AMBURY PROPERTIES

PROPOSED PLAN CHANGE
231 TAHUNA ROAD, OHINEWAI

GEOTECHNICAL ASSESSMENT REPORT

INITIA REF P-000529 REV A

OCTOBER 2019

Your Report Summary

The summary below outlines the principal geotechnical considerations for the site located at 231 Tahuna Road, Ohinewai. It is important that reference is made to the relevant sections in the main body of the report for further detail.

Report Ref	Geotechnical Consideration	Summary Advice/Recommendations
3.0	Geology and Groundwater Conditions	The site is generally underlain by a surficial layer (3 to 13 m thick) of alluvial soils comprising recently deposited sands (Taupo Pumice Alluvium) and very soft clays/silts and peat (Rotokawau Formation). Older alluvial soils (interbedded sands, silts, clays and peat) of the Karapiro, Puketoka and Whangamarino Formations underlie these surficial soils. The basement rock (interbedded claystone, sandstone, siltstone and coal measures) known as the Te Kuiti Formation occurs at a depth of approximately 100 m below ground level. Groundwater is present from near surface levels (0.5 to 1.0 m depth)
3.2	Site Stratigraphy and Zoning	Low lying areas of the site (below RL 7.5 m) are typically mantled by between 5 and 10 m of highly compressible soils (Rotokawau Formation). Areas of the site with higher ground surface elevations (RL 9.0 m or higher) are directly underlain by more competent soils (Karapiro & Puketoka Formation). **Refer Figure 529-002 in Appendix A.**
4.4.3 and 4.4.4	Liquefaction	The surface soils (Taupo Pumice Alluvium) are predominantly sandy and saturated. These soils, together with the deeper Karapiro/Puketoka Formation sands, are susceptible to liquefaction under an ultimate limit state (ULS) earthquake event. Without mitigation measures, liquefaction of near surface soils could cause failure of shallow foundations which presents a 'life-safety' risk for future buildings. Pavements, buried services (pipes, manholes and tanks) can also be badly damaged. Mitigation of liquefaction effects will need to be addressed for detailed design of buildings and civil infrastructure. **Refer to Figure 529-003 in Appendix A.**
4.5.2	Settlement	The soils at this site are considered to be highly compressible and could be expected to settle by between 100 mm and 2,000 mm under typical building surcharge pressures of 45 kPa or greater without improvement measures. Low lying areas of the site that are underlain by greater thicknesses of the Rotokawau Formation soils (very soft silts/clays and peat) are at greater risk of settlement. Where, possible future development in these areas should be avoided or minimised. **Refer to Figure 529-004 in Appendix A**
4.7.2	Ground Improvements	Ground improvements will be required to support future development of buildings, roads, yard areas, and the rail siding across the site. There are a wide range of ground improvement options available, varying between deep pile foundations to preloading. **Refer to Table 4-4**
5	Further work	Additional geotechnical investigations, analysis and design will be required to confirm and develop ground improvement options and to provide detailed geotechnical advice for design of the site earthworks, civil infrastructure and individual buildings.

Contents

1. Introduction

1.1 Objective

This report outlines the findings of a geotechnical investigation undertaken for a site located at 231 Tahuna Road, Ohinewai and has been prepared in support of a proposed plan change application. Preliminary geotechnical analysis and interpretation has been undertaken to identify geotechnical engineering constraints and considerations for development of the land. Preliminary recommendations and options for ground improvements required to facilitate development of the site are presented.

The results of the geotechnical investigations are presented in a standalone factual geotechnical investigation report which is attached as Appendix B. The scope of geotechnical investigations undertaken to date is considered appropriate for a high level, planning assessment, however, further stages of investigation will be essential to support specific future development at the site.

1.2 Background and Proposed Development

Ambury Properties Limited, the property holding associate of the New Zealand Comfort Group Limited (NZCG), is proposing to develop land on the corner of Lumsden Road and Tahuna Road, Ohinewai (Allotment 405, Lots 1 and 2 DPS 29288 and Lots 2-3 474347). The property is zoned Rural in the operative and proposed Waikato District Plans. The proposed development - 'Sleepyhead Estate' will be a mixed-use, master-planned community located adjacent to the Waikato Expressway and the North Island Main Trunk railway at Ohinewai.

The proposed NZCG 100,000m^2 factory will be the major industrial anchor for the project. It will be accommodated in a 66ha industrial hub with rail siding access from the North Island Main Trunk railway. The project will also include 8.5ha of commercial development including a service station, local convenience stores and factory outlet shops. Thirty-three hectares of residential land for approximately 1100 new houses will also be provided, together with about 60ha of public open space.

Ambury has lodged a submission on the proposed Waikato District Plan requesting that the land be rezoned to a mix of industrial, residential and business zone to accommodate the mixed-use community. To support the proposed rezoning, Ambury is also seeking to embed a structure plan for Ohinewai within the District Plan. The structure plan will provide a framework for the development of the wider site, outlining the location of activities, the indicative road network and the general location of the green spaces that will provide for recreation and the management of stormwater.

The conceptual site layout plan[1], dated 3 October 2019, for the proposed Sleepyhead Estate is attached in Appendix A.

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[1] Adapt Studio Ltd: Framework; Ohinewai Development, Illustrative Masterplan, Drawing 1805-018, dated 3 October 2019, Rev J.

2. Project Site

2.1 Location

The site is located on the eastern side of State Highway 1, at 231 Tahuna Road and Balemi Road, Ohinewai. The total site area is approximately 178 ha and is made up of the properties legally described as; Allotment 405, Whangamarino Parish (~37 ha), Lot 1, DPS 29288 (~68 ha), Lot 2, DP 29288 (~61 ha), Lot 3, DP 474347 (~11 ha) and Lot 2, DP 474347 (~0.8 ha). The location of the site and the individual property boundaries are presented in Figure 2-1 below.

Figure 2-1: Site location and boundaries

2.2 Description

The site is presently almost completely grass covered and is used for agricultural purposes. It is bounded by Tahuna Road to the south, Balemi Road and other agricultural land to the north, Department of Conservation land (including Lake Rotokawau) to the east, and Lumsden Road to the west.

The land is typically low lying and flat except for a ridgeline on the southern boundary (which Tahuna Road has been formed on) and two "spurs" which run in a north-south direction through the two southern properties (Lots 1 and 2, DP 29288). With reference to Figure 529-001 attached in Appendix A, ground surface elevations vary between approximately RL 20 m on the southern boundary with Tahuna Road and RL 6 m at the far eastern end of the site. Except for the localised ridge and spurs, the general site grade falls very gently from west to east.

The Waikato River is located approximately 1 km to the west of the site.

2.3 Published Geology

The published geological map (Figure 2-2 below and Figure 529-002 in Appendix A) shows the site sits over two surface geological formations, both members of the Tauranga Group. The Tauranga Group includes a range of marine, estuarine and terrestrial sediments deposited primarily during the Quaternary in the Bay of Plenty, Waikato and Auckland regions.

The bright yellow formation shown on Figure 2-2 is described on the Published Geological Map (1:250,000 – GNS Geomaps) as Tauranga Group, early to middle Pleistocene Age pumiceous river deposits comprising highly weathered, coarse pumiceous and rhyolitic sands and current-bedded grits, with interbedded peat and local gravels.

The pale-yellow material is also defined on the geological map (1:250,000 – GNS Geomaps) as Tauranga Group but a more recent (Holocene Age) deposit (last 2,000-10,000 years). This is described as comprising pumice sand, silt and gravel with peat beds.

The geotechnical investigation data for the site is consistent with the geological map.

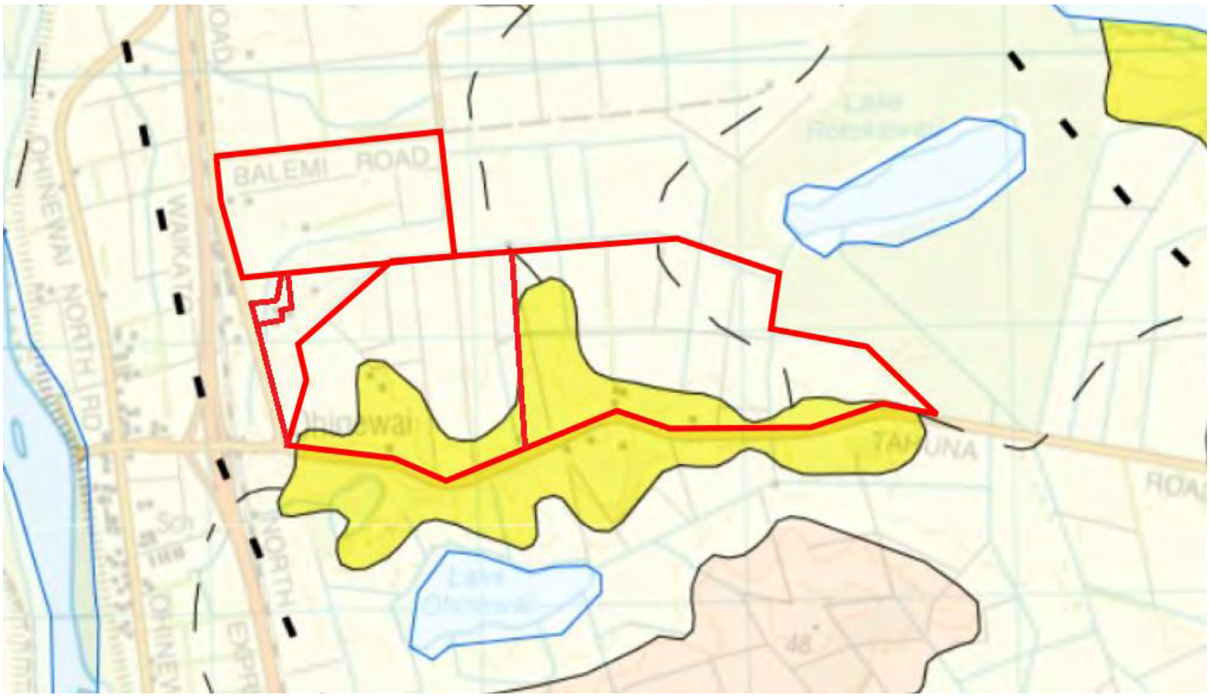

Figure 2-1: Geological Map (Source GNS GeoMaps)

3. Geotechnical Investigations and Subsurface Conditions

3.1 General

Preliminary advice presented in this report is based on an early stage geotechnical investigation comprising a limited number of fully cored machine boreholes, Cone Penetration Tests, and Test Pits completed across the site between September 2018 and July 2019. Investigation locations were selected by Initia to provide an overview of the ground conditions across the entire site (tests spaced at approximately 250m centres where possible). A geotechnical investigation plan showing the locations of the investigation works completed is presented on Figure 529-01 in Appendix A.

In addition to the recent investigations, Initia has sourced the results of historical investigations undertaken for a proposed Ohinewai Opencast Coal Mine in 1986[2] (refer to the Geotechnical Factual Report in Appendix B).

The results of all available investigations have been used to develop a preliminary ground surface model. However, it should be noted that the nature and continuity of the ground conditions away from the test locations is inferred and it should be appreciated that actual conditions may vary away from the test locations.

3.2 Site Stratigraphy

The results of the geotechnical investigations indicate the site is underlain by variable Tauranga Group soils. The Tauranga Group encompasses highly variable soil types which are subdivided into different ‘formations’ of increasing age. These are;

I. Taupo Pumice Alluvium (sourced from the Taupo eruption circa 50 AD);
II. Rotokawau Formation (informal name assigned by the authors of the Ohinewai Open Cast Coal Mine investigation reports and adopted in this report)
III. Karapiro Formation
IV. Puketoka Formation
V. Whangamarino Formation

The Whangamarino Formation was encountered at a depth of between 30 and 55 m below ground level in the Ohinewai Coal Mine investigations but was not encountered during the recent CPT and borehole investigations for this project (max investigation depth 25 m). As this material was not investigated, it is not referenced extensively in this report, however, it is understood to comprise Pliocene Age silty CLAY and clayey SILT with layers of PEAT, SAND and GRAVEL.

As it was not possible to determine the difference between the Karapiro Formation and Puketoka Formation units from the investigations completed to date (mainly CPTs), these two units, of similar Age and engineering properties, have been grouped together for the purposes of reporting and preliminary analyses.

The historical geotechnical investigations undertaken for the proposed Ohinewai Opencast Coal Mine show that the Tauranga Group soils extend to depths of approximately 60 to 110 m below ground level. The underlying unit is the Te Kuiti Group which comprises interbedded layers of siltstone, sandstone, claystone and coal measures. As the Te Kuiti Group is well below the depth of specific investigation for this project and likely of minor engineering relevance to the development proposed at

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[2] State Coal Mines: Ministry of Energy; Ohinewai Opencast Feasibility Study; Geotechnical Investigations Phase II, December 1986, Volume 1 and Volume 2, prepared by RWL Mining Consultants

the site, this material type is not discussed further in this report except as to reference the depth to 'bedrock'.

A summary of the geology and material types present at the site is outlined in Table 3-1 below.

Table 3-1: Overall summary of geology and site stratigraphy at the Ohinewai site

Group	Formation	Generic Description	Age	Typical thickness (m)
Tauranga Group	Taupo Pumice Alluvium	Fine to medium SAND, Sandy SILT	~ 2000 years	0 to 3
	Rotokawau Formation	PEAT, Clayey SILT and silty CLAY	< 20,000 years	0 to 10
	Karapiro Formation	Fine to coarse SAND with common gravel beds	Pleistocene	20 to 40 (combined thickness)
	Puketoka Formation	Interbedded SILT, medium to coarse SAND, pumiceous GRAVEL and PEAT		
	Whangamarino Formation	Silty CLAY and clayey SILT with layers of PEAT, SAND & GRAVEL	Pliocene	30 to 80

The Taupo Pumice Alluvium and Rotokawau Formations are surficial deposits that occupy low-lying areas. The Taupo Pumice Alluvium is predominantly a pumiceous silty sand which is commonly between 1 and 3 m thick. The Rotokawau Formation is dominated by thick peat and is underlain by very soft silts and clays.

The Karapiro and Puketoka Formations vary considerably in grain size and composition but generally comprise silt, silty SAND, gravel and some peat.

The results of the investigations indicate that the Karapiro and Puketoka Formation materials form a 'paleo-topographic' surface at the site, with very recent infilling by the Rotokawau Formation "swamp" deposits and the Taupo Pumice Alluvium. The elevation of the 'paleo-topographic' Karapiro/Puketoka Formation unit is interpreted to sit between RL 9 and RL 20 m, i.e. the Karapiro/Puketoka Formation unit generally occurs at ground surface level over the higher parts of the site (above RL 9 m). The upper few metres of the Puketoka/Karapiro Formation is typically dominated by silty SANDs and sandy SILTs. The lowest parts of the site (surface levels of RL 7.5 m and lower) are usually dominated by greater thicknesses of the Rotokawau Formation.

The following tables outline the approximate depth and layer thicknesses of the relevant geological units at each of the five properties; Allotment 405 (north west site), Lot 2 DPS 28288 (south west site), Lot 1, DPS 28288 (south east site) and Lots 2 & 3 DP 474347.

Table 3-2: Allotment 405 – Site Stratigraphy

Surface levels	Taupo Pumice Alluvium		Rotokawau Formation		Puketoka Formation & Karapiro Formation	
	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)
“High” Ground Surface elevation > RL 9.0	-	0	-	0	0	> 20 m
“Intermediate” Ground Surface elevation < RL 9.0, > RL 7.5	0	1.0 to 4.0 [2.5]	1.0 to 4.0	1.0 to 4.0 [1.5]	3.8 to 5.7 [5]	> 20 m
“Low” Ground Surface elevation < RL 7.5	0	1.5 to 4.0 [2]	1.5 to 4.0	6.0 to 10 [8]	10.3 to 11.5 [10.5]	> 20 m

1. Bracketed values indicate average thickness

Table 3-3: Lot 2, DPS29288 – Site Stratigraphy

Surface levels	Taupo Pumice Alluvium		Rotokawau Formation		Puketoka Formation & Karapiro Formation	
	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)
“High” Ground Surface elevation > RL 9.0	-	0	-	0	0	> 20 m
“Intermediate” Ground Surface elevation < RL 9.0, > RL 7.5	0	1.5 to 3 [2]	1.5 to 3	1.5 to 4 [2]	3.0 to 6.0 [4]	> 20 m
“Low” Ground Surface elevation < RL 7.5	0	0.5 to 3.0 [1.0]	0.5 to 3.0	7 to 9 [8]	9.2 to 10.7 [10]	> 20 m

1. Bracketed values indicate average thickness

Table 3-4: Lot 1, DPS29288 – Site Stratigraphy

Surface levels	Taupo Pumice Alluvium		Rotokawau Formation		Puketoka Formation & Karapiro Formation	
	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)
“High” Ground Surface elevation > RL 9.0	-	0	-	0	0	> 20 m
“Intermediate” Ground Surface elevation < RL 9.0, > RL 7.5	No tests performed in this elevation range					
“Low” Ground Surface elevation < RL 7.5	0	0 to 3.0 [0.5]		5.5 to 13.5 [8.0]	6.5 to 13 [9.0]	> 20 m

1. Bracketed values indicate average thickness

Table 3-5: Lots 2 and 3, DP 474347 – Site Stratigraphy

Surface levels	Taupo Pumice Alluvium		Rotokawau Formation		Puketoka Formation & Karapiro Formation	
	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)	Depth (m)	Thickness (m)
“High” Ground Surface elevation > RL 9.0	-	0	-	0	0	> 20 m
“Intermediate” Ground Surface elevation < RL 9.0, > RL 7.5	0	1.0 to 3.0 [2.1]	1.0 to 3.0 [2.0]	0 to 10.4 [3.0]	4.0 to 13.0 [5.0]	> 20 m
“Low” Ground Surface elevation < RL 7.5	No tests performed in this elevation range					

1. Bracketed values indicate average thickness

3.3 Test Results

Tables 3-5 and 3-6 below present a summary of in situ test results from the recent investigations and laboratory testing from historical geotechnical investigations. There is extensive additional laboratory test data from the Ohinewai Opencast Coal Mine investigations; Table 3-6 reports only the results considered pertinent to the plan change assessment of the site.

Table 3-5: In situ test results – Recent Investigations

Geological Unit	Formation	In situ strength parameters – range & [25th percentile]	
		SPT ‘N’	CPT q_c (MPa)
Tauranga Group	Taupo Pumice Alluvium	4* [4]	1.5 to 6.0 [2.5]
	Rotokawau Formation	0 - 2 [0]	0.05 to 0.4 [0.15]
	Karapiro Formation and Puketoka Formation	4-31 [9]	0.5 to 15 [2.0]

* Single test result

Table 3-6: Laboratory Test Results – Ohinewai Opencast Coal Mine Investigations

Soil type	Laboratory Test Results – Range and [mean]								
	Bulk density (t/m^3)	Dry Density (t/m^3)	Water content (%)	Undrained Shear Strength (kPa)	Atterberg Limits			Mv m^2/MN	Cv m^2/yr
					LL	PL	PI		
Rotokawau Formation – Clay/Silt/Peat			120-240 [160]	0.8-20 [8.5]				1.8 to 2.5	0.44 to 16
Karapiro Formation SAND	1.37-2.35 [1.73]	0.74-2.01 [1.24]	15-85 [42]	-	-				
Puketoka Formation Clay/Silt	1.34-1.90 [1.66]	0.64-1.39 [1.08]	29-115 [55]		40-180 [79]	21-86 [38]	19-91 [41]	0.28	11 – 29
Puketoka Formation Sand	1.32-2.71 [1.70]	0.58-2.06 [1.16]	8.4-109 [48]	-	-	-	-		

3.4 Groundwater

During the Initia investigations, groundwater was encountered at a depth of 0.5 to 1.5 m below ground level in the 'Intermediate ground' areas (RL 7.5 to 9 m) and at near surface levels in the "Low ground" areas of the site (RL 6.0 to 7.5 m). The groundwater measurements were taken from CPTs and the three machine boreholes only and are therefore not considered to provide a reliable measure of groundwater levels and variance across the site.

Based on the results of investigations, and observations of ground surface saturation at the time of investigation, groundwater levels are expected to vary between RL 7 m and RL 6 m across the majority of the site. Higher levels may be present around the ridge at the southern and southwestern boundaries and the two north-south "spurs" where ground surface elevations are as high as RL 20 m. Further monitoring would be required to confirm this.

Regional groundwater levels are expected to be controlled by the Waikato River (to the west) and Lake Rotokauwau (to the east).

For detailed geotechnical analyses purposes, groundwater should be assumed to be at 0.5 m depth where site levels are at RL 7.5 m or higher and at ground surface level where the site levels are below RL 7.0 m.

4. Geotechnical Considerations for Development

4.1 Overview

The site is underlain by recent (Holocene Age) alluvial soils which are susceptible to liquefaction (ULS seismic events) and are highly compressible. These materials extend to depths of up to 15 m below ground level. The underlying Pleistocene Age (Puketoka Formation and Karapiro Formation) soils are less compressible but may still be susceptible to liquefaction. The geotechnical conditions at the site are variable depending on their location within the proposed parcel boundaries and will present significant engineering challenges for development of the land.

From the results of investigations completed to date, several areas of the site have been identified with challenging ground conditions. This is predominantly land that is underlain by significant thicknesses of the Rotokawau Formation (containing highly compressible peat and other very soft soils). Reference should be made to Figure 529-004 in Appendix A which zones land according to ‘settlement’ magnitudes resulting from an assumed uniform surcharge applied over the entire site. Development over areas of the site zoned red on Figure 529-004 (settlements > 500 mm) will be therefore be highly constrained. For this reason, the Masterplan for the site largely excludes future development in this zone (refer Adapt Studio, Rev J presented in Appendix A).

The remainder of the site is generally considered suitable for development and the construction of commercial and residential buildings and associated infrastructure. However, the land has been identified as having a high liquefaction severity number (LSN) due to the presence of surface alluvial sands and also as moderately to highly compressible when loaded. Therefore, ground improvements will be required over most of the site to support for future building development.

The advice presented in this report is intended to support the plan change application only. Further geotechnical investigations and analysis are essential for the subdivision and for specific building developments on the site.

4.2 General

Based on our understanding of the proposed development detailed in the Illustrative Masterplan (Adapt Studio, Rev J) and our knowledge of the geology and local ground conditions, the principal geotechnical considerations for development of the site are as follows;

- Earthworks and cut/fill to form level building platforms;
- Liquefaction susceptibility and consequential effects during and following seismic events;
- Settlement of compressible soils due to placement of new fill and/or future buildings loads;
- Installation/construction of civil infrastructure such as three water services (stormwater, sewer and water main), internal roads and yard areas, the rail siding, car parking etc;
- Ground improvements to address liquefaction and settlement risks;
- Foundation for new buildings – light industrial to residential;

The above geotechnical considerations are discussed in the following subsections.

As the investigations undertaken and discussed in this report have been completed to provide an overview of the site conditions to assess and support a planning change application, further geotechnical investigations, geotechnical analysis and detailed design will be required to support any specific development of the land.

4.3 Earthworks

As outlined in Section 2.2, the site is typically flat to gently sloping except for the ridge along the southern boundary and the two spurs which run approximately north-south through the centre of the site. Design surface levels for the site are expected to range between RL 10 m at the western most edge of the site and RL 7 m at the eastern end of Lot 1, DPS 29288. It is anticipated that overall site grades would be east and north east, with possible stormwater treatment at the eastern end of Lot 1, DPS 29288. The following earthworks are expected to be required to facilitate development;

i. Cuts to lower the north-south trending “spurs” which are presently as high as RL 16 m. Cut depths may be as much as 6 m at localised ‘high-points’ but with a typical depth of 2 to 4 m.
ii. Re-grading of the “ridge” that runs along the southern boundary of the site. These works are expected to comprise cuts of up to about 5 - 6 m depth but generally 2-3 m depth to form more uniformly sloping ground or terraces suitable for future buildings.
iii. Placement of fill between the existing “spurs” and over the north western corner of the site (Allotment 405) to provide a gently sloping grade (approximately 1%) to the north and east.
iv. Possible construction of swales along the northern boundary of Lot 3 DP 474347 and Lots 1 and 2 DPS 29288 to convey stormwater and overland flows to the east for treatment before being discharged into Lake Rotokawau.

The key earthworks considerations are summarised below;

- Cuts extending below RL 7 in the west and below RL 6.0 in the east will almost certainly encounter groundwater. As the upper soils at the western end of the site are predominantly sandy, groundwater inflows are expected to be significant and difficult to control. This is particularly relevant for installation of buried services (see Section 4.6 below).
- The upper silty sands (Taupo Pumice Alluvium) are likely to be suitable for re-use as engineered fill. Sand dominated material can usually be compacted to an engineered standard, even at relatively high water contents. If the soils are ‘silt’ dominated (>35-40%) they may need to be conditioned (dried-back) prior to placement.
- Lime and cement stabilisation of the upper soils may be required to provide increased strength to the fill and to mitigate the risk/effects of liquefaction from a ULS seismic event (see Section 4.4 below).
- Excavations through the southern “ridge” and the two north-south trending “spurs” are expected to extend through a mixture of sands and silts which could be used (likely with some conditioning) for engineered fill. Excavation in these areas of the site will result in some surface unloading (“load compensation”) for future building platforms, i.e. the risk of settlement, due to future building loads, may not need to be mitigated in these areas.
- For the lower lying areas of the site (below RL 9.0 m), excavations which extend below the surface “crust” of silty sand (Taupo Pumice Alluvium) which varies between 0.5 m and 4.5 m in thickness, will encounter very soft clay/silt or peat (Rotokawau Formation) with undrained shear strengths as slow as 5-10 kPa. This material is very unlikely to be suitable for re-use as engineered fill and will not support earthmoving or construction traffic.
- It is recommended that a minimum 800 mm to 1,000 m thickness of the Taupo Pumice Alluvium layer, where underlain by Rotokawau Formation, is left in situ to support earthworks plant and compaction of new fill. Alternatively, a minimum 500 mm thick layer of Soft Pit Run (SPR) will be required to form a “working platform” to enable compaction of subsequent layers over the top of the Rotokawau Formation. At the eastern end of the site (Lot 1, DPS29288), the Taupo Pumice Alluvium layer is as thin as 300 mm; therefore a working layer of SPR or similar may need to be formed over the subgrade prior to placing any new fill.
- Allowance should be made for significant volumes of “unsuitable” soil which is likely to be encountered across the entire site. Further investigation will be required to determine the spatial extent of unsuitable soils.

- Allowance should be made for importation of significant volumes of fill from off-site to lift ground levels above existing site levels (there is unlikely to be enough fill available from designated "cut" areas). Imported fill should preferentially be cohesive soils and/or SPR (completely to highly weathered rock, usually quarry over-burden).
- Placement of new fill will initiate settlement of the underlying soils which may take several months or more to complete (see Section 4.5 below). Monitoring of settlement magnitudes and rates will be required. The ground will also need to be over-filled to account for settlement of the deeper soils, i.e. so that design surface levels are achieved following completion of the settlement process.

4.4 Site Seismicity & Liquefaction Susceptibility

4.4.1 Site Subsoil Class

With the exception of the southern ridge line and the two north-south "spurs" (high ground, RL > 9.0 m), the site is underlain by between 1 and 14.5 m thickness of very soft soil (Rotokawau Formation) with an undrained shear strength of < 12.5 kPa. These soils are underlain by moderate strength clays/silts, silty sands and peat of the Karapiro and Puketoka Formations to the full depth of investigation (25 m below ground level). Rock (Te-Kuiti Group siltstone, claystone, sandstone) is inferred from a depth of approximately 100 m below ground level based on historical investigation data at the south eastern end of the site.

Where there is more than 10 m of Rotokawau Formation underlying the site in the low lying areas (typically < RL 7.5m), a seismic subsoil Class E – soft soil site – should be assumed in accordance with NZS 1170.5. Parts of the site (areas with a ground surface elevation higher than RL 9.0 m, where the Rotokawau Formation layer is absent or less than 10 m thick) could be re-classified as Class D – deep soil site – during subsequent stages of investigation. However, there is presently insufficient data available to delineate where Class D versus Class E conditions prevail.

For geotechnical analysis purposes, there is no difference in the Peak Ground Acceleration for a Class D and Class E site.

4.4.2 Peak ground acceleration for geotechnical analyses

The peak ground acceleration for the site – both SLS and ULS design cases - has been derived based on NZS1170.5 and the NZTA Bridge Manual assuming the parameters outlined in Table 4-2 below.

Table 4-2: Seismic parameters for derivation of site PGA

Design assumption	Parameter
Building Importance Level	IL2 (typical commercial/industrial building assumed, to be confirmed by designer) – assumes less than 5,000 people within the building
Building design life	50 years (assumed, to be confirmed by designer)
Return Period	500 Years – ULS Event (Table 3.2, NZS 1170.5)
Near Fault Factor	1.0 (distance to nearest fault > 20 km)
Site subsoil class	E (soft soil site, as above)
Site subsoil class factor	1.0 (Table 3.2, NZS 1170.5)

Assuming the above parameters, design peak ground accelerations (PGAs) and earthquake magnitudes are as follows.

- SLS – 25 Year Annual Exceedance Probability: PGA = 0.05g, Magnitude 5.8
- ULS – 500 Year Annual Exceedance Probability: PGA = 0.22g, Magnitude 5.8

4.4.3 Liquefaction Susceptibility

Liquefaction susceptibility analyses have been undertaken using the results of the site-specific Cone Penetration Tests (CPTs) applied to the analysis method presented by Boulanger and Idriss (2014). The CPTs were analysed for both the SLS (25-year AEP) and ULS (500 year AEP) seismic events as outlined above. A groundwater level of 0.5 m below current ground level was assumed for consistency in assessing liquefaction susceptibility site wide.

The results of the analyses indicate that there is a negligible risk of liquefaction occurring during a SLS seismic event. However, for the Ultimate Limit State (ULS) event, there is a very high likelihood of liquefaction occurring from near surface levels over most of the site. This is because the site is largely underlain by fully saturated, sand-dominated soils from near surface levels (Taupo Pumice Alluvium) and the underlying Karapiro/Puketoka Formation which extends to the full depth of investigation. The majority of the site is therefore considered to be susceptible to liquefaction to depths greater than 25 m below ground level. The Rotokawau Formation (peat and soft clays/silts) is not susceptible to liquefaction as it is dominated by clays, silts and peat.

Results of the liquefaction susceptibility analyses undertaken for the ULS seismic event (PGA = 0.22g) are attached in Appendix C.

4.4.4 Liquefaction Effects

Liquefaction can affect land and development in the following ways:

- Ejection of sand/silt boils to ground surface level;
- Deformation and rupture of pavements;
- Flotation of manhole risers and buried services, including rupture of pipes which move differentially;
- Total and differential settlement of building structures and floor slabs, possibly resulting in structural collapse;
- Lateral spreading towards an unsupported face, e.g. coastline, river bank etc

An important factor in controlling the effects of liquefaction is the “crust thickness”, i.e. the thickness of non-liquefiable soils (e.g. soils above groundwater level or soils which are not susceptible to liquefaction such as gravels and clay/silt dominated soils) that overly liquefaction susceptible soils. Experience from the Canterbury sequence of earthquakes has shown that the effects of liquefaction on buildings, pavements and services are largely mitigated for land which has a crust thicknesses greater than 3 m.

The Liquefaction Severity Number (LSN) is an index which was developed following the Canterbury Sequence of earthquakes and relies on data from a large database of land and dwelling damage. The LSN accounts for the cumulative thickness of liquefaction, the degree of liquefaction, crust-thickness, and the depth at which liquefaction occurs. It is a useful index for categorising the effects of liquefaction for differing ground conditions and variability in soils – both spatially and in elevation. A description of the expected effects of liquefaction – assigned LSN values ranging between 1 and >50 – is presented in Table 4-3 below.

Table 4-3: Liquefaction Severity Number (LSN) and observed effects

LSN Range	Predominant Performance
0 -10	Little to no expression of liquefaction, minor effects
10 -20	Minor expression of liquefaction, some sand boils
20 -30	Moderate expression of liquefaction, with sand boils and some structural damage
30 -40	Moderate to severe expression of liquefaction, settlement can cause structural damage
40 -50	Major expression of liquefaction, undulations and damage to ground surface, severe total and differential settlements of structures
> 50	Severe damage, extensive evidence of liquefaction at surface severe total and differential settlements affecting structures, damage to services

The results of the preliminary liquefaction analyses undertaken as part of this site wide geotechnical assessment indicate that parts of the site (those areas underlain Taupo Pumice Alluvium and Karapiro/Puketoka Formation) have a Liquefaction Severity Number > 50 (typically between 60 and 100), i.e. severe damage could be expected to buildings and infrastructure at ground surface level. Almost all of Allotment 405 (north western end of site) and approximately half of Lot 2 and 3 DP 474347 and Lot 2, DPS 29288 (south western end of site), are at risk of severe damage should a ULS seismic event occur. By contrast, the majority of Lot 1, DPS 29288 (south eastern end of site) is expected to have little to minor expression of liquefaction following a ULS seismic event (LSN values less than 15). This is because the eastern end of the site is almost directly underlain by the very soft Rotokawau Formation clays/silts and peat that are not liquefaction susceptible. Figure 529-003 attached in Appendix A presents the predicted LSN for each CPT and zoning of the site depending on the LSN range.

Ground improvements will therefore be required over the majority of the site to ensure that there is at least 3 m of non-liquefiable material (“crust thickness”) beneath the floor slab of any future building and a minimum of approximately 2.5 m below the underside of any shallow foundations. This is to address “life-safety” requirements for ULS design, i.e. to ensure that there is no structural collapse of the buildings that could result in loss of life. Distortion and cracking of the floor slabs, and possible differential settlement/distortion of the structure, could still occur. However, it is generally accepted that such damage could either be repaired if it cost effective to do so, or alternatively, that the structures would be demolished and re-constructed. Greater resilience can be considered, if required, to maintain full serviceability of the building following a ULS seismic event. However, this would usually involve significant additional cost associated with a greater depth of ground improvement. Further detail on ground improvement options is outlined in Section 4.7.

Though not required for life-safety purposes, it is recommended that consideration be given to providing resilience to liquefaction for roads, rail sidings, and other pavements such as yards. This could be limited to simply ensuring that there is a non-liquefiable “crust” of at least 1 m beneath pavements. Buried services would need to be detailed to accommodate significant differential settlements and to resist buoyancy pressures for manholes and other below ground structures.

4.5 Soil Compressibility and Settlement Considerations

4.5.1 Overview

The Ohinewai site is underlain by a sequence of compressible geological units. The Rotokawau Formation, in particular, is highly compressible as it is comprised of interbedded layers of PEAT and very soft clayey SILT and silty CLAY with undrained shear strengths less than 10 kPa.

Settlement will occur at the site as a result of one or more of the following activities which will likely be required as part of the development of the land for use as commercial and/or residential;

1. Placement of new fill above present ground levels. For every 1 m of new bulk fill placed and compacted to an engineered standard, the equivalent surcharge pressure would be approximately 17-20 kPa.
2. Construction of building floor slabs including the underlying pavement formation, i.e. the “dead load” of the slab. This would usually include approximately 6 kPa for a 300 mm thick layer of subbase/basecourse and approximately 4 kPa for the floor slab (175 mm thick), i.e. a total of 10 kPa “dead load”.
3. Distributed “live load” acting on the floor slab, e.g. racking for storage purposes. The majority of new light industrial/warehouse buildings are detailed for a peak floor slab live load of 35 kPa which usually equates to approximately 25 kPa fully distributed live load, taking account of aisle widths and uneven load distribution.
4. Concentrated pressures directly beneath shallow foundations supporting the building structure (typically 50-100 kPa, serviceability stress).
5. Dewatering of soils (lowering of the groundwater level below historical levels) resulting in an increase in vertical effective stress (reduced “buoyancy” between soil particles).

4.5.2 Settlement

Total settlement is the combination of three different types of settlement;

- **Elastic settlement.** This is settlement which usually occurs instantaneously due to shear deformation following loading (within hours/days). Elastic settlement is usually greatest in granular soils (gravels/sands) as the soil particles are densified/re-ordered on loading.
- **Consolidation settlement.** This occurs as pore-water is gradually squeezed out of the soil matrix, allowing the void space previously occupied by water to “collapse”, thereby densifying the soil. Consolidation settlement is usually the largest component of total settlement and can be the most difficult to quantify. The time taken for consolidation settlement to complete (usually referred to as the point at which 90% of the theoretical maximum consolidation settlement has occurred) is dependent on the permeability of the soil, the thickness of the compressible layer and the drainage distance to the top/ bottom of the layer, e.g. a 1 m thick layer of sandy silt with high permeability underlain by gravel will consolidate exponentially faster than a 10 m thick layer of clay with very low permeability.
- **Secondary compression (creep);** Secondary compression or “creep” settlement can occur over long periods of time (i.e. over the full design life of the structure). This process is usually caused by creep, a viscous behaviour where the soil particles/grains become so closely packed they start to plastically deform themselves and/or by long-term degradation of organic matter in organic soil types. Secondary compression is a significant risk where peat and very soft soils exist (e.g. the Rotokawau Formation). Secondary compression can be as much as 20% of the total settlement for normally consolidated soils.

4.5.3 Preliminary Settlement Analyses

Preliminary settlement analyses have been undertaken to assess the potential magnitude of total settlement assuming the following potential surface loading;

i.	Bulk earthworks filling, up to 1 m in height	20 kPa
ii.	Building floor slab dead load:	10 kPa
iii.	Building floor slab - distributed live load:	15 kPa
	Total gross applied pressure:	**45 kPa**

In some cases, the height of bulk filling will be considerably greater than 1 m, particularly in the low lying areas of the site, toward the eastern end of Lot 1 DPS 29288, needing to be lifted to the design subgrade levels for flooding/overland flow requirements, however, this assumed fill height has been applied uniformly to allow direct comparison of the settlement potential/ variability across the site.

The preliminary settlement analyses were undertaken using the geotechnical analysis software package, CPeT-IT which relies on published correlations between Cone Penetration Test results with the constrained modulus of the soil. The results include a component of secondary compression which is greatest in the Rotokawau Formation unit.

The results of the preliminary settlement analyses are presented on Figure 529-004 in Appendix A. In general, the predicted total settlements for a surcharge pressure of 45 kPa, vary between 25 mm to 80 mm in areas directly underlain by Karapiro/Puketoka Formation in the south and west of the site and beneath the two prominent spurs. These settlement estimates increase to greater than 2,000 mm where the thickness of the Rotokawau Formation unit is approximately 10 m (eastern end of Lot 1, DPS29288).

For comparison purposes, a simple one-dimensional calculation (ignoring depth influence factors) has been undertaken using the Mv values measured in laboratory testing (site specific and for the Ohinewai Opencast Mine investigations (Mv = 1.0 and 3.5 m^2/MN for the Rotokawau Formation) and assumed values of Mv = 0.1 to 0.3 m^2/MN for Karapiro/Puketoka Formation.

Consolidation settlement magnitudes within the Rotokawau Formation are expected to range between approximately 50 and 150 mm per 1 m layer thickness (for a 45 kPa surcharge pressure). Similarly, assuming Mv values of 0.1 to 0.3 m^2/MN for the Karapiro/Puketoka Formation, settlements are expected to be approximately 5 mm to 15 mm per metre thickness (45 kPa surcharge). Considering, for example, the inferred ground conditions at the location of CPT40 (8 m thickness of Rotokawau Formation and 6 m of Karapiro/Puketoka Formation for a total CPT depth of 14 m), the total consolidation settlement could be expected to be in the range of 450 mm to 1300 mm. This compares well with the predicted total settlement of 700 mm using CPeT-IT. It is noted that the actual settlement at this location could be 100 to 300 mm greater depending on the actual depth of compressible soils within the Karapiro/Puketoka Formation unit extending below the investigation depth.

Available laboratory test data indicates that the Rotokawau Formation is approximately 10 to 20 times more compressible than the Karapiro/Puketoka Formation soils. Therefore, wherever the Rotokawau Formation soils are present, some form of ground improvement will be required to reduce settlement magnitudes and/or to address settlement effects. Where the underlying thickness of the Rotokawau Formation soils is in excess of 4-5m development on this land will likely be challenging and constrained.

4.5.4 Settlement Interpretation

As illustrated on Figure 529-004, the majority of the site, excluding the “high ground” areas where the ground surface elevation is greater than approximately RL 9.0 m (directly underlain by Karapiro/Puketoka Formation soils), is considered to be moderately to highly compressible (200mm to

>500mm estimated settlement). Areas of the site which have predicted settlements greater than 50-80 mm (for a 45 kPa surcharge) will likely require some form of ground improvement/treatment to reduce settlement magnitudes and/or mitigate the effects of settlement. Ground improvement options are presented in Section 4.7.

Most of Lot 1, DPS 29288 at the east of the site is considered to be highly compressible with predicted settlements ranging between approximately 800 mm and > 2,000 mm. This is also the case at the far eastern end of Allotment 405 and the central part of Lot 2 DPS 29288 where predicted settlements are typically in excess of 500mm. Therefore, it may not be practical to develop these areas of the site and this is reflected in the designation of these areas in the Illustrative Masterplan (Adapt Studios, Rev J) for use as vegetated areas with wetlands and very minor levels of development (small lightweight structures, paths, sports fields and gardens).

Long-term, secondary compression or “creep” settlement is likely to occur in large areas of the site, following completion of consolidation settlement. Such settlements could occur over the design life of the structure (50 years or more) if not addressed as part of ground improvements and/or allowed for in design and detailing of buildings and pavements.

Post-construction total settlements can be tolerated to some degree, provided that differential settlement magnitudes are minimised to no more than approximately 1 in 250 (e.g. up to 50 mm settlement over a distance of 12.5m could be accommodated by appropriately detailed floor slabs and most structures). Settlement tolerant structures (e.g. steel portal frames) and flexible cladding systems (e.g. timber) should also be considered.

Areas of high ground which are cut down to form gently graded land (approximately 1%) or terraced building platforms will be load compensated by the weight of soil removed, e.g. ground with a present surface elevation of RL 13.0 m cut to a design subgrade level of RL 10.0 m will be load compensated by as much as 3 m x 17 kN/m^3 = 51 kPa. Thus, new buildings constructed in this situation will experience significantly reduced settlements. These areas should be carefully surveyed prior to and following earthworks so that compensation effects can be assessed, and the scope of ground improvement works rationalised (noting that liquefaction susceptibility may still need to be addressed in these areas).

4.6 Civil Infrastructure

To prepare the site for light industrial, commercial, retail and possible residential development, it will be necessary to install internal roads, buried services (gravity fed services such as sanitary sewer and stormwater being of greatest relevance from a geotechnical perspective), car parking, yard areas and a rail siding off the North Island Main Trunk line. The following preliminary advice and comment is provided in relation to construction of new infrastructure at this site.

4.6.1 Buried Services

Groundwater levels at the site are high (near surface levels) and occur in combination with loose sand present from ground surface over the majority of the site, except the eastern end of Lot 1, DPS 29288. Excavating trenches or pits below groundwater level, for installation of buried services, is expected to be problematic due to the potential for “running sands” and unstable, low strength clays/silts. Therefore, wherever possible, it is advisable to limit the depth of buried services or alternatively to “lift” the site levels above groundwater level using cohesive soils or SPR. This would enable new services to be trenched and installed within new fill materials or maintained in the upper natural soils, above groundwater level. Where this is not practical, trenchless installation methods such as pipe thrusting should be considered for construction of buried services. Trench shields are unlikely to be suitable or safe, however, sheet piles could be considered.

As outlined in Sections 4.4 and 4.5, both seismic (liquefaction induced) and static (consolidation/creep) settlement may occur across large areas of the site. It is therefore recommended that gravity fed services be specifically detailed with contingent drainage grade to accommodate localised sag in the pipelines. Flexible pipes (such as HDPE) and flexible joints/connections should also be used. Manholes and other below ground structures (e.g. buried tanks) should also be specifically detailed to resist buoyancy pressures from elevated groundwater levels and from liquefied soils following a ULS seismic event.

To mitigate the effects of static settlement due to placement of new fill during subdivision earthworks, it is recommended that buried services be installed following completion of consolidation settlement. This could be established by installing and monitoring settlement pins at ground surface level following earthworks completion.

Flexible service connections may be required where services enter new buildings, particularly where differing levels of ground improvement have been employed inside and outside of building footprints.

4.6.2 Roads and Rail Siding

New roads (trafficked by heavy and light vehicles) and the proposed rail siding are likely to traverse areas of the site underlain by poor ground conditions. As road and rail traffic is largely ‘transient’, long term consolidation and creep settlement from vehicle and train surcharging is unlikely to occur if the roads/rail are constructed close to current grade. However, improvements to the subgrade strength are likely to be required to support construction of road and rail pavements. A minimum 1 m thickness of stabilised or high strength subgrade (e.g. new engineered fill) is likely to be required to support future road and rail traffic. This will help raft out vehicle wheel loads and train loads and mitigate the effects of liquefaction should a ULS seismic event occur. Further comment is provided in Section 4.7 below.

Where light vehicle accessways are proposed to developments in the eastern area of Lot 1 DPS 29288 (access to sports fields, and market garden areas) these roads should be constructed with a minimal increase in ground level where possible. Should filling be necessary to create the required level, the road surface can be left unsealed, and left to settle for a period before being paved at a later date. An allowance should be made for future maintenance comprising relevelling the accessway by patching or placement of a new surface layer on the pavement should significant surface deformation occur (likely 2-5 years) under loading. Alternatively, preloading of roads and rail siding could be considered to mitigate the risks.

4.6.3 Yard Areas

Areas of the site that are intended to be used for medium to long term storage (e.g. shipping containers stored adjacent to the rail siding and outside buildings) may require ground improvement to minimise settlements to acceptable limits and to mitigate settlement effects. Ground improvement options for heavily loaded yard areas are presented in Section 4.7 below, however, it is likely that yard areas with concrete pavements may need to be treated similarly to building floor slabs. Alternatively, the yard areas could be left unsealed (exposed unbound granular pavement surface) and left to settle for a period (likely years) before being sealed at a later date. Flexible pavement surfaces such as asphalt could also be considered and re-sealed/maintained as required if significant ground surface deformation occurs under loading.

4.6.4 Car parks

Areas of the site that are underlain by relatively low strength and highly compressible soils could be utilised for car parking (light vehicles). The surcharge imposed by vehicles is low and hence consolidation and long-term settlement of these areas would be expected to be minimal (assuming the ground is not lifted with fill). Provided that a reasonable subgrade (at least 800 mm of soil with a CBR > 3%) is present overlying the soft soils, car park pavements could likely be formed without any requirement for ground improvement.

4.7 Ground Improvement Options

4.7.1 General

As outlined above, some form of ground improvement is expected to be required beneath future building platforms, road carriageways, rail sidings, and yard areas. The selected ground improvement method will need to address one or more of the following geotechnical issues identified for this site;

- Liquefaction susceptibility of the near surface and deep subsoils. A minimum 3 m thick “crust” of non-liquefiable soils is required to support future buildings formed on grade to address ‘life-safety’ risk.
- Consolidation and secondary compression settlement effects due to the placement of new fill (to lift site levels), as well as building dead and live loads.
- Low strength subgrade conditions for construction of new pavements (rail siding, roads, yards floor slabs etc).

4.7.2 Ground Improvement Options

Table 4-4 outlines possible ground improvement options, pros and cons for each and a qualitative assessment of cost (low, medium or high).

Table 4-4: Ground Improvement Options

Ground improvement option	Details	Addresses risks from		Pros	Cons	Relative cost appraisal
		Liquefaction	Settlement			
Preloading	All building platforms and some pavements (those with medium to long term sustained heavy loading, e.g. yard storage areas, rail corridor, areas of fill embankment) could be preloaded with soil/rock (locally sourced or imported) and held for a period of 12-18 months. Regular monitoring of instrumentation required throughout preload period.	No	Yes	Usually the most cost-effective form of ground improvement for settlement where there is a readily available supply of preload material (on site or offsite). Preload material can be re-used for other buildings once initial preload is complete. Provides a uniformly improved platform which should be suitable for a shallow foundation/slab on grade solution for future buildings. Preload pressure can be designed to the equivalent long-term building surcharge pressure. Large open site, with limited space constraints, well suited to earthworks type operations.	Not a complete improvement option in isolation – ground will still require treatment to mitigate liquefaction effects. Preload timeframes are uncertain. May require importation of significant volume of preload material if no suitable on-site source is available (e.g. Soft Pit Run or GAP65). Secondary settlement (creep) likely to continue even after preloading and will need to be designed for.	Low
Stone columns/ rammed aggregate piers	The ground beneath building platforms is improved by installation of columns of hardfill at a regular grid spacing. The columns are usually 600 mm to 1,000 mm in diameter and spaced in a triangular arrangement of 2D to 3.5D (D=column diameter), depending on the nature of the soils (a typical spacing of 2.5D should be assumed for this site). The columns are installed either by 'vibro-replacement' where aggregate is fed into the ground and vibrated by a probe that both densifies the natural ground (depending on the properties of the ground) and compacts the aggregate in the column. Alternatively, 'piers' can be installed by "ramming" aggregate in thin lifts from the base of the pier to ground surface level. In both cases, the result of this stabilisation method is the formation of a thick 'raft' that acts as a composite soil mass that fully translates and distributes building loads to the toe level of the piers/columns. Column/pier depths at this site could vary between 8 and 15 m depth. Stone columns and rammed aggregate piers are often used in combination with a reinforced gravel raft beneath building footprints to reduce the centre to centre spacing of the columns/piers and to help ensure the ground below the buildings behaves a uniform, composite founding material.	Yes (in the upper soils)	Partly	Provides a uniformly improved raft of ground suitable for supporting buildings on shallow foundation/slab on grade. Cost-effective when compared against traditional piled foundation options. Usually very effective method of ground improvement for sites which are largely dominated by sandy material. Large number of quarries located within 20 km of site.	There is no continuous and reliable end-bearing stratum for columns/piers to bear on. Therefore, settlement may still occur in the deeper soils, below the column/pier toe level. This could be mitigated by preloading. Requires significant volume of imported aggregate to construct columns/piers. Ground conditions are highly variable (peats, sands, clays etc) which could make installation problematic. The effectiveness of the stone columns will be variable due to the interlayering of sandy and silty deposits (meaning a relatively high density of columns is likely to be required) Some areas of the site may be too soft and compressible to confine stone columns when they are axially loaded. Soils at and below the toe level of the columns may be liquefiable under a ULS event which would could result in loss of end bearing.	Medium
Deep soil mixed (DSM) columns	Similar concept to Stone Columns and Rammed Aggregate Piers; building loads are effectively supported by bearing on ground at a greater depth (8-15 m) by installation of regularly spaced soil/cement mixed columns, typically 600 mm to 1,000 mm in diameter. The difference between stone column/RAPs and DSMs is that DSMs involve in situ stabilisation of the natural soils by injection of cement (and/or other suitable binders) and mixing by auger to form a column of relatively high material (typically around 1 MPa compressive strength).	Yes (in the upper soils)	Partly	Provides a uniformly improved raft of ground for supporting building on shallow foundation/slab on grade. Cost effective when compared against traditional piled solutions Avoids requirement to import large volume of granular material, as with stone columns/RAPs.	No continuous and reliable end bearing stratum for DSMs to bear on. Therefore, settlement may still occur in the deeper soils below the DSM toe level. This could be mitigated by preloading. Requires significant volume of cement for binding the soils. May be difficult to achieve a uniform/consistent column strength due to variable soil types (sands/clays/peats). Peat may not bind with cement. Soils at and below the toe level of the columns may be liquefiable under a ULS event which would could result in loss of end bearing.	Medium
Reinforced gravel raft	The upper soils are excavated and removed and replaced with high strength structural fill (using quarry graded hardfill such as GAP65), often reinforced with multiple layers of geogrid, to form a structural raft to support building structures and floor slabs. The minimum thickness of the raft (which can be a combination of new hardfill associated with ground raising and below ground hardfill replacement) would need to be approximately 3 m for buildings. This option is unlikely to be cost effective for external pavements/yards.	Yes	No (only partially)	Provides a uniform and stiff bearing layer to support buildings on shallow foundations and slabs on grade. Simple operation that could be easily conducted as part of 'normal' earthworks operations.	Not a complete solution in isolation, i.e. the ground would also require treatment for settlement (e.g. by preloading). Requires significant volume of structural fill imported from off site and disposal of the excavated material – either on site or off site. Excavation below groundwater level may be problematic	Medium

Table 4-4: Ground Improvement Options (continued)

Ground improvement option	Details	Addresses risks from		Pros	Cons	Relative cost appraisal
		Liquefaction	Settlement			
Excavation and re-compaction – Ground Improved raft	An upper layer of natural ground (where the Taupo Pumice Alluvium is present) is excavated to a depth below design subgrade level and replaced successively in 300 mm thick layers. Heavy compaction (using a 10t roller with vibratory mode capability) is applied to each successive layer to achieve a high degree of compaction. Cement and lime could be added to the materials to improve overall strengths if needed. The improved "raft" of high strength ground is sufficiently dense so as to mitigate the liquefaction susceptibility risk under a ULS seismic event meaning buildings and pavements can be safely supported on grade. The minimum thickness of the raft (which could be a combination of new, compacted bulk fill associated with ground raising and compacted natural soils) would need to be approximately 3 m for buildings and approximately 1 m for pavements. The soils would most economically be stabilised by excavation to a maximum of 2.5 m below ground level. This would be completed by standard earthmoving plant together. The strength of the stabilised raft could be improved using layers of geogrid between layers .	Yes (upper 3 m)	No (only partially)	Provides a uniform and stiff bearing layer to support buildings on shallow foundations and slabs bearing on grade. Cost effective solution - works could be completed as a simple bulk earthworks operation. No need to import or export significant volumes of material to/from the site. The site is very large and has ample space for bulk earthworks operations (eg. laying out and conditioning of soils on site).	Not a complete solution in isolation, i.e. the untreated ground would also require treatment for settlement (e.g. by preloading). Excavation below groundwater level may be problematic, requiring installation of diversion/cut-off drains around the perimeter of the excavation. A stiff layer of soil would be required at the base of the excavation to support trafficking of earthmoving plant. Excavation depths may therefore be limited, or special treatment may be required at the excavation base (e.g. by the use of BIDIM geotextile and/or geogrid).	Low-medium
Dynamic Compaction (DC)	The upper 3 to 5 m is compacted by dropping a heavy weight (approx. 10t) with a diameter of 1 to 2 m from a height of 6 to 10 m using a large crawler crane. The weight is dropped several times in one location until the compaction effectiveness is reduced (the optimum number of drops is usually determined by a trial prior to commencing). Drop locations are usually spaced at 1.5 to 2 x D (D= diameter of the weight). The "pitted" surface requires re-levelling and surface compaction following completion	Yes (upper soils)	No (only partially)	Very effective in sandy and other granular soils such as those present at near surface levels at this site. Simple operation that has been widely used and tested in New Zealand. Effectiveness can be easily assessed by performing tests pre and post DC.	Only suitable in predominantly sandy soils. Is not suitable for areas directly underlain by clayey and peat soils (e.g. Rotokawau Formation). Will require significant filling following compaction to building levels back up to original (pre DC) site elevations.	Low

4.7.3 Ground Improvement Option Selection

With reference to the various options outlined in Table 4-4 above, the following key criteria were considered for the selection of a recommended ground improvement option for this site for consideration as part of the geotechnical assessment process;

- Mitigation of liquefaction susceptibility risk (providing a minimum 3 m thick raft of non-liquefiable soils below any future building platform and up to 1 m below future road and yard pavements and the rail siding)
- Minimisation of consolidation and secondary compression settlement to magnitudes that are considered tolerable to future buildings, floor slabs and other pavements subject to sustained loading (e.g. yard areas)
- Provides for a subgrade of sufficient strength and thickness for construction of new road pavements and car parks
- Cost effectiveness
- Performance and effectiveness/risk
- Availability of resources (preferably locally)

With respect to the above criteria, we recommend that one of the two following options be considered when assessing future development on this site:

1. Excavation and re-compaction to form a stabilised raft <u>in combination with</u> preloading, or
2. Dynamic compaction <u>in combination with</u> preloading

Excavation and re-compaction or dynamic compaction will address the surficial soils (upper 2 to 3 m) providing a minimum crust thickness of 3 m below future building platforms and at least 1 m below future pavements (yards, roads, rail sidings etc). Preloading is intended to address long term settlement issues and would be required over the majority of all future building platforms and in other areas of the site subject to sustained surface loading (e.g. yard areas). These options are discussed in more detail below.

In Situ Raft Stabilisation

Excavation and re-compaction to form a ground improved raft of upper soils would involve excavation of the existing silty SAND (Taupo Pumice Alluvium) to a depth of between 1.5 m and 2.5 m below present ground level, beneath future building footprints. The same material (excluding any peat and/or soft clay encountered over this depth range) would then be progressively re-compacted in 300-350 mm thick lifts (loose thickness). Lime and cement could be blended with each layer using a hoe to improve the strength of the soil.

To provide a minimum crust thickness of at least 3m below future building slabs, the balance of the raft (1.5 to 0.5 m) would need to be formed using engineered fill to lift the site above present ground levels. New fill would ideally be SPR (quarry overburden) or alternatively cohesive soils (clays/silts) that are not susceptible to liquefaction. The thickness of new fill above present ground level will vary depending on the design levels of the building platform versus present site levels and the maximum practical cut (constrained by groundwater levels and the presence of peat and/or very soft clays/silts that underlie the Taupo Pumice Alluvium). It is recommended that at least 600 mm of Taupo Pumice Alluvium be left in situ over the underlying very soft soils to provide a working platform for supporting earthworks plant. The upper 300 mm of this layer may be able to be stabilised in situ using heavy vibratory rolling. If there is an insufficient thickness of Taupo Pumice Alluvium left in situ, it may be necessary to import SPR and place a working layer of at least 400 mm thickness in the base of the excavation. This would be used to form a ‘stiff’ platform on which to place and compact subsequent layers of stabilised fill.

For external pavements areas (yards, heavy traffic zones, road carriageways and the rail siding, the depth of the stiff crust could be decreased to between 1 and 1.5 m. As with the building platforms, the stiff crust can be made up of a combination of improved subgrade (excavated and recompacted) and/or new imported fill (preferably SPR).

The depth and thickness of the in-situ stabilisation and thickness of new, high strength fill will vary across the site and potentially across individual building platforms. This will need to be assessed on a case by case basis and will require further investigation.

The strength of the raft could be improved using layers of geogrid between compacted layers.

Groundwater levels beneath an area proposed to be in situ stabilised would need careful consideration to ensure the excavation and replacement is feasible and can be undertaken safely.

Dynamic Compaction

Dynamic Compaction (DC) could be considered as an alternative to in situ raft stabilisation for treating surface soils (upper 2-3 m). A preliminary dynamic compaction trial was undertaken (August 2019) on the site in an area underlain by 3-5m of Taupo Pumice alluvium. The method was confirmed to effectively mitigate the liquefaction susceptibility of these near surface sandy soils. As outlined in Table 4-4, Dynamic Compaction (DC) involves the repeated dropping of a heavy weight (8-12t) from a height of 6-10 m. The amount of energy (tonne.metres), and the number of drops required to compact the ground adequately will depend largely on the material type and thickness. The drop height, weight, number of drops and spacing of the drops will need to be determined by performing a trial on site in various different locations. However, for preliminary assessment purposes, we recommend allowing for the following:

- 8 to 12t weight, 1.5 to 2.0 m in diameter
- Drop height of 6 to 10 m
- Drop spacing of approx. 1.5 x weight diameter
- Min. 5 drops per location

Following completion of DC, the pitted surface will need to be re-levelled and recompacted to densify the disturbed soils around the drop locations. As the site level will be substantially lower following DC works, the platform will need to be lifted to design grade using imported fill (sourced either from on site or offsite). To ensure there is a min. 3 m thick raft beneath future building platforms, the imported fill layer may need to be at least 1 m thick.

Dynamic compaction should only be attempted in areas which are underlain by granular soils (e.g. Taupo Pumice Alluvium and Karapiro/Puketoka Formation sands). It is not usually an effective method for compaction of cohesive (clay/silt) soils or peats. The effectiveness of DC on soils below groundwater level is also somewhat limited as the pore water in the soil matric cannot rapidly dissipate.

DC results in significant ground vibrations within 20 to 50 m of the works area. Whilst most of the works are likely to be sufficient well offset from neighbouring properties, vibration effects may need to be addressed for neighbouring properties located within 50 m of the site.

Preloading

Preloading is required to address medium to long term settlement issues associated with consolidation and secondary compression of soils extending to great depths (40 m or more below ground level). Of primary concern is the Rotokawau Formation soils (very soft silts/clays and peat) which are between 10 and 20 times more compressible that the other geological units present at the site (Puketoka Formation and Karapiro Formation). The Rotokawau Formation varies between less than 1 m and 13.5 m in thickness across the site and is thickest at the eastern end of Lot 1, DPS 29288.

Where the thick layers of organic soils/peat (Rotokawau Formation) are present at the eastern end of the site these can have large proportion of secondary 'creep' settlement which may continue to occur for the design life of a structure and may be outside tolerable limits. This secondary settlement is very difficult to predict and often cannot be eliminated solely by the placement of preload and surcharging.

Preloading is likely to be required in the following areas:

- All building platforms that aren't load compensated (i.e. "unloaded" by cut earthworks) or positioned entirely over "high ground with an elevation of RL > 9 m" that is underlain directly by Karapiro/Puketoka Formation soils;
- All yard areas which could be subjected to medium to long term loading and the rail siding.
- Roads and rail siding where fill is being placed to lift the design levels

The required preload height will depend on the nature of the development (i.e. light industrial versus commercial/retail buildings), however, for preliminary purposes we recommend allowance for the following:

i. A 35 kPa surcharge pressure which could be formed using Soft Pit Run, 2.0 m high (unit weight of 17-18 kN/m^3 with nominal compaction) or a site sourced material (e.g. Taupo Pumice Alluvium) to a height of 2.2 -2.3 m (unit weight of 15-16 kN/m^3 with nominal compaction).
ii. The preload should extend over the entire building footprint plus an additional width of 5 m around all boundaries.
iii. Installation of preload monitoring instrumentation including profilometers, piezometers, extensometers and survey pins with regular monitoring;
iv. A hold period of approximately 12-18 months (to be confirmed) to allow for up to 90% of theoretical maximum consolidation to occur. This preload period can be reduced by either surcharging (placing additional fill on top of the preload) or by installation of "wick drains". Given the relatively sandy nature of the subsoil materials above and below the Rotokawau Formation, the use of "wick drains" is unlikely to provide much benefit.

Actual preload details and timeframes would be the subject of a detailed preload design. Following completion of the consolidation period, the preload material can be removed and either used directly as bulk fill material or as a preload for additional, future building platforms.

It is recommended that a trial preload be undertaken in at least two locations at the site, as early as possible prior to commencing any future building developments. Information from trial preloads can be used to rationalise preload design (optimising preload heights and extents), to determine the likely magnitude of settlements (to assess over-fill heights) and post-construction settlements (so that these can be accommodated in building design). A trial preload would also be used to determine timeframes for completion of the consolidation period. Preload instrumentation, such as profilometers, piezometers and extensometers installed beneath a trial preload, could be used to enable back-calculation of soil parameters (the compressibility and permeability of the various soil units) which could then be used to engineer 'production' preloads.

4.8 Building Foundations and Floor Slabs

Provided that the building platforms are subject to the ground improvement works to mitigate liquefaction and/or settlement risks, as outlined in Section 4.7 below, future building structures and floor slabs could be fully supported on grade, i.e. shallow pad footings for support of portal frame structures and strip footings to support perimeter precast panel walls.

As outlined in Section 4.4, it is essential that a minimum "crust thickness" (non-liquefiable soils) of at least 2.5 m is present below the underside of all shallow foundations to eliminate the life-safety threat from liquefaction during a ULS seismic event.

Piled foundation options could be considered as an alternative for support of building structures. However, as there is no continuous and reliable end-bearing strata to bear on to, piles would need to rely on skin friction resistance only and may need to extend to considerable depths to achieve suitable load capacities. As the potential for liquefaction in sandy layers of the Karapiro and Puketoka

Formation is high (ULS seismic case) a significant component of negative skin friction would need to be considered for design. The load contribution from post-seismic downdrag effects is likely to make deep pile foundations highly inefficient for support of building structures. Furthermore, supporting building structures on piled foundations and floor slabs on grade may result in the floor slab “hanging-up” on pile caps with sag deformation of the slab between pile locations.

5. Further Work

As noted throughout this document, further geotechnical investigations and detailed geotechnical analysis will be required to support the subdivision and consenting stage of any future development.

The scope of additional geotechnical investigations is likely to include the following;

- Fully cored machine boreholes extending to depths of approximately 30 m below ground level with regular sampling for laboratory testing;
- Installation of groundwater monitoring instrumentation (piezometers) for measuring groundwater levels and assessing seasonal groundwater fluctuations;
- Infill Cone Penetration Tests (CPTs) to achieve a regular, typical spacing of approximately 50m between each test in future development areas;
- Test pits extending to depths of approximately 3 m below ground level for categorisation/characterisation of near surface soils, and for bulk sampling and laboratory testing;
- A suite of laboratory testing to characterise soils for earthworks design, confirm liquefaction susceptibility, and assess soil compressibility characteristics.

The above investigations would likely be completed in stages as the development is progressed.

Following completion of investigations, the following geotechnical appraisal and analysis work will be required;

- Additional settlement and liquefaction analyses;
- Assessment of the suitability of site won material for re-use as engineered fill and derivation of compaction criteria for earthworks specifications;
- Confirmation of the proposed ground improvement option;
- Design of a trial preload, or alternatively a production preload for a future building platform;
- Assessment of post-construction settlements, following preloading, to confirm that these can be tolerated by the building structures, floor slabs and pavements;
- Assessment of subgrade strengths for pavement design.

6. Conclusions

A preliminary geotechnical investigation has been undertaken as part of a geotechnical assessment of the site located between Tahuna Road and Balemi Road, Ohinewai. The objective of the investigation was to assess the suitability of the site for mixed use development ranging between light industrial, warehouse/factory buildings to residential dwellings.

The conclusions and preliminary geotechnical advice presented in this report are intended to support a feasibility assessment for development of the land. Further geotechnical investigations and detailed geotechnical analyses will be required for design.

Ground Conditions

1. The site is underlain by Tauranga Group soils comprising a surface layer of Taupo Pumice Alluvium (1-3 m thick) over Rotokawau Formation soils (1 to 13.5 m thick) and Karapiro/Puketoka Formation extending to depths of around 40 m below ground level. The Whangamarino Formation occurs below the Karapiro/Puketoka Formation unit and is underlain by Te Kuiti Group "bedrock" at approximately 100 m depth.
2. The Rotokawau Formation is a recent alluvial deposit comprised of very soft soils (clays/silts and peat) with typical undrained shear strengths of 5 to 10 kPa. This material is highly compressible.
3. The Karapiro/Puketoka Formation soils are Pleistocene Age deposits comprising interbedded sands, silts, clays and peat with some gravel beds. These soils are considerably less compressible than the Rotokawau Formation but are still expected to settle under surcharge pressures.
4. The lower lying areas of the site (RL 7.5 m and below) are generally characterised by greater thicknesses of the Rotokawau Formation and are therefore considerably more challenging, from a geotechnical perspective, to develop. By contrast, areas of the site with surface elevations greater than RL 9.0 m are typically directly underlain by Karapiro/Puketoka Formation soils that are of higher strength and less compressible.
5. There are several areas of the site which are considered to be significantly constrained for future development. These are delineated as areas of potential 'large magnitude' settlement (hatched red on Figure 529-004 in Appendix A).
6. Groundwater is expected at near surface levels (0.5 to 1.5 m below ground level).

Earthworks

7. The Taupo Pumice Alluvium (silty, pumiceous sand) and the Karapiro/Puketoka Formation soils are expected to be largely suitable for re-use as engineered fill. Some conditioning and blending may be required to achieve suitable compaction specifications.
8. Excavation below groundwater level should be avoided wherever possible as groundwater inflows are likely to be significant and could result in "running sands" and instability of soft clays/silts and peat.
9. The Rotokawau Formation soils are very unlikely to be suitable for use as engineered fill;
10. Wherever possible, a minimum "working cover" of approximately 800 mm should be maintained above the surface of the very soft Rotokawau Formation soils. Alternatively, a layer of SPR may need to be placed over the top of the soft soils to provide a working platform upon which fill can be compacted over.
11. Placement of fill above existing ground level is likely to initiate ground surface settlement which will need to be considered for design and construction of civil infrastructure and buildings. A sufficient lag time should be allowed between completion of fill and construction of civil infrastructure and new buildings.
12. Where "high ground" areas of the site are cut down, these areas will be partially to fully load compensated. This will mitigate or eliminate the settlement potential from future building loads.

13. Allowance should be made for undercut and removal of significant volumes of unsuitable soil and for importation of quality bulk fill (e.g. soft put run/quarry overburden) or cohesive soils (clays/silts)

Site Seismicity and Liquefaction

14. Where more than 10 m of very soft soils with an undrained shear strength of less than 12.5 kPa (Rotokawau Formation) is present, the site should be categorised as Class E – soft soil site for seismic design purposes. Elsewhere, the site could be considered Class D, however there is presently insufficient investigation data to accurately delineate these areas.
15. Preliminary liquefaction analyses were undertaken using CPT test results to assess the liquefaction susceptibility of the subsoils under both SLS (50-year AEP) and ULS (500-year AEP) seismic events. The results indicate that there is a low risk of liquefaction occurring under SLS conditions. However, under ULS shaking (PGA = 0.22g), the subsoils are considered to be liquefiable from near surface (below groundwater level).
16. The potential effects of liquefaction are potentially "severe" over parts of the site (liquefaction severity number, LSN > 50) with potential for large magnitude total and differential settlements affecting structures, and damaging services. The variability of potential liquefaction effects across the site is presented on Figure 529-003 in Appendix A.
17. Liquefaction of the near surface soils (Taupo Pumice Alluvium) may present a "life-safety" risk for buildings supported on shallow foundations embedded within or over this layer.
18. Ground improvements will be required to mitigate the effects of liquefaction at this site.

Settlement

19. Settlement is expected to occur across most of the site where new stresses are introduced to the ground (e.g. placement of new fill, building floor slab dead loads and live loads, foundation bearing pressures etc). Figure 529-004 presents the range of settlements anticipated across the site for a uniform surface loading of 45 kPa (1 m of bulk fill, slab dead weight of 10 kPa and a distributed floor slab live load of 15 kPa).
20. Total estimated settlements for a 45 kPa surcharge pressure generally range between 100 mm to > 2,000 mm with the magnitude of settlement proportional to the thickness of the Rotokawau Formation soils. These materials are between 10 and 20 times more compressible than the Karapiro/Puketoka Formation soils.
21. Preloading of most building platforms, yard areas, the rail siding and possibly some road corridors is recommended to mitigate the risk of post-construction settlements affecting buildings and pavements.
22. Even following preloading, ongoing secondary compression (creep) settlement may still occur over the design life of the structures. The magnitude of post construction settlement will need to be carefully evaluated to confirm that the future ground movement can be accommodated by building structures and infrastructure.
23. Areas of "high ground" (RL > 9 m) which are cut down to form gently graded land or terraced platforms for buildings will be partially or wholly load compensated for future building loads. These areas would therefore not require preloading.

Civil Infrastructure

24. Installation of buried services below groundwater level is likely to be problematic due to the presence of high groundwater levels in combination with loose sands at near surface levels. Trenches are unlikely to maintain any stability. It is therefore recommended that trenchless installation methods be considered (e.g. thrusting) for service installation, or that service trenches are maintained above groundwater level (in new fill and natural soils).
25. The ground beneath future road pavements, yards and the rail siding should be improved to a depth of between 1.0 and 1.5 m below ground level to provide a stiff raft for support of the

pavements, for effective load spreading and to mitigate the effects liquefaction during a ULS seismic event.

26. Yard areas and the future rail siding should also be preloaded to minimise the risk of long-term settlement effects.

Ground Improvements

27. Various different ground improvement options have been presented in Table 4-4 of this report. These are intended to minimise post-construction settlements, to provide a stiff raft for future buildings and pavements to bear on and to mitigate the effects of liquefaction following a ULS seismic event. Pros and cons of each option, along with a qualitative assessment of costings are also presented in the table.
28. Two different ground improvement options have been identified as being potentially well-suited to this site;
    a. Excavation and re-compaction of upper soils (sands only) in combination with Preloading; and
    b. Dynamic Compaction in combination with preloading. The pros and cons of these two options, along with concept design details are presented in Section 4.7.3.
29. Field trials have been undertaken to confirm the viability of Dynamic Compaction and results demonstrate the feasibility of this method. A preload trial is also recommended to determine required preload heights, extents, timeframes and post-construction settlement magnitudes.
30. Vibration effects from Dynamic Compaction will need to be considered for any properties within 50 m of the works area.

Building Foundations

31. Provided that future building platforms have been subject to ground improvement that effectively mitigates the risk of liquefaction in the upper soils and settlement, it is expected that most structures could be supported on shallow foundations with a slab bearing on grade. Settlement tolerant structures and cladding systems are recommended. Floor slabs should be post-tensioned or fibre reinforced or otherwise designed to tolerate some differential settlement.

Further work

32. Additional geotechnical investigations and geotechnical analyses will be required to support design and detailing of the subdivision earthworks, civil infrastructure and all new buildings. A provisional scope of further investigation and analysis is outlined in Section 5. This will need to be confirmed as development details and plans are finalised.

7. Applicability

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

Report prepared by:	Report reviewed by:
Nick Speight **Senior Geotechnical Engineer**	Matthew Wansbone **Senior Geotechnical Engineer**

Document control record

Report Title	Proposed Plan Change, 231 Tahuna Road, Ohinewai Geotechnical Assessment Report
Initia Project Reference	P-000529
Client	AMBURY PROPERTIES

Revision	Date	Revision detail	Author	Reviewer	Approved by
A	31/10/19	Draft Issue for Comment	M. Wansbone	N. Speight	M. Wansbone

Current Revision	A

Appendix A: Figures

File Ref: 1805_018_Illustrative_Masterplan.indd

1. REALIGNED LUMSDEN / BALEMI ROADS SO SIDING CROSSES AT 90 DEGREES
2. CARGO / FREIGHT STORAGE AREA
3. PRIMARY INDUSTRIAL TENANT WITH DIRECT ACCESS TO RAIL SIDING, OFFICE AND CAR PARKING
4. ACCESS TO RAIL SIDING AND FACTORY SITE
5. LIFESTYLE LOTS TO REMAIN
6. MAIN LIGHT INDUSTRIAL AREA
7. SHARED PATH CONNECTION TO EXISTING OHINEWAI, PRIMARY SCHOOL AND WAIKATO RIVER
8. SERVICE CENTRE WITH TRUCK STOP AND CONVENIENCE RETAIL
9. EMERGENCY SERVICE BUILDINGS AND BUS DEPOT
10. FACTORY OUTLET STORES
11. POTENTIAL FUTURE ROAD ACCESS IF ADJOINING FARM IS DEVELOPED
12. COMMUNITY FACILITY / HALL / COMMUNITY HUB
13. COMMUNITY CORNER SHOP
14. SPORTS FIELDS
15. MARKET GARDEN AND PROCESSING AREA / CAFE
16. SHARED PATH CONNECTIONS INTO DOC RESERVE
17. ORCHARD / BEE HIVES AND PROCESSING AREA
18. FULL THREE WAY INTERSECTION. DESIGN TBC
19. LEFT IN / LEFT OUT INTERSECTION. DESIGN TBC
20. REINSTATEMENT OF HISTORIC TRAIN STATION AND POSSIBLE SERVICE TO AUCKLAND / HAMILTON

N

0 250m

1:7,500 @ A3

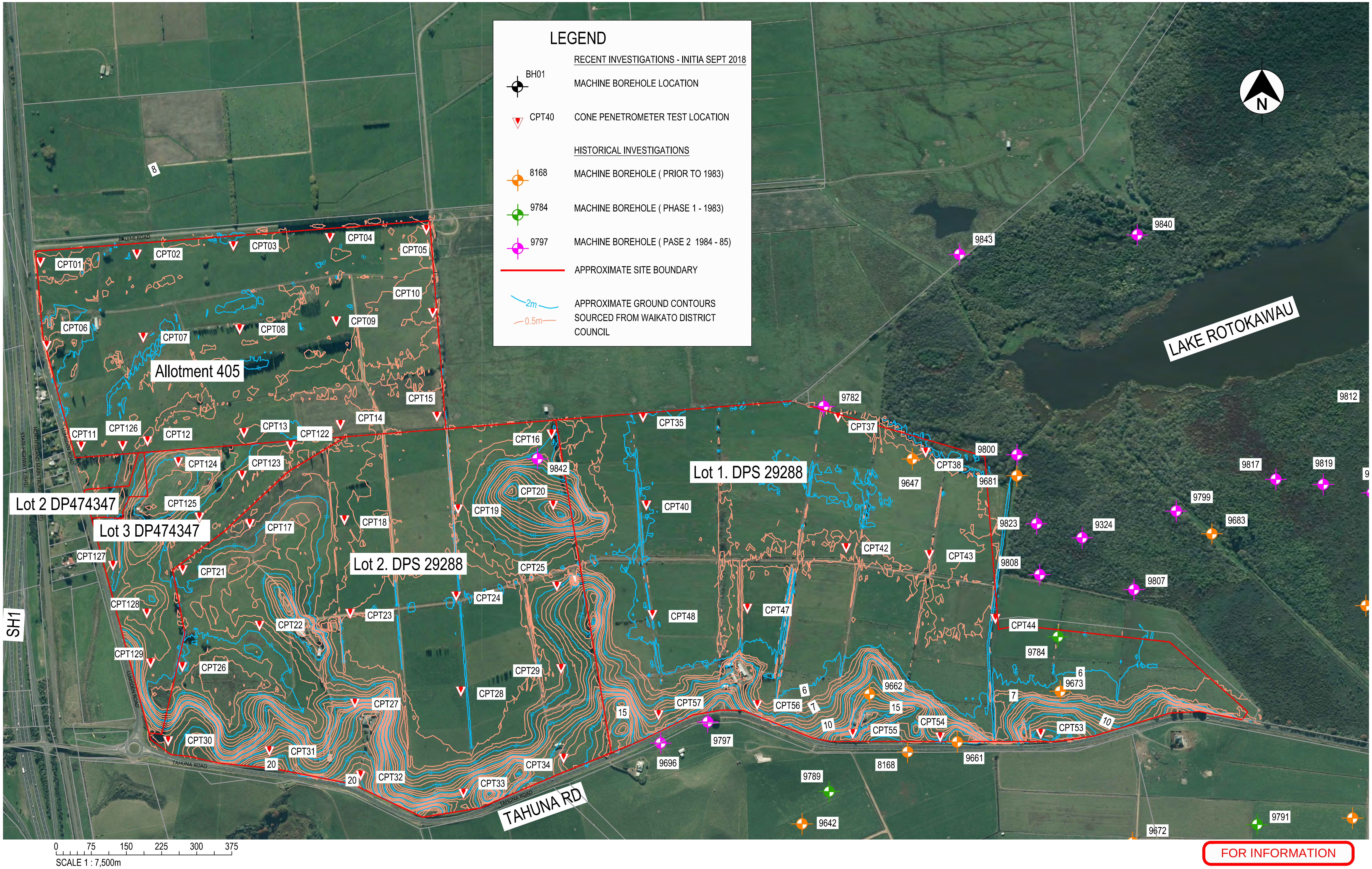
OHINEWAI STRUCTURE PLAN

Illustrative Masterplan

Date: 03 October 2019 | Revision J

Drawing Number: 1805_018

Plan prepared by Adapt Studio Ltd for Gaze Property Solutions



FOR INFORMATION

Rev	Revision Description	Designed	Drawn	Checked
B	Lots 2 & 3 DP474347 added	AW	GA	AW
A	First Issue	NS	LN	NS

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AMBURY PROPERTIES

PROPOSED MIXED USE COMMERCIAL AND LIGHT INDUSTRIAL DEVELOPMENT

GEOTECHNICAL INVESTIGATION
TEST LOCATION PLAN
AT 231 TAHUNA ROAD, OHINEWAI

Initia Project ref: P000529

Figure Number 529-001

Revision B

Document No.

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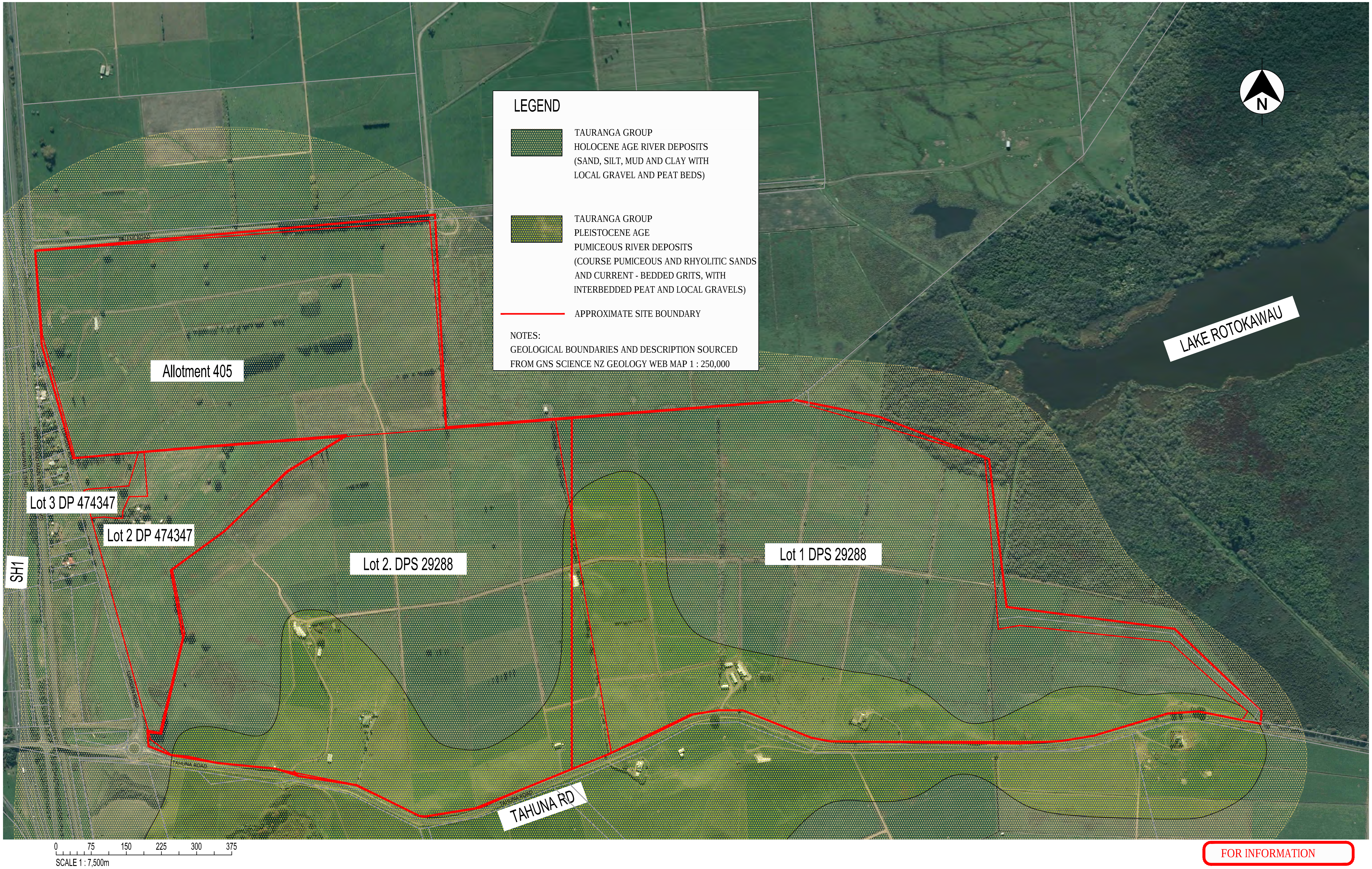

LEGEND

🟩 TAURANGA GROUP
HOLOCENE AGE RIVER DEPOSITS
(SAND, SILT, MUD AND CLAY WITH
LOCAL GRAVEL AND PEAT BEDS)

🟨 TAURANGA GROUP
PLEISTOCENE AGE
PUMICEOUS RIVER DEPOSITS
(COURSE PUMICEOUS AND RHYOLITIC SANDS
AND CURRENT - BEDDED GRITS, WITH
INTERBEDDED PEAT AND LOCAL GRAVELS)

🟥 APPROXIMATE SITE BOUNDARY

NOTES:
GEOLOGICAL BOUNDARIES AND DESCRIPTION SOURCED
FROM GNS SCIENCE NZ GEOLOGY WEB MAP 1 : 250,000

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Rev	Revision Description	Designed	Drawn	Checked
B	Lots 2 & 3 DP474347 Added	AW	GA	AW
A	First Issue	NS	LN	NS

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AMBURY PROPERTIES

PROPOSED MIXED USE COMMERCIAL & LIGHT INDUSTRIAL DEVELOPMENT

GEOLOGICAL MAP

Initia Project ref: P000529

Figure Number 529-002

Revision B

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Document No.

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A	First Issue	LN	LN	NS

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AMBURY PROPERTIES

PROPOSED MIXED USE COMMERCIAL & LIGHT INDUSTRIAL DEVELOPMENT

LIQUEFACTION SEVERITY
FOR ULS EARTHQUAKE
(PGA = 0.22g MW = 5.8)

Initia Project ref: P000529

Figure Number 529-003

Revision B

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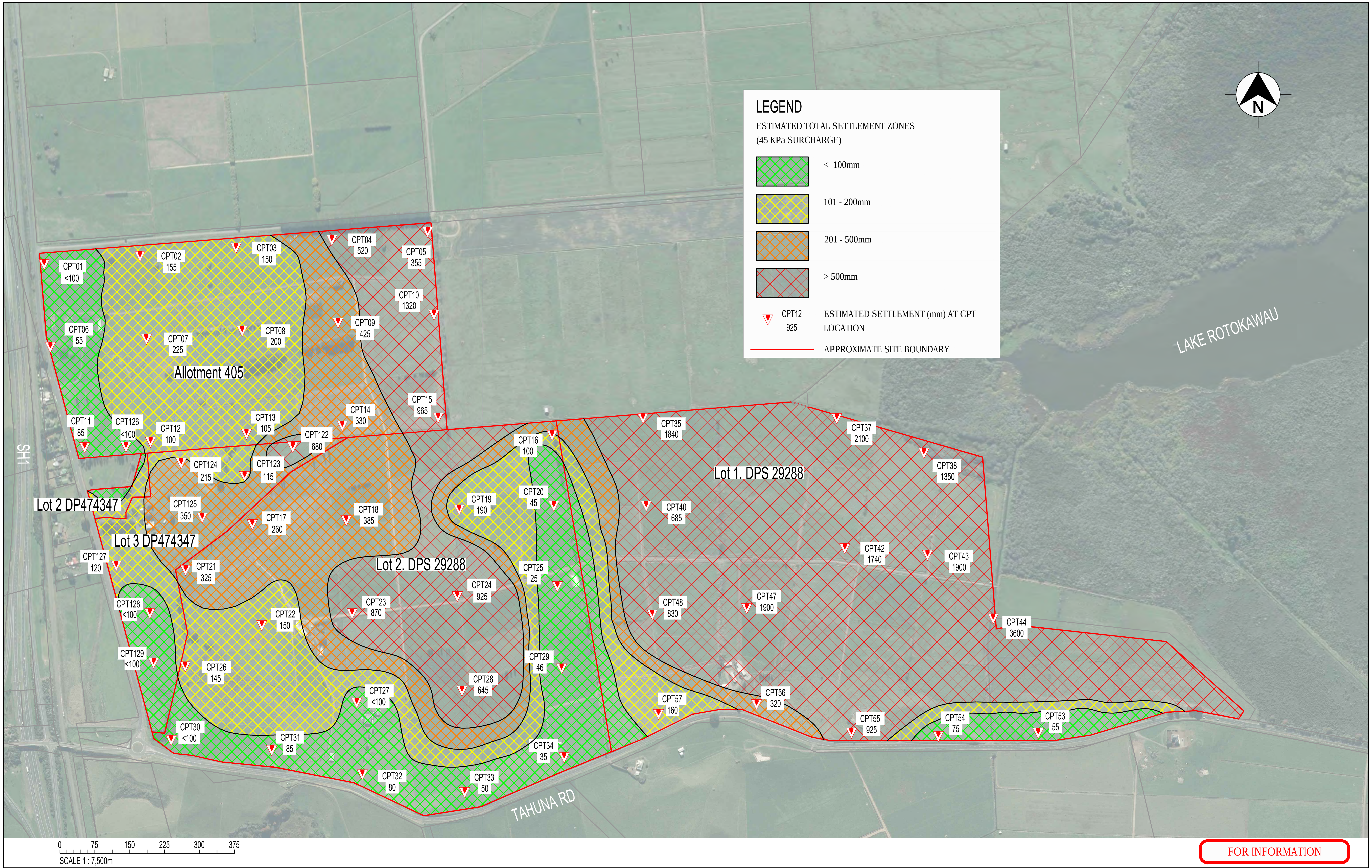

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B	LOTS 2 & 3 DP 474347 ADDED	AW	GA	AW
A	First Issue	LN	LN	NS
Rev	Revision Description	Designed	Drawn	Checked

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AMBURY PROPERTIES

PROPOSED MIXED USE COMMERCIAL & LIGHT INDUSTRIAL DEVELOPMENT

SETTLEMENT ZONING PLAN
45 KPa SURCHARGE

Initia Project ref: P000529

Figure Number 529-004

Revision B

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Document No.

Appendix B: Geotechnical Factual Report

INITIA
GEOTECHNICAL SPECIALISTS

AMBURY PROPERTIES

231 TAHUNA ROAD, OHINEWAI

GEOTECHNICAL FACTUAL INVESTIGATION REPORT

INITIA REF P-000529 REV 2

OCTOBER 2019

Table of Contents

1.1 Introduction

This factual report presents the results of a preliminary geotechnical investigation and laboratory testing undertaken across the site located at 231 Tahuna Road, Ohinewai, Waikato. The purpose of the geotechnical investigation was to assess the ground conditions and evaluate geotechnical constraints and opportunities for a proposed mixed-use development.

The geotechnical investigations are preliminary only and if development on this site was to occur, detailed geotechnical investigations will be required to support design and consenting stages of the project.

This report is a factual summary of the site and geotechnical investigations and laboratory testing only. Interpretation of the geotechnical data and preliminary geotechnical advice on the development potential of the land will be presented in a separate report.

1.2 Site Description

1.2.1 Location

The site encompasses five legal properties located on the eastern side of State Highway 1, at 231 Tahuna Road and Balemi Road, Ohinewai. The total site area is approximately 178 ha and is made up of the properties legally described as Allotment 405, Whangamarino Parish (~37 ha), Lot 2, DP 474347 (~0.8 ha), Lot 3, DP 474374 (~10.9 ha), Lot 1, DPS 29288 (~68 ha) and Lot 2, DP 29288 (~61 ha). The location of the site and the individual property boundaries are presented in Figure 1 below.

Figure 1: Site location and legal boundaries

1.2.2 Description

The site is presently almost completely grass covered and is used for agricultural purposes. It is bounded by Tahuna Road to the south, Balemi Road and other agricultural land to the north, Department of Conservation land (including Lake Rotokawau) to the east, and Lumsden Road to the west.

The land is typically low lying and flat with the exception of a low ridgeline on the southern boundary (which Tahuna Road has been formed on) and two spurs which run in a north south direction through the two southern properties (Lots 1 and 2, DP 29288). With reference to Figure 529-01 attached in Appendix A, ground surface elevations vary between approximately RL 20 m on the southern boundary with Tahuna Road and RL 6 m at the far eastern end of the site. With the exception of the localised ridge lines, the general site grade falls very gently from west to east.

The Waikato River is located approximately 1 km to the west of the site.

1.3 Development Proposal

The Illustrative Masterplan for the development (Adapt Studio, Revision J) shows that the proposed development could include the following;

- A single use development over the 37 ha property at the north of the site, including a 5 to 10 ha warehouse/factory with surrounding yards and carparking;
- A rail connection from the main trunk line (west of the site) along the northern boundary of Allotment 405 (37 ha property);
- Light industrial development over Lot 3 DP 474374 – the 10.9 ha property at the western side of the site;
- Mixed light industrial and retail development, with possible residential development at the eastern end of Lot 2 DPS 29288 - the 61ha property at the south western end of the site;
- Residential and community facilities over Lot 1 DPS 29288 – the 68 ha property – at the south eastern end of the site;
- Internal roads and installation of civil services;
- Parks and reserve land.

1.4 Site Investigations

1.4.1 General

Geotechnical investigations were carried out at the site in three stages. The first stage of the investigation was completed between 5 September and 14 September 2018, the second stage on 31 October 2018 and the third stage on 29 July 2019. The Stage 1 investigations comprised a limited number of machine boreholes and Cone Penetration tests (CPTs). Test pits were completed for the Stage 2 investigations to collect soil samples for laboratory testing. The Stage 3 investigations were completed following provision of access to Lot 2 and 3 DP 474374. Investigation locations were selected by Initia to provide an overview of the ground conditions across the entire site (tests spaced at approximately 250 m centres). Co-ordinates were extracted from AutoCAD for the proposed test locations and were set out on site using a hand-held GPS unit.

Several of the proposed investigations (CPTs) at the eastern end of the site could not be undertaken due to the saturated nature of the ground at the time of the fieldwork.

A geotechnical investigation location plan is presented on Figure 529-01 in Appendix A. Investigation locations should be considered approximate only (+/- 10 m from actual locations)

1.4.2 Historical Geotechnical Investigations

As part of a desk study assessment of the site, Initia has located a series of reports which document the results of an extensive geotechnical investigation undertaken in Ohinewai in the early 1980's for a proposed opencast coal mine. As part of this investigation, several deep machine boreholes were drilled over multiple investigation phases within the site boundaries (specifically within Lot 1, DP 29288) and to the south and south east of the site. The locations of all known investigations undertaken for the Ohinewai open-cast coal mine feasibility study are presented on Figure 529-01 attached in Appendix A. Data from the Phase 2 geotechnical investigation[1] has only been able to be sourced. Copies of the relevant machine borehole logs (BH 9782, BH9783, BH9796, BH9797 and

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[1] State Coal Mines: Ministry of Energy; Ohinewai Opencast Feasibility Study; Geotechnical Investigations Phase II, December 1986, Volume 1 and Volume 2, prepared by RWL Mining Consultants

BH9842)[2] are attached in Appendix F of this report. Other borehole logs are available within the Phase 2 investigation report however, these were wash-drilled to a depth of approximately 60 m and are therefore of little value for the purposes of this assessment.

1.4.3 Recent Investigations

1.4.3.1 Stage 1 Investigations

Machine Boreholes

The drilling of three cored machine boreholes (at two locations) was undertaken over the period 6 to 10 September, 2018. Borehole 1 (BH1) was drilled to a depth of 17 m using a tractor mounted, rotary coring drilling rig, supplied and operated by DCN Drilling Ltd. In situ strength testing, comprising shear vane tests (in cohesive soils) and standard penetration tests (in sands) were performed at 1.5 m depth intervals. A combination of open-barrel and HQ3 triple tube coring was undertaken throughout this borehole, however, due to the soft/loose nature of the soils, core recovery was limited and the borehole was abandoned above the target depth of 25 m.

A sonic rig was used to re-drill borehole BH1 (BH01a) to achieve better core recovery. In situ testing (SPTs) was commenced from the termination depth of borehole BH1 (17 m depth) and borehole BH01a was terminated at the target depth of 24.5 m.

Borehole BH2 was also drilled using the Sonic rig and achieved relatively successful core recovery. As with BH01/BH01a, in situ strength testing (shear vanes and SPTs) were carried out at 1.5 m depth intervals. BH02 was terminated at a depth of 21 m below ground level.

All drilling works were carried out under the full-time supervision of a senior field geologist from Geotechnics Ltd. The recovered drill core was logged in accordance with the New Zealand Geotechnical Society "Field Description of Soil and Rock" Guidelines.

Investigation locations are presented on Figure 529-01 in Appendix GFR-A. Machine borehole logs and core photographs are presented in Appendix GFR-B. A summary of the machine borehole details is presented in Table 1 below.

Table 1: Summary of machine borehole investigations

Investigation ID	Easting (mE, NZTM2000)	Northing (mN, NZTM2000)	Elevation (m, RL)[1].	Termination depth (m, b.g.l)
BH1	1791070	5849472	10.5	16.95 m
BH1a	1791070	5849471	10.5	24.45 m
BH2	1791894	5849542	6.5	21.0 m

Note 1: The ground surface elevations presented are based on interpretation from Waikato Regional Council LIDAR and are expected to be accurate to + or – 1m.

Cone Penetration Tests

A total of 48 No. Cone Penetration Tests (CPTs) were carried out by Geotech Drilling Ltd between 5 and 14 September 2018. A further 9 CPTs were proposed but were deleted (CPT's 36, 39, 41, 45, 46, 49, 50, 51, 52) due to site access issues associated with the saturated, soft ground at the time of investigation.

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[2] New Zealand State Coal Mines: Ohinewai Underground Prospect; Geotechnical Testing of Core Samples from Boreholes 9802, 9803, 9084 and 9805, prepared by Central Laboratories, Report 2-85/19 Vol1 and Vol 2

The CPTs were extended either to the target depth of 25 m below ground level or until ‘refusal’ occurred (from a combination of cone resistance and skin friction) or from failure of the reaction anchors which were embedded in the upper, soft soils.

The CPT investigation locations are presented on Figure 529-01 in Appendix GFR-A. CPT traces (qc, fs, friction ratio and pore water pressure profiles only) are attached in Appendix C. A summary of the CPT tests is presented in Table 2 below.

Table 2: Summary of Cone Penetration Test investigations

CPT Ref	Easting (mE, NZTM2000)	Northing (mN, NZTM2000)	Elevation (m, RL)[1]	Termination depth (m, b.g.l)	Comment
1	1791057	5849650	8.0	4.5	Refusal on dense sand
2	1791263	5849667	8.0	25	Target depth
3	1791469	5849685	8.0	25	Target depth
4	1791675	5849702	8.0	25	Target depth
5	1791881	5849720	7.5	25	Target depth
6	1791070	5849472	10.5	25	Target depth
7	1791276	5849489	8.0	25	Target depth
8	1791482	5849507	7.5	25	Target depth
9	1791688	5849524	7.5	25	Target depth
10	1791894	5849543	6.5	25	Target depth
11	1791144	5849257	8.5	20.5	Refusal on dense sand
12	1791285	5849268	8.5	25	Target depth
13	1791491	5849286	8.5	25	Target depth
14	1791697	5849303	7.5	25	Target depth
15	1791903	5849321	7.0	20.3	Refusal on dense sand
16	1792148	5849283	8.0	14.4	Reaction anchor failure
17	1791504	5849091	7.0	17.1	Reaction anchor failure
18	1791706	5849100	7.5	17.7	Refusal on dense sand
19	1791949	5849123	7.0	11.5	Reaction anchor failure
20	1792152	5849131	14.5	22.8	Reaction anchor failure
21	1791361	5848993	7.5	17.5	Reaction anchor failure
22	1791524	5848874	8.5	13.5	Refusal on dense sand
23	1791718	5848900	6.5	15.8	Reaction anchor failure
24	1791945	5848937	6.0	18.6	Reaction anchor failure
25	1792160	5848958	7.5	11.8	Reaction anchor failure
26	1791360	5848786	8.0	12.5	Refusal on dense sand
27	1791728	5848708	11.0	6.0	Refusal on dense sand
28	1791955	5848734	6.0	17.0	Reaction anchor failure
29	1792169	5848782	7.0	11.4	Reaction anchor failure
30	1791329	5848628	13.0	6.5	Refusal on dense sand
31	1791546	5848606	16.5	16.5	Refusal on dense sand
32	1791741	5848554	19.5	25	Target depth
33	1791960	5848516	13.0	9.4	Refusal on dense sand

CPT Ref	Easting (mE, NZTM2000)	Northing (mN, NZTM2000)	Elevation (m, RL)[1]	Termination depth (m, b.g.l)	Comment
34	1792174	5848591	13.0	19.5	Reaction anchor failure
35	1792344	5849319	6.0	25	Target depth
37	1792760	5849319	6.5	25	Target depth
38	1792947	5849244	6.0	25	Target depth
40	1792350	5849131	6.0	14.0	Reaction anchor failure
42	1792777	5849040	6.5	25	Target depth
43	1792955	5849025	6.5	21	Reaction anchor failure
44	1793096	5848889	6.0	20	Reaction anchor failure
47	1792566	5848911	7.5	10.7	Reaction anchor failure
48	1792364	5848897	6.0	11.3	Reaction anchor failure
53	1793193	5848643	14.0	13.3	Reaction anchor failure
54	1792978	5848636	11.5	12.3	Reaction anchor failure
55	1792791	5848643	16.0	12.7	Reaction anchor failure
56	1792587	5848705	7.0	13.2	Reaction anchor failure
57	1792377	5848684	9.5	11.5	Reaction anchor failure

Note 1: The ground surface elevations presented are based on interpretation from Waikato Regional Council Lidar and are expected to be accurate to + or – 1m.

1.4.3.2 Stage 2 Investigations

Test Pits

Six machine excavated test pits were undertaken on 31 October 2018 using a 12t excavator operated by Broughton Contracting Ltd. The test pits were undertaken to sample the natural soils for lime / cement binder laboratory testing. Bulk samples (20 kg) bags were recovered from each of the test pits and transported to the Stevenson's Laboratory for testing. Sampling was carried out on the spoil stockpile from each test pit using the hand sampling method.

All works were carried out under the full-time supervision of a senior field specialist from Initia Ltd. The recovered test pit spoil was logged in accordance with the New Zealand Geotechnical Society "Field Description of Soil and Rock" Guidelines.

Investigation locations are presented on Figure 529-01 in Appendix GFR-A. Test pit logs and photographs are presented in Appendix GFR-D. A summary of the test pit investigations is presented in Table 3 below.

Table 3: Summary of test pit investigations

Investigation ID	Easting (mE, NZTM2000)	Northing (mN, NZTM2000)	Elevation (m, RL)[1].	Termination depth (m, b.g.l)
TP01	1791142	5849410	10	2.0
TP02	1791213	5849592	10	2.5
TP03	1791454	5849618	8.0	3.2
TP04	1791765	1791765	8.0	2.7
TP05	1791696	1791696	8.0	2.8
TP06	1791467	1791467	8.0	2.5

Note 1: The ground surface elevations presented are based on interpretation from Waikato Regional Council LIDAR and are expected to be accurate to + or – 1m.

Laboratory Testing

Samples taken from the test pits on the 31 October 2018 were tested by Stevenson's Laboratory who are an IANZ accredited civil materials testing laboratory. Testing included blending 1% lime and between 3 to 5% cement (proportion by dry mass of the soil) with the samples and allowing a 7-day curing time. Soaked Californian Bearing Ratio (CBR) tests were then performed on the cured samples. Particle Size Distribution (PSD) tests were also performed on representative samples from the test pits.

A summary of the laboratory testing completed with location references is outlined in Table 4 below. The results of the laboratory testing are presented in Appendix GFR-E.

Table 4: Laboratory testing schedule

Sample Ref #	Location	Depth (m)	Material	Quantity Soaked CBR%	Quantity Soaked CBR% + Binder			No. PSD
				Natural	1% Lime + 3% Cement	1% Lime + 4% Cement	1% Lime + 5% Cement	
1	TP01	0.5-1.0	SAND yellow brown with orange bands	1	1	1	1	1
2	TP01	1.3-1.6	SAND with pumice gravels		1	1	1	1
3	TP02	2.0-2.5	SAND with pumice gravels	1	1	1	1	1
4	TP03	1.3-1.6	SAND - grey wet		1	1	1	1
5	TP03	3.1	SAND with some silt grey light brown		1	1	1	1
6	TP05	0.5-0.8	SAND yellow brown with orange bands		1	1	1	1
7	TP05	2.5-2.8	SAND, grey	1	1	1	1	1

1.4.3.3 Stage 3 Investigations

Cone Penetrometer Testing (CPT) comprising 8 no. test locations was undertaken on 29 July 2019 within Lot 2 and 3 DP 474374. This testing was completed by Geotech Drilling Limited using a track mounted CPT rig which utilises screw in hold down anchors. These CPTs were advanced to their target depth of 20 m below ground level or 'refusal' (as a result of the failure of the reaction anchors which were embedded in the upper, soft soils; or effective refusal on a dense sand/gravel layer).

These ground investigation works were set out and managed by an Initia geotechnical engineer. The completed test elevations were surveyed with precise survey by SurveyWorx.

Investigation locations are presented on Figure 529-01 in Appendix GFR-A CPT traces (qc, fs, friction ratio and pore water pressure profiles only) are attached in Appendix C. A summary of the CPT testing completed is presented in Table 5 below.

Table 5: CPT testing summary

CPT Ref	Easting (mE, NZTM2000)	Northing (mN, NZTM2000)	Ground surface elevation (m, RL)[1]	Termination depth (m, b.g.l)	Comment
122A	1791581	5849251	7.0	20.0	Target depth
123	1791461	5849175	7.6	16.5	Refusal on dense sand
124	1791338	5849195	10.4	14.0	Reaction anchor failure
125	1791360	5849079	7.7	16.6	Refusal on dense sand
126	1791239	5849248	7.5	19.0	Refusal on dense sand
127	1791213	5849014	8.1	17.0	Refusal on dense sand
128	1791286	5848910	9.1	19.8	Target depth
129	1791284	5848790	8.4	12.5	Reaction anchor failure

Note 1: The ground surface elevations presented are from precise survey completed by SurveyWorx and are expected to have an accuracy of +/- 0.1m.

1.5 Applicability

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

Report prepared by:

Andy Wakelin
Senior Geotechnical Engineer

Report reviewed by:

Nick Speight
Senior Geotechnical Engineer
Director

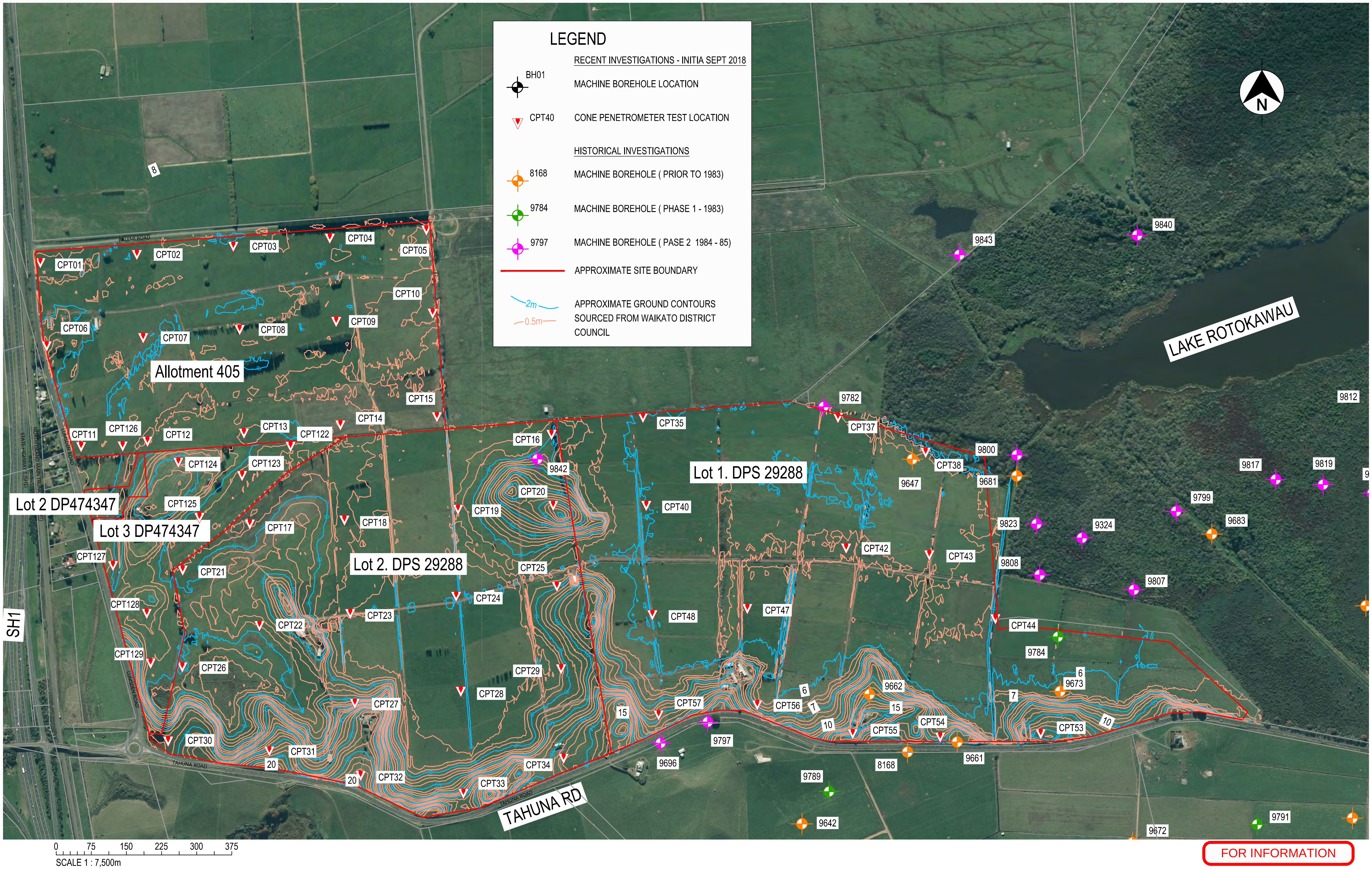
Document control record

Report Title	231 Tahuna Road, Ohinewai Geotechnical Factual Investigation Report
Initia Project Reference	P-000529
Client	Ambury Properties

Revision	Date	Revision detail	Author	Reviewer	Approved by
1	Oct 18	First Issue	M. Wansbone	N. Speight	M. Wansbone
2	Oct 19	Updated for 12.8ha block	A. Wakelin	N. Speight	N. Speight

Current Revision	2

Appendix A: GFR-Geotechnical Investigation Plan



FOR INFORMATION

					NOT FOR CONSTRUCTION THIS DRAWING IS NOT TO BE USED FOR CONSTRUCTION UNLESS SIGNED AS APPROVED
					APPROVED:
B	Lots 2 & 3 DP474347 added	AW	GA	AW	
A	First Issue	NS	LN	NS	DATE:
Rev	Revision Description	Designed	Drawn	Checked	Scale AS SHOWN / Original Size A3

INITIA
GEOTECHNICAL SPECIALISTS

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AMBURY PROPERTIES

PROPOSED MIXED USE COMMERCIAL AND LIGHT INDUSTRIAL DEVELOPMENT

GEOTECHNICAL INVESTIGATION
TEST LOCATION PLAN
AT 231 TAHUNA ROAD, OHINEWAI

Initia Project ref: P000529

Figure Number 529-001

Revision B

Appendix B: GFR-Machine Borehole Logs and Photos

BOREHOLE LOG

GEOTECHNICS

BOREHOLE No.: **BH01**

SHEET: 1 OF 2

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

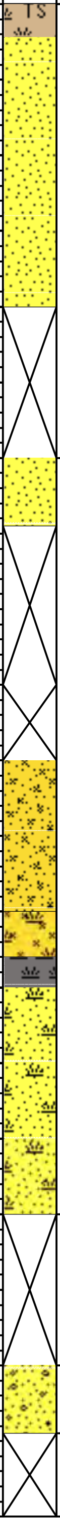
CO-ORDINATES: (NZTM2000)	5849472.01 mN 1791070.14 mE	DRILL TYPE:	Tractor Rig	HOLE STARTED:	06/09/2018
				HOLE FINISHED:	06/09/2018
R.L.:	10.5 m	DRILL METHOD:	RO	DRILLED BY:	DCN
DATUM:	NZVD2016	DRILL FLUID:		LOGGED BY: RBE	CHECKED: RBE

GEOLOGICAL — ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION. | FLUID LOSS (%) 25 50 75 | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (cm) 20 60 200 600 2000 | Description and Additional Observations

CORE RECOVERY (%)	METHOD	TESTS
46	OB	
30	OB	
66	SPT	1/1 1/1 1/1 **N=4**
0	TT	
66	SPT	1/2 2/2 2/2 **N=8**
0	TT	
0	SPT	1/0 0/0 0/1 **N=1**
19	TT	
66	SPT	0/0 0/0 1/3 **N=4**
33	TT	
100	SPT	1/2 2/2 3/6 **N=13**
0	TT	
33	SPT	1/1 1/3 3/3 **N=10**

RL (m)	DEPTH (m)
8	1
7	2
6	3
5	4
4	5
3	6
2	7
1	8
0	9



GEOLOGICAL	MOISTURE CONDITION	Description and Additional Observations
Topsoil	M	fine SAND, organic, blackish brown
Tauranga Group		fine SAND, loose, yellowish brown, becoming light brown with orange bands, and minor brown organic stained layers *1.50m:* light brown
		No recovery
	S	fine SAND, saturated, grey
		No recovery
		No recovery. Grey silt adhering to SPT
		sandy SILT, saturated, dilatant, light brown. Sand is fine grained
		organic SILT, saturated, non plastic, dark brown
		PEAT, with abundant wood, fibrous, saturated, dark brown to black
		medium to coarse SAND, organic with peat, minor fine gravel, wet to saturated, black
		medium to coarse SAND, organic stained, minor fine angular gravel; saturated, blackish brown
		Core lost, not recovered. Washings of medium to coarse sand, grey in pit
	S	medium to coarse SAND, with fine angular gravel, minor subrounded medium gravel; light brown to black
		Core lost, not recovered.Washings of medium SAND, greyish brown, in pit

COMMENTS

Hole Depth
16.95m

BOREHOLE No.: **BH01**

SHEET: 2 OF 2

GEOTECHNICS

BOREHOLE LOG

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: (NZTM2000) 5849472.01 mN 1791070.14 mE
R.L.: 10.5m
DATUM: NZVD2016

DRILL TYPE: Tractor Rig
DRILL METHOD: RO
DRILL FLUID:

HOLE STARTED: 06/09/2018
HOLE FINISHED: 06/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

GEOLOGICAL

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.

Tauranga Group

ENGINEERING DESCRIPTION

FLUID LOSS (%) 25 50 75 | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION \ WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (cm) 20 60 200 600 2000 | Description and Additional Observations

CORE RECOVERY (%)	METHOD	TESTS	MOISTURE CONDITION	Description and Additional Observations
0	TT			[CONT] Core lost, not recovered.Washings of medium SAND, greyish brown, in pit
55	SPT	7/3 2/2 3/4 **N=11**	S	medium to coarse SAND,abundant fine gravel, minor medium gravel, saturated, light grey
0	TT			Core lost. Washings of medium to coarse grey sand in pit *12.00m:* Hole cased to 12m and continued
88	SPT	3/3 3/3 4/4 **N=14**	S	medium to coarse SAND, saturated, with pumice fragments, and light coloured pumiceous bands
28	TT			Concentrated gravel washings at top, then fine to medium SAND, minor pumice, light brown
100	SPT	2/2 3/5 6/8 **N=22**		medium SAND, light brown, with minor fine pumice gravel
0	TT			No recovery
100	SPT	1/3 6/8 8/8 **N=30**	S	medium SAND, light brown, with minor fine pumice gravel
4	TT			fine to medium SAND, greenish grey then light grey *15.50m:* greenish grey
88	SPT	1/3 5/6 8/12 **N=31**		fine to medium SAND, saturated, dark greenish grey

RL (m)	DEPTH (m)
-2	11
-3	12
-4	13
-5	14
-6	15
-7	16
-8	17
-9	18
-10	19

16.95m: END OF BOREHOLE

16.95m: Hole collapsing, abandoned

COMMENTS

Hole Depth
16.95m

Scale 1:50

Rev.: A

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH01a**

SHEET: 1 OF 3

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: (NZTM2000) 5849472.01 mN 1791070.14 mE
R.L.: 10.5m
DATUM: NZVD2016

DRILL TYPE: Sonic Rig
DRILL METHOD: SNC
DRILL FLUID:

HOLE STARTED: 07/09/2018
HOLE FINISHED: 07/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

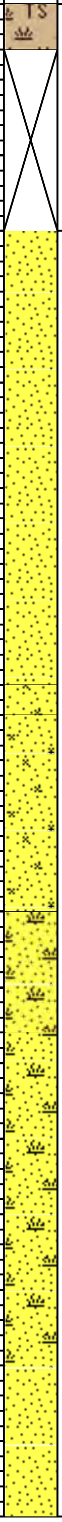
GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION. | FLUID LOSS (%) 25 50 75 | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (cm) 20 60 200 600 2000 | Description and Additional Observations

WATER: 10/09/2018 W/L on completion and after 60hrs

GEOLOGICAL	CORE RECOVERY (%)	METHOD	MOISTURE CONDITION	Description and Additional Observations
Topsoil	20	SNC	M	organic fine SAND, non plastic, moist, dark brown
Tauranga Group				No recovery
	83	SNC	S	fine SAND, wet to saturated, light brown and orange brown *1.80m:* light grey
	33	SNC		
	100	SNC		silty fine SAND, dllatant, saturated, grey
	92	SNC		silty fine SAND, dilatant, saturated. light brown
	56	SNC		organic fine SAND, peaty, saturated, blackish brown and orange brown; abundant wood at top
	20	SNC		organic fine to medium SAND, minor gravel, saturated, blackish brown
				medium to coarse SAND, organic stained, minor rounded fine gravel

RL (m)	DEPTH (m)
8	1
7	2
6	3
5	4
4	5
3	6
2	7
1	8
0	9



COMMENTS

Hole Depth
24.45m

Scale 1:50

Rev.: A

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH01a**

SHEET: 2 OF 3

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: (NZTM2000) 5849472.01 mN 1791070.14 mE
R.L.: 10.50m
DATUM: NZVD2016
DRILL TYPE: Sonic Rig
DRILL METHOD: SNC
DRILL FLUID:
HOLE STARTED: 07/09/2018
HOLE FINISHED: 07/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

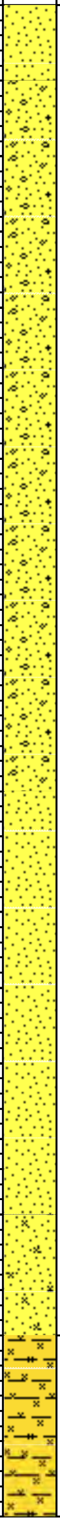
GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION: Tauranga Group

Column headings: FLUID LOSS (%) 25 50 75 | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION \ WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (cm) 20 60 200 600 2000 | Description and Additional Observations

RL (m)	DEPTH (m)
-2	11
-3	12
-4	13
-5	14
-6	15
-7	16
-8	17
-9	18
-10	19
-11	

CORE RECOVERY (%)	METHOD	TESTS
80	SNC	
80	SNC	
80	SNC	
10	SNC	
100	SNC	
80	SNC	
88	SPT	2/2 3/3 3/5 **N=14**
90	SNC	
100	SPT	1/1 1/2 2/3



MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	Description and Additional Observations
S		medium to coarse SAND, organic stained, minor rounded fine gravel
		medium to coarse SAND, light grey, with abundant fine gravel and minor medium gravel
		medium SAND, some coarse sand, and minor fine rounded gravel
		medium to coarse SAND, minor fine pumice gravel, light grey to dark greenish grey, medium dense
		medium SAND, wet, grey
		fine to medium SAND, grey, with bands of light grey silt
		silty fine SAND, saturated, light grey *18.80m:* sharp contact at base
M	F-St	clayey SILT, low plasticity, stiff, moist, light grey mottled yellowish brown
		clayey SILT, low plasticity, moist, light grey

COMMENTS

Hole Depth
24.45m

Scale 1:50

Rev.: A

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH01a**

SHEET: 3 OF 3

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: (NZTM2000) 5849472.01 mN 1791070.14 mE
R.L.: 10.5m
DATUM: NZVD2016

DRILL TYPE: Sonic Rig
DRILL METHOD: SNC
DRILL FLUID:

HOLE STARTED: 07/09/2018
HOLE FINISHED: 07/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	FLUID LOSS (%) 25 50 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (cm) 20 60 200 600 2000	Description and Additional Observations
Tauranga Group			100	SNC		N=8					M	F-St				clayey SILT, medium plasticity, moist, grey, with minor light black mottles *20.80m:* minor silty dark green inclusions
			100	SPT		1/1 1/2 2/2 N=7		-12	21							*21.00m:* low plasticity
			100	SNC				-13	22							*22.00m:* minor yellowish brown mottles *22.60m:* grey and brown
			100	SPT		1/0 1/0 1/2 N=4		-14	23							*22.70m:* light brown *23.00m:* low to medium plasticity
			95	SNC												
			100	SPT		0/1 2/2 1/2 N=7		-15	24							
																24.45m: Target depth
								-16	25							
								-17	26							
								-18	27							
								-19	28							
								-20	29							

COMMENTS

Hole Depth
24.45m

Scale 1:50

Rev.: A

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH02**

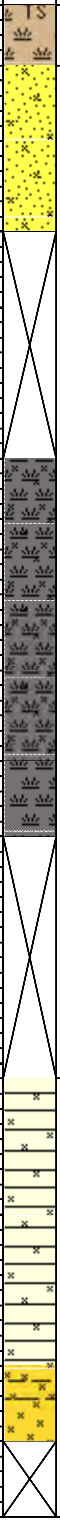
SHEET: 1 OF 3

PROJECT: Ambury Properties		LOCATION: Tahuna/Lumsden Rds	JOB No.: 1008214.0000
CO-ORDINATES: (NZTM2000)	5849541.82 mN 1791894.30 mE	DRILL TYPE: Sonic Rig	HOLE STARTED: 10/09/2018
		DRILL METHOD: SNC	HOLE FINISHED: 10/09/2018
R.L.:	6.50 m		DRILLED BY: DCN
DATUM:	NZVD2016	DRILL FLUID:	LOGGED BY: RBE CHECKED: RBE

GEOLOGICAL | ENGINEERING DESCRIPTION

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION. | FLUID LOSS (%) 25 50 75 | WATER | CORE RECOVERY (%) | METHOD | CASING | TESTS | SAMPLES | RL (m) | DEPTH (m) | GRAPHIC LOG | MOISTURE CONDITION / WEATHERING | STRENGTH/DENSITY CLASSIFICATION | SHEAR STRENGTH (kPa) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (cm) 20 60 200 600 2000 | Description and Additional Observations

WATER: 10/09/2018 on completion ▼



GEOLOGICAL	CORE RECOVERY (%)	METHOD	TESTS	MOISTURE CONDITION	STRENGTH/DENSITY	Description and Additional Observations
Topsoil	80	SNC				organic SILT peaty, non plastic, wet, black
Tauranga Group				S		silty fine SAND, pumiceous, saturated, light brown
	0	SPT	0/0 0/0 0/0 **N=0**			Sample not recovered. Traces peat at 1.5m at base of previous run
	28	SNC				
	0	SPT	0/0 0/0 0/0 **N=0**		VS	silty PEAT, fibrous, saturated, loosely consolidated, blackish brown
	100	SNC				*4.50m:* Very soft, tube easily driven. SPT estimated at N=0
	100	PT				
	0	SNC	0/0 0/0 0/0 **N=0**			PEAT, fibrous, saturated, black
						Barrel driven too deep, Sample displaced and not recovered
	0	SPT				
	40	SNC	0/0 0/0 0/0 **N=0**	M	VS	silty CLAY, medium to high plasticity, very soft, light green with white mottles *7.80m:* light brown *8.90m:* fibrous wood and roots to 9m
	100	SPT	0/0 0/0 0/0 **N=0**			clayey SILT/silty CLAY, high plasticity, moist, light brown
						SILT, minor clay, low to no plasticity, moist, dark brown
						No recovery. Grey silt adhering to core barrel

RL (m)	DEPTH (m)
6	1
5	2
4	3
3	4
2	5
1	6
0	7
-1	8
-2	9

COMMENTS

Hole Depth
21m

Scale 1:50

Rev.: A

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH02**

SHEET: 2 OF 3

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: 5849541.82 mN
(NZTM2000) 1791894.30 mE
R.L.: 6.50 m
DATUM: NZVD2016

DRILL TYPE: Sonic Rig
DRILL METHOD: SNC
DRILL FLUID:

HOLE STARTED: 10/09/2018
HOLE FINISHED: 10/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

GEOLOGICAL: Tauranga Group

CORE RECOVERY (%)	METHOD	TESTS	RL (m)	DEPTH (m)
0	SNC			
100	SPT	1/1 2/2 2/1 **N=7**	-4	11
100	SNC			
100	SPT	1/1 0/1 1/0 **N=2**	-5	12
95	SNC		-6	13
100	SPT	0/0 0/0 0/0 **N=0**	-7	14
0	SNC			
100	SPT	1/0 0/0 0/0 **N=0**	-8	15
100	SNC		-9	16
88	SPT	3/4 5/6 8/9 **N=28**	-10	17
100	SNC			
88	SPT	2/2 3/4 4/3 **N=14**	-11	18
85	SNC		-12	19
88	SPT	1/0 1/0 0/0	-13	

ENGINEERING DESCRIPTION

MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	Description and Additional Observations
		[CONT] No recovery. Grey silt adhering to core barrel
M	S	SILT, minor clay, low plasticity, moist, light brown
W-S		SILT, trace fine sand,wet to saturated, dilatant, non plastic, light brown *11.80m:* weakly to non dilatant *12.00m:* dilatant, trace organics, minor fine pumice gravel
M	VS	SILT, abundant organic fragments, non plastic, moist, greyish brown *13.20m:* brown, with abundant organics
		organic SILT, non plastic, moist, dark brown
		No recovery
	VS	organic SILT, minor clay, low to no plasticity, moist, blackish brown
W		SILT, some clay, low to no plasticity, wet, minor organics
M		fine sandy SILT, non plastic, moist, light grey with minor brown organic staining
S		medium SAND, saturated, grey, with white pumiceous speckles
		silty fine to medium SAND, saturated, grey, to greenish grey *20.00m:* sharp horizontal contact at base

COMMENTS

Hole Depth
21m

GEOTECHNICS

BOREHOLE LOG

BOREHOLE No.: **BH02**

SHEET: 3 OF 3

PROJECT: Ambury Properties
LOCATION: Tahuna/Lumsden Rds
JOB No.: 1008214.0000

CO-ORDINATES: (NZTM2000) 5849541.82 mN 1791894.30 mE
R.L.: 6.50 m
DATUM: NZVD2016
DRILL TYPE: Sonic Rig
DRILL METHOD: SNC
DRILL FLUID:
HOLE STARTED: 10/09/2018
HOLE FINISHED: 10/09/2018
DRILLED BY: DCN
LOGGED BY: RBE
CHECKED: RBE

GEOLOGICAL										ENGINEERING DESCRIPTION						
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION.	FLUID LOSS (%) 25 50 75	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa) 10 25 50 100 200	COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250	DEFECT SPACING (cm) 20 60 200 600 2000	Description and Additional Observations
Tauranga Group			95	SNC		N=1					M	F-St				clayey SILT, low plasticity, moist, greenish grey, stiff *20.90m:* firm, green and light brown
						● 38/10 kPa in barrel		-14	21							21m: Target depth
								-15	22							
								-16	23							
								-17	24							
								-18	25							
								-19	26							
								-20	27							
								-21	28							
								-22	29							

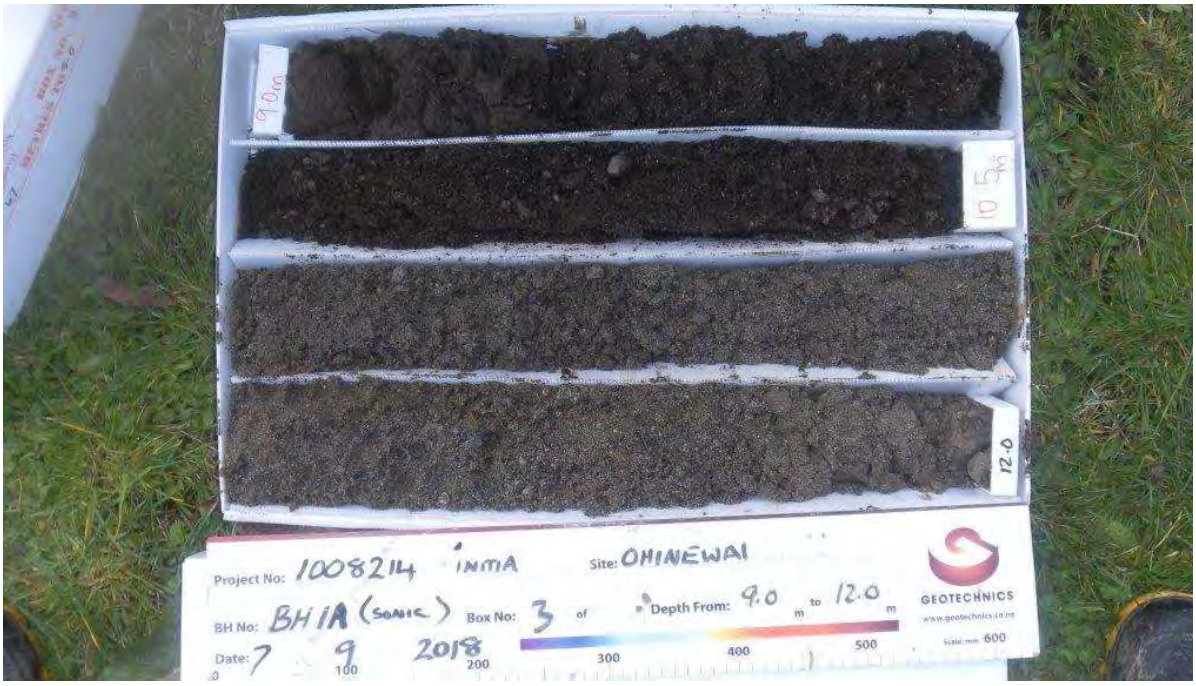
COMMENTS

Hole Depth
21m

Borehole 1a Core Photos

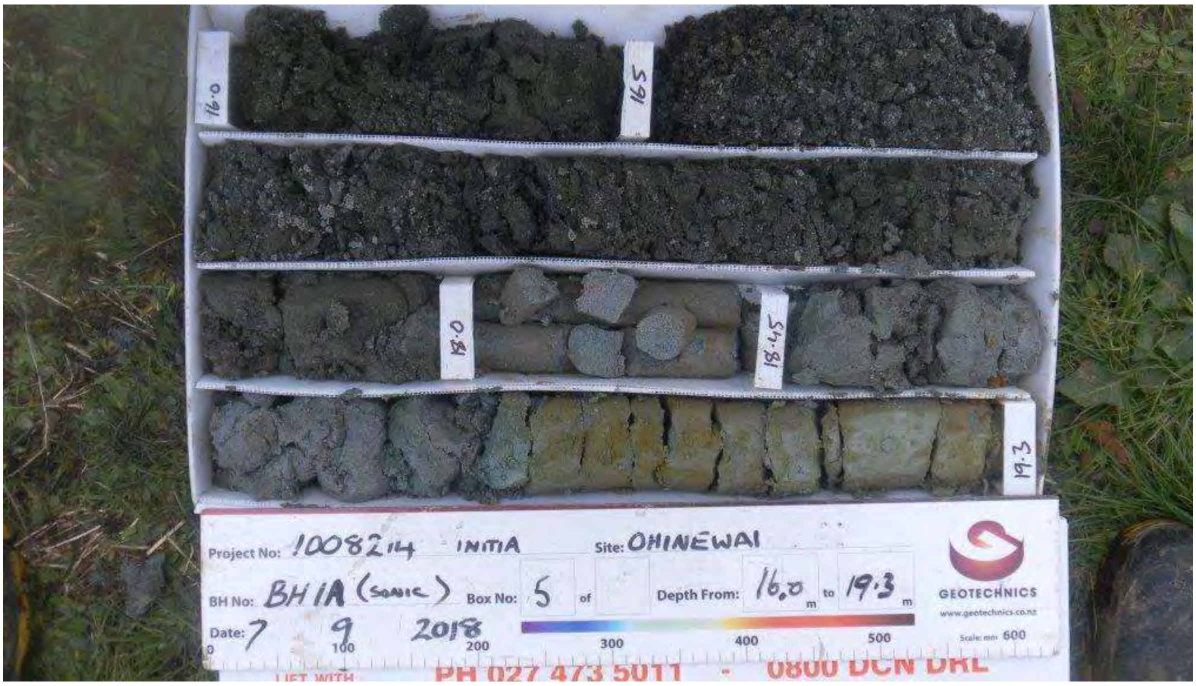
Borehole 1a: 0 to 4.7 m

Borehole 1a: 4.7 to 9.0 m

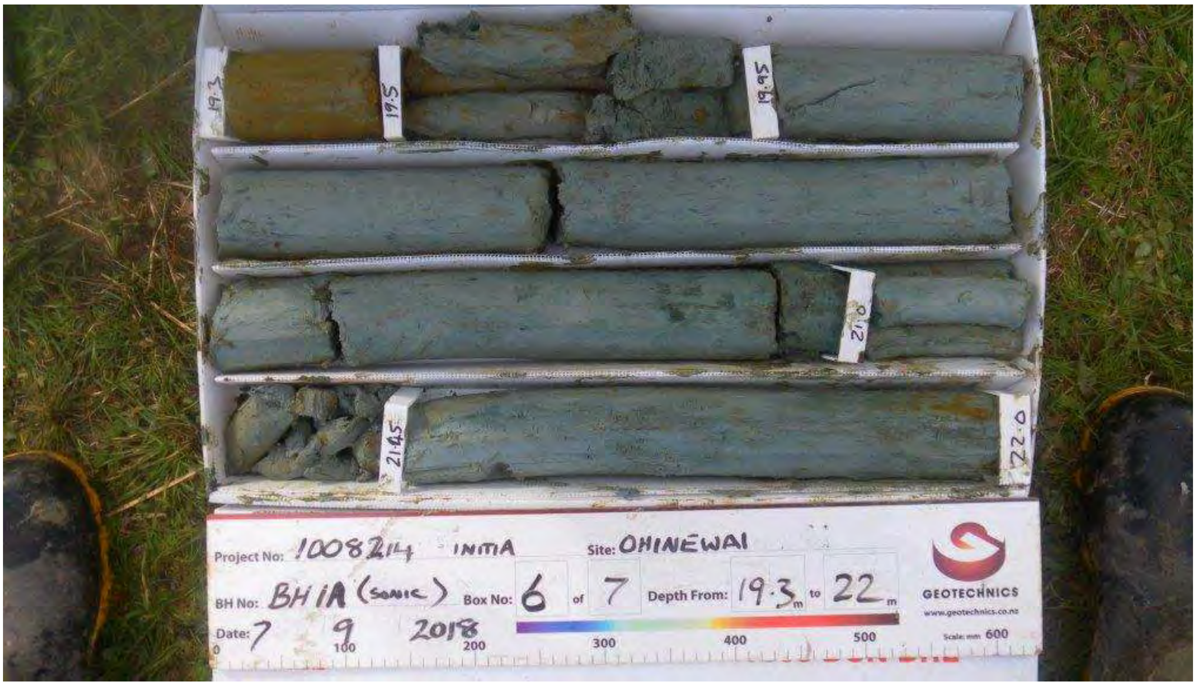


Borehole 1a: 9.0 to 12.0 m

Borehole 1a: 12.0 to 16.0 m



Borehole 1a: 16.0 to 19.3 m



Borehole 1a: 19.3 to 22.0 m

Borehole 1a: 22.0 to 24.45 m

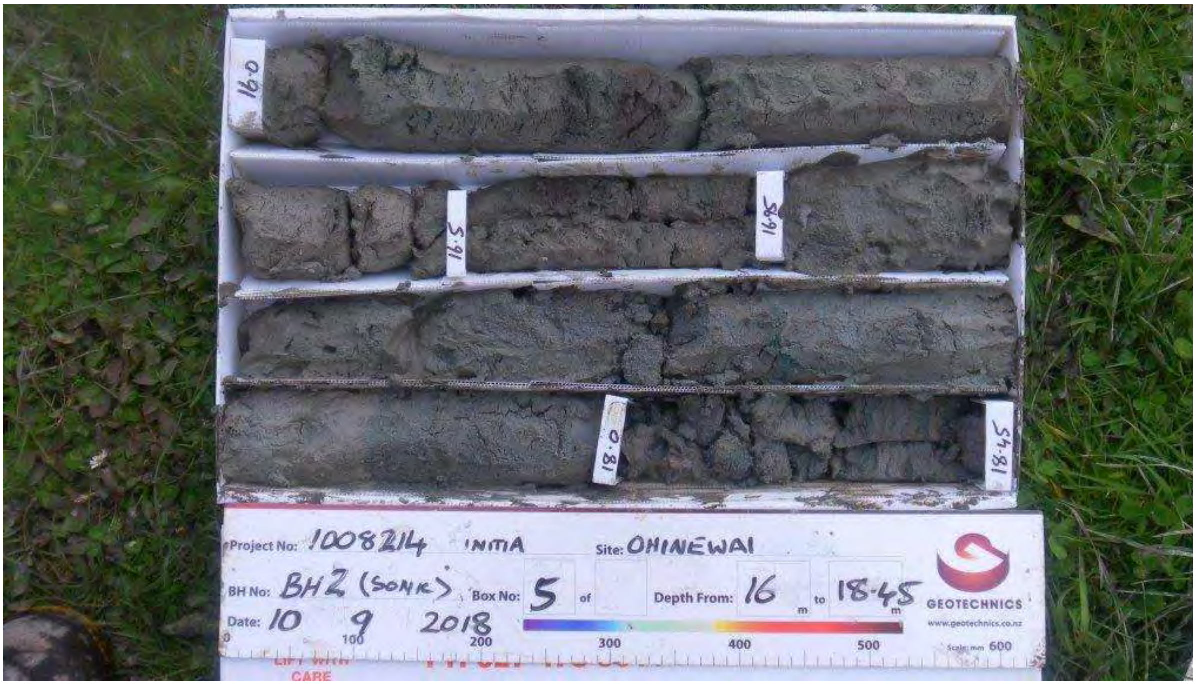
Borehole 2 Core Photos

Borehole 2: 0 to 3.7 m

Borehole 2: 3.7 to 9.5 m

Borehole 2: 9.5 to 12.45 m

Borehole 2: 12.45 to 16.0 m

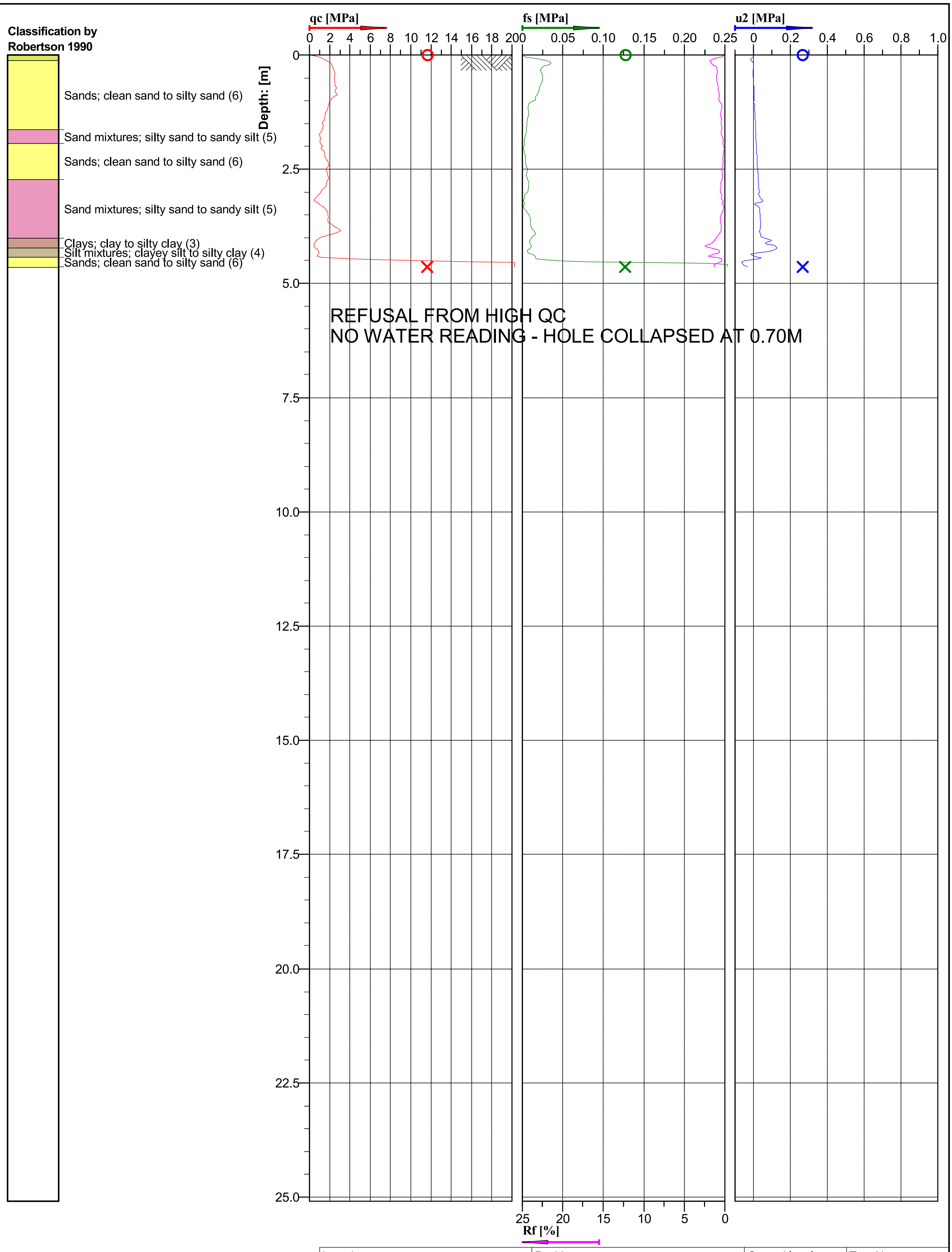


Borehole 2: 16.0 to 18.45 m

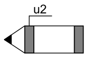
Borehole 2: 18.45 to 21.3 m

Borehole 2: 21.3 to 22.5 m

Appendix C: GFR-Cone Penetrometer Test Logs

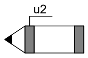


REFUSAL FROM HIGH QC
NO WATER READING - HOLE COLLAPSED AT 0.70M



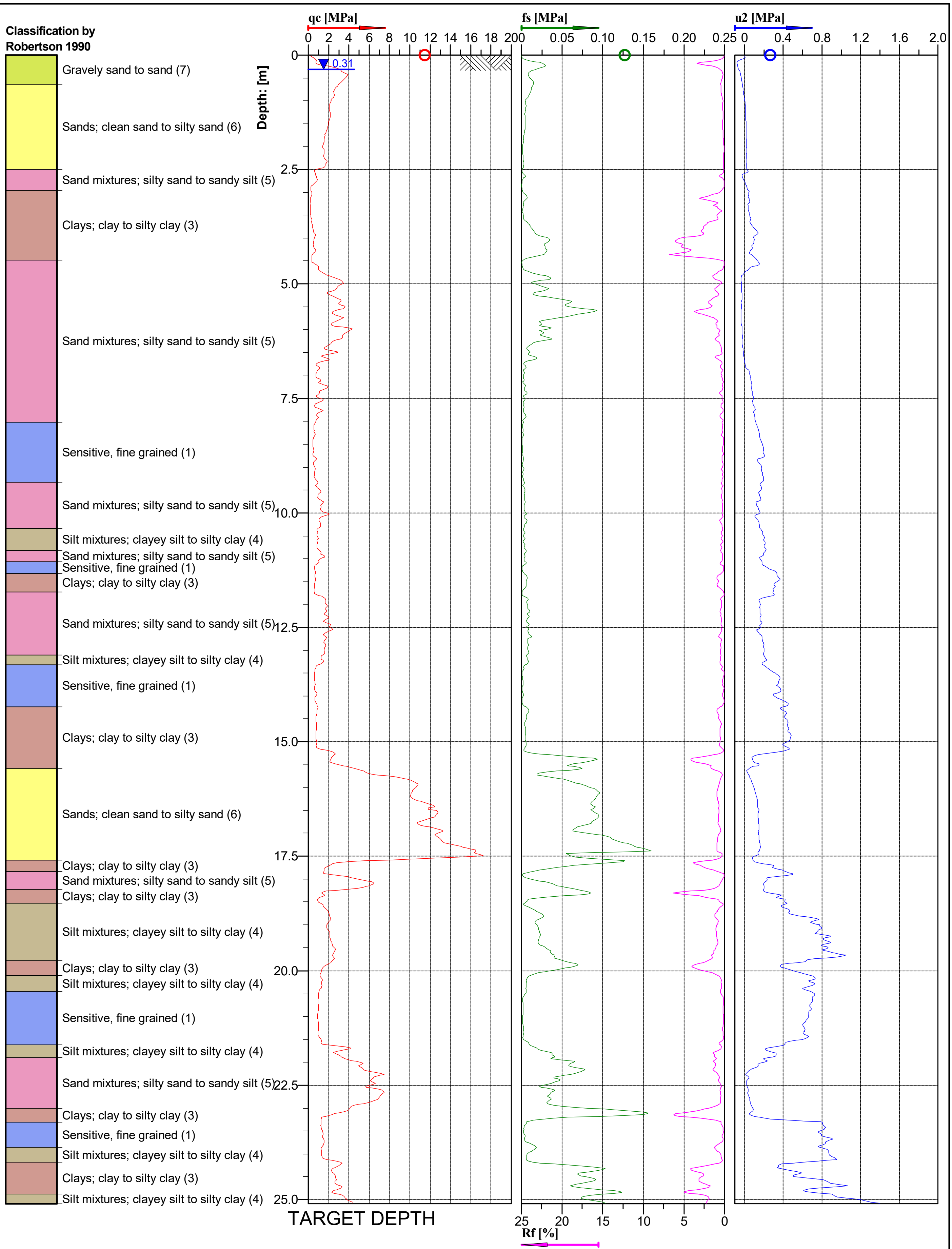
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

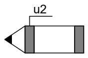
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT01
Project ID:	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48027, E 175.16078		File: CPT01.cpt	



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT02
Project ID:	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48006, E 175.16313		File: CPT02.cpt	

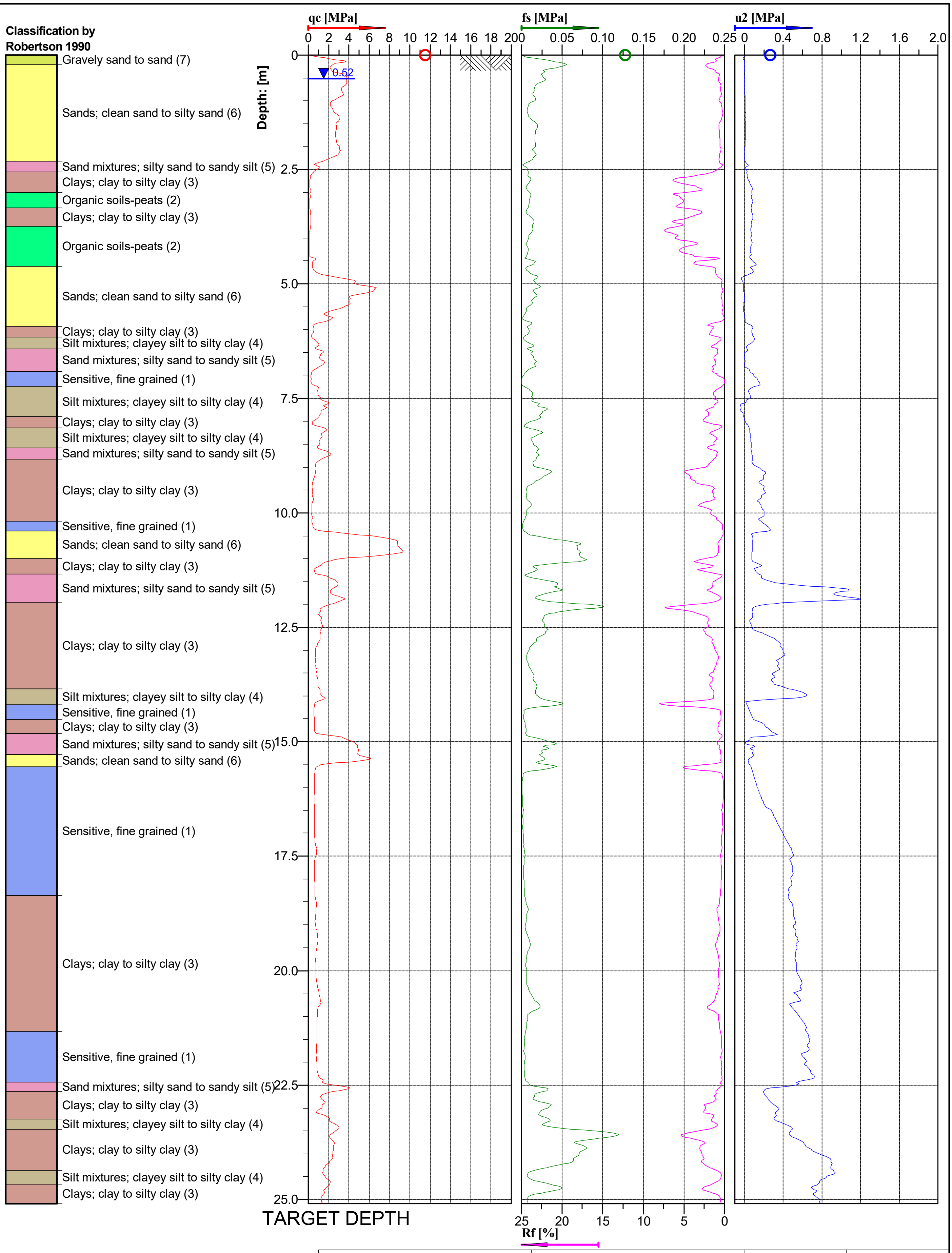


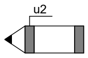


GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

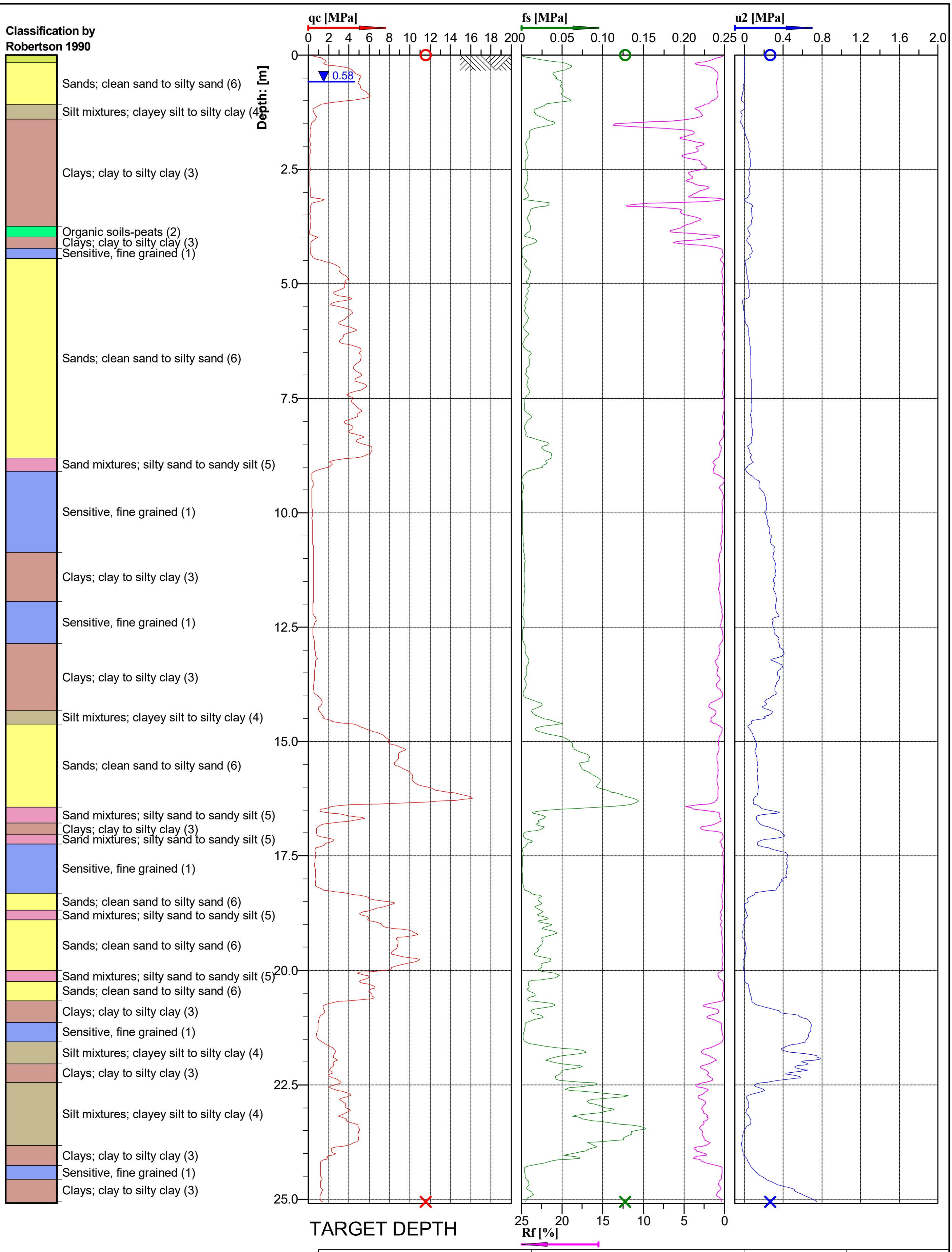
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT03
Project ID: P-000529	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.47987, E 175.16545		File: CPT03.cpt	



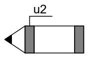


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT04
Project ID: P-000529	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.47971, E 175.16782		File: CPT04.cpt	

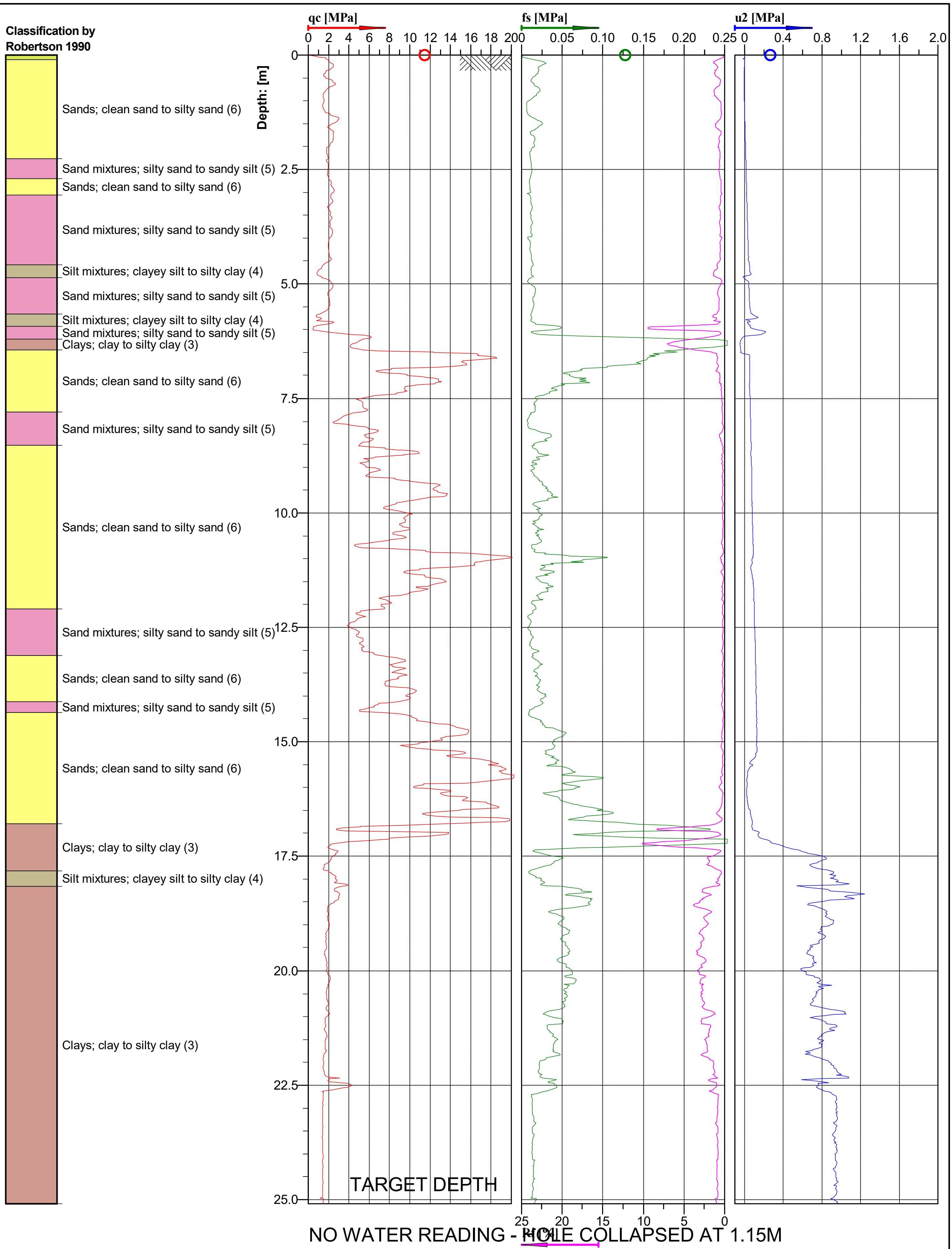


TARGET DEPTH

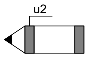


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID: P-000529	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.47955, E 175.17014		File: CPT05.cpt	

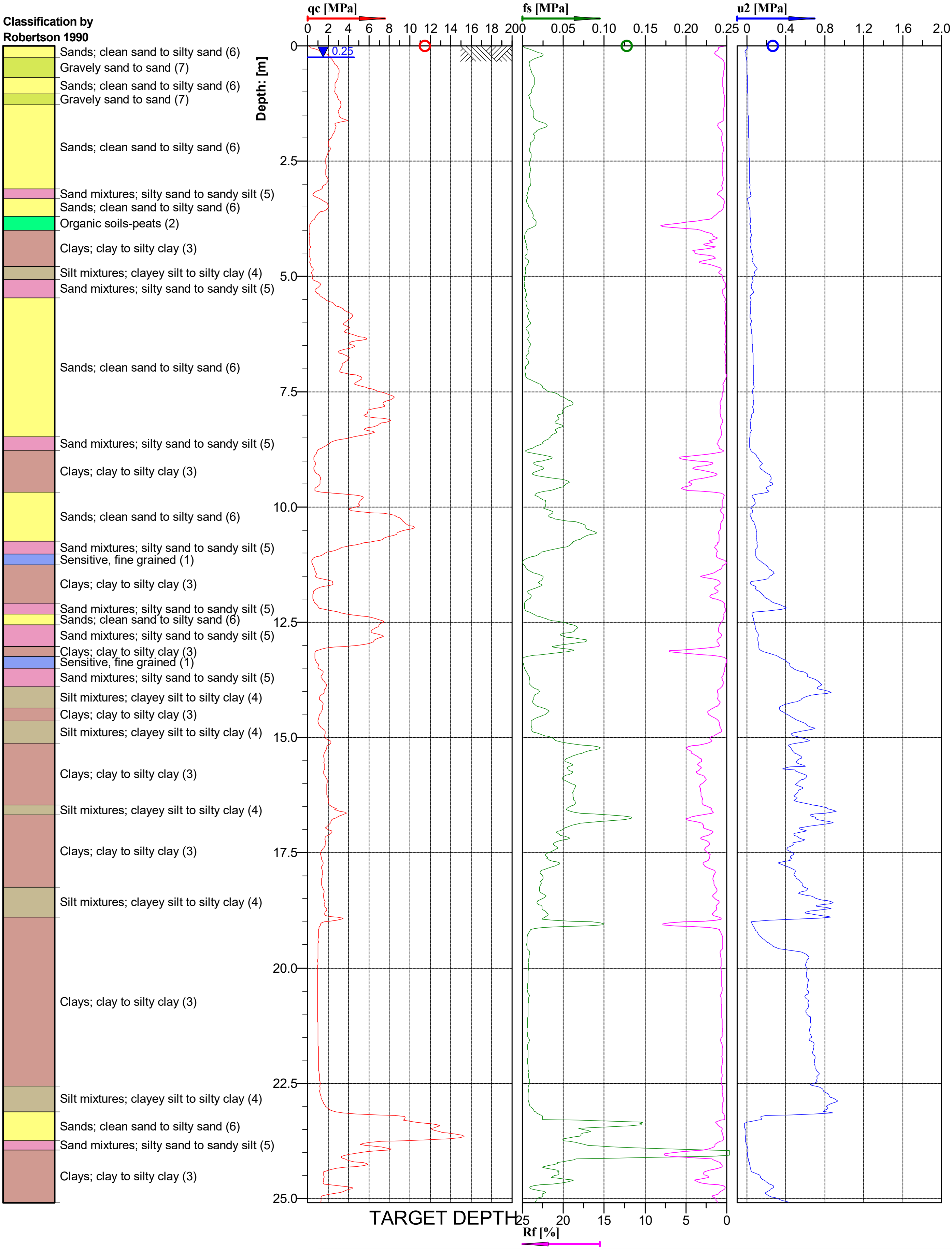


NO WATER READING - HOLE COLLAPSED AT 1.15M



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

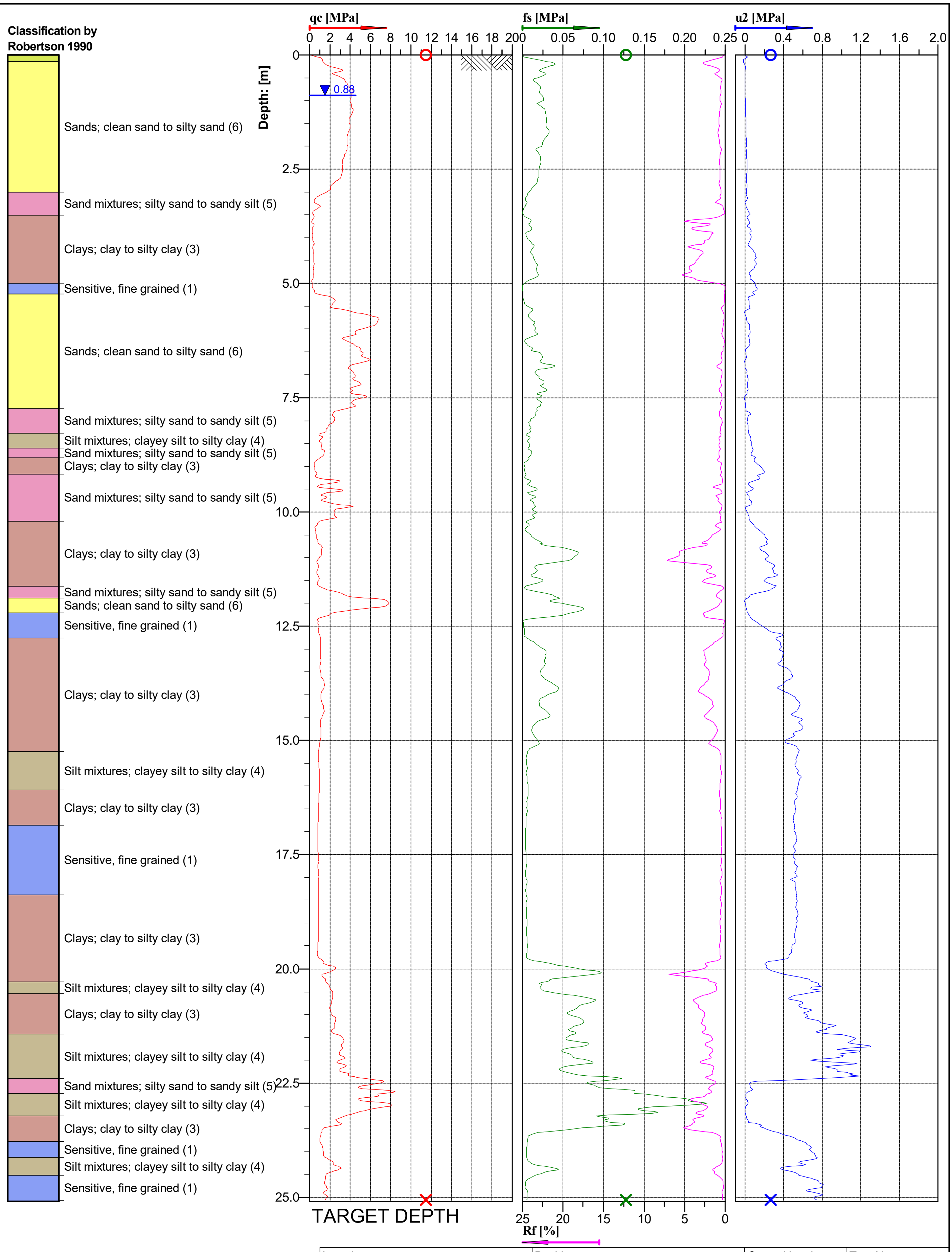
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID: P-000529	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48188, E 175.16107		File: CPT06.cpt	

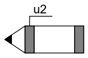


u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

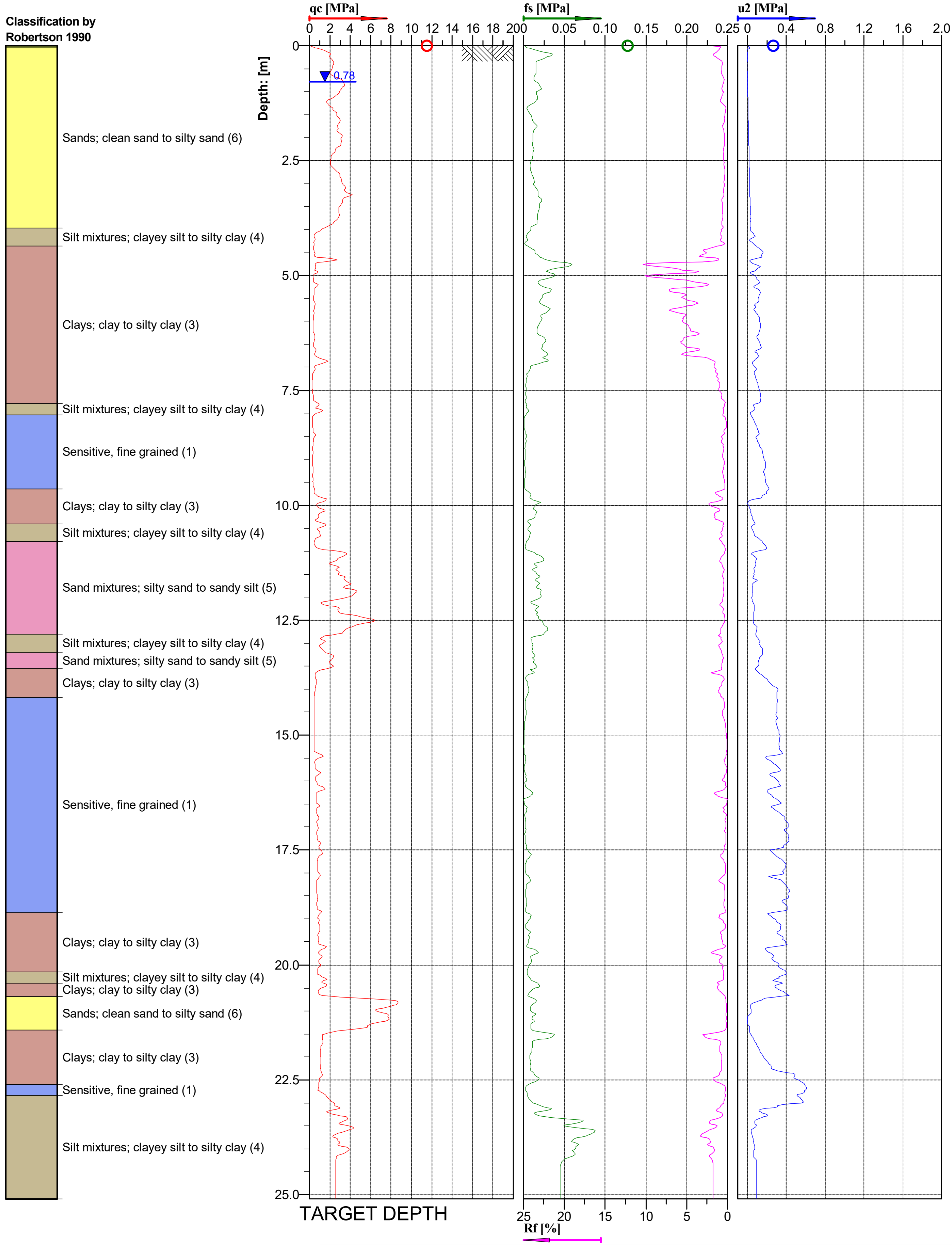
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID: P-000529	Client: INITIA	Date: 5/9/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48152, E 175.16328		File: CPT07.cpt	

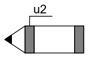




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

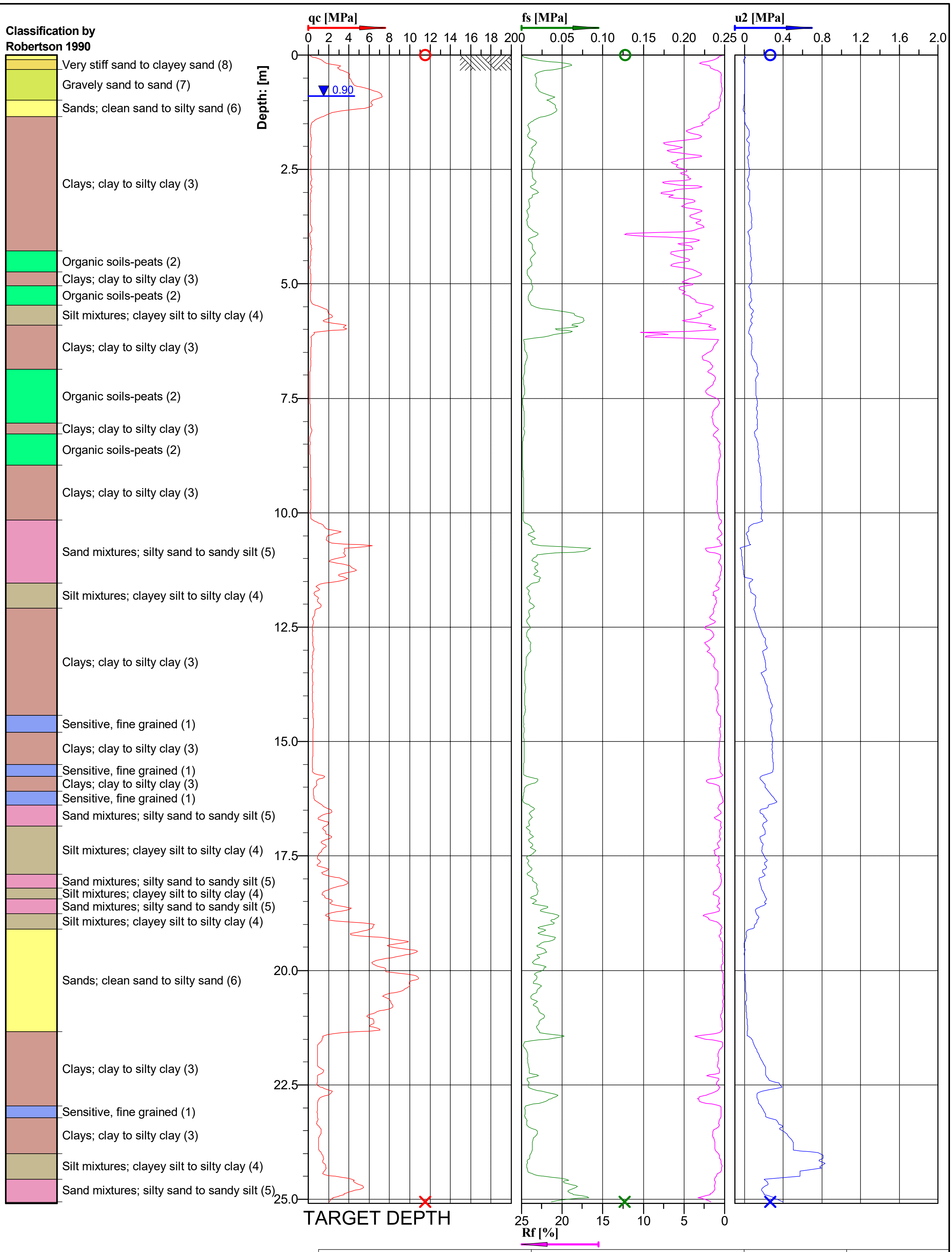
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID: p-000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48152, E 175.16568		File: CPT08.cpt	

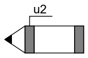




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

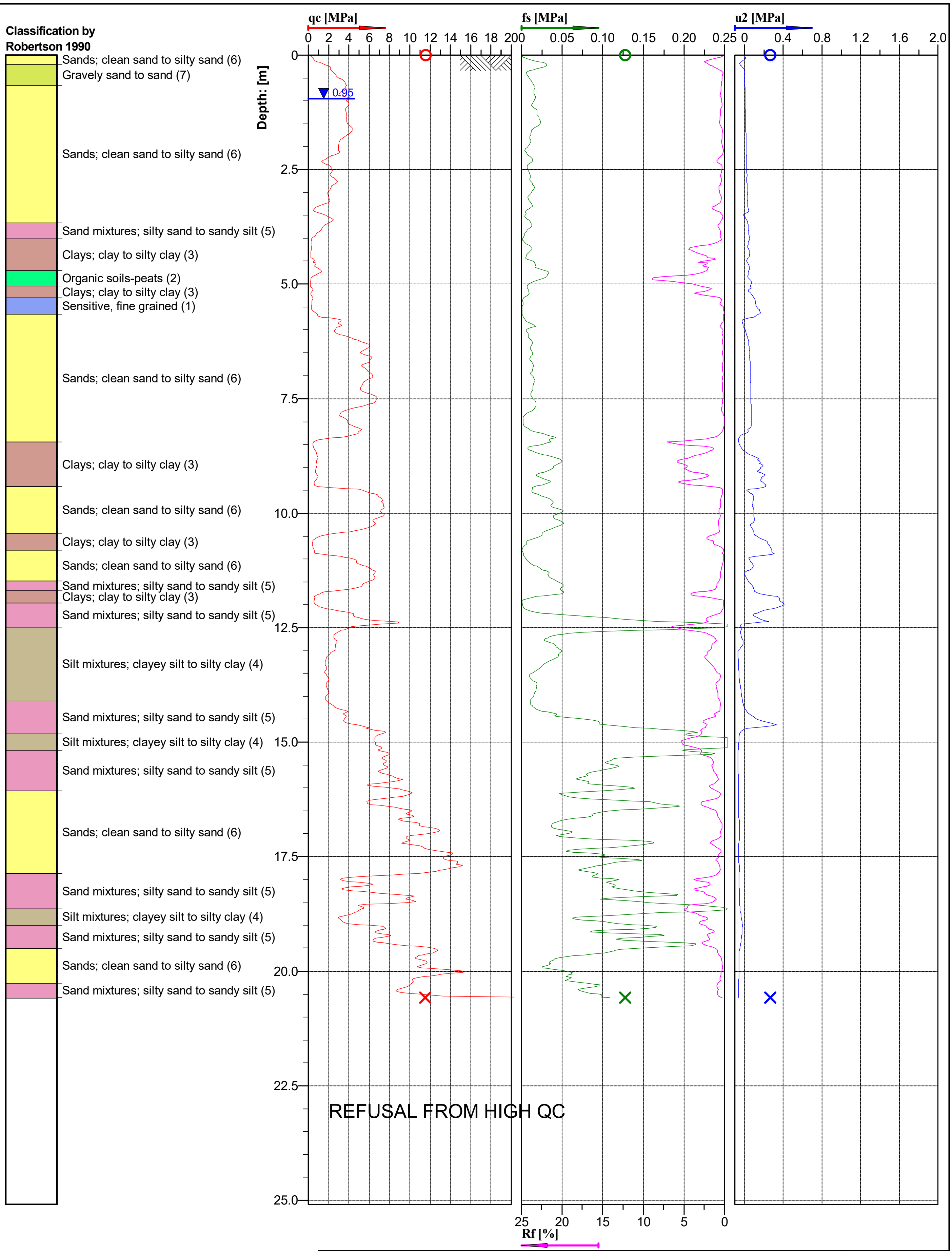
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID: P-000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48129, E 175.16801		File: CPT09.cpt	



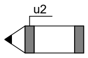


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID: P-000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48115, E 175.17032		File: CPT10.cpt	

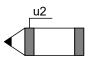


REFUSAL FROM HIGH QC



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

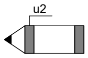
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID: P-0000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48384, E 175.16191		File: CPT11.cpt	



GEOTECH DRILLING

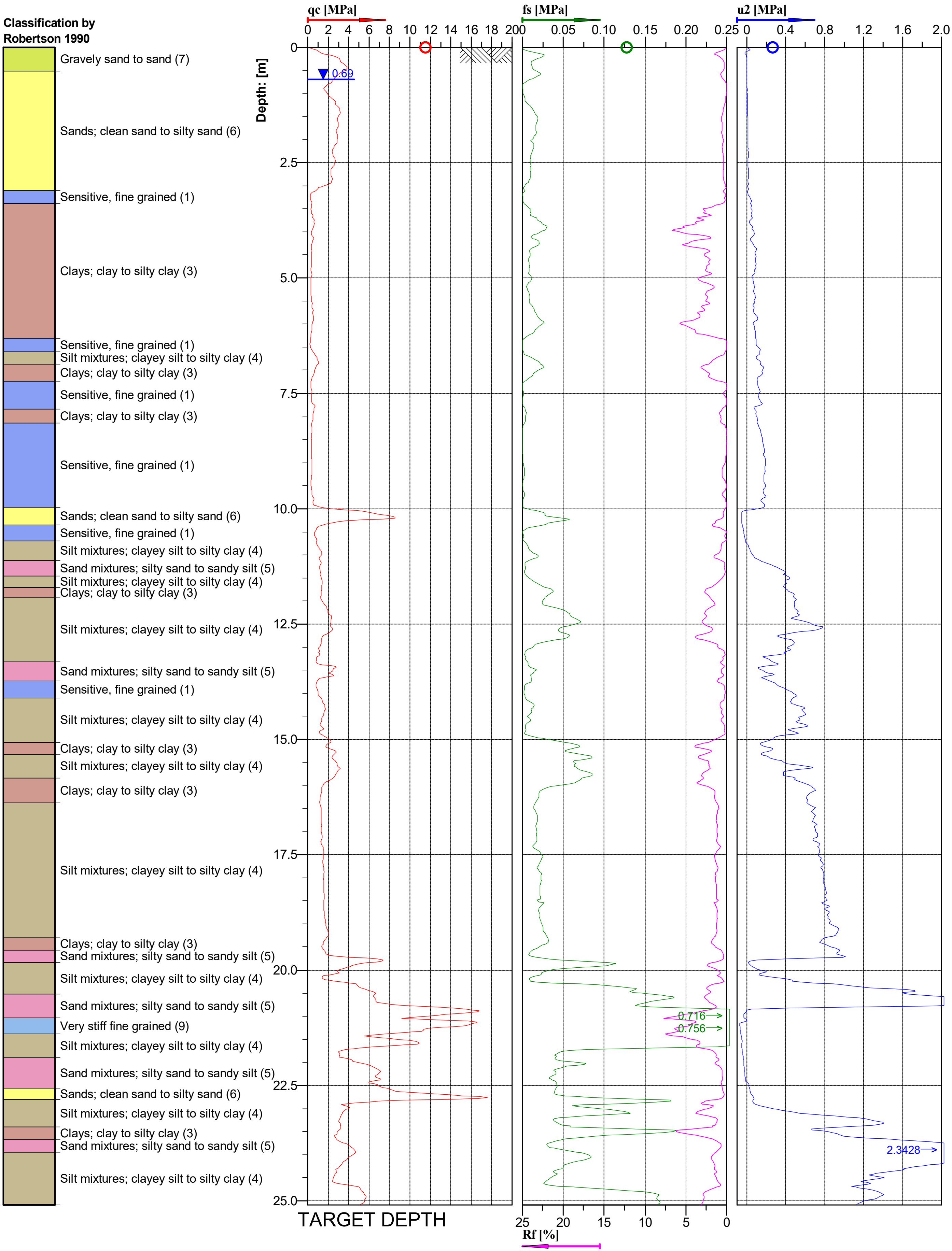
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location:	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT12
Project ID: P-000529	Client:	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48365, E 175.16353		File: CPT12.cpt	

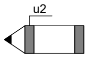


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT13
Project ID: P-000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48350, E 175.16586		File: CPT13.cpt	

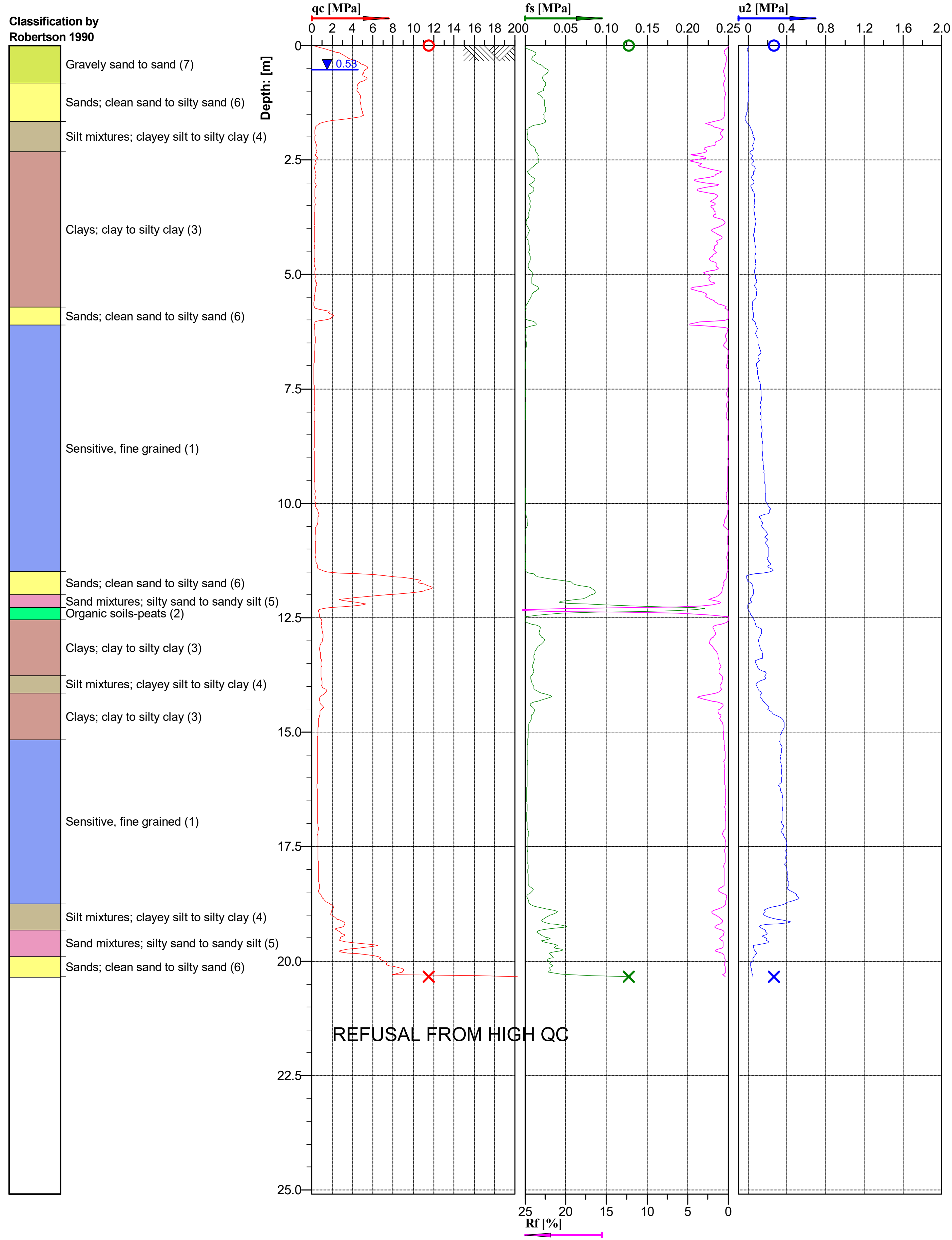


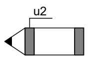
GEOTECH DRILLING



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

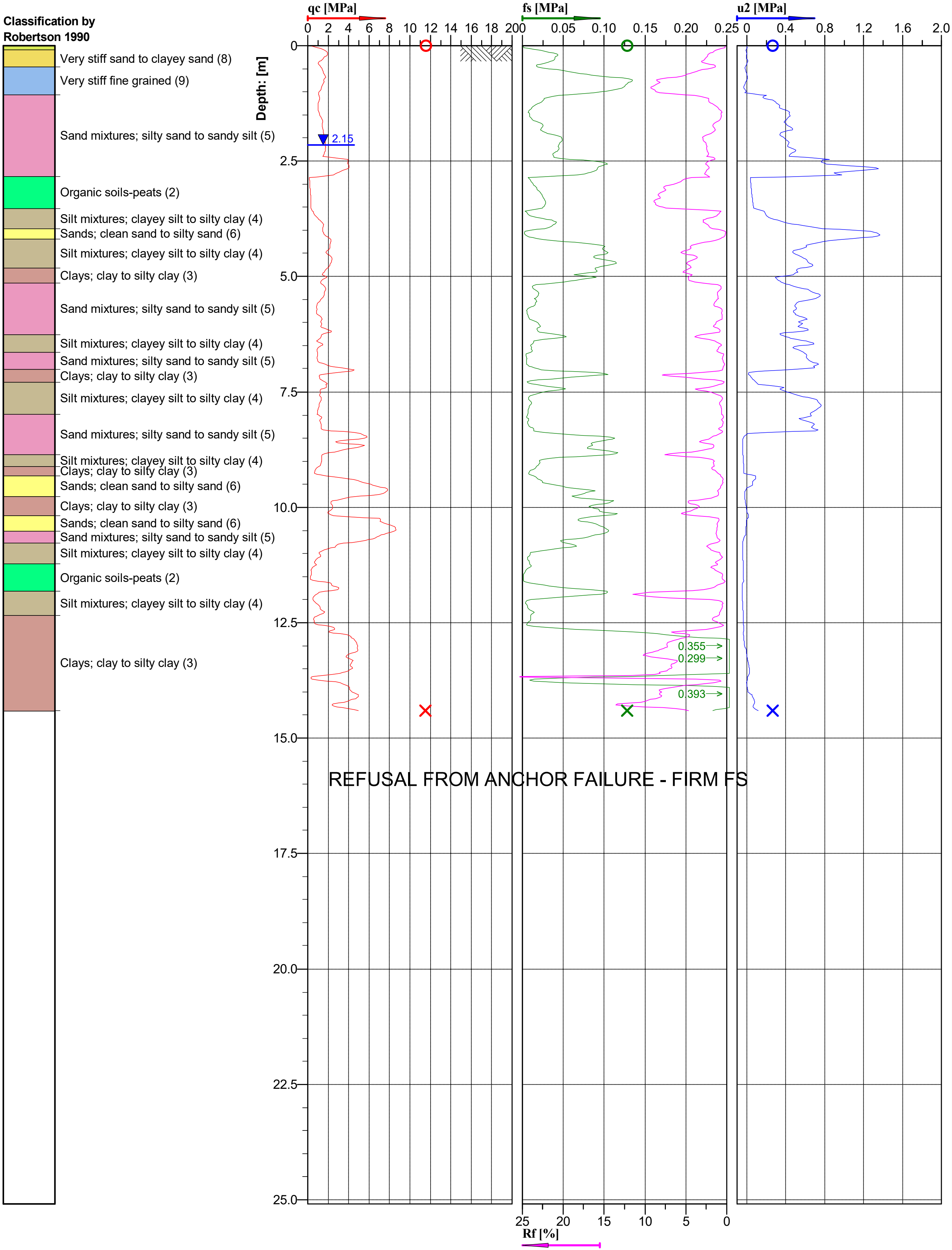
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT14
Project ID: P-000529	Client: INITIA	Date: 6/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/2	Fig.:
S 37.48330, E 175.16814		File: CPT14.cpt	



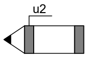


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT15
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48305, E 175.17047		File: CPT15.cpt	

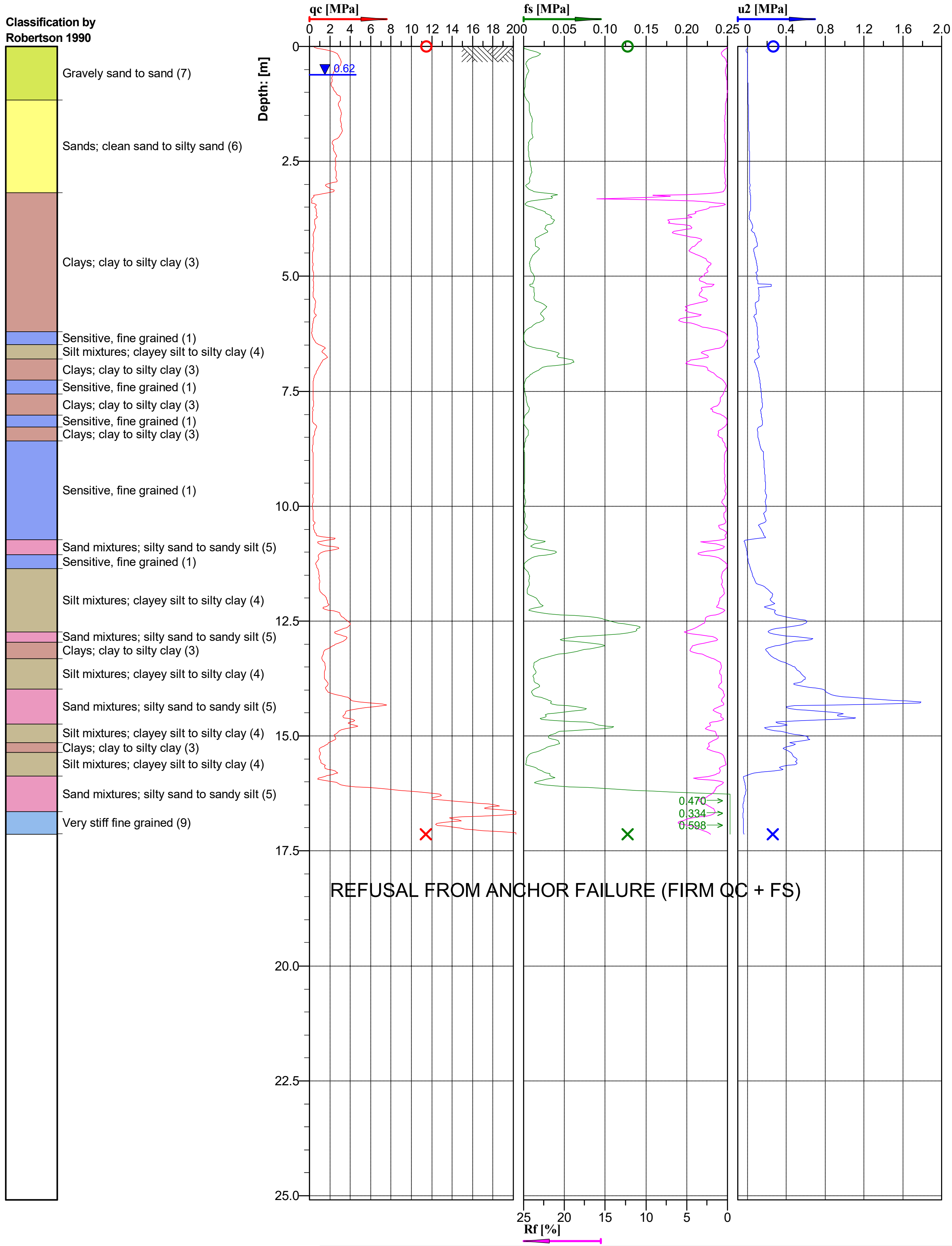


GEOTECH DRILLING

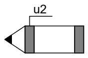


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT16
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48338, E 175.17322		File: CPT16.cpt	

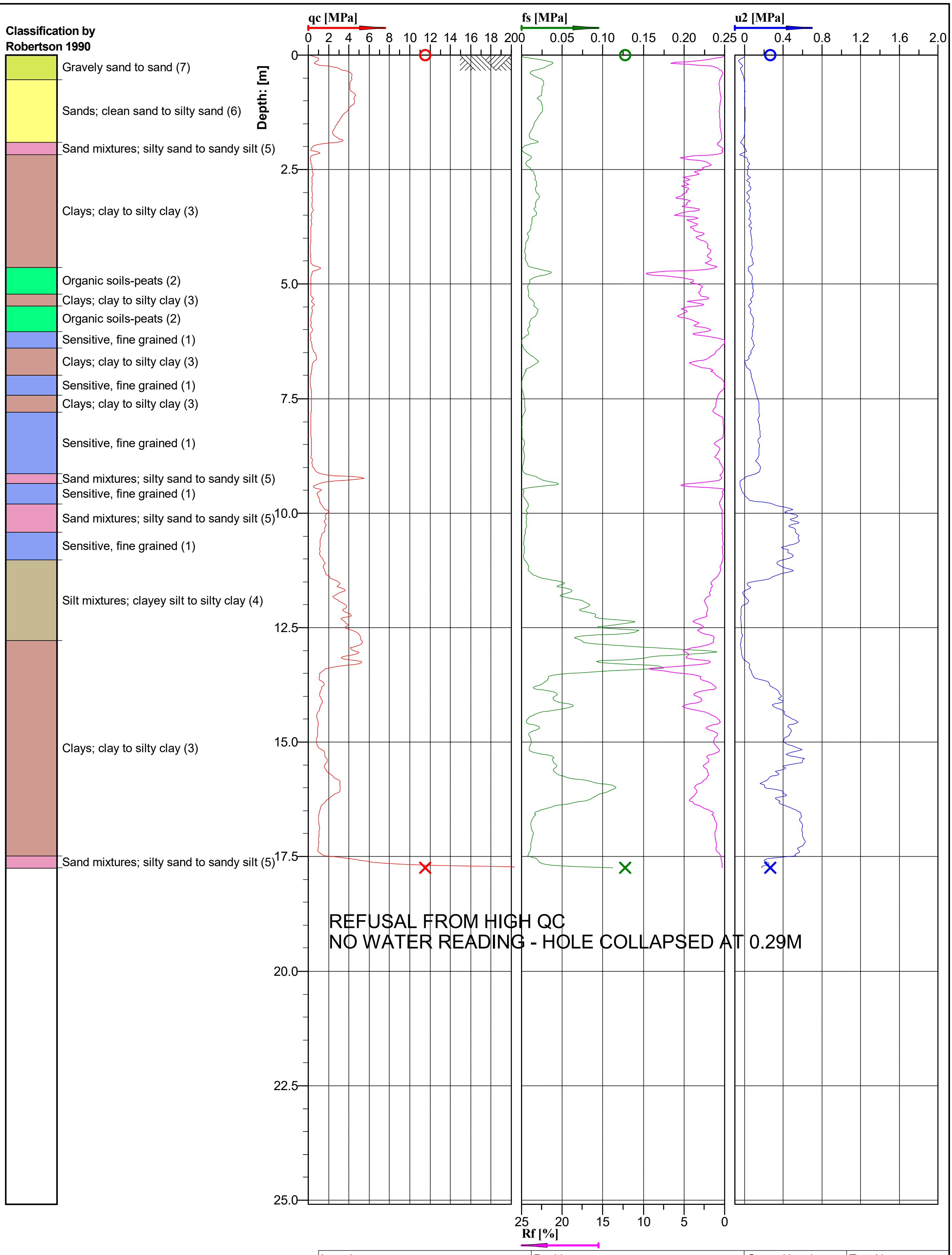


GEOTECH DRILLING



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

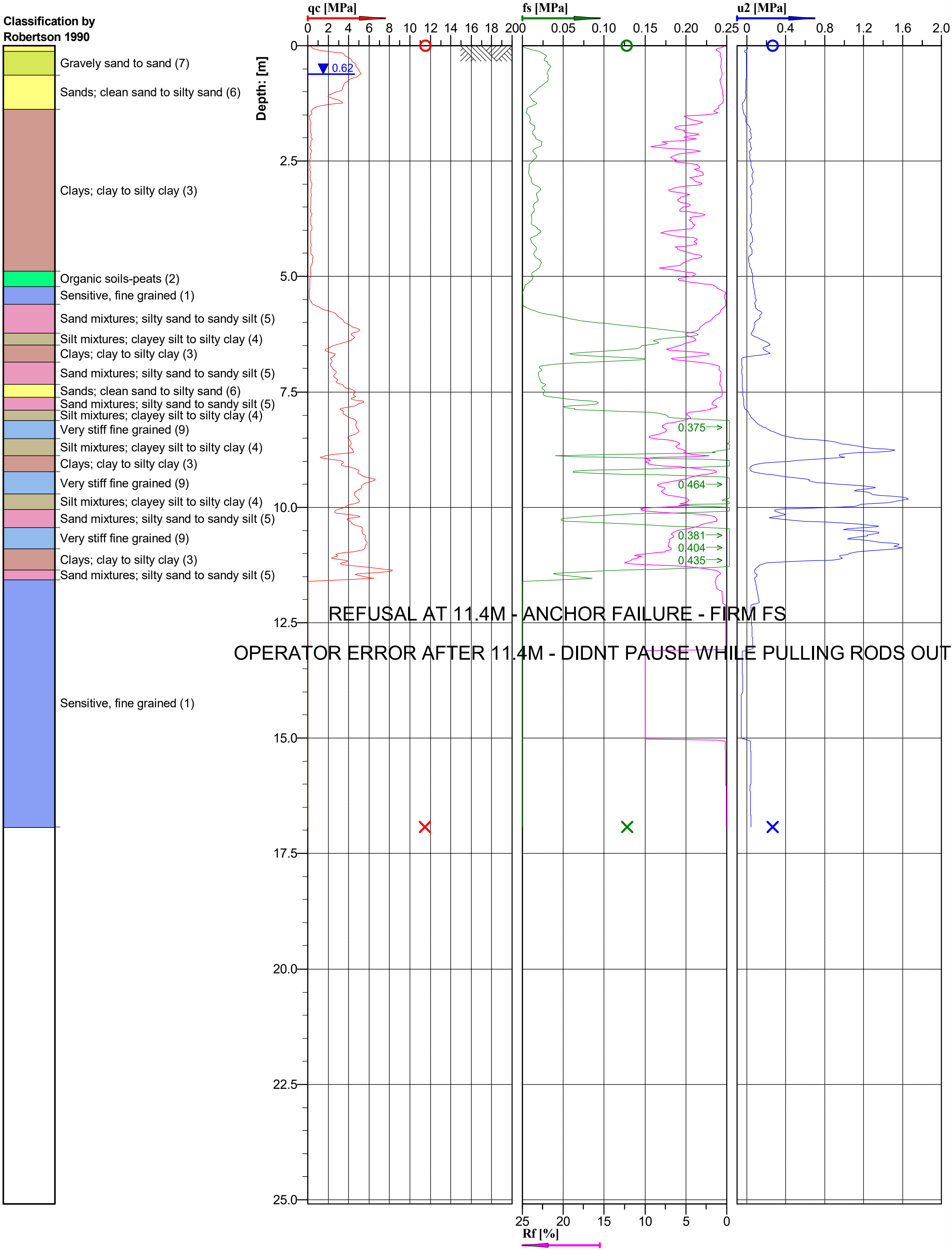
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT17
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48520, E 175.16595		File: CPT17.cpt	



REFUSAL FROM HIGH QC
NO WATER READING - HOLE COLLAPSED AT 0.29M

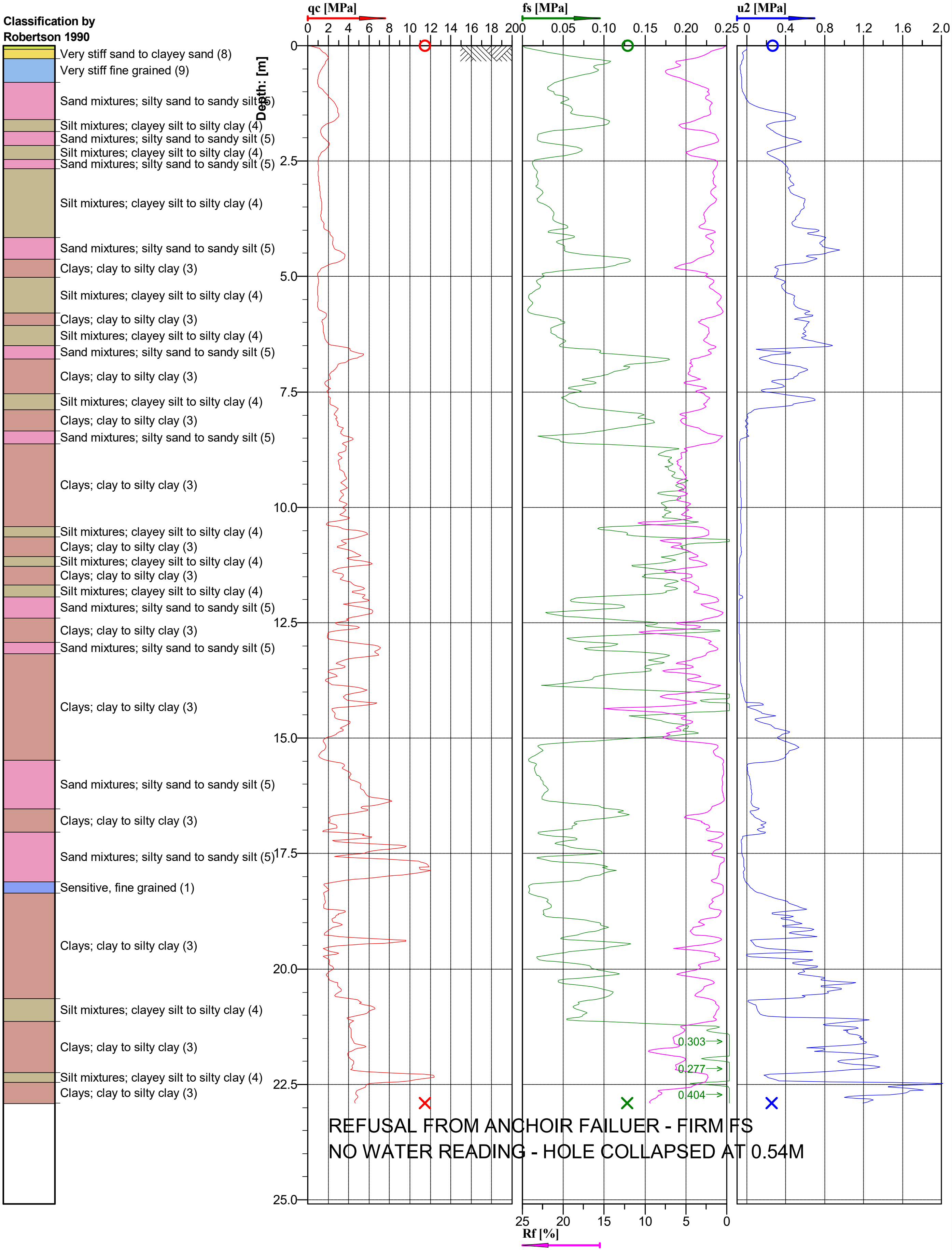
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT18
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48512, E 175.16832		File: CPT18.cpt	



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT19
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48494, E 175.17104		File: CPT19.cpt	



REFUSAL FROM ANCHOIR FAILUER - FIRM FS

NO WATER READING - HOLE COLLAPSED AT 0.54M

GEOTECH DRILLING

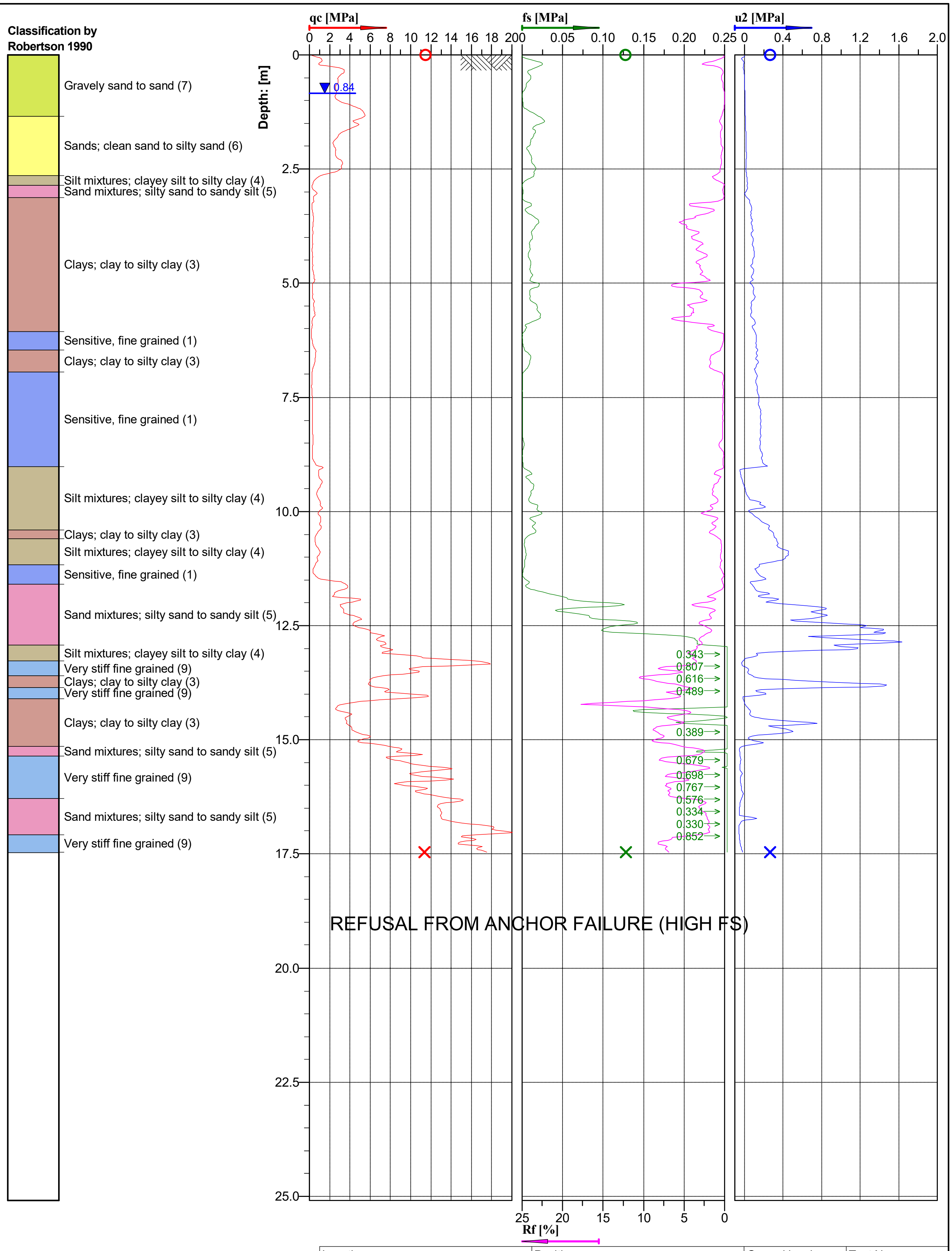
u2

Cone No: 4696

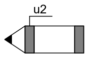
Tip area [cm2]: 10

Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT20
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48481, E 175.17332		File: CPT20.cpt	

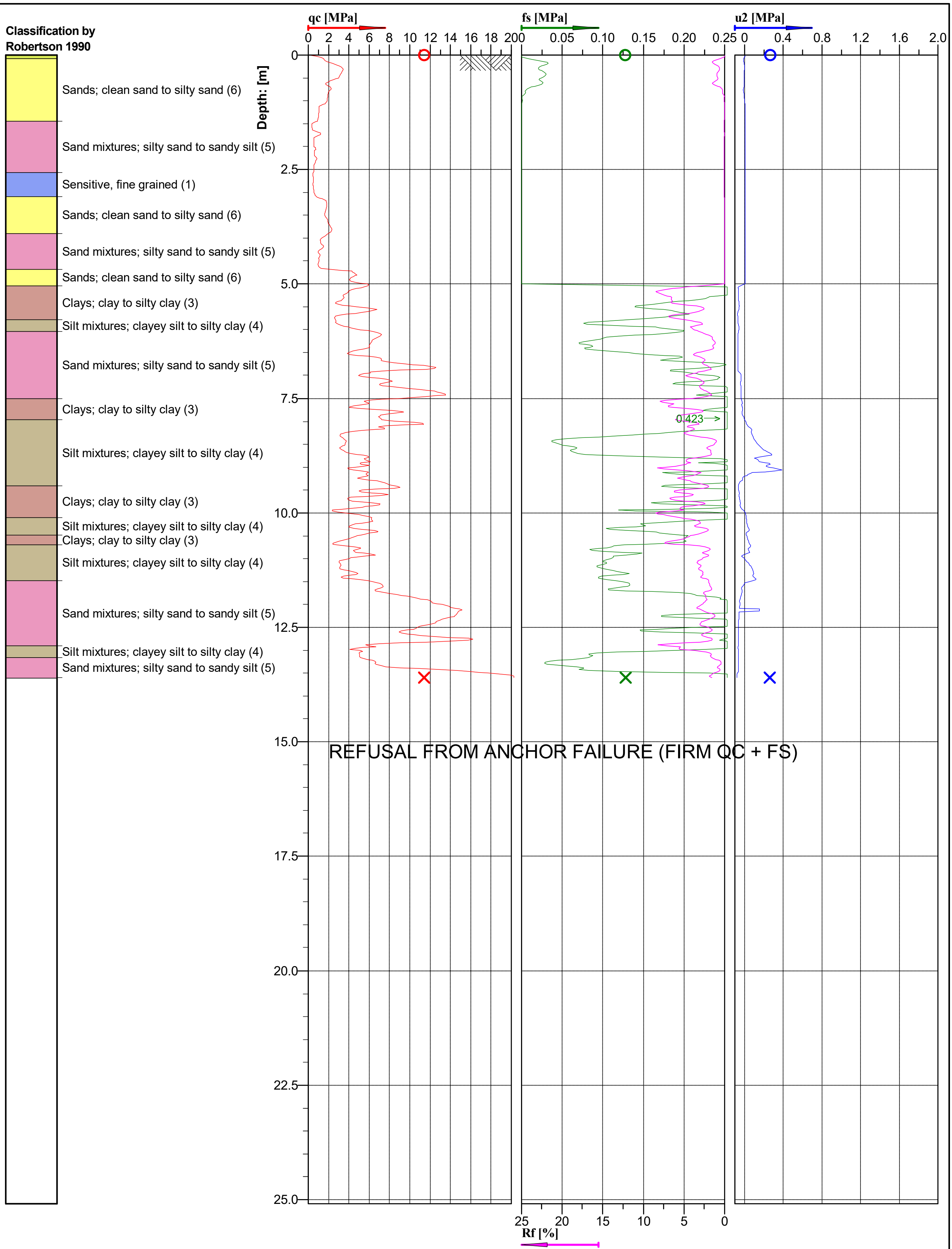


REFUSAL FROM ANCHOR FAILURE (HIGH FS)



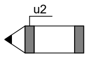
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT21
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48623, E 175.16447		File: CPT21.cpt	



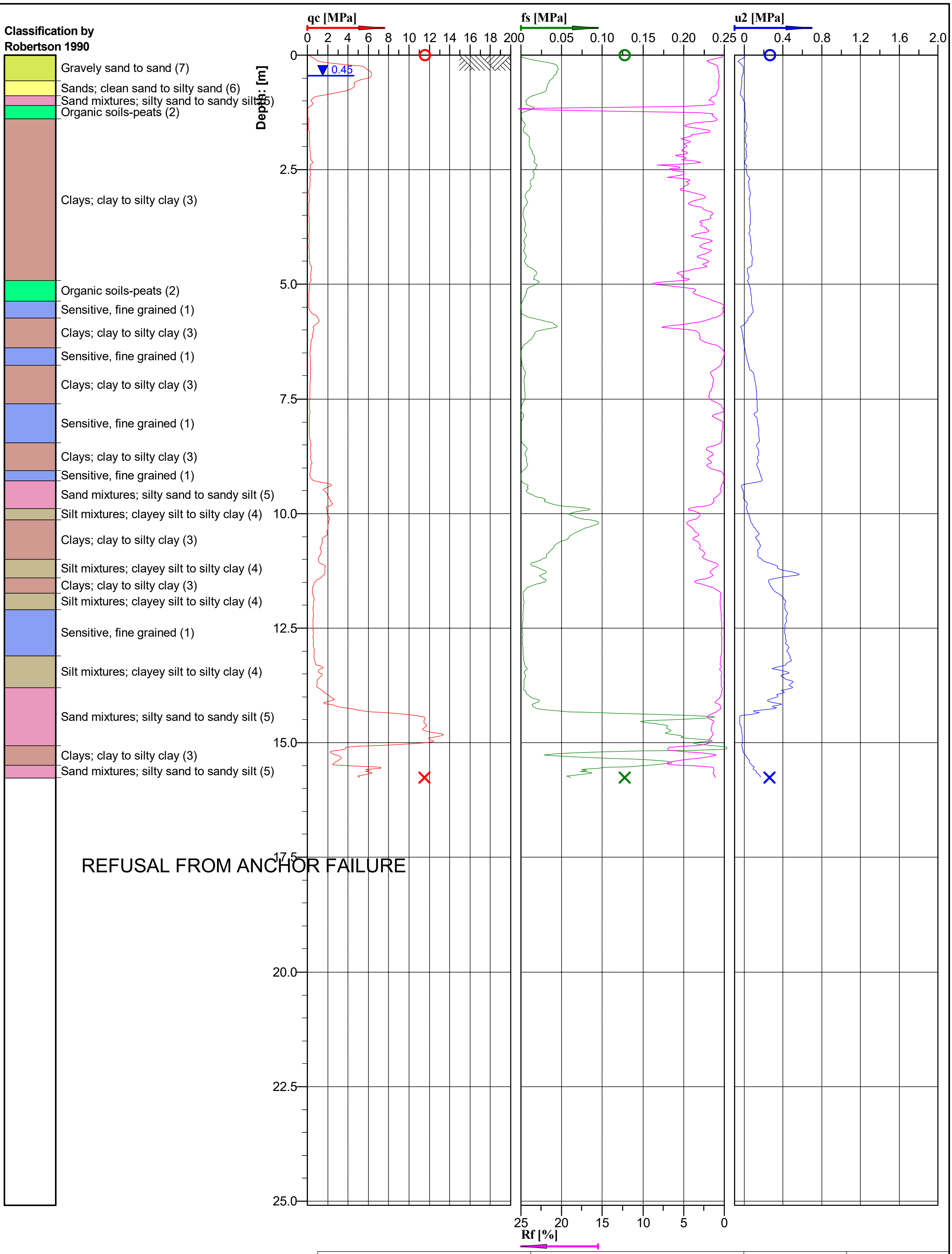
REFUSAL FROM ANCHOR FAILURE (FIRM QC + FS)

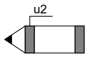
GEOTECH DRILLING



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

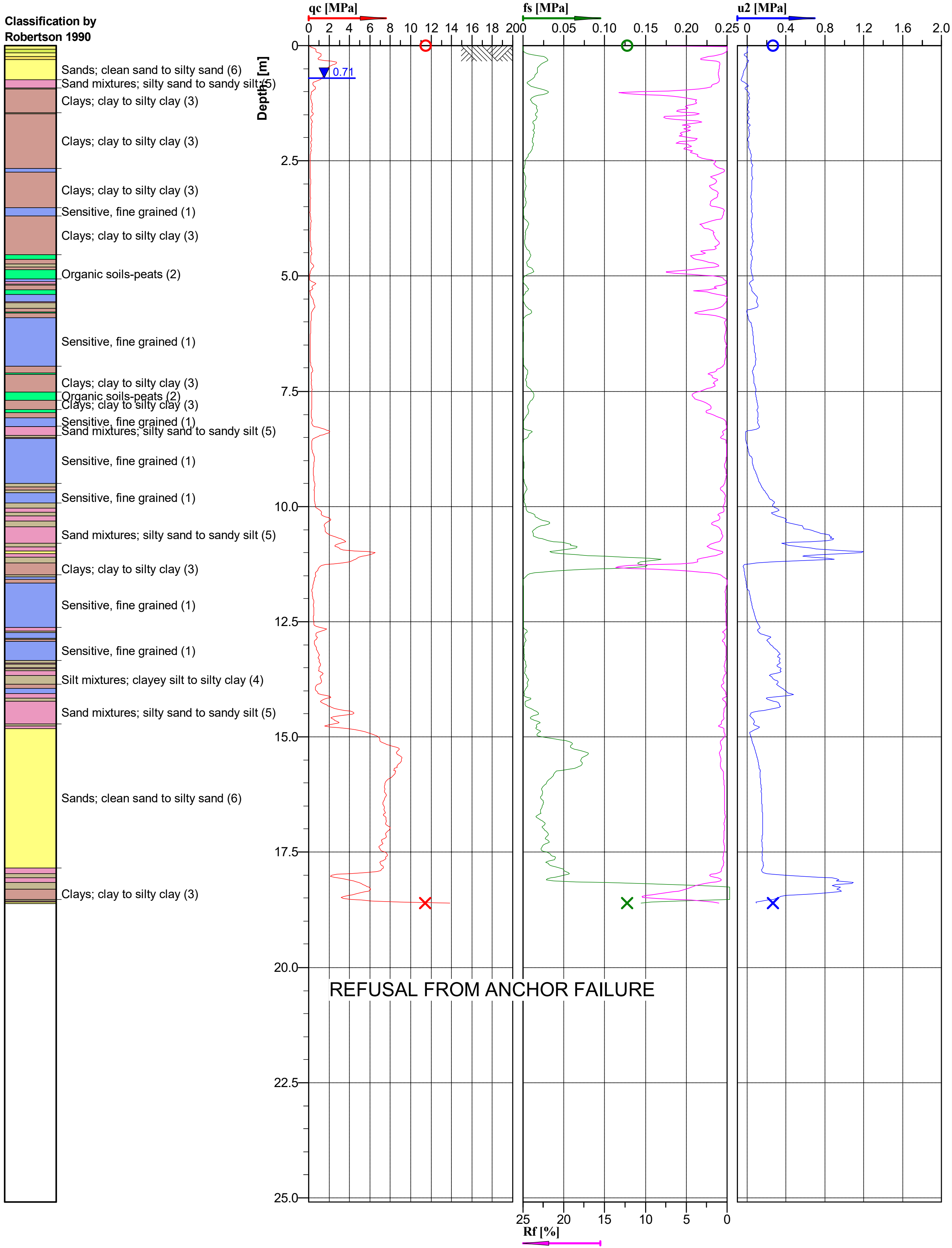
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT22
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48719, E 175.16631		File: CPT22.cpt	

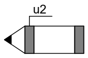




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

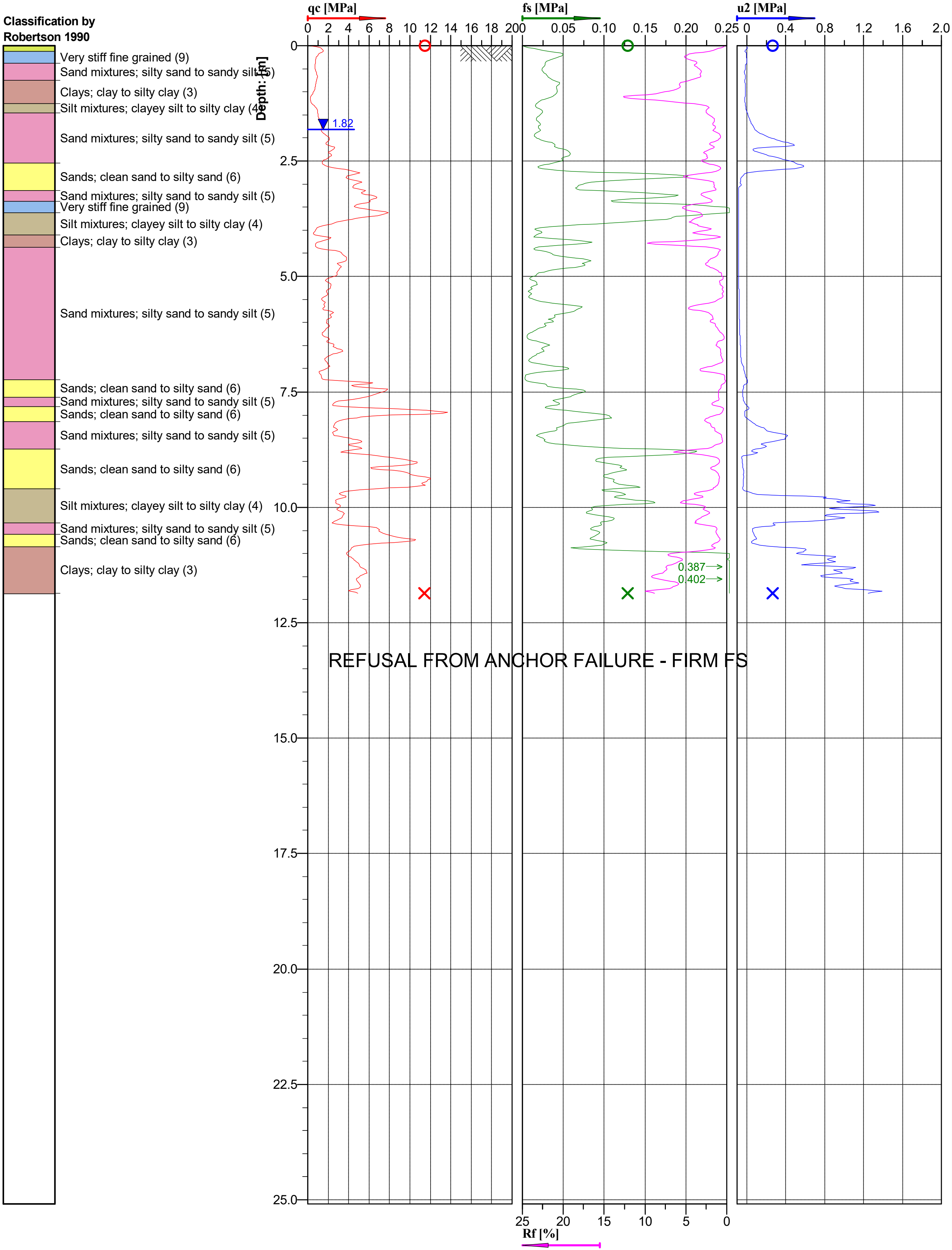
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT23
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48687, E 175.16838		File: CPT23.cpt	



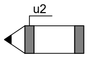


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT24
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48652, E 175.17104		File: CPT24.cpt	

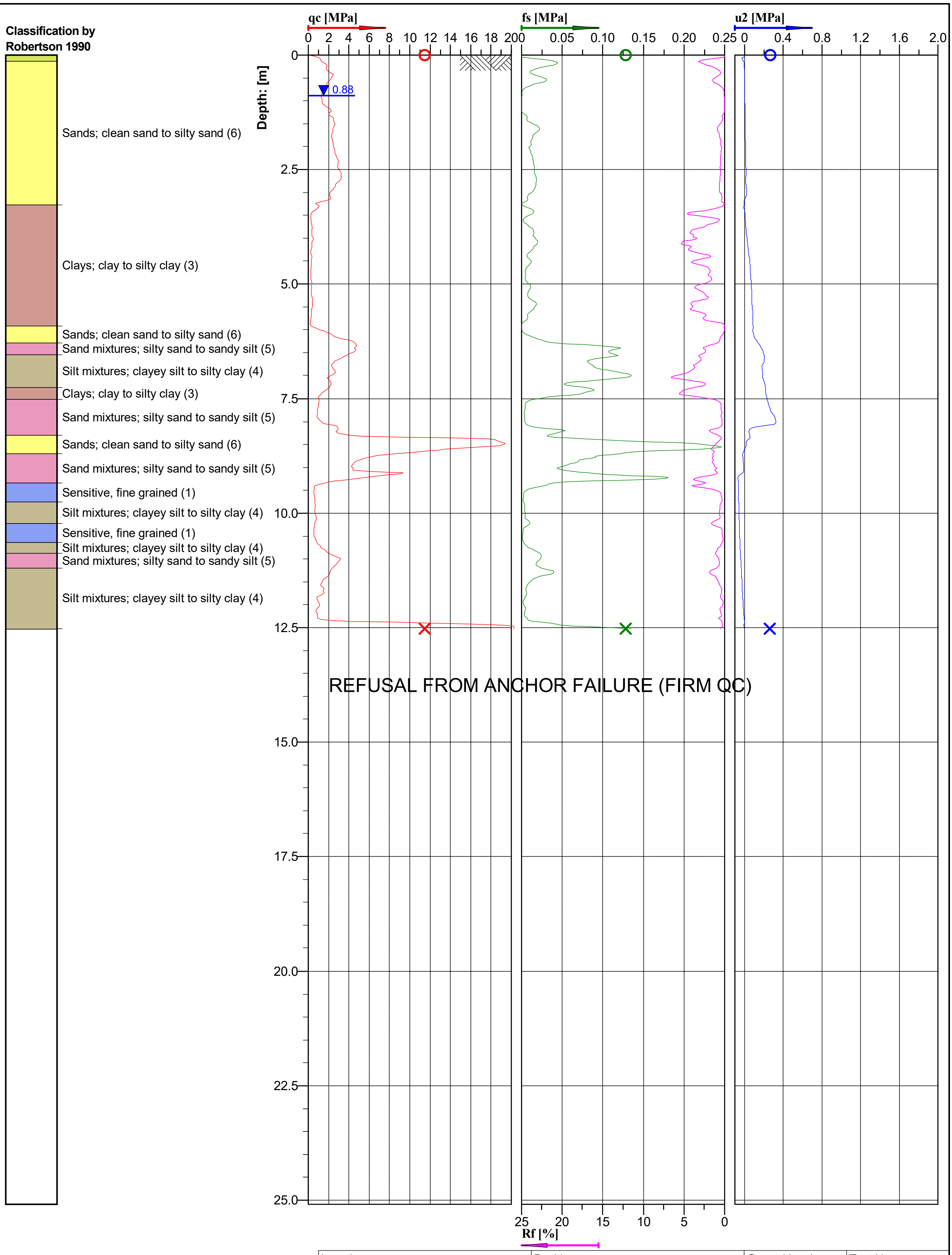


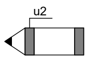
REFUSAL FROM ANCHOR FAILURE - FIRM FS



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

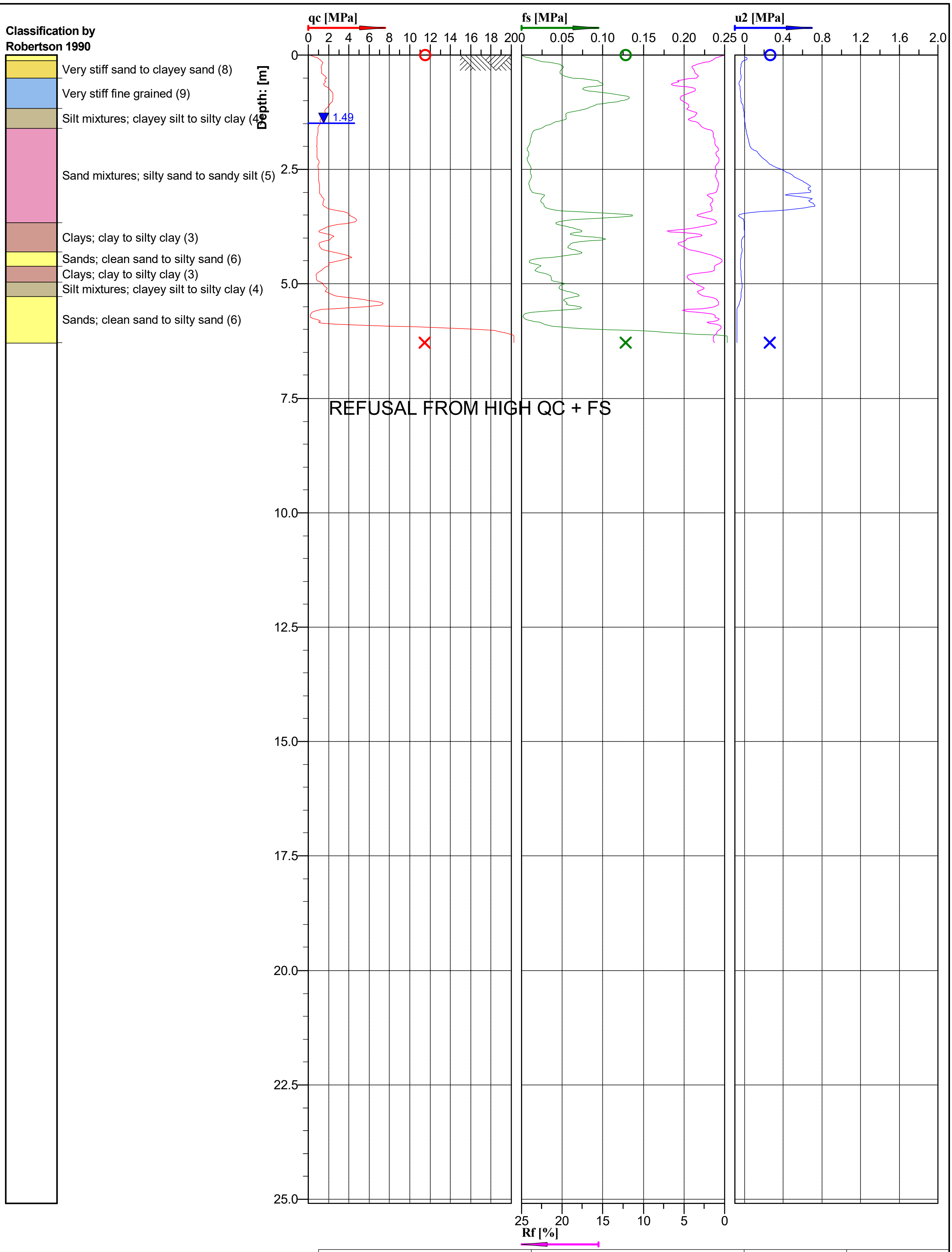
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT25
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48631, E 175.17348		File: CPT25.cpt	

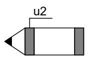




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

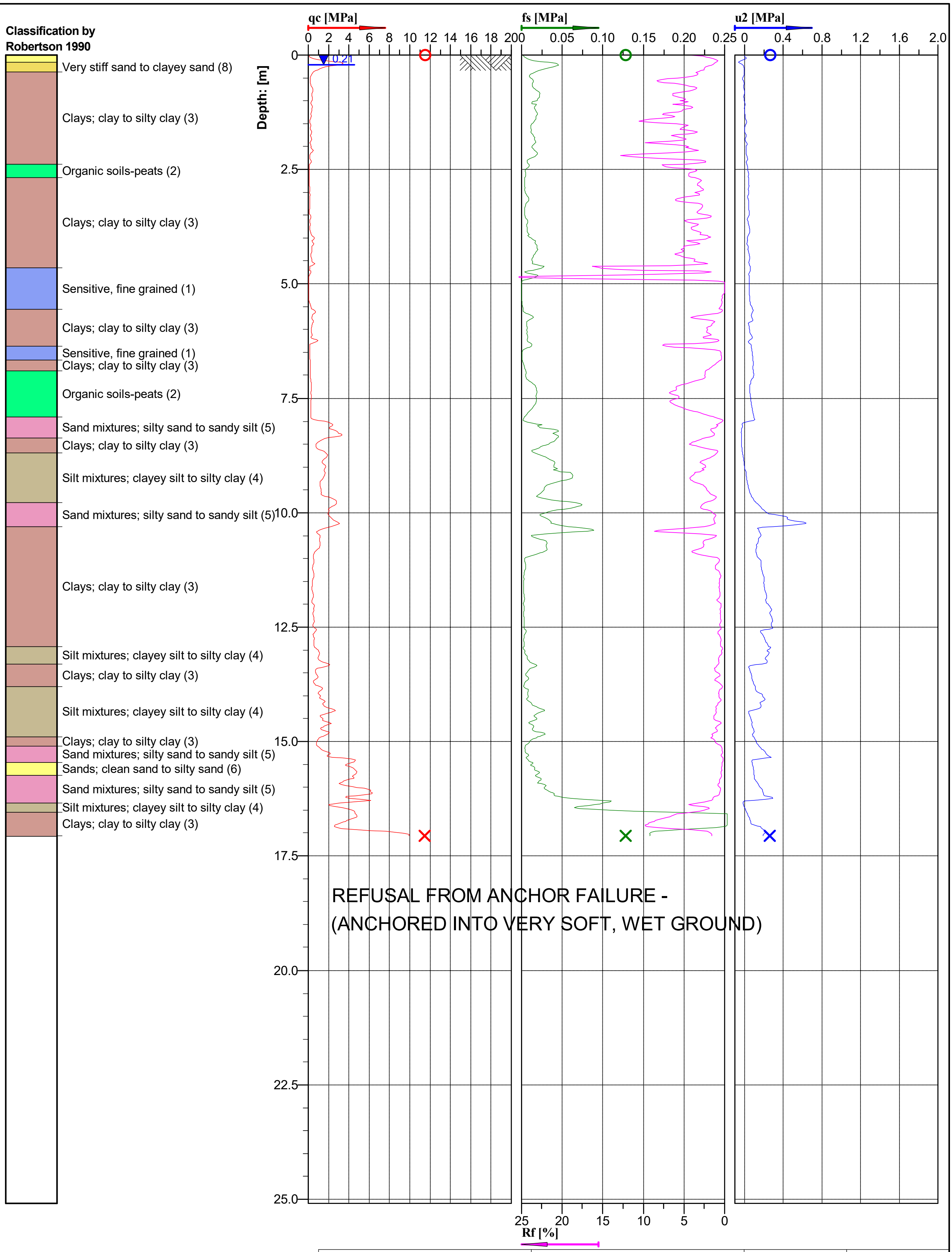
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT26
Project ID: P-000529	Client: INITIA	Date: 7/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48804, E 176.16447		File: CPT26.cpt	





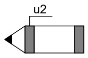
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT27
Project ID: P-000529	Client: INITIA	Date: 10/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48860, E 175.16864		File: CPT27.cpt	



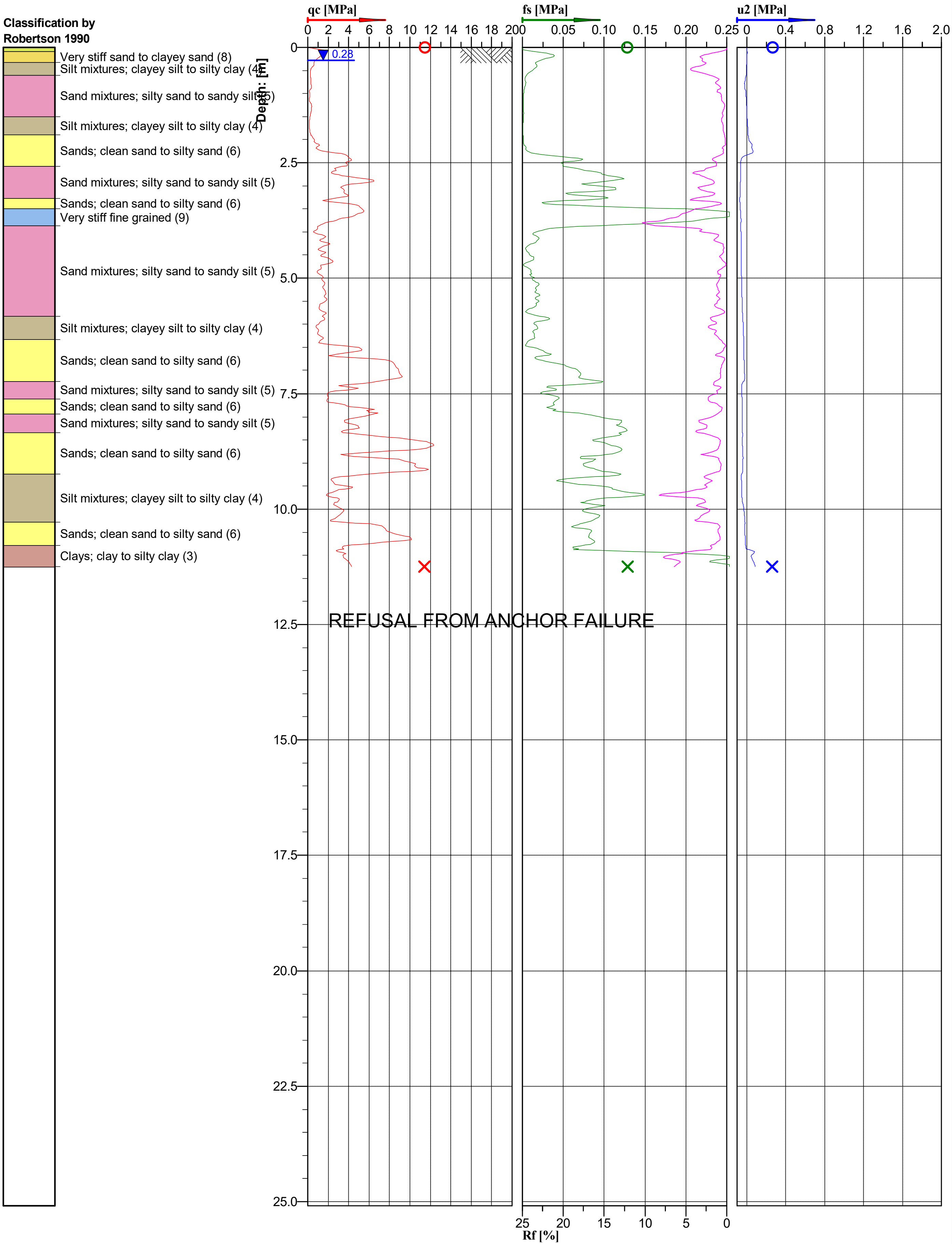
REFUSAL FROM ANCHOR FAILURE -
(ANCHORED INTO VERY SOFT, WET GROUND)

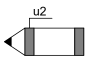
GEOTECH DRILLING



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

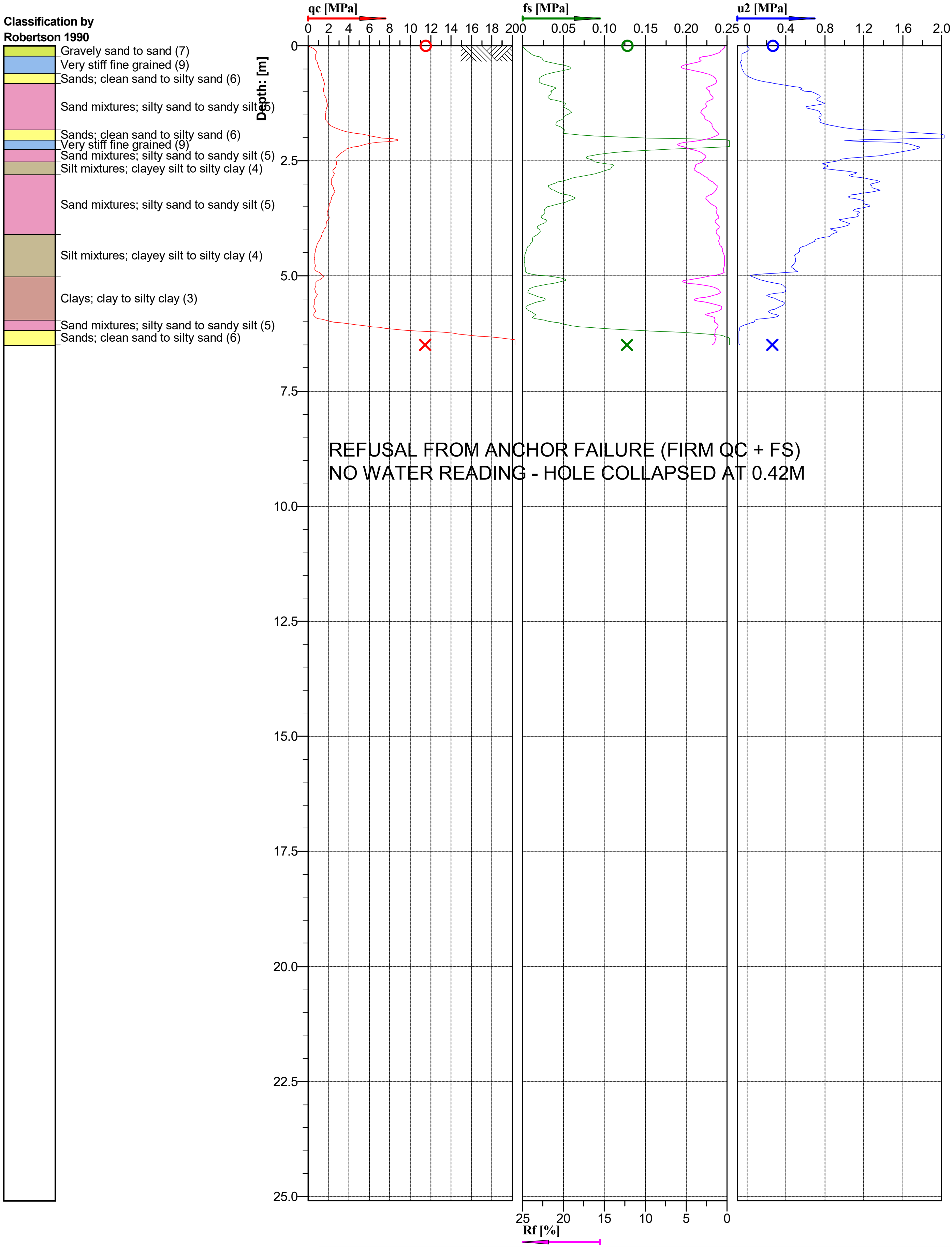
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT28
Project ID: P-000529	Client: INITIA	Date: 10/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48830, E 175.17116		File: CPT28A.cpt	





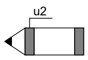
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT29
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48792, E 175.17363		File: CPT29.cpt	



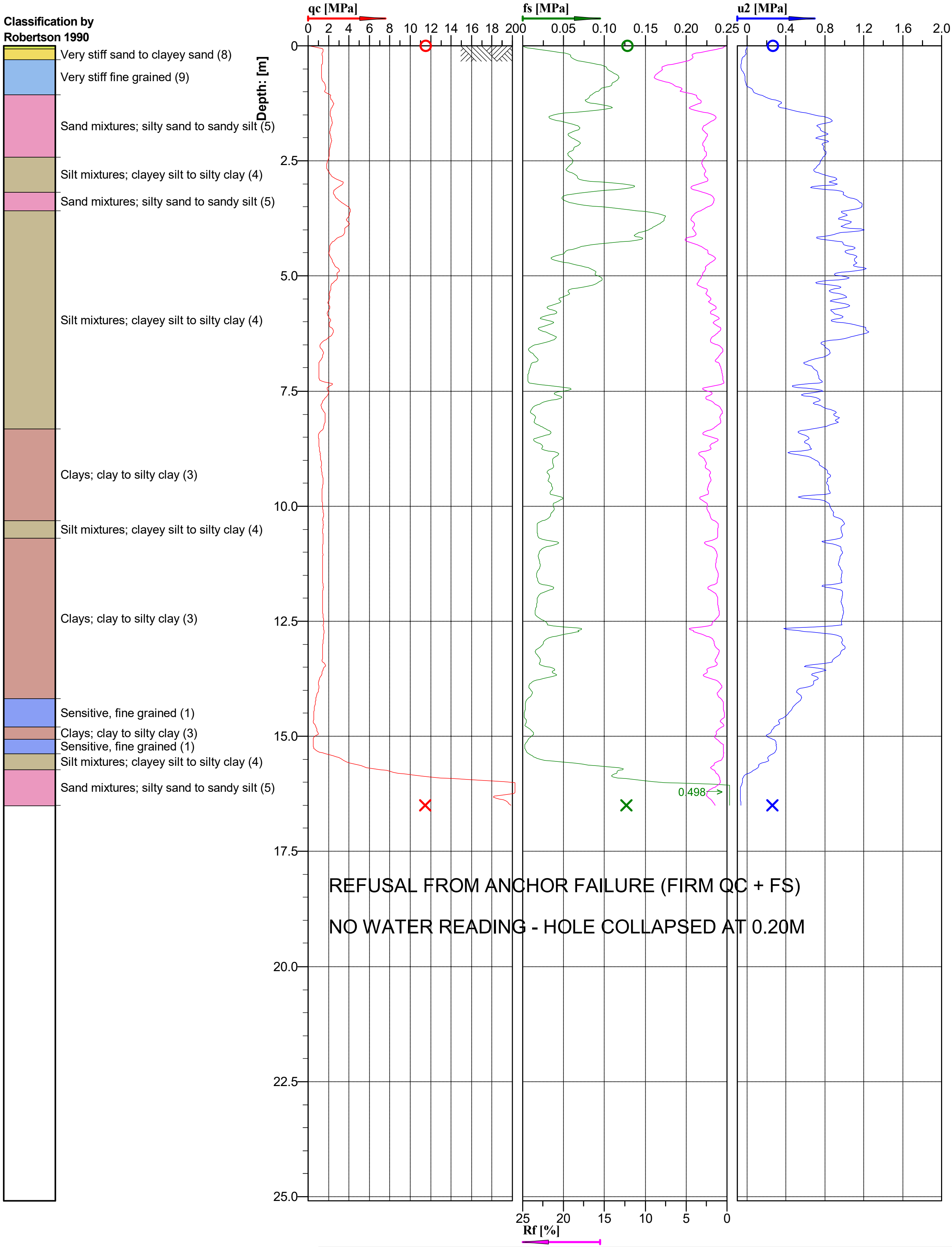
REFUSAL FROM ANCHOR FAILURE (FIRM QC + FS)
NO WATER READING - HOLE COLLAPSED AT 0.42M

GEOTECH DRILLING



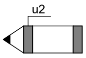
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT30
Project ID: P-000529	Client: INITIA	Date: 10/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48946, E 175.16418		File: CPT30.cpt	



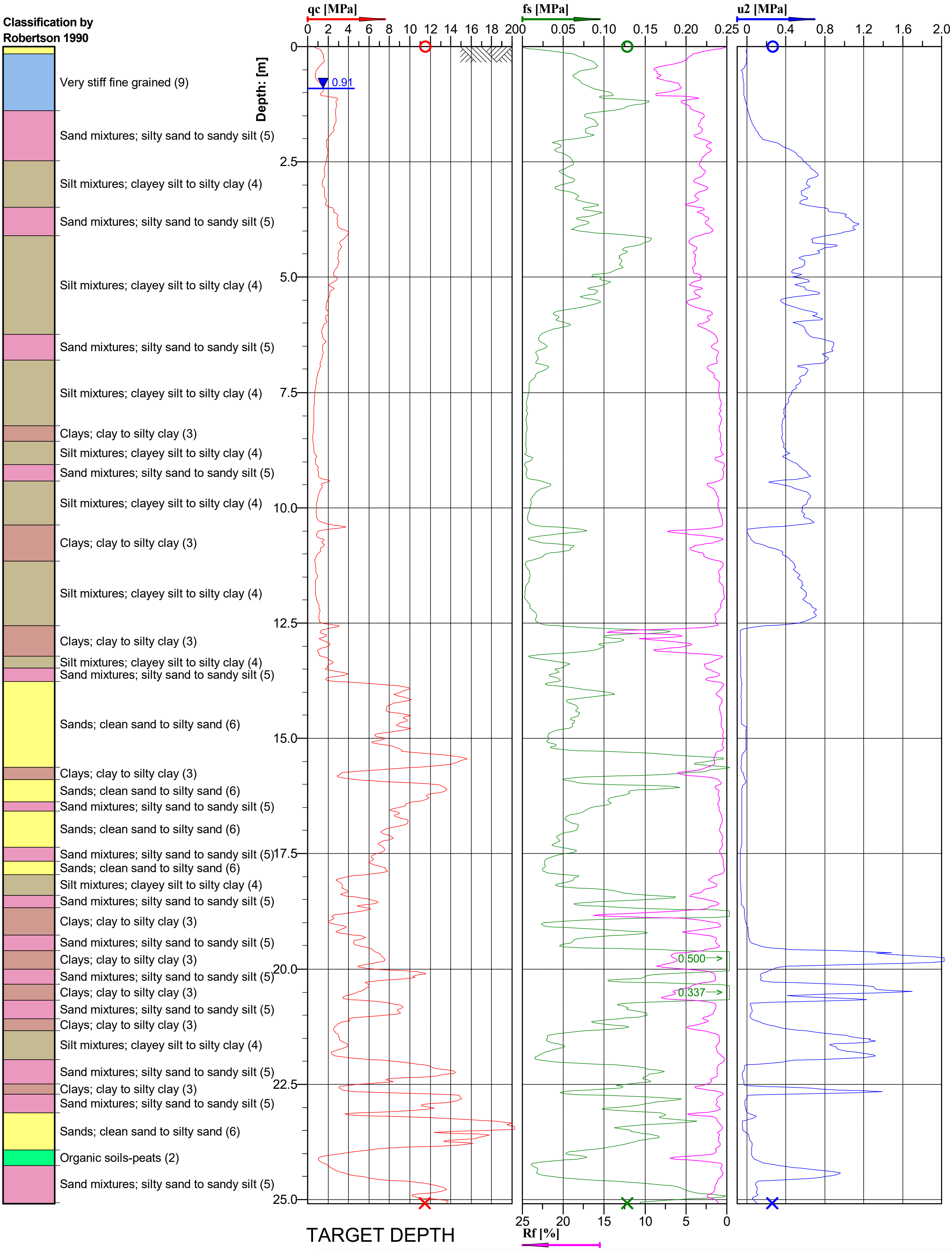
REFUSAL FROM ANCHOR FAILURE (FIRM QC + FS)

NO WATER READING - HOLE COLLAPSED AT 0.20M

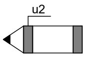


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT31
Project ID: P-000529	Client: INITIA	Date: 10/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48962, E 175.16664		File: CPT31.cpt	

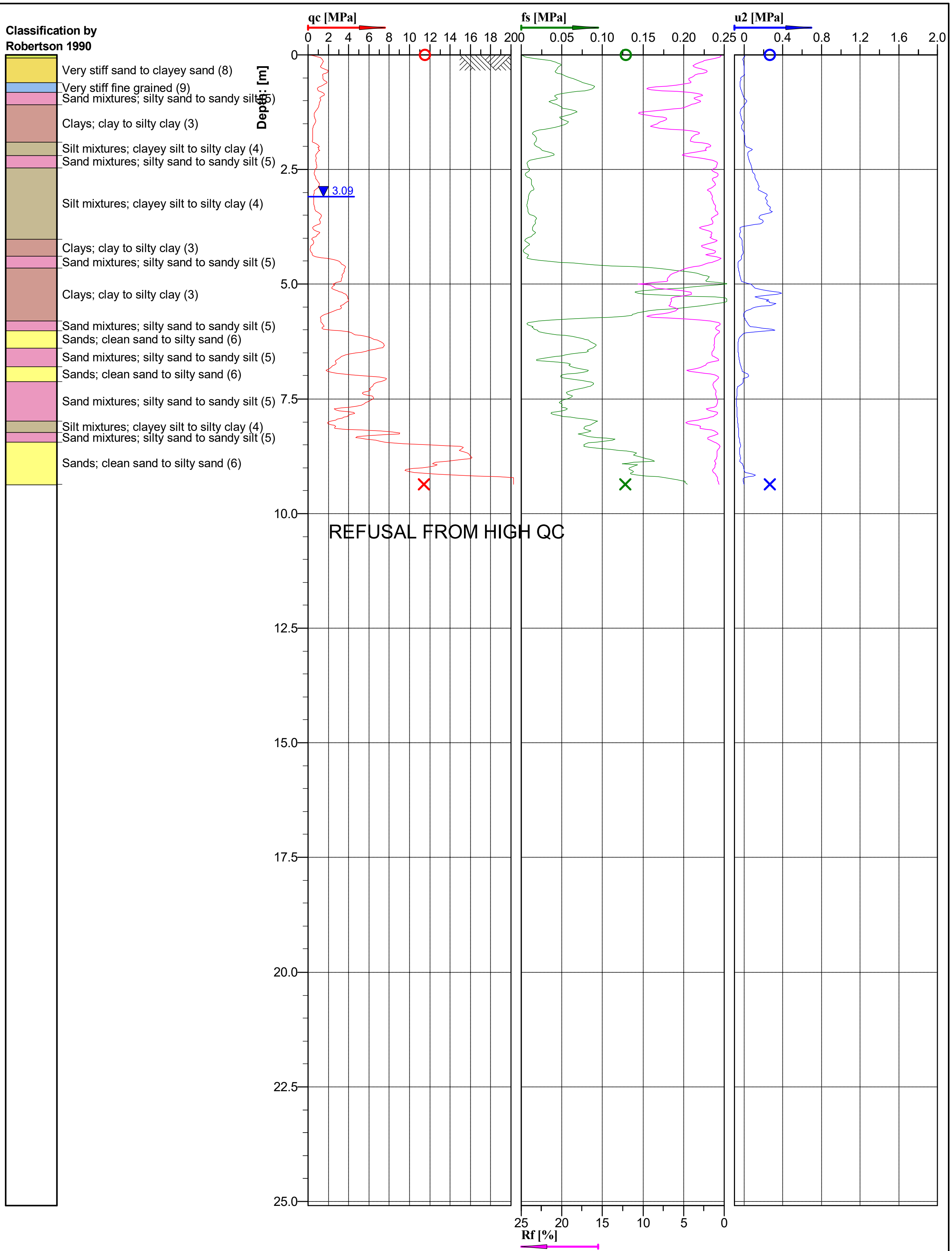


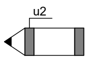
TARGET DEPTH



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

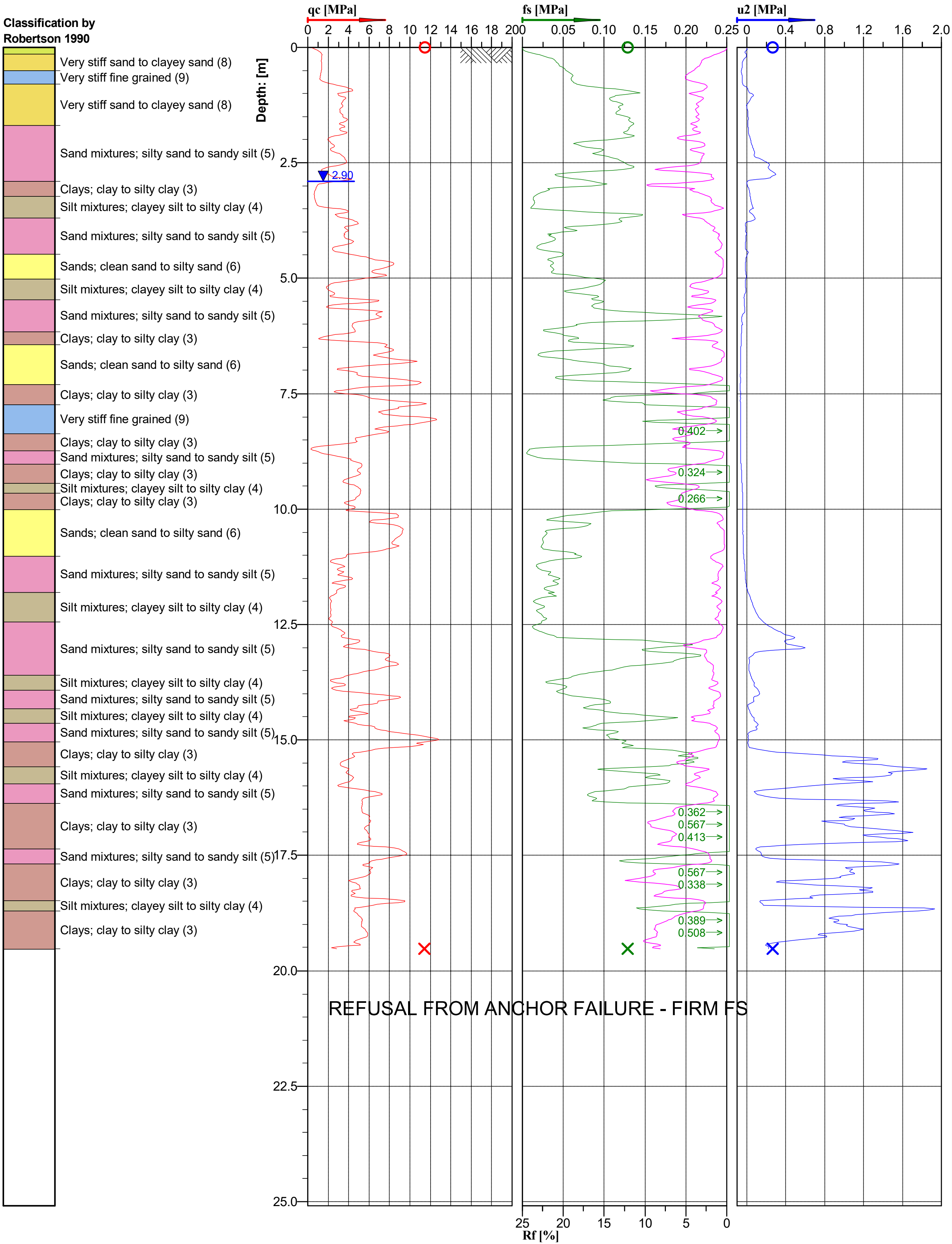
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT32
Project ID: P-000529	Client: INITIA	Date: 10/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.49004, E 175.16878		File: CPT32.cpt	

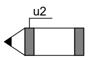




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT33
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.49033, E 175.17131		File: CPT33.cpt	

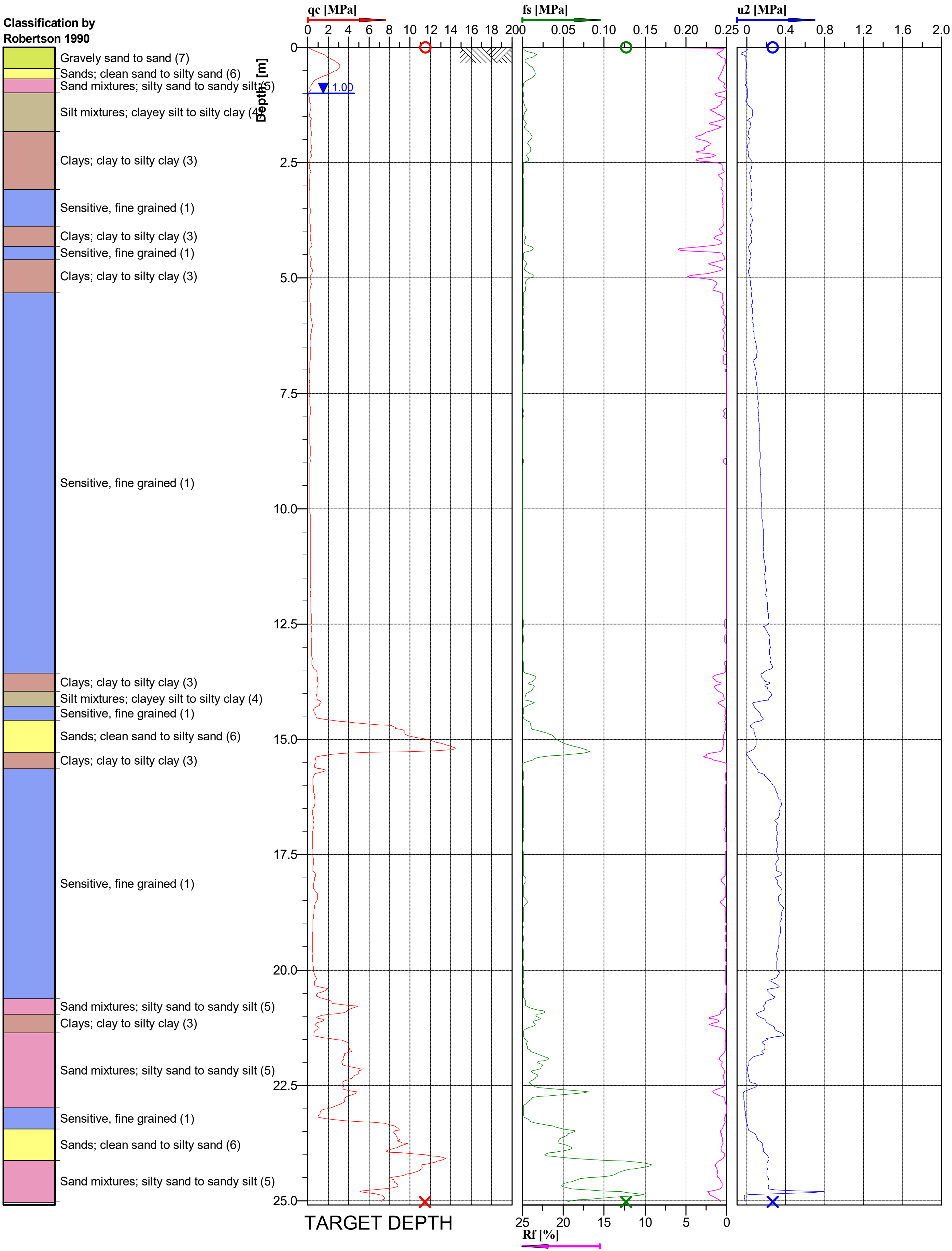


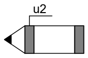


GEOTECH DRILLING

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

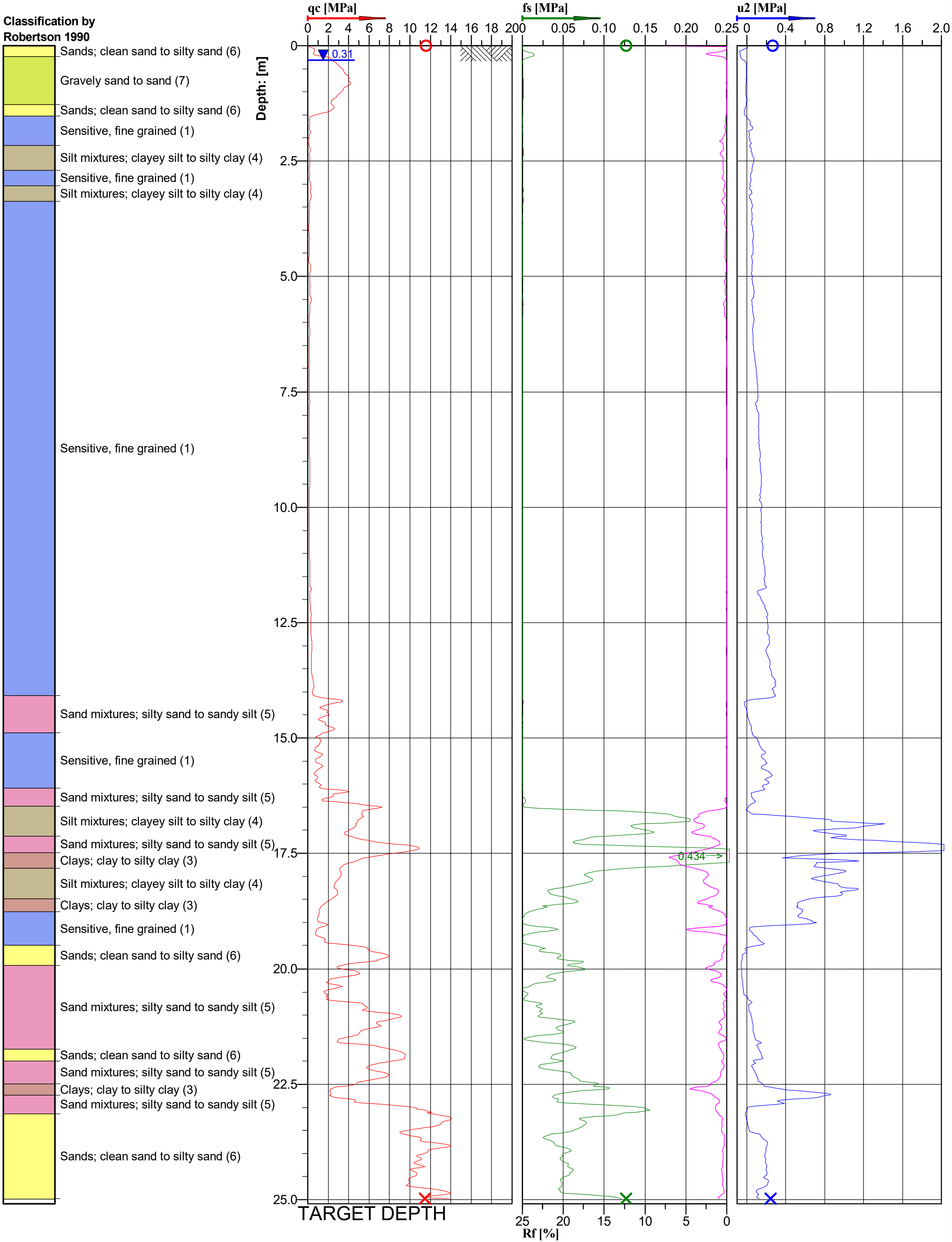
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT34
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48961, E 175.17375		File: CPT34.cpt	

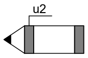




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

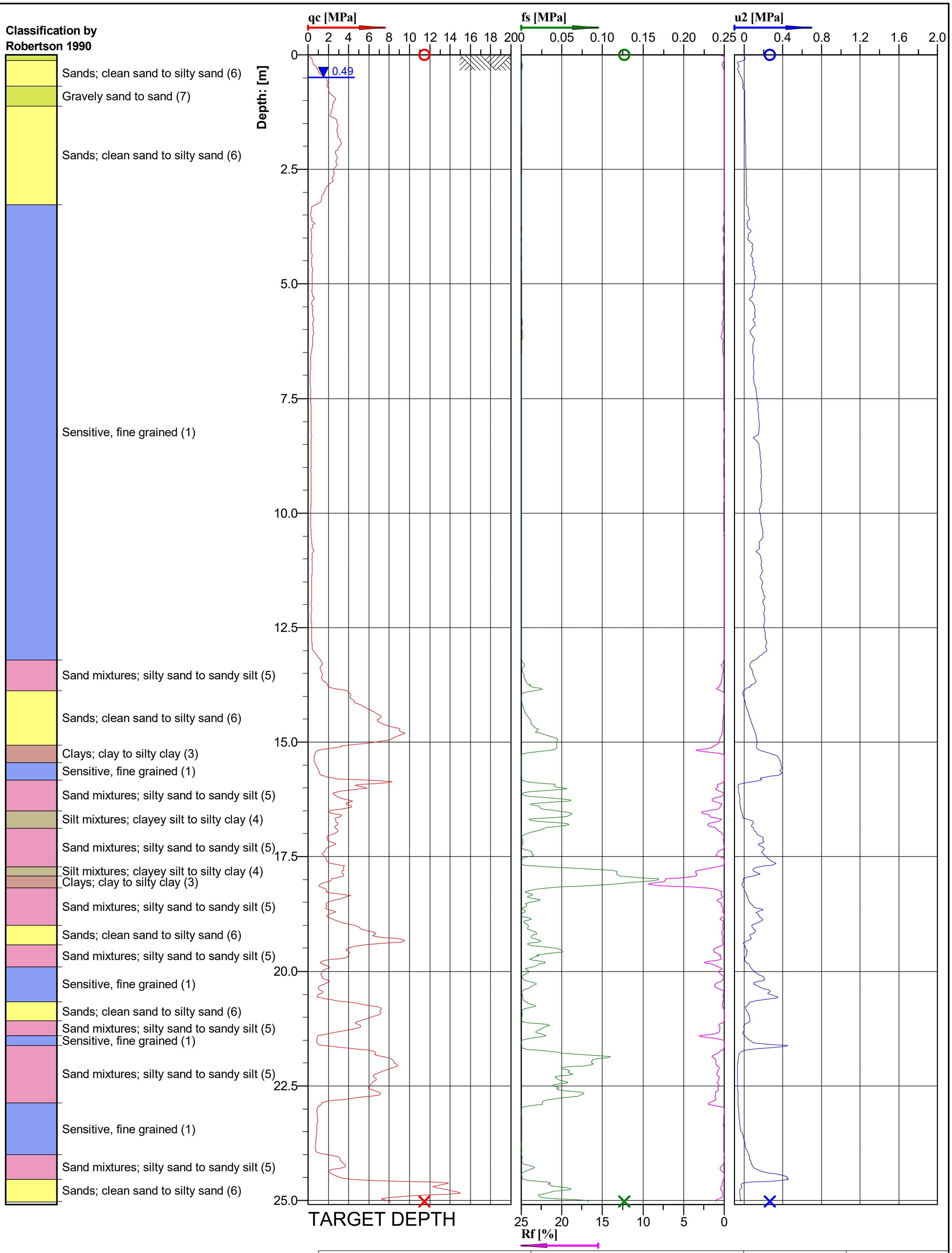
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT35
Project ID: P-000529	Client: INITIA	Date: 13/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48311, E 175.17529		File: CPT35.cpd	

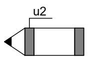




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

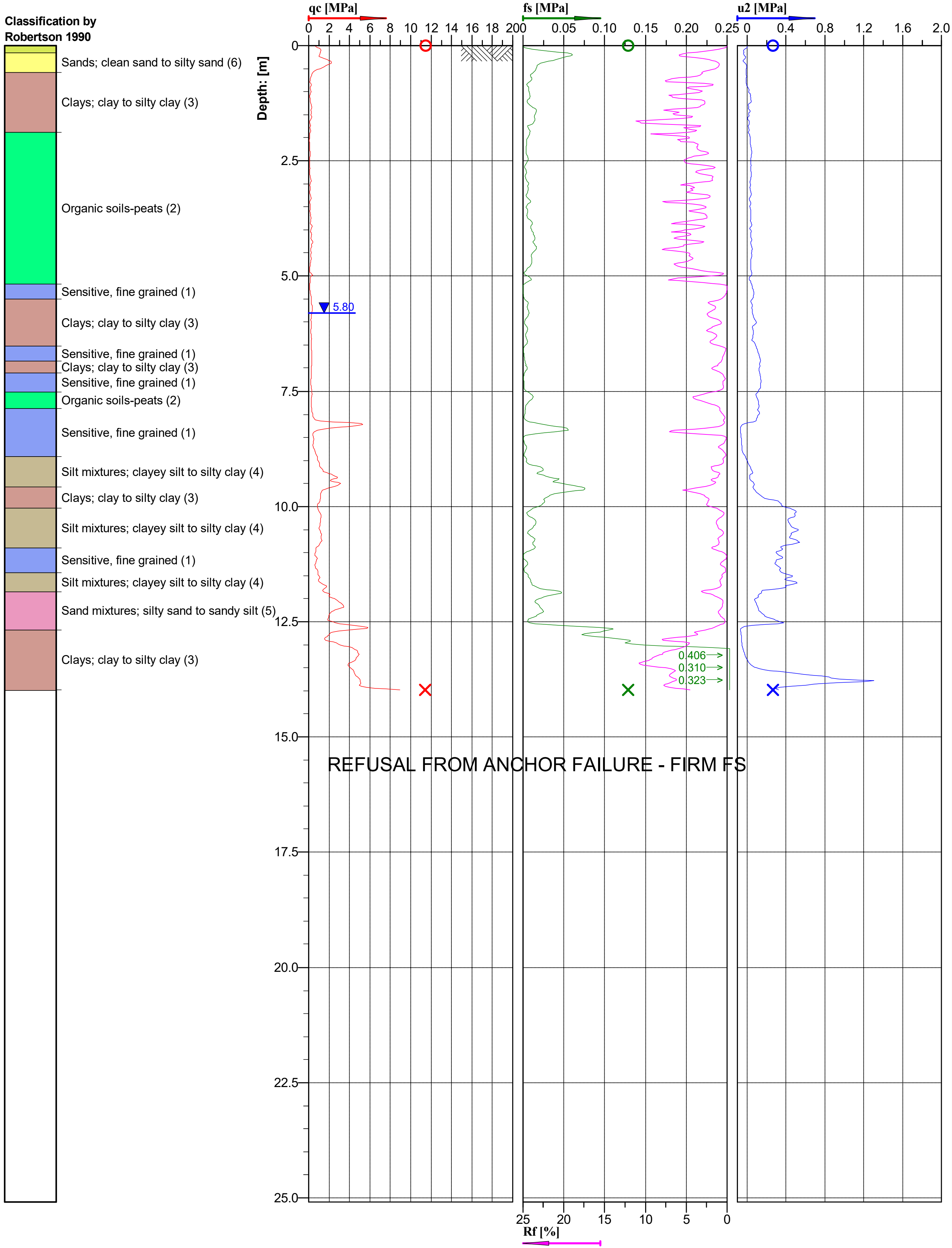
Location: OHINEWAI
Position: X: 0.00 m, Y: 0.00 m
Ground level: 0.00
Test No.: CPT37
Project ID: P-000529
Client: INITIA
Date: 13/09/2018
Scale: 1 : 112
Project: TAHUNA RD
Page: 1/1
Fig.:
S 37.48291, E 175.18016
File: CPT37.cpt

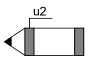




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT38
Project ID: P-000529	Client: IN ITIA	Date: 13/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48356, E 175.18230		File: CPT38.cpt	

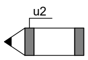




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

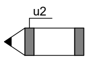
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT40
Project ID: P-000529	Client: INITIA	Date: 11/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48471, E 17.17561		File: CPT40.cpt	

GEOTECH DRILLING



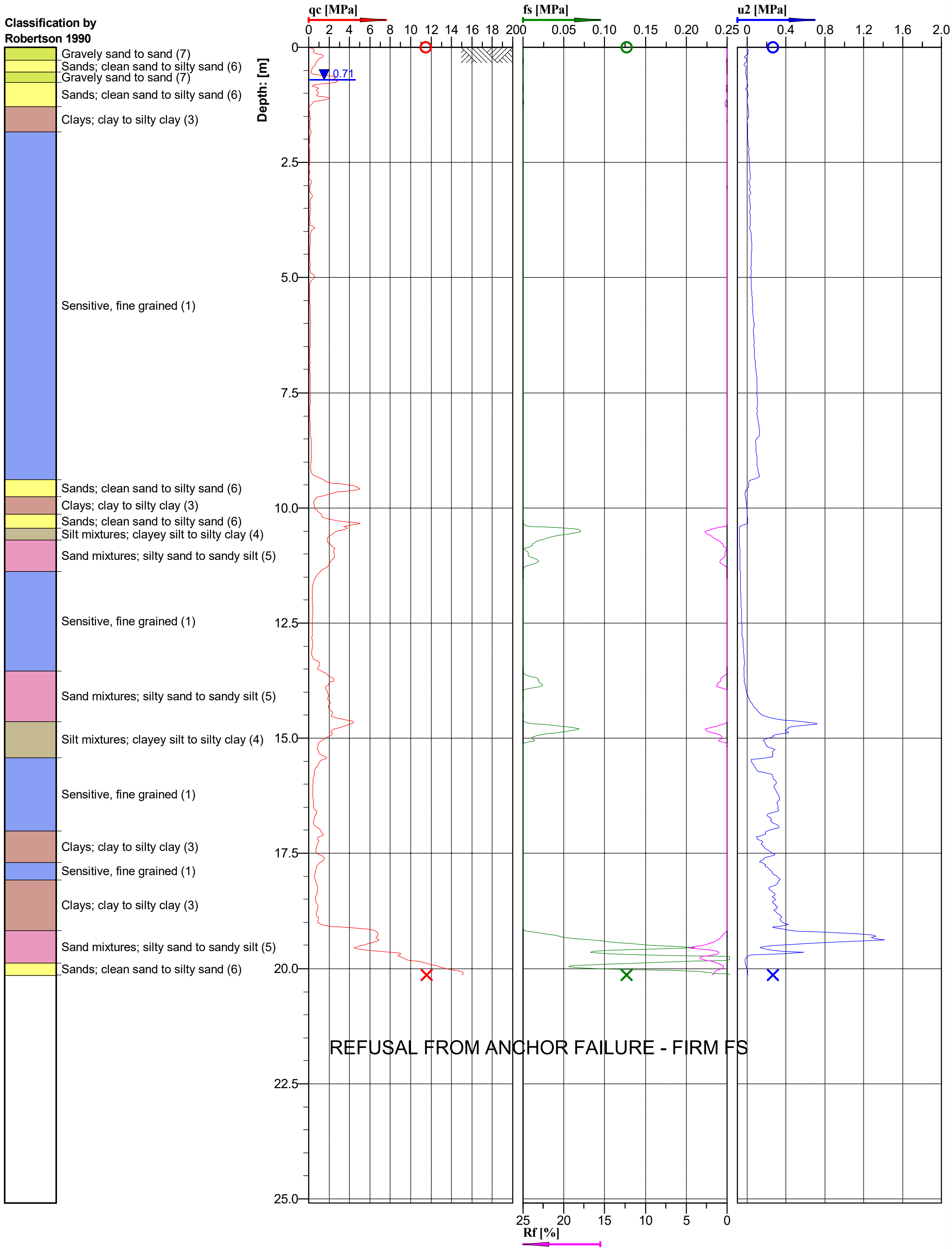
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

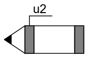
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT42
Project ID: P-000529	Client: INITIA	Date: 13/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48545, E 175.18045		File: CPT42.cpt	



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

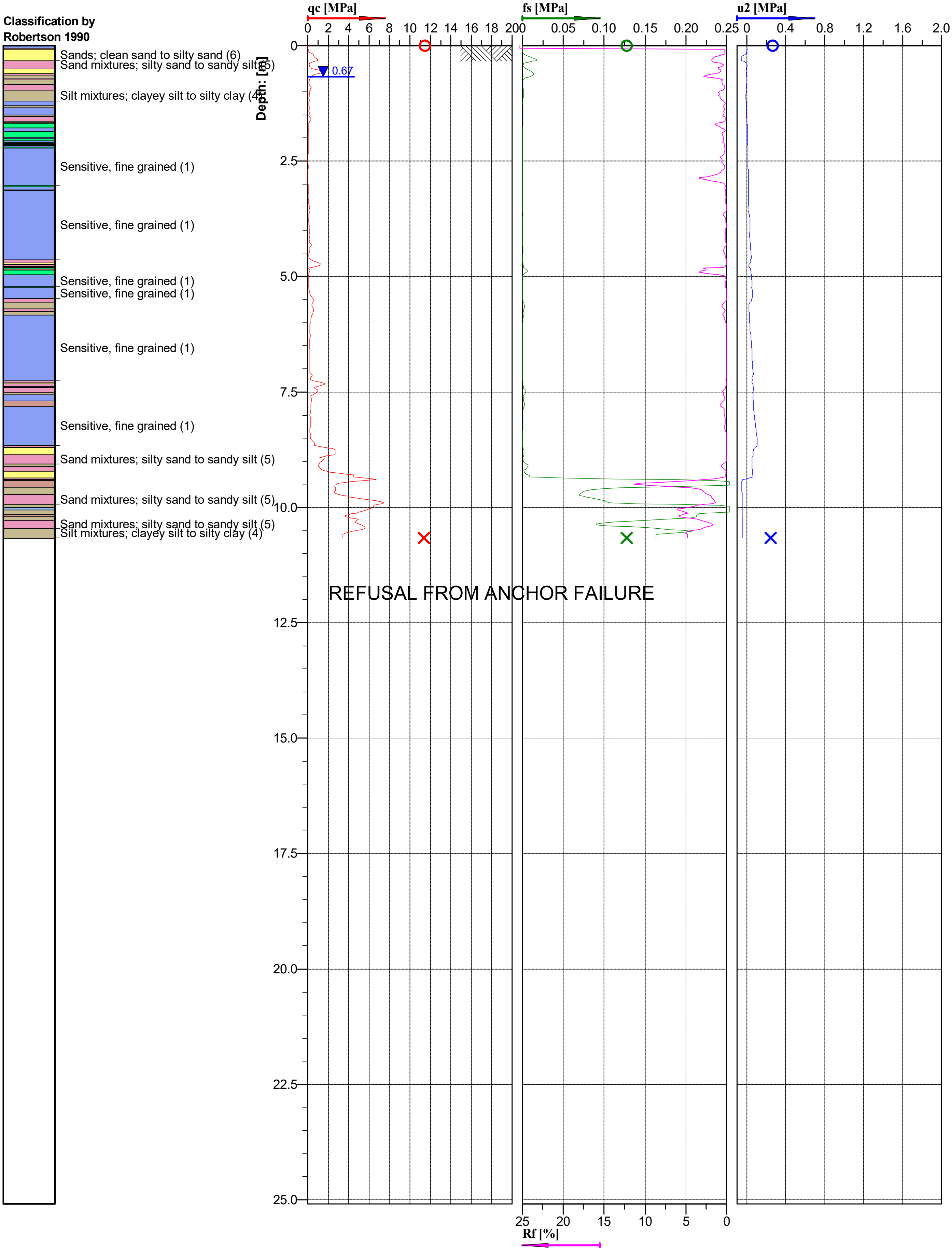
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT43
Project ID: P-000529	Client: INITIA	Date: 13/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48552, E 175.18256		File: CPT43.cpt	

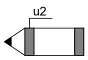




Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

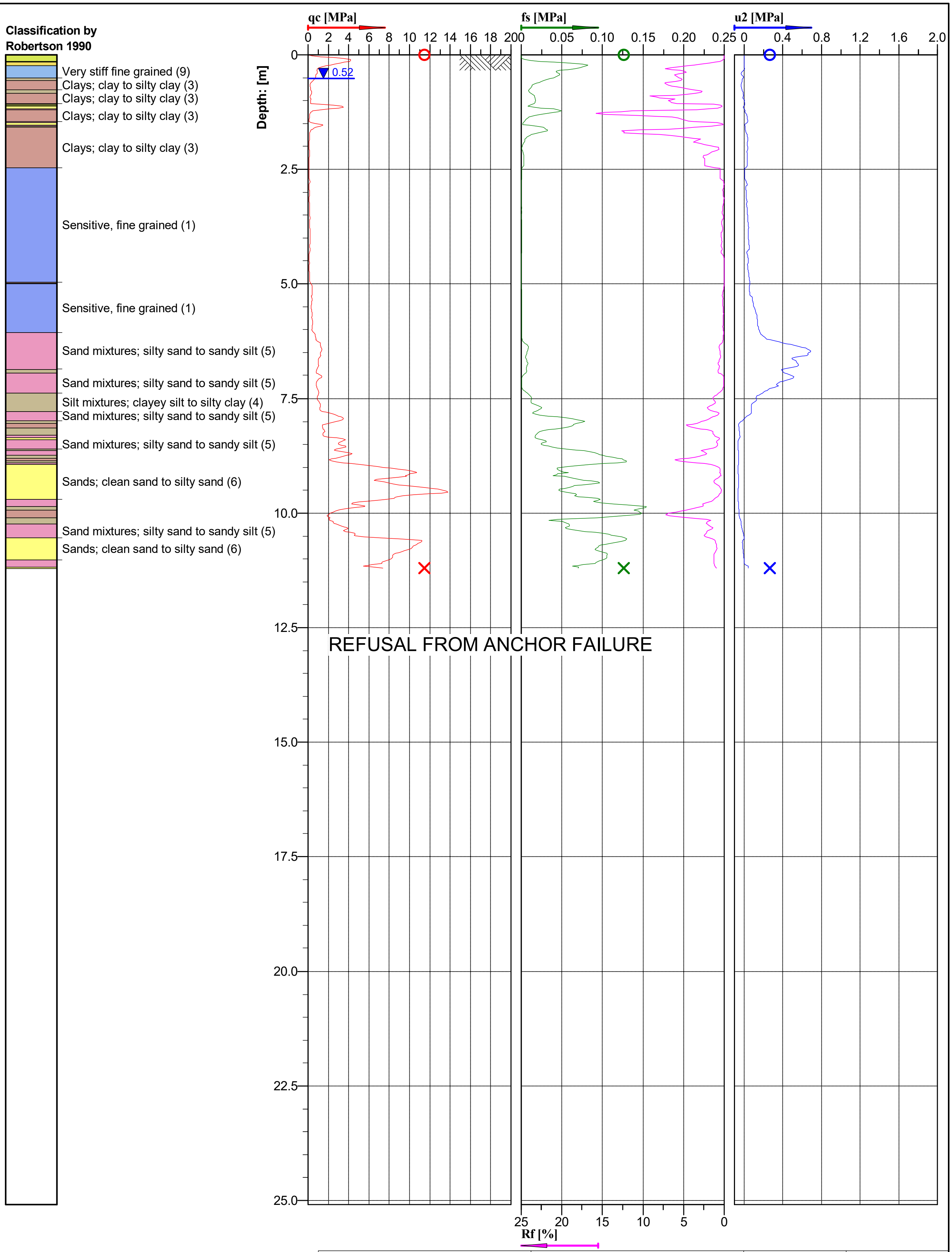
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT44
Project ID: P-000529	Client: INITIA	Date: 13/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48675, E 175.184110		File: CPT44.cpt	



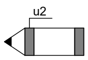


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT47
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48668, E 175.17799		File: CPT47.cpt	

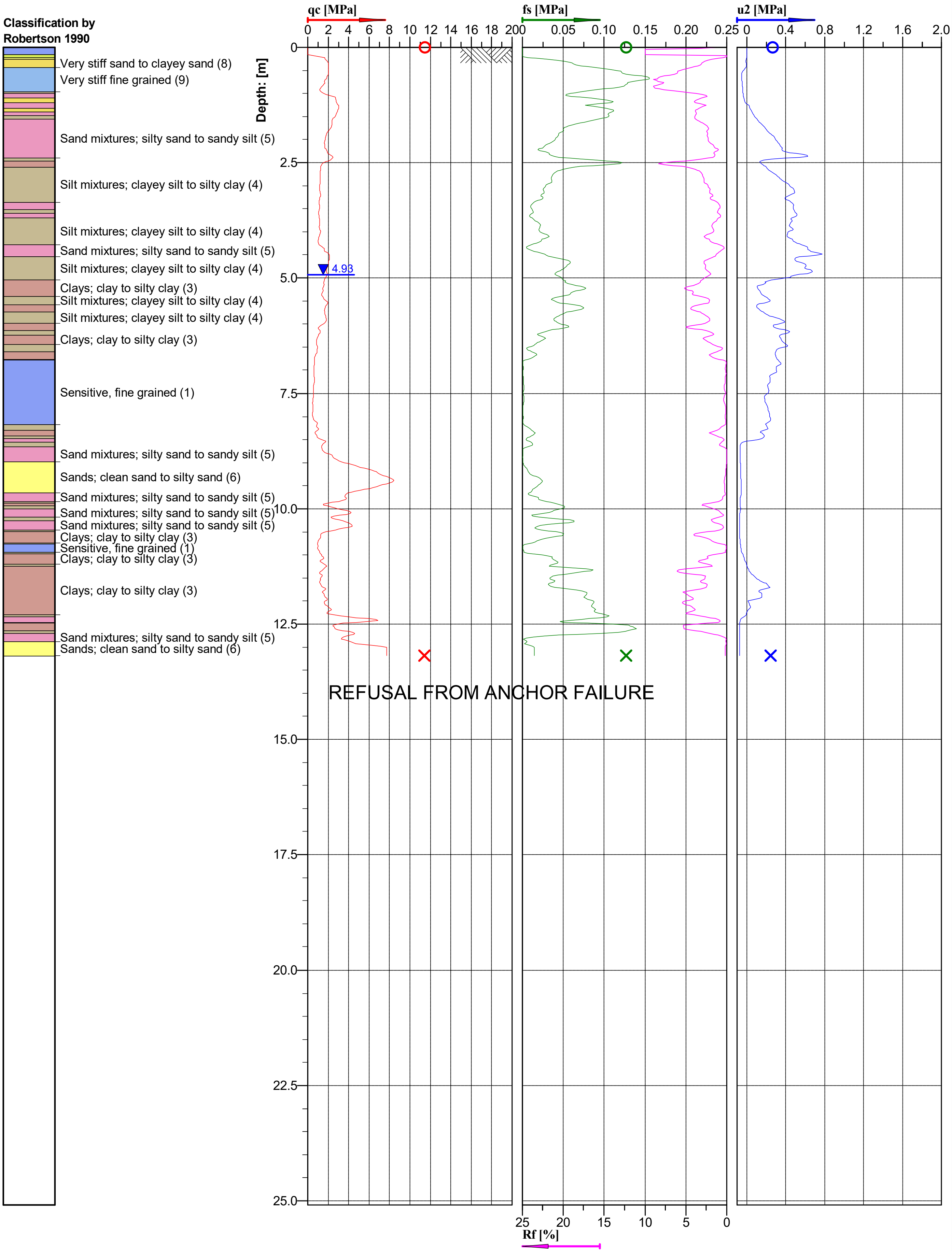


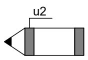
REFUSAL FROM ANCHOR FAILURE



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

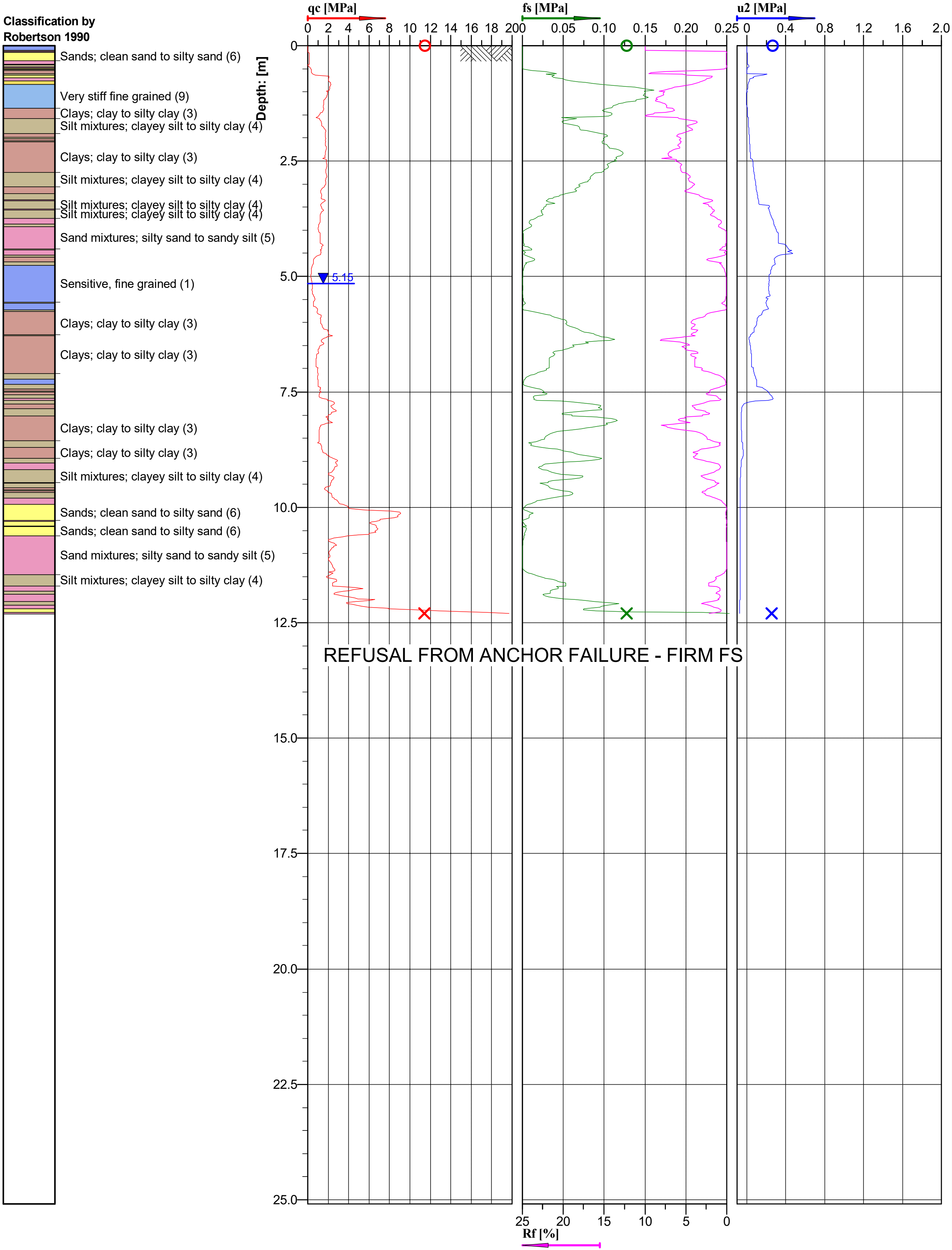
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT48
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48680, E 175.17578		File: CPT48.cpt	



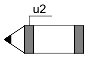


Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT53
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48892, E 175.18521		File: CPT53.cpt	

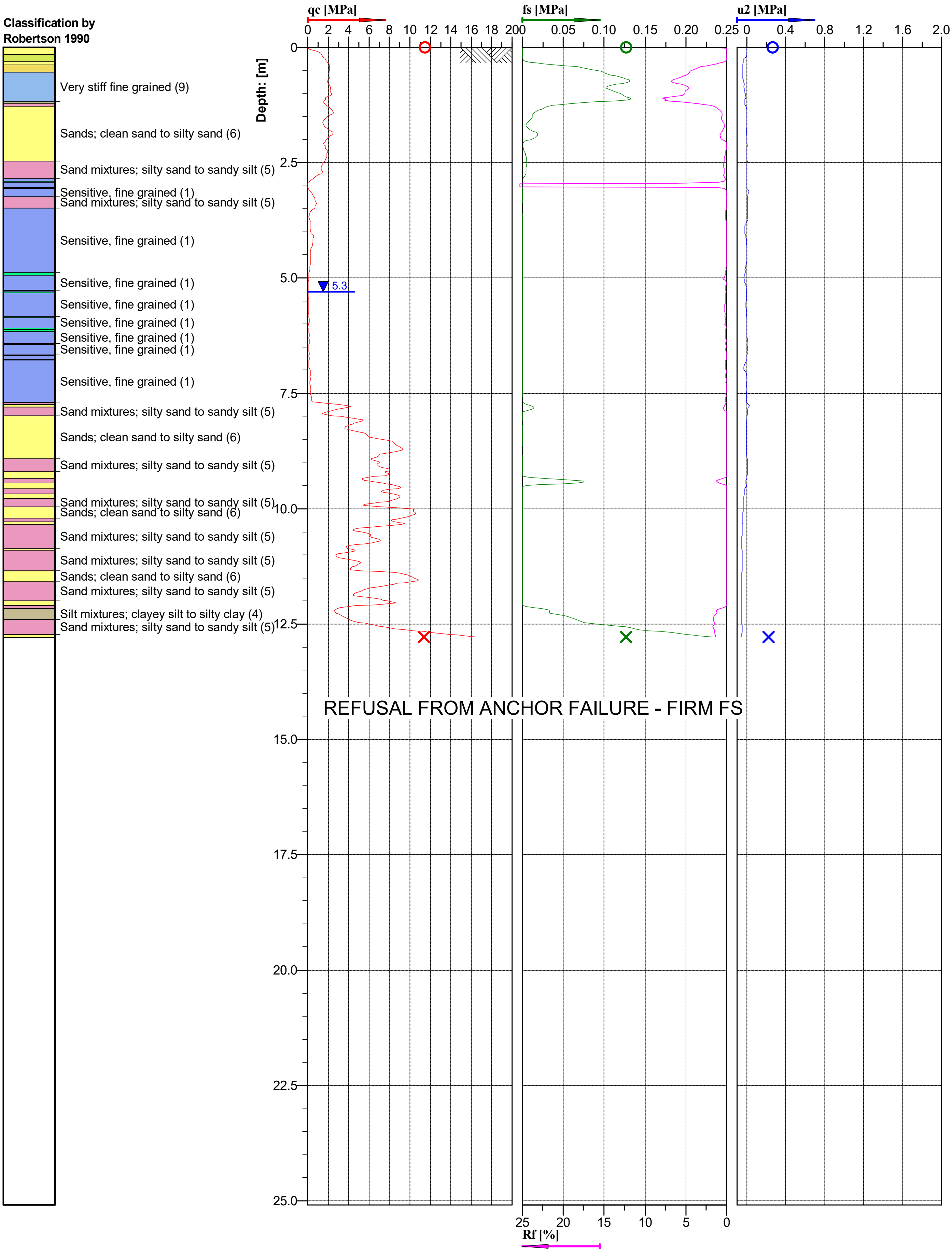


REFUSAL FROM ANCHOR FAILURE - FIRM FS



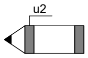
Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT54
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48909, E 175.18282		File: CPT54.cpt	



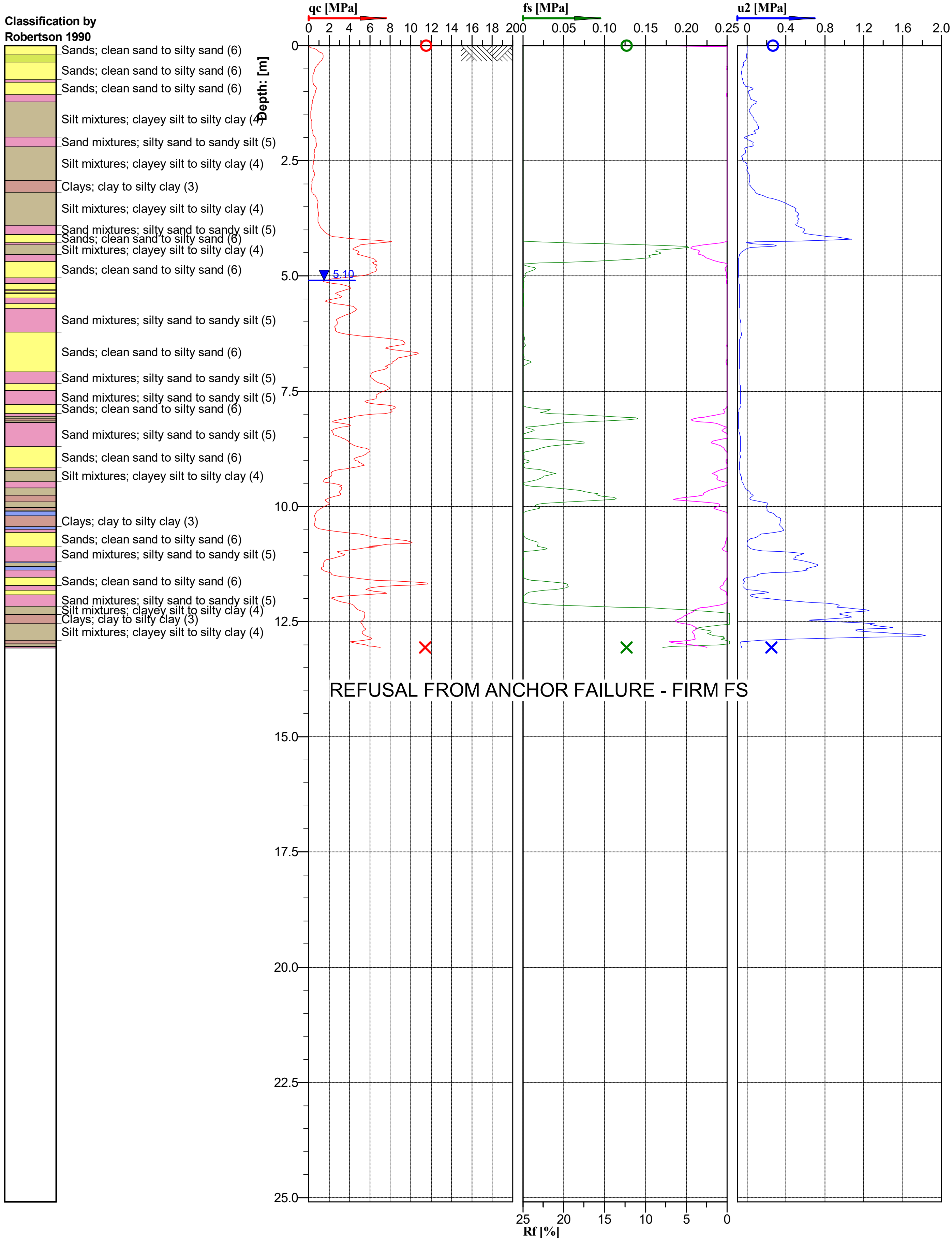
REFUSAL FROM ANCHOR FAILURE - FIRM FS

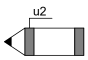
GEOTECH DRILLING



Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

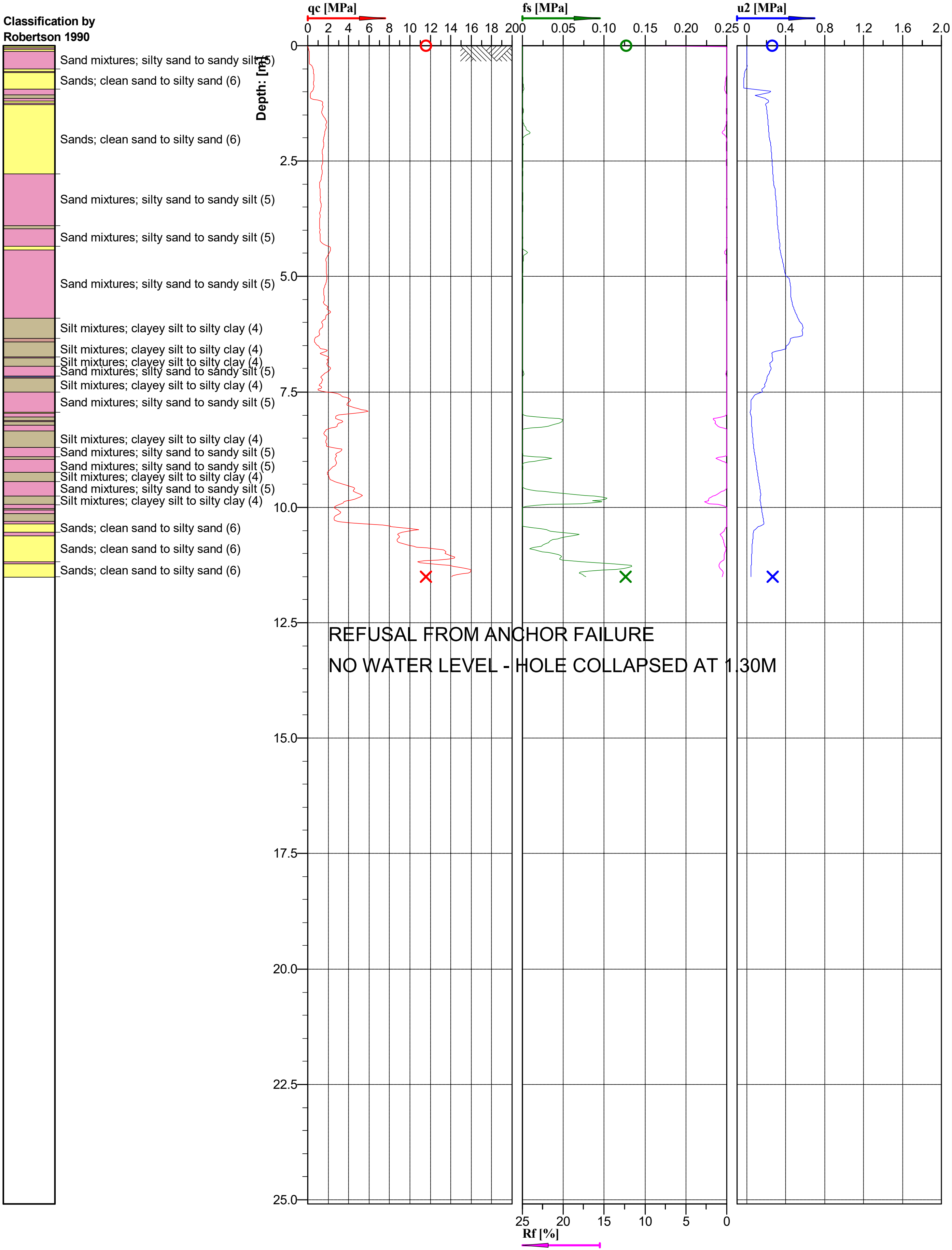
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT55
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48901, E 175.18073		File: CPT55A.cpt	





Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT56
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48853, E 175.17838		File: CPT56.cpt	



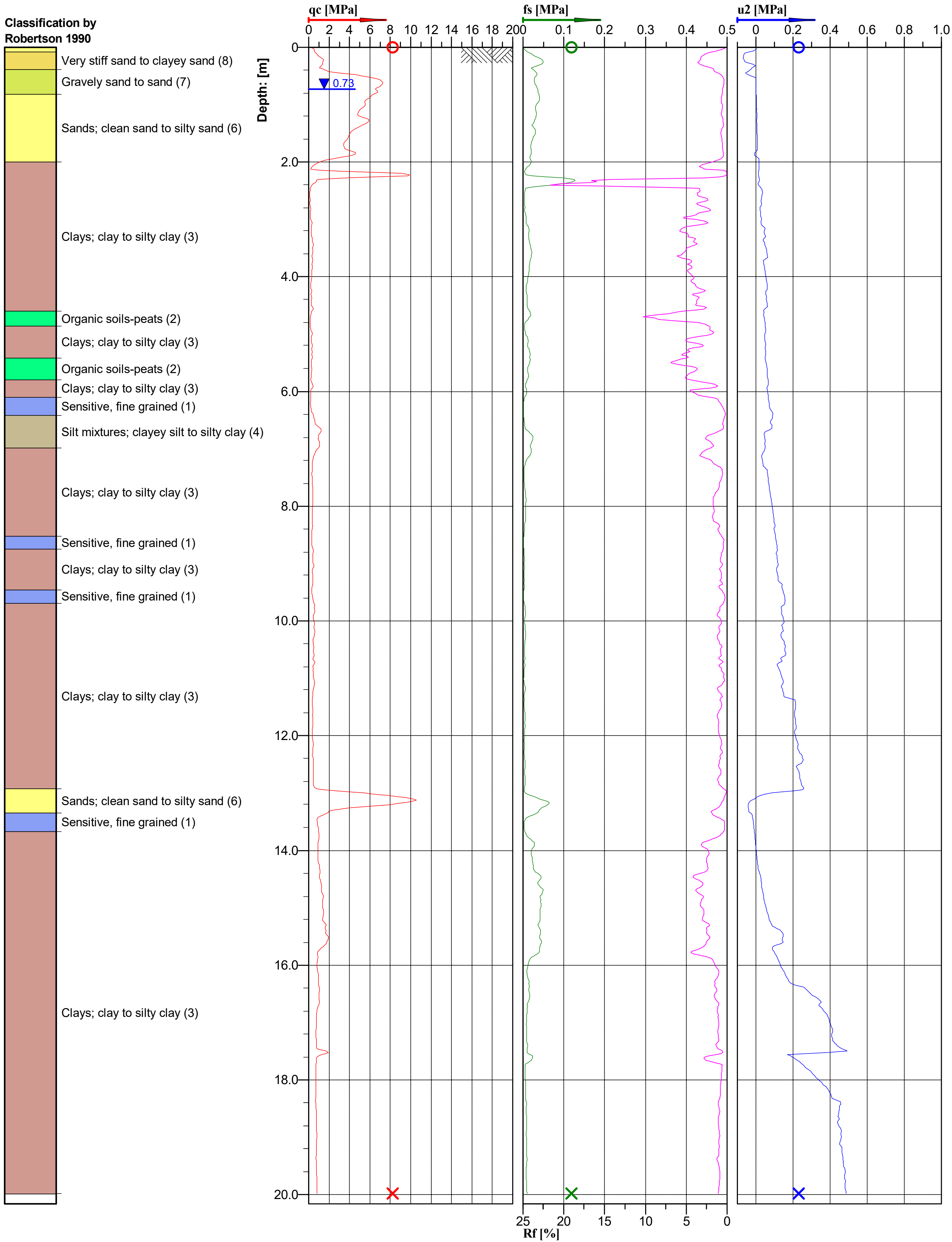
REFUSAL FROM ANCHOR FAILURE

NO WATER LEVEL - HOLE COLLAPSED AT 1.30M

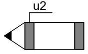
u2

Cone No: 4696
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT57
Project ID: P-000529	Client: INITIA	Date: 14/09/2018	Scale: 1 : 112
Project: TAHUNA RD		Page: 1/1	Fig.:
S 37.48875, E 175.17607		File: CPT57A.cpt	



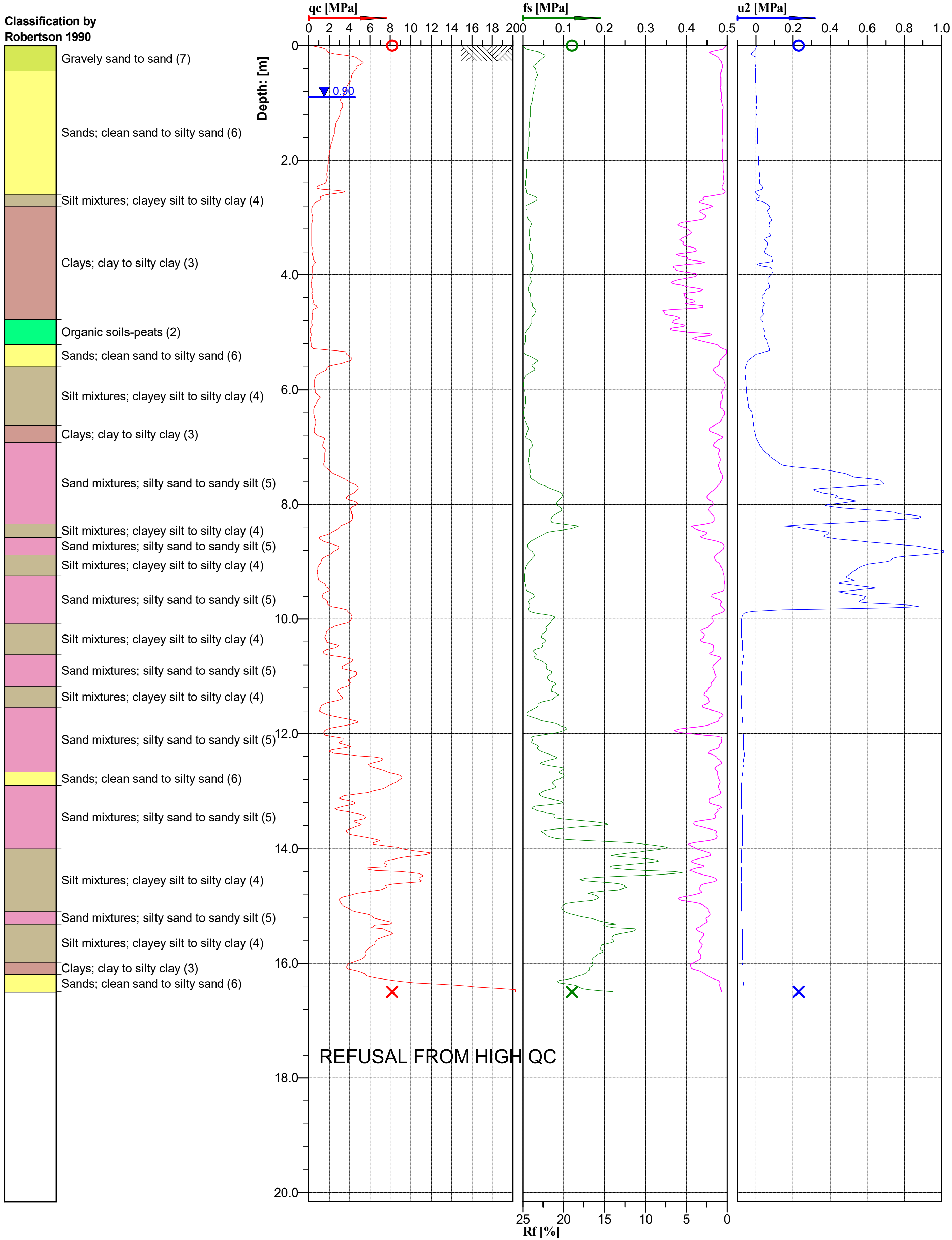
TARGET DEPTH



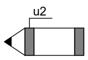
GEOTECH DRILLING

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

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT122
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.483793, E 175.166852		File: CPT122A.cpt	

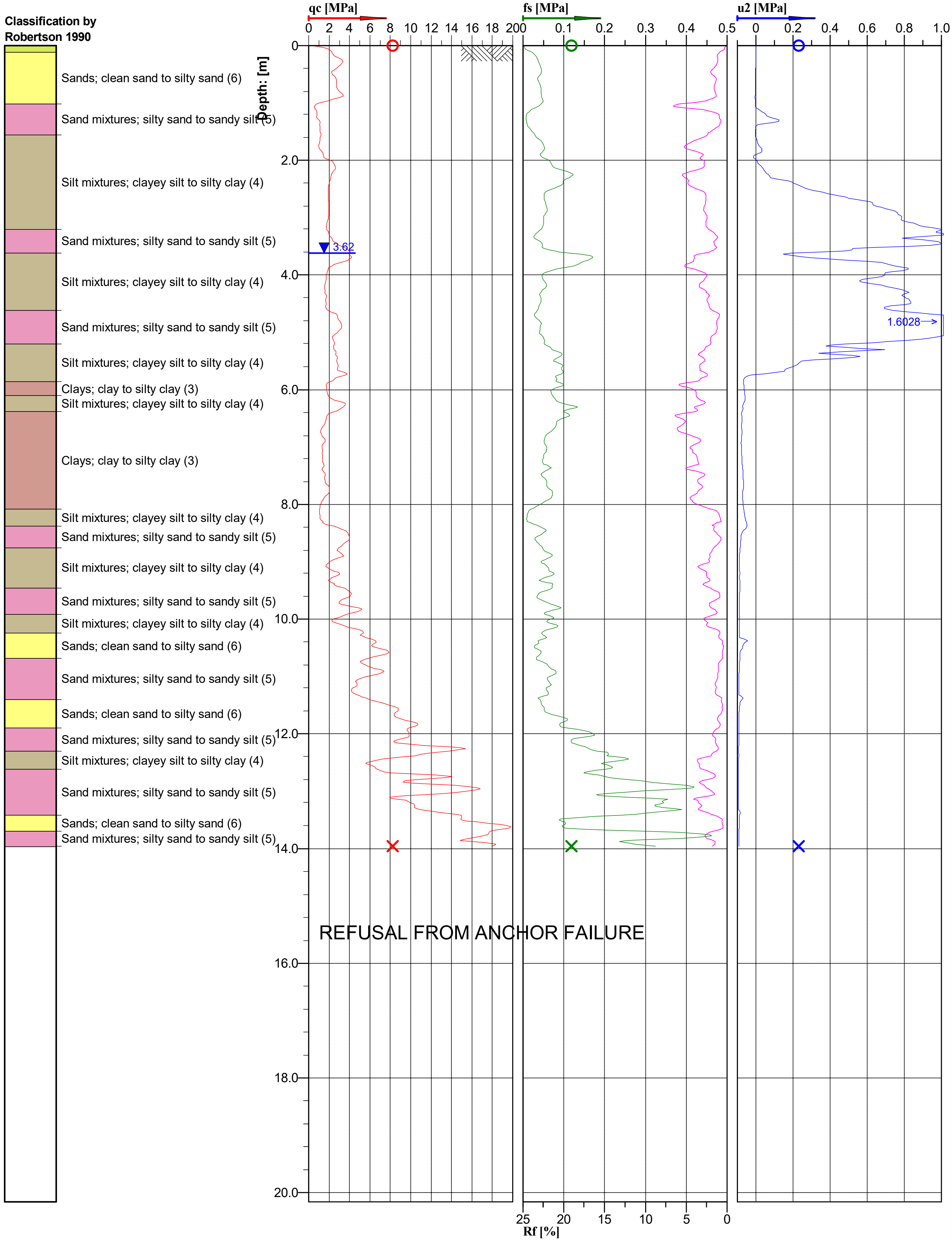


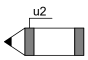
REFUSAL FROM HIGH QC



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

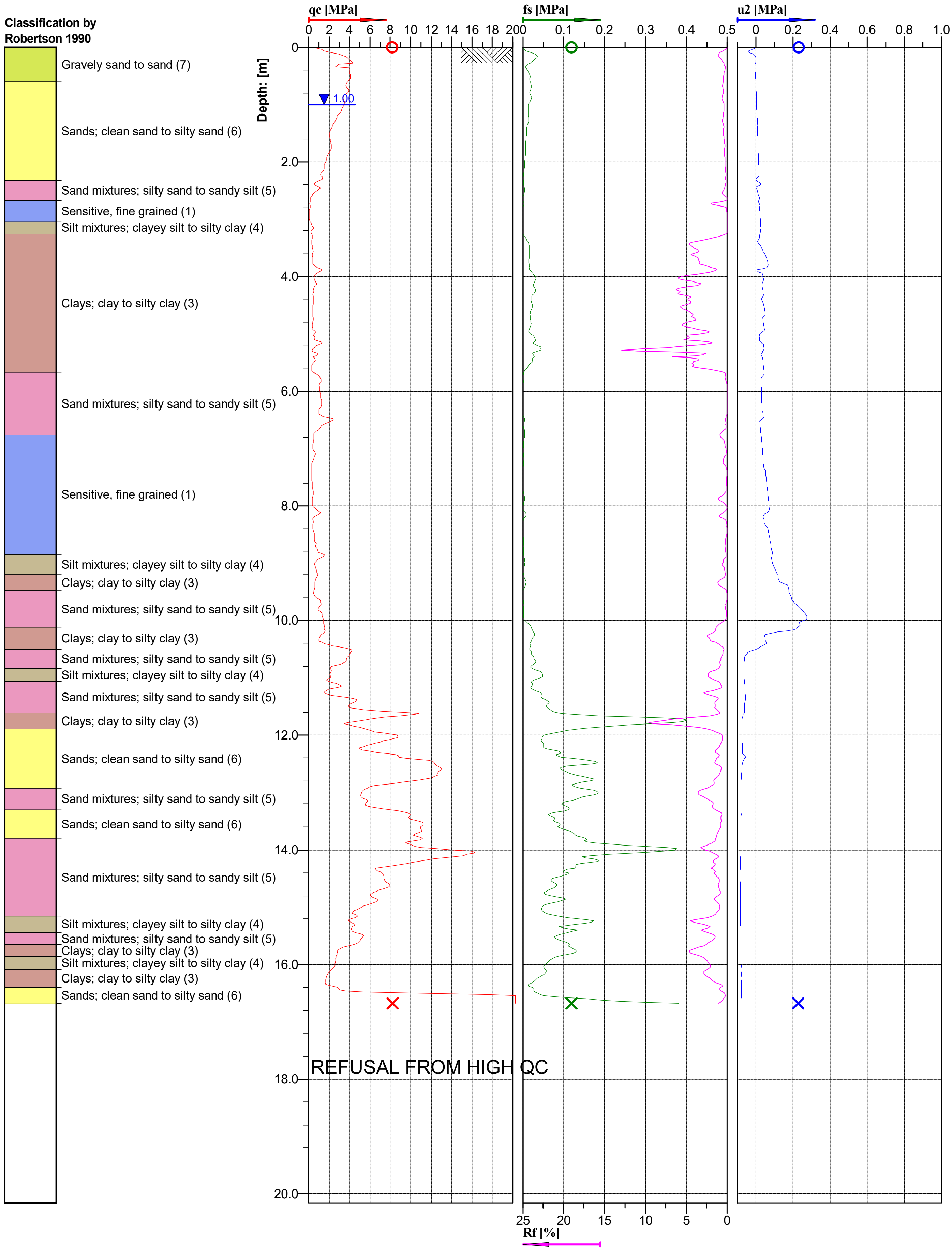
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT123
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.484504, E 175.165512		File: CPT123.cpt	

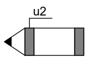




Cone No: 5332
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT124
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.484350, E 175.164110		File: CPT124.cpd	

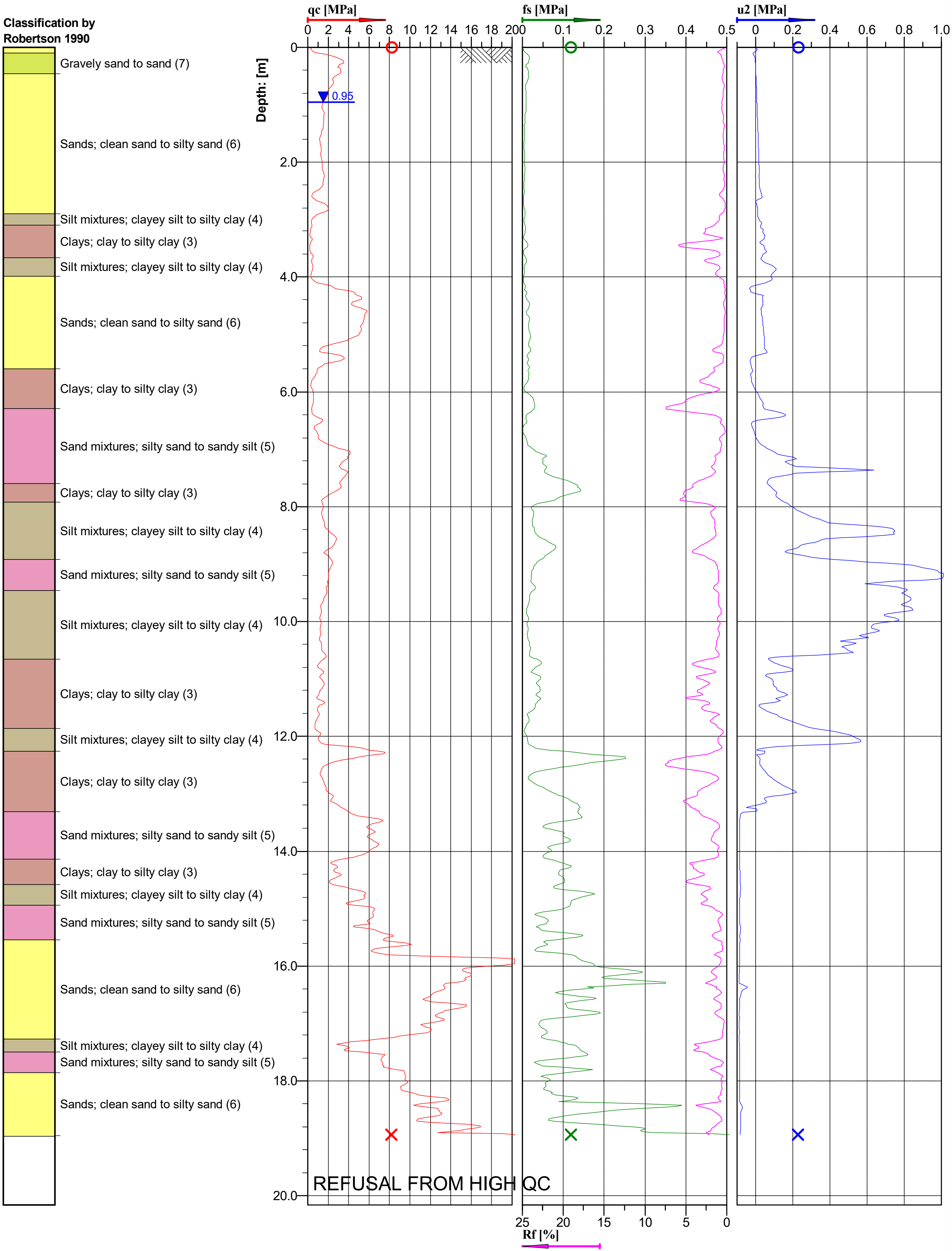




GEOTECH DRILLING

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

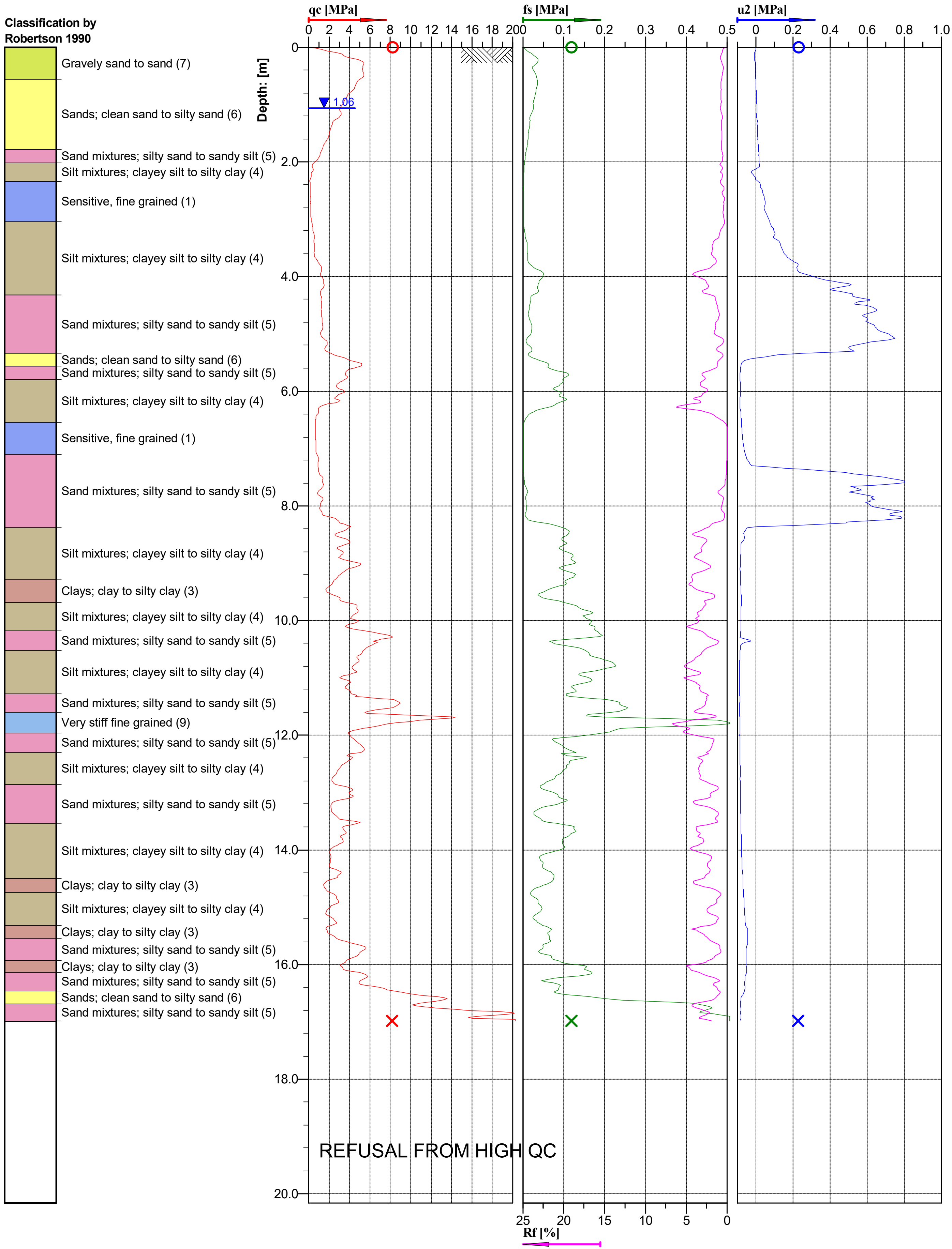
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT125
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.485390, E 175.164390		File: CPT125.cpt	

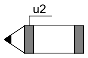


u2

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

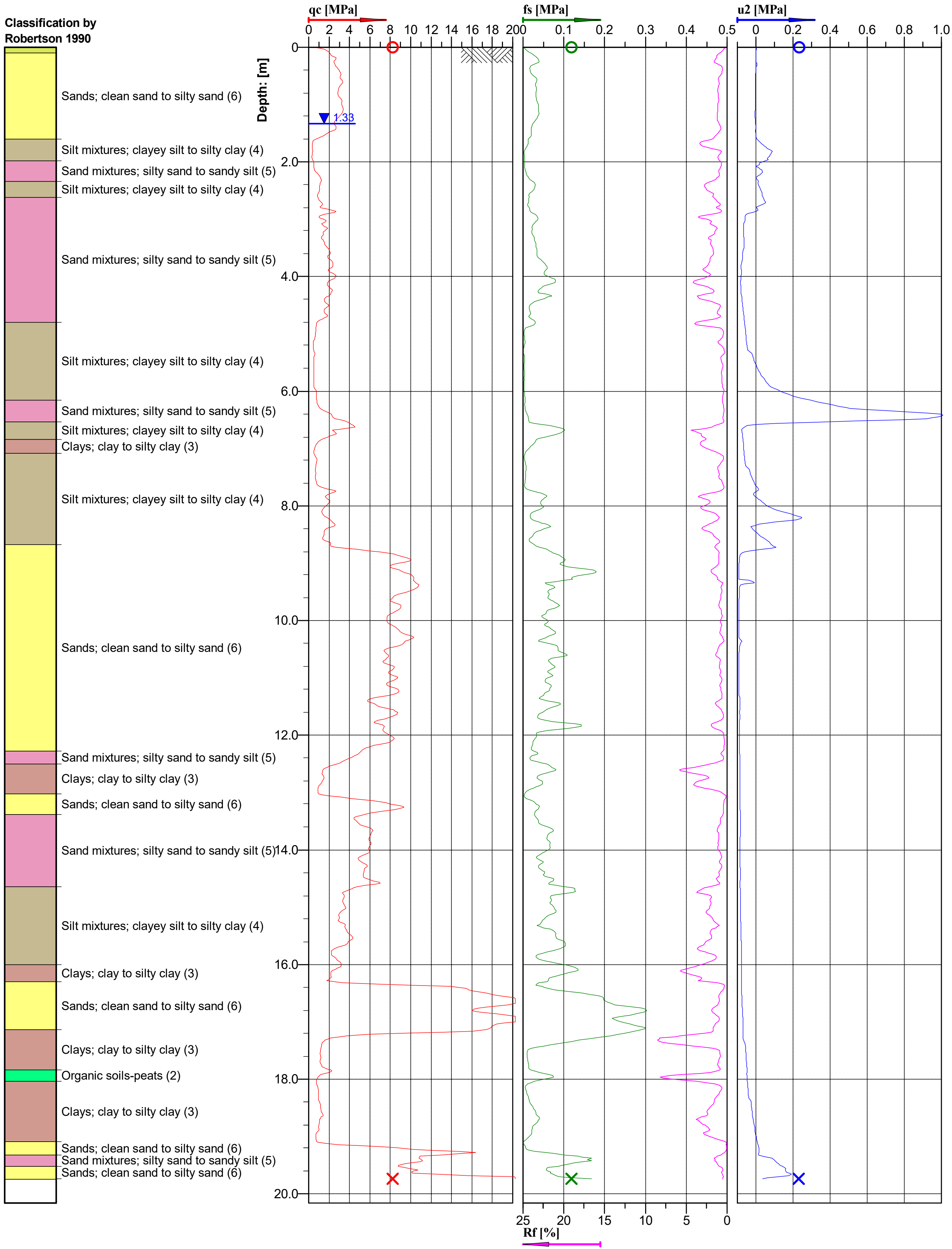
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT126
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.483886, E 175.162978		File: CPT126.cpt	





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

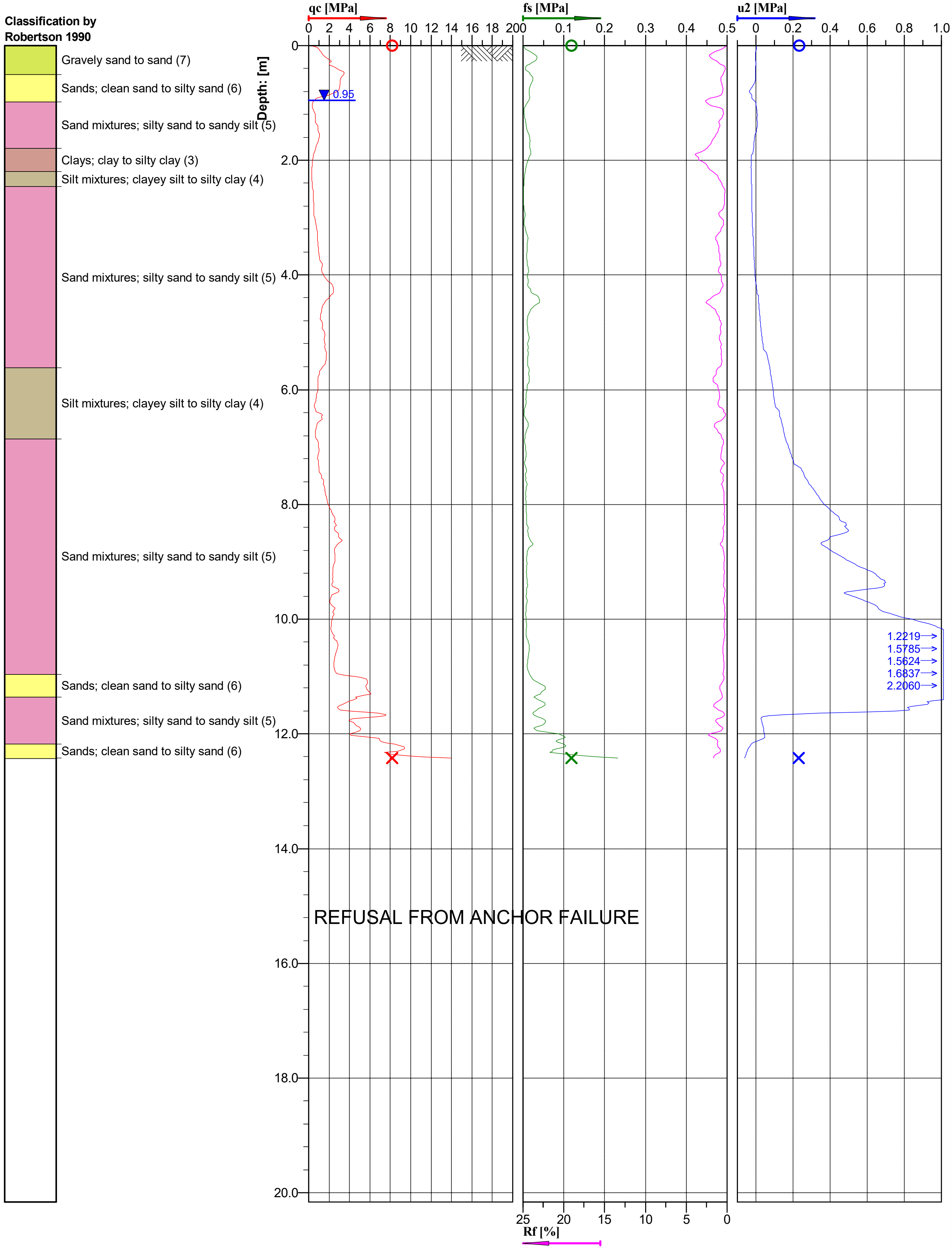
Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT127
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.485998, E 175.162748		File: CPT127.cpt	

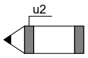


REFUSAL FROM HIGH QC

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

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT128
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.486924, E 175.163606		File: CPT128.cpt	





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

Location: OHINEWAI	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT129
Project ID:	Client: INITIA	Date: 29/07/2019	Scale: 1 : 90
Project: SLEEPYHEAD		Page: 1/1	Fig.:
S 37.488008, E 175.163614		File: CPT129.cpt	

Appendix D: GFR-Test Pit Investigation Logs

TEST PIT LOG

HOLE NO.:	TP01
JOB NO.:	P-000529
CLIENT:	Ambury properties
PROJECT:	Sleepyhead Ohinewai
SITE LOCATION:	Lumsden Rd Block
CO-ORDINATES:	1791143mE, 5849411mN (NZTM)
ELEVATION:	10m
CONTRACTOR:	Broughton
RIG:	12t Ex
DRILLER:	Heb
START DATE:	31/10/2018
END DATE:	31/10/2018
LOGGED BY:	KND

MATERIAL DESCRIPTION
(See Classification & Symbology sheet for details)

Topsoil

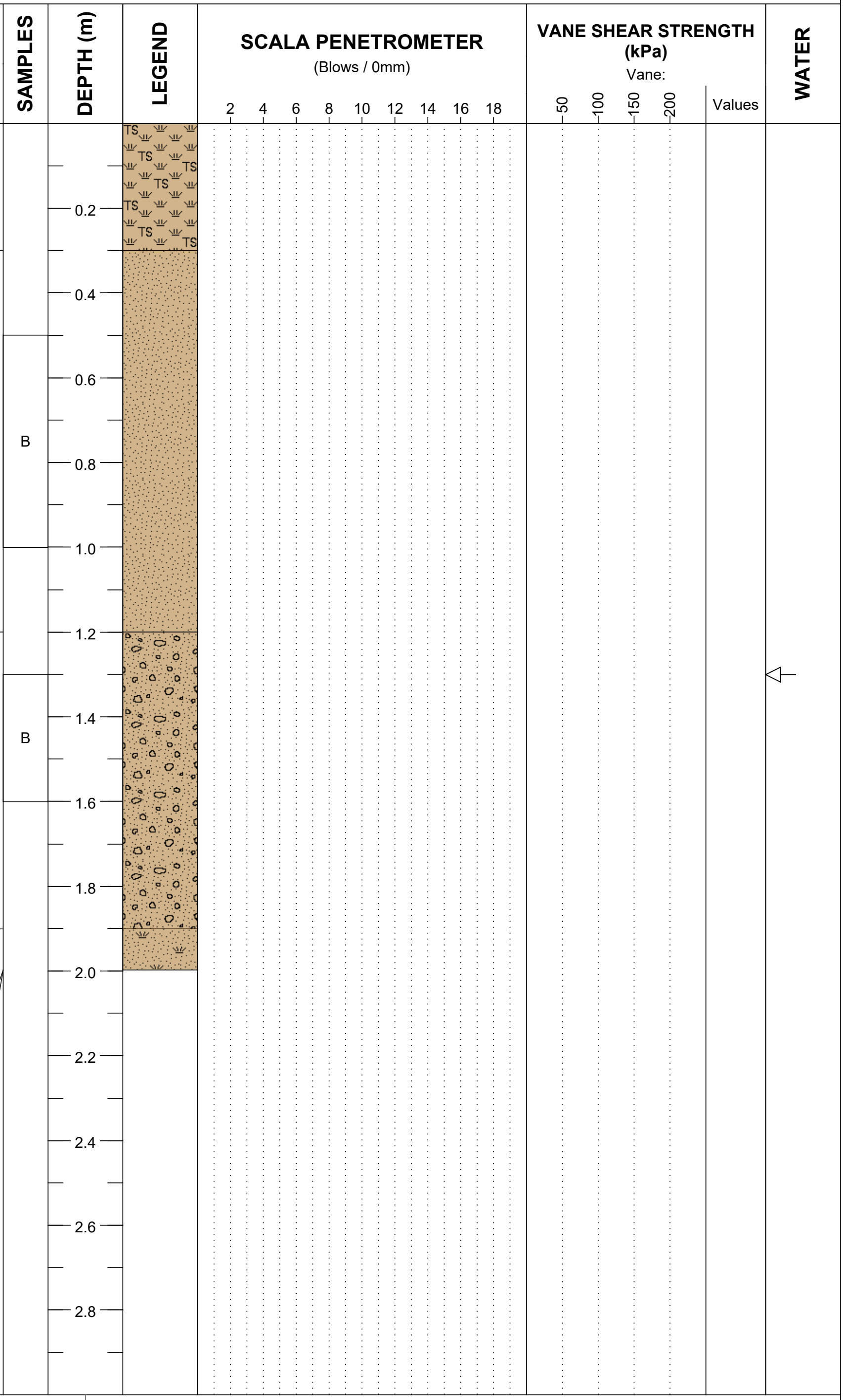
SAND; yellowish brown, with light brown and orange bands.
Loose; moist; sand, fine.

SAND, with some gravel; yellowish brown, white.
Loose; moist; sand, fine; gravel, fine; (Pumiceous gravel).

SAND; grey.
Saturated; sand, fine; some fibrous peat / organics in the base of the excavation. .

Running sands - pit collpase

EOH: 2.00m



REMARKS

WATER

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☑ Test Pit

TEST PIT LOG

HOLE NO.: TP02

JOB NO.: P-000529

CLIENT: Ambury properties
PROJECT: Sleepyhead Ohinewai

SITE LOCATION: Lumsden Rd Block
START DATE: 31/10/2018
CO-ORDINATES: 1791213mE, 5849592mN (NZTM)
ELEVATION: 10m
END DATE: 31/10/2018
CONTRACTOR: Broughton
RIG: 12t Ex
DRILLER: Heb
LOGGED BY: KND

MATERIAL DESCRIPTION

(See Classification & Symbology sheet for details)

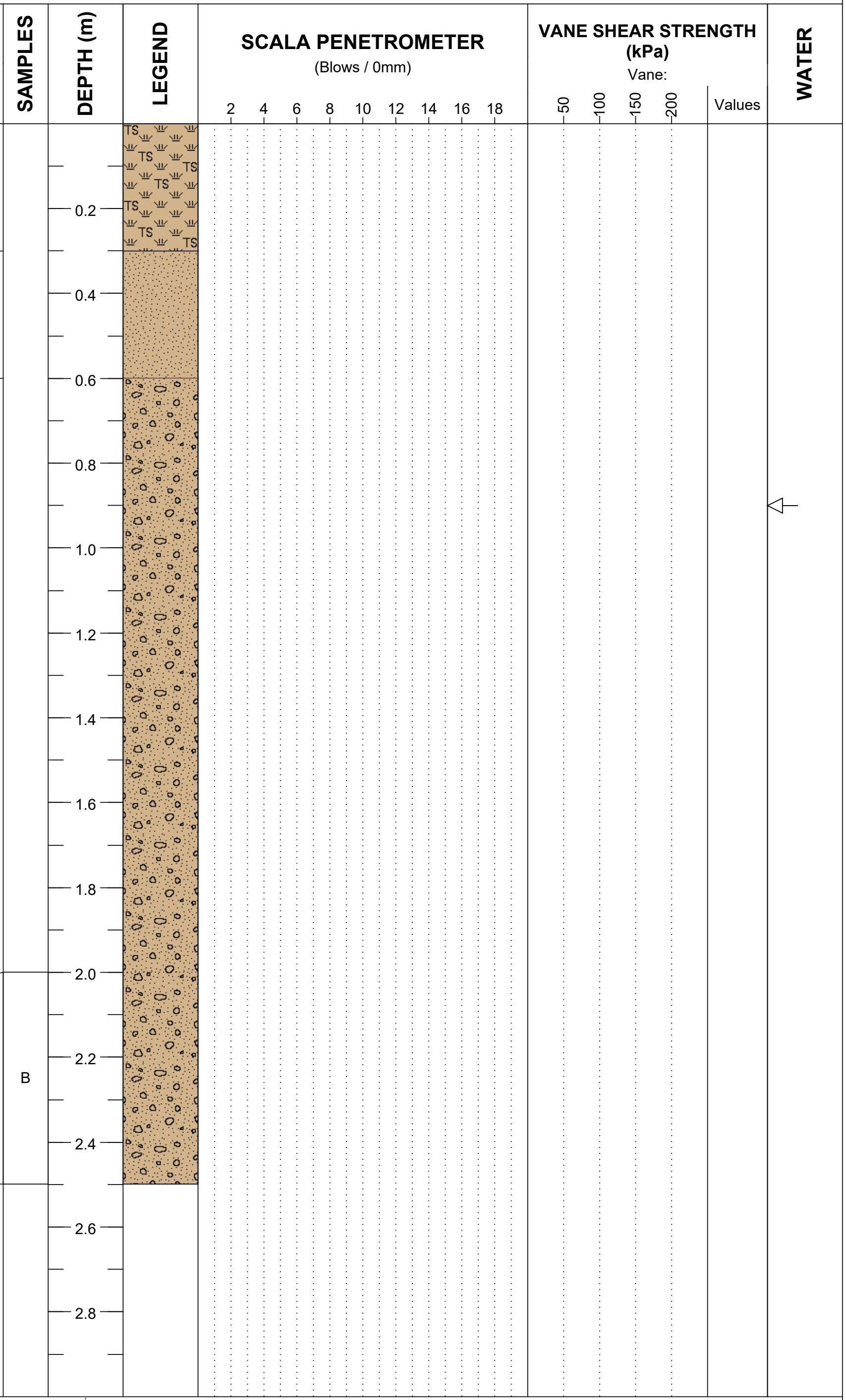
Topsoil

SAND, with trace silt; yellowish brown.
Loose; moist; sand, fine to medium.

SAND, with some gravel; light brown mottled white.
Moist; sand, fine to coarse; gravel, fine to medium; (Pumiceous gravel).

2.0m - 2.5m: Occasional rootlets.

EOH: 2.50m



REMARKS

WATER

▼ Standing Water Level
◁ Out flow
▷ In flow

INVESTIGATION TYPE

☐ Hand Auger
☑ Test Pit

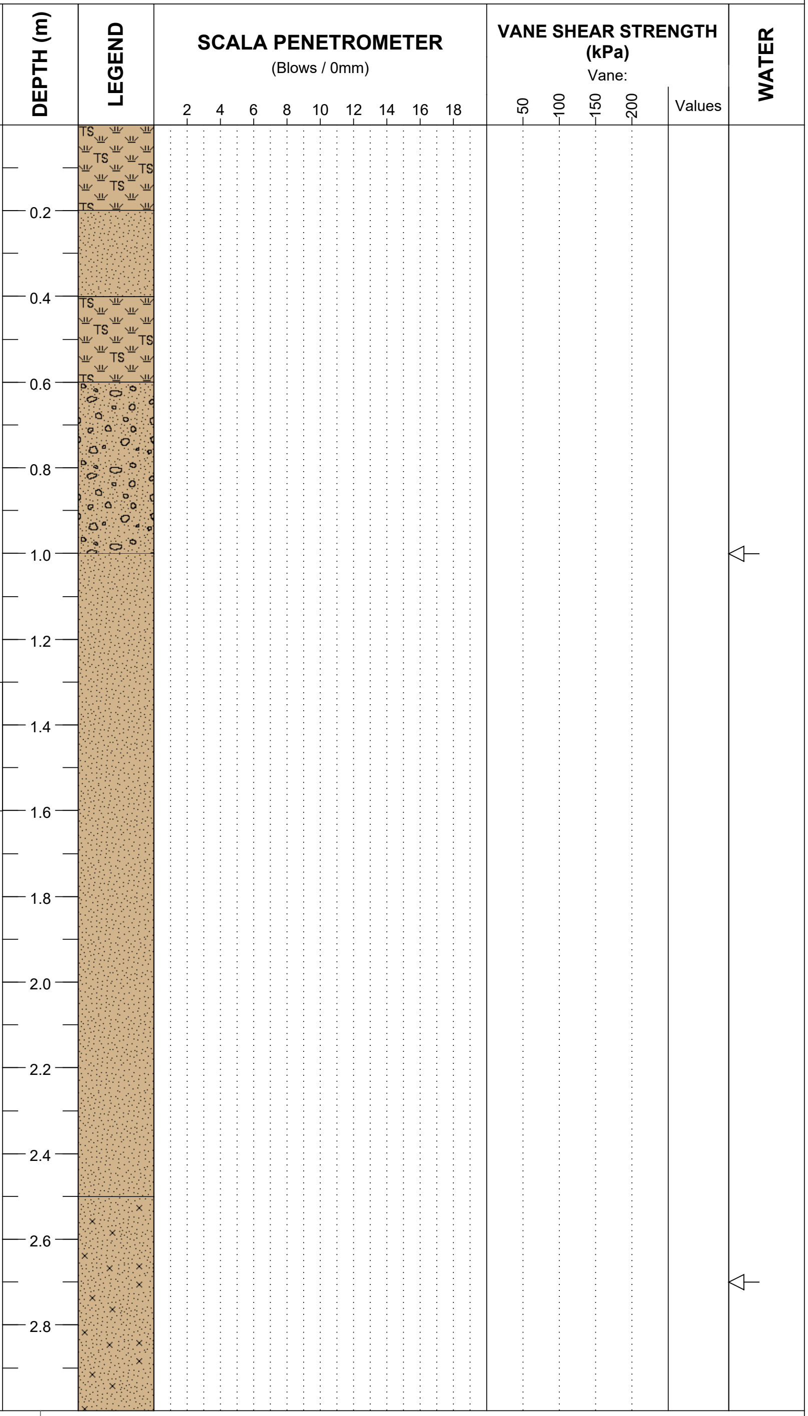
TEST PIT LOG

HOLE NO.: TP03
JOB NO.: P-000529

CLIENT: Ambury properties
PROJECT: Sleepyhead Ohinewai

SITE LOCATION: Lumsden Rd Block
CO-ORDINATES: 1791454mE, 5849618mN (NZTM)
ELEVATION: 8m
CONTRACTOR: Broughton
RIG: 12t Ex
DRILLER: Heb
START DATE: 31/10/2018
END DATE: 31/10/2018
LOGGED BY: KND

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES
Topsoil	
SAND, with some gravel; light brown mottled orange and brown staining. Moist; sand, fine; gravel, fine to medium; FILL.	
SILT, with minor sand. Sand, fine; Buried Topsoil FILL?.	
SAND, with minor gravel; yellowish brown, with light brown and orange bands.. Wet; sand, fine; gravel, fine to coarse.	
SAND; light grey. Saturated; sand, fine.	B
SAND, with some silt; light grey to light brown. Saturated; sand, fine; Occasional tree roots (up to 50mm dia.). 2.7m: Flowing water	



REMARKS

WATER

- ▼ Standing Water Level
- ◁ Out flow
- ▷ In flow

INVESTIGATION TYPE

- ☐ Hand Auger
- ☑ Test Pit

TEST PIT LOG

HOLE NO.: TP03

CLIENT: Ambury properties

PROJECT: Sleepyhead Ohinewai

JOB NO.: P-000529

SITE LOCATION: Lumsden Rd Block

START DATE: 31/10/2018

CO-ORDINATES: 1791454mE, 5849618mN (NZTM)

ELEVATION: 8m

END DATE: 31/10/2018

CONTRACTOR: Broughton

RIG: 12t Ex

DRILLER: Heb

LOGGED BY: KND

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 0mm) 2 4 6 8 10 12 14 16 18	VANE SHEAR STRENGTH (kPa) Vane: 50 100 150 200	Values	WATER
[CONT] SAND, with some silt; light grey to light brown. Saturated; sand, fine; Occasional tree roots (up to 50mm dia.).	B		▨				
EOH: 3.20m		3.2					
		3.4					
		3.6					
		3.8					
		4.0					
		4.2					
		4.4					
		4.6					
		4.8					
		5.0					
		5.2					
		5.4					
		5.6					
		5.8					

REMARKS

WATER

▼ Standing Water Level

◁ Out flow

▷ In flow

INVESTIGATION TYPE

☐ Hand Auger

☑ Test Pit

INITIA

TEST PIT LOG

HOLE NO.: TP04

JOB NO.: P-000529

CLIENT: Ambury properties

PROJECT: Sleepyhead Ohinewai

SITE LOCATION: Lumsden Rd Block

START DATE: 31/10/2018

CO-ORDINATES: 1791766mE, 5849601mN (NZTM)

ELEVATION: 8m

END DATE: 31/10/2018

CONTRACTOR: Broughton

RIG: 12t Ex

DRILLER: Heb

LOGGED BY: KND

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	**SAMPLES**	**DEPTH (m)**	**LEGEND**	**SCALA PENETROMETER** (Blows / 0mm) 2 4 6 8 10 12 14 16 18	**VANE SHEAR STRENGTH (kPa)** Vane: 50 100 150 200	Values	**WATER**
Topsoil			TS				
SAND, with some gravel; yellowish brown mottled orange white. Sand, fine to coarse; gravel, fine to medium; (Pumiceous Gravel).		0.2					
		0.4					
		0.6					
		0.8					◁—
		1.0					
SAND, with minor silt; light grey. Saturated; sand, fine.		1.2					
		1.4					
		1.6					
		1.8					
		2.0					
		2.2					
		2.4					
		2.6					
EOH: 2.70m							
2.7m - 2.7m: large tree roots / stumps in base of hole. Hole collapsed at 2.7m		2.8					

REMARKS

WATER

▼ Standing Water Level
◁— Out flow
▷— In flow

INVESTIGATION TYPE

☐ Hand Auger
☑ Test Pit

TEST PIT LOG

HOLE NO.: TP05

JOB NO.: P-000529

CLIENT: Ambury properties

PROJECT: Sleepyhead Ohinewai

SITE LOCATION: Lumsden Rd Block

START DATE: 31/10/2018

CO-ORDINATES: 1791697mE, 5849374mN (NZTM)

ELEVATION: 8m

END DATE: 31/10/2018

CONTRACTOR: Broughton

RIG: 12t Ex

DRILLER: Heb

LOGGED BY: KND

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 0mm) 2 4 6 8 10 12 14 16 18	VANE SHEAR STRENGTH (kPa) Vane: 50 100 150 200	Values	WATER
Topsoil			TS				
SAND; light brown yellowish orange . Wet; sand, fine to coarse.	B	0.2 0.4 0.6 0.8					
SAND; light grey. Saturated; sand, fine.		1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4					◁
2.7m - 2.8m: tree stumps and organics at base of pit. Pit collapse at 2.8m	B	2.6					
EOH: 2.80m		2.8					

REMARKS

WATER

▼ Standing Water Level

◁ Out flow

▷ In flow

INVESTIGATION TYPE

☐ Hand Auger

☑ Test Pit

TEST PIT LOG

HOLE NO.: TP06

JOB NO.: P-000529

CLIENT: Ambury properties

PROJECT: Sleepyhead Ohinewai

SITE LOCATION: Lumsden Rd Block

START DATE: 31/10/2018

CO-ORDINATES: 1791468mE, 5849334mN (NZTM)

ELEVATION: 8m

END DATE: 31/10/2018

CONTRACTOR: Broughton

RIG: 12t Ex

DRILLER: Heb

LOGGED BY: KND

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	SAMPLES	DEPTH (m)	LEGEND	SCALA PENETROMETER (Blows / 0mm)	VANE SHEAR STRENGTH (kPa) Vane:	Values	WATER
Topsoil		0.0 – 0.25	TS				
SAND; yellowish brown with orange bands. Moist; sand, fine.		0.25 – 0.8					
SAND; grey. Saturated; sand, fine. 1.8m - 1.9m: Log		0.8 – 2.4					
SILT; dark brown. Saturated; PEAT. 2.4m - 2.5m: Logs - high water inflow. Pit collapse at 2.5m		2.4 – 2.5					◁—

EOH: 2.50m

REMARKS

WATER

▼ Standing Water Level

◁— Out flow

▷— In flow

INVESTIGATION TYPE

☐ Hand Auger

☑ Test Pit

Generated with CORE-GS by Geroc - Test Pit - 27/11/2018 5:10:04 PM

Appendix E: GFR-Laboratory Testing Results

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183103*	Report Number:	*30607T*
Date of Issue:	*13th November 2018*	Page 1of 3 Pages	

FINAL REPORT FOR *INITIA LTD*

Clients Address:	*PO Box 47647* *Ponsonby* *AUCKLAND 1144*
Attention:	*Kent Dalziel*
Reference:	*P-000529*
Subject:	***AGGREGATE TESTING***
Clients Instructions:	*Conduct the tests as detailed below on the aggregate sample received*
Test Methods:	*1. NZS4402: 1986: Test* *2.1 Determination of the Water Content* *2.8.1: Particle Size Distribution – Wet Sieve Method* *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*
Date Sampled:	*31st October 2018*
Date Received:	*31st October 2018*
Date of Tests:	*October – November 2018*
Description of Sample:	***Sand with Pumice Gravels – TP01 1.3 – 1.6m***
Source:	*Lumsden Road*
Job:	*Block Trail Pits*

Notes:
i. *Field sample received in its natural state.*
ii. *Sampling of aggregate is not covered by this report.*

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ
ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL

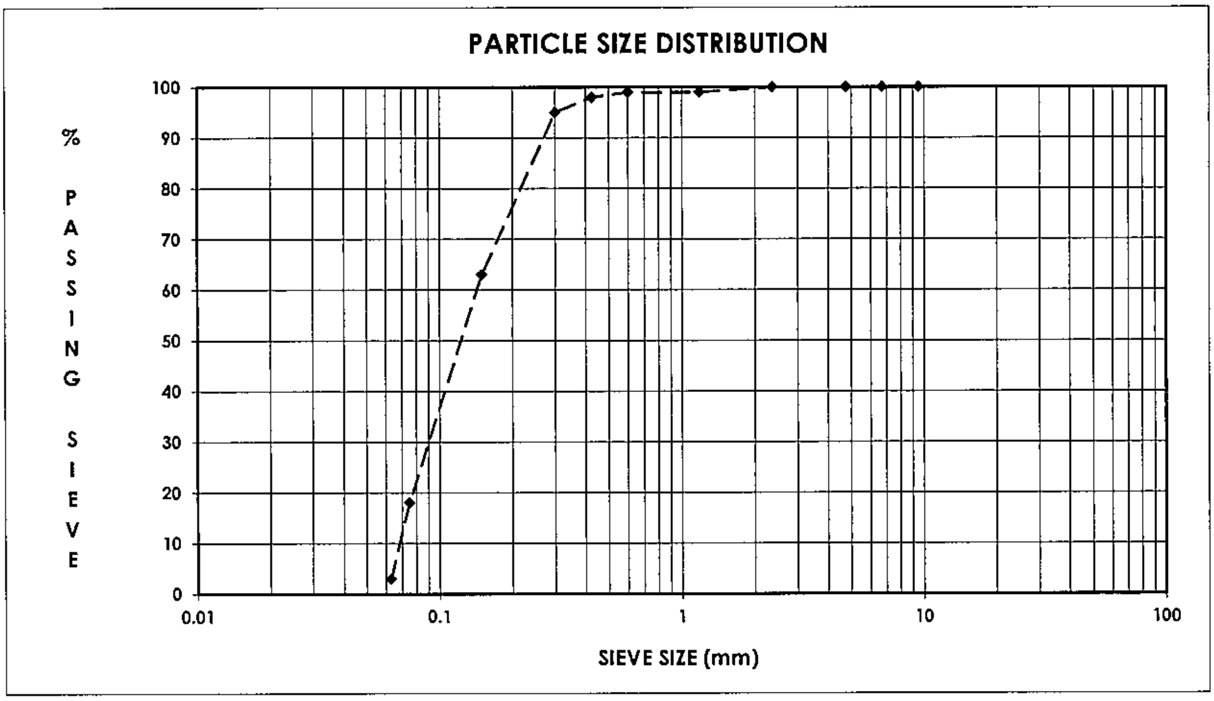
TEST RESULTS

Material:	***Sand with Pumice Gravels – TP01 1.3 – 1.6m***	Test No:	***183103***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***85.0%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	-	**100**	**100**	**100**	**100**	**99**	**99**	**98**	**95**	**63**	**18**	**3**
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference ***Fineness Modulus:*** -



TEST RESULTS

Material:	***Sand with Pumice Gravels – TP01 1.3 – 1.6m***	Test No:	***183103***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - Laboratory Batched Sample
Two Hour Delay (Before Compaction)

		Result		
Compaction effort		***NZ Standard Compaction***		
Surcharge mass	*(kg)*	***4.0***		
Period of Air Cure	*(Days)*	***3***		
Period of Soaking	*(Days)*	***4***		
Lime Added	*(%)*	***1***	***1***	***1***
Cement Added	*(%)*	***3***	***4***	***5***
Dry density	*(t/m³)*	***0.80***	***0.80***	***0.80***
Compacted Water Content	*(%)*	***76.9***	***77.8***	***77.3***
Soaked Water Content	*(%)*	***64.8***	***66.6***	***67.5***
Swell	*(%)*	***-0.2***	***-0.4***	***-0.6***
Rate of penetration	*(mm/min)*	***1***	***1***	***1***
Depth CBR recorded	*(mm)*	***5.0***	***5.0***	***5.0***
California Bearing Ratio	**CBR**	***10%***	***10%***	***11%***

Notes:
- *i.* *Negative swell implies shrinkage.*
- *ii.* *Test performed on fraction passing 19mm sieve (100%).*
- *iii.* *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183102*	Report Number:	*30608T*
Date of Issue:	*13th November 2018*		Page 1of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:
PO Box 47647
Ponsonby
AUCKLAND 1144

Attention: *Kent Dalziel*

Reference: *P-000529*

Subject: ***AGGREGATE TESTING***

Clients Instructions: *Conduct the tests as detailed below on the aggregate sample received*

Test Methods:
1. *NZS4402: 1986: Test*
    - *2.1 Determination of the Water Content*
    - *2.8.1: Particle Size Distribution – Wet Sieve Method*
    - *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*

Date Sampled: *31st October 2018*

Date Received: *31st October 2018*

Date of Tests: *October – November 2018*

Description of Sample: ***Sand Yellow Brown with Orange Bands – TP01 0.5 – 1.0m***

Source: *Lumsden Road*

Job: *Block Trail Pits*

Notes:
i. *Field sample received in its natural state.*
ii. *Sampling of aggregate is not covered by this report.*

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

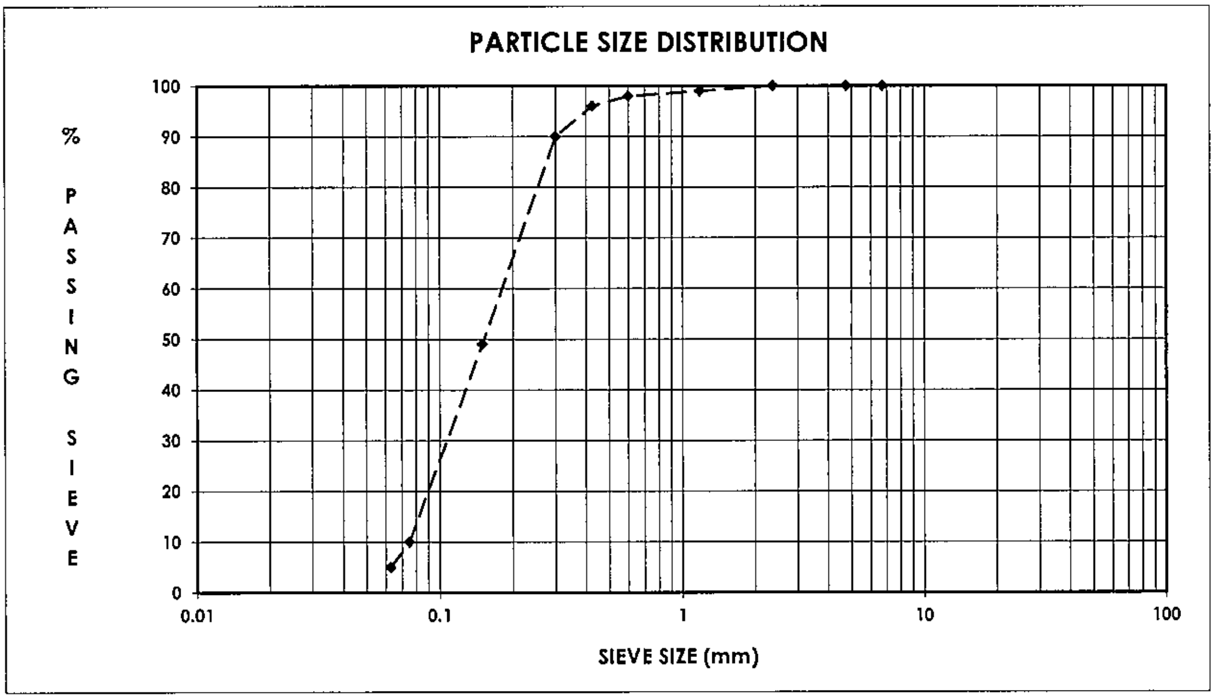
TEST RESULTS

Material:	***Sand Yellow Brown with Orange Bands – TP01 0.5 – 1.0m***	Test No:	***183102***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***64.3%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	-	-	***100***	***100***	***100***	***99***	***98***	***96***	***90***	***49***	***10***	***5***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference **Fineness Modulus:** -



TEST RESULTS

Material:	***Sand Yellow Brown with Orange Bands – TP01 0.5 – 1.0m***	Test No:	***183102***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - *Laboratory Batched Sample*
Two Hour Delay (Before Compaction)

		Result			
Compaction effort		***NZ Standard Compaction***			
Surcharge mass	*(kg)*	***4.0***			
Period of Air Cure	*(Days)*	***3***			
Period of Soaking	*(Days)*	***4***			
Lime Added	*(%)*	***Natural***	***1***	***1***	***1***
Cement Added	*(%)*		***3***	***4***	***5***
Dry density	*(t/m³)*	***0.86***	***0.88***	***0.88***	***0.90***
Compacted Water Content	*(%)*	***64.6***	***61.5***	***61.4***	***58.5***
Soaked Water Content	*(%)*	***62.7***	***56.6***	***56.5***	***55.6***
Swell	*(%)*	***0.0***	***-0.2***	***-0.4***	***0.0***
Rate of penetration	*(mm/min)*	***1***	***1***	***1***	***1***
Depth CBR recorded	*(mm)*	***5.0***	***5.0***	***5.0***	***5.0***
California Bearing Ratio	**CBR**	*8%*	*8%*	*8%*	*12%*

Notes:
- *i.* *Negative swell implies shrinkage.*
- *ii.* *Test performed on fraction passing 19mm sieve (100%).*
- *iii.* *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183104*	Report Number:	*30609T*
Date of Issue:	*13th November 2018*		Page 1 of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:
PO Box 47647
Ponsonby
AUCKLAND 1144

Attention: *Kent Dalziel*

Reference: *P-000529*

Subject: ***AGGREGATE TESTING***

Clients Instructions: *Conduct the tests as detailed below on the aggregate sample received*

Test Methods:
1. *NZS4402: 1986: Test*
   - *2.1 Determination of the Water Content*
   - *2.8.1: Particle Size Distribution – Wet Sieve Method*
   - *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*

Date Sampled: *31st October 2018*

Date Received: *31st October 2018*

Date of Tests: *October – November 2018*

Description of Sample: ***Sand with Pumice Gravels – TP02 2.0 – 2.5m***

Source: *Lumsden Road*

Job: *Block Trail Pits*

Notes:
i. *Field sample received in its natural state.*
ii. *Sampling of aggregate is not covered by this report.*

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ
ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

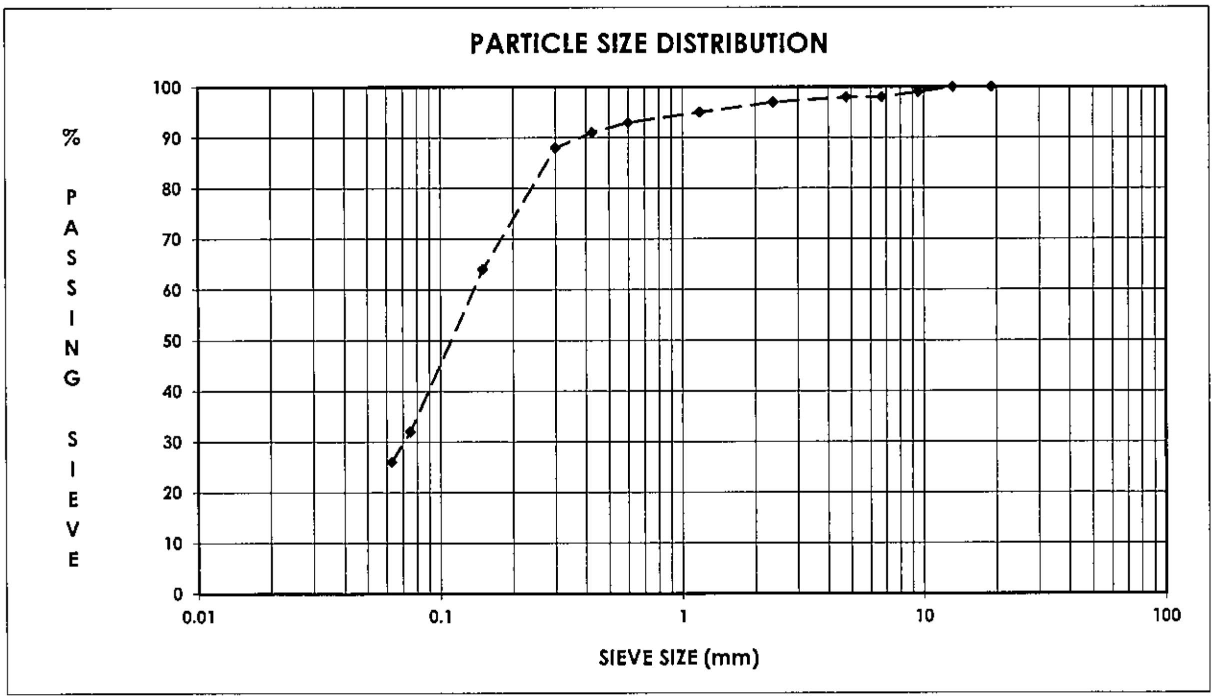
TEST RESULTS

Material:	***Sand with Pumice Gravels – TP02 2.0 – 2.5m***	Test No:	***183104***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***101.1%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	***100***	***100***	***99***	***98***	***98***	***97***	***95***	***93***	***91***	***88***	***64***	***32***	***26***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference ***Fineness Modulus:*** -



TEST RESULTS

Material:	***Sand with Pumice Gravels – TP02 2.0 – 2.5m***	Test No:	***183104***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - Laboratory Batched Sample
Two Hour Delay (Before Compaction)

		Result			
Compaction effort		***NZ Standard Compaction***			
Surcharge mass	*(kg)*	***4.0***			
Period of Air Cure	*(Days)*	***3***			
Period of Soaking	*(Days)*	***4***			
Lime Added	*(%)*	***Natural***	***1***	***1***	***1***
Cement Added	*(%)*		***3***	***4***	***5***
Dry density	*(t/m³)*	***0.70***	***0.72***	***0.72***	***0.72***
Compacted Water Content	*(%)*	***100.5***	***94.7***	***93.3***	***91.5***
Soaked Water Content	*(%)*	***84.6***	***75.0***	***78.6***	***76.6***
Swell	*(%)*	***-0.6***	***-0.2***	***-0.4***	***-0.4***
Rate of penetration	*(mm/min)*	***1***	***1***	***1***	***1***
Depth CBR recorded	*(mm)*	***5.0***	***5.0***	***5.0***	***5.0***
California Bearing Ratio	**CBR**	***6%***	***11%***	***11%***	***11%***

Notes:
- *i.* *Negative swell implies shrinkage.*
- *ii.* *Test performed on fraction passing 19mm sieve (100%).*
- *iii.* *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183105*	Report Number:	*30610T*
Date of Issue:	*13th November 2018*		Page 1of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:
PO Box 47647
Ponsonby
AUCKLAND 1144

Attention: *Kent Dalziel*

Reference: *P-000529*

Subject: ***AGGREGATE TESTING***

Clients Instructions: *Conduct the tests as detailed below on the aggregate sample received*

Test Methods:
1. NZS4402: 1986: Test
  2.1 Determination of the Water Content
  2.8.1: Particle Size Distribution – Wet Sieve Method
  6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens

Date Sampled: *31st October 2018*

Date Received: *31st October 2018*

Date of Tests: *October – November 2018*

Description of Sample: ***Sand Yellow Brown with Orange Bands – TP05 0.5 – 0.8m***

Source: *Lumsden Road*

Job: *Block Trail Pits*

Notes:
i. Field sample received in its natural state.
ii. Sampling of aggregate is not covered by this report.

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ ACCREDITED LABORATORY

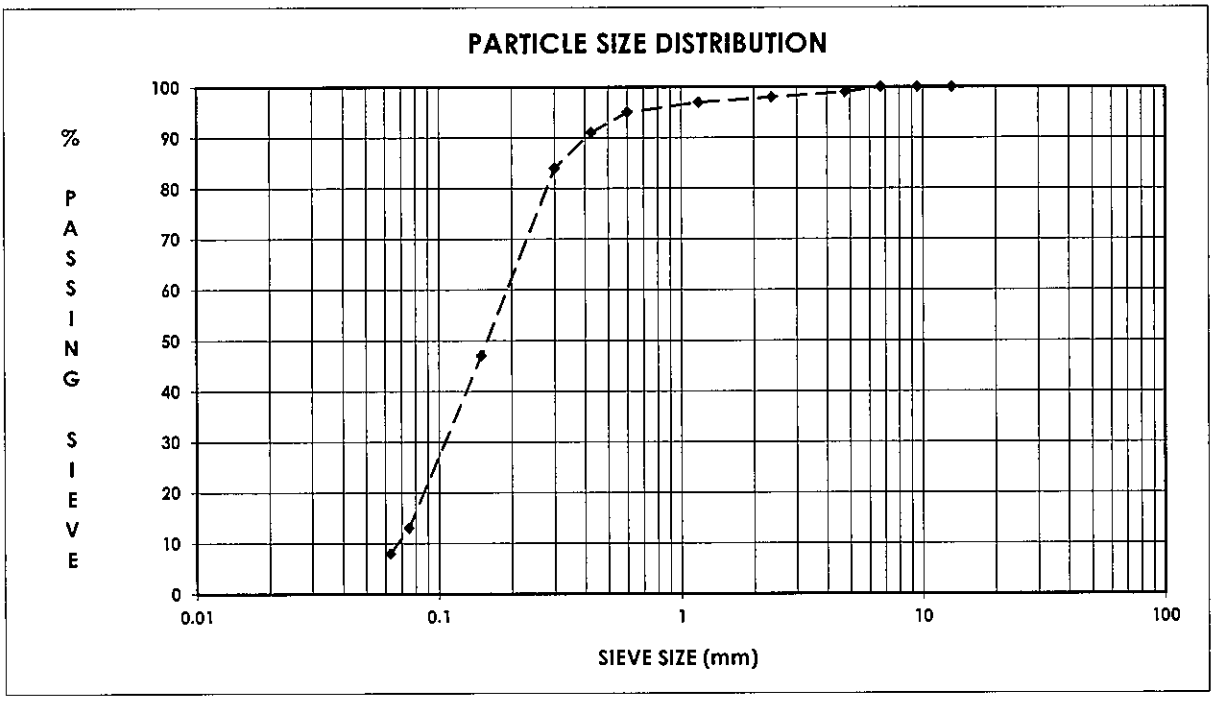
All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

TEST RESULTS

Material:	***Sand Yellow Brown with Orange Bands – TP05 0.5 – 0.8m***	Test No:	***183105***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***79.3%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	***100***	***100***	***100***	***99***	***98***	***97***	***95***	***91***	***84***	***47***	***13***	***8***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
(Dry) = Oven Dried Sample	(Wet) = % passing finest sieve obtained by difference								***Fineness Modulus:***				-	



TEST RESULTS

Material:	***Sand Yellow Brown with Orange Bands – TP05 0.5 – 0.8m***	Test No:	***183105***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - Laboratory Batched Sample
Two Hour Delay (Before Compaction)

		Result		
Compaction effort		***NZ Standard Compaction***		
Surcharge mass	*(kg)*	***4.0***		
Period of Air Cure	*(Days)*	***3***		
Period of Soaking	*(Days)*	***4***		
Lime Added	*(%)*	***1***	***1***	***1***
Cement Added	*(%)*	***3***	***4***	***5***
Dry density	*(t/m³)*	***0.78***	***0.78***	***0.78***
Compacted Water Content	*(%)*	***73.2***	***75.3***	***73.5***
Soaked Water Content	*(%)*	***69.2***	***68.9***	***67.5***
Swell	*(%)*	***0.0***	***0.0***	***-0.2***
Rate of penetration	*(mm/min)*	***1***	***1***	***1***
Depth CBR recorded	*(mm)*	***5.0***	***5.0***	***5.0***
California Bearing Ratio	**CBR**	***8%***	***8%***	***10%***

Notes:
- *i.* *Negative swell implies shrinkage.*
- *ii.* *Test performed on fraction passing 19mm sieve (100%).*
- *iii.* *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183106*	Report Number:	30611T
Date of Issue:	*13th November 2018*		Page 1of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:
PO Box 47647
Ponsonby
AUCKLAND 1144

Attention: *Kent Dalziel*

Reference: *P-000529*

Subject: ***AGGREGATE TESTING***

Clients Instructions: *Conduct the tests as detailed below on the aggregate sample received*

Test Methods:
1. *NZS4402: 1986: Test*
    - *2.1 Determination of the Water Content*
    - *2.8.1: Particle Size Distribution – Wet Sieve Method*
    - *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*

Date Sampled: *31st October 2018*

Date Received: *31st October 2018*

Date of Tests: *October – November 2018*

Description of Sample: ***Sand – Grey Wet – TP03 1.3 – 1.6m***

Source: *Lumsden Road*

Job: *Block Trail Pits*

Notes:
i. *Field sample received in its natural state.*
ii. *Sampling of aggregate is not covered by this report.*

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

THIS REPORT MAY NOT BE REPRODUCED EXCEPT IN FULL

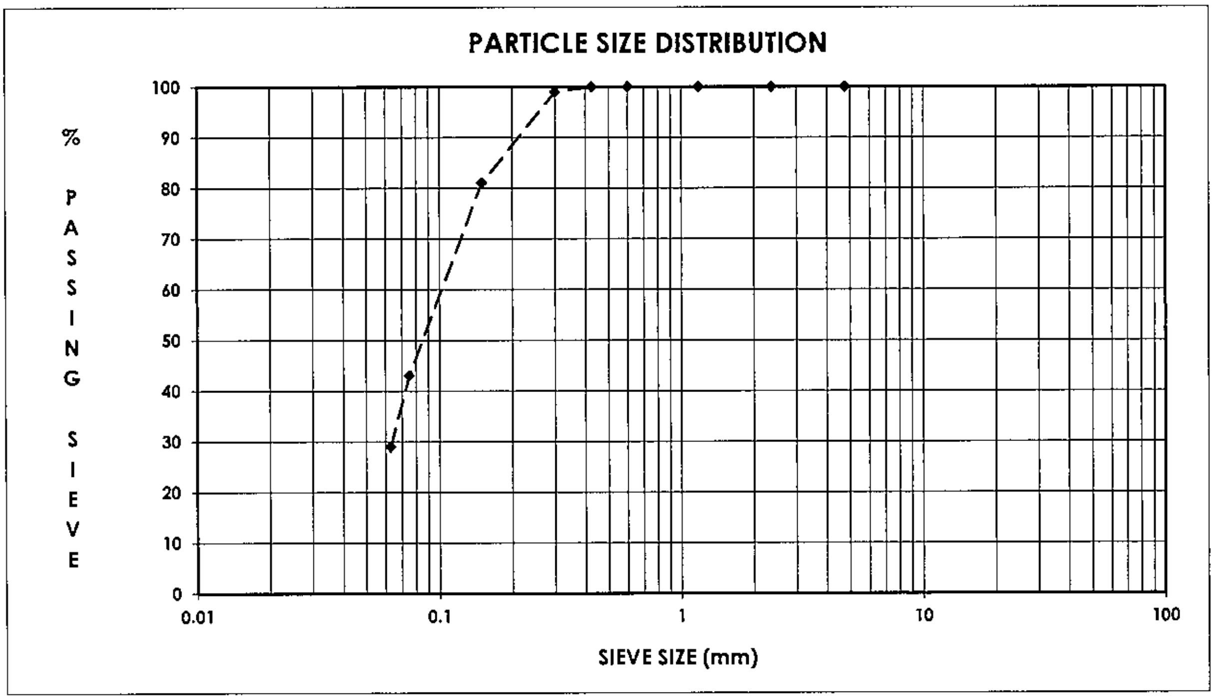
TEST RESULTS

Material:	***Sand – Grey Wet – TP03 1.3 – 1.6m***	Test No:	***183106***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***82.4%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	-	-	-	***100***	***100***	***100***	***100***	***100***	***99***	***81***	***43***	***29***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference ***Fineness Modulus:*** -



TEST RESULTS

Material:	***Sand – Grey Wet – TP03 1.3 – 1.6m***	Test No:	***183106***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - Laboratory Batched Sample
Two Hour Delay (Before Compaction)

		Result		
Compaction effort		***NZ Standard Compaction***		
Surcharge mass	*(kg)*	***4.0***		
Period of Air Cure	*(Days)*	***3***		
Period of Soaking	*(Days)*	***4***		
Lime Added	*(%)*	***1***	***1***	***1***
Cement Added	*(%)*	***3***	***4***	***5***
Dry density	*(t/m³)*	***0.78***	***0.80***	***0.80***
Compacted Water Content	*(%)*	***77.5***	***75.3***	***74.0***
Soaked Water Content	*(%)*	***70.4***	***67.5***	***66.5***
Swell	*(%)*	***-0.8***	***-1.0***	***-1.6***
Rate of penetration	*(mm/min)*	***1***	***1***	***1***
Depth CBR recorded	*(mm)*	***5.0***	***5.0***	***5.0***
California Bearing Ratio	**CBR**	***3%***	***5%***	***6%***

Notes:
i. *Negative swell implies shrinkage.*
ii. *Test performed on fraction passing 19mm sieve (100%).*
iii. *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183107*	Report Number:	*30612T*
Date of Issue:	*13th November 2018*		Page 1of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:	*PO Box 47647* *Ponsonby* *AUCKLAND 1144*
Attention:	*Kent Dalziel*
Reference:	*P-000529*
Subject:	***AGGREGATE TESTING***
Clients Instructions:	*Conduct the tests as detailed below on the aggregate sample received*
Test Methods:	*1. NZS4402: 1986: Test* *2.1 Determination of the Water Content* *2.8.1: Particle Size Distribution – Wet Sieve Method* *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*
Date Sampled:	*31st October 2018*
Date Received:	*31st October 2018*
Date of Tests:	*October – November 2018*
Description of Sample:	***Sand – Grey Light Brown – TP03 3.1m***
Source:	*Lumsden Road*
Job:	*Block Trail Pits*

Notes:
i. Field sample received in its natural state.
ii. Sampling of aggregate is not covered by this report.

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

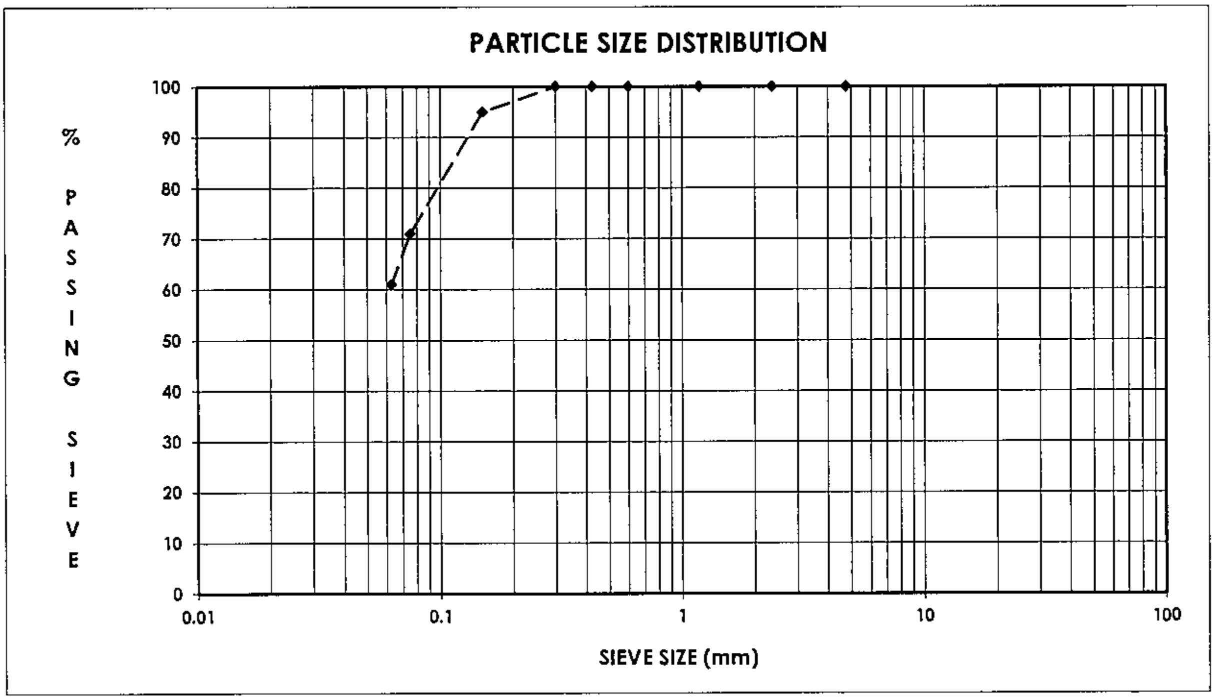
TEST RESULTS

Material:	***Sand – Grey Light Brown – TP03 3.1m***	Test No:	***183107***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***78.2%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	-	-	-	***100***	***100***	***100***	***100***	***100***	***100***	***95***	***71***	***61***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference ***Fineness Modulus:*** -



TEST RESULTS

Material:	***Sand – Grey Light Brown – TP03 3.1m***	Test No:	***183107***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - Laboratory Batched Sample
Two Hour Delay (Before Compaction)

	Result		
Compaction effort	***NZ Standard Compaction***		
Surcharge mass *(kg)*	***4.0***		
Period of Air Cure *(Days)*	***3***		
Period of Soaking *(Days)*	***4***		
Lime Added *(%)*	***1***	***1***	***1***
Cement Added *(%)*	***3***	***4***	***5***
Dry density *(t/m^3)*	***0.82***	***0.82***	***0.84***
Compacted Water Content *(%)*	***73.1***	***72.9***	***71.5***
Soaked Water Content *(%)*	***66.5***	***66.4***	***65.9***
Swell *(%)*	***-3.0***	***-3.2***	***-2.2***
Rate of penetration *(mm/min)*	***1***	***1***	***1***
Depth CBR recorded *(mm)*	***5.0***	***5.0***	***5.0***
California Bearing Ratio CBR	*3%*	*3%*	*3.5%*

Notes:
- *i.* *Negative swell implies shrinkage.*
- *ii.* *Test performed on fraction passing 19mm sieve (100%).*
- *iii.* *Lime and cement added as a percentage of dry mass.*

STEVENSON

STEVENSON AGGREGATES LIMITED
Drury Quarry
Corner Quarry / Fitzgerald Roads, Drury
Auckland
www.stevenson.co.nz

Test Number:	*183108*	Report Number:	*30613T*
Date of Issue:	*13th November 2018*		Page 1of 3 Pages

FINAL REPORT FOR *INITIA LTD*

Clients Address:	*PO Box 47647* *Ponsonby* *AUCKLAND 1144*
Attention:	*Kent Dalziel*
Reference:	*P-000529*
Subject:	***AGGREGATE TESTING***
Clients Instructions:	*Conduct the tests as detailed below on the aggregate sample received*
Test Methods:	*1. NZS4402: 1986: Test* *2.1 Determination of the Water Content* *2.8.1: Particle Size Distribution – Wet Sieve Method* *6.1.1: California Bearing Ratio (CBR) – Remoulded Specimens*
Date Sampled:	*31st October 2018*
Date Received:	*31st October 2018*
Date of Tests:	*October – November 2018*
Description of Sample:	***Sand – Grey – TP05 2.5 – 2.8m***
Source:	*Lumsden Road*
Job:	*Block Trail Pits*

Notes:
i. *Field sample received in its natural state.*
ii. *Sampling of aggregate is not covered by this report.*

for STEVENSON AGGREGATES LTD

T A WHITMORE
IANZ APPROVED SIGNATORY

IANZ
ACCREDITED LABORATORY

All tests reported herein have been performed in accordance with the laboratory's scope of accreditation

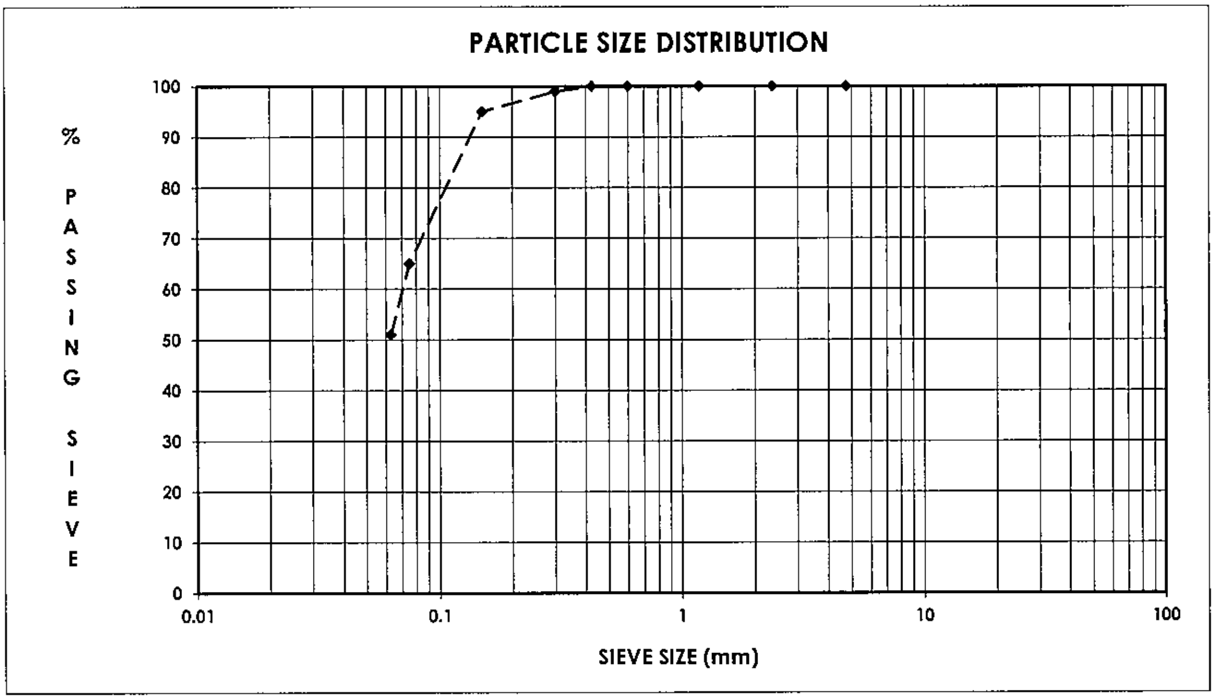
TEST RESULTS

Material:	***Sand – Grey – TP05 2.5 – 2.8m***	Test No:	***183108***
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

TEST METHOD	RESULT	SPECIFICATION
Particle Size Distribution (Wet Sieve Method)	***See below***	-
Water Content (Natural)	***73.5%***	-

SIEVE SIZE (mm)	37.5	19	13.2	9.5	6.7	4.75	2.36	1.18	.600	.425	.300	.150	.075	.063
% PASSING SIEVE (Wet)	-	-	-	-	-	***100***	***100***	***100***	***100***	***100***	***99***	***95***	***65***	***51***
MAXIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MINIMUM SPECIFIED LIMIT	-	-	-	-	-	-	-	-	-	-	-	-	-	-

(Dry) = Oven Dried Sample (Wet) = % passing finest sieve obtained by difference ***Fineness Modulus:*** -



TEST RESULTS

Material:	**Sand – Grey – TP05 2.5 – 2.8m**	Test No:	**183108**
Source:	*Lumsden Road*	Date Sampled:	*31st October 2018*
Job:	*Block Trail Pits*	Reference No.:	*P-000529*

CALIFORNIAN BEARING RATIO - *Laboratory Batched Sample Two Hour Delay (Before Compaction)*

		Result			
Compaction effort		**NZ Standard Compaction**			
Surcharge mass	*(kg)*	**4.0**			
Period of Air Cure	*(Days)*	**3**			
Period of Soaking	*(Days)*	**4**			
Lime Added	*(%)*	**Natural**	**1**	**1**	**1**
Cement Added	*(%)*		**3**	**4**	**5**
Dry density	*(t/m³)*	**0.82**	**0.84**	**0.84**	**0.84**
Compacted Water Content	*(%)*	**72.8**	**69.1**	**69.0**	**67.9**
Soaked Water Content	*(%)*	**68.5**	**65.1**	**64.1**	**62.0**
Swell	*(%)*	**-1.8**	**-1.4**	**-1.4**	**-1.6**
Rate of penetration	*(mm/min)*	**1**	**1**	**1**	**1**
Depth CBR recorded	*(mm)*	**5.0**	**5.0**	**5.0**	**5.0**
California Bearing Ratio	**CBR**	**3%**	**3.5%**	**3.5%**	**6%**

Notes:
i. *Negative swell implies shrinkage.*
ii. *Test performed on fraction passing 19mm sieve (100%).*
iii. *Lime and cement added as a percentage of dry mass.*

Appendix F: GFR-Historical Investigation Data

INVESTIGATION GEOLOGY LTD
consulting geologists

LOG OF DRILL HOLE

PROJECT: OHINEWAI OPENCAST FEASIBILITY STUDY

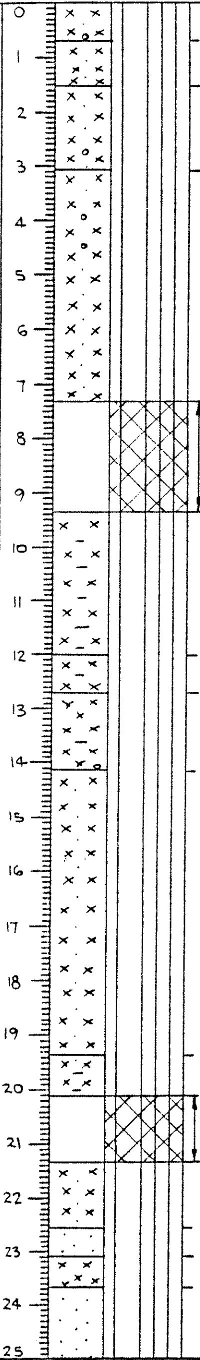
HOLE No. 9782

FEATURE .... LOCATION .... CO-ORDINATES 632 829.18N 336 733.04E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 6.08m

STRATIGRAPHIC UNIT: TAURANGA GROUP

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — altitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)
V. wk lt br - br SANDY SILT with a silty peat layer (< 10mm thk), gravel layers (<15mm)	Firm, moist, non plastic core compressed
V. wk lt grey olive f SANDY SILT	Firm, moist/wet, non plastic, core compressed
V. wk lt br - grey SANDY SILT with rare gravel (< 10mm)	Firm, wet, non plastic, core compressed
V. wk olive grey SANDY SILT with pumiceous gravels (<10mm) grading to f SANDY SILT	Highly dilatant, disturbed by drilling low cohesion
	CORE NOT SEEN Washdrilled 7.30 - 9.34m
V. wk greyish grn CLAYEY SILT	Soft, moist-wet, mod plasticity
V.wk greyish grn CLAYEY SILT lam. with carb plant material (<2mm thk)	Soft, moist, low plasticity
V.Wk lt grey SILT grading into greenish grey - greyish grn CLAYEY SILT, abund pumiceous aggregate & wood frags grading to greyish grn SILT with rare plant material & yellowish grey pumiceous gravels	V. soft, moist, low-mod plasticity
V. wk greyish grn v.f- f SANDY SILT, massive, bedded	V. soft, moist, low-mod plasticity
V. wk greyish grn CLAYEY SILT with rare sand	Firm - stiff, moist, mod plasticity
	CORE NOT SEEN Washdrilled 20.08 - 21.32 m
V. wk greenish grey - crs SANDY SILT	Compact, wet
V.wk greenish blue grn - dusky blue grn sl silty med to pebbly SAND, 2:1 volcanic rock frags to pumice.	Compact, wet
V.wk lt olive grey SILT interbedded with peat (<60mm thk)	Firm, moist, low plasticity
V.wk greenish grey crs - pebbly SAND 90% pumice, well rounded pebble (<20 mm) pumice (<120mm)	compact, wet



ROCK WEATHERING: SW MW HW | RELATIVE STRENGTH: S MS MW W | TEST RESULT | CORE LOSS/LIFT %: 5 10 50 | DATE/DEPTH | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT

DRILLER: BROWN BROS

STARTED: 2 - 7 - 84

FINISHED: 27 - 7 - 84

DRILL: FAILING

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
(cms)
Spacing of natural defects.
Defects/m of core

EXPLANATION
25m - 103.75m logged in detail by W.L. Leask (S.C.M)
* Core from 0.0 - 25.0m interval held by S.C.M.

PROJECT: OHINEWAI
HOLE NO: 9782
LENGTH: 162.30m
CORE BOXES: 19 *

LOGGED: A.H.M.
DATE: 5-7-84
TRACED: R.B.K.
CHECKED: D.E.W.
ORIGINAL SCALE 1:100

SHEET 1 OF 4 DRG NO ....

INVESTIGATION GEOLOGY LTD
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LOG OF DRILL HOLE

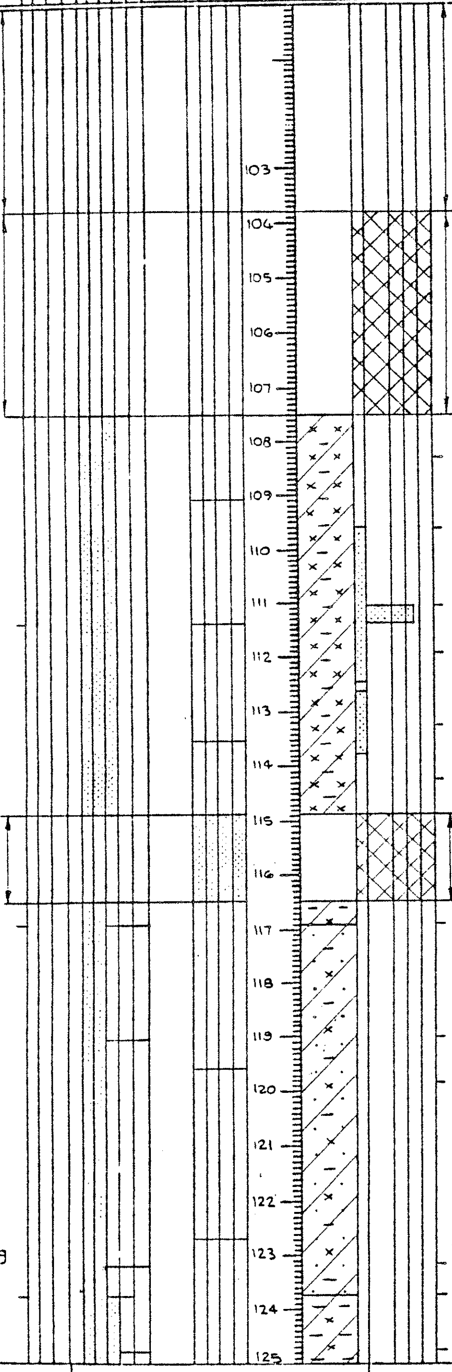
PROJECT: OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9782

FEATURE: .... LOCATION: .... CO-ORDINATES: 632 829.18N 336 733.04E

ANGLE FROM HORIZONTAL: 90° DIRECTION: .... R.L. COLLAR: 6.08m

DESCRIPTION OF CORE (weathering, relative strength, colour, name, defect type, lithological features (bedding, foliation, mineralogy, cement etc), stratigraphic unit)	Depth H.A.D. (m)	DEFECT DESCRIPTION (joints, bedding, seams, shatter, shear and crush zones, foliation, schistosity — attitude, spacing, continuity, roughness, infilling, etc.) / SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)
TAURANGA GROUP	to 103.75	Tauranga Group logged by W. Leask of State Coal Mines
	103.75 – 107.50	CORE NOT SEEN BY R.W.L. 103·75 - 107·50m
MANGAKOTUKU SILTSTONE: Mod-wk, dark green CLAYEY SILTSTONE with rare carb. fragments	107.5 – 115	core highly disturbed during drilling jt, 30°, sm, slick jts, sub-horiz, sm, 20-50mm apart jt, 30°, sm, slick jt, sub-horiz, sm, slick core highly disturbed during drilling
	115 – 116.5	CORE NOT SEEN
PUKEMIRO SANDSTONE: Mod-strong, dark greenish-grey muddy SANDSTONE - glauconitic - indications of bedding sub-horiz - siltstone laminae increasing with depth	116.5 – 123.8	contact, sharp, sub-horiz, with thin layer silty clay sub-horiz, 10-20mm thick silty clay layers present, firm, moist highly plastic, 100mm apart, drilling induced sub-horiz, 5-10mm thick SILTY CLAY layer
Mod-wk, greyish green SILTY CLAYSTONE with thin sandy laminae	123.8 – 125	horiz, 10mm thick SILTY CLAY layer



DATE/DEPTH | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT

WEATHERING	RELATIVE STRENGTH
UW — Unweathered	VS — Very Strong
SW — Slightly weathered	S — Strong
MW — Moderately weathered	MS — Moderately strong
HW — Highly weathered	MW — Moderately weak
CW — Completely weathered	W — Weak
	VW — Very weak

DEFECT LOG: Spacing of natural defects. Defects/m of core (cms)

DRILLER: BROWN BROS

STARTED: 16-7-84

FINISHED: 27-7-84

DRILL: FAILING

EXPLANATION
Tauranga Group logged by W. Leask of State Coal

PROJECT: OHINEWAI
HOLE NO: 9782
LENGTH: 162.30m
CORE BOXES: 19
LOGGED: D.E.W.
DATE: JULY 1984
TRACED: R.B.K.
CHECKED: B.W.R.
ORIGINAL SCALE 1:100
SHEET 2 OF 4
DRG NO ....

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PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9783

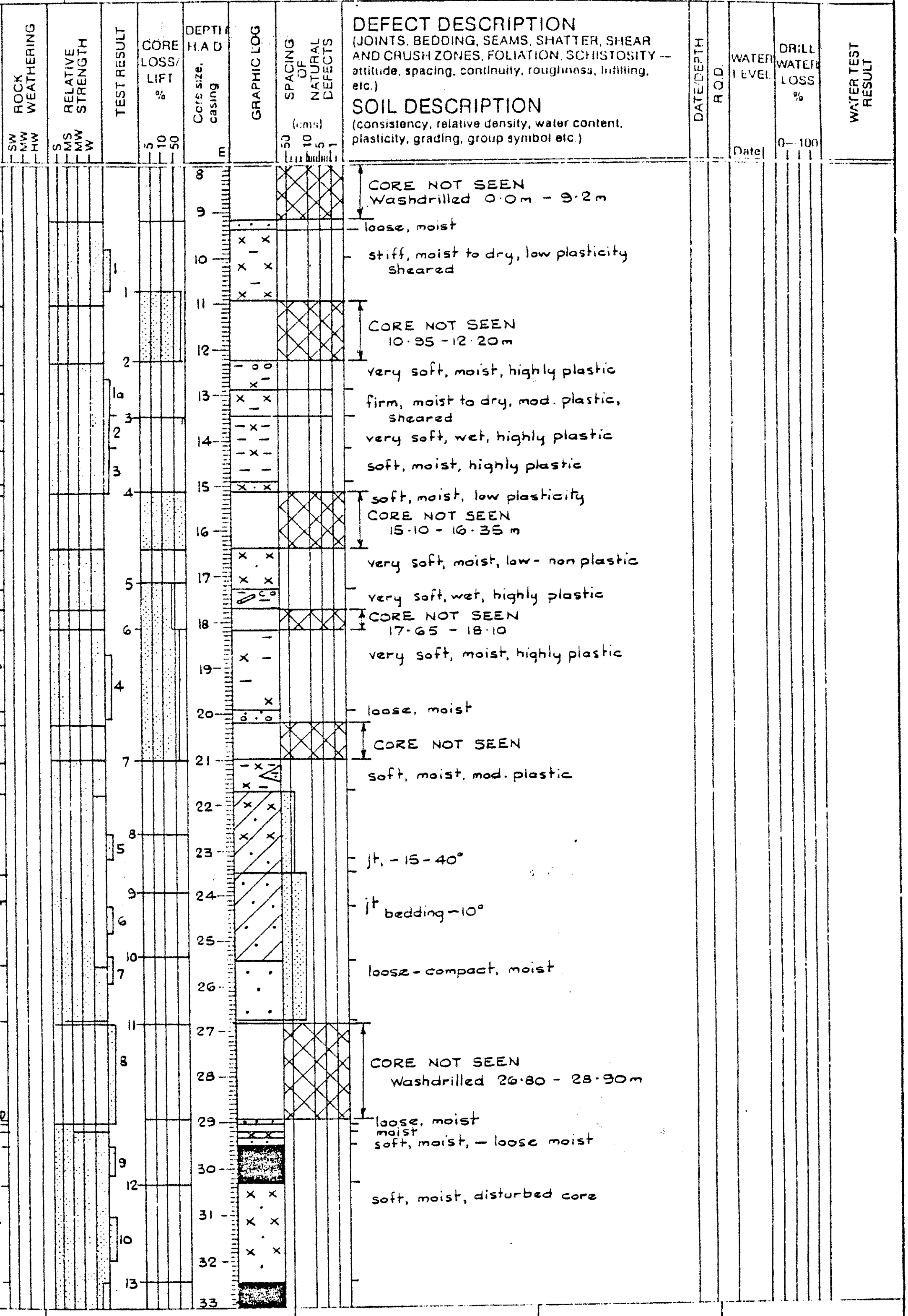
FEATURE .... LOCATION .... CO-ORDINATES 632 339·9 N 337 239·5 E

LOG OF DRILL HOLE

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 6·4m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)
Drillers logs indicate peat & clay	CORE NOT SEEN Washdrilled 0·0m - 9·2m
Very wk, light grey fine SAND (pumice)	loose, moist
Very wk, light grey CLAYEY SILT	stiff, moist to dry, low plasticity Sheared
Drillers log indicates very wk SILTY SAND	CORE NOT SEEN 10·95 - 12·20m
Very wk, light brown SILTY CLAY, carbonaceous	very soft, moist, highly plastic
Very wk, light grey SILTY CLAY	firm, moist to dry, mod. plastic, Sheared
Very wk, mxd light br., light grey SILTY CLAY	very soft, wet, highly plastic soft, moist, highly plastic
Very wk, grey SANDY SILT	soft, moist, low plasticity CORE NOT SEEN 15·10 - 16·35 m
Very wk, greyish-green SANDY SILT with SILTY CLAY laminae	very soft, moist, low- non plastic
Very wk light brown SILTY CLAY carbonaceous	very soft, wet, highly plastic CORE NOT SEEN 17·65 - 18·10
Very wk, lightgrey SILTY CLAY carb. grading to a darker gr-br, near base	very soft, moist, highly plastic
Very wk, br. SAND grading to a very wk, fine sandy gravel	loose, moist CORE NOT SEEN
Very wk, light br. SILTY CLAY carb, with fine sandy horizons	soft, moist, mod. plastic
Wk, light bluish - grey fine SANDY SILTSTONE	jt, - 15 - 40°
Wk, light bluish-grey muddy fine SANDSTONE, graded quartz-feldspar Indications of bedding at 10°	jt bedding - 10°
Very wk, bluish-grey SAND, graded, bedded	loose - compact, moist
Strong - mod. strong bluish- grey SANDSTONE graded	
Drillers log indicates fine SAND & GRAVEL	CORE NOT SEEN Washdrilled 26·80 - 28·90m
Very wk, bluish-grey GRAVELLY SAND · coarse qtz-feldspar	loose, moist
Very wk, dk, red-br. PEAT laminated	moist soft, moist,
Very wk, green-gr. SILT & bl-gr SAND interbedded	— loose moist
Very wk, dk, red.-br. PEAT with wood fragments, laminated	soft, moist, disturbed core
Very wk, greyish white SANDY SILT. Pumice slightly carbonaceous	
Wk- very wk, red.-br PEAT, laminated	

TAURANGA GROUP



DRILLER: BROWN BROS

STARTED: 5 - 8 - 83

FINISHED: 19 - 9 - 83

DRILL: FAILING

WEATHERING
- UW — Unweathered
- SW — Slightly weathered
- MW — Moderately weathered
- HW — Highly weathered
- CW — Completely weathered

RELATIVE STRENGTH
- VS — Very Strong
- S — Strong
- MS — Moderately strong
- MW — Moderately weak
- W — Weak
- VW — Very weak

DEFECT LOG

(cms) 100 50 10 5 1 — Spacing of natural defects.

1 2 10 20 50 — Defects/m of core

EXPLANATION

PROJECT: OHINEWAI

HOLE NO: 9783

LENGTH: 192·0 m

CORE BOXES: 51

LOGGED: R. B. W.

DATE: AUG '83

TRACED: M. F. S.

CHECKED: B. W. R.

ORIGINAL SCALE: 1:100

SHEET 1 OF 7 DRG NO

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9783

FEATURE .... LOCATION .... CO-ORDINATES 632 339·9 N 337 239·5 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 6.4m

DESCRIPTION OF CORE

WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT

TAURANGA GROUP

Wk - very wk, dark red.-br. PEAT, laminated

Drillers log:
greywacke GRAVEL

Very wk, grey-white SILT, pumiceous, laminated, carbonated streaks

Very wk, gr.-white SILT, pumiceous
Wk - very wk, dk red.-br PEAT, lam.
Very wk, br. gravelly, coarse SAND

Very wk, brown, fine SAND with rare gravel slightly pumiceous

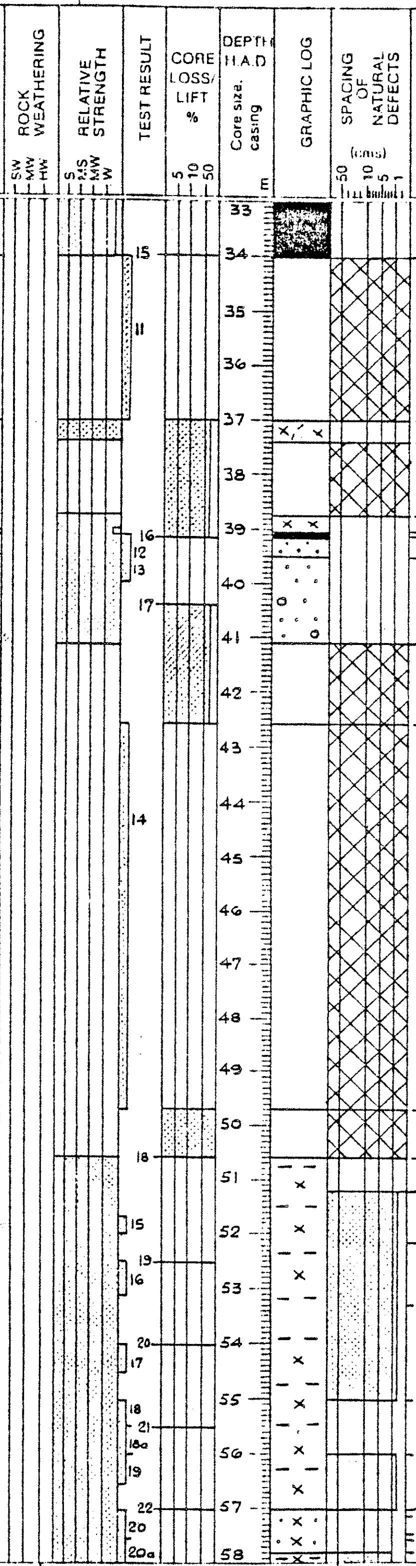
Drillers log:
41·10 - 42·60m Sands
42·60 - 49·70m Gravel

Drillers log: Blue silts

Very wk, light greenish-bl to grey SILTY CLAY
Very wk, br-gr. SILTY CLAY micaceous
Very wk, grey to greenish-grey SILTY CLAY

Very wk grey SILTY CLAY with rare fine sand, bedding horizontal

Verywk, lt. br. SILTY fine SAND, carb.
Very wk, dk red.-br. carb. SILTY SAND
Very wk, lt brown SILTY fine SAND carb., coarser with depth
Very wk, brown SILTY CLAY



DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.)

SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)

washdrilled
34·0 - 37·00 m

Soft, non-plastic

CORE NOT SEEN
37·4 - 38·8 m

Soft, moist, plastic
moist
loose, wet, core disturbed

loose, wet, moist

CORE NOT SEEN
41·10 - 42·60 m

washdrilled
42·60 - 49·70 m

CORE NOT SEEN
49·70 - 50·60 m

firm - stiff, moist, highly plastic
stiff, moist, mod. plastic
stiff, moist, highly plastic
random, slickensided surfaces

jt, 50° slickensided

Very stiff, moist, highly plastic

very stiff, moist, closely spaced slickensided surfaces
dense, moist
" "
" "
stiff, moist

DATE/DEPTH | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT

DRILLER: BROWN BROS

STARTED: 5 - 8 - 83

FINISHED: 19 - 9 - 83

DRILL: FAILING

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
Spacing of natural defects (cms)
Defects/m of core

EXPLANATION

PROJECT: OHINEWAI
HOLE NO: 9783
LENGTH: 192·0 m
CORE BOXES: 51

LOGGED: R. B. W.
DATE: 1 - 9 - 83
TRACED: M. F. S.
CHECKED: B. W. R.
ORIGINAL SCALE: 1 : 100

SHEET 2 OF 7 DRG NO ....

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LOG OF DRILL HOLE

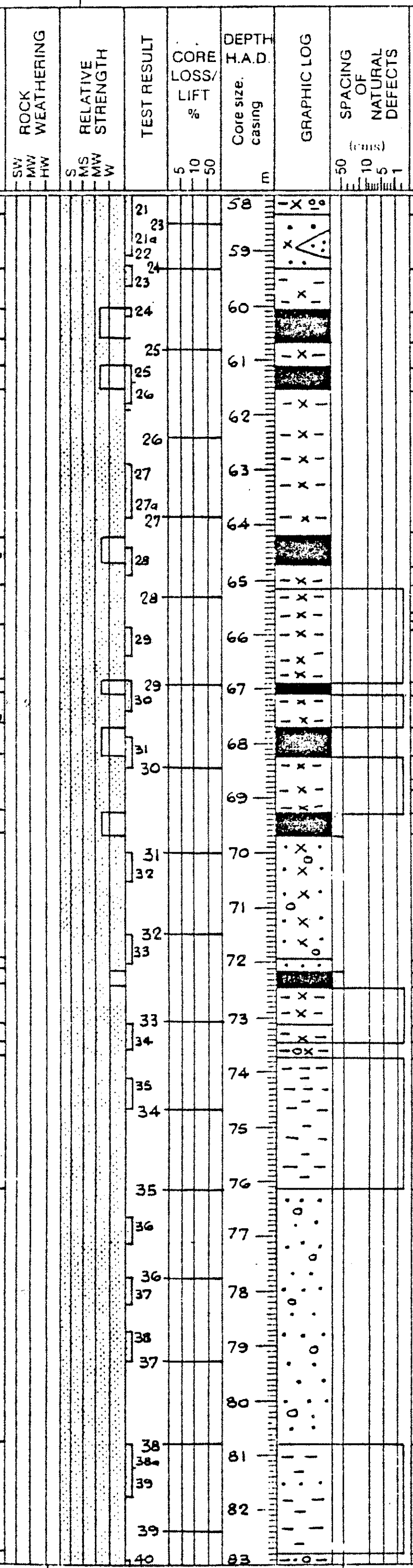
PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY
HOLE No. 9783

FEATURE .... LOCATION .... CO-ORDINATES 632 339·9N 337 239·5E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 6.4m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)
Very wk, br. SILTY CLAY, carb	firm, moist, highly plastic
Very wk, gr-wh. SILTY fine SAND interbedded with wh. very fine SANDS (pumice)	Dense, moist
Very wk, red.-br. SILTY CLAY, carb.	Very stiff, moist, highly plastic
Mod. wk - wk dk red.-br PEAT	moist
Very wk, dk red-br SILTY CLAY carb.	stiff, moist, highly plastic
Mod. wk, dk red.-br. PEAT	moist
Very wk, dk gr SILTY CLAY, carb	Very stiff, highly plastic
Mod. wk - wk, dk br. PEAT bedded with v. wk greyish-br SILTY CLAY carb.	moist firm, stiff, moist, highly plastic
Very wk cream SILTY CLAY	stiff, moist, highly plastic, jt, 60°, slickensided jt 60°, slickensided
Very wk, lt br	stiff, moist, highly plastic
Mod wk - wk, dk red.-br. PEAT	moist
Very wk, lt red.-br SILTY CLAY, carb	stiff, moist, highly plastic
Mod. wk - wk dk red.-br. PEAT	moist
Very wk, red.-br SILTY CLAY, carb.	Very stiff, moist, mod. plastic highly carb highly carb
Mod. wk - wk, dk red.-br. PEAT lam.	
Very wk lt grey SILTY SAND with rare fine gravel pumiceous	compact, loose, wet
Very wk, lt grey with blk coarse SAND	loose
wk, dk, red.-br. PEAT, laminated	moist jt - 60°, slickensided
Very wk, lt gr-br. SILTY CLAY	very stiff, moist - dry hly pl
Very wk, dk br SILTY CLAY, carb	very stiff, moist, hly pl.,
Very wk, greenish-grey, fine SILTY CLAY with GRAVEL	very stiff, moist, highly plastic
Very wk lt grey CLAY	stiff, moist, highly plastic
Very wk, lt grey SILTY SAND with rare gravel, pumiceous no apparent bedding	compact, moist
Very wk, lt greyish green CLAY with rare sand, laminated	stiff, moist, highly plastic
Very lt gr.-grn, CLAY with sand & fine gr.	stiff, moist, high plasticity

TAURANGA GROUP



DATE/DEPTH | R.Q.D. | WATER LEVEL Date | DRILL WATER LOSS % 0—100 | WATER TEST RESULT

DRILLER: BROWN BROS

STARTED: 5 - 8 - 83

FINISHED: 19 - 9 - 83

DRILL: FAILING

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
(cms)
Spacing of natural defects.
Defects/m of core

EXPLANATION

PROJECT: OHINEWAI
HOLE NO: 9783
LENGTH: 192·0m
CORE BOXES: 51

LOGGED: R. B. W.
DATE: SEPT '83
TRACED: M. F. S.
CHECKED: B. W. R.
ORIGINAL SCALE 1 : 100

SHEET 3 OF 7
DRG NO ....

INVESTIGATION GEOLOGY LTD
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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY
HOLE No. 9783

FEATURE .... LOCATION .... CO-ORDINATES 632 339·9N 337 239·5E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 6.4m

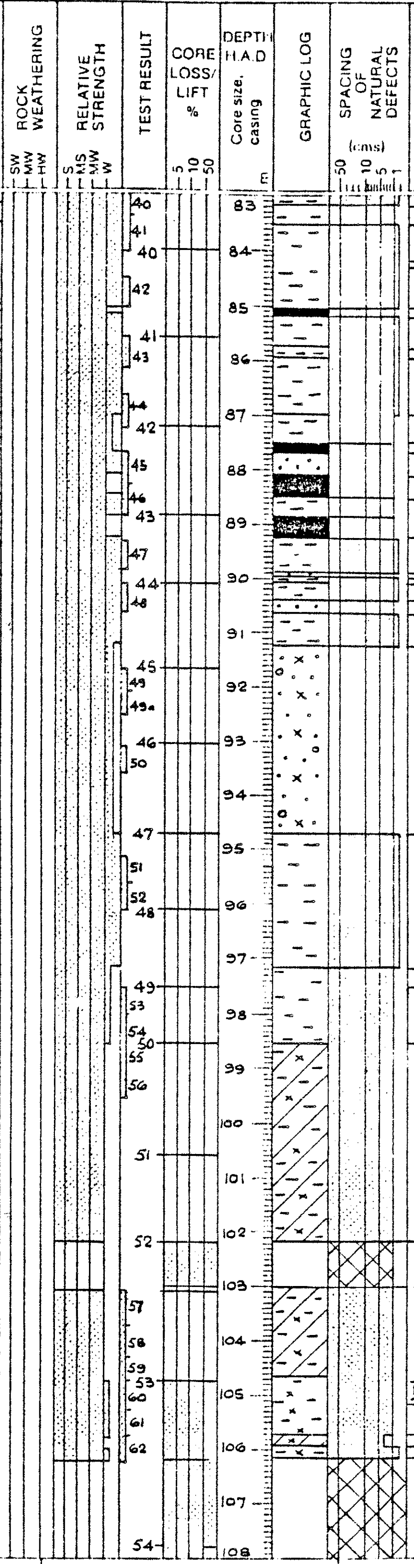
DESCRIPTION OF CORE
WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT

TAURANGA GROUP

Very wk, lt greyish-green CLAY
Very wk, lt brown CLAY, carb.
Very wk, grey CLAY with horizon
Wk, dk red.-br PEAT laminated
Very wk, grey CLAY
Very wk, dk br. CLAY, carb. with peat laminations
Very wk, grey CLAY
Wk - very wk dk br CLAY, hly carb.
Wk - very wk dk red.-br PEAT, lam.
Very wk, gry-wh. SAND (fine, crs, gr., bedd. pumiceous
Mod wk - wk, dk red.-brn PEAT, lam.
Very wk, dk br CLAY, highly carbonaceous
Wk, dk, red.-br. PEAT
Very wk. dk br. CLAY with gr. (pumice) carb
Very wk. lt grey SILTY fine SAND (pumice)
Very wk, dk br CLAY carb
Very wk, lt grey CLAY
Very wk, lt grey SILTY SAND (pumice)
Very wk, br. CLAY grading into v. wk lt gr clay, (carb.)
Very wk, lt grey SILTY SAND with rare gravel pumiceous
Very wk, lt brn CLAY, carb. with rare peat laminae

GLEN AFTON CLAYSTONE

Wk-very wk br. & lt greyish-grn CLAYST. laminated slightly carbonaceous
Wk-very wk, lt greyish-grn CLAYSTONE laminated
Wk, dk greyish-grn SILTY CLAYSTONE laminated 5°
Drillers log: indicates papa
Wk, lt br. SILTY CLAYSTONE with rare v. fine sand
Wk - v. wk dk grey SILTY CLAYST. laminated - 5°



DEFECT DESCRIPTION
(JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY – attitude, spacing, continuity, roughness, infilling, etc.)

SOIL DESCRIPTION
(consistency, relative density, water content, plasticity, grading, group symbol etc.)

Stiff, moist, highly plastic,
jts, 10° slickensided
jt, 50°, slickensided
moist
stiff, moist, high plasticity,
Very stiff, moist, low plasticity,
moist
compact, moist
moist
Very stiff, moist, mod. plastic,
moist
stiff, moist, highly plastic,
compact, moist
Very stiff, moist, highly plastic,
stiff, moist, highly plastic, highly
compact, moist
stiff, moist, highly plastic, highly
jts - 45°, slickensided
compact, moist
Very stiff, moist, highly plastic, small irregular fissures
moist - dry, highly plastic,
moist, highly plastic,
jts, 10-20° & 90° slickensided many small random fissures
CORE NOT SEEN
Core highly disturbed
jts - 45° slickensided
moist
moist, dry
CORE NOT SEEN (106·15 - 108·15 m)

DATE/DEPTH	R.Q.D.	WATER LEVEL (Date)	WATER LOSS % (0- 100)	WATER TEST RESULT

DRILLER: BROWN BROS
STARTED: 5-8-83
FINISHED: 19-9-83
DRILL: FAILING

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
(cms)
Spacing of natural defects
Defects/ m of core

EXPLANATION

PROJECT OHINEWAI
HOLE NO 9783
LENGTH 192·0m
CORE BOXES 51
LOGGED R.B.W.
DATE SEPT '83
TRACED M.F.S.
CHECKED B.W.R.
ORIGINAL SCALE 1:100
SHEET 4 OF 7 DRG NO.

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LOG OF DRILL HOLE

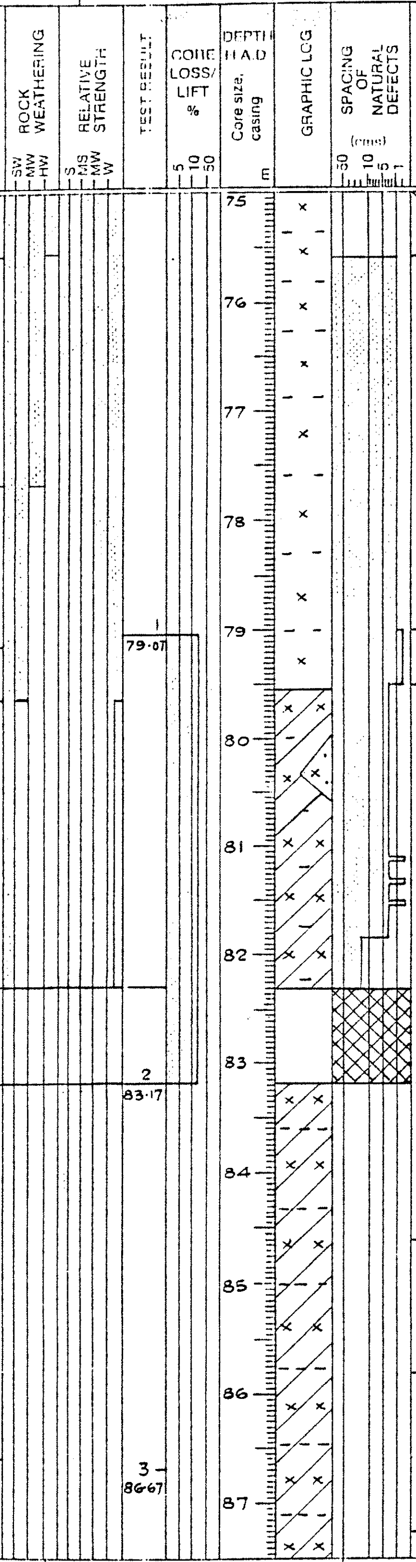
PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9796

FEATURE – LOCATION – CO-ORDINATES 632 099.71 N 336 401.26 E

ANGLE FROM HORIZONTAL 90° DIRECTION – R.L. COLLAR 12.95 m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH
	WASH - DRILLED TO 75.0 m	
PUKEMIRO SANDSTONE CW V. wk, mottled, lt grey, orange & deep red, silty CLAY with rare fine sand Becoming lt grey with orange ironstained joints	Jts, 10 mm apart, 60°-40°, sm - slick	4/1/85
MW, V wk, dk grey silty CLAY		
MW, V wk, greyish-brn silty CLAY	Jts <10 mm apart, slick, random, moist - dry, med. plastic	
SW Wk - V wk, greyish-green clayey SILTSTONE with wk - V wk dk green silty SANDSTONE, < 10 mm thick bedding subhoriz., highly glauconitic	Jts 10-50 mm apart, sm. - slick 10°-60° 81·07 m - 50 mm zone Jnts < 5 mm, sm. - slick, random	
	81·30 m - 100 mm zone jts < 5 mm sm., slick, random	
	81·50 m - 200 mm zone " " sm., slick, random	
	NO CORE 82·32 - 83·17	7/1/85
GLEN AFTON CLAYSTONE wk, greyish-green silty CLAYSTONE. Thin (10 mm) wk. sandy, dk green fine, sandy siltstone bed (184·54 m) subhoriz.	Jt, subhoriz, sm., either side of f. sandy siltstone layer	
	Core redrilled 85·85 - 86·67 m core disturbed 85·85 - 86·10 m	
wk greenish grey silty CLAY-STONE	Jts, slick, subhoriz. & subvert.	



R.Q.D. | WATER LEVEL Date | DRILL WATER LOSS % 0—100 | WATER TEST RESULT

DRILLER: DRILLWELL

STARTED: 31/1/85

FINISHED: 9/1/85

DRILL: TRIPLE TUBE

WEATHERING
- UW — Unweathered
- SW — Slightly weathered
- MW — Moderately weathered
- HW — Highly weathered
- CW — Completely weathered

RELATIVE STRENGTH
- VS — Very Strong
- S — Strong
- MS — Moderately strong
- MW — Moderately weak
- W — Weak
- VW — Very weak

▨

DEFECT LOG

(cms) 100 50 10 5 1 0·1 — 2 10 20 100 1000 — Spacing of natural defects. Defects/ m of core

EXPLANATION
sm. - smooth
sl. - slickensided
horiz. - horizontal
vert. - vertical
Jts - joints
carb. - carbonaceous

PROJECT: OHINEWAI

HOLE NO: 9796

LENGTH: 32·00 m

CORE BOXES: 12

LOGGED: R. B. W.

DATE: JAN '85

TRACED: M.F.S.

CHECKED:

ORIGINAL SCALE 1 : 50

SHEET 1 OF 3 DRG NO

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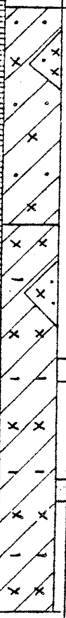
LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY
HOLE No. 9797
FEATURE – LOCATION – CO-ORDINATES 632 139.12 N 336 501.67 E
ANGLE FROM HORIZONTAL 90° DIRECTION – R.L. COLLAR 17.02 m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	ROCK WEATHERING SW MW HW	RELATIVE STRENGTH S MS MW W	TEST RESULT	CORE LOSS/ LIFT % 5 10 50	DEPTH H.A.D. Core size, casing m	GRAPHIC LOG	SPACING OF NATURAL DEFECTS (cms) 50 10 5 1	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH	R.Q.D.	WATER LEVEL Date	DRILL WATER LOSS % 0—100	WATER TEST RESULT
					80								
					81								
					82			Wash drilled to 86·96 m see log from W. Leask, STATE COAL MINES					
					83				11/1/85				
					84								
					85								
					86								
PUKEMIRO SANDSTONE Wk - V wk, dk grn, fine - med., silty SANDSTONE with thin (< 100 mm) wk - v wk greyish-grn, fine sandy siltstone lenses, bedding subhoriz., highly glauconitic					87								
					88								
Wk, greyish-grn, clayey SILT STONE with thin (< 20mm thick) wk, dk grn, silty, fine - med. sandstone laminae, highly glauconitic, bedding subhoriz., with rounded clasts of wk dk grn silty, fine - med SANDSTONE, highly glauconitic. At 90·33 m & 92·70m 30mm thick irregularly shaped lens of wk yel.-brn CLAYSTONE, with bivalve fossils					89								
					90			Shear zones, subhoriz. 20mm thick, Jts < 1mm apart, sm.					
					91			Jts 10-50 mm apart, sm.- slick 0-30°	14/1/85				
			1 91·64		92								



DRILLER: DRILLWELL
STARTED: 10-1-85
FINISHED: 17-1-85
DRILL: TRIPLE - TUBE

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
(cms) 100 50 10 5 1 0.1 Spacing of natural defects.
1 2 10 20 100 1000 Defects/ m of core

EXPLANATION
Casing at 86·96m
Triple Tubed 87.0m – 123.29m

PROJECT: OHINEWAI
HOLE NO: 9797
LENGTH: 36·33 m
CORE BOXES: 13
LOGGED: R.B.W.
DATE: JAN '85
TRACED: M.F.S.
CHECKED:
ORIGINAL SCALE 1:50
SHEET 1 OF 4
DRG NO

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

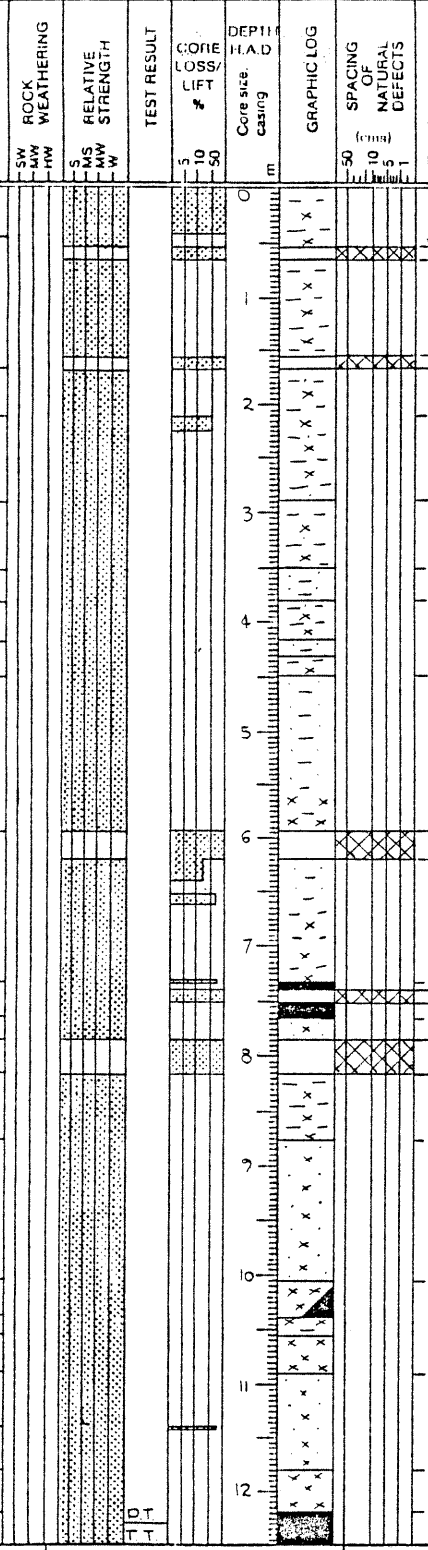
HOLE No. 9842

FEATURE .... LOCATION .... CO-ORDINATES 632 711 . 08 N 336 144. 89 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

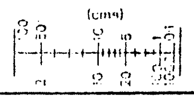
DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH
V.wk, dk. br. SILTY CLAY topsoil	Soft	
V.wk, lt. orge-br. SILTY CLAY	CORE LOSS 0·12 m soft - firm, wet	7/5/85
	CORE LOSS 0·12m Firm	
V wk, wh SILTY CLAY with minor sand		
V. wk, dk br SILTY CLAY	Stiff	
V wk, wh (red & br mottled) SILTY CLAY with some sand	Firm - stiff (CL)	
V wk, pink & wh mottled CLAYEY SAND	Soft - v. soft (CL)	
V. wk, wh SILTY CLAY with sand coarse sandy clay horizon		
V wk, wh CLAYEY crs - F SAND with laminae of soft wh SILTY CLAY. Clayey sands are C.W. pumice -ash - abrades to silt / clay / water mixture		
V. wk, lt. yel - wh CLAYEY SANDS & soft SILTY CLAYS. C.W. pumice ash abrades to silt / clay / water. Minor rotten organic matter in basal 10cm	CORE LOSS 0·26m	
V.wk, dk. br F PEAT	CORE LOSS 0·10m moist	
V.wk, dk.br SILTY F SAND	Compact, wet (SM) CORE LOSS 0·30m	
V.wk, dk. br SILTY CLAY with minor rotten leaf material	Wet, firm, mod. plastic (CL)	
V. wk, lt grey-br SILTY v.F. SAND, with minor clay. Silt & clay proportions vary within unit	Wet, compact (SM)	
V.wk dk br. - blk. organic SILT & F PEAT	Moist, stiff (OL)	
V. wk pale grey-br CLAYEY SILT	(ML)	
V. wk. dk br-grey v.f. SAND with minor SILT	(SP - SM) Compact	7/5/85
100mm dk. br org. silt, thin laminae alt. with v. f. sand		
V wk, lt & dk. br. lam. org. SILT	stiff	
V wk blk. F. PEAT	Wet, stiff	

TAURANGA GROUP



R.Q.D.	WATER LEVEL	DRILL WATER LOSS %	WATER TEST RESULT
	Date	0—100	

DRILLER: DRILLWELL	WEATHERING UW — Unweathered SW — Slightly weathered MW — Moderately weathered HW — Highly weathered CW — Completely weathered	RELATIVE STRENGTH VS — Very Strong S — Strong MS — Moderately strong MW — Moderately weak W — Weak VW — Very weak	DEFECT LOG Spacing of natural defects. Defects/ m of core	PROJECT: OHINEWAI HOLE NO: 9842 LENGTH: 191.85m CORE BOXES: 65	LOGGED: B.G.S DATE: 7-29/5/85 TRACED: R.B.K. CHECKED: .... ORIGINAL SCALE 1:50



STARTED: 7-5-85

FINISHED: 29-5-85

DRILL: RIG. No 1

EXPLANATION

SHEET 1 OF 16 DRG NO ....

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9842

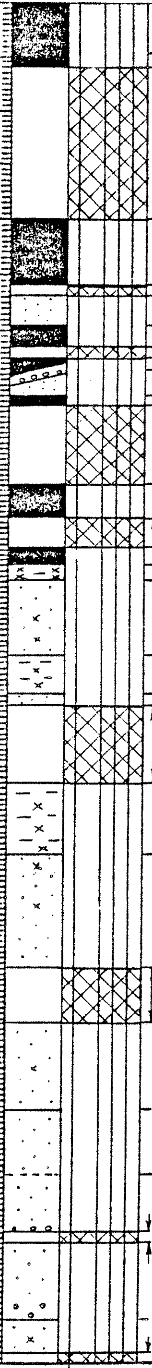
FEATURE .... LOCATION .... CO-ORDINATES 632 711.08 N 336 144.89 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEPTH H.A.D (m)	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH
V wk, blk f PEAT		Wet, stiff	
	13	Wet, Soft	
		CORE LOSS 1·4m	7/5/85
	14		
V. wk, blk f PEAT with wood frags		Wet	
	15	CORE LOSS 0·10m	
V.wk, dk grey med-crs SAND with minor f. gravel. Org rich at base		Saturated, loose	
V.wk blk PEAT with partly rotten wood, f. gravel at base		Saturated, disturbed sample	
		CORE LOSS 0·10m	
V.wk. lt br-grey f SAND, minor silt	16	Wet, compact (SP-SM)	
V.wk, blk. f PEAT		Saturated, Firm-stiff	
		CORE LOSS 0·75m	8/5/85
V. wk. blk. PEAT, wood frags dominant	17		
		CORE LOSS 0·30m	
as above			
V. wk. dk grey-br CLAYEY crs SILT		Compact	
V wk. dk br-grey v.f. SAND with minor silt & rotten plant rootlets Basal 100mm org rich	18	Saturated compact (SP-SM)	
V. wk, lt br SILTY CLAY with basal 100mm f PEAT horizon			
V. wk dk grey f & crs SAND (pumice)		Saturated, loose	
	19	CORE LOSS 0·70m	
V. wk. lt grey-br or dk grey SILTY CLAY with rare f org material		Firm - stiff	
	20		
V. wk, lt grey br thinly bedded v.f SAND, SILTY v.f. SAND & crs SAND, pumice tephra & tephra derived			
	21		
		CORE LOSS 0·50m	
V.wk. dk. br. med SAND with minor silt Tephra or tephra derived	22	Loose (SP-SM)	
V. wk, dk br med-crs SAND pumice. Sl coarsening - crs Sand at base	23	Loose	
crs SAND (pumice) coarsening to f GRAVEL (pumice) at base		Loose	
		CORE LOSS 0·10m	
V.wk, lt grey-br crs SAND to f GRAVEL (pumice)	24		
V. wk, dk br-grey, med SAND with some silt. Pumice Sl - mod weath.		Saturated, loose	
	25	CORE LOSS 0·20m	

TAURANGA GROUP

Column headings: ROCK WEATHERING (SW MW HW) | RELATIVE STRENGTH (S MS MW W) | TEST RESULT | CORE LOSS/LIFT % (5 10 50) | Core size casing | GRAPHIC LOG | SPACING OF NATURAL DEFECTS (cm) (50 10 5 1) | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT



WEATHERING	RELATIVE STRENGTH
UW — Unweathered	VS — Very Strong
SW — Slightly weathered	S — Strong
MW — Moderately weathered	MS — Moderately strong
HW — Highly weathered	MW — Moderately weak
CW — Completely weathered	W — Weak
	VW — Very weak

DEFECT LOG
(cmm)
Spacing of natural defects.
Defects/m of core

DRILLER: DRILLWELL

STARTED: 7-5-85

FINISHED: 29-5-85

DRILL: RIG Nº 1

EXPLANATION

PROJECT: Ohinewai
HOLE NO: 9842
LENGTH: 191.85m
CORE BOXES: 65

LOGGED: B.G.S.
DATE: 7-29/5/85
TRACED: R.B.K
CHECKED: ....
ORIGINAL SCALE 1:50

SHEET 2 OF 16 DRG NO ....

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9842

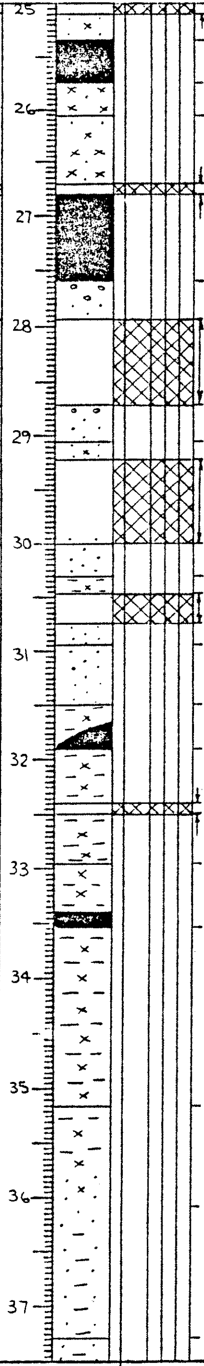
FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N 336 144·89 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)
V.wk, dk br-grey med SAND with some silt. Pumice sl-mod weath	CORE LOSS 0·20m
V.wk, blk. f PEAT	Stiff
V.wk, lt grey & dk br SANDY SILT	Compact
V.wk, lt grey-wh SILTY f SAND to f SANDY SILT, lam	Compact
	CORE LOSS 0·10m
V.wk, blk f PEAT with some partly decomposed wood	Stiff
V.wk, lt grey-br f GRAVEL, fining down to crs SAND (pumice)	Loose
	CORE LOSS 0·75m
V.wk, lt grey f GRAVEL fining down to med SAND pumice	Loose
V.wk, lt grey-br SILTY v.f. SAND	Loose (SM)
	CORE LOSS 0·80m
V wk, dk br f SAND	Poorly graded (SP)
V.wk, dk br-grey f & crs SANDS	Loose, f poorly graded sand crs well graded sand
V.wk, dk br org SILTY CLAY	Firm (CL)
	CORE LOSS 0·27m
V. wk, dk br f SAND	Loose, poorly graded (SP)
V.wk, lt grey med SAND, pumice	Loose (SP)
V.wk dk grey-br org SILTY CLAY & f PEAT	Firm
V.wk, dk br grey SILTY CLAY with some f org. frags	V. stiff
	CORE LOSS 0·10m
V.wk, lt grey-pinkish br SILTY CLAY	Stiff - v. stiff
V.wk, blk. org SILTY CLAY, grading downwards into f PEAT	V. stiff
V.wk, dk br to dk grn-grey SILTY CLAY with some decaying rootlets.	V. stiff (CL)
V.wk, dk grn-grey SILTY CLAY with some f sand. Micaceous f sand concentrated thin laminae. Sand content incr. downwards	V. stiff (CL)
V.wk, dk grn.grey SANDY CLAY micaceous., lam in part, alt clayey f sand / silty clay	V. stiff
V.wk, dk grey CLAYEY f SAND Micaceous, massive	Loose

TAURANGA GROUP

ROCK WEATHERING: SW MW HW | RELATIVE STRENGTH: S MS MW W | TEST RESULT | CORE LOSS/LIFT %: 5 10 50 | DEPTH H.A.D Core size. casing m | GRAPHIC LOG | SPACING OF NATURAL DEFECTS (mm) 50 10 5 1 | DATE/DEPTH | R.Q.D. | WATER LEVEL Date | DRILL WATER LOSS % 0—100 | WATER TEST RESULT



DATE/DEPTH: 8/5/85

DATE/DEPTH: 9/5/85

DRILLER: DRILLWELL

STARTED: 7-5-85

FINISHED: 29-5-85

DRILL: RIG Nº 1

WEATHERING
- UW — Unweathered
- SW — Slightly weathered
- MW — Moderately weathered
- HW — Highly weathered
- CW — Completely weathered

RELATIVE STRENGTH
- VS — Very Strong
- S — Strong
- MS — Moderately strong
- MW — Moderately weak
- W — Weak
- VW — Very weak

DEFECT LOG

(mm) Spacing of natural defects. Defects/m of core

EXPLANATION

PROJECT: Ohinewai

HOLE NO: 9842

LENGTH: 191.85m

CORE BOXES: 65

LOGGED: B.G.S.

DATE: 7-29/5/85

TRACED: R.B.K.

CHECKED: ....

ORIGINAL SCALE 1:50

SHEET 3 OF 16 DRG NO ....

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

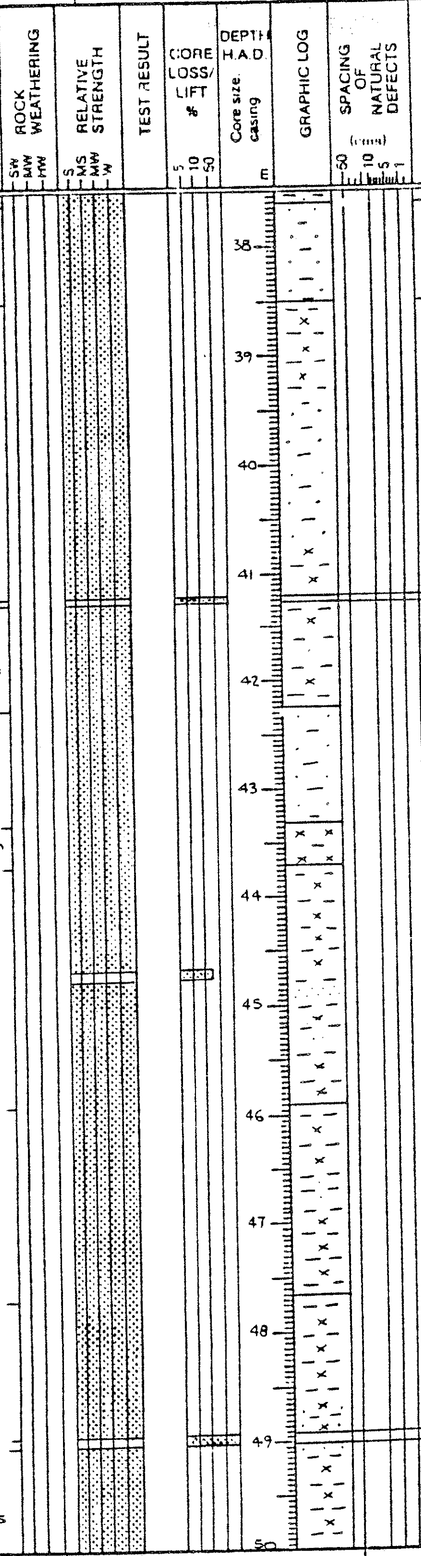
HOLE No. 9842

FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N / 336 144·89 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH
V.wk, dk grn-grey to grey CLAYEY f SAND, micaceous	Compact	9/5/85
V wk, dk grey SILTY CLAY to CLAYEY f SAND decreasing sand content towards base	Stiff	
	CORE LOSS 0·05m	
V wk, dk grn-grey SILTY CLAY with some sand. Thinly lam, micaceous. Variable proportions of sand, silt & clay	V. stiff	
V wk, dk grey, v f SAND with some clay. Massive micaceous fining towards base	Compact	
gradational V.wk, dk grey CLAYEY crs SILT with some sand	Compact (ML)	
V.wk, dk grey SILTY CLAY with v rare sand in thin laminae	V. stiff	
V.wk, dk grey SILTY CLAY with v rare sand (micaceous) homogenous	V. stiff	9/5/85
V.wk, dk grey SILTY CLAY with rare laminae of disintergrated leaf, thinly lam.	V. stiff	
V.wk, f SAND	loose, poorly graded	
	CORE LOSS 0·10m	
V.wk, dk grey-greyish br SILTY CLAY with v.rare rotten ?root frags	V. stiff	

TAURANGA GROUP



R.Q.D. | WATER LEVEL | DRILL WATER LOSS % 0—100 | WATER TEST RESULT

DRILLER: DRILLWELL	WEATHERING UW — Unweathered SW — Slightly weathered MW — Moderately weathered HW — Highly weathered CW — Completely weathered	RELATIVE STRENGTH VS -- Very Strong S -- Strong MS -- Moderately strong MW — Moderately weak W — Weak VW -- Very weak	DEFECT LOG Spacing of natural defects. Defects/ m of core	PROJECT: Ohinewai HOLE NO: 9842 LENGTH: 191.85m CORE BOXES: 65	LOGGED: B.G.S. DATE: 7-29/5/85 TRACED: R.B.K. CHECKED: ORIGINAL SCALE 1 50
STARTED: 7-5-85 FINISHED: 29-5-85 DRILL: RIG Nº 1	EXPLANATION			SHEET 4 OF 16	DRG NO ..

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LOG OF DRILL HOLE

PROJECT: OHINEWAI OPENCAST FEASIBILITY STUDY
HOLE No. 9842
FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N 336 144·89 E
ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE (WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT)	DEPTH H.A.D. Core size, casing m	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH
V.wk, dk br-grey med SAND with some silt. Pumice sl-mod weath	25	CORE LOSS 0·20m	
V.wk, blk. f PEAT		Stiff	
v.wk, lt grey & dk br SANDY SILT	26	Compact	
V.wk, lt grey-wh SILTY f SAND to f SANDY SILT, lam		Compact	
		CORE LOSS 0·10m	
V.wk, blk. f PEAT with some partly decomposed wood	27	Stiff	
V.wk, lt grey-br f GRAVEL, fining down to crs SAND (pumice)		Loose	
	28	CORE LOSS 0·75m	
V.wk, lt grey f GRAVEL fining down to med SAND pumice	29	Loose	
V.wk, lt grey-br SILTY v.f. SAND		Loose (SM)	
		CORE LOSS 0·80m	8/5/85
V wk, dk br f SAND	30	Poorly graded (SP) Loose, f poorly graded sand	
V.wk, dk br-grey f & crs SANDS		crs well graded sand	
V.wk, dk br org SILTY CLAY		Firm (CL)	
		CORE LOSS 0·27m	
V. wk, dk br f SAND		Loose, poorly graded (SP)	
V.wk, lt grey med SAND, pumice	31	Loose (SP)	
V.wk dk grey-br org SILTY CLAY & f PEAT		Firm	
V.wk, dk br grey SILTY CLAY with some f org. frags	32	V. stiff	
		CORE LOSS 0·10m	
V.wk, lt grey-pinkish br SILTY CLAY		Stiff - v. stiff	
V.wk, blk. org SILTY CLAY, grading downwards into f PEAT	33	V. stiff	
V.wk, dk br to dk grn-grey SILTY CLAY with some decaying rootlets.	34 35	V. stiff (CL)	
V. wk, dk grn-grey SILTY CLAY with some f sand. Micaceous f sand concentrated thin laminae. Sand content incr. downwards	36	V. stiff (CL)	9/5/85
V.wk, dk grn. grey SANDY CLAY micaceous., lam in part, alt clayey f sand / silty clay	37	V. stiff	
V.wk, dk grey CLAYEY f SAND Micaceous, massive		Loose	

TAURANGA GROUP

DRILLER: DRILLWELL
STARTED: 7-5-85
FINISHED: 29-5-85
DRILL: RIG. No 1

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
MS — Moderately strong
MW — Moderately weak
W — Weak
VW — Very weak

DEFECT LOG
(cms)
Spacing of natural defects.
Defects/ m of core

EXPLANATION

PROJECT: Ohinewai
HOLE NO: 9842
LENGTH: 191.85m
CORE BOXES: 65
LOGGED: B.G.S.
DATE: 7-29/5/85
TRACED: R.B.K.
CHECKED:
ORIGINAL SCALE 1:50
SHEET 3 OF 16
DRG NO

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9842

FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N 336 144·89 E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE
WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT

ROCK WEATHERING (SW MW HW) | RELATIVE STRENGTH (S MS MW W) | TEST RESULT | CORE LOSS/LIFT % (5 10 50) | DEPTH H.A.D. (Core size, casing, E) | GRAPHIC LOG | SPACING OF NATURAL DEFECTS (cms) (50 10 5 1)

DEFECT DESCRIPTION
(JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.)
SOIL DESCRIPTION
(consistency, relative density, water content, plasticity, grading, group symbol etc.)

DATE/DEPTH | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT

TAURANGA GROUP

TAURANGA GROUP

V.wk, dk grn-grey to grey CLAYEY f SAND, micaceous

V wk, dk grey SILTY CLAY to CLAYEY f SAND

decreasing sand content towards base

v wk, dk grn-grey SILTY CLAY with some sand. Thinly lam, micaceous. Variable proportions of sand, silt & clay

V wk, dk grey, v f SAND with some clay. Massive micaceous fining towards base

gradational

V.wk, dk grey CLAYEY crs SILT with some sand

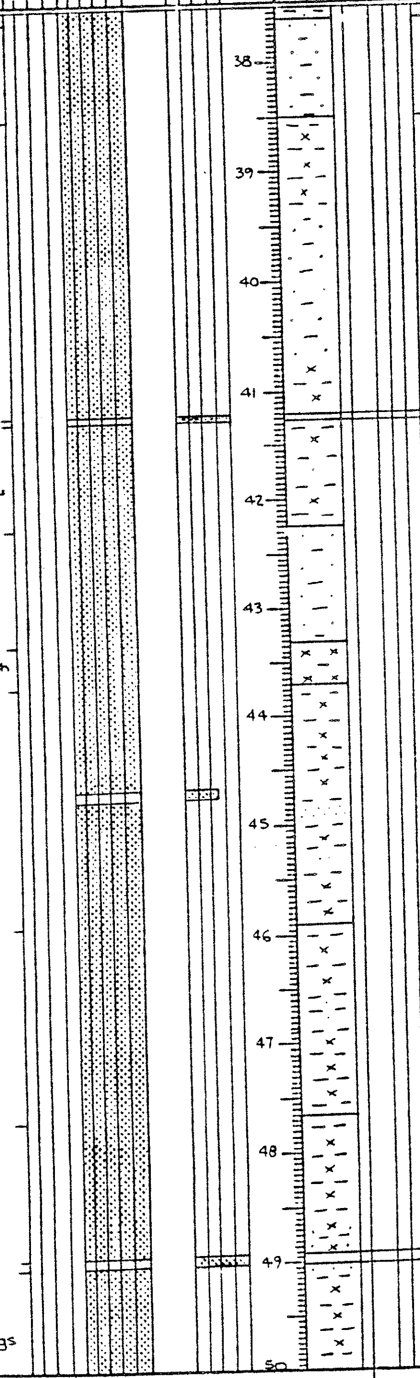
V.wk, dk grey SILTY CLAY with v rare sand in thin laminae

V.wk, dk grey SILTY CLAY with v rare sand (micaceous) homogenous

V.wk, dk grey SILTY CLAY with rare laminae of disintergrated leaf, thinly lam.

V.wk, f SAND

V.wk, dk grey - greyish br SILTY CLAY with v.rare rotten ? root frags



Compact

Stiff

CORE LOSS 0·05m

V. stiff

Compact

Compact (ML)

V. stiff

V. stiff

V. stiff

loose, poorly graded

CORE LOSS 0·10m

V. stiff

9/5/85

9/5/85

DRILLER: DRILLWELL

STARTED: 7-5-85

FINISHED: 29-5-85

DRILL: RIG Nº 1

WEATHERING	RELATIVE STRENGTH
UW — Unweathered	VS -- Very Strong
SW — Slightly weathered	S -- Strong
MW — Moderately weathered	MS -- Moderately strong
HW — Highly weathered	MW — Moderately weak
CW — Completely weathered	W — Weak
	VW — Very weak

▨

DEFECT LOG
(cms)
Spacing of natural defects.
Defects/m of core

EXPLANATION

PROJECT: Ohinewai
HOLE NO: 9842
LENGTH: 191.85m
CORE BOXES: 65
LOGGED: B.G.S.
DATE: 7-29/5/85
TRACED: R.B.K
CHECKED: ....
ORIGINAL SCALE 1:50
SHEET 4 OF 16
DRG NO ....

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LOG OF DRILL HOLE

PROJECT: OHINEWAI OPENCAST FEASIBILITY STUDY

HOLE No. 9842

FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N 336 144·89 E

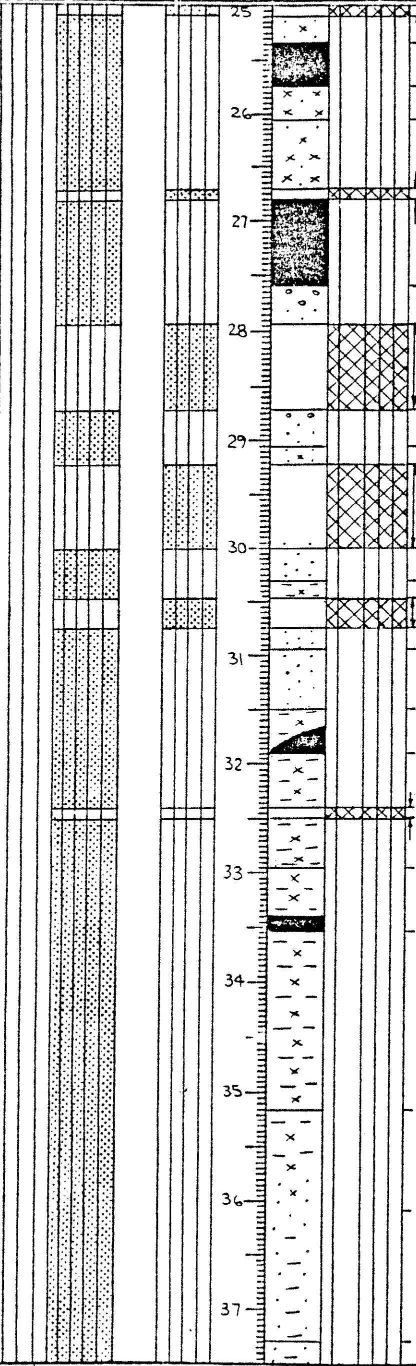
ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE
WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT

ROCK WEATHERING (SW MW HW) | RELATIVE STRENGTH (S MS MW W) | TEST RESULT | CORE LOSS/LIFT % (10 50) | DEPTH H.A.D (Core size, casing) | GRAPHIC LOG | SPACING OF NATURAL DEFECTS (cmm)

DEFECT DESCRIPTION
(JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.)
SOIL DESCRIPTION
(consistency, relative density, water content, plasticity, grading, group symbol etc.)

DATE/DEPTH | R.Q.D. | WATER LEVEL (Date) | DRILL WATER LOSS % (0—100) | WATER TEST RESULT



TAURANGA GROUP

V.wk, dk br-grey med SAND with some silt. Pumice sl-mod weath	CORE LOSS 0·20m	
V.wk, blk. f PEAT	Stiff	
V.wk, lt grey & dk br SANDY SILT	Compact	
V.wk, lt grey-wh SILTY f SAND to f SANDY SILT, lam	Compact	
	CORE LOSS 0·10m	
V.wk, blk. f PEAT with some partly decomposed wood	Stiff	
V.wk, lt grey-br f GRAVEL, fining down to crs SAND (pumice)	Loose	
	CORE LOSS 0·75m	
V.wk, lt grey f GRAVEL fining down to med SAND pumice	Loose	
V.wk, lt grey-br SILTY v.f. SAND	Loose (SM)	
	CORE LOSS 0·80m	8/5/85
V wk, dk br f SAND	Poorly graded (SP)	
V.wk, dk br-grey f & crs SANDS	Loose, f poorly graded sand crs well graded sand	
V.wk, dk br org SILTY CLAY	Firm (CL)	
	CORE LOSS 0·27m	
V wk, dk br f SAND	Loose, poorly graded (SP)	
V.wk, lt grey med SAND, pumice	Loose (SP)	
V.wk dk grey-br org SILTY CLAY & f PEAT	Firm	
V.wk, dk br grey SILTY CLAY with some f org. frags	V. stiff	
	CORE LOSS 0·10m	
V.wk, lt grey-pinkish br SILTY CLAY	Stiff - v. stiff	
V.wk, blk. org SILTY CLAY grading downwards into f PEAT	V. stiff	
V.wk, dk br to dk grn-grey SILTY CLAY with some decaying rootlets.	V. stiff (CL)	
V.wk, dk grn-grey SILTY CLAY with some f sand. Micaceous f sand concentrated thin laminae. Sand content incr downwards	V. stiff (CL)	
V.wk, dk grn. grey SANDY CLAY micaceous., lam in part, alt clayey f sand / silty clay	V. stiff	9/5/85
V.wk, dk grey CLAYEY f SAND Micaceous, massive	Loose	

DRILLER: DRILLWELL

STARTED: 7-5-85

FINISHED: 29-5-85

DRILL: RIG No 1

WEATHERING
UW — Unweathered
SW — Slightly weathered
MW — Moderately weathered
HW — Highly weathered
CW — Completely weathered

RELATIVE STRENGTH
VS — Very Strong
S — Strong
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▨

DEFECT LOG
(cmm)
Spacing of natural defects.
Defects/ m of core

EXPLANATION

PROJECT: Ohinewai
HOLE NO: 9842
LENGTH: 191.85m
CORE BOXES: 65

LOGGED: B.G.S.
DATE: 7-29/5/85
TRACED: R.B.K.
CHECKED: ....
ORIGINAL SCALE 1:50

SHEET 3 OF 16 DRG NO ....

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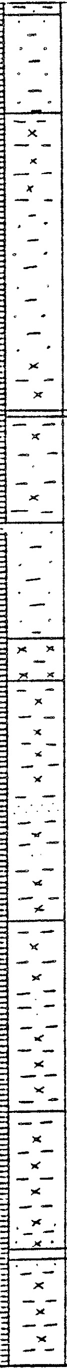
LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY
HOLE No. 9842
FEATURE .... LOCATION .... CO-ORDINATES 632 711·08 N 336 144·89 E
ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24m

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	DEPTH H.A.D. (m)	DEFECT DESCRIPTION / SOIL DESCRIPTION	DATE/DEPTH
V.wk, dk grn-grey to grey CLAYEY f SAND, micaceous	38	Compact	9/5/85
V wk, dk grey SILTY CLAY to CLAYEY f SAND decreasing sand content towards base	39, 40, 41	Stiff	
		CORE LOSS 0·05m	
v wk, dk grn-grey SILTY CLAY with some sand. Thinly lam, micaceous. Variable proportions of sand, silt & clay	42	V. stiff	
V wk, dk grey, v f SAND with some clay. Massive micaceous fining towards base	43	Compact	
gradational V.wk, dk grey CLAYEY crs SILT with some sand		Compact (ML)	
V.wk, dk grey SILTY CLAY with v rare sand in thin laminae	44, 45	V. stiff	
V.wk, dk grey SILTY CLAY with v rare sand (micaceous) homogenous	46, 47	V. stiff	9/5/85
V.wk, dk grey SILTY CLAY with rare laminae of disintergrated leaf, thinly lam.	48	V. stiff	
V.wk, f SAND		loose, poorly graded CORE LOSS 0·10m	
V.wk, dk grey - greyish br SILTY CLAY with v.rare rotten ?root frags	49, 50	V. stiff	

TAURANGA GROUP



DRILLER: DRILLWELL
STARTED: 7-5-85
FINISHED: 29-5-85
DRILL: RIG Nº 1

WEATHERING
UW — Unweathered
SW — Slightly weathered
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VS — Very Strong
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DEFECT LOG
Spacing of natural defects.
Defects/m of core

EXPLANATION

PROJECT: Ohinewai
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SHEET 4 OF 16 DRG NO ....

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LOG OF DRILL HOLE

PROJECT OHINEWAI OPENCAST FEASIBILITY STUDY

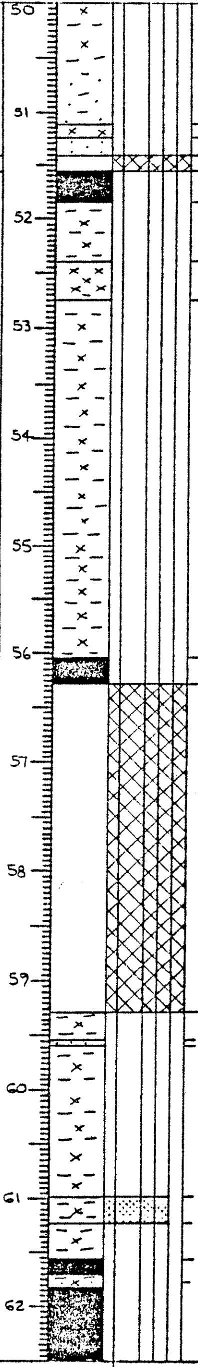
HOLE No. 9842

FEATURE .... LOCATION .... CO-ORDINATES 632 711.08N 336 144.89E

ANGLE FROM HORIZONTAL 90° DIRECTION .... R.L. COLLAR 8.24

DESCRIPTION OF CORE WEATHERING, RELATIVE STRENGTH, COLOUR, NAME, DEFECT TYPE, LITHOLOGICAL FEATURES (bedding, foliation, mineralogy, cement etc), STRATIGRAPHIC UNIT	ROCK WEATHERING SW MW HW	RELATIVE STRENGTH S MS MW W	TEST RESULT	CORE LOSS/LIFT % 5 10 50	DEPTH H.A.D. Core size casing m	GRAPHIC LOG	SPACING OF NATURAL DEFECTS (cms) 50 10 5 1	DEFECT DESCRIPTION (JOINTS, BEDDING, SEAMS, SHATTER, SHEAR AND CRUSH ZONES, FOLIATION, SCHISTOSITY — attitude, spacing, continuity, roughness, infilling, etc.) SOIL DESCRIPTION (consistency, relative density, water content, plasticity, grading, group symbol etc.)	DATE/DEPTH	R.Q.D.	WATER LEVEL Date	DRILL WATER LOSS % 0—100	WATER TEST RESULT
					50			v. stiff					
V. rare CLAYEY f SAND, laminae													
V. wk, dk br organic SILT					51								
V. wk, dk br f SAND								Loose, poorly graded. (SP)					
								CORE LOSS 0.15m					
V. wk, dk br f PEAT								Compact					
V. wk, dk orge br to lt grey SILTY CLAYS with some f organic material					52			V. stiff					
V. wk, dk br organic SILT with minor clay								Compact					
v. wk, dk grey SILTY CLAY					53			V. stiff					
					54								
greyish-br													
V wk, dk grey-br SILTY CLAY					55								
V. wk, dk br f PEAT with some rotten wood					56			V. stiff	9/5/85				
					57								
					58			CORE LOSS 3.0m					
					59								
V. wk, dk grey-br SILTY CLAY with some disintegrated leaf frags.								V. stiff					
								? cemented (sm)					
V. wk, lt br - lt grey SILTY CLAY with rare rotten f root material. 40mm silty sand layer at top. 50-80mm thk organic rich horizons					60								
V. wk, lt pinkish-brown SILTY CLAY					61			jts, random orient, slick, spacing ≤ 10mm, v.stiff					
V. wk, dk br silty clay								Stiff					
V. wk, blk. f PEAT & dk br organic SILTY CLAY, with a 120mm v. wk. yel-br SILTY SAND horizon								V. stiff					
					62			loose					

TAURANGA GROUP



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DEFECT LOG
(cms) 50 20 10 5 2 1
Spacing of natural defects.
Defects/m of core

EXPLANATION

PROJECT: Ohinewai

HOLE NO: 9842

LENGTH: 191.85m

CORE BOXES: 65

LOGGED: B.G.S.

DATE: 7-29/5/85

TRACED: R.B.K.

CHECKED: ....

ORIGINAL SCALE 1:50

SHEET 5 OF 16

DRG NO ....