



Watercare Services Limited

Whenuapai Redhills Wastewater Package 1 Geotechnical Interpretive Report

March 2021

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1. Introduction

1.1 General

GHD Limited (GHD) has been commissioned by Watercare Services Limited (Watercare) to undertake a geotechnical assessment relating to a proposed gravity sewer, pump station and rising sewer main, located in Whenuapai, Auckland. The location of each element is presented as Figure 1A in Appendix A.

The purpose of this report is to provide geotechnical recommendations to support the design of the elements outlined in Section 1.2 and in accordance with GHD's scope of services defined in Section 1.3. The recommendations made in this report are based on a Geotechnical Factual Report (T&T 2021) which is currently in a draft format and will be finalised on completion of the groundwater monitoring programme.

The limitations and references associated with this report follow the main text as Sections 8 and 9 respectively.

1.2 Proposed design

1.2.1 Pipe alignments

It is proposed to construct approximately 2.5 km of wastewater pipelines to service planned residential subdivision within the greater area. The proposed alignment is presented as Figure 1A in Appendix A and will be separated into a gravity sewer main and a rising main. It is understood that the position of this pipe may change slightly as the design progresses however in general the location and length of the pipes is as follows:

- Gravity sewer main (approximately 740 m length). The gravity sewer main will be located immediately north of Brigham Creek Road between Totara Creek and Joseph McDonald Road and flow from the north east to south west and terminate at 23-27 Brigham Creek Road.
- Pump station and rising main (approximately 1.8 km length). The rising main begins at a pumping station, where the gravity sewer main terminates, located at 23-27 Brigham Creek Road. The rising main then trends in a south east direction along Spedding Road to the intersection with Maramari Road where it will connect with the Massey Connector (outside the scope of this report).

Multiple manholes along the alignment are included within the proposed design and their positions are shown on the geological long sections included in Appendix D and discussed in Section 4.

The proposed pipe construction and invert levels are as follows:

- The gravity sewer main is proposed to be constructed of a 375 mm PVC pipe. Invert levels range between approximately 2.4 – 6.3 meters below ground level (m bgl) however typically range between 2.5 m and 3.0 m bgl.
- The rising main is proposed to comprise a 560 mm outer diameter PE 100 pipe. Invert levels follow the ground level profile and range between approximately 1.4 – 2.6 meters below existing ground level (m bgl).

1.2.2 Pumping station

A proposed pump station plan has been provided and is included in Appendix A as Drawing 3-AWD32.C001. The pump station is shown to be at the interface of the gravity and rising main at 23-27 Brigham Creek Road.

The details of this pumping station were under development at the time of the preparation of this report. However, it is understood that the pumping station footprint will measure approximately 25 m wide by 15 m long and will include:

- Two ~ 8 m deep wet well
- Five ~ 5 m deep storage tanks
- Two ~ 2.4 m deep valve chamber

The existing ground level undulates slightly with an overall gentle dip to the southeast therefore earthworks will be required to provide a level platform. The area will be paved upon installation of the pump station and connect to a proposed cul-de-sac immediately east of the pumping station. It is expected some amount of cut will be required to allow this connection.

A wetland exists immediately north of the proposed pumping station and establishment of a wetland riparian strip is proposed along this boundary. The details of this are yet to be confirmed.

1.2.3 Proposed pipe construction approach

It is currently proposed to install the gravity and rising main pipeline through open trench (OT) excavation methods, however Horizontal Direction Drilling (HDD) may also be employed. The manholes will be installed in open excavations.

1.3 Scope of services

This report is intended to provide geotechnical recommendations to the civil and wastewater designers to allow the progression of design. The geotechnical recommendations are based on a Geotechnical Factual Report, T&T 2021.

The scope of this report includes:

- Desktop review of available information including:
 - Published geological maps
 - Historical aerial photography
- Interpretation of geotechnical data included within T&T 2021 for the purposes of developing an engineering geology ground model, engineering geological units and geological site characterisation
- Slope stability assessment where the alignment or pump station is proposed near a slope
- Assessment of site seismicity and liquefaction risk
- Provision of geotechnical design parameters
- Discussion of key geotechnical risks and recommendations for design and construction

2. Site setting

2.1 Site layout

2.1.1 General

The overall alignment is approximately 2.5 km long and its location is detailed in Section 1.2.1. The gravity sewer main and the rising main both have a unique design chainage, both starting at CH 00 at the location of the pump station (i.e. the gravity sewer increases in chainage to the north and the rising main increases in chainage to the south). These chainages, coupled with manhole locations and names, are presented on the geological long sections included in Appendix D (see Section 4).

Three connecting streams are present over the site, known as Slaughter House Stream, Sinton Stream and Totara Stream. These are presented on Figure 1A in Appendix A.

A more detailed review of the surrounding area is given in the following sections.

2.1.2 Gravity sewer main

The gravity main sewer is located in the approximate northern third of the alignment, commencing adjacent to a stormwater pond in a recently constructed residential development located between Dale Road and Brigham Creek Road. The gravity sewer main trends in a south west direction from the stormwater pond, through agricultural land towards Brigham Creek Road at CH 167 (RP 0.650). The following features are of note between CH 740 and CH 167 and are illustrated in Figure 1:

- Recent earthworks associated with the construction of a swale for a stormwater pond between SSMH-12 to SSMH-11
- A small stream, known as Slaughter House Stream, approximately 0.5 m wide and 0.2 m deep runs adjacent to SSMH-11 to SHMH-5 offset approximately 3.6 m at its closest point (SSMH-8).

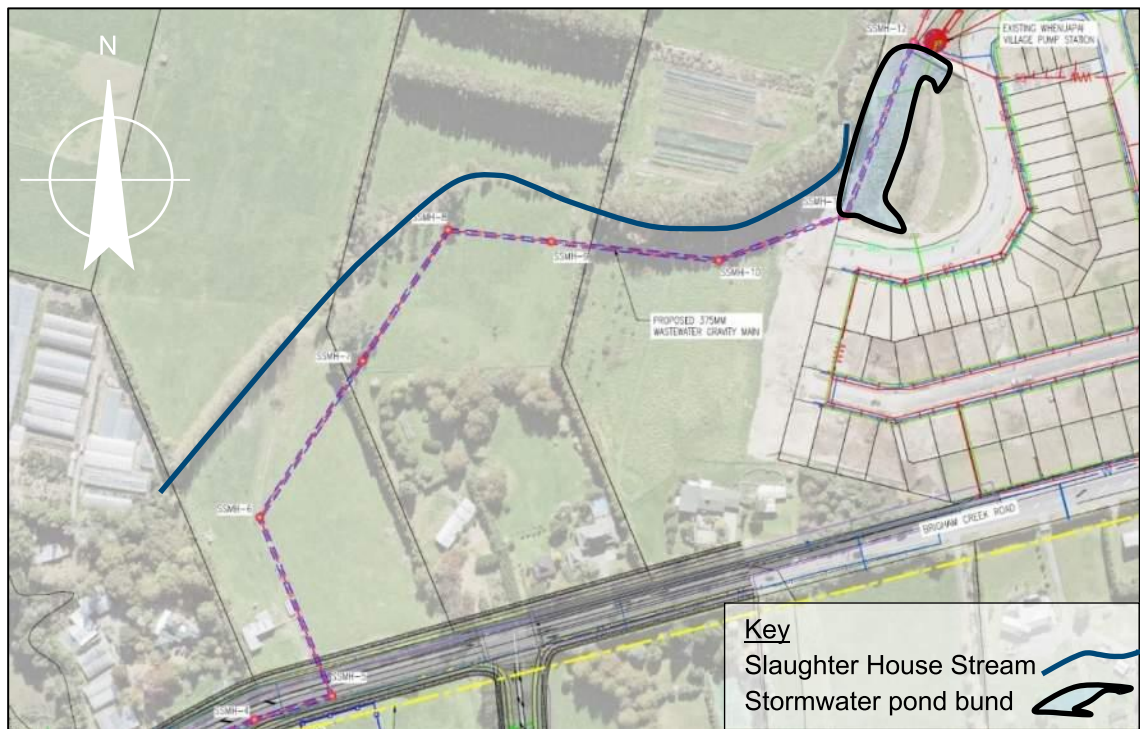


Figure 1 Features of note along between CH 167 and CH 740 along gravity sewer main alignment

The alignment turns west at CH 167 (SWMH-5) and runs along the southern edge (east bound lane) of Brigham Creek Road for approximately 85 m where it turns south at CH 82 into 23-27 Brigham Creek Road.

23-27 Brigham Creek Road is currently an open agricultural field that dips gently to the south west with no significant features other than a small wetland shown in Figure 2 below. The south-western boundary of this property is formed by Sinton Stream, which resides approximately 5.0 m below the ground level of 23-27 Brigham Creek Road. The banks of Sinton Stream are steep (>45°) and densely vegetated.

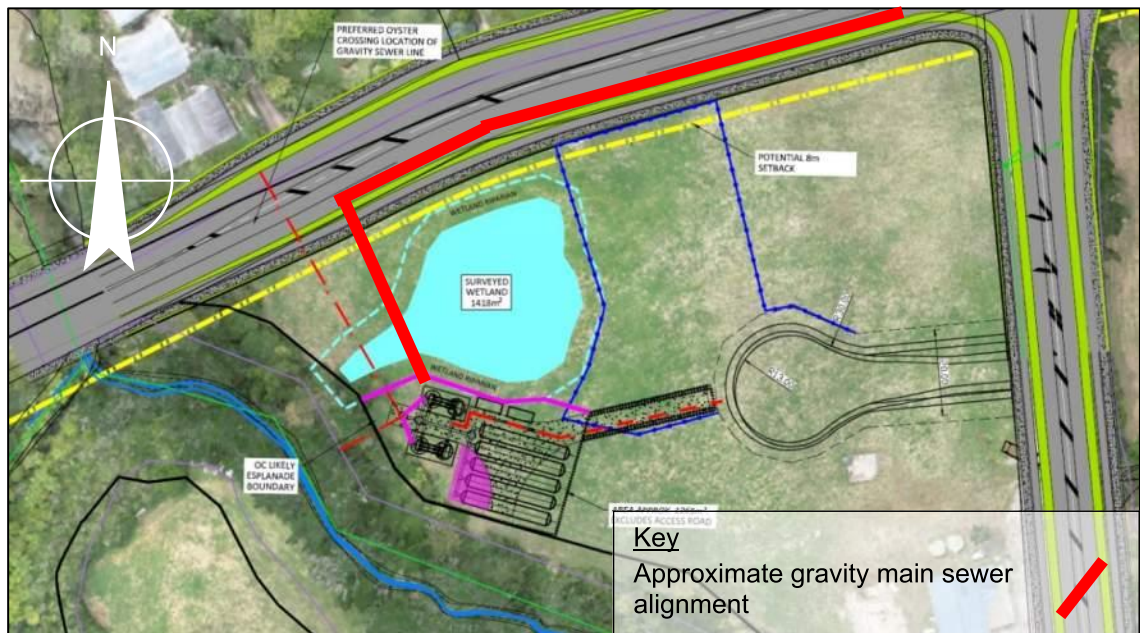


Figure 2 Location of wetland within 23-27 Brigham Creek Road

2.1.3 Rising main

The proposed rising main is located over the southern two thirds of the total alignment. The rising main begins at the proposed pump station (see Figure 2 above). The rising main then follows Spedding Road to the termination of the alignment at the intersection of Mamari Road and Spedding Road. It is proposed to connect the proposed pipe to the Massey Connector at this point. It is however noted that the investigations within T&T 2021 extend over the proposed Massey Connector location and this should be reviewed by the Massey Connector team.

It should be noted that Spedding Road does not currently extend beyond CH 120, but it will be extended to CH 912 as part of development works by others. The road extension will include the culverted crossing of Sinton Stream between CH 220 and CH 250.

2.2 Historical aerial photography

Retrolens Historical Image Resource and Google Earth were accessed to obtain information on the site's history via aerial photography between the available date ranges of 1940 and 2017. The historical aerial photographs are included in Appendix B coupled with a brief description of relevant features for each. A summary of the site history is given below.

The first available image dated 1940 shows rural grassed lands with sporadic buildings present. Slaughter House Stream and Sinton Stream are shown in their current positions. Brigham Creek Road and Spedding Road are shown in their current position.

Minimal development is noted on the historical aerial photographs until 2015 when the photograph shows recent development adjacent the northern most end of the alignment and includes the creation of the stormwater pond (see Figure 1). The only significant feature of note is earthworks occurring in the area of the wetland (see Figure 2) in the photograph dated 1996 suggesting this feature is manmade.

2.3 Published geology

2.3.1 1:250,000 Geological Map of Auckland

The 1:250,000 Geological Map of Auckland (Edbrooke 2001) shows the gravity sewer main to straddle the geological boundary of Tauranga Group Alluvium and Tauranga Group Puketoka Formation. The rising main is shown to be underlain by the Puketoka Formation only. An extract of the geological map is presented as Figure 3 with the units identified with their corresponding map descriptions in Table 1. It is noted that the 1:250,000 map presents the same geology as the 1:50,000 published geological map.

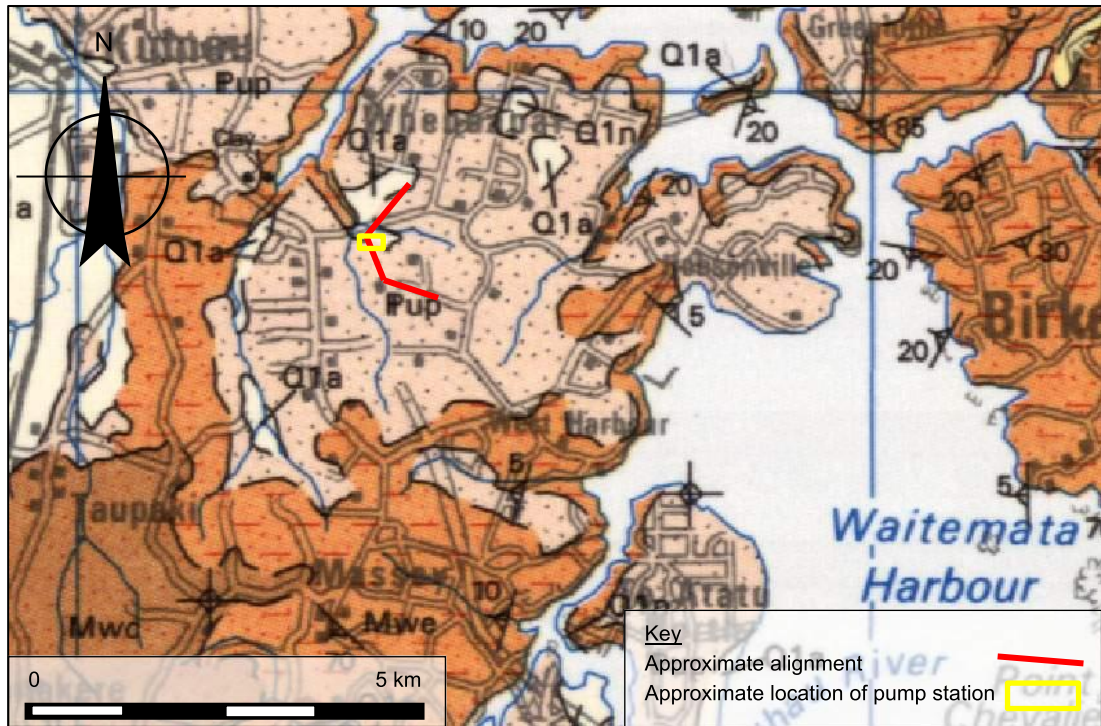
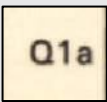




Figure 3 Extract from 1:250,000 geological map

Table 1 Extract from 1:250,000 geological map of the Auckland area key

Map Symbol	Group	Geological Unit	Description (Edbrooke, 2001)
	Tauranga Group	Alluvium / Colluvium	Alluvial / colluvial deposits, estuarine deposits, lacustrine / swamp deposits and fan deposits
	Waitemata Group	East Coast Bays Formation	Alternating sandstone and mudstone with variable volcanic content and interbedded volcanoclastic grit beds.
	Tauranga Group	Puketoka Formation	Pumiceous mud, sand and gravel with muddy peat and lignite; rhyolite pumice, including non-welded ignimbrite, tephra and alluvial pumice deposits; massive micaceous sand.

2.3.2 New Zealand Geotechnical Database

NZGD was reviewed, however no relevant logs were identified.

3. Site investigation summary

3.1 General

A ground investigation was completed by Tonkin and Taylor along the proposed alignment to inform design. The factual information is reported in T&T 2021 attached as Appendix C. T&T 2021 should be referred to for locations, results, methods and calibration certificates. It should be noted that a 100 series naming convention has been used for the gravity main and a 01 series has been used for the rising main.

3.2 Summary of investigation data

A summary of the available information presented in T&T 2021 is included below. This includes test locations requested by GHD coupled with historical records completed as part of previous packages of work.

- 33 hand auger boreholes to a maximum depth of 5.3 m
- 11 Machine Boreholes to a maximum depth of 21.1 m
- 17 Cone Penetration Tests to a maximum depth of 17.5 m
- Installation of 9 piezometers

The geotechnical testing completed as part of the works included:

- 9 Falling & Rising Slug Tests
- 14 natural moisture contents
- 18 Atterberg Limits Tests (NZS 4402:1986 Tests 2.2, 2.3 & 2.4)
- 29 Wet Sieve particle size distributions (NZS 4402:1986 Test 2.8.1)
- 5 hydrometer particle size distributions (NZS 4402:1986 Test 2.8.4)
- 6 Unconfined Compressive Strength Tests (NZS 4402:1986 Test 6.3.1)
- 7 Organic Matter Ignition Tests (NZS 4402:1986 Test 3.1.2)
- 4 One-Dimensional Consolidation Test (NZS 4402:1986 Test 7.1)
- 5 Hydrometer Test (NZS 4402:1986 Test 2.8.4)

4. Engineering geology

4.1 Engineering geological ground model

4.1.1 General

The ground model has been developed based ground investigation data gathered from T&T 2021 (see Section 0), a study of the geomorphology (see Section 4.3) and experience within the region. It is presented as geological long sections included within Appendix D and should be reviewed in conjunction with the discussions in this assessment.

The ground model has been developed to highlight the expected ground conditions along the alignment.

4.1.2 Ground model uncertainty

The ground model has required some interpretation between locations where the alignment has changed or locations were difficult to access.

4.2 Summary of ground conditions

In general, the geology along the alignment can be described as alluvial soils (Tauranga Group) that overlie weathered sedimentary soil and rock (East Coast Bays Formation) to depth. Localised deposits of the Albany Conglomerate were also encountered below 7.5 m below ground level.

The Tauranga Group can be split into

- undifferentiated recent alluvium in low lying areas adjacent streams; and
- less recent Puketoka Formation in all other areas.

However, for the purposes of this report the materials are all referred to as Tauranga Group alluvium.

The interface of the Tauranga Group and the East Coast Bays Formation (ECBF) is typically within 2.0 m to 3.0 m of ground surface near the pump station and deepens to over 15.0 m along other parts of the alignment. The interface along the alignment has been delineated, where possible, in the geological long sections presented in Appendix D (see Section 4.1).

A brief summary of each unit coupled with a summary of available testing is included below for each geological unit. These sections should be reviewed in conjunction with the ground model discussed in Section 4.1 and the borehole records included in T&T 2021. Where average values have been provided they should not be used as design value. They provide an indication only.

4.2.1 Topsoil

Topsoil (surficial, decomposed organic matter) was encountered where the test locations were advanced through grassed areas. This was typically confined to the gravity sewer main alignment as the rising main passes through the road. The material is comprised organic rich silt and varies in thickness, typically between 0.2 – 0.5 m.

4.2.2 Fill

Limited amounts of fill were encountered on site. The most significant deposit was encountered in the northern most end of the gravity sewer alignment between SSMH11 and SSMH12 and in test locations HA110A, HA110B and HA111. This fill is likely associated with the adjacent stormwater bund works (see Section 2.1.2).

The fill was typically described as being stiff to very stiff silty clay. Topsoil appears to be intermixed throughout the profile therefore it is likely that the material was placed with limited earthworks control.

A summary of the tests completed within the deposit are included as Table 2 below.

Table 2 Summary of bund fill in-situ and laboratory testing

Test	Number of tests	Range of results	Average value
Undrained shear strength (kPa) ¹	13	16 to 219	102
Organic content (%)	1	6	-
Water content (%)	1	52	-
Liquid limit (%)	1	71	-
Plastic limit (%)	1	35	-
Plasticity index	1	36	-

¹ obtained from a hand held shear vane

4.2.1 Tauranga Group Alluvium (TGA)

General

Tauranga Group deposits were encountered from ground level, below any topsoil or fill. The profile was layered and alternated between the following four sub-units:

- TGA-C: Silty clay / clayey silt
- TGA-St: Silt / sandy silt
- TGA-Sa: Sand / silty sand
- TGA-O: Organic clay

The majority of the deposit falls into either TGA-C or TGA-St type soils. Very generally, TGA-C typically sits towards the top of the deposit grading to TGA-St below approximately 5.0 m bgl. TGA-St was however locally encountered near surface, particularly in the eastern most extent of the alignment. TGA-O and TGA-Sa was sporadically encountered in thin layers, typically no thicker than 0.5 m, and did not appear to be laterally continuous.

A brief summary of each sub-unit is presented in the following sub-sections. Atterberg test results for all sub-units is plotted on a Casagrande graph presented as Figure 4 below. The majority of the data indicates high plasticity clays are present, with plasticity indices generally in excess of 25.

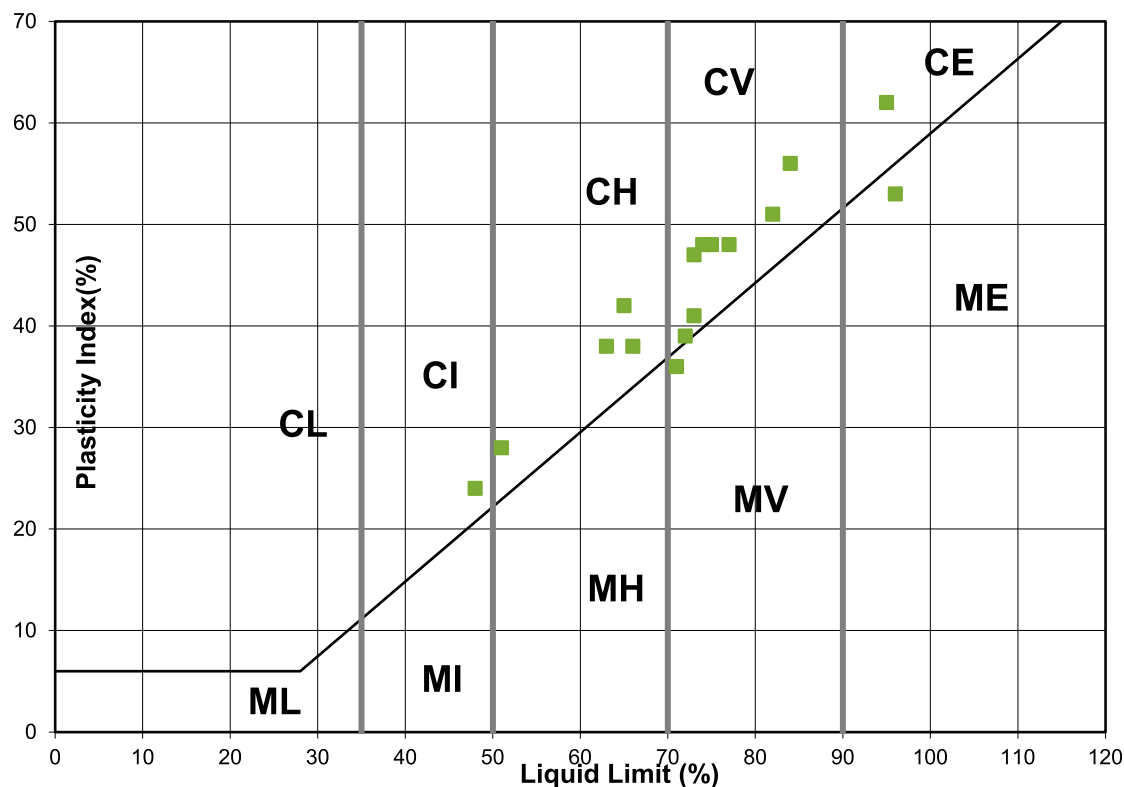


Figure 4: Casagrande (A-line) graph (PI vs LL)

TGA-C: Silty clay / clayey silt

TGA-C was generally located within 5.0 m from ground level. It was typically described as being a stiff silty clay or clayey silt with varying amounts of sand. A summary of the available testing is presented as Table 3 below.

Table 3 Summary of in-situ and laboratory testing for TGA-C

Test	Number of tests	Range of results	Average value
Undrained shear strength (kPa) ¹	79	25 to 200	93
Organic content (%)	3	3 to 20	9
Moisture content (%)	8	38 to 50.1	43
Liquid limit (%)	8	63 to 84	71
Plastic limit (%)	8	23 to 32	27
Plasticity index	8	24 to 56	44

Test	Number of tests	Range of results		Average value
Particle size distribution (%)	-	Sand	Silt	Clay
Wet sieve	5	23 to 61	39 to 76	
Hydrometer	4	7 to 22	48 to 72	21 to 44
¹ obtained from a hand held shear vane				

TGA-St: Silt / sandy silt

TGA-St was described as being a stiff either silt or sandy silt with some clay. This was the dominant unit within the Tauranga Group materials and encountered either near surface or below the TGA-C.

A summary of the available testing is presented as Table 4 below.

Table 4 Summary of in-situ and laboratory testing for TGA St

Test	Number of tests	Range of results		Average value
Undrained shear strength (kPa) ¹	88	19 to 218		101
Moisture content (%)	6	42 to 69.4		53
Liquid limit (%)	7	48 to 135		85
Plastic limit (%)	7	23 to 33		32
Plasticity index	7	28 to 95		53
Particle size distribution (%)	-	Sand	Silt	Clay
Wet sieve	7	10 to 33	67 to 90	
¹ obtained from a hand held shear vane				

TGA-Sa: Sand / silty sand

TGA-Sa was typically described as being a loose to medium dense sand or silty sand. SPTs completed within the material were limited given the thin layers in which it was encountered. Where possible, uncorrected SPT N values ranged between 4 and 15. No other in situ or laboratory testing was completed in the sand dominant layers of the TGA-Sa group.

TGA-O: Organic clay

TGA-O was typically described as being stiff organic silty clay or clayey silt. It was typically located in localised pockets no larger than 0.5 m thick and confined to the northern half of the alignment.

A summary of the available testing is presented as Table 5 below.

Table 5 Summary of in-situ and laboratory testing for TGA-O

Test	Number of tests	Range of results		Average value
Undrained shear strength (kPa) ¹	3	16 to 96		-
Organic content (%)	3	6 to 15		9
Moisture content (%)	1	52		-
Liquid limit (%)	4	66 to 148		104
Plastic limit (%)	4	28 to 60		43
Plasticity index	4	36 to 88		62
Particle size distribution (%)	-	Sand	Silt	Clay
Wet sieve	3	13 to 18	81 to 87	
¹ obtained from a hand held shear vane				

4.2.2 Albany Conglomerate

Albany conglomerate rock was identified in BH05B located at CH 200 of the rising main alignment at a depth of 7.5 m bgl and in BH116 at CH 640 along the gravity sewer at a depth of 13.5 m bgl. This unit was typically described as being a completely to highly weathered sandstone or conglomerate. It was typically recovered as a gravel and is inferred to be weakly cemented.

A summary of the available testing is presented as Table 6 below.

Table 6 Summary of in-situ and laboratory testing for the Albany Conglomerate

Test	Number of tests	Range of results	Average value
Undrained shear strength (kPa) ¹	1	119	-
UCS (kPa)	1	730	-
Water content (%)	1	22.6	-
Bulk density	1	2.05	-
Dry density	1	1.65	-
Young's Modulus	1	94	-
¹ obtained from a hand held shear vane			

4.2.3 East Coast Bays Formation residual soils

Residual East Coast Bays Formation soils were typically located near surface in the northern third of the alignment. It was typically described as being a stiff to very stiff clayey silt or a sandy silt.

A summary of the available testing is presented as Table 7 below.

Table 7 Summary of in-situ and laboratory testing for ECBF residual soil

Test	Number of tests	Range of results		Average value
Undrained shear strength (kPa) ¹	5	34 to 186		93
Particle size distribution (%)	-	Sand	Silt	Clay
Wet sieve	3	30 to 50	50 to 70	
¹ obtained from a hand held shear vane				

4.2.4 East Coast Bays Formation weathered rock

ECBF weathered rock was encountered below the residual soils and was typically described as being extremely weak becoming very weak sandstone interbedded with siltstone.

A summary of the available testing is presented as Table 8 below.

Table 8 Summary of in-situ and laboratory testing for weathered ECBF rock

Test	Number of tests	Range of results	Average value
UCS (kPa)	4	610 to 1200	910
Water content (%)	4	20.5 to 24	22
Bulk density	4	1.98 to 2.06	2.03
Dry density	4	1.65 to 1.7	1.66
Young's Modulus (MPa)	4	85 to 183	131.5

4.3 Geomorphology

GHD is in general agreement that the published geological map suitably represents the greater area. However, GHD would note the following based on our site walkover and a review of the contours:

- The mapped geology (see Section 2.3.1) shows Totara Creek to be flanked by ECBF north of Brigham Creek Road. This has occurred due the creek incising a 5 to 10 m deep channel through the overlying alluvium and into ECBF weathered rock. A walkover by GHD identified this exposure continuing south within the similar sized banks of Sinton Stream adjacent 22-27 Brigham Creek Road.
- Brigham Creek Road is level with the surrounding topography along the northern side of the road. The southern side of the road is however formed a by an approximately 30° 1.5 m high batter when compared to the adjacent topography. It is therefore expected that the road is founded on a fill batter approximately 1.5 m deep along the southern edge thinning to ground level along the northern side of the road.
- The gravity sewer is shown to pass in and out of the Puketoka Formation and recent alluvium between CH 167 and CH 647 on the published geological map. The recent alluvium is associated with the Slaughter House Stream flood plain however it could

possibly include colluvium from the gentle slope above to the south. The alignment through this area is presented as Figure 5 below. The geology within this area is expected to be highly variable.

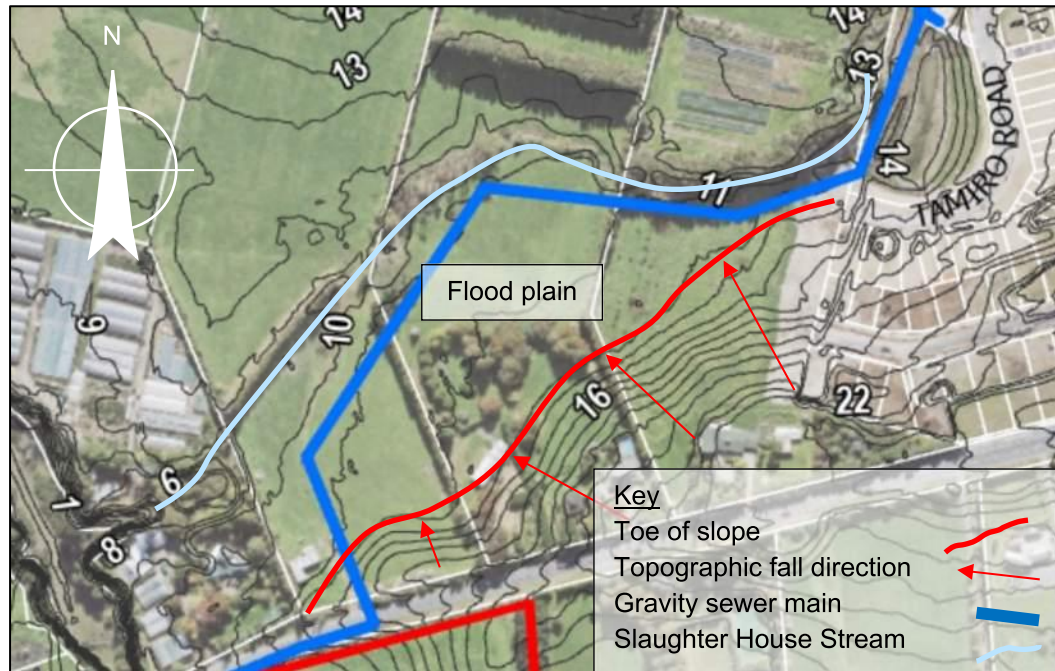


Figure 5 Gravity sewer main between CH 167 and CH 647 geomorphology

4.4 Groundwater conditions

4.4.1 Static groundwater levels

Static groundwater monitoring was underway during the time of the preparation of this report. The monitoring to date show groundwater levels to range between 0.4 m bgl to 4.8 m bgl.

4.4.2 Hydraulic conductivity

The hydraulic conductivity (permeability) of the main geological units across the site was assessed in T&T 2021. These values are summarised below in Table 9.

Significant variation in the hydraulic conductivity can exist from the encountered materials as a function of preferential flow paths created from defects (bedding planes or joints) or more/less permeable layers or lenses. These are provided for reference only.

Table 9 Hydraulic Conductivity of main stratigraphic units

Geological Unit	Saturated Hydraulic Conductivity kH (m/s)
Tauranga Group	8.2 x 10 ⁻⁸
	8.7 x 10 ⁻⁸
	1.7 x 10 ⁻⁷
	1.7 x 10 ⁻⁷
	5.8 x 10 ⁻⁷
Residual East Coast Bays Formation Silts and Sands	5.1 x 10 ⁻⁷
	9.3 x 10 ⁻⁷
	1.0 x 10 ⁻⁶
Albany Conglomerate	2.2 x 10 ⁻⁵

5. Geotechnical assessment

5.1 Geotechnical design parameters

Recommended geotechnical design parameters for the geological units summarised in Section 4.2 are presented in Table 10 below. These parameters have been developed from review of existing site investigation data, existing reports (Section 0) as well as our experience of similar materials within the Auckland region.

Table 10 Geotechnical design parameters

Geological Unit	Shear Strength Su (kPa)	Bulk Unit Weight, γ (kN/m ³)	Effective Cohesion c' (kPa)	Angle of Internal Friction ϕ' (°)	Unconfined Compressive Strength, UCS (MPa)
Non-Engineered Fill	50	18	0	28	NA
TGA-C	50	18	2	28	NA
TGA-St	50	17	1	28	NA
TGA-Sa	-	18	-	30	NA
TGA-O	50	16	0	28	NA
ECBF Residual Soil	60	18	5	30	NA
ECBF weathered rock	1000	21	25	35	1.0

NA: Not Applicable

5.2 Site seismic classification

The Damage Control Limit State (“DCLS”) and Serviceability Limit State (“SLS”) design earthquake loadings for the assessment of liquefaction and the stability and displacement of soil structures have been calculated in accordance with the NZTA Bridge Manual (NZTA 2018a). The equation used in is reproduced below:

- $PGA = C_{0,1000} \times (R_u/1.3) \times f \times g$

The various input parameters for the equation are presented in Table 11 below.

Table 11 Input parameters for determination of peak ground acceleration

Seismic Case	Input Parameter	Parameter Value	Comment
General	Importance Level (IL)	3	NZS 1170.0
	Design Life	100 years	Client Specified
	Subsoil Class	D	NZS 1170.5 Clause 3.1.3.2 to 3.1.3.5
	DCLS Return Period	1/2500	Table 3.3 NZS1170.0
	SLS Return Period	1/25	Table 3.3 NZS1170.0
	Effective Magnitude Earthquake	5.9	NZTA 2018b Table C6.1

Seismic Case	Input Parameter	Parameter Value	Comment
Ultimate Limit State	1000 year return period PGA coefficient ($C_{0,1000}$)	0.19	NZTA 2018b Table C6.1
	Return Period Factor (R_u)	1.8	NZTA 2018a Table 3.5
	Site subsoil class factor (f)	1.00	NZTA 2018a Section 6.2.2
Serviceability Limit state	25 year return period PGA coefficient ($C_{0,1000}$)	0.2	NZTA 2018a Figure 6.1(a)
	Return Period Factor (R_s)	0.25	Table 3.5 NZS 1170.5
	Site subsoil class factor (f)	1.0	NZTA 2018a Section 6.2.2

The following PGA's have been calculated, accordingly:

- DCLS PGA = 0.26 g
- SLS PGA = 0.04 g

Where retaining walls are unanchored and are designed to support surfaces, driveways, laydown areas and the like and do not provide direct support to building footings, we recommend that the DCLS acceleration is used in conjunction with a wall displacement factor of 0.3*.

* - the use of wall displacement factors is described in detail in "Earthquake geotechnical engineering practice, Module 6 : Earthquake resistant retaining wall design. MBIE & NZGS, May 2017."

5.3 Liquefaction vulnerability assessment

The liquefaction vulnerability of the proposed Whenuapai-Redhills wastewater pipelines has been assessed using the ground investigation results and geological characterization of the site outlined in Section 4. The assessment aims to determine whether the reported subsurface conditions are prone to liquefaction during earthquake, and more generally to discuss the induced effects on the proposed pipelines.

The laboratory data available in Appendix C and summarised in Section 4.2 for each unit, includes eighteen Atterberg Limit tests completed between 1.5 m bgl and 5.8 m bgl along the alignment. The Plasticity Index (PI) values were greater than 24 in all tests, with a median PI of 48. These results indicate that the clay and silt mixtures encountered are highly plastic. Soils that exhibit PI greater than 12 are generally considered unlikely to liquefy (MBIE 2016). It should be noted that the soil descriptions included on the borehole logs does not always reflect the high plasticity materials reported in the laboratory test results.

Although there is the potential for thin, isolated liquefiable lenses to exist, for design purposes, this site can be considered non-liquefiable.

5.4 Slope Stability

5.4.1 Qualitative assessment

The only slope stability risks to be considered for this project are at the pump station which is located within a few metres of the banks of the Sinton Stream.

The underlying geological profile at the pump station comprises Tauranga Group alluvium to approximately 2.5 m depth followed by residual ECBF soils grading to weathered rock at 4.0 m bgl. The proposed elements of the pumping station are typically founded at depths greater than 4.0 m bgl therefore will be embedded into weathered rock.

Weathered rock poses a small risk of instability. However, it is possible that the crest of the Sinton Stream banks will regress with time possibly exposing the buried tanks. A cross section through the pump station and Sinton River is presented as Figure 6 and shows the stream banks and an assumed 1 V (vertical) to 3 H (horizontal) regression slope angle.

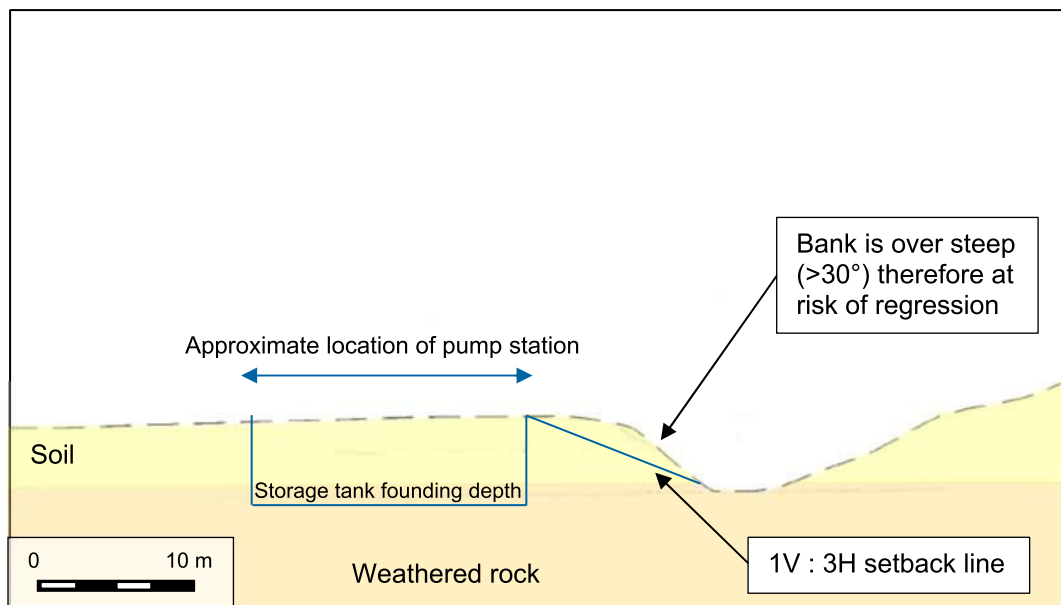


Figure 6 Cross section through pump station

It is recommended that the pump station be set back 6 m from the crest of the slope to allow for the regression of the slope.

5.5 Buoyancy

The majority of the proposed sewer alignment, manholes and detention tanks will be hollow during the majority of their operation, with occasional periods where they will be full with wastewater. In addition, the proposed invert level of these structures, coupled with the generally shallow groundwater level, means that it is more likely they will experience uplift forces (buoyancy) as opposed to settlement resulting from foundation loading. Buoyancy forces could potentially damage the infrastructure or cause heave of the overlying ground.

We recommend that all pipe sections, tanks and shafts be designed to resist buoyancy forces at a depth below the groundwater table. This will likely comprise of the use of 'flanges' or over excavation of shafts and backfill around a concrete base pad. The use of uplift piles may also be required in some sections.

6. Design considerations

6.1 Pump station recommendations

6.1.1 Local geological profile

The following geological profile can be expected based on boreholes (HA112, BH110 and BH111) and CPTs (CPT111-112):

- Topsoil up to 0.4 m thick;
- Tauranga alluvial soils below the topsoil to 2.5 m bgl;
- ECBF residual soils to 4 m bgl;
- ECBF weathered rock beyond 4 m bgl, comprising extremely weak to weak sandstone units with a gradual increase in stiffness over depth up to 7.5 mbgl where unweathered sandstone was encountered.

6.1.2 Groundwater

Groundwater levels of approximately 2.0 m bgl were observed within the boreholes. Excavations deeper than this are likely to require dewatering measures. The risk of settlements resulting from drawdown are discussed in Section 7.

6.1.3 Switch room

Details of the above ground switch room were not provided at the time of the preparation of this report however are expected to be light weight container / portacom type structures.

It is recommended that the switch rooms are founded on short piles or strip and pad foundations. The foundations should embed past the base of the wetland which is approximately 0.5 m to 1.0 m below the existing contours below the pump station. The choice of foundation will be dependent on the final location of the switch room and the proposed loadings.

An Ultimate Bearing Strength of 300 kPa is available for short bored piles with diameters up to 0.6 m, or strips no greater than 0.7 m wide embedded within natural ground. This reduces to a Design Bearing Strength of 150 kPa using a Strength Reduction Factor of $\phi = 0.5$ as per B1/VM4.

Shallow footings should be designed to Site Soil Class H1 with the corresponding depths as per AS 2870:2011 requirements.

6.1.4 Storage tanks, wet well and valve chamber

Founding conditions

The storage tanks, wet wells and valve chamber are to be founded below ground level. These will be excavated through the generalised profile in Section 6.1.1 and will be founded on the following geological units:

- The wet well is founded 8 m bgl therefore expected to be embedded in unweathered sandstone (SPT $N > 50$);
- The valve chambers is founded 2.5 m bgl therefore expected to be founded at the interface of the ECBF soils and the overlying Tauranga Group alluvium;
- The storage tanks' invert levels typically range between 5.2 and 5.5 mbgl therefore expected to be founded on weathered sandstone units (SPT $N > 50$).

Positioning

The pump station should be set back 6 m from the crest of the slope as outlined in Section 5.4.1. This will remove the risks to the station from slope instability.

Backfill

Due to the water content of the in situ material, use of site won material as backfill will not be feasible.

We therefore recommend an imported, engineered backfill is used. This should be placed and compacted in accordance with a formal site-specific Specification.

6.1.5 Pavement design

The proposed pavement subgrade will either be formed of engineered fill placed to backfill around the various elements or Tauranga Group alluvium likely comprising stiff silty clay. It is therefore recommended that an unsoaked CBR of 3% is adopted for design. To achieve the CBR value it is recommended that the formation level is proof rolled, inspected and any soft, loose or deleterious material is removed and replaced with compacted granular fill.

6.2 Sinton Stream crossing

6.2.1 General

It is understood that an earth embankment is proposed to be constructed by the developer where the rising main alignment crosses Sinton Stream between CH 220 and CH 250. The design of this embankment is outside the scope of this report however it is expected that the weight of embankment will induce settlement. These settlements should be assessed and the effect on the pipe studied.

It is also noted that a change in 'bedrock' occurs below this stream with the north underlain by Albany Conglomerate and the south underlain by the East Coast Bays Formation rock. This is unlikely to significantly effect design given the relative depth to rock is similar however this should be assessed by the designer.

6.3 Pipe design

6.3.1 Native soil modulus

The native soil modulus is a function of the pipe design, foundation soils and installation technique, which were under development at the time of the preparation of this report. These values will therefore be confirmed at a later stage of design.

6.3.2 Backfill

Trench backfill

Trench backfill should be placed in accordance with the Watercare or Auckland Transport Minimum Requirements as appropriate. Any site specific Specification should take the following into account:

- It is recommended that in areas where the alignment passes through permeable land (i.e. the gravity main sewer), an impermeable clay 'cap' should be placed to prevent surface sheet flows from flooding the trench.

- Trench backfill material should retain a similar permeability to the in-situ ground conditions, to avoid interfering with transient groundwater flows that may instigate slope instability.

Trench stops

To control the potential transient flow of groundwater within backfilled trench excavations, which could lead to over saturation of supporting soils and/or permanent groundwater drawdowns, trench-stops consisting of clay or bentonite, or the use of sheet piles. The requirement for the use of trench stops should be determined in further design stages (this includes sizing and spacing). This may require supporting hydrogeological analysis.

6.4 Earthworks

6.4.1 Permanent cuts

The design of permanent cuts are currently not proposed. If during the progression of design they are required a proposed a preliminary angle of no greater batter angle than 1V : 3H within Puketoka Formation and East Coast Bays Formation materials should be adopted. However, the design of any cuts is a function of existing structures, geology, geomorphology etc. and should therefore be discussed with GHD prior to finalisation.

7. Construction Considerations

7.1 General

We have not identified any significant geotechnical risks that would preclude the use of an open trench methodology or Horizontal Directional Drilling (HDD). However, each method has inherent risks during construction which need to be addressed and controlled by the Contractor.

It is recommended this section (and the ground model in Section 4 and the geotechnical parameters in Section 5) is reviewed by the Contractor prior to the commencement of construction.

7.2 Temporary groundwater drawdown induced settlement

Groundwater was recorded at relatively shallow depths across the site, generally ranging from 1.5 – 4.0 mbgl, with an average level of approximately 2.0 mbgl. It is anticipated that the majority of excavations required for pipe, shaft and tank installation will be below the groundwater table. Management of inflowing groundwater will therefore be required. Dewatering of these excavations will cause localised drawdown of the groundwater table, which may induce settlement of the surrounding ground surface.

Proper management of inflowing groundwater will also help to mitigate the risk of trench excavation collapse. The contractor should manage groundwater drawdown and ground settlement as part of temporary works design and during construction. We recommend that dilapidation surveys of existing structures and ongoing settlement monitoring are considered, particularly where the pipelines will be constructed adjacent to existing developments.

Consideration should also be given to higher groundwater pressures and inflow rates along uncemented sand layers and through rock defects, when excavating within the ECBF rock.

For the construction of shafts, appropriate temporary support that prevents groundwater inflow into the excavation should be considered. This may include designs such as driven steel sheet piles and ground curtains.

7.3 Rock defects

Rock defects were encountered within the ECBF rock. These defects may daylight within deep excavations, particularly those for the gravity trunk sewer adjacent to the pump station. Kinematic failure may be induced along these defects causing cave-in of the excavations.

If encountered, the defects may also act as conduits for groundwater seepage into the excavations. This could result in higher pressure and faster than anticipated groundwater inflows.

7.4 Trench, shaft and chamber excavation short term stability

Instability of trench, shaft and chamber excavations could result in injury or death of persons in the trench and damage to equipment.

Temporary support will be required where shafts and trenches are greater than 1.5 m deep and is recommended beyond 1.0 m deep for trenches on sloping ground. Design and implementation of suitable temporary support solutions is the responsibility of the contractor and should be assessed and approved by a suitably qualified geotechnical professional.

GHD notes that sand dominated layers below the groundwater table exist along the alignment and therefore will be at risk of 'running sands' (i.e. immediate collapse of the layer upon excavation).

7.1 Hydraulic fracturing and surface heave

Where it is proposed to install the pipelines via Horizontal Directional Drilling (HDD), there is risk of hydraulic fracturing ('frac-out') or surface heave due to fluid pressure from the injected slurry. This risk is highest in sections of the alignment where surface cover is shallow (e.g. < 3.0 m) and/or where soft or sandy and recently deposited alluvial soils exist.

The Contractor should review the anticipated ground conditions and associated material parameters (section 4 and 5) prior to undertaking any HDD activities (in particular afore mentioned areas where increased risk is expected).

7.2 Variable ground conditions

The expected ground conditions along the alignment are predominantly Tauranga Group alluvial soils, however residual and weathered ECBF, as well as localised deposits of recent alluvium, colluvium, and man-made fill, were encountered. Variable ground conditions may be associated with localised fluctuations in groundwater pressure. Other risks to the proposed construction of the sewer and pump station, associated with the variable ground conditions expected, include:

- Possibility of buried logs within organic/peat lenses in Puketoka Formation however it should be noted none were encountered during the investigation
- Sandy/soft and saturated lenses, within Puketoka Formation, Colluvium, and recently deposited alluvium

7.3 Soft and compressible soils

Soft or compressible soils are expected along the alignment of the pipe alignments. Where soft or compressible materials are encountered, they should be over-excavated and replaced with compacted fill.

7.4 Disaggregation of ECBF Rock

ECBF rock can disaggregate when mechanically worked, and break down to a 'sticky paste'. This disaggregation generally occurs when particles are broken down to a clay size. These clay particles then swell. Although the majority of the rock that the alignment is expected to be constructed in is Sandstone, the finer grained 'matrix' is typically comprised of silt and clay particles. The residually weathered soil that overlies the sandstone may also disaggregate more readily than the less weathered parent rock.

7.5 Inspections and Certification

At this stage, GHD are not retained to carry out site observations, any form of advice during site works, or to provide a PS4 for the works.

8. Limitations

This report has been prepared by GHD Limited for Watercare and may only be used and relied on by Watercare for the purpose agreed between GHD and Watercare as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Watercare arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by Watercare and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

Data queried from the New Zealand Geotechnical Database (NZGD) have been considered in the preparation of this report. Where boreholes, test pits, cone penetration tests, laboratory tests, geophysical tests and similar work have been performed and recorded by others, the data are included and used in the form provided by others to the NZGD. No warranty or representation whatsoever (including as to its accuracy, adequacy, completeness, or fitness for any purpose) is provided by GHD in connection with the data.

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An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended, abbreviated, or issued in part in any way without prior written approval by GHD. GHD does not accept liability in connection with the issuing of an unapproved or modified version of this report.

This report is based on information obtained from specific investigation locations, test points and sample points undertaken at a specific point in time. As a result such information may not represent the conditions that may be encountered across the site at any future point in time. The actual characteristics of materials may vary significantly. Ground and groundwater conditions have been inferred between locations. Ground conditions, including groundwater levels and contaminant concentrations can change over time. GHD does not accept liability in connection with varied conditions.

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. If the revealed ground or

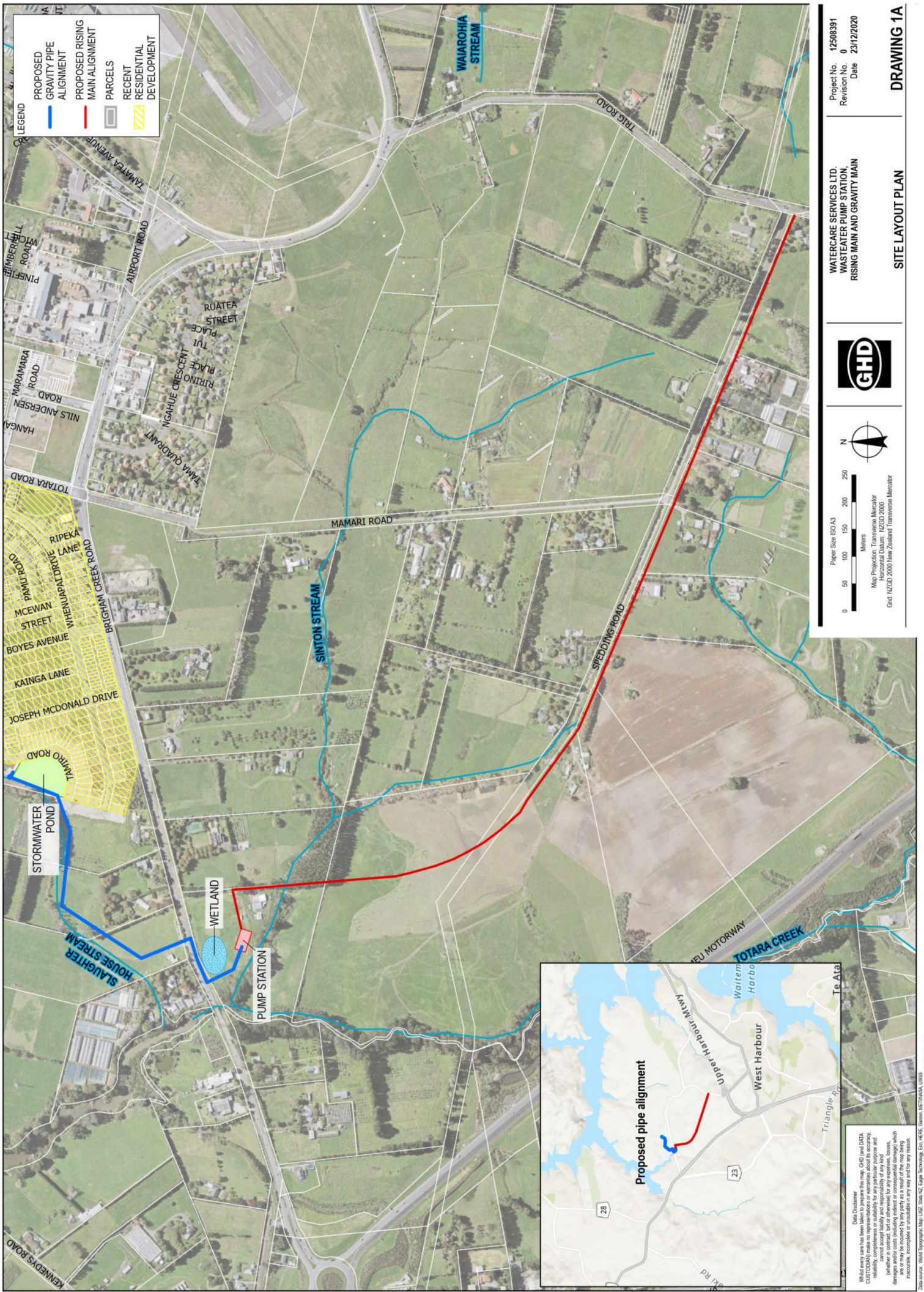
groundwater conditions vary from those assumed or described in this report the matter should be referred back to GHD.

9. References

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Appendices

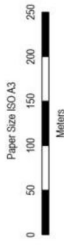
Appendix A – Drawings



- LEGEND**
- PROPOSED GRAVITY PIPE ALIGNMENT
 - PROPOSED RISING MAIN ALIGNMENT
 - PARCELS
 - RECENT RESIDENTIAL DEVELOPMENT

Project No. 12508391
 Revision No. 0
 Date 23/12/2020

WATERCARE SERVICES LTD.
 WASTEATER PUMP STATION,
 RISING MAIN AND GRAVITY MAIN

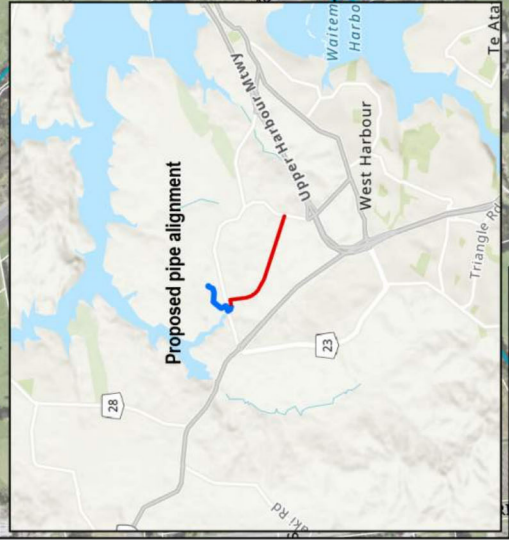


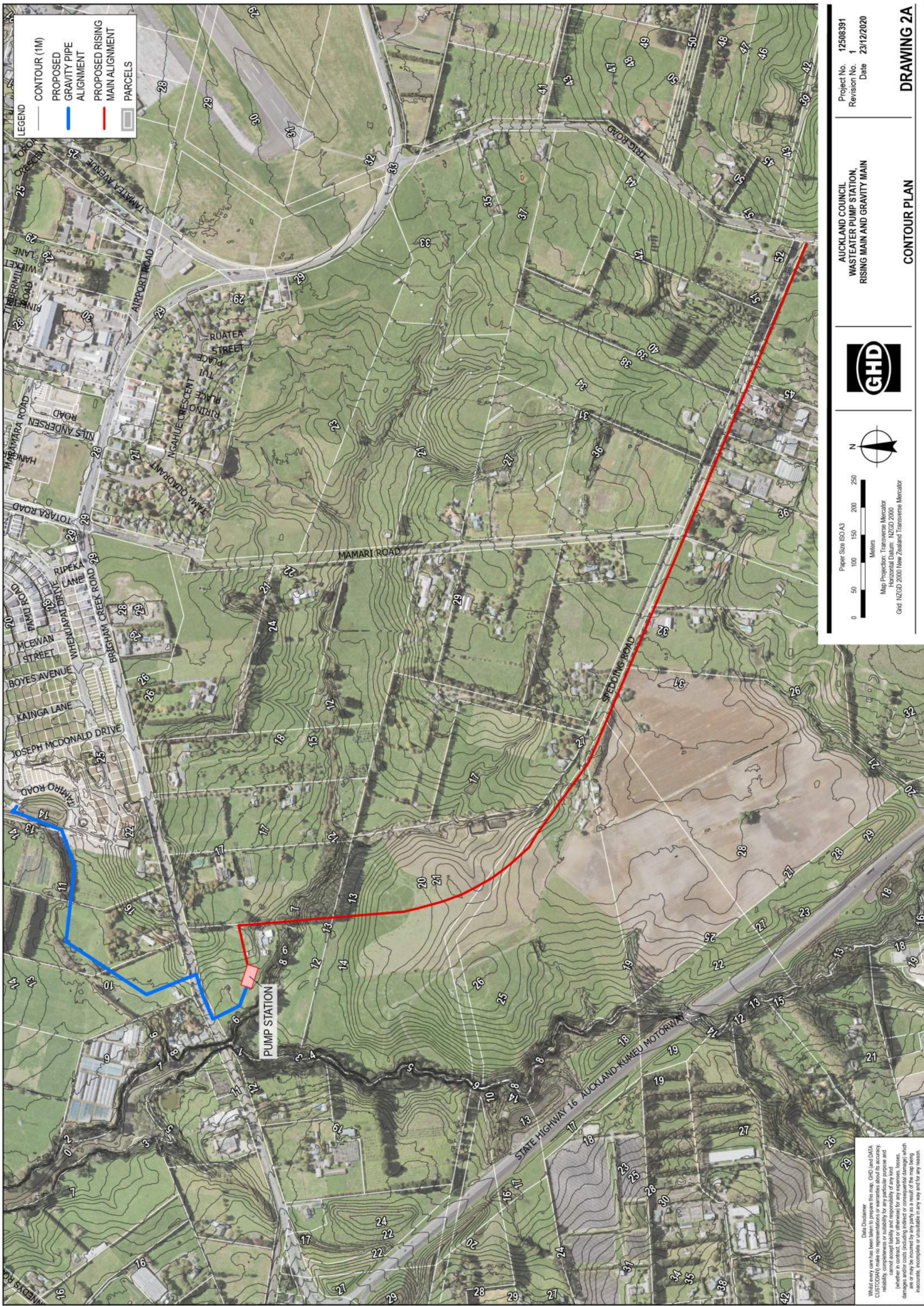
Map Projection: Transverse Mercator
 Horizontal Datum: NZGD 2000
 GCS: NZGD 2000 New Zealand Transverse Mercator

DRAWING 1A

SITE LAYOUT PLAN

Data Disclaimer
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- LEGEND**
- CONTOUR (1M)
 - PROPOSED GRAVITY PIPE ALIGNMENT
 - PROPOSED RISING MAIN ALIGNMENT
 - ▭ PARCELS

Project No. 12508391
 Revision No. 1
 Date 23/12/2020

AUCKLAND COUNCIL
 WASTEATER PUMP STATION,
 RISING MAIN AND GRAVITY MAIN



Paper Size ISO A3
 0 50 100 150 200 250
 Meters

Map Projection: Transverse Mercator
 Horizontal Datum: NZGD 2000
 GCS: NZGD 2000 New Zealand Transverse Mercator

DRAWING 2A

CONTOUR PLAN

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LEGEND

LOCAL ELEVATION (M)

HIGH: 58.375

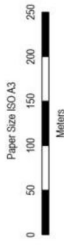
LOW: -0.843

PROPOSED GRAVITY PIPE ALIGNMENT

PROPOSED RISING MAIN ALIGNMENT

Project No. 12508391
 Revision No. 1
 Date 23/12/2020

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DRAWING 3A

HILLSHADE PLAN

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Appendix B – Historical aerial photography

Historical Aerial Photographs

Comments



1940 – SN70335 - Retrolens

Rural grassed plains



1961 – Retrolens (unknown SN)

Housing at NE end. Growth of vegetation (trees). Additional roads down the southern end



1980 – SN5783 - Retrolens

Removal of vegetation at SW end replaced with extended roads down the southern end



2000– Auckland Council GeoMaps

Clearer distinctions in property of lands through vegetation, fencing, crops, etc. More buildings/houses scattered around the area. New growth and removal of vegetation at the eastern ends



**2006 – Auckland Council
GeoMaps**

No significant changes



**2008 – Auckland Council
GeoMaps**

No significant changes



2010-11 – Auckland Council GeoMaps

No significant changes



2015-16 – Auckland Council GeoMaps

No significant changes



**2017 – Auckland Council
GeoMaps**

Latest available aerial shot.

No significant changes

Appendix C – Geotechnical Factual Report



**Whenuapai-Redhills
Wastewater Servicing Rising
Main/Gravity Main and
Interim Pump Station
(Package 1)**

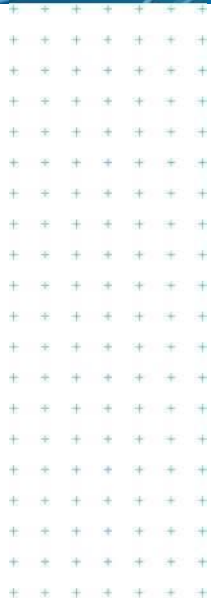
**Geotechnical Ground Investigation
Factual Report**

Prepared for
Watercare Services Limited

Prepared by
Tonkin & Taylor Ltd

Date
January 2021

Job Number
1014985.0000



Document Control

Title: Whenuapai-Redhills Wastewater Servicing Rising Main/Gravity Main and Interim Pump Station (Package 1), Geotechnical Ground Investigation Factual Report					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
December 2020	0.1	Draft – Laboratory Test Results Pending	Chris Monk	Ben Westgate	Robert Hillier
January 2021	1.0	Geotechnical Factual Report – Groundwater monitoring Pending	Chris Monk	Ben Westgate	Robert Hillier

Distribution:

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1 Introduction

Tonkin & Taylor Ltd (T+T) was engaged by Watercare Services Limited (Watercare) to conduct a ground investigation at Whenuapai-Redhills (Figure 1, Appendix A). The investigations were undertaken to assess the ground conditions along the alignment of the proposed Whenuapai-Redhills Wastewater Servicing Rising Main / Gravity Main Pipeline and Interim Pump Station.

T+T provided geotechnical services in accordance with our proposal dated 28 October 2020¹ and included the scope of works summarised below:

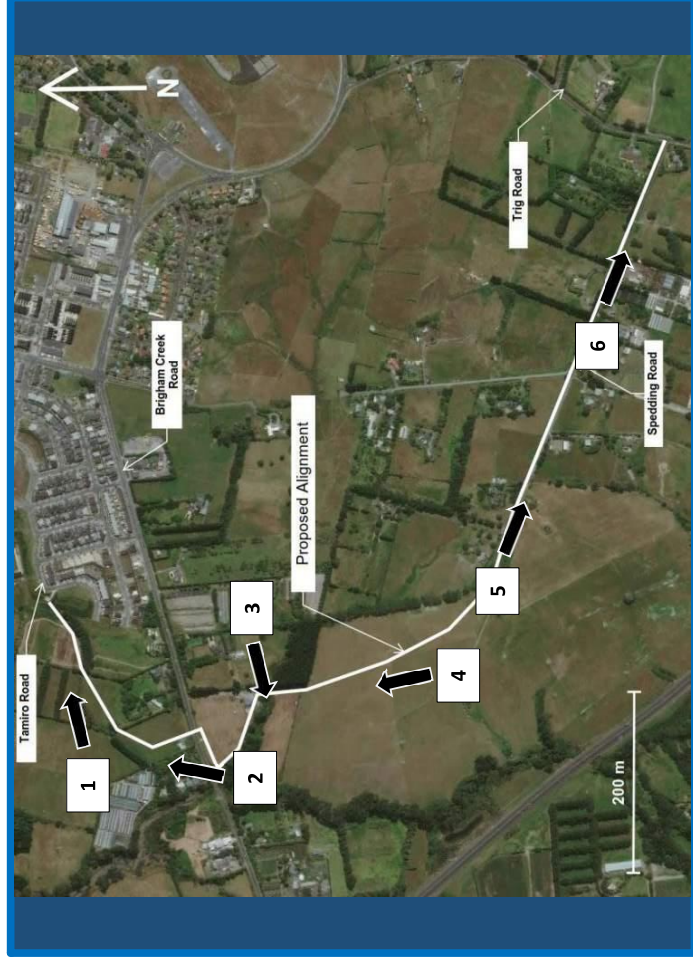
- Eleven (11) rotary cored machine boreholes drilled to between 2.5 and 22 m depth;
- Fifteen (15) Cone Penetration Tests (CPT) with pore water pressure (u) to refusal;
- Twenty-two (22) geotechnical hand augered boreholes to depths between 2.5 and 7.5 m, with associated Scala Penetrometer tests;
- Four (4) environmental hand augers to depths between 1.0 and 2.0 m;
- Installation of nine (9) standpipe piezometers with level loggers for continuous monitoring of groundwater conditions; and
- Submission of 23 samples to the Geotechnics soils laboratory for geotechnical analysis.

This factual report details the results of the 2020 geotechnical assessment, including ground investigation locations, the type of investigation methods undertaken, and the suite of samples submitted to the laboratory, along with the testing results received.

At the time of reporting, a final round of groundwater measurement is planned to occur in March 2021. Once the last round of groundwater measurement is completed, a final version of this report, with all data, will be issued.

¹ T+T (October 2020) *TT 1014985 Watercare – Whenuapai Redhills Package 1 – LOE_Rev2_20201028*. T+T Ref: 1014985.0000

2 Site Description



Site Description

The Package 1 ground investigation site is located in Whenuapai Auckland, between Tamiro Road at the northern end and Trig Road at the southern end.

This section of the proposed alignment is approximately 2.5 km in length.

The alignment crosses private residential properties at the northern end of the alignment between Tamiro Road and Brigham Creek Road. This section is relatively flat and crosses paddocks and farmland with occasional minor gully features.

The section of the alignment from Brigham Creek Road to Spedding Road consists of gently rolling hills and is across farmland with a gully in the centre.

The section of the alignment between Spedding Road and Trig Road extends along the road berm and is flat with a small hill at the Trig Road end.



3 Published geology

The published geological map of the area² indicates that the site is underlain by undifferentiated alluvium of the Tauranga Group for the northern section of the alignment. Pumiceous deposits of the Tauranga Group occur near the surface for the remainder of the alignment and alternating sandstone and mudstone deposits of the East Coast Bays Formation (ECBF) is the basement geology for the area. Within the ECBF, layers of Albany Conglomerate have been identified.

The location of the alignment is shown in the context of the regional geology as presented on Figure 3.1 below.

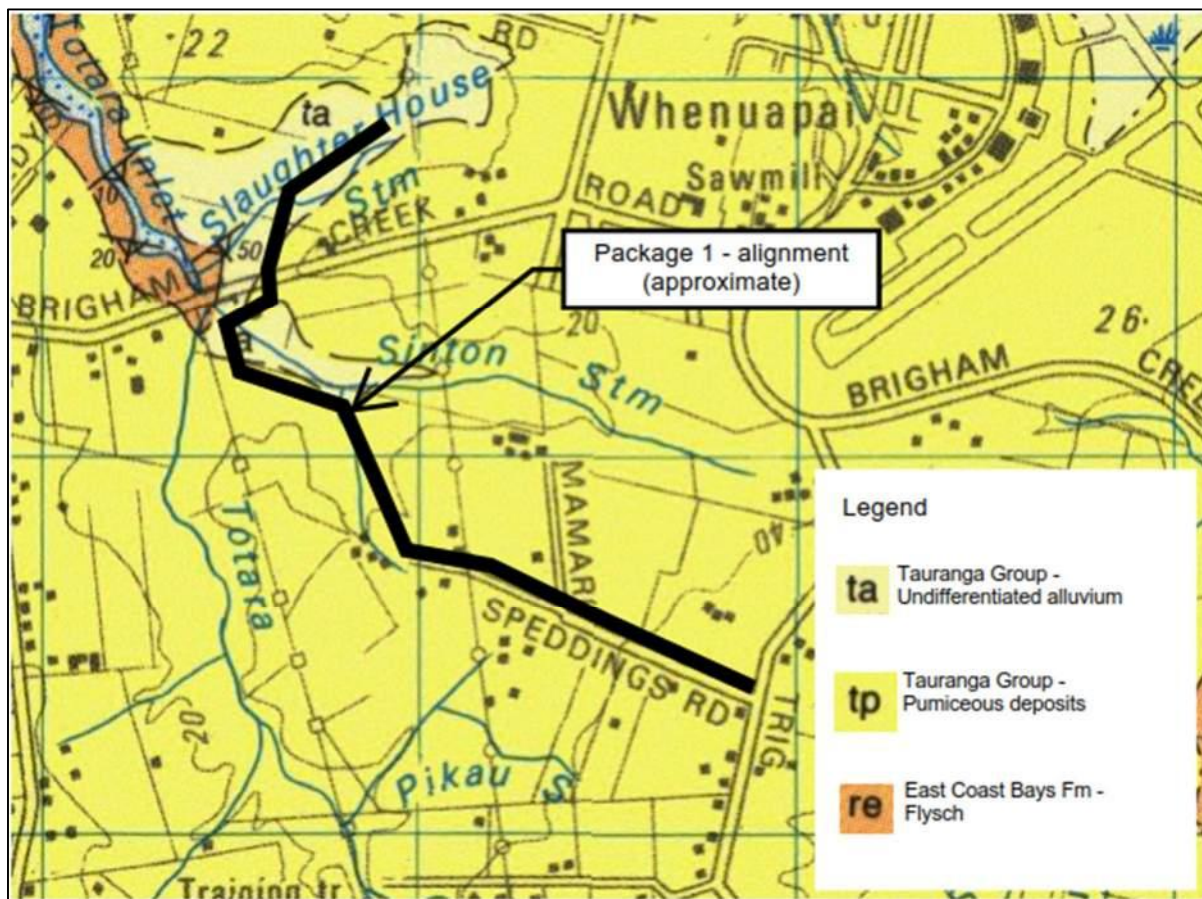


Figure 3-1: Published geology in relation to the project area

² Kermode, L.O. 1992. Geology of the Auckland Urban Area. 1:50,000. Institute of Geological & Nuclear Sciences.

4 Site investigations

The project-specific ground investigations undertaken by T+T in 2020 were prioritised in areas without existing ground investigation data. However, there is a portion of Spedding Road that has previously been investigated and for ease of reference, those previously completed investigations are included in this report.

4.1 Previously completed investigations

T+T have completed rotary cored machine boreholes and CPT's along Spedding Road as part of the North Waitakere Sewer project in 2009. Those investigations are summarised in Table 4.1 below and the investigation locations are shown on Figure 1 in Appendix A. The logs for the previously completed investigations are attached in Appendix B.

Table 4-1: Summary of previously completed investigations

Test Reference	Site	Location (NZTM)		Depth (m)
		Easting (m)	Northing (m)	
Machine Drilled Boreholes				
BH43	NORSGA Wastewater Project – (AGD5882)	1744395	5925634	5
BH44	NORSGA Wastewater Project – (AGD5882)	1744291	5925675	5
BH45	NORSGA Wastewater Project – (AGD5882)	1744196	5925716	5
BH46	NORSGA Wastewater Project – (AGD5882)	1744093	5925760	5
BH47	NORSGA Wastewater Project – (AGD5882)	1743995	5925801	5
BH48	NORSGA Wastewater Project – (AGD5882)	1743750	5925890	5
Cone Penetrometer Tests				
CPT36	NORSGA Wastewater Project – (AGD5882)	1743873	5925859	7.9
CPT43	NORSGA Wastewater Project – (AGD5882)	1744287	5925688	10.5

4.2 Project specific investigations

Ground investigations were carried out at the project site between 2 November 2020 and 8 December 2020, (Figure 1, Appendix A). The investigations comprised:

- Eleven (11) rotary cored machine boreholes;
- Fifteen (15) cone penetrometer tests (CPT's);
- Twenty-two (22) geotechnical hand augered boreholes with associated Scala Penetrometer testing;
- Four (4) environmental hand augered boreholes;
- Installation of nine (9) standpipe piezometers with level loggers for continuous monitoring of groundwater conditions.

The investigation locations were determined by the designer (GHD). The final position of each investigation location was chosen on a case-by-case basis by T+T, with consideration given to health and safety, access constraints, and the presence of nearby overhead and/or buried services.

The as-built position of each ground investigation was surveyed by Axis Consulting to a positional accuracy of 50 mm in the horizontal plane, and 5 mm in the vertical plane.

All geological materials recovered during the investigations were logged and photographed in accordance with the NZGS (2005) field description of soil and rock guidelines. The following sections describe and summarise the geotechnical investigations undertaken for this project.

4.2.1 Machine boreholes

The machine drilling of eleven (11) vertical boreholes was undertaken during the period between 2 and 23 November 2020. The works were carried out using a track-mounted machine borehole rig, supplied and operated by McMillan Drilling Limited under full time supervision from an engineering geologist or geotechnical engineer from T+T. Core was recovered during drilling using PQ sized triple tube rotary coring. Wash drilling was used in a single case for BH05B to quickly drill a hole to facilitate installation of a standpipe piezometer adjacent to BH05A.

The termination depth of each borehole was agreed with the designer (GHD) during drilling on site.

In situ Standard Penetration Testing (SPT) was carried out at regular (1.5 m) intervals for the length of each rotary cored machine borehole. Hand-held shear vane tests were undertaken on material contained within the end of the core barrel for the portion of the borehole within the soil profile. Corrected undrained shear strength values are presented on the borehole logs in kPa.

The boreholes were drilled at key locations along the Package 1 proposed alignment and the investigation locations are presented on Figure 1 in Appendix A. Summary borehole logs and core photographs are presented in Appendix C. Summary borehole details are presented in Table 4-2 below.

Table 4-2: Summary of the Machine Boreholes

BH ID	Location (NZTM)		Ground Surface Elevation (NZVD)	Depth (m bgl)
	Easting (m)	Northing (m)	RL (m)	
BH05A*	1743191.1	5926551.9	9.0	15.14
BH05B*	1743191.3	5926553.7	9.2	7.0
BH06*	1743208.2	5926435.0	12.6	15.12
BH07	1743224.8	5926205.3	21.8	6.0
BH08*	1743457.3	5926036.5	24.6	10.95
BH110*	1743051.9	5926611.7	9.6	15.11
BH111*	1743088.2	5926614.2	9.9	18.04
BH111A	1743090.2	5926614.2	9.9	2.5
BH113*	1743286.2	5926965.5	12.2	20.0
BH116*	1743342.7	5926934.4	13.6	18.23
BH117*	1743092.7	5926691.0	10.9	21.15

*denotes installation of a piezometer

Cone Penetration Tests

Fifteen (15) Cone Penetrometer Tests (CPT's) were completed by Ground Investigation Ltd between 2 and 18 November 2020. In all cases, the CPT's were advanced to 'refusal' which occurred when the

cone terminated on, or within a hard impenetrable strata (cone resistance >20 MPa) such as rock or dense sand.

The CPT locations are presented on Figure 1, Appendix A. CPT logs are appended in Appendix D. A summary of the CPT's is presented in Table 4-3 below.

Table 4-3: Summary of the CPT results

CPT ID	Location (NZTM)		Ground Surface Elevation (NZVD)	Termination depth (m)	Reason for termination
	Easting (m)	Northing (m)	RL (m)		
CPT02	1743191.6	5926559.0	9.5	10.57	High friction resistance
CPT03	1743186.3	5926510.5	10.2	11.23	Danger of buckling rods
CPT04	1743209.6	5926417.5	13.7	9.72	High friction resistance
CPT05	1743220.3	5926265.9	20.1	19.27	High friction resistance
CPT06	1743304.7	5926145.2	22.8	13.46	Inclination high or rapid increase
CPT07	1743414.9	5926065.7	20.8	16.06	Inclination high or rapid increase
CPT08	1744106.9	5925758.1	39.6	13.08	High pore water pressure
CPT111	1743068.8	5926625.3	9.3	5.02	High friction resistance
CPT112	1743076.8	5926598.1	9.6	5.73	High friction resistance
CPT117	1743357.6	5927037.2	13.7	18.0	High cone end resistance
CPT121	1743241.4	5926964.4	11.6	13.22	High total load
CPT126	1743234.1	5926918.1	11.8	17.54	Limit of reaction force
CPT128	1743077.2	5926742.2	10.8	16.05	High total load
CPT129	1743011.3	5926655.9	7.8	3.28	High friction resistance
CPT131	1743108.6	5926585.1	9.9	11.29	High friction resistance

4.2.3 Hand augered boreholes

4.2.3.1 Geotechnical hand augered boreholes

Twenty-two (22) hand augers were advanced for the purpose of geological logging and in-situ material testing. Each hand auger also included a Scala Penetrometer test at the end of the investigation to test material stiffness/density beneath the auger termination depth. The hand augers were completed by engineering geologists from T+T and Geotechnics Ltd between 25 November and 8 December 2020.

Each hand auger had a target depth of 5.0 m or refusal, whichever occurred first. A Scala Penetrometer Tests were then undertaken for a further 2 m or refusal. In-situ hand-held shear vane testing was completed at 300- or 500-mm intervals within each auger where cohesive soils were encountered, and the corrected undrained shear strength is shown on the logs in kPa.

The hand auger locations are presented on Figure 1 in Appendix A. Hand auger logs are attached to this report in Appendix E. Summary hand auger details are presented in Table 4-4 below.

Table 4-4: Hand Auger Summary

Hand auger ID	Location (NZTM)		Ground Surface Elevation (NZVD)	Hand auger depth (m bgl)	Scala Penetrometer depth (m bgl)	Reason for termination
	Easting (m)	Northing (m)	RL (m)			
HA03	1743214.3	5926343.5	19.4	5.2	6.4	Target depth
HA04	1743388.9	5926082.1	21.2	5.2	6.85	Target depth
HA05	1743549.7	5925977.7	27.2	5.2	7.2	Target depth
HA06	1743672.8	5925924.3	30.7	5.2	7.25	Target depth
HA07	1743823.0	5925859.5	32.9	5.0	5.5	Refusal
HA07A	1743968.7	5925813.7	35.6	5.0	5.8	Refusal
HA08	1744277.5	5925683.6	49.1	5.0	5.85	Refusal
HA08A	1744164.5	5925734.6	41.8	5.0	6.2	Target depth
HA107A	1743320.8	5926927.6	13.5	5.0	6.65	Target depth
HA107B	1743265.2	5926922.3	12.3	5.0	6.85	Target depth
HA108	1743173.5	5926898.6	11.5	5.0	6.7	Target depth
HA109	1743136.4	5926901.8	11.0	5.2	7.25	Target depth
HA110A	1743387.7	5926999.3	14.6	5.0	6.85	Target depth
HA110B	1743376.7	5926965.4	14.7	5.0	6.95	Target depth
HA111	1743395.9	5927039.3	14.4	3.5	6.45	Target depth
HA112	1743164.2	5926554.9	9.6	Not undertaken		Terminated (contamination)
HA113	1743032.1	5926630.2	7.9	2.6	2.6	Refusal
HA114	1743108.4	5926872.8	11.0	5.2	7.25	Target depth
HA115	1743054.0	5926794.2	9.9	5.0	6.0	Refusal
HA116	1743047.9	5926675.9	8.8	3.35	3.35	Refusal
HA117	1743138.4	5926564.4	10.0	5.0	6.3	Refusal
HA119	1743195.9	5926938.0	11.4	5.2	7.2	Target depth

4.2.3.2 Environmental hand augers

Four (4) hand augers were advanced for the purpose of environmental sampling and testing. The hand augers were completed by a contaminated land specialist from T+T between 4 and 10 November 2020. Each hand auger was completed to a target depth of 1.0 m, or 2.0 m. The hand augers were logged to NZGS 'Field Description of Soil and Rock' guidelines.

The hand auger locations are presented on Figure 1 in Appendix A. Hand auger logs are attached to this report in Appendix E. Summary hand auger details are presented in Table 4-5 below.

The results will be provided in a separate report.

Table 4-5: Environmental Hand Auger Summary

Hand auger ID	Location (NZTM)		Ground Surface Elevation (NZVD)	Hand auger depth (m)	Reason for termination
	Easting (m)	Northing (m)	RL (m)		
ENVR-HA03	1744024.4	5925787.0	36.7	1.0	Target depth
ENVR-HA04	1744104.7	5925759.8	39.5	1.0	Target depth
ENVR-HA05	1744151.8	5925739.9	41.0	1.0	Target depth
ENVR-HA101	1743340.3	5926989.6	12.8	2.0	Target depth

5 Hydrogeology

Groundwater levels have been measured on a 6-weekly cycle, and the final round of measurement is due in March 2021, at which point this report will be finalised and reissued.

5.1 Piezometer details

Groundwater piezometers were installed in nine (9) of the eleven (11) machine boreholes following the completion of drilling at each location. The screened interval depths for the 50 mm standpipe piezometers were selected based on instruction from the designer (GHD). Summary details of the piezometer installations are presented in Table 5-1 below. Installation records are present in the borehole logs attached in Appendix C.

5.2 In-situ permeability (slug) testing

5.2.1 Overview

This section presents the results of in-situ permeability (hydraulic conductivity) testing and analysis for the boreholes installed for the Whenuapai-Redhills wastewater Scheme. Slug testing was undertaken in a total of nine (9) boreholes between 17 November and 7 December 2020. Table 5-1 provides details of the boreholes used for slug testing.

Table 5-1: Boreholes used for slug testing details

Borehole	Screen length (m)	Screen depth (m bgl)	Bore diameter (mm)
BH05A	3	8.5 – 11.5	50
BH05B	2	3.5 – 5.5	50
BH06	1.5	3.5 – 5.0	50
BH08	3	3.0 – 6.0	50
BH110	3	8.0 – 11.0	50
BH111	2	3.0 – 5.0	50
BH113	2	2.0 – 4.0	50
BH116	3	2.0 – 5.0	50
BH117	2	2.0 – 4.0	50

5.2.2 Field methods

The methodology for permeability testing was undertaken in accordance with the Investigation Scope (specification) provided to T+T³. A slug with an approximate volume of 1.25 L (1 m length and 40 mm diameter), was used to complete the slug tests. Static water levels (SWL) were measured in each borehole prior to the tests (Table 5-2). The slug tests comprised:

- Falling head test, which commenced when the slug was fully submerged into the well to displace water; and
- Rising head test, which commenced immediately after the slug was removed from the well.

³ Whenuapai-Redhills Wastewater Servicing Rising Main/Gravity Main and Interim Pump Station Ground Investigation Scope (Package 1) REVISION 2 October 2020.

In accordance with the Investigation Scope³, where the test response was less than one hour three sets of falling and rising head tests were carried out on each bore. Where the test duration was longer than one hour, the number of tests was reduced to one rising and one falling head test.

Changes in water level during the tests were recorded at 1 second intervals by Solinst brand level loggers (unvented pressure transducers), and manually every 5 minutes using a handheld dip-meter. The transducer data was corrected for the effect of atmospheric pressure changes, with barometer readings recorded at the BH111 location.

5.2.3 Field results

Groundwater levels in BH05A, BH110 and BH113 recovered within 30 minutes of the first falling head tests, therefore three sets of falling and rising head tests were conducted on these wells. For BH110 and BH113, all tests were completed in 30 minutes. The first falling and rising head test in BH05A lasted 30 minutes each, and the second two sets had a duration of only 20 minutes.

Groundwater level data collected by the level logger is recorded with respect to metres of hydraulic head above the level logger. These level logger data were converted to equivalent values with respect to metres below ground (m bgl) for the purpose of analysis. A comparison between manual dip data and corrected level logger data (at the same clock time) was compared for each borehole to check for consistency between methods. Figure 5-1 provides an example of this comparison using BH110 test data.

Figure 5-2 shows example groundwater level data recorded by the level logger (transducer) in BH05A. Table 5-2 shows the groundwater levels (m bgl) at start of each test, and the duration of each test.

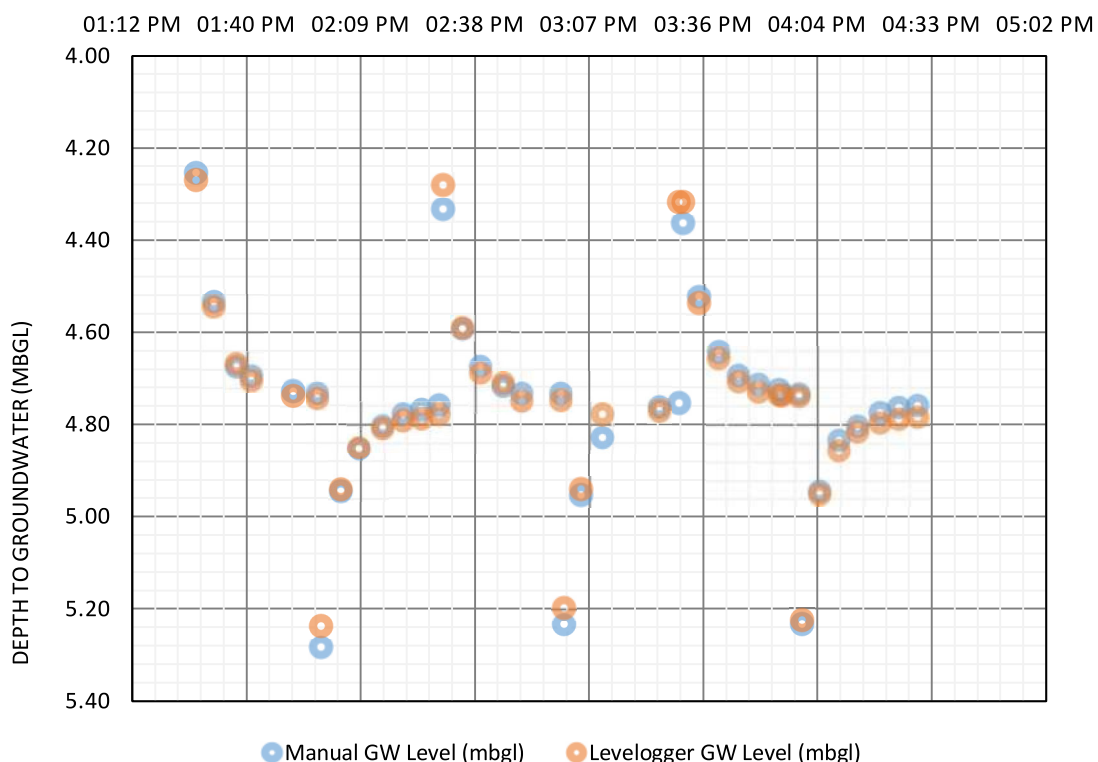


Figure 5-1: Comparison of manual dip data and level logger (transducer) data, for the falling and rising head tests in BH110.

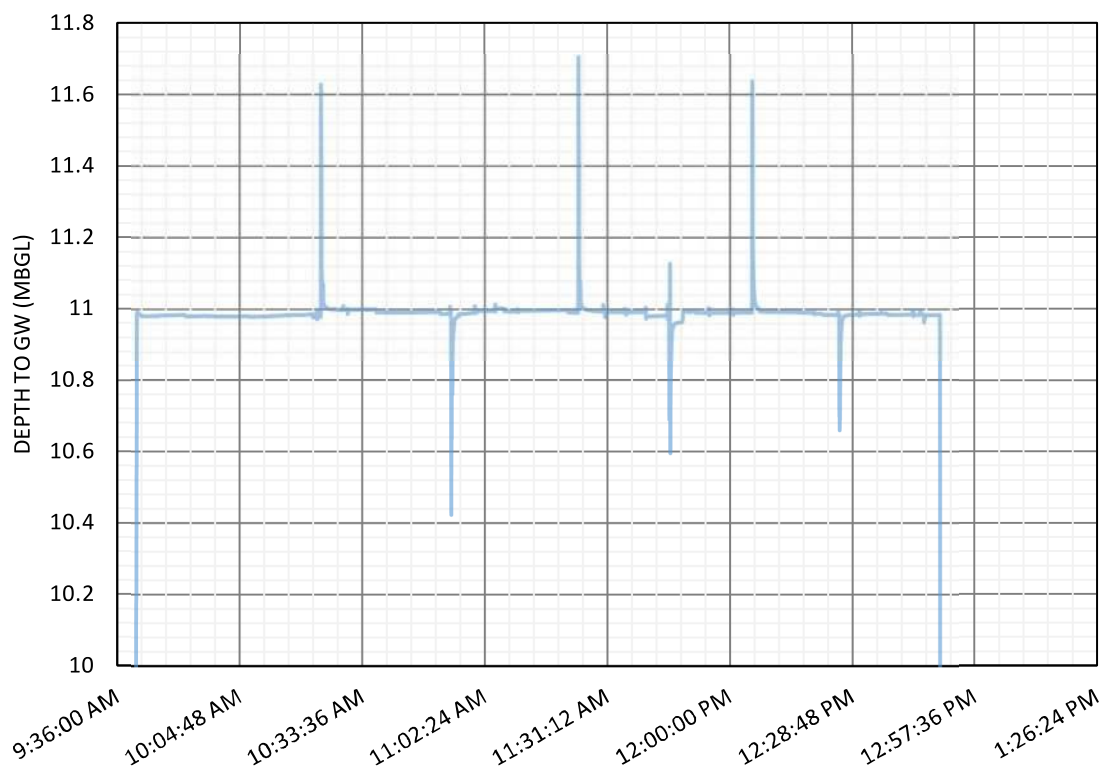


Figure 5-2: Example groundwater level data recorded by the level logger (transducer) in BH05A

Table 5-2: Groundwater level (m bgl) at start of each test, and duration of each test

Borehole	Slug test number	Groundwater level (m bgl) at start of falling head test	Groundwater level (m bgl) at start of rising head test	Duration of test (mins) ¹
BH05A	1	0.37	0.38	30 (30)
BH05A	2	0.38	0.36	15 (18)
BH05A	3	0.36	0.37	19 (21)
BH05B	1	2.25	3.00	60 (62)
BH06	1	2.44	2.47	60 (60)
BH08	1	1.21	1.16	60 (60)
BH110	1	4.75	4.75	31 (30)
BH110	2	4.75	4.78	30 (30)
BH110	3	4.78	4.77	30 (30)
BH111	1	1.94	1.87	60 (60)
BH113	1	1.89	1.86	31 (30)
BH113	2	1.86	1.92	30 (32)
BH113	3	1.92	1.86	30 (30)
BH116	1	0.76	0.65	60 (60)
BH117	1	2.25	2.28	60 (60)

1 Value outside of brackets denotes falling head test duration, value inside brackets denotes rising head test duration

5.2.4 Analysis methods

To calculate the hydraulic conductivity of the screened lithology the rising and falling head tests were analysed using the Hvorslev, and Bouwer & Rice methods available in AquiferTest Pro⁴. This analysis was undertaken to validate the field data. The Designers are responsible for the calculation of the final permeability values.

Butler⁵ recommends matching the straight-line slug test solutions to the data within recommended normalised head ranges to provide a reliable data analysis. For the Hvorslev method this range is recommended to be from 0.15 to 0.25, and 0.20 to 0.30 for the Bouwer & Rice method.

The Hvorslev solution⁴ assumes the following:

- Unconfined or non-leaky confined aquifer of infinite extent;
- Homogeneous, isotropic aquifer of uniform thickness;
- Water table is horizontal prior to the test;
- Instantaneous injection/withdrawal of a volume of water results in an instantaneous change in water level;
- Inertia of water column and non-linear well losses are negligible;
- Fully penetrating well;
- The well is considered to be of an infinitesimal width;
- Flow is horizontal toward or away from the well;

And the Bouwer & Rice method⁴ assumes:

- Unconfined or leaky-confined aquifer (with vertical drainage from above) of infinite extent;
- Homogeneous, isotropic aquifer of uniform thickness;
- Water table is horizontal prior to the test;
- Instantaneous change in head at start of test;
- Inertia of water column and non-linear well losses are negligible
- Fully or partially penetrating well
- The well storage is not negligible
- The flow to the well is in a steady state
- There is no flow above the water table

5.2.5 Analysis results

The hydraulic conductivities results obtained from each rising and falling head is summarised in Table 5-4. The AquiferTest Pro⁴ report outputs are provided in Appendix F.

The average hydraulic conductivity values for each borehole are provided in Table 5-5. These include adopting the average value obtained from each field method (falling head and rising head) and each analysis method (Hvorslev, and Bouwer & Rice).

We note that the x-axis (time axis) of a selection of AquiferTest Pro⁴ output plots in Appendix F do not show the overall duration of the test, because these have been adjusted to illustrate the test results with respect to the recommended normalised head ranges (i.e. Hvorslev method: from 0.15

⁴ AquiferTest Pro: Version 9.0, build 9.0.0.5, Waterloo Hydrogeologic, Ontario, Canada

⁵ Butler, J.J., Jr., 1998. The Design, Performance, and Analysis of Slug Tests, Lewis Publishers, New York, 252p

to 0.25, and Bouwer & Rice method: from 0.20 to 0.30). The duration of each slug test is shown in Table 5-2.

The slug test method is used to estimate permeability values for the geologic medium immediately outside the screened section of each borehole and the results are typically valid within an order of magnitude. A summary of the measured hydraulic conductivity for the lithology at each screened interval is provided in Table 5-3 below:

Table 5-3: Hydraulic Conductivity at each Piezometer Screen

Investigation ID	Screened depth (m bgl)	Hydraulic Conductivity (m/s)	Expected range for lithology
BH05A	8.5 – 11.5	2.2×10^{-5}	Yes
BH05B	3.5 – 5.5	8.2×10^{-8}	Yes
BH06	3.5 – 5.0	9.3×10^{-7}	Yes
BH08	3.0 – 6.0	1.7×10^{-7}	Yes
BH110	8.0 – 11.0	1.0×10^{-6}	Yes
BH111	3.0 – 5.0	5.1×10^{-7}	Yes
BH113	2.0 – 4.0	5.8×10^{-7}	Yes
BH116	2.0 – 5.0	8.7×10^{-8}	Yes
BH117	2.0 – 4.0	1.7×10^{-7}	Yes

As shown in Table 5-4, the hydraulic conductivity results are similar (within the same order of magnitude) when:

- Both the falling and rising head test results are compared.
- Both the Hvorslev, and Bouwer and Rice methods are compared.
- The falling head and rising head tests were repeated, due to the short duration of the test due to the rapid recovery of groundwater levels in the borehole.

Table 5-4: Hydraulic conductivities estimated using the Hvorslev and Bouwer & Rice methods in AquiferTest Pro⁴

Borehole	Geologic Formation	Screened lithology (m)	Hydraulic conductivities (m/s)		
			Test	Bouwer & Rice Method	Hvorslev Method
BH05A	Albany conglomerate	Weathered sandstone and conglomerate	Falling head 1	9.6E-06	6.4E-06
			Rising head 1	2.1E-05	2.6E-05
			Falling head 2	2.2E-05	2.3E-05
			Rising head 2	2.3E-05	2.0E-05
			Falling head 3	1.8E-05	1.6E-05
			Rising head 3	3.6E-05	4.2E-05
BH05B ¹	Tauranga group	Silt, sand (See note ¹)	Falling head	1.1E-07	1.3E-07
			Rising head	3.4E-08	5.3E-08
BH06	East coast bay Formation	Silt, sand	Falling head	8.4E-07	1.1E-06
BH08	Tauranga group	Silt	Rising head	7.7E-07	1.0E-06
			Falling head	2.0E-07	2.6E-07
BH110	East coast bay Formation	Unweathered siltstone and sandstone	Rising head	9.5E-08	1.3E-07
			Falling head 1	1.1E-06	1.3E-06
			Rising head 1	8.5E-07	8.6E-07
			Falling head 2	1.2E-06	1.4E-06
			Rising head 2	9.2E-07	1.1E-06
			Falling head 3	8.9E-07	9.9E-07
BH111	East coast bay Formation	Sand, moderately weathered siltstone sandstone	Rising head 3	7.4E-07	7.6E-07
			Falling head	4.0E-07	5.7E-07
			Rising head	4.9E-07	5.9E-07

Borehole	Geologic Formation	Screened lithology (m)	Hydraulic conductivities (m/s)		
			Test	Bouwer & Rice Method	Hvorslev Method
BH113	Tauranga group	Silt, and Sand	Falling head 1	7.1E-07	8.1E-07
			Rising head 1	5.2E-07	6.1E-07
			Falling head 2	5.7E-07	7.8E-07
			Rising head 2	5.1E-07	6.2E-07
			Falling head 3	5.7E-07	7.0E-07
			Rising head 3	3.2E-07	2.6E-07
BH116	Tauranga group	Silt, sand, clay	Falling head	1.0E-07	1.4E-07
			Rising head	4.4E-08	6.0E-08
BH117	Tauranga group	Silt	Falling head	2.2E-07	2.7E-07
			Rising head	9.0E-08	1.2E-07

- 1 Geological description based on BH05A log. BH05B log does not exist because it was completed using wash drilling method (no core available). BH05A and BH5B are positioned approximately 2 metres apart.

Table 5-5: Average hydraulic conductivity results

Borehole	Average hydraulic conductivity (m/s)	Average hydraulic conductivity (m/day)
BH05A	2.2E-05	1.9
BH05B	8.2E-08	7.1E-03
BH06	9.3E-07	8.1E-02
BH08	1.7E-07	1.5E-02
BH110	1.0E-06	8.7E-02
BH111	5.1E-07	4.4E-02
BH113	5.8E-07	5.0E-02
BH116	8.7E-08	7.5E-03
BH117	1.7E-07	1.5E-02

5.3 Groundwater level monitoring

Groundwater level monitoring commenced in nine (9) of the eleven (11) machine boreholes following the completion of drilling at each location. The screened interval depths for the 50 mm standpipe piezometers are presented in Table 5-1. Installation records are present in the borehole logs attached in Appendix C.

Continuous groundwater level monitoring was undertaken at 15-minute intervals and was completed using Solinst brand level loggers (unvented pressure transducers). These data were corrected for the effect of atmospheric pressure changes, with barometer readings recorded at the BH111 location. Manual groundwater level readings were collected using a handheld dip-meter during installation and retrieval of the level loggers.

Figure 5-13 shows the results of groundwater level monitoring during the monitoring period, presented as levels recorded m bgl. Figure 5-13 also shows the groundwater levels (m bgl) recorded relative to hourly rainfall data recorded at a nearby weather station⁶.

Figure 5-4 shows the results of groundwater level monitoring during the monitoring period, presented as levels with respect to m RL.

We note that the final round of measurement is due in March 2021, at which point this report will be updated and reissued.

⁶ Sourced from Cliflo, agent number 41351 MOTAT, located approx. 15 km southeast of the site <https://cliflo.niwa.co.nz/>

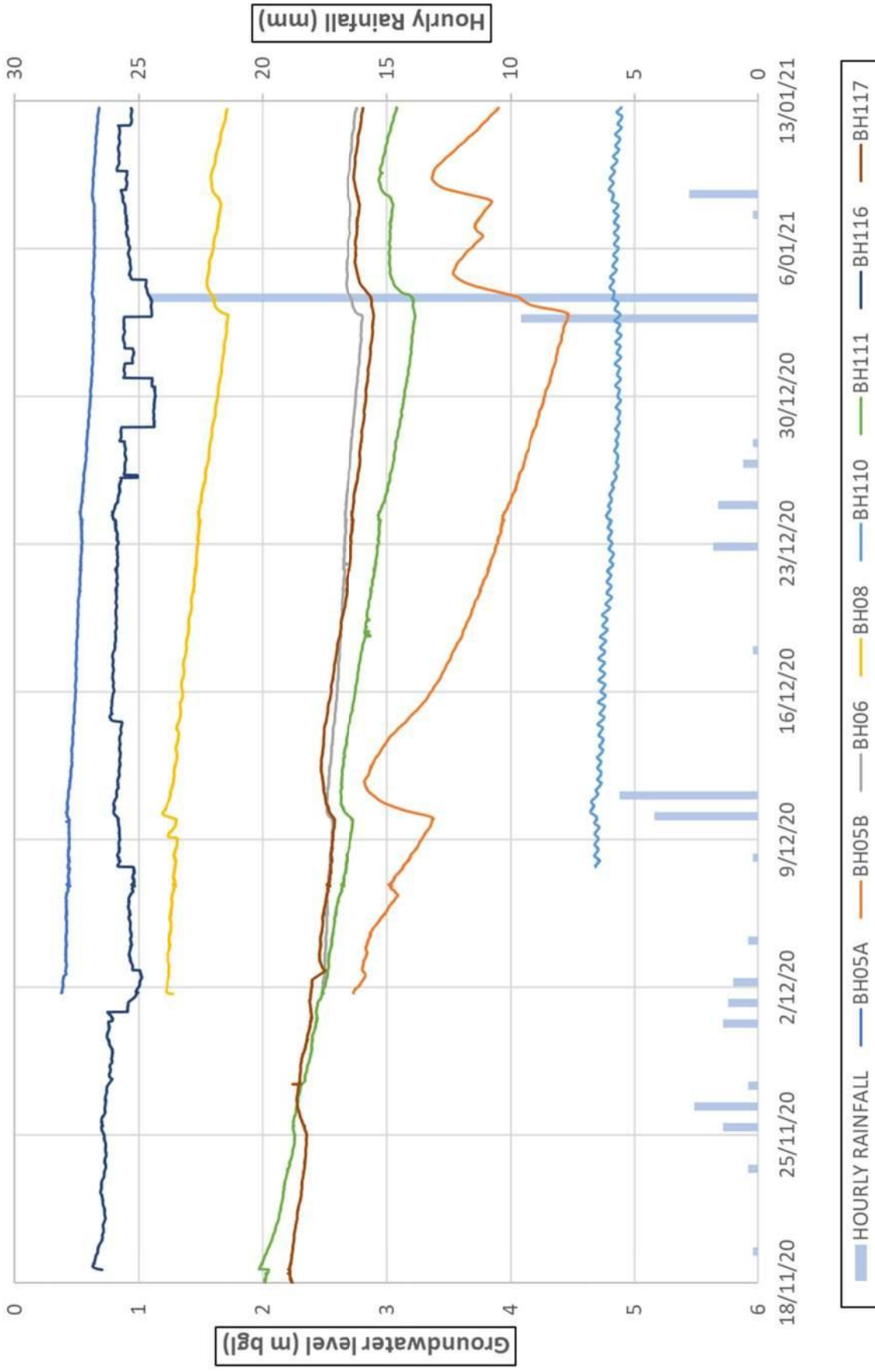


Figure 5-3: Continuous groundwater level monitoring results (m bgl), and rainfall (mm) recorded at the MOTAT gauging site located approx. 15 km southeast of the site.

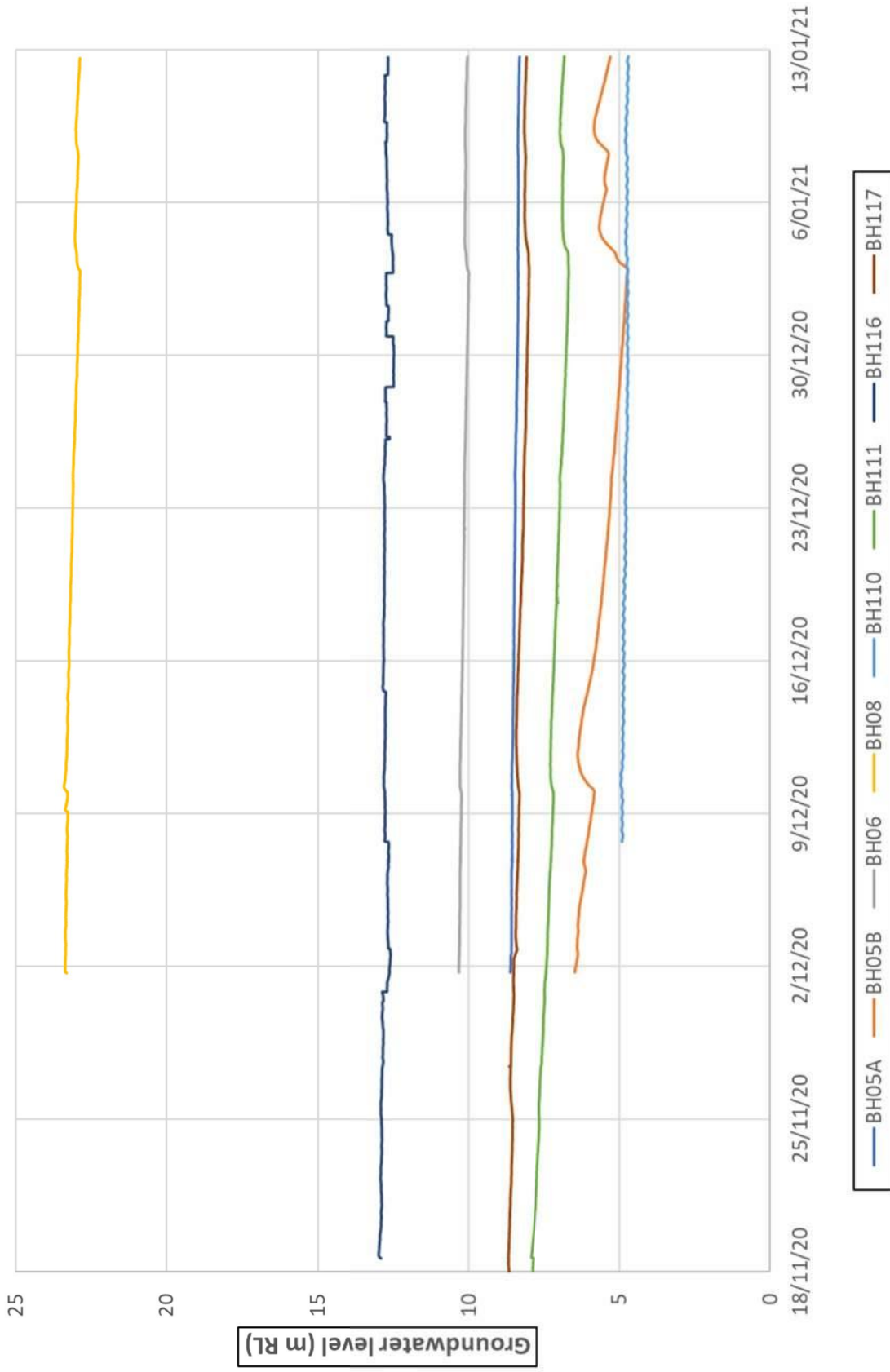


Figure 5-4: Continuous groundwater level monitoring results (m RL)

6 Laboratory Testing

6.1 Geotechnical testing

Samples collected during the borehole and hand auger investigations have been selected for a series of geotechnical laboratory tests. The samples and test schedules have been selected in consultation with the designer (GHD).

Soil samples (disturbed) recovered from the investigations have been collected from SPT samples from nine boreholes and from six hand augered boreholes. Rock core has been selected from five boreholes for unconfined compressive strength (UCS) testing.

All laboratory testing was undertaken by Geotechnics in their IANZ accredited laboratory located in Onehunga.

A summary of the geotechnical laboratory testing schedule is included in Table 6-1, and the results of all geotechnical laboratory tests are presented in Appendix G.

Table 6-1 Geotechnical laboratory testing summary

Investigation ID	Sample Depth (m)	Test Type						
		NMC NZS4402 Test 2.1	Atterberg Limits NZS4402 Test 2.2, 2.3, 2.4	PSD Sieve NZS4402 Test 2.8.1	PSD Hydro NZS4402 Test 2.8.4	UCS NZS4402 Test 6.3.1	1D Consol NZS4402 Test 7.1	Organic Matter NZS4402 Test 3.1.2
BH05A	3.5	X	X	X				
BH05A	6							X
BH05A	14.2					X		
BH06	1.5	X	X					
BH06	3			X				
BH06	5			X				
BH06	13.8					X		
BH07	2.5	X	X	X				
BH07	5.5	X	X	X				
BH08	1.5	X	X	X				
BH08	3	X	X	X				
BH08	6						X	
BH110	1.5	X	X		X			
BH110	3.5			X				
BH110	9.4					X		
BH111	1.5	X	X		X			
BH111	3			X				
BH111	7.3					X		
BH113	3			X				
BH113	4.5		X		X			
BH113	5.7		X	X				X
BH113	6.0			X			X	X

Investigation ID	Sample Depth (m)	Test Type						
		NMC NZS4402 Test 2.1	Atterberg Limits NZS4402 Test 2.2, 2.3, 2.4	PSD Sieve NZS4402 Test 2.8.1	PSD Hydro NZS4402 Test 2.8.4	UCS NZS4402 Test 6.3.1	1D Consol NZS4402 Test 7.1	Organic Matter NZS4402 Test 3.1.2
BH113	16.2					X		
BH116	1.5		X	X				
BH116	4.5						X	X
BH116	5		X	X				
BH116	17.5					X*		
BH117	1.5			X				
BH117	3		X	X				X
BH117	4.5						X	X
HA108	2.4	X	X	X				
HA109	2.5	X		X				
HA110A	3.4	X	X	X				X
HA114	3.5	X	X		X			
HA115	2.6	X	X	X				
HA119	1.5	X	X		X			

Note: * the UCS sample for BH116 at 17.5 m failed before the UCS test could be completed

7 Applicability Section

This report has been prepared for the exclusive use of our client Watercare Services Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:

Authorised for Tonkin & Taylor Ltd by:

.....

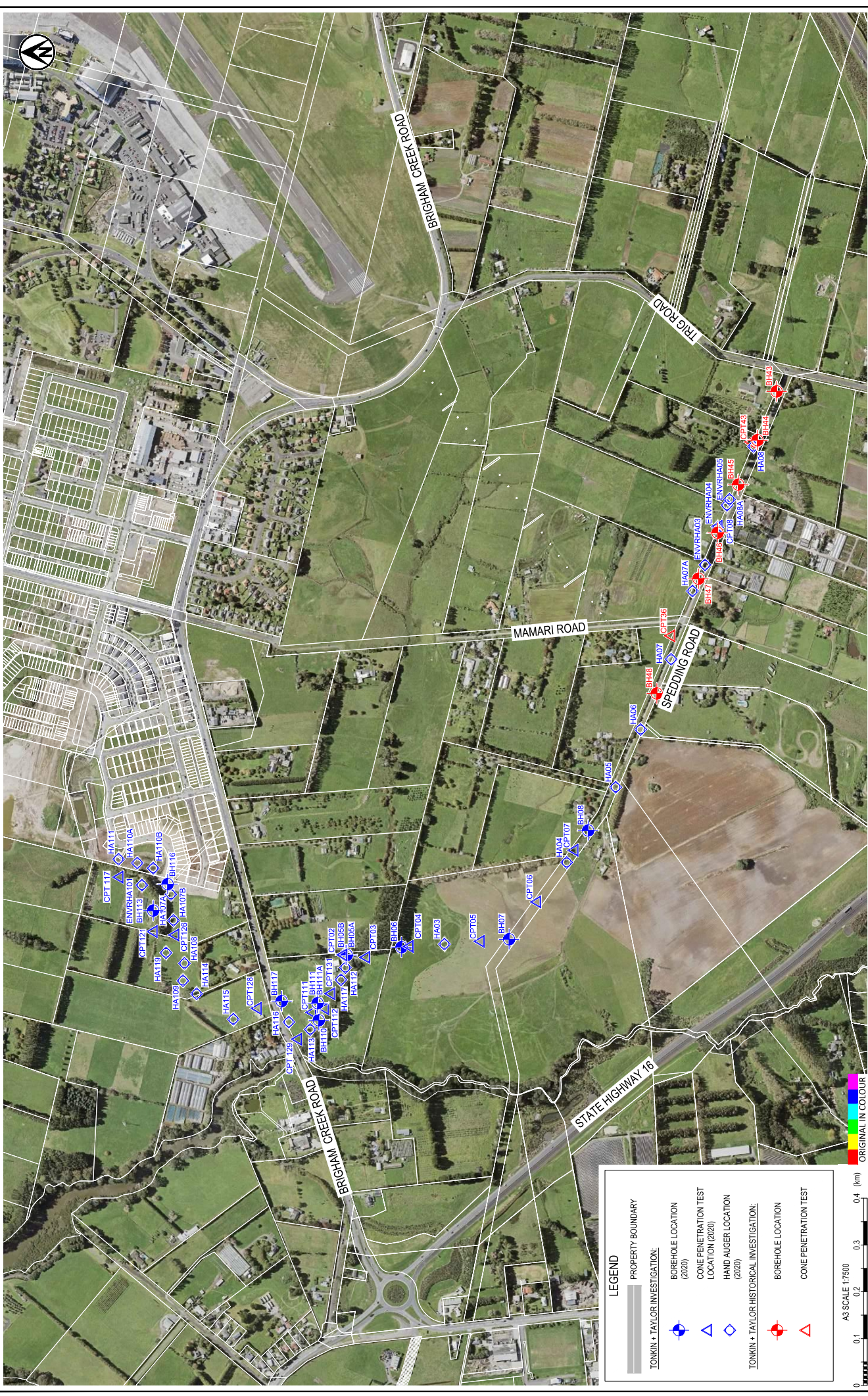
Chris Monk
Engineering Geologist

.....

Robert Hillier
Project Director

CBM
\\ttgroup.local\files\aklprojects\1014985\issueddocuments\1014985_whenuapai-redhills_gfr_20210127 final.docx

Appendix A: Site Location Plan



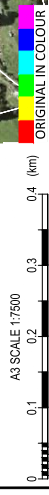
LEGEND

PROPERTY BOUNDARY
 TONKIN + TAYLOR INVESTIGATION:

- BOREHOLE LOCATION (2020)
- CONE PENETRATION TEST LOCATION (2020)
- HAND AUGER LOCATION (2020)

TONKIN + TAYLOR HISTORICAL INVESTIGATION:

- BOREHOLE LOCATION
- CONE PENETRATION TEST



NOTE:

- AERIAL PHOTO SOURCED FROM LINZ DATA SERVICE - https://data.linz.govt.nz/layer/65407-aerial-40075m-ortho-aerial-photos-2017 - LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 17/12/2020.
- PROPERTY BOUNDARY SOURCES FROM LINZ DATA SERVICE - https://data.linz.govt.nz/layer/59596-panorama-licenced-by-linz-for-re-use - LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 17/12/2020.

PROJECT No. 1014985		DESIGNED	Dec 20
CLIENT WATERCARE SERVICES LIMITED		DRAWN	Dec 20
PROJECT WHENUAUAI AND REDHILLS WASTEWATER SCHEME		CHECKED	Dec 20
TITLE GEOTECHNICAL INVESTIGATION SITE INVESTIGATION PLAN		DATE	
SCALE (A3)	1:7500	APPROVED	
FIG No.	FIGURE 1	DATE	
REV	1		

Appendix B: Previous Investigation Logs

SOURCE: NZGD



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH44
Hole Location: refer site plan
SHEET 1 OF 1

PROJECT: NorthWaitakSewer-SI		LOCATION: Hobsonville-Westharbour-Whenuapai		JOB No: 26182.001														
CO-ORDINATES 808417.6 mN 386910.9 mE		DRILL TYPE: Terrier		HOLE STARTED: 5/6/09														
R.L. 49.80 m		DRILL METHOD: Percussion		HOLE FINISHED: 5/6/09														
DATUM		DRILL FLUID:		DRILLED BY: JRSS														
				LOGGED BY: RBE														
				CHECKED: CJL														
GEOLOGICAL		ENGINEERING DESCRIPTION																
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL			100								ML	M	Vst					SILT non plastic, friable, brown
PUKETOKA FORMATION			100			● 88/41kPa in situ		49	1		ML	W						SILT slightly to non plastic, greyish light brown
			100			● 141/75kPa in situ		48	2		ML							clayey SILT moderately plastic, light brown with yellow-brown mottles -moderately plastic, greyish light brown with occasional yellow-brown mottles
			60			● 113/70kPa in situ		47	3		ML							SILT some clay, slightly plastic, greyish light brown
			50			● 88/63kPa in situ		46	4		ML			St				core lost
			50			● 94/78kPa in situ		45	5		ML			St				SILT slightly to non plastic, light whitish grey
PUKETOKA FORMATION								44	5									core lost
								43	6									hand augered to 5.8m 18/6/09: SILT some clay, trace fine sand, weakly to non plastic, light whitish grey
								42	7									END OF BOREHOLE 5.8m (target depth)
								41	8									
								40	9									
								39	10									

SOURCE: NZGD



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH46
 Hole Location: refer site plan
 SHEET 1 OF 1

PROJECT: NorthWaitakSewer-SI		LOCATION: Hobsonville-Westharbour-Whenuapai		JOB No: 26182.001	
CO-ORDINATES 808498.7 mN 386710.8 mE		DRILL TYPE: Terrier		HOLE STARTED: 5/6/09	
R.L. 39.50 m		DRILL METHOD: Percussion		HOLE FINISHED: 5/6/09	
DATUM		DRILL FLUID:		LOGGED BY: RBE CHECKED: CJL	
GEOLOGICAL			ENGINEERING DESCRIPTION		
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS WATER CORE RECOVERY (%) METHOD CASING	TESTS	SAMPLES R.L. (m) DEPTH (m) GRAPHIC LOG	CLASSIFICATION SYMBOL MOISTURE / WEATHERING CONDITION STRENGTH/DENSITY CLASSIFICATION SHEAR STRENGTH (kPa) COMPRESSIVE STRENGTH (MPa) DEFECT SPACING (mm)	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL			39	ML W VSt	SILT non plastic, organic stained, dark brown
PUKETOKA FORMATION	water level on completion	• 117/22kPa in situ	1	ML Sat	SILT some fine sand, non plastic, light brown
	100	• 107/60kPa in situ	2	St	clayey SILT light greyish white moderately plastic, with vertical bands of dark brown silt (fissure filling) -moderately plastic, light greyish white
	100	• 88/47kPa in situ	3	ML	-light greyish white mottled dark brown -moderately plastic, dark brown -light brown mottled dark brown -light brown
	100	• 107/33kPa in situ	4	ML VSt	clayey SILT sandy, slightly plastic, light brown
	80	• 111/55kPa in situ	5	SM	fine sandy SILT non plastic, light brown with vertical black rootlets silty fine SAND light grey with occasional rootlets
			5		END OF BOREHOLE 5m (target depth)
			6		
			7		
			8		
			9		
			10		

SOURCE: NZGD



TONKIN & TAYLOR LTD
BOREHOLE LOG

BOREHOLE No: BH47
Hole Location: refer site plan
SHEET 1 OF 1

PROJECT: NorthWaitakSewer-SI				LOCATION: Hobsonville-Westharbour-Whenuapai				JOB No: 26182.001										
CO-ORDINATES 808537.9 mN 386612. mE				DRILL TYPE: Terrier				HOLE STARTED: 5/6/09										
R.L. 36.10 m				DRILL METHOD: Percussion				HOLE FINISHED: 5/6/09										
DATUM				DRILL FLUID:				LOGGED BY: RBE CHECKED: CJL										
GEOLOGICAL				ENGINEERING DESCRIPTION														
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION	
																	ROCK DESCRIPTION	
TOPSOIL								36		ML	W/Sat	St					SILT organic stained, dark brown	
PUKETOKA FORMATION	water level on completion	80	80			● 83/31kPa in situ		35	1	SM		Sat					fine sandy SILT non plastic, greyish brown	
																	SILT non plastic, brown	
																	clayey SILT moderately plastic, brownish light grey	
																	SILT some clay, slightly plastic, light grey	
																	fine sandy SILT non plastic, brownish light grey, occasional black rootlets	
						● 86/31kPa in situ		34	2	ML							-becoming grey no core (displaced)	
						● 91/36kPa in situ		33	3	ML							fine sandy SILT weakly to non plastic, grey	
						● 122/41kPa in situ		32	4	ML		VSt					no core (displaced)	
						● 188/78kPa in situ		31	5								END OF BOREHOLE 5m (target depth)	
								30	6									
								29	7									
								28	8									
								27	9									
								26	10									

SOURCE: NZGD



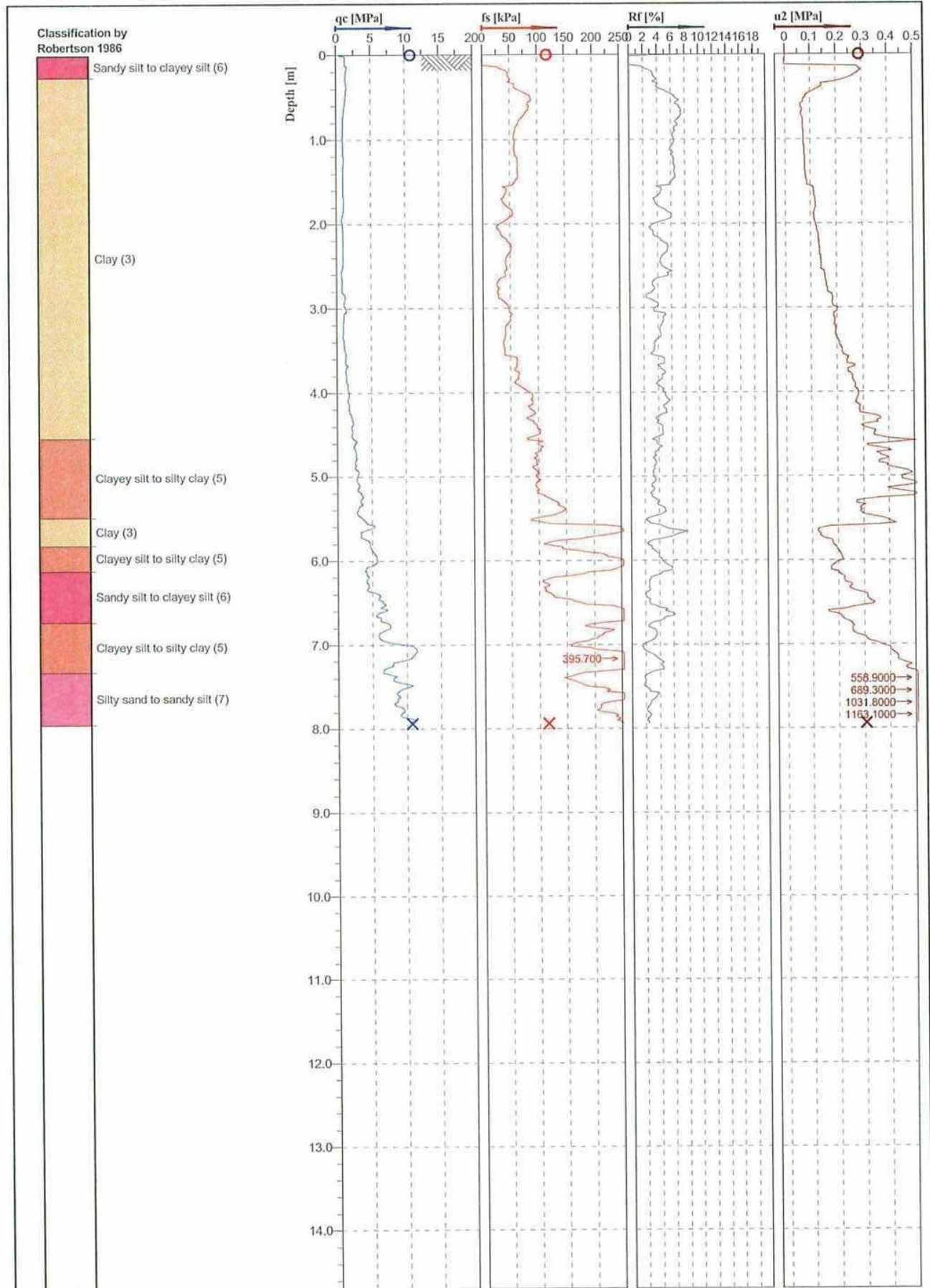
TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH48
Hole Location: refer site plan
SHEET 1 OF 1

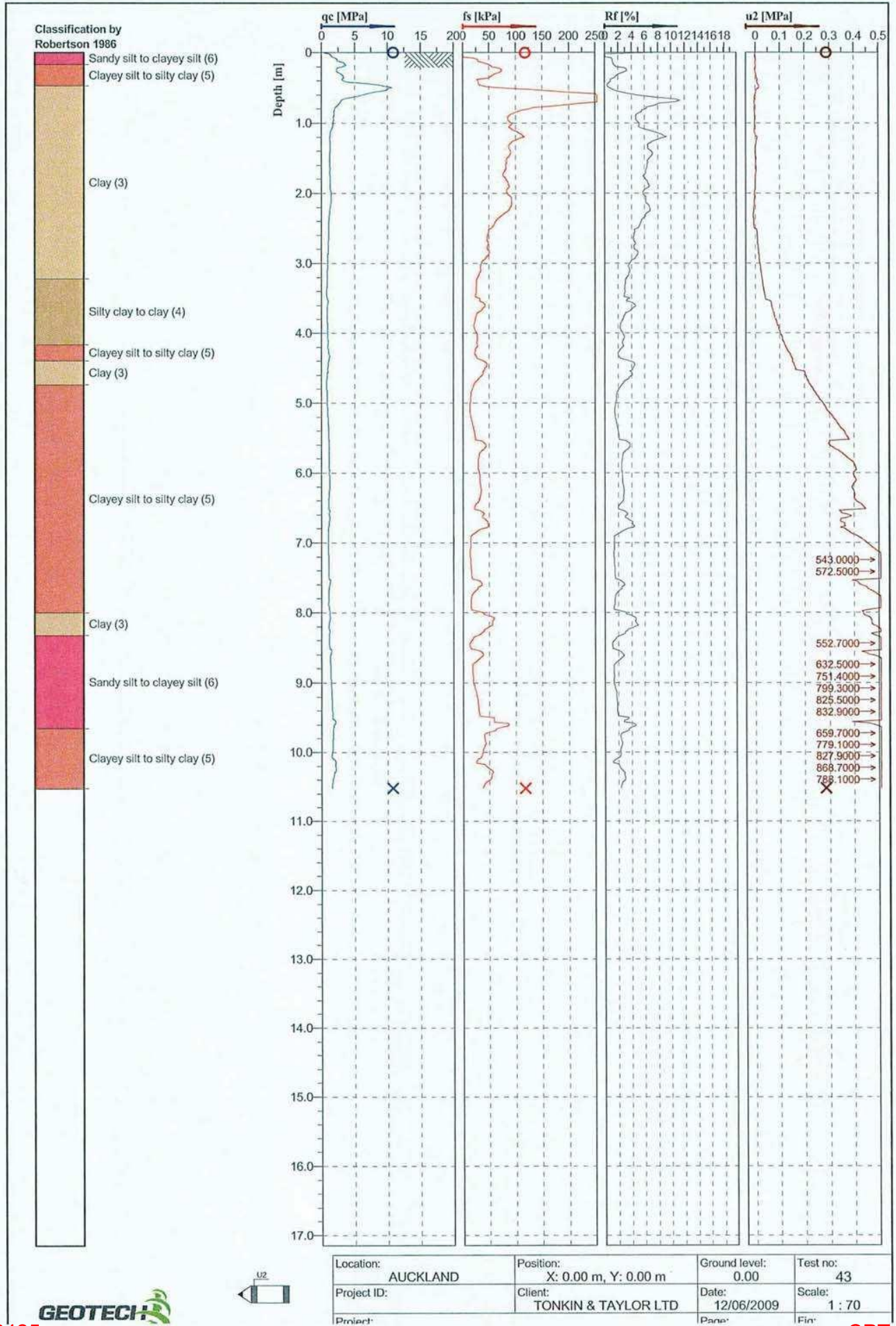
PROJECT: NorthWaitakSewer-SI		LOCATION: Hobsonville-Westharbour-Whenuapai JOB No: 26182.001																	
CO-ORDINATES 808623. mN 386365.6 mE		DRILL TYPE: Terrier				HOLE STARTED: 5/6/09													
R.L. 31.80 m		DRILL METHOD: Percussion				HOLE FINISHED: 5/6/09													
DATUM		DRILL FLUID:				DRILLED BY: JRSS		LOGGED BY: RBE CHECKED: CJL											
GEOLOGICAL		ENGINEERING DESCRIPTION																	
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSION STRENGTH (kPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.		
																		15	30
TOPSOIL											ML	W/Sat	St					SILT organic stained, brown	
PUKETOKA FORMATION			100			● 97/56kPa in situ		31	1		ML						clayey SILT slightly plastic, yellow-brown -moderately plastic, light grey-white mottled yellow-brown		
			100			● 94/60kPa in situ		30	2								-moderately plastic, light grey-white		
			100			● 58/33kPa in situ		29	3								-light grey-white mottled yellow-brown		
			100			● 81/38kPa in situ		28	4		ML						-highly plastic, light brown		
		hole dry on completion		40			● 141/86kPa in situ		27	5		ML		VSt				-brown SILT slightly plastic, brown with abundant black mottles -grey brown with abundant black rootlets	
								26	6								fine sandy SILT non plastic, grey core lost		
								25	7										
								24	8										
								23	9										
								22	10										
																	END OF BOREHOLE 5m (target depth)		

SOURCE: NZGD



Location: AUCKLAND	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 36
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 12/06/2009	Scale: 1 : 60
Project:	Panel:	File:	

SOURCE: NZGD



Location: AUCKLAND	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 43
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 12/06/2009	Scale: 1 : 70
Project:		Pane:	Fig:

Appendix C: Machine Borehole Logs



BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 1 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
 (NZTM2000) 1743191.10 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Top	Sandy gravelly SILT, trace organics; brown & grey. Firm, moist, low plasticity; sand, fine to coarse, Quartz, gravel, fine to coarse, subangular, unweathered, Basalt & Concrete; organics, rootlets.				PQTT	46	1 @ 0.10m 1 x Glass Jar 1x plastic Jar												
	Silty CLAY, minor sand, trace organics; light brown mottled orange and dark brown, speckled black, homogeneous. Stiff, moist, high plasticity; sand, fine; organics, rootlets. 0.35 - 0.75m: CORE LOSS						7 @ 0.35m 1 x plastic Jar (Corrosivity)												
	Silty CLAY, minor sand, trace organics; light brown mottled orange & dark brown, speckled black, homogeneous. Stiff, moist, high plasticity; sand, fine; organics, rootlets. 0/- kPa						2 @ 1.00m 1 x Glass Jar 1x plastic Jar												
	Sandy SILT, some clay; light brown mottled orange & dark brown speckled white and black, homogeneous. Stiff, moist, high plasticity; sand, fine.				SPT	86													
	Silty CLAY, minor sand, trace organics; light brown mottled orange & dark brown speckled black & white, homogeneous. Stiff, moist; sand, fine; organics, rootlets.						93/44 kPa												
	Sandy SILT, trace organics; brown spotted black, homogeneous. Stiff, moist, low plasticity; sand, fine; organics, rootlets.				PQTT	124	0/1 1/0 1/1 N=3												
	SILT, some sand, minor clay, trace organics; light brown mottled orange, homogeneous. Stiff, moist, low plasticity; sand, fine; organics, rootlets.																		
	SILT, minor clay, trace organics; light green - grey, speckled black. Firm to stiff, moist, low plasticity; organics, fibrous. 2.00 - 2.17m: Grey-brown mottled brown, speckled black				SPT	100	3 @ 2.00m 1 x Glass Jar 1x plastic Jar 1x Split 1x Duplicate												
Tauranga Group	SILT, trace clay; grey-brown mottled brown, speckled black. Firm to stiff, moist, low plasticity.																		
	3.0 - 3.5 m: Push Tube				PQTT	0	8 @ 2.90m 1 x plastic Jar (Corrosivity)												
	SILT, trace clay; grey-brown mottled brown, speckled black. Firm, moist, low plasticity.				PT	173	4 @ 3.00m 1 x Glass Jar 1x plastic Jar	28/9 kPa											
	SILT, trace organics; brown speckled black. Firm, moist, low plasticity; organics, fibrous. 3.65m: grades light brown						9 @ 3.00m	0/0 0/1 1/1 N=3											
	SILT, minor sand, trace organics and clay; light green, speckled black. Firm, moist, medium plasticity; sand, fine; organics, fibrous. 4.03m: Light brown mottled brown, speckled black				PQTT	100	5 @ 4.00m 1 x Glass Jar 1x plastic Jar												
	Sandy SILT, trace organics; light brown mottled brown, speckled black. Stiff, moist, low plasticity; sand, fine; organics, fibrous.							19/4 kPa Core disturbed by drilling process											
	Silty SAND; green speckled black, homogeneous. Medium dense, moist, poorly graded; sand, fine.				SPT	100		2/3 3/3 3/4 N=13											
	SAND, minor silt; light brown speckled black. Medium dense, moist, poorly graded; sand, fine.																		

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth 15.15m

Scale 1:25

Box 1, 0.0c-3.0m

BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 2 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
 (NZTM2000) 1743191.10 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Tauranga Group	4.95 - 5.35 m: CORE LOSS						6 @ 5.00m 1 x Glass Jar 1x plastic Jar											
	Organic clayey SILT, trace rootlets; dark brown speckled black. Stiff, moist, high plasticity. Organics; amorphous				PQTT	61			5.5									
	6.25 - 6.45 m: CORE LOSS				SPT	55	0/- kPa 1/0 0/1 0/1 N=2		6.0			6.00m: Shear Vane failed						
	PEAT (AMORPHOUS), minor sand; dark brown, homogeneous. Firm to stiff, moist; sand, fine.				PQTT	100			6.5									
Albany Conglomerate	Organic SILT; dark brown speckled black. Stiff, moist, low plasticity. Organics; amorphous				PQTT	100			7.0									
	PEAT (AMORPHOUS), minor sand; dark brown. Firm to stiff, moist; sand, fine.				PQTT	100			7.5									
	7.50m: Very stiff				SPT	106	116/29 kPa 0/1 2/2 3/4 N=11		8.0									
	Completely weathered, grey, SANDSTONE. Extremely Weak, (Recovered as SAND; grey. Medium dense, moist, poorly graded; sand, fine).				PQTT	23			8.5									
Albany Conglomerate	8.2 - 9.0 m: CORE LOSS				PQTT	23			9.0									
	9.0 - 9.45 m: Solid Cone SPT				SPT	0	UTP 3/3 5/5 5/6 N=21 Solid		9.5			9.00 - 10.50m: Re-drilled due to core loss						
	Completely weathered, brown-grey, massive, SANDSTONE. Extremely Weak, (Recovered as SAND, minor gravel; brown-grey. Medium dense, moist, poorly graded; sand, fine to coarse; gravel, fine to coarse, subangular, unweathered, Sandstone & Siltstone).																	

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth 15.15m

Scale 1:25

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
 (NZTM2000) 1743191.10 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
	10.05 - 10.5 m: CORE LOSS				PQTT	57												
	Highly weathered, brown and dark grey, CONGLOMERATE. Extremely Weak. Very weakly cemented (Recovered as Gravelly SAND; brown & dark grey. Medium dense, moist; sand, fine to coarse; gravel, fine to coarse, subangular, unweathered).				SPT	93	UTP 4/4 5/5 7/7 N=24		10.5									
	Highly weathered, grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (Recovered as GRAVEL; grey. Moist; gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & Siltstone).				PQTT	76			11.0									
	Moderately weathered, grey, SANDSTONE. Extremely Weak, Weakly cemented. SAND; grey. Very dense, moist, poorly graded; sand, fine.				PQTT	76			11.5			0						
	11.75 - 12.0 m: CORE LOSS																	
	12.0 - 12.25 m: Solid cone SPT				SPT	100	UTP 5/21 27/23 N>=50		12.0									
	Highly weathered, brown & grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (Recovered as Sandy GRAVEL; brown & grey. Medium dense, moist, poorly graded; gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & siltstone; sand, fine to coarse).				PQTT	56			12.5									
	Highly weathered, grey, CONGLOMERATE. Extremely Weak, Very weakly cemented (recovered as GRAVEL; grey. Gravel, fine to coarse, subrounded to subangular, unweathered, Sandstone & Siltstone)				PQTT	56			13.0			0						
	Moderately weathered, grey, SANDSTONE. Extremely Weak, very weakly cemented. (Recovered as SAND; grey. Very dense, moist, poorly graded; sand, fine).				PQTT	56			13.5									
	13.5 - 13.64 m: Solid Cone SPT				SPT	0	15/35 for 65mm N>=50 Solid		13.5									
	Unweathered, grey, SANDSTONE. Extremely Weak, Widely spaced fractures. (Recovered as SAND; grey. Very dense, moist, poorly graded; sand, fine).				PQTT	129			14.0									
	13.96 - 13.98m: Slightly weathered, grey, SILTSTONE. Extremely Weak. SILT; grey. Hard, moist, low plasticity.				PQTT	129			14.5			63						

11.80m: J, 60° dip, VN, CN
 11.84m: J, 65° dip, CN

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:

BH05A

SHEET: 4 OF 4

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 17/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926551.90 mN
 (NZTM2000) 1743191.10 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.00m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
	15.0 - 15.14 m: Solid Cone SPT				SPT	0	13/37 for 70mm N>=50 Solid			X								
								15.5										
								16.0										
								16.5										
								17.0										
								17.5										
								18.0										
								18.5										
								19.0										
								19.5										

COMMENTS: Piezometer installed with screened interval from 8.5 - 11.5 m.

Hole Depth
15.15m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926551.90 mN (NZTM2000) 1743191.10 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020	
R.L.: 9.00m	DRILL METHOD: RC	HOLE FINISHED: 18/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: ROM
		CHECKED: CBM	

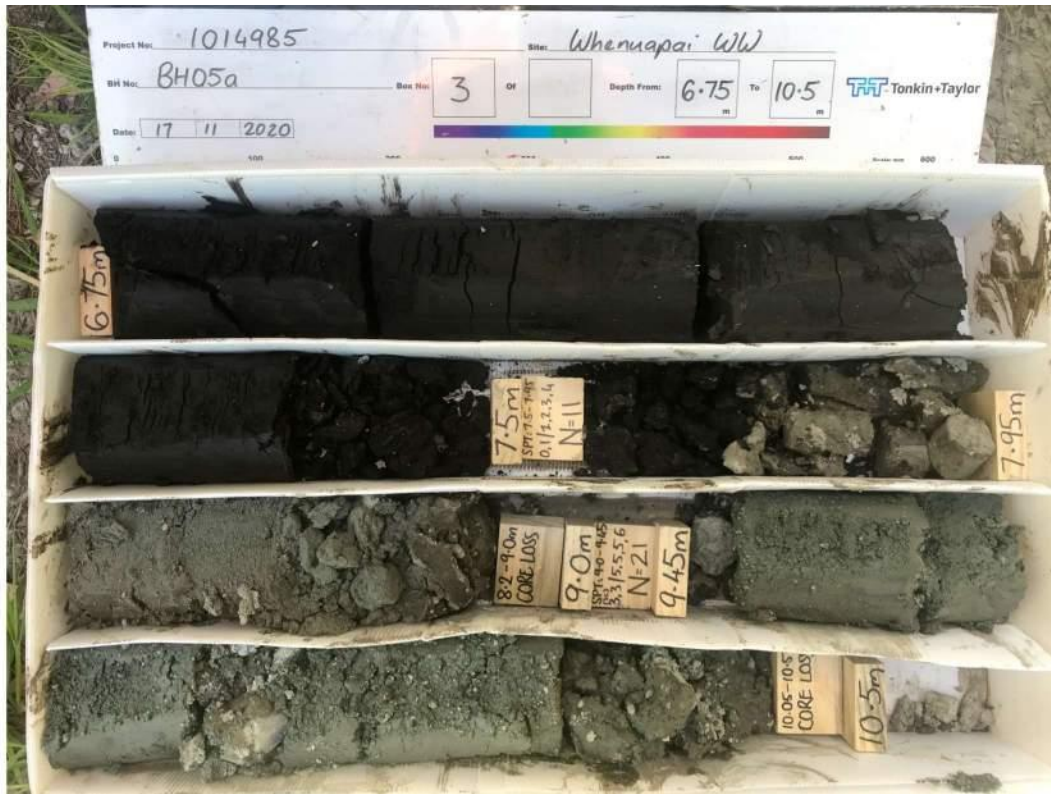


0.00-3.00m



3.00-6.75m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926551.90 mN 1743191.10 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020
R.L.:	9.00m	DRILL METHOD: RC	HOLE FINISHED: 18/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



6.75-10.50m



10.50-13.20m

CORE PHOTOS

BOREHOLE No.: **BH05A**

SHEET: 3 OF 3

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926551.90 mN 1743191.10 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 17/11/2020
R.L.:	9.00m	DRILL METHOD: RC	HOLE FINISHED: 18/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



13.20-15.14m



BOREHOLE LOG

BOREHOLE No.:

BH05B

SHEET: 1 OF 2

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 18/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926553.70 mN
 (NZTM2000) 1743191.30 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.20m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering <small>UW MW CW SW VW EW</small>	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm) <small>2000 500 100 50 20</small>	RQD (%)	Description & Additional Observations					
	Wash drilled to 7.0 m BGL. See BH05A for geology details																	

01/11/2020

COMMENTS: 50 mm standpipe piezometer with screened interval from 3.5 - 5.5 m.

Hole Depth
7m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:

BH05B

SHEET: 2 OF 2

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 18/11/2020

FINISH DATE: 18/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926553.70 mN
 (NZTM2000) 1743191.30 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.20m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering <small>UW MW CW SW WW EW</small>	Rock Strength <small>U5 U10 U15 W5 W10 W15 EW</small>	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Description & Additional Observations	Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation								Defect Log	Fracture Spacing (mm)	RQD (%)						
										<small>2000 500 100 50 20</small>								
	Wash drilled to 7.0 m BGL. See BH05A for geology details				W 0													
	7m: END OF INVESTIGATION																	

COMMENTS: 50 mm standpipe piezometer with screened interval from 3.5 - 5.5 m.

Hole Depth
7m

Scale 1:25

General Log - 21/11/2020 8:28:00 AM - Produced with Core-GS by GeRec

Rev.: A

BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 2 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
 (NZTM2000) 1743208.20 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
East Coast Bays Formation	[Cont.] Silty SAND; grey. Loose, moist; sand, fine.																		
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as SILT, trace sand; grey. Very Stiff, moist; sand, fine.).				PQTT	100			5.5										
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Sandy SILT; grey. Very Stiff, moist, non-plastic; sand, fine).								6.0										
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Loose, moist; sand, fine).				SPT	100	0/- kPa crumble soils 1/2 1/3 2/3 N=9		6.5										
	6.45 - 6.6 m: CORE LOSE								6.5										
	Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Sandy SILT; grey. Hard, moist, non-plastic; sand, fine). 6.90 - 6.95m: Silty SAND; grey. Loosely packed, moist; sand, fine. 6.95 - 7.17m: Very stiff.				PQTT	85			7.0										
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine). 7.40 - 7.50m: Sandy SILT; light grey. Very stiff, moist, non-plastic; sand, fine. 7.50 - 7.95m: Sand, coarse.				SPT	100	0/- kPa crumble soils 2/2 2/3 3/3 N=11		7.5										
	7.95 - 8.1 m: CORE LOSS								8.0										
	Highly weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine). Highly weathered, grey, SILTSTONE. Extremely Weak. (Recovered as Clayey SILT, minor sand; grey. Hard, moist, high plasticity; sand, fine).				PQTT	85			8.5										
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Medium dense, moist; sand, fine). 9.00 - 9.20m: Sand, coarse.								9.0										
Moderately weathered, grey, SILTSTONE. Extremely Weak. (Recovered as SILT, trace sand; grey. Hard, moist; sand, fine).				SPT	100	0/- kPa crumble soils 2/3 4/5 6/7 N=22		9.5											
Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine). 9.54 - 9.57m: Highly weathered, grey, SILTSTONE. Extremely Weak, (SILT; grey. Hard, moist, low plasticity).								9.5											

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
 (NZTM2000) 1743208.20 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE				ROCK DEFECTS															
	Soil: Classification, colour, consistency / density, moisture, plasticity	Rock: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
East Coast Bays Formation	[Cont.] Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine).		UW	2	PQTT	100	UTP 9/15 20/26 4 for 10mm N>=50	10.5				81								
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Dense, moist; sand, medium). - INTERBEDDED WITH - Moderately weathered, grey, SILTSTONE. Extremely Weak.		UW	2	SPT	100		10.5				0								
	Moderately weathered, grey, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Dense, moist; sand, medium). 10.81 - 11.1 m: CORE LOSS		UW	2				11.0												
	Unweathered, medium grained, SANDSTONE. Very Weak, very weakly cemented. 11.21 - 11.25m: Moderately weathered, SILTSTONE. Extremely Weak. 11.50 - 11.57m: Unweathered, grey, SILTSTONE. Very Weak.		UW	2	PQTT	75		11.5				75		11.24m: BF, 0° dip, N, CN 11.44 - 11.48m: BF, 0° dip, MN, Sands						
	Unweathered, grey, medium grained, SANDSTONE. Very Weak. 11.78 - 11.84m: Unweathered, grey, SILTSTONE. Very Weak, Carbonaceous. 11.84 - 12.00m: Unweathered, grey, medium grained, SANDSTONE. Very Weak.		UW	2				12.0				0		11.76m: BF, 0° dip, N, CN 11.88m: DD						
	12 - 12.12 m: SOLID SPT 12.12 - 12.6 m: CORE LOSS		UW	2	SPT	0	25/25 for 45mm N>=50 Solid	12.5												
	Unweathered, grey, medium grained, SANDSTONE. Very Weak. 13.18 - 13.26m: Unweathered, grey, SILTSTONE. Very Weak.		UW	2	PQTT	65		13.0				28		12.76 - 12.80m: BF, 0° dip, MN, Sands 12.90 - 12.93m: BF, 0° dip, MN, Sands 13.00 - 13.15m: BZ, 70° dip, N, CN 13.18m: BF, 0° dip, VN, CN 13.21m: DD 13.34m: BF, 0° dip, VN, CN 13.41m: BF, 0° dip, VN, CN						
	13.5 13.65 m: SOLID SPT 13.63 - 13.8 m: CORE LOSS		UW	2	SPT	0	16/34 for 55mm N>=50 Solid	13.5				0								
	Unweathered, grey, medium grained, SANDSTONE. Very Weak. 13.80 - 13.84m: Unweathered, grey, SILTSTONE. Very Weak. 14.40 - 14.90m: medium to coarse grained SANDSTONE		UW	2	PQTT	87		14.0				73		13.86m: DD 14.09m: BF, 0° dip, N, CN 14.23m: BF, 0° dip, T, CN 14.26m: BF, 0° dip, VN, CN 14.41m: BF, 0° dip, VN, CN						
	14.90 - 15.00m: Unweathered, grey, medium to coarse grained, SANDSTONE. Extremely Weak, Weakly cemented.		UW	2				14.5						14.57m: BF, 0° dip, T, CN 14.64m: BF, 0° dip, T, CN 14.79m: BF, 0° dip, T, CN 14.86m: BF, 0° dip, MN, CN						

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth 15.12m

Scale 1:25

General Log - 21/11/2020 8:31:50 AM - Produced with Core-GS by GeRoc

Box 4, 8.6-11.5m

Box 5, 11.5-14.3m

Rev.: A



BOREHOLE LOG

BOREHOLE No.:

BH06

SHEET: 4 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 19/11/2020

FINISH DATE: 19/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926435.00 mN
 1743208.20 mE
 (NZTM2000)

R.L. GROUND: 12.60m
 R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
 Station/Surveyed

DIRECTION:
 ANGLE FROM HORIZ.: -90°

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering <small>UW MW CW SW WW EW</small>	Rock Strength	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm) <small>2000 500 100 50 20</small>	RQD (%)						Description & Additional Observations
	15 - 15.12 m: SOLID SPT				SPT	0	21/29 for 45mm N>=50 Solid		X			0	14.94m: BF, 10° dip, N, CN					
	15.12m: END OF INVESTIGATION																	

COMMENTS: Piezometer installed with screened interval from 3.5 - 5.0 m

Hole Depth
15.12m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926435.00 mN 1743208.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020
R.L.:	12.60m	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA
			CHECKED: CBM



0.00-2.70m



2.70-5.55m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926435.00 mN (NZTM2000) 1743208.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020	
R.L.: 12.60m	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: YCWA
			CHECKED: CBM



5.55-8.60m



8.60-11.48m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926435.00 mN 1743208.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 19/11/2020
R.L.:	12.60m	DRILL METHOD: RC	HOLE FINISHED: 19/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



11.48-14.26m



14.26-15.12m



BOREHOLE LOG

BOREHOLE No.:

BH07

SHEET: 1 OF 2

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 20/11/2020

FINISH DATE: 20/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926205.30 mN
 (NZTM2000) 1743224.80 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 21.80m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
TSoil	Organic SILT; brown. Stiff, moist, low plasticity; organics, amorphous and rootlets.																	
	0.35 - 0.50m: Light brown mottled orangish brown.				PQTT	100			21									
Tauranga Group	Clayey SILT; light grey mottled orangish brown. Very stiff, moist, high plasticity.																	
	1.95 - 2.40m: Stiff.				SPT	66	168/67 kPa		1.0									
	2.40 - 3.00m: Firm to stiff.								1.5									
East Coast Bays Formation	3.0 - 3.5 m: PUSH TUBE				PT	100	58/11 kPa		3.0									
	Clayey SILT; organish brown. Firm, moist, medium plasticity.								3.5									
	Sandy SILT; grey. Firm, moist, non-plastic; sand, fine.				SPT	100			4.0									
	Clayey SILT; grey. Firm, moist, high plasticity.				PQTT	100			4.5									
	Sandy SILT; grey. Firm, moist, low plasticity; sand, fine.				SPT	100	40/9 kPa		4.5									
									17									

COMMENTS:

Hole Depth 6m

Scale 1:25

Box 1, 0.0-2.6m

20/11/2020



BOREHOLE LOG

BOREHOLE No.:

BH07

SHEET: 2 OF 2

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 20/11/2020

FINISH DATE: 20/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926205.30 mN
 (NZTM2000) 1743224.80 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 21.80m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering <small>UW MW CW SW MV CV</small>	Rock Strength <small>CS OS SW EW</small>	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm) <small>2000 500 100 50 20</small>	RQD (%)						Description & Additional Observations
East Coast Bays Formation	[Cont.] Sandy SILT; grey. Firm, moist, low plasticity; sand, fine.		PQTT	100	● 93/17 kPa	16	5.5	[Yellow pattern with 'x' marks]									Box 2, 2.6-4.0m	
	SILT, some clay, minor sand; grey. Stiff, moist, low plasticity; sand, fine.																	
	6m: END OF INVESTIGATION																	

COMMENTS:

Hole Depth
6m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926205.30 mN 1743224.80 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 20/11/2020
R.L.:	21.80m	DRILL METHOD: RC	HOLE FINISHED: 20/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



0.00-2.55m



2.55-6.00m

BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 1 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
 (NZTM2000) 1743457.30 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Fill	Sandy SILT, trace organics; brown. Firm, moist, low plasticity; sand, fine; organics, rootlets.		UW		PQTT	100	3 @ 0.10m 1 x Glass Jar 1 x Plastic Jar	24	0.5									
	Silty sandy CLAY, trace organics; brown, orange & light grey mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, rootlets.		UW		PQTT	100	1 @ 0.25m 1 x Plastic Jar Compositivity	24	0.5									
	Sandy SILT; brown mottled orange. Stiff, moist, low plasticity; sand, fine.		UW					24	0.5									
	Clayey sandy SILT; brown & orange mottled orange. Stiff, moist, medium plasticity; sand, fine.		UW					24	0.5									
	Silty CLAY, trace organics; light grey-grey mottled orange & brown. Stiff, moist, high plasticity; organics, rootlets.		UW		PQTT	100	5 @ 1.00m 1 x Glass Jar 1 x Plastic Jar	24	1.0									
	Clayey sandy SILT, trace organics; grey mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, rootlets.		UW		SPT	100	81/41 kPa 1/1 1/1 1/2 N=5	23	1.5									
	1.95 - 2.05 m: CORE LOSS							23	2.0									
	Clayey sandy SILT, trace organics; grey mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, fibrous.		UW		PQTT	90	6 @ 2.00m 1 x Glass Jar 1 x Plastic Jar	22	2.0									
	Clayey SILT, minor sand, trace organics; light grey-brown mottled orange. Stiff, moist, medium plasticity; sand, fine; organics, fibrous.		UW		PQTT	90	2 @ 2.30m 1 x Plastic Jar Corrosivity	22	2.5									
	Sandy SILT, trace organics; light grey-brown mottled orange. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW					22	2.5									
Tauranga Group	SILT, minor sand, trace organics; light brown mottled orange, speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW		SPT	122	7 @ 3.00m 1 x Glass Jar 1 x Plastic Jar	21	3.0									
	SILT, minor clay and sand, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW					21	3.0									
	Sandy SILT, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW		PQTT	66	8 @ 4.00m 1 x Glass Jar 1 x Plastic Jar	20	4.0									
	Sandy SILT, trace organics; grey speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW		SPT	155	52/12 kPa 0/1 1/0 1/0 N=4	20	4.5									

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth 10.95m

Scale 1:25

Rev.: A



BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 2 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
 (NZTM2000) 1743457.30 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Tauranga Group	SILT, minor clay, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; organics, fibrous.		UW	10	PQTT	100	9 @ 5.00m 1 x Glass Jar 1 x Plastic Jar	19	5.5	X									
	6.0 - 6.5 m: Push tube				PT	0	47/19 kPa 1/0 1/1 1/2 N=5		6.0	X									
	SILT, minor clay, trace organics; brown-grey spotted dark brown. Firm to stiff, moist, low plasticity; organics, fibrous. 6.80 - 6.92m: Grades to: Sandy SILT				SPT	100		18	6.5	X									
	SILT, minor sand, trace organics; brown speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous. 7.00m: Grades to: some sand				PQTT	100			7.0	X									
	Sandy SILT, trace organics; light brown & brown speckled black. Very loose, moist, poorly graded; sand, fine; organics, fibrous.				PQTT	100			7.5	X									
	SILT, some sand, trace organics; brown mottled light brown speckled black. Firm, moist, low plasticity; sand, fine; organics, fibrous.				SPT	100	0/0 0/1 1/1 N=3		17	8.0	X								
	Sandy SILT, trace organics; light brown speckled black. Firm, moist, low plasticity; sand, fine; organics, fibrous.				PQTT	100			16	8.5	X								
	Sandy SILT, trace organics; dark brown speckled black. Firm to stiff, moist, low plasticity; sand, fine; organics, fibrous. Sandy SILT, minor organics and clay; brown spotted black. Stiff, moist, low plasticity; sand, fine; organics, fibrous. 9.35m: Grades to: No Sand				SPT	117	59/19 kPa 1/1 2/2 2/2 N=8		15	9.0	X								

7.40 - 7.65m: Core disturbed due to core drop-out and re-drilling

7.65m: Core run extended to 7.65m due to core drop out of barrel

8.10 - 9.00m: Core disturbed due to core drop-out and re-drilling

Box 3, 5.2-9.4m

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth
10.95m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:

BH08

SHEET: 3 OF 3

DRILLED BY: Vincent

LOGGED BY: ROM

CHECKED: CBM

START DATE: 23/11/2020

FINISH DATE: 23/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926036.50 mN
 (NZTM2000) 1743457.30 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 24.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						
Tauranga Group	[CONT] Sandy SILT, minor clay and organics; brown spotted black. Stiff, moist, low plasticity; sand, fine; organics, fibrous				PQTT	100			10.5										
	Silty SAND, trace organics; light brown-grey spotted black. Loose to medium dense, moist, poorly graded; sand, fine; organics, fibrous. 10.88 - 10.93m: Decomposed wood 10.93m: Brown spotted black				SPT	100	133/31 1/2 2/2 3/3 N=10		14										
	10.95m: END OF INVESTIGATION								11.0										
									11.5										
									12.0										
									12.5										
									13.0										
									13.5										
									14.0										
									14.5										

COMMENTS: Piezometer installed with screened interval from 3.0 to 6.0 m

Hole Depth
10.95m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926036.50 mN 1743457.30 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 23/11/2020
R.L.:	24.60m	DRILL METHOD: RC	HOLE FINISHED: 23/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-2.40m



2.40-5.20m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926036.50 mN (NZTM2000) 1743457.30 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 23/11/2020	
R.L.: 24.60m	DRILL METHOD: RC	HOLE FINISHED: 23/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: ROM
			CHECKED: CBM



5.20-8.35m



8.35-10.95m



BOREHOLE LOG

BOREHOLE No.:
BH110

SHEET: 1 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
TSoil	SILT, trace rootlets; brown. Stiff, moist, non-plastic.						1 @ 0.10m											
	SILT, trace sand; light brown mottled orangish brown. Stiff to very stiff, moist, low plasticity; sand, fine. <i>0.50 - 0.80m: Trace rootlets.</i>				PQTT	100	8 @ 0.80m 3 @ 0.90m		0.50					0.50m: PID - 0.6 ppm				
Tauranga Group	Silty CLAY; light brown mottled orangish brown. Very stiff, moist, high plasticity. <i>0.80 - 0.90m: Trace rootlets.</i>						4 @ 1.25m		1.00					1.00m: PID - 0.3 ppm				
	1.50 - 2.45m: Light brown.				SPT	84	153/59 kPa / 1 2/1 3/2 N=8		1.50									
	Silty SAND; light brown mottled orangish brown. Loosely packed, saturated; sand, fine.				PQTT	100	5 @ 1.95m		2.00									
East Coast Bays Formation	Sandy SILT; grey. Tightly packed, moist; sand, fine.						9 @ 2.30m		2.50									
	3.1 - 3.5 m: PUSH TUBE				PQTT	100	96/16 kPa		3.00									
	Sandy SILT; grey. Hard, moist, non-plastic; sand, fine.				PT	100	0/- kPa crumble Push Tube @ 3.10m		3.50									
	3.87 - 4.0 m: CORE LOSS				SPT	100	5/10 15/17 18 for 65mm N>=50		4.00									
	Moderately weathered, grey, SANDSTONE. Extremely weak. (Recovered as SAND, grey. Very dense, moist; sand fine)				PQTT	79	7 @ 4.00m		4.50									
	Moderately weathered, grey, SILTSTONE. Extremely weak. (Recovered as Sandy SILT, grey. hard, moist, low plasticity; sand fine)				SPT	0	UTP 6/25 20/30 for 45mm N>=50 Solid		5.00									
4.77 - 4.87 m: CORE LOSS																		

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth 15.11m

Scale 1:25

Rev.: A



BOREHOLE LOG

BOREHOLE No.:
BH110

SHEET: 2 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE				ROCK DEFECTS												
	Soil: Classification, colour, consistency / density, moisture, plasticity Rock: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	Moderately weathered, grey, fine, SANDSTONE. Extremely Weak. (Recovered as SAND; grey. Tightly packed, moist; sand, fine)											5.16m: DD					
	Moderately weathered, grey, SILTSTONE. Very Weak.			PQTT			5.5			55	5.32m: BF, 0° dip, N, CN 5.40m: BF, 0° dip, N, CN 5.44m: DD 5.59m: DD						
	Moderately weathered, grey, fine SANDSTONE. Extremely weak. (Recovered as Silty SAND, grey. Very dense, moist; sand fine)			PQTT	91		6.0			0	0	5.90m: DD					
	Slightly weathered, grey, SANDSTONE. Extremely weak, very weakly cemented. (Recovered as Silty SAND, grey. Very dense, moist; sand fine)			SPT	0	10/25 35/15 for 10mm N>=50 Solid		6.5				6.60m: BF, 0° dip, N, CN					
	6.93m: Carbonaceous			PQTT	100		7.0				67	6.85m: BF, 0° dip, T, CN					
	Unweathered, grey, SANDSTONE. Very Weak.			PQTT			7.5				0	7.10 - 7.30m: BZ, 80° dip, N, CN					
	7.5 - 7.63 m: Solid SPT			SPT	0	11/39 for 55mm N>=50 Solid		8.0				7.91 - 7.93m: BF, 10° dip, N, CN 7.98m: BF, 0° dip, N, CN 8.07m: BF, 0° dip, VN, CN					
	Unweathered, grey, fine to coarse, SANDSTONE. Very Weak.			PQTT	89		8.5				45	8.42m: BF, 0° dip, N, CN					
	8.00 - 8.15m: Unweathered SILTSTONE. Very Weak.						9.0				0	8.65 - 8.67m: BF, 0° dip, N, coarse sands 8.70m: BF, 0° dip, VN, CN 8.73 - 8.77m: BZ, 30° dip, VN, CN					
	8.15 - 8.3 m: CORE LOSS						9.5				54	8.82m: BF, 0° dip, MN, medium grained sands 8.86m: BF, 0° dip, VN, CN 8.91m: BF, 0° dip, VN, CN 8.94m: BF, 0° dip, VN, CN 9.23m: DD 9.36m: BF, 10° dip, VN, CN 9.42m: BF, 0° dip, VN, CN					
	Unweathered, grey, fine to coarse, SANDSTONE. Very Weak.			SPT	0	5/21 50 for 25mm N>=50 Solid		9.61m: BF, 10° dip, VN, CN				9.77m: BF, 0° dip, VN, CN					
	Unweathered, grey, fine, SANDSTONE. Very Weak.						9.90m: BF, 0° dip, VN, CN										
9.0 - 9.18 m: SOLID SPT																	
9.30 - 9.40m: Unweathered SILTSTONE. Very Weak.																	
9.90 - 9.97m: Unweathered SILTSTONE. Very Weak.																	

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth
15.11m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:
BH110

SHEET: 3 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
(NZTM2000) 1743051.90 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE						ROCK DEFECTS											
	Soil: Classification, colour, consistency / density, moisture, plasticity Rock: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	Unweathered, grey, medium to coarse, SANDSTONE. Very Weak, Weakly cemented.	UW	VS	PQTT	100		10.13				54	10.13m: BF, 0° dip, VN, CN 10.22m: BF, 0° dip, N, CN 10.30m: BF, 0° dip, VN, CN 10.37m: BF, 0° dip, VN, CN						
	Unweathered, grey, SILTSTONE. Very Weak.						10.5				0							
	Unweathered, grey, fine, SANDSTONE. Very Weak.						11.0				48	10.74 - 10.77m: BF, 30° dip, N, CN 10.84m: BF, 0° dip, N, CN 10.94m: DD						
	11.22 - 11.23m: Unweathered SILTSTONE. Very Weak.						11.5				21	11.09m: DD 11.22m: BF, 0° dip, VN, CN 11.29m: BF, 0° dip, VN, CN 11.36m: BF, 20° dip, VN, CN						
	11.35 - 11.53m: SANDSTONE grades fine to medium grained						12.0				0	11.53 - 11.57m: BF, 0° dip, MN, Sands 11.65 - 11.73m: BZ, VN, CN 11.79m: BF, 0° dip, VN, CN 11.85m: DD						
	11.85 - 11.95m: Unweathered SILTSTONE. Very Weak						12.5				55	12.19m: BF, 0° dip, VN, CN 12.23m: DD 12.29m: BF, 10° dip, VN, CN						
	12.0 - 12.09 m: SOILD SPT						13.0					0	12.48m: BF, 0° dip, VN, CN 12.59m: BF, 0° dip, N, Sandstone gravels 12.64m: BF, 10° dip, N, CN 12.68m: BF, 0° dip, VN, CN 12.70m: DD 12.75m: DD 12.99m: DD					
	Unweathered, grey, fine, SANDSTONE. Very Weak.						13.5					0	13.17m: BF, 0° dip, VN, CN 13.29m: BF, 0° dip, VN, CN					
	Unweathered, grey, SILTSTONE. Very Weak. 12.21 - 12.29m: Carbonaceous						14.0					32	13.63m: BF, 10° dip, N, CN 13.74m: BF, 0° dip, MN, CN 13.77m: BF, 0° dip, N, CN 13.88m: BF, 0° dip, MN, CN					
	12.29 - 12.35m: Carbonaceous 12.63 - 12.64m: SANDSTONE interbed 12.69 - 12.70m: SANDSTONE interbed						14.5						14.10m: DD 14.16m: BF, 0° dip, N, CN 14.25 - 14.29m: BF, VN, CN					
	Unweathered, grey, fine, SANDSTONE. Very Weak, Weakly cemented.																	
	13.37 - 13.46m: Unweathered SILTSTONE. Very Weak.																	
Unweathered, grey mottled light grey, fine to medium grained, SANDSTONE. Weak, Moderately cemented.																		
Unweathered, grey, fine, SANDSTONE. Very Weak. 14.21 - 14.22m: Unweathered SILTSTONE. Very Weak.																		
14.4 - 14.75 m: CORE LOSS																		
Unweathered, grey, SANDSTONE. Very weak																		
Unweathered, grey, SILTSTONE. Very Weak.																		

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth 15.11m

Scale 1:25

General Log - 21/12/2020 8:45:31 AM - Produced with Core-GS by GeRec

Box 5, 9.6-11.9m

Box 6, 11.9-14.1m

Rev.: A



BOREHOLE LOG

BOREHOLE No.:
BH110

SHEET: 4 OF 4

DRILLED BY: Mackenzie, Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 13/11/2020

FINISH DATE: 16/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926611.70 mN
1743051.90 mE
(NZTM2000)

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total
Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering <small>UW MW CW SW WW EW</small>	Rock Strength <small>CS SS SW WW EW</small>	Sampling Method Core Recovery (%)	Testing N	RL (m) Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%) <small>25 50 75</small>	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation								Defect Log	Fracture Spacing (mm) <small>2000 500 100 50 20</small>	RQD (%)						Description & Additional Observations
	15.0 - 15.11 m: SOLID SPT				SPT	0	23/27 for 35mm N>=50 Solid	X			0						
	15.11m: END OF INVESTIGATION																

COMMENTS: Piezometer installed with screened interval from 8.0 - 11.0 m

Hole Depth
15.11m

Scale 1:25

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926611.70 mN (NZTM2000) 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020	
R.L.: 9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: YCWA
			CHECKED: CBM



0.00-2.50m



2.50-5.10m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926611.70 mN 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.:	9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



5.10-7.10m



7.10-9.61m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926611.70 mN 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.:	9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



9.61-11.90m



11.90-14.10m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926611.70 mN 1743051.90 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 13/11/2020
R.L.:	9.60m	DRILL METHOD: RC	HOLE FINISHED: 16/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



14.10-15.11m

BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 1 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
 (NZTM2000) 1743088.20 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE																
	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS								
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation								Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Top	Clayey SILT, some organics; brown. Very stiff, moist, high plasticity; organics, rootlets.																
Tauranga Group	Clayey SILT, trace sand; light brown. Stiff, moist, high plasticity; sand, fine. 0.3 - 1.4 m: CORE LOSS																
	Clayey SILT, trace sand; light brown mottled brown. Stiff, moist, high plasticity; sand, fine.																
	Clayey SILT, minor organics, trace sand; brown. Firm, moist, high plasticity; sand, fine; organics, rootlets.																
	Sandy SILT; grey mottled orangish brown. Firm, moist, non-plastic; sand, fine.																
East Coast Bays Formation	Silty SAND; grey. Medium dense, moist; sand, fine.																
	3.45 - 3.7 m: CORE LOSS																
	Moderately weathered, grey, fine grained, SANDSTONE. Extremely Weak, (Recovered as Silty SAND; grey. Medium dense, moist; sand, fine) 3.90 - 4.05m: Recovered as GRAVEL																
	Moderately weathered, grey fine grained SANDSTONE; Extremely weak. (Recovered as fine grained SAND; grey. Dense, moist.)																
	Moderately weathered, grey SILTONE; Extremely weak. (Sandy SILT; grey. Hard, moist, low plasticity; sand, fine.) 4.70 - 4.72m: SILT; light brown. Moist, low plasticity. 4.85m: 2 mm thick SILT; light brown. 4.90 - 4.95m: SAND; grey. Dense, moist; sand, fine.																

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Box 1, 0.0-3.5m

BOREHOLE LOG

BOREHOLE No.:
BH111

SHEET: 2 OF 4

DRILLED BY: Vincent
LOGGED BY: YCWA
CHECKED: CBM
START DATE: 10/11/2020
FINISH DATE: 11/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743088.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation	Description & Additional Observations																		
East Coast Bays Formation	4.95 - 5.05 m: CORE LOSS						PQTT	81			5.5				65	5.23m: BF, 10° dip, VN, CN 5.27 - 5.28m: BF, 0° dip, MN, light brown veneer					
	Slightly weathered, grey, fine grained SANDSTONE. Very Weak. 5.05 - 5.15m: SAND; grey. Dense, moist; sand, fine. 5.28 - 5.32m: Slightly weathered, grey, SILTSTONE. Very Weak. 5.40m: Carbonaceous																				
	Unweathered, light grey, fine grained SANDSTONE. Weak.						PQTT	12				5.5			0						
	5.56 - 6.0 m: CORE LOSS																				
	Slightly weathered, grey, fine grained SANDSTONE. Very Weak, Carbonaceous [logged after solid SPT testing].						SPT	100	8/15 15/25 10 for 15mm N>=50 Solid			6.0				0					
	Slightly weathered, grey, fine, SANDSTONE. Very Weak, (Recovered as GRAVEL).																				
	6.42 - 6.6 m: CORE LOSS																				
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 6.68 - 6.72m: SILTSTONE																				
	6.90 - 6.92m: SILTSTONE						PQTT	84				7.0				53	6.60m: BF, 0° dip, N, CN 6.68m: BF, 0° dip, N, CN 6.77m: BF, 0° dip, N, CN 6.87m: BF, 0° dip, N, CN				
	7.20 - 7.26m: SILTSTONE																7.00m: DD 7.20m: DD				
Unweathered, grey, SILTSTONE. Very Weak. - INTERBEDDED WITH - Unweathered, grey, fine, SANDSTONE. Very Weak.						SPT	100	8/12 17/23 10 for 20mm N>=50 Solid			7.5				0	7.40m: BF, 0° dip, VN, CN					
Unweathered, grey, fine grained SANDSTONE. Very Weak.																					
8.32 - 8.33m: SILTSTONE 8.37 - 8.38m: SILTSTONE 8.44 - 8.53m: SILTSTONE 8.53 - 8.90m: Weakly cemented SANDSTONE						PQTT	80				8.0				45	8.15m: DD 8.30m: BF, 0° dip, VN, CN 8.42m: BF, 0° dip, VN, CN 8.44m: BF, 0° dip, VN, CN 8.49m: BF, 0° dip, VN, CN 8.53m: DD					
8.9 - 9.0 m: CORE LOSS																					
Unweathered, grey, SANDSTONE. Very Weak, carbonaceous. [logged after solid SPT test].						SPT	95	15/25 35/15 for 10mm N>=50 Solid			9.0				0						
9.24 - 9.45 m: CORE LOSS																					
Unweathered, grey, fine grained SANDSTONE. Very Weak.																					
9.78 - 9.80m: SILTSTONE 9.86 - 9.97m: SILTSTONE											9.5				31	9.50m: DD 9.68m: DD 9.78m: BF, 0° dip, N, CN 9.83m: DD 9.86m: DD					

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth
18.04m

Scale 1:25

Rev.: A



BOREHOLE LOG

BOREHOLE No.:

BH111

SHEET: 3 OF 4

DRILLED BY: Vincent

LOGGED BY: YCWA

CHECKED: CBM

START DATE: 10/11/2020

FINISH DATE: 11/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
 (NZTM2000) 1743088.20 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE				ROCK DEFECTS												
	Soil: Classification, colour, consistency / density, moisture, plasticity Rock: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	[CONT] unweathered, grey, fine grained SANDSTONE. Very Weak. 10.02 - 10.06m: Fine to coarse grained SANDSTONE 10.24 - 10.48m: Fine to coarse grained SANDSTONE	UW	25	PQTT	83		10.02			31	10.02m: BF, 0° dip, VN, CN 10.06 - 10.11m: BF, 0° dip, N, CG (grey silt) 10.15m: DD 10.21m: BF, 0° dip, N, CN 10.24m: BF, 0° dip, N, CN 10.38m: DD 10.44m: DD						
	10.5 - 10.63 m: Solid SPT			SPT	0	20/27 for 50mm N>=50 Solid	10.5			0							
	10.63 - 11.15 m: CORE LOSS						11.0										
	Unweathered, grey, fine grained SANDSTONE. Very Weak. Unweathered, grey, coarse grained SANDSTONE. Very Weak.	UW	25	PQTT	62		11.5			9	11.22m: BF, 0° dip, N, CN 11.28m: BF, 0° dip, N, CN 11.36m: BF, 0° dip, N, CN 11.45m: DD 11.50m: DD 11.59m: DD						
	Unweathered, grey, fine grained SANDSTONE. Very Weak. 11.61 - 11.65m: SILTSTONE 11.77 - 11.82m: Coarse grained SANDSTONE	UW	25	PQTT	62		12.0			0	11.73m: DD 11.77m: BF, 0° dip, N, CN 11.82m: DD 11.88m: DD						
	Unweathered, grey, SILTSTONE. Very Weak.			SPT	80	5/14 30/20 for 25mm N>=50 Solid	12.5										
	Unweathered, grey, fine grained SANDSTONE. Very Weak.			PQTT	100		13.0			61	12.46m: DD 12.63 - 12.73m: BZ, 70° dip, VN, CN 12.87m: DD						
	12.74 - 12.77m: SILTSTONE						13.5			0	13.14m: DD 13.27m: DD 13.32m: BF, 0° dip, N, CN 13.42m: DD						
	13.14 - 13.20m: SILTSTONE			SPT	100	20/30 for 30mm N>=50 Solid	14.0					13.76m: DD 13.85m: DD					
	Unweathered, grey, SILTSTONE. Very Weak.			PQTT	73		14.5			46	14.02m: DD 14.10m: DD 14.15m: DD						
Unweathered, grey, fine grained SANDSTONE. Very Weak.						14.88					14.88m: DD						

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 3.0 - 5.0 m.

Hole Depth 18.04m

Scale 1:25

Rev.: A

General Log - 21/11/2020 8:46:57 AM - Produced with Core-GS by GeRec

Box 4, 8.3-11.5m

Box 5, 11.5-13.6m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926614.20 mN 1743088.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.:	9.90m	DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



0.00-3.45m



3.45-6.00m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926614.20 mN 1743088.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.:	9.90m	DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM:	NZVD2016	LOGGED BY: YCWA	CHECKED: CBM



6.00-8.30m



8.30-11.45m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926614.20 mN (NZTM2000) 1743088.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020	
R.L.: 9.90m	DRILL METHOD: RC	HOLE FINISHED: 11/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: YCWA
			CHECKED: CBM



11.45-13.60m



13.60-16.50m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926614.20 mN 1743088.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 10/11/2020
R.L.:	9.90m	DRILL METHOD: RC	HOLE FINISHED: 11/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: YCWA CHECKED: CBM



16.50-18.00m

BOREHOLE LOG

BOREHOLE No.:
BH111A

SHEET: 1 OF 1

DRILLED BY: Vincent
LOGGED BY: YCWA
CHECKED: CBM
START DATE: 12/11/2020
FINISH DATE: 12/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926614.20 mN
(NZTM2000) 1743090.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 9.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Tauranga Group	SILT, minor rootlets; brown. Stiff to very stiff, low plasticity.																	
	Clayey SILT; light brown mottled orangish brown. Stiff, moist, high plasticity. 0.60 - 0.80m: Trace rootlets. Firm.																	
	Clayey SILT, minor organics, trace sand; brown. Firm, moist, high plasticity; organics, fleck; sand, fine.																	
	1.75 - 2.0 m: CORE LOSS																	
	2.0 - 2.5 m: PUSH TUBE																	
	2.5m: END OF BOREHOLE																	

COMMENTS: Drilled 1.5 m from BH111 to recover core in the upper 2.5 m.

Hole Depth
2.5m

Scale 1:25

CORE PHOTOS

BOREHOLE No.: **BH111A**

SHEET: 1 OF 1

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926614.20 mN 1743090.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 12/11/2020 HOLE FINISHED: 12/11/2020
R.L.:	9.90m	DRILL METHOD: RC	DRILLED BY: McMillan Drilling
DATUM:	NZVD2016		LOGGED BY: YCWA CHECKED: CBM



0.00-2.50m

BOREHOLE LOG

BOREHOLE No.:
BH113

SHEET: 1 OF 4

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 04/11/2020
FINISH DATE: 05/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
Top	Sandy SILT, trace organics; dark brown. Firm, saturated, low plasticity; Sand, fine grained; sand, fine; organics, rootlets.						2 @ 0.10m	12		TS									
	Sandy SILT, minor clay, trace organics: brown mottled orange & dark brown. Stiff, dry to moist, low plasticity; Sand, fine; organics, rootlets						3 @ 0.50m	0.5											
	0.55 - 1.5 m: CORE LOSS				PQTT	36													
	SILT, minor clay, minor sand, trace organics: brown mottled orange. Stiff, moist, low plasticity; Sand, fine; organics, rootlets				SPT	33	0/- kPa Shear vane failed - core 1/1 0/1 1/1 N=3	1.5											
	1.65 - 2.2 m: CORE LOSS																		
Tauranga Group	Sandy SILT, trace organics; brown mottled orange, speckled white & black. Firm, moist, low plasticity; Sand, fine; organics, rootlets				PQTT	76		10											
	Fine to coarse SAND, some gravel, minor silt; green-grey speckled white. Loose, saturated, moderately well graded; gravel, fine to medium grained, sub-rounded gravel.				SPT	68	16/0 kPa Soil shear strength value 1/1 1/1 1/2 N=5	9											
	4.17 - 14.20m: SILTSTONE gravel				PQTT	80													
	4.3 - 4.5 m: CORE LOSS																		
	SILT, some clay, trace organics; grey-green. Stiff, moist, moderate plasticity; organics, rootlets				SPT	108	0/- kPa No shear vane Cohesion 0/0 0/1 1/0 N=2	4.5											

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

General Log - 21/11/2020 9:09:47 AM - Produced with Core-GS by GeRoc

Hole Depth 20m
Scale 1:25

Box 1, 0.0-4.0m



BOREHOLE LOG

BOREHOLE No.:
BH113

SHEET: 2 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 04/11/2020

FINISH DATE: 05/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Tauranga Group	[CONT] SILT, some clay, trace organics; grey-green. Stiff, moist, moderate plasticity; organics, rootlets																		
	5.50m: Grades: Light brown				PQTT	100			5.5										
	Organic SILT, minor clay, trace organics; brown speckled black. Firm, moist, low plasticity; organics, rootlets																		
	6.0 - 6.5 m: Push Tube				PT	0	96/10 kPa 1 @ 6.00m		6.0										
	SILT, trace clay, trace organics; grey speckled black. Firm to stiff, moist, low plasticity; organics, carbonaceous.				SPT	100	0/0 0/0 0/1 N=1		6.5										
	Clayey SILT, trace organics; grey-green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.				SPT	111	0/- kPa 0/0 1/0 0/1 N=2		7.5										
	9.00 - 9.05m: Brown mottled grey-green, speckled black.				PQTT	100			8.5										
	9.50m: Grey-brown speckled black.				SPT	148	79/30 kPa 0/1 2/0 1/1 N=4		9.0										

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth
20m

Scale 1:25

Rev.: A

General Log - 21/11/2020 9:09:47 AM - Produced with Core-GS by GeRec

Box 2, 4.0-7.3m

Box 3, 7.3-9.8m

BOREHOLE LOG

BOREHOLE No.:
BH113

SHEET: 3 OF 4

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 04/11/2020
FINISH DATE: 05/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
(NZTM2000) 1743286.20 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Tauranga Group	[CONT] Clayey SILT, trace organics; grey-green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.		UW		POTT	100		2	10.5										
	Clayey SILT, minor sand, trace organics; light green speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets.		UW		SPT	122	78/38 kPa 1/1 1/2 1/3 N=7	10.5											
	SILT, trace organics; grey, brown & light green. Firm, moist, low plasticity; organics, rootlets.		UW					11.0											
	Clayey SILT, trace organics; grey-brown & light green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.		UW		POTT	100		11.5											
	SILT, trace organics; brown, grey-brown & light green. Firm - stiff, moist, low plasticity; organics, rootlets.		UW					12.0											
	Clayey SILT, trace organics; grey-brown & light green speckled black. Stiff, moist, moderate plasticity; organics, rootlets.		UW		SPT	128	44/10 kPa 0/1 3/3 3/3 N=12	12.0											
	Sandy SILT, trace organics; grey & grey-green. Stiff, moist, low plasticity; Sand, fine; organics, wood fragments.		UW					12.5											
East Coast Bays Formation	13.05m: Grey		UW		POTT	100		13.0											
	Silty fine to coarse SAND, trace gravel, trace organics; grey & grey-green. Medium dense, moist, well graded; Gravel, fine to coarse grained, sub-angular Siltstone & Sandstone; organics, wood fragments.		UW		SPT	124	UTP 5/5 6/12 10/12 N=40	13.5											
	Moderately weathered, grey and grey-green, fine, SANDSTONE. Extremely Weak, bedded, thin. - INTERBEDDED WITH - Moderately weathered, grey and grey-green, SILTSTONE. Extremely Weak, thin, (recovered as Gravelly SAND).		UW		POTT	100		14.5											
	Moderately weathered, grey SILTSTONE; Extremely weak (Recovered as, Clayey SILT, some sand; grey. Hard, moist, low plasticity).		UW					14.5											
Slightly weathered, grey, SANDSTONE; EW		UW					14.5												

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth 20m

Scale 1:25

Box 4, 9.8-12.5m

Box 5, 12.5-14.9m



BOREHOLE LOG

BOREHOLE No.:

BH113

SHEET: 4 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 04/11/2020

FINISH DATE: 05/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926965.50 mN
 (NZTM2000) 1743286.20 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 12.20m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
East Coast Bays Formation	15.0 - 5.37 m: Core Loss				SPT	0	2/5 10/17 24 for 75mm N>=50 Solid	-3					0						
	Slightly weathered, grey SILTSTONE; Very weak				PQTT	100		15.5						15.66m: BF, 12° dip, VN, CN					
	15.65m: Very weak							16.0				36		15.85 - 15.87m: BZ 15.90m: BF, 18° dip, VN, CN 15.98m: BF, 15° dip, VN, CN					
	16.5 - 16.91m: Solid cone SPT				SPT	0	2/4 6/8 23/13 for 35mm N>=50 Solid	-4					0	16.10 - 16.19m: BZ 16.25 - 16.32m: BZ 16.35m: BF, 12° dip, VN, CN					
	Unweathered, grey, SILTSTONE. Weak, laminated. - INTERBEDDED WITH - Unweathered, grey, SANDSTONE. Weak.				PQTT	100		16.5						17.15m: BF, 15° dip, VN, CN 17.26m: BF, 0° dip, VN, CN 17.30m: BF, 15° dip, VN, CN					
18.0 - 18.28 m: Solid cone SPT					SPT	0	12/25 30/20 for 50mm N>=50 Solid	-5				28		17.45m: BF, 13° dip 17.49m: BF, 12° dip, VN, Brown veneer 17.51 - 18.00m: BZ 17.55m: J, 55° dip, N 17.60m: J, 55° dip, VN 17.88m: J, 55° dip, VN					
								17.0											
								17.5											
								18.0											
								18.5											
								19.0											
								19.5											

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 4.0 m. SPT calibration undertaken between 13.5 - 18.0 m.

Hole Depth 20m
 Scale 1:25

General Log - 21/11/2020 9:09:47 AM - Produced with Core-GS by GeRec

Box 6, 14.9-17.4m

Box 7, 17.4-18.3m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-4.00m



4.00-7.30m

CORE PHOTOS

BOREHOLE No.: **BH113**

SHEET: 2 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



7.30-9.75m



9.75-12.45m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



12.45-14.90m



14.90-17.40m

CORE PHOTOS

BOREHOLE No.: **BH113**

SHEET: 4 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926965.50 mN 1743286.20 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 04/11/2020
R.L.:	12.20m	DRILL METHOD: RC	HOLE FINISHED: 05/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



17.40-18.28m

BOREHOLE LOG

BOREHOLE No.:
BH116

SHEET: 1 OF 4

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 02/11/2020
FINISH DATE: 03/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE				Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation												Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Fill	SILT, some sand, minor clay, trace gravel, trace organics; Dark brown. Stiff, moist, moderate plasticity; Sand, fine grained; Gravel, fine grained, angular; organics, rootlets [FILL]				UW	15			1 @ 0.10m	13.60	0.0										
	Silty CLAY; some sand, trace gravel; trace organics; Brown mottled orange and dark brown. Very stiff, moist, high plasticity. Sand, fine to coarse grained; Gravel; fine grained, angular Basalt; organics, rootlets [FILL].				UW	15			2 @ 0.50m	13.0	0.5										
Tauranga Group	Silty CLAY, some sand, trace organics; grey-brown mottled orange, speckled white. Very stiff, moist, high plasticity; Sand, fine grained; Gravel, fine grained, angular; organics, rootlets. 0.85 - 1.5 m: CORE LOSS				UW	15	PQTT	56	3 @ 1.00m	12.5	1.0										
	Sandy SILT, trace organics; grey mottled orange & brown. Stiff, moist, low plasticity; Sand, fine grained; organics, rootlets.				UW	15	SPT	77	0/- kPa Geo not present - service clearance 1/0 1/1 1/1 N=4 4 @ 2.00m	12.0	1.5										
	Grades to: Silty fine grained SAND, trace organics; grey mottled orange & brown. Loose, moist, poorly graded; Sand, fine; organics, rootlets 2.80m: Grades: grey				UW	15	PQTT	138	7 @ 3.00m	11.5	2.5										
	3.05 - 3.45 m: CORE LOSS				UW	15	SPT	11	0/- kPa Geo not present - service clearance 0/1 0/1 0/1 N=2 5 @ 3.45m	11.0	3.0										
	3.45 - 3.95 m: PUSH TUBE				UW	15	PT	0	8 @ 4.00m	10.5	3.5										
	Silty CLAY, minor sand; green-grey. Very stiff, moist, high plasticity; Sand, fine.				UW	15	PQTT	100	6 @ 4.50m	10.0	4.0										
	Organic Silty CLAY, trace organics; dark brown speckled black, Firm, moist, high plasticity; organics, carbonaceous 4.5 - 5.0 m: PUSH TUBE				UW	15	PT	0	0/- kPa Geo not present - service clearance	9.5	4.5										

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

Box 1, 0.0-2.8m

Rev.: A



BOREHOLE LOG

BOREHOLE No.:

BH116

SHEET: 2 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
 (NZTM2000) 1743342.70 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS															
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering UW MV MW CW SW VW EW	Rock Strength US MS MWS CS SS VSS ES	Sampling Method SPT PQTT	Core Recovery (%)	Testing 9 @ 5.00m 0/0 0/0 1/1 N=2	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm) 2000 500 100 50 20	RQD (%)	Description & Additional Observations	Fluid Loss (%) 25 50 75	Water Level	Casing	Installation	Core Box No
Tauranga Group	[CONT] Organic Silty CLAY, trace organics; dark brown speckled black, Firm, moist, high plasticity; organics, carbonaceous			SPT	140		5.5						5.00 - 5.45m: Core extended					
	Silty CLAY, trace organics; grey speckled black. Stiff, moist, high plasticity; organics, rootlets			PQTT	100		6.0											
	6.00m: Grades: green speckled black			SPT	106	0/- kPa 1/1 1/1 0/1 N=3	6.5											
	6.90m: Grades: brown speckled black			PQTT	100		7.0											
	Grades to: Clayey SILT; grey-green. Firm to stiff, moist, moderate plasticity.			SPT	100	69/31 kPa 0/0 1/0 1/1 N=3	7.5											
	Grades to: SILT; grey. Soft to firm, moist, low plasticity, slightly sensitive.						8.0											
	Grades to: Clayey SILT; grey-green. Stiff, moist, moderate plasticity, slightly sensitive.			PQTT	60		8.5											
	Grades to: SILT, minor clay; brown. Firm to stiff, moist, low plasticity, slightly sensitive.						9.0						9.00m: Shear vane indicates material is sensitive. Minimal sensitivity recognized during tactile remoulding					
	Silty CLAY, grey-green. Stiff, moist, high plasticity.			SPT	133	53/9 kPa 1/1 1/1 1/2 N=5	9.5											
SILT; grey-brown & grey-green. Soft to firm, moist, low plasticity, slightly sensitive.																		
SILT, minor clay; grey-green & brown-grey. Firm to stiff, moist, low plasticity, slightly sensitive.																		

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

General Log - 21/11/2020 9:52:52 AM - Produced with Core-GS by GeRoc

Box 2, 2.9-6.8m

Box 3, 6.8-9.5m



BOREHOLE LOG

BOREHOLE No.:
BH116

SHEET: 3 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
(NZTM2000) 1743342.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Tauranga Group	Silty CLAY, grey-green. Stiff, moist, high plasticity.		UW	10	PQTT	100		10.5	10.5	X	2000							
	Sandy CLAY, some silt, trace organics. Grey-green speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, carbonaceous		UW	10	SPT	142	98/32 kPa 1/1 2/1 2/3 N=8	11.0	11.0	X	500							
	12.6 - 13.5 m: CORE LOSS		UW	10	PQTT	100		11.5	11.5	X	100							
	11.62 - 11.76m: J, 25° dip, VN, CN		UW	10	SPT	128	85/31 kPa 0/1 2/1 2/2 N=7	12.0	12.0	X	50							
Albany Conglomerate	Completely weathered, grey speckled black, SANDSTONE. Extremely Weak, (Recovered as Fine SAND, some silt, trace carbonaceous material; grey speckled black. Medium dense, moist, poorly graded)		UW	10	PQTT	100		13.0	13.0	X	20							
	14.70m: Sand, fine to medium grained 14.85m: SILTSTONE coarse gravel-sized clasts x2		UW	10	SPT	115	119/57 kPa 2/2 3/4 3/4 N=14	13.5	13.5	X	20							
	Completely weathered, grey-green, SANDSTONE. Extremely Weak, (Recovered as Gravelly SAND).		UW	10	PQTT	100		14.5	14.5	X	20							

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

Box 4, 9.5-11.9m

Rev.: A



BOREHOLE LOG

BOREHOLE No.:

BH116

SHEET: 4 OF 4

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 02/11/2020

FINISH DATE: 03/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926934.40 mN
 (NZTM2000) 1743342.70 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 13.60m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		ROCK DEFECTS																
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Albany Conglomerate	[CONT] Completely weathered, grey-green, SANDSTONE. Extremely weak (Recovered as Gravelly SAND)		UW		SPT	100	4/3 6/12 13/20 for 40mm N>=50		15.5										
	Slightly weathered, grey fine to medium grained SANDSTONE; Very weak				PQTT	100			15.5					15.42 - 15.53m: J, 35° dip, VN, CN 15.50m: BF, 6° dip, VN, CN 15.57m: BF, 6° dip, VN, CN 15.63m: BF, 15° dip, VN, CN 15.63 - 15.75m: J, VN, CN 15.74 - 15.84m: BZ, CN					
	15.92 - 15.94m: Slightly weathered, grey SILTSTONE; Extremely weak 16.00 - 16.50m: Recovered as: Gravelly SAND due to core drop-out and re-drilling.								16.0				12						
	16.5 - 16.88 m: Solid cone SPT				SPT	0	8/14 18/16 16 for 75mm N>=50 Solid		16.5				0	16.00 - 16.50m: Core disturbed due to drilling process (fell out of barrel)					
	Slightly weathered, grey, SANDSTONE. Very Weak, moderately thick, (60%). - INTERBEDDED WITH - Slightly weathered, grey, SILTSTONE. Very Weak, thin, (40%).				PQTT	84			17.0				36	16.88m: BF, 6° dip, VN, CN 16.94m: BF, 6° dip, VN, CN 16.95m: BF, 4° dip, VN, CN 16.97m: BF, 12° dip, VN, CN 17.11m: BF, 25° dip, VN, CN 17.11 - 17.28m: J, 45° dip, VN, CN 17.15m: BF, 4° dip, VN, CN 17.28m: BF, 10° dip, VN, CN 17.49m: BF, 10° dip, VN, CN					
	17.83 - 18.0 m: CORE LOSS								17.8					17.80m: DD					
18.0 - 18.23 m: Solid cone SPT				SPT	0	11/22 45/5 for 5mm N>=50 Solid		18.0				0							
18.23m: END OF INVESTIGATION								18.5											

COMMENTS: 50 mm standpipe piezometer installed with screened interval from 2.0 - 5.0 m.

Hole Depth
18.23m

Scale 1:25

General Log - 21/11/2020 9:52:52 AM - Produced with Core-GS by GeRec

Box 5, 11.9-15.4m

Rev.: A

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926934.40 mN 1743342.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020
R.L.:	13.60m	DRILL METHOD: RC	HOLE FINISHED: 03/11/2020
DATUM:	NZVD2016	LOGGED BY: ROM	CHECKED: CBM



0.00-2.90m



2.90-6.75m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926934.40 mN (NZTM2000) 1743342.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020	
R.L.: 13.60m	DRILL METHOD: RC	HOLE FINISHED: 03/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: ROM
			CHECKED: CBM



6.75-9.45m



9.45-11.85m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926934.40 mN 1743342.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 02/11/2020 HOLE FINISHED: 03/11/2020
R.L.:	13.60m	DRILL METHOD: RC	DRILLED BY: McMillan Drilling
DATUM:	NZVD2016		LOGGED BY: ROM CHECKED: CBM



11.85-15.42m



15.42-18.23m

BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 1 OF 5

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 06/11/2020
FINISH DATE: 09/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)					
Tsoil	Sandy SILT, trace organics; dark brown. Firm, saturated, low plasticity; Sand, fine; organics, rootlets [TOPSOIL].						2 @ 0.10m											
	Sandy SILT, some clay, trace organics; Brown mottled orange. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets 0.55m: Brown mottled orange speckled white				PQTT	52	3 @ 0.50m		0.5									
Tauranga Group	0.78 - 1.5m: Core Loss								1.0									
	Silty fine grained SAND, minor organics; brown-grey. Medium dense, moist, poorly graded; organics, wood.				SPT	84	1/3 4/5 5/5 N=19		1.5									
	Clayey SILT, minor sand, trace organics; grey-brown speckled black. Stiff, moist, moderate plasticity; Sand, fine; organics, rootlets				PQTT	64	4 @ 2.00m		2.0									
	2.63 - 3.0m: Core Loss									2.5								
	Organic SILT, some clay, trace organics; dark grey - brown. Stiff, moist, low plasticity; organics, wood.				SPT	100	5 @ 3.00m 1/1 1/1 N=4		3.0									
Grades to: Organic Clayey SILT, trace organics; dark grey-brown. Stiff, moist, low plasticity; organics, wood.				PQTT	83	6 @ 4.00m		4.0										
4.5 - 5.0m: PUSH TUBE				PT	0	1 @ 4.50m		4.5										

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25



BOREHOLE LOG

BOREHOLE No.:

BH117

SHEET: 2 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
 (NZTM2000) 1743092.70 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Tauranga Group	Organic Clayey SILT; dark grey-brown. Stiff, moist, low plasticity; organics, wood. 5.20m: grey-brown, mottled brown speckled black		UW	10	SPT	100	7 @ 5.00m 0/0 1/1 2/1 N=5	5.5	5.5	[Yellow speckled pattern]									
	Sandy organic SILT; dark brown speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous 6.85m: Sand inclusions (5%); dark brown, speckled black spotted grey 7.10m: Grades: grey-brown		UW	10	PQTT	100	0/0 1/1 1/1 N=4	6.0	6.5	[Yellow speckled pattern]									
	Sandy SILT, trace organics; light grey-green, speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous 8.10m: Grades: grey-brown, mottled brown, speckled black 8.90 - 9.00m: Fine to medium grained SAND; grey. Medium dense, moist, poorly graded.		UW	10	SPT	100	0/0 2/1 2/2 N=7	7.5	8.0	[Yellow speckled pattern]									
	Sandy SILT, trace organics; grey speckled black. Stiff, moist, low plasticity; Sand, fine; organics, fibrous 9.28 - 9.29m: Wood (10mm) 9.34 - 9.35m: Wood (10mm)		UW	10	SPT	100	1/2 2/3 4/3 N=12	9.0	9.5	[Yellow speckled pattern]									
	Fine to coarse SAND, minor silt, trace organics; grey. Medium dense, moist, poorly graded; organics, wood. Sandy SILT, some clay, trace organics; grey speckled black. Stiff, moist, low plasticity; sand, fine; organics, fibrous.		UW	10				9.5		[Yellow speckled pattern]									

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Box 2, 3, 8, 7, 1m

Box 3, 7, 1+9, 8m

Rev.: A



BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 3 OF 5

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 06/11/2020
FINISH DATE: 09/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
Tauranga Group	Fine SAND, some silt, trace organics; grey & brown. Loose, moist, poorly graded; organics, wood		UW		PQTT	100			10.5										
	Fine SAND, some silt, some organics; grey. Loose, moist, poorly graded; organics, wood 9.75 - 9.80m: Wood		UW						10.5										
	Clayey SILT, trace organics; light green. Stiff, moist, moderate plasticity; organics, fibrous. 10.34 - 10.39m: Wood		UW		SPT	113	1/2 1/2 2/2 N=7		10.5										
	Sandy SILT, some clay, trace organics; light grey-green. Stiff, moist, low plasticity; organics, fibrous. 10.40m: brown		UW						11.0										
	Silty SAND, trace organics; brown mottled grey. Medium dense, moist, poorly graded; sand, fine; organics, fibrous. 11.03 - 11.07m: Wood		UW		PQTT	80			11.5										
	Silty SAND, some clay, trace organics; brown. Medium dense, moist, poorly graded; sand, fine; organics, wood.		UW		SPT	108	1/2 3/4 4/4 N=15		12.0										
	SAND, some silt, trace organics; grey. Medium dense, moist, poorly graded; sand, fine; organics, wood.		UW						12.5										
	Grades to: Sandy SILT, minor clay, trace organics; grey. Very stiff, moist, low plasticity; Sand, fine; organics, wood		UW		PQTT	90			13.0										
	13.50m: Grey & brown, speckled black		UW						13.5										
	13.90m: Grey		UW		SPT	124	1/1 2/2 3/3 N=10		13.5										
Sandy SILT, some clay, trace organics. Grey & brown speckled black. Very stiff, moist, low plasticity; Sand, fine; organics, carbonaceous.		UW		PQTT	100			14.0											
		UW						14.5											

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Box 4, 9.8-12.6m

Box 5, 12.6-15.0m



BOREHOLE LOG

BOREHOLE No.:
BH117

SHEET: 4 OF 5

DRILLED BY: Mackenzie
LOGGED BY: ROM
CHECKED: CBM
START DATE: 06/11/2020
FINISH DATE: 09/11/2020
CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
JOB No.: 1014985.0000
LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
(NZTM2000) 1743092.70 mE

DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
R.L. COLLAR:
DATUM: NZVD2016
SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS			Fluid Loss (%)	Water Level	Casing	Installation	Core Box No	
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)						Description & Additional Observations
East Coast Bays Formation	Sandy SILT, some clay, trace carbonaceous. Grey & brown speckled black. Very stiff, moist, low plasticity; Sand, fine				SPT	144	2/2 3/3 3/5 N=14		15.5			0							
	Fine to medium grained SAND, some silt, trace carbonaceous; light green & brown. Medium dense, moist, poorly graded				PQTT	85			16.0			0							
	16.35 - 16.5m: Core Loss																		
	Sandy SILT, some clay, trace carbonaceous light green. Stiff, moist, low plasticity; Sand, fine				SPT	128	2/3 2/4 3/4 N=13		16.5			0							
	Fine SAND, some silt, trace carbonaceous; light green - grey. Loosely packed, moist, poorly graded				PQTT	80			17.0			0							
	17.30m: minor silt											0							
	17.60m: some silt											0							
	18.10 - 18.14m: Wood (40mm)											0							
	Slight weathered, brown, fine grained SANDSTONE; Very weak				SPT	100	6/6 4/4 4/6 N=18		18.0			0							
	Highly weathered, grey-green speckled white, coarse, SANDSTONE. Extremely Weak, (Recovered as fine to coarse SAND, minor gravel; grey-green speckled white, red, brown & green. Medium dense, moist, poorly graded).				PQTT	28			18.5			0							
18.75 - 19.5m: Core Loss											0								
Highly weathered, grey-green speckled white, red, brown & green, coarse, SANDSTONE. Extremely Weak, (Recovered as Fine to coarse SAND, minor gravel; grey-green speckled white, red, brown & green. Very dense, moist, poorly graded).				SPT	77	4/4 5/7 21/18 for 50mm N>=50		19.5			0								

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

General Log - 21/12/2020 10:12:47 AM - Produced with Core-GS by GeiRoc

Box 6, 15.0-17.8m



BOREHOLE LOG

BOREHOLE No.:

BH117

SHEET: 5 OF 5

DRILLED BY: Mackenzie

LOGGED BY: ROM

CHECKED: CBM

START DATE: 06/11/2020

FINISH DATE: 09/11/2020

CONTRACTOR: McMillan Drilling

PROJECT: Watercare Whenuapai-Redhill GI
 JOB No.: 1014985.0000
 LOCATION: Whenuapai

CO-ORDINATES: 5926691.00 mN
 (NZTM2000) 1743092.70 mE

DIRECTION:
 ANGLE FROM HORIZ.: -90°

R.L. GROUND: 10.90m
 R.L. COLLAR:
 DATUM: NZVD2016
 SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	DESCRIPTION OF CORE		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS				Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity	ROCK: Weathering, colour, fabric, name, strength, cementation									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations					
East Coast Bays Formation	Moderately weathered, grey, fine SANDSTONE; Extremely weak, weakly cemented (Recovered as Fine grained SAND, trace silt; grey. Very dense, moist, poorly graded)		UW	MS	PQTT	42			20.5										
	20.38 - 21.0 m: Core Loss																		
	Moderately weathered, grey, fine SANDSTONE; Extremely weak, weakly cemented (Recovered as Fine grained SAND, trace silt; grey. Very dense, moist, poorly graded)		UW	MS	SPT	100	17/33 for 30mm N>=50		21.0										
	21.15m: END OF INVESTIGATION																		

COMMENTS: 50 mm standpipe piezometer with screened interval from 2.0 - 4.0 m.

Hole Depth
21.15m

Scale 1:25

Rev.: A

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926691.00 mN (NZTM2000) 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020	
R.L.: 10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020	
DATUM: NZVD2016		DRILLED BY: McMillan Drilling	LOGGED BY: ROM
			CHECKED: CBM



0.00-3.75m



3.75-7.05m

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: (NZTM2000)	5926691.00 mN 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020
R.L.:	10.90m	DRILL METHOD: RC	HOLE FINISHED: 09/11/2020
DATUM:	NZVD2016		DRILLED BY: McMillan Drilling
			LOGGED BY: ROM CHECKED: CBM



7.05-9.75m



9.75-12.60m

CORE PHOTOS

BOREHOLE No.: **BH117**

SHEET: 3 OF 4

PROJECT: Watercare Whenuapai-Redhill GI		LOCATION: Whenuapai	JOB No.: 1014985.0000
CO-ORDINATES: 5926691.00 mN (NZTM2000) 1743092.70 mE	DRILL TYPE: Track-mounted	HOLE STARTED: 06/11/2020 HOLE FINISHED: 09/11/2020	
R.L.: 10.90m	DRILL METHOD: RC	DRILLED BY: McMillan Drilling	
DATUM: NZVD2016		LOGGED BY: ROM	CHECKED: CBM



12.60-15.00m



15.00-17.80m

