

To:	Doyle Smith Knight Investments Limited
From:	Shane Lander Principal Geotechnical Engineer (Geotechnical Assessments) Tobias Francis Associate Geotechnical Engineer (Coastal Assessments)
Copy:	Daniel Nakhle Knight Investments Limited
Subject:	Application for Fast Track Referral, various sites Clarks Beach Road, Clarks Beach (Orawaahi)
Date:	15 July 2025
Project Ref:	J01842
Document ID:	627403
Revision Status:	For Fast Track Referral Application

1 INTRODUCTION

Knight Investments Limited is advancing plans to develop the site (Orawaahi) at

- Clarks Beach Road - Lot 3 DP 337204 (no address allocated)
- 156 Clarks Beach Road - Lot 1 DP 337204

for residential and commercial uses under the Fast-track Approvals Act 2024. The proposed masterplan envisions approximately 780 residential dwellings, a retirement village, neighbourhood centre activities, light industrial business land, a cultural centre and open / recreational spaces, encompassing a total of approximately 75ha.

Works are also required on:

- 115 Clarks Beach Road (Lot 1020 DP 578599, Lot 1012 DP 573987, Lot 1018 DP 573987, Lot 1001 DP 560664, Lot 1003 DP 560664, Lot 801 DP 526153, Lot 200 DP 567326, 9/14 SH Lot 300 DP 526153, 4/23 SH Lot 100 DP 560664), for works associated with required infrastructure/roading upgrades.
- Lot 4 DP 116708 held as Local Purpose Reserve (Esplanade), located at southern edge of the site, adjacent to the Coastal Marine Area (“CMA”).
- A portion of land which is vested as legal road, as per GeoMaps (but unformed), which is located between the subject site and the CMA.
- Clarks Beach Road.

LDE has been engaged to provide a concise high-level assessment of the site's geotechnical stability and coastal erosion (the latter for Lot 3 DP 337204), the anticipated challenges, and how these can be effectively managed throughout development. If the referral application is accepted, then more substantive geotechnical and coastal evaluations will be undertaken.

1.1 LDE's Experience

LDE's Principal Geotechnical Engineer, Shane Lander (CPEng, CMEngNZ), brings over 25 years of specialist geotechnical experience spanning land development, infrastructure, and quarry remediation projects. He is widely

regarded as a leading expert in the geotechnics of the Clarks Beach and adjacent Glenbrook areas, having been instrumental in the successful delivery of nearly all major subdivisions in the surrounding region. This includes a preliminary investigation within Lot 3 DP 337204, and since their inception over 10 years ago, overseeing all geotechnical aspects on stages 1 to 8 of the 137 Clarks Beach residential subdivision directly north of the study area, and stages 1 to 6 of the Kahawai Point subdivision just to the south (across the inlet). His work included preliminary geotechnical investigations at 115 Clarks Beach Road. Shane's extensive involvement in these developments has given him an unparalleled understanding of the area's subsurface conditions and associated construction challenges. His proven track record in navigating these complexities provides a high level of confidence that the geotechnical aspects of the Orawaahi development can be effectively addressed to support safe, efficient, and resilient residential construction.

1.2 Existing Reports

In preparing this memorandum, LDE have reviewed the following reports:

- Lander Geotechnical Consultants Limited, Geotechnical Investigation Report for Proposed Subdivision at 137 Clarks Beach Road, Ref No J00318, dated 10 June 2016.
- Lander Geotechnical Consultants Limited, Geotechnical Report for Earthworks Consent at 162¹ Clarks Beach Road, Kingseat, Ref No J01842, dated 28 September 2021.
- Tonkin and Taylor Ltd, Southwest Waste Water Pump Station Options Study, Ref No 1012888.2000.v1, dated May 2022.

The most relevant report is the Lander 2021 report, which involved the drilling and interpretation of 18 hand auger boreholes across the site. A site plan showing various test locations and full borehole records (for Lot 3 DP 337204 only) are attached in Appendix A.

2 SITE GEOLOGY AND GEOMORPHOLOGY

Published geological maps of the area indicate that the site is underlain by Puketoka Formation of the Tauranga Group. Puketoka Formation soils were formed between the late Pliocene to middle Pleistocene epochs and generally consist of moderately consolidated mixtures of clays, silts and sands. They can typically contain organic-rich layers and inclusions. Discrete, non-continuous layers of sensitive pumiceous silts can also be present within this geology.

According to the same published maps, beneath the Puketoka Formation is extremely weak to very weak siltstone / sandstone of the East Coast Bays Formation (ECBF) of the Waitemata Group. At this site, the depth to reach ECBF is currently undetermined. The Waitemata Group was formed during early to late Miocene epoch and comprises alternating siltstone and sandstone flysch deposits with some volcanoclastic deposits particularly in the upper horizons of the formation.

¹ i.e. Lot 3 DP 337204

The geotechnical characteristics at the site are generally well understood. The site is for the most part gentle or undulating and, the coastal foreshore area aside, there are no geomorphic signs of large scale ground instability. The general area is considered to be at low risk from earthquake occurrence and liquefaction susceptibility, however this will need to be substantiated during more detailed studies.

3 GEOTECHNICAL CONSIDERATIONS

3.1 Earthworks and Infrastructure

Bulk earthworks - such as cuts and fills - are expected to be relatively limited across the site. However, the presence of sensitive alluvial soils presents a key geotechnical consideration, as these materials can lose strength and structure when disturbed by earthworks machinery. These challenges are manageable through the application of conventional geotechnical drainage techniques and robust construction management practices, similar to those successfully implemented in the adjacent residential developments.

Installation of roads and trenched services will need to contend with elevated groundwater levels (within 2 to 3m of the ground surface according to Lander 2021) and variable soil consistency and strength. For road construction, there is also a risk of subgrade degradation due to prolonged exposure to weather and traffic loading during construction. These issues can be effectively mitigated through proactive site management, temporary trench support where required, and appropriate ground improvement methods such as lime stabilisation, subgrade undercutting, and aggregate replacement.

3.2 Building Foundations and Ground Conditions

From a geotechnical standpoint, the site presents no significant constraints in terms of bearing capacity or settlement for conventional residential buildings (NZS3604), or lightweight buildings for commercial and neighbourhood centre activities.

At the detailed design stage, foundations will need to account for localised variability in soil strength and stiffness. Where weaker soils are encountered, footing designs will need to be tailored accordingly. Based on our experience in nearby subdivisions, stiffened pod-raft foundations represent a practical and proven solution for low- to mid-rise buildings (1 to 3 storeys). For residential buildings exceeding three storeys or outside NZS3604, or for commercial / light industrial buildings, shallow foundations may still be viable, subject to site-specific geotechnical conditions and structural design loads. In cases involving heavier multi-storey structures or long, narrow terrace configurations with 'skinny' building footprints, ground improvement (e.g. preloading) or foundation piling may be required to mitigate differential settlement risks.

Expansive soils - susceptible to seasonal shrink-swell movements - have been identified in adjacent developments and are likely present on this site. These can be effectively managed with appropriate foundation solutions, such as pod-raft systems designed in accordance with AS2870, to minimise long-term differential movement.

For buildings incorporating basements (if any), groundwater conditions must be carefully considered. Temporary works should address seepage and inflow control during excavation, while permanent designs will need to accommodate tanking requirements, hydrostatic uplift (buoyancy), and/or provide drainage to basement walls. Long-term groundwater drawdown is not expected to be a limiting factor for partial basements on this site.

4 KEY GEOTECHNICAL RECOMMENDATIONS

In light of the geotechnical considerations discussed above, we recommend the following next steps to support a more substantive application and de-risk future development:

- 1. Targeted Geotechnical Site Investigations:** Prior to detailed design and construction, further site-specific geotechnical investigations should be undertaken, tailored to the scale and nature of the proposed subdivision and earthworks. These investigations should confirm subsurface conditions and identify any site-specific constraints. We anticipate that an appropriate investigation would include a combination of Cone Penetration Tests (CPTs), hand auger boreholes, and representative soil sampling. Slope stability of the steep foreshore slopes should be undertaken at this time, in conjunction with a more detailed coastal erosion study.
- 2. Laboratory Testing of Soil Samples:** Collected samples should undergo laboratory testing to assess key geotechnical parameters, including strength, compressibility, permeability, expansivity, and susceptibility to erosion or dispersion. These properties will inform foundation design, earthworks management, and long-term performance.

Based on our prior investigations in adjacent developments, we do not anticipate significant challenges arising from these tests. However, undertaking them is essential to confirm assumptions and optimise design outcomes.

5 PRELIMINARY COASTAL EROSION ASSESSMENT

The site includes coastal margins along the Taihiki River, a tidal inlet of the Manukau Harbour. Portions of the property are within areas identified as susceptible to coastal instability and erosion (ASCIE). However, the region-wide hazard mapping by Auckland Council is broad-brush and based on generalised coastal classifications, which may not reflect local geomorphology with high precision. The indicative ASCIE lines from Council mapping are shown on the appended plan (Appendix B). A detailed, site-specific assessment would likely show a reduced inland extent of ASCIE.

Accordingly, a preliminary site-specific coastal erosion assessment has been undertaken using our knowledge of local conditions and in reference to regional coastal hazard guidance. Key parameters and assumptions are summarised in Table 1, and the extent of potential landward retreat is calculated using Equation 1, which combines long-term retreat (LTR) and slope regression for soft cliff environments.

Equation 1

$$ASCIE_{SOFTCLIFF} = (LTR_H \times T) \times F + \left(\frac{H_t}{\tan \alpha} \right)$$

Where:

- LTR_H = horizontal long-term erosion rate (m/100 yr)
- T = planning timeframe (yrs)
- F = factor for uncertainty and sea level rise
- H_t = cliff height (m)
- α = stable slope angle (degrees)

For the **unlikely but conceivable scenario** of maximum coastal retreat and regression over a long-term planning horizon (e.g. 100 years under RCP8.5 sea level rise projections), the following estimates apply:

- For a 4 m high cliff: potential regression = ~31 m inland (from cliff toe)
- For a 10 m high cliff: potential regression = ~41 m inland (from cliff toe)

Table 1: Preliminary Coastal Hazard Assessment Parameters

Parameter	Value / Description
Cliff Type	Soft Cliff (Alluvium)
Cliff Height Range, H_t	4m-10m
Existing Cliff Angle	~30-50 degrees
Characteristic Stable Angle, α	26 degrees (likely), 18 degrees (unlikely but conceivable)
Erosion Rate, LTR_H	1.5-3m/100 years (depends on exposure rating and model scenario)
Exposure Rating (Manukau Harbour)	2 out of 4 (1 could be adopted for more sheltered parts of embayment)
Factor for uncertainty in erosion rates, and accounting for sea level rise, F	Use 1 for likely scenario Use 3.5 for sea level rise (RCP8.5)

It is further noted that the coastal margin is contained within an esplanade reserve under the Part Tidal Lands of Manukau Harbour Survey Office Plan 67474. The proposed scheme includes coastal restoration and forming walkway access along this margin. Further planting and vegetation with appropriate coastal foreshore species are positive in terms of land stability and coastal regression processes.

Coastal inundation resulting from extreme storm tides are not considered to be an issue with regard to the proposal, given that any development will be above and set back from cliff slope areas.

6 CONCLUSIONS

The topography and ground conditions at the Lot 3 DP 337204 and 156 Clarks Beach Road (Lot 1 DP 337204) plus the various other sites listed in Section 1 are reasonably well understood from a geotechnical perspective. Based on our experience with adjacent large-scale residential developments, earthworks and subdivision construction on this site are expected to be generally straightforward and manageable.

Subject to appropriately scoped geotechnical investigations that give due consideration to both known and potential subsurface conditions, the site is considered suitable for the proposed development. As a minimum, we recommend these investigations include hand auger boreholes, deep Cone Penetration Testing (CPT), and laboratory testing to assess expansive soil behaviour.

During the detailed design phase, the following geotechnical and engineering measures may be required to ensure safe and efficient development:

1. **Foundation Solutions:** Tailored foundation designs - such as raft foundations, ground improvement, or piling - may be necessary in areas with weaker soils or where expansive soils are present.
2. **Soil Integrity Management:** Installation of geotechnical drainage and robust construction management practices will help prevent loss of strength in sensitive alluvial soils disturbed by earthworks.
3. **Temporary Trench Support:** Where deep trenching is required (e.g., for services), temporary support measures such as shoring and benching should be provided to ensure safety and stability.
4. **Subgrade Stabilisation:** Roads may require ground improvement techniques such as lime stabilisation, undercutting, and aggregate replacement to ensure long-term subgrade performance, supported by careful construction practices.
5. **Coastal Hazard Setback:** It is recommended that any development structures are situated back from the coastal hazard or areas susceptible to coastal instability and erosion. The scheme indicates all built development would be outside the coastal esplanade.

On the basis of current knowledge and experience, we see no geotechnical impediments to the proposed development by Knight Investments Limited proceeding as planned.

7 LIMITATIONS

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

This report has been prepared exclusively for Knight Investments Limited in accordance with the brief given to us or the agreed scope and they will be deemed the exclusive owner on full and final payment of the invoice. Information, opinions, and recommendations contained within this report can only be used for the purposes with which it was intended. LDE accepts no liability or responsibility whatsoever for any use or reliance on the report by any party other than the owner or parties working for or on behalf of the owner, such as local authorities, and for purposes beyond those for which it was intended.

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

For and on Behalf of LDE Ltd

S G Lander
Principal Geotechnical Engineer
CMEngNZ, CPEng

APPENDIX A

LANDER GEOTECHNICAL CONSULTANTS LTD

- **TEST LOCATION PLANS**
- **BOREHOLE RECORDS (LOT 3 DP 337204 ONLY)**



Legend and/or Notes:

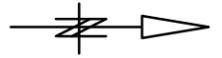
-  Hand Auger Borehole
-  Machine Borehole
-  Site Boundary
-  Cross-Section

BASE PLAN SOURCE: AUCKLAND COUNCIL GIS DATABASE

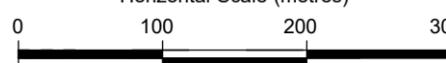
revision	description	drawn	approved	date	 Horizontal Scale (metres)  Vertical Scale (metres)	drawn	MVC		client:	KNIGHT INVESTMENTS LIMITED
						approved	SGL		project:	137 CLARKS BEACH ROAD, CLARKS BEACH
						date	10.05.16		title:	SITE INVESTIGATION PLAN
						scale	1:5000		project no:	J 00318
						original size	A3			

Legend and/or Notes:

 Hand Auger Borehole



BASEMAP: AUCKLAND COUNCIL GEOMAPS [RETRIEVED 15.07.21]

revision	description	drawn	approved	date	 Horizontal Scale (metres)  Vertical Scale (metres)	drawn	PL		client:	KNIGHT INVESTMENTS LIMITED
						approved	TT		project:	162 CLARKS BEACH ROAD, CLARKS BEACH
						date	15.07.21		title:	SITE INVESTIGATION PLAN
						scale	1:5000		project no:	J 01842
						original size	A3			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 01

Sheet 1 of 18

Vane Head: 2153	Logged By: NM	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY, orange/brown. Very stiff, moist, medium plasticity, insensitive [ASH]					0.5		157/83	1.9	
silty CLAY, orange streaked grey. Very stiff, moist, medium plasticity, insensitive [PUKETOKA FORMATION] becoming wet					1.0		136/93	1.5	
becoming moderately sensitive becoming light grey					1.5		139/59	2.4	
with trace fine to medium sand					2.0		216+		
becoming hard becoming orange streaked light grey					2.5		176/89	2.0	
clayey SILT, orange streaked light grey. Very stiff, saturated, low plasticity, with fine to medium sand, moderately sensitive becoming red and orange streaked light grey					3.0		216+		
at 3.0m, becoming hard EOB at 3.0m. Target Depth					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater encountered at 2.4m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked: PL	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 02

Sheet 2 of 18

Vane Head: 3195	Logged By: AT	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
Description: Refer to site plan									
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT, orange/brown streaked brown. Very stiff, moist, low plasticity, insensitive [ASH]					0.5		154/85	1.8	
becoming stiff					1.0		98/71	1.4	
clayey SILT, light brown streaked orange/brown. Very stiff, moist, low to medium plasticity, moderately sensitive [PUKETOKA FORMATION]					1.5		154/74	2.1	
					2.0		191+		
					2.5		151/71	2.1	
EOB at 3.0m. Target Depth					3.0		191+		
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered . UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked:	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No.

HA 03

Sheet 3 of 18

Vane Head:
2007

Logged By:
AH

Processor :
AH

Date:
14.07.21

Borehole Location: mN mE Ground R.L.
Description: Refer to site plan

SOIL DESCRIPTION

TOPSOIL

clayey SILT, mottled orange/brown. Very stiff, moist, medium to high plasticity, insensitive [ASH]

silty CLAY, brown mottled grey/orange. Very stiff, moist, high plasticity, moderately sensitive [PUKETOKA FORMATION]

slight fine sandy clayey SILT, brown mottled yellow/orange. Very stiff, moist, medium plasticity, moderately sensitive, with trace pumice

becoming grey/pink mottled orange/brown, moist to wet

silty CLAY, mottled grey/pink. Hard, moist to wet, high plasticity, insensitive

becoming streaked pink/red/grey

silty SAND, grey/red and orange/brown mottled. Firm, saturated, no plasticity, moderately sensitive, with trace fine gravel

slightly fine sandy silty CLAY, streaked orange/pink/grey. Hard, wet to saturated, medium to high plasticity

EOB at 3.0m. Target depth

Legend

Depth (m)

Standing Water Level

Vane Shear (kPa) peak / residual

Soil Sensitivity

Sample and Laboratory / Other Test Details

0.5

128/67

1.9

1.0

135/58

2.3

1.5

164/64

2.6

2.0

212/112

1.9

2.5

45/22

2.0

3.0

224+

3.5

4.0

4.5

5.0

5.5

6.0



Comments:
Groundwater encountered at 2.4m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter:
50mm

Checked:
PL

Topsoil

Fill

Clay

Silt

Sand

Gravel

Organic

Pumice

Sandstone

Siltstone

Limestone

Volcanic

Plutonic

No Core

+++

+++

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 04

Sheet 4 of 18

Vane Head: 2007
 Logged By: AH
 Processor: AH
 Date: 14.07.21

Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY, mottled orange/brown. Stiff, moist, high plasticity, insensitive [ASH]					0.5		99/51	1.9	
with trace fine sand									
becoming moderately sensitive					1.0		93/38	2.4	
slightly fine sandy clayey silt, mottled orange/brown. Stiff, moist, medium to high plasticity moderately sensitive									
fine gravelly SAND, dark orange/brown. Hard, wet to saturated, no plasticity					1.5		UTP		
limited sample recovery									
EOB at 1.7m. Too hard to auger further. Scala penetrometer test commenced and found effective refusal (ER) at 1.9m.					2.0				Scala Penetrometer Test (Blows/100mm)
					2.5				— 18
					3.0				— 20+ (ER)
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater encountered at 1.3m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	+++
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked:	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 05

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Vane Head: 2007	Logged By: AH	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
Description: Refer to site plan									
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT, mottled orange/brown. Very stiff, dry to moist, medium plasticity, moderately sensitive [ASH] becoming moist becoming grey mottled orange/brown becoming stiff					0.5		147/58	2.5	
					1.0		93/42	2.2	
sandy SILT, grey mottled orange/brown. Very stiff, moist, low plasticity, sensitive [PUKETOKA FORMATION] becoming mottled orange/grey, wet					1.5		160/19	8.4	
silty SAND, grey. Very stiff, wet, no plasticity, extra sensitive limited sample recovery becoming stiff, saturated, sensitive					2.0	▽	93/16	5.8	
					2.5		131/13	10	
EOB at 3.0m. Target Depth					3.0		192/16	11.9	
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater encountered at 2.0m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	+++	
		50mm	Fill		Gravel		Siltstone		No Core		
		Checked:	Clay		Organic		Limestone				
			Silt		Pumice		Volcanic				

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 06

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Vane Head: 2007	Logged By: AH	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.
Description:	Refer to site plan		

SOIL DESCRIPTION

Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL					
clayey SILT, dark orange/brown. Very stiff, dry to moist, low plasticity, moderately sensitive [ASH]	0.5		141/42	3.4	
sightly sandy SILT, light grey/brown. Very stiff, dry to moist, no plasticity, moderately sensitive [PUKETOKA FORMATION]	1.0		128/42	3.0	
becoming moist	1.5		90/19	3.1	
becoming wet	2.0	▽	87/19	5.1	
becoming stiff	2.5		87/26	3.3	
becoming light grey, saturated, with trace fine gravel	3.0		51/16	3.2	
becoming sensitive limited sample recovery	3.5				
becoming moderately sensitive	4.0				
becoming orange	4.5				
EOB at 3.0m. Target Depth	5.0				
	5.5				
	6.0				

	Comments: Groundwater encountered at 1.7m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil	Sand	Sandstone	Plutonic	+++
		50mm	Fill	Gravel	Siltstone	No Core	
		Checked:	Clay	Organic	Limestone		
			Silt	Pumice	Volcanic		

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 07

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Vane Head: 3175	Logged By: AH	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
Description: Refer to site plan									
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT, orange mottled light grey. Stiff, dry, low plasticity, sensitive, with trace limonite [FILL]									
BURRIED TOPSOIL					0.5		82/18	4.5	
clayey SILT, orange/brown streaked light grey. Very stiff, moist, low plasticity, moderately sensitive, with trace limonite [PUKETOKA FORMATION]					1.0		115/49	2.4	
becoming wet, low to medium plasticity					1.5		116/51	2.3	
becoming stiff					2.0		61/30	2.0	
with silt clast inclusions									
becoming saturated									
silty fine grained SAND, orange/brown. Hard, saturated, no plasticity, with minor limonite					2.5	▽	UTP		
EOB at 3.0m. Target Depth					3.0		UTP		
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater encountered at 2.4m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked: PL	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 08

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Vane Head: 2153	Logged By: NM	Processor : AH	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY, orange/brown. Hard, moist, medium plasticity [ASH]					0.5		216+		
silty CLAY, grey streaked orange/brown. Hard, moist, medium plasticity [PUKETOKA FROMATION]					1.0		216+		
becoming orange streaked light grey					1.5		216+		
becoming very stiff, insensitive					2.0		185/120	1.5	
becoming saturated becoming hard					2.5		216+		
EOB at 3.0m. Target Depth					3.0		216+		
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater encountered at 2.4m. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked: PL	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 09

Sheet 9 of 18

Vane Head: 2153	Logged By: NM	Processor : MB	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT, orange. Hard, moist, low plasticity [ASH] becoming orange/grey					0.5		216+		
clayey SILT, orange streaked grey. Hard, moist, low plasticity [PUKETOKA FORMATION]					1.0		216+		
silty CLAY, orange streaked light grey. Hard, moist, medium plasticity					1.5		216+		
clayey SILT, orange streaked light grey. Hard, moist, low plasticity becoming wet					2.0		216+		
silty CLAY, orange streaked light grey. Very stiff, wet, medium to high plasticity, moderately sensitive					2.5		123/46	2.7	
EOB at 3.0m. Target Depth.					3.0		139/71	2.0	
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered . UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic		
		50mm	Fill		Gravel		Siltstone		No Core		
		Checked: PL	Clay		Organic		Limestone				
			Silt		Pumice		Volcanic				

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 10

Sheet 10 of 18

Vane Head: 2153	Logged By: NM	Processor : MB	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY, orange. Very stiff, moist, medium plasticity, insensitive [ASH]					0.5		188/127	1.5	
becoming wet					1.0		130/93	1.4	
becoming hard					1.5		154/102	1.5	
clayey SILT, grey streaked orange. Very stiff, wet, low plasticity, insensitive [PUKETOKA FORMATION]					2.0		216+		
becoming red/orange streaked grey					2.5		154/89	1.7	
silty CLAY, red and orange streaked grey. Very stiff, wet, medium plasticity, insensitive					3.0		130/77	1.7	
EOB at 3.0m. Target Depth					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered . UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked:	Clay		Organic		Limestone			
		PL	Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 11

Sheet 11 of 18

Vane Head: 3175	Logged By: AT	Processor : MB	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.
Description: Refer to site plan			

SOIL DESCRIPTION

Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
	0.0				
	0.5		191+		
	1.0		173/67	2.6	
	1.5		191/51	3.7	
	2.0	▽	136/37	3.7	
	2.5		UTP		
	3.0		UTP		
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				

TOPSOIL

clayey SILT, orange mottled grey. Very stiff, moist, low plasticity, with trace limonite, with topsoil leaching to 0.5m [PUKETOKA FORMATION]

becoming orange mottled light grey
becoming moderately sensitive

with trace fine sand

becoming wet

becoming saturated

with minor fine sand, with minor limonite
becoming hard

EOB at 3.0m. Target Depth



Comments:
Groundwater encountered at 2.1m.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter: 50mm	Topsoil		Sand		Sandstone		Plutonic	
	Fill		Gravel		Siltstone		No Core	
Checked: PL	Clay		Organic		Limestone			
	Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED	Auger Borehole No. HA 12				
Project Location : 162 CLARKS BEACH ROAD CLARKS BEACH	Sheet 12 of 18				
Job Number: J01842	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">Vane Head: 1750</td> <td style="width:25%;">Logged By: PL</td> <td style="width:25%;">Processor : PL</td> <td style="width:25%;">Date: 14.07.21</td> </tr> </table>	Vane Head: 1750	Logged By: PL	Processor : PL	Date: 14.07.21
Vane Head: 1750	Logged By: PL	Processor : PL	Date: 14.07.21		

Borehole Location:	mN	mE	Ground R.L.
Description: Refer to site plan			

SOIL DESCRIPTION	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL	[diagonal lines]					
clayey SILT with trace fine sand, orange streaked orange/brown. Stiff, moist, no plasticity, moderately sensitive [ASH]	[cross-hatch]	0.5		85/42	2.0	
with minor fine sand						
becoming very stiff		1.0		158/73	2.2	
silty CLAY with trace fine sand, orange streaked orange/brown. Very stiff, moist, medium plasticity, insensitive	[stippled]	1.5		154/100	1.5	
becoming orange/light brown, hard		2.0		204/108	1.9	
silty CLAY with trace fine sand, orange streaked light brown/orange. Very stiff, moist, medium plasticity, insensitive [PUKETOKA FORMATION]	[stippled]	2.5		181/119	1.5	
becoming orange and brown streaked light grey, medium to low plasticity						
at 3.0m, becoming hard		3.0		223/127	1.8	
EOB at 3.0m. Target Depth.						
		3.5				
		4.0				
		4.5				
		5.0				
		5.5				
		6.0				

	Comments: Groundwater not encountered. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil	Sand	Sandstone	Plutonic	+++++
		50mm	Fill	Gravel	Siltstone	No Core	+++++
		Checked:	Clay	Organic	Limestone		
		RZ	Silt	Pumice	Volcanic		

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 13

Sheet 13 of 18

Vane Head: 1750	Logged By: PL	Processor : PL	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
Description: Refer to site plan									
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY with trace fine sand, orange streaked brown/orange. Very stiff, moist, medium plasticity, insensitive, with trace topsoil leaching to 0.4m [ASH]					0.5		193/112	1.7	
becoming moderately sensitive					1.0		181/77	2.4	
becoming orange									
becoming hard, insensitive					1.5		204/123	1.7	
silty CLAY with trace fine sand, light grey/orange streaked orange. Hard, moist, medium plasticity, insensitive [PUKETOKA FORMATION] becoming light grey and orange/red streaked orange/light brown					2.0		227/135	1.7	
clayey SILT with trace fine sand, red and orange streaked light grey/white. Very stiff, moist, low plasticity					2.5		173/104	1.7	
becoming very stiff, medium to low plasticity, insensitive									
becoming low plasticity									
at 3.0m, becoming moderately sensitive					3.0		135/69	2.0	
EOB at 3.0m. Target Depth.									
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				



Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter:	Topsoil	Sand	Sandstone	Plutonic
50mm	Fill	Gravel	Siltstone	No Core
Checked:	Clay	Organic	Limestone	
RZ	Silt	Pumice	Volcanic	

Client : KNIGHT INVESTMENTS LIMITED
Project Location : 162 CLARKS BEACH ROAD
 CLARKS BEACH
Job Number: J01842

Auger Borehole No. HA 14
 Sheet 14 of 18
 Vane Head: 1750
 Logged By: PL
 Processor : PL
 Date: 14.07.21

Borehole Location: mN mE Ground R.L.
 Description: Refer to site plan

SOIL DESCRIPTION		Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
TOPSOIL							
clayey SILT with trace fine sand, orange/brown. Very stiff, moist, low plasticity, sensitive [ASH]			0.5		189/39	4.8	
silty CLAY with trace fine sand, orange streaked light brown/orange. Very stiff, moist, medium plasticity, insensitive [PUKETOKA FORMATION] becoming orange/brown becoming orange streaked orange/brown			1.0		158/92	1.7	
becoming orange streaked light grey, hard, moderately sensitive			1.5		208/100	2.1	
becoming orange and brown streaked white, with trace pumiceous inculsions becoming very stiff			2.0		185/77	2.4	
becoming white streaked light brown			2.5		169/62	2.7	
EOB at 3.0m. Target Depth.			3.0		173/81	2.1	
			3.5				
			4.0				
			4.5				
			5.0				
			5.5				
			6.0				

	Comments: Groundwater not encountered. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil	Sand	Sandstone	Plutonic	+++++
		50mm	Fill	Gravel	Siltstone	No Core	+++++
		Checked:	Clay	Organic	Limestone		
			Silt	Pumice	Volcanic		

Client : KNIGHT INVESTMENTS LIMITED	Auger Borehole No. HA 15				
Project Location : 162 CLARKS BEACH ROAD CLARKS BEACH	Sheet 15 of 18				
Job Number: J01842	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">Vane Head: 2007</td> <td style="width:25%;">Logged By: AH</td> <td style="width:25%;">Processor : PL</td> <td style="width:25%;">Date: 13.07.21</td> </tr> </table>	Vane Head: 2007	Logged By: AH	Processor : PL	Date: 13.07.21
Vane Head: 2007	Logged By: AH	Processor : PL	Date: 13.07.21		

Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
silty CLAY, dark brown/grey. Very stiff, dry to moist, medium plasticity, moderately sensitive [ASH]					0.5		119/58	2.1	
silty CLAY, grey mottled orange/brown. Very stiff, dry to moist, high plasticity, moderately sensitive [PUKETOKA FORMATION]					1.0		106/48	2.2	
clayey SILT, light grey. Very stiff, moist, medium plasticity, moderately sensitive					1.5		147/38	3.9	
with limited to no sample recovery					2.0		128/38	3.4	
becoming insensitive					2.5		144/112	1.3	
at 3.0m, becoming moderately sensitive					3.0		109/51	2.1	
EOB at 3.0m. Target Depth.					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	50mm	Topsoil		Sand		Sandstone		Plutonic	
	Checked: RZ	Fill		Gravel		Siltstone		No Core			
		Clay		Organic		Limestone					
		Silt		Pumice		Volcanic					

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

Auger Borehole No. HA 16

Sheet 16 of 18

Vane Head: 3195	Logged By: AT	Processor : PL	Date: 14.07.21
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Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT, dark brown streaked orange/brown. Very stiff, dry, low plasticity, with trace topsoil leaching to 0.4m [ASH]					0.5		191+		
becoming moderately sensitive becoming moist					1.0		112/45	2.5	
becoming light grey, low to medium plasticity, with trace silt clast inclusions					1.5		135/58	2.3	
silty SAND, grey/brown. Hard, moist, low plasticity					2.0		UTP		
clayey SILT with trace fine sand, light grey. Very stiff, wet, low plasticity, moderately sensitive, with trace silt clast inclusions					2.5		140/40	3.6	
EOB at 3.0m. Target Depth.					3.0		134/38	3.5	
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked:	Clay		Organic		Limestone			
			Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED

Project Location : 162 CLARKS BEACH ROAD
CLARKS BEACH

Job Number: J01842

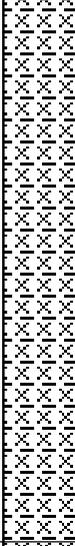
Auger Borehole No. HA 17

Sheet 17 of 18

Vane Head: 3195	Logged By: AT	Processor : PL	Date: 12.07.21
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Borehole Location:	mN	mE	Ground R.L.
Description: Refer to site plan			

SOIL DESCRIPTION

TOPSOIL				
clayey SILT, orange/brown. Very stiff, moist, low plasticity, moderately sensitive [ASH]		0.5	150/74	2.0
		1.0	191+	
		1.5	191+	
becoming wet				
becoming red streaked orange/brown				
becoming saturated		2.0	191+	
clayey SILT, orange/brown streaked light grey. Very stiff, moist, low plasticity, with trace limonite [PUKETOKA FORMATION]		2.5	191+	
at 2.3m, becoming white mottled red, no plasticity, with trace silt clast inculsions				
at 2.0m, becoming stiff, moderately sensitive		3.0	58/24	2.0
EOB at 3.0m. Target Depth.				
		3.5		
		4.0		
		4.5		
		5.0		
		5.5		
		6.0		

Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
	0.5		150/74	2.0	
	1.0		191+		
	1.5		191+		
	2.0		191+		
	2.5		191+		
	3.0		58/24	2.0	
	3.5				
	4.0				
	4.5				
	5.0				
	5.5				
	6.0				



Comments:
Groundwater not encountered.
UTP = unable to penetrate.
EOB = end of borehole.

Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
50mm	Fill		Gravel		Siltstone		No Core	
Checked:	Clay		Organic		Limestone			
RZ	Silt		Pumice		Volcanic			

Client : KNIGHT INVESTMENTS LIMITED	Auger Borehole No. HA 18				
Project Location : 162 CLARKS BEACH ROAD CLARKS BEACH	Sheet 18 of 18				
Job Number: J01842	<table border="1" style="width:100%; border-collapse: collapse;"> <tr> <td style="width:25%;">Vane Head: 1750</td> <td style="width:25%;">Logged By: PL</td> <td style="width:25%;">Processor : PL</td> <td style="width:25%;">Date: 14.07.21</td> </tr> </table>	Vane Head: 1750	Logged By: PL	Processor : PL	Date: 14.07.21
Vane Head: 1750	Logged By: PL	Processor : PL	Date: 14.07.21		

Borehole Location:	mN	mE	Ground R.L.	Legend	Depth (m)	Standing Water Level	Vane Shear (kPa) peak / residual	Soil Sensitivity	Sample and Laboratory / Other Test Details
Description: Refer to site plan									
SOIL DESCRIPTION									
TOPSOIL									
clayey SILT with trace fine sand, orange/brown. Very stiff, moist, low plasticity [ASH]									
silty CLAY, orange/brown streaked light grey/orange. Very stiff, moist, medium plasticity, insensitive [PUKETOKA FORMATION] becoming red and orange streaked orange/light grey with trace fine sand, with trace fine gravel sized silt clast inculsions becoming hard					0.5		116/73	1.6	
becoming orange and white streaked red					1.0		270+		
becoming orange and white streaked red					1.5		270+		
clayey SILT with trace fine sand, red streaked white. Very stiff, moist, low to no plasticity, insensitive					2.0		139/81	1.7	
silty CLAY, black, orange and light grey streaked red/brown. Very stiff, wet, medium plasticity at 2.4m, becoming white and red streaked orange/brown, medium to low plasticity at 2.5m, becoming red and orange streaked white					2.5		143/89	1.6	
clayey SILT with trace fine sand, orange/brown streaked white. Stiff, moist, low plasticity, moderately sensitive, with trace fine gravel sized silt clast inculsions EOB at 3.0m. Target Depth.					3.0		96/42	2.3	
					3.5				
					4.0				
					4.5				
					5.0				
					5.5				
					6.0				

	Comments: Groundwater not encountered. UTP = unable to penetrate. EOB = end of borehole.	Borehole Diameter:	Topsoil		Sand		Sandstone		Plutonic	
		50mm	Fill		Gravel		Siltstone		No Core	
		Checked:	Clay		Organic		Limestone			
		RZ	Silt		Pumice		Volcanic			

APPENDIX B

ASCIE LINES (FROM COUNCIL GEOMAPS)



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ASCIE Plan



Scale @ A3
= 1:2,500

Date Printed:
3/07/2025

