ORMISTON ASSOCIATES LTD
CONSULTANTS IN GEOTECHNICAL ENGINEERING, GEOLOGY & ENGINEERING GEOLOGY
Level 2, 90 Symonds Street, Grafton, Auckland 1010
P O Box 47-822 Ponsonby Auckland 1144 New Zealand
Telephone 09-302 2193 Facsimile 09-302 2197
Email: mail@ormiston.co.nz

Ref. **5429**

GEOTECHNICAL INVESTIGATION FOR THE PROPOSED STORMWATER IMPROVEMENTS FOR BLACKPOOL, WAIHEKE ISLAND

For: **Auckland Council**
Private Bag 92300
Victoria Street West
AUCKLAND 1142

By: **Ormiston Associates Ltd.**
P.O. Box 47-822
Ponsonby
AUCKLAND 1144

Date: **1st May 2024**

TABLE OF CONTENTS

1. Introduction

As requested by Healthy Waters, we have undertaken a site investigation and provide geotechnical input for the proposed stormwater improvements in Blackpool, Waiheke Island. Our brief and objectives were to undertake and provide the following:

(i) Review existing available information.
(ii) Undertake geotechnical ground investigations as required.
(iii) Provide comments on slope stability and design input for reinforced slopes or retaining walls if required.
(iv) Recommendations for culvert foundations and backfill.
(v) Prepare geotechnical specifications for re-use and compaction of excavated material.

The findings presented in this report will be used in design by Auckland Council appointed Consultants and contractors.

2. Proposed Development

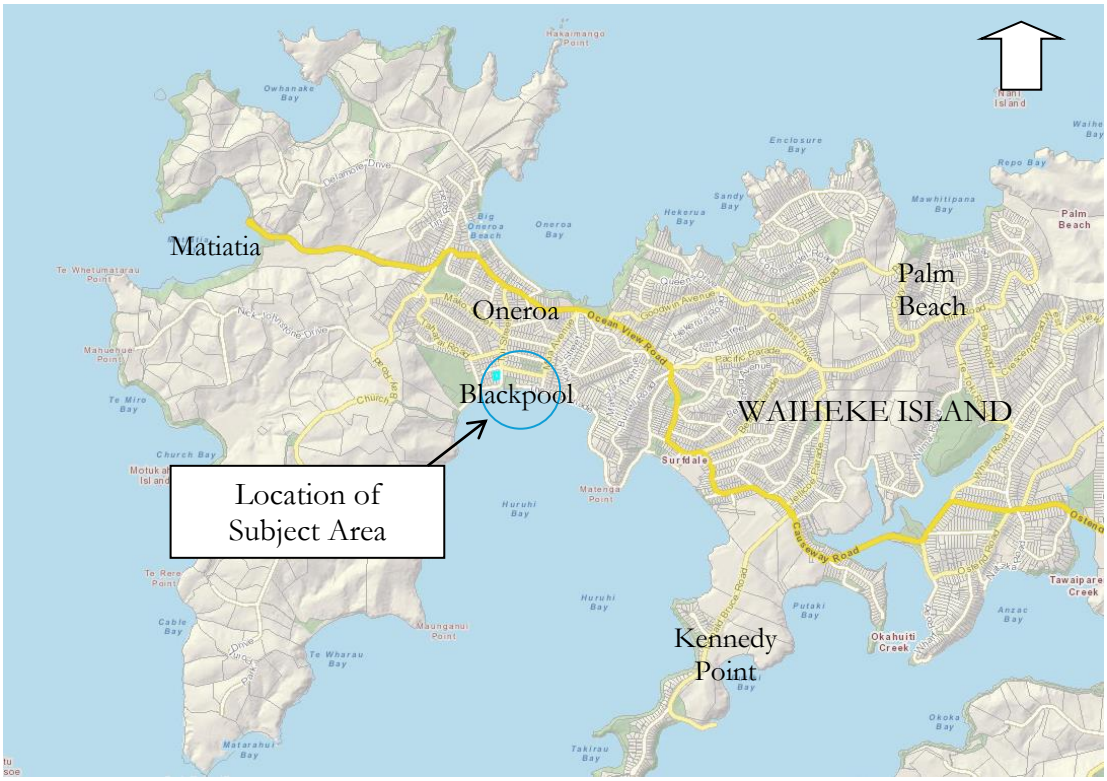
Detailed concept drawings of the proposed development prepared by Auckland Council have been provided to us. The drawings indicate that the proposed stormwater improvement works will largely be undertaken on Ridge Road, Nikau Road, Tui Street, Manuka Road and Moa Avenue, and the works will likely include the following:

(i) Widening and deepening existing open channels.
(ii) Installing new open channels.
(iii) Installing culverts across roads and driveway crossings.
(iv) Installing new stormwater pipes, manholes and inlets.

The drawings indicate that the excavations for the proposed roadside channels will range up to approximately 1.6m depth, with a large portion of the proposed excavations less than 1.2m depth. Various concrete pipe culverts and manholes are proposed, with pipe sizes ranging from approximately 630mm to 1800mm diameter. The excavations for the concrete pipes range up to approximately 2.8m maximum depth (although typically in the order of 1.2m to 1.6m depth). We understand that the culverts under the driveway crossings may comprise plastic Promax Enduro tanks (with the ends cut off), with concrete box culverts 1.0m deep and between 1.0m to 3.0m wide to be used under the road carriageway. The excavations for the proposed box culverts will generally be in the order of 1.2m to 1.9m depth.

3. Site Description

The area of the proposed stormwater improvement works is located largely within a naturally infilled embayment and associated broad gully features that slope gently to very gently to the south towards the foreshore at Blackpool Beach. The area of proposed works includes well established residential developments, Blackpool Park and Blackpool Cemetery. Refer to the **Location Map** below showing the general location of the proposed stormwater improvement works.



Location Map: Blackpool, Waiheke Island

The existing stormwater network in the Blackpool area comprises various culverts, pipes, manholes, catchpits, open channels and roadside channels, both shallow and deep. Some of the open channels show minor erosion in places and in some areas the channels were overgrown.

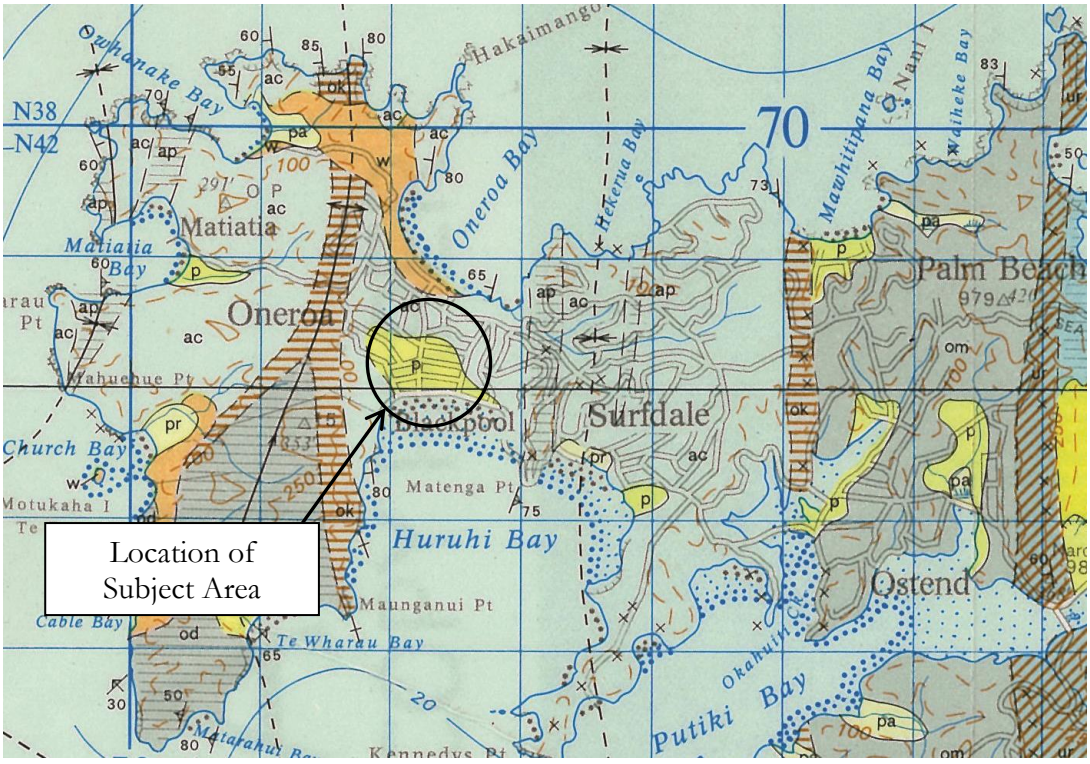
At the time of our investigation, we did not observe any obvious signs of recent or active deep-seated slope instability in the areas of the proposed stormwater improvements. In our opinion, there are no significant steep slopes in the areas of the proposed works that would pose a hazard to the proposed development from the global stability viewpoint.

The general area of the proposed works is shown on the attached Site Plan, Drawing No. 5429-1, with the location of site features approximate. This plan is based on drawings prepared and provided by Auckland Council, and we have adapted these drawings for our use.

4. Geology

4.1 General

Reference has been made to Geological Map Part Sheets N38, 39, 42 and 43 Waiheke (Schofield 1979) 1:63,360 which indicates that the main area within the Blackpool embayment is underlain by alluvial deposits of the Tauranga Group (see extract from the geological map below). The slopes rising the north, west and east of the embayment comprise weathered greywacke deposits of the Clevedon Mudstone Formation, now formerly part of the Waipapa Group. The alluvial soils can comprise interbedded lays of silts, clays, sands and gravels. The weathered greywacke deposits typically comprise stiff to very stiff interbedded clays and silts of various plasticity.



Extract from Geological Map showing western end of Waiheke Island

The soils observed in our boreholes are interpreted to be in part fill, alluvial deposits and weathered greywacke deposits.

4.2 Seismic Hazard

Liquefaction and lateral spreading are natural geological processes that can occur in geologically young non cohesive soil deposits (i.e. generally weak silts and loose sandy soils) with a high groundwater table as a result of cyclic loading during a seismic event (earthquake). Stiff to very stiff clay dominant soils are generally considered non-liquefiable because of their cohesive nature, and cohesive soils do not tend to suffer the same large ground settlements typically associated with liquefaction in sands and other susceptible non cohesive soils.

Reference has been made to the 'Liquefaction Vulnerability Areas' layers on Auckland Council website GeoMaps. The 'basis assessment' layer in GeoMaps indicates that liquefaction is possible in the southern portion of the Blackpool embayment, in the area extending south of Nikau Road and towards and including the foreshore. Based on the soils observed in our boreholes, including those drilled as part of other assessments in the area, we concur with Council's assessment that there is a risk of liquefaction occurring in the southern portion of Blackpool where liquefiable soils are present. The risk of liquefaction occurring north of Nikau Road and the side slopes ascending from the Blackpool embayment is considered to be low given that these soils were generally stiff to very stiff and clay dominant.

The proposed stormwater works are conservatively assessed as Importance Level 2 (IL2) structures in accordance with AS/NZS 1170.0. Based on the recommendations in the MBIE and the New Zealand Geotechnical Society publication (Module 1), the peak horizontal ground acceleration (a_{max}) for design using the methodology in the NZTA Bridge Manual is as follows:

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

where,

$C_{0,1000}$ = unweighted peak ground acceleration coefficient corresponding to the design return period (NZTA Bridge Manual).
R = return period factor (from Table 3.5 in NZS 1170.5).
f = site response factor corresponding to the soil Class.
g = acceleration from gravity.

Using the following parameters:

$C_{0,1000}$ = 0.17
R = 1.0 for ULS (for 1/500 year event) and 0.25 for SLS (for 1/25 year event)
f = 1.33 (for all soil classes)

we get, a_{max} = 0.17 x (1.0/1.3) x 1.33 x g = 0.17g for ULS event

and a_{max} = 0.17 x (0.25/1.3) x 1.33 x g = 0.04g for the SLS event

5. Review of Existing Borehole Information

As part of the geotechnical assessment, we have undertaken a review of borehole information provided on the New Zealand Geotechnical Database, as well as a review of geotechnical borehole information obtained during site investigations previously undertaken on properties in the immediate area by Ormiston Associates Ltd. A summary of the findings of the review is outlined below.

5.1 Borehole information obtained from New Zealand Geotechnical Database

(i) Moa Avenue – Geotechnical site investigation in road reserve by GHD Ltd.

The site investigation included the drilling of three (3) machine cored borehole located in the road reserve and outside 26, 36 and 46 Moa Avenue respectively. The machine boreholes were drilled to depths of between 9.45m and 10.95m and generally encountered a thin layer of fill overlying alluvial deposits, with more recent marine deposits also encountered in the borehole drilled at the bottom of Moa Avenue near the foreshore (outside 46 Moa Avenue). The alluvial deposits generally comprised interbedded, stiff to very stiff silts and clayey silts, with occasional sandy gravel and sand lenses. Standing groundwater levels recorded in the boreholes were in the order of 0.6m to 1.5m depth. The boreholes were drilled and groundwater levels recorded in April 2018.

(ii) 32 Nikau Road – Geotechnical site investigation by GWE Consulting Ltd

The site investigation included the drilling of four (4) hand auger boreholes, with the boreholes spread out across the property. The boreholes were drilled to depths of between 1.0m and 3.0m and the soils encountered comprised alluvial deposits from the ground surface. The alluvial deposits generally comprised interbedded, firm to very stiff silts and clays, with some intermixed sand silty sand lenses. Standing groundwater levels recorded in the boreholes ranged from 0.4m to 0.7m depth (groundwater was not encountered in the 1.0m deep borehole). The boreholes were drilled and groundwater levels recorded in April 2018.

(iii) 10 The Esplanade

The site investigation was for a water bore, with the borehole drilled in 2004 to 118m depth. The borehole log only provides a general soil description, indicating clay to 2m depth overlying interbedded gravel and clay to 11m, which is then underlain by mudstone to the base of the borehole. The borehole log indicates a static groundwater level at the ground surface.

(iv) Blackpool Park

The site investigation was for a water bore, with the borehole drilled in 1993 to 59m depth. The borehole log only provides a general soil description, indicating clay to 4m depth overlying interbedded silts and clays to 23m, which is then underlain by greywacke deposits to the base of the borehole. The borehole log indicates a static groundwater level at 18m depth.

(v) 22 Tui Street

The site investigation was for a water bore, with the borehole drilled in 2007 to 70m depth. The borehole log only provides a general soil description, indicating soft clay to 12m depth overlying mudstone and greywacke to the base of the borehole. The borehole log indicate a static groundwater level at 3.5m depth.

5.2 Projects undertaken previously in the general area by Ormiston Associates Ltd.

(i) 78 Mako Street

The geotechnical investigation at the site in 2003 included the drilling of three hand auger boreholes to depths of between 3.0m to 5.0m. Scala Penetrometer testing was undertaken from the base of the boreholes in order to assess soil strengths at depth. The soils observed in the boreholes comprised a layer of fill up to 0.7m overlying alluvial deposits. The alluvial soils generally comprised interbedded firm to very stiff clays and silts, and loose sandy silt. Groundwater was recorded at a depth of between 0.2m and 1.3m in the boreholes.

(ii) 37 Tui Street

The geotechnical investigation at the site in 2018 included the drilling of four hand auger boreholes to depths of between 0.7m to 1.2m. Scala Penetrometer testing was undertaken from the base of the boreholes in order to assess soil strengths at depth. The soils observed in the boreholes comprised a layer of fill (in one borehole only) overlying alluvial deposits. The alluvial soils generally comprised loose to dense sands. Groundwater was recorded at a depth of between 0.7m and 0.8m in the boreholes.

(iii) 14 The Esplanade

The geotechnical investigation at the site in 2011 included the excavation of one testpit to 1.1m depth and the drilling of four hand auger boreholes to depths of between 0.3m to 0.6m. Scala Penetrometer testing was undertaken from the base of the testpit and boreholes in order to assess soil strengths at depth. The soils observed in the boreholes comprised a layer of fill up to 0.3m depth overlying alluvial deposits. The alluvial soils observed generally comprised gravels intermixed with shells. Groundwater was not encountered in the testpit or boreholes.

(iv) 46 Ridge Road

The wastewater investigation at the site in 2004 included the drilling of two hand auger boreholes to depths of between 1.0m and 1.1m. The soils observed in the boreholes comprised alluvial deposits which generally comprised silts and clayey silts. Groundwater was not encountered in the boreholes.

(v) 6 Nikau Road

The wastewater investigation at the site in 2006 included the drilling of three hand auger boreholes to depths of between 1.0m and 1.2m. The soils observed in the boreholes comprised alluvial deposits which generally comprised clayey silts. Groundwater was recorded at a depth of 0.9m in one the boreholes, with the other boreholes dry.

(vi) 11 Nikau Road

The geotechnical investigation at the site in 2011 included the drilling of four hand auger boreholes to depths of between 3.0m to 4.0m. Scala Penetrometer testing was undertaken from the base of the boreholes in order to assess soil strengths at depth. The soils observed in the boreholes comprised a layer of fill up to 0.8m depth overlying alluvial deposits. The alluvial soils generally comprised interbedded loose sands, and firm to stiff silts and clays. Groundwater was recorded at depths of between 0.8m and 1.2m in the boreholes.

(vii) 23-25 Nikau Road

The wastewater investigation at the site in 2003 included the drilling of three hand auger boreholes to depths of between 0.3m and 3.5m. The soils observed in the boreholes comprised alluvial deposits. The alluvial soils generally comprised interbedded silts, sandy silts and gravelly silts. Groundwater was encountered at a depth 3.2m in one of the boreholes.

(viii) 7 Manuka Road

The wastewater investigation at the site in 1995 included the drilling of two hand auger boreholes to a depth of 1.0m. The soils observed in the boreholes comprised alluvial deposits. The alluvial soils generally comprised interbedded clayey silts, sandy silts. Groundwater was encountered at between 0.5m and 0.6m in the boreholes.

(ix) 18 Moa Avenue

The wastewater investigation at the site in 1995 included the drilling of two hand auger boreholes to a depth of 1.0m. The soils observed in the boreholes comprised alluvial deposits. The alluvial soils generally comprised interbedded clayey silts and sandy silts. Groundwater was not encountered in the boreholes

6. Geotechnical Site Investigations

Subsurface conditions in the area of the proposed works were investigated by the drilling of thirty three (33) 50mm hand auger boreholes, BH1 to BH33, at the locations shown on the Site Plan. The boreholes were drilled to depths of between 0.2m and 3.0m below the existing ground level. The boreholes were terminated at a target depth of 3.0m, or when gravels were encountered (including both road fill gravels and natural alluvial gravels) or where boreholes could not be progressed due to suction from an elevated groundwater table.

7. Engineering Geology and Subsoil Conditions

The subsoil conditions encountered at the location of the investigation boreholes are summarised below and in **Table 1**, with a full description of the site soils shown on the attached borehole logs. The locations of the boreholes is indicated on the Site Plan. The subsurface conditions used for this assessment have been extrapolated between the boreholes, and our opinions and recommendations are based on this assumption. However, even though such inference is made, no guarantee can be made as to the validity of such inferences or assumptions due to the inherent variability of natural soil deposits. Consequently, variations between the boreholes may exist.

The soil descriptions are generally based on the New Zealand Geotechnical Society Guidelines for the Description of Soils and Rocks, dated 2005.

- A fill layer was observed in all boreholes, except boreholes BH27 and BH28 located at the bottom of Tui Street adjacent to the Blackpool Cemetery. It is inferred that the existing fill was placed as part of formation of the roads, channel drains, buried services or for driveway access onto the private properties. In general, the fill comprised silts and gravels and was highly variable in strength and composition.
- Weathered greywacke deposits were encountered below the fill in boreholes BH2, BH3 and BH33. These deposits generally comprised stiff to very stiff interbedded silts and clays.
- Alluvial deposits were encountered beneath the fill in most of the boreholes. In BH27 and BH28 the alluvial deposits comprise silty gravels. In the remaining boreholes (where the fill could be penetrated), the alluvial deposits comprised interbedded soft to very stiff silts and clays, with occasional sandy silts and sands. Organic soils were observed below the fill in BH29, BH30 and BH32.
- The boreholes were checked for groundwater on completion of drilling, with groundwater recorded in most boreholes (refer to **Table 1**).

Table 1: Summary of Borehole Depths

Borehole No.	Borehole Depth	Fill Depth	GWL Depth	Comments
BH1	0.75m	>075m	Dry	Borehole terminated in gravel fill
BH2	3.0m	0.6m	2.7m	Fill overlying v. stiff greywacke deposits
BH3	3.0m	0.3m	2.9m	Fill overlying stiff to v. stiff greywacke deposits
BH4	3.0m	0.3m	Dry	Fill overlying alluvial deposits
BH5	0.5m	>0.5m	Dry	Borehole terminated in gravel fill
BH6	3.0m	0.5m	2.6m	Fill overlying v. stiff alluvial deposits
BH7	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH8	3.0m	0.8m	Dry	Fill overlying v. stiff alluvial deposits
BH9	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH10	3.0m	0.5m	Dry	Fill overlying v. stiff alluvial deposits
BH11	0.2m	>0.2m	Dry	Borehole terminated in gravel fill
BH12	1.8m	0.5m	1.3m	Fill overlying stiff to v. stiff alluvial deposits
BH13	3.0m	0.4m	Dry	Fill overlying v. stiff alluvial deposits
BH14	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH15	3.0m	0.2m	1.2m	Fill overlying soft alluvial deposits (incl. sand)
BH16	3.0m	0.6m	1.2m	Fill overlying stiff to v. stiff alluvial deposits
BH17	3.0m	0.5m	1.4m	Fill overlying stiff to v. stiff alluvial deposits
BH18	1.6m	0.6m	0.9m	Fill overlying v. stiff alluvial deposits (incl. sand)
BH19	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH20	3.0m	1.2m	Dry	Fill overlying stiff to v. stiff alluvial deposits
BH21	3.0m	0.7m	2.9m	Fill overlying stiff to v. stiff alluvial deposits
BH22	2.5m	0.6m	1.6m	Fill overlying soft to stiff alluvial deposits
BH23	3.0m	0.4m	1.5m	Fill overlying stiff to v. stiff alluvial deposits
BH24	3.0m	0.7m	Dry	Fill overlying stiff to v. stiff alluvial deposits
BH25	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH26	0.4m	>0.4m	Dry	Borehole terminated in gravel fill
BH27	0.3m	N.E.	Dry	Alluvial deposits from ground surface (gravels)
BH28	0.2m	N.E.	Dry	Alluvial deposits from ground surface (gravels)
BH29	2.7m	0.6m	Dry	Fill overlying v. stiff alluvial deposits
BH30	3.0m	0.7m	2.5m	Fill overlying stiff to v. stiff alluvial deposits
BH31	3.0m	0.3m	2.9m	Fill overlying stiff to v. stiff alluvial deposits
BH32	3.0m	0.7m	2.0m	Fill overlying firm to v. stiff alluvial deposits
BH33	3.0m	0.5m	3.0m	Fill overlying v. stiff greywacke deposits

Notes:
(i) Boreholes drilled and groundwater levels recorded on 27th, 28th and 29th February 2024.
(ii) GWL – groundwater level
(iii) N.E. – not encountered

7.1 Additional Comments

We provide the following additional comments regarding the underlying soil conditions with respect to the proposed development:

(i) The soil conditions observed in the hand auger boreholes drilled as part of this geotechnical assessment were generally consist with that observed in the soil encountered in other projects undertaken within the general area.

(ii) More granular soils (i.e. sands and gravels) are more prevalent on the gentle slopes closer to the foreshore and in the southern portion of Blackpool (i.e. south of Rata Street).

(iii) The groundwater levels recorded were variable across the area investigated, with a shallow groundwater level recorded in the boreholes drilled in the western half of Nikau Road. The boreholes drilled in the western half of Nikau Road was also the area where softer alluvial deposits and sandy soils were encountered.

(iv) The groundwater levels recorded during our geotechnical assessment represent a late summer groundwater condition. Higher groundwater levels should be anticipated during the wetter winter months and following periods of heavy rainfall. It should also be noted that groundwater levels on the gentle slopes closer to the foreshore and in the southern portion of Blackpool are likely to be influenced by tides and hence will fluctuate regularly.

Typical effective soil parameters for the soils observed in the boreholes are outlined in **Table 2** below. It should be noted that there will likely be high variability in these parameters with depth (and groundwater level) and over short distances between boreholes due to the inherent variability of natural soil deposits.

Table 2: Typical Soil Properties

Soil Type	Unit Weight γ	Effective Friction Angle Ø′	Effective Cohesion c′
Fill (non engineered)	18 kN/m^3	23°	3 kPa
Weathered Greywacke Deposits (very stiff soils)	18 kN/m^3	30°	6 kPa
Soft clay/silt Alluvial Deposits (c_u up to 50kPa)	17 kN/m^3	25°	3 kPa
Stiff clay/silt Alluvial Deposits (c_u greater than 50kPa)	17 kN/m^3	28°	5 kPa
Non cohesive Alluvial Deposits (sand and gravel dominant soils)	17 kN/m^3	32°	-

8. Land Stability

8.1 General

As stated in the **Site Description**, slopes in the area of the proposed stormwater improvements are generally gently to very gently sloping. At the time of our investigation, we did not observe any obvious signs of recent or active deep-seated slope instability in the areas of the proposed stormwater improvements. In our opinion, there are no significant steep slopes in the areas of the proposed works that pose a significant hazard to the proposed development from the global stability viewpoint.

8.2 Existing Roadside Channel Batter Slopes

The existing open roadside channels in the Blackpool area vary widely in depth and width. The batter slope angles of the existing channels are highly variable, including shallow angles in the order of 5° to 10°, and very steep batter slope angles ranging up to 50° to 70° (and near vertical in places). In general, the steep batter slopes are performing well with only limited erosion and instability present. Given the gentle gradient along the base of the existing (and proposed) roadside channel drains, high flow velocities in the channels are not anticipated.

8.3 Recommended Road Channel Batter Slopes

We understand that the following aspects needs to be considered with respect to proposed batter slopes for roadside channels:

(i) The stability of the batter slope with respect to the underlying soil conditions.

(ii) The batter slopes will be topsoiled and planted where possible.

(iii) Minimise the batter slopes where possible to allow safe egress for pedestrians that may enter the channel.

(iv) Provide a maximum batter slope angle to locations where the width of the channel is constricted.

Based on the above requirements, we provide the following recommendations for the proposed roadside channel batter slopes.

(i) To allow egress of persons who may enter the channel (by accident or for maintenance), we recommend that the side batter slopes of the channels have a maximum nominal batter slope of 1V in 1.5H (34°).

(ii) Where steeper batter slope is proposed, or the width of the channel is constrained by site features/structures such that a steep batter slope is required, a maximum nominal batter slope of 1V in 0.5H (63°) is recommended. Where the depth of a very steeply sided channel exceeds 1.0m, a safety barrier should be constructed adjacent to the steep portion of the channel.

(iii) We point that there is always a risk of localised instability of the steeper batter slopes where they are subject to flooding and rapid drawdown of flood waters however, any such debris can be removed as required as part of regular drain maintenance.

8.4 Excavations During Construction

For temporary excavations for the pipes or culverts during construction, we recommend that the lower 1.5m is excavated vertical, with the excavation above 1.5m cut on a 45º (1V to 1H) batter slope angle. Where there is an active carriageway or structures located with 1.5x height of the excavation, or where there are site constraints that limit the use of a batter slope, the excavation must be temporarily supported using a trenching shield or equivalent suitable structure. We recommend that any large bulk excavations are undertaken during fine weather and when there is a favourable weather forecast. All excavations must be undertaken with extreme care and giving due consideration to any adjacent structures (both above ground and buried structures).

It should be noted that natural variations in soil composition and strength is possible over short distances due to natural weathering processes, especially where fill is present. Consequently, we recommend that any deep excavations are inspected by a geotechnical engineer to determine if any additional temporary site works are required to provide a safe and stable work environment. All excavations on site should be undertaken in accordance with current Health and Safety at Work Act (2015).

9. Retaining Wall Design Parameters

9.1 General

We understand that retaining structures may be constructed as part of the proposed stormwater upgrade. Outlined below are general retaining wall design parameters for various soil conditions. The application design parameters will depend on the type and location of the retaining walls, and we recommend that Ormiston Associates Ltd. is consulted to determine what design parameters are applicable for each wall location.

All retaining walls must be designed for any and all applicable surcharge loads (i.e. structures, traffic loads or sloping ground) and include provision for sloping ground in front of the retaining wall if applicable.

Free standing retaining walls can be designed for 'Active' (K_a) earth pressure conditions. Where a rigid retaining wall is required to limit wall deflection (e.g. to minimise ground settlement above/behind a wall retaining wall) or the retaining wall is to be connected to a rigid structure, soil pressures may be determined for 'At-Rest' (K_o) earth pressure conditions, where $K_o = 0.50$ for level ground above the wall. For the case of sloping ground above a retaining wall restrained from moving, K_o is a function of the ground slope, where $K_o(\beta) = K_o \times [1 + \text{Sin}(\beta)]$.

9.2 Greywacke Deposits

We provide the following design parameters for free standing retaining walls constructed in residually to completely weathered greywacke deposits (vert stiff soils):

(i) Internal friction angle $\text{Ø} = 30°$

(ii) Unit weight of soil $\gamma = 18\text{kN/m}^3$

(iii) Active Earth Pressure Coefficient K_a – see **Table 3** below

(iv) The undrained shear strength for pole embedment $c_u = 100\text{kPa}$ (natural ground)

(v) For gravity retaining walls, a dependable foundation bearing pressures of 150kPa is applicable for Ultimate Limit State design.

(vi) The embedment for cantilever retaining walls can be undertaken using Broms or other appropriate method.

Table 3: Active Earth Pressure Coefficients – Greywacke Soils

Slope Angle Above Wall	Active Earth Pressure Coefficient (K_a)
0º	0.33
5º	0.35
10º	0.38
15º	0.41
20º	0.44

9.3 Alluvial Soils (clays/silts)

We provide the following design parameters for free standing retaining walls constructed in clay dominant, stiff to very stiff alluvial deposits:

(i) Internal friction angle Ø = 28°

(ii) Unit weight of soil $\gamma = 17kN/m^3$

(iii) Active Earth Pressure Coefficient K_a – see **Table 4** below

(iv) The undrained shear strength for pole embedment c_u = 50kPa (natural ground)

(v) The embedment for cantilever retaining walls can be undertaken using Broms or other appropriate method.

(vi) For gravity retaining walls, a dependable foundation bearing pressures of 120kPa is applicable for Ultimate Limit State design.

Table 4: Active Earth Pressure Coefficient – Clays/Silts Alluvial Soils

Slope Angle Above Wall	Active Earth Pressure Coefficient (K_a)
0º	0.36
5º	0.38
10º	0.41
15º	0.44
20º	0.49

9.4 Alluvial Soils (sands/gravels)

We provide the following design parameters for free standing retaining walls constructed alluvial deposits comprising loose sands and gravels:

(i) Internal friction angle Ø = 32°

(ii) Unit weight of soil $\gamma = 17kN/m^3$

(iii) Active Earth Pressure Coefficient K_a – see **Table 5** below

(iv) Broms Charts for cohesionless soils should be used for design of piled retaining walls.

(v) For gravity retaining walls, a dependable foundation bearing pressures of 75kPa is applicable for Ultimate Limit State design. For gravity retaining walls, the exposed foundation soils should be proof rolled with a drum roller or heavy plate compactor prior to construction of the retaining wall.

Table 5: Active Earth Pressure Coefficient – Sands/Gravels Alluvial Soils

Slope Angle Above Wall	Active Earth Pressure Coefficient (K_a)
0º	0.31
5º	0.32
10º	0.34
15º	0.37
20º	0.40

10. Culvert Foundations

All proposed culverts and pipes must be bedded on a layer of compacted hardfill placed on stiff natural ground (i.e. having a minimum undrained shear strength of 50kPa). A geotextile cloth comprising A24 Bidim (or similar) should be placed on the exposed natural soils prior to placing the hardfill (the geotextile acts as a separation barrier between the natural soils and hardfill).

Where soft soils (i.e. having an undrained shear strength less than 50kPa) are encountered, it may be necessary to undercut and increase the depth of the compacted hardfill bedding layer. In areas where there is a deep soft soil layer, or an elevated groundwater table, a deeper undercut may be impractical, and it may be necessary to reinforce the hardfill with one or more layers of geogrid (such as Tensar TX160 or similar).

11. Fill Compaction Specification

11.1 General

As noted above, all proposed culverts and pipes must be bedded on a layer of compacted hardfill placed on stiff natural ground following placement of a geotextile separation cloth. We recommend that the hardfill under driveway culverts and pipes up to 1.0m diameter are bedded on hardfill with a minimum depth of 200mm, with the hardfill comprising a well compacted GAP20 overlying GAP40. Where hardfill greater than 200mm is required, GAP65 can be used beneath the GAP20. The placement and grade of hardfill used must comply with the relevant Auckland Council and Auckland Transport guidelines.

We recommend that the exposed soils in the base of the excavations for the box culverts and pipes is inspected by a geotechnical engineer or engineering geologist to confirm if the underlying soil conditions are acceptable, or if any modification to the undercut and hardfill is required.

11.2 Hardfill Compaction

Hardfill placed beneath proposed culverts and pipes must be placed in layers not exceeding 150mm (loose thickness) and compacted with heavy plate compactor or a vibrating steel drum roller (where soft soils are present, a pedestrian vibrating steel drum roller should be used instead of a ride on dual drum roller). We recommend that the compaction of the hardfill placed beneath proposed culverts and pipes is checked using a calibrated Clegg Impact Soil Tester, with a nominal Clegg Impact Value (CIV) of 30 adopted to verify the hardfill compaction is acceptable.

The placement and compaction of backfill around pipes and culverts must be undertaken in accordance with the manufacturer's specifications. Where concrete box culverts are proposed within the road carriageway, the hardfill backfill adjacent to the culverts should comprise compacted GAP40.

11.3 Landscaping Fill

Where excavated soils are used to reprofile the ground slope either side of new driveway culverts, the fill must be a minimum track rolled in placed in thin layers and the final fill batter must not exceed 1V in 2H (26°). The track rolled fill should extend beyond the final fill profile and then trimmed to the final batter slope (this will reduce the risk of a 'soft edge', which can be prone to erosion and slippage). A steeper fill batter slope is acceptable where retaining or a reinforced soil slope is proposed.

12. Temporary Dewatering

The groundwater levels recorded in the hand auger boreholes, and as noted on other site investigations in the area, indicate a highly variable groundwater table within the area of the proposed works. Nearer the beach and foreshore, the groundwater level will likely fluctuate with the tides. As a consequence, standing groundwater may be encountered during excavations, especially where deeper excavations are proposed. On this basis, provision should be made temporary diversion and dewatering (pumping) around the area of the excavation.

13. Limitation

This report has been prepared for the sole benefit of **Auckland Council** as our client with respect to the brief for the proposed stormwater improvement work in Blackpool and to be used in design by their appointed Consultants. It is not to be relied upon or used out of context by any other person without reference to Ormiston Associates Ltd. The reliance by other parties on the information or opinions contained in the report shall, without prior review and agreement in writing, be at such parties sole risk.

We trust the above meets your present requirements. If there are any further queries, please do not hesitate to contact the undersigned.

Yours faithfully,
ORMISTON ASSOCIATES LTD.

Glenn R. Gill
C P Eng., Geotechnical Engineer

Reviewed by:

Leigh G. Dooley
C P Eng., Geotechnical Engineer

Boreholes

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH1

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly (fg to cg).
			SILT, trace of clay, very stiff, dry, non-plastic, brown and orange, frequent gravels (fg to mg).
	1		End of Borehole 0.75m (Unable to progress - gravels)
	2		
	3		
	4		
	5		

223+

UTP - Gravel

Groundwater: Groundwater Not Encountered 29th February 2024

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method Hand Auger
Date Drilled 29th Feb. 2024
Drilled By JH
Shear Vane No. GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH2

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL, minor gravels (fg).
		SILT, some clay, very stiff, dry to moist, non-plastic, brownish orange, mottled orange.
WAIHEKE GREYWACKE GROUP	1	SILT, some clay, very stiff, moist, low plasticity, brownish orange and light grey.
		Clayey, very stiff, moist, low to moderate plasticity, brownish orange and light grey.
	2	Some clay, very stiff, moist, low plasticity, light grey and orange.
		Becomes moist to wet, occasional weakly cemented clasts (2mm Dia.).
		Trace of clay, very stiff, wet, slightly plastic, orange and light grey.
	3	Frequent limonite gravels (fg to mg).
		End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 29th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

Depth (m)	Field vane (peak)	Remoulded
1	223+	
	175	41
2	156	57
	124	38
3	172	16
	131	32

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH3

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remoulded; 50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description	Depth (m)	Groundwater	Vane Shear Strength (kPa)
FILL			SILT, clayey, very stiff, dry to moist, orange, intermixed with brown, occasional gravels (fg to cg).			
WAIHEKE GREYWACKE GROUP	1		CLAY, silty, very stiff, moist, moderate plasticity, orange with some brown. Becomes orange, mottled light grey. Becomes highly plastic.	1		156 / 54; 116 / 57; 88 / 45
	2		SILT, clayey, very stiff, moist, moderately plastic, orange, mottled light grey. Some clay, stiff, wet, low plastic, orange, mottled light grey and reddish orange, frequent weakly cemented clasts (1mm to 5mm Dia.).	2	29th February 2024	68 / 28; 139 / 81
	3		End of Borehole 3.0m (Target Depth)	3		190 / 37
	4			4		
	5			5		

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH4

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit: FILL; ALLUVIAL DEPOSITS

Depth (m) | Graphic Log

SILT, stiff, dry to moist, non-plastic, brown, frequent gravels (fg to cg).

SILT, clayey, very stiff, moist, low to moderate plasticity, light brownish grey, mottled orange.

CLAY, silty, very stiff, moist, moderate to highly plastic, light brownish grey, mottled orange.

Becomes light bluish grey with some orange.

Becomes orange, mottled light bluish grey.

End of Borehole 3.0m (Target Depth)

Groundwater: Groundwater Not Encountered 29th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

Depth (m)	Field vane (peak)	Remoulded
1	159	37
1	193	74
1	156	71
2	113	57
2	144	79
3	130	51

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method: Hand Auger
Date Drilled: 29th Feb. 2024
Drilled By: BM
Shear Vane No.: DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH5

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline): Field vane (peak); Remoulded; 50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description	Depth (m)
FILL	0		SILT, gravelly (fg to cg), very stiff, dry, non-plastic, brown, intermixed, light grey and orange.	0
			GRAVEL (mg to cg), medium dense, dry non-plastic, dark grey.	
			SILT, gravelly (fg to cg), dense, dry, non-plastic, brown with some grey.	
	1		End of Borehole 0.5m (Unable to progress - gravels)	1
	2			2
	3			3
	4			4
	5			5

Groundwater: Groundwater Not Encountered 29th February 2024

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH6

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remoulded; 50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly (fg to mg).
			SILT, trace of clay, very stiff, dry to moist, non-plastic, orange and red, mottled light grey.
			Gravelly, (fg to mg), dense, dry, non-plastic, dark brown.
ALLUVIAL DEPOSITS	1		SILT, trace of clay, very stiff/hard, dry, non-plastic, dark brown.
			Becomes light brown, mottled brownish orange.
			Some clay, very stiff, moist to wet, low plasticity, light brownish orange.
	2		Trace of sand, occasional reddish brown staining.
			Pocket of light bluish grey, faint organic odour.
			Clayey, very stiff, moist, low to moderate plasticity, light grey and brownish orange.
	3		End of Borehole 3.0m (Target Depth)
	4		
	5		

Groundwater: 29th February 2024

Vane shear results: UTP; 223+; 210; 38; 223+; 223+; 223+

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

BOREHOLE LOG BH7

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly (fg to cg).
			SILT, trace of clay, very stiff, dry to moist, non-plastic, red and orange, mottled light grey.
			Gravelly (fg to cg), dense, moist, non-plastic, dark brown.
			End of Borehole 0.4m (Unable to progress - gravels)
	1		
	2		
	3		
	4		
	5		

UTP

Groundwater: Groundwater Not Encountered 29th February 2024

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH8

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remouldedd

Geol. Unit	Depth (m)	Graphic Log	Description	Depth (m)	Groundwater	Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
FILL			VOID - Hole drilled from base of existing hole for signpost.			
			SILT, some clay, very stiff, moist, low plasticity, brown with occasional orange.			
ALLUVIAL DEPOSITS			TOPSOIL (Buried).			
	1		CLAY, silty, very stiff, moist, moderate plasticity, light brown.	1	Groundwater Not Encountered 29th February 2024	131 / 35
			Becomes light brown, and orange.			118 / 29
						127 / 41
	2			2		140 / 48
			Becomes highly plastic.			223+
	3		End of Borehole 3.0m (Target Depth)	3		150 / 61
	4			4		
	5			5		

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

BOREHOLE LOG BH9

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log		Depth (m)	Groundwater
FILL	0		TOPSOIL, gravelly (fg to cg).	0	
			SILT, gravelly (fg to cg), hard/dense, dry, non-plastic, brownish orange.		
			End of Borehole 0.4m (Unable to progress - gravels)		
	1			1	
	2			2	
	3			3	
	4			4	
	5			5	

UTP

Groundwater Not Encountered 29th February 2024

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	29th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH10

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			TOPSOIL
			SILT, some clay, very stiff, dry to moist, slightly plastic, brownish grey.
ALLUVIAL DEPOSITS	1		SILT, some clay, trace of sand, very stiff, moist, orange and brownish grey.
			CLAY, silty, very stiff, moist, moderate to high plasticity, light grey.
	2		Becomes light grey and orange.
	3		End of Borehole 3.0m (Target Depth)
	4		
	5		

Groundwater: 28th February 2024 — Groundwater Not Encountered

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

223+

172

41

146

41

143

54

146

70

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method: Hand Auger
Date Drilled: 28th Feb. 2024
Drilled By: JH
Shear Vane No.: GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for: Auckland Council

Job No: 5429

Project: Blackpool Stormwater Improvements, Waiheke

Borehole Location: see site plan

Surface Elevation: Datum:

Surface Conditions:

BOREHOLE LOG BH11

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak)

Remoulded

50 100 150 200

UTP

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		SILT, gravelly (fg to cg), dense, dry, non-plastic, brown and dark grey.
			End of Borehole 0.2m (Unable to progress - gravels)
	1		
	2		
	3		
	4		
	5		

Depth (m): 1 2 3 4 5

Groundwater: Groundwater Not Encountered 28th February 2024

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method Hand Auger

Date Drilled 28th Feb. 2024

Drilled By BM

Shear Vane No. DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH12

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			SILT, trace of clay, very stiff, dry, slightly plastic, brown, occasional gravels (fg to cg), occasional pockets of clay (orange).
ALLUVIAL DEPOSITS	1		SILT, some clay, very stiff, moist, low plasticity, brownish orange and light grey.
			Gravelly (fg to cg), sandy (fg to cg), dense, moist to wet, non-plastic, brownish orange and grey.
			Becomes saturated.
			CLAY, silty, stiff, wet, moderate to highly plastic, bluish grey and orange.
	2		Becomes firm to stiff, hole collapsing due to extreme suction.
			End of Borehole 1.8m (Unable to continue - extreme suction)
	3		
	4		
	5		

Groundwater: 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak)

Remoulded

50 100 150 200

198+

UTP

91

23

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method: Hand Auger
Date Drilled: 28th Feb. 2024
Drilled By: BM
Shear Vane No.: DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH13

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			TOPSOIL, gravel and shells, dense.
			SILT, trace of clay, very stiff, dry to moist, non-plastic, brown, frequent gravels.
ALLUVIAL DEPOSITS	1		SILT, clayey, some sand, very stiff, moist, low to moderate plasticity, light brownish grey and orange.
			Sandy, some clay, very stiff, moist, low plasticity, brownish orange and light grey.
			Sandy, clayey, very stiff, moist, moderate plasticity, light grey and orange.
	2		CLAY, silty, very stiff, moist, high plasticity, light grey and orange.
	3		End of Borehole 3.0m (Target Depth)
	4		
	5		

Depth (m): 1, 2, 3, 4, 5

Groundwater: Groundwater Not Encountered 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

Depth (m)	Field vane (peak)	Remoulded
1	108	41
1	175	54
2	185	45
2	146	38
3	194	76
3	121	45

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method: Hand Auger
Date Drilled: 28th Feb. 2024
Drilled By: JH
Shear Vane No.: GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH14

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly.
			SILT, trace of clay, trace of sand, hard, dry to moist, non-plastic, brownish orange, frequent gravel inclusions.
	0.4		End of Borehole 0.4m (Unable to progress - gravels)

Depth (m): 1, 2, 3, 4, 5

Groundwater: Groundwater Not Encountered 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH15

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			SILT, stiff, dry, non-plastic, brown, frequent gravels (fg to cg).
ALLUVIAL DEPOSITS			SILT, trace of clay, very stiff, moist, low plasticity, brownish grey and orange.
	1		SAND (cg), silty, medium dense, moist to wet, non-plastic, brownish orange, frequent gravels (fg to cg).
			Becomes saturated.
	2		SILT, clayey, soft, saturated, low to moderate plasticity, brown, (poor recovery ~5%).
	3		End of Borehole 3.0m (Target Depth)
	4		
	5		

Groundwater: 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

UTP

UTP

28

14

34

17

31

14

99

57

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

ORMISTON ASSOCIATES LTD

CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH16

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		SILT, very stiff, dry, non-plastic, brown, frequent gravels (fg to cg).
		Becomes brown, intermixed with orange and light grey.
ALLUVIAL DEPOSITS	1	SILT, sandy (cg), very stiff, moist, non-plastic, orange, frequent gravels (fg).
		Becomes wet.
		CLAY, some sand (cg), firm, wet, moderate to high plasticity, bluish grey with some orange, occasional minor organic inclusions.
		Becomes very stiff.
	2	
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

198+

UTP

142

57

119

65

99

31

68

28

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

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CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH17

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remouldered; 50 100 150 200

Geol. Unit	Depth (m)	Description	Groundwater
FILL		TOPSOIL, gravelly (fg to mg).	
ALLUVIAL DEPOSITS		SILT, some clay, trace of sand, very stiff, moist, low plasticity, brownish orange and light brownish orange.	
		SAND, gravelly (fg), silty, loose, moist, brownish orange.	
	1	SILT, clayey, trace of sand, very stiff, moist, moderate plasticity, light bluish grey and orange. Pocket of silty sand ~50mm.	28th February 2024
		CLAY, silty, very stiff, moist, high plasticity, light grey, mottled orange.	
	2	Silty, some sand (fg), very stiff, moist to wet, moderate to high plasticity, light bluish grey.	
		SILT, some clay, trace of sand, stiff, moist to wet, low to moderate plasticity, light grey with occasional brown and greenish grey.	
	3	End of Borehole 3.0m (Target Depth)	
	4		
	5		

Vane Shear Strength (kPa)	Depth (m)
111	1
22	
83	
19	
175	
38	
178	2
32	
73	
16	
99	3
35	

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH18

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			TOPSOIL, gravelly.
			SILT, some sand, trace of clay, very stiff, dry to moist, non-plastic, brownish orange and bluish grey.
ALLUVIAL DEPOSITS	1		SAND, silty, loose, moist, non-plastic, light brownish grey, occasional gravels (fg).
			Trace of clay, loose, saturated, non-plastic, brownish orange and light grey, frequent gravels (fg to mg).
			SILT, some clay, trace of sand, very stiff, moist to wet, low to moderate plasticity, light grey.
	2		End of Borehole 1.6m (Hole collapsing due to suction)
	3		
	4		
	5		

Depth (m): 1, 2, 3, 4, 5

Groundwater: 28th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak)

Remoulded

50 100 150 200

223+

N/A - Gravel

137

51

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH19

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly.
			SILT, gravelly (fg to cg), some sand, hard, dry to moist, non-plastic, brownish orange.
			End of Borehole 0.4m (Unable to progress - gravels)
	1		
	2		
	3		
	4		
	5		

Depth (m): 1 2 3 4 5

Groundwater: Groundwater Not Encountered 28th February 2024

N/A - Gravel

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method Hand Auger
Date Drilled 27th Feb. 2024
Drilled By JH
Shear Vane No. GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Gentle slope, grass

BOREHOLE LOG BH20

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remoulded; 50 100 150 200

Groundwater: Groundwater Not Encountered 28th February 2024

Geol. Unit	Depth (m)	Description
FILL	0	SILT, stiff, dry to moist, non-plastic, brown, intermixed with orange and grey, frequent gravels (fg to cg), occasional glass fragments.
		Occasional pockets of clay.
ALLUVIAL DEPOSITS	1	SILT, sandy (fg to mg), stiff, moist to wet, non-plastic, dark brownish grey.
		CLAY, silty, very stiff, moist, moderate plasticity, bluish grey, mottled orange.
		Becomes grey with some orange.
	2	SILT, sandy (fg), very stiff, moist, non-plastic, grey, some orange.
		Becomes moist to wet.
		CLAY, silty, trace of sand (fg), very stiff, wet, moderate to high plasticity, grey and orange.
		Becomes bluish grey.
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

UTP - Gravel

62 / 17

127 / 48

130 / 37

108 / 31

82 / 28

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

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CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH21

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL
			SILT, some clay, very stiff, moist, low plasticity, brownish orange and brown.
ALLUVIAL DEPOSITS	1		SILT, some clay, very stiff, moist, low plasticity, light brownish grey and orange.
	2		Clayey, stiff, moist to wet, low to moderate plasticity, light grey and orange.
	3		Trace of clay, trace of sand, stiff, moist to wet, non-plastic, light grey and orange.
			End of Borehole 3.0m (Target Depth)
	4		
	5		

Groundwater: 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

Depth (m)	Field vane (peak)	Remoulded
0	207	61
1	124	45
1	86	32
2	105	38
2	102	38
3	124	29

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH22

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Graphic Log	Description
FILL			GRAVEL (mg to cg).
			SILT, some clay, very stiff, moist, low plasticity, brown, mottled orange.
ALLUVIAL DEPOSITS	1		SILT, some clay, very stiff, moist, low plasticity, light bluish grey and orange.
			SILT, very stiff, moist, non-plastic, brownish orange and light grey, occasional gravels (fg to cg).
			Some clay, trace of sand, soft to firm, wet, low plasticity, bluish grey.
	2		Sandy, loose, saturated, light grey, occasional roots/wood inclusions, very poor recovery.
			End of Borehole 2.5m (Extreme Suction - Poor Recovery)
	3		
	4		
	5		

Groundwater: 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

213
32
UTP
29
6
13
3
54
19

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
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Observations

BOREHOLE LOG BH23

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL
		SILT, very stiff, dry, non-plastic, brown, intermixed with orange and some light grey, occasional gravels (fg).
ALLUVIAL DEPOSITS	1	SILT, trace of clay, very stiff, dry to moist, slightly plastic, orange, brown and light grey, frequent gravels (fg).
		Clayey, stiff, moist, low to moderate plasticity, orange and light grey, frequent gravels (fg).
		SAND (fg to mg), some silt, loose to medium dense, saturated, non-plastic, bluish grey.
	2	CLAY, silty, trace of sand (fg), moist to wet, highly plastic, bluish grey.
		Becomes bluish grey and orange.
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

198+

59

20

125

51

161

96

116

59

122

57

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

ORMISTON ASSOCIATES LTD

CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

BOREHOLE LOG BH24

Sheet 1 of 1

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL, gravelly.
		SILT, some sand, trace of clay, very stiff, moist, non-plastic, brownish orange and brown.
ALLUVIAL DEPOSITS	1	SILT, clayey, trace of sand, very stiff, moist, low to moderate plasticity, brownish orange and grey. Pocket of sandy SILT (sensitive), becomes light grey with occasional orange.
	2	CLAY, silty, trace of sand, very stiff, moist, moderate to high plasticity, light grey. Becomes light bluish grey.
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: Groundwater Not Encountered 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak); Remoulded

50 100 150 200

UTP; 102; 10; 118; 45; 92; 41; 96; 38; 89; 25

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH25

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description	Depth (m)
FILL	0		SILT, stiff, dry to moist, non-plastic, dark brown, occasional gravels (fg to cg).	0
			GRAVELLY (fg to cg), dense, dry to moist, non-plastic, light brown, orange and light grey.	
			End of Borehole 0.4m (Unable to progress - gravels)	
	1			1
	2			2
	3			3
	4			4
	5			5

Groundwater: Groundwater Not Encountered 28th February 2024

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH26

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
FILL	0		TOPSOIL, gravelly.
			SILT, some clay, very stiff, dry, non-plastic, brownish orange and brown.
			End of Borehole 0.4m (Unable to progress - gravels)
	1		
	2		
	3		
	4		
	5		

Groundwater: Groundwater Not Encountered 28th February 2024

UTP - Gravels

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method Hand Auger
Date Drilled 28th Feb. 2024
Drilled By JH
Shear Vane No. GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH27

Sheet 1 of 1

Lithologic Key

FILL | TOP SOIL | SAND | CLAY | SILT | SILT clayey | SILT sandy | ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak)

Remoulded

50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description	Depth (m)	Groundwater
ALLUVIAL DEPOSITS	0		GRAVEL (fg to cg), rounded, silty, some sand (fg to cg), dense, moist, non-plastic, dark brown and grey, frequent minor organic inclusions.	0	
			End of Borehole 0.3m (Unable to progress - gravels)		
	1			1	
	2			2	Groundwater Not Encountered 28th February 2024
	3			3	
	4			4	
	5			5	

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	28th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

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CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH28

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)
Field vane (peak)
Remoulded
50 100 150 200

Geol. Unit	Depth (m)	Graphic Log	Description
ALLUVIAL DEPOSITS	0		TOPSOIL, gravelly.
			GRAVEL (fg to cg), silty, dense, non-plastic, well rounded, brown.
			End of Borehole 0.2m (Unable to progress - gravels)
	1		
	2		
	3		
	4		
	5		

Groundwater: Groundwater Not Encountered 28th February 2024

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method Hand Auger
Date Drilled 28th Feb. 2024
Drilled By JH
Shear Vane No. GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH29

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL
		SILT, gravelly, very stiff, moist, non-plastic, brown, intermixed with orange. Becomes dry, orange and brown.
ALLUVIAL DEPOSITS	1	ORGANIC SILT, firm to stiff, moist, low plasticity, black.
		ORGANIC CLAY, stiff, moist, highly plastic, dark grey and dark brown with some black.
		CLAY, silty, very stiff, moist, moderate to high plasticity, light grey some brown. Becomes brownish grey.
	2	Becomes bluish grey and light grey.
		SILT, clayey, stiff, moist, moderate plasticity, light bluish grey.
		SILT, dense, moist, non-plastic, light bluish grey and brown.
		End of Borehole 2.7m (Too Dense to Auger)
	3	
	4	
	5	

Groundwater: Groundwater Not Encountered 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

124 / 19

143 / 48

150 / 61

111 / 35

223+

UTP

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	LGD
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD

CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH30

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL, gravelly.
		SILT, stiff, moist, non-plastic, brown intermixed with yellow, frequent gravel inclusions (mg), occasional topsoil inclusions.
ALLUVIAL DEPOSITS	1	ORGANIC SILT, firm, moist, moderate plasticity, black.
		CLAY, silty, very stiff, moist, moderate to high plasticity, light brown, occasional rootlets.
		Becomes light grey.
	2	SILT, trace of clay, very stiff, moist, slight plasticity, light brown, occasional brown stains.
		Occasional pockets of highly plastic clay.
		CLAY, silty, very stiff, moist, moderate to high plasticity, light brownish grey with brown stains.
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

223+

172 / 73

102 / 41

127 / 38

143 / 22

86 / 29

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	LGD
Shear Vane No.	GEO500

ORMISTON ASSOCIATES LTD
CONSULTING GEOTECHNICAL ENGINEERS, GEOLOGISTS & ENGINEERING GEOLOGISTS

Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH31

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		TOPSOIL
		SILT, trace of clay, very stiff, moist, non-plastic, brown and brownish orange.
ALLUVIAL DEPOSITS		SILT, trace of clay, trace of sand, very stiff, moist, non-plastic, light grey and brownish orange.
	1	Some clay, very stiff, moist, low plasticity, brownish orange and light grey.
		Clayey, very stiff, moist, low to moderate plasticity, brownish orange and light grey.
		Trace of sand, becomes light grey with occasional orange.
	2	Trace of sand, trace of clay, very stiff, moist, low plasticity, light grey with occasional bluish grey.
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 27th February 2024

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

Depth (m)	Field vane (peak)	Remoulded
1	140	38
	108	38
2	197	38
	131	38
3	96	29

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc. The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	JH
Shear Vane No.	GEO500

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Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	Level, grass

BOREHOLE LOG BH32

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline) — Field vane (peak); Remoulded; 50 100 150 200

Geol. Unit	Depth (m)	Description
FILL		SILT, gravelly (fg to cg), dense, dry, non-plastic, brown, intermixed with orange.
		SILT, very stiff, dry, non-plastic, brown, frequent gravels (fg).
		Gravelly (fg to cg), very dense, non-plastic, dry, brown, intermixed with orange.
ALLUVIAL DEPOSITS		SILT, some clay, stiff, moist, low plasticity, brown.
	1	ORGANIC SILT, stiff, moist, low to moderate plasticity, black and dark brown.
		CLAY, stiff, moist, high plasticity, brownish grey with some orange, occasional minor organic inclusions.
		Becomes brownish orange with some light grey.
		SILT, sandy (fg), stiff, wet, non-plastic, brownish grey and bluish grey.
	2	CLAY, silty, trace of sand (fg), firm to stiff, saturated, high plasticity, bluish grey and brownish grey (poor recovery).
	3	End of Borehole 3.0m (Target Depth)
	4	
	5	

Groundwater: 27th February 2024

Vane shear values: UTP; 147; 37; 105; 40; 102; 40; 48; 17; 51; 25; 71; 34

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Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

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Observations

Prepared for:	Auckland Council
Job No:	5429
Project:	Blackpool Stormwater Improvements, Waiheke
Borehole Location:	see site plan
Surface Elevation:	Datum:
Surface Conditions:	

BOREHOLE LOG BH33

Sheet 1 of 1

Lithologic Key: FILL; TOP SOIL; SAND; CLAY; SILT; SILT clayey; SILT sandy; ORGANIC soils

Geol. Unit	Depth (m)	Description
FILL		SILT, very stiff, dry, non-plastic, brown, intermixed with orange, frequent gravels (fg to cg).
WAIHEKE GREYWACKE GROUP	1	SILT, trace of clay, very stiff, dry to moist, non-plastic, dark brown.
		Becomes brown and orange.
		Clayey, very stiff, moist, low to moderate plasticity, orange with some brown, occasional gravels (fg).
		Becomes orange, mottled light grey.
	2	CLAY, silty, very stiff, moist, moderate plasticity, orange, mottled light grey.
		Becomes orange, mottled light grey and reddish orange.
		SILT, some clay, very stiff, moist, low to plasticity, orange, mottled light grey.
		Becomes light grey, mottled orange.
	3	Becomes low to moderate plasticity.
		End of Borehole 3.0m (Target Depth)
	4	
	5	

Vane Shear Strength (kPa) Corrected (Per NZGS Guideline)

Field vane (peak) / Remoulded

50 100 150 200

198+

142 / 62

108 / 71

170 / 76

156 / 62

127 / 54

Groundwater: 27th February 2024

Note: Logged in accordance with 'The guidelines for the classification and description of soil and rock for engineering purposes' Dec 2005 as outlined by The NZ Geotechnical Society Inc.
The subsurface data described above has been determined at this specific borehole location. Such data will not identify any variations away from this location

Drill Method	Hand Auger
Date Drilled	27th Feb. 2024
Drilled By	BM
Shear Vane No.	DR5405

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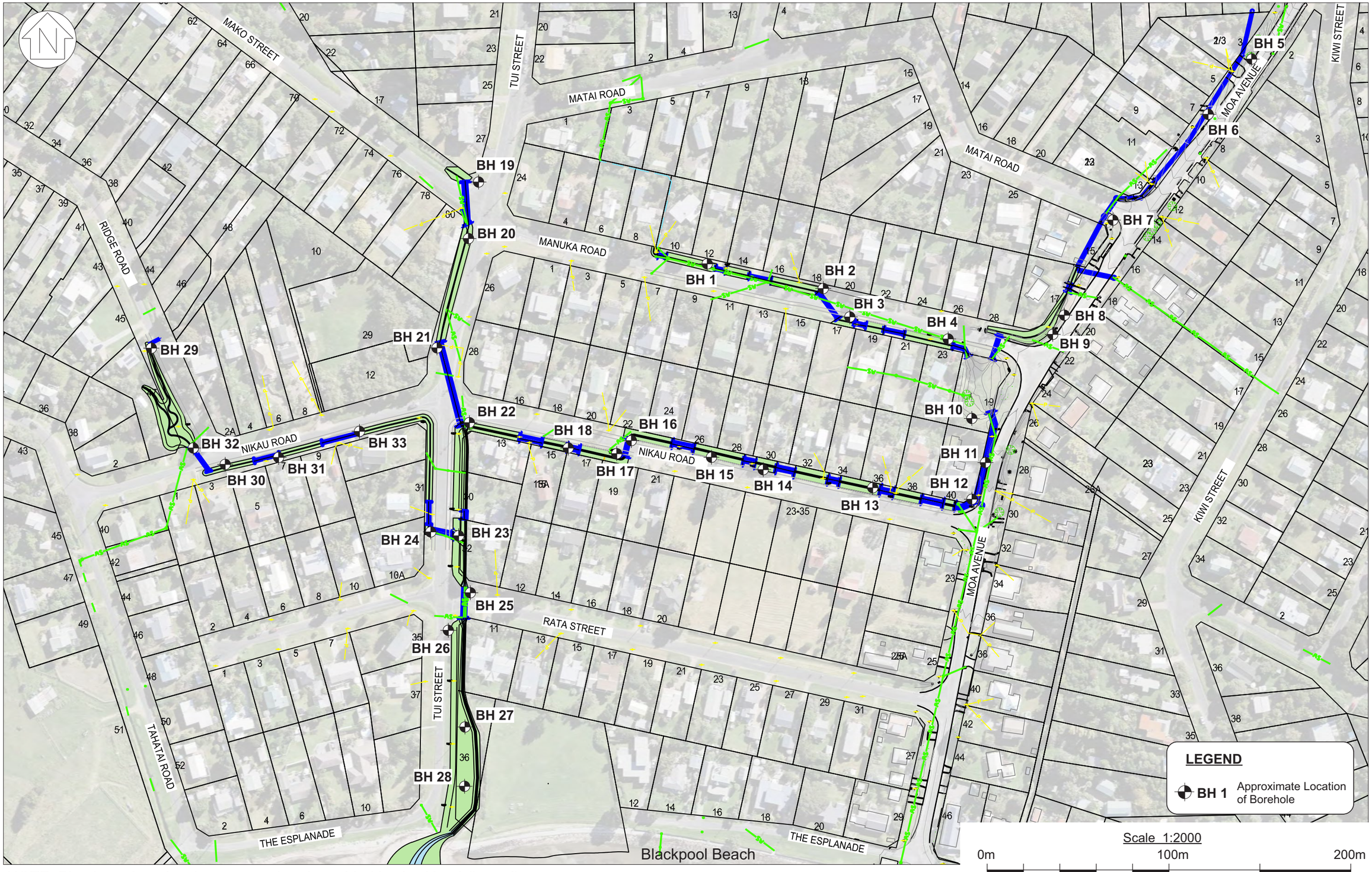
Observations

Site Plan



NOTE: Plan based on drawing prepared and provided by Auckland Council

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CONSULTANTS IN GEOTECHNICAL ENGINEERING, GEOLOGY & ENGINEERING GEOLOGY

Level 2, 90 Symonds Street, Grafton, Auckland City
P O Box 47-822, Ponsonby, Auckland 1144, New Zealand
Ph (09) 302 2193 Fax (09) 302 2197 Email: mail@ormiston.co.nz

CLIENT: Auckland Council
LOCATION: Blackpool Stormwater Improvements
TITLE: Site Plan

SCALE: 1:2000 @ A3
DRAWN: BM
DATE: 1st May 2024
CHECKED: GRG

DRAWING NO
5429-1
SHEET 1 OF 1