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Nukuhau Structure Plan

Geotechnical Report

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CONFIDENTIAL

wsp

150 YEARS IN AOTEAROA

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Disclaimers and Limitations

We have prepared this report in accordance with the brief provided. The contents of the report are for the sole use of the Client, and no responsibility or liability will be accepted to any third party. Data or opinions contained within the report may not be used in other contexts or for any other purposes without our prior review and agreement.

The recommendations in this report are based on data collected at specific locations and by using suitable investigation techniques. Only a finite amount of information has been collected to meet the specific financial and technical requirements of the Client's brief and this report does not purport to completely describe all the site characteristics and properties. The nature and continuity of the ground between test locations has been inferred using experience and judgement and it must be appreciated that actual conditions could vary from the assumed model.

Subsurface conditions relevant to construction works should be assessed by contractors who can make their own interpretation of the factual data provided. They should perform any additional tests as necessary for their own purposes.

 For further information regarding this geotechnical assessment, please do not hesitate to contact WSP.

1 Introduction

WSP has been engaged by a consortium of landowners to prepare a Structure Plan (SP) and lodge an application for a Private Plan Change (PPC) to Taupo District Council (TDC) to rezone areas of land in the Taupo District Plan (TDP). The proposed residential development of 780 or more residential lots will potentially be developed in due course on approval. A geotechnical report is required by TDC as a part of the PPC process. To inform this report, WSP undertook a preliminary general ground investigation across the subject sites and produced a high-level report intended to gauge sufficient and easily identifiable geotechnical constraints to the proposed change of use and subsequent development. This current report is an update to the previous high-level report, following initial peer review and subsequent deep geotechnical investigations.

This updated report details the findings of the initial investigations, as well as the more recent deep geotechnical investigations. The Ministry of Business, Innovation and Employment's Module 2[1] guidance document has been utilised to inform the supplementary geotechnical investigative work, primarily around quantum of testing, with special emphasis on:

- development constraints due to published and identified geological and geomorphic features;
- identifying typical development constraints around soil types, primarily for civil development purposes;
- identifying potential stormwater disposal methodologies (dwellings and roading), taking account of the hydrologic constraints and recommendations within the TDC Code of Practice for the Development of Land and other relevant standards;
- identifying the anticipated level of additional investigation, modelling and reporting that will be required to accompany subdivision consents in due course.
- Additional geohazards that may have an impact on the development, including liquefaction, lateral spread, slope stability, expansive soils, flooding, and geothermal-induced settlement.

Where geohazards are identified on the proposed development block, we have sought to identify how they could potentially be mitigated so as not to create 'intolerable risk' to future development. The geohazards investigated here, and in context of the plan change process, have been evaluated in the context of the Waikato Regional Council 13.1.1 Risk management framework[2]:

'*Regional and district plans shall incorporate a risk-based approach into the management of subdivision, use and development in relation to natural hazards. This should be in accordance with relevant standards, strategies and plans, and ensure that:*

a. new development is managed so that natural hazard risks do not exceed acceptable levels;
b. intolerable risk is reduced to tolerable or acceptable levels
c. the creation of new intolerable risk is avoided;
d. any intolerable risk as a result of existing use and development is as low as reasonably achievable; and

[1] Minsitry of Business, Innovation and Employment Module 2 - https://www.building.govt.nz/assets/Uploads/building-code-compliance/b-stability/b1-structure/geotechnical-guidelines/geotech-module-2.pdf
[2] Waikato Regional Council 13.1.1 Risk Management Framework - https://www.waikatoregion.govt.nz/Council/Policy-and-plans/Regional-Policy-Statement/RPS2016/Part-B/13/1/Implementation-methods/1/

e. *where intolerable risk remains, the risks will be managed until an acceptable level is achieved*

2 Site Description

At the timing of this report, the proposed development covers six general land areas – Sites 1 to 6 – as detailed in Table 1 below. Residential development of 800 or more houses is proposed on the total land package. The development comprises a Greenfields landform and currently consists of gently rolling farm paddocks and lifestyle blocks, with some residential dwellings and implement sheds. The locations of the six sites are shown in Figure 1.

Table 1: Site details

	Owner	Land area (ha)	Address	Appellation	CFR	Land Status
1	Rajasingham Family Trust	9.0936	24 Acacia Bay Road and 27 Watene Lane	Rangatira 8A6B1 Block Maori Land Plan 22228	SA56B/732	General Land
2	Lexus Trustees 11 Limited	14.5540	48 Acacia Bay Road	Lot 2 DPS 86303	SA68B/415	General Land
3	CN Top Investment Limited	22.2778	6 Poihipi Road	Lot 2 DP 384060	336049	General Land
4	Taupo District Council	1.6890	Poihipi Road	None	No CFR allocated	General Land
5	Numerous	14.67	29 – 79 Watene Lane	Numerous	Numerous	General & Maori Freehold Land
6	Rangatira 8A17 Trust	15.00	200 Lakewood Drive	Numerous	Numerous	General Land

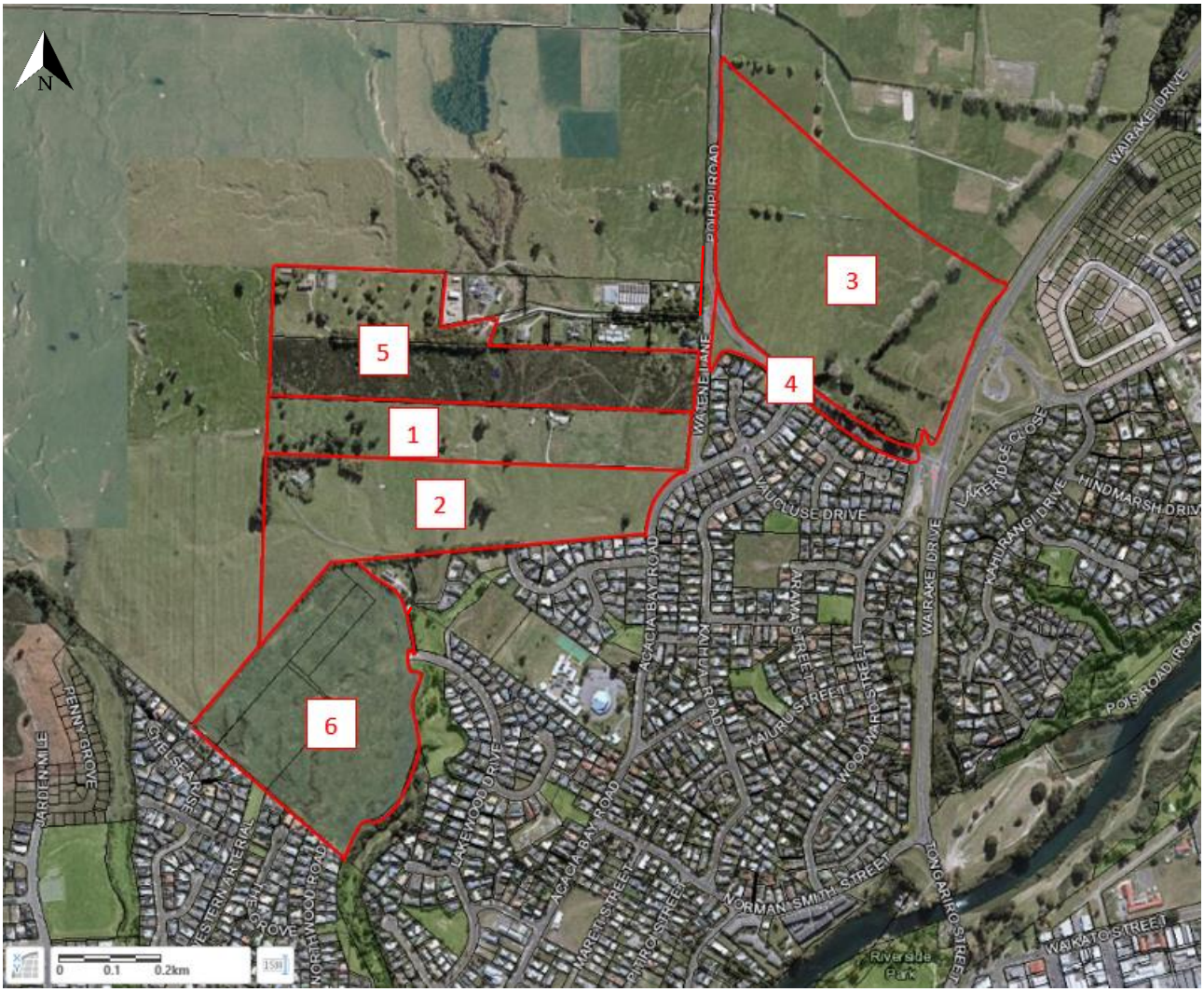


Figure 1: Sites 1 – 6 (outlined in red)

3 Geological Setting

3.1 Published geology

The GNS New Zealand 1:250k geological map for the Rotorua area indicates that the site is largely underlain by pumice sands of the Taupo Pumice Formation. The main material type is described as "Non-welded, loose to poorly consolidated to sintered, white to pale grey rhyolite ignimbrite with white to pale pink pumice clasts; commonly includes charcoal fragments and logs; fall deposits; minor alluvium". Areas of the site may be underlain by pumice sands of the Oruanui formation, which is described as "Non-welded, cream to pale pink-brown rhyolite ignimbrite with pumice clasts in a sandy ash matrix; minor fall deposits".

3.2 Likely Soil Types

Based on the published geology for the area, the likely surficial soil types (likely to be encountered in relatively shallow bulk earthworks and foundation influence zones for light timber framed dwellings) are pumice sands and ashy silts. Soil types will vary, and it is possible that there will be zones of silt and clay in some areas.

Some excavation and replacement of surface materials and ashy silts that may be encountered are likely to be required in order to achieve the 'good ground' provision for roads and structures as

required by New Zealand Standards NZS4404 and NZS3604. The depth to 'good ground' will need to be confirmed during detailed investigation and design of either the individual subdivisions or prior to building consents for individual structures.

3.3 Active faults

According to the GNS Active Faults Database[3], there are four identified active faults with several splays within a 5 km radius of the site. The closest of these is the Karapiti fault, which is located approximately 2.5 km to the northwest of the site at its closest point, as shown in Figure 2 (taken from GNS Active Faults Database).

GNS Science have recently produced an updated fault map update for TDC. These updated faults have not yet been added to GNS's Active Faults Database, however Figure 3 has been taken from Taupō District Council's online fault line mapping information[4] and shows several newly identified faults near the proposed development area. One of these faults passes into the northwest corner of Site 5, and development should be excluded from the fault avoidance area either side of this identified fault. The Active Faults Database should be reviewed for updates during each stage of the development.

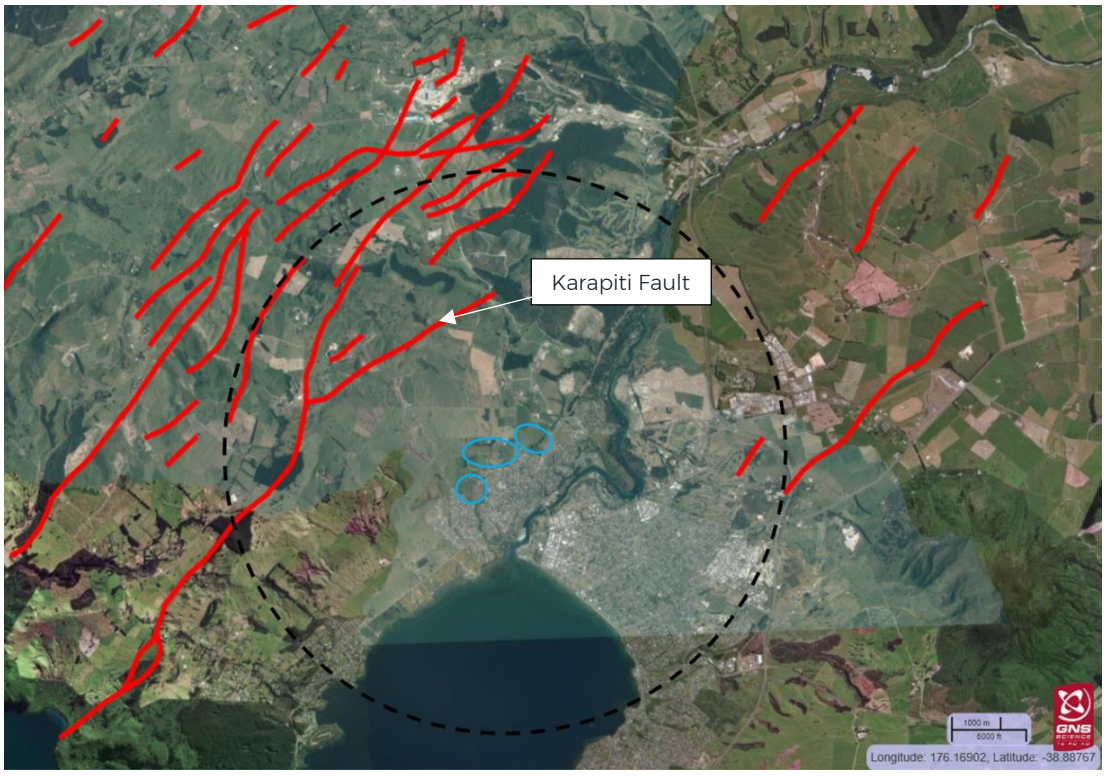


Figure 2: Identified active faults near the sites (shown in red). Approximate site locations are circled in blue. Approximate 5 km radius from sites is shown by the dashed black line.

[3] http://data.gns.cri.nz/af/
[4] https://www.taupodc.govt.nz/property-and-rates/fault-line-mapping

Figure 3: Taupo District Active Faults (update October 2020). Site areas outlined in red (indicative only) Background image taken from https://taupo.maps.arcgis.com/apps/webappviewer/index.html

4 Geotechnical Assessment

The site has been evaluated with respect to the known geological and geotechnical hazards common to New Zealand, in particular the Central North Island.

4.1 Site Walkover and Geomorphic Assessment

1.1.1 Site walkover

A site walkover of five of the six sites was undertaken on 21 February 2019 by members of WSP to identify any geomorphic features that may have an impact on the development proposal. Site 5 could not be accessed, but visual observations were made from adjacent sites. The geomorphic observations for each site were as follows:

Sites 1 and 2 (Figure 4 Figure 5, Figure 6, Figure 7, and Figure 13):

- The site generally consists of gently rolling farm paddocks;
- Some steep-sided gullies were observed and are incised up to approximately 5 m deep;
    - Most notable of the gullies is the extension of the Brentwood Gully, which splits into two and runs through Sites 1 and 2 (see Figure 4 and Figure 7), becoming steeper-sided and deeper towards the boundary with Site 5. This gully is understood to not generally have running water other than during heavy rainfall events;
- An infilled gully was observed within Site 2 as shown in Figure 4, and is likely an area of uncontrolled fill.
- Relatively small tomos were observed throughout the property and are characteristic of the nature of the soils in the area. An example of this is shown in Figure 13 where a tomo has formed around the base of a fence post. The observed tomos ranged in size from approximately 200 mm diameter to 500 mm diameter.

Site 3 (Figure 8, Figure 9, and Figure 10):

- The site is generally relatively flat;
- Shallow gullies (up to 2 m deep) were observed throughout that were dry during the site walkover but likely channel overland flow in heavy rainfall events. A deeper gully (up to 3m deep) is present in the middle of the property running towards the southeast;
- Stormwater infiltration basins are present in the southeast corner of the property, as shown in Figure 8 and Figure 10;
- No evidence of tomos was observed on this site; however due to the nature of the soils beneath the property, they may still be present.

Site 4

- Site 4 is an existing road (Poihipi Road) and no residential development is proposed here.

Site 5:

- Could not be accessed during the walkover. From the boundary with Site 2, Site 5 appears to be similar in nature to Sites 1 and 2 – i.e. undulating hills with some deeply incised gullies;
- The site is covered in scrub at the boundary with Sites 1 and 2;

- Aerial photographs and contour maps show that the Brentwood Gully Extension becomes steep sided and deep through this site, as shown in Figure 4.

Site 6 (Figure 11, Figure 12, and Figure 14):

- Gently rolling farm paddock that slopes south towards the lake;
- Was planted in pine trees until recently, tree stumps have been removed;
- A gully runs through the centre of the property, varying between 1 m deep in the north and 4 m deep in the south – see Figure 11 and Figure 12. A large tomo entrance was observed within this gully, as shown in Figure 14, measuring in the order of greater than 1m wide. No moisture was evident at the time of observation.

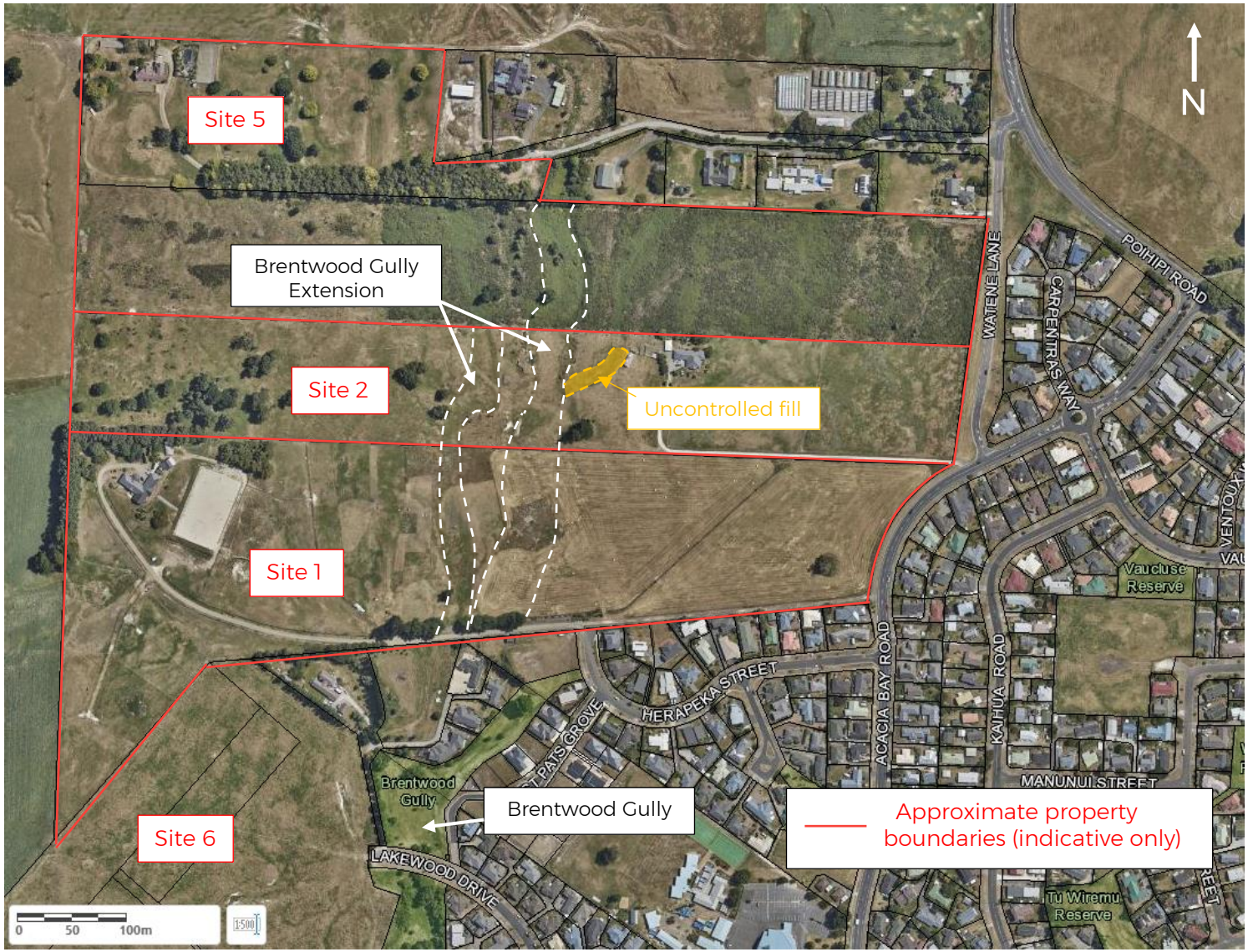


Figure 4: Sites 1, 2, and 5 (outlined in red). Background image taken from TDC's Mapi Service

Figure 5: Site 1 general overview, looking southeast

Figure 6: Site 2 general overview, looking east

Figure 7: Large gully on Site 2 (extension of Brentwood Gully)

Figure 8 - Site 3 (outlined in red). Background image taken from TDC's Mapi Service.

Figure 9: Site 3 general overview, looking northeast

Figure 10: Site 3 stormwater infiltration basin

Figure 11: Site 6 (outlined in red). Background image taken from TDC's Mapi Service. NB Gullies throughout site.

Figure 12: Site 6 general overview, looking southeast. NB gully at centre.

Figure 13: Tomo on fenceline between Sites 1 and 2

Figure 14: Tomo in gully on Site 6

4.2 Intrusive Investigations

Intrusive geotechnical site investigations were undertaken to assist in providing recommendations for development suitability. Investigations consisted of a combination of Cone Penetration Tests (CPTs), rotary core boreholes, and shallow hand augers. The investigation locations are shown on the plans in Figure 15, Figure 16, and Figure 17.

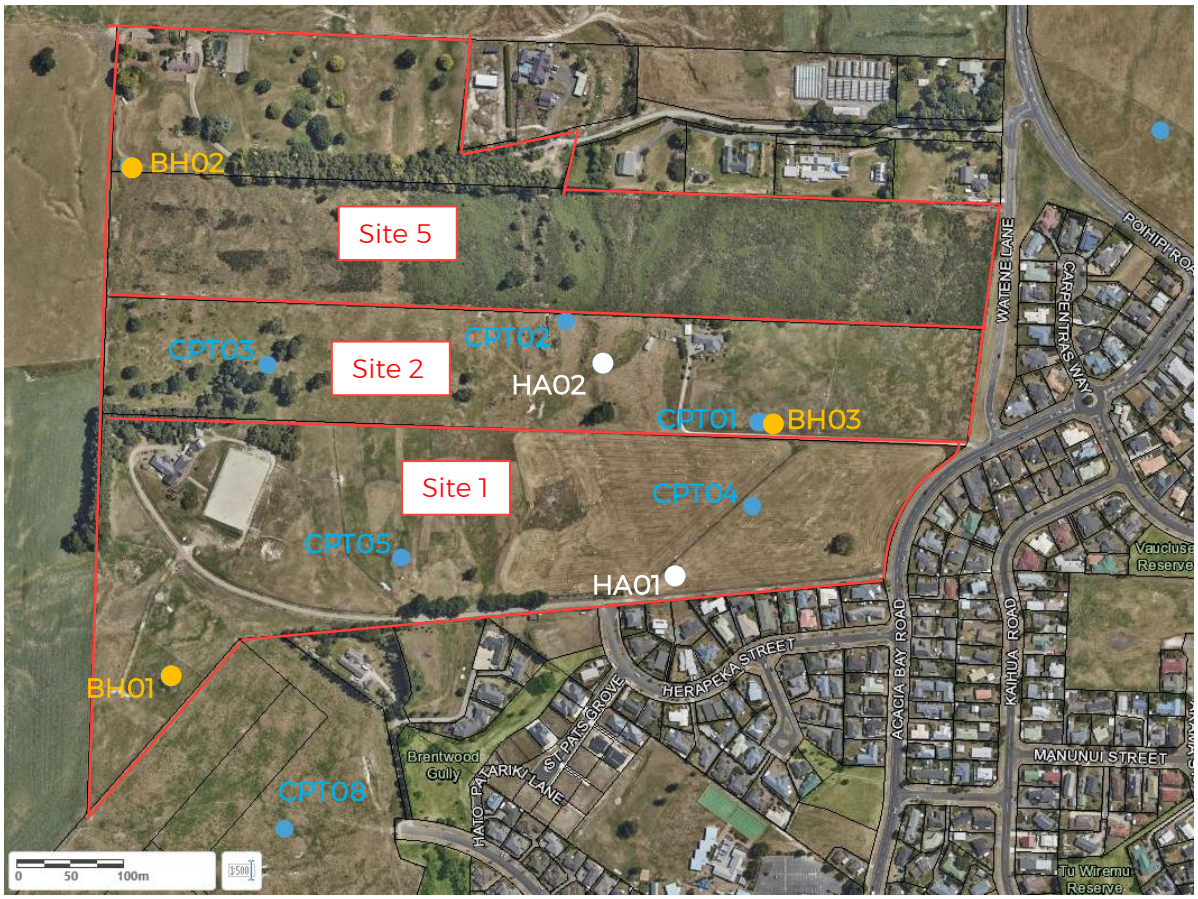


Figure 15: Investigation Locations - Sites 1,2, and 5

Figure 16: Investigation Locations - Site 6

Figure 17: Investigation Locations - Site 3

4.1.1 Cone Penetration Tests

Eleven (11) CPTs were undertaken to a target depth of 15.0 m below ground level (bgl) by Geotech Drilling Limited using a truck mounted rig. CPTs were undertaken during July 2020. The test locations were distributed throughout the sites excluding Site 4. Site 4 was excluded from testing as it is an existing road (Poihipi Road) and no residential development is proposed here. If the proposed development goes ahead it is likely changes to the road within Site 4 will occur and future testing may be required for this.

CPT results are included in Appendix A.

4.1.2 Boreholes

Four (4) rotary cored boreholes were undertaken throughout the 6 sites during July 2020. Standard Penetration Tests (SPTs) were undertaken at 1.5 m intervals within the boreholes. BH02 to 04 were hydro-excavated for the first 1.5 m for service clearance purposes so no material was recovered.

develop a profile of the soil types at Sites 1, 2, and 6. Site 5 was not able to be accessed during the walkover.

Hand auger logs and photographs are included in Appendix C. Descriptions of the outcrops encountered on site are included below. Materials recovered from the field were logged in the field following the methods and procedures in the NZ Geotechnical Society Guidelines[5].

Site 1:

HA01 was conducted at the eastern end of Site 1, at the approximate location shown in Figure 15. The hand auger encountered material generally consistent with the Taupo Pumice Formation.

Several hand augers were conducted during the construction of the house at the western end of the property. These hand augers were consistent with material encountered in HA01 to a depth of approximately 3.0 m bgl.

Site 2:

HA02 was conducted in a gully that appears to have been filled (Figure 18), at the approximate location shown in Figure 15. The auger refused at 0.2 m bgl.

An outcrop of pumice sands was observed at the western end of Site 2 (Figure 19) and could generally be described as 'fine to coarse SAND with some gravel; white; dry; poorly graded; gravel, subangular pumice. Crushes to fine to coarse sand with minor gravel. [TAUPO PUMICE FORMATION]'.

Figure 18: Filled gully on Site 2

[5] Field Description of Soil and Rock, Guideline for the field Classification and Description of Soil and Rock for Engineering Purposes, 2005.

Figure 19: Pumice sand outcrop on Site 2

Site 3:

Two hand augers (HA03 and HA04) were conducted to a depth of 1.0 m bgl at the approximate location shown in Figure 17. No outcrops were observed at this site. The hand augers both encountered material that was generally consistent with the Taupo Pumice Formation.

Site 6:

No hand augers were conducted at Site 6. An outcrop of white pumice sand was observed in a gully running down the centre of the site and could generally be described as 'fine to coarse poorly graded SAND with some subangular pumice gravel; white; dry;. Crushes to fine to coarse sand with minor gravel. [TAUPO PUMICE FORMATION]'.

4.3 Ground Conditions

We have interpreted the results of the investigation using our knowledge of soils in the area to infer ground conditions in the general vicinity of the proposed development. Table 2 below presents a generalised soil profile of the area based on the results of the deep geotechnical investigations. Soil descriptions from the reported CPT results differ from descriptions of materials that were encountered in the boreholes. There is currently no reliable correlation of penetration resistance in pumice soils, and these differences are likely to be due to the underlying pumice soils being crushed during penetration causing the CPT to overestimate fine-grained soils (silts and clays) rather than coarse grained material (sands and gravels).

The material recovered in the boreholes was relative consistent across the four locations. The vertical profile of the subsurface material encountered in the boreholes is summarised in Table 2.

Table 2: Generalised subsurface profile

Layer	Depth below ground to top of layer (m)	Depth below ground to base of layer (m)	Soil Description	Density
1	0.0	0.2	Topsoil	NA
2	0.2	2.0	Fine to coarse SAND	Loose (BH01, 03, 04) Medium dense (BH02)
3	2.0	10.0	Interbedded GRAVEL and SAND, with localised silt and silty SAND layers	Loose to medium dense
4	10.0	12.0	Interbedded GRAVEL and SAND, with localised silt and silty SAND layers	Medium Dense
5	12.0	15.0	Fine to coarse SAND with gravel	Medium Dense

SPT results were variable across each test location in the top 10 m, varying between loose and medium dense. The soils generally became more consistently medium dense below this depth. The near-surface SPT results in BH04 (Site 3) were notably lower than the other sites, with N values ranging from 0 – 2 in the top 6 m. These low N values are likely to result in bearing capacity issues for shallow residential foundations and areas of this site may require excavation and recompaction of soils in order to meet the 'good ground' requirements of NZS3604:2011.

The CPT results indicate variable soil types with depth; however, they show reasonably consistent results across the sites. The soil descriptions from the CPTs indicate the soils are much finer grained than those from the boreholes. As noted above, this could be due to the underlying pumice soils being crushed during penetration.

CPT02, 07, and 10 encountered a layer of organic material, likely buried topsoil, between approximately 4.5m to 5.0 m bgl. This layer was also encountered in BH03 at a similar depth. These investigation locations are dispersed across the project area which indicate isolated areas of organic material could be present throughout the sites at approximately 4.5m to 5.0m depth.

Cross sections have been produced using both borehole and CPT information and are included in Appendix D. These provide a more detailed breakdown of soil types with depth.

A possible large tomo was encountered in the base of CPT02. The CPT operators reported running a dip meter down the CPT hole upon completion and did not encounter the base by the time the dip meter ran out at 30 m bgl. There is no record of this tomo in the CPT, so it is inferred that the top of the void is at 15 m bgl. CPT02 was undertaken on the boundary of Site 2 and Site 5, within the base of the Brentwood Gully Extension. This feature therefore may be related to stormwater infiltration and it is recommended that further investigation in the form of geophysics takes place to help delineate this feature prior to development in this area.

4.4 Groundwater

Groundwater levels encountered during testing ranged from 4.50 m below existing ground level, to greater than 15 m below existing ground level. Groundwater was encountered at a depth of 4.50 m bgl in BH01 and CPT02, and a saturated layer was encountered at 4.50 m bgl in BH03. Poor core recovery in BH01 made identification of the material at 4.50 m bgl difficult; however, the material encountered at 4.50 m bgl was inferred to be a buried silty topsoil layer. It is inferred that

this near-surface groundwater encountered is localised perched water, possibly perching in this topsoil layer, rather than being representative of the groundwater table.

5 Seismic Setting

5.1 Site Subsoil Class

NZS 1170.5:2004 provides the basis for evaluating the Site Subsoil Class. Based on the results of the literature review and site investigations, the site is inferred to be Class C (Shallow Soil Site), conservatively assuming that bedrock is present within approximately 50 m or so of the ground surface. The selection of Class C (rather than class D) is due to the lack of deep geotechnical investigation data in the area and has been chosen as it results in a higher peak ground acceleration and is therefore considered a worst-case scenario.

5.2 Earthquake Return Period

Specific application of NZS 1170.5:2002 is considered appropriate for the plan change investigation. For assessment purposes, it is assumed that proposed buildings will have a 50-year design life and an importance level of 2.

NZS 1170.5:2002 establishes the earthquake annual probability of exceedances for the serviceability limit state (SLS1) and ultimate limit state (ULS) as 1/25 and 1/500 years, respectively.

5.3 Seismic Parameters Summary

Design Life	50 years
Importance Level	2
Ultimate Limit State (ULS) annual probability of exceedance	1/500 years
Serviceability Limit State (SLS) annual probability of exceedance	1/25 years
Unweighted peak ground acceleration coefficient, $C_{0,1000}$	0.38 (Taupō)[6]
Return period factor ULS, R_u	1.0
Return period factor SLS, R_u	0.25
Site response factor, f	1.33 (Class C)

The peak ground acceleration for the site has been calculated in accordance with the NZGS Earthquake Geotechnical Engineering Guidelines Module 1 and NZS1170.5:2004:

$$a_{max} = C_{0,1000} \cdot \frac{R_u}{1.3} \cdot f \cdot g$$

Resultant peak ground accelerations for use in design:

ULS - a_{max} = 0.39g, M_w = 6.1

SLS - a_{max} = 0.10g, M_w = 6.1

[6] https://www.nzta.govt.nz/assets/resources/bridge-manual/docs-3rd-edition/Bridge-manual-commentary-pdf-complete-v1.0.pdf, Table 6A.1

6 Liquefaction Potential

6.1 General

Liquefaction can occur when seismic shaking generates an increase in porewater pressure and a resultant reduction in effective stress, leading to loss of shear strength and ground deformation that may be particularly damaging for engineering structures depending on the:

- Depth to/presence of groundwater;
- Presence/thickness and strength of non-liquefiable soils;
- Density, grading, composition and age of the soils;
- Earthquake magnitude and ground acceleration.

The material encountered in both the boreholes and CPTs was generally loose in the near surface. Groundwater was not generally encountered at the near surface in the investigation locations, with the exceptions of BH01 and CPT02 where water was encountered at 4.50 m bgl and 4.00 m bgl respectively. This near-surface groundwater is inferred to be perched groundwater layers, possibly due to recent heavy rainfall or perched drilling fluids. Groundwater is inferred to have been encountered at depths of 12.5m and 14.5m depth in CPT01 and CPT05 respectively.

6.2 Results

A liquefaction analysis was completed using CLiq v3.0.2.4 to understand the likely performance of the soils beneath the development under seismic cycling. The parameters described in Section 5.3 and the groundwater levels described in Section 4.4 have been used for this analysis. The results of these analyses are included in Appendix E. Table 3 summarises the expected total settlements and Table 4 summarises the potential lateral displacements within the soil profile for both deep and shallow groundwater depths.

Liquefaction can cause lateral displacement to structures near sloping land or open cut faces. Lateral displacement was estimated at the CPT & Borehole locations assuming a 2-5m high open face at the Brentwood gully and extensions where appropriate, and 2m high open face in Site 3.

Under SLS events, the ground shaking is insufficient to induce settlements or lateral displacement. The relevant clauses from the New Zealand Building Code (NZBC) (25mm of settlement over a distance of 6m) are thus met with regards to the SLS event. Under the ULS event, the ground shaking has potential to cause settlement and lateral displacement in localised areas, particularly in the vicinity of BH01 and CPT02. These levels of liquefaction induced settlement and lateral spread can typically be mitigated by following the measures detailed in the Canterbury Guidelines[7]; however, further investigation should be considered to constrain these areas, determine levels of potential differential settlement, and inform design. Given the known high levels of uncertainty associated with liquefaction analysis in volcanic soils, it is possible that the predicted settlements are over-conservative, and that settlements of less than predicted at the site may occur in a ULS event.

Actual groundwater levels were not confirmed, although it is thought that the areas with a high, possibly perched groundwater table are likely localised. Installation and monitoring of piezometers throughout the sites should be considered during the subdivision stage to confirm the depths of groundwater across the sites and constrain areas of high groundwater. If shallow groundwater or loose material is encountered in other areas during construction, then further liquefaction analysis should be undertaken to inform foundation design.

[7] MBIE, 'Repairing and rebuilding houses affected by the Canterbury earthquakes', version 3, updated 29 May 2018.

Settlements and lateral displacements are likely to be much higher where shallow groundwater is encountered, due to the loose nature of the near-surface soils encountered during the investigations. Additional liquefaction analyses were completed assuming shallow groundwater levels to demonstrate this difference in potential settlements. The shallow groundwater results indicate liquefaction induced settlement and lateral displacement could be potential hazards across the sites, however as mentioned above, these predicted settlements may be over-conservative.

These liquefaction analyses have been undertaken using the current ground levels of the site. This analysis will be impacted by the final finished levels of each site and should be reviewed when the final cut and fill levels are confirmed during civil design.

Table 3: Results of Liquefaction Analyses – Vertical Settlements

Location	Normal GW			Shallow GW comparison	
	Groundwater depth, m	Settlement (cm)		Groundwater depth, m	Settlement (cm)
		ULS (0.39g)	SLS (0.10g)		ULS (0.39g)
CPT01	12.5	0	0	4.5	14
CPT02	4	9	0	4.5	9
CPT 03a	15	0	0	4.5	15
CPT 04	12.5	0	0	4.5	8
CPT 05	14.5	0.15	0	4.5	15
CPT 06	15	0	0	4.5	12
CPT 07	15	0	0	4.5	4
CPT 08	15	0	0	4.5	17
CPT 09	15	0	0	4.5	15
CPT 10	15	0	0	4.5	0
CPT 11	15	0	0	4.5	12

Table 4 Results of Liquefaction Analyses – Lateral Displacement under ULS (0.39g)

	Normal GW		Shallow GW comparison	
Location	Groundwater depth, m	Displacement (cm)	Groundwater depth, m	Displacement (cm)
CPT01	12.5	0	4.5	70
CPT02	4	0	4.5	0
CPT 03a	15	0	4.5	70
CPT 04	12.5	0	4.5	50
CPT 05	14.5	0.2	4.5	90
CPT 06	15	0	4.5	50
CPT 07	15	0	4.5	25
CPT 08	15	0	4.5	275
CPT 09	15	0	4.5	380
CPT 10	15	0	4.5	0
CPT 11	15	0	4.5	225
CPT10 with BH04	15	0	4.5	0
CPT09 with BH04	15	0	4.5	385
CPT01 with BH03	15	0	4.5	85
CPT05 with BH01	14.5	0.5	4.5	195
CPT03a with BH02	15	0	4.5	310

7 Fill Induced Settlements

Fill induced settlements can occur under certain circumstances, either within the fill itself or in the underlying stratum as a function of the additional imposed load of that fill. Civil design of bulk earthworks should consider settlement to ensure that they do not affect structures placed on fill in the future.

Specific care and investigations should focus on fill-induced settlements in the area of uncontrolled fill on Site 2 that is shown in Figure 4. No other uncontrolled fill or obviously soft areas

were noted during the site walkover. Site 5 was not able to be examined during the initial walkover due to access constraints, and due to thick vegetation cover during the geotechnical investigation phase. However, testing and analysis should still be undertaken during detailed civil design to confirm if settlement is likely to be an issue and needs to be accommodated.

8 Bulk Earthworks

Bulk earthworks in the form of cutting and filling will likely be required on each site in order to level the land for development. The civil design had not been completed at the time of producing this report; however, it is assumed that the individual sites will be made relatively level with a cut to fill process. The likely cut and fill depths will vary across the six sites, but are anticipated to be minimal (in the order of 1 – 2 m) for Site 3 and the eastern halves of Sites 1, 2, and 5. Site 6 and the western halves of Sites 1, 2, and 5 may require more levelling, possibly stepped as terraces or with larger cutting and/or filling depths that may require some form of retaining in localised areas (2 m+, anticipated to be less than 5 m). These levels should be determined during civil design, however, are not anticipated to pose significant constraints to residential land development. Indicative areas of likely cut and fill depths are included in Figure 20, Figure 21, and Figure 22.

Any bulk earthworks that are required shall be undertaken in accordance with NZS4431:1989 – Code of Practice for Earth Fill for Residential Development. Topsoil across the sites should be stripped and stockpiled beyond the earthworks footprint and can then be reused in the berms and other areas outside the building envelopes as required.

Some acceptable fill material will likely be able to be won from the sites themselves in the process of levelling the gullies and ridges, however the amount of usable material will need to be calculated during detailed civil design. It is anticipated that the soils will have a Compaction Factor in the order of 0.65-0.70 when compacted to optimum dry density, however this should be confirmed during civil design.

Unsuitable material will need to be cut to waste and disposed of off-site or placed and tagged as uncertified fill. In the event that insufficient fill material can be won from the sites, acceptable fill material will need to be imported from elsewhere.

Any carriageway footprints shall be undercut a further 450 mm and recompacted to ensure that an acceptable roadway subgrade is achieved. Other areas, such as footpaths and vehicle crossings, may also require subgrade improvements dependant on the results of onsite testing and verification.

Care should be taken during cut and fill operations to ensure that stormwater flow paths remain intact or that stormwater flows are redirected to other appropriate flow paths or ponds on site.

Figure 20: Indicative estimated cut and fill depth areas at Site 3 (green = estimated 1-2m, orange 2m+)

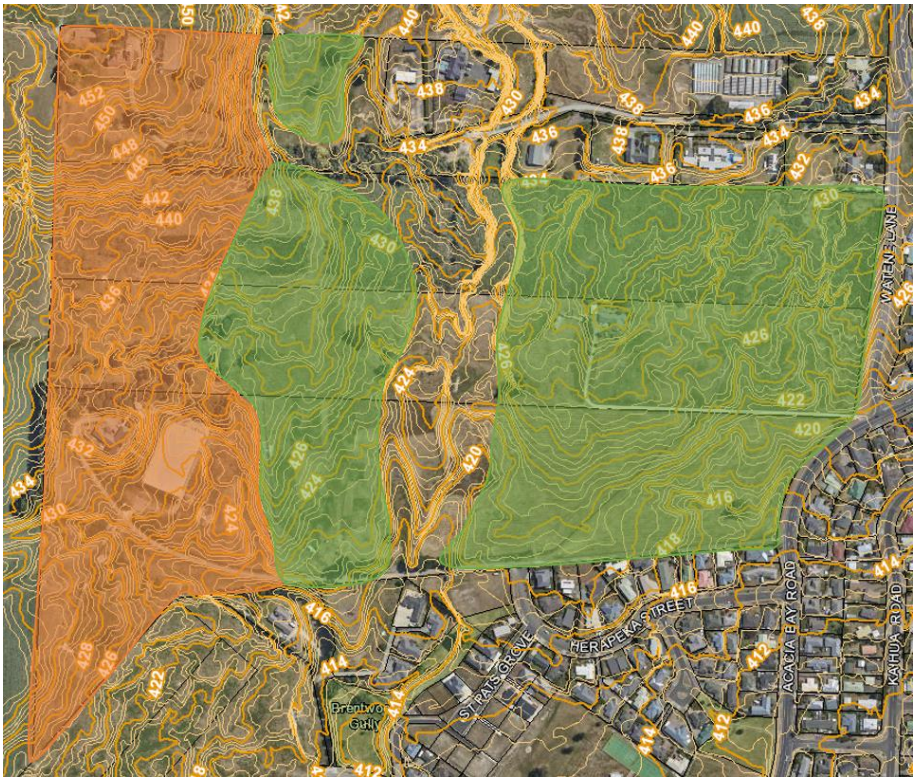


Figure 21: Indicative estimated cut and fill depth areas at Sites 1, 2, and 5 (green = estimated 1-2m, orange 2m+)

Figure 22: Indicative estimated cut and fill depth areas at Site 6 (green = estimated 1-2m, orange 2m+)

9 Stormwater Requirements

Stormwater analysis and disposal requirements are covered in the detailed WSP Stormwater report titled *Nukuhau Structure Plan Stormwater Strategy*. The likely stormwater requirements for the six sites are outlined in the following sections.

9.1 Construction Stormwater Control

Stormwater will need to be adequately controlled during subdivision construction in line with Erosion and Sediment control guidelines current at the time of construction. This will likely include maintaining stormwater flow paths, directing stormwater into settlement ponds, and disposing of stormwater appropriately off site. Consideration will need to be given to how to adequately control site stormwater during heavy rainfall events.

9.2 Permanent Stormwater disposal

This section should be read in conjunction with WSP Report '*Nukuhau Plan Change, Stormwater Management*', which tables the proposed disposal and mitigation measures for the site in regard to stormwater management. Appropriate stormwater disposal will be critical in reducing the risk of excessive erosion and tomo formation throughout the sites.

The natural water table and any effects that development may have on this through recharge are relevant, with most of the geohazards being exacerbated by the presence of groundwater. The elevation of the sites varies between 50 and 98 m higher than lake level, and the natural water table is inferred to sit deeper than 15 m below existing ground level. Localised elevated water

tables were detected during the geotechnical investigations and are inferred to be perched water tables. Further investigation of the groundwater table is recommended to identify and constrain these areas of elevated groundwater levels.

According to TDC's Stormwater Strategy[8], permanent stormwater disposal must be able to manage a 10% AEP rainfall event for the catchment, with stormwater from higher intensity rainfall events to be managed by "secondary flow paths, ponds, and other suitable methods up to a 1% AEP event for the catchment".

As a general requirement, natural overland flow paths should be maintained where possible to aid in permanent stormwater disposal. This should include the larger gullies on Sites 1 and 2 (for example, the Brentwood Gully Extension) as shown in Figure 4. Care should be taken during detailed design to limit the increase of stormwater flows into these gullies, due to the potential impacts downstream (for example soil erosion and increased tomo formation). Erosion of gully sides may result in a slope stability hazard, impacting on nearby residential lots.

Each residential lot should have an appropriate system for managing stormwater for that property. On-lot infiltration is important to disperse infiltration throughout the catchment, thereby reducing flows at the base of the catchment. Stormwater flows from kerb and channel should be directed to appropriate detention areas. Detention strategies, as detailed in the separate stormwater report, can include:

- Underground storage tanks
- Oversized piped network
- Road-side swales with detention weirs
- Maximising infiltration in treatment swales throughout the road network
- Oversized infiltration pits on each lot (or multiple pits) to ensure maintenance and performance contingencies

10 Other Geohazards

10.1 Lateral Spread/Ground Deformation

The site walk-overs indicated no areas that could readily be identified as ground deformation due to historic seismic activity, including surface emanations such as sand deposits due to liquefaction. It should be noted that the ground has been materially modified by pastoral activities, so it would also be unlikely that these types of features would have been preserved to view. The potential for lateral spread in future seismic events has been discussed in Section 6, and is largely dependent on the depth to groundwater.

10.2 Slope Stability

Little evidence of slope instability was observed during the site walkover and geotechnical investigations; however slope stability should be considered during civil design especially in localised areas where cut or fill heights exceed 1.5m. Slope stability may be an issue near some of the deeper gullies, for example the Brentwood Gully Extension in Figure 4. A preliminary slope stability model has been run using Slope/W on a cross section of the Brentwood Gully Extension in Site 5, using an estimated topographic profile taken from TDC's Mapi Service[9]. The soil profile was taken from nearby BH02, and parameters were estimated using the material encountered and local knowledge of soil behaviour in the area. The groundwater table is assumed to be below the base of the gully at this location. The horizontal seismic coefficient used for this analysis is 0.2

[8] Taupo District Council Stormwater Strategy (2009) - https://www.taupodc.govt.nz/our-council/policies-plans-and-bylaws/district-strategies/stormwater-strategy/Documents/Stormwater-Strategy.pdf
[9] http://gis.taupodc.govt.nz/Html5Viewer/?viewer=mapi

(0.5*PGA). This value was determined from Table 1 of Melo & Sharma (2004)[10], and takes into account limiting factors on the maximum acceleration that can be transmitted through soil in a seismic event.

Standard acceptable Factors of Safety (FOS) are considered 1.5 for static long term conditions, and 1.0 for ULS seismic conditions. Considering this, the results of this analysis, shown in Figure 23 and Figure 24, suggest that failures may encroach up to 6m back from the cliff edge in both the static and seismic cases. To address this potential issue, it is recommended that lots are offset 10 m from cliff edges. Figure 25 and Figure 26 give indications of the FOS of a failure encroaching 10m back from the slope crest in both static and ULS seismic cases, and both are above standard acceptable limits.

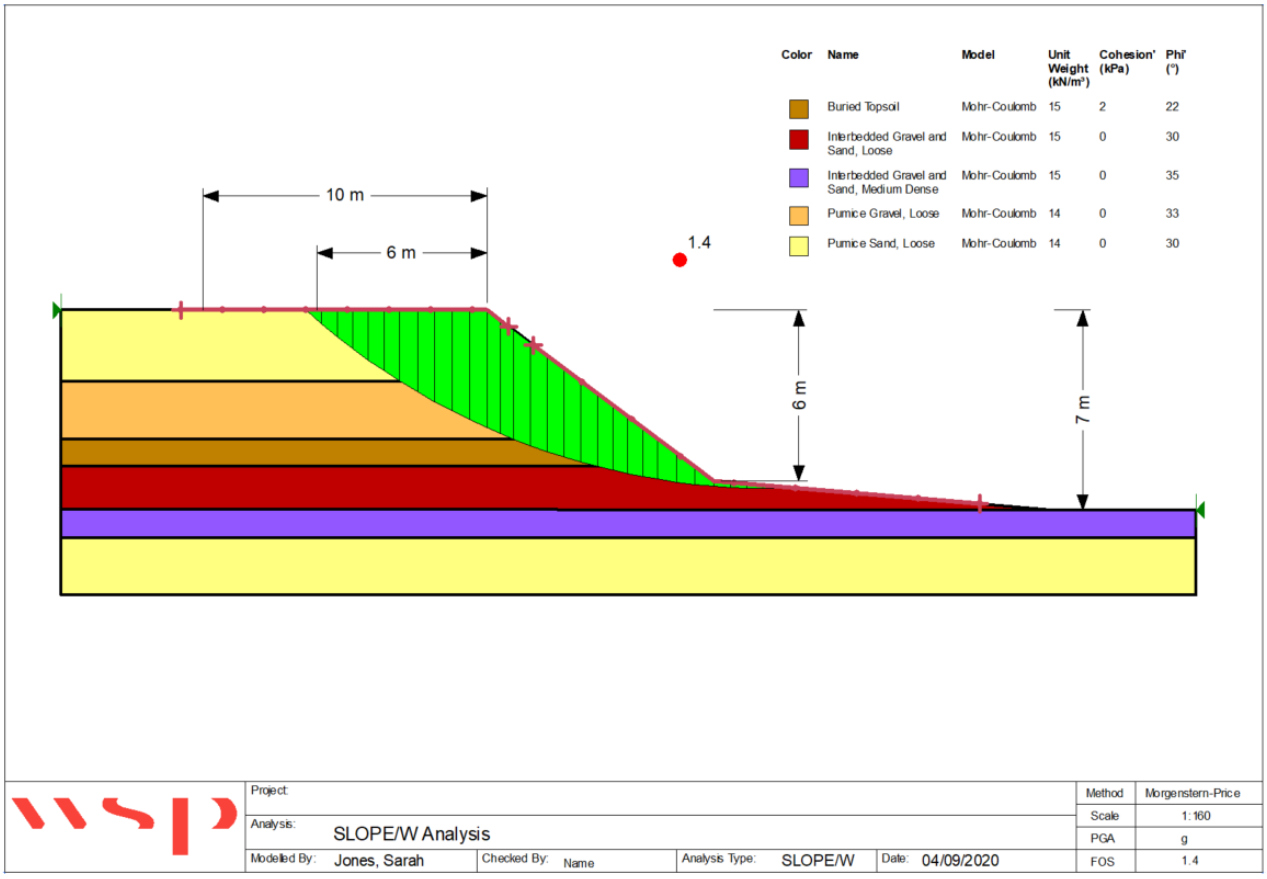


Figure 23: Slope Stability Model at Brentwood Gully Extension, static

[10] https://www.iitk.ac.in/nicee/wcee/article/13_369.pdf

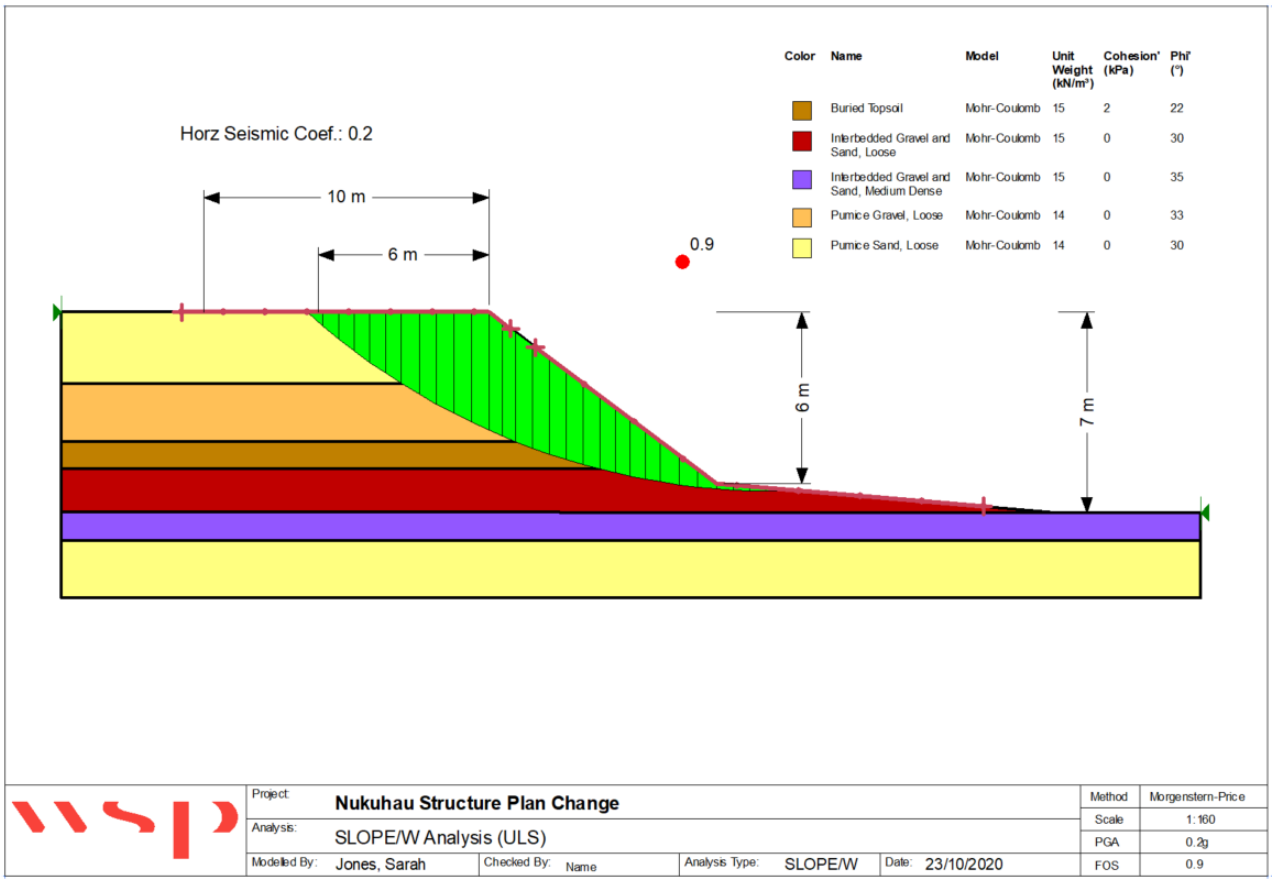


Figure 24: Slope Stability Model at Brentwood Gully Extension, ULS

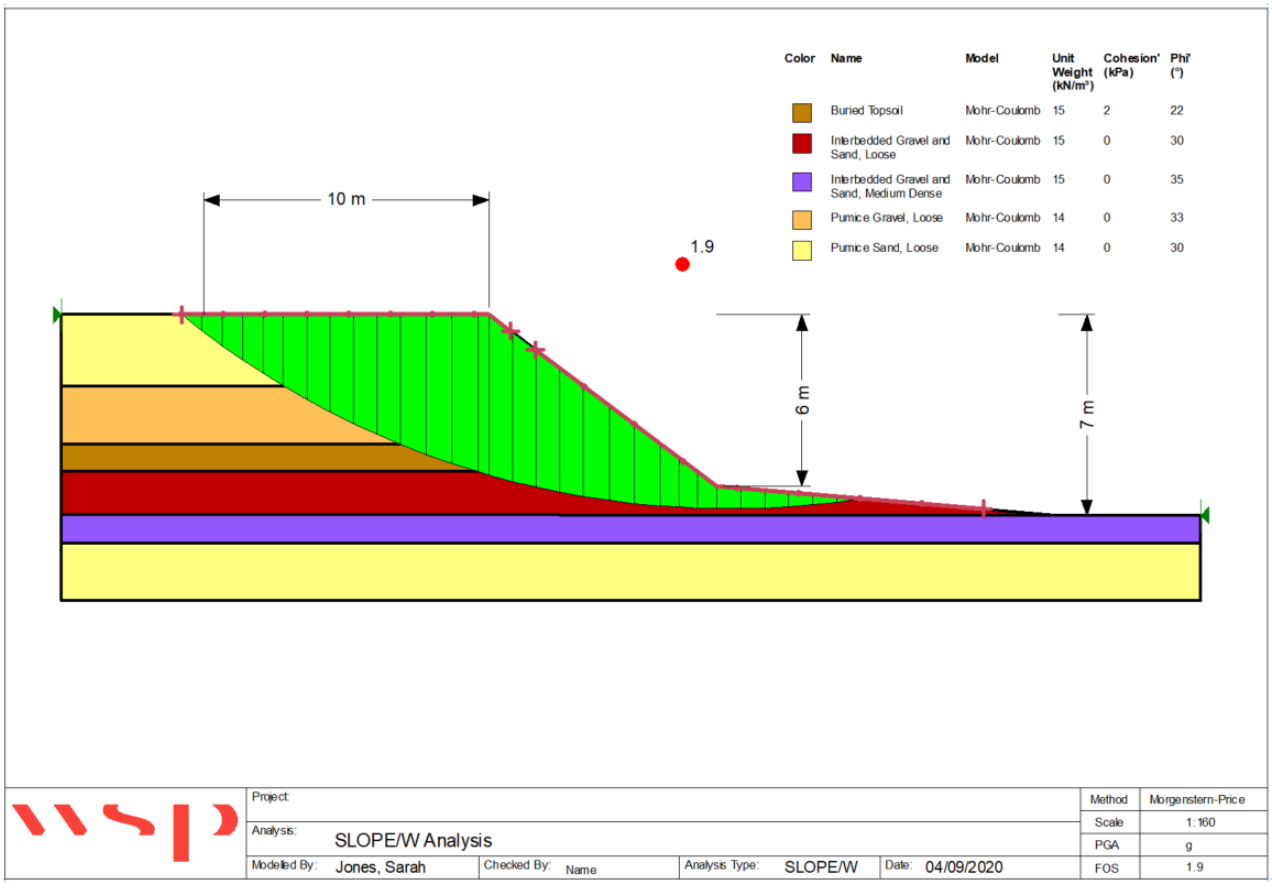


Figure 25: Slope Stability Model at Brentwood Gully Extension, static, failure 10m back from slope edge

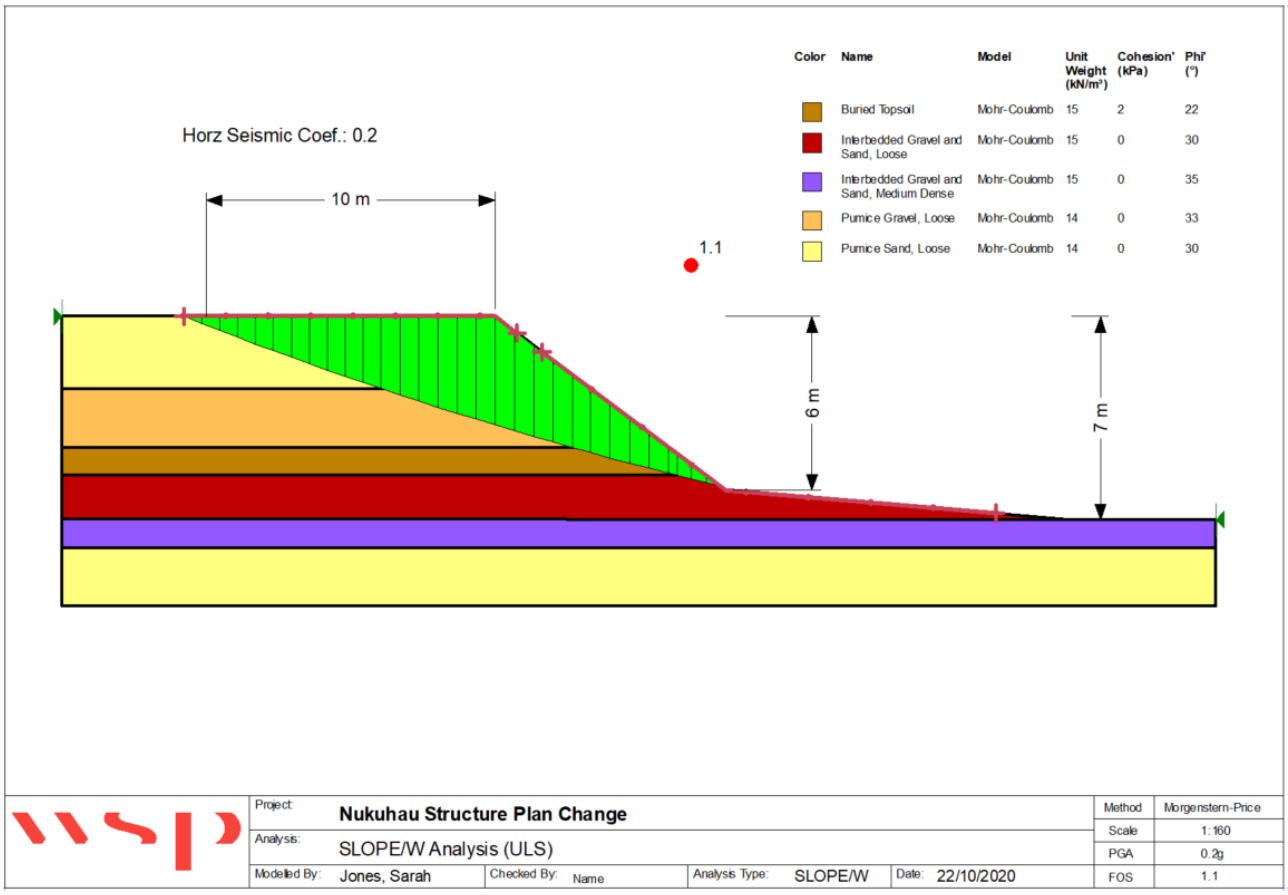


Figure 26: Slope Stability Model at Brentwood Gully Extension, ULS, failure 10m back from slope edge

10.3 Geothermal Induced Settlement

The proposed plan change area sits within the Wairakei – Tauhara Geothermal Field, which is subject to a number of areas of subsidence due to geothermal draw down. Information was sought from Contact Energy regarding settlement due to geothermal power development in the Nukuhau area in particular. The information provided indicates that this area is not within a known subsidence bowl and had not experienced significant settlement during the last area wide survey in February 2017. The latest monitoring data is included for information in Appendix F.

10.4 Expansive Soils

Thin clay layers were encountered at depths generally greater than 3.0 m bgl in several CPTs (excluding CPT04 and 05 where they were encountered within the top 3 m). These layers are currently considered unlikely to be shallow enough to have an impact on standard residential foundations, however this should be reassessed when final levels are known. It should also be noted that CPTs tend to overestimate the fines content in pumice soils, and the fine soils encountered in the Central North Island generally do not exhibit expansive behaviour. It is therefore considered unlikely that these layers would have an impact on residential foundations. If clay layers are exposed during earthworks, further testing should be undertaken to confirm the shrink/swell potential of the clays as per NZS3604:2011. If these clays are identified as being expansive and are likely to be impacted by seasonal groundwater table fluctuations, it is recommended to either remove the material or use specific engineering design (SED) for the foundations.

10.5 Flooding

No evidence of areas prone to flooding issues, including areas of ponding, were encountered during the investigations. Flooding may foreseeably be an issue in the Brentwood Gully Extensions identified in Figure 4 where higher stormwater flows could be expected during storm events. For this reason, it is recommended to avoid development in these areas without further hydrologic studies.

10.6 Tomos

Tomos are likely to be encountered throughout the sites due to the nature of the soils. Tomos are commonly encountered throughout the pumice-derived soils of Taupō region and observations taken from the site walkovers suggest that they are in general no more or less prevalent here than the rest of the region. The exception to this is the previously mentioned potential tomo encountered in the base of CPT02, where further investigation is recommended.

Mitigation techniques for commonly encountered smaller tomos could include excavating and backfilling those that are encountered at shallow enough depths and diverting stormwater from entering known tomos.

Larger tomos may require additional investigation and site specific design for remediation.

11 Conclusions and Recommendations

Based on the above information, we consider that these six sites would be generally suitable for residential development from a geotechnical perspective. Observed areas of immediate concern have been highlighted and will need to be addressed during the civil design stage. It should be noted that due to the nature of the assessment of these sites, further unsuitable areas and or soils may be encountered during subdivision development and consideration should be given to this during the civil design stage.

The most significant uncertainty is in regard to the groundwater table. We believe that the permanent groundwater table is greater than 15 m bgl and unlikely to pose a risk to potential residential development. However, elevated or perched water tables need to be identified and measures taken to reduce the risk to acceptable levels.

Earthworks in the form of cut and fill or terracing will likely be needed to make the land suitable for residential development. Initial investigations suggest that some material may be able to be ‘won’ from the sites for use in filling, however this should be investigated and confirmed during the civil design stage.

In order to meet the requirements of New Zealand Standard NZS 4404:2010 ‘Land Development and Subdivision Infrastructure’ and the TDC Code of Practice for the Development of Land for subdivision of existing lots, we recommend the following:

- Further detailed geotechnical investigations with accompanying subsurface investigations should be undertaken prior to each stage of subdivision development to inform detailed civil design and to identify areas of loose near-surface soils such as that encountered in BH04 (Site 3);
- Shallow ‘NZS 3604:2011[11]-type’ geotechnical investigations should ultimately be undertaken on each lot prior to application for building consent, to ascertain whether individual lots

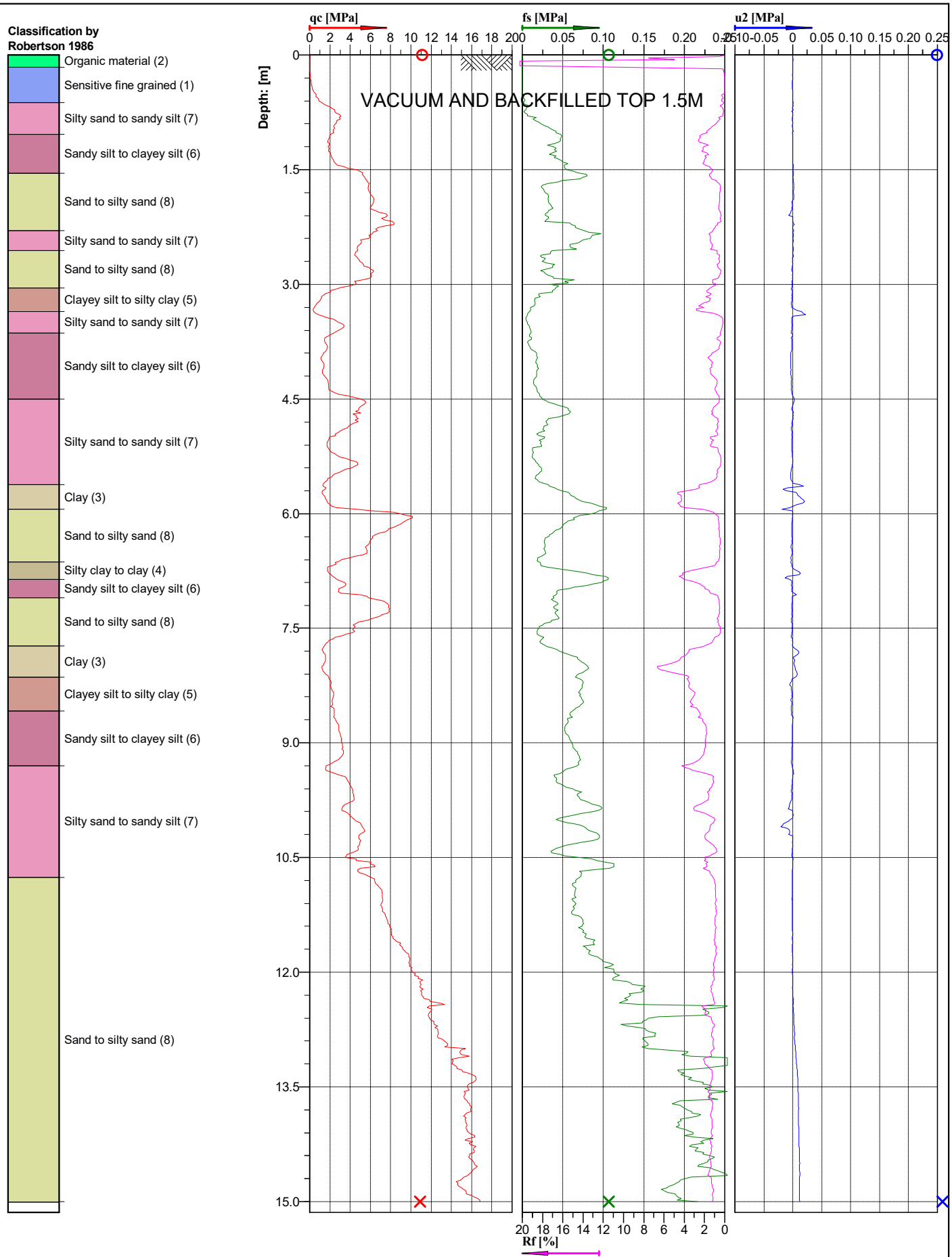
[11] New Zealand Standard NZS:3604:2011 ‘Timber-framed buildings’

are able to be designed using the proprietary designs from that standard, or whether specific engineering design is required;

- Existing stormwater flow paths and gullies should be maintained where possible to avoid stormwater concentration in one area, and reduce the chance of tomo formation. Requirements in the detailed stormwater report will supersede the requirements of this report;
- Dwellings should be provisionally offset at least 10 m from any steep-sided gullies such as the Brentwood Gully extension shown in Figure 4 and the stormwater infiltration basins in Site 3, shown in Figure 8, in order to reduce the risk to dwellings from potential slope instability. It should be noted that subsequent detailed civil design may overrule this requirement if the landform is sufficiently modified and/or retained.
- Construction should be avoided on any areas of historic or uncontrolled fill, including the fill found on Site 2 that is outlined in Figure 4. Further investigation or removal of this fill is recommended prior to housing development in any areas of uncontrolled fill.
- Further investigation should be undertaken in the area surrounding CPT02 to determine the presence and extent of a possible large tomo at 15 m depth and its impact on future development. Geophysical investigations are recommended in this location to help to define the extent of the affected area. No construction is recommended in this area until the exact extent of this feature has been investigated and assessed.
- Construction should be avoided within any fault avoidance areas, including that of the fault identified in the north-western corner of Site 5 as shown in Figure 3.
- Further investigation into groundwater levels across the site by installing and monitoring piezometers prior to subdivision. These would be particularly useful in the localised areas where potential perched groundwater has been identified. The investigation points are discrete points and have been generalised to provide a geotechnical model for analysis. However, it should be noted that perched groundwater may exist at locations within the site that were not investigated. The depth to groundwater is uncertain. The groundwater depth will significantly influence liquefaction potential.
- In the event that shallow groundwater levels are identified and the probability of liquefaction increases from “low” (groundwater at depths greater than 15m), to “high” to “very high” (elevated or perched groundwater levels), measures such as those recommended in Canterbury Guidelines[12] can be utilised to mitigate any risk to residential structures.
- Further liquefaction analysis at the civil design stage when final ground levels are known as this will affect the amount of settlement experienced at each site during seismic events.

[12] MBIE, ‘Repairing and rebuilding houses affected by the Canterbury earthquakes’, version 3, updated 29 May 2018.

Appendix A Cone Penetration Test Results



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GEOTECH DRILLING

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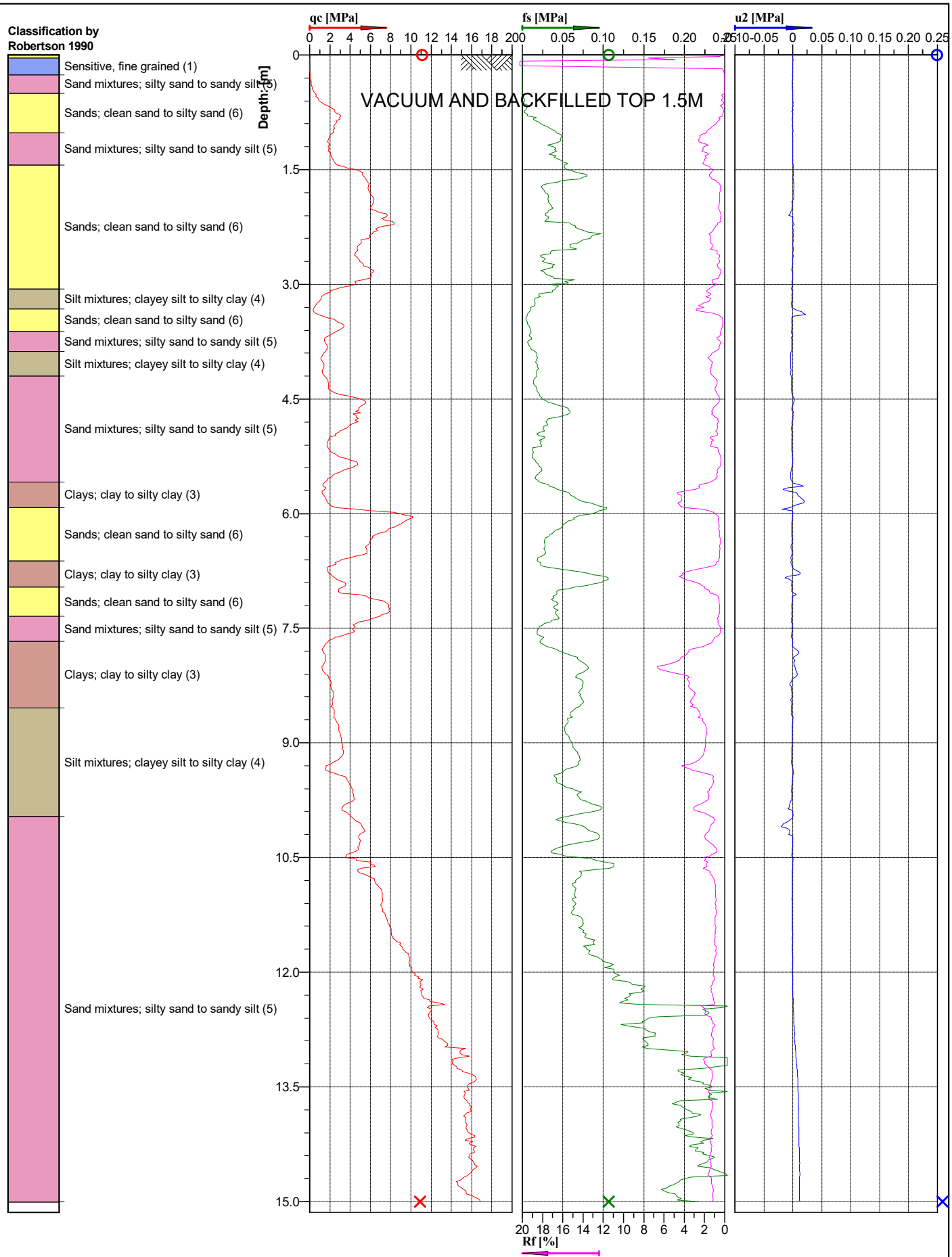
Sleeve area [cm2]: 150



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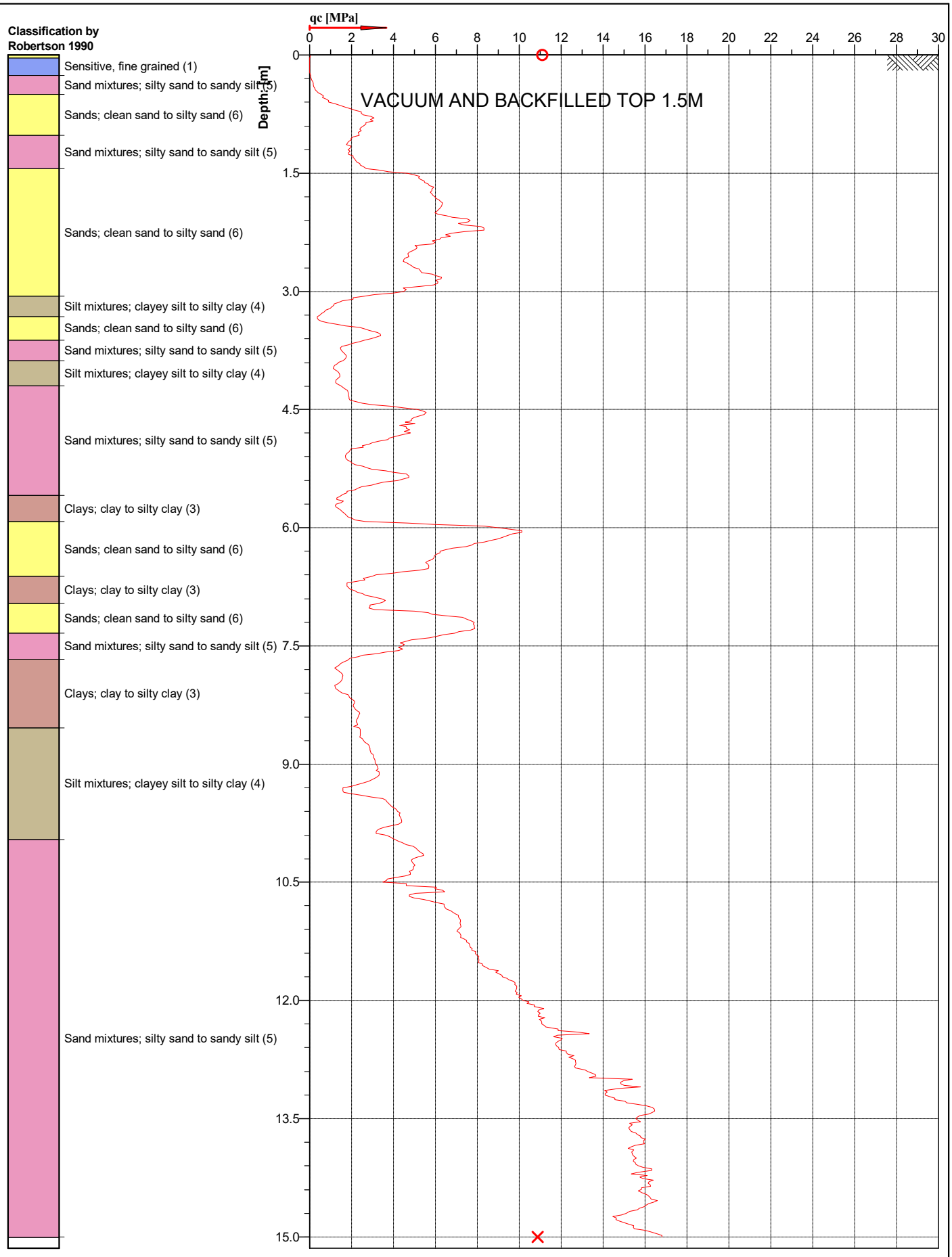

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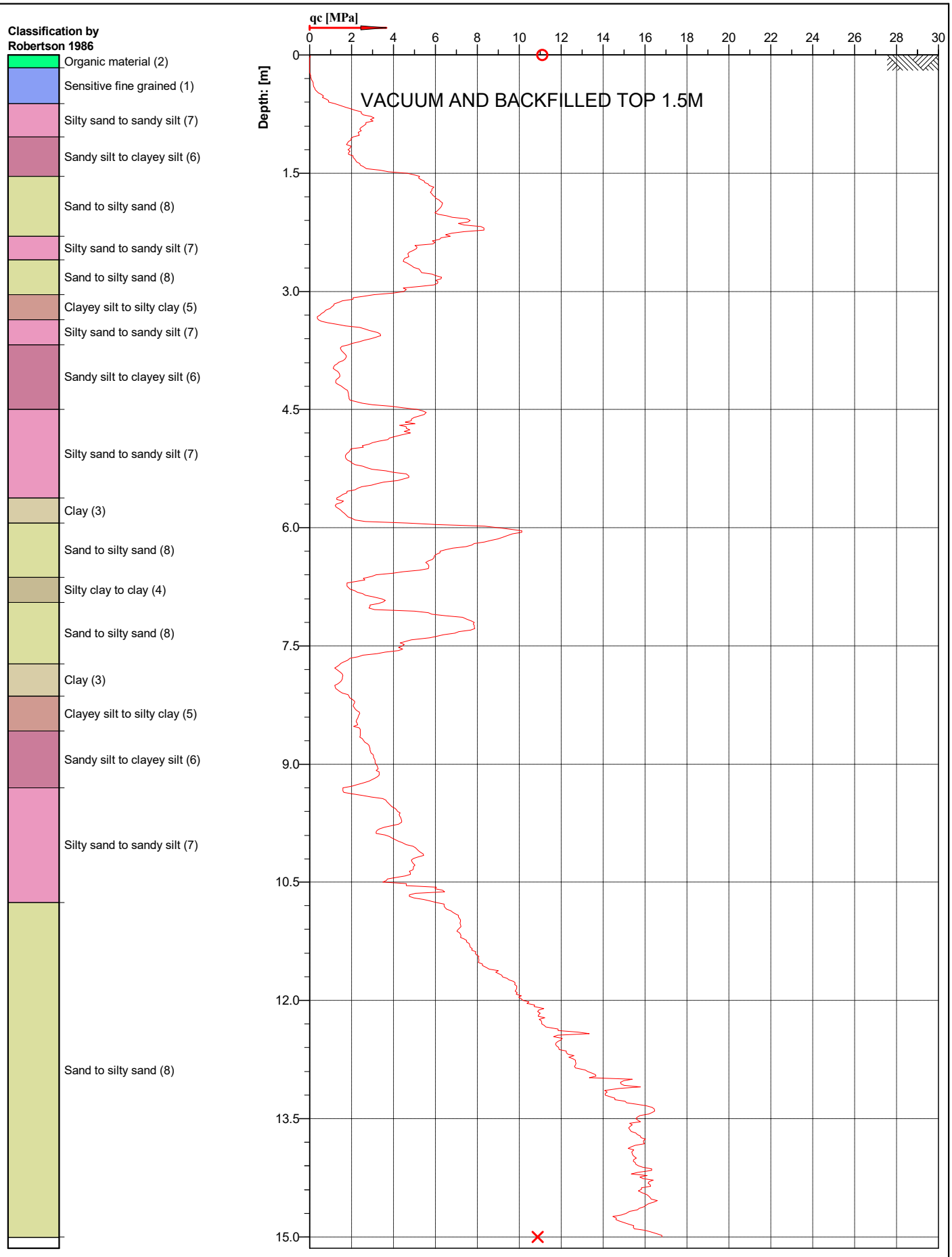

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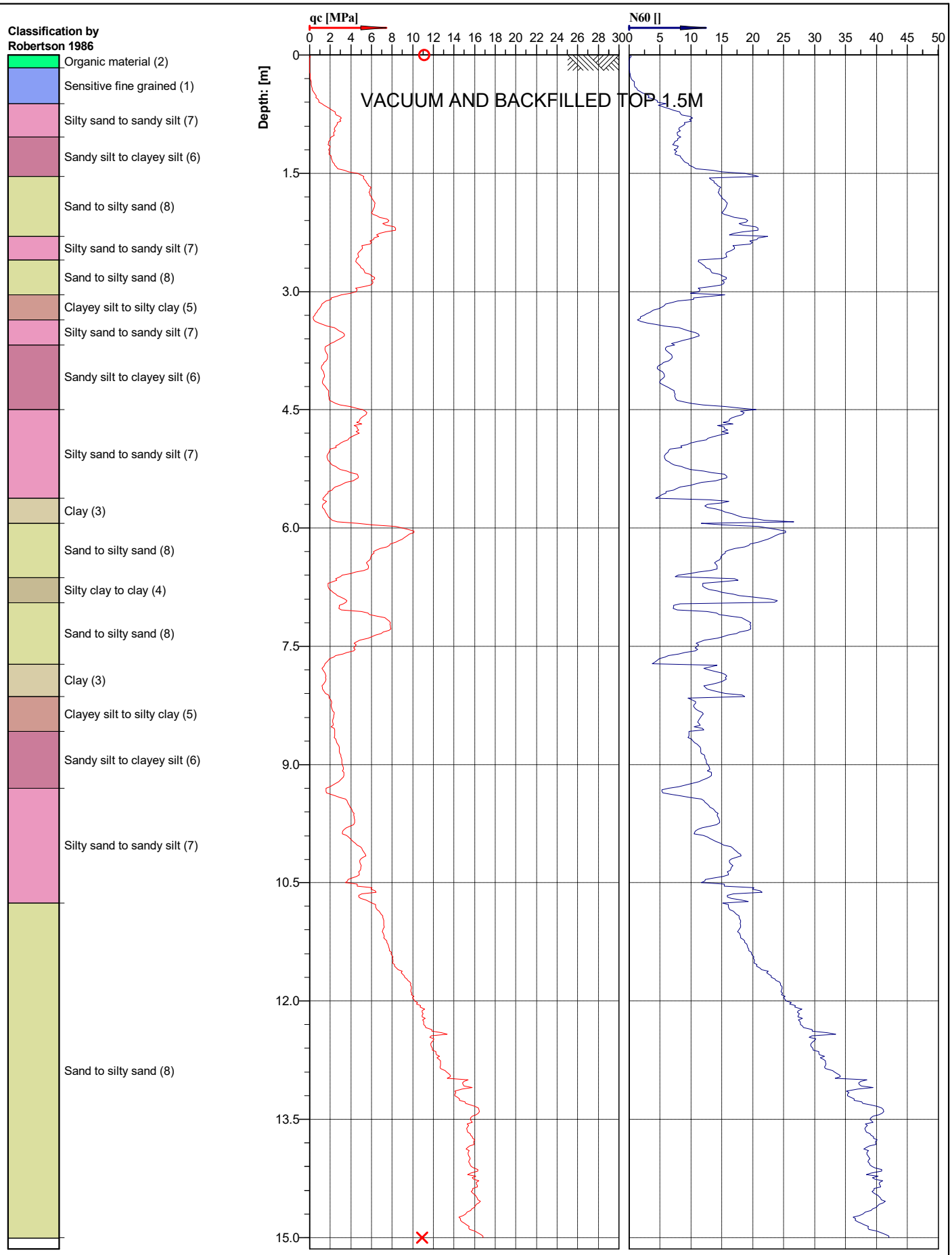

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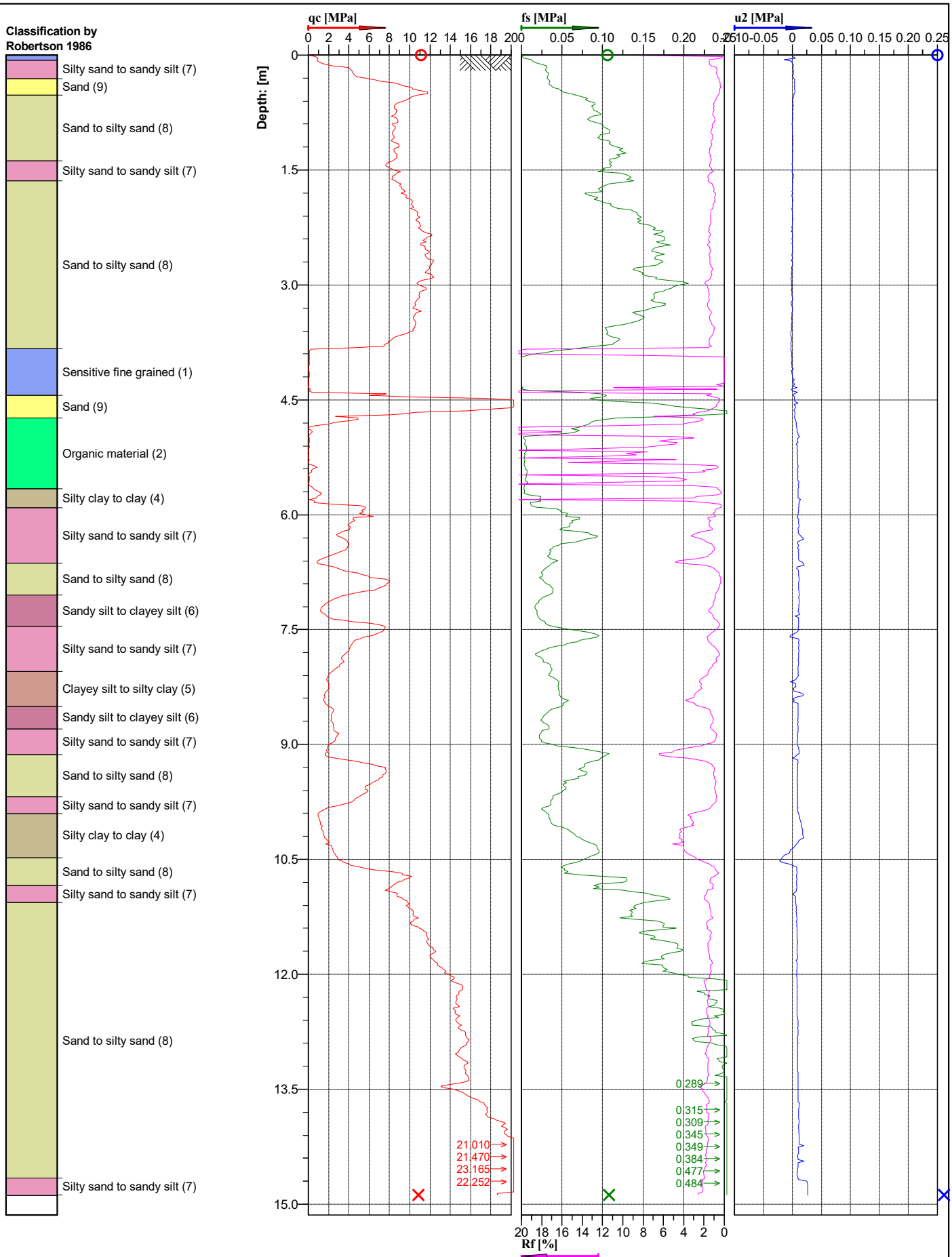

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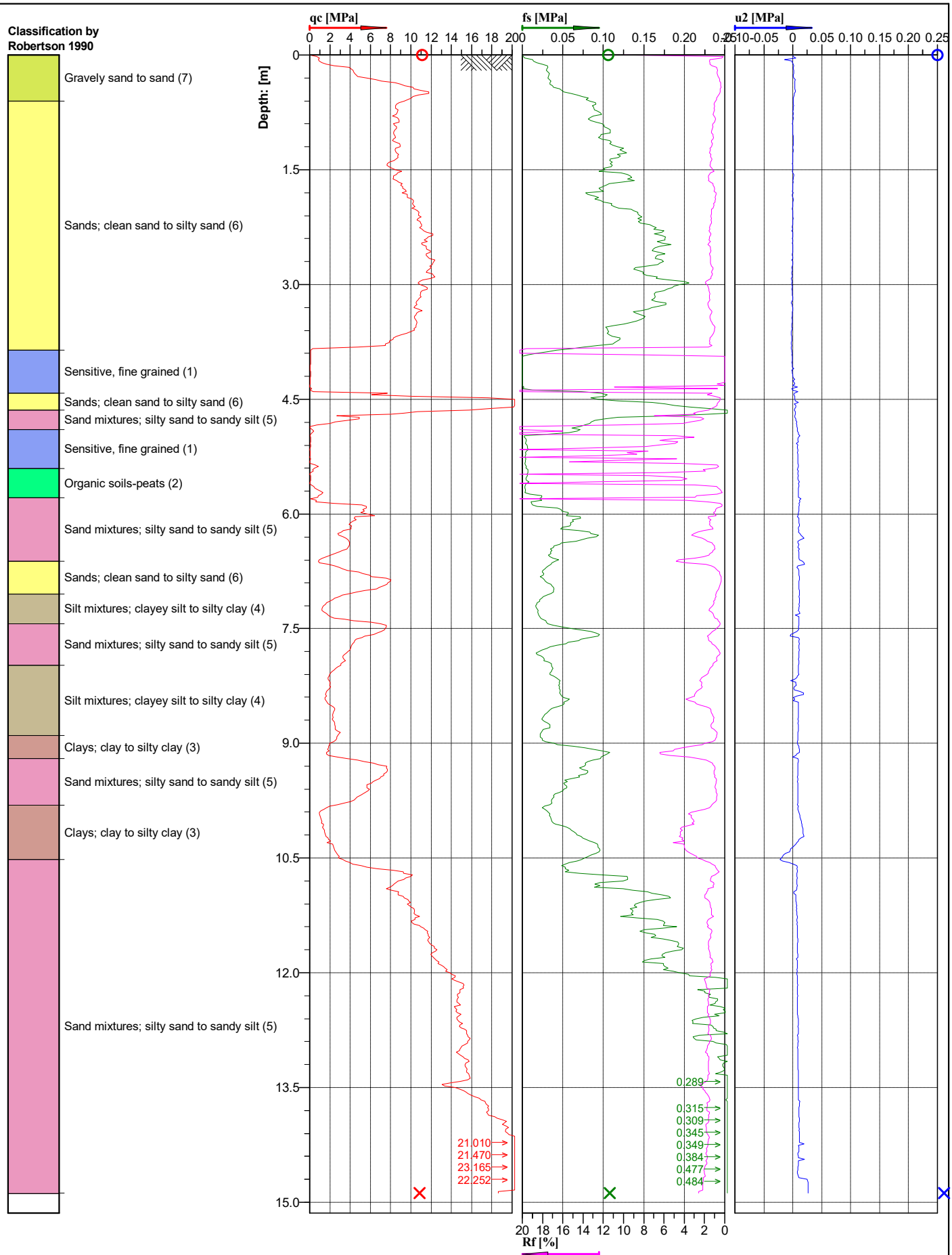

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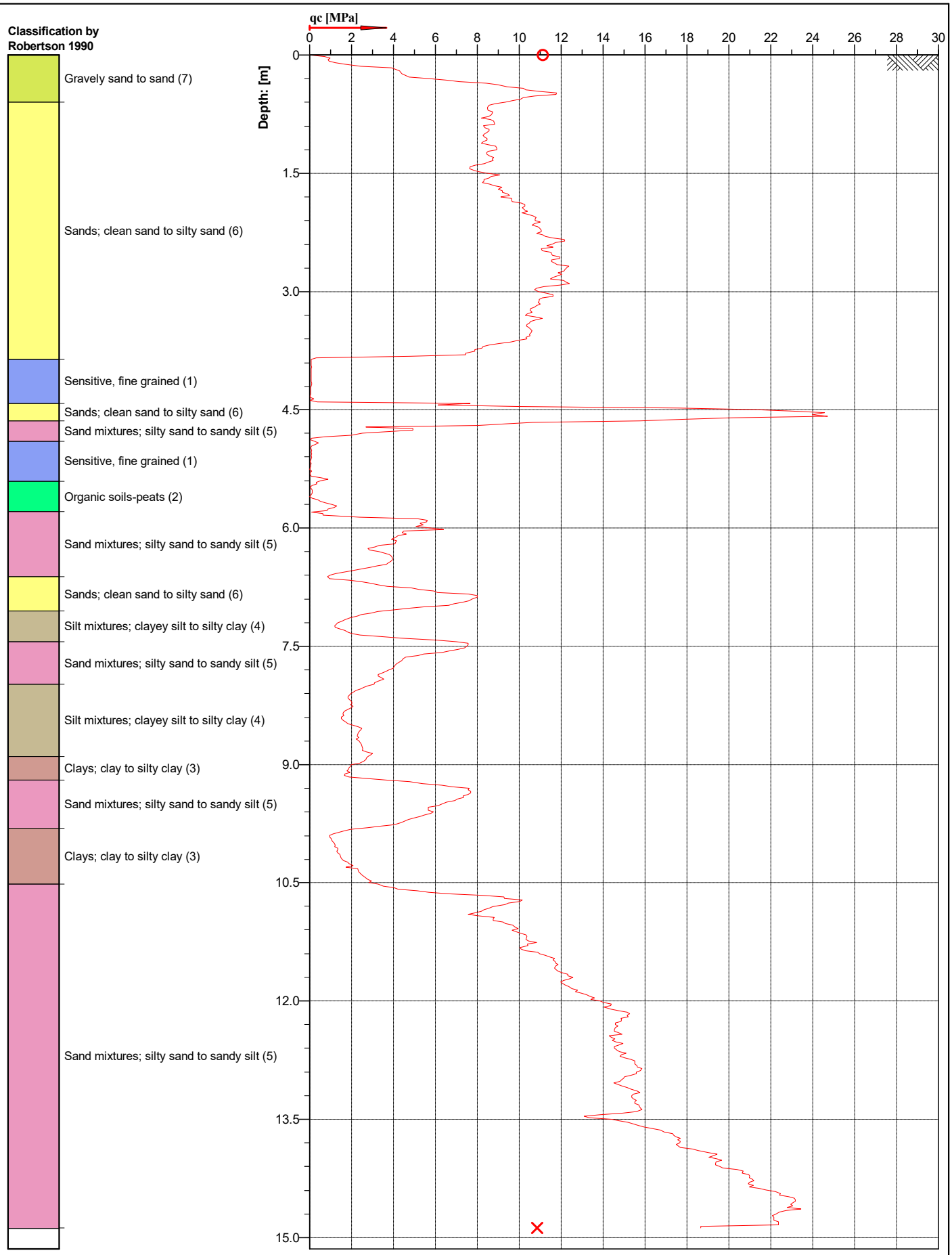

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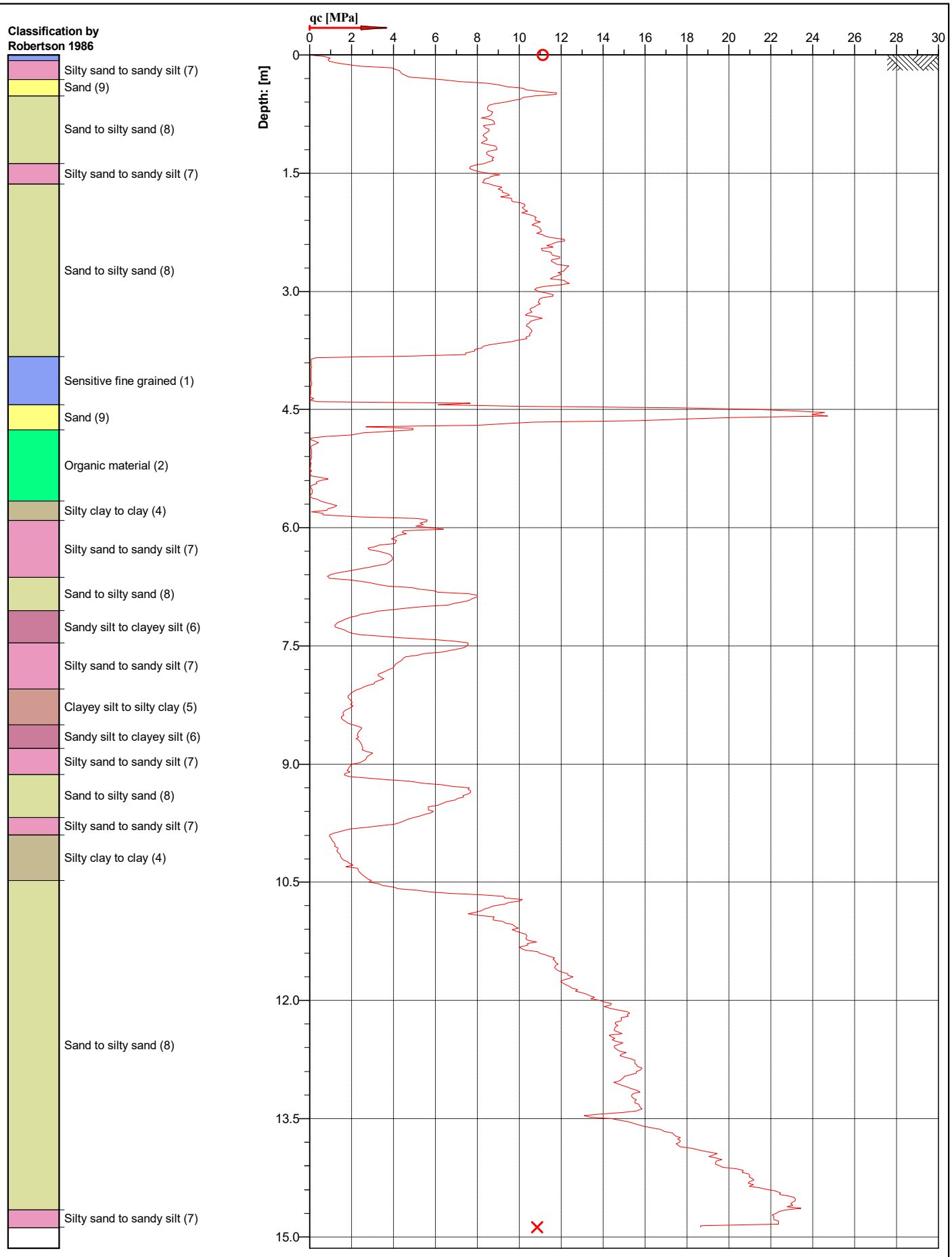

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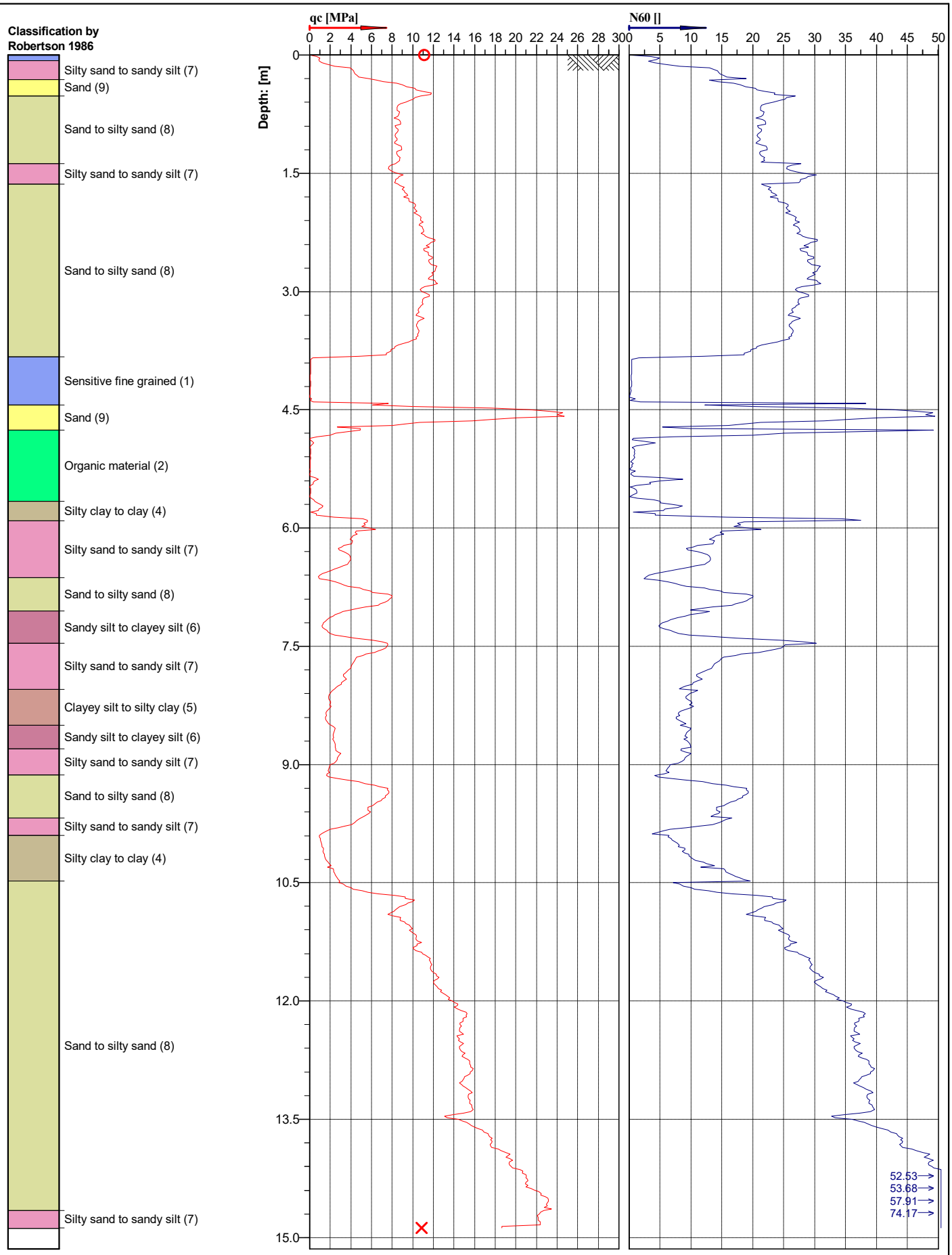

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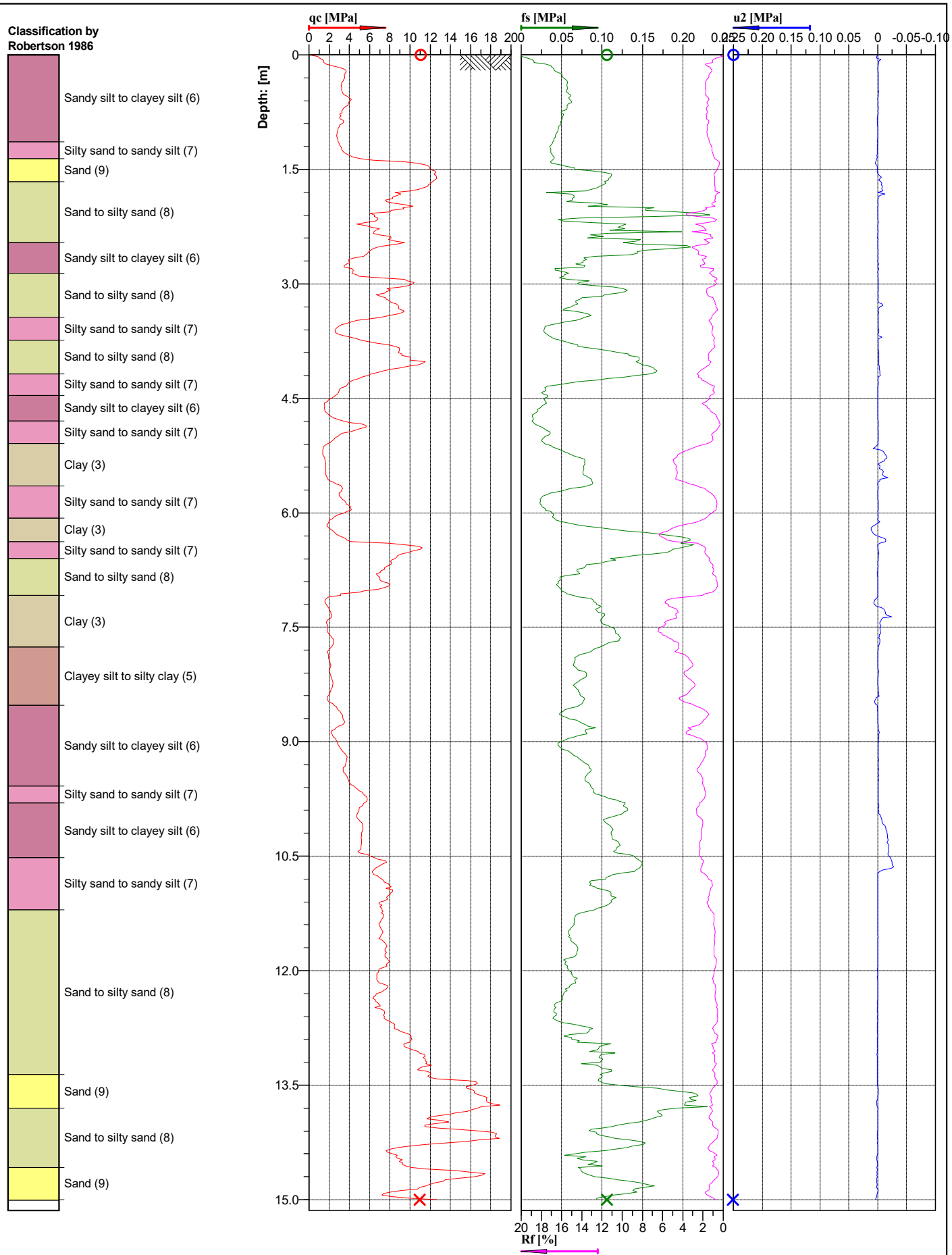

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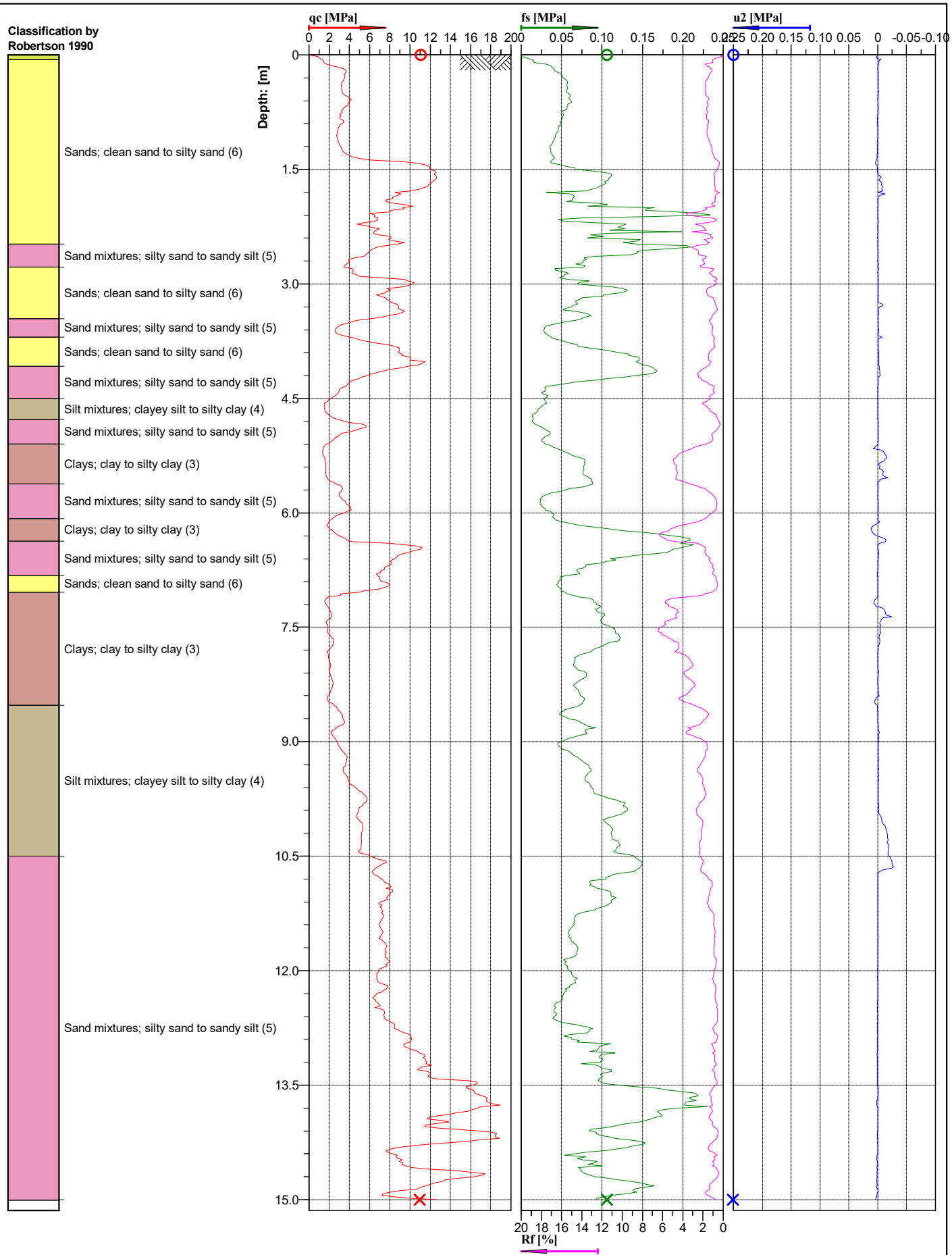

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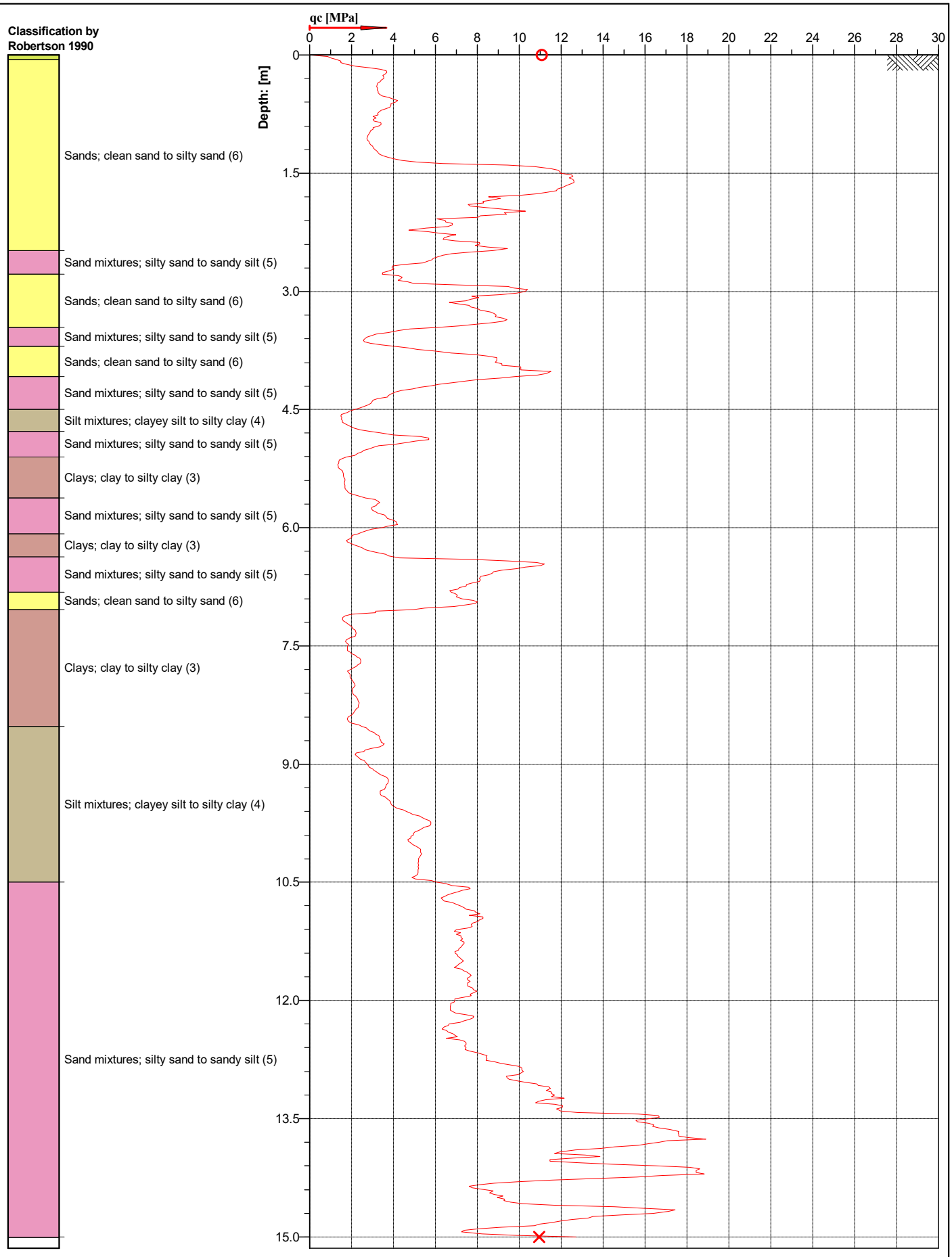

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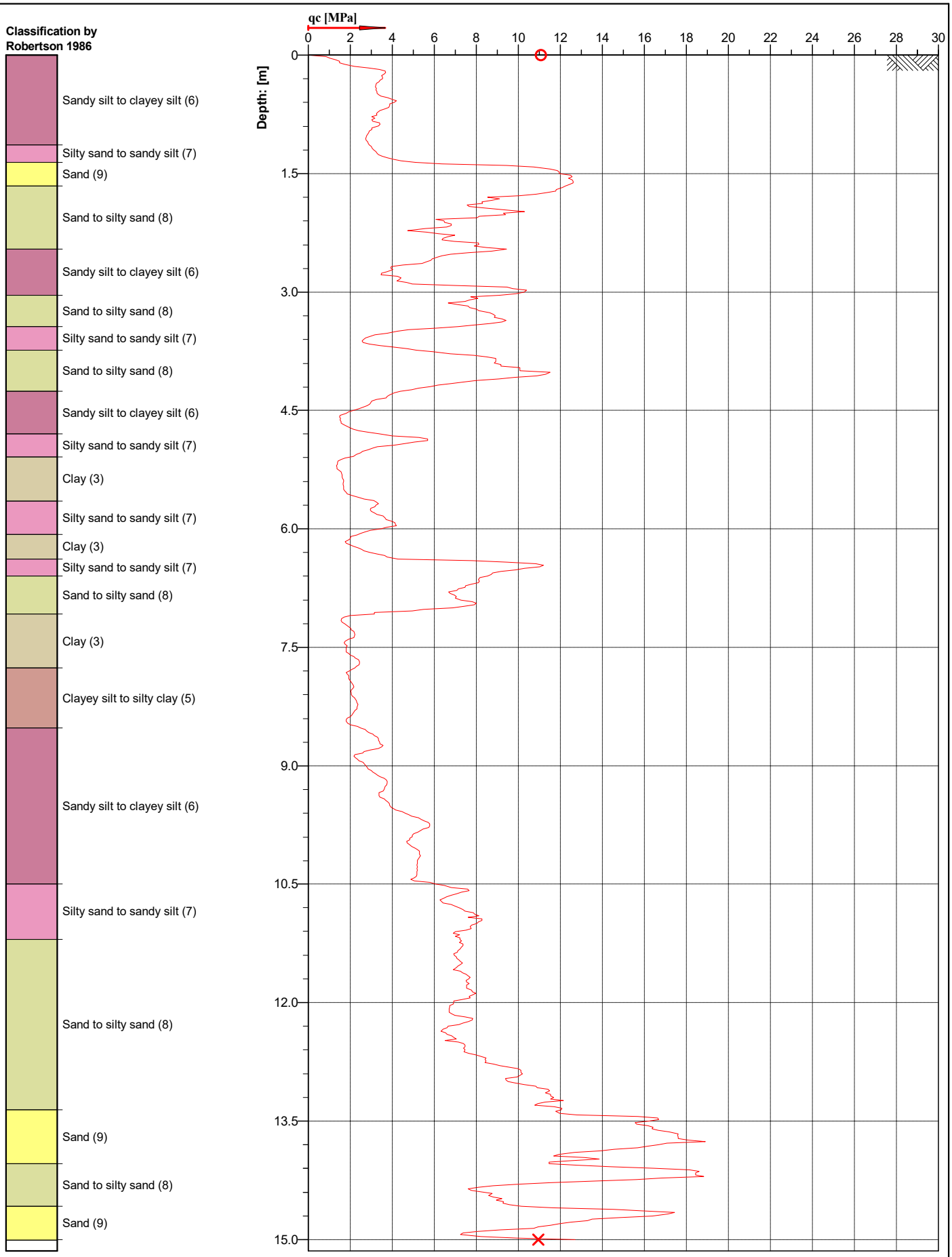

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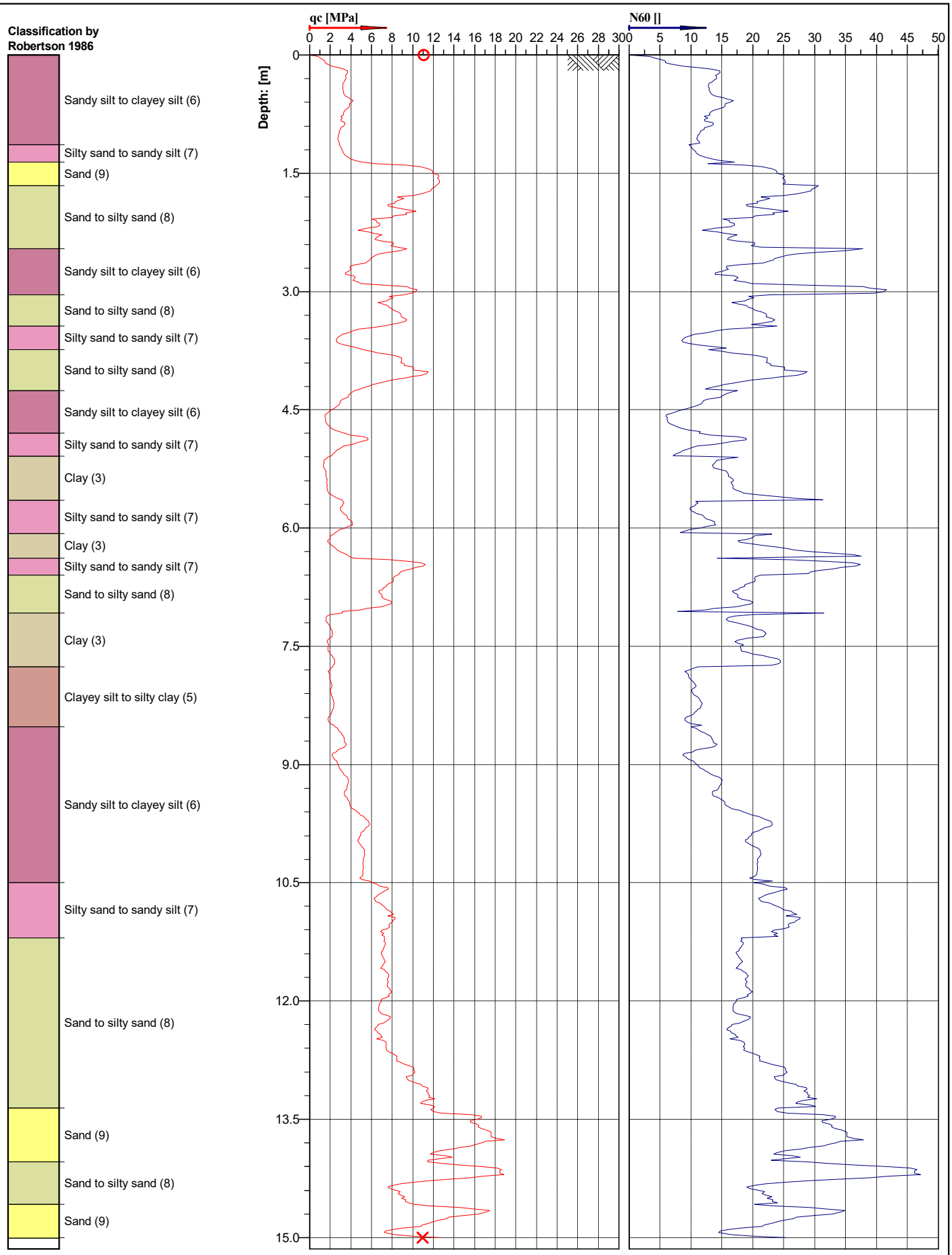
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67310 E 176.05612		File: CPT03.cpt	

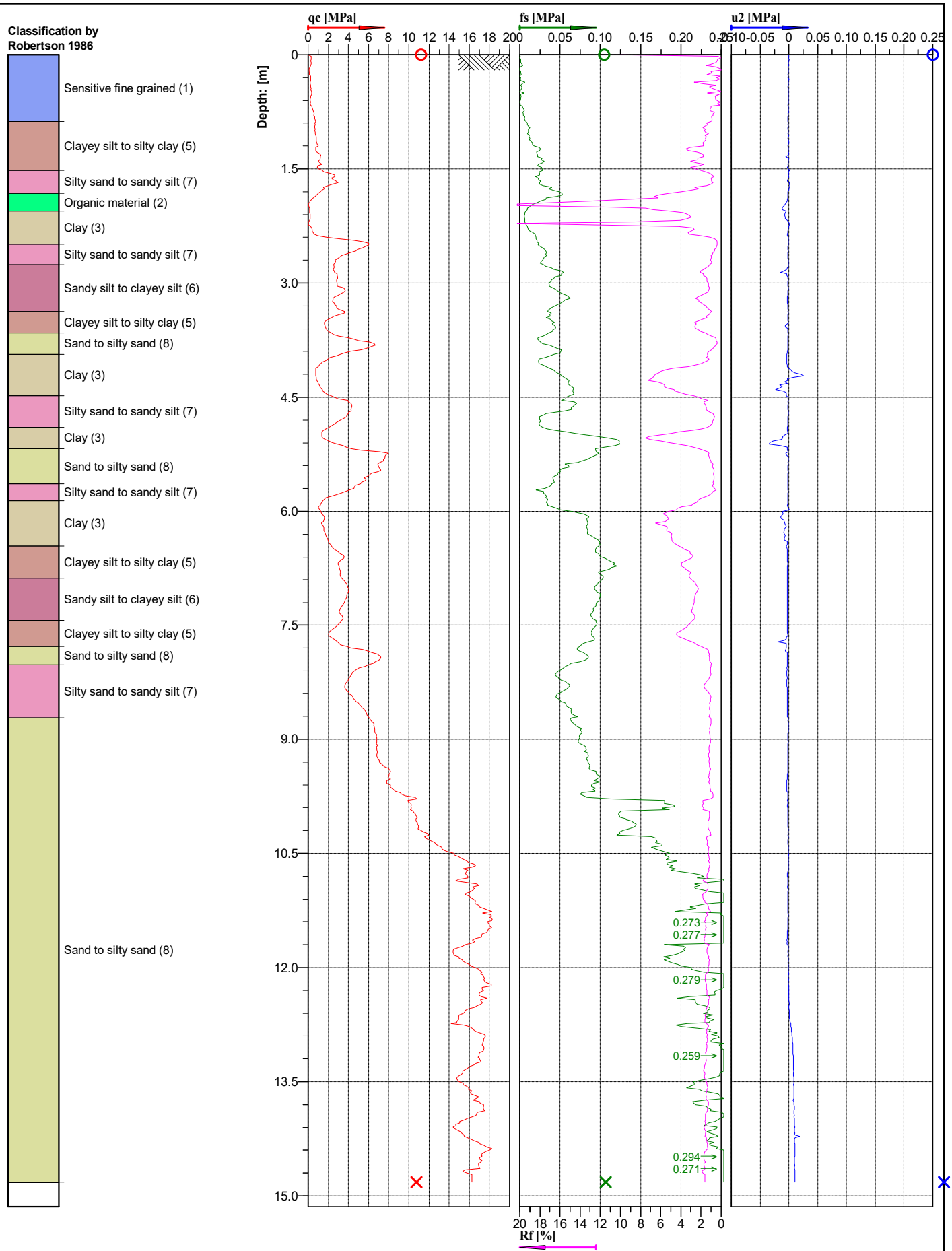


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO3A
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67310 E 176.05612		File: CPT03.cpt	

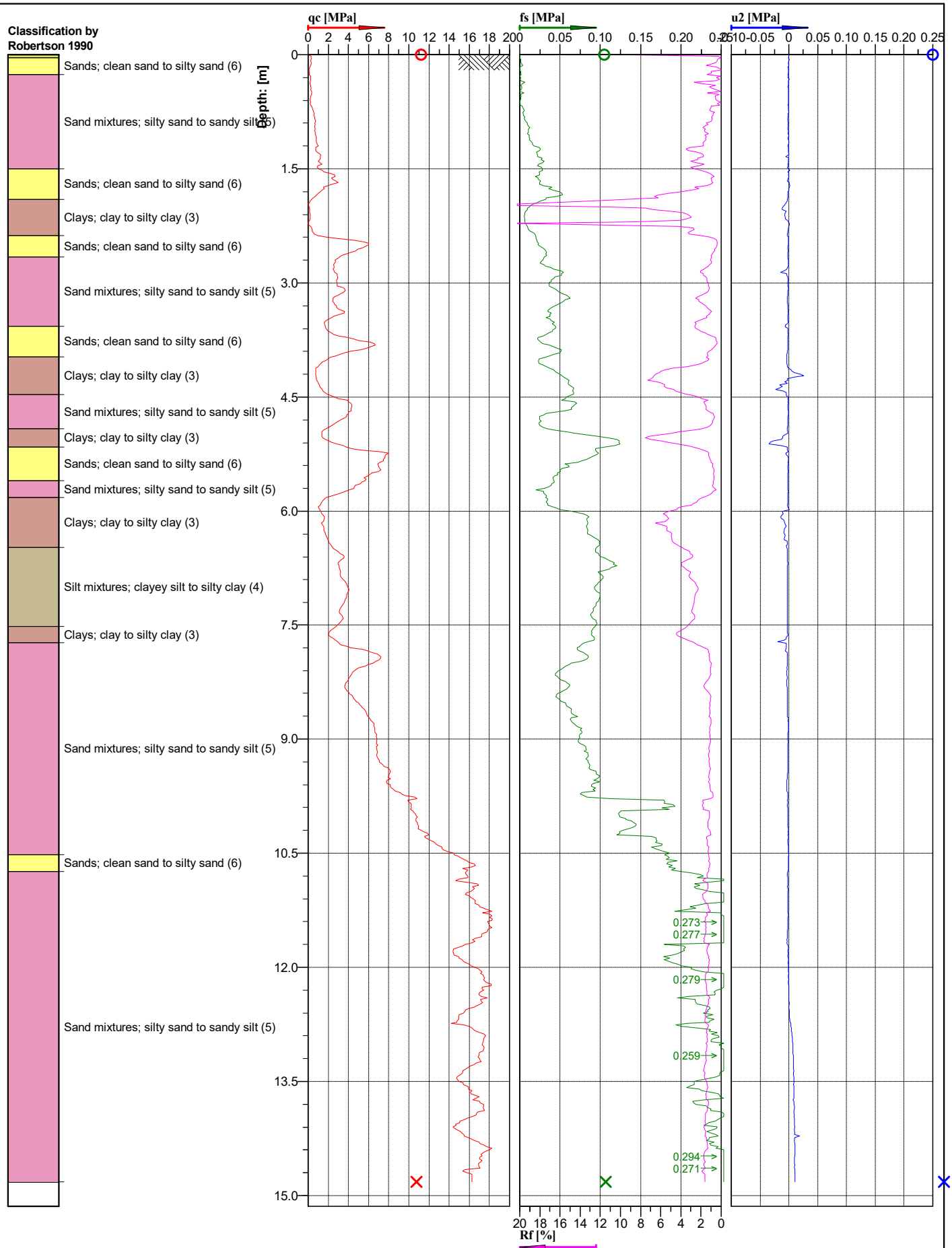


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO4
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67410 E 176.06133		File: CPT04.cpt	

GEOTECH DRILLING

u2

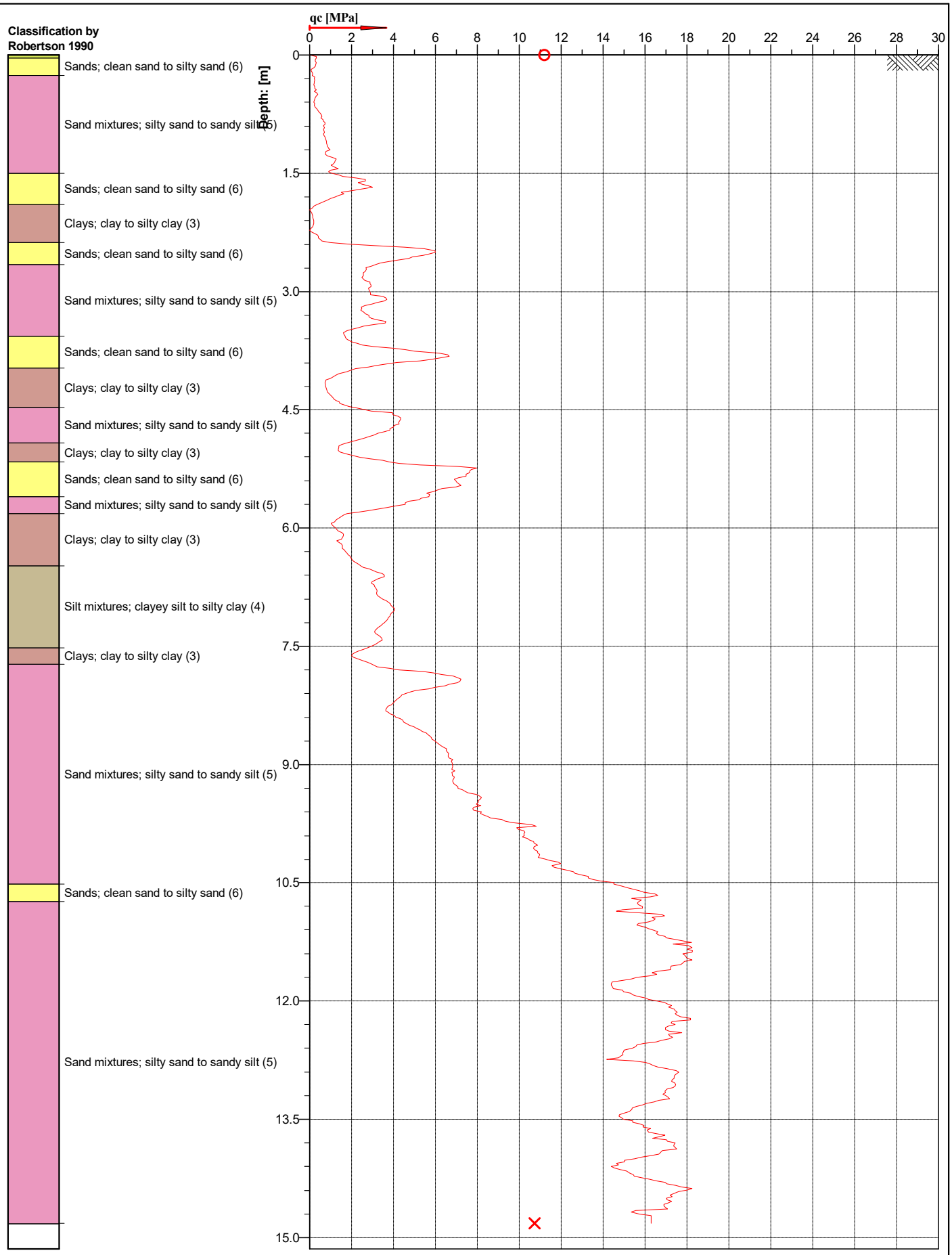
Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150



Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO4
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67410 E 176.06133		File: CPT04.cpt	

GEOTECH DRILLING

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

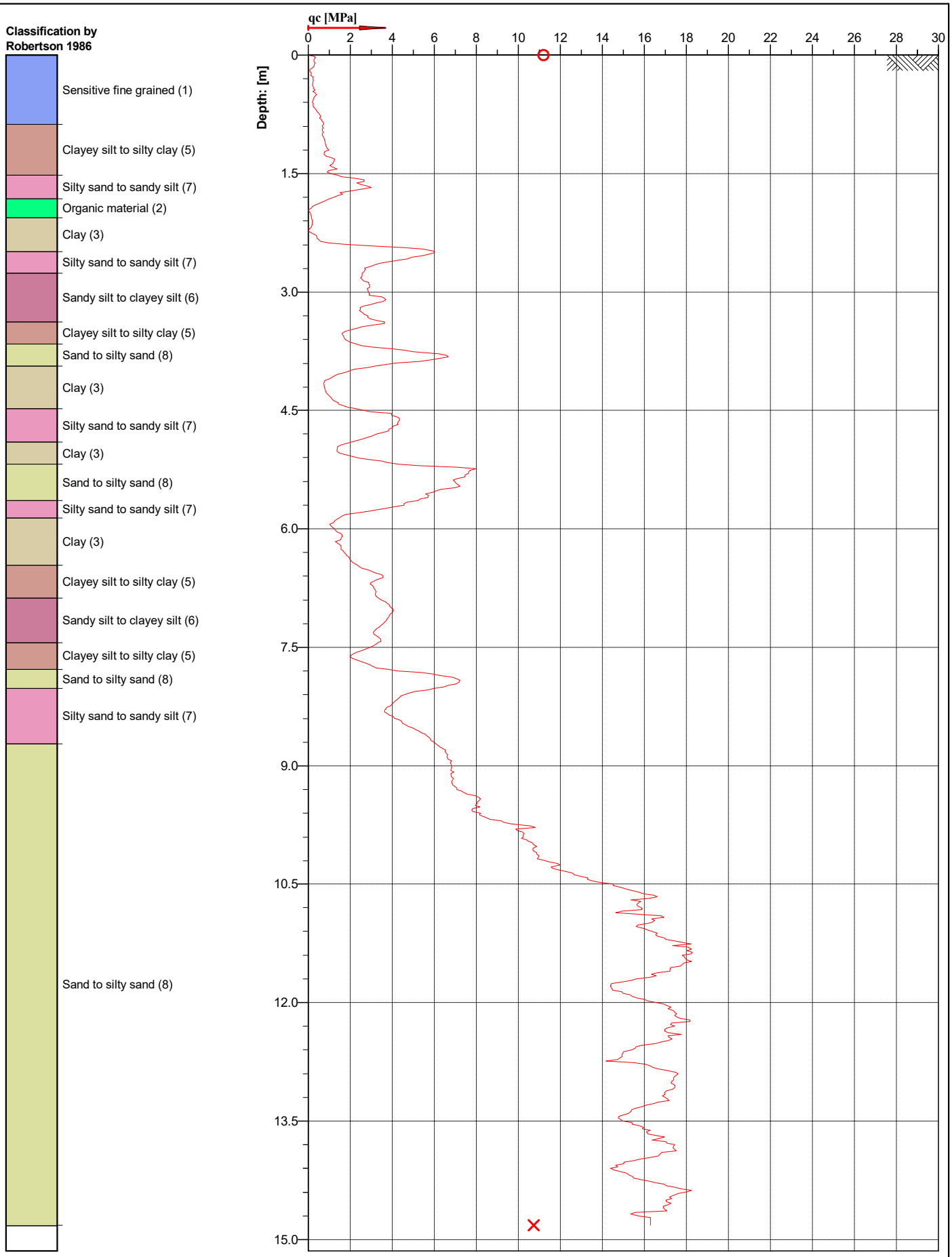


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO4
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67410 E 176.06133		File: CPT04.cpt	

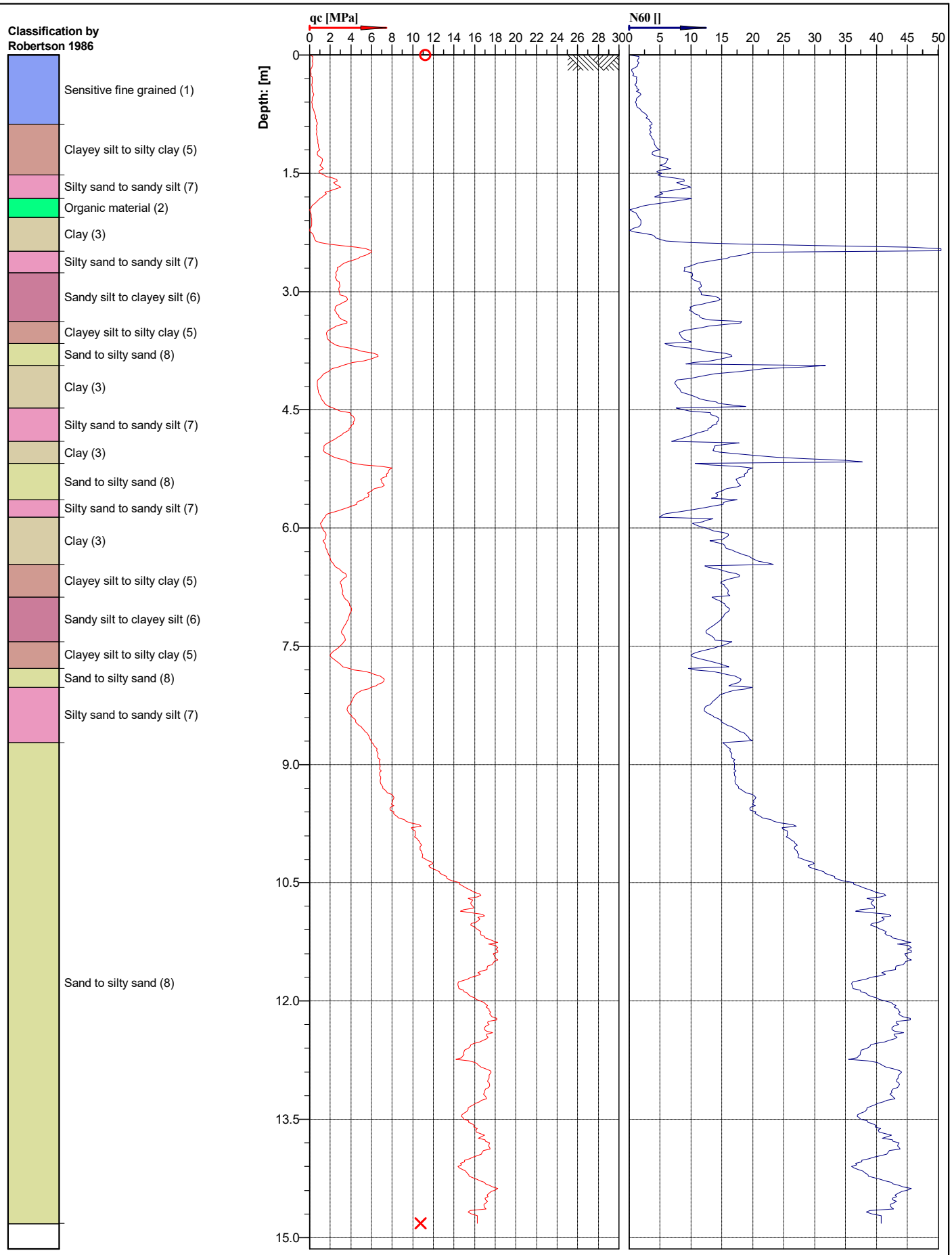


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO4
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67410 E 176.06133		File: CPT04.cpt	

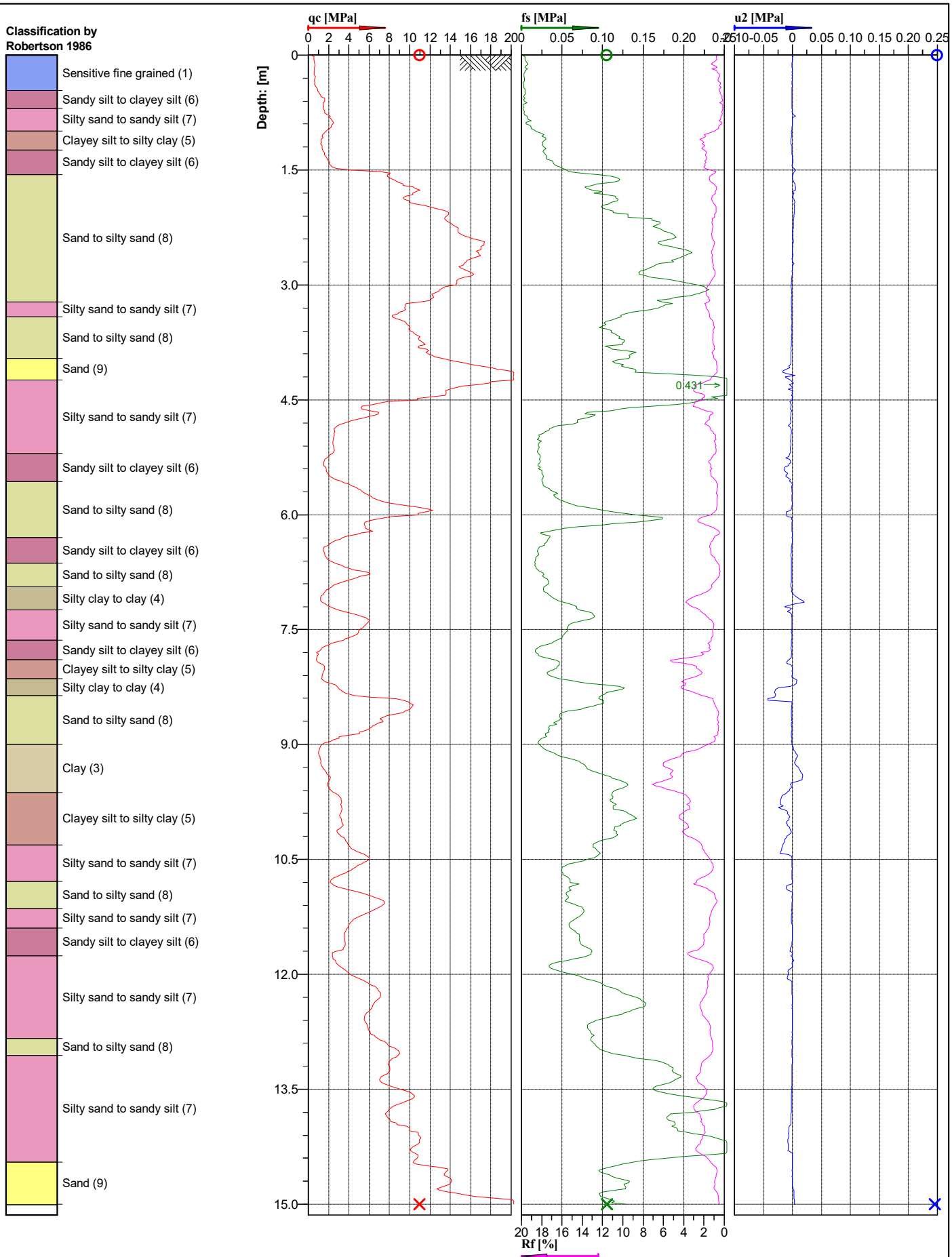


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPTO4
Project ID: 2-37400.00	Client: WSP	Date: 7/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67410 E 176.06133		File: CPT04.cpt	

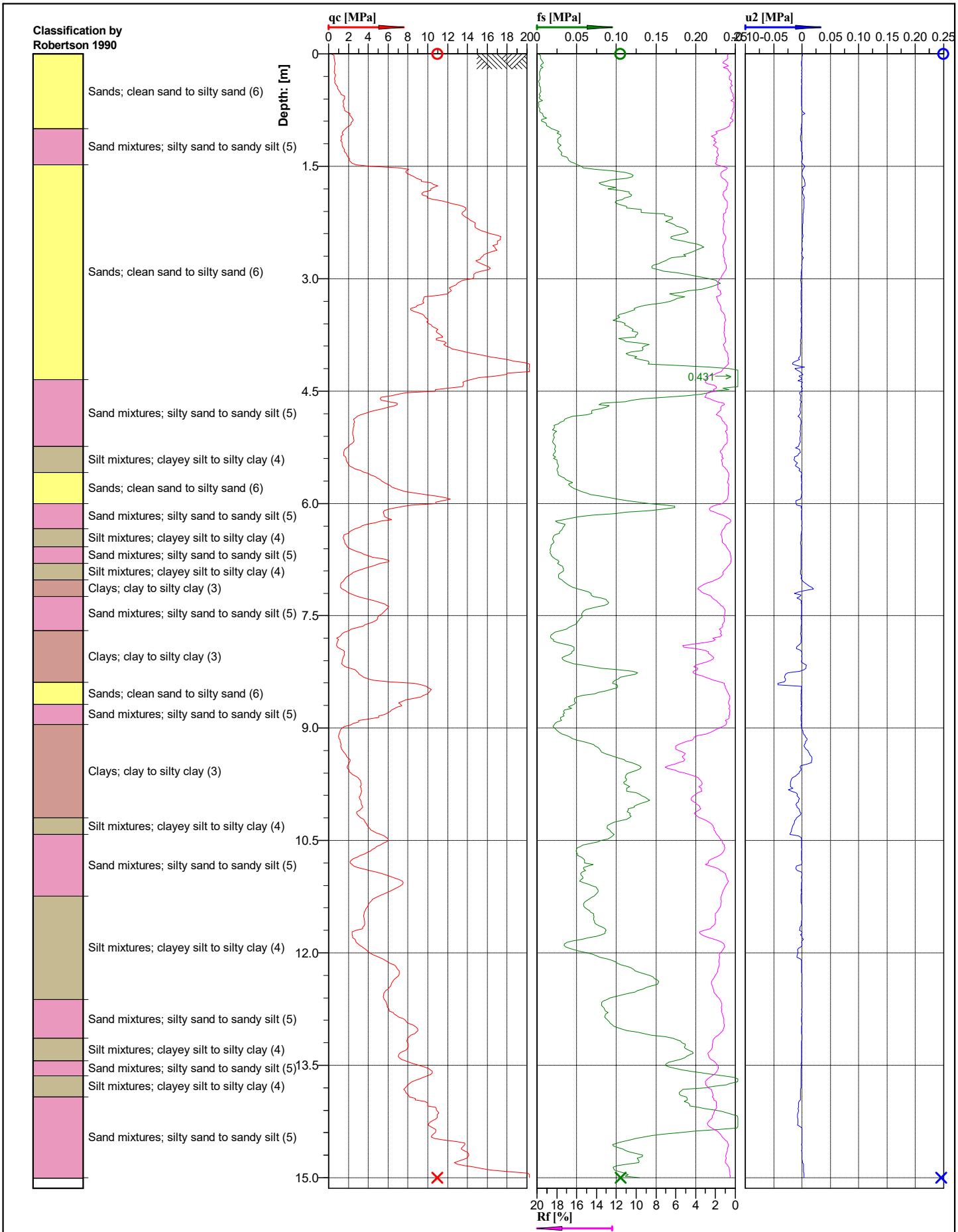


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67479 E 176.05763		File: CPT05.cpt	

GEOTECH DRILLING

u2

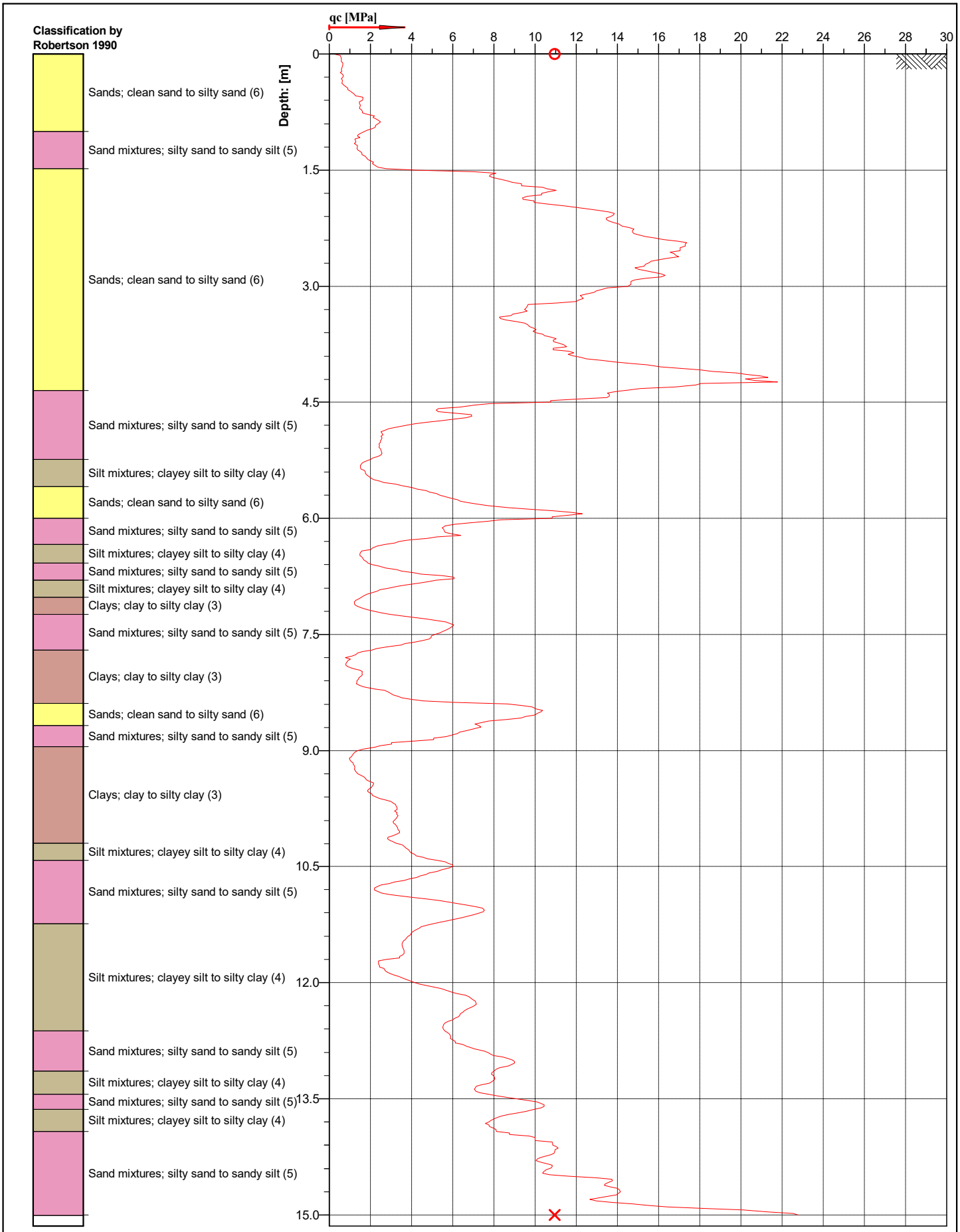
Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150



GEOTECH DRILLING

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67479 E 176.05763		File: CPT05.cpt	

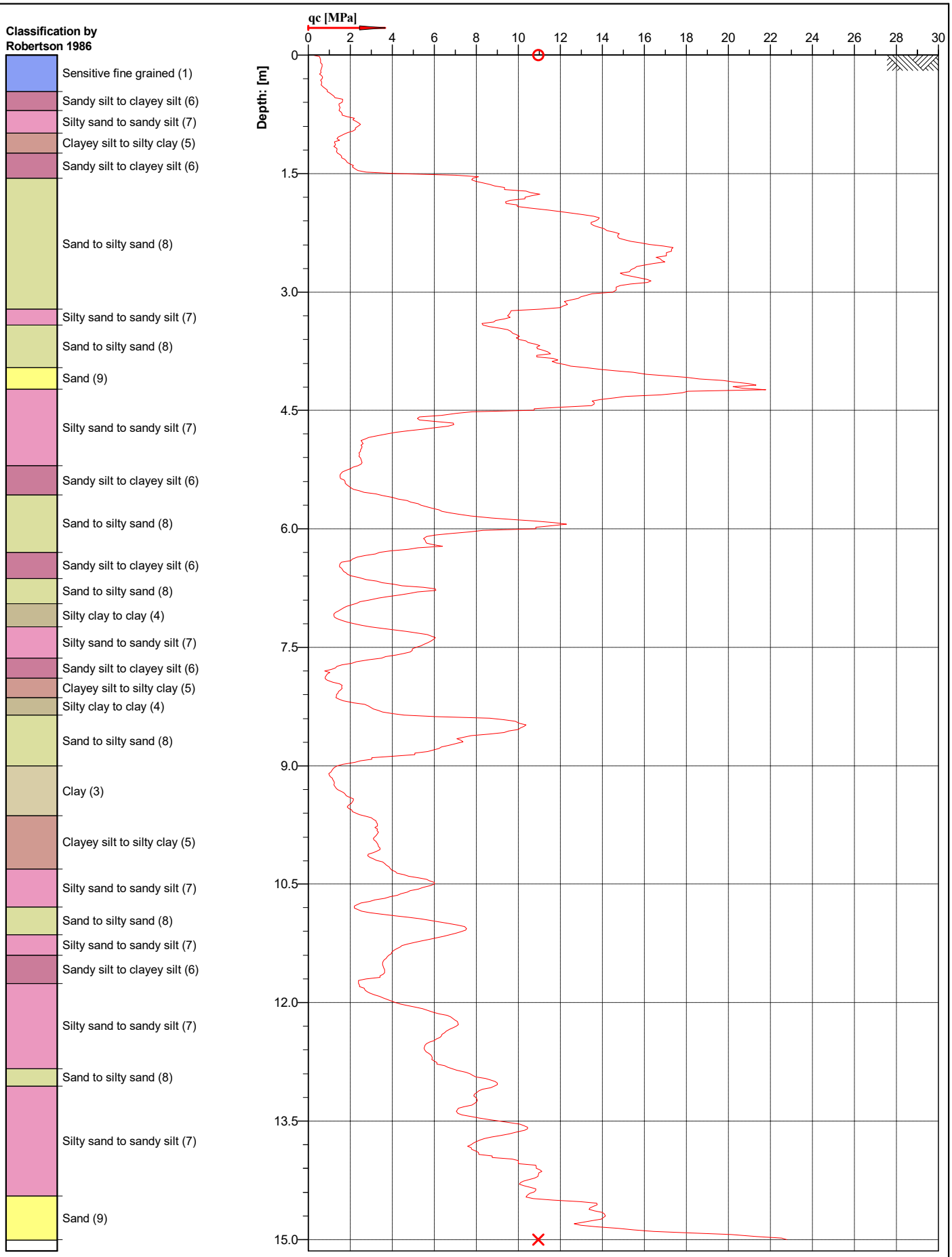


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67479 E 176.05763		File: CPT05.cpt	

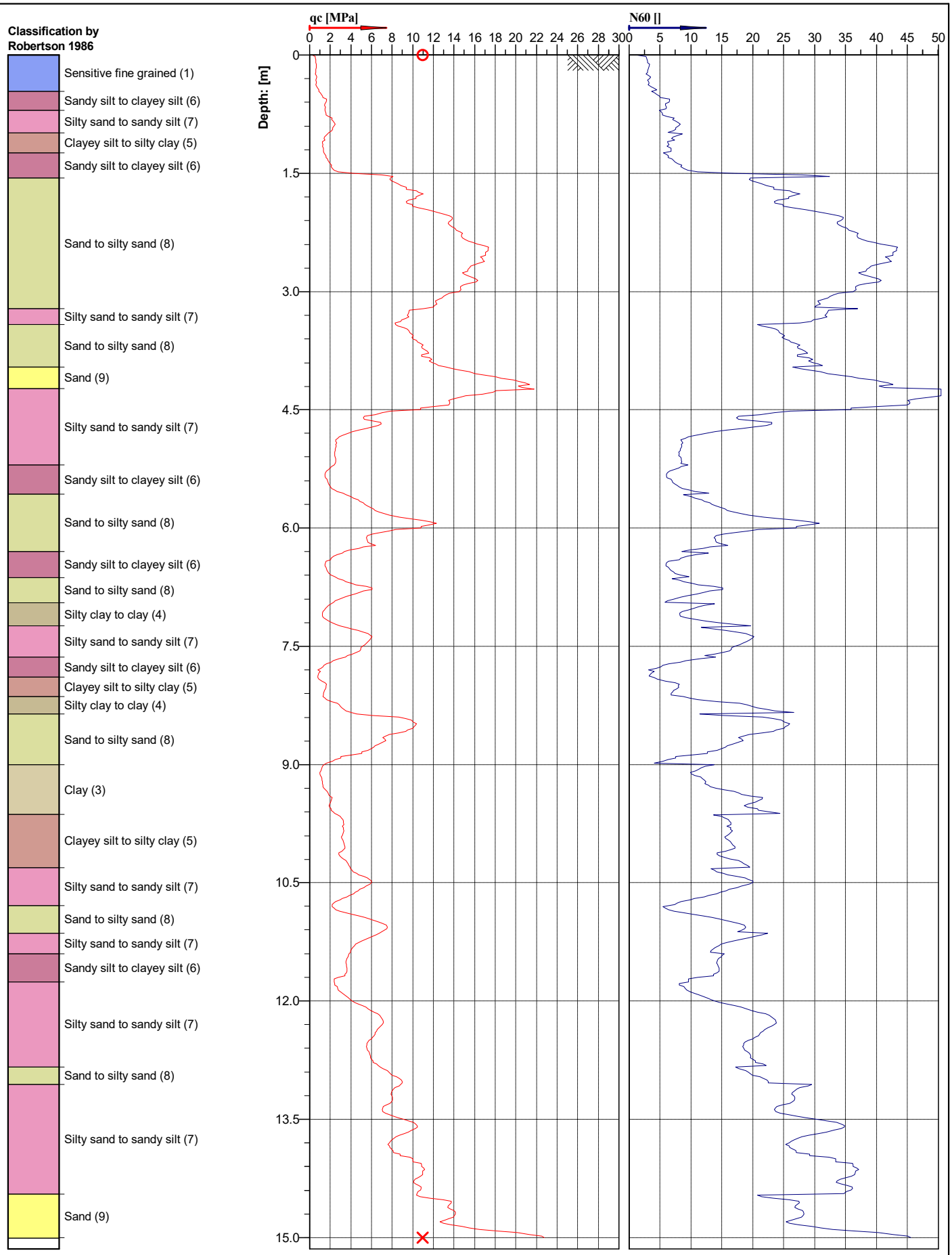


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67479 E 176.05763		File: CPT05.cpt	

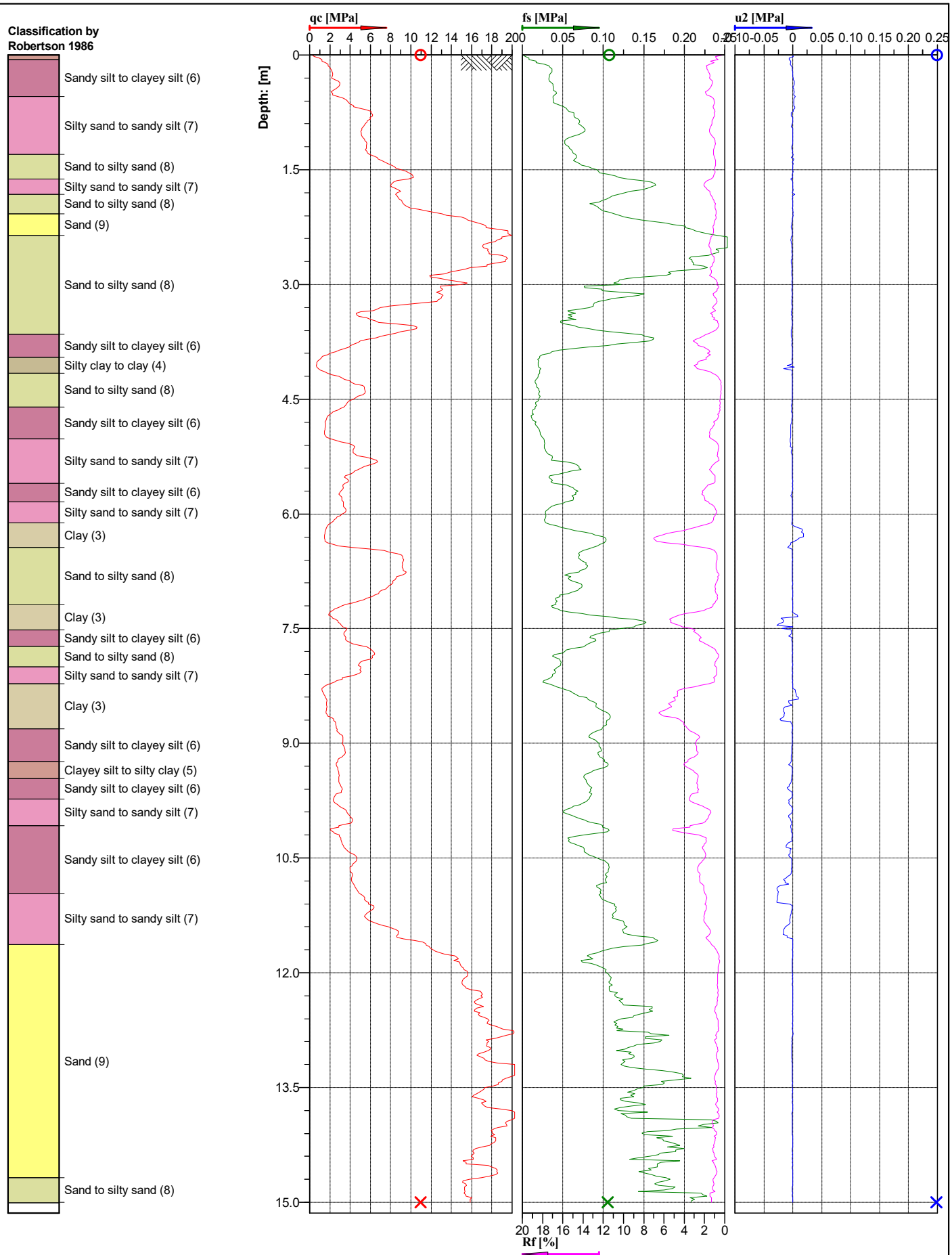


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67479 E 176.05763		File: CPT05.cpt	

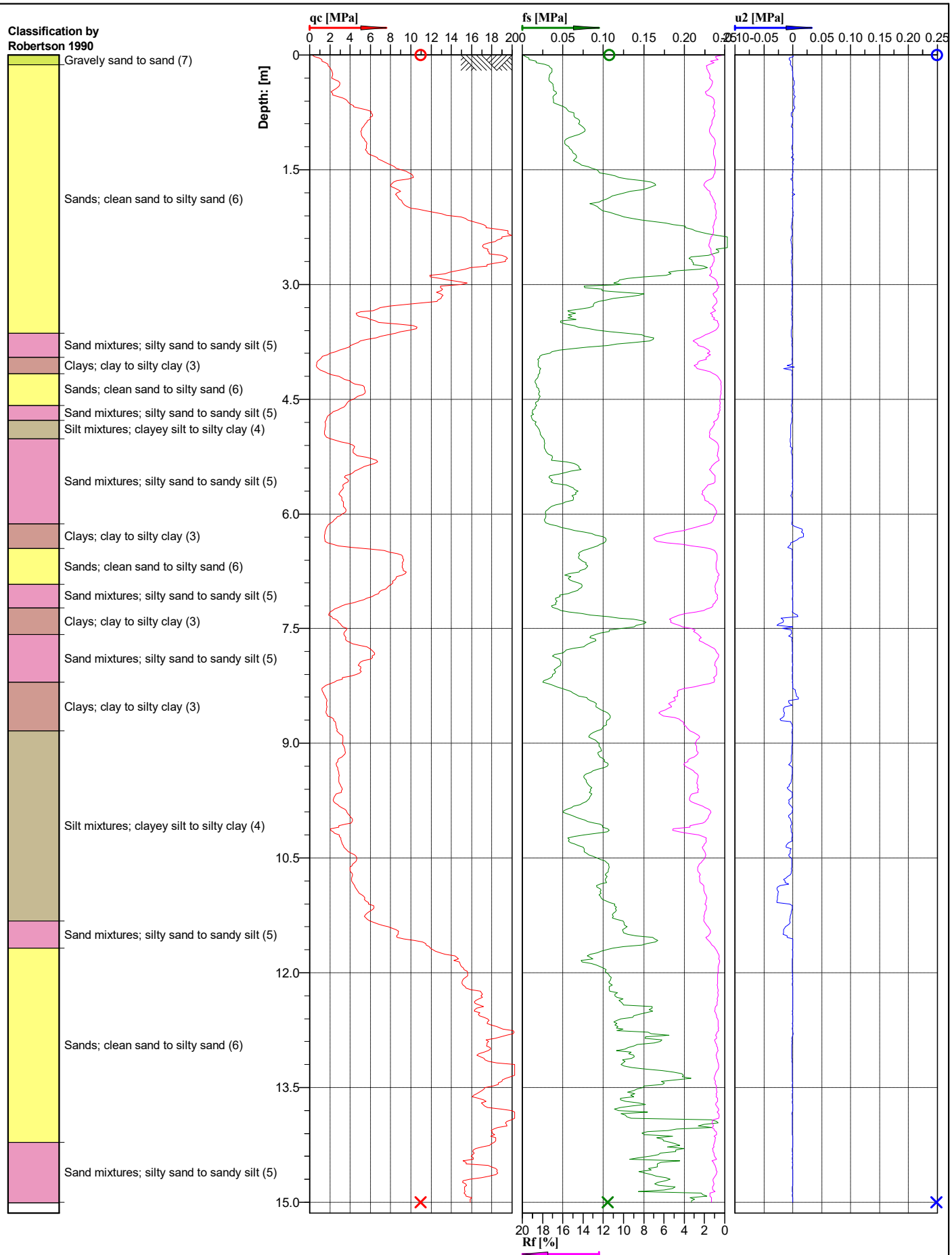


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67772 E 176.05433		File: CPT06.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

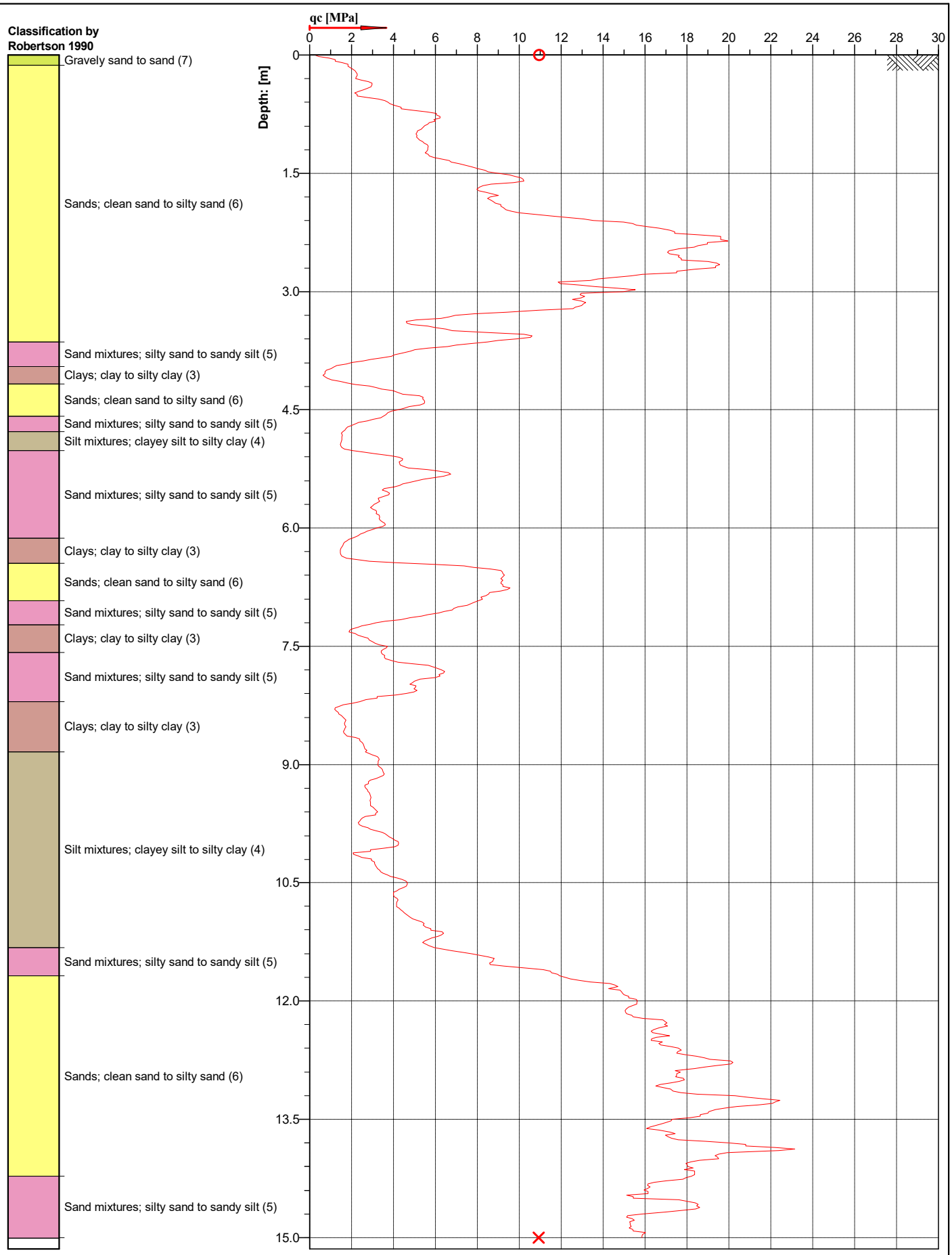


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67772 E 176.05433		File: CPT06.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

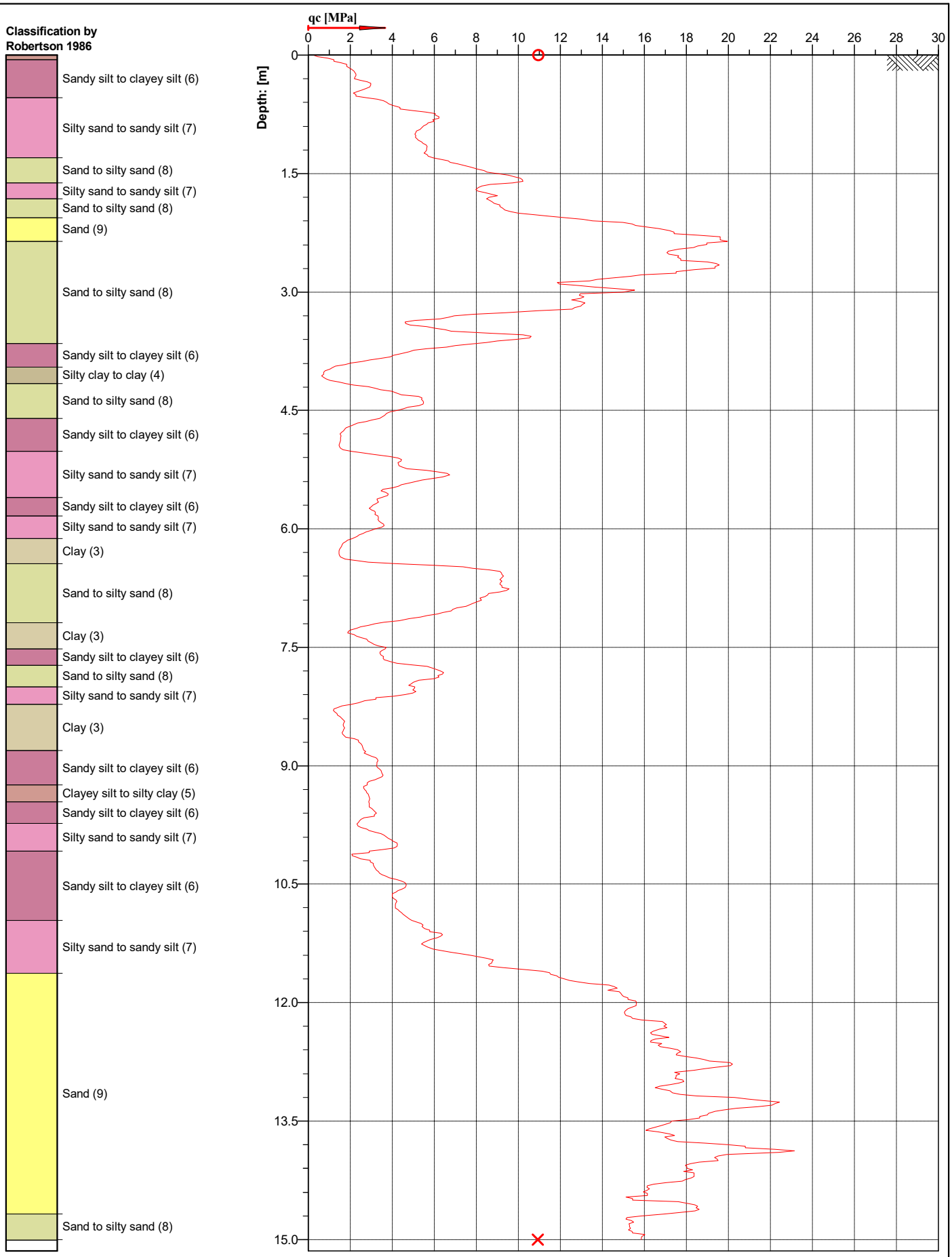


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67772 E 176.05433		File: CPT06.cpt	

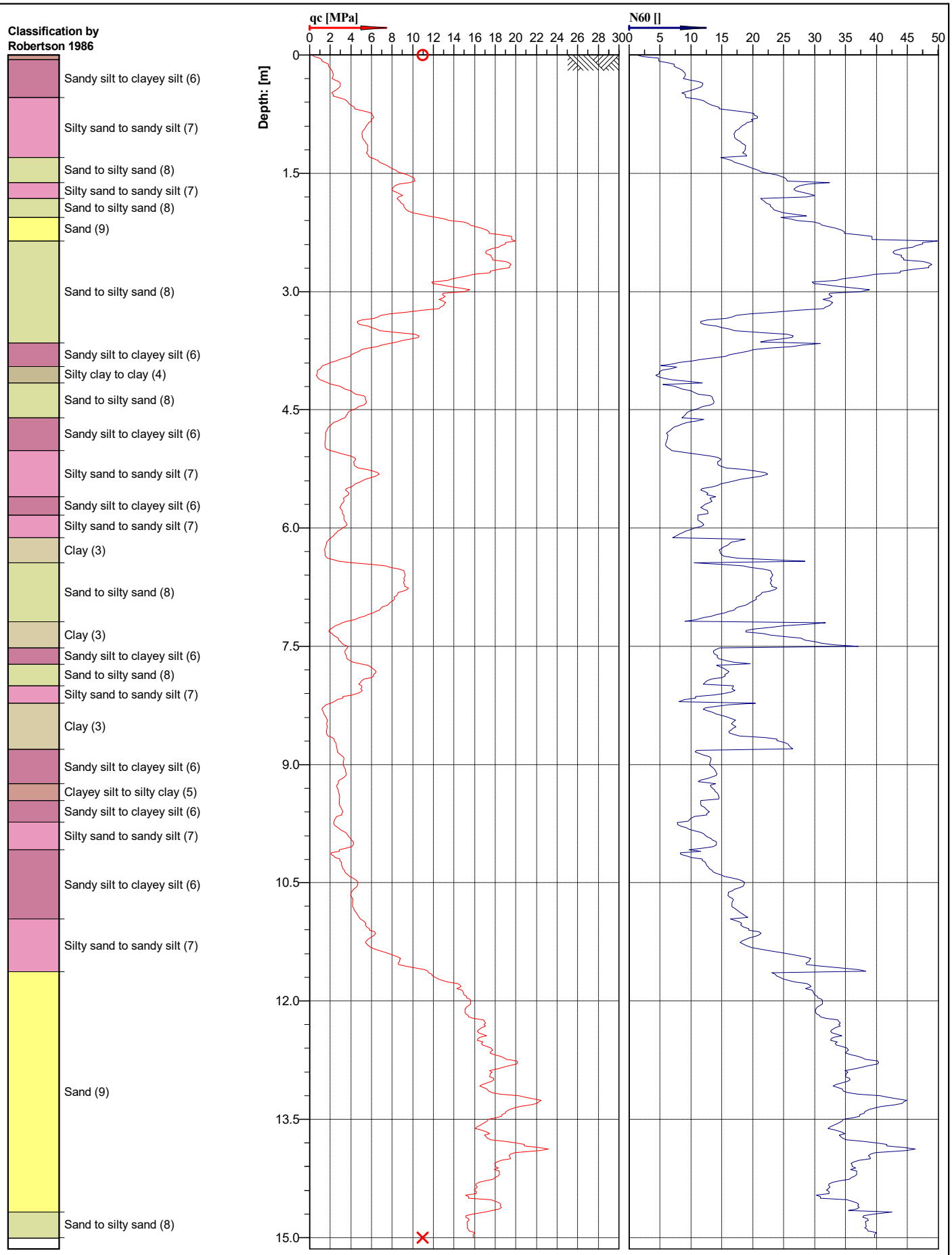


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67772 E 176.05433		File: CPT06.cpt	

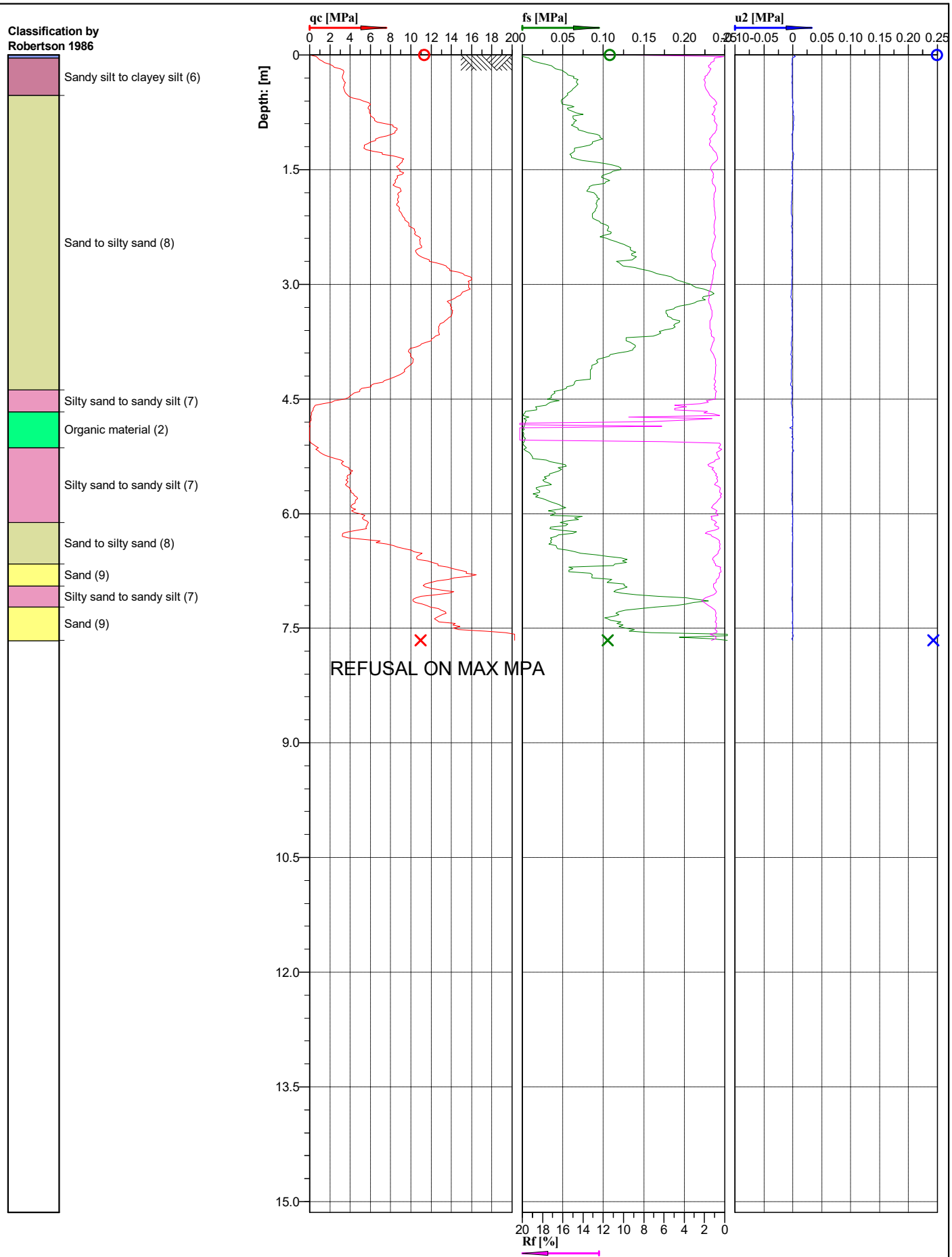


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67772 E 176.05433		File: CPT06.cpt	

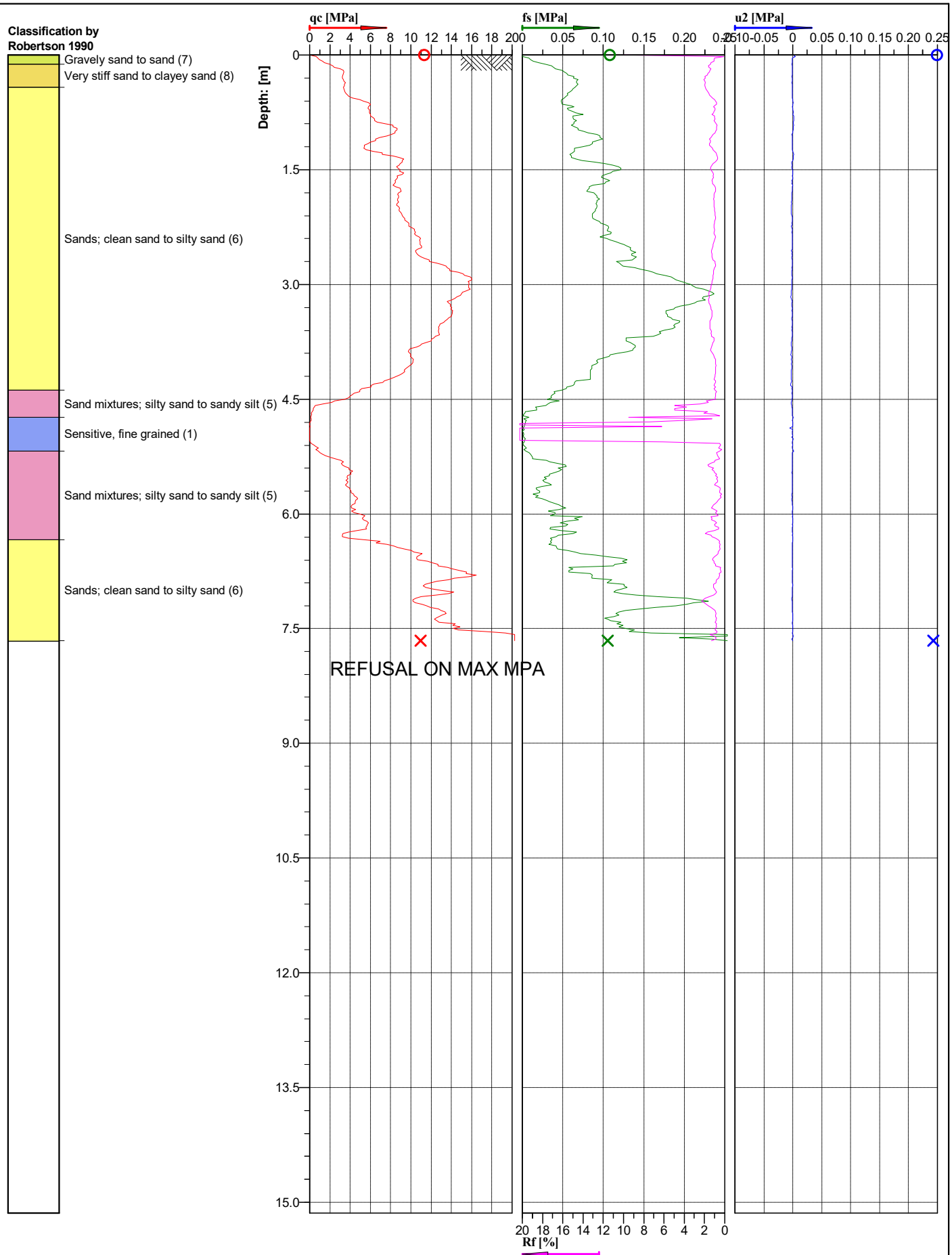


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67896 E 176.05641		File: CPT07.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

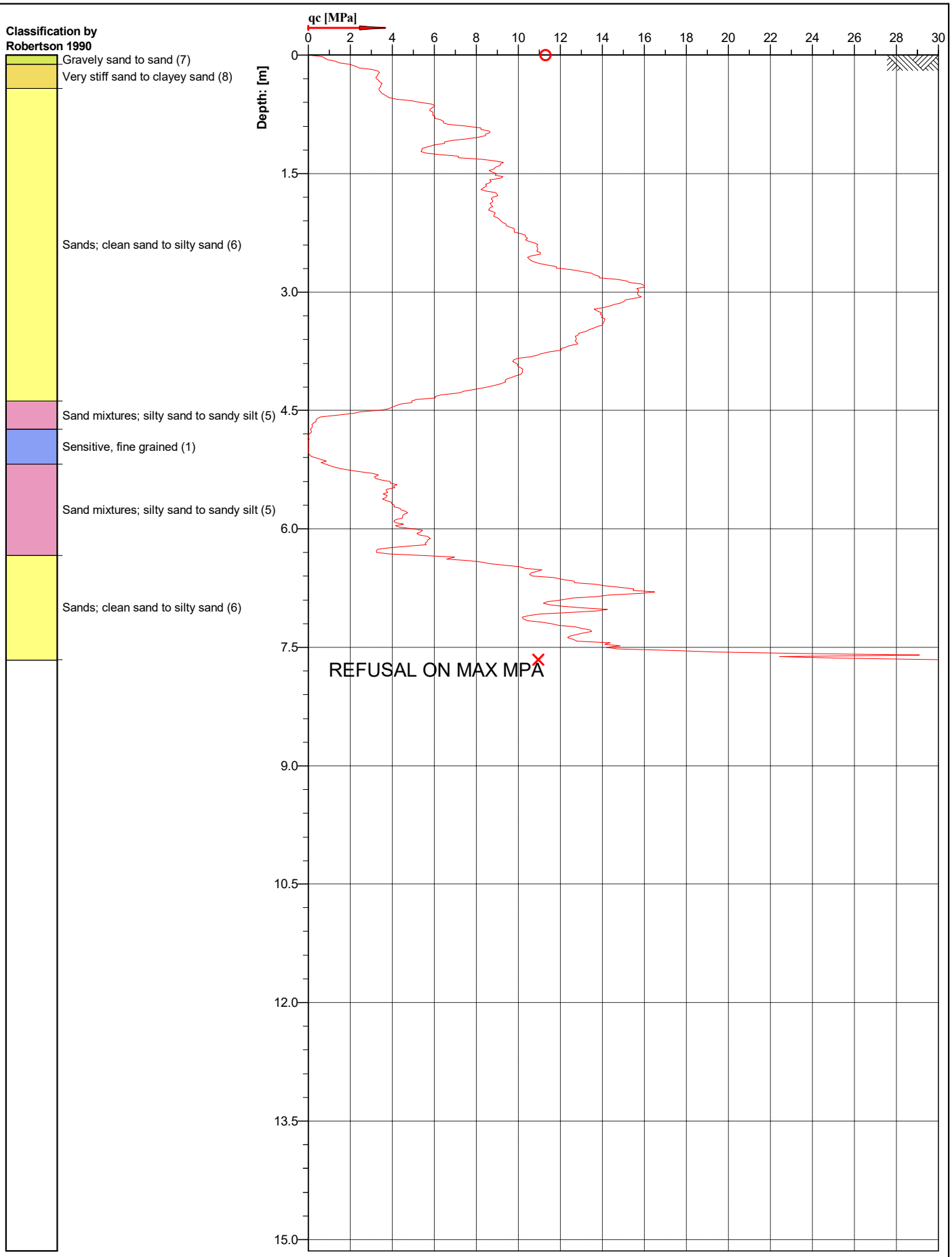


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67896 E 176.05641		File: CPT07.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

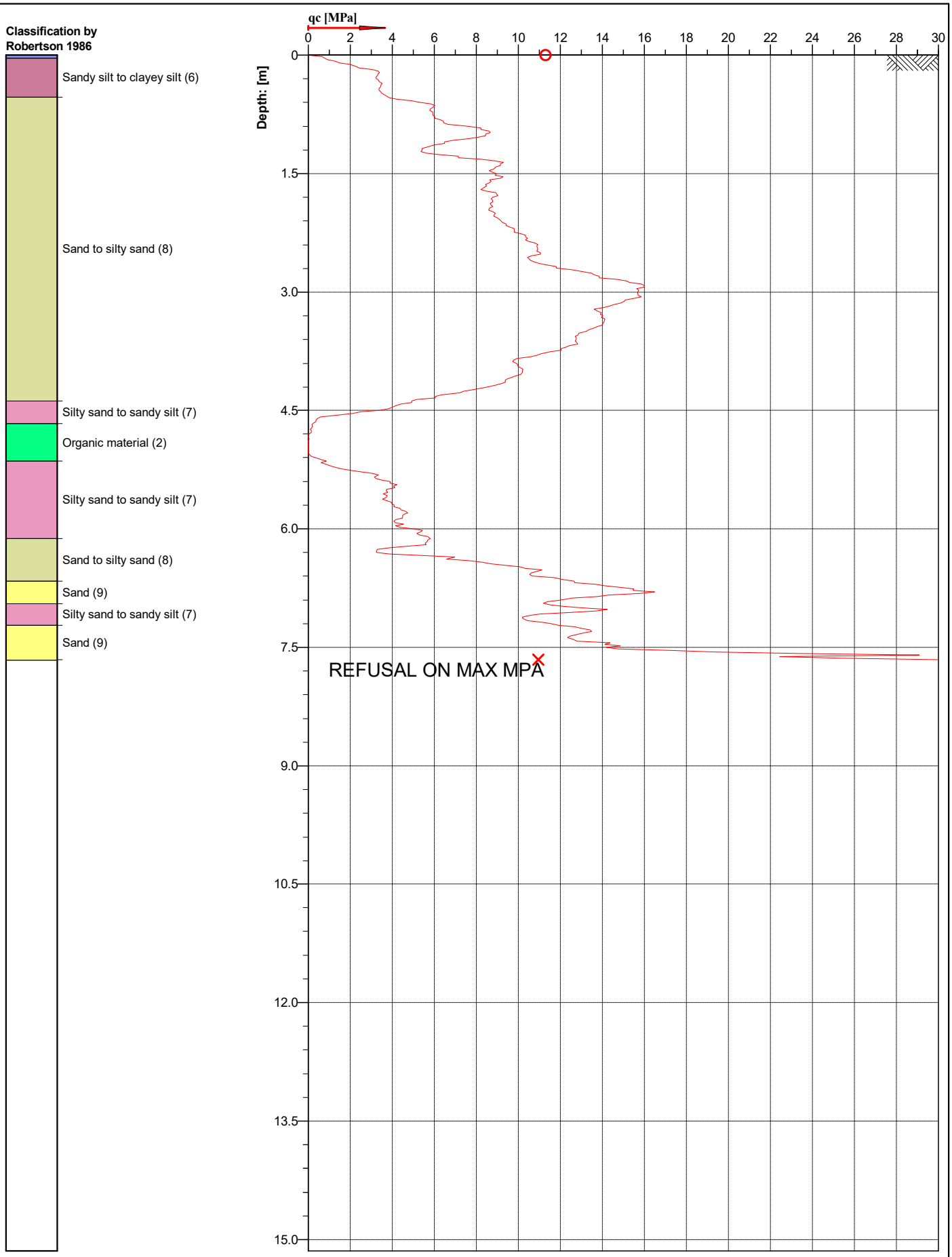


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67896 E 176.05641		File: CPT07.cpt	

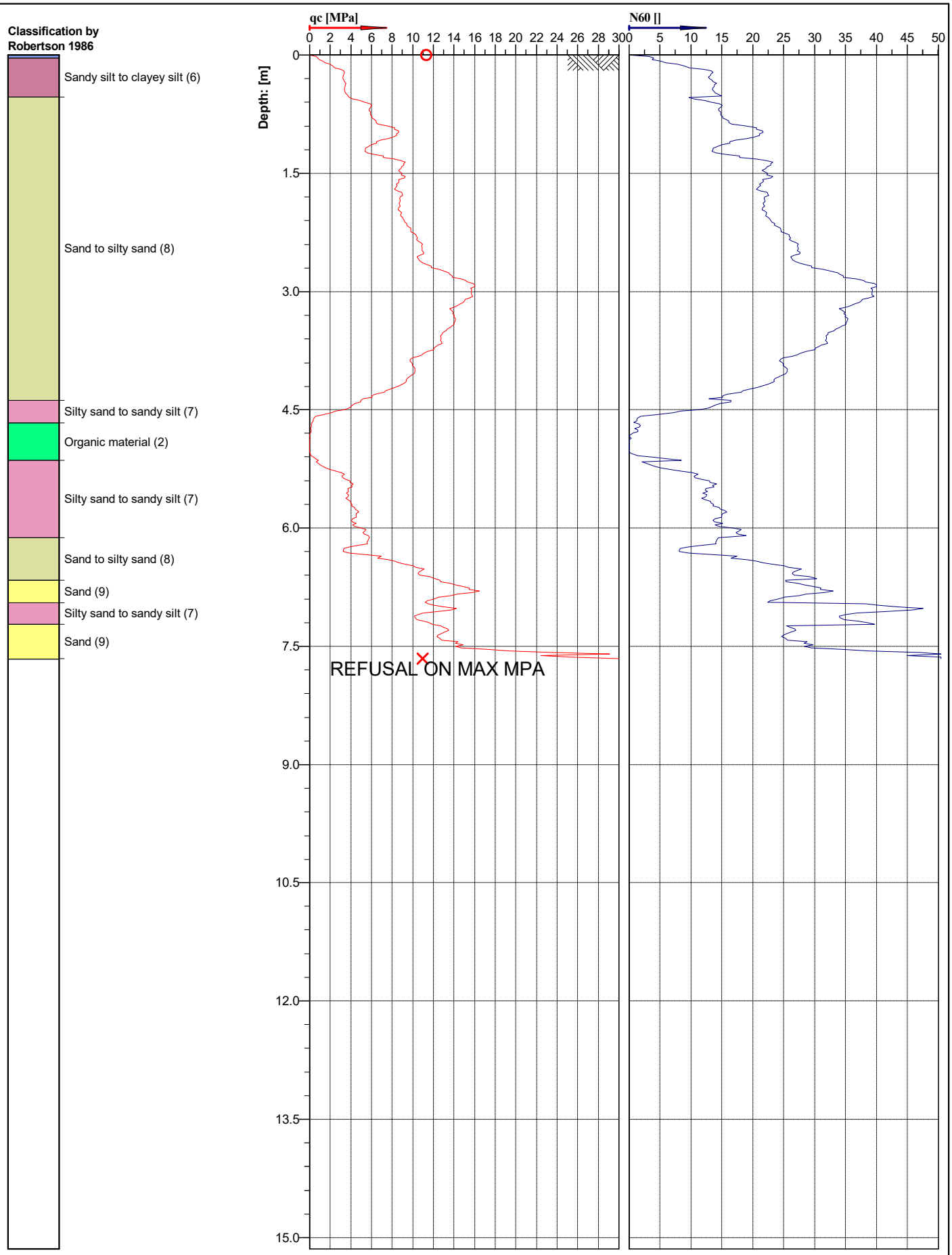


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67896 E 176.05641		File: CPT07.cpt	

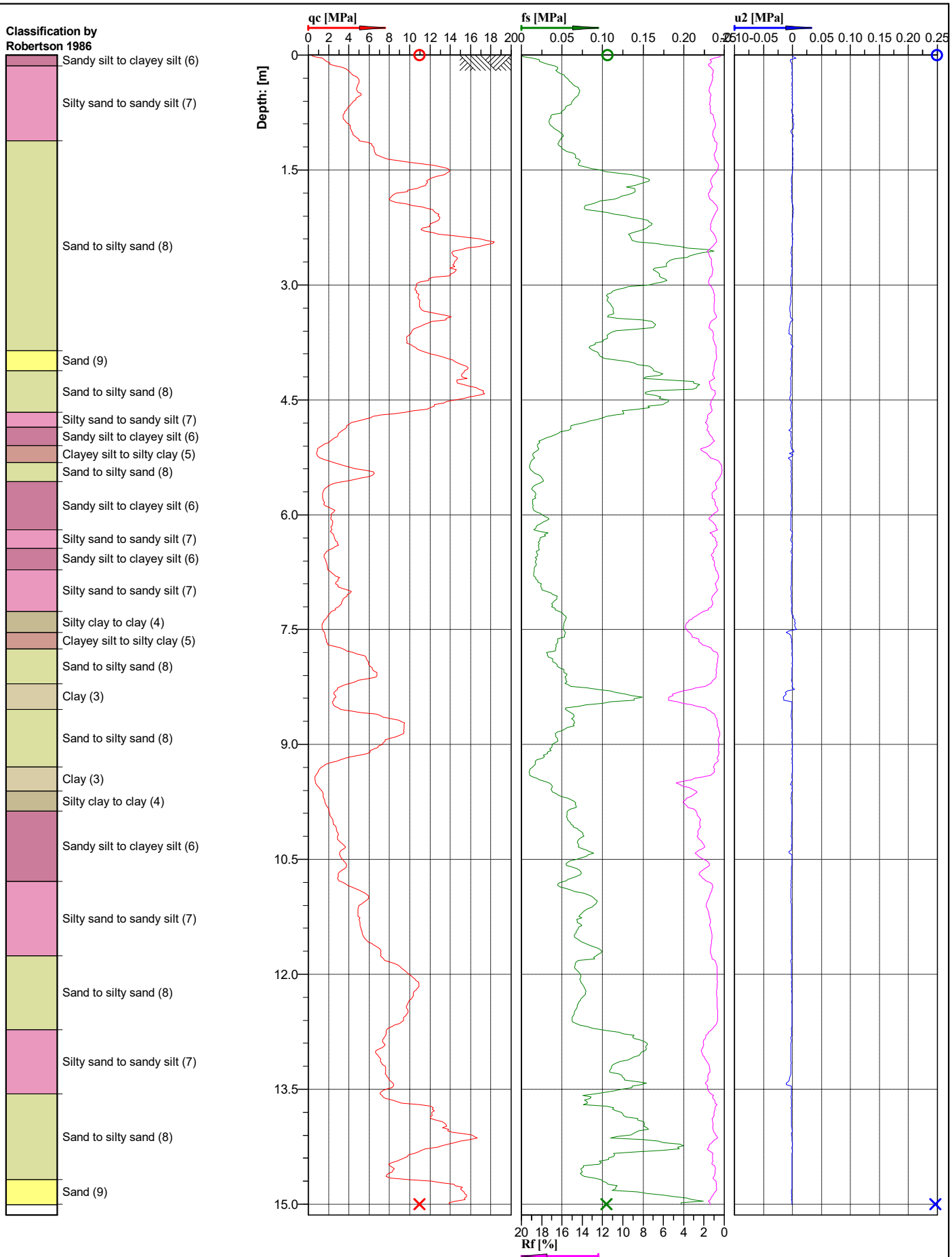


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67896 E 176.05641		File: CPT07.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

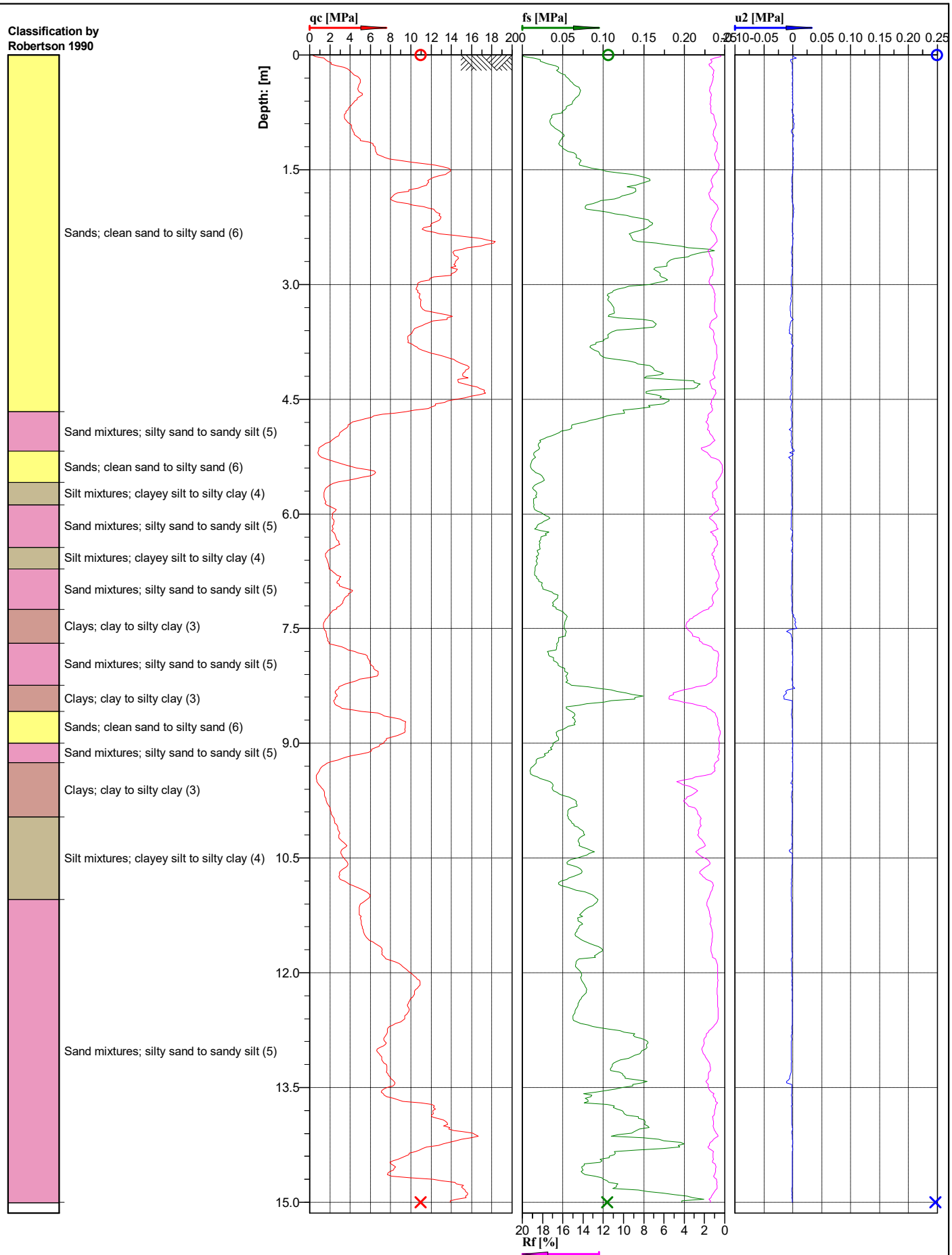


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67713 E 176.05646		File: CPT08.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

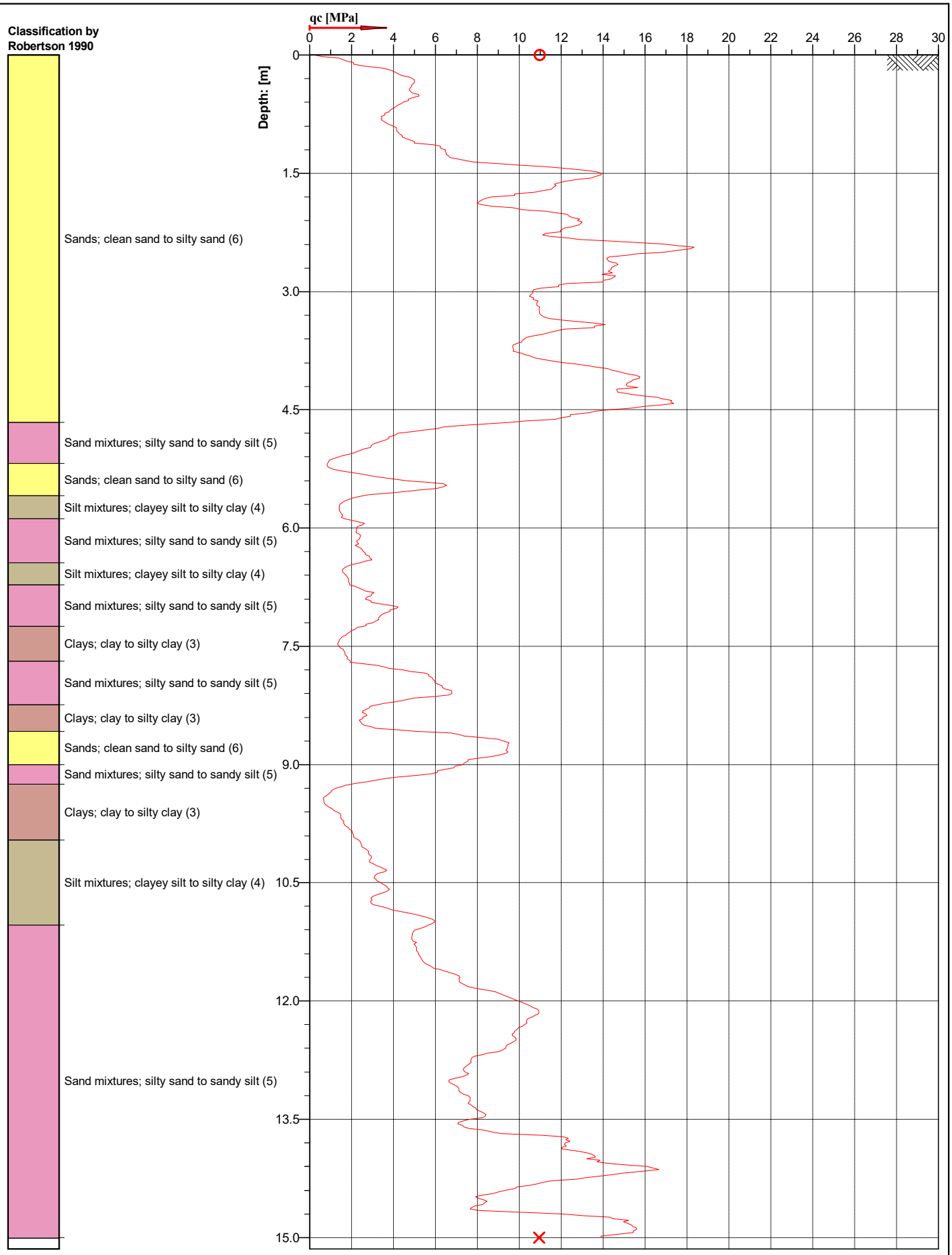


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67713 E 176.05646		File: CPT08.cpt	

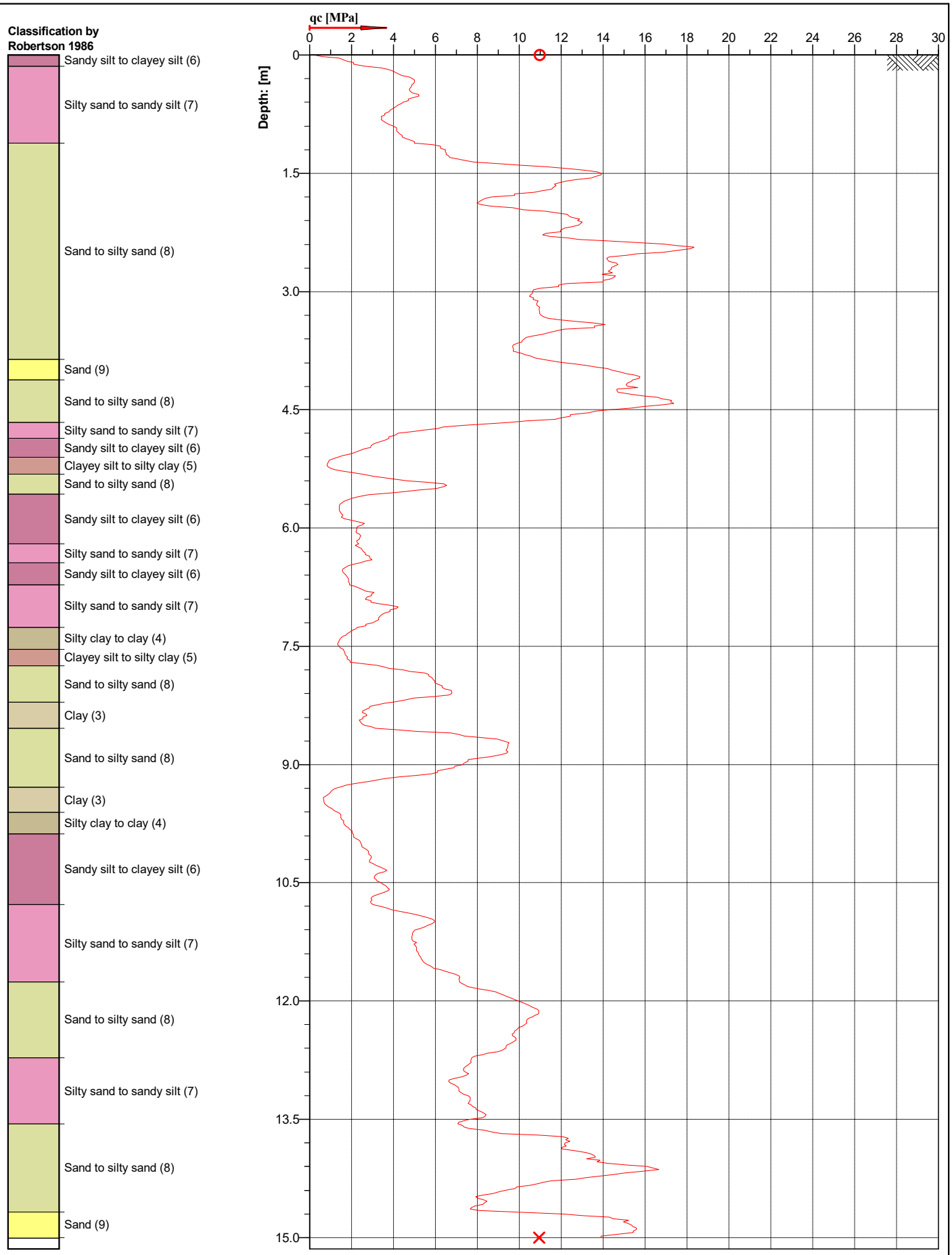


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67713 E 176.05646		File: CPT08.cpt	

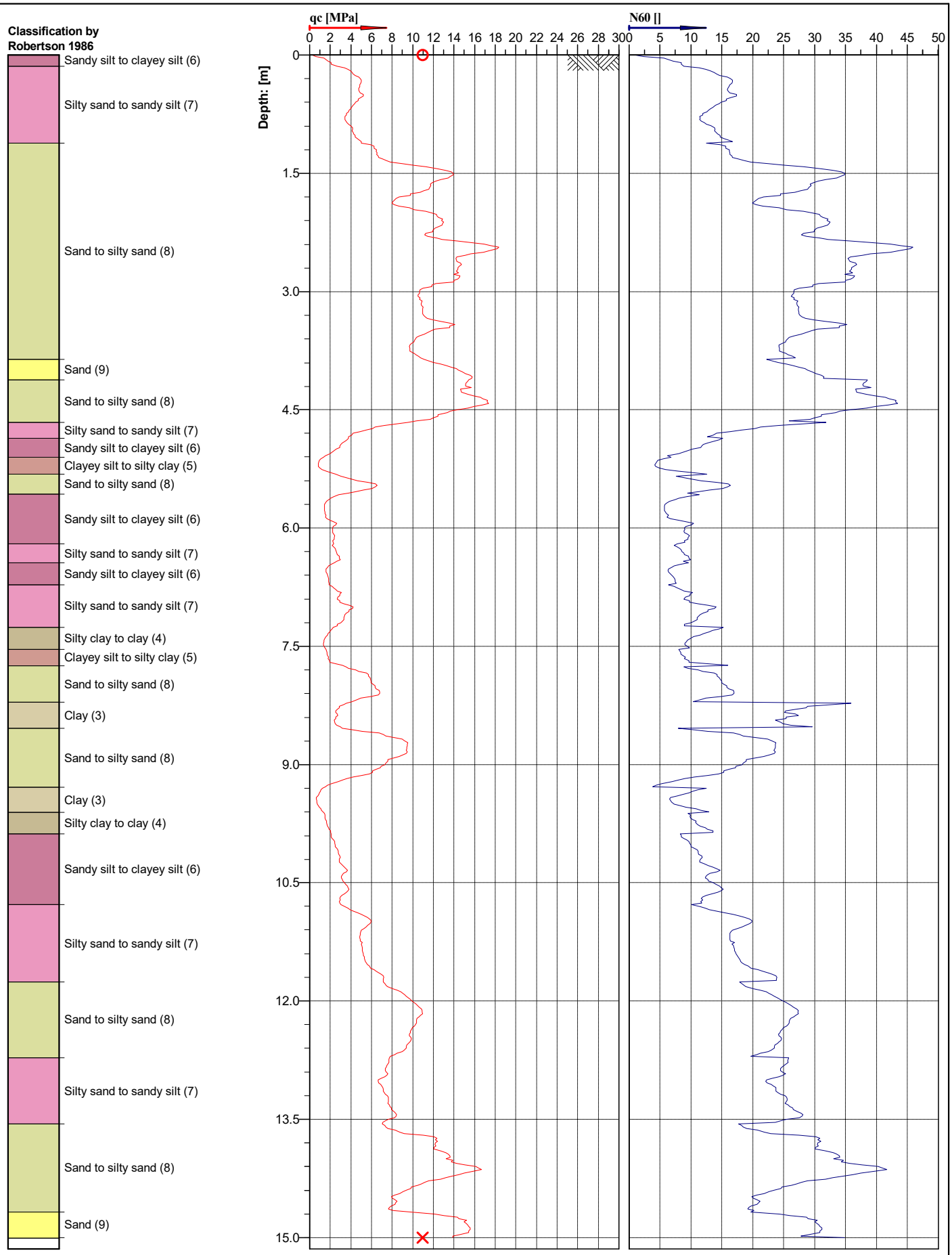


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67713 E 176.05646		File: CPT08.cpt	

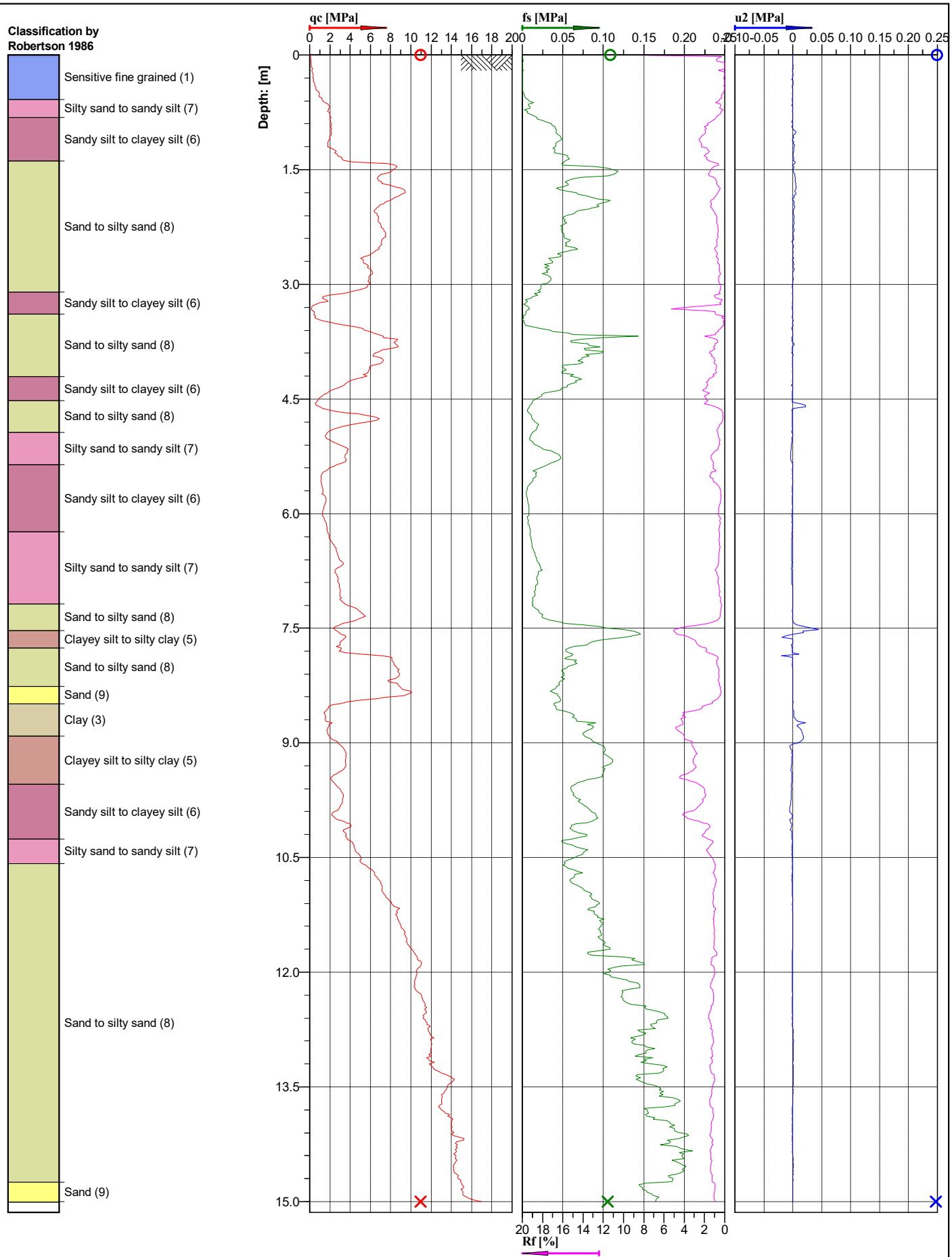


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

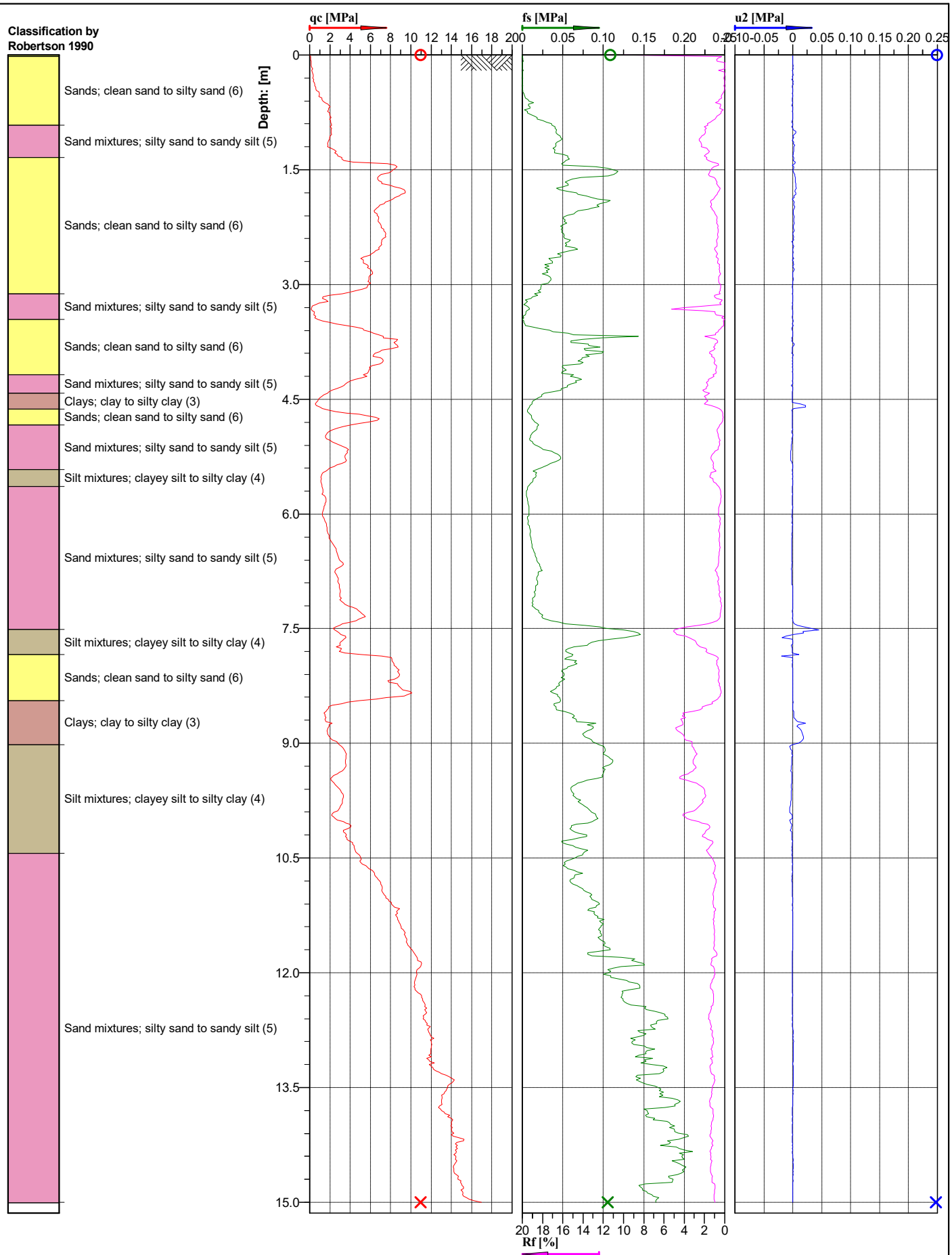
Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67713 E 176.05646		File: CPT08.cpt	



GEOTECH DRILLING

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67090 E 176.06573		File: CPT09.cpt	

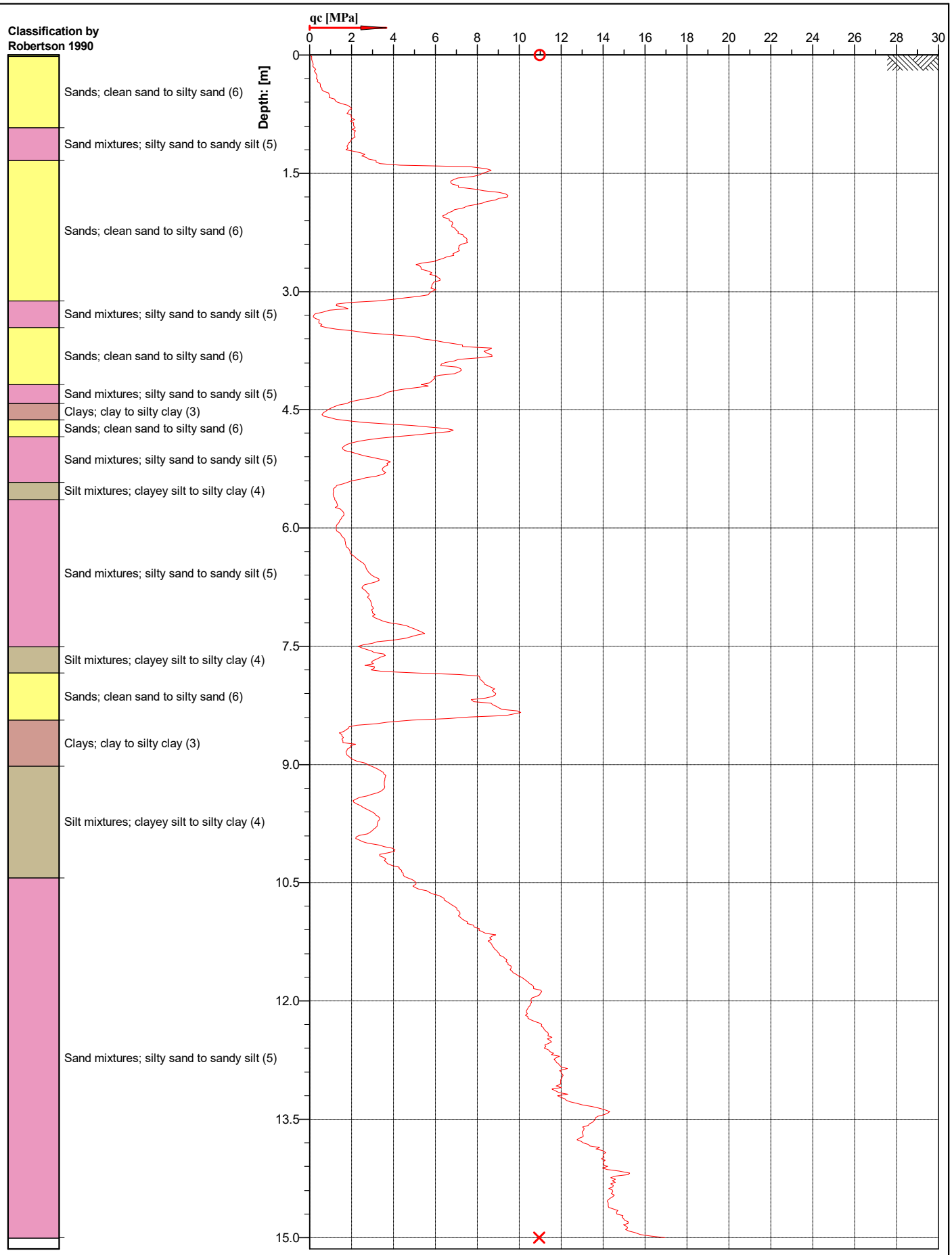


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67090 E 176.06573		File: CPT09.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

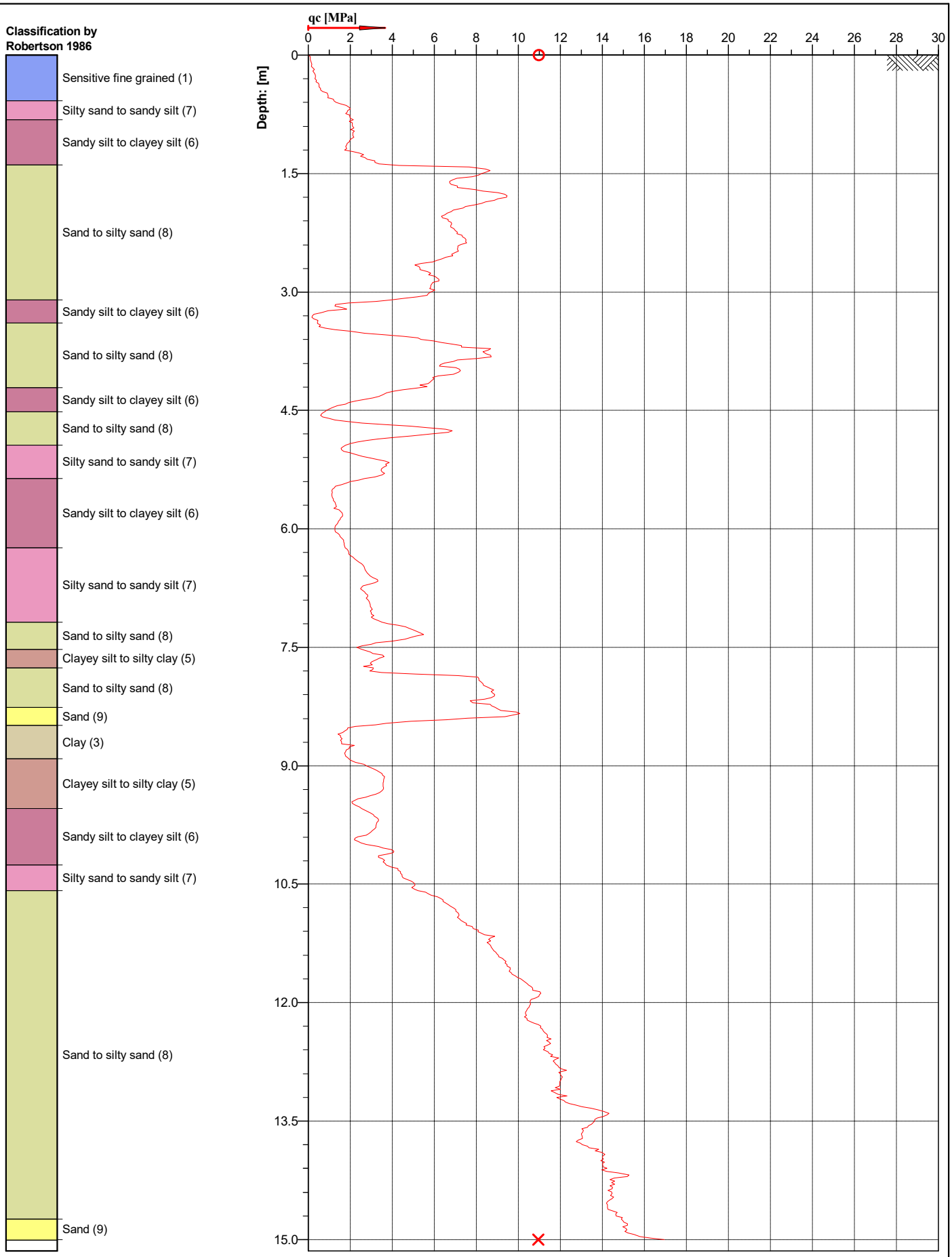


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67090 E 176.06573		File: CPT09.cpt	

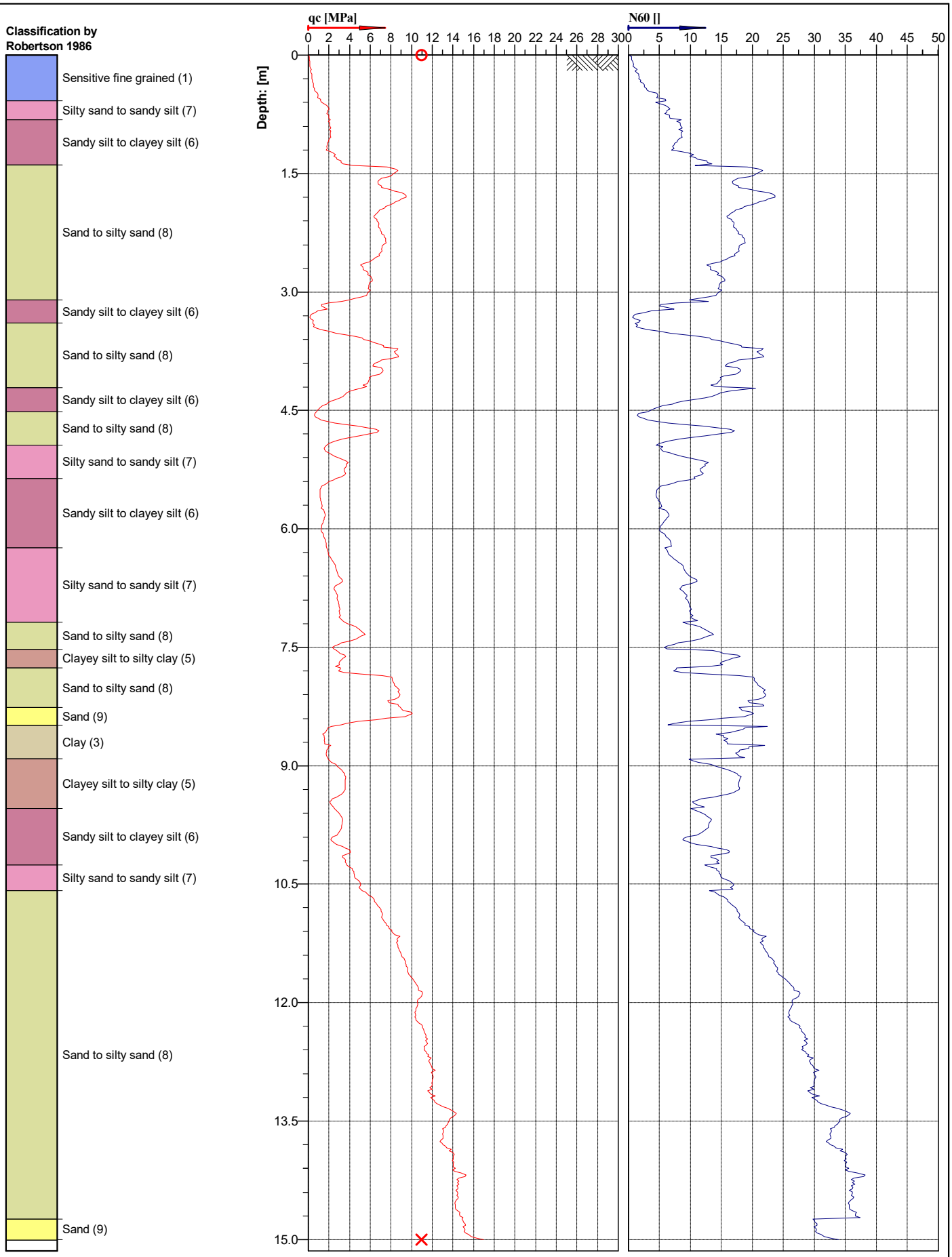


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67090 E 176.06573		File: CPT09.cpt	

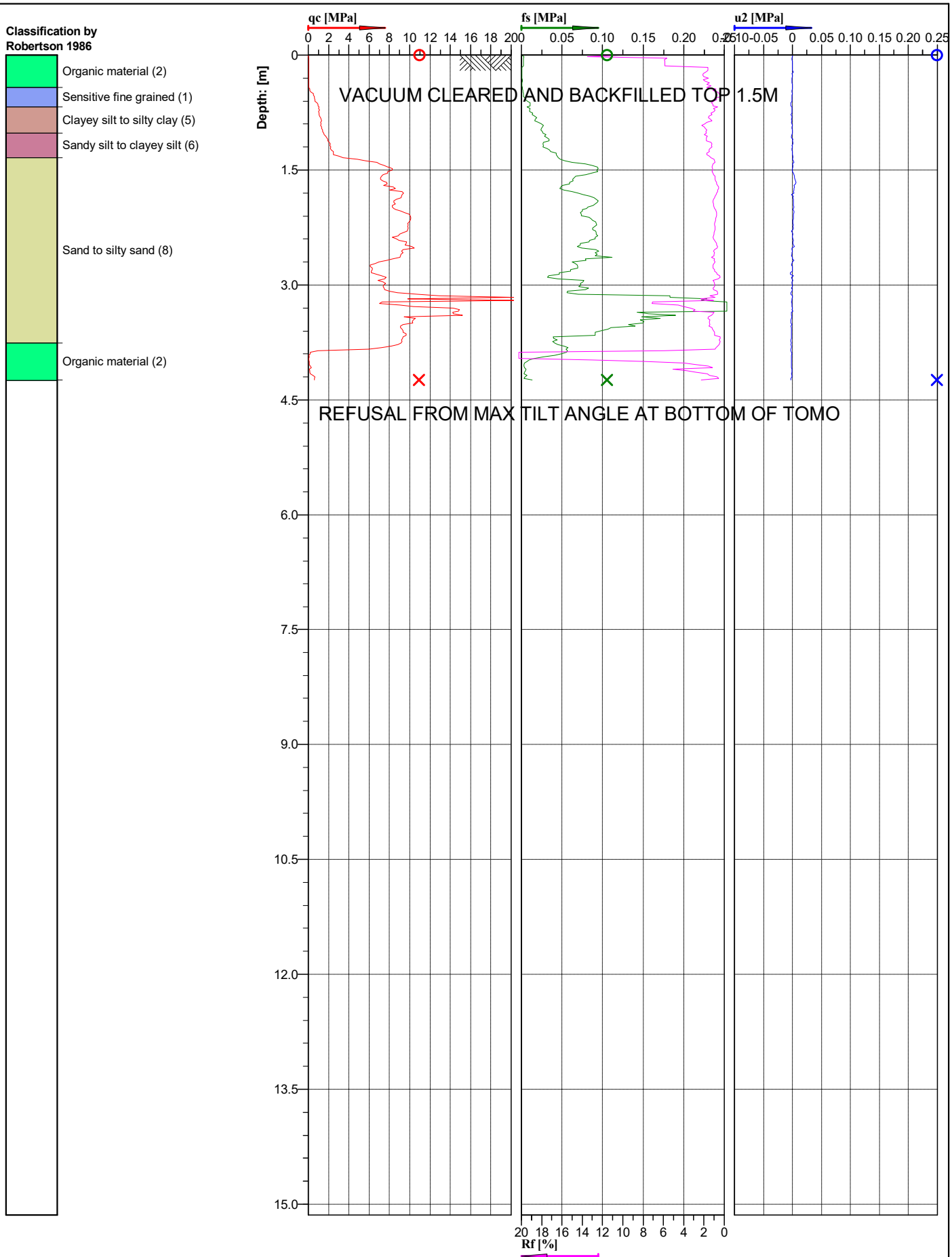


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67090 E 176.06573		File: CPT09.cpt	

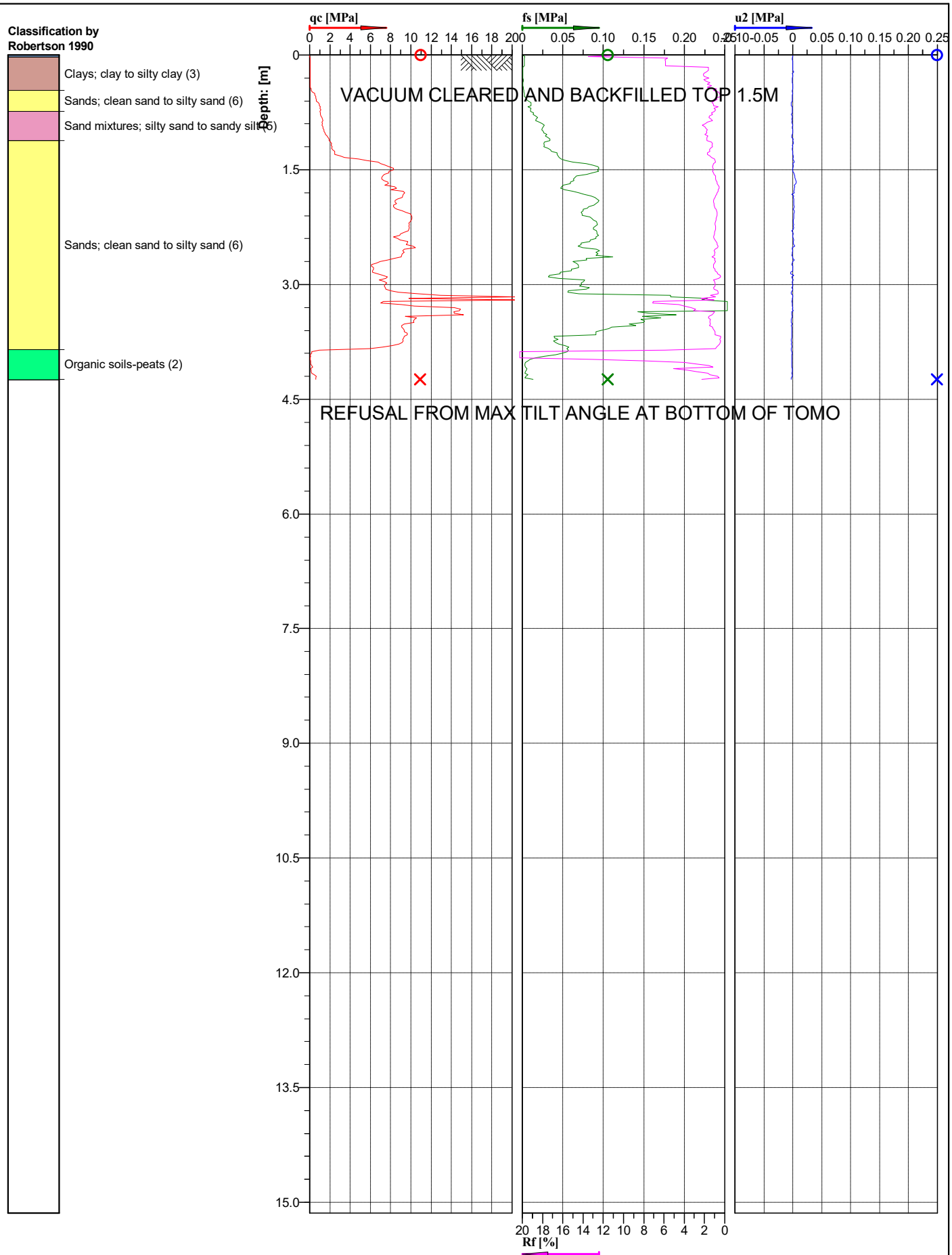


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67017 E 176.06998		File: CPT10.cpd	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

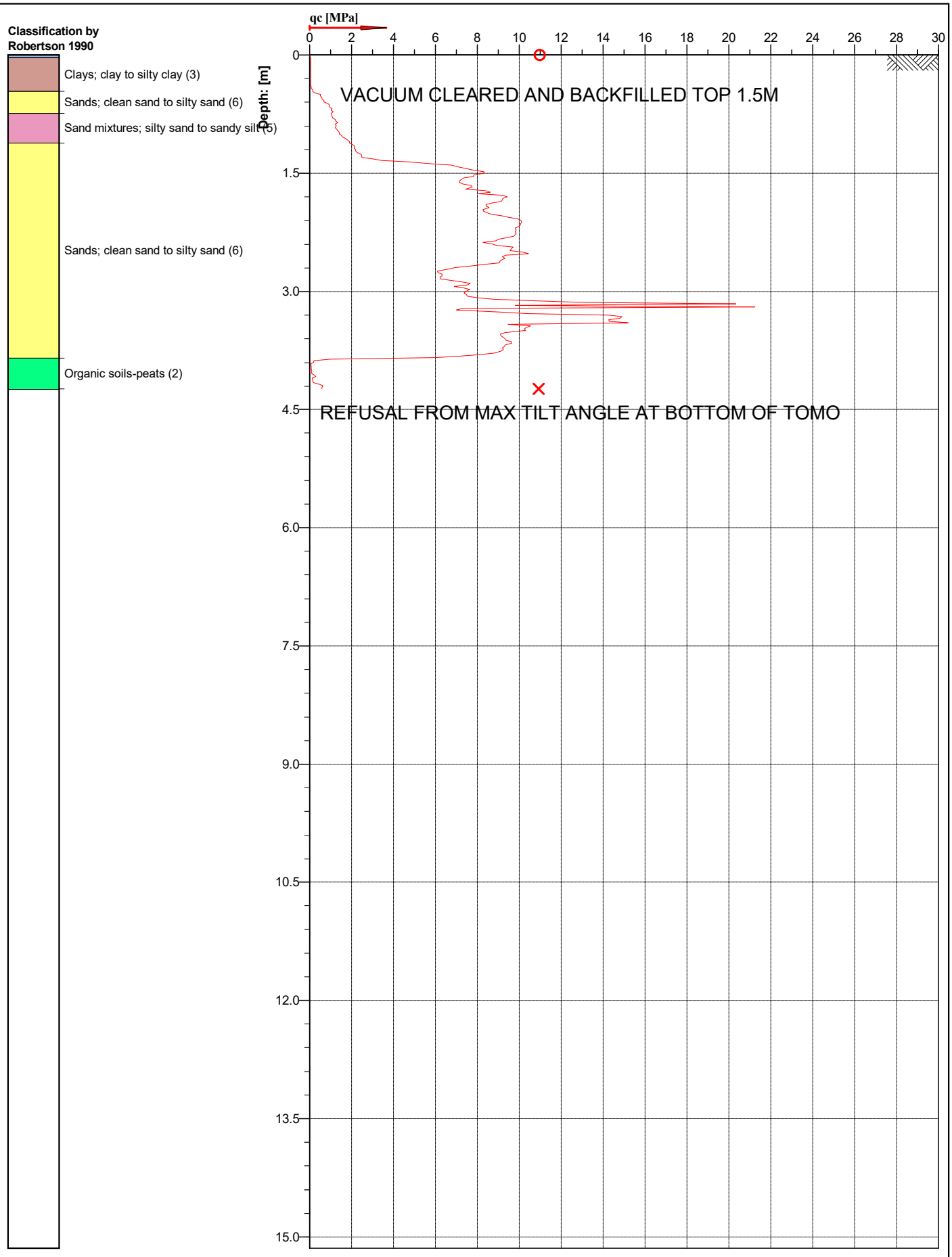


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67017 E 176.06998		File: CPT10.cpd	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

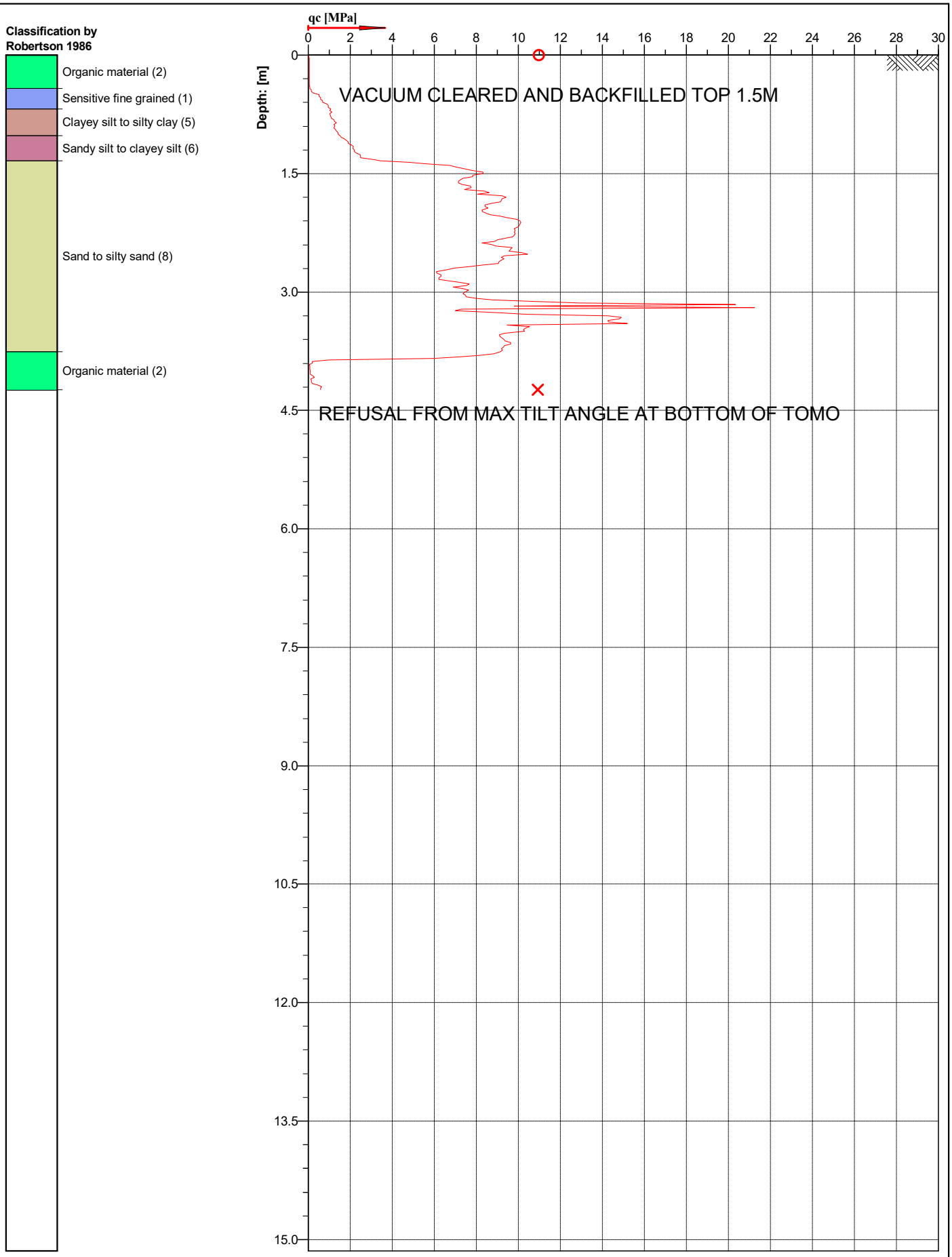


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67017 E 176.06998		File: CPT10.cpd	

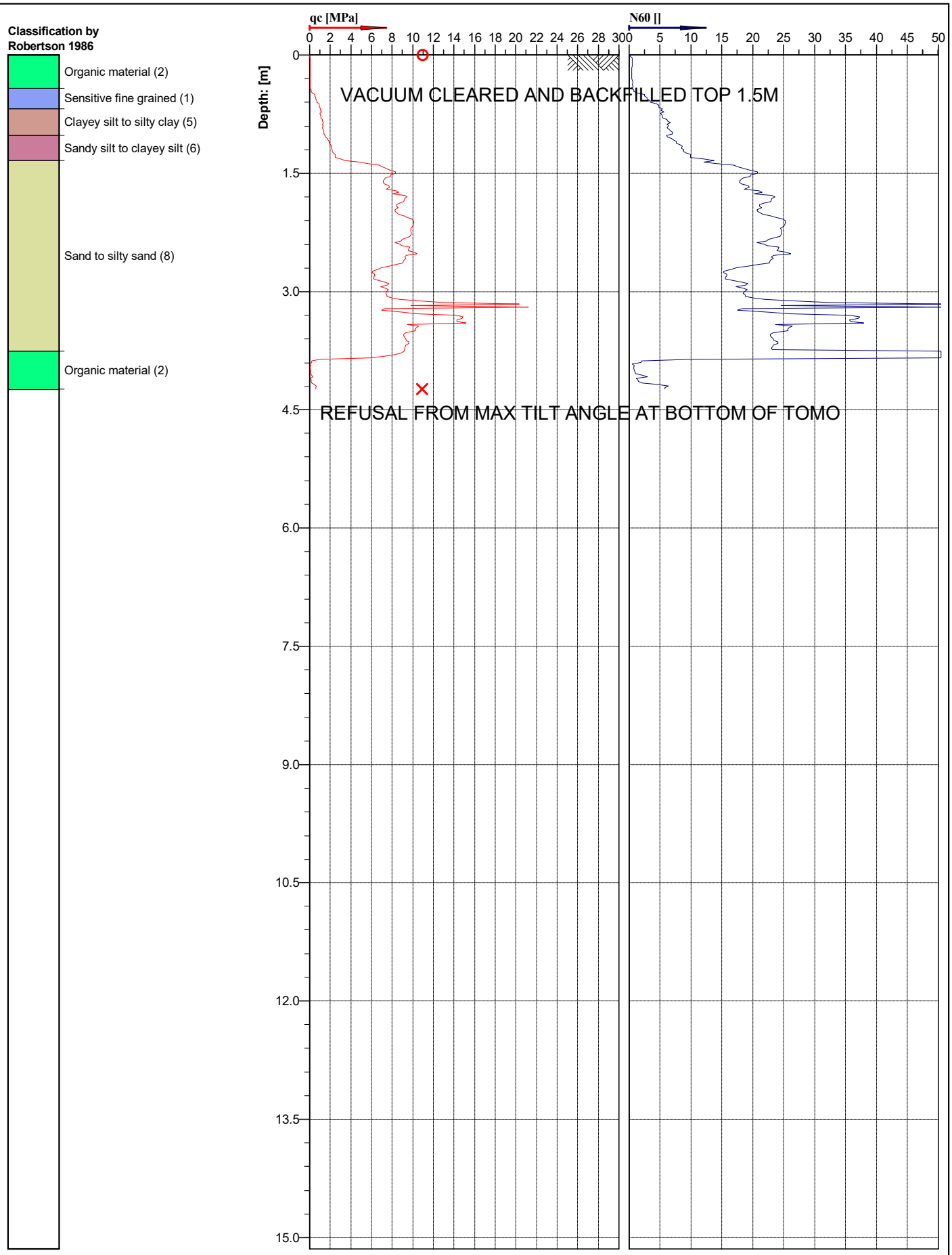


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67017 E 176.06998		File: CPT10.cpd	

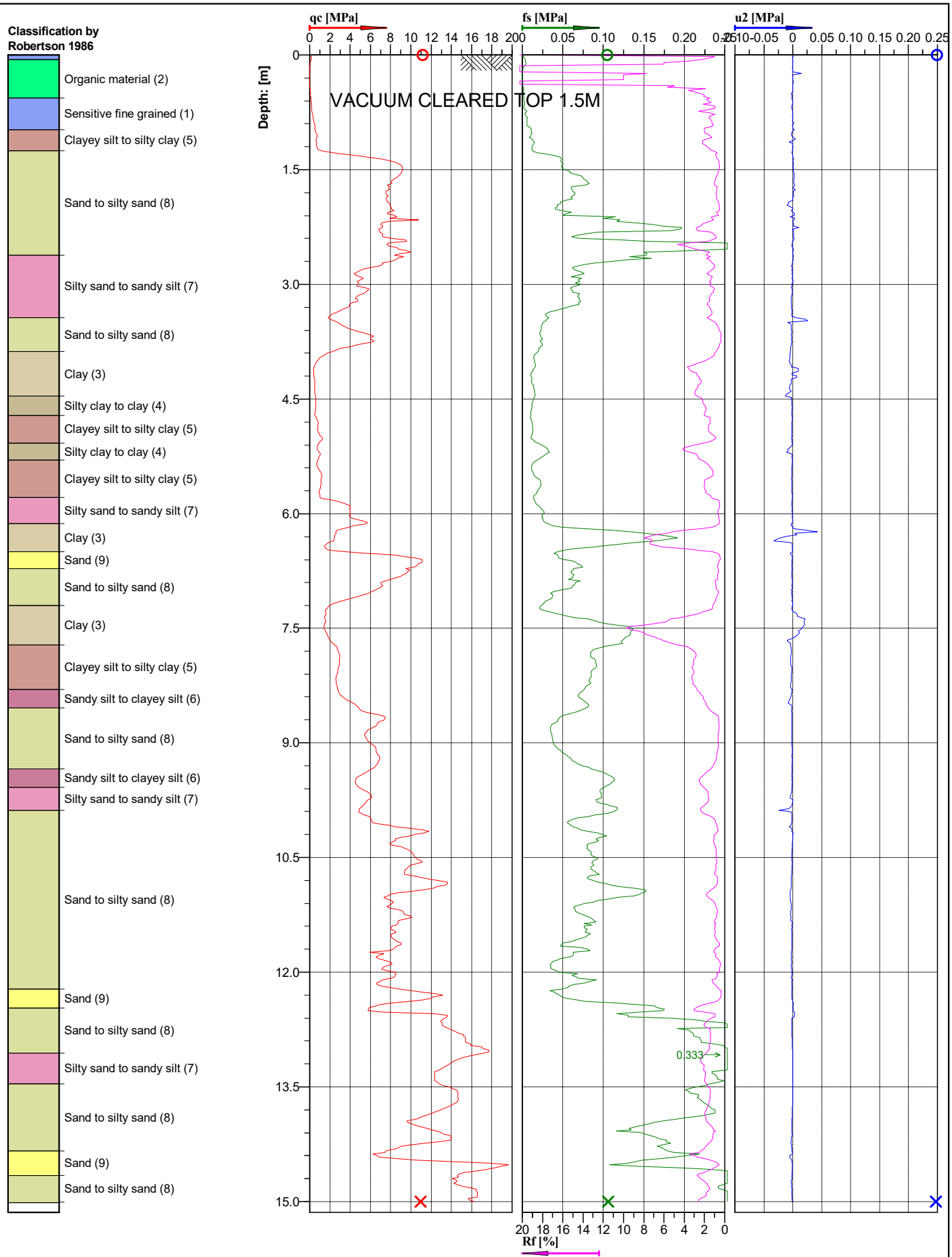


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.67017 E 176.06998		File: CPT10.cpd	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

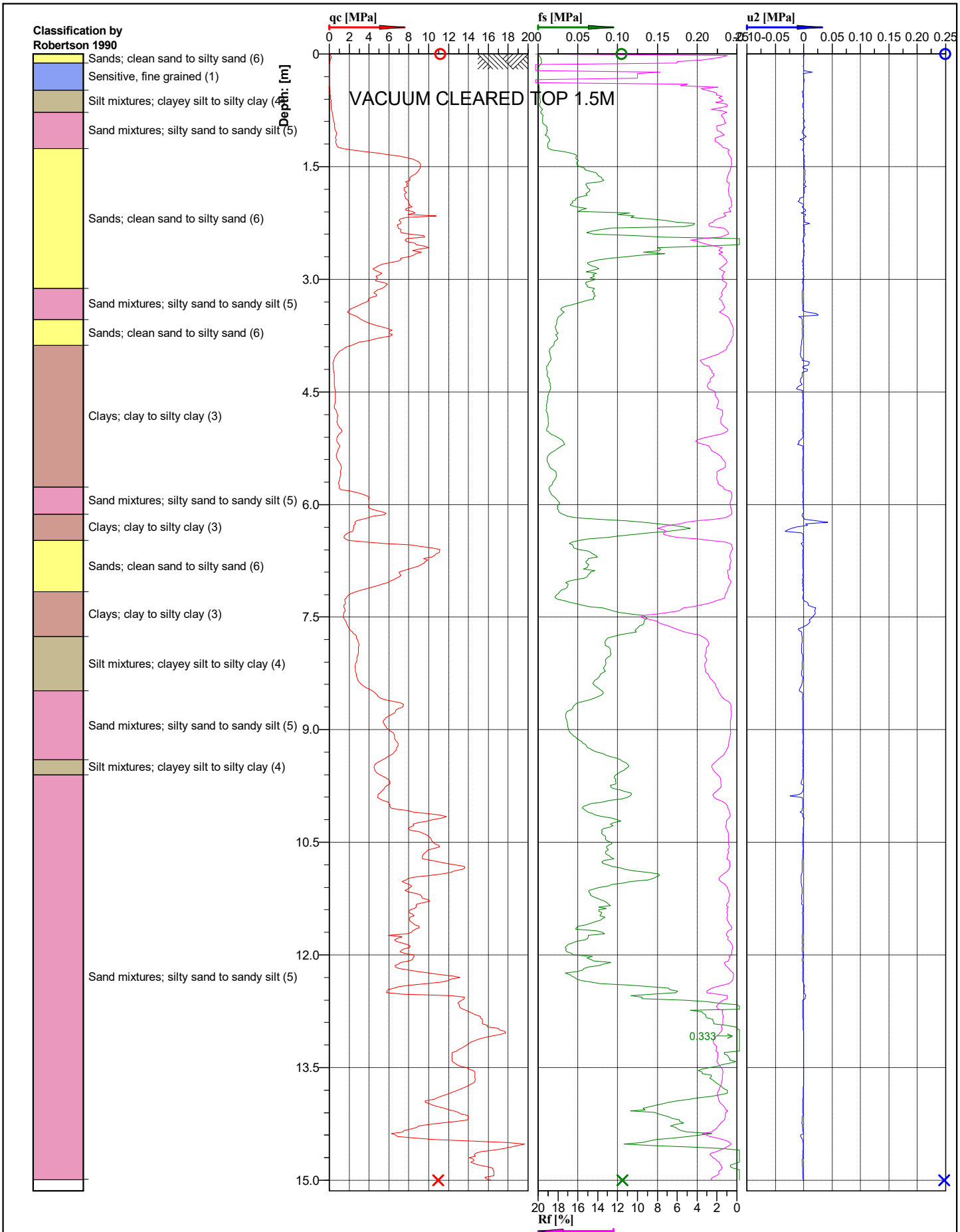


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.66830 E 176.06473		File: CPT11.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

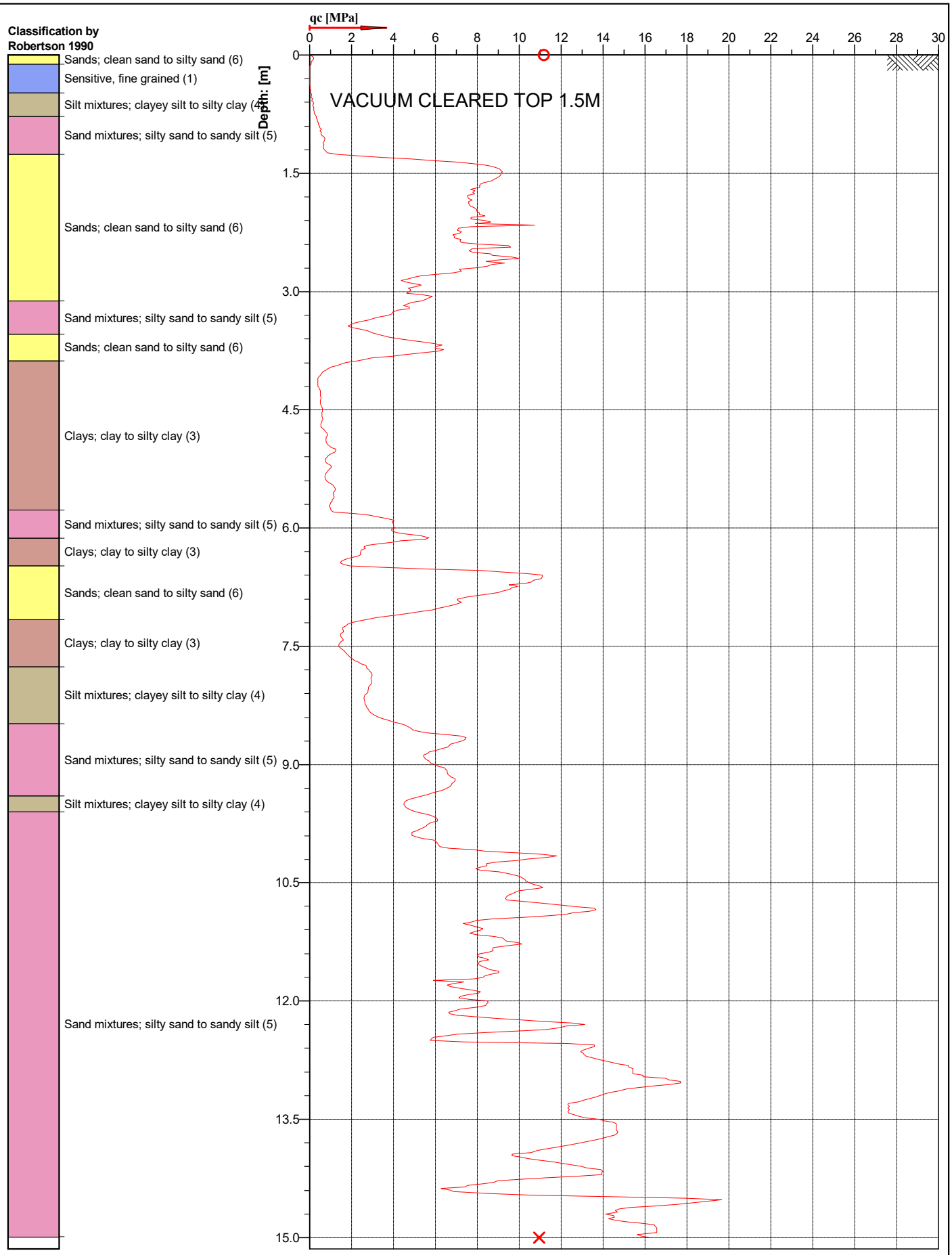


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 67
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.66830 E 176.06473		File: CPT11.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

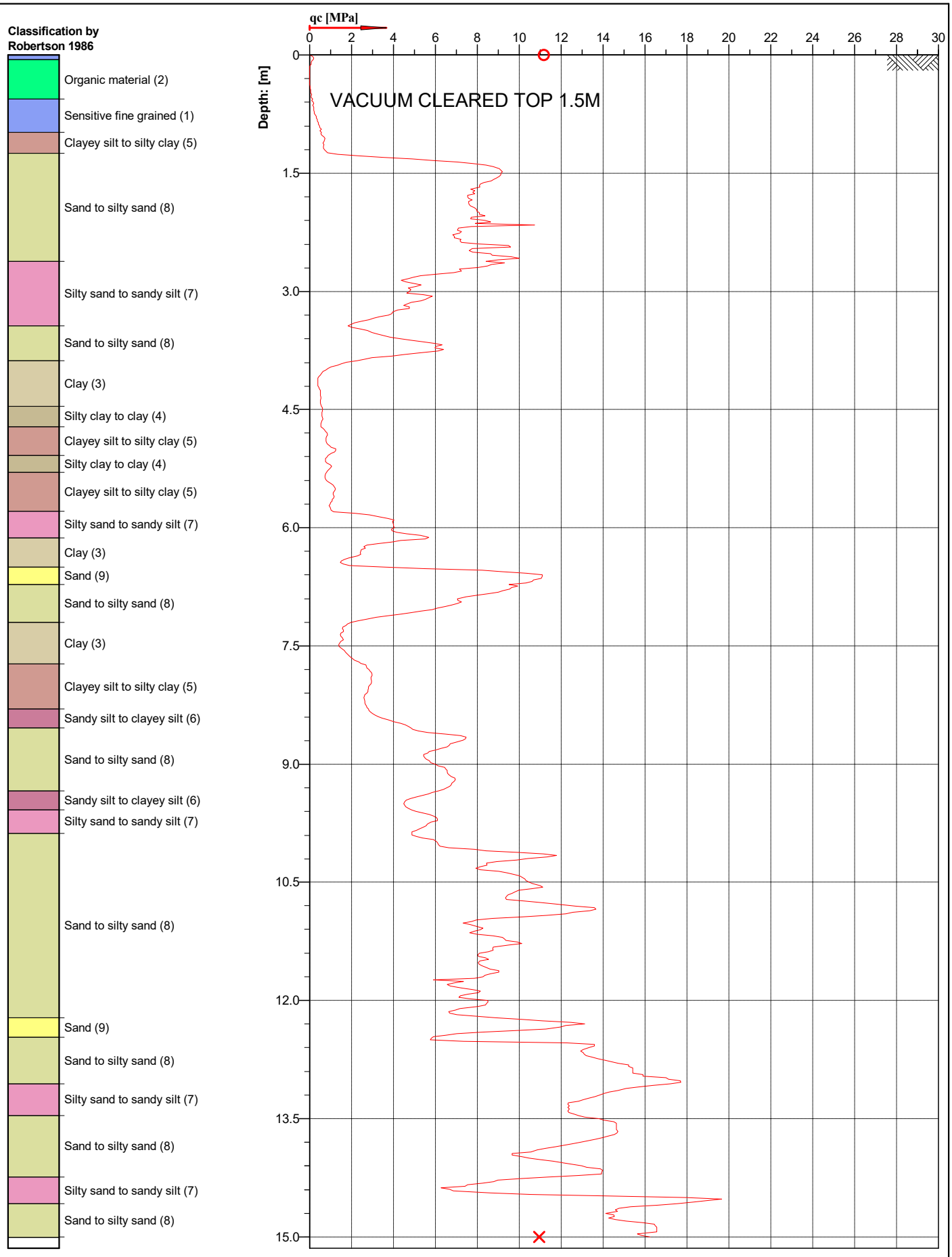


Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.66830 E 176.06473		File: CPT11.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

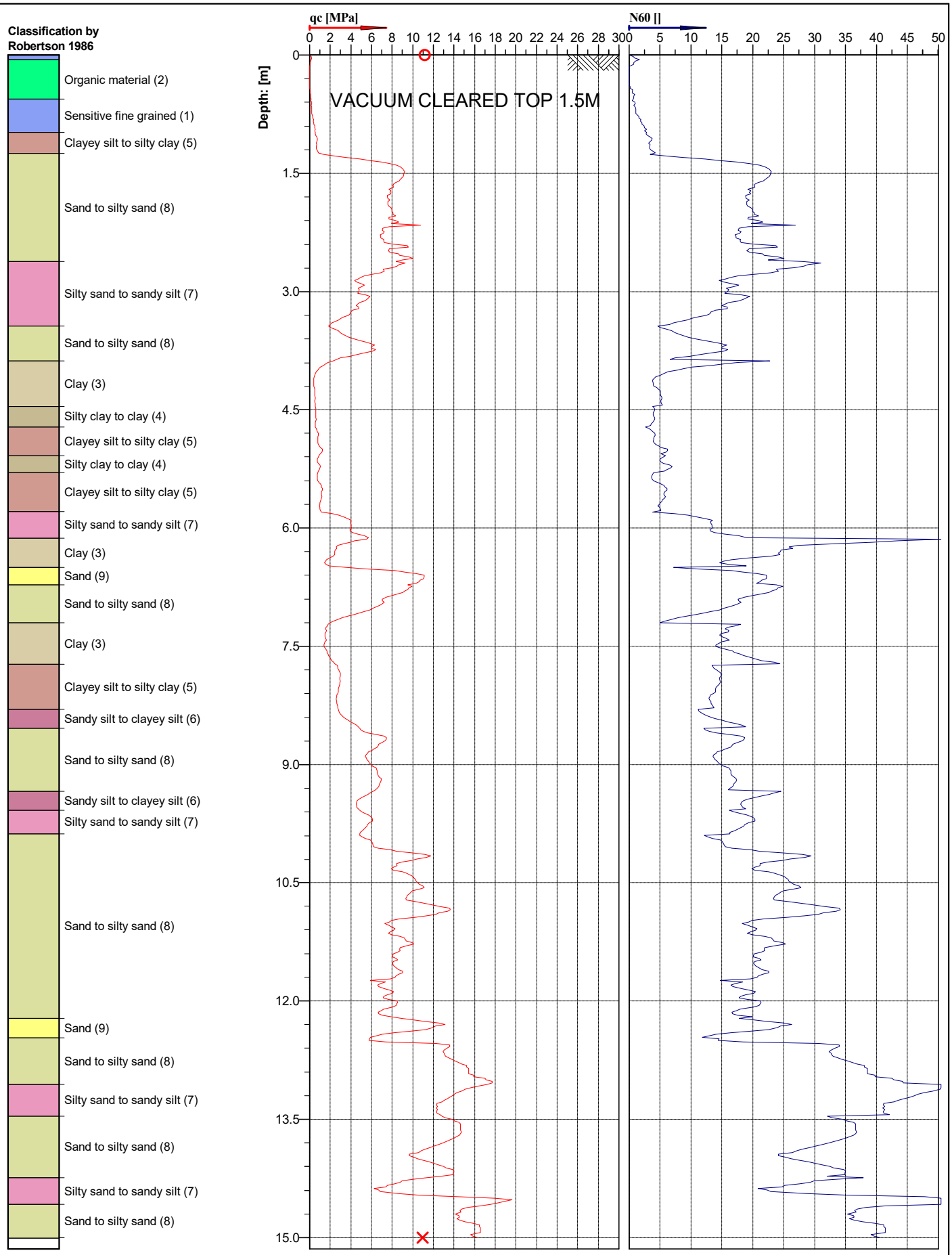


GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.66830 E 176.06473		File: CPT11.cpt	



Location: TAUPO	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: 2-37400.00	Client: WSP	Date: 8/07/2020	Scale: 1 : 65
Project: NUKUHAU GEOTECHNICAL INVESTIGATIONS		Page: 1/1	Fig.:
S 38.66830 E 176.06473		File: CPT11.cpt	

GEOTECH DRILLING

u2

Cone No: 5447
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Appendix B Borehole Logs and Core Photographs

Borehole No. BH01

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1865775 E 5714779 N		
Client:	Various	*Ref. Grid:*	NZTM	*Depth:*	15.45 m
Project No.:	2-37400.00	*R.L.:*	Approx. 427.5 m	*Inclination:*	Vertical
Location:	Nukuhau, Taupo	*Datum:*			

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	SILT with trace sand and rootlets; dark brown. Firm; wet; slightly plastic; sand, fine. [TOPSOIL]												
	Fine to coarse SAND with minor gravel and silt; light brown. Loose; wet; poorly graded; gravel, fine to medium, subrounded pumice. 0.40m: Graded to brownish grey.							72					
		426	1										
					8	5// 2/2/2/2		78					
	Silty fine SAND; grey. Loose; wet; uniformly graded.		2										
	Fine to medium GRAVEL with minor sand and trace silt; light brown. Loose; saturated; poorly graded; gravel, subrounded pumice; sand, coarse.							71					
			3		5	3// 1/1/1/2		67					
	Fine to medium SAND with minor gravel and silt; light brown. Loose; wet; poorly graded; gravel, fine to medium, subrounded pumice.	424						10					
			4								SWL 4.50m 1/07		
	Fine to medium GRAVEL with minor sand and trace silt; light brown. Loose; saturated; poorly graded; gravel, subrounded pumice; sand, coarse.				6	1// 0/2/2/2		56	Rotary cored				
	SILT with some sand and clay; brown. Firm; wet; slightly plastic; sand, fine to coarse pumice.		5										
	Silty fine to coarse SAND with minor gravel; brown. Wet; poorly graded; gravel, fine, subangular pumice.	422						55					
	Fine to coarse SAND with trace silt; brown. Wet; poorly graded.												
	SILT with some sand and minor clay; dark brown. Firm; wet; slightly plastic; sand, fine to coarse.		6										
	Sandy SILT; dark brown. Firm; wet; slightly plastic; sand, fine to coarse.				6	5// 1/2/2/1		56					
	Fine to medium GRAVEL with minor sand; light brown. Loose; wet; poorly graded; gravel, subangular pumice; sand, coarse.							7					
		420	7										
	Silty fine SAND with trace gravel; light brown. Loose; wet; uniformly graded; gravel, fine, subangular pumice.				6	2// 2/1/2/1		44					
			8					86					
	Sandy SILT; light brown. Stiff; wet; non plastic.												
	Fine to medium SAND with trace silt; greyish brown. Medium dense; wet; uniformly graded.												
			9		12	6// 3/3/3/3		67					
	9.50m: Grey.	418						55		HQ			

BOREHOLE SOIL LOG A4 - WSP 2-37400.00_NUKUHAU BHS.GPJ WSP-OPUS2019_VER11X.GDT 23/10/20

Notes:
Groundwater recorded at 4.5 m bgl prior to start of drilling on day 2.

Started:	30/06/2020	*Finished:*	1/07/2020
Drilling Co.:	Geotech Drilling	*Drilling Rig:*	DB8 Tracked Rig
Logged by:	SJ	*Checked by:*	HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH01

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1865775 E 5714779 N		
Client:	Various	*Ref. Grid:*	NZTM	*Depth:*	15.45 m
Project No.:	2-37400.00	*R.L.:*	Approx. 427.5 m	*Inclination:*	Vertical
Location:	Nukuhau, Taupo	*Datum:*			

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	Fine SAND with some silt; light brown. Wet; uniformly graded.							55					
	Fine to medium SAND with trace silt; greyish brown. Medium dense; wet; uniformly graded.												
	Fine SAND with some silt; light brown. Medium dense; wet; uniformly graded.				17	7// 4/4/5/4		56					
	Fine to medium SAND with trace silt; greyish brown. Medium dense; wet; uniformly graded.												
	Silty fine SAND; light brown. Medium dense; wet; uniformly graded.		11										
	Fine SAND with some silt; light brown. Wet; uniformly graded.	416						79					
	Fine to medium SAND with trace silt; grey. Wet; uniformly graded.												
	Sandy fine GRAVEL; greyish brown and white. Wet; poorly graded; gravel, subangular pumice; sand, fine to coarse.		12		15	7// 4/3/4/4		44					
	NO CORE RECOVERY							0	Rotary cored				
			13										
	Sandy fine GRAVEL; greyish brown and white. Wet; poorly graded; gravel, subangular pumice; sand, fine to coarse.	414			20	9// 5/4/5/6		44					
			14					16					
										HQ			
	Fine to coarse SAND with trace gravel; light greyish brown. Wet; poorly graded; gravel, fine, subangular pumice.		15		22	11// 5/5/6/6		44					
	END OF BOREHOLE AT 15.45m - Target Depth Reached	412											
			16										
			17										
		410											
			18										
			19										
		408											

Notes:
Groundwater recorded at 4.5 m bgl prior to start of drilling on day 2.

Started:	30/06/2020	*Finished:*	1/07/2020
Drilling Co.:	Geotech Drilling	*Drilling Rig:*	DB8 Tracked Rig
Logged by:	SJ	*Checked by:*	HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Location: Nukuhau **Borehole:** BH01 **Depth:** 0.00-4.95m bgl

Location: Nukuhau **Borehole:** BH01 **Depth:** 4.95-10.50m bgl

Location: Nukuhau **Borehole:** BH01 **Depth:** 10.50-15.45m bgl

Borehole No. BH02

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1865741 E 5715251 N
Client:	Various	*Ref. Grid:*	NZTM
Project No.:	2-37400.00	*R.L.:*	Approx. 449.5 m
Location:	Nukuhau, Taupo	*Datum:*	

Depth: 15.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	NO CORE RECOVERY - hydro-excavation for service clearance.		1					0					
	Fine to coarse SAND with minor silt and trace gravel; light brownish grey. Medium dense; wet; poorly graded; gravel, fine, subrounded pumice and volcanics.	448			14	7// 4/3/4/3		100					
	2.25m: Minor gravel, trace silt. Moist.		2					98					
	Fine to coarse GRAVEL with some sand; black and brown. Medium dense; wet; poorly graded; gravel, subangular volcanics; sand, medium to coarse.	446	3		19	10// 4/5/5/5		44					
	Medium to coarse GRAVEL with trace fine gravel and sand; light brownish grey. Wet; poorly graded; gravel, subangular pumice; sand, coarse.		4					98					
	Silty fine SAND; grey. Wet; uniformly graded.												
	Fine GRAVEL with some sand and trace silt; brown. Wet; poorly graded; gravel, subangular; sand, coarse.				8	3// 1/1/3/3		67					
	SILT; light brown. Firm; moist; non-plastic.		5										
	Fine to medium GRAVEL with some silt and minor sand; brown. Loose; wet; poorly graded; gravel, subangular volcanics; sand, coarse.												
	Silty fine to coarse SAND with minor gravel; brown. Wet; well graded; gravel, fine, subangular volcanics.	444						87	Rotary cored				
	Fine to medium GRAVEL with trace sand and silt; interbedded with layers of SILT with minor sand and trace clay; brown and black. Wet; gravel, poorly graded, subangular volcanics; silt, firm, non-plastic.		6										
	Silty fine SAND with trace clay and gravel; light brownish grey. Wet; uniformly graded.				12	3// 2/3/3/4		89					
	Fine to medium GRAVEL with minor sand and trace silt; brown. Wet; poorly graded; gravel, subangular volcanics and pumice.												
	Fine to medium SAND with trace silt; brown. Loose; wet; poorly graded.												
	Fine to coarse SAND with some silt and trace gravel; brown. Loose; wet; poorly graded; gravel, fine, subangular pumice.												
	Fine to coarse SAND with trace silt; grey. Wet; well graded.		7					67					
	SILT with some clay and trace sand; dark brown. Firm; wet; slightly plastic.												
	Fine to medium GRAVEL with some silt and trace clay; brown. Wet; poorly graded; gravel, subangular pumice and volcanics.												
	Fine to medium GRAVEL with trace sand; light brown. Loose; wet; poorly graded. 7.60m: Trace silt.	442			6	4// 2/3/1/0		44					
	SILT with minor to some sand and trace clay; brown. Firm to stiff; wet; slightly plastic; sand, fine. 50mm thick bands of medium GRAVEL to 8.2m.		8					99					
	Silty fine SAND; brown. Loose; wet; poorly graded.												
		440	9		8	1// 1/2/3/2		78					
								100					

Notes:

Started: 1/07/2020 *Finished:* 2/07/2020
Drilling Co.: Geotech Drilling *Drilling Rig:* DB8 Tracked Rig
Logged by: SJ *Checked by:* HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH02

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1865741 E 5715251 N
Client:	Various	*Ref. Grid:*	NZTM
Project No.:	2-37400.00	*R.L.:*	Approx. 449.5 m
Location:	Nukuhau, Taupo	*Datum:*	

Depth: 15.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	Fine to medium SAND with trace silt; brown and grey. Wet; poorly graded.*(continued)*							100	Rotary cored	HQ			
	Silty fine SAND; brown. Stiff; wet; non-plastic; sand, fine.												
	Fine to coarse SAND with minor gravel and trace silt; grey, black, and brown. Medium dense; wet; well graded; gravel, subangular volcanics.		11		20	9// 5/5/5/5		100					
		438						60					
			12		18	8// 4/5/4/5		89					
	12.55m: Some fine to medium gravel.												
	12.8m: Minor gravel, minor silt. 12.90m: Coarse sand and fine gravel. Silt absent.		13					88					
	Fine to coarse SAND with trace silt and gravel; light brown. Medium dense; wet; well graded; gravel, fine, subangular pumice.	436											
	13.60m: Some fine to coarse gravel, minor silt.		14		17	8// 5/3/4/5		56					
	Coarse SAND with minor gravel; grey, black, and brown. Wet; poorly graded; gravel, fine subangular volcanics.							70					
	Fine to coarse SAND with some gravel and trace silt; light brown. Wet; poorly graded; gravel, fine to medium, subangular pumice.												
	Fine SAND with trace silt; light brown. Wet; well graded.												
	Fine to coarse SAND with trace silt and gravel; light brown. Medium dense; wet; well graded; gravel, fine, subangular pumice.		15		15	8// 3/4/4/4		89					
		434											
	END OF BOREHOLE AT 15.45m - Target Depth Reached		16										
			17										
		432											
			18										
			19										
		430											

Notes:

Started: 1/07/2020 *Finished:* 2/07/2020
Drilling Co.: Geotech Drilling *Drilling Rig:* DB8 Tracked Rig
Logged by: SJ *Checked by:* HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Location: Nukuhau **Borehole:** BH02 **Depth:** 0.00-5.10m bgl

Location: Nukuhau **Borehole:** BH02 **Depth:** 5.10-8.85m bgl

Location: Nukuhau **Borehole:** BH02 **Depth:** 8.85-12.90m bgl

Location: Nukuhau **Borehole:** BH02 **Depth:** 12.90-15.45m bgl

Borehole No. BH03

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1866334 E 5715013 N
Client:	Various	*Ref. Grid:*	NZTM
Project No.:	2-37400.00	*R.L.:*	Approx. 428 m
Location:	Nukuhau, Taupo	*Datum:*	

Depth: 15.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	NO CORE RECOVERY - hydro-excavation for service clearance.		1					0					
	Fine to medium SAND with minor silt; light brownish grey. Loose; moist; poorly graded.				7	4// 2/2/2/1		89					
	2.05m: Fine to coarse SAND with trace fine to medium gravel.	426	2					100					
	Fine to coarse GRAVEL with minor sand; black and brownish grey. Loose; wet; poorly graded; gravel, subrounded pumice and volcanics; sand, coarse.		3		6	4// 2/2/1/1		67					
	4.20m: Gravel becomes pumice only.	424	4					71					
	Silty fine SAND; grey. Wet; uniformly graded.												
	Fine SAND with some silt and minor gravel; grey and light brown. Wet; poorly graded; gravel, fine, subangular pumice.				1	0// 0/0/1/0		73					
	Fine to medium GRAVEL with minor sand and silt; light brownish grey. Very loose; wet; poorly graded; gravel, subangular pumice; sand, fine to coarse.		5										
	SILT with some sand; dark brown. Very soft; wet; non-plastic; sand, fine to coarse. Organic smell. 5.20m: Brown. Organic smell absent.							90	Rotary cored				
	Fine to medium GRAVEL with trace sand; light brownish grey. Wet; poorly graded; gravel, subangular pumice; sand, coarse.												
	Fine to coarse SAND with trace silt and gravel; light brownish grey. Medium dense; moist; poorly graded; gravel, fine to coarse, subangular pumice.	422	6		17	6// 4/4/5/4		56					
	Coarse SAND and fine GRAVEL with trace silt; light brown. Wet; poorly graded; gravel, subangular pumice and volcanics. 6.65m: Minor silt.							100					
	Fine GRAVEL with trace sand; brown. Saturated; poorly graded; gravel, subangular pumice and volcanics; sand, coarse.		7										
	Silty fine to medium SAND with minor clay; dark orangish brown. Wet; uniformly graded.												
	Fine to coarse SAND with minor to some silt; light brown. Wet; poorly graded.												
	Fine GRAVEL with trace sand; brown. Very loose; saturated; poorly graded; gravel, subangular pumice and volcanics; sand, coarse.				2	6// 1/0/0/1		22					
	Sandy SILT with trace clay; light brown. Soft; wet; non-plastic; sand, fine.	420	8										
	Coarse SAND and fine GRAVEL; light brown. Wet; poorly graded; gravel, subangular pumice and volcanics; sand, coarse.							92					
	Silty fine SAND, tending to sandy SILT in areas; light brown. Wet; uniformly graded.												
	Fine SAND with some silt; light brown. Loose; wet; uniformly graded. 8.90m: Minor silt.		9										
	9.40m: Trace fine gravel, and lenses of silty SAND.				7	4// 2/2/2/1		40					
		418						95					

BOREHOLE SOIL LOG A4 - WSP 2-37400.00_NUKUHAU BHS.GPJ WSP-OPUS2019_VER11X.GDT 23/10/20

Notes:

Started:	2/07/2020	*Finished:*	2/07/2020
Drilling Co.:	Geotech Drilling	*Drilling Rig:*	DB8 Tracked Rig
Logged by:	SJ	*Checked by:*	HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH03

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1866334 E 5715013 N		
Client:	Various	*Ref. Grid:*	NZTM	*Depth:*	15.45 m
Project No.:	2-37400.00	*R.L.:*	Approx. 428 m	*Inclination:*	Vertical
Location:	Nukuhau, Taupo	*Datum:*			

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	Fine to coarse SAND with trace silt and gravel; grey. Wet; well graded; gravel, fine, subangular volcanics.							95	Rotary cored	HQ			
	Fine SAND with minor silt and trace gravel; light brown. Wet; uniformly graded; gravel, fine, subangular volcanics.												
	Fine to coarse SAND with trace silt and gravel; light brown and dark grey. Medium dense; wet; well graded; gravel, fine, subangular volcanics.				13	5// 3/3/3/4		78					
	Fine to coarse SAND with minor silt and gravel; light brown and white. Wet; poorly graded; gravel, fine to medium, subangular pumice.		11										
	11.05m: Light brown. Gravel, pumice and volcanics.	416	12					75					
					23	10// 5/6/6/6		89					
	12.90m: Some gravel.		13					93					
	Gravelly fine to coarse SAND with minor silt; light brown. Medium dense; wet; poorly graded; gravel, fine to medium, subangular pumice and volcanics.												
		414	14		31	14// 7/7/8/9		89					
								87					
	Fine to coarse SAND with minor silt and gravel; light brown. Medium dense; wet; poorly graded; gravel, fine to medium, subangular pumice and volcanics.		15										
					30	11// 7/8/7/8		89					
	END OF BOREHOLE AT 15.45m - Target Depth Reached	412	16										
			17										
		410	18										
			19										
		408											

BOREHOLE SOIL LOG A4 - WSP 2-37400.00_NUKUHAU BHS.GPJ WSP-OPUS2019_VER11X.GDT 23/10/20

Notes:

Started:	2/07/2020	*Finished:*	2/07/2020
Drilling Co.:	Geotech Drilling	*Drilling Rig:*	DB8 Tracked Rig
Logged by:	SJ	*Checked by:*	HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Location: Nukuhau **Borehole:** BH03 **Depth:** 0.00-5.40m bgl

Location: Nukuhau **Borehole:** BH03 **Depth:** 5.40-8.80m bgl

Location: Nukuhau **Borehole:** BH03 **Depth:** 8.80-12.70m bgl

Location: Nukuhau **Borehole:** BH03 **Depth:** 12.70-15.45 bgl

Borehole No. BH04

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1866877 E 5715381 N
Client:	Various	*Ref. Grid:*	NZTM
Project No.:	2-37400.00	*R.L.:*	Approx. 432 m
Location:	Nukuhau, Taupo	*Datum:*	

Depth: 15.45 m
Inclination: Vertical

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	NO CORE RECOVERY - hydro-excavation for service clearance.		1					0					
	Fine to medium SAND with trace silt and gravel; light grey. Very loose; moist; poorly graded; gravel, fine, subangular pumice.	430	2		2	0// 1/0/0/1		67					
								100					
	No core recovery.		3		0	0// 0/0/0/0		0					
		428	4					76					
	Fine to medium SAND with trace silt and gravel; light grey. Moist; poorly graded; gravel, fine, subangular pumice.												
	Coarse SAND and fine to coarse GRAVEL												
	Sandy fine to coarse GRAVEL; light grey and black. Very loose; wet; well graded; gravel, subangular pumice and volcanics; sand, fine to coarse.				1	1// 1/0/0/0		44	Rotary cored				
	Fine to coarse SAND with some silt and minor gravel; dark brown and yellowish brown. Wet; poorly graded; gravel, fine to medium, subangular pumice.		5										
	Silty fine to coarse SAND; dark brown. Wet; well graded.							95					
	Fine to medium GRAVEL with some sand; light grey speckled black. Moist; poorly graded; gravel, subangular pumice and volcanics; sand, fine to coarse.												
	Fine to medium SAND with some silt; dark brown. Wet; poorly graded.	426	6										
	Medium to coarse SAND; light grey. Very loose; moist; poorly graded.				0	1// 0/0/0/0		22					
	Fine to coarse SAND with minor silt and gravel; dark yellowish brown. Wet; poorly graded; gravel, fine, subangular pumice.												
	6.85m: Trace silt. Light yellowish brown.		7					95					
	Silty fine to medium SAND, tending to sandy SILT in areas; brown. Firm; wet; non-plastic; uniformly graded.												
	Fine to coarse SAND with trace silt and gravel; light brownish grey. Medium dense; wet; poorly graded; gravel, fine, subangular pumice and volcanics.				15	6// 4/4/3/4		89					
		424	8										
	8.25m: Minor silt.							92					
	Sandy SILT; brown. Stiff; wet; non-plastic.												
	8.70m: Tending to silty fine SAND.		9										
	Fine to medium SAND with trace silt; grey. Medium dense; wet; poorly graded.				10	2// 1/3/3/3		100					
								99					
	Silty fine SAND; brown. Wet; uniformly graded.	422											

Notes:

Started: 3/07/2020 *Finished:* 3/07/2020
Drilling Co.: Geotech Drilling *Drilling Rig:* DB8 Tracked Rig
Logged by: SJ *Checked by:* HP

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Borehole No. BH04

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	1866877 E 5715381 N		
Client:	Various	*Ref. Grid:*	NZTM	*Depth:*	15.45 m
Project No.:	2-37400.00	*R.L.:*	Approx. 432 m	*Inclination:*	Vertical
Location:	Nukuhau, Taupo	*Datum:*			

GEOLOGY	MAIN DESCRIPTION / DETAIL DESCRIPTION	R.L. (m)	DEPTH (m)	GRAPHIC LOG	TESTS: SPT 'N' VALUE	TESTS: SPT BLOW COUNTS OR SHEAR VALUE	CORE: CORE TYPE	CORE: TOTAL CORE RECOVERY (%)	DRILLING: DRILLING METHOD	DRILLING: CASING	DRILLING: BASE OF HOLE & WATER LEVEL	NOTES / OTHER TESTS	INSTALLATION DETAILS
	Silty fine SAND; brown. Wet; uniformly graded. *(continued)*												
	Fine to coarse SAND with some silt and trace gravel; light brown. Medium dense; wet; well graded; gravel, fine, subangular pumice.							99					
					13	4// 3/3/3/4		78					
	11.00m: Brownish grey.		11					79					
		420	12		22	8// 5/6/5/6		67					
	12.50m: Minor silt.								Rotary cored				
			13										
					27	10// 6/7/7/7							
		418	14										
			15							HQ			
					26	11// 6/7/6/7							
	END OF BOREHOLE AT 15.45m - Target Depth Reached												
		416	16										
			17										
		414	18										
			19										
		412											

Notes:

Started:	3/07/2020	*Finished:*	3/07/2020
Drilling Co.:	Geotech Drilling	*Drilling Rig:*	DB8 Tracked Rig
Logged by:	SJ	*Checked by:*	HP

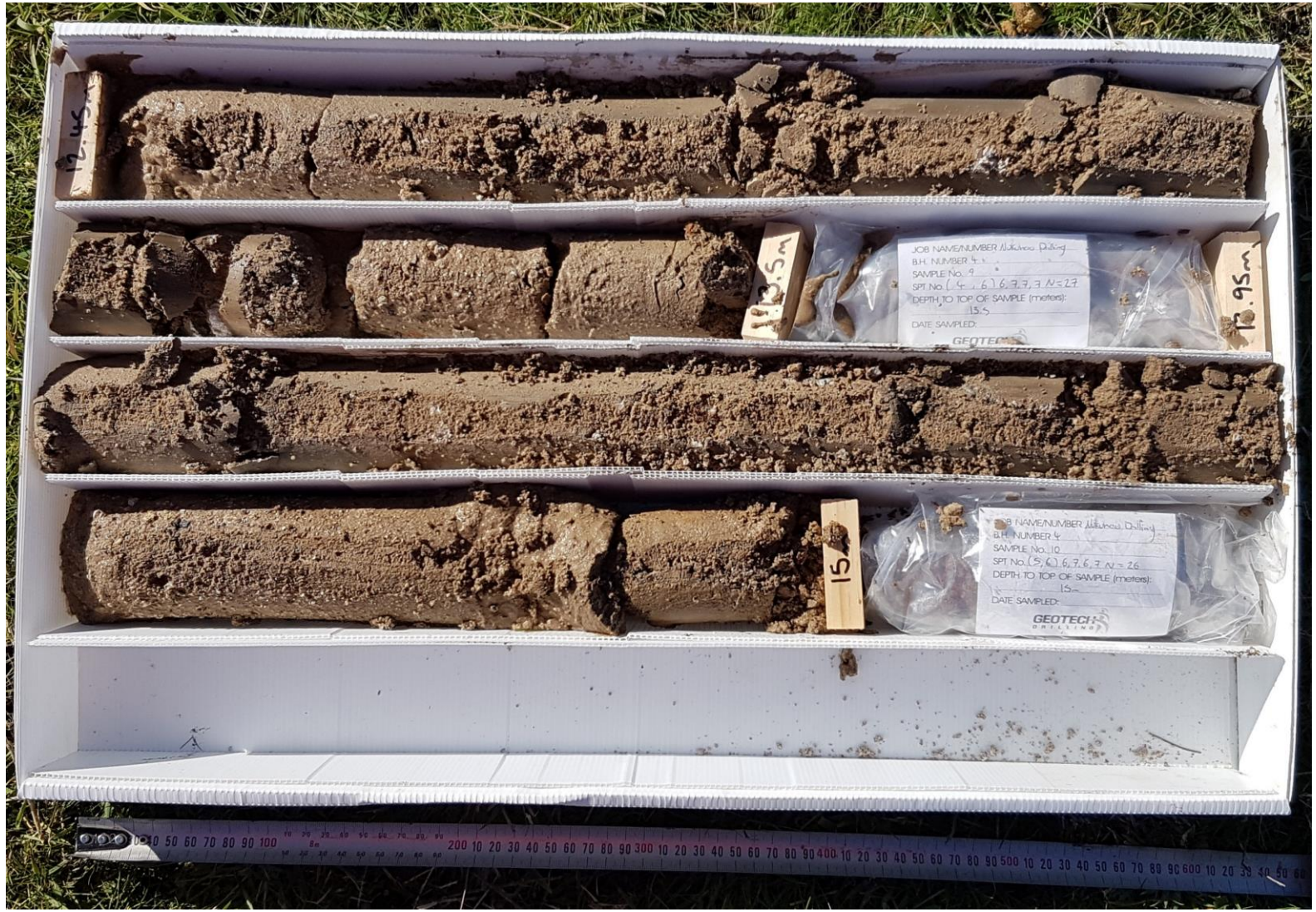
Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:50 @ A4

Location: Nukuhau **Borehole:** BH04 **Depth:** 0.00-5.35m bgl

Location: Nukuhau **Borehole:** BH04 **Depth:** 5.35-8.70m bgl

Location: Nukuhau **Borehole:** BH04 **Depth:** 8.70-12.45m bgl



Location: Nukuhau **Borehole:** BH04 **Depth:** 12.45-15.45 bgl

Appendix C Hand Auger Logs and Photographs

Auger Scala No. HA01

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	Not established
Client:	Various	*Ref. Grid:*	n/a
Project No.:	2-37400.00	*R.L.:*	Not established
Location:	Nukuhau, Taupo		

GEOLOGY	DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS: SCALA PENETROMETER (Blows per mm) 0 2 4 6 8 10 12 14 16 18 20	SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES
Topsoil		SILT with trace sand; brown. Firm; dry; low plasticity; sand, fine. [TOPSOIL]								
Taupo Pumice Formation		Fine to coarse SAND with trace to minor silt; yellow. Dry; poorly graded. [TAUPO PUMICE FORMATION]								
		0.70m: Trace silt and gravel; white. Gravel, fine to medium pumice.								
	1	END OF AUGER AT 1m - Target Depth Reached				1				
	2					2				
	3					3				
	4					4				

Notes:
Conducted in Site 1.
Groundwater not encountered in hand auger.

Test Methods:
Determination of the Penetration Resistance of a Soil, NZS 4402 Test 6.5.2:1988
Guideline for Hand Held Shear Vane Test, NZ Geotechnical Soc., 2001

Date Tested: 21/02/2019
Tested by: SJ
Checked by: IG

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:25 @ A4

Location: Nukuhau **Borehole:** HA01 **Depth:** 0.00-1.00m bgl

Auger Scala No. HA02

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	Not established
Client:	Various	*Ref. Grid:*	n/a
Project No.:	2-37400.00	*R.L.:*	Not established
Location:	Nukuhau, Taupo		

GEOLOGY	DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS: SCALA PENETROMETER (Blows per mm) 0 2 4 6 8 10 12 14 16 18 20	SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES
Fill		Fine to coarse SAND with minor silt and gravel; brown. Dry; poorly graded; gravel, angular to subangular pumice and volcanics. [FILL]								
	1	END OF AUGER AT 0.2m - Unable to Advance Auger - Too Hard				1				
	2					2				
	3					3				
	4					4				

Notes:
Conducted in Site 2.
Groundwater not encountered in hand auger.

Test Methods:
Determination of the Penetration Resistance of a Soil, NZS 4402 Test 6.5.2:1988
Guideline for Hand Held Shear Vane Test, NZ Geotechnical Soc., 2001

Date Tested: 21/02/2019
Tested by: SJ
Checked by: IG

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:25 @ A4

Auger Scala No. HA03

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	Not established
Client:	Various	*Ref. Grid:*	n/a
Project No.:	2-37400.00	*R.L.:*	Not established
Location:	Nukuhau, Taupo		

GEOLOGY	DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS: SCALA PENETROMETER (Blows per mm) 0 2 4 6 8 10 12 14 16 18 20	SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES
Taupo Pumice Formation	0	SILT with minor sand; brown. Dry; firm; low plasticity; sand, fine. [TOPSOIL]				0				
		Fine to coarse SAND with minor silt and trace gravel; yellow. Dry; poorly graded; gravel, fine to medium, subrounded to subangular pumice. [TAUPO PUMICE FORMATION]								
		0.50m: Trace silt; white.								
	1	END OF AUGER AT 1m - Target Depth Reached				1				
	2					2				
	3					3				
	4					4				

Notes:
Conducted in Site 3.
Groundwater not encountered in hand auger.

Test Methods:
Determination of the Penetration Resistance of a Soil, NZS 4402 Test 6.5.2:1988
Guideline for Hand Held Shear Vane Test, NZ Geotechnical Soc., 2001

Date Tested: 21/02/2019
Tested by: SJ
Checked by: IG

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:25 @ A4

Location: Nukuhau **Borehole:** HA03 **Depth:** 0.00-1.00m bgl

Auger Scala No. HA04

Project:	Nukuhau Geotechnical Investigation	*Coordinates:*	Not established
Client:	Various	*Ref. Grid:*	n/a
Project No.:	2-37400.00	*R.L.:*	Not established
Location:	Nukuhau, Taupo		

GEOLOGY	DEPTH (m)	DESCRIPTION	GRAPHIC LOG	WATER LEVEL	R.L. (m)	DEPTH (m)	SOIL TESTS: SCALA PENETROMETER (Blows per mm) 0 2 4 6 8 10 12 14 16 18 20	SHEAR STRENGTH (kPa)	OTHER TESTS	SAMPLES
Taupo Pumice Formation Topsoil	0	SILT with minor sand; brown. Dry; firm; low plasticity; sand, fine. [TOPSOIL]				0				
		Fine to coarse SAND with minor silt and trace gravel; yellow. Dry; poorly graded; gravel, fine to medium, subrounded to subangular pumice. [TAUPO PUMICE FORMATION]								
		0.40m: Trace silt; white.								
	1	END OF AUGER AT 1m - Target Depth Reached				1				
	2					2				
	3					3				
	4					4				

Notes:
Conducted in Site 3.
Groundwater not encountered in hand auger.

Test Methods:
Determination of the Penetration Resistance of a Soil, NZS 4402 Test 6.5.2:1988
Guideline for Hand Held Shear Vane Test, NZ Geotechnical Soc., 2001

Date Tested: 21/02/2019
Tested by: SJ
Checked by: IG

Logged in accordance with NZ Geotechnical Society Guidelines (2005). See attached key sheet for explanation of symbols.

Scale 1:25 @ A4

Location: Nukuhau **Borehole:** HA04 **Depth:** 0.00-1.00m bgl

Appendix D Cross Sections


CPT11
POIHIPI ROAD
BH04
CPT10
CPT09
WAIRAKEI DRIVE
BH02
CPT02
CPT03
WATENE LANE
CPT01
BH02
CPT04
CPT05
VAUCLUSE DRIVE
LAKERIDGE CLOSE
HINDMARSH
BH01
TERAPEKA STREET
ACACIA BAY ROAD
ARAMA STREET
KAIHUA ROAD
KAHURANGI DRIVE
CPT08
CPT06
LAKEWOOD DRIVE
WHETU PLACE
KAIURU STREET
WOODWARD STREET
CPT07
CHELSEA RISE
CHERRY DRIVE
ACACIA BAY ROAD

A

A'

Elevation (metres)

Distance Along Baseline (metres)

(Projected -11 m)
CPT03
SBTn

(Projected 114 m)
CPT05
SBTn

(Projected -184 m)
CPT06
SBTn

(Projected 4 m)
CPT08
SBTn

(Projected -7 m)
CPT07
SBTn

Prepared for:

Prepared by:

wsp

Legend:

Borehole Naming
- AS 12 *Auger Scala No.*
- BH 20 *Borehole No.*
- CPT 5 *Cone Penetration Test No.*
- TP 65 *Trial Pit No.*

Surface Types
- *Existing Ground Profile*

Boundary Types
- *Weathered Boundary*
- *Inferred/Assumed Boundary*

Density
- Very Loose
- Loose
- Medium Dense
- Dense
- Very Dense

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

Consistency
- Very Soft
- Soft
- Firm
- Stiff
- Very Stiff
- Hard

Mod. SBTn
1. CCS: Clay-like - Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-like - Dilative
4. TC: Trans. - Contractive
5. TD: Trans. - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

Selected Lithological Graphics

Title: **Engineering Geology Section A - A'**
Nukuhau Ground Model

Project: **Nukuhau Structure Plan**
Nukuhau, Taupo

Project Number: 2-37400.00

Date: 09-2020

Vertical Scale: 1:250

Horizontal Scale: 1:2500

H 1:2500 2.5
V 1:250 0.25

2019 A3 FENCE SOIL AND CPT - DXF VERSION NUKUHAU GROUND MODEL 2 - COPY.GPJ 21090827 BEN.GPJ 1/9/20

B

B'

(Projected -110 m)
CPT02

(Projected 67 m) (Projected 56 m)
CPT01 BH03

(Projected 61 m)
CPT04

SBTn

Elevation (metres)

Distance Along Baseline (metres)

2019 A3 FENCE SOIL AND CPT - DXF VERSION NUKUHAU GROUND MODEL 2 - COPY.GPJ 21090827 BEN.GPJ 1/9/20

H 1:1000
V 1:250

1
0.25

Prepared for:

Prepared by:

WSP

Legend:

Borehole Naming

AS 12 *Auger Scala No.*
BH 20 *Borehole No.*
CPT 5 *Cone Penetration Test No.*
TP 65 *Trial Pit No.*

Surface Types

Existing Ground Profile

Boundary Types

Weathered Boundary
Inferred/Assumed Boundary

Density

- Very Loose
- Loose
- Medium Dense
- Dense
- Very Dense

Soil Behaviour Type / SBTn

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

Consistency

- Very Soft
- Soft
- Firm
- Stiff
- Very Stiff
- Hard

Mod. SBTn

1. CCS: Clay-like - Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-like - Dilative
4. TC: Trans. - Contractive
5. TD: Trans. - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

Selected Lithological Graphics

- Zone of no core recovery
- BSI Gravel
- BSI Sandy Gravel
- BSI Sand
- BSI Silty Sand
- BSI Sandy Silt
- BSI Gravelly Sand
- BSI Silt

Title: **Engineering Geology Section B-B'**
Nukuhau Structure Plan

Project: **Nukuhau Structure Plan**
Nukuhau, Taupo

Project Number:	*Date:*	
2-37400.00	09-2020	*Vertical Scale:* 1:250 *Horizontal Scale:* 1:1000

C

C'

0 100 200 300 400 500 600 700 800 900

450 445 440 435 430 425 420 415

Elevation (metres)

(Projected 8 m)
CPT11
SBTn
0 5 10 15 20 25

(Projected -168 m)
CPT09
SBTn
0 5 10 15 20 25

(Projected 8 m)
BH04
SBTn
2
0
1
0
15
10
13
22
27
26

(Projected 122 m)
CPT10
SBTn
5 10 15 20 25

0 100 200 300 400 500 600 700 800 900

Distance Along Baseline (metres)

2019 A3 FENCE SOIL AND CPT - DXF VERSION NUKUHAU GROUND MODEL 2 - COPY.GPJ 21090827 BEN.GPJ 1/9/20

H 1:2500 2.5
V 1:200 0.2

Prepared for:

Prepared by:

wsp

Legend:

Borehole Naming
- AS 12 *Auger Scala No.*
- BH 20 *Borehole No.*
- CPT 5 *Cone Penetration Test No.*
- TP 65 *Trial Pit No.*

Surface Types
- *Existing Ground Profile*

Boundary Types
- *Weathered Boundary*
- *Inferred/Assumed Boundary*

Density
- Very Loose
- Loose
- Medium Dense
- Dense
- Very Dense

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

Consistency
- Very Soft
- Soft
- Firm
- Stiff
- Very Stiff
- Hard

Mod. SBTn
1. CCS: Clay-like - Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-like - Dilative
4. TC: Trans. - Contractive
5. TD: Trans. - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

Selected Lithological Graphics
- Zone of no core recovery
- BSI Silty Sand
- BSI Sand
- BSI Gravel
- BSI Gravelly Sand
- BSI Sandy Silt

Estimate ground level

Title: **Engineering Geology Section C-C'**
Nukuhau Structure Plan

Project: **Nukuhau Structure Plan**
Nukuhau, Taupo

Project Number:	*Date:*	*Vertical Scale:* 1:200
2-37400.00	09-2020	*Horizontal Scale:* 1:2500

D

D'

Elevation (metres)

Distance Along Baseline (metres)

(Projected -37 m)
BH01

(Projected 154 m)
CPT03

(Projected 45 m)
CPT02

(Projected -188 m)
CPT04

(Projected -126 m)
CPT01

(Projected -103 m)
CPT09

(Projected 186 m)
CPT11

(Projected -100 m)
BH04

(Projected -239 m)
CPT10

SBTn

Legend:

Borehole Naming

AS 12 *Auger Scala No.*
BH 20 *Borehole No.*
CPT 5 *Cone Penetration Test No.*
TP 65 *Trial Pit No.*

Surface Types

Existing Ground Profile

Boundary Types

Weathered Boundary
Inferred/Assumed Boundary

Density

- Very Loose
- Loose
- Medium Dense
- Dense
- Very Dense

Soil Behaviour Type / SBTn

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

Consistency

- Very Soft
- Soft
- Firm
- Stiff
- Very Stiff
- Hard

Mod. SBTn

1. CCS: Clay-like - Sensitive
2. CC: Clay-like - Contractive
3. CD: Clay-like - Dilative
4. TC: Trans. - Contractive
5. TD: Trans. - Dilative
6. SC: Sand-like - Contractive
7. SD: Sand-like - Dilative

Estimate ground level

Selected Lithological Graphics

- Topsoil
- BSI Gravel
- BSI Sandy Gravel
- BSI Sand
- BSI Silt
- Zone of no core recovery
- BSI Silty Sand
- BSI Sandy Silt
- BSI Gravelly Sand

Prepared for:

Prepared by:

wsp

H 1:5000
V 1:200

5
0.2

2019 A3 FENCE SOIL AND CPT - DXF VERSION NUKUHAU GROUND MODEL 2 - COPY.GPJ 21090827 BEN.GPJ 1/9/20

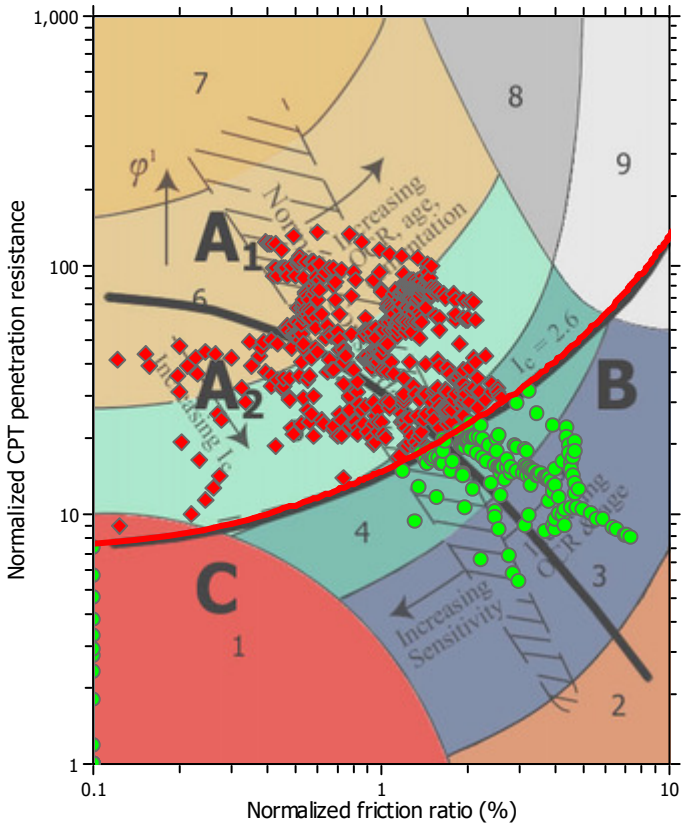
Title: **Engineering Geology Section D-D'**
Nukuhau Structure Plan

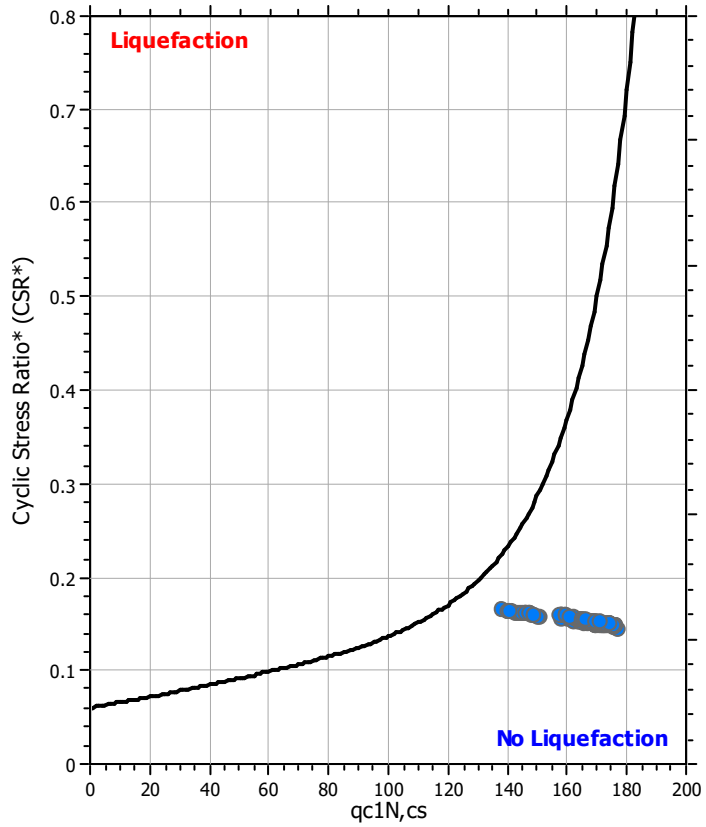
Project: **Nukuhau Structure Plan**
Nukuhau, Taupo

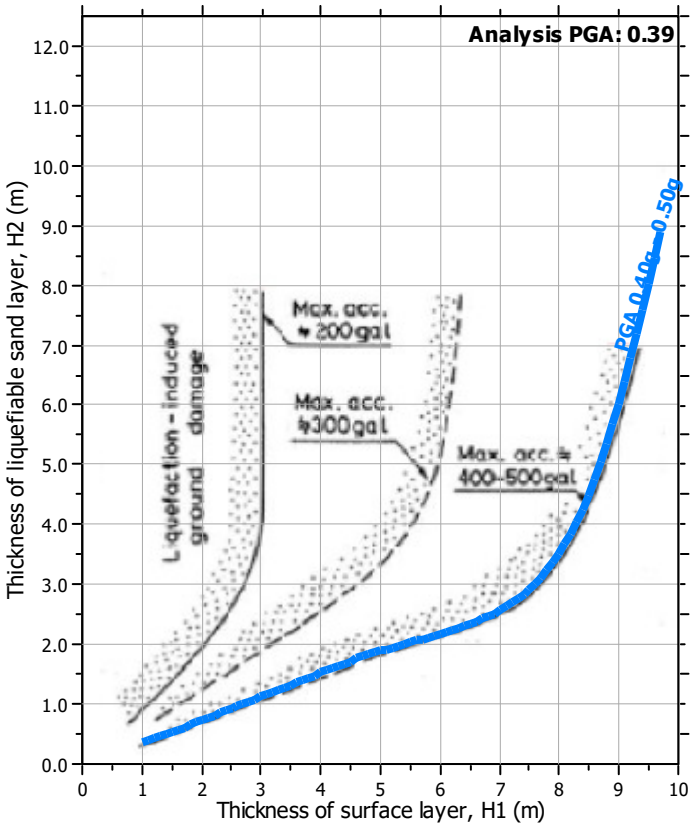
Project Number:	*Date:*	*Vertical Scale:* 1:200
2-37400.00	09-2020	*Horizontal Scale:* 1:5000

Appendix E Liquefaction Analysis Results

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	12.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	12.50 m	Fill height:	N/A	Limit depth:	N/A

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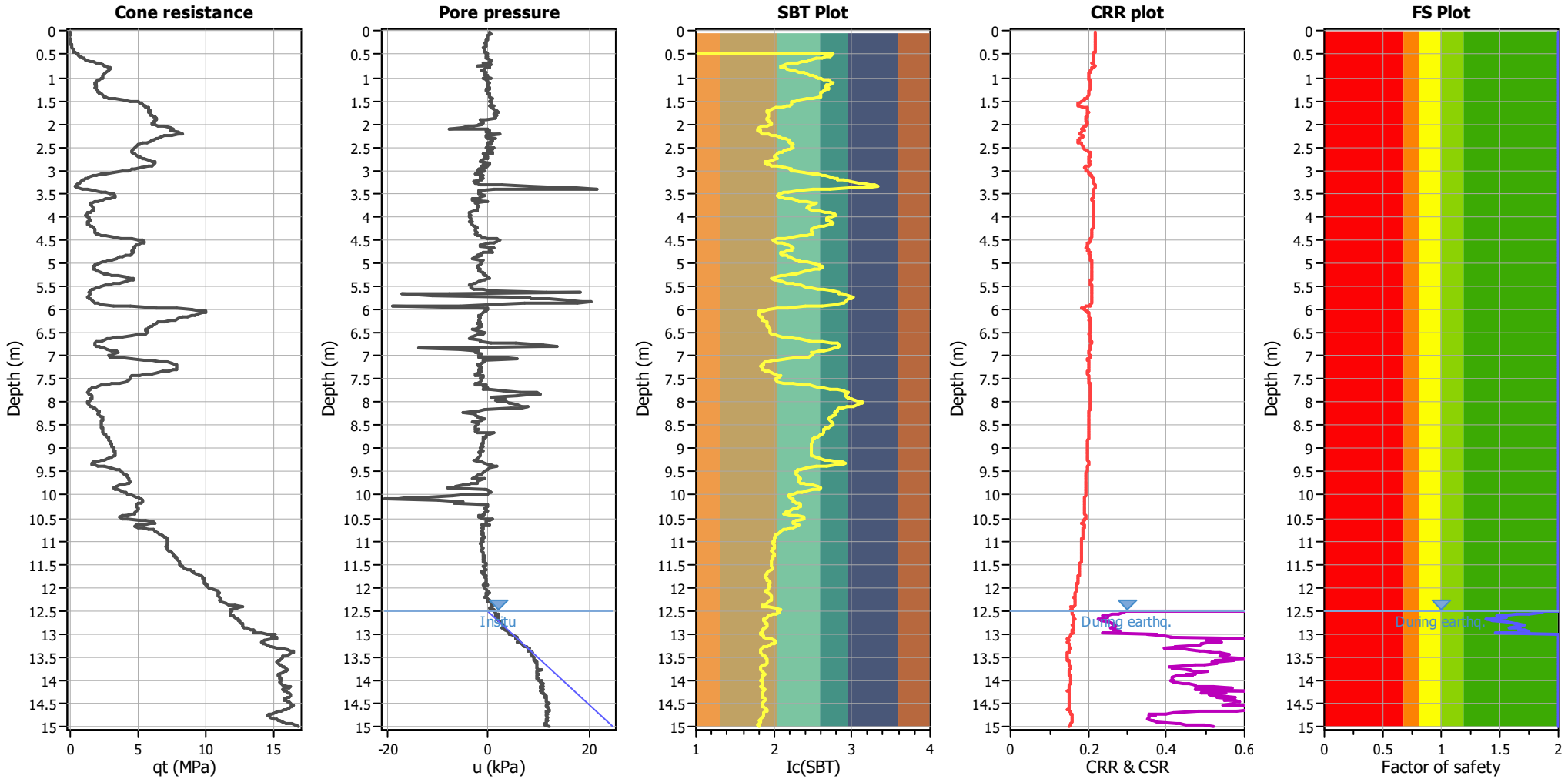
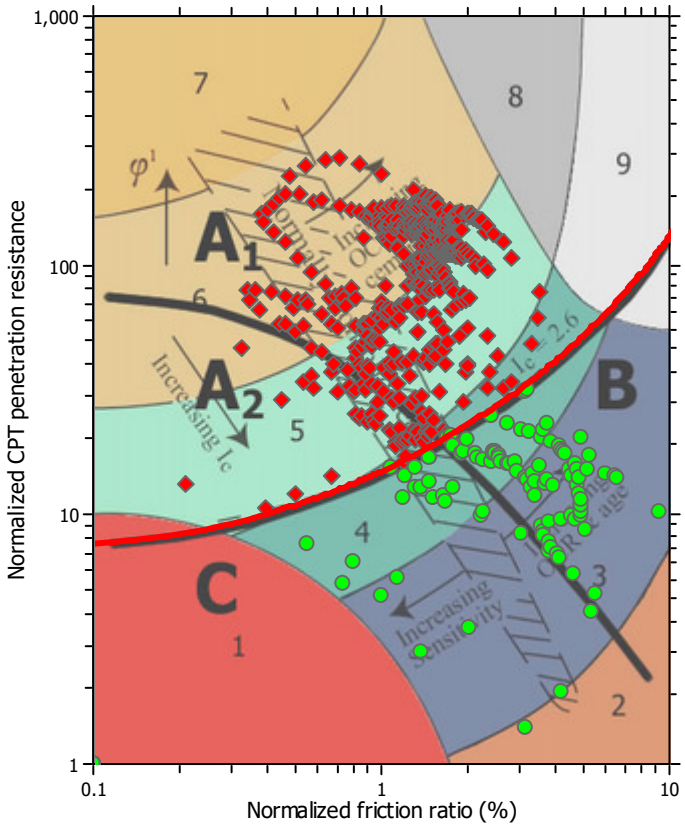
Project: Nukuhau Structure Plan
Location: Nukuhau, Taupo

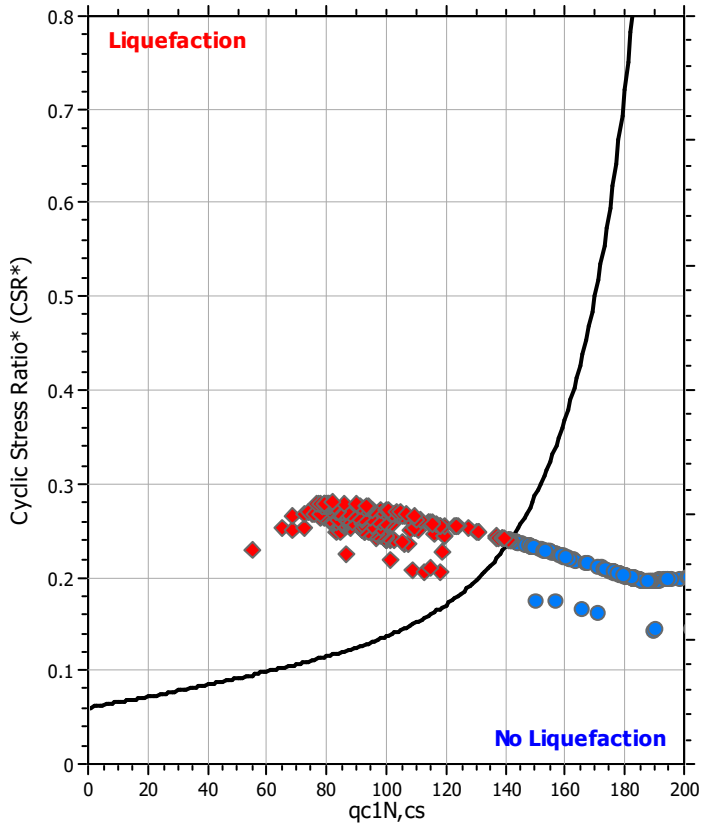
CPT: CPT01
Total depth: 15.00 m

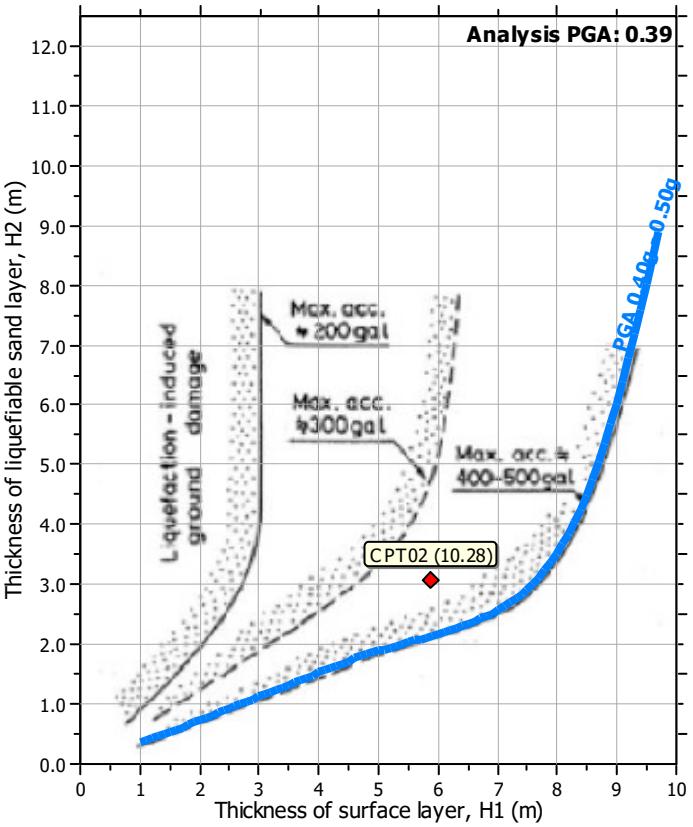


Analysis method:	B&I (2014)	G.W.T. (in-situ):	12.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	12.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.00 m	Fill height:	N/A	Limit depth:	N/A

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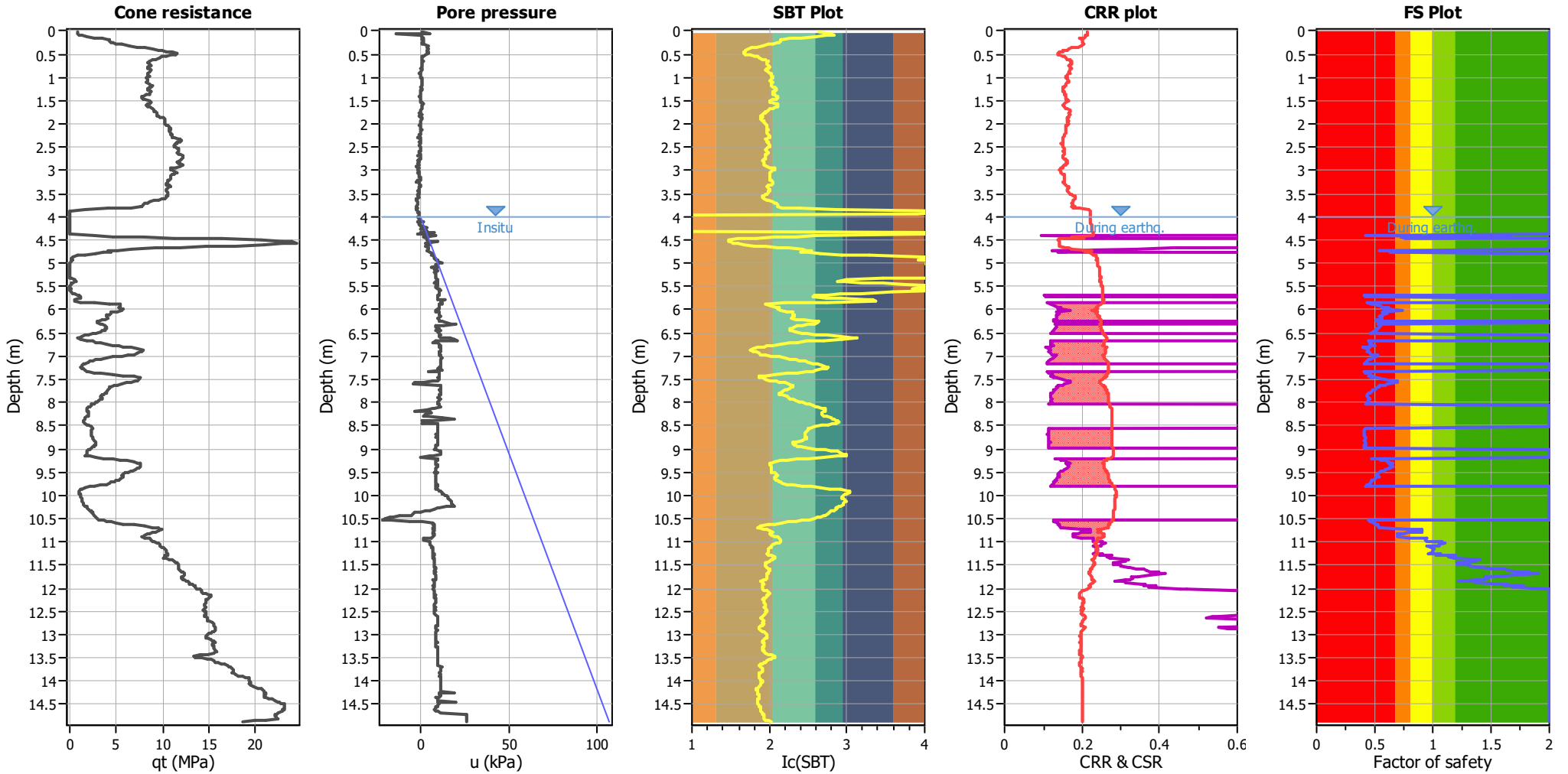
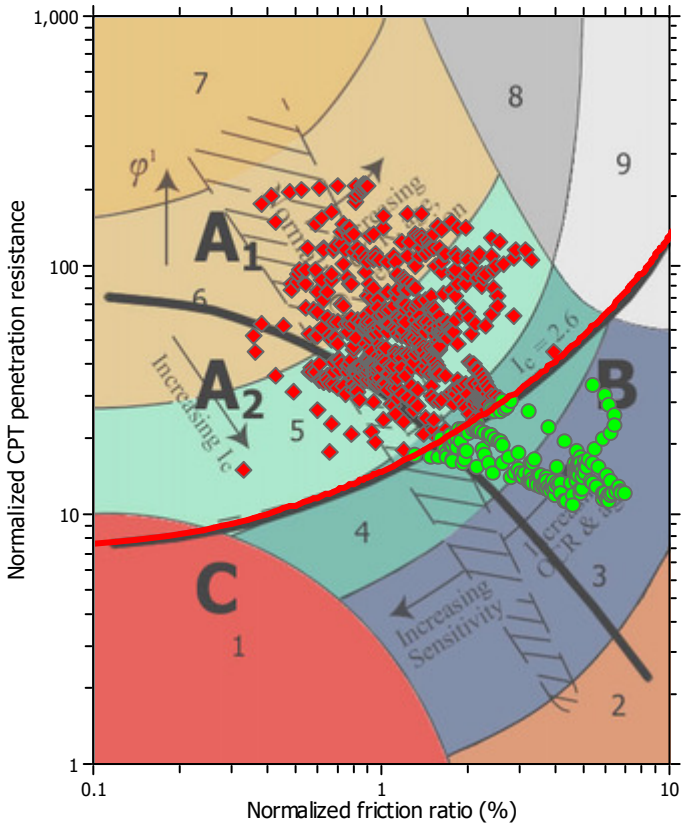
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

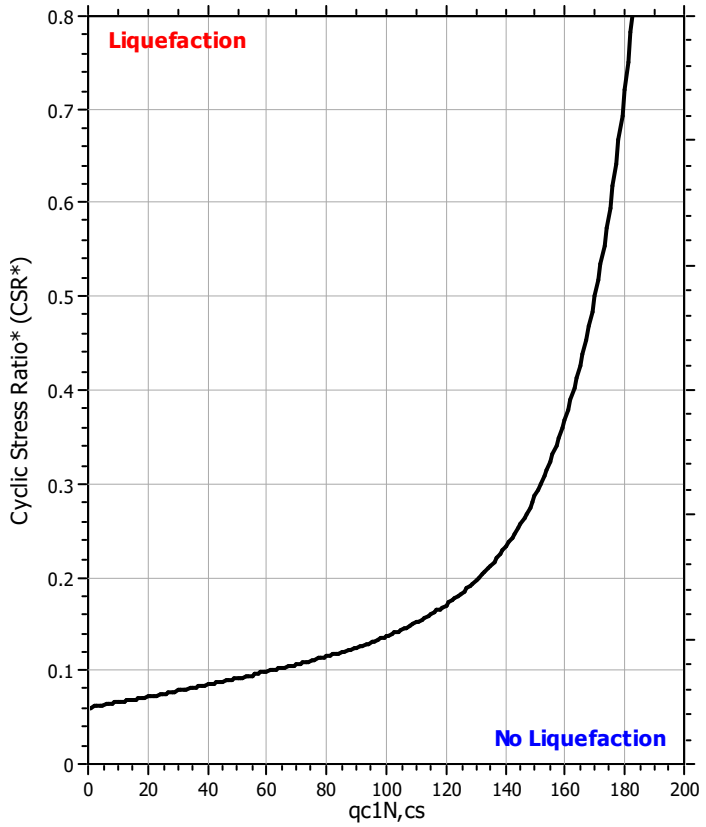
CPT: CPT02
Total depth: 14.88 m

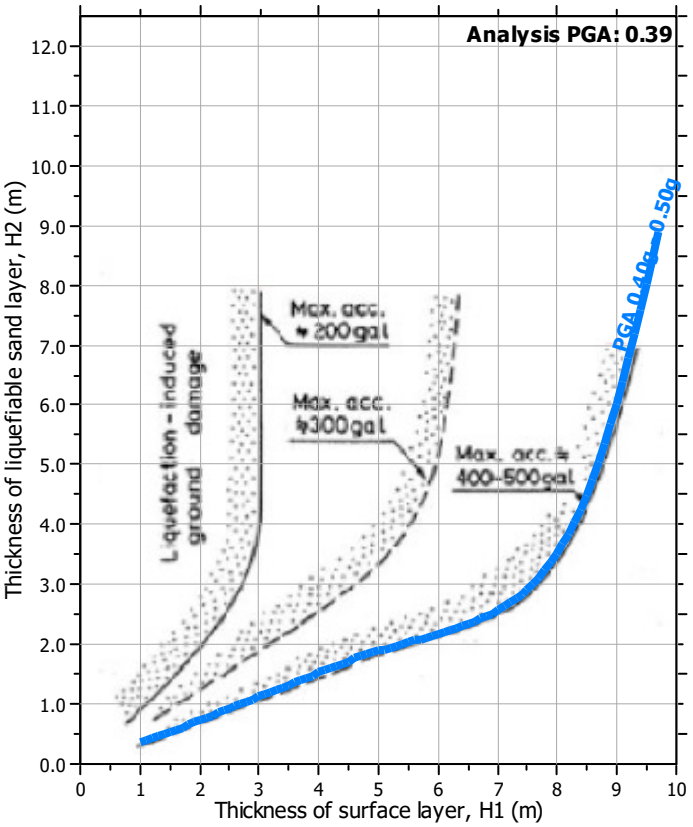


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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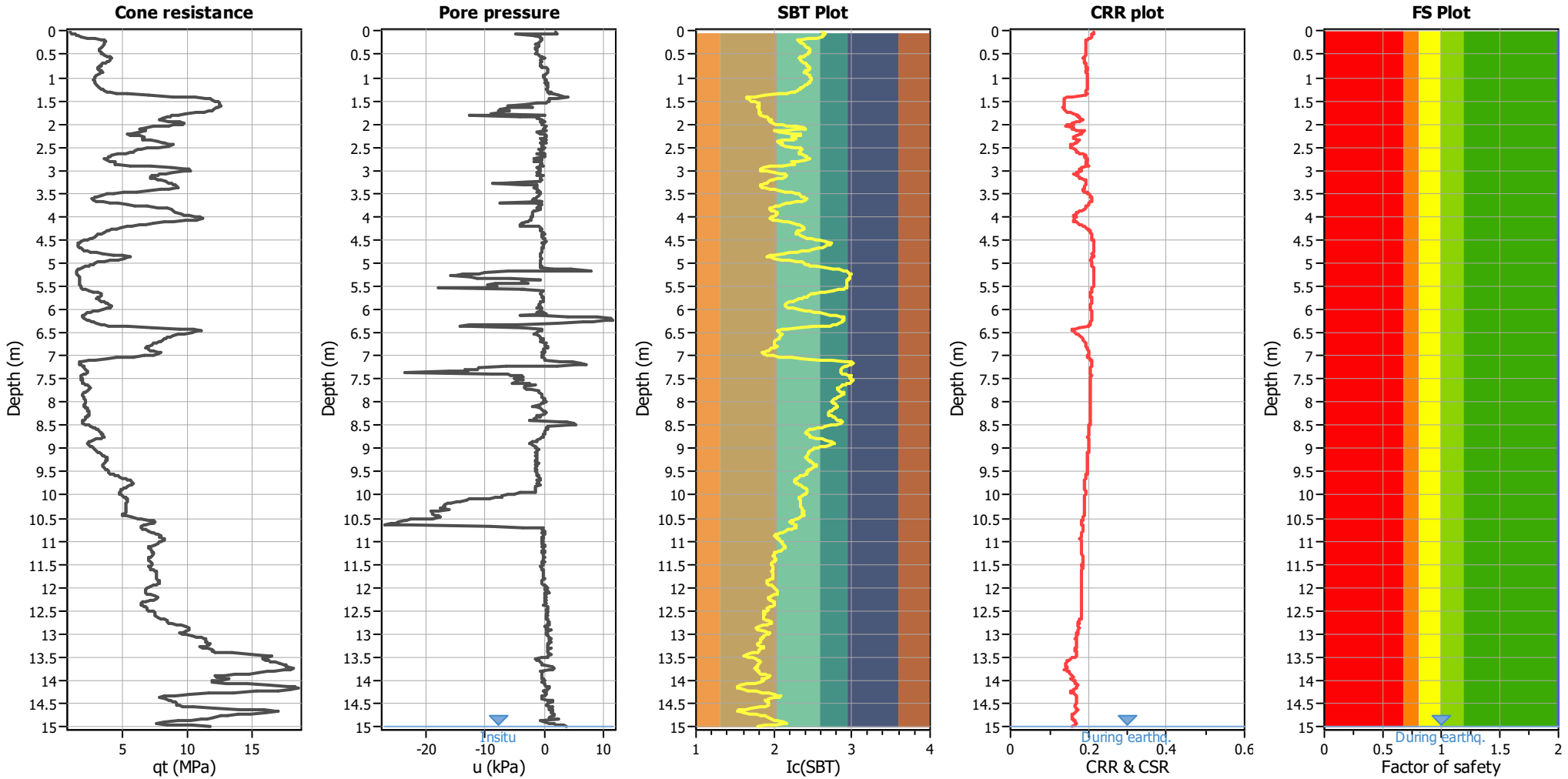
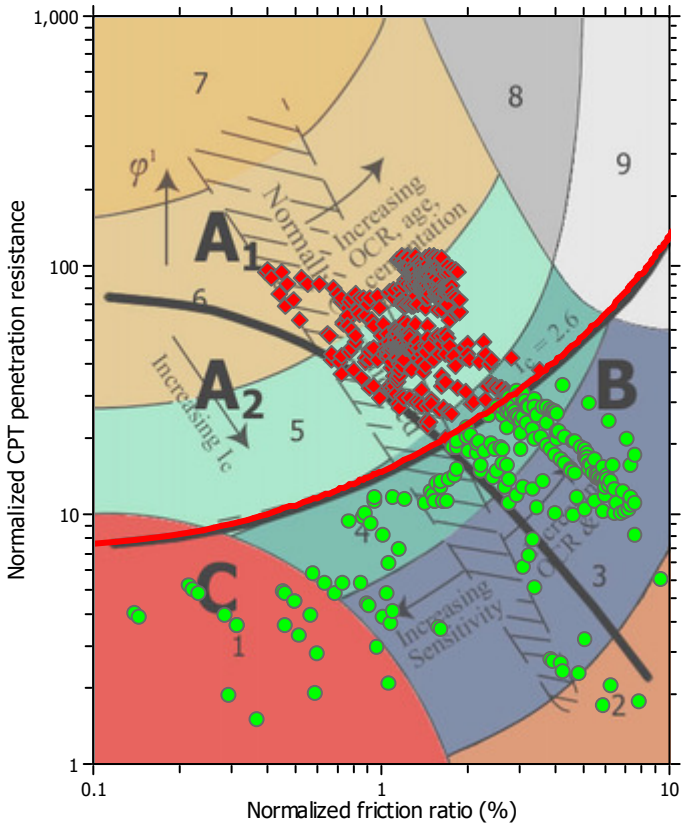
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

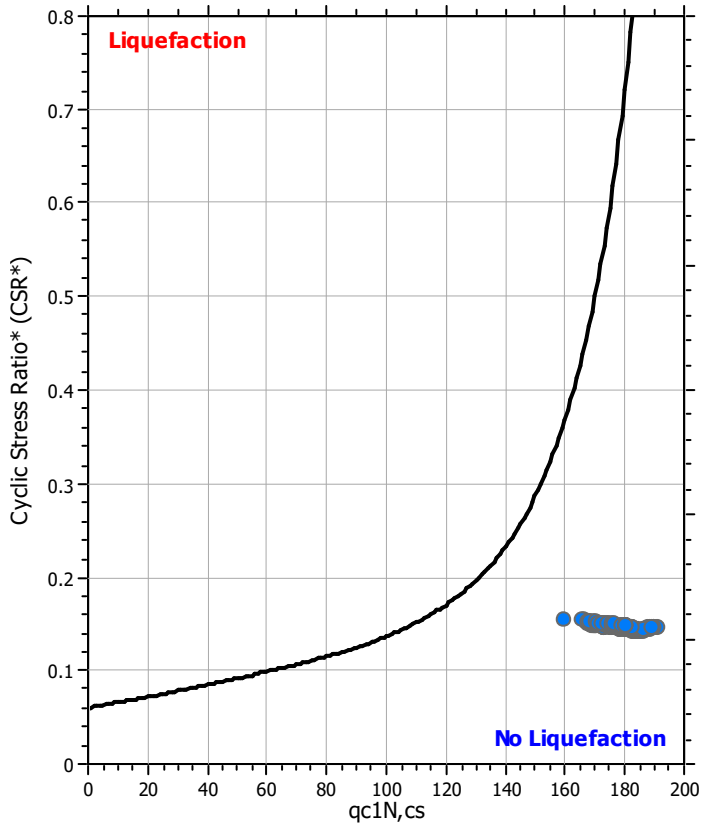
CPT: CPT03
Total depth: 15.00 m

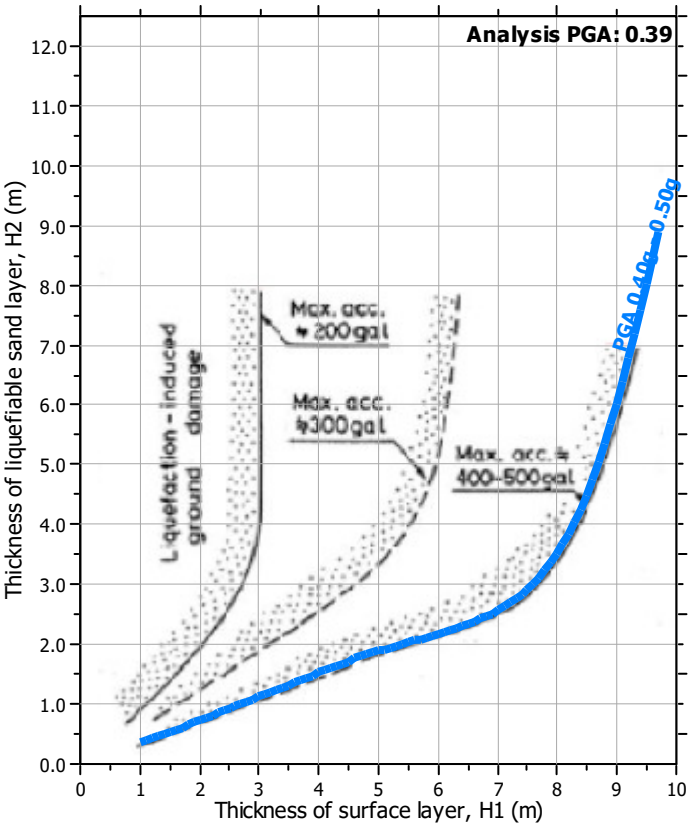


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	12.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	12.50 m	Fill height:	N/A	Limit depth:	N/A

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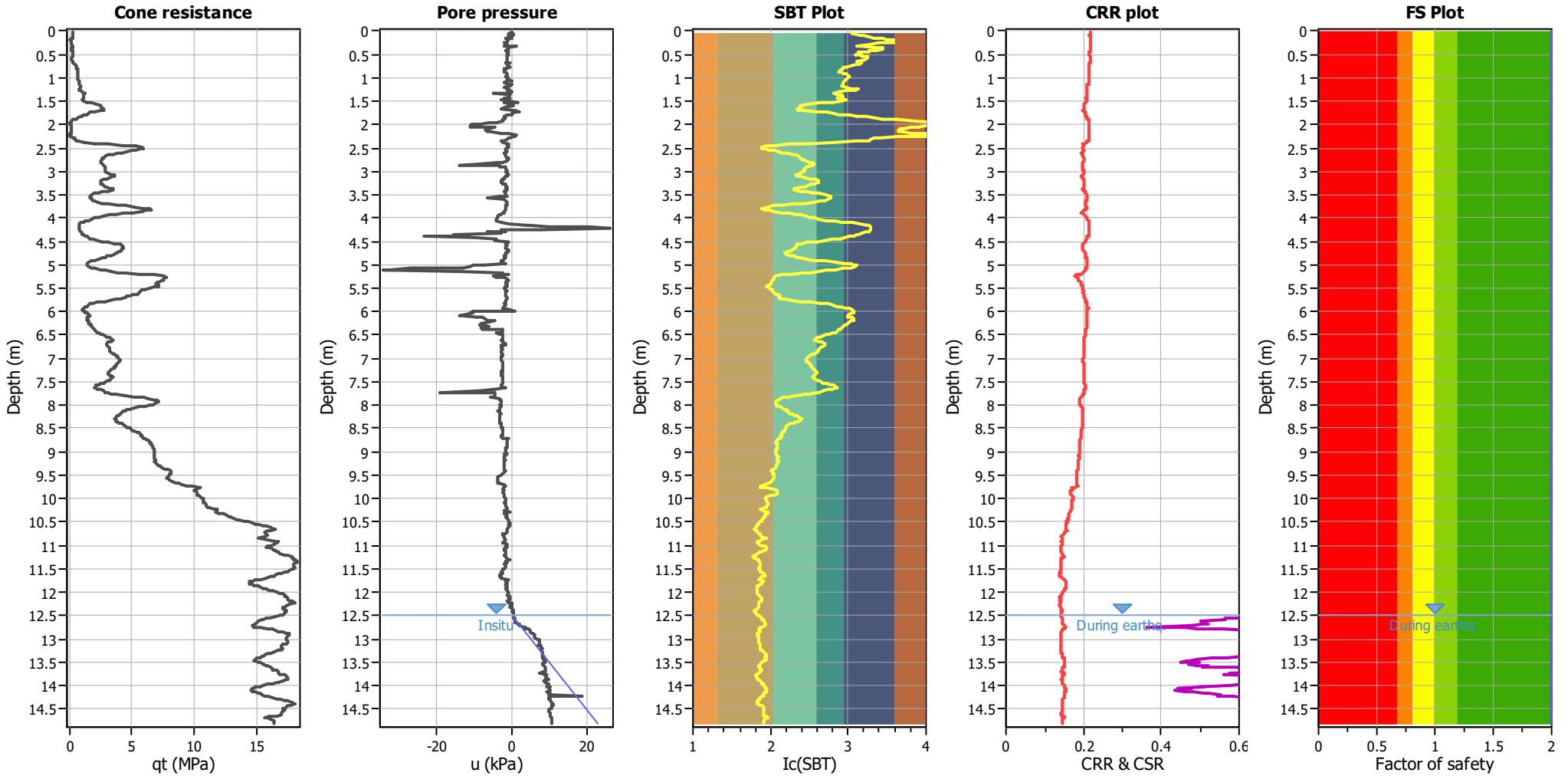
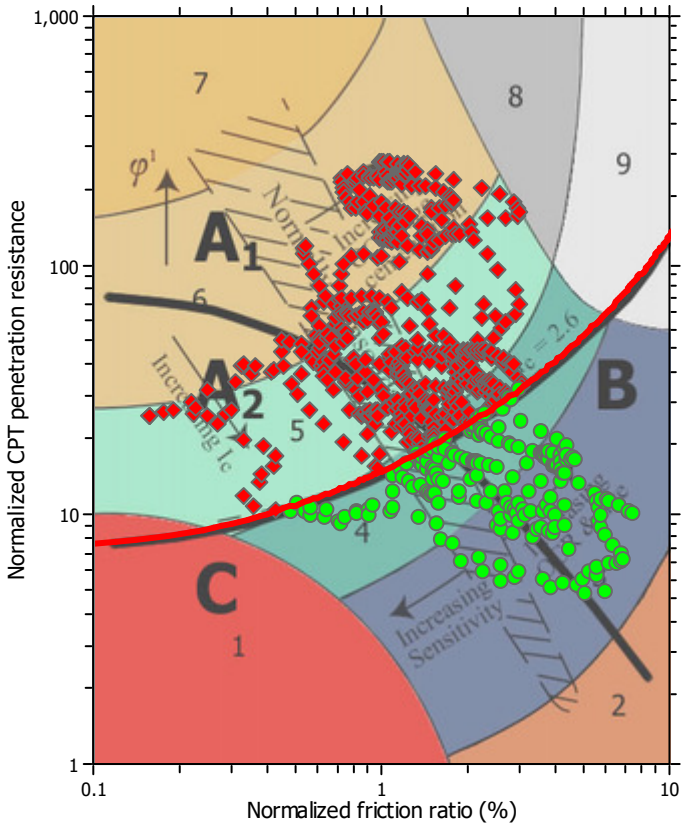
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

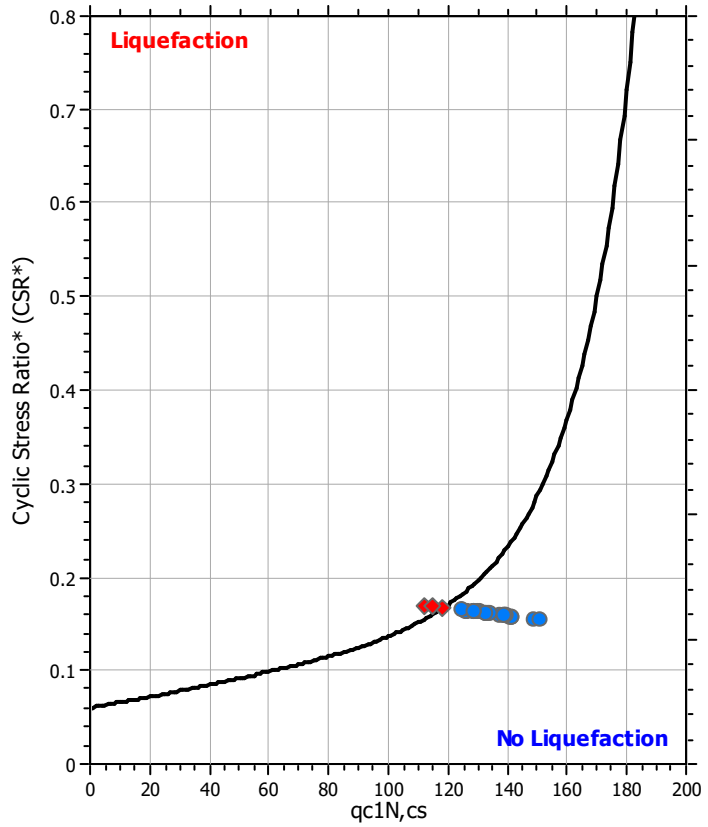
CPT: CPT04
Total depth: 14.82 m

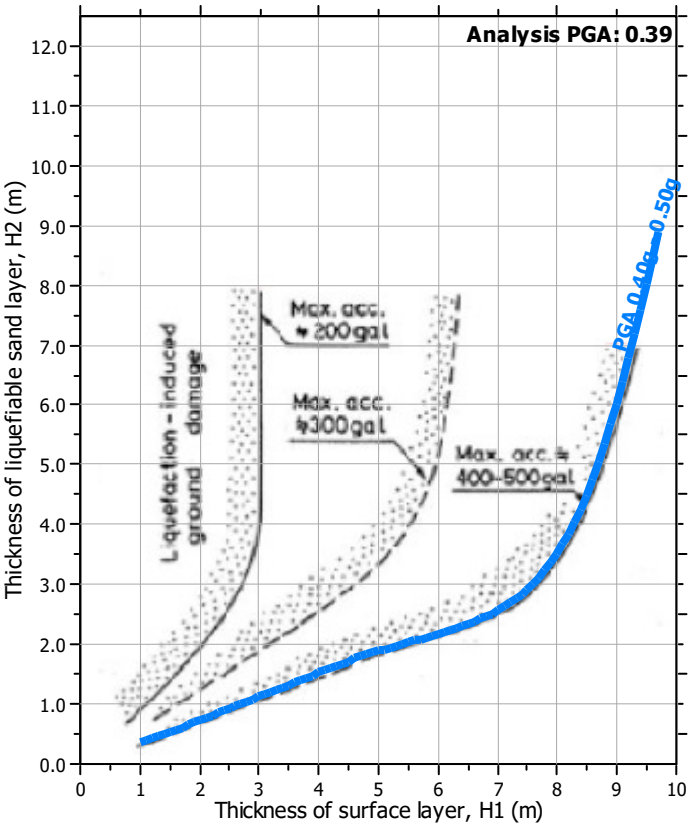


Analysis method:	B&I (2014)	G.W.T. (in-situ):	12.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	12.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	14.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	14.50 m	Fill height:	N/A	Limit depth:	N/A

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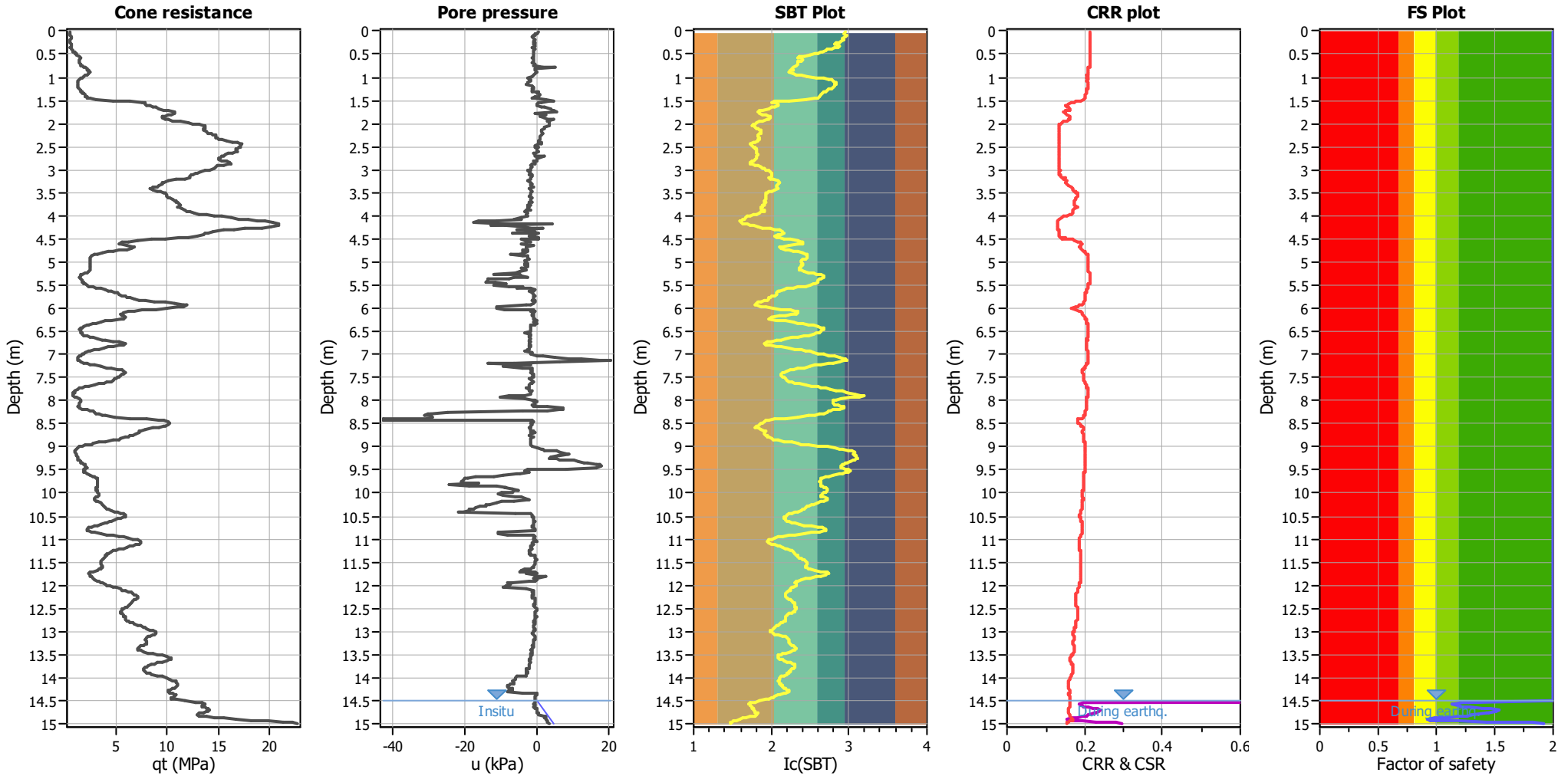
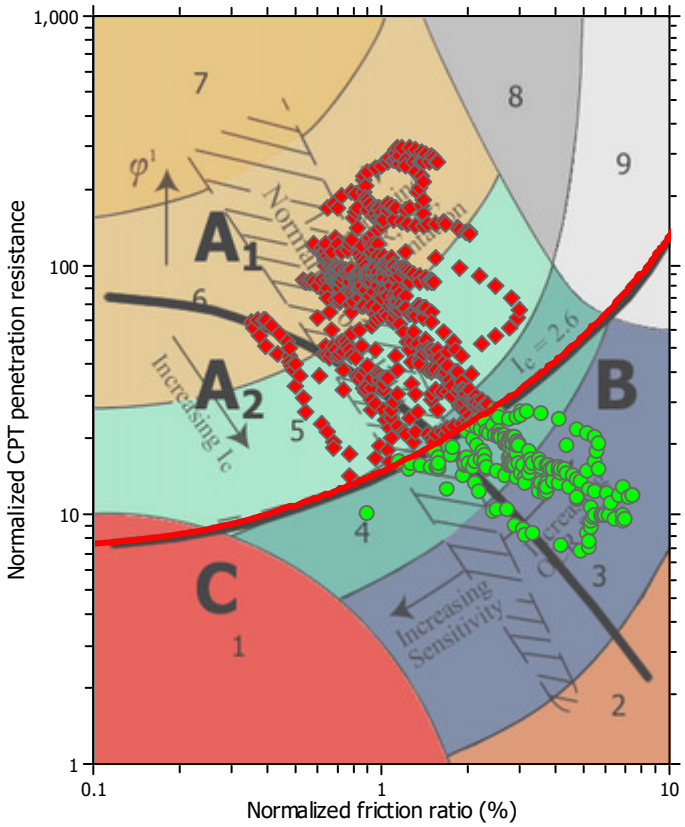
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

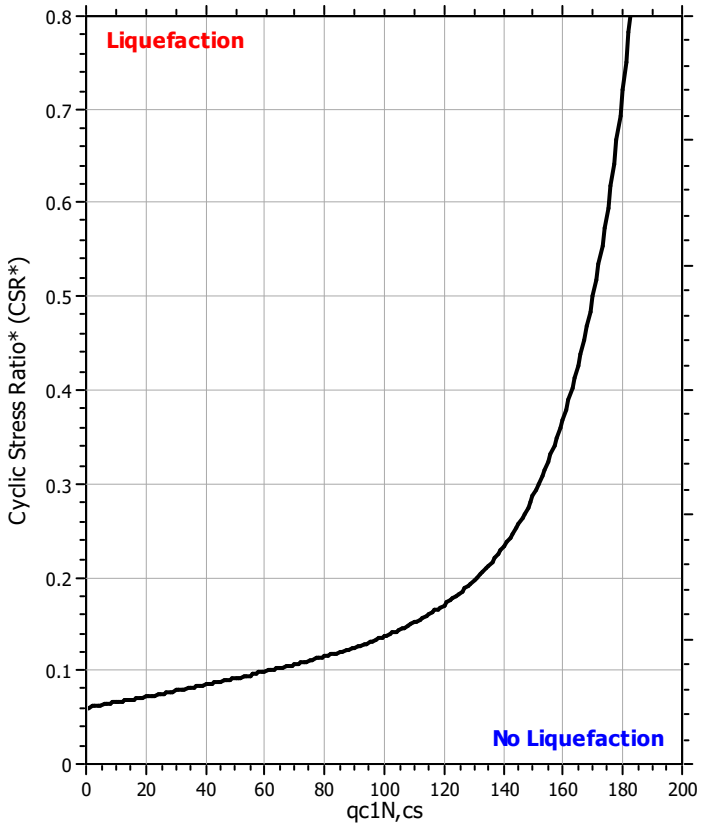
CPT: CPT05
Total depth: 15.00 m

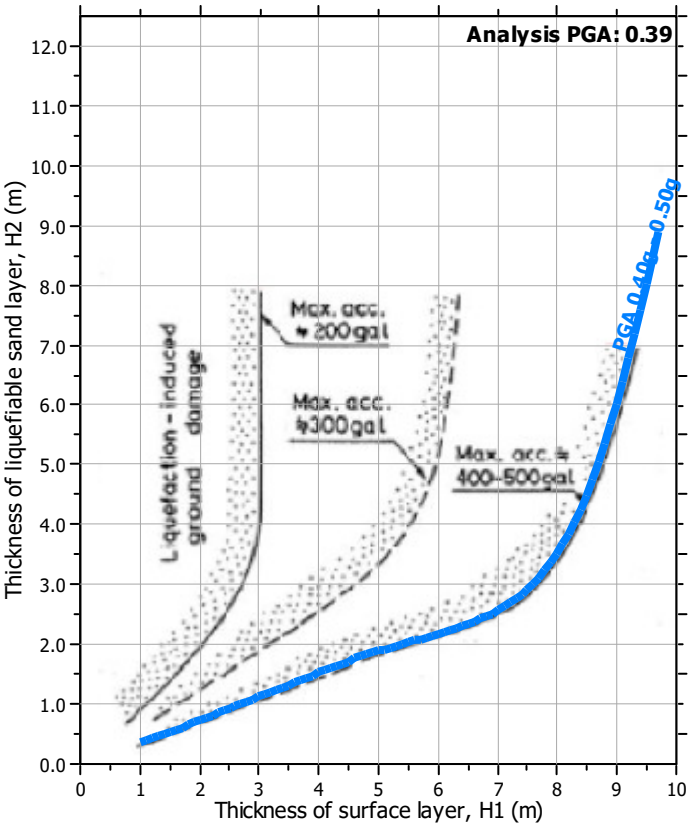


Analysis method:	B&I (2014)	G.W.T. (in-situ):	14.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	14.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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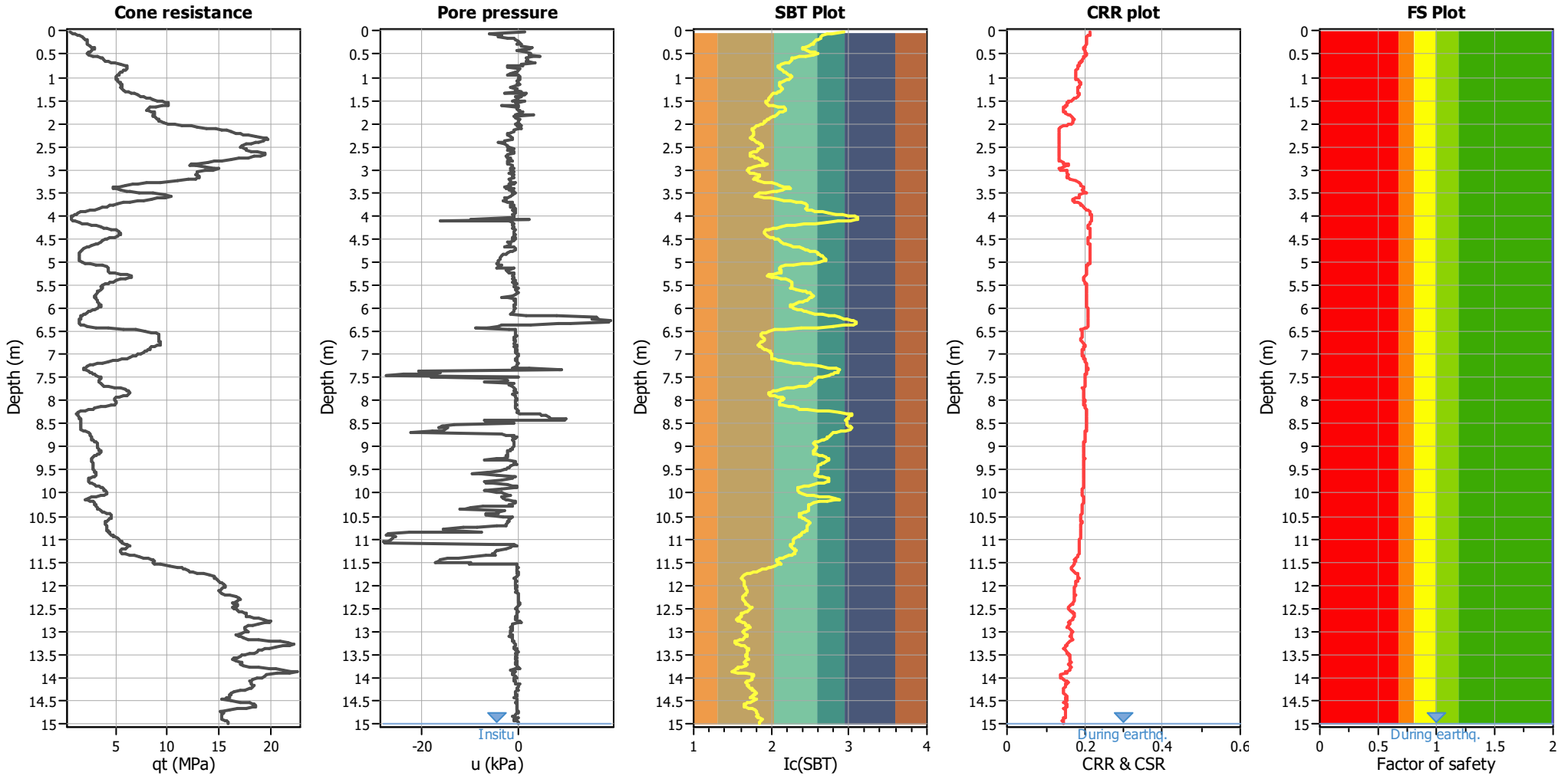
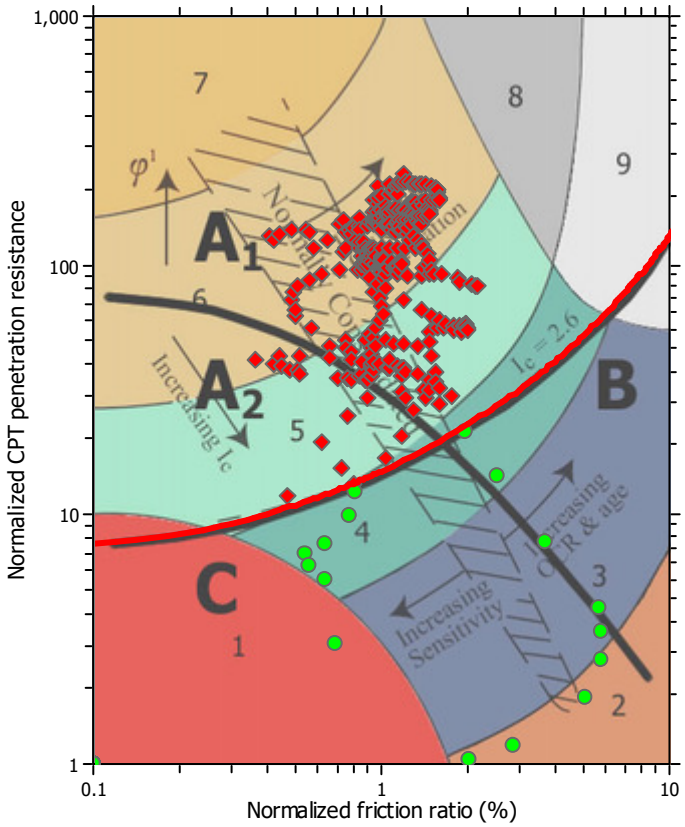
Project: Nukuhau Structure Plan
Location: Nukuhau, Taupo

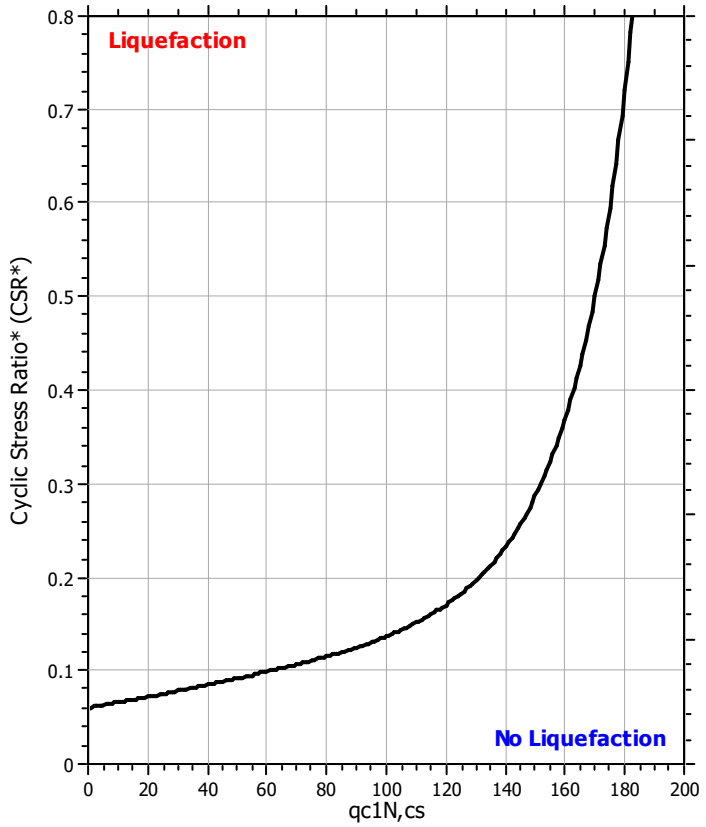
CPT: CPT06
Total depth: 15.00 m

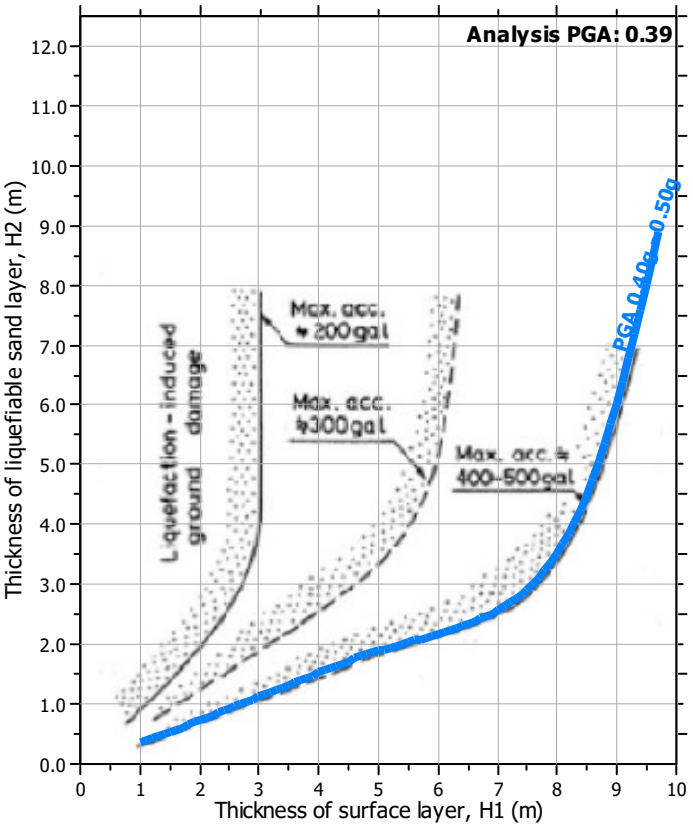


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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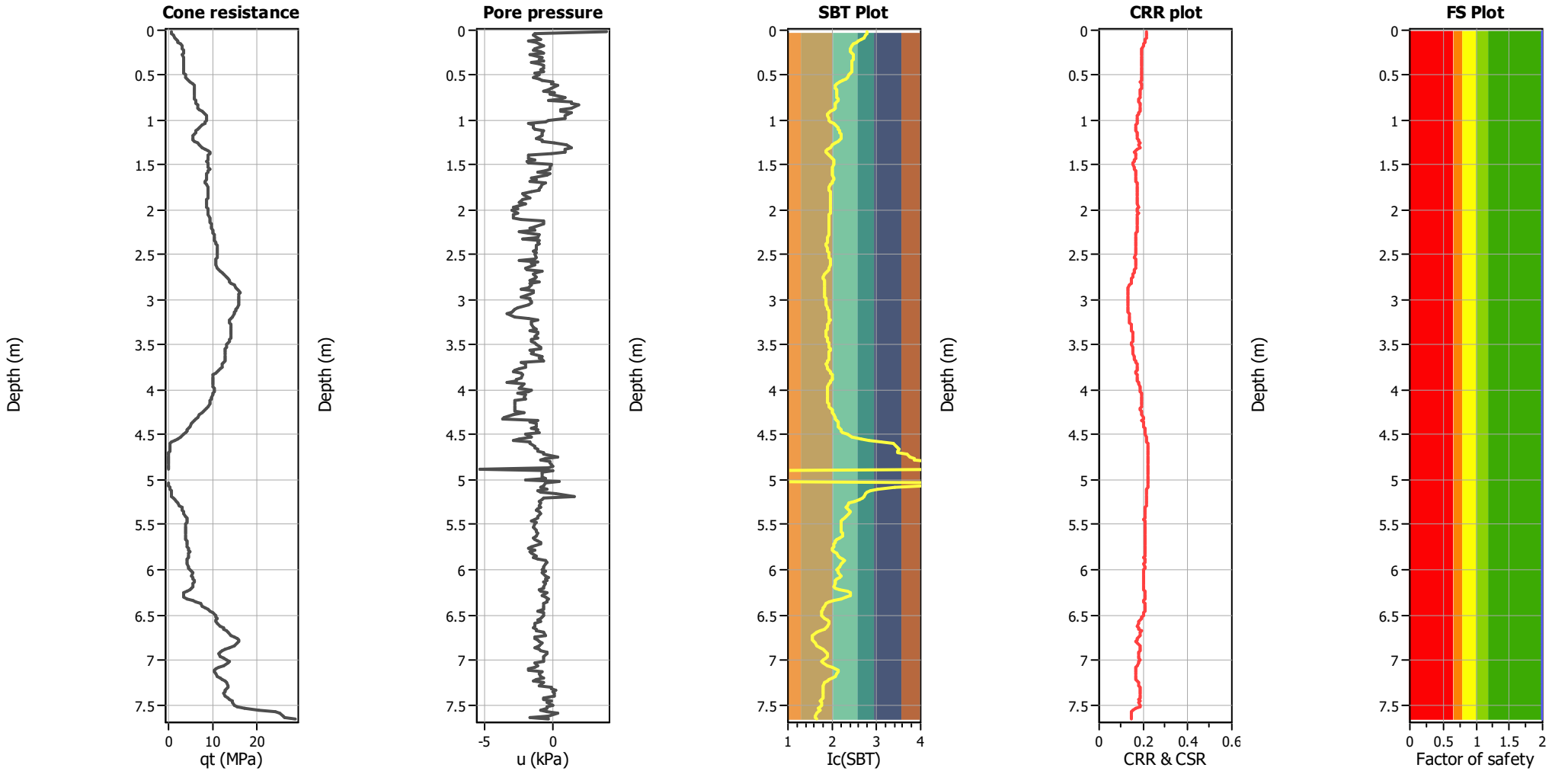
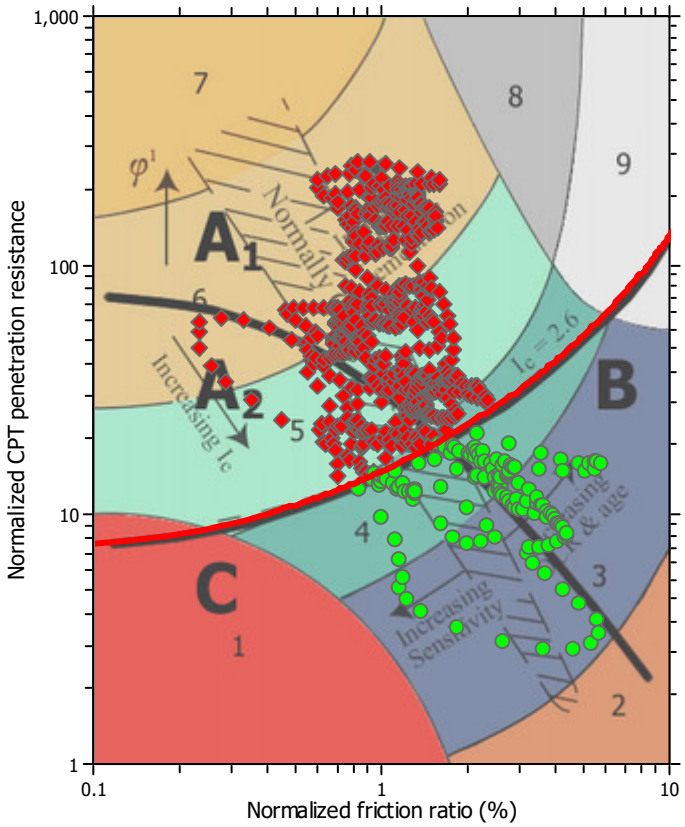
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

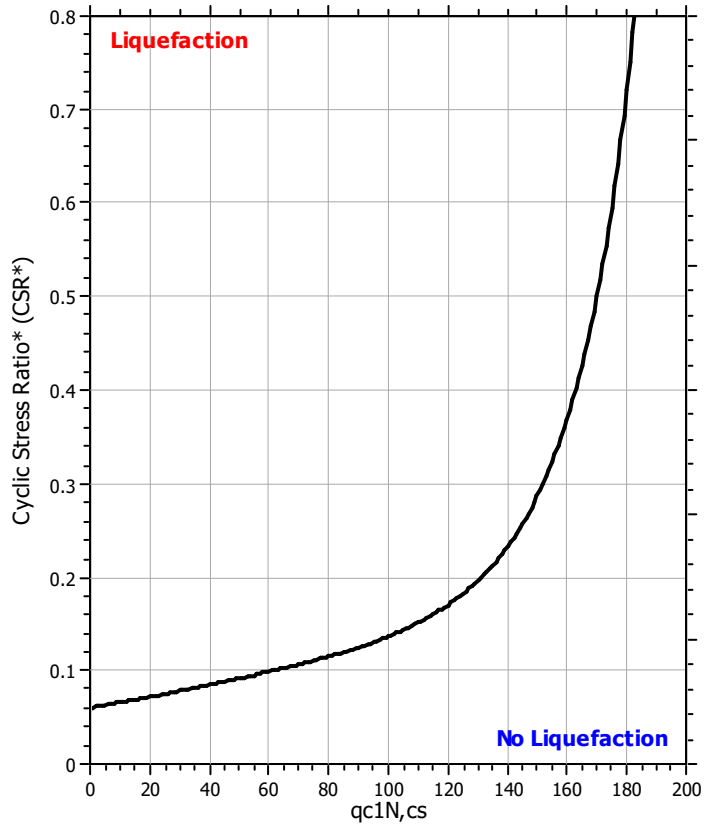
CPT: CPT07
Total depth: 7.66 m

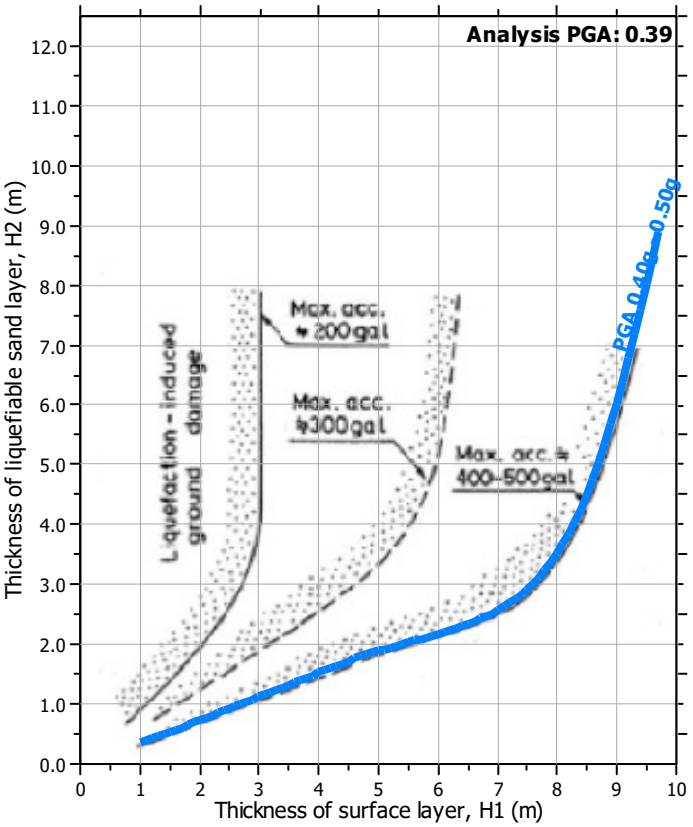


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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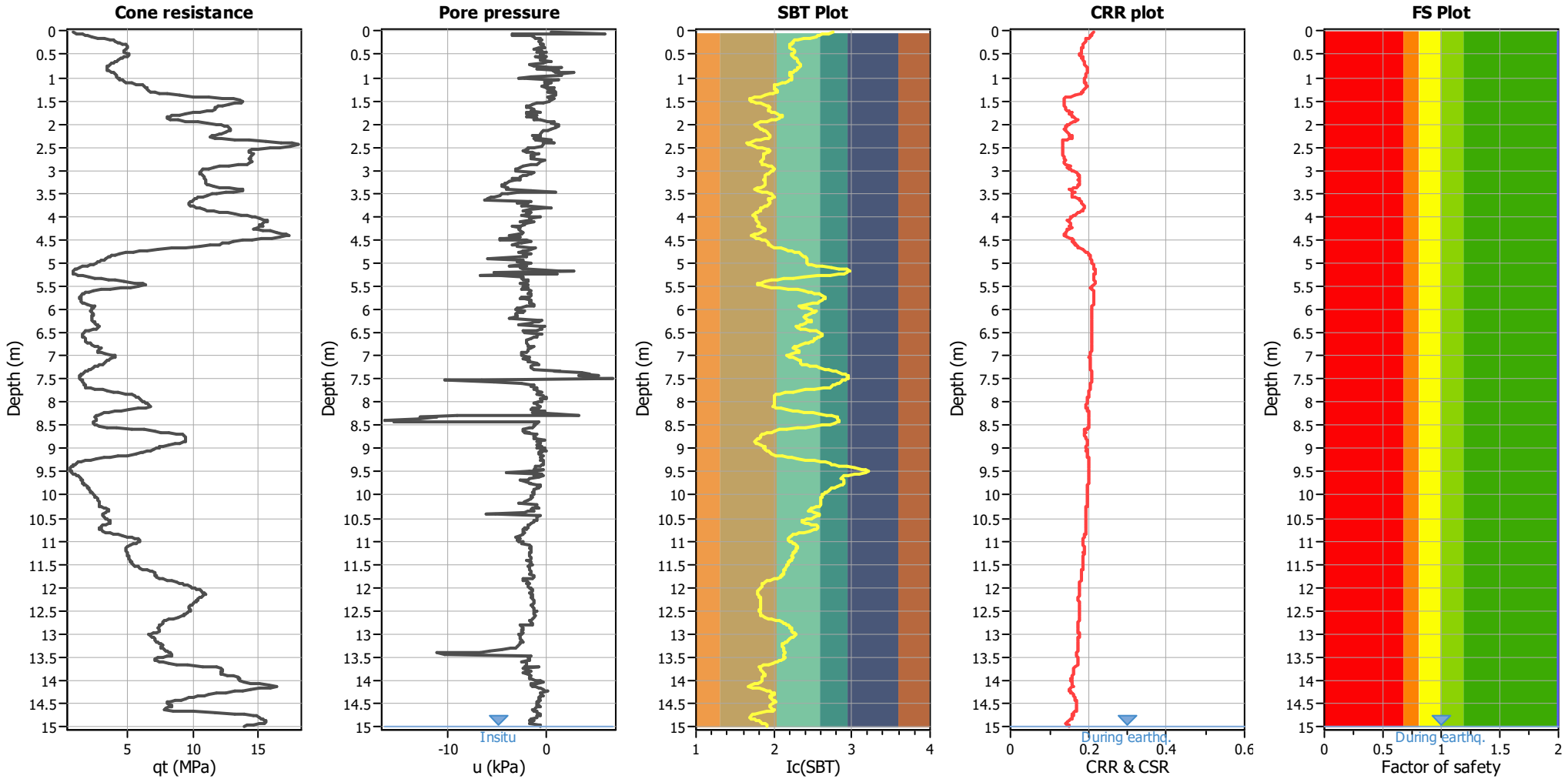
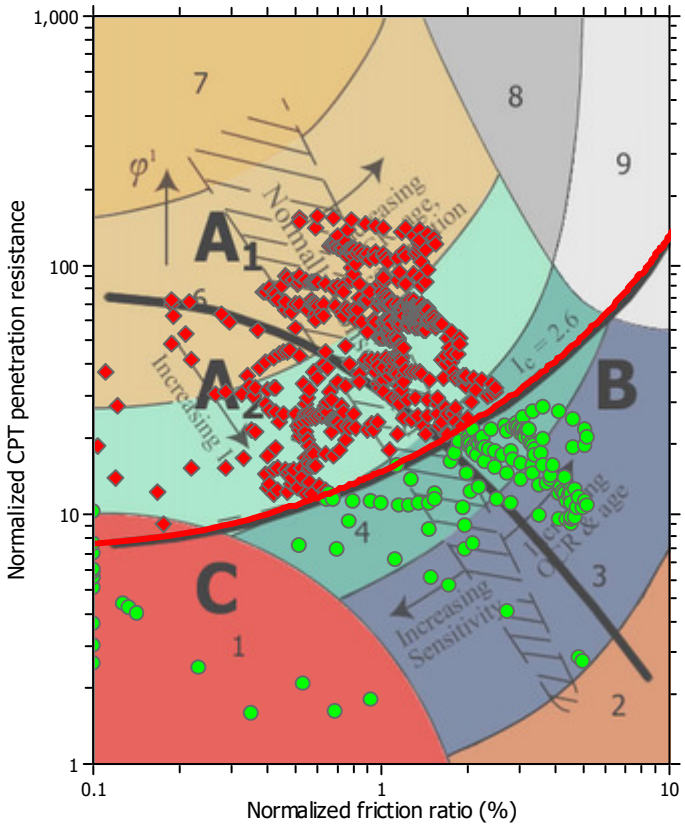
Project: Nukuhau Structure Plan
Location: Nukuhau, Taupo

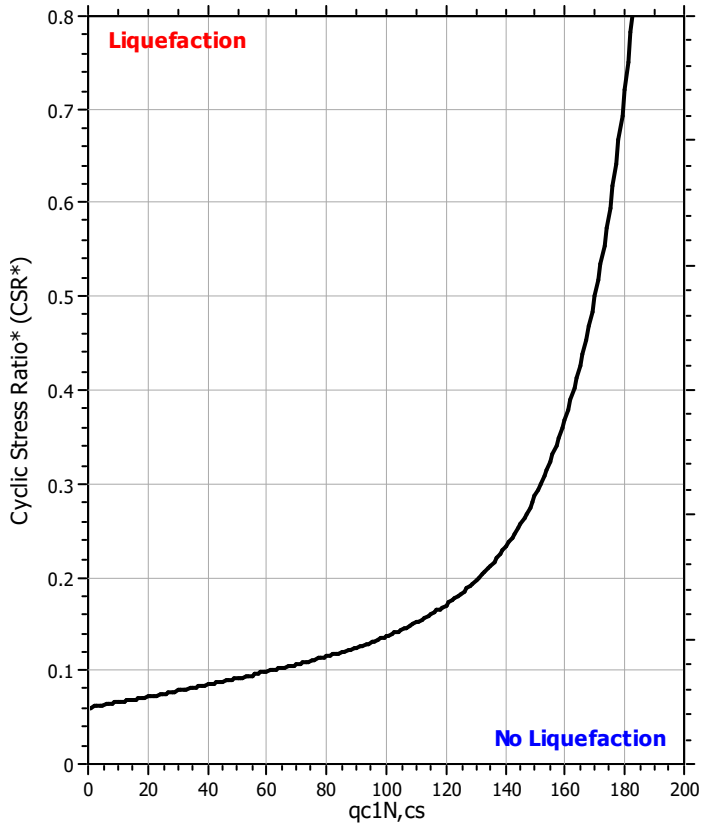
CPT: CPT08
Total depth: 15.00 m

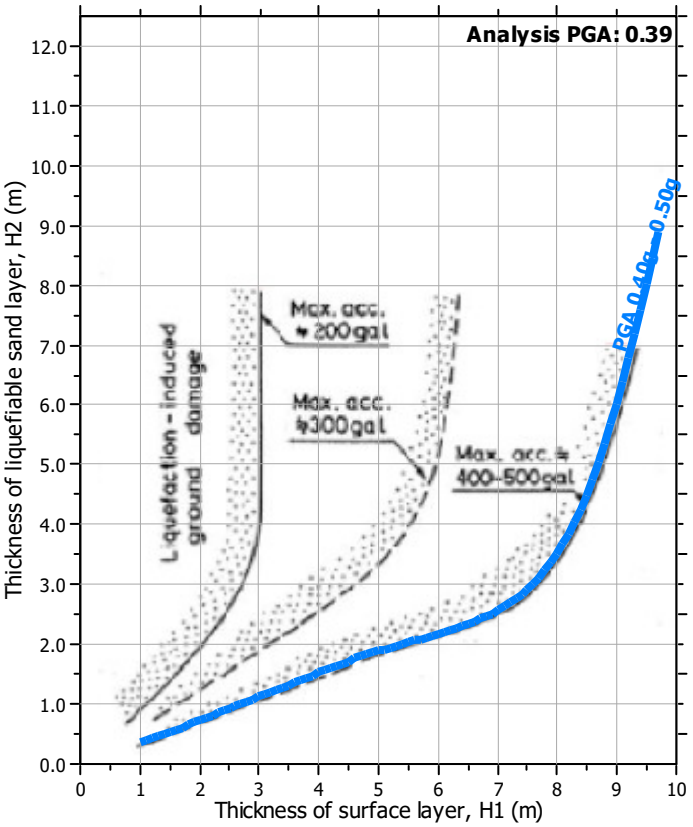


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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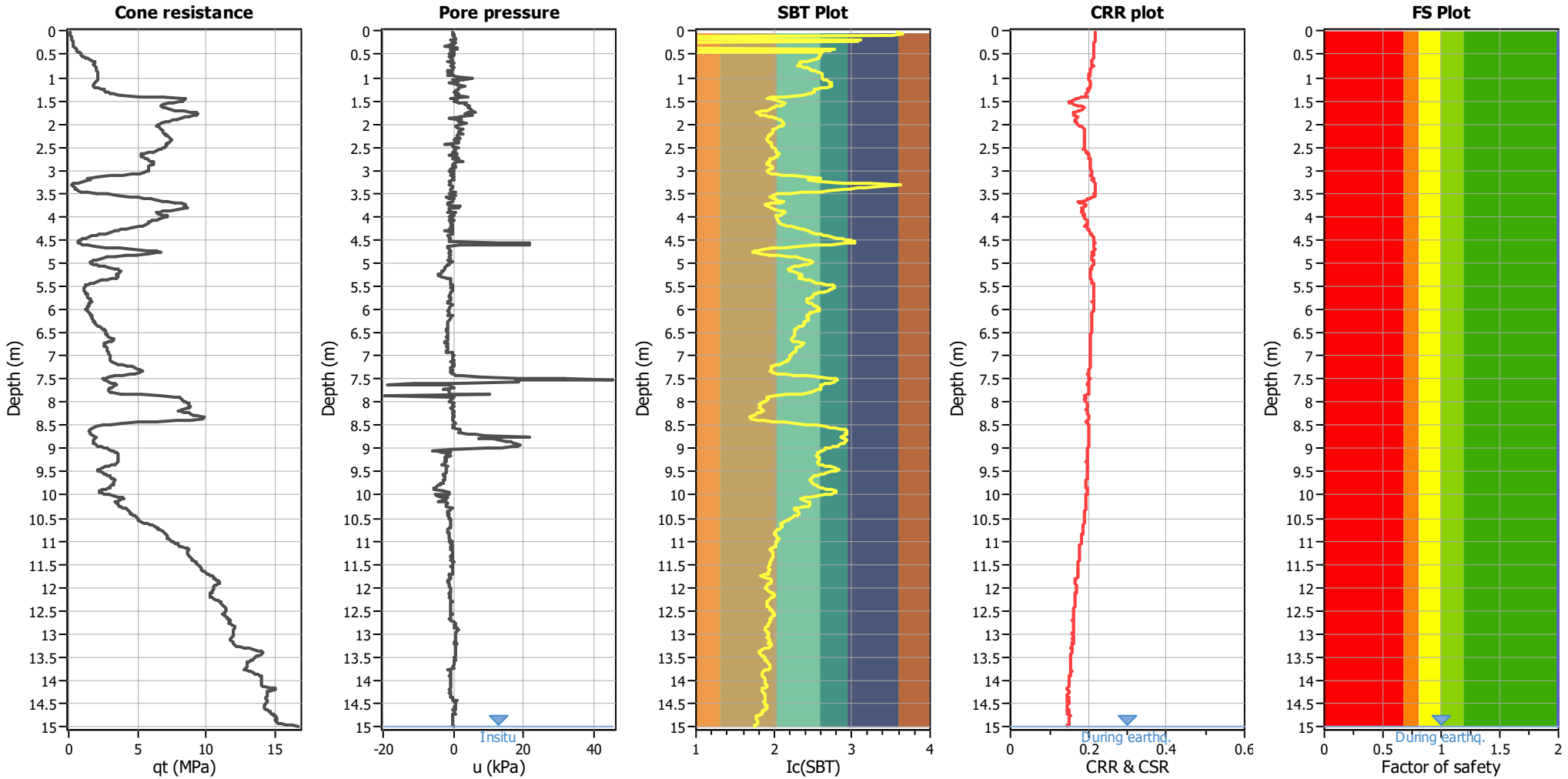
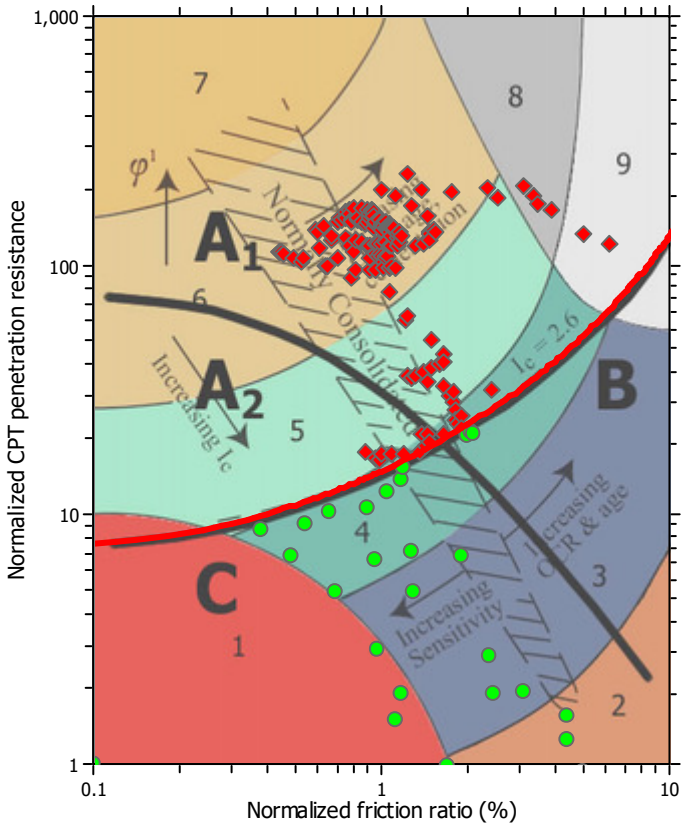
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

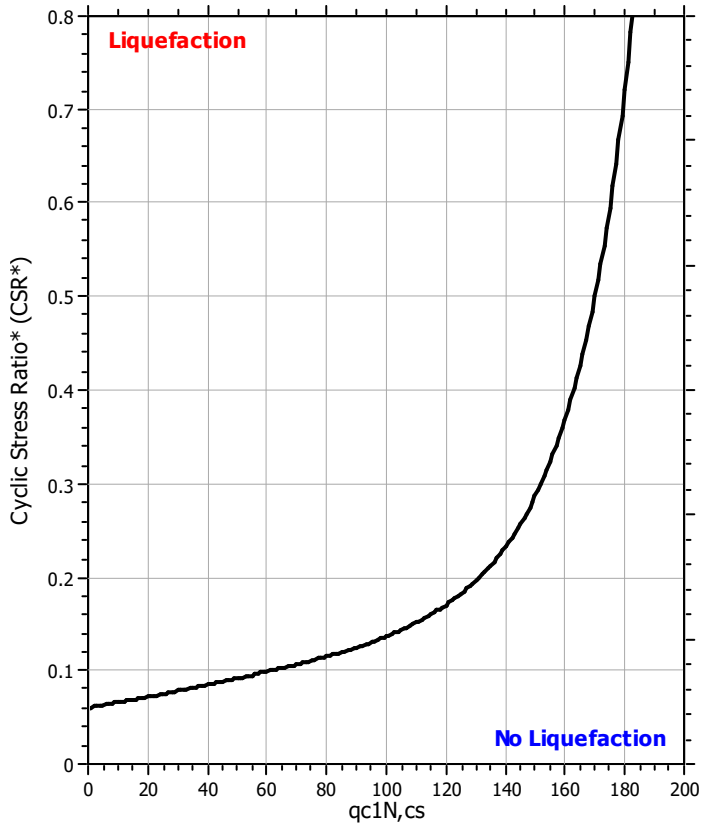
CPT: CPT09
Total depth: 15.00 m

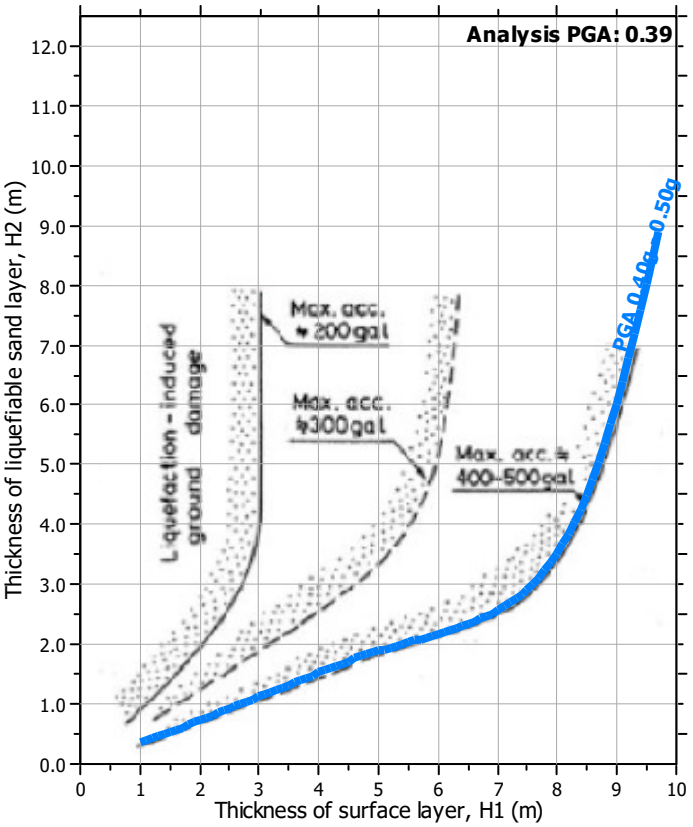


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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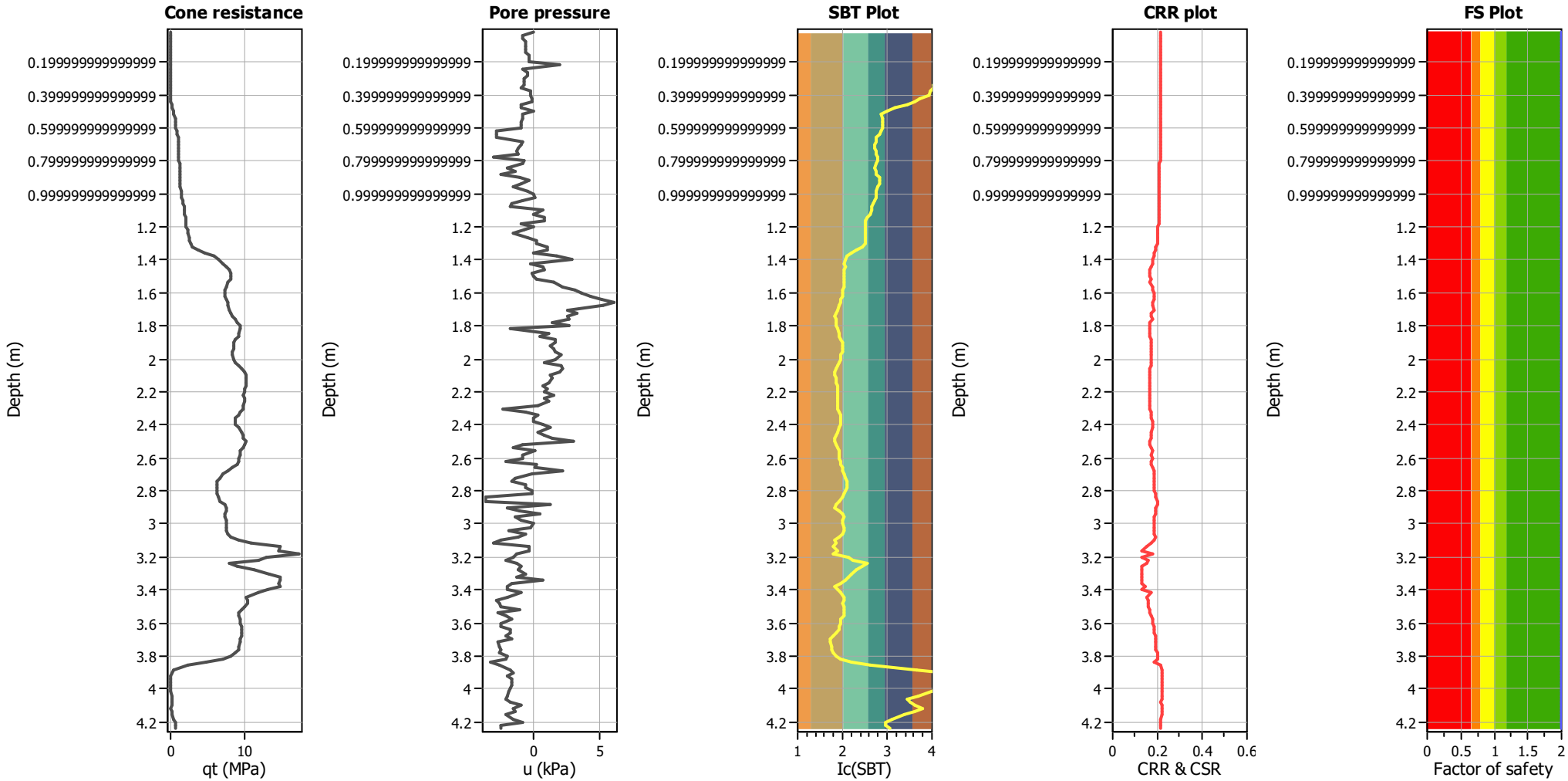
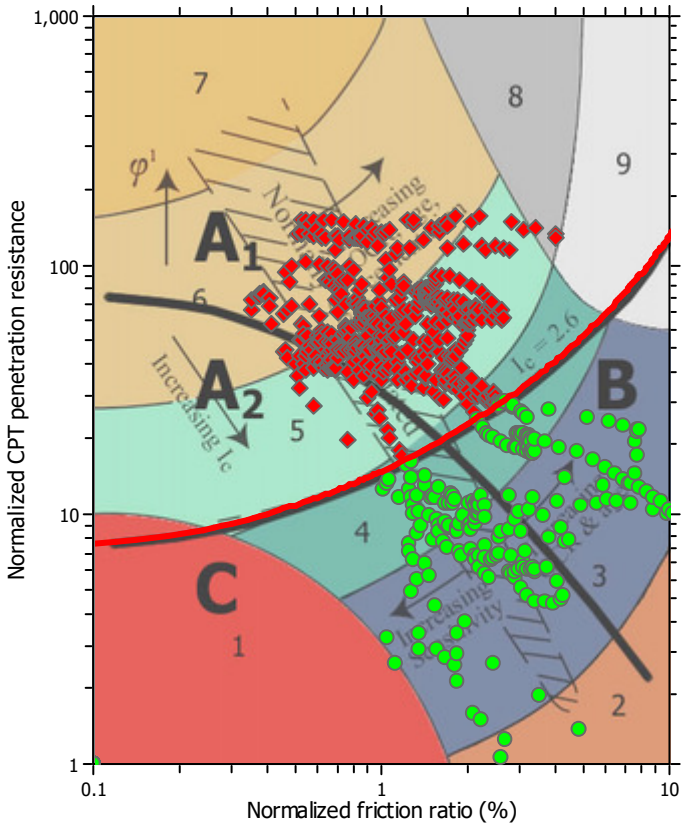
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

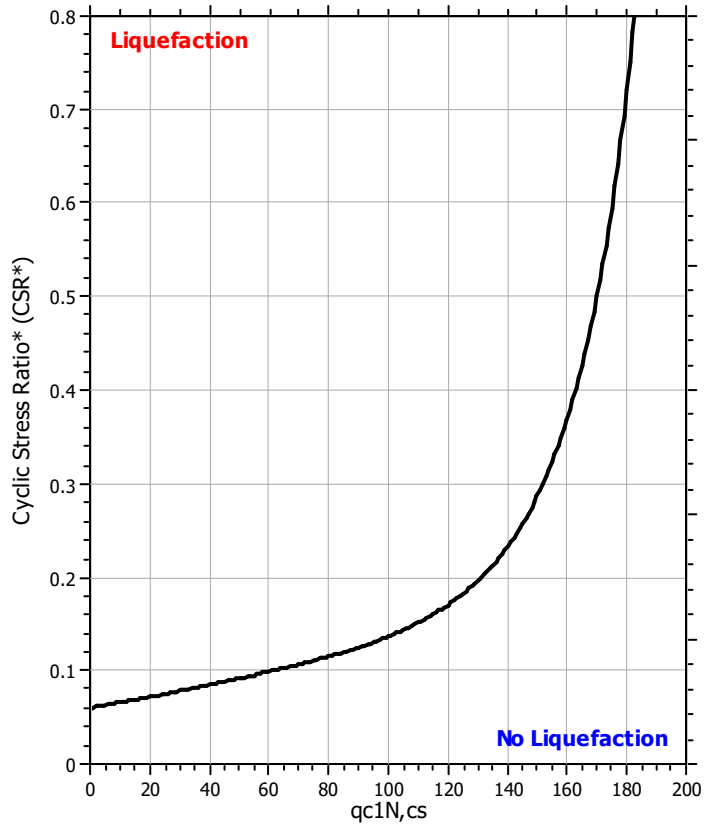
CPT: CPT10
Total depth: 4.24 m

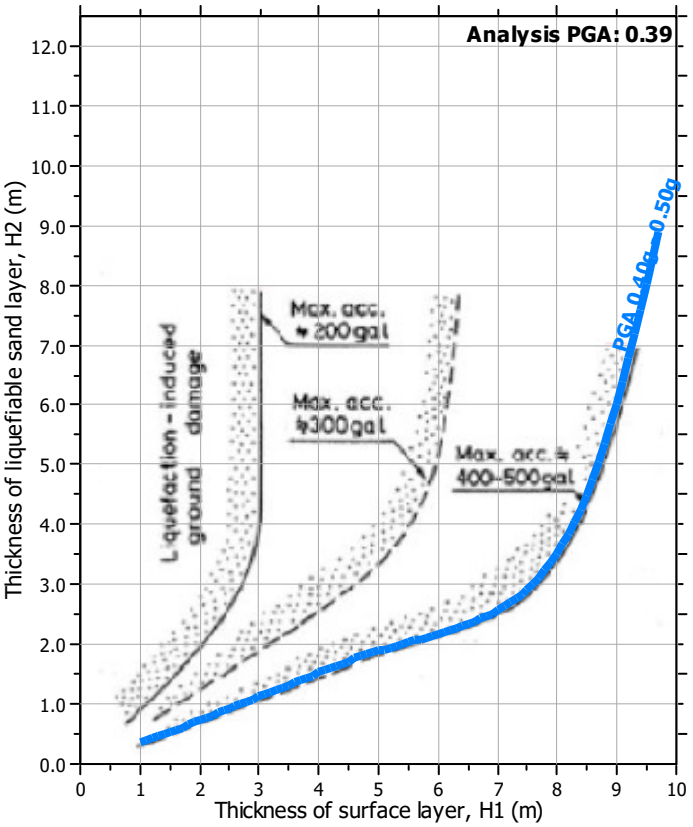


Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A		
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth applied:	No
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	Limit depth:	N/A
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes	MSF method:	Method based

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	15.00 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	15.00 m	Fill height:	N/A	Limit depth:	N/A

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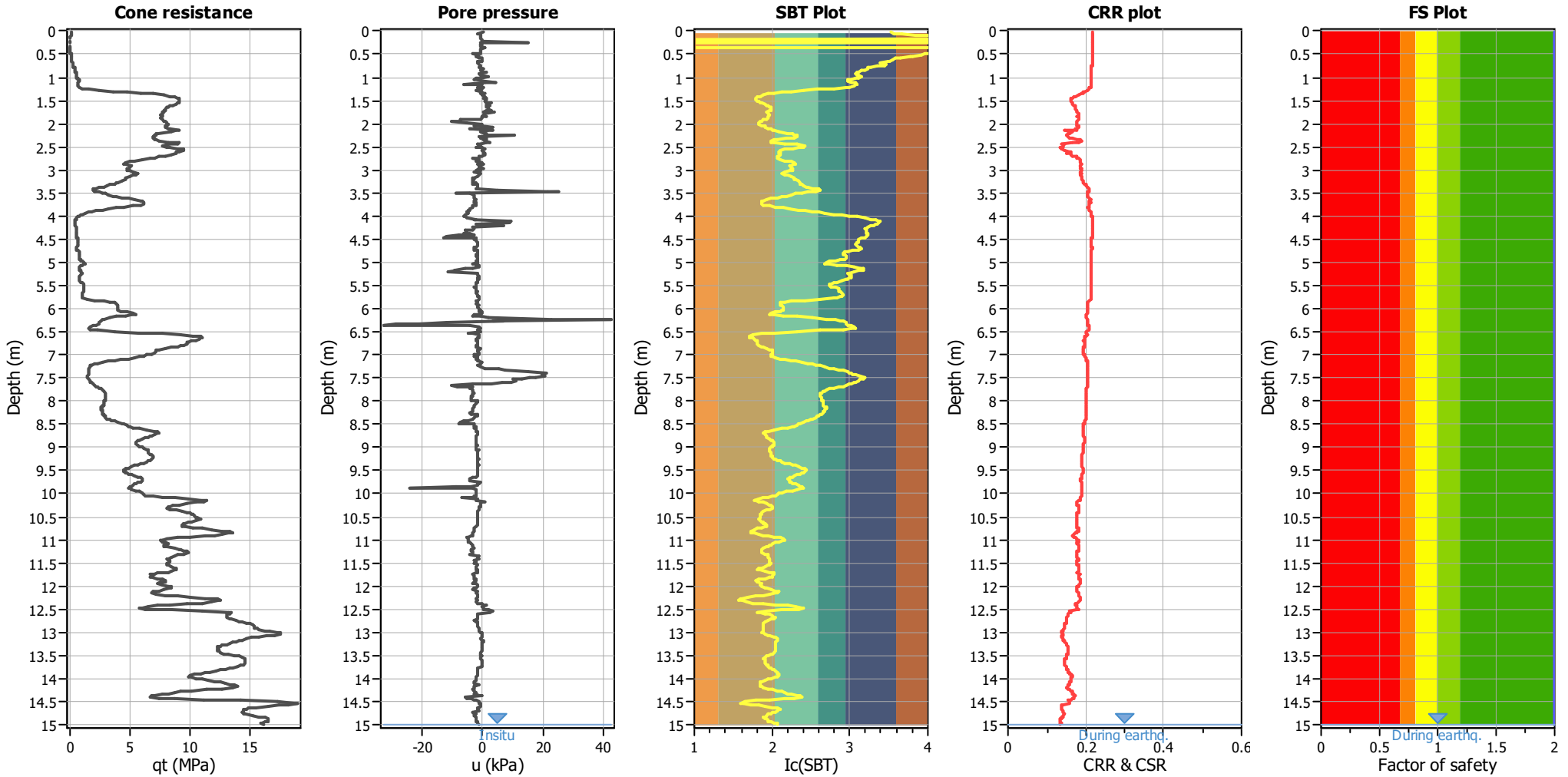
Project: Nukuhau Structure Plan
Location: Nukuhau, Taupo

CPT: CPT11
Total depth: 15.00 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	15.00 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	15.00 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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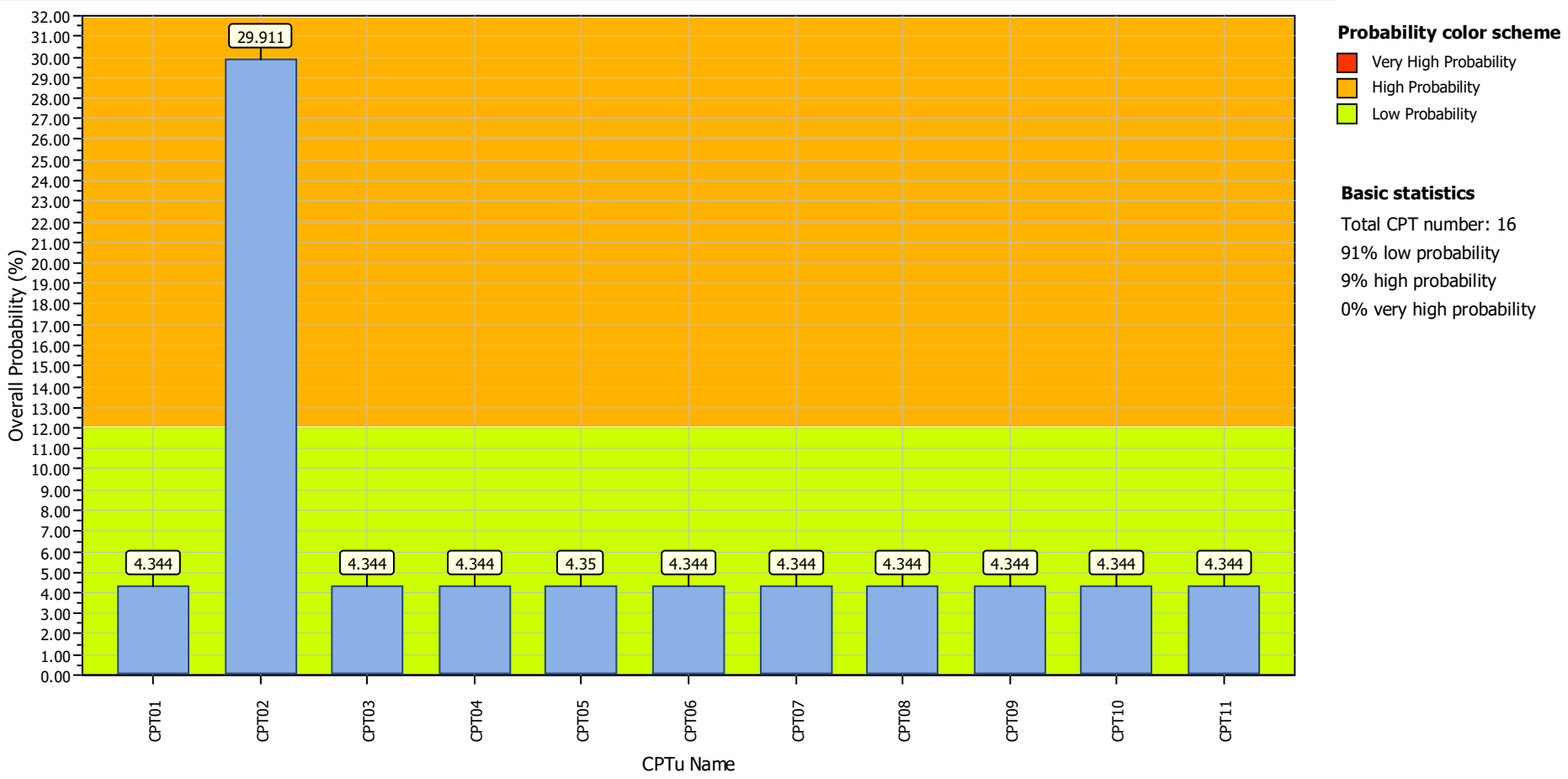
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall Probability for Liquefaction report



Probability color scheme

- Very High Probability
- High Probability
- Low Probability

Basic statistics

Total CPT number: 16
91% low probability
9% high probability
0% very high probability

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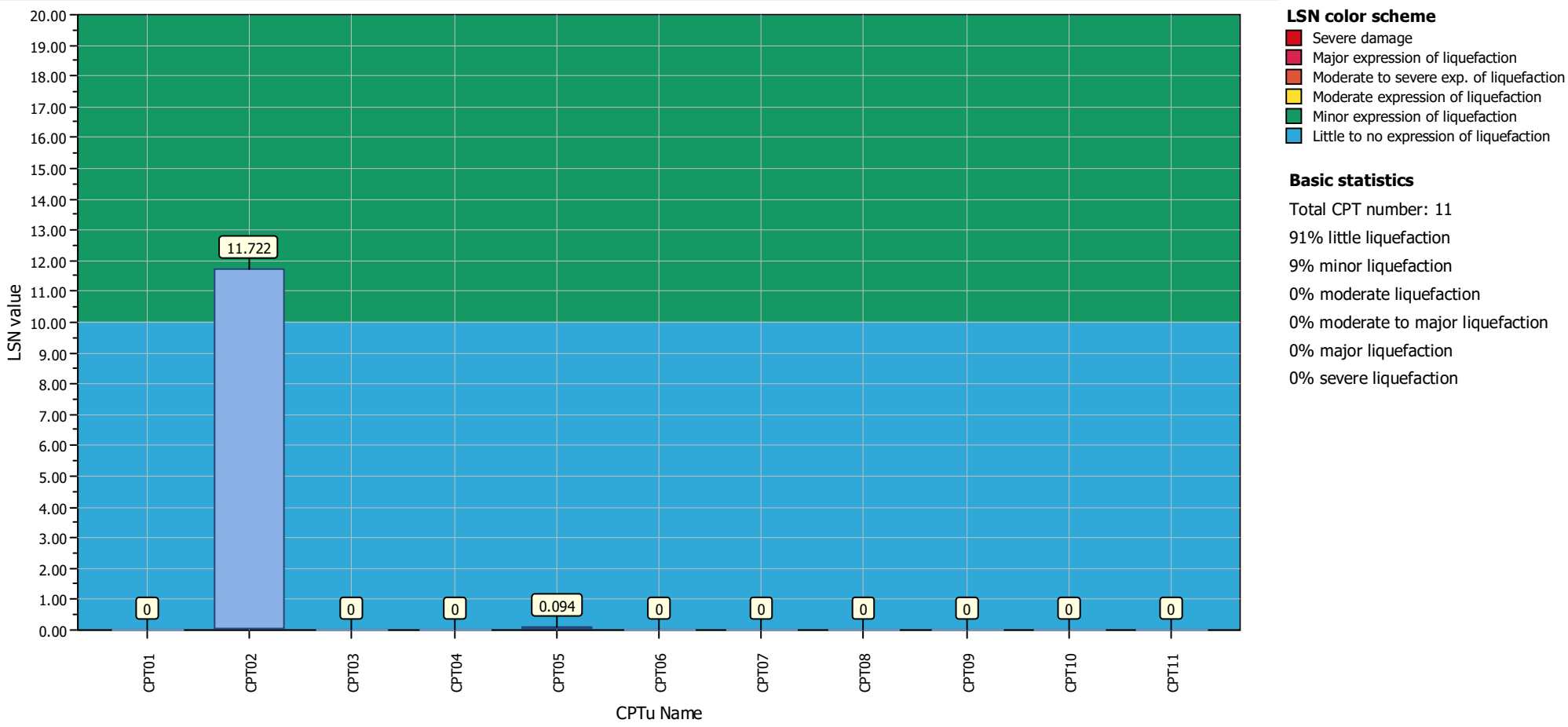
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

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: 11

91% little liquefaction

9% minor liquefaction

0% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

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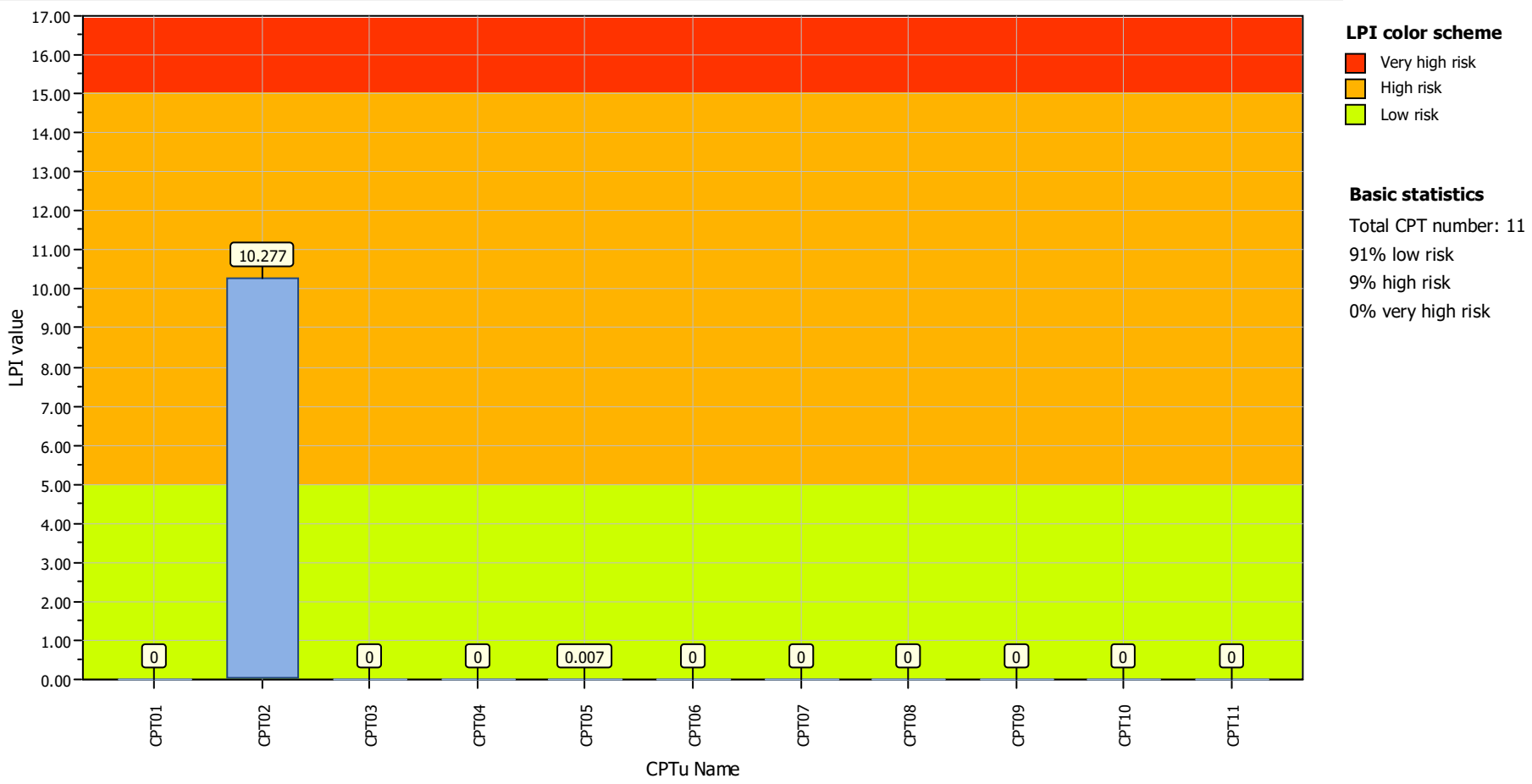
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall Liquefaction Potential Index report



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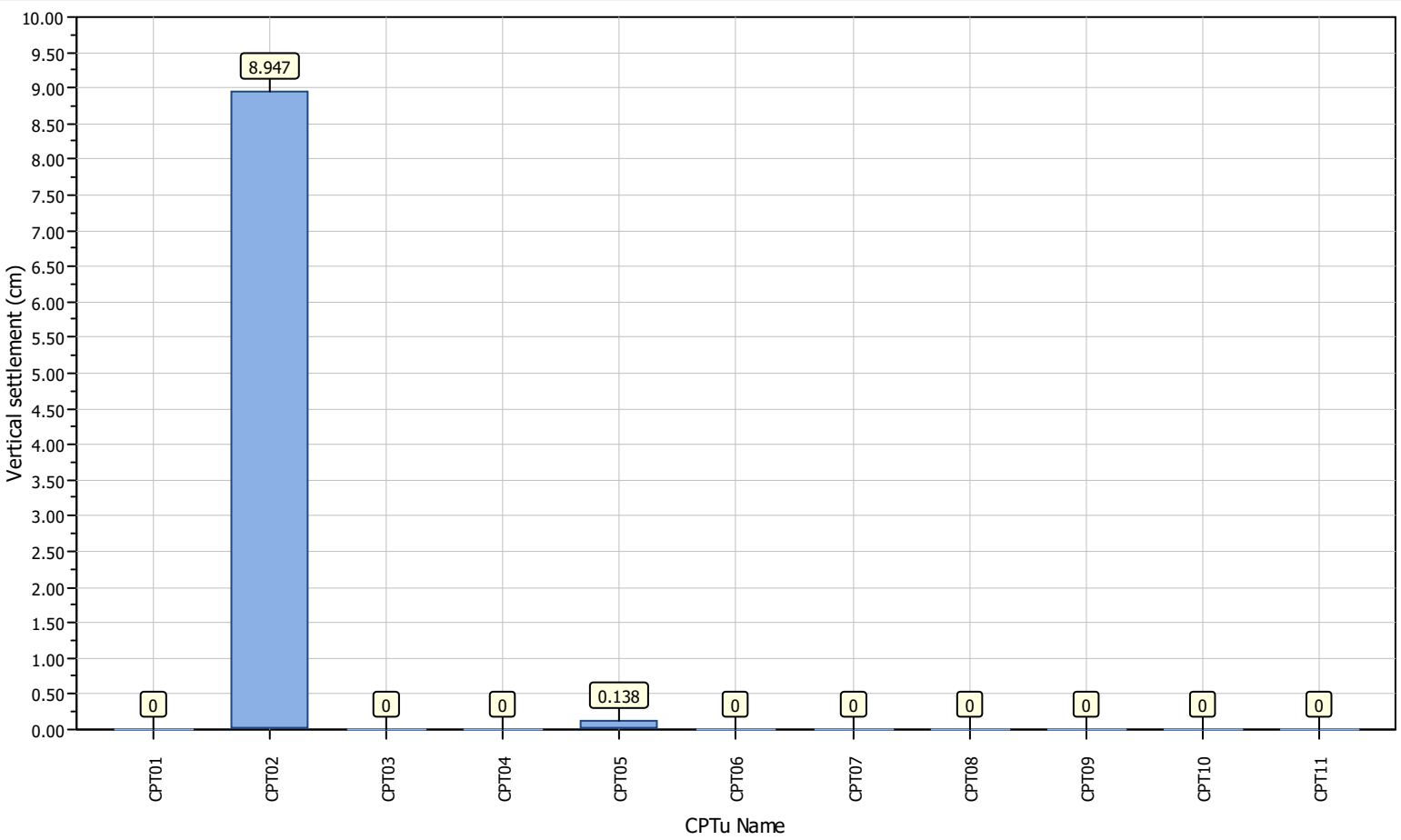
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall vertical settlements report



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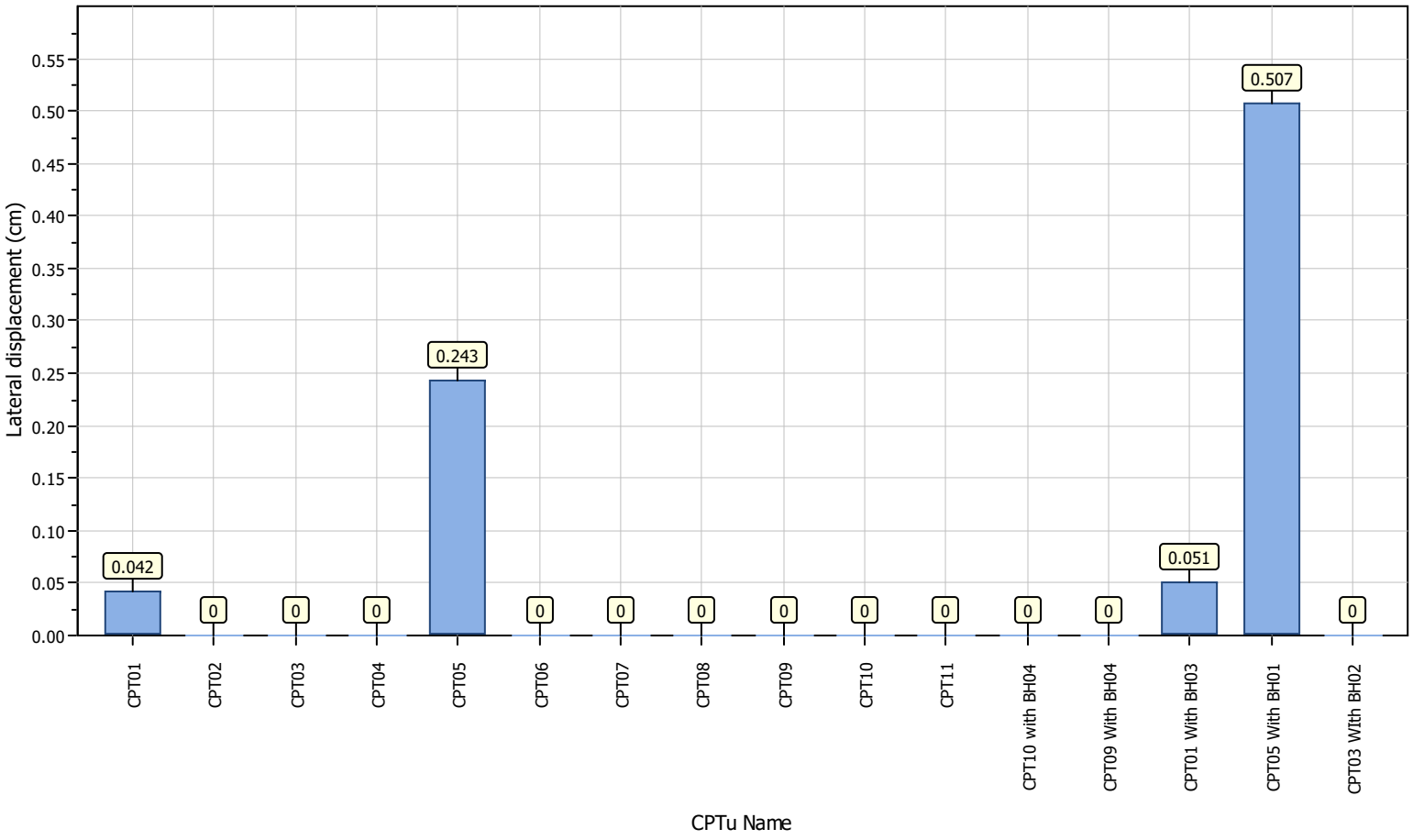
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall lateral displacements report



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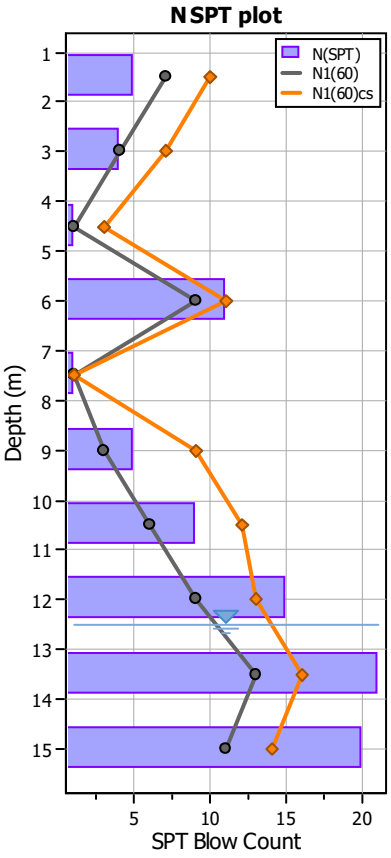
SPT BASED LIQUEFACTION ANALYSIS REPORT

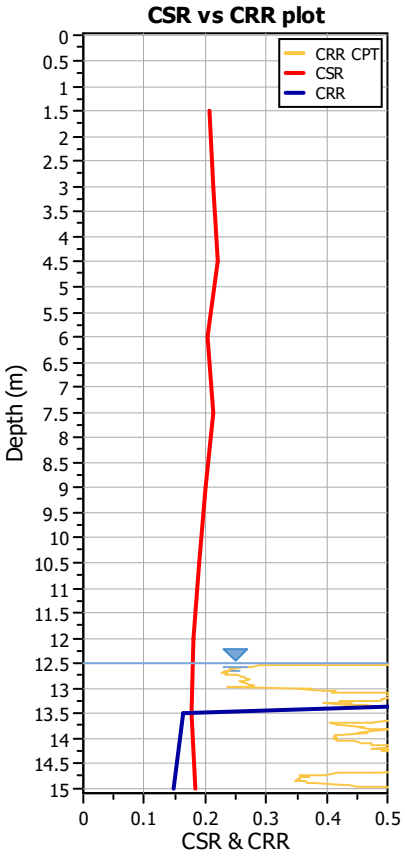
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

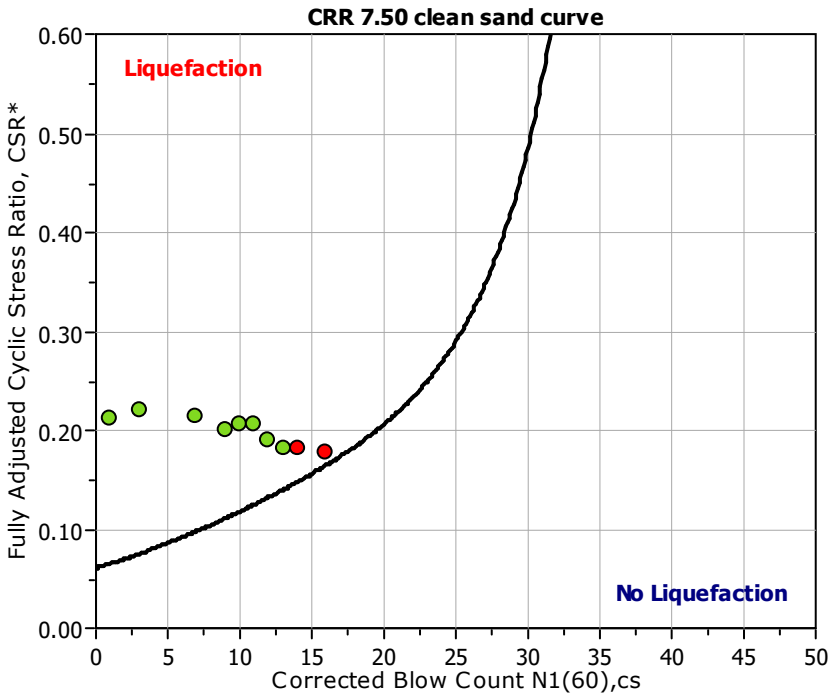
Borehole Name : BH03

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	12.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	12.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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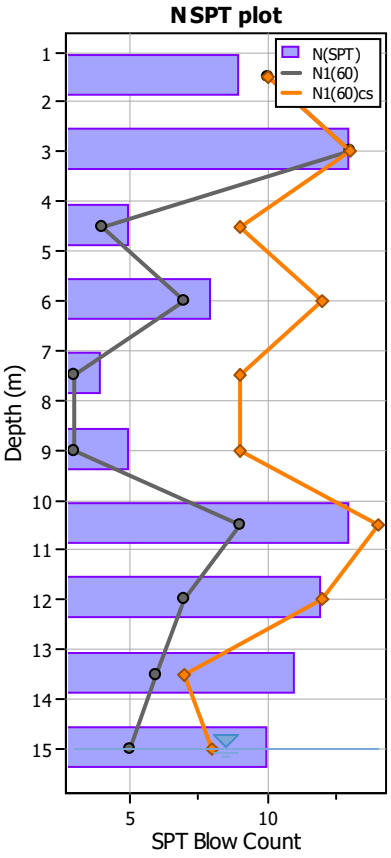
SPT BASED LIQUEFACTION ANALYSIS REPORT

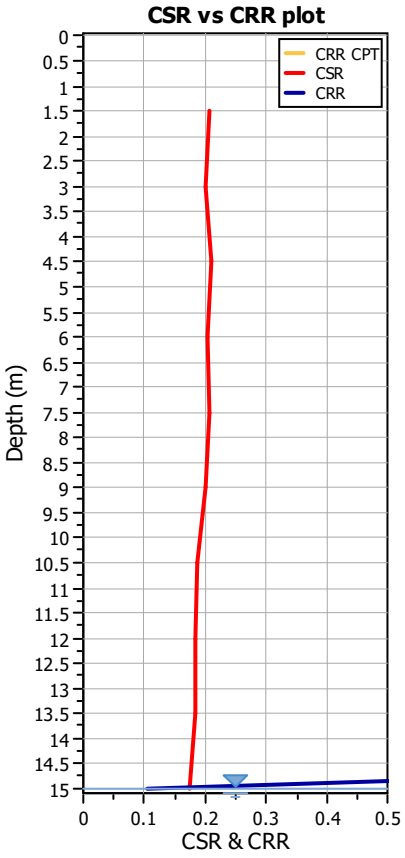
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

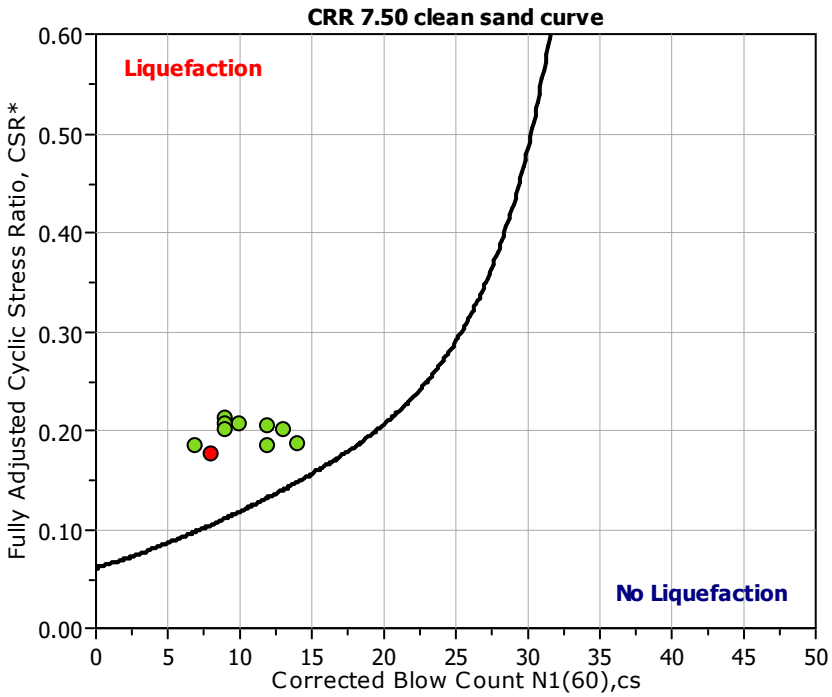
Borehole Name : BH02

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	15.00	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	15.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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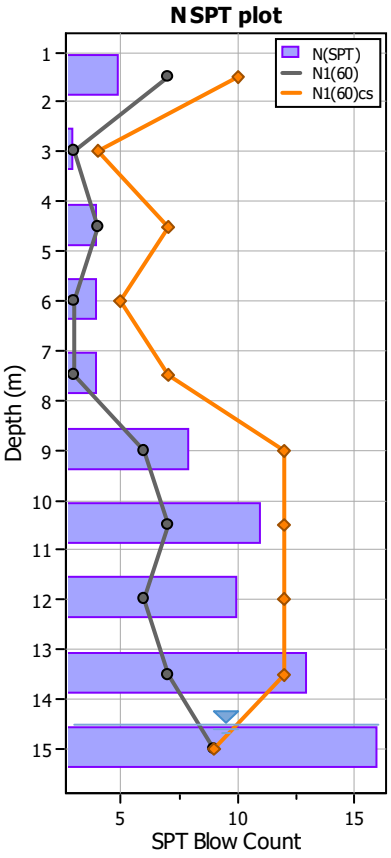
SPT BASED LIQUEFACTION ANALYSIS REPORT

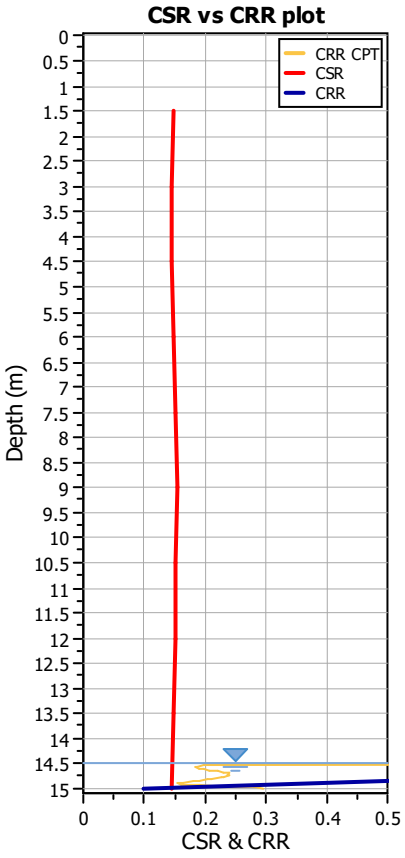
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

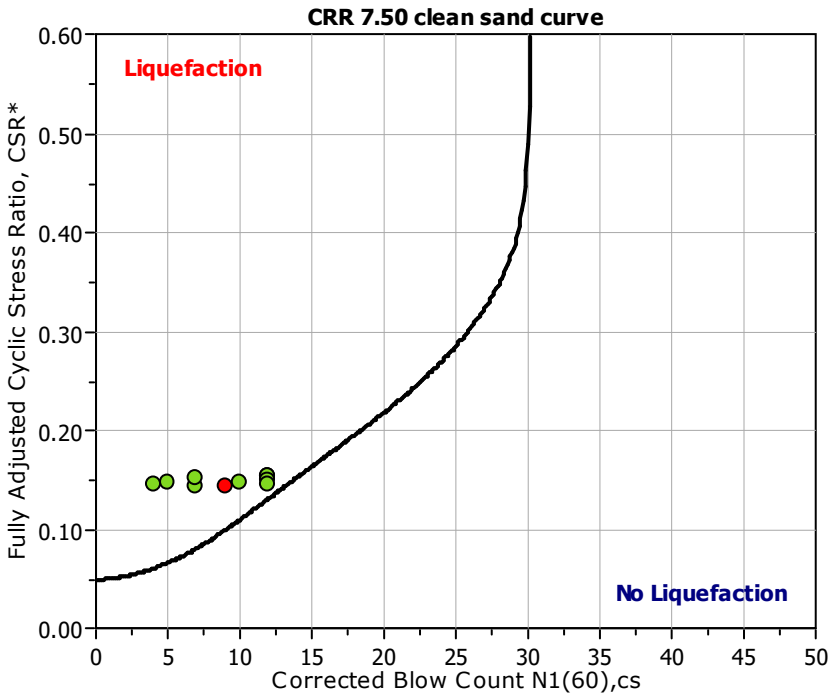
Borehole Name : BH01

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	14.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Seed	G.W.T. (earthq.):	14.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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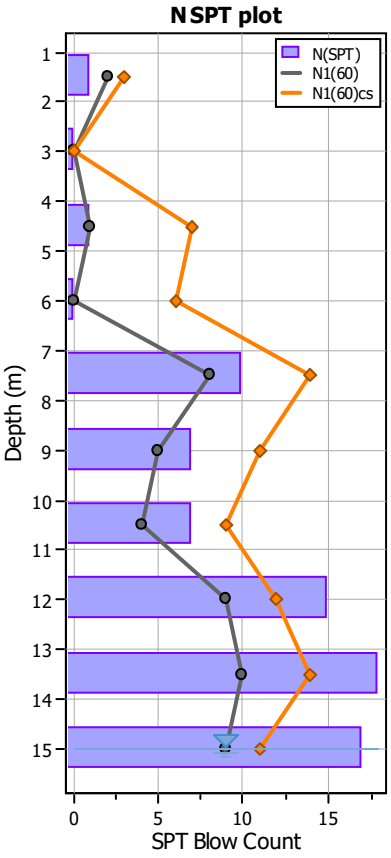
SPT BASED LIQUEFACTION ANALYSIS REPORT

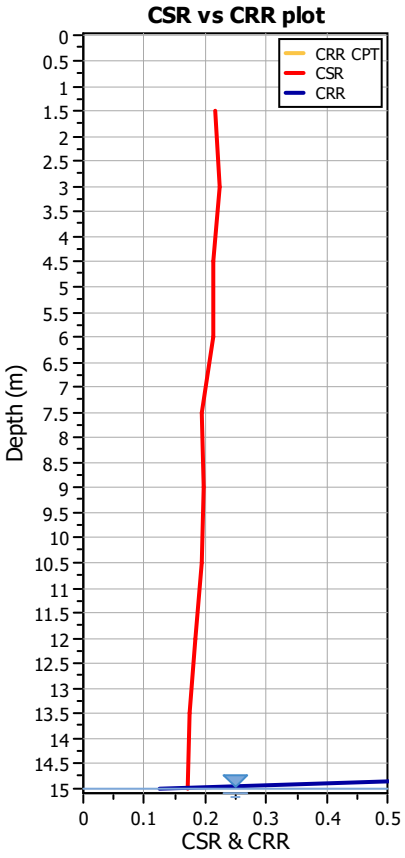
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

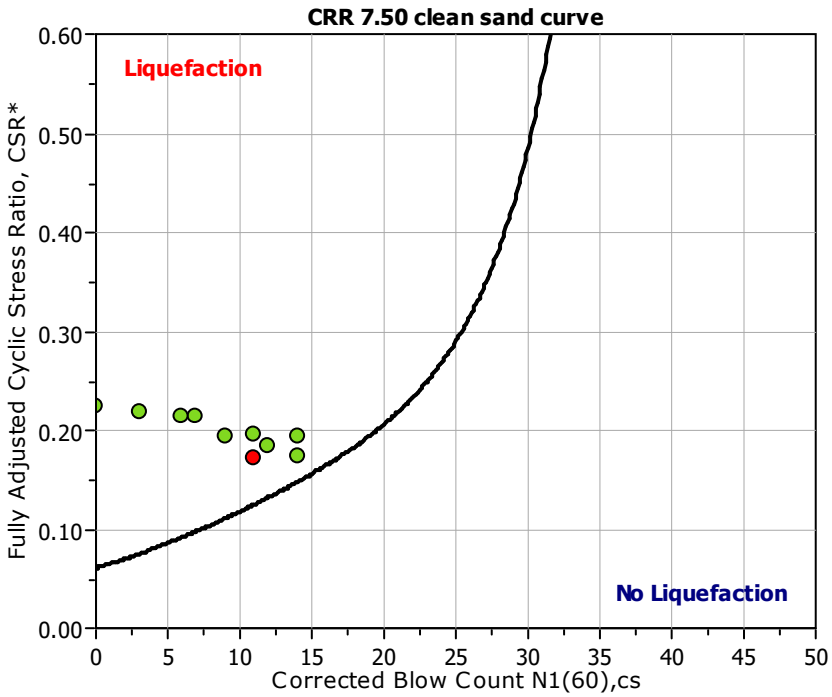
Borehole Name : BH04

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	15.00	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	15.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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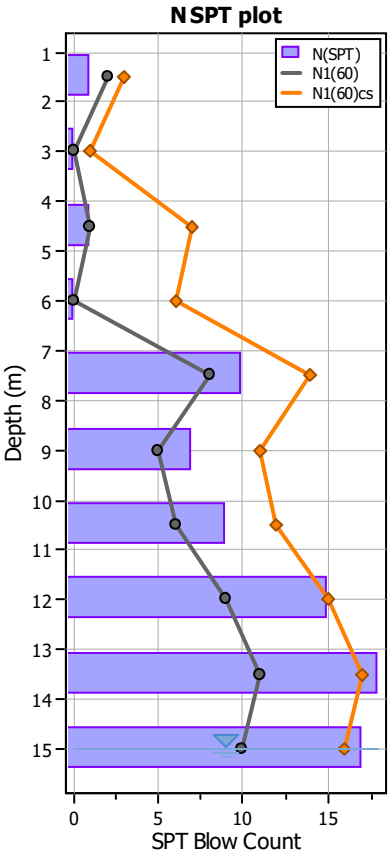
SPT BASED LIQUEFACTION ANALYSIS REPORT

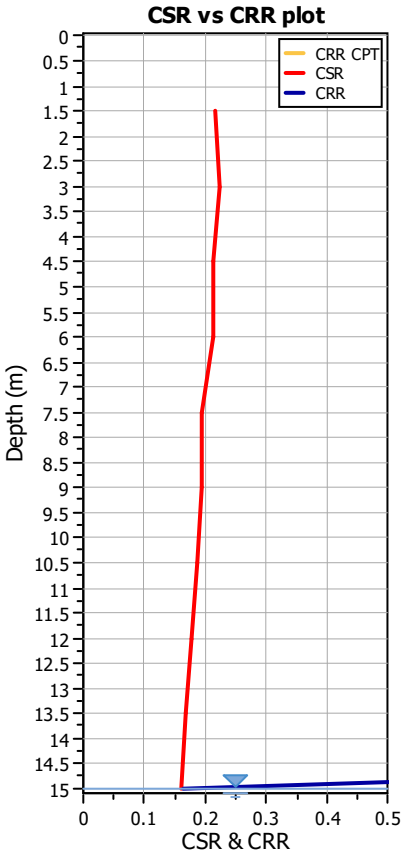
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

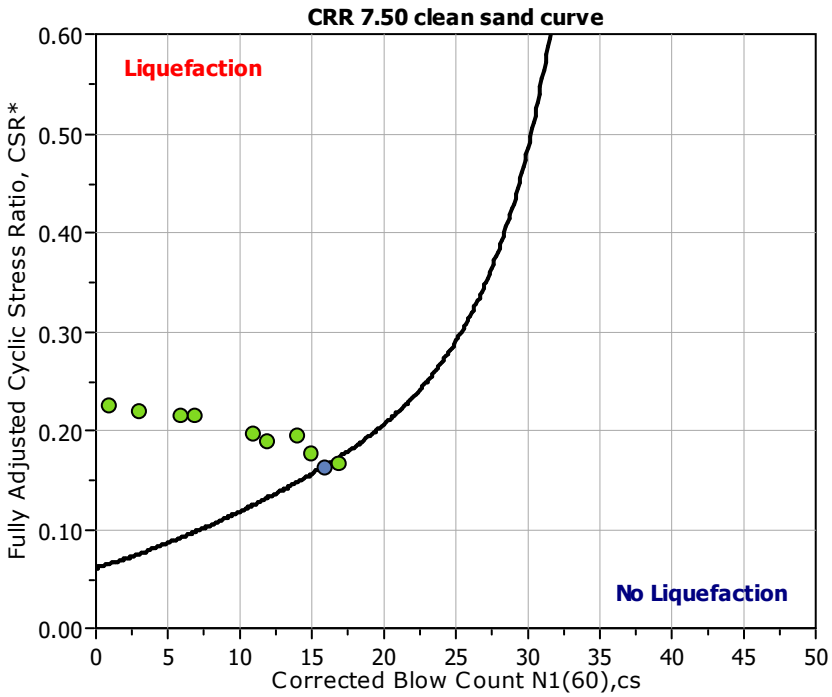
Borehole Name : BH04

:: Input parameters and analysis properties ::

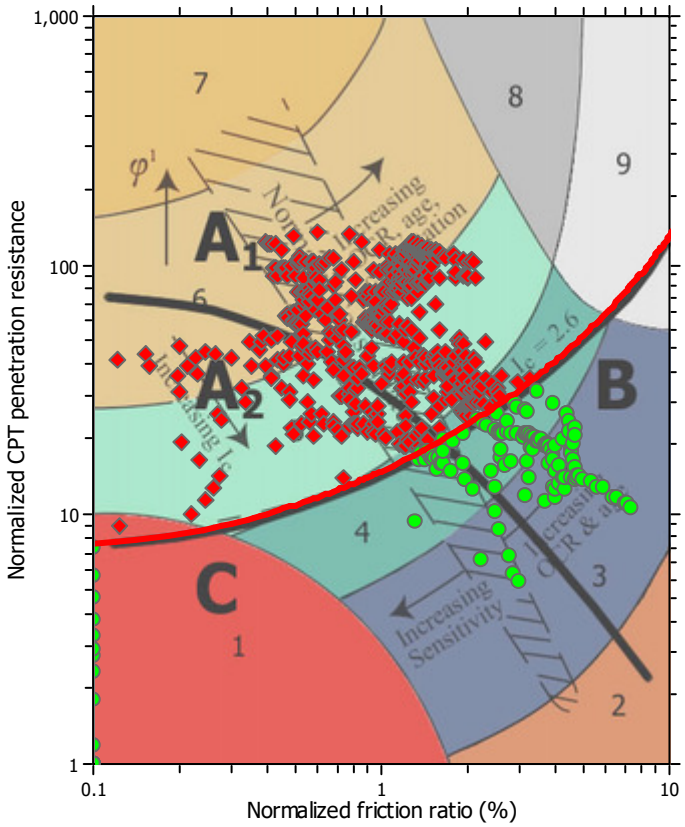
Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	15.00	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	15.00		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				

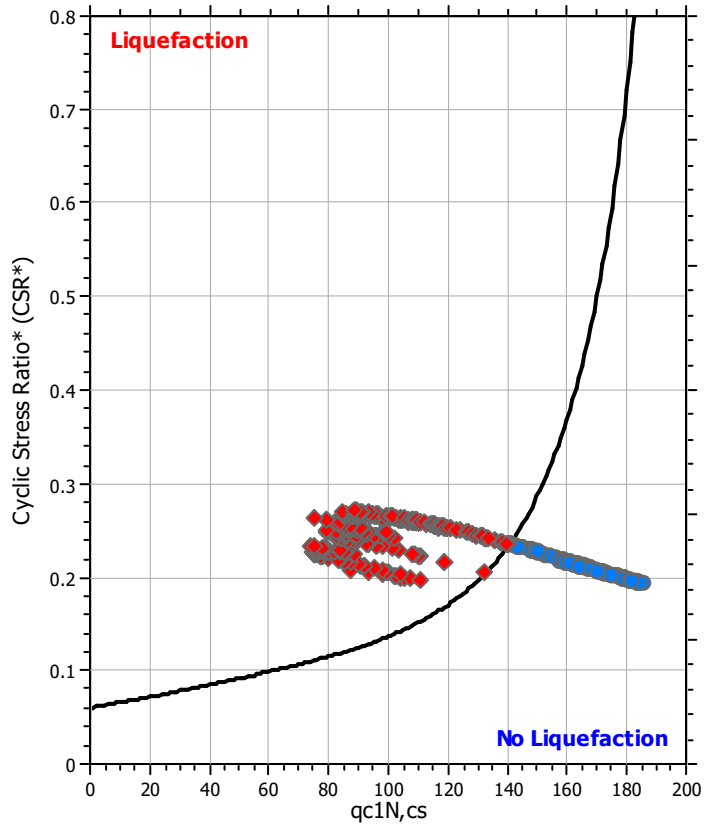


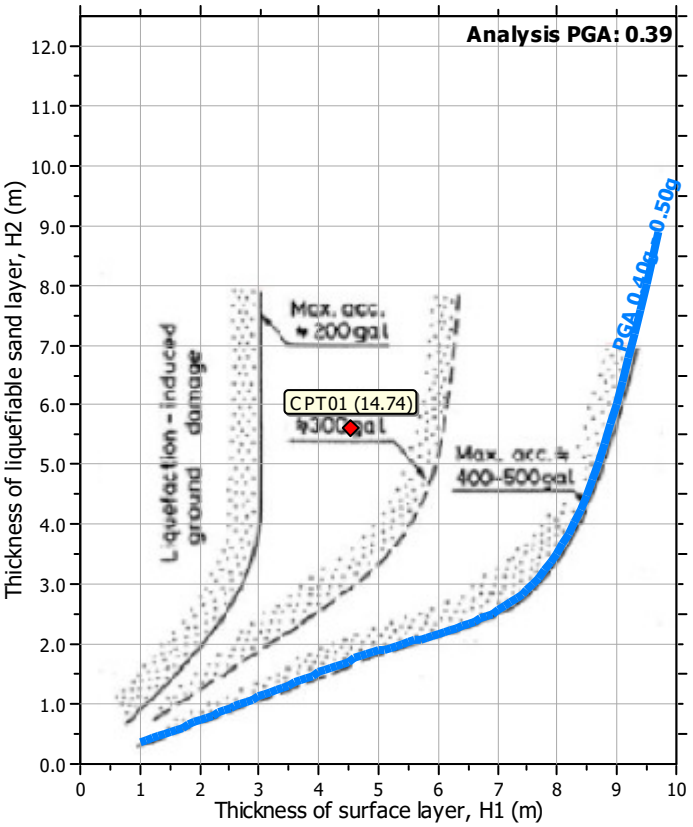




Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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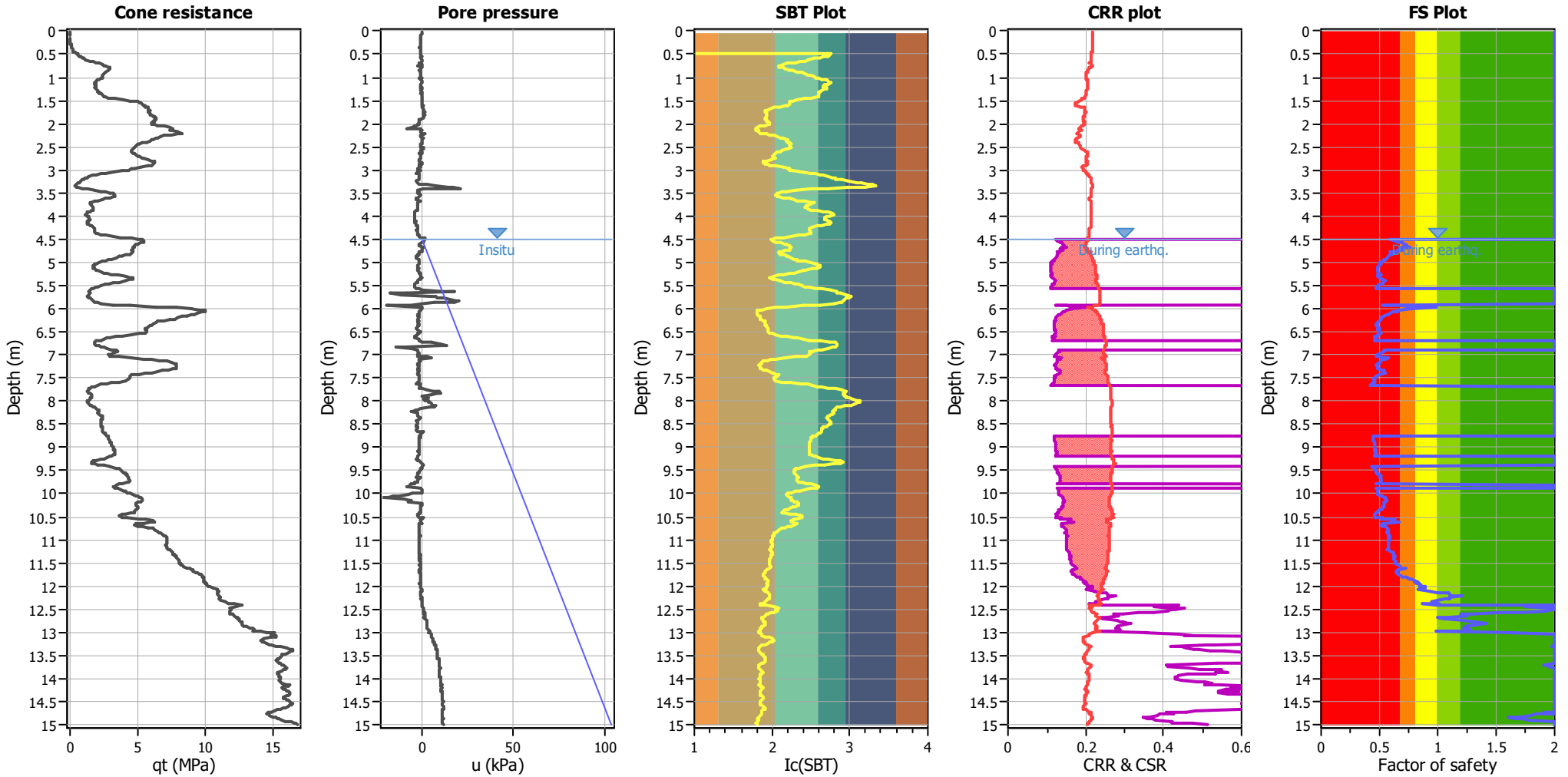
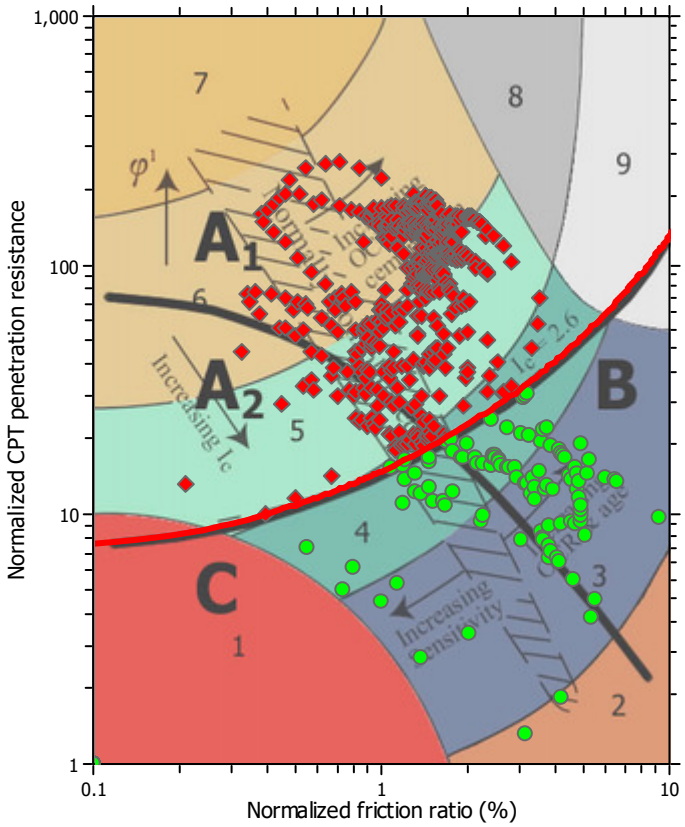
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

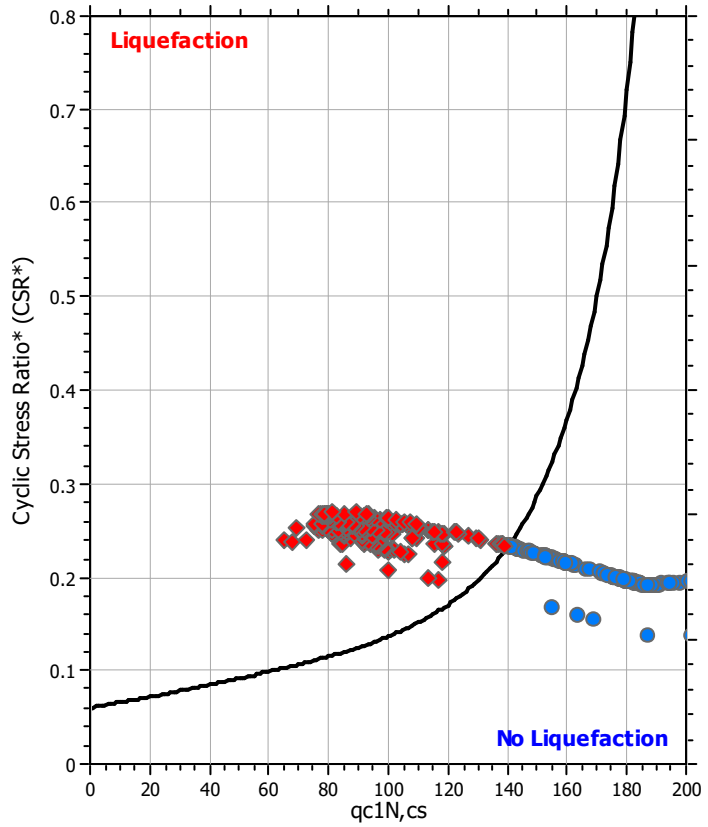
CPT: CPT01
Total depth: 15.00 m

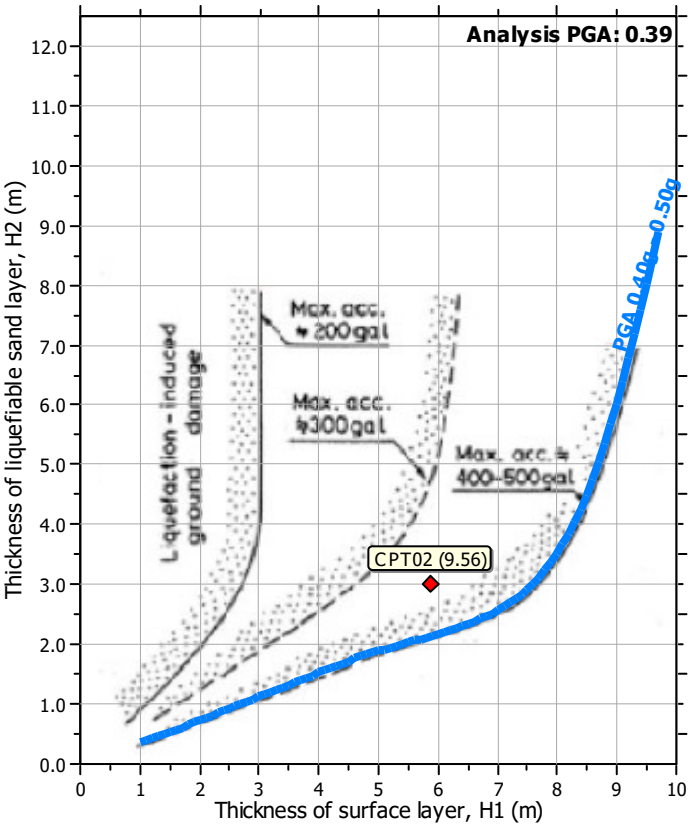


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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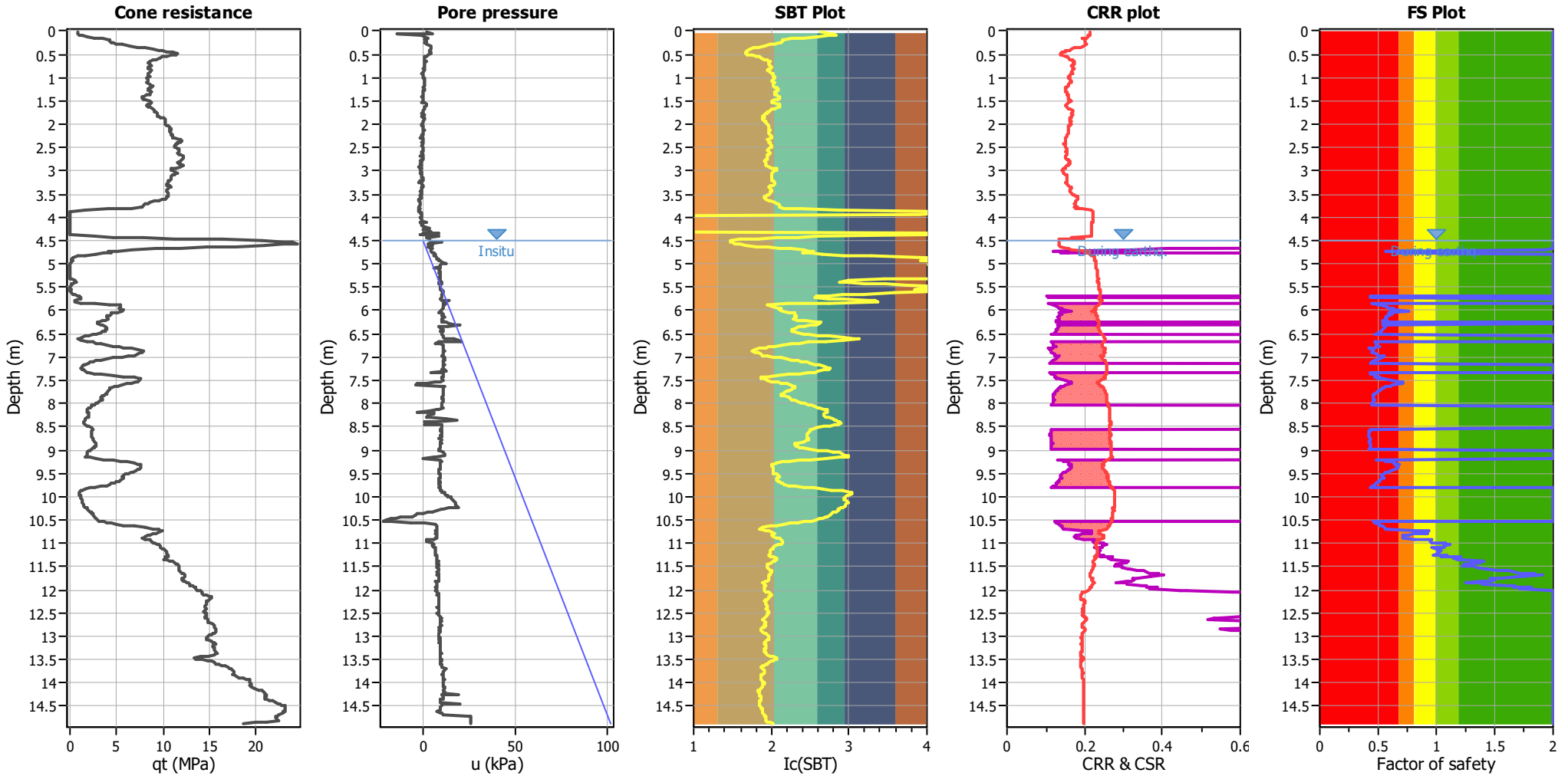
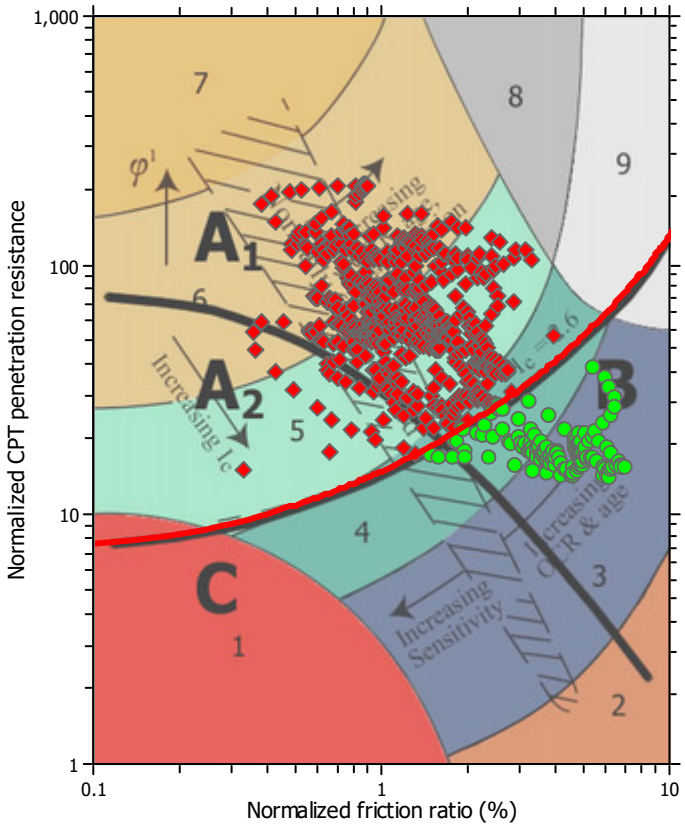
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

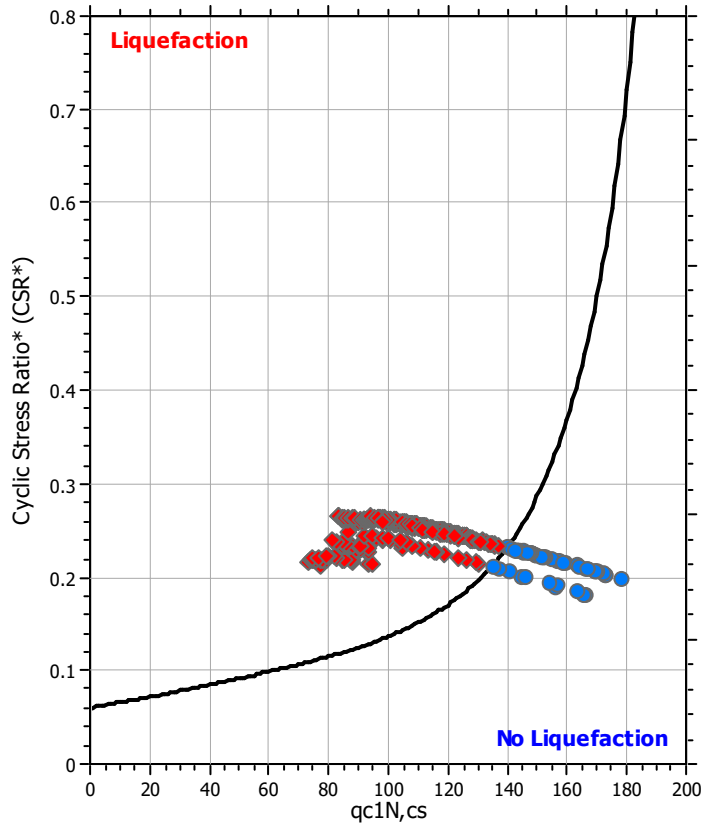
CPT: CPT02
Total depth: 14.88 m

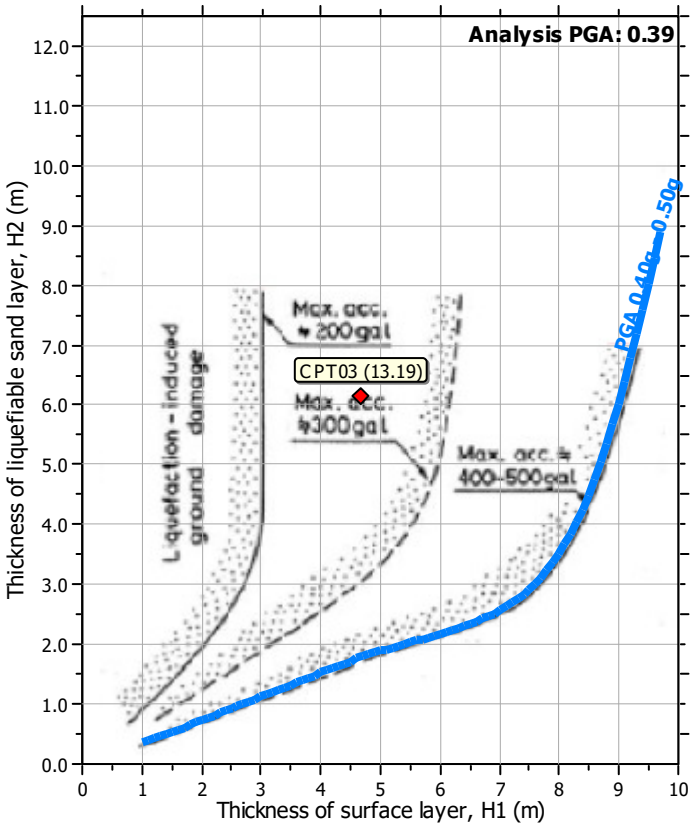


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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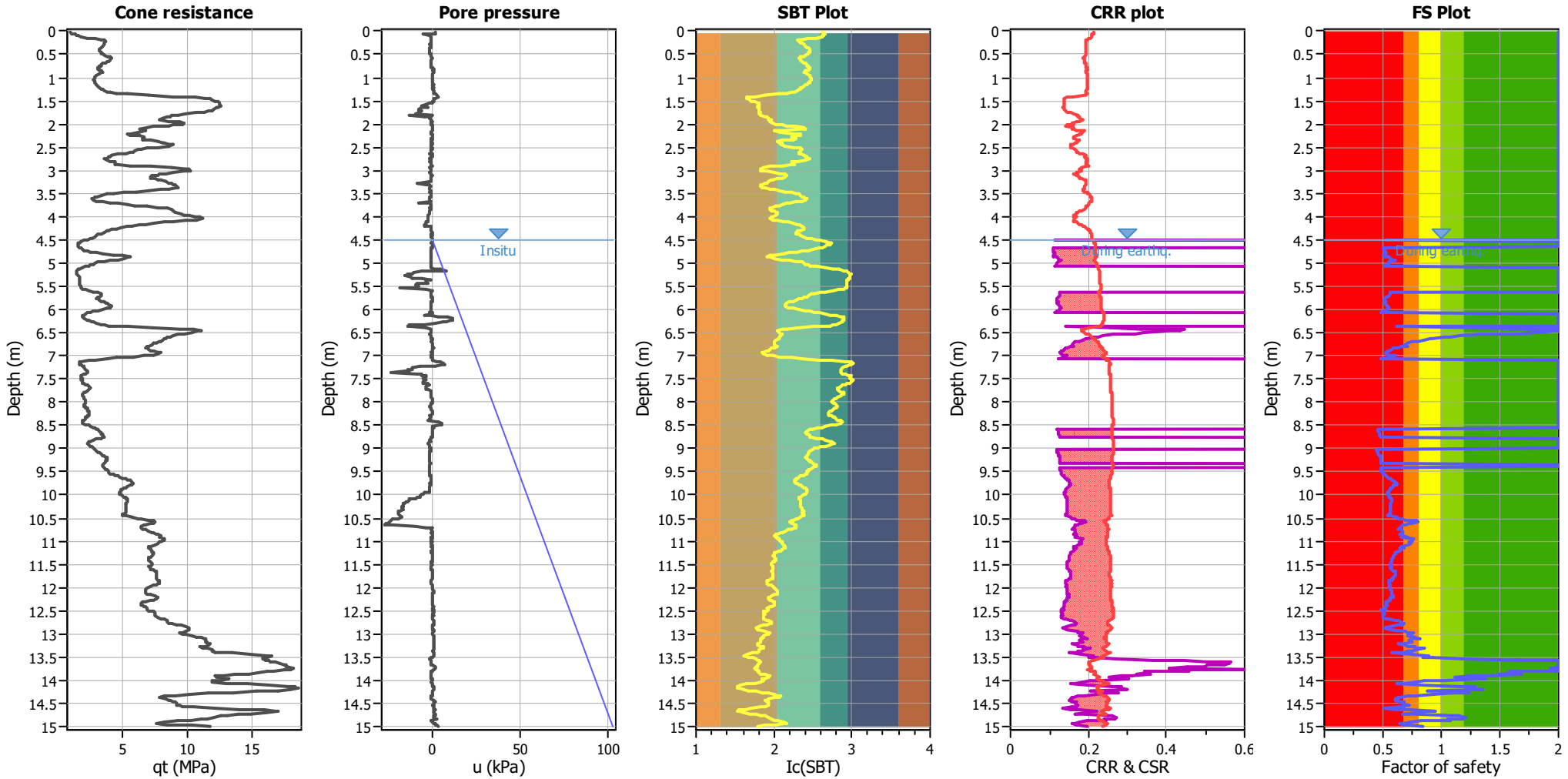
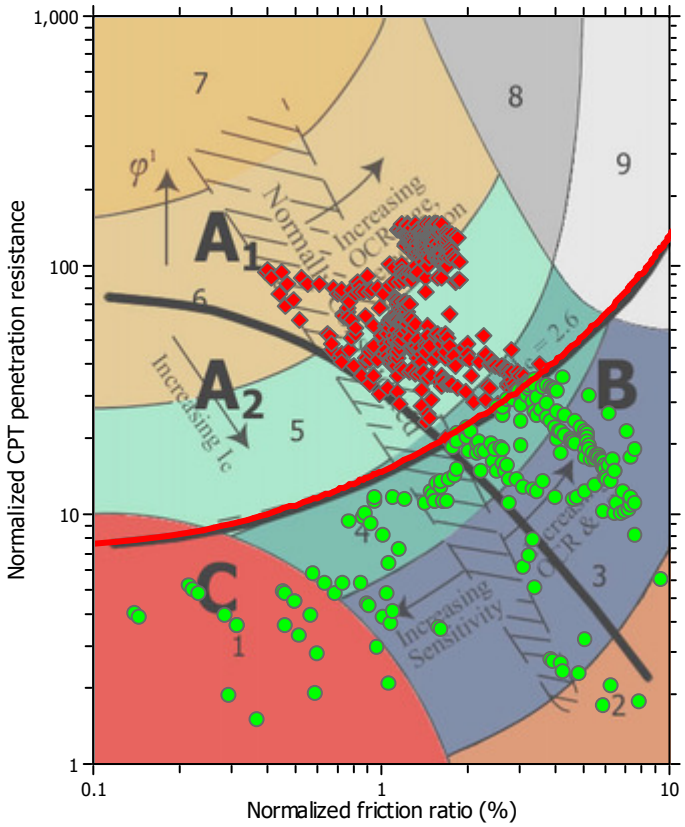
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

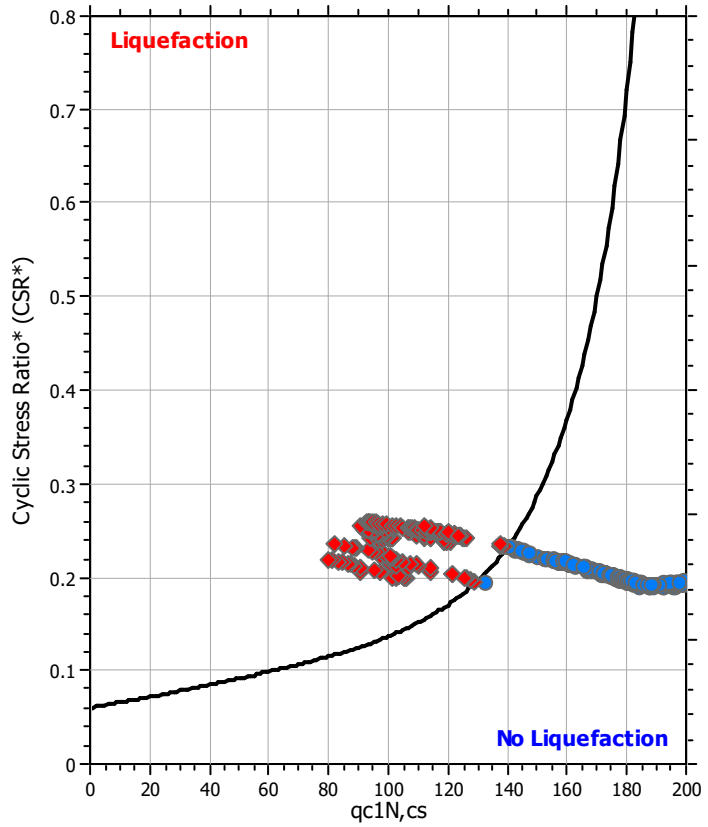
CPT: CPT03
Total depth: 15.00 m

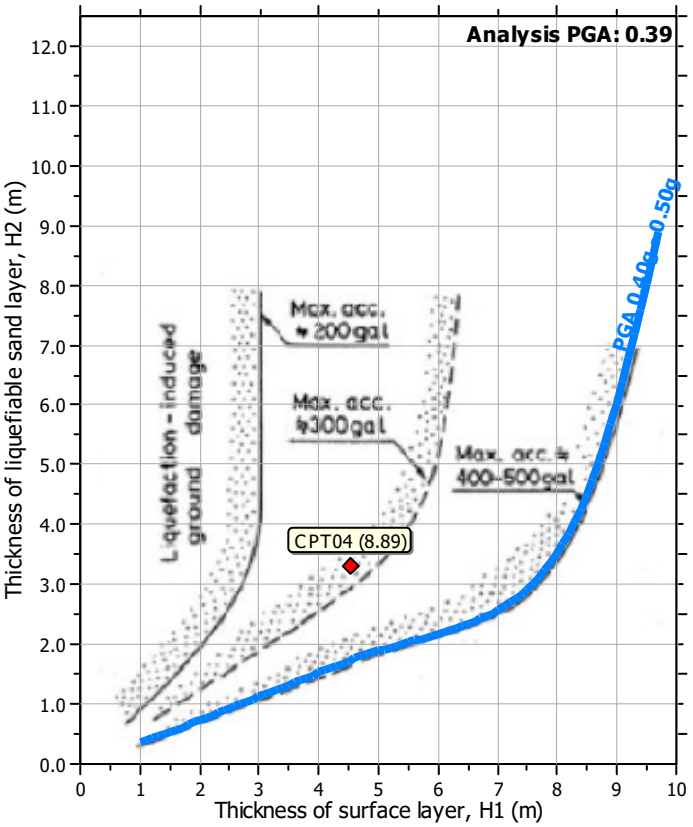


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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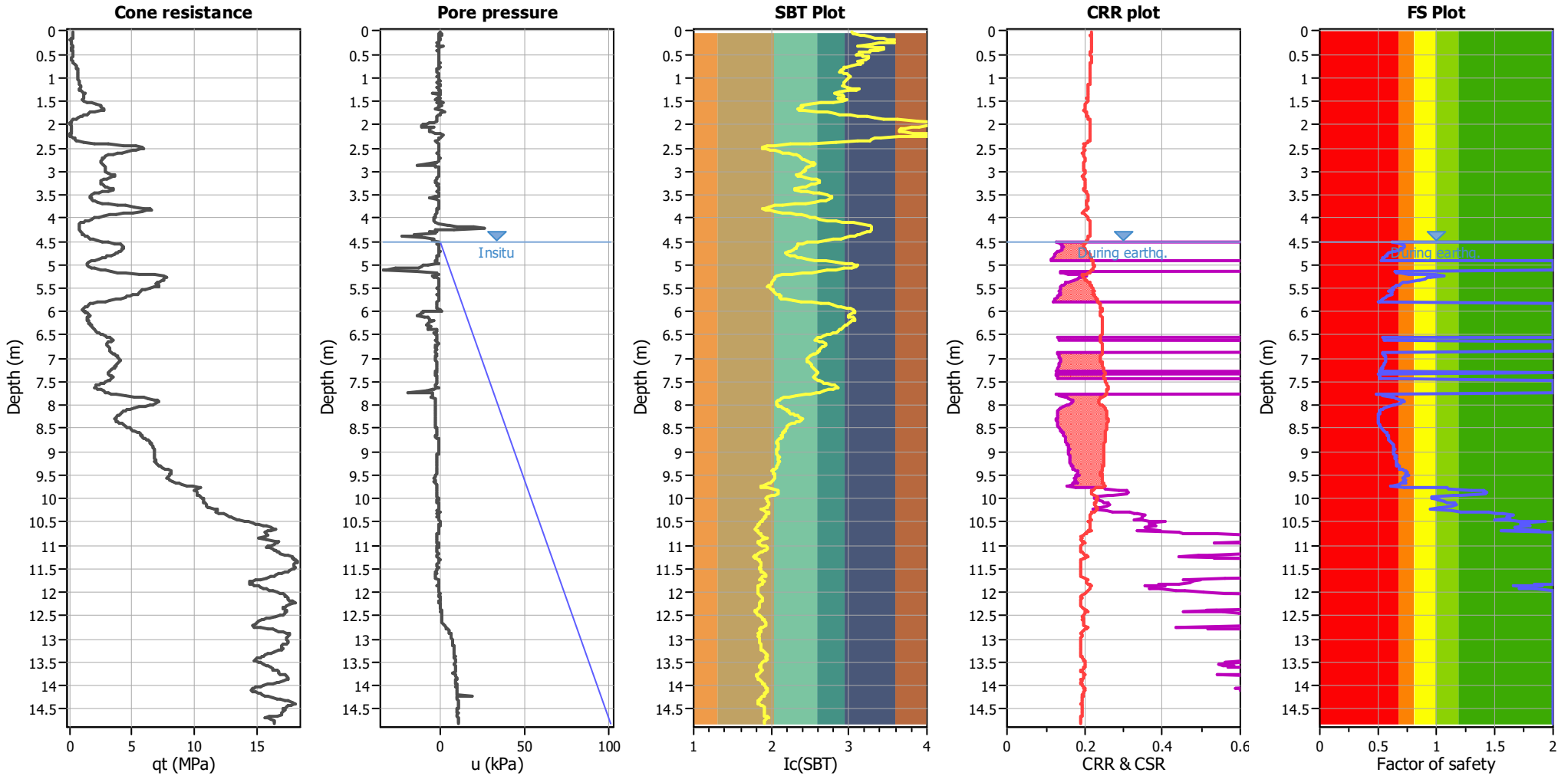
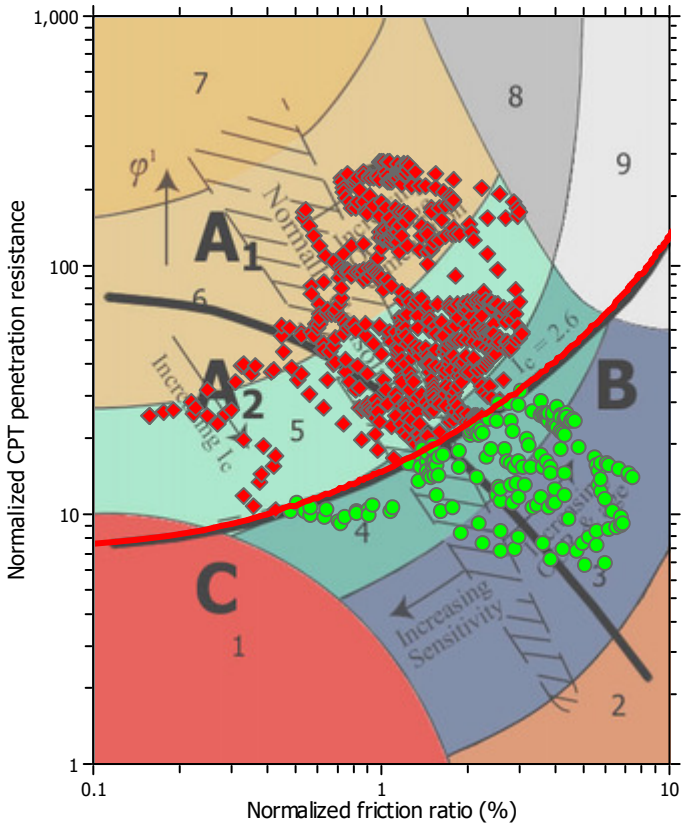
Project: Nukuhau Structure Plan
Location: Nukuhau, Taupo

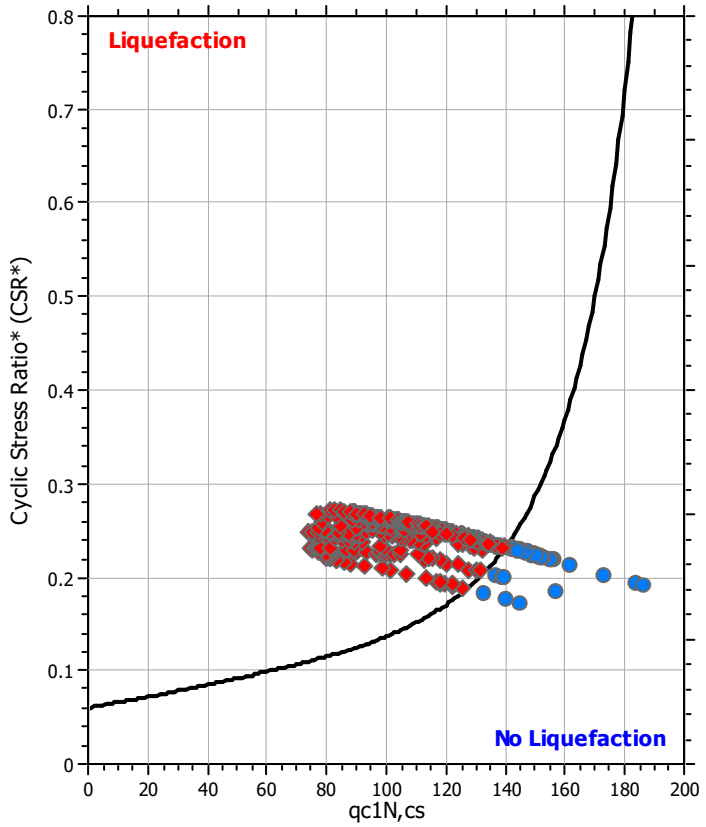
CPT: CPT04
Total depth: 14.82 m

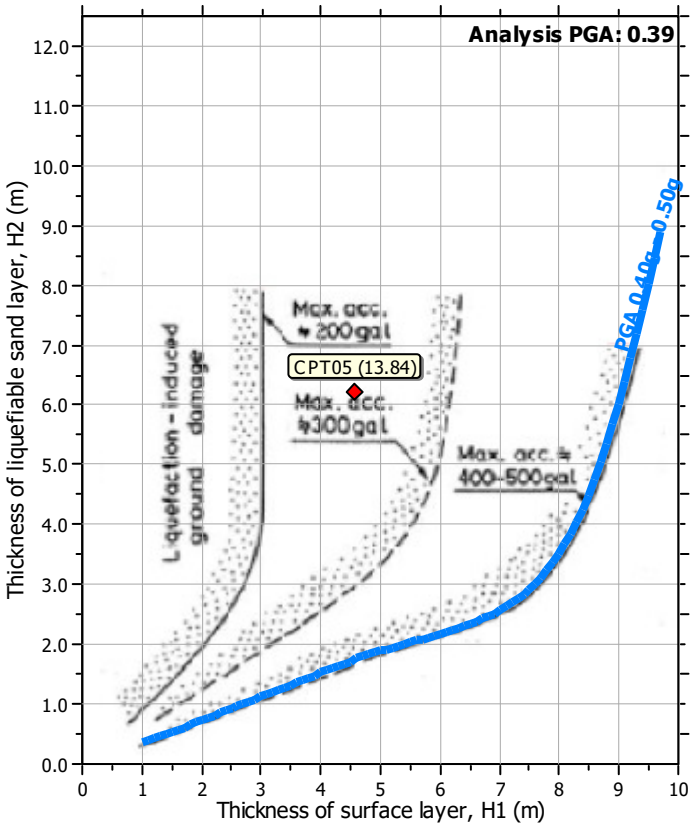


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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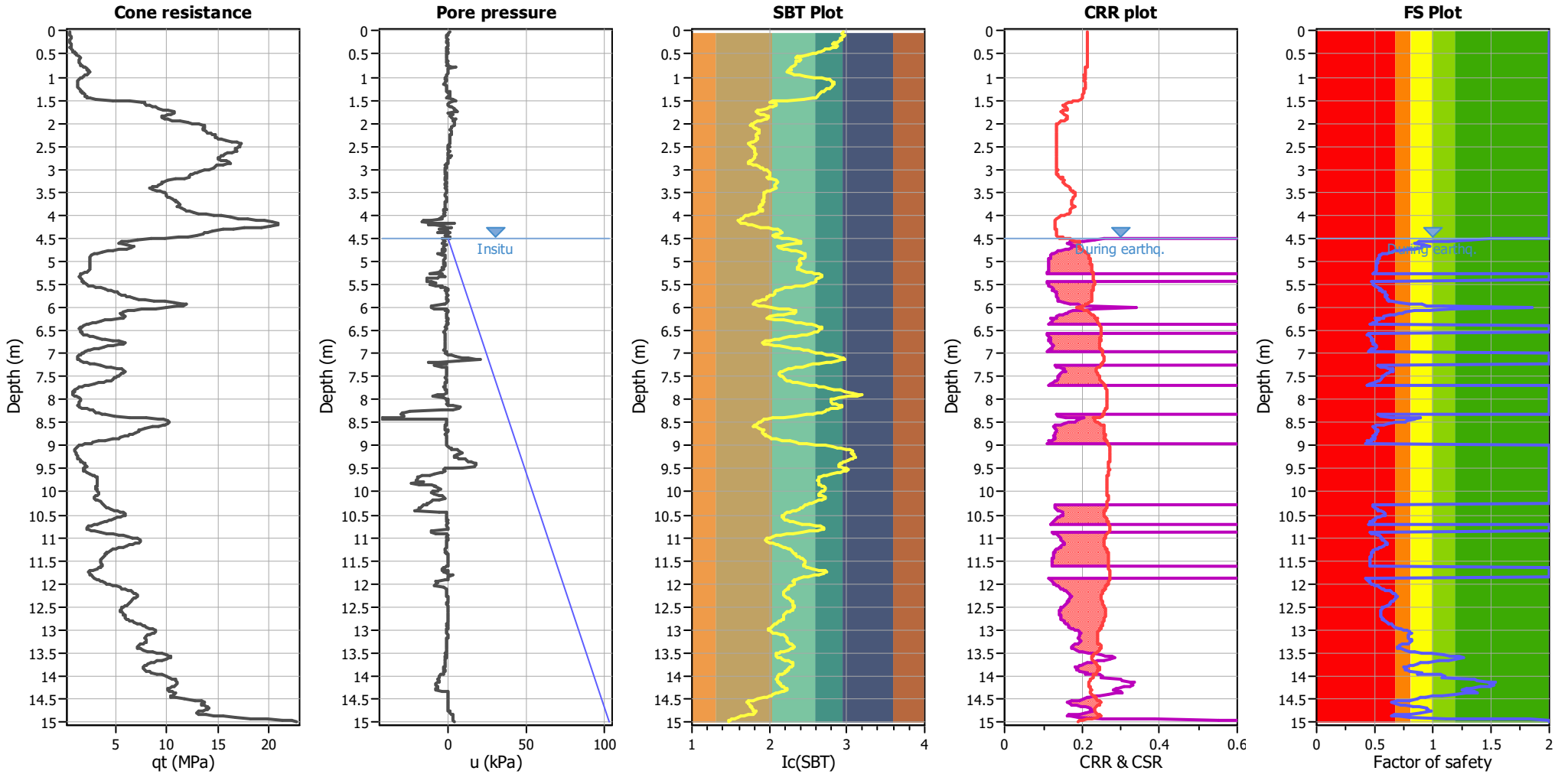
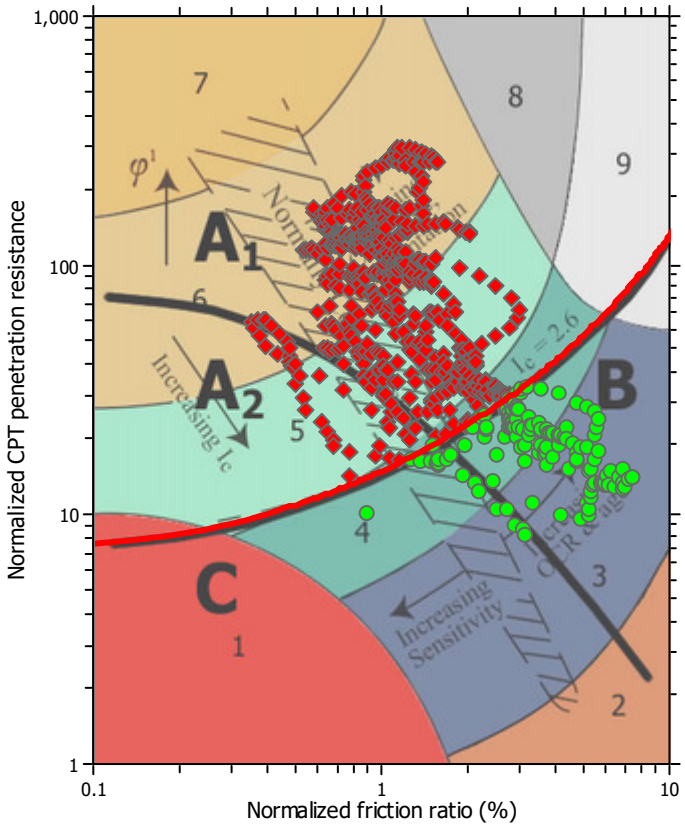
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

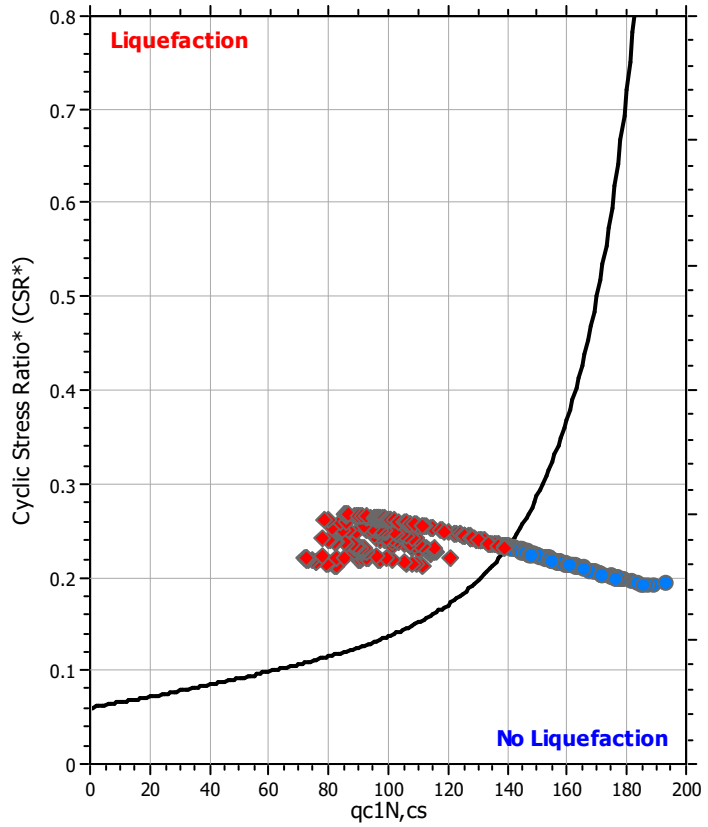
CPT: CPT05
Total depth: 15.00 m

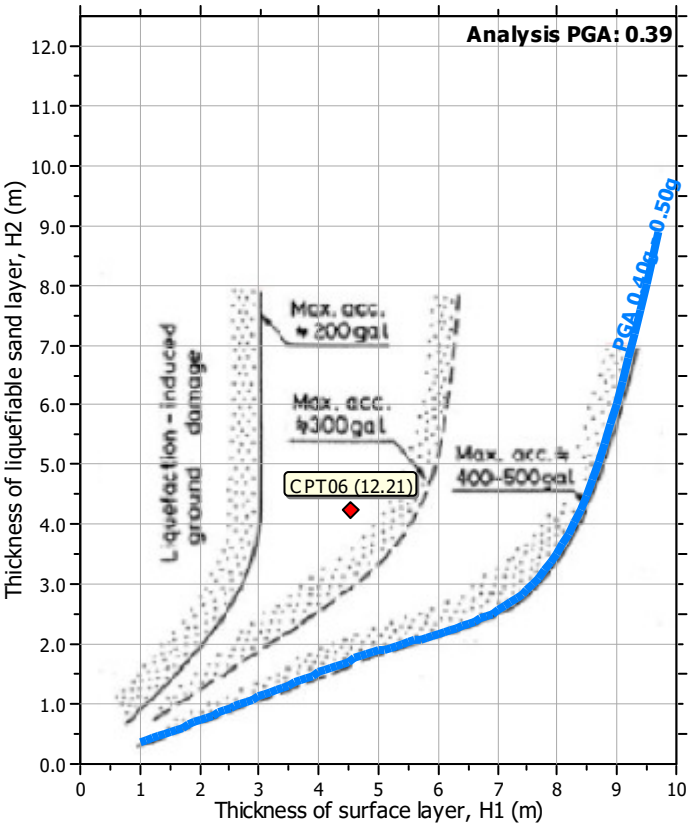


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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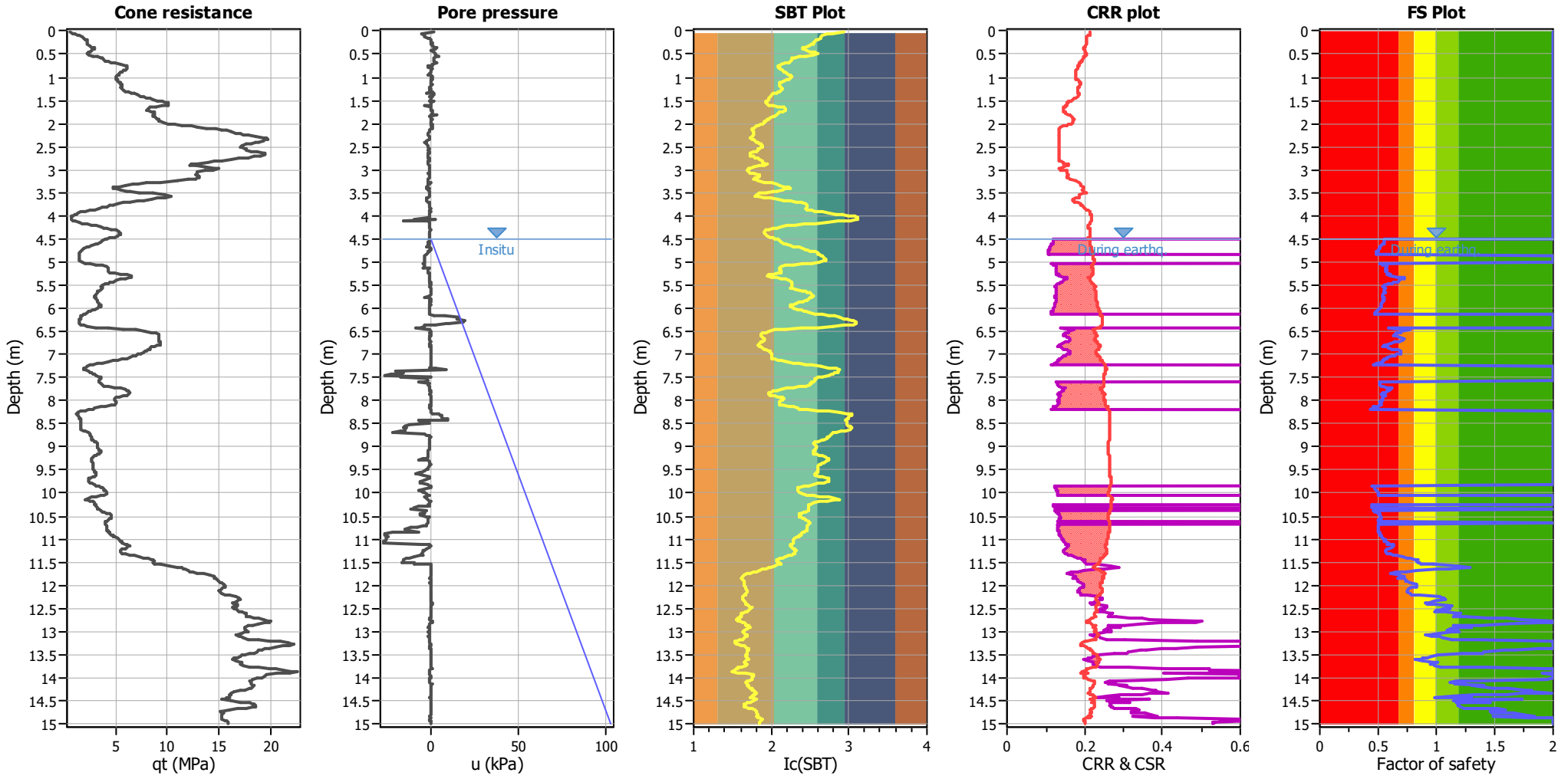
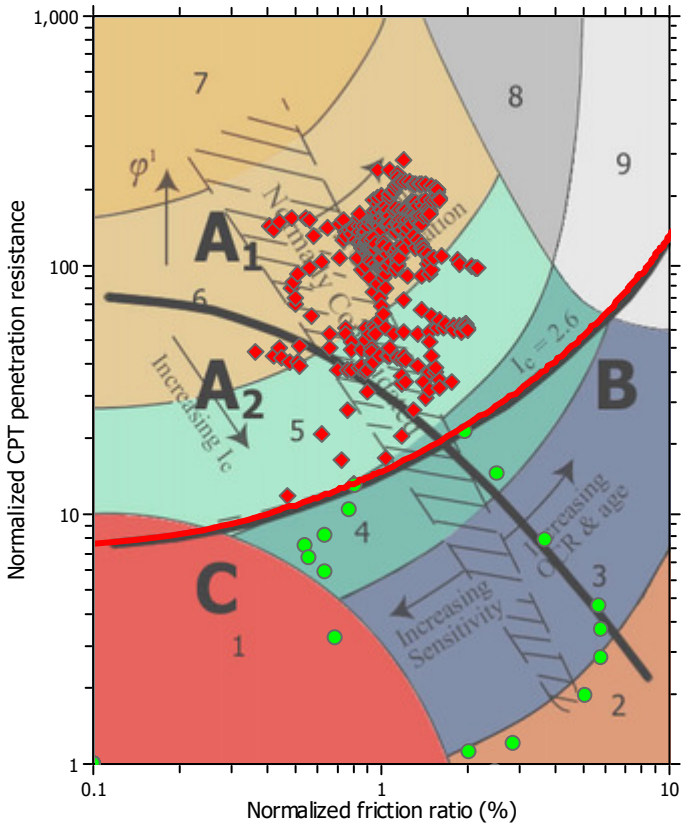
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

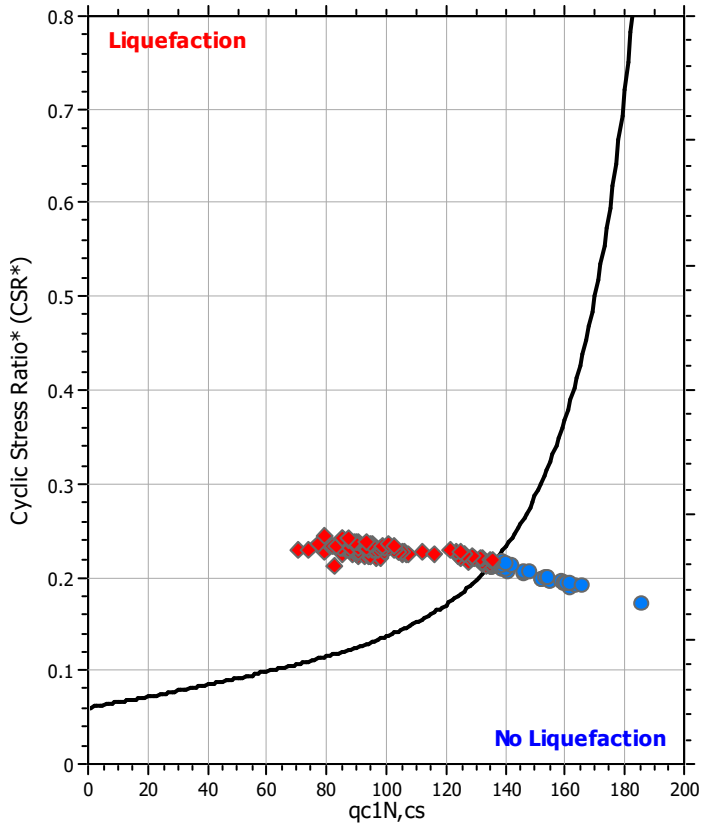
CPT: CPT06
Total depth: 15.00 m

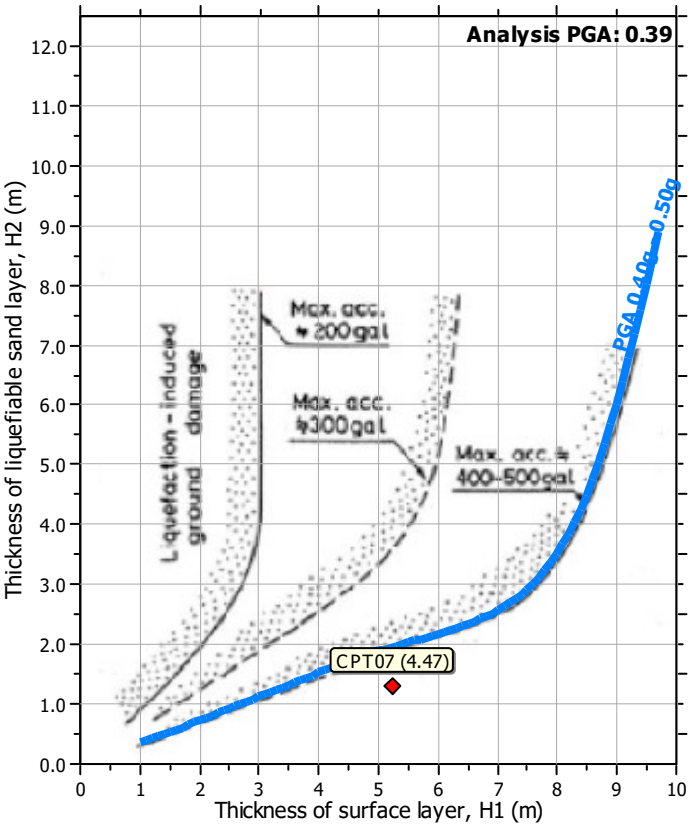


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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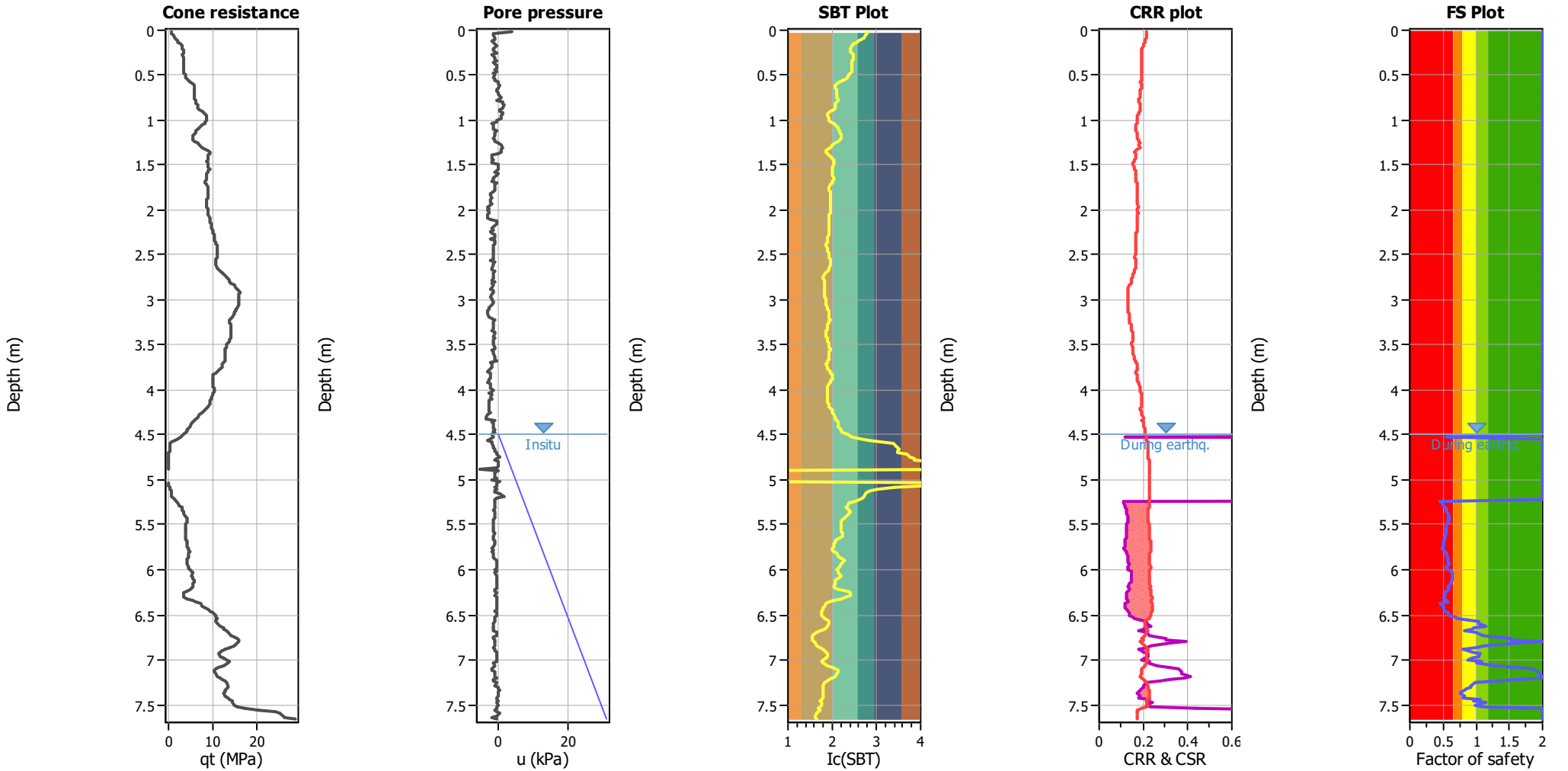
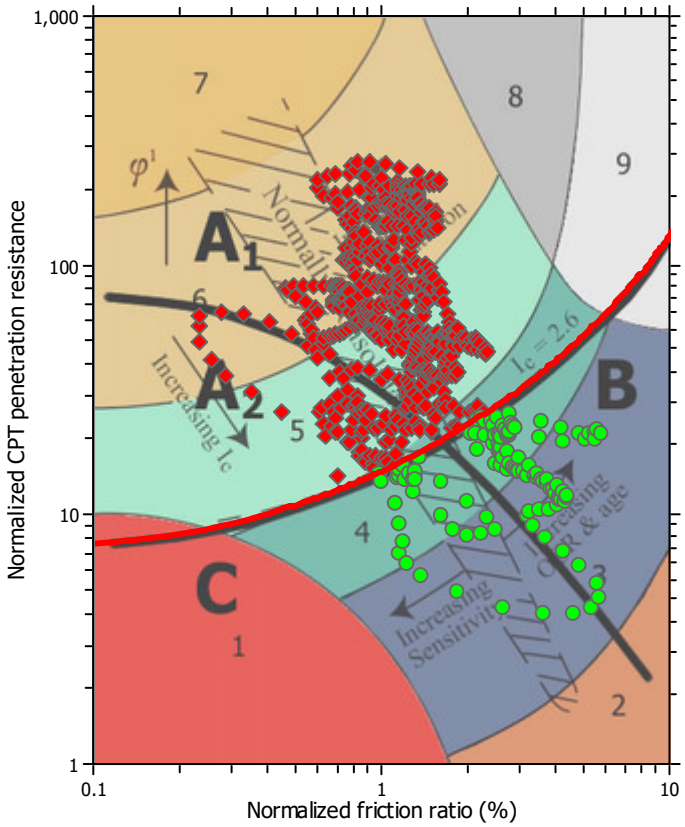
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

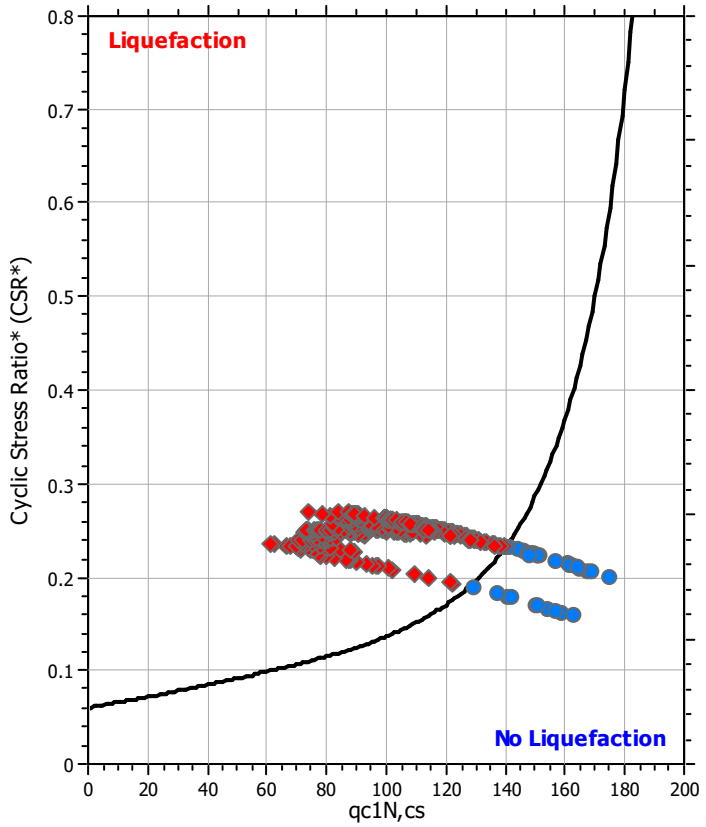
CPT: CPT07
Total depth: 7.66 m

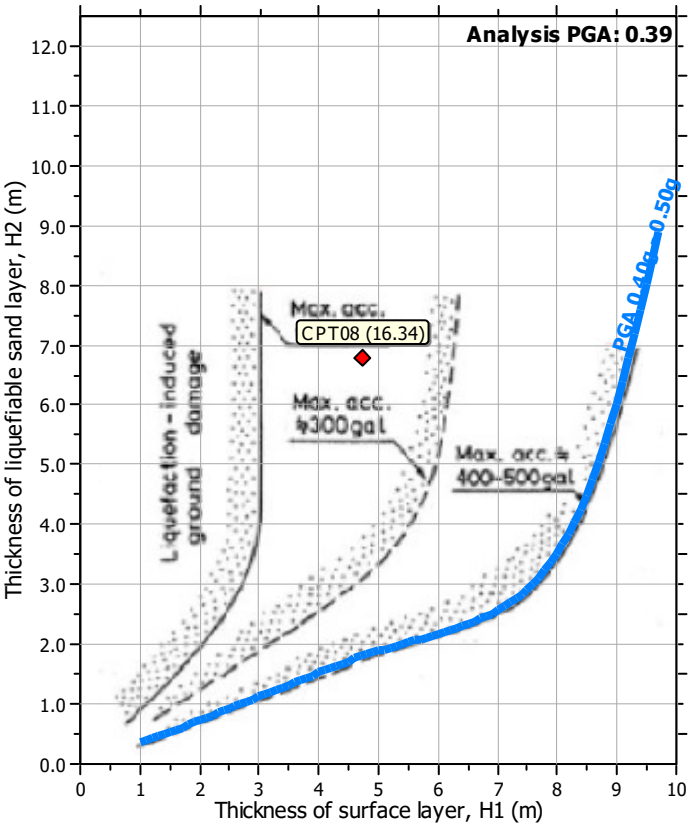


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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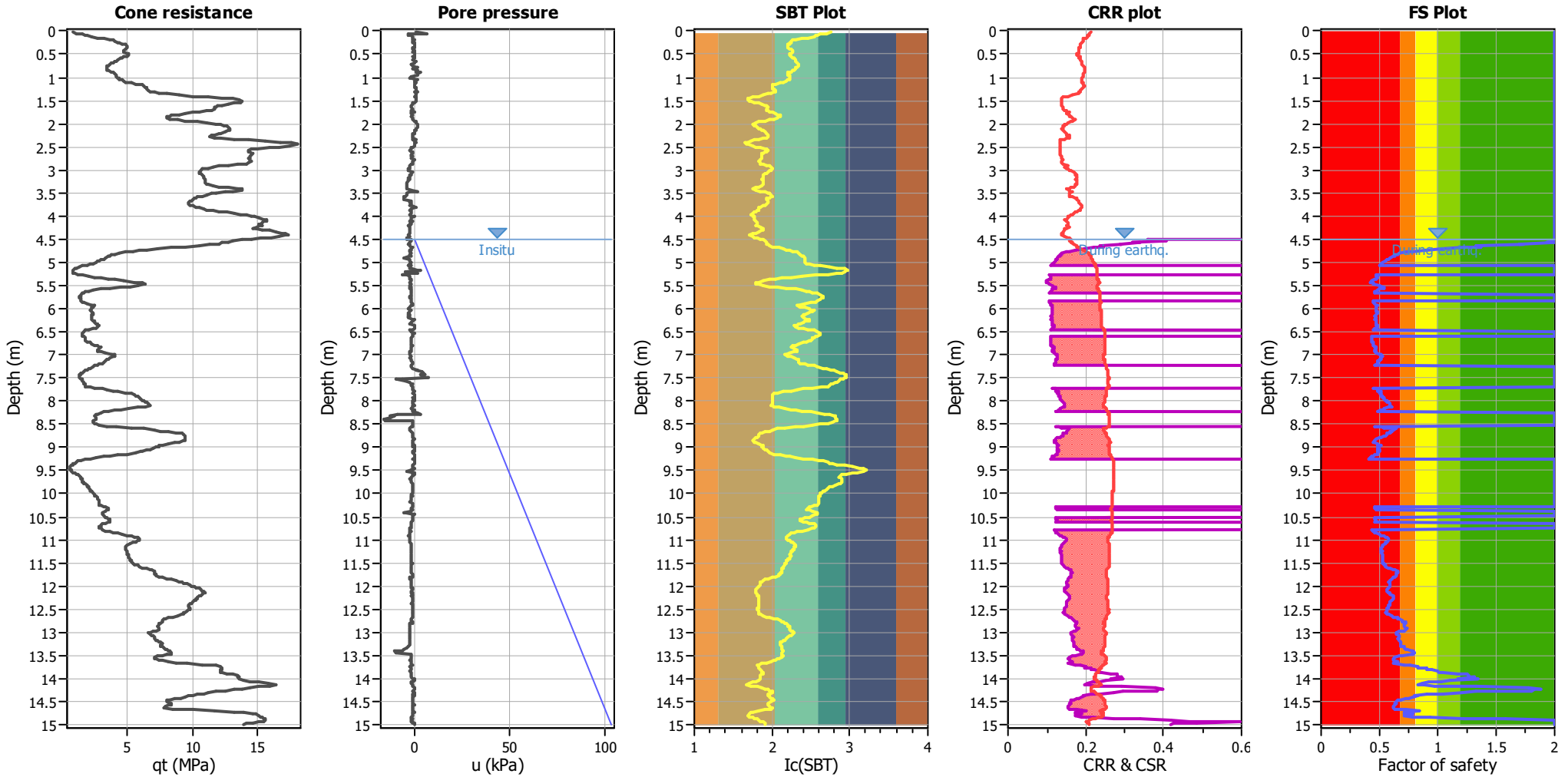
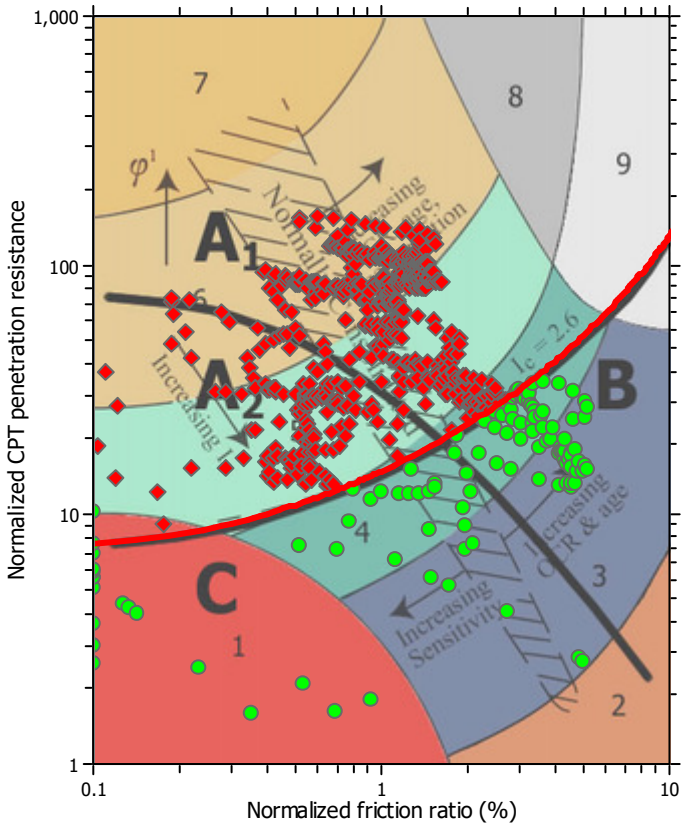
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

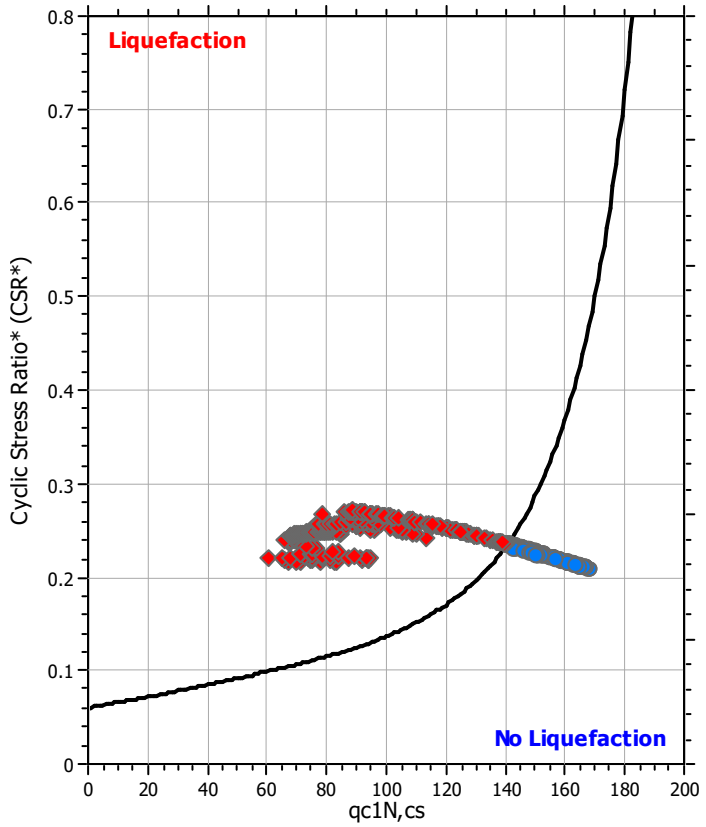
CPT: CPT08
Total depth: 15.00 m

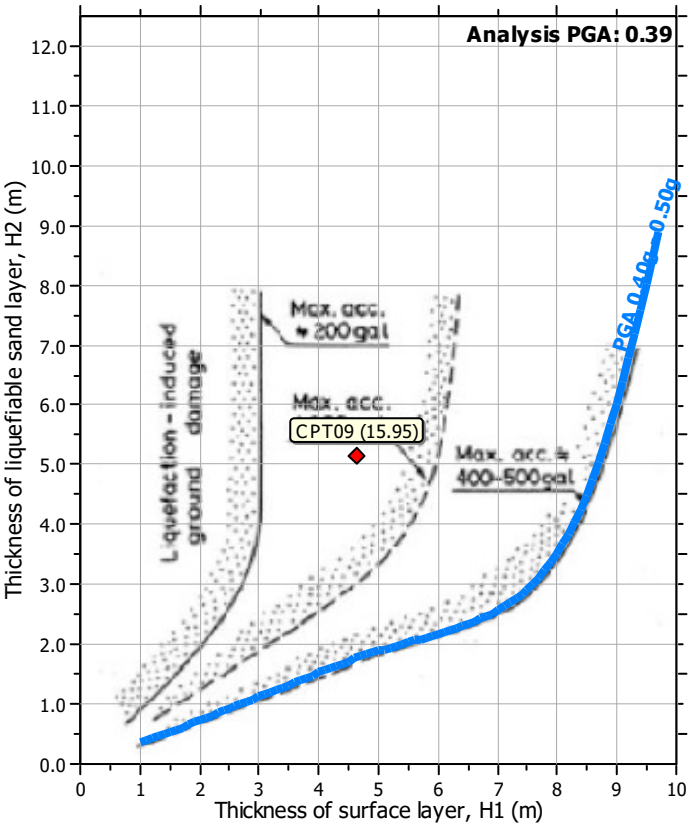


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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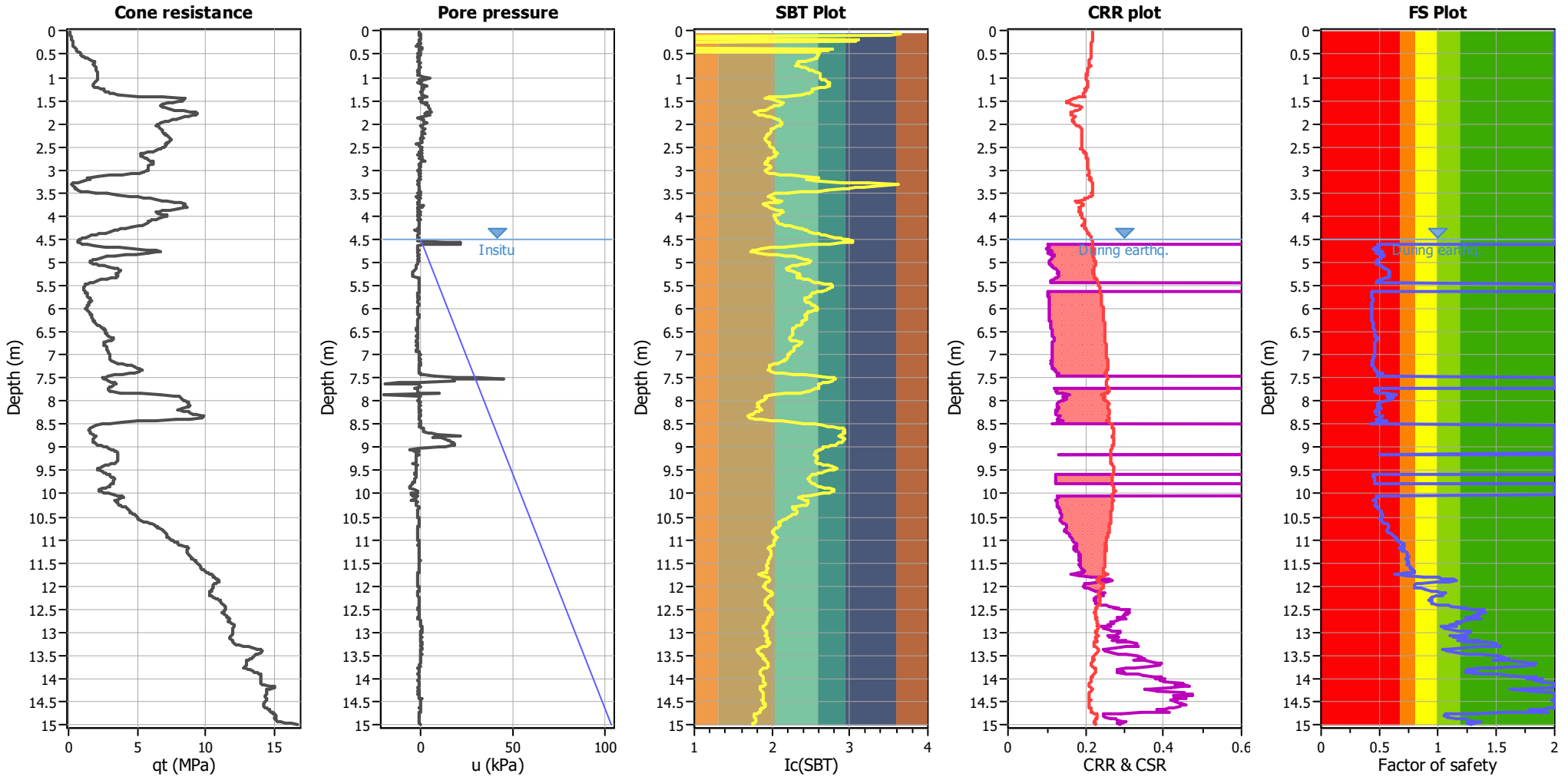
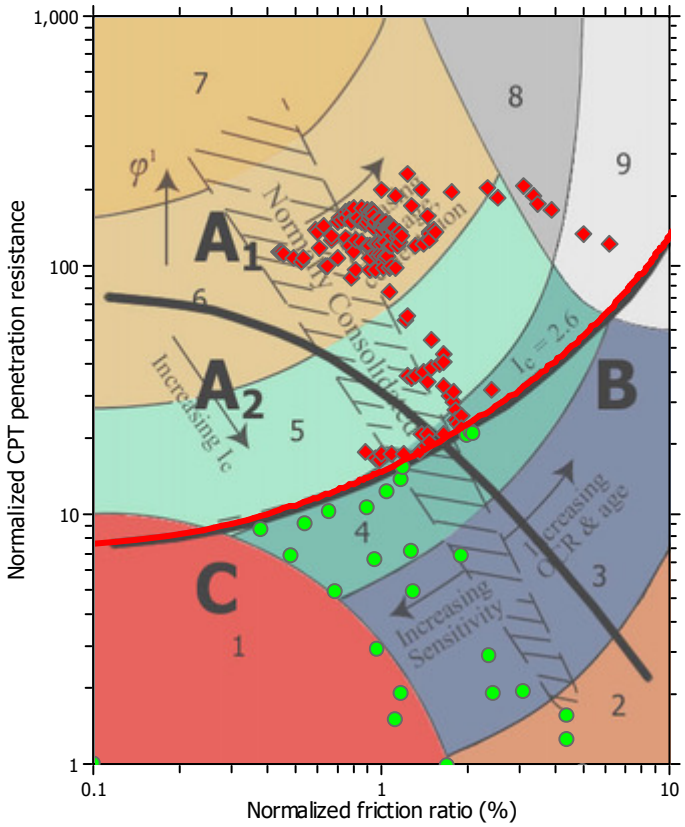
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

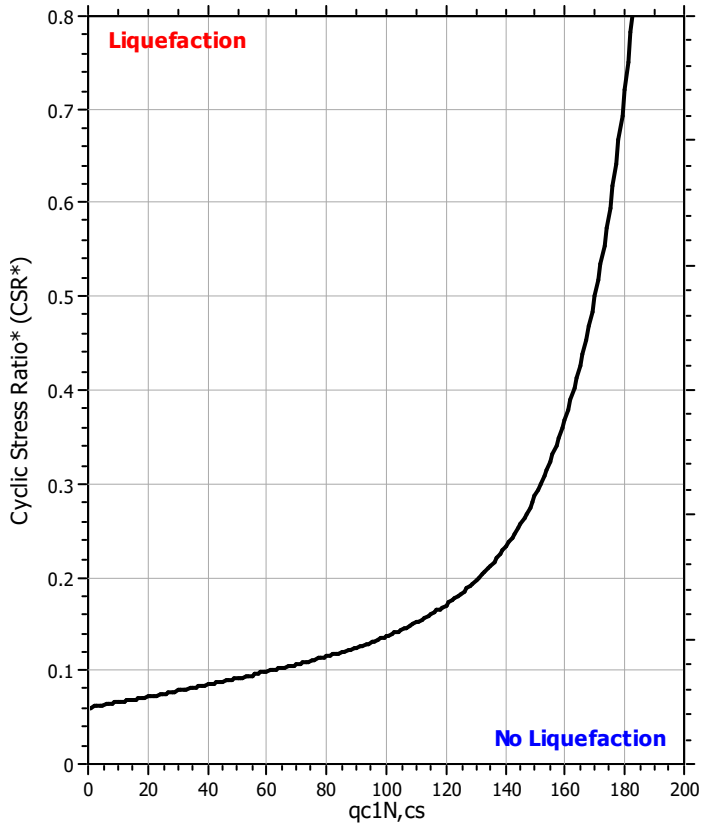
CPT: CPT09
Total depth: 15.00 m

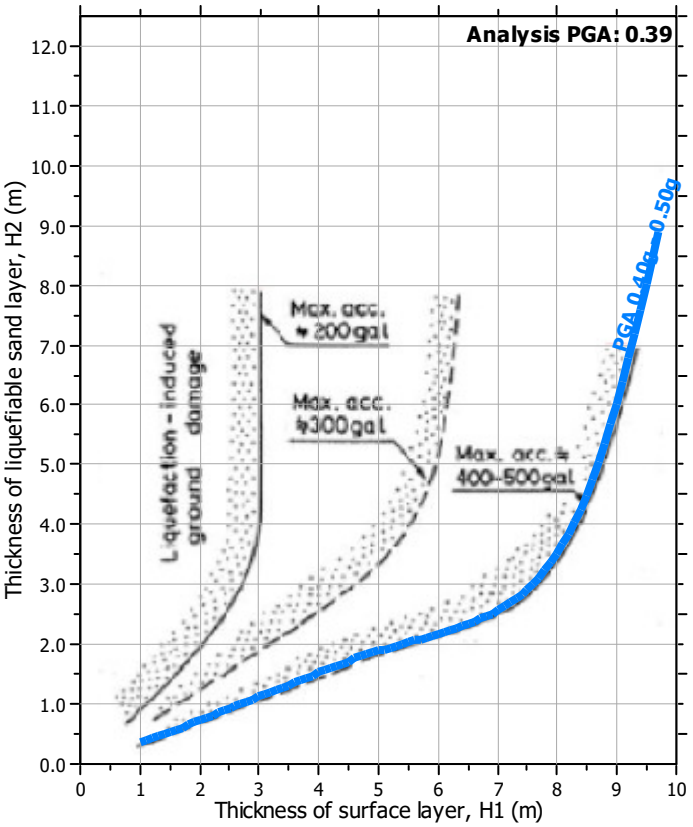


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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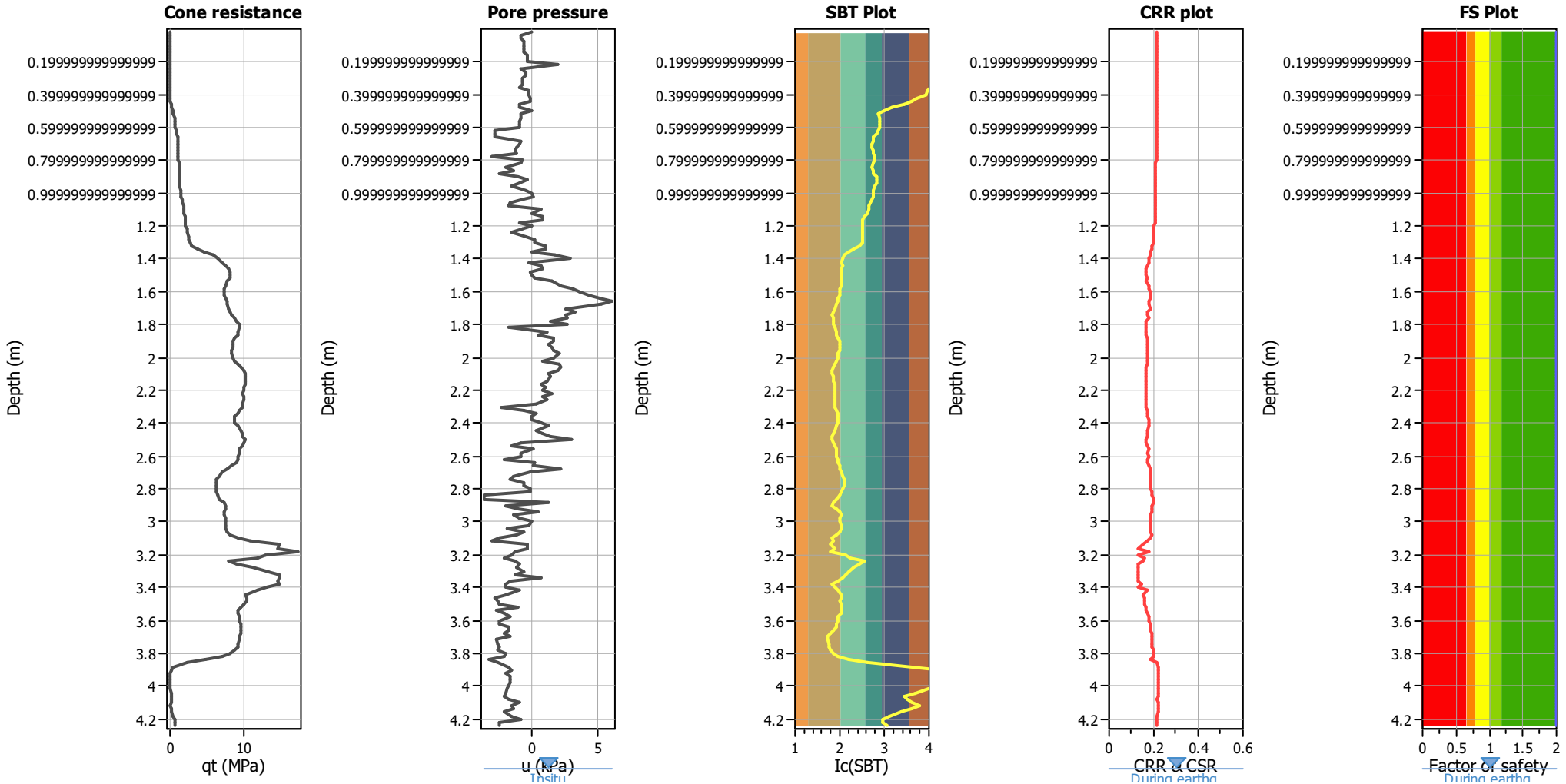
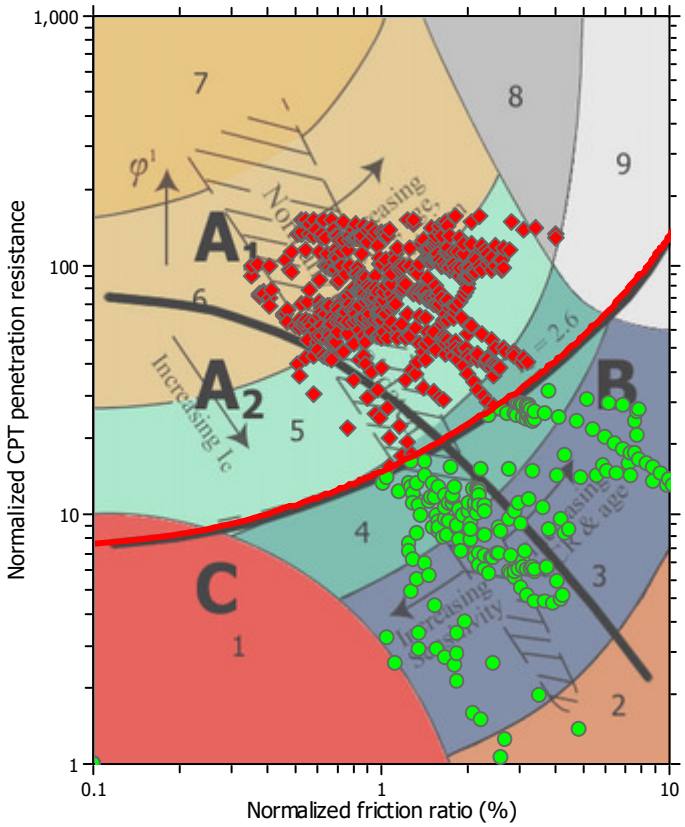
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

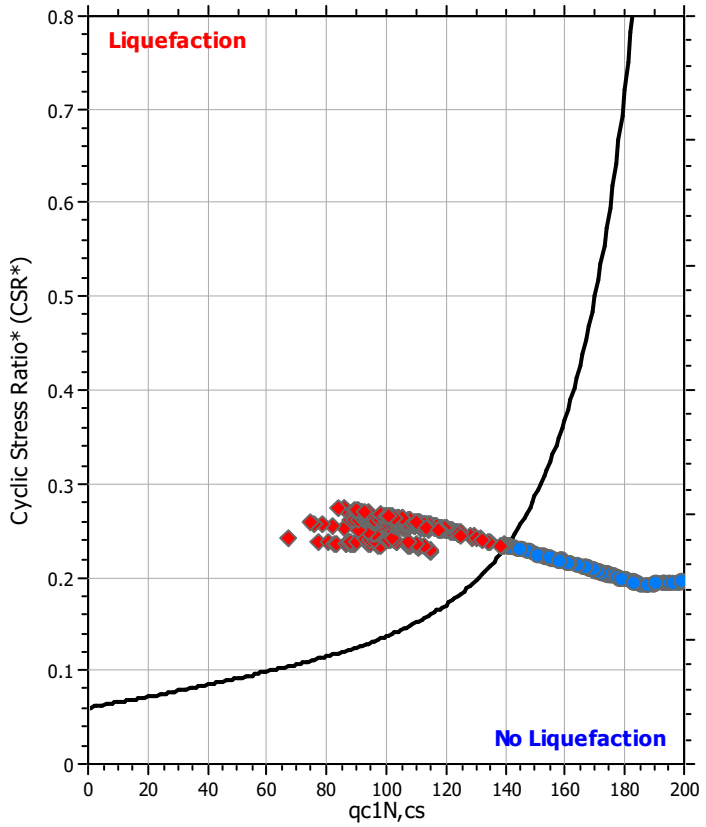
CPT: CPT10
Total depth: 4.24 m

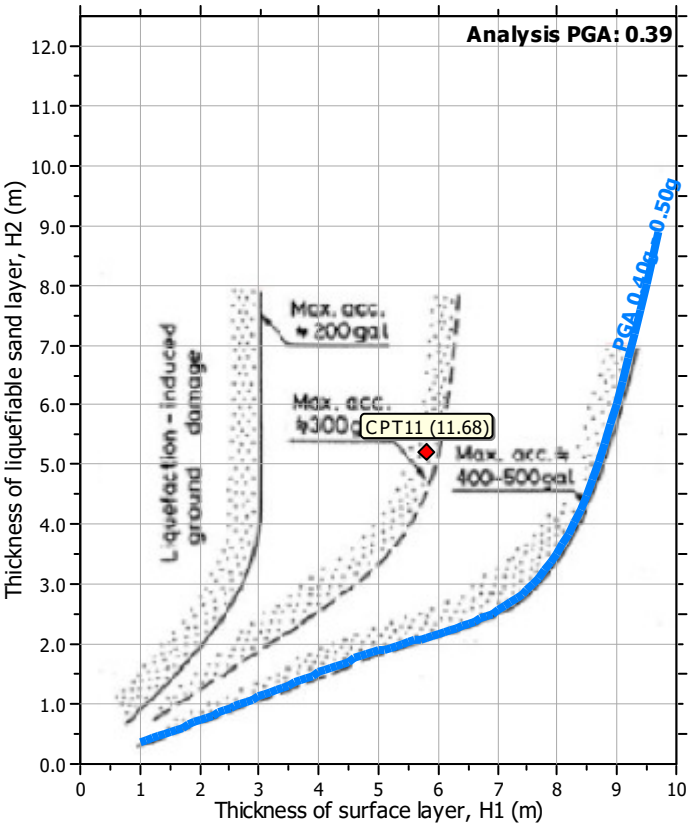


Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

Liquefaction analysis summary plots







Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWT (erthq.):	4.50 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K_σ applied:	Yes
Earthquake magnitude M_w:	6.10	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.39	Use fill:	No	Limit depth applied:	No
Depth to water table (insitu):	4.50 m	Fill height:	N/A	Limit depth:	N/A

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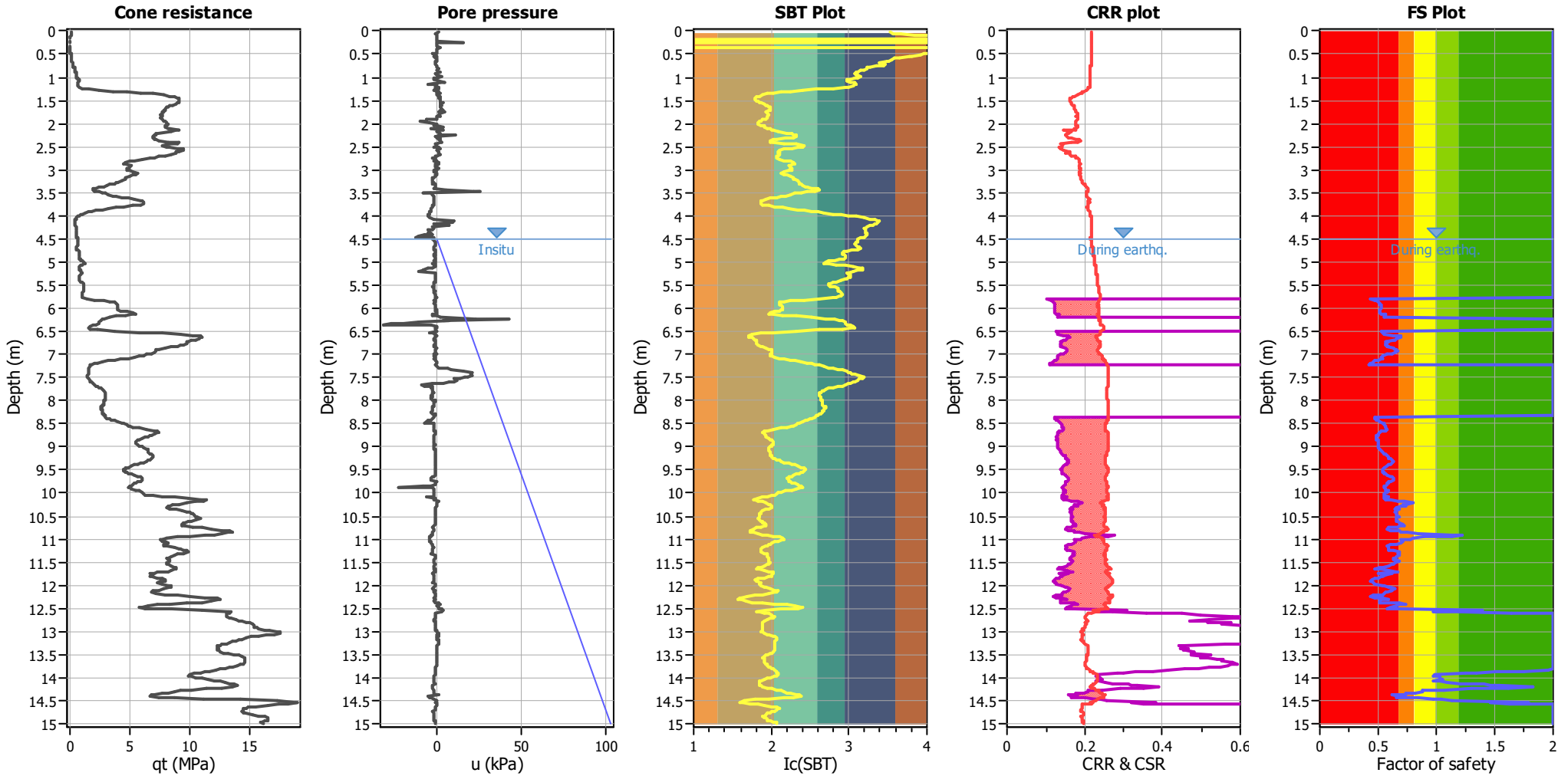
Project: **Nukuhau Structure Plan**
Location: **Nukuhau, Taupo**

CPT: CPT11
Total depth: 15.00 m



Analysis method:	B&I (2014)	G.W.T. (in-situ):	4.50 m	Use fill:	No	Clay like behavior applied:	.
Fines correction method:	B&I (2014)	G.W.T. (earthq.):	4.50 m	Fill height:	N/A	Limit depth applied:	No
Points to test:	Based on Ic value	Average results interval:	3	Fill weight:	N/A	Limit depth:	N/A
Earthquake magnitude M_w:	6.10	Ic cut-off value:	2.60	Trans. detect. applied:	No	MSF method:	Method based
Peak ground acceleration:	0.39	Unit weight calculation:	Based on SBT	K_σ applied:	Yes		

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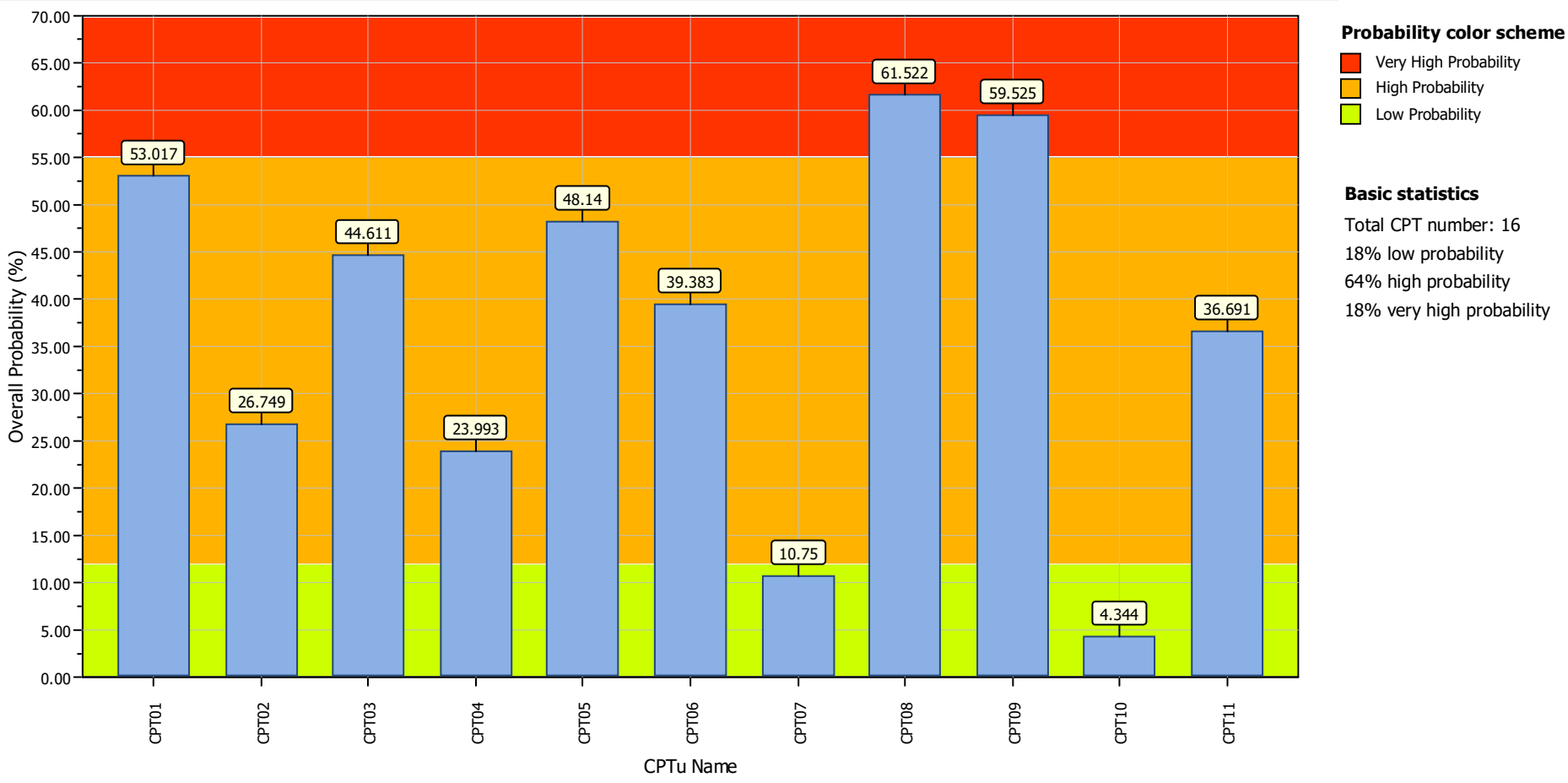
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall Probability for Liquefaction report



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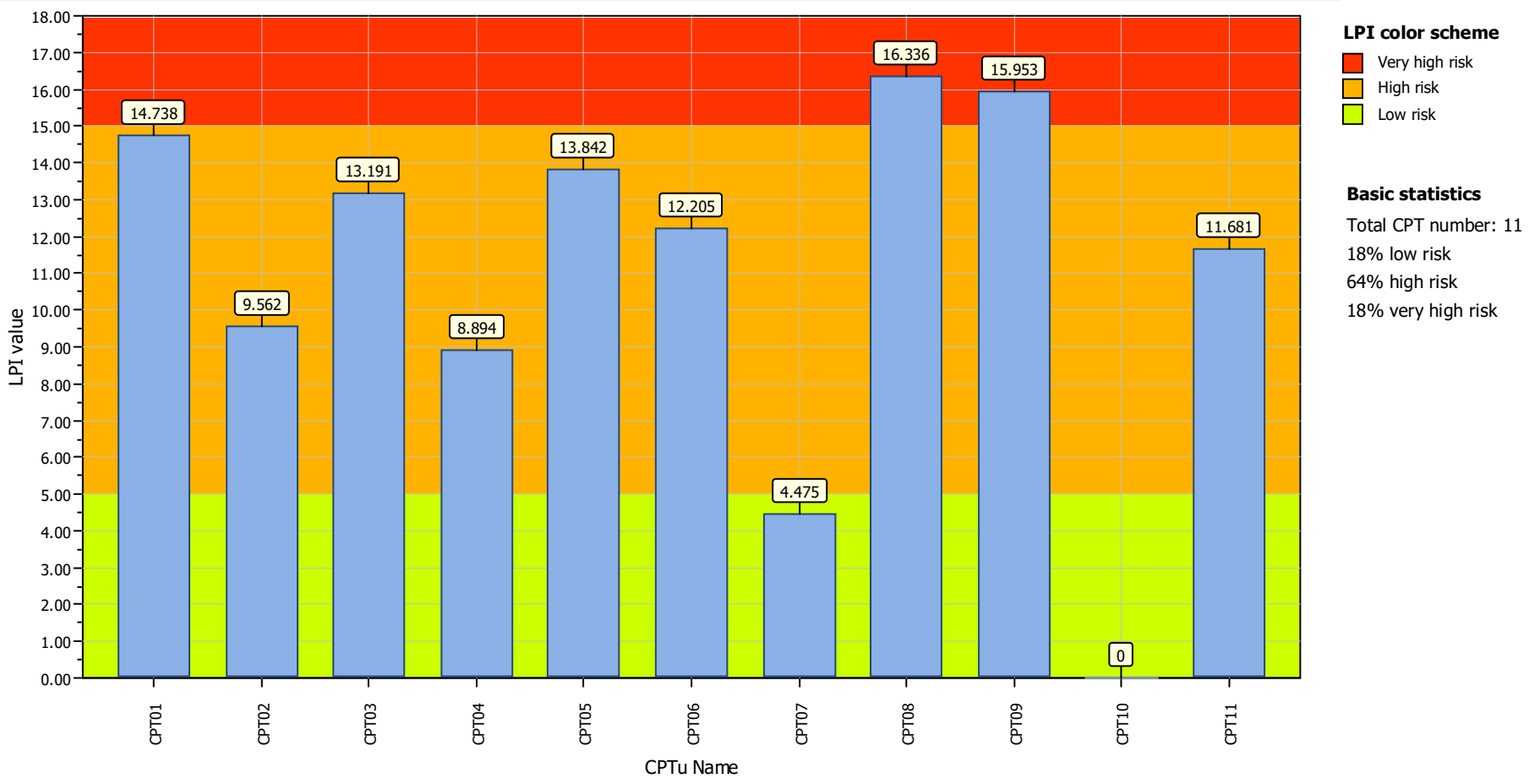
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall Liquefaction Potential Index report



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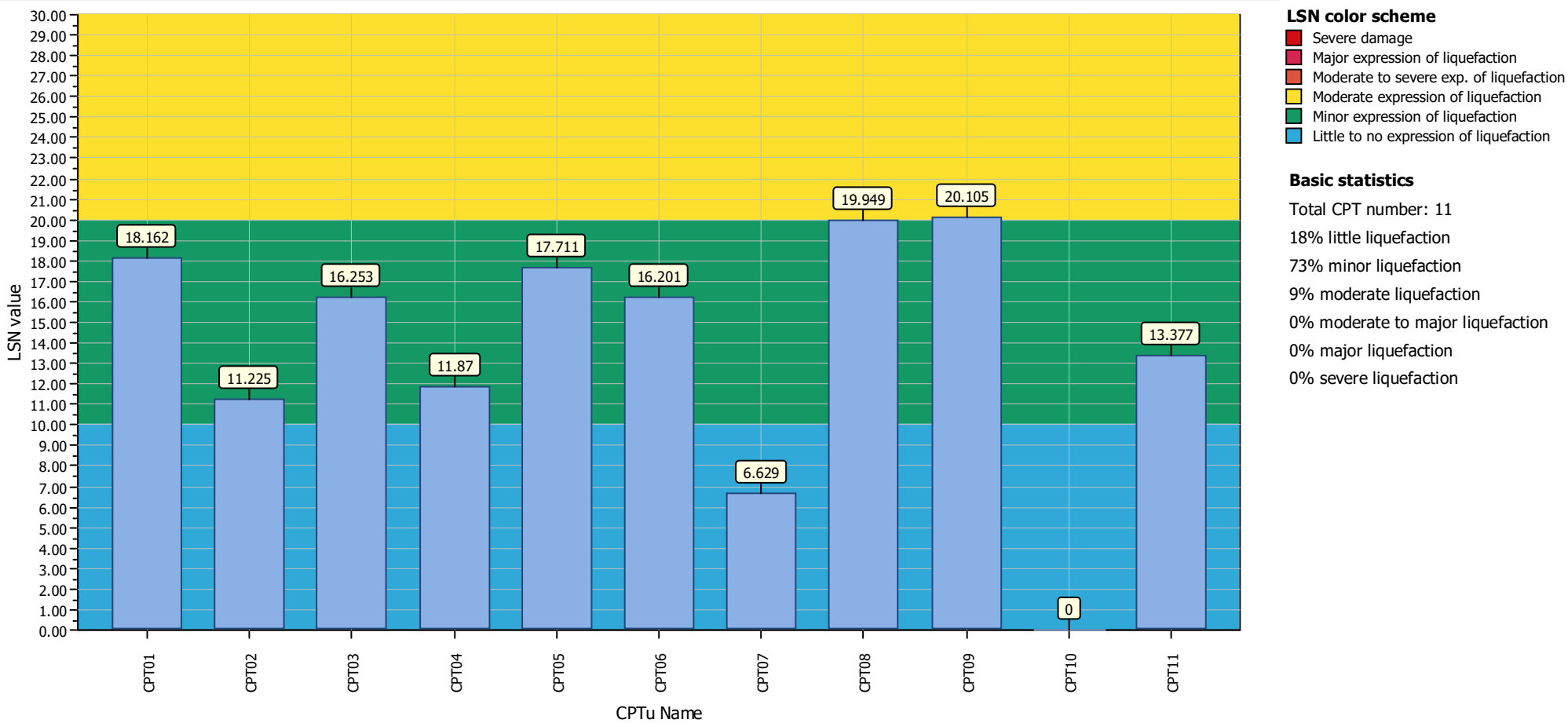
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

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: 11

18% little liquefaction

73% minor liquefaction

9% moderate liquefaction

0% moderate to major liquefaction

0% major liquefaction

0% severe liquefaction

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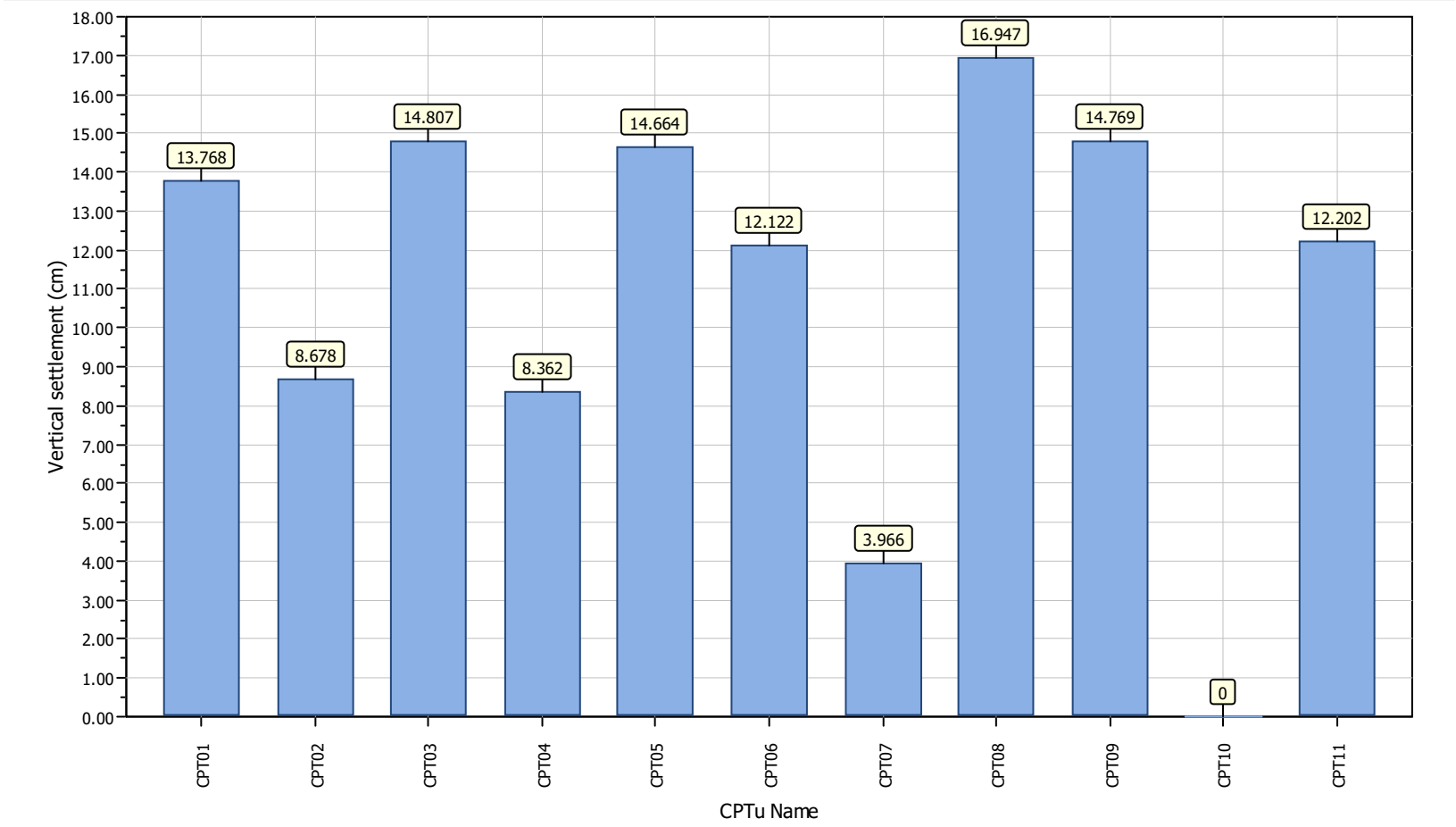
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall vertical settlements report



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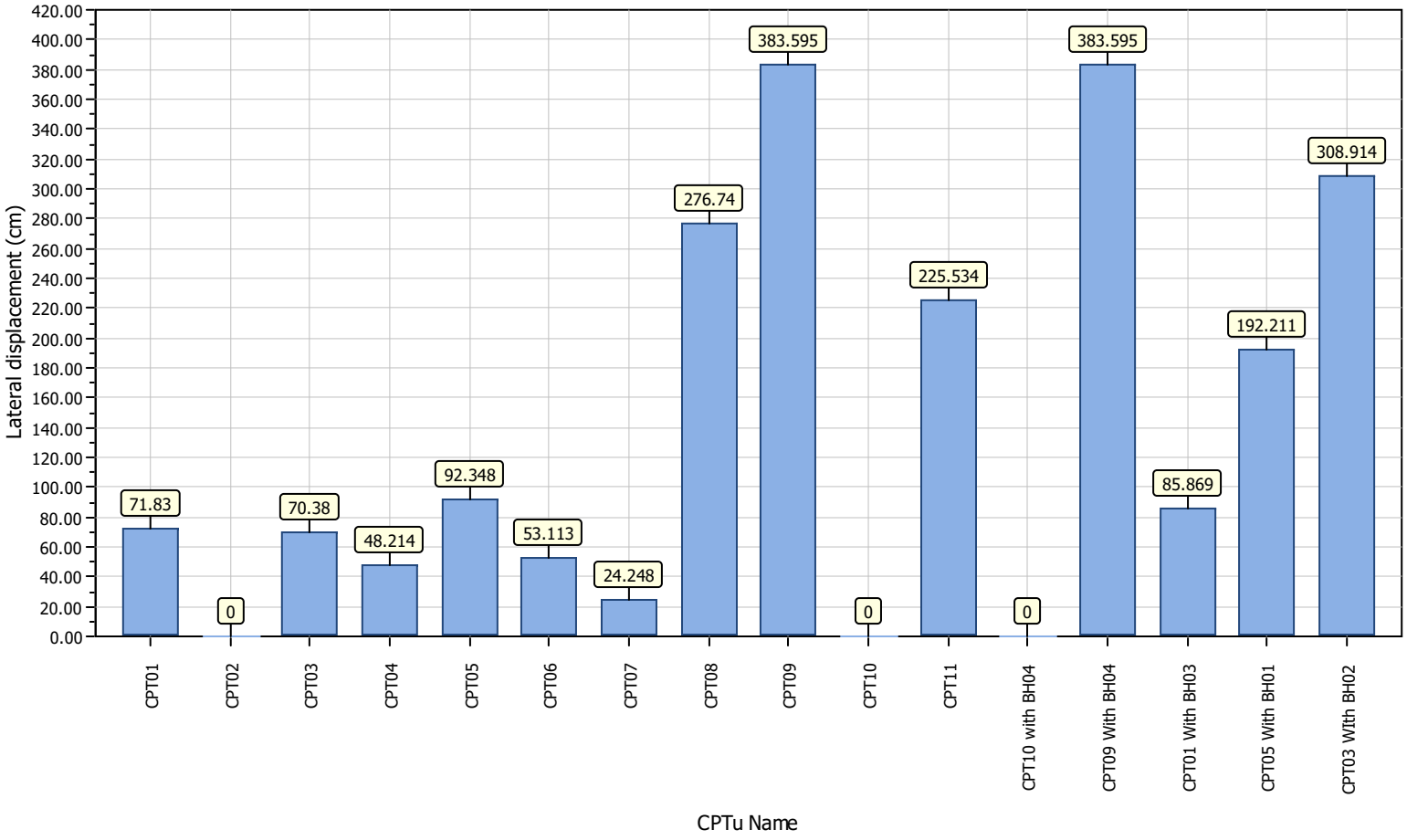
Project title : Nukuhau Structure Plan

Location : Nukuhau, Taupo

Overall lateral displacements report



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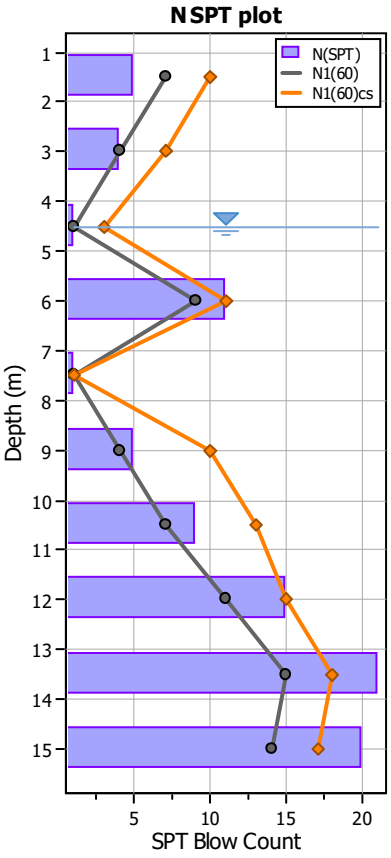
SPT BASED LIQUEFACTION ANALYSIS REPORT

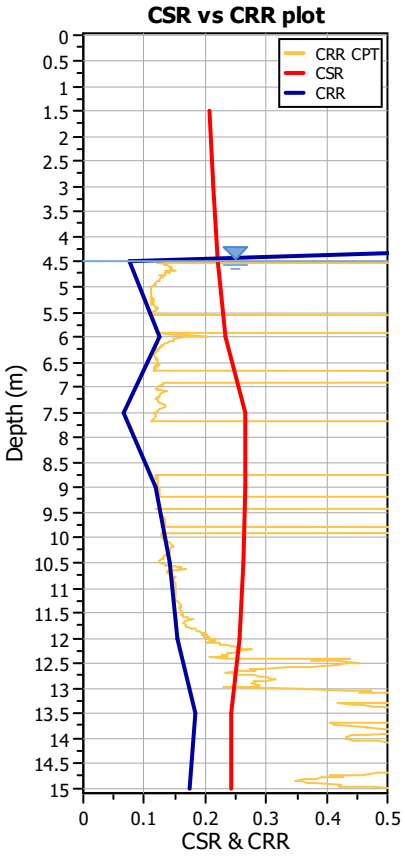
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

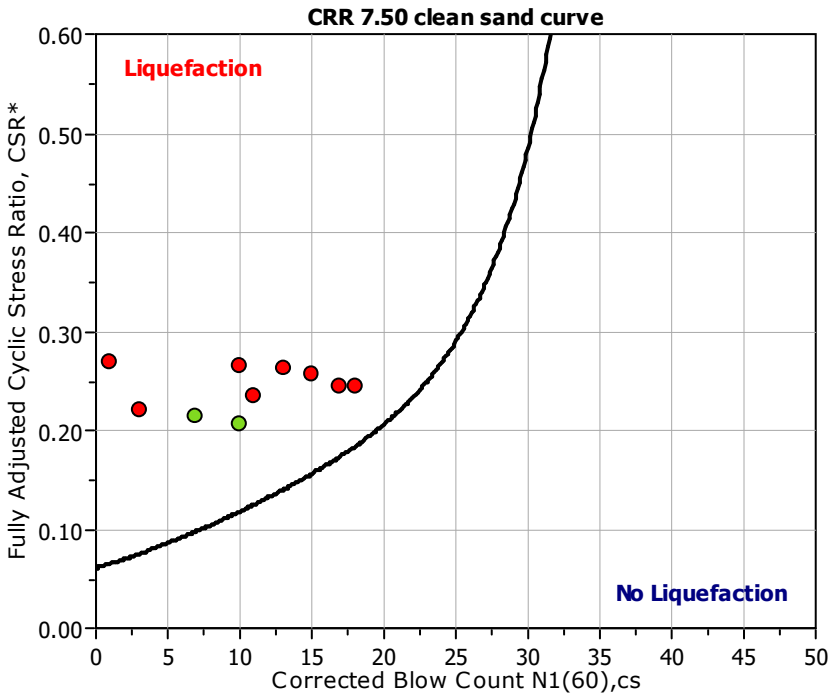
Borehole Name : BH03

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	4.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	4.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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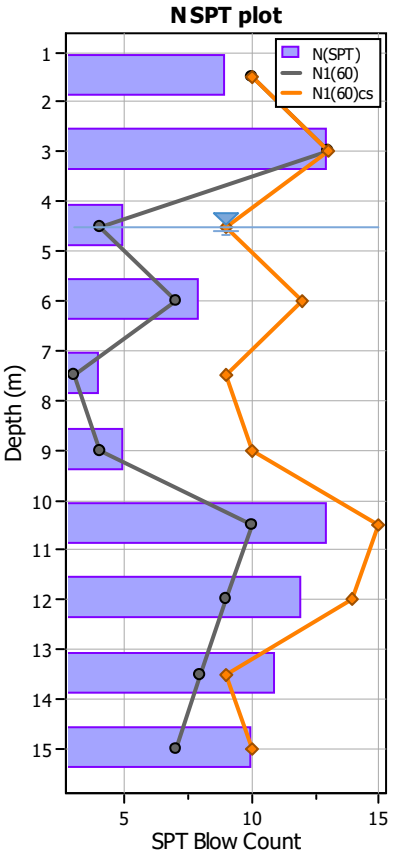
SPT BASED LIQUEFACTION ANALYSIS REPORT

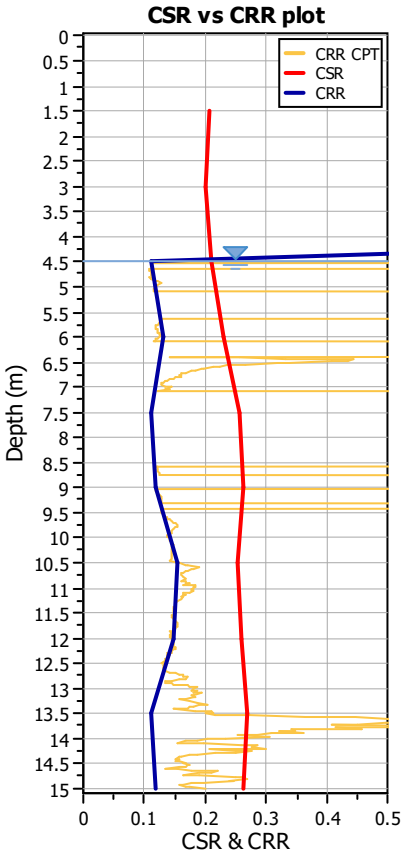
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

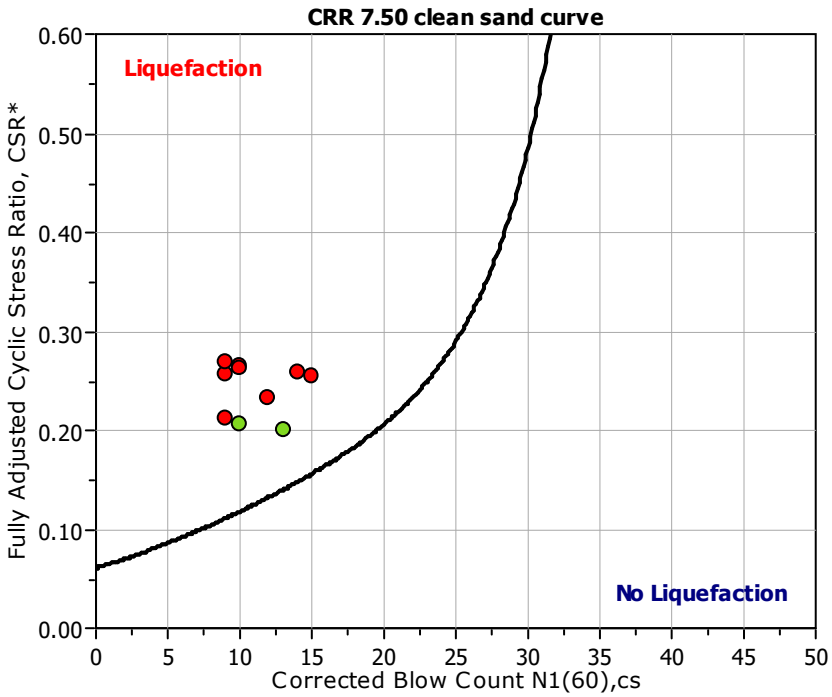
Borehole Name : BH02

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	4.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	4.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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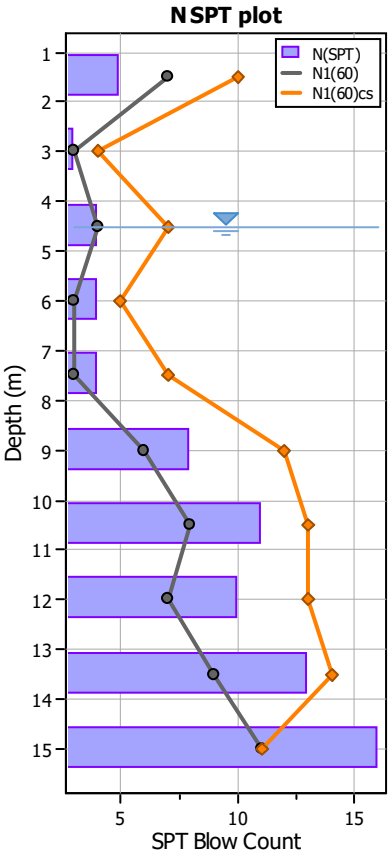
SPT BASED LIQUEFACTION ANALYSIS REPORT

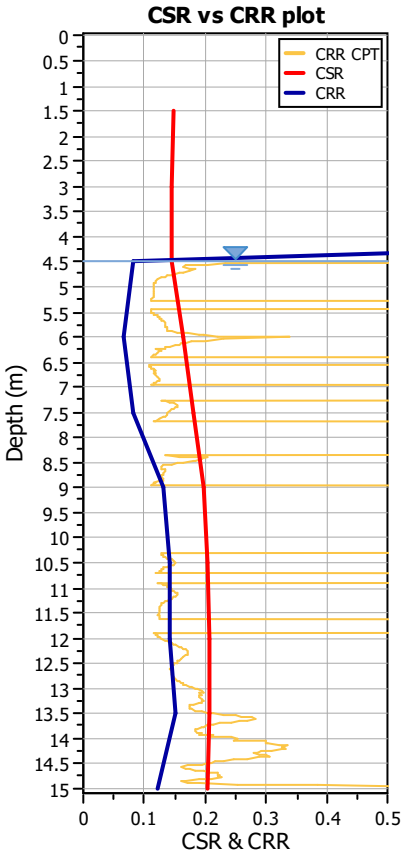
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

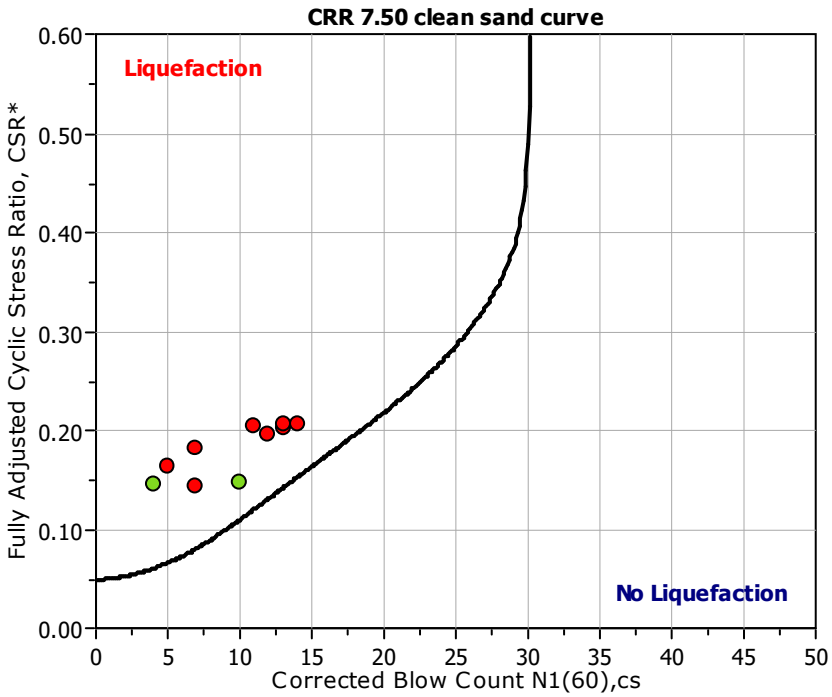
Borehole Name : BH01

:: Input parameters and analysis properties ::

Analysis method:	NCEER 1998	G.W.T. (in-situ):	4.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Seed	G.W.T. (earthq.):	4.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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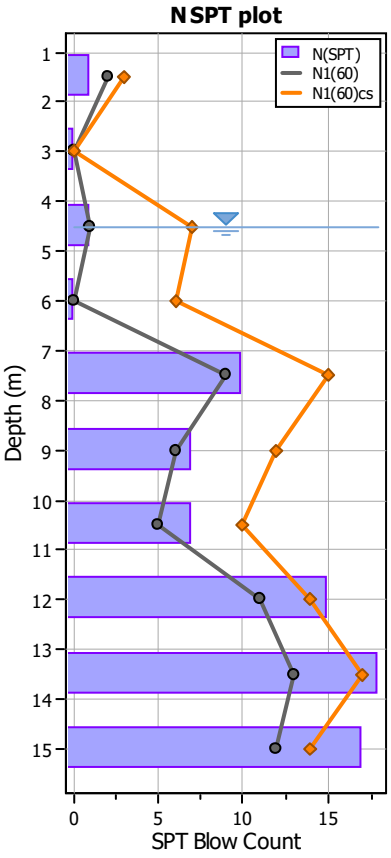
SPT BASED LIQUEFACTION ANALYSIS REPORT

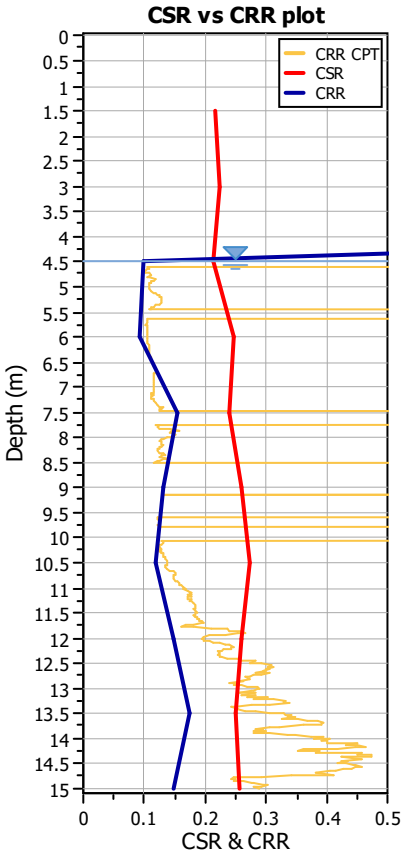
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

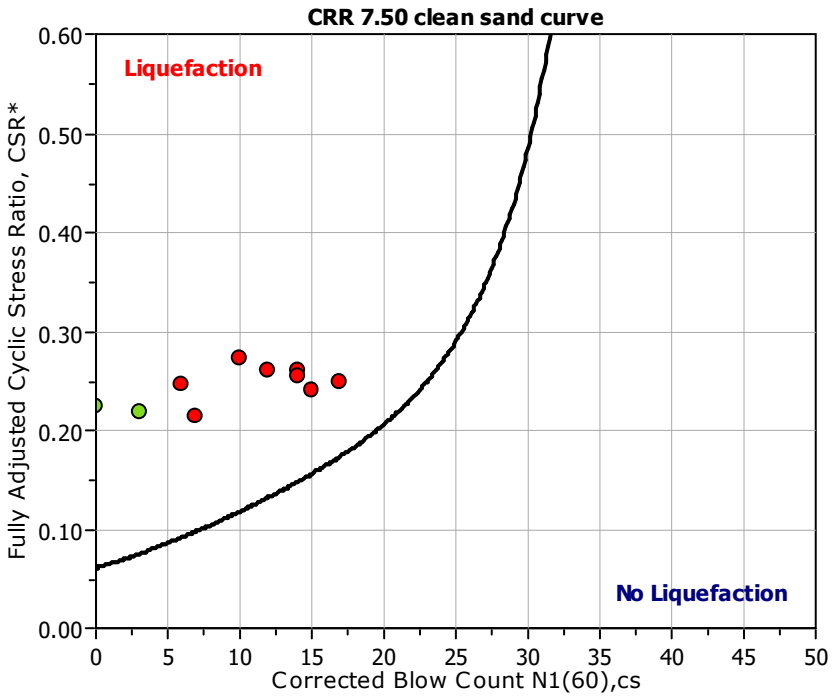
Borehole Name : BH04

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	4.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	4.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







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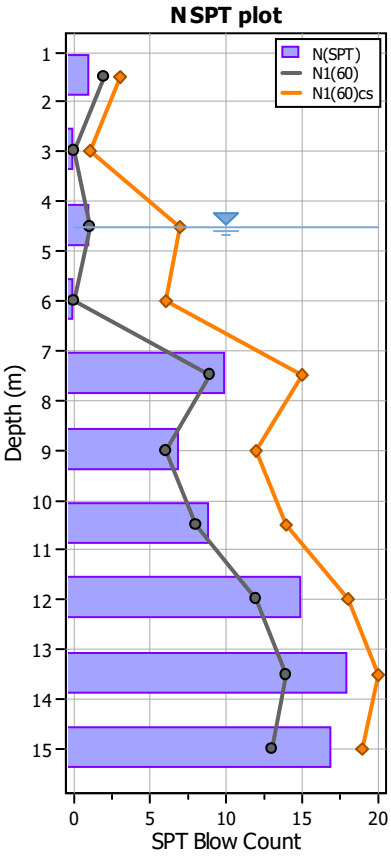
SPT BASED LIQUEFACTION ANALYSIS REPORT

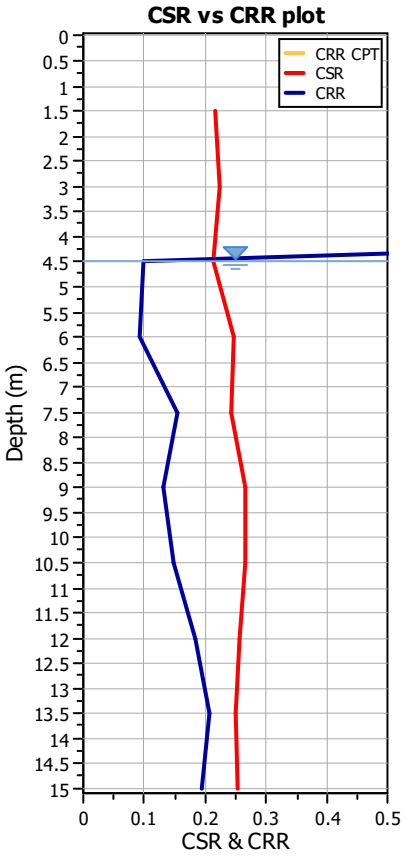
Project title : Nukuhau Structure Plan **Location : Nukuhau, Taupo**

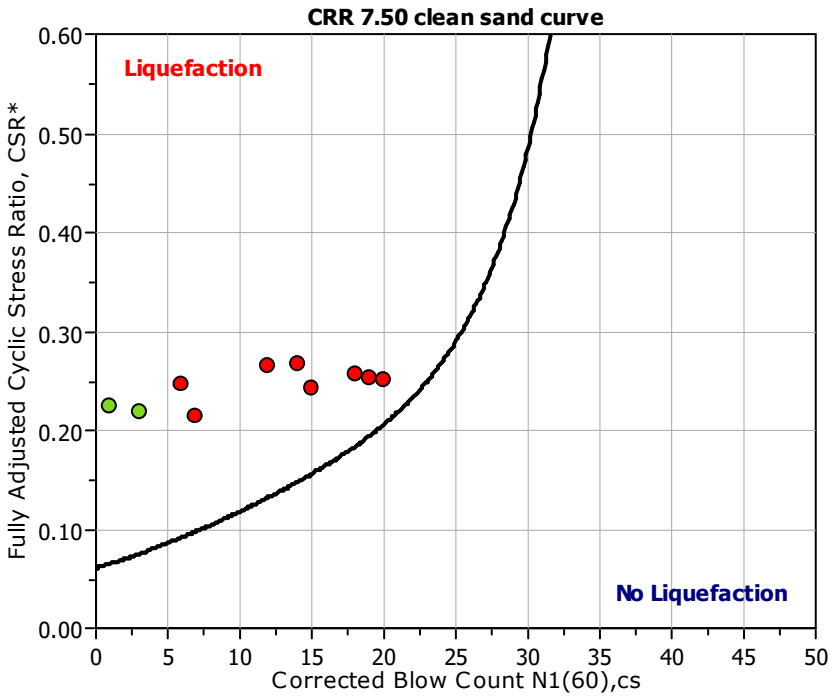
Borehole Name : BH04

:: Input parameters and analysis properties ::

Analysis method:	Idriss & Boulanger 2014	G.W.T. (in-situ):	4.50	EQ site conditions:	Same as initial
Fines correction method:	Idriss & Boulanger 2014	G.W.T. (earthq.):	4.50		
Sampling method:	Standard Sample	Earthquake magnitude M_w:	6.10		
Borehole diameter:	65 mm to 11 5mm	Peak ground acceleration:	0.39		
Rod length:	1.50	SPT results rounding mode:	Nearest		
Hammer energy ratio:	0.90				







Appendix F Contact Energy Monitoring Data

LEGEND:

- BM levelled in Feb-2017 showing rate of ground level change in mm/yr for Jan-2015 to Feb-2017 period
- BM new or first time levelled after Jan-2015 survey
- existing BM not levelled in Jan-2015 or Feb-2017 surveys

NOTES:
- contour interval is 5mm/yr
- negative values show subsidence
- origin for Jan-2015 survey is A93 (Aratiatia) *
- origin for Feb-2017 survey is A93 (Aratiatia) *

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