoring to identify when the majority of static settlements have occurred / the sites are suitable for the construction of buildings.

6.5 SLOPE STABILITY

There are several existing cut and fill slopes on the site, some of which have been cut at steep angles and are unlikely to have adequate factors of safety for residential purposes. The proposed / conceptual earthworks plan referenced in Section 2 of this report has accounted for this and the following has been proposed:

1. Cut earthworks to reduce the overall slope of the north-western elevated platform and height of the bank near the stream channel. (Location 1 in Figure 31)
2. Fill earthworks to buttress the existing steep cut slopes below the south-western elevated platform and elevated road which connects the north-western and south-western platforms. (Location 2 in Figure 31)
3. Potential retaining structures along the western boundary with the more elevated land to the west. (Location 3 in Figure 31)

The proposed earthworks plan does include some cut earthworks to existing slopes (Location 3 in Figure 31) but at gentle angles in the order of 22-25°, which are considered to be suitable based on observations of the existing natural and cut slopes performance as well as the soil stratigraphy observed (refer to HA08, Appendix B). based on the preliminary assessment, the risk is considered adequately low that no further assessment is required at this stage. Further assessment will be required at later stages to assess the factor of safety of the proposed cut and fill slopes and to provide details for any retaining wall design.

Figure 31: Excerpt from proposed / conceptual earthworks plan (refer Section 2 for details)

6.6 STREAM BANK STABILITY

The proposed / conceptual development plans provided (refer to Section 2) include a proposal to realign the existing eastern ephemeral stream along the eastern site boundary as indicated in Figure 32.

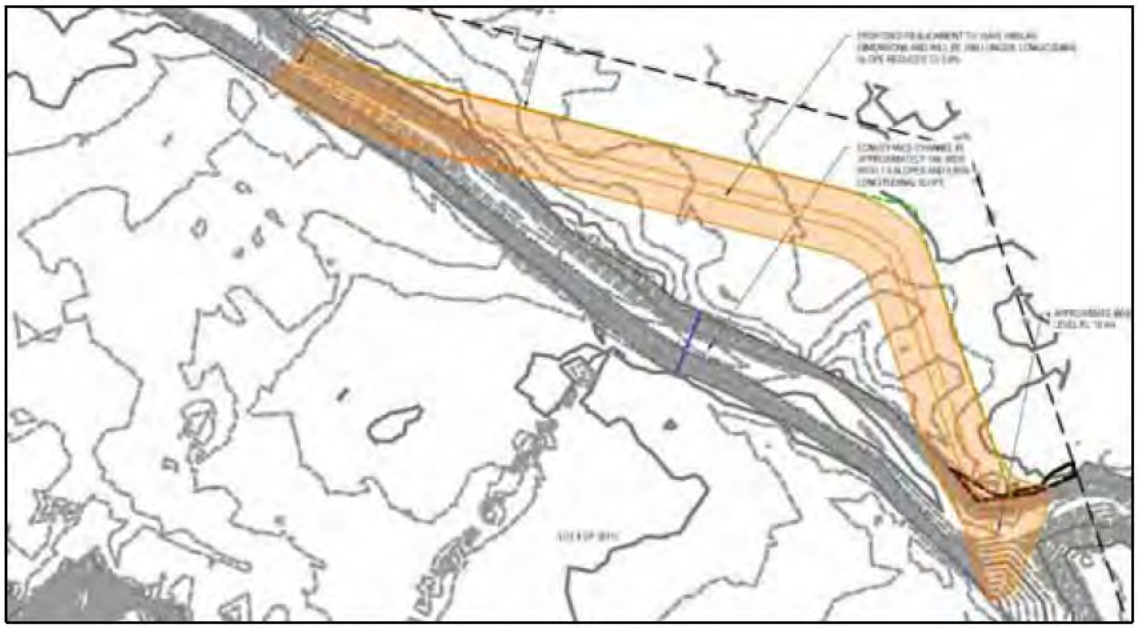

Figure 32: Excerpt from proposed development plans indicating the eastern ephemeral stream realignment.

We have undertaken a review of recent aerial imagery obtained following Cyclone Gabrielle (Figure 33) in order to identify possible levels, flows and effects on the stream banks under extreme rainfall events. The review indicates the stream levels during the event may have reached close to the top of the banks and that some small-scale instability occurred in areas along the bank.

Figure 33: Aerial Imagery of the eastern ephemeral stream channel post Cyclone Gabrielle.

Based on the review of the performance of the stream banks during Cyclone Gabrielle, we consider the risk of significant bank instability is low provided that:

- As proposed, any new channels dimensions are equal to or greater than the previous channel and that bank slopes are kept to a shallow slope angle (i.e. 1V:3H or less).
- Adequate investigations are undertaken, and mitigation measures are put in place. Mitigation options will need to be confirmed following additional works but are likely to involve similar measure to those indicate below:
    - Filter fabrics and / or erosion protecting matting and vegetation in areas of low scour risk, and
    - Filter fabric overlain by vegetated rip-rap in areas with high scour / erosion risk.

The most significant locations of scour are expected to be:

- Along the western bank at the beginning of the proposed realigned channel where there is a sharp bend to the north (to follow the eastern boundary),
- In the north of the proposed realigned channel, along the outside bend (northern bank) where the proposed channel diverts to the west (to rejoin the existing channel), and
- Where the proposed realigned channel rejoins with the existing channel (along the southern bank).

6.7 Expansive Soils

Site investigations did not encounter any soils across the site which exhibited properties typically associated with expansive soils. In addition there was no obvious signs of distress to existing buildings and the area is not known for having expansive soils. The risk is therefore considered low and no further assessment is required at this stage.

6.8 Bearing Capacity

Site investigations indicate that the natural soils (below any topsoil, fill or organic soils) typically comprises of very stiff to hard Sandy SILT to Silty CLAY near surface and the underlying soils typically comprise of dense to very dense gravels. Both units are expected to have a geotechnical ultimate bearing capacity of at least 300kPa (100kPa allowable).

In addition, shallow liquefaction or cyclic softening is not expected across the site and therefore significant loss of bearing capacity below shallow foundations is not expected under seismic conditions.

7 SUMMARY & RECOMMENDATIONS

From our preliminary assessment of the geotechnical hazards and risks affecting the site, and our experience in subdivision earthworks and mitigating engineering measures, we consider that the ground conditions within the proposed Plan Change area for 174 & 176 Brookvale Road, Havelock North are geotechnically suitable for the proposed residential land use as indicated in the Vermont Street Partners Conceptual Masterplan (Draft Rev. 3 – April 2006) and Maven Associates Limited Proposed Earthworks Plans ref. Project No. 135041, Rev A.

The preliminary assessment indicates the primary geotechnical risks associated with the site are likely to comprise of those listed below. It should be noted that whilst present, these risks are not expected to jeopardize any future development and can be adequately defined and mitigated though further investigations, analyses and typical engineering measures.

Further assessment and mitigating engineering measures are likely to be required, in particular, for the geotechnical risks associated with the following:

- Liquefaction Risk - Further work will need to focus on defining the extents of specific risks classes and will likely require the use of a specialised drill rig capable of drilling gravels and undertaking CPT testing in combination.
- Areas with potential for significant static settlements due to loading from the proposed fill earthworks.
- Areas where cut and fill slopes are proposed.
- Potential for stream bank scouring to occur.

Engineering measures are likely to involve:

- Liquefaction - Additional investigations & analysis to better investigate the risks present and allow mapping of liquefaction risk areas categorised based on MBIE Guidance to allow for appropriate foundation design in future. Additional notes on the recommended further assessment of liquefaction risks are detailed in Section 8.
- Static Settlements - Additional investigations & analysis to provide better estimates and settlement monitoring during construction in order to assess when lots within these areas are suitable for building construction.
- Slope Stability - Analyses to identify suitable cut and fill slope configurations and retaining wall design.
- Stream Bank Erosion – Review of potential flow calculations / indicative extreme levels and recommendations pertaining to erosion and scour protection.

Further investigations and analysis are expected to be undertaken at the resource consent stage and will involve significant deep investigations (machine boreholes and CPT testing) along with a higher density of shallow testing to investigate subsoil suitability and better define the extents of any filling and / or organic soils. Significant analyses will also be required to delineate risk categories for the site and to provide earthworks recommendations pertaining to the proposed development (including any recommendations pertaining to static settlements, monitoring and the time required to allow for the majority of static settlements to occur).

8 Future Assessment of Liquefaction Risk

As the project progresses to later stages, additional assessment of the liquefaction risk will be required. We have undertaken some sensitivity analyses to investigate key areas to cover in future assessments of liquefaction, these are detailed below.

- The main risk of liquefaction is within the south-central area and eastern stream where CPT's indicate that Silty SANDs to Sandy SILTs make up the majority of the soil profile. Significant additional testing will be needed to further investigate the liquefaction potential of these soils and to define the extents of specific liquefaction risk areas / technical category (TC) zones.
- The CPT analysis indicates that these soils have fines contents of typically between 40% to 50%. We consider that these estimates may be low and that further investigations could be undertaken to sample these soils and compare the fines content. This will assist in identifying a suitable 'fines fitting parameter' / C(FC).
- Plasticity Index (PI) testing can be undertaken on samples which the current analysis indicates have liquefaction potential. This will assist in identifying a suitable Ic cut-off for the soils. We note that the sensitivity analysis indicates that assuming an Ic cut-off of 2.35 (typically 2.6) has a significant effect on the estimated effects of liquefaction (reducing the expected site TC Class of CPT08 from a Hybrid TC2/3 Class to a TC2 Class under ULS conditions – providing much more economical foundation options). This testing is not guaranteed to produce favourable results, but we consider there is sufficient cause to further investigate the potentially liquefiable soils.

9 LIMITATIONS

This report has been prepared exclusively for Ed Sundstrum C/o Vermont Street Partners No. 4 Limited with respect to the particular brief given to us. No liability is accepted in respect to its use for any other purpose, or by any other person or entity other than the clients' consultants and/or any relevant council authorities. For any future developments within the parcel of land assessed, significant additional geotechnical investigations analysis and reporting will be required.

The analysis, opinions and recommendations given in this report are preliminary only and have been undertaken in general accordance with current standards, codes and guidance at the time of this report. These may be subject to change over time or due to significant changes to the proposed development. Therefore, if the project is modified in any significant way, or more than 24 months have passed since the date of this report, then Hawke's Bay Geotech should be given an opportunity to confirm that the recommendations are still valid.

Many of the values reported in geotechnical engineering are estimates due to the variability of ground conditions, soil properties and the difficulty in assessing the response these to earthquake loading. It should be noted that many geotechnical methods of analysis carry some uncertainty and observations of effects can vary significantly from actual values i.e. within 50% to 200% of estimates. Therefore the values included within this report are intended to be used as a proxy for assessing the potential site performance and should not be considered to represent actual values, particularly at the early stages of the project.

The preliminary engineering advice included in this report have been based on available information including sources from other consultants and contractors which have been assumed to be correct, we accept no liability for incorrect information by third parties. Investigation data only reflects the site conditions encountered at the time of the investigations and is undertaken at discrete locations. It should be noted that due to natural ground variability, conditions may vary from those assumed between investigation points. In addition, changes to site levels or earthworks not covered in this report can have a significant effect on the engineering advice and recommendations given. Therefore, we should be notified immediately if there are any significant variations to the ground conditions assumed in this report or any significant earthworks which are not discussed in this report.

Appendix A

Previous Reports & Ground Investigation Logs

REPORT

Stratagroup Consulting Engineers Ltd

Geotechnical Investigation Report for
Proposed commercial developments at
Te Mata Mushroom Farm, Havelock Nth

Report prepared for:

STRATAGROUP CONSULTING ENGINEERS LTD

Report prepared by:

Tonkin & Taylor Ltd

Distribution:

STRATAGROUP CONSULTING ENGINEERS LTD	3 copies
Tonkin & Taylor Ltd (FILE)	1 copy

June 2013

T&T Ref: 29272

Table of contents

1 Introduction

Tonkin & Taylor Ltd have carried out a geotechnical investigation at the Te Mata Mushroom farm {located at 174 Brookvale Road, Havelock North in Havelock North) to provide comment on the proposed commercial developments to be located in the area shown on the site plan provided {Figure 1- Appendix A).

This report is based on visual inspection, aerial photography analysis, logging eight digger test pits. The test pit locations are shown on the site plan provided {Figure 1- Appendix A) and the test pit logs are provided in Appendix B.

2 Site Description and Proposed Developments

The existing Te Mata mushroom farm developments comprise a series of commercial buildings at the end of a long driveway near the south eastern corner of lot 2 DP 7771. The proposed developments comprise a new culinary school, cafe, education centre, dairy, growing room and compost facility and are all located on adjacent land parcels surrounding the existing mushroom farm site. The culinary school, cafe, education centre and dairy are all proposed at Lot 1 DP 16311, located north of the existing mushroom farm development as shown in Figure 1 (Appendix A). The new growing room and compost room proposed are to be located to the south east and west of the existing building (at Lot 2 DP 16311 and Lot 3 DP 28543) respectively. All the proposed building locations are on relatively flat land.

We understand that the culinary school, cafe, education centre and dairy are of immediate concern as these proposed developments are intended to be built in the near future. The new growing room and compost facility are understood to be longer term concerns as these building are not proposed for construction at this stage.

3 Geology - Overall Stability

The geological assessment of the site has been based on the following information:

a) Review of existing geological maps (GNS QMAP for Hawkes bay- Sheet 8)

b) Review of previous T&T projects in the Havelock North area.

c) Intrusive trial pit site investigation carried out by T&T.

The most recent published 1:250,000 geological map shows that the site is underlain by Quaternary alluvial deposits comprising interbedded gravels, sands, silt and mud, forming alluvial terraces of the Heretaunga Plains.

Recent T&T experience of nearby sites in the area have confirmed the above geology.

4 Investigations

The recent investigations in April 2013 consisted of excavating and logging eight test pits by a geotechnical engineer and undertaking six Scala penetration tests (by Civil Services Ltd). Six test pits were situated in the grassed fields, north of the existing mushroom farm buildings, whilst two tests pits were located at the location of the compost facility and new growing room. A 15 tonne digger with a lm wide bucket was used for the excavation, and the target depth of 3.8 - 4m was achieved on most test pits. Laboratory testing comprising hydrometer and particle size distribution of a sample from Test Pit 1 was undertaken.

One Scala penetration tests was conducted at the location of each proposed building.

The test pit and Scala penetration test logs are appended to this report (Appendix B) and the locations are shown on the Site plan (Figure 1 - Appendix A). Lab test results are attached in Appendix C.

5 Subsurface Conditions

5.1 Topsoil

Topsoil was identified across the site from ground level and extended to approximately 0.3m below ground level (bgl). This layer comprised gravelly silt. This layer was determined to be firm and dry. A layer of buried topsoil (extending to 0.7m bgl) was found at test pit 8, however it is understood that this upper material in this area has been removed since these test pits were conducted.

5.2 Alluvial deposits

Alluvial deposits were generally found beneath topsoil and extended beyond the base of the test pits. These alluvial deposits comprised moist to saturated, firm to very stiff/dense, silts and medium to fine grained silty sands and gravel.

In some of the test pits, where these soils were found to be saturated (at depths between 3.Sm - 4m), this material was found to be very sensitive. The lab test results from Test Pit 1 of this saturated material indicated that a high silt and sand content {75% sand and silt combined) was present in these soils. Dense river gravels were found at depths between 2 - 3.7 m in Test pits 2, 3 and 7.

The Scala Penetration test results indicated 1- 2 blows/S0mm of penetration near the top of this layer, increasing to approximately 4 - Sm at a depth of 3m below ground level.

5.3 Groundwater

Ground water was intercepted in some of the tests pits and was generally between 3.6 - 4m below ground level (bgl). It is considered that water levels will be consistent across the site area with limited seasonal variation between winter and summer.

5.4 Material Characteristics and in-situ geotechnical testing

Based on site investigation data, the deposits are characterised by the following table:

Table 1 - General site profiles geological descriptions

Layer No.	Unit	Description	Depth to top of layer (m)	Typical NZGS Strength Characterization
1	**Topsoil**	Sandy Silt, minor gravel, greyish brown. Contains rootlets. dry	G.L	Firm
2	**Alluvial Deposits** - **Sand silt, cla e silt and silt**	Silt, Silty (medium to fine) Sand and Sandy Silt. White/Orange Brown., non-plastic, Friable. Moist to Wet	0.3m	Stiff to very stiff
3	**Alluvial Deposits** - **River gravels**	Sandy Siltstone. Orangey Brown, Moist to Wet	lm -1.Sm*	Dense

**River gravels only found in TP 2, 3, 7*

6 Geotechnical considerations

6.1 Seismicity and liquefaction potential

6.1.1 General

Building/structural response to direct shaking is not covered in this geotechnical report and such issues should be addressed by the structural engineers/ architects.

6.1.2 Site Subsoil Class

The NZGS guidelines {2010) recommend the use of the NZS1170 (2004) seismic loadings for liquefaction analysis in the absence of site specific seismic modelling. In accordance with the New Zealand Standard NZS 1170.5:2004 and on the basis of the readily available geotechnical data, the site is classified as a Class D (deep soil) site.

6.1.3 Design levels and assumptions

In the absence of a detailed seismic study, it is appropriate to design the development earthworks, foundations and structures in accordance with the New Zealand code of practice NZS 1170.5:2004[1]. The dwellings are understood to have an Importance Level 2 as defined in NZS 1170.0:2002[2]. The site is classified as Class D -deep soil site and can be inferred to have the following design peak ground accelerations (PGAs) expected from the design earthquakes under serviceability limit state (SLS) and ultimate limit state (ULS) conditions (refer to Table 2 below).

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[1] NZSll70.5:2004. *Structural Design Actions - Earthquake Actions (New Zealand).* SANZ
[2] NZS 1170.0:2002. *Structural Design Actions - General Principles.* SANZ

Table 2: Design peak ground accelerations for a Class B - Rock site

Design Life* (years)	Serviceability Limit State (SLS)		Ultimate Limit State (ULS)	
	Annual exceedance probability	Peak ground acceleration	Annual exceedance probability	Peak ground acceleration
S0	1/25	O.llg	1/500	0.44 g

**Design life to be verified by the structural engineer/architect, as appropriate. If different from than that assumed, or if this changes during the project life then these values and the opinions in this report will require review.*

6.1.4 Susceptibility to Liquefaction

Seismic liquefaction occurs when excess pore pressures are generated in loose, saturated, generally cohesionless soil during earthquake shaking, causing the soil to undergo a partial to near-complete loss of shear strength. Such a loss of shear strength can result in settlement, bearing capacity yield or failure and/or horizontal movement of the soil mass. The occurrence of liquefaction is dependent on several factors, including the intensity and duration of ground shaking, soil density, particle size distribution, and elevation of the groundwater table.

The liquefaction susceptibility of material at the site has been assessed using the results of the site observations and test pit investigations.

The liquefaction susceptibility of each layer is summarised in Table 3. The susceptibility of the layers has been considered for both the ultimate limit state (ULS) and serviceability limit state (SLS) seismic loadings. The assessments are based on the current (non-improved) ground conditions.

Table 3: Liquefaction susceptibility of profile

Layer No.	Unit	Depth range (m, bgl)	Liquefaction susceptibility for 25 year EQ event (SLS condition)	Liquefaction susceptibility for 500 year EQ event (ULS condition)
1	Topsoil	0-0.3m	'Negligible'	'Low'
2	Alluvial Deposits - Sand silt, cla e silt and silt	0.3-4.0m	'Low'	'moderate'
3	Alluvial Deposits - River gravels	2.0-4.0m	'Low'	'Low

7 Foundations

The six Scala Penetrometer tests conducted from the ground level were terminated at between 0.4m to 4.4m bgl with blow counts in excess of 10 blows per 25mm penetration. Based on this, a bearing strength of 150 kPa should be adopted for foundation design and relates to a working load of 50 kPa, and an ultimate limit state bearing capacity of 75 kPa.

Shallow foundations are recommended and should be in compliance with NZS 3404:2011[3]. Shallow strip and pad foundations of the residential buildings should extend a minimum of 0.Sm below surface level to minimise seasonal shrink swell effects.

The eight test pits that were excavated as part of the site geotechnical investigation were loosely backfilled. If buildings or access roads are to be located over or across these test pits, the pits should be carefully excavated and backfilled with compacted hardfill.

8 Pavement Design

A subgrade CBR of 5% is suitable for pavement design for the alluvial sediments. During construction, further in-situ testing should be undertaken to identify any soft or weak areas which may require undercutting and replacement with compacted hardfill.

9 Services

Typically groundwater was not identified in the upper 2m and all test pits were stable. However, if services are to be installed at significant depths {>2m depth) groundwater may be encountered and this could affect stability of the trenches.

[3] NZS 3604:2011. *Timber Framed Buildings*. SANZ

8 Applicability

This report has been prepared for the benefit of Stratagroup Consulting Engineers Ltd with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

The information in this report is considered by T&T to be accurate at the date of issue, and should be regarded as representing likely site conditions at the time of completion of this report. T&T does not warrant the accuracy and /or validity of the information provided by others and referenced. Opinions are based on data from the limited test locations so the nature and continuity of subsoil away from the investigation locations is inferred and it must be appreciated that actual conditions could vary from the assumed model. Should further information become available regarding the site conditions, T&T reserves the right to review the report.

During foundation construction the site should be examined by an engineer competent to judge whether exposed subsoil conditions are as expected and thus compatible with the conclusions drawn in this report. We would be pleased to provide this inspection service to you. Regardless, it is important that we be contacted if there is variation is subsoil conditions from those described in this report.

The test pits were backfilled with limited compaction. Therefore careful consideration needs to be given to design and placement of new services and foundations. Recompaction of the backfilled materials may be required to ensure these locations are suitable for foundations/services.

Tonkin & Taylor Ltd

Environmental and Engineering Consultants

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
	-- - ---.....".
Shiraz Soysa	Robert Hillier
Geotechnical Engineer	Geotechnical Group Manager

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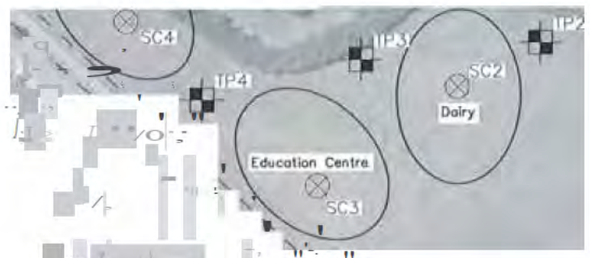
Appendix A: Site Investigation Plan

- Figure 1- Site plan



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Appendix B: Investigation Logs

- Test Pit logs - Tonkin & Taylor 2013
- Scala Penetration tests report and logs - Civil Sercives 2013

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EXCAVATION LOG

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SHEET 1 OF 1

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EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

SAMPLES, TESTS

SOIL NAME, PLASTICITY OR PARTICLES SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS

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TONKIN & TAYLOR LTD

EXCAVATION LOG

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EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

SAMPLES, TESTS

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TONKIN & TAYLOR LTD

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EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

SAMPLES, TESTS

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TONKIN & TAYLOR LTD

EXCAVATION LOG

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EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

SAMPLES, TESTS

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TONKIN & TAYLOR LTD

EXCAVATION LOG

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SHEET 1 OF 1

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wrcu

Appendix C: Laboratory Test Results

23 Morgan Street, Newmarket
Auckland 1023, New Zealand

GEOTECHNICS

p. +64 9 356 3510
w. www.geotechnics.co.nz

Form No.: P6
Form Date: January 2004

Plate No.:
Site: **Te Mata Mushroom Farm, Havelock North, Hawkes Bay**

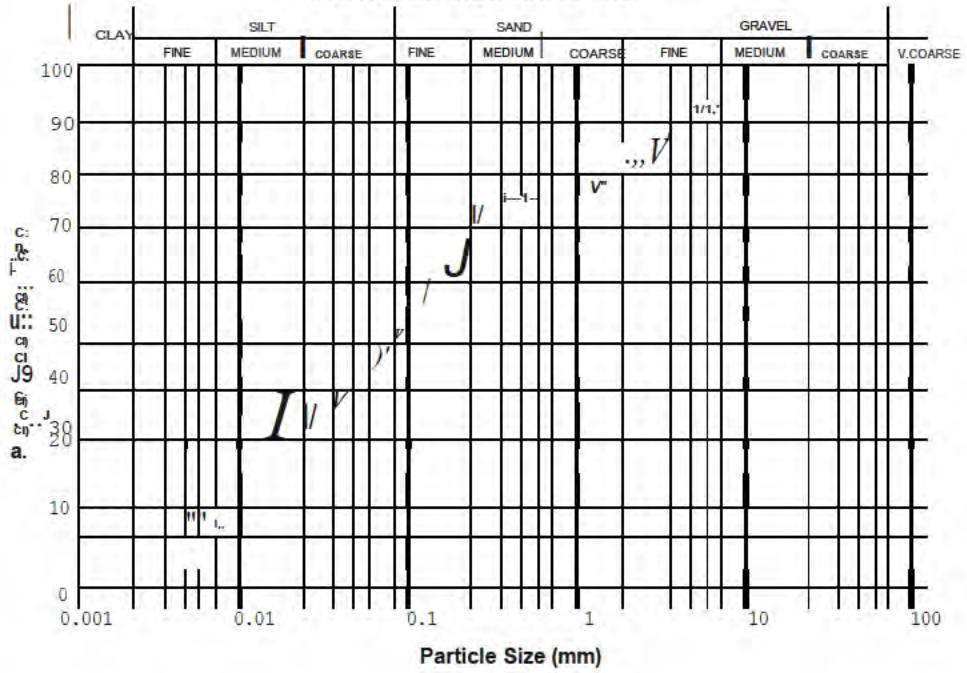
Page of

Your Job No.: **29272**
Our Job No.: **616070.000**

BH **No.**: **---** Sample ID.: **Test Pit** Depth (m): **3.7**

Test Method Used : NZS 4402:1986 Test 2.8.1 Wet Sieve Test 2.8.4 Hydrometer

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total% Passing	Sieve (mm)	Total% Passing
26.5	---	0.425	75
19.0	—	0.300	74
13.2	100	0.212	71
9.50	99	0.150	62
6.70	96	0.090	52
4.75	92	0.063	45
3.35	88		
2.00	82		
1.18	78		
0.600	76		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0389	39
0.0290	35
0.0217	31
0.0162	26
0.0124	21
0.0091	17
0.0067	13
0.0049	9
0.0035	7
0.0015	3

Sample history : As received.
Solid Density (assumed) : 2.65 Um^3
Description: sandy SILT with some gravel and trace of clay, saturated-very soft lumps, light greenish grey.

Remarks: Two representative sub samples were split from the original sample for wet sieve and hydrometer analysis. The wet sieve sample was washed over 0.063mm test sieve, until the individual particles were clean. The material retained on 0.063mm test sieve was oven dried and dry sieved. The hydrometer sample was oven dried at the end of the test to determine the mass passing 0.063mm for hydrometer calculations.
The sieve data was combined with the hydrometer analysis to give a continuous curve.
Suspension pH 8.0
The classification of gravel-sand-silt-clay components are described on the basis of particle size analysis.
Sample description is not IANZ endorsed.

Entered by : **T** Date: **btrlr** Checked by: Date: **6/5 (t 3**

INVESTIGATION REPORT - GROUND TESTING

PROJECT:	Te Mata Mushroom Farm, Geotechnical Investigation
CLIENT:	Tonkin & Taylor Ltd
ENGINEER:	Tonkin & Taylor Ltd
DATE & TIME:	16-May-13
TESTED BY:	ES
LOCATIONS:	Refer photos below and attached A3 plan
TEST METHODS:	Scala Penetrometer

Report Number: CSR13/020

Site Photographs

Looking approximately south

Looking approximately south-east

Comments:

As requested, Scala penetrometer tests were performed across the site near the locations requested. Site 1 was located furthest from the requested location, due to the presence of a large stockpile at the requested location. Sites 1 - 5 all performed on generally flat grassed area. Site 6 performed at a similar ground level to sites 1-5, but there has been recent cut earthworks in this area.

Approved for issue:

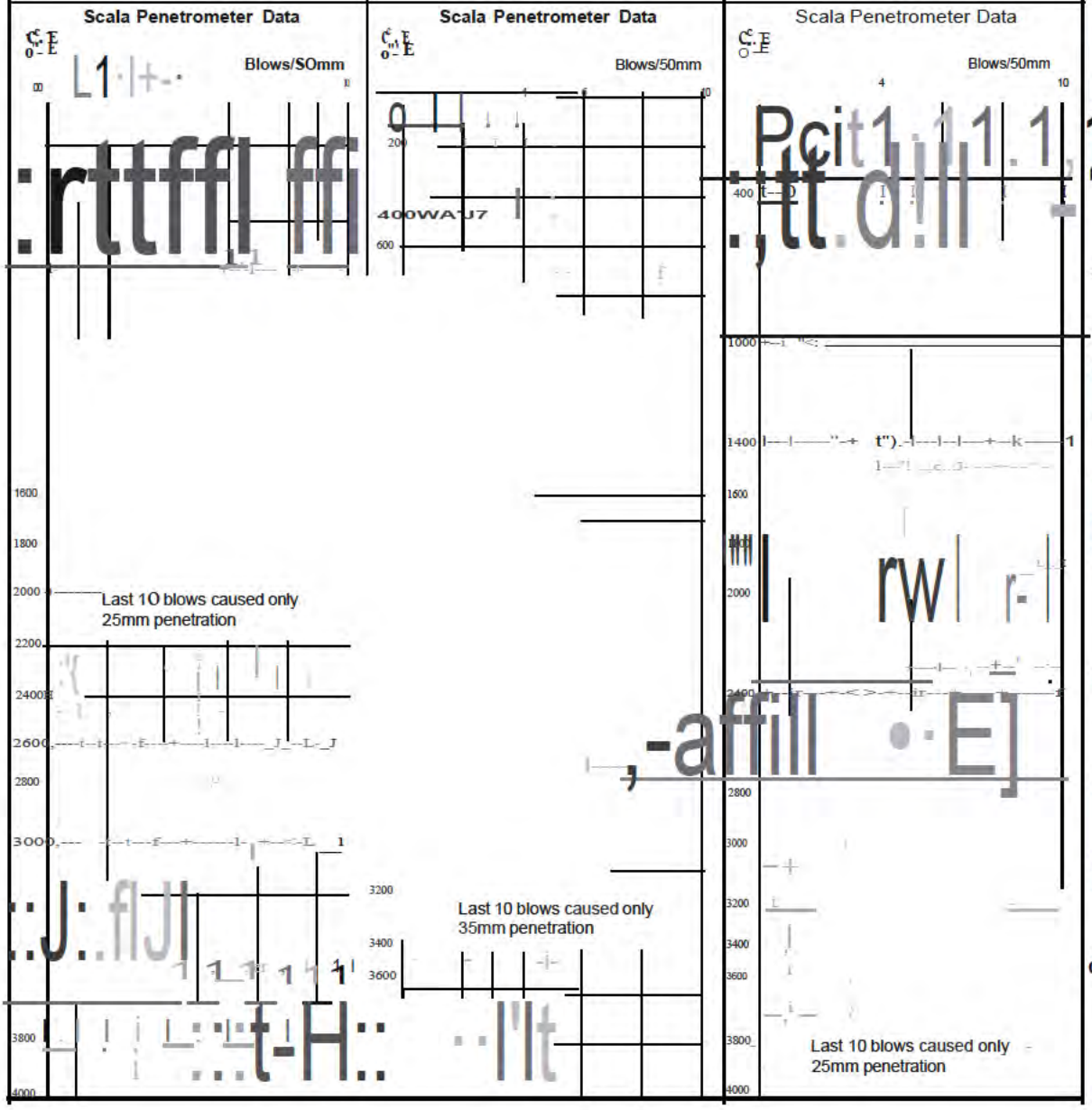
Issue date: 17-May-13

INVESTIGATION REPORT - GROUND TESTING

PROJECT:	Te Mata Mushroom Farm, Geotechnical Investigation
CLIENT:	Tonkin & Taylor Ltd
ENGINEER:	Tonkin & Taylor Ltd
DATE & TIME:	16-May-13
TESTED BY:	ES
TEST SITE:	1 - 3
LOCATION:	Refer photos page 1 and attached A3 plan
TEST METHODS:	Scala Penetrometer

Report Number: CSR13/020

SITE 1	SITE2	SITE 3
Scala Penetrometer Data	Scala Penetrometer Data	Scala Penetrometer Data



Comments:
All depths measured from ground levels at corresponding sites. Each test was stopped when 10blows/50mm exceeded (but still shown as 10blows/50mm on graphs here).

Testing Specifications:
Scala penetrometer testing specification NZS 4402:1988 Test 6.5.2

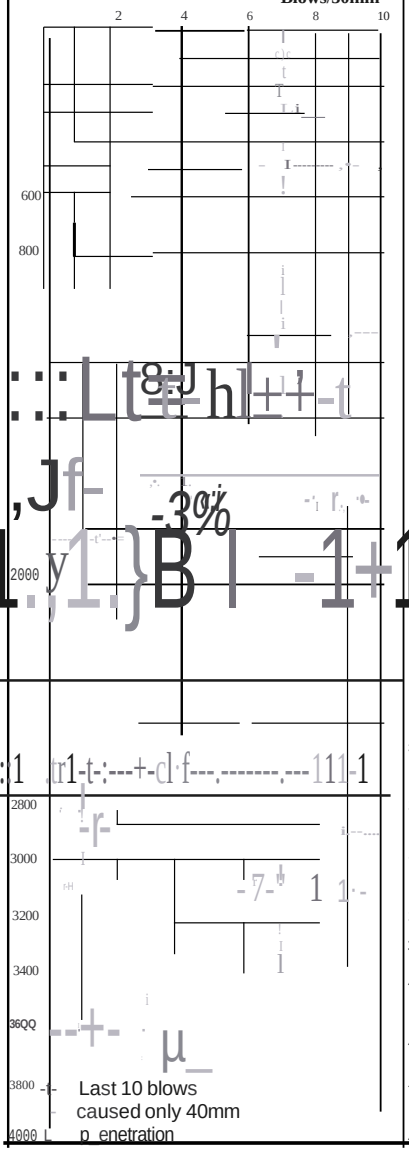
INVESTIGATION REPORT - GROUND TESTING

PROJECT:	Te Mata Mushroom Farm, Geotechnical Investigation
CLIENT:	Tonkin & Taylor Ltd
ENGINEER:	Tonkin & Taylor Ltd
DATE & TIME:	16-May-13
TESTED BY:	ES
TEST SITE:	4-6
LOCATION:	Refer photos page 1 and attached A3 plan
TEST METHODS:	Scala Penetrometer

Report Number: CSR13/020

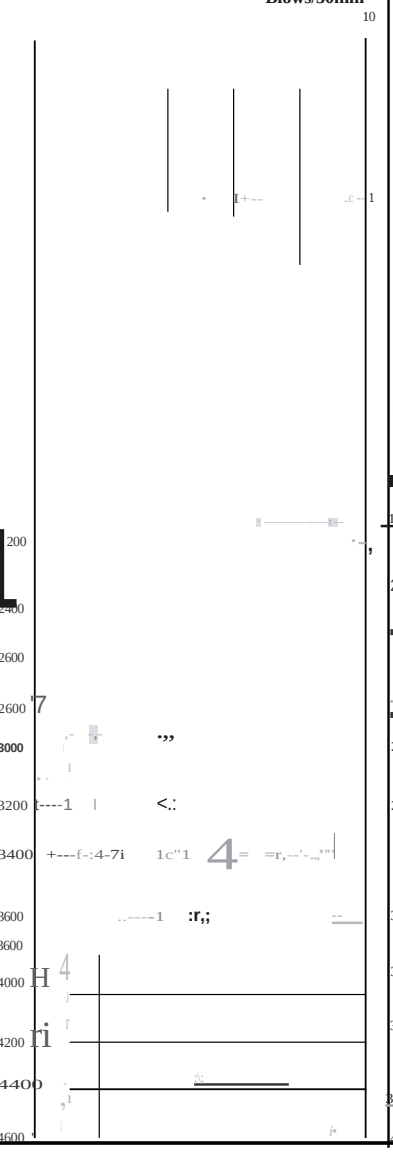
SITE4

Scala Penetrometer Data



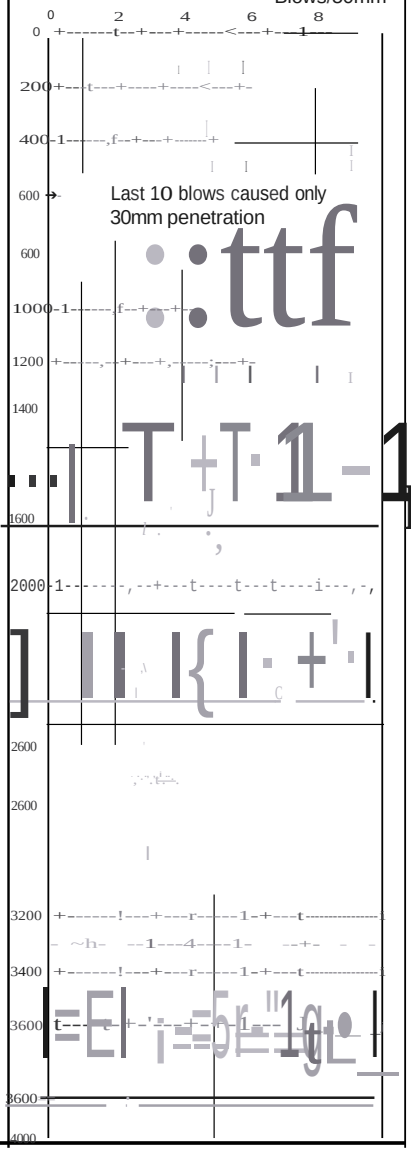
SITES

Scala Penetrometer Data



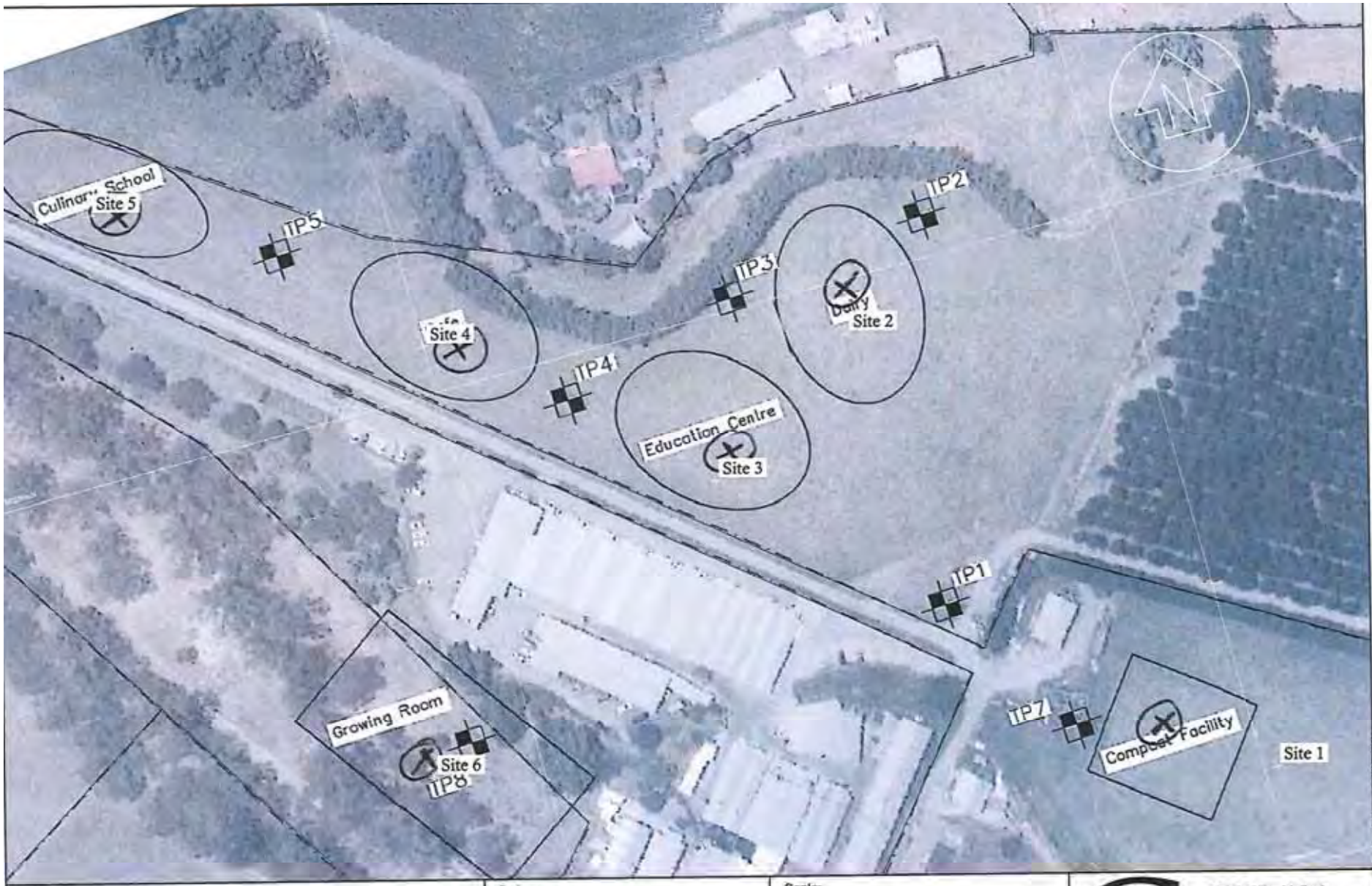
SITE6

Scala Penetrometer Data



Comments:
Testing at site 5 did not reach refusal (10blows/50mm or more), and maximum depth had already exceeded the 4m maximum depth indicated by Tonkin & Taylor representative.

Testing Specifications/Notes:
Scala testing specification NZS 4402:1988 Test 6.5.2.



Title:
Penetrometer Test Locations
Te Mata Mushroom Farm,16 May 2013.
174 Brookvale Road, Havelock North

Datum:
NZGD2000, HB Circuit
Handheld GPS Positions

Scale:
1:1000 (A3)

CIVIL SERVICES (HB) LTD
Unit 8, 88 Taradale Road
PO Box 5011, NAPIER 4145
Phone/Fax: (06) 843 6998
Web Site: www.civilservices.co.nz
Email: admin@civilservices.co.nz

Date Plotted: Fri May 17 09:03:24 2013

REPORT

Tonkin+Taylor

Mushroom Farm Extension - 174 Brookvale Rd, Havelock North

Geotechnical Investigation Report

Prepared for
Northpeak Properties Limited
Prepared by
Tonkin & Taylor Ltd
Date
July 2020
Job Number
1014649.v1

Exceptional thinking together
www.tonkintaylor.co.nz

Document Control

Title: Mushroom Farm Extension - 174 Brookvale Rd, Havelock North					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
July 2020	1	Geotechnical Report	JSTE	NAH	JRL

Distribution:

Northpeak Properties Limited	1 PDF copy
Tonkin & Taylor Ltd (FILE)	1 PDF copy

Table of contents

1 Introduction and background

Tonkin & Taylor Ltd (T+T) has been engaged by Northpeak Properties Ltd to provide geotechnical consultancy services to support construction of light structures at the Te Mata Mushroom Farm, 174 Brookvale Rd, Havelock North. Previously, T+T provided geotechnical information in a June 2013[1] report for proposed commercial developments at the Mushroom Farm. This report was based on 'shallow' test pit investigations.

In June 2019 Hastings District Council (HDC)[2] introduced new guidelines for minimum investigations to assess liquefaction potential. The mushroom farm is located on the boundary of sites mapped as medium liquefaction vulnerability and very low to low liquefaction vulnerability. Accordingly, the minimum investigations to obtain Building Consent are either machine drilled boreholes or CPTs to a minimum depth of 10.15 m, or a depth that is considered suitable by a qualified and experienced geotechnical professional.

This report presents the results of more recent investigations, analyses and recommendations revised to address the HDC guidelines regarding liquefaction. It also includes foundation recommendations for relatively lightweight structures.

2 Site investigations

2.1 Historic investigations – 2013

Investigations undertaken in April 2013 consisted of:

- 8 No. test pits to between 3.8 to 4 m below ground level (bgl); and
- 6 No. Scala Penetrometer tests.

Alluvial deposits containing silty sands and gravel were generally found beneath the layer of topsoil. Cohesive alluvial material was found in five of the test pits while dense river gravels were found at depths between 2 to 3.7 m bgl in three of the test pits.

2.2 2020 investigations

Geotechnical investigations were carried out at the subject site in early July 2020 to supplement the existing data and obtain information suitable for foundation design for the proposed works. The investigations were undertaken by Geotech Drilling Ltd. The investigations comprised:

- 4 No. Cone Penetrometer Tests (CPT1 to CPT4); and
- 2 No. Machine Boreholes (BH1 to BH2).

The locations of the investigations are presented on Figure 1, Appendix A. The site investigation logs are presented in Appendix B.

2.2.1 Cone Penetration Tests (CPTs)

4 No. CPTs were completed at the Mushroom Farm site, up to 4.5 m bgl. All CPTs terminated at refusal, which occurred due to the cone terminating on or within a dense gravel layer (tip resistance greater than 20 MPa).

[1] Tonkin & Taylor Ltd. *Geotechnical Investigation Report for Proposed commercial developments at Te Mata Mushroom Farm, Havelock Nth.* June 2013. T+T Ref: 29272

[2] HDC. *Guidelines for Geotechnical Site Investigation (Liquefaction) for Subdivision and Land Development Resource Consent Applications Hastings District*. June 2019.

2.2.2 Machine Boreholes (BHs)

2 No. machine boreholes were completed at the Mushroom farm site to 9.2 m bgl. Material encountered from the boreholes was logged by a T+T engineering geologist, in general accordance with NZGS guidelines. In situ testing comprising Standard Penetration Tests (SPTs) was conducted in the machine boreholes in the rock unit. Three consecutive Standard Penetrometer Tests (SPTs) were completed to N>50, indicating very dense gravels, before termination of the holes.

2.3 Ground Model

A ground model has been developed based on the information obtained during the test pits, CPT and BH investigations as well as a review of nearby (within 85 m of the boreholes) Hawkes Bay Regional Council groundwater well logs (#258 and #1129). The subsurface model is presented in Table 2.1.

Table 2.1: Subsurface conditions summary

Geological Unit	Description	Depth range	Typical CPT cone resistance – qc (MPa) [average]	SPT 'N' value
Topsoil/Fill	Sandy SILT, gravelly SILT	0 – 0.6 m	4 – 15 [8]	-
Alluvium – silts	Sandy SILT, clayey SILT	0.6 – 3 m	0 – 6 [2]	6 to 10
Alluvium – gravels	GRAVEL	3 – 9.2 m proved	>15	22 to 50+

Well log #258 indicates the gravel layer extends to 20 m bgl, and well log #1129 indicates it extends to 14 m bgl. These logs are presented in Appendix B. Underlying the gravels are interbedded sands and silts. Published geology[3] indicates these extend for over 100 m.

2.4 Groundwater

In the 2013 investigations groundwater was generally encountered between 3.6 to 4 m bgl. More recent CPT investigations indicate groundwater was between 3.2 to 3.5 m bgl. The historic well logs indicate that the groundwater can get as high as 1 m bgl, indicating seasonal fluctuations.

3 Geotechnical considerations

Recommendations and opinions contained in this report are based on data obtained from geotechnical investigations at point locations across the site. The nature and continuity of the subsoil away from these locations is inferred but it must be appreciated that actual conditions may vary from the assumed model.

Based on the ground model outlined in Section 2, the key geotechnical considerations for relatively lightweight structures are:

- Site seismicity and liquefaction potential; and
- Consolidation settlement from static loading.

Further details on each of these considerations are provided below.

[3] Institute of geological and nuclear sciences. 1:250 000 Geological Map 8. Hawkes Bay.

3.1 Site seismicity

3.1.1 Design criteria for liquefaction analysis

As per the June 2013 report, the site subsoil class is Class D – Deep soil site on the basis that the depth to bedrock is likely to exceed allowable levels, and soil strengths exceed minimum values as per NZS 1170.5. Accordingly, the design peak ground accelerations (PGAs) for the geotechnical analyses under Serviceability Limit State (SLS) and Ultimate Limit State (ULS) conditions were calculated using the GNS Science Consultancy Report 2015/186 (October 2017) and are presented in Table 3.1.

Table 3.1: Design peak ground accelerations

Design Life* (years)	Serviceability Limit State (SLS)			Ultimate Limit State (ULS)		
	Return Period (years)	Peak Ground Acceleration	Magnitude	Return Period (years)	Peak Ground Acceleration	Magnitude
50 years	25	0.14g	6.2	500	0.42g	6.5

*Design life assumed to be 50 years and Importance Level 2 was used, to be confirmed by Structural Engineer

3.2 Liquefaction assessment

3.2.1 General

Seismic liquefaction occurs when excess pore pressures are generated in loose, saturated, generally cohesionless soil during earthquake shaking, causing the soil to undergo a partial to near-complete loss of shear strength. Such a loss of shear strength can result in settlement, bearing capacity yield or failure and/or horizontal movement of the soil mass. The occurrence of liquefaction is dependent on several factors, including the intensity and duration of ground shaking, soil density, particle size distribution, and elevation of the groundwater table.

3.2.2 Liquefaction potential

The liquefaction susceptibility of material at the site has been assessed using the results of the 4 No. site specific CPTs. The susceptibility of various layers has been considered for both the SLS and ULS seismic loadings as presented in Table 3.1 above.

The groundwater in the analysis has been conservatively assumed to be 2 m bgl to reflect the likely worst-case groundwater levels.

Table 3.2 outlines the liquefaction assessment for the site.

Table 3.2: Liquefaction assessment summary

Layer depth	Analysis Method	Material Description	Liquefaction Assessment – SLS event	Liquefaction Assessment – ULS event
0 – 4.5 m bgl	Boulanger and Idriss (2014) and Zhang, Robertson & Brachman (2002)	Sandy silts and clayey silts	Analyses indicate that under SLS conditions the material is unlikely to liquefy.	Analyses indicate that under ULS conditions (500 year return period) **thin lenses of material (less than 0.5 m thick) are potentially liquefiable**. These lenses are generally non continuous (vertically and horizontally) through the soil profile.
5 – 9.2 m bgl (with a likelihood of up to 14 m bgl)	Borehole core observation	Gravels	This layer is unlikely to be liquefiable due to insitu strengths and permeable nature of the fabric.	

The liquefaction analyses outputs are presented in Appendix C.

3.2.3 Consequences of liquefaction

The key consequences of liquefaction under ULS levels of shaking are ejecta and vertical settlement, with site specific comments outlined below:

- Ejecta is unlikely at this site due to the relative thickness of non-liquefiable crust compared with the thickness of potentially liquefiable material across the site;
- Vertical settlements are likely to be minor and easily accommodated by robust foundation design; and
- Differential settlement is not expected to exceed 1 in 500 due to the relatively uniform ground conditions across the site and to the low likelihood of ejecta due to the crust.

Due to the lack of any significant watercourses or “free faces” identified within 300 m of the building location, the risk of lateral spread is considered negligible.

3.3 Foundation design criteria

3.3.1 Shallow foundations

For relatively lightweight structures (framed structures with slab on grade, less than 10 kPa loads), shallow foundations are recommended. Shallow strip and pad foundations of the buildings should extend a minimum of 0.5 m below surface level to minimise seasonal shrink swell effects. To ensure the new structures do not pull apart under an ULS design earthquake due to ground oscillation and differential settlements (from liquefaction), we recommend that any shallow pad and strip footings are interconnected and tied together (with ground beams) in both longitudinal and lateral directions across the building footprint.

Table 3.3 outlines the bearing capacity considered appropriate for use in design for rib raft foundations these values apply to the “rib”.

Table 3.3: Bearing capacities for shallow foundations

	Geotech ultimate bearing pressure	ULS bearing pressure	Allowable bearing pressure
Bearing on engineered fill after ground improvement works	300 kPa	150 kPa	100 kPa

3.3.2 Consolidation settlement

Total and differential consolidation settlements from light weight structures (loads less than 10 kPa), are estimated to be less than 25 mm. More robust analyses should be undertaken if floor loads are to exceed 10 kPa.

Verification of this assumption should be undertaken once design loads have been confirmed by the structural engineer.

3.4 Slab Design Criteria

A subgrade CBR of 3% is considered suitable for design of slabs bearing on natural ground.

For slabs bearing on engineered hardfill with geogrid reinforcement a CBR of 5% is considered suitable.

3.5 Recommended construction observations

It is recommended that during construction the subgrade with insitu testing be undertaken by a suitably qualified geotechnical engineer to ensure ground conditions are consistent with the assumptions on which this report is based.

4 Applicability

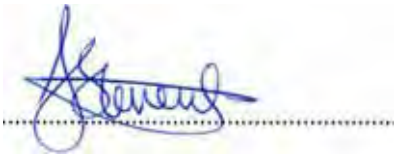
This report has been prepared for the exclusive use of our client Northpeak Properties Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that this report will be used by Hastings District Council in undertaking its regulatory functions in connection with the Mushroom Farm extension.

Earthquakes are unique and impose different levels of shaking in different directions on different sites. The results of the liquefaction susceptibility analyses and the estimates of consequences presented within this document are based on regional seismic demand and published analysis methods, but it is important to understand that the actual performance may vary from that calculated.

Tonkin & Taylor Ltd

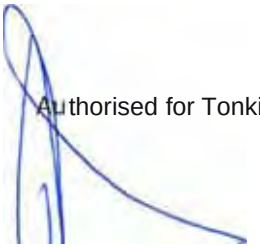
Report prepared by:



Josie Stevens

Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:



ohn Leeves

Project Director, CPEng

Reviewed for Tonkin & Taylor Ltd by Nathan Hickman, Geotechnical Engineer

JSTE
p:\1014649\workingmaterial\t+t_mushroom farm_geotech report_1014649.docx

Appendix A: Site Investigation Plan

L:\1014649\WorkingMaterial\CAD\FIG\1014649-F1.dwg 2020-Jul-21 10:29:40 AM Plotted By: JONALD CASTRO

Tonkin+Taylor

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NOTE:

1. AERIAL PHOTOSOURCED FROM GOOGLE EARTH. (C) 2020 IMAGERY DATE: 27/03/2018
2. COORDINATE DATUM: NZGD2000, NEW ZEALAND TRANSVERSE MERCATOR (NZTM2000).

PROJECT No.	1014946	
DESIGNED	XX	Jul.20
DRAWN	JC	Jul.20
CHECKED		
APPROVED	DATE	

CLIENT NORTHPEAK PROPERTIES LTD

PROJECT 174 BROOKVALE ROAD, HAVELOCK NORTH

TITLE TE MATAMUSHROOM FARM
SITE INVESTIGATION

SCALE (A3) AS SHOWN FIG No. A3FL REV 1

Appendix B: Site Investigation Logs

- **Borehole Logs**
- **CPT Logs**
- **HDC Groundwater Well Logs**

BOREHOLE LOG

BOREHOLE No.: **BH01**

SHEET: 1 OF 1

PROJECT: Te Mata Mushrooms		LOCATION: 174 Brookvale Rd, Havelock North	JOB No.: 1014649.0000
CO-ORDINATES: (NZTM2000)	5602804.00 mN 1934984.00 mE	DRILL TYPE:	HOLE STARTED: 09/07/2020 HOLE FINISHED: 09/07/2020
R.L.:	11.00m	DRILL METHOD: RC	DRILLED BY: Geotech Drilling Ltd
DATUM	NZVD2016	DRILL FLUID:	LOGGED BY: JWY CHECKED: TRMC

GEOLOGICAL																		ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	FLUID LOSS (%) 25 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 200	DEFECT SPACING (mm) 20 200 600 2000			Description and Additional Observations
Topsoil											M	St						TOPSOIL and rootlets.
Fill																		Gravelly SILT, some sand; dark brown. Stiff, moist, low plasticity; sand, fine.
			93	HA				10	1									Clayey SILT; dark grey, mottled brown. Stiff, moist, medium to high plasticity.
Holocene Alluvial Deposits			100	SPT		0/2 1/1 2/2 **N=6**		9	2		W	F						Sandy SILT, minor clay; dark greyish brown. Firm, wet, low plasticity, slightly dilatant.
			76	HQTT														2.75-3.0m: CORE LOSS.
			66	SPT		4/4 5/5 5/7 **N=22**		8	3		S	MD						Sandy, fine to medium, minor coarse GRAVEL, trace silt; dark bluish grey. Medium dense, saturated, well graded; sand, fine to coarse.
Box 1, 0.0-3.7m																		3.3-3.45m: CORE LOSS.
			100	HQTT				7	4									[CONT] Sandy, fine to medium, minor coarse GRAVEL, trace silt; dark bluish grey. Medium dense, saturated, well graded; sand, fine to coarse.
			0	SPT		4/2 3/3 3/3 **N=12**		6	5									4.5-4.95m: CORE LOSS.
			28	HQTT								VD						Medium to coarse GRAVEL, some cobbles, minor sand, and silt; dark brownish grey. Very dense, well graded; gravel, sub-angular to sub-rounded, greywacke; sand, fine to coarse.
Pleistocene Alluvium / Colluvium and Fan Deposits																		5.25-6.0m: CORE LOSS.
			50	SPT		12/21 22/23 for 75mm **N>=50**		5	6									[CONT] Medium to coarse GRAVEL, some cobbles, minor sand, and silt; dark brownish grey. Very dense, well graded; gravel, sub-angular to sub-rounded, greywacke; sand, fine to coarse.
			91	HQTT				4	7									6.15-6.3m: CORE LOSS.
																		[CONT] Medium to coarse GRAVEL, some cobbles, minor sand, and silt; dark brownish grey. Very dense, well graded; gravel, sub-angular to sub-rounded, greywacke; sand, fine to coarse.
Box 2, 3.7-8.0m			94	SPT		11/22 25/25 for 50mm **N>=50**		3	8									7.4-7.5m: CORE LOSS.
																		[CONT] Medium to coarse GRAVEL, some cobbles, minor sand, and silt; dark brownish grey. Very dense, well graded; gravel, sub-angular to sub-rounded, greywacke; sand, fine to coarse.
			41	HQTT							W							Sandy, fine to medium and minor coarse GRAVEL, some silt, minor gravel; dark brown. Very dense, wet, well graded; gravel, sub-rounded, greywacke.
Box 3, 8.0-9.2m																		8.23-9.0m: CORE LOSS.
			100	SPT		17/33 for 50mm **N>=50**		2	9									[CONT] Sandy, fine to medium and minor coarse GRAVEL, some silt, minor gravel; dark brown. Very dense, wet, well graded; gravel, sub-rounded, greywacke.
																		9.15m: END OF BOREHOLE

COMMENTS:

Hole Depth 9.15m

Scale 1:50

Rev.: A

BoreLog - 24/07/2020 11:20:51 am - Produced with Core-GS by GeRoc

CORE PHOTOS

BOREHOLE No.: **BH01**

PROJECT: Te Mata Mushrooms		LOCATION: 174 Brookvale Rd, Havelock North	JOB No.: 1014649.0000
CO-ORDINATES: (NZTM2000)	5602804.00 mN 1934984.00 mE	DRILL TYPE:	HOLE STARTED: 09/07/2020
R.L.:	11.00m	DRILL METHOD: RC	HOLE FINISHED: 09/07/2020
DATUM	NZVD2016	DRILL FLUID:	DRILLED BY: Geotech Drilling Ltd
			LOGGED BY: JWY CHECKED: TRMC

0.00-3.70m

3.70-7.95m

CORE PHOTOS

BOREHOLE No.: **BH01**

PROJECT: Te Mata Mushrooms		LOCATION: 174 Brookvale Rd, Havelock North	JOB No.: 1014649.0000
CO-ORDINATES: (NZTM2000)	5602804.00 mN 1934984.00 mE	DRILL TYPE:	HOLE STARTED: 09/07/2020
R.L.:	11.00m	DRILL METHOD: RC	HOLE FINISHED: 09/07/2020
DATUM	NZVD2016	DRILL FLUID:	DRILLED BY: Geotech Drilling Ltd
			LOGGED BY: JWY CHECKED: TRMC

7.95-9.15m

BOREHOLE LOG

BOREHOLE No.: **BH02**

SHEET: 1 OF 1

PROJECT: Te Mata Mushrooms		LOCATION: 174 Brookvale Rd, Havelock North	JOB No.: 1014649.0000
CO-ORDINATES: (NZTM2000)	5602860.00 mN 1935206.00 mE	DRILL TYPE:	HOLE STARTED: 09/07/2020 HOLE FINISHED: 09/07/2020
R.L.:	12.00m	DRILL METHOD: RC	DRILLED BY: Geotech Drilling Ltd
DATUM	NZVD2016	DRILL FLUID:	LOGGED BY: JWY CHECKED: TRMC

GEOLOGICAL																		ENGINEERING DESCRIPTION
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	FLUID LOSS (%) 25 50 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 200	DEFECT SPACING (mm) 20 60 200 600 2000	Description and Additional Observations
Topsoil											M	St				TOPSOIL, and rootlets.
Holocene Alluvial Deposits			60	HA				11	1							SILT, some clay; dark brown, mottled light brown. Stiff, moist, medium plasticity.
			100	SPT		2/2 3/2 2/3 **N=10**		10	2							
			100	HQTT												
			44	SPT		5/8 9/10 11/10 **N=40**		9	3		W	D				Sandy, fine and some medium GRAVEL, minor silt; dark brownish grey. Dense, wet, well graded; gravel, sub-rounded, greywacke.
			47	HQTT				8	4							3.45-4.0m: CORE LOSS.
Box 1, 0.0-4.7m			100	SPT		10/40 for 75mm **N>=50**		7	5			VD				COBBLES, minor gravel and sand; dark brownish grey. Dense, wet, gap graded; cobbles and gravel, sub-rounded, greywacke; sand, fine.
Pleistocene Alluvium / Colluvium and Fan Deposits			85	HQTT												Sandy, fine to medium GRAVEL, some silt; dark greyish brown. Very dense, wet, well graded; gravel, sub-rounded, greywacke.
			90	SPT		6/24 for 65mm **N>=50**		6	6							
			31	HQTT				5	7							6.215-7.0m: CORE LOSS.
			100	SPT		10/22 25/25 for 75mm **N>=50**		4	8							Sandy, coarse GRAVEL, minor silt, some cobbles; dark grey. Very dense, wet, well graded; gravel and cobbles, sub-rounded, greywacke.
			50	HQTT												Sandy, fine to medium GRAVEL, minor silt; dark brownish grey. Very dense, well graded; gravel, greywacke.
Box 2, 4.7-9.2m			100	SPT		17/20 50 for 65mm **N>=50**		3	9							
																9.21m: END OF BOREHOLE

COMMENTS:

Hole Depth 9.21m

Scale 1:50

Rev.: A

BoreLog - 24/07/2020 11:20:28 am - Produced with Core-GS by GeRoc

CORE PHOTOS

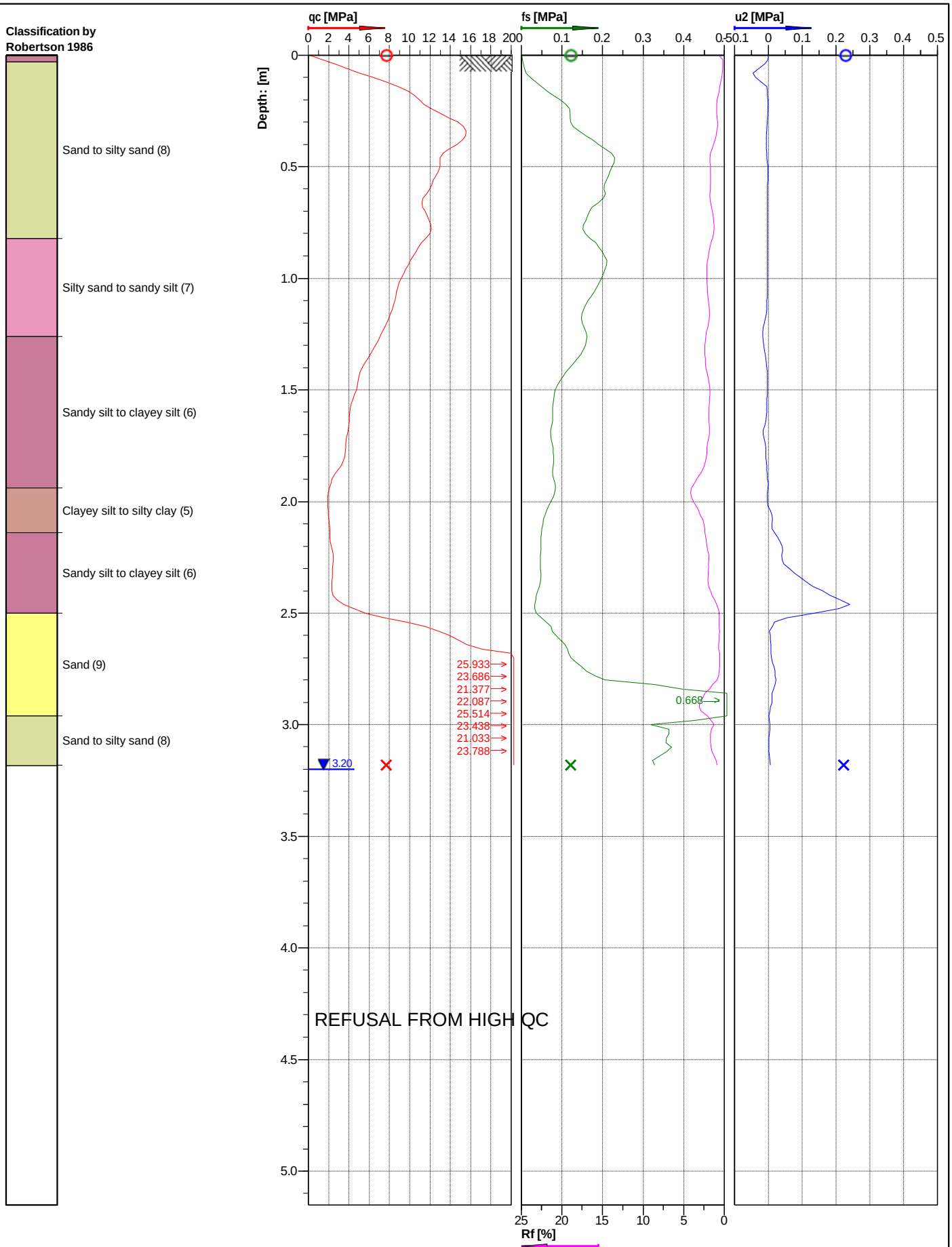
BOREHOLE No.: **BH02**

SHEET: 1 OF 1

PROJECT: Te Mata Mushrooms		LOCATION: 174 Brookvale Rd, Havelock North	JOB No.: 1014649.0000
CO-ORDINATES: (NZTM2000)	5602860.00 mN 1935206.00 mE	DRILL TYPE:	HOLE STARTED: 09/07/2020
R.L.:	12.00m	DRILL METHOD: RC	HOLE FINISHED: 09/07/2020
DATUM	NZVD2016	DRILL FLUID:	DRILLED BY: Geotech Drilling Ltd
			LOGGED BY: JWY CHECKED: TRMC

0.00-4.65m

4.65-9.21m



Location: HAVELOCK NORTH	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT01
Project ID:	Client: TONKIN + TAYLOR	Date: 1/07/2020	Scale: 1 : 23
Project: 174 BROOKVALE RD		Page: 1/1	Fig.:
S 39.65836, E 176.90698		File: CPT01.cpt	

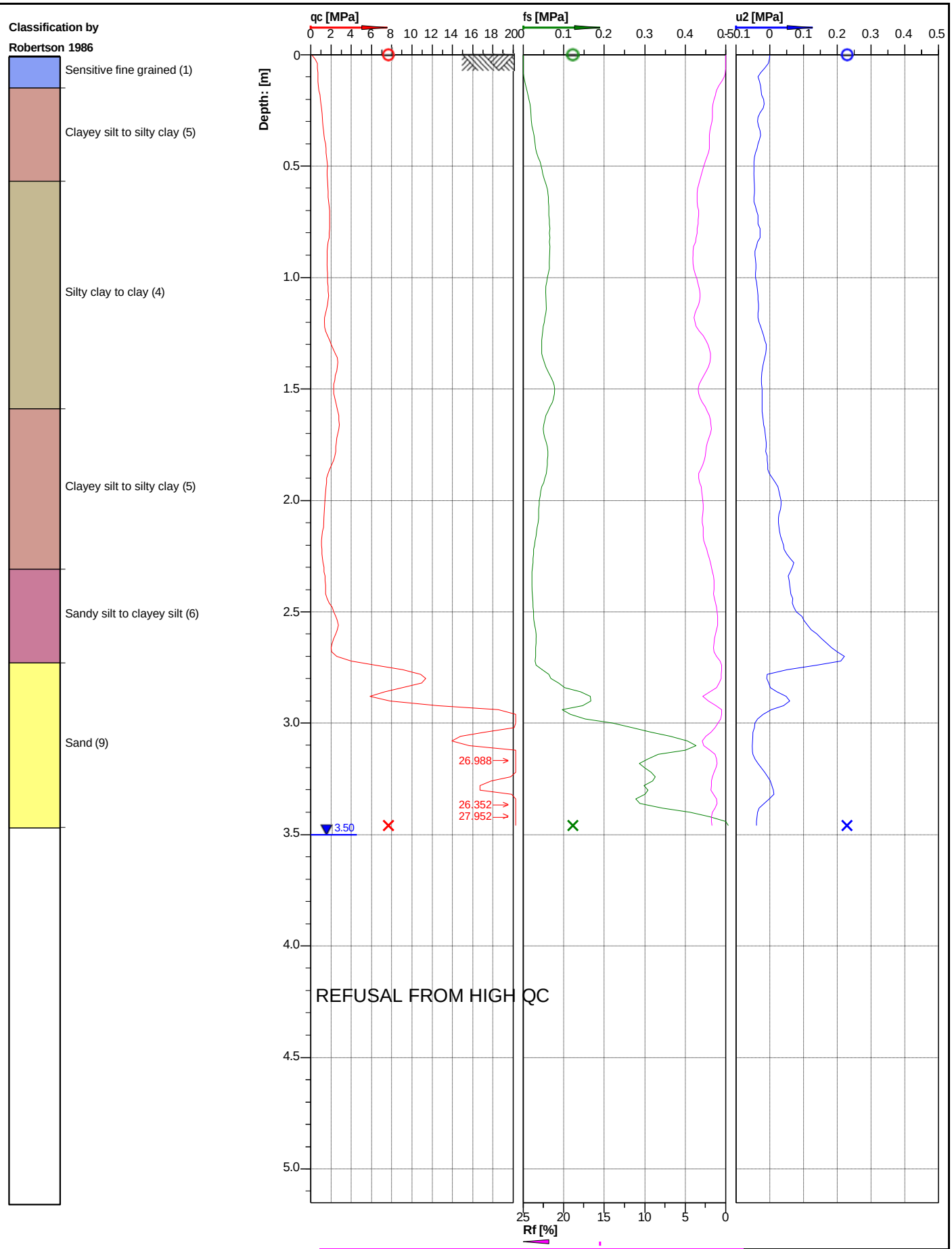
GEOTECH DRILLING

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.: CPT02
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Project: 174 BROOKVALE RD		Page: 1/1	Fig.:
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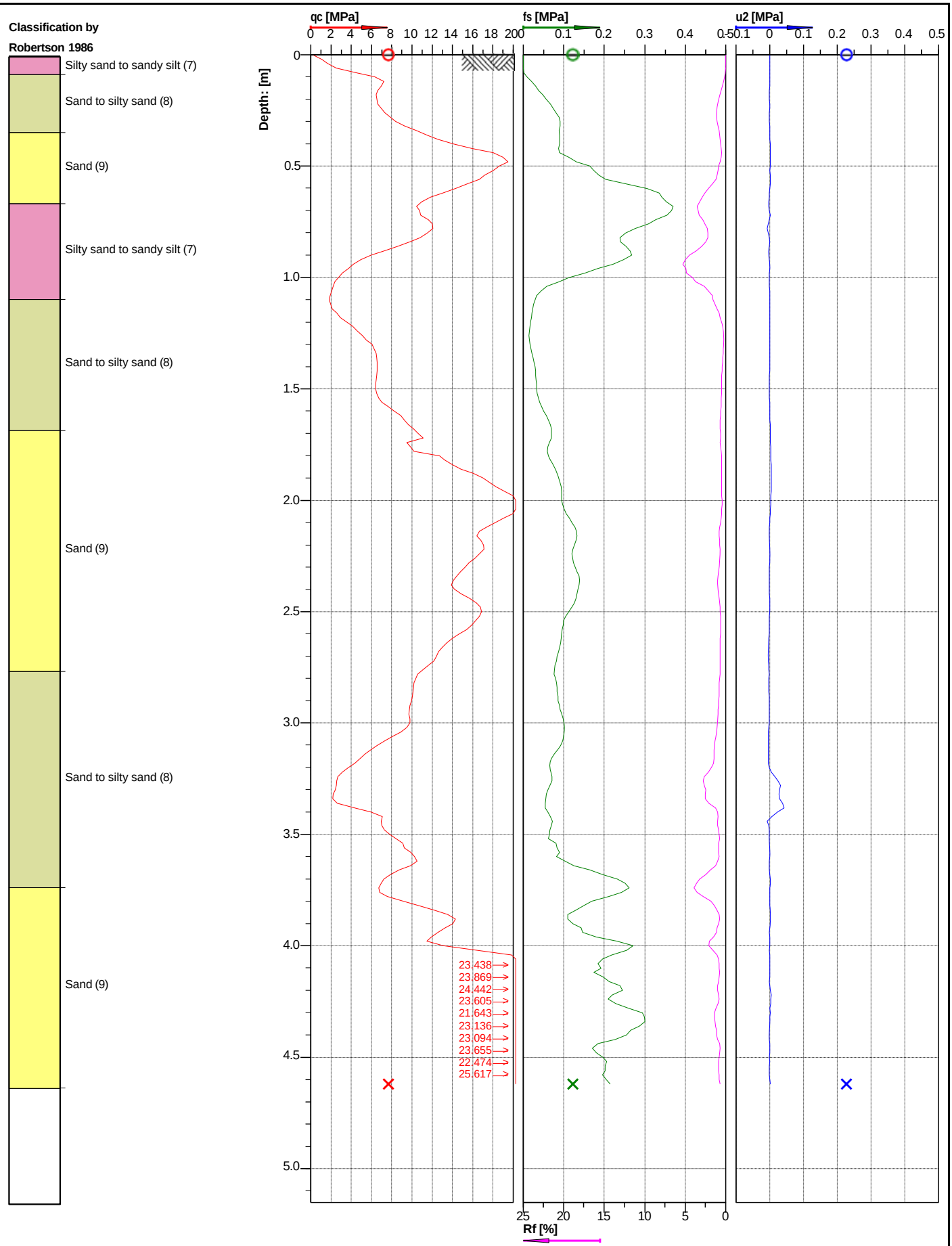
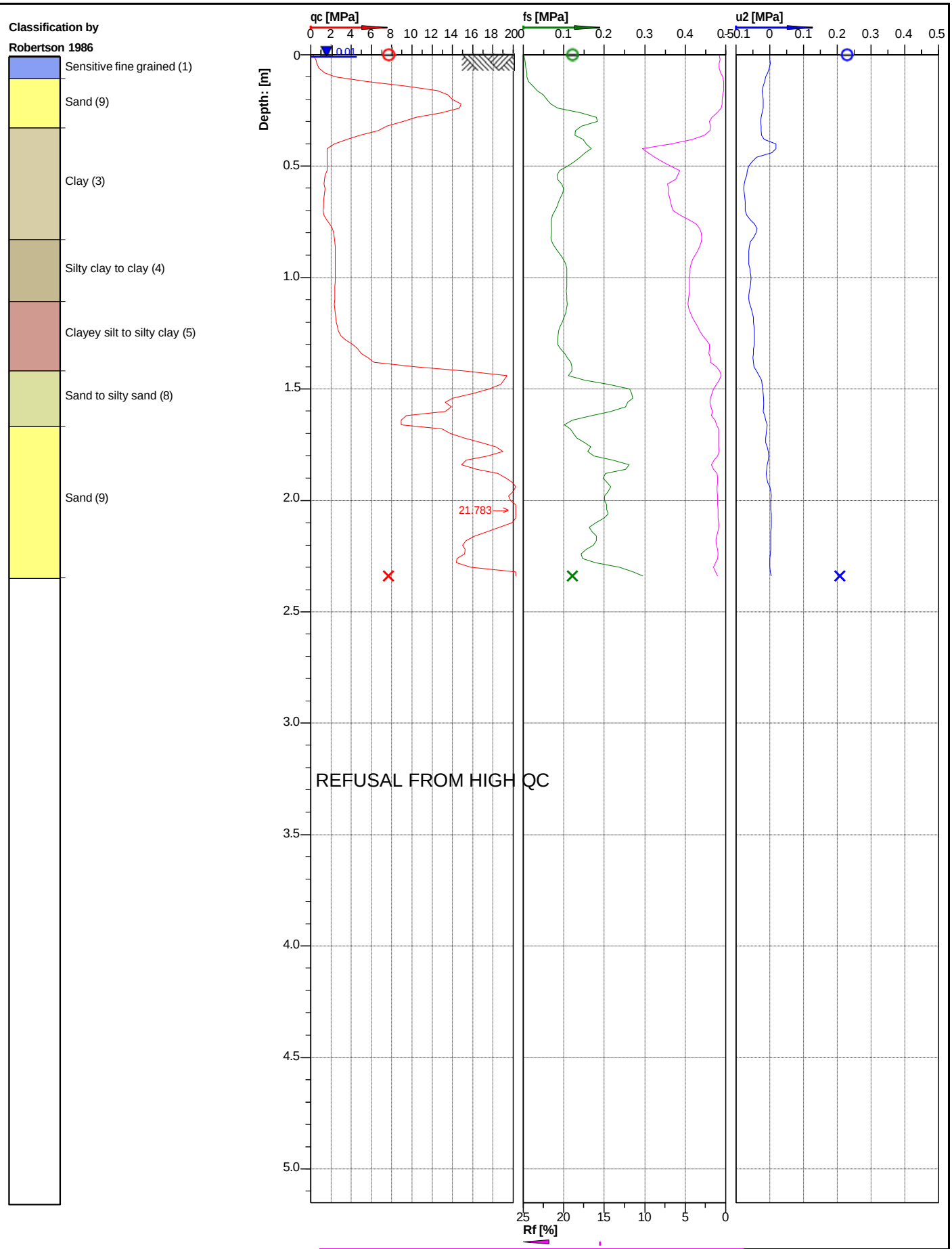
Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150



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.: CPT03
Project ID:	Client: TONKIN + TAYLOR	Date: 1/07/2020	Scale: 1 : 23
Project: 174 BROOKVALE ROAD		Page: 1/1	Fig.:
S 39.65990, 176.90498		File: CPT03A.cpt	



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: TONKIN + TAYLOR	Date: 1/07/2020	Scale: 1 : 23
Project: 174 BROOKVALE RD		Page: 1/1	Fig.:
S 39.65976, E 176.90570		File: CPT04.cpt	

Well 258

IDENTIFICATION

WQ Site:	
Easting:	1935043.142
Northing:	5602759.745
Method:	
Address:	BROOKVALE RD

WELL INFORMATION

Drill date:	27/11/1972
Driller:	Boag & Hill Ltd
Casing Diameter (mm):	100
Bore Depth (m)	
Well Depth (m):	23.46
Screen top (m):	23.46
Screen bottom (m):	0
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Aquifer Information

Inital Water Level	-2
Aquifer Condition	Confined
Aquifer Lithology	

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	
Hydralic Conductivity	
Storativity	
Transmissivity	
Aquifer Thickness	
Number Of Pumping Steps	
Duration	
Maximum Draw Down	
Maximum Pumping Rate	2
Report Number	
Bore No	258

Bore Log (m)

Lithology	CLAY
From Depth	0
To Depth	3

Lithology	GRAVEL with clay
From Depth	3
To Depth	14

Lithology	GRAVEL

From Depth	14
To Depth	20

Lithology	SILTSTONE
From Depth	20
To Depth	23

Well 1129

IDENTIFICATION

WQ Site:	1908
Easting:	1935129.206
Northing:	5602830.837
Method:	Differential GPS
Address:	BROOKVALE RD HAVELOCK NTH (L/C)

WELL INFORMATION

Drill date:	09/07/1981
Driller:	Hill Well Drillers Ltd
Casing Diameter (mm):	200
Bore Depth (m)	
Well Depth (m):	18.1
Screen top (m):	15.2
Screen bottom (m):	21.2
Open hole top (m):	
Open hole bottom (m):	
Water level access:	Unknown

Bore Consents

Consent Id	WP000744T
Consent Type	Ground-water consent
Use One	Cropping
Use Two	Irrigation

Aquifer Information

Inital Water Level	0
Aquifer Condition	Confined
Aquifer Lithology	

Aquifer Test

Test Reliability	Unreliable
Specific Capacity	3
Hydralic Conductivity	
Storativity	
Transmissivity	
Aquifer Thickness	
Number Of Pumping Steps	
Duration	1
Maximum Draw Down	5
Maximum Pumping Rate	16
Report Number	
Bore No	1129

Bore Log (m)

Lithology	TOPSOIL

From Depth	0
To Depth	1

Lithology	brown CLAY (soft)
From Depth	1
To Depth	3

Lithology	blue/brown GRAVEL
From Depth	3
To Depth	14

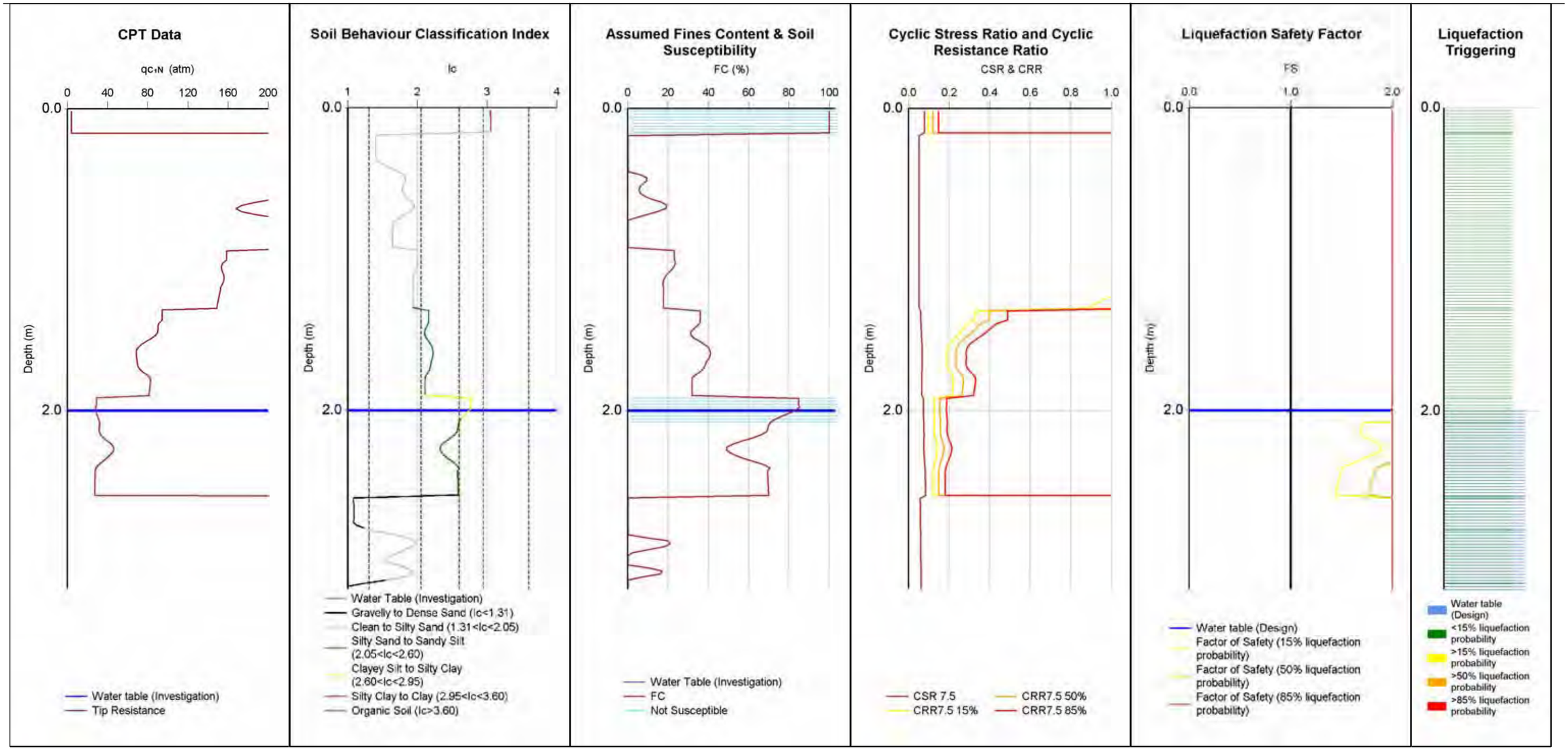
Lithology	yellow CLAY with gravel
From Depth	14
To Depth	14

Lithology	yellow CLAY
From Depth	14
To Depth	15

Lithology	blue/brown GRAVEL
From Depth	15
To Depth	20

Lithology	blue CLAY (mud)
From Depth	20
To Depth	23

Appendix C: CPT liquefaction calculator outputs



Note: Inverse filtered Qc/Fs data (10 cm²) used.

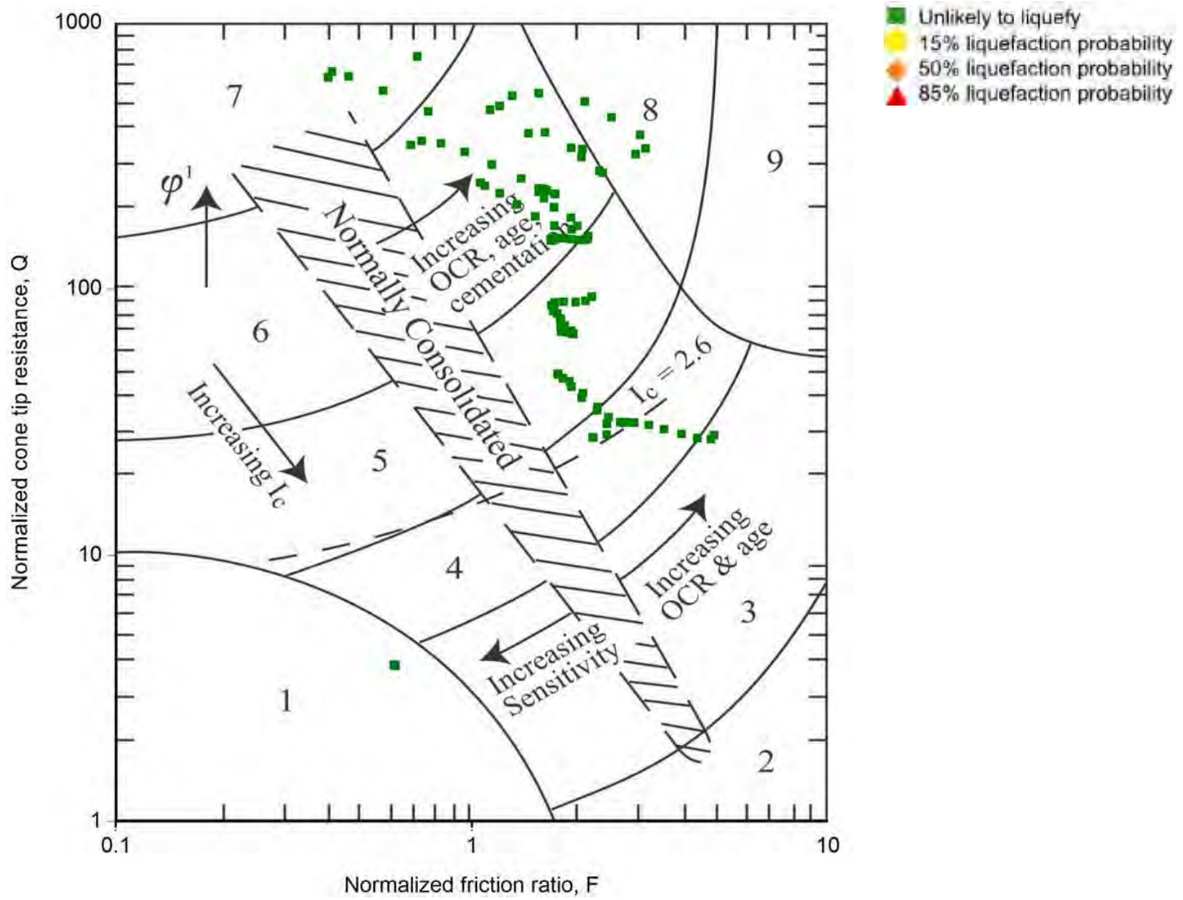
	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT1 - SLS	160818	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	1	0	0	0	3.2	0
	50%	0	0	0	0	3.2	0
	85%	0	0	0	0	3.2	0

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL

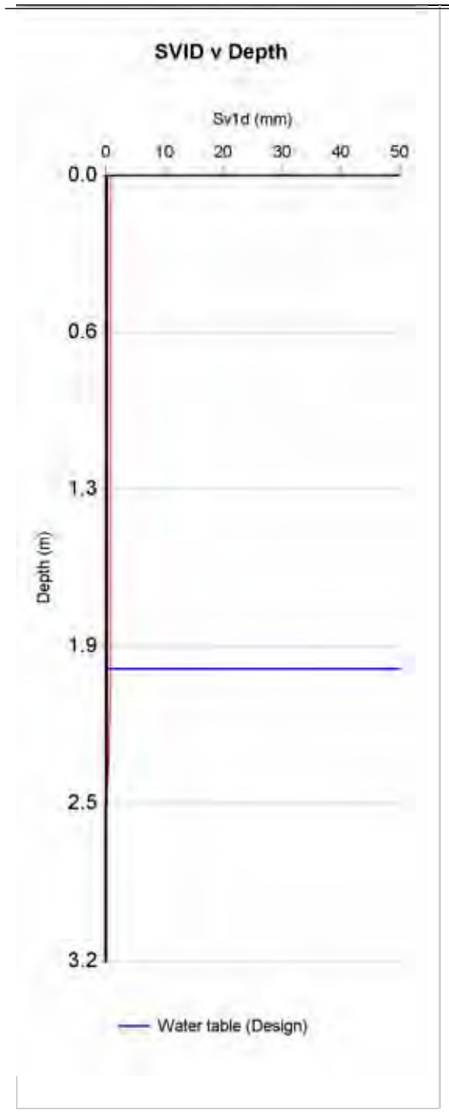
Tonkin + Taylor Exceptional thinking together V2.4.15	CLIENT: **Northpeak Properties Limited** PROJECT: **Te Mata Mushroom Farm** TITLE: **CPT Liquefaction Analyses - SLS 1/25 yr** COMMENT:	LOCATION: 174 Brookvale Rd, Havelock North JOB NUMBER: **1014649**	DATE: 23/07/2020 ANALYSED: poll PAGE: 1 of 15 pages	

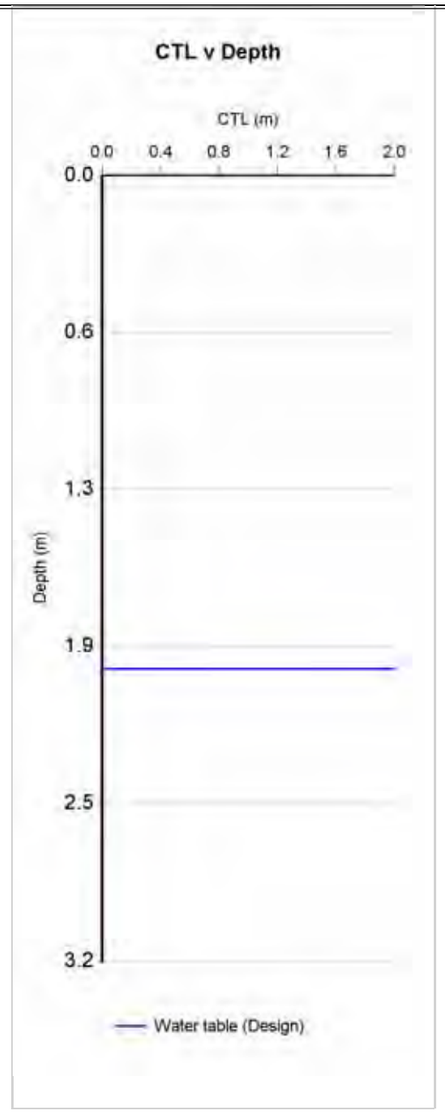


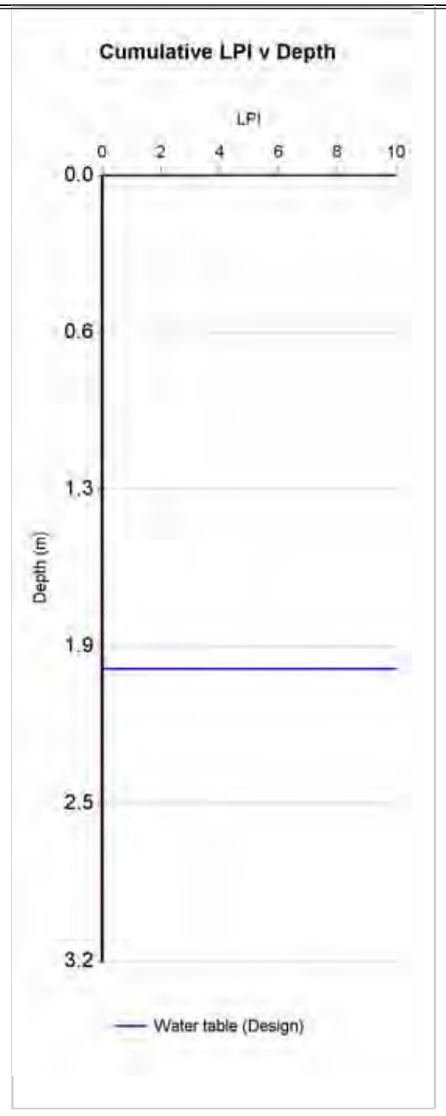
1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

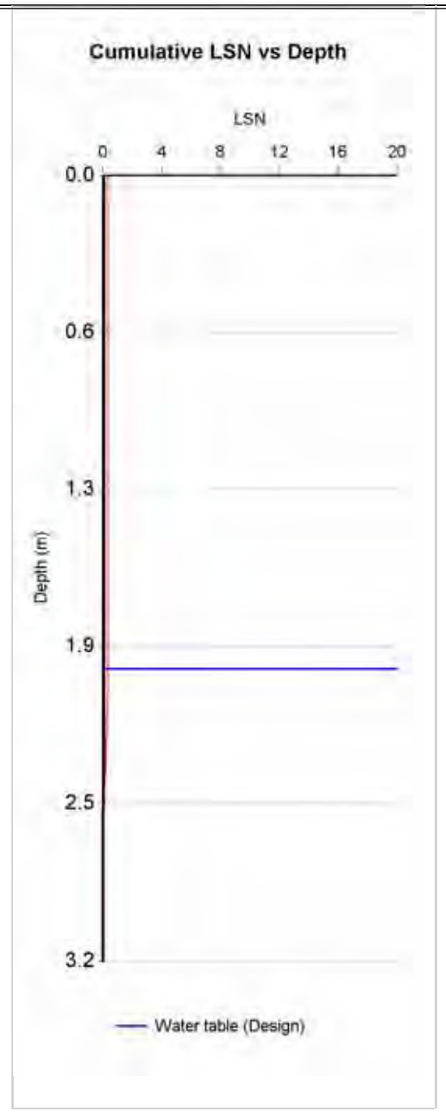
*Heavily overconsolidated or cemented

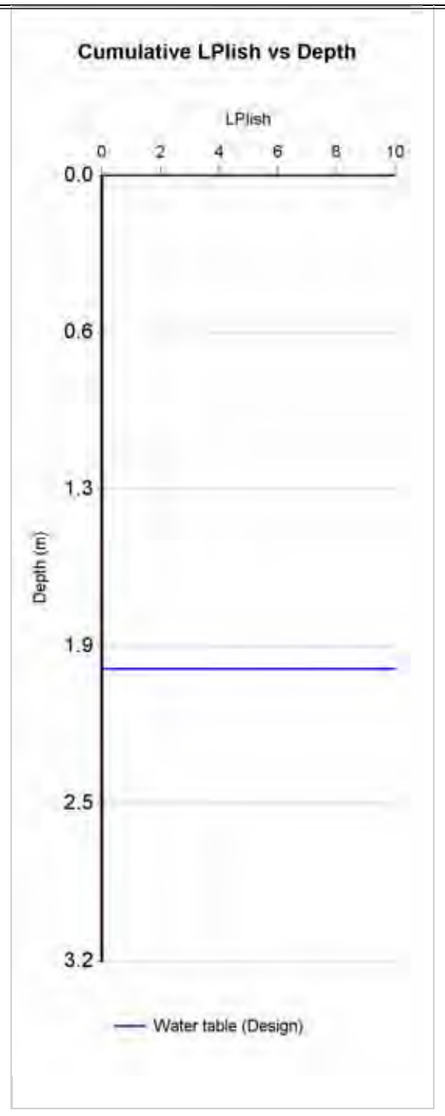
CPT-based soil behavior type classification chart by Robertson (1990)



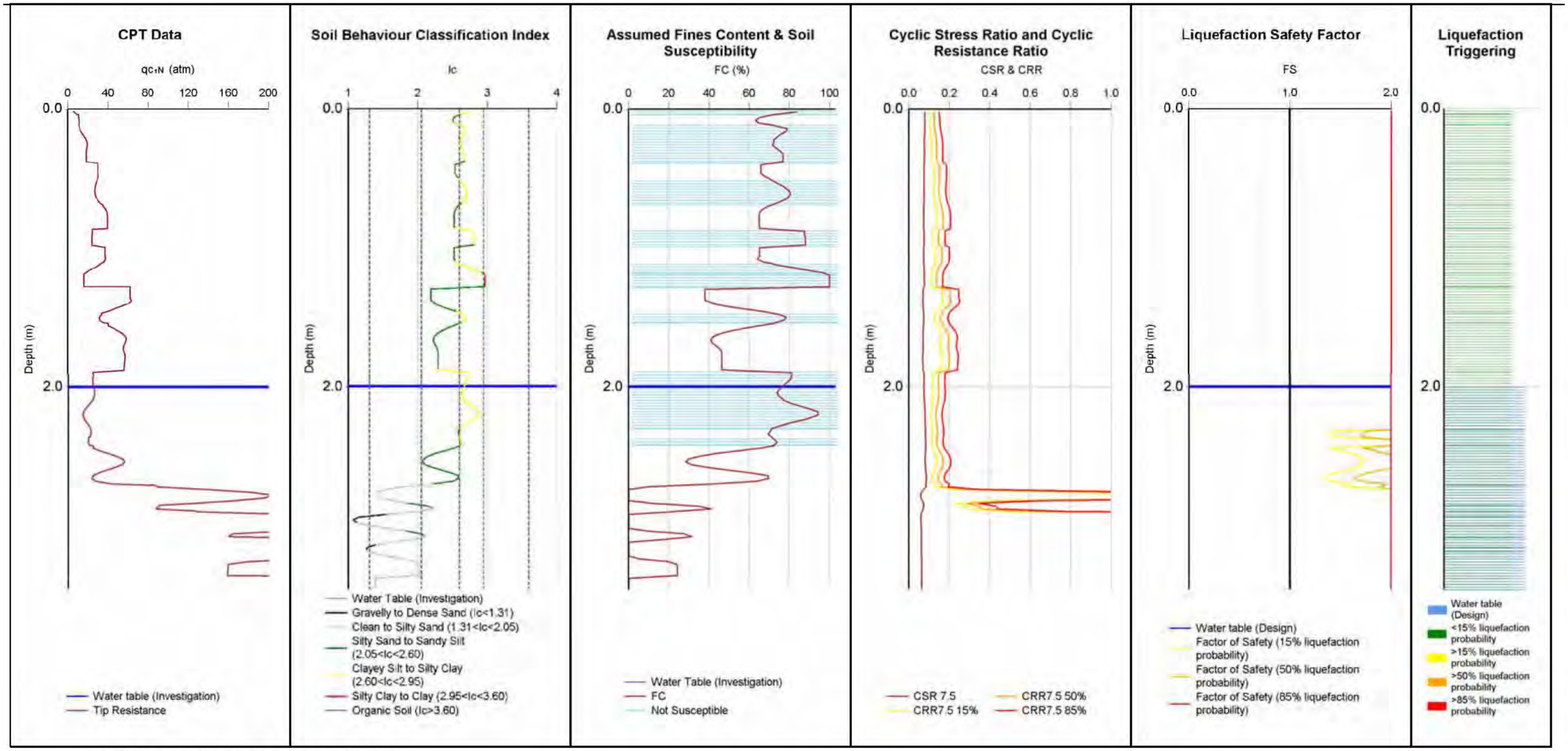








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT1 - SLS	160818	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	



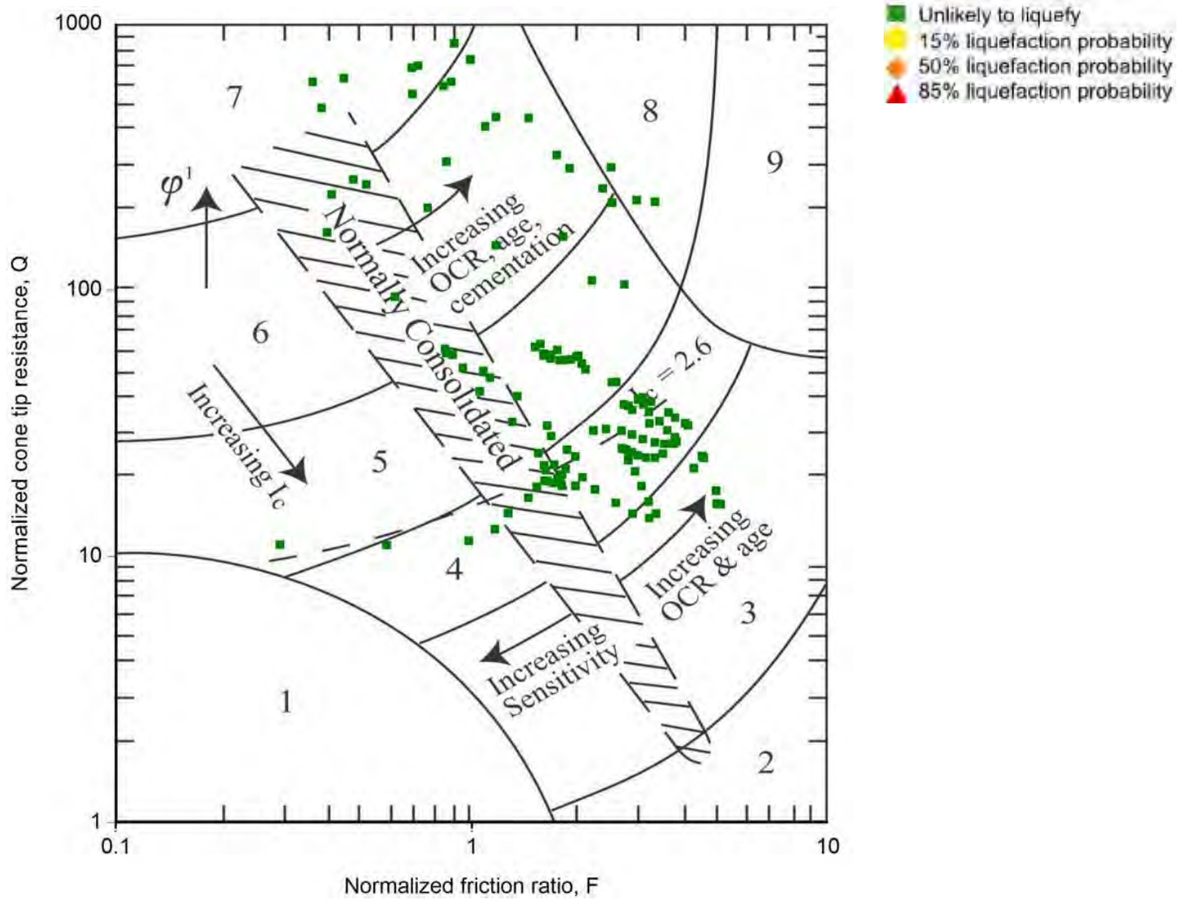
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT2 - SLS	160819	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	1	0	0	0	3.5	0
	50%	0	0	0	0	3.5	0
	85%	0	0	0	0	3.5	0

Reviewed by:

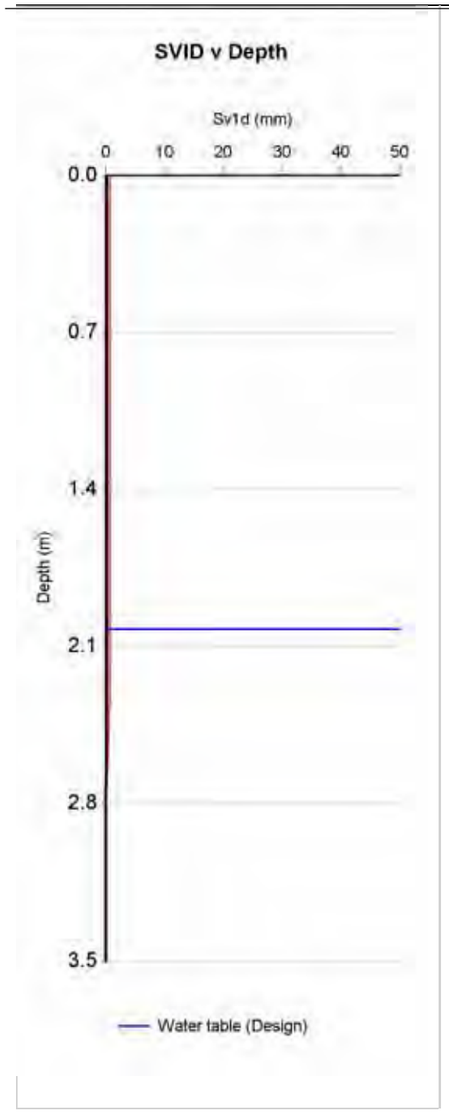
CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL

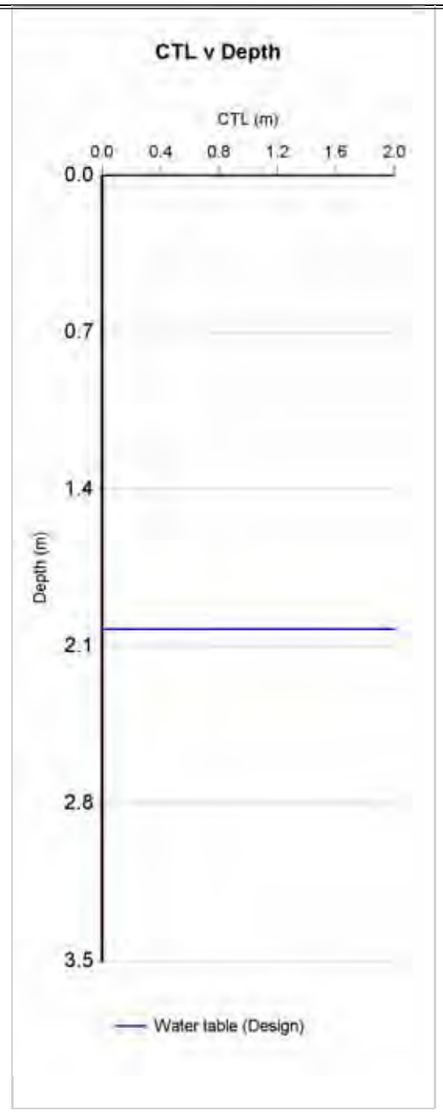


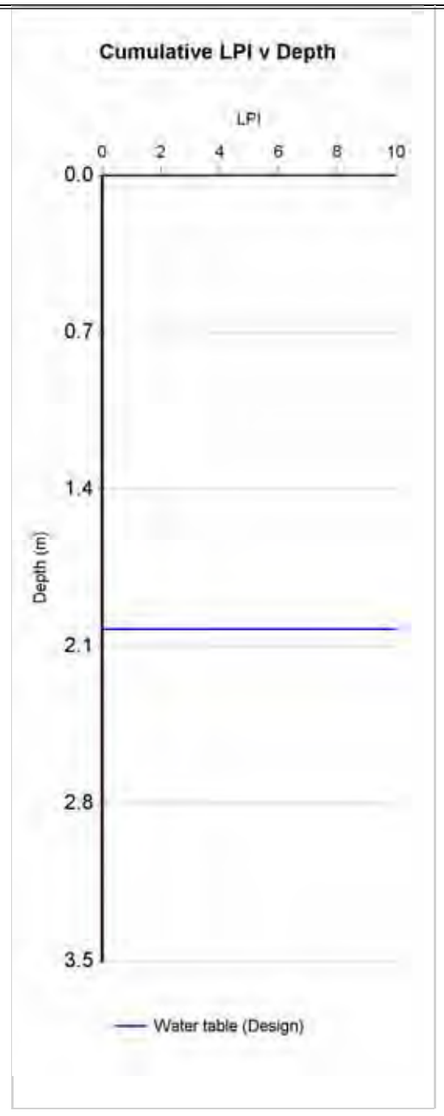
1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

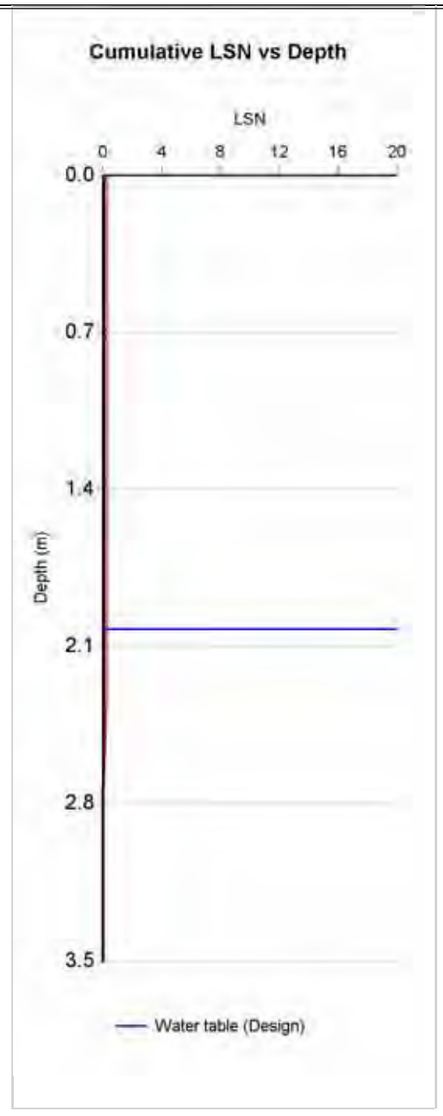
*Heavily overconsolidated or cemented

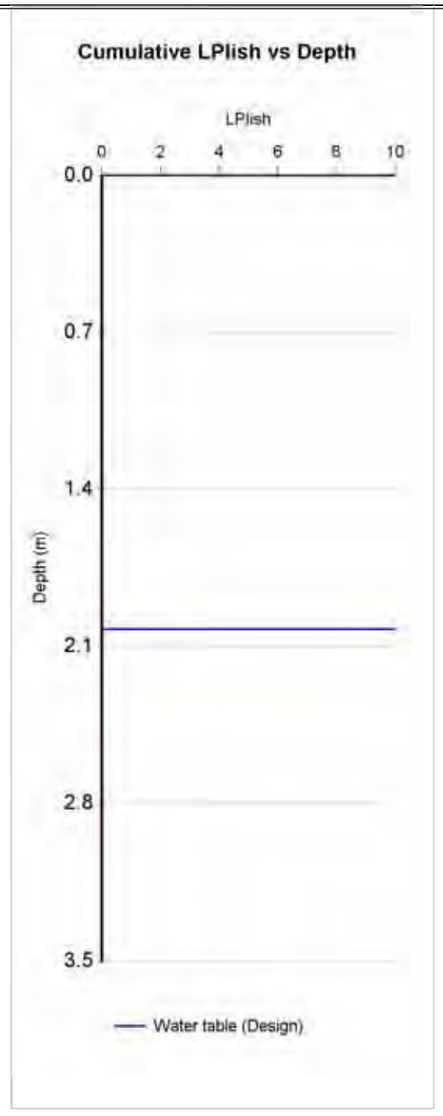
CPT-based soil behavior type classification chart by Robertson (1990)



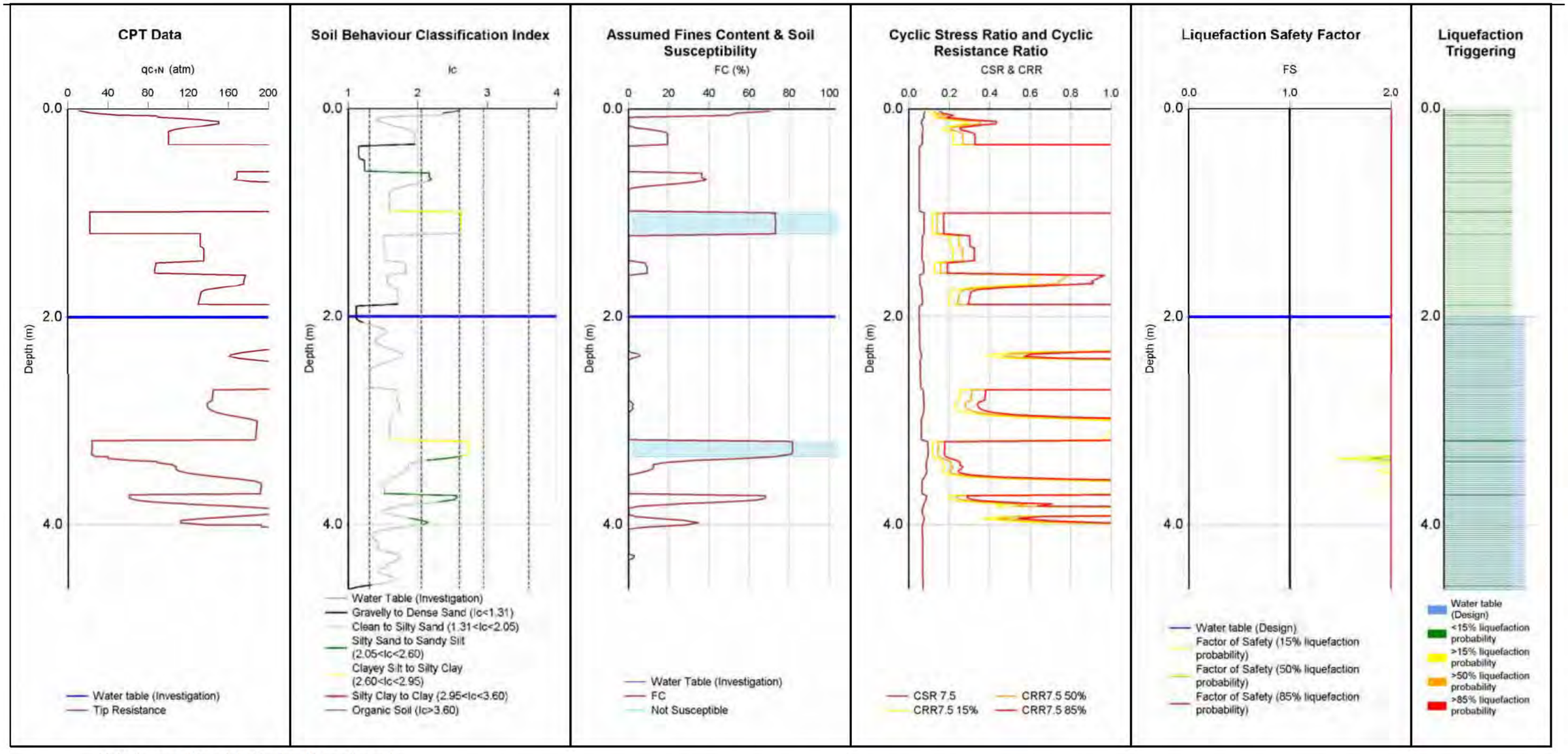








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT2 - SLS	160819	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	



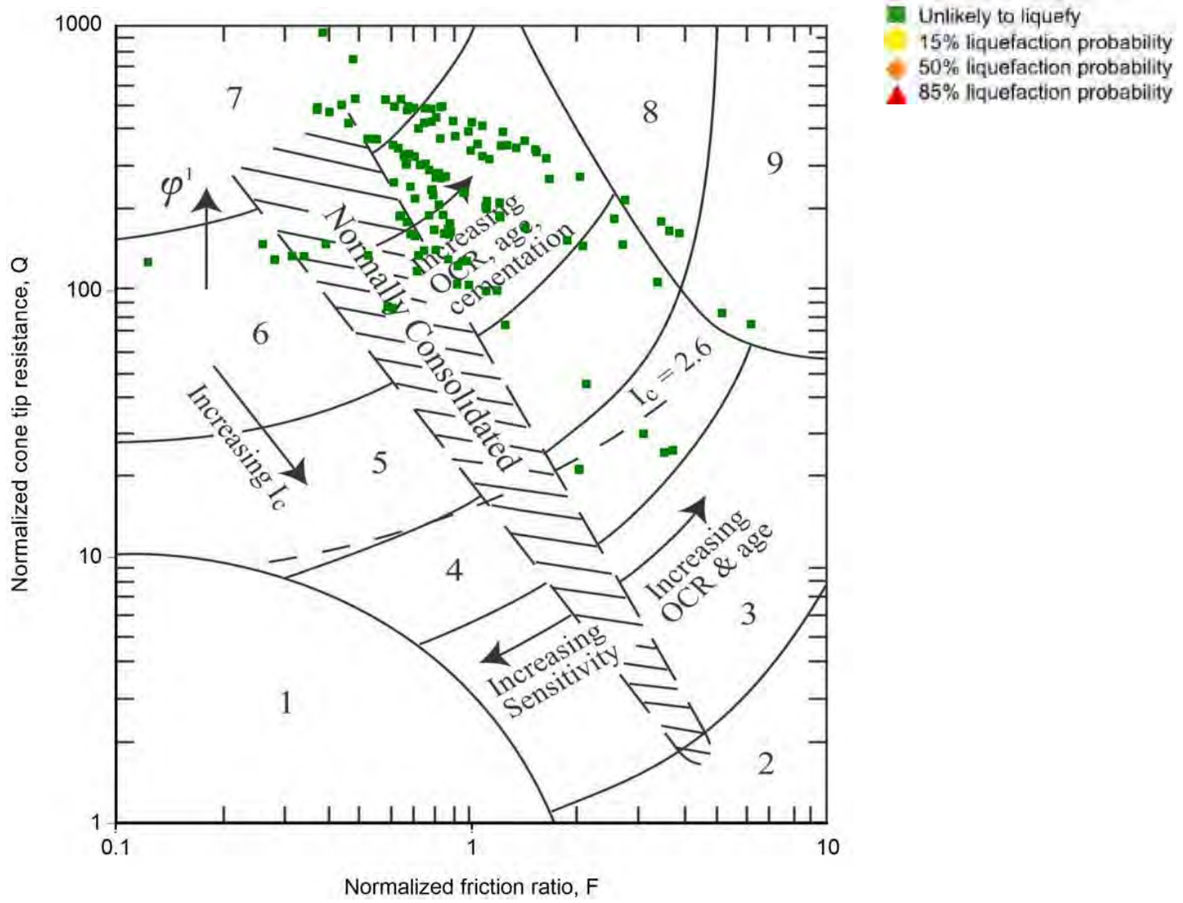
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT3 - SLS	160820	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
OUTPUT	15%	0	0	0	0	4.6	0
	50%	0	0	0	0	4.6	0
	85%	0	0	0	0	4.6	0

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL



1. Sensitive, fine grained
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8. Very stiff sand to clayey sand *
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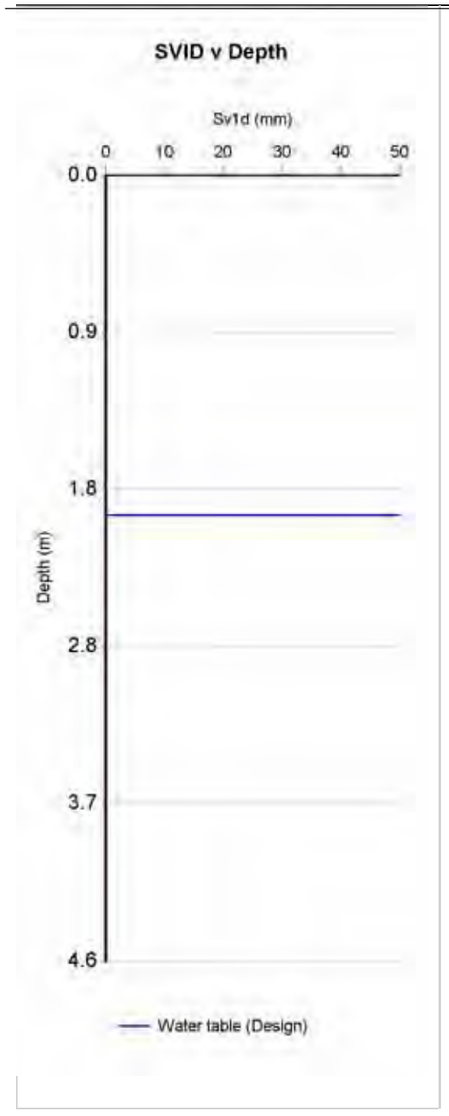
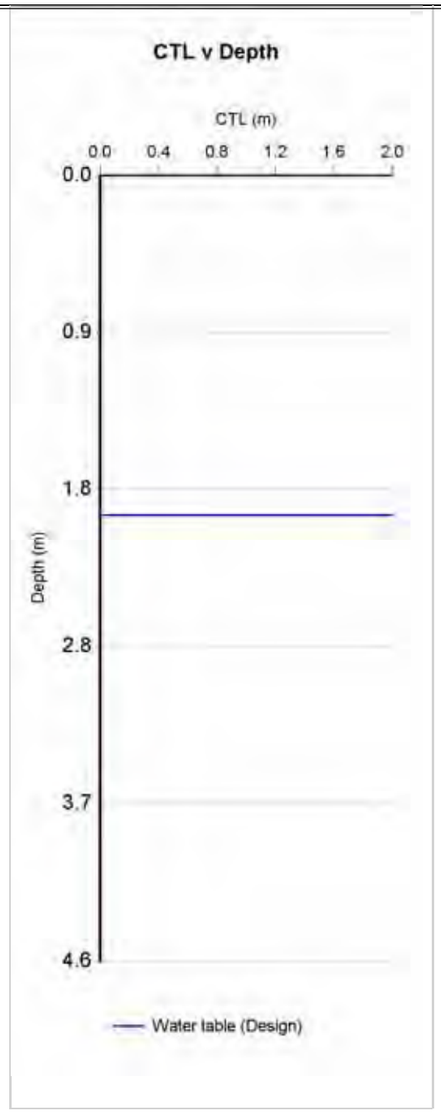
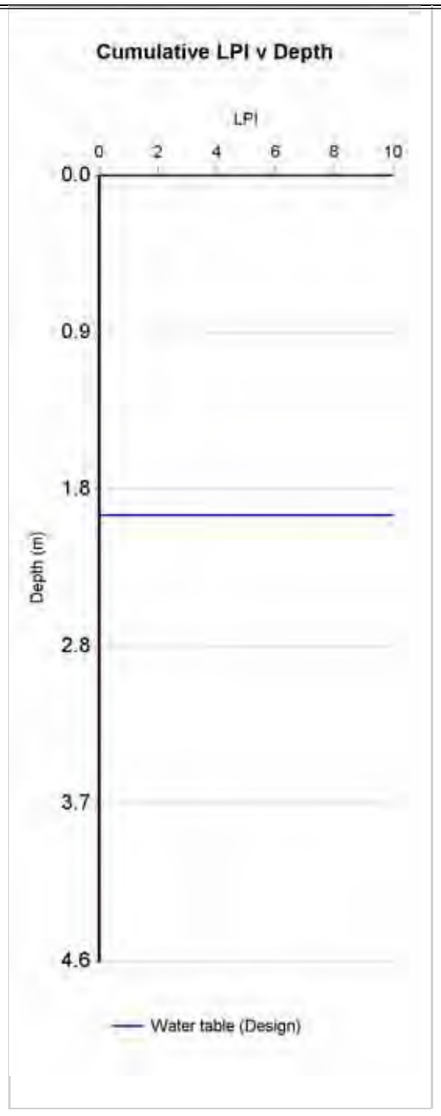
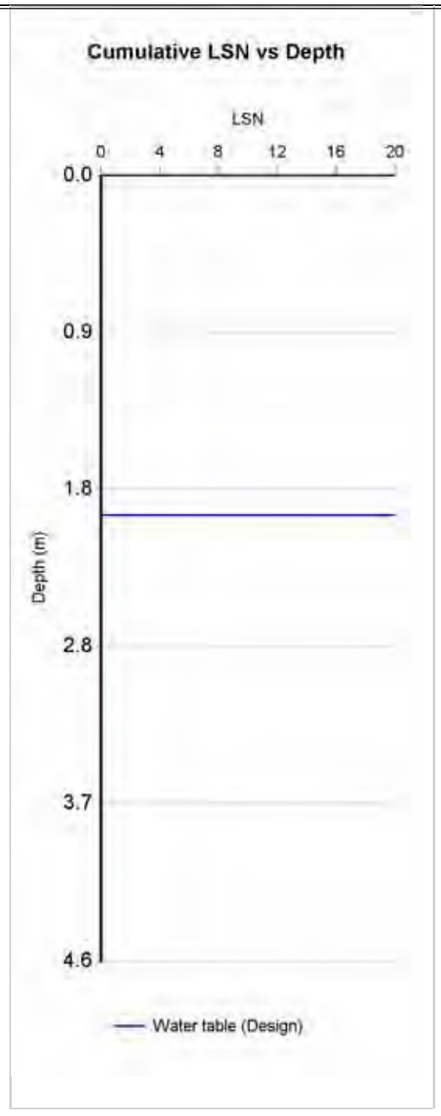
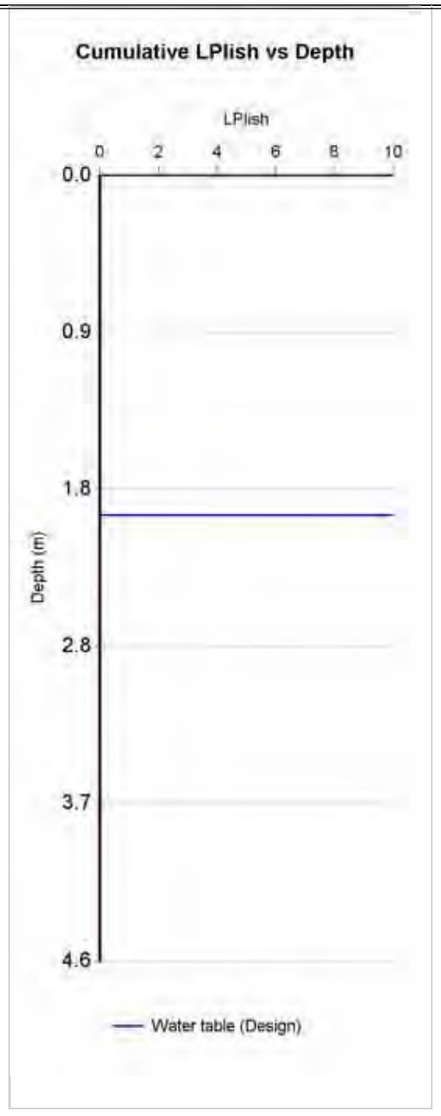
CPT-based soil behavior type classification chart by Robertson (1990)



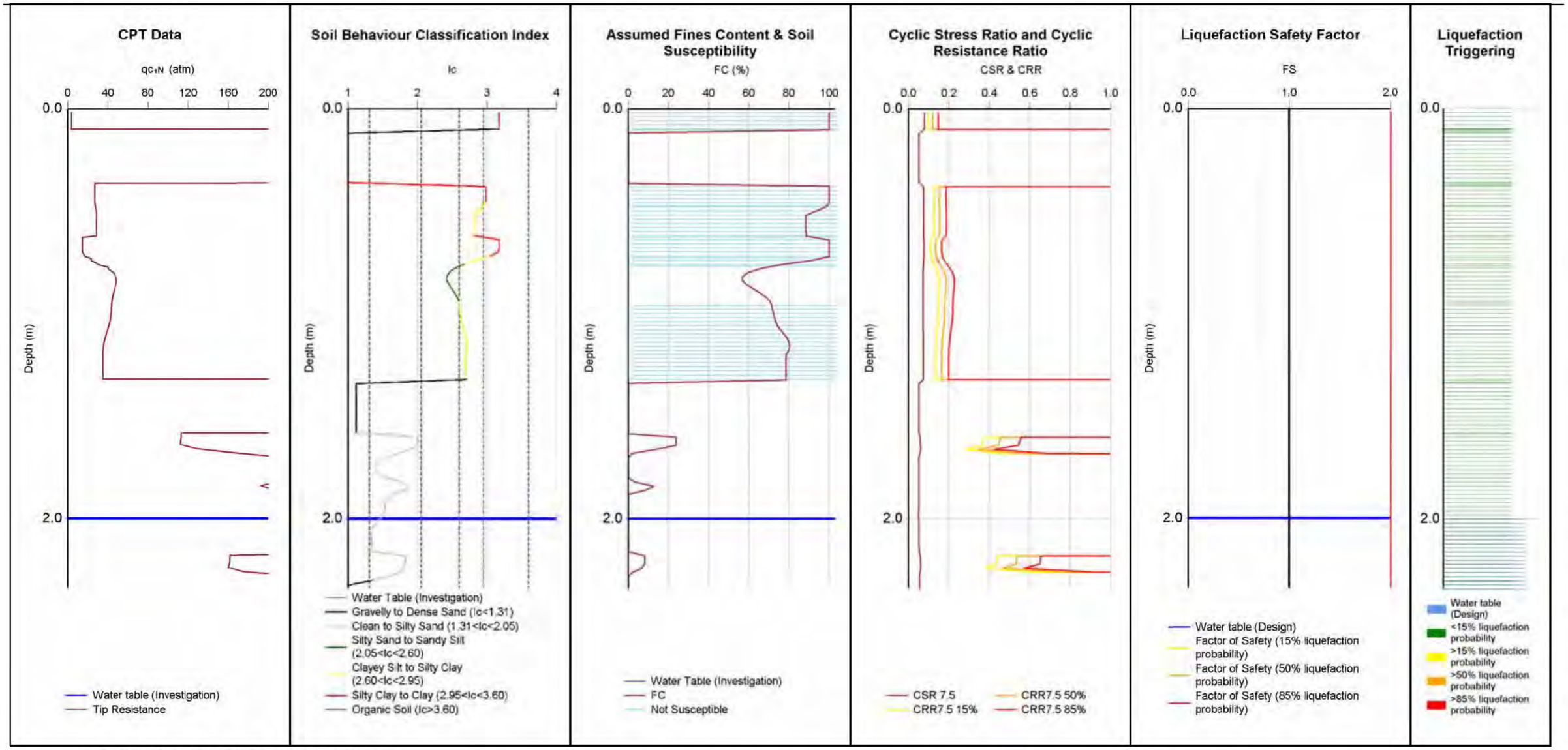








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT3 - SLS	160820	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	



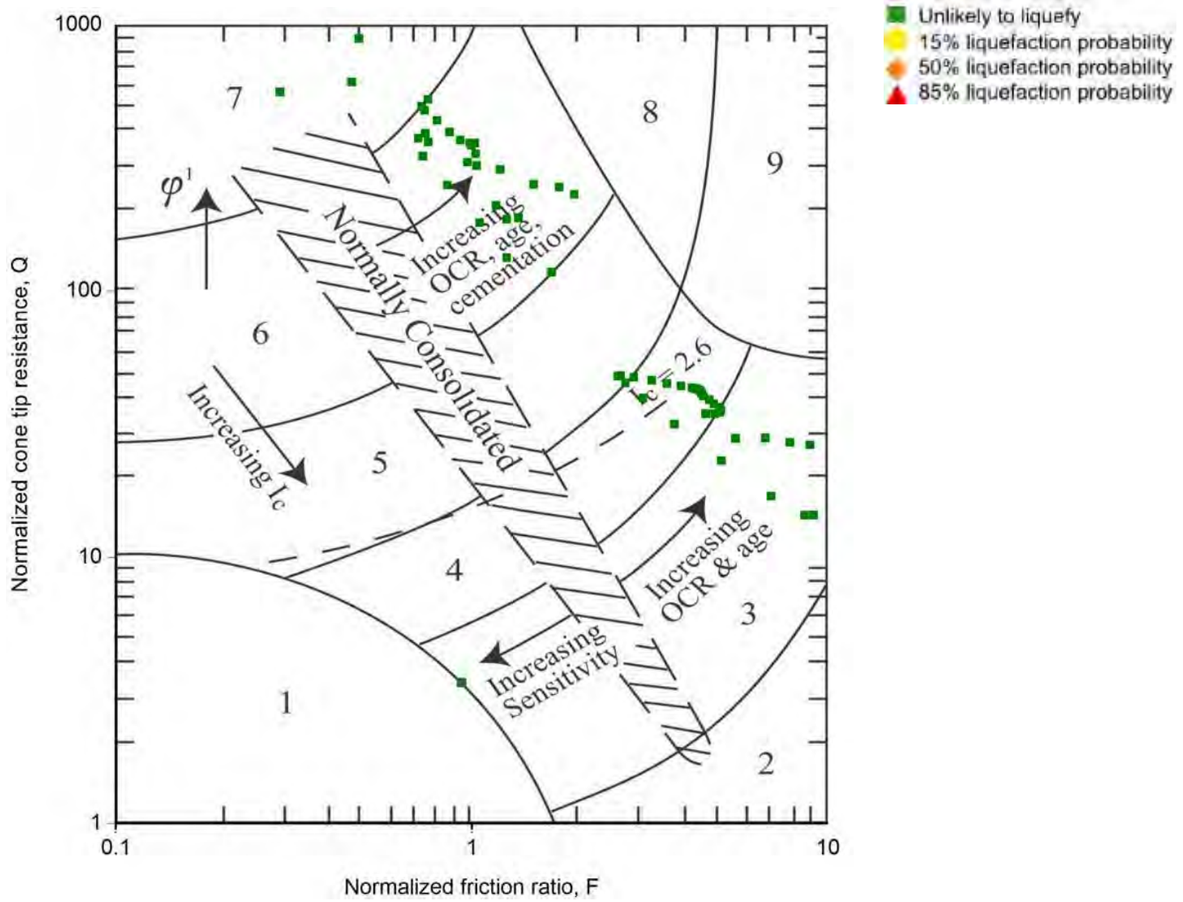
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT4 - SLS	160821	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	0	0	0	0	2.3	0
	50%	0	0	0	0	2.3	0
	85%	0	0	0	0	2.3	0

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL



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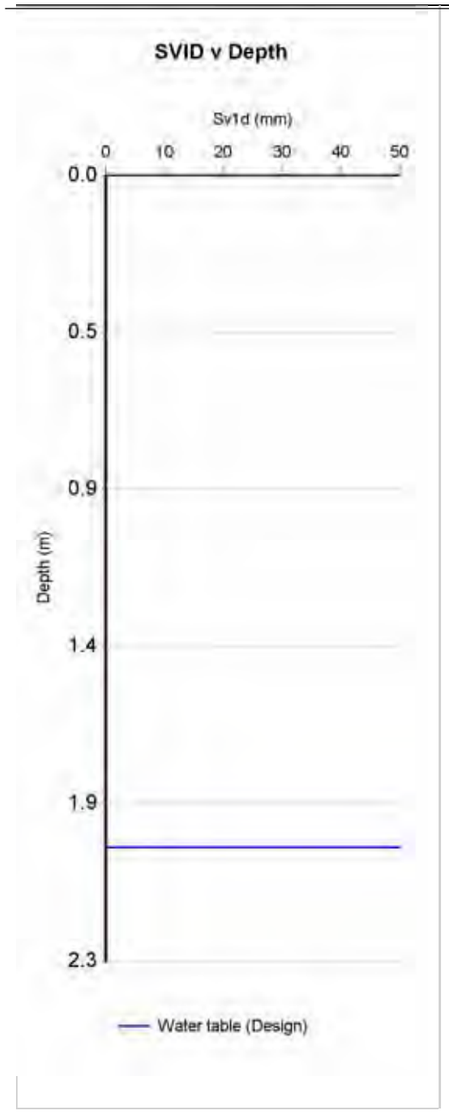
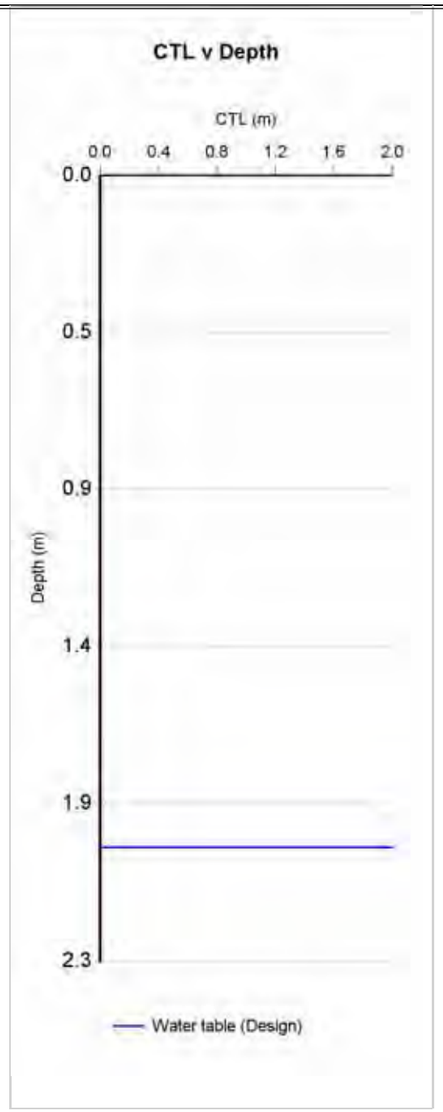
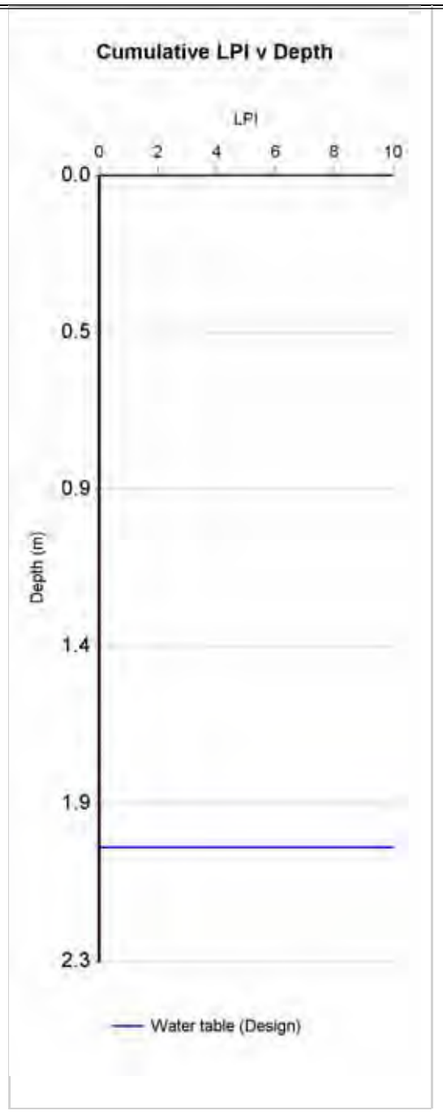
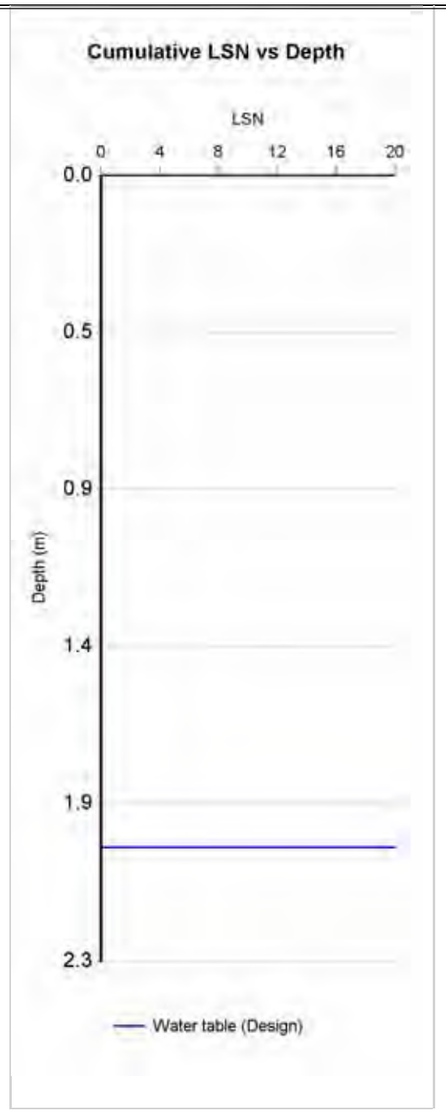
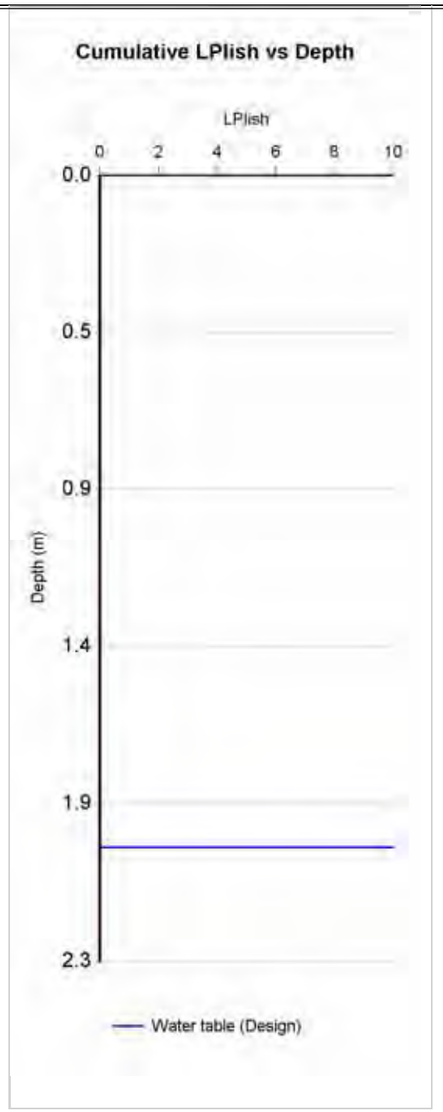
CPT-based soil behavior type classification chart by Robertson (1990)



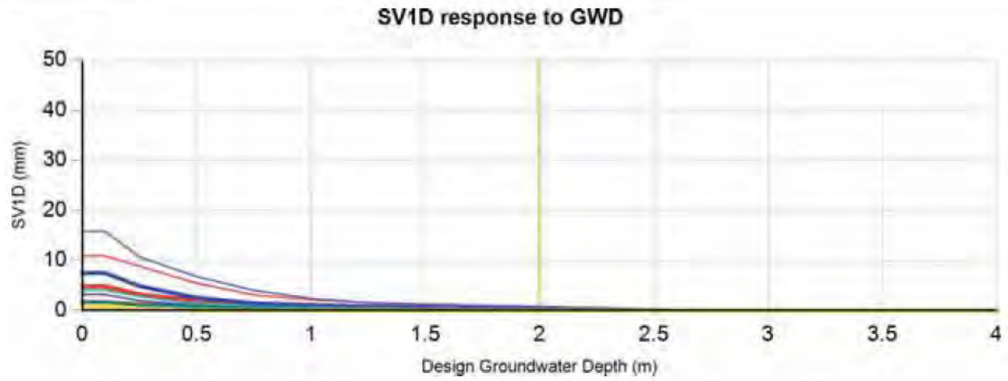


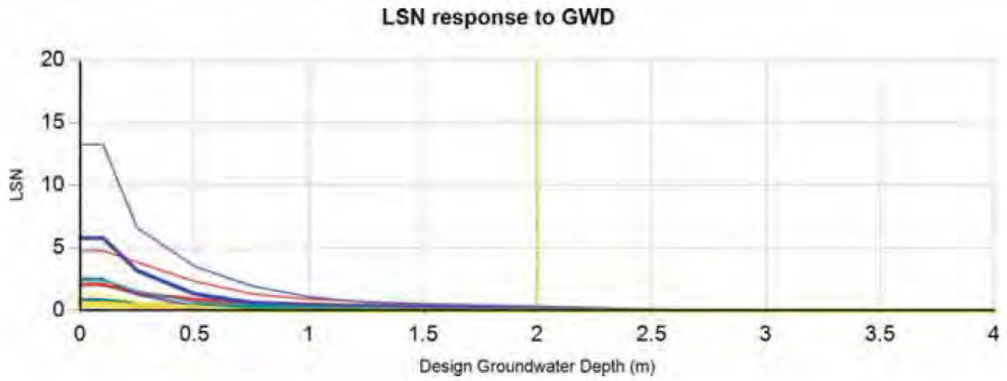


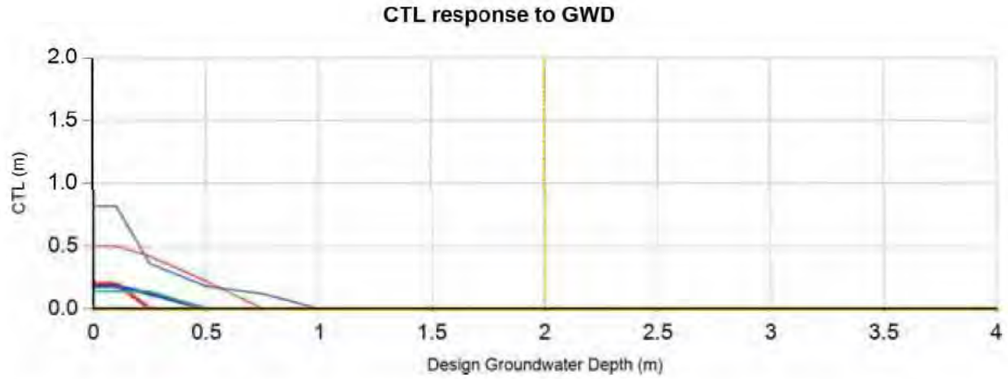


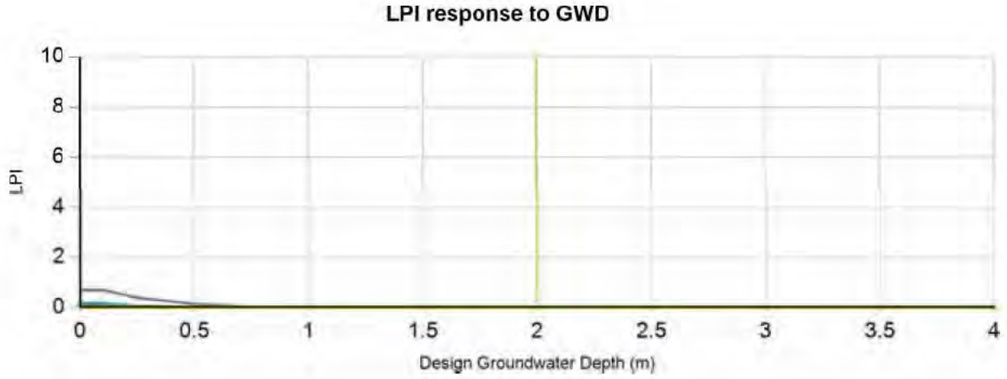


	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT4 - SLS	160821	1/07/2020	0	6.2	0.14	BI-2014	ZRB-2002	18		0	







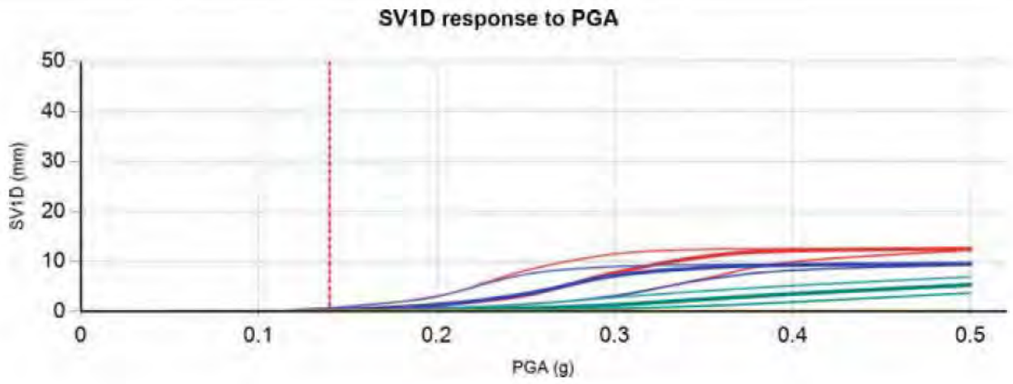


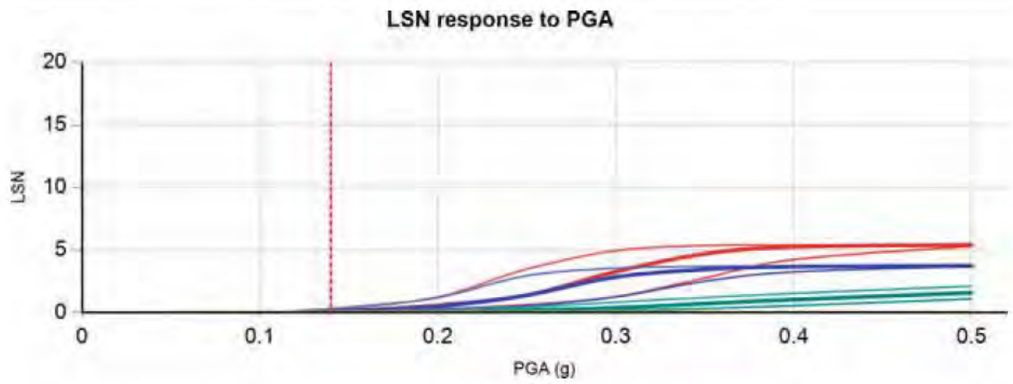
Vertical dotted line/s indicate design groundwater depth at the CPT locations.

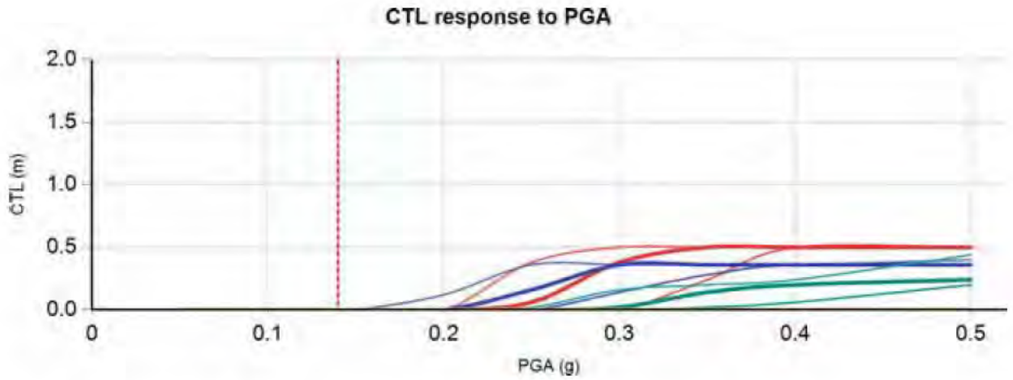
Note: Inverse filtered Qc/Fs data (10 cm²) used.

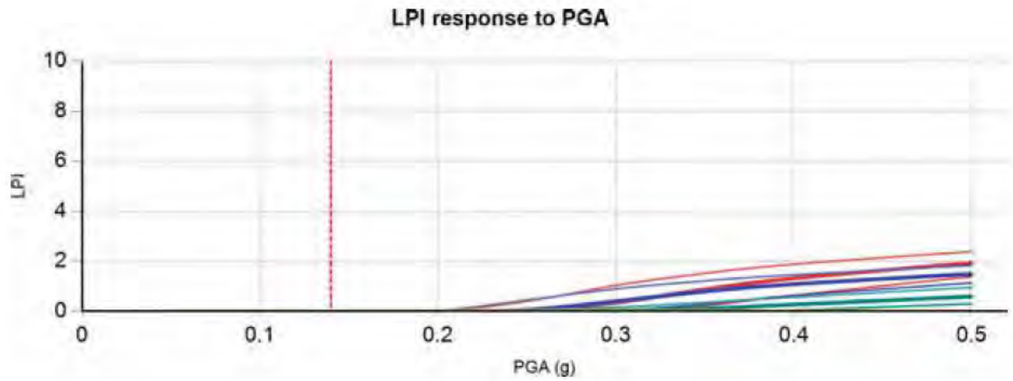
Run Description	TTGD ID	Investigation Date	Magnitude	PGA (g)	Trigger Method	Settlement Method	CFC	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
CPT1 - SLS	160818	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT2 - SLS	160819	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT3 - SLS	160820	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT4 - SLS	160821	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	

Thicker lines represent the 50% probability of exceedence case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.









Vertical dotted line/s indicate user specified PGA at the CPT locations. (actual PGA)

Note: Inverse filtered Qc/Fs data (10 cm²) used.

Run Description	TTGD ID	Investigation Date	Magnitude	PGA (g)	Trigger Method	Settlement Method	CFC	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
CPT1 - SLS	160818	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT2 - SLS	160819	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT3 - SLS	160820	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
CPT4 - SLS	160821	1/07/2020	6.2	0.14	BI-2014	ZRB-2002		18		0	
Thicker lines represent the 50% probability of exceedence case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.											

The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.

Table 1.1-1 Summary of inputs for liquefaction analysis

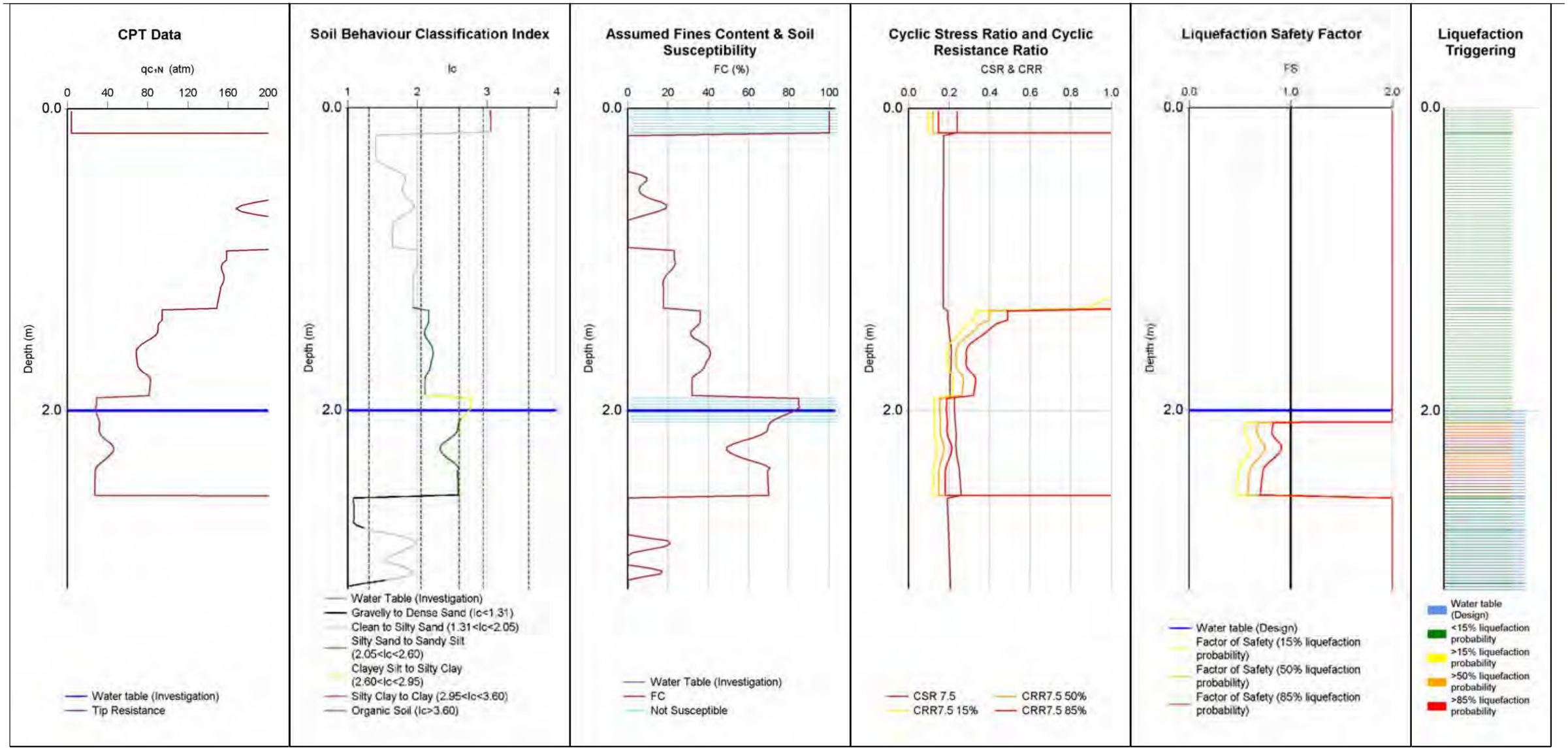
ID	TTGD 160818	TTGD 160819	TTGD 160820	TTGD 160821
CPT Name	CPT01	CPT02	CPT03	CPT04
Run description	CPT1 - SLS	CPT2 - SLS	CPT3 - SLS	CPT4 - SLS
PGA	0.14g	0.14g	0.14g	0.14g
Magnitude	6.2	6.2	6.2	6.2
Depth to groundwater at time of Investigation (m)	2	2	2	2
Depth to groundwater for design (m)	2	2	2	2
Predrill depth (m)	0	0	0	0
Assumed predrill tip resistance and skin friction	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	ZRB-2002	ZRB-2002	ZRB-2002	ZRB-2002
Total depth of CPT (m)	3.18	3.46	4.62	2.34
Minimum depth of analysis (m)	0	0	0	0
Maximum depth of analysis (m)	3.18	3.46	4.62	2.34
Inverse Filtering applied?	Yes (10 cm^2)	Yes (10 cm^2)	Yes (10 cm^2)	Yes (10 cm^2)

Table 1.1-2 Summary of Ic inputs for liquefaction analysis

ID	Run description	From (m)	To (m)	Ic
TTGD 160818	CPT1 - SLS	0	0	0
TTGD 160818	CPT1 - SLS	0	5	2.6
TTGD 160819	CPT2 - SLS	0	0	0
TTGD 160819	CPT2 - SLS	0	5	2.6
TTGD 160820	CPT3 - SLS	0	0	0
TTGD 160820	CPT3 - SLS	0	5	2.6
TTGD 160821	CPT4 - SLS	0	0	0
TTGD 160821	CPT4 - SLS	0	5	2.6

Table 1.1-3 Summary of Fc inputs for liquefaction analysis

ID	Run description	From (m)	To (m)	Fc
TTGD 160818	CPT1 - SLS	0	3.18	0 CFC
TTGD 160819	CPT2 - SLS	0	3.46	0 CFC
TTGD 160820	CPT3 - SLS	0	4.62	0 CFC
TTGD 160821	CPT4 - SLS	0	2.34	0 CFC



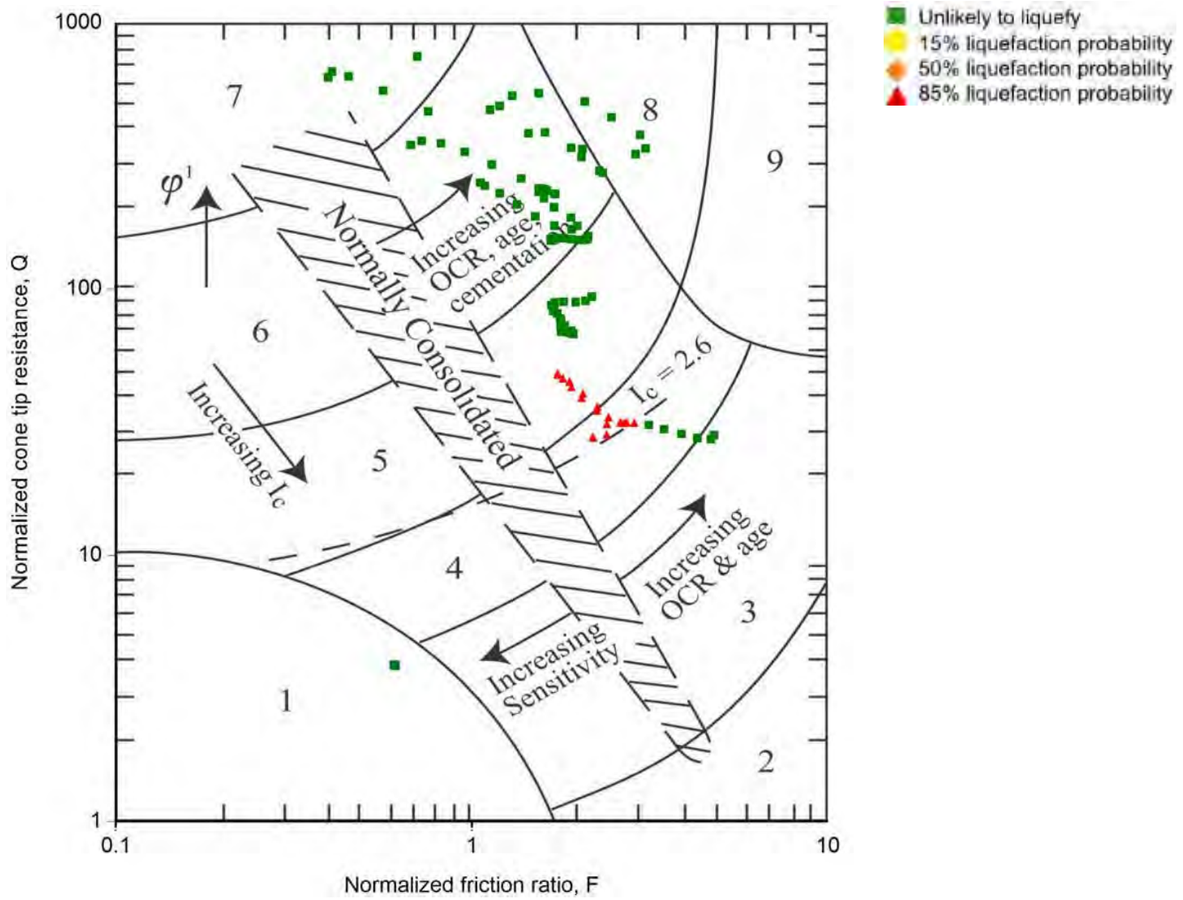
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT1 - ULS	160818	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	13	0.5	2	5	2.2	3
	50%	12	0.5	2	5	2.2	2
	85%	11	0.5	1	5	2.2	1

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL



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8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

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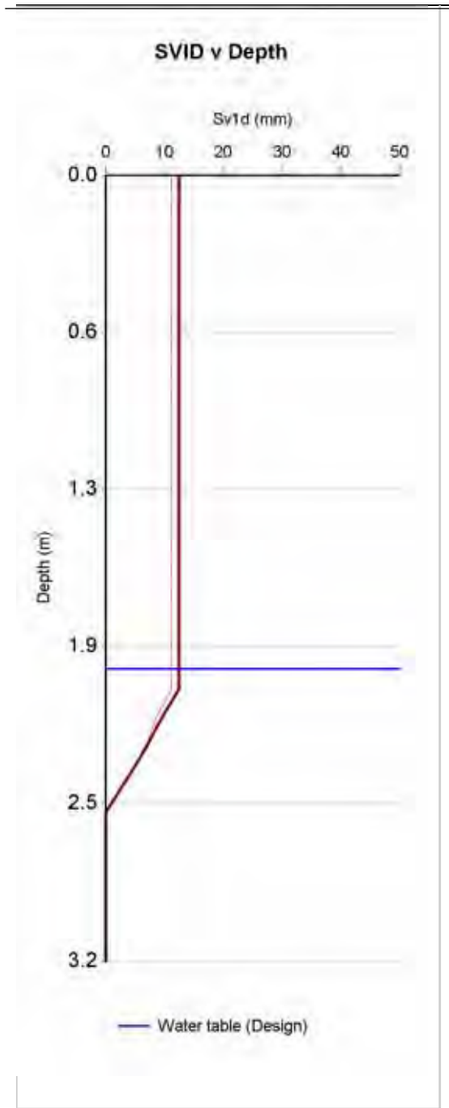
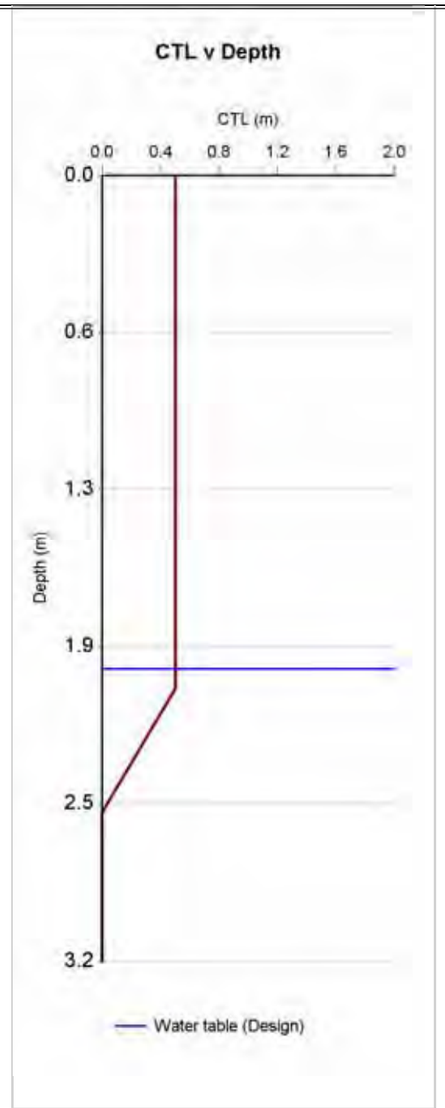
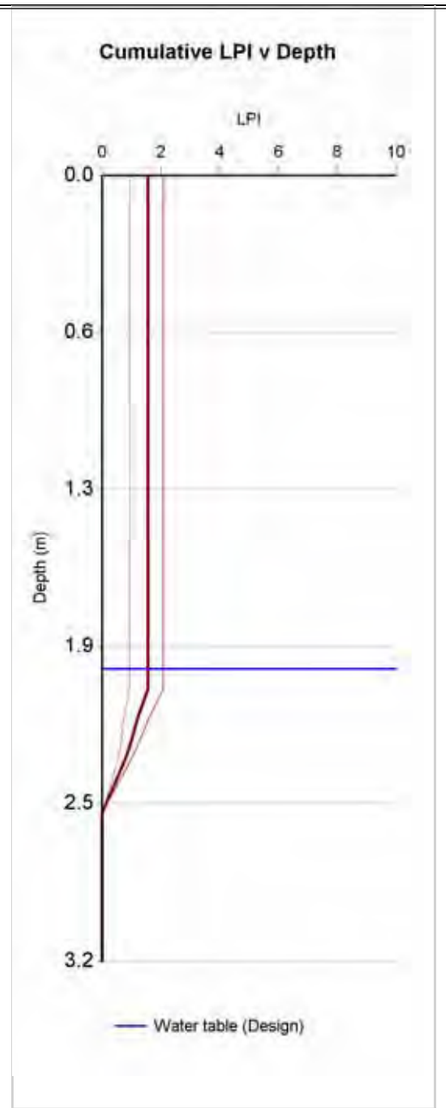
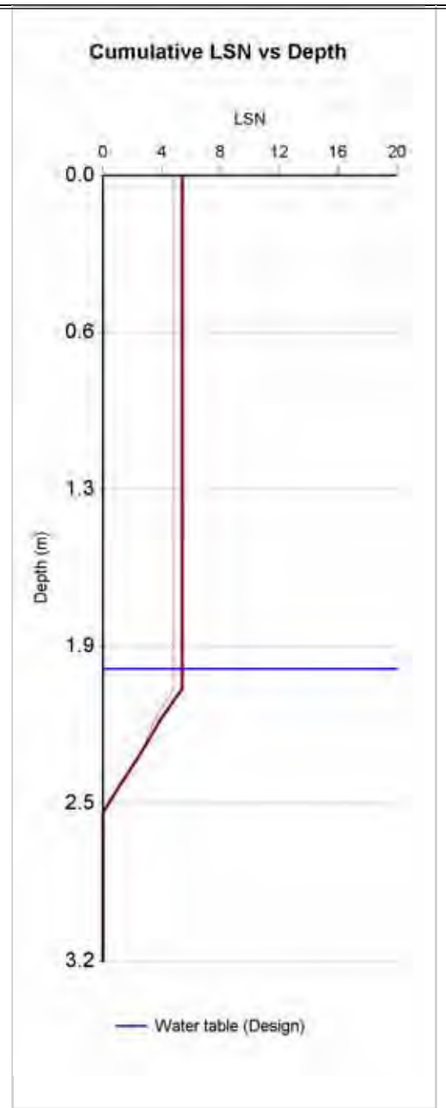
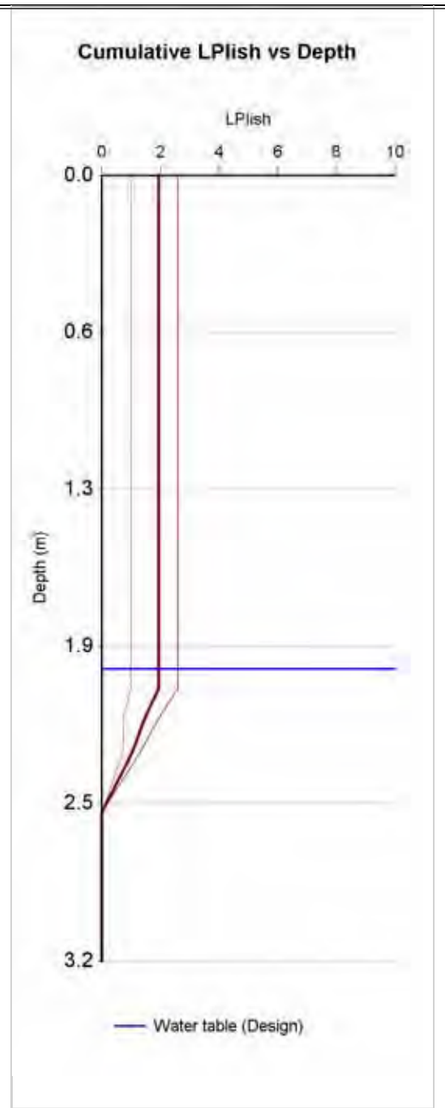
CPT-based soil behavior type classification chart by Robertson (1990)



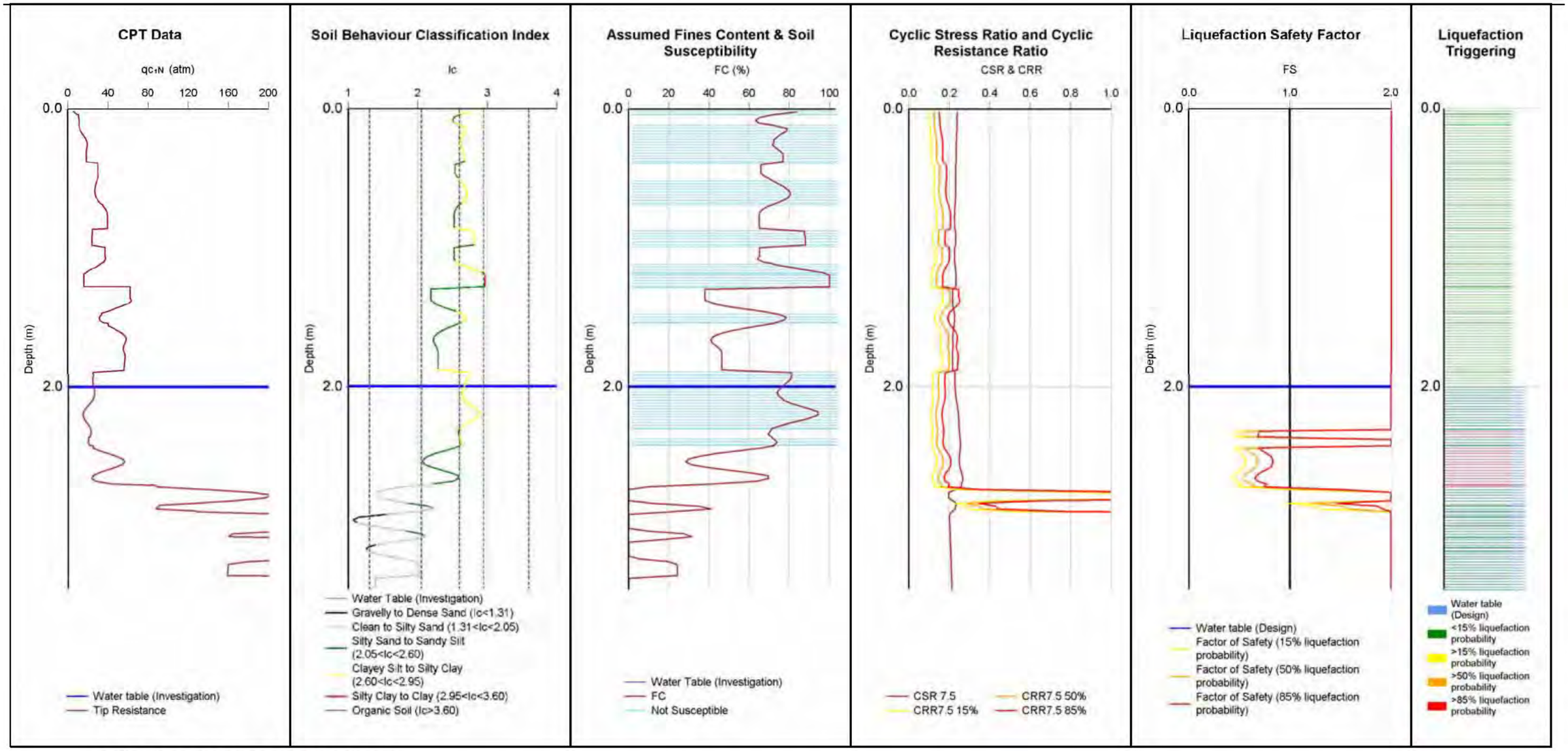








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT1 - ULS	160818	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	



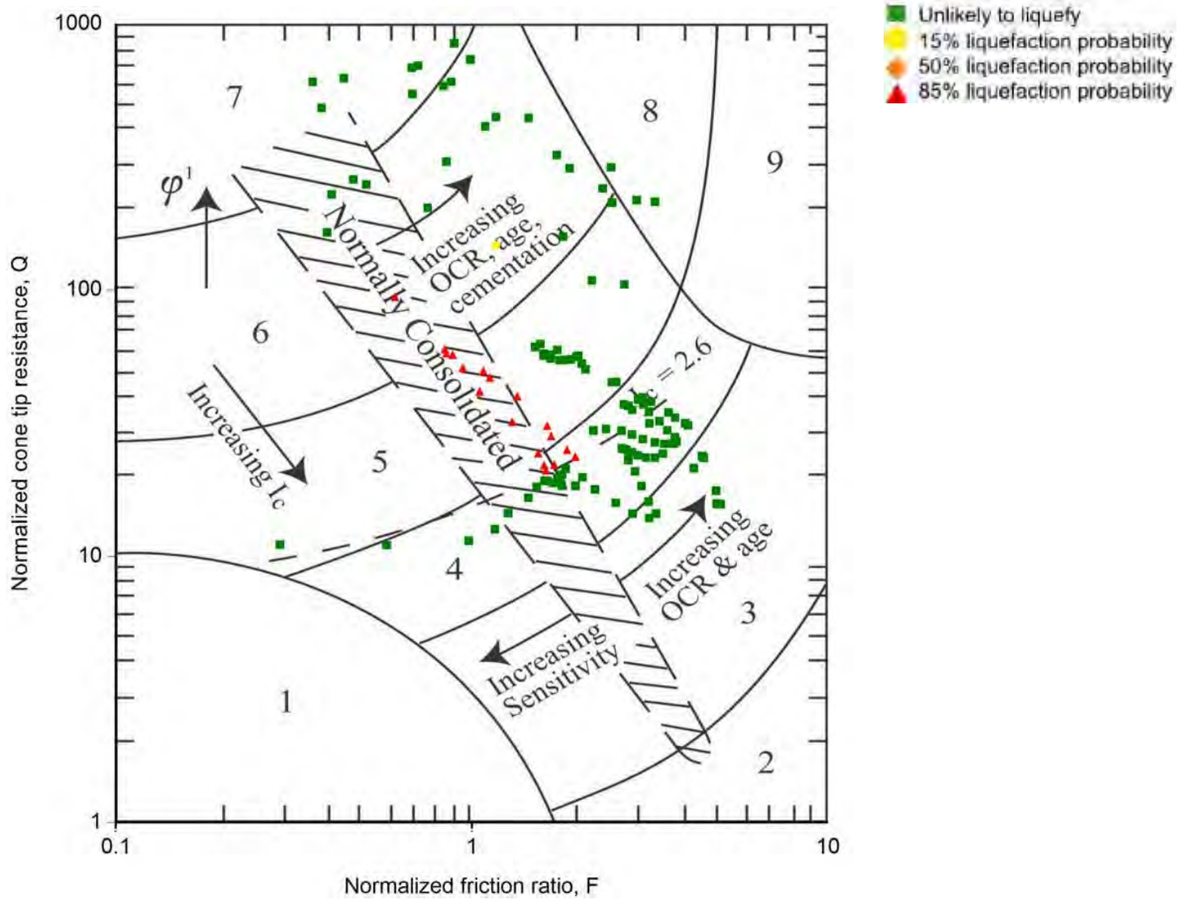
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT2 - ULS	160819	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	10	0.4	2	4	2.5	2
	50%	9	0.4	1	4	2.5	1
	85%	9	0.4	1	4	2.5	1

Reviewed by:

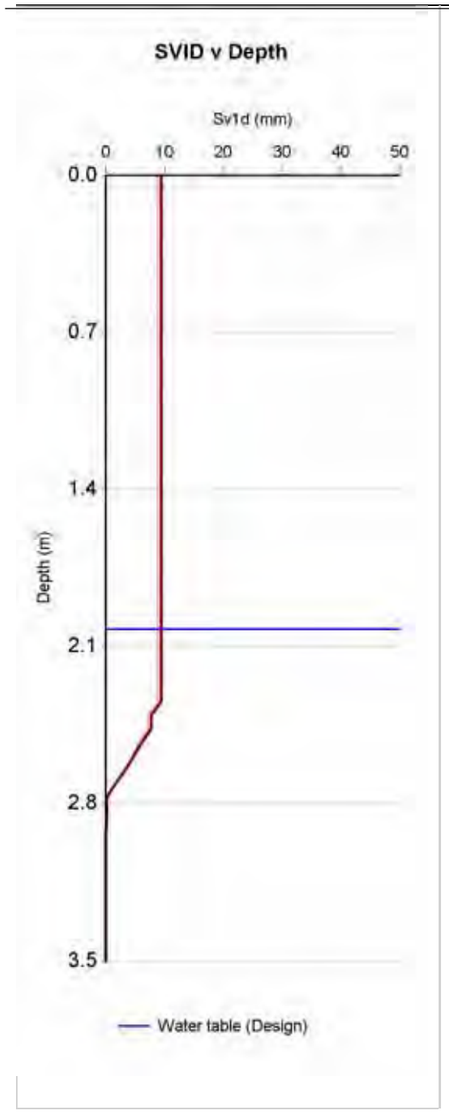
CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL

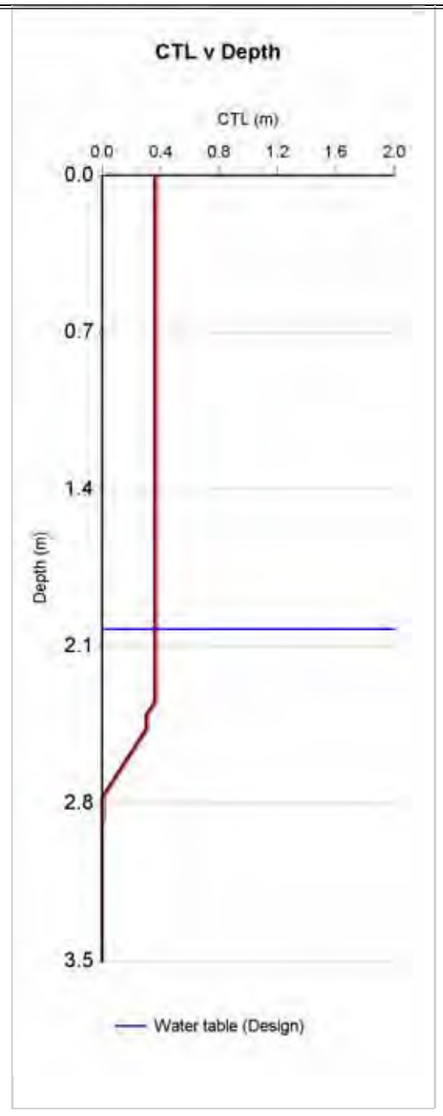


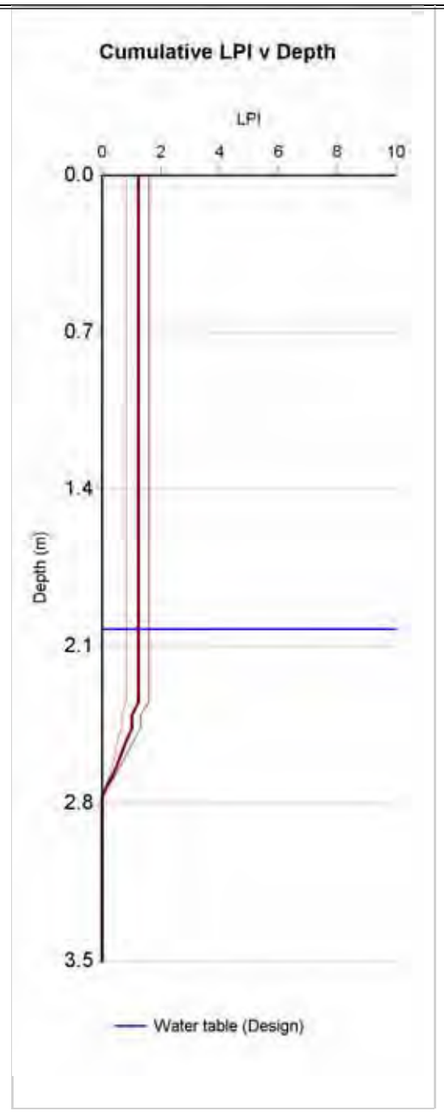
1. Sensitive, fine grained
2. Organic soils - peats
3. Clays - silty clay to clay
4. Silt mixtures - clayey silt to silty clay
5. Sand mixtures - silty sand to sandy silt
6. Sands - clean sand to silty sand
7. Gravelly sand to dense sand
8. Very stiff sand to clayey sand *
9. Very stiff, fine grained *

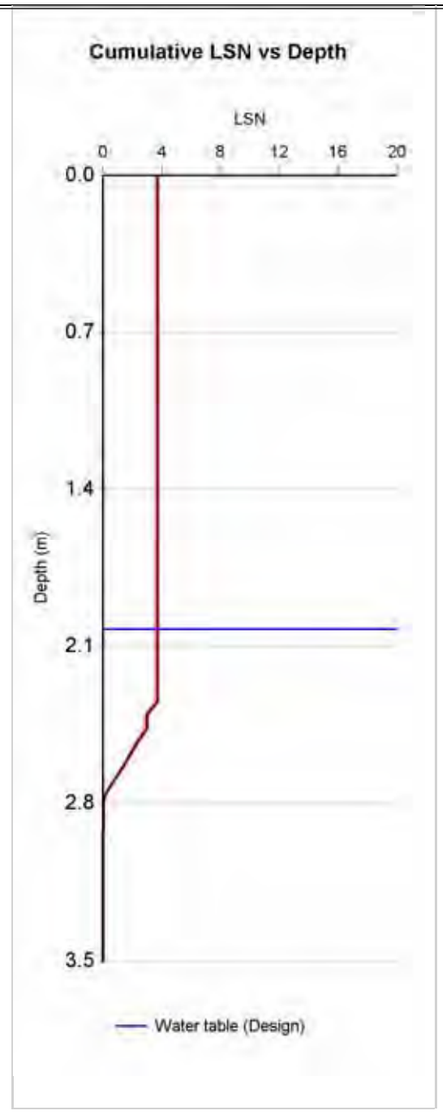
*Heavily overconsolidated or cemented

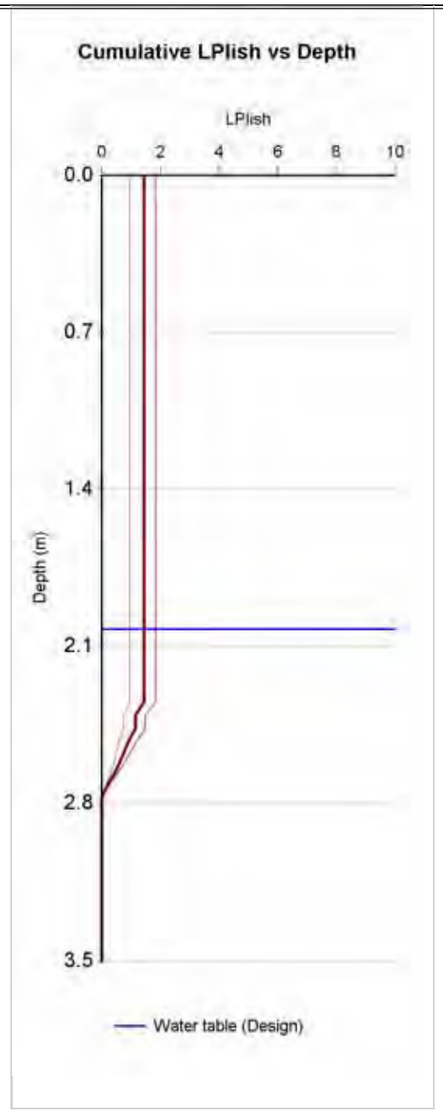
CPT-based soil behavior type classification chart by Robertson (1990)



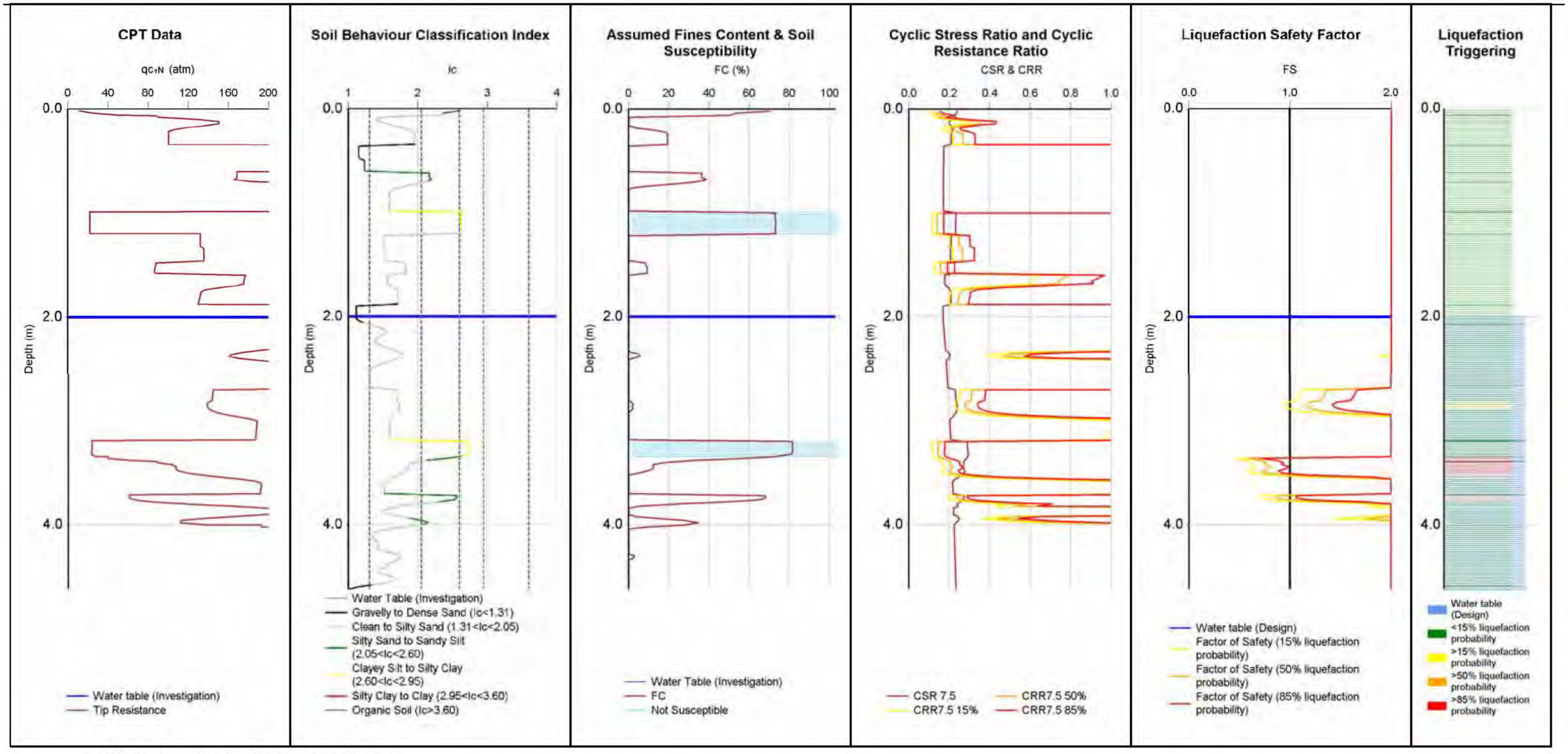








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT2 - ULS	160819	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	



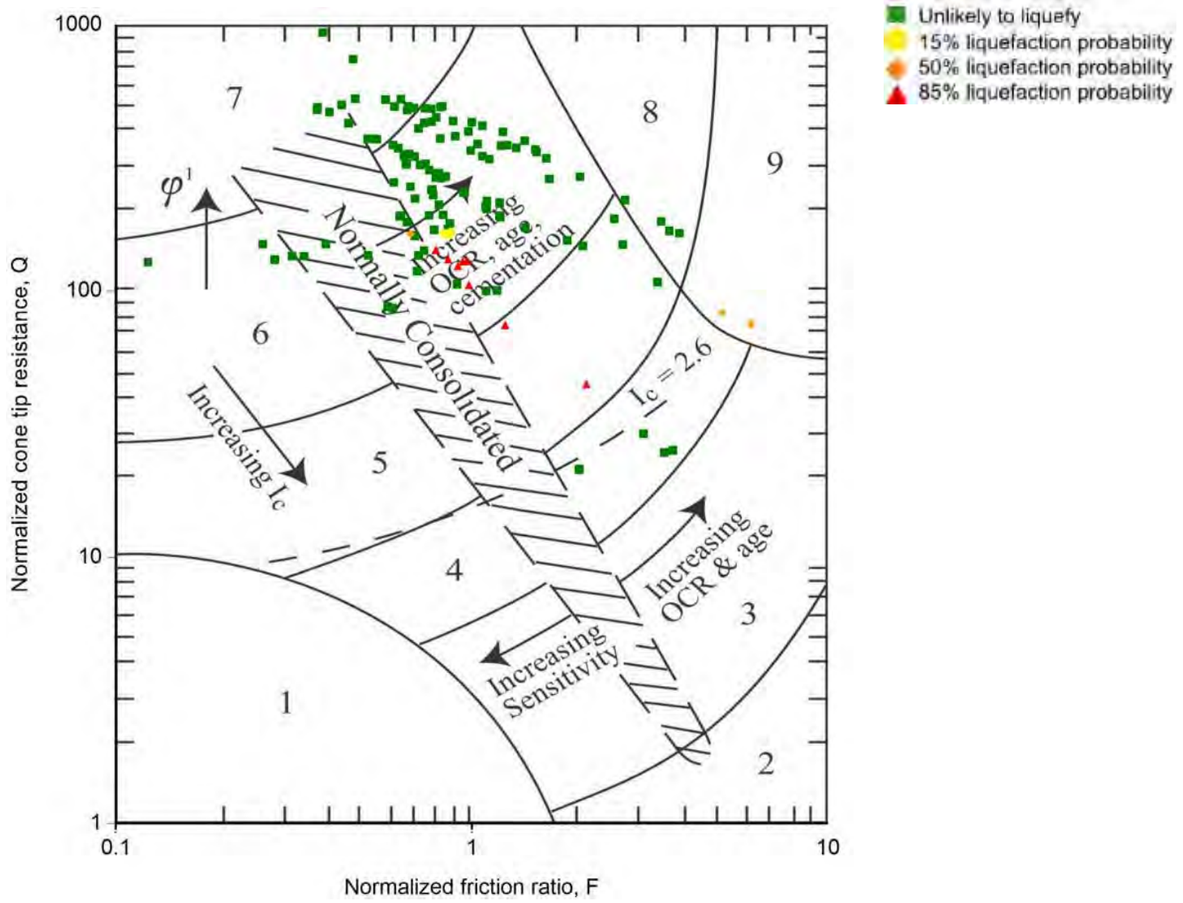
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT3 - ULS	160820	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPlish
OUTPUT	15%	6	0.3	1	2	3.4	1
	50%	4	0.2	0	1	3.4	0
	85%	3	0.2	0	1	3.4	0

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL



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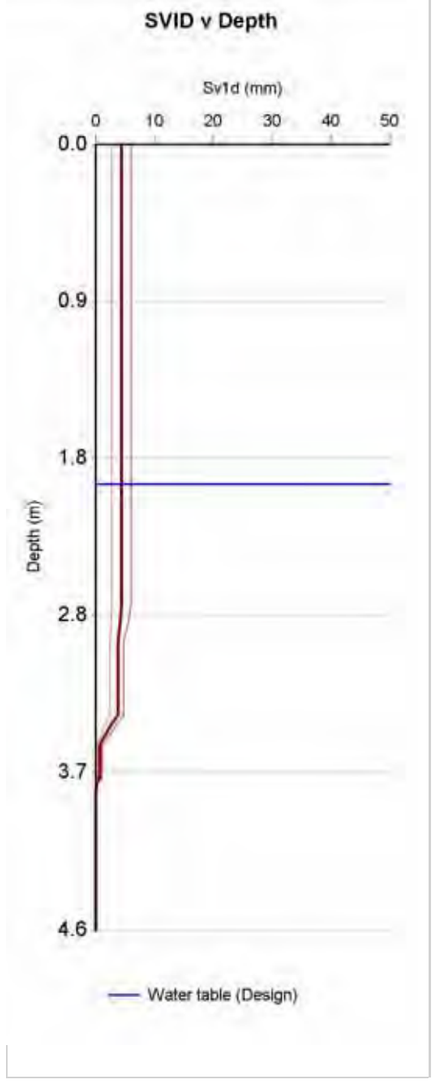
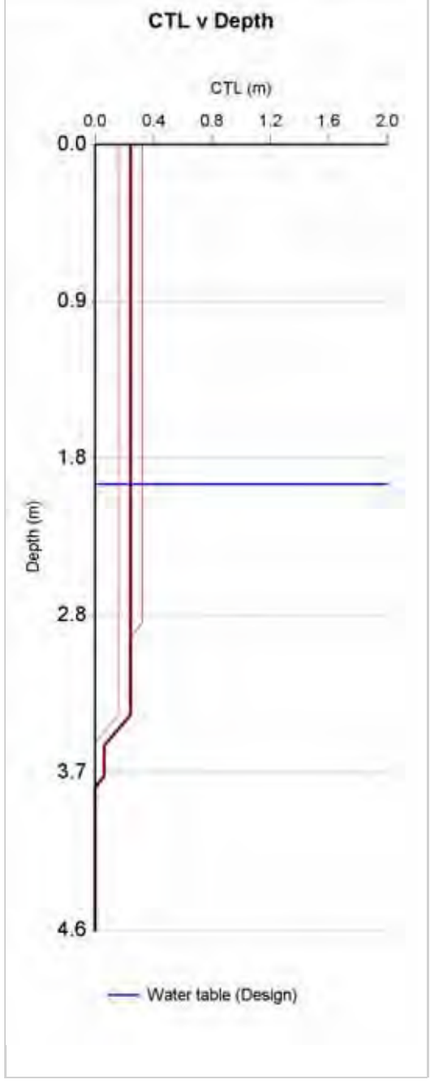
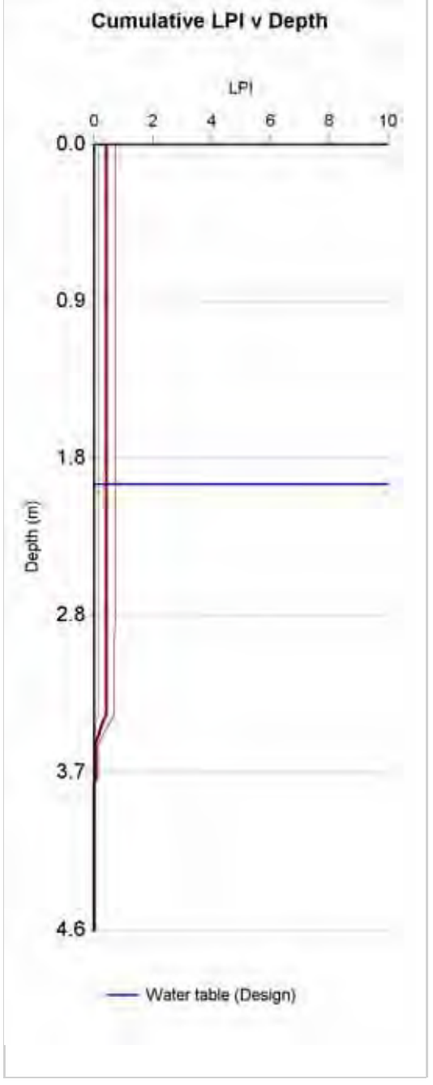
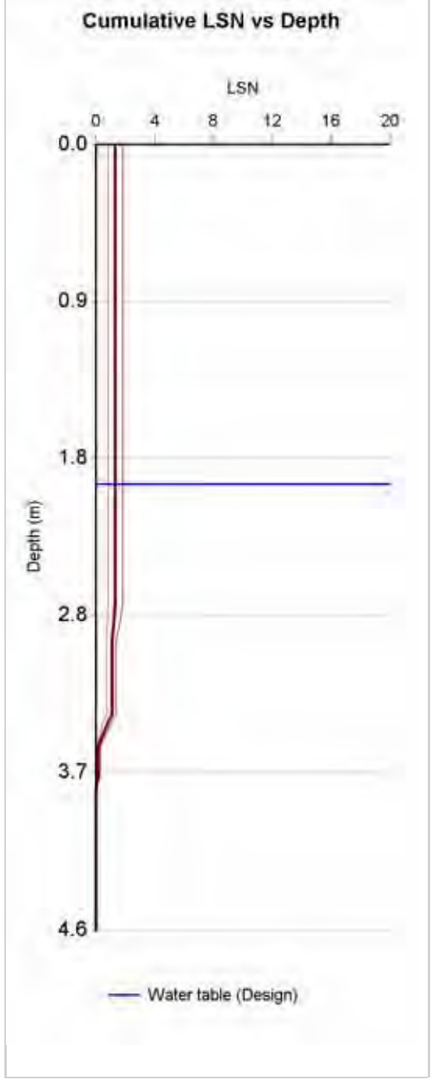
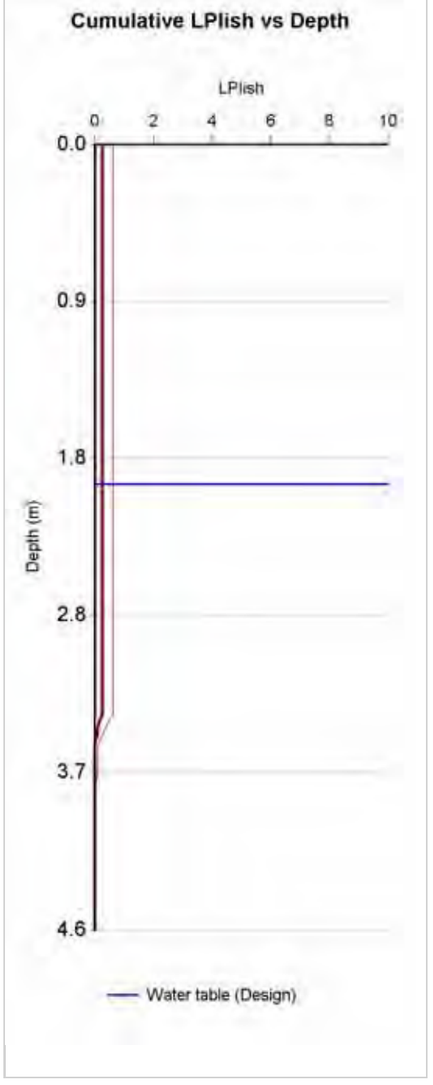
CPT-based soil behavior type classification chart by Robertson (1990)



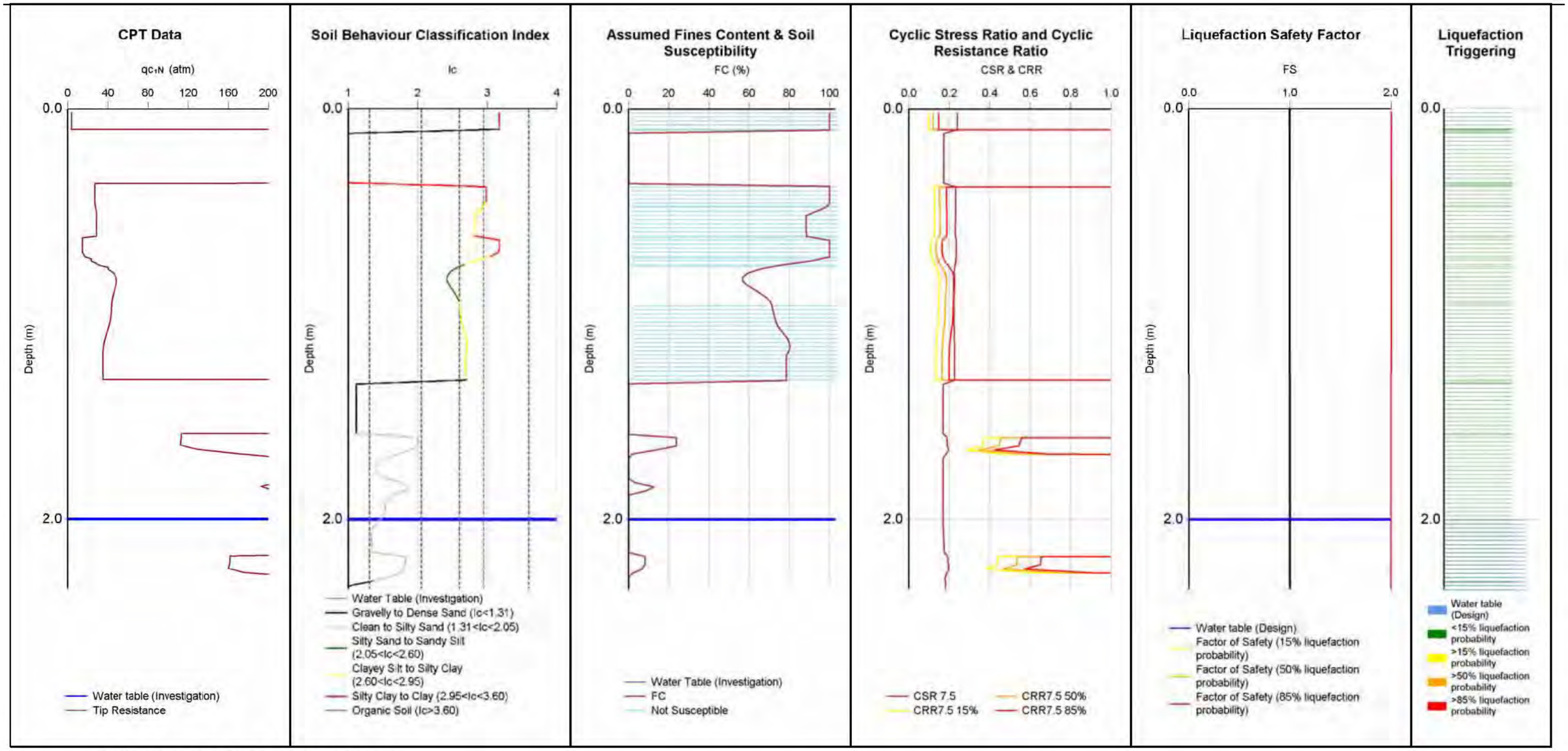








	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT3 - ULS	160820	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	



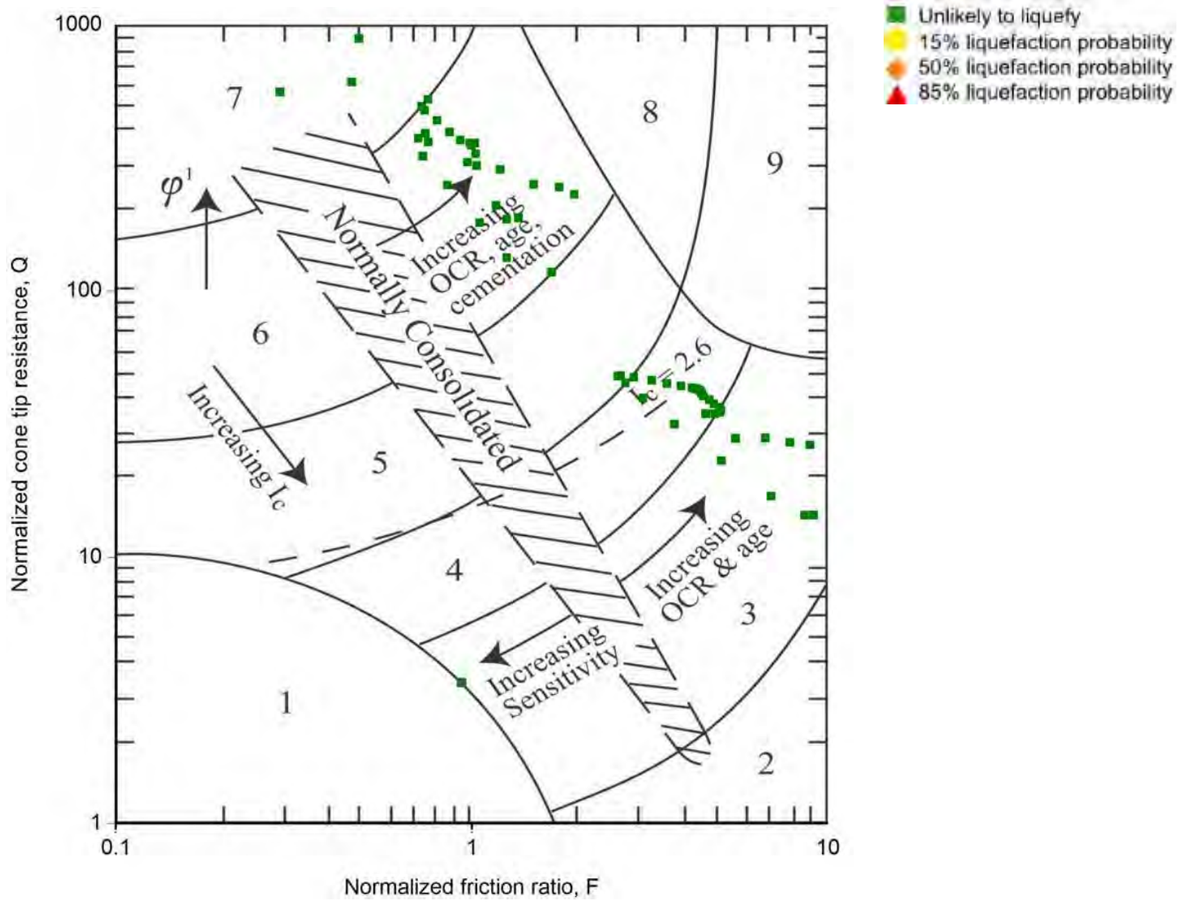
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT4 - ULS	160821	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	

	PL	SV1D (mm)	CTL (m)	LPI	LSN	CT (m)	LPIish
OUTPUT	15%	0	0	0	0	2.3	0
	50%	0	0	0	0	2.3	0
	85%	0	0	0	0	2.3	0

Reviewed by:

CPT Inversion	POLL
Groundwater	POLL
Susceptibility	POLL
Triggering	POLL
Consequence	POLL



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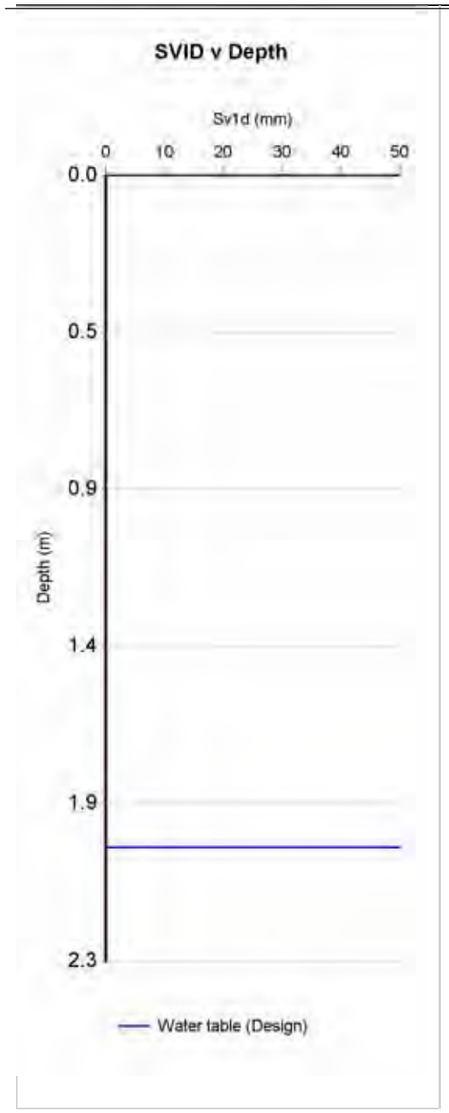
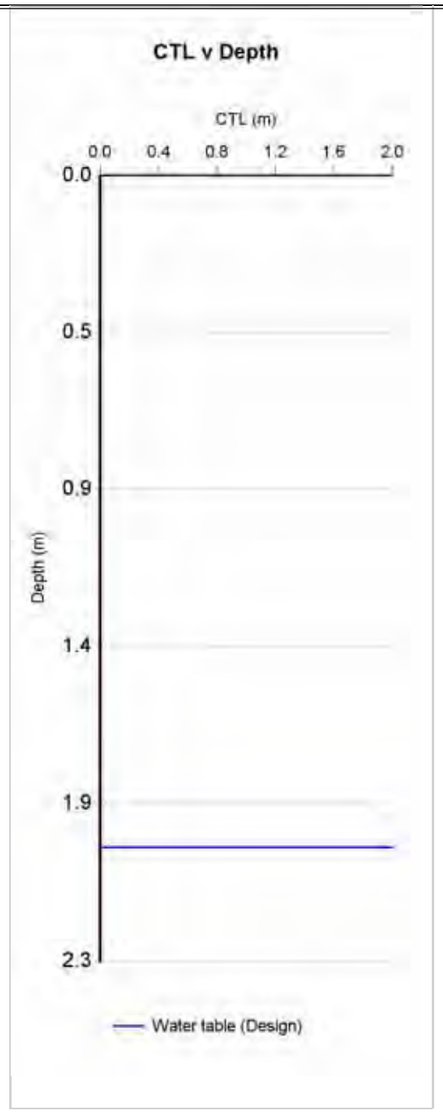
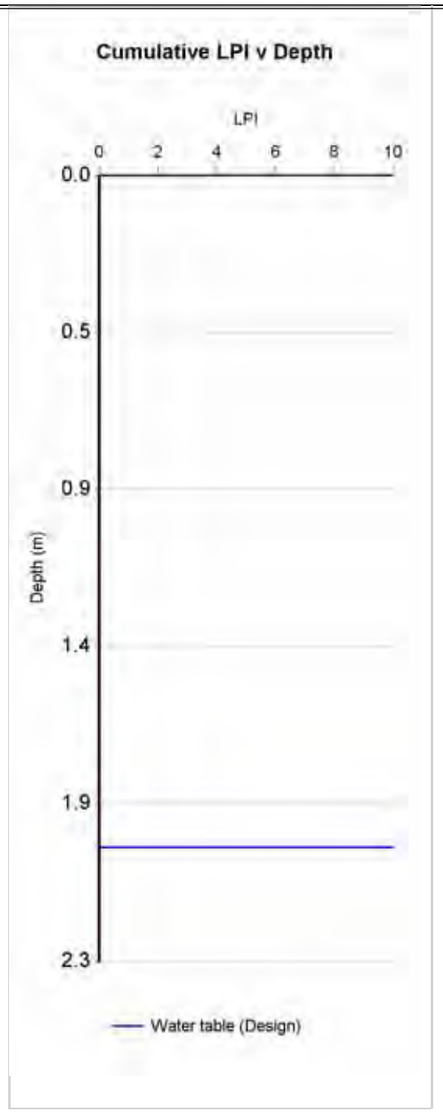
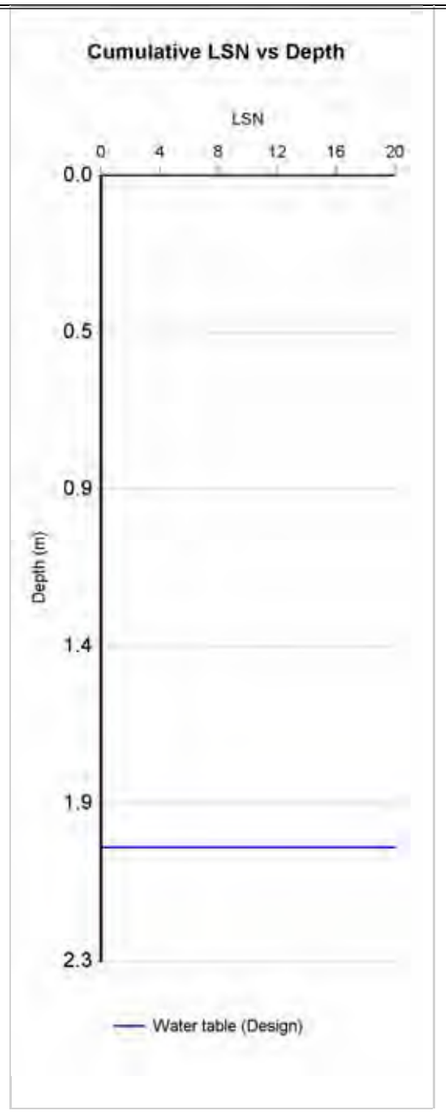
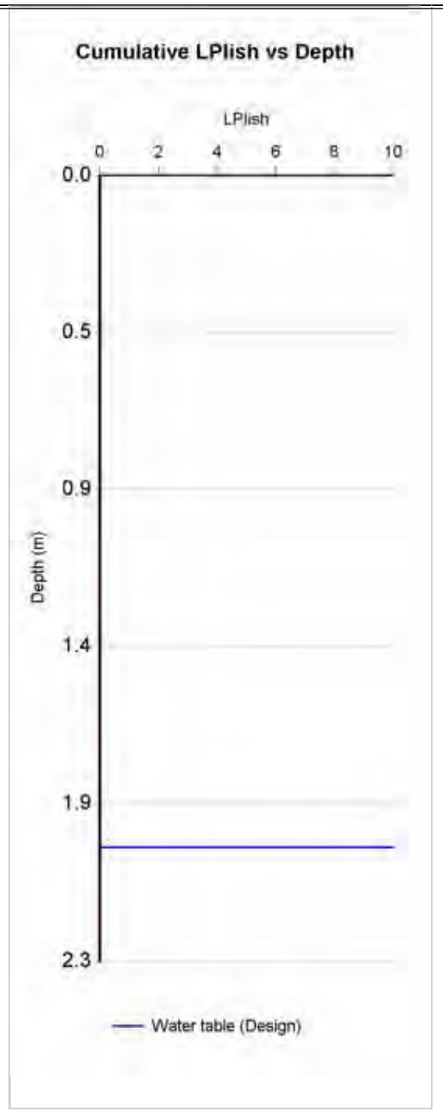
CPT-based soil behavior type classification chart by Robertson (1990)



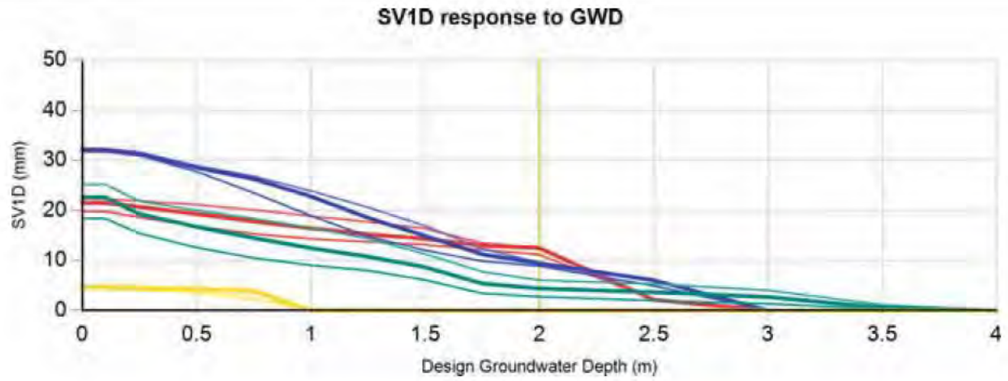


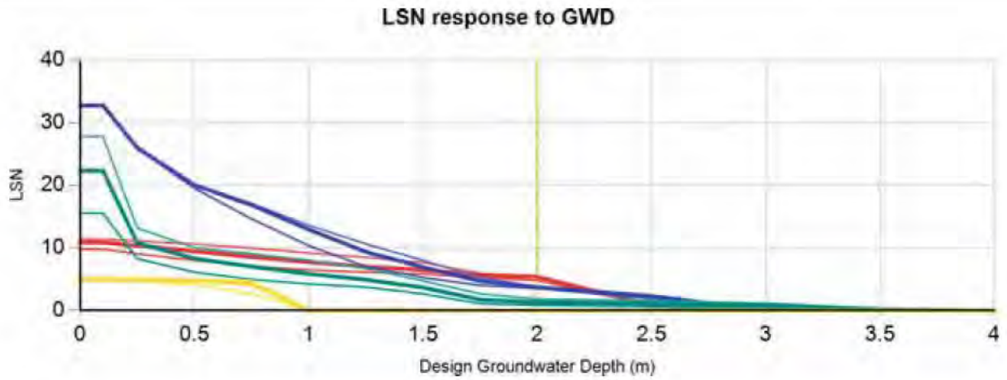


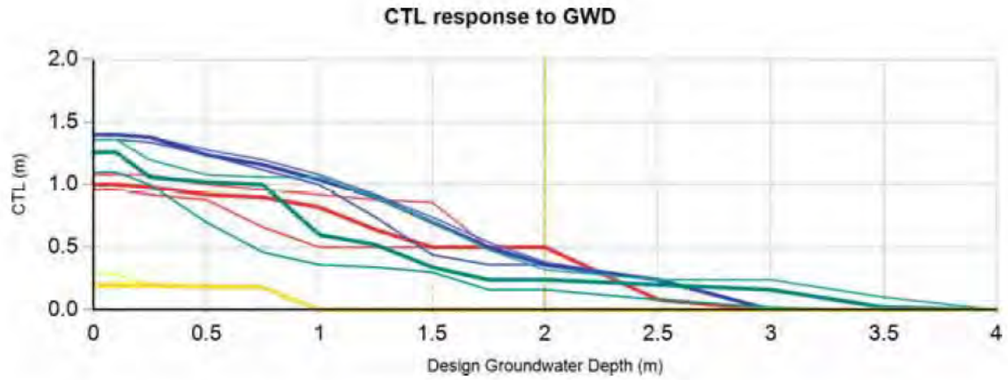


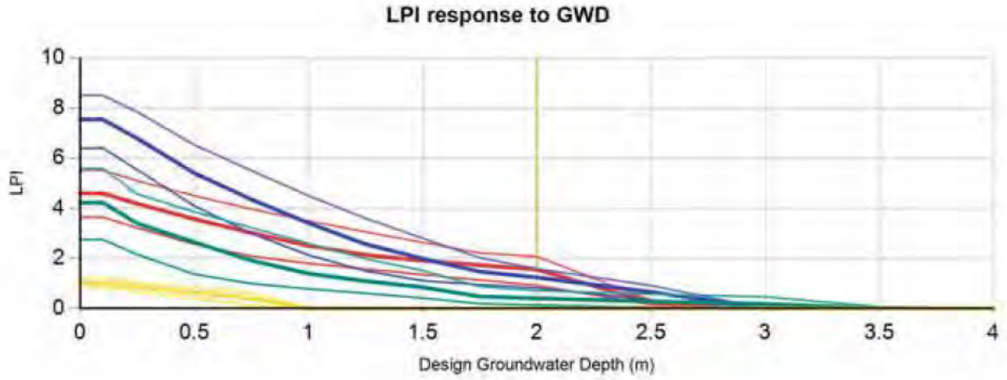


	Run Description	TTGD ID	Investigation Date	Pre-drill (m)	Magnitude	PGA (g)	Trigger Method	Settlement Method	ɣ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
INPUT	CPT4 - ULS	160821	1/07/2020	0	6.5	0.42	BI-2014	ZRB-2002	18		0	





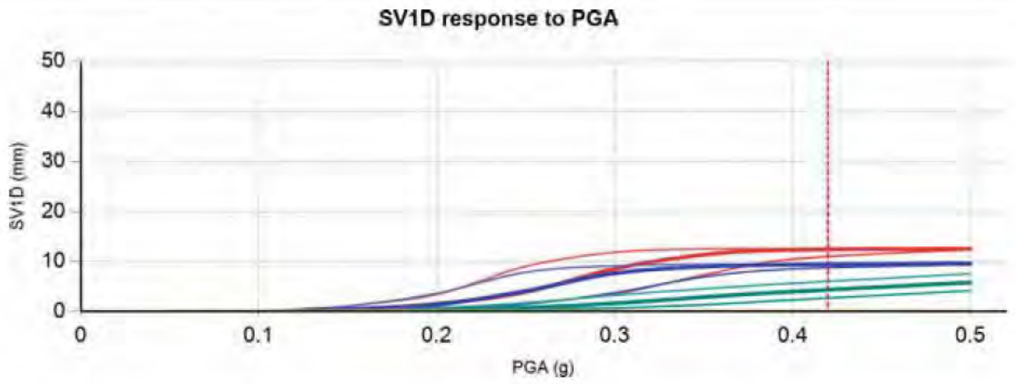


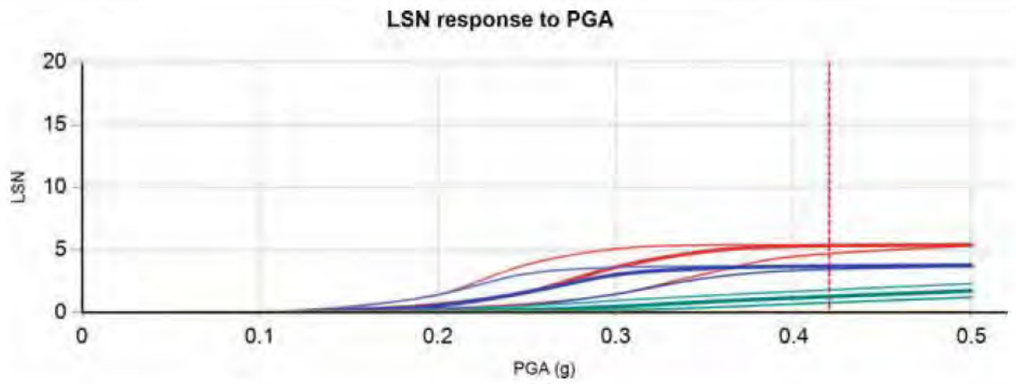


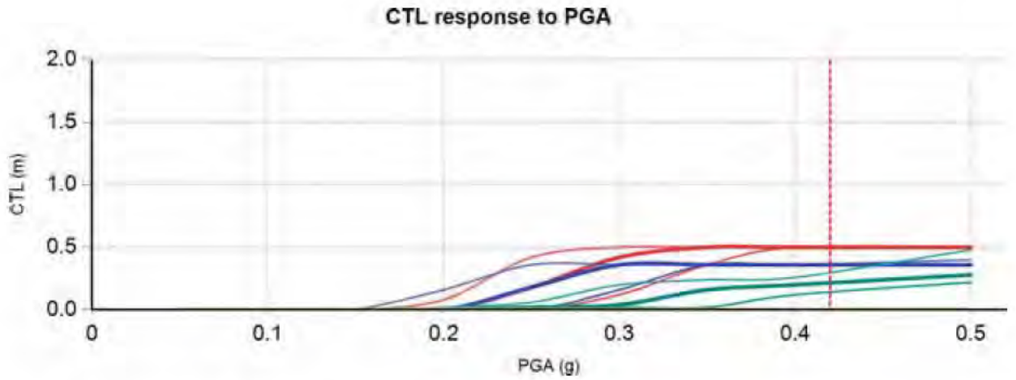
Vertical dotted line/s indicate design groundwater depth at the CPT locations.

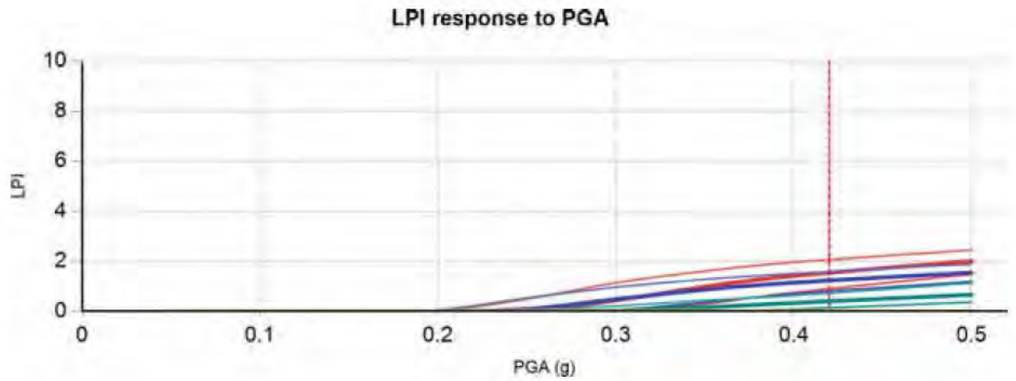
Note: Inverse filtered Qc/Fs data (10 cm²) used.

	Run Description	TTGD ID	Investigation Date	Magnitude	PGA (g)	Trigger Method	Settlement Method	CFC	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
	CPT1 - ULS	160818	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
	CPT2 - ULS	160819	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
	CPT3 - ULS	160820	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
	CPT4 - ULS	160821	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
	Thicker lines represent the 50% probability of exceedence case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.											









Vertical dotted line/s indicate user specified PGA at the CPT locations. (actual PGA)

Note: Inverse filtered Qc/Fs data (10 cm²) used.

Run Description	TTGD ID	Investigation Date	Magnitude	PGA (g)	Trigger Method	Settlement Method	CFC	γ (kN/m³)	Surcharge/Cut/Fill	Surcharge (kPa)	Cut/Fill Height (m)
CPT1 - ULS	160818	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
CPT2 - ULS	160819	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
CPT3 - ULS	160820	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
CPT4 - ULS	160821	1/07/2020	6.5	0.42	BI-2014	ZRB-2002		18		0	
Thicker lines represent the 50% probability of exceedence case and the thinner lines to the bottom and top of the thicker lines represent the 85% and 15% probability of exceedance cases respectively.											

The inputs listed in Table 1.1-1 below have been adopted for the liquefaction analysis.

Table 1.1-1 Summary of inputs for liquefaction analysis

ID	TTGD 160818	TTGD 160819	TTGD 160820	TTGD 160821
CPT Name	CPT01	CPT02	CPT03	CPT04
Run description	CPT1 - ULS	CPT2 - ULS	CPT3 - ULS	CPT4 - ULS
PGA	0.42g	0.42g	0.42g	0.42g
Magnitude	6.5	6.5	6.5	6.5
Depth to groundwater at time of Investigation (m)	2	2	2	2
Depth to groundwater for design (m)	2	2	2	2
Predrill depth (m)	0	0	0	0
Assumed predrill tip resistance and skin friction	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa	qc= 2 MPa & Fs= 0.01 MPa
Trigger method	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)	Boulanger & Idriss (2014)
Settlement method	ZRB-2002	ZRB-2002	ZRB-2002	ZRB-2002
Total depth of CPT (m)	3.18	3.46	4.62	2.34
Minimum depth of analysis (m)	0	0	0	0
Maximum depth of analysis (m)	3.18	3.46	4.62	2.34
Inverse Filtering applied?	Yes (10 cm^2)	Yes (10 cm^2)	Yes (10 cm^2)	Yes (10 cm^2)

Table 1.1-2 Summary of Ic inputs for liquefaction analysis

ID	Run description	From (m)	To (m)	Ic
TTGD 160818	CPT1 - ULS	0	0	0
TTGD 160818	CPT1 - ULS	0	5	2.6
TTGD 160819	CPT2 - ULS	0	0	0
TTGD 160819	CPT2 - ULS	0	5	2.6
TTGD 160820	CPT3 - ULS	0	0	0
TTGD 160820	CPT3 - ULS	0	5	2.6
TTGD 160821	CPT4 - ULS	0	0	0
TTGD 160821	CPT4 - ULS	0	5	2.6

Table 1.1-3 Summary of Fc inputs for liquefaction analysis

ID	Run description	From (m)	To (m)	Fc
TTGD 160818	CPT1 - ULS	0	3.18	0 CFC
TTGD 160819	CPT2 - ULS	0	3.46	0 CFC
TTGD 160820	CPT3 - ULS	0	4.62	0 CFC
TTGD 160821	CPT4 - ULS	0	2.34	0 CFC

www.tonkintaylor.co.nz

LWP Ltd
145c Colombo Street
Christchurch 8023
03 3107420
021 495229

The Te Mata Mushroom Company Ltd
PO Box 8137
Havelock North

Attention: Marcus Hill

Project Ref: HBT021

10 November 2022 Te Mata Mushrooms Investigation.doc

RMA20210509 - Application for Earthworks Consent, Te Mata Mushrooms Limited, 176 Brookvale Road, Havelock North

1. Background

The Te Mata Mushroom Company Limited (TMM) operated a mushroom growing and harvesting business at their property at 174 Brookvale Road, Havelock North. This operation ceased operations in October 2022.

As part of a proposed Stormwater Management Plan, TMM excavated a stormwater pond on a near-level paddock located on the eastern side of the property under Hawkes Bay Regional Council (HBRC) Resource Consent AUTH-121214-01. Construction of the pond was undertaken during mid to late 2020. It is understood that construction of the stormwater pond was undertaken by TMM on the understanding that the required earthworks could be undertaken as a permitted activity. However, concern was raised by Hastings District Council (HDC) regarding the earthworks and the associated requirement for consent under the District Plan. In response to concerns expressed by the Council, TMM backfilled the excavation. No documentation of the methodology utilised for excavation or backfilling of the pond was undertaken.

Subsequent to backfilling of the pond, HDC notified TMM that excavation and backfilling of the pond had breached Section 27.1.6A of the Hastings District Plan and sought that TMM apply for retrospective resource consent for the activities undertaken. In September 2021, an application (RMA20210509) for excavation and backfilling of the pond prepared by Strategy Ltd was lodged with HDC. Following review of this application, HDC sought further information from the applicant under Section 92 of the Resource Management Act (RMA) 1991. It is understood that no further action was undertaken to address the outstanding Section 92 request until a meeting between the applicant, HDC and HBRC was arranged on site on the 12th July 2022.

Subsequent to the July 2022 site meeting with HDC staff a draft methodology was prepared on behalf of TMM setting out a proposed methodology for addressing the outstanding information requested by HDC. A copy of the methodology is appended as Attachment 1 to this report. This agreed methodology is also referenced in a subsequent abatement notice issued by HDC on the 14th October 2022 and appended to the aforementioned abatement notice.

Results of investigations undertaken to date are summarised in this report.

2. Results of Preliminary Investigations

2.1.1 Enquiries with TMM staff and contractors

Discussions with TMM staff did not identify any personnel with direct knowledge of earthworks undertaken for stormwater pond construction/backfilling. Similarly, Aqualine Contractors (who were suggested by HDC as the civil contractor who had completed earthworks relating to the pond) indicated they had no knowledge of works undertaken at the TMM site in mid to late-2020. Consequently, these enquiries did not yield any useful information to assist characterisation of the methodology utilised for the earthworks or the source and nature of backfill materials utilised.

2.1.2 Hydrological conditions preceding the HDC site visit on 17 November 2020

HDC staff visited the TMM site on 17 November 2020 documented the location, layout and general characterises of the of the pond. A summary of notes recorded at the time provided to the July 2022 site meeting indicate the following:

> *The pond comprises of a near square shape which measures approximately 25m x 35m at the base of the pond, splaying out to the top of the pond wall on an average angle of approximately 30^{o}.*
>
> *The top of the pond wall measures approximately 37m x 44m, with an approximate depth (vertically top to bottom) of 4.1m.*
>
> *Of that overall depth of 4.1m it is estimated that 2.3m would be excavated below natural ground with the additional 1.8m being the bund that has been built up from natural ground.*
>
> *Encompassing the pond at the top of the bund is an overflow trench measuring on average 600mm wide by 400mm depth.*
>
> *At the time of the Council site visit (17/11/2020) the pond was not lined, nor did it have an overflow pipe. It does however currently have a discharge pipe near the top of the bund wall, close to the Northern corner of the pond, which would discharge to the North-eastern side of the pond towards an ephemeral stream approximately 20m away.*

Figure 1 shows a photograph taken during the Council's site visit showing the general layout of the site, including the presence of standing water in the pond. Based on the photographs the standing water level in the pond would appear to be no greater than 1 metre below natural ground level (or alternatively, of the order of 2 to 3 metres below the top of the bund).

Figure 1. *Photograph of TMM stormwater pond taken by HDC on 17/11/2020. (view from northern corner looking south).*

Figure 2 shows a plot of daily rainfall totals recorded at Kaiapo Road and Awanui Stream at Flume, the two closest HBRC rainfall monitoring sites to the TMM property. These sites are located approximately 8.5 km north-west and 10 km south-west of the TMM site respectively. The data shows a total of 110.5mm rainfall at Kaiapo Road and 99mm of rainfall at Awanui Stream at Flume over the two weeks preceding the HDC site visit on 17 November 2020. A majority of this rainfall was recorded as occurring between the 8th and 11th November, with totals between 60 to 70mm recorded at both sites on the 9th of November, with a further 20mm recorded on the 11th November.

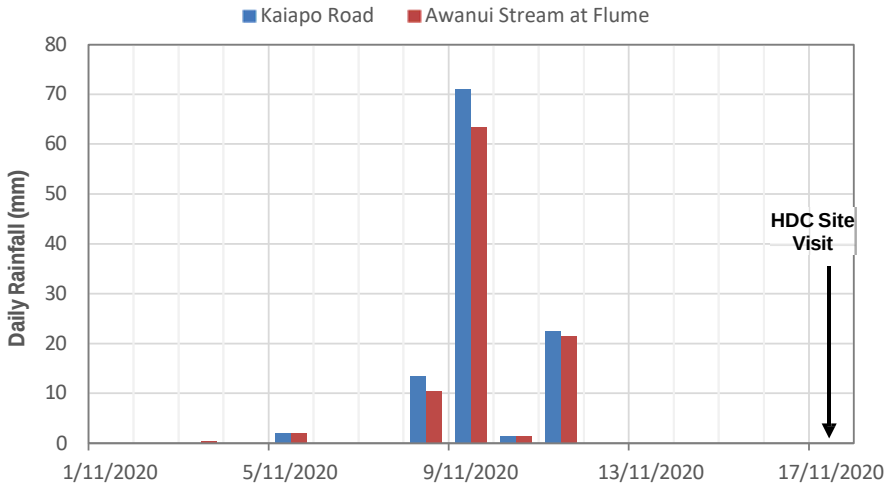


Figure 2. *Rainfall at Kaiapo Road and Awanui Stream at Flume, 1-17 November 2020 (source HBRC)*

Figure 3 shows a plot of groundwater levels recorded in Well 1611, the closest HBRC groundwater monitoring site to the TMM property which is screened in the uppermost water-bearing layer. This well is located approximately 1,350 metres north of the TMM site and screened at between 16.4 and 18.0 m below ground level (bgl) in a layer of brown gravel (recorded as extending between 12 and 21 m bgl)

which is overlain by a sequence of blue clay and silt[1]. The data show a recovery in groundwater levels of approximately 0.2 metres between measurements recorded on the 3rd November and 4th December 2020. It is assumed this groundwater level recovery is associated with the heavy rainfall recorded in mid-November. While the maximum water level recovery over this period is unknown, it is clear that groundwater levels following the mid-November 2020 rainfall were likely to have been toward the typical seasonal maximum.

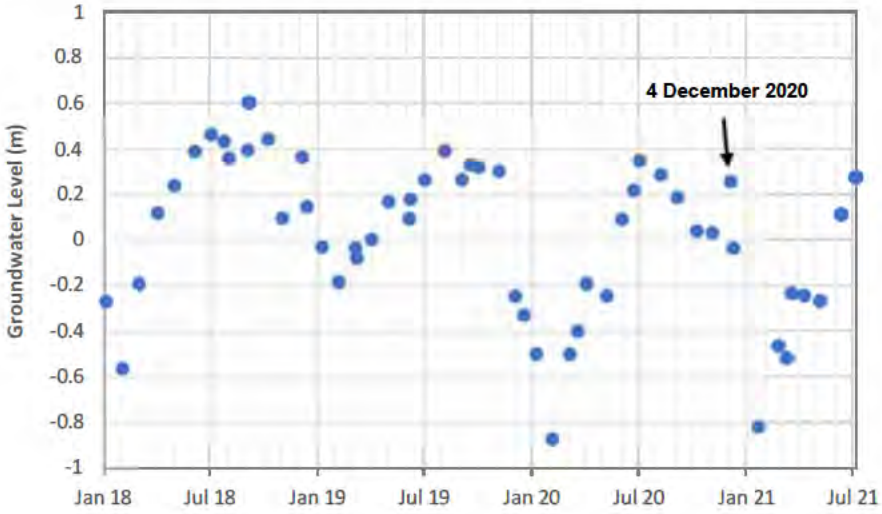


Figure 3. *Groundwater levels recorded in Well 16202, Jan 2018 to Jul 2020.*

Figure 4 shows a plot of static groundwater levels recorded on the HBRC Wells database in the vicinity of the TMM Site. The data shows static levels along Brookvale Road are relatively tightly constrained, ranging between -2.18m bgl and -2.54m bgl. The limited range of static water levels in this area is interpreted to reflect the hydraulic connection between shallow groundwater and the nearby Mangateretere Stream. To the east of Brookvale Road, static water levels generally increase to around 4 metres bgl in the vicinity of the TMM stormwater pond and 5 metres bgl closer to Te Mata Mangateretere Road. This increase in depth to groundwater east of Brookvale Road reflects the difference between the topographic gradient (~0.007 m/m) and the hydraulic gradient (~0.004 m/m) in the shallow aquifer.

Overall, while no data is available from the TMM site, groundwater levels at the time of the HDC visit were likely to have been close to the historical maximum, possibly of the order of 3 to 3.5 metres below ground level in the vicinity of the TMM pond. This level is appreciably lower that the standing water level observed in the pond, indicating the standing water observed is unlikely to be groundwater.

[1] i.e., similar hydrogeological conditions to the TMM site, albeit with a thicker surficial confining layer

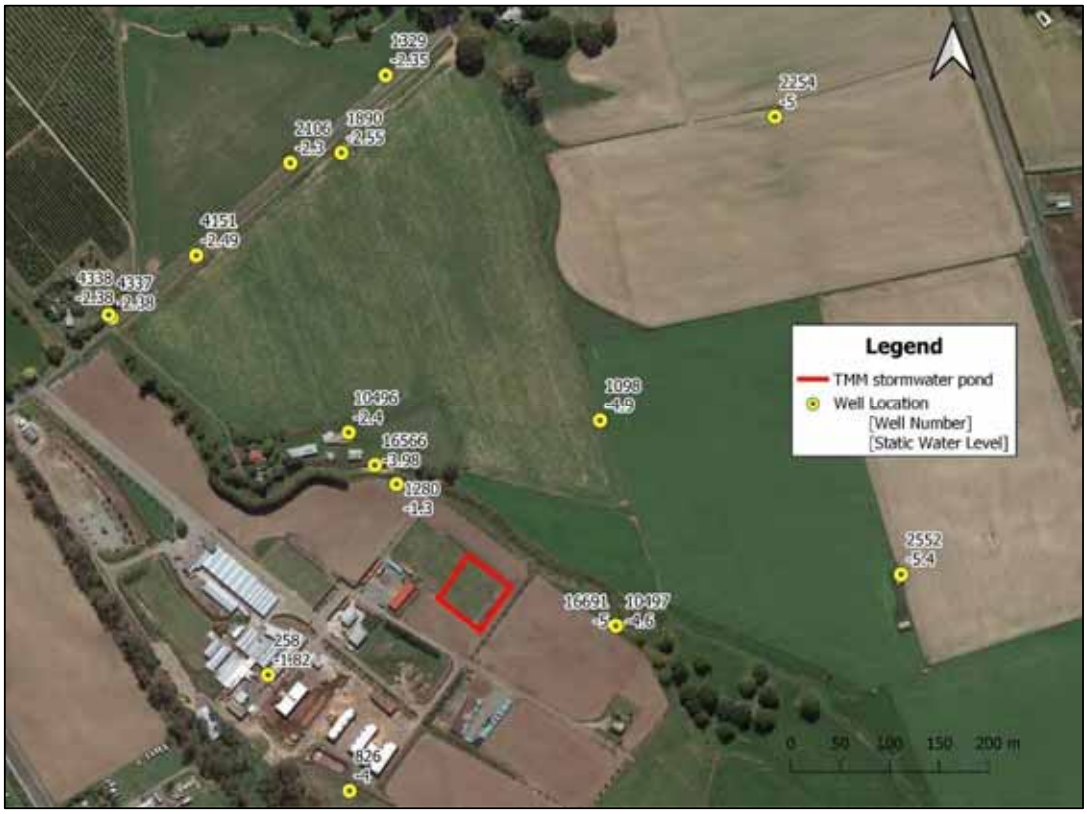


Figure 4. *Static water levels recorded in the vicinity of the TMM site (source HBRC).*

Although no data is available to directly confirm, given the proposed purpose of the pond, it would appear that the water observed in the pond by HDC staff on 17 November 2020 is likely to reflect stormwater generated across the wider TMM site in response to ~100 mm of rainfall between the 9th to 11th November. Although shallow groundwater levels recovered following the mid-November 2020 rainfall, they appear to have remained within the typical seasonal range. At the TMM pond site this is likely to be of the order of 3 to 3.5 metres below ground level, significantly below the standing water level observed at the time of the Council site visit.

Of note is the maintenance of a significant depth (possibly of the order of 1 metre) of standing water in the pond, at least six days after the most recent rainfall. This observation suggests a sufficient depth of aquitard materials was retained under the pond invert to significantly retard the hydraulic connection between the pond and the underlying aquifer.

3. Geological Investigations

Field investigations were undertaken at the TMM pond site to identify the location, thickness and composition of fill materials, following the methodology outlined in Attachment 1. Results of these

investigations are summarised in the report from Bay Geological Services Ltd which is appended as Attachment 2 to this report.

The overall objective of the geological investigations was to:

a) delineate the approximate footprint of the former pond/bund; and,

b) identify composition and depth of fill soils and to collect samples for soil quality analysis

3.1 Shallow Trench Investigation

On 28 and 29 September 2022, a series of shallow trenches were scraped by the excavator to expose the near-surface soils along each side of the projected perimeter of the pond/bund footprint.

However, the shallow excavations only provided very approximate bounds of the pond/bund and did not identify a well-defined fill/natural ground delineation of the perimeter. Using the soils excavation information, the approximated corners of the pond/bund footprint were surveyed by a registered surveyor. A plan of the approximated pond boundaries is provided in Appendix A of the Bay Geological Services Ltd report in Attachment 2.

3.2 Bore Hole Investigations

Following completion of the shallow trenches, the subsurface conditions at the TMM pond site were further investigated by excavating ten, 25 mm diameter, 1.6- to 2.1-metre-deep hand auger bore holes within the area identified as the possible pond/bund footprint. Figure 5 shows the location of the individual hand auger holes.

Figure 5. *Location of hand auger holes utilised for the TMM pond investigations.*

The hand auger bore holes were completed across the bare, grassed paddock where there was little demarcation of the bounds of the pond or bund. Therefore, the distribution of bore holes across the site resulted in several being augered in the centre of the pond area, and several on the perimeter. The bore logs revealed some variation in sub-Fill soils, but generally the base of the Fill was observed as slightly clayey silt soils. Table 1 provides a summary of the hand auger hole results.

***Table 1**. Summary of Bore Hole Results (from Bay Geological Services Ltd)*

Bore ID	Location	Depth (m bgl)	Depth to base of fill (m bgl)	Lithology at base of fill
1	Centre	2.00	1.70	SILT: slightly clayey, greyish blue
2	West	1.80	1.60	SILT: slightly clayey to clayey, brown and grey
3	West	2.10	1.50	SILT: slightly clayey to clayey, orangey brown and brown (Fe^{2+}, Mn)
4	North	1.60	1.40	SILT: slightly clayey, orangey brown (Fe2+, Mn)
5	North	1.60	0.90	SILT: slightly clayey, pale yellow and orangey brown (Fe2+)
6	Centre	1.90	1.60	SAND: fine - med, with fine - med gravels, bluish grey
7	Centre	1.50	N/A	Did not reach base of fill
8	East	1.40	0.70	SILT: slightly clayey, orangey brown and brown (Fe2+, Mn)
9	South	1.20	0.60	SILT: slightly clayey, orangey brown and black (Fe2+, Mn)
10	South	2.00	1.95	SILT: slightly clayey, orangey brown and brown (Fe2+)

In summary, the bore hole data revealed fill soils extending from ground level to depths between approximately 0.6 and 1.95 m bgl across the approximated footprint of the former pond/bund. The Fill soils generally comprised of a mixture of topsoil and multi-coloured slightly clayey silts with occasional fine sand and gravels. A bag of rubbish was uncovered near Bore Hole No. 6 and fragments of black plastic were encountered within several of the bore holes.

The soils encountered below the fill generally comprised slightly clayey, pale yellow, orangey brown and brown, greyish blue, greyish khaki, silt with brown iron staining mottle, black manganese staining and small nodules. The hand auger data indicated the fill soils extended from ground level to depths of between 0.6 and 1.9 metres across the approximate footprint of the pond/bund. Bore holes 6, 1 and 10

illustrate a profile of the pond invert, with the depth of fill increasing from 1.6 to 1.9 metres from nor-west to south-east (reflecting excavation of a level pond invert into an alluvial terrace sloping to the north-west).

The shallow groundwater system in the vicinity of Brookvale Road is overlain by a thin layer of low permeability sediments[2] which limit hydraulic connection between the underlying aquifer system and the surface environment. As illustrated on Figure 6 drillers logs from bores from the area surrounding the TMM pond indicate the thickness of the surficial low permeability sediments varies between 0 and 8.6 metres. However, in general, the logs tend to indicate the low permeability materials (typically described as 'brown clay' or brown clay with silt) are likely to be of the order of 2.5 to 3 metres in thickness in the vicinity of the TMM pond site.

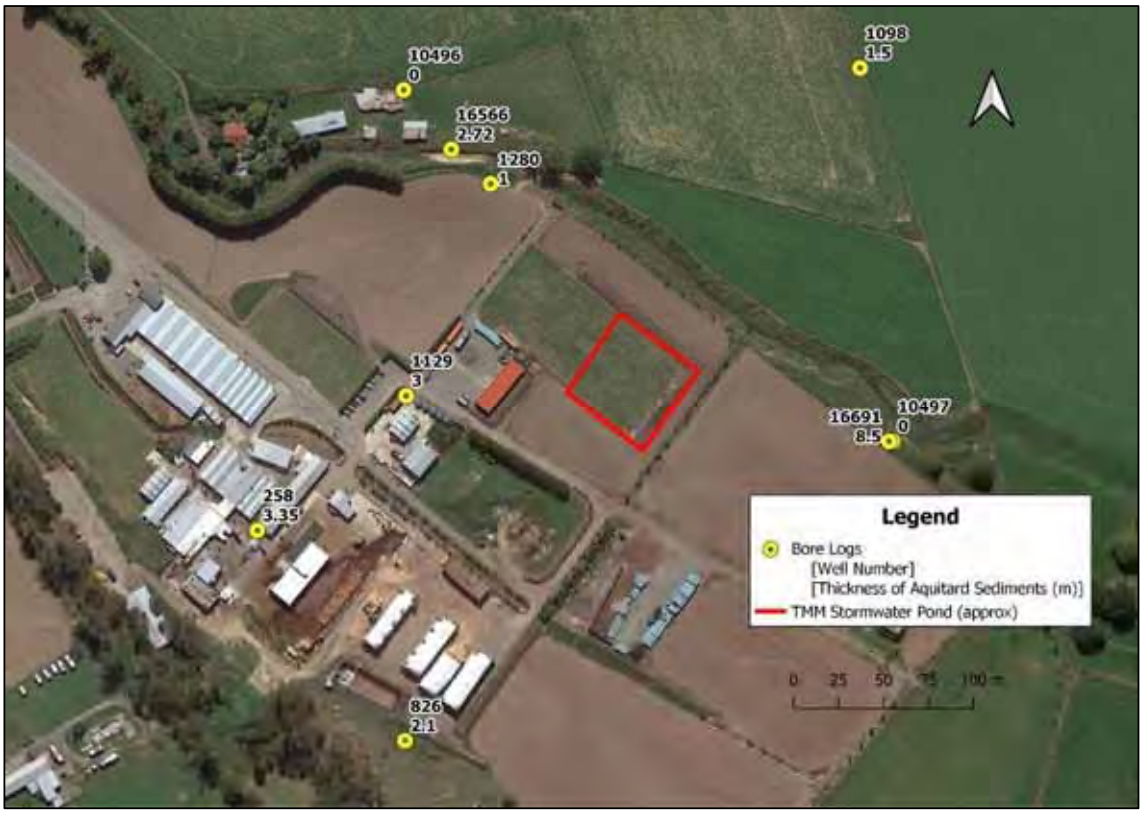


Figure 6. *Thickness of surficial low permeability sediments in the vicinity of the TMM pond indicated on drillers logs (source HBRC).*

To illustrate the likely construction of the TMM pond with respect to the surficial low permeability layer, Figure 7 shows the approximate position of the pond on a geological cross section generated for the

[2] These sediments have, at times, been referred to as forming '*aquitard*'. However, it is not clear that they meet the technical definition for an aquitard which requires the underlying aquifer to be fully saturated (i.e., the potentiometric surface occurs within the overlying low permeability sediments) as, to the east of Brookvale Road, the water table appears to occur under the base of the surficial sediments.

Havelock North Board of Enquiry process. The figure shows the invert of the pond completed within '*clayey silt*' sediments between 0.5 and 1.0 metres above the top of the underlying water-bearing alluvium. This is consistent with the geological investigations and observation of standing water at the time of the HDC site visit on 17 November 2020.

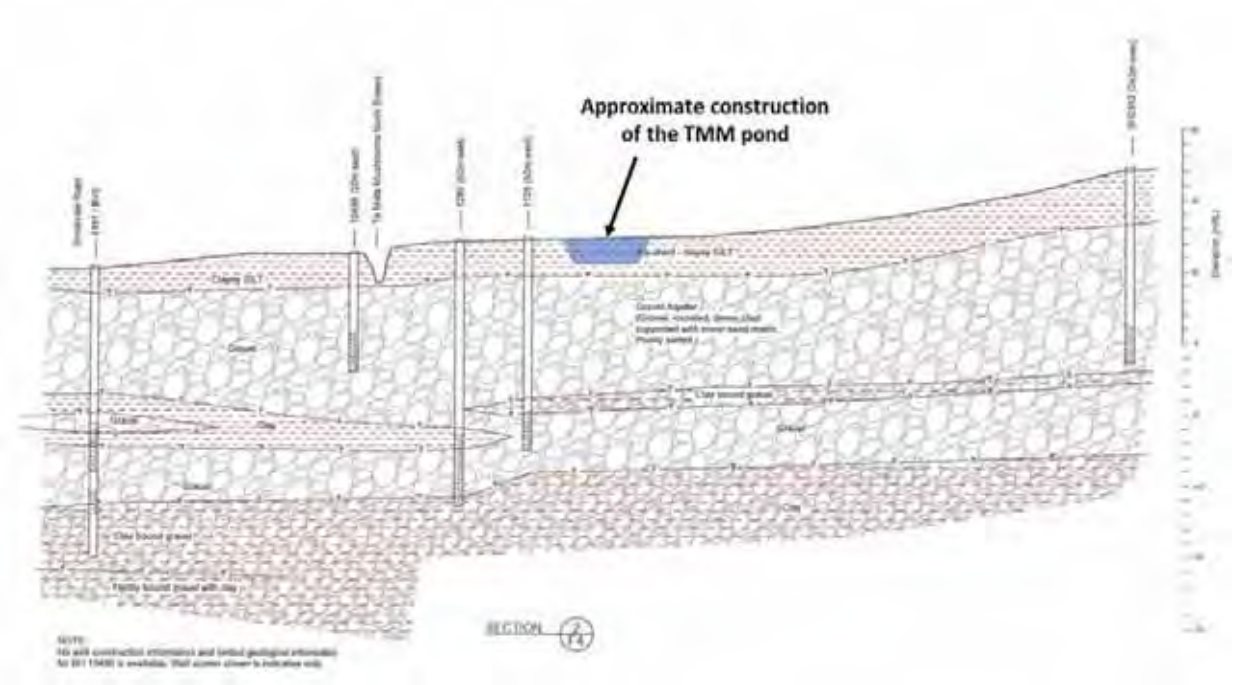


Figure 7. *Approximate position and construction of the TMM pond illustrated on a geological cross section running south-east from Brookvale Road (modified from Tonkin and Taylor, 2016[3]).*

The investigation methodology attached as Appendix 1 proposed undertaking Scalia penetrometer tests in the hand auger holes to provide an assessment of material compaction. However, a review of the methodology by Tonkin and Taylor (provided in email correspondence from HDC to Brydon Hughes, 11 August, 2022) stated that Scala penetrometer testing is typically unreliable as an indicator for strength in cohesive (clay) soils, and therefore Scala probe tests were not completed across the site. As it turned out Scalia testing would not have been possible due to the variable texture of the fill materials which contained occasional coarse-grained sediments which made such testing impractical. It is however noted that the near-level topography across the former pond site (which made delineation of pond boundaries difficult) indicates that limited settlement of the fill materials has likely occurred following placement suggesting a reasonable degree of compaction.

[3] Tonkin and Taylor, 2016; Bacteriological Contamination Investigation. Brookvale Road Water Supply Bores, Havelock North. Report prepared for Hastings District Council, November 2016.

4. Soil Contamination Investigation

Given the uncertain providence of (at least a portion) of the materials utilised to infill the pond, soil sampling was undertaken to ascertain the presence of any potential contaminants in the fill materials. Soil sampling was undertaken in conjunction with the geological investigations described in the previous section with samples collected at 0.5 metre intervals from each of the hand auger holes completed. Samples were analysed for:

- Metals
- Asbestos
- Acid herbicides (AH)
- Organochlorine Pesticides (OCP)
- Semi-volatile organic compounds (SVOC)
- Polycyclic aromatic hydrocarbons (PAH)
- Total petroleum hydrocarbons (TPH)

A description of the sampling methodology and sample results is contained in the EAM report Appended as Attachment 3.

In summary, results indicate all AH, OCP, SVOC, PAH and TPH results were recorded as being below laboratory method detection limits. Asbestos was not detected in the samples analysed. In general, metal concentrations were recorded at concentrations to be expected from an uncontaminated Hawke's Bay soil. The only exception was at Sample Sites #6 (lead and zinc), #8 (zinc), and #10 (zinc). At these sites, contaminant concentrations only marginally exceed the values expected for an uncontaminated Hawke's Bay soil.

Overall, sampling undertaken indicates the backfilled soils are largely contaminant free and do not pose a risk to human or environmental health. In terms of the overall fill composition, the report notes:

> *During the site excavations and auguring, it was noted that generally the fill material was devoid of foreign material. However, a wool fadge was noted at Sample Site #6 (refer Appendix B). The contents of the wool fadge appeared to be domestic refuse such as plastic and decomposing organic matter. There were no components within the fadge that would constitute a significant contaminant source.*

5. Risks to Drinking Water Supply

The s92 request issued by HDC sought additional information to characterise the risks to drinking water supply derived municipal supply wells located along Brookvale Road associated with construction and subsequent backfilling of the TMM stormwater pond. The methodology developed from the July 2022 site meeting outlined a range of investigations that would be undertaken to assist characterisation of potential risks to groundwater quality arising from pond construction and subsequent decommissioning.

Results from investigations undertaken to data indicate that:

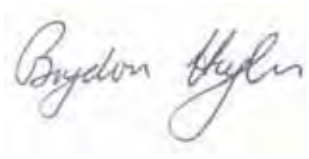
- The invert of the pond was constructed to a depth of between 1.6 to 1.9 metres below ground. Available geological information indicates excavation of the pond did not occur through the full depth of the surficial low permeability (clayey silt) layer, with a minimum of 0.5 and 1.0 metres remining intact below the pond invert. The limited hydraulic connection between the pond and underlying aquifer through the remaining low permeability sediments is illustrated by the depth of standing water observed in the pond at the time of the Councils 17 November 2020 site visit, which occurred at least 6-days following any significant rainfall at site.
- The fine-grained nature of the fill materials are unlikely to form a preferential pathway for surface contaminants to infiltrate into underlying groundwater, particularly given the variable nature of the local geology (indicated by drillers logs) and other features in the area (such as the un-named ephemeral stream located approximately 40 metres north of the pond which is incised to a similar (or greater) depth into the surficial low permeability sediments.
- Backfill material infilling the pond appears to comprise a mixture of native soil materials used to form the bund around the pond, combined with imported fill. While the providence of the fill is unknown, soil testing undertaken across the former pond site indicate the backfilled soils are contaminant free and do not pose a risk to human or environmental health.

Overall, available data does not indicate that excavation and subsequent backfilling of the stormwater pond on the TMM sites presents an elevated risk to downgradient groundwater quality given the excavation did not fully penetrate the surficial low permeability layer and the absence of contaminants within the backfill materials.

6. Summary

In September Te Mata Mushrooms applied for retrospective resource consent for the excavation and subsequent backfilling of a stormwater pond on their property located at 174 Brookvale Road, Havelock North. A review of available information, including data from site investigations undertaken in September 2022, does not indicate construction and subsequent backfilling of the pond presents an elevated risk to down-gradient groundwater quality.

Yours Sincerely



Brydon Hughes
Director

Attachment 1 - Preliminary Site Investigation Methodology

Te Mata Mushrooms

RMA20210509 – Earthworks Consent

It is proposed to undertake investigations related to RMA20210509 in two stages, the first to confirm the nature and physical characteristics of the pond fill materials with a subsequent stage to investigate any resulting hydrogeological impacts.

Stage 1 Methodology

1. Enquiries with TMM staff and Aqualine Contractors to establish the timeframe and methodology for excavation and subsequent backfilling of the pond, including the potential source of backfill materials. Best endeavours will be undertaken to collect information from personnel who completed on-site works.

2. A review of rainfall and groundwater levels records over the period preceding the HDC site visit on 17 November 2020 to establish potential sources of standing water observed in the pond.

3. Field investigations:

    a) The exact location of the pond is uncertain. However, as outlined in Attachment 1, a review of photographs provided by HDC, along with a map included in the Stradegy 2021 Resource Consent Application and the HDC website GIS image have been used to approximate the location and areal extent of the pond footprint. Using online maps, GPS coordinates at each corner of the footprint have also been identified to provide an indicative layout of the pond.

    To enable final delineation of the pond footprint, four shallow trenches will be excavated across the nominal pond boundaries to identify the contact between natural and cut ground. Once the final cut area is delineated, GPS co-ordinates for the nominal pond boundaries will be recorded.

    b) Ten hand auger holes completed along transects at right angles across the pond area and a minimum of 2 hand auger holes completed in undisturbed materials adjacent to the margins of the pond. Indicative locations of the investigation holes are shown on Attachment 1.

    Each auger hole will be logged to characterise the geological materials present and, if practicable, extend to sufficient depth to tag the underlying alluvium to identify the depth of undisturbed materials below the base of the excavation. GPS locations for all holes will be recorded.

    Following completion all holes will be backfilled with appropriate soil materials and compacted.

c) Scala penetrometer tests, terminating above the underlying alluvium, will be undertaken in all investigation holes to assess material compaction.

   The investigation procedure will involve completion of a Scala test between 0 to 1 m depth below ground level (bgl) after which the bore will be augered to 1 m bgl. This procedure will be repeated from 1 to 2 m bgl. The bore holes will then be excavated to approximately 2.5 m depth bgl to tag underlying gravels. The Scala Penetrometer tests will not be completed below 2 m depth bgl due to the possible presence of gravels.

d) Collection of soil samples at 500 mm depth increments from a minimum of 5 hand augur holes (nominally one sample adjacent to each side of the pond and one sample in the central area). Samples will be collected a 1 metre depth increments from the remaining augur holes. Samples will be analysed for a suite of contaminants including heavy metals, asbestos, herbicides, total petroleum hydrocarbons (TPH) and organo-chlorines.

Results of the Stage 1 investigations will be utilised to characterise the physical characteristics of the pond infill materials and evaluate requirements for further hydrogeological investigations.

Attachment 2 - Bay Geological Services Limited Soil Investigation

Bay Geological Services Ltd
RD6
Napier 4186

mobile: s 9(2)(a)
email: s 9(2)(a)

30 October, 2022 BGS336-01rpt

The Te Mata Mushroom Company Limited
PO Box 8137
Havelock North 4157

Attention: Marcus Hill

Dear Marcus,

SOILS INVESTIGATION AT FORMER STORMWATER POND
74 BROOKVALE ROAD, HAVELOCK NORTH

1.0 INTRODUCTION

The Te Mata Mushroom Company Limited (TMM) operated a mushroom growing and harvesting business at their property at 174 Brookvale Road, Havelock North, until recently mothballing the factory in October, 2022. The site is a gently sloping, low elevation alluvial terrace which extends westwards to a 20 m high escarpment that forms the western boundary, and an unnamed stream at the eastern boundary.

As part of a proposed Stormwater Management Plan, TMM excavated a stormwater pond on a near-level paddock located on the eastern side of the property. Not a lot is known about extent of the excavation, but several site images were provided by TMM which are included in Appendix A. A summary of an inspection completed by Hastings District Council (HDC) on 17 November, 2020 included approximate dimensions of the pond as detailed below:

- Top of Pond Wall: 37 m x 44 m at the base of the Pond
- Interior base: 25 m x 35 m at the base of the Pond
- Batter slope: 30°angle
- Bund height: 1.8 m above ground level
- Estimated Pond depth: 4.1 m from top of bund (2.3 m below ground level).

The pond was subsequently backfilled with unknown material.

Bay Geological Services Ltd. was engaged by TMM to conduct a field investigation of soils within the vicinity of the general pond area to identify the location, and thickness and composition of the Fill. The project area was accessed southeast off 174 Brookvale Road, past the shop and factory buildings, and along a track which led to the site southeast of the implement shed.

At the time of the field investigation, the project area was observed as a near-level, grassed paddock with no discerning features or evidence of the former pond or bund.

On 28 and 29 September 2022, a site investigation was conducted across the project site which commenced with initial topsoil scraping with an hydraulic excavator in an attempt to delineate the fill/no fill zones and identify the perimeter of the former pond and bund footprint. Following this, a series of ten hand augers were completed up to approximately 2 m depth within the area approximated as the pond/bund footprint, as interpreted from the soils exposed shallow trenches.

2.0 SITE LOCATION AND DESCRIPTION

The approximately 23.5 ha property is located at 174 Brookvale Road, Havelock North accessed from the southeast of the road, approximately 2.5 km east of the village (refer Figure 1). The operation is spread out across an area of flat land at the base of a hill, and comprises a series of large mushroom growing sheds, retail shop, compost processing facilities, implement sheds and stacked straw.

The topography of the project area is extensive alluvial terraces, bound to the west by a 20 m high escarpment and a minor stream to the east which drains approximately northward. The former pond area is located past the shop and growing sheds, along a track toward the implement sheds, and across a bare, grassed paddock to the southeast.

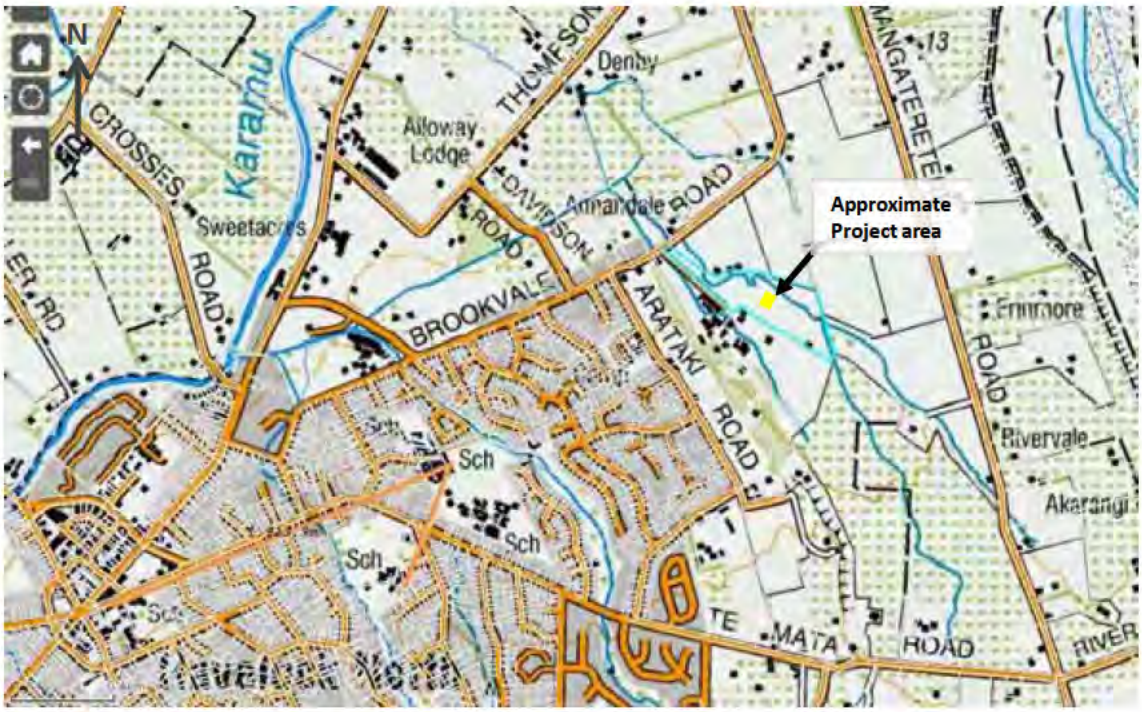


Figure 1. Topo map showing the approximate project area east of Havelock North

3.0 DETAILS OF MAPPED SOILS

A review of the published soils map from across the Havelock North area was completed which revealed a variety of soils present across the TMM site, being from an alluvial source (refer Figure 2). The soils across the project area are mapped as Poporangi (32), which are described as 30 to 45 cm ashy sandy loam on sandy loam (loess) on pan over gravel at >60 cm, with poor water drainage perched on pan (Griffiths, 2001).

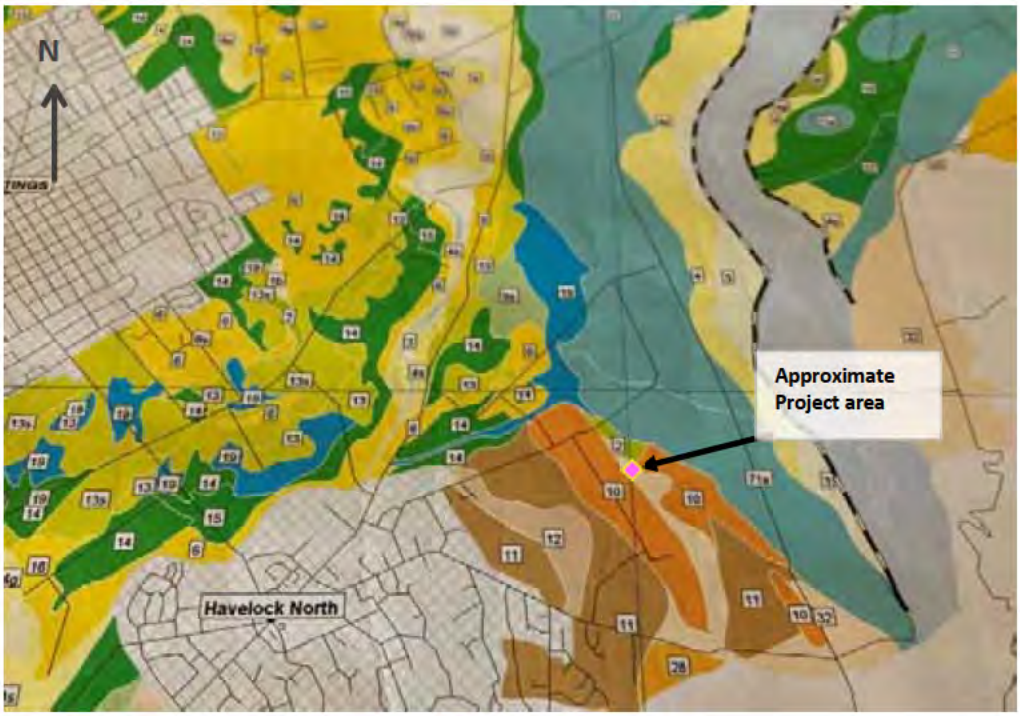


Figure 2. Soils map across the project area east of Havelock North

3.1 Details of Groundwater Well Bore Logs

In addition, a review of the HBRC website was carried out to identify surrounding groundwater wells within a close vicinity of the project area with the data included in Appendix B. The search revealed five wells within approximately 200 m of the project site as displayed in Figure 3.

Figure 3. HBRC wells map showing locations of nearby wells (HBRC)

The majority of the five wells are drilled to shallow depths, with top screens <17.00 metres below ground level (bgl). One intermediate depth well is drilled to 30.80 m bgl with a top screened at 29.00 m bgl. The wells are screened across blue/brown gravel aquifers with static water levels (SWL) ranging from -5.00 to 0.00 m bgl; however, the latter may represent no actual reading. The details of the surrounding wells are provided in Table 1, along with descriptions of aquifer lithology as recorded on the HBRC bore logs. Although not a lot of detail is provided for the upper 2 to 3 m of the bore holes, the near-surface soils are predominantly described as brown silt and clay. Only Well No. 10497 records near-surface gravel to 4.30 m bgl, and the 2.10 m of topsoil reported in Well No. 826 is likely to be brown silt.

Table 1. Details of Groundwater Bores near the project area (source HBRC)

Details of Wells within close vicinity of the Project Area					
Well No.	**Well (bore) depth (m)**	**Screen (m)**	**Aquifer/ lithology**	**Near-surface lithology (m bgl)**	**SWL (m bgl)**
1280	25.00	16.80 – 22.80	blue/brown gravel	0.00 - 1.00 brown silt 1.00 – 13.00 brown gravel	-1.30
1129	18.10	15.20 – 21.20	blue/brown gravel	0.00 - 3.00 brown clay 3.00 – 13.50 blue/brown gravel 13.50 – 15.20 yellow clay	0.00
10497	30.80	29.00 – 30.80	blue/brown gravel	0.00 – 4.30 red gravel 4.30 – 7.30 brown clay	-4.60
16691	13.40 (16.00)	11.50 – 13.40	brown gravel	0.50 – 8.60 brown clay 8.60 – 9.50 brown gravel	-5.00
826	26.40	?	brown gravel with clay	0.00 – 2.10 topsoil 2.10 – 6.90 blue/brown gravel 6.90 – 8.40 yellow clay	-4.00

The closest are Well Nos.1129 and 1280, located approximately 120 and 130 m west and north of the central project area, respectively. The HBRC online bore logs are included in Appendix B.

The upper section of the bore logs describes the following soils:

- Well No. 1129 records topsoil from the surface to 1.00 m bgl, overlying soft brown clay to 3.00 m bgl and blue/brown gravel to 13.50 m bgl.
- The near-surface lithology for Well No.1280 is logged as brown silt to 1.00 m depth bgl, overlying blue/brown gravel to 22.80 m bgl with a thin clay bed from 13.00 to 13.10 m bgl.

4. SOILS INVESTIGATION

The project area is currently a near-level grassed paddock with no variation in elevation or evidence of the former pond or bund. An on-site soils investigation was completed to:

a) delineate the approximate footprint of the former pond/bund; and,
b) identify composition and depth of Fill soils and enable soil sampling by EAM Ltd. for soil quality analysis.

In order to complete the soils investigation at the site, the following methods were used:

- the subsurface conditions at the site were initially inspected using a small hydraulic excavator to scrape shallow trenches to delineate the approximate perimeter of the former pond/bund; and,
- hand auger borings were completed in the areas of fill identified in the shallow trenches to depths ranging from 1.6 to 2.1 m bgl in order to measure depths to the base of the Fill soils and describe the Fill soils.

4.1 Shallow Trench Investigation

On 28 and 29 September 2022, a series of shallow trenches were scraped by the excavator to expose the near-surface soils along each side of the projected perimeter of the pond/bund footprint. An overview of the site with several of the shallow trenches is presented in Figure 4.

Figure 4. A series of trenches were excavated across the approximated perimeter of the footprint of the former pond (view east).

However, the shallow excavations only provided very approximate bounds of the pond/bund, and did not identify a well-defined fill/natural ground delineation of the perimeter. Using the soils excavation information, the approximated corners of the pond/bund footprint were surveyed by Surveying the Bay, with the plan presented in Appendix A.

4.2 Bore Holes

Following completion of the shallow trenches, the subsurface conditions at the site were further investigated by excavating ten, 1” diameter (diam.), 1.6- to 2.1-metre-deep hand auger bore holes within the area identified as the possible pond/bund footprint. The hand auger borings are designated Bore Hole Nos. 1 to 10, with the locations shown in Figure 5.

The bore holes were augured to measure the thickness of the Fill and describe the composition of the Fill soils and if possible, the underlying natural ground. Photographs taken during the soils investigation are included in Appendix C.

Figure 5. Aerial image of the former pond/bund area showing Bore Hole locations

The bore logs for the ten bore holes are included in Appendix D, and a summary of the results from the ten bore holes are summarised in Table 2.

Table 2. Summary of Bore Hole Results

Summary of Bore Hole Results				
Bore No.	Location	Depth (m bgl)	Depth to Base of Fill (m bgl)	Lithology at base of fill
1	centre	2.00	1.70	SILT: slightly clayey, greyish blue
2	west	1.80	1.60	SILT: slightly clayey to clayey, brown and grey
3	west	2.10	1.50	SILT: slightly clayey to clayey, orangey brown and brown (Fe^{2+}, Mn)
4	north	1.60	1.40	SILT: slightly clayey, orangey brown (Fe^{2+}, Mn)
5	north	1.60	0.90	SILT: slightly clayey, pale yellow and orangey brown (Fe^{2+})
6	centre	1.90	1.60	SAND: fine - med, with fine - med gravels, bluish grey
7	centre	1.50	did not reach base of fill	did not reach base of fill
8	east	1.40	0.70	SILT: slightly clayey, orangey brown and brown (Fe^{2+}, Mn)
9	south	1.20	0.60	SILT: slightly clayey, orangey brown and black (Fe^{2+}, Mn)
10	south	2.00	1.95	SILT: slightly clayey, orangey brown and brown (Fe^{2+})

4.3 Results of Bore Hole Investigation

The 1” diam. hand auger bore holes were completed across the bare, grassed paddock where there was little demarcation of the bounds of the pond or bund. Therefore, the distribution of bore holes across the site resulted in several being augered in the centre of the pond area, and several on the perimeter. The bore logs revealed some variation in sub-Fill soils, but generally the base of the Fill was observed as slightly clayey silt soils.

4.3.1 Bore Hole Nos. 5, 8 and 9

Bore Hole Nos.5, 8 and 9 were augered to depths of 1.6, 1.4 and 1.2 m bgl, respectively at locations where near-surface fill soils were exposed by the hydraulic excavator. Due to no indication across the paddock of the bounds of the pond, as a result, the three bore holes were completed near the pond/bund perimeter.

The Bore Hole Fill depths ranged from 0.6 to 0.9 m bgl and Fill soils comprised a mixture of topsoil and dark brown, brown and orangey brown, slightly clayey Silts. A layer of fine sand and gravels was logged from 0.8 to 0.9 m depth in Bore Hole No.5 only, which was interpreted as the base of the Fill.

The soils below the Fill generally comprised slightly clayey, pale yellow, orangey brown and brown Silt with iron staining mottle and black manganese nodules and staining.

4.3.2 Bore Hole Nos. 1, 2, 3, 4, 6, 7 and 10

The Bore Hole Nos.1, 2, 3, 4, 6, 7 and 10 were hand augered within the vicinity of the centre of the former pond footprint.

The bore hole Fill depths ranged from 1.5 to 1.95 m bgl and comprised a mixture of topsoil and dark brown, brown and orangey brown, slightly clayey Silts. Fragments of black plastic were encountered in several of the bore holes, and very soft bluish grey slightly clayey Silt was logged in Bore Hole No.1. Occasional fine sand and gravels were at logged in Bore Hole Nos. 2, 4, 6 and 10. It is noted that a fragment of black plastic was encountered at 1.8 m depth in Bore Hole No. 10, and a bag of rubbish was uncovered within the top 1 m near Bore Hole No. 6.

The soils below the Fill generally comprised slightly clayey, pale yellow, orangey brown and brown, greyish blue, greyish khaki, Silt with brown iron staining mottle, black manganese staining and small nodules.

The hand auger boring at Bore Hole No.7 revealed a dark grey and brown, slightly clayey Silt with large gravels from 1.2 to 1.4 m bgl, and due to the presence large gravels could not deepen the bore hole. It is interpreted that the base of the Fill zone was not encountered at Bore Hole No. 7, the location for which is within the central pond area.

Each of the 1” diam. hand auger bore hole was backfilled with bentonite pellets as provided by Honnor Welldrillers.

4.3.3 Summary of the Hand Auger Investigation

The bore hole data revealed Fill soils extending from ground level to depths between approximately 0.6 and 1.95 m bgl across the approximated footprint of the former pond/bund. The Fill soils are generally comprised of a mixture of topsoil and multi-coloured slightly clayey Silts with occasional fine sand and gravels. A bag of rubbish was uncovered near Bore Hole No. 6 and fragments of black plastic were encountered within several of the bore holes. The base of the Fill was not determined in Bore Hole No. 7, which revealed dark grey and brown, slightly clayey Silt with large gravels from 1.2 to 1.4 m bgl.

Initially, compaction testing of the backfilled material using Scala penetrometer probes was proposed. However, a review of the investigation methodology by Tonkin and Taylor (provided in email correspondence from HDC to Brydon Hughes, 11 August, 2022) stated that Scala penetrometer testing is typically unreliable as an indicator for strength in cohesive (clay) soils. Furthermore, during the soils investigation, the hand augers borings revealed occasional gravel intervals and rare cobbles, which are not suitable for Scala tests.

The slightly clayey to clayey silt and alluvial soils were noted as typically firm during the hand auger borings. However, at the 1.5 m deep bgl base of Bore Hole 7, the Fill soils comprised very wet and soft, slightly clayey Silt with large gravels which precluded deeper investigation.

It was noted during the field inspection that area of investigation was near-level, with no obvious areas of settlement delineating the extend of the former pond. It is unlikely that excess fill was placed over the pond area (i.e., over-filled to provide pre-load compaction), which suggests a reasonable degree of compaction was achieved at the site.

5. SUMMARY DISCUSSION

In about 2020, the Te Mata Mushroom Company Ltd (TMM) excavated a large pond on a near-level paddock on the eastern side of their property at 174 Brookvale Road, Havelock North, in order to store stormwater collected from across the site. It is understood that prior to the pond being operational, it was required to be backfilled; however, details of pond dimensions and backfilled soils are unknown.

The project area is located on the eastern side of the TMM site, which comprises about 23.5 ha of flat land at the base of a hill, and includes a series of large mushroom growing sheds, retail shop, compost processing facilities, implement sheds and stacked straw. The former pond area is located past the main buildings and along a track toward the implement sheds, and across a bare, grassed paddock to the southeast. The topography of the project area is extensive alluvial terraces, bound to the west by a 20 m high escarpment and a minor stream to the east which drains approximately northward.

The soils across the former pond area are mapped as Poporangi (32) which are described as 30 to 45 cm ashy sandy loam on sandy loam (loess) on pan over gravel at >60 cm, with poor water drainage perched on pan (Griffiths, 2001). The five closest bore logs for groundwater wells describe top screens <17 m depth bgl, SWL's from 0.00 to -5.00 m bgl, and near-surface soils predominantly comprising brown silt and clay (HBRC).

On 28 and 29 September 2022, a soils investigation was completed which included shallow trenches excavated along the perimeters of the estimated pond/bund footprint, along with ten shallow (up to 2 m depth bgl) hand auger borings. The approximated perimeter of the approximated pond/bund footprint was surveyed by Surveying the Bay using the information determined from the soils investigation.

The ten hand auger bore holes revealed Fill soils extending from ground level to depths between approximately 0.6 and 1.95 m bgl across the approximated footprint of the former pond. The Fill soils are generally comprised of a mixture of topsoil and multi-coloured slightly clayey Silts with occasional fine sand and gravels. A bag of rubbish was uncovered near Bore Hole No. 6 and fragments of black plastic were encountered within several of the bore holes. The base of the Fill was not able to be determined in Bore Hole No. 7, which revealed dark grey and brown, slightly clayey Silt with large gravels from 1.2 to 1.4 m bgl.

6. REFERENCES

Griffiths, E., 2001: Soils of the Heretaunga Plains – a guide to their management. Grifftech and Hawke's Bay Regional Council, Napier, New Zealand.

Hawkes Bay Regional Council website (www.hbrc.govt.nz).

Stradegy Planning, 2021: Resource Consent Application for Land Use, The Te Mata Mushrooms Company Limited. Report No. 17013. Stradegy, Napier, New Zealand.

Report Limitations

This report has been written based on conditions as they existed at the time of the desktop study, and is also based on information collected from third parties, and there is no interpretation made on potential changes that may occur across the site. The third-party information used for the study has not been independently verified, and Bay Geological Services Ltd. accepts no responsibility for any errors or omissions. Subsurface conditions may exist across the site that are not able to be detected or revealed by the desktop study within the scope of the project and are therefore not taken into account.

APPENDICES

APPENDIX A

Images of the Project Site

Figure A1: Aerial photograph across the excavated Stormwater Pond at the TMM Brookvale site (unknown source).

Figure A2: Aerial photograph across the project area at the TMM Brookvale site with overlay of approximate pond locality (Stradegy, 2021).

Figure A3: Surveyed perimeter of the former pond determined from bore hole data (Surveying the Bay).

APPENDIX C

Site Investigation Photographs

Figure C1: Overview across former pond area and shallow trenches (view east).

Figure C2: Shallow trench over Bore Hole Nos. 1 and 2.

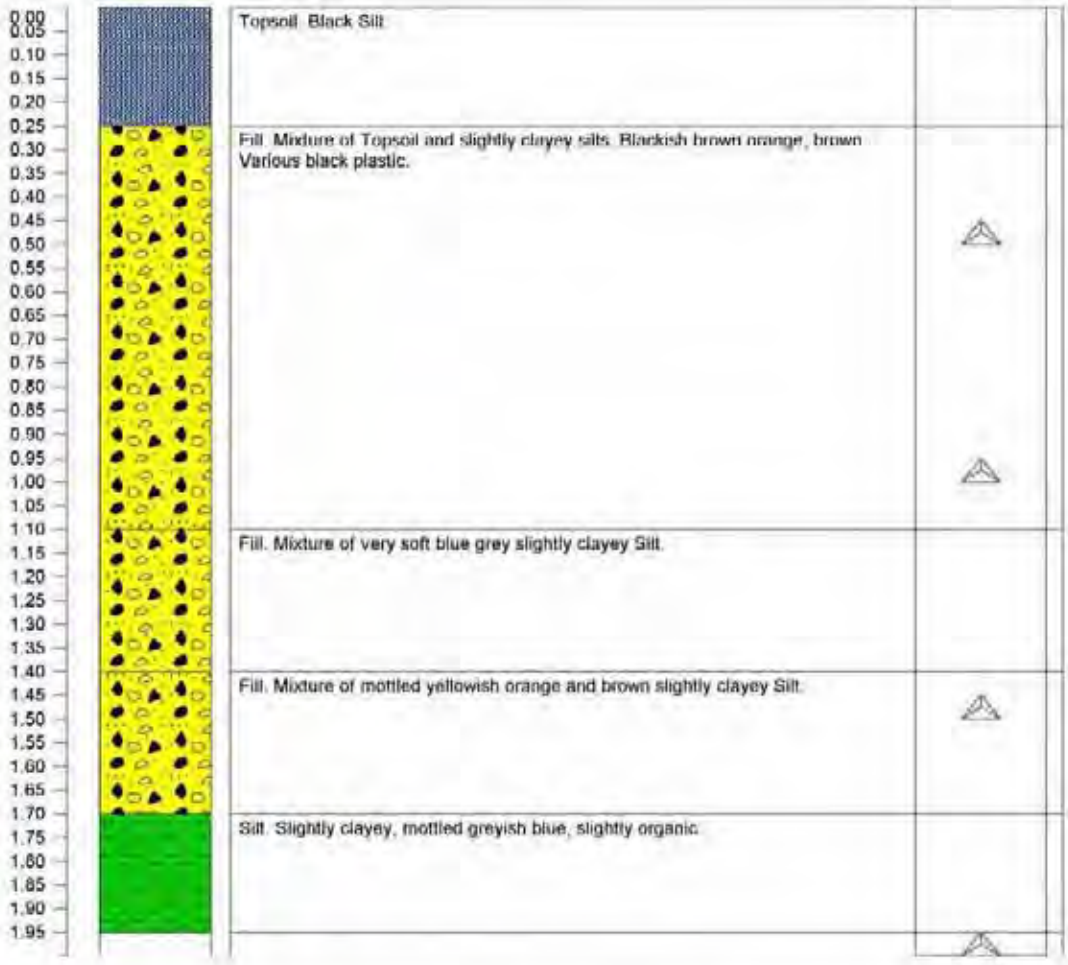
Figure C3: Shallow trench revealing rubbish bag near Bore Hole No. 6.

Figure C4: Shallow trench near Bore Hole No. 8.

APPENDIX D

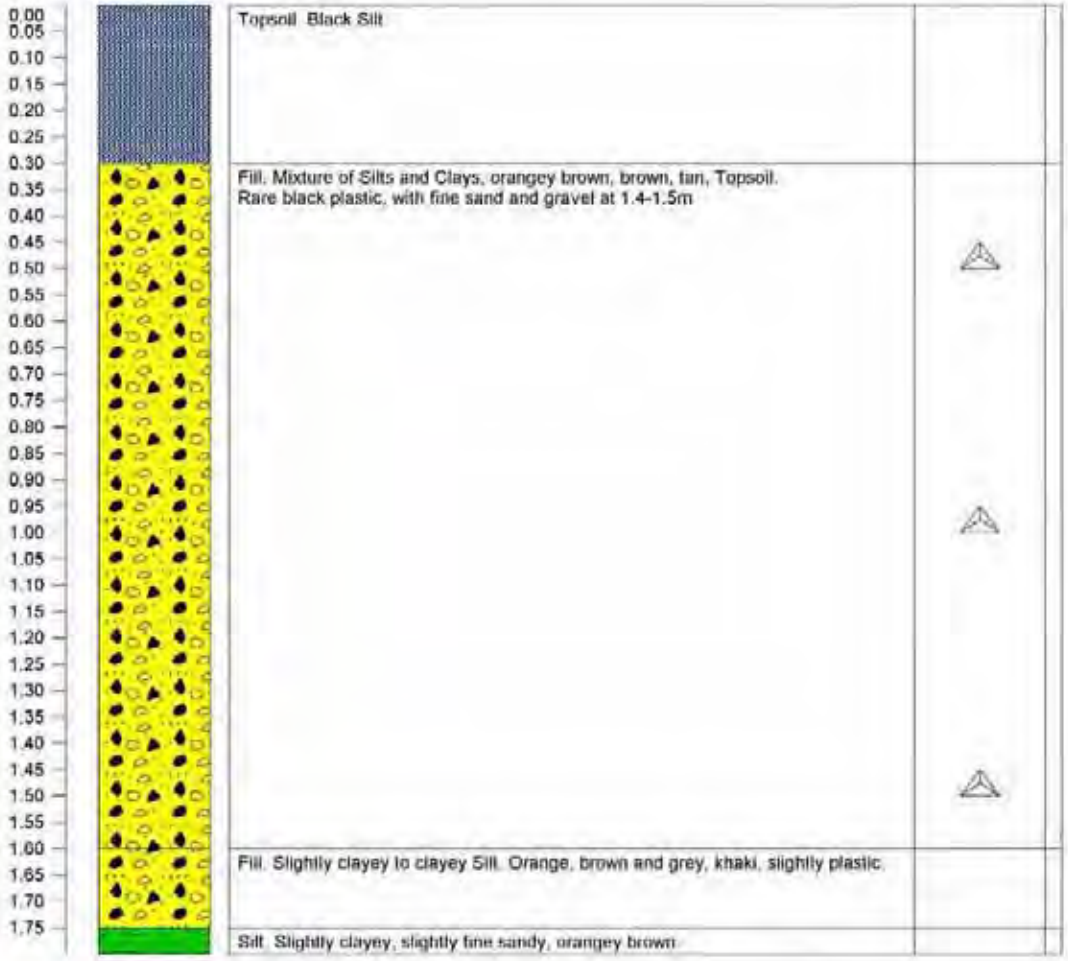
Bore logs

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	**1** **Easting:** 1935259 **Northing:** 5602836



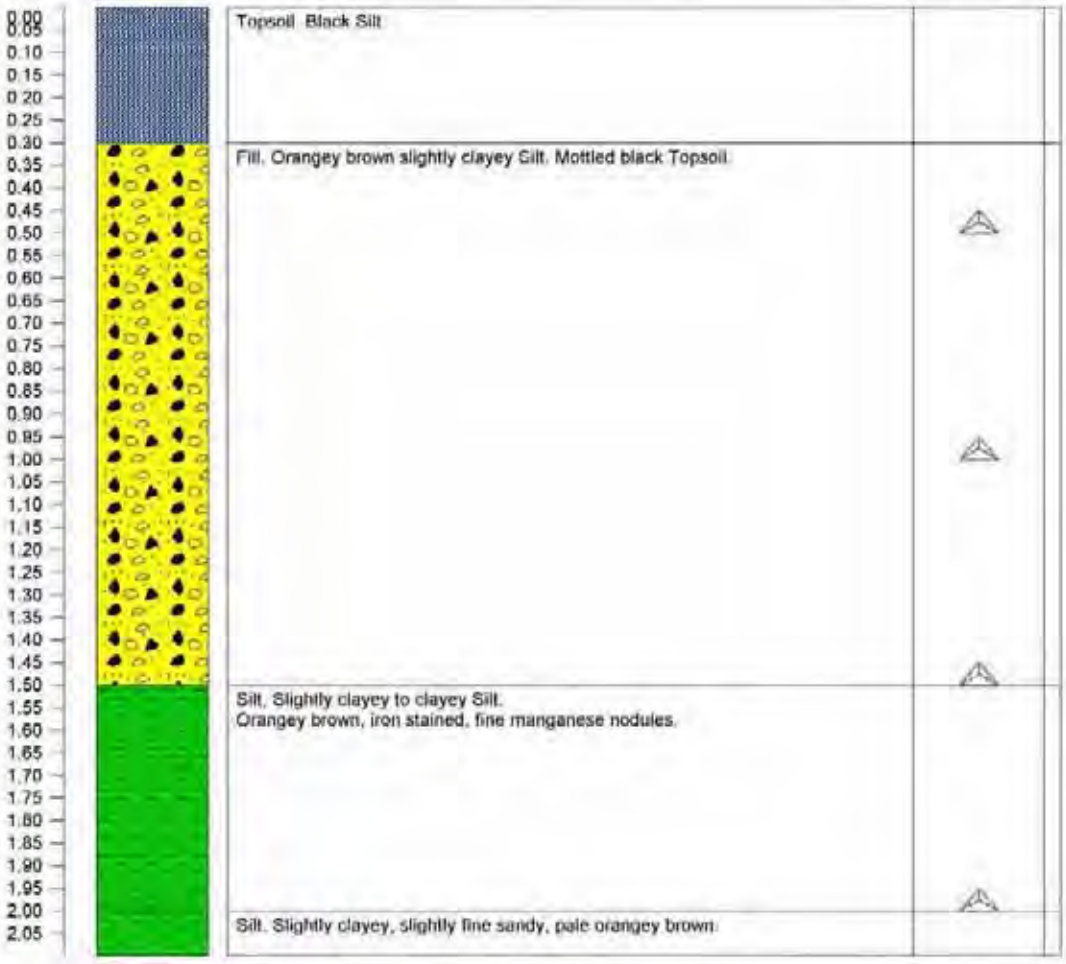
Bay Geological Services Ltd

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	**2** **Easting:** 1935244 **Northing:** 5602612



Bay Geological Services Ltd

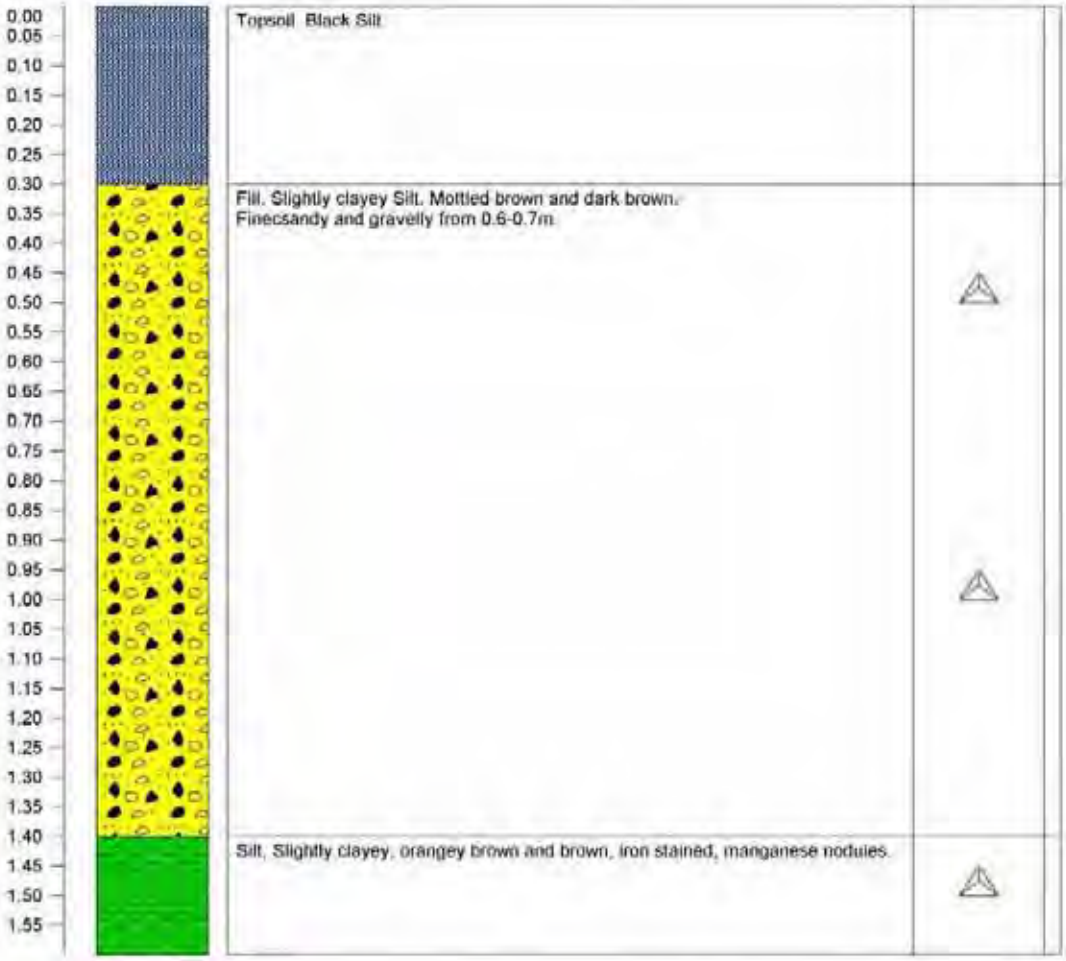
Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	3 **Easting:** 1935228 **Northing:** 5802821



Bay Geological Services Ltd

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022

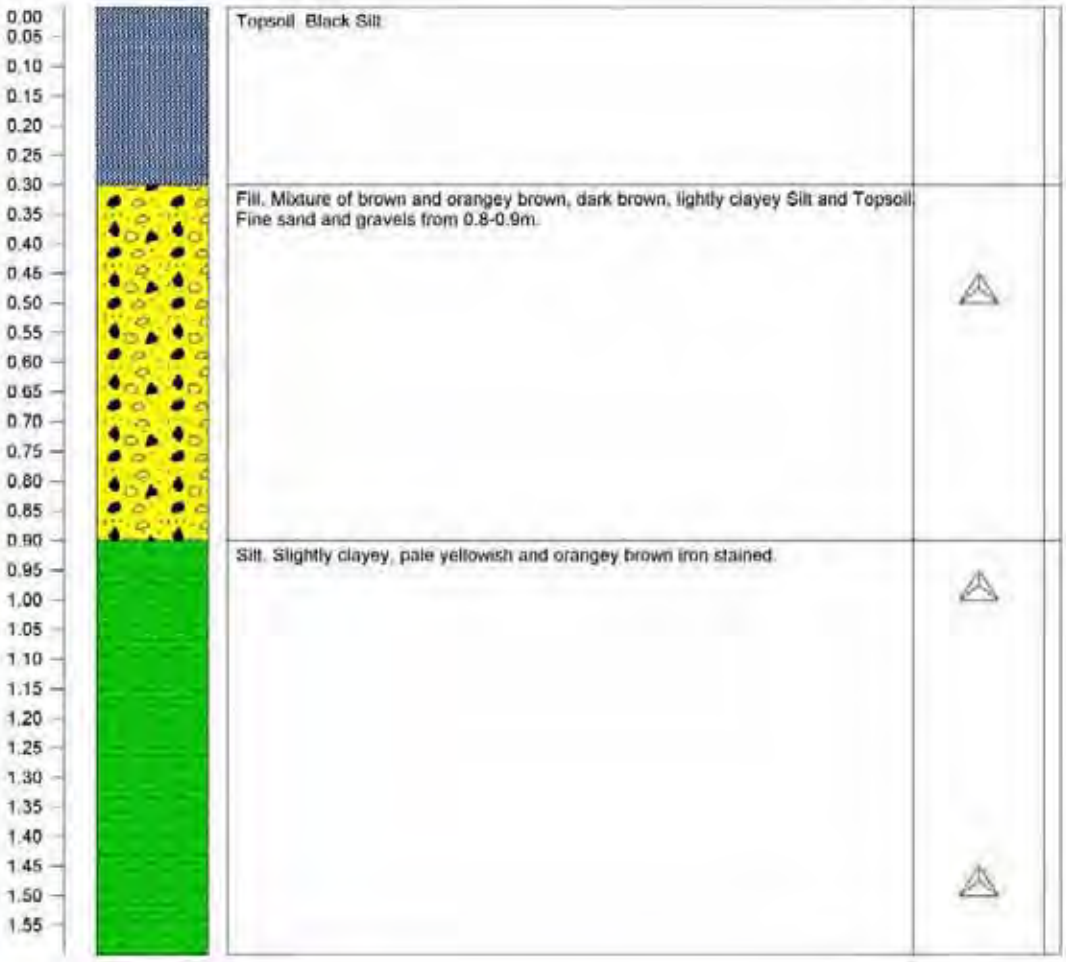
BORE LOG # 4 **Easting:** 1935232 **Northing:** 5602845



Bay Geological Services Ltd

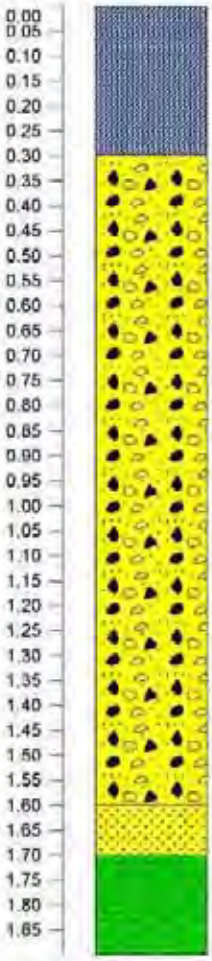
Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022

BORE LOG # 5 **Easting:** 1935251 **Northing:** 5802845



Bay Geological Services Ltd

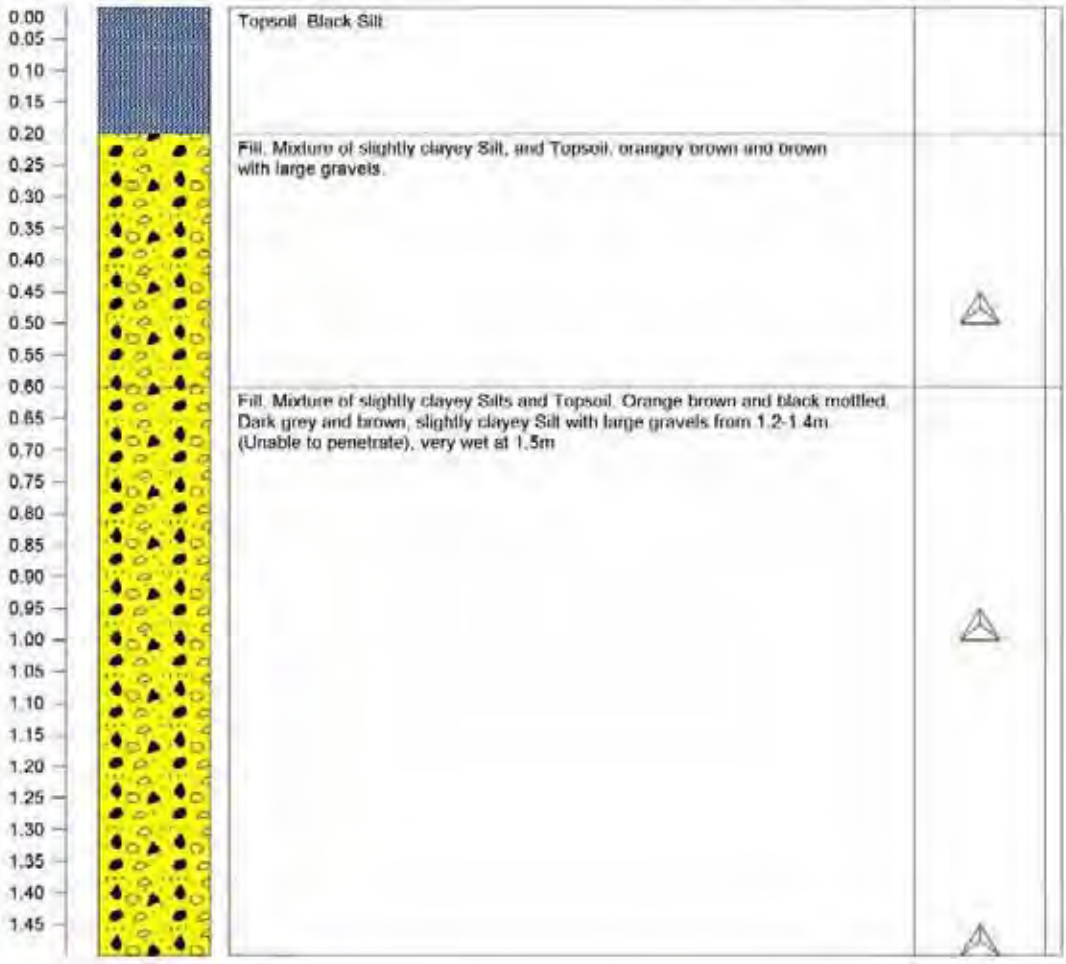
Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	6 **Easting:** 1935248 **Northing:** 5602845



Depth (m)	Lithology	Lithologic Description	Sample
0.00 – 0.25		Topsoil. Black Silt	
0.25 – 1.60		Fill. Mixture of slightly clayey Silt, and Topsoil. Dark brown and brown. Fine-medium sandy, fine gravel, dark greyish brown at 0.6m. Slightly clayey Silts, dark brown and brown at 0.7m.	
1.60 – 1.70		Sand. Fine to medium Sand, fine to medium gravels, blueish grey.	
1.70 – 1.85		Silt. Slightly clayey, orange brown and brown (mottled) iron stained, manganese nodules.	

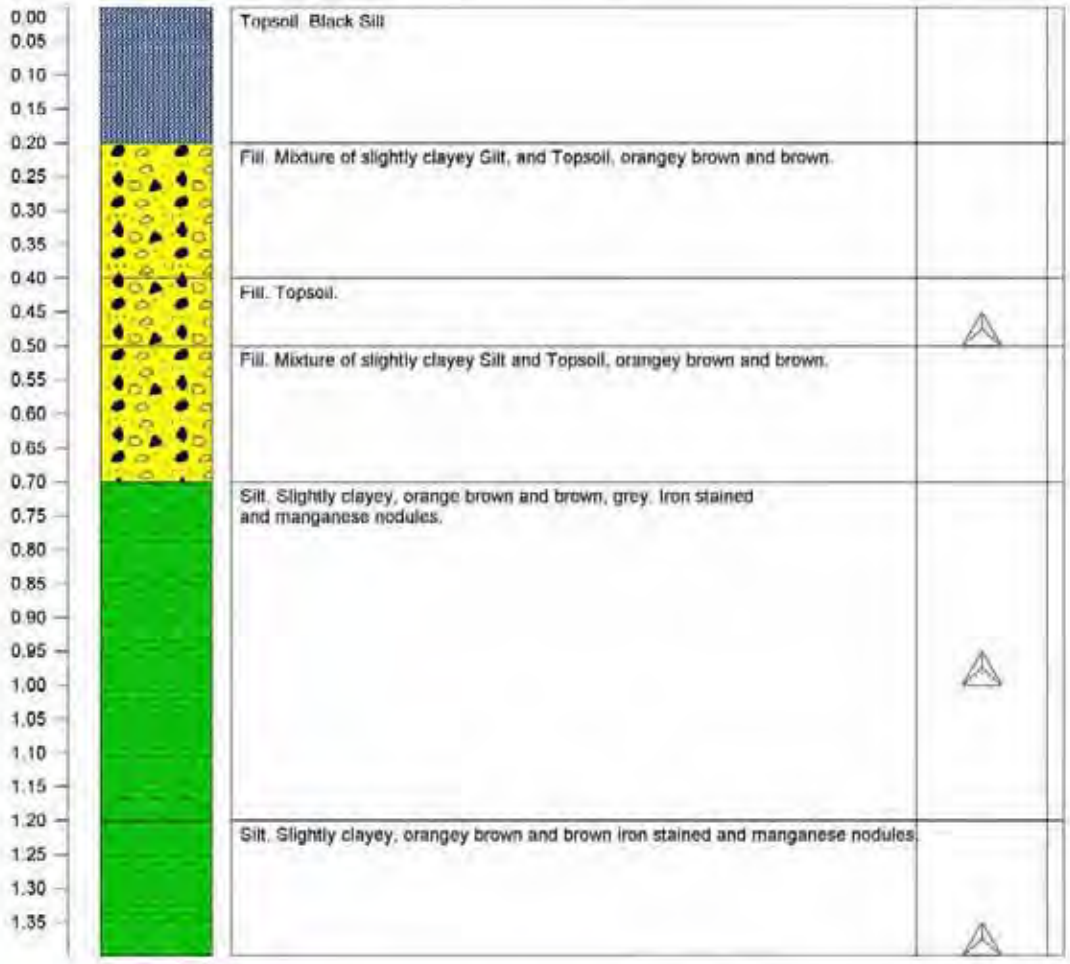
Bay Geological Services Ltd

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	7 **Easting:** 1935240 **Northing:** 5602829



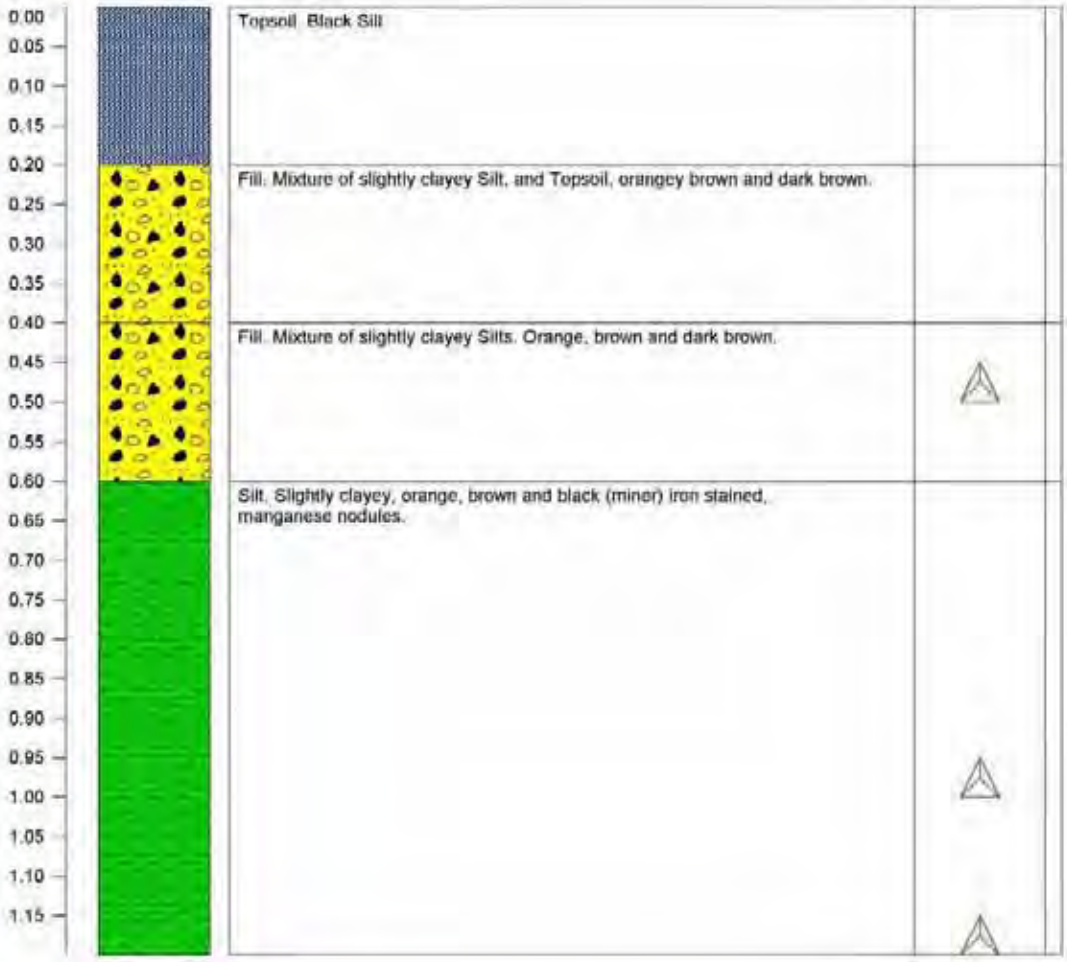
Bay Geological Services Ltd

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	8 **Easting:** 1935280 **Northing:** 5602843



Bay Geological Services Ltd

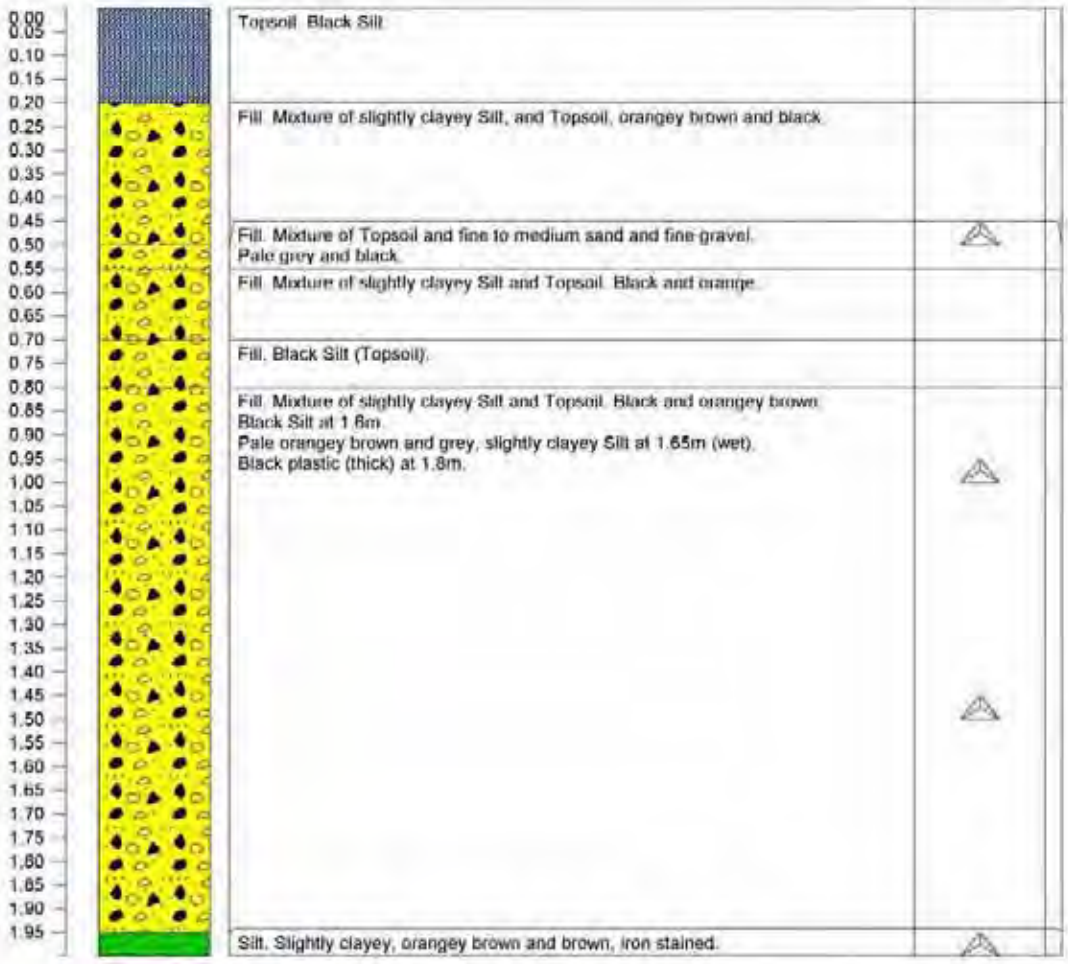
Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022
BORE LOG #	9 **Easting:** 1935252 **Northing:** 5802805



Bay Geological Services Ltd

Project	TE MATA MUSHROOMS POND INVESTIGATION
Project No	BGS 336-01
Client	TE MATA MUSHROOMS
Recorded By	ALEXANDRA JOHANSEN-PRINCIPAL GEOLOGIST
Date	28/9/2022

BORE LOG # 10 **Easting:** 1935267 **Northing:** 5602626



Bay Geological Services Ltd

Attachment 3 - EAM Soil Contamination Investigation

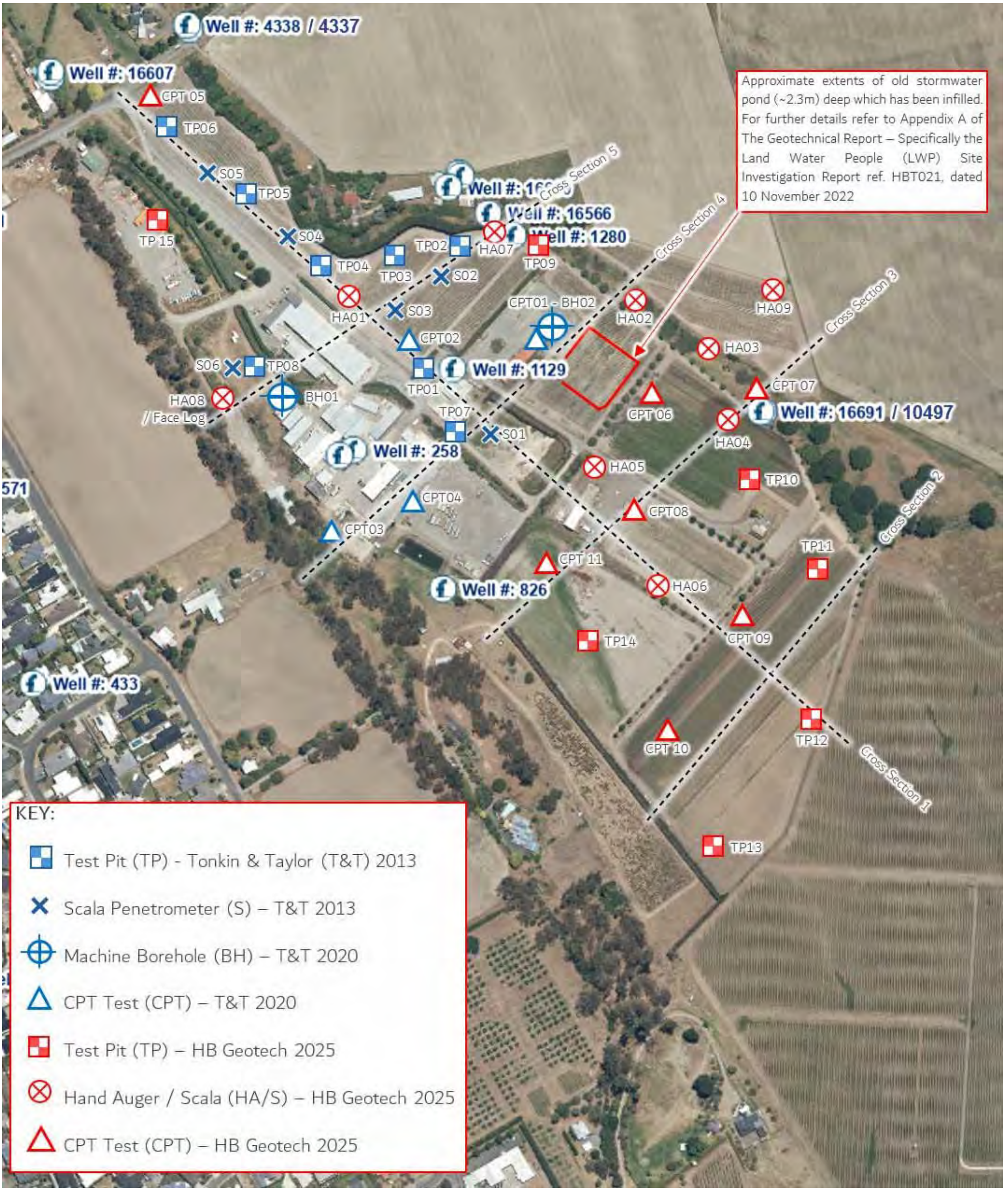
Appendix B

HBRC Well Logs & HB Geotech Site Investigations

TEST LOCATION PLAN

PROJECT: 25030

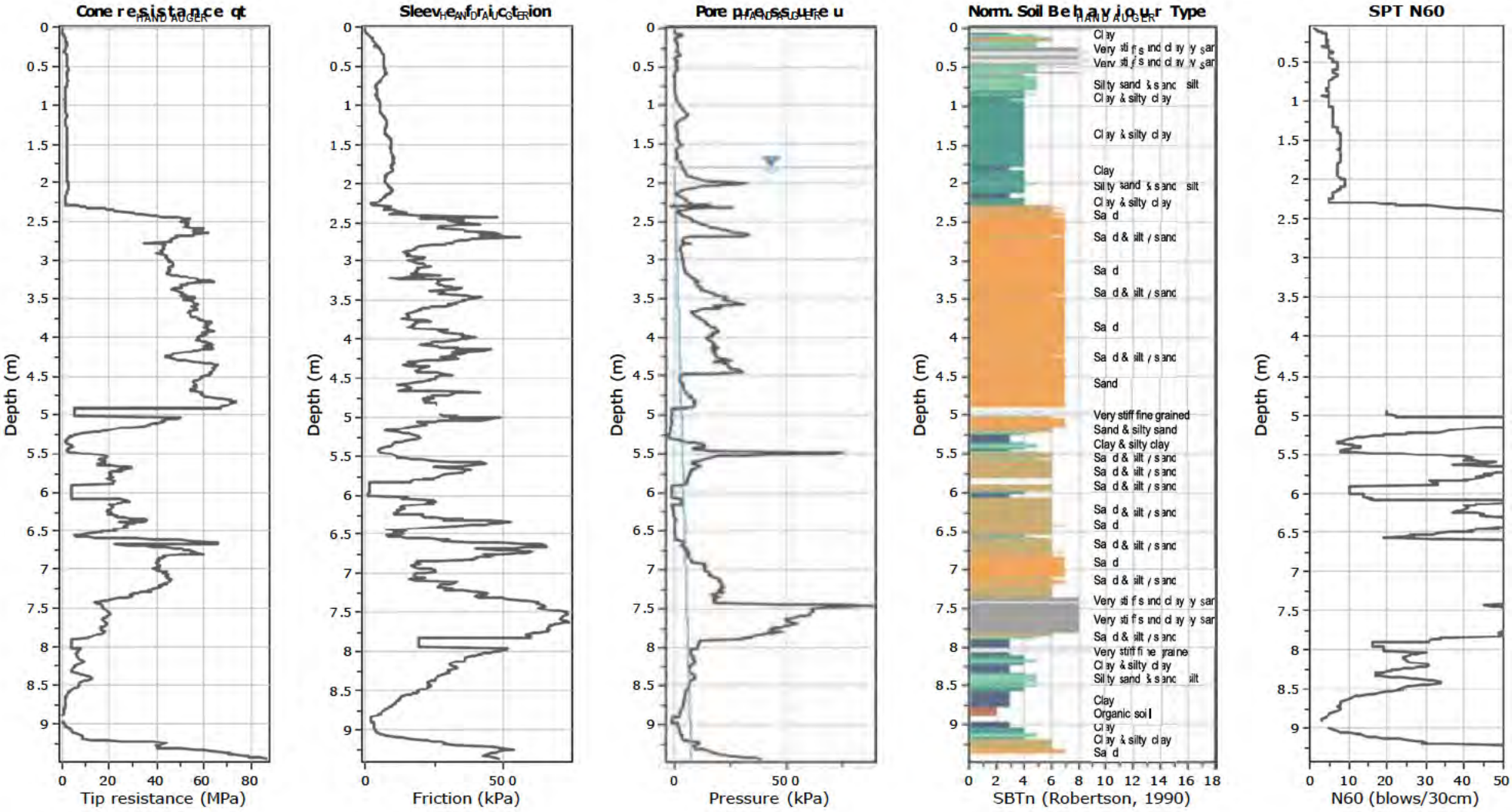
CLIENT:	Ed Sundstrum C/o Vermont Street Partners No. 4 Ltd
PROJECT:	Geotechnical Investigations
LOCATION:	174 & 176 Brookvale Road, Havelock North



Hawkes Bay Geotech
Geotechnical Engineers

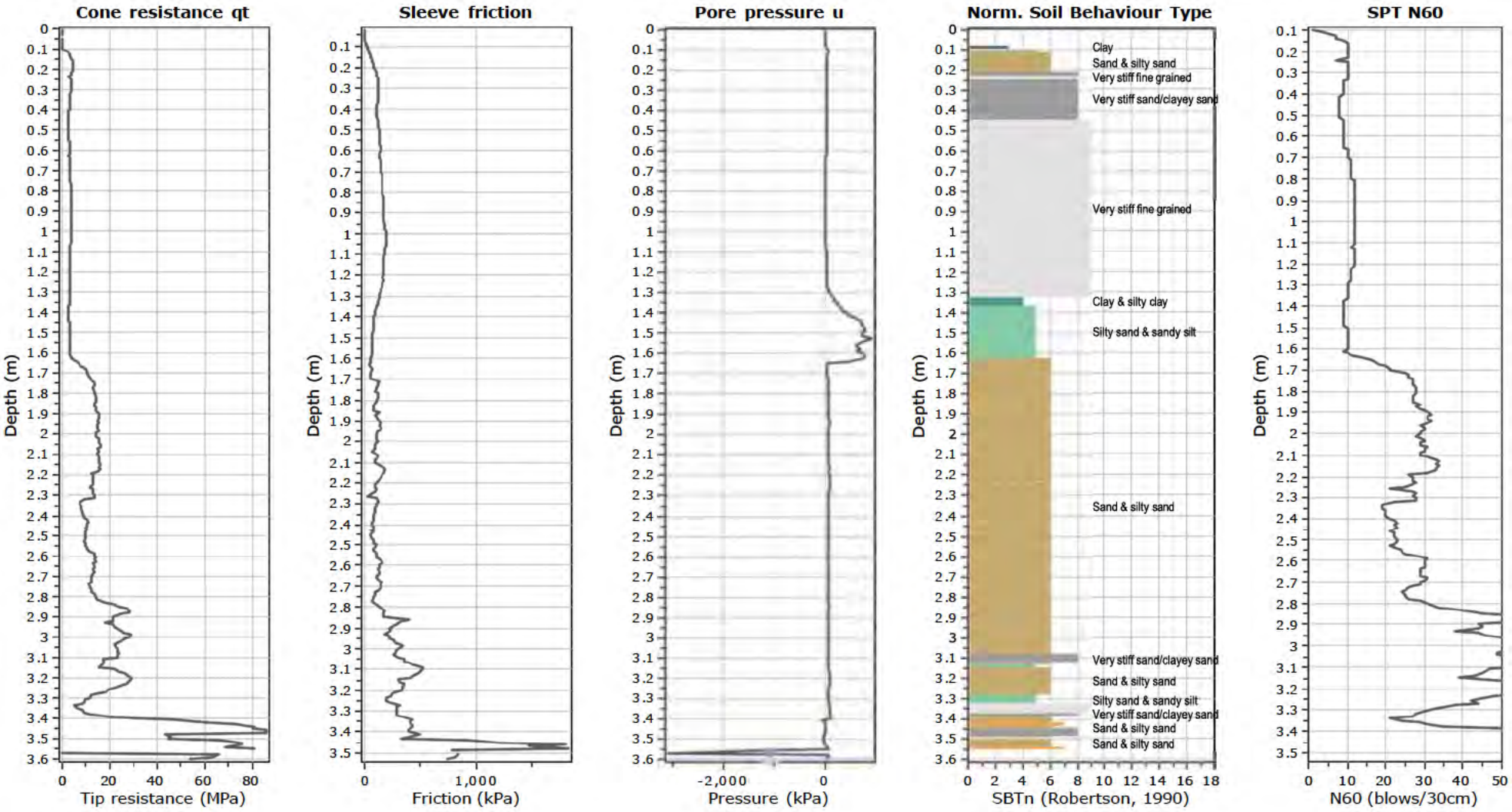
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 05
Total depth: 9.45 m



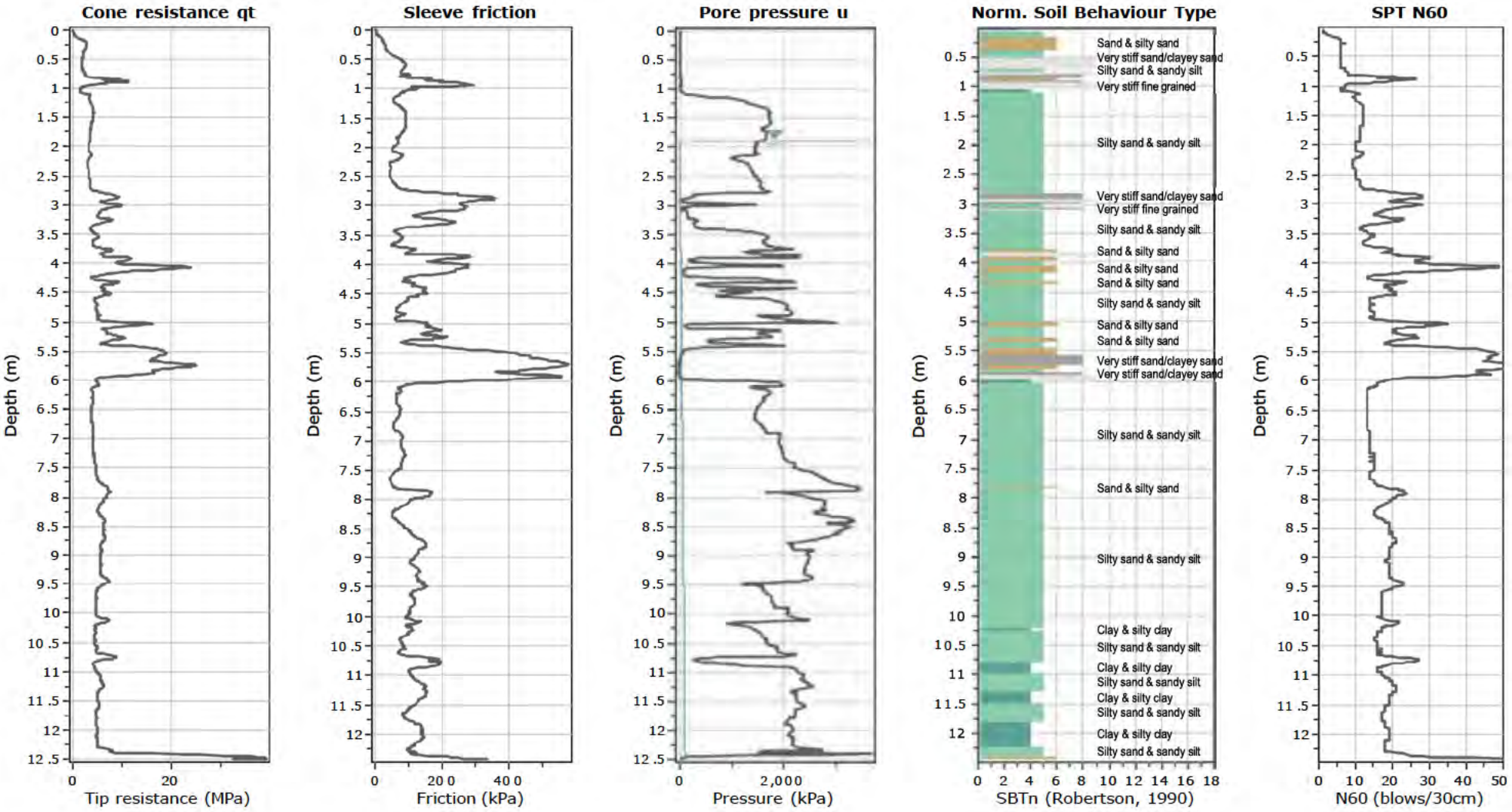
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 06
Total depth: 3.60 m



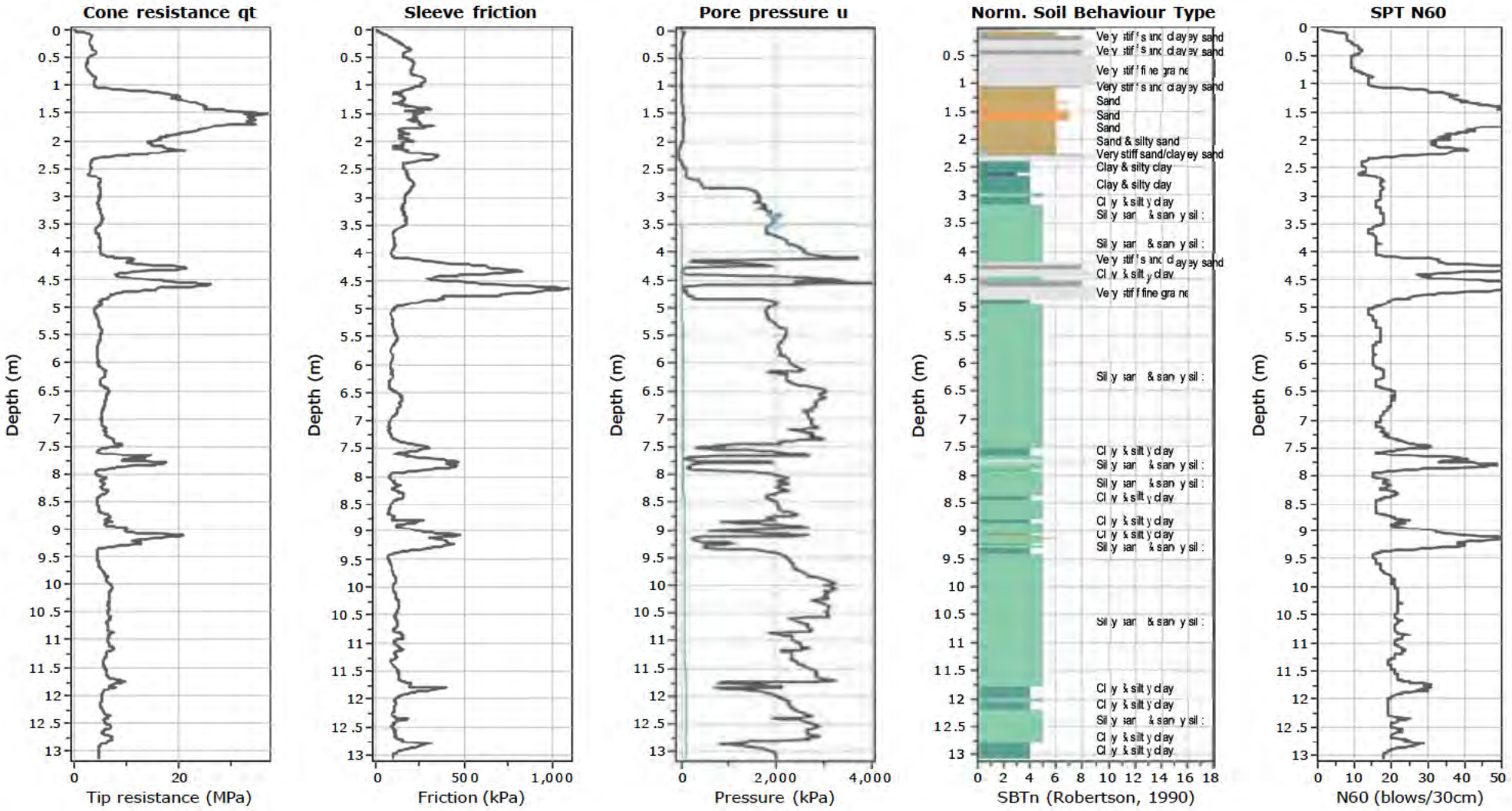
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 07
Total depth: 12.49 m



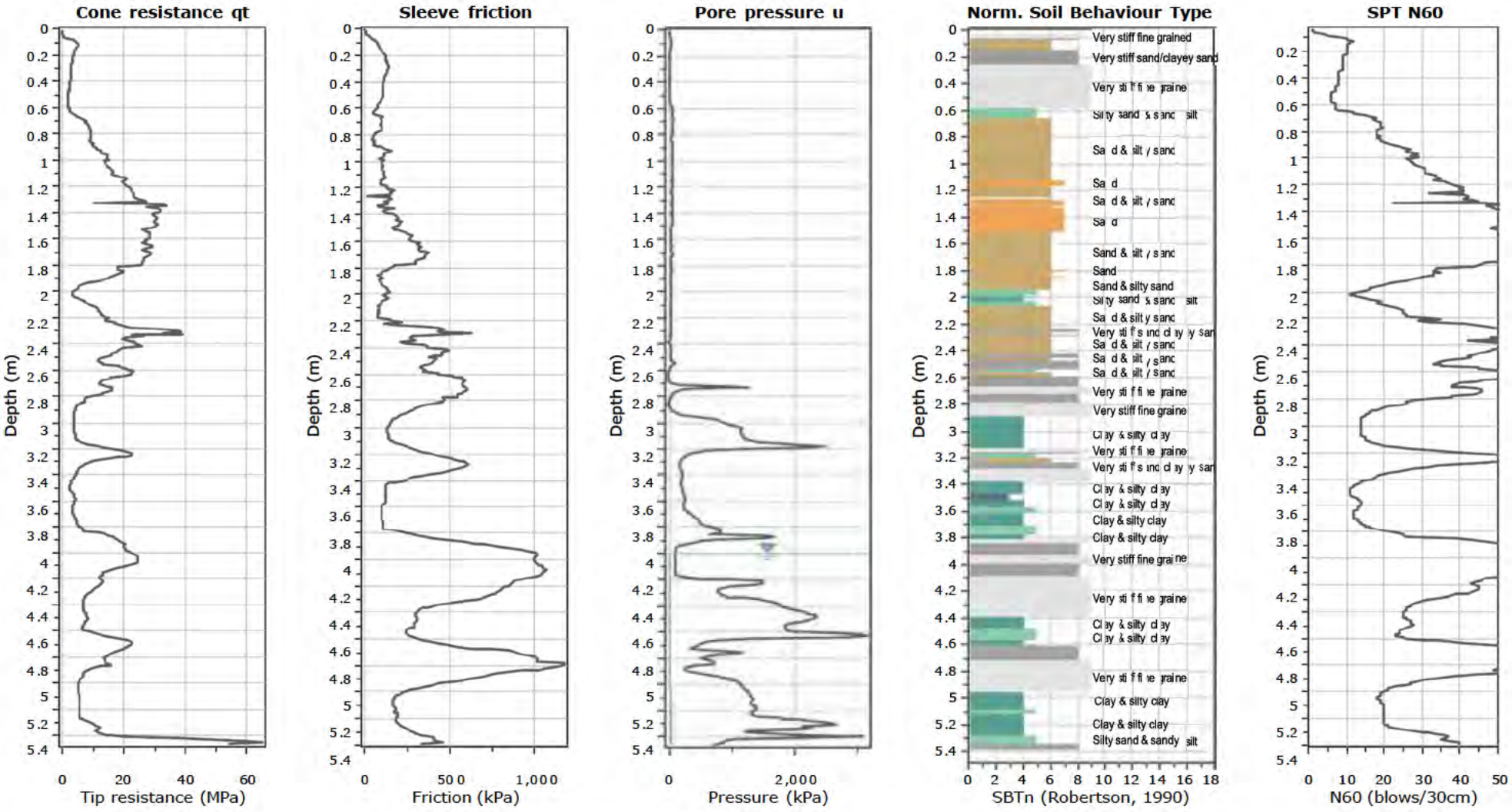
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 08
Total depth: 13.12 m



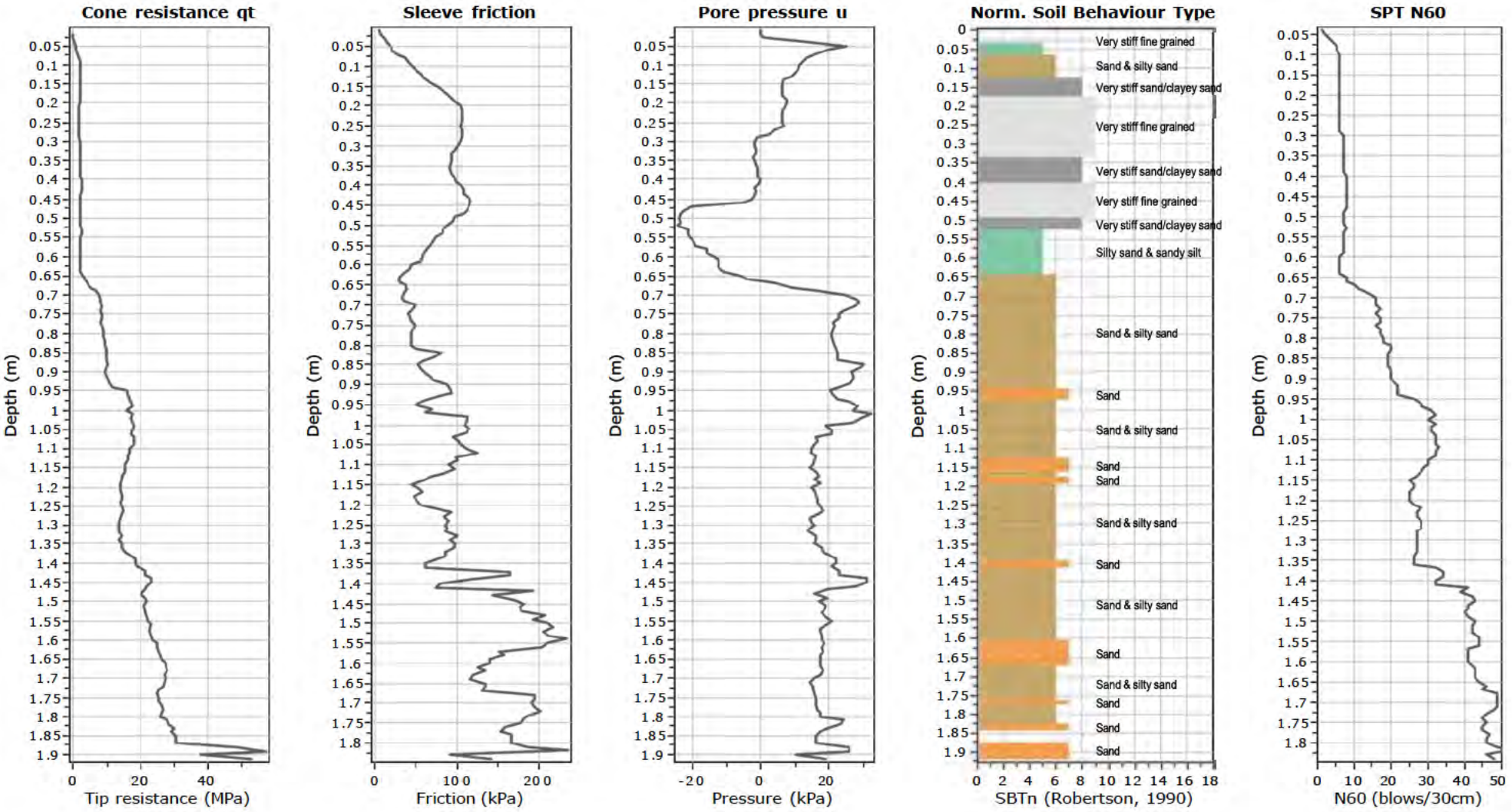
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 09
Total depth: 5.46 m



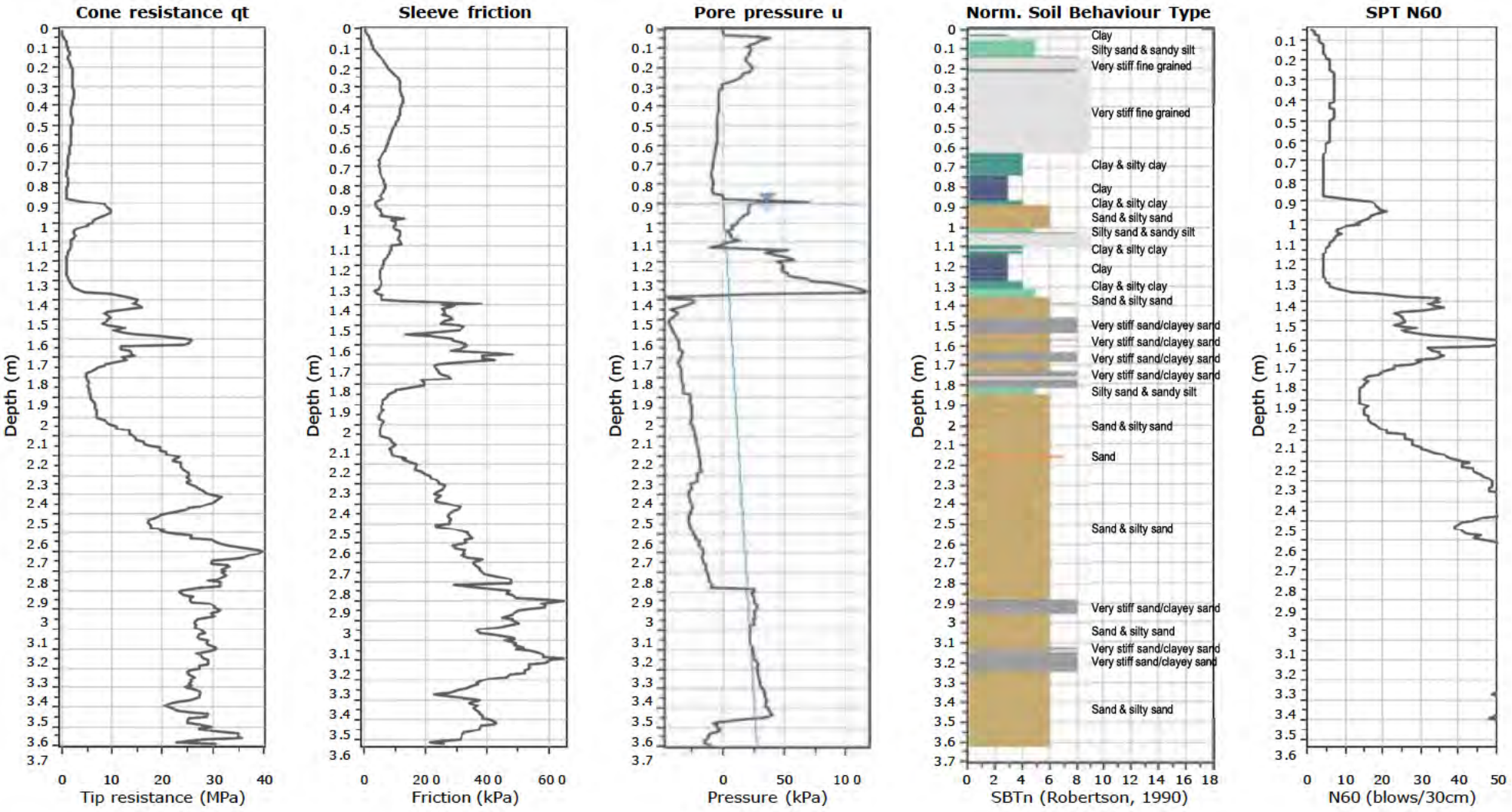
Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 10
Total depth: 1.91 m



Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 11
Total depth: 3.69 m



Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA01**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602895.54mN, 1935033.20mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Material Description	Water	In-situ Testing: Vane undrained shear strength, s_u (kPa)	In-situ Testing: Dynamic cone penetrometer (blows / 50mm)	Shear Vane Values (kPa) Vane ID: 3762 peak / residual (sensitivity)
0	Topsoil	TOPSOIL: Brown organic SILT with some sand and minor clay.				
	Alluvium	Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.				219
0.5						191 / 59 (3.2)
						219
						219
1.0		SILT with some sand and minor to some clay: Light greyish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.				219
						209 / 75 (2.8)
1.5						187 / 66 (2.8)
		SILT with some sand and minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff, moist.				178 / 56 (3.2)
						187 / 59 (3.2)
2.0		SILT with some sand and minor to some clay: Light greyish-brown with trace mottle, very stiff, high plasticity, wet.				137 / 50 (2.7)
						131 / 50 (2.6)
2.5						134 / 41 (3.3)
						125 / 41 (3.0)
						125 / 34 (3.7)
3.0						128 / 34 (3.8)
		Clayey SILT with minor fine sand: Light greyish-brown with trace to minor brownish mottle, very stiff, high plasticity, wet.				141 / 44 (3.2)
						112 / 34 (3.3)
3.5						128 / 31 (4.1)
			Groundwater level encountered during drilling.			
		Silty CLAY with trace sand: Light bluish-grey, very stiff, high plasticity, saturated.				141 / 31 (4.5)
						131 / 34 (3.9)
4.0						125 / 31 (4.0)
		Sandy GRAVEL with minor silt: light brownish grey, dense, saturated.				

Hole Depth: 4.30m

Termination: Refusal in Gravels.

Remarks:

Vane peak
Vane residual
Vane Unable to Penetrate (UTP)
Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA/S02**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602906.52mN, 1935265.69mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water	In-situ Testing: Vane undrained shear strength, s_u (kPa) 50 100 150 200 / Dynamic cone penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: peak / residual (sensitivity)	Depth (m)
0.0	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.				0.0
0.5	Alluvium		Organic SILT with minor sand and clay: blackish-brown, low plasticity, firm, moist to wet.	Groundwater not encountered			-0.5
			0.65m - 0.70m: Charcoal with silt.				
1.0			Sandy GRAVEL with minor silt: brownish grey, dense, wet.		12		-1.0
1.5							-1.5

Hole Depth: 1.00m

Termination: Refusal in Gravels.

Remarks:

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

- ● Vane peak
- ○ Vane residual
- ◆ Vane Unable to Penetrate (UTP)
- ▼ Standing Groundwater Level

Hand Auger Log

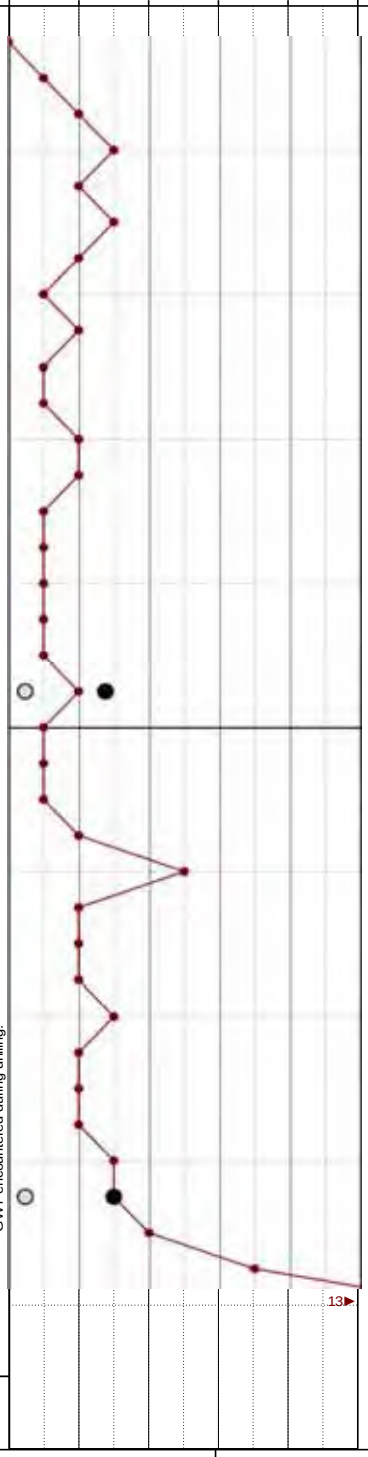
HAWKE'S BAY GEOTECH

Test ID:	**HA/S03**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602841.10mN, 1935353.71mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description
0	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.
	Alluvium		Organic SILT with minor sand and clay: blackish-brown, low plasticity, firm, moist to wet.
0.5			Sandy GRAVEL with minor silt: brownish grey, loose, wet.
			Organic SILT with minor sand and clay: blackish-brown, low plasticity, firm, moist to wet.
			Organic Silty CLAY: blackish-brown, high plasticity, firm, wet.
1.0			Gravelly SAND to Sandy GRAVEL: greyish-brown, medium dense, wet.
1.5			Sandy SILT with trace organics; greyish brown, stiff, low plasticity, wet to saturated.
			Sandy GRAVEL with minor silt: brownish grey, medium dense to dense, saturated.

Water: GWT encountered during drilling.



Shear Vane Values (kPa)
Vane ID: 3762
peak / residual (sensitivity)

69 / 12 (5.8)

75 / 12 (6.3)

Depth (m): 0.5, 1.0, 1.5

Hole Depth:	1.90m	**Termination:**	Refusal in Gravels.

Remarks:

Vane peak
Vane residual
Vane Unable to Penetrate (UTP)
Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA/S04**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602776.83mN, 1935380.10mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water	In-situ Testing: Vane undrained shear strength, s_u (kPa) 50 100 150 200; Dynamic cone penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 3762 peak / residual (sensitivity)	Depth (m)
0.0	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.				0.0
	Alluvium		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.			203 / 56 (3.6)	
0.5			Clayey SILT with minor fine sand: Light greyish-brown with trace to minor brownish mottle, very stiff to hard, high plasticity, moist.			219+	-0.5
			Sandy SILT with trace clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, moist to wet.			219+	
1.0			Sandy GRAVEL with minor silt: light brownish grey, dense, moist to wet.	Groundwater not encountered		219+	-1.0
						UTP	
1.5					11 15		-1.5
2.0							-2.0

Hole Depth: 1.25m

Termination: Refusal in Gravels.

Remarks:

Vane peak
Vane residual
Vane Unable to Penetrate (UTP)
Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

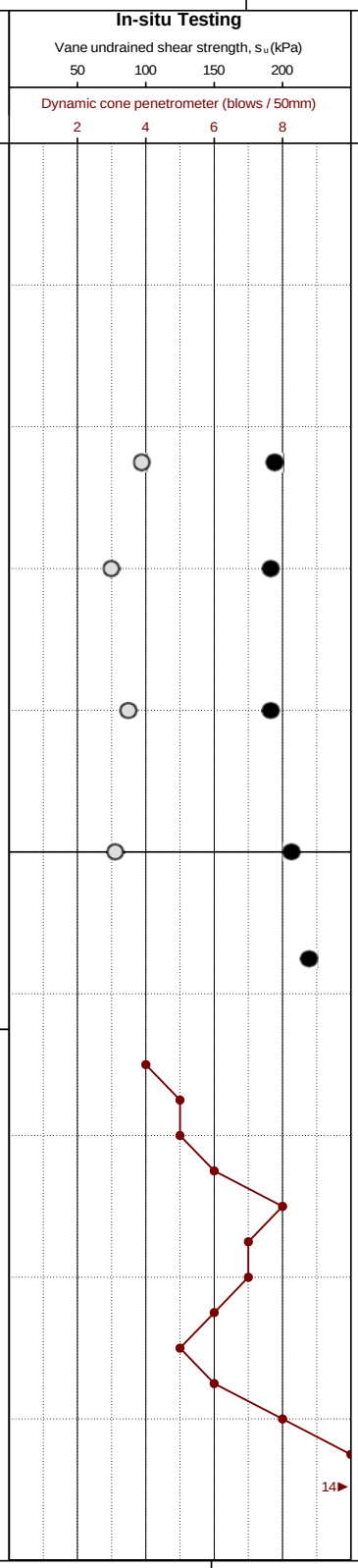
HAWKE'S BAY GEOTECH

Hand Auger Log

Test ID: HA/S05
Project ID: 25030
Sheet: 1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602746.03mN, 1935253.53mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Material Description	Water
0.0	Uncertified Fill	TOPSOIL & Gravel FILL.	
0.5	Alluvium	Clayey SILT with minor fine sand: Light greyish-brown with trace to minor brownish mottle, very stiff, high plasticity, moist to wet.	Groundwater not encountered
1.0		Sandy SILT with trace to minor clay: Light brown with trace orangish-brown mottle, very stiff to hard, low plasticity, moist to wet.	
		Sandy GRAVEL with minor silt: light brownish grey, dense, moist to wet.	
1.5			



Shear Vane Values (kPa)	
Vane ID: 3762	peak / residual (sensitivity)
194 / 97 (2.0)	
191 / 75 (2.5)	
191 / 87 (2.2)	
206 / 78 (2.6)	
219+	

Hole Depth: 1.25m
Termination: Refusal in Gravels.

Remarks:

Vane peak
Vane residual
Vane Unable to Penetrate (UTP)
Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA/S06**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602644.66mN, 1935302.61mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water	In-situ Testing: Vane undrained shear strength, s_u (kPa) 50 100 150 200; Dynamic cone penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 3762 peak / residual (sensitivity)	Depth (m)
	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.				
	Alluvium		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Groundwater not encountered		219+	
			Sandy GRAVEL with minor silt: light brownish grey, dense, moist to wet.				
0.5					11 11 14		-0.5

Hole Depth: 0.40m

Termination: Refusal in Gravels.

Remarks:

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

- Vane peak
- Vane residual
- Vane Unable to Penetrate (UTP)
- Standing Groundwater Level

Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA07**
Project ID:	25030
Sheet:	1 of 1

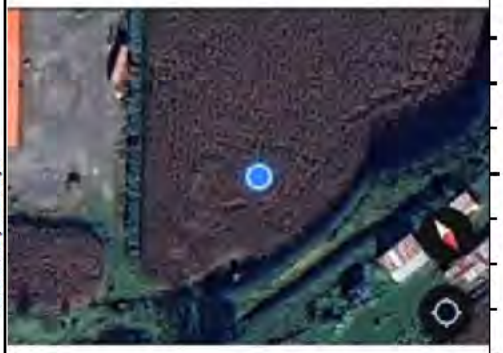
Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602938.08mN, 1935160.97mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water
0.0	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.	
0.5	FILL		FILL - Organic SILT with minor gravel, sand and clay: blackish-brown, low plasticity, firm, moist to wet.	
			0.80m: ...becoming with trace gravel and very weak.	
			Indicative Fill	
1.0				
1.5			1.60m - 2.40m: VERY WEAK - Hand auger advanced under very light weight to 2.4m. Some organics recovered, rootlets and decaying plant matter. Saturated from 1.8 to 2.4m.	
				
2.0				Inflow in very weak layer.
2.5	Alluvium		Organic SILT with minor sand and clay: blackish-brown, low plasticity, firm, moist to wet. Organic odor.	
3.0	Alluvium		Sandy GRAVEL with minor silt: brownish grey, loose, wet.	

Additional Details: This area was infilled in the past and the old channel diverted to a more staight path. Please refer to the images below and the Geotechnical Report for further details.

Test Location (2014 Aerial Imagery)

Test Location (2023 Aerial Imagery)



Indicative Extents (white line is old channel)

Hole Depth:	3.10m
Termination:	Refusal in Gravels.

Remarks: Auger undertaken in an area where in filling of the old stream channel was suspected. Organics and Fill encountered in this area is expected to be very localized..

- ● Vane peak
- ○ Vane residual
- ◆ Vane Unable to Penetrate (UTP)
- ▼ Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

Hand Auger / Face Log 08

HAWKE'S BAY GEOTECH

Test ID:	**HA08**
Project ID:	25030
Sheet:	1 of 2

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602808.45mN, 1934921.75mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water
0.0	Topsoil		TOPSOIL: Brown organic SILT with some sand and minor clay.	Groundwater not encountered
	Alluvium		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	
0.5			Sandy Silty GRAVEL with minor clay: light brownish grey, tightly packed, dry to moist.	
1.0				
1.5				
2.0				
2.5				
3.0				
3.5				
4.0			Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	

Hole Depth: 8.00m

Termination: Refusal in Gravels.

Remarks: Note: Log is based on face observations taken in road cuts and in cut slopes below the road as indicated in the photos. The depths are indicative only given the log is not exactly continuous..

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

- Vane peak
- Vane residual
- Vane Unable to Penetrate (UTP)
- Standing Groundwater Level

HAWKE'S BAY GEOTECH

Hand Auger / Face Log 08 Cont...

Test ID:	**HA08**
Project ID:	25030
Sheet:	2 of 2

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602895.54mN, 1935033.20mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Graphic Log	Material Description	Water
4.5			Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Groundwater not encountered
5.0				
5.5				
6.0	Alluvium		Sandy GRAVEL with some silt and minor clay: light brownish grey, tightly packed, dry to moist. Well cemented.	
6.5				
7.0			Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	
7.5				
8.0				

Hole Depth: 8.00m

Termination: Refusal in Gravels.

Remarks: Note: Log is based on face observations taken in road cuts and in cut slopes below the road as indicated in the photos. The depths are indicative only given the log is not exactly continuous..

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

- ● Vane peak
- ○ Vane residual
- ◆ Vane Unable to Penetrate (UTP)
- ▼ Standing Groundwater Level

Hand Auger Log

HAWKE'S BAY GEOTECH

Test ID:	**HA09**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602905.68mN, 1935403.15mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Test Location:**	Refer to Test Location Plan	**Checked By:**	CJG

Depth (m)	Geology	Material Description	Water	In-situ Testing: Vane undrained shear strength, s_u (kPa) 50 100 150 200 / Dynamic cone penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 3762 peak / residual (sensitivity)
0.0	Topsoil	TOPSOIL: Brown organic SILT with some sand and minor clay.			
0.5	Alluvium	Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.			219+
					219+
					219+
1.0					219+
		Clayey SILT with minor fine sand: Light greyish-brown with trace to minor brownish mottle, very stiff, high plasticity, moist to wet.	Groundwater not encountered		219+
					219+
1.5					187 / 69 (2.7)
2.0					181 / 66 (2.7)
		Silty CLAY with trace sand: Light greyish-brown with trace to minor brownish mottle, very stiff, high plasticity, moist to wet.			184 / 75 (2.5)
2.5					191 / 81 (2.4)
		Andy SILT with trace clay: Light brown with slight orangish-brown mottle, very stiff to hard, low plasticity, wet.			219+
3.0		Sandy GRAVEL with minor silt: light brownish grey, dense, wet.			

Hole Depth: 3.20m **Termination:** Refusal in Gravels.

Remarks:

Vane peak
Vane residual
Vane Unable to Penetrate (UTP)
Standing Groundwater Level

Materials logged and described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID:	**TP09**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602940.24mN, 1935199.22mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground	**Checked By:**	CJG
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map		

Depth (m)	Graphic Log	Material Description	Geology	Water
0		TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil	
0.5		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium	
1.0				
1.5		SILT with minor sand and clay: light brown, very stiff, low plasticity, moist to wet.		
2.0		Clayey SILT with minor fine sand: Light greyish-brown with trace to minor brownish mottle, very stiff, high plasticity, wet.		
2.5				
3.0		GRAVEL with some sand, minor silt and trace clay: bluish grey, dense, saturated.		◁
3.5				
4.0				

In-situ Testing

Shear Vane, Su (kPa): 50 100 150 200

Dynamic Cone Penetrometer (blows / 50mm): 2 4 6 8

Shear Vane Values (kPa)	Depth (m)
Vane ID: 19	
peak / residual (sensitivity)	
191 / 44 (4.3)	
172 / 34 (5.1)	
156 / 50 (3.1)	-1.0
159 / 37 (4.3)	
141 / 34 (4.1)	
144 / 37 (3.9)	-2.0
159 / 37 (4.3)	
	-3.0
	-4.0

Hole Depth: 4.20m

Termination: Safe Excavation Depth

Remarks:

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005)

- ● Vane peak
- ○ Vane residual
- ◆ Vane UTP
- ▼ Standing water level
- ◁ Groundwater inflow
- ▷ Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID:	**TP10**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602729.82mN, 1935386.54mE
Project:	Geotechnical Investigations	**System:**	NZTM
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map

Test Date:	26/05/2025
Logged By:	CJG
Checked By:	CJG

Depth (m)	Graphic Log	Material Description	Geology	Water	In-situ Testing: Shear Vane, Su (kPa) 50 100 150 200 / Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 19 peak / residual (sensitivity)	Depth (m)
0.0		TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil				0.0
0.5		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium			219+ 219+	-0.5
1.0		Sandy GRAVEL with some silt and trace clay; light brownish grey, tightly packed (dense to very dense), moist to wet.					-1.0
1.5							-1.5
2.0							-2.0
2.5							-2.5
3.0							-3.0
3.5							-3.5
4.0		GRAVEL with minor sand, silt and trace clay: light greyish brown, dense, saturated.		◁			-4.0

Hole Depth: 4.00m

Termination: Safe Excavation Depth

Remarks:

Groundwater seepage can be seen at the base of the pit in the Photo.

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005)

- ● Vane peak
- ○ Vane residual
- ◆ Vane UTP
- ▼ Standing water level
- ◁ Groundwater inflow
- ▷ Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID: TP11
Project ID: 25030
Sheet: 1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602668.96mN, 1935455.83mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground	**Checked By:**	CJG
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map		

Depth (m)	Material Description	Geology
0.0	TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil
0.5	Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium
1.0	SILT with minor sand and clay: light greyish brown, very stiff, low plasticity, moist to wet.	
1.5	Sandy GRAVEL with some silt and trace clay; light brownish grey, tightly packed (dense to very dense), moist to wet. Fine to medium with some coarse gravel.	
2.0	GRAVEL with minor sand, silt and trace clay: light greyish brown, dense, moist to wet. Fine to coarse with trace cobbles.	
2.5	2.5m: .. Becoming wet.	
3.0		
3.5		
4.0		

Water: Groundwater Not Encountered

In-situ Testing
Shear Vane, Su (kPa) — 50, 100, 150, 200
Dynamic Cone Penetrometer (blows / 50mm) — 2, 4, 6, 8

Shear Vane Values (kPa)
Vane ID: 19
peak / residual (sensitivity)

206 / 56 (3.7)
219+
219+

Hole Depth: 4.40m

Termination: Safe Excavation Depth

Remarks:

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005).

- Vane peak
- Vane residual
- Vane UTP
- Standing water level
- Groundwater inflow
- Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID:	**TP12**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602506.73mN, 1935424.77mE
Project:	Geotechnical Investigations	**System:**	NZTM
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map
Test Date:	26/05/2025		
Logged By:	CJG		
Checked By:	CJG		

Depth (m)	Material Description	Geology	Water
0.0	TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil	
0.5	Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium	
1.0	Sandy GRAVEL with some silt and trace clay; light brownish grey, tightly packed (dense to very dense), moist to wet. Fine to medium with some coarse gravel.		
1.5	GRAVEL with minor sand, silt and trace clay: light greyish brown, dense, moist to wet. Fine to coarse with trace cobbles.		
2.0			
2.5	2.5m: .. Becoming wet.		
3.0			
3.5			
4.0			
4.5			
5.0			
5.5			
6.0	GRAVEL with minor sand and silt: dark grey, tightly packed, wet to saturated. Fine to coarse with trace cobbles.		

In-situ Testing

Shear Vane, Su (kPa): 50 100 150 200

Dynamic Cone Penetrometer (blows / 50mm): 2 4 6 8

Shear Vane Values (kPa)	Depth (m)
Vane ID: 19	
peak / residual (sensitivity)	
206 / 56 (3.7)	
	-1.0
	-2.0
	-3.0
	-4.0
	-5.0
	-6.0

Hole Depth: 6.00m

Termination: Safe Excavation Depth

Remarks:

Maximum excavator reach.

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005)

- Vane peak
- Vane residual
- Vane UTP
- Standing water level
- Groundwater inflow
- Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID: TP13
Project ID: 25030
Sheet: 1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602399.29mN, 1935360.58mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground	**Checked By:**	CJG
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map		

Depth (m)	Material Description	Geology	Water	In-situ Testing: Shear Vane, Su (kPa) 50 100 150 200 / Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 19 peak / residual (sensitivity)	Depth (m)
0.0	TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil				0.0
0.5	Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium			206 / 56 (3.7)	-0.5
	Sandy GRAVEL with some silt and trace clay; light brownish grey, tightly packed (dense to very dense), moist to wet. Fine to medium with some coarse gravel.					
1.0	GRAVEL with minor sand, silt and trace clay: light greyish brown, dense, moist to wet. Fine to coarse with trace cobbles.					-1.0
1.5						-1.5
2.0						-2.0
2.5	2.5m: .. Becoming wet.		Groundwater Not Encountered			-2.5
3.0						-3.0
3.5						-3.5
4.0						-4.0

Hole Depth: 4.40m

Termination: Safe Excavation Depth

Remarks:

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005) .

- Vane peak
- Vane residual
- Vane UTP
- Standing water level
- Groundwater inflow
- Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID:	**TP14**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602592.59mN, 1935246.79mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground	**Checked By:**	CJG
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map		

Depth (m)	Graphic Log	Material Description	Geology	Water	In-situ Testing: Shear Vane, Su (kPa) 50 100 150 200 / Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: 19 peak / residual (sensitivity)	Depth (m)
0		TOPSOIL: Brown organic SILT with some sand and minor clay.	Topsoil				0
0.5		Sandy SILT with trace to minor clay: Light yellowish-brown with slight orangish-brown mottle, very stiff to hard, low plasticity, moist.	Alluvium			191 / 56 (3.4)	-0.5
1.0		Sandy GRAVEL with some silt and trace clay; brownish grey, tightly packed (dense to very dense), moist to wet. Fine to medium with some coarse gravel.					-1.0
1.5		GRAVEL with minor sand, silt and trace clay: bluish grey, dense, wet (Saturated at 2.0m).					-1.5
2.0				◁			-2.0
2.5							-2.5
3.0							-3.0
3.5							-3.5
4.0							-4.0
4.5		Silty CLAY with trace fien sand: grey, very stiff to hard, high plasticity, saturated.				206 / 56 (3.7) 219+	-4.5
5.0							-5.0

Hole Depth: 5.20m

Termination: Safe Excavation Depth

Remarks:

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005)

- ● Vane peak
- ○ Vane residual
- ◆ Vane UTP
- ▼ Standing water level
- ◁ Groundwater inflow
- ▷ Groundwater outflow

UTP = Unable to Penetrate

Test Pit Log

HAWKE'S BAY GEOTECH

Test ID:	**TP15**
Project ID:	25030
Sheet:	1 of 1

Client:	Ed Sundstrum C/o Vermont Street Partners No. 4 L	**Coordinates:**	5602941.62mN, 1934881.08mE	**Test Date:**	26/05/2025
Project:	Geotechnical Investigations	**System:**	NZTM	**Logged By:**	CJG
Location:	174 & 176 Brookvale Road, Havelock North	**Elevation:**	Ground	**Checked By:**	CJG
Test Site:	Refer to Test Location Plan	**Located By:**	Site Map		

Depth (m)	Graphic Log	Material Description	Geology	Water	In-situ Testing: Shear Vane, Su (kPa) 50 100 150 200 / Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8	Shear Vane Values (kPa) Vane ID: N/A peak / residual (sensitivity)	Depth (m)
0.0		FILL: Varying colours and composition. Significant organic soils and wood debris encountered. Some bluish grey soils with organic odour also encountered. Fill is with some to minor gravel but becomes gravelly below ~1.0m in the location investigated. The natural soils are considered to be indicated by the brownish Gravel unit at the base of the pit which was similar to natural units encountered across the site.	Uncertified Fill				0.0
3.5		Sandy GRAVEL with some silt and trace clay; light brown, tightly packed (dense to very dense), moist.	Alluvium				-3.5

Hole Depth: 3.80m

Termination: Safe Excavation Depth

Remarks:

14 Ton Excavator used. Soils were piled separately and replaced in their natural order with bucket compaction and track rolling at surface.

Materials described in general accordance with NZGS Field Description of Soil and Rock (2005)

- Vane peak
- Vane residual
- Vane UTP
- Standing water level
- Groundwater inflow
- Groundwater outflow

UTP = Unable to Penetrate

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 258

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	27/11/1972
NZTM Easting	1935043.142	**Driller**	Boag & Hill Ltd
NZTM Northing	5602759.745	**Casing Diameter (mm)**	100
Method		**Bore Depth (m)**	
Address	BROOKVALE RD	**Well Depth (m)**	23.4599990844727
		Screen top (m)	23.4599990844727
		Screen bottom (m)	0
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-1.82
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	Confined
Comments	Permit number is 258 Metric Grid Reference : V21:7.4 199990 Driller is BOAG Owner is TE NGAWA FARM Well location is BROOKVALE RD Legal description is LOT 1 DP 16311 BLK 1V TE MATA SD Depth of casing is 23.46m

Aquifer Test

Test Date	27-11-1972
Report Number	
Maximum Pumping Rate (l/s)	1.55
Maximum DrawDown (m)	
Duration (hours)	

Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	3.35	CLAY
3.35	14.02	GRAVEL with clay
14.02	20.11	GRAVEL
20.11	23.46	SILTSTONE

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 826

IDENTIFICATION		WELL INFORMATION	
WQ Site	2376	**Drill Date**	01/03/1979
NZTM Easting	1935120.247	**Driller**	Boag & Hill Ltd
NZTM Northing	5602639.651	**Casing Diameter (mm)**	100
Method		**Bore Depth (m)**	
Address	ARATAKI RD HAVELOCK NTH	**Well Depth (m)**	26.3999996185303
		Screen top (m)	26.3999996185303
		Screen bottom (m)	0
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-4
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	Confined
Comments	Permit number is 826 Metric Grid Reference : V21:8.4 201984 Driller is BOAG & HILL Owner is HUNTER D M Well location is ARATAKI RD HAVELOCK NTH General remarks : Screen type is 2m PERFORATED Legal description is LOT 1 DP 13265 BLK 1V TE MATA SD D

Aquifer Test

Test Date	01-03-1979
Report Number	

Maximum Pumping Rate (l/s)	3.6
Maximum DrawDown (m)	
Duration (hours)	
Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	2.1	TOPSOIL
2.1	6.9	blue/brown GRAVEL
6.9	8.4	yellow CLAY (very cemented)
8.4	12	(soft)
12	24	brown GRAVEL
24	26.4	fine brown GRAVEL (very fine)

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 1129

IDENTIFICATION		WELL INFORMATION	
WQ Site	1908	**Drill Date**	09/07/1981
NZTM Easting	1935129.206	**Driller**	Hill Well Drillers Ltd
NZTM Northing	5602830.837	**Casing Diameter (mm)**	200
Method	Differential GPS	**Bore Depth (m)**	
Address	BROOKVALE RD HAVELOCK NTH (L/C)	**Well Depth (m)**	18.1000003814697
		Screen top (m)	15.1999998092651
		Screen bottom (m)	21.2000007629395
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	0
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	Confined
Comments	Screen type is 6m STAINLESS STEEL 2.5mm SLOT Legal description is LOT 2 DP 16311 BLK 1V TE MATA SD & BLK Measuring point: top of casing Previous owner - Davidson, H J & others Not sampled on site visit June 2003. Unable to locate sampling point.

Aquifer Test

Test Date	09-07-1981
Report Number	
Maximum Pumping Rate (l/s)	15.5
Maximum DrawDown (m)	5
Duration (hours)	1

Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	3.1

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	1	TOPSOIL
1	3	brown CLAY (soft)
3	13.5	blue/brown GRAVEL
13.5	14.5	yellow CLAY with gravel
14.5	15.2	yellow CLAY
15.2	20.3	blue/brown GRAVEL
20.3	22.92	blue CLAY (mud)

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 1280

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	18/09/1982
NZTM Easting	1935181.227	**Driller**	Hill Well Drillers Ltd
NZTM Northing	5602945.961	**Casing Diameter (mm)**	200
Method	Hand-held GPS	**Bore Depth (m)**	
Address	BROOKVALE RD HAVELOCK NTH (L/C)	**Well Depth (m)**	25
		Screen top (m)	16.7999992370605
		Screen bottom (m)	22.7999992370605
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-1.3
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	Confined
Comments	Permit number is 1280 Metric Grid Reference : V21:7.4 197991 Driller is HILL Owner is THOMPSON T N Well location is BROOKVALE RD HAVELOCK NTH Screen type is 6m STAINELSS STEEL Legal description is LOT 1 DP 16311 BLK 1V TE MATA SD Depth of casing i

Aquifer Test

Test Date	18-09-1982
Report Number	
Maximum Pumping Rate (l/s)	

Maximum DrawDown (m)	
Duration (hours)	
Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	1	brown SILT
1	13	blue/brown GRAVEL
13	13.1	brown CLAY
13.1	16.5	blue/brown GRAVEL
16.5	17.8	GRAVEL (very cemented)
17.8	22.8	blue/brown GRAVEL
22.8	25	blue CLAY

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 1910

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	12/06/1985
NZTM Easting	1935275.539	**Driller**	Hill Well Drillers Ltd
NZTM Northing	5602085.161	**Casing Diameter (mm)**	150
Method	Differential GPS	**Bore Depth (m)**	
Address	ALBANY LANE OFF ARATAKI RD HAVELOCK NORT	**Well Depth (m)**	55.2999992370605
		Screen top (m)	55.2999992370605
		Screen bottom (m)	61.1599998474121
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-29
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	
Comments	Permit number is 850190 Driller was Hill Welldrillers Legal description:Lot2, DP 4464, Blk IV Te mata S.D. Blk I Kidnappers S.D. Screen type:PVC 125mm Length: 5.86m Location:Albany lane off arataki road Havelock North API Steel 56m Owner is Errig

Aquifer Test

Test Date	02-04-1987
Report Number	138
Maximum Pumping Rate (l/s)	10.66

Maximum DrawDown (m)	5.77
Duration (hours)	12
Number Of Pumping Steps	627
Aquifer Thickness (m)	
Transmissivity (m^2/d)	950
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	1.85

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	0.5	TOPSOIL with sand
0.5	1.5	SILT (cemented, pan)
1.5	3	SILT (cemented, pan)
3	3.75	red/yellow SAND
3.75	12.8	brown/red GRAVEL with clay (tight bands)
12.8	14.8	white CLAY
14.8	16	blue CLAY (sticky)
16	28	blue CLAY (dense)
28	32.8	brown/red GRAVEL (stained)
32.8	33.1	brown CLAY with sand
33.1	34.2	brown/red GRAVEL (tight)
34.2	48.5	blue CLAY (sticky, firm)
48.5	53.5	brown GRAVEL (loose)
53.5	53.8	brown GRAVEL with clay (tight)

53.8	55.3	brown GRAVEL (loose)
55.3	56	brown CLAY
56	56.1	blue CLAY
56.1	93	blue CLAY

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 4337

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	08/04/1999
NZTM Easting	1934900.909	**Driller**	Honnor Drilling Limited
NZTM Northing	5603126.057	**Casing Diameter (mm)**	100
Method		**Bore Depth (m)**	
Address	BROOKVALE & NAPIER ROAD	**Well Depth (m)**	44
		Screen top (m)	
		Screen bottom (m)	
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-2.38
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	
Comments	There is some doubt about the association of the lithological log and the other details, Consent dated 19/8 1999 refers to 150mm hole, drillers record refers to 100 mm hole and a drill date of 8/4/1999.

Aquifer Test

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	2.8	SILT with clay
2.8	8.5	GRAVEL (good water yield)
8.5	9.8	brown GRAVEL with clay
9.8	12	brown GRAVEL with clay (tight)

12	12.6	brown CLAY
12.6	14.7	blue CLAY
14.7	14.9	(wood)
14.9	15.4	blue SILT
15.4	16.3	blue CLAY
16.3	17.1	coarse blue GRAVEL
17.1	18.2	blue/brown GRAVEL
18.2	21.5	brown GRAVEL with clay/sand
21.5	22.5	GRAVEL with clay (claybound)
22.5	31	medium GRAVEL with clay/sand (water yielding)
31	36	medium GRAVEL with sand
36	38.5	GRAVEL (looser, water yielding)
38.5	40.2	GRAVEL with clay (tight claybound)
40.2	44	GRAVEL (looser, water yielding)

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 4338

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	23/03/1999
NZTM Easting	1934897.906	**Driller**	Honnor Drilling Limited
NZTM Northing	5603129.059	**Casing Diameter (mm)**	400
Method		**Bore Depth (m)**	
Address	BROOKVALE & NAPIER ROADS, HAVELOCK NORTH	**Well Depth (m)**	36
		Screen top (m)	
		Screen bottom (m)	
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-2.38
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	
Comments	There is somef doubt about the association of the lithological log with the other details of the well. The drill date is prior to the consent date.

Aquifer Test

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	2.8	brown TOPSOIL with silt
2.8	3.1	brown CLAY with gravel
3.1	3.8	brown GRAVEL
3.8	7	brown GRAVEL (water yielding)

7	9.5	brown CLAY
9.5	10.8	blue CLAY
10.8	11.1	blue/brown GRAVEL
11.1	11.5	blue CLAY with gravel
11.5	12.8	blue CLAY
12.8	13.3	PEAT/VEG/WOOD (wood)
13.3	14.8	blue CLAY
14.8	15.2	coarse blue GRAVEL
15.2	17.8	blue CLAY
17.8	18.1	blue GRAVEL
18.1	22	brown/red GRAVEL with clay
22	36	red GRAVEL with clay (tight claybound)

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 10497

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	24/10/1958
NZTM Easting	1935398.476	**Driller**	Boag & Hill Ltd
NZTM Northing	5602793.874	**Casing Diameter (mm)**	100
Method	Hand-held GPS	**Bore Depth (m)**	
Address	ARATAKI	**Well Depth (m)**	30.7999992370605
		Screen top (m)	29
		Screen bottom (m)	30.7999992370605
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-4.6
Initial Water Level Date	
Aquifer Lithology	
Aquifer Condition	Flowing confined
Comments	Bore Sealed by Honnor's 23/11/201. Permit number is 10497 Metric Grid Reference : V21:452645 Driller is V F BOAG Owner is GEORGE WHEELER Well location is ARATAKI Pump capacity is 909.7 Screen type is PERF PIPE Water level is -4.6M/581024

Aquifer Test

Test Date	24-10-1958
Report Number	
Maximum Pumping Rate (l/s)	15.45

Maximum DrawDown (m)	
Duration (hours)	
Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	
Specific Capacity ((l/s)/m)	

Bore Log

From Depth (m)	To Depth (m)	Lithology
0	4.3	red GRAVEL
4.3	7.3	brown CLAY
7.3	8.5	SILT with sand
8.5	9.8	GRAVEL with sand
9.8	12.8	blue CLAY (mud)
12.8	19.5	SAND with gravel
19.5	23.8	blue CLAY (mud)
23.8	24.4	GRAVEL
24.4	25.9	LIMESTONE with sand
25.9	26.8	brown CLAY
26.8	30.8	brown GRAVEL

HAWKES BAY REGIONAL COUNCIL
TE KAUNIHERA Ā-ROHE O TE MATAU-A-MĀUI

Well Number: 16691

IDENTIFICATION		WELL INFORMATION	
WQ Site		**Drill Date**	14/11/2017
NZTM Easting	1935396.474	**Driller**	Honnor Drilling Limited
NZTM Northing	5602793.874	**Casing Diameter (mm)**	100
Method	Hand-held GPS	**Bore Depth (m)**	16
Address	174 Brookvale Road, Havelock North	**Well Depth (m)**	13.3999996185303
		Screen top (m)	11.5
		Screen bottom (m)	13.3999996185303
		Open hole top (m)	
		Open hole bottom (m)	
		Water access	Unknown

Aquifer Information

Initial Water Level	-5
Initial Water Level Date	14-11-2017
Aquifer Lithology	
Aquifer Condition	
Comments	Very hard gravel, could not advance casing beyond 13.4 m

Aquifer Test

Test Date	14-11-2017
Report Number	
Maximum Pumping Rate (l/s)	5
Maximum DrawDown (m)	5.68
Duration (hours)	0.5
Number Of Pumping Steps	
Aquifer Thickness (m)	
Transmissivity (m^2/d)	
Storativity	
Hydralic Conductivity (m/d)	

Specific Capacity ((l/s)/m)	0.88

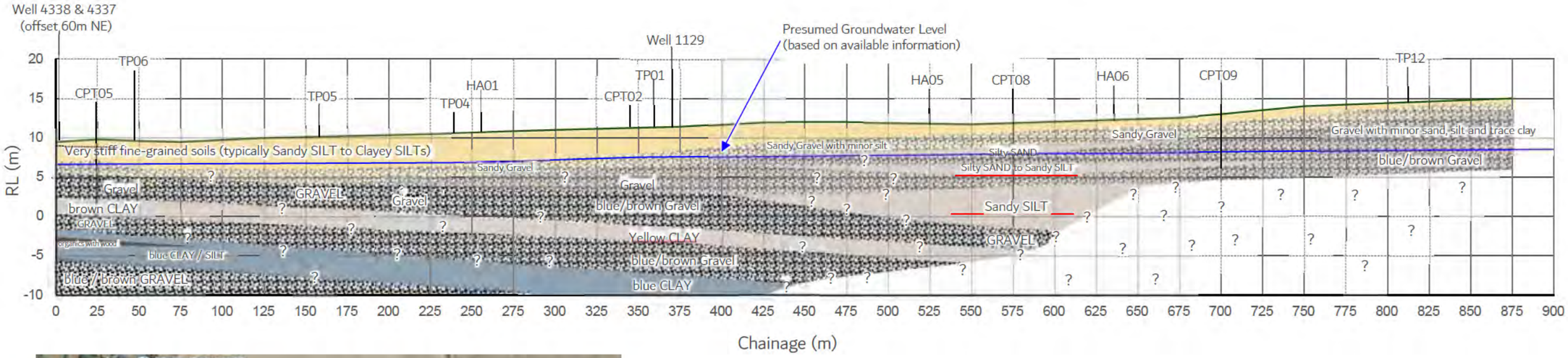
Bore Log

From Depth (m)	To Depth (m)	Lithology
0	0.5	TOPSOIL
0.5	8.6	brown CLAY
8.6	9.5	brown GRAVEL
9.5	10.8	blue CLAY
10.8	11	brown GRAVEL
11	12.8	blue GRAVEL with clay (clay bound gravel)
12.8	13.5	brown GRAVEL with clay (clay bound gravel)
13.5	16	brown GRAVEL

Appendix C

Preliminary Ground Models

PRELIMINARY GROUND MODEL - CROSS SECTION 01 (Note 5 x Vertical Exaggeration)



Notes:

- Ground profile is indicative only and RL's are based on NZVD 2016. 5 x Vertical exaggeration has been applied.

- Soil stratigraphy is based on investigations by HB Geotech and other parties including Well Logs in the area, particularly for the deeper soils.

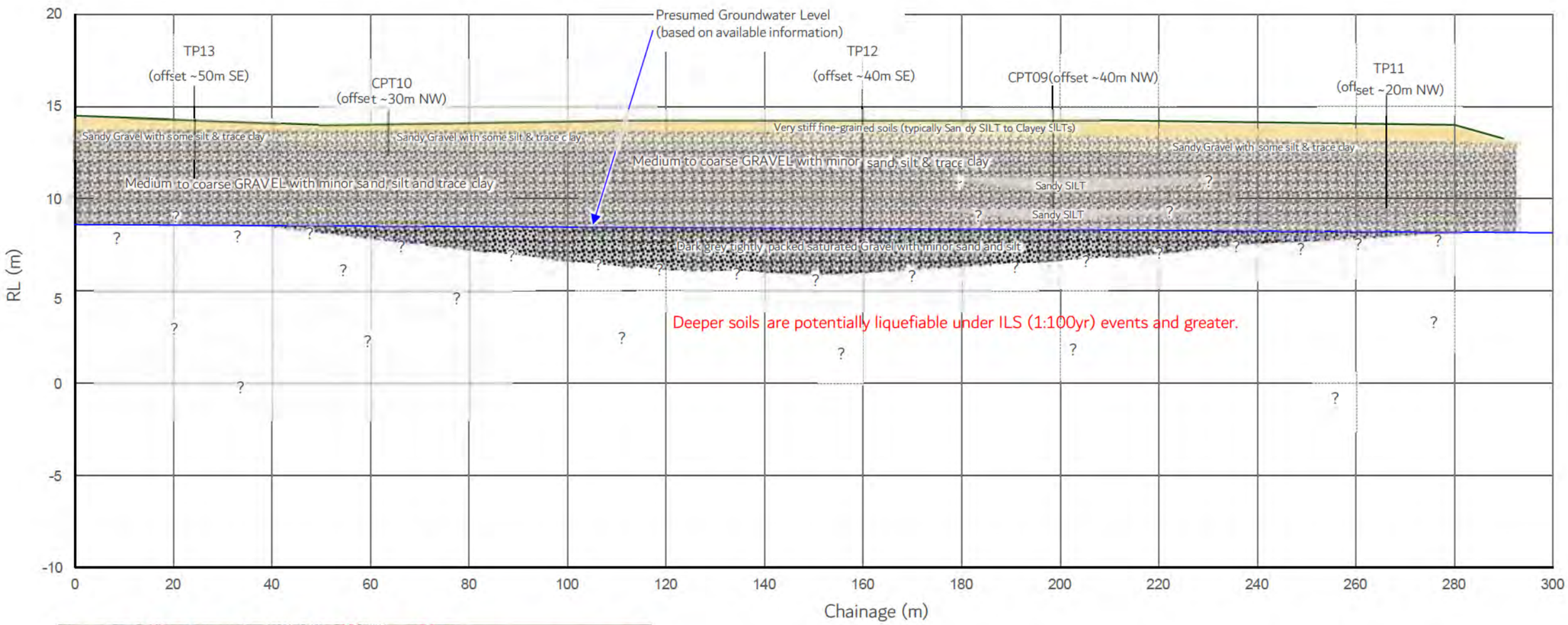
- Well Logs are considered suitable for differentiating between gravels, sands and fine-grained soils but typically not for differentiating between clays & silts.

- Ground conditions between investigations points have been inferred and therefore natural ground conditions may vary from those assumed.

- Red underlined units are potentially liquefiable under ILS (1:100yr) events and greater.

HAWKE'S BAY GEOTECH	Project:	174 & 176 Brookvale Road, Havelock North - Plan Change Assessment		
	Project ID:	25030	Drawing Ref:	25030 – Section 1
	Drawn By:	CJG	Drawing Date:	4/06/2025
	Scale:	As shown	Issued For:	Information

PRELIMINARY GROUND MODEL - CROSS SECTION 02 (Note 4 x Vertical Exaggeration)



Notes:

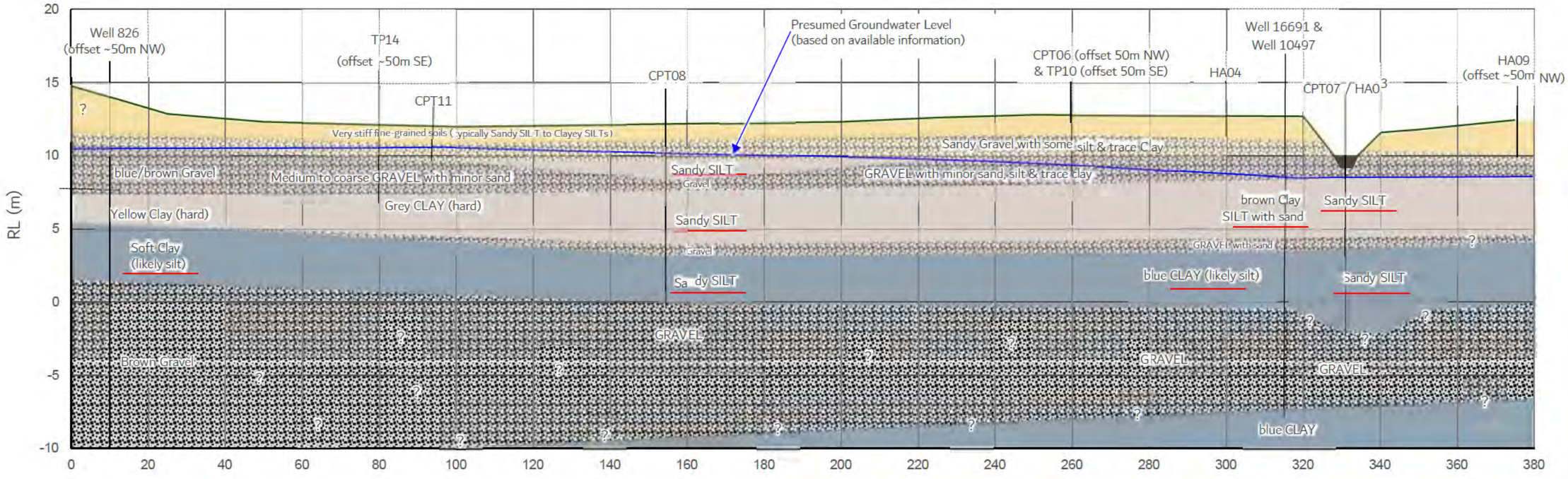
- Ground profile and test locations are indicative only and RL's are based on NZVD 2016. 4 x Vertical exaggeration has been applied.

- Soil stratigraphy is based on investigations by HB Geotech and other parties including Well Logs in the area, particularly for the deeper soils.

- Ground conditions between investigations points have been inferred and therefore natural ground conditions may vary from those assumed.

HAWKE'S BAY GEOTECH	Project:	174 & 176 Brookvale Road, Havelock North - Plan Change Assessment		
	Project ID:	25030	Drawing Ref:	25030 – Section 2
	Drawn By:	CJG	Drawing Date:	4/06/2025
	Scale:	As shown	Issued For:	Information

PRELIMINARY GROUND MODEL - CROSS SECTION 03 (Note 4 x Vertical Exaggeration)



Notes:

- Ground profile is indicative only and RL's are based on NZVD 2016. 5 x Vertical exaggeration has been applied.

- Soil stratigraphy is based on investigations by HB Geotech and other parties including Well Logs in the area, particularly for the deeper soils.

- Well Logs are considered suitable for differentiating between gravels, sands and fine-grained soils but typically not for differentiating between clays & silts.

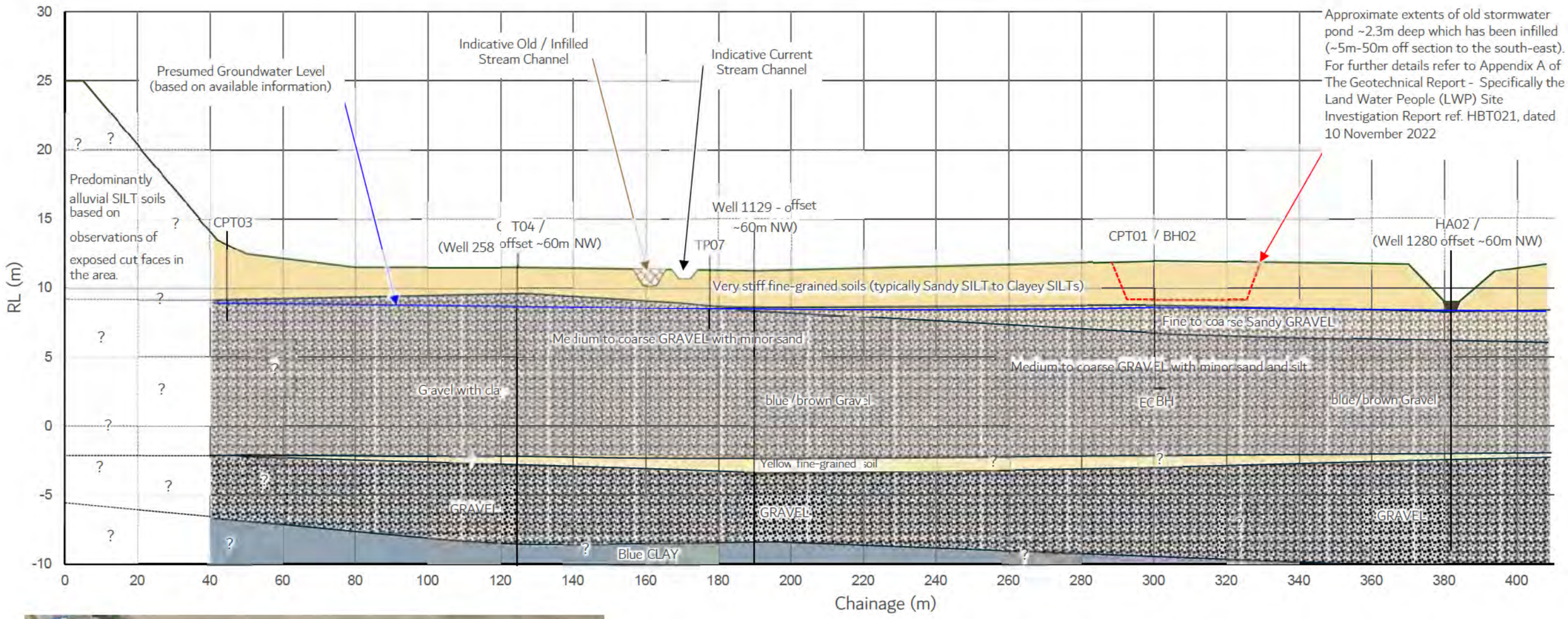
- Ground conditions between investigations points have been inferred and therefore natural ground conditions may vary from those assumed.

- Red underlined units are potentially liquefiable under ILS (1:100yr) events and greater.

HAWKE'S BAY GEOTECH

Project:	174 & 176 Brookvale Road, Havelock North - Plan Change Assessment		
Project ID:	25030	Drawing Ref:	25030 – Section 3
Drawn By:	CJG	Drawing Date:	4/06/2025
Scale:	As shown	Issued For:	Information

PRELIMINARY GROUND MODEL - CROSS SECTION 04 (Note 4 x Vertical Exaggeration)



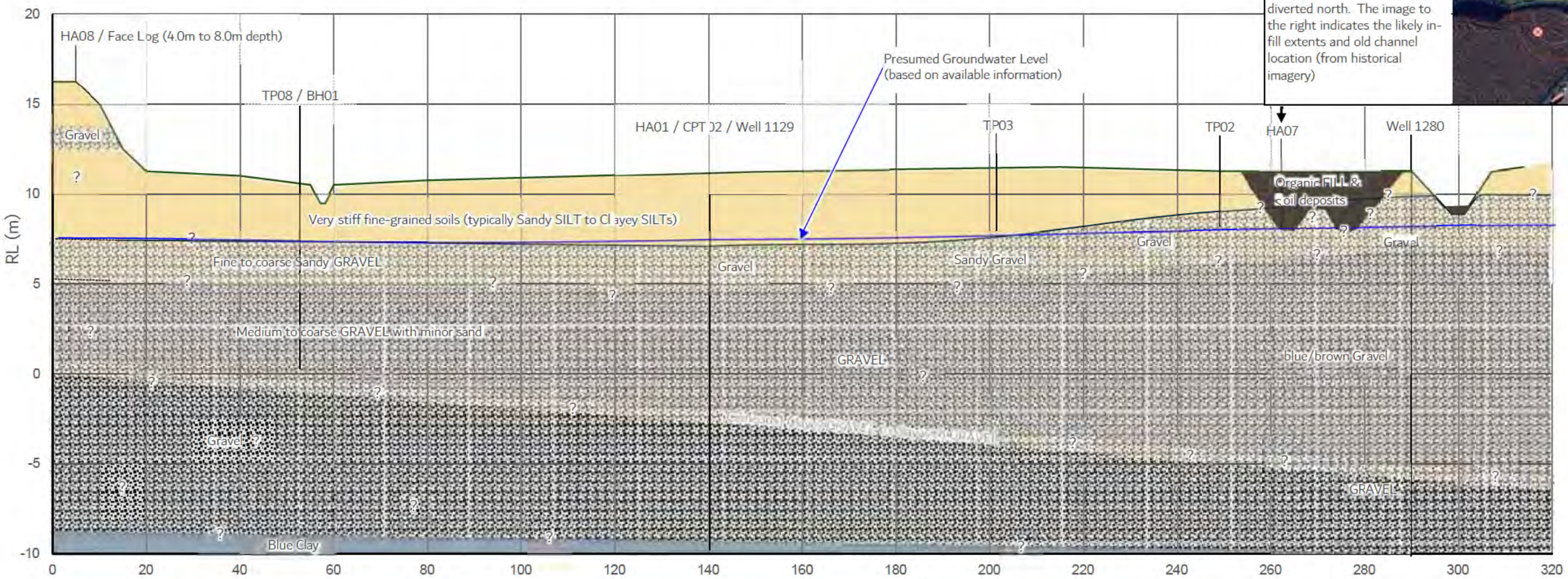
Notes:

- *Ground profile is indicative only and RL's are based on NZVD 2016. 4 x Vertical exaggeration has been applied.*
- *Soil stratigraphy is based on investigations by HB Geotech and other parties including Well Logs in the area, particularly for the deeper soils.*
- *Well Logs are considered suitable for differentiating between gravels, sands and fine-grained soils but typically not for differentiating between clays & silts.*
- *Ground conditions between investigations points have been inferred and therefore natural ground conditions may vary from those assumed.*

HAWKE'S BAY GEOTECH

Project:	174 & 176 Brookvale Road, Havelock North - Plan Change Assessment		
Project ID:	25030	Drawing Ref:	25030 – Section 4
Drawn By:	CJG	Drawing Date:	4/06/2025
Scale:	As shown	Issued For:	Information

PRELIMINARY GROUND MODEL - CROSS SECTION 05 (Note 4 x Vertical Exaggeration)



HA07 was undertaken in the location of an old infilled stream channel which has been diverted north. The image to the right indicates the likely in-fill extents and old channel location (from historical imagery)

Notes:

- *Ground profile is indicative only and RL's are based on NZVD 2016. 4 x Vertical exaggeration has been applied.*
- *Soil stratigraphy is based on investigations by HB Geotech and other parties including Well Logs in the area, particularly for the deeper soils.*
- *Well Logs are considered suitable for differentiating between gravels, sands and fine-grained soils but typically not for differentiating between clays & silts.*
- *Ground conditions between investigations points have been inferred and therefore natural ground conditions may vary from those assumed.*

HAWKE'S BAY GEOTECH

Project:	174 & 176 Brookvale Road, Havelock North - Plan Change Assessment		
Project ID:	25030	Drawing Ref:	25030 – Section 4
Drawn By:	CJG	Drawing Date:	5/06/2025
Scale:	As shown	Issued For:	Information

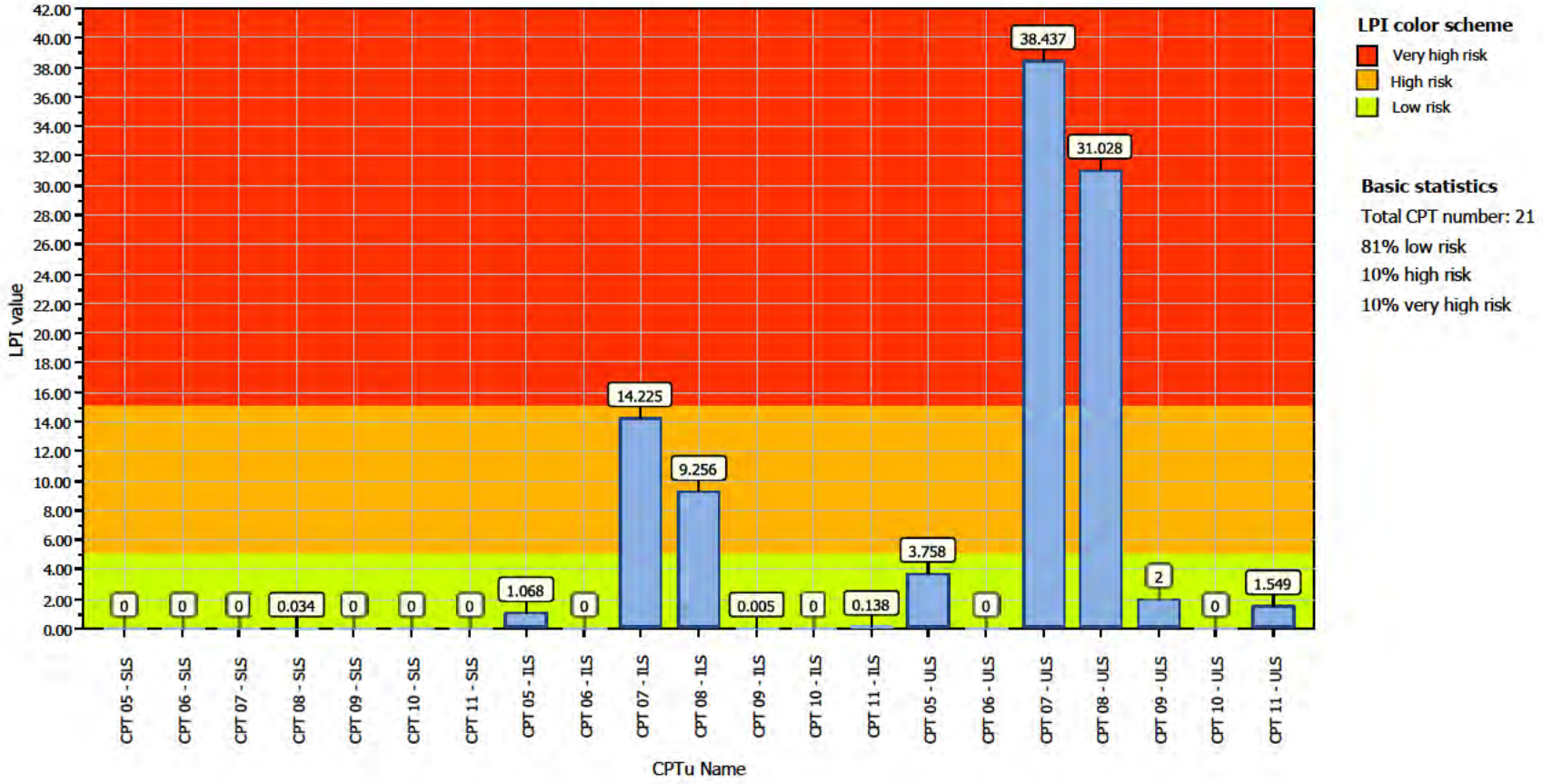
Appendix D

Preliminary Liquefaction Analysis Outputs

Project title : Preliminary Liquefaction Assessment

Location : 174 & 176 Brookvale Road, Havelock North

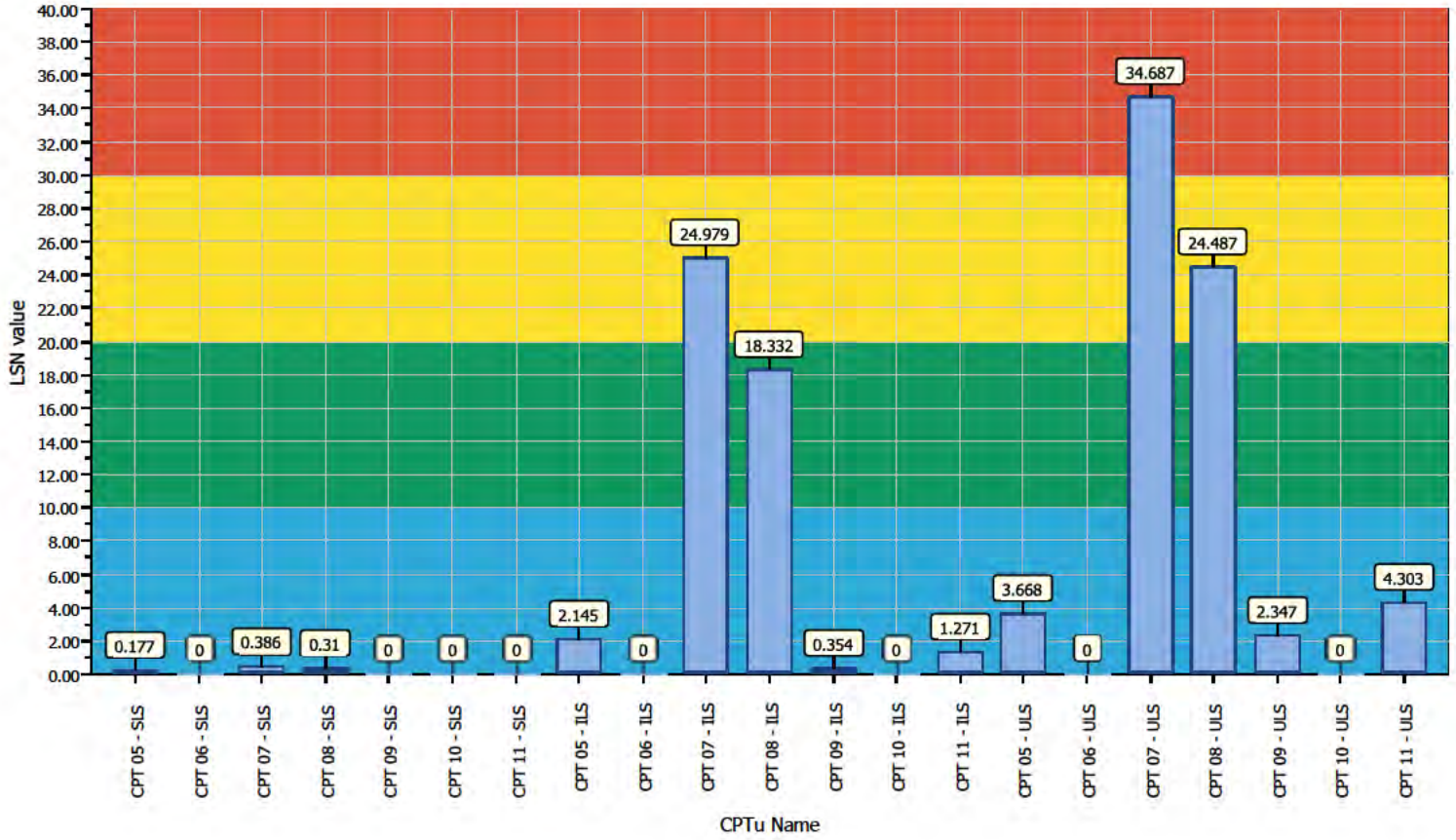
Overall Liquefaction Potential Index report



Project title : Preliminary Liquefaction Assessment

Location : 174 & 176 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: 21

81% little liquefaction

5% minor liquefaction

10% moderate liquefaction

5% moderate to major liquefaction

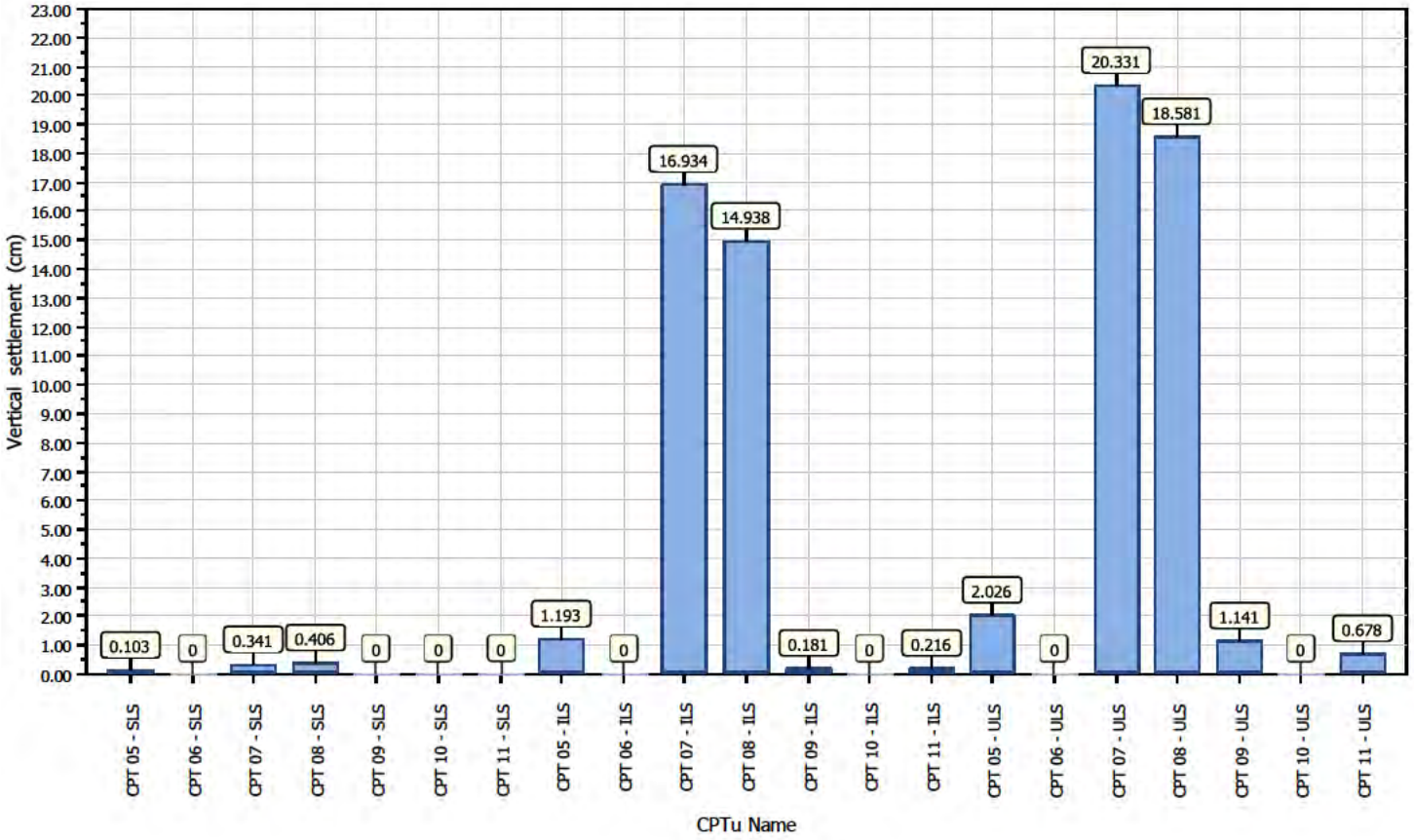
0% major liquefaction

0% severe liquefaction

Project title : Preliminary Liquefaction Assessment

Location : 174 & 176 Brookvale Road, Havelock North

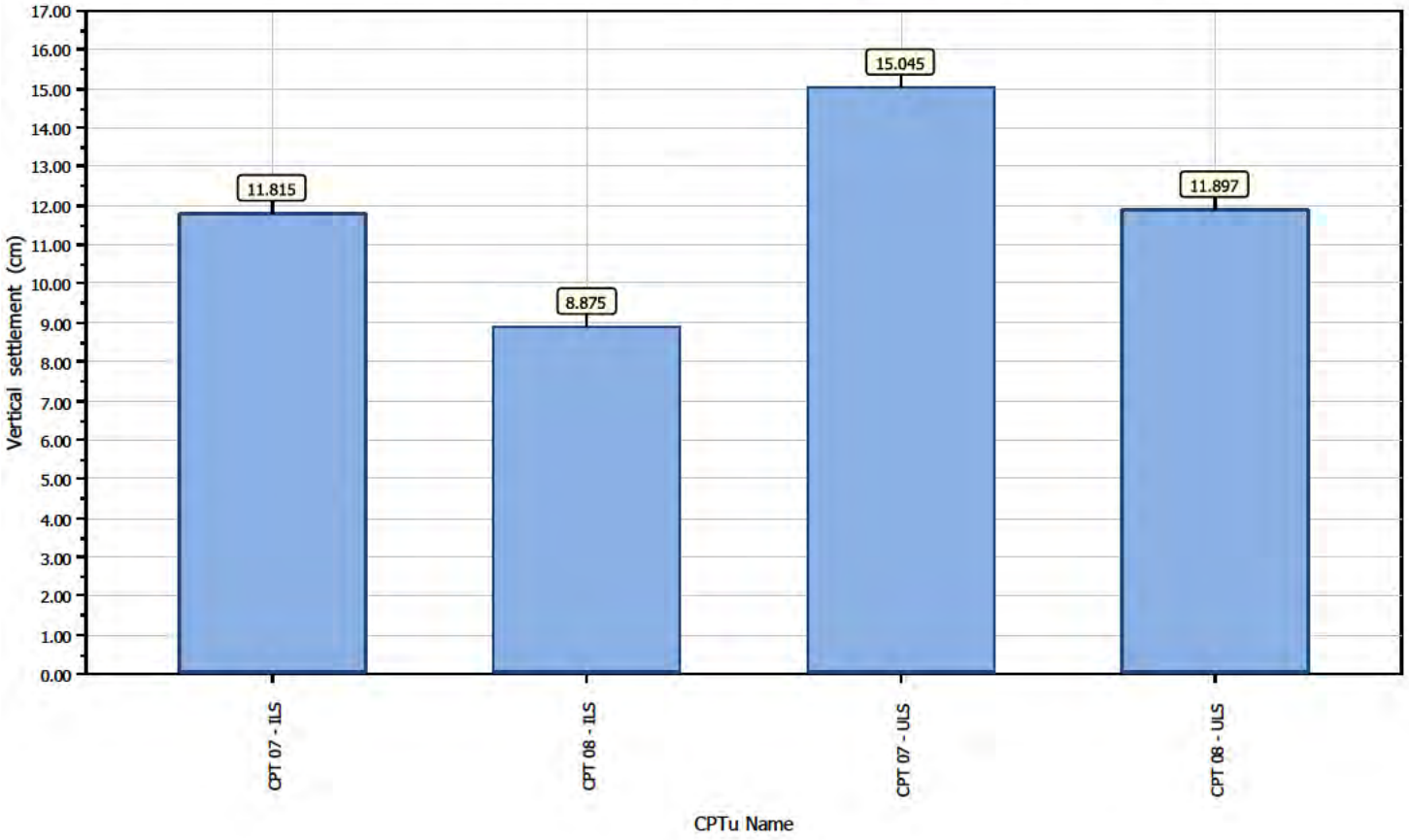
Overall vertical settlements report



Project title : Preliminary Liquefaction Assessment

Location : 174 & 176 Brookvale Road, Havelock North

Overall vertical settlements report - Indexed (Limited) to 10m Depth

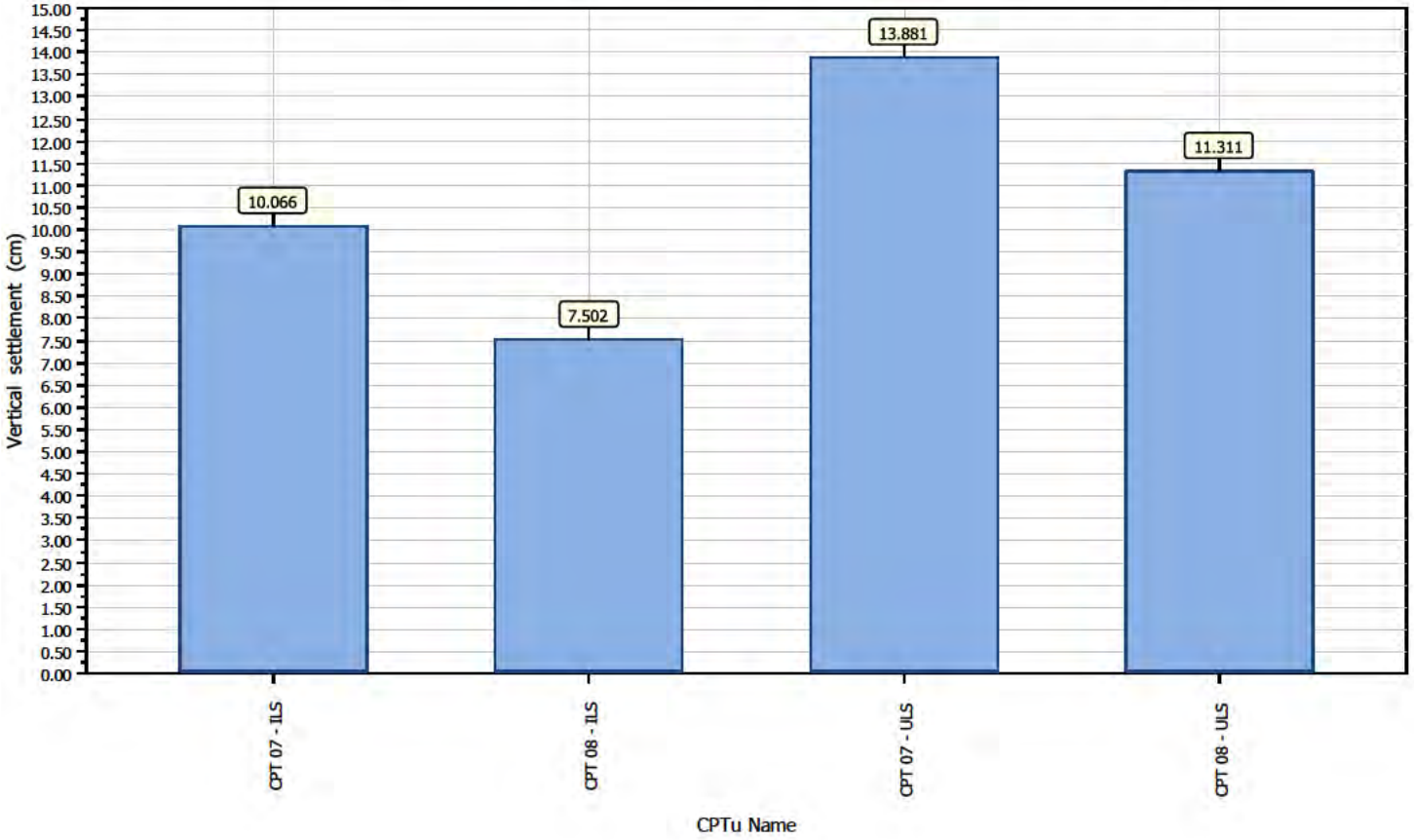


Project title : Preliminary Liquefaction Assessment

Location : 174 & 176 Brookvale Road, Havelock North

Sensitivity Check - C(FC) = 0.2

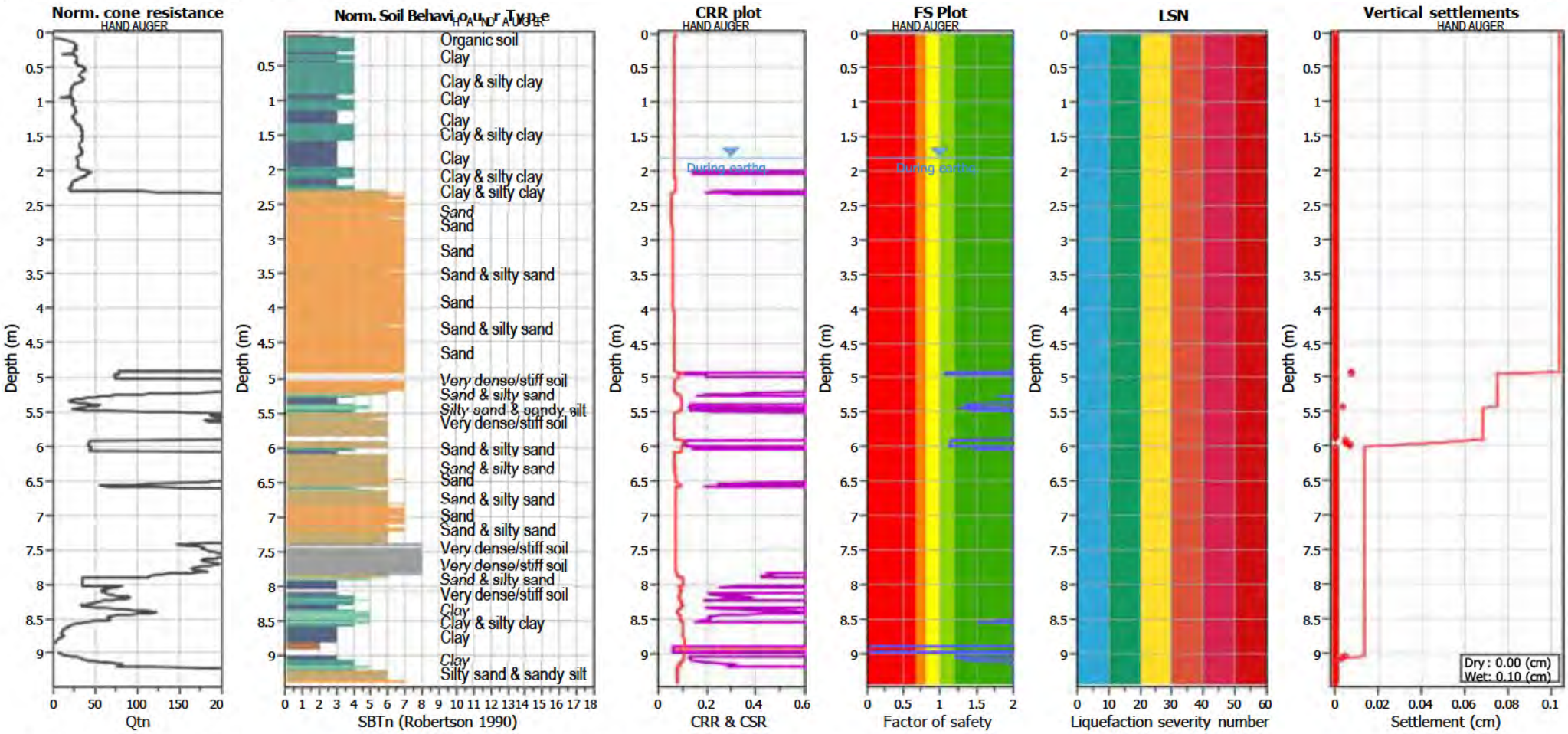
Overall vertical settlements report - Indexed (Limited) to 10m Depth



Hawkes Bay Geotech
Geotechnical Engineers

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

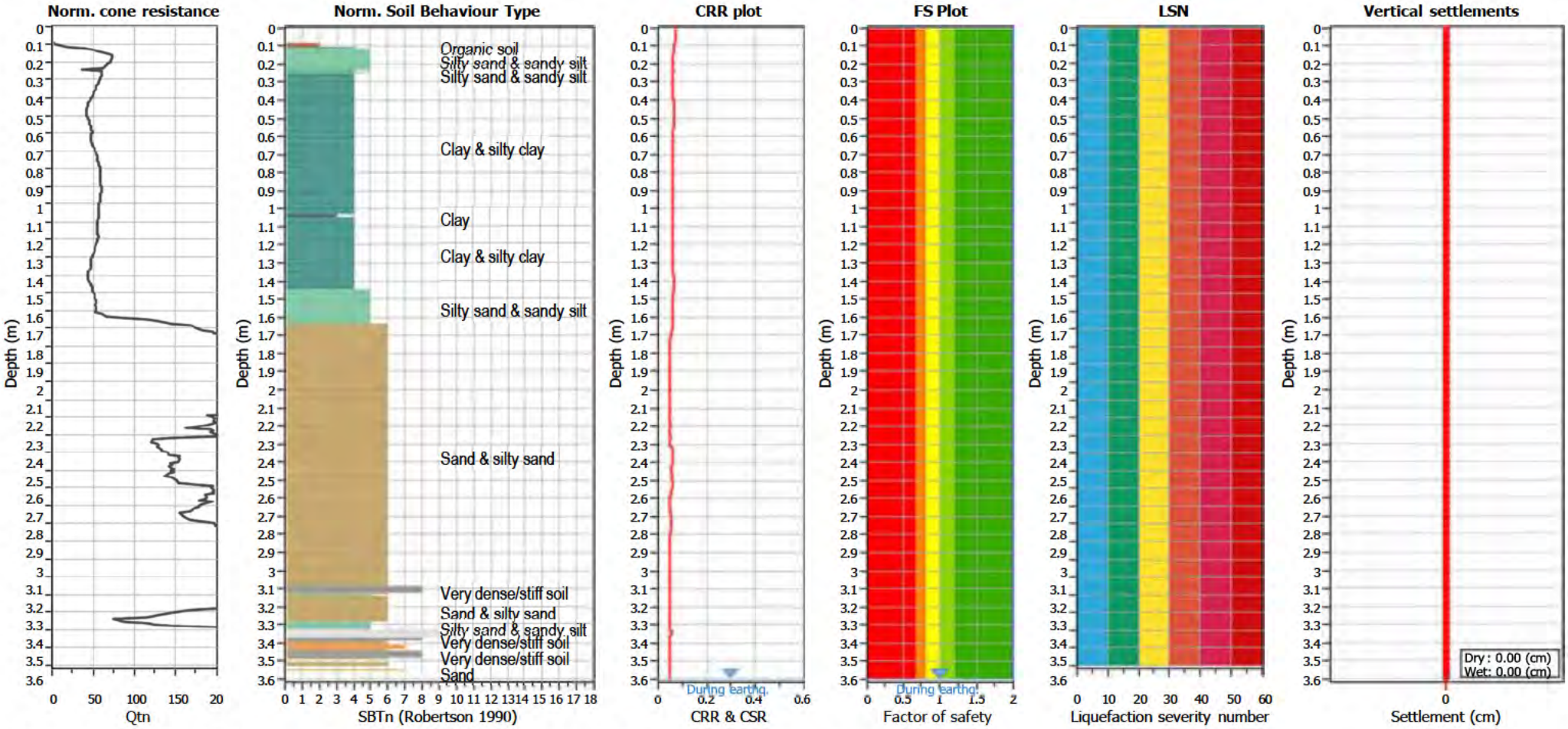
CPT: CPT 05 - SLS
Total depth: 9.45 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.80 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

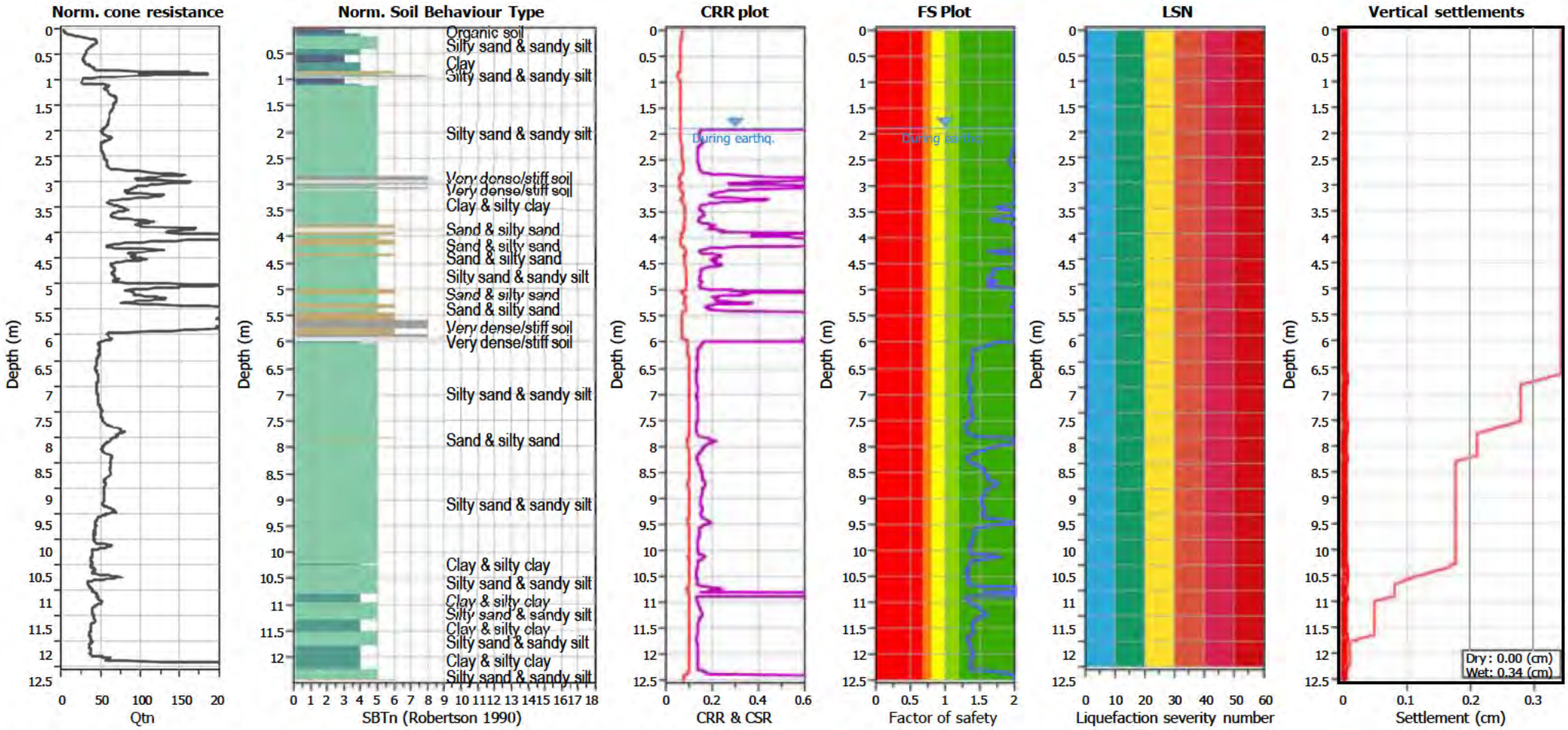
CPT: CPT 06 - SLS
Total depth: 3.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.60 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.60 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

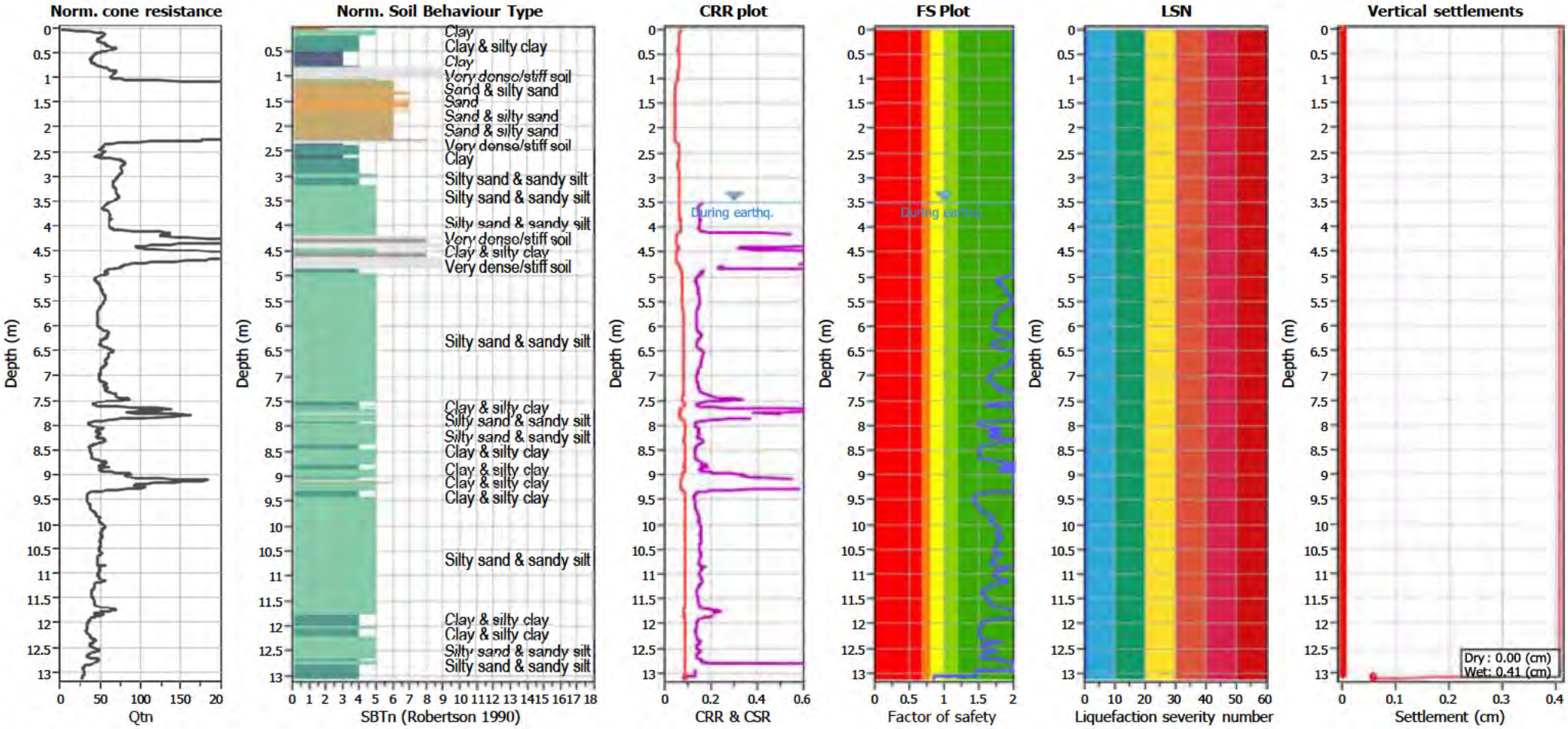
CPT: CPT 07 - SLS
Total depth: 12.49 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.90 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_o applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

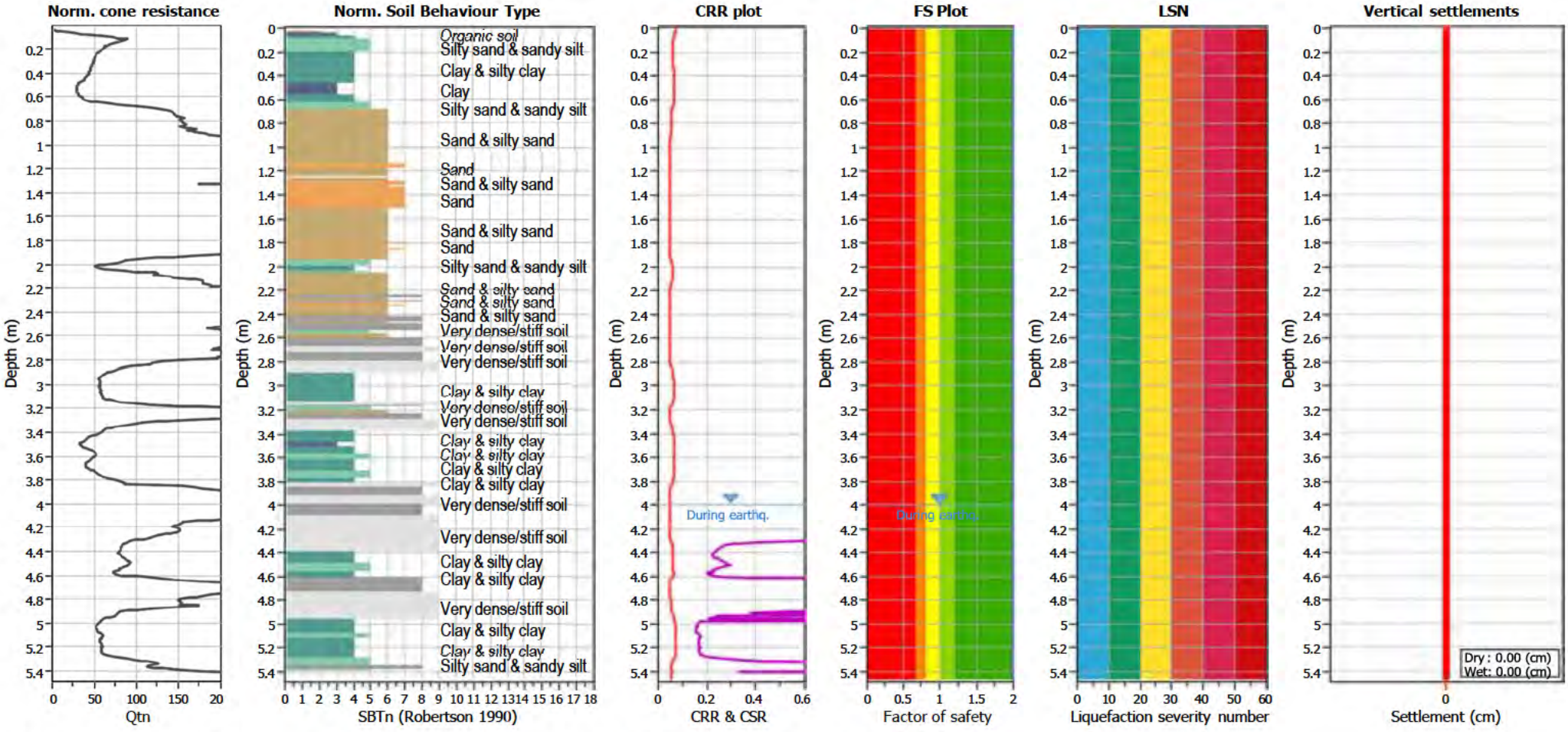
CPT: CPT 08 - SLS
Total depth: 13.12 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

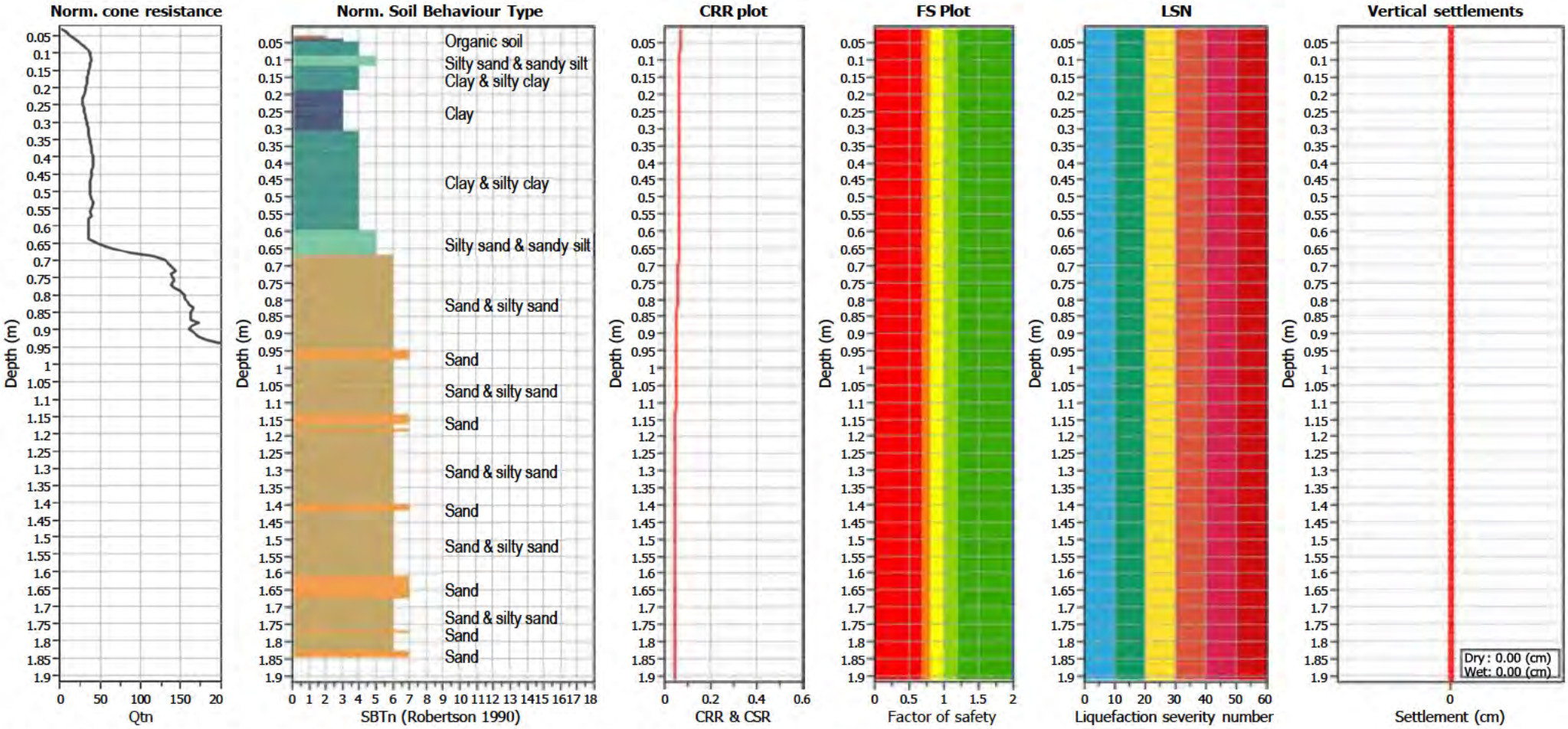
CPT: CPT 09 - SLS
Total depth: 5.46 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_o applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

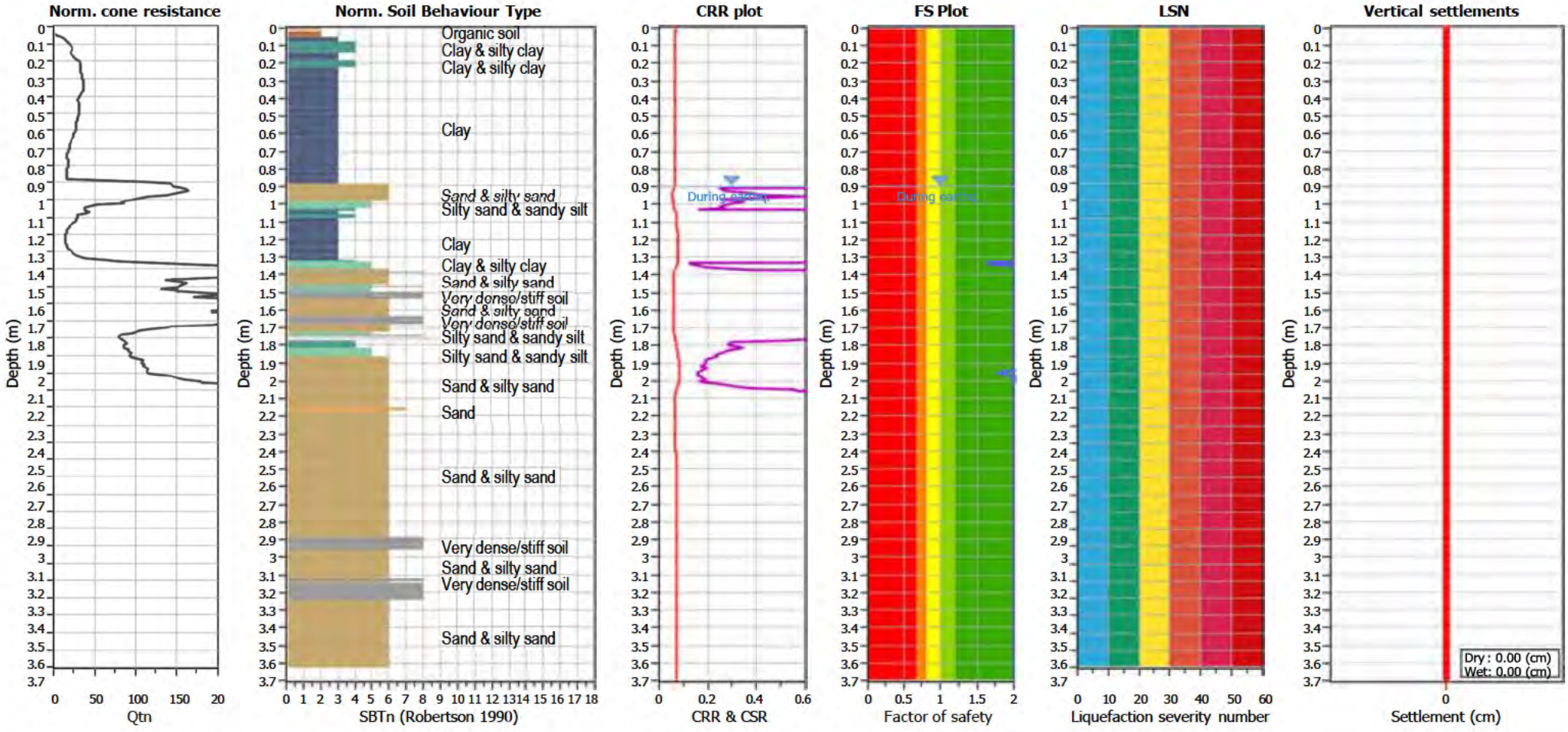
CPT: CPT 10 - SLS
Total depth: 1.91 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

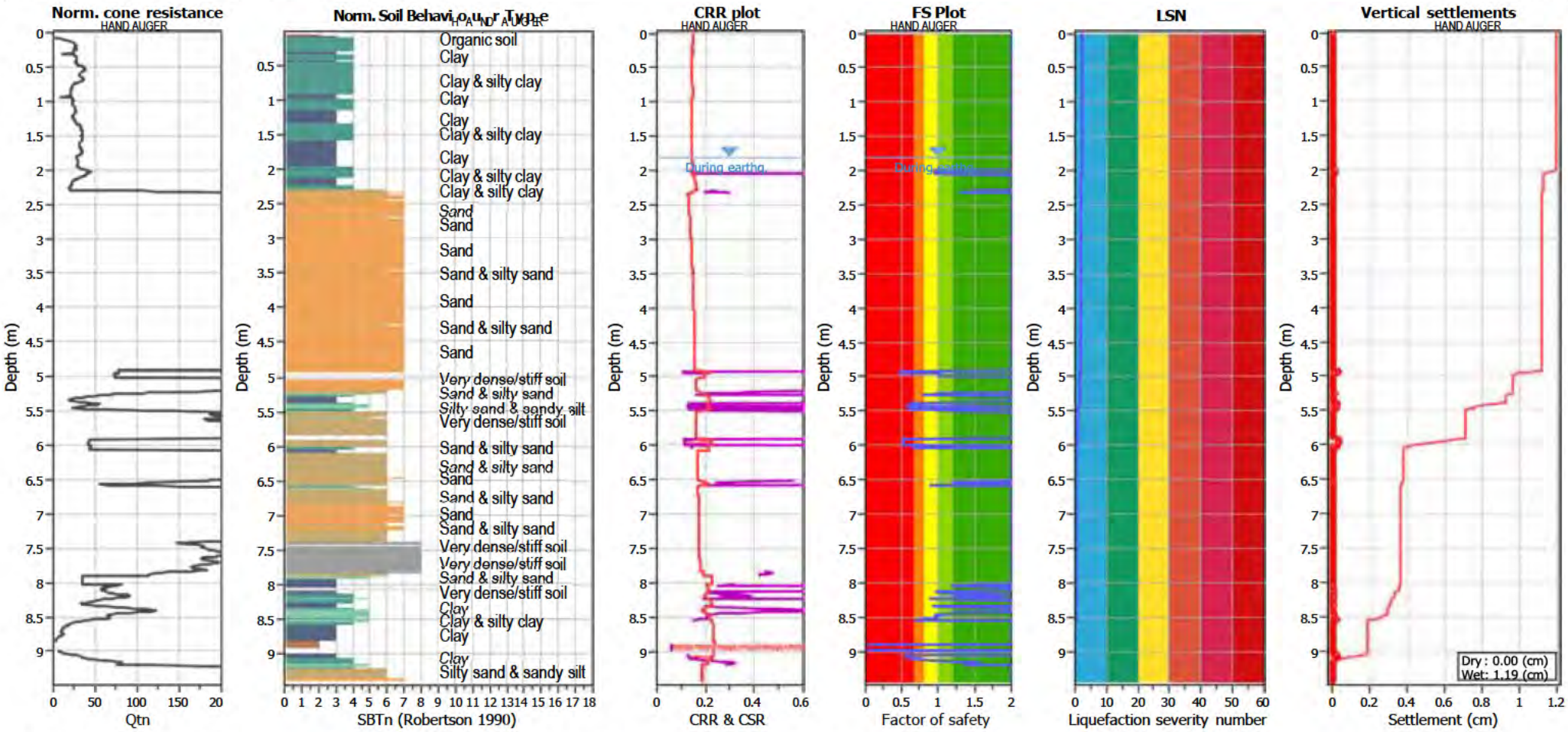
CPT: CPT 11 - SLS
Total depth: 3.69 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.90 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.40	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.12	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

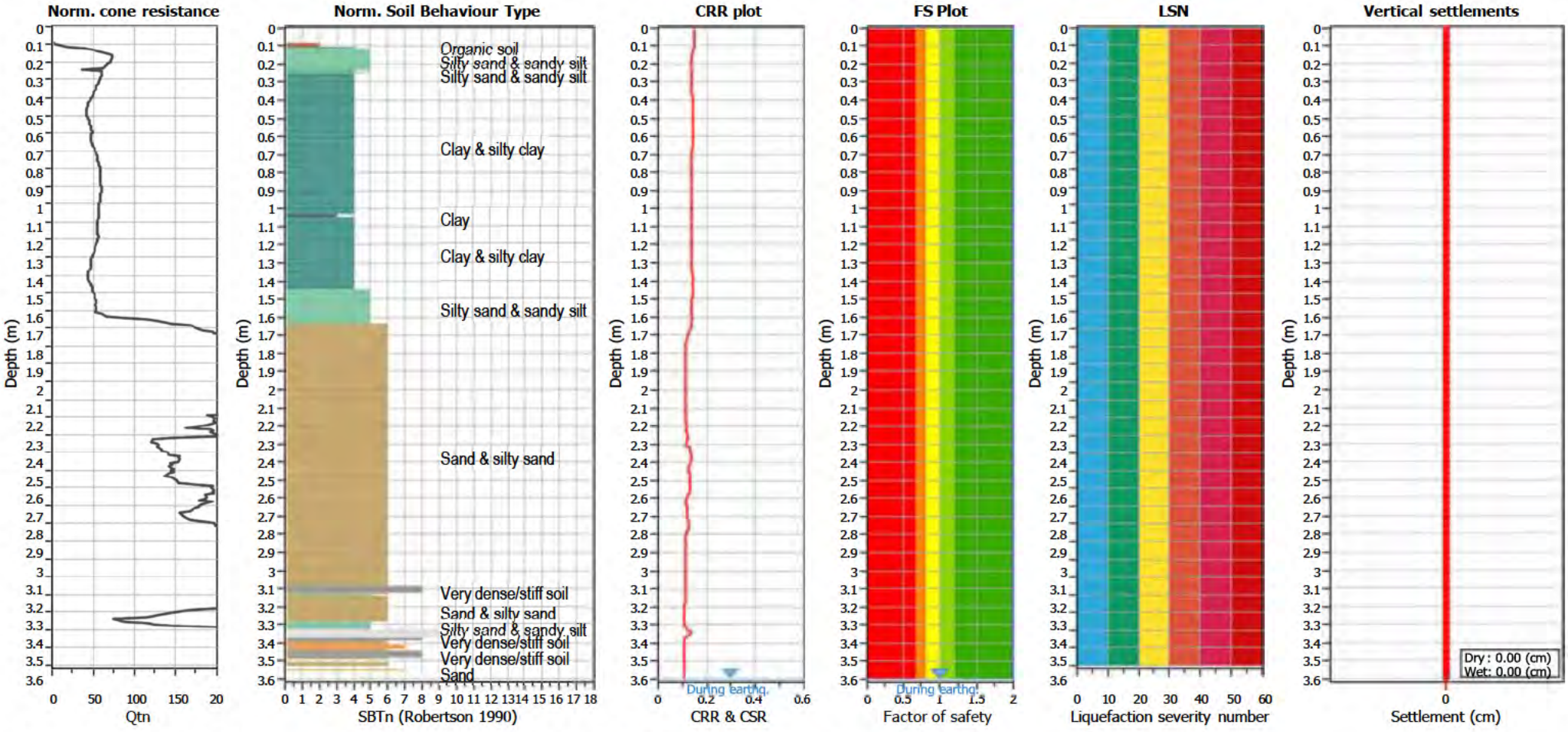
CPT: CPT 05 - ILS
Total depth: 9.45 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.80 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

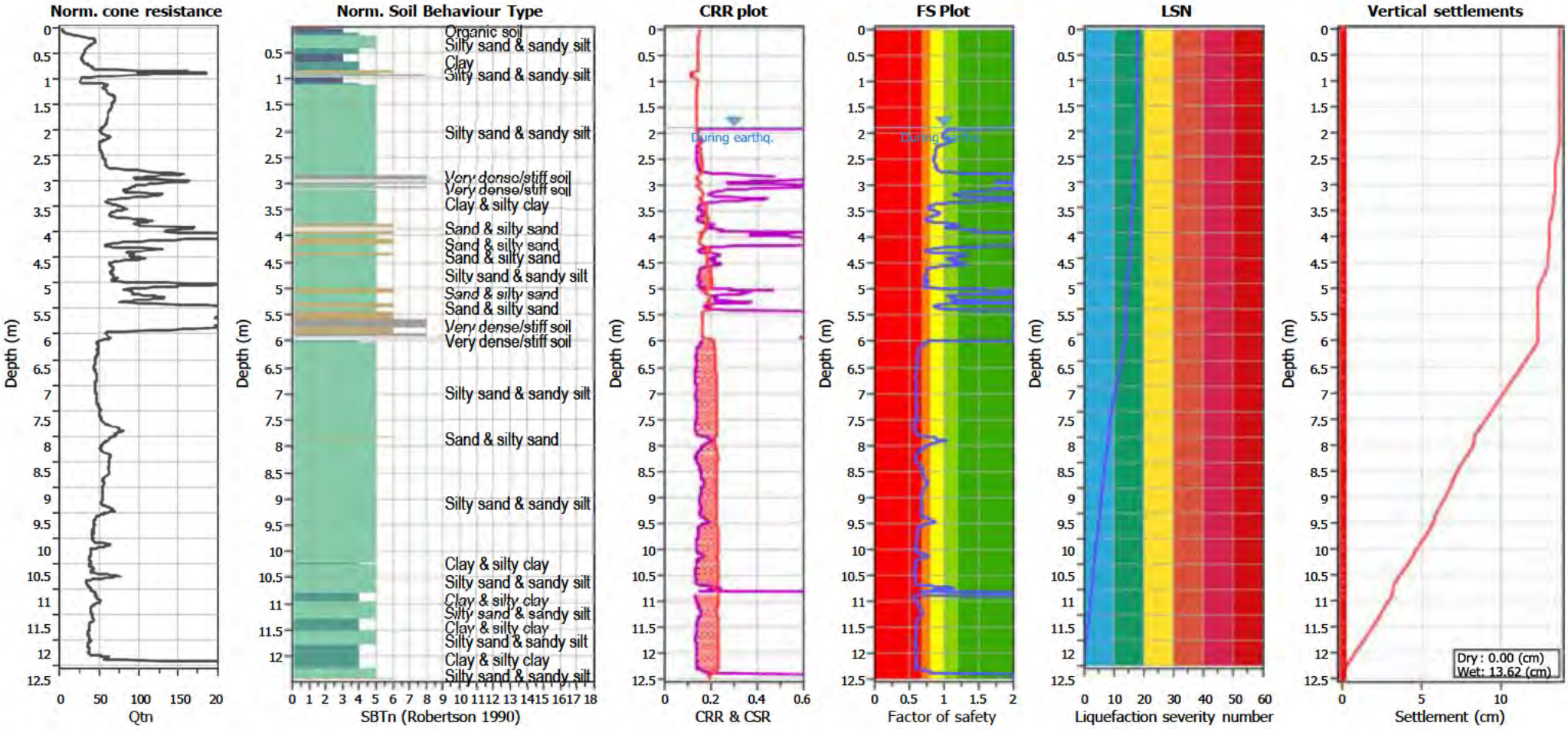
CPT: CPT 06 - ILS
Total depth: 3.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.60 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.60 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

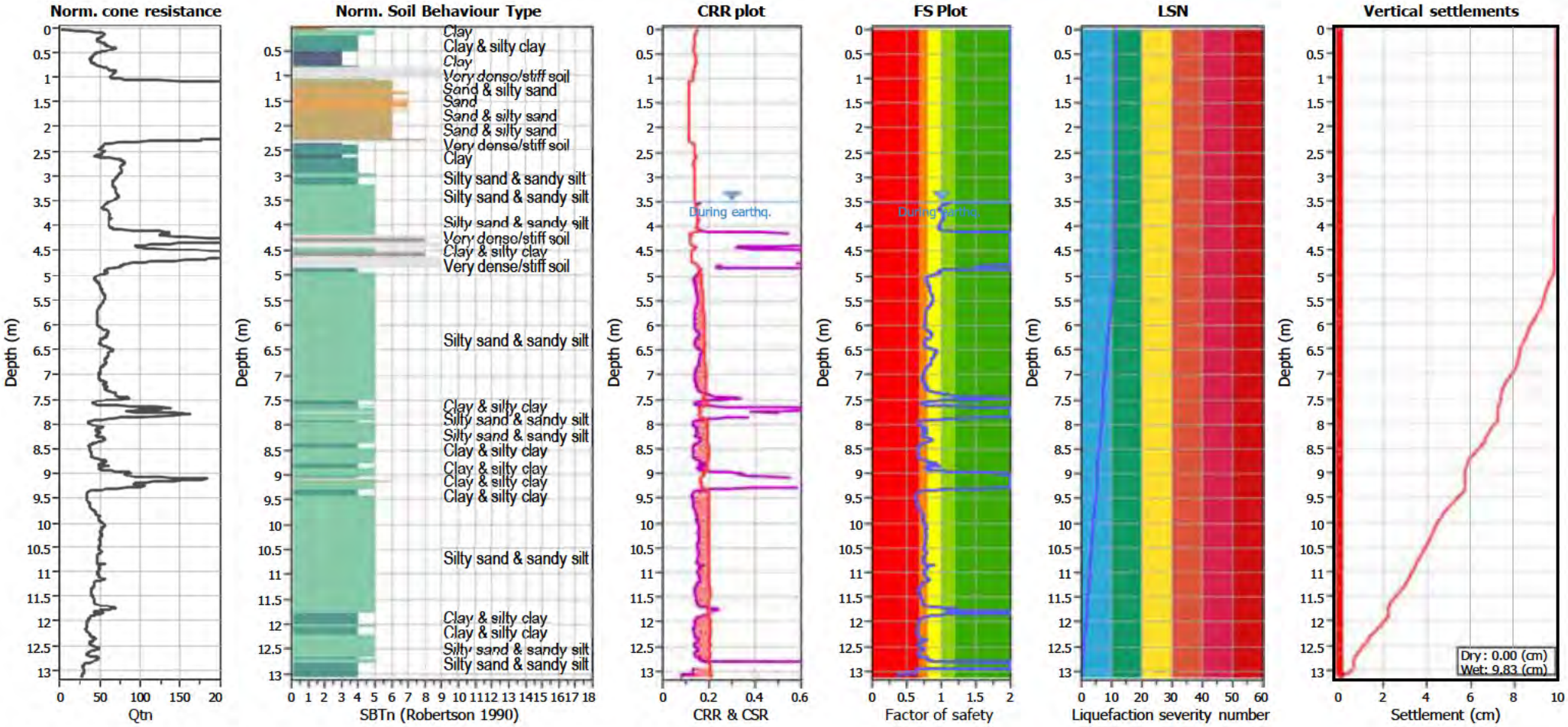
CPT: CPT 07 - ILS
Total depth: 12.49 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.90 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

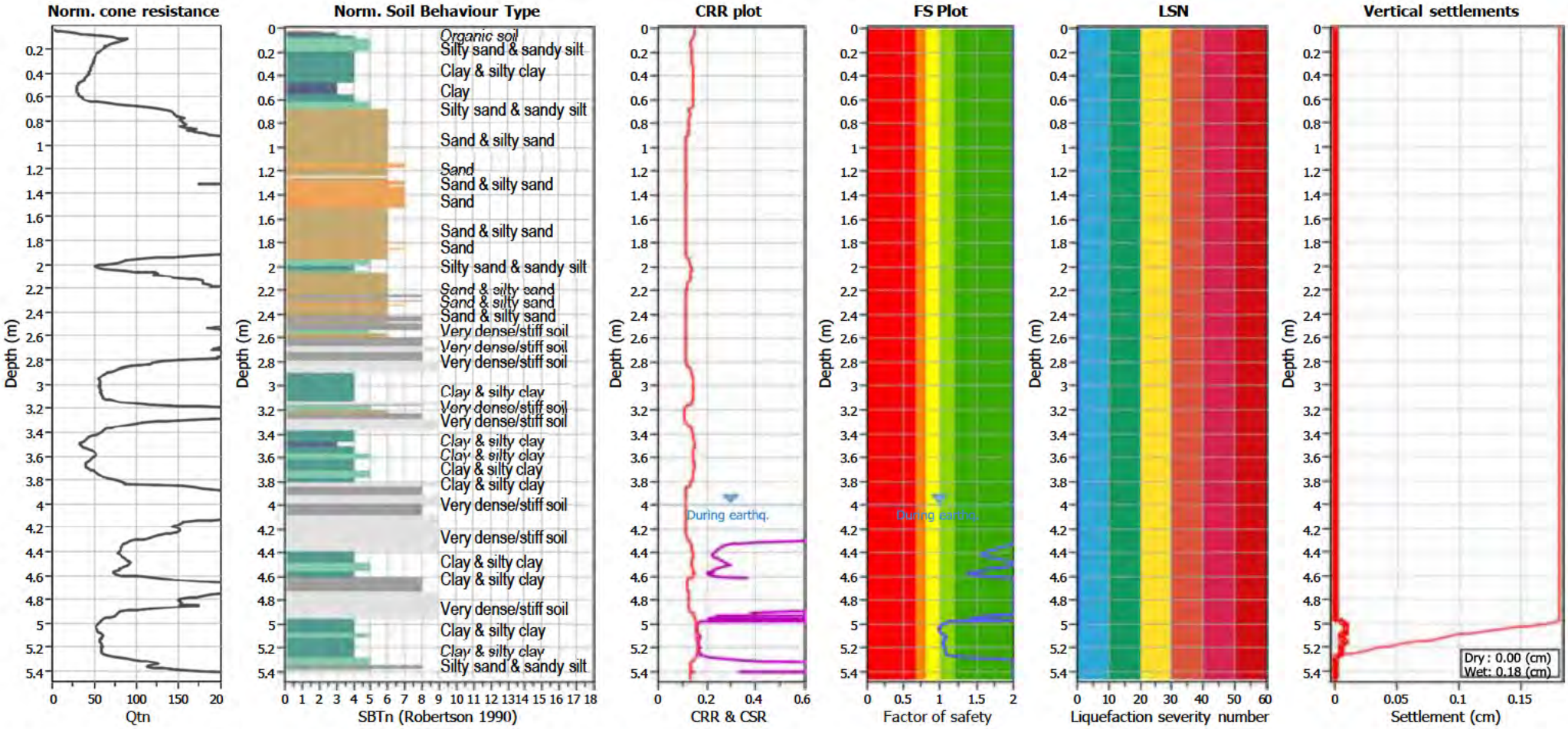
CPT: CPT 08 - ILS
Total depth: 13.12 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

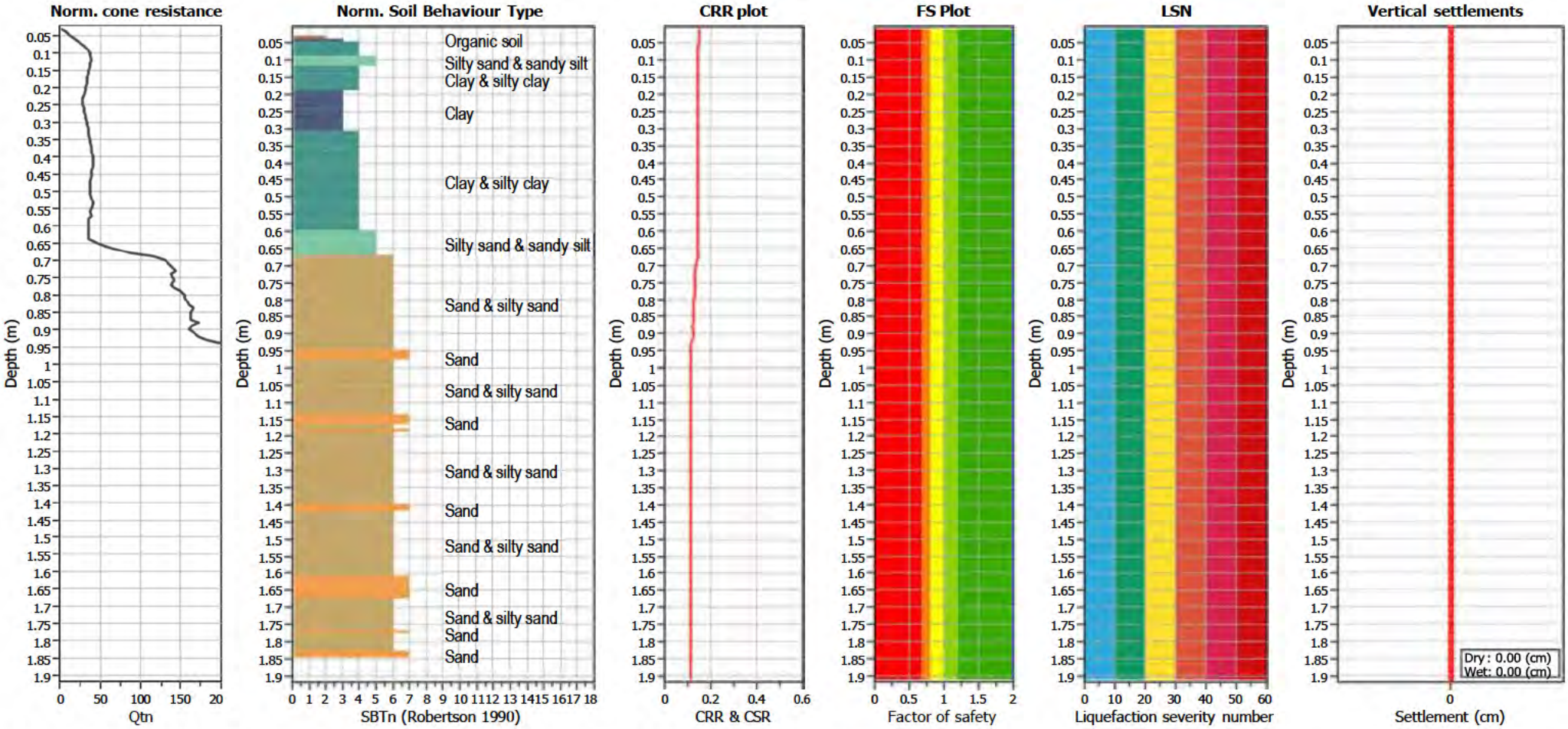
CPT: CPT 09 - ILS
Total depth: 5.46 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

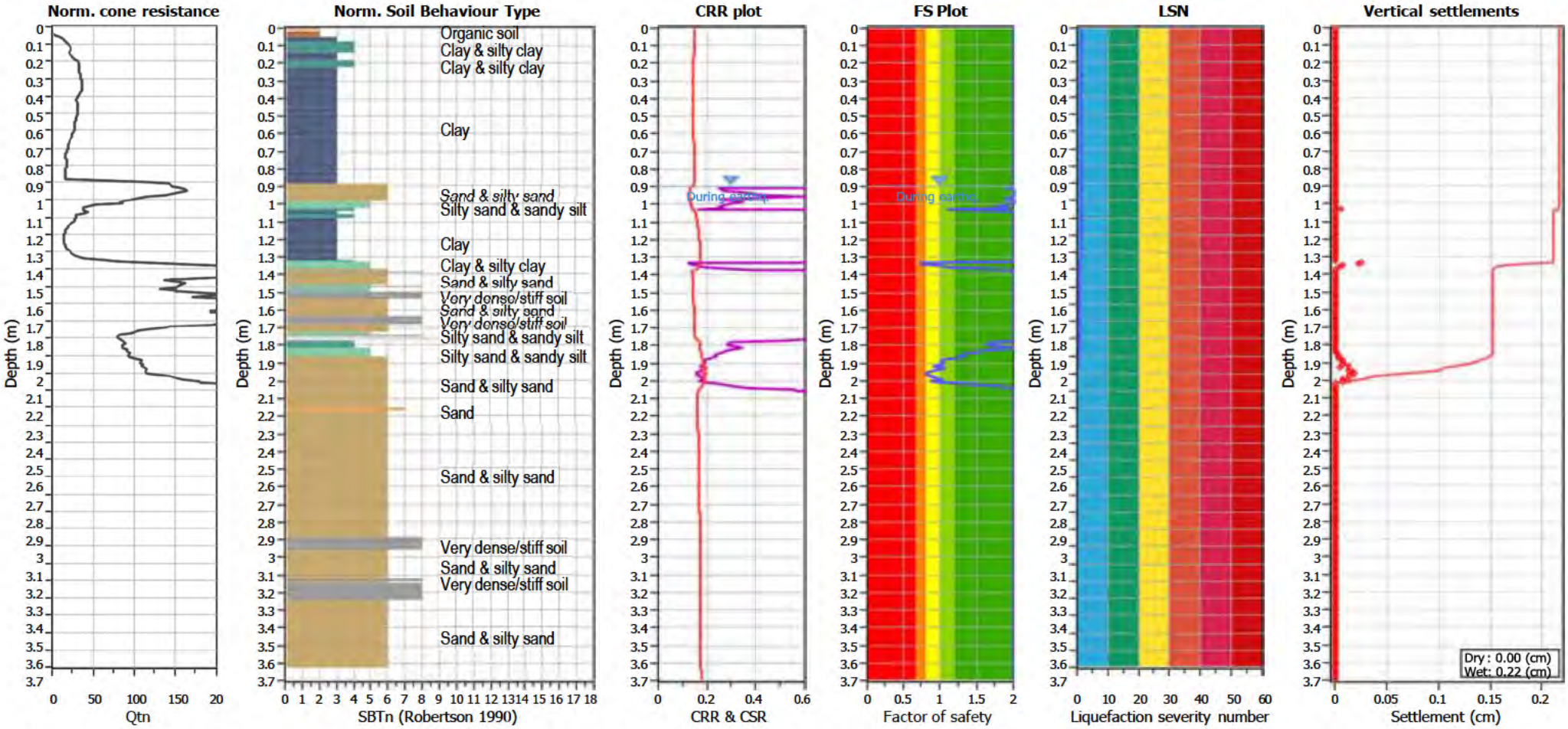
CPT: CPT 10 - ILS
Total depth: 1.91 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

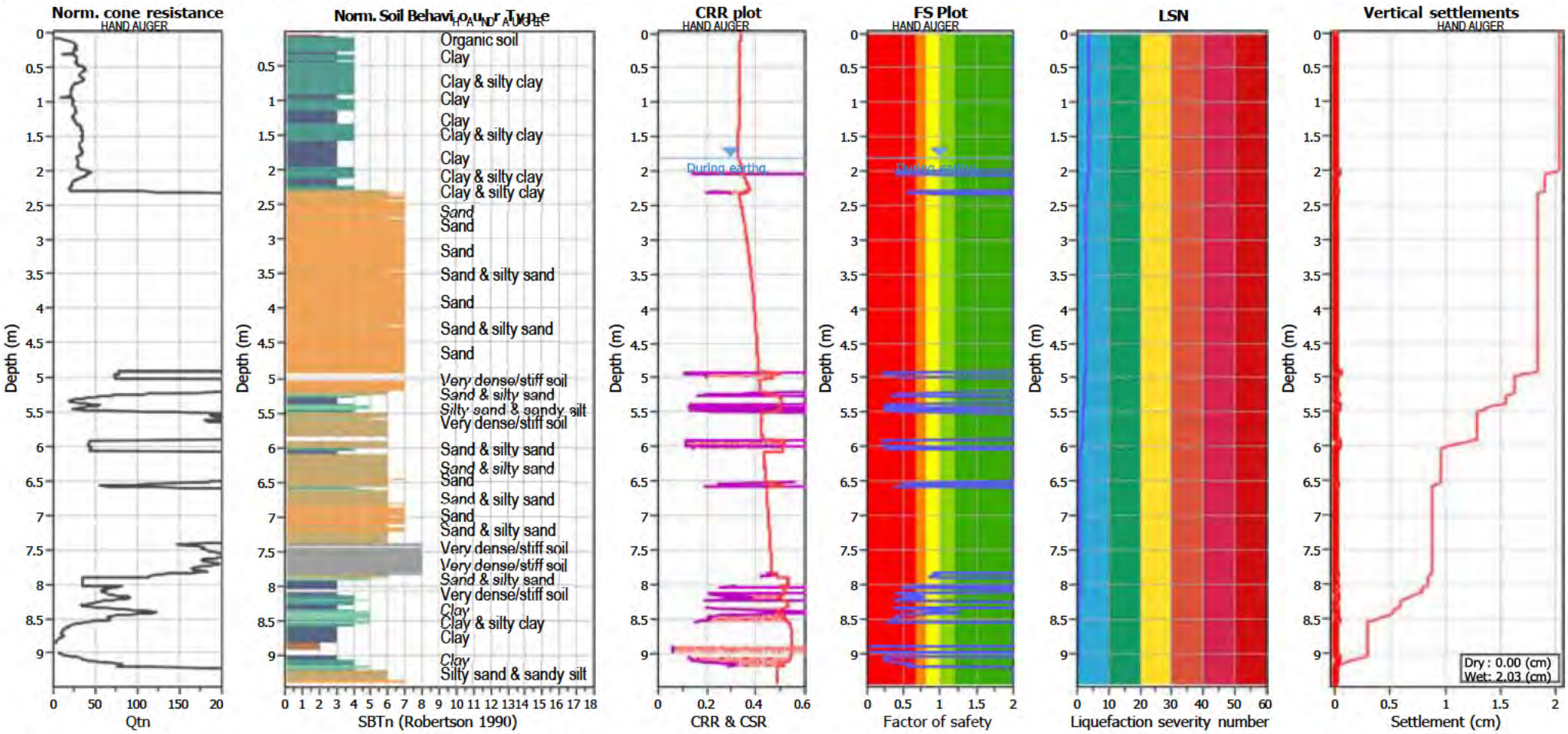
CPT: CPT 11 - ILS
Total depth: 3.69 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.90 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.70	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.26	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

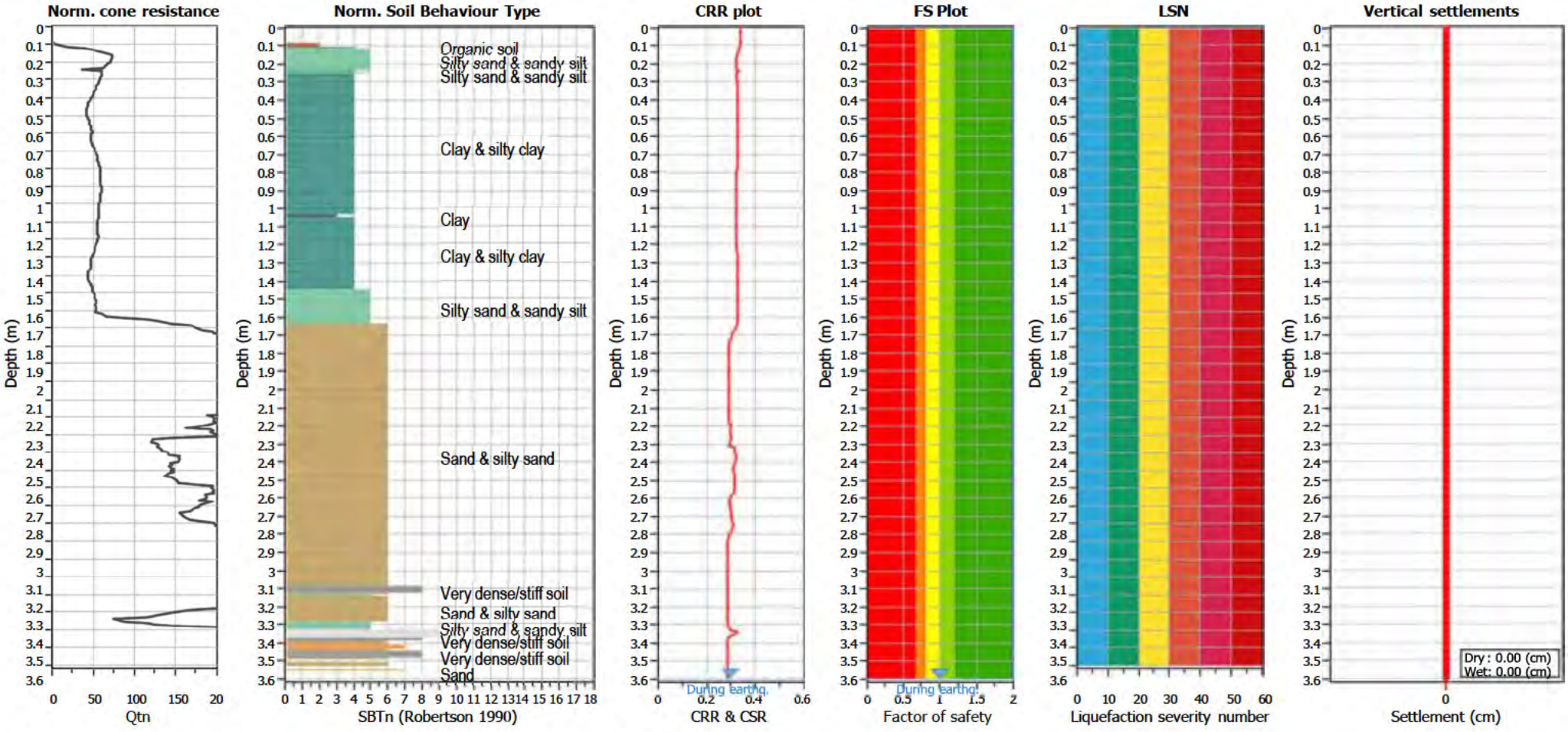
CPT: CPT 05 - ULS
Total depth: 9.45 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.80 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.80 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

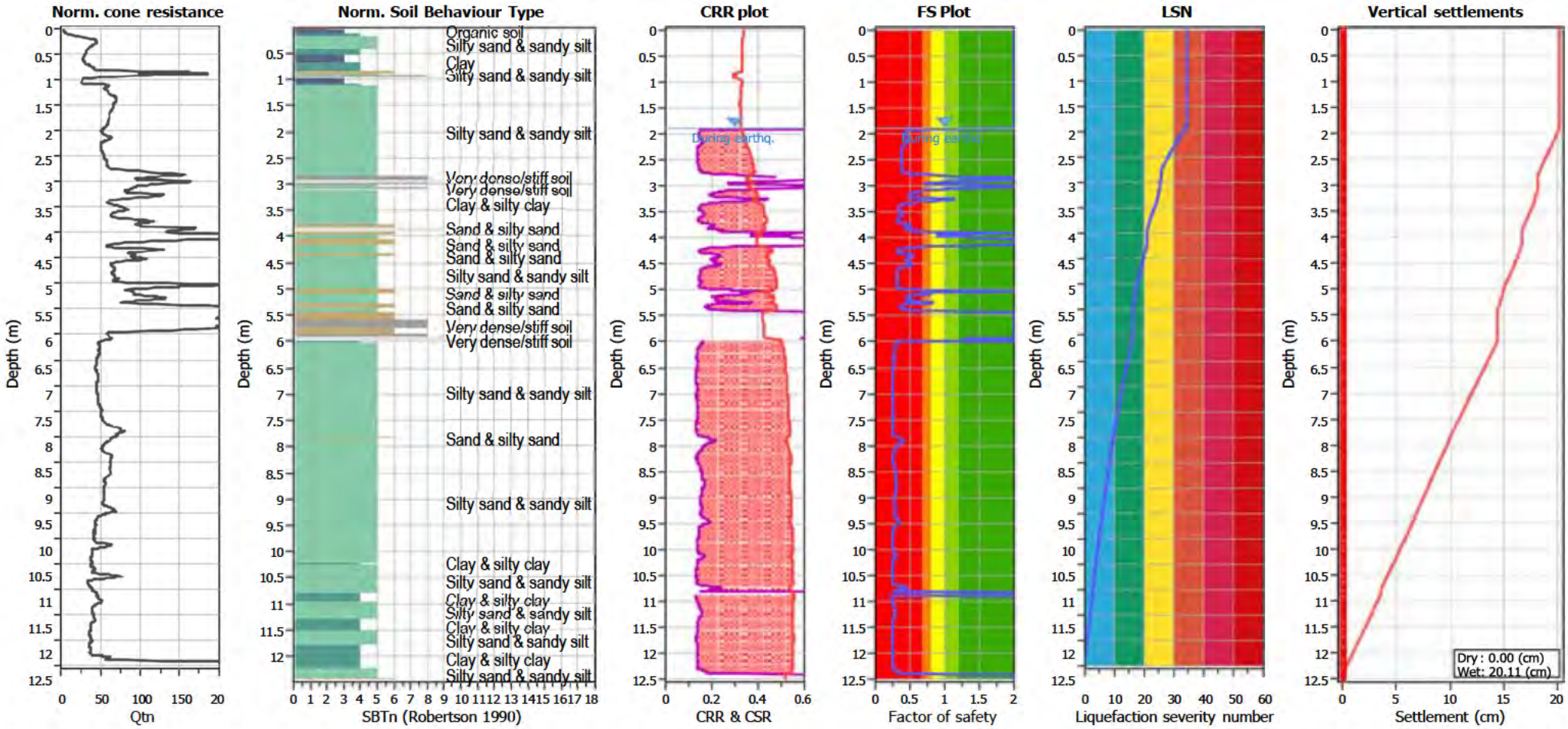
CPT: CPT 06 - ULS
Total depth: 3.60 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.60 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.60 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

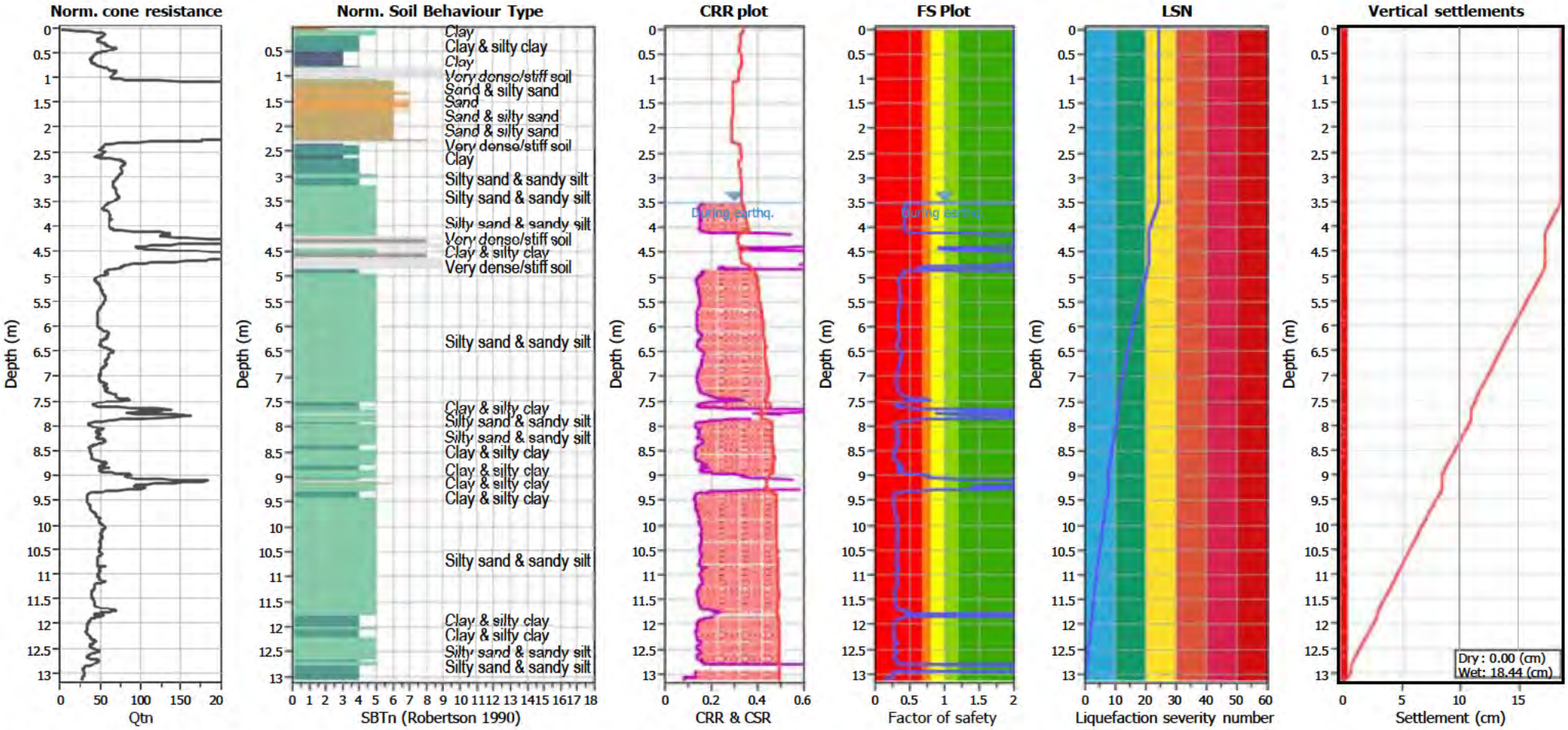
CPT: CPT 07 - ULS
Total depth: 12.49 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	1.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	1.90 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

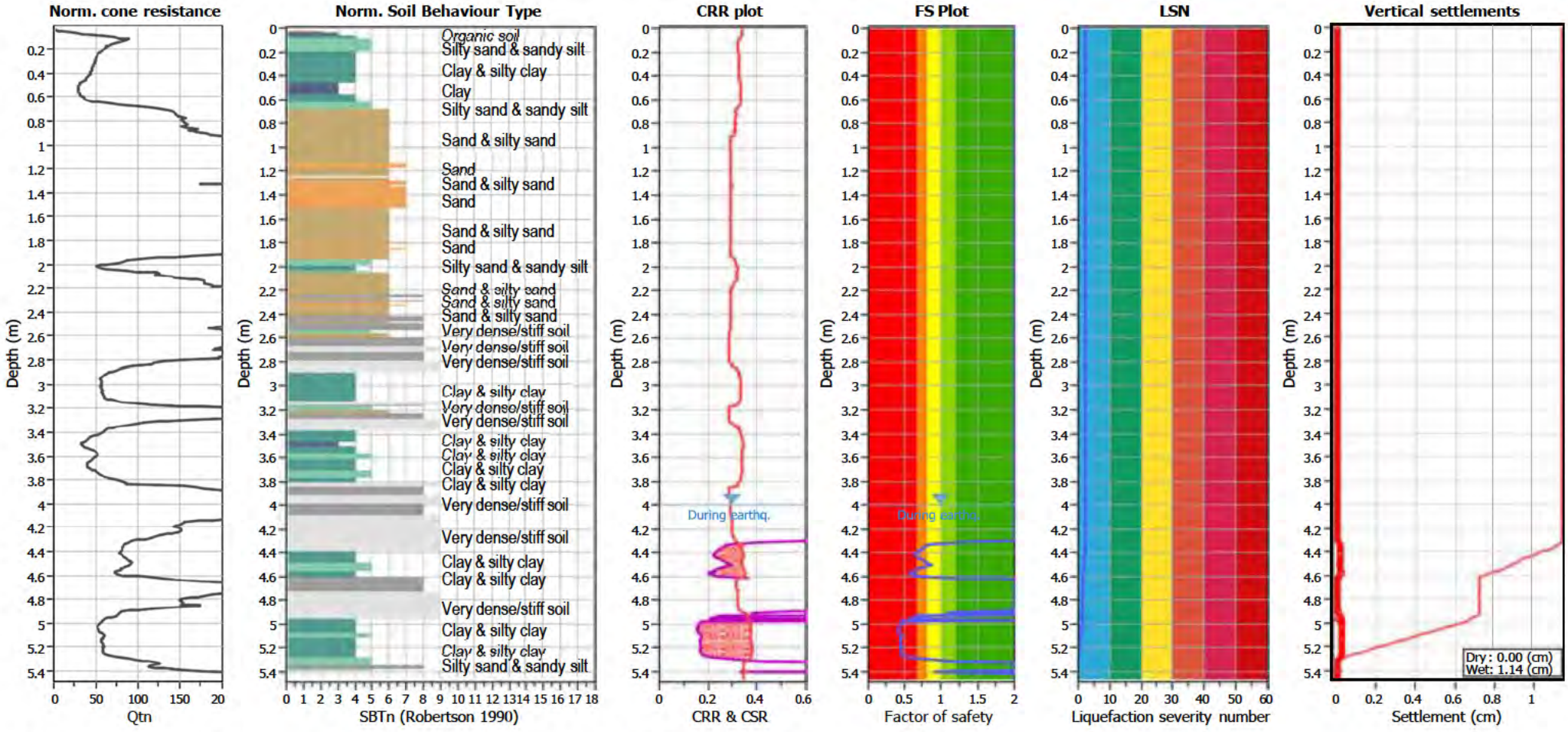
CPT: CPT 08 - ULS
Total depth: 13.12 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

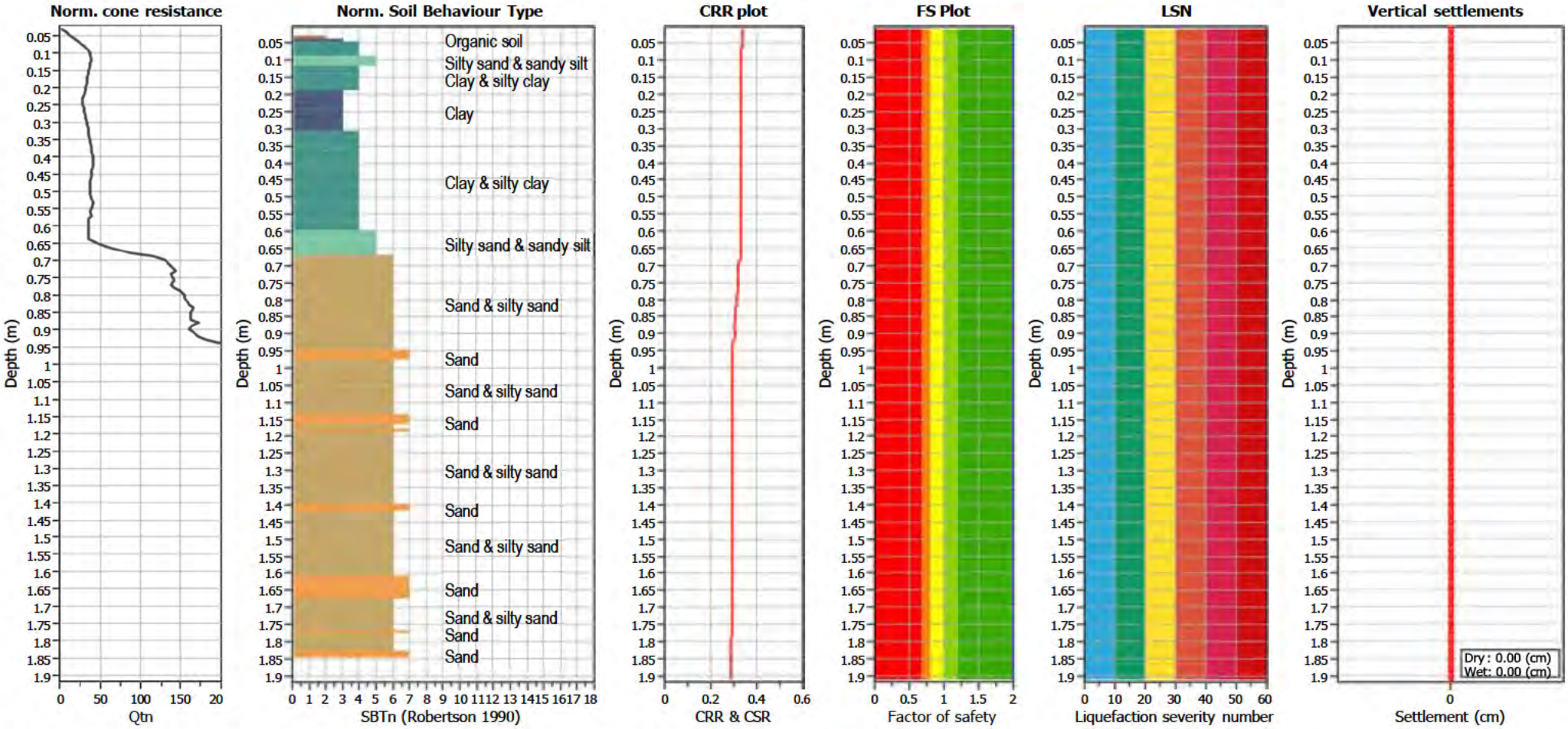
CPT: CPT 09 - ULS
Total depth: 5.46 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

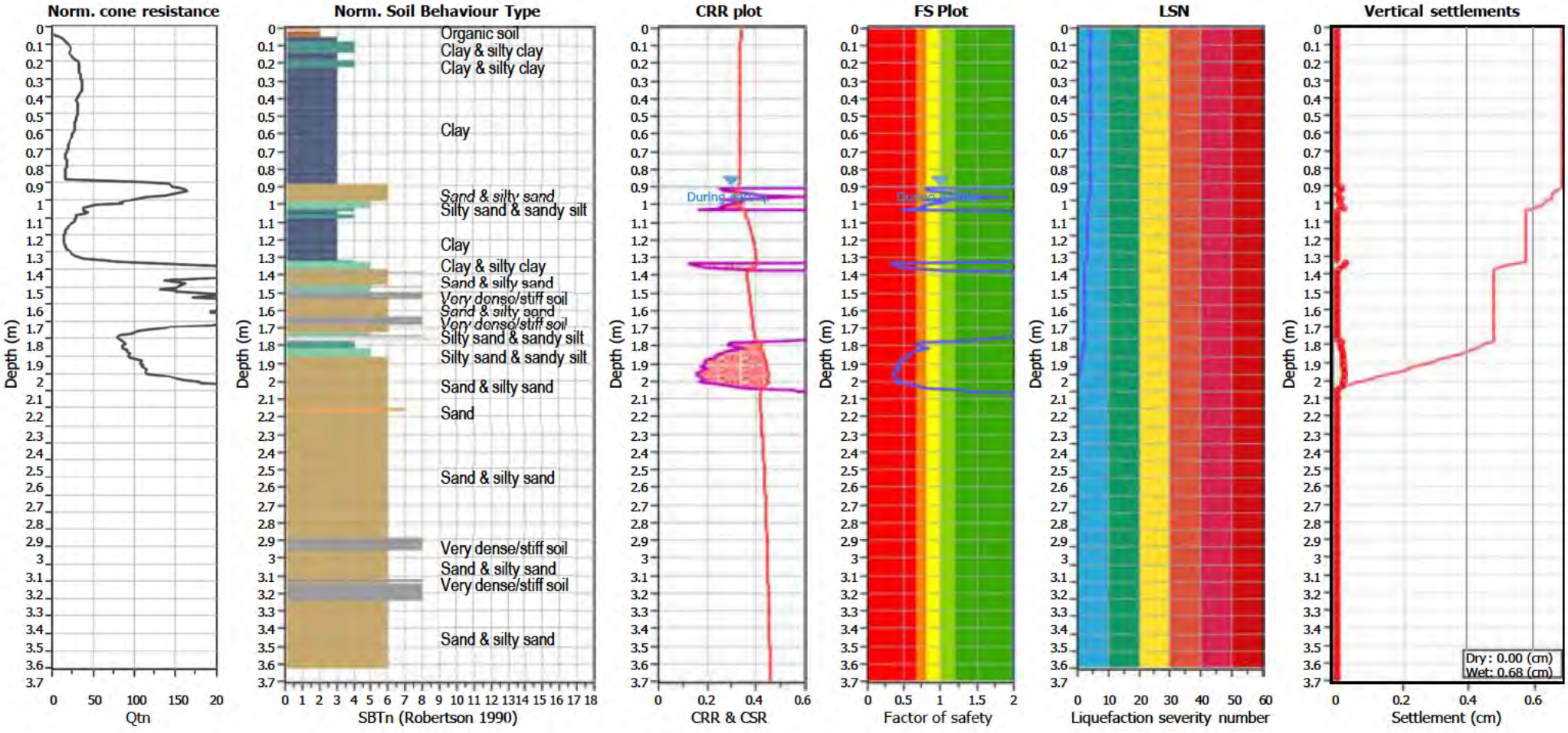
CPT: CPT 10 - ULS
Total depth: 1.91 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	3.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	3.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Project: Preliminary Liquefaction Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 11 - ULS
Total depth: 3.69 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	0.90 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	0.90 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	1	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	7.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.58	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Appendix E

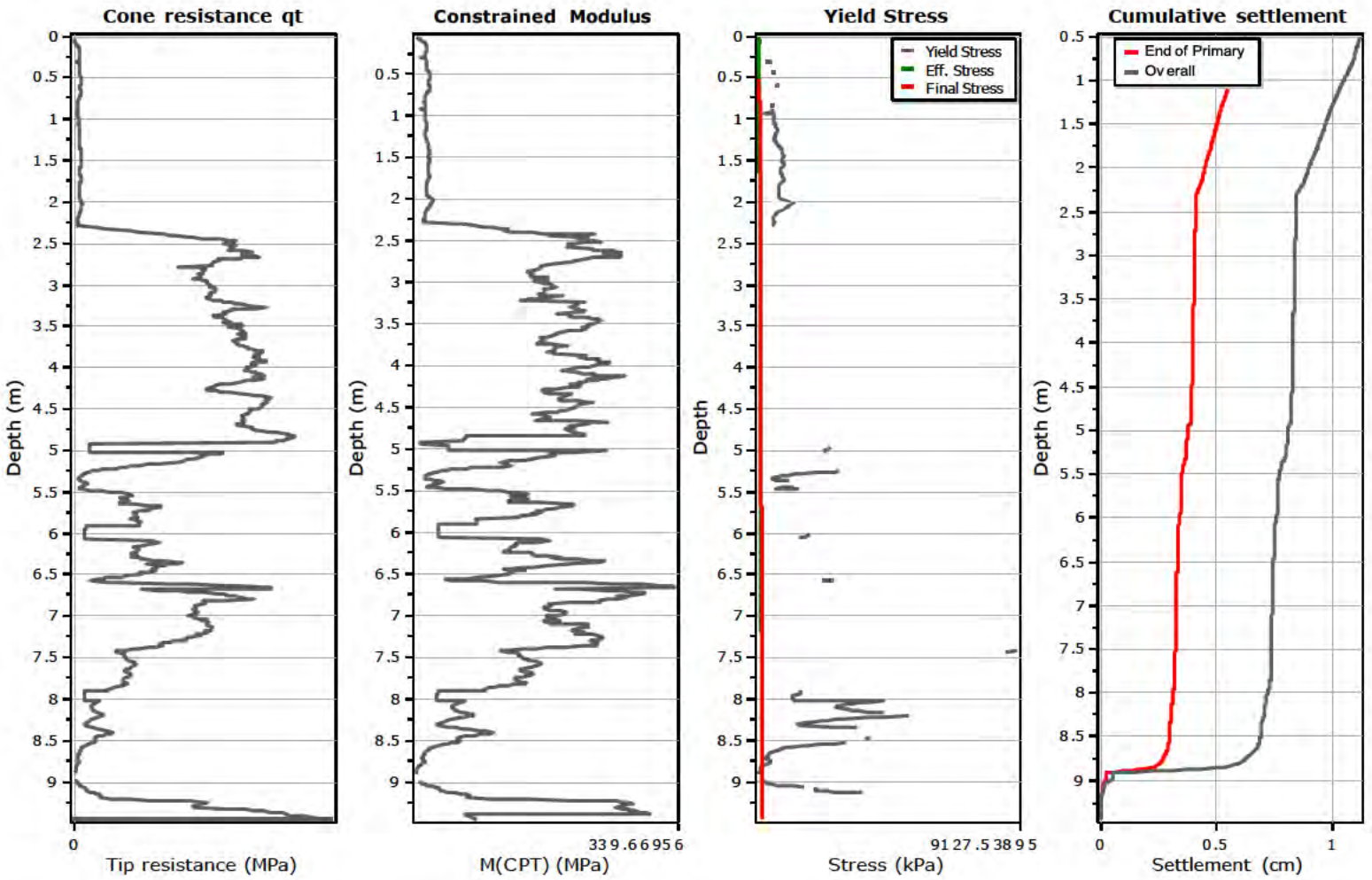
Preliminary Static Settlement Checks

Hawkes Bay Geotech
Geotechnical Engineers

Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 05
Total depth: 9.45 m

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 100.00 (m)
L/B: 1.0
Footing pressure: 25.00 (kPa)
Embedment depth: 0.50 (m)
Footing is rigid: No
Remove excavation load: Yes
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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

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

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

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

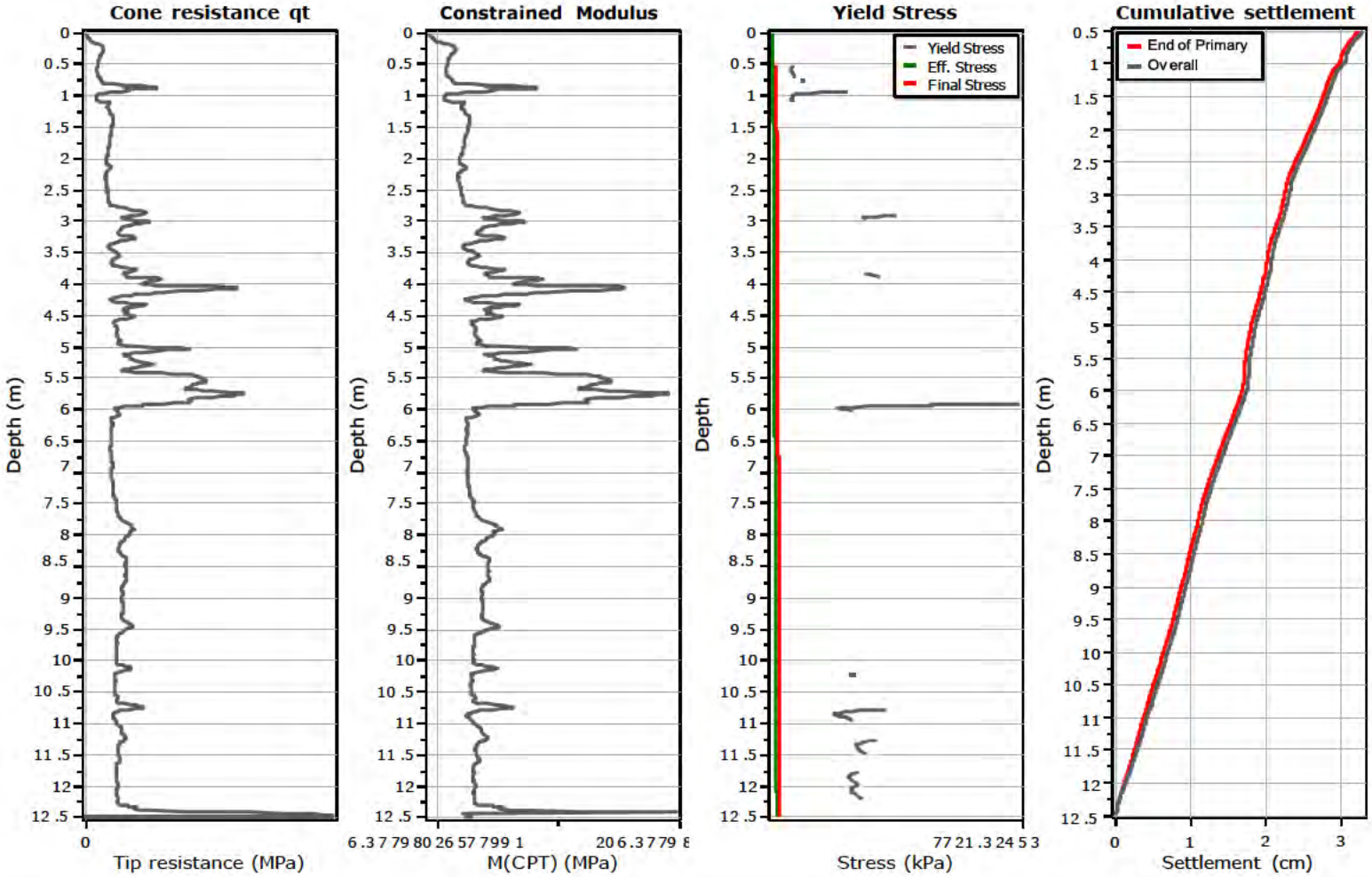
where t_p is the duration of primary consolidation

Hawkes Bay Geotech
Geotechnical Engineers

Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 07
Total depth: 12.49 m

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 100.00 (m)
L/B: 1.0
Footing pressure: 110.00 (kPa)
Embedment depth: 0.50 (m)
Footing is rigid: No
Remove excavation load: Yes
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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

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

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

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

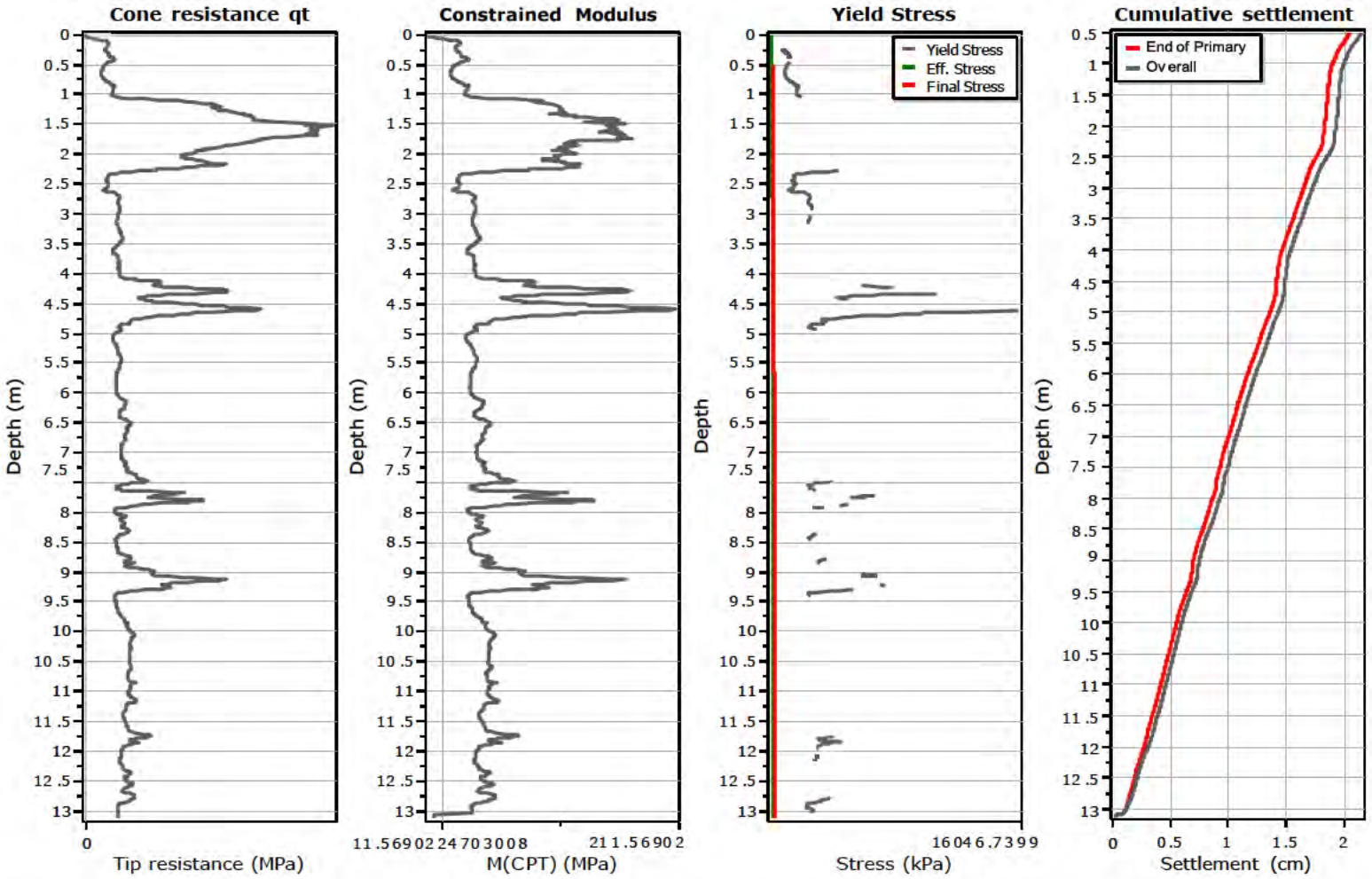
where t_p is the duration of primary consolidation

Hawkes Bay Geotech
Geotechnical Engineers

Project: Preliminary Site Assessment
Location: 174 & 176 Brookvale Road, Havelock North

CPT: CPT 08
Total depth: 13.12 m

Settlements calculation according to theory of elasticity*



Calculation properties

Footing type: Rectangular
Footing width: 100.00 (m)
L/B: 1.0
Footing pressure: 80.00 (kPa)
Embedment depth: 0.50 (m)
Footing is rigid: No
Remove excavation load: Yes
Apply 20% rule: No
Calculate secondary settlements: Yes
Time period for primary consolidation: 6 months
Time period for second. settlements: 600 months

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

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

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

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

where t_p is the duration of primary consolidation