

Appendix J Technical Memo

Memo

To:	Jurie Groenewald	Job No:	1092369 (Phase B401)
From:	Andrew Stiles	Date:	13 February 2025
cc:	Jim Jefferis; Jon Payne; Simonne Eldridge; Andrew Shallard; Andrea Brabant		
Subject:	Redvale Landfill : Project Rex Task C2 : Stability Review Technical Memo		

1 Introduction

1.1 Background

In mid-2024 we carried out a concept geotechnical stability assessment of potential Options C1 and B1 to create additional airspace at Redvale. The results of that study were reported in our “*Concept Geotechnical Stability Assessment : Summary Technical Memo : v2*” dated 18 July 2024, (Ref 1). The principal conclusions from that concept geotechnical stability assessment were :

- a) Eastern part of Northern Boundary, Eastern Boundary, Southern Boundary and Managed Fill :
 - i) The assessed stability of the proposed Option C1 and Option B1 waste slopes satisfied design criteria for design groundwater, elevated (high) groundwater and seismic loads.
- b) Western part of Northern Boundary, ie the ‘Phase 10 Bund’ :
 - i) Stability analyses of the proposed Option C1 and Option B1 waste slopes indicated that they satisfied design criteria for design groundwater, elevated (high) groundwater and seismic loads.
 - ii) The analyses showed however that calculated Factors of Safety (FoS) were particularly sensitive to assumptions of groundwater levels.

The assessment recommended additional geotechnical works as part of the ongoing design process, namely :

- a) Replacement piezometers to confirm that the design groundwater levels assumed for the concept study, and hence stability assessments, are realistic. The following were recommended :
 - i) Western part of Northern Boundary : 4 No. replacement vibrating wire piezometers
 - ii) Managed Fill : 2 No. vibrating wire piezometers

Installation of the above 6 No. vibrating wire piezometers was carried out in October 2024, with the results of the works discussed in this Stability Review Technical Memo

- b) A programme of test pits, or shallow window-sample boreholes, or similar was proposed along the Eastern and Southern Boundaries to assess the depth to competent Northland Allochthon below the proposed perimeter bunds. Following discussions with WMNZ this work has been deferred to the detailed design stage, and following confirmation of the Project Rex concept being adopted.

1.2 Additional Geotechnical Works

Following completion of the Summary Technical Memo : v2, as requested by WMNZ, we submitted a proposal, (Ref 2), dated 13 August 2024, to carry out additional geotechnical investigations to support the results of the concept study. In particular we proposed investigations to clarify and confirm groundwater conditions along the western part of the landfill's Northern Boundary and the Managed Fill extension. The scope of work was essentially as proposed in the concept study report, and noted in Section 1 above, namely to :

- a) Install replacement piezometers along the Northern Boundary. The existing piezometers in that area of the site had been no longer functioning reliably after about 2010, and the objective of the replacement piezometers was therefore to confirm current groundwater levels for design;
- b) There was only limited ground and groundwater information available for the Managed Fill area, which lies outside the main landfill boundary. A borehole, with piezometers, was proposed to be installed in that area to allow ground and groundwater condition to be confirmed;

Following installation of the piezometers, the instruments would be monitored until readings indicated that they had stabilised and that measured levels were therefore judged representative of insitu longer-term current groundwater conditions.

The proposal was accepted by WMNZ and boreholes drilled, and vibrating wire piezometers installed in October 2024. Geotechnics have monitored the piezometers since they were installed with between 6 No. and 7 No. readings since then, and the latest reading on 21 January 2025. Review of the monitoring data confirms that the piezometers have essentially stabilised, albeit with a continuing very slight gradual decrease in levels, and this memo therefore presents the brief Stability Review Technical Memo, identified as Task C2 in the proposal and forming the principal deliverable.

Please note that this Stability Review Technical Memo should be read in conjunction with the earlier Summary Technical Memo, (Ref 1), and reference to that earlier Technical Memo is made as appropriate.

2 Fieldwork

2.1 Machine boreholes

Four machine boreholes were carried out, three along the Northern Boundary and one in the proposed Managed Fill area. The boreholes were drilled by DrillForce Ltd, with the works supervised by a T+T Engineering Geologist on a visiting basis and who also logged and photographed the core. The investigation locations are shown on Figure 1 in Appendix A and are summarised in Table 1 below, with borehole logs enclosed in Appendix B.

Borehole locations were proposed by T+T and, following site discussions between T+T, WMNZ and DrillForce, revised slightly to allow for practical access constraints. The as-drilled locations were subsequently surveyed by WMNZ.

2.2 Vibrating wire piezometers

The vibrating wire piezometers were made up and installed under the direct supervision of Geotechnics Ltd, who commissioned the instruments, took the baseline readings, and have continued regular monitoring readings since installation. The piezometers are grouted into position with particular care taken for the installation of the double-piezometers in Boreholes W136 and W138. Installation details of the vibrating wire piezometers are included in Table 1.

Table 1 : Boreholes and Vibrating Wire Piezometer Installation Details

Borehole				Piezometer		
ID No.	Location	Ground RL (m)	Depth (m)	ID No.	Tip depth (m)	Tip RL (m)
W135	Northern Boundary	79.70	15.50	Pz 40	15.00	64.70
W136	Northern Boundary	78.45	15.50	Pz 41	8.00	70.45
				Pz 42	15.00	63.45
W137	Northern Boundary	88.85	15.50	Pz 43	15.10	73.75
W138	Managed Fill	78.38	15.50	Pz 44	7.10	71.28
				Pz 45	15.10	63.28

3 Ground and groundwater conditions

3.1 Ground conditions

3.1.1 General

An Engineering Geology Plan progressively prepared for the Western Property as part of the ongoing (now largely complete) landfill development is enclosed as Figure 2 in Appendix A, and the locations of the four recent boreholes have been added to that Plan. The plans indicate that the majority of the northern, eastern and southern landfill boundaries, and the proposed Managed Fill extension, will be underlain by Northland Allochthon Mudstone and Siltstone, likely overlain to varying degrees by recent fill and/or Pleistocene sediments. Considering each of the four current boreholes in more detail :

3.1.2 Borehole W135

Borehole W135 is located towards the western end of the Northern Boundary Phase 10 Bund, see Figure 2, with the borehole log enclosed in Appendix B. Encountered ground conditions are summarised below in Table 2.

Ground conditions encountered generally match those expected, ie fill overlying in-situ Pleistocene Sediments and Northland Allochthon. Figure 2 shows expected bedrock geology at the BH W135 location to be Northland Allochthon sheared Mudstone with Limestone identified to the immediate west and east of the borehole location. The borehole showed similar lithologies with a Mudstone band overlying Limestone at the base of the borehole.

Table 2 : Summary log of BH W135

Depth to top of unit	Unit thickness	Description	Unit
0.00 m			
	8.19 m	Very stiff to hard, grey gravelly clayey Silt and silty Clay	Fill
8.19 m			
	3.26 m	Firm to stiff to very stiff, grey and greenish grey, silty Clay with trace of sand and organic material	Pleistocene sediments
11.55 m			
	2.49 m	Unweathered dark grey sheared Mudstone	Northland Allochthon
14.04 m			
	>1.46 m	Unweathered light grey, pervasively sheared muddy Limestone	Northland Allochthon

3.1.3 Borehole W136

Borehole W136 is located in the central part of the Northern Boundary, see Figure 2, with the borehole log enclosed in Appendix B. The borehole location was selected to confirm ground and groundwater conditions along Cross-section N1, which was the principal cross-section analysed through the Northern Boundary, and was in turn based on Cross-section 19A-N1 from the T+T 2014 Phase 19A Geotechnical Assessment Report, (Ref 3). Encountered ground conditions are summarised below in Table 3.

Table 3 : Summary log of BH W136

Depth to top of unit	Unit thickness	Description	Unit
0.00 m			
	5.07 m	Very stiff to hard, grey gravelly Clay and medium dense clayey Gravel	Fill
5.07 m			
	4.73 m	Very stiff, grey and orange, silty Clay with varying organic content	Pleistocene sediments
9.80 m			
	>5.70 m	Unweathered dark grey sheared Mudstone	Northland Allochthon

Ground conditions encountered generally match those expected, ie fill overlying in-situ Pleistocene Sediments and Northland Allochthon. The borehole profile shows a good match with the analysed Cross-section N1 profile and the Northland Allochthon mudstone bedrock mapped on Figure 2.

3.1.4 Borehole W137

Borehole W137 is located towards the eastern end of the Northern Boundary Phase 10 Bund, see Figure 2, with the borehole log enclosed in Appendix B. Encountered ground conditions are summarised below in Table 4 :

Table 4 : Summary log of BH W137

Depth to top of unit	Unit thickness	Description	Unit
0.00 m			
	10.90 m	Very stiff to hard, grey gravelly Clay and medium dense clayey Gravel	Fill
10.90 m			
	3.35 m	Stiff to very stiff, grey and orange mottled, silty Clay with variable organic content	Pleistocene sediments
14.25 m			
	>1.25 m	Slightly weathered to unweathered dark grey sheared Mudstone	Northland Allochthon

Ground conditions encountered generally match those expected, ie fill overlying in-situ Pleistocene Sediments and Northland Allochthon, with the borehole basal lithology matching the Northland Allochthon mudstone bedrock mapped on Figure 2.

3.1.5 Borehole W138

Borehole W138 is located within the former Managed Fill area, to the south of the central part of the Landfill's southern boundary, see Figure 2, with the borehole log enclosed in Appendix B. Encountered ground conditions are summarised below in Table 5 :

Table 5 : Summary log of BH W138

Depth to top of unit	Unit thickness	Description	Unit
0.00 m			
	6.32 m	Soft to firm, and firm to stiff variable Cay, gravelly Clay and clayey Gravel	Fill
6.32 m			
	1.53 m	Stiff, grey and light orange banded, silty Clay with variable organic content including roots	Pleistocene sediments
7.85 m			
	>7.65 m	Moderately weathered becoming unweathered, dark grey sheared Mudstone	Northland Allochthon

Ground conditions encountered generally match those expected, ie relict fill from the Managed Fill stockpile, overlying in-situ Pleistocene Sediments and Northland Allochthon. The thickness of fill is greater than expected however and is likely to be, at least in part, remaining material from the earlier Managed Fill stockpile works. The borehole has confirmed the basal lithology as Northland Allochthon, supporting the Engineering Geology Plan in Figure 2, which shows the Thrust Fault, separating Northland Allochthon and Waitemata Group materials, to be towards the western boundary of the proposed Managed Fill landfill extension.

3.1.6 Discussion

The four additional boreholes recently completed along the landfill's Northern Boundary and within the Managed Fill extension area all encountered ground conditions matching those expected from previous geotechnical studies and engineering geology mapping, ie fill overlying in-situ Pleistocene Sediments and Northland Allochthon.

3.2 Groundwater conditions

3.2.1 General

During and following construction in the early 1990s of the Phase 10 Bund along the Northern Boundary, a number of monitoring wells and vibrating wire and pneumatic piezometers were installed. However many of those existing piezometers are no longer functional, either due to their age or having been destroyed by construction activities, or are giving what are considered anomalous groundwater data, (Ref 5). In the area of the proposed Managed Fill extension there was limited groundwater information available. For purposes of the earlier Summary Technical Memo assessment a conservative approach was therefore adopted, with groundwater conditions generally assumed to be either 3 m below existing ground level (Design Case) or 1 m below existing ground level (High Case).

The vibrating wire piezometers installed in the four recent boreholes have allowed current groundwater conditions to be assessed and compared to historic data and the levels assumed for the earlier assessment. Where current levels differ from those assumed earlier then if necessary the stability analyses have been repeated using the current groundwater data.

3.2.2 Piezometer monitoring data to date

Table 6 below summarises the vibrating wire monitoring carried out by Geotechnics Ltd to date for the six piezometers, identifies what are considered to be appropriate design groundwater levels and compares the current levels with the available historic data. The Geotechnics record sheets are enclosed in Appendix C and plots of measured piezometric level and depth below ground level against time are presented as Figures 3 and 4 respectively in Appendix A.

Table 6 : Summary of vibrating wire piezometer data :

Borehole ID	Piezometer			
	ID	Measured piezometric levels		
		GW range RL (m) (23/10/2024 to 21/01/25)	Assumed design GW RL (m)	Depth (m) GW below existing ground level
W135	Pz 40	68.44 to 69.40	68.8	10.9
W136	Pz 41 (shallow)	72.85 to 74.02	73.5	5.0
	Pz 42 (deep)	72.57 to 73.66	73.0	5.5
W137	Pz 43	76.80 to 78.19	77.1	11.8
W138	Pz 44 (shallow)	73.23 to 73.69	73.5	4.9
	Pz 45 (deep)	72.28 to 73.12	72.5	5.9

Considering the data summarised in Table 6:

- a) The measured piezometric levels, for all piezometers, show a very slight trend of falling levels over the 3 months monitored to date. The rate of decrease is very slight, with a maximum variation over that time period of 1.39 m for Pz 43, but with other piezometers typically showing values of about 1 m or less. The piezometers were installed towards the start of summer, so it is not clear yet as to whether the decrease reflects a seasonal trend, which may be reversed as we head into wetter winter, or reflects the continuing very slow depressurisation of the ground following the effects of the drilling fluid. However, based on the measured range an assumed groundwater level has been defined for each piezometer, as shown in Table 6.

- b) Briefly reviewing the current piezometric data and comparing to historic data at each borehole location :
- i) Borehole W135 : Pz 40 :
 - There are no historic boreholes/piezometers near Borehole W135;
 - Pz 7, about 45 m to the north-east, shows historic groundwater levels similar to those recorded for the current Pz 40;
 - However W7, about 50 m north, and Pz 8 about 40 m to the north-west, showed levels typically lower and higher respectively compared to Pz 40.
 - ii) Borehole W136 : Pz 41 and Pz 42 :
 - The nearest historic piezometers to Pz 41/Pz 42 are Pz 16 and Pz 39, both about 70 m east and north-east respectively, and considered too distant to allow a meaningful comparison;
 - The assumed design groundwater levels for PZ 41 and Pz 42 matches well with the groundwater profile assumed earlier along Cross-section N1, and which was based on Cross-section 19A-N1 from the T+T 2014 Phase 19A Geotechnical Assessment Report, (Ref 3).
 - The shallow and deep piezometers show similar measured groundwater levels, confirming a hydrostatic groundwater profile and, in particular, that groundwater is not “perched” in the Fill overlying the in-situ Pleistocene sediments and Northland Allochthon.
 - iii) Borehole W137 : Pz 43 :
 - Pz 4 and Pz 37, both located about 20 m to 25 m north-east of Pz 43 both show historic measured groundwater levels comparable to those in Pz 43.
 - iv) Borehole W138 : Pz 44 and Pz 45 :
 - Existing historical groundwater data in the vicinity of the Managed Fill extension area is limited and contradictory;
 - The assumed design groundwater levels for Pz 44 (shallow, in the Pleistocene sediments) and Pz 45 (deep, in the Northland Allochthon) are RL 73.5 m and RL 72.5 m respectively, ie about 1 m difference. Those ground water levels, assuming hydraulic connectivity, therefore indicate groundwater in the base of the Fill;
 - Assuming a general northerly dipping /flowing groundwater regime (Ref 4) this suggests that there is hydraulic connectivity between the two piezometers (both in in-situ materials) but with a slight downwards hydraulic gradient (drainage);
 - The earlier analysis assumed that a high groundwater profile at 1 m below the design basegrade, that is assumed groundwater levels of RL 64 m below the proposed extension lowest point;
 - The current recorded groundwater level vs the current design basegrade levels therefore suggest groundwater heads of up to 10 m above the approximate RL 65 m proposed base of the Managed Fill extension excavation. This is discussed further below.

3.2.3 Discussion

The piezometer monitoring to date indicates that :

- a) Groundwater conditions along the Phase 10 Bund portion of Northern Boundary are considered generally similar to those recorded historically and assumed for both the previous phases of design and for the analyses considered in the earlier Summary Technical Memo. The monitoring data also confirms a hydrostatic groundwater profile and, in particular, that groundwater is not “perched” in the Fill overlying the in-situ Pleistocene sediments and Northland Allochthon.
- b) Within the proposed Managed Fill extension area, measured piezometric levels are at about RL 73.5 m to RL 72.5 m corresponding to groundwater within the base of the fill, assuming hydraulic connectivity. Such piezometric levels potentially suggest groundwater heads of up to 10 m at the lowest point of the proposed Managed Fill extension basegrade. However the following points should be noted :
 - i) Site experience has shown the Pleistocene sediments, and particularly the underlying Northland Allochthon mudstone/siltstones, are often found to be effectively dry when excavating;
 - ii) The location of Borehole W138 with Pz 44/Pz 45 is approximately 75 m north-west (upslope) of the proposed Managed Fill extension’s RL 65 m lowest basegrade level. The borehole/piezometers location corresponds to a design basegrade level of about RL 75 m and a previously assumed groundwater level of RL 74 m; both levels are therefore above the current measured piezometric levels.
 - iii) The existing ground profile generally falls south-eastwards, towards Sedimentation Pond 6 (and the proposed lowest point of the Managed Fill extension basegrade) and it is expected that the existing groundwater profile will follow a similar profile, ie dipping down eastwards towards the low ground corresponding to Sedimentation Pond 6 and the workshop area further to the east.

Such a view is supported by the base of Sedimentation Pond 6 (which is located over the approximate base area of the proposed Managed Fill extension) and the adjacent workshop area being below RL 65 m, and with no known issues with groundwater seepages or the like. In addition it is understood that construction of Sedimentation Pond 6B, and shear key works, immediately west of Sedimentation Pond 6, included excavations to RL 64 m or lower. So far as is known, no issues were encountered during construction with groundwater seepages or inflows into the excavations.

In summary therefore, the recent investigations and piezometer monitoring suggest a groundwater table extending into the base of the fill and dipping down eastwards towards the low ground of Sedimentation Pond 6 and the adjacent workshop area.

4 Slope stability

4.1 General

The following sections review the slope stability analyses and conclusions presented in the earlier Summary Technical Memo, in light of the ground and groundwater conditions interpreted from the recent borehole drilling and piezometer monitoring.

4.2 Northern Boundary

Machine boreholes W135, W136 and W137 carried out along the Phase 10 Bund portion of the Northern Boundary (ie the western half) all encountered ground conditions matching those expected

from previous geotechnical studies and engineering geology mapping, ie fill overlying in-situ Pleistocene Sediments and Northland Allochthon.

Measured piezometric levels installed in those boreholes are considered generally similar to those recorded historically and assumed for both the previous phases of design and for the analyses considered in the earlier Summary Technical Memo. The monitoring data from the shallow (Pz 41) and deep (Pz 42) piezometers in Borehole W136 also confirms a hydrostatic groundwater profile and, in particular, that groundwater is not “perched” in the Fill overlying the in-situ Pleistocene sediments and underlying Northland Allochthon.

Considering the reassessed slope stability along the two specific cross-sections analysed in the earlier Summary Technical Memo, (see locations on Option C1 and B1 location plans in Appendix D) :

- a) Cross-section N1 : Although no recent boreholes were drilled in the vicinity of this cross-section, the general conclusions from the recent boreholes and piezometer monitoring along the western half of the Northern boundary are considered equally valid for this cross-section. In particular that groundwater levels are likely at up to at least 5 m depth, and hence much greater than the 3m depth (design) or 1 m depth (high) groundwater levels assumed in the earlier analyses. The results of the earlier slope stability analyses are therefore considered to remain valid and conservative,
- b) Cross-section N2 : Borehole W136, with shallow (Pz 41) and deep (Pz 42) piezometers, was installed along the Cross-section N2 alignment. The borehole and piezometer monitoring data confirmed the ground and groundwater conditions assumed for Cross-section N2, albeit with slightly shallower assumed groundwater levels. The results of the earlier slope stability analyses are therefore considered to remain valid and conservative,

4.3 Eastern and Southern Boundary

No recent investigations were carried out along the Eastern or Southern Boundaries. However the conclusions from the boreholes and piezometers along the western half of the Northern Boundary give confidence that stability models are valid and conservative (in particular with respect to assumed groundwater conditions).

4.4 Managed Fill

Borehole W138 confirmed ground conditions within the proposed Managed Fill extension are generally similar to elsewhere on the Landfill, ie Fill, overlying Pleistocene sediments, overlying Northland Allochthon mudstone. The encountered depth of fill, at 6.32 m, was greater than expected and at least the upper portion likely represents fill remaining from the original Managed Fill stockpile. The base of the fill is at RL 72.06, which is about 3 m below the proposed basegrade level of about RL 75 m at the Borehole W138 location. That therefore suggests the immediate materials underlying basegrade at that location would be fill, rather than competent Northland Allochthon assumed in the earlier analyses. Similarly, the borehole suggests that an approximately 8 m deep (to below RL 70.53 m) excavation would be necessary at the borehole location to allow the basegrade to be formed in Northland Allochthon materials. The current basegrade profile is conceptual, and options could include redesigning (lowering) the basegrade, to allow removal of the Fill and Pleistocene sediments, or removing those materials and replacing with engineered fill to form the current proposed basegrade profile.

As discussed in Section 3.2.3 above, the piezometer monitoring data suggests groundwater levels for the shallow and deep piezometers at about RL 73.5 m and RL 72.5 respectively, ie within the fill materials and about 2 m to 3 m below the proposed basegrade level at the borehole/piezometers location. The available data therefore suggests that groundwater is likely to lie below design

basegrade, dipping south-eastwards down towards the current Sedimentation Pond 6. However provisionally, allowance should be made for installing underdrainage over at least a portion of the lower part of the basegrade.

The landfill basegrade would need to be constructed either on in-situ competent Northland Allochthon materials, or on appropriately engineered fill. The existing fill and underlying Pleistocene sediments identified in the recent Borehole W138 would therefore need to be removed and replaced with engineered fill in order to achieve the required quality basegrade. The extent of the fill encountered in Borehole W138 is not known and as part of detailed design additional boreholes to assess its extent, and the depth to Northland Allochthon bedrock, would be required. Such boreholes would also allow the groundwater conditions in the area to be confirmed.

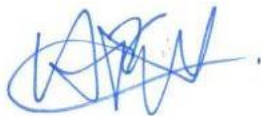
On the assumption that basegrade would be formed either in Northland Allochthon bedrock or engineered fill then, in view of the generally favourable groundwater conditions, it is considered that the slope stability of the Cross-section MF1 basegrade analysed earlier would remain acceptable.

5 Applicability

This Stability Review Technical Memo has been prepared for the exclusive use of our client WMNZ, 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.

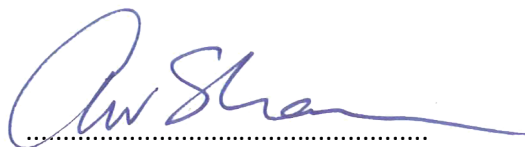
Tonkin & Taylor Ltd
Environmental and Engineering Consultants

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.....
Andrew Shallard
Senior Principal Environmental
Engineer

Authorised for Tonkin & Taylor Ltd by:



.....
Simonne Eldridge
Project Director

References

1. T+T : 18 July 2024 : Concept Geotechnical Stability Assessment : Summary Technical Memo : v2
2. T+T : 24 July 2024 : Letter of Engagement, Redvale Landfill, Project Rex, Additional Geotechnical Works
3. T+T : March 2014 : Phase 19A Development Geotechnical Assessment Report, Ref No. 24976.320
4. T+T : December 2013 : Consents Renewal Geotechnical Review Report, Ref No. 29331.300,
5. WMNZ : 29 May and 17 June 2024 : Piezometer and monitoring well data spreadsheets,

Appendix A Figures



NOTES:

1. Height Datum: L&S 1946 (Auckland MSL)
2. Origin of Levels: Redvale GPS Base Station 67.365m R.L. Derived from a Site Calibration.
3. Original survey in terms of Geodetic Datum 1949

Grid:
NZTM (2000)
Elevation Datum: NZVD 2016

WM
New Zealand

WM New Zealand
Engineering, Research & Development
Auckland
New Zealand
wm.nz

Waste Management
Redvale Landfill
P.O. Box 228, Silverdale
Auckland Council

Scale @ A4:
Scale @ A3: 1:2500

12d file: 06 EOM Jun24

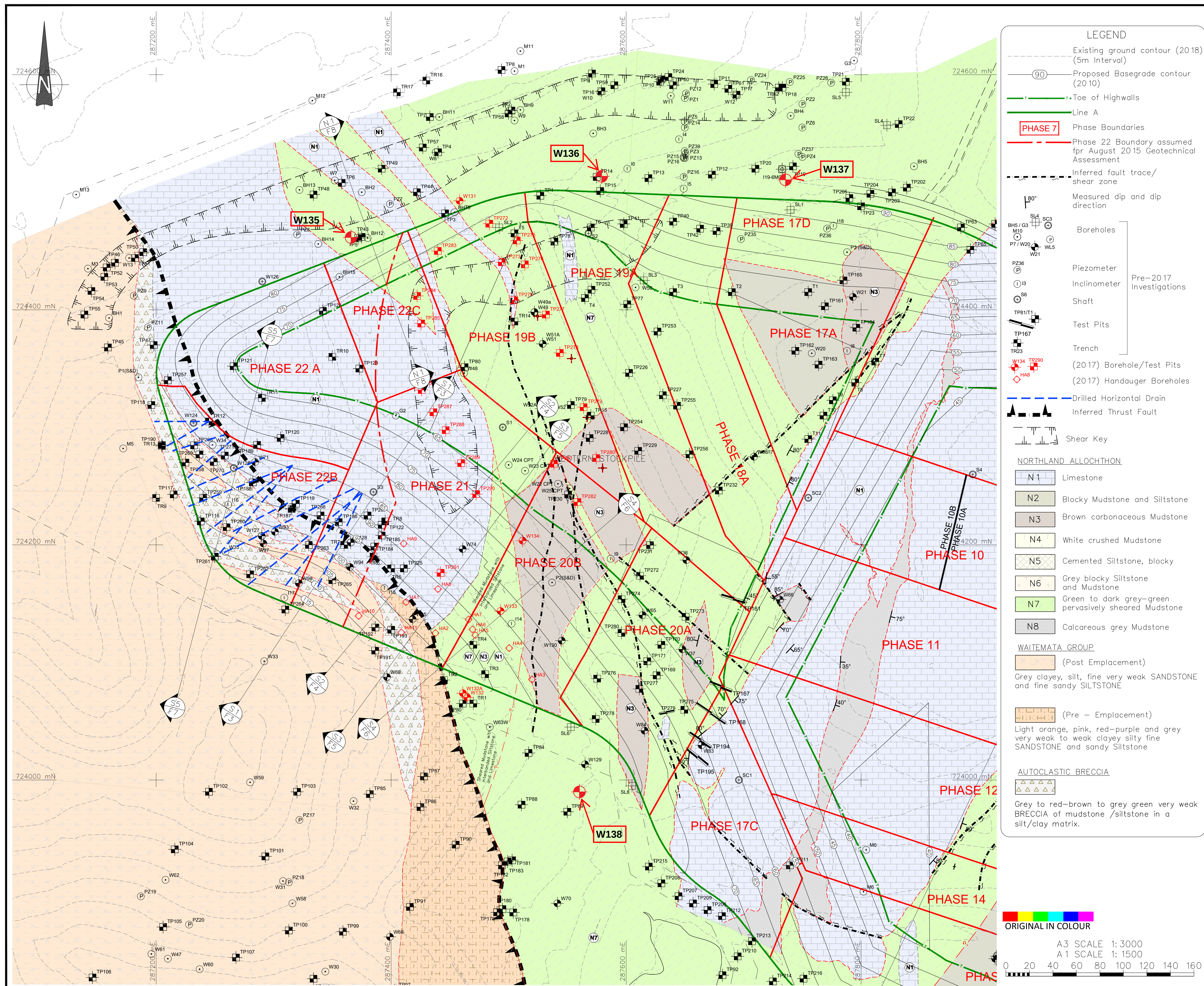
Project: Rex

Site Investigation
Location Plan

	Name	Date
Surveyed:	MG	July 24
Designed:		
Drawn:	MG	July 24
Checked:		
Project Manager:		

Issue	Description	Date	Approved

Figure 1



NOTES :

1. N1, N2 etc refer to material types as defined in the Technical Specification.
2. Refer to previous Geotechnical Reports for test pit and borehole logs.
3. Testpits and boreholes are correct in plan position only. Subsequent earthworks are likely to have changed surface elevation.
4. Boundaries and distribution of geological units approximate only and inferred from available information.
5. Cell Phase Layout as currently advised by WMNZ
6. Drawing to be read in conjunction with text of "Phase 21, Phase 22B and Phase 22C Geotechnical Assessment Report, 1004846.0203, April 2019".
7. Existing contours supplied by Waste Management, June 2018 contours surveyed by Precision Aerial Surveys (PAS) modified as follows:
 - July 2016 contours surveyed by PAS used under western limerock stockpile.
 - June 2003 contours surveyed by Stimpson Surveyors used beneath trees at top of Southern Highwall.

0	First Issue		
REVISION	DESCRIPTION	BY	DATE
DESIGNED :		APS	Mar.
DRAWN :		KAH	Mar.
DESIGN CHECKED :			
DRAFTING CHECKED :			

CADFILE : \\1004846.0203-F2.dwg
APPROVED :
NOT FOR CONSTRUCTION
This drawing is not to be used for construction
purposes unless signed as approved
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Waste Management

REDVALE LANDFILL

Project Rex

Engineering Geology Plan
showing Additional Boreholes

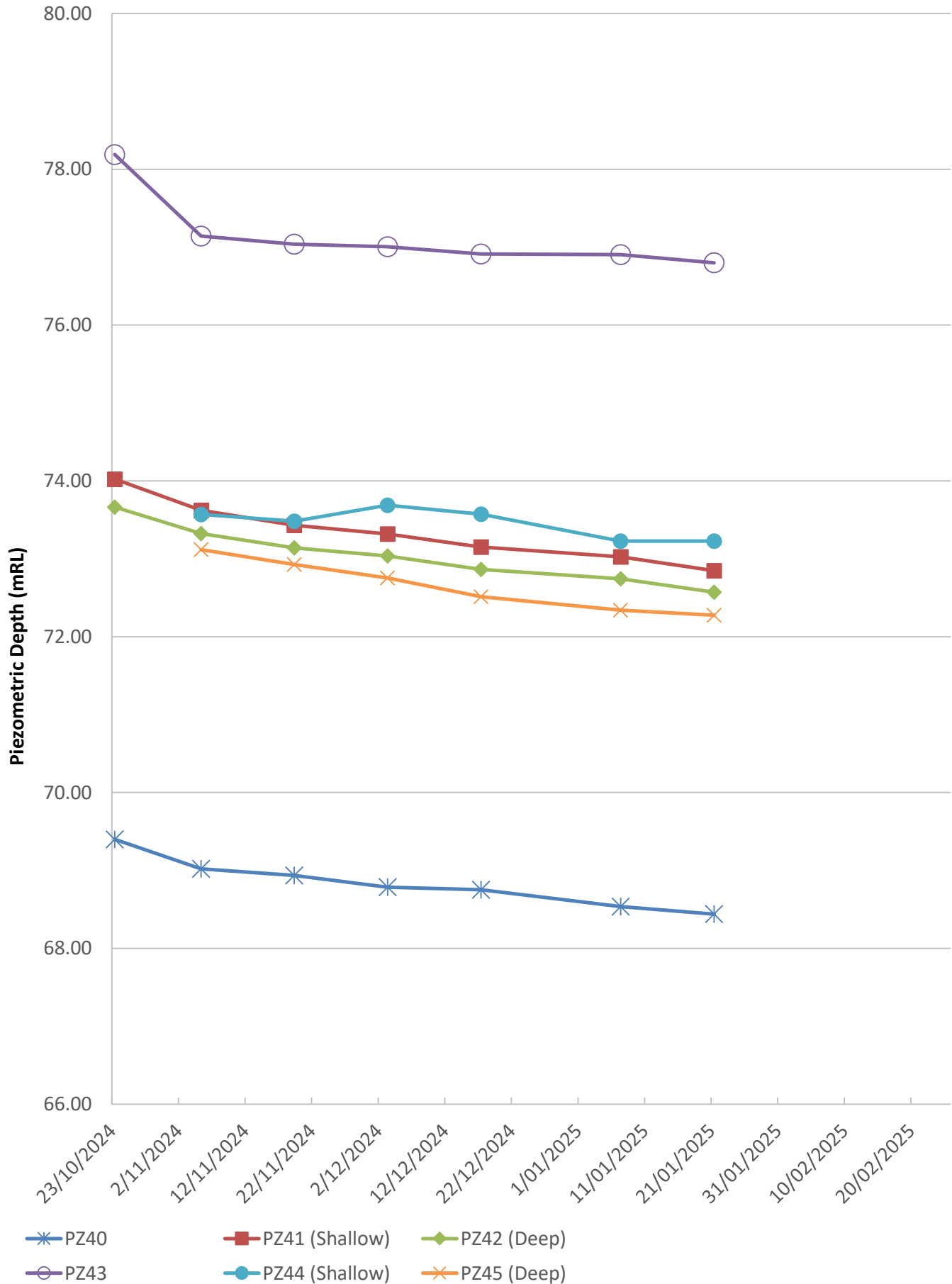
SCALES (AT A1 SIZE,
AS SHOWN)

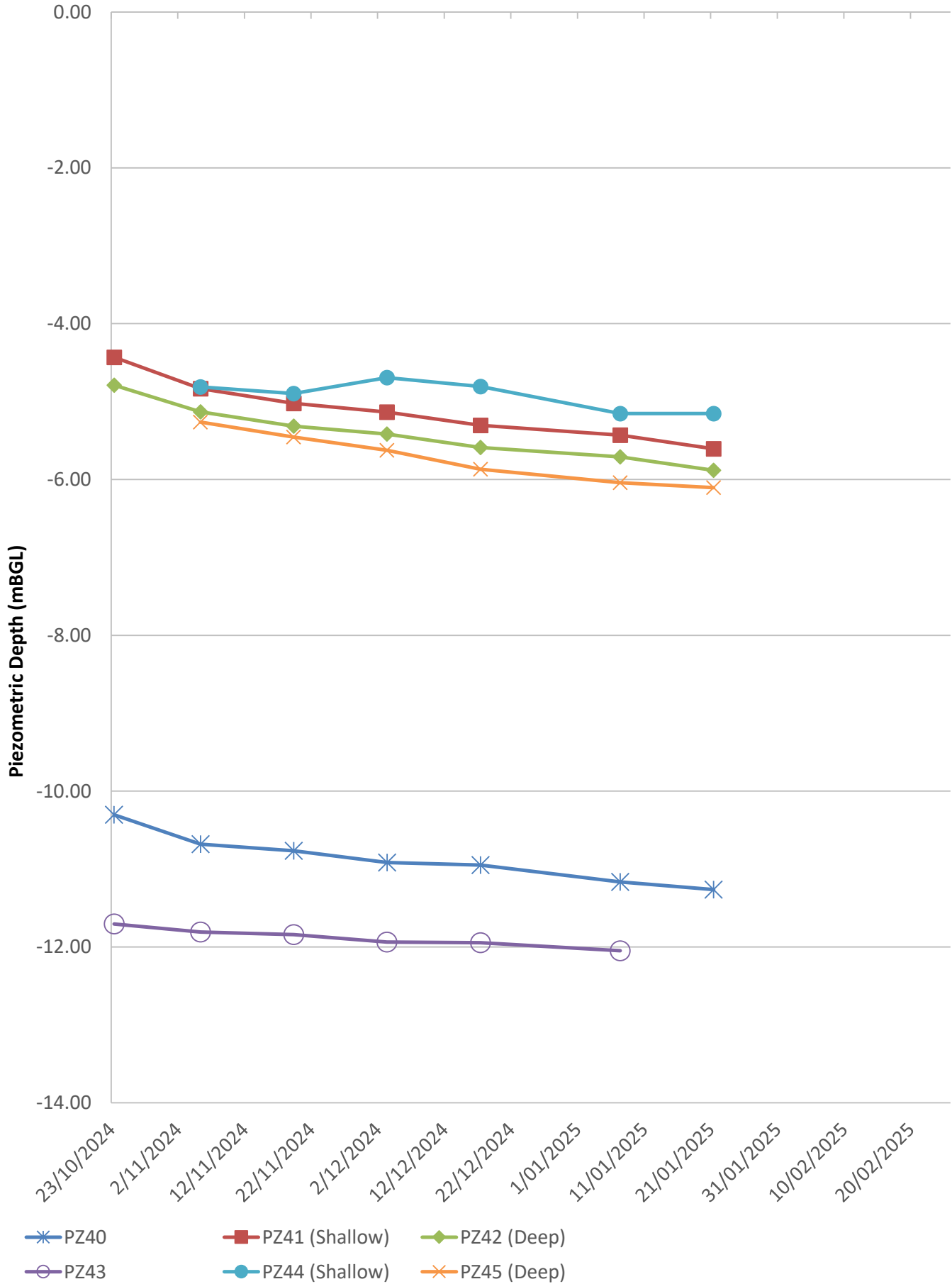
Figure 2

REV.	0
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DRAWING STATUS: PRELIMINARY DRAFT

1092369: Project Rex
Piezo RL readings (mRL) vs time
Figure 3





Appendix B Borehole Logs

BOREHOLE LOG

BOREHOLE No.:
W135

SHEET: 1 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 17/10/2024

FINISH DATE: 17/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724455.91 mN
(EDENTM1949) 287366.92 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.70m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station/Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Fill	0.00m: Cobbly GRAVEL; light grey. Medium dense, dry, poorly graded; gravel, coarse, up to 50 mm sub-rounded to angular grey (fill - embankment)	UW	UW	UW	UW						2000	20		25			
	0.15m: Gravelly SILT, some cobbles; bluish grey. Very stiff to hard, dry to moist, poorly graded, up to 30 mm sub-angular to angular grey (fill - embankment)	SW	SW	SW	SW			79			200	20		50			
	1.50m: Gravelly SILT, trace clay; bluish grey. Very stiff to hard, dry to moist, poorly graded; gravel, fine, up to 5 mm sub-angular to angular grey (fill - embankment)	SW	SW	SW	SW			78			200	20		50			
	2.90m: Clayey SILT, some gravel; bluish grey. Very stiff to hard, dry to moist, poorly graded (fill - embankment)	SW	SW	SW	SW			77			200	20		50			
	4.50m: Organic CLAY, some silt, trace gravel; grey and mottled orange. Very stiff, moist, medium to high plasticity wood fragments (partially decomposed) (fill - embankment)	SW	SW	SW	SW			76			200	20		50			
	4.70m: Gravelly CLAY; grey and mottled orange. Very stiff, moist, medium to high plasticity (fill - embankment)	SW	SW	SW	SW			75			200	20		50			
	4.87m: Clayey SILT, minor gravel; dark grey and mottled orange. Very stiff to hard, dry to moist, low to medium plasticity (fill - embankment)	SW	SW	SW	SW						200	20		50			
	5.00m: Gravelly COBBLES, minor silt; grey. Loose to medium dense, dry to moist, poorly graded; cobbles, up to 60 mm sub-	SW	SW	SW	SW						200	20		50			

Design Groundwater Depth 10.30mBGL (69.40mRL) measured in PZ40 at 10:27AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:

W135

SHEET: 2 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 17/10/2024

FINISH DATE: 17/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724455.91 mN
(EDENTM1949) 287366.92 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.70m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station/Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Fill	rounded to angular grey (fill - embankment)							74									
	5.35m: CORE LOSS - Suspect loose granular material dropped out of barrel							6									
	6.00m: CLAY, some organic, minor cobbles; grey with streaked orange. Stiff to very stiff, moist to wet, medium to high plasticity wood fragments (partially decomposed) (fill - embankment)							73									
								7									
	7.50m: Gravelly SILT, some organic, minor clay; light grey. Very stiff to hard, moist to wet, non-plastic to low plasticity; organics, rootlets rootlets (fill - embankment)							72									
								8									
	8.19m: Silty CLAY, minor organic, trace gravel; brownish grey. Very stiff, moist; organics, rootlets rootlets (partially decomposed) (fill - embankment)																
	8.25m: CLAY, minor organic; greenish grey. Stiff to very stiff, moist to wet, medium plasticity carbonaceous flecks (Alluvium - Pleistocene).							71									
								9									
	9.00m: Silty CLAY, some sand, trace organic; pinkish grey. Stiff, moist to wet, medium to high plasticity carbonaceous flecks (Alluvium - Pleistocene).																
Tauranga Group	9.36m: Silty CLAY, trace organic; reddish grey and speckled orange. Stiff, moist to wet, medium to high plasticity carbonaceous flecks (Alluvium - Pleistocene).							70									
	9.92m: Silty SAND, trace organic; brownish grey. Medium dense, moist, well graded carbonaceous flecks; sand, fine (Alluvium - Pleistocene).							10									
	10.20m: CLAY, trace organic; greenish grey. Firm to stiff, moist to wet, high plasticity carbonaceous material (Alluvium - Pleistocene).																
	10.75m: CLAY, some organic; dark greenish grey. Stiff, moist to wet, medium to high plasticity carbonaceous flecks and							69									

10.30m: PZ40 23/10/2024 10:27:00 am
69.40mRL

Design Groundwater Depth 10.30mBGL (69.40mRL) measured in PZ40 at 10:27AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:
W135

SHEET: 3 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 17/10/2024

FINISH DATE: 17/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724455.91 mN
(EDENTM1949) 287366.92 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 79.70m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

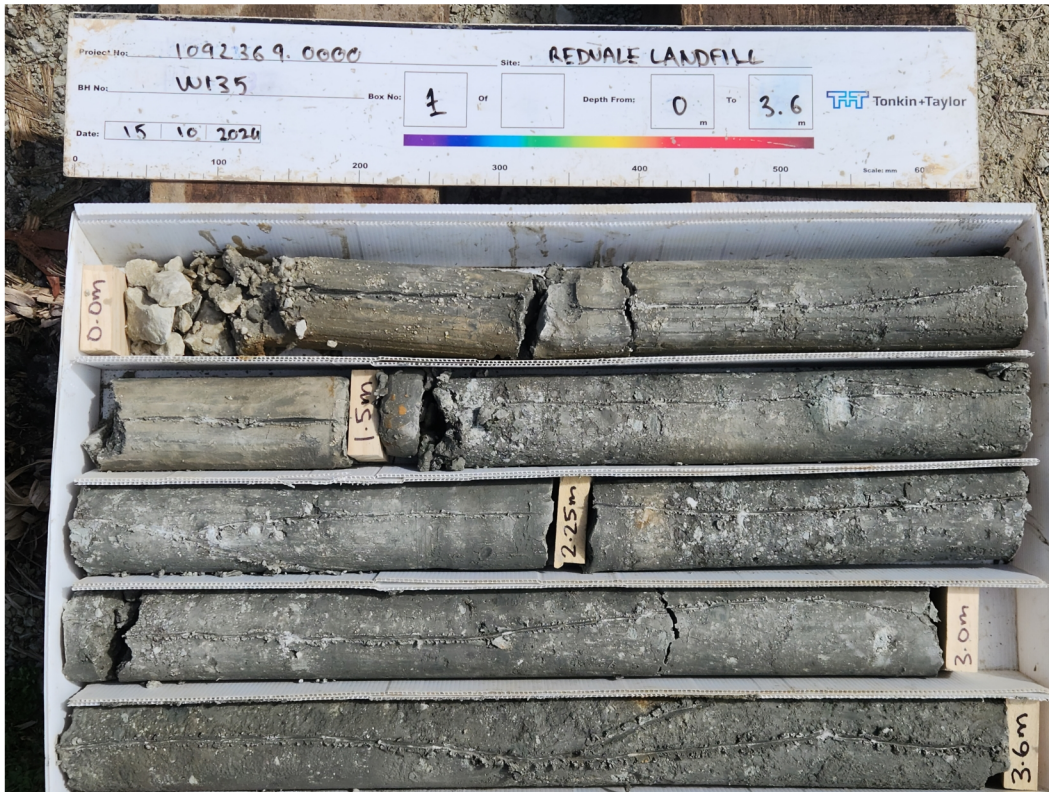
GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Tauranga Group	wood fragments (partially decomposed) (Alluvium - Pleistocene).																
	11.25m: CLAY, trace organic; dark greenish grey. Very stiff, moist to wet, medium plasticity root fibres less than 2mm diameter (Alluvium - Pleistocene).																
Northland Allocthon (Mangakahia Complex)	11.55m: Unweathered to slightly weathered, Dark Grey, sheared, MUDSTONE, Extremely weak.						68										
	11.65m: Unweathered, Dark Grey, sheared, MUDSTONE, Extremely weak.						12										
							67						12.35-13.50m: BZ, 5°, UN, R, Clean (CN)				
	13.50m: Unweathered, Greenish Grey, sheared, MUDSTONE, Extremely weak.						13										
							66						13.80-15.50m: BZ, IR, SL, Clean (CN)				
	14.04m: Unweathered, Light Grey with Mixed White, pervasively sheared, extremely closely spaced, Micritic Muddy, LIMESTONE, Weak.						14										
	14.50m: Unweathered, Light Greyish White, pervasively sheared, extremely closely spaced, Muddy, LIMESTONE, Weak.						15										
	15.5m: Target depth						64										
							16										

Design Groundwater Depth 10.30mBGL (69.40mRL) measured in PZ40 at 10:27AM on 23 October 2024.

CORE PHOTOS

BOREHOLE No.: W135
Hole Location: Northern Boundary Access Road
SHEET: 1 OF 3

PROJECT: Redvale Landfill: Project Rex	LOCATION: Landfill Access Road, Dairy Flat 0794	JOB No.: 1092369.0000.400
CO-ORDINATES: (EDENTM1949) 724455.911 mN 287366.921 mE	DRILL TYPE: DF250T	HOLE STARTED: 17/10/2024
R.L.: 79.70m	METHOD: Rotary cored	HOLE FINISHED: 17/10/2024
DATUM: NZVD2016		DRILLED BY: Drillforce Ltd
		LOGGED BY: CHST
		CHECKED: APS



0.00-3.60m

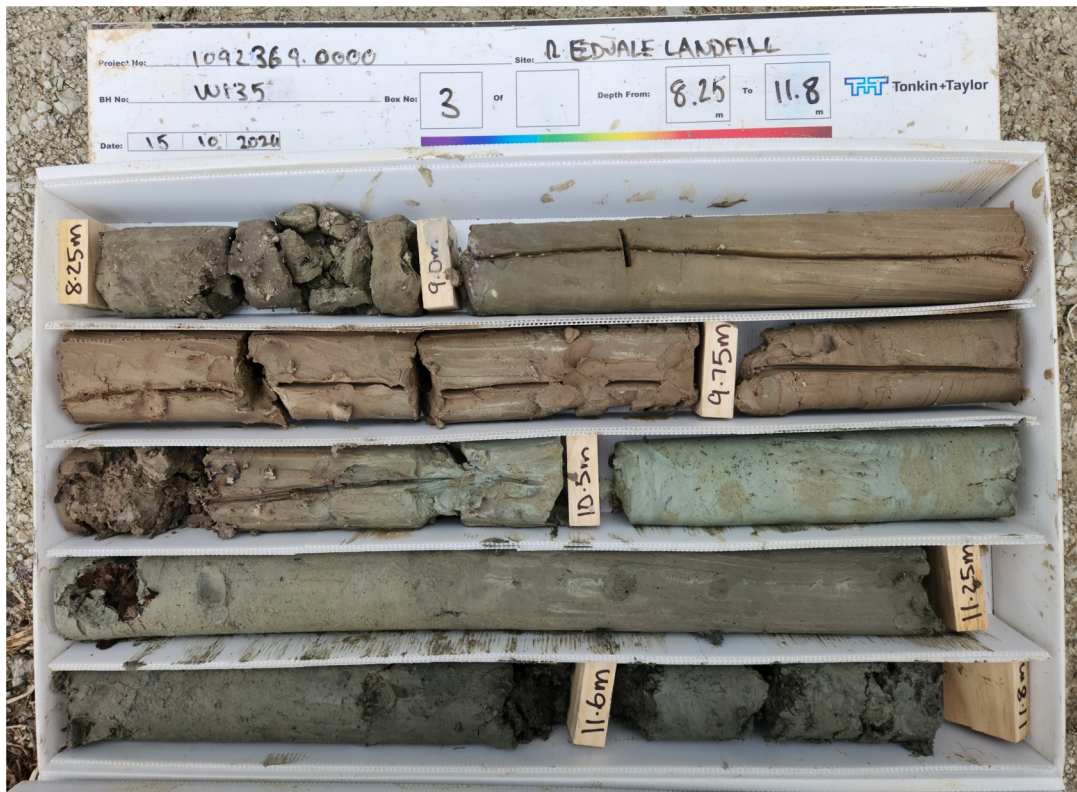


3.60-8.25m

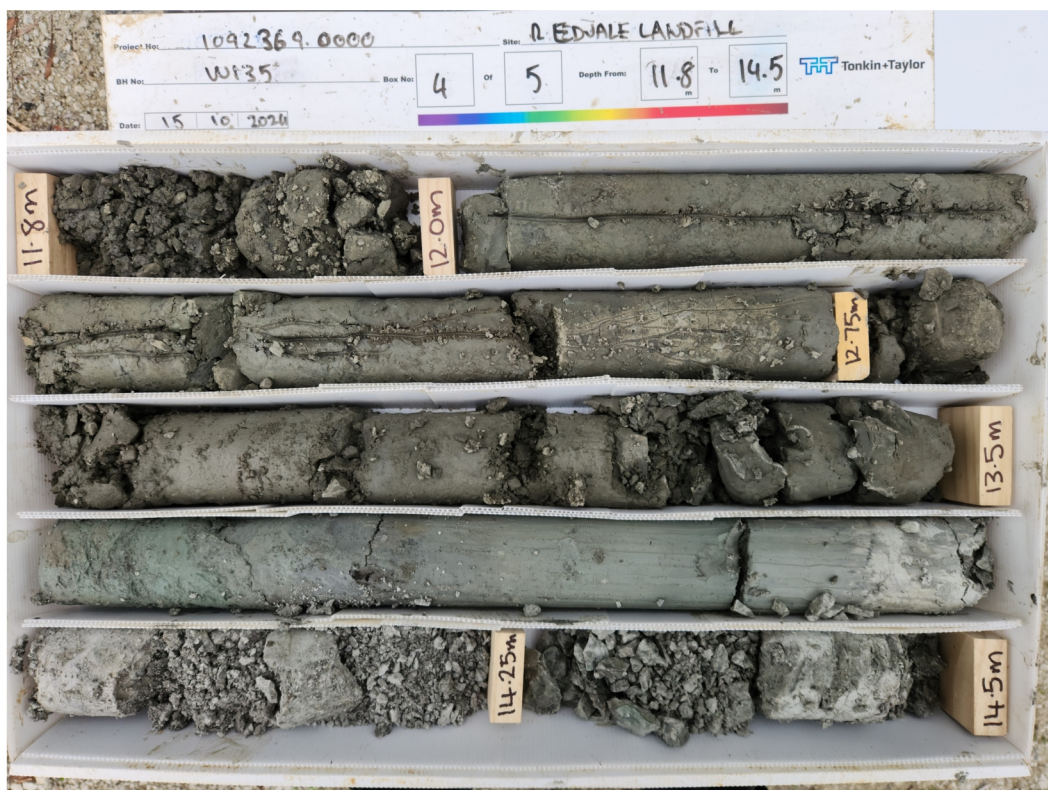
CORE PHOTOS

BOREHOLE No.: W135
Hole Location: Northern Boundary Access Road
SHEET: 2 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724455.911 mN 287366.921 mE	DRILL TYPE: DF250T	HOLE STARTED: 17/10/2024
R.L.:	79.70m	METHOD: Rotary cored	HOLE FINISHED: 17/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



8.25-11.80m



11.80-14.50m

CORE PHOTOS

BOREHOLE No.: **W135**

Hole Location: Northern Boundary Access Road

SHEET: 3 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724455.911 mN 287366.921 mE	DRILL TYPE: DF250T	HOLE STARTED: 17/10/2024
R.L.:	79.70m	METHOD: Rotary cored	HOLE FINISHED: 17/10/2024
DATUM:	NZVD2016		DRILLED BY: Drillforce Ltd
			LOGGED BY: CHST
			CHECKED: APS



14.50-15.50m

BOREHOLE LOG

BOREHOLE No.:

W136

SHEET: 1 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 15/10/2024

FINISH DATE: 15/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724508.83 mN
(EDENTM1949) 287576.21 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.45m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station\Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering SW W F C V	Rock Strength CS S W F C V	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	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	0.00m: Clayey GRAVEL, some cobbles; light brownish grey. Loose to medium dense, moist, poorly graded; fill includes, plastic; gravel, medium to coarse, up to 60 mm (fill)					78										
	0.60m: Gravelly CLAY; bluish grey. Stiff to very stiff, moist; gravel, fine to medium grey (fill - embankment)					1										
	2.36m: Clayey GRAVEL, some sand; dark bluish grey. Medium dense to dense, moist, poorly graded; gravel, medium to coarse, up to 60 mm (fill - embankment)					2										
	3.26m: Gravelly CLAY; dark grey with mixed bluish grey. Stiff to very stiff, moist, poorly graded; gravel, medium to coarse, up to 60 mm (fill - embankment)					3										
	3.50m: Silty GRAVEL, some clay; dark grey with mixed bluish grey. Loose to medium dense, moist to wet, poorly graded; gravel, medium to coarse, up to 50 mm (fill - embankment)					4										
	4.07m: Gravelly COBBLES, some clay; dark bluish grey. Medium dense, moist, poorly graded; cobbles, up to 150 mm sub-angular to angular (fill - embankment)					5										
	4.30m: Gravelly CLAY; bluish grey. Stiff to very stiff, moist, poorly graded; gravel, coarse, up to 60 mm (fill - embankment)															
Tauranga Group	4.57m: CLAY, some gravel; dark grey and mottled orange. Very stiff, moist (fill - embankment)															
	5.07m: CLAY, minor gravel; dark grey and orange. Very stiff, moist, high plasticity (Alluvium - Pleistocene).															

Design Groundwater Depth 4.43mBGL (74.02mRL) measured in PZ41 at 10:30AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:
W136

SHEET: 2 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 15/10/2024

FINISH DATE: 15/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724508.83 mN
(EDENTM1949) 287576.21 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.45m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Tauranga Group	[CONT] 5.07m: CLAY, minor gravel; dark grey and orange. Very stiff, moist, high plasticity (Alluvium - Pleistocene).							6									
	6.14m: Organic CLAY, some silt; grey with banded orange. Very stiff, moist, high plasticity wood fragments (partially decomposed) (Alluvium - Pleistocene).							72									
Tauranga Group	6.50m: CORE LOSS - Suspect obstruction in front of barrel, Wood obstructing barrel.							7									
	7.50m: Organic CLAY; bluish grey and banded orange. Stiff to very stiff, moist to wet, high plasticity wood fragments (partially decomposed) wood and roots (Alluvium - Pleistocene).							71									
	7.88m: CLAY, trace organic; dark bluish grey. Stiff to very stiff, moist, high plasticity carbonaceous flecks and rootlets (Alluvium - Pleistocene).							8									
	8.44m: CLAY; dark bluish grey. Very stiff, moist, high plasticity (Alluvium - Pleistocene).							70									
	8.65m: Silty CLAY, trace organic; dark bluish grey. Very stiff to hard, moist, medium to high plasticity; organics, rootlets rootlets (partially decomposed) (Alluvium - Pleistocene).							9									
								69									
Hukerenui Mudstone	9.80m: Unweathered, Greenish Grey, MUDSTONE, Extremely weak.							10									
	10.30m: Unweathered, Dark Bluish Grey, MUDSTONE, Extremely weak.							68									

Design Groundwater Depth 4.43mBGL (74.02mRL) measured in PZ41 at 10:30AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:
W136

SHEET: 3 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 15/10/2024

FINISH DATE: 15/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724508.83 mN
(EDENTM1949) 287576.21 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.45m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

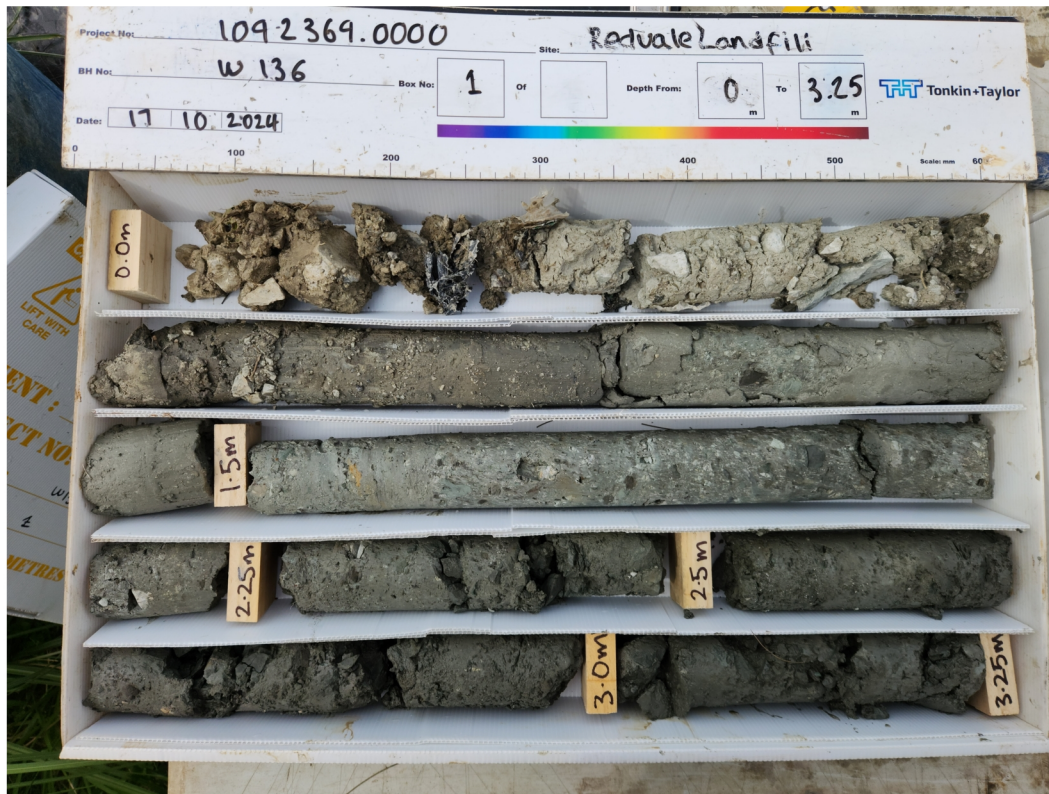
GEOLOGICAL UNIT	MATERIAL DESCRIPTION		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref # / Fluid Loss %)	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation										Description & Additional Observations	Defect Log	Fracture Spacing (mm)	RQD (%)				
Hukerenui Mudstone	[CONT] 10.30m: Unweathered, Dark Bluish Grey, MUDSTONE, Extremely weak.		UW	VS	SW	100		67	12			2000	20		25			
	12.00m: Unweathered, Dark Bluish Grey, broken, Shelly, MUDSTONE, Extremely weak to very weak.		UW	VS	SW	100		66	13			2000	20		25			
	13.00m: Unweathered, Dark Grey, MUDSTONE, Extremely weak to very weak.		UW	VS	SW	100		65	14			2000	20		25			
			UW	VS	SW	100		64	15			2000	20		25			
			UW	VS	SW	100		63	15			2000	20		25			
	15.5m: Target depth		UW	VS	SW	100		2	16			2000	20		25			

Design Groundwater Depth 4.43mBGL (74.02mRL) measured in PZ41 at 10:30AM on 23 October 2024.

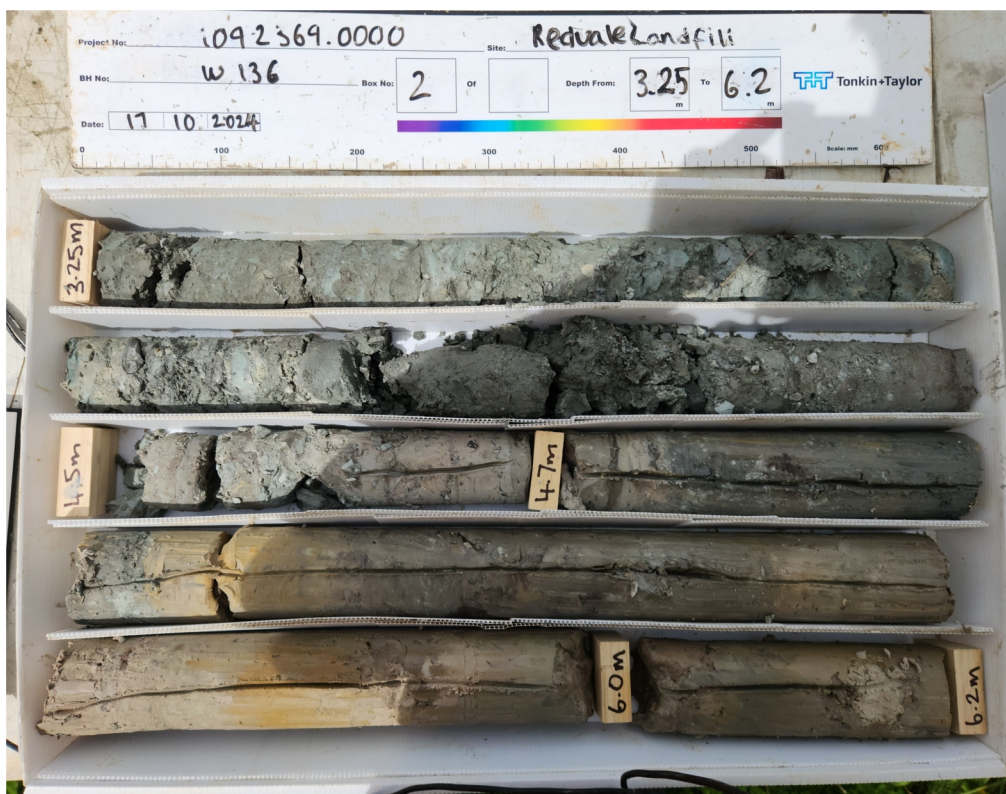
CORE PHOTOS

BOREHOLE No.: W136
Hole Location: Northern Boundary Access Road
SHEET: 1 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724508.83 mN 287576.21 mE	DRILL TYPE: DF250T	HOLE STARTED: 15/10/2024
R.L.:	78.45m	METHOD: Rotary cored	HOLE FINISHED: 15/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



0.00-3.25m



3.25-6.20m

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724508.83 mN 287576.21 mE	DRILL TYPE: DF250T	HOLE STARTED: 15/10/2024
R.L.:	78.45m	METHOD: Rotary cored	HOLE FINISHED: 15/10/2024
DATUM:	NZVD2016		DRILLED BY: Drillforce Ltd
			LOGGED BY: CHST
			CHECKED: APS

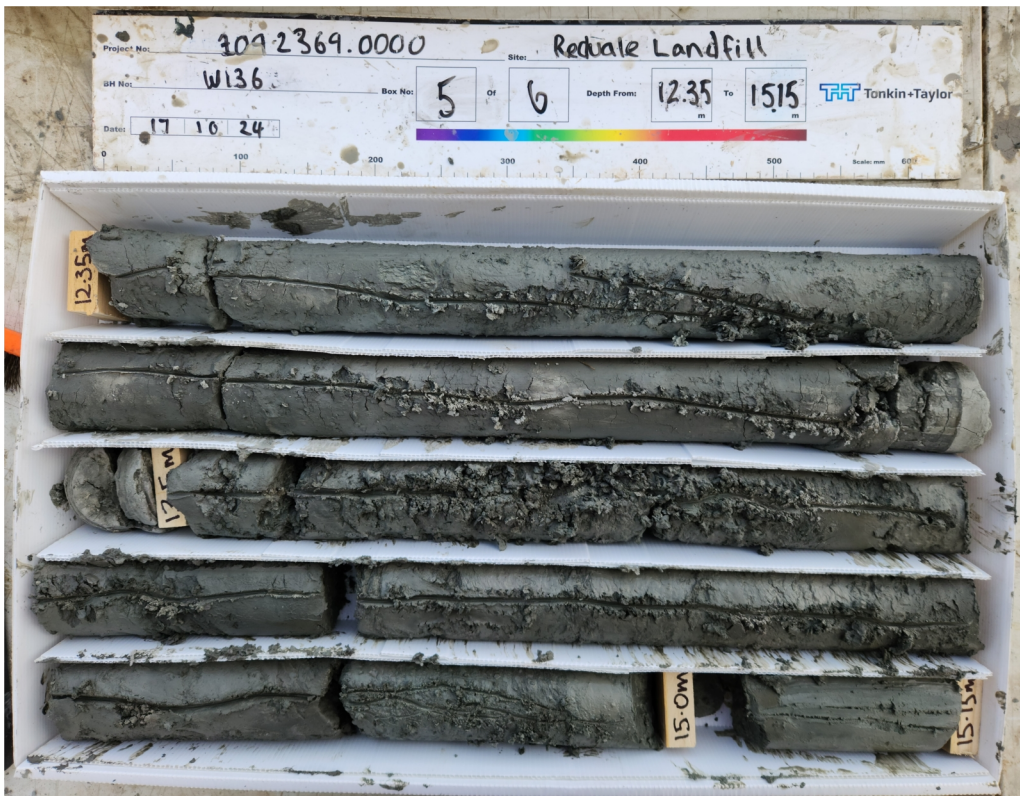


6.20-10.10m



10.10-12.35m

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724508.83 mN 287576.21 mE	DRILL TYPE: DF250T	HOLE STARTED: 15/10/2024
R.L.:	78.45m	METHOD: Rotary cored	HOLE FINISHED: 15/10/2024
DATUM:	NZVD2016		DRILLED BY: Drillforce Ltd
			LOGGED BY: CHST
			CHECKED: APS



12.35-15.15m



15.15-15.50m

BOREHOLE LOG

BOREHOLE No.:

W137

SHEET: 1 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 21/10/2024

FINISH DATE: 21/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724503.85 mN
(EDENTM1949) 287735.05 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 88.85m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station/Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering UW SW MW CW RW	Rock Strength Q₅₀ Q₁₀₀ Q₂₀₀ Q₃₀₀ Q₄₀₀ Q₅₀₀ Q₆₀₀ Q₇₀₀ Q₈₀₀ Q₉₀₀ Q₁₀₀₀	Sampling Method Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
									Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Fill	0.00m: Clayey medium to coarse GRAVEL, some sand, minor organics; light brownish grey. Medium dense, moist, poorly graded. Gravel, up to 30mm, sub-rounded to angular; organics, rootlets. (fill - embankment).															
	0.30m: Gravelly CLAY, some sand; dark bluish grey. Very stiff to hard, moist, poorly graded; gravel, fine to medium, sub-rounded to angular. (fill - embankment).															
	0.55m: Clayey medium to coarse GRAVEL, minor sand; dark bluish grey. Medium dense, moist to wet, poorly graded. Gravel, sub-rounded to angular, unweathered to slightly weathered, moderately strong, limestone. (fill - embankment).															
	1.32m: Clayey medium to coarse GRAVEL, some sand; brownish grey with streaked orange. Medium dense to dense, moist, poorly graded. Gravel, up to 60mm, sub-rounded to angular, unweathered, moderately strong, limestone. (fill - embankment).															
	1.50m: Gravelly CLAY, some sand; bluish grey. Dense, moist, medium plasticity; gravel, medium to coarse, up to 50mm, sub-angular to angular, unweathered, moderately strong, limestone. (fill - embankment).															

Box 0.00-2.85m

Design Groundwater Depth 10.66mBGL (78.19mRL) measured in PZ43 at 10:34AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:
W137

SHEET: 2 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 21/10/2024

FINISH DATE: 21/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724503.85 mN
(EDENTM1949) 287735.05 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 88.85m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION		Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Description & Additional Observations	Water Level (Ref #) / Fluid Loss (%)	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	[CONT] 1.50m: Gravelly CLAY, some sand; bluish grey. Dense, moist, medium plasticity; gravel, medium to coarse, up to 50mm, sub-angular to angular, unweathered, moderately strong, limestone. (fill - embankment).																		
	6.50m: CORE LOSS																		
	7.50m: Gravelly SILT, some clay; bluish grey. Medium dense to dense, dry to moist, poorly graded; gravel, medium to coarse, sub-angular to angular, unweathered, moderately strong, limestone. (fill - embankment).																		
	10.20m: CORE LOSS.																		
	10.50m: Gravelly CLAY, some silt. Medium dense to dense, dry to moist, medium plasticity; gravel, medium to coarse, up to 60mm, sub-angular to angular, unweathered, moderately strong, limestone. (fill - embankment).																		
	10.76m: CLAY, some gravel. Stiff to very stiff, moist, medium to																		

10.66m :PZ43 23/10/ 2024 10:34:00 am
78.19mRL

Design Groundwater Depth 10.66mBGL (78.19mRL) measured in PZ43 at 10:34AM on 23 October 2024.

BOREHOLE LOG

BOREHOLE No.:

W137

SHEET: 3 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 21/10/2024

FINISH DATE: 21/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: Northern Boundary Access Road

CO-ORDINATES: 724503.85 mN
(EDENTM1949) 287735.05 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 88.85m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total
Station/Surveyed

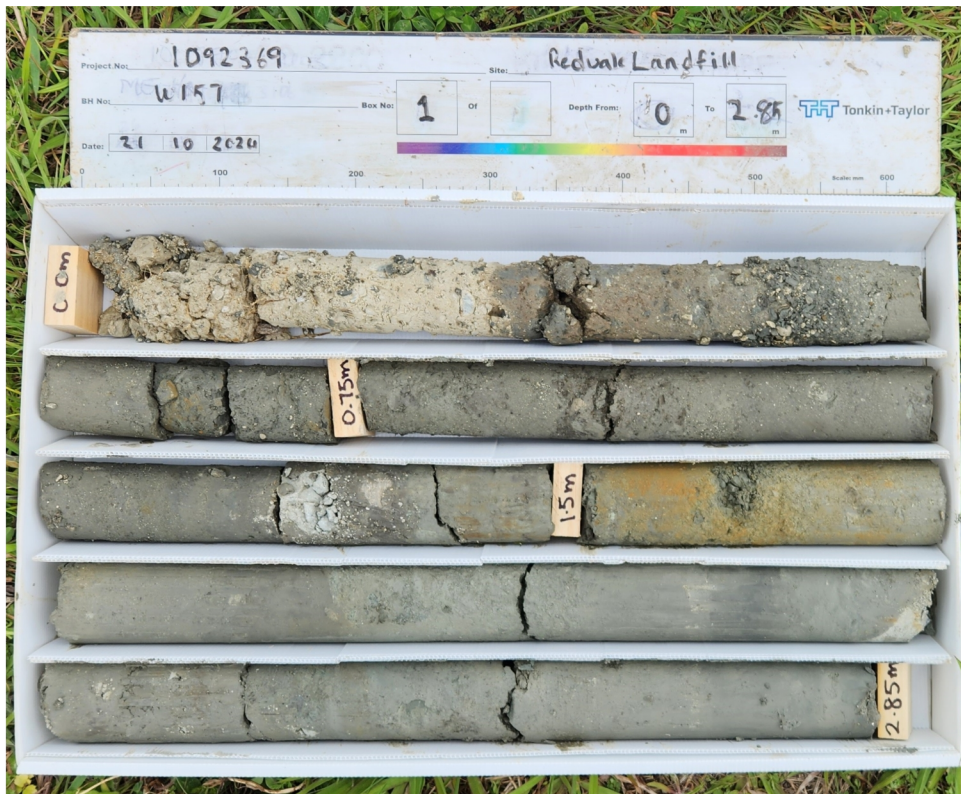
GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Tauranga Group	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	UW SW VW HW CW VW SW UW	Q10 Q15 Q20 Q25 Q30 Q35 Q40 Q45 Q50 Q55 Q60 Q65 Q70 Q75 Q80 Q85 Q90 Q95 Q100	IS S W VW HW CW VW SW UW							2000 1500 1000 500 200 100 50 20			25 50 75			
	high plasticity; gravel, medium to coarse, up to 40mm, sub-angular to angular, unweathered, moderately strong, white, limestone. (fill - embankment).																
	10.90m: CLAY, trace wood and trace gravel; light brownish grey. Stiff to very stiff, moist to wet, high plasticity; gravel, fine to medium. (Alluvium - Pleistocene).																
	11.08m: CLAY, minor organics; grey with streaked orange. Stiff, moist to wet, medium to high plasticity; organics, wood fragments (partially decomposed). (Alluvium - Pleistocene).																
	11.90m: Fine SAND; light greyish brown. Medium dense, moist, well graded. (Alluvium - Pleistocene).																
	12.00m: CLAY, minor organics, trace gravel; orange mottled light grey. Stiff to very stiff, moist, medium to high plasticity; organics, wood fragments (partially decomposed). (Alluvium - Pleistocene).																
	12.18m: Gravelly CLAY, trace organic flecks; black flecked dark grey; gravel, fine to medium; organics, carbonaceous flecks. (Alluvium - Pleistocene).																
	12.35m: CORE LOSS - Suspect material dropped out of barrel.																
	12.75m: CLAY; orange streaked light grey. Stiff to very stiff, moist, high plasticity. (Alluvium - Pleistocene).																
	13.28m: CLAY, trace organic flecks; orange streaked light grey. Firm to stiff, moist, high plasticity; organics, carbonaceous flecks. (Alluvium - Pleistocene).																
Northland Allocthon (Mangakahia Complex)	13.50m: Silty CLAY, some organics; orange mottled light greyish brown. Stiff to very stiff, moist, medium to high plasticity; organics, timber fragments (partially decomposed). (Alluvium - Pleistocene).																
	14.13m: Silty CLAY; dark brownish grey. Stiff to very stiff, moist, medium plasticity. (Alluvium - Pleistocene).																
	14.25m: Unweathered to slightly weathered, dark bluish grey, fissile, sheared with polished surfaces, MUDSTONE. Extremely weak.																
	15.5m: Target depth																

Design Groundwater Depth 10.66mBGL (78.19mRL) measured in PZ43 at 10:34AM on 23 October 2024.

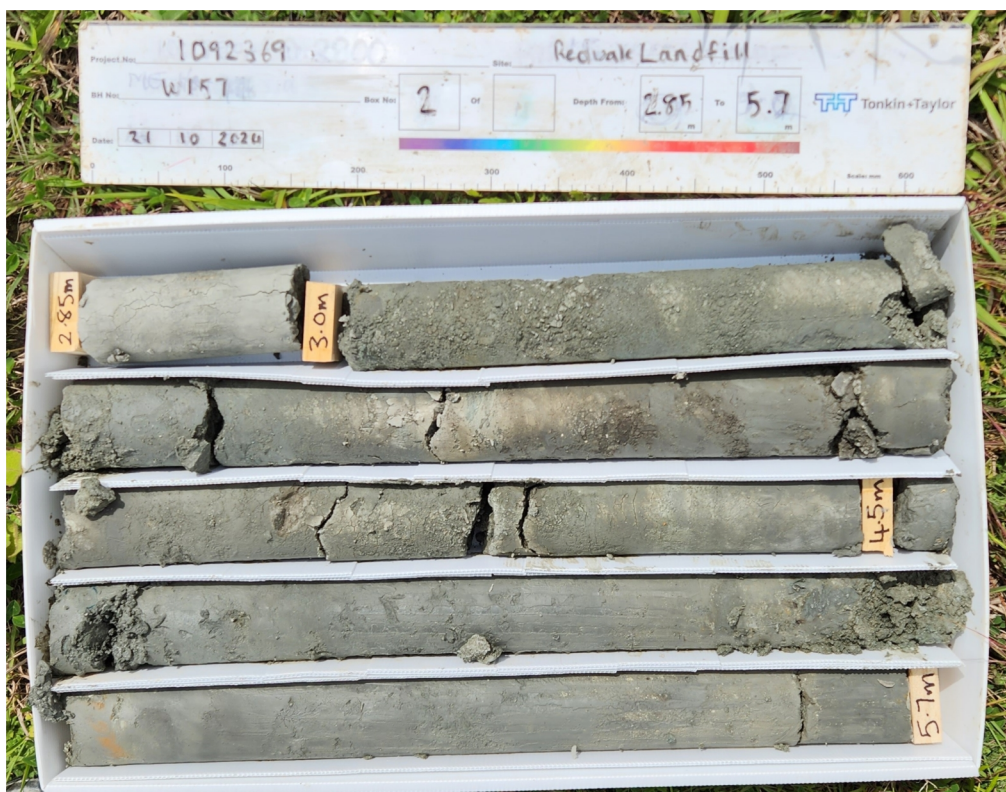
CORE PHOTOS

BOREHOLE No.: **W137**
Hole Location: Northern Boundary Access Road
SHEET: 1 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724503.85 mN 287735.05 mE	DRILL TYPE: DF250T	HOLE STARTED: 21/10/2024
R.L.:	88.85m	METHOD: Rotary cored	HOLE FINISHED: 21/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



0.00-2.85m

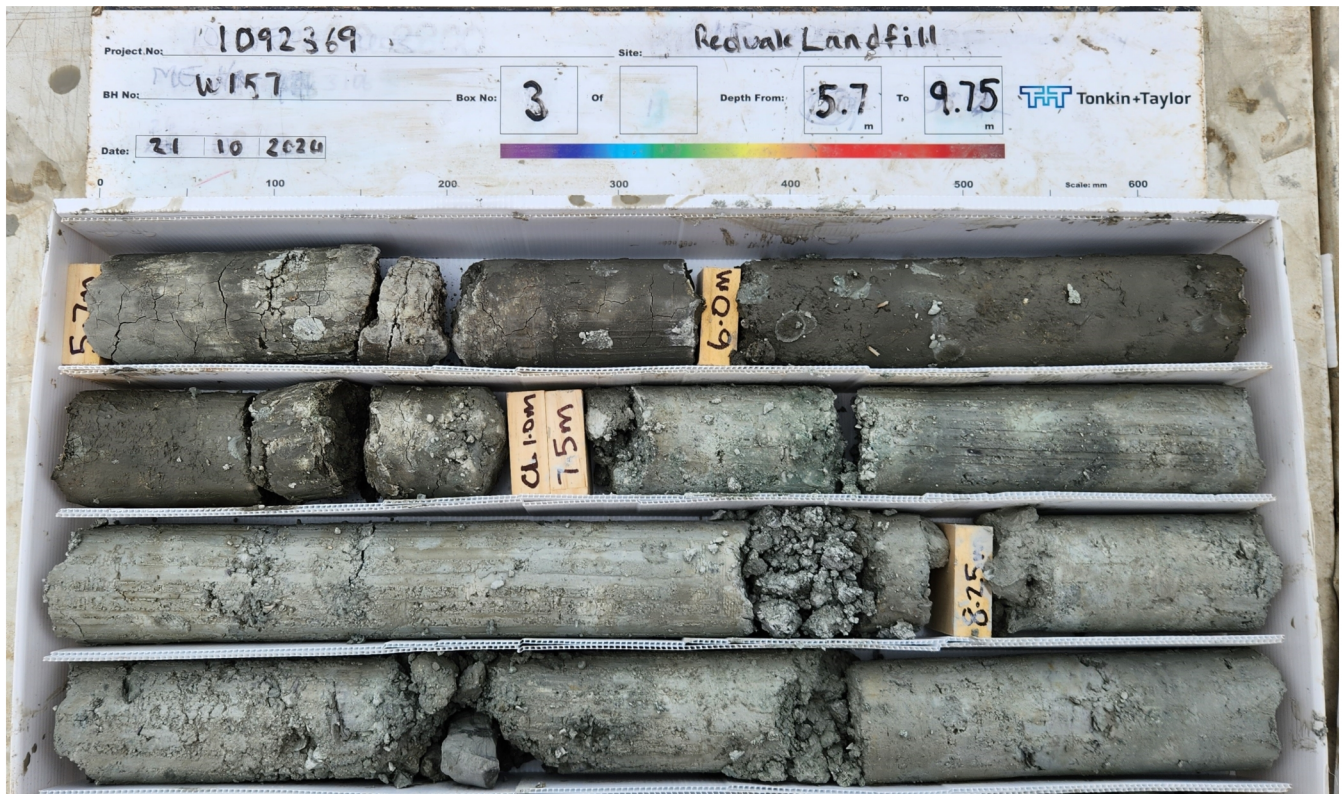


2.85-5.70m

CORE PHOTOS

BOREHOLE No.: **W137**
Hole Location: Northern Boundary Access Road
SHEET: 2 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724503.85 mN 287735.05 mE	DRILL TYPE: DF250T	HOLE STARTED: 21/10/2024
R.L.:	88.85m	METHOD: Rotary cored	HOLE FINISHED: 21/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



5.70-9.75m



9.75-13.65m

CORE PHOTOS

BOREHOLE No.: **W137**
Hole Location: Northern Boundary Access Road
SHEET: 3 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	724503.85 mN 287735.05 mE	DRILL TYPE: DF250T	HOLE STARTED: 21/10/2024
R.L.:	88.85m	METHOD: Rotary cored	HOLE FINISHED: 21/10/2024
DATUM:	NZVD2016		DRILLED BY: Drillforce Ltd
			LOGGED BY: CHST
			CHECKED: APS



13.65-15.50m

BOREHOLE LOG

BOREHOLE No.:
W138

SHEET: 1 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 22/10/2024

FINISH DATE: 22/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: South of managed fill area

CO-ORDINATES: 723897.20 mN
(EDENTM1949) 287559.79 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.38m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	UW SW PW CW RW	Q10 Q15 Q20 Q25 Q30 Q35 Q40 Q45 Q50 Q55 Q60 Q65 Q70 Q75 Q80 Q85 Q90 Q95 Q100	IS SS CS MS PS FS GS HS LS MS PS FS GS HS LS	100 90 80 70 60 50 40 30 20 10 0						2000 1500 1000 500 200 100 50 20			25 50 75			
Fill	0.00m: CORE LOSS - Suspect loose granular material dropped out of barrel							78									
	0.45m: Gravelly CLAY, some silt; orange and yellow mottled dark brown. Soft to firm, moist, well graded; gravel, medium to coarse, up to 40 mm sub-angular to angular (fill)																
	0.80m: Gravelly CLAY, minor cobbles; orange speckled dark grey. Very stiff, moist; gravel, medium to coarse; cobbles, up to 70 mm sub-angular limestone (fill)							1									
	1.55m: Gravelly CLAY, some sand; dark grey with banded yellow. Firm to stiff, moist to wet, poorly graded; gravel, medium to coarse, up to 10 mm sub-angular limestone (fill)							2									
	2.50m: CORE LOSS - Suspect loose granular material dropped out of barrel							3									
	3.00m: Gravelly SILT, some clay; grey with mixed yellow. Soft, moist to wet, medium plasticity; gravel, medium to coarse, up to 40 mm sub-angular to angular limestone (fill)																
	3.15m: Gravelly SILT, some clay; dark grey with speckled green and yellow. Firm, moist, poorly graded; gravel, medium to coarse, up to 20 mm sub-angular to angular limestone (fill)																
	4.20m: CLAY, some gravel; dark grey with speckled black, yellow and orange black. Very stiff, moist, poorly graded; fill includes, plastic; gravel, medium to coarse, up to 20 mm sub-angular to angular limestone (fill).																
	4.50m: Clayey GRAVEL; dark grey and black with speckled yellow. Medium dense, moist, poorly graded; fill includes, plastic; gravel, medium to coarse, up to 20 mm sub-angular to angular limestone (fill)																
	4.85m: Gravelly CLAY; dark grey with speckled red and yellow. Stiff, moist, poorly graded; gravel, medium to coarse, up to 20 mm sub-angular to angular limestone (fill)																
								73									
													4.81m: PZ44 5/11/2024 09:30:00 am 73.57mRL				
													5.26m: PZ45 5/11/2024 09:27:00 am 73.12mRL				

Design Groundwater Depth 4.81mBGL (73.57mRL) measured in PZ44 at 09:30AM on 5 November 2024.

BOREHOLE LOG

BOREHOLE No.:
W138

SHEET: 3 OF 3

DRILLED BY: Leon Mahara

LOGGED BY: CHST

CHECKED: APS

START DATE: 22/10/2024

FINISH DATE: 22/10/2024

CONTRACTOR: Drillforce Ltd

PROJECT: Redvale Landfill: Project Rex

JOB No.: 1092369.0000.400

LOCATION: South of managed fill area

CO-ORDINATES: 723897.20 mN
(EDENTM1949) 287559.79 mE

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.38m

R.L. COLLAR:

DATUM: NZVD2016

SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT	MATERIAL DESCRIPTION	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK MASS DISCONTINUITIES				Water Level (Ref #) / Fluid Loss (%)	Casing	Installation	Core Box No
										Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations				
Northland Allocthon (Mangakahia Complex)	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	UW SW PW CW VW	Q10 Q5 Q2.5 Q1 Q0.5	IS SS WS WS WS						2000 1500 1000 500 200 100 50 20				25 50 75			
	[CONT] 8.70m: Unweathered, Bluish Grey, broken and sheared with polished surfaces, MUDSTONE, Extremely weak.							67					10.53-12.00m: DD, 5°, UNST, R				
								12									
								66					12.40m: J, 35°, UN, R				
								13									
								65									
								14									
								64									
	14.70m: Unweathered, Bluish Grey, broken, MUDSTONE, Extremely weak.							15					----- PZ45 15.1mBGL				
								63									
	15.5m: Target depth							16									
								62									

Design Groundwater Depth 4.81mBGL (73.57mRL) measured in PZ44 at 09:30AM on 5 November 2024.

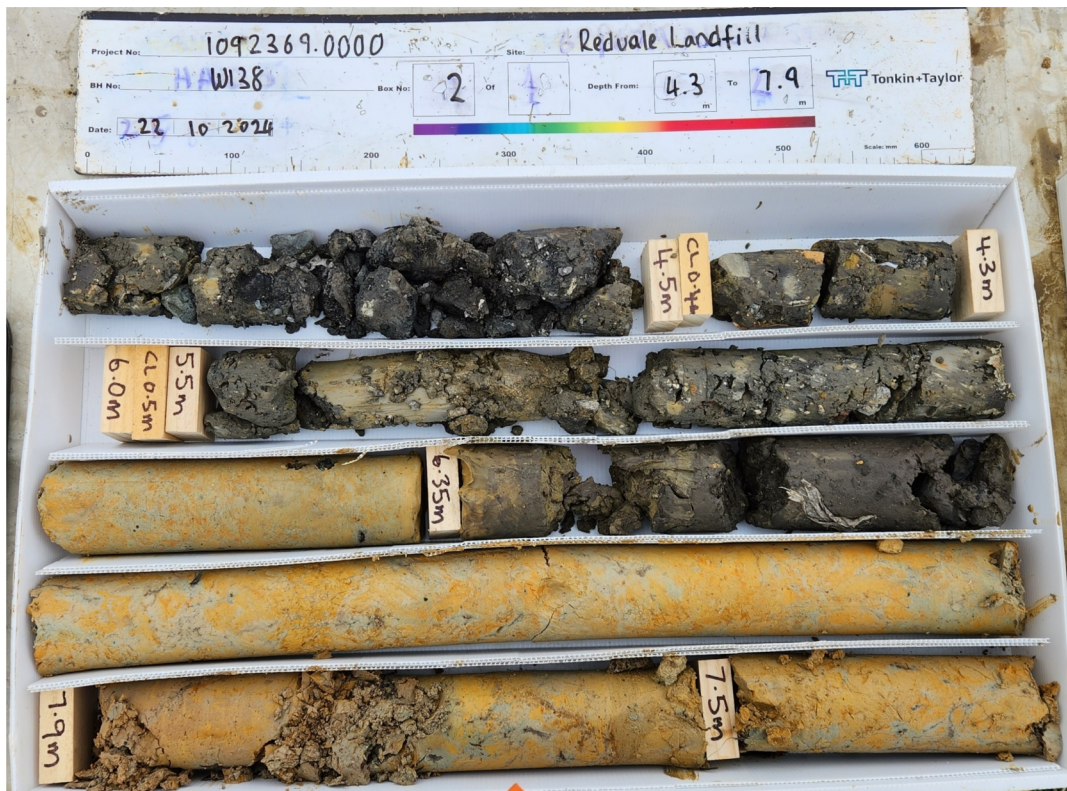
CORE PHOTOS

BOREHOLE No.: W138
Hole Location: South of managed fill area
SHEET: 1 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	723897.20 mN 287559.79 mE	DRILL TYPE: DF250T	HOLE STARTED: 22/10/2024
R.L.:	78.38m	METHOD: Rotary cored	HOLE FINISHED: 22/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



0.00-4.30m



4.30-7.90m

CORE PHOTOS

BOREHOLE No.: **W138**
Hole Location: South of managed fill area
SHEET: 2 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	723897.20 mN 287559.79 mE	DRILL TYPE: DF250T	HOLE STARTED: 22/10/2024
R.L.:	78.38m	METHOD: Rotary cored	HOLE FINISHED: 22/10/2024
DATUM:	NZVD2016	LOGGED BY: CHST	CHECKED: APS



7.90-10.65m

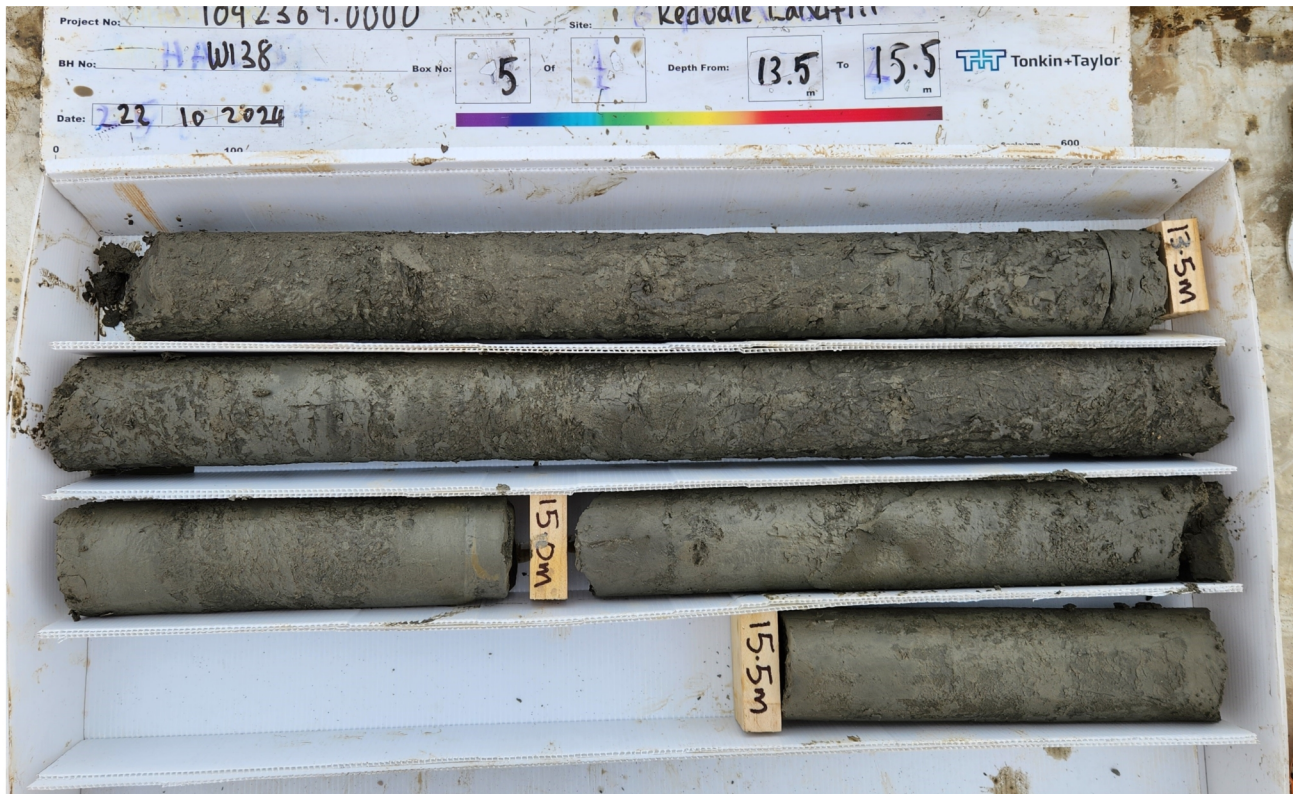


10.65-13.50m

CORE PHOTOS

BOREHOLE No.: **W138**
 Hole Location: South of managed fill area
 SHEET: 3 OF 3

PROJECT: Redvale Landfill: Project Rex		LOCATION: Landfill Access Road, Dairy Flat 0794 JOB No.: 1092369.0000.400	
CO-ORDINATES: (EDENTM1949)	723897.20 mN 287559.79 mE	DRILL TYPE: DF250T	HOLE STARTED: 22/10/2024
R.L.:	78.38m	METHOD: Rotary cored	HOLE FINISHED: 22/10/2024
DATUM:	NZVD2016		DRILLED BY: Drillforce Ltd
			LOGGED BY: CHST
			CHECKED: APS



13.50-15.50m