



GEOTECHNICAL INVESTIGATION REPORT

Milldale Stages 14-17 Water Reservoir

Fulton Hogan Land Development Ltd
AK26-027AD Rev.1

7 August 2026

STATEMENTS OF QUALIFICATIONS AND EXPERIENCE

Chris Ritchie

My full name is Christopher John Hugh Ritchie.

I am a Principal Geotechnical Engineer at Gibb Ritchie Geotechnical Engineers Limited (GRGE). GRGE is a specialist geotechnical engineering consultancy based in Takapuna, Auckland, for which I am a founding director since 2025. I hold the qualifications of MSc (Engineering Geology) from The University of Auckland, which I completed in 2010. I am a Chartered Professional Engineer and Chartered Member of Engineering New Zealand. I have 17 years of professional experience in engineering geology and geotechnical engineering in the Auckland region. My experience has been primarily in land and building development and linear infrastructure, the last 14 years have been focused in the North Auckland area. Large portions of my work in this time have been focused on development of land and the investigation and assessment of roading corridors in Northland Allochthon terrain.

I have been engaged by Fulton Hogan Land Development Limited (FHLD) (the Applicant) to undertake an assessment of the Geotechnical Engineering associated with the Milldale Stages 14-17 project and to prepare this report in support of the substantive application under the Fast-track Approvals Act 2024 (FTAA).

While this is not an Environment Court proceeding, I confirm that I have prepared this assessment in accordance with the applicable professional and ethical obligations of my profession and that the opinions expressed are within my area of expertise.

Sam Gibb

My full name is Samuel Edward Gibb.

I am a Principal Geotechnical Engineer at Gibb Ritchie Geotechnical Engineers Limited (GRGE). GRGE is a specialist geotechnical engineering consultancy based in Takapuna, Auckland, for which I am a founding director since 2025. I hold the qualification of Bachelor of Science in Civil Engineering from The University of Plymouth (UK), which I completed in 2008. I am a Chartered Professional Engineer and Chartered Member of Engineering New Zealand. I have 15 years' experience working as a Geotechnical Engineer in New Zealand, predominantly in the Auckland region. My main area of expertise is land development of various scales in Auckland. I have been involved in numerous site investigations, hazard analyses, remedial design, review, and construction monitoring of land development projects including assessment and classification of dam infrastructure.

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Grant Murray

My full name is James Grant Murray.

Since 2016 I have been operating as an independent consulting engineer specialising in geotechnical and dam safety engineering. I have over 40 years of geotechnical engineering experience leading major infrastructure projects in New Zealand and internationally. I am a Chartered Professional Engineer, Recognised Dam Safety Engineer (PIC & DSAP) and Fellow of Engineering New Zealand. I have specific expertise in foundation design, ground improvement, liquefaction assessment, seismic design, and infrastructure design leadership. I have led geotechnical design teams on Alliance contracts for infrastructure projects and served as Independent Engineer and Lenders Technical Advisor on complex dam, hydropower and tunnelling projects across Asia.

I have been engaged as a sub-consultant by Gibb Ritchie Geotechnical Engineers Ltd to support them in the preparation and review of this report for Fulton Hogan Land Development Limited (FHLD) (the Applicant) as part of their substantive application under the Fast-track Approvals Act 2024 (FTAA).

While this is not an Environment Court proceeding, I confirm that I have prepared this assessment in accordance with the applicable professional and ethical obligations of my profession and that the opinions expressed are within my area of expertise.

LIMITATIONS AND USE OF THIS REPORT

This report has been prepared by Gibb Ritchie Geotechnical Engineers for the exclusive use of Fulton Hogan Land Development Ltd in relation to the Milldale Stages 14-17 Water Reservoir project. It has been prepared in accordance with the scope of work and the specific purpose agreed with the client.

The report should not be used for any other project, site, or purpose without the prior written consent of Gibb Ritchie Geotechnical Engineers. Where a party other than the named client seeks to rely on or use this report, they must first obtain such consent. Gibb Ritchie Geotechnical Engineers accepts no responsibility or liability to any other party who may use or rely on the contents of this report without authorisation.

This report is based on information available at the time of preparation, including site conditions observed and data obtained during the investigation. Subsurface conditions can vary significantly between investigation locations, and no warranty is given that the conditions described are representative of those across the entire site.

If you have any questions about the content or use of this report, please contact Gibb Ritchie Geotechnical Engineers for clarification.

Date	Revision	Comments
7 July 2026	A	Internal Review
16 July 2026	0	Draft for Client Review
7 August 2026	1	Final

Name	Position	Signature
Chris Ritchie	Principal Geotechnical Engineer, CPEng	
Grant Murray	Recognised Dam Safety Engineer	
Sam Gibb	Principal Geotechnical Engineer, CPEng	

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1 INTRODUCTION

Gibb Ritchie Geotechnical Engineers Limited (GRGE) was engaged by Fulton Hogan Land Development Ltd, to carry out a geotechnical investigation and assessment of a proposed water reservoir near Milldale, Auckland.

The Project relates to approximately 231ha of land centred around Wainui Road in Wainui, Auckland. The proposal provides for a comprehensively planned urban development including residential neighbourhoods, a supporting commercial node, transport and servicing infrastructure, open space, wetland and ecological restoration, and associated enabling works. The scope of work and associated terms and conditions of our engagement were detailed in our services proposal referenced AK26-027AA Rev 0 dated 11 February 2026 and variation dated 3 June 2026.

The application seeks approvals necessary to facilitate the staged development of the Project, including a suite of resource consents required under the FTAA framework.

The substantive application is supported by a comprehensive set of technical assessments and plans addressing the environmental, servicing and infrastructure matters associated with the proposal. This report should be read alongside the Planning Report and the appended technical reports and drawings lodged in support of the substantive application.

This report addresses matters relating to Geotechnical and Dam Engineering associated with the Water Reservoir as part of the wider project proposal. It seeks to describe the dam structure and its classification status, geotechnical investigation undertaken, the ground conditions encountered, identify and quantify geotechnical risks to the dam and reservoir, and provide recommendations with respect to geotechnical aspects of the proposed dam and reservoir including site preparation, temporary works, dam foundation construction, seepage requirements and site / subsoil classification, as detailed in our proposal.

This report has been prepared having regard to the relevant statutory and technical framework applicable to the proposal, including the Auckland Code of Practice for Land Development and Subdivision: Chapter 2 – Earthworks and Geotechnical (Version 2) and the New Zealand Dam Safety Guidelines (2024).

This report provides a level of investigation and preliminary analysis to broadly characterise the key geohazards pertinent to the earth dam embankment and reservoir and provide preliminary design details for these. Further geotechnical investigation and analysis will be required prior to detailed design of the reservoir and the dam.

2 SITE DETAILS

The reservoir is an area known as Te Korowai o Maraeariki and is located to the north of the Ōrewa River, zoned Rural Production under the AUP. This area is characterised by more undulating to steep terrain, with a series of ridgelines separated by incised gullies extending from the Ōrewa River. The land is predominantly managed pasture interspersed with streams and natural wetlands, together with pine plantations, exotic vegetation and gorse scrub. Relatively large areas of indigenous vegetation are also present, including a Significant Ecological Area – Terrestrial Overlay in the north-western portion of the site.

Where the reservoir is located, the site topography rises from the Orewa Awa at RL15m, to a broad near-flat platform alluvial terrace. To the north the topography slopes gently up to approximately RL35m.

3 PROPOSED DEVELOPMENT

Brief details for the development are as follows:

- The water reservoir comprises an excavation up to 11m below existing ground level and low-height earth dam embankment (maximum height 3.8m above existing ground level, typical height <3m), the freeboard is set at 1.2m below top of earth dam embankment.
- The reservoir is predominantly formed in cut below natural ground levels with fills placed around the downslope perimeter for additional storage volume in a partial “turkey nest” arrangement.
- The reservoir location is offset approximately 30m from the Orewa Awa at its closest point.
- Proposed reservoir batter slopes are 1V:3H.
- The total reservoir volume is 95,000m³.
- A spillway will be provided in accordance with Auckland Unitary Plan requirements (E7.6.1.12)
- An inlet from the Orewa Awa comprises a manhole with wing wall and submersible pump to fill the reservoir after completion.

The earthworks design by Woods depicts cut volumes of 128,295m³ and fills of 8,188m³ with the excess cut to be removed from site.

Figure 1: Site Location Plan



Figure 2: Proposed Reservoir Layout



4 DAM CLASSIFICATION STATUS

4.1 Definition

Under the Building (Dam Safety) Regulations 2022, a dam is considered “classifiable” if it is:

- 4 m or more in height and stores 20,000 m³ or more of water (or other fluid).

Dams below these thresholds are not subject to the requirements of the regulations, but owners are encouraged to follow good practice for safety and maintenance.

4.2 Applicability

In a turkey nest configuration, the earth dam embankment height is measured from the crest of the filled earth dam embankment to the downstream toe / natural ground interface at the lowest point. For the subject dam this height has been measured as 3.8 m and is therefore not a “large dam” and does not meet the 4 m threshold for a classifiable dam and is not subject to the mandatory requirements of the Building (Dam Safety) Regulations 2022.

In terms of Schedule 1 cl. 22 of the Building Act a dam of this size is also exempt from the requirement to obtain a Building Consent. Therefore, no further regulatory action is required under the Building Act for such a dam, but best practice guidelines should still be considered.

4.3 Regional Regulatory Requirements

An assessment against the Auckland Unitary Plan E7.6.1.12 Damming Water – off-stream dams was carried out. Based on the proposed storage of 95,000m³ this exceeds the 20,000m³ limit stated in Standard E7.6.1.2(2) and therefore is likely to be a discretionary activity in accordance with Table E7.4.1(A35).

5 DESKTOP STUDY

5.1 Related Documents

The following documents were reviewed during preparation of this report:

- Geotechnical Investigation for Milldale Stages 14-17, prepared by Gibb Ritchie Geotechnical Engineers Ltd referenced AK26-027AC Rev 0, dated 5 June 2026.
- Geotechnical Investigation for Milldale North, prepared by CMW Geosciences referenced AKL2024-0257AB Rev 3, dated 25 March 2025.
- Geotechnical Investigation for Milldale Stages 10-13, prepared by CMW Geosciences referenced AKL2024-0257AB Rev 3, dated 25 March 2025.

No specific investigations for this site are contained within these reports, however testing data on the geotechnical units has been incorporated into the ground model for this site.

5.2 Existing Information

No existing geotechnical information is available for the site.

5.3 Site History

In order to determine the site history, historical area photographs from the website Retrolens and Auckland Council GIS were reviewed between 1940 and present day. In summary the area has been used for farming from the 1940s with minimal changes occurring to present day.

5.4 Published Geology

Published geological maps¹ for the area depict the regional geology for the area as comprising either Middle Pleistocene - Late Pleistocene River and Hill Slope Deposits or Hukerenui mudstone of the Northland Allochthon. A description of these geological units can be found in the table below.

5.5 Geomorphology

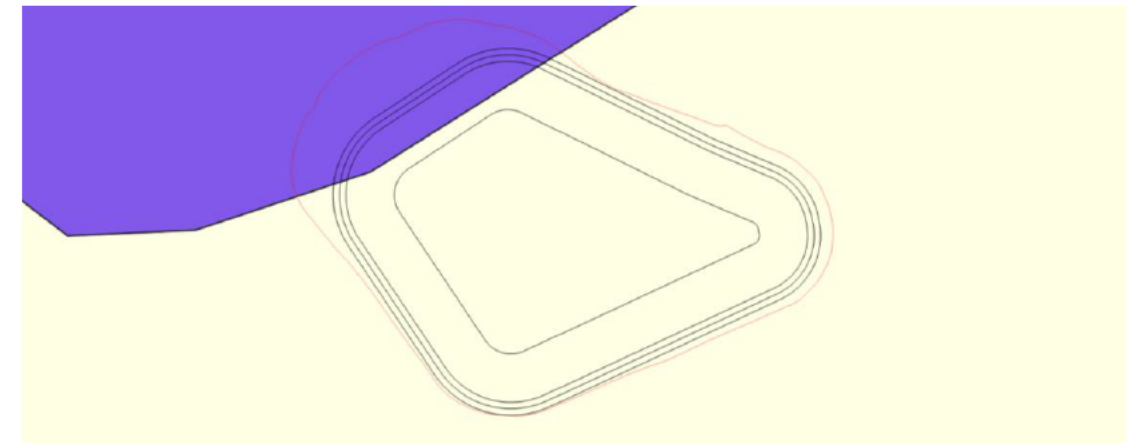
The site geomorphology can be broadly described by the following:

- The site occupies a broad alluvial terrace and gentle hill slope which is bound by watercourses to the northwest and the Orewa Awa to the south.
- This terrace is near flat before gently sloping from RL20m in the south to RL30 in the north.
- The watercourse to the east is within a gully that falls at approximately 1V in 5H to 1V in 8H.
- The Orewa Awa bank falls to the southeast at approximately 1V:4H.

Table 1: Summary of Typical Conditions of Mapped Geological Units

Middle Pleistocene - Late Pleistocene River and Hill Slope Deposits	
QMap Code and description	IQa Predominantly pumiceous sand, silt, mud and clay, with interbedded gravel and peat.
Formation	River and beach deposits
Typical Composition, Weathering/ Layering and Variability	Interbedded clays, silts and sands with and without organics, dependent on the origin. Some horizons of pumiceous sands from distal eruptive centres. Can be highly variable.
Behaviour, Instability Mechanism(s) and Principal Potential Geohazards	Liquefaction (if sandy lenses are present), typically too old to liquefy. Lateral Spread if liquefiable near a free face. Prone to comparatively poor bearing capacity characteristics. Secondary creep settlements due to decomposing organic content. Typically, partially consolidated due to the age of the deposits.
Hukerenui Mudstone of the Mangakahia Complex of the Northland Allochthon	
QMap Code and description	KKh - Red, brown, green and grey, typically noncalcareous, commonly highly sheared mudstone, with small serpentinite bodies.
Formation	Moderate slopes and ridges characterised by hummocky debris lobes, often without clearly identifiable head scarps. Geomorphology reflects deep soil creep of the most weathered deposits.
Typical Composition, Weathering/ Layering and Variability	Hard silts and clays in red, brown, green, black, and purple with clasts of weathered extremely to very weak siltstone and sandstone. Commonly highly sheared matrix between clasts. Weathered transitional zone difficult to distinguish from underlying, less weathered rock mass, identifiable by subtle changes in moisture content and strength of clasts. Sheared matrix predominately silts and clays.

Figure 3 Geology Map from QMAP, purple is Kkh, light yellow is IQa



¹ Edbrooke, S.W. (compiler) 2001. Geology of the Auckland area. GNS 1:250 000 geological map 3.

6 INVESTIGATIONS AND RESULTS

6.1 Field Investigation

The scope of fieldwork completed is shown below:

Table 2 Site Investigation

Test IDs	Test Type	No. of Tests	Depth Range (m)
HA01 to HA08-26, HA21-26,	Hand Auger Borehole	9	4 - 5m
CPT40 to CPT44-26, CPT47 to 48-26	Cone Penetration Tests	6	14.5 - 21.6m
MH06-26	Machine Borehole	1	15.45-19.88m
TP58 to 65-26	Test Pits	8	2.2 – 4.1m

Engineering logs of the relevant investigations are presented in Appendix B.

The approximate locations of the respective investigation sites referred to above are shown on the Geotechnical Investigation Plan as Drawing 39.

6.2 Groundwater

During the investigation, completed in early winter conditions (June 2026) groundwater was encountered at depths ranging from 0.4m to > 5m below existing ground levels.

Within a number of the boreholes, groundwater monitoring piezometers were installed to various depths below existing ground level using 32mm uPVC, gravel and bentonite plug fitted with a toby cover. Results of groundwater monitoring undertaken following the investigation is presented below.

Table 3: Piezometer Details

Test ID	Screen (mbgl)	Depth	Screened Soil Formation	25 June 2026	24 July 2026
				Depth (mbgl)	Depth (mbgl)
HA21-26	0 – 5		Alluvium	0.7	0.96
MH06-26	6 - 12		Northland Allochthon	2.27	2.44

6.3 Laboratory Testing

All testing was scheduled by GRGE and carried out by Babbage Ltd, an IANZ registered Testing Authority. The extent of testing carried out is presented below. Certificates for the test results are presented in Appendix C.

Table 4: Laboratory Testing

Test ID/ Location	Type of Tests	Test Method	Depth (m bgl)
TP62-26	Atterberg Limits, Standard Compaction Constant Head Permeability Test in Triaxial Cell	NZS4402: 1986: Test 2.1 to 2.4 NZS4402: 1986: Test 4.4.1	1.5 – 1.6
TP63-26	Atterberg Limits, Standard Compaction Constant Head Permeability Test in Triaxial Cell	NZS4402: 1986: Test 2.1 to 2.4 NZS4402: 1986: Test 4.4.1	2.5-2.6
TP64-26	Atterberg Limits	NZS4402: 1986: Test 2.1 to 2.4	1.8-1.9
TP64-26	Constant Head Permeability Test in Triaxial Cell	BS EN ISO 17892-11: 2019: Part 11	1.2-1.6
TP65-26	Atterberg Limits	NZS4402: 1986: Test 2.1 to 2.4	0.5-0.6
TP65-26	Constant Head Permeability Test in Triaxial Cell	BS EN ISO 17892-11: 2019: Part 11	1.0-1.3

Table 5: Laboratory Test Results

Test Location	Depth (mbgl)	Gravel (%)	Sand (%)	Silt (%)	Clay %	LL (%)	PL (%)	PI (%)	MC (%)	OMC (%)	MDD (t/m ²)	k _v (m/s)
TP62-26	1.5 – 1.6	0	1	47	52	77	21	56	39.2	26	1.44	1.9x10 ⁻⁹
TP63-26	2.5 – 2.6	0	1	40	59	95	22	73	53.5	28	1.39	1.1x10 ⁻⁹
TP64-26	1.2 – 1.6	0	2	28	70	99	25	74	70.9	-	-	1.1x10 ⁻⁹
TP65-26	1.0 – 1.3	0	0	35	65	105	31	74	55.1	-	-	3.2x10 ⁻¹⁰

Note: Gravel, sand and fines percentages are by weight, LL = liquid limit, PL = plasticity limit, PI = plasticity index, LS = linear shrinkage, MC = Natural Moisture Content, OMC = Optimum Moisture Content, MDD = Maximum Dry Density, k_v = coefficient of permeability

7 GROUND MODEL

7.1 Encountered Geology and Stratigraphy

An interpretation of the local geology based on the ground investigation is provided in the following table including material description, geological history and geomorphology. The Hukerenui mudstone was not encountered during our investigation. Instead, a shattered mudstone that appeared closer to the deposits of the Whangai Formation was observed.

Three geological cross sections (Sections P, Q and R) have been produced at the locations noted on Figure 4 and shown on Drawings 40, 41, and 42.

Table 6: Ground Model

Geology (Map Code)	Geotechnical Unit	Material Description	Geomorphology and History	Key Geotechnical Hazard
Middle to Late Pleistocene Hill and River Deposits (IQa)	Firm Alluvium	Firm low to moderate plasticity clays and silts. Some organics (wood fragments)	Elevated areas of alluvial soils likely deposited when sea levels were much higher. Erosive surface incised by the Orewa Awa.	Soils expected to be over consolidated due to previous loading. Soils compressible under high fill / building loading. Firm alluvium has low bearing strength. Liquefaction unlikely due to age of deposits.
	Stiff to Very Stiff Alluvium	Stiff to very stiff low plasticity clays and silts.		
Undifferentiated Mangakahia Complex	Residual Soil	Stiff plastic clays and silts. Typically wet.	Situated on the most elevated slopes on site.	Potential for highly expansive soils.
	Transitional Soil	Stiff silts and clays with clasts of extremely weak highly weathered siltstone and sandstone clasts. Relic sheared fabric noted within soil mass. Moist to wet.	Typically gentle to moderate slopes, hummocky ground in areas of steeper slopes. Some debris lobes noted at the base of slopes.	Prone to slope instability when exposed in cuts or overloaded with fills. Likely to rapidly degrade and soften if exposed to weather.
	Rockmass	Moderately to slightly weathered extremely to very weak grey siltstone. Highly sheared with some slickenside surfaces on defects. Typically recovered as a silty gravel, typically dry.	Material highly sheared due to depositional environment.	Likely to rapidly weather and soften when exposed.

7.2 Groundwater

The groundwater results suggest that measured groundwater (typically RL27-28m) is an isolated perched level above the Orewa Awa (RL15m).

Regional groundwater modelled by Williamson Water Advisory suggests that groundwater in this area is approximately RL17-22m.

7.3 Recommended Geotechnical Parameters

Table 7 Preliminary Geotechnical Design Parameters

Geotechnical Unit	Testing Results			Unit Weight	Drained	Undrained
	Shear Vane Strength Range (kPa)	CPT Cone value (Qc)	γ (kN/m ³)	Drained Cohesion c' (kPa)	Drained Friction Angle ϕ' (deg)	Undrained Shear Strength S_u (kPa)
Firm Alluvium	20-50	>1	17	3	25	38
Stiff Alluvium	50 – 200	1 – 2	17	3	28	65
Residual Soil	50-200	1-2	18	5	28	80
Transitional Soil	>200kPa	2 - 8	19	8*	21*	55*
Rockmass**	-	>15	20	20*	28*	150*

Notes:

γ = soil unit weight (conservative value determined from CPT correlations and typical published values for similar soil types)

c' = effective cohesion (conservative industry accepted value)

ϕ' = effective friction angle (conservative industry accepted value, CPT correlations)

S_u = undrained shear strength (lower bound from vane shear testing and CPT correlations)

* Material properties adopted from CMW Geosciences report on Stages 10-13 Milldale.²

** Significant persistent sheared zones may be present within the rock mass which would present lower shear strength values than the characteristic values above.

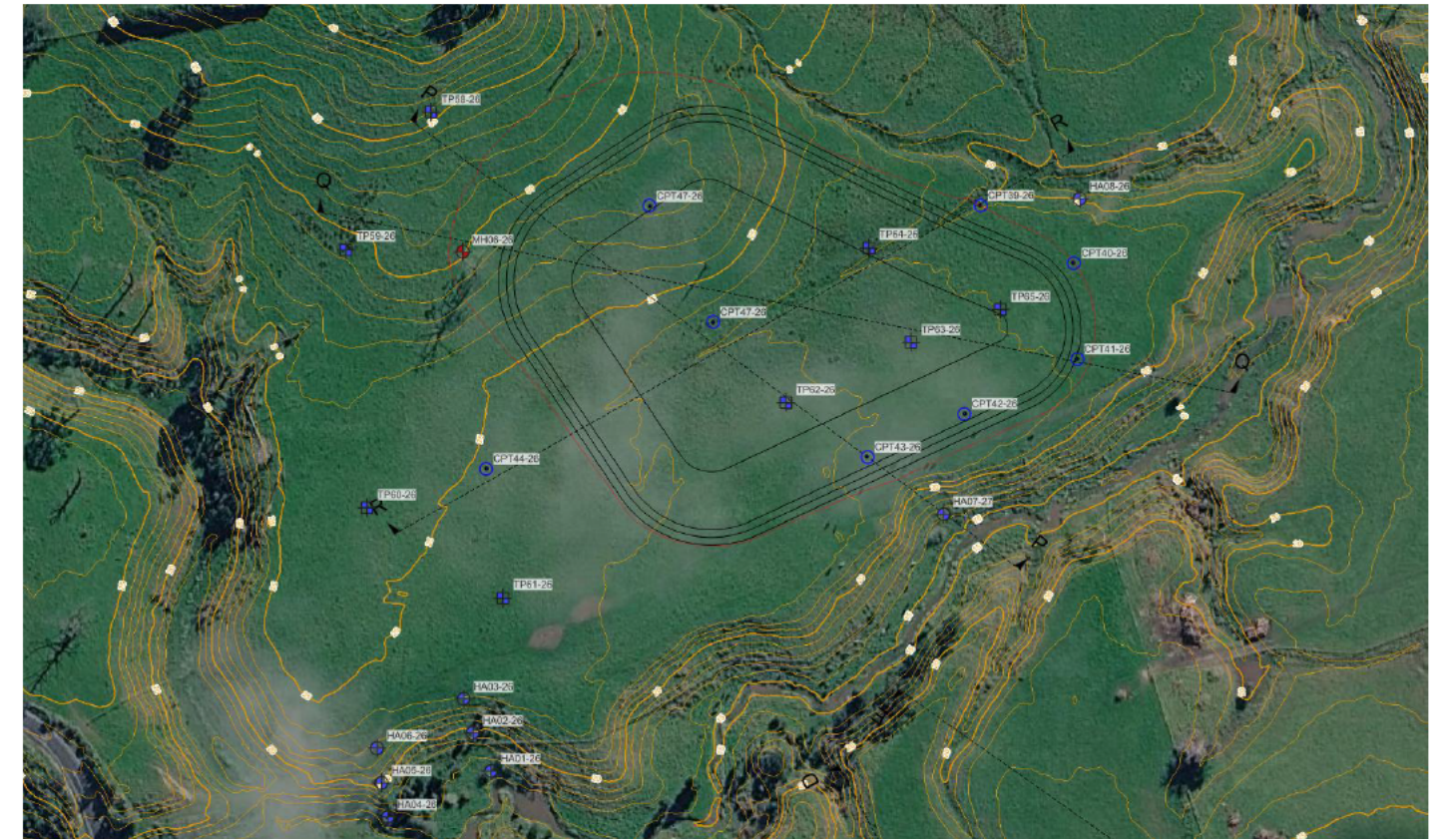


Figure 4 Site Investigation Plan and Cross Section Locations

² Geotechnical Investigation for Milldale Stages 10-13, prepared by CMW Geosciences referenced AKI 2024-0257AB Rev 3, dated 25 March 2025.

8 GEOHAZARDS ASSESSMENT

A full risk assessment in accordance with Auckland Council Code of Practice for Land Development Chapter 2 Geotechnical Engineer can be found in Appendix D. From this assessment the key geohazards for this project are assessed as:

- Slope stability of reservoir cut slopes, both permanent and in temporary cases.
- Settlement of earth dam embankment.
- Seepage failure,

The following section provides further detail, including analysis of these hazards, where appropriate, these have been carried out with reference to the New Zealand Dam Safety Guidelines – Module 3: Investigation, Design and Analysis³.

8.1 Seismicity

Module 3 of the MBIE Dam guidelines (Section 4.3) recommends that seismic performance criteria be assessed by the following:

- Safety Evaluation Earthquake (SEE)– The earthquake that would result in the most severe ground motion which a dam and appurtenant structures must be able to endure without uncontrolled release of the reservoir.
- Operating Basis Earthquake (OBE) – The earthquake for which a dam, appurtenant structures and mechanical, electrical, power, control, and communication equipment that fulfils a dam safety critical function is designed to remain operational, with any damage being minor and readily repairable following the event.

For the purpose of this assessment, we have considered the dam to have a “low” classification status, and the return period for each seismic case determined for this classification (Section 4.3.4.1 and Table 4.2 of Module 3).

We have determined the low classification on the assumption that a credible rainy day failure mode resulting in a catastrophic breach and loss of above ground storage results that is contained within the Orewa Awa and does not exceed the consequences of a 100 yr AEP flood event.

A seismic assessment has been carried out in general accordance with NZGS guidance⁴ to calculate the peak horizontal ground acceleration or PGA (amax) as follows:

$$a_{max} = C_{0,1000} \frac{R}{1.3} f \times g$$

Where: $C_{0,1000}$ = unweighted PGA coefficient (subsoil class C)

R = return period factor given in NZS1170.5 Table 3.5

f = site response factor subject to subsoil class (subsoil class C)

g = acceleration due to gravity

Table 8 Seismic Acceleration Parameters

Limit State	AEP	R	PGA(g)	Magnitude
OBE	1/150	0.25	0.06	6.5
SEE	1/500	1.0	0.15*	6.5

AEP = annual exceedance probability, *SEE determined as at least half of MCE event (1 in 2500 year) but no more than 1 in 1000 event

8.2 Liquefaction

General performance levels for liquefied deposits are presented below (as obtained from MBIE Module 3).

Figure 5: MBIE Module 3 Liquefaction Performance Levels

PERFORMANCE LEVEL	EFFECTS FROM EXCESS PORE WATER PRESSURE AND LIQUEFACTION	CHARACTERISTICS OF LIQUEFACTION AND ITS CONSEQUENCES	CHARACTERISTIC F_L , LPI
L0	Insignificant	No significant excess pore water pressures (no liquefaction).	$F_L > 1.4$ LPI=0 LSN <10
L1	Mild	Limited excess pore water pressures; negligible deformation of the ground and small settlements.	$F_L > 1.2$ LPI = 0 LSN = 5 – 15
L2	Moderate	Liquefaction occurs in layers of limited thickness (small proportion of the deposit, say 10 percent or less) and lateral extent; ground deformation results relatively small in differential settlements.	$F_L = 1.0$ LPI < 5 LSN 10 – 25
L3	High	Liquefaction occurs in significant portion of the deposit (say 30 percent to 50 percent) resulting in transient lateral displacements, moderate differential movements, and settlement of the ground in the order of 100mm to 200mm.	$F_L < 1.0$ LPI = 5 – 15 LSN = 15 – 35
L4	Severe	Complete liquefaction develops in most of the deposit resulting in large lateral displacements of the ground, excessive differential settlements and total settlement of over 200mm.	$F_L < 1.0$ LPI > 15 LSN > 30
L5	Very severe	Liquefaction resulting in lateral spreading (flow), large permanent lateral ground displacements and/or significant ground distortion (lateral strains/stretch, vertical offsets and angular distortion).	

The liquefaction susceptibility of the soils at this site was assessed in accordance with MBIE/NZGS guidance⁵ based on the following assumptions:

- In accordance with MBIE/NZGS guidance¹ and in the absence of site-specific shear wave velocity measurements, no aging / strength gain factor has been applied.
- Soils are also classified with respect to their grain size and plasticity to assess liquefaction susceptibility. For this project, a cut-off threshold soil behaviour type index value (I_c) of 2.6 was used to distinguish between liquefiable ($I_c < 2.6$) and non-liquefiable ($I_c > 2.6$) soils.
- Specific liquefaction analyses were undertaken for an IL2 structure, using the software package CLiq using the Boulanger and Idriss (2014) method. The cyclic stress ratio (CSR), being a function of the earthquake magnitude for the design return period event, was compared to the cyclic resistance ratio (CRR), being a function of the CPT cone resistance (q_c) and friction ratio (F_r).
- Free-field liquefaction induced settlements were determined in accordance with Zhang et al. (2002).
- Thin-layer correction was applied based on the rate of change of the soil behaviour type index value (I_c) method

³ New Zealand Society on Large Dams (NZSOLD). (2024). *New Zealand Dam Safety Guidelines – Module 3: Investigation, Design and Analysis*. Wellington, New Zealand.

⁴ NZ Geotechnical Society publication “Earthquake geotechnical engineering practice, Module 1: Overview of the standards”, (March 2016)

⁵ Earthquake Geotechnical Engineering Practice, Module 3: Identification, assessment and mitigation of liquefaction hazards”, (November 2021)

Table 9 Calculated Liquefaction Settlements

CPT No.	OBE Settlement (mm)	SEE Settlement (mm)	Depth to Liquefiable Layer (m)
CPT39-26	0	<10	9
CPT40-26		<15	12
CPT41-26		<5	11.5
CPT42-26		<5	11.5
CPT43-26		<5	13.0
CPT44-26		<10	5.0
CPT47-26		<10	5.0
CPT48-26		<5	6.5
Note: All settlement and depths based on existing ground profile			

Based on the above results, the site is expected to perform well, with negligible liquefaction induced settlements. Results can be found in Appendix E.

A review of the potential for lateral spreading was undertaken based on the liquefiable layers thickness, continuity between CPT traces and depth relevant to the free face of the Orewa. No feasible lateral spread failure mechanism was determined and therefore we consider the site low risk of lateral spread.

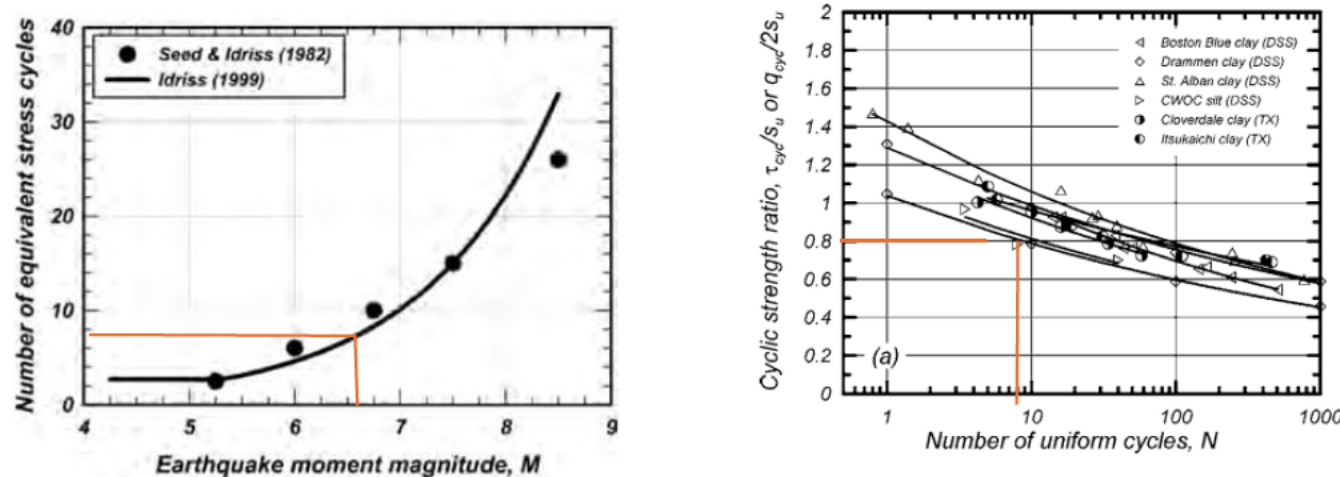
8.3 Cyclic Softening

The fine-grained alluvium, while not liquefiable due to its high plasticity, may be susceptible to some strength loss, referred to as cyclic softening, during a ULS seismic event.

Cyclic softening analyses of those soils was carried out in accordance with Boulanger⁶ and Idriss⁷. This correlates earthquake magnitude to the estimated number of equivalent stress cycles and then correlates number of cycles to a cyclic shear strength ratio (Figure 6).

Based on the above assessment, 2 stress cycles are estimated during the SEE M6.5 earthquake resulting in a worst-case cyclic shear strength of 80% of the peak shear strength. Reduced shear strengths should be considered during foundation design.

Figure 6: Relationship Between Earthquake Magnitude and Mean Number of Uniform Stress Cycles and Relationship Between cyclic Strength Ratio and Number of Uniform Stress Cycles



⁶ Boulanger, R.W. and Idriss, I. M. (2007) Evaluation of Cyclic Softening in Silts and Clays, Journal of Geotechnical and Environmental Engineering, Vol 133, Issue 6.

8.4 Slope Stability

Slope stability analysis has been carried out for two cross sections which were selected as the highest reservoir cut slope, earth dam embankment height and proximity to the Orewa Awa.

Slope stability analyses were undertaken using the Morgenstern-Price method of slices under translational failure mechanisms (generally being the critical mechanism) using the proprietary software SLIDE Version 6. The proposed landforms were assessed with the following performance standards in accordance with NZ Dam Safety Guidelines Module 3 noted below.

Table 10 Slope Stability Factor of Safety Performance Targets from NZ Dam Safety Guidelines

Condition	Required Minimum Factor of Safety
Long term steady state	1.5
End of Construction before reservoir filling	1.3
Full or partial rapid drawdown	1.2 to 1.3
OBE	1.0
SEE	1.0*
Post Earthquake	1.2 to 1.3
Note*: Deformations are acceptable provided they do not lead to an uncontrolled release of the impounded contents	

The following tables summarise the slope stability factors of safety achieved for both the existing and proposed landforms.

Table 11 Proposed Sections Factor of Safety Requirements

Section	Proposed Slope Stability Minimum Factor of Safety					
	Long Term	End Construction of	Rapid Drawdown	OBE	SEE	Post Earthquake
P-P	1.5	1.5 / 2.0	1.2 / 1.1	1.3	1.0	1.7
Q-Q	1.6	1.4 / 1.5	1.1 / 1.0	1.8	1.2	2.2

Based on the stability modelling, the reservoir slope and earth dam embankment do not meet the slope stability Factor of Safety for rapid drawdown cases. Remediation options can be found in Section 9.2. Outputs from the stability modelling can be found in Appendix F.

8.4.1 PC120 Auckland Unitary Plan Landslide Assessment

A landslide risk assessment in accordance with Appendix 24 of Plan Change 120 to the Auckland Unitary Plan (PC120) was carried out and can be found in Appendix G. In summary:

- Large scale landslide susceptibility is mapped as very low within the footprint of the reservoir.
- Shallow landslide susceptibility is mapped as generally very low to medium.
- To determine run-out susceptibility, the highest landslide susceptibility class mapped within 150m upslope of the site was reviewed. This shows very high shallow landslide susceptibility on the neighbouring slopes above the reservoir.

We undertook a Method 1 risk assessment for three hazard scenarios, Method 2 was deemed not appropriate given there is no person at risk for the reservoir. The result was a low landslide risk for the three scenarios. Therefore, based on the desktop assessment, we consider that landslide hazard result is Low (acceptable) under Appendix 24 of PC120.

⁷ Idriss, I. M. and Boulanger, R. W. (2008) Soil Liquefaction During Earthquakes. Monograph 12, Earthquake Engineering Research Institute.

8.5 Static Settlement

The proposed earth dam embankment may induce settlement of the underlying compressible alluvial soils. An initial screening exercise using CPeT-IT was undertaken to determine the risk of static settlement for the embankment, with primary settlements calculated according to the following formula:

$$S_p = \sum \frac{\Delta\sigma_v}{M_{CPT}} \Delta z$$

Where: $\Delta\sigma_v$ = change in effective stress
 M_{CPT} = constrained modulus from CPT
 Δz = change in depth

Secondary creep settlements were calculated according to the following equation:

$$S_c = C_\alpha \cdot \Delta z \cdot \log\left(\frac{t}{t_p}\right)$$

Where: C_α = coefficient of secondary compression
 t_p = duration of primary consolidation (24 months assumed)
 t = duration of design life (50 years)

The following table displays the results of this assessment, outputs can be found in Appendix H.

Table 1 CPT Settlement Estimations

CPT No.	Compressible soil thickness (m)	Proposed Fill Height (m)	Primary Settlement, T90 (mm)	Secondary Creep Settlement (mm)
CPT39-26	10	3	110	10
CPT40-26	12	3	160	40
CPT41-26	5	2	70	30
CPT42-26	10	2	60	30

Based on the above results, 60 to 110mm of primary settlement is anticipated during construction of the earth dam embankment. Recommendations in respect to this are made in Section 9.3.

8.5.1 Time Rate of Settlement

The rate of consolidation settlement is dictated by the rate in which excess pore water pressures can dissipate, this is dictated by the soils permeability and thickness. The ground model presents assumes an average compressible silt / clay layer thickness of 10m. In most cases, the compressible layer is underlain by low permeability rock that will present only 1-way drainage.

Time rates of settlement are notoriously difficult to estimate due to their depositional environment where there is inherent material composition lateral and depth variability and presence of intermediate sand lenses. Reference to coefficient of vertical consolidation (C_v) laboratory data taken from the subdivision testing on the southern side of the Orewa Awa shows a wide scatter of data although a value of 5m²/year of the firm alluvium looks to provide a reasonable lower bound estimate for preliminary design purposes.

Based on those values, the following settlement timeframes are estimated:

Table 13 Time Rates of Settlement

Soil Layer Thickness (m)	Hdr (m)	Time to Reach t90 (years)
		Firm
5	5	3
10	10	5
15	15	10

Note: Hdr = maximum drainage path length

It is noted that C_v values measured in the lab represent a particularly small volume of soil and can therefore be conservative as they don't take into account thin sand lenses and other discontinuities within the soil mass. Actual settlement timeframes may therefore be less than those tabulated above.

9 RECOMMENDATIONS

9.1 Site Suitability

Based on the assessment undertaken in this report, the following recommendations are made to avoid, remedy or mitigate potential adverse effects associated with the proposal and to support the appropriate implementation of the reservoir and earth dam embankment.

In general, the proposed reservoir area is suitable for the proposed activity, provided recommendations in the following sections are implemented into the detailed design and construction of the earth dam embankment and reservoir.

9.2 Slope Stabilisation

Results of the slope stability analyses discussed in Section 8.5 demonstrate that design landform gradients through the reservoir and earth dam embankment slopes do not meet the requisite slope stability factors of safety during a rapid drawdown event.

For the reservoir, a shear key will be required where transitional materials daylight at the base of the slope as well as undercutting and replacement of the exposed Northland Allochthon rock mass with an engineered clay cap. This capping is required to avoid rapid degradation of the rock mass as well as improve slope stability factors of safety; details can be found in Section 9.4.1.

For the reservoir slope below the earth dam embankment face, which is anticipated to be in firm to stiff alluvial soils, a shear key and engineered clay capping is proposed at the base to improve slope stability factors of safety.

The resultant slope stability factors of safety are displayed in the Table below.

Table 14: Remediated Case Slope Stability Factors of Safety

Section	Remediated Slope Stability Minimum Factor of Safety		Remedial works
	Rapid Drawdown Dam Slope	Rapid Drawdown Reservoir	
P-P	1.2	1.2	Earth dam = 3m wide by 1.5m deep shear key at base of dam slope. Earth dam slope to be benched in with 3m wide engineered fill. Reservoir = benched in engineered clay cap 1m in width.
Q-Q	1.2	1.2	Earth dam = 4m wide by 1.5m deep shear key at base of earth dam slope. Earth dam slope to be benched in with 3m wide engineered fill. Reservoir = 3m wide by 2.5 deep shear key at base of reservoir slope (to top of Northland Allochthon rock mass). Slope to be benched in engineered clay cap 1m in width.

9.2.1 Unidentified Sheared Zones

There is a possibility of unidentified significant persistent sheared zones in Northland Allochthon geologies which would affect the global stability of the reservoir slope which has not been considered in the stability modelling.

It is therefore important that careful construction monitoring including geological mapping by a suitably experienced Engineering Geologist or Geotechnical Engineer with experience in this geology is carried out during its excavation.

The implementation of shear keys designed during construction to mitigate the risk has been successfully carried out within the Milldale Development and is common practice in this geological setting.

9.2.2 Creep Movement

It is expected that creep movement will occur on cut slopes in natural ground steeper than 1V:4H. The proposed reservoir slopes are up to 1V:3H and therefore will undergo seasonal creep movement, this is particularly prevalent in Northland Allochthon geologies. It is expected that this slope will be planted out, and with no structures planned, as such we consider this movement is acceptable without further mitigation.

9.3 Settlement Mitigation

Based on the CPT estimations made in Section 8.5.1, primary settlements are expected to be 'built out' during earthworks, however settlement monitoring should be carried out to confirm this magnitude and likely post construction settlement. If significantly greater settlements are observed during construction it is recommended that additional fill is placed on the dam to ensure the design freeboard is still achieved over the design life.

9.4 Earthworks

All earthwork activities must be carried out in general accordance with the requirements of NZS 4431:2022⁸ and the requirements of the Auckland Council Infrastructure Development Code under the guidance of a Chartered Geotechnical Engineer. A geotechnical works specification has been provided with the main subdivision GIR (referenced AK26-027AB) which provides the requirements for site preparation, fill placement, subsoil drainage, compaction requirements, quality assurance observations and testing and as-built requirements.

A summary of the key project specific construction risks, as presented in the Project Risk Register in Appendix D are as follows:

Table 15: Key Construction Risks

Item	Mitigation Measures
Excavatability	Excavations likely to comprise alluvial soils which are able to be excavated using typical earthworking plant. No evidence of harder limestone units found in previous stages of the development.
Sediment Retention Ponds	Geotechnical Engineer to have input on the locations of these when situated on slopes. May require structural design including key and compaction specifications, subgrade inspections and QA of embankment materials.
Stockpile Locations	The locations including the heights must be approved by the Geotechnical Engineer. Issues in respect to bearing capacity failures on alluvial soils.
Groundwater management	Given the depth and extent of excavation, the contractor should make allowance for groundwater infiltration and surface water with pumping likely required at the beginning of each shift. Based on the groundwater monitoring results a perched level exists above the base of the reservoir.

9.4.1 Capping of Rock Mass

The effects of rapid weathering/degradation of the transition and rock mass can cause significant softening to subgrades if left untreated. The use of clay fill capping has been successful in protecting the rock mass from this rapid weathering and is recommended to be carried out below the formation to a minimum of 1m below finished level.

9.4.2 Material Reuse

The alluvial soils typically comprise highly plastic clays typically above the A-line with >98% fines content and of this a minimum 50% clay content. Permeability testing shows very low permeability (1×10^{-9} m/s) of these materials.

This confirms that the site-won alluvial soils are suitable to be used as engineered fill for the dam construction, however they are significantly wet of optimum and will require extensive drying. Table 16 below shows natural moisture (NMC) contents versus optimum moisture content (OMC) for compaction curves, the samples were taken early winter (June 2025) and reflect NMC of this season.

⁸ Standards New Zealand (2022) Engineered fill construction for lightweight structures, NZS 4431:2022

Table 16: Compaction Test Results

Test Location and Geology	Natural Moisture Content (%)	Optimum moisture content (%)
TP62-26 1.5-1.6m Alluvial CLAY	43	26
TP63-26 2.5-2.6m, Alluvial CLAY	56.71	28

From wider earthworks experience working in Northland Allochthon, natural moisture content of the rock mass is expected to be in the order of 15-25%, thorough blending by discing is a good method of reducing moisture in the overwet alluvial soils for placement as engineered fill.

This will need to be carefully done to avoid creating a higher permeability fill due to the presence of gravels, additional testing of this blended fill is required during construction.

9.5 Preliminary Dam and Reservoir Design

9.5.1 Foundation

The earth dam embankment is founded on firm alluvial soils comprising firm to stiff highly plastic clays. Topsoil, vegetation, loose surficial materials, and any unsuitable soils should be stripped from the foundation footprint prior to embankment construction.

The embankment should be keyed into the underlying firm alluvial foundation soils by excavating a continuous foundation key trench along the earth dam embankment centreline. The key trench should extend through any surficial loose or disturbed materials and penetrate the firm natural alluvial soils to provide a positive connection between the embankment and foundation. The purpose of the key is to improve stability and to reduce the potential for seepage along the embankment–foundation interface.

Exposed foundation surfaces should be scarified, moisture-conditioned as necessary, and compacted prior to placement of embankment materials. The key trench and foundation preparation should be inspected by a suitably qualified engineering geologist or geotechnical engineer to confirm that firm, competent alluvial soils have been exposed and that all unsuitable materials have been removed.

A typical detail is shown on Drawing 43 of this arrangement.

9.5.2 Seepage

The proposed reservoir storage is predominantly below existing ground level with a maximum embankment height of up to 3.8m. Laboratory testing indicates the site-won clay fill has a permeability of approximately 1×10^{-9} m/s and is expected to provide an effective seepage barrier when suitably compacted.

Given the relatively low retained water head and low permeability of the proposed embankment material, seepage through the embankment is not anticipated to govern design. Accordingly, a detailed seepage analysis has not been undertaken. Construction should focus on adequate compaction, removal of topsoil and organic materials, keying the embankment into the subgrade, and mitigation of potential seepage paths.

In order to improve slope stability of the natural ground below the earth dam under rapid drawdown conditions, it is proposed to bench out and replace the face with engineered clay fill, this will also allow us to remove any potential seepage pathways such as organics and sand bands within the alluvial soils.

Capping of the Northland Allochthon rock mass is standard earthworks practice at Milldale and is recommended to be undertaken within the reservoir slopes and floor to avoid rapid degradation and potential seepage of this material. Capping comprises undercutting 1m of the rock mass and transitional soils and replacement with engineered fill.

Whilst preliminary laboratory testing shows that alluvial soils are clay rich and of low permeability, additional testing should be carried out during construction.

Groundwater monitoring within the reservoir platform suggests that a perched level is present at shallow depths (1-2m below existing ground surface). It is expected that some degree of seepage will occur into the reservoir from the natural ground.

9.5.3 Spillway

At this stage the spillway for the earth dam embankment has not yet been designed. As part of detailed design, the stability of the spillway should be assessed, the design should include erosion protection measures such as rock armouring, energy dissipation structures, or vegetative stabilisation. The design should consider AUP E7.6.1.11 items 6, 7, 8.

9.5.4 Inlet Structure

In order to fill the reservoir, an inlet structure to pump water from the Orewa Awa is proposed. The intake comprises a 2.5m diameter manhole chamber with 1.5m wingwall inlet which houses a submersible pump. The ground conditions here are soft to stiff alluvial soils.

The intake structure, wingwall, and wet well should be founded on competent natural alluvial soils free of topsoil, organics, any unsuitable material encountered at foundation level should be excavated and replaced with compacted granular fill.

Excavations extending below groundwater level should be undertaken with appropriate temporary dewatering measures. Excavation side slopes should be designed in accordance with NZGS Worksafe guidance and actual ground conditions encountered during construction. Temporary shoring may be required where excavation stability cannot be maintained.

Provided foundations are constructed on the stiff alluvial soils, an ultimate bearing capacity in the order of 300kPa may be assumed for preliminary design. The final allowable bearing pressure should be confirmed at detailed design.

A minimum 300 mm layer of compacted AP65 or equivalent granular foundation material should be placed beneath the wet well base slab and intake structure foundations.

Groundwater levels may fluctuate in response to stream levels. Detailed design should assess buoyancy and uplift pressures acting on the wet well during periods when the structure is empty and groundwater levels are elevated. The structure should achieve an adequate Factor of Safety against flotation under the most adverse groundwater conditions.

The intake structure and wingwall are located within the active stream channel and are potentially susceptible to scour and debris impact during flood events. Riprap protection should extend beneath and around the intake structure and wingwall to prevent undermining, riprap sizing and extent should be confirmed by the project civil engineer.

9.5.5 Auckland Unitary Plan Considerations

The following long maintenance and monitoring considerations outside the scope of this practice should be made to comply with AUP E7.6.1.11.

9) Trees or vegetation which could weaken the dam stability or prevent inspection of the dam embankment must not be allowed to grow on or near the embankment.

(10) Stock must not be allowed to damage the crest and faces of the dam.

(11) The dam structure and spillway must be inspected at least once every 12 months and following any operation of the flood spillway. Any damage recorded at times of inspecting, or noticed at any other time, must be remedied as soon as practicable.

9.6 Civil Works

Inputs for civil works such as roading are included below.

Table 13: Key Civil Inputs

Item	Value	Comment
Subgrade CBR	1-3% Firm Alluvium 5-6% Engineered Fill	To be confirmed by DCP testing once subgrade exposed
Typical Topsoil Depths	100 – 300mm	

9.7 Certification

An earthfills completion report, in general accordance with NZS4431:2022 is an appropriate method of certification of the engineered fills placed to form the reservoir.

10 FURTHER WORK

The following further work is recommended as the project progresses:

- Further geotechnical investigation and design prior to detailed design of the reservoir and dam.
- During construction, regular inspections and testing will be required.

11 CLOSURE

Gibb Ritchie Geotechnical Engineers has prepared this report for Fulton Hogan Land Development Ltd in accordance with the agreed scope of work for the Milldale Stages 14-17 Water Reservoir project. It provides geotechnical information and recommendations to assist in design and construction planning.

We view this report as part of an ongoing process. Our team can provide further input during detailed design and construction to help ensure that the recommendations are applied effectively and to provide advice should any unexpected ground conditions arise.

If you have any questions about the report, or if you would like to discuss the next steps for your project, please contact our team.

USING YOUR GIBB RITCHIE REPORT

Geotechnical reporting relies on interpretation of site information using experience, professional judgement, and opinion. As such, all geotechnical reports carry an inherent level of uncertainty, often greater than in other engineering disciplines. The notes below provide guidance on what can reasonably be expected from this report and its inherent limitations.

Purpose of this report

This report has been prepared specifically for Fulton Hogan Land Development Ltd and the Milldale Stages 14-17 Water Reservoir project. The contents may not meet the needs of others who may have different objectives or requirements. The report has been prepared using generally accepted geotechnical engineering and engineering geology practices. The opinions and conclusions are based on those principles.

Dependence on available information

This report is based on the information available at the time of preparation, including investigation results and referenced data. If further information becomes available or the project scope changes, the findings may no longer be valid. In such cases, Gibb Ritchie Geotechnical Engineers should be engaged to review and update the report.

Applicability to your project

The findings and recommendations in this report relate solely to the site and project described. They should not be applied to other sites or projects, as subsurface conditions and requirements differ between locations and developments. Similarly, applying data or conclusions from other sites to this project may lead to incorrect assumptions.

Interpretation of subsurface condition

Site investigations provide information at discrete locations. Conditions between or beyond these points may differ. Geological interfaces may be more variable than inferred, and actual conditions may only become clear during construction. Engineering judgement has been applied to interpret the available data, but no investigation can remove all uncertainty.

Changes in subsurface conditions

Ground and groundwater conditions can change over time, whether due to natural processes (seasonal variation, settlement, erosion) or human activities (earthworks, adjacent development). This report reflects conditions observed at the time of investigation. Confirmation of conditions may be necessary if significant time has passed before construction.

Role during construction

Recommendations in this report are based on selective point sampling and interpretation. It is strongly recommended that Gibb Ritchie Geotechnical Engineers remain involved during construction to confirm assumptions, review any changes in conditions, and provide timely advice if unexpected ground conditions are encountered.

Use by other parties

This report has been prepared for the named client. Where other design professionals or third parties intend to rely on it, they must first seek consent from Gibb Ritchie Geotechnical Engineers. Misinterpretation of geotechnical reports can lead to costly design or construction issues, and our continued involvement helps reduce these risks.

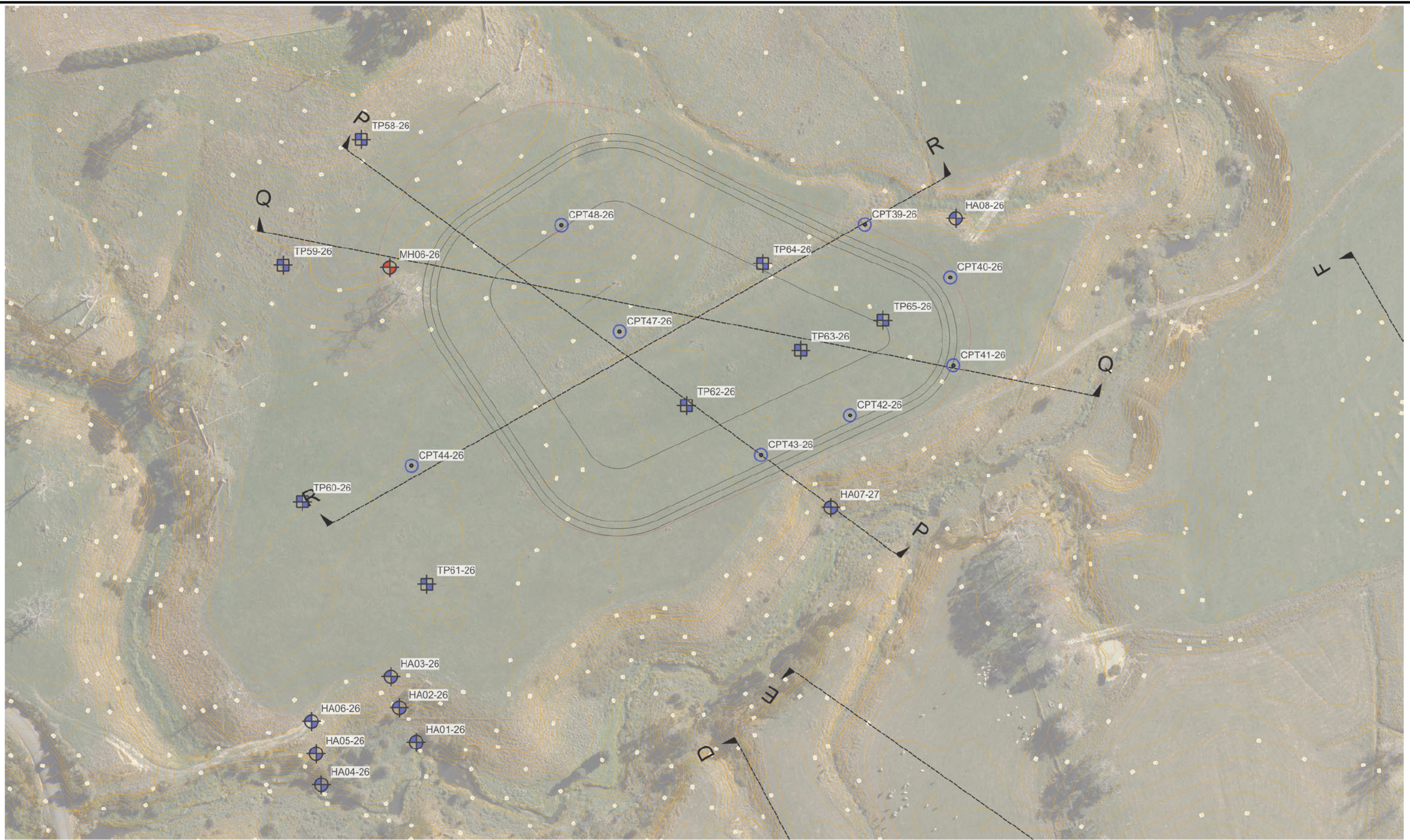
Environmental matters

Unless explicitly stated, this report does not address environmental issues such as contamination, waste management, or disposal of materials. These require separate investigation and specialist advice.

If you have any questions about the content or use of this report, please contact Gibb Ritchie Geotechnical Engineers for clarification.

APPENDIX A

Drawings



LEGEND:
— SITE BOUNDARY
▲ CROSS SECTION LOCATION

Gibb Ritchie Geotechnical Engineers Investigations

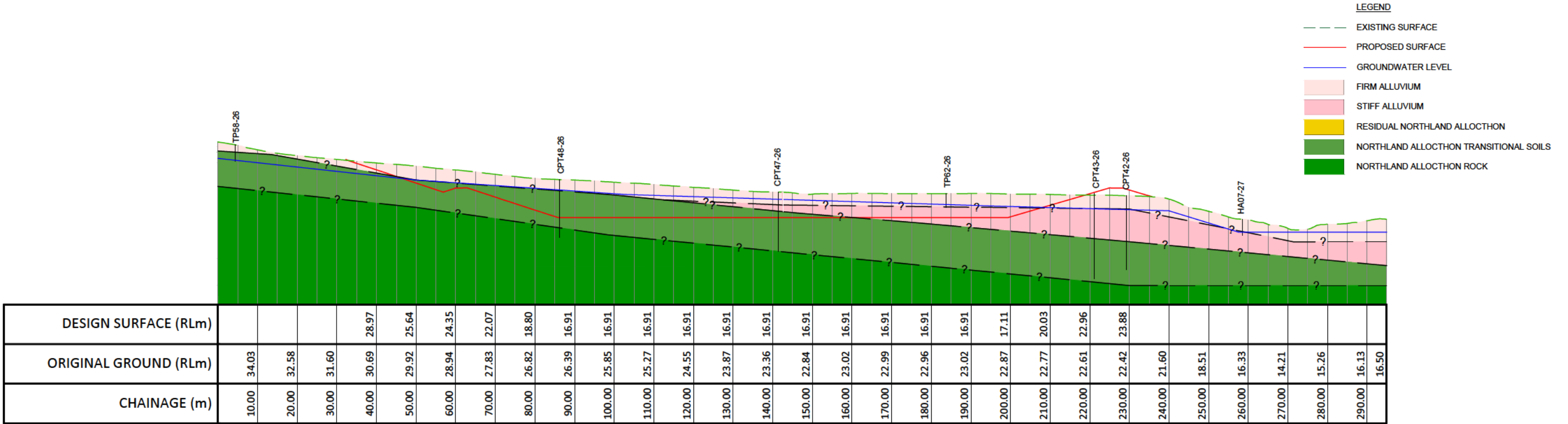
- HA01-26
- HA02-26
- HA03-26
- HA04-26
- HA05-26
- HA06-26
- TP58-26
- TP59-26
- TP60-26
- TP61-26
- TP62-26
- TP63-26
- TP64-26
- TP65-26
- MH06-26
- CPT44-26
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- CPT43-26
- CPT41-26
- CPT40-26
- HA08-26

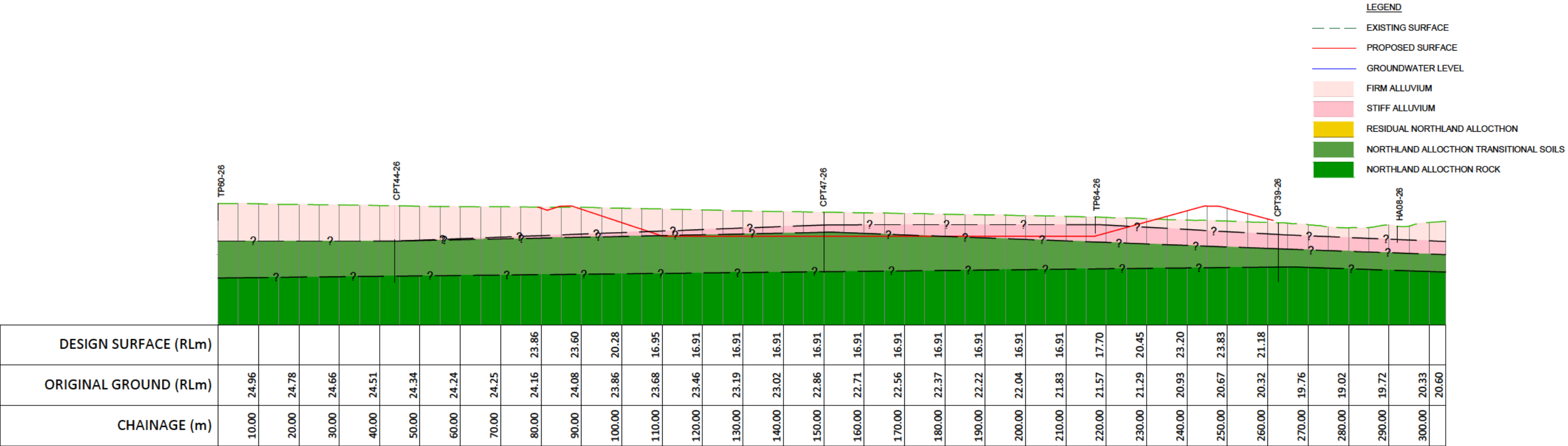
Existing Investigations

- HA07-27
- HA01-26
- HA02-26
- HA03-26
- HA04-26
- HA05-26
- HA06-26
- TP58-26
- TP59-26
- TP60-26
- TP61-26
- TP62-26
- TP63-26
- TP64-26
- TP65-26
- MH06-26
- CPT44-26
- CPT47-26
- CPT48-26
- CPT42-26
- CPT43-26
- CPT41-26
- CPT40-26
- HA08-26

NOTES: 1. BASE MAP ADAPTED FROM AUCKLAND COUNCIL OPEN DATA VIA QGIS

CLIENT:	FULTON HOGAN LAND DEVELOPMENT LTD		DRAWN:	CR	PROJECT:	AK26-027
PROJECT:	MILLDALE STAGES 14-17 WAINUI EAST		CHECKED:	SG	DRAWING:	39
TITLE:	SITE INVESTIGATION PLAN		REVISION:		SCALE:	1:1000
			DATE:	14/07/2026	SHEET:	A3 L





GEOLOGICAL LONG SECTION S



A	8/07/26	FOR INTERNAL REVIEW	CR	GIBB RITCHIE GEOTECHNICAL ENGINEERS	CLIENT: FULTON HOGAN LAND DEVELOPMENT	DRAWN: IS	PROJECT: AK26-027
0	31/07/26	FOR CLIENT ISSUE	CR		PROJECT: MILLDALE RESERVOIR	CHECKED: SG	FIGURE: 41
						REVISION: 0	SCALE: 1:1000
					TITLE: GEOLOGICAL LONG SECTION S	DATE: 08/07/6	SHEET: A3
REV	DATE	DESCRIPTION	BY				

APPENDIX B

Investigation Records

Coordinate System : EPSG:2193

Easting (m) : 1746156.97

Northing (m) : 5948020.89

Ground Elevation : 24.39 (m)

Total Depth : 15.45 m BGL

Drill Rig : Hanjin 8D

Driller Supplier : Topdrill Geotech

Logged By : IS

Reviewed By : CR

Date : 08/06/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

TCR %	RQD	Drilling Method	Water	Testing		Depth (m)	Elevation (m)	Soil Origin	Graphic Log	Material Description	Consistency	Weathering	Estimated Strength					Defect Spacing (mm)	Defect Description type, inclination, planarity, roughness, coating, thickness
				SPT (N Value)	Shear Vane (Peak/Residual)								EW	VW	W	MS	S		
93	87	HQ Coring	SWL				24.0	Alluvial		clayey SILT, dark brown, moist, low plasticity, TOPSOIL.	St								
						1.0			silty CLAY, yellow with mottled pale grey, Stiff, moist, high plasticity,	St									
						23.0			clayey SILT, pale grey with mottled orange, Stiff, moist, high plasticity,	St									
									As above, but: pale grey with mottled and dark grey,	St									
100	0		1-0-0-1-1-2 N = 4	77/16 .8		2.0			As above, but: pale grey with mottled orange,										
76	67					22.0				St									
100	0		0-0-1-2-1-2 N = 6	95.2/ 16.8		3.0	Mangakahi a transition		Clayey SILT, light grey, Stiff, moist, medium plasticity .	St									
										As above, but.									
100	100					20.0				St									
										As above, but.									
100	0		3-4-6-8-8-9 N = 31	196/		5.0													
										As above, but.									
100	57				19.0														
100	0	3-4-6-6-8-8 N = 28			18.0			St											
100	100				17.0														
100	0	4-6-9-8-8-8 N = 33			8.0														
95	0				16.0	Mangakahi a Rock Mass		Completely weathered, light grey slightly green, SILTSTONE; extremely weak; very fine grained, moist, ("highly sheared fabric, slickensided defect surfaces").											
100	0	5-5-7-8-8-9 N = 32			15.0				EW	CW								SZ, 65°, CV, SO, CL, OP	
100	0																		
100	0																		

SZ, 65°, CV, SO, CL,
OP

Coordinate System : EPSG:2193

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				SPT (N Value)	Shear Vane (Peak/Residual)								EW	VW	W	MS	S			VS	ES
100	0	HQ Coring				14.0	14.0	Mangakahi a Rock Mass		Completely weathered, light grey slightly green, SILTSTONE; extremely weak; very fine grained, moist, ("highly sheared fabric, slickensided defect surfaces"). (continued)	EW	CW									
100	0		-11-12-13-13-1 N = 50		11.0																
100	99				13.0					Moderately to slightly weathered, light grey slightly green, SILTSTONE; very weak; very fine grained, moist, ("highly sheared fabric, slickensided defect surfaces").											
100	0		5-6-5-7-8-10 N = 30		12.0						VW	MW-SW									
100	99				13.0																
100	0		6-8-11-7-13-11 N = 42		14.0																
90	76				10.0					As above, but: fine to medium grained.	VW	MW-SW									
100	0		2-7-9-10-9-12 N = 40		15.0					As above, but: Completely weathered, extremely weak; fine grained.	EW	CW									
						9.0															
MH06-26 Terminated at 15.45 m																					

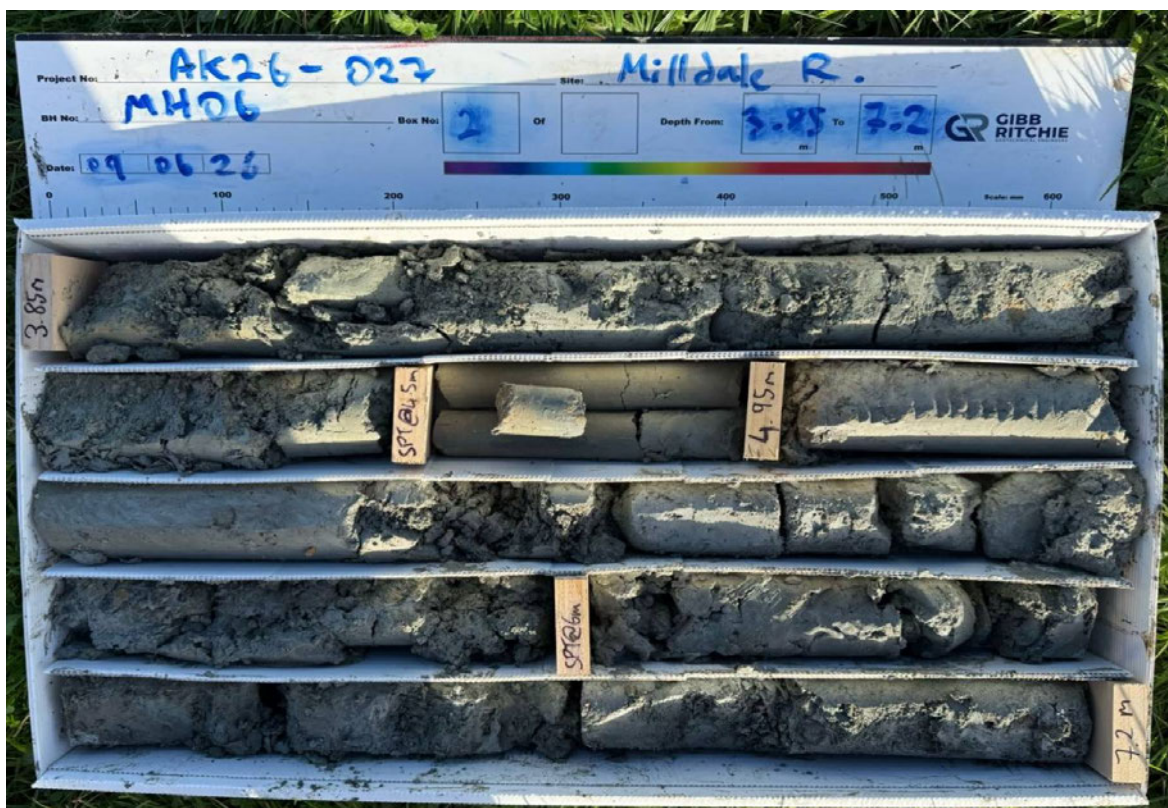


Photo description

MH06 - Milldale Reservoir

Client

Fulton Hogan Land Development Ltd

Location

522 Wainui Road, Wainui 0992, New Z...

Project name

Milldale North

Project No

AK26-027

Scale

Not to Scale

BH No

MH06-26

BH Depth

0.0m -
7.2m

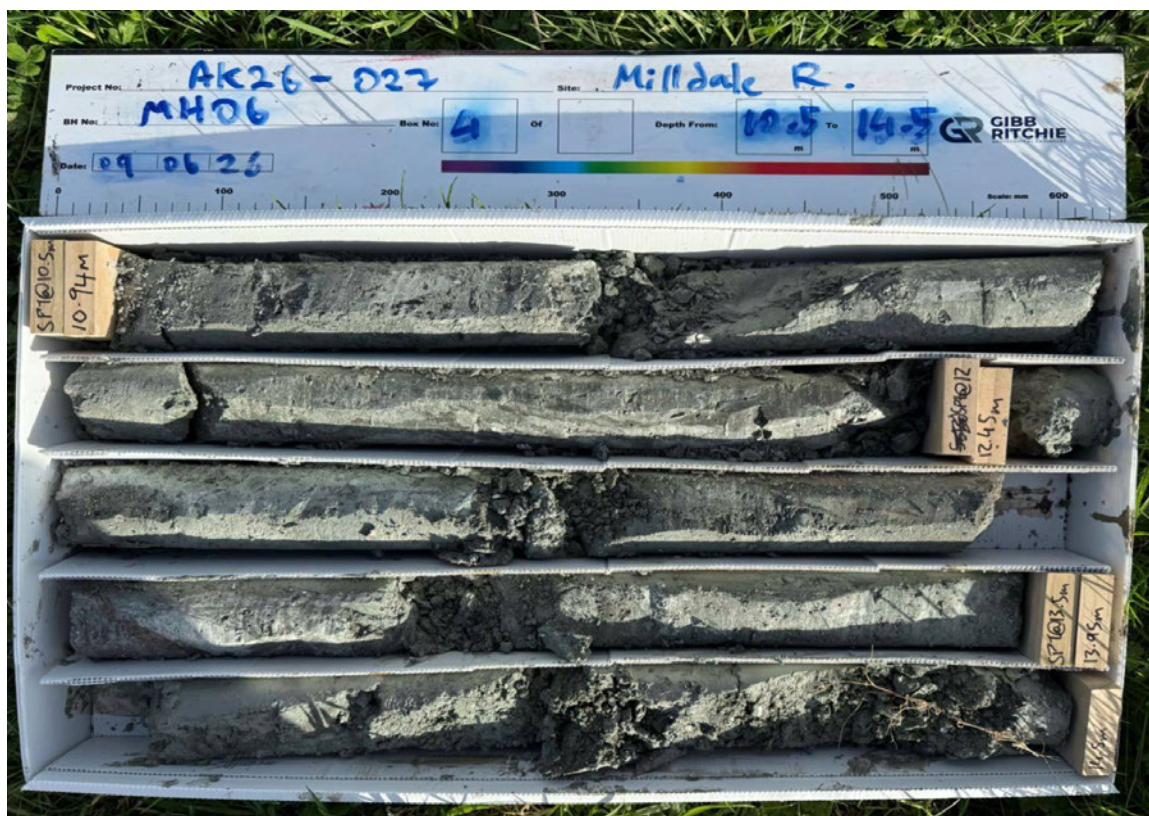


Photo description	MH06 - Milldale Reservoir		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
BH No	MH06-26	BH Depth	7.2m - 14.5m



Photo description	MH06 - Milldale Reservoir		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
BH No	MH06-26	BH Depth	14.5m - 15.45m

Drillers Machine Borehole Log

HOLE NO.:
MBH06
CLIENT: Gibb Ritchie Geotechnical Engineers
PROJECT: Geotechnical Assessment

JOB NO.:
TD4729
SITE LOCATION: Milldale North

START DATE: 08/06/2026

CO-ORDINATES: 1746156.67mE, 5948019.15mN

ELEVATION: Ground

END DATE: 09/06/2026

CONTRACTOR: Topdrill Limited

RIG: Track Mounted Hanjin 8-D

DRILLER: Sean Ellis

MATERIAL DESCRIPTION (See Classification & Symbology sheet for details)	DRILL METHOD HQT	DEPTH	SPT N-VALUE	SPT DATA	GRAPHIC	WATER	INSTALLATION
			10 20 30 40				
Brown Silty Clay. SPT @ 1.50m = 1.0.0.1.1.2.		1					
Brown Silty Clay. SPT @ 3.00m = 0.0.1.2.1.2.		2		N=4			
Green-ish Silty Clay. SPT @ 4.50m = 3.4.6.8.8.9.		3		N=6			
Green-ish Silty Clay. SPT @ 6.00m = 3.4.6.6.8.8 (Solid nose cone used).		4		N=31			
Green-ish Silty Clay. SPT @ 7.50m = 4.6.9.8.8.8.		5		N=28			
Green-ish Mudstone. SPT @ 9.00m = 5.5.7.8.8.9 (solid nose cone used).		6		N=33			
Green-ish Mudstone. SPT @ 10.50m = 7.11.12.13.12 for 10mm remaining (solid nose cone used).		7		N=32			
Green-ish Mudstone. SPT @ 12.00m = 5.6.5.7.8.10 (solid nose cone used).		8		N=37			
Green-ish Mudstone. SPT @ 13.50m = 6.8.11.7.13.11 (solid nose cone used).		9		N=30			
Green-ish Mudstone. SPT @ 15.00m = 2.7.9.10.9.12 (solid nose cone used).		10		N=42			
EOH: 15.45m		11		N=40			
		12					
		13					
		14					
		15					

REMARKS

Method: HQ Triple Tube Coring (HQT)

Total Coreboxes = 5

GWL measured with dipmeter at 1.00m (Due to drilling fluids in BH this can be Inaccurate reading)

Piezo Install = Screen 32mm PVC 12.00m - 6.00m and Plain 32mm PVC 6.00m - +0.50m with upstand toby Installed

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746840.89	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5947752.77	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 40.00 (m)	Reviewed By :	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 4.1 m BGL	Date : 11/06/2026	Loc Comment :

General comments: Pit dimensions 0.9m wide 4.5m long

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
	0.2	Alluvial		OL	SILT, dark brown black, dry, low plasticity, contains some rootlets.	D			40.00	
	0.4			CH	silty CLAY, light grey mottled orange, Very Stiff, moist, high plasticity,	M	VSt	28	39.70	
	0.6							137.2		
	0.8							196	39.00	
	1.0			CH	As above, but: Very Stiff to Hard,	M	VSt-H		39.00	
	1.2									
	1.4									
	1.6	Mangakahi a Rock Mass		SLT	Completely weathered, light brown mottled orange, SILTSTONE; extremely weak; fine to medium grained, dry, (thick bedded. Recovered as silt with some clasts).	D	EW		38.50	shear vane unable to penetrate
	1.8									
	2.0								38.00	shear vane unable to penetrate
	2.2								37.80	
	2.4			SLT	Completely weathered, light bluish grey, SILTSTONE; extremely weak; fine to medium grained, moist, (Recovered as silt with some silt clasts).	M	EW			shear vane unable to penetrate
	2.6									
	2.8									
	3.0								37.00	shear vane unable to penetrate
	3.2				As above, but.				36.80	Water seepage observed on base and right-hand side of excavation from digger's perspective; water flow trickling shear vane unable to penetrate
	3.4									
	3.6			SLT		M	EW			
	3.8									
	4.0								36.00	shear vane unable to penetrate
					TP58-26 Refusal at 4.1 m					



Photo description	TP58-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP58-26	TP Depth	0.0-4.1m

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746128.59	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5948035.91	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 25.00 (m)	Reviewed By : Chris Ritchie	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 2.2 m BGL	Date : 11/06/2026	Loc Comment :

General comments: pit dimensions 0.9m wide

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
	0.2	Alluvial		OL	clayey SILT, dark brown black, wet, high plasticity, contains trace rootlets.	W			25.00	
	0.4			CH	silty CLAY, trace of sand; light grey mottled orange, Very Stiff, moist to wet, high plasticity, Trace fine to coarse sand.	W-M	VSt	25.2 128.8	24.80	
	0.6									
	0.8									
	1.0									
	1.2									
	1.4									
	1.4									
	1.6									
	1.8	Mangakahi a Rock Mass		SLT	Completely weathered, light bluish grey, SILTSTONE; extremely weak; fine grained, moist, (Recovered as silt with some silt clasts).	M	EW	14 142.8	24.00	
	2.0								23.60	shear vane unable to penetrate
	2.2								23.00	shear vane unable to penetrate
Not Encountered					TP59-26 Refusal at 2.2 m (Refusal on hard ground)					

Water	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
N/A Not Encountered	XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.



Photo description	TP59-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP59-26	TP Depth	0.0-2.2m

Coordinate System : EPSG:2193

Easting (m) : 1746135.46

Northing (m) : 5947929.15

Ground Elevation : 21.21 (m)

Total Depth : 4.1 m BGL

Excavator : 13T Long Reach

Excavator Supplier : Murray Flood

Logged By : Alex Zohrab

Reviewed By : Chris Ritchie

Date : 10/06/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

General comments: pit dimensions 0.9m wide, 4.5m long

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks	
Water Inflow	0.2	Alluvial		OL	clayey SILT, dark brown, moist, high plasticity, contains some rootlets.	M			21.21	water seeping from base of excavation	
	0.4										21.05
	0.6			CH	silty CLAY, orange brown mottled pale grey; Stiff, moist to wet, high plasticity,	W-M	St	22 58	21.00		
	0.8										
	1.0				As above, but: pale grey mottled orange,			28 67.2	20.21		
	1.2			CH		W-M	St		20.00		
	1.4				As above, but: wet to saturated,			23.2 58.8	19.71		
	1.6							36.4 64.4			
	1.8							37 70	19.00		
	2.0							35.5 67.2			
2.2											
2.4											
2.6	CH			W-	St	35.5 67.2					
2.8											
3.0											
3.2											
3.4											
3.6											
3.8											
4.0				CH	silty CLAY, pale bluish grey; Stiff, wet, high plasticity, contains minor brown wood 1-3mm.	W	St	30.8 70	18.00		
								23.2 68.6	17.61		
					TP60-26 Terminated at 4.1 m (Excavation Wall Instability)						
Water Inflow Weathering Altering Consistency Density Rock Strength Tests&Results											



Photo description	TP60-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP60-26	TP Depth	0.0-4.1m

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746186.13	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5947889.11	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 20.00 (m)	Reviewed By : Chris Ritchie	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 3.2 m BGL	Date : 10/06/2026	Loc Comment :

General comments: pit dimensions 0.9m wide 4.0m long

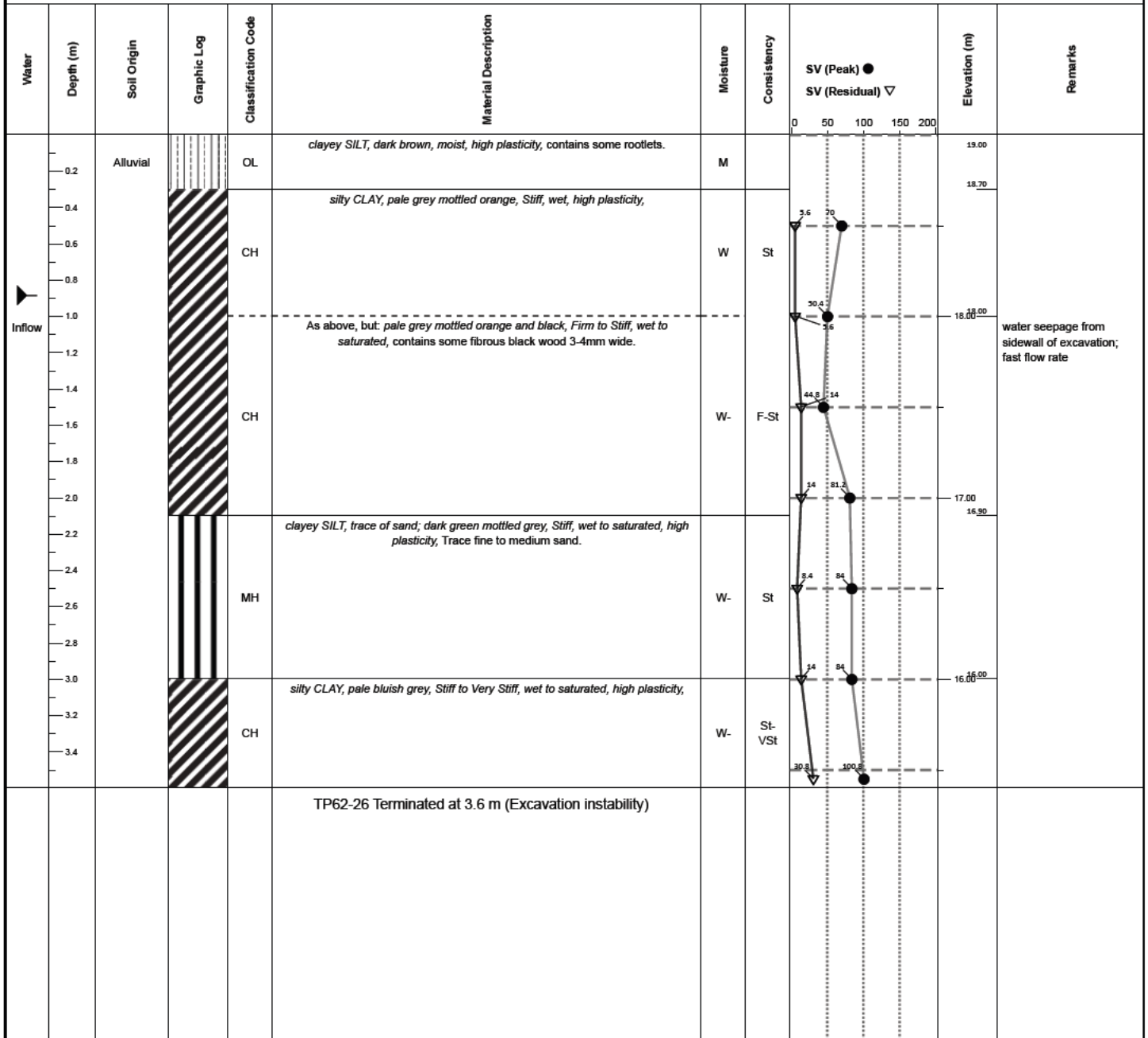
Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks							
Inflow	0.2	Alluvial		OL	sandy SILT, dark brown, moist, high plasticity,	M			20.00	water seeping from side of excavation, water flow trickling							
	0.4			CH	silty CLAY, pale grey mottled orange, Stiff, wet, high plasticity,	W	St	44.8 5.6	19.70								
	0.6			CH	As above, but: wet to saturated,	W-	St	7 58.8	19.50								
	0.8			CH	As above, but contains minor dark brown wood.				19.00.00								
	1.0			CH		W-	St	23.2 36	18.00								
	1.2			CH		W-	St	23.2 81.2	18.00								
	1.4			CH		W-	St	23.2 78.4	17.80								
	1.6			CH		W-	St	23.2 75.6	17.60								
	1.8			CH		W-	St	23.2 75.6	17.00								
	2.0			CH		W-	St	23.2 75.6	17.00								
				TP61-26 Terminated at 3.2 m (Excavation instability)													
<table><tr><td>Water Inflow</td><td>Weathering XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh</td><td>Altering XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered</td><td>Consistency VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet</td><td>Density VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense</td><td>Rock Strength VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high</td><td>Tests&Results U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.</td></tr></table>											Water Inflow	Weathering XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	Altering XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	Consistency VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	Density VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	Rock Strength VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	Tests&Results U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.
Water Inflow	Weathering XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	Altering XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	Consistency VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	Density VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	Rock Strength VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	Tests&Results U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.											



Photo description	TP61-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP61-26	TP Depth	0.0-3.2m

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746298.81	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5947985.52	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 19.00 (m)	Reviewed By : Chris Ritchie	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 3.6 m BGL	Date : 10/06/2026	Loc Comment :

General comments: pit dimensions 0.9m wide, 4.0m long



Water	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
Inflow	XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.



Photo description	TP62-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP62-26	TP Depth	0.0-3.6m

Coordinate System : EPSG:2193

Easting (m) : 1746334.49

Northing (m) : 5948005.11

Ground Elevation : 18.00 (m)

Total Depth : 2.5 m BGL

Excavator : 13T Long Reach

Excavator Supplier : Murray Flood

Logged By : Alex Zohrab

Reviewed By : Chris Ritchie

Date : 10/06/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

General comments: pit dimensions 0.9m wide, 3.5m long

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
Inflow	0.2	Alluvial		OL	clayey SILT, dark brown, moist, high plasticity, with some rootlets.	M			18.00	
	0.4			CH	silty CLAY, pale grey mottled orange, Stiff to Very Stiff, moist to wet, high plasticity,	W-M	St-VSt	36.4 103.6	17.70	
	0.6				As above, but: wet to saturated,				17.20	
	0.8			CH		W-	St-VSt	14 84	17.00	water seepage from left sidewall of excavation from digger's perspective; flow rate trickling water seepage from left side wall of excavation from digger's perspective; high flow rate
	1.0			CH				42 33.4	16.20	
	1.2			CH	As above, but: pale grey mottled orange and black, contains some fibrous highly decomposed wood 1-2mm wide.	W-	St-VSt	14 25	16.00	
	1.4									
	1.6									
	1.8									
	2.0									
	2.2									
	2.4									
					TP63-26 Terminated at 2.5 m (wall instability)					
Water Inflow Weathering XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh Altering XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered Consistency VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet Density VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense Rock Strength VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high Tests&Results U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.										



Photo description	TP63-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP63-26	TP Depth	0-2.5m

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746336.80	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5948025.15	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 18.00 (m)	Reviewed By : Chris Ritchie	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 4 m BGL	Date : 10/06/2026	Loc Comment : test pit moved 10m southeast due to swampy ground in original loca

General comments: Pit dimensions 0.9m wide, 4m long

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
		Alluvial		OL	clayey SILT, dark brown, moist, high plasticity, contains some rootlets.	M			18.00	
	0.2			CH	Silty CLAY, pale grey mottled orange, Firm to Stiff, moist to wet, high plasticity .	W-M	F-St	42, 19.6	17.70	
	0.4				As above, but: Firm to Stiff, contains some brown wood.				17.40	
	0.6			CH		W-M	F-St	36.8, 14	17.00	water seepage from left sidewall of excavation from digger's perspective; flow rate trickling
	0.8									
	1.0			CH		W-M	F-St			
	1.2									
	1.4									
	1.6			MH	clayey SILT, yellow brown mottled brown, Very Stiff to Hard, moist to wet, high plasticity,	W-M	VSt-H	196	16.40	
	1.8									
	2.0			CH	Silty CLAY, pale bluish grey, Stiff, moist to wet, high plasticity, contains some dark brown rootlets.	W-M	St	23.2, 92.4	16.00	
	2.2									
	2.4				As above, but: Very Stiff .					
	2.6			CH		W-M	VSt	36.4, 103.8	15.50	
	2.8									
	3.0			CH		W-M	VSt	36.4, 142.8	15.00	
	3.2									
	3.4				As above, but: trace of sand; pale bluish grey mottled green, Trace fine to medium sand.	W-M	VSt	23.2, 100.8	14.50	
	3.6			CH		W-M	VSt	36.4, 112		
	3.8									
					TP64-26 Terminated at 4 m (Maximum reach of digger)					

Water	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
Inflow	XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.



Photo description	TP64-26		
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP64-26	TP Depth	0.0-4.0m

Coordinate System : EPSG:2193	Excavator : 13T Long Reach	Job Number : AK26-027
Easting (m) : 1746378.38	Excavator Supplier : Murray Flood	Client : Fulton Hogan Land Development Ltd
Northing (m) : 5948013.57	Logged By : Alex Zohrab	Project : Milldale North
Ground Elevation : 18.00 (m)	Reviewed By : Chris Ritchie	Location : 522 Wainui Road, Wainui 0992, New Zealand
Total Depth : 3.6 m BGL	Date : 10/06/2026	Loc Comment :

General comments: 0.9m wide, 4.5m long

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks		
Water Inflow	0.2	Alluvial		OL	clayey SILT, dark brown, moist, high plasticity, minor rootlets.	M			18.00	water seepage form left sidewall of excavation from digger's perspective; flow rate trickling		
	0.4			CH	Silty CLAY, pale grey mottled orange, Stiff to Very Stiff, moist to wet, high plasticity .	W-M	St-VSt	40.6	100.5		17.70	
	0.6											
	0.8											
	1.0				As above, but: Firm to Stiff, wet to saturated .			22.4	64.4		17.00	
	1.2											
	1.4			CH		W-	F-St	17.8	11.2			
	1.6											
	1.8				As above, but: Firm, contains some dark brown highly decomposed wood 10-20cm wide.							16.20
	2.0			CH		W-	F	33.6	11.2		16.00	
2.2												
2.4												
2.6	CH		silty CLAY, pale grey mottled orange, Stiff, wet to saturated, high plasticity,	W-	St	15.86		15.60				
2.8												
3.0	CH		silty CLAY, light bluish grey, Stiff, wet to saturated, high plasticity,	W-	St	23.2	38.8	15.00				
3.2												
3.4												
					TP65-26 Terminated at 3.6 m (wall instability)							
Water Inflow Weathering XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh Altering XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered Consistency VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet Density VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense Rock Strength VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high Tests&Results U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.												



Photo description			
Client	Fulton Hogan Land Development Ltd		
Location	522 Wainui Road, Wainui 0992, New Z...		
Project name	Milldale North		
Project No	AK26-027	Scale	Not to Scale
TP No	TP65-26	TP Depth	

Coordinate System : EPSG:2193

Easting (m) : 1746190.58

Northing (m) : 5947835.11

Ground Elevation : 19.00 (m)

Total Depth : 4 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : Ilhan Serif

Reviewed By : Chris Ritchie

Date : 26/05/2026

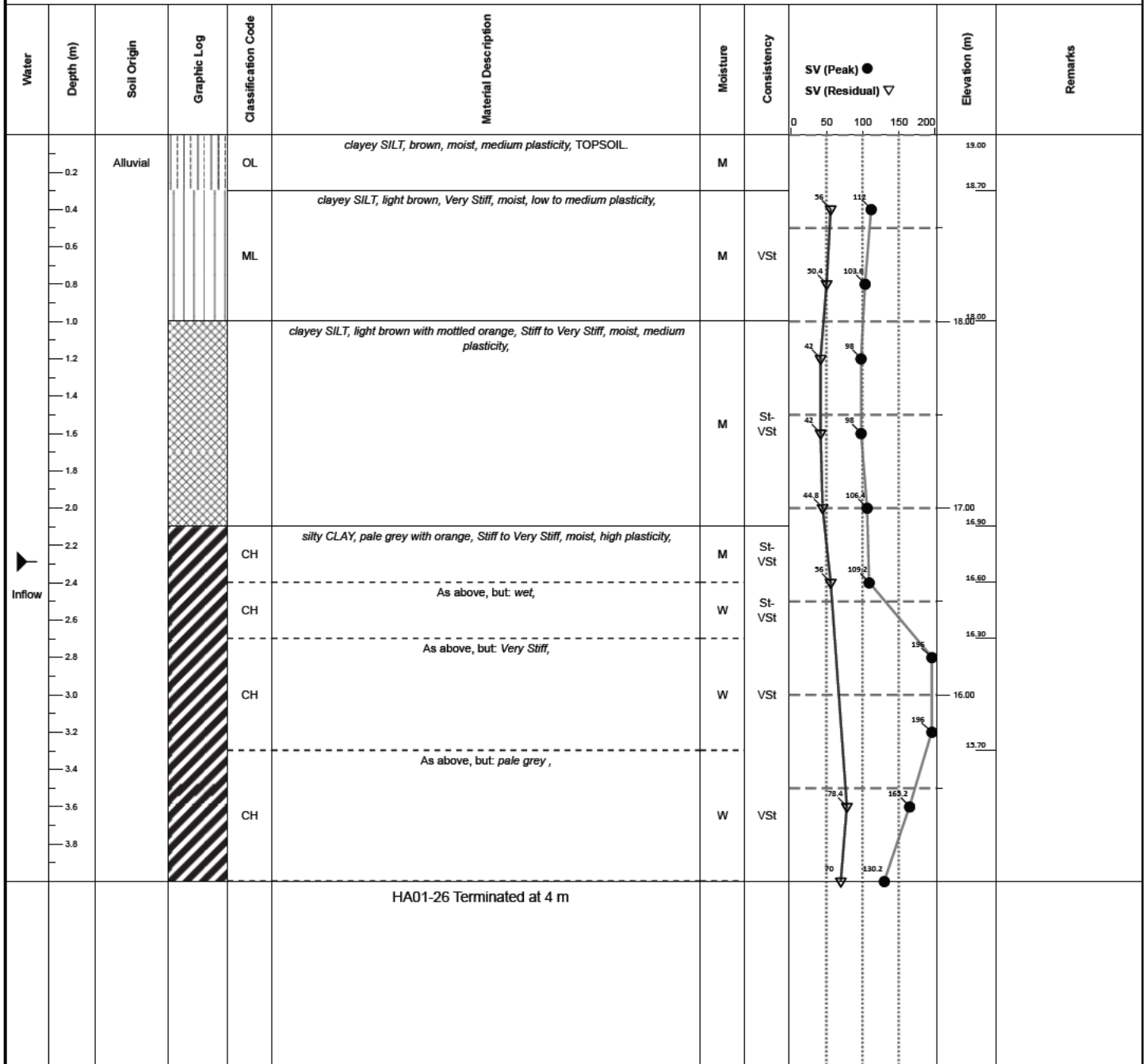
Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :



Water Inflow	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
	XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.

Coordinate System : EPSG:2193

Easting (m) : 1746187.01

Northing (m) : 5947851.04

Ground Elevation : 19.00 (m)

Total Depth : 4 m BGL

Drill Rig :

Driller Supplier :

Logged By : Ilhan Serif

Reviewed By :

Date : 26/05/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
		Alluvial		OL	clayey SILT, brown, moist, low plasticity, TOPSOIL.	M			19.00	
	0.2								18.80	
	0.4			ML	clayey SILT, dark grey slightly brown, Very Stiff, moist, low to medium plasticity,	M	VSt	32.2	140	
	0.6								18.40	
	0.8				As above, but: orange and pale brown, medium to high plasticity,			67.2	134.6	
	1.0								18.00	
	1.2			MH		M	VSt	70	140	
	1.4									
	1.6							67.2	142.8	
	1.8									
	2.0							70	140	17.00
	2.2				silty CLAY, pale grey with mottled orange, Very Stiff, moist, high plasticity,					
	2.4			CH		M	VSt	67.2	131.6	
	2.6									
	2.8							98	168	
	3.0				clayey SILT, grey, Stiff to Very Stiff, moist, medium plasticity,				16.10	
	3.2					M	St-VSt	30.8	92.4	16.00
	3.4									
	3.6			CH	silty CLAY, light grey, Firm to Stiff, wet, high plasticity,			28	61.6	13.60
	3.8					W	F-St			
N/A								33.2	19.6	
Not Encountered					HA02-26 Terminated at 4 m					

Coordinate System : EPSG:2193

Easting (m) : 1746180.56

Northing (m) : 5947866.35

Ground Elevation : 20.00 (m)

Total Depth : 4 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : Ilhan Serif

Reviewed By : Chris Ritchie

Date : 26/05/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
	0.2	Alluvial		OL	clayey SILT, brown, moist, low plasticity, TOPSOIL.	M			20.00	
	0.4			MH	clayey SILT, light brown slightly yellow, Stiff, moist, high plasticity,	M	St	41.7 86.8	19.80	
	0.6				As above, but: pale grey with mottled yellow,				19.40	
	0.8							47.6 92.4	19.00	
	1.0			MH		M	St	36.4 102.2	18.80	
	1.2							41.7 92.4	18.40	
	1.4							33.6 89.6	18.00	
	1.6							41.7 92.4	17.60	
	1.8							33.6 78.4	17.20	
	2.0							41.7 92.4	16.80	
	2.2							44.8 75.6	16.40	
	2.4							41.7 81.2	16.00	
	2.6								15.60	
	2.8								15.20	
	3.0								14.80	
	3.2								14.40	
	3.4								14.00	
	3.6								13.60	
	3.8								13.20	
Inflow					HA03-26 Terminated at 4 m					

Water	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
Inflow 	XW : Extremely weathered DW : Distinctly weathered HW : Highly weathered MW : Moderately weathered SW : Slightly weathered FR : Fresh	XA : Extremely altered DA : Distinctly altered HA : Highly altered MA : Moderately altered SA : Slightly altered	VS : Very soft S : Soft F : Firm St : Stiff VSt : Very stiff H : Hard FR : Friable Moisture D : Dry M : Moist W : Wet	VL : Very loose L : Loose MD : Medium dense D : Dense VD : Very dense	VLS : Very low LS : Low MS : Medium HS : High VH : Very high XH : Extremely high	U50 : Undisturbed 50mm diam tube. D : Disturbed sample. SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm. PP : Hand penetrometer estimate of unconfined compressive strength, kPa. S : Vane shear value kPa. DCP : Dynamic Cone Penetrometer test.

Coordinate System : EPSG:2193

Easting (m) : 1746146.12

Northing (m) : 5947814.34

Ground Elevation : 19.00 (m)

Total Depth : 5 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : Alex Zohrab

Reviewed By : Chris Ritchie

Date : 26/05/2026

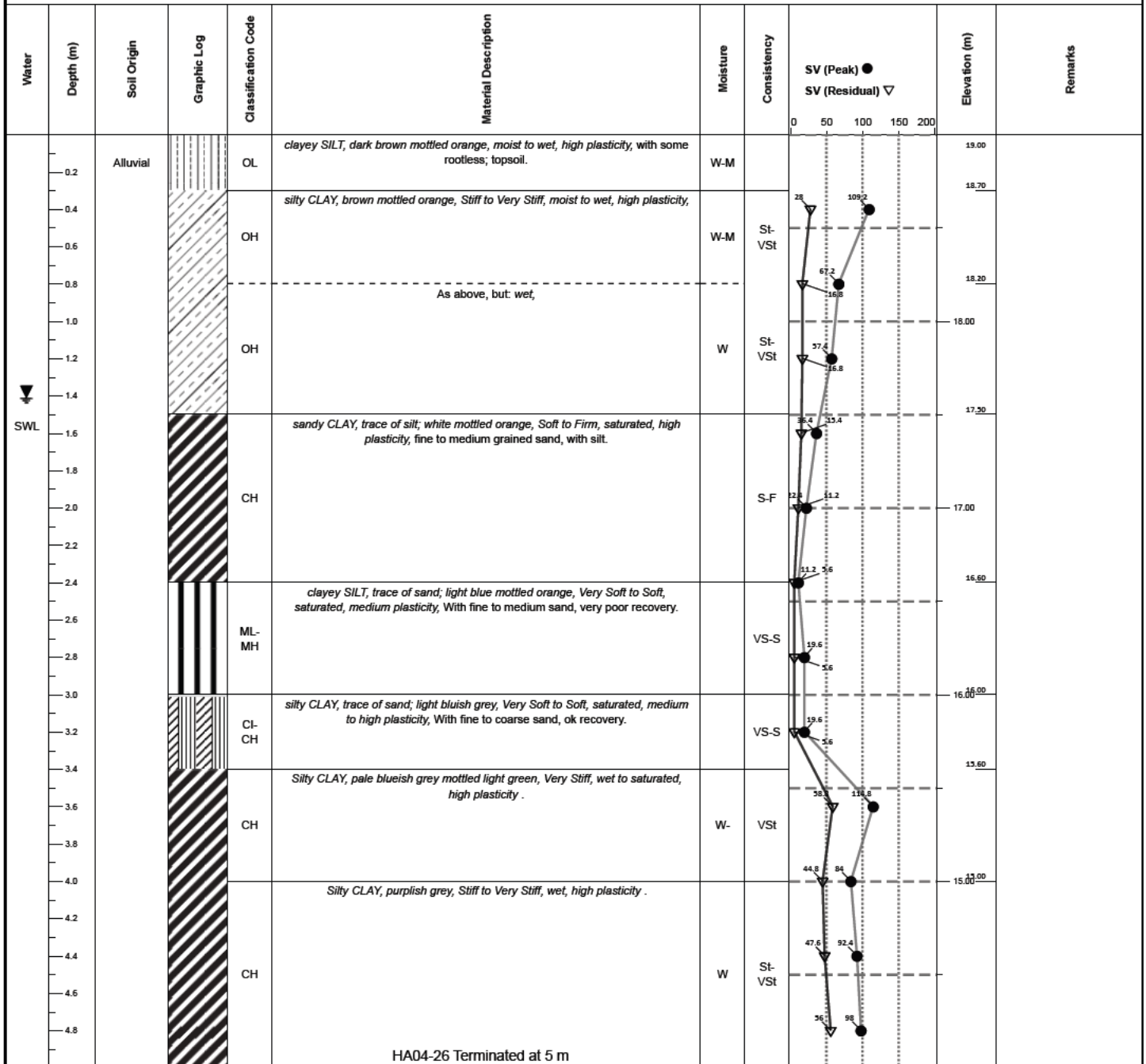
Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :



Water	Weathering	Altering	Consistency	Density	Rock Strength	Tests&Results
SWL	XW : Extremely weathered	XA : Extremely altered	VS : Very soft	VL : Very loose	VLS : Very low	U50 : Undisturbed 50mm diam tube.
	DW : Distinctly weathered	DA : Distinctly altered	S : Soft	L : Loose	LS : Low	D : Disturbed sample.
	HW : Highly weathered	HA : Highly altered	F : Firm	MD : Medium dense	MS : Medium	SPT : Standard Penetration Test, N = number of blows to drive 50mm sampler 300mm with a 63.6kg hammer falling 762mm.
	MW : Moderately weathered	MA : Moderately altered	St : Stiff	D : Dense	HS : High	PP : Hand penetrometer estimate of unconfined compressive strength, kPa.
	SW : Slightly weathered	SA : Slightly altered	VSt : Very stiff	VD : Very dense	VH : Very high	S : Vane shear value kPa.
	FR : Fresh		H : Hard		XH : Extremely high	DCP : Dynamic Cone Penetrometer test.
			FR : Friable			
			Moisture			
			D : Dry			
			M : Moist			
			W : Wet			

Coordinate System : EPSG:2193

Easting (m) : 1746146.16

Northing (m) : 5947832.76

Ground Elevation : 19.00 (m)

Total Depth : 4 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : AZ

Reviewed By :

Date : 26/05/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks		
	0.2	Alluvial		OL	clayey SILT, dark brown, moist, medium to high plasticity, with minor rootlets; topsoil.	M			19.00			
	0.4			CH	silty CLAY, pale brown mottled orange, Very Stiff, moist, high plasticity,	M	VSt	30.4	18.70			
	0.6											
	0.8			CH	As above, but: pale brown streaked orange and black,	M	VSt	42	86.8	18.30		
	1.0				silty CLAY, white streaked orange, Stiff, moist to wet, high plasticity,				134	18.10		
	1.2											
	1.4			CH			W-M	St	33.5	73.6	18.00	
	1.6											
	1.8											
	2.0											
	2.2						As above, but: Stiff to Very Stiff,				17.00	
	2.4											
	2.6	CH			W-M	St-VSt	44.8	96.6				
	2.8											
	3.0											
	3.2				Silty CLAY, pale blue mottled grey, Stiff, wet, high plasticity .				16.00			
	3.4								15.90			
	3.6	CH				W	St	26.6	64.4			
	3.8											
SWL - possibly perched groundwater					HA05-26 Terminated at 4 m							

Coordinate System : EPSG:2193

Easting (m) : 1746143.33

Northing (m) : 5947850.23

Ground Elevation : 19.19 (m)

Total Depth : 4 m BGL

Drill Rig :

Driller Supplier :

Logged By : AZ

Reviewed By :

Date : 26/05/2026

Job Number : AK26-027

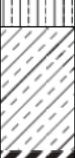
Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

General comments: hand auger moved 1m to crest of slope because of metal in race in original location

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
		Fill		OL	sandy SILT, trace of gravel; dark brown black, dry, low plasticity, fine to medium grained sand, trace fine to medium gravel, with some rootlets.	D			19.19	
	0.2			OH	silty CLAY, trace of gravel; dark brown mottled light brown, Stiff, moist, medium to high plasticity, with fine to medium gravel.	M	St	33.8 32.4	19.09	
	0.4								18.69	
	0.5									
	0.6	Alluvial		CH	silty CLAY, pale brown mottled orange, Very Stiff, moist, high plasticity,	M	VSt	39.2 114.8		
	0.8									
	1.0									
	1.2				silty CLAY, white streaked orange, Stiff, moist to wet, high plasticity,			36.4 81.2	18.66.99	
	1.4									
	1.6							44.8 86.8		
	1.8									
	2.0			CH		W-M	St	23.2 38.8	17.00	
	2.2									
	2.4							28 72.8		
	2.6									
	2.8				silty CLAY, light bluish white streaked orange, Stiff to Very Stiff, moist to wet, high plasticity,			41 112	16.39	
	3.0			CH		W-M	St-VSt	39.2 86.8	16.00	
	3.2									
	3.3				silty CLAY, pale blue, Stiff, moist to wet, high plasticity,				13.89	
	3.4	Residual		CH		W-M	St	47.8 96.8		
	3.6									
	3.8							39.2 86.8		
N/A										
Not Encountered					HA06-26 Terminated at 4 m					

Loc Comment :

Page 1 of 1

Coordinate System : EPSG:2193

Easting (m) : 1746265.09

Northing (m) : 5947896.65

Ground Elevation : 19.00 (m)

Total Depth : 4 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : Ilhan Serif

Reviewed By :

Date : 09/06/2026

Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :

Water	Depth (m)	Soil Origin	Graphic Log	Classification Code	Material Description	Moisture	Consistency	SV (Peak) ● SV (Residual) ▽	Elevation (m)	Remarks
		Alluvial		OL	clayey SILT, dark brown, moist, low plasticity, TOPSOIL.	M			19.00	
	0.2								18.80	
	0.4				clayey SILT, brown slightly grey, Very Stiff, moist, medium plasticity,	M	VSt	36.0	134.4	
	0.6									
	0.8							44.8	140.0	
	1.0									
	1.2				clayey SILT, light brown with grey, Stiff, moist, medium plasticity,	M	St	23.2	86.8	
	1.4									
	1.6			MH	As above, but: pale brown with mottled orange, wet, high plasticity,	W	St	28.0	36.0	
	1.8									
	2.0			CH	silty CLAY, orange and pale grey, Firm to Stiff, wet, high plasticity,	W	F-St	23.2	80.4	
	2.2									
	2.4			CH	As above, but: Soft to Firm,	W	S-F	39.2	51.2	
	2.6			CH	As above, but: saturated,		S-F			
	2.8			CH	As above, but: pale grey slightly blue, Stiff,		St	33.6	86.8	
	3.0									
	3.2			CH	As above, but: Firm,		F	36.0	51.8	
	3.4									
	3.6			CH	As above, but: Stiff,		St	30.8	51.2	
	3.8									
					HA08-26 Terminated at 4 m			36.4	84.0	

Coordinate System : EPSG:2193

Easting (m) : 1746206.20

Northing (m) : 5948016.61

Ground Elevation : 23.00 (m)

Total Depth : 4 m BGL

Drill Rig : Hand Auger

Driller Supplier : Gibb Ritchie Geotechnical Engineers Ltd

Logged By : Ilhan Serif

Reviewed By :

Date : 26/05/2026

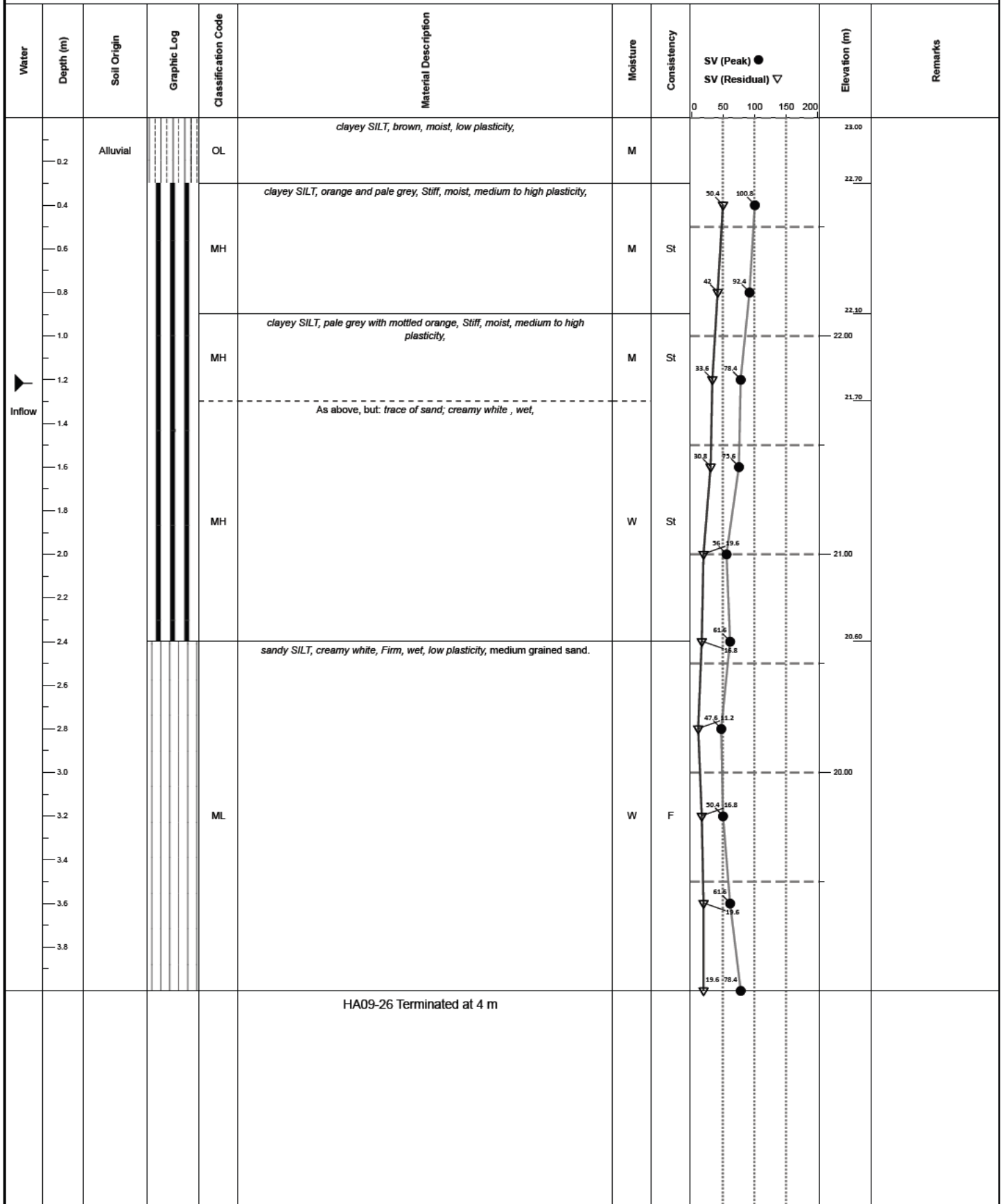
Job Number : AK26-027

Client : Fulton Hogan Land Development Ltd

Project : Milldale North

Location : 522 Wainui Road, Wainui 0992, New Zealand

Loc Comment :



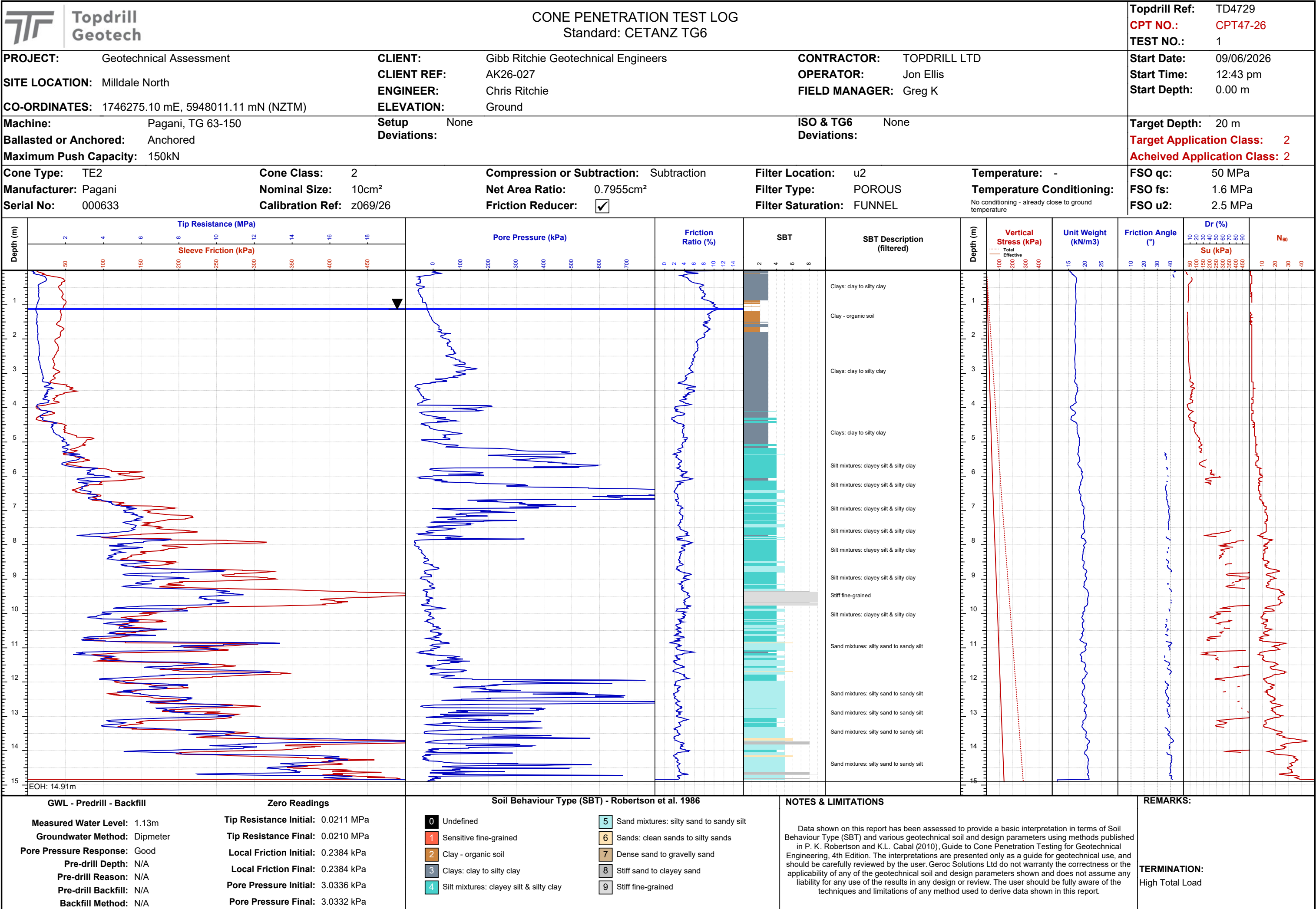
TF Topdrill Geotech		CONE PENETRATION TEST LOG Standard: CETANZ TG6					Topdrill Ref: TD4729 CPT NO.: CPT40-26 TEST NO.: 1						
PROJECT: Geotechnical Assessment		CLIENT: Gibb Ritchie Geotechnical Engineers		CONTRACTOR: TOPDRILL LTD		Start Date: 08/06/2026							
SITE LOCATION: Milldale North		CLIENT REF: AK26-027		OPERATOR: Jon Ellis		Start Time: 4:31 pm							
CO-ORDINATES: 1746417.65 mE, 5948036.92 mN (NZTM)		ENGINEER: Chris Ritchie		FIELD MANAGER: Greg K		Start Depth: 0.00 m							
Machine: Pagani, TG 63-150		Setup None		ISO & TG6 None		Target Depth: 20 m							
Ballasted or Anchored: Anchored		Deviations:		Deviations:		Target Application Class: 2							
Maximum Push Capacity: 150kN						Acheived Application Class: 2							
Cone Type: TE2		Cone Class: 2		Compression or Subtraction: Subtraction		FSO qc: 50 MPa							
Manufacturer: Pagani		Nominal Size: 10cm²		Net Area Ratio: 0.7955cm²		FSO fs: 1.6 MPa							
Serial No: 000633		Calibration Ref: z069/26		Friction Reducer: ☒		FSO u2: 2.5 MPa							
Depth (m)	Tip Resistance (MPa)		Pore Pressure (kPa)	Friction Ratio (%)	SBT	SBT Description (filtered)	Depth (m)	Vertical Stress (kPa) Total Effective	Unit Weight (kN/m3)	Friction Angle (°)	Dr (%)		N ₆₀
	Sleeve Friction (kPa)										Su (kPa)		
1							1						
2							2						
3						Clays: clay to silty clay	3						
4							4						
5							5						
6							6						
7							7						
8						Clays: clay to silty clay	8						
9							9						
10						Clays: clay to silty clay	10						
11						Clays: clay to silty clay	11						
12						Silt mixtures: clayey silt & silty clay	12						
13						Silt mixtures: clayey silt & silty clay	13						
14						Silt mixtures: clayey silt & silty clay	14						
15						Sand mixtures: silty sand to sandy silt	15						
16							16						
17						Silt mixtures: clayey silt & silty clay	17						
18						Silt mixtures: clayey silt & silty clay	18						
19							19						
EOH: 19.17m													
GWL - Predrill - Backfill			Zero Readings			Soil Behaviour Type (SBT) - Robertson et al. 1986			NOTES & LIMITATIONS			REMARKS:	
Measured Water Level: 1.98m			Tip Resistance Initial: 0.0211 MPa			0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained			Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.			TERMINATION: High Total Load	
Groundwater Method: Dipmeter			Tip Resistance Final: 0.0209 MPa										
Pore Pressure Response: Good			Local Friction Initial: 0.2385 kPa										
Pre-drill Depth: N/A			Local Friction Final: 0.2383 kPa										
Pre-drill Reason: N/A			Pore Pressure Initial: 3.0326 kPa										
Pre-drill Backfill: N/A			Pore Pressure Final: 3.0296 kPa										
Backfill Method: N/A													

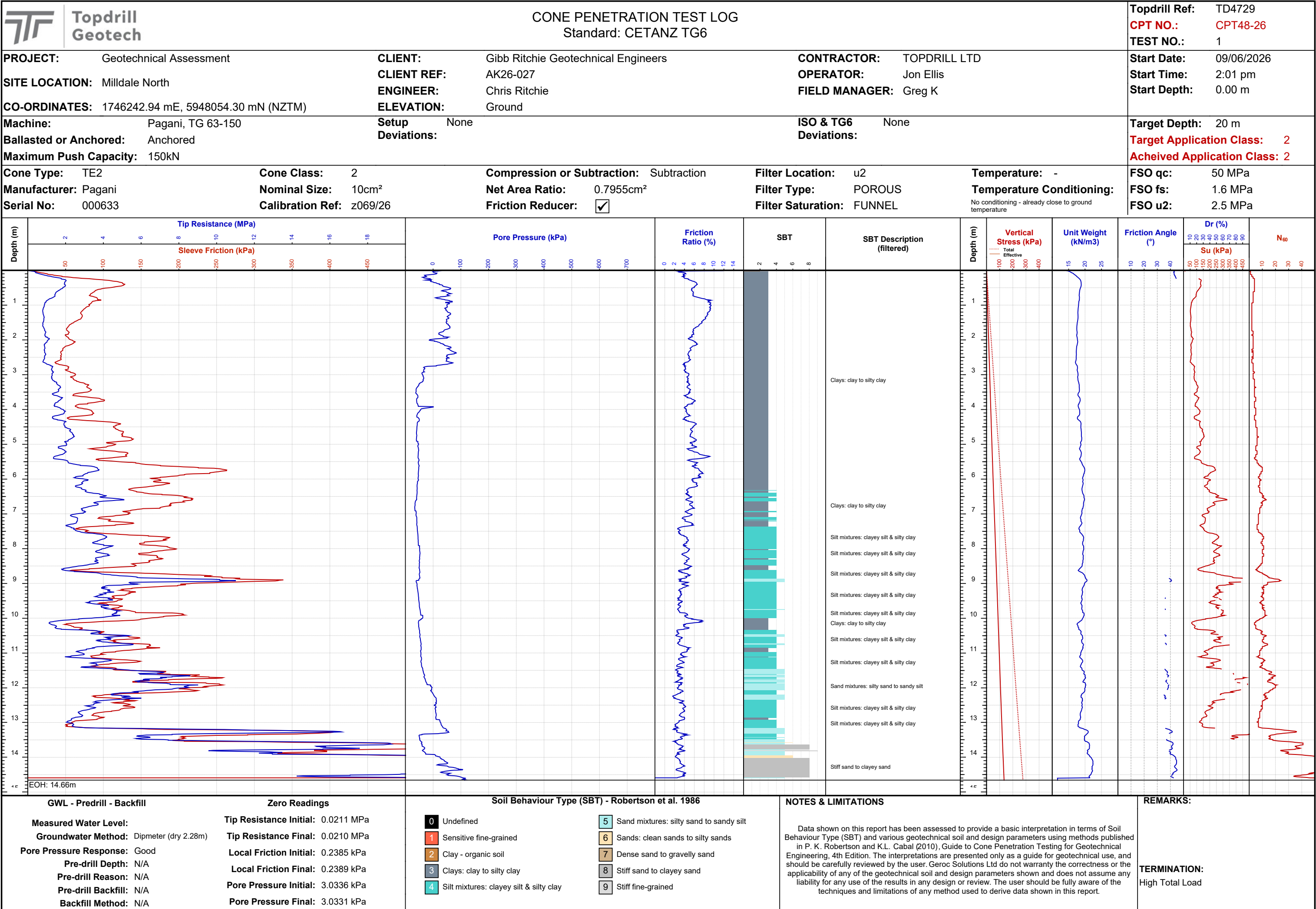
TF Topdrill Geotech		CONE PENETRATION TEST LOG Standard: CETANZ TG6					Topdrill Ref: TD4729 CPT NO.: CPT41-26 TEST NO.: 1						
PROJECT: Geotechnical Assessment		CLIENT: Gibb Ritchie Geotechnical Engineers		CONTRACTOR: TOPDRILL LTD		Start Date: 08/06/2026							
SITE LOCATION: Milldale North		CLIENT REF: AK26-027		OPERATOR: Jon Ellis		Start Time: 6:08 pm							
CO-ORDINATES: 1746407.88 mE, 5947988.28 mN (NZTM)		ENGINEER: Chris Ritchie		FIELD MANAGER: Greg K		Start Depth: 0.00 m							
Machine: Pagani, TG 63-150		Setup Deviations: None		ISO & TG6 Deviations: None		Target Depth: 20 m							
Ballasted or Anchored: Anchored						Target Application Class: 2							
Maximum Push Capacity: 150kN						Acheived Application Class: 2							
Cone Type: TE2		Cone Class: 2		Compression or Subtraction: Subtraction		FSO qc: 50 MPa							
Manufacturer: Pagani		Nominal Size: 10cm²		Net Area Ratio: 0.7955cm²		FSO fs: 1.6 MPa							
Serial No: 000633		Calibration Ref: z069/26		Friction Reducer: ☒		FSO u2: 2.5 MPa							
Depth (m)	Tip Resistance (MPa)		Pore Pressure (kPa)	Friction Ratio (%)	SBT	SBT Description (filtered)	Depth (m)	Vertical Stress (kPa) Total Effective	Unit Weight (kN/m3)	Friction Angle (°)	Dr (%)		N ₆₀
	Sleeve Friction (kPa)										Su (kPa)		
1						Clays: clay to silty clay	1						
2						Clays: clay to silty clay	2						
3						Clays: clay to silty clay	3						
4							4						
5							5						
6							6						
7							7						
8						Clays: clay to silty clay	8						
9							9						
10							10						
11						Clays: clay to silty clay	11						
12						Silt mixtures: clayey silt & silty clay	12						
13						Silt mixtures: clayey silt & silty clay	13						
14						Clays: clay to silty clay	14						
15						Clays: clay to silty clay	15						
16							16						
17						Silt mixtures: clayey silt & silty clay	17						
GWL - Predrill - Backfill		Zero Readings		Soil Behaviour Type (SBT) - Robertson et al. 1986			NOTES & LIMITATIONS			REMARKS:			
Measured Water Level:		Tip Resistance Initial: 0.0210 MPa		0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained			Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.			TERMINATION: High Total Load			
Groundwater Method: Dipmeter (dry 2.10m)		Tip Resistance Final: 0.0210 MPa											
Pore Pressure Response: Good		Local Friction Initial: 0.2377 kPa											
Pre-drill Depth: N/A		Local Friction Final: 0.2383 kPa											
Pre-drill Reason: N/A		Pore Pressure Initial: 3.0309 kPa											
Pre-drill Backfill: N/A		Pore Pressure Final: 3.0305 kPa											
Backfill Method: N/A													

TF Topdrill Geotech		CONE PENETRATION TEST LOG Standard: CETANZ TG6					Topdrill Ref: TD4729 CPT NO.: CPT42-26 TEST NO.: 1																						
PROJECT: Geotechnical Assessment		CLIENT: Gibb Ritchie Geotechnical Engineers		CONTRACTOR: TOPDRILL LTD		Start Date: 09/06/2026																							
SITE LOCATION: Milldale North		CLIENT REF: AK26-027		OPERATOR: Jon Ellis		Start Time: 9:28 am																							
CO-ORDINATES: 1746367.14 mE, 5947966.81 mN (NZTM)		ENGINEER: Chris Ritchie		FIELD MANAGER: Greg K		Start Depth: 0.00 m																							
Machine: Pagani, TG 63-150		Setup Deviations: None		ISO & TG6 Deviations: None		Target Depth: 20 m																							
Ballasted or Anchored: Anchored						Target Application Class: 2																							
Maximum Push Capacity: 150kN						Acheived Application Class: 2																							
Cone Type: TE2		Cone Class: 2		Compression or Subtraction: Subtraction		FSO qc: 50 MPa																							
Manufacturer: Pagani		Nominal Size: 10cm²		Net Area Ratio: 0.7955cm²		FSO fs: 1.6 MPa																							
Serial No: 000633		Calibration Ref: z069/26		Friction Reducer: ☒		FSO u2: 2.5 MPa																							
Depth (m)	Tip Resistance (MPa)		Pore Pressure (kPa)	Friction Ratio (%)	SBT	SBT Description (filtered)	Depth (m)	Vertical Stress (kPa) Total Effective	Unit Weight (kN/m3)	Friction Angle (°)	Dr (%)																		
	Sleeve Friction (kPa)										Su (kPa)		N ₆₀																
1						Clays: clay to silty clay	1																						
2					Clays: clay to silty clay		2																						
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TF Topdrill Geotech		CONE PENETRATION TEST LOG Standard: CETANZ TG6					Topdrill Ref: TD4729 CPT NO.: CPT43-26 TEST NO.: 1						
PROJECT: Geotechnical Assessment		CLIENT: Gibb Ritchie Geotechnical Engineers		CONTRACTOR: TOPDRILL LTD		Start Date: 09/06/2026							
SITE LOCATION: Milldale North		CLIENT REF: AK26-027		OPERATOR: Jon Ellis		Start Time: 10:58 am							
CO-ORDINATES: 1746327.94 mE, 5947960.70 mN (NZTM)		ENGINEER: Chris Ritchie		FIELD MANAGER: Greg K		Start Depth: 0.00 m							
Machine: Pagani, TG 63-150		Setup Deviations: None		ISO & TG6 Deviations: None		Target Depth: 20 m							
Ballasted or Anchored: Anchored						Target Application Class: 2							
Maximum Push Capacity: 150kN						Acheived Application Class: 2							
Cone Type: TE2		Cone Class: 2		Compression or Subtraction: Subtraction		FSO qc: 50 MPa							
Manufacturer: Pagani		Nominal Size: 10cm²		Net Area Ratio: 0.7955cm²		FSO fs: 1.6 MPa							
Serial No: 000633		Calibration Ref: z069/26		Friction Reducer: ☒		FSO u2: 2.5 MPa							
Depth (m)	Tip Resistance (MPa)		Pore Pressure (kPa)	Friction Ratio (%)	SBT	SBT Description (filtered)	Depth (m)	Vertical Stress (kPa) Total Effective	Unit Weight (kN/m3)	Friction Angle (°)	Dr (%)		N ₆₀
	Sleeve Friction (kPa)										Su (kPa)		
1						Clays: clay to silty clay	1						
2						Clay - organic soil	2						
3							3						
4							4						
5							5						
6							6						
7						Clays: clay to silty clay	7						
8							8						
9							9						
10							10						
11							11						
12							12						
13						Clays: clay to silty clay Clays: clay to silty clay	13						
14						Silt mixtures: clayey silt & silty clay	14						
15						Silt mixtures: clayey silt & silty clay	15						
16						Silt mixtures: clayey silt & silty clay	16						
17						Silt mixtures: clayey silt & silty clay	17						
18						Silt mixtures: clayey silt & silty clay	18						
19						Clays: clay to silty clay	19						
20						Clays: clay to silty clay	20						
21						Clays: clay to silty clay	21						
22	EOH: 21.55m					Clays: clay to silty clay	22						
GWL - Predrill - Backfill		Zero Readings		Soil Behaviour Type (SBT) - Robertson et al. 1986			NOTES & LIMITATIONS			REMARKS:			
Measured Water Level:		Tip Resistance Initial: 0.0210 MPa		0 Undefined 1 Sensitive fine-grained 2 Clay - organic soil 3 Clays: clay to silty clay 4 Silt mixtures: clayey silt & silty clay 5 Sand mixtures: silty sand to sandy silt 6 Sands: clean sands to silty sands 7 Dense sand to gravelly sand 8 Stiff sand to clayey sand 9 Stiff fine-grained			Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. GeroC Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.			TERMINATION: High Total Load			
Groundwater Method: Dipmeter (dry 2.08m)		Tip Resistance Final: 0.0210 MPa											
Pore Pressure Response: Good		Local Friction Initial: 0.2381 kPa											
Pre-drill Depth: N/A		Local Friction Final: 0.2382 kPa											
Pre-drill Reason: N/A		Pore Pressure Initial: 3.0322 kPa											
Pre-drill Backfill: N/A		Pore Pressure Final: 3.0357 kPa											
Backfill Method: N/A													

TF Topdrill Geotech		CONE PENETRATION TEST LOG Standard: CETANZ TG6					Topdrill Ref: TD4729 CPT NO.: CPT44-26 TEST NO.: 1						
PROJECT: Geotechnical Assessment		CLIENT: Gibb Ritchie Geotechnical Engineers		CONTRACTOR: TOPDRILL LTD		Start Date: 09/06/2026							
SITE LOCATION: Milldale North		CLIENT REF: AK26-027		OPERATOR: Jon Ellis		Start Time: 3:20 pm							
CO-ORDINATES: 1746186.90 mE, 5947949.94 mN (NZTM)		ENGINEER: Chris Ritchie		FIELD MANAGER: Greg K		Start Depth: 0.00 m							
Machine: Pagani, TG 63-150		Setup Deviations: None		ISO & TG6 Deviations: None		Target Depth: 20 m							
Ballasted or Anchored: Anchored						Target Application Class: 2							
Maximum Push Capacity: 150kN						Acheived Application Class: 2							
Cone Type: TE2		Cone Class: 2		Compression or Subtraction: Subtraction		FSO qc: 50 MPa							
Manufacturer: Pagani		Nominal Size: 10cm²		Net Area Ratio: 0.7955cm²		FSO fs: 1.6 MPa							
Serial No: 000633		Calibration Ref: z069/26		Friction Reducer: ☒		FSO u2: 2.5 MPa							
Depth (m)	Tip Resistance (MPa)		Pore Pressure (kPa)	Friction Ratio (%)	SBT	SBT Description (filtered)	Depth (m)	Vertical Stress (kPa) Total Effective	Unit Weight (kN/m3)	Friction Angle (°)	Dr (%)		N ₆₀
	Sleeve Friction (kPa)										Su (kPa)		
1						Clays: clay to silty clay	1						
2							2						
3							3						
4							4						
5						Clays: clay to silty clay	5						
6							6						
7							7						
8							8						
9						Silt mixtures: clayey silt & silty clay	9						
10						Clays: clay to silty clay	10						
11						Clays: clay to silty clay	11						
12						Silt mixtures: clayey silt & silty clay	12						
13							13						
14						Silt mixtures: clayey silt & silty clay	14						
15						Sand mixtures: silty sand to sandy silt	15						
16						Silt mixtures: clayey silt & silty clay	16						
17							17						
18						Clays: clay to silty clay	18						
19							19						
EOH: 18.88m													
GWL - Predrill - Backfill		Zero Readings		Soil Behaviour Type (SBT) - Robertson et al. 1986			NOTES & LIMITATIONS			REMARKS:			
Measured Water Level:		Tip Resistance Initial: 0.0211 MPa		0 Undefined			Data shown on this report has been assessed to provide a basic interpretation in terms of Soil Behaviour Type (SBT) and various geotechnical soil and design parameters using methods published in P. K. Robertson and K.L. Cabal (2010), Guide to Cone Penetration Testing for Geotechnical Engineering, 4th Edition. The interpretations are presented only as a guide for geotechnical use, and should be carefully reviewed by the user. Geroc Solutions Ltd do not warranty the correctness or the applicability of any of the geotechnical soil and design parameters shown and does not assume any liability for any use of the results in any design or review. The user should be fully aware of the techniques and limitations of any method used to derive data shown in this report.			TERMINATION: High Total Load			
Groundwater Method: Dipmeter (dry 1.92m)		Tip Resistance Final: 0.0207 MPa		1 Sensitive fine-grained									
Pore Pressure Response: Good		Local Friction Initial: 0.2386 kPa		2 Clay - organic soil									
Pre-drill Depth: N/A		Local Friction Final: 0.2384 kPa		3 Clays: clay to silty clay									
Pre-drill Reason: N/A		Pore Pressure Initial: 3.0333 kPa		4 Silt mixtures: clayey silt & silty clay									
Pre-drill Backfill: N/A		Pore Pressure Final: 3.0317 kPa		5 Sand mixtures: silty sand to sandy silt									
Backfill Method: N/A				6 Sands: clean sands to silty sands									
				7 Dense sand to gravelly sand									
				8 Stiff sand to clayey sand									
				9 Stiff fine-grained									





APPENDIX C

Laboratory Test Results

Please reply to: J. Franklin

Page 1 of 4

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

7th July 2026

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL

Dear Sir,

Re: MILLDALE NORTH

Your Reference: AK26-027

Report Number: 69130#L/PERM Milldale North TP62-26

Test Pit No: TP62-26

Sample No: BULK

Depth: 1.50 – 1.60m

The following report presents the results of constant head permeability testing at BGL of a bulk soil sample delivered to this laboratory on the 15th of June 2026. The client request was to measure the coefficient of permeability of a compacted cylindrical specimen of soil in a triaxial apparatus, under known conditions of effective stress, and under a constant hydraulic gradient (constant head). Test results are summarised below, with page 4 showing a graph of flow vs. time for the sample.

Please note that at your request this test was carried out on a compacted soil sample rather than an undisturbed push-tube soil sample. The test results contained in this report therefore relate to the compacted condition, and do not apply to the *in situ* soil.

Test standards used were:

Water Content:

NZS4402: 1986: Test 2.1

Permeability Tests:

BS EN ISO 17892-11: 2019: Part 11

Test Procedure

The sample was sieved through a 4.75mm sieve, then the water content of the sieved sample was adjusted to target the optimum water content value of 26% (*determined from the compaction curve test on the sample*). Next the sample was compacted into a 60mm diameter metal tube, targeting the maximum dry density (1.44t/m³) determined from the compaction curve test. It was then extruded from the push-tube and set up in a triaxial cell.

Saturation of the sample was achieved in distinct stages by 50kPa increments of cell pressure and back pressure, with a differential pressure of 10kPa (*cell pressure 10kPa greater than back pressure*) in order to maintain a small positive effective stress. Saturation occurred through both the top and bottom ends of the sample. The porewater pressure coefficient (*B*) was measured at the start of the initial saturation stage, and again after the final saturation stage (*the check for saturation*).

The final saturation stage used a cell pressure of 400kPa and a back pressure of 390kPa. The bottom (base drainage) line was then closed & the sample was left overnight, allowing the porewater pressure to equalise throughout the sample. Saturation was then confirmed by closing the top (back pressure) line & increasing the cell pressure to 440kPa, observing the resulting increase in porewater pressure. A porewater pressure coefficient (B) of 1.00 was achieved, confirming saturation of the sample (ie. $B \geq 0.95$).

Excess porewater pressure was then dissipated during the consolidation cycle by opening the top (back pressure) line, resulting in an effective stress of 50kPa.

Next, the back (top) pressure was decreased to 375kPa and the base (bottom) pressure was then set at 405kPa, resulting in a head difference of 30kPa. The permeability of the sample was then measured using this constant head of 30kPa and a mean effective stress of 50kPa. The flow of water during the permeability test was vertically from the base of the sample to the top. As per the test standard, the permeability has been reported to two significant figures.

PERMEABILITY TEST RESULTS	
Sample Identification	TP62-26 / BULK / 1.50 – 1.60m
Initial Sample Dimensions	60.5mm diameter X 102.4mm length
Initial Water Content	24.2 %
Final Water Content	40.1 %
Initial Bulk Density	1.74 t/m ³
Final Bulk Density	2.10 t/m ³
Initial Dry Density	1.40 t/m ³
Final Dry Density	1.50 t/m ³
Average Laboratory Temperature during Permeability test	21.0°C
Cell Confining Pressure	440 kPa
Back (top) Pressure	375 kPa
Base (bottom) Pressure	405 kPa
Mean Effective Stress	50 kPa
Constant Head	30 kPa
COEFFICIENT OF PERMEABILITY at 20°C*	1.9 X 10⁻⁹ m/s

**The coefficient of permeability was measured in the vertical direction, and is the average of the permeabilities calculated for four test intervals. The measured permeability has been corrected to give the corresponding permeability at 20 °C as per section 7.3 of the test standard.*

Sample Description (*not part of BGL IANZ Accreditation*)**TP62-26 / TUBE / 1.50 – 1.60m:**

CLAY, highly plastic, brownish grey with orange speckles, very moist, organics & rootlets.

The constant head applied to the sample during the permeability test was 30kPa, which is equivalent to an elevation head of water of 3.066m. The hydraulic gradient (*ratio of elevation head of water to flow path length*) applied during the permeability test was 30.58. The permeant water used for this test was de-aired tap water.

Please note that after the test the sample was broken up into small pieces for the water content test. It also enabled identification of any hidden larger particles. There were no particles found that exceeded 1/6 (10.1mm) of the sample diameter.

This test was carried out in a laboratory in which the temperature is controlled to be kept within the specification of the test standard.

Please note that the test results relate only to the sample as-received, and relate only to the sample under test. The calculation of the coefficient of permeability assumes the application of Darcy's law for laminar flow of water under saturated conditions. It is possible that the size of the specimen does not adequately represent the fabric features present in field conditions.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

CONSTANT HEAD PERMEABILITY TEST

BS EN ISO 17892-11: 2019 Part 11: Permeability Tests / NZS4402: 1986: Test 2.1

Tested By:	JF / SG	June & July 2026
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Compiled By:	JF	6/07/2026
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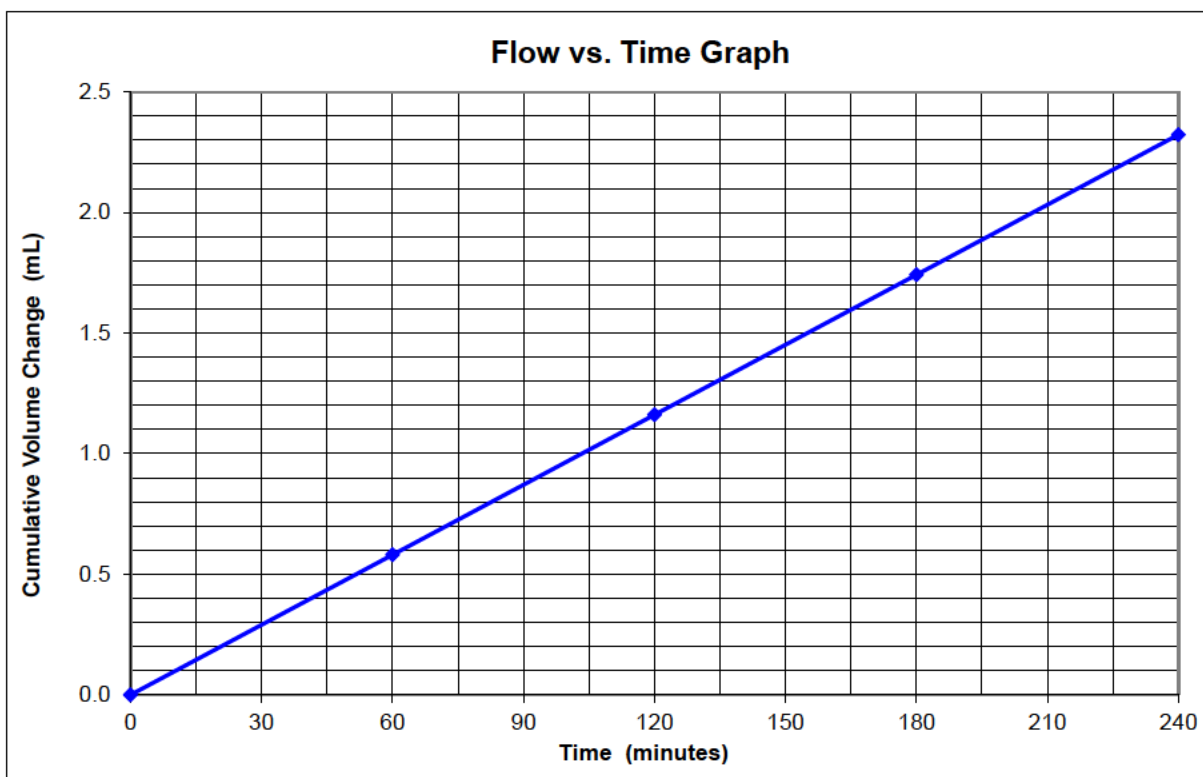
Checked By:	JF	7/07/2026
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Version Number:	6	Version Date:	July 2022	Authorised By:	W. Campton
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Borehole Number:	TP62-26	Sample Number:	BULK	Depth:	1.50 - 1.60m
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Head Difference = 30 kPa Effective Stress = 50 kPa

Coefficient of Permeability (k_v) = 1.9×10^{-9} m/s

[illegible]

Please reply to: J. Franklin

Page 1 of 4

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

24th June 2026

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL

Dear Sir,

Re: MILLDALE NORTH

Your Reference: AK26-027

Report Number: 69130#L/PERM Milldale North TP64-26

Test Pit No: TP64-26

Sample No: TUBE

Depth: 1.20 – 1.60m

The following report presents the results of constant head permeability testing at BGL of a 63.5mm diameter (ID) undisturbed push-tube soil sample delivered to this laboratory on the 15th of June 2026. The client request was to measure the coefficient of permeability of a cylindrical specimen of soil in a triaxial apparatus, under known conditions of effective stress, and under a constant hydraulic gradient (constant head). Test results are summarised below, with page 4 showing a graph of flow vs. time for the sample.

Test standards used were:

Water Content:

NZS4402: 1986: Test 2.1

Permeability Tests:

BS EN ISO 17892-11: 2019: Part 11

Test Procedure

The sample was extruded from the push-tube and trimmed to length. The sample was then set up in a triaxial cell. Saturation of the sample was achieved in distinct stages by 50kPa increments of cell pressure and back pressure, with a differential pressure of 10kPa (*cell pressure 10kPa greater than back pressure*) in order to maintain a small positive effective stress. Saturation occurred through both the top and bottom ends of the sample. The porewater pressure coefficient (*B*) was measured at the start of the initial saturation stage, and again after the final saturation stage (*the check for saturation*).

The final saturation stage used a cell pressure of 400kPa and a back pressure of 390kPa. The bottom (base drainage) line was then closed & the sample was left overnight, allowing the porewater pressure to equalise throughout the sample. Saturation was then confirmed by closing the top (back pressure) line & increasing the cell pressure to 440kPa, observing the resulting increase in porewater pressure. A porewater pressure coefficient (*B*) of 1.00 was achieved, confirming saturation of the sample (ie. $B \geq 0.95$).

Excess porewater pressure was then dissipated during the consolidation cycle by opening the top (back pressure) line, resulting in an effective stress of 50kPa.

Next, the back (top) pressure was decreased to 375kPa and the base (bottom) pressure was then set at 405kPa, resulting in a head difference of 30kPa. The permeability of the sample was then measured using this constant head of 30kPa and a mean effective stress of 50kPa. The flow of water during the permeability test was vertically from the base of the sample to the top. As per the test standard, the permeability has been reported to two significant figures.

PERMEABILITY TEST RESULTS	
Sample Identification	TP64-26 / TUBE / 1.20 – 1.60m
Initial Sample Dimensions	63.4mm diameter X 100.1mm length
Initial Water Content	95.3 %
Final Water Content	93.5 %
Initial Bulk Density	1.45 t/m ³
Final Bulk Density	1.49 t/m ³
Initial Dry Density	0.74 t/m ³
Final Dry Density	0.77 t/m ³
Average Laboratory Temperature during Permeability test	20°C
Cell Confining Pressure	440 kPa
Back (top) Pressure	375 kPa
Base (bottom) Pressure	405 kPa
Mean Effective Stress	50 kPa
Constant Head	30 kPa
COEFFICIENT OF PERMEABILITY at 20°C*	1.1 X 10⁻⁹ m/s

**The coefficient of permeability was measured in the vertical direction, and is the average of the permeabilities calculated for four test intervals.*

Sample Description (*not part of BGL IANZ Accreditation*)

TP64-26 / TUBE / 1.20 – 1.60m:

SILT, clayey, firm to stiff, slightly to moderately plastic, light brown with black speckles, moist, organic staining & wood inclusions.

The constant head applied to the sample during the permeability test was 30kPa, which is equivalent to an elevation head of water of 3.066m. The hydraulic gradient (*ratio of elevation head of water to flow path length*) applied during the permeability test was 30.97. The permeant water used for this test was de-aired tap water.

Please note that after the test the sample was broken up into small pieces for the water content test. It also enabled identification of any hidden larger particles. There were two particles found that exceeded 1/6 (10.6mm) of the sample diameter. These were 52mm X 30mm & 28 X 6mm in size, were comprised of wood, and were located at the bottom end of the sample.

This test was carried out in a laboratory in which the temperature is controlled to be kept within the specification of the test standard.

Please note that the test results relate only to the sample as-received, and relate only to the sample under test. The calculation of the coefficient of permeability assumes the application of Darcy's law for laminar flow of water under saturated conditions. It is possible that the size of the specimen does not adequately represent the fabric features present in field conditions.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

CONSTANT HEAD PERMEABILITY TEST

BS EN ISO 17892-11: 2019 Part 11: Permeability Tests / NZS4402: 1986: Test 2.1

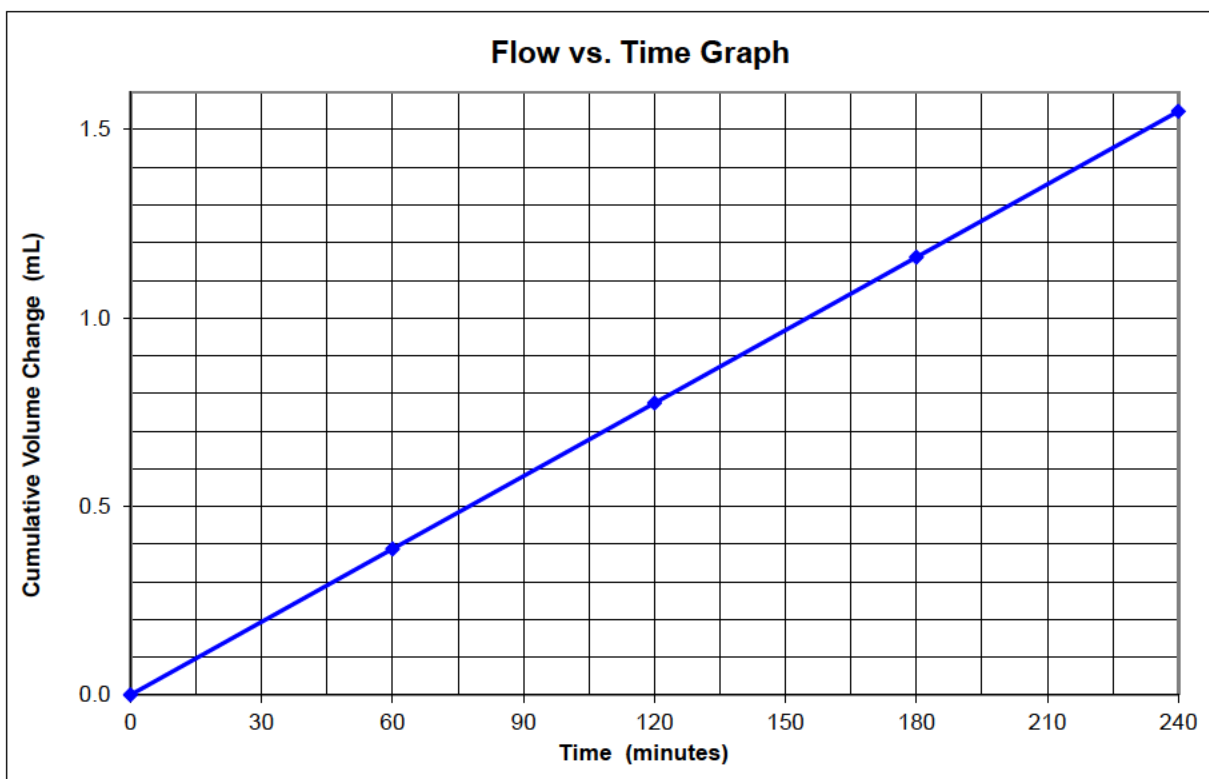
Version Number:	6	Version Date:	July 2022	Authorised By:	W. Campton
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Borehole Number:	TP64-26	Sample Number:	TUBE	Depth:	1.20 - 1.60m
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Head Difference = 30 kPa Effective Stress = 50 kPa

Coefficient of Permeability (k_v) = 1.1×10^{-9} m/s

TIME (minutes)	Cumulative Volume Change (mL)	TIME (minutes)	Cumulative Volume Change (mL)
0	0.00		
60	0.39		
120	0.77		
180	1.16		
240	1.55		



Please reply to: J. Franklin

Page 1 of 4

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

29th June 2026

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL

Dear Sir,

Re: MILLDALE NORTH

Your Reference: AK26-027

Report Number: 69130#L/PERM Milldale North TP65-26

Test Pit No: TP65-26

Sample No: TUBE

Depth: 1.00 – 1.30m

The following report presents the results of constant head permeability testing at BGL of a 63.5mm diameter (ID) undisturbed push-tube soil sample delivered to this laboratory on the 15th of June 2026. The client request was to measure the coefficient of permeability of a cylindrical specimen of soil in a triaxial apparatus, under known conditions of effective stress, and under a constant hydraulic gradient (constant head). Test results are summarised below, with page 4 showing a graph of flow vs. time for the sample.

Test standards used were:

Water Content:

NZS4402: 1986: Test 2.1

Permeability Tests:

BS EN ISO 17892-11: 2019: Part 11

Test Procedure

The sample was extruded from the push-tube and trimmed to length. The sample was then set up in a triaxial cell. Saturation of the sample was achieved in distinct stages by 50kPa increments of cell pressure and back pressure, with a differential pressure of 10kPa (*cell pressure 10kPa greater than back pressure*) in order to maintain a small positive effective stress. Saturation occurred through both the top and bottom ends of the sample. The porewater pressure coefficient (*B*) was measured at the start of the initial saturation stage, and again after the final saturation stage (*the check for saturation*).

The final saturation stage used a cell pressure of 400kPa and a back pressure of 390kPa. The bottom (base drainage) line was then closed & the sample was left overnight, allowing the porewater pressure to equalise throughout the sample. Saturation was then confirmed by closing the top (back pressure) line & increasing the cell pressure to 440kPa, observing the resulting increase in porewater pressure. A porewater pressure coefficient (*B*) of 0.95 was achieved, confirming saturation of the sample (ie. $B \geq 0.95$).

Excess porewater pressure was then dissipated during the consolidation cycle by opening the top (back pressure) line, & bottom (base drainage) line, resulting in an effective stress of 50kPa.

Next, the back (top) pressure was decreased to 375kPa and the base (bottom) pressure was then set at 405kPa, resulting in a head difference of 30kPa. The permeability of the sample was then measured using this constant head of 30kPa and a mean effective stress of 50kPa. The flow of water during the permeability test was vertically from the base of the sample to the top. As per the test standard, the permeability has been reported to two significant figures.

PERMEABILITY TEST RESULTS	
Sample Identification	TP65-26 / TUBE / 1.00 – 1.30m
Initial Sample Dimensions	63.1mm diameter X 100.2mm length
Initial Water Content	61.6 %
Final Water Content	62.2 %
Initial Bulk Density	1.63 t/m³
Final Bulk Density	1.68 t/m³
Initial Dry Density	1.01 t/m³
Final Dry Density	1.04 t/m³
Average Laboratory Temperature during Permeability test	20.5°C
Cell Confining Pressure	440 kPa
Back (top) Pressure	375 kPa
Base (bottom) Pressure	405 kPa
Mean Effective Stress	50 kPa
Constant Head	30 kPa
COEFFICIENT OF PERMEABILITY at 20°C*	3.2 X 10⁻¹⁰ m/s

**The coefficient of permeability was measured in the vertical direction, and is the average of the permeabilities calculated for four test intervals. The measured permeability has been corrected to give the corresponding permeability at 20°C as per section 7.3 of the test standard.*

Sample Description (not part of BGL IANZ Accreditation)

TP65-26 / TUBE / 1.00 – 1.30m:

CLAY, stiff, highly plastic, light grey with orange mottles, moist.

The constant head applied to the sample during the permeability test was 30kPa, which is equivalent to an elevation head of water of 3.066m. The hydraulic gradient (*ratio of elevation head of water to flow path length*) applied during the permeability test was 30.84. The permeant water used for this test was de-aired tap water.

Please note that after the test the sample was broken up into small pieces for the water content test. It also enabled identification of any hidden larger particles. There were no particles found that exceeded 1/6 (10.5mm) of the sample diameter that may have affected the test results.

This test was carried out in a laboratory in which the temperature is controlled to be kept within the specification of the test standard.

Please note that the test results relate only to the sample as-received, and relate only to the sample under test. The calculation of the coefficient of permeability assumes the application of Darcy's law for laminar flow of water under saturated conditions. It is possible that the size of the specimen does not adequately represent the fabric features present in field conditions.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

CONSTANT HEAD PERMEABILITY TEST

BS EN ISO 17892-11: 2019 Part 11: Permeability Tests / NZS4402: 1986: Test 2.1

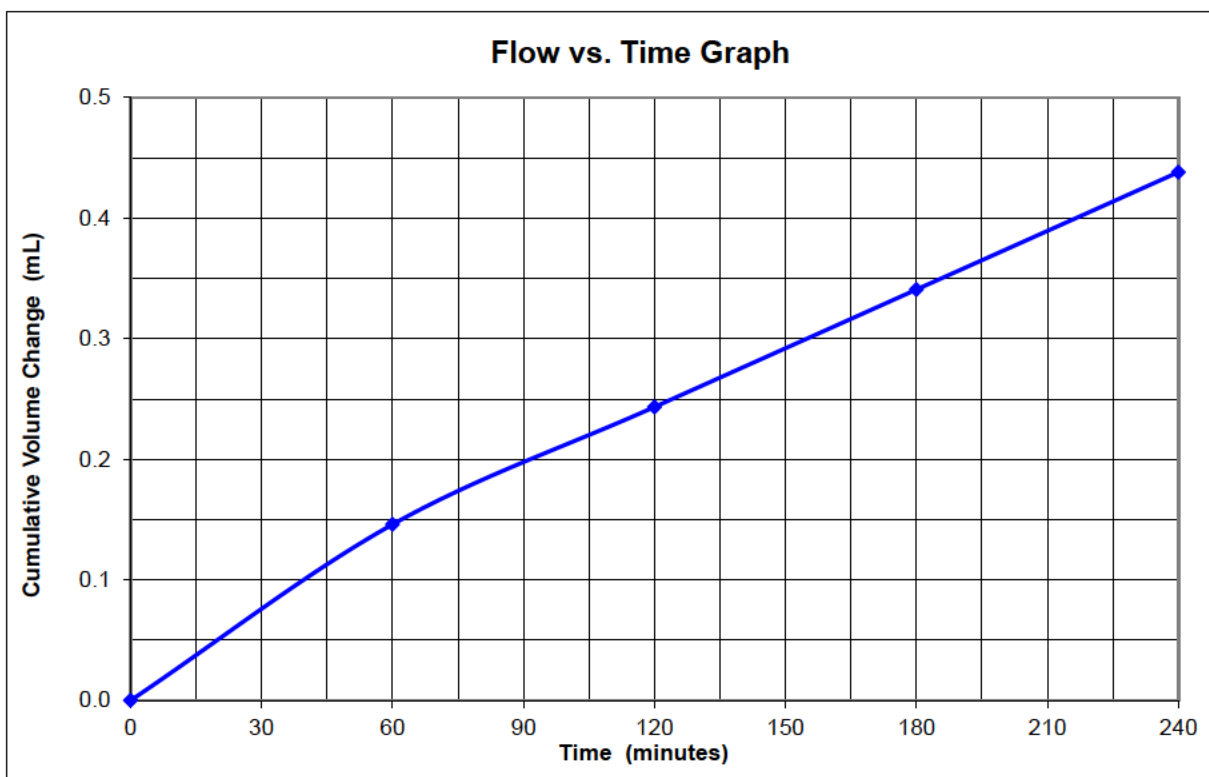
Version Number:	6	Version Date:	July 2022	Authorised By:	W. Campton
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Borehole Number:	TP65-26	Sample Number:	TUBE	Depth:	1.00 - 1.30m
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Head Difference = 30 kPa Effective Stress = 50 kPa

Coefficient of Permeability (k_v) = 3.2×10^{-10} m/s

TIME (minutes)	Cumulative Volume Change (mL)	TIME (minutes)	Cumulative Volume Change (mL)
0	0.00		
60	0.15		
120	0.24		
180	0.34		
240	0.44		



Please reply to: J. Franklin

Page 1 of 4

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

7th July 2026

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL

Dear Sir,

Re: MILLDALE NORTH

Your Reference: AK26-027

Report Number: 69130#L/PERM Milldale North TP63-26

Test Pit No: TP63-26

Sample No: BULK

Depth: 2.50 – 2.60m

The following report presents the results of constant head permeability testing at BGL of a bulk soil sample delivered to this laboratory on the 15th of June 2026. The client request was to measure the coefficient of permeability of a compacted cylindrical specimen of soil in a triaxial apparatus, under known conditions of effective stress, and under a constant hydraulic gradient (constant head). Test results are summarised below, with page 4 showing a graph of flow vs. time for the sample.

Please note that at your request this test was carried out on a compacted soil sample rather than an undisturbed push-tube soil sample. The test results contained in this report therefore relate to the compacted condition, and do not apply to the *in situ* soil.

Test standards used were:

Water Content:

NZS4402: 1986: Test 2.1

Permeability Tests:

BS EN ISO 17892-11: 2019: Part 11

Test Procedure

The sample was sieved through a 4.75mm sieve, then the water content of the sieved sample was adjusted to target the optimum water content value of 28% (*determined from the compaction curve test on the sample*). Next the sample was compacted into a 60mm diameter metal tube, targeting the maximum dry density (1.39t/m³) determined from the compaction curve test. It was then extruded from the push-tube and set up in a triaxial cell.

Saturation of the sample was achieved in distinct stages by 50kPa increments of cell pressure and back pressure, with a differential pressure of 10kPa (*cell pressure 10kPa greater than back pressure*) in order to maintain a small positive effective stress. Saturation occurred through both the top and bottom ends of the sample. The porewater pressure coefficient (*B*) was measured at the start of the initial saturation stage, and again after the final saturation stage (*the check for saturation*).

The final saturation stage used a cell pressure of 400kPa and a back pressure of 390kPa. The bottom (base drainage) line was then closed & the sample was left overnight, allowing the porewater pressure to equalise throughout the sample. Saturation was then confirmed by closing the top (back pressure) line & increasing the cell pressure to 440kPa, observing the resulting increase in porewater pressure. A porewater pressure coefficient (B) of 0.99 was achieved, confirming saturation of the sample (ie. $B \geq 0.95$).

Excess porewater pressure was then dissipated during the consolidation cycle by opening the top (back pressure) line, resulting in an effective stress of 50kPa.

Next, the back (top) pressure was decreased to 375kPa and the base (bottom) pressure was then set at 405kPa, resulting in a head difference of 30kPa. The permeability of the sample was then measured using this constant head of 30kPa and a mean effective stress of 50kPa. The flow of water during the permeability test was vertically from the base of the sample to the top. As per the test standard, the permeability has been reported to two significant figures.

PERMEABILITY TEST RESULTS	
Sample Identification	TP63-26 / BULK / 2.50 – 2.60m
Initial Sample Dimensions	60.5mm diameter X 102.2mm length
Initial Water Content	27.8 %
Final Water Content	44.9 %
Initial Bulk Density	1.71 t/m ³
Final Bulk Density	2.08 t/m ³
Initial Dry Density	1.34 t/m ³
Final Dry Density	1.43 t/m ³
Average Laboratory Temperature during Permeability test	19.5°C
Cell Confining Pressure	440 kPa
Back (top) Pressure	375 kPa
Base (bottom) Pressure	405 kPa
Mean Effective Stress	50 kPa
Constant Head	30 kPa
COEFFICIENT OF PERMEABILITY at 20°C*	7.3 X 10⁻¹⁰ m/s

**The coefficient of permeability was measured in the vertical direction, and is the average of the permeabilities calculated for four test intervals. The measured permeability has been corrected to give the corresponding permeability at 20 °C as per section 7.3 of the test standard.*

Sample Description (not part of BGL IANZ Accreditation)

TP63-26 / TUBE / 2.50 – 2.60m:

CLAY, silty, highly plastic, bluish grey with light orange mottles, very moist, organic inclusions.

The constant head applied to the sample during the permeability test was 30kPa, which is equivalent to an elevation head of water of 3.066m. The hydraulic gradient (*ratio of elevation head of water to flow path length*) applied during the permeability test was 30.71. The permeant water used for this test was de-aired tap water.

Please note that after the test the sample was broken up into small pieces for the water content test. It also enabled identification of any hidden larger particles. There were no particles found that exceeded 1/6 (10.1mm) of the sample diameter.

This test was carried out in a laboratory in which the temperature is controlled to be kept within the specification of the test standard.

Please note that the test results relate only to the sample as-received, and relate only to the sample under test. The calculation of the coefficient of permeability assumes the application of Darcy's law for laminar flow of water under saturated conditions. It is possible that the size of the specimen does not adequately represent the fabric features present in field conditions.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

CONSTANT HEAD PERMEABILITY TEST

BS EN ISO 17892-11: 2019 Part 11: Permeability Tests / NZS4402: 1986: Test 2.1

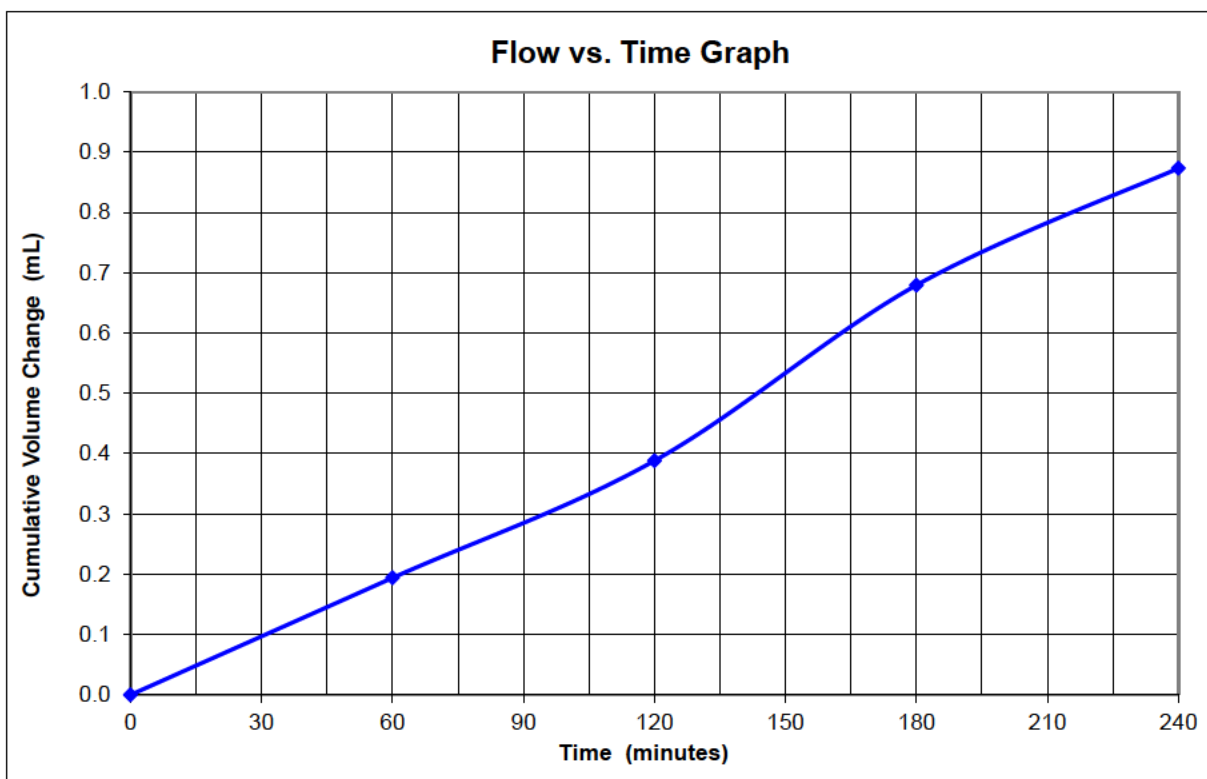
Version Number:	6	Version Date:	July 2022	Authorised By:	W. Campton
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Borehole Number:	TP63-26	Sample Number:	BULK	Depth:	2.50 - 2.60m
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Head Difference = 30 kPa Effective Stress = 50 kPa

Coefficient of Permeability (k_v) = 7.3×10^{-10} m/s

TIME (minutes)	Cumulative Volume Change (mL)	TIME (minutes)	Cumulative Volume Change (mL)
0	0.00		
60	0.19		
120	0.39		
180	0.68		
240	0.87		



Please reply to: J. Franklin

Page 1 of 6

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

23rd June 2026

HYDROMETER PARTICLE-SIZE DISTRIBUTION TESTING

Dear Sir,

Re: MILLDALE NORTH

Your Reference: AK26-027

Report Number: 69130#L/HYD Milldale North

The following report presents the results of hydrometer particle-size distribution testing at BGL of soil samples delivered to this laboratory on the 15th of June 2026. Test results are summarised below, with the following pages showing graphs and detailed results.

Test standards used were:

Water Content:	NZS4402: 1986: Test 2.1
Wet Sieve Test:	NZS4402: 1986: Test 2.8.1
Hydrometer Test:	NZS4402: 1986: Test 2.8.4

Test Pit Number	Sample Number	Depth (m)	Hydrometer Grading (% of Dry Mass)			
			GRAVEL (2 – <9.50mm)	SAND (0.06 – 2mm)	SILT FRACTION (0.002 – 0.06mm)	CLAY FRACTION (< 0.002mm)
TP62-26	BULK	1.50 – 1.60	0	1	47	52
TP63-26	BULK	2.50 – 2.60	0	1	40	59
TP64-26	TUBE	1.20 – 1.60	0	2	28	70
TP65-26	TUBE	1.00 – 1.30	0	0	35	65

The whole soils were used for these hydrometer tests. As the organic content of the soils tested was very low, peroxide pretreatment was not carried out. A solid density of 2.65t/m³ was assumed for these hydrometer tests, and is not part of the IANZ endorsement for this report.

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. Test 2.8.1: wet sieve & Test 2.8.4: hydrometer, the 'percentages passing' / 'percentages finer than' are reported to nearest 1%.

Please note that the test results relate only to the samples as-received, and relate only to the samples under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

Job Number:	69130#L	Sheet 1 of 1	Page 3 of 6
Registration Number:	3195		
Report Number:	69130#L/HYD Milldale North		
Project:	MILLDALE NORTH		
PARTICLE-SIZE DISTRIBUTION BY HYDROMETER		Tested By:	JG / SG
		Compiled By:	SG
		Checked By:	SG
Test Methods: NZS4402: 1986: Test 2.1, Test 2.8.1, Test 2.8.4			18-Jun-26
			22-Jun-26
			22-Jun-26
Version Number:	8	Version Date:	November 2025
		Authorised By:	W. Campton

Borehole Number:	TP62-26	Sample Number:	BULK
		Sample Depth:	1.50 - 1.60m

Water Content (%): 39.2

Sample History: Natural / Air Dried / Oven Dried / Unknown

pH of sedimentation suspension: 8.0

Dispersing agents used: sodium hexametaphosphate & sodium hydroxide

Particle-size (mm)	% Finer Than
0.212	100
0.063	99
0.044	96
0.031	92
0.023	87
0.016	82
0.012	77
0.0087	74
0.0063	67
0.0045	62
0.0032	58
0.0025	54
0.0014	49

HYDROMETER ANALYSIS (% of dry mass)

GRAVEL	Medium	< 9.5 - 6mm	0
	Fine	6 - 2mm	0

0 %

SAND	Coarse	2.0 - 0.6mm	0
	Medium	0.6 - 0.2mm	0
	Fine	0.2 - 0.06mm	1

1 %

SILT FRACTION	Coarse	0.06 - 0.02mm	14
	Medium	0.02 - 0.006mm	19
	Fine	0.006 - 0.002mm	14

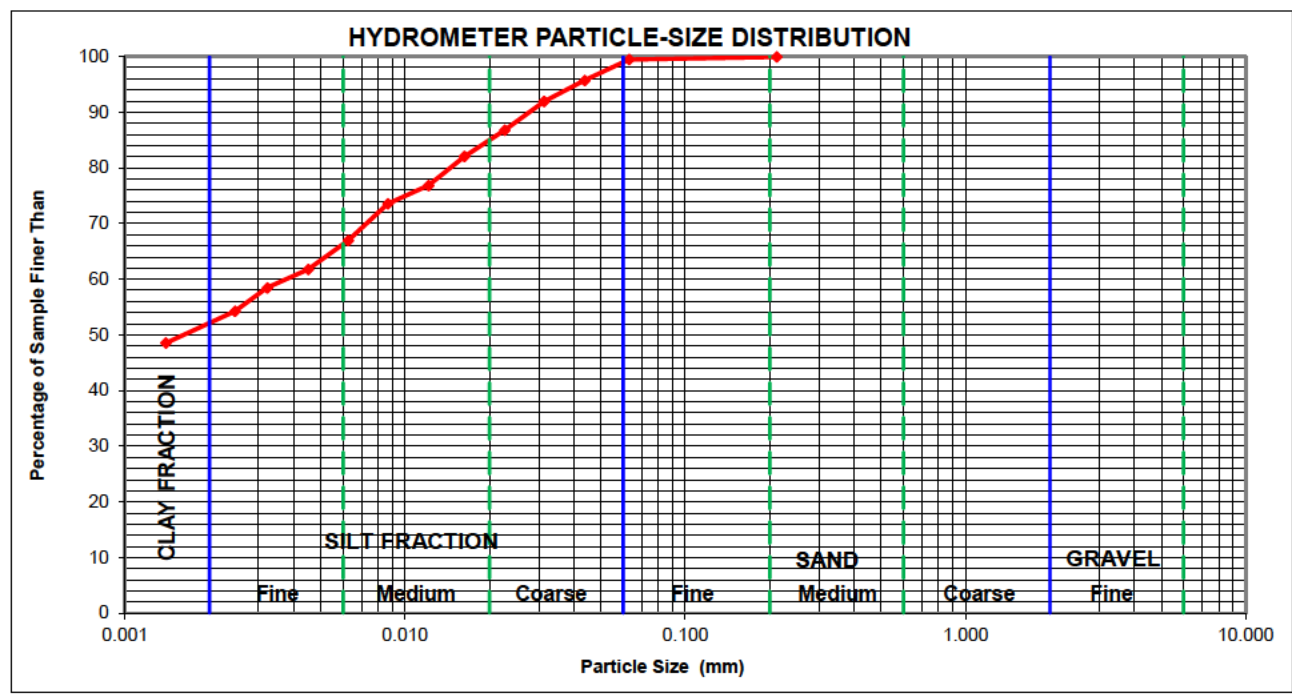
47 %

CLAY FRACTION	< 0.002mm	
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52 %

100%

HYDROMETER TEST WAS CARRIED OUT ON THE WHOLE SOIL / SOIL FRACTION PASSING A 9.50mm SIEVE



Job Number:	69130#L	Sheet 1 of 1	Page 4 of 6
Registration Number:	3195		
Report Number:	69130#L/HYD Milldale North		
Project:	MILLDALE NORTH		
PARTICLE-SIZE DISTRIBUTION BY HYDROMETER		Tested By:	SG / JF / JG
		Compiled By:	SG
		Checked By:	SG
Test Methods: NZS4402: 1986: Test 2.1, Test 2.8.1, Test 2.8.4			
Version Number:	8	Version Date:	November 2025
		Authorised By:	W. Campton

Borehole Number:	TP63-26	Sample Number:	BULK
		Sample Depth:	2.50 - 2.60m

Water Content (%): 53.5

Sample History: Natural / Air Dried / Oven Dried / Unknown

pH of sedimentation suspension: 8.0

Dispersing agents used: sodium hexametaphosphate & sodium hydroxide

Particle-size (mm)	% Finer Than
0.212	100
0.063	99
0.046	96
0.033	93
0.023	91
0.017	86
0.012	83
0.0089	77
0.0064	72
0.0046	68
0.0033	65
0.0023	61
0.0010	49

HYDROMETER ANALYSIS (% of dry mass)

GRAVEL	Medium	< 9.5 - 6mm	0
	Fine	6 - 2mm	0

0 %

SAND	Coarse	2.0 - 0.6mm	0
	Medium	0.6 - 0.2mm	0
	Fine	0.2 - 0.06mm	1

1 %

SILT FRACTION	Coarse	0.06 - 0.02mm	10
	Medium	0.02 - 0.006mm	18
	Fine	0.006 - 0.002mm	12

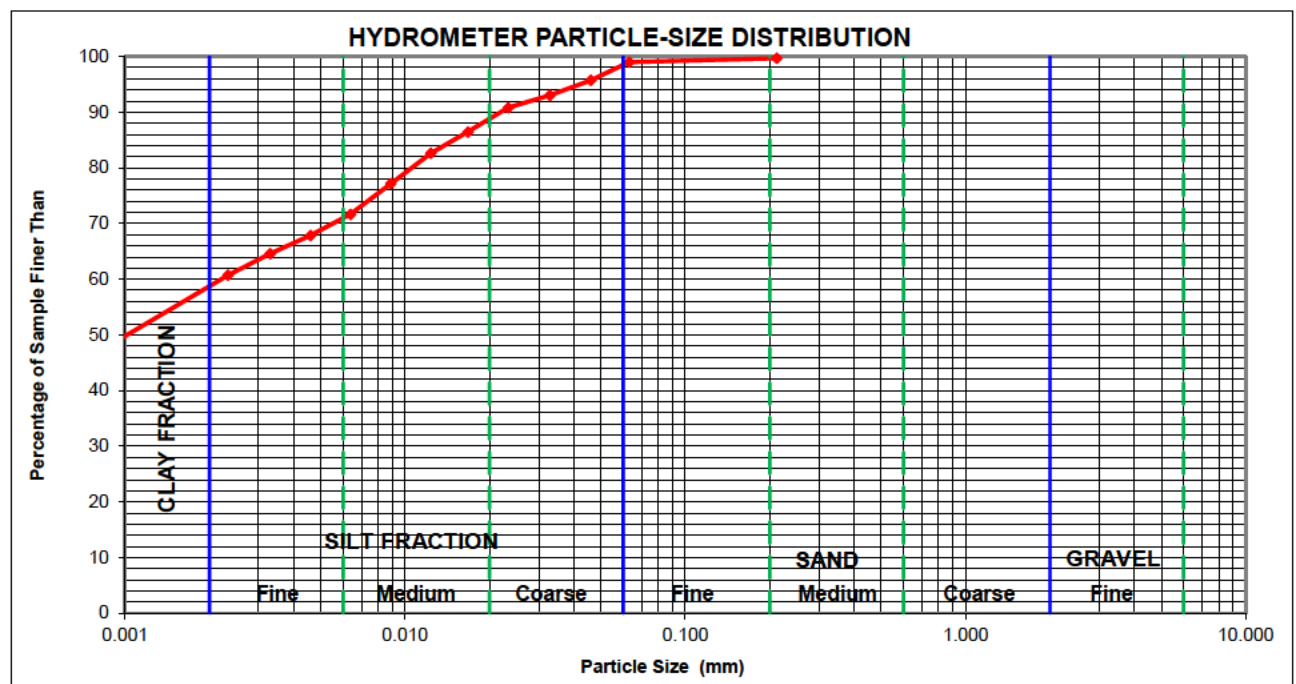
40 %

CLAY FRACTION	< 0.002mm	
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59 %

100%

HYDROMETER TEST WAS CARRIED OUT ON THE WHOLE SOIL / SOIL FRACTION PASSING A 9.50mm SIEVE



Job Number:	69130#L	Sheet 1 of 1	Page 5 of 6
Registration Number:	3195		
Report Number:	69130#L/HYD Milldale North		
Project:	MILLDALE NORTH		
PARTICLE-SIZE DISTRIBUTION BY HYDROMETER		Tested By:	SG / JG / JF
		Compiled By:	SG
		Checked By:	SG
Test Methods: NZS4402: 1986: Test 2.1, Test 2.8.1, Test 2.8.4			19-Jun-26
			22-Jun-26
			22-Jun-26
Version Number:	8	Version Date:	November 2025
		Authorised By:	W. Campton

Borehole Number:	TP64-26	Sample Number:	TUBE
		Sample Depth:	1.20 - 1.60m

Water Content (%): 70.9

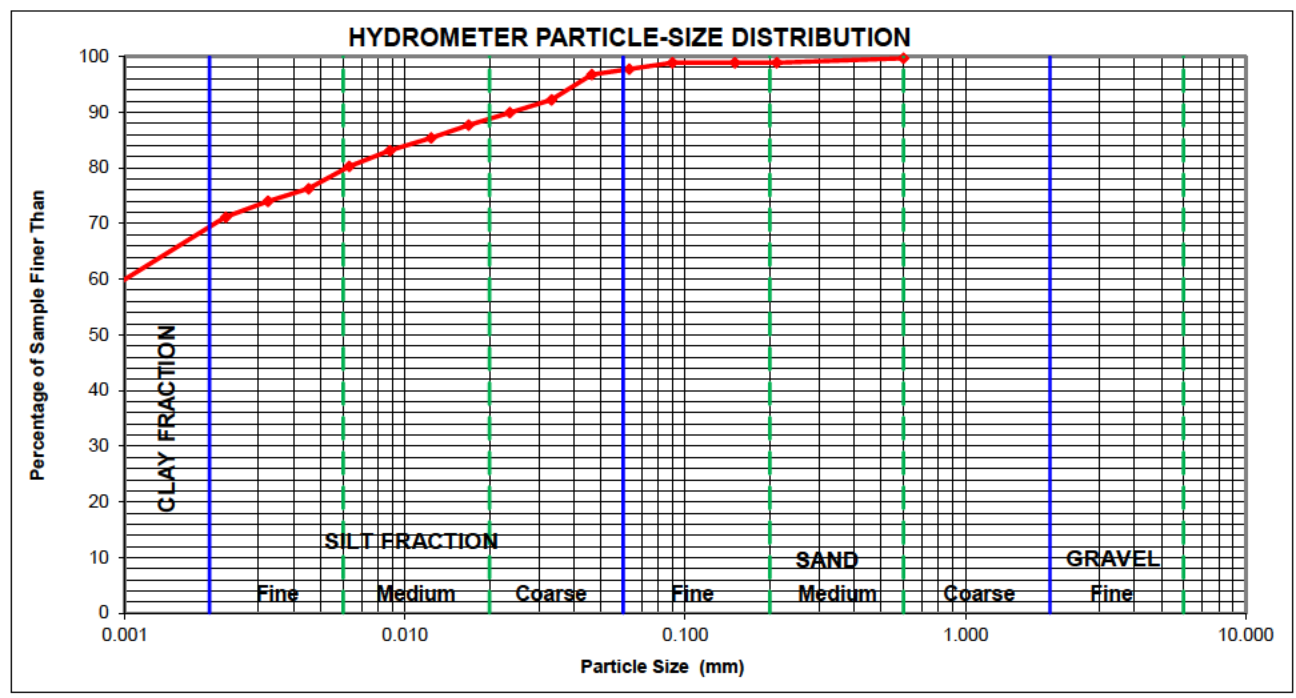
Particle-size (mm)	% Finer Than
0.600	100
0.212	99
0.150	99
0.090	99
0.063	98
0.046	97
0.033	92
0.024	90
0.017	88
0.012	85
0.0088	83
0.0063	80
0.0045	76
0.0032	74
0.0023	71
0.0009	59

Sample History: Natural / Air Dried / Oven Dried / Unknown
pH of sedimentation suspension: 8.5
Dispersing agents used: sodium hexametaphosphate & sodium hydroxide

HYDROMETER ANALYSIS (% of dry mass) TOTAL

GRAVEL	Medium	< 9.5 - 6mm	0	0	%
	Fine	6 - 2mm	0		
SAND	Coarse	2.0 - 0.6mm	0	2	%
	Medium	0.6 - 0.2mm	1		
	Fine	0.2 - 0.06mm	1		
SILT FRACTION	Coarse	0.06 - 0.02mm	9	28	%
	Medium	0.02 - 0.006mm	9		
	Fine	0.006 - 0.002mm	10		
CLAY FRACTION		< 0.002mm	70	100%	

HYDROMETER TEST WAS CARRIED OUT ON THE WHOLE SOIL / SOIL FRACTION PASSING A 9.50mm SIEVE



PARTICLE-SIZE DISTRIBUTION BY HYDROMETER

Test Methods: NZS4402: 1986: Test 2.1, Test 2.8.1, Test 2.8.4

Tested By:	JG / SG	18-Jun-26
Compiled By:	SG	22-Jun-26
Checked By:	SG	22-Jun-26

Version Number:	8	Version Date:	November 2025	Authorised By:	W. Campton
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Borehole Number:	TP65-26	Sample Number:	TUBE
		Sample Depth:	1.00 - 1.30m

Water Content (%): 55.1

Sample History: Natural / Air Dried / Oven Dried / Unknown

pH of sedimentation suspension: 8.0

Dispersing agents used: sodium hexametaphosphate & sodium hydroxide

Particle-size (mm)	% Finer Than
0.063	100
0.045	99
0.032	96
0.023	94
0.016	93
0.012	90
0.0086	87
0.0062	81
0.0044	77
0.0032	70
0.0024	67
0.0014	62

HYDROMETER ANALYSIS (% of dry mass)

GRAVEL	Medium	< 9.5 - 6mm	0
	Fine	6 - 2mm	0

0 %

SAND	Coarse	2.0 - 0.6mm	0
	Medium	0.6 - 0.2mm	0
	Fine	0.2 - 0.06mm	0

0 %

SILT FRACTION	Coarse	0.06 - 0.02mm	6
	Medium	0.02 - 0.006mm	13
	Fine	0.006 - 0.002mm	16

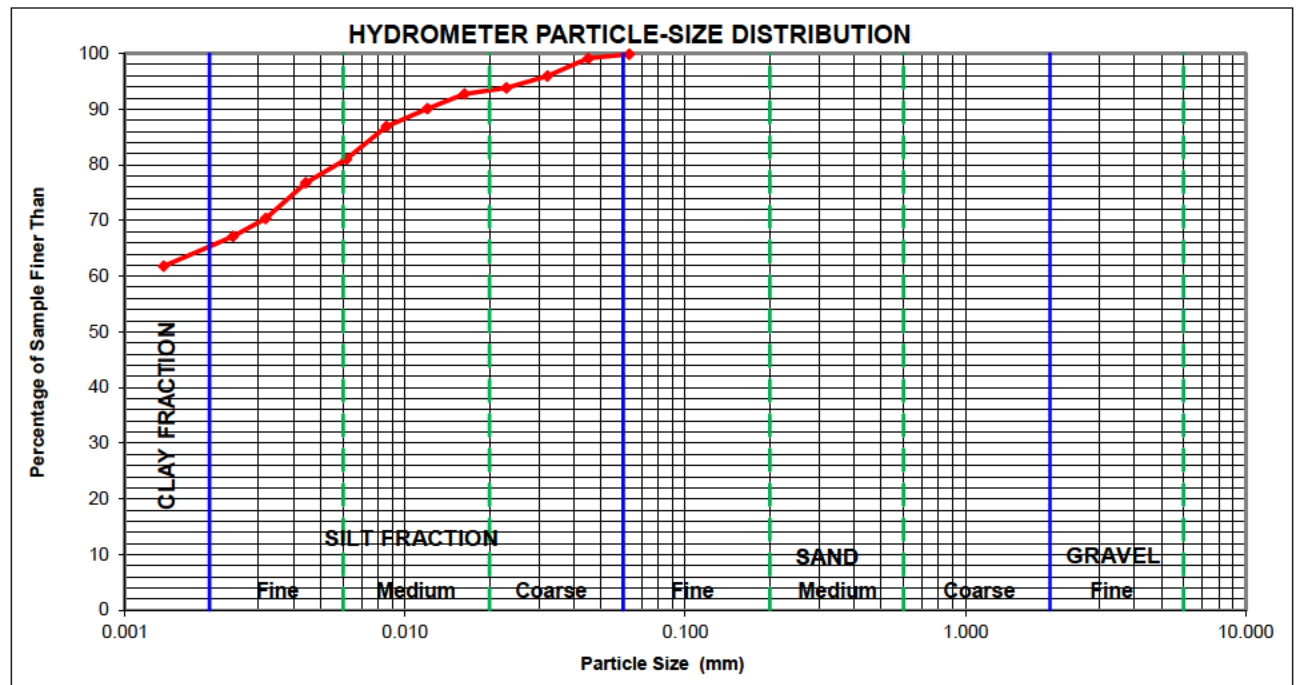
35 %

CLAY FRACTION	< 0.002mm	
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65 %

100%

HYDROMETER TEST WAS CARRIED OUT ON THE WHOLE SOIL / SOIL FRACTION PASSING A 9.50mm SIEVE



Please reply to: J. Franklin

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Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

22nd June 2026

ATTERBERG LIMITS TESTING

Dear Sir,

Re: MILDDALE NORTH
Your Reference: AK26-027
Report Number: 69130#L/AL2 Milldale North

The following report presents the results of Atterberg Limits testing at BGL of soil samples delivered to this laboratory on the 15th of June 2026. Test results are summarised below, with page 3 showing where the samples plot on the Unified Soil Classification System (Casagrande) Chart.

Test standards used were:

Water Content:	NZS4402: 1986: Test 2.1
Liquid Limit:	NZS4402: 1986: Test 2.2
Plastic Limit:	NZS4402: 1986: Test 2.3
Plasticity Index:	NZS4402: 1986: Test 2.4

Test Pit Number	Sample Number	Depth (m)	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
TP62-26	BULK	1.50 – 1.60	39.2	77	21	56
TP63-26	BULK	2.50 – 2.60	53.5	95	22	73
TP64-26	TUBE	1.20 – 1.60	70.9	99	25	74
TP65-26	TUBE	1.00 – 1.30	55.1	105	31	74

The whole soils were used for the water content tests (the soils were in an unknown state), and for the liquid limit and plastic limit tests. The soils were wet up and dried where required for the liquid limit and plastic limit tests.

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. Test 2.2: liquid limit and test 2.3: plastic limit are reported to the nearest whole number.

Please note that the test results relate only to the samples as-received, and relate only to the samples under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



All tests reported herein have been performed in accordance with the laboratory's scope of accreditation. This report may not be reproduced except in full & with written approval from BGL.

DETERMINATION OF THE LIQUID LIMIT, PLASTIC LIMIT & THE PLASTICITY INDEX

Test Methods: NZS4402: 1986: Test 2.2, Test 2.3 and Test 2.4

Tested By:	SG / DT / JL	June 2026
Compiled By:	JF	22/06/2026
Checked By:	JF	22/06/2026
Authorised By:	Wayne Campton	

Version Number:	8	Version Date:	August 2025
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SUMMARY OF TESTING

Borehole Number	Sample Number	Depth (m)	Liquid Limit	Plastic Limit	Plasticity Index	Soil Classification Based on USCS Chart Below
TP62-26	BULK	1.50 - 1.60	77	21	56	CH
TP63-26	BULK	2.50 - 2.60	95	22	73	CH
TP64-26	TUBE	1.20 - 1.60	99	25	74	CH
TP65-26	TUBE	1.00 - 1.30	105	31	74	CH

The chart below & soil classification terminology is taken from ASTM D2487-17 (Reapproved 2025) "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)", February 2025, & is based on the classification scheme developed by A. Casagrande in the 1940's (Casagrande, A., 1948: Classification and identification of soil. Transactions of the American Society of Civil Engineers, v. 113, p. 901-930). The chart below & the soil classification given in the table above are included for your information only, and are not included in the IANZ endorsement for this report.

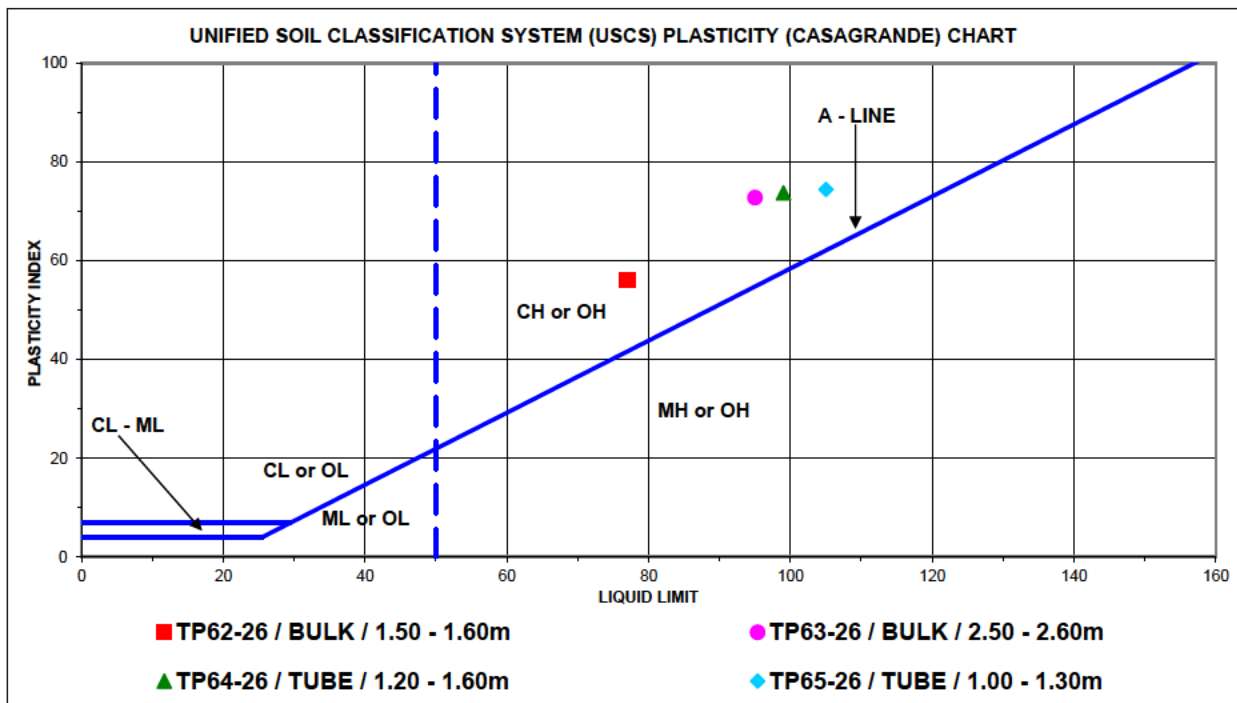


CHART LEGEND

CL = CLAY, low plasticity ('lean' clay)
OL = ORGANIC CLAY or ORGANIC SILT, low liquid limit
ML = SILT, low liquid limit
CL - ML = SILTY CLAY

CH = CLAY, high plasticity ('fat' clay)
OH = ORGANIC CLAY or ORGANIC SILT, high liquid limit
MH = SILT, high liquid limit ('elastic silt')

Please reply to: J. Franklin

Page 1 of 4

Gibb Ritchie Geotechnical Engineers
505 Lake Road
Takapuna
Auckland 0622

Job Number: 69130#L
BGL Registration Number: 3195
Checked by: JF

Attention: **CHRIS RITCHIE**

24th June 2026

DRY DENSITY / WATER CONTENT RELATIONSHIP (STANDARD COMPACTION CURVE) TESTING

Dear Sir,

Re: MILLDALE NORTH
Your Reference: AK26-027
Report Number: 69130#L/CC Milldale North

The following report presents the results of standard compaction curve testing at BGL of bulk soil samples delivered to this laboratory on the 15th of June 2026. Test results are summarised below, with the following pages showing graphs and detailed results.

A single shear vane test was carried out on each compacted sample while it was still in the proctor mould, and these results are included on the results tables and water content / density graphs. The shear vane results are included for your information only, and are not included in the IANZ endorsement for this report.

Test standards used were:

Water Content: NZS4402: 1986: Test 2.1
NZ Standard Compaction: NZS4402: 1986: Test 4.1.1
Vane Shear Strength: NZ Geotechnical Society Guideline 2001*

**Not part of the IANZ endorsement for this report.*

Table 1: TP62-26 / BULK / 1.50 – 1.60m

Sample Identification	Maximum Dry Density (t/m ³)	Optimum Water Content (%)	As-received Water Content (%)	Assumed Solid Density (t/m ³)
TP62-26 / BULK / 1.50 – 1.60m	1.44	26	43.0	2.63
CLAY, highly plastic, brownish grey with orange speckles, very moist, organics & rootlets.				

Note that sample descriptions are not part of BGL IANZ Accreditation.

Table 2: TP63-26 / BULK / 2.50 – 2.60m

Sample Identification	Maximum Dry Density (t/m ³)	Optimum Water Content (%)	As-received Water Content (%)	Assumed Solid Density (t/m ³)
TP63-26 / BULK / 2.50 – 2.60m	1.39	28	57.1	2.65
CLAY, silty, highly plastic, bluish grey with light orange mottles, very moist, organic inclusions.				

As per the reporting requirements of NZS4402: 1986: Test 2.1: water content is reported to two significant figures for values below 10%, and to three significant figures for values of 10% or greater. As per the reporting requirements of NZS4402: 1986: Test 4.1.1: New Zealand Standard Compaction Test, maximum dry density is reported to the nearest 0.01t/m³, optimum water content is reported to the nearest 0.2% for values below 5%, to the nearest 0.5% for values from 5 to 10%, and to the nearest whole number for values greater than 10%.

For calculating the air voids percentages the assumed solid density values in the tables above were used. Please note that these assumed values are not part of the IANZ endorsement for this report.

Please note that the test results relate only to the samples as-received, and relate only to the samples under test.

Thank you for the opportunity to carry out this testing. If you have any queries regarding the content of this report please contact the person authorising this report below at your convenience.

Yours faithfully,

Justin Franklin
Key Technical Person
Laboratory Manager
Babbage Geotechnical Laboratory



Tests indicated as not accredited are outside the scope of the laboratory's accreditation. This report may not be reproduced except in full & with written approval from BGL.

Determination of the Dry Density / Water Content Relationship by Standard Compaction

Test Method: NZS4402: 1986: Test 4.1.1

Version Number:	5	Version Date:	February 2023	Tested By:	JG	June 2026
				Compiled By:	JG	24/06/2026
				Checked By:	SG	24/06/2026
				Authorised By:	W. Campton	

Sample ID:	TP62-26 / BULK	Depth:	1.50 - 1.60m
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Sample History: Air-dried from as-received water content
Compaction Used: New Zealand Standard Compaction
Test Performed On: Whole Soil / Fraction Passing the 10mm Sieve
Solid Density of Soil Particles: 2.63 t/m³ (measured / assumed)
As-received Water Content (%): 43.0

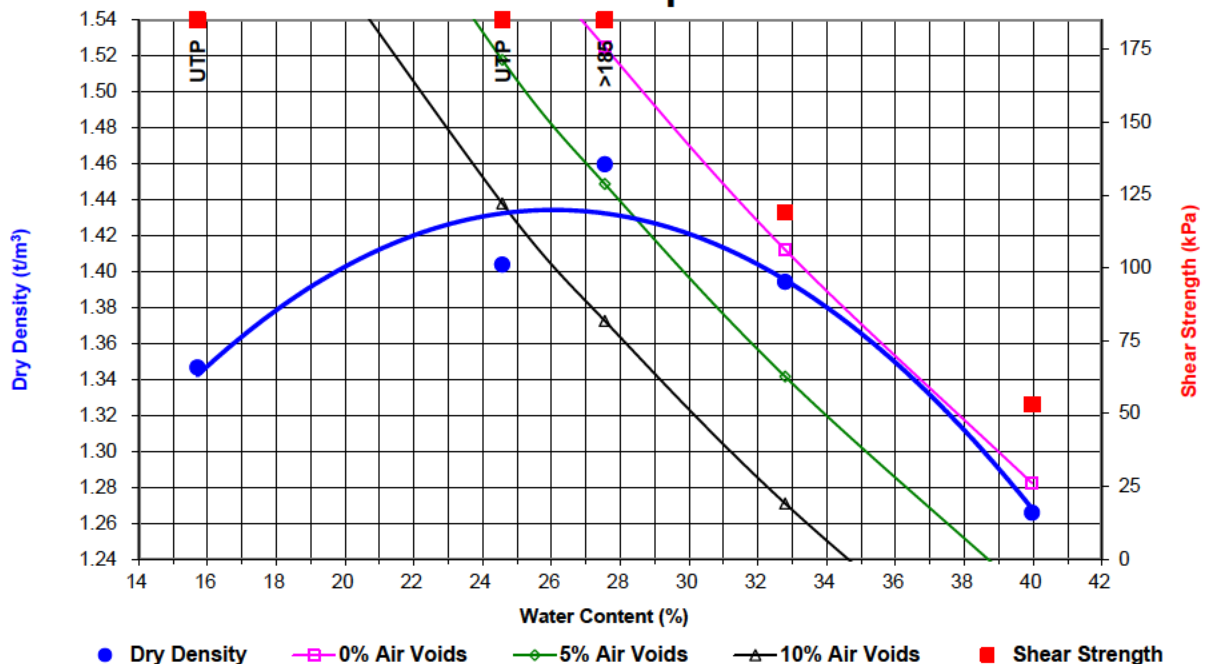
TEST RESULTS

Water Content (%)	15.7	24.6	27.5	32.8	40.0
Bulk Density (t/m ³)	1.56	1.75	1.86	1.85	1.77
Dry Density (t/m ³)	1.35	1.40	1.46	1.39	1.27
Air Voids (%)	27.6	12.1	4.3	1.3	1.3
Shear Strength (kPa)	UTP*	UTP*	>185	119	53

*UTP = unable to penetrate sample with the shear vane.

Maximum Dry Density:	1.44 t/m³	Optimum Water Content:	26 %
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Standard Compaction Curve



Determination of the Dry Density / Water Content Relationship by Standard Compaction

Test Method: NZS4402: 1986: Test 4.1.1

Version Number:	5	Version Date:	February 2023	Tested By:	JL / DT	June 2026
				Compiled By:	JL	24/06/2026
				Checked By:	SG	24/06/2026
				Authorised By:	W. Campton	

Sample ID: **TP63-26 / BULK** **Depth:** **2.50 - 2.60m**

Sample History: Air-dried from as-received water content
Compaction Used: New Zealand Standard Compaction
Test Performed On: Whole Soil / Fraction Passing the 10mm Sieve
Solid Density of Soil Particles: 2.65 t/m³ (measured / assumed)
As-received Water Content (%): **57.1**

TEST RESULTS

Water Content (%)	18.8	23.0	27.4	32.3	37.7	42.2
Bulk Density (t/m ³)	1.59	1.65	1.79	1.84	1.80	1.76
Dry Density (t/m ³)	1.34	1.34	1.41	1.39	1.31	1.24
Air Voids (%)	24.4	18.5	8.4	2.6	1.4	1.0
Shear Strength (kPa)	UTP*	UTP*	>185	135	92	53

*UTP = unable to penetrate sample with the shear vane.

Maximum Dry Density: **1.39 t/m³** **Optimum Water Content:** **28 %**

Standard Compaction Curve

