Appendix 6

Geotechnical Report

GEOTECHNICAL INVESTIGATION REPORT

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

SECTION 1 SO 65970, DIP ROAD, KAMO, WHANGAREI

Project Reference: 19103
2 July 2021

CONTENTS

1 INTRODUCTION 1

2 SITE SETTING 1

2.1 DESKTOP REVIEW 1
2.2 HISTORICAL AERIAL IMAGERY 3
2.3 PUBLISHED GEOLOGY 3
2.4 SITE CHARACTERISTICS 4

3 GROUND CONDITIONS 6

3.1 SUBSURFACE INVESTIGATIONS 6
3.2 GROUND CONDITIONS 8
3.2.1 Topsoil 9
3.2.2 Alluvium 9
3.2.3 Residual soil 9
3.2.4 Weathered airfall deposits (lapilli tephra) 9
3.2.5 Basalt 10
3.3 LABORATORY TESTING 10
3.4 MATERIAL STRENGTH PARAMETERS AND DISCUSSION 11
3.5 SOIL MOISTURE PROFILE AND GROUNDWATER CONDITIONS 11
3.6 SEISMIC SUBSOIL CATEGORY AND HAZARD 12

4 NATURAL HAZARDS AND GROUND DEFORMATION POTENTIAL 13

4.1 GENERAL 13
4.2 SLOPE INSTABILITY 13
4.2.1 Scoria Cone Slope 13
4.2.2 Stream Bank Slope 14
4.2.3 Remainder of Site 15
4.3 COMPRESSIBLE GROUND AND CONSOLIDATION SETTLEMENT 15
4.4 COLLAPSIBLE SOIL BEHAVIOUR 15
4.5 GROUND SHRINKAGE AND SWELLING POTENTIAL 15
4.6 TREE ROOT DEFORMATION 16
4.7 CONCLUSIONS 16

5 ENGINEERING RECOMMENDATIONS 16

5.1 EARTHWORKS 16
5.1.1 General Design 17
5.1.2 Cuts 17
5.1.3 Earth fills 17
5.1.4 Retaining Walls 18
5.2 RESTRICTED BUILDING AREAS 19
5.3 FOUNDATION DESIGN 19
5.4 ROADING 20

6 OTHER CONSIDERATIONS 20

APPENDIX A: GEOTECHNICAL INVESTIGATION PLAN
APPENDIX C: GEOTECHNICAL INVESTIGATION DATA
APPENDIX D: LABORATORY TEST CARTIFICATES

1 INTRODUCTION

LDE Ltd was engaged by Onoke Heights Limited to undertake a geotechnical suitability assessment for a proposed residential development at Section 1 SO 65970, Dip Road, Kamo, Whangarei (Lot 1).

The proposed development is expected to comprise approximately 70 moderate to high intensity residential lots, generally ranging from 400m^2 to 700m^2. The subdivision will be serviced by a vested public road through the site, connecting Dip Road to Tuatara Drive, along with a series of .

The purpose of the investigation was to determine the nature of the ground beneath the site, assess the geotechnical hazards posed to the development, and to provide engineering recommendations for site development and future dwelling construction. The assessment of the site has been undertaken to satisfy the requirements of the Resource Management Act and Whangarei District Council Environmental Engineering Standards (WDC EES).

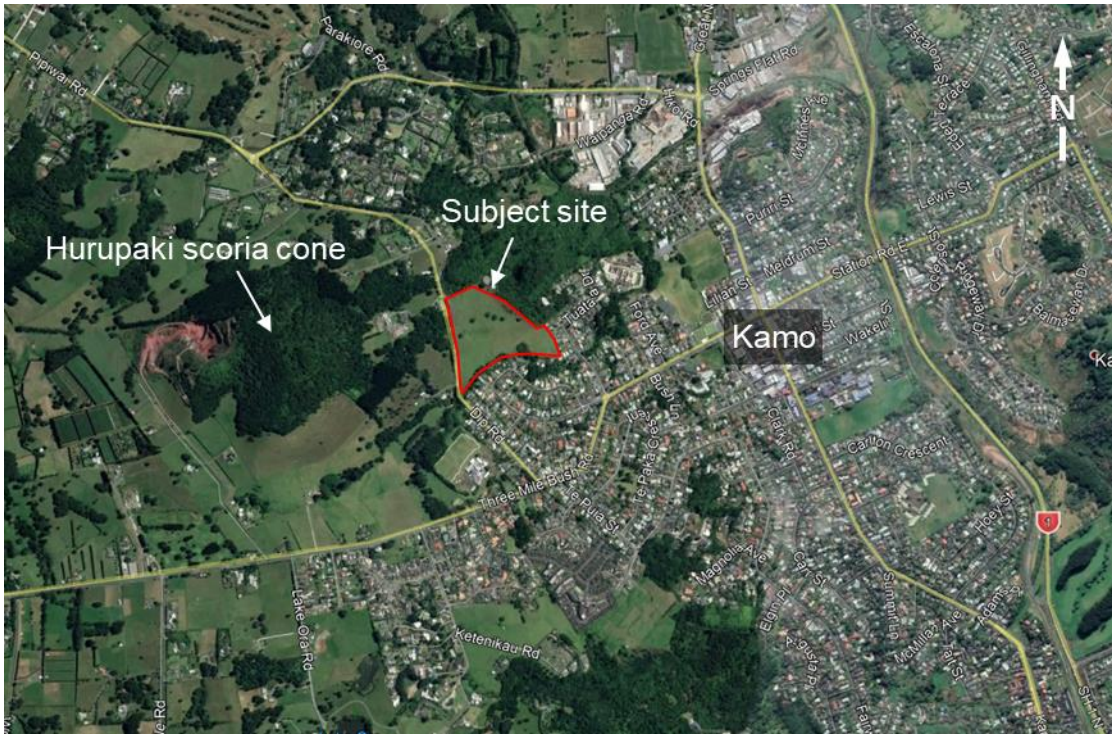

Figure 1: Location of the subject site (source: Google Earth).

2 SITE SETTING

2.1 Desktop Review

The site is legally described as Section 1 SO 65970, comprising an area of 6.87ha on the eastern side of Dip Road, approximately 5.5km northwest of Whangarei CBD. The site is

bordered by residential areas to the south and south-west, with bush to the immediate north and north east.

The site is positioned on the lower south-western slopes of an un-named hill and broadly comprises south and south-west facing slopes.

The site is entirely in pasture with some scattered native trees through the middle of the site. A small stream flows east-ward along the southern site boundary, with the banks covered in native bush.

The site is mapped entirely as low instability hazard on the Whangarei District Council Hazard Maps. The slopes to the northeast of the site are mapped as moderate instability hazard. The only high hazard area identified in the vicinity of the site is a large, narrow gully landform to the northeast of the site as shown on Figure 2.

The lower edge of the site is mapped as flooding prone, however this is confined to the banks of the stream so does not have any effect on the subject site.

No other hazards are mapped as affecting the subject site on either the WDC or NRC hazards maps.

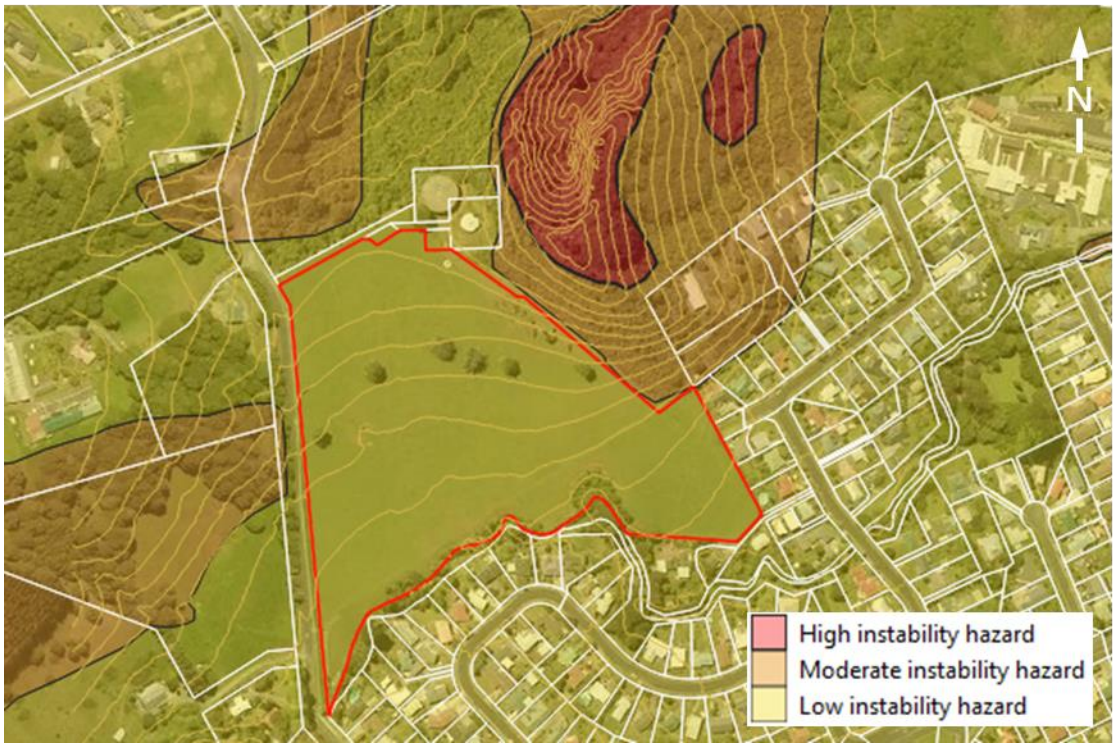

Figure 2: Stability hazard map of the subject site (data from WDC). Subject site outlined in red.

2.2 Historical Aerial Imagery

Historical aerial images of the site have been reviewed dating back to 1942. Images have been sourced from Retrolens and more recent satellite imagery has been sourced from Google Earth.

1942

The site shown to be in similar condition to existing. The bulk of the site is in pasture, with the steeper areas to the northeast being in low scrub.

Notably, a clear track is present leading into the gully feature (high instability hazard area indicated on Figure 2) directly from the railway line to the northeast. The gully itself is in scrub and the track appears overgrown. This appears to indicate that the gully is more likely a disused scoria quarry. Given the age at state of this feature by 1942, it is inferred that this was likely used in the early 1900s and was perhaps a borrow area for the construction of the North Auckland railway line.

1979

The site appears lightly overgrown by this time but no other significant changes are noted. By this time the reservoir has been constructed on the crest immediately north of the site.

Google Earth (2002 – Present)

The site was cleared prior to 2002 and appears to have remained in open pasture since this time.

In 2012 a large tree was cleared from the central-western area of the site, creating a small hollow in the slope that remains in the present topography.

No other changes are noted through the series of available images.

2.3 Published Geology

The 1:250,000 geological map of the region[1] shows the site as being underlain by Kerikeri Volcanic Group scoria across the northern edge of the site, with basalt lava flows to the south occupying the bulk of the site (Figure 3).

The geomorphology of the site is broadly consistent with the mapped geology, except that the boundary of the scoria cone is expected to align with the steepening slope, further east within the site.

[1] Edbrooke, S.W.; Brook, F.J. (compilers) 2009: Geology of the Whangarei area : scale 1:250 000. Lower Hutt: GNS Science. Institute of Geological & Nuclear Sciences 1:250,000 geological map 2. 68 p. + 1 folded map

It appears from the geological map and the wider geomorphology, that the scoria cone to the north-east of the site is a parasitic cone stemming from Hurupaki to the west of the site.

The NRC 'Managing Northland Soils' Map shows the site as being underlain by YO – Waiotu friable clay. The soils map does not recognise the scoria cone as mapped on the GNS geology map. The soils are described as well to moderately drained.

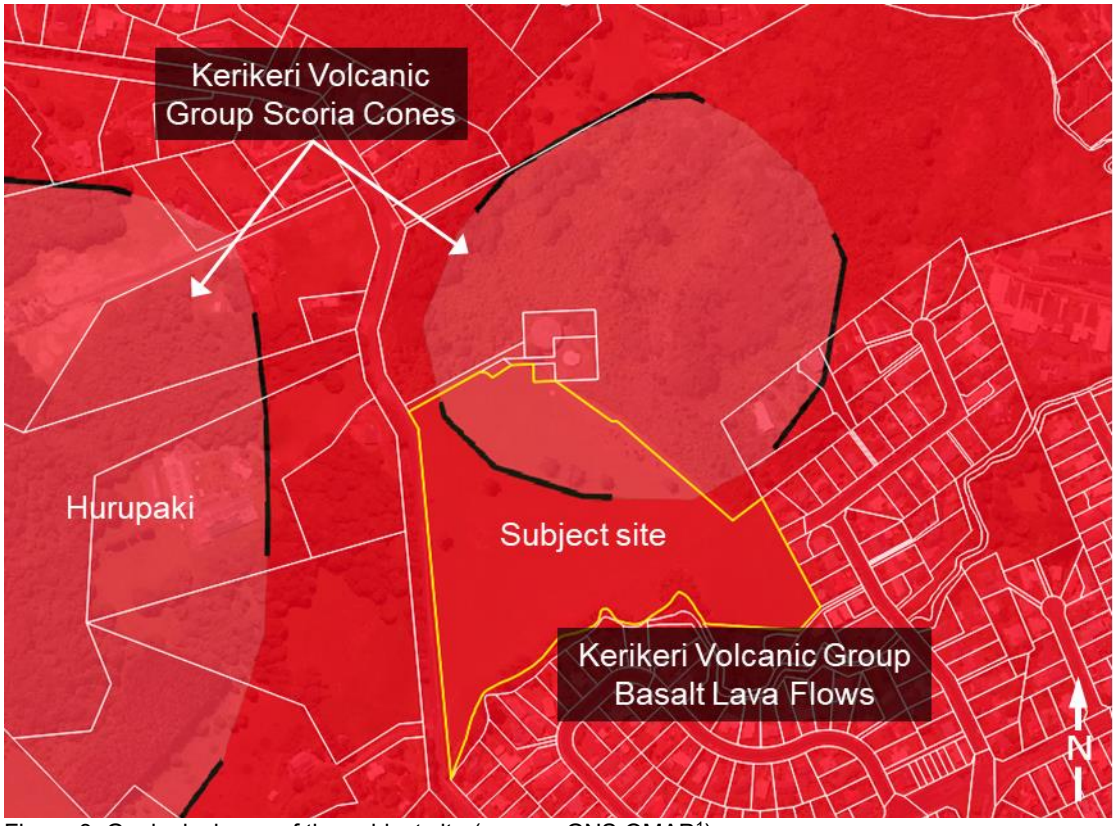

Figure 3: Geological map of the subject site (source: GNS QMAP[1]).

2.4 Site Characteristics

The topography of the site is shown on Figure 4 below, and the on the attached geotechnical investigation plan.

The northern half of the site broadly comprises a broad south facing slope of up to 1V:5H (11°). The slope is generally linear and converging towards the south. Towards the northern boundary the slopes flatten off.

The north-eastern edge of the site borders the mapped scoria cone, with the side slope of this feature forming a steep bank at the boundary, with slopes up to approximately 1V:2H (27°) (Figure 4). A rough track is cut along of the top of this slope, appearing to follow the alignment of the watermains which pass through the site.

The southern part of the site broadly comprises waning slopes which flatten towards the stream at the southern boundary of the site. The stream bank is generally a low, shallow slope. Towards the east the stream becomes more deeply incised, with an arcuate slope some 8m high at 1V:2H (27°) extending into the site at this point (Figure 5).

The stream bed appears to expose in situ basalt in places however this is more likely to be very large, displaced boulders.

Areas of erosion are noted within the steep slope at the edge of the scoria cone, and at the crest of the arcuate slope above the stream. This likely the result of livestock tracking and digging, rather than natural erosion.

Figure 4: Topographic plan of the subject site with notable site features identified. Contours shown at 1m interval with 5m major contours, falling from north to south through the site. See attached investigaiton for full scale plan.

Figure 5: Photo showing the steep slope at the north-eastern boundary.

Figure 6: View east over the crest of the arcuate stream bank slope, showing area of erosion or livestock tracking.

3 GROUND CONDITIONS

3.1 Subsurface Investigations

Our investigations of the site included the following work:

- 23 hand auger boreholes (HA01 to HA23) taken to a target depth of 3-5m or refusal, with measurements of undrained shear strength taken at 200mm increments using a shear vane.
- 13 Scala penetrometer tests carried out from the base of, or concurrent with select hand auger boreholes, to depths of up to 9.8m.

- 5 additional Scala penetrometer tests to 1.0m depth, carried out across the site for the purpose of characterising road subgrade conditions (RP01 to RP05).
- 7 Cone Penetration Tests (CPTu) tests to refusal, at depth of 7.7m to 18.0m below ground level (CPT01 to CPT07).
- 1 Flat Plate Dilatometer test to refusal and one Seismic DMT test (DMT01 and SDMT01/A).
- 1 rotary cored machine borehole to 14.8m depth (BH01).
- Laboratory triaxial testing of undisturbed push tube samples from BH01 and CPT01 targeted to zones of low strength ground.
- Allophane content testing on the same samples.

Initial shallow testing (hand augers and Scalas) was carried out in November 2019. Deep testing (CPTs, DMTs and MBH01) was undertaken in February 2021.

The investigations are summarised in Table 1 and 2 below.

Table 1: Summary of hand auger investigation. **Bold** indicates that refusal was met, all other boreholes and Scalas were taken to target depth.

Point ID	Hole depth (m)	Scala depth (m)	Depth to weathered airfall deposit (m)	Volcanic alluvium
HA01	5.00	-	1.20	-
HA02	5.00	-	1.50	-
HA03	5.00	6.80	1.10	-
HA04	3.00	**4.90**	1.70	-
HA05	3.00	4.85	1.10	-
HA06	3.00	5.80	1.70	-
HA07	3.20	-	2.50	-
HA08	**4.00**	9.80	1.50	-
HA09	5.00	-	1.80	-
HA10	3.00	-	-	-
HA11	5.00	-	3.30	-
HA12	3.00	4.85	1.50	-
HA13	5.00	-	1.90	-
HA14	3.00	**5.85**	1.40	-
HA15	3.00	**4.20**	-	✔
HA16	3.00	**3.90**	-	✔
HA17	**0.50**		-	✔

HA18	3.00	**3.15**	1.40	-
HA19	5.00	9.80	1.00	-
HA20	**3.70**	-	1.80	-
HA21	3.00	4.75	1.00	-
HA22	**3.00**	-	1.90	-
HA23	**2.50**	**3.25**	-	✔

Table 2: Summary of deep testing. All units are inferred from strength profiles at CPT and DMT tests.

Point ID	Depth (m)	Depth to weathered airfall deposit (m)	Depth to basalt (m)	Groundwater depth (m)
CPT-01	16.39	2.00	16.3	-
CPT-02	12.39	1.90	12.3	-
CPT-03	7.71	1.80	-	-
CPT-04	12.67	1.70	12.6	-
CPT-05	18.02	3.40	18	-
CPT-06	16.29	2.10	16.2	3.80
CPT-07	13.29	1.40	13.2	-
DMT-01	11.8	1.80		n/a
SDMT-01/A	11.8	1.60		n/a
MBH-01	14.8	2.25	10.6	dry

3.2 Ground Conditions

In summary, our investigation found the site to be predominantly underlain by volcanic soils associated with the Kerikeri Volcanic Group, with in situ **basalt** encountered or inferred from below 10-18m depth across the site.

The soils broadly comprised an upper unit of ash-derived **residual soil**, to 1.0 to 3.0m depth, and an underlying unit of **weathered airfall deposits** (lapilli tephra).

Volcanic clay and silt **alluvium** was encountered at several test sites around the southern edge of the site, adjacent to the stream.

These materials are described in more detail below.

3.2.1 Topsoil

Topsoil was encountered across the site, to depths of 0.1m to 0.2m, comprising generally dry to moist, slightly organic silt.

3.2.2 Alluvium

Alluvium was encountered across the lower edge of the site adjacent to the stream, within the gently sloping to flat areas (HA15 – HA17, HA23). This comprised generally very stiff to hard, low plasticity, moist, silt and clayey silt soils with variable sand and gravel. Undrained shear strengths were generally >150kPa and the soils were generally insensitive. Some low strengths (21kPa, 58kPa) were encountered near the surface at HA15, although these may be affected by gravels.

3.2.3 Residual soil

Ash-derived residual soil of the Kerikeri Volcanic Group was encountered below topsoil across most of the site, to depths ranging from 1.0m to 3.3m . This unit comprised variable low to high plasticity, very stiff to hard, homogenous clay and silt soils. Undrained shear strengths through this unit were generally >150kPa across most test sites, and the soils were typically insensitive to moderately sensitive.

CPT testing in this unit generally encountered consistent clayey silt and silty clay behaviour type with qc values of 2-4MPa (inferred undrained shear strength generally 150 to >200kPa).

3.2.4 Weathered airfall deposits (lapilli tephra)

Weathered airfall deposits were encountered below the residual ash soils, from between 1.0m and 3.3m depth.

This unit comprised predominantly low plasticity or non-plastic, moist to wet silt with variable sand, clay and gravel. Gravels consisted of generally very weak, fine to coarse basalt scoria and fine accretionary ash lapilli.

The soils notable had a greasy feel and showed and apparent moisture increase on disturbance, indicative of significant allophane content.

Vane shear strengths within this unit were highly variable but generally in the range of 50-100kPa, and typically showed moderate to very sensitive behaviour. This unit is marginally cohesive which may significantly influence the suitability of vane testing, particularly were outlying results were found.

Scala penetrometer testing in this unit generally indicated very loose soil, with test values typically around 0.5 blows per 50mm. Although some improvement with depth was noted in deeper Scalas this is likely to be influenced by skin friction and loss of efficiently with depth, rather than indicating increasing soil strength or density.

Scala refusal was met at some test sites, likely due to striking a larger, competent basalt boulder within the soil profile.

CPT testing through this unit showed highly variable cone resistance and sleeve friction. Lower-bound values through the soil profile generally indicated very low soil strength at most test sites (qc = 0.25 to 0.5MPa, inferred undrained shear strengths of 20-40kPa). DMT testing was generally consistent with CPT results, indicating similarly low shear strengths.

3.2.5 Basalt

Slightly weathered, moderately strong to strong basalt rock was encountered in MBH01 from 10.6m depth. This is expected to be intact lava flow of the Kerikeri Volcanic Group.

Basalt is inferred from below the depth of refusal at all CPT tests, possibly with the exception of CPT03 which refusals much shallower than the other tests, and may have struck a boulder within the tephra deposit.

One SPT test was carried out at the base of MBH01, refusing with no penetration (unable to seat), confirming high intact rock strong.

3.3 Laboratory Testing

Two consolidated undrained triaxial compression tests were carried out on from samples collected at 3.5m in CPT01 and 3.0m in BH01, to further characterise the strength of the weathered airfall deposit in areas where very low strength was indicated by in situ testing. Summary results are tabulated below.

Table 3: Summary of triaxial test results. Laboratory reports appended.

Test site	Sample depth (tested)	Total stress		Effective stress		Bulk density* (kN/m^3)	Dry density (kN/m^3)
		Phi (°)	C (kPa)	Phi' (°)	C' (kPa)		
BH01	3.0m (3.22-3.35)	10	22	30	11	1.38	0.67
CPT01	3.5m (3.67-3.84)	11	28	28	16	1.35	0.68

*Note bulk density is following saturation of the sample and not representative of natural condition.

The results show relatively high soil strength when compared to the very low in-situ testing results. Bulk and dry density are notably very low.

Allophane presence testing (non-quantitative) was carried out on both samples, and indicated allophane content of 5-7%.

3.4 Material Strength Parameters and Discussion

The following material strength parameters have been adopted as part of our assessment, based on the in situ and laboratory testing carried out, and our previous experience in similar materials.

The strength testing appears to show that conventional in-situ tests do not accurately predict the strength of the lapilli tephra soils (weathered airfall deposits). It is expected that this is the result of the very low soil density and open soil structure, which allows particles to redistribute before shearing under high point loads, consistent with the behaviour of collapsible soils. As a result, we expect that the CPT, DMT and DCP results significant under-predict the soil mass strength as it relates to slope stability and foundations. The triaxial tests are considered representative of lower bound in-situ effective strength parameters for this unit.

Table 4: Summary of adopted material strength parameters.

	Characteristic test values			Adopted parameters			
Unit	Shear vane (kPa)	DCP (bl/50mm)	CPT qc (MPa)	Unit weight (kN/m^3)	Su (kPa)	Eff. cohesion C' (kPa)	Eff. friction angle, Φ' (°)
Residual soil/ alluvium (very stiff to hard CLAY/SILT)	150	-	2-4	17.5	150	5	30
Weathered airfall deposits (sensitive SILT with sand and gravel)	50 - 100	0.25 - 0.5		13	50	10	30
Basalt	-	-	>50	26	-	-	-

3.5 Soil Moisture Profile and Groundwater Conditions

The soil profile across the site appears to be well draining with the near surface soils being generally dry to moist.

The allophonic soils encountered at depth across the site were found to wet up significantly on disturbance, but generally as a moist appearance when undisturbed. It is understood that this is the result of water being released from allophane as they break down.

Groundwater was encountered at CPT06 at 3.8m depth. All other CPTs were dipped at found to be dry. The machine borehole (MBH01) was dipped shortly after completion of drilling and was found to be dry, indicating both a low water table (>15m) and very rapid drainage through the basalt resulting in loss of drilling water.

Based on the observations of surface and groundwater, and the nature of the soils and rock beneath the site, it is expected that the groundwater table is near-flat lying through the site at approximately RL145 – RL150m. The water table is therefore expected to be relatively shallow across the lower edge of the site and at significant depth through the more elevated areas.

Given the free draining nature of the deeper soils and rock, the steady slope through the site, and the lack up upslope catchment, it is expected that the groundwater table is fairly steady through seasons and is unlikely to be significantly influence by extreme rainfall events. A shallow wetting front may develop during period of prolonged rainfall, however this is expected to be confined to the upper residual ash soils.

3.6 Seismic Subsoil Category and Hazard

The seismic subsoil category has been assessed in accordance with NZS1170.5 to support seismic hazard assessment and the design of future structures at the site.

Based on apparent strengths through the upper soil profile, as derived from *in situ* shear vane, Scala penetrometer, and CPT testing, the site would appear to be consistent with Class D or E, soft or very soft soil sites.

However, triaxial testing indicates relatively high strength through the same soils, and based on the inferred undrained shear strength derived from triaxial tests the site would be considered Class C, shallow soil site.

The shear wave velocity profile from SDMT01/A shows V_s values of 180 to 280m/s through the upper 10m of the soil profile. On the assumption that V_s values through the underlying basalt are high (i.e. >1500m/s), it can be inferred that the overall $V_{s\,30}$ value is likely to be greater than 360m/s, indicating site Class B. However, the depth and continuity of the basalt has not been proven, and not consideration of the underlying material has been given (likely to be Northland Allochthon mudstone).

On the balance of the site observations and inferred underlying geology at the site, a seismic subsoil category of Class C should be adopted for design purposes.

For IL2 structures (dwellings and habitable sheds) and for the design of residential retaining and earth structures, a peak ground acceleration of 0.13g for the 500-year return period ULS event, and 0.03 for the 25-year return period, SLS event should be adopted.

4 NATURAL HAZARDS AND GROUND DEFORMATION POTENTIAL

4.1 General

This section summarises our assessment of the natural hazards within the property as generally defined in Section 106 of the Resource Management Act (1991 and subsequent amendments) and Section 71 of the Building Act (2004), and the potential risk that these present to the proposed development in terms of vertical and lateral ground deformation.

4.2 Slope Instability

The site is entirely mapped as low instability hazard, while the steep scoria cone slopes above the north-east boundary are mapped as moderate instability (see Figure 2).

This is broadly consistent with our initial appraisal of the site, with the exception that

- The steep scoria cone slopes extend further downslope than the mapped moderate instability area. The steep slopes extending into the site through the north-eastern boundary should be considered moderate hazard in line with the slopes above.
- The steep arcuate slope area above the stream (at the location of HA19) appears to be of similar stability hazard to the scoria cone slopes, and should be considered as moderate hazard.

Qualitative assessment of the stability hazard through theses areas has been undertaken based on the findings of the subsurface investigation, laboratory testing, and geomorphic study. These areas are photographed in Figure 5 and 6 respectively, and are broadly delineated by the white dashed line on Figure 4.

4.2.1 Scoria Cone Slope

This slope appears to be underlain by a similar profile as that throughout the site, comprising a surficial, residually weathered fine ash deposit overlying sensitive silt soils (weathered lapilli tephra). The upper slope, above the site boundary, is expected to be underlain by more competent (higher strength) weathered scoria, overlain by similar weathered ash soils. The slope profile and engineering geological cross section are shown on the attached drawing in Appendix A.

The slope presents no evidence of recent or historical instability. The gully landform (expected to be a man-made feature through historical quarrying) to the north of the slope, comprises side

slopes at near-vertical angles, averaging 2V:1H (~65°), and show no evidence of historical failure. The ground conditions in this area are expected to be consistent with those extending into the subject site.

It can therefore be inferred that at the natural slope angle of up to 1V:1.5H, but limited to 1V:2H within the site, the factor of safety is significant higher than minimum requirements for residential development, at least with respect to deep seated failure. As a result we consider that the bulk earthworks likely to be associated with the development will have negligible effect on the deeper seated (or global) factor of safety.

Shallow seated instability is of greater concern, where minor cuts into the toe of the slope are carried out, particularly where these extend below ~1.5m depth and expose lower strength tephra soils.

It is recommended that any cuts into the toe of the scoria cone slope be support by engineered retaining structures.

4.2.2 Stream Bank Slope

This slope affects a relatively small areas of the site against the southern boundary. The slope itself is largely obscured in bush, below the fenceline, however the head of the slope is noted by an area of minor erosion and terracettes. The erosion in this area is likely the result of livestock damage.

The testing at the head of the area (HA19) showed a deep profile of tephra soils extending to below the base of the slope. Low strength is indicated by Scala testing to depth, however the soils are expected to be similar to those subject to triaxial testing, and are therefore expected to be relatively strong (and highly cohesive in particular).

The slope is steep (averaging 1V:2H, locally steeper), and appears to have been formed through stream bank erosion and the stream has incised its path below the site. As a result, it is inferred that the present slope angle is representative of its stable angle of repose (i.e. factor of safety just above 1). The establishment of bush over the slope may improve this slightly.

In any case, we consider the factor of safety in the area immediately above this area to be below the generally accepted criteria for building sites.

Without further specific assessment, we consider that a minimum building setback of 5m from slopes steeper than 1V:3H should be adopted within this area to mitigate the risk of under-slips at the edge of building sites. To avoid reducing the factor of safety of the slope, no fill should be placed within 3m of slopes steeper than 1V:3H.

4.2.3 Remainder of Site

The bulk of the site comprises gentle to moderate slopes which are considered stable. The stability is not expected to be significantly influenced by development earthworks or the loads imposed by residential buildings, provided these works are carried out in accordance with the recommendations given in Section 5 below.

4.3 Compressible Ground and Consolidation Settlement

With the exception of surficial topsoil, no compressible materials were encountered during the site investigation. The subsoils may be considered as incompressible under the expected loads of moderate earth fills and residential dwellings, subject to the recommendations given in Section 5 below.

4.4 Collapsible Soil Behaviour

The weathered airfall deposits (lapilli tephra) underlying most of the subject site, appears to display collapsible soil behaviour.

Triaxial testing appears to indicate high soil strength under confined loading conditions, however, where the soil is unconfined (such as in cut batters), or subject to very high point loads (such as highly loaded end bearing piles), much lower effective strength should be expected.

It is expected that this can be managed through careful earthworks and foundation design in accordance with the recommendations given in Section 5 below.

4.5 Ground Shrinkage and Swelling Potential

Plastic soils can be subject to shrinkage and swelling in response to seasonal changes in moisture content. The magnitude of shrinkage and swelling is a function of clay content and clay reactivity within the upper soil profile (generally within 1.5m of finished ground level).

The near surface soils (residual soil) were found to have variably low to high plasticity. The soils are derived from fine ash which is known to weather to form reactive smectite clays, and in our experience is consistent with moderately to highly expansive soils (i.e. Class M or H1 in terms of AS2870 (2011).

The underlying silt soils (weathered airfall deposits) appear to have low clay content and low plasticity. These should generally be considered as slightly expansive (Class S) unless specific testing shows that a lesser site class is appropriate.

The expansivity of these soils is somewhat mitigated by their favourable drainage properties. While the shallow soils can become extremely dry during periods of drought, extreme wetting is unlikely to occur, particularly post-development where infiltration of surface water is significantly limited by impervious areas.

Expansive soil characteristics can be exacerbated by earthworks, where the moisture content of both cut and filled ground is put out of equilibrium for a period of time until a stable state is reached.

Conventional shallow foundations should be designed for the appropriate site class depending on the finished ground level and underlying soils specific to each building platform. This should be confirmed as part of subdivision completion reporting and site specific assessment.

4.6 Tree Root Deformation

Several large trees are present across the upper part of the site. Their presence can have a significant effect on foundation perform, particularly with respect to expansive soils.

Their effect on expansive soils should be considered wherever foundations are laterally within 1.5x the mature tree height. This should be considered regardless of whether the tree remains or recently removed.

Root barriers (chemical or physical) should be considered wherever foundations are within the dripline of the tree.

Where trees are to be removed, care should be taken to ensure stumps are completely dug out and the resulting cavity is backfilled with well compacted (engineered) hardfill.

4.7 Conclusions

From our assessment of the natural hazard and ground deformation risks presented to the proposed development we consider that a building can be safely located on the site, provided that the recommendations given in Section 5 are adhered to.

5 ENGINEERING RECOMMENDATIONS

5.1 Earthworks

Earthworks for the development are expected to include large-scale cut to fill operation to form level building platforms, roads and stormwater ponds. The earthworks should be carried out in accordance with the recommendations below.

5.1.1 General Design

It is recommend that the finished ground level be designed to minimise deep cuts as far as possible (where deep is generally >3.0m), particularly for building areas, to avoid exposing potentially problematic allophanic and collapsible lapilli tephra. This can broadly be achieved by having building platforms near existing ground level and including a many small cut-fill platforms rather than forming larger platforms encompassing multiple lots.

It may be beneficial to import suitable clean fill to minimise earthworks volumes using site-won material. This will reduce risks associated with the issues outline below regarding the use of lapilli tephra as fill.

The earthworks design should be subject to geotechnical review prior to engineering approval.

5.1.2 Cuts

Unretained cuts up to 3.0m high are considered suitable within any gentle to moderately sloping areas through the subdivision Such cuts should be battered no steeper than 1V:2.5H, or otherwise retained.

On any slopes steeper than 1V:4H but not steeper than 1V:3H, unretained cuts should be limited to 1.5m in height.

Any cuts into slopes steeper than 1V:3H (being confined to the steep area along the north-eastern boundary), all cuts should be supported by engineered retaining structures, or otherwise subject to specific assessment.

Deeper cuts into the underlying tephra may become problematic. These soils are expected to stand relatively steeply un-retained, but without confinement may not support surcharge loading (i.e. for building or filling above cut slopes), and stability may become a concern. For deeper cuts into tephra (i.e. >3-4m depth), over-cutting and then capping with cohesive fill may be required to provide confinement to these soils.

5.1.3 Earth fills

The upper ~1.0 - 3.0m of the soil profile, comprising weathered ash, is expected to be generally suitable as earth fill.

The underlying tephra soils, which are expected to have high allophane content, are less suitable. Upon reworking, these soils are expected to decrease significant in strength, become

excessively wet or saturated, and lose significant volume where high compaction forces are used.

With a specifically developed methodology supported by laboratory testing and field trials, bulk filling using the allophonic soils may be possible. It is expected that this will require spreading, discing and drying for an extended period before carefully compacting to achieve the required specification for engineered fill.

Treatment of these soils using additives (e.g. lime and cement) may be feasible depending on allophane content. However, research has shown treatment with relatively low lime addition has only a temporary effect on soil properties, and significant lime addition is required to achieve lasting improvement. Discussion of this is included in a Hiway Stabilizers research paper[2]. The allophane content appears to be high enough that it will influence treatment properties and will likely require uneconomic quantities of additives to achieve lasting results.

Alternatively, imported clean fill such as quarry strippings may be used in stead of site won material. This will reduce earthworks volumes with potentially problematic materials and reduce the overall project risk that these present.

All earth fills should be placed in accordance with NZS4431 (1989). Compaction control should generally be in terms of air voids, dry density and vane strength, but should be confirmed based on the specific materials used and laboratory standard compaction testing.

It is expected that fills can be placed up to 4m thick without specific assessment, based on the strength profile of the underlying soils. Unretained fill batters should be formed at no steeper than 1V:2.5H unless otherwise approved.

If the lapilli tephra material is used as fill, it should generally not be used to form the faces of fill batters unless otherwise approved as it will require capping layers. Clean cohesive fill (imported or residual soils) should be used for this purpose.

5.1.4 Retaining Walls

Any retaining walls constructed as part of the subdivision works should be subject to specific engineering design.

Conventional cantilevered timber pole and gravity retaining systems are considered suitable for the site. The near surface soils were generally free from any large rocks which may obstruct the drilling of pile holes.

[2] http://hiways.co.nz/assets/Uploads/allophanes-conference-paper.pdf

Retaining walls should be designed for the specific ground conditions at their locations. The material strength parameters given in Section 3.4 are considered appropriate for design.

For walls founded in cut ground on lapilli tephra soils:

- Any cantilevered pole retaining walls should allow for no lateral support for the first 1m of embedment to avoid over-loading the shallow, unconfined soil.
- Shallow bearing gravity or concrete cantilevered walls should be founded a minimum of 1.0m below cleared ground level with no reliance on the first 1.0m of embedment. Walls should be designed for a geotechnical ultimate bearing capacity of 150kPa, to limit loads on shallow unconfined tephra soils. These walls may otherwise be set within a capping layer of clean cohesive clay fill.

5.2 Restricted Building Areas

The following building restrictions are provided to ensure the development of individual lots take due account for potential slope instability and ground conditions at likely foundation depths.

- Buildings should be set back a minimum of 5m from stream bank slopes steeper than 1V:3H (18°) along the southern edge of the site, without specific geotechnical assessment and foundation design.
- Any buildings on slope steeper than 1V:4H (generally along the north-eastern boundary of the site, should be subject to specific geotechnical assessment and foundation design.

These restrictions should be reviewed and confirmed at the time of subdivision completion, to take into account any earthworks or retaining constructed as part of the development.

5.3 Foundation Design

The shallow ash soils to 2m depth are of high strength and appear favourable for standard building foundations (i.e. shallow timber piles, strip footings, raft slabs).

Where building sites are cut down onto tephra soils, foundation options will need to be considered carefully. High point loadings have the potential to cause soil collapse. As a result, we expect that foundation bearing pressures will need to be limited, particularly at shallow depth where the soil is less confined.

For preliminary design shallow bearing raft-slab or shallow pile foundations should be designed for a geotechnical ultimate bearing capacity of 150kPa. Shallow gravel rafts may be adopted to spread loads to achieve this reduced bearing pressure using conventional slab designs.

For deeper pile foundations embedded into tephra soils, piles may be designed for drained soil conditions in accordance with the NZ Building Code (B1/VM4), using the effective stress soil parameters give in Section 3.4.

Conventional raft slab type foundations are expected to be suitable, and for lightly clad single level structures on-grade construction is expected to be suitable. Where a greater bearing capacity is required (i.e. for multistorey or heavy cladding/roofing materials), undercutting and backfilling with gravel hardfill may be required to distribute foundation loads more evenly.

5.4 Roading

The ash soils at existing ground level (below topsoil) appear generally favourable to support pavements, based on the result of shallow Scalas across the site (RP1-RP5). Being of high strength and well-drained, it is expected that conventional minimum pavement depths in accordance with the WDC EES will be acceptable. Likewise engineering fills of the same material are expected to be favourable.

The underlying tephra soils show very low results under Scala testing, which is conventionally used for determination of subgrade CBR and pavement design. This is thought to be due to the collapsing nature of the soils under this type of testing.

Small strain deflection testing (i.e. light weight/falling weight deflectometer, plate load testing, benkleman beam testing) on cut in-situ tephra soils is expected to yield a more reasonable result. These soils may still fall outside the limits for minimum pavements thickness (i.e. less than 7% CBR). Thickened reinforced pavements or subgrade stabilisation may be required.

It is recommended that where earthfill is required to from pavement subgrades, use of the tephra soils is avoided entirely unless a specific methodology and subgrade testing is carried out to confirm suitability. Residual soil or imported fill should be used for the purpose.

6 OTHER CONSIDERATIONS

This report has been prepared exclusively for Onoke Heights Limited with respect to the particular brief given to us. Information, opinions and recommendations contained in it cannot be used for any other purpose or by any other entity without our review and written consent. LDE Ltd accepts no liability or responsibility whatsoever for or in respect of any use or reliance upon this report by any third party.

This report was prepared in general accordance with current standards, codes and practice at the time of this report. These may be subject to change.

Opinions given in this report are based on visual methods, and subsurface investigations at discrete locations. It must be appreciated that the nature and continuity of the subsurface materials between these locations are inferred and that actual conditions could vary from that described herein. We should be contacted immediately if the conditions are found to differ from that described in this report.

This report should be read in its entirety to understand the context of the opinions and recommendations given.

For and on behalf of LDE Ltd

Report prepared by:

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Report reviewed by:

Aaron Holland
CPEng, CMEngNZ
Chartered Professional Engineer
(Geotechnical, civil and structural)

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L:\19100 to 19199\19103 67 Dip Road, Three Mile Bush\05 Reporting\19103 GIR Onoke Heights, Dip Road, Kamo.docx

APPENDIX A

GEOTECHNICAL INVESTIGATION PLAN AND CROSS SECTION

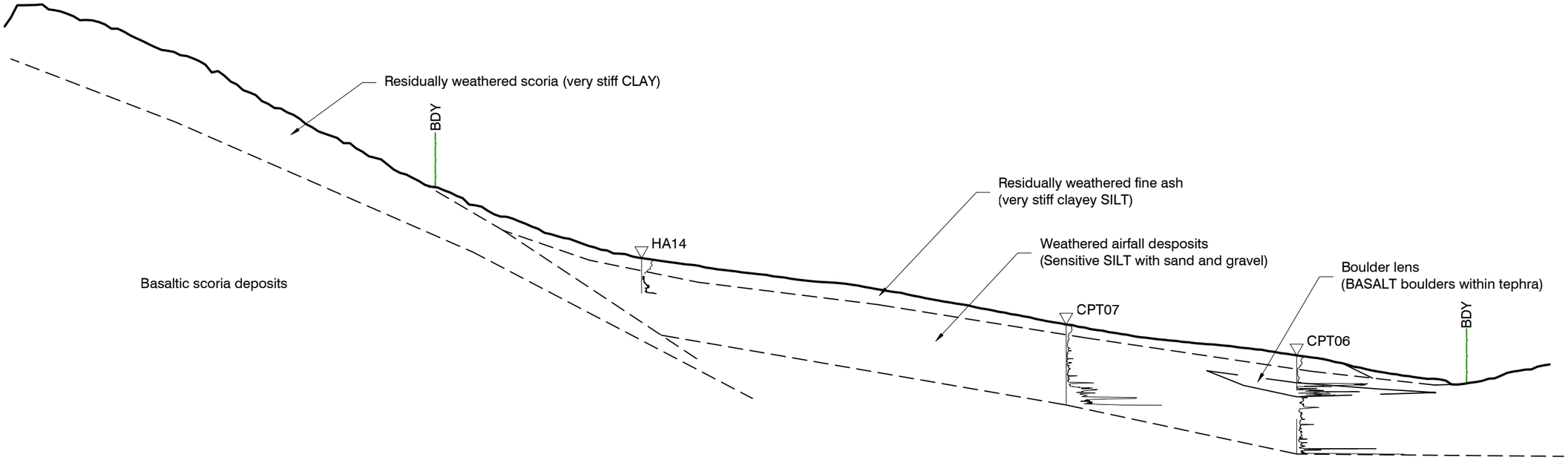
Notes:
1/ Base aerial and boundaries sourced from LINZ (cc-by 4.0)
2/ Investigaiton locations shown approximately only, located by hand held GPS.
3/ Contours derived from NRC LiDAR DEM (2018 survey).

LAND DEVELOPMENT & ENGINEERING LTD.

Geotechnical Investigation Plan

Section 1 SO 65970, Dip Road, Kamo

Project Number:	19103
Date:	25/06/2021
Drawn by:	FWH
Scale A3:	1 : 1500



Notes:
1/ Topographic section derived from NRC LiDAR DEM (2018).
2/ Investigation points show approximately, projected up to ~12m.
3/ Investigaiton data plotted for information only, see attached logs for detail profiles.
4/ All material boundaries are approximate. The wider geological boundaries and are inferred only, based on geomorphic and desktop study of the site.

0 7.5 15 22.5 30 37.5

Scale 1:750 (m)

Original Size = A3

CLIENT: Onoke Heights Ltd

PROJECT: Onoke Heights Subdivision
Section 1 SO 65970, Dip Road, Kamo
Whangarei

DRAWING TITLE: Engineering Geological Cross Section

No.	REVISION	BY	DATE
0		--	dd.mm.yy

DESIGN:	--
DRAWN:	FWH
DATE:	25.06.21
CHECKED:	--
SCALE A3:	750

PROJECT STATUS: INFORMATION

PROJECT: 19103

SHEET: 1 of 1

DRAWING No: G01

REV: 0

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APPENDIX B

GEOTECHNICAL INVESTIGATION DATA

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA01**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050591mN, 1716613mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	179.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology
0.0	Organic SILT; brown. Dry.	Topsoil
	Clayey SILT. Very stiff; low plasticity; dry to moist.	Kerikeri Volcanic Group - Residual soil
0.5	CLAY; brownish orange. Very stiff; high plasticity; moist.	
1.0		
1.5	Clayey SILT, with some gravel, with minor sand. Stiff to very stiff; low plasticity; moist; gravel, fine to medium, very weak scoria/basalt lapilli.	Kerikeri Volcanic Group - Weathered airfall deposit
2.0	2.0m - 2.4m: Clayey SILT; brownish orange. Very stiff; moist.	
2.5		
3.0	3.0m: wet to saturated, black and orange mottling	
3.5	3.5m - 3.6m: Clayey SILT; brownish orange. Very stiff; high plasticity; moist.	
	3.8m: wet to saturated	
4.0		
4.5	4.5m: moist to wet	
5.0		
5.5		

Water: Groundwater Not Encountered

In-situ Testing

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

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

Test Values	RL (m)
130 / 33	179.0
157 / 33	178.5
91 / 19	178.0
141 / 78	177.5
63 / 28	177.0
63 / 31	176.5
100 / 34	
85 / 38	176.0
88 / 44	175.5
176 / 44	
130 / 36	175.0
138 / 63	174.5
	174.0

Hole Depth: 5.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA02**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050532mN, 1716588mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	175m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Test Values	RL (m)
0.0	Organic SILT; dark brown. Moist.	Topsoil		175.0
	SILT; brownish orange. Very stiff; non-plastic; dry to moist.	Kerikeri Volcanic Group - Residual soil		
0.5	CLAY, with minor silt; brownish orange. Very stiff; low plasticity; moist.		141 / 44	174.5
1.0			146 / 41	174.0
1.5	Clayey SILT, with some sand and gravel; dark brownish grey. Very stiff; moist to wet; gravel, fine to medium, very weak basalt/scoria lapilli.	Kerikeri Volcanic Group - Weathered airfall deposit	122 / 31	173.5
2.0	2.1m: wet		116 / 16	173.0
	2.3m: increasing clay, moist			
2.5	2.5m - 2.7m: highly plastic, clay dominated zone		138 / 38	172.5
	2.7m: becomes gravel/scoria dominated, shear vanes may not be valid			
3.0			85 / 41	172.0
			47 / 36	
3.5				171.5
4.0			28	171.0
4.5				170.5
5.0			50	170.0
5.5				169.5

Water: Groundwater Not Encountered

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

Hole Depth: 5.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

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Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA03**				
Project ID:	19103				
Sheet:	1 of 2				
Client:	Onoke Heights Limited	**Coordinates:**	6050549mN, 1716651mE	**Test Date:**	26/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	173.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249

Depth (m)	Material Description	Geology
0.0	Silty CLAY, with some rootlets; brownish orange. Hard; high plasticity; dry to moist; friable.	Kerikeri Volcanic Group - Residual soil
0.3	0.3m: highly plastic, moist	
1.0	Clayey SILT, with trace sand and gravel; brown, some black mno speckling. Very stiff; low plasticity; moist; gravel, fine, extremely weak basalt/scoria lapilli; friable, sensitive.	Kerikeri Volcanic Group - Weathered airfall deposits
1.4	1.4m: increasing moisture, moist to wet	
1.6	1.6m - 1.8m: brownish orange	
2.0	Sandy gravelly SILT. Non-plastic; wet to saturated; gravel, fine, extremely weak basalt/scoria lapilli; firm to stiff/very loose (marginally cohesive), friable, sensitive, allophanic - greasy. .	
3.2	3.2m: auger grinds, larger weak basalt cobble/coarse gravel	
4.0	4.0m: saturated, no inflow	
5.0		

Water: Groundwater Not Encountered

In-situ Testing

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

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

Test Values	RL (m)
205+ / 73	173.5
205+ / 88	
205+ / 146	
203 / 134	
177 / 72	172.5
136 / 18	
121 / 32	172.0
164 / 70	
92 / 15	
101 / 26	171.5
61 / 26	
58 / 15	
73 / 44	171.0
99 / 18	
99 / 41	170.5
120 / 15	
101 / 31	170.0
101 / 38	169.5
99 / 41	
91 / 35	169.0
	168.5
	168.0

Hole Depth: 5.00m **Termination:** Reached target depth

Remarks:

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

UTP = Unable to Penetrate

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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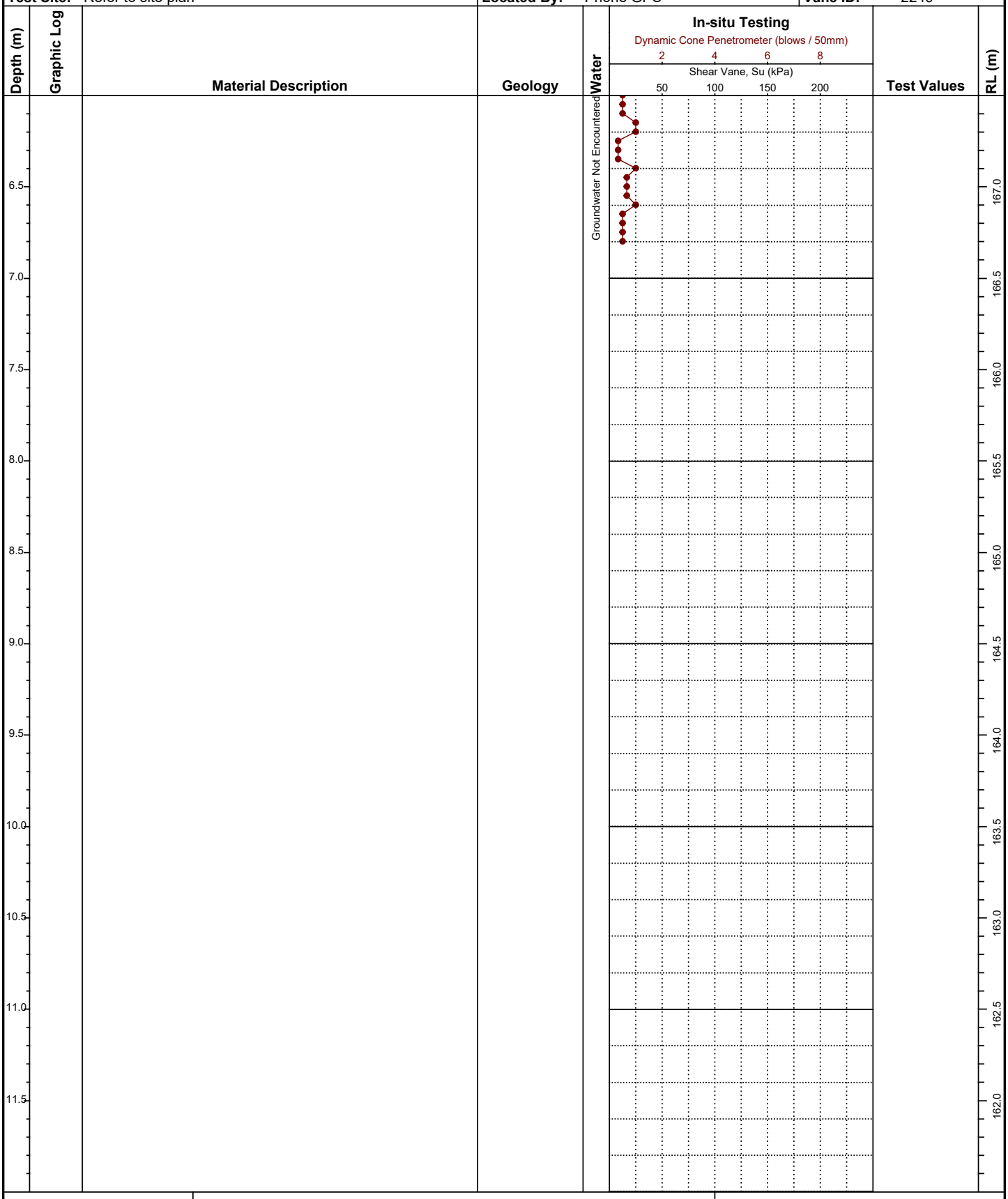
Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA03**
Project ID:	19103
Sheet:	2 of 2

Client:	Onoke Heights Limited	**Coordinates:**	6050549mN, 1716651mE	**Test Date:**	26/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	173.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249



Hole Depth: 5.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA04**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050579mN, 1716683mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	177.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249

Depth (m)	Material Description	Geology	Water	In-situ Testing	Test Values	RL (m)
0.0	Organic SILT; dark brown. Dry; rootlets, friable.	Topsoil	Groundwater Not Encountered	UTP		177.5
	CLAY, with some silt; reddish brown; homogeneous. Hard; high plasticity; moist.	Kerikeri Volcanic Group - Residual soil		205+		
0.5	Clayey SILT; brownish orange; homogeneous. Very stiff to hard; high plasticity; moist; friable.					177.0
	0.8m - 1.2m: some clay, orange			196 / 91		
1.0						176.5
	1.2m - 1.7m: minor clay, brown, very friable			205+ / 96		
1.5				161 / 35		176.0
	Sandy SILT, with some gravel, with minor clay; dark brownish grey, some black and orange mottling. Very loose to loose; non-plastic; wet; sand, coarse; gravel, fine, clasts of extremely weak scoria/basalt lapilli; allophanic - greasy .	Kerikeri Volcanic Group - Weathered Airfall Deposit		88 / 15		
2.0				107 / 15		175.5
	2.2m - 2.3m: SILT; brown. Stiff; non-plastic; wet; homogenous.			63 / 22		
2.5				66 / 23		175.0
				88 / 29		
3.0				79 / 22		174.5
				72 / 26		
3.5						174.0
4.0						173.5
4.5						173.0
5.0				13		172.5
5.5						172.0

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

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

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

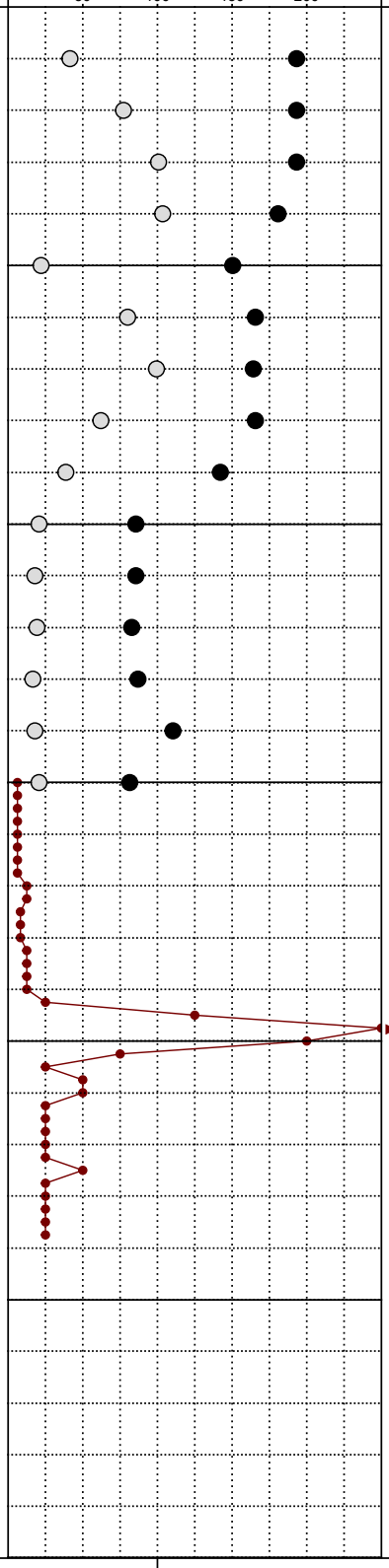
Method: 50mm hand auger, DCP

Test ID:	**HA05**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050504mN, 1716594mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	170m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology
0.0	TS SILT, with some rootlets/organics and sand; light brown. Dry; sand, fine.	Topsoil
	SILT, with some clay; brownish orange. Very stiff to hard; low plasticity; moist.	Kerikeri Volcanic Group - Residual soil
0.5	0.7m: trace of clay	
1.0	SILT, with trace sand; brown. Low plasticity; moist; sand, fine.	Kerikeri Volcanic Group - Weathered airfall deposit
	1.3m - 1.7m: trace of clay, light brownish orange	
1.5	1.7m - 1.9m: no clay, some fine sand, brown	
2.0	Sandy SILT, with some gravel; dark brownish grey. Stiff to very stiff; moist to wet; gravel, fine to medium, very weak bassalt/scoria lapilli; sensitive.	
2.5		
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		

Water: Groundwater Not Encountered



Test Values
193 / 41
193 / 77
193 / 101
181 / 104
150 / 22
166 / 80
164 / 99
166 / 62
142 / 39
86 / 21
86 / 18
83 / 19
87 / 17
110 / 18
81 / 21

RL (m): 169.5, 169.0, 168.5, 168.0, 167.5, 167.0, 166.5, 166.0, 165.5, 165.0, 164.5

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

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Hand Auger Borehole Log

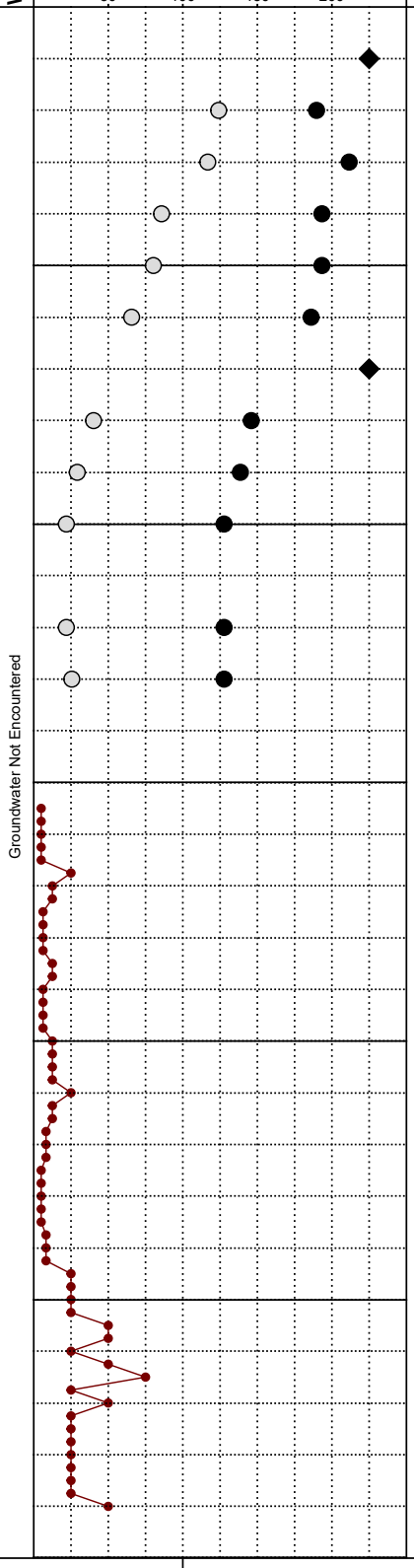
Method: 50mm hand auger, DCP

Test ID:	**HA06**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050503mN, 1716669mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CP
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	164.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	1945

Depth (m)	Material Description	Geology
0.0	Organic clayey SILT; brown. Dry; friable, rootlets.	Topsoil
0.5	Silty CLAY, with trace gravel; reddish brown. Very stiff; high plasticity; moist; gravel, fine. 0.5m: increase silt	Kerikeri Volcanic Group - Residual soil
1.0	Clayey SILT, with trace gravel; reddish brown. Very stiff; high plasticity; moist; gravel, fine, very weak basalt/scoria lapilli. 1.0m - 1.7m: reddish orange, less plastic (low plasticity)	
2.0	Clayey SILT, with trace gravel; brown. Very stiff; high plasticity; wet; gravel, fine, very weak basalt/scoria lapilli; sensitive.	Kerikeri Volcanic Group - Weathered airfall deposit
2.3	Sandy SILT, with trace gravel. Stiff to very stiff; non-plastic; saturated; gravel, fine, very weak basalt/scoria lapilli; sensitive. 2.3m: gravel becomes fine to medium (max. 20mm), saturated	
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		

Water: Groundwater Not Encountered



Test Values
UTP
190 / 124
212 / 117
193 / 86
193 / 80
186 / 66
UTP
146 / 40
139 / 29
128 / 22
128 / 22
128 / 26

RL (m): 164.0, 163.5, 163.0, 162.5, 162.0, 161.5, 161.0, 160.5, 160.0, 159.5, 159.0

Hole Depth: 3.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA07**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050521mN, 1716696mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	167.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic SILT; dark brown. Dry to moist.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200		167.5
	Silty CLAY; brownish orange. Very stiff; high plasticity; moist. 0.3m: decreasing silt (some)	Kerikeri Volcanic Group - Residual soil				172 / 81	
1.0	1.0m: silty, trace of fine gravel (completely weathered scoria), low plasticity					177 / 83	166.5
1.5	1.4m: trace of silt, high plasticity					146 / 72	166.0
2.0	2.1m: minor black/brown mottling					157 / 38	165.5
2.5	SILT, with some sand and gravel; brown. Stiff; moist to wet; gravel, fine to medium, very weak scoria/basalt lapilli. 2.8m: minor black mottling, moist	Kerikeri Volcanic Group - Weathered airfall deposits				71 / 28 160 / 42	165.0
3.0	3.0m: moist to wet					130 / 38 138 / 56	164.5
3.5							164.0
4.0							163.5
4.5							163.0
5.0							162.5
5.5							162.0

Hole Depth: 3.20m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA08**
Project ID:	19103
Sheet:	1 of 2

Client:	Onoke Heights Limited	**Coordinates:**	6050553mN, 1716724mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	173.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249

Depth (m)	Material Description	Geology
0.0	Organic SILT; dark brownish orange. Very stiff to hard; dry to moist.	Topsoil
	CLAY, with some silt; brownish orange; homogeneous. Hard; high plasticity; moist; slightly friable.	Kerikeri Volcanic Group - Residual soil
1.0	Clayey SILT; orange. Very stiff to hard; low plasticity; moist.	
1.5	Sandy SILT, with some gravel, with minor clay; dark brownish grey, some black and orange mottling. Very loose to loose/firm to stiff; non-plastic; wet; sand, coarse; gravel, fine, clasts of extremely weak scoria and basalt lapilli; allophanic - greasy.	Kerikeri Volcanic Group - Weathered airfall deposits
2.0	1.9m - 2.1m: SILT; brown. Stiff; non-plastic; wet; homogenous.	
	2.2m: becoming saturated, no inflow	
4.0		

Water: Groundwater Not Encountered

In-situ Testing

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

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

Test Values	RL (m)
205+ / 117	173.0
205+ / 143	172.5
164 / 102	172.0
117 / 18	
113 / 20	
137 / 53	171.5
83 / 29	
51 / 20	171.0
58 / 26	
56 / 26	170.5
66 / 32	170.0
66 / 25	
▶10 ▶20 ▶12	169.5
	169.0
	168.5
	168.0

Hole Depth: 4.00m

Termination: impenetrable material (gravel)

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

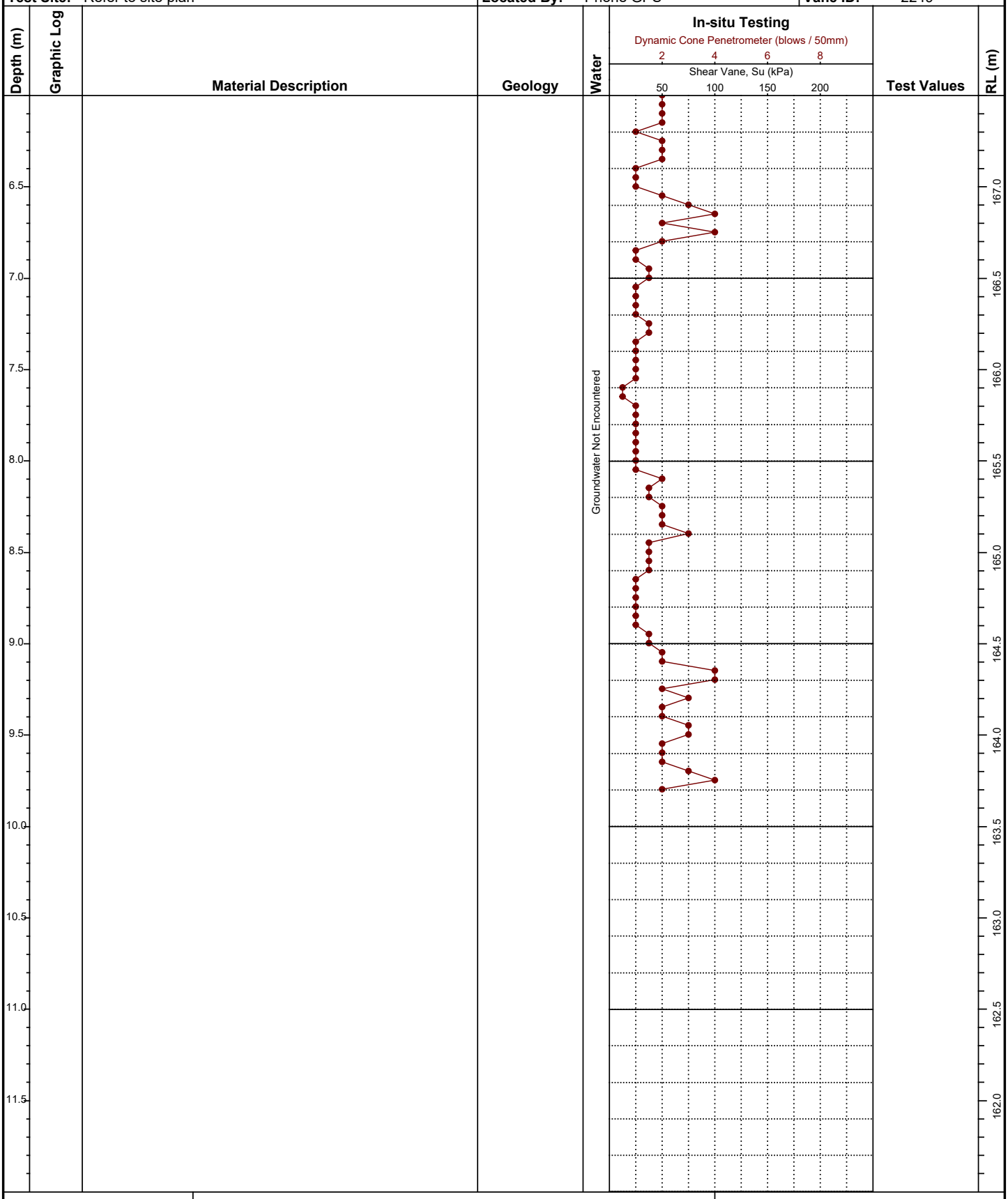
UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA08**
Project ID:	19103
Sheet:	2 of 2

Client:	Onoke Heights Limited	**Coordinates:**	6050553mN, 1716724mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	173.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249



Hole Depth: 4.00m **Termination:** impenetrable material (gravel)

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA09**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050459mN, 1716600mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	164m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic clayey SILT; dark brown. Dry to moist.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200		164.0
	Clayey SILT; brownish orange. Very stiff; low plasticity; moist.	Kerikeri Volcanic Group - Residual soil					
0.5	CLAY, with some silt; brownish orange. Very stiff; high plasticity; moist.					172 / 91	163.5
1.0	1.1m: becomes silty, low plasticity					157 / 102	163.0
1.5						219+ / 110	162.5
2.0	SILT, with minor sand and gravel; brown. Stiff; non-plastic; moist to wet; gravel, very weak scoria/basalt lapilli.	Kerikeri Volcanic Group - Weathered airfall deposits				74 / 25	162.0
						56 / 31	
2.5						60 / 31	161.5
3.0	3.2m: wet to saturated, increasing scoria lapilli					58 / 36	161.0
3.5						85 / 34	160.5
						81 / 34	
4.0						78 / 31	160.0
						85 / 49	
4.5						81 / 44	159.5
5.0						85 / 47	159.0
5.5							158.5

Hole Depth: 5.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA10**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050421mN, 1716609mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	158.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8 / Shear Vane, Su (kPa) 50 100 150 200	Test Values	RL (m)
0.0	Organic SILT; dark brown. Non-plastic; dry; rootlets.	Topsoil	Groundwater Not Encountered			158.5
0.5	Silty CLAY. Very stiff; low plasticity; moist.	Kerikeri Volcanic Group - Residual soil			169 / 47	158.0
0.8	0.8m: some silt, highly plastic					
1.0					201 / 88	157.5
1.5					219+ / 75	157.0
2.0					219+ / 60	156.5
2.5					194 / 55	156.0
3.0					219+ / 74	155.5
3.5						155.0
4.0						154.5
4.5						154.0
5.0						153.5
5.5						153.0

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger

Test ID:	**HA11**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050439mN, 1716656mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	157.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	SILT, with some rootlets; light brown. Dry.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200	150+ / 46	157.5
	Clayey SILT; brownish orange. Hard; low plasticity; dry to moist.	Kerikeri Volcanic Group - Residual soil				193+ / 120	
0.5	0.5m: minor gravel, fine black weak basalt/scoria lapilli, moist					193+ / 117	157.0
						193+ / 98	
1.0						193+ / 97	156.5
						193+ / 135	
1.5						193+ / 178	156.0
						193+ / 92	
2.0						193+ / 128	155.5
						193+ / 119	
2.5						193+ / 163	155.0
						193+ / 166	
3.0						193+ / 98	154.5
						193+ / 104	
3.5	Clayey SILT, with trace gravel; brown. Stiff; high plasticity; moist; gravel, fine, weak basalt/scoria lapilli; sensitive. 3.5m: moist to wet	Kerikeri Volcanic Group - Weathered airfall deposit				193+ / 102	154.0
	3.8m: wet					150 / 66	
4.0	4.0m: some sand					72 / 30	153.5
	4.2m: no sand, moist					66 / 22	
4.5	Sandy gravelly SILT. Stiff and loose; non-plastic; moist; sand, fine to coarse, gravel, fine to medium, weak basalt/scoria lapilli. 4.9m - 5.0m: becoming silty, brownish orange					62 / 21	153.0
						104 / 18	
5.0						110 / 54	152.5
						90 / 33	
5.5						98 / 29	152.0
						102 / 26	
						69 / 25	

Hole Depth: 5.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA12**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050462mN, 1716721mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	159m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic SILT; dark brown, organic stained. Dry to moist; Trace rootlets.					135 / 44	159.0
	SILT, with trace clay; brownish orange. Hard; low plasticity; moist.					193 / 94	
0.5	0.6m: some clay					193 / 113	158.5
1.0						193 / 120	
	1.2m - 2.1m: trace of clay, orange					193 / 121	158.0
1.5	1.7m: minor fine sand					193 / 108	
						193 / 110	157.5
2.0	2.1m - 2.7m: trace gravel, fine, black, extremely weak residually weathered lapilli					163 / 25	
	2.3m: some fine sand					138 / 35	157.0
2.5	2.5m: pockets of lensoidal, extremely weak, black to dark red weathered gravel/scoria lapilli					131 / 28	
						190 / 72	156.5
	Sandy gravelly SILT; cark greyish brown, black and orange mottling. Very stiff; wet; sand, fine to coarse, gravel, fine to medium, very weak basalt/scoria lapilli.					113 / 36	
3.0						83 / 25	156.0
						124 / 15	
3.5						173 / 30	155.5
4.0							155.0
4.5							154.5
5.0							154.0
5.5							153.5

Groundwater Not Encountered

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA13**				
Project ID:	19103				
Sheet:	1 of 1				
Client:	Onoke Heights Limited	**Coordinates:**	6050489mN, 1716747mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	163.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic SILT; dark brown. Dry.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200		163.5
	Silty CLAY; brownish orange. Very stiff; high plasticity; moist.	Kerikeri Volcanic Group - Residual soil					
0.5	0.6m: trace of silt					166 / 55	163.0
	0.8m: some black mottling						
1.0						212 / 89	162.5
	1.2m: silty						
	1.3m - 1.9m: predominantly SILT, low plasticity					160 / 50	
1.5						144 / 22	162.0
2.0	SILT, with some gravel, with minor sand; dark greyish brown. Stiff to very stiff; non-plastic; wet; gravel, fine to medium, very weak basalt/scoria lapilli.	Kerikeri Volcanic Group - Weathered Airfall Deposit				128 / 24	161.5
	2.2m: increasing scoria					103 / 16	
2.5	2.4m - 4.0m: decreasing gravel (some), brownish orange					110 / 25	161.0
3.0	3.0m: wet to saturated					97 / 20	160.5
						71 / 22	
3.5	3.4m: trace of gravel, some black mottling, moist to wet					119 / 34	160.0
4.0	4.0m: wet					71 / 27	159.5
	4.2m: trace black mottling, wet to saturated					113 / 39	
4.5	4.5m: brownish orange					116 / 39	159.0
	4.8m: increasing scoria, saturated						
5.0						160 / 20	158.5
5.5							158.0

Hole Depth: 5.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

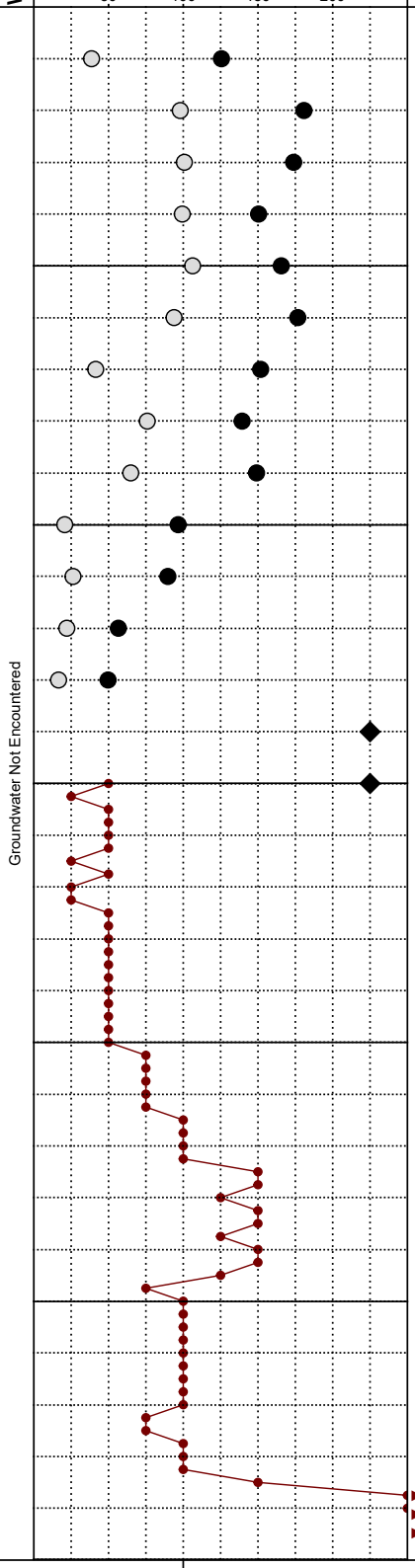
Method: 50mm hand auger, DCP

Test ID:	**HA14**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050521mN, 1716773mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	168.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology
0.0	SILT; brownish orange. Low plasticity; dry.	Topsoil
	Clayey SILT. Very stiff; low plasticity; dry to moist.	Kerikeri Volcanic Group - Residual soil
0.5	0.5m: moist	
	0.6m - 0.9m: orange	
1.0	0.9m - 1.4m: trace fine gravel (very weak basalt/scoria lapilli), brown	
1.5	SILT, with minor sand, with trace gravel. Very stiff; non-plastic; moist; sand, fine to coarse; gravel, fine, very weak basalt/scoria lapilli.	Kerikeri Volcanic Group - Weathered airfall deposit
	1.7m: some gravel, fine to medium, sub angular to sub rounded	
2.0	1.9m: no gravel	
	2.1m - 3.0m: variable silt, clay, sand and gravel, gravels fine to medium, brownish grey with brown and orange mottling, moist to wet	
2.5		
	2.8m: mostly gravel lapilli, moist to wet, crushes under auger	
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		

Water: Groundwater Not Encountered



Test Values	RL (m)
126 / 39	
181 / 98	
174 / 101	168.0
150 / 99	
166 / 106	
177 / 94	167.5
152 / 41	
139 / 76	167.0
149 / 65	
97 / 21	166.5
90 / 26	
57 / 22	166.0
50 / 17	
UTP	165.5
UTP	
	165.0
	164.5
	164.0
	163.5
	163.0

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

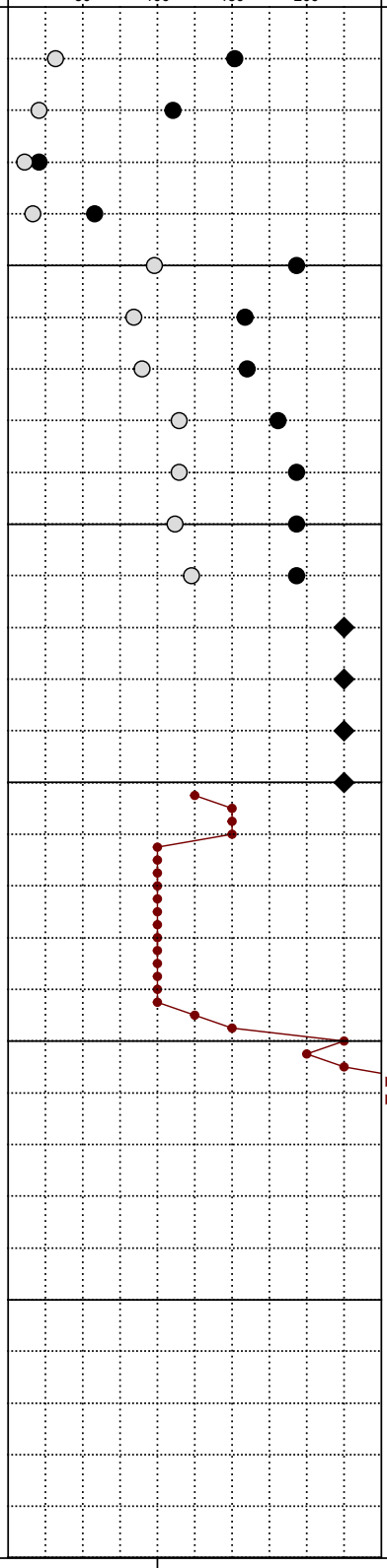
Method: 50mm hand auger, DCP

Test ID:	**HA15**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050343mN, 1716609mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	154m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology
0.0	Organic SILT; brownish black. Dry to moist; some rootlets.	Topsoil
0.5	Silty sandy GRAVEL; brownish grey, some orange mottling. Loose; dry; gravel, fine to medium, subround, very weak basalt/scoria lapilli.	Alluvium (Kerikeri Volcanic Group derived)
1.0	Sandy SILT, with trace gravel; brownish orange, some orange mottling. Firm to stiff; non-plastic; moist; sand, fine to medium; gravel, fine.	
1.5	Clayey SILT; brownish orange. Very stiff; low plasticity; moist.	
2.0	2.1m: minor gravel, fine, black, very weak basalt/scoria lapilli	
2.5	2.5m: some gravel as above	
3.0		
3.5		
4.0		
4.5		
5.0		
5.5		

Water: Groundwater Not Encountered



Test Values	RL (m)
152 / 32	153.5
110 / 21	
21 / 11	
58 / 17	
193+ / 98	153.0
159 / 84	
160 / 90	152.5
181 / 115	
193+ / 115	
193+ / 112	152.0
193+ / 123	
UTP	151.5
UTP	
UTP	
UTP	151.0
	150.5
	150.0
	149.5
	149.0
	148.5

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA16**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050394mN, 1716643mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	155m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology
0.0	Organic SILT; dark brown. Dry.	Alluvium (Kerikeri Volcanic Group derived)
0.5	SILT; reddish brown. Very stiff to hard; low plasticity; dry. 0.3m - 3.0m: trace of clay, brownish orange, moist	
0.8	0.8m: some clay, increasing plasticity	
1.5	1.5m: minor gravel, black, sub angular, very weak basalt/scoria lapilli	
2.2	2.2m: trace of clay	
3.0		

Groundwater Not Encountered

In-situ Testing

Dynamic Cone Penetrometer (blows / 50mm)

Shear Vane, Su (kPa)

Depth (m)	Test Values	RL (m)
0.0	135 / 26	155.0
0.5	193+ / 110	154.5
	193+ / 126	
	193+ / 131	
1.0	193+ / 132	154.0
	193+ / 155	
	193+ / 156	
1.5	193+ / 124	153.5
	193+ / 135	
2.0	193+ / 152	153.0
	193+ / 167	
	193+ / 134	
2.5	193+ / 149	152.5
	193+ / 138	
3.0	193+ / 131	152.0
3.5	10 11 10	151.5
4.0		151.0
4.5		150.5
5.0		150.0
5.5		149.5

Hole Depth: 3.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA17**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050385mN, 1716693mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	152m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	

Depth (m)	Graphic Log	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm) 2 4 6 8 / Shear Vane, Su (kPa) 50 100 150 200	Test Values	RL (m)
0.0	TS TS TS	Organic SILT; brown. Dry.	Topsoil	Groundwater Not Encountered			152.0
		Clayey SILT, with trace gravel; brownish orange, some dark specks. Very stiff; high plasticity; moist; gravel, fine, subround.	Residual soil				
0.5		Silty CLAY; brownish orange. Very stiff; high plasticity; moist.					151.5
1.0							151.0
1.5							150.5
2.0							150.0
2.5							149.5
3.0							149.0
3.5							148.5
4.0							148.0
4.5							147.5
5.0							147.0
5.5							146.5

Hole Depth: 0.50m **Termination:** impenetrable material

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

● Vane peak ▼ Standing water level
○ Vane residual ◁ Groundwater inflow
◆ Vane UTP ▷ Groundwater outflow
UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA18**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050416mN, 1716731mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CP
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	154m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	1945

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic clayey SILT; brown. Dry; friable, rootlets.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200	UTP	154.0
	Silty CLAY, with trace gravel; reddish brown. Very stiff; high plasticity; moist; gravel, fine.	Kerikeri Volcanic Group - Residual soil				204 / 93	
0.5						212 / 106	153.5
						190 / 109	
1.0	1.2m: rare completely weathered coarse gravels/cobbles					182 / 102	153.0
						UTP	
1.5	Clayey sandy SILT, with minor gravel; dark brownish orange. Very stiff; high plasticity; moist; gravel, fine, very weak basalt/scoria lapilli.	Kerikeri Volcanic Group - Weathered airfall deposit				146 / 33	152.5
	1.8m - 2.2m: brown, wet					146 / 66	
2.0						109 / 18	152.0
	2.2m - 2.7m: brownish black					120 / 18	
2.5	2.6m: saturated					182 / 26	151.5
	Silty CLAY; greyish orange. Very stiff; high plasticity; wet.					255+	
3.0						UTP	151.0
						20	
3.5							150.5
4.0							150.0
4.5							149.5
5.0							149.0
5.5							148.5

Hole Depth: 3.00m

Termination: Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

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Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA19**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050435mN, 1716810mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	FWH
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	153.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	2249

Depth (m)	Material Description	Geology
0.0	SILT, with some clay; brownish orange; homogeneous. Hard; low plasticity; dry.	Kerikeri Volcanic Group - Residual soil
0.2m	moist	
1.0	Sandy SILT, with some gravel, with minor clay; dark brownish grey, some black and orange mottling. Very loose to loose, sensitive; non-plastic; wet; sand, coarse; gravel, fine, clasts of extremely weak scoria and basalt lapilli; allophanic greasy.	Kerikeri Volcanic Group - Weathered airfall deposits
1.6m	1.8m: SILT, brown; Stiff; non-plastic; wet; homogenous.	
2.0	2.1m: wet to saturated	
4.0	4.0m: saturated, no inflow	
4.4	4.4m - 4.8m: becoming heavily black stained, MnO deposit	
4.8	4.8m - 5.0m: brownish orange, heavy black mottling	
5.0		

Water: Groundwater Not Encountered

In-situ Testing

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

Shear Vane, Su (kPa) 50 100 150 200

Test Values
UTP
205+ / 126
184 / 114
191 / 134
143 / 58
83 / 15
91 / 15
70 / 15
UTP
99 / 19
105 / 26
73 / 18
92 / 29
72 / 29
110 / 48
UTP
137 / 32

RL (m): 153.0, 152.5, 152.0, 151.5, 151.0, 150.5, 150.0, 149.5, 149.0, 148.5, 148.0, 147.5, 147.0, 146.5, 146.0, 145.5, 145.0, 144.5, 144.0

Hole Depth: 5.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

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Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA20**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050489mN, 1716817mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	162.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Test Values	RL (m)
0.0	Organic SILT; dark brown. Dry.	Topsoil		162.5
	SILT; brownish orange. Very stiff; low plasticity; moist.	Kerikeri Volcanic Group - Residual soil		
0.5	CLAY, with trace silt; brownish orange. Very stiff; low plasticity; moist.		180 / 66	162.0
1.0	Clayey SILT; brownish orange. Very stiff; low plasticity; moist.		121 / 44	161.5
1.5	1.6m: increase SILT, low plasticity		172 / 128	161.0
2.0	SILT, with some gravel, with minor sand; dark greyish brown. Firm to stiff; non-plastic; wet; gravel, fine to medium, very weak scoria/basalt lapilli.	Kerikeri Volcanic Group - Weathered Airfall Deposits	36 / 16	160.5
	2.2m: wet to saturated		78 / 24	
2.5			85 / 25	160.0
			44 / 24	
3.0	3.0m: increasing weak scoria/basalt lapilli		94 / 25	159.5
			125 / 31	
3.5	3.6m: saturated		88 / 39	159.0
4.0				158.5
4.5				158.0
5.0				157.5
5.5				157.0

Water: Groundwater Not Encountered

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

Hole Depth: 3.70m **Termination:** hard material

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA21**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050467mN, 1716857mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	153.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	SILT, with trace rootlets; dark brown. Dry.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200	159 / 30	153.5
0.5	Clayey SILT; orange brown, trace orange mottling. Hard; low plasticity; dry to moist. 0.3m - 1.0m: brown, moist	Kerikeri Volcanic Group - Residual soil				193 / 86	153.0
	0.8m: minor gravel, fine to medium, black, basalt/scoria lapilli					193 / 98	
1.0	SILT, with some sand, with minor gravel. Stiff to very stiff; moist; sand, fine; gravel, fine to medium, very weak basalt/scoria lapilli.	Kerikeri Volcanic Group - Weathered airfall deposit				193 / 110	152.5
1.5	1.4m: trace of clay					126 / 40	152.0
2.0	Sandy gravelly SILT, with minor clay. Stiff to very stiff; non-plastic; moist; gravel, fine to medium, very weak basalt/scoria lapilli.					150 / 79	151.5
2.5	2.9m - 3.0m: becoming sandy, brownish grey with orange brown and brown mottling					138 / 66	151.0
3.0						121 / 37	150.5
3.5						108 / 26	150.0
4.0						81 / 19	149.5
4.5						79 / 26	149.0
5.0						58 / 25	148.5
5.5						55 / 26	148.0
						102 / 25	
						128 / 39	

Hole Depth: 3.00m **Termination:** Reached target depth

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm Hand Auger

Test ID:	**HA22**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050418mN, 1716861mE	**Test Date:**	05/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	CK
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	149m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Phone GPS	**Vane ID:**	835

Depth (m)	Material Description	Geology	Water	In-situ Testing: Dynamic Cone Penetrometer (blows / 50mm)	In-situ Testing: Shear Vane, Su (kPa)	Test Values	RL (m)
0.0	Organic SILT; dark brown. Dry.	Topsoil	Groundwater Not Encountered	2 4 6 8	50 100 150 200		149.0
	CLAY, with some silt; brownish orange. Very stiff to hard; high plasticity; moist.	Kerikeri Volcanic Group - Residual soil					
0.5						219+ / 81	148.5
1.0	0.9m: silty					193 / 47	148.0
1.5						196 / 53	147.5
2.0	Clayey SILT; brownish orange. Very stiff; low plasticity; moist.	Kerikeri Volcanic Group - Weathered airfall deposit				207 / 38	147.0
	2.3m: some black mottling						
2.5						219+ / 44	146.5
	2.6m - 3.0m: no clay, trace of gravel; brown; wet, non-plastic; gravel, fine very weak basalt/scoria lapilli.					63 / 28	
3.0						UTP	146.0
3.5							145.5
4.0							145.0
4.5							144.5
5.0							144.0
5.5							143.5

Hole Depth: 3.00m **Termination:** impenetrable material

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

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

UTP = Unable to Penetrate

Hand Auger Borehole Log

Method: 50mm hand auger, DCP

Test ID:	**HA23**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050396mN, 1716885mE	**Test Date:**	27/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	145.5m	**Checked By:**	DD
Test Site:	Refer to site plan	**Located By:**	Plan setout	**Vane ID:**	131

Depth (m)	Material Description	Geology
0.0	SILT, with trace rootlets; dark brown. Dry.	Topsoil
0.5	Clayey SILT; brownish orange. Very stiff to hard; low plasticity; dry to moist.	Alluvium (Kerikeri Volcanic Group derived)
0.5	0.5m: minor fine gravel, sub angular, black; moist	
1.0	1.0m - 1.6m: dark brown, becomes sensitive	
1.4	1.4m: minor sand (weak scoria lapilli)	
1.6	1.6m - 2.0m: some gravel, fine to medium very weak basalt/scoria lapilli; brownish red with trace orange mottling	
2.0	2.0m - 2.5m: variable sand, silt, clay and fine gravel lapilli	
2.5		

Water: Groundwater Not Encountered

In-situ Testing

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

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

Depth (m)	Test Values	RL (m)
0.0	155 / 41	145.5
0.5	193 / 90	145.0
1.0	192 / 77	144.5
1.5	193 / 109	144.0
2.0	193 / 127	143.5
2.5	UTP	143.0
3.0	193 / 37	142.5
3.5	139 / 21	142.0
4.0	UTP	141.5
4.5	193 / 28	141.0
5.0	UTP	140.5
5.5	UTP	140.0

DCP: 11, 12

Hole Depth: 2.50m

Termination: impenetrable material

Remarks:

Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).
No correlation is implied between shear vane and DCP values.

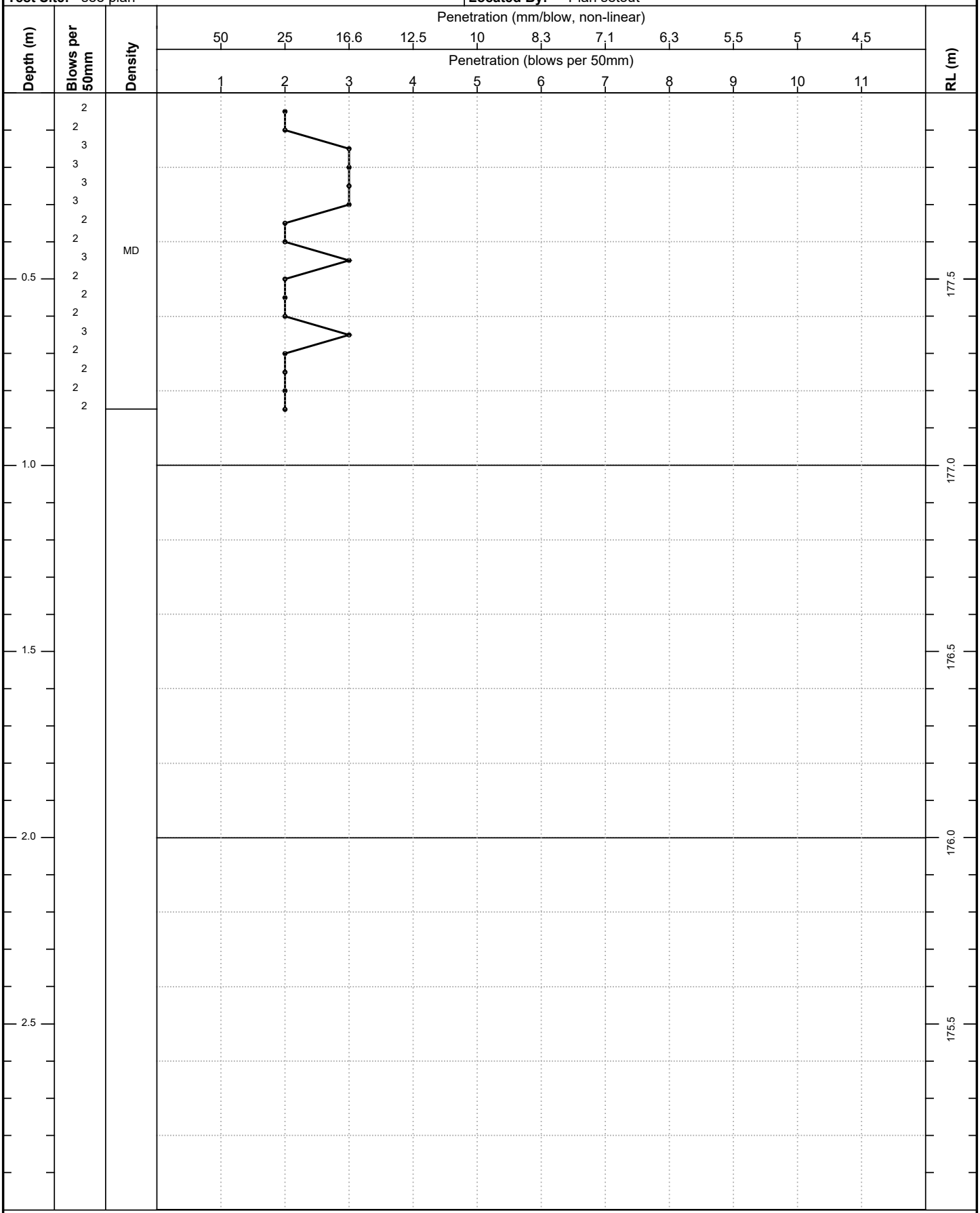
- Vane peak
- Vane residual
- Vane UTP
- Standing water level
- Groundwater inflow
- Groundwater outflow

UTP = Unable to Penetrate

Scala Penetrometer Test Log

Test ID:	**RP01**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050579mN, 1716623mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	178m	**Checked By:**	DD
Test Site:	see plan	**Located By:**	Plan setout		

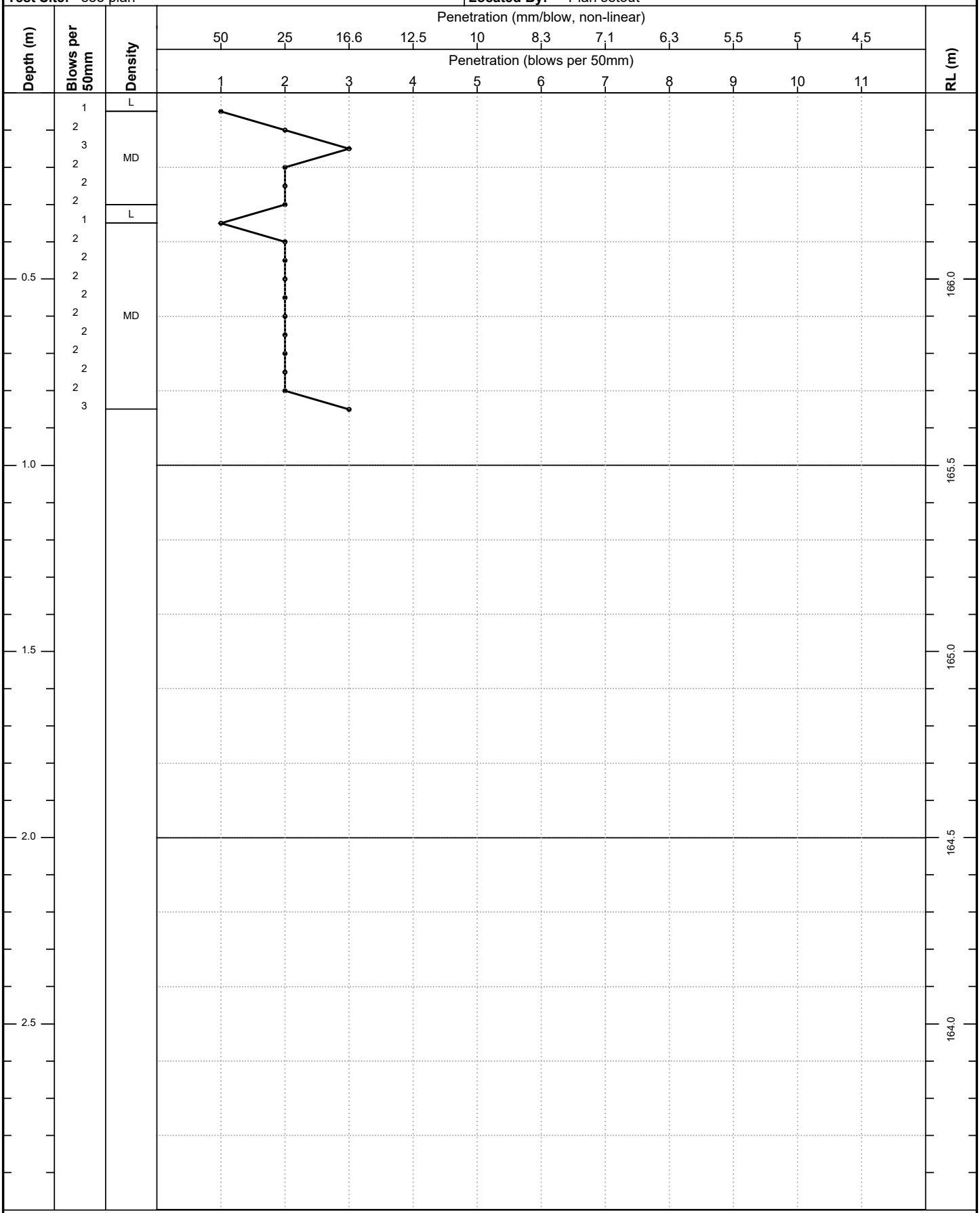


Remarks: Results may be affected by skin friction, particularly where the tested depth exceeds 1.5m. Density classification in terms of NZGS Field Description of Soil and Rock (2005).

Scala Penetrometer Test Log

Test ID:	**RP02**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050513mN, 1716763mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	166.5m	**Checked By:**	DD
Test Site:	see plan	**Located By:**	Plan setout		

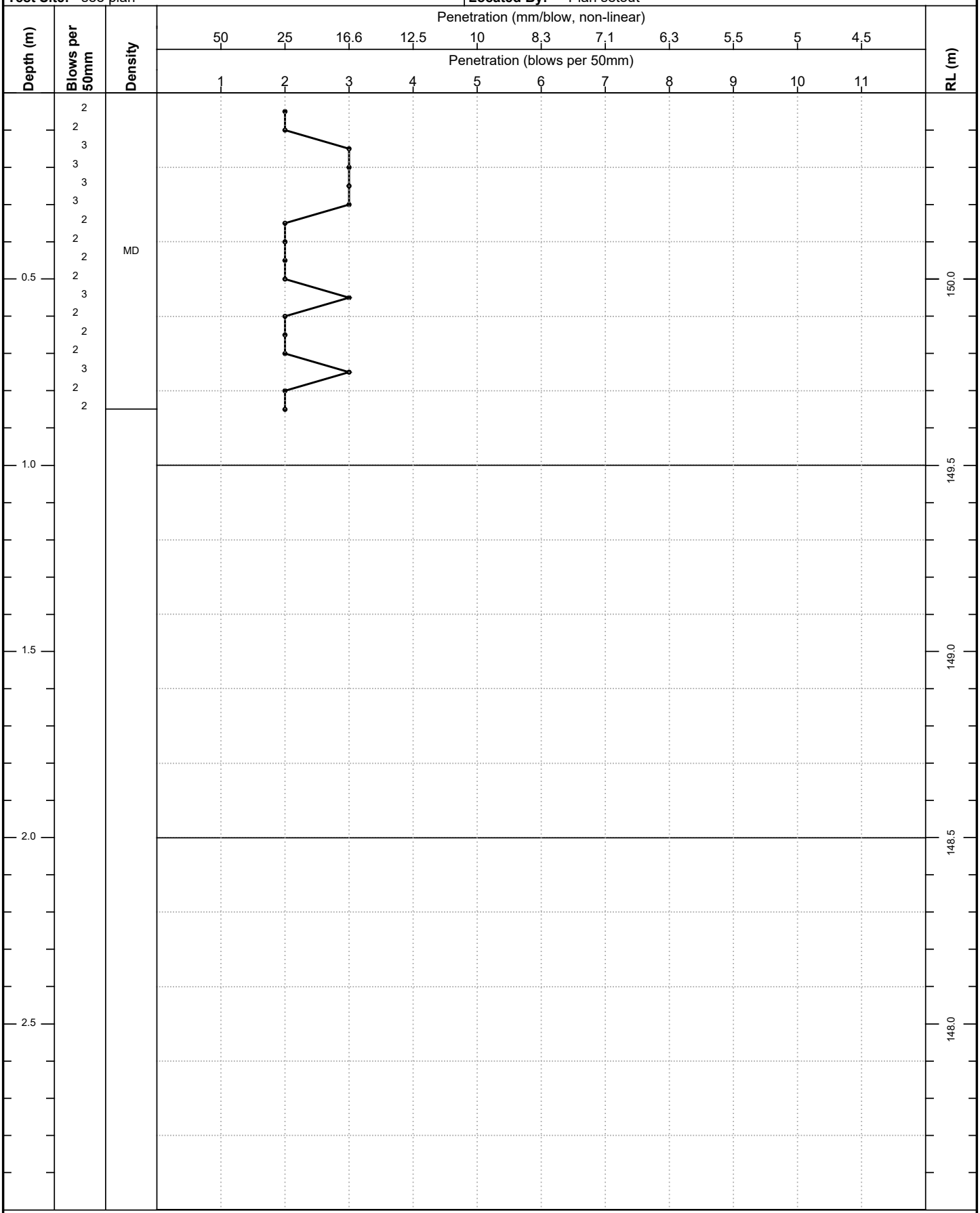


Remarks: Results may be affected by skin friction, particularly where the tested depth exceeds 1.5m. Density classification in terms of NZGS Field Description of Soil and Rock (2005).

Scala Penetrometer Test Log

Test ID:	**RP03**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050448mN, 1716867mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	150.5m	**Checked By:**	DD
Test Site:	see plan	**Located By:**	Plan setout		

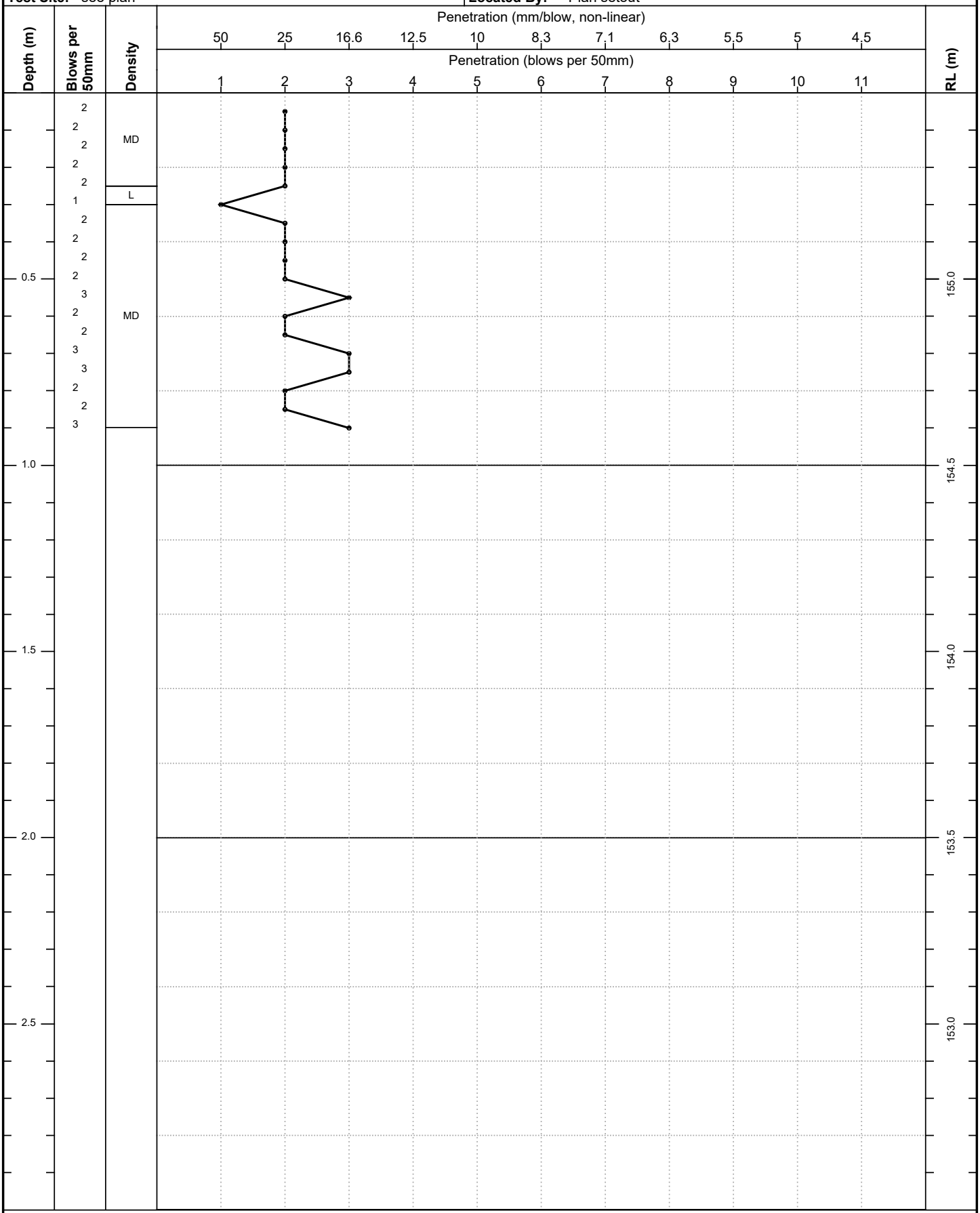


Remarks: Results may be affected by skin friction, particularly where the tested depth exceeds 1.5m. Density classification in terms of NZGS Field Description of Soil and Rock (2005).

Scala Penetrometer Test Log

Test ID:	**RP04**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050431mN, 1716728mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	155.5m	**Checked By:**	DD
Test Site:	see plan	**Located By:**	Plan setout		

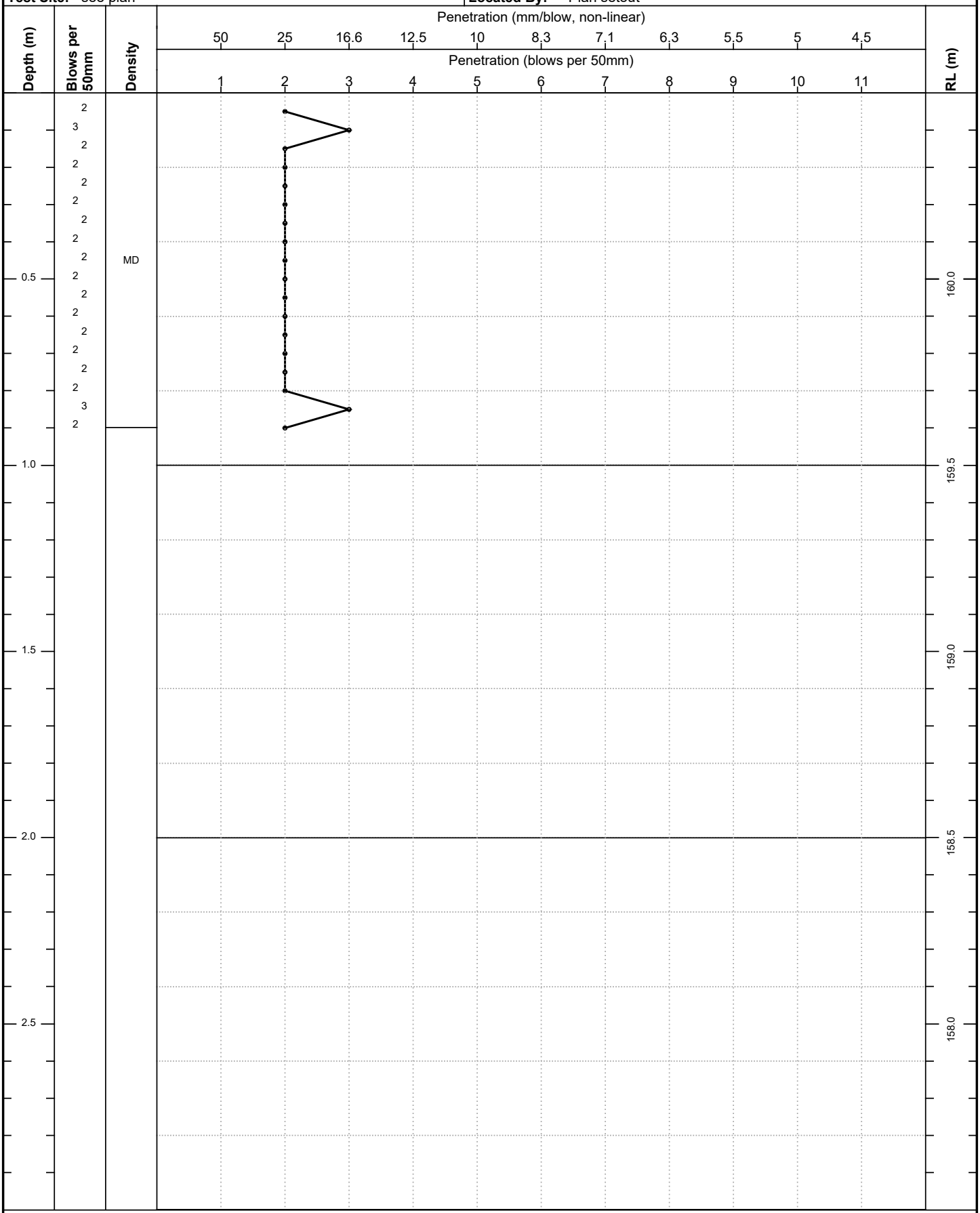


Remarks: Results may be affected by skin friction, particularly where the tested depth exceeds 1.5m. Density classification in terms of NZGS Field Description of Soil and Rock (2005).

Scala Penetrometer Test Log

Test ID:	**RP05**
Project ID:	19103
Sheet:	1 of 1

Client:	Onoke Heights Limited	**Coordinates:**	6050437mN, 1716609mE	**Test Date:**	28/11/2019
Project:	Geotechnical Suitability Assessment for Subdivision	**System:**	NZTM	**Logged By:**	AM
Location:	67 Dip Road, Three Mile Bush	**Elevation:**	160.5m	**Checked By:**	DD
Test Site:	see plan	**Located By:**	Plan setout		



Remarks: Results may be affected by skin friction, particularly where the tested depth exceeds 1.5m. Density classification in terms of NZGS Field Description of Soil and Rock (2005).

BOREHOLE LOG

HOLE NO.: MBH01

CLIENT: CC Developments LTD

PROJECT: Subdivision Suitability

JOB NO.: 19103

SITE LOCATION: 67 Dip Road, Three Mile Bush

CO-ORDINATES: 1716656mE, 6050495mN (NZTM)

ELEVATION: Ground

START DATE: 10/02/2021

END DATE: 10/02/2021

CONTRACTOR: DS Geotechnical **RIG:** LT140

DRILLER: Damian Spratt

LOGGED BY: CP

DEPTH	GRAPHIC	MATERIAL DESCRIPTION (In accordance with NZGS 'Field Description of Soil and Rock' (2005))	GEOLOGY	METHOD	TCR (%)	SPT N-VALUE (Uncorrected)	TEST DATA	WATER
0.0		Organic SILT with minor clay, dark brown, moist, rootlets	Topsoil	HQTT	100%			Groundwater Not Encountered
		CLayey SILT with minor fine sand (black), brown, moist, highly plastic	Weathered Ash - Kerikeri Volcanic Group					
		0.6m - 2.3m: grading to brownish orange and becoming increasingly greasy						
1.0								
		1.8m: becoming wet		HQTT	100%			
2.0								
		SILT with trace sand, clay and fine gravel. Brown. Low plasticity; wet to saturated: brittle/sensitive becoming greasy on disturbance (allophanic). Gravel is extremely weak angular scoria to 15mm, and fine rounded accretionary lapilli.	Lapilli Tephra - Kerikeri Volcanic Group	HQTT	46%			
	N/R	Sandy SILT with some gravel, trace clay. Brown with clasts of reddish brown, black, and yellowish brown. Non-plastic; saturated, becoming greasy on disturbance (allphanic). Gravel is extremely weak to weak angular scoria to 20mm and fine accretionary lapilli. Clasts break down to saturated clay/silt under firm hand pressure.		Push Tube Sample	100%			
3.0		2.8m - 3.0m: assumed core loss						
		3.0m - 3.4m: push tube sample (triaxial test)		HQTT	100%			
4.0								
	N/R	4.5m - 4.9m: push tube sample (not tested)		Push Tube Sample	100%			
5.0				HQTT	100%			
		5.3m: outlying scoria gravel clast, 50mm, black with minor yellow staining, very weak						
		5.3m - 9.0m: grading to brownish orange with yellow, black and reddish brown clasts						
6.0		6.0m: trrace clay		HQTT	100%			
7.0				HQTT	100%			
8.0				HQTT	100%			
9.0		Clayey SILT with some gravel. Blackish brown. Wet; highly plastic; gravel is dark grey highly vesicular basalt, weak to moderately strong, angular.		HQTT	100%			

REMARKS

Hole terminated at target depth. Borehole dry shortly after drilling.

REF	DATE / TIME	LEVEL	REMARK

LDE Whangarei

127 Bank St, Whangarei

Ph: 0800 397 566

info@lde.co.nz

BOREHOLE LOG

HOLE NO.: MBH01

CLIENT: CC Developments LTD

JOB NO.: 19103

PROJECT: Subdivision Suitability

SITE LOCATION: 67 Dip Road, Three Mile Bush

START DATE: 10/02/2021

CO-ORDINATES: 1716656mE, 6050495mN (NZTM)

ELEVATION: Ground

END DATE: 10/02/2021

CONTRACTOR: DS Geotechnical

RIG: LT140

DRILLER: Damian Spratt

LOGGED BY: CP

DEPTH	GRAPHIC	MATERIAL DESCRIPTION (In accordance with NZGS 'Field Description of Soil and Rock' (2005))	GEOLOGY	METHOD	TCR (%) (25, 50, 75)	SPT N-VALUE (Uncorrected) (10, 20, 30, 40)	TEST DATA	WATER
		[CONT] Clayey SILT with some gravel. Blackish brown. Wet; highly plastic; gravel is dark grey highly vesicular basalt, weak to moderately strong, angular.	[CONT] Lapilli Tephra -	HQTT	100%			
11.0		Slightly weathered BASALT, dark grey, highly vesicular, moderately strong to strong, yellow and black discoloration along vertical joints, iron oxide staining in vesicles.	Basalt Lava Flow - Kerikeri Volcanic Group	HQTT	100%			
12.0								
13.0				HQTT	100%			
		13.4m: becoming less vesicular						
		13.8m: becoming more vesicular		HQTT	100%			
14.0		14.0m: becoming less vesicular						
		14.2m: quartz clast with serpentinization around exterior (entrained clast from country rock)						
		EOH: 14.80m					50 for 15mm N=50 for 0mm	
15.0								
16.0								
17.0								
18.0								
19.0								

Groundwater Not Encountered

REMARKS

Hole terminated at target depth. Borehole dry shortly after drilling.

REF	DATE / TIME	LEVEL	REMARK

LDE Whangarei

127 Bank St, Whangarei

Ph: 0800 397 566

info@lde.co.nz

CORE PHOTOS

HOLE NO.: MBH01

JOB NO.: 19103

0.00-3.40m

3.40-6.80m

6.80-9.60m

9.60-12.50m

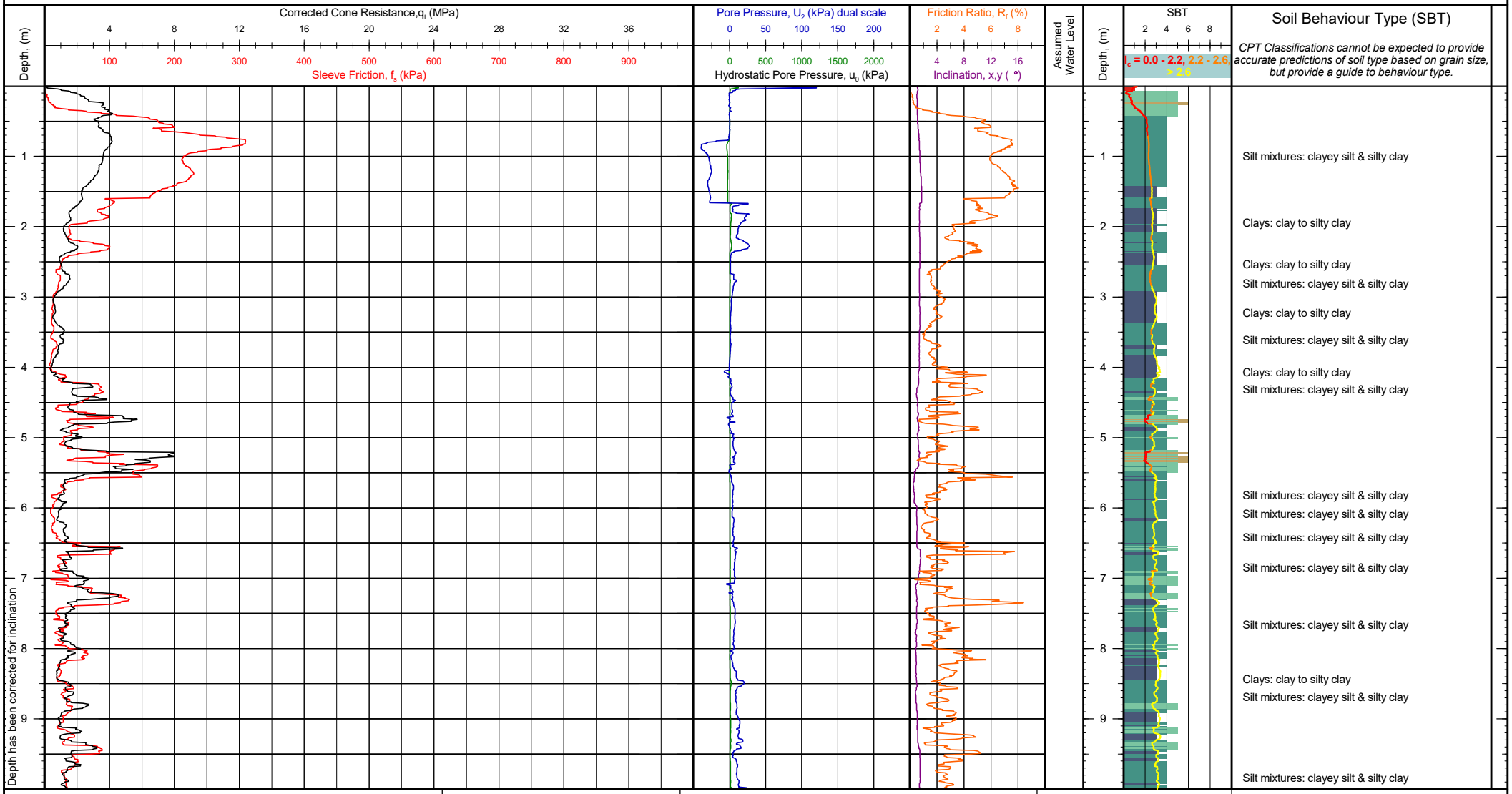
CORE PHOTOS

HOLE NO.: MBH01

JOB NO.: 19103

12.50-14.80m

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
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- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050565.67, 1716688.48	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.681908,174.289509	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	16.39
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

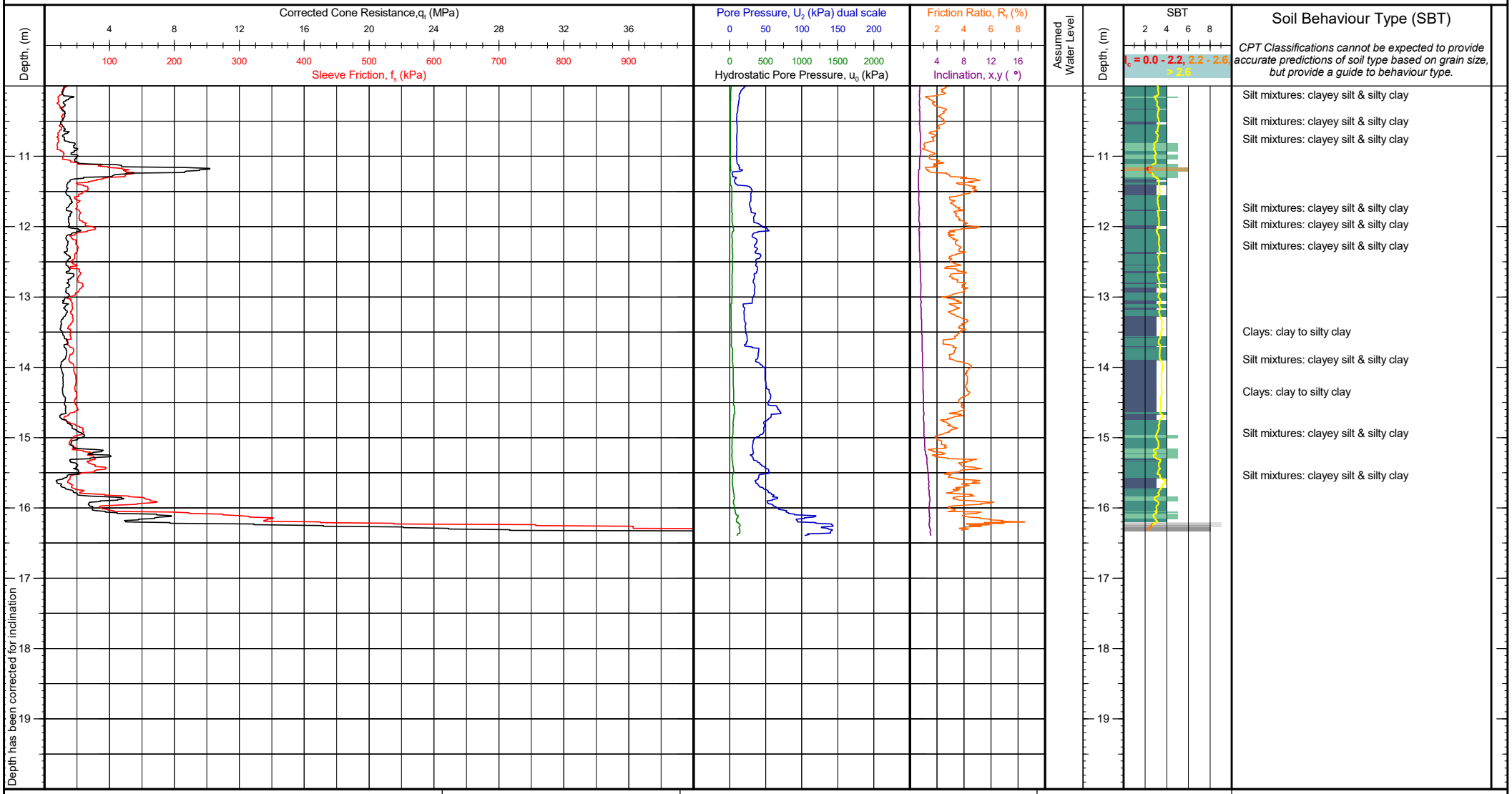
Client Reference:

Test Number: **CPT-01**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050565.67, 1716688.48	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.681908,174.289509	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	16.39
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

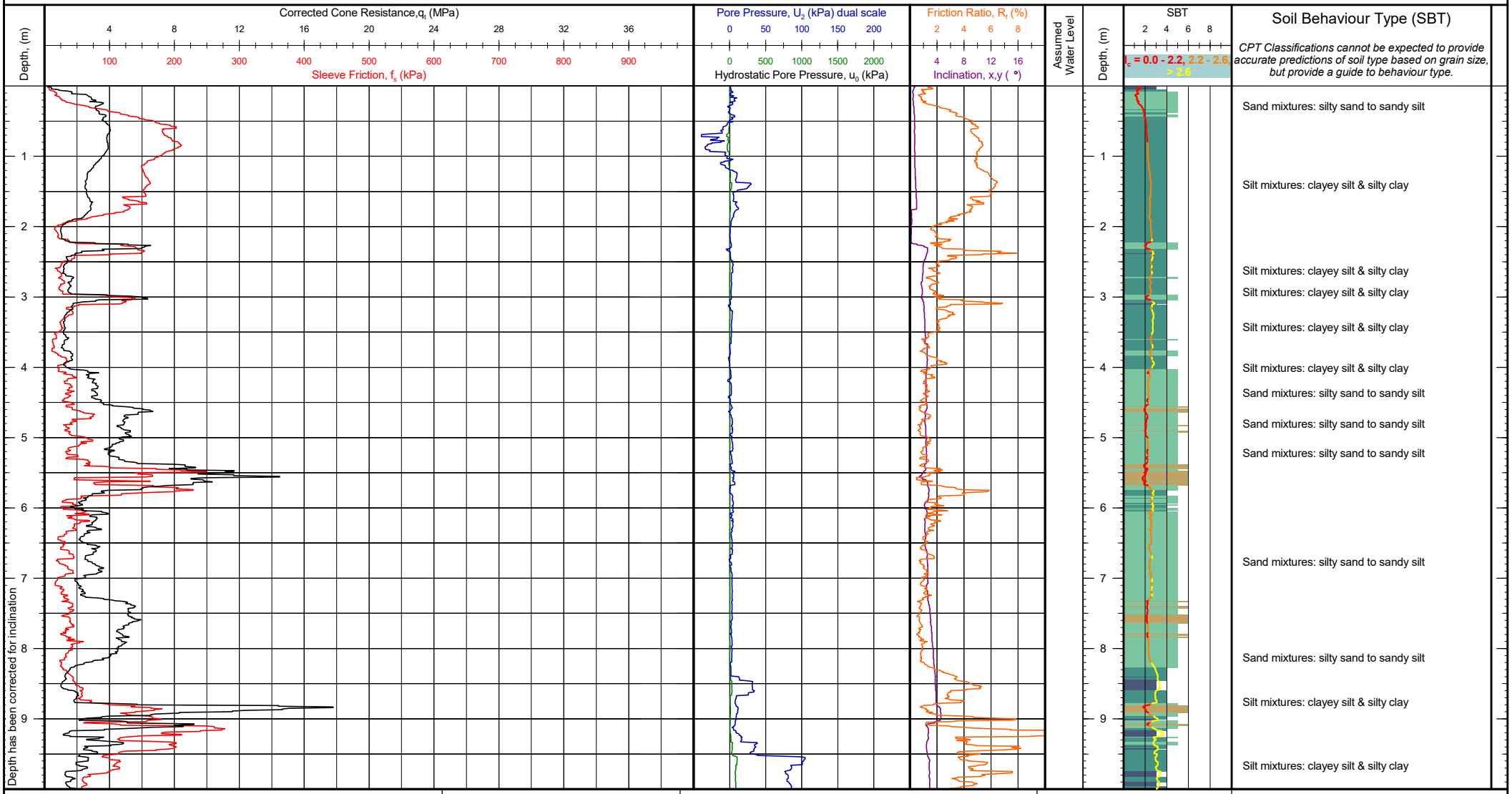
Client Reference:

Test Number: **CPT-01**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050550.22, 1716614.61	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682056,174.288695	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	12.39
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High friction resistance		

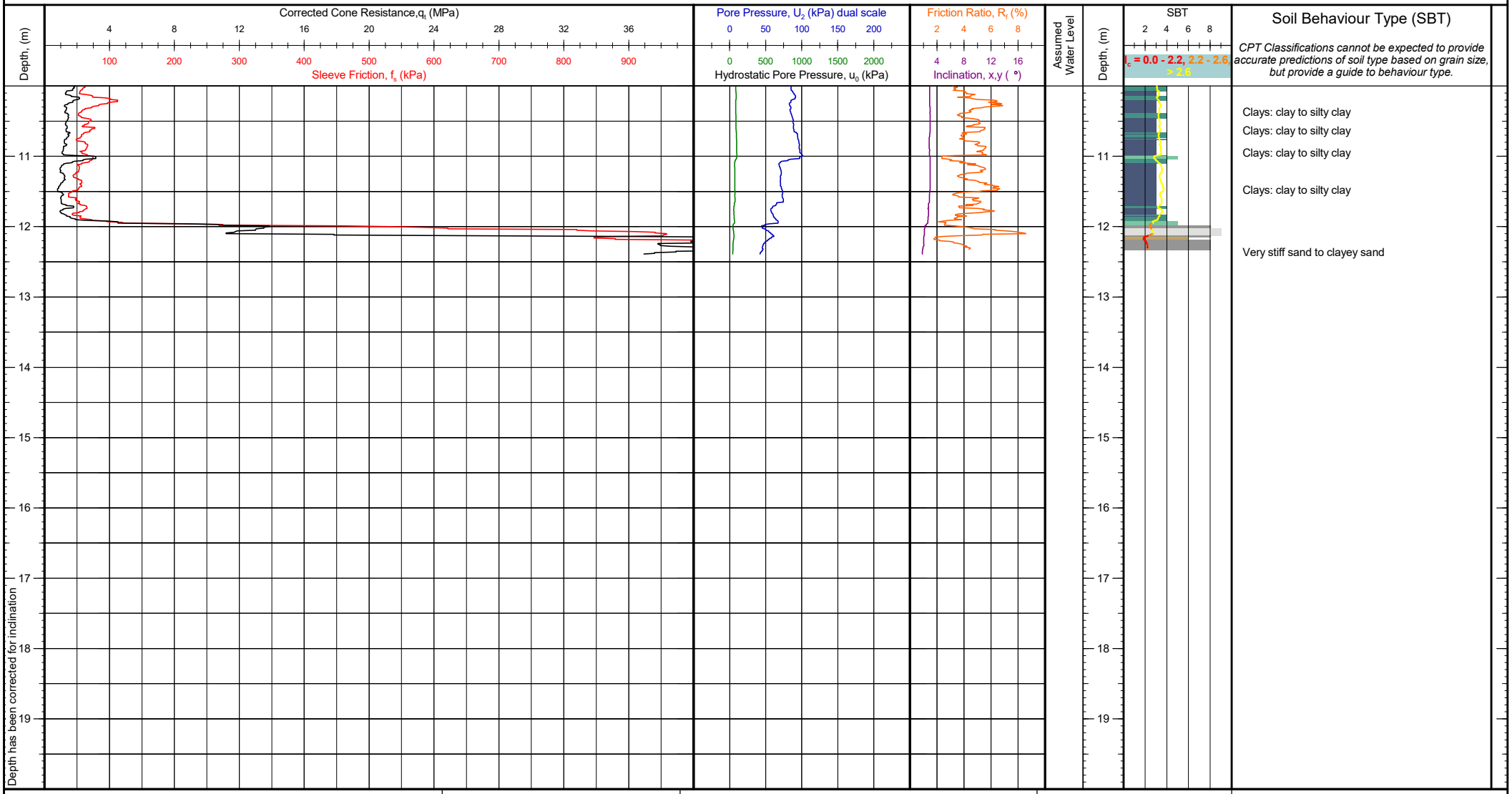
Client Reference:

Test Number: **CPT-02**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050550.22, 1716614.61	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682056,174.288695	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	12.39
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High friction resistance		

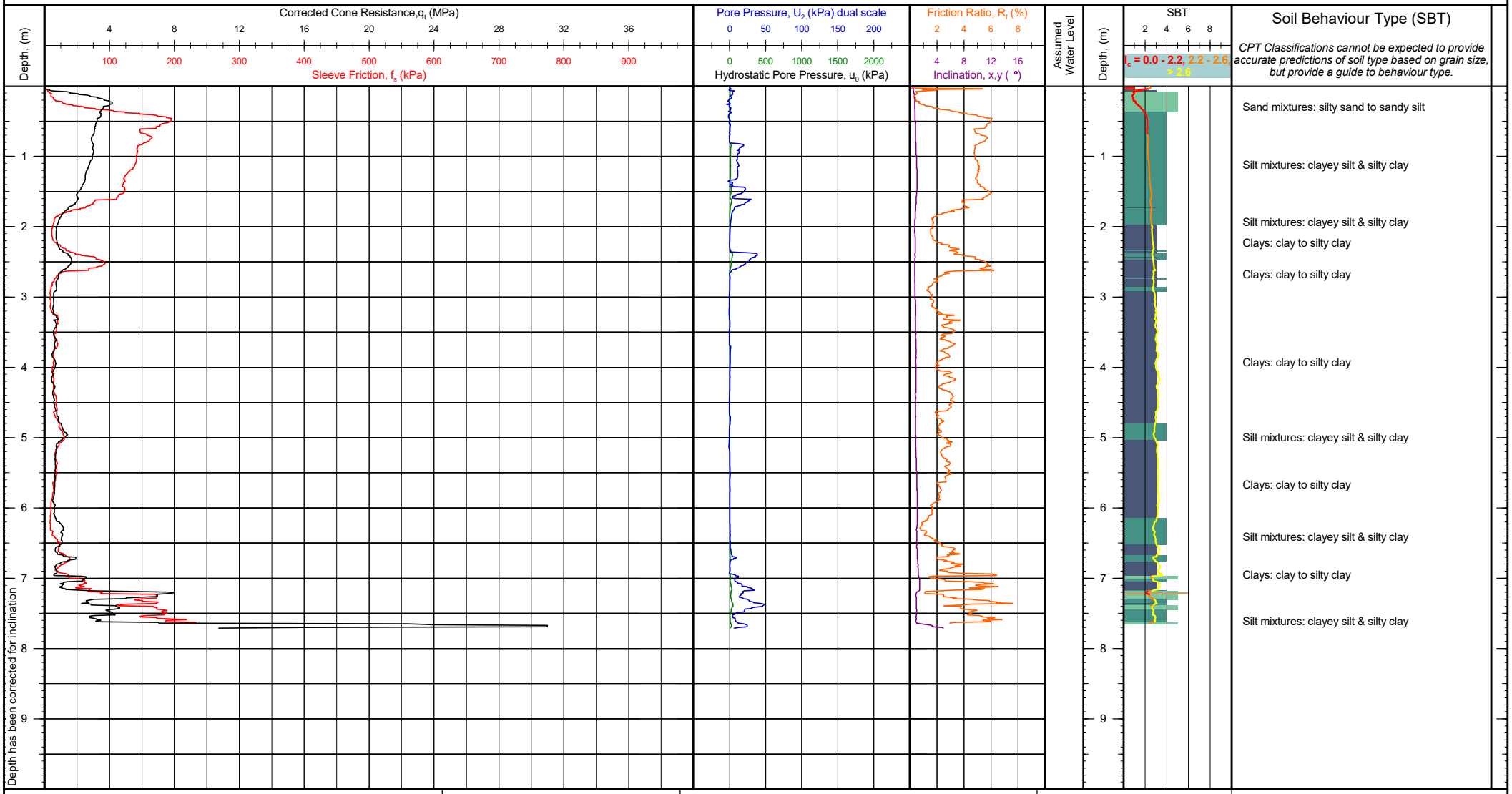
Client Reference:

Test Number: **CPT-02**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050520.21, 1716594.03	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682329,174.288472	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	7.71
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	Inclination high or rapid increase		

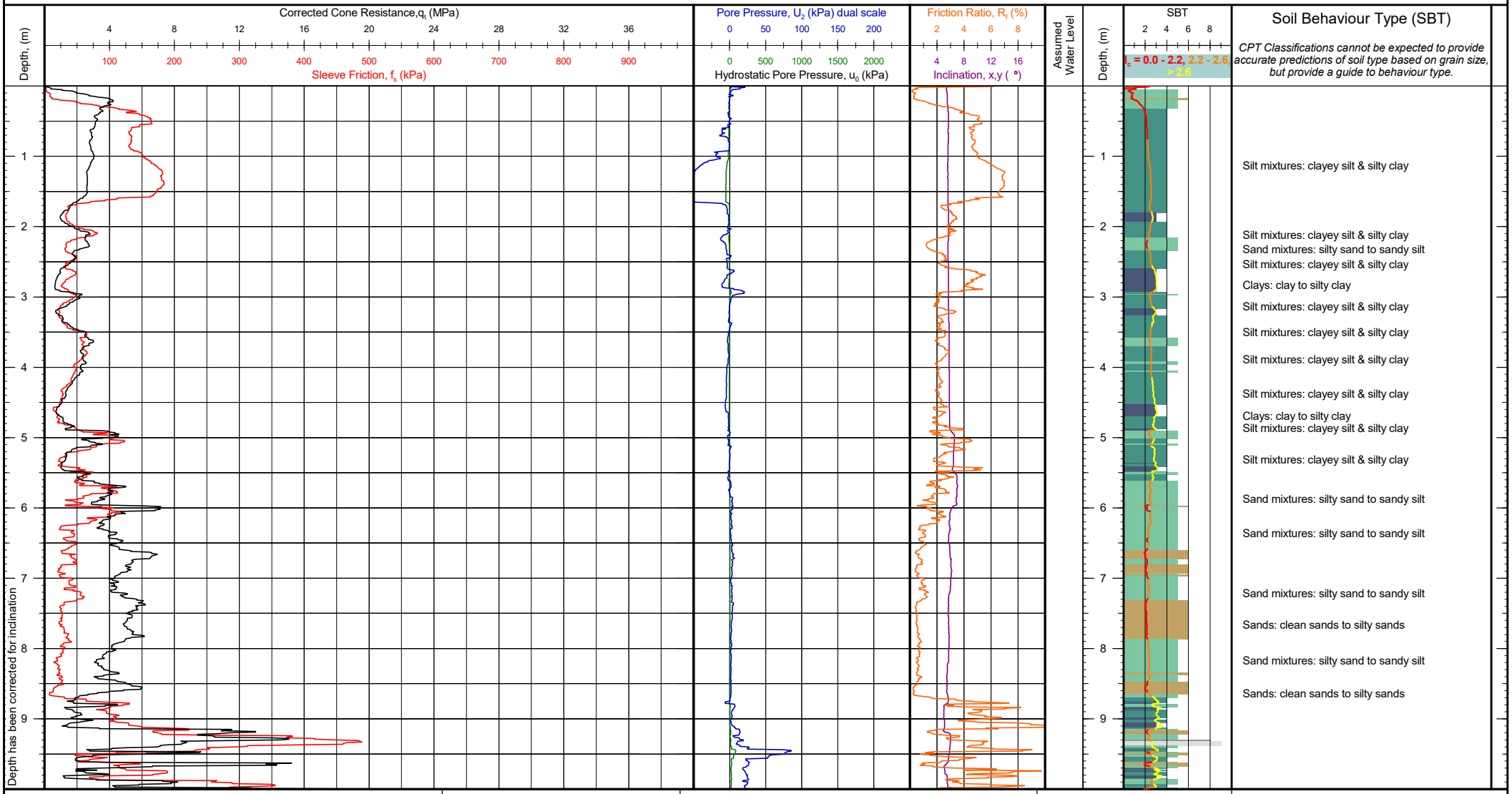
Client Reference:

Test Number: **CPT-03**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sands: clean sands to silty sands
- Sand mixtures: silty sand to sandy silt
- Sands: clean sands to silty sands

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050497.39, 1716650.30	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ291	**WGS84 (deg):**	-35.682528,174.289097	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	12.67
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

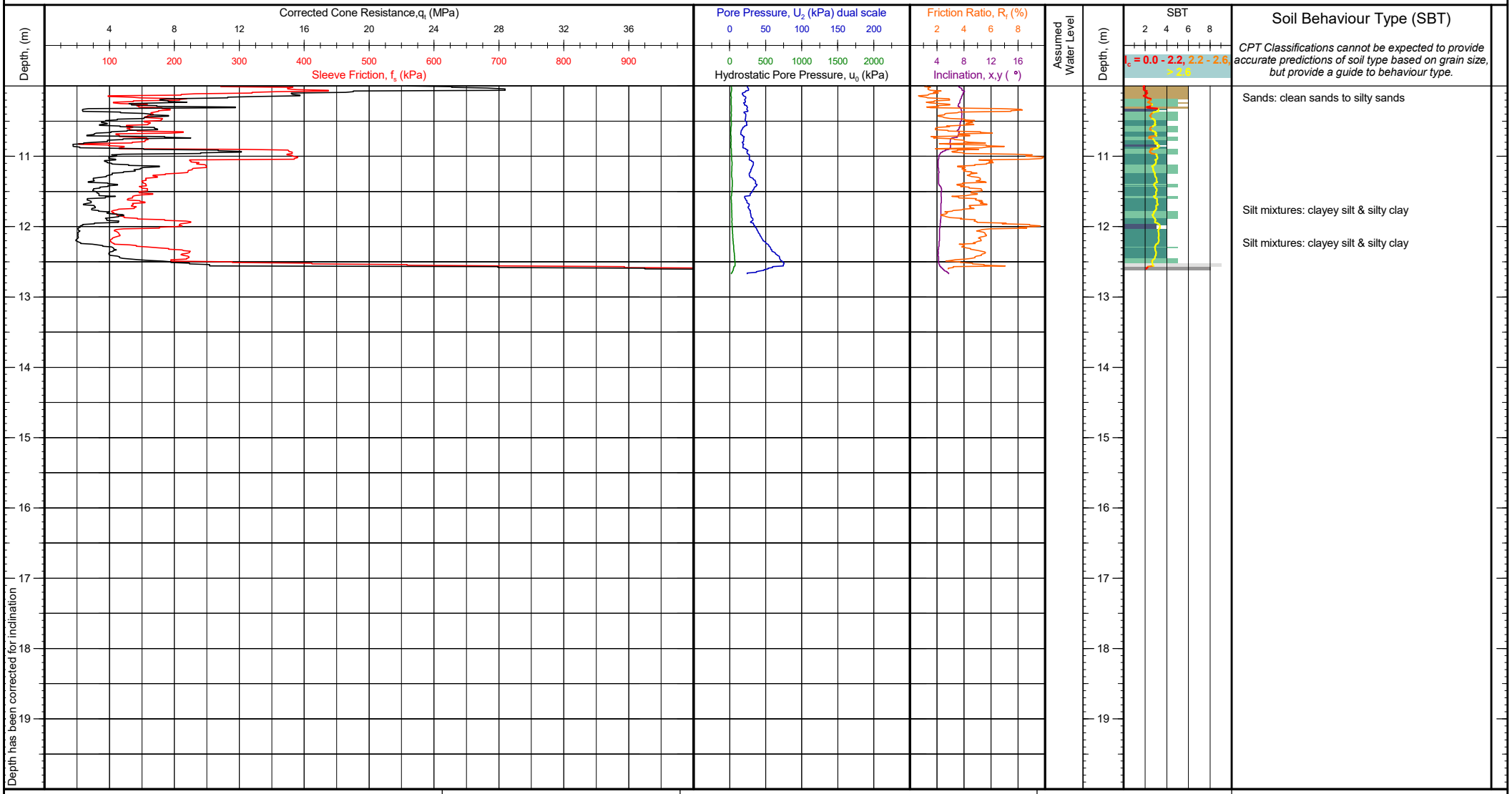
Client Reference:

Test Number: **CPT-04**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

Sands: clean sands to silty sands

Silt mixtures: clayey silt & silty clay

Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050497.39, 1716650.30	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ291	**WGS84 (deg):**	-35.682528,174.289097	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	12.67
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

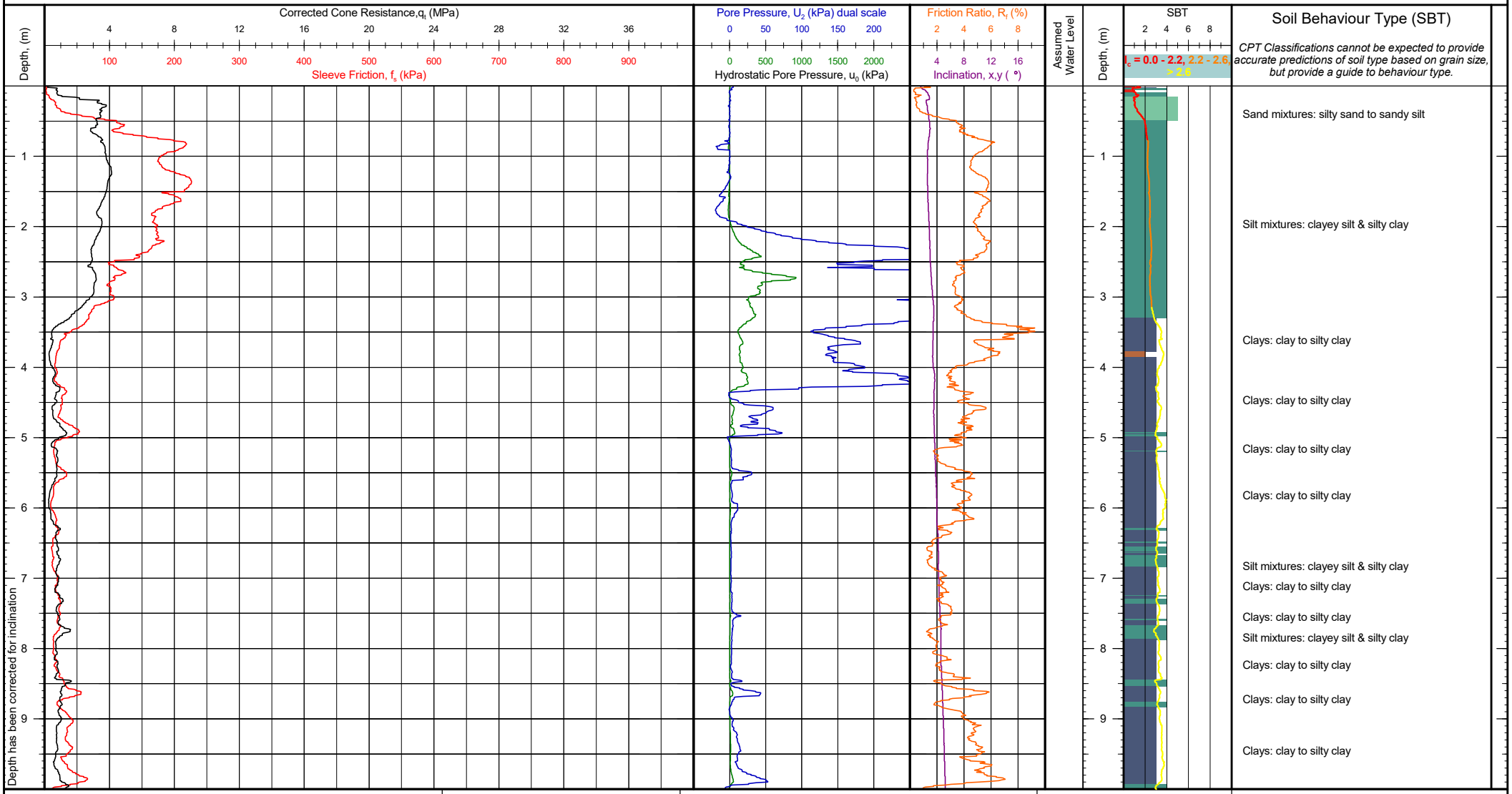
Client Reference:

Test Number: **CPT-04**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay
- Clays: clay to silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050455.93, 1716656.90	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682901,174.289176	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	18.02
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	Danger of buckling rods		

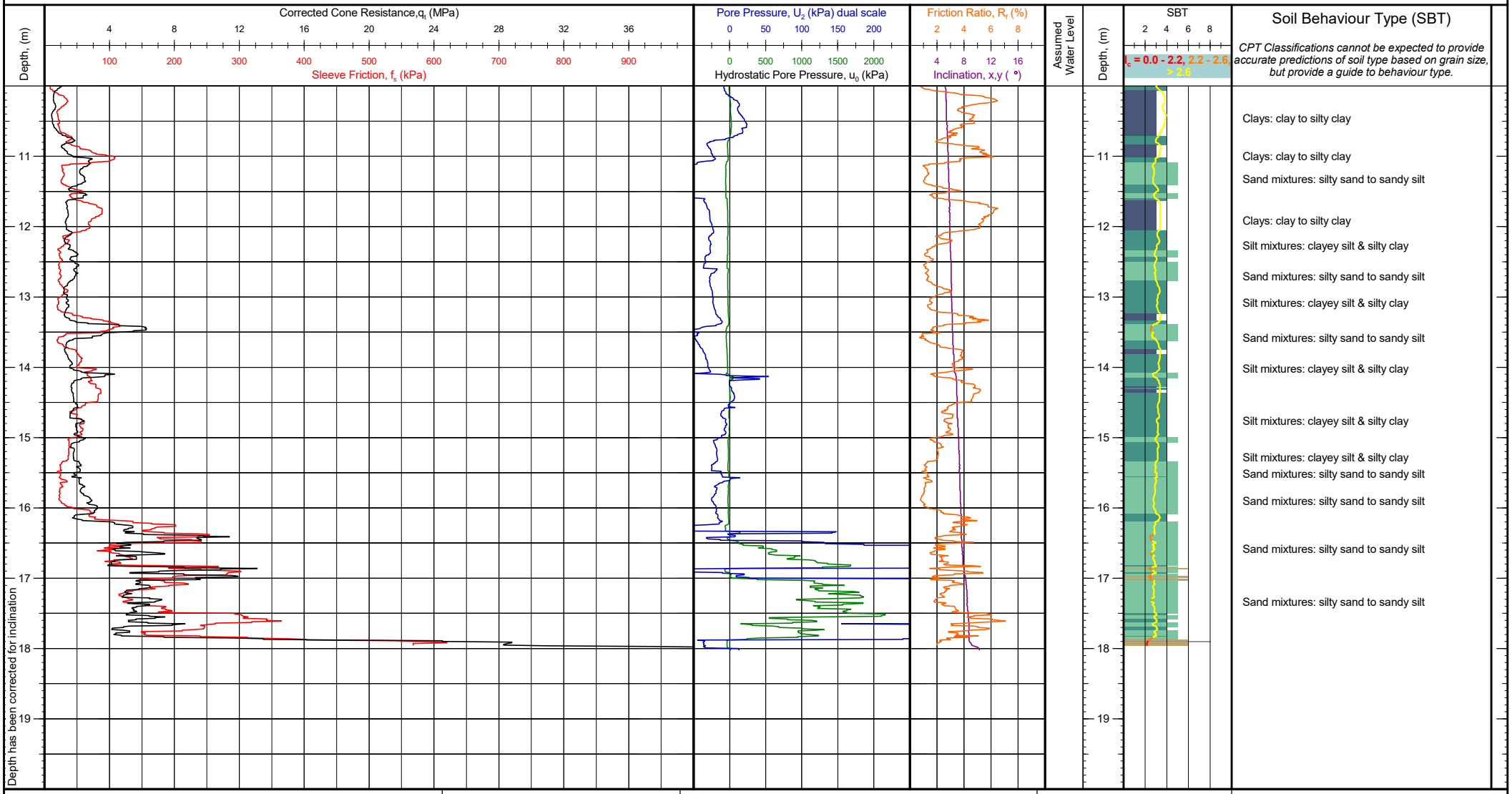
Client Reference:

Test Number: **CPT-05**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Clays: clay to silty clay
- Clays: clay to silty clay
- Sand mixtures: silty sand to sandy silt
- Clays: clay to silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050455.93, 1716656.90	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682901,174.289176	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	18.02
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	Danger of buckling rods		

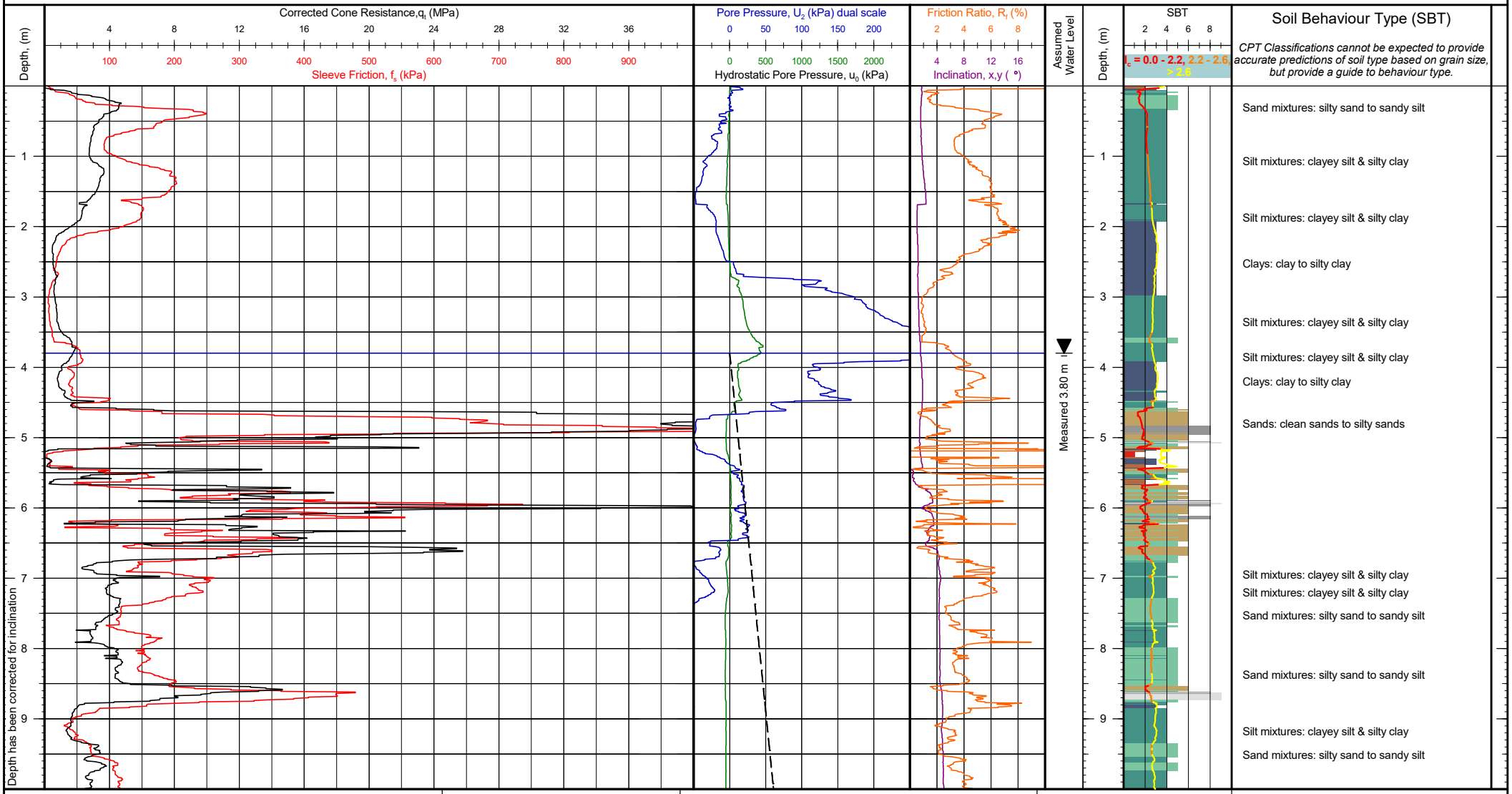
Client Reference:

Test Number: **CPT-05**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050409.56, 1716774.86	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.683305,174.290486	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	16.29
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

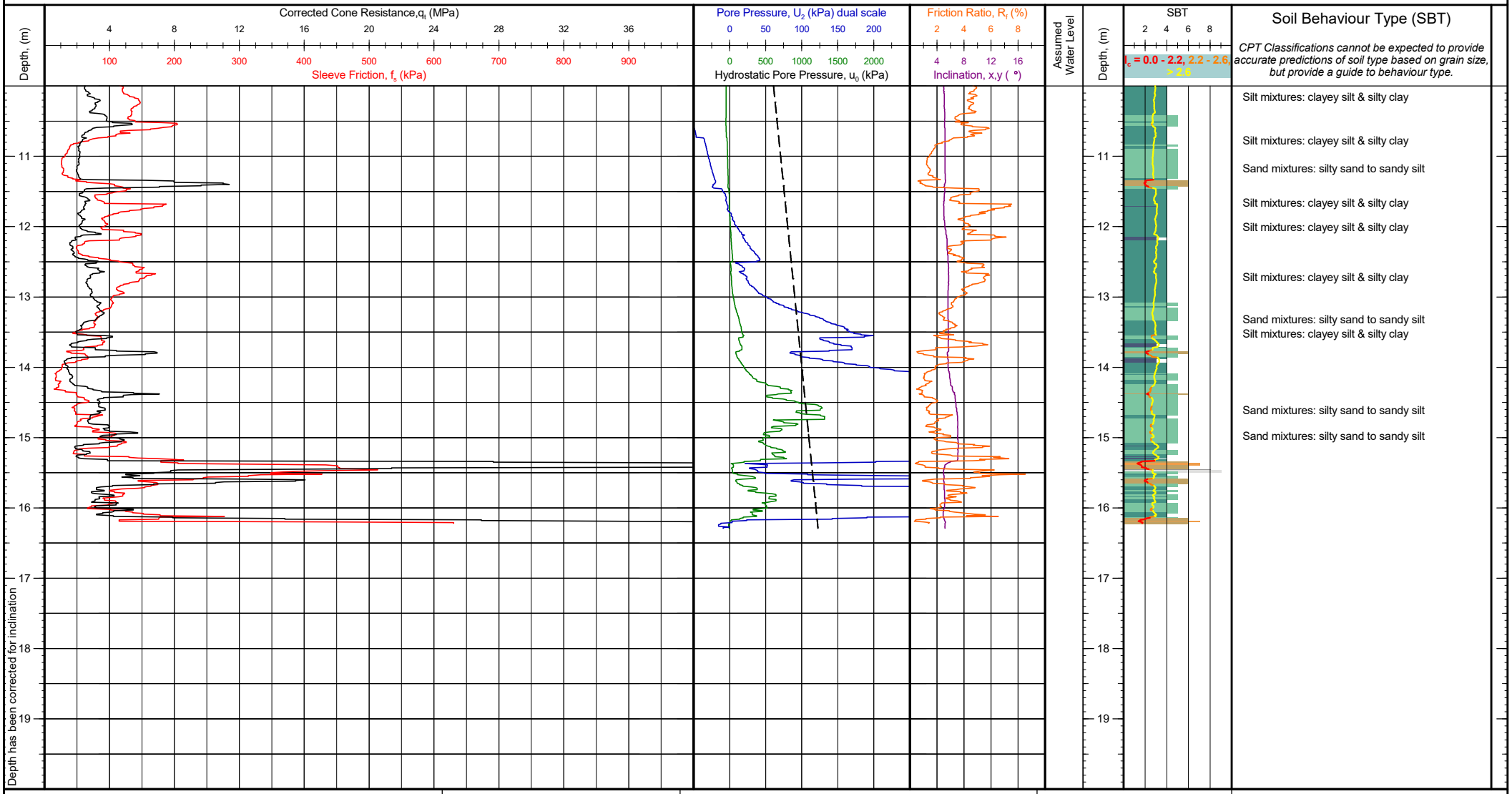
Client Reference:

Test Number: **CPT-06**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Silt mixtures: clayey silt & silty clay
- Sand mixtures: silty sand to sandy silt
- Sand mixtures: silty sand to sandy silt

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050409.56, 1716774.86	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.683305,174.290486	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	16.29
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

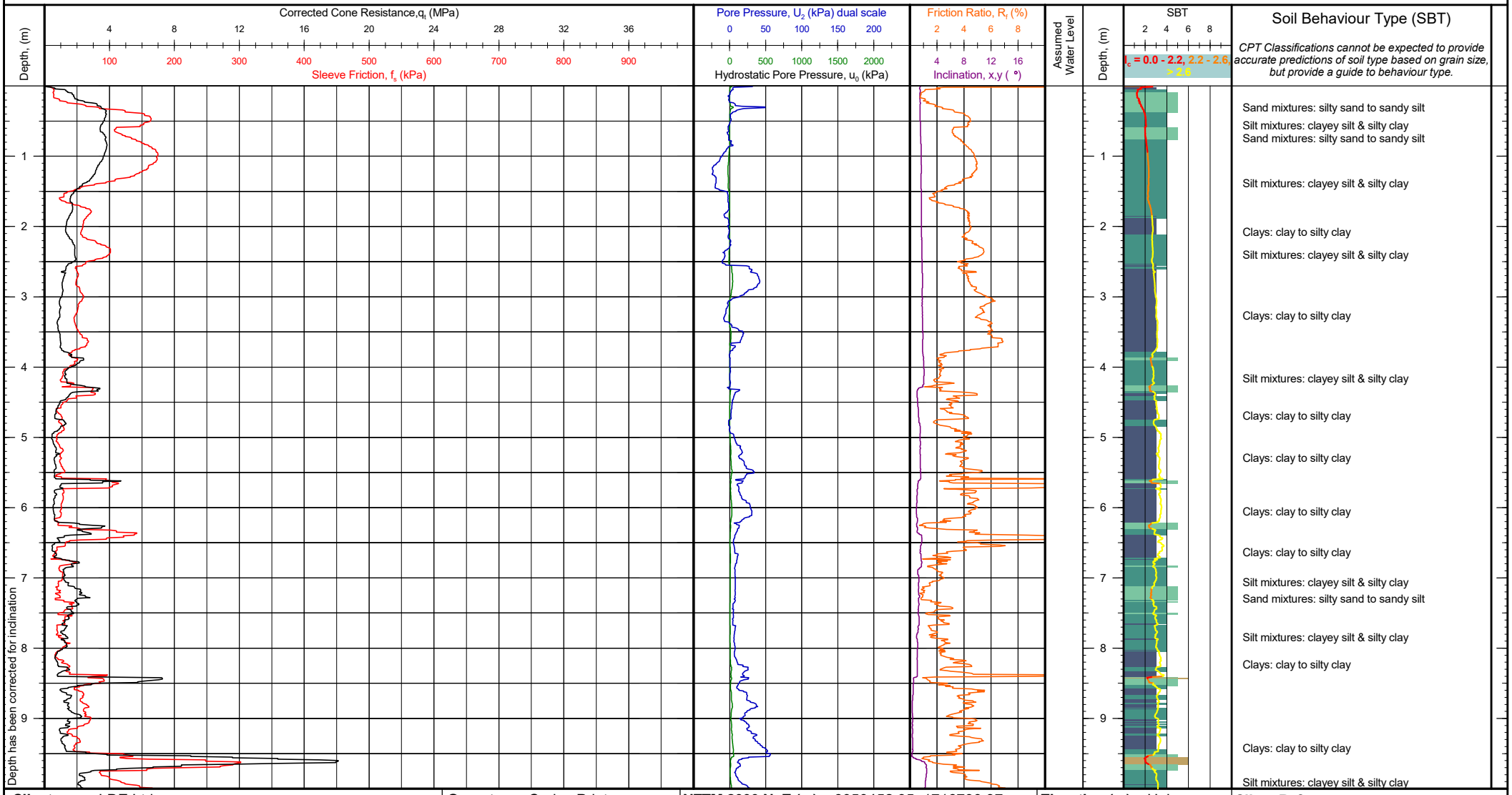
Client Reference:

Test Number: **CPT-06**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Soil Behaviour Type (SBT)

CPT Classifications cannot be expected to provide accurate predictions of soil type based on grain size, but provide a guide to behaviour type.

Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Clays: clay to silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay
Sand mixtures: silty sand to sandy silt
Silt mixtures: clayey silt & silty clay
Clays: clay to silty clay
Clays: clay to silty clay
Silt mixtures: clayey silt & silty clay

Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050452.95, 1716790.37
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682912,174.290651
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**	
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance

Elevation (m):	Unknown
Date of Test:	10/02/2021
Depth (m):	13.29
Pre Drill (m):	N/A

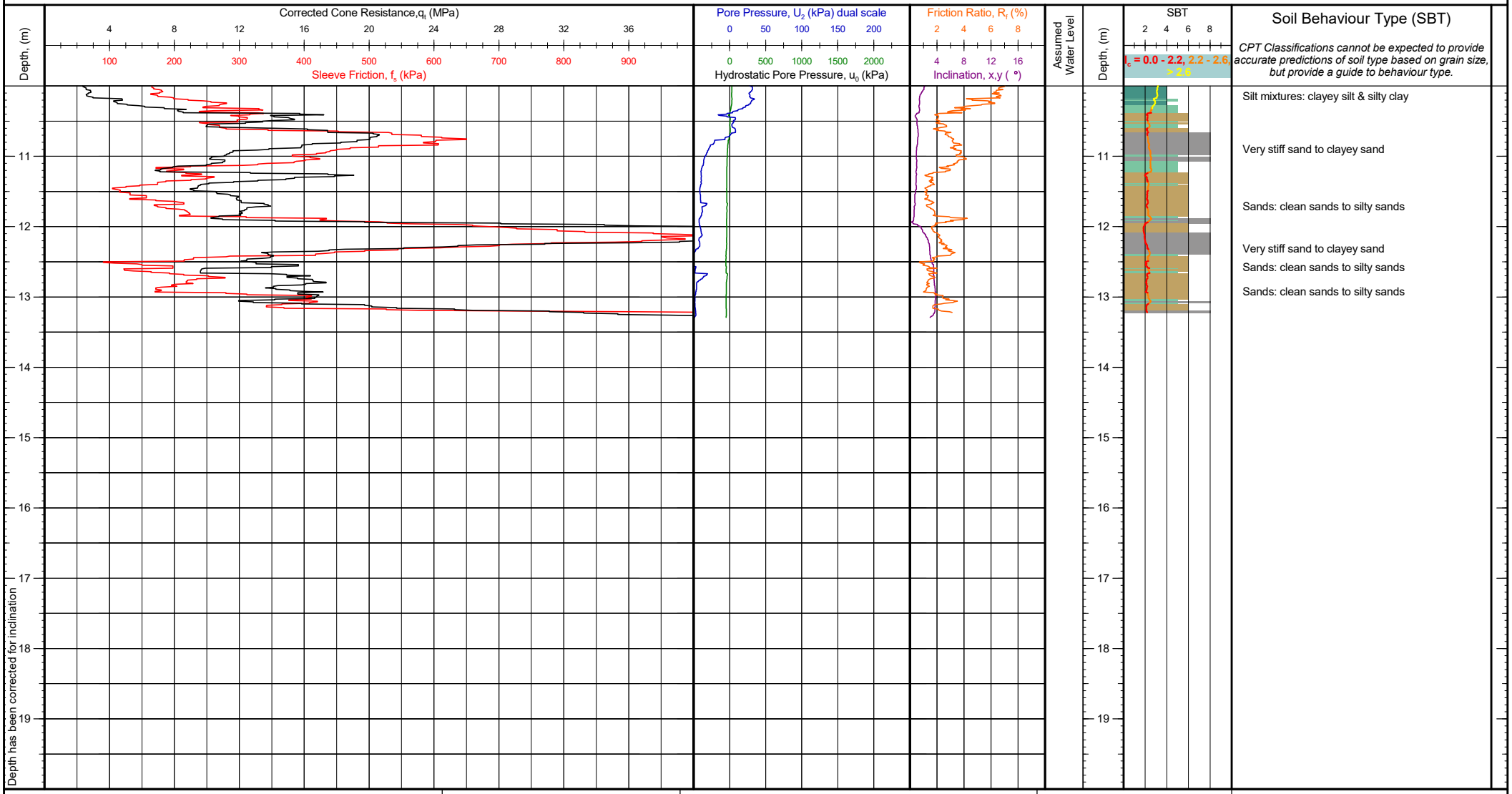
Client Reference:

Test Number: **CPT-07**

G.I. Job Ref: 210082

Comments:

CONE PENETRATION TEST (CPT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050452.95, 1716790.37	**Elevation (m):**	Unknown
Project:	Dip Road	**Cone Ref:**	MKJ325	**WGS84 (deg):**	-35.682912,174.290651	**Date of Test:**	10/02/2021
Location:	Kamo, Whangarei	**Cone Type:**	10cm^2 Compression	**Location Method:**	Handheld GPS	**Depth (m):**	13.29
Engineer:	Finlay Wallen-Halliwell	**Area Ratio:**	0.80	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**Filter Type:**	u_2	**Termination Reason:**	High cone end resistance		

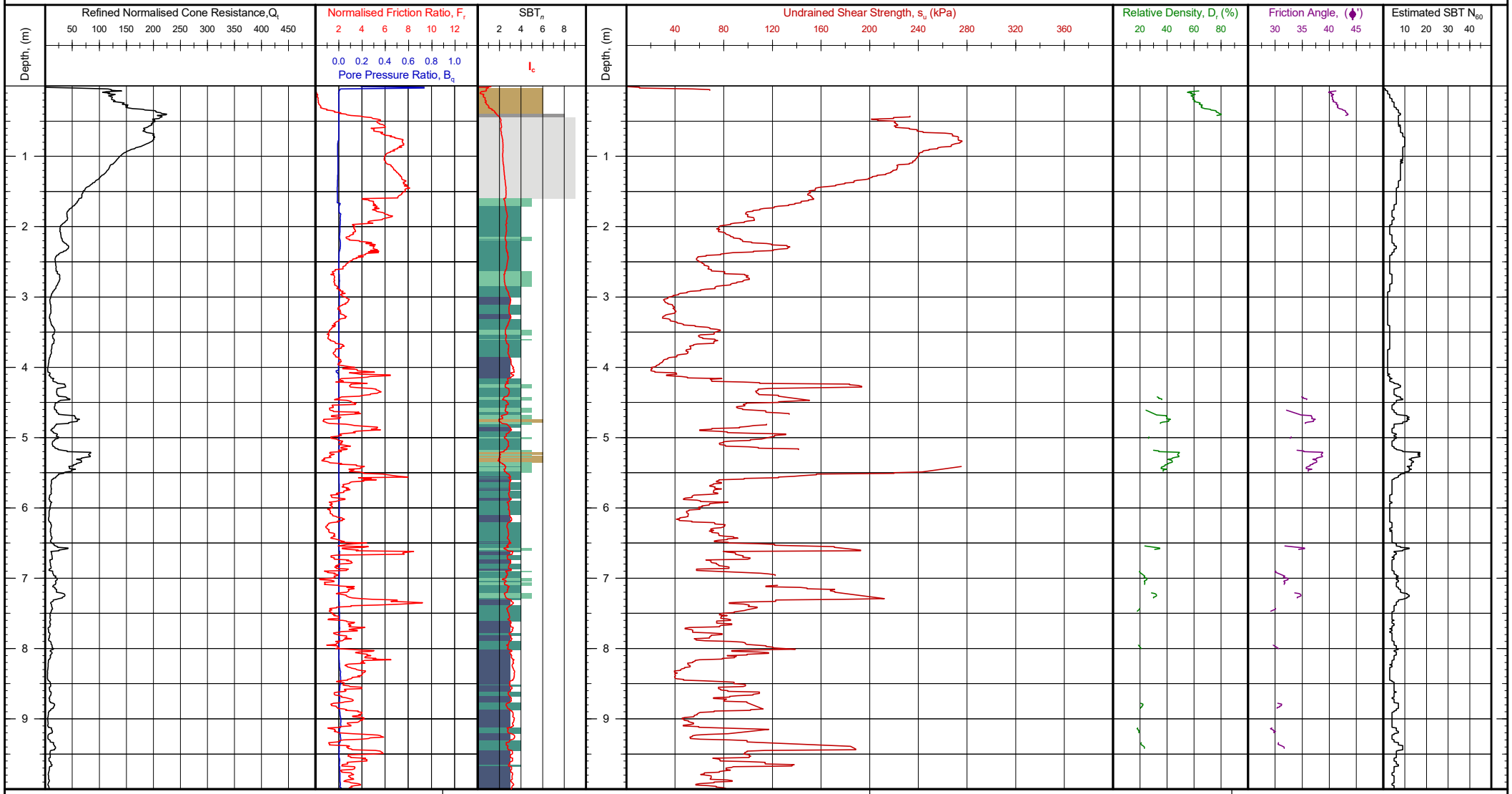
Client Reference:

Test Number: **CPT-07**

G.I. Job Ref: 210082

Comments:

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

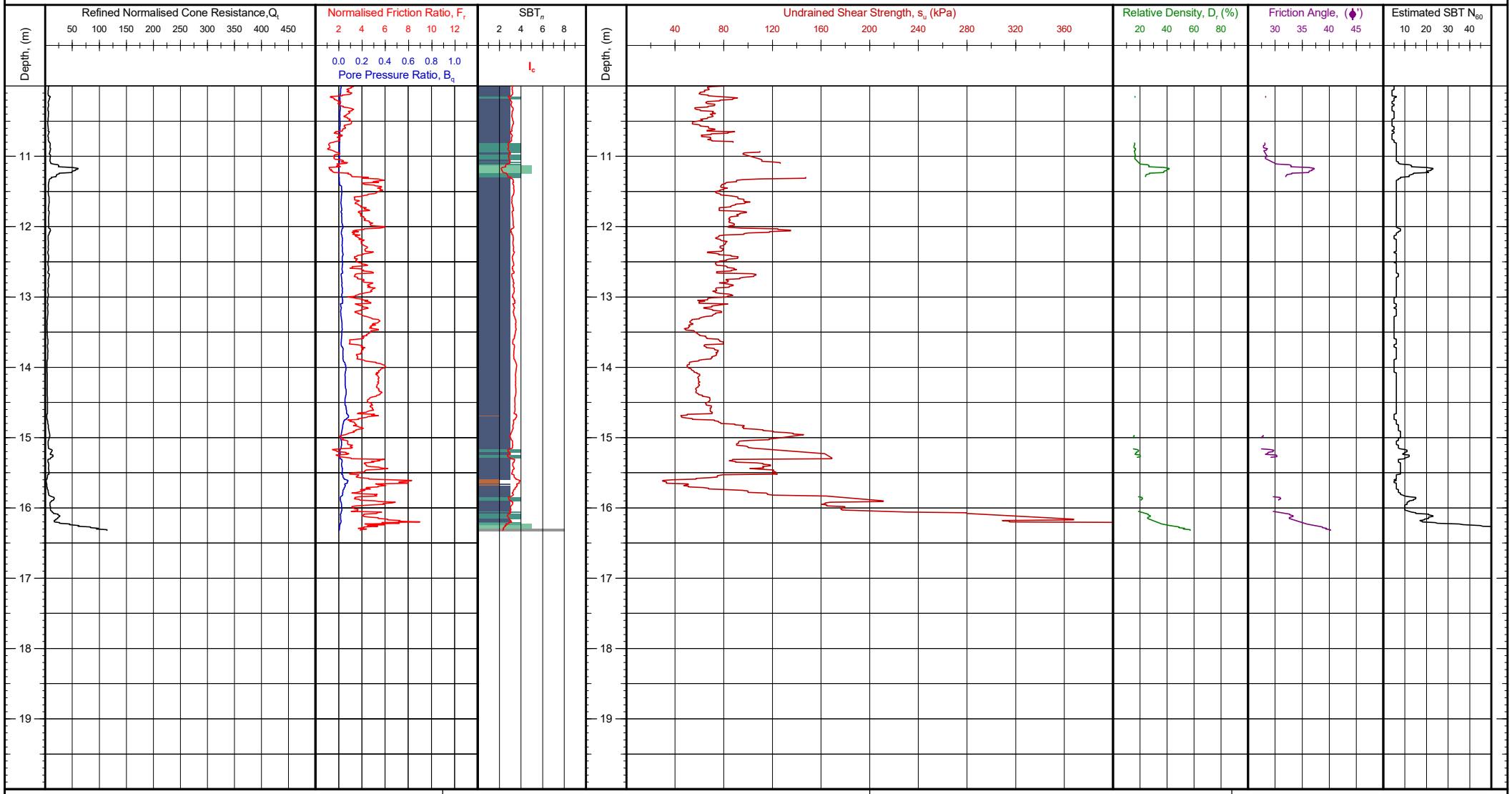
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-01**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

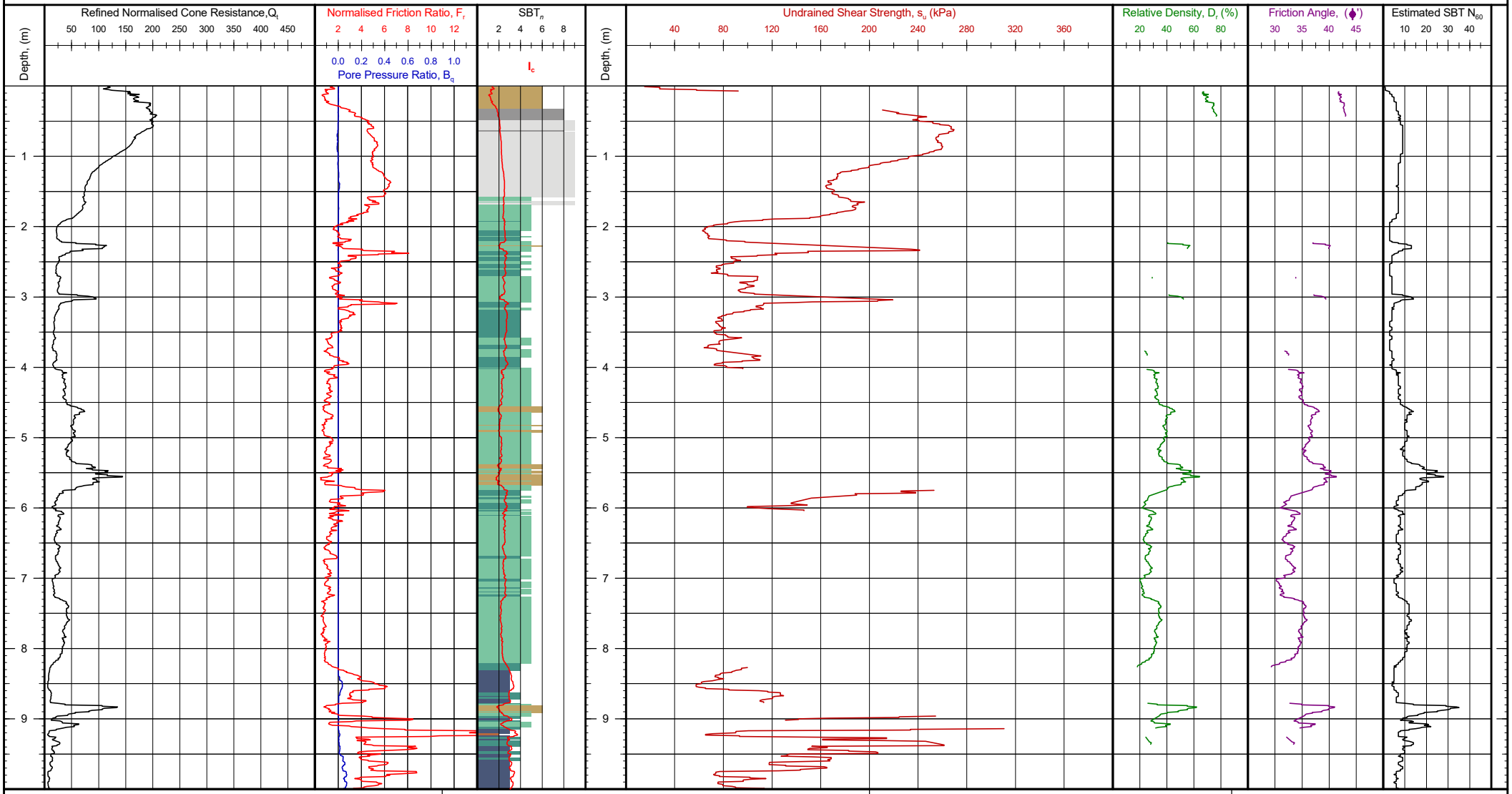
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-01**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

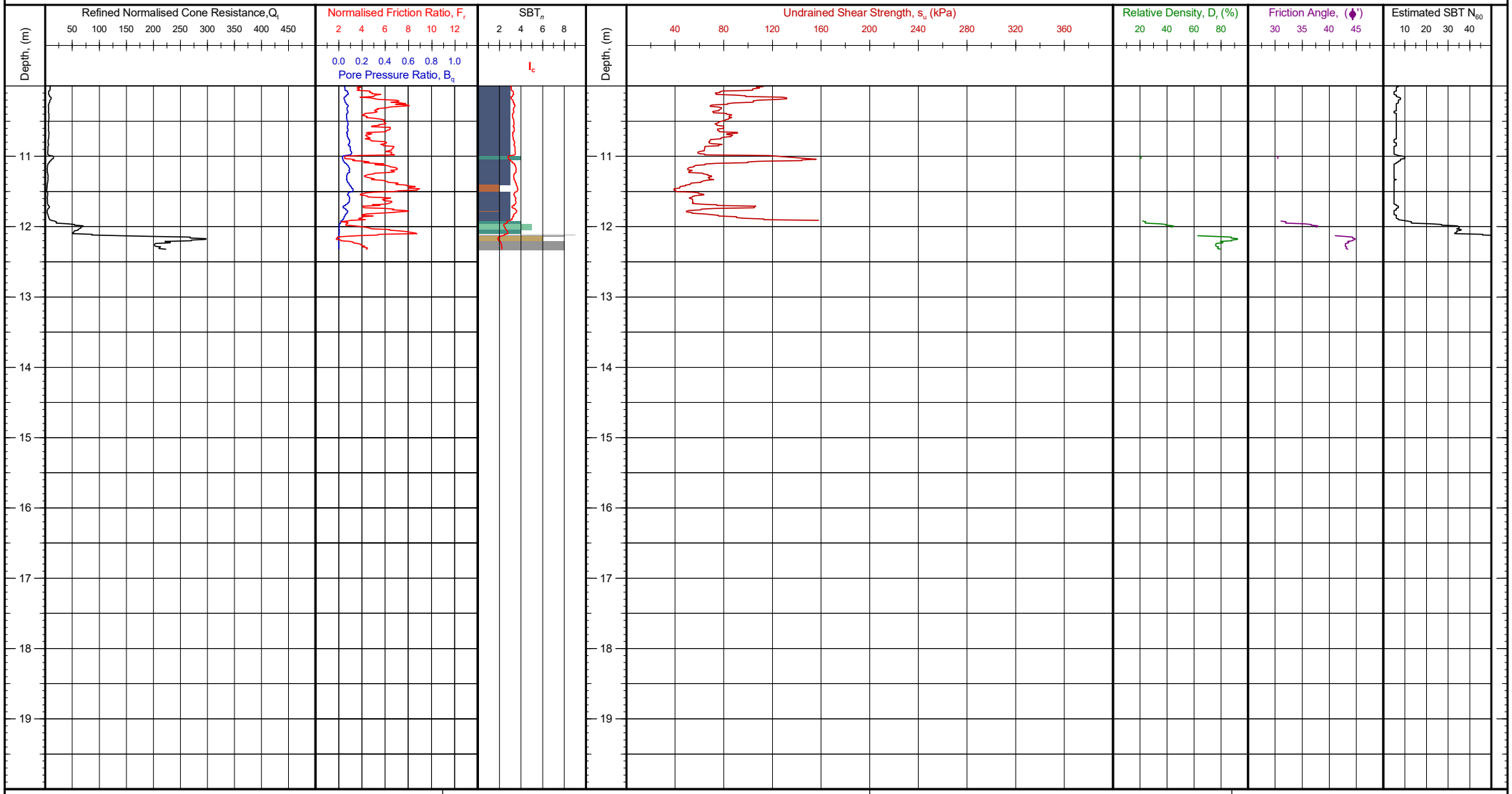
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-02**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

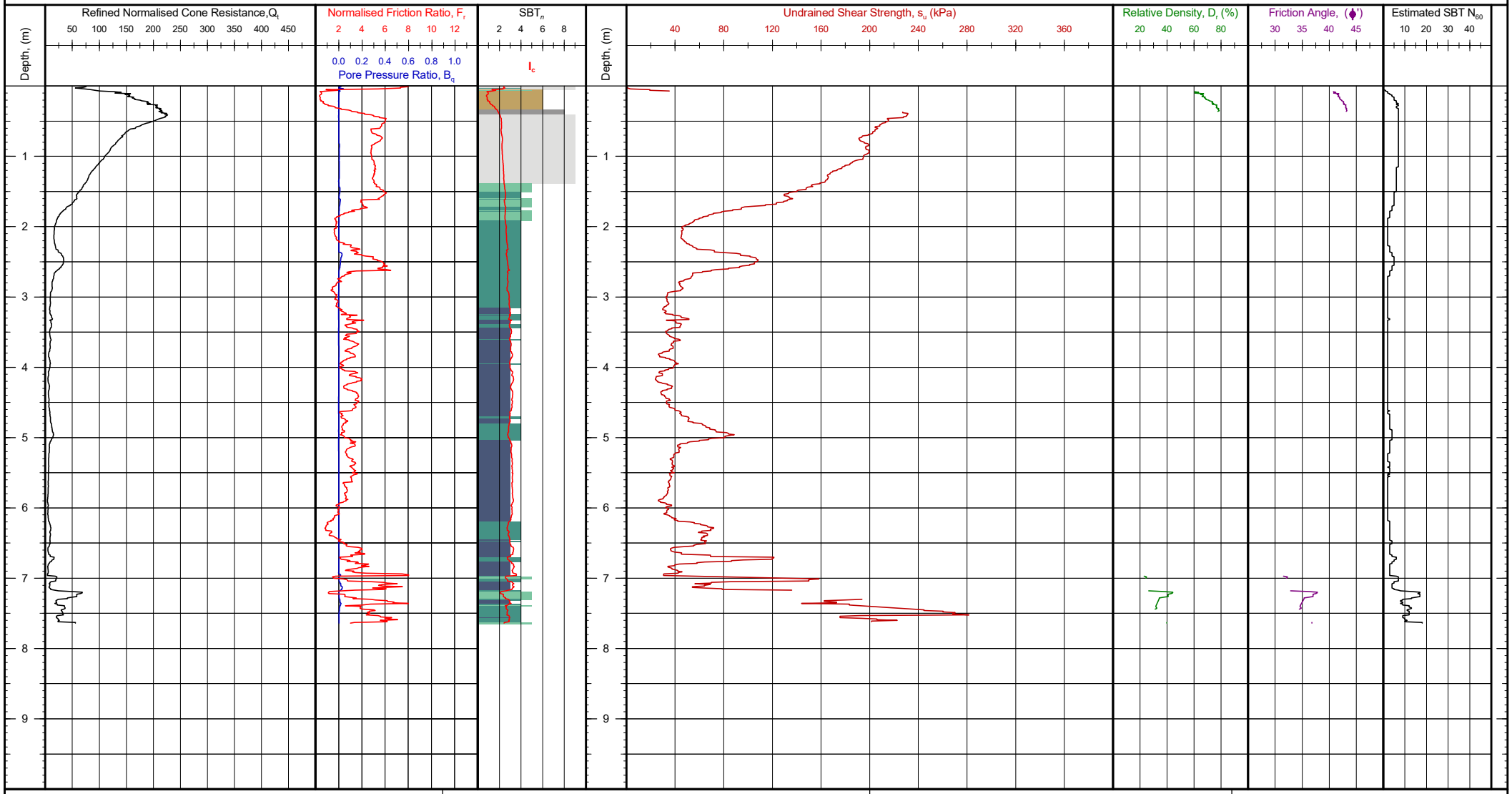
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-02**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

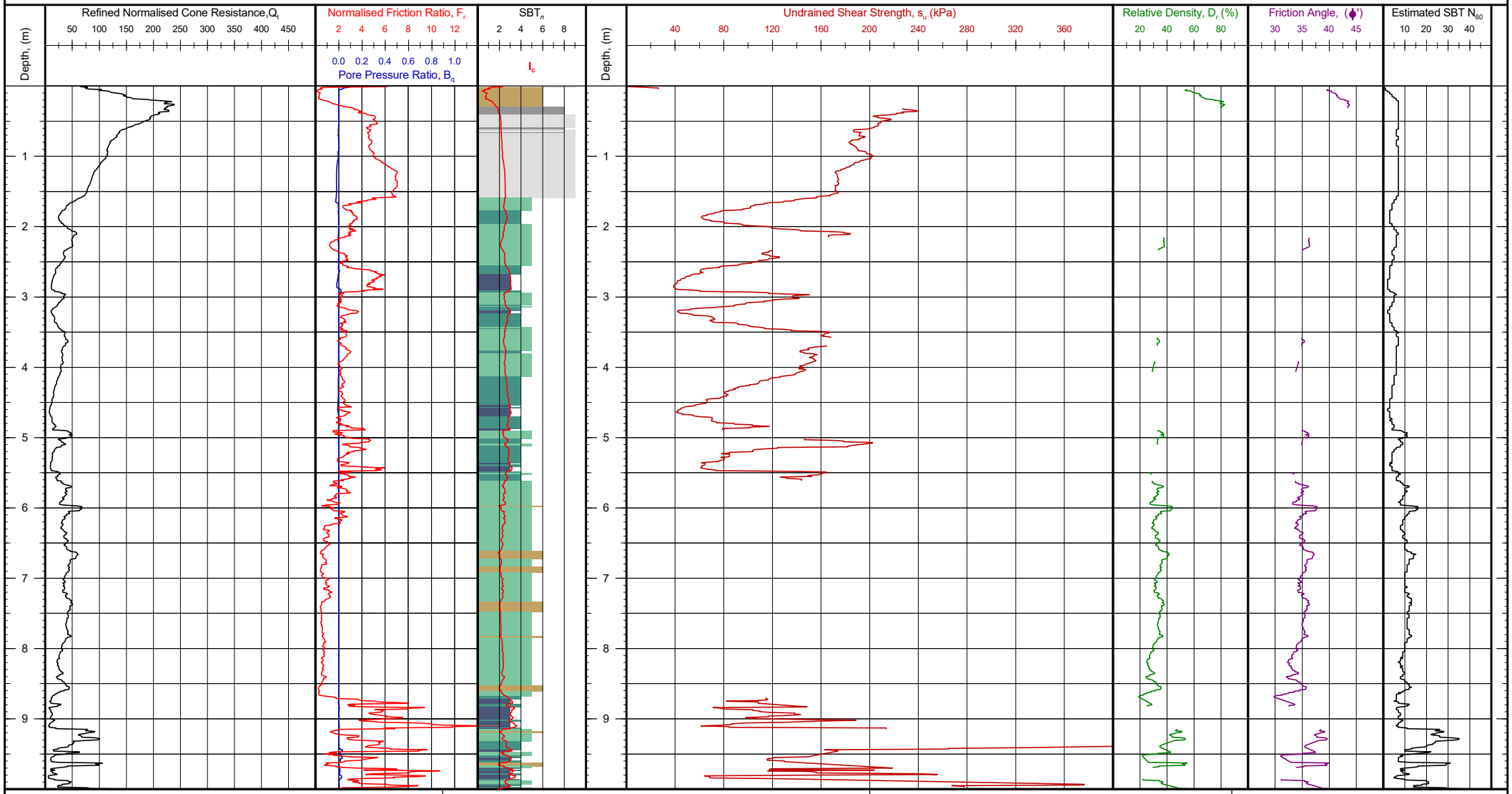
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-03**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

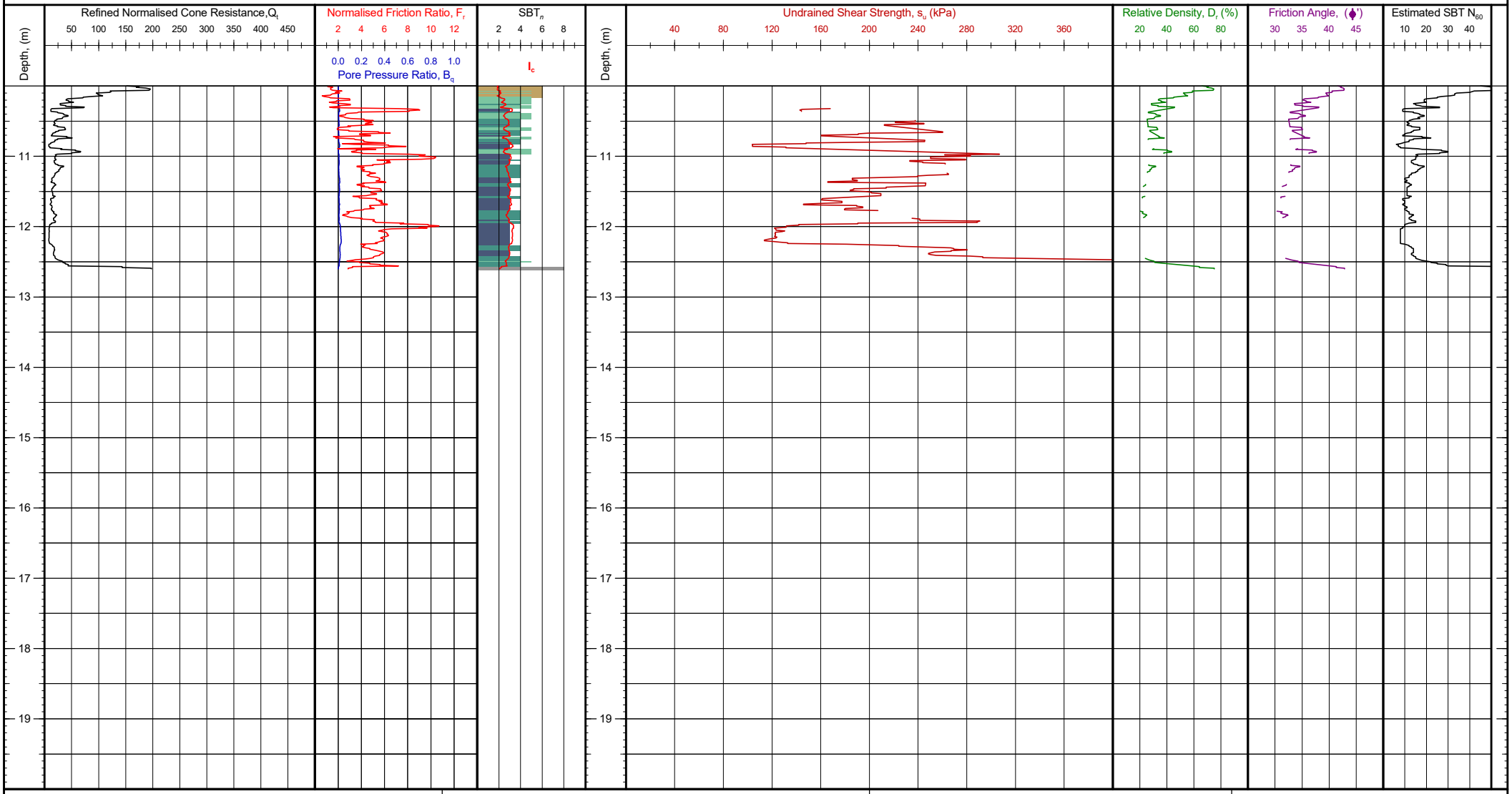
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-04**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

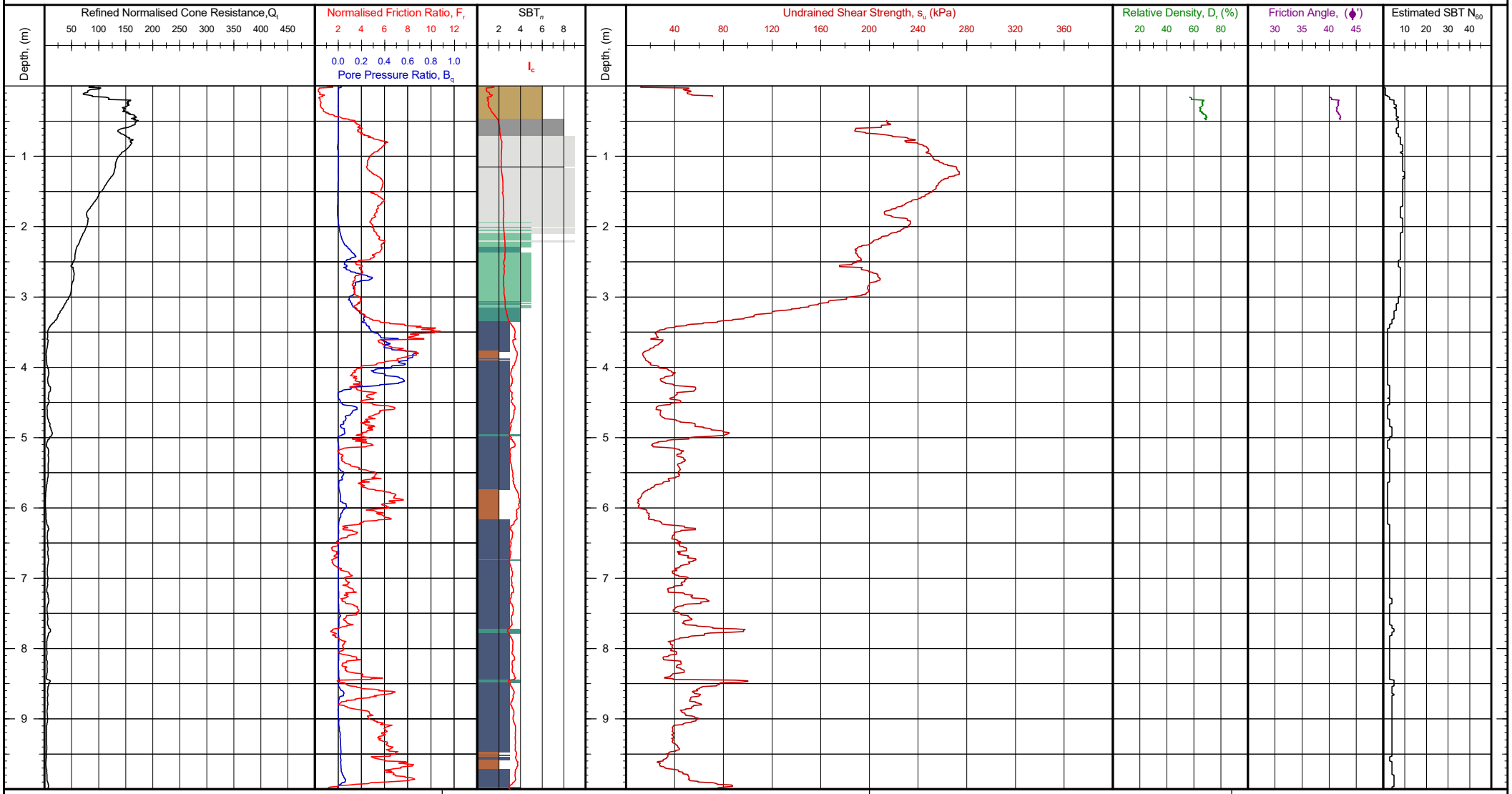
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-04**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

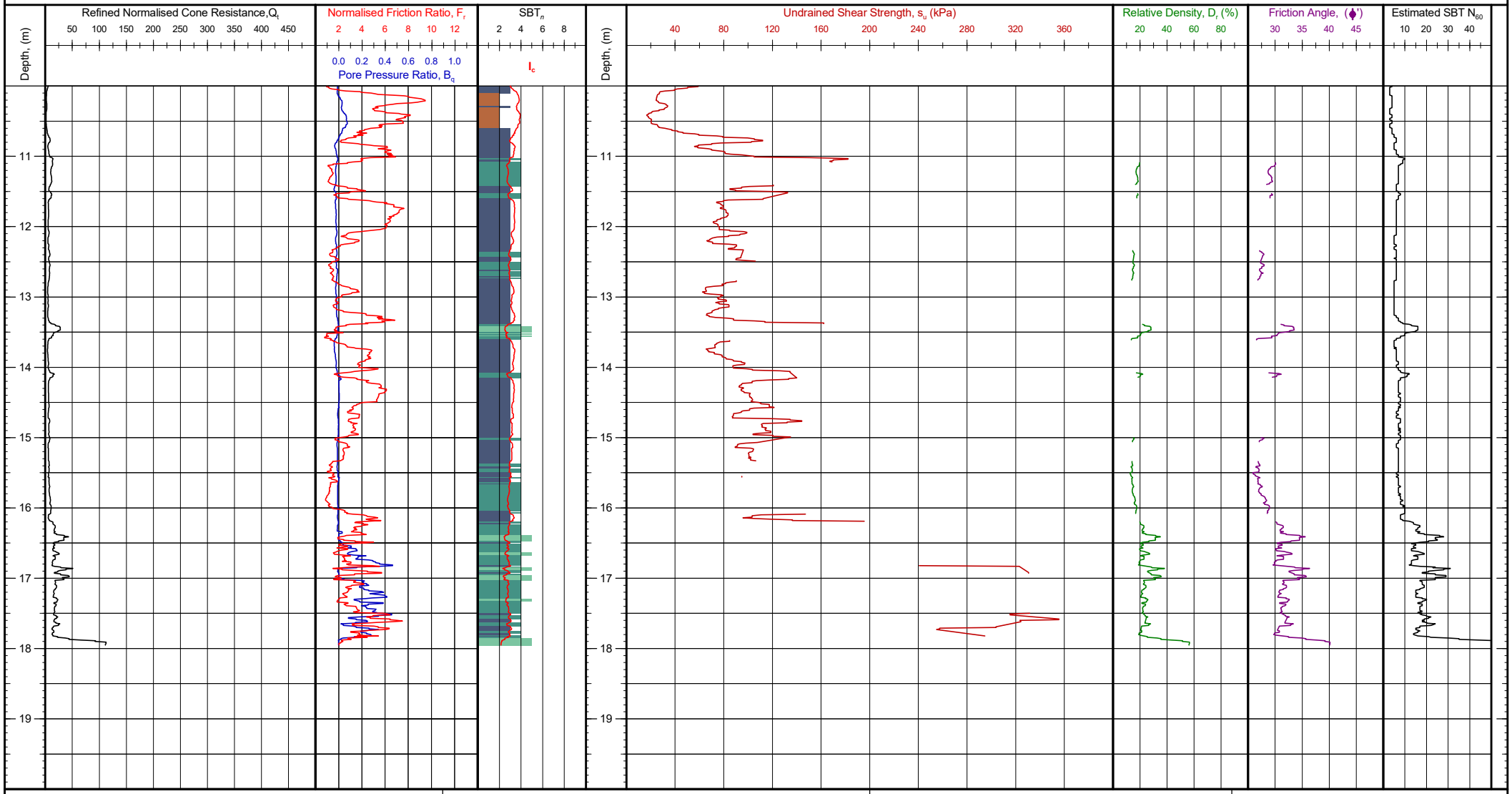
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-05**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

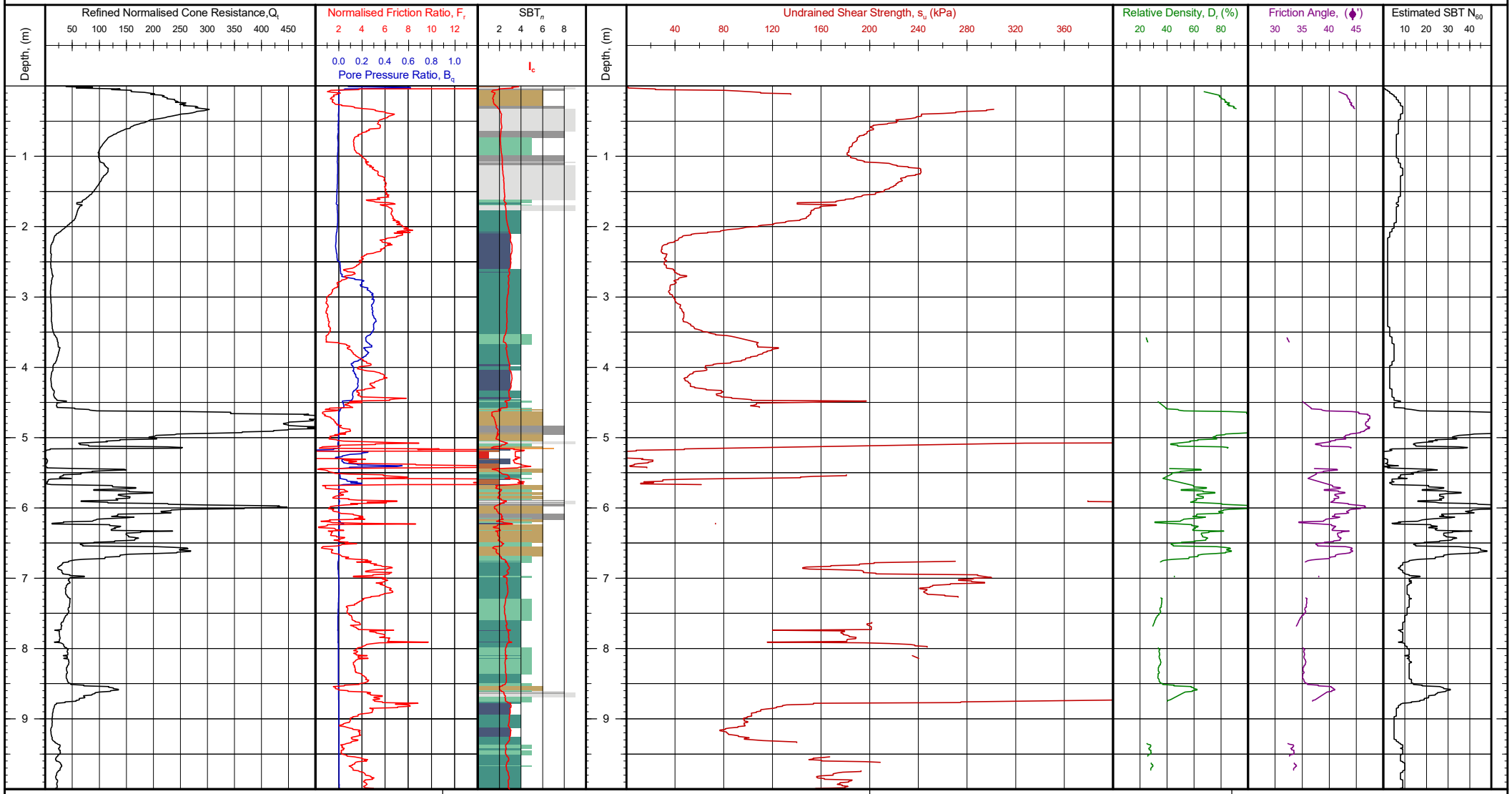
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-05**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

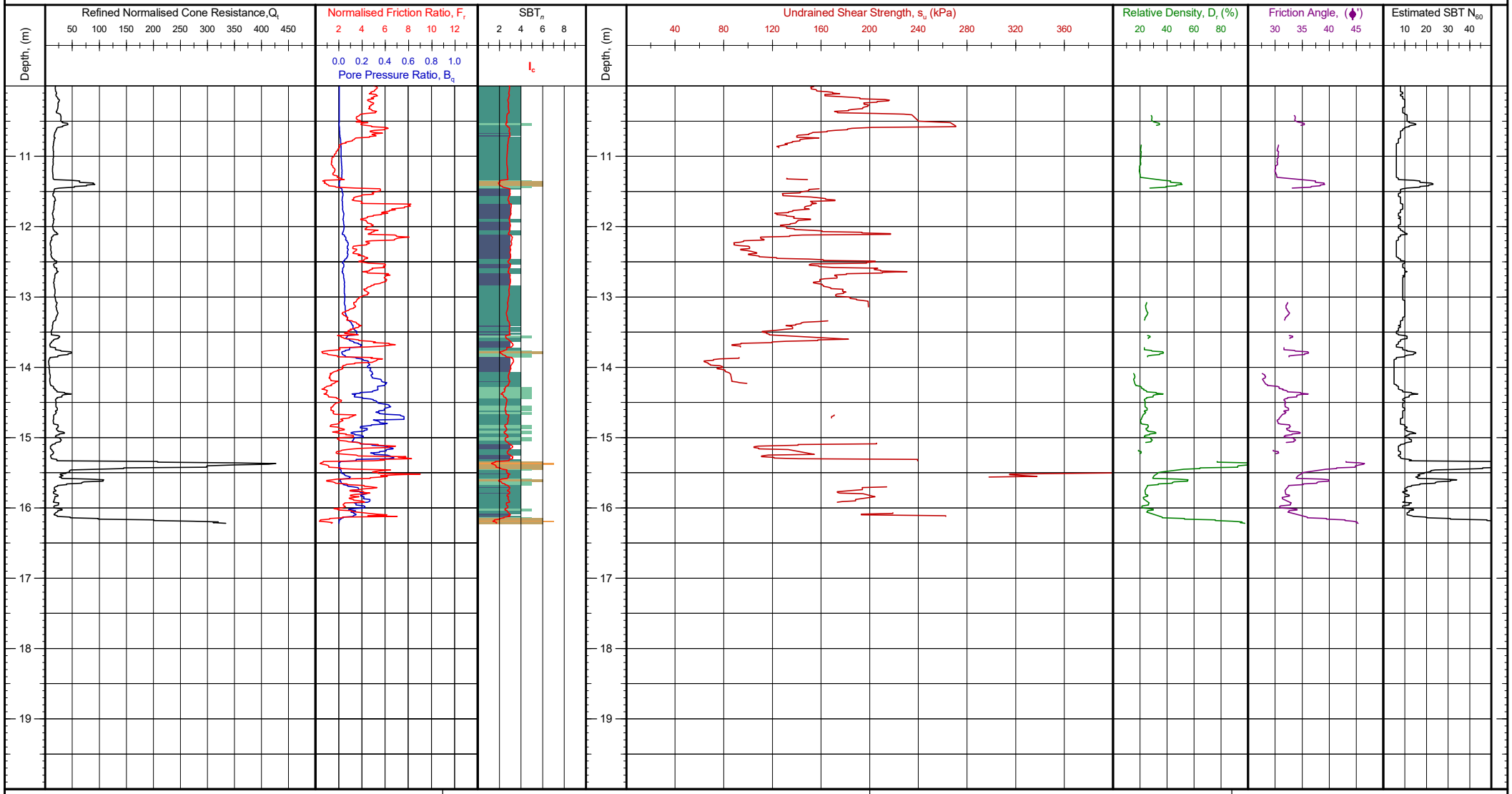
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-06**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

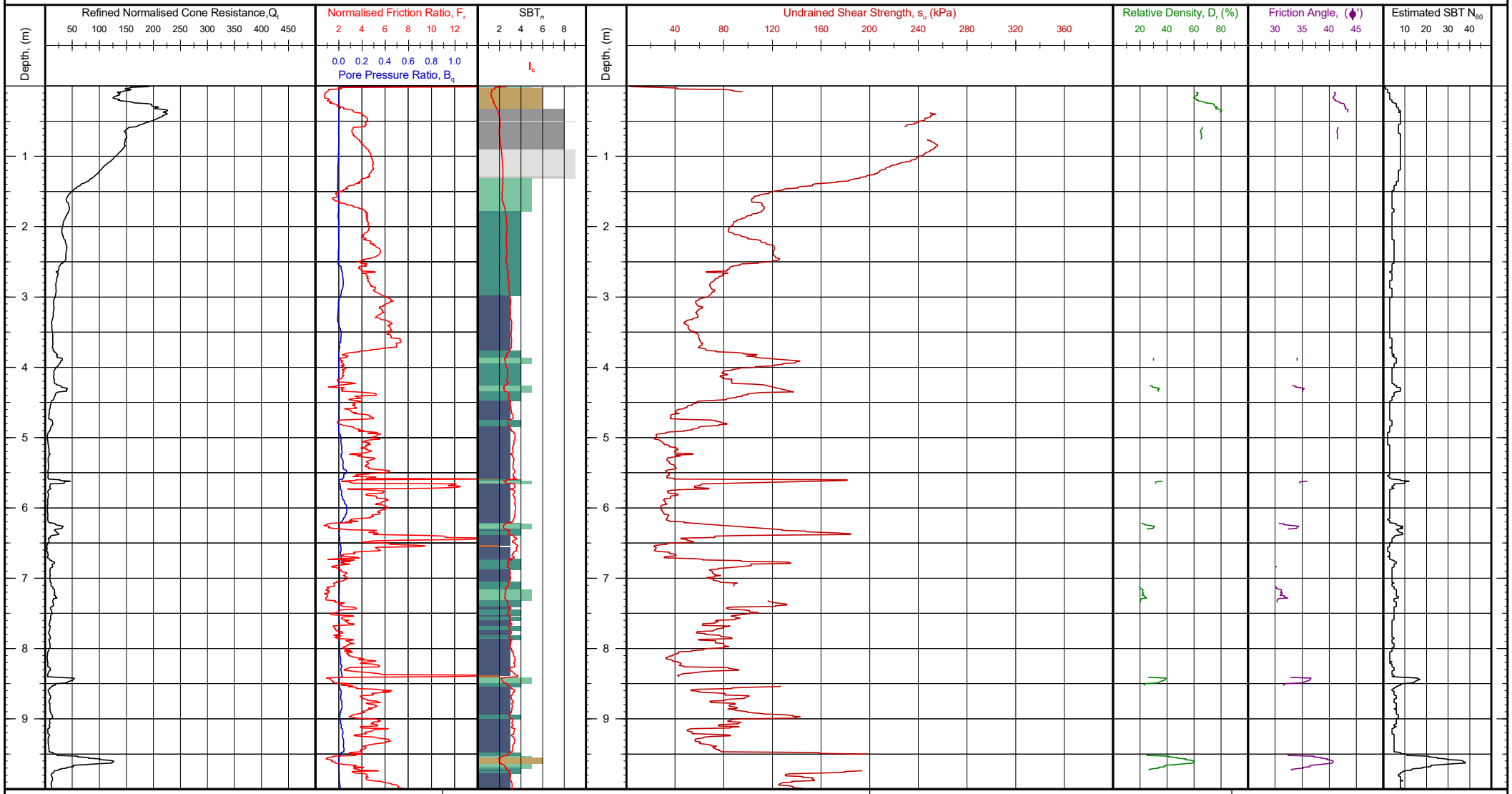
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-06**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

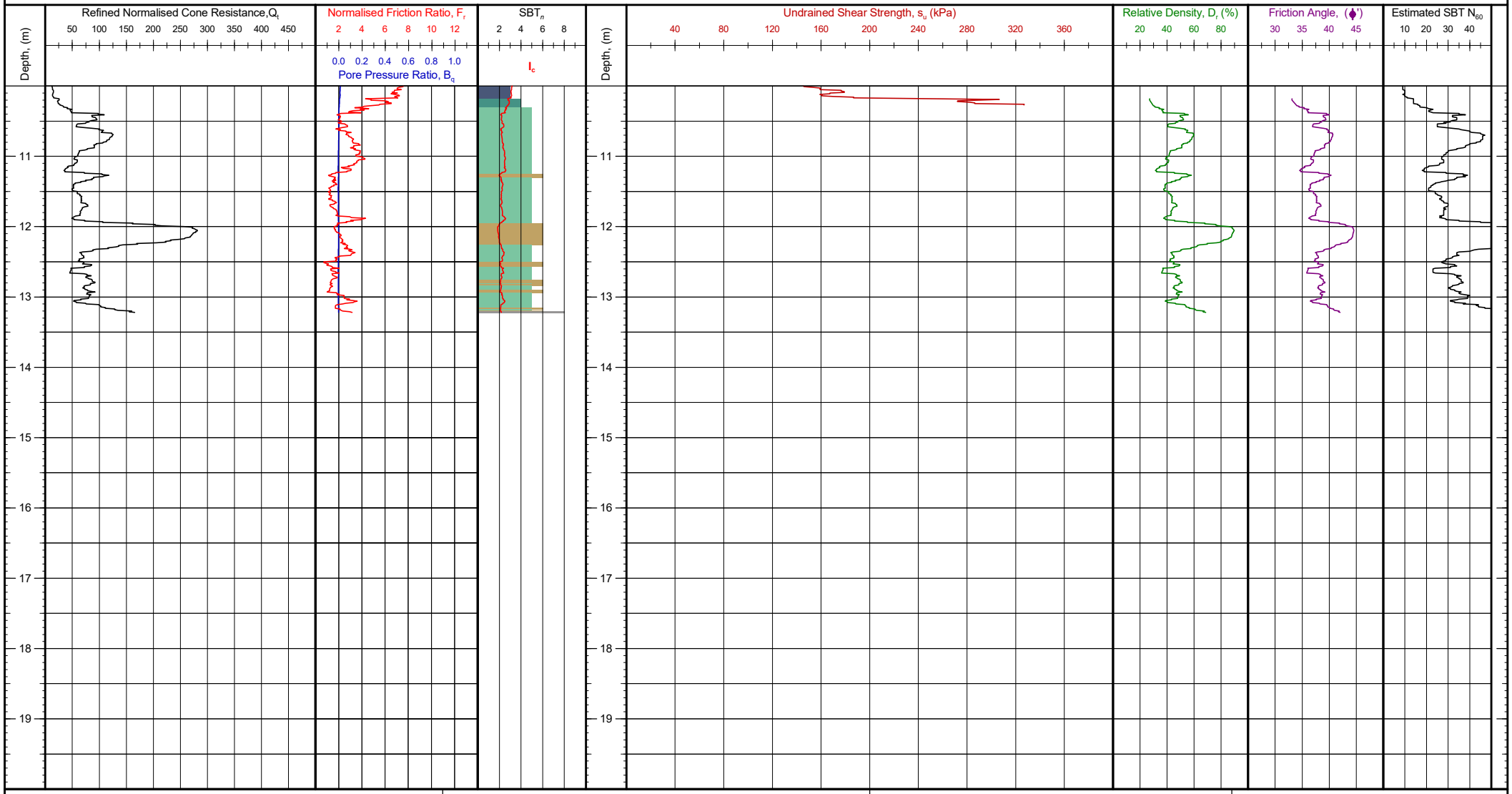
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-07**

G.I. Job Ref: 210082

CPT PARAMETER LOG



Client: LDE Ltd

Project: Dip Road

Location: Kamo, Whangarei

Engineer: Finlay Wallen-Halliwell

Contractor: Ground Investigation Ltd

Soil Behaviour Type SBT_n - Robertson et al. 1990

0	Undefined	5	Sand mixtures: silty sand to sandy silt
1	Sensitive fine grained	6	Sands: clean sands to silty sands
2	Organic: Organic clay/silt, peat	7	Dense sand to gravelly sand
3	Clay: clay to silty clay	8	Stiff sand to clayey sand
4	Silt mixtures: clayey silt & silty clay	9	Stiff silt/clay

Notes and Limitations:

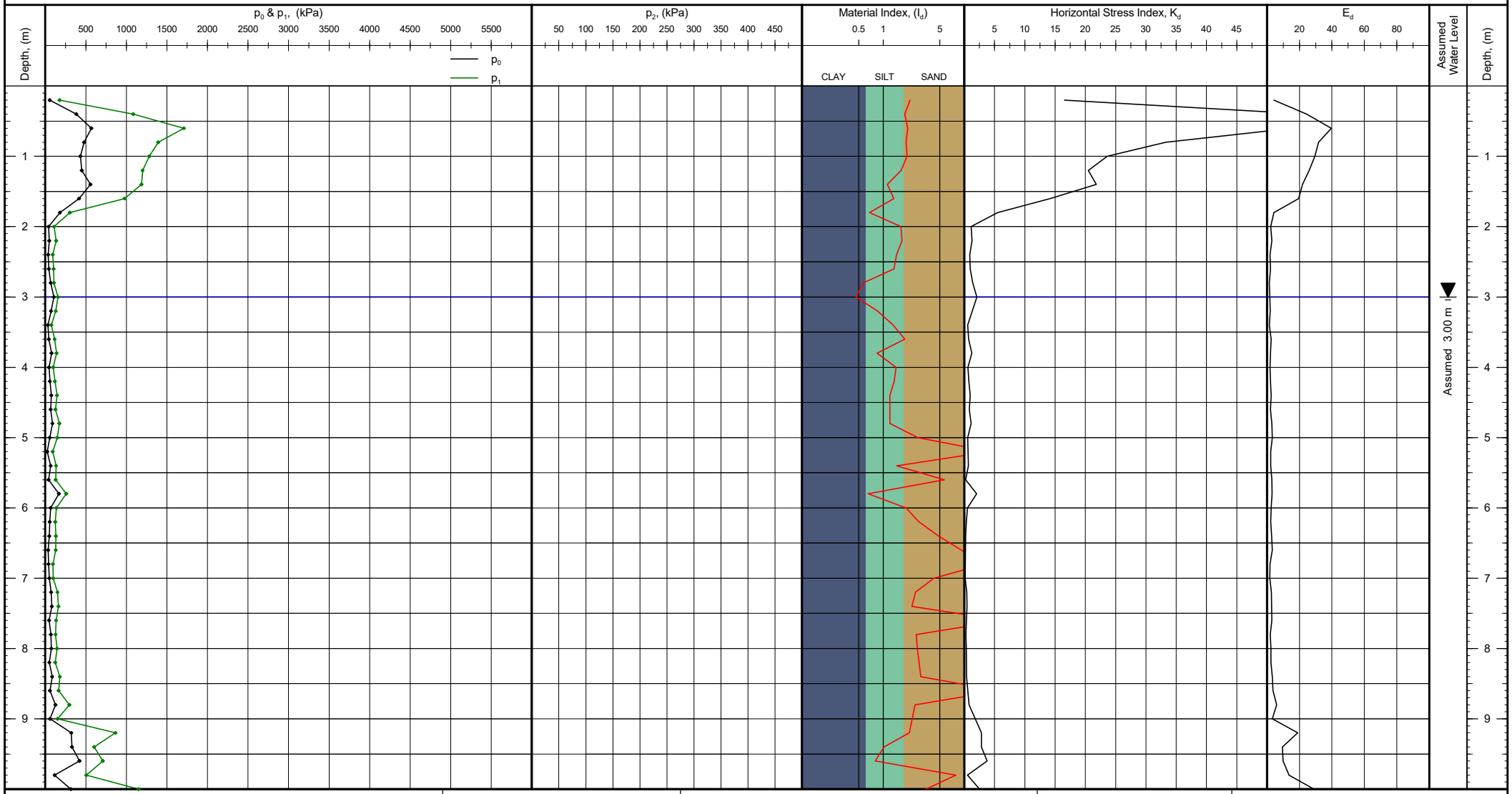
Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P.K. Robertson and K.L. Cabel (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use and should be carefully reviewed by the user. Ground Investigation Ltd. does not warrant the correctness or applicability of any of the geotechnical soil and design parameter shown and does not assume any liability for any use of the results in any design or review. The used should be fully aware of the techniques and limitations of any method used to derive data shown in this report.

Client Reference:

Test Number: **CPT-07**

G.I. Job Ref: 210082

FLAT DILATOMETER TEST (DMT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050552.71, 1716619.34	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682033,174.288747	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	11.80
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	8 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	69 kPa	**Termination Reason:**	Maximum Nominal Pressure		

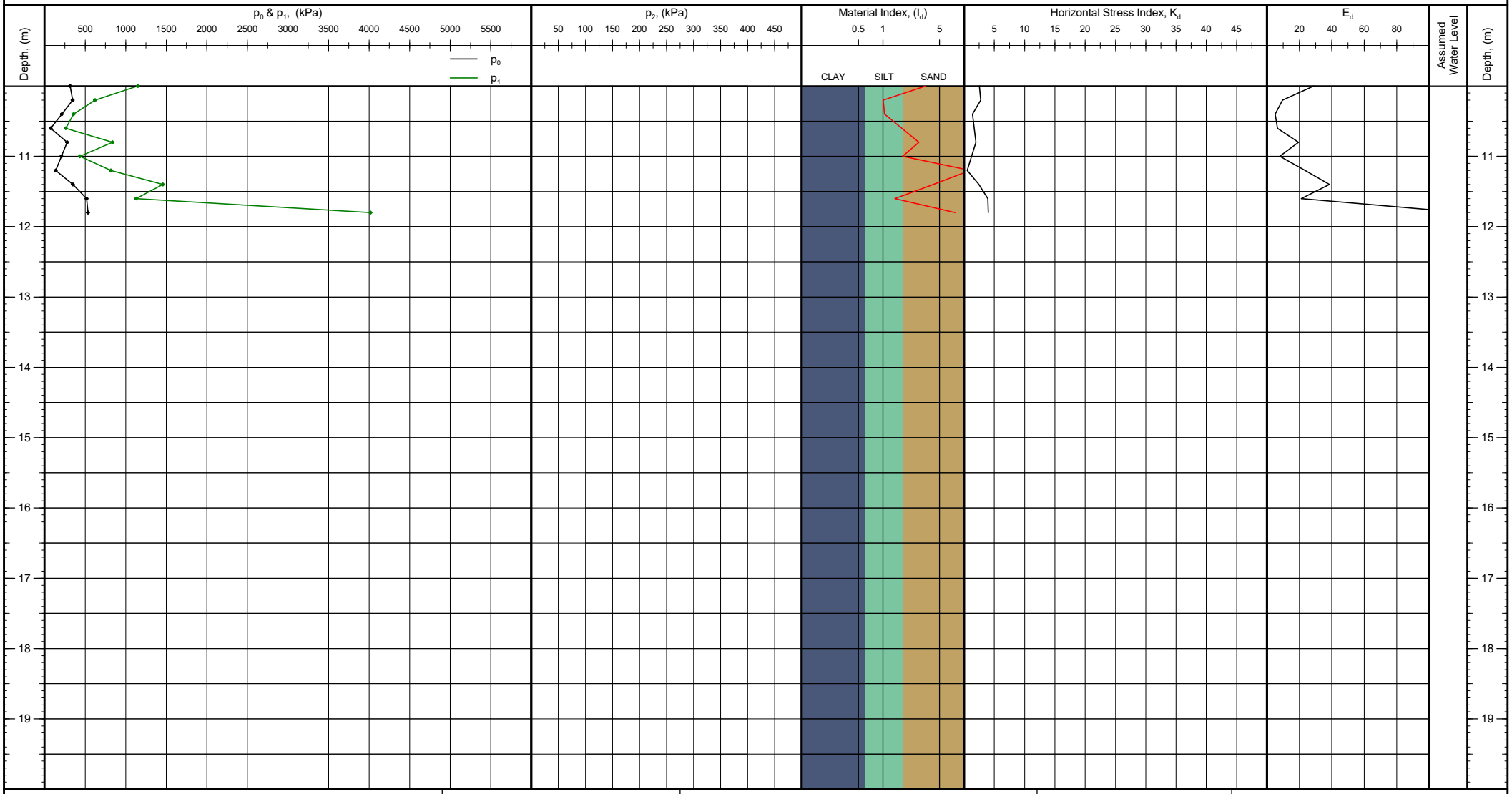
Client Reference:

Test Number: **DMT-01**

G.I. Job Ref: 210082

Comments:

FLAT DILATOMETER TEST (DMT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050552.71, 1716619.34	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682033,174.288747	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	11.80
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	8 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	69 kPa	**Termination Reason:**	Maximum Nominal Pressure		

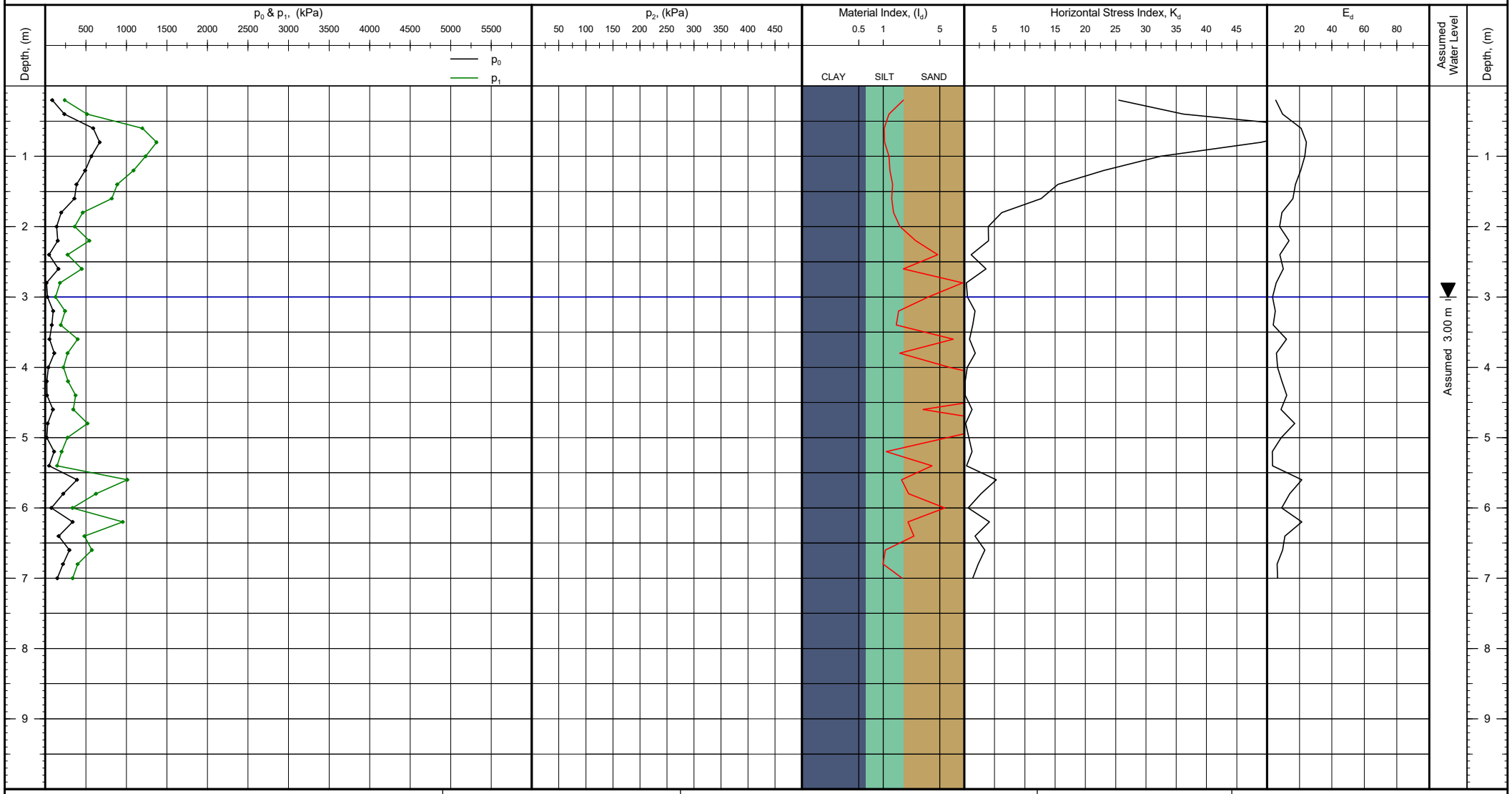
Client Reference:

Test Number: **DMT-01**

G.I. Job Ref: 210082

Comments:

FLAT DILATOMETER TEST (DMT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050496.52, 1716649.20	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682536,174.289085	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	7.60
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	8 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	74 kPa	**Termination Reason:**	Other - see notes		

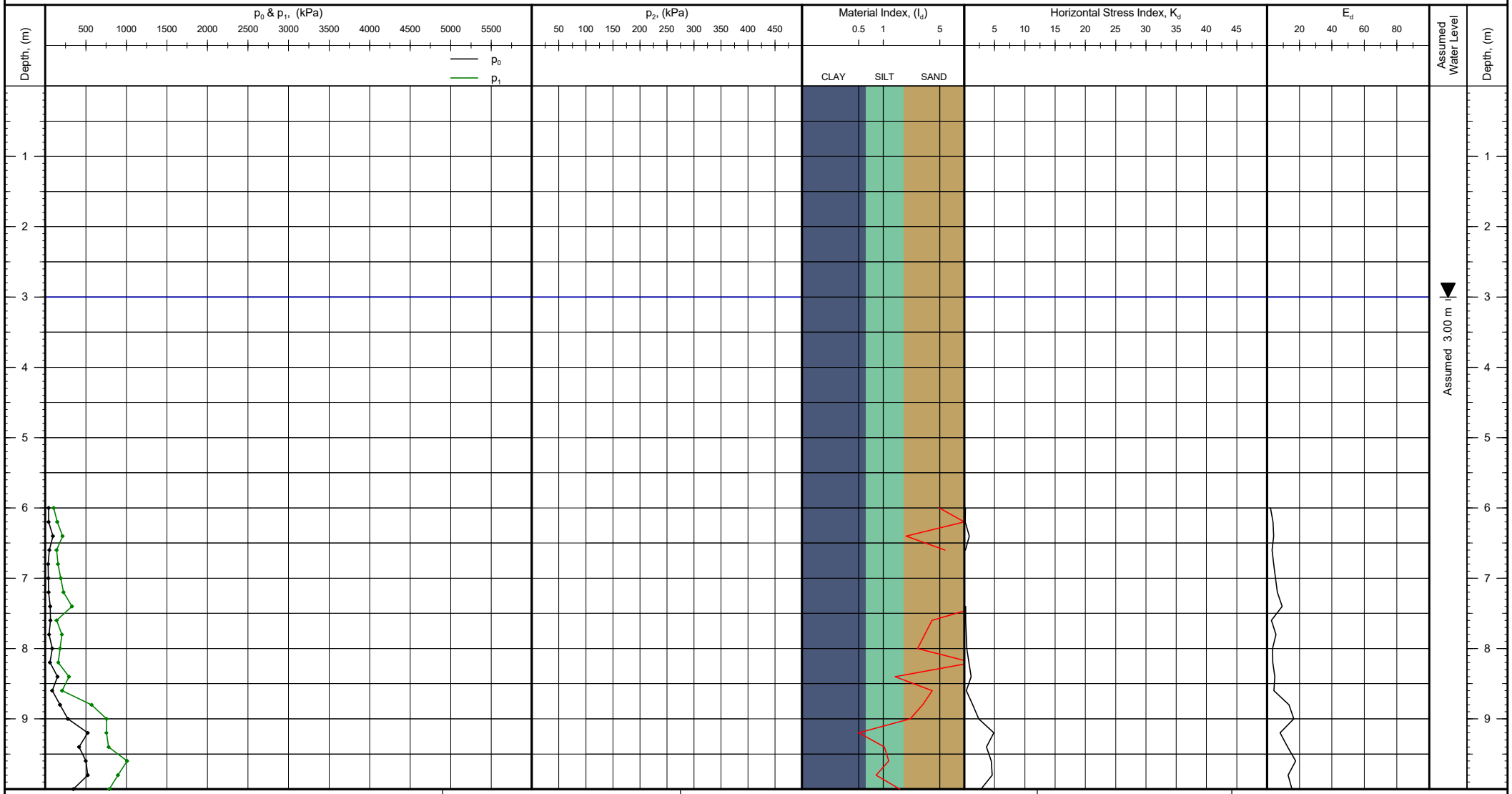
Client Reference:

Test Number: **SDMT-01**

G.I. Job Ref: 210082

Comments: Diagram overinflated, restart test from 6.00m with SDMT-01A

FLAT DILATOMETER TEST (DMT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050497.76, 1716647.50	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682525,174.289066	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	11.80
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	13 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	71 kPa	**Termination Reason:**	Maximum Nominal Pressure		

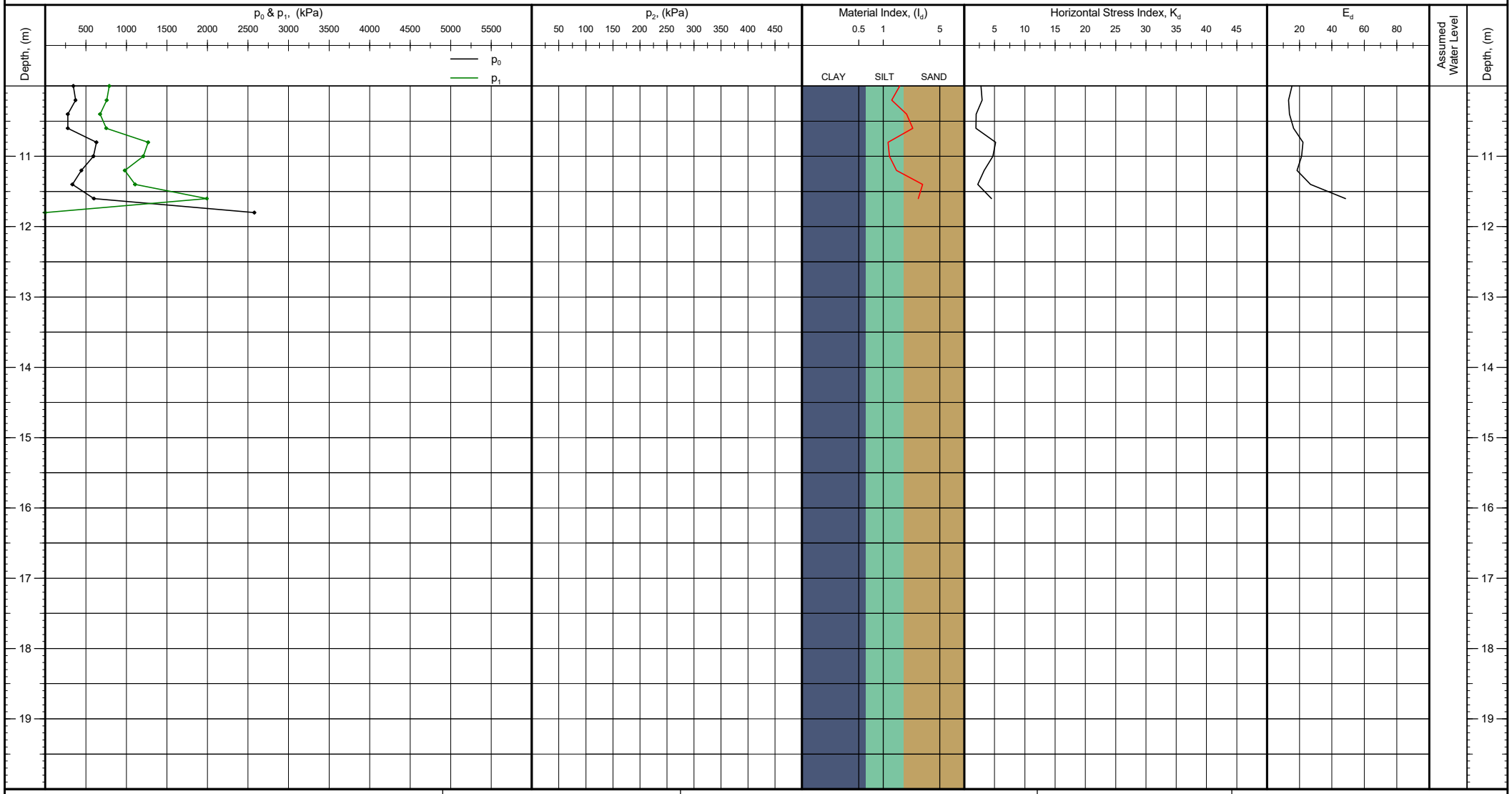
Client Reference:

Test Number: **SDMT-01A**

G.I. Job Ref: 210082

Comments:

FLAT DILATOMETER TEST (DMT) LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050497.76, 1716647.50	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682525,174.289066	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	11.80
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	13 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	71 kPa	**Termination Reason:**	Maximum Nominal Pressure		

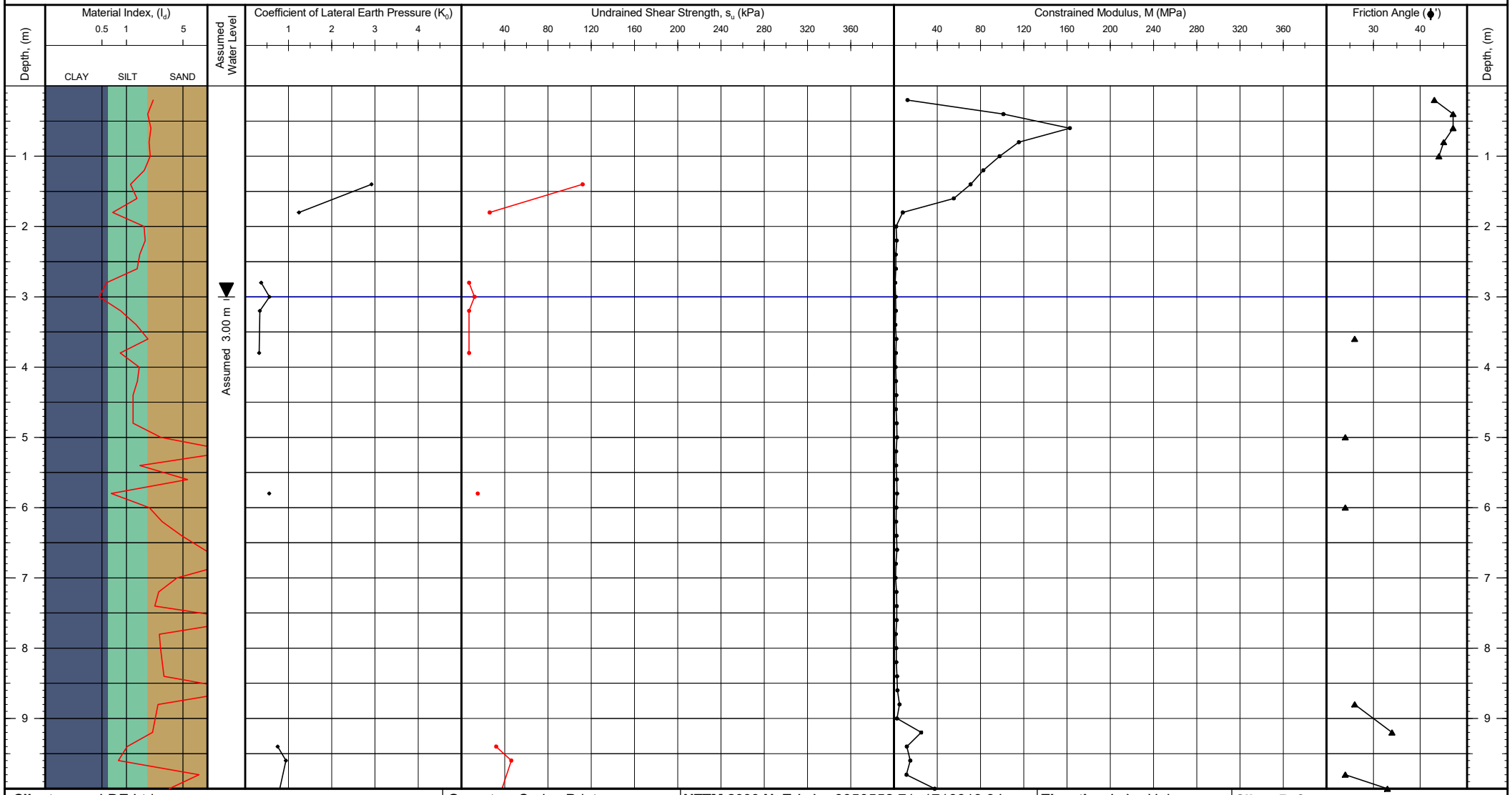
Client Reference:

Test Number: **SDMT-01A**

G.I. Job Ref: 210082

Comments:

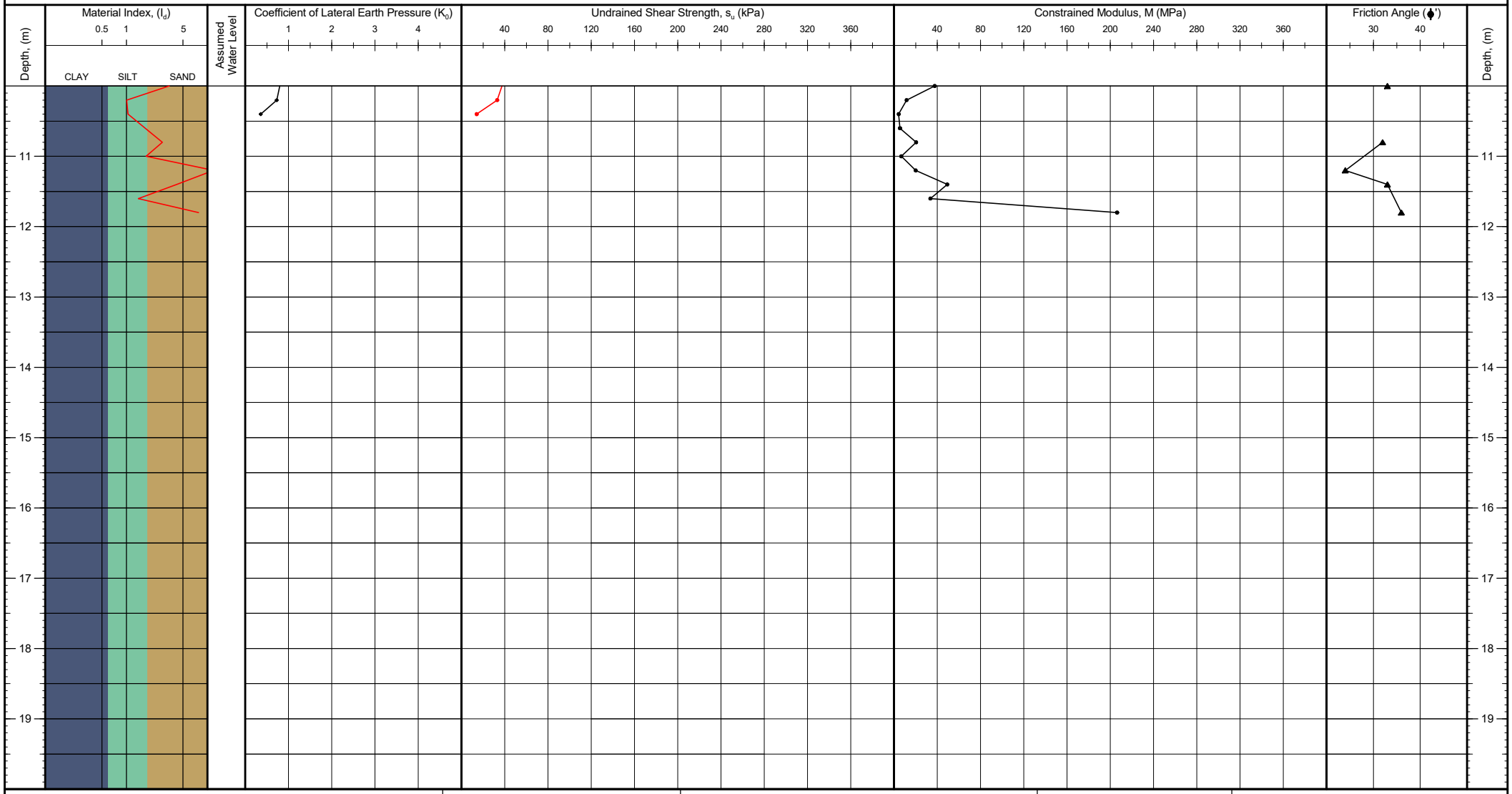
DMT PARAMETER LOG



Client: LDE Ltd	**Operator:** Carlos Prieto	**NZTM 2000 N, E (m):** 6050552.71, 1716619.34	**Elevation (m):** Unknown	**Client Reference:**	
Project: Dip Road	**Blade Reference:** N/A	**WGS84 (deg):** -35.682033,174.288747	**Date of Test:** 11/02/2021		
Location: Kamo, Whangarei	**Diaphragm Thickness:** 0.25 mm	**Location Method:** Handheld GPS	**Depth (m):** 11.80	**Test Number:**	**DMT-01**
Engineer: Finlay Wallen-Halliwell	**A-Reading Calibration:** 8 kPa	**Surveyor:**	**Pre Drill (m):** N/A		
Contractor: Ground Investigation Ltd	**B-Reading Calibration:** 69 kPa	**Termination Reason:** Maximum Nominal Pressure		**G.I. Job Ref:** 210082	

Comments:

DMT PARAMETER LOG



Client:	LDE Ltd	**Operator:**	Carlos Prieto	**NZTM 2000 N, E (m):**	6050552.71, 1716619.34	**Elevation (m):**	Unknown
Project:	Dip Road	**Blade Reference:**	N/A	**WGS84 (deg):**	-35.682033,174.288747	**Date of Test:**	11/02/2021
Location:	Kamo, Whangarei	**Diaphragm Thickness:**	0.25 mm	**Location Method:**	Handheld GPS	**Depth (m):**	11.80
Engineer:	Finlay Wallen-Halliwell	**A-Reading Calibration:**	8 kPa	**Surveyor:**		**Pre Drill (m):**	N/A
Contractor:	Ground Investigation Ltd	**B-Reading Calibration:**	69 kPa	**Termination Reason:**	Maximum Nominal Pressure		

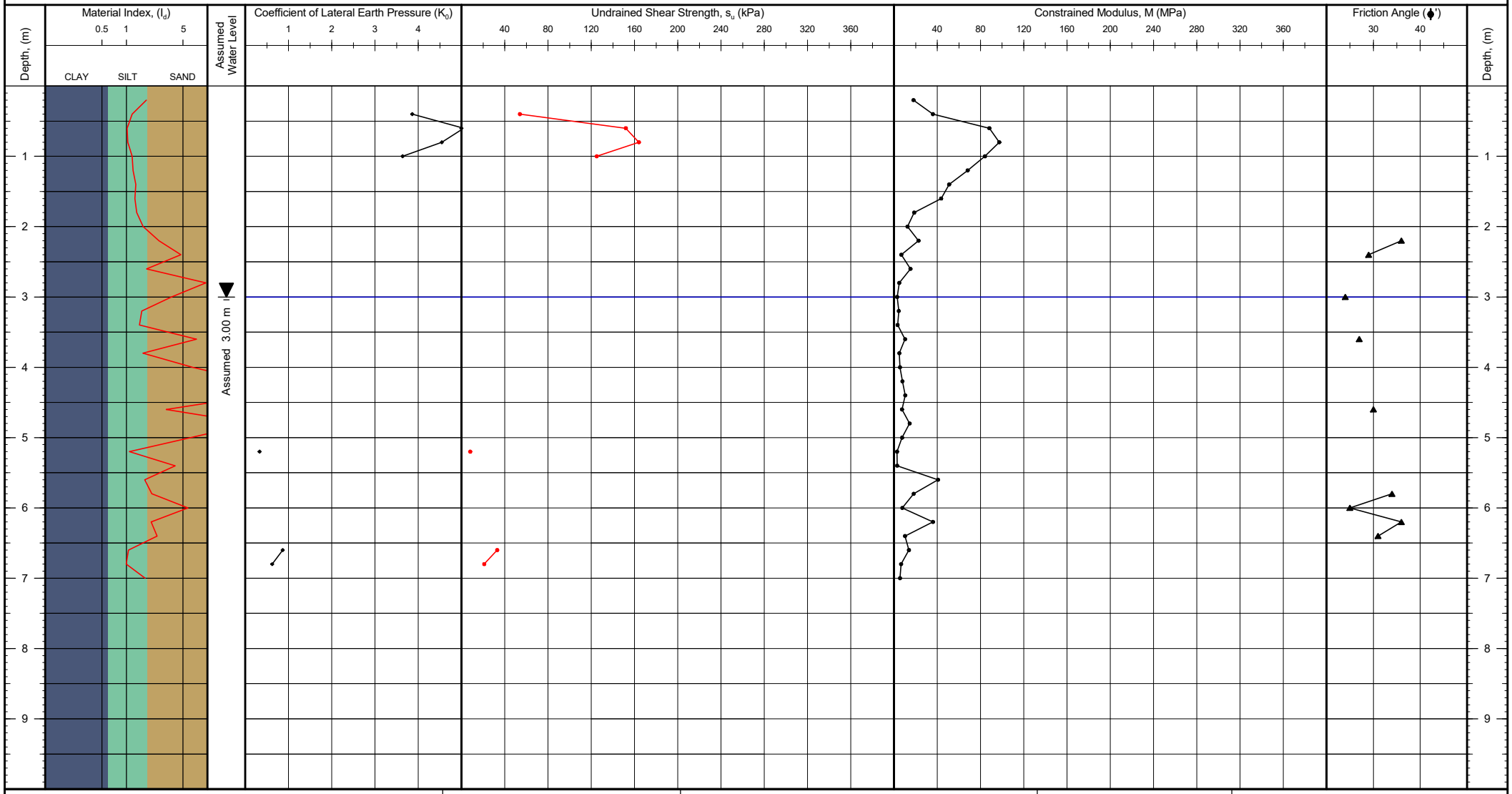
Client Reference:

Test Number: **DMT-01**

G.I. Job Ref: 210082

Comments:

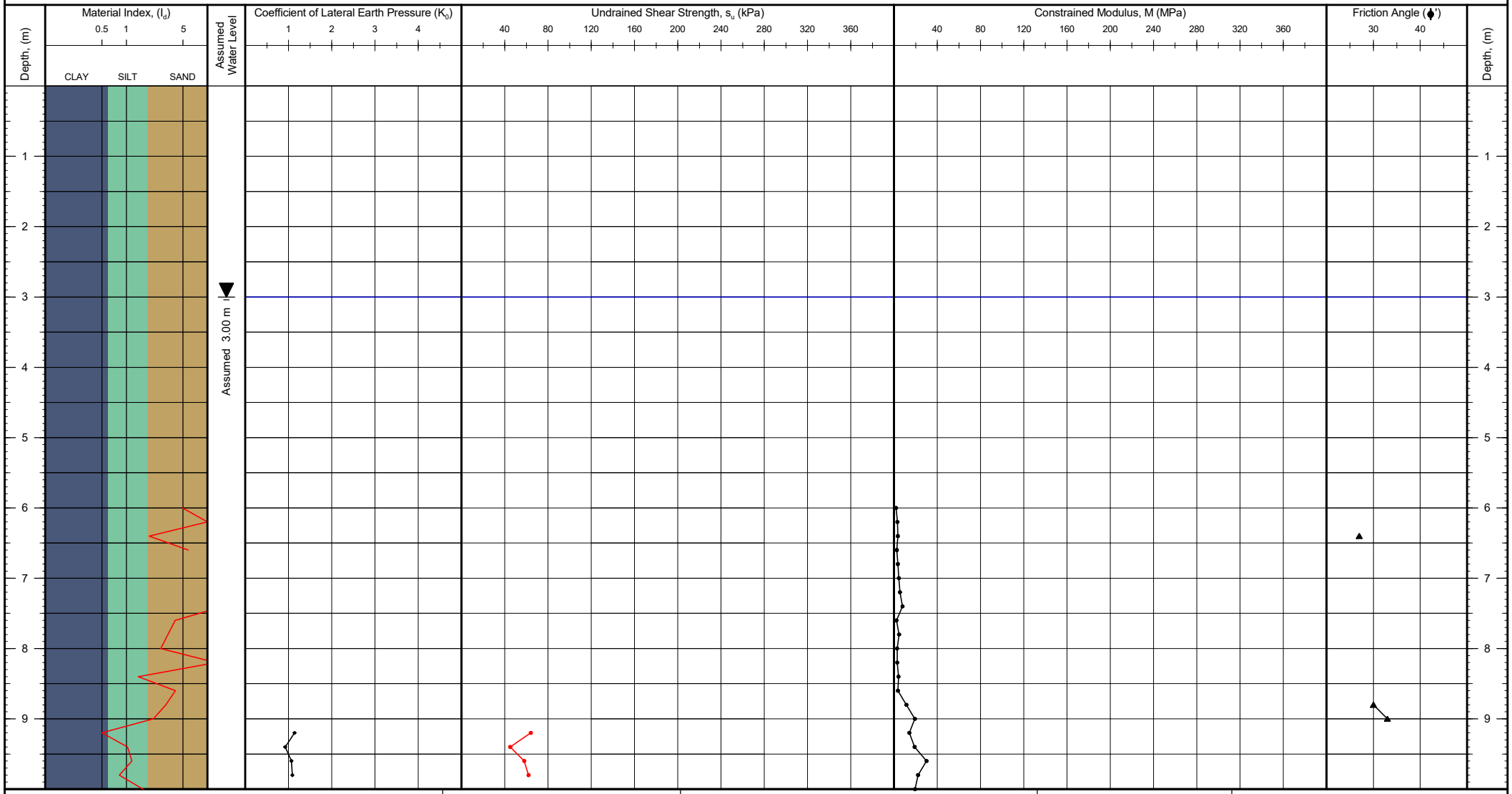
DMT PARAMETER LOG



Client: LDE Ltd	**Operator:** Carlos Prieto	**NZTM 2000 N, E (m):** 6050496.52, 1716649.20	**Elevation (m):** Unknown	**Client Reference:**	
Project: Dip Road	**Blade Reference:** N/A	**WGS84 (deg):** -35.682536,174.289085	**Date of Test:** 11/02/2021		
Location: Kamo, Whangarei	**Diaphragm Thickness:** 0.25 mm	**Location Method:** Handheld GPS	**Depth (m):** 7.60	**Test Number:** SDMT-01	
Engineer: Finlay Wallen-Halliwell	**A-Reading Calibration:** 8 kPa	**Surveyor:**	**Pre Drill (m):** N/A		
Contractor: Ground Investigation Ltd	**B-Reading Calibration:** 74 kPa	**Termination Reason:** Other - see notes		**G.I. Job Ref:** 210082	

Comments: Diagram overinflated, restart test from 6.00m with SDMT-01A

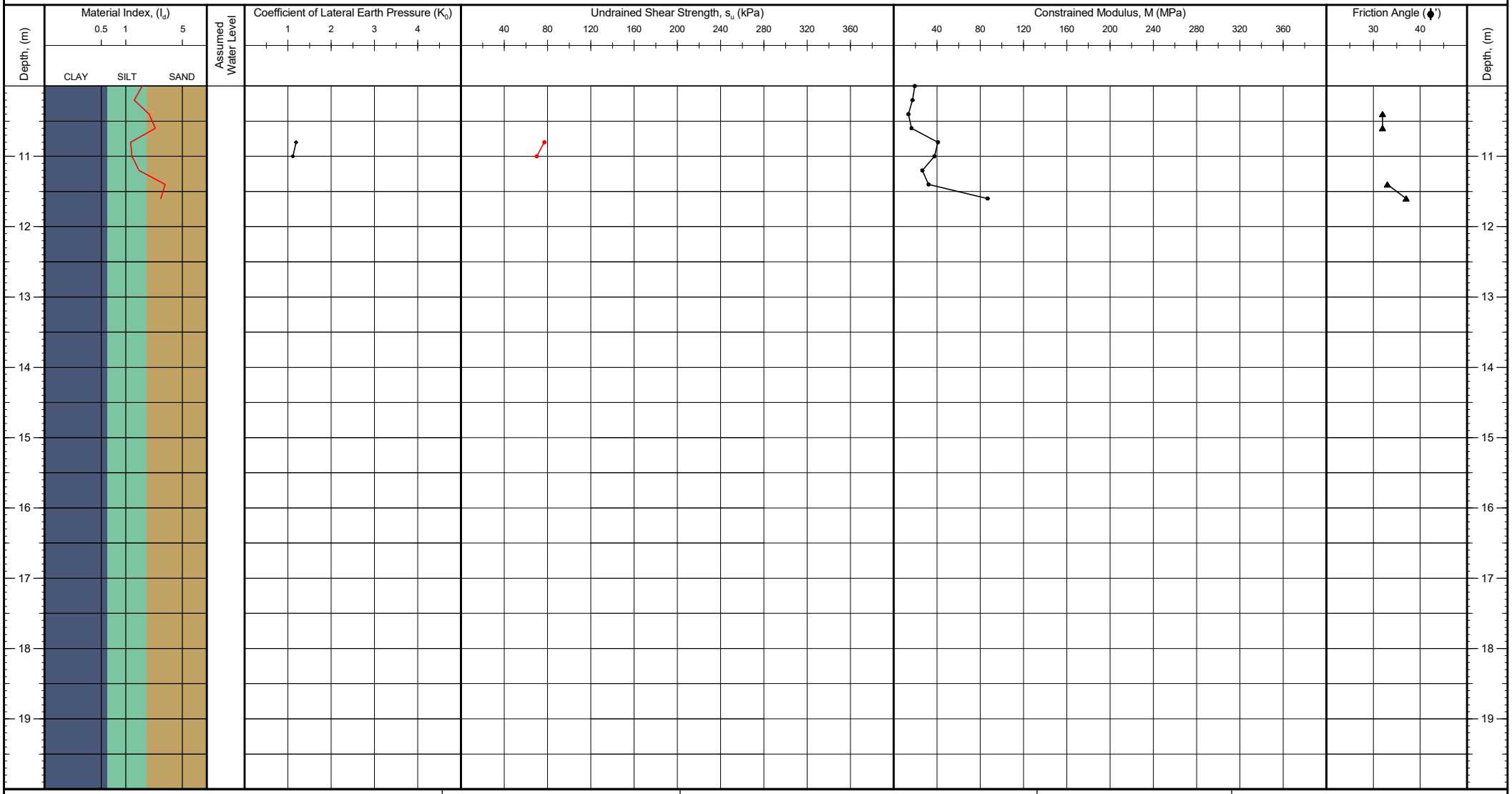
DMT PARAMETER LOG



Client: LDE Ltd	**Operator:** Carlos Prieto	**NZTM 2000 N, E (m):** 6050497.76, 1716647.50	**Elevation (m):** Unknown	**Client Reference:**	
Project: Dip Road	**Blade Reference:** N/A	**WGS84 (deg):** -35.682525,174.289066	**Date of Test:** 11/02/2021	**Test Number:** SDMT-01A	
Location: Kamo, Whangarei	**Diaphragm Thickness:** 0.25 mm	**Location Method:** Handheld GPS	**Depth (m):** 11.80		
Engineer: Finlay Wallen-Halliwell	**A-Reading Calibration:** 13 kPa	**Surveyor:**	**Pre Drill (m):** N/A		
Contractor: Ground Investigation Ltd	**B-Reading Calibration:** 71 kPa	**Termination Reason:** Maximum Nominal Pressure		**G.I. Job Ref:** 210082	

Comments:

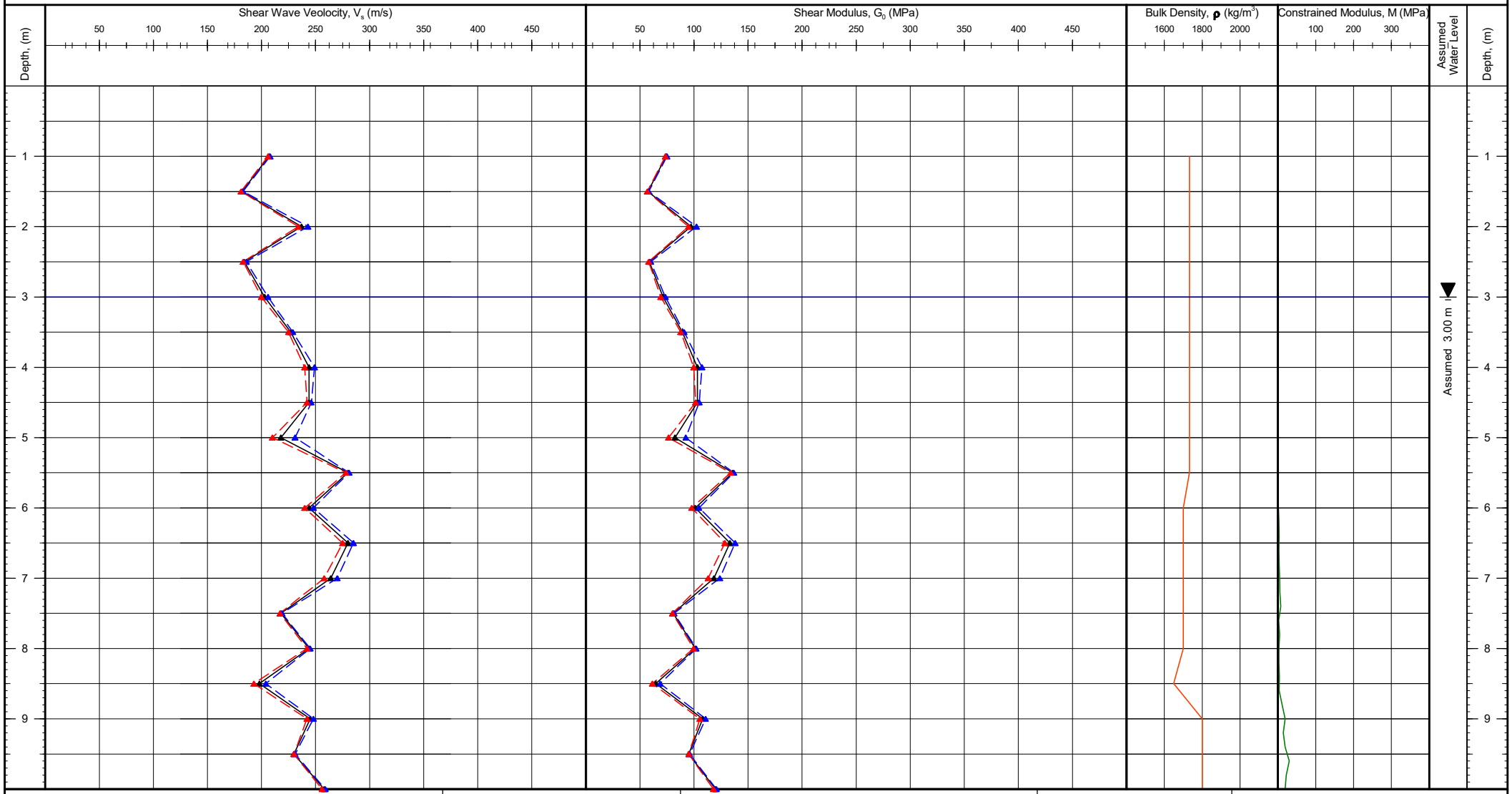
DMT PARAMETER LOG



Client: LDE Ltd	**Operator:** Carlos Prieto	**NZTM 2000 N, E (m):** 6050497.76, 1716647.50	**Elevation (m):** Unknown	**Client Reference:**	
Project: Dip Road	**Blade Reference:** N/A	**WGS84 (deg):** -35.682525,174.289066	**Date of Test:** 11/02/2021	**Test Number:**	**SDMT-01A**
Location: Kamo, Whangarei	**Diaphragm Thickness:** 0.25 mm	**Location Method:** Handheld GPS	**Depth (m):** 11.80		
Engineer: Finlay Wallen-Halliwell	**A-Reading Calibration:** 13 kPa	**Surveyor:**	**Pre Drill (m):** N/A		
Contractor: Ground Investigation Ltd	**B-Reading Calibration:** 71 kPa	**Termination Reason:** Maximum Nominal Pressure		**G.I. Job Ref:** 210082	

Comments:

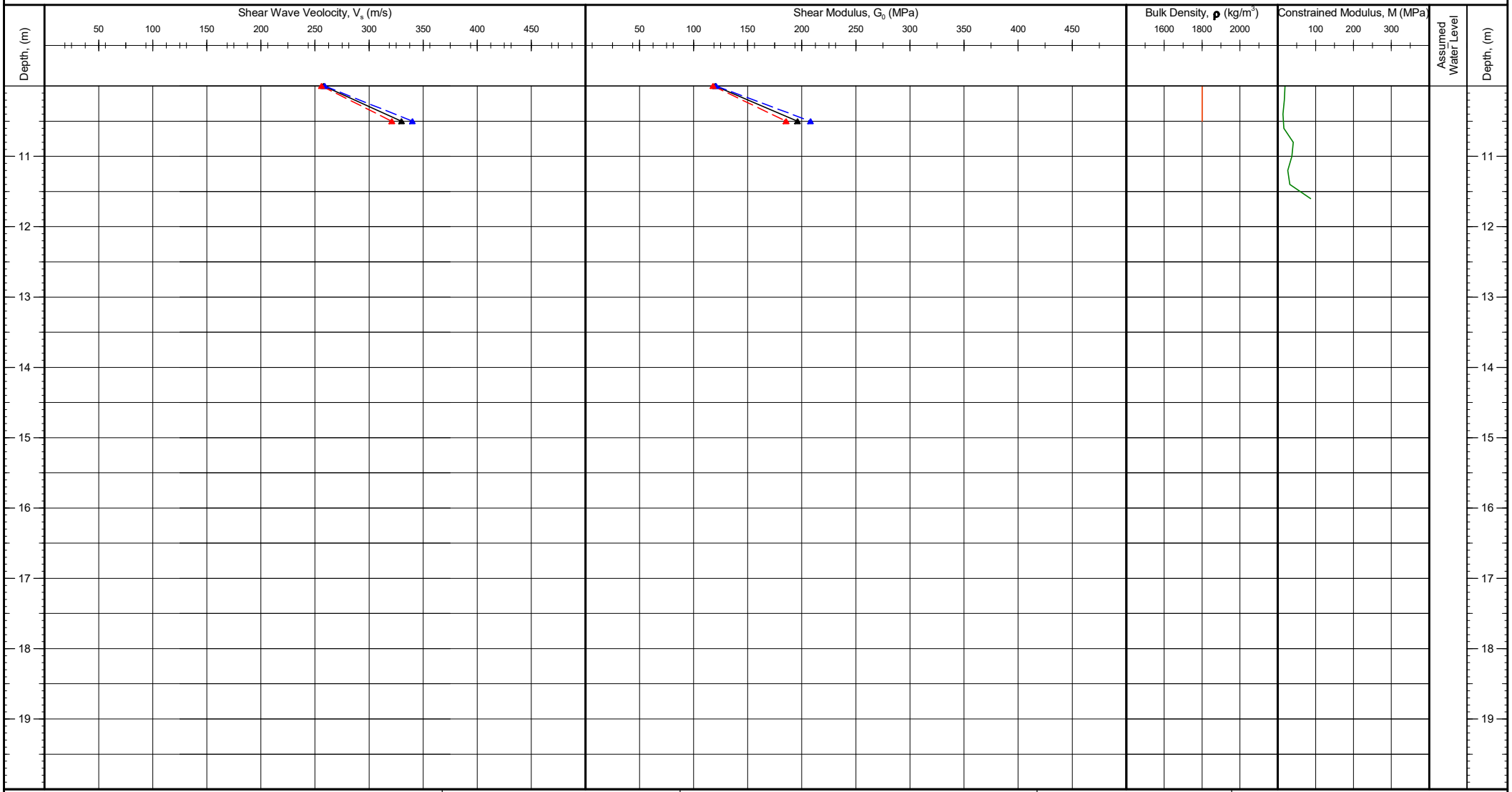
FLAT DILATOMETER TEST (DMT) SEISMIC LOG



Client:	LDE Ltd	Estimated from CPT	**NZTM 2000 N, E (m):** 6050497.76, 1716647.50	**Elevation (m):** Unknown	**Client Reference:**
Project:	Dip Road	Measured Lower Bound	**WGS84 (deg):** -35.682525,174.289066	**Date of Test:** 11/02/2021	
Location:	Kamo, Whangarei	Measured Average Bound	**Location Method:** Handheld GPS	**Depth (m):** 11.80	**Test Number:** SDMT-01A
Engineer:	Finlay Wallen-Halliwell	Measured Upper Bound	**Surveyor:**	**Pre Drill (m):** N/A	
Contractor:	Ground Investigation Ltd	ρ from G_0 Calculation	**Termination Reason:** Maximum Nominal Pressure		**G.I. Job Ref:** 210082

Comments:

FLAT DILATOMETER TEST (DMT) SEISMIC LOG



Client:	LDE Ltd	Estimated from CPT	**NZTM 2000 N, E (m):**	6050497.76, 1716647.50	**Elevation (m):**	Unknown	**Client Reference:**
Project:	Dip Road	Measured Lower Bound	**WGS84 (deg):**	-35.682525,174.289066	**Date of Test:**	11/02/2021	
Location:	Kamo, Whangarei	Measured Average Bound	**Location Method:**	Handheld GPS	**Depth (m):**	11.80	**Test Number:** SDMT-01A
Engineer:	Finlay Wallen-Halliwell	Measured Upper Bound	**Surveyor:**		**Pre Drill (m):**	N/A	
Contractor:	Ground Investigation Ltd	ρ from G_0 Calculation	**Termination Reason:**	Maximum Nominal Pressure			**G.I. Job Ref:** 210082

Comments:

CPT ZEROS AND DRIFT

G.I. Job Ref: 210082

Cone Reference	CPT Name	Push Number	Tip Resistance			Local Friction			Pore Pressure		
			Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)	Initial (MPa)	Final (MPa)	Difference (kPa)
MKJ325	CPT-01	1	23.892	23.913	21.3	0.2950	0.2950	0.0	2.8524	2.8522	-0.2
MKJ325	CPT-02	1	23.940	23.950	10.6	0.2958	0.2961	0.3	2.8515	2.8513	-0.2
MKJ325	CPT-03	1	23.950	23.865	-85.4	0.2959	0.2955	-0.4	2.8513	2.8545	3.2
MKJ291	CPT-04	1	20.142	20.137	-5.3	0.2963	0.2969	0.6	2.9389	2.9380	-0.9
MKJ325	CPT-05	1	23.924	23.876	-48.0	0.2958	0.2954	-0.4	2.8530	2.8543	1.3
MKJ325	CPT-06	1	23.945	23.897	-48.1	0.2955	0.2953	-0.2	2.8532	2.8546	1.4
MKJ325	CPT-07	1	23.956	23.902	-53.4	0.2950	0.2958	0.8	2.8521	2.8527	0.6

Client: LDE Ltd
Project: Dip Road

Location: Kamo, Whangarei
Engineer: Finlay Wallen-Halliwell

Note: Zero difference colour-coded based on application classes following ISO 22476-1:2012. Blue indicates Class 1, green Class 2, orange Class 3 and red Class 4. Grey represents if a test is below Class 4.

APPENDIX C

LABORATORY TEST CERTIFICATES

GEOTECHNICS

Our Ref: 1100731.0000/Rep1
Customer Ref: 19103
4 March 2021

LDE Ltd
192 Bank Street
Regent
Whangarei 0112

Attention: Finlay Wallen-Halliwell

Dear Finlay

67 Dip Road, Kamo, Whangarei

Laboratory Test Report

Customer's Instructions

We performed CU triaxial tests on received samples as instructed by Finlay Wallen-Halliwell in emails dating 11 and 16 February.

Sampling Procedure

Samples have been tested as received from the customer.

Sample Location Plan

Not applicable.

Samples

Three tube samples were received. Samples were labelled with reference numbers.

Date of Sample Receipt

15/02/2021

Test Method(s)

ISO 17892:2018 Part 9 - Consolidated triaxial compression tests on water saturated soils

NZS 4402: 1986 Test 2.1 - Water Content

Material Description

Descriptions are provided in the attached presentation pages.

Test Results

Test results are attached.

Test Remarks

Test remarks are included in the presentation page.

General Remarks

Samples not destroyed during testing, will be retained for one month from the date of this report before being discarded.

Descriptions are enclosed for your information, are not covered under the IANZ endorsement of this report.

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

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of the letterhead page.

GEOTECHNICS LTD

Report prepared by:

.....

Cameron Tier
Instrumentation Technician

Authorised for Geotechnics by:

.....

Steven Anderson
Project Director

Report checked by:

.....

Helen Wang
Triaxial Laboratory Manager
Approved Signatory

ACCREDITED IANZ TESTING LABORATORY

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

4-Mar-21
t:\geotechnicsgroup\projects\1100731\issueddocuments\20210304 dip road cati.rep1.docx

GEOTECHNICS
1 Hill Street
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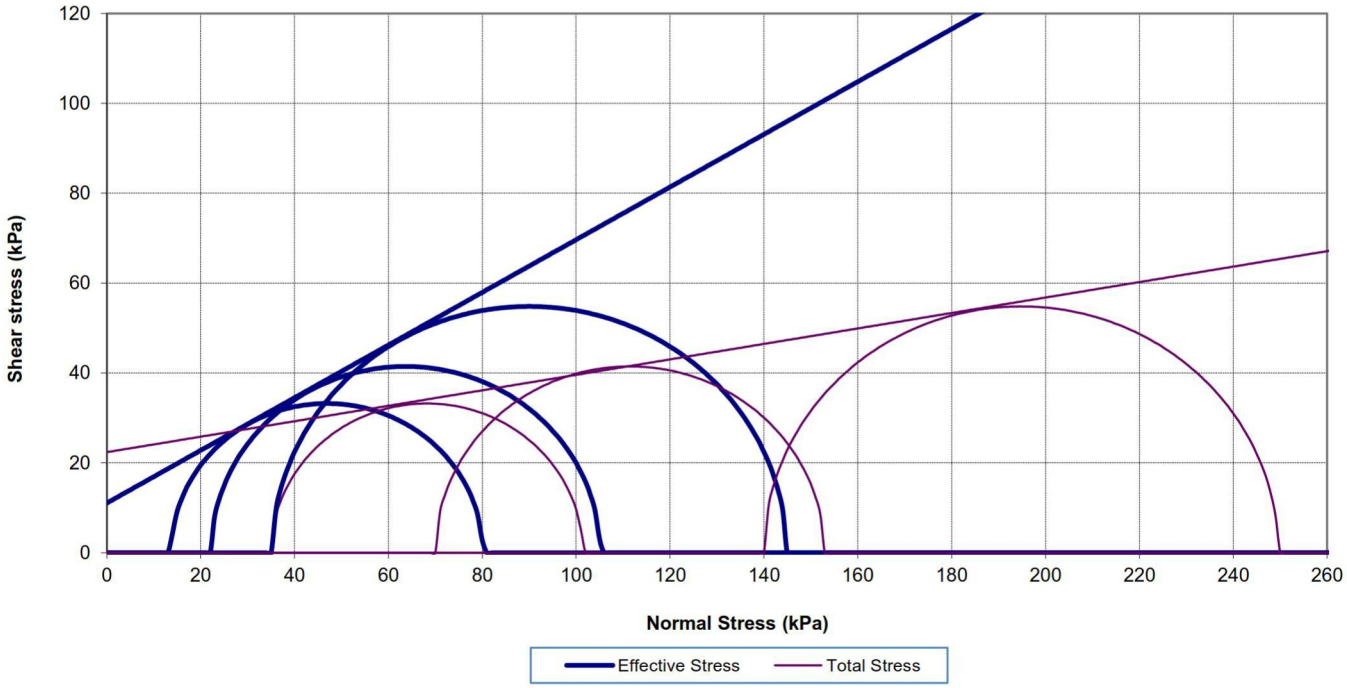
Auckland
New Zealand
p. +64 9 356 3510

Geotechnics Project ID: 1100731.0000
QESTLab Work Order ID:
Customer Project ID: 19103

Site: 67 Dip Road, Kamo, Whangarei
Location ID: BH01
Sample Ref.: --
Depth: 3.22 - 3.35 (m)
Test method used: ISO 17892-9:2018 Part 9 Isotropic consolidated-undrained triaxial compression test on water saturated soils (CIU)
NZS 4402:1986 Test 2.1 Determination of Water Content

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST (MULTI-STAGE)

MOHR CIRCLES OF TOTAL AND EFFECTIVE STRESSES



General Sample Parameters

Initial Sample Height:	124.71	mm	Initial Water Content:	105	%
Initial Sample Diameter:	60.77	mm	Initial Bulk Density:	1.38	t/m³
Initial B Value:	36	%	Initial Dry Density:	0.67	t/m³
B Value before Consolidation:	98	%	Final Water Content:	104	%

Test Results

	At the End of Consolidation Stage					Failure Values						Failure Mode & Photo
	Effective Stress		Back	Volumetric		Deviator Stress	Vertical	Effective Stress		Corrections (kPa)		
	Horizontal σ_h'(kPa)	Vertical σ_v'(kPa)	Pressure (kPa)	Strain (%)	Rate (%/hr)	$(\sigma_v' - \sigma_h')$ (kPa)	Strain ε (%)	Vertical σ_v' (kPa)	Horizontal σ_h'(kPa)	Membrane $(\Delta\sigma_v)_m$	Filter P $(\Delta\sigma_v)_{fp}$	
Stage 1	35	36	450	0.56	0.01	66.41	1.85	80.11	13.70	1.08	0.00	
Stage 2	70	71	450	1.46	0.00	82.91	1.50	105.11	22.20	0.88	0.00	
Stage 3	140	141	450	2.93	0.00	109.62	1.60	144.82	35.20	0.93	0.00	

	Total			Effective		
Angle of Frictional Resistance:	ϕ =	10	°	ϕ' =	30	°
Cohesion:	c =	22	kPa	c' =	11	kPa
Linear Regression Coefficient:	r =	0.997		r =	1.000	

Sample History: Undisturbed core trimmed at natural water content.

Soil description: SAND, silty, lightly packed, orangey brown with dark brown and light grey.

Test Speed: 0.022 (mm/min)

Test Remarks: The sample was saturated by increments of cell pressure and back pressure.
It was drained from both ends in the consolidation stages.
Failure for each stage was determined by either the maximum effective stress ratio or the maximum deviator stress. Strength parameters have been derived by using a linear regression fitting method.

Approved Signatory: Date: 4/03/2021

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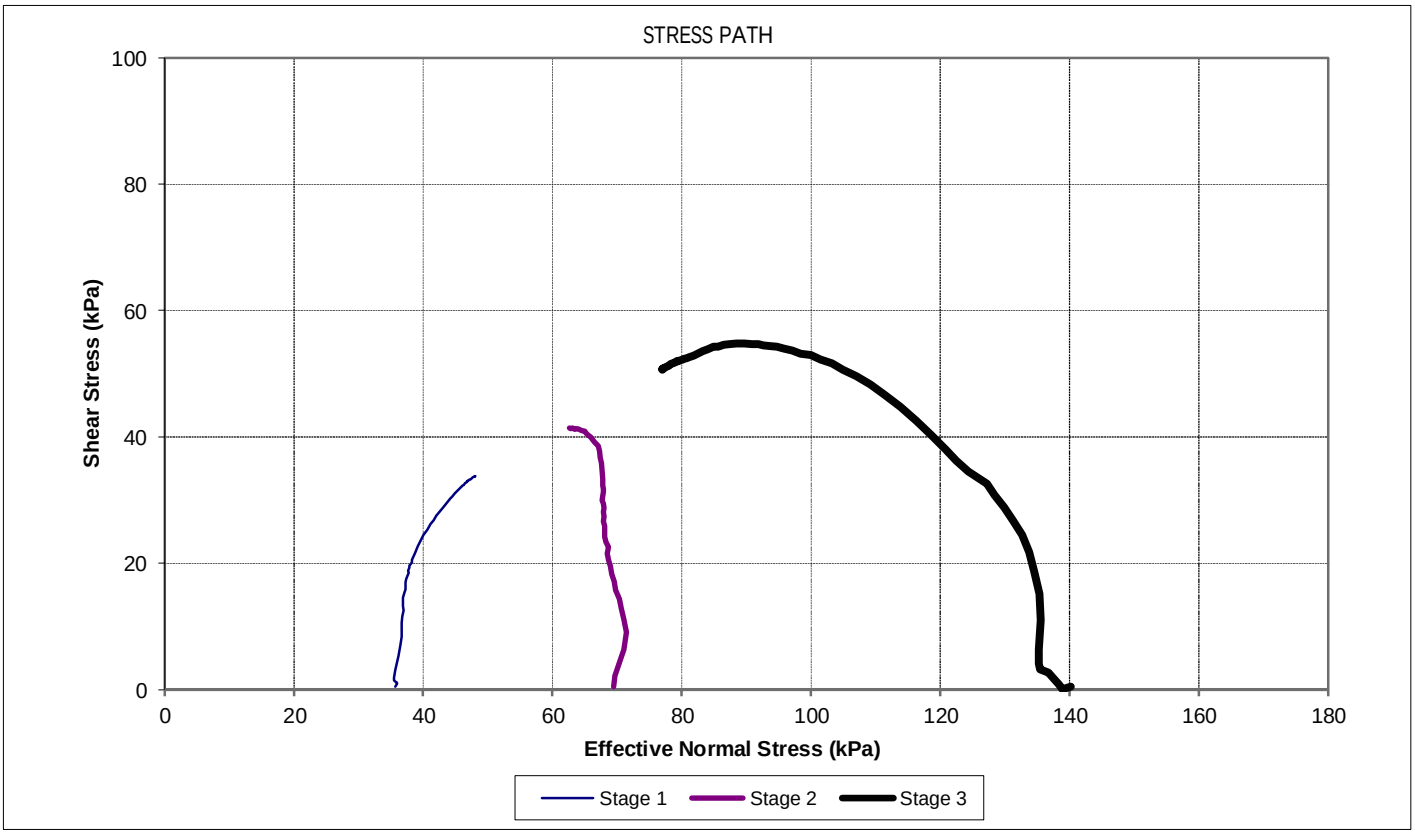
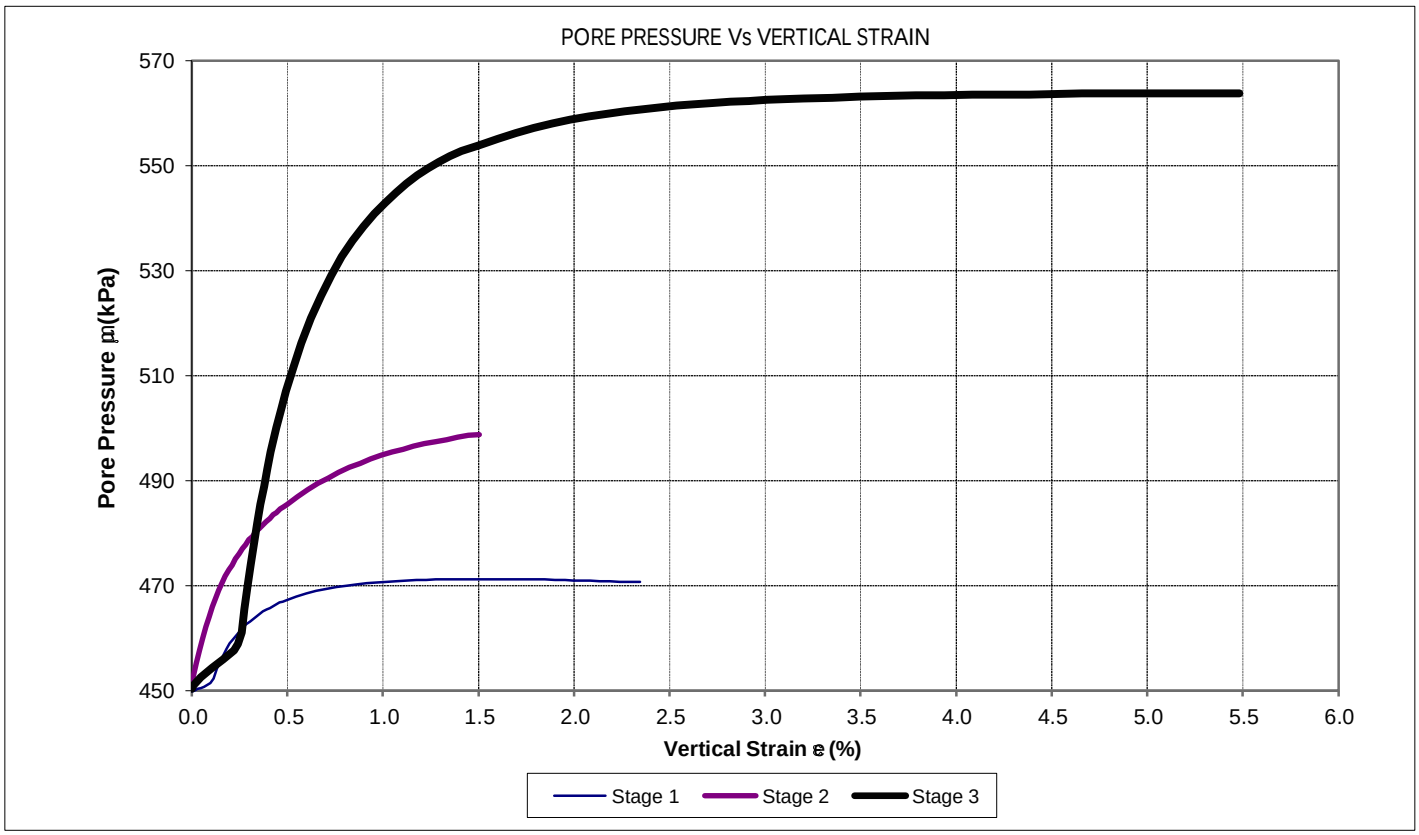
Site: 67 Dip Road, Kamo, Whangarei
Location ID: BH01
Sample Ref.: --
Depth: 3.22 - 3.35 (m)
Test method used: ISO 17892-9:2018 Part 9 Isotropic consolidated-undrained triaxial compression test on water saturated soils (CIU)
NZS 4402:1986 Test 2.1 Determination of Water Content

GRAPHS





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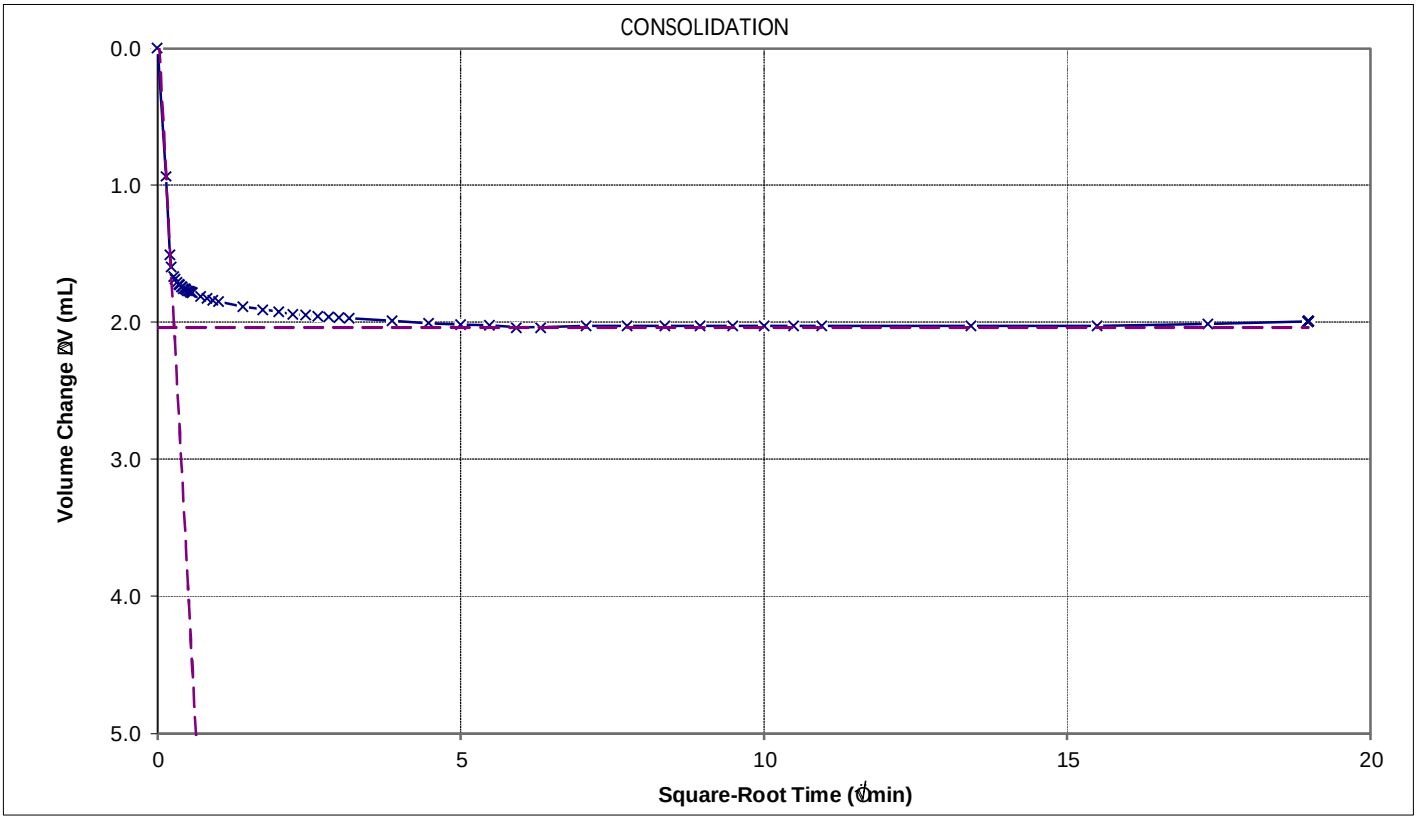
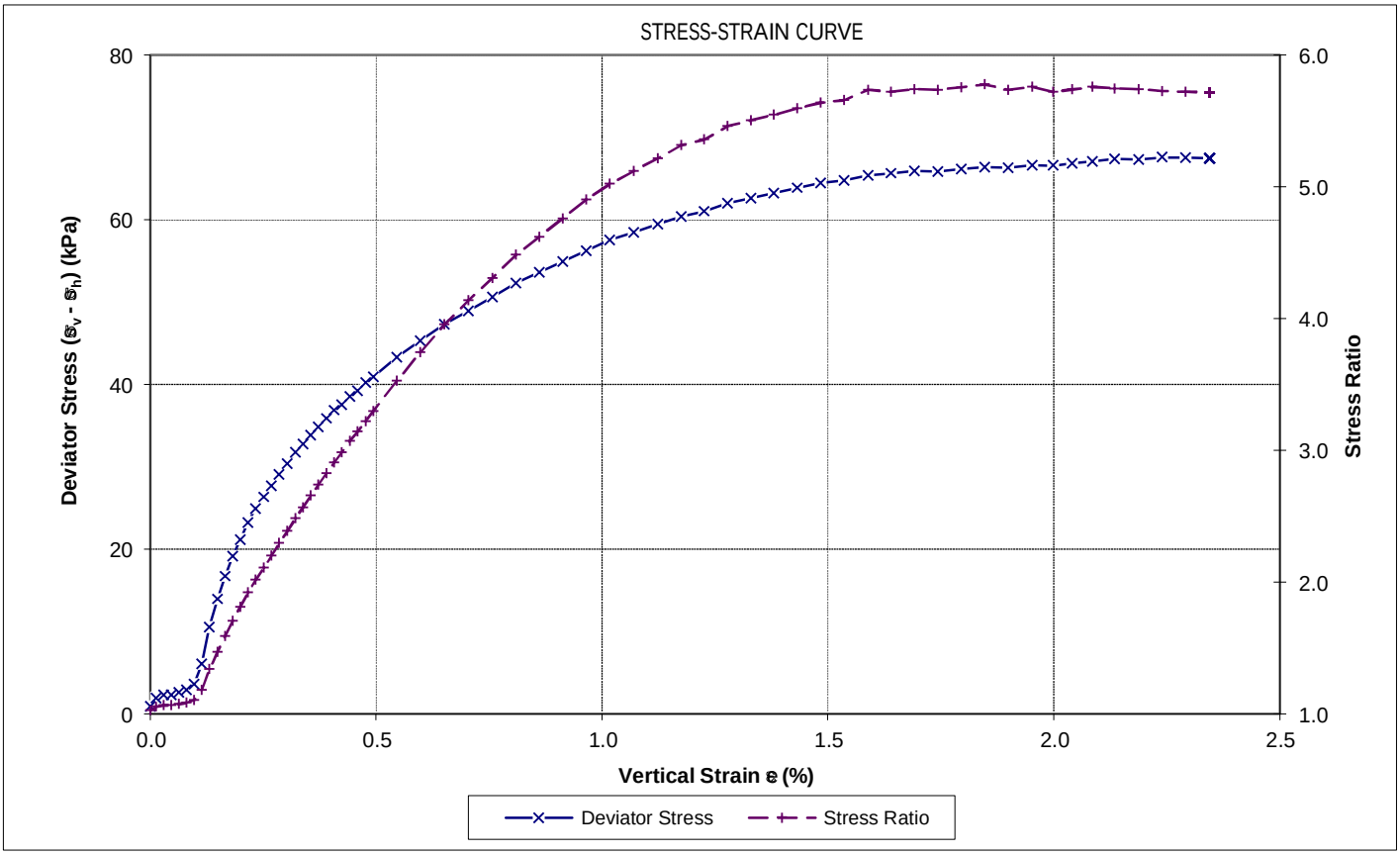
STAGE 1 GRAPHS





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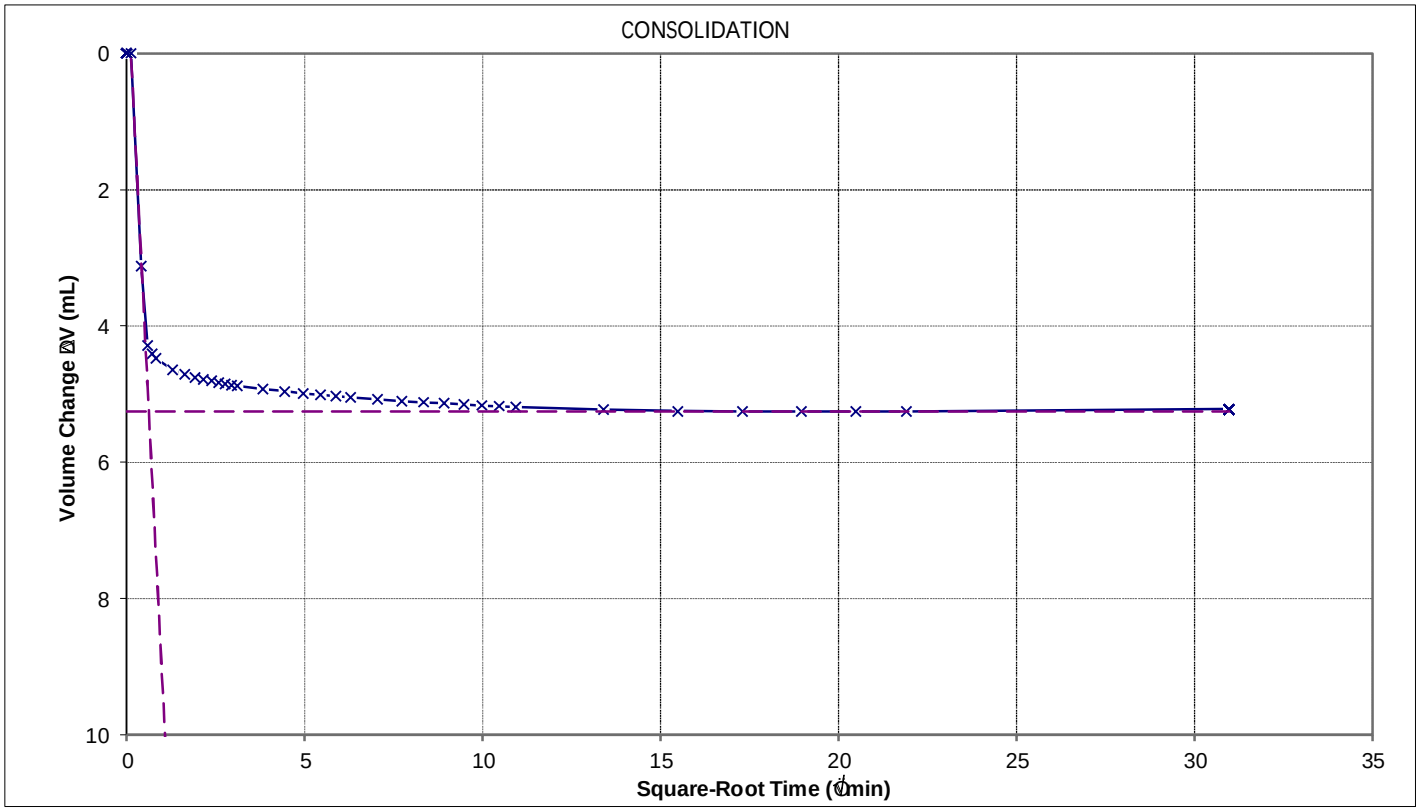
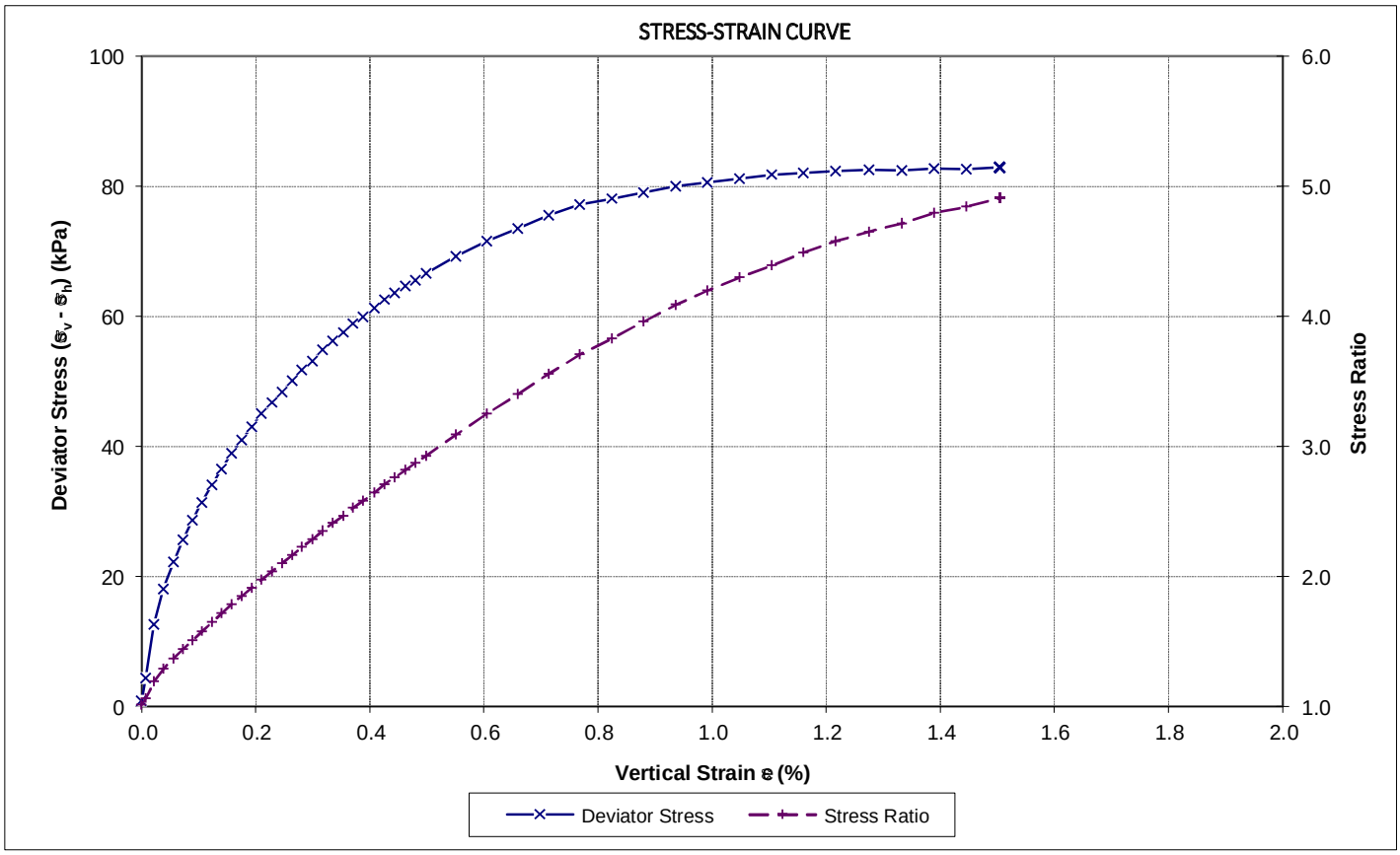
STAGE 2 GRAPHS





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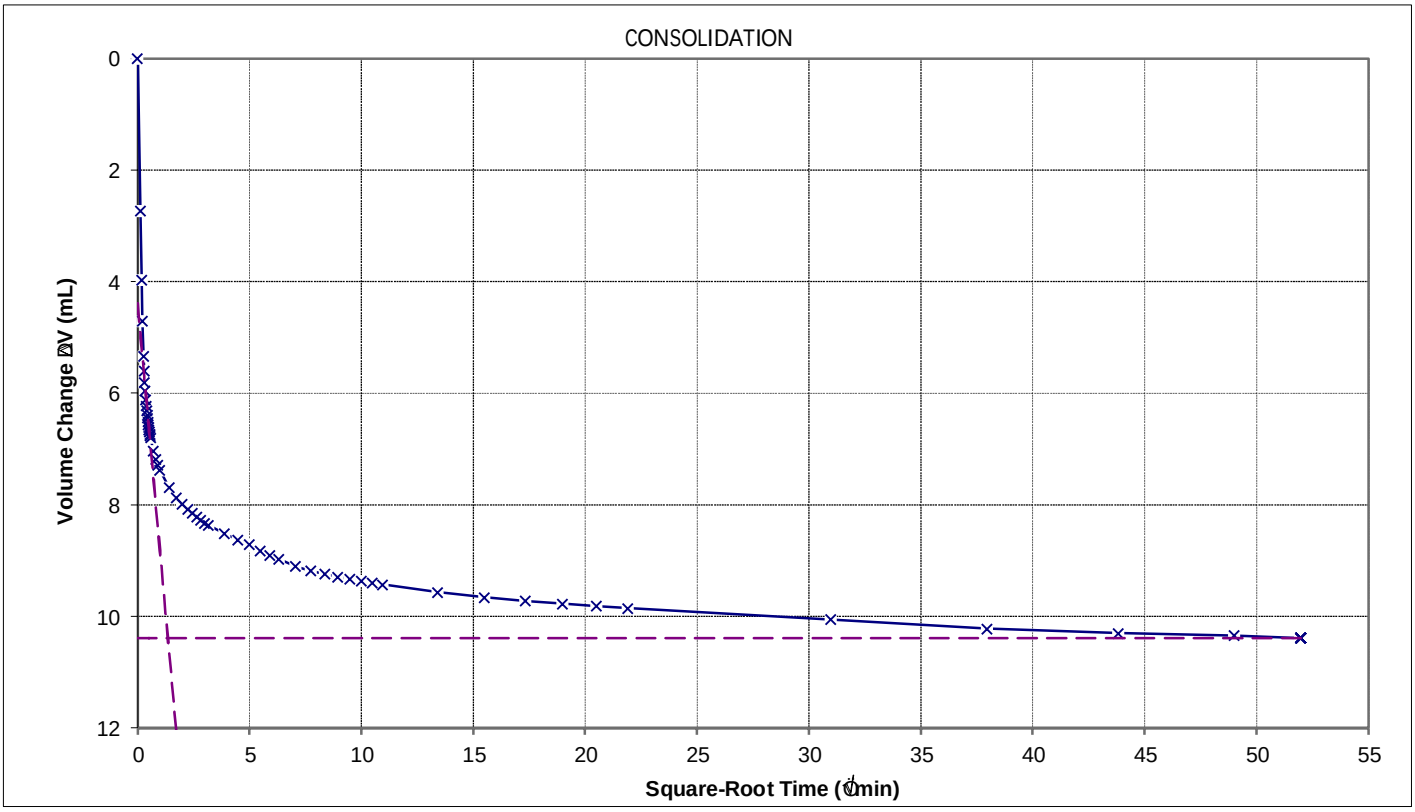
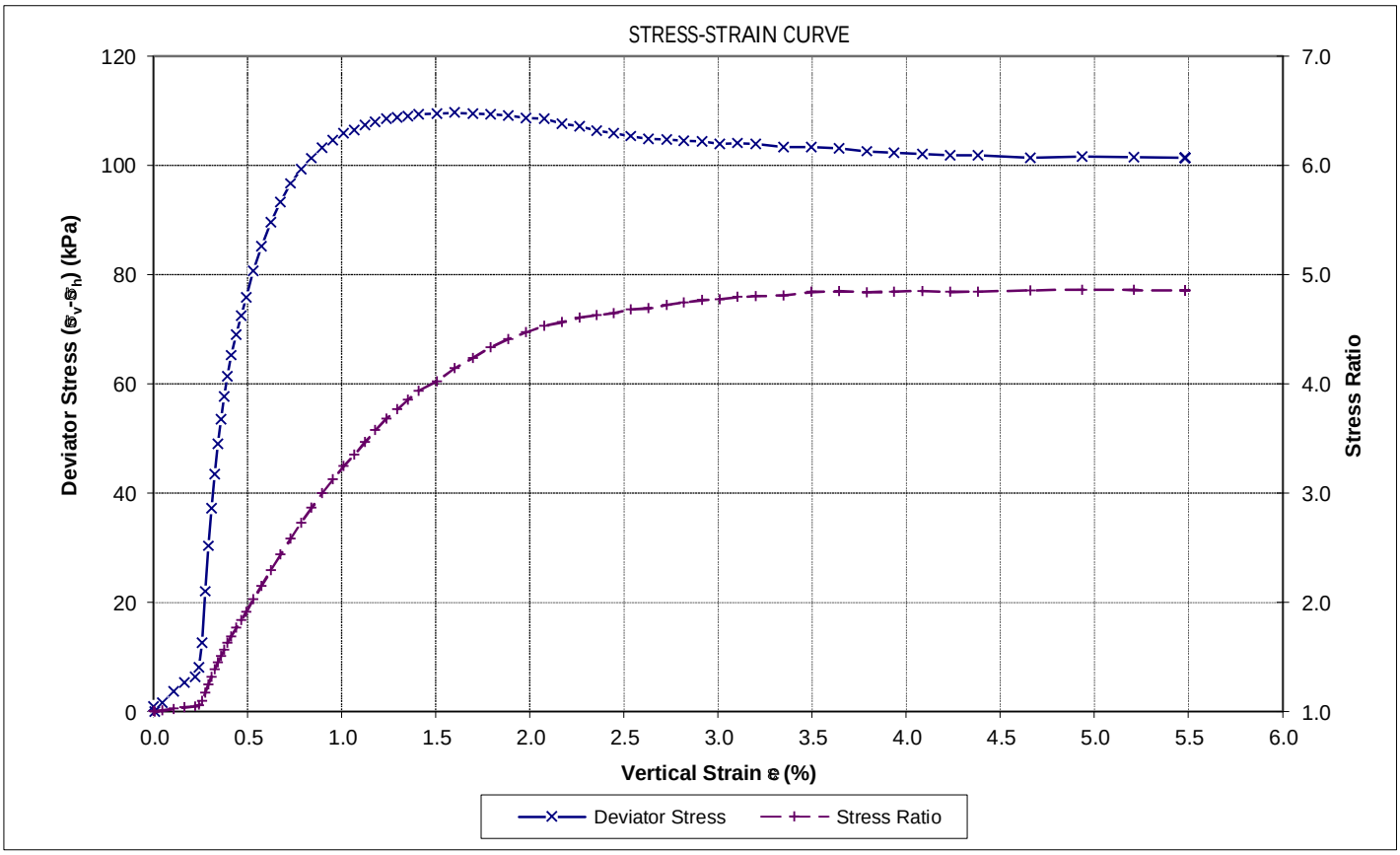
NZS 4402:1986 Test 2.1 Determination of Water Content

STAGE 3 GRAPHS





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Customer Project ID: 19103

Site: 67 Dip Road, Kamo, Whangarei
Location ID: CPT01
Sample Ref.: --
Depth: 3.67-3.84 (m)
Test method used: ISO 17892-9:2018 Part 9 Isotropic consolidated-undrained triaxial compression test on water saturated soils (CIU)
NZS 4402:1986 Test 2.1 Determination of Water Content

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST (MULTI-STAGE)

MOHR CIRCLES OF TOTAL AND EFFECTIVE STRESSES

General Sample Parameters

Initial Sample Height:	175.03	mm	Initial Water Content:	96.0	%
Initial Sample Diameter:	85.64	mm	Initial Bulk Density:	1.34	t/m³
Initial B Value:	30	%	Initial Dry Density:	0.68	t/m³
B Value before Consolidation:	94	%	Final Water Content:	101	%

Test Results

	At the End of Consolidation Stage					Failure Values						Failure Mode & Photo
	Effective Stress		Back	Volumetric		Deviator Stress	Vertical	Effective Stress		Corrections (kPa)		
	Horizontal σ_h'(kPa)	Vertical σ_v'(kPa)	Pressure (kPa)	Strain (%)	Rate (%/hr)	$(\sigma_v' - \sigma_h')$ (kPa)	Strain ε (%)	Vertical σ_v' (kPa)	Horizontal σ_h'(kPa)	Membrane $(\Delta\sigma_v)_m$	Filter P $(\Delta\sigma_v)_{fp}$	Planar
Stage 1	35	36	500	0.40	0.00	83.24	1.91	100.64	17.40	0.38	2.80	
Stage 2	70	71	500	1.16	0.00	105.04	1.34	133.64	28.60	0.26	1.96	
Stage 3	140	141	500	1.80	0.00	134.87	1.23	180.77	45.90	0.24	1.81	

	Total			Effective		
Angle of Frictional Resistance:	ϕ =	11	°	ϕ' =	28	°
Cohesion:	c =	28	kPa	c' =	16	kPa
Linear Regression Coefficient:	r =	0.994		r =	1.000	

Sample History: Undisturbed core trimmed at natural water content.

Soil description: SAND, silty, lightly packed, orangey brown with dark brown, light yellow grey and black.

Test Speed: 0.025 (mm/min)

Test Remarks: The sample was saturated by increments of cell pressure and back pressure.
It was drained from radial boundary and both ends in the consolidation stages.
Failure for each stage was determined by either the maximum effective stress ratio or the maximum deviator stress. Strength parameters have been derived by using a linear regression fitting method.

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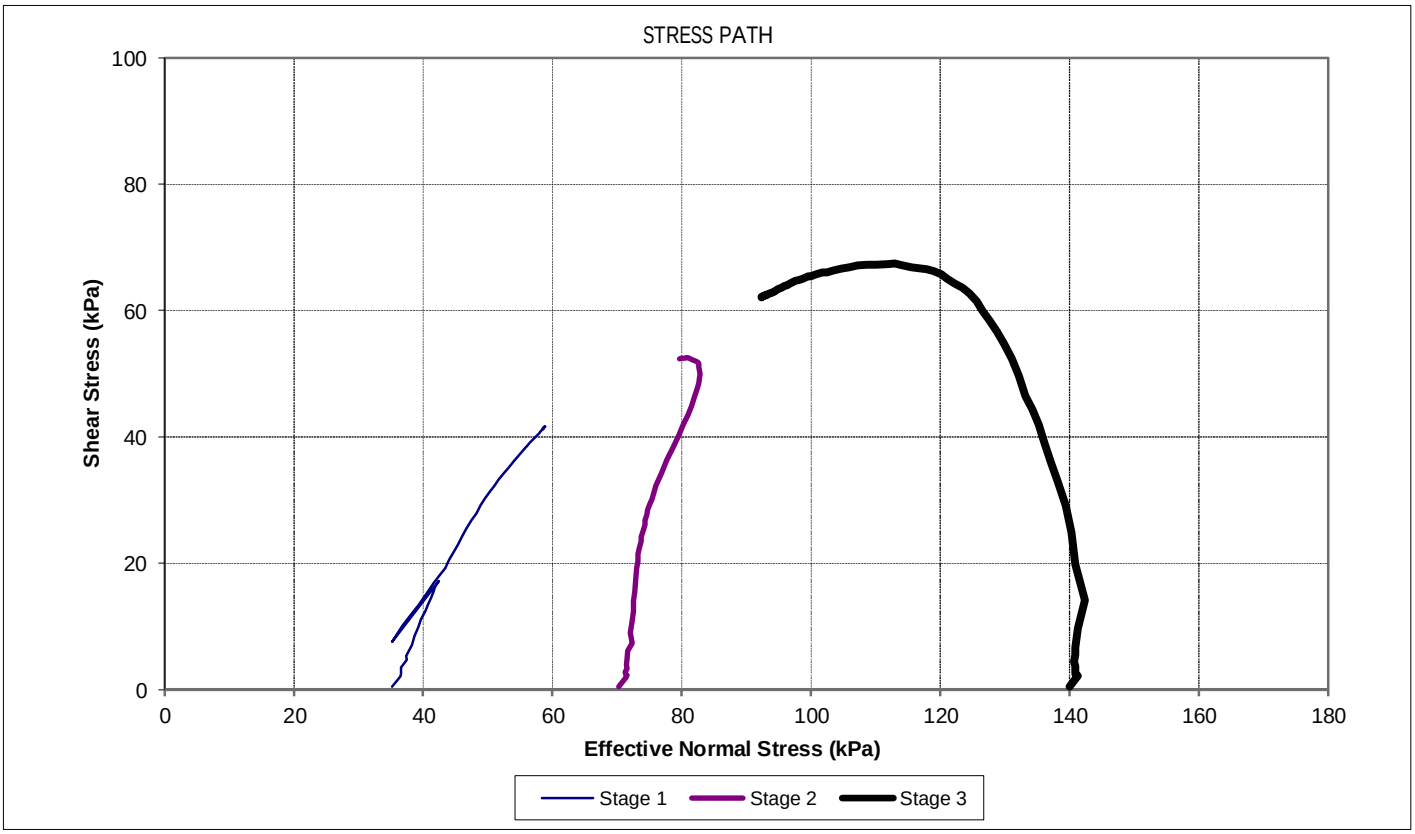
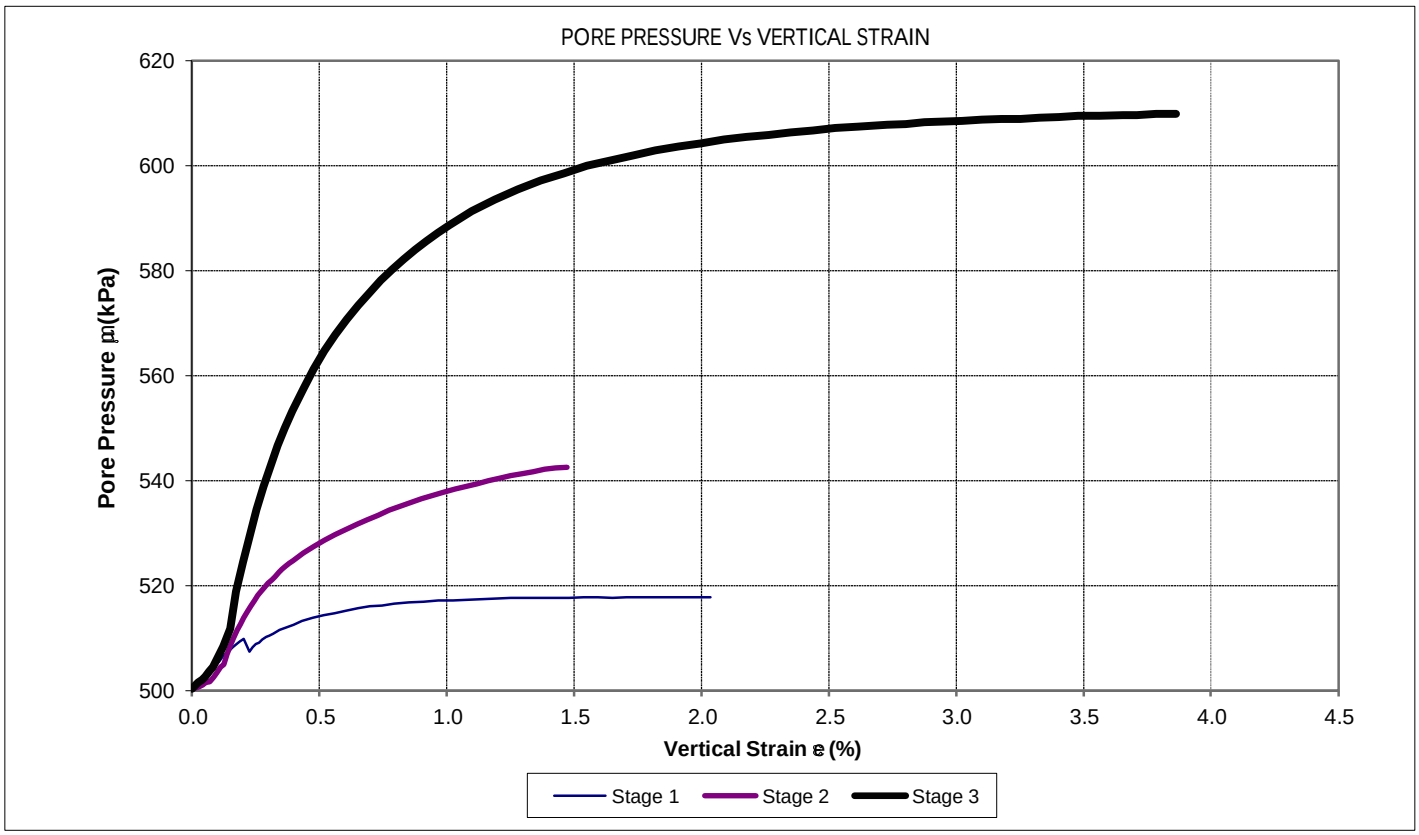
Location ID: CPT01
Sample Ref.: --
Depth: 3.67-3.84 (m)
Test method used: ISO 17892-9:2018 Part 9 Isotropic consolidated-undrained triaxial compression test on water saturated soils (CIU)
NZS 4402:1986 Test 2.1 Determination of Water Content

GRAPHS





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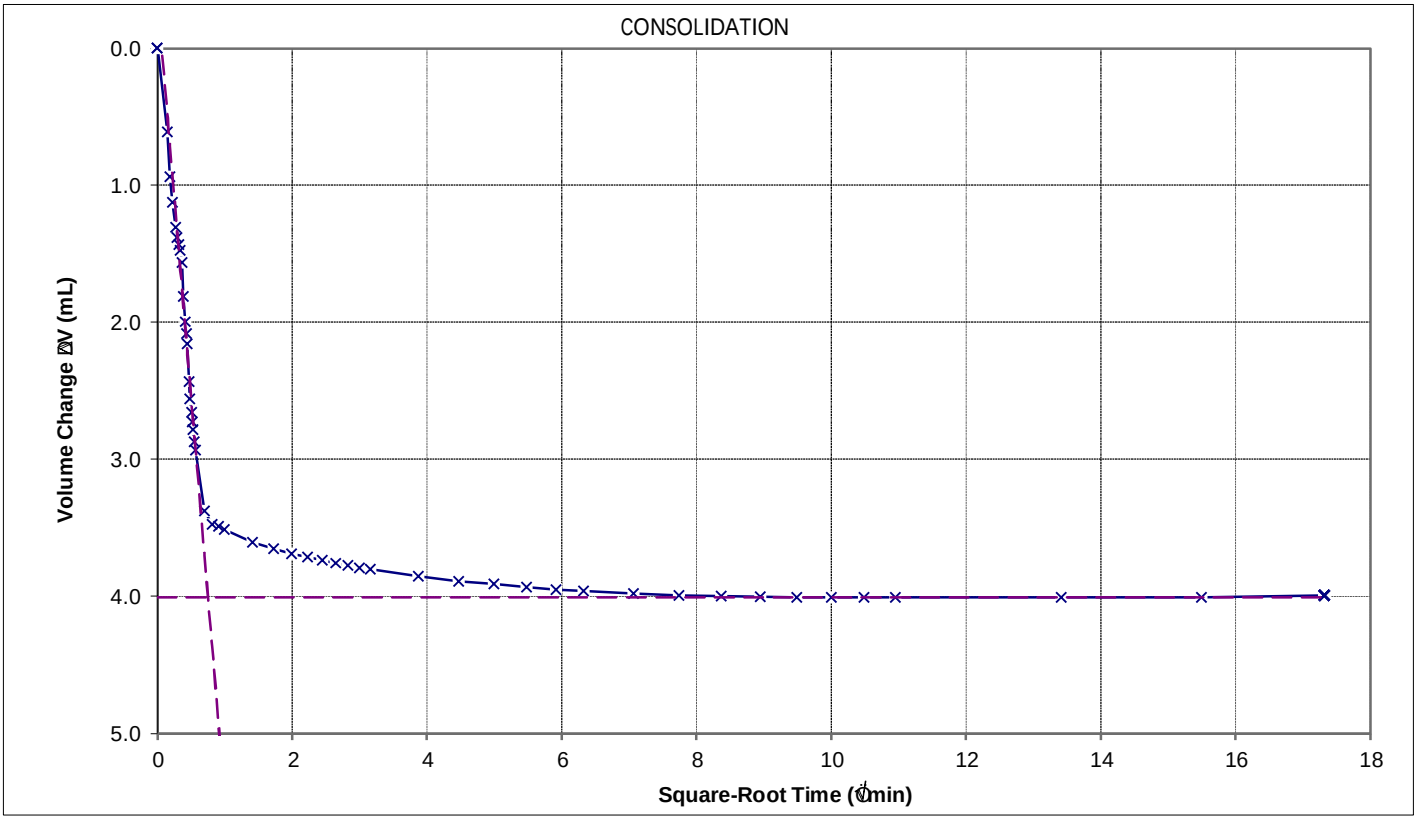
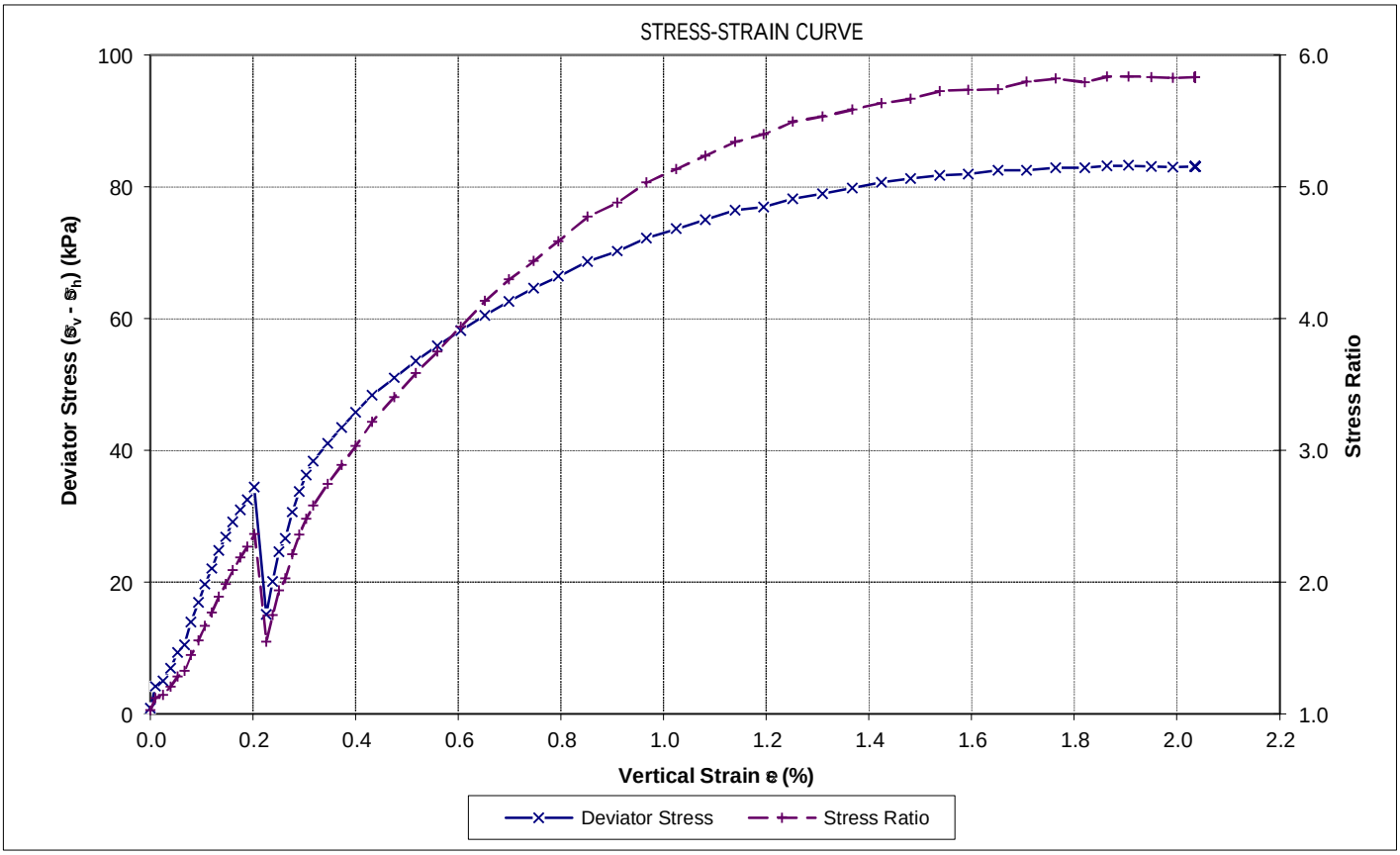
STAGE 1 GRAPHS





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Depth: 3.67-3.84 (m)
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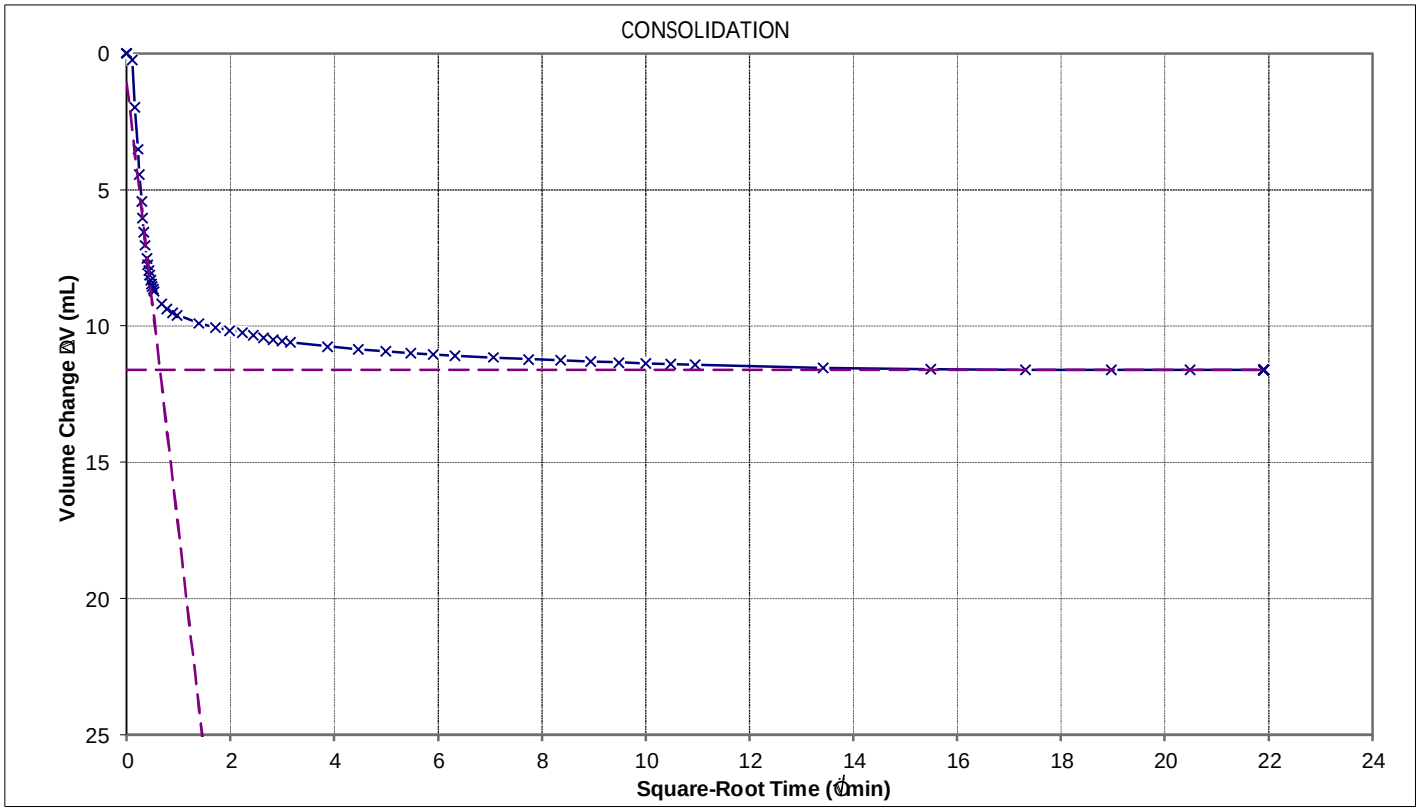
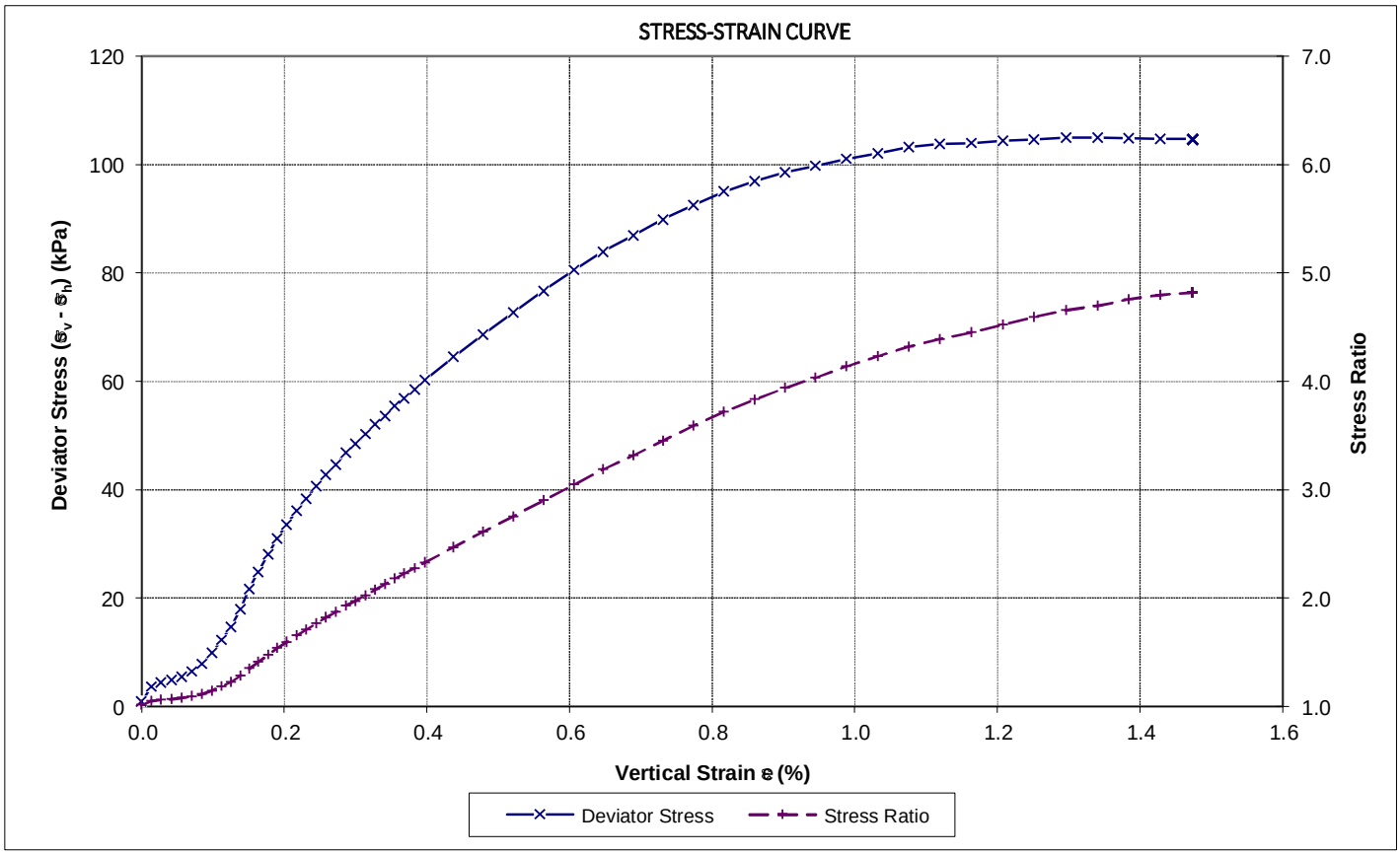
STAGE 2 GRAPHS





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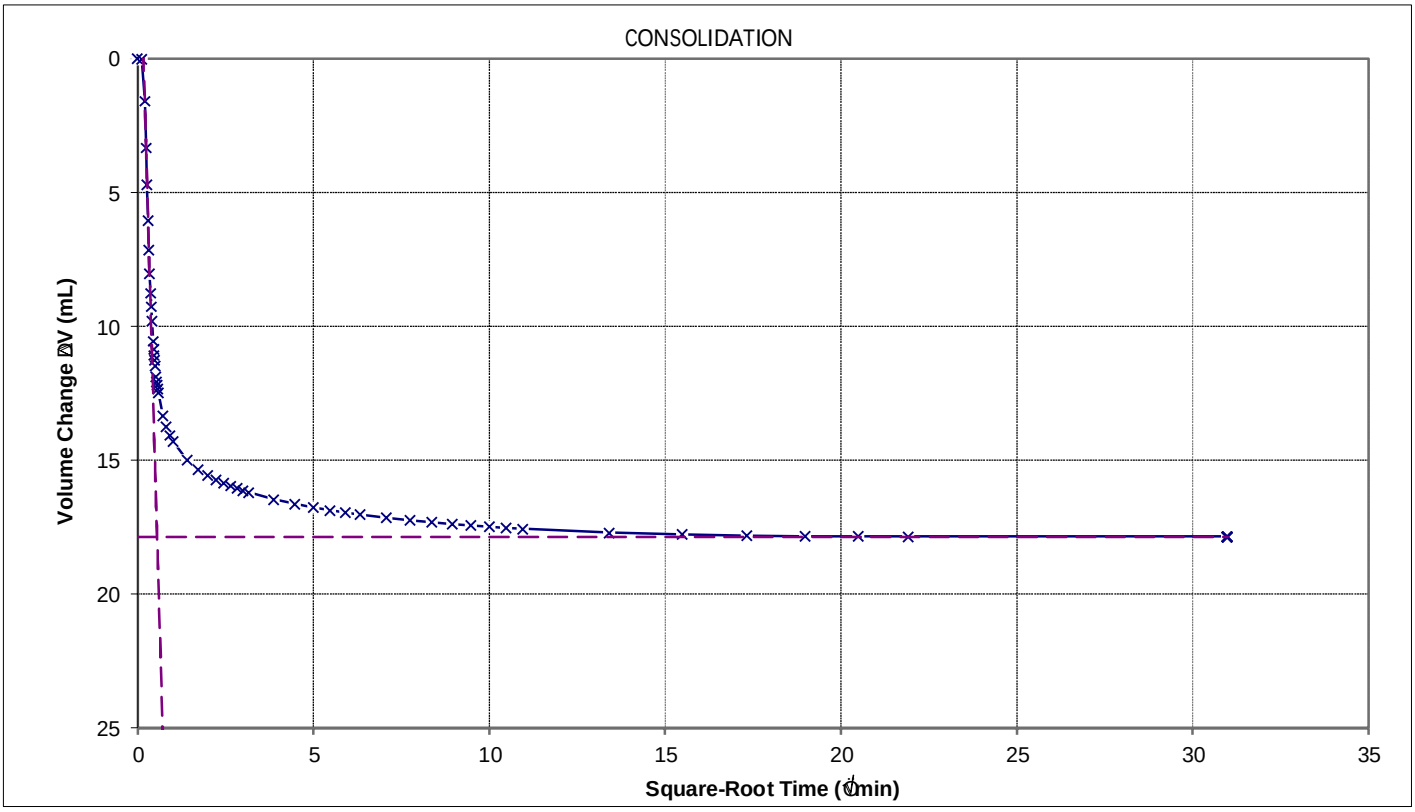
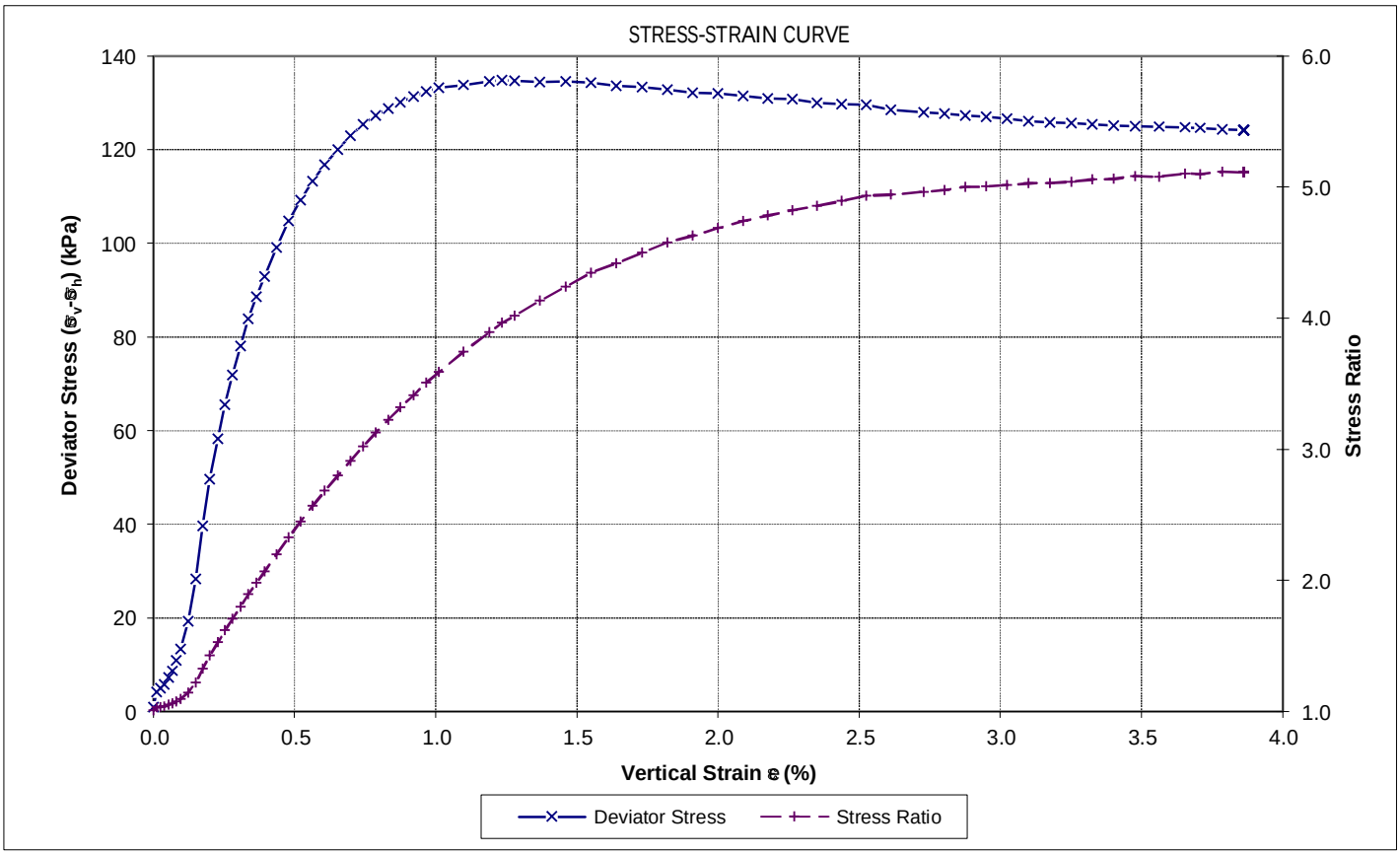
Sample Ref.: --
Depth: 3.67-3.84 (m)
Test method used: ISO 17892-9:2018 Part 9 Isotropic consolidated-undrained triaxial compression test on water saturated soils (CIU)
NZS 4402:1986 Test 2.1 Determination of Water Content

STAGE 3 GRAPHS





Approved Signatory: Date: 4/03/2021

GEOTECHNICS

Our Ref: 1100731.2.0.0/Rep2
Customer Ref: 19103
5 March 2021

Land Development & Exploration Limited
Warkworth
PO Box 471
0941

Attention: Finlay Wallen-Halliwell

Dear Finlay

67 Dip Road Kamo Whangarei

Laboratory Test Report

Samples from the above mentioned site have been tested as received according to your instructions and the results are included in this report. Results apply only to the sample(s) tested.

Descriptions are enclosed for your information, but are not covered under the IANZ endorsement of this report.

This report has been prepared for the benefit of Land Development & Exploration Limited, with respect to the particular brief given to us and it cannot be relied upon in other contexts or for any other purpose without our prior review and agreement.

This report may be reproduced only in full.

Samples not destroyed during testing will be retained for one month from the date of this report before being discarded. If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

GEOTECHNICS LTD

Report prepared by:

.....
Tylah Wardrope
Laboratory Technician

Authorised for Geotechnics by:

.....
Paul Burton
Project Director

Report checked by:

.....
Ryan Milligan
Project Manager
Approved Signatory
5-Mar-21
t:\geotechnicsgroup\projects\1100731\workingmaterial\tga lab\lde 67 dip road kamo whangarei-cu.docx

ACCREDITED IANZ TESTING LABORATORY

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

GEOTECHNICS

15C Amber Crescent
Judea
Tauranga 3110
New Zealand
p +64 7 571 0280

Geotechnics Project Number	1100731.2.0.0
QESTLab Work Order ID	W21TG-0038
Customer Project ID	19103

Detection of the Presence of Allophane in Soils - NZS 4402:1986 Test 3.4

TEST DETAILS

LOCATION	**Description**	67 Dip Road Kamo Whangare		
	Data	N/A		
SAMPLE	**Geotechnics ID**	S21TG000081		
	Reference	CPT01	**Top Depth**	3.85m
	Sampled By	Others, Tested As Received	**Bottom Depth**	**3.86m**
	Description	silty SAND, lightly packed, orange brown with dark brown, light yellow grey and black.		
SPECIMEN	**Reference**		**Depth**	
	Description			

TEST RESULTS

Colour Intensity	Pink to Red
Allophane Content	**5% to 7%**

This result is an approximate indication of allophane content.

Bright Red - More than 7% Allophane Presence
Pink to Red - 5 to 7 % Allophane Presence
Colourless - Less than 5% Allophane Presence

TEST REMARKS

• The material used for testing was natural. • This test result is IANZ accredited.•Date tested 05/03/2021

Approved Signatory Ryan Milligan

Date 05/03/2021

GEOTECHNICS

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Geotechnics Project Number	1100731.2.0.0
QESTLab Work Order ID	W21TG-0038
Customer Project ID	19103

Detection of the Presence of Allophane in Soils - NZS 4402:1986 Test 3.4

TEST DETAILS

LOCATION	**Description**	67 Dip Road Kamo Whangare		
	Data	N/A		
SAMPLE	**Geotechnics ID**	S21TG000082		
	Reference	BH01	**Top Depth**	3.36m
	Sampled By	Others, Tested As Received	**Bottom Depth**	**3.38m**
	Description	silty SAND, lightly packed, orange brown with dark brown and light grey.		
SPECIMEN	**Reference**		**Depth**	
	Description			

TEST RESULTS

Colour Intensity	Pink to Red
Allophane Content	**5% to 7%**

This result is an approximate indication of allophane content.

Bright Red - More than 7% Allophane Presence
Pink to Red - 5 to 7 % Allophane Presence
Colourless - Less than 5% Allophane Presence

TEST REMARKS

• The material used for testing was natural. • This test result is IANZ accredited.•Date tested 05/03/2021

Approved Signatory Ryan Milligan

Date 05/03/2021

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WARKWORTH | WHANGANUI | WHANGAREI

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