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



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### **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<sup>2</sup> to 700m<sup>2</sup>. 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<sup>1</sup> 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.





<sup>&</sup>lt;sup>1</sup> 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<sup>1</sup>).

## 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.



2/07/2021



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 investigation 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.

	Hole	Scala	Depth to weathered airfall	Volcanic
Point ID	depth (m)	depth (m)	deposit (m)	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. Lowerbound 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.

Test site	Sample	Total st	ress	Effectiv	e stress	Bulk	Dry
	depth	Phi (°)	C (kPa)	C (kPa) Phi' (°) C' (kPa)		density*	density
	(tested)					(kN/m³)	(kN/m³)
BH01	3.0m	10	22	2 20 11		1.38	0.67
BIIOT	(3.22-3.35)	10	22	00			
CPT01	3.5m	11	28	28	16	1.35	0.68
CETUT	(3.67-3.84)		28 28 16	10			

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

\*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 1. Carrinary of a	adoptod mat	onal offorigin p	aramotor	0.											
	Characteristic test values Adopted parameters														
Unit	Shear vane (kPa)	DCP (bl/50mm)	CPT qc (MPa)	Unit weight (kN/m <sup>3</sup> )	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	-	-	-								

Table 4: Summary of adopted material strength parameters.

## 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<sub>s</sub> values of 180 to 280m/s through the upper 10m of the soil profile. On the assumption that V<sub>s</sub> values through the underlying basalt are high (i.e. >1500m/s), it can be inferred that the overall V<sub>s 30</sub> 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 northeastern 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  $\sim$ 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<sup>2</sup>. 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.

<sup>&</sup>lt;sup>2</sup> 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.



#### GEOTECHNICAL INVESTIGATION REPORT PROPOSED RESIDENTIAL DEVELOPMENT SECTION 1 SO 65970, DIP ROAD, KAMO, WHANGAREI



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:

Varthe

Finlay Wallen-Halliwell BSc, PMEG Engineering Geologist

Report reviewed by:

Holla

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

#### Find out more about LDE professionals

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2/07/2021



# **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).



120 m



Notes:

1/ Topographic section derived from NRC LiDAR DEM (2018). 2/ Investigation points show approximately, projected up to ~12m.
3/ Investigation 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.

Copyright: LDE Ltd. All rights reserved / Do not scale off drawings / Confirm all dimensions on site prior to work								3		JO (III)	Original Size = A3
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**APPENDIX B** 

**GEOTECHNICAL INVESTIGATION DATA** 



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Materials are descri	bed in general accordance with NZGS 'Field Descriptio	on of Soil and Roc	:k' (2	2005)				y vai ► Vai	ne resi	iuual P		Groundwater Inflov	w

Hand Auger Borehole Log Method: 50mm hand auger, DCP											Test I Proje Sheet	D: ct ID: t:	<b>HA05</b> 19103 1 of 1	
Clier Proj Loca Test	nt: ect: ation: Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ1 170 <u>Plar</u>	0504 ГМ m <u>n se</u> t	lmN, 1	7165	94m	E		Test I Logg Chec Vane	Date: ed By ked B ID:	28/11/201 : AM : DD <u>131</u>	9
th (m)	phic Log			er	[	)ynamic ( 2	In-s	situ enetr	Testi ometer 6	ing r (blow	s / 50mr 8	n)		Ĵ.
Dep	Gra	Material Description	Geology	Wat		50	Shear 10	r Van )0	e, Su ( 15	(kPa) i0	200		Test Values	RL
		SILT, with some rootlets/organics and sand; light brown. Dry; sand, fine. SILT, with some clay; brownish orange. Very stiff to hard; low plasticity; moist.	Topsoil / Kerikeri Volcanic Group - Residual soil			O	<b>.</b>	) )			•		193 / 41 193 / 77 193 / 101 181 / 104	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1.0-* -> -> 1.5-*		SILT, with trace sand; brown. Low plasticity; moist; sand, fine. 1.3m - 1.7m: trace of clay, light brownish orange 1.7m - 1.9m: no clay, some fine sand, brown 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.	Kerikeri Volcanic Group - Weathered airfall deposit		0			>	•	•			150 / 22 166 / 80 164 / 99 166 / 62	168.5 169.0
2.0-×			_	Groundwater Not Encountered	0	.0	•	•	•			142 / 39 86 / 21	1 1 1 1 168.0	
2.5_					O O O		•						86 / 18 83 / 19 87 / 17	1 1 1 1
-^^ - ^ 3.0-					•0		•	•					110 / 18 81 / 21	1 1 1 1
3.5- - - 4.0- - - - - - - - - - - - - - - - - - -	Depth	3.00m Termination: Reached target depth											► 10	E         I
Rem	arks:								Vane	e resid	ual	▲	Groundwater inflo	w
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	U	TP = Ur	nable to	o Penetrate	JW

	LAND	Hand Auge Method: 50	er Boreh	<b>IO</b> DCP	le	Lc	g			Test ID Project Sheet:	: ID:	<b>HA06</b> 19103 1 of 1	
Clie Proj Loc Tes	nt: ect: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ <sup>-</sup> 164 Pho	5050 TM 1.5m one	3mN, GPS	17166	69m	ιE	Test Da Logged Checke Vane II	ate: d By: ed By: D:	27/11/2019 CP DD 1945	
Depth (m)	Graphic Log	Material Description	Geology	Water		Dynamic 2 50	In- Cone I Shea	situ Penetr 4 ar Van	Testing ometer (blov 6 le, Su (kPa) 150	ws / 50mm) <u>8</u> 200		Test Values	RL (m)
		Organic clayey SILT; brown. Dry; friable, rootlets. Silty CLAY, with trace gravel; reddish brown. Very stiff; high plasticity; moist; gravel, fine. 0.5m: increase silt 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) Clayey SILT, with trace gravel; brown. Very stiff; high plasticity; wei; gravel, fine, very weak basalt/scoria lapilli; sensitive. 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	Kerikeri Volcanic Group - Residual soil	Groundwater Not Encountered								UTP 190 / 124 212 / 117 193 / 86 193 / 80 186 / 66 UTP 146 / 40 139 / 29 128 / 22 128 / 22 128 / 22	59.0 159.5 160.0 160.5 161.0 161.5 162.0 162.5 163.0 163.5 164.0 161.5 162.0 165.5 163.6 164.0
	_												-
Hole Depth: 3.00m  Termination: Reached target depth Remarks:								● ● ●	Vane pea Vane resid Vane UTF	k dual o	▼ Sta	anding water leve oundwater inflow oundwater outflov	I v
No correlation is implied between shear vane and DCP values.									ι	JTP = Una	ble to P	enetrate	

Clie	CLAND ent:	Hand Auger Borehole Log Method: 50mm Hand Auger Coordinates: 6050521mN 1716696mE										Te Pr Sł Te	est II rojec neet: est D	D: st ID: state:	HA07 19103 1 of 1 05/11/2019								
Pro Loc Tes	ject: ation: t Site:	Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	System: Elevation: Located By:	NZ 167 Pho	TM 7.5m one (	GPS	;					Logged By: Checked By Vane ID:			CK : DD 835								
th (m)	phic Log			er	In-situ Testing Dynamic Cone Penetrometer (blo 2 4 6							ows / 5	50mm) 8	)		m)							
Dep	Gra	Material Description	Geology	Wat		5	50	Shea 1	ır Van 00	e, Su 1	(kPa) 50	) 2	00		Test Values	RL (							
	× × ×	Organic SILT; dark brown. Dry to moist	Topsoil Kerikeri Volcanic													-							
- - 0.5- -	× × × × × × × × × × × × × × × × × × × ×	Silty CLAY; brownish orange. Very stiff; high plasticity; moist. 0.3m: decreasing silt (some)	Group - Residual soil					0							172 / 81	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							
- 1.0- -	× × × × × × × × × × × × ×	1.0m: silty, trace of fine gravel (completely weathered scoria), low plasticity								ntered				0				•		177 / 83	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
1.5-	× × × × × × × × × × ×	1.4m: trace of silt, high plasticity		twater Not Encour			C	>		•					146 / 72	1 1 1 1 1 1 1 1 1 1							
2.0-	× × × × × × × × × × ×	.1m: minor black/brown mottling									Ground		-0-					•				157 / 38	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
2.5_	× × × × × × × × × × × × × × × × × × ×	SILT, with some sand and gravel; brown. Stiff; moist to wet; gravel, fine to medium, very weak scoria/basalt lapilli.	Kerikeri Volcanic Group - Weathered airfall		(	0	•				_				71 / 28	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							
		2.8m: minor black mottling, moist	deposits			O					•				160 / 42								
3.0-		3.0m: moist to wet				0	0			•					130 / 38	164.5							
3.5_														· · · · · · · ·	1367 50	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1							
4.0-																1 1 1 1							
																-							
4.5-																163.0							
																-							
5.0_																1 1 1							
5.5																1 1 1 1 1							
																$\left  \right $							
Hole Depth: 3.20m Termination: Reached target depth								•	Van	e pea	ak		▼ St	anding water leve	I								
Remarks:						•	Van Van	e res e UT	idual P		$\diamondsuit$ G	roundwater inflow roundwater outflow	N										
No correlation is implied between shear vane and DCP values.											UTP	= Una	able to F	Penetrate									

Generated with CORE-GS by Geroc - HA/TP Log v5 - 22/06/2021 2:08:33 PM
Clie		DEVELOPMENT ENGINE ERRING Onoke Heights Limited	mm hand auger, D Coordinates:	0 0 0 0 0 0 5	le 0553	Lo BmN,	<b>OQ</b> , 171	<b>J</b> 16724	4mE		Te Pi Si Te	est ID: roject heet: est Da	ID: te:	<b>HA08</b> 19103 1 of 2 27/11/2019	
Pro Loc Tes	ject: ation: t Site:	Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	System: Elevation: Located By:	NZ 173 Pho	ΓM .5m one G	SPS					Lo Ci Va	ogged hecke ane ID	By: d By: :	FWH DD 2249	
th (m)	phic Log			er	C	)ynam 2	nic Co	In-sit ne Per 4	t <b>u Te</b> etrom	esting leter (b 6	g blows / :	50mm) 8			m)
Dep	Gra	Material Description	Geology	Wat		50	)	Shear \ 100	/ane,	Su (kP 150	°a) 2	200	Т	est Values	RL (
	"S""""""""""""""""""""""""""""""""""""	Organic SILT; dark brownish orange. Very stiff to hard: dry to moist	Topsoil												$\left  - \right $
- - 0.5- -	× × × × × × × × × × × × × × ×	CLAY, with some silt; brownish orange; homogeneous. Hard; high plasticity; moist; slightly friable.	/ Kerikeri Volcanic Group - Residual soil						0					205+ / 117	1 1 1 1 1 173.0
- - 1.0- - -		Clayey SILT; orange. Very stiff to hard; low plasticity; moist.								0		•		205+ / 143	1 1 1 1 1 1
- 1.5-		Sandy SILT, with some gravel, with minor clay; dark	Kerikeri Volcanic	-	0			0	•					164 / 102 117 / 18	1 1 1 172.0
		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	Weathered airfall deposits		0				•					113 / 20	
2.0-		basait iapiili; aliophanic - greasy.				¢	)			•				137 / 53	171.5
-		1.9m - 2.1m: SILT; brown. Stiff; non-plastic; wet; homogenous. 2.2m: becoming saturated, no inflow			(	)		•						83 / 29	
- 2.5_ -				ntered	0		•							51 / 20	171.0
	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~			Encoul	Ò	)(	•							58 / 26	Ę
3.0_				undwater Not	¢	)(	•							56 / 26	170.5
- 3.5–				Gro	(	0	•							66 / 32	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
-					C	)	•							66 / 25	5
4.0-								•				•	<ul> <li>▲ 10</li> <li>▲ 20</li> <li>▲ 12</li> <li>▲ 12</li> </ul>	) ) 2	1 1 1
						-		-							Ē
4.5-															1 1 1 1
															F
5.U- -							>								1 1 1
5.5															
															168.
						_									F
Hol	e Depth	a: 4.00m Termination: impenetrable material (grave	el)						• v	ane p	eak		L Sta	nding water leve	el
rter	narks:									′ane re ′ane U	esidual ITP	>   1	(} Gro ≻ Gro	undwater inflow undwater outflo	w
Mat No d	erials ar correlati	e described in general accordance with NZGS 'Field Description on is implied between shear vane and DCP values.					UTP	= Unab	e to Pe	netrate					

Client:	Onoke Heights Limited	Method: 50m	m hand auger, I Coordinates:	DCP 605	<b>e</b>	L <b>O</b> ( nN, 17	<b>g</b> 71672	4mE		Te Pr St Te	est ID: roject neet: est Da	ID: te:	HA08 19103 2 of 2 27/11/2019	
Project: Location: Test Site:	Geotechnical Suitability Assessment fo 67 Dip Road, Three Mile Bush Refer to site plan	or Subdivision	System: Elevation: Located Bv:	NZT 173 Pho	™ .5m ne GF	PS					ogged hecke ane ID	ву: d By: ):	⊢vvH DD 2249	
th (m) shic Log				er	Dy	rnamic C 2	In-si Cone Pe	itu Te	esting neter (b 6	J lows / {	50mm) 8		-	(n
Dep Gra <sub>l</sub>	Material Descriptio	on	Geology	Wat		50	Shear 10	Vane, )	Su (kPa 150	a) 2	00	1	est Values	RL (
o     o       6.5     -       6.5     -       7.5     -       8.0     -       8.0     -       9.0     -       9.0     -       10.0     -       11.0     -       11.0     -       11.15     -	Material Description	on	Geology	Groundwater Not Encountered									<u>est Values</u>	ТІТІТІТІТІТІТІТІТІТІТІТІТІТІТІТІТІТІТІ
							<u> </u>							F
Hole Deptl Remarks:	n: 4.00m Termination: impend	etrable material (gravel)	)				-	• v	/ane pe	eak		▼ Sta	nding water level	I
Materials a	re described in general accordance with I	NZGS 'Field Description	n of Soil and Ro	ck' (2	005).			<ul><li>∨</li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li><li></li></ul> <li></li>	′ane re ′ane U	sidual TP UTP	=   Inat	Gro     Gro	oundwater inflow oundwater outflov	v

Clie	ent: ject: ation:	Concke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush	50mm Hand Auge Coordinates: System: Elevation:	r 605 NZ <sup>-</sup> 164	le 5045 TM	<b>L</b> 9mN	<b>OQ</b> 1, 17	<b>9</b> 166	00m	٦E		Te Pro Sh Te Lo Ch	st ID: oject II eet: st Date gged I necked	D: e: By: Bv:	HA09 19103 1 of 1 05/11/2019 CK DD	1
Tes (ш) ц	t Site: Dic Log	Refer to site plan	Located By:	Pho	one (	GPS	mic Co	In-s	situ <sup>Penetr</sup>	Tes	ting er (blo 6	Va ws/5	ne ID: 0mm)		835	(m
Dept	Grap	Material Description	Geology	Wate		5	50	Shea 1	ir Var 00	ne, Su 1	(kPa) 50	) 20	00	Te	est Values	RL (
1		Organic clayey SILT; dark brown. Dry to moist. Clayey SILT; brownish orange.	Topsoil Kerikeri Volcanic Group - Residual soil													
0.5-		CLAY, with some silt; brownish orange. Very stiff; high plasticity; moist.					÷	0							172 / 91	1 1 1 1 1 163.5
- 1.0-		1.1m: becomes silty, low plasticity						(	<b>)</b> —		•				157 / 102	1 1 1 1
1.5-									0				•		219+ / 110	1 1 1 1 1 162.5
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	Ţ	(	)									74 / 25	1 1 1 1 162.0
25				ot Encountere		0	•								56 / 31	5
-				Groundwater N		0	•								60 / 31	1 1 1 1
3.0_		3.2m: wet to saturated, increasing scoria lapilli				0-	•								58 / 36	161.0
- 3.5–						0		•							85 / 34	1   1 160.5
- - 4.0-						0		•							81 / 34 78 / 31	60.0
-						C	>	•							85 / 49	
4.5-						C	)	•							81 / 44	1 1 1 1 159.5
5.0_	× * × * • •						)	•							85 / 47	1 1 1 1 159.0
5.5-																1 1 1 1 158.5
																-
Hol Ren	e Depth narks:	: 5.00m   I ermination: Reached target depth							•	Van Van	ne pea ne resi	ak idual	۲ >	_ Stan ├ Grou	ding water leve ndwater inflow	el ,
Mate No c	erials ar correlati	e described in general accordance with NZGS 'Field Descript on is implied between shear vane and DCP values.	ion of Soil and Roc	:k' (2	005	).			•	Van	ne UTI	P UTP :	⊃ Unable=	⊢ Grou e to Per	ndwater outflo etrate	w

(		Hand	Auger Boreh	<b>10</b>	le	Lo	g				Test Proje Shee	ID: ect ID: et:	<b>HA10</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: at <u>Sit</u> e:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdi 67 Dip Road, Three Mile Bush Refer to site plan	ivision Coordinates: Elevation: Located By:	605 NZT 158 Pho	0421 ГМ .5m o <u>ne</u> G	mN, 17 PS	7166	09m	ιE		Test Logo Cheo Vane	Date: ged By cked E e ID:	05/11/2019 : CK By: DD 835	9
(m) u	hic Log			-	D	ynamic C 2	In-s Cone P	<b>situ</b> enetr 4	Test omete	ing r (blow	s / 50m 8	ım)		(e
Dept	Grap	Material Description	Geology	Wate		50	Shea 1(	r Van 00	ie, Su 15	(kPa) 50	200		Test Values	RL (n
-		Organic SILT; dark brown. Non-plastic; dry; rootlets.	Topsoil											-
- 0.5_ -	× × × × × × × × × × × × ×	Silty CLAY. Very stiff; low plasticity; moist.	Kerikeri Volcanic Group - Residual soil			0				•			169 / 47	158.0
-	× × × × ×	0.8m: some silt, highly plastic												E
1.0- - -	× × × × × × ×			untered			-0-				•		201 / 88	1 1 1 157.5
- 1.5_	× × × × × × × × ×			ater Not Encor			Ò					•	219+ / 75	157.0
- - 2.0–	× × × × × × × × ×			Groundw		0-						•	219+ / 60	6.5
-	× × × × × × ×													1 1 1
2.5_	× × × × × ×					0					•		194 / 55	1 1 1 1
- - 3.0-	× × × × × ×			_		(	<b>)</b>					•	219+ / 74	1 1 1 1 155.5
- - 3.5-														
-														1 1 1 1
4.0- -														1 1 1 1
- 45														-
-														1 1 1 1
5.0_														1 1 1 1
- 5.5-														53.0
-														
Hol	e Depth	: 3.00m Termination: Reached targe	et depth	1	L	:	:	•	: Vane	: e peak	:	:	Standing water lev	el
Remarks:											ual	<	Groundwater inflov	v
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.											TP = L	⊳ Jnable to	Groundwater outflo	w

(		Hand Auge Method:	or Boreh	0	le	L	.0	g				Te Pr Sh	st ID: oject I leet:	D:	<b>HA11</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ1 157 Plar	043 ГМ .5m n se	9m	N, 17	7166	656n	nE		Te Lo Ch Va	st Dat gged lecked ine ID:	e: By: d By:	27/11/2019 AM DD 131	
(m)	nic Log					Dyna	amic C	In-	situ <sup>Penet</sup>	Tes romet	ting er (blo	ows / 5	i0mm) s			
Dept	Grapl	Material Description	Geology	Wate			50	Shea 1	ar Vai 00	ne, Su 1	i (kPa 150	) 20		_ т	est Values	RL (n
-		SILT, with some rootlets; light brown. Dry. Clayey SILT; brownish orange. Hard: low plasticity: dry to moist	Topsoil Kerikeri Volcanic Group - Residual soil			(	D				•	•			150+ / 46 193+ / 120	-
0.5_		0.5m: minor gravel, fine black weak basalt/scoria lapilli, moist								) )		•			193+ / 117	1 1 1 1
-	× × × × × × × × × × × × × × × × × × ×							(	)			•			193+ / 98	F
1.0_	× × × × ×							(	)(			•			193+ / 97 193+ / 135	156.5
- - 1.5-	× × × × × × × × × × × × × × × × × × ×									0		0.			193+ / 178	
-	× × × × × × × × × × × ×							-C	)			•			193+ / 92	1 1 156
-	× × × × × × × × × × × × × × × × × × ×									0		•			193+ / 128	F
2.0-	× × × × × × × × × × × × × × × × × × ×			pe						)(		•		_	193+ / 119	1 1 1
-	× × × × × × × × × × × × × × × ×			ncounter							0				193+ / 166	-
2.5_	× × × × × × × × × × × × × × × × × ×			ter Not E				<u>.</u>	)						193+ / 98	155.0
-	× × × × × × × × × × × × × × × × × × ×			oundwat											193+ / 104	F
- 3.0_				Ğ					0			•			193+ / 102	1   1 154.5
-	× × × × × × × × × ×						C	,		······	•				150 / 66	F
- 3.5_	× × × × × × × × × × × × × × × × × × ×	Clayey SILT, with trace gravel; brown. Stiff; high plasticity; moist; gravel, fine, weak basalt/scoria lapilli; sensitive.	Kerikeri Volcanic Group - Weathered airfall deposit			0									72 / 30 66 / 22	1   1 154.0
-	× × × × × × × × × × × × × × × × × × ×	'3.5m: moist to wet			C	)	•								62 / 21	F
- 4.0-	× × × × × × × ×	4 0m: some sand			-0	)			•						104 / 18	53.5
-	× × × × × × × × × × × × × × × × × × ×	4.2m: no sand, moist					0		•						110 / 54	
4.5	× × × × × × × × × × ×					0		•							90 / 33	_ 
-		Sandy gravelly SILT. Stiff and loose; non-plastic; moist; sand, fine to coarse, gravel, fine to madium, week basel/section (apilities)				0		•	•						98 / 29	1 1
-		4.9m - 5.0m: becoming silty, brownish orange			(	)			•						102 / 26	-
5.0_ - -					(	<b>)</b> —	•								69 / 25	1 1 1
55																
																152
-																F
Hol	e Depth	Image: 5.00m         Termination: Reached target depth			l	:	:	:	•	: Var	: ne pe	: ak	<u> </u>	 Sta	nding water leve	l el
Rer	narks:								0	Var	ne res	sidual	<	∱ Gro	oundwater inflow	,
Mat	erials ar	e described in general accordance with NZGS 'Field Descripti	on of Soil and Roc	:k' (2	005	).			•	Var	ne UT	Р	5	≻ Gro	undwater outflo	w
No	correlati	on is implied between shear vane and DCP values.		-								UTP	= Unabl	e to Pe	enetrate	

(		Hand Auge Method: 50m	r Borek	10 DCP	le	e Lo	g				Test Proje Shee	ID: ect ID: t:	<b>HA12</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: at Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ <sup>-</sup> 159 Pla	504 TM 9m	62mN, 1	7167	'21m	ηΕ		Test Logg Chec Vane	Date: ed By: ked By ID:	28/11/2019 AM y: DD 131	
(m) u	hic Log					Dynamic (	In- Cone F	<b>situ</b> Penetr 4	Test	ting er (blov 6	vs / 50mi	m)		(
Dept	Grap	Material Description	Geology	Wate		50	Shea 1	ar Var 00	ne, Su 1	(kPa) 50	200		Test Values	RL (n
-		Organic SILT; dark brown, organic stained. Dry to moist; Trace rootlets.				O			•				135 / 44	-
0.5-	* * * * * * * * * * * * * * * * * * * *	Hard; low plasticity; moist.					C	)			•		193 / 94	58.5
-	× × × × × × × × × × × × × × × × × × × × × ×	0.6m: some clay							)		•		193 / 113 193 / 120	
- 1.0_	× × × × × × × × × × × × × × × × × × × × × ×							(	)(		•		193 / 121	1   1 158.0
-	× × × × × × × × × × × × × × × × × × × × × ×	1.2m - 2.1m: trace of clay, orange						0			•		193 / 108 193 / 110	-
1.5- -	****** ******** *******					0				•			163 / 25	1 1 1 1
-	× × × × × × × × × × × × × × × × × × × × × × ×	1.7m: minor fine sand							•				138 / 35	- 0
-	× × × × × × × × × × × × × × × × × × ×	2.1m - 2.7m: trace gravel, fine, black, extremely weak residually weathered lapilli		ncountered			<b>o</b>		•		•		190 / 72	111
- 2.5_	× × × × × × × × × × × × × × × × × × × × × × ×	2.3m: some fine sand 2.5m: pockets of lensoidal, extremely weak, black to dark		ater Not Er		0		•					113 / 36	1 1
-		sandy gravelly SILT; cark greyish brown, black and orange mottling.	-	Groundw	(				•				83 / 25	
- 3.0_	0 X X 0 X 2 X 2 X 2 X 2 X 2 X	Very stiff; wet; sand, fine to coarse, gravel, fine to medium, very weak basalt/scoria lapilli.		-		-0				•	)		173 / 30	1 1 1 156.0
-					Ĩ									-
3.5-														1 1 1 1
- - 4.0														5.0
-														1 1 1
- 4.5-						>								154.5
-					•	•			•	-				-
5.0_					_									154.0
5.5														2
-														1 1
														Ē
Hol	e Depth narks	: 3.00m Termination: Reached target depth						•	Van	e peal	k	⊥ s	standing water leve	el
1.101									Van	e resi	dual	< 0	Groundwater inflow	'
Mat No	erials ar correlatio	e described in general accordance with NZGS 'Field Descriptio on is implied between shear vane and DCP values.	n of Soil and Ro	ck' (2	200	5).		1•	Van	e UTF ເ	, JTP = U	l≻ ⊄ nable to	Froundwater outflo Penetrate	w

		Hand Auge Method:	50mm Hand Auge	0	le	Lo	bg				T P S	est ID roject heet:	): t ID:	<b>HA13</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ1 163 Pho	0489 ГМ .5m one G	)mN, SPS	1710	6747	mE		T L C V	est Da ogged heckd ane II	ate: d By: ed By D:	05/11/2019 CK : DD 835	)
(m)	nic Log				[	Dynami 2	lı c Con	n-sit	u Te	sting eter (b	g lows /	50mm)			
Depth	Grapł	Material Description	Geology	Water		50	Sł		ane, S	5u (kP 150	a) 2	200		Test Values	RL (m
-	TS W W	Organic SILT; dark brown. Dry.	Topsoil Kerikeri Volcanic												-
0.5		Silty CLAY; brownish orange. Very stiff; high plasticity; moist.	<sup>⊥</sup> Group - Residual soil			С	)			•	Þ			166 / 55	1 1 1 1 163.0
															F
1.0-		-0.8m: some black mottling					(	<u> </u>				•		212 / 89	2.5
															162
	× × × × × × × × × ×	1.2m: silty 1.3m - 1.9m: predominantly SILT, low plasticity				Ò				•				160 / 50	F
1.5-					O	)				•				144 / 22	1 1 1 1 162.0
2.0-		SILT, with some gravel, with minor sand; dark greyish brown. Stiff to very stiff; non-plastic; wet; gravel, fine to medium,	Kerikeri Volcanic Group - Weathered Airfall	red	C	)			•					128 / 24	1 1 1 161.5
		very weak basalt/scoria lapilli. 2.2m: increasing scoria	Deposit	Joounte	0			٠						103 / 16	F
2.5_		2.4m - 4.0m: decreasing gravel (some), brownish orange		oundwater Not Er	¢	)		•						110 / 25	1 1 1 1 161.0
- 3.0- -		3.0m: wet to saturated		Gr	0			•						97 / 20	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
					Ö	)	•							71 / 22	F
3.5-		"3.4m: trace of gravel, some black mottling, moist to wet				0			•					119 / 34	1 1 1 1 160.0
4.0-		4.0m: wet			¢	)	•							71 / 27	59.5
		4.2m: trace black mottling, wet to saturated				0			•					113 / 39	
4.5-		4.5m: brownish orange				-0			•					116 / 39	159.0
5.0_		4.8m: increasing scoria, saturated			0					•				160 / 20	8.5
-															1 1 1
5.5-															1 1
															$\vdash$
Hol Ren	e Depth narks:	: 5.00m   Termination: Reached target depth							● Va	ane pe	eak esidua	I	▼ St	anding water leve	el /
Materials are described in general accordance with NZGS 'Field Description of Soil and Rock' (2005).												= Una	⊳ Gi ble to F	roundwater outflo	w

Clie	CLAND ent:	Hand Auge Method: 50	mm hand auger, D	O CP 605	le	<b>L</b> 21mN	<b>OQ</b>	<b>)</b> 1677	73m	E		Test Proj She Test	t ID: ect ID: et: t Date:	<b>HA14</b> 19103 1 of 1 27/11/2019	9
Pro Loc Tes	ject: ation: t Site:	Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	System: Elevation: Located By:	NZ <sup>-</sup> 168 Plai	TM 5.5n n se	n etout	,			_		Log Che Van	ged By cked E e ID:	/: AM By: DD 131	-
th (m)	phic Log	·		er		Dynan 2	nic Co	In-s one Pe	itu enetro	Testi ometer 6	ing r (blow	s / 50r 8	nm)		(m)
Dep	Gra	Material Description	Geology	Wat		50	0	Shear 10	Van 0	e, Su ( 15	kPa) 0	200		Test Values	RL (
		SILT; brownish orange. Low plasticity; dry. Clayey SILT. Very stiff; low plasticity; dry to moist. 0.5m: moist 0.6m - 0.9m: orange 0.9m - 1.4m: trace fine gravel (very weak basalt/scoria lapilli) , brown	Kerikeri Volcanic Group - Residual soil			0-		O	)		•			126 / 39 181 / 98 174 / 101 150 / 99 166 / 106 177 / 94	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
- 1.5- - -	x D 0 x x x z D 0 x x x x z x z 0 x x x x x z x z x x x x x x z x z x x x x x x x x x x x x x x x x x x x	SILT, with minor sand, with trace gravel. Very stiff; non-plastic; moist; sand, fine to coarse; gravel, fine, very weak basalt/scoria lapilli. 1.7m: some gravel, fine to medium, sub angular to sub rounded	Kerikeri Volcanic Group - Weathered airfall deposit			0		)		•				152 / 41 139 / 76 149 / 65	1 1 1 1 1 167.0
2.0-	× × × 0 0 × 0 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			(	0		•						97 / 21 90 / 26	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
2.5_		2.8m: mostly gravel lapilli, moist to wet, crushes under auger		ot Encountered		)•								50 / 17 UTP	1 1 1 1 166.0
3.0	> X . 0 X * . X			Groundwater N										UTP	.0 165.5
4.0-															1 1 1 1 1.5 165
45_															0 16
-															1 1 1 1 1
5.0_					 		•								1 1 1 1 163.5
5.5_														▶ 10 ▶ 10 ▶ 12	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Hol Ren	e Depth narks:	: 3.00m Termination: Reached target depth							•	Vane Vane	e peak e resid	ual	<b>▼</b> ♦	Standing water lev Groundwater inflov	vel w
Mate No c	erials are correlatio	e described in general accordance with NZGS 'Field Description is implied between shear vane and DCP values.	ion of Soil and Roc	:k' (2	2005	5).			•	Vane	e UTP U	TP = l	⊳ Unable to	Groundwater outflo o Penetrate	w

Clie	ent:	Conce Heights Limited Geotechnical Suitability Assessment for Subdivision	r Boreh Im hand auger, D Coordinates:	0CP 605	<b>le</b>	<b>L</b> 3mN	<b>O</b>	<b>g</b> 7166	09m	١E		Te Pr Sh Te	est ID oject neet: est Da	): t ID: ate: d By	HA15 19103 1 of 1 27/11/2019	)
Loc Tes	ation: t Site:	67 Dip Road, Three Mile Bush Refer to site plan	Elevation: Located By:	154 Pla	m n se	tout						Ch Va	necko Ine II	ed B D:	y: DD 131	
th (m)	ohic Log			er		Dyna	mic C 2	In-s	<b>situ</b> <sup>Penetr</sup> 4	Test omete	t <b>ing</b> er (blo 6	ws / 5	i0mm) B			(n
Depi	Grap	Material Description	Geology	Wat		ŧ	50	Shea 1	ar Van 00	ie, Su 1	(kPa) 50	20	00		Test Values	RL (
-		Organic SILT; brownish black. Dry to moist; some rootlets.	Topsoil			O					•				152 / 32	-
- 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)		·····C	)			•						110 / 21 21 / 11	1 1 1 1
-	× × × × × × × × × × × × × × × × × × ×	Sandy SILT, with trace gravel; brownish orange, some orange mottling. Firm to stiff: non-plastic: moist: sand, fine to medium:	-		0		•								58 / 17	-
1.0_ -	× × × × × × × × × × × × × × × × × × ×	gravel, fine. Clayey SILT; brownish orange.							)		•	•			193+ / 98 159 / 84	1 1 1 153.0
-	× × × × × × × × × × × × × × × × × × ×	Very stiff; low plasticity; moist.						0			•				160 / 90	
-	× × × × × ×			pa					0			•			181 / 115	1 1 1
- - 2.0-	× × × × × × × × × × × × × × × × × × ×			Encounter			<u>.</u>		-0-			•			193+ / 112	2.0
-	× × × × × × × × × × × × × × × × × × ×	2.1m: minor gravel, fine, black, very weak basalt/scoria lapilli		water Not						>		•			193+ / 123	1 1 1
- 2.5–	× × × × × × × × × × × × × × × × × × ×	2.5m: some gravel as above		Ground											UTP	51.5
-	× × × × × × × × × × × × × × × × × × ×														UTP	
- 3.0–	× × × × × × × ×			-							•				UTP	1 1 1 151.0
-																-
3.5_																1 1 1 1 150.5
- 4.0-										-			<			1 1 1
-															▶11 ▶12	-
4.5-																1 1 1 1 1
- 5.0–																1   1 149.0
5.5																5
-					 											1 1 1 1 1 148
	o Dorth	· 2.00m							-					_		<u> </u>
Rer	narks:	. o.oom premination. Reached target depth								Van Van	e pea e resi	ak idual		▼ :	Standing water leve Groundwater inflow	el /
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.										Van	e UTI	P UTP :	= Una	ble to	Groundwater outflo	w

Clie Pro	ent: ject: ation:	Conoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush	omm hand auger, D Coordinates: System: Elevation:	0CP 605 NZ 155	lе <sup>0394</sup> гм тм	Lo 4mN	<b>Og</b> , 171	16643	3mE		T P S T L C	est ID roject heet: est Da ogged	ID: te: By: d By:	HA16 19103 1 of 1 28/11/2019 AM DD	)
Tes (E)	t Site: bit Log	Refer to site plan	Located By:	Plai	n set	Dynan	nic Cor	In-si ne Per 4	tu Te	estin neter (t	g blows /	50mm)	): 	131	(
Dept	Grap	Material Description	Geology	Wate		50	s D	hear \ 100	/ane,	Su (kF 150	Pa)	200	-	Test Values	RL (n
	<b>G</b>	Material Description         Organic SILT; tark brown.         Dry.         SILT; reddish brown.         Very stiff to hard; low plasticity; dry.         0.3m - 3.0m: trace of clay, brownish orange, moist         0.8m: some clay, increasing plasticity         1.5m: minor gravel, black, sub angular, very weak basalt/scoria lapilli         2.2m: trace of clay	Geology Alluvium (Kerikeri Volcanic Group derived)	Groundwater Not Encountered										Test Values         135 / 26         193+ / 110         193+ / 126         193+ / 131         193+ / 132         193+ / 132         193+ / 155         193+ / 156         193+ / 152         193+ / 152         193+ / 167         193+ / 134         193+ / 138         193+ / 131	50.5 151.0 151.5 152.0 152.5 153.0 153.5 154.0 154.5 RU
- - - - - - - - - - - - - - - - - - -															1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
Hol Rei	e Depth narks:	: 3.00m Termination: Reached target depth							• v	'ane p 'ane r	eak esidua		▼ Sta	anding water lev	el v
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.												<u>e Unat</u>	▷ Gro ble to Po	oundwater outflo	w

(		Hand Auge Method: 5	r Borel	<b>10</b> er	le	L	0	g				T P S	est I roje heet	D: ct ID: ::	<b>HA17</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ 152 Pho	038 FM m one (	5ml GPS	N, 17	7166	693n	nE		T L C V	est I ogg hec ane	Date: ed By ked E ID:	05/11/2019 <b>/:</b> CK <b>3y:</b> DD	9
(	Log							In-	situ	Tes	sting	3				
ա) ւ	hic I					Dyna	mic ( 2	Cone F	Peneti 4	rome	ter (bl 6	ows /	50mn 8	n)		<del>-</del>
ept	irap	Matorial Description	Goology	Vate				Shea	ar Var	ne, S	u (kPa	a)			Toet Values	()  -
	TS W W	Organic SILT: brown.	Topsoil				50	1		-	150		200		Test values	
		Dry.		of End												F
-	<u>× × × ×</u> × × × × ×	Clayey SILT, with trace gravel; brownish orange, some dark	Residual soil	ter No												F
0.5-	××××	Very stiff; high plasticity; moist; gravel, fine, subround.	/	ewbr												1.5
-		Silty CLAY; brownish orange.					<u>.</u>	÷						÷		15
		Very stin; high plasticity; moist.					<u>.</u>		<u> </u>					<u>.</u>		Ę
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1.0-																151.0
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3.0_																19.0
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- 3.5-							-	-			1	-	-	1		نہ
-																148
																t
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4.0-							<u>.</u>	<u>.</u>	<u> </u>	<u>.</u>				<u>+</u>		148.0
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4.5-																47.5
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Hol	e Denti	: 0.50m Termination: impenetrable material	<u> </u>		I	:	:	:		:			:	:	Standing water !	
Rer	narks:								1	va	пе ре	:аК		<b>_</b>	Stanuing water lev	/ei
									$ ^{\circ}$	Va	ne re	sidua	I	$\triangleleft$	Groundwater inflo	w
Mat	erials a	e described in general accordance with NZGS 'Field Descriptic	n of Soil and Ro	ock' (2	005	).			◆	Va	ne U1	ΤP		$\triangleright$	Groundwater outfle	ow
No	correlati	on is implied between shear vane and DCP values.										UTF	P = Ur	nable t	o Penetrate	

(	LAND	Hand Auge	mm hand auger, D	<b>О</b> СР	le	Lo	ວູ	)				Tes Pro Sh	st ID: oject ID eet:	<b>H</b> : 19 <sup>-</sup> 1 c	<b>A18</b> 103 f 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located Bv:	605 NZ 154 Pho	0416 FM m one G	∂mN, ∂PS	17 <sup>.</sup>	1673	31m	E		Tes Log Ch Va	st Date gged B ecked I ne ID:	: 27/ y: CP By: DD 194	11/2019 0 45	
th (m)	phic Log			er	[	Dynam 2	ic Co	In-s one Pe	itu '	Testi ometer 6	ng (blov	ws / 50	Omm)			(m)
Dep	Gra	Material Description	Geology	Wat		50		Shear 10	Van 0	e, Su ( 15	kPa) 0	20	0	Test	Values	RL (
-	× × ×	Organic clayey SILT; brown. Dry: friable. rootlets.	Topsoil Kerikeri Volcanic													-
- - 0.5- -	× × × × × × × × × × × × × × × × ×	Silty CLAY, with trace gravel; reddish brown. Very stiff; high plasticity; moist; gravel, fine.	Group - Residual soil					O	D				•	20	UTP 04 / 93 2 / 106	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
-	× × ×								0			•		. 19	0 / 109	
1.0_	× × × × × × ×	1 2m: rare completely weathered coarse gravels/cobbles		red				—Ċ	)			•	•	18	2 / 102 UTP	1 1 1 1 153.0
	× × × ×			counte		0								. 14	16/33	
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	vater Not End												1 1 1 152.5
		1.8m - 2.2m: brown, wet		roundv			0			•				14	6 / 66	Ŀ
2.0-	× • × • •			Ū	-0				•					- 10	9 / 18	52.0
-		2.2m - 2.7m: brownish black			O				•					12	20 / 18	
-						)						•		18	32 / 26	
2.5_		2.6m: saturated														151.5
-	× × × × ×	Silty CLAY; greyish orange.													255+	Ē
- 3.0-	× × ×							•						-	UTP	- 0.1
										•				▶20		15
-																-
- 3.5-																1 I 0.5
-																1 31
-																E
4.0-														-		50.0
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4.5-																149.5
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-																
5.5-																148.
																t
																$\left  \right $
Hol	e Depth	: 3.00m Termination: Reached target depth							•	Vane	pea	k	▼	Standing	water leve	I
Rer	narks:								0	Vane	resi	dual	$\triangleleft$	Groundw	ater inflow	
Mat	oriale ar	e described in general accordance with NZGS 'Field Descript	ion of Soil and Poo	k' (?	005			-	٠	Vane	UTF	D	$\triangleright$	Groundw	ater outflov	v
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.											Unable	to Penetra	te			

	LAND	Hand Auge Method: 50r	r Boreh		le	e Log	g			Test Proje Shee	ID: ect ID: et:	<b>HA19</b> 19103 1 of 1	
Clie Proj Loc Tes	nt: ect: ation: Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ 153 Pho	504 TM 3.5n	35mN, 17 n GPS	716	810r	nΕ	Test Logg Chec Vane	Date: jed By: ked By ID:	27/11/2019 FWH /: DD 2249	
th (m)	phic Log			er		Dynamic C	In Cone	- <b>situ</b> Penet 4	trometer (blo	ows / 50m 8	m)		(m
Dep	Grag	Material Description	Geology	Wat		50	She	ar Va 100	ne, Su (kPa 150	i) 200		Test Values	RL (
0.5           1.0-           2.5-           3.0-           3.5-           5.5-           6.5-           6.5-           7.5-           8.0		SILT, with some clay; brownish orange; homogeneous.         Idard; Moveplasticity; dry.         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 darnet legitif; eacy-plastic; wet; homogenous.         2.1m: wet to saturated         4.0m: saturated, no inflow         4.4m - 4.8m: becoming heavily black stained, MnO deposit         4.8m - 5.0m: brownish orange, heavy black mottling	Kerikeri Volcanic Group - Residual soil Kerikeri Volcanic Group - Weathered airfall deposits	Groundwater Not Encountered								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	5 146.0 146.5 147.0 147.5 148.0 148.5 149.0 149.5 150.0 150.5 151.0 151.5 152.0 152.5 153.0 R
8.5 9.0 9.5													11111111111111111111111111111111111111
Hole	Depth	: 5.00m Termination: Reached target depth						•	Vane pe	ak	▼ s	tanding water leve	1
Ren Mate	erials ar	e described in general accordance with NZGS 'Field Description	on of Soil and Roc	:k' (2	200	5).		○ -   ◆	Vane res	sidual "P		Groundwater inflow	N
No c	orrelatio	on is implied between shear vane and DCP values.								UTP = U	nable to	Penetrate	

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(		Hand Auge	50mm Hand Auge	1 <b>0</b>	le	Lo	g				Test Proj Shee	ID: ect ID: et:	<b>HA20</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZT 162 Pho	0489r FM .5m one GI	mN, 17 PS	71681	17m	E		Test Logg Cheo Vano	Date: ged By cked B e ID:	05/11/2019 : CK Sy: DD 835	1
th (m)	ohic Log			er	Dy	/namic C 2	In-s Cone Pe	i <b>tu</b> 1 enetro	Test	i <b>ng</b> r (blow	/s / 50m 8	וm)		(m
Dep	Gra	Material Description	Geology	Wat		50	Shear 10	Vane	e, Su 15	(kPa) 50	200		Test Values	RL (
-	××××××××××××××××××××××××××××××××××××××	Organic SILT; dark brown. Dry. SILT; brownish orange. Very stiff; low plasticity; moist.	Topsoil Kerikeri Volcanic Group - Residual soil											-
0.5- - - 1.0-		CLAY, with trace silt; brownish orange. Very stiff; low plasticity; moist.				0	)				•		180 / 66	1 1 1 1 1 1.5 162.0
- - 1.5–		Clayey SILT; brownish orange. Very stiff; low plasticity; moist.		tered				Ç	D	•			172 / 128	61.0 16
-		1.6m: increase SILT, low plasticity SILT, with some gravel, with minor sand; dark greyish brown	Kerikeri Volcanic Group -	ter Not Encount		_								
2.0-		Firm to stiff; non-plastic; wet; gravel, fine to medium, very weak scoria/basalt lapilli. 2.2m: wet to saturated	Weathered Airfall Deposits	Groundwa	-0-•	•	•						36 / 16 78 / 24	1 1 1 1
2.5_					Ó		•						85 / 25	160.0
-					0	•							44 / 24	-
3.0_		N3.0m: increasing weak scoria/basalt lapilli					•						94 / 25	1 1 1 1 159.5
3.5_					C	)							125 / 31	159.0
-	0	<sup></sup> ^3.6m: saturated					•						00739	-
4.0-														1 1 1 1
- 4.5-														8.0
-														111
5.0_														157.5
5.5														
-														1 1 1
														F
Hol Rer	e Deptł narks:	: 3.70m   Termination: hard material						•	Vane Vane	e peak e resio	k Jual	<b>▼</b> ⇔	Standing water leve Groundwater inflow	el '
Mat No (	erials ar correlati	e described in general accordance with NZGS 'Field Description on is implied between shear vane and DCP values.	on of Soil and Roc	:k' (2	005).			•	Vane	e UTP U	JTP = L	⊳ Jnable to	Groundwater outflo Penetrate	w

(	LAND	Hand Auge Method: 50r	r Boreh	<b>0</b>	le L	-0(	3			1	Test II Projec Sheet:	D: ct ID: :	<b>HA21</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ1 153 Plar	0467ml ™ .5m ∩ setout	N, 17 t	1685	57ml	E	1	Test D Logge Check Vane I	oate: ed By: ced By D:	27/11/2019 : AM <b>y:</b> DD 131	)
th (m)	phic Log			ter	Dyna	amic Co 2	In-si one Pe	itu 1 enetro	Testin meter ( 6	ng (blows	/ 50mm 8	)		(m)
Dep	Gra	Material Description	Geology	Vai		50	Snear 10	vane 0	, Su (ki 150	Ра)	200		Test Values	R
- - - - - - - -		SILT, with trace rootlets; dark brown. Dry. Clayey SILT; orange brown, trace orange mottling. Hard; low plasticity; dry to moist. 0.3m - 1.0m: brown, moist 0.8m: minor gravel, fine to medium, black, basalt/scoria lapilli	Topsoil Kerikeri Volcanic Group - Residual soil		0		0	0		•	•		159 / 30 193 / 86 193 / 98 193 / 110	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
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		C	)	)	•	•				126 / 40 150 / 79 138 / 66	1 1 1 1 1 1
1.5_ - -					0			•					121 / 37 108 / 26	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.	-	t Encountered	-0		•						81 / 19 79 / 26	151.5
2.5_				oundwater No	·····Ò····	•							58 / 25 55 / 26	151.0
- - 3.0-		2.9m - 3.0m: becoming sandy, brownish grey with orange brown and brown mottling		Ū	•	)	•		<b>-</b>				102 / 25 128 / 39	0.5
- - - 3.5-						>			-					0.0 150
						*								5 15
-						*								1 1 1 1
4.5-														149.0
5.0_ - -														1 1 1 1
5.5_														148.0
Ho	e Denth	: 3.00m Termination: Reached target depth						•	<u> </u>					<u> </u>
Rer	narks:	e described in general accordance with NZGS 'Field Description	on of Soil and Roo	:k' (2	005).			• •	vane p Vane r Vane l	peak residu UTP	ıal		atanging water leve Groundwater inflow Groundwater outflo	ei / /w
No	correlati	on is implied between shear vane and DCP values.		(2						UT	P = Una	able to	Penetrate	

(		Hand Au	ger Boreh	<b>0</b>	le	L	0	g				Te Pr Sh	est ID: oject neet:	ID:	<b>HA22</b> 19103 1 of 1	
Clie Pro Loc Tes	ent: oject: cation: st Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ <sup>-</sup> 149 Pho	041 FM m one (	8mN GPS	J, 17	7168	61m	ιE		Te Lo Cł Va	est Dat ogged necket ne ID	te: By: d By: :	05/11/2019 CK DD 835	)
(m) th	hic Log					Dynai	mic C 2	In-s	<b>situ</b> Penetri 4	Test omete	<b>ting</b> er (blo 6	ows/5	50mm) 8			u)
Dept	Grap	Material Description	Geology	Wate		5	0	Shea 1	ir Van 00	e, Su 1	(kPa) 50	) 2	<u>0</u> 0	т	est Values	RL (I
-		Organic SILT; dark brown. Dry. CLAY, with some silt; brownish orange. Very stiff to hard; high plasticity; moist.	Topsoil Kerikeri Volcanic Group - Residual soil													-
0.5- - -								0					•		219+ / 81	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
- 1.0–		∕0.9m: silty		ered			)					•			193 / 47	1 1 1 1 148.0
- - 1.5-	× × × × × × × × ×			ter Not Encounte		(	0					C			196 / 53	1 1 1 1 147.5
- - 2.0-		Clayey SILT; brownish orange.	Kerikeri Volcanic	Groundwa		-0-							•		207 / 38	7.0
-		Very stiff; low plasticity; moist. 2.3m: some black mottling	Weathered airfall deposit				· · · · · · · · · · · · · · · · · · ·									1 1 1
2.5_	× × × × × × × × × × × × × × × × × ×	2.6m - 3.0m: no clay, trace of gravel; brown; wet, non-					•						•		219+ / 44 63 / 28	1 1 1 146.5
- 3.0-	× × × × × × × × × × × × × × × × × ×	plastic; gravel, line very weak basali/scona lapilit.					•						•		UTP	1 I I
-																1 1 1
- 3.5_ -																145.5
- 4.0-																1 1 1 145.0
- - 4.5-	•															44.5
-											÷					 
5.0_																144.0
5.5-																1 1 1 1
-																-
Hol	e Depth narks:	: 3.00m <b>Termination</b> : impenetrable material							•	Van	e pea	ak	-	Star	iding water leve	əl
				14.40	005				•	Van Van	e res e UT	idual P	< [	Gro     Gro	undwater inflow undwater outflo	/ w
No No	eriais ar correlati	e described in general accordance with NZGS 'Field Des on is implied between shear vane and DCP values.	scription of Soil and Roc	к (2	005)	).						UTP	= Unab	le to Pe	netrate	

(		Hand Aug	er Boreh	<b>O</b> CP	le	Lo	g				Tes Pro She	t ID: ject ID eet:	HA23 : 19103 1 of 1	
Clie Pro Loc Tes	ent: ject: ation: t Site:	Onoke Heights Limited Geotechnical Suitability Assessment for Subdivision 67 Dip Road, Three Mile Bush Refer to site plan	Coordinates: System: Elevation: Located By:	605 NZ1 145 Plar	039 ГМ .5m n_set	6mN, 1 tout	7168	385n	ηΕ		Tes Log Che Van	t Date ged B ecked I ne ID:	: 27/11/2019 y: AM By: DD 131	9
h (m)	hic Log			r		Dynamic 2	In- Cone I	<b>situ</b> Peneti 4	Test	ting er (blov 6	ws / 50 8	mm)		n)
Dept	Grap	Material Description	Geology	Wate		50	She	ar Var 100	ne, Su 1	(kPa) 50	200	)	Test Values	RL (r
	TS ≝ ™_TS	SILT, with trace rootlets; dark brown.	Topsoil											-
	× × × × × × × × × × ×	Dry.	Alluvium (Kerikeri			O				•····			. 155 / 41	E
	× × × × × × ×	Very stiff to hard; low plasticity; dry to moist.	derived)				C	)			•••••		193 / 90	-
0.5-	× × × × × × × × × × × × × × × × × × ×	0.5m: minor fine gravel, sub angular, black; moist							ļ		•		192 / 77	145.0
	× × × × × × × × × × × × × × × × × × ×						0							$\left  \right $
	× × × × × ×							0.			••••		. 193 / 109	Ę
1.0-		1.0m - 1.6m: dark brown, becomes sensitive							ò		•		193 / 127	144.5
				-									UTP	Ē
				ntered		$\sim$							402/27	E
1.5-		►1.4m: minor sand (weak scoria lapilli)		Encou									193/3/	14.0
	×××××× ××××××	1.6m - 2.0m: some gravel, fine to medium very weak		er Not	C	)			•				. 139 / 21	1
	<u> </u>	basalt/scoria lapilii; brownish red with trace orange mottling		dwate								····•	UTP	+
2.0-	× × × × × × ×			Grour	(	<b>)</b>							193 / 28	3.5
		2.0m - 2.5m: variable sand, silt, clay and fine gravel lapilli											100720	143
	× × × ×											•	UTP	
	0 × × × × ×											····•	UTP	+
2.5-				1					<u>.</u>					1 1 143.(
-														-
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3.0-									•				-	1 142.5
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5.5-														40.0
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Hol	e Depth narks:	: 2.50m   <b>Termination</b> : impenetrable material						- •	Van	ne pea	ık	▼	Standing water lev	rel
								0	Van	ne resi	idual	$\triangleleft$	Groundwater inflov	N
Mat	eriale ar	e described in general accordance with NZGS 'Eield Descri	tion of Soil and Por	·k' (?	005	)		•	Van	ne UTF	Ρ	$\triangleright$	Groundwater outflo	ow
No	correlation	on is implied between shear vane and DCP values.		/n (2						I	UTP =	Unable	to Penetrate	

Client:			Ints Limited	Sc	ala F	Pene		eter	<b>Test</b>	<b>Log</b> N, 171662	3mE	Test ID: Project Sheet: Test Da	<b>ID:</b> 1910 1 of 1 ite: 28/11	<b>01</b> 3 1 1/2019
Locatio	n: 67 [ n: 67 [	Dip Roa	d, Three Mile	Bush	for Subaiv	ision	Eleva Locat	tion: ed By:	178m Plan setou	t		Checke	dBy: AM	
pth (m)	ows per mm	nsity	50	25	16.6	12.5	Penetratior 10 Penetrati	n (mm/blow 8 <sub>1</sub> 3 on (blows p	r, non-linea 7 <sub>i</sub> 1 per 50mm)	r) 6 <sub>i</sub> 3	5,5	5	4,5	Ē
å	Ble	De	1	2	3	4	5	<u>6</u>	7	8	9	10	11	R
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Remark	(S' Doci	ulte mov	ha affected l	ov ckin friction	porticulo	rlywboro	the tested (	lopth oxee	odo 1 5m [	Doncity cla	scification	in torms of	NZCS Field	
	Desc	cription of	of Soil and Ro	ock (2005).	i, particula	ny where		зерш ехсе	cuə 1.0111. l	Jensity Cia	samualiU(1			

Client: Project:		DE GINEER vke Heig	hts Limitec	d y Assess	Sca	<b>Ia F</b>	Pene	etror	nete	er To	<b>est</b> 0513mN M	Log	3mE	Test ID Project Sheet: Test Da Logged	t ID:	<b>RP02</b> 19103 1 of 1 28/11/20 AM	)19
Locatio Test Sit	n: 67[ e: see	)ip Road plan	d, Three M	ile Bush				Ele	vation: ated By:	166. Plan	5m setout			Checke	əd By: [		
th (m)	vs per im	sity	50	0 2	25	16.6	12.5	Penetrati 10 Penetra	ion (mm/t 8 <sub>1</sub> : ation (blo	olow, nor 3 ws per 5	n-linear <u>)</u> 7 <sub>.</sub> 1 i0mm)	) 6 <sub>1</sub> 3	5 <sub>1</sub> 5	5	4,5		(E
Dep	Blov 50m	Den	1		2	3	4	5	<b>6</b>	•	7	8	9	10	11		RL (
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Remark	(S: Res	ults may	be affected	d by skin f	riction	particula	arly where	e the teste	d denth e	xceeds	1.5m D	ensity cla	ssification	in terms o	f NZGS	Field	
	Desc	ription c	of Soil and I	Rock (200	, )5).			-			_	,		-			

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Client:			ING Ind	Sc	ala F	Pene		eter	<b>Test</b>	Log	7mE	Test ID Project Sheet: Test Da	<b>ID:</b> 1910 1 of 1 ate: 28/11	<b>03</b> 3 1 1/2019
Project Locatio Test Sit	: Geo on: 67[ te: see	otechnic Dip Roa plan	al Suitability As d, Three Mile E	ssessment Bush	for Subdiv	rision	Syste Eleva Locat	m: tion: ed By:	NZTM 150.5m Plan setou	t		Logged Checke	By: AM d By: DD	
th (m)	ws per Im	sity	50	25	16.6	12.5	Penetration 10 Penetratio	n (mm/blow 8 <sub>1</sub> 3 on (blows j	/, non-linea 7 <sub>i</sub> 1 per 50mm)	ır) 6 <sub>1</sub> 3	5 <sub>,</sub> 5	5	4 <sub>.</sub> 5	Ē
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Remar	(S' Boo	ulte mov	be affected by	ckin friction	porticulo	rly whore t	ho tostod a	lonth oxee	ods 1 5m	Doncity old	ssification	in torms of	NZCS Field	
	Desc	cription of	of Soil and Roc	k (2005).	, parucuia						oomoalion			

Client:			ING ghts Limited	Sca	ala F	Pene	trom	dinates:	<b>Test</b>	Log	8mE	Test ID: Project Sheet: Test Da	<b>RP</b> <b>ID</b> : 1910 1 of 1 <b>ite</b> : 28/11	<b>04</b> 3 1 1/2019
Project Locatio Test Sit	: Geo n: 67[ te: see	otechnic Dip Roa plan	al Suitability As d, Three Mile E	ssessment † Bush	for Subdiv	vision	Syste Eleva Locat	em: N ition: ted By: F	NZTM 155.5m Plan setou	t		Logged Checke	IBy: AM edBy: DD	
th (m)	vs per m	sity	50	25	16.6	12.5	Penetration 10 Penetrati	n (mm/blow 8 <sub>i</sub> 3 ion (blows r	, non-linea 7 <sub>1</sub> 1 per 50mm)	r) 6 <sub>1</sub> 3	5 <sub>1</sub> 5	5	4 <sub>i</sub> 5	Ê
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<u>Remar</u>	ks: Resi	l ults may	be affected by	skin friction	, particula	rly where t	the tested	depth excee	eds 1.5m. l	Density cla	ssification	in terms of	f NZGS Field	
	Desc	cription	of Soil and Roc	k (2005).										

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Client:		DE GINEER	INT Ints Limited	S	cala	ı Pen	etr	<b>OM</b>	eter	<b>Test</b>	Log	9mE	Test ID Project Sheet: Test Da	: <b>RF</b> ID: 191 1 of ite: 28/1	<b>*05</b> 03 1 11/2019
Project: Locatio Test Sit	: Geo n: 67 [ :e: see	otechnic Dip Roa plan	al Suitability d, Three Mil	/ Assessme le Bush	ent for Su	Ibdivision		Syster Elevat Locate	n: ion: ed By:	NZTM 160.5m Plan setou	t		Logged Checke	IBy: AM edBy: DD	
th (m)	vs per m	sity	50	25	16	.6 12.	Pen .5 Pe	etration 10 enetratio	(mm/blow 8 <sub>1</sub> 3 on (blows p	r, non-linea 7 <sub>1</sub> 1 per 50mm)	r) 6 <sub>1</sub> 3	5 <sub>,</sub> 5	5	4,5	Ē
Dep	Blov 50m	Den	1	2	3	3 4		5	Ģ	7	Ŗ	9	10	11	RL
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Remark	(s: Resu	ults may	be affected	by skin fric	tion, part	icularly whe	ere the t	tested d	epth exce	eds 1.5m.	: Density cla	ssification	in terms of	f NZGS Fiel	Id
	Desc	cription of	of Soil and F	Rock (2005)	).										

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			BOREHOLE	LOG				HOLE NO.: MBH0 Page 1 of 2	<b>1</b>
	NT:	CC Developments LTD						JOB NO.: 19103	
SITE	LOCAT	<b>ION:</b> 67 Dip Road, Three Mile Bush					START	DATE: 10/02/2021	
CO-O	RDINA TRACT(	<b>FES:</b> 1716656mE, 6050495mN (NZTM) <b>DR:</b> DS Geotechnical <b>RIG:</b> LT1	40 DRILL	TION: Ground ER: Damian Spratt	t		END LOGG	DATE: 10/02/2021 ED BY: CP	
DEPTH	GRAPHIC	MATERIAL DESCF In accordance with NZGS 'Field Descripti	RIPTION ion of Soil and Rock' (2005)	GEOLOGY	МЕТНОD	50 TCR (%)	10 SPT 20 N-VALUE 30 (Uncorrected)	TEST DATA	WATER
	TS 业业	Organic SILT with minor clay, dark brown, moist	, rootlets	Topsoil	:				
	×   ×   ×   ×   ×   ×   ×   ×   ×   ×	CLayey SILT with minor fine sand (black), brown	ı, moist, highly plastic յ increasingly greasy	Weathered Ash - Kerikeri Volcanic Group	HQTT				
-2.0		1.8m: becoming wet			НДТТ	400%			
		SILT with trace sand, clay and fine gravel. Brown brittle/sensitive becoming greasy on disturbance weak angular scoria to 15mm, and fine rounded Sandy SILT with some gravel, trace clay. Brown black and vellowish brown Non-plastic saturat	n. Low plasticity; wet to saturated: (allophanic). Gravel is extremely accretionary lapilli. with clasts of reddish brown, ed becoming grassy on	Lapilli Tephra - Kerikeri Volcanic Group	натт	46%			
-3.0	N/R N/ N/R N	disturbance (allphanic). Gravel is extremely wea and fine accretionary lapilli. Clasts break down to	k to weak angular scoria to 20mm o saturated clay/silt under firm		oush Fube ample	- %00			
	√/R N/ × × × × × × × × ×	hand pressure. 2.8m - 3.0m: assumed core loss 3.0m - 3.4m: push tube sample (triaxial test)				%			
-4.0	× × × × × × × × ×				Н	100			ered
5.0	N/R N/ N/R N N/R N/ X X X	4.5m - 4.9m: push tube sample (not tested)			Push Tube Sample	-1-00%			Not Encounte
	× × × × × × × × × × × × × × × × × × ×	5.3m: outlying scoria gravel clast, 50mm, black with mir weak 5.3m - 9.0m: grading to brownish orange with yellow, b	nor yellow staining, very vlack and reddish brown		НДТТ	.100%			roundwater
-6.0	* * * * * * * * * * *	clasts 6.0m: trrace clay			-				9
					HQH				
- - - - - - - - - - - - - - - - - - -					натт	100%			
-9.0		Clayey SILT with some gravel. Blackish brown. V grey highly vesicular basalt, weak to moderately	<i>N</i> et; highly plastic; gravel is dark strong, angular.		натт				
		i at target denth. Borehole dry shortly after drilling	REF DATE / TIME LEVEL	RE	EMARK			LDE Whangarei	
Hole le	minated	at target depth. Borenole dry shortiy aiter drilling.					12	7 Bank St, Whang	arei
								Ph: 0800 397 566	

Generated with CORE-GS by Geroc - Borehole Simplified V1 - 5/03/2021 7:07:30 PM

								HOLE NO.:	
		EVELOPMENT	BUREHULE	LUG					1
CLIE	ENT:	CC Developments LTD						JOB NO.:	
PRC	JECT:	Subdivision Suitability						19103	
SITE	LOCAT	<b>FION:</b> 67 Dip Road, Three Mile Bush					STA	RT DATE: 10/02/2021	
		ITES:         1716656mE, 6050495mN (NZTM)           OP:         DS Geotechnical		ATION: Ground EP: Damian Sprat	+		E	ND DATE: 10/02/2021	
001			DAL				5		
DEPTH	GRAPHIC	MATERIAL DESC In accordance with NZGS 'Field Descript	RIPTION ion of Soil and Rock' (2005)	GEOLOGY	METHOD	5 TCR (%)	0 SPT 0 N-VALUE 0 (Uncorrected	TEST DATA	WATER
		[CONT] Clayey SILT with some gravel. Blackish is dark grey highly vesicular basalt, weak to mo	n brown. Wet; highly plastic; gravel derately strong, angular.	[CONT] Lapilli Tephra -	HQT H	100%			
									-
		Slightly weathered BASAL I, dark grey, highly v strong, yellow and black discoloration along ver vesicles.	esicular, moderately strong to tical joints, iron oxide staining in	Basalt Lava Flow - Kerikeri Volcanic Group		%004			ountered
		13.4m beroming less vesicular			нот	400%			Groundwater Not Enco
		13.4m: becoming less vesicular							 
		<ul> <li>14.0m: becoming less vesicular</li> <li>14.2m: quartz clast with serpentinization around exteri country rock)</li> </ul>	or (entrained clast from		HQT	400%			•
		EOH: 14.80m			[			50 for 15mm	-
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Hole to	arminated	d at target depth. Borehole dry shortly after drilling.						LDE Whangarei	
- •		, , , , , , ,						127 Bank St, Whanga	arei
								Ph: 0800 397 566 info@lde.co.nz	

o@lde.co.nz



JOB NO.:



#### 0.00-3.40m



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3.40-6.80m



#### **CORE PHOTOS**

**JOB NO.:** 19103



6.80-9.60m



9.60-12.50m



#### **CORE PHOTOS**

**JOB NO.:** 19103



12.50-14.80m















GROUND

		Corrected Cone Resistance,q <sub>t</sub> (MPa) Por													Pore Pressure, U <sub>2</sub> (kPa) dual scale						tion Ra	tio, R <sub>f</sub> (%)	_			SBT	Soil Behaviour Typ		Т		
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t), (		400	+ + +		+ + +			+ + +		+ + +	700	+ + +	+ + +		1			+ +	+ +		-	-+	+ + +	12 10	ssur tter I	th, (		++++ 22222	CPT Classifications cannot be ex	pected to provide	
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Client: LDE Ltd C									Conc				J			2000 1 (dc-	ini, ⊑ ( ~\.	un).	25 60	20.22	, 171 177	20014	05			101 101	IKI UWI I	Chefit Reference:			
Project: Dip Road										Correl		1002		manelar		0304	+ (ue(	y): 		-35.08	2000,	174.	2000	50	Date 0		. 10/	202/2021			
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Engineer: Finlay Wallen-Halliwell										Area Ratio: 0.80							or:					Pr				111 (m)	: N//	4			
Contractor: Ground Investigation Ltd										Filter Type: u <sub>2</sub>							ation	n Rea	son:	High fr	riction	resis	stanc	е					G.I. Job Ref: 210082		
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Ê		4 8	1	2 Co	rrected Cone I 16	Resistance,q <sub>i</sub> 20	(MPa) 24	28	32	36		Pore Pres	ssure, U <sub>2</sub> (kl 50 100	Pa) dual sca 150 20	ale 00	Friction F	Ratio, R <sub>f</sub> (%) 6 8	ed	2	SBT 2 4 6 8	Soil Behaviour Type (SB	T)
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Proje	ect:	Dip Road		Cone F	Ref: MI	KJ325		WGS	84 (deg	g):	-35.68	32329	,174.288	472	Date o	of Test	: 10/02/2021					
Loca	tion:	Kamo, Wha	ngarei		Cone T	ype: 10	Cm <sup>-</sup> Cor	mpression	Locat	tion Me	ethod:	Hand	held	GPS		Depth	(m):	7.71	Test Number: CPT-	-03		
	neer: racto-	Finiay Walle	en-Halliwe		Area R	atio: 0.8	50		Surve	eyor:	Deces	. I.a 11.:		Pre Drill (m): N/A								
Cont			suyation	Llu			Filler I	ype: u <sub>2</sub>	2		Ierm	ination	Reason	: Inclina	ation h	lign or ra	apia increa	ise			G.I. JOD RET: 210082	
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Corrected Cone Resistance,q <sub>t</sub> (MP												Pa)								Pore	e Pres	sure, L	J <sub>2</sub> (kPa)	dual so		Fri 2	iction R	atio, R <sub>f</sub>	(%) 8	ed vel	)	SBT 2 4 6 8				Soil Behaviour Type (SBT)		
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Proje	ct:	Dip	Roa	b							Con	e Ref:	: MK.	J325			WG	iS84	(deg	<b>)</b> :		-35.68	32912	,174.2	29065	1	Date o	of Test	: 10/02/2021			
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Engir	neer:	Finl	ay W	allen-	Halliw	/ell					Area	a Ratio	<b>o:</b> 0.80	)			Sur	veyo	or:								Pre D	rill (m)	: N/A		_	
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1		Refined N	ormalised	Cone Re	sistance ()	Norm	nalised Frict	tion Ratio F	SBT	r	<u> </u>				Undrained Shea	ur Strength	s (kPa)				Relativ	ve Den	sity D (	(%)	Friction	Angle	(▲')	Estin	nated 9	BEN
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Proj	ect:	Dip F	Road											co. siity	Sana to Sanay Sill	geotechr	ation in ter nical soil ar	ms of Soil nd design i	Behaviour T	using me	) and va	rious blished	in P.K.							
	ntion <sup>.</sup>	Kam	n Wh≏	ngarei					1 Sensitive fin	ne graineo	t i	6 S	ands: clear	n sands	to silty sands	Robertso Geotech	on and K.L nical Engir	. Cabel (20 neering, 4th	10), Guide Edition. Th	to Cone F he interpr	enetrati	on Test are pres	ing for sented	Tes	st Nur	nber	r:	CF	РТ-(	)2
		Finte							2 Organic: Org	ganic clay	y/silt, peat	7 D	ense sand	to grav	elly sand	only as a the user.	Ground Ir	geotechnic	ai use and Ltd. does i	should be	e carefull nt the co	y reviev	ved by ss or							
Engi	neer:	Finia	y vvaile	en-Halli	well				3 Clay: clay to	silty clay	,	8 St	tiff sand to	clayey	sand	applicabi	nty of any s not assur	of the geo me any liab	echnical so ility for any	use of th	sign para e results	meter s in any	nown design							
Cont	tracto	r: Grou	nd Inve	estigatio	on Ltd				4 Silt mixtures	s: clayey s	silt & silty c	lay 9 St	tiff silt/clay			or review of any m	<ol> <li>The used ethod used</li> </ol>	a should be d to derive	e tully aware data showr	e of the te n in this re	chniques port.	s and lii	nitations	<sup>'</sup> G.I.	Job Re	ef:	2100	82		

















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Client	t:	LDE Ltd			e วิธีI <sub>n</sub> -	5 Sand mixtures: silt	ששש v sand to sandv silt	Data shown on this	report has been as	ssessed to p	provide a ba	asic	Clier		si ence:				
Proje	ct:	Dip Road		Sensitive fine grained		6 Sands: clean sand	s to silty sands	geotechnical soil ar Robertson and K.L.	nd design paramete . Cabel (2010), Gui	ers using me de to Cone l	ethods public Penetration	ished in P.K. Testing for				-		•	
Locat	ion:	Kamo, Whangarei	2	Organic: Organic clay/s	ilt, peat	7 Dense sand to gra	velly sand	Geotechnical Engin only as a guide for the user. Ground In	eering, 4th Edition. geotechnical use a vestigation Ltd. doo	. The interpr nd should be es not warra	etations are e carefully ant the corre	e presented reviewed by ectness or	Tes	t Nu	mber:	C	;PT-	-04	
Engir	eer:	Finlay Wallen-Halliwell	3	Clay: clay to silty clay		8 Stiff sand to clayey	sand	applicability of any and does not assur or review. The used	of the geotechnical me any liability for a d should be fullv aw	soil and dea ny use of th are of the te	sign param le results in echniques a	eter shown any design and limitations							
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# FLAT DILATOMETER TEST (DMT) SEISMIC LOG

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# FLAT DILATOMETER TEST (DMT) SEISMIC LOG

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## **CPT ZEROS AND DRIFT**



G.I. Job Ref: 210082

		Push		Tip Resistance			Local Friction			Pore Pressure	
Cone Reference	CPT Name	Number	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



**APPENDIX C** 

LABORATORY TEST CERTIFICATES





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.

#### Page 2 of 12

#### **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:

velen Wing

Helen Wang Triaxial Laboratory Manager Approved Signatory



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

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



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



Geotechnics Ltd

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


Geotechnics Ltd

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



Geotechnics Ltd





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 t	he End of	Consolida	tion Sta	ge				Failure V	alues			Failure Mode & Photo
	Effective	Stress	Back	Volu	netric		Deviator Stress	Vertical	Effecti	ve Stress	Correction	is (kPa)	Planar
	Horizontal	Vertical	Pressure	Strain	Rate		(σ <sub>v</sub> ' - σ <sub>h</sub> ')	Strain	Vertical	Horizontal	Membrane	Filter P	rialiai
	σ <sub>h</sub> '(kPa)	σ <sub>v</sub> -(kPa)	(kPa)	(%)	(%/hr)		(kPa)	ε <b>(%)</b>	σ <sub>v</sub> - (kPa)	$\sigma_{h}'(kPa)$	$(\Delta \sigma_v)_m$	(Δσ <sub>v</sub> ) <sub>fp</sub>	
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	131 2 5 1
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 I	Resistance	e:	$\phi =$	11	0		<b>φ</b> ' =	28	0			
Cohesio	n:			<b>c</b> =	28	kPa		<b>c'</b> =	16	kPa			
Linear R	egression Co	pefficient		r =	0.994			r =	1.000				
Sample	History:	Undistur	bed core t	rimmed	at natura	l water o	content.						
Soil deso	cription:	SAND, sil	ty, lightly	packed,	orangey k	orown wi	th dark brown, lig	pht yellow	grey and b	olack.			
Test Spe	ed:	0.0	025	(mm/mi	n)								
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.													

Approved Signatory:

Date:

4/03/2021

CPT01

Geotechnics Project ID:

**Customer Project ID:** 

Location ID:

QESTLab Work Order ID:

Page 8 of 12

1100731.0000

19103



Geotechnics Ltd



Geotechnics Ltd



Geotechnics Ltd

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



Geotechnics Ltd

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



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.

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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 Ware Laborat echnician

Report checked by:

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

Authorised for Geotechnics by:

.....

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

Paul Burton **Project Director** 

CREDITED

15c Amber Crescent, Judea, Tauranga | PO Box 317, Tauranga 3140 p +64 7 571 0280 | tauranga@geotechnics.co.nz | www.geotechnics.co.nz 1 of 3

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	15C Amber Crescent		Contachnics Ducient Number	2 01 3
	Judea			1100731.2.0.0
	Tauranga 3110		QESTLab Work Order ID	W21TG-0038
GEOTECHNICS	New Zealand		Customer Project ID	19103
	p +64 7 571 0280			
	Detection of the Pres	sence of Allophane in Soils	- NZS 4402:1986 Test 3	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, orang	e brown with dark brown, light yel	ow 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 allopha	ne content.	
		Bright Red - More than 7% Allophane Pres	sence	
		Pink to Red - 5 to 7 % Allophane Presen Colourless - Less than 5% Allophane Pres	ence	
		TEST REMARKS		
The material used for testing was	s natural. • This test result is IANZ acc	redited.•Date tested 05/03/2021		
Approved Signatory Ryan Mill	ligan			
Date a las las las las las las las las las l	174			
	021			Page 1

	15C Amber Crescent			۲ of ۲
	ludea		Geotechnics Droject Number	JUJ 1100731 200
	Tauranga 3110		OFSTI ah Work Order ID	W21TG-0038
	New Zealand		Customer Project ID	10103
GEOTECHNICS	n +64 7 571 0280		customer Project ib	19105
	p 1017 571 0200	<u> </u>		
	Detection of the Pres	sence of Allophane in Soils	s - NZS 4402:1986 Test 3	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, orang	ge 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 alloph	ane content.	
		Bright Red - More than 7% Allophane Pre	sence	
		Pink to Red - 5 to 7 % Allophane Preser		
The material used for testing wa	as natural. • This test result is IANZ acc	redited.•Date tested 05/03/2021		
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Approved Signatory Ryan Mil	ligan			
Date 05/03/20	021			
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