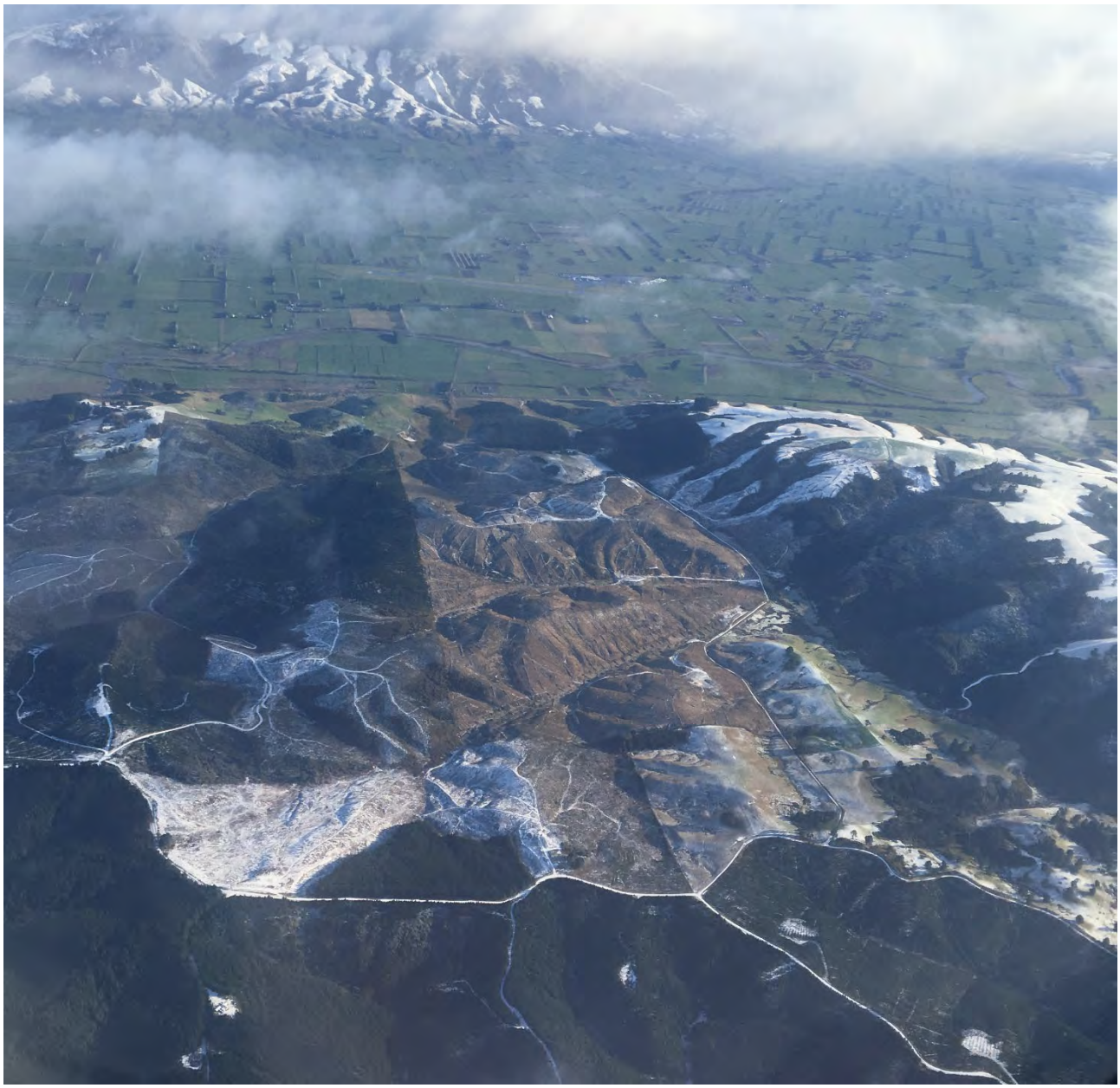
Appendix 6: Geotechnical Factual Report



Dunedin City Council

Waste Futures Phase 2, Workstream 3 Smooth Hill Landfill Smooth Hill Consenting - Geotechnical Factual Report

August 2020 (updated May 2021

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1. Introduction

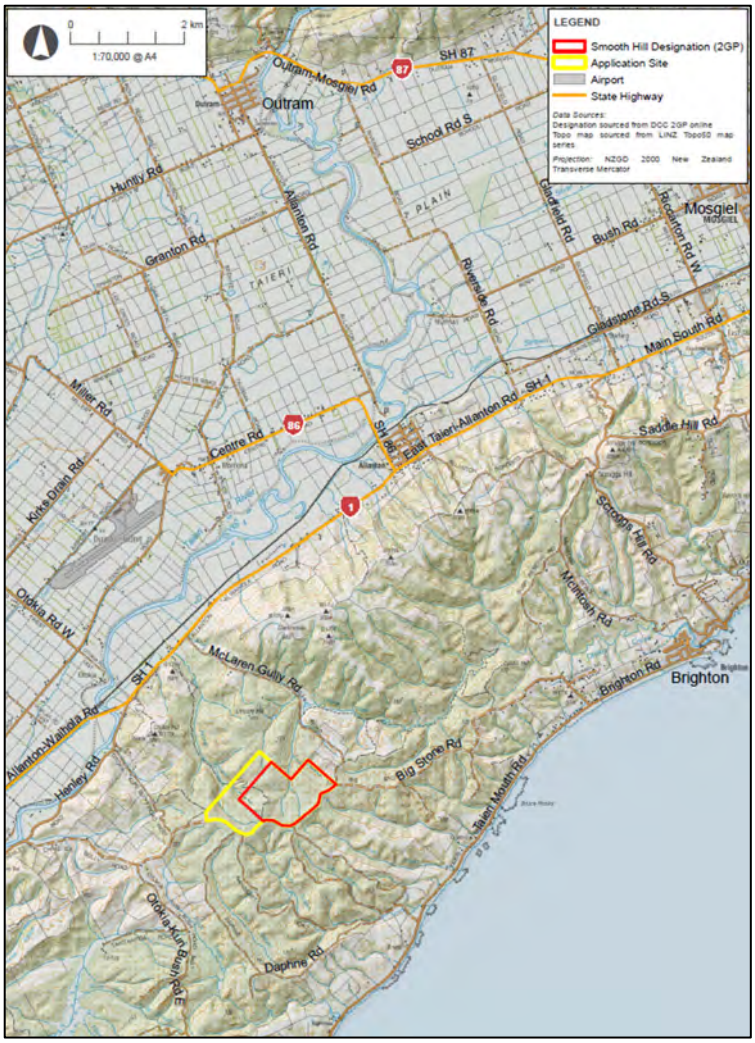
1.1 Project background

The Dunedin City Council (Council) collects residential waste and manages the disposal of both residential and most commercial waste generated from the Dunedin City area and environs.

The Council has embarked on the Waste Futures Project to develop an improved comprehensive waste management and diverted material system for Dunedin, including future kerbside collection and waste disposal options. As part of the project, the Council has confirmed the need to develop a new landfill to replace the Council's current Green Island Landfill, which is envisaged to reach full capacity in the next few years. Final closure could be around 2028 depending on the closure strategy adopted by the Council.~~likely to come to the end of its functional life sometime between 2023 and 2028~~.

The Council commenced siting studies for a new landfill location in the late 1980's and early 1990's and selected the Smooth Hill site in south-west Dunedin, shown in Figure 1 below, as the preferred location. At that time, the site was designated in the Dunedin District Plan, signalling and enabling its future use as a landfill site. The Council also secured an agreement with the then ~~current~~ landowner, Fulton Hogan Ltd, to purchase the land and the Council took ownership of the land in September 2020. Since the 1990's the Council extended the life of Green Island Landfill and further development of the Smooth Hill site has been on hold.

Figure 1 Site location (Updated May 2021)



As part of the Waste Future's Project, the Council has reconfirmed the technical suitability of Smooth Hill for the disposal of waste and. The Council has proceeded to develop a concept design for the landfill and associated road upgrades. The concept design (the subject of this report) for the landfill has been developed by GHD Ltd (GHD) with technical input from Boffa Miskell and represents contemporary good practice landfill design that meets adopted New Zealand landfill design standards.

The Council lodged applications for resource consents for Smooth Hill landfill with both the Otago Regional Council and Dunedin City Council in August 2020. The applications included an earlier version of this report. This report has now been revised to reflect both the changes in the design and in response to s92 questions.

While being similar in many ways to the previous design, the key changes are summarised as follows:

- The landfill size has been reduced. The revised landfill lies within the footprint of Stage 1 and Stage 2 of the original design, with the western Stages 3, 4 and 5 no longer included (for comparison see Drawings 12506381-01-C102 and C104). In overall terms:
  - the footprint of the landfill is reduced from 44.5 ha to 18.6 ha
  - landfill (gross) capacity is reduced from approximately 7.9-million m^3 to 3.3-million m^3
  - net waste capacity is reduced from 6.2-million m^3 to 2.9-million m^3
  - the predicted landfill life has reduced from 55-years to 40-years
- Practical adjustments to the general construction of the landfill, including:
  - Landfill staging and construction sequencing, to a more typical 'bottom-up' filling methodology, which improves the intermediate and overall landform stability of the new design (Drawing 12506381-01-C210 to C214)
  - Leachate containment and collection systems adjusted to reflect the revised construction sequencing
  - Construction phase systems for stormwater diversion, treatment and control
  - Relocation of the attenuation basin to the west of the revised landfill footprint rather than immediately downstream of the landfill toe.

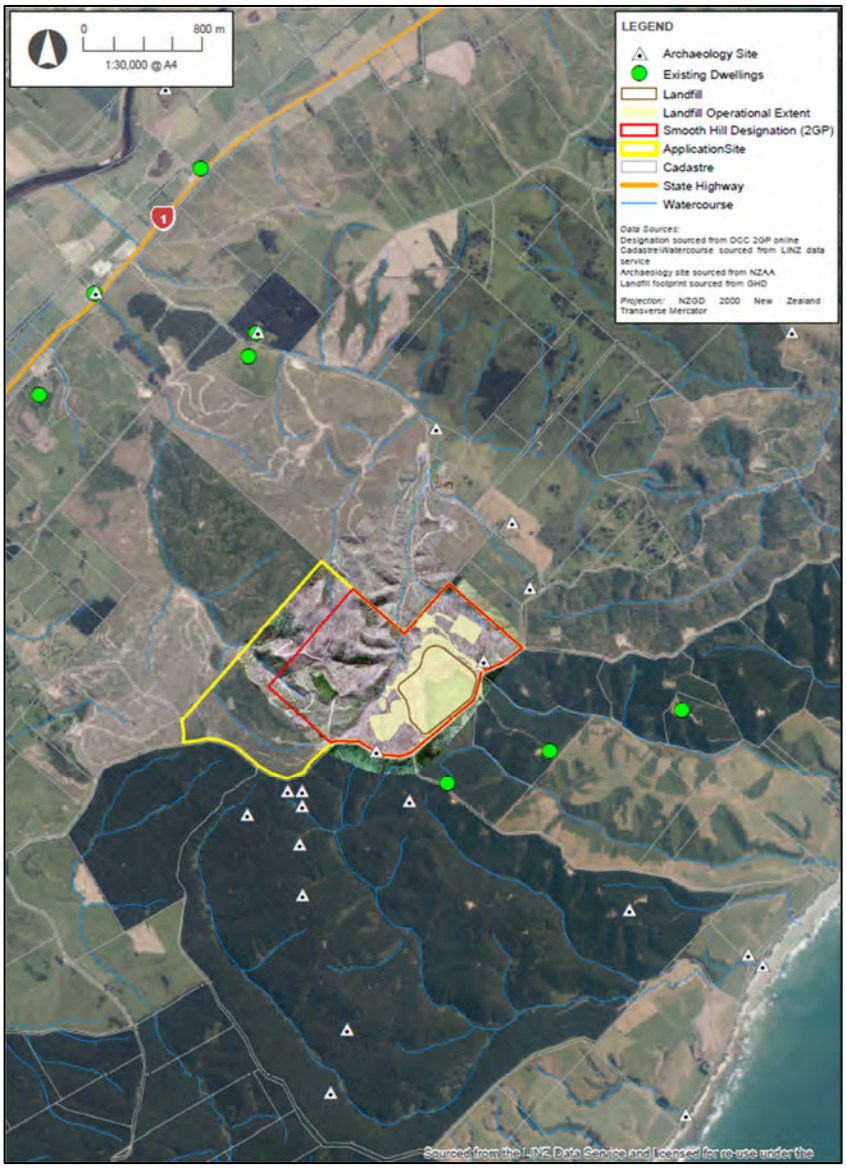
1.2 Project Overview

The proposal includes the following key components:

- The staged construction, operation, and aftercare of a Class 1 landfill within the existing designated site to accept municipal solid waste. The landfill will have a capacity of approximately 6 million cubic metres (equivalent to 5 million tonnes), and expected life (at current Dunedin disposal rates) of approximately 55 years. The landfill will receive waste only from commercial waste companies or bulk loads.
- Infrastructure to safely collect, manage, and dispose of landfill leachate, gas, groundwater, and stormwater to avoid consequential adverse effects on the receiving environment.
- Facilities supporting the operation of the landfill, including staff and maintenance facilities.
- Environmental monitoring systemss.
- Landscape and ecological mitigation, including planting.
- Upgrades to McLaren Gully Road including its intersection with State Highway 1, and Big Stone Road, to facilitate vehicle access to the site.

The proposed Smooth Hill landfill site is located approximately 23 km southwest of Dunedin City. The boundary of the proposed site is shown in Figure 2. The waste facility itself will operate within these boundaries.

Figure 2 Site Environs (Updated May 2021)



1.3 Scope of geotechnical investigation

This report presents the factual results of the geotechnical investigation along with published and Client supplied geotechnical data related to the proposed waste site development. The purpose of the investigation was to assess the subsurface geotechnical and hydrogeological conditions at the proposed Smooth Hill landfill site. The hydrogeology is reported separately.

This information in this report has been used to inform and support the landfill design and the Assessment of Environmental Effects (AEE) and resource consent applications.

2. Site Setting

2.1 Site description

The proposed site is bordered by Big Stone Road along its southern boundary. Access from State Highway 1 (SH1) is currently via McLaren Gully Road. The proposed site is bounded to the north and west by forestry land, and to the northeast by farmland. Figure 3 provides a closer view of the proposed site.

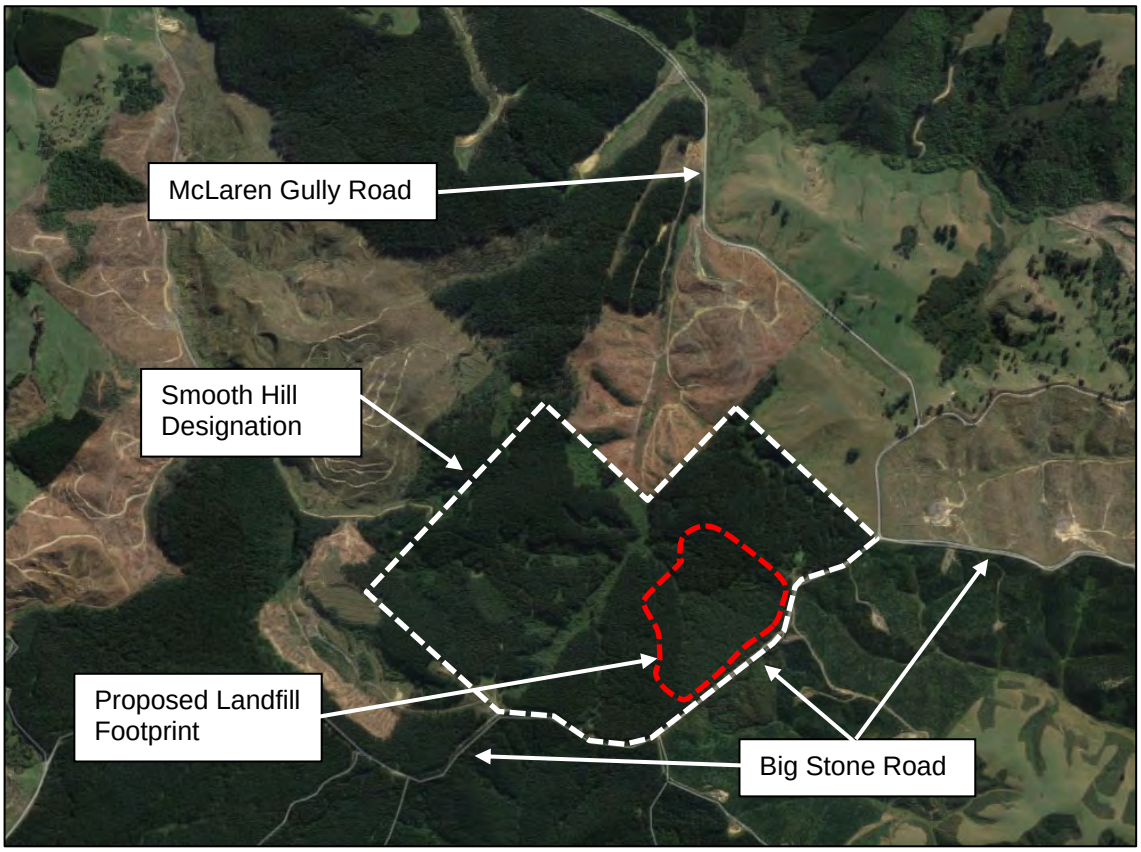


Figure 3 Proposed landfill site (base image sourced from Google Maps) (Updated May 2021)

The proposed site is located in a south to north trending gully, which is fed by smaller gullies from the east, west and south. The flow direction for water exiting the gully is from the south to the north. The slopes around the southern half of the site form a natural “amphitheatre” shape, which is bisected by a larger central ridge, and a smaller ridge in the south-western corner – both trending south to north.

The site was, until recently, covered by a Radiata Pine plantation, the site cover is now a mixture of scrub, bare earth, forestry waste and replanted pine. A number of existing forestry tracks provide access around the site.

The ground is typically wet and boggy in the base of the gullies where there is standing or seeping water.

2.2 Local geology

2.2.1 Published geology

A review of the available geological maps (Bishop [1994], and Bishop and Turnbull [1996]) covering the site shows that the main lithology expected to be encountered is the Henley Breccia unit. Although not shown on the geological map, it is expected that the Henley Breccia unit is overlain by several metres of loess deposits, and locally by alluvium and colluvium.

Figure 4 presents an excerpt from the Bishop (1994) geological map.

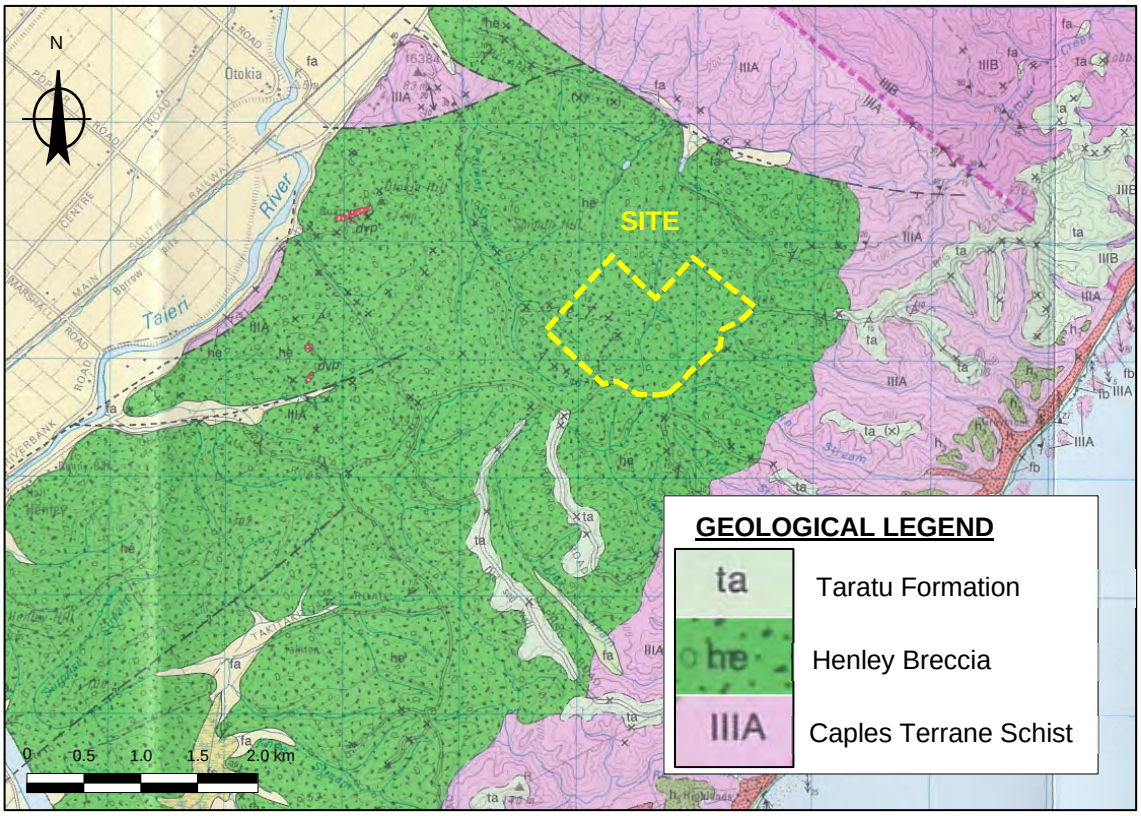


Figure 4 Excerpt from 1:50,000 Geology of the Milton Area (Bishop, 1994)

2.2.2 Expected lithologies

The basement rock in the proposed site area is expected to be Caples Terrane schist, textural zone IIIA (map symbol *IIIA*), which comprises well foliated quartzofeldspathic schist with prominent quartz veins. The schist was metamorphosed in the Jurassic period, and the metamorphic grade (textural zone) increases northward.

The schist basement is overlain unconformably by the Upper Cretaceous Henley Breccia (map symbol *he*) – a terrestrial sequence of piedmont breccias and conglomerates up to 1000 m thick. The breccia was derived from a high-standing schist block immediately west of the present-day Titri Fault. Henley Breccia was tilted before the formation of the Otago peneplain, which was cut across both it and the schist basement prior to the deposition of a relatively thin set of transgressive Upper Cretaceous to Tertiary terrestrial and shallow marine sediments (Bishop & Turnbull, 1996).

Taratu Formation (map symbol *ta*) is mapped as outcropping along the tops of several ridgelines to the south and east of the site, but not on this site. The Taratu Formation unconformably overlies the Henley Breccia and comprises yellow quartz sand and pebble conglomerate, with minor clay, carbonaceous siltstone and lignite, and limonite and silica cemented quartz conglomerate.

Bishop (1994), and Bishop & Turnbull (1996) have not mapped surficial materials such as loess, weathered bedrock or organic soils. However, the following description of loess soils in Otago is provided in Bishop & Turnbull (1996): "*In the Dunedin map area, such unmapped surficial materials are dominated by loess which, where remobilised, grades into loess colluvium… Loess forms a widespread blanket across most of eastern Otago, particularly near the coast... Loess typically forms a yellow-brown, massive layer or series of layers, mixed at the base with weathered bedrock and overlain by darker organic-rich soil. Columnar jointing and shrinkage cracks are common. Where loess mantles slopes, down-slope creep and alluvial processes have incorporated clasts of weathered underlying material, upslope material, and organic matter to form 'loess colluvium'."*

Loess deposits mantle much of the site, being present predominantly on the slopes and ridges of the site, with loess colluvium predominantly in the valley bases. The thickness of loess varies.

In the bottom of the valleys, there is some alluvial material.

2.2.3 Nearby faults

There are a number of mapped faults in the Otago region. The known faults within close proximity to the landfill site are listed in Table 1. Fault data has been gathered from the GNS Active Faults Database website, and from Stirling, McVerry, et al (2012).

Active faults are defined by GNS and NZS 1170:2004 as faults with recurrence periods of less than 2000 years. On the basis of this definition the closest known active fault to the site is the Alpine Fault at a distance of approximately 240 km to the north-west, which is also classified as a 'Major Fault' by NZS 1170:2004.

Whilst the Alpine Fault is the closest "active fault" there has been recent research on the recurrence intervals of the Titri and Akatore faults. This new data will be included in the seismic hazard assessment of the site.

Table 1 Summary of known faults

Fault Name	Approximate Distance from Site	Maximum Likely Magnitude, M_W	Average Recurrence Interval (years)
Titri Fault*	3 km NW	unknown	unknown
Akatore Fault	6 km SE	7.4	3,480
Maungatua Fault	10 km NW	unknown	unknown
North Taieri Fault	13 km N	unknown	unknown
Hyde Fault	47 km NNW	7.2	12,810
Billy's Ridge Fault	47 km NNE	7.1	9,470
Taieri Ridge Fault	50 km NNE	7.1	9,750
Fault #8894 (GNS)	50 km SW	unknown	unknown
Tuapeka Fault	56 km NW	unknown	unknown
Clifton Fault	56 km SW	unknown	5,000 – 10,000
Logan Burn Fault	60 km NW	unknown	3,500 – 5,000
Blue Mountain Fault	70 km W	7.3	12,690
Long Valley Fault	75 km NW	6.8	2,810
Gimmerburn Fault Zone	76 km N	7.2	5,850
Old Man Fault	85 km NW	7.4	362,150
Spylaw Fault	89 km W	7.3	12,440
Alpine Fault	240 km NW	8.1	340
* - Stirling et al 2012			

2.3 Historic mining

Anecdotal evidence provided by a local resident indicates historic mining may have occurred in this area of Otago. A review of publicly available data with regard to historic mining has been carried out. The following sources were consulted:

- Regional geological maps (Benson [1968], McKellar [1990], Bishop [1994], and Bishop & Turnbull [1996]
- Historic aerial photographs, retrieved from the Retrolens historic imagery resource
- Mindat.org: www.mindat.org
- NZ Mine Plans website: https://mineplans.nzpam.govt.nz
- Appendices to the Journals of the House of Representatives, 1890 Session I, Section C: https://atojs.natlib.govt.nz/cgi-bin/atojs?a=d&d=AJHR1890-I&e=10--1-0

The sources consulted suggest that the geological unit containing a potential valuable commodity in this part of Otago is the Taratu Formation (also known as Taratu Coal Measure on older geological maps). The main commodity mined in the region appears to be coal/lignite. ~~In the vicinity of the proposed landfill, the Taratu Formation only occurs as a relatively thin layer at the top of the higher ridges on the eastern edge of the designation area and away from the proposed landfill footprint or appurtenant structures. Outcrops and boreholes associated with the Taratu Formation at the site do not show any lignite layers within these Taratu materials~~. It is considered highly unlikely that mining would have occurred within the designation area.

The only know abstraction on the site is a small borrow pit associated with the Taratu Formation deposits on the eastern edge of the designation area. Fulton Hogan have used this as a borrow site for gravel used to form logging tracks in the site vicinity.

2.4 Previous investigations

GHD is not aware of any previous investigations at the proposed landfill site, though an existing piezometer was found adjacent to the north-eastern site entrance.

3. Summary of Investigations

3.1 General

GHD carried out two phases of geotechnical investigations between 27 May to 17 June 2019 (Phase I), and between 24 October to 7 November 2019 (Phase II). McNeill Drilling was the drilling subcontractor used for the first phase, and Speight Drilling Ltd was the drilling subcontractor used for the second phase. The investigations comprised machine boreholes and test pits. All investigation works were carried out under the supervision of a GHD Engineering Geologist.

The second phase of investigations was designed to address gaps in the ground model data that were identified following the end of the first phase. Due to restrictions in place for the second phase (surveys of protected native lizards, and nesting native falcons), there were areas that could not be accessed for investigation and as a consequence a number of planned borehole and test pits were either re-located or not completed. These areas have since been excluded from the re-designed landfill footprint and therefore the requirement to undertake additional investigation in these areas is removed.

Shallow test pitting and sampling to confirm the distribution of loess and its properties will be part of the detailed design investigation, should a mineral liner be part of the liner system.

Materials recovered from the investigation were logged following the methods and procedures in the New Zealand Geotechnical Society's (NZGS) "*Guideline for the Field Description of Soil and Rock for Engineering Purposes*" (2005).

Shear vane testing was undertaken in accordance with NZGS's "*Guideline for Hand Held Shear Vane Test*" (2001). The peak and remoulded shear strength values shown on the attached logs (Appendix B) represent dial readings off the vane, adjusted using the BS 1377 calibration.

An investigation location plan is provided in Appendix A.

3.1.1 Logging Taratu Formation vs Henley Breccia

The Taratu Formation has not been previously mapped within the designated landfill area. It is known to occur along ridges south-east of the site. However, the presence of rounded quartz conglomerate in the recovererd core on site was interpreted in early versions of this report as the presence of the Taratu Formation on the ridges at the site. Upon further review, it is uncertain if what had earlier been logged as Taratu is actually Taratu, or in fact part of the Henley Breccia. On the Dunedin South map, the Henley Breccia does refer to quartz conglomerates which would fit with the logged cores. Given that the geological map does not include Taratu Formation on the ridge tops in the vicinity of the site, this material has been re-classified as Henley Breccia.

Whilst of interest from a geological point of view, the geotechnical performance of the two units is very similar. For this reason, whether the unit is Taratu Formation or Henley Breccia is academic to the design of the landfill.

3.2 Machine boreholes

McNeill Drilling drilled ten machine boreholes (BH01 to BH10) between 27 May and 16 June 2019, using a truck mounted UDR600 rig. Speight Drilling Ltd drilled five machine boreholes (BH201 to BH203, BH209 and BH211) between 24 October and 7 November 2019, using a tracked, Maruka-mounted rig.

All boreholes were drilled from ground surface, with no hand or hydro-excavation carried out.

Core samples were retrieved by rotary drilling methods using PQ (96 mm diameter) triple tube drilling. BH201 and BH202 were cored to approximately 10.0 m below ground level (bgl), and then wash drilled (no core recovered) to their termination depth.

Where practical, vane shear strengths were measured in the end of the core barrel with a hand held shear vane, using the techniques described in the NZGS guideline.

Table 2 summarises the details of the investigation machine boreholes. Borehole logs are provided in Appendix B.

The target depth of the boreholes was set during the concept phase and designed to provide a broad understanding of the geology and the intended structure, such that a ground model could be developed. The target depth of the test pits was to establish the depth to rock.

Table 2 Summary of machine boreholes

Test ID	Site Location	Commenced	Completed	Total Depth (m bgl)	Termination Reason	Piezometer
BH01	Attenuation Basin Foundation	6/06/2019	6/06/2019	15.0	Target Depth	Yes, x 2
BH02	Toe Bund Foundation	27/05/2019	28/05/2019	15.0	Target Depth	Yes, x 2
BH03	Toe Bund Foundation	28/05/2019	29/05/2019	20.0	Target Depth	Yes, x 2
BH04	Toe Bund Foundation	6/06/2019	7/06/2019	15.0	Target Depth	Yes, x 2
BH05	Central Ridge	29/05/2019	30/05/2019	30.0	Target Depth	Yes, x 2
BH06	Southwest Ridge	13/06/2019	14/06/2019	30.0	Target Depth	No
BH07	Central Ridge	30/05/2019	4/06/2019	20.0	Target Depth	Yes, x 2
BH08	Southeast Perimeter	11/06/2019	11/06/2019	20.0	Target Depth	No
BH09	Western Perimeter	12/06/2019	12/06/2019	16.5	Target Depth	Yes, x 1
BH10	Northeast Ridge	04/06/2019	05/06/2019	20.0	Target Depth	Yes, x 2
BH201	Southern Perimeter	28/10/2019	01/11/2019	61.0	Target Depth	Yes, x 1
BH202	Southern Perimeter	2/11/2019	4/11/2019	60.6	Target Depth	Yes, x 1
BH203	Southwest Perimeter	7/11/2019	7/11/2019	19.7	Target Depth	No
BH204	Western Ridge	Not completed				
BH209	Western Perimeter	24/10/2019	24/10/2019	10.0	Target Depth	No
BH210	Central gully base	Not completed				
BH211	Eastern Gully Base	4/11/2019	6/11/2019	25.2	Target Depth	Yes, x2

3.3 Piezometers

Piezometers were installed in selected boreholes to allow for permeability testing and follow-up groundwater measurements.

Groundwater was not encountered in BH06, BH08, BH203 or BH209 - therefore, no piezometers were installed.

Piezometers were typically nested, with two 32 mm PVC pipes installed in each borehole (except BH09, BH201 and BH202). The pipe was slotted over the targeted screened zone and surrounded by a coarse sand pack. Bentonite seals were placed above and below each screened zone. For borehole logs where double piezometers are installed (a and b) these are presented as a single log showing the double piezometer installation.

The piezometer details were provided by GHD hydrogeologists to suit the conditions encountered in each borehole. Table 3 summarises the piezometer details.

Table 3 Summary of piezometer details

Borehole ID	Piezometer ID	Screened From (m bgl)	Screened To (m bgl)
BH01	BH01a	2.0	4.0
	BH01b	8.0	9.0
BH02	BH02a	3.0	5.0
	BH02b	7.0	9.0
BH03	BH03a	8.3	10.3
	BH03b	13.0	15.0
BH04	BH04a	4.5	6.5
	BH04b	12.0	16.0
BH05	BH05a	14.0	16.0
	BH05b	19.0	22.0
BH07	BH07a	11.5	14.5
	BH07b	16.8	19.8
BH09	BH09a	14.5	16.5
BH10	BH10a	13.5	15.5
	BH10b	18.0	20.0
BH201	BH201	54.0	60.0
BH202	BH202	54.0	60.0
BH211	BH211a	8.5	11.5
	BH211b	22.0	25.0

3.4 Test pits

Under the supervision of GHD, Fulton Hogan excavated eleven test pits between 27 May 2019 and 12 June 2019, using a 22 tonne excavator.

Where practical and safe, vane shear strengths were measured in the base and sides of the excavation with a hand held shear vane, using the techniques described in the NZGS guideline.

Table 4 summarises the details of the test pits. Test pit logs are provided in Appendix B.

Table 4 Test pit summary

Test Pit ID	Site Location	Excavation Date	Termination Depth (m bgl)	Termination Reason	Materials Encountered
TP01	Manuka gully (stockpile area)	12/06/2019	2.5	Target Depth	Alluvium, HW rock, siltstone
TP02	Manuka gully (stockpile area)	12/06/2019	2.6	Target Depth	Colluvium, alluvium, buried topsoil, siltstone
TP03	Manuka gully (stockpile area)	12/06/2019	2.0	Target Depth	Alluvium, siltstone
TP05	Southwest gully base	13/06/2019	3.3	Target Depth	Colluvium, HW rock, siltstone
TP06	Gully east of central ridge	13/06/2019	2.5	Target Depth	Alluvium, siltstone
TP07	Southwest gully base	28/05/2019	2.5	Target Depth	Loess, siltstone, breccia
TP08	Gully between southern ridges	28/05/2019	4.5	End of reach	Fill, buried topsoil, loess
TP09	Southeast gully outflow	13/06/2019	3.0	Target Depth	Slip debris, buried topsoil, alluvium, sandstone
TP10	Future laydown area	10/06/2019	3.6	Target Depth	Loess, HW siltstone
TP11	Future laydown area	10/06/2019	3.8	Target Depth	Loess, HW siltstone
TP12	Future laydown area	10/06/2019	4.4	Target Depth	Fill, buried topsoil, loess, HW siltstone

*Note: TP04 was deleted from the field programme

3.5 Bulk samples

Bulk samples of loess and completely weathered (CW) rock were collected from shallow test pits on 7 and 13 November 2019. The shallow test pits were excavated by Fulton Hogan, with a 20 tonne excavator. The bulk sample details are summarised in Table 5.

Table 5 Bulk sample summary

Bulk Sample ID	Sample Date	Sample Depth	Sampled Material
BS01	7/11/2019	0.5 m bgl	Loess
BS02	7/11/2019	1.0 m bgl	Loess / CW rock
BS03	7/11/2019	0.7 m bgl	Loess
BS04	7/11/2019	1.5 m bgl	Loess / CW rock
BS05	13/11/2019	0.6 m bgl	Loess
BS06	13/11/2019	1.0 m bgl	Loess / CW rock
BS07	13/11/2019	0.5 m bgl	Loess
BS08	13/11/2019	0.6 m bgl	Loess
BS09	13/11/2019	1.2 m bgl	Loess / CW rock
BS10	13/11/2019	0.7 m bgl	Loess
BS11	13/11/2019	1.3 m bgl	Loess
BS12	13/11/2019	0.4 m bgl	Loess
BS13	13/11/2019	1.2 m bgl	Loess
BS14	13/11/2019	0.5 m bgl	Loess
BS15	13/11/2019	1.1 m bgl	Loess / CW rock

3.6 Groundwater

To monitor whether the groundwater had returned to a static level after drilling, manual groundwater measurements were taken on several occasions during the field investigation programme. This was because, groundwater levels noted during or immediately after drilling are typically in an elevated state due to the use of water during the drilling process, and therefore may not represent a static groundwater level. Groundwater levels may also fluctuate seasonally.

At the completion of drilling BH01, prior to piezometer installation, the drillers observed artesian groundwater, in that groundwater was flowing out of the top of the borehole; the subsequent level measured in the shallow piezometer in BH01~~a~~ was also above ground level. However, since installation, the integrity of the shallow piezometer (BH01a) has been compromised and it is no longer possible to record a groundwater level, but groundwater can be observed leaking from around the edge of the installation indicating that artesian groundwater is present.

BH201 and BH202 were wash drilled to approximately 60 m to ensure interception of the groundwater table along the southern boundary.

An existing piezometer (comprising a single 50 mm PVC pipe, in a 100 mm diameter borehole) was discovered adjacent to the northeast site access. No information about this piezometer (drill date, target, etc.) is available. The base of this piezometer was measured at 42.50 m bgl.

In updating this report in May 2021, it has been decided that the groundwater level data is presented in the Groundwater Report[1] (GHD, 2021).

3.7 Investigation coordinates

Positions for machine boreholes and test pits were recorded by Woods Surveying. Coordinates are presented in the North Taieri Circuit (2000) projection, and elevation Reduced Levels (RL) are presented in terms of New Zealand Vertical Datum (2016).

[1] GHD, 2021, *Smooth Hill Landfill Consenting – Groundwater Report*

BH06, BH08 and all test pits were picked up with a cluster of points around the pads. The coordinates for the most central pickup point haves been selected to represent the test location. These points are marked with an asterisk (*) in the table below.

TP05, TP07, TP08, and all of the Phase II investigations have not yet been surveyed. Coordinates for these test locations have been estimated from Google Earth and are marked with a double asterisk (**) in the table below. Elevations for these points have been estimated from the Stantec contour map presented in Appendix A.

Table 6 summarises the position coordinates for all test locations.

Table 6 Summary of test location positions

Test Location ID	Easting	Northing	Elevation (m RL)
BH01	396465.49	788214.52	96.01
BH02	396358.59	788022.89	97.41
BH03	396428.38	787998.34	107.48
BH04	396563.60	788063.75	108.15
BH05	396459.76	787862.12	129.50
BH06	396168.25*	787593.98*	149.75*
BH07	396493.65	787671.87	139.73
BH08	396809.71*	787700.67*	143.89*
BH09	395951.84	788050.36	132.80
BH10	396788.26	788118.50	139.07
BH201	396596**	787540**	144**
BH202	396181**	787498**	144**
BH203	395779**	787672**	182**
BH209	395775**	788148**	132**
BH211	396598**	787965**	107**
TP01	395988.85	788077.23	121.20
TP02	396103.50	788056.91	110.40
TP03	396262.16	788048.16	102.61
TP05	396281**	787868**	105**
TP06	396585.70	787800.45	108.24
TP07	396182**	787790**	120**
TP08	396303**	787682**	115**
TP09	396577.97	787947.86	101.04
TP10	396820.11	788079.25	140.74
TP11	396907.03	788032.98	141.24
TP12	396956.93	787986.46	142.28
BS01 / BS02	396149**	787571**	150**
BS03 / BS04	396202**	787994**	135**
BS05 / BS06	396537**	787504**	152**
BS07	396500**	787616**	141**
BS08 / BS09	396490**	787771**	130**
BS10 / BS11	396441**	787922**	119**
BS12 / BS13	396382**	787582**	132**
BS14 / BS15	396366**	787738**	120**

3.8 Laboratory testing

3.8.1 Phase I test schedule

Selected samples obtained from Phase I of the geotechnical investigation were tested at the IANZ accredited Central Testing Services laboratory in Alexandra. Table 7 summarises the laboratory testing programme undertaken.

Table 7 Summary of geotechnical laboratory testing

Sample Source	Depth From (m bgl)	Depth To (m bgl)	Atterberg Limits - NZS 4402:1986, Test 2.2, 2.3 & 2.4	Particle Size Distribution - NZS 4402:1986, Test 2.8.1 & 2.8.4.	NZ Standard Compaction - NZS 4402:1986, Test 4.1.1	Pinhole Dispersion and Crumb Test - ASTM D4647 & ASTM D6572	Triaxial Permeability - ASTM D5084
TP10	2.2	3.6	x	x	x	x	x
BH05 BH07 (combined)	0.0 0.0	1.2 1.4	x	x	x	x	x
* - using de-aired tap water							

3.8.2 Phase II test schedule

On completion of Phase I of the geotechnical investigation a further suite of samples were tested by Central Testing Services in Alexandra. Two suites of lab testing were undertaken with the following purposes:

- To determine the suitability of the Loess soils for either lime or bentonite stabilisation as a method of reducing erodibility/ dispersivity. Eight (8) bulk samples were combined and divided into four sub-samples. The four sub-samples were then tested as outlined in Table 8.
- To determine suitability of CW-HW Henley Breccia Soils for use as engineered fill beneath the landfill liner. Two samples were tested as outlined in Table 9.

Table 8 Summary of geotechnical laboratory testing for stabilised soils.

Sample Source	Sub-sample Number	Atterberg Limits - NZS 4402:1986, Test 2.2, 2.3 & 2.4	Lime demand test (NSW Transport; Roads & Maritime Services Test Method T144 (Not IANZ Accredited))	Atterberg Limits - NZS 4402:1986, Test 2.2, 2.3 & 2.4 (Stabilised Soil)	NZ Standard Compaction - NZS 4402:1986, Test 4.1.1	Shear Strength – Shear Vane – NZGS 2001	Pinhole Dispersion and Crumb Test - ASTM D4647 & ASTM
BS01 (0.5m) BS03 (0.7m)	Sub-sample #1	X	X	X (Lime Stabilised – 1 day curing)	X	X	X
BS07 (0.5m) BS08 (0.6m)	Sub-sample #2	X	X	X (Lime Stabilised – 7 day curing)	X	X	X
BS10 (0.7m) BS11 (1.3m)	Sub-sample #3	X		X (Bentonite Stabilised – 1 day curing)	X	X	X
BS12 (0.4m) BS13 (1.2m)	Sub-sample #4	X		X (Bentonite Stabilised- 7 day curing)	X	X	X

Table 9 Summary of geotechnical laboratory testing for engineered fill

Sample Source	Depth From (m bgl)	Depth To (m bgl)	Atterberg Limits - NZS 4402:1986, Test 2.2, 2.3 & 2.4	NZ Standard Compaction - NZS 4402:1986, Test 4.1.1	Unconfined Compressive Strength of Soil, NZS 4402:1986: Test 6.3.1
BH05	2.7	7.2	X	X	X
BH10	2.4	7.0	X	X	X

3.8.3 Phase III test schedule

A third round of laboratory testing will be undertaken on the performance of the loess, should a mineral liner be included in the detailed design of the liner system. This will require fresh samples to be taken of the loess.

~~3.8.3~~3.8.4 Phase I test results

Table 10 to Table 15 summarise the results of the laboratory testing outlined in Section 3.8.1. Detailed laboratory test results are presented in Appendix C.

Table 10 Summary of particle size distribution test results (NZS 4402:1986, Test 2.8.1 and 2.8.4)

Sample Source	Geological Unit	Percent Passing (%)			
		Gravel (2 to 60 mm)	Sand (0.06 to 2 mm)	Silt (0.002 to 0.06 mm)	Clay (<0.002 mm)
TP10	Loess	6	13	72	9
BH05/BH07	Loess	1	10	60	29

Table 11 Summary of Atterberg limit test results (NZS 4402:1986, Test 2.1, 2.2, 2.3 and 2.4)

Sample Source	Geological Unit	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
TP10	Loess	15.5	39	28	11
BH05/BH07	Loess	23.6	42	23	19

Table 12 Summary of NZ standard compaction test results (NZS 4402:1986, Test 2.1 and 4.1.1)

Sample Source	Geological Unit	Water Content – As Received (%)	Maximum Dry Density (t/m3)	Optimum Water Content (%)
TP10	Loess	15.5	1.71	16.0
BH05/BH07	Loess	23.6	1.70	17.5

Table 13 Summary of pinhole dispersion test results (ASTM D4647-13e1)

Sample Source	Geological Unit	Elapsed Time (min)	Flow Rate (ml/s)	Outflow Colour	Hole Diameter Pre-test	Hole Diameter Post-test	Classification
TP10	Loess	1	0.25	Slightly dark	1.0 mm	~2.0 mm (4 mm at exit)	Dispersive (D)
		5	0.27	Moderately dark			
		10	0.31	Dark			
BH05 / BH07	Loess	1	0.25	Barely visible	1.0 mm	~2.0 mm	Dispersive (D)
		5	0.27	Moderately dark			
		10	0.49	Very dark			

Table 14 Summary of crumb test results (ASTM D6572-13e2 (Method B))

Sample Source	Geological Unit	Elapsed Time	Estimated Slaking	Observations	Crumb Test Classification
TP10	Loess	2 min	~50%	No colloidal cloud	Grade 4 (Highly Dispersive)
		1 hr	~100%	Dense colloidal cloud over	
		6 hr	~100%	Moderate colloidal	
BH05/BH07	Loess	2 min	~20%	No colloidal cloud	Grade 4 (Highly Dispersive)
		1 hr	~100%	Dense colloidal cloud over	
		6 hr	~100%	Dense colloidal cloud over	

Table 15 Summary of triaxial permeability test results (ASTM D5084-16a)

Sample Source	Geological Unit	Cell Pressure (kPa)	Initial Permeability (m/s)	Final Permeability (m/s)
TP10	Loess	610	2.9×10^{-8}	3.2×10^{-8}
TP10	Loess	727	2.7×10^{-8}	2.8×10^{-8}
BH05/BH07	Loess	460	1.7×10^{-9}	2.1×10^{-9}
BH05/BH07	Loess	527	5.6×10^{-10}	5.3×10^{-10}

~~3.8.4~~3.8.5 Phase II test results

Table 16 to Table 20 summarise the results of the laboratory testing outlined in Section 3.8.2. Detailed laboratory test results are presented in Appendix C.

Table 16 Summary of Atterberg limit test results (Natural Soils)

Sample	Geological Unit	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index
Sub-sample #1	Loess (untreated)	25	41	25	16
Sub-sample #2	Loess (untreated)	25	41	25	16
Sub-sample #3	Loess (untreated)	25	41	25	16
Sub-sample #4	Loess (untreated)	25	41	25	16

Table 17 Summary of lime demand test results

Sample	Geological Unit	pH 0 % added Lime	pH 1 % added Lime	pH 2 % added Lime	pH 3 % added Lime	pH 4 % added Lime	pH 5 % added Lime	pH 6 % added Lime	pH 7 % added Lime
Sub sample #1	Loess (untreated)	5.12	10.15	12.12	12.42	12.46	12.49	12.48	12.42
Sub-sample #1	Loess (untreated)	5.16	10.31	12.08	12.5	12.55	12.56	12.55	12.55

Table 18 Summary of Atterberg limit test results (Henley Breccia Formation)

Sample	Geological Unit	Liquid Limit	Plastic Limit	Plasticity Index
BH05 2.7 – 7.2 m	Henley Breccia – CW Siltstone	41	25	16
BH10 2.4 – 7.0 m	Henley Breccia – CW Siltstone / Sandstone	37	23	14

Table 19 Summary of NZ standard compaction test results (Henley Breccia Formation)

Sample Source	Geological Unit	Maximum Dry Density (t/m3)	Optimum Water Content (%)
BH05 2.7 – 7.2 m	Henley Breccia – CW Siltstone	1.76	16.0
BH10 2.4 – 7.0 m	Henley Breccia – CW Siltstone / Sandstone	1.85	14.0

Table 20 Summary of unconfined compressive strength of re-compacted samples (Henley Breccia Formation)

Sample Source	Geological Unit	Unconfined Compressive Strength (kPa)
BH05 2.7 – 7.2 m	Henley Breccia – CW Siltstone	100
BH10 2.4 – 7.0 m	Henley Breccia – CW Siltstone / Sandstone	93

4. References

The following documents have been consulted in preparation of the guideline:

- Bishop, D.G. 1994, *Geology of the Milton area*. *Scale 1:50,000, Institute of Geological & Nuclear Sciences geological map 9. 1 sheet + 32 p,* Institute of Geological & Nuclear Sciences Ltd, Lower Hutt, New Zealand
- Bishop, D.G. Turnbull, I.M. (compilers) 1996, *Geology of the Dunedin Area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 21. 1 sheet + 52 p,* Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Limited
- GNS Active Faults Database, *http://maps.gns.cri.nz/website/af/viewer.htm*
- New Zealand Geotechnical Society, 2001, *Guideline for Handheld Shear Vane Test*
- New Zealand Geotechnical Society, 2005, *Guideline for the Field Classification and Description of Soil and Rock for Engineering Purposes*
- Stantec (not dated), *Smooth Hill Site – Plan*, Reference 80510415-01-001-S10, Revision A
- Stirling, McVerry, et al, 2010, *National Seismic Hazard Model for New Zealand: 2010 Update*. Bulletin of the Seismological Society of America, Vol. 102, No. 4, pp. 1514-1542, August 2012

5. Limitations

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

GHD otherwise disclaims responsibility to any person other than the Client and Council officers, consultants, the hearings panel and submitters associated with the resource consent and notice of requirement process for the Smooth Hill Landfill Project arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

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

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

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

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

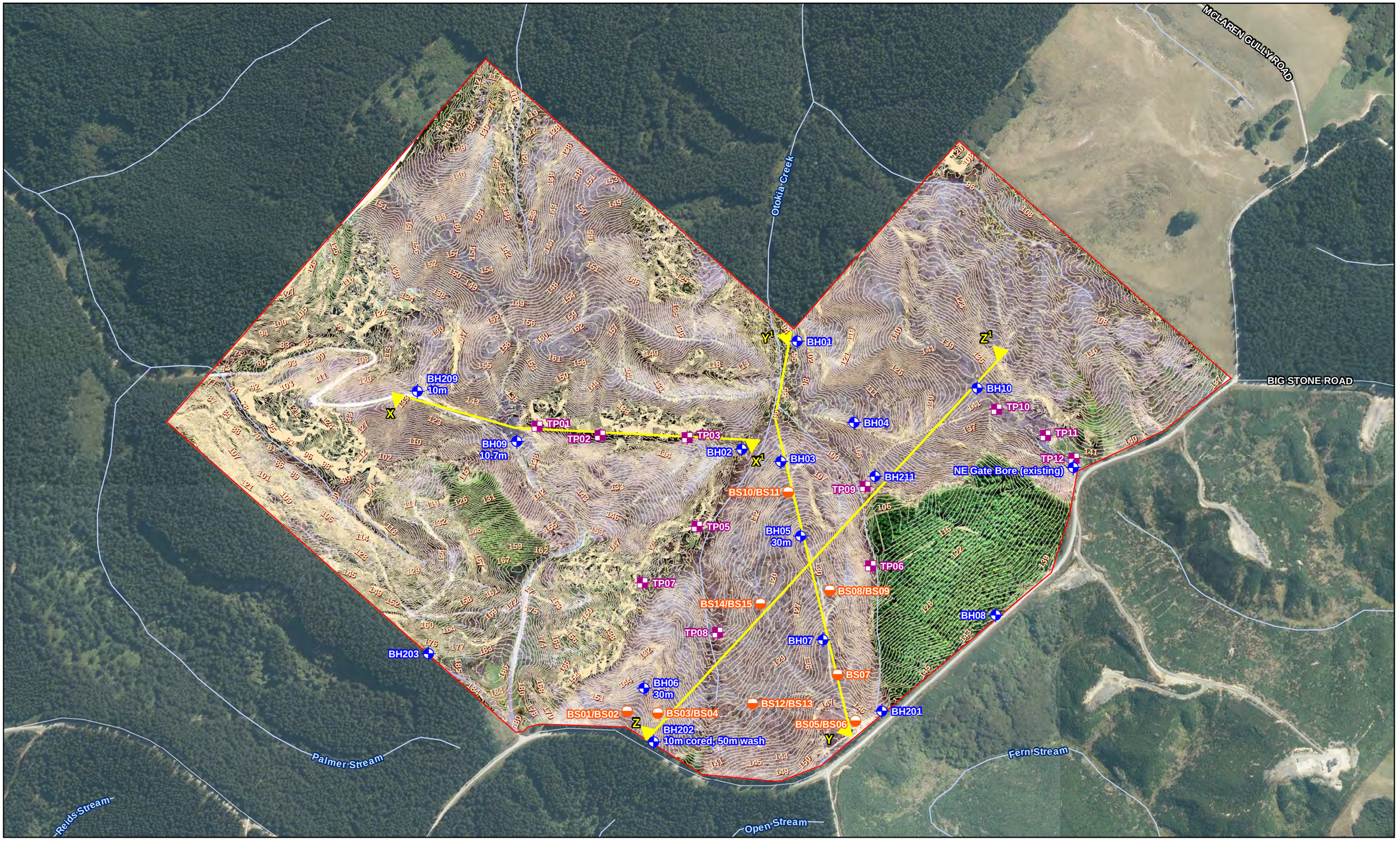
The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of vegetation and topography. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

Appendices

Appendix A – Plans



Paper Size A3

0 50 100 200

Metres

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

N

LEGEND

- Site boundary
- Cross section location
- Borehole
- Test pit
- Bulk sample location
- Waterways
- Contours (1m)

Dunedin City Council
Smooth Hill Landfill
Geotechnical and Hydrogeological

Job Number	12506381
Revision	A
Date	17 Aug 2020

Investigation Location Plan

Figure A1

N:\NZ\Christchurch\Projects\51\12506381\GIS\Maps\Deliverables\Geo\12506381_Z001_Geo_InvestigationLocations.mxd

Level 3, 138 Victoria Street, PO Box 13 468, Christchurch 8141, New Zealand **T** 64 3 378 0900 **F** 64 3 378 8001 **E** chcmail@ghd.com **W** www.ghd.com

Data source: Aerial imagery - Stantec, LINZ & esri (); General topo - LINZ 2019; Contours - Stantec Created by:jrprice

Appendix B – Borehole and Test Pit Logs and Photographs

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Dam foundation
Job Number: 12506381
Commenced: 6/06/2019 Completed: 6/06/2019

Hole No. : BH01
Sheet : 1 of 2
Hole Length : 15.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396465.49 Northing: 788214.52 System: TAIETM2000
RL: 96.01 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
96.01	0	0.00 - 1.20 Fine to medium gravelly SILT, trace fine to coarse sand, trace clay; light yellow brown & orange brown. Stiff, moist, low plasticity. (COLLUVIUM?). Gravel clasts comprise quartz and schist, sub angular to sub rounded.	COLLUVIUM	M	St				PQTT				77			
94.81	1.2	1.20 - 2.70 Inferred CORELOSS. Possible slip base & stream alluvium lost? Driller said it "was so soft, it was like drilling nothing". Tried pushing down with no water or rotation, but still could not retrieve core. Same for next coreloss zone at 3.0 m to 3.9 m.	ALLUVIUM		"				PQTT				20			
93.31	2.7	2.70 - 2.90 Silty CLAY, trace fine sand; grey & orange brown. Soft to firm, moist, high plasticity. (ALLUVIUM?).		M	S-F											
93.11	2.9	2.90 - 3.00 Silty fine to coarse SAND, trace organics; grey. Poorly graded. (ALLUVIUM?). Note no moisture condition or density determined and logged.			"				PQTT				0			
92.81	3.2	3.00 - 3.90 Inferred CORELOSS. Possible alluvium loss?														
92.11	3.9	3.90 - 4.40 Slightly weathered, light grey fine to coarse SANDSTONE; moderately strong to strong; well indurated, no defects. (HENLEY BRECCIA).	HENLEY BRECCIA						PQTT		SW		100			
91.61	4.4	4.40 - 4.80 Slightly weathered, grey SILTSTONE; very weak to weak; poorly indurated, no defects.									SW		22			
91.21	4.8	4.80 - 5.28 Slightly weathered, light grey fine to coarse SANDSTONE; very weak to weak; poorly indurated, no defects. 5.28 - 5.38 From 5.28 m, becomes moderately strong to strong, well indurated. 5.38 - 6.00 From 5.38 m, becomes very weak to weak, poorly indurated. 6.00 - 6.25 From 6.00 m, becomes moderately strong to strong, well indurated. 6.25 - 6.80 From 6.25 m, becomes very weak to weak, poorly indurated.							PQTT		SW		98			
											SW		80			
											SW					
											SW					
											SW					
89.21	6.8	6.80 - 7.80 Slightly weathered, light yellow brown & reddish brown SILTSTONE; very weak to weak; poorly indurated, no defects. From 6.9 m, becomes light grey & reddish brown. From 7.05m, becomes light grey with purple-brown layers. From 7.3 m to 7.4 m, becomes fin									SW		100			
											SW		97			
88.21	7.8	7.80 - 8.30 Slightly weathered, light grey with purple-brown layers fine to medium SANDSTONE; very weak to weak; poorly indurated, no defects.							PQTT		SW		53			
87.71	8.3	8.30 - 9.00 Inferred CORELOSS in gravel layer. Gravel present on ends of core abutting this zone. Fine to medium gravel, quartz and schist clasts, sub angular to sub rounded.			"								53			
87.01	9	9.00 - 9.50 Slightly weathered, grey and brown SILTSTONE; very weak to weak; poorly indurated, no defects.							PQTT		SW		100			
86.51	9.5	9.50 - 11.30 Slightly weathered, light grey with purple-brown layers fine to medium SANDSTONE; very weak to weak; poorly indurated, no defects.									SW		100			

Notes and Comments:
End of Hole @ 15.00m, Target Depth.

Looks like drill pad on slip debris pile. Scarp above (east) of pad.
Ground stripped ~0.6 m, including all topsoil.
Piezo installed 10/06/2019.
As of end of 07/06/2019, driller has been unable to recover core from last run. keeps slipping out of barrel. Will try again before piezo install on 10/06/2019.
Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNiells
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Dam foundation
Job Number: 12506381
Commenced: 6/06/2019 Completed: 6/06/2019

Hole No. : BH01
Sheet : 2 of 2
Hole Length : 15.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396465.49 Northing: 788214.52 System: TAIETM2000
RL: 96.01 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
11	11.3		From 10.5 m: 10 mm thick bedding visible.	HENLEY BRECCIA					122mm	PQTT		SW		100 100			
12	12.2		11.30 - 13.10 Unweathered, grey BRECCIA; moderately strong to strong; fine to medium gravel size clasts, coarse sand matrix, matrix supported, well indurated, no defects. Clasts are quartz and schist, angular to sub rounded, 300-600 mm bedding. From 11.7 m: very few							PQTT		UW		97 97			
13	12.8 13.1		13.10 - 15.00 From 13.1 m, becomes weak to moderately strong, fine to coarse gravel clasts, clast supported, moderate to well indurated. Note - As of end of 07/06/2019, driller has been unable to recover core from last run. keeps slipping out of barrel. Will try aga							PQTT		UW		100 100			
14										PQTT		UW					
15			End of Hole @ 15.00m,Target Depth.														
16																	
17																	
18																	
19																	
20																	

Notes and Comments:
End of Hole @ 15.00m, Target Depth.

Looks like drill pad on slip debris pile. Scarp above (east) of pad.
Ground stripped ~0.6 m, including all topsoil.
Piezo installed 10/06/2019.
As of end of 07/06/2019, driller has been unable to recover core from last run. keeps slipping out of barrel. Will try again before piezo install on 10/06/2019.
Refer to explanation sheets for abbreviation and symbols

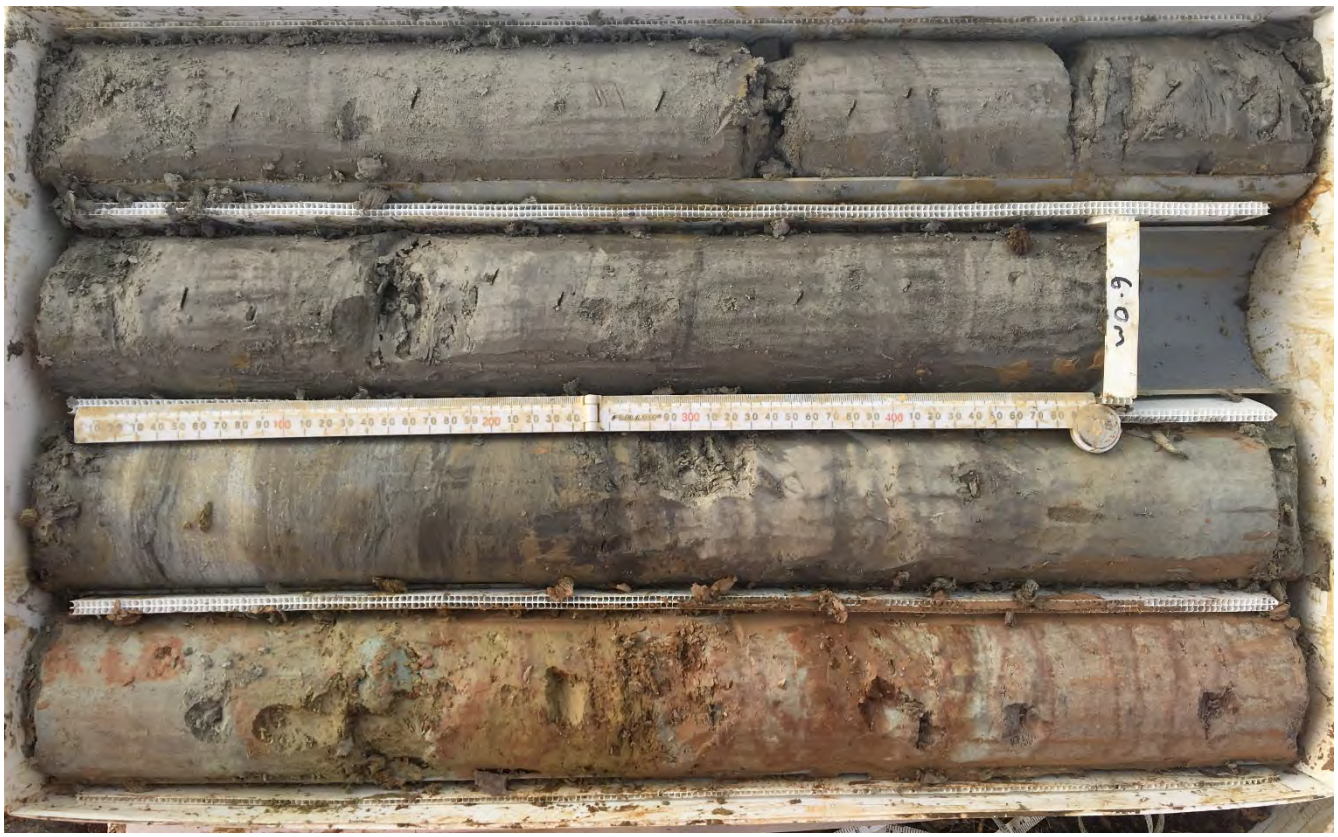
Inclination: Vertical Orientation:
Contractor: McNiells
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

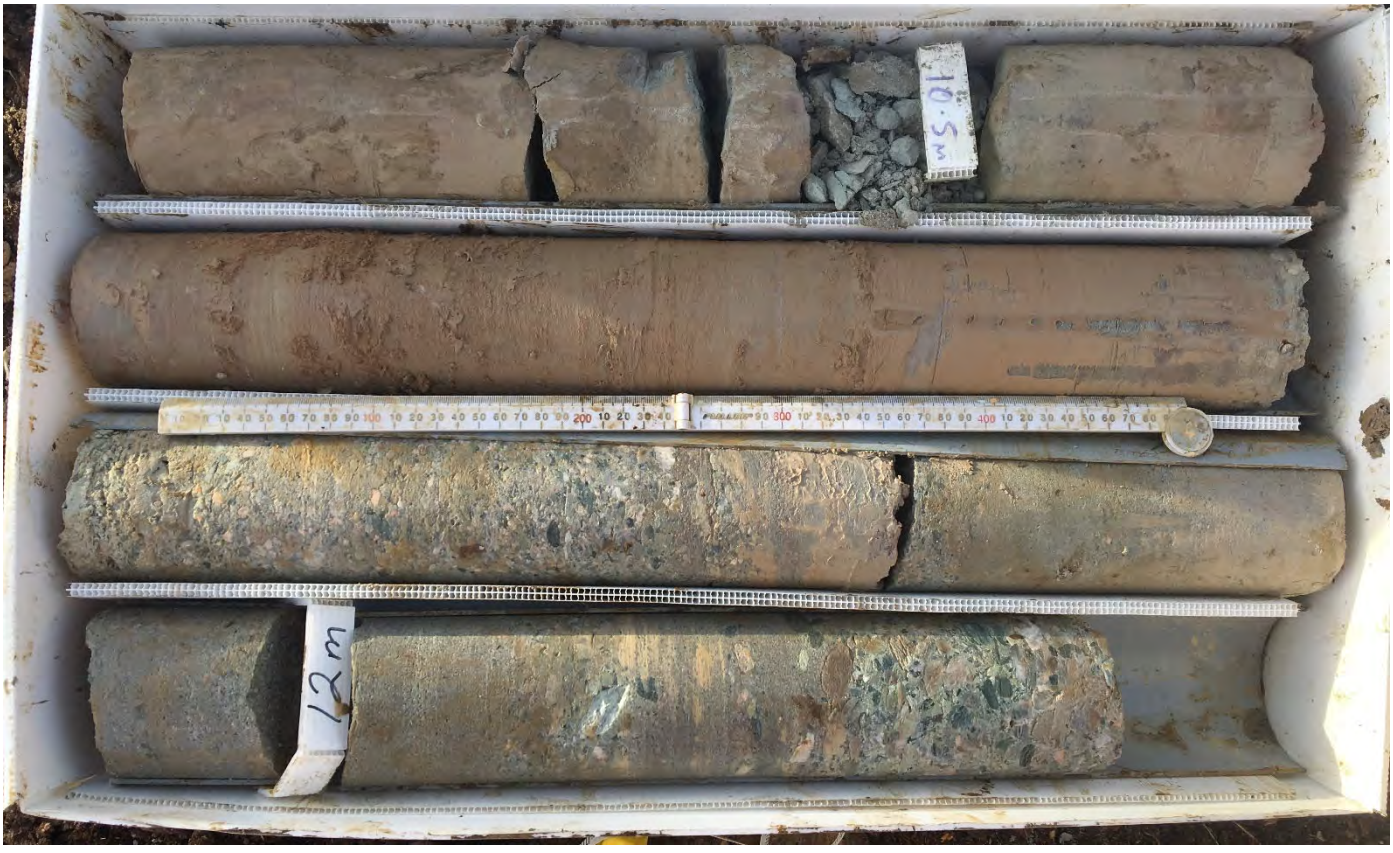
Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 3
Borehole ID	BH01	

Box 1 of 5: 0.00 m to 4.80 m

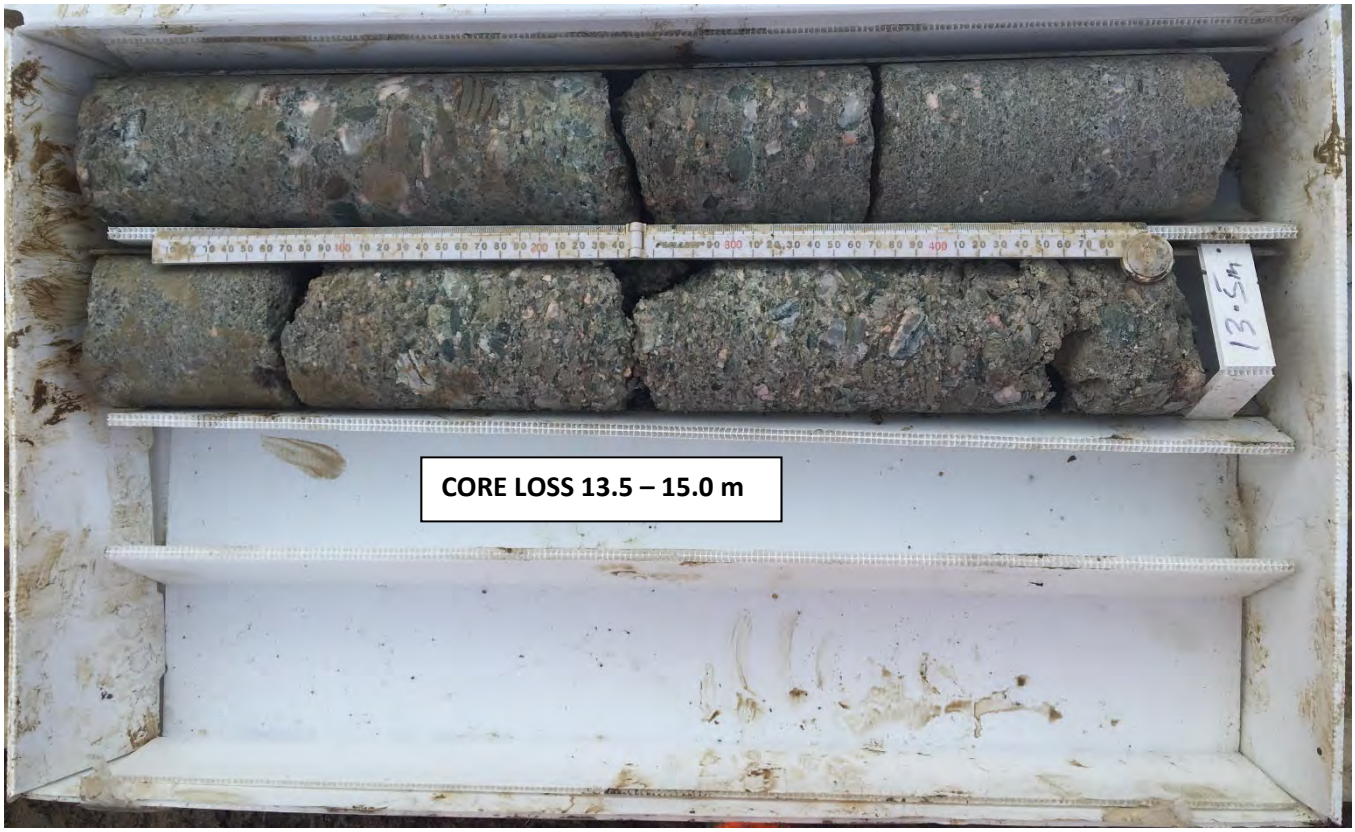


Box 2 of 5: 4.80 m to 7.20 m

Box 3 of 5: 8.20 m to 10 .20 m



Box 4 of 5: 10.20 m to 12.40 m



Box 5 of 5: 12.40 m to 15.00 m (EOH)

GHD	Project : Smooth Hill Landfill Consenting Client : Dunedin City Council Site : Smooth Hill Toe bund Job Number: 12506381	Hole No. : BH02	
		Sheet	: 1 of 2
		Hole Length	: 15.00m
		Scale @ A4	: 1:50
	Commenced: 27/05/2019 Completed: 28/05/2019	Logged	: MF
Easting: 396358.59	Northing: 788022.89 System: TAIETM2000	Processed	: HB
RL: 97.41	Datum: NZVD2016	Checked	: JS

Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Result
0 – 0.5	0.00 - 0.50 Inferred CORELOSS			"	
0.5 – 1.5	0.50 - 1.50 SILT, minor clay, trace to minor fine sand; light grey & brown. Stiff to very stiff, moist, non plastic. Contains Fe weathered spots & small (<50mm) lenses of Fe staining. (LOESS)	LOESS	M	St-VSt	
1.5 – 2.15	1.50 - 2.15 Inferred CORELOSS	HISTORIC [PRE GLACIAL] ALLUVIUM		"	SV@1.5m 42/5
2.15 – 2.45	2.15 - 2.45 Fine sandy SILT, trace clay; light grey. Firm, moist, non plastic (transitions into)		M	F	
2.45 – 2.6	2.45 - 2.60 Silty fine SAND; grey. 'Very loose to loose', saturated, poorly graded (ALLUVIUM?). Moisture content may be influenced by drilling fluid in loose materials.		S	VL-L	
2.6 – 2.9	2.60 - 2.90 Fine sandy SILT; grey. Firm, moist, non plastic. Rootball at 2.8-2.9 m		M	F	SV@2.8m /
2.9 – 3.35	2.90 - 3.35 Inferred CORELOSS (Likely gravel that got washed away)			"	
3.35 – 3.7	3.35 - 3.70 GRAVEL; light grey. 'Very loose to loose', saturated, gravel is fine, angular to subangular quartz & schist. Fines matrix washed away. Moisture content may be influenced by drilling fluid in loose materials. (ALLUVIUM? TOP OF BRECCIA?) End of day 27/05/19.	HENLEY BRECCIA	S	VL-L	
3.7 – 3.95	3.70 - 3.95 Fine to coarse SAND, minor to some fine gravel; grey. 'Very dense' soil or extremely weathered to very weathered rock (BRECCIA), dry, non plastic; gravel is fine quartz & schist, angular to subangular.		D	VD	
3.95 – 5.3	3.95 - 5.30 Unweathered, bedded, alternating grey fine SANDSTONE & SILTSTONE; very weak; bedding 300 to 500 mm thick, uniform grainsize within layers. Quartz vein noted at 4.6 m at 60 degrees to core axis, (bedding horizontal?).				SV@4.3m UTP
5.3 – 5.7	5.30 - 5.70 Unweathered, grey SANDSTONE (BOULDER); strong; lithified fine angular gravel layers, no defects (BRECCIA).				
5.7 – 5.9	5.70 - 5.90 Silty CLAY; dark grey. Firm to stiff, moist, high plasticity (not lithified).		M	F-St	
5.9 – 6.4	5.90 - 6.40 Unweathered, bedded, alternating grey fine SANDSTONE & SILTSTONE; very weak; bedding 300 to 500 mm thick, uniform grainsize within layers. 10 mm coal lense at 6.11 - 6.12 m.				
6.4 – 6.55	6.40 - 6.55 Unweathered, grey silty fine SANDSTONE; weak to moderately strong.				
6.55 – 9.1	6.55 - 9.10 Unweathered, grey BRECCIA; weak to moderately strong; semi distinct bedding, no defects. Clasts are quartz & schist, fine to medium gravel size, angular to subrounded. Coarse SAND matrix.				
9.1 – 9.2	9.10 - 9.20 SILT; grey. Very stiff to hard, dry, non plastic (not lithified).		D	VSt-H	
9.2 – 9.8	9.20 - 9.80 Unweathered, grey BRECCIA; weak to moderately strong; semi distinct bedding, no defects. Clasts are quartz & schist, fine to medium gravel size, angular to subrounded. Coarse SAND matrix. Lithified solid.				

Method: PQTT (all runs)

Run	TCR / SCR / RQD (%)	Weathering
1	67	
2	50	
3	70 / 63	DW-RS
4	109 / 100	UW
5	100 / 100	UW, UW, UW
6	100 / 100	UW
7	96 / 96	UW, UW

Column headings: RL (m), Depth (m), Graphic, Material Description, Geological Unit, Moisture condition, Consistancy / Relative density, Sample (Number / Type, Result), Casing, Method, Flush Return (%) (25 50 75), Weathering (EW), Estimated Strength (MPa) (VW W MS S VS ES), TCR SCR RQD (%), Defect Spacing (mm) (20 60 200 600 2000), Instrumentation Installation, Water level

Notes and Comments:

End of Hole @ 15.00m, Target Depth.

Groundwater SWL at 0.23 mbgl (31/05/2019).

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical
Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id: GEO1826

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Toe bund
Job Number: 12506381
Commenced: 27/05/2019 Completed: 28/05/2019

Hole No. : BH02
Sheet : 2 of 2
Hole Length : 15.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396358.59 Northing: 788022.89 System: TAIETM2000
RL: 97.41 Datum: NZVD2016

RL (m) / Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
11		9.80 - 11.00 From 9.8 m: clast size increased to coarse breccia.	HENLEY BRECCIA					122mm	PQTT		UW					
		11.00 - 11.80 From 11.0m: less lithified, weak to moderately strong							PQTT		UW		100 100			
12		11.80 - 12.40 Clast size changes back to fine to medium gravel, more matrix dominaed, moderately strong to strong. From 12.35 m: matric changes from coarse sand to SILT, minor to some clay (looks like fine powder of crushed rock). Clast size increases again, moderatel							PQTT		UW		100 100			
13		12.40 - 13.50 From 12.4 m: becomes weak to moderately strong.							PQTT		UW		100 100			
14		13.50 - 15.00 From: 13.35 m: matrix changes to coarse sand/silt mix, harder lithification,, moderately strong to strong.							PQTT		UW		100 100			
15		End of Hole @ 15.00m,Target Depth.														

Notes and Comments:
End of Hole @ 15.00m, Target Depth.
Groundwater SWL at 0.23 mbgl (31/05/2019).
Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id: GEO1826

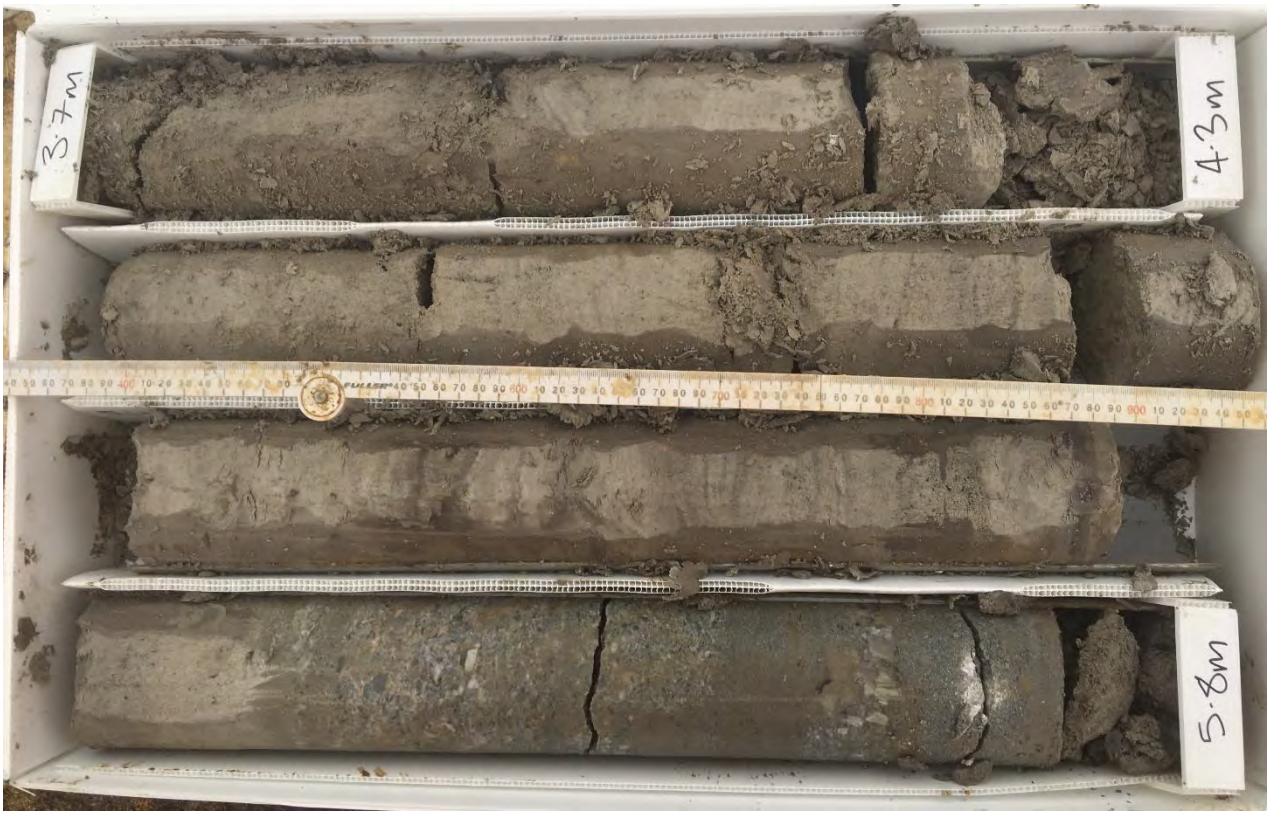
Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
27/05/19	00:00		15

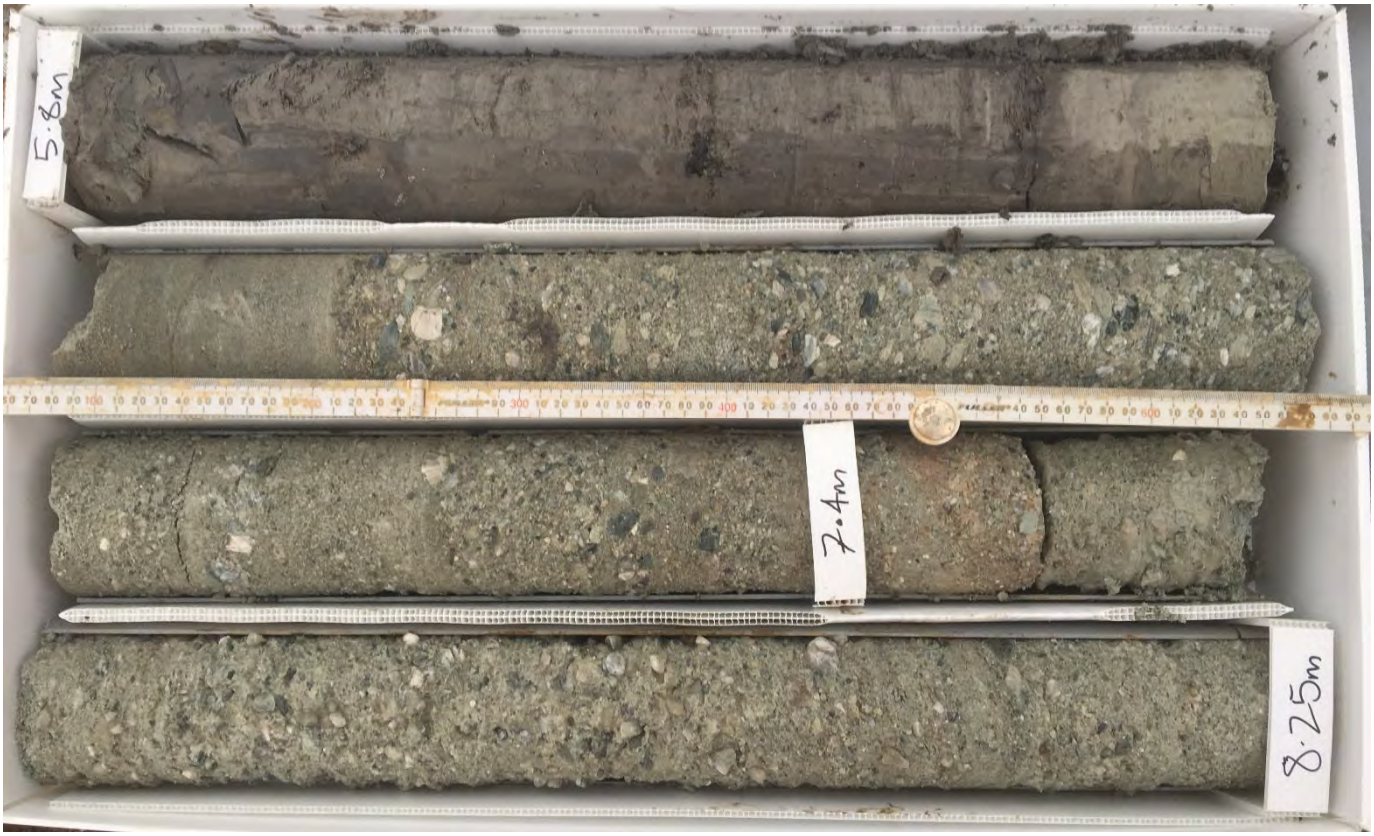
Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 3
Borehole ID	BH02	

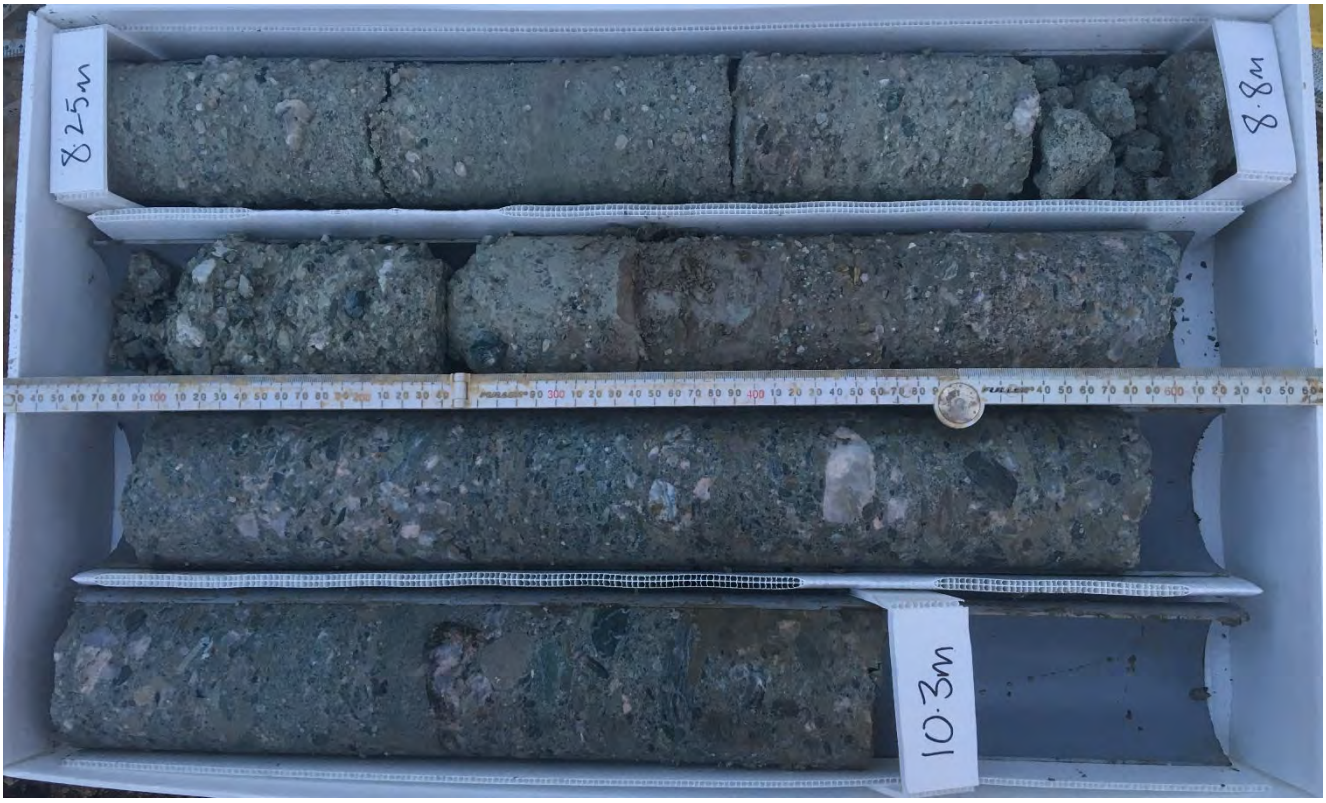
Box 1 of 6: 0.0 m to 3.7 m



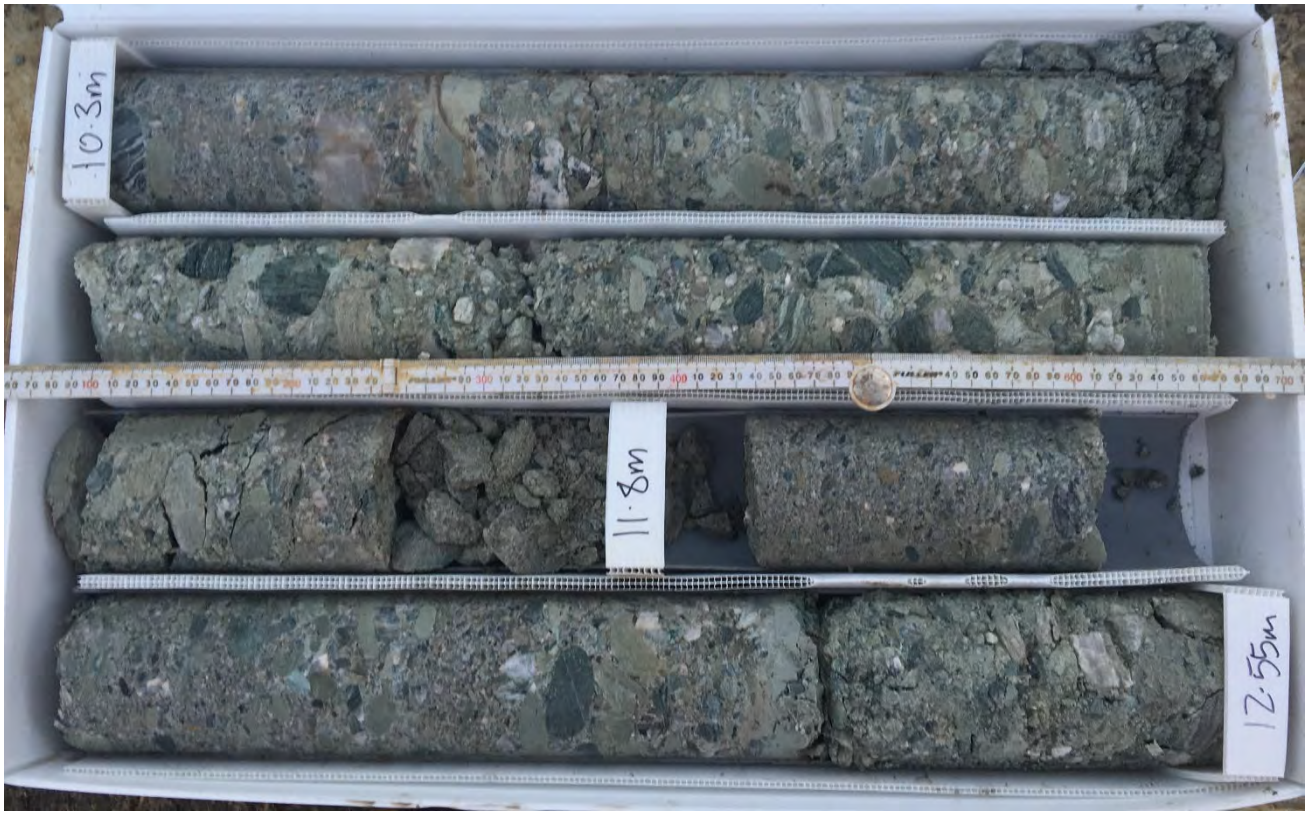
Box 2 of 6: 3.7 m to 5.8 m



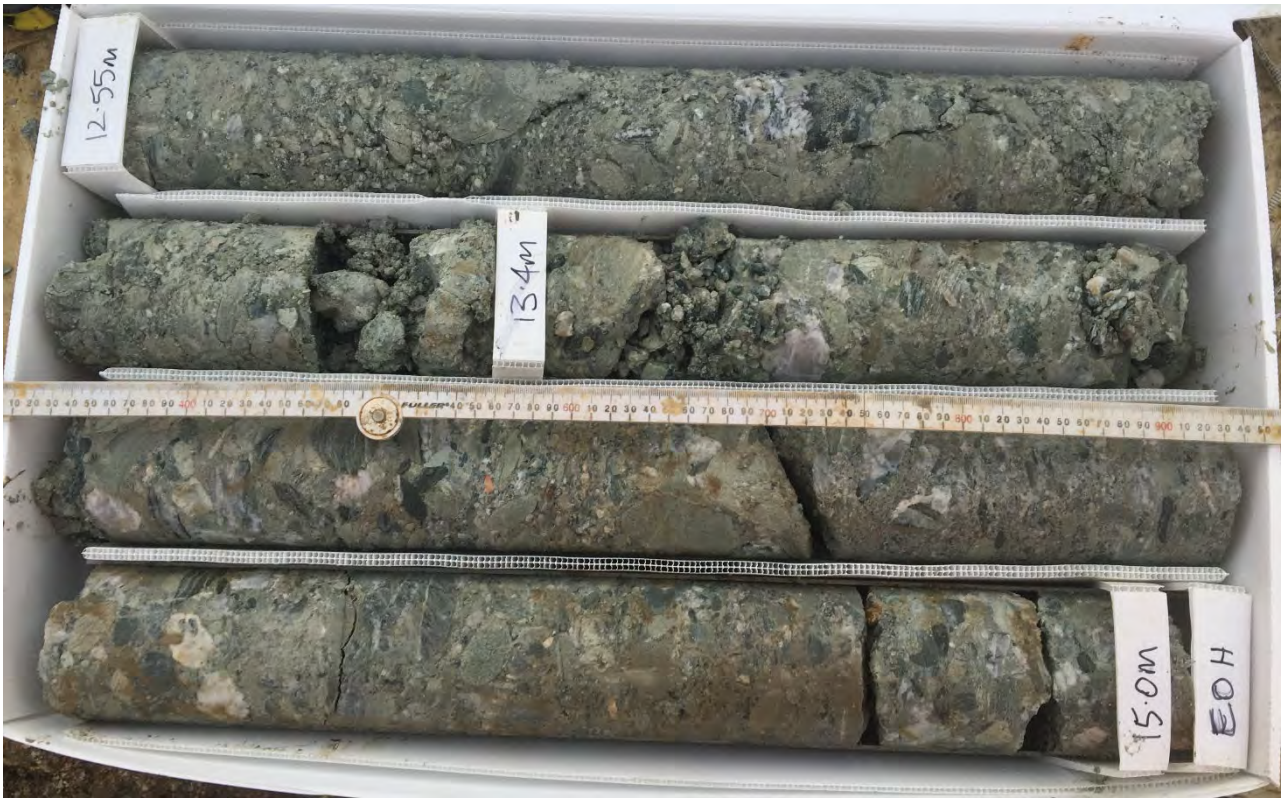
Box 3 of 6: 5.8 m to 8.25 m



Box 4 of 6: 8.25 m to 10.3 m



Box 5 of 6: 10.3 m to 12.55 m



Box 6 of 6: 12.55 m to 15.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Toe bund/central ridge
Job Number: 12506381
Commenced: 28/05/2019 Completed: 29/05/2019

Hole No. : BH03
Sheet : 1 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396428.38 Northing: 787998.34 System: TAIETM2000
RL: 107.48 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
107.48	0	0.00 - 0.20 TOPSOIL SILT, minor clay; light brown & grey. Very stiff, moist, low plasicity; organics mixed in soil.	TOPSOIL	M	VSt				PQTT				73			
107.28	0.2	0.20 - 1.90 Clayey SILT, trace fine sand, trace fine gravel; yellow brown & light grey. Very stiff to hard, moist, high plasticity. (LOESS).	LOESS	M	VSt-H		SV@1.5m 140/									
105.58	1.9	1.90 - 2.30 SILT, minor clay, minor fine sand; ligt grey & light orange brown. Very stiff to hard, dry to moist, low plasticity.		D-M	VSt-H				PQTT				100			
105.18	2.3	2.30 - 2.60 SILT, minor fine sand, trace clay; light grey and orange brown. Hard, dry, non plastic. Variable Fe staining throughout core.		D	'H'											
104.88	2.6	2.60 - 3.20 Inferred CORELOSS			"											
104.48	3.2	3.20 - 3.65 Silty, coarse sandy GRAVEL; brown. 'Very loose to loose', moist, well graded (completely weathered rock? never lithified?), clasts angular to sub angular; quartz & schist. Moisture content may be influenced by drilling fluid in loose materials.		M	VL-L				PQTT				60			
104.03	3.65	3.65 - 5.70 Fine to coarse GRAVEL, some silt, minor fine to coarse sand; purple. 'Dense', dry, well graded (highy weathered rock?), sub angular to angular clasts; quartz & schist. End of shift 28/05/19 at 17:16.		D	D											
101.78	5.7	5.70 - 6.05 Highly weathered, reddish grey BRECCIA Boulder; strength undetermined.							PQTT		HW		27			
101.43	6.05	6.05 - 6.20 Fine to coarse GRAVEL, some silt, minor fine to coarse sand; purple. 'Dense', dry, well graded (highy weathered rock?), sub angular to angular clasts; quartz & schist.	HENLEY BRECCIA	D	D											
101.28	6.2	6.20 - 6.60 SILT, minor fine to medium sand, trave to minor fine gravel; grey & yellow brown. Very stiff, moist, non plastic.		M	VSt				PQTT				100			
100.88	6.6	6.60 - 7.50 (800 mm coreloss assumed this unit) Fine to medium GRAVEL; white &grey. ' Very loose to loose', moist, well graded. Clasts are angular to sub angular quartz & schist. Any matrix has been washed away. Moisture content may be influenced by drilling fluid in loose materials.		M	'VL-L'								38			
100.03	7.5	7.50 - 7.90 SILT, trace fine gravel; brown, grey, light purple. Hard, dry, non plastic. (Transitions from hard silt to siltstone).		D	H											
99.63	7.9	7.90 - 8.45 Unweathered, dark grey SILTSTONE; weak to moderately strong; no obvious small scale bedding, no defects.			"				PQTT		UW		100			
99.03	8.45	8.45 - 8.90 Unweathered, grey fine SANDSTONE; weak to moderately strong; no obvious small scale bedding, no defects.									UW		100			
98.58	8.9	8.90 - 9.20 Inferred CORELOSS (loose sand layer washed away?).														
98.28	9.2	9.20 - 10.10 Unweathered, bedded, alternating dark grey & grey SILTSTONE & SANDSTONE; weak to moderately strong, no obvious small scale bedding, no defects. ~300-400 mm alternating SILTS.							PQTT		UW		73 69			

Groundwater level at the end of drilling 29-05-2019

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
Groundwater SWL at 3.9 mbgl during piezo install.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id: GEO1826

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Toe bund/central ridge
Job Number: 12506381
Commenced: 28/05/2019 Completed: 29/05/2019

Hole No. : BH03
Sheet : 2 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396428.38 Northing: 787998.34 System: TAIETM2000
RL: 107.48 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
	10.1		10.10 - 10.70 Unweathered, grey fine to medium SANDSTONE; very weak to weak; no defects.							PQTT		UW		123			
	10.7		10.70 - 10.90 SILT, minor clay; brown. Very stiff to hard, dry to moist, non plastic; looks organic in origin. (Buried topsoil?).		D-M	VSt-H						UW		100			
11	10.9 11.05		10.90 - 11.05 Unweathered, light grey SILTSTONE; very weak to weak; no defects.									UW					
			11.05 - 13.65 Unweathered, light grey & white BRECCIA; moderately strong to strong; Clasts; quartz & schist, fine to medium gravel size, angular to sub angular. Matrix supported, coarse sand matrix.														
12														100			
												UW		100			
13																	
	13.65		13.65 - 14.20 Unweathered, light grey fine SANDSTONE; moderately strong to strong; no defects. From 13.79 to 13.82 m: thin SILT layer, stiff.											94			
14	14.2		14.20 - 17.20 Unweathered, light grey & white BRECCIA; moderately strong to strong; Clasts; quartz & schist, fine to medium gravel size, angular to sub angular. Matrix supported, coarse sand matrix. Distict beds of fine & coarse clasts. 200 mm thick beds for both grain sizes.	HENLEY BRECCIA								UW		94			
														107			
15														100			
16																	
														93			
17														93			
	17.2		17.20 - 17.60 Fine to medium SAND; grey. 'Dense', dry to moist, poorly graded, non lithified. (SANDSTONE. Extremely weak to very weak, completely weathered to residual soil).		D-M	D						CW-RS					
	17.6		17.60 - 18.25 Unweathered, light grey fine SANDSTONE; moderately strong to strong; no defects.									UW					
18	18.25		18.25 - 19.25 Unweathered, grey BRECCIA; moderately strong to strong; no bedding evident, quartz & schist clast supported matrix, angular to sub angular up to 80 mm in size.											107			
												UW		100			
19																	
	19.25		19.25 - 20.00 Unweathered, light grey fine SANDSTONE; moderately strong to strong; One defect: Joint at 19.4 m, Very steeply inclined (75 degrees to core axis), stepped to planar, rough, tight, Fe staining.						122mm			UW		100			
			End of Hole @ 20.00m,Target Depth.											100			
20																	

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
Groundwater SWL at 3.9 mbgl during piezo install.

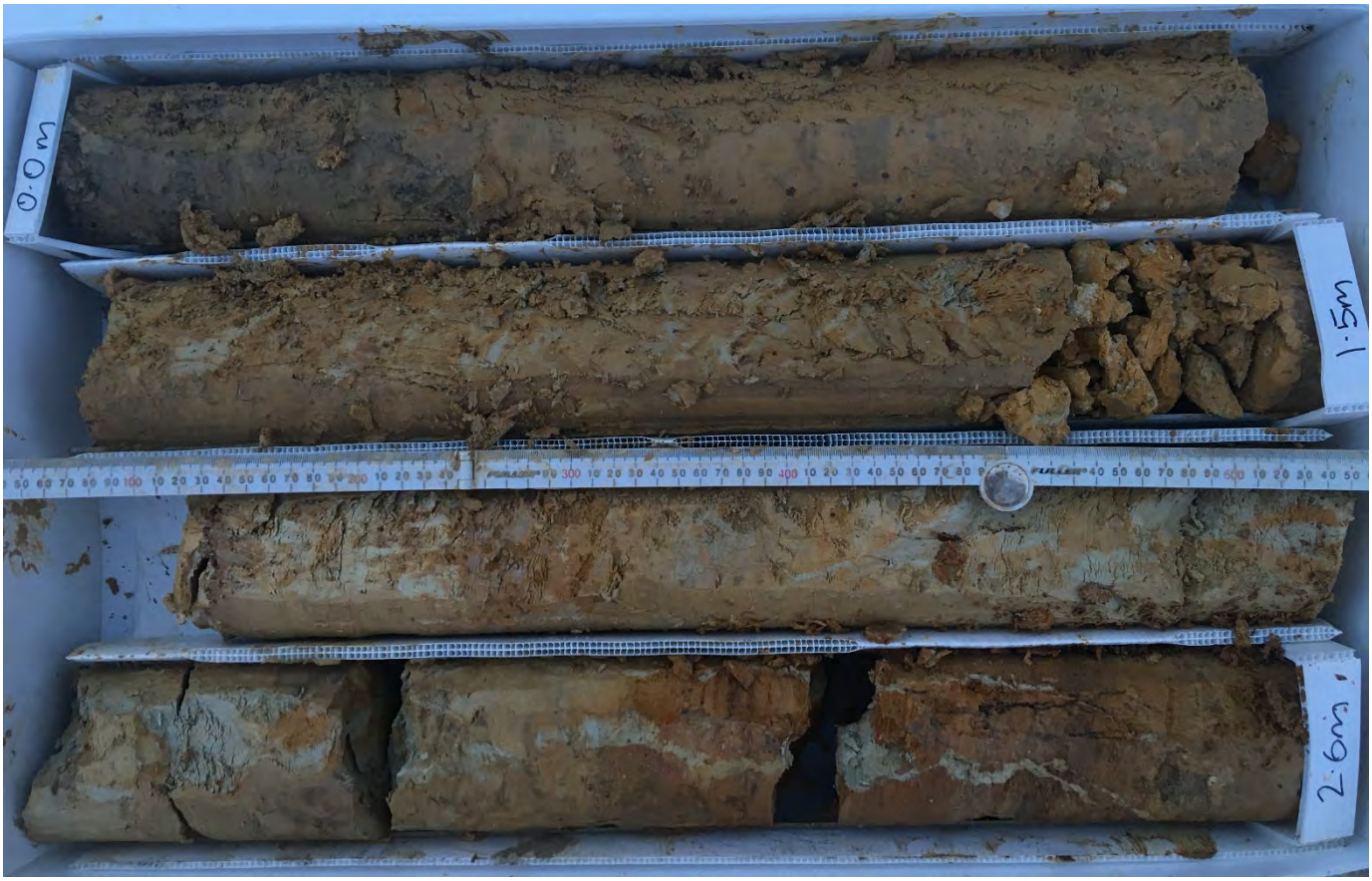
Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id: GEO1826

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
29/05/19	00:00	3.9	20

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 4
Borehole ID	BH03	



Box 1 of 8: 0.0 m to 2.6 m

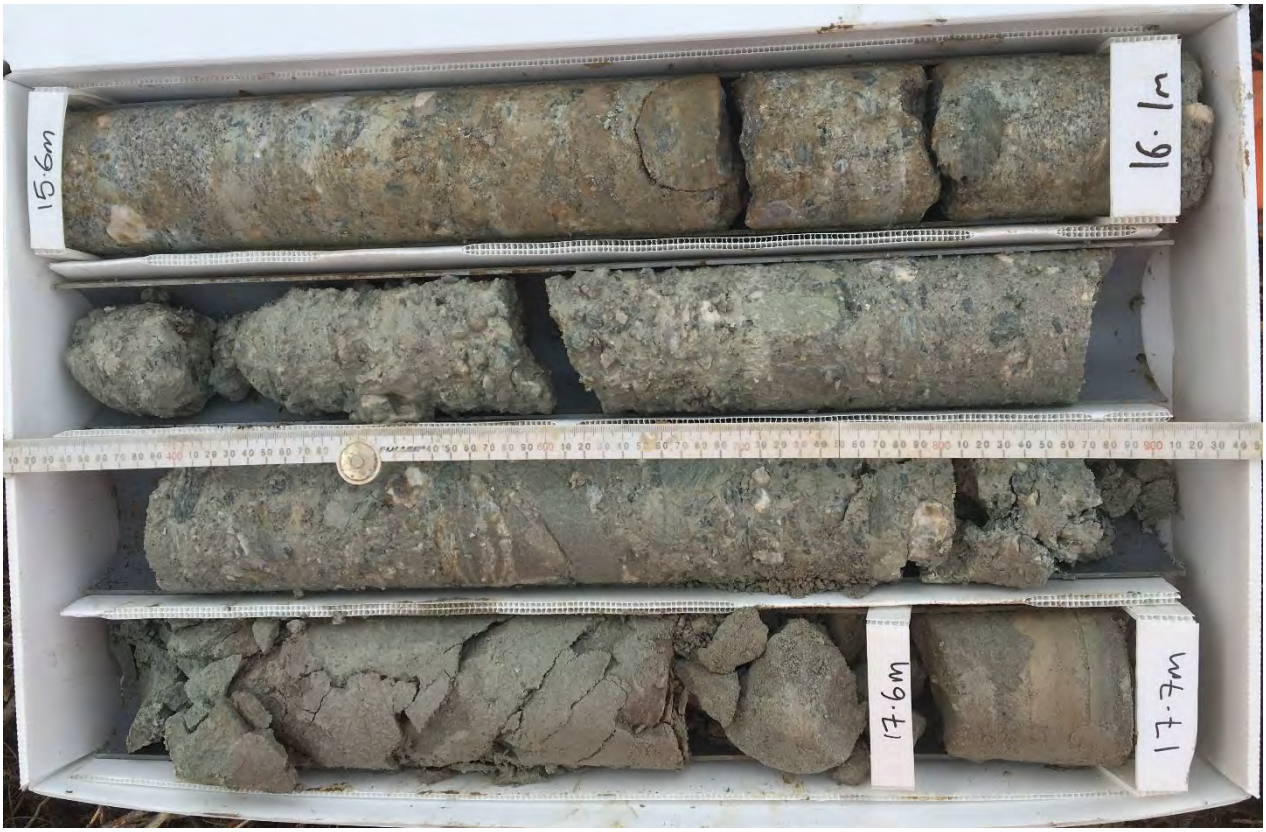
Box 2 of 8: 2.6 m to 6.25 m

Box 3 of 8: 6.25 m to 9.25 m

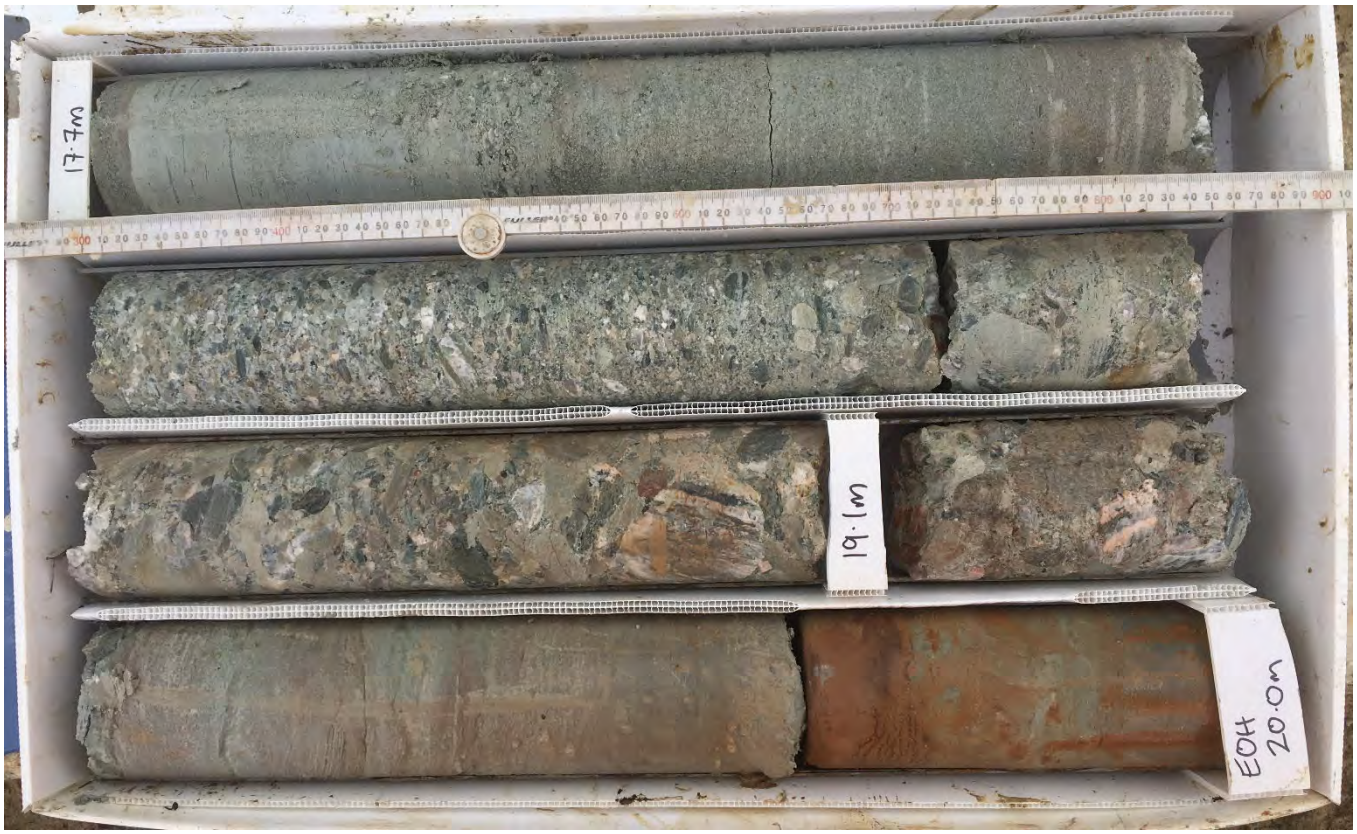
Box 4 of 8: 9.25 m to 11.05 m

Box 5 of 8: 11.05 m to 13.3 m

Box 6 of 8: 13.3 m to 15.6 m



Box 7 of 8: 15.6 m to 17.7 m



Box 8 of 8: 17.7 m to 20.0 m (EOH)

Project : Smooth Hill Landfill Consenting Client : Dunedin City Council Site : Smooth Hill Toe bund foundation Job Number: 12506381	**Hole No. : BH04** Sheet : 1 of 2 Hole Length : 15.00m Scale @ A4 : 1:50
Commenced: 6/06/2019 Completed: 7/06/2019	Logged : MF
Easting: 396563.6 Northing: 788063.75 System: TAIETM2000	Processed : HB
RL: 108.15 Datum: NZVD2016	Checked : JS

Depth (m)	Material Description	Geological Unit	Moisture condition	Consistency / Relative density	Method	Weathering	TCR / SCR / RQD (%)
0 – 0.25	0.00 - 0.25 SILT, minor clay; dark grey. Firm, moist, low plasticity. (TOPSOIL/FILL). From 0.2 m: some intermixing with underlying soil.	FILL	M	F	PQTT		100
0.25 – 0.9	0.25 - 0.60 SILT, minor clay, trace fine sand, trace organics (roots); orange brown. Stiff, moist, low plasticity. (LOESS). 0.60 - 0.90 From 0.6m, becomes light grey with orange-brown streaks, stiff to very stiff.	TOPSOIL / LOESS	M / M	St / St-VSt			
0.9 – 1.4	0.90 - 1.40 Silty fine to medium SAND; grey with orange streaks. Density undetermined, moist, poorly graded. from 1.1 m, becomes trace fine gravek, sub angular to sub rounded quartz and schist.	LOESS	M				
1.4 – 1.5	1.40 - 1.50 (BURIED TOPSOIL) SILT with roots; grey. Stiff to very stiff, moist, non plastic.	BURIED TOPSOIL	M	St-VSt	PQTT	HW	73
1.5 – 2.45	1.50 - 2.45 Silty, fine to coarse sandy, fine to medium GRAVEL; orange brown. Density undetermined, moisture content undetermined, well graded, quartz and schist clasts, sub angular to sub rounded. (Heavily weathered rock?).			"			
2.45 – 2.8	2.45 - 2.80 Inferred CORELOSS.						
2.8 – 4.4	2.80 - 4.40 Moderately weathered, light grey & orange brown fine to medium SANDSTONE; very weak to weak; poorly indurated, no defects. Fe banding throughout. Fe bands change angle downhole from sub horiztontal to sub vertical & back & back. Bedding 1-20 mm thick. (HENLEY BRECCIA).	HENLEY BRECCIA			PQTT	MW	100 / 100
4.4 – 4.7	4.40 - 4.70 Moderately weathered, CONGLOMERATE; extremely weak to very weak; poorly indurated, well graded, fine to coarse quartz and schist clasts, sub angular to rounded, silt matrix, matrix supported.			"	PQTT	MW	20 / 0
4.7 – 5.9	4.70 - 5.90 Inferred CORELOSS from this run.						
5.9 – 6.4	5.90 - 6.40 Inferred CORELOSS from this run.			"			
6.4 – 7.0	6.40 - 7.00 Slightly weathered, grey with purple-brown layers fine to medium SANDSTONE; very weak to weak; poorly indurated, poorly graded.				PQTT	SW	69 / 69
7.0 – 7.4	7.00 - 7.40 From 7.0 m, becomes moderately strong to strong, well indurated.					SW	
7.4 – 8.4	7.40 - 8.40 From 7.4 m, becomes very weak to weak, poorly indurated.				PQTT	SW	100 / 75
8.4 – 8.7	8.40 - 8.70 From 8.40 m, becomes moderately strong to strong, well indurated.					SW	
8.7 – 8.85	8.70 - 8.85 Slightly weathered, BRECCIA; moderately strong to strong; fine to medium gravel clasts, fine to coarse sand matrix.					SW	
8.85 – 9.6	8.85 - 9.60 Slightly weathered, light grey fine to coarse SANDSTONE; very weak to weak; poorly indurated, poorly graded, no defects.				PQTT	SW	83 / 63
9.6 – 10.1	9.60 - 10.10 From 9.6 m, becomes moderately strong to strong, well indurated.					SW	

Water level: 7-06-2019 (approx. 2.0 m)

Notes and Comments:

End of Hole @ 15.00m, Target Depth.

Groundwater at 2.52 mbtoc (TOC 0.53 m agl) - corrected groundwater at 1.99 mbgl 07/06/2019.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: McNiells

Equipment: Mounted Rig

Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Toe bund foundation
Job Number: 12506381
Commenced: 6/06/2019 Completed: 7/06/2019

Hole No. : BH04
Sheet : 2 of 2
Hole Length : 15.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396563.6 Northing: 788063.75 System: TAIETM2000
RL: 108.15 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
10	10.1																
	10.6		10.10 - 10.60 Slightly weathered, grey BRECCIA; moderately strong to strong; well indurated, fine to medium gravel clasts, fine to coarse sand matrix, matrix supported. Clasts are quartz & schist, sub rounded to angular. Very wide spaced defects.	HENLEY BRECCIA						PQTT		SW		83			
	10.8		10.60 - 10.80 Slightly weathered, light grey fine to coarse SANDSTONE; very weak to weak; poorly indurated, no defects.									SW		63			
11	11.1		10.80 - 11.10 Slightly weathered, brown SILTSTONE; very weak to weak; poorly indurated, no defects. From 11.0 m, becomes light grey.									SW					
			11.10 - 11.50 Slightly weathered, light grey & pinkish grey BRECCIA; weak to moderately strong; moderate to well indurated, no defects, fine to coarse gravel clasts, fine to coarse sand matrix, clast supported. Clasts are quartz and schist sub angular to angular. Note: clast size dcreases with depth. 11.50 - 12.20 From 11.5 m, becomes moderately strong to strong, well indurated, fine to medium gravel clasts. 12.20 - 15.00 From 12.2 m, becomes weak to moderately strong, moderate to well indurated, fine to coarse gravel clasts. From 13.9sm: clasts mostly medium to coarse gravel.							PQTT		SW		97			
12												SW		97			
												SW					
										PQTT		SW		88			
13														56			
												SW					
										PQTT				100			
14														73			
15			End of Hole @ 15.00m,Target Depth.														
16																	
17																	
18																	
19																	
20																	

Notes and Comments:
End of Hole @ 15.00m, Target Depth.

Groundwater at 2.52 mbtoc (TOC 0.53 m agl) - corrected groundwater at 1.99 mbgl 07/06/2019.

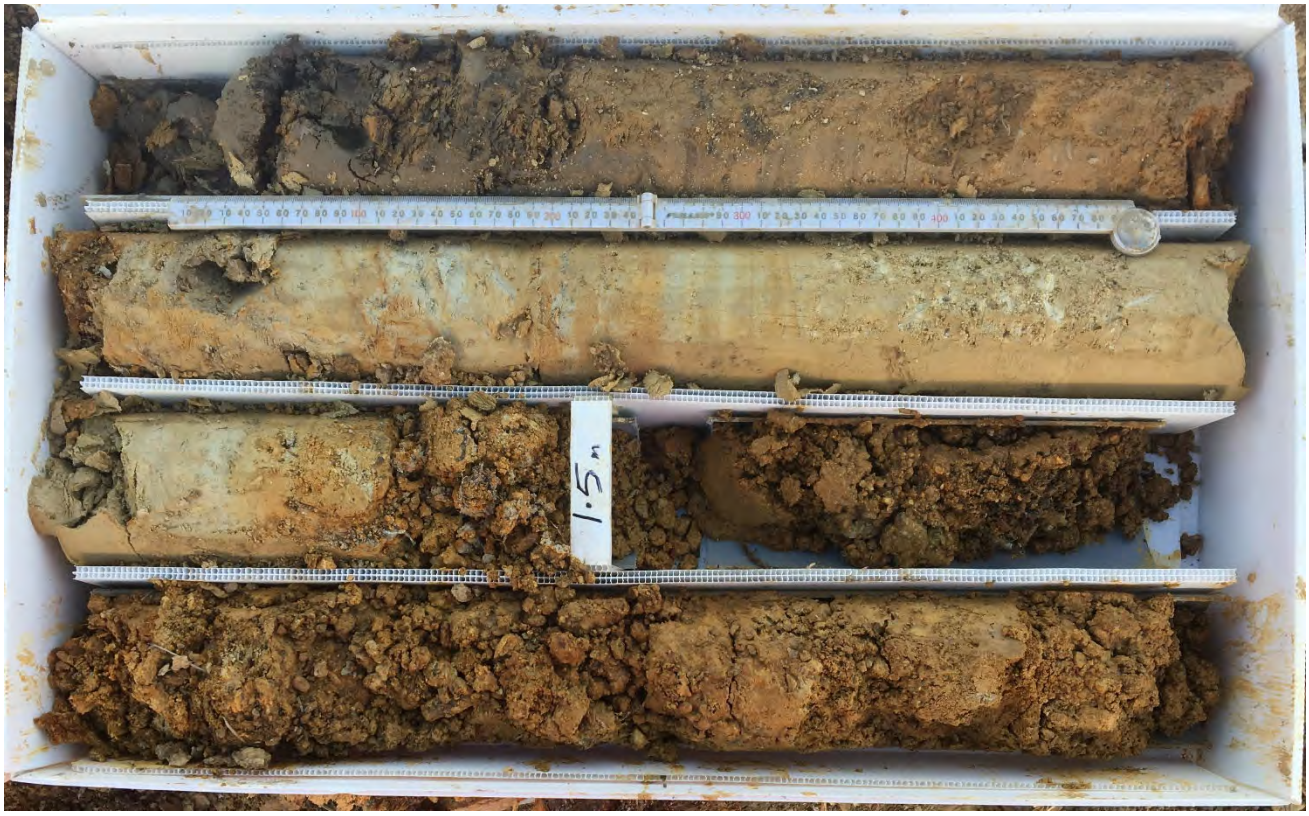
Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNiells
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

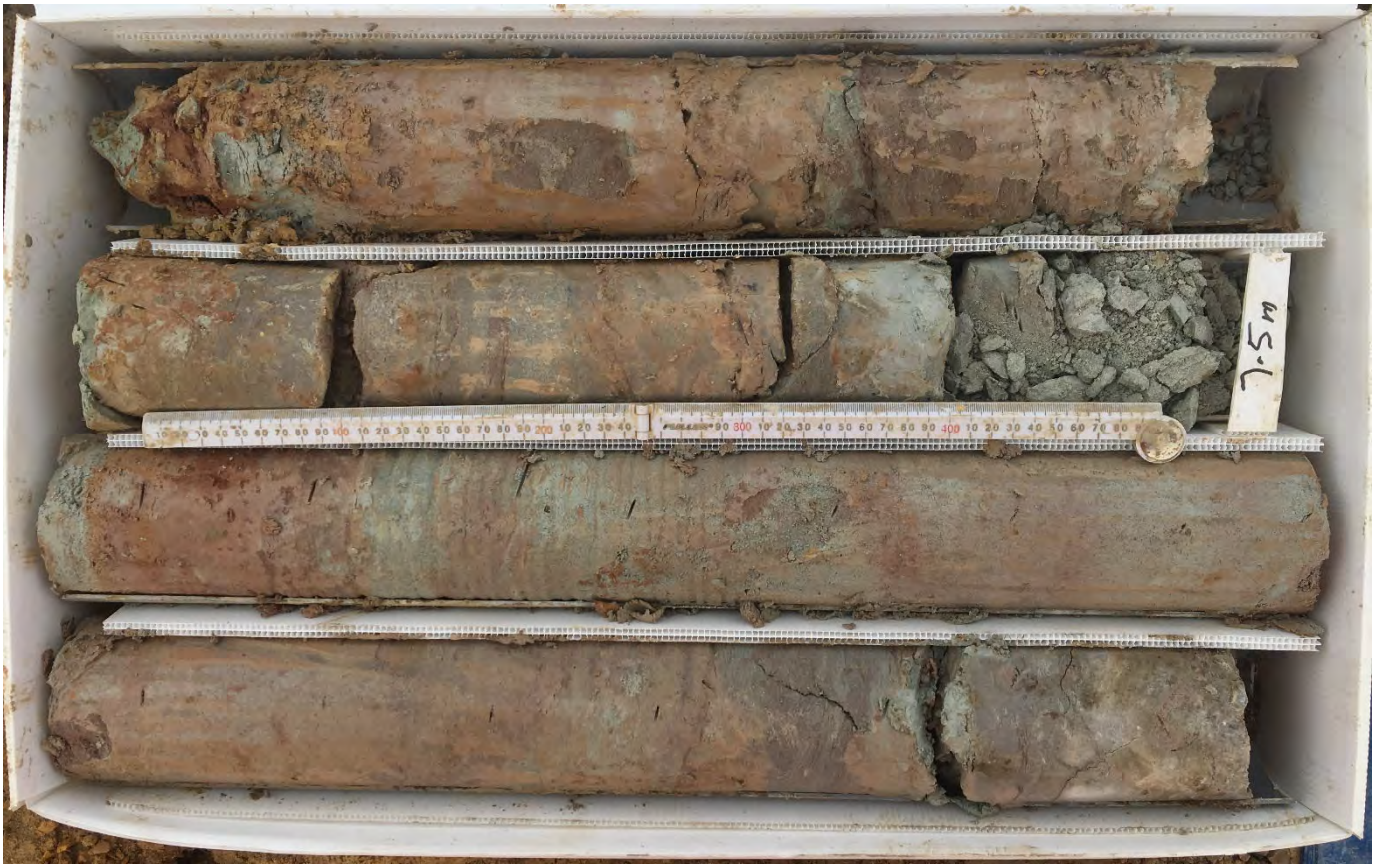
Date	Time	Reading (mbgl)	Hole depth (mbgl)
07/06/19	00:00	1.99	15

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 3
Borehole ID	BH04	



Box 1 of 6: 0.0 m to 2.7 m

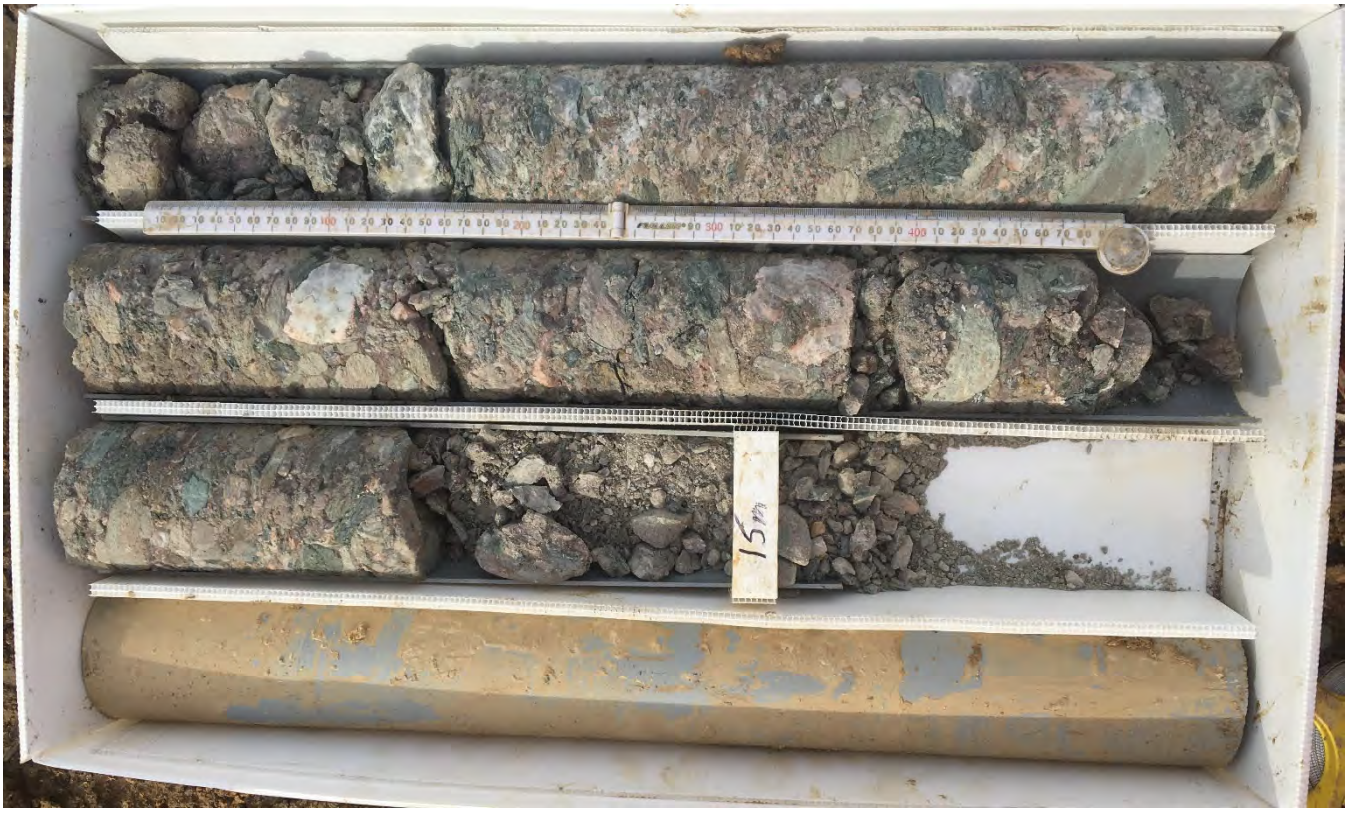
Box 2 of 6: 2.7 m to 5.9 m



Box 3 of 6: 5.9 m to 8.7 m

Box 4 of 6: 8.7 m to 11.1 m

Box 5 of 6: 11.1 m to 13.5 m



Box 6 of 6: 13.5 m to 15.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Central ridge
Job Number: 12506381
Commenced: 29/05/2019 Completed: 30/05/2019

Hole No. : BH05
Sheet : 1 of 3
Hole Length : 30.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396459.76 Northing: 787862.12 System: TAIETM2000
RL: 129.5 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
129.5	0	0.00 - 0.80 Clayey SILT; grey & dark orange brown. Very stiff, moist, high plasticity. (LOESS).	LOESS	M	VSt				PQTT				100			
128.7	0.8	0.80 - 1.00 SILT, minor clay, trace fine sand; orange brown with some grey. Very stiff, moist, low plasticity.		M	VSt											
128.5	1	1.00 - 1.50 Fine to medium gravelly SILT, trace clay; orange brown & white. Very stiff, moist, low plasticity.		M	VSt		SV@1.5m UTP									
128	1.5	1.50 - 2.70 Inferred CORELOSS Catcher did not grip sample. Note: No shear vane undertaken at 2.7 m due to no core.			"				PQTT				0			
127.3	2.2	2.70 - 2.80 Fine to medium gravelly SILT, trace clay; orange brown & white. Very stiff, moist, low plasticity.		M	VSt				PQTT				53			
		2.80 - 3.50 Inferred CORELOSS (Washed away?).			"											
126.5	3	3.50 - 3.70 Fine to medium GRAVEL; creamy white. Undetermined density, undetermined moisture condition, well graded, quartz & schist gravel, angular to sub angular.		M	VSt											
126.3	3.2	3.70 - 3.80 Fine to medium gravelly SILT, trace clay; orange brown & white. Very stiff, moist, low plasticity. Fe staining on upper contact.		D-M	H											
126.2	3.3	3.80 - 4.00 SILT, trace organics; light grey. Hard, dry to moist, non plastic.		M	VSt											
125.5	4	4.00 - 4.45 Fine gravelly SILT, trace clay, trace organics; orange brown & light grey. Very stiff, moist, non plastic. Note no shear vane at 4.2 m due to material being too gravely.		D-M	H				PQTT				103			
125.05	4.45	4.45 - 5.70 SILT, trace clay, trace organics; light grey with orange brown streaks. Hard, dry to moist, non plastic. From 5.1 m, becomes orange brown with some light grey. From 5.35 m, 2-3 mm Fe "gravel" beds. From 5.6 m, becomes very thinly laminated (2-3mm).		M	St-VSt		SV@5.7m UTP									
123.8	5.7	5.70 - 5.90 Silty CLAY, trace fine sand, trace organics; brown to grey. Stiff to very stiff, moist, high plasticity.		M	H											
123.6	5.9	5.90 - 6.50 SILT, trace clay, trace organics; light grey with black flecks. Hard, moist, non plastic, Fe staining. Note: Fe stained contact at 6.50 m.		M	H				PQTT		MW		100			
123	6.5	6.50 - 6.80 SILT, trace medium gravel (schist), brown to grey. Hard, moist, non plastic. Note: dark orange brown Fe stained contact at 6.80 m.		D	H						MW					
122.7	6.8	6.80 - 7.20 SILT, trace organics; light grey & orange brown, with black flecks. Hard, dry, non plastic, thin (<1mm) 'rusty' laminations.									MW					
122.3	7.2	7.20 - 7.75 Moderately weathered, dark grey with black streaks SILTSTONE; very weak to weak; thinly beded, contains organic rich layers, defects 500-1000 mm spacing.									MW		100 87			
121.75	7.75	7.75 - 7.80 Moderately weathered, grey SANDSTONE; very weak; 50 mm bedded layer within siltstone.									SW					
121.7	7.8	7.80 - 8.50 Moderately weathered, dark grey with black streaks SILTSTONE; very weak to weak; thinly beded, contains organic rich layers, defects 500-1000 mm spacing. From, 7.9 m: 2-5 mm thick lignite layers. At 8.2 m: 20 mm lignite layer. At 8.32 m to 8.37 m: 50 mm lignite layer. At 8.42 m to 8.44 m: 20 mm lignite layer.							PQTT		SW		93			
121	8.5	8.50 - 8.70 From 8.5 m, becomes slightly weathered, lignite									SW		93			

Notes and Comments:
End of Hole @ 30.00m, Target Depth.

~ 0.5 m topsoil stripped to make drill pad
Groundwater SWL at 16.4 mbgl during piezo install.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id: GEO1826

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project	: Smooth Hill Landfill Consenting	Hole No.	: BH05
Client	: Dunedin City Council	Sheet	: 2 of 3
Site	: Smooth Hill Central ridge	Hole Length	: 30.00m
Job Number: 12506381		Scale @ A4	: 1:50
Commenced: 29/05/2019	Completed: 30/05/2019	Logged	: MF
Easting: 396459.76	Northing: 787862.12	Processed	: HB
System: TAIETM2000		Checked	: JS
RL: 129.5	Datum: NZVD2016		

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
			layers gone but occassional organic rich layers remain. 8.70 - 9.10 From 8.7 m. becomes weak to moderately strong.														
			9.10 - 9.60 Slightly weathered, grey SANDSTONE; weak to moderately strong; fine sand to coarse gravel size grains, wide spaced defects, no organic content.														
			9.60 - 9.77 Slightly weathered, grey SILTSTONE; weak to moderately strong; bedded siltstone layer in sandstone.														
			9.77 - 13.20 Slightly weathered, grey SANDSTONE; weak to moderately strong; fine sand to coarse gravel size grains, wide spaced defects, no organic content. From 10.2 m, becomes fine grained. At 10.25 m to 10.27 m: 20 mm lignite layer. From 10.9 m, becomes fine to coarse sand, trace fine gravel (quartz & schist) grainsize. From 11. 4 m, becomes fine sand grainsize, occassional organic layers (thin), occassional defects (~ 1/m), black staining. From 12.69 m to 12.73 m, organic rich 2 mm lignite layer at each end.	LOESS						PQTT		SW		97 97			
			13.20 - 14.10 From 13.20 m, becomes moderately strong to strong.							PQTT		SW		100 100			
	14.1		14.10 - 14.60 Unweathered, massive, grey & white BRECCIA; moderately strong to strong; fine to coarse gravel size clasts, coarse sand matrix. Matrix supported. Clasts are angular to sub angular quartz and schist, some clasts up to 100 mm in grainsize.	HENLEY BRECCIA						PQTT		SW		100 100			
			14.60 - 15.60 From 14.6 m, becomes weak to moderately strong. Softer matrix.							PQTT		UW		100 93			
			15.60 - 16.20 From 15.6 m, becomes moderately strong to strong. Matrix more lithified.							PQTT		UW		87 67			
			16.20 - 16.60 From 16.20 m, becomes weak to moderately strong. Matrix less lithified.							PQTT		UW		100 93			
			16.60 - 17.10 From 16.60 m, becomes moderately strong to strong. Matrix more lithified.							PQTT		UW		100 94			
			17.10 - 17.70 From 17.1 m, becomes weak to moderately strong. Matrix less lithified.							PQTT		UW					
	17.7		17.70 - 18.10 Inferred CORELOSS (weaker rock matrix?).			"				PQTT		UW					
	18.1		18.10 - 18.50 Unweathered, massive, grey & white BRECCIA; very weak to weak; fine to coarse gravel size clasts. Clast supported. Clasts are angular to sub angular quartz and schist, some clasts up to 100 mm in grainsize. Weaker matrix resulted in lots of rock breakup during drilling/extraction from tube. Note: do not think it is defect controlled or open in ground. From 18.3 m, becomes coarse gravel dominated. 18.50 - 19.20 From 18.50 m, becomes moderately strong to strong. Matrix more lithified.							PQTT		UW					
	19.2		19.20 - 20.00 Slightly weathered, grey fine SANDSTONE; very weak to weak; orange Fe stained layer every ~ 300 mm.							PQTT		SW					

Notes and Comments:

End of Hole @ 30.00m, Target Depth.

~ 0.5 m topsoil stripped to make drill pad
Groundwater SWL at 16.4 mbgl during piezo install.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: McNeills

Equipment: Mounted Rig

Shear Vane Id: GEO1826

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project	: Smooth Hill Landfill Consenting	Hole No.	: BH05
Client	: Dunedin City Council	Sheet	: 3 of 3
Site	: Smooth Hill Central ridge	Hole Length	: 30.00m
Job Number:	12506381	Scale @ A4	: 1:50
Commenced:	29/05/2019 Completed: 30/05/2019	Logged	: MF
Easting:	396459.76 Northing: 787862.12 System: TAIETM2000	Processed	: HB
RL:	129.5 Datum: NZVD2016	Checked	: JS

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
21	20		Core breaks on Fe stained layers but unlikely layers are open in ground. The weakest plane is what breaks during handling. The Fe stained layers probably indicate time gaps in depositional history.							PQTT		SW		100			
			20.00 - 20.55 From 20.0 m, very weak to weak, occassional slightly weathered, grey siltstone layers (bedding) up to 50 mm.									SW		94			
			20.55 - 20.65 From 20.55 m, becomes moderately strong to strong.									SW					
			20.65 - 21.80 From 20.65 m, becomes very weak to weak.									SW		103			
22	21.95		21.80 - 21.95 From 21.8 m, becomes weak to moderately strong.									SW		100			
	22.4		21.95 - 22.00 At 21.9 m: slightly weathered, grey SILTSTONE (20 mm bedded layer).									SW					
			22.00 - 22.40 From 22.0 m, becomes moderately strong to strong									SW					
23			22.40 - 24.10 Slightly weathered, grey pinkish white BRECCIA; moderately strong to strong; clast supported, fine to coarse gravel size clasts, angular to sub angular quartz and schist clasts.									SW		87			
			From 23.8 m, becomes fine gravel size clasts with occassional coarse gravel clasts.									SW		87			
24			24.10 - 24.30 From 24.1 m, becomes very weak to weak. Soft matrix.									SW					
			24.30 - 24.65 From 24.3 m, becomes moderately strong to strong.									SW		100			
			24.65 - 24.75 From 24.65 m, becomes very weak to weak. Soft matrix.									SW					
25			24.75 - 26.65 From 24.75 m, becomes moderately strong to strong. Hard matrix (well indurated).	HENLEY BRECCIA								SW					
			Note: from 25.3 m to 26.65 m, clast size increasing.									SW					
26												SW		87			
	26.65		26.65 - 26.80 SILT; brown. Hard, dry, non plastic. Breaks down from completely weathered to residual, brown SILTSTONE; extremely weak to very weak.		D	H						CW-RS					
27			26.80 - 27.20 Silty SAND; light grey. 'Very dense', dry, moderately graded.		D	VD						CW-RS					
	27.3		27.20 - 27.30 From 27.2 m, becomes SILT brown. Hard, dry, non plastic.		D	H						CW-RS					
	27.8		27.30 - 27.80 From 27.3 m, becomes fine to medium SAND; brown. 'Dense', dry, poorly graded. Breaks down from completely weathered to residual, brown fine to medium SANDSTONE; very weak.		D	D						CW-RS					
28			27.80 - 28.40 Slightly weathered, light brown, grey, white BRECCIA; weak to moderately strong; clast supported, fine to coarse gravel size quartz and schist clasts, angular to sub angular.									SW					
			28.40 - 30.00 From 28.4 m, becomes unweathered, moderately strong to strong, clast size increases.									UW					
29																	
			End of Hole @ 30.00m,Target Depth.						122mm	PQTT							

Notes and Comments:

End of Hole @ 30.00m, Target Depth.

~ 0.5 m topsoil stripped to make drill pad
Groundwater SWL at 16.4 mbgl during piezo install.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: McNeills

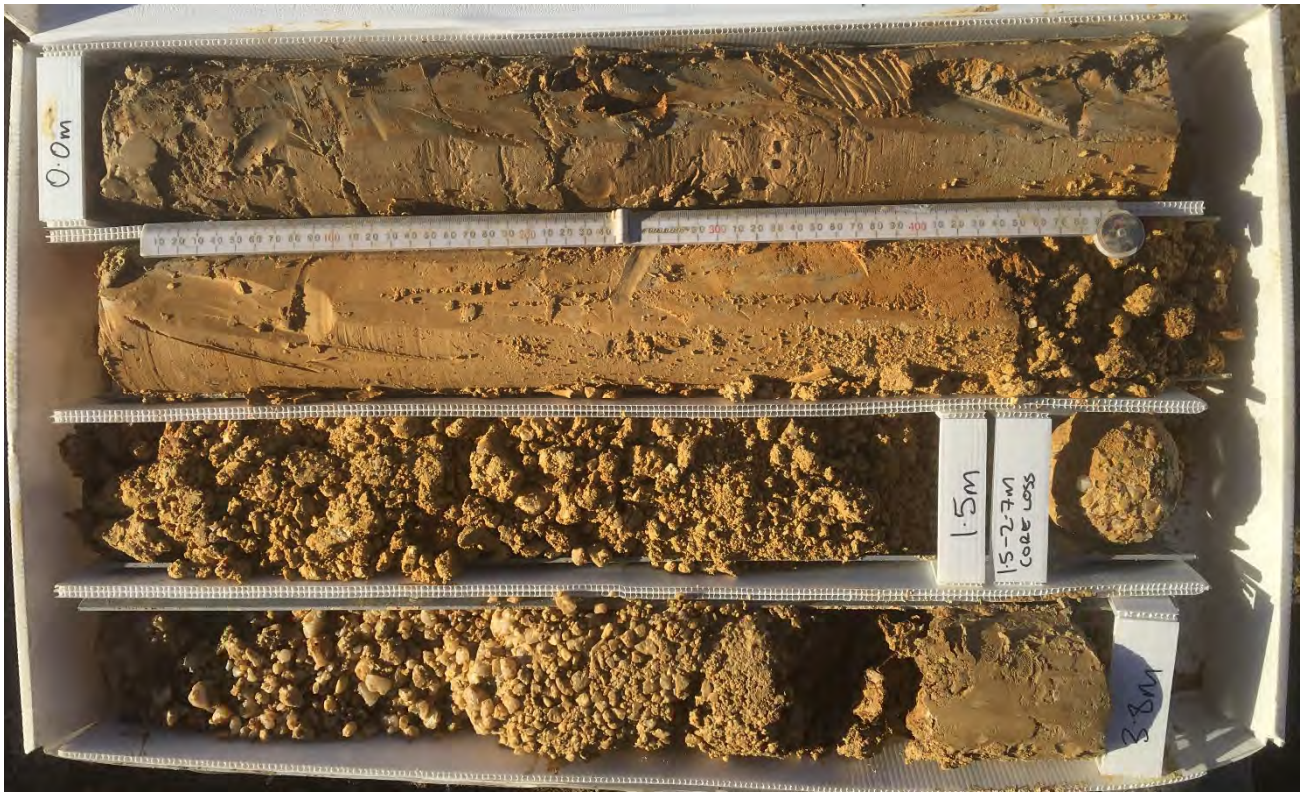
Equipment: Mounted Rig

Shear Vane Id: GEO1826

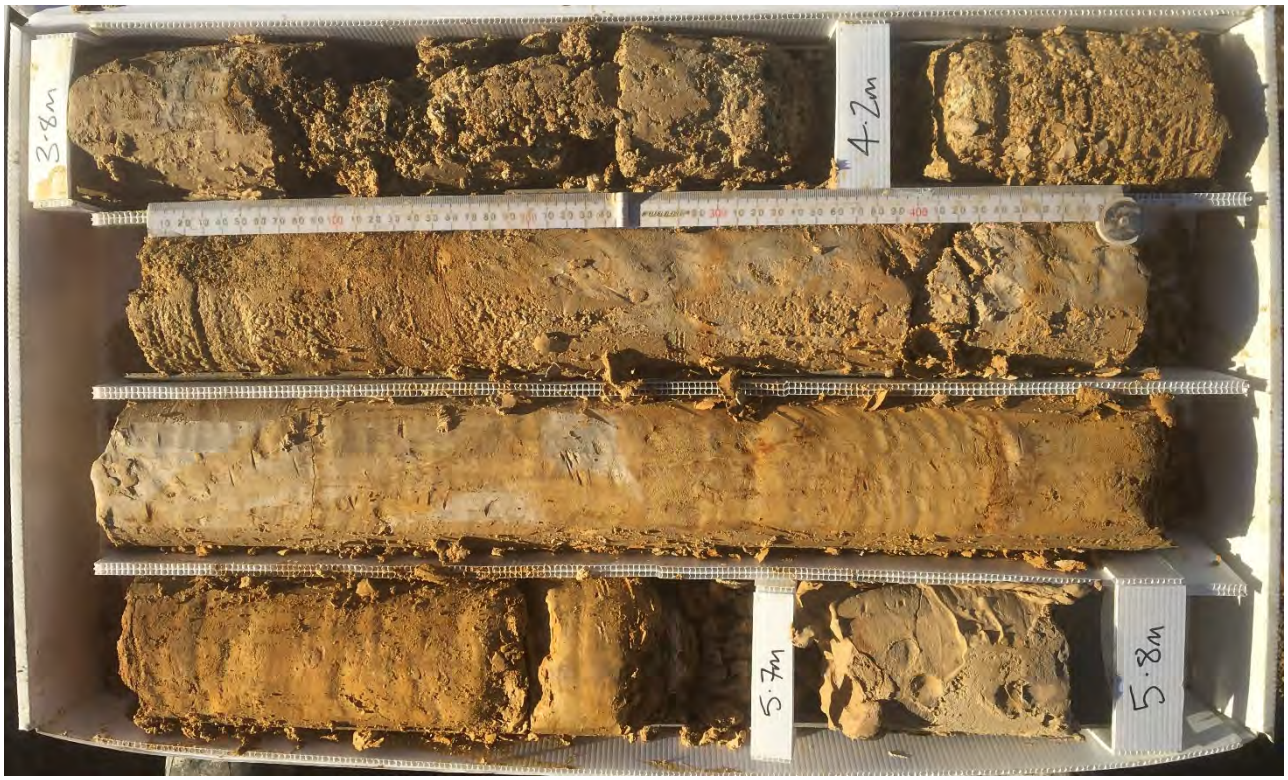
Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
30/05/19	00:00		30

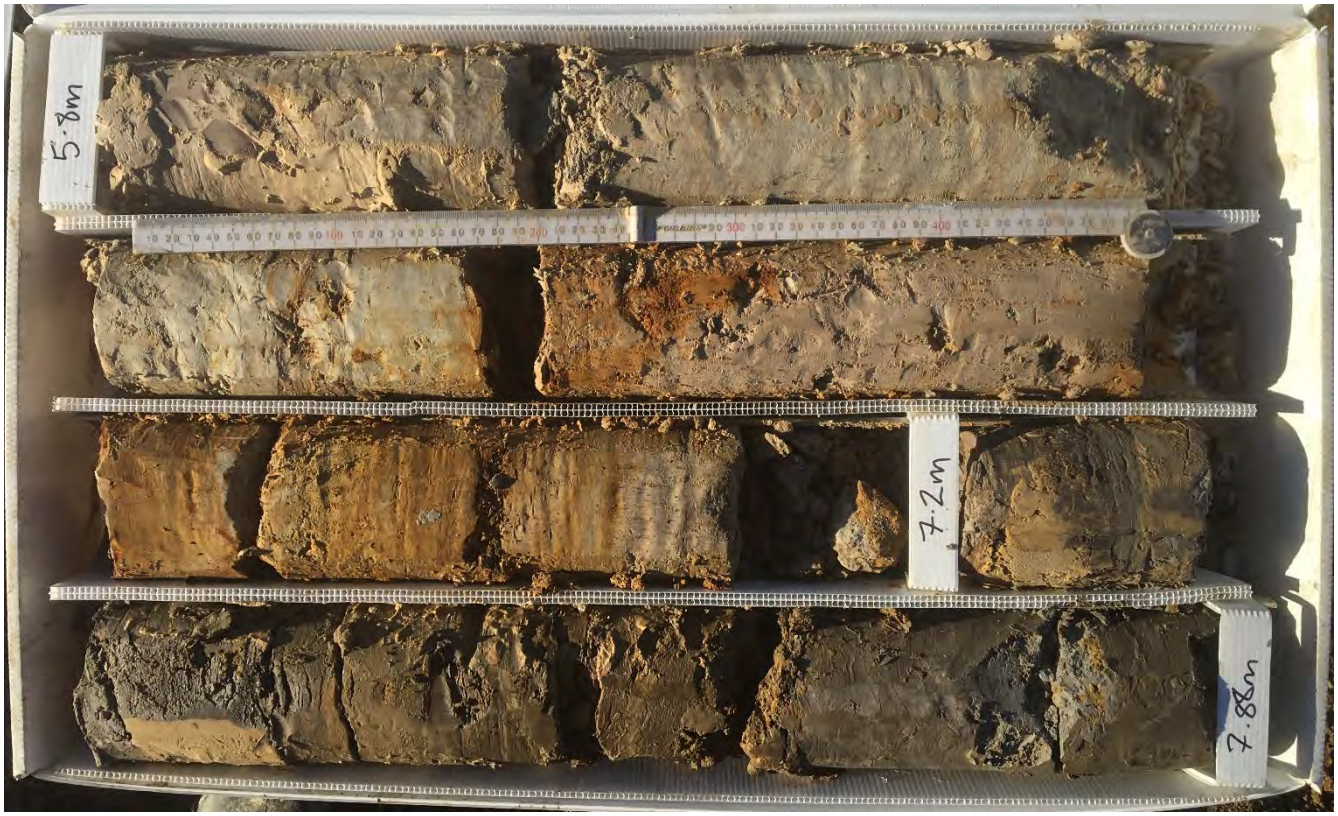
Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 7
Borehole ID	BH05	



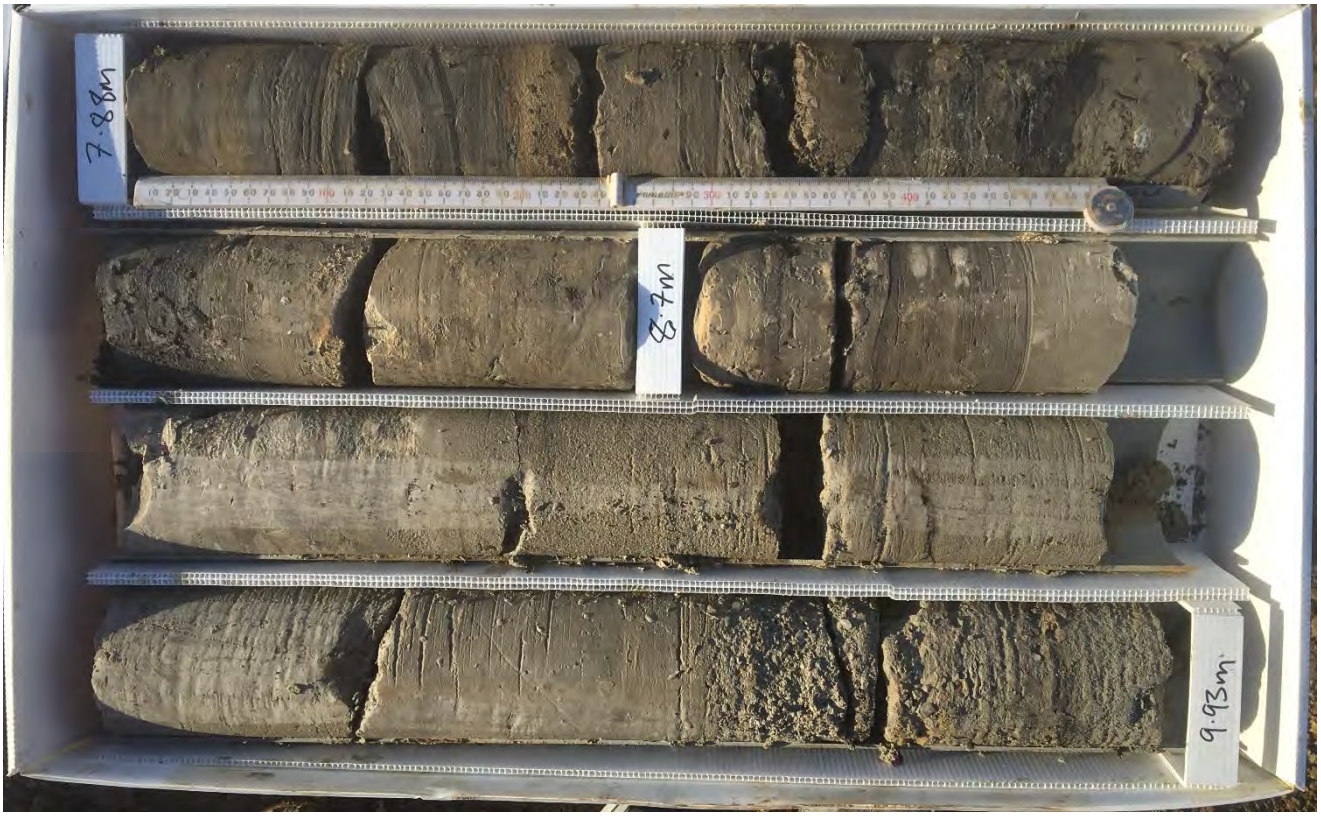
Box 1 of 14: 0.0 m to 3.8 m



Box 2 of 14: 3.8 m to 5.8 m



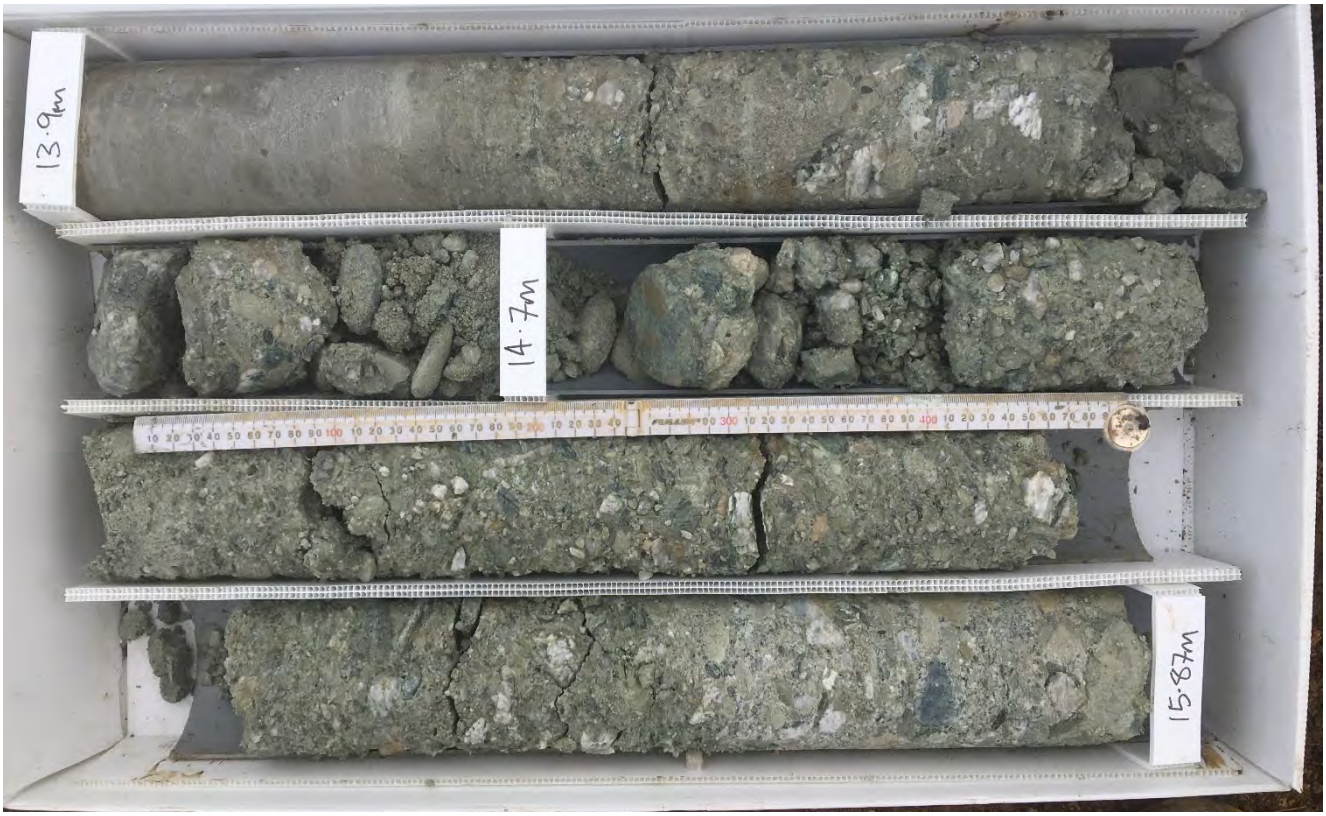
Box 3 of 14: 5.8 m to 7.88 m



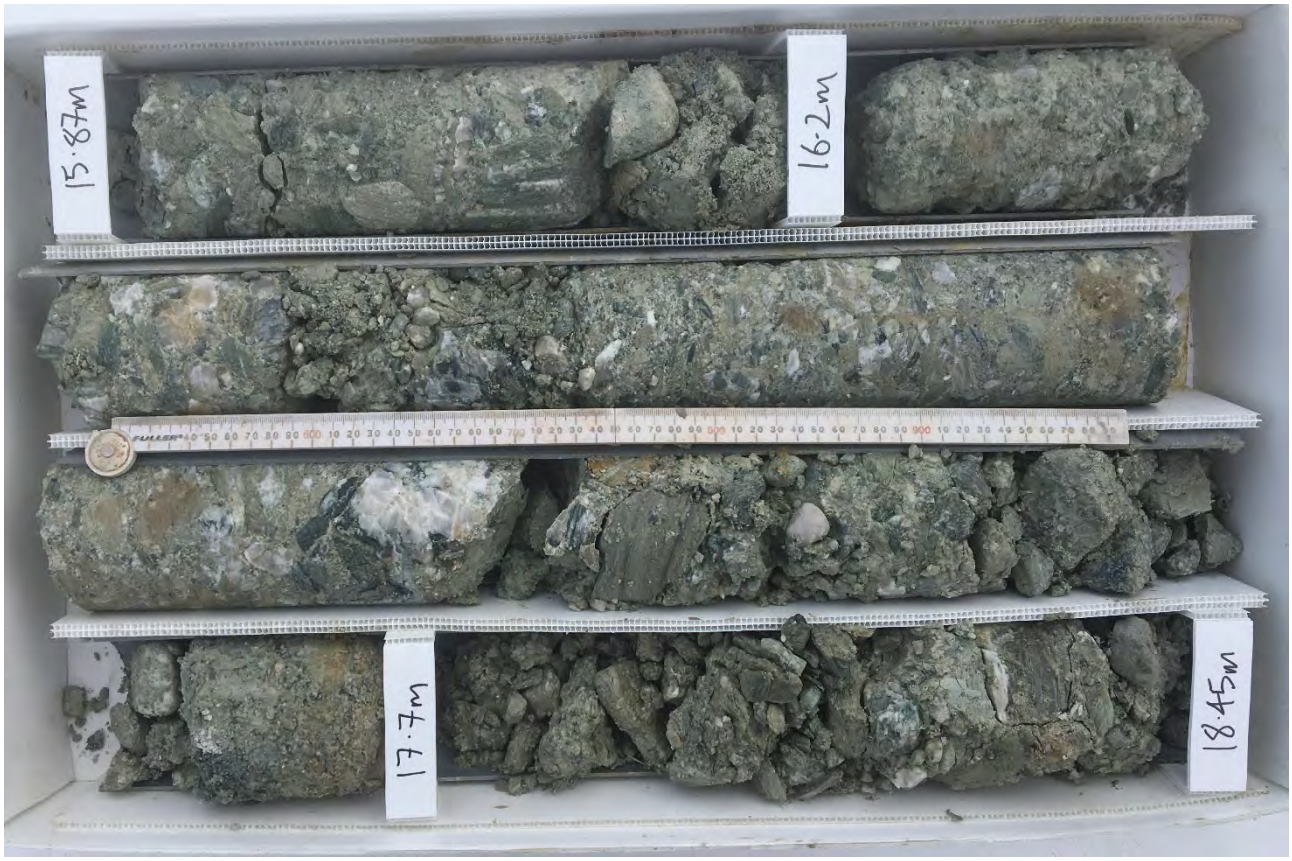
Box 4 of 14: 7.88 m to 9.93 m

Box 5 of 14: 9.93 m to 11.87 m

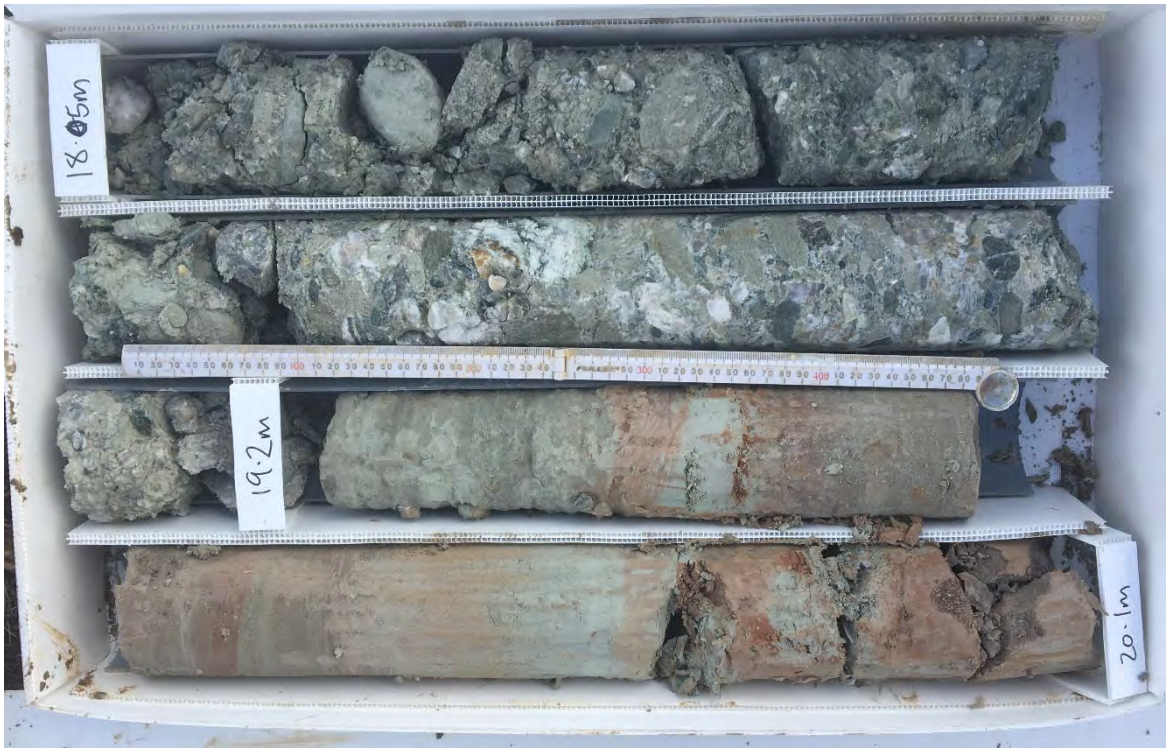
Box 6 of 14: 11.87 m to 13.9 m



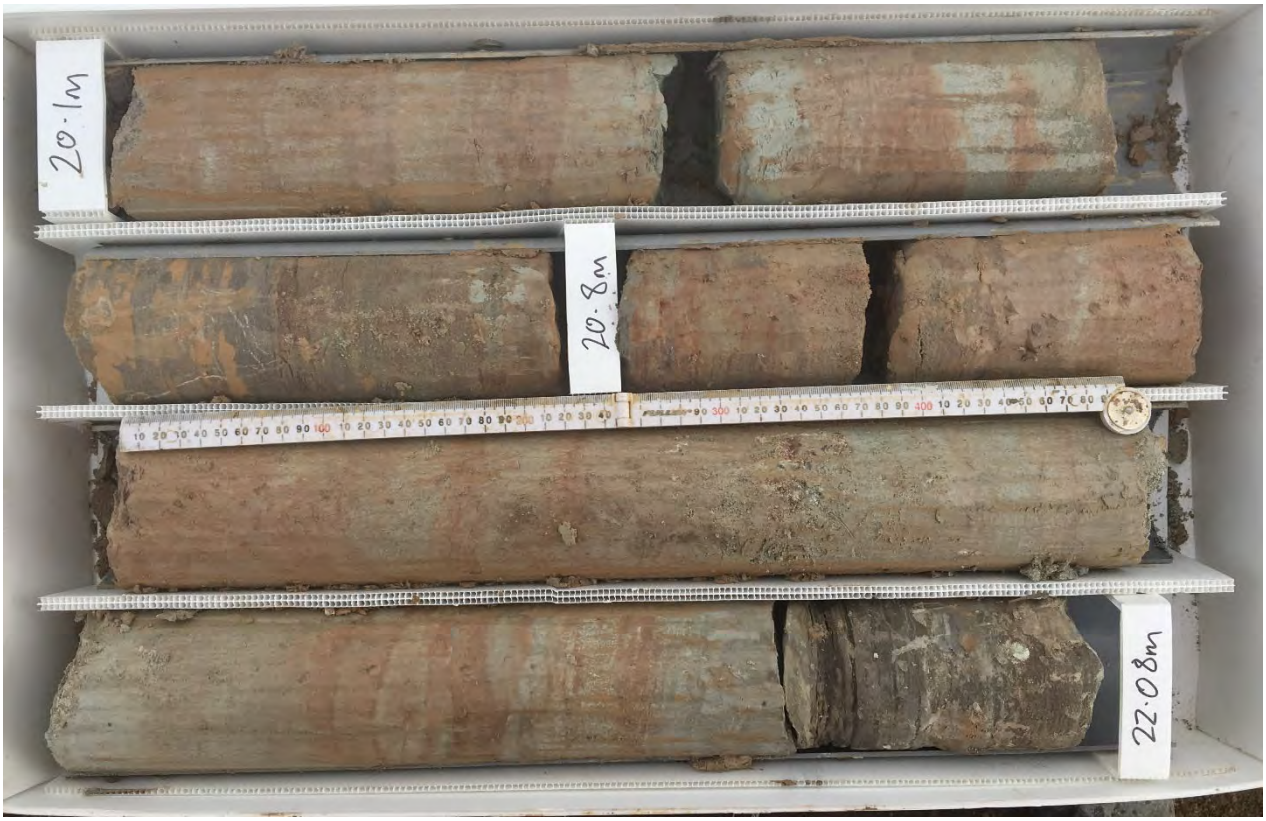
Box 7 of 14: 13.9 m to 15.87 m



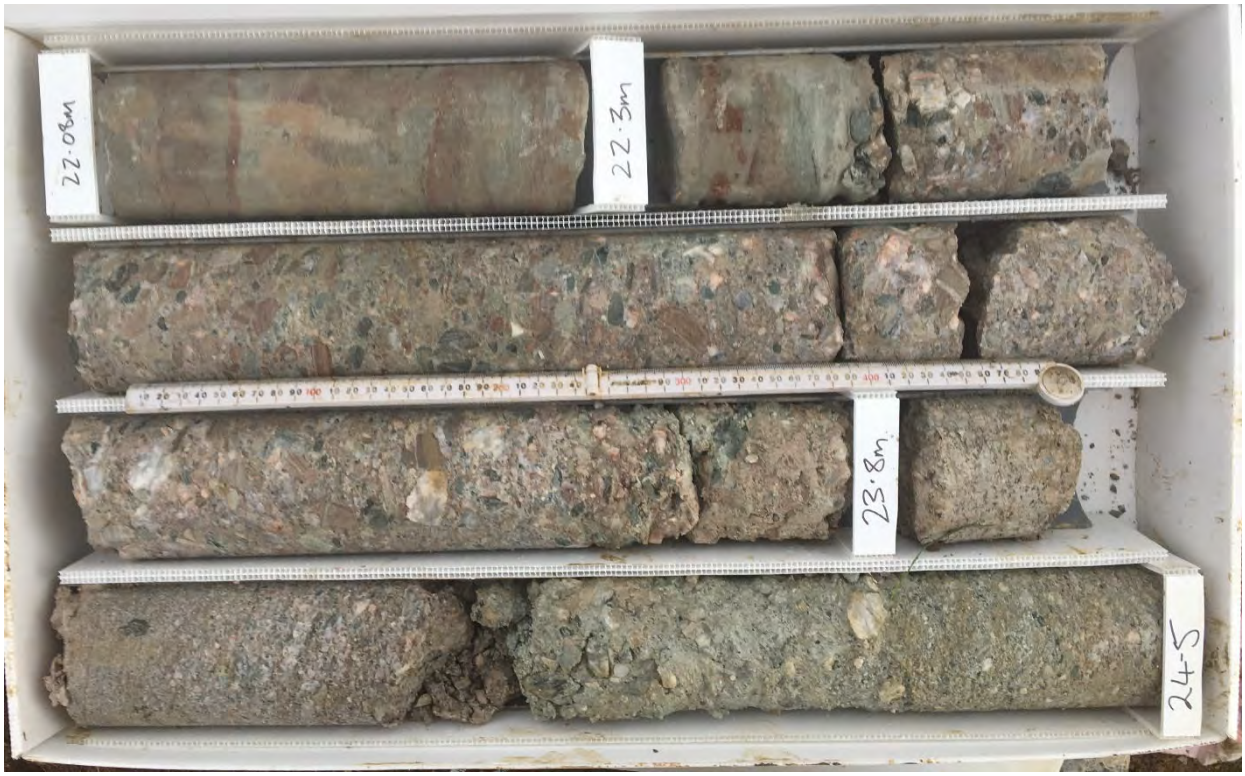
Box 8 of 14: 15.87 m to 18.45 m



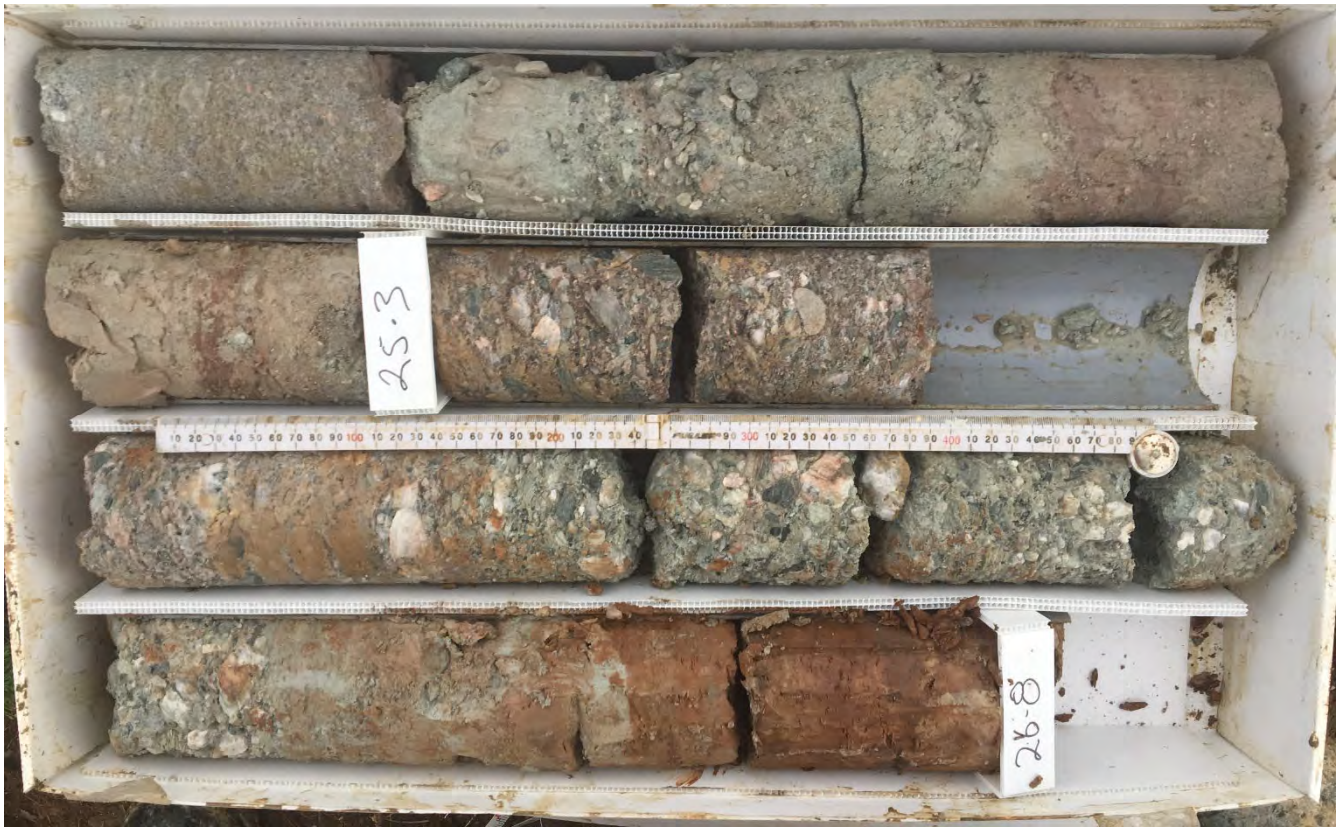
Box 9 of 14: 18.45 m to 20.1 m



Box 10 of 14: 20.1 m to 22.08 m

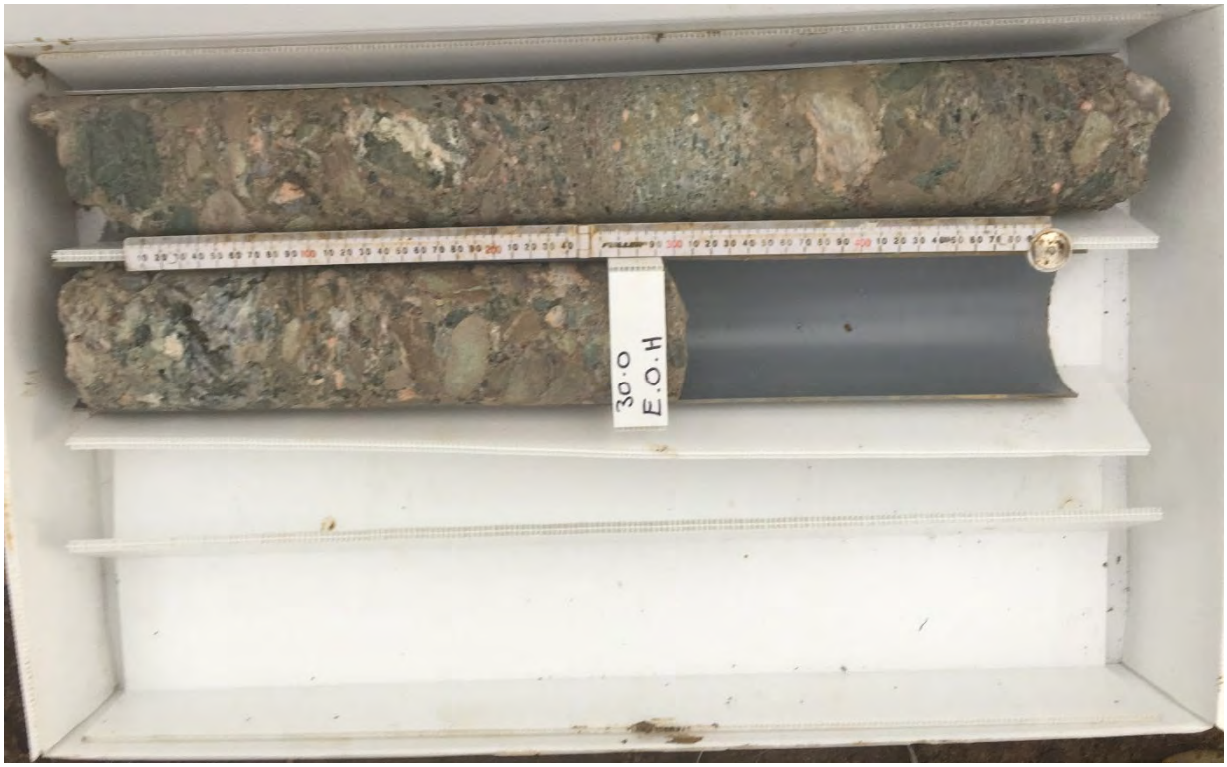


Box 11 of 14: 22.08 m to 24.5 m



Box 12 of 14: 24.5 m to 26.8 m

Box 13 of 14: 26.8 m to 29.0 m



Box 14 of 14: 29.0 m to 30.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Ridge
Job Number: 12506381
Commenced: 13/06/2019 Completed: 14/06/2019

Hole No. : BH06
Sheet : 1 of 3
Hole Length : 30.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 396168.25 Northing: 787593.98 System: TAIETM2000
RL: 149.75 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
149	0	Top 250 mm dug out for drill pad (TOPSOIL)	TS													
	0.25	SILT, trace to minor clay, trace fine to medium sand, trace fine gravel; grey and orange-brown. Very stiff, moist, low plasticity (LOESS)	LOESS	M	VSt				PQTT				83 17			
1																
	1.25	Highly weathered, yellow-brown SILTSTONE; extremely weak; no defects (HENLEY BRECCIA)	HENLEY BRECCIA													
148	1.5	Highly weathered, thinly bedded, yellow-brown silty fine SANDSTONE; extremely weak; no defects; iron-staining in layers and spots; trace organics throughout;							PQTT				100 89			
2																
147		2.70 m: 170 mm layer gravelly SANDSTONE							PQTT		HW		93 75 75			
3																
146																
4																
145		4.90 m: 200mm loose sand/pebbly layer; likely coreloss depth							PQTT				78 78 78			
5																
144		5.50 - 5.70 m: Fine gravel (quartz and schist, angular to sub-angular) layer														
6																
143		6.70 - 7.20 m: moderately weathered, very weak to weak							PQTT				100 100 100			
7																
	7.2	Moderately weathered, yellow-brown SILTSTONE; very weak to weak; very widely spaced defects														
142		7.30 - 7.75 m: light grey with black flecks														
		7.75 m: orange-brown with black streaks; break on bedding plane, dark iron-staining on face														
8	8.18	Moderately weathered, grey, fine to coarse SANDSTONE; extremely weak to very weak							PQTT		MW		60 60 60			
141		8.10 - 8.70 m: CORELOSS														
	8.7	Moderately weathered, fine to medium SANDSTONE; very weak to weak; widely spaced defects														
9																
		9.25 m: tight break, iron-stained face, staining decreases for 50 mm above and below break							PQTT				100 87 87			
140		9.72 m: 15-20 mm dark brown layer														
10																

Notes and Comments:
End of Hole @ 30.00m, Target Depth.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Ridge
Job Number: 12506381
Commenced: 13/06/2019 Completed: 14/06/2019

Hole No. : BH06
Sheet : 2 of 3
Hole Length : 30.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 396168.25 Northing: 787593.98 System: TAIETM2000
RL: 149.75 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
	10.2		9.75 m: tight break, iron stained face; core stained below break, but not above														
	10.45		10.00 - 10.20 m: with some fine rounded gravel														
139			10.20 - 10.45 m: CORELOSS														
			Moderately weathered, laminated to moderately thickly bedded, light grey and orange-brown SANDSTONE; extremely to very weak; poorly indurated; very widely spaced defects							PQTT				83 83 83			
11			10.75 m: 100 mm SILTSTONE, black basal contact														
			10.85 m: 60 mm light grey with black flecks, minor organic inclusions														
138			11.00 m: yellow-brown and orange-brown														
			11.10 m: 2-3 mm iron stained 'rusty' layer									MW					
12			11.55 m: 70 mm light grey interbed														
			12.00 JT, 45°, pl, r, CLAY, Iron stained clay infill.														
	12.25		12.25 m: 100 mm minor organics, orange-brown and black layer														
137	12.45		Moderately weathered grey and white CONGLOMERATE; very weak to weak; clasts, fine to medium, rounded to sub-rounded, quartz and schist							PQTT				56 56 56			
			12.54 - 13.40 m: CORELOSS														
13	13.34		Moderately weathered grey and white CONGLOMERATE; very weak to weak; clasts, fine to medium, rounded to sub-rounded, quartz and schist														
			Slightly weathered, grey with occasional black, fine to medium SANDSTONE; very weak to weak; poorly indurated, no defects. Closely to very closely spaced laminations of lignite														
136																	
														87 87 87			
14																	
135																	
				HENLEY BRECCIA													
15																	
	15.4		Slightly weathered, grey with occasional black SILTSTONE; very weak to weak; no defects; occasional lignite											100 100 100			
134			15.60 m: 100 mm SANDSTONE														
	16		Slightly weathered, grey with occasional black, fine to medium SANDSTONE; very weak to weak; no defects; occasional lignite														
16			16.40 - 16.60 m: minor fine gravel (quartz and schist) 'pebbly conglomerate'														
133																	
			17.05 - 17.25 m: SILTSTONE									SW		100 100 87			
17																	
132	17.6		Slightly weathered, light grey BRECCIA; extremely weak to weak; no defects; clasts: quartz and schist, fine to medium gravel size, angular to sub-rounded; matrix supported; matrix: fine to coarse sand														
	18																
18	18.2		18.00 - 18.20 m: CORELOSS							PQTT				87 63 63			
			Slightly weathered, light grey BRECCIA; extremely weak to weak; no defects; clasts: quartz and schist, fine to medium gravel size, angular to sub-rounded; matrix supported; matrix: fine to coarse sand														
131																	
			19.10 - 19.20 m: unweathered, weak to moderately strong														
19			19.20 - 19.40 m: moderately strong to strong, well indurated														
	19.4		Unweathered, light grey and black fine to medium SANDSTONE; very weak to weak; very widely spaced defects; with moderately widely spaced laminated very thin to thin beds									UW		93 65 47			
130																	

Notes and Comments:
End of Hole @ 30.00m, Target Depth.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project : Smooth Hill Landfill Consenting		Hole No.	: BH06
Client : Dunedin City Council		Sheet	: 3 of 3
Site : Southwest Ridge		Hole Length	: 30.00m
Job Number: 12506381		Scale @ A4	: 1:50
Commenced: 13/06/2019	Completed: 14/06/2019	Logged	: MF
Easting: 396168.25	Northing: 787593.98	Processed	: HB
RL: 149.75	Datum: NZVD2016	Checked	: JHS

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
			of lignite and widely spaced moderately thin siltstone beds Unweathered, light grey and black fine to medium SANDSTONE; very weak to weak; very widely spaced defects; with moderately widely spaced laminated very thin to thin beds of lignite and widely spaced moderately thin siltstone beds *(continued from layer starting at 19.4m)* 20.20 m: fine to coarse sand 20.70 m: fine to medium sand 21.06 m: 230 mm siltstone interbed 21.70 m: very thinly bedded (2-10 mm) 22.20 m: moderately thickly bedded (~ 300 mm) 22.40 m: 150 mm siltstone interbed 22.75 m: laminated (2-10 mm) 27.50 - 28.50 m: very closey spaced fractures, possibly drilling induced 28.40 - 28.50 m: dark grey-brown for 100 mm 28.70 - 28.80 m: dark brown layer - looks like lithified topsoil Unweathered, light grey BRECCIA; weak to moderately strong; no defects; moderately well indurated; clasts: quartz and schist, fine gravel size, sub-angular to sub-rounded; matrix supported; matrix: fine to coarse sand End of Hole @ 30.00m,Target Depth.	HENLEY BRECCIA						PQTT	UW	VW W MW VS ES	93 65 47 100 100 100 87 87 87 100 100 100 88 88 88 100 32 32 76 76 76	20 60 200 600 2000		

Notes and Comments:
End of Hole @ 30.00m, Target Depth.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

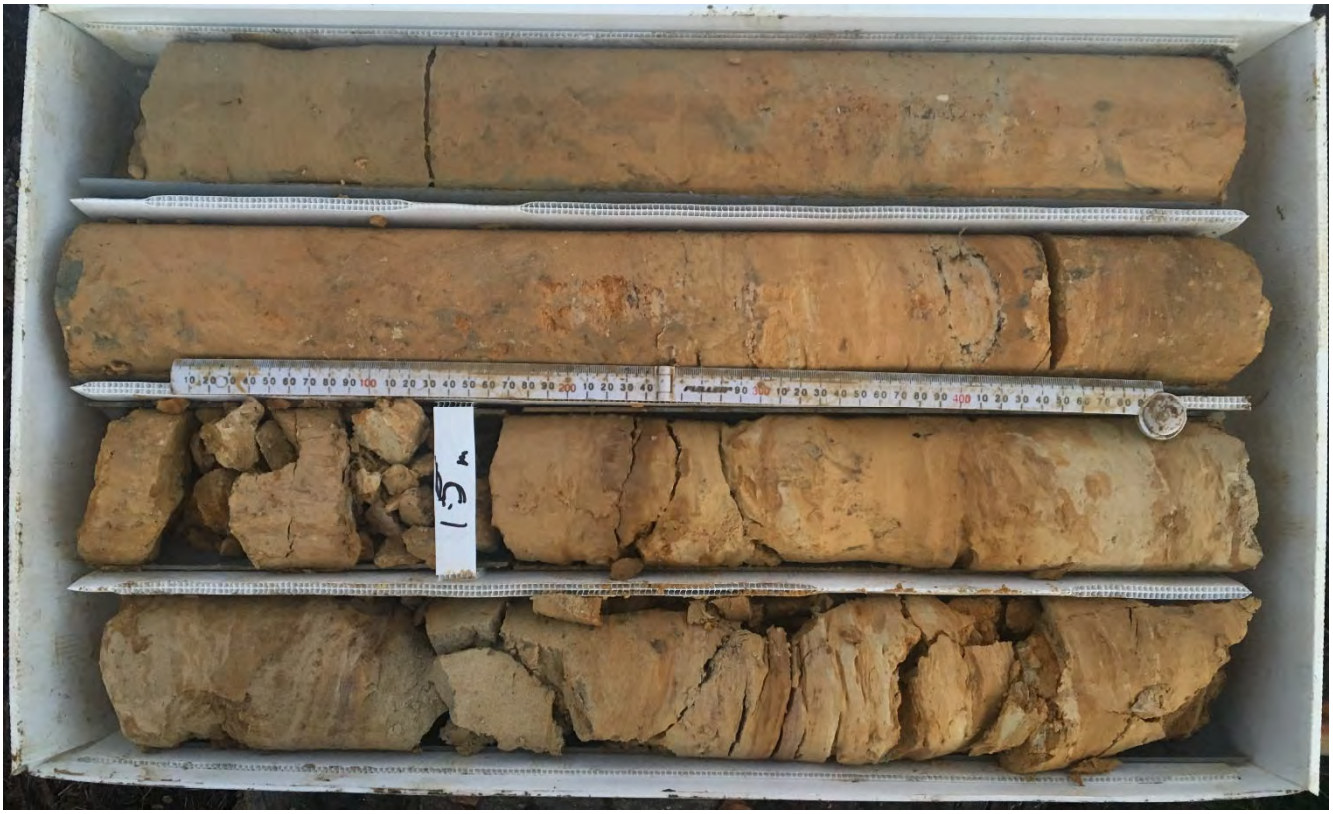
Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
14/06/19	00:00		30

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 7
Borehole ID	BH06	



Box 1 of 13: 0.0 m to 2.4 m

Box 2 of 13: 2.4 m to 4.6 m

Box 3 of 13: 4.6 m to 7.2 m

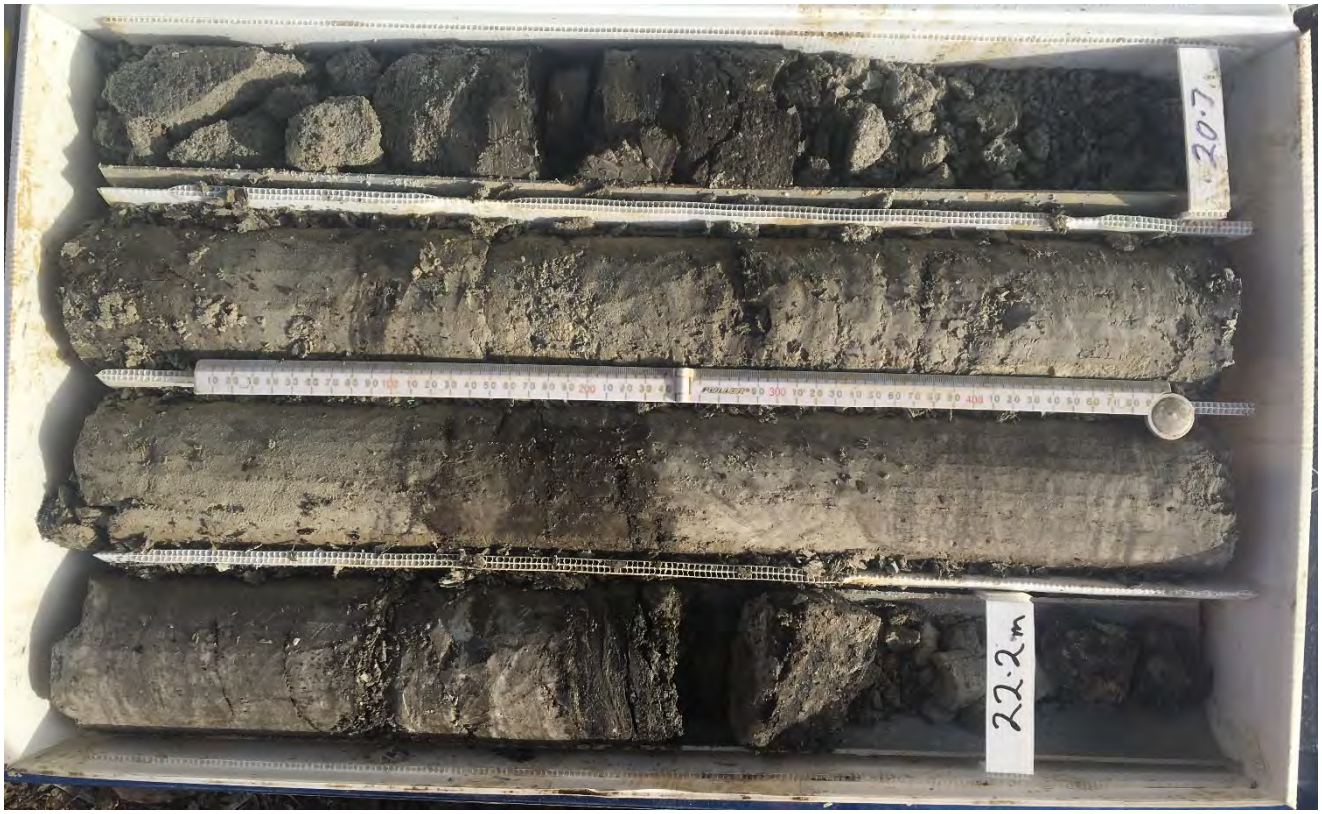
Box 4 of 13: 7.2 m to 10.0 m

Box 5 of 13: 10.0 m to 13.2 m

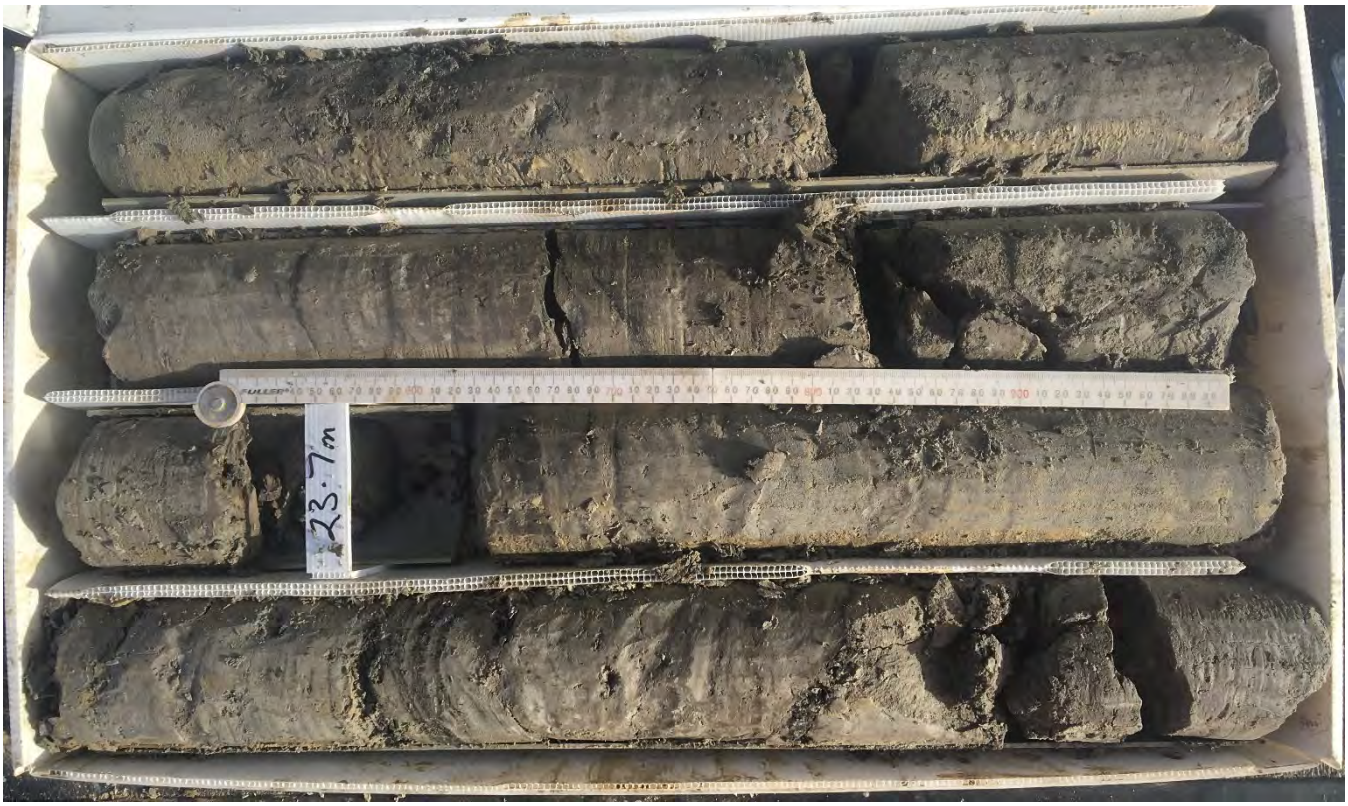
Box 6 of 13: 13.2 m to 15.6 m

Box 7 of 13: 15.6 m to 17.7 m

Box 8 of 13: 17.7 m to 20.2 m



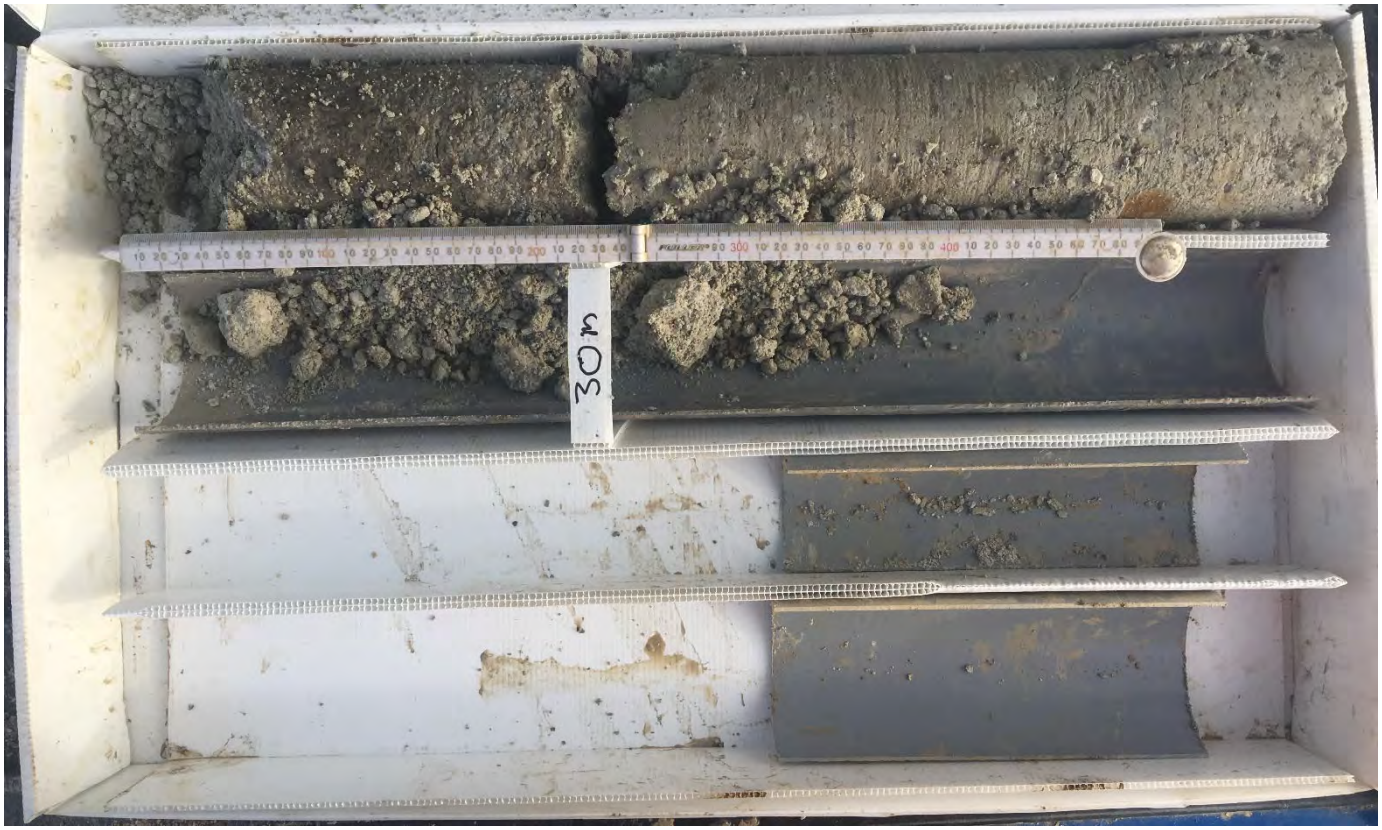
Box 9 of 13: 20.2 m to 22.2 m



Box 10 of 13: 22.2 m to 24.7 m

Box 11 of 13: 24.7 m to 27.0 m

Box 12 of 13: 27.0 m to 29.3 m



Box 13 of 13: 29.3 m to 30.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Central ridge
Job Number: 12506381
Commenced: 30/05/2019 Completed: 4/06/2019

Hole No. : BH07
Sheet : 1 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396493.65 Northing: 787671.87 System: TAIETM2000
RL: 139.73 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
	0		0.00 - 1.40 SILT, minor clay, trace fine sand, trace organics; light grey & orange brown. Very stiff, moist, low plasticity. (LOESS). From 1.25 m to 1.30 m, 50 mm layer with minor to some Fe "rusty" inclusions (red to brown).	LOESS	M	St				PQTT				84			
	1.4		1.40 - 2.05 Fine sandy SILT, minor fine gravel; yellow brown. Hard, dry, non plastic. (Inferred CORELOSS 1.4-1.6 m).		D	'H'				PQTT				85			
			2.05 - 2.80 From 2.05 m, Fe staining in layers for 250 mm.		D	H											
			2.80 - 3.40 From 2.8 m, no gravel, Fe stained layers common.		D	H				PQTT				100			
	3.4		3.40 - 3.75 SILT, some clay; light grey & yellow brown with orange brown layers. Hard, dry, non plastic. Fe stained layers throughout.		D	H											
	3.75		3.75 - 3.90 Clayey SILT, trace fine sand, trace organics; grey to brown. Stiff to very stiff, moist, high plasticity. Possibly organic origin.		M	St-VSt											
	3.9		3.90 - 4.10 SILT, some clay; light grey & yellow brown with orange brown layers. Hard, dry, non plastic. Fe stained layers throughout.		D	H											
	4.1		4.10 - 4.80 Grades into: Moderately weathered, thinly layered, ight grey & yellow brown SILTSTONE; very weak; widely spaced defects. (HENLEY BRECCIA).	HENLEY BRECCIA						PQTT		MW		100			
	4.8		4.80 - 5.95 From 4.8 m, becomes moderately weathered, alternating bedded SILTSTONE & fine SANDSTONE; very weak to weak; bedding 200-400 mm thick. Note at 5.17m: 2 x 5-8 mm organic rich layers.											100			
	5.95		5.95 - 7.20 Slightly weathered to moderately weathered, light grey & yellow brown BRECCIA; weak to moderately strong; coarse sand matrix, matrix supported. Clasts are fine to coarse gravel quartz and schist, angular to sub rounded.							PQTT		SW-MW		100			
			7.20 - 8.10 From 7.2 m, becomes very weak to moderately strong. Matric less indurated.											100			
	8.1		8.10 - 8.80 Slightly weathered to moderately weathered, light grey & brown silty fine SANDSTONE; very weak to moderately strong.							PQTT		SW-MW		93			
	8.8		8.80 - 9.33 Slightly weathered to moderately weathered, light grey & yellow brown BRECCIA; weak to moderately strong; coarse sand matrix, matrix supported. Clasts are fine to medium gravel quartz and schist, angular to sub rounded. Note: less indurated matrix. 9.33 - 9.40 From 9.33 m, becomes extremely weak, non indurated silty GRAVEL (some components as breccia). 9.40 - 9.70 From 9.4 m, becomes weak to moderately strong.							PQTT		SW-MW		100			
														97			

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
~ 300 mm topsoil & 100-200 mm loess stripped to make drill pad.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Central ridge
Job Number: 12506381
Commenced: 30/05/2019 Completed: 4/06/2019

Hole No. : BH07
Sheet : 2 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396493.65 Northing: 787671.87 System: TAIETM2000
RL: 139.73 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistency / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
10	10.25	matrix more indurated, fine to coarse gravel clasts. 9.70 - 10.00 From 9.7 m, becomes fine to medium gravel size clasts.									SW-MW					
10	10.65	10.00 - 10.10 Slightly weathered to moderately weathered, grey SILTSTONE; very weak to weak.									SW-MW					
11		10.10 - 10.25 Slightly weathered to moderately weathered, grey SANDSTONE; very weak to weak.							PQTT		SW		100			
11		10.25 - 10.65 Slightly weathered to moderately weathered, fine to medium grained, grey BRECCIA; very weak to weak. Note at 10.60 m: minor break on bedding plane, Fe staining. *10.60 - 10.80* BP, 70°, pl, r, VN, CLAY, Fe staining											100			
12		10.65 - 11.00 Slightly weathered, dark grey fine sandy SILTSTONE; very weak to weak; occassional organic layers up to 10 mm thick. 11.00 - 13.00 From 11.0 m, becomes unweathered Note at 11.7 m: End of shift 30/05/2019.							PQTT		UW		100			
13	13	13.00 - 13.30 Unweathered, CONGLOMERATE; weak to moderately strong; fine gravel to coarse sand.									UW					
13	13.3	13.30 - 14.70 Unweathered, light grey & white fine to coarse BRECCIA; very weak to weak; no defects. Clasts quartz and schist, sub angular to sub rounded, matrix supported, medium to coarse sand matrix, weakly indurated.							PQTT		UW		83			
14													78			
14	14.7	14.70 - 15.10 Unweathered, grey SILTSTONE; very weak to weak; no defects.	HENLEY BRECCIA								UW					
15	15.1	15.10 - 15.50 Unweathered, grey fine to medium SANDSTONE; very weak to weak; no defects.							PQTT		UW		92			
15	15.5	15.50 - 15.80 Unweathered, grey SILTSTONE; very weak to weak; no defects.									UW		92			
15	15.8				"											
16		15.80 - 17.30 Unweathered, light grey fine gravelly fine to coarse SANDSTONE; very weak to weak; no defects. No obvious bedding. Note inferred boundary at at approximately 17.3 m - unsure of coreloss location.							PQTT		UW		40			
17													33			
17	17.3	17.30 - 19.50 Unweathered, brown SILTSTONE; very weak to weak; no defects. From 17.65 m, becomes dark grey. From 17.85 m, becomes grey.							PQTT		UW		47			
18													27			
19													78			
19	19.5	19.50 - 20.00 Unweathered; light grey, white & purple BRECCIA; weak to moderately strong; no defects. Coarse sand matrix, matrix supported, medium to well indurated. End of Hole @ 20.00m,Target Depth.							PQTT		UW		78			
20																

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
~ 300 mm topsoil & 100-200 mm loess stripped to make drill pad.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
04/06/19	00:00		20

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 4
Borehole ID	BH07	

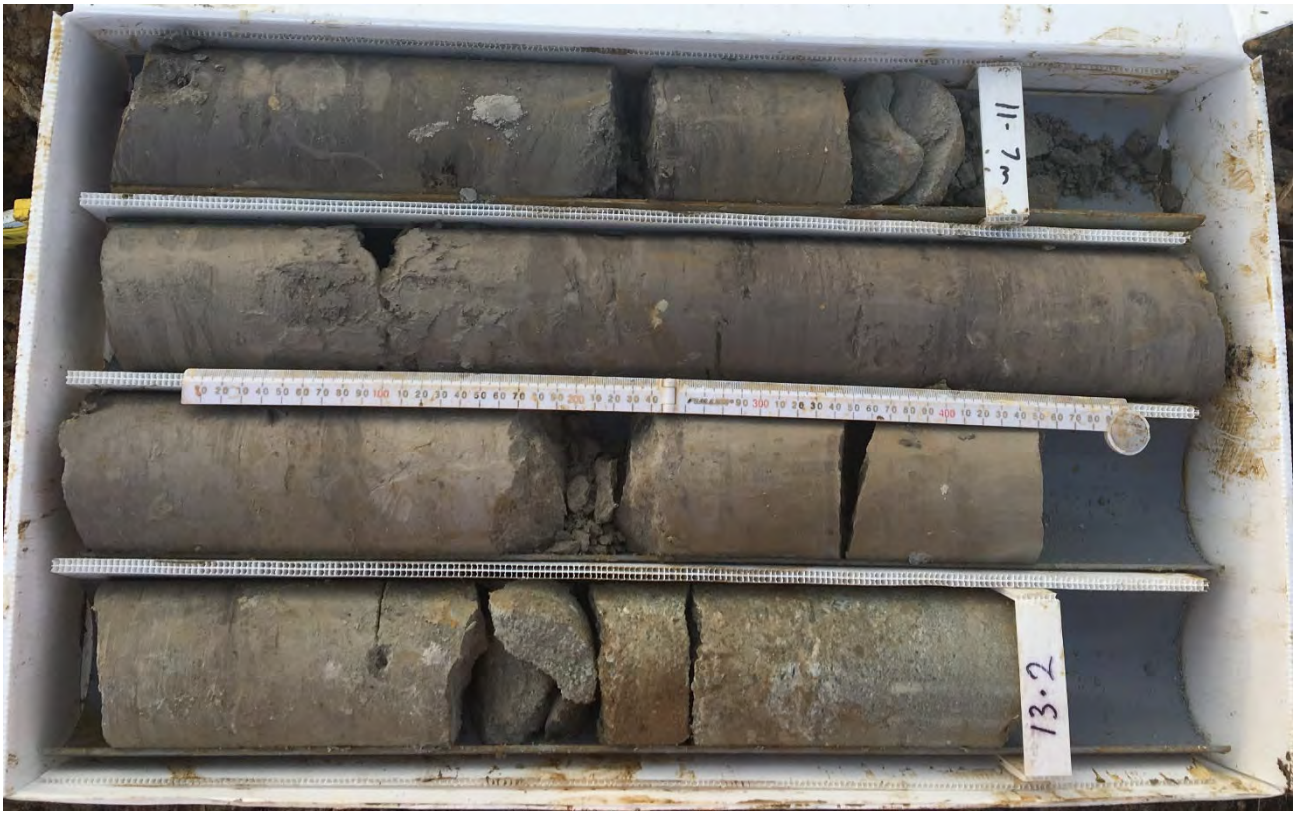
Box 1 of 8: 0.0 m to 2.7 m

Box 2 of 8: 2.7 m to 4.8 m

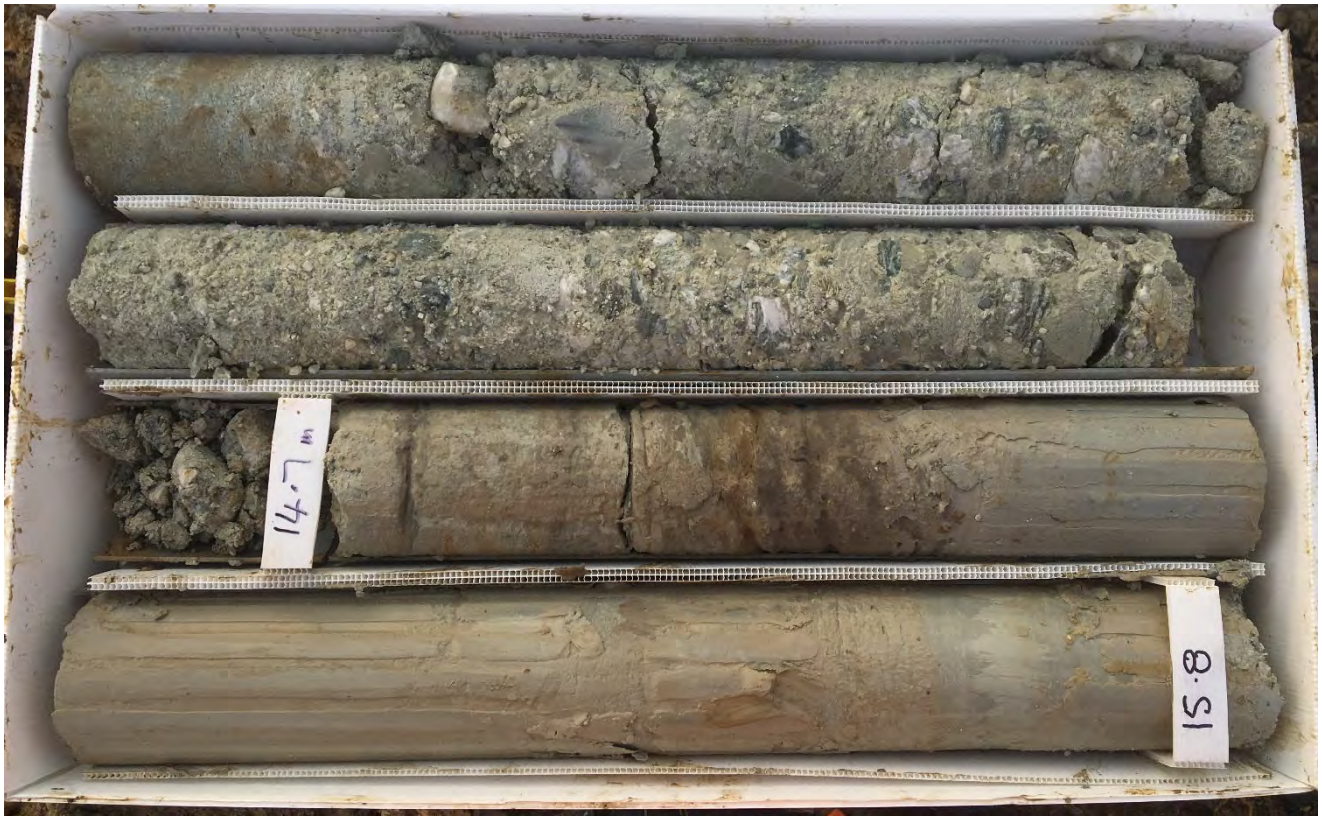
Box 3 of 8: 4.8 m to 7.0 m

Box 4 of 8: 7.0 m to 9.1 m

Box 5 of 8: 9.1 m to 11.2 m



Box 6 of 8: 11.2 m to 13.2 m



Box 7 of 8: 13.2 m to 15.8 m

Box 8 of 8: 15.8 m to 20.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Big Stone Road
Job Number: 12506381
Commenced: 11/06/2019 Completed: 11/06/2019

Hole No. : BH08
Sheet : 1 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 396809.71 Northing: 787700.67 System: TAIETM2000
RL: 143.89 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
143	0	TOPSOIL; silt, trace to minor clay, trace fine sand; dark grey and yellow-brown. Very stiff, moist, low plasticity; trace roots	TS	M	VSt				PQTT				68			
	0.25	SILT, trace clay, trace fine sand; grey mottled orange-brown. Very stiff, moist, low plasticity (LOESS)		M	VSt											
142	1	0.60 m: more orange-brown mottled grey														
		1.50 m: grey and brown mottled orange iron stained inclusions														
	1.84	1.84 - 2.86 m: CORE LOSS	LOESS						PQTT				23			
141	2															
	2.86	Fine sandy SILT, trace clay; light grey-brown. Very stiff, dry, low plasticity		D	VSt		SV@3m 194 kPa		PQTT				100			
140	3	3.00 m: light grey and orange; iron stained laminations					SV@3.5m UTP									
	3.75	SILT, trace to minor clay, trace coarse sand (rusty); light grey and orange-brown. Very stiff to hard, moist, low plasticity		M	VSt-H				PQTT				90			
	4.1	SILT, minor to some clay; brown with black flecks and streaks. Very stiff to hard, dry to moist, high plasticity; trace to minor organics (BURIED TOPSOIL)	BTS	D-M	VSt-H											
139	4															
	4.4	Highly weathered, grey, orange-brown and yellow-brown BRECCIA; very weak to weak; no defects; clasts: quartz and schist, sub-angular to sub-rounded, fine gravel size; matrix: fine to coarse sand; matrix supported							PQTT		HW		100			
	5	Highly weathered, grey and orange-brown SILTSTONE; extremely weak to very weak; no defects											100			
138	5.2	Highly weathered, grey, orange-brown and yellow-brown BRECCIA; very weak to weak; no defects; clasts: quartz and schist, sub-angular to sub-rounded, fine to medium gravel, matrix: fine to coarse sand; matrix supported											100			
	6	6.20 - 6.90 m: CORELOSS (inferred silty GRAVEL)														
	6.2												53			
137	6.9	Fine to medium GRAVEL; orange-brown, white, yellow-brown and grey. Poorly graded; inferred silt matrix from minimal matrix recovery; gravel, quartz and schist, angular to sub-rounded.	HENLEY BRECCIA						PQTT		MW		40			
	7												33			
	7.1	Moderately weathered, grey, orange-brown and white BRECCIA; weak; gravel quartz and schist, angular to sub-rounded, fine to medium gravel; matrix: fine to coarse sand; matrix supported														
136	7.4															
	7.65	Slightly weathered, light grey SILTSTONE; very weak to weak; no defects (grades into next unit)											100			
	8	Slighty weathered, light grey fine to coarse SANDSTONE; very weak to weak; no defects											100			
135	8.1								PQTT		SW		100			
	9	Slightly weathered, light grey and grey BRECCIA; weak to moderately strong; no defects; no visible bedding; matrix: fine to coarse sand, matrix supported; clasts: quartz and schist, sub-rounded to angular, fine to medium gravel size														
		9.00 - 14.10 m: unweathered, fine to coarse gravel size clasts, clast supported									UW		93			
134													93			
													93			

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
Groundwater not encountered. No piezos were installed.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Big Stone Road
Job Number: 12506381
Commenced: 11/06/2019 Completed: 11/06/2019

Hole No. : BH08
Sheet : 2 of 2
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 396809.71 Northing: 787700.67 System: TAIETM2000
RL: 143.89 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
133	11		Slightly weathered, light grey and grey BRECCIA; weak to moderately strong; no defects; no visible bedding; matrix: fine to coarse sand, matrix supported; clasts: quartz and schist, sub-rounded to angular, fine to medium gravel size *(continued from layer starting at 8.1m)*	HENLEY BRECCIA						PQTT		UW		93 93 93			
			11.20 m: fine to medium gravel sized clasts, moderately strong to strong							PQTT				100 100 100			
132	12		11.60 m: fine to coarse gravel clasts, weak to moderately strong							PQTT				97 97 97			
131	13									PQTT				69 67 43			
130	14		14.10 - 14.60 m: CORELOSS														
14.1	14.6		Unweathered, grey silty fine to medium SANDSTONE; very weak to weak; no defects; no visible bedding							PQTT				100 100 100			
129	15		16.40 m: 100 mm breccia interbed														
16.75			Fine to coarse grained SANDSTONE, moderately strong to strong, with very closely spaced very thin interbeded of gravelly sandstone; fine gravel.							PQTT				100 100 100			
128	16		17.50 m: weak to moderately strong, moderately well indurated														
127	17									PQTT				100 100 100			
17.95			Unweathered, light grey, grey and white BRECCIA; moderately strong to strong; no defects; no visible bedding; matrix: fine to coarse sand; clasts: schist and quartz, angular to sub-rounded, fine to coarse gravel size; clast supported							PQTT				100 100 100			
126	18		19.20 m: clasts predominantly medium to coarse gravel sized														
19.5			Unweathered, light grey fine to coarse SANDSTONE; moderately strong to strong; no defects; well indurated; no visible bedding							PQTT				100 100 100			
125	19		End of Hole @ 20.00m,Target Depth.														
124	20																

Notes and Comments:
End of Hole @ 20.00m, Target Depth.
Groundwater not encountered. No piezos were installed.

Refer to explanation sheets for abbreviation and symbols

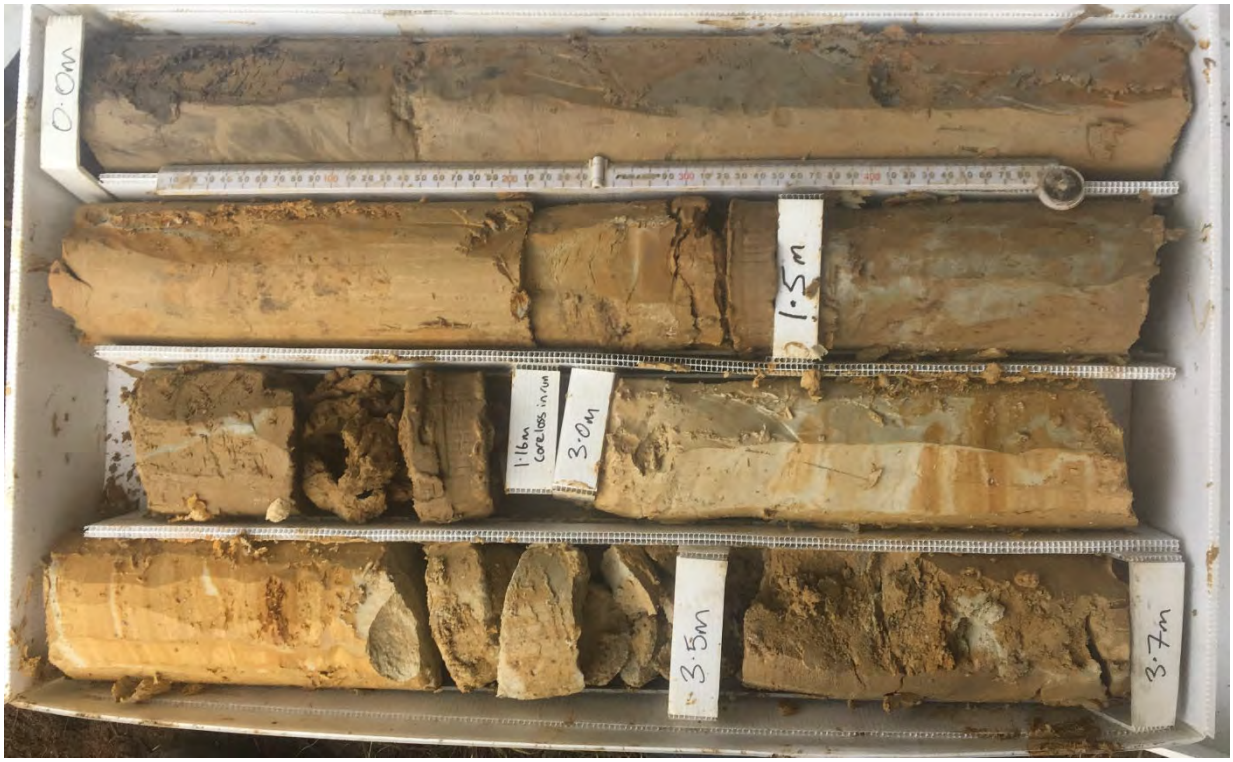
Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
11/06/19	00:00		20

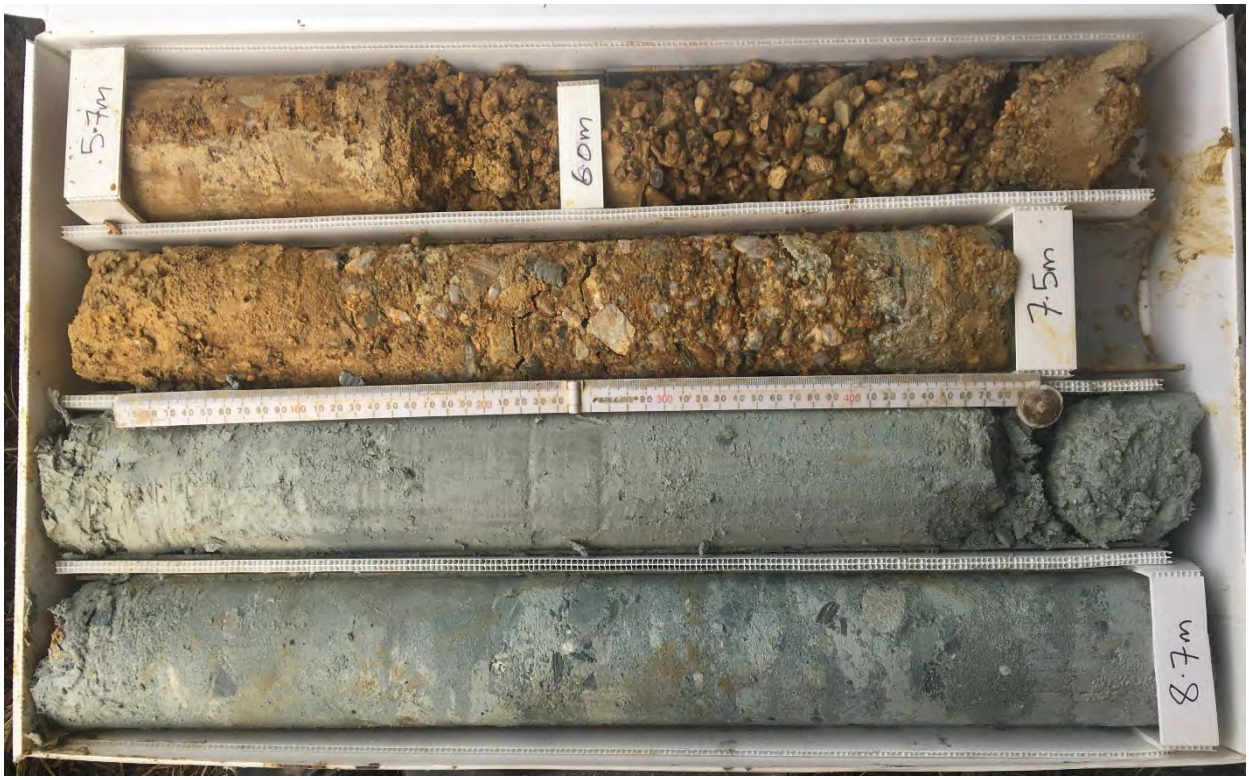
Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 4
Borehole ID	BH08	

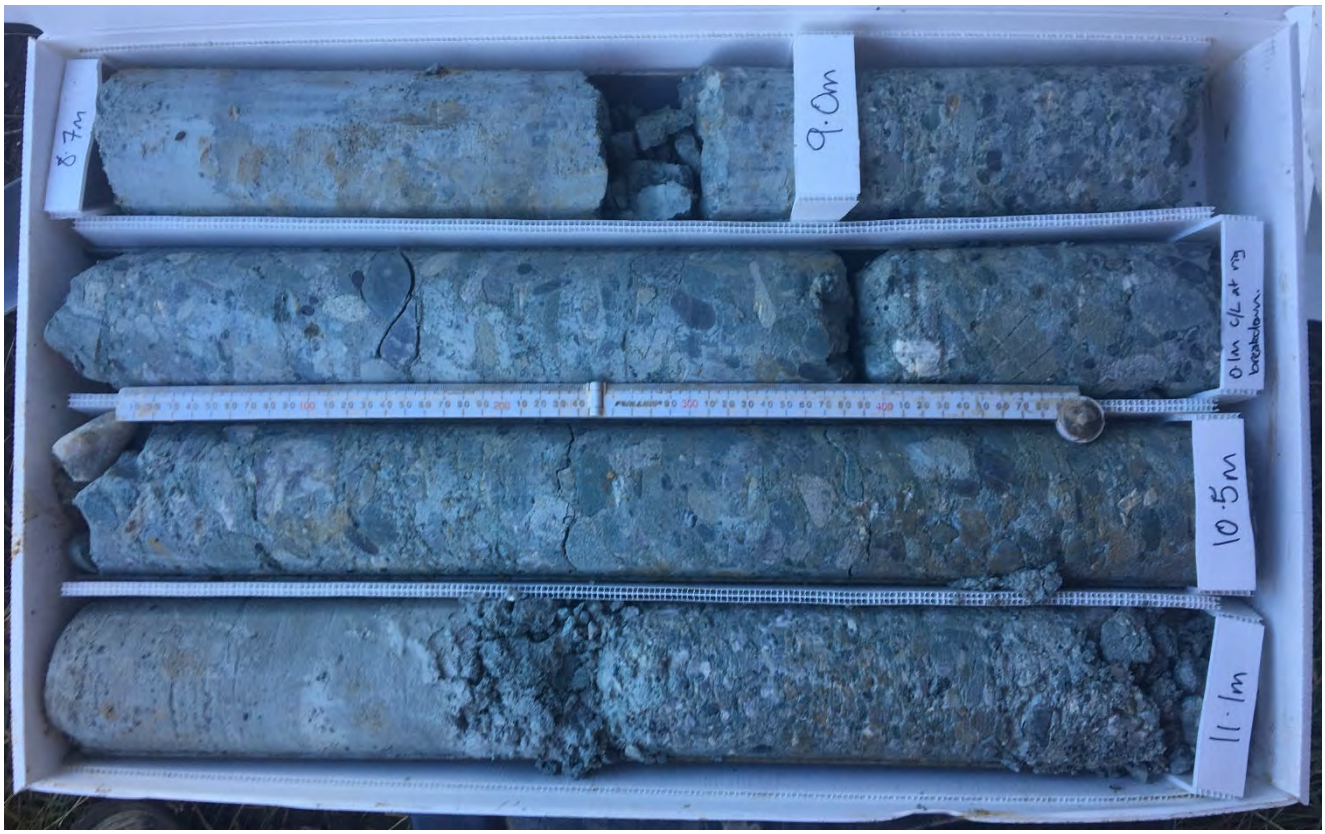


Box 1 of 8: 0.0 m to 3.7 m

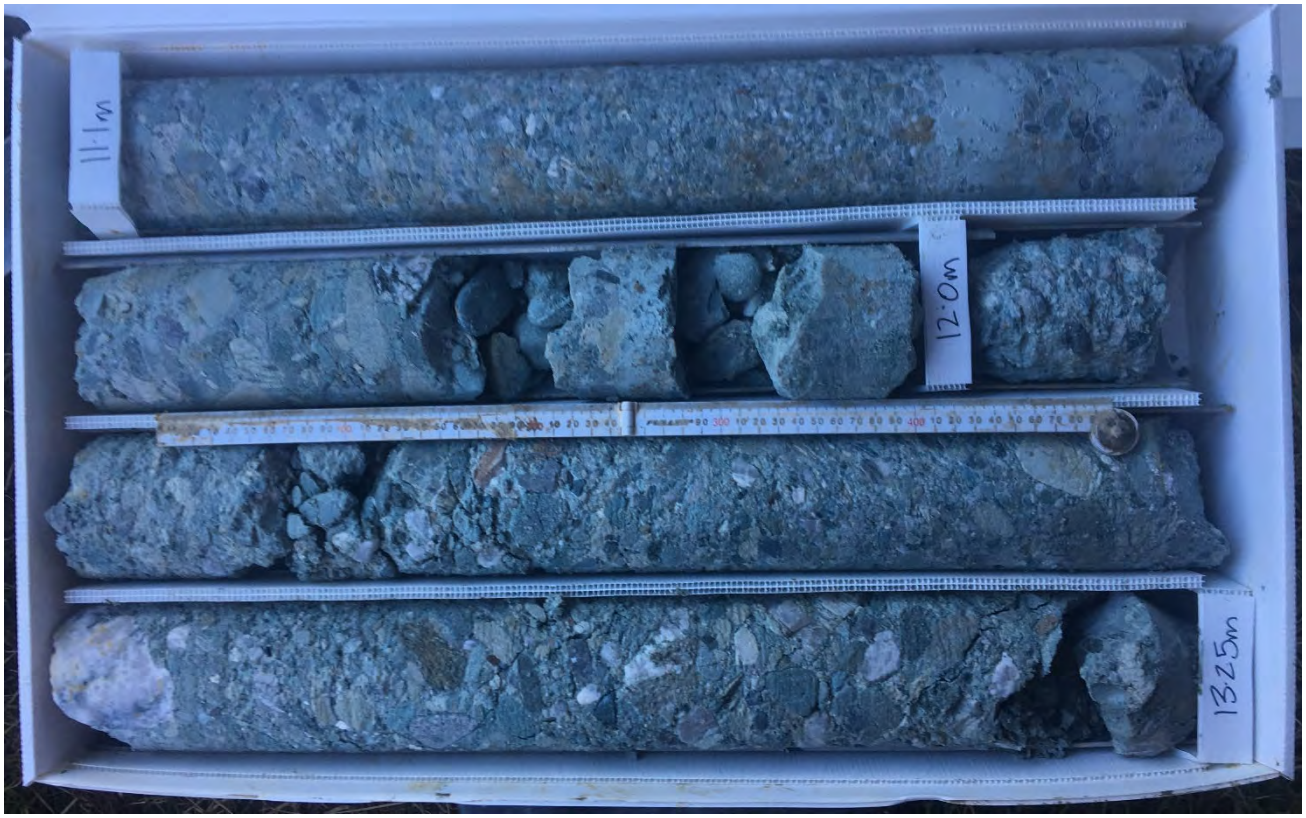
Box 2 of 8: 3.7 m to 5.7 m



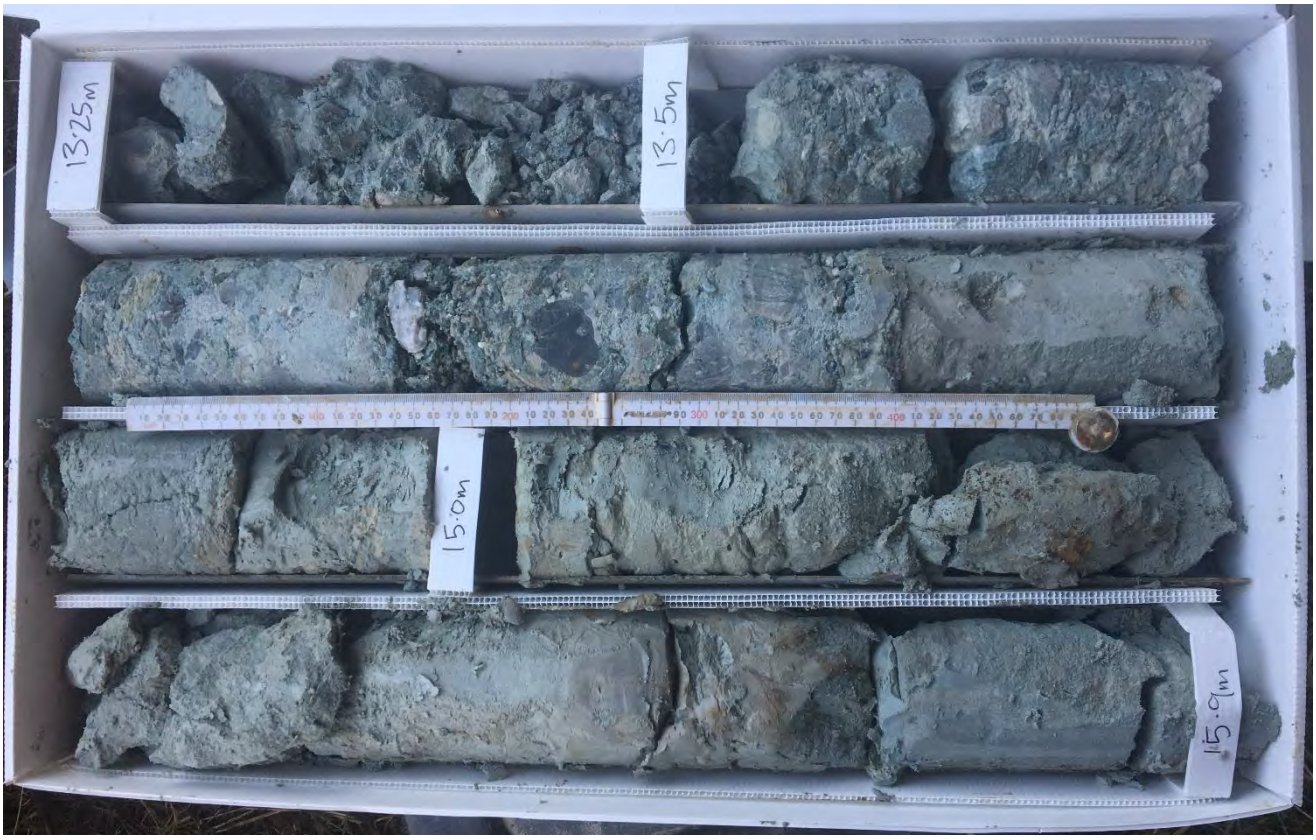
Box 3 of 8: 5.7 m to 8.7 m



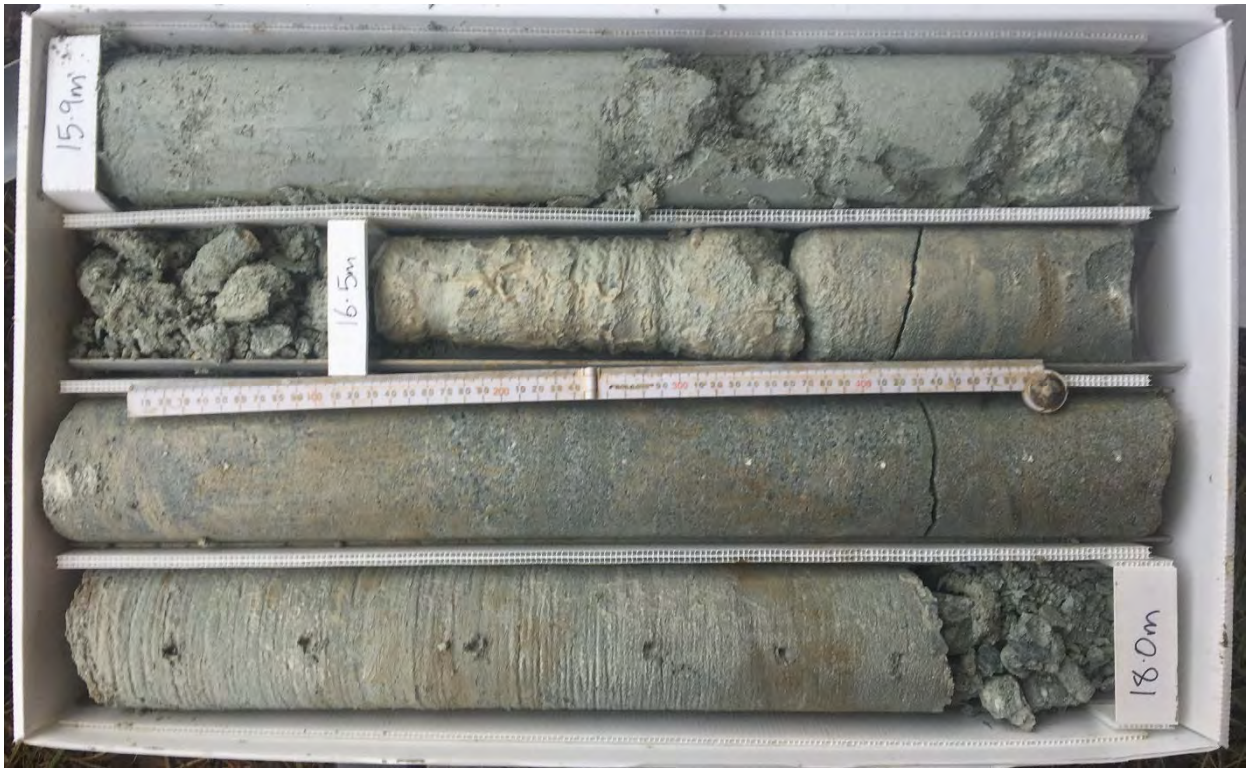
Box 4 of 8: 8.7 m to 11.1 m



Box 5 of 8: 11.1 m to 13.25 m



Box 6 of 8: 13.25 m to 15.9 m



Box 7 of 8: 15.9 m to 18.0 m

Box 8 of 8: 18.0 m to 20.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Western Boundary
Job Number: 12506381
Commenced: 12/06/2019 Completed: 12/06/2019

Hole No. : BH09
Sheet : 1 of 2
Hole Length : 16.50m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 395951.84 Northing: 788050.36 System: TAIETM2000
RL: 132.8 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
132	0.5	0.00 - 0.50 m: CORELOSS (FILL: reworked Loess)	FILL													
132	1.1	SILT, trace to minor clay, trace fine to coarse sand, trace fine gravel; grey and orange-brown. Very stiff, moist, low plasticity; gravel: angular, iron stained (LOESS) 0.90 m: brown	LOESS	M	VSt				PQTT				67			
131	1.5	Fine gravelly SILT, trace clay; yellow-brown and orange-brown. Stiff to very stiff, moist, low plasticity	LOESS	M	St-VSt				PQTT				40			
130	2.4	1.50 - 2.40 m: CORELOSS *inferred Henley Breccia from minimal recovery	HENLEY BRECCIA						PQTT				0			
130	2.6	Gravelly medium to coarse SAND; yellow-brown. Poorly graded; gravel: fine, quartz and schist, sub-angular to rounded.	HENLEY BRECCIA	M	F				PQTT				0			
129	3	Sandy SILT, minor gravel, trace clay; yellow-brown, orange-brown and grey. Firm, moist, low plasticity. Gravel: fine to medium, quartz and schist, angular to rounded. Sand: fine to medium	HENLEY BRECCIA						PQTT				0			
128	4	3.00 - 9.10 m: CORELOSS *inferred gravelly sand (Henley Breccia) from minimal recovery	HENLEY BRECCIA						PQTT				0			
127	5		HENLEY BRECCIA						PQTT				0			
126	6		HENLEY BRECCIA						PQTT				0			
125	7		HENLEY BRECCIA						PQTT				0			
124	8		HENLEY BRECCIA						PQTT				0			
123	9		HENLEY BRECCIA						PQTT		SW		100 93			
	9.1	Slightly weathered, thinly laminated, grey silty fine SANDSTONE; very weak; very wide spaced defects														

Notes and Comments:
End of Hole @ 16.50m, Target Depth.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Western Boundary
Job Number: 12506381
Commenced: 12/06/2019 Completed: 12/06/2019

Hole No. : BH09
Sheet : 2 of 2
Hole Length : 16.50m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JHS

Easting: 395951.84 Northing: 788050.36 System: TAIETM2000
RL: 132.8 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
122	10		Slightly weathered, thinly laminated, grey silty fine SANDSTONE; very weak; very wide spaced defects *(continued from layer starting at 9.1m)*							PQTT				100 93			
121	11		10.80 m: very weak to weak							PQTT		SW		100 100 100			
	12		11.90 m: extremely to very weak; trace to minor fine gravel: quartz and schist, angular to sub-angular														
120	12.4		12.40 - 16.50 m: CORELOSS *minimal silty fine sand and angular to sub-rounded, quartz and schist gravel recovered (Inferred weathered breccia)	HENLEY BRECCIA						PQTT				27 20 16			
119	13																
118	14									PQTT				15 0 0			12-06-2019 Groundwater at 13.93 mbgl
117	15																
116	16									PQTT				0 0 0			
115	17		End of Hole @ 16.50m,Target Depth.														
114	18																
113	19																
	20																

Notes and Comments:
End of Hole @ 16.50m, Target Depth.

Refer to explanation sheets for abbreviation and symbols

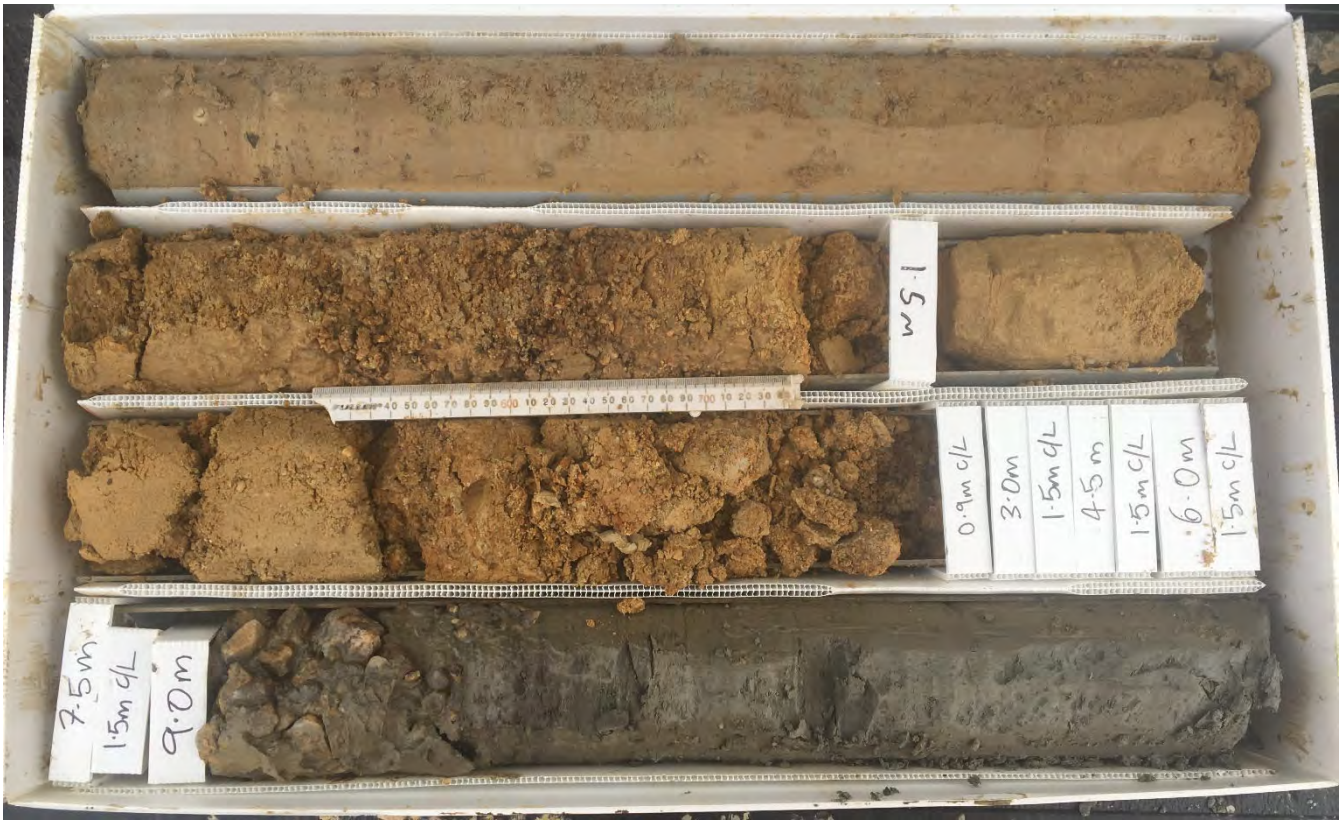
Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: UDR600 (truck mounted)
Shear Vane Id:

Ground Water Level

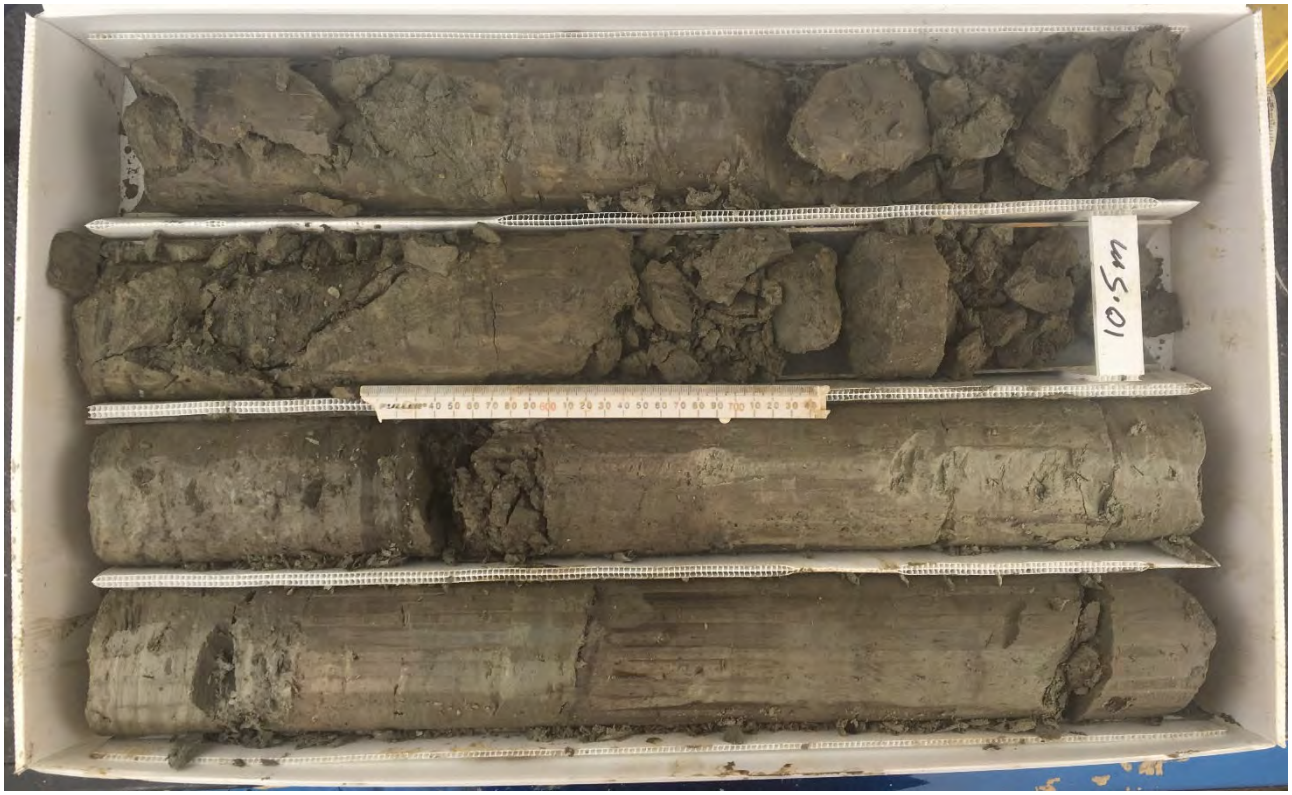
Date	Time	Reading (mbgl)	Hole depth (mbgl)
12/06/19	00:00	13.93	16.5

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 7 August 2019

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 2
Borehole ID	BH09	



Box 1 of 3: 0.0 m to 9.6 m



Box 2 of 3: 9.6 m to 11.7 m

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 2 of 2
Borehole ID	BH09	

Box 3 of 3: 11.7 m to 16.5 m (EOH)

Project	: Smooth Hill Landfill Consenting	Hole No.	: BH10
Client	: Dunedin City Council	Sheet	: 1 of 3
Site	: Smooth Hill Eastern ridge	Hole Length	: 20.00m
Job Number: 12506381		Scale @ A4	: 1:50
Commenced: 4/06/2019	Completed: 5/06/2019	Logged	: MF
Easting: 396788.26	Northing: 788118.5	Processed	: HB
RL: 139.07	Datum: NZVD2016	Checked	: JS

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
	0		0.00 - 0.25 SILT, trace fine sand, trace clay; brown. Firm to stiff, moist, low plasticity. (TOPSOIL).	TOPSOIL	M	F-St											
	0.25		0.25 - 1.60 CORELOSS			"				PQTT				12			
1	1.6		1.60 - 2.40 Fine sandy SILT; light greyb& yellow brown. Stiff, moist, low plasticity.	LOESS	M	St				PQTT				136			
2	2.4		2.40 - 2.60 Completely weathered to residual soil, fine to coarse SAND, minor silt; colour unspecified. Density unspecified, moist, poorly graded. (HENLEY BRECCIA).		M					PQTT		CW-RS		93			
	2.6		2.60 - 3.30 High weathered, pebbly coarse SAND; colour unspecified. Density unspecified, moist, poorly graded. (Heavily weathered, very weak to weak rock?).		M					PQTT		HW		93			
3	3.3		3.30 - 4.90 Moderately weathered, grey, orange brown & yellow brown SILTSTONE; very weak to weak, no defects. (HENLEY BRECCIA).	Henley Breccia						PQTT		MW		86			
4			At 4.3 m, 300 mm SANDSTONE layer.											86			
5	4.9		4.90 - 6.60 Moderately weathered, light grey & organge brown fine SANDSTONE; very weak to weak; no defects. Occasional lignite inclusions.							PQTT		MW		93			
			At 5.5 m: 140 mm SILTSTONE layer.											93			
6	6.6		6.60 - 7.05 Moderately weathered, orange brown, white & grey, fine to medium pebbly CONGLOMERATE; very weak to weak; coarse sand matrix, matrix supported. Clasts are quartz & schist, sub angular to rounded.							PQTT		MW		28			
7	7.05		7.05 - 7.60 Moderately weathered, light grey & orange brown SILTSTONE; very weak to weak; no defects noted.									MW		28			
	7.72		7.60 - 7.72 Moderately weathered, orange brown, white & grey, fine to medium pebbly CONGLOMERATE; very weak to weak; coarse sand matrix, matrix supported. Clasts are quartz & schist, sub angular to rounded.			"											
8	7.6		7.72 - 8.80 Inferred CORELOSS. Offisiders dropped rod & bent end & it did not pick up core.														
	8.8		8.80 - 9.10 Inferred CORELOSS depth.			"											
9	9.1		9.10 - 9.55 Moderately weathered, orange brown, white & grey, fine to medium pebbly CONGLOMERATE; very weak to weak; coarse sand matrix, matrix supported. Clasts are quartz & schist, sub angular to rounded.							PQTT		MW		75			
	9.55		9.55 - 11.40 Slightly weathered, grey SANDSTONE; very weak									SW		75			

Notes and Comments:

End of Hole @ 20.00m, Target Depth.

Hole extended to find groundwater.
Groundwater at 10.17 mbgl 07/06/2019.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: McNeills

Equipment: Mounted Rig

Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Eastern ridge
Job Number: 12506381
Commenced: 4/06/2019 Completed: 5/06/2019

Hole No. : BH10
Sheet : 2 of 3
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396788.26 Northing: 788118.5 System:
RL: 139.07 Datum: NZVD2016

RL (m) / Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
11		to weak; thinly bedded (1-10 mm). Only artificial breaks. Occasional lignite. From 10.4 m, becomes yellow brown, fine to coarse SANDSTONE. 11.40 - 11.60 From 11.4 m, becomes weak to moderately strong. 11.60 - 17.40 From 11.6 m, becomes very weak to weak.	Henley Breccia						PQTT		SW		106 81			
12		Note: From 15.5 m: lignite content increases. From 15.6 m: 40 mm lignite. From 15.8 m: 100 mm lignite rich layer.							PQTT				114 96			
13									PQTT				92 92			
14																
15									PQTT				89 89			
16																
17		17.40 - 17.65 From 17.4 m, becomes moderately strong to strong, well indurated. 17.65 - 19.20 From 17.65 m, becomes very weak to weak, poorly indurated.							PQTT				103 100			
18									PQTT				100 100			
19		19.20 - 19.80 From 19.2 m, becomes weak to moderately strong, moderate to well indurated. 19.80 - 20.00 From 19.8 m, becomes moderately strong to							PQTT				100 100			7-06-2019

Notes and Comments:
End of Hole @ 20.00m, Target Depth.

Hole extended to find groundwater.
Groundwater at 10.17 mbgl 07/06/2019.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
07/06/19	00:00	10.17	20

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Smooth Hill Eastern ridge
Job Number: 12506381
Commenced: 4/06/2019 Completed: 5/06/2019

Hole No. : BH10
Sheet : 3 of 3
Hole Length : 20.00m
Scale @ A4 : 1:50
Logged : MF
Processed : HB
Checked : JS

Easting: 396788.26 Northing: 788118.5 System:
RL: 139.07 Datum: NZVD2016

RL (m) / Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
		strong, well indurated.														
		End of Hole @ 20.00m,Target Depth.														

Notes and Comments:
End of Hole @ 20.00m, Target Depth.

Hole extended to find groundwater.
Groundwater at 10.17 mbgl 07/06/2019.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: McNeills
Equipment: Mounted Rig
Shear Vane Id:

Ground Water Level

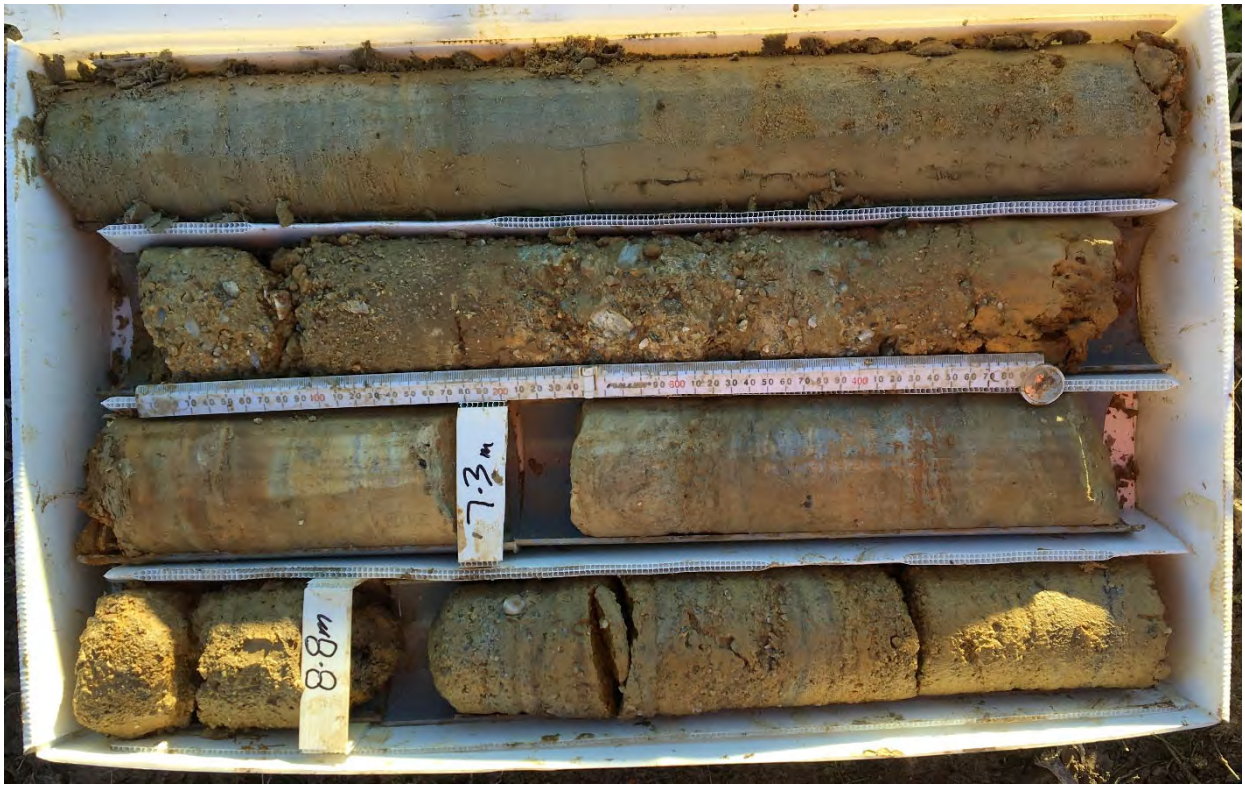
Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL - HB PROCESSING - KB EDITS.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

Project	Smooth Hill Landfill Consenting	
Client	Dunedin City Council	
Job number	12506381	Page 1 of 4
Borehole ID	BH10	

Box 1 of 8: 0.0 m to 3.2 m

Box 2 of 8: 3.2 m to 5.8 m

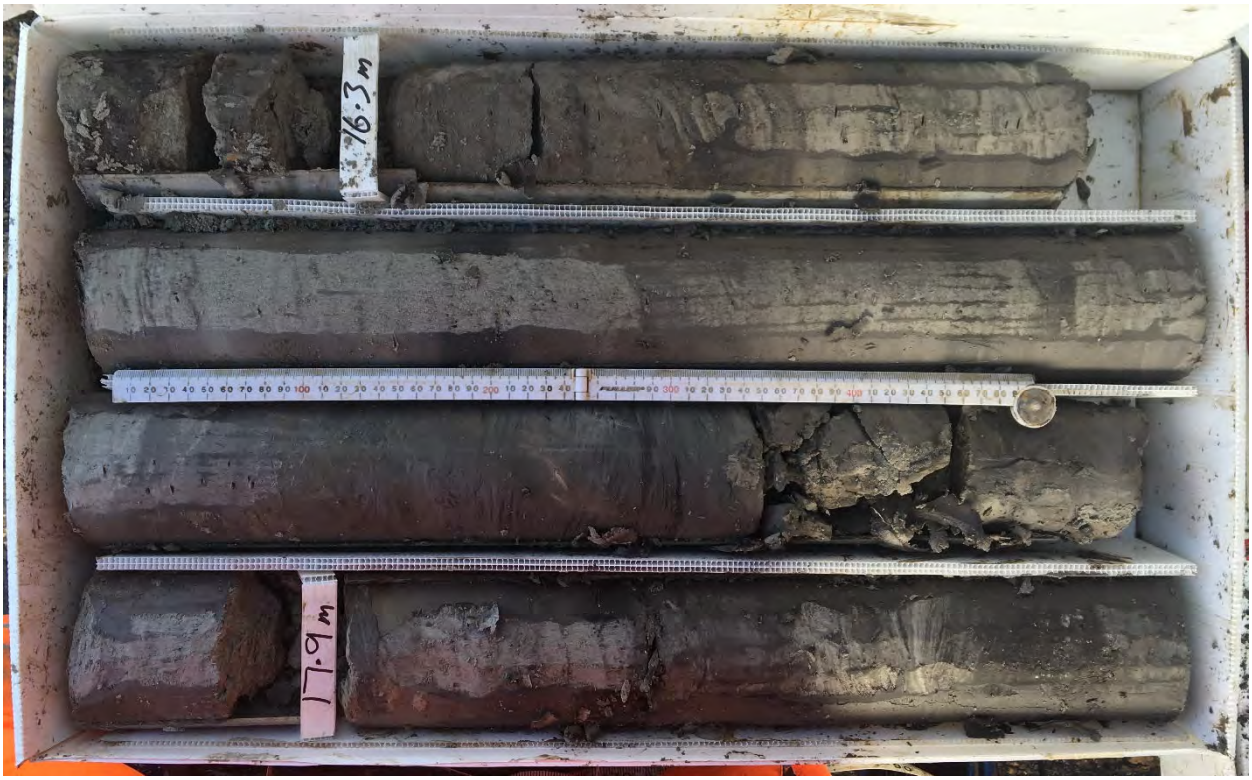


Box 3 of 8: 5.8 m to 9.2 m

Box 4 of 8: 9.2 m to 11.6 m

Box 5 of 8: 11.6 m to 13.8 m

Box 6 of 8: 13.8 m to 16.0 m



Box 7 of 8: 16.0 m to 18.4 m

Box 8 of 8: 18.4 m to 20.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Manuka Gully (Stockpile Area)
Job Number: 12506381
Commenced: 12/06/2019 Completed: 12/06/2019

Hole No. : TP01
Sheet : 1 of 1
Hole Length : 2.50m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 395988.85 Northing: 788077.23 System: TAIETM2000
RL: 121.2 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
121	0		SILT, trace to minor clay; dark grey-brown. Firm, wet, low plasticity; minor to some organics/roots (TOPSOIL)	TS	W	F											
	0.2		SILT, trace clay, trace fine to medium sand; light grey with orange streaks. Stiff to very stiff, moist, low plasticity; iron-stained organics throughout (ALLUVIUM)	ALLUVIUM	M	St-VSt											
	0.7		Gravelly SILT, minor clay, minor fine to coarse sand; orange-brown. Very stiff, moist to wet, low plasticity; gravel: fine to medium, quartz and schist, sub-angular to rounded; highly weathered rock (HENLEY BRECCIA) 1.10 m: grey with some orange-brown	HENLEY BRECCIA	M-W	VSt						HW					
120	1																
	1.9		Slightly weathered, grey with black streaks SILTSTONE; very weak; ripped easily with toothed excavator bucket									SW					
119	2																
			End of Hole @ 2.50m,Target Depth.														
118	3																
117	4																
	5																

Notes and Comments:
End of Hole @ 2.50m, Target Depth.

Soils too gravelly for shear vane.
Groundwater seepage into test pit at 1.0 mbgl

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - toothed bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Manuka Gully (Stockpile Area)
Job Number: 12506381
Commenced: 12/06/2019 Completed: 12/06/2019

Hole No. : TP02
Sheet : 1 of 1
Hole Length : 2.60m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396103.5 Northing: 788056.91 System: TAIETM2000
RL: 110.4 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
110	0		SILT, trace to minor fine sand, trace to minor clay; brown. Firm, moist, low plasticity; minor organics/roots (TOPSOIL)	TOPSOIL	M	F		SV@0.3m 65/17 kPa									
	0.6		Silty SAND, trace clay; light grey with orange-brown streaks. 'Loose to medium dense', poorly graded; sand: fine (COLLUVIUM)	COLLUVIUM		'L-MD'											
109	1.4		SILT, minor clay, trace to minor fine sand; brown. Firm, moist, low plasticity; wood fragments throughout layer, most at top (BURIED TOPSOIL)	BURIED TOPSOIL	M	F		SV@1.8m 90/33 kPa									
108	2.1		Gravelly SILT; grey. Wet, well graded; gravel: fine to coarse (ALLUVIUM)	ALLUVIUM	W												
	2.4		Slightly weathered, grey SILTSTONE; ripped easily with toothed bucket (HENLEY BRECCIA)	HB								SW					
107			End of Hole @ 2.60m,Target Depth.														
106																	

Water level: 12-06-2019 Groundwater seepage into test pit at 0.4 mbgl

Notes and Comments:
End of Hole @ 2.60m, Target Depth.
Groundwater seepage into test pit at 0.4 mbgl.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - toothed bucket
Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
12/06/19	00:00	0.4	2.6

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Manuka Gully (Stockpile Area)
Job Number: 12506381
Commenced: 12/06/2019 Completed: 12/06/2019

Hole No. : TP03
Sheet : 1 of 1
Hole Length : 2.00m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396262.16 Northing: 788048.16 System: TAIETM2000
RL: 102.61 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
102	0		SILT, trace to minor fine sand, trace to minor clay; brown. Soft, moist to wet, low plasticity; minor organics/roots (TOPSOIL)	TOPSOIL	M-W	S											
	0.7		Silty SAND, trace clay; light grey with brown streaks. Moist, poorly graded; sand is fine (ALLUVIUM)	ALLUVIUM	M												
101	1.2		Gravelly SILT; grey. Wet to saturated, well graded; gravel: fine to coarse		W - S												12-06-2019 Groundwater encountered at 1.2 mbgl
	1.7		Slightly weathered, grey SILTSTONE; extremely to very weak; no defects - ripped easily (HENLEY BRECCIA)	HB								SW					
100	2		End of Hole @ 2.00m,Target Depth.														
99	3																
98	4																
	5																

Notes and Comments:
End of Hole @ 2.00m, Target Depth.

Test pit sides too soft to get shear vane readings.
Groundwater encountered at 1.2 mbgl.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - toothed bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
12/06/19	00:00	1.2	2

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Gully Base
Job Number: 12506381
Commenced: 13/06/2019 Completed: 13/06/2019

Hole No. : TP05
Sheet : 1 of 1
Hole Length : 3.30m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396281 Northing: 787868 System: TAIETM2000
RL: 125 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
124	0		SILT, minor clay; brown. Soft, wet to saturated, low plasticity; minor organics throughout (TOPSOIL)	TOPSOIL	W-S	S											
	0.7		Silty fine to medium SAND; grey and yellow-brown. 'Loose', wet, poorly graded (COLLUVIUM)	COLLUVIUM	W	'L'											
123	1		Fine to coarse SAND, minor to some silt; grey with black streaks. 'Loose', saturated, poorly graded; organics throughout		S	'L'											
	1.4		Tree trunks and branches with some gravel. Groundwater outflow from base of layer														
	1.8		SILT, minor clay, trace fine sand; grey with yellow-brown streaks. Stiff, moist, low plasticity; highly weathered rock (HENLEY BRECCIA)	HENLEY BRECCIA	M	St						HW					
122	2.8		Slightly weathered, SILTSTONE; ripped easily									SW					
	3		End of Hole @ 3.30m,Target Depth.														
121	4																
120	5																

13-06-2019 Groundwater flowing into pit

Notes and Comments:
End of Hole @ 3.30m, Target Depth.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - toothed bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
13/06/19	00:00	1.9	3.3

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Gully East of Central Ridge
Job Number: 12506381
Commenced: 13/06/2019 Completed: 13/06/2019

Hole No. : TP06
Sheet : 1 of 1
Hole Length : 2.50m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396585.7 Northing: 787800.45 System: TAIETM2000
RL: 108.24 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
108	0		Organic SILT, minor clay; dark brown-grey. Firm, moist, low plasticity; minor to some roots (TOPSOIL)	TOPSOIL	M	F											
	0.5		SILT, minor clay, light grey with orange-brown streaks. Stiff, moist, low plasticity; minor organic inclusions (ALLUVIUM)	ALLUVIUM	M	St											
107	1																
106	2																
	2.3		SILTSTONE; difficult to rip (HENLEY BRECCIA)	HB													
105	3		End of Hole @ 2.50m,Target Depth.														
104	4																
	5																

Notes and Comments:
End of Hole @ 2.50m, Target Depth.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - toothed bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
13/06/19	00:00		2.5

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Gully Base
Job Number: 12506381
Commenced: 28/05/2019 Completed: 28/05/2019

Hole No. : TP07
Sheet : 1 of 1
Hole Length : 2.50m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396182 Northing: 787790 System: TAIETM2000
RL: 120 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
120	0		SILT/organic matter, brown. Soft, moist to saturated, fibrous, non plastic (TOPSOIL)	TOPSOIL	M-W	S				TP		SW					28-05-2019 Water perched on SILTSTONE
	0.5		SILT, minor clay, trace fine sand; light grey and yellow-brown. Stiff to very stiff, moist, low plasticity (LOESS)	LOESS	M	St-VSt											
119	1																
	1.4		Slightly weathered, grey SILTSTONE; weak to moderately strong; no defects (HENLEY BRECCIA)	HENLEY BRECCIA													
118	2																
	2.4		BRECCIA														
			End of Hole @ 2.50m,Target Depth.														
117	3																
116	4																
115																	

Notes and Comments:
End of Hole @ 2.50m, Target Depth.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - smooth bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
28/05/19	00:00	1.4	2.5

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Gully Between Southern Ridges
Job Number: 12506381
Commenced: 28/05/2019 Completed: 28/05/2019

Hole No. : TP08
Sheet : 1 of 1
Hole Length : 4.50m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396303 Northing: 787682 System: TAIETM2000
RL: 115 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
115	0		SILT, minor clay, trace fine sand; dark grey. Firm to stiff, moist, low plasticity;, minor organic matter (FILL)	FILL	M	F-St											
	0.6		0.50 m: grass and trees - buried surface, saturated		S												
114	1		SILT, minor clay, trace fine sand; dark grey. Firm to stiff, wet, low plasticity; trace to minor organics (BURIED TOPSOIL)	BURIED TOPSOIL	W	F-St											
	1.2		SILT, minor to some clay, trace fine sand; light grey and yellow-brown. Stiff to very stiff, moist, low plasticity; trace organics (LOESS)	LOESS	M	St-VSt											
113	2																
112	3																
	3.5		SILT, some coarse sand, minor fine gravel; light grey. Stiff to very stiff, moist, non-plastic; gravel comprises quartz and schist; highly weathered rock (HENLEY BRECCIA)	HENLEY BRECCIA	M	St-VSt						HW					
111	4																
			End of Hole @ 4.50m,End of Reach.														
110																	

Notes and Comments:
End of Hole @ 4.50m, End of Reach.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator - smooth bucket
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
28/05/19	00:00		4.5

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : South East Gully Outflow
Job Number: 12506381
Commenced: 13/06/2019 Completed: 13/06/2019

Hole No. : TP09
Sheet : 1 of 1
Hole Length : 3.00m
Scale @ A4 : 1:25
Logged : MF
Processed : MF
Checked : MF

Easting: 396577.97 Northing: 787947.86 System: TAIETM2000
RL: 101.04 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
101	0		SILT, minor fine to coarse gravel; yellow-brown and grey. Stiff, moist, low plasticity; minor organic content (SLIP DEBRIS)	SLIP DEBRIS	M	St											
	0.4		Branches and grass (BURIED VEGETATION)														
	0.5		SILT, minor clay; brown. Firm to stiff, moist, low plasticity (BURIED TOPSOIL)	BTS	M	F-St											
	0.7		Gravelly silty SAND; orange-brown. Moist, poorly graded; gravel is fine; sand is fine to coarse (ALLUVIUM)	ALLUVIUM	M												
100	1		1.00 m: light grey and orange-brown														
			1.30 m: light grey with orange-brown streaks														
99	2																
	2.7		Fine SANDSTONE; easily ripped (HENLEY BRECCIA)	HB													
98	3		End of Hole @ 3.00m,Target Depth.														
97	4																
	5																

Notes and Comments:
End of Hole @ 3.00m, Target Depth.
Test pit dug to side of gully base - too boggy in gully base to excavate

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor:
Equipment: 22t Excavator
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project	: Smooth Hill Landfill Consenting	Hole No.	: TP10
Client	: Dunedin City Council	Sheet	: 1 of 1
Site	: Future Laydown Area	Hole Length	: 3.60m
Job Number:	12506381	Scale @ A4	: 1:25
Commenced:	10/06/2019 Completed: 10/06/2019	Logged	: MF
Easting:	396820.11 Northing: 788079.25 System: TAIETM2000	Processed	: HB
RL:	140.74 Datum: NZVD2016	Checked	: MF

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
140	0		SILT, trace to minor clay, trace fine sand; dark grey. Very stiff, moist, low plasticity; tree roots throughout (TOPSOIL)	TOPSOIL	M	VSt											
	0.4		SILT, minor clay; light grey and yellow-brown. Very stiff, moist, low plasticity; root webs throughout (LOESS)		M	VSt		SV@0.5m 136/62 kPa									
139	1							SV@1m 194 kPa									
	1.2		SILT, minor fine sand, trace clay; orange-brown and light grey. Very stiff, dry, low plasticity	LOESS	D	VSt		SV@1.5m 194 kPa									
138	2							SV@2m 194 kPa									
	2.2		SILT, minor fine sand, trace clay; orange-brown. Very stiff, dry, low plasticity; iron-stained horizon		D	VSt											
			SILT; orange-brown and grey alternating. Very stiff, dry, non-plastic		D	VSt	2.20	SV@2.5m UTP									
137	3							SV@3m UTP				HW					
			Highly weathered SILTSTONE (HENLEY BRECCIA) 3.00 - 3.60 m: hard, root webs visible in places	HENLEY BRECCIA		H		SV@3.5m UTP									
136	4		End of Hole @ 3.60m,Target Depth.				3.60										
	5																

Notes and Comments:

End of Hole @ 3.60m, Target Depth.

EOH at 3.6 mbgl, too hard to dig/end of reach.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: Fulton Hogan

Equipment: 22t excavator

Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Future Laydown Area
Job Number: 12506381
Commenced: 10/06/2019 Completed: 10/06/2019

Hole No. : TP11
Sheet : 1 of 1
Hole Length : 3.80m
Scale @ A4 : 1:25
Logged : MF
Processed : HB
Checked : MF

Easting: 396907.03 Northing: 788032.98 System: TAIETM2000
RL: 141.24 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
141	0		SILT, trace to minor clay, trace fine sand; dark grey and orange-brown. Very stiff, moist, low plasticity; tree roots extend to approximately 1.2 m bgl (TOPSOIL)	TOPSOIL	M	VSt											
	0.5		SILT, trace to minor clay; grey with orange-brown streaks. Very stiff, moist, low plasticity (LOESS)	LOESS	M	VSt		SV@0.5m 140/36 kPa									
140	1							SV@1m 194 kPa									
	1.3		SILT, trace clay; light grey/white and orange-brown. Very stiff, dry, low plasticity; powdery when crumbled, iron-staining throughout; strength increases with depth 1.80 m: 50-100 mm iron-stained layer. 2.00 m: 50-100 mm iron-stained layer.		D	VSt	1.50	SV@1.5m 194 kPa									
139	2							SV@2m UTP									
	2.6		Highly weathered, orange-brown SILTSTONE (HENLEY BRECCIA) 2.70 m: light grey and orange-brown 3.00 m: grey and orange-brown.	HENLEY BRECCIA			3.50	SV@2.8m UTP				HW					
138	3							SV@3.7m UTP									
137	4		End of Hole @ 3.80m,Target Depth.														

Notes and Comments:
End of Hole @ 3.80m, Target Depth.
EOH at 3.08 mbgl, too hard to excavate.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Fulton Hogan
Equipment: 22t excavator
Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
10/06/19	00:00		3.8

Project	: Smooth Hill Landfill Consenting	Hole No.	: TP12
Client	: Dunedin City Council	Sheet	: 1 of 1
Site	: Future Laydown Area	Hole Length	: 4.40m
Job Number: 12506381		Scale @ A4	: 1:25
Commenced: 10/06/2019	Completed: 10/06/2019	Logged	: MF
Easting: 396596.93	Northing: 787986.46	Processed	: HB
System: TAIETM2000		Checked	: MF
RL: 142.28	Datum: NZVD2016		

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
142	0		SILT, minor clay, trace fine sand, dark grey and brown. Stiff to very stiff, moist, low plasticity. Trace to minor roots (FILL)	FILL	M	St-VSt		SV@0.4m 139/44 kPa									
	0.7		Sandy SILT, grey. Very stiff, dry, non-plastic; some large roots extend to approximately 1.2 m bgl; trace organics; sand is fine (BURIED TOPSOIL).	BTS	D	VSt											
141	1		Sandy SILT; light grey, light yellow-brown and orange-brown. Very stiff, dry, non-plastic; sand is fine; occasional roots to 1.2 m bgl; strength increases with depth (LOESS)		D	VSt	1.00	SV@1m UTP									
140	2							SV@2m UTP									
			2.50 m: 50-100 mm iron-stained layer	LOESS													
139	3							SV@2.9m UTP									
			3.60 m: 50-100 mm iron-stained layer														
138	4		Highly weathered, SILTSTONE (HENLEY BRECCIA)	HB			4.00					HW					
			End of Hole @ 4.40m,Target Depth.					SV@4.4m UTP									

Notes and Comments:

End of Hole @ 4.40m, Target Depth.

EOH at 4.4 mbgl, deepest excavator could excavate soil.
Groundwater not encountered.

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:

Contractor: Fulton Hogan

Equipment: 22t excavator

Shear Vane Id: GEO2288

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)
10/06/19	00:00		4.4

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 29 July 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 1 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
144	0	Clayey SILT, trace fine sand; dark grey. Soft, moist to wet, high plasticity; minor to some organic matter, reducing with depth (TOPSOIL)	TS	M-W	S											
	0.35	SILT, minor clay, trace fine sand; grey and orange-brown. Very stiff, moist, low plasticity (LOESS)	LOESS	M	VSt				PQTT				100			
143	1	1.00 - 1.90 m: grey and brown														
142	1.9	SILT, trace clay; light grey with orange-brown streaks. Very stiff, moist, non-plastic; completely weathered (HENLEY BRECCIA)		M	VSt				PQTT		CW		96			
	2.65	SILT, some clay to clayey; red-brown, orange-brown and grey. Firm to stiff, moist, high plasticity; minor rock fragments; completely weathered		M	F-St											
141	3	SILT, trace to minor clay; red-brown. Very stiff to hard, moist, low plasticity; completely weathered		M	VSt-H				PQTT				100 62			
	3.4	Moderately weathered, grey and yellow-brown, moderately thickly bedded, fine to medium grained SANDSTONE; very weak; very widely spaced defects														
140	4	4.20 - 5.00 m: fine to coarse sand														
139	5	*4.60* BP, 10°, pl, r, Fe-stained, black 4.90 - 5.00 m: grades into breccia	HENLEY BRECCIA						PQTT		MW		88 34			
138	6	Moderately weathered, brown, grey, orange-brown and red-brown BRECCIA; extremely to very weak; very widely spaced defects; matrix supported; fine sandy silt matrix; clasts are angular to subrounded, quartz and schist, fine to coarse gravel. Soil description: fine to coarse gravelly, fine sandy silt														
	6.45	*6.12* JT, 15°, pl, r, clean *6.15* JT, 85°, pl, r, clean *6.17* JT, 20°, pl, r, clean 6.30 - 6.45 m: transition from moderately to slightly weathered							PQTT				100 70			
137	7	Slightly weathered, grey and light grey BRECCIA; very weak to weak; no defects; matrix supported; fine sand matrix; clasts are angular to subrounded, quartz and schist, fine to coarse gravel 7.00 - 7.90 m: weak to moderately strong 7.20 - 7.90 m: clast supported 7.50 - 7.90 m: medium to coarse gravel														
136	7.9	Slightly weathered, grey and light grey BRECCIA; extremely to very weak; no defects; matrix supported; fine to medium sand matrix; clasts are angular to subrounded, quartz and schist, fine to coarse gravel. Soil description: fine to coarse gravelly, fine sandy silt							PQTT		SW		100 48			
135	8.6	Slightly weathered, grey and light grey BRECCIA; weak to moderately strong; no defects; matrix supported; fine to medium sand matrix; clasts are angular to subrounded, quartz and schist, fine to coarse gravel 9.10 - 9.35 m: 250 mm light grey, fine grained SANDSTONE							PQTT				100 29			
134	9															

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 4 December 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 2 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
133	10.8		Slightly weathered, grey and light grey BRECCIA; weak to moderately strong; no defects; matrix supported; fine to medium sand matrix; clasts are angular to subrounded, quartz and schist, fine to coarse gravel *(continued from layer starting at 8.6m)*							PQTT		SW		100 29			
			10.8 m to 61.0 m: Wash drilling							Wash drilled							

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 4 December 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 3 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
123	21		10.8 m to 61.0 m: Wash drilling *(continued from layer starting at 10.8m)*							Wash drilled							
122	22																
121	23																
120	24																
119	25																
118	26																
117	27																
116	28																
115	29																
114																	

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 4 December 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 4 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
113	31		10.8 m to 61.0 m: Wash drilling *(continued from layer starting at 10.8m)*							Wash drilled							
112	32																
111	33																
110	34																
109	35																
108	36																
107	37																
106	38																
105	39																
104																	

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 4 December 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 5 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
103	41		10.8 m to 61.0 m: Wash drilling *(continued from layer starting at 10.8m)*							Wash drilled							
102	42																
101	43																
100	44																
99	45																
98	46																
97	47																
96	48																
95	49																
94																	

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 6 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
93	51		10.8 m to 61.0 m: Wash drilling *(continued from layer starting at 10.8m)*							Wash drilled							
92	52																
91	53																
90	54																
89	55																
88	56																
87	57																
86	58																
85	59																
84																	

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 29/10/2019 Completed: 1/11/2019

Hole No. : BH201
Sheet : 7 of 7
Hole Length : 61.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396596 Northing: 787540 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
83	61		10.8 m to 61.0 m: Wash drilling *(continued from layer starting at 10.8m)*							Wash drilled							
			End of Hole @ 61.00m,Target Depth.														
82	62																
81	63																
80	64																
79	65																
78	66																
77	67																
76	68																
75	69																
74																	

Notes and Comments:
End of Hole @ 61.00m, Target Depth.

0.0 - 10.8 m PQTT coring
10.8 - 61.0 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track Mounted Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report of Photographs

Site Identification: BH201

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	28/10/2019	**Completed**	01/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.8 m		

Box 1 of 5: 0.00 m to 2.30 m

Box 2 of 5: 2.30 m to 4.50 m

CLIENTS | PEOPLE | PERFORMANCE

Report of Photographs

Site Identification: BH201

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	28/10/2019	**Completed**	01/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.8 m		

Box 3 of 5: 4.50 m to 6.80 m

Box 4 of 5: 6.80 m to 9.00 m

CLIENTS | PEOPLE | PERFORMANCE

Report of Photographs

Site Identification: BH201

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	28/10/2019	**Completed**	01/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.8 m		

Box 5 of 5: 9.00 m to 10.80 m

10.80 m to 61.00 m (EOH) – Wash drilled, no core recovered

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 1 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
144	0	SILT, trace to minor clay; grey and orange-brown. Firm to stiff, moist, low plasticity (FILL/COLLUVIUM?)	FILL/COLLUVIUM?	M	F-St				PQTT							
		0.30 - 0.80 m: brown and grey, very stiff			VSt											
143	1	0.80 - 0.90 m: trace clay, grey, stiff, minor to some organic matter (roots)			St								100			
		0.90 - 1.20 m: grey and brown, very stiff, trace iron-oxide nodules, "chaotic" texture			VSt											
	1.5	1.20 - 1.60 minor iron-oxide nodules														
142	2	SILT, trace to minor clay; dark brown. Very stiff, moist, low plasticity; small branches (BURIED TOPSOIL)	T	M	VSt-H				PQTT				100			
		SILT, trace clay; orange-brown and grey; Very stiff to hard, moist, non-plastic; trace iron-oxide nodules; completely weathered (HENLEY BRECCIA)														
141	3	2.60 - 2.80 m: minor to some iron-oxide nodules - increases with depth														
	3.5	Gravelly, sandy SILT; orange-brown, brown and grey; Very stiff to hard, moist, non-plastic; sand is medium to coarse; gravel is fine to medium, angular to subrounded, quartz and schist; completely weathered		M	VSt-H				PQTT				94			
140	4	4.10 - 4.50 m: CORE LOSS							PQTT		CW		0			
	4.5	4.50 - 5.70 m: CORE LOSS							PQTT				0			
139	5															
	5.7	Gravelly, sandy SILT; orange-brown, brown and grey; Very stiff to hard, moist, non-plastic; sand is medium to coarse; gravel is fine to medium, angular to subrounded, quartz and schist; completely weathered	HENLEY BRECCIA	M	VSt-H				PQTT				100			
138	5.9	SILT, trace to minor clay; grey and brown. Very stiff to hard, moist, non-plastic; completely weathered		M	VSt-H											
	6.3	Gravelly, silty SAND; orange-brown. Moist; well sorted; sand is fine to coarse; gravel is fine to medium, angular to subrounded, quartz and schist; completely weathered		M					PQTT				95			
137	6.75	Gravelly, sandy SILT; orange-brown and grey. Firm, moist, non-plastic; sand is fine to coarse; gravel is fine to medium, angular to subrounded, quartz and schist; completely weathered		M	F											
	7.4	Highly weathered, light brown, thinly to moderately thickly bedded SILTSTONE; extremely weak; no defects. Soil description: SILT, minor clay; hard							PQTT		HW		100			
136	7.8	Moderately weathered, dark grey, thinly bedded SILTSTONE; extremely to very weak; no defects; trace to minor lignite									MW		83			
	8	Moderately weathered, light grey, fine to coarse grained SANDSTONE; very weak; no defects														
	8.2	Moderately weathered, black, LIGNITE; very weak, no defects														
135	8.5	Slightly weathered, light grey and grey, thinly to moderately thickly bedded, fine to medium grained SANDSTONE; very weak; no defects; occasional lignite layers							PQTT		SW		100			
	9	8.60 - 8.85 m: fine to coarse sand											90			
134		8.99 - 9.02 m: 30 mm lignite														

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 6 November 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 2 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
133	11		9.84 - 9.89 m: 50 mm lignite Slightly weathered, light grey and grey, thinly to moderately thickly bedded, fine to medium grained SANDSTONE; very weak; no defects; occasional lignite layers *(continued from layer starting at 8.5m)* 10.30 - 10.45 m: 150 mm lignite	HENLEY BRECCIA						PQTT		SW		100 90			
132	12		10.60 m to 60.60 m: Wash drilled							Wash drilling							
131	13																
130	14																
129	15																
128	16																
127	17																
126	18																
125	19																
124																	

10.6

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 3 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
123	21		10.60 m to 60.60 m: Wash drilled *(continued from layer starting at 10.6m)*	HENLEY BRECCIA						Wash drilling							
122	22																
121	23																
120	24																
119	25																
118	26																
117	27																
116	28																
115	29																
114																	

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 6 November 2019

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 4 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
113	31		10.60 m to 60.60 m: Wash drilled *(continued from layer starting at 10.6m)*	HENLEY BRECCIA						Wash drilling							
112	32																
111	33																
110	34																
109	35																
108	36																
107	37																
106	38																
105	39																
104																	

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 5 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
103	41		10.60 m to 60.60 m: Wash drilled *(continued from layer starting at 10.6m)*	HENLEY BRECCIA						Wash drilling							
102	42																
101	43																
100	44																
99	45																
98	46																
97	47																
96	48																
95	49																
94																	

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 6 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
93	51		10.60 m to 60.60 m: Wash drilled *(continued from layer starting at 10.6m)*	HENLEY BRECCIA						Wash drilling							
92	52																
91	53																
90	54																
89	55																
88	56																
87	57																
86	58																
85	59																
84	60																

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southern Boundary
Job Number: 12506381
Commenced: 2/11/2019 Completed: 4/11/2019

Hole No. : BH202
Sheet : 7 of 7
Hole Length : 60.60m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396181 Northing: 787498 System: TAIETM2000
RL: 144 Datum: NZVD2016

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample: Number / Type	Sample: Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
			10.60 m to 60.60 m: Wash drilled *(continued from layer starting at 10.6m)*														
	61		End of Hole @ 60.60m,Target Depth.														
	62																
	63																
	64																
	65																
	66																
	67																
	68																
	69																

Notes and Comments:
End of Hole @ 60.60m, Target Depth.

0.0 - 10.6 m PQTT coring
10.6 - 60.6 m wash drilling

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

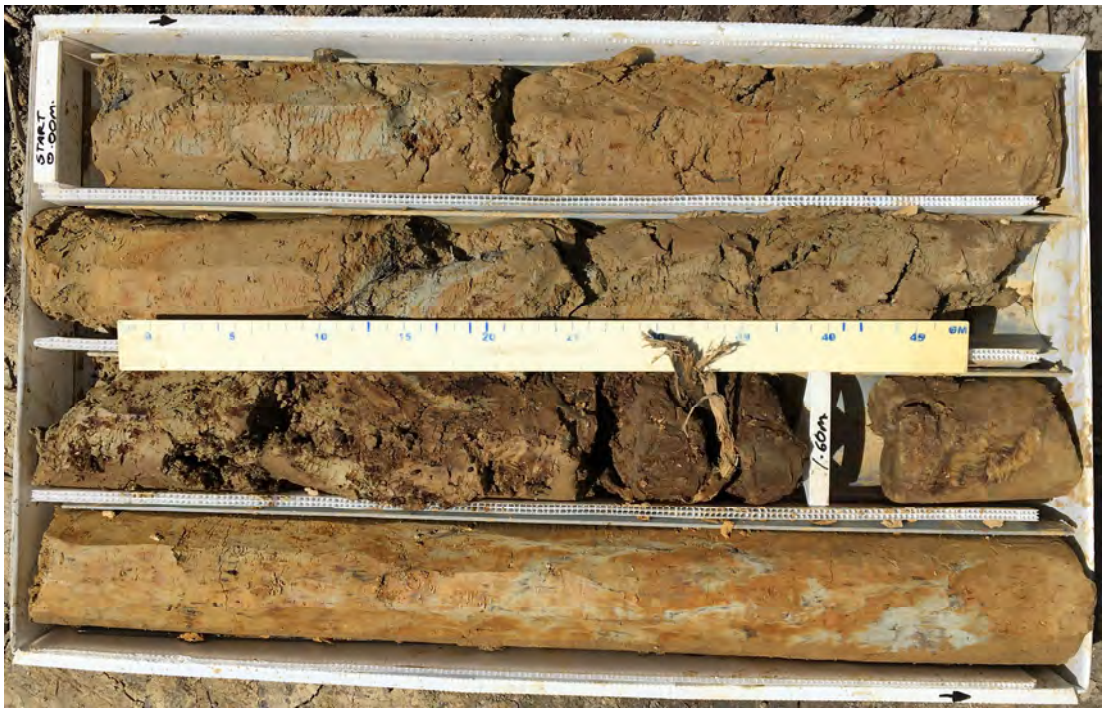
Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

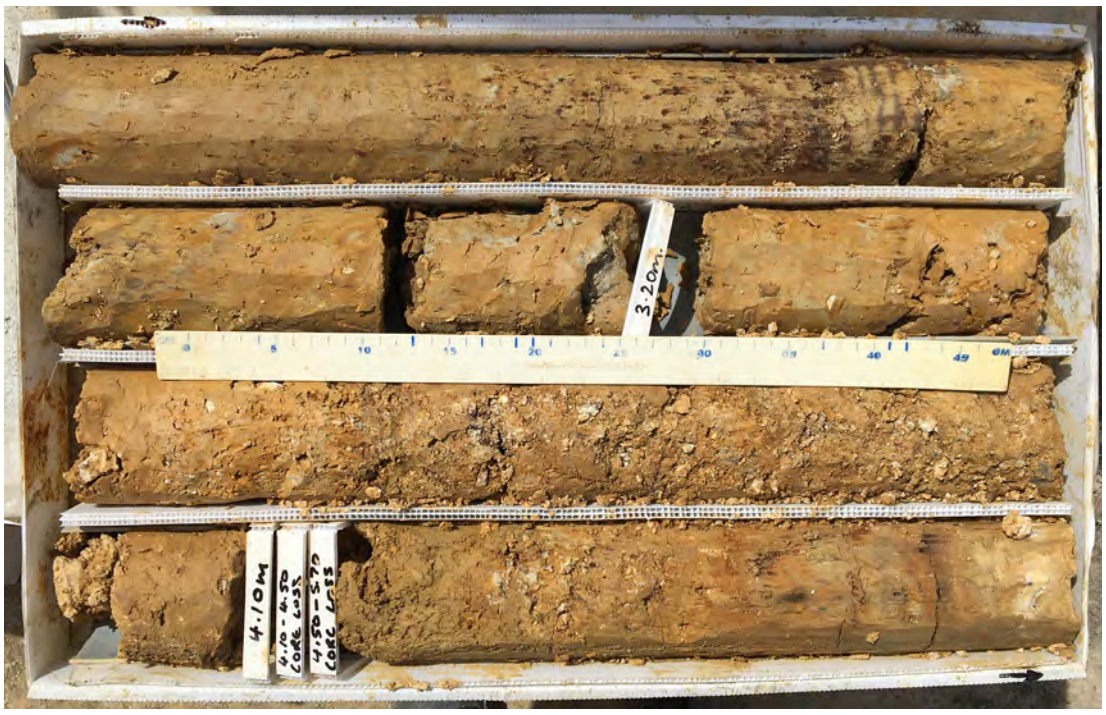
Report of Photographs

Site Identification: BH202

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	02/11/2019	**Completed**	04/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.6 m		



Box 1 of 4: 0.00 m to 2.30 m



Box 2 of 4: 2.30 m to 6.10 m

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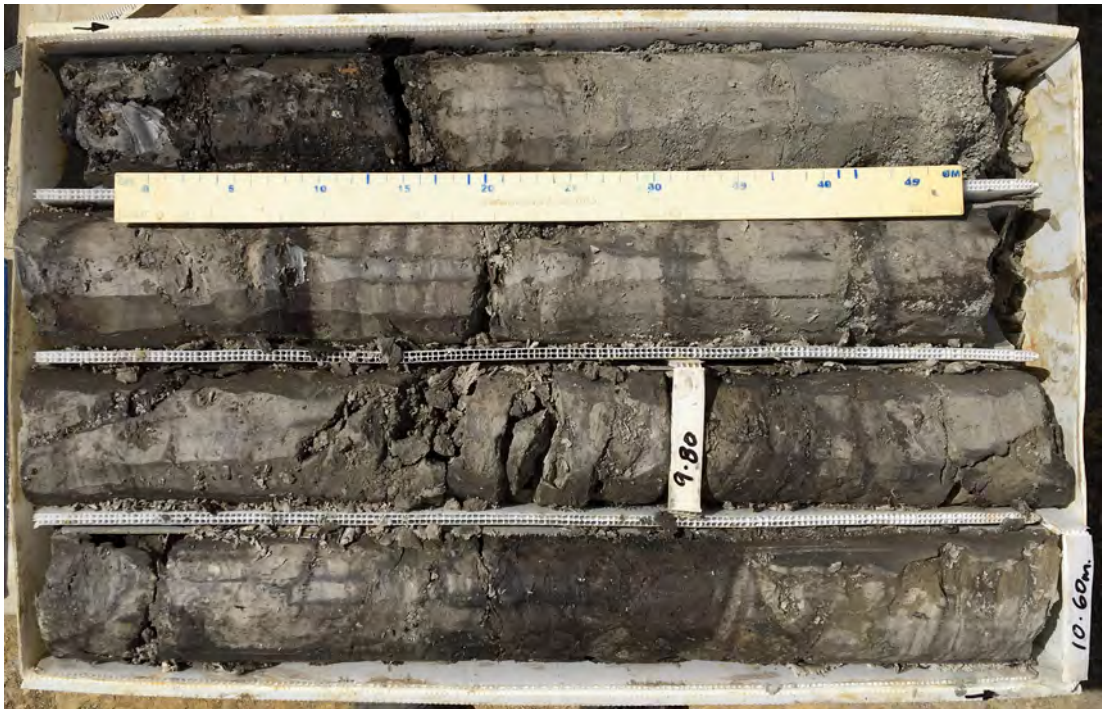
Report of Photographs

Site Identification: BH202

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	02/11/2019	**Completed**	04/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.6 m		

Box 3 of 4: 6.10 m to 8.30 m



Box 4 of 4: 8.30 m to 10.60 m

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Report of Photographs

Site Identification: BH202

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	02/11/2019	**Completed**	04/11/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.6 m		

10.60 m to 60.60 m (EOH) – Wash drilled, no core recovered

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Boundary
Job Number: 12506381
Commenced: 7/11/2019 Completed: 7/11/2019

Hole No. : BH203
Sheet : 1 of 2
Hole Length : 19.70m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 395779 Northing: 787672 System: TAIETM2000
RL: 182 Datum: NZVD2009

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
181	0		Highly weathered, cream, orange-brown and yellow-brown, CONGLOMERATE; extremely weak; no defects; matrix supported; matrix is fine to coarse sandy silt; clasts are fine, rounded to subrounded, quartz and schist gravel. Soil description: gravelly sandy silt (Henley Breccia)	HENLEY BRECCIA						PQTT		HW		96 85			
180	1.1		Highly weathered, orange-brown and grey, laminated to moderately thickly bedded SILTSTONE; extremely weak; no defects. Soil description: Silt, minor fine to medium sand, hard														
179	2.1		1.90 - 2.10 m: moderately weathered, grey with occasional orange-brown Grades into: moderately weathered, grey with occasional orange-brown, laminated to moderately thickly bedded, silty fine grained SANDSTONE; extremely weak; no defects. Soil description: silty fine sand							PQTT				97 76			
178	2.9		Moderately weathered, brown and grey, moderately thickly bedded CONGLOMERATE; very weak to weak; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine, rounded to subangular, quartz and schist gravel							PQTT				100 66			
177	4.8		Moderately weathered, brown and grey, BRECCIA; very weak; no defects; matrix supported; matrix is silty fine sand; clasts are fine to medium, angular to subrounded, quartz and schist gravel (HENLEY BRECCIA)							PQTT		MW		98 58			
176	5.8		5.80 - 6.00 m: CORE LOSS														
175	6		BRECCIA (continued from 4.8 m) 6.10 - 6.40 m: iron staining, orange-brown							PQTT				82 28			
174	7.5		Moderately weathered, orange-brown, very thinly to moderately thickly bedded SILTSTONE; very weak; no defects; moderately widely spaced lignite layers 5-20 mm thick 7.90 - 11.15 m: slightly weathered, grey	HENLEY BRECCIA						PQTT		SW		100 89			
173										PQTT				100 87			
172																	

Notes and Comments:
End of Hole @ 19.70m, Target Depth.
Groundwater not encountered

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Southwest Boundary
Job Number: 12506381
Commenced: 7/11/2019 Completed: 7/11/2019

Hole No. : BH203
Sheet : 2 of 2
Hole Length : 19.70m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 395779 Northing: 787672 System: TAIETM2000
RL: 182 Datum: NZVD2009

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
171	11		Moderately weathered, orange-brown, very thinly to moderately thickly bedded SILTSTONE; very weak; no defects; moderately widely spaced lignite layers 5-20 mm thick *(continued from layer starting at 7.5m)*							PQTT		SW		100			
			10.00 - 10.10 m: fine SANDSTONE											87			
	11.15		Unweathered, light grey, laminated to moderately thickly bedded, fine grained SANDSTONE; very weak; no defects; moderately widely spaced lignite layers 5-30 mm thick							PQTT				100			
170	12													53			
169	13									PQTT				100			
														100			
168	14											UW					
	14.55		14.45 - 14.55 m: grades into BRECCIA	HENLEY BRECCIA						PQTT				100			
167	15		Unweathered, light grey, BRECCIA; weak to moderately strong; no defects; clast supported; matrix is fine to coarse sand; clasts are fine, quartz and schist, angular to subangular gravel											81			
	15.4		Unweathered, light grey, laminated to moderately thickly bedded, fine grained SANDSTONE; very weak to weak; no defects														
166	16		16.00 - 16.15 m: moderately strong							PQTT				100			
														92			
165	17		17.30 - 17.60 m: grades into BRECCIA							PQTT				97			
	17.6		Slightly weathered, light grey and white, BRECCIA; moderately strong to strong; no defects; clast supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel											75			
164	18																
163	19									PQTT		SW		83			
														19			
162			End of Hole @ 19.70m,Target Depth.														

Notes and Comments:
End of Hole @ 19.70m, Target Depth.
Groundwater not encountered

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 28 November 2019

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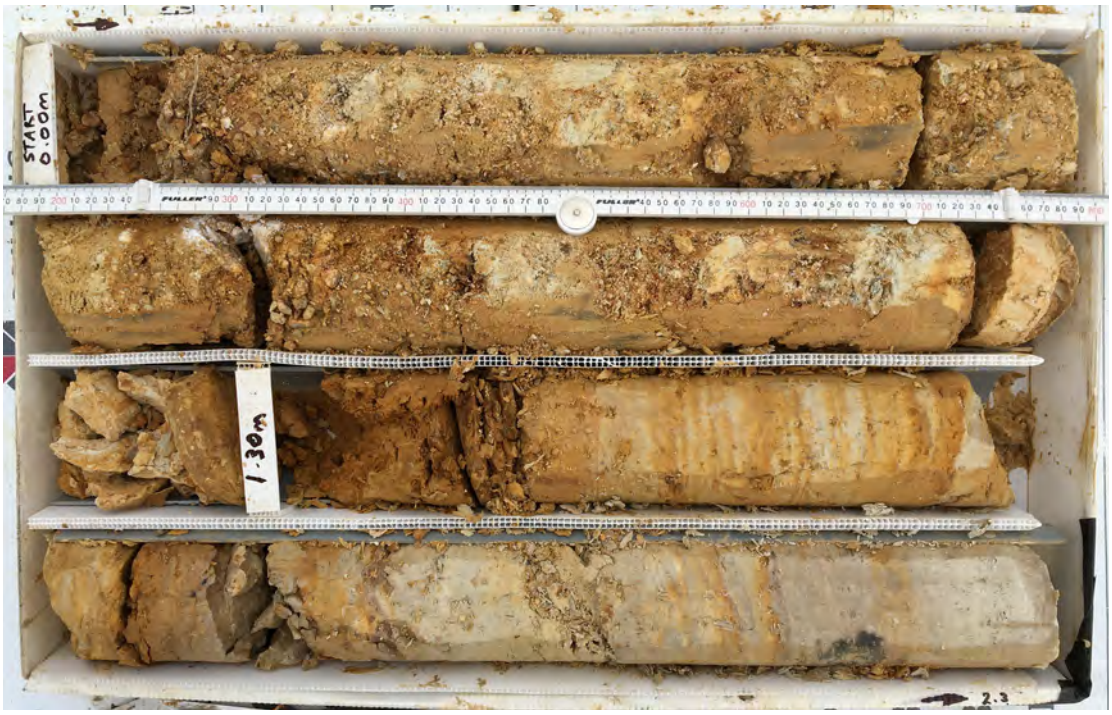
Report of Photographs

Site Identification: BH203

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	07/11/2019	**Completed**	07/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 19.7 m		



0.00 m to 2.30 m

2.30 m to 4.60 m

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Report of Photographs

Site Identification: BH203

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	07/11/2019	**Completed**	07/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 19.7 m		

4.60 m to 6.90 m

6.90 m to 9.20 m

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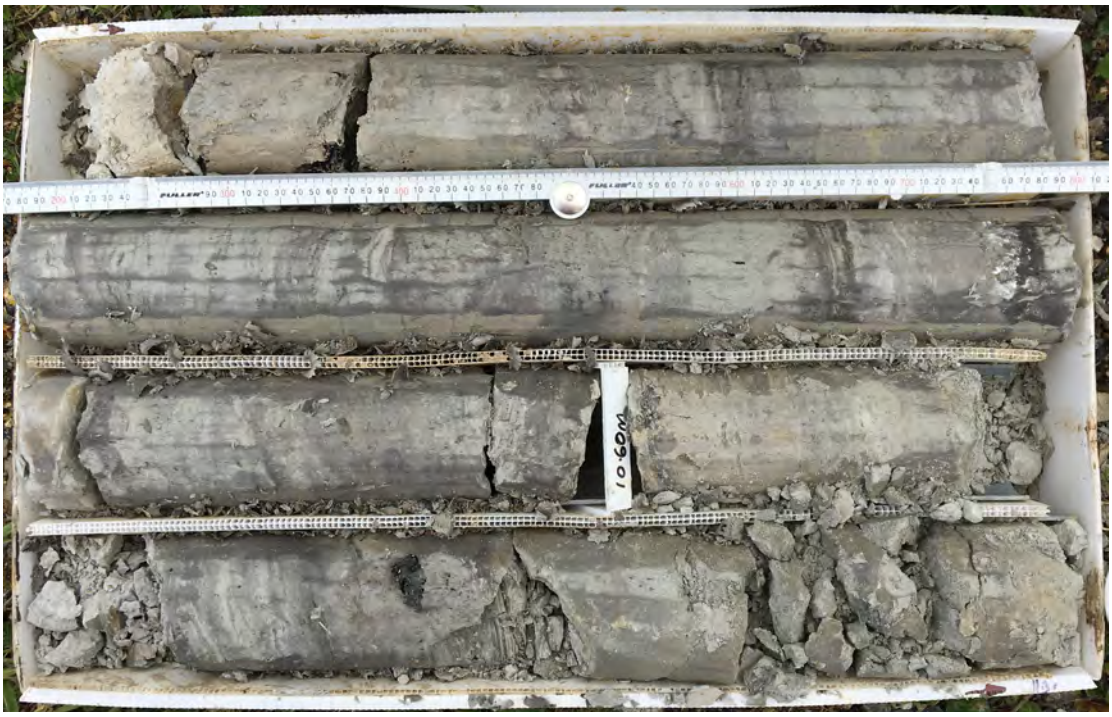
Report of Photographs

Site Identification: BH203

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	07/11/2019	**Completed**	07/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 19.7 m		



9.20 m to 11.30 m

11.30 m to 13.40 m

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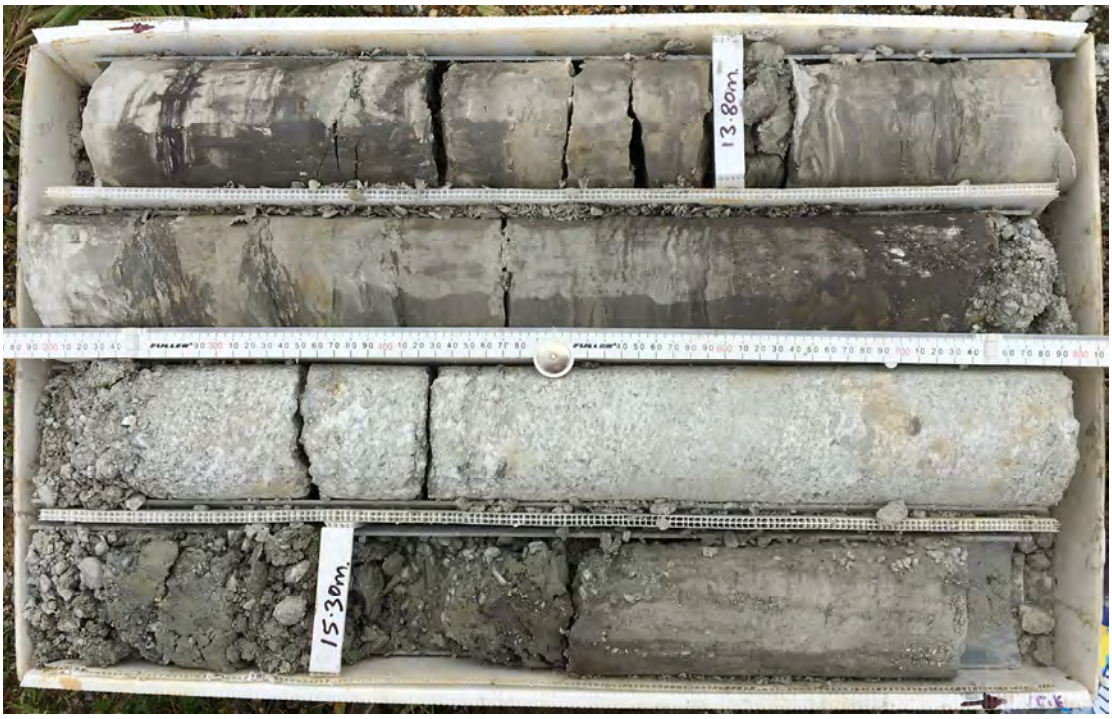
Report of Photographs

Site Identification: BH203

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	07/11/2019	**Completed**	07/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 19.7 m		



13.40 m to 15.60 m

15.60 m to 17.90 m

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Report of Photographs

Site Identification: BH203

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	07/11/2019	**Completed**	07/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 19.7 m		

17.90 m to 19.70 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Western Boundary
Job Number: 12506381
Commenced: 24/10/2019 Completed: 24/10/2019

Hole No. : BH209
Sheet : 1 of 1
Hole Length : 10.00m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 395775 Northing: 788148 System:
RL: 132 Datum:

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
0	0	Intermixed: clayey SILT, sandy SILT, and SILT with minor clay; grey and brown. Soft to firm, moist to wet, low to high plasticity; wood fragments throughout (FILL)	FILL	M-W	S-F				PQTT				92			
	0.6	SILT, minor clay, trace find sand; light grey and orange-brown. Very stiff, moist, low plasticity; trace fine gravel sized iron oxide nodules (LOESS) 0.80 - 3.15 m: grey-brown and orange-brown	LOESS	M	VSt				PQTT				100			
1																
2									PQTT				100			
3	3.15	Gravelly SILT; grey, cream and brown. Very stiff to hard, dry to moist, non-plastic; gravel is fine to medium, rounded to subangular quartz and schist; highly weathered (Henley Breccia)	HENLEY BRECCIA	D-M	VSt-H				PQTT		HW		96			
	3.6	SILT, minor to some clay; grey with orange-brown streaks. Firm to stiff, moist, high plasticity		M	F-St											
4	4	Moderately weathered, orange-brown, very thinly to moderately thickly bedded fine-grained SANDSTONE; very weak; no defects							PQTT				100 86			
		4.80 - 5.30 m: light grey														
5	5.3	Moderately weathered, brown and orange-brown CONGLOMERATE; extremely weak; no defects; matrix supported; clasts are fine to medium, rounded to subangular, quartz and schist gravel; silty sand matrix. Soil description: gravelly silty sand							PQTT		MW		100 60			
6	5.9	Moderately weathered, orange-brown, very thinly to moderately thickly bedded fine-grained SANDSTONE; very weak; no defects														
	6.65	Slightly weathered, grey, laminated to moderately thinly bedded fine-grained SANDSTONE; very weak; no defects							PQTT				100 100			
7	7.3	Slightly weathered, brown with occasional orange-brown and white, moderately thinly to moderately thickly bedded, fine to medium-grained SANDSTONE; very weak; no defects; minor fine quartz and schist gravel														
	7.8	Slightly weathered, brown and orange-brown CONGLOMERATE; extremely weak; no defects; clast supported; silty sand matrix; clasts are fine to coarse, rounded to subangular, quartz and schist gravel. Soil description: silty, sandy, fine to coarse gravel							PQTT		SW		100 0			
8																
9									PQTT				94 0			
10		End of Hole @ 10.00m,Target Depth.														

Notes and Comments:
End of Hole @ 10.00m, Target Depth.
Groundwater not encountered

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Tracked Rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report of Photographs

Site Identification: BH209

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	24/10/2019	**Completed**	24/10/2019
Site	Western Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.0 m		

Box 1 of 5: 0.00 m to 2.40 m

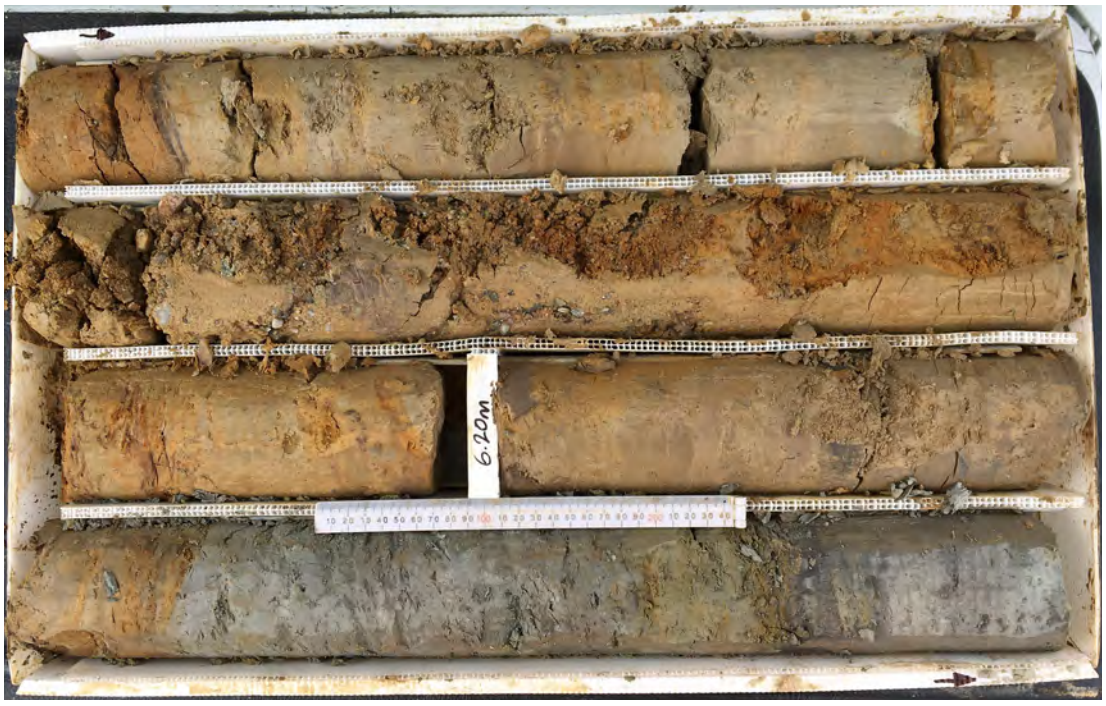
Box 2 of 5: 2.40 m to 4.70 m

CLIENTS | PEOPLE | PERFORMANCE

Report of Photographs

Site Identification: BH209

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	24/10/2019	**Completed**	24/10/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.0 m		



Box 3 of 5: 4.70 m to 7.15 m

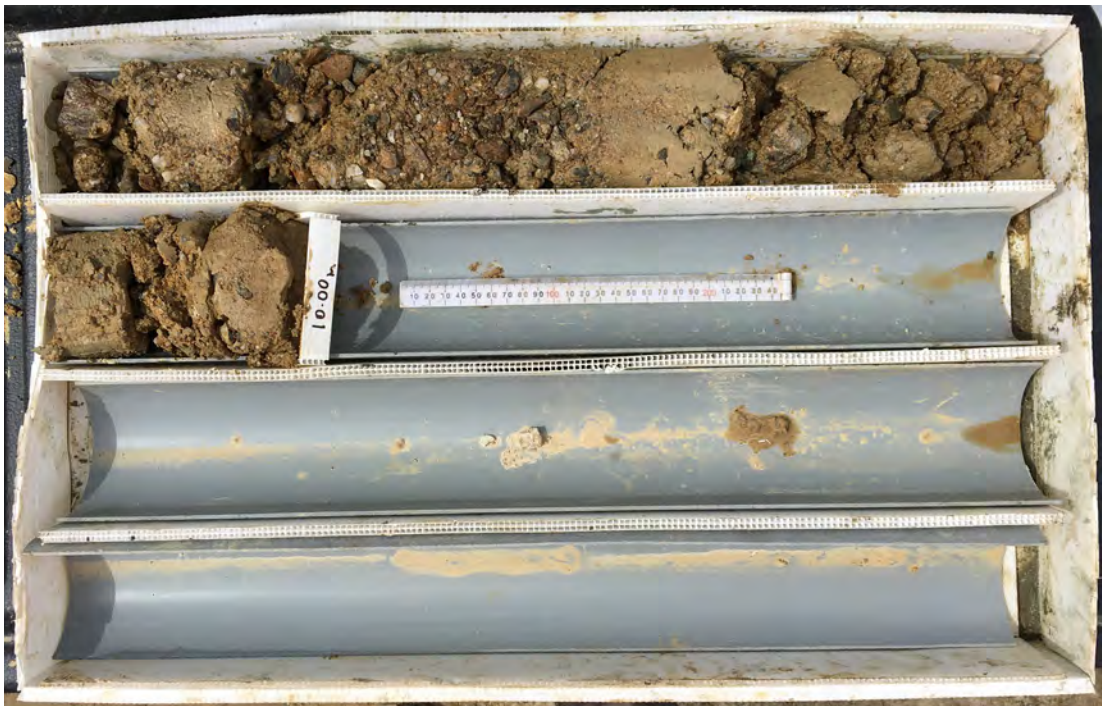
Box 4 of 5: 7.15 m to 9.20 m

CLIENTS | PEOPLE | PERFORMANCE

Report of Photographs

Site Identification: BH209

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	24/10/2019	**Completed**	24/10/2019
Site	Southern Boundary	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 10.0 m		



Box 5 of 5: 9.20 m to 10.0 m (EOH)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Eastern gully base
Job Number: 12506381
Commenced: 4/11/2019 Completed: 6/11/2019

Hole No. : BH211
Sheet : 1 of 3
Hole Length : 25.20m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396598 Northing: 787965 System: TAIETM2000
RL: 107 Datum: NZVD2009

Depth (m)	Material Description	Geological Unit	Moisture condition	Consistency / Relative density	Method	TCR / SCR / RQD (%)	Weathering
0.00–0.35	0.00 - 0.35 m: CORE LOSS (inferred at top of run)						
0.35–0.7	SILT, minor fine to medium sand, trace clay; grey, orange-brown and dark grey intermixed. Stiff to very stiff, moist, low plasticity (FILL)	FILL	M	St-VSt	PQTT	78	
0.7–1.6	SILT, trace to minor fine to medium sand; grey and orange-brown. Very stiff, moist, low plasticity; trace to minor iron-oxide nodules (LOESS)	LOESS	M	VSt			
1.6–1.8	1.60 - 1.80 m: CORE LOSS (inferred depth)						
1.8–1.95	SILT (continued from 0.7 m)				PQTT	75	
1.95–3.2	Sandy SILT, minor fine gravel; orange-brown and grey. Very stiff to hard, moist, non-plastic; sand is fine to medium; gravel is angular to rounded quartz and schist; completely weathered breccia (HENLEY BRECCIA) 2.40 - 2.80 m: firm to stiff 2.80 - 3.20 m: very stiff	HENLEY BRECCIA	M	VSt-H F-St VSt	PQTT	62	CW
3.2–3.7	3.20 - 3.70 m: CORE LOSS						
3.7–4.2	SILT; dark grey. Firm to stiff, moist, low plasticity; completely weathered siltstone		M	F-St	PQTT	100	
4.2–4.6	Gravelly SAND; grey. Moist; sand is fine to coarse; gravel is fine, angular to subrounded, quartz and schist; completely weathered breccia		M	VSt-H			
4.6–5.2	4.60 - 5.20 m: CORE LOSS						
5.2–5.4	Gravelly SAND (continued from 4.2 m)		M	VSt-H	PQTT	59 / 25	
5.4–6.2	Highly weathered, orange-brown and grey, moderately thickly bedded BRECCIA; extremely weak; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine to medium, angular to rounded, quartz and schist gravel. Soil description: gravelly sand						HW
6.2–6.75	Slightly weathered, light grey and white, moderately thickly bedded SILTSTONE; very weak to weak; no defects				PQTT	100 / 93	SW
6.75–	Slightly weathered, light grey and white BRECCIA; weak to moderately strong; no defects; clast supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel 8.80 - 9.90 m: very weak to weak				PQTT PQTT	100 / 70 100 / 79	

Notes and Comments:
End of Hole @ 25.20m, Target Depth.
Groundwater at 2.81 m bgl in shallow piezo (25/11/19)

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Eastern gully base
Job Number: 12506381
Commenced: 4/11/2019 Completed: 6/11/2019

Hole No. : BH211
Sheet : 2 of 3
Hole Length : 25.20m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396598 Northing: 787965 System: TAIETM2000
RL: 107 Datum: NZVD2009

RL (m)	Depth (m)	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
96	11	9.90 - 11.80 m: weak to moderately strong Slightly weathered, light grey and white BRECCIA; weak to moderately strong; no defects; clast supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel *(continued from layer starting at 6.8m)*	HENLEY BRECCIA						PQTT		SW		100 92			
									PQTT				100 60			
95	12 11.8	Slightly weathered, grey SILTSTONE; very weak; no defects; trace to minor fine gravel, content decreases with depth							PQTT				97 90			
		Slightly weathered, brown, SILTSTONE; very weak; no defects; possible lithified topsoil							PQTT				100 87			
94	13	13.50 - 13.65 m: grey														
93	13.65 14	Slightly weathered, grey, fine to coarse grained SANDSTONE; very weak to weak; no defects														
		Slightly weathered, grey and white BRECCIA; weak to moderately strong; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel							PQTT				100 46			
92	15															
91	16 16.1	Slightly weathered, grey, fine to coarse grained SANDSTONE; very weak; no defects							PQTT				100 35			
	16.6	Slightly weathered, grey and white BRECCIA; very weak; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine to medium, angular to subrounded, quartz and schist gravel							PQTT				100 84			
90	17 17.6	Slightly weathered, grey, fine to medium grained SANDSTONE; very weak; no defects							PQTT				100 86			
89	18 18.3	Slightly weathered, grey and white BRECCIA; moderately strong to strong; no defects; clast supported; fine to coarse sand matrix; clasts are fine to medium, angular to subrounded, quartz and schist gravel														
88	19 19.1	Slightly weathered, grey and white BRECCIA; very weak to weak; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel							PQTT				100 71			
87	20															

Notes and Comments:
End of Hole @ 25.20m, Target Depth.
Groundwater at 2.81 m bgl in shallow piezo (25/11/19)

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

Date	Time	Reading (mbgl)	Hole depth (mbgl)

Project : Smooth Hill Landfill Consenting
Client : Dunedin City Council
Site : Eastern gully base
Job Number: 12506381
Commenced: 4/11/2019 Completed: 6/11/2019

Hole No. : BH211
Sheet : 3 of 3
Hole Length : 25.20m
Scale @ A4 : 1:50
Logged : MF
Processed : MF
Checked : JHS

Easting: 396598 Northing: 787965 System: TAIETM2000
RL: 107 Datum: NZVD2009

RL (m)	Depth (m)	Graphic	Material Description	Geological Unit	Moisture condition	Consistancy / Relative density	Sample Number / Type	Sample Result	Casing	Method	Flush Return (%)	Weathering	Estimated Strength (MPa)	TCR SCR RQD (%)	Defect Spacing (mm)	Instrumentation Installation	Water level
86	21		Slightly weathered, grey and white BRECCIA; very weak to weak; no defects; matrix supported; matrix is fine to coarse sand; clasts are fine to coarse, angular to subrounded, quartz and schist gravel *(continued from layer starting at 19.1m)*	HENLEY BRECCIA						PQTT		SW		96 51			
			21.00 - 25.20 m: occasional cobble-sized clast														
85	22		22.00 - 25.20 m: clast supported							PQTT				100 63			
			22.65 - 23.00 m: moderately strong to strong														
84	23									PQTT				100 36			
83	24		24.00 - 24.40 m: moderately strong to strong														
82	25									PQTT				92 68			
			End of Hole @ 25.20m,Target Depth.														
81	26																
80	27																
79	28																
78	29																
77																	

Notes and Comments:
End of Hole @ 25.20m, Target Depth.
Groundwater at 2.81 m bgl in shallow piezo (25/11/19)

Refer to explanation sheets for abbreviation and symbols

Inclination: Vertical Orientation:
Contractor: Speight Drilling
Equipment: Track mounted rig
Shear Vane Id:

Ground Water Level

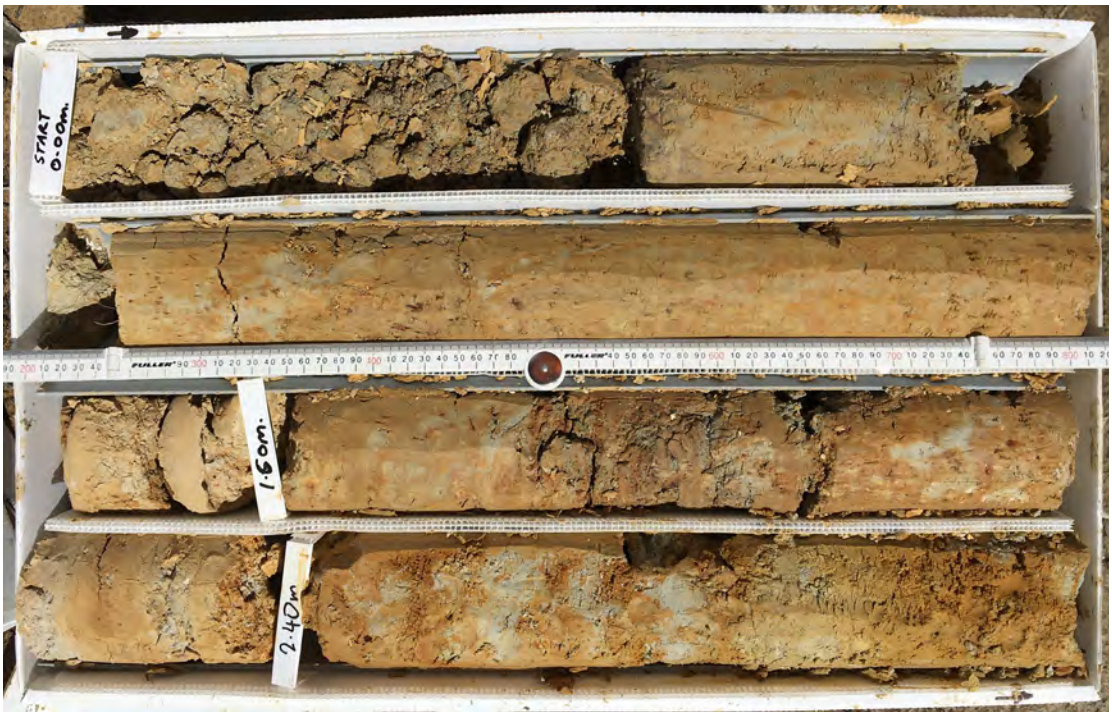
Date	Time	Reading (mbgl)	Hole depth (mbgl)

Report ID: GENERAL_LOG || Project: 12506381 GINT LOGS SMOOTH HILL.GPJ || Library: GHD - NZGD.GLB || Date: 9 March 2021

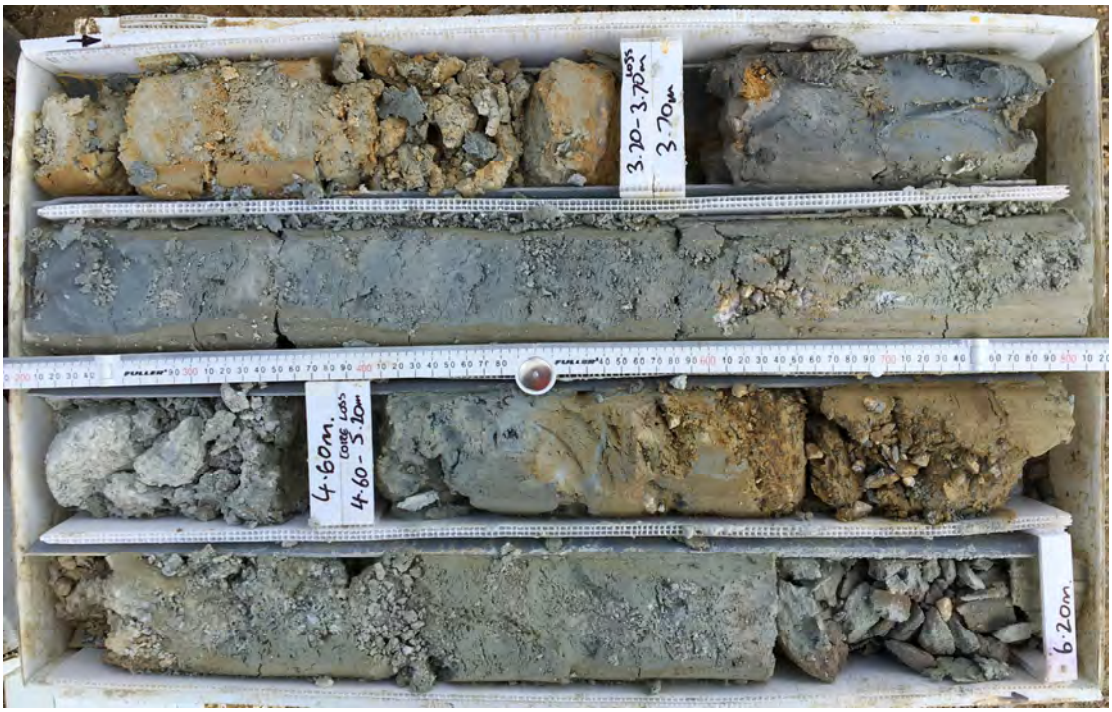
Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m – 25.2 m		



0.00 m to 2.80 m

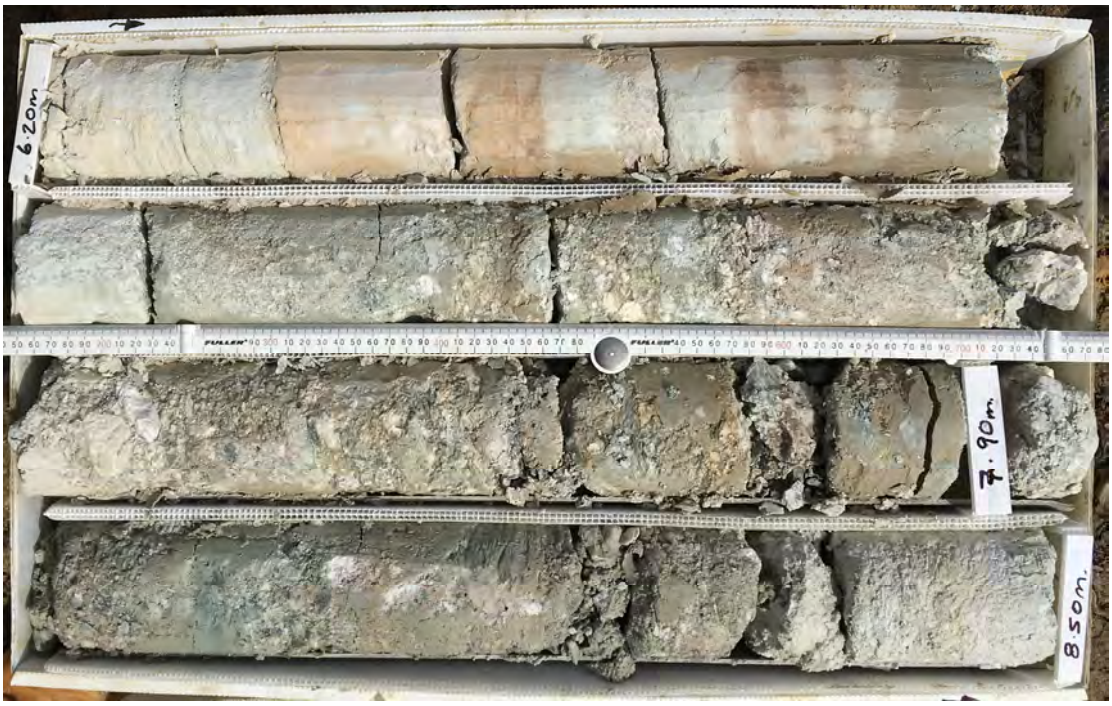


2.80 m to 6.20 m

Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 25.2 m		



6.20 m to 8.50 m

8.50 m to 10.70 m

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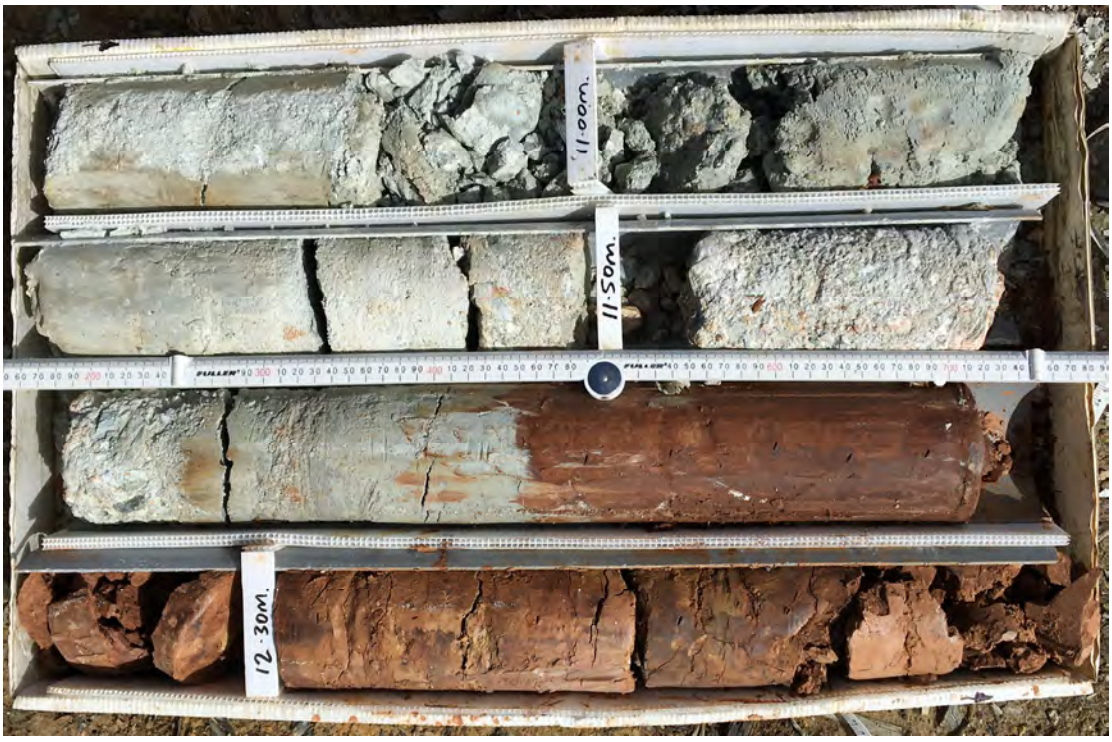
Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 25.2 m		



10.70 m to 12.80 m

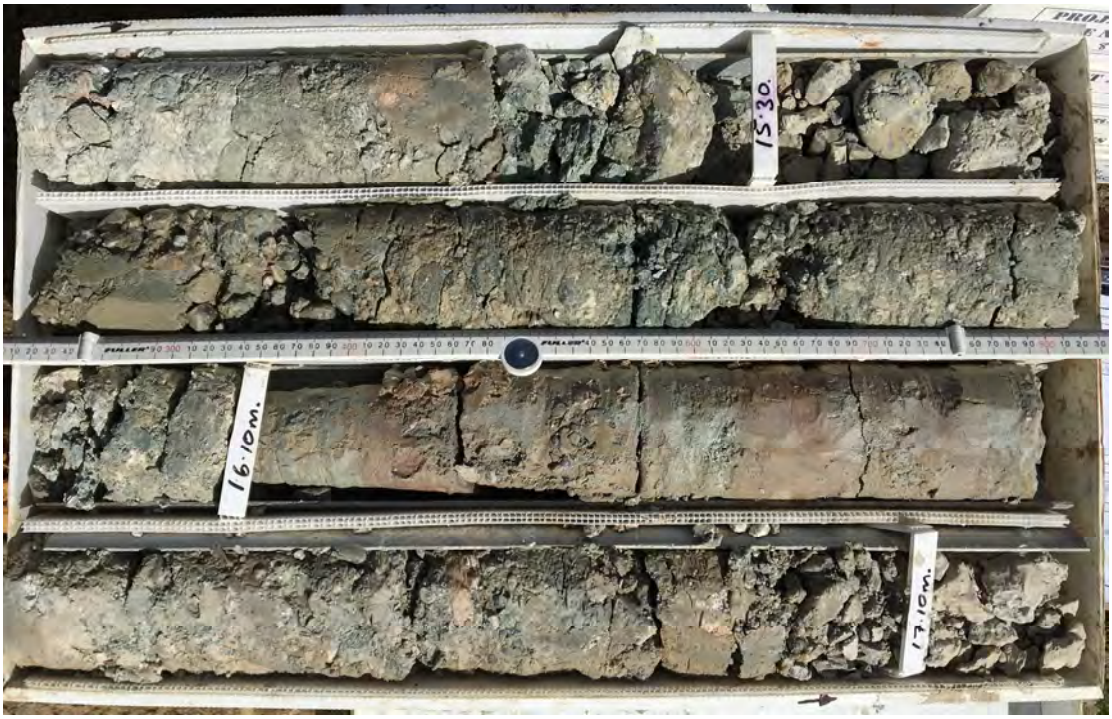
12.80 m to 14.90 m

CLIENTS | PEOPLE | PERFORMANCE

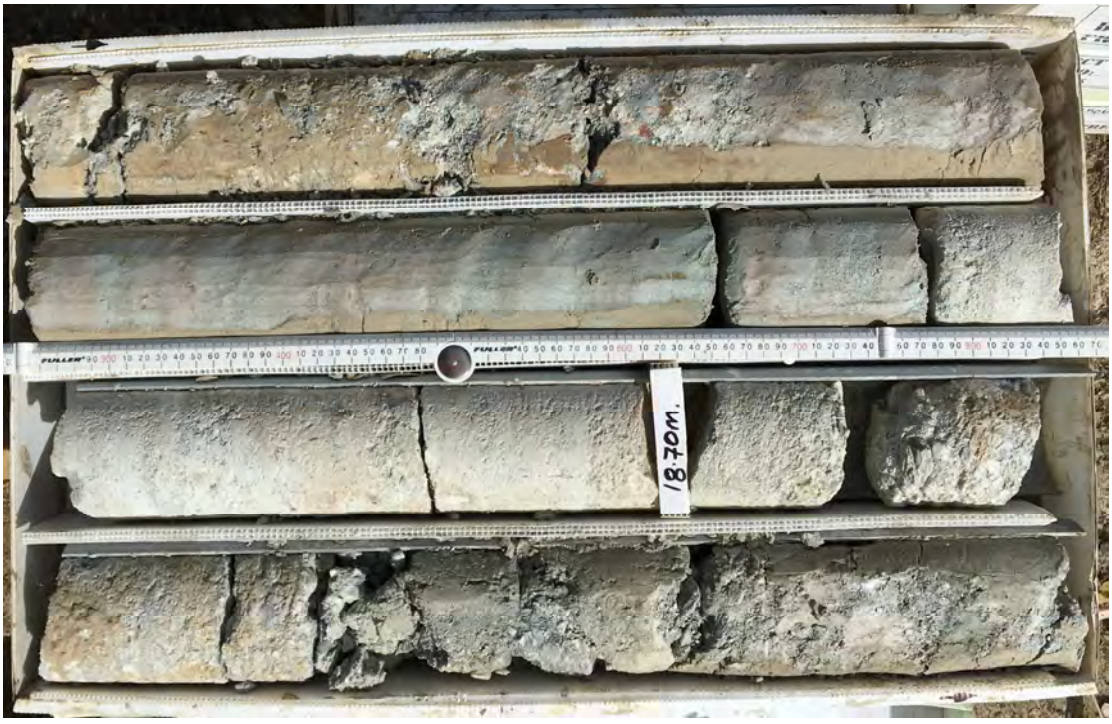
Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 25.2 m		



14.90 m to 17.20 m

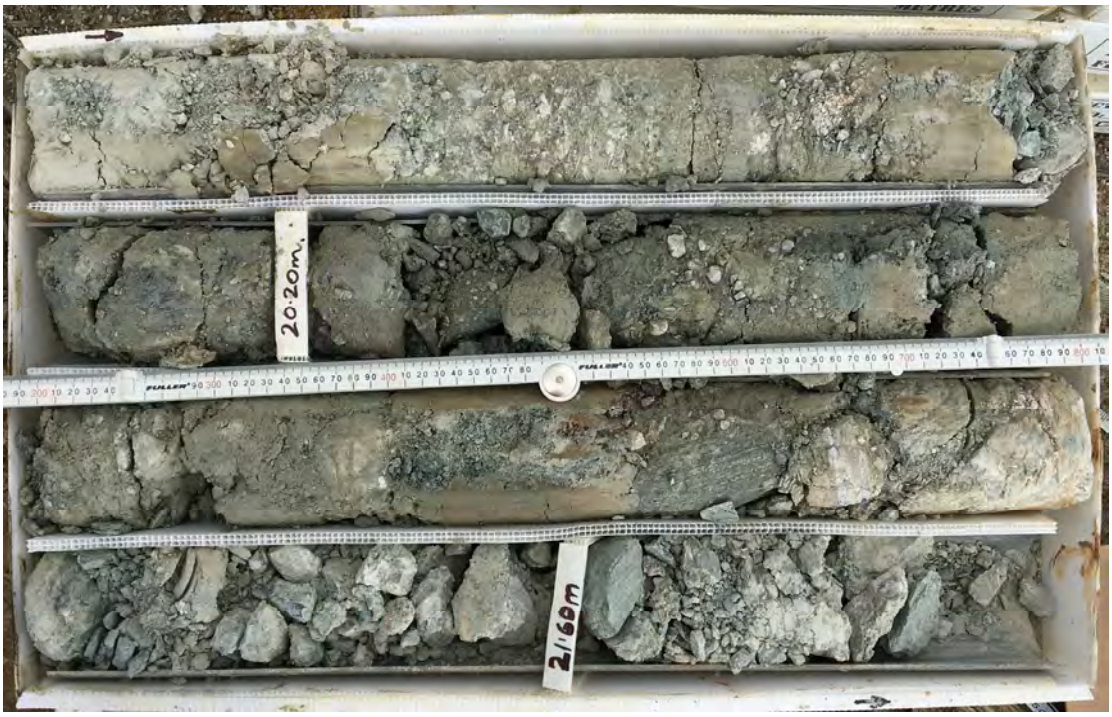


17.20 m to 19.50 m

Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 25.2 m		



19.50 m to 21.70 m

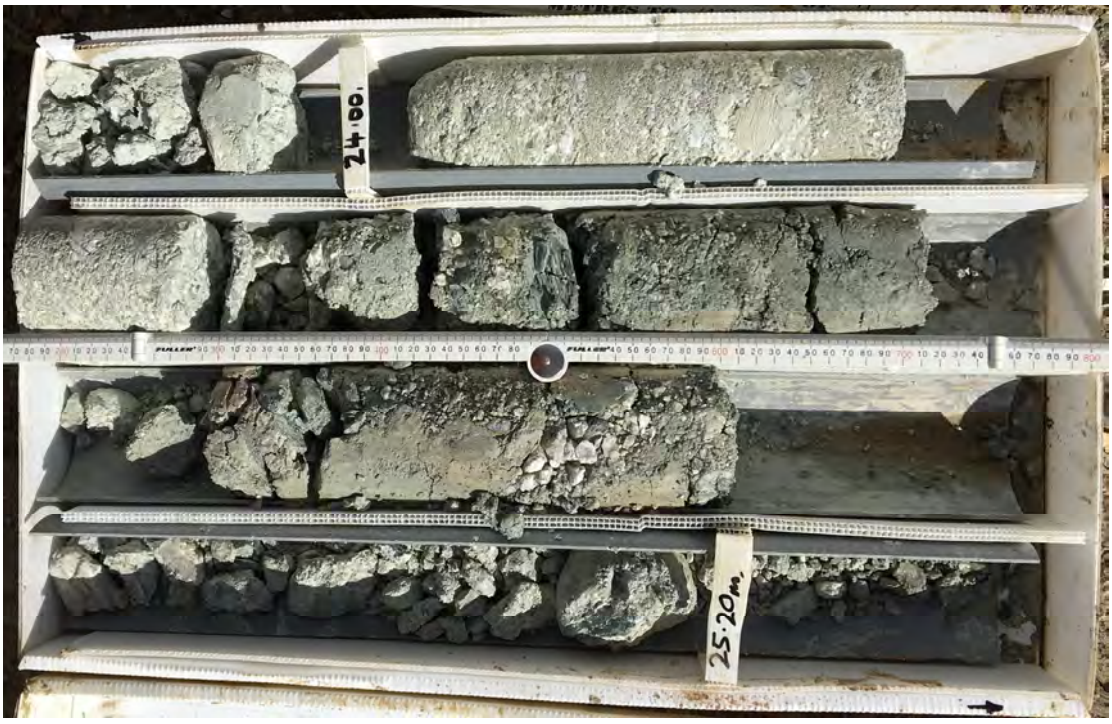
21.70 m to 23.90 m

CLIENTS | PEOPLE | PERFORMANCE

Report of Photographs

Site Identification: BH211

Project	Waste Futures WS3 – Smooth Hill	**Commenced**	04/11/2019	**Completed**	06/11/2019
Site	Smooth Hill	**Logged By**	MF		
Job #	12506381	**Checked By**			
Client	Dunedin City Council	**Core Depth**	0.0 m to 25.2 m		



23.90 m to 25.20 m (EOH)

Appendix C – Laboratory Testing Results

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/1963

Date: 23 July 2019

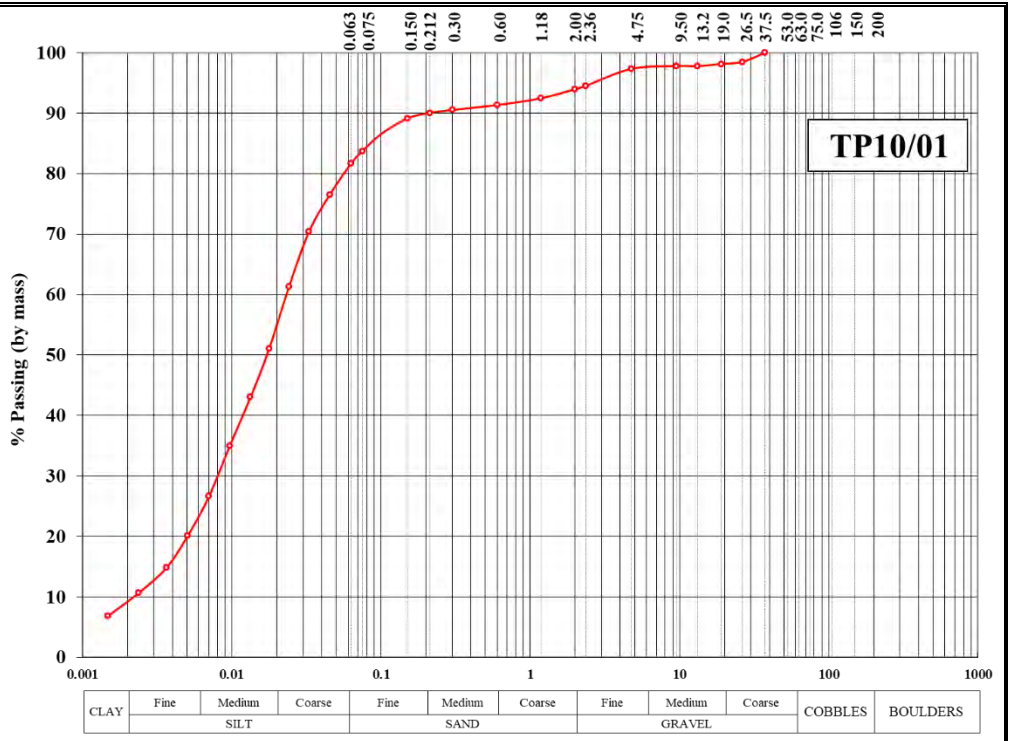
TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – SILT with some sand, minor gravel and minor clay**	**Client Job No:**	**12506381**
Sample Source:	**TP10/01**	**Sample Depth:**	**2.2m to 3.6m**
Date & Time Sampled:	**10-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	100
26.5	98
19.0	98
13.2	98
9.50	98
4.75	97
2.36	95
2.00	94
1.18	92
0.60	91
0.30	91
0.212	90
0.150	89
0.075	84
0.063	82

Fraction Size	Interpolated % Passing
60 µm	81
20 µm	55
6 µm	23
2 µm	9



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 9.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0mm to 20.0mm	2	Fine Sand	200 µm to 60 µm	9
Medium Gravel	20.0mm to 6.0mm	1	Coarse Silt	60 µm to 20 µm	26
Fine Gravel	6.0mm to 2.00 mm	3	Medium Silt	20 µm to 6 µm	32
Coarse Sand	2.00mm to 600 µm	3	Fine Silt	6 µm to 2 µm	14
Medium Sand	600 µm to 200 µm	1	Clay	< 2 µm	9

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	15.5 %
Liquid Limit: (LL)	39
Plastic Limit: (PL)	28
Plasticity Index: (PI)	11
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

Note:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the sample method * and sampling.*
- *This report may not be reproduced except in full.*

Tested By: L.T. Smith **Date:** 4 to 15-Jul-19

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/1963

Date: 23 July 2019

TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

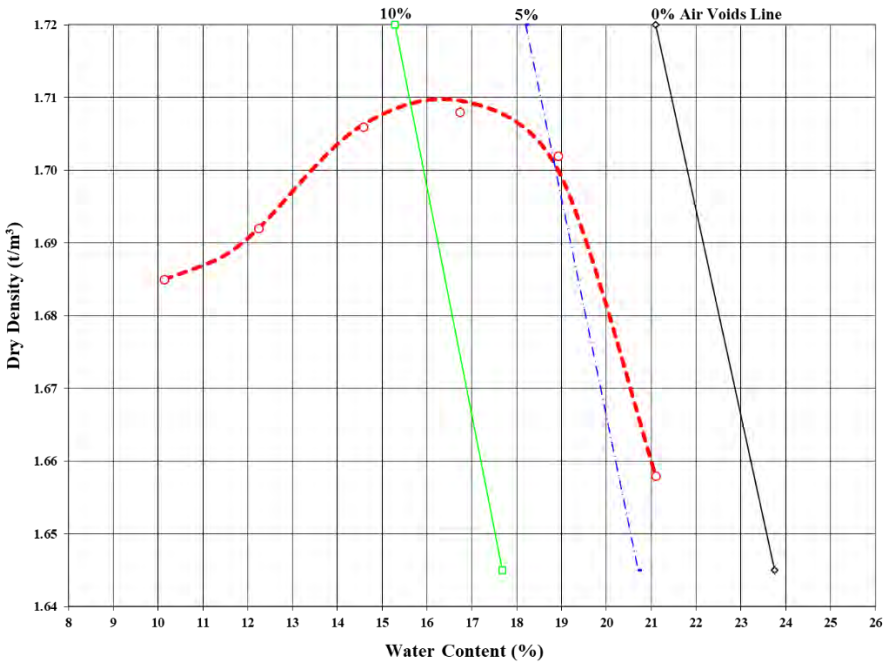
Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – SILT with some sand, minor gravel and minor clay**	**Client Job No:**	**12506381**
Sample Source:	**TP10/01**	**Sample Depth:**	**2.2m to 3.6m**
Date & Time Sampled:	**10-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

WATER CONTENT & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.1 & 4.1.1

% Retained (+19.0mm Fraction)	**2.0 %**
Water Content: ("All In" As Received)	**15.5 %**
Maximum Dry Density: (-19.0mm Fraction)	**1.71 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**16.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19.0mm test sieve.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*



Note:

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- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith** **Date:** **4 to 15-Jul-19**

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

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Reference No: 19/1963

Date: 23 July 2019

TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – SILT with some sand, minor gravel and minor clay**	**Client Job No:**	**12506381**
Sample Source:	**TP10/01**	**Sample Depth:**	**2.2m to 3.6m**
Date & Time Sampled:	**10-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

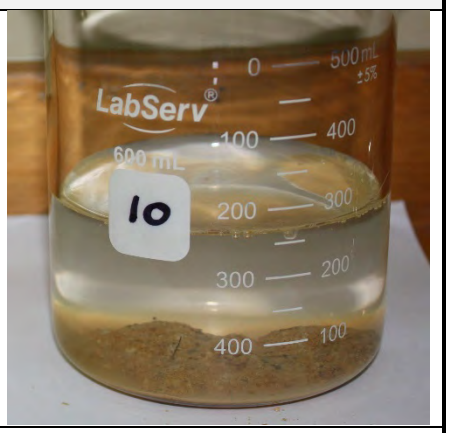
PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	1	0.25	Slightly Dark
50	5	0.27	Moderately Dark
50	10	0.31	Dark

Diameter of Hole at Start of Test:	**1.0mm**
Diameter of Hole at End of Test:	**≈ 2.0mm (4.0mm at exit)**
Water Content Prior to Test:	**16.2 %**
Dry Density of Sample Tested:	**1.63 t/m^3**
Pinhole Dispersion Classification – Method B:	**Dispersive (D)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 50 %	No colloidal cloud
1 hr	≈ 100%	Dense colloidal cloud over
6 hr	≈ 100 %	Moderate colloidal cloud over
Crumb Test Classification:		**Grade 4 (Highly Dispersive)**



Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

Note:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the sample method * and sampling.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith** **Date:** **4 to 15-Jul-19**

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/1963

Date: 23 July 2019

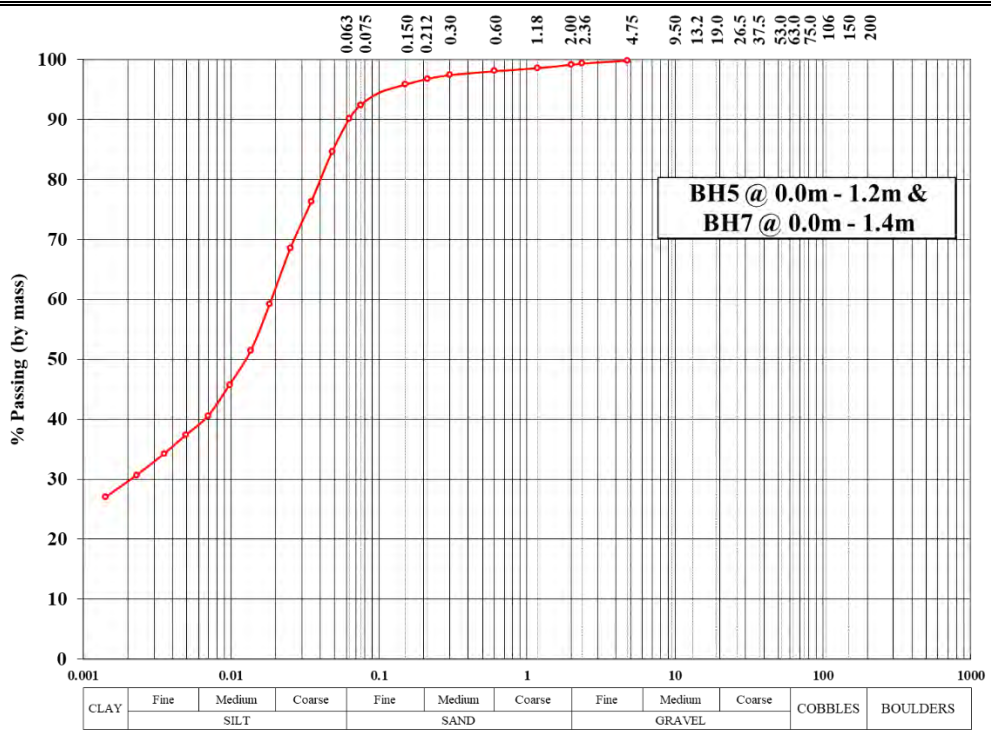
TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – Silty CLAY with minor sand and trace of gravel**	**Client Job No:**	**12506381**
Sample Source:	**BH5 @ 0.0m to 1.2m & BH7 @ 0.0m to 1.4m**	**Sample Depth:**	**Combined (0.0m to 1.4m)**
Date & Time Sampled:	**21-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

PARTICLE SIZE ANALYSIS (NZS 4402:1986, Test 2.8.1 & 2.8.4)

Test Sieve (mm)	% Passing (by mass)
37.5	
26.5	
19.0	
13.2	
9.50	
4.75	100
2.36	99
2.00	99
1.18	99
0.60	98
0.30	97
0.212	97
0.150	96
0.075	92
0.063	90

Fraction Size	Interpolated % Passing
60 µm	89
20 µm	62
6 µm	39
2 µm	29



The sample was received in a natural state. The percentage passing the 63µm test sieve was obtained by difference. The pH of the hydrometer suspension was 8.5. Sodium hexametaphosphate was used as a dispersant.

PARTICLE SIZE ANALYSIS & HYDROMETER ANALYSIS RESULTS - NZS 4402:1986, Test 2.8.1 & 2.8.4

Description	Fraction Range	% Within Range	Description	Fraction Range	% Within Range
Coarse Gravel	60.0mm to 20.0mm	-	Fine Sand	200 µm to 60 µm	8
Medium Gravel	20.0mm to 6.0mm	-	Coarse Silt	60 µm to 20 µm	27
Fine Gravel	6.0mm to 2.00 mm	1	Medium Silt	20 µm to 6 µm	23
Coarse Sand	2.00mm to 600 µm	1	Fine Silt	6 µm to 2 µm	10
Medium Sand	600 µm to 200 µm	1	Clay	< 2 µm	29

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4	
Water Content: ("All In" As Received)	**23.6 %**
Liquid Limit: (LL)	**42**
Plastic Limit: (PL)	**23**
Plasticity Index: (PI)	**19**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

Note:

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Tested By: **L.T. Smith** **Date:** **4 to 15-Jul-19**

Checked By:

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/1963

Date: 23 July 2019

TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

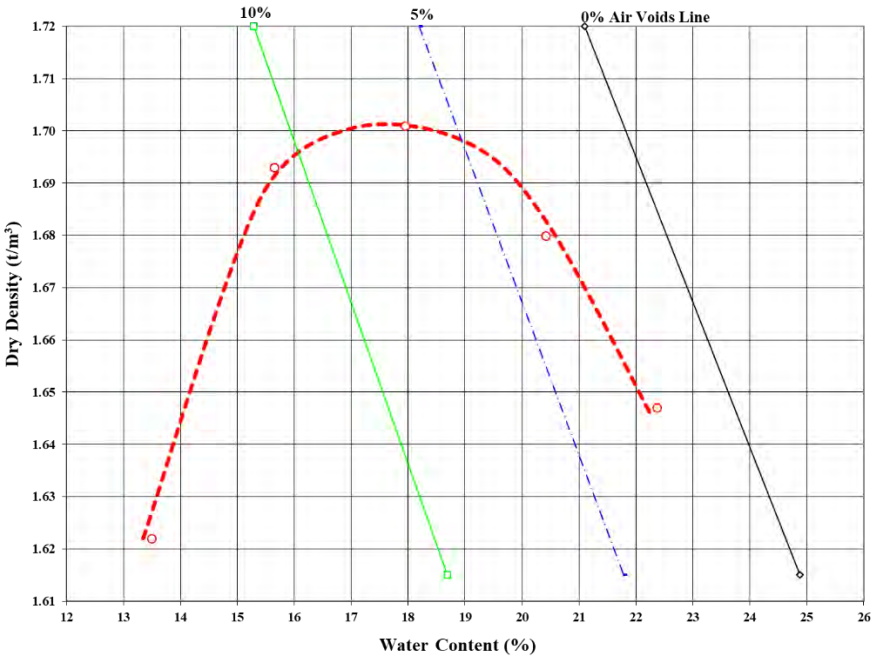
Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – Silty CLAY with minor sand and trace of gravel**	**Client Job No:**	**12506381**
Sample Source:	**BH5 @ 0.0m to 1.2m & BH7 @ 0.0m to 1.4m**	**Sample Depth:**	**Combined (0.0m to 1.4m)**
Date & Time Sampled:	**21-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

WATER CONTENT & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.1 & 4.1.1

% Retained (+19.0mm Fraction)	**0.0 %**
Water Content: ("All In" As Received)	**23.6 %**
Maximum Dry Density: (-19.0mm Fraction)	**1.70 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**17.5 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19.0mm test sieve.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*



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Tested By: **L.T. Smith** **Date:** **4 to 15-Jul-19**

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Reference No: 19/1963

Date: 23 July 2019

TEST REPORT: DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – Silty CLAY with minor sand and trace of gravel**	**Client Job No:**	**12506381**
Sample Source:	**BH5 @ 0.0m to 1.2m & BH7 @ 0.0m to 1.4m**	**Sample Depth:**	**Combined (0.0m to 1.4m)**
Date & Time Sampled:	**21-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit / Borehole ***	**Date Received:**	**26-Jun-19**

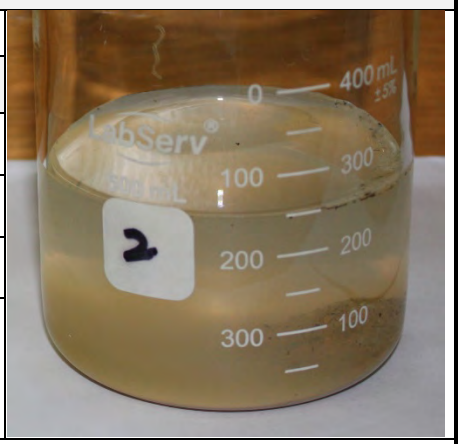
PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	1	0.25	Barely Visible
50	5	0.27	Moderately Dark
50	10	0.49	Very Dark

Diameter of Hole at Start of Test:	**1.0mm**
Diameter of Hole at End of Test:	**≈ 2.0mm**
Water Content Prior to Test:	**17.8 %**
Dry Density of Sample Tested:	**1.62 t/m^3**
Pinhole Dispersion Classification – Method A:	**Dispersive (D)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	≈ 20 %	No colloidal cloud
1 hr	≈ 100%	Dense colloidal cloud over
6 hr	≈ 100 %	Dense colloidal cloud over
Crumb Test Classification:		**Grade 4 (Highly Dispersive)**



Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

Note:

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- *This report may not be reproduced except in full.*

Tested By: L.T. Smith **Date:** 4 to 15-Jul-19

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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Reference No: 19/1963-1

Date: 3 August 2019

TEST REPORT – SMOOTH HILL LANDFILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – SILT with some sand, minor gravel and minor clay**	**Client Job No:**	**12506381**
Sample Source:	**TP10/01**	**Sample Depth:**	**2.2m to 3.6m**
Date & Time Sampled:	**10-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit**	**Date Received:**	**26-Jun-19**

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL – ASTM D5084-16a			
Cell Pressure: (kPa)	**610**	**Compaction:**	**95% NZ Standard**
Saturation Back Pressure: (kPa)	**600**	**Solid Density: (t/m^3)**	**2.67**
Effective Confining Pressure: (kPa)	**10**	**Temperature During Test: (°C)**	**20.5**
Saturation by Pore Pressure Response: (B Value)	**0.98**	**Permeant Liquid Used:**	**De-aired Tap Water**

Sample Status:	**Initial**	**Final**
Sample Dimensions: (mm)	**105.02 ϕ x 115.29**	**106.02 ϕ x 117.05**
Bulk Density: (t/m^3)	**1.92**	**1.98**
Water Content: (%)	**18.0**	**26.3**
Dry Density: (t/m^3)	**1.62**	**1.57**
Saturation By Calculation: (%)	**75**	**100**
Void Ratio: (*e*)	**0.65**	**0.70**
Constant Head: (kPa)	**3.0**	**5.0**
Hydraulic Conductivity: (k_{20})	**2.9 x 10^{-8} m/s**	**3.2 x 10^{-8} m/s**

Note:

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Tested By: **N.P. Danischewski** **Date:** **11-Jul-19 to 3-Aug-19**

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Reference No: 19/1963-1

Date: 3 August 2019

TEST REPORT – SMOOTH HILL LANDFILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – SILT with some sand, minor gravel and minor clay**	**Client Job No:**	**12506381**
Sample Source:	**TP10/01**	**Sample Depth:**	**2.2m to 3.6m**
Date & Time Sampled:	**10-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Test Pit**	**Date Received:**	**26-Jun-19**

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL – ASTM D5084-16a			
Cell Pressure: (kPa)	**727**	**Compaction:**	**95% NZ Standard**
Saturation Back Pressure: (kPa)	**650**	**Solid Density: (t/m^3)**	**2.67**
Effective Confining Pressure: (kPa)	**77**	**Temperature During Test: (°C)**	**18.0**
Saturation by Pore Pressure Response: (B Value)	**0.99**	**Permeant Liquid Used:**	**De-aired Tap Water**

Sample Status:	**Initial**	**Final**
Sample Dimensions: (mm)	**105.04 ϕ x 115.72**	**105.27 ϕ x 116.26**
Bulk Density: (t/m^3)	**1.89**	**1.99**
Water Content: (%)	**17.8**	**24.0**
Dry Density: (t/m^3)	**1.60**	**1.61**
Saturation By Calculation: (%)	**71**	**97**
Void Ratio: (*e*)	**0.67**	**0.66**
Constant Head: (kPa)	**3.0**	**10.0**
Hydraulic Conductivity: (k_{20})	**2.7 x 10^{-8} m/s**	**2.8 x 10^{-8} m/s**

Note:

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Tested By: **N.P. Danischewski** **Date:** **11-Jul-19 to 3-Aug-19**

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Date: 3 August 2019

TEST REPORT – SMOOTH HILL LANDFILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – Silty CLAY with minor sand and trace of gravel**	**Client Job No:**	**12506381**
Sample Source:	**BH5 @ 0.0m to 1.2m & BH7 @ 0.0m to 1.4m**	**Sample Depth:**	**Combined (0.0m to 1.4m)**
Date & Time Sampled:	**21-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Borehole**	**Date Received:**	**26-Jun-19**

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL – ASTM D5084-16a			
Cell Pressure: (kPa)	**460**	**Compaction:**	**95% NZ Standard**
Saturation Back Pressure: (kPa)	**450**	**Solid Density: (t/m^3)**	**2.71**
Effective Confining Pressure: (kPa)	**10**	**Temperature During Test: (°C)**	**20.0**
Saturation by Pore Pressure Response: (B Value)	**0.97**	**Permeant Liquid Used:**	**De-aired Tap Water**

Sample Status:	**Initial**	**Final**
Sample Dimensions: (mm)	**105.01 ϕ x 115.08**	**106.2 ϕ x 117.40**
Bulk Density: (t/m^3)	**1.94**	**1.96**
Water Content: (%)	**18.7**	**25.9**
Dry Density: (t/m^3)	**1.63**	**1.56**
Saturation By Calculation: (%)	**77**	**95**
Void Ratio: (*e*)	**0.66**	**0.74**
Constant Head: (kPa)	**3.0**	**5.0**
Hydraulic Conductivity: (k_{20})	**1.7 x 10^{-9} m/s**	**2.1 x 10^{-9} m/s**

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Tested By: **N.P. Danischewski** **Date:** **11-Jul-19 to 3-Aug-19**

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Reference No: 19/1963-1

Date: 3 August 2019

TEST REPORT – SMOOTH HILL LANDFILL INVESTIGATIONS

Client Details:	**GHD, Level 3, 138 Victoria Street, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess – Silty CLAY with minor sand and trace of gravel**	**Client Job No:**	**12506381**
Sample Source:	**BH5 @ 0.0m to 1.2m & BH7 @ 0.0m to 1.4m**	**Sample Depth:**	**Combined (0.0m to 1.4m)**
Date & Time Sampled:	**21-Jun-19**	**Sampled By:**	**M. Fitzmaurice**
Sample Method:	**Borehole**	**Date Received:**	**26-Jun-19**

CONSTANT HEAD PERMEABILITY TEST IN A TRIAXIAL CELL – ASTM D5084-16a			
Cell Pressure: (kPa)	**527**	**Compaction:**	**95% NZ Standard**
Saturation Back Pressure: (kPa)	**450**	**Solid Density: (t/m^3)**	**2.71**
Effective Confining Pressure: (kPa)	**77**	**Temperature During Test: (°C)**	**19.5**
Saturation by Pore Pressure Response: (B Value)	**0.97**	**Permeant Liquid Used:**	**De-aired Tap Water**

Sample Status:	**Initial**	**Final**
Sample Dimensions: (mm)	**104.96 ϕ x 114.97**	**104.52 ϕ x 115.45**
Bulk Density: (t/m^3)	**1.94**	**2.03**
Water Content: (%)	**18.7**	**24.3**
Dry Density: (t/m^3)	**1.63**	**1.64**
Saturation By Calculation: (%)	**77**	**100**
Void Ratio: (*e*)	**0.66**	**0.66**
Constant Head: (kPa)	**3.0**	**5.0**
Hydraulic Conductivity: (k_{20})	**5.6 x 10^{-10} m/s**	**5.3 x 10^{-10} m/s**

Note:

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Tested By: **N.P. Danischewski** **Date:** **11-Jul-19 to 3-Aug-19**

Checked By:

Approved Signatory

A.P. Julius
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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/3782-1

Date: 7 January 2020

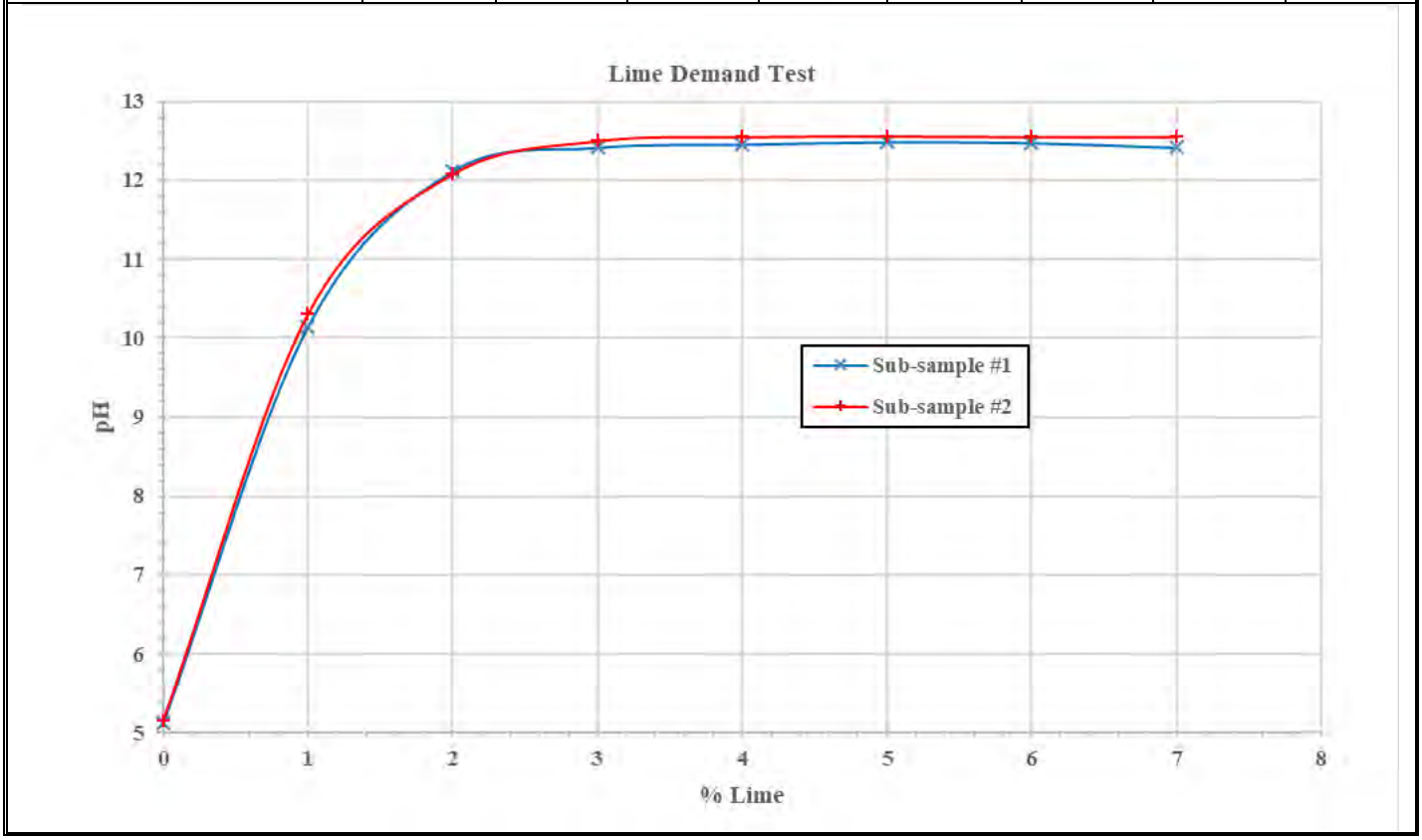
TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Client Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

LIME DEMAND TEST – NSW Transport; Roads & Maritime Services Test Method T144 (Not IANZ Accredited)

Sample Description:	**Loess - Natural Soil Sub-sample #1**	**Loess - Natural Soil Sub-sample #2**
% Passing 2.36mm Test Sieve:	**99.5%**	**99.5%**
Lime Type:	**Taylors Hydrated Lime**	**Taylors Hydrated Lime**
pH of Lime Solution	**12.60**	**12.63**

% Added Lime: (by dry mass)	**0%**	**1%**	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**
pH Sub-sample #1:	**5.12**	**10.15**	**12.12**	**12.42**	**12.46**	**12.49**	**12.48**	**12.42**
pH Sub-sample #2:	**5.16**	**10.31**	**12.08**	**12.50**	**12.55**	**12.56**	**12.55**	**12.55**



Note:

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Tested By: **L.T. Smith** **Date:** **9 to 17-Dec-19**

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Reference No: 19/3782-1

Date: 7 January 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Client Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

WATER CONTENT & PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.1, 2.2, 2.3 & 2.4				
Sample Description:	**Loess - Natural Soil**			
Water Content: (As Received)	**25.0 %**			
Sub-sample ID	**#1**	**#2**	**#3**	**#4**
Liquid Limit: (LL)	**41**	**41**	**41**	**41**
Plastic Limit: (PL)	**25**	**25**	**25**	**25**
Plasticity Index: (PI)	**16**	**16**	**16**	**16**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.				

Note:

- ***IANZ endorsement of this report applies to the samples as received.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith** **Date:** **9 to 17-Dec-19**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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Reference No: 19/3782-2

Date: 17 January 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Client Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

PLASTICITY INDEX RESULTS - NZS 4402:1986, Tests 2.2, 2.3 & 2.4				
Sample Description:	**Loess - Natural Soil**			
Sub-sample ID:	**#1**	**#2**	**#3**	**#4**
Sample Additive (By Dry Mass)	**2.5% Lime**	**2.5% Lime**	**3.0% Bentonite**	**3.0% Bentonite**
Time Cured For:	**1 day**	**7 days**	**1 day**	**7 days**
Liquid Limit: (LL)	**54**	**55**	**42**	**40**
Plastic Limit: (PL)	**30**	**32**	**23**	**23**
Plasticity Index: (PI)	**24**	**23**	**19**	**17**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.				

Note:

- ***IANZ endorsement of this report applies to the samples as received.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith** **Date:** **9 to 17-Jan-20**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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Reference No: 19/3782-3

Date: 29 January 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 2.5% Added Hydrated Lime (by dry mass)**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

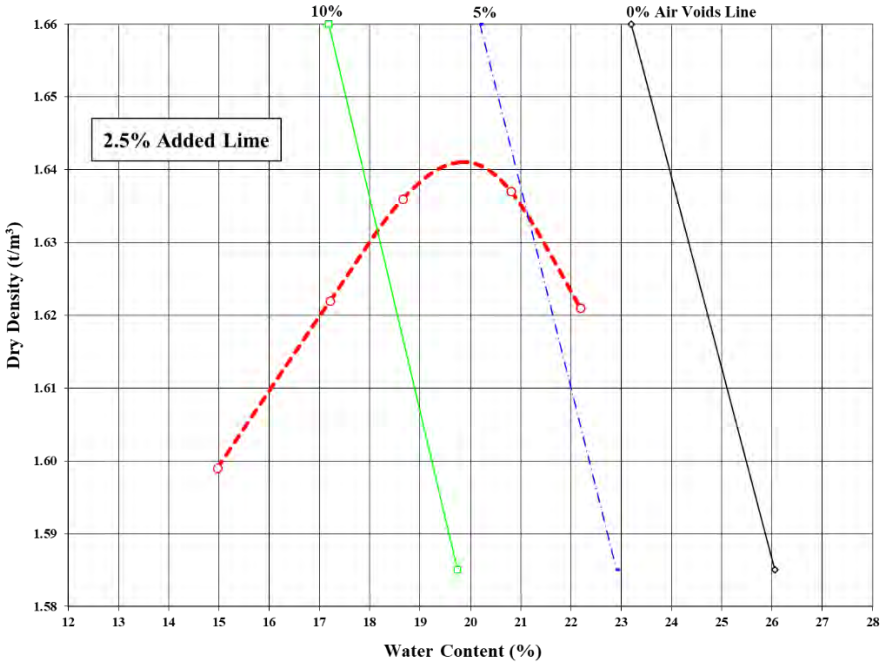
NZ STANDARD COMPACTION - NZS 4402:1986, Test 4.1.1
SHEAR STRENGTH RESULTS - NZGS 2001

% Retained: (+19.0mm Test Sieve)	**0.0 %**
Maximum Dry Density:	**1.64 t/m^3**
Optimum Water Content:	**20.0 %**

Individual Results

Water Content (%)	Dry Density (t/m^3)	Shear Strength (kPa)	
		Shear Strength	Residual Strength
15.0	1.599	UTP	UTP
17.2	1.622	UTP	UTP
18.7	1.636	UTP	UTP
20.8	1.637	UTP	UTP
22.2	1.621	> 210	-

Notes:
- *The material was received in a natural state.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*
- *UTP = unable to penetrate.*
- *The material tested was whole soil.*



General Notes:
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- *This report may not be reproduced except in full.*

Tested By: C. Fisher **Date:** 24 to 29-Jan-20

Checked By:

All tests reported herein have been performed in accordance with the scope of the laboratory's accreditation

IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 19/3782-3

Date: 29 January 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 2.5% Added Hydrated Lime (by dry mass)**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

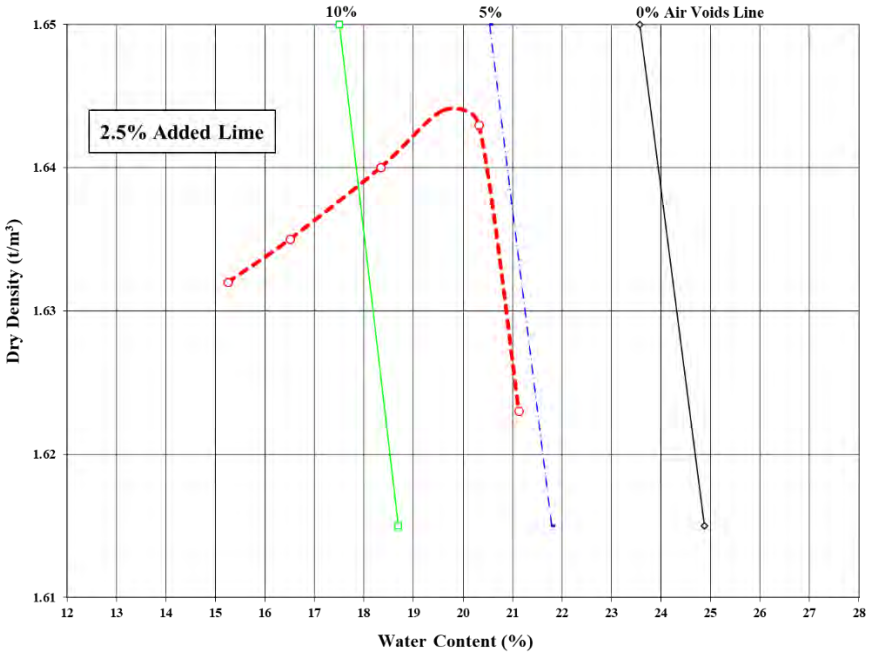
NZ STANDARD COMPACTION - NZS 4402:1986, Test 4.1.1
SHEAR STRENGTH RESULTS - NZGS 2001

% Retained: (+19.0mm Test Sieve)	**0.0 %**
Maximum Dry Density:	**1.64 t/m^3**
Optimum Water Content:	**20.0 %**

Individual Results

Water Content (%)	Dry Density (t/m^3)	Shear Strength (kPa)	
		Shear Strength	Residual Strength
15.3	1.632	UTP	UTP
16.5	1.635	UTP	UTP
18.3	1.640	UTP	UTP
20.3	1.643	> 210	-
21.1	1.623	183	71

Notes:
- *The material was received in a natural state.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*
- *UTP = unable to penetrate.*
- *The material tested was whole soil.*



General Notes:
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Tested By: C. Fisher **Date:** 24 to 29-Jan-20

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Date: 29 January 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 3.0% Added Bentonite (by dry mass)**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

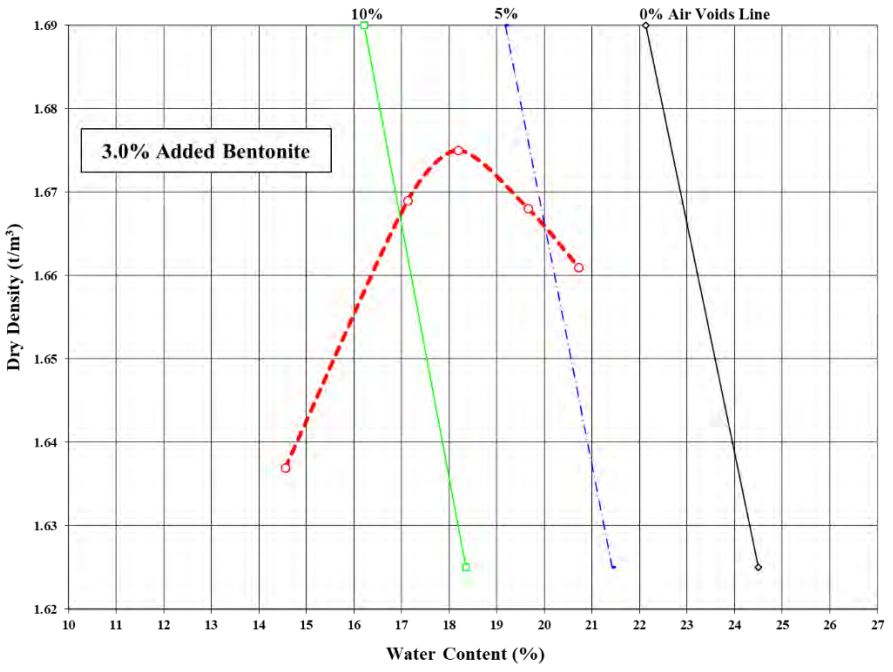
NZ STANDARD COMPACTION - NZS 4402:1986, Test 4.1.1
SHEAR STRENGTH RESULTS - NZGS 2001

% Retained: (+19.0mm Test Sieve)	**0.0 %**
Maximum Dry Density:	**1.67 t/m^3**
Optimum Water Content:	**18.0 %**

Individual Results

Water Content (%)	Dry Density (t/m^3)	Shear Strength (kPa)	
		Shear Strength	Residual Strength
14.6	1.637	UTP	UTP
17.1	1.669	> 210	-
18.2	1.675	> 210	-
19.7	1.668	> 210	-
20.7	1.661	183	123

Notes:
- *The material was received in a natural state.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*
- *UTP = unable to penetrate.*
- *The material tested was whole soil.*



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Tested By: C. Fisher **Date:** 24 to 29-Jan-20

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TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 3.0% Added Bentonite (by dry mass)**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Received:**	**6-Dec-19**

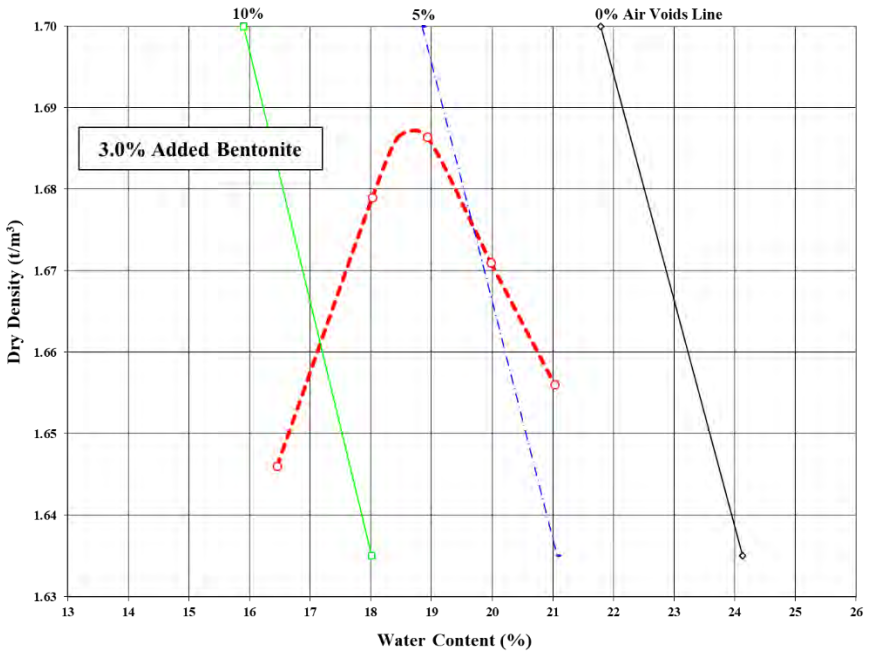
NZ STANDARD COMPACTION - NZS 4402:1986, Test 4.1.1
SHEAR STRENGTH RESULTS - NZGS 2001

% Retained: (+19.0mm Test Sieve)	**0.0 %**
Maximum Dry Density:	**1.69 t/m^3**
Optimum Water Content:	**19.0 %**

Individual Results

Water Content (%)	Dry Density (t/m^3)	Shear Strength (kPa)	
		Shear Strength	Residual Strength
16.5	1.646	UTP	UTP
18.0	1.679	> 210	-
18.9	1.686	> 210	-
20.0	1.671	186	87
22.0	1.656	147	81

Notes:
- *The material was received in a natural state.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*
- *UTP = unable to penetrate.*
- *The material tested was whole soil.*



General Notes:
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Tested By: C. Fisher **Date:** 24 to 29-Jan-20

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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Reference No: 19/3782-4

Date: 10 February 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 2.5% Added Hydrated Lime (by dry mass) – 1 day curing**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Requested:**	**20-Jan-20**

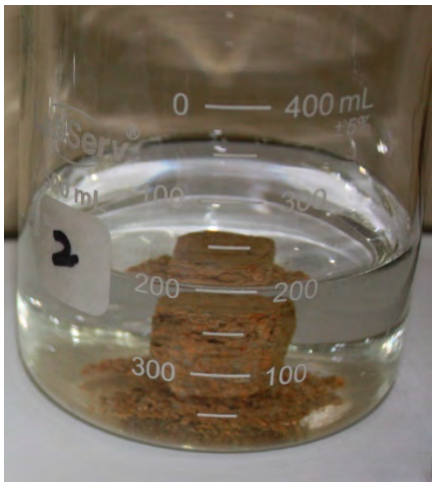
PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	5	0.43	Completely Clear
50	10	0.44	Completely Clear
180	15	0.67	Completely Clear
380	20	0.95	Completely Clear
1020	25	1.82	Completely Clear

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**1.0 mm**
Water Content Prior to Test:	**20.0 %**
Dry Density of Sample Tested:	**1.56 t/m^3**
Pinhole Dispersion Classification – Method A: (1 Day Curing)	**ND1 (Non-Dispersive)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	< 2%	Clear – no colloidal cloud evident
1 hr	≈ 5%	Clear – no colloidal cloud evident
6 hr	≈ 5% - 10%	Clear – no colloidal cloud evident
Crumb Test Classification: (1 Day Curing)		**Grade 1 (Non-Dispersive)**



Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

General Notes:

- *IANZ endorsement of this report applies to the samples as received.*
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Tested By: L.T. Smith **Date:** 25-Jan-20 to 7-Feb-20

Checked By:

All tests reported herein have been performed in accordance with the scope of the laboratory's accreditation

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Reference No: 19/3782-4

Date: 10 February 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 2.5% Added Hydrated Lime (by dry mass) – 7 days curing**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Requested:**	**20-Jan-20**

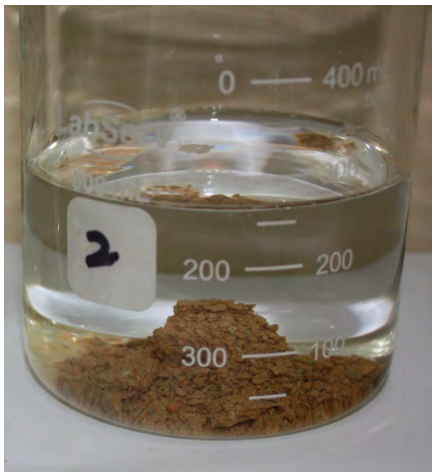
PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	5	0.30	Completely Clear
50	10	0.30	Completely Clear
180	15	0.60	Completely Clear
380	20	0.94	Completely Clear
1020	25	1.73	Completely Clear

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**1.0 mm**
Water Content Prior to Test:	**19.7 %**
Dry Density of Sample Tested:	**1.56 t/m^3**
Pinhole Dispersion Classification – Method A: (7 Day Curing)	**ND1 (Non-Dispersive)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	< 1%	Clear – no colloidal cloud evident
1 hr	≈ 30%	Clear – no colloidal cloud evident
6 hr	≈ 60%	Clear – no colloidal cloud evident
Crumb Test Classification: (7 Day Curing)		Grade 1 (Non-Dispersive)



Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

General Notes:

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Tested By: L.T. Smith **Date:** 25-Jan-20 to 7-Feb-20

Checked By:

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Reference No: 19/3782-4

Date: 10 February 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 3.0% Added Bentonite (by dry mass) – 1 day curing**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Requested:**	**20-Jan-20**

PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	1	0.50	Dark
50	3	1.23	Very Dark
50	5	2.23	Very Dark

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**3.0 mm**
Water Content Prior to Test:	**17.6 %**
Dry Density of Sample Tested:	**1.60 t/m^3**
Pinhole Dispersion Classification – Method B: (1 Day Curing)	**D (Dispersive)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	< 2%	Colloidal cloud evident around cube
1 hr	≈ 55%	Heavy colloidal cloud ≈ 20mm deep covering entire bottom
6 hr	≈ 80%	Heavy colloidal cloud ≈ 20mm deep covering entire bottom
Crumb Test Classification: (1 Day Curing)	**Grade 4 (Dispersive)**	

Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

General Notes:

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Tested By: L.T. Smith **Date:** 25-Jan-20 to 7-Feb-20

Checked By:

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Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 3.0% Added Bentonite (by dry mass) – 7 days curing**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Requested:**	**20-Jan-20**

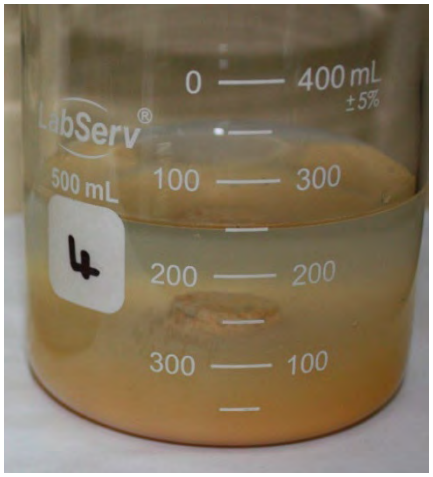
PINHOLE DISPERSION TEST: ASTM D4647-13e1

Head (mm)	Elapsed Time (min)	Flow Rate (ml/s)	Colour of Outflow (Cloudiness)
50	1	1.43	Very Dark
50	3	2.33	Very Dark
50	5	2.58	Very Dark

Diameter of Hole at Start of Test:	**1.0 mm**
Diameter of Hole at End of Test:	**4.0 mm**
Water Content Prior to Test:	**17.9 %**
Dry Density of Sample Tested:	**1.60 t/m^3**
Pinhole Dispersion Classification – Method B: (7 Day Curing)	**D (Dispersive)**

CRUMB TEST: ASTM D6572-13e2 (Method B)

Elapsed Time	Estimated Slaking	Observations Recorded
2 min	**< 1%**	**Colloidal cloud evident around cube**
1 hr	**≈ 40%**	**Heavy colloidal cloud ≈ 20mm deep covering entire bottom**
6 hr	**≈ 95% - 100%**	**Heavy colloidal cloud ≈ 20mm deep covering entire bottom**
Crumb Test Classification: (7 Day Curing)		**Grade 4 (Dispersive)**



Note:

- *Distilled water was used in the pinhole dispersion and crumb test. Both tests were carried out on remoulded samples.*
- *The pinhole dispersion sample was compacted to 95% NZ standard compaction.*
- *Photograph at completion of the crumb test.*
- *The sample tested was the fraction passing the 2.00mm sieve.*

General Notes:

- *IANZ endorsement of this report applies to the samples as received.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith** **Date:** **25-Jan-20 to 7-Feb-20**

Checked By:

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Reference No: 19/3782-4

Date: 10 February 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Loess**	**Order No:**	**N/A**
Sample Source:	**BS01 @ 0.5m, BS03 @ 0.7m, BS07 @ 0.5m, BS08 @ 0.6m, BS010 @ 0.7m, BS011 @ 1.3m, BS012 @ 0.4m and BS013 @ 1.2m combined – 2.5% Added Hydrated Lime (by dry mass)**		
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Unknown**	**Date Requested:**	**20-Jan-20**

PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.2, 2.3 & 2.4	
Sample Description:	**Loess - 2.5% Added Hydrated Lime (by dry mass)**
Time Cured For:	**28 days**
Liquid Limit: (LL)	**53**
Plastic Limit: (PL)	**30**
Plasticity Index: (PI)	**23**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

General Notes:

- ***IANZ endorsement of this report applies to the samples as received.***
- ***This report may not be reproduced except in full.***

Tested By: **L.T. Smith** **Date:** **25-Jan-20 to 7-Feb-20**

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 20/228

Date: 4 March 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

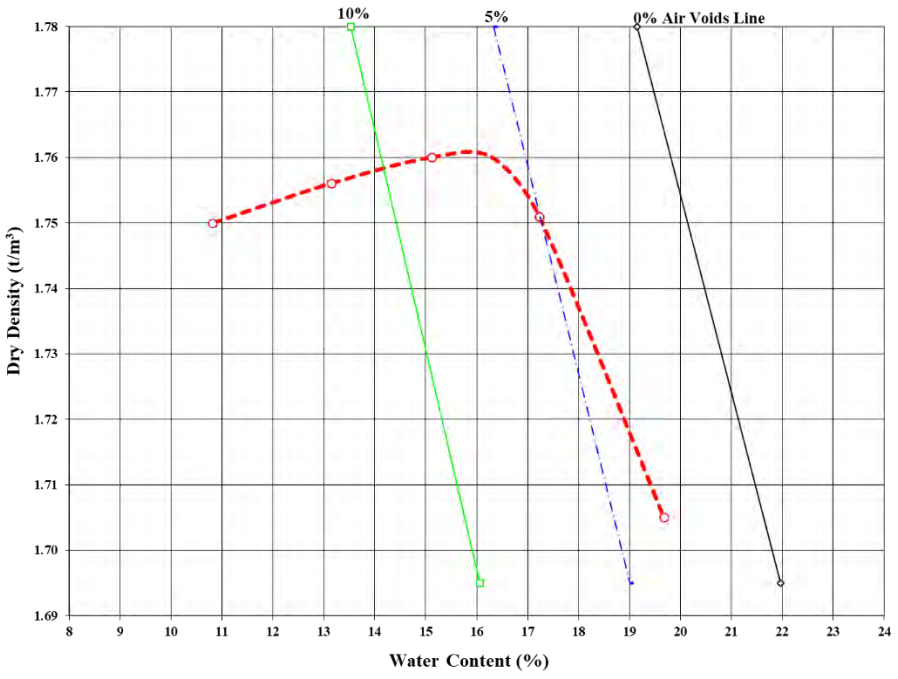
Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Siltstone – Sandy SILT with minor clay**	**Client Order No:**	**Not Stated**
Sample Source:	**BH05 @ 2.7m - 7.2m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Borehole ***	**Date Received:**	**December 2019**

WATER CONTENT & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.1 & 4.1.1

% Retained (+19.0mm Fraction)	**0.0 %**
Water Content: ("All In" As Received)	**13.7 %**
Maximum Dry Density:	**1.76 t/m^3**
Optimum Water Content:	**16.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was whole soil.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*



PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.2, 2.3 & 2.4	
Liquid Limit: (LL)	**41**
Plastic Limit: (PL)	**25**
Plasticity Index: (PI)	**16**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

Note:

- *Information contained in this report which is Not IANZ Accredited relates to the sample descriptions based on NZ Geotechnical Society Guidelines 2005, the sample method * and sampling.*
- *This report may not be reproduced except in full.*

Tested By: **L.T. Smith, N.P. Danischewski, C. Fisher & C. Pearson** **Date:** **10-Jan-20 to 4-Mar-20**

Checked By:

Tests indicated as Not Accredited are outside the scope of the laboratory's accreditation

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Reference No: 20/228

Date: 4 March 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

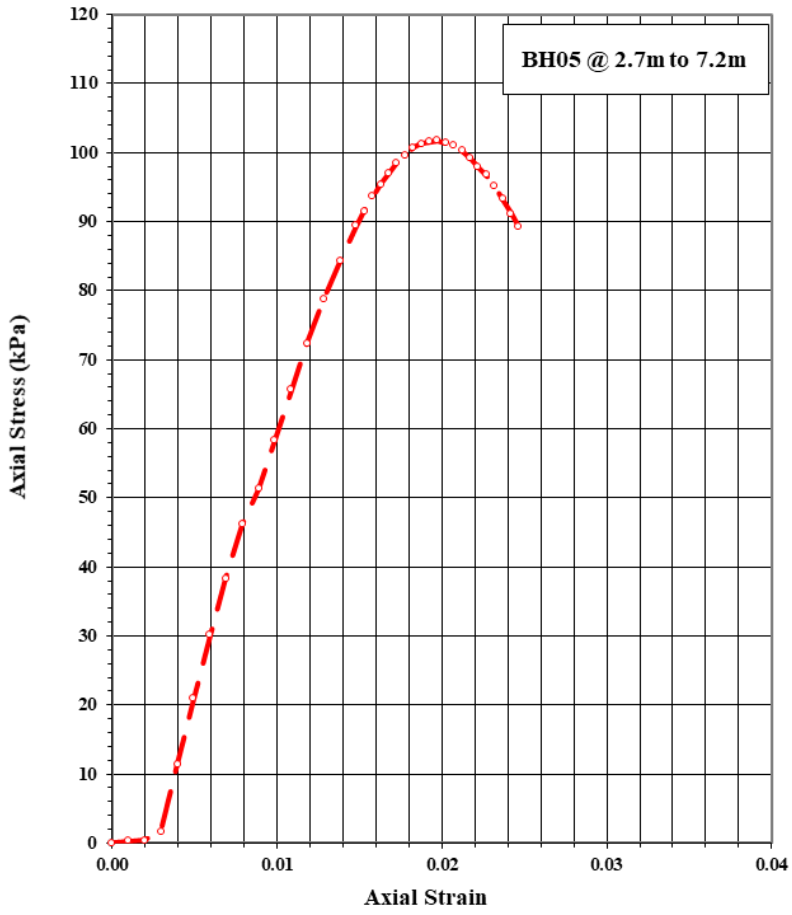
Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Siltstone – Sandy SILT with minor clay**	**Client Order No:**	**Not Stated**
Sample Source:	**BH05 @ 2.7m - 7.2m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Borehole ***	**Date Received:**	**December 2019**

UNCONFINED COMPRESSIVE STRENGTH - NZS 4402:1986, Test 6.3.1

Sample Diameter: (mm)	**101.50**
Sample Length: (mm)	**202.68**
Length / Diameter Ratio:	**2.00**
Bulk Density: (t/m^3)	**1.94**
Water Content: (%)	**15.9**
Dry Density (t/m^3)	**1.67**
Mode of Failure:	**Plastic / Plastic Brittle**
Strain @ Failure:	**2.0 %**
Load @ Failure:	**0.840 kN**
Unconfined Compressive Strength:	**100 kPa**

Notes:

1. *Dry density rounded to the nearest 0.01 t/m^3.*
2. *The rate of axial compression was 0.40 mm/min.*



Note:

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Tested By: L.T. Smith, N.P. Danischewski, C. Fisher & C. Pearson **Date:** 10-Jan-20 to 4-Mar-20

Checked By:

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IANZ ACCREDITED LABORATORY
Accreditation No: 434

Central Testing Services
18 Ngapara St, P.O. Box 397, Alexandra 9340, Central Otago, New Zealand
P: 03 4487644, W: www.centraltesting.co.nz, E: info@centraltesting.co.nz

Reference No: 20/228

Date: 4 March 2020

TEST REPORT – DCC SMOOTH HILL INVESTIGATIONS

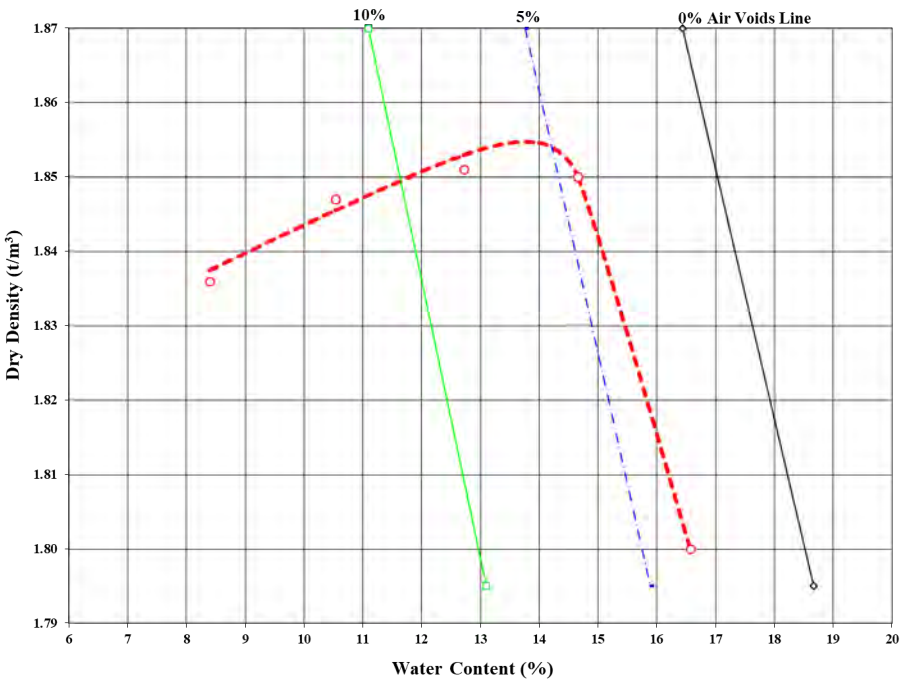
Client Details:	**GHD Ltd, P.O. Box 13468, Christchurch**	**Attention:**	**J. Southworth**
Job Description:	**DCC Smooth Hill Landfill Investigations**		
Sample Description:	**Sands & Sandstone; SILT & SAND with minor clay**	**Client Order No:**	**Not Stated**
Sample Source:	**BH10 @ 2.4m - 7.0m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Borehole ***	**Date Received:**	**December 2019**

WATER CONTENT & NZ STANDARD COMPACTION - NZS 4402:1986, Test 2.1 & 4.1.1
DRY DENSITY & ABSORPTION - NZS 3111:1986, Test 12

% Retained (+19.0mm Fraction)	**8.0 %**
Water Content: ("All In" As Received)	**11.9 %**
Dry Density: (+19.0mm Fraction)	**2.45 t/m^3**
Absorption (+19.0mm Fraction)	**3.7 %**
Maximum Dry Density: (-19.0mm Fraction)	**1.85 t/m^3**
Optimum Water Content: (-19.0mm Fraction)	**14.0 %**

Notes:

- *The sample was received in a natural state.*
- *The material tested in the NZ Standard Compaction test was the fraction passing a 19.0mm test sieve.*
- *The air voids lines were calculated from an assumed solid density of 2.70 t/m^3.*



PLASTICITY INDEX RESULTS - NZS 4402:1986, Test 2.2, 2.3 & 2.4	
Liquid Limit: (LL)	**37**
Plastic Limit: (PL)	**23**
Plasticity Index: (PI)	**14**
Note: The sample was received in a natural state. The plasticity index material tested was the fraction passing the 425 µm test sieve.	

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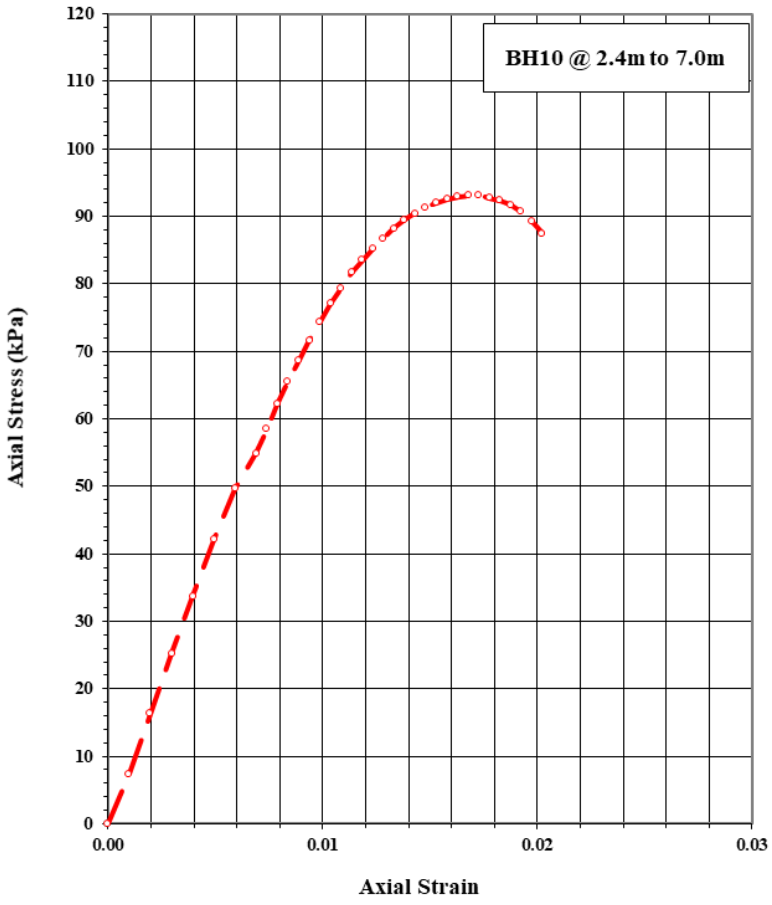
Sample Source:	**BH10 @ 2.4m - 7.0m**	**Sample Label No:**	**N/A**
Date & Time Sampled:	**Unknown**	**Sampled By:**	**GHD Ltd Staff**
Sample Method:	**Borehole ***	**Date Received:**	**December 2019**

UNCONFINED COMPRESSIVE STRENGTH - NZS 4402:1986, Test 6.3.1

Sample Diameter: (mm)	**101.49**
Sample Length: (mm)	**202.66**
Length / Diameter Ratio:	**2.00**
Bulk Density: (t/m^3)	**2.00**
Water Content: (%)	**13.9**
Dry Density (t/m^3)	**1.76**
Mode of Failure:	**Plastic / Plastic Brittle**
Strain @ Failure:	**1.7 %**
Load @ Failure:	**0.767 kN**
Unconfined Compressive Strength:	**93 kPa**

Notes:

1. *Dry density rounded to the nearest 0.01 t/m^3.*
2. *The rate of axial compression was 0.40 mm/min.*



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Tested By: L.T. Smith, N.P. Danischewski, C. Fisher & C. Pearson **Date:** 10-Jan-20 to 4-Mar-20

Checked By:

Approved Signatory

A.P. Julius
Laboratory Manager

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This report has been prepared by Matt Fitzmaurice, John Southworth and Dhugal McQuistan under the direction of Samantha Webb, a Technical Director and Engineering Geologist with GHD Ltd. Matt has 9 years as an engineering geologist, John has 23 years experience as an engineering geologist and Dhugal has 4 years experience as a geotechnical engineer. Samantha has 30 years in all aspects of engineering geology including a number of landfill projects and has the following qualifications BSc (Hons) Earth Sciences and MSc Engineering Geology.

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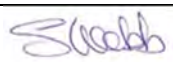
Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev01	M. Fitzmaurice/ J. Southworth	S.Webb		S.Douglass		17-8-20
Rev02	J.Southworth	S.Webb		S.Douglass		24-05-21

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