Appendix J: Geotechnical Report

REPORT

Tonkin+Taylor

Omarunui Landfill Area B

Geotechnical Report

Prepared for
Hastings District Council
Prepared by
Tonkin & Taylor Ltd
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Executive summary

Hastings District Council (HDC) has commenced planning for the development of further areas of the Omarunui Landfill site for future solid waste landfilling with a view to applying for resource consents for such development. This further development will take place in part of the site known as Area B. HDC engaged Tonkin + Taylor (T+T) to undertake a geotechnical site investigation for the proposed development area in the landfill.

T+T undertook geotechnical investigations across Areas B and C in 2009 to determine ground conditions and assess the feasibility of the site for future use within the landfill complex. The investigations determined that the underlying materials typically comprised weathered sandstone, siltstone and limestones of the Pleistocene aged Petane formation. The key geotechnical concerns at the time were the permeability of the underlying rock mass and the limited availability of finer material for use as liner.

T+T has since completed a concept civil design of the landfill for this consent application. The key features of this design include:

- Bulk earthworks to remove 800,000 m^3 of material from the centre of Area B;
- Placement of about 90,000 m^3 of engineered fill;
- A steep cut batter along the eastern boundary of the site, outside of the landfill footprint;
- Construction of a toe bund at the northern end of Area B;
- Filling with refuse up to RL80 m (approximately 50 m deep); and
- Associated leachate and stormwater management systems.

During 2018 T+T completed additional geotechnical investigations to confirm the stability of the toe bund, and eastern highwall as well as assessing the suitability for local materials as bulk and structural fill.

Our 2018 investigation and subsequent analysis has indicated the following key geotechnical considerations:

- The eastern highwall is expected to perform adequately at a slope not exceeding 1V:2H, although erosion will need to be managed by hydroseeding and/or placement of erosion matting following excavation;
- A 10 m high toe bund is proposed to provide toe resistance to support the final filled Area B airspace. The bund foundations are expected to comprise an engineered fill shear key which will involve undercut and replacement of the alluvium underlying the toe bund;
- The former borrow area at the southern end of Area B was backfilled between 2005 and 2012. The depth of this backfill is up to 22 m and includes a sharp former highwall transition under the current access road. Differential settlement across the former highwall under the loading of the final landfill could cause differential settlement and result in damage to the liner. It is recommended that the margins of this area, are cut down 5 m deep and laid back at a slope of about 1V:3H with the resulting excavation backfilled with engineered fill. Settlement of this area will need to be monitored during construction and filling; and
- There is likely to be a deficiency of finer grained materials that are suitable for use as liner on site. This may require the use of materials containing sand, or borrowing of material from siltstones within Area C for the soil; components of any liner system. The overall lining system will need to rely on geosynthetic components (Geosynthetic Clay Liner (GCL) and geomembrane) and this is described in the Engineering Report.

Section 3(v)(a) of the Omarunui Landfill Management Plan (LMP) in the Proposed Hastings District Plan (Operative in Part) sets out the requirements for geotechnical investigations to inform the development of new areas within the site for waste disposal.

A summary of the investigations completed to satisfy the LMP is provided in the table below.

Summary of Landfill Management Plan Geotechnical Investigation Requirements (Section 3(v)(a))

LMP Requirements	Commentary
1 Accurate geological mapping of the waste disposal area and the immediately surrounding area	Geological mapping has been completed by T+T between 2009 and 2018. A geological map is provided in Appendix A.
2 The appropriate number of shallow diamond drill holes with continuous coring and permeability testing in the waste disposal area	Geotechnical investigations comprising machine boreholes have been completed across the proposed landfill designation in 2009 and 2018. Packer testing and slug testing have been completed within a number of the machine boreholes. The borehole logs are provided in Appendix B and C with in situ testing is provided in Appendix F.
3 Shallow investigation trenches to correlate between drill holes and natural outcrop.	A number of test pit investigations have been completed to supplement the machine boreholes in 2009 and 2018. The test pit investigations are provided in Appendix B and C.
4 Grainsize and permeability studies on the naturally occurring soil cover and post Nukumaruan sediments	Geotechnical laboratory testing has been completed on a number of samples in both 2009 and 2018. This has included particle size distribution tests (gradings) and permeability testing on disturbed and undisturbed samples. Geotechnical laboratory testing is provided in Appendix D.
5 Grainsize, compaction and permeability tests on material potentially suitable as a compacted, impermeable blanket. If such materiel is found on site, borrow areas are to be defined.	Permeability testing has been completed on undisturbed and disturbed samples for material proposed to be used as landfill liner. This is further discussed in Section 6.
6 Identification and definition of potential borrow areas of refuse cover material	Site won sandstone and siltstone is proposed to be used as daily cover material. This material will be gained from material removed during bulk earthworks to form the landfill airspace. Further discussions are provided in Section 6.
7 Identification and recording of relatively permeable layers both prior to and during the course of site preparation	The site geological conditions comprise interbedded sandstone, limestone and occasional siltstones. The geological conditions appear to vary significantly both vertically and laterally. Further discussions on the site geology is provided in Section 3.

1 Introduction

1.1 Background

Tonkin & Taylor Ltd (T+T) has been engaged by Hastings District Council (HDC) to provide engineering and planning inputs for the proposed development and operation of Area B of the Omarunui Landfill in Puketapu, Hawkes Bay. This report presents the results of the historical and recent geotechnical investigations and outlines the geotechnical considerations to be addressed for the design of the proposed landfill extension.

T+T undertook geotechnical investigations in 2009 to determine the geological and hydrogeological conditions of Areas B and C at Omarunui Landfill. That work found that Areas B and C are underlain by a sequence of shallow marine sandstones and limestones (Petane Formation) with deposits of colluvium and alluvium present on the slope margins and valley floors.

This report has been prepared to provide geotechnical input to the landfill consent design and to update the geotechnical design input since 2009, with an emphasis on seismic performance and liquefaction. Further work has been completed to assess the performance of the proposed landfill cut slopes. This report supersedes and replaces any previous geotechnical reports prepared in relation to development in Area B.

The work has been undertaken in accordance with our proposal dated 16 November 2017[1] to support the Notice of Requirement (NoR) and resource consent applications for the development of Area B.

The recommendations and opinions in this report are based on data from borehole, CPT investigations, test pits, laboratory test results and review of published information and historical reports. The nature and continuity of subsoil away from site investigations are inferred but it must be appreciated that actual conditions could vary from the assumed model.

1.2 Scope of work

Our scope of works has included:

- A review of the 2009 investigations with respect to updates in geotechnical engineering practise since then;
- A site walkover of Area B by an engineering geologist and senior geotechnical engineer to inspect recent borrow areas and changes in site layout since 2009;
- Reinstallation of monitoring well BC7;
- Drilling and logging of 5 additional boreholes in Area B (BC10 to14);
- Pushing of 10 Cone Penetrometer Tests (CPTs) at the base of Area B;
- Pushing of 13 CPTs in the former quarry fill area at the southern end of Area B;
- Excavation and logging of 7 trial pits in the centre of Area B to assess the excavatability of the rock;
- Collation of the historical and recent investigations into a geological model with site plans and geological cross sections;
- Assessment of seismic subclass;
- Assessment of liquefaction potential for the valley alluvial materials;
- Slope stability assessment of the landfill toe bund area and proposed eastern highwall;

[1] Tonkin & Taylor Ltd, 16 November 2017, Omarunui Landfill-Area B Consents, T+T Ref: 1000647.1000

- Geotechnical design of the toe bund and associated ground improvement works;
- Settlement assessment of the backfilled area;
- Preparation of preliminary geotechnical drawings; and
- Preparation of this report and associated appendices.

1.3 Site description

The Omarunui Landfill is located on Omarunui Road approximately 5 km west of Taradale. The existing landfill in Area D infills a west-facing valley located centrally within a triangular block of hills that is bounded by the flood plains of the Tutaekuri River to the east, and the broad, flat Moteo Valley to the west. Access to the site is via a 2 km long sealed road off Omarunui Road. An alternative access, via a farm track, exists off Swamp Road within Moteo Valley although this is not used for landfill operations.

Area B comprises a series of steep narrow gullies amongst a larger broad valley within the north eastern portion of the site. The valley in Area B is surrounded by ridgelines on the western, southern and eastern portion of the site. The southern and central portions of Area B comprise level plateaus, which have been heavily modified by contractors for use as borrow and fill areas as part of the ongoing landfill operation. A small contractor's compound and aggregate stockpile yard forms the south eastern corner of Area B.

The following photographs illustrate the site topography and layout.

Photograph 1-1: Looking north towards down centre of Area B. Proposed toe bund location in the background.

Photograph 1-2: Looking south from proposed toe bund position. Note limestone outcrop in right of foreground.

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Photograph 1-3: Looking west towards the centre of Area B from the top of the eastern ridgeline.

1.4 Proposed development

The proposed development of Area B is to include:

- Bulk earthworks excavation of approximately 800,000 m^3 to form a lower a basegrade level at approximately RL25 to 30m with landfill side slopes between 1V:2H and 1V: 3H. The earthworks will involve up to 30 m cut in the centre of the site and grading back of the valley side slopes with a 50 m high eastern highwall;
- Construction of a toe bund at the northern end of the Valley with a stormwater treatment pond and leachate pump station.
- Construction of geosynthetic landfill liner system;
- Installation of leachate pumping system and landfill gas wells/pipelines;
- Backfilling in stages with refuse up to approximately RL80m at the crest of Area B; and
- Capping of the landfill with a soil capping system.

2 Ground and groundwater conditions

2.1 Geology

Published geological maps[2] indicate the site is underlain by late Pliocene aged (1.8 to 3.6 Million years old (Ma)) interbedded limestone, sandstone and siltstone of the Petane Formation.

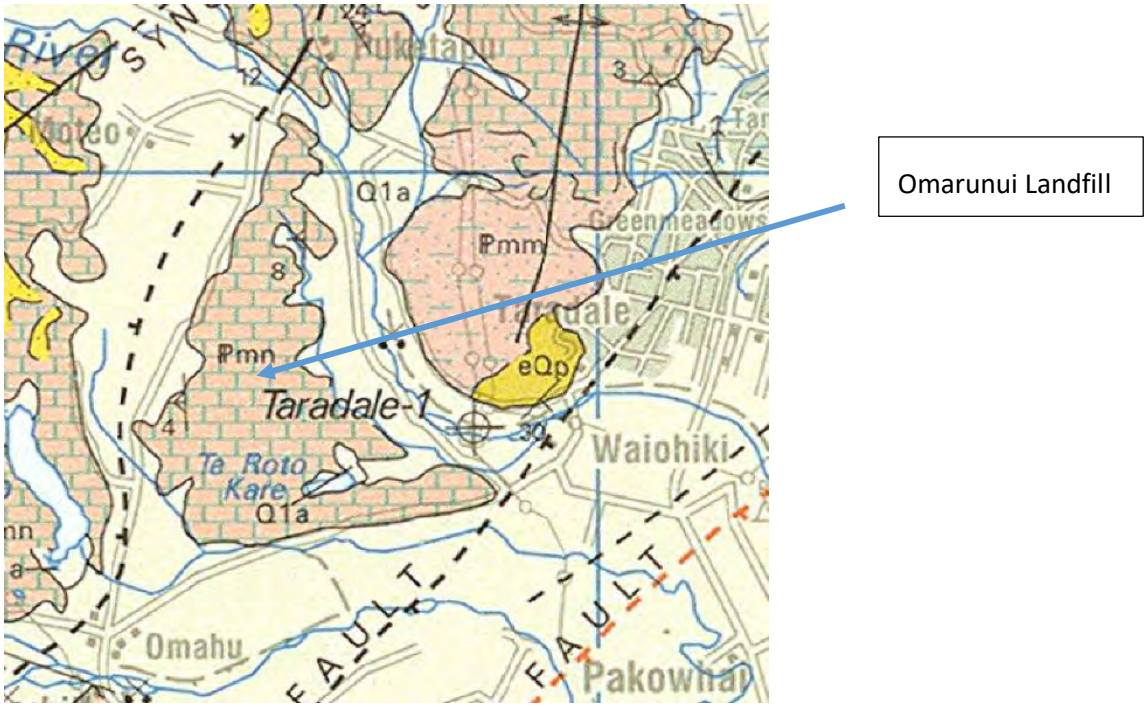

Figure 2.1: Geological Map of the Napier Area- Source (Lee et al, 2001)

[2] Lee, J.M; Bland, K.J; Townshend, D.B; Kamp, P.J.J. (compilers) 2001, Geology of the Hawkes Bay area, Institute of Geological and Nuclear Sciences 1:250 000 geological map 9.1 sheet +93 p. lower Hutt, New Zealand

2.2 Previous geotechnical assessment

2.2.1 Early consultant involvement and 2001 T+T investigations

A detailed engineering geological investigation of Area A of the Omarunui Landfill Site was carried out by P.M. Hancock and Associates in 1983[3]. This investigation was carried out to determine the most suitable areas for refuse disposal. Information summarising that investigation was presented in the report entitled, "Hawkes Bay Refuse Disposal Scheme: Engineering Geology Report: March, 1983." The work carried out in that investigation included geological mapping of the entire site, drilling of six boreholes, and in-situ permeability testing (packer testing, static head permeability testing, dispersion testing, and tracer testing).

T+T conducted a geotechnical investigation of Area D in August 2001 as part of developing the Area D landfill extension[4]. The work carried out during that investigation included surface geological mapping, excavation of 14 test pits, drilling of 10 boreholes with in situ permeability testing, and laboratory compaction testing of soils. The key findings of that investigation were:

- The subsoils at the Area D site typically consisted of sub-horizontally bedded sand-rich marine sediments, with relatively thin layers of shelly limestone and rounded greywacke gravels and conglomerates;
- Two northwest and northeast trending normal faults were mapped on site, although no surface traces were observed. These faults are believed to be greater than 20,000 years old and are not considered to be active;
- It is unlikely that fault movement will occur on the nearest active fault (the Napier Fault) within the design life of the Area D extension. The risk of displacement on the faults observed in Area D is considered to be very low;
- Well monitoring indicates the presence of both regional and localised perched groundwater systems beneath the Area D footprint. The regional groundwater has a hydraulic gradient of 1V:50H to the southeast beneath Area D and southwest beneath Area A. The shallow slope of the water suggests that the transmissivity of the underlying sandstone and limestone units is very high; and
- The measured permeability of the sandstones and limestone units ranged from 4.1×10^{-6} m/s to 1×10^{-8} m/s. Locally higher permeabilities may occur due to discrete defects and dissolution cavities in the limestone units.

2.2.2 2009 Investigations

T+T carried out a detailed site investigation of Areas B and C during February and March 2009, including:

- Surficial engineering geological mapping;
- Excavation of 24 No. test pits;
- Drilling of 9 No. fully cored machine boreholes (BC1 to 9), to depths of up to 60 m;
- Installation of 6 No. groundwater monitoring wells; and
- Rock mass permeability (Packer Test) testing.

[3] Hancock and Associates, Hawke's Bay Refuse Disposal Scheme Engineering Geology Report, March 1983.
[4] Tonkin & Taylor, Omarunui Landfill Area D Extension, Hydrogeological and Geotechnical Investigation, August 2001

The key conclusions of the 2009 investigations were that the site is suitable provided that:

- Erodible material below the proposed landfill footprint are removed to provide a stable subgrade for the liner;
- Sub-liner and bund foundation groundwater pressures are controlled through incorporation of suitable drainage measures;
- An appropriate liner foundation is constructed;
- The stormwater system at the site is designed to control erosion; and
- Subsurface geology is carefully logged during construction by a qualified geologist to identify any features not identified during the 2009 investigation.

2.3 Recent geotechnical investigations (2018)

The most recent ground investigation programme was undertaken to focus on Area B, in particular to establish further controls on the groundwater regime in Area B and assess the foundation conditions for the toe bund and cut slopes surrounding the landfill. The investigation comprised:

- A site walkover to assess changes since 2009 with particular attention to recently excavated area for borrow materials in the centre and north of the valley;
- Re-installation of the monitoring well at BC7 to replace an existing well that was destroyed during recent earthworks;
- Drilling and logging of five additional boreholes (BC10 to 14), ranging in depths from 10.5 to 60m with Standard Penetration Testing (SPTs) undertaken within the overlying soil units;
- Installation of monitoring wells in BC10 and BC14 to a maximum depth of 66 m below ground level;
- Pushing of 10 No CPTs at the base of Area B;
- Pushing of 13 No CPTs across the backfilled area at the southern end of Area B;
- Logging of 7 No test pits undertaken across Area B; and
- Collection of samples for later geotechnical laboratory testing from both the test pits and machine boreholes.

The details of the geotechnical investigations are provided in Table 2.1 below.

Table 2.1: Ground Investigation Summary

Investigation ID	Date Completed	Coordinates (HB Circuit 1949)		Ground Elevation (m RL)	Total Depth (m)	Location
		Northing (m)	Easting (m)			
BC5	2009	711979.4	309595.9	77.38	60	Area B/C boundary
BC6	2009	712110.0	309723.2	22.9	10	Bottom of Area C at proposed leachate pond
BC7	2009 Re-established 2018 as BC7A	711707.6	309691.3	60.21	43.5	Southern Area B, in existing quarry area
BC8	2009	711912.26	309779.36	51.31	38.5	Central Area B
BC9	2009	711679.65	309893.48	70.18	56	Eastern boundary of Area B

Investigation ID	Date Completed	Coordinates (HB Circuit 1949)		Ground Elevation (m RL)	Total Depth (m)	Location
		Northing (m)	Easting (m)			
BC10	2018	712068.18	310011.7	78.78	60	North-eastern corner of Valley B
BC11	2018	712027.42	309762.31	24.98	12.15	Toe bund location
BC12	2018	712076.00	309742.63	23.85	10.5	Toe bund location
BC13	2018	711877.83	309862.38	46.74	25.5	Centre of Area B
BC14	2018	711809.24	310008.75	83.34	66	Eastern boundary of Area B
CPT1	2018	712083.5	309737.6	23.59	6.0	Base of Area B
CPT3	2018	712059.6	309752.2	24.27	1.3	Base of Area B
CPT4	2018	712033.6	309780.2	26.36	3.4	Base of Area B
CPT5	2018	712000.8	309762	25.68	9.0	Base of Area B
CPT6	2018	711989.5	309784.2	27.37	7.8	Base of Area B
CPT7	2018	711955.9	309745.6	27.56	3.2	Base of Area B
CPT8	2018	711912.2	309725.6	29.61	6.6	Base of Area B
CPT9	2018	711883.2	309720.6	30.66	3.9	Base of Area B
CPT10	2018	711844.1	309754	32.98	4.2	Base of Area B
CPT11	2018	711808.4	309786.6	35.82	4.1	Base of Area B
CPT12	2018	711782.9	309687.9	57.71	7.1	Backfill area- South of Area B
CPT13	2018	711741.7	309699.3	55.70	12.9	Backfill area- South of Area B
CPT14	2018	711729	309738.4	54.29	1.9	Backfill area- South of Area B
CPT15	2018	711714.9	309769.8	53.11	11.5	Backfill area- South of Area B
CPT16A**	2018	711697.9	309718.2	56.55	17.1	Backfill area- South of Area B
CPT17	2018	711665.7	309693.2	59.05	4.7	Backfill area- South of Area B
CPT18	2018	711681.6	309678.6	58.68	3.9	Backfill area- South of Area B
CPT19	2018	711643.3	309650.3	58.61	9.4	Backfill area- South of Area B
CPT20	2018	711607.5	309636.9	55.68	0.7	Backfill area- South of Area B
CPT21	2018	711587.4	309709.9	50.31	0.9	Backfill area- South of Area B
CPT22	2018	711630.2	309733.8	51.00	1.8	Backfill area- South of Area B
CPT23	2018	711669.7	309758.4	51.96	9.9	Backfill area- South of Area B
CPT24	2018	711628.5	309667.7	57.37	7.8	Backfill area- South of Area B
Area B-TP01	2018	711996.3	309891.5	56.29	2.9	Centre of Area B

Investigation ID	Date Completed	Coordinates (HB Circuit 1949)		Ground Elevation (m RL)	Total Depth (m)	Location
		Northing (m)	Easting (m)			
Area B-TP02	2018	711992.9	309934.1	57.62	4	Centre of Area B
Area B-TP03	2018	711914.3	309905.2	53.11	4.5	Centre of Area B
Area B-TP04	2018	711909.1	309827.3	49.32	4	Centre of Area B
Area B-TP05	2018	711871.3	309793.4	49.10	1	Centre of Area B
Area B-TP06	2018	711857.1	309883.2	46.23	3.5	Centre of Area B
Area B-TP07	2018	711816.6	309856.9	43.26	2.8	Centre of Area B
TP14	2009	711871.53	309737.19	31.8	2.2	Area B Valley
TP15	2009	711940.18	309740.43	27.5	2.2	Area B Valley
TP16	2009	711995.35	309769.44	22.2	3.6	Area B Valley
TP17	2009	712039.62	309789.72	26.9	2.8	Area B Valley
TP18	2009	712080.84	309750.77	18.1	2.1	Area B Valley

*CPT2 was removed from the scope due to access constraints.

**CPT16A pushed following shallow refusal of CPT16

The geotechnical investigation locations are presented on DWG 1000647.1000-03 in Appendix A.

The records of the geotechnical investigations are provided in Appendix B.

2.4 Groundwater monitoring

Monitoring wells were constructed in a number of the 2009 and 2018 boreholes as summarised in Table 2.2 below. The spatial locations of these wells are shown on DWG 1000647.1000-03 in Appendix A. The screened intervals were selected based on information obtained from previous investigations and groundwater monitoring which indicates that the regional groundwater table is between 19 and 23 mRL.

Prior to monitoring well construction, each hole was flushed with clean water to remove soil cuttings and drilling fluids. Each well comprised 50 mm I.D. Class E uPVC pipe encased with Grade 7.14 Walton Park Sand (neutral clean graded sand) around the screened interval, a bentonite seal, and either pea gravel or cement-bentonite grout for the remainder of the hole. Joints were threaded and sealed with O-rings to reduce contamination of the water inside the wells. The screened sections of the well pipes were machine slotted with 0.5 mm slots in 3 run sets with a 7 mm spacing, and end caps were placed onto the base of the pipes. A minimum of 0.5 m of sand was placed above the slotted section of the pipe, below a bentonite seal of at least 1.0 m. Steel lockable upstands were cemented in at the top of each monitoring well for protection.

BC8, 11, 12 and 13 were not instrumented and were backfilled with pea gravel and bentonite.

Table 2.2: Monitoring well summary table

Well	Total Depth (m)	Well Screen Depth (m bgl)	Well Screen Depth (m RL)	Rock Type Screened	Co-ordinates (HB Circuit 1949)		Ground level (m RL)	Depth to GW Level (m)	GW Level (m RL)
					Northing (m)	Easting (m)			
BC5	60	57-60	17.4 – 20.4	SST	711979.4	309595.9	77.4	57.9	19.5
BC6	10	7-10	12.9 – 15.9	LST / SST	712110.0	309723.2	22.9	3.4	19.5
BC7*	43.5	37.5-43.5	16.7 – 22.7	SST	711707.6	309691.3	60.2	40.5	19.7
BC7A	27.8	24.8-27.8	30.3-33.3	SST	711700.4	309690.0	58.1	20.6	37.5
BC9	56	50-56	14.2 – 20.2	SST	711679.7	309893.5	70.2	50.6	19.6
BC10	59	56-59	19.8-22.8	SST	712068.2	310011.7	78.8	58.05	20.75
BC14	66	60-66	17. 34-23.34	SST	711809.2	310008.8	83.34	57.43	25.91

*BC7 destroyed during construction works

2.5 Laboratory testing

Laboratory testing has been carried out for the purposes of assessing compaction characteristics of the various materials likely to be used as fill, and permeability testing for checking suitability of the on-site materials for use as a liner.

Additional laboratory testing was completed in 2018 to assess the strength of the underlying sandstone and limestone rock for excavation. Testing comprised unconfined compressive strength (UCS) testing and Consolidated Undrained (CU) Triaxial testing to assess material parameters for slope stability analyses. We note that the friction angle calculated within the CU triaxial test is very high and we anticipate this is due to cementation of one of the samples. We have used a more conservative value in our analysis, consistent with our experience with similar materials.

Geotechnics Ltd was engaged to complete the laboratory testing and the results of the testing are included in Appendix E of this report.

3 Subsurface conditions

3.1 General

The following subsections describe the assessed stratigraphic sequence and structure below the proposed landfill footprint and immediate surrounding area. The geological descriptions and commentary regarding the geological structure have been based on information obtained from boreholes, test-pits, CPT testing and surface outcrops. Geological conditions away from the investigations are inferred, and therefore it must be appreciated that actual conditions could vary from the assumed model.

3.2 Site stratigraphy

3.2.1 Introduction

The geological units present within Area B comprise variably interbedded sedimentary siltstone, sandstone and limestone of the Petane Formation[5] [6]. The units described in Sections 3.2.2 to 3.2.4 below were deposited within the same general depositional environment (i.e. a shallow marine environment), with localised accumulations of shell and greywacke gravel beds. Consequently, the thickness of each of the three units is laterally highly variable, with interfingering of the units being a reflection of the active depositional environment.

A site-specific stratigraphic sequence was mapped and described by Hancock and Associates, who subdivided the geology into five distinct limestone units within a variably cemented, sandstone-dominated sequence. Although a broadly similar stratigraphic sequence was mapped in Areas B and C, the naming convention adopted by Hancock and Associates has not been retained in this report as the limestone units were not found to be laterally continuous or of uniform thickness across the site.

Detailed and location-specific descriptions can be found in the borehole logs (Appendix B). The main characteristics and distribution of the geological units identified at the proposed landfill site are presented below. Geological cross sections for Area B and C are presented in Appendix A, Drawings 10 to 13.

3.2.2 Siltstone

Siltstone is the uppermost unit of the Petane Formation exposed within the site. Siltstone was found at the northern end of the investigation area capping the northern ridge in Area C. Borehole BC3 (North of Area C) in the centre of the ridgeline encountered 12 m thickness of Siltstone typically described as weak to very weak, slightly sandy, moderately weathered light brown Siltstone.

Some completely weathered siltstone has been exposed in isolated pockets of Area B, generally around TP3 (2018) and the north of the valley where material has been stripped for use as landfill liner. These materials typically comprise moist to wet sandy silts with trace clay.

Photograph 3-4: Borrow pit area at the north of Area B where silts are currently being extracted for liner material.

[5] Field. B et al, 1997, Cretaceous –Cenozoic and Petroleum Systems of the East Coast Region, NZ Institute of Geological and Nuclear Sciences.
[6] Bea, A.G, 1995, Pliocene Limestone and Their Scallops, Lithostratigraphy, Pectinid Biostratigraphy and Paleogology of eastern North Island late Neogene Limestone, NZ Institute of Geological and Nuclear Sciences.

3.2.3 Limestone

Limestone is both vertically and laterally highly variable across the site. Limestone outcrops are commonly found about the flanks of the main valley in Areas B. Limestone caps the central ridgeline at the centre of Area B and is visible north of Area B (north of BC6).

The Limestone typically consists of shelly and sandy limestone with localised pockets and beds of sand, shells, and greywacke pebbles.

Outcrops of the Limestone units show that it is can be relatively thick (up to 10 m), shelly, sandy and weak to moderately strong (10 to 30 MPa) when well cemented. However, where Limestone is weathered and/or was never fully cemented, the Limestone is extremely weak (<1 MPa unconfined compressive strength) and in places can be described as a variably cemented calcareous sand. In some outcrops and sections of core, the Limestone contains generally widely spaced (600 mm to 2 m) open (width ranging from 1 to 10 cm) dissolution cavities. These are generally horizontally elongated with approximately 20 to 30% of the shells having been dissolved. In outcrops, some cavities are shown to have developed vertically, possibly along rock joint defects.

Photograph 3-5: Limestone exposure at the centre of Area B showing sub horizontal bedding.

3.2.4 Sandstone

Sandstone comprises massive (non-bedded), relatively homogeneous, weak, light yellowish brown, very fine to fine sandstone. The sandstone units frequently become silty with depth and contain occasional localised beds of shell fragments and rare lenses of greywacke gravel. Sandstone forms the largest proportion of the lithological sequence at the site.

Sandstone forms the lower flanks of the main valleys and the eastern flanks in Area B. Exposures of the sandstone are rare due to its weakly cemented state and the presence of colluvial cover. Sandstone is also exposed along the cut accessway to the quarried area adjacent to borehole BC5 along the central ridgeline separating Areas B and C, and is also exposed in the outcrop adjacent to borehole BC9 in the east of Area B.

While the Sandstone is generally slightly cemented and of very weak material strength, some sandstone units encountered in boreholes are uncemented and are more appropriately described as very dense fine to medium sands. Drilling through these units was difficult, with typically poor core recovery and locking of the drilling casing (in BC10). The sands also proved to be difficult to recover for drillers in the 1983 Hancock investigation and in the 2009 T+T investigation.

3.2.5 Colluvium

Colluvium covers the lower third of the valley slopes within Area B and is typically up to 1 m thick. The colluvium is predominantly loose, un-cemented, friable fine to medium sand (reworked weathered sandstone and Loess), although it also contains minor boulder-sized blocks of limestone.

3.2.6 Alluvium

Alluvium fills the lower plain within the main valleys in Area B and comprises sandy organic silt and silty fine to medium sands. CPT testing in the base of the valley indicates the alluvium is up to 9 m deep in these confined gullies.

SPT blow counts ('N' values) within this unit ranged between 1 to 8 blows/300 mm in BC6, BC11 and BC12 at the base of Area B. Measured shear strengths in BC6 ranged between 30 to 50 kPa in the silt fraction of the alluvium.

CPT testing indicated strengths (cone resistances) of the alluvium were typically between 1 to 2 MPa.

3.2.7 Topsoil

The test-pit excavations showed that the investigation area is overlain by a 0.2 to 0.3 m thick layer of topsoil which typically thickens to up to 1 m in the base of the valleys (TP17, BC6).

The test-pitting showed that approximately the top 1 m of material beneath the topsoil was typically dense and partially cemented. This appears to be a result of acid-leaching of the soils (podsolisation), which probably occurred prior to clearing of the native bush.

3.2.8 Non-engineered fill

The southern end of Area B has been extensively filled by up to 22 m depth shown in the highlighted area on attached drawings (1000647.1000-DWG 3 to 9). This area is known colloquially on site as "the quarry". It is understood this area was first excavated to obtain liner soils for Area A. The excavation was subsequently backfilled with material sourced from construction of Area D. This area now forms borrow areas for the operation of Area D and the M.W. Lizette contractor's compound.

The fill material typically comprises sandy silt and fine sands with some organics and greywacke gravel clasts with minor clay. SPT N values within this material ranged from 4 to 25 blows. This material appears to be highly variable and is considered to have been end tipped and track rolled with minimal compaction effort.

A number of CPTs were pushed in this area to assess the strength characteristics of the fill. The CPT traces indicated that the majority of the material is behaving as a sandy silt to clayey silt with cone resistances typically ranging from 1 to 2 MPa. Discrete lenses of denser sandy material were also encountered (up to 20 MPa). We have inferred that the CPTs have refused on the underlying rock surface although there is a potential that buried boulders or dense layers within the fill could have prevented further penetration.

3.3 Groundwater

The regional aquifer is formed in both the sandstone and limestone lithology beneath the site. Groundwater data collected in March 2009 and 2018 confirm that the regional water table is located at about 19 to 22 mRL beneath Areas B and C.

Monitoring of BC7A confirms that there is perched groundwater within the limestone and sandstone at about RL 35 to 40 m. The CPT tests indicate that the overlying non-engineered fill unit is dry and the perched water is within the rock mass.

For more detailed assessment of the groundwater and hydrogeology of the site, please refer to the T+T 2018 Hydrogeological report.

3.4 Geological structure

Field mapping and structural contour analysis using borehole and outcrop data indicate a flat-lying to gentle north westerly dipping bedrock sequence. The northeast and north-northeast trending normal faults postulated in the T+T 2001 investigations of Area D[7] are not readily traced into Area B. The observed lateral variation in stratigraphy is most likely as a result of rapid facies changes during deposition in a shallow marine environment.

A northeast-southwest trending normal fault was identified in the quarry at the eastern edge of Area B. Stratigraphic offset on the footwall of this fault is approximately 5 to 6m to the northwest. The location of the fault is presented on the geological map in Drawing 4 (Appendix A). Other minor faults are likely to be present within the site, although these are not readily identifiable. There are no surface traces associated with the faults and the faults are not observed as displacing the younger alluvium and colluvial soils.

Faults within the existing landfill footprint (Area D) and Areas B and C are understood to be associated with the broad folding of the geological sequence west of Napier (the Matapiro Syncline) rather than faulting associated with seismic activity within the major fault zones of the region (Waipukurau-Poukawa, Haumoana and Ruahine/Mohaka Fault Zones)[8].

The geological structure of the site is further illustrated on the attached drawings in Appendix A.

4 Seismic shaking hazard

4.1 Seismic site subsoil class

The site is located within a seismically active region of New Zealand that has been specifically studied by the Institute of Geological and Nuclear Sciences (GNS). The faults mapped at the site are not recorded on the GNS database of active faults. The nearest known active fault is the Napier Fault located approximately 6 to 10 km east of the site[9].

Based on the site investigations we consider that seismic subsoil Class C – Shallow Soil is considered appropriate for the site.

T+T's seismic assessment has been undertaken in accordance with the recommendations in the NZTA Bridge Manual and the New Zealand Code of Practice NZS 1170.5:2004 to represent the following design performance requirements.

This equates to design earthquake loads as shown in Table 4.1 below:

Table 4.1: Ground seismic hazard

Seismic design case	Return Period	Magnitude	Peak Ground Acceleration
SLS	1 in 25 year	6.2	0.11

[7] Tonkin & Taylor Ltd, August 2001, Omarunui Landfill Area D Extension, Hydrogeological and Geotechnical Investigation".
[8] Begg. J, Hull, A., Robinson, R. (1996), "Earthquake Hazard Analysis – Stage 1 Recurrent of Large Earthquakes Determined from Geological and Seismological Studies in the Hawke's Bay Area" Institute of Geological and Nuclear Sciences, Client Report 1996/33591 D.10.
[9]Berryman, K., McVerry, G., and Villamor, P. (1997), "Hawke's Bay Region Earthquake Hazard Analysis Programme 3 – Stage 2 – A Numerical Assessment of the Earthquake Hazard in the Hawke's Bay Region," Institute of Geological and Nuclear Sciences, Client Report 33591D.

ULS	1 in 500 year	6.9	0.42

4.2 Liquefaction assessment

It is our recommendation that all soft or loose sediments under the basegrade layer be removed during the initial bulk earthworks. Given the extent of the alluvial soils is restricted to the narrow gullies in the centre of the site we anticipate this should be achievable with large plant (>20 T excavators), however, this will need to be confirmed with the earthworks contractor as the excavations would need to extend below the groundwater level and temporary haul roads would need to be constructed.

If this excavation and subsequent removal of the alluvial soils is not possible then a detailed liquefaction risk assessment should be undertaken prior to detailed design to assess the risk of liquefaction induced settlements and effects on the landfill liner using the existing borehole and CPT data.

5 Geotechnical considerations

5.1 Geotechnical properties

Geotechnical properties have been assigned to each of the various geological units encountered at the site and for landfill components. These are based on field observations (including limited in situ testing), material descriptions, results of the previous investigation work detailed in Section 2.2, geotechnical laboratory testing and published and unpublished values for similar material. A summary of the recommended parameters for design is presented in Table 5.1. These parameters are similar to those used for the design of the Area D extension (T+T 2001 report). It is noted that, for the weakly cemented and highly fractured sandstone and limestone units, undisturbed samples for strength testing are difficult to recover and assessed rock mass strengths provide the best guide to rock mass properties.

Table 5.1: Summary of effective stress soil strength parameters

Material Type	Bulk Density (kN/m^3)	Effective Cohesion (kPa)	Effective Friction Angle (°)	Comments
Refuse	14	5	25	Based on published correlations.
HDPE Liner contact	-	0	Post Peak textured 16 Peak textured 25	Friction angle between geomembrane and soil interface from published data[10] [11]
Engineered Fill	18	2	32	Assumes compacted slightly silty sand fill.
Colluvium/ Alluvium	17	0	28	Based on SPT's, material descriptions and back-analysis of existing slopes
Highly Weathered Sandstone	17	6	30	For weathered sandstone units strength parameters are based on SPT's and material descriptions
Sandstone	19	10	34	For sandstone units strength parameters are based on SPT's >50, material descriptions and an assessment of cemented rock mass characteristics (where cemented).
Limestone	18	50	38	For Limestone units strength parameters are assessed rock mass strengths based on Defect spacing, RQD, and assessed strength of intact rock material).

5.2 Rock mass permeability

5.2.1 Slug testing

Slug tests were undertaken at all installed monitoring wells on 13 May 2009. One slug of water was removed from each well using a stainless steel bailer that was a snug fit in the well casing. In all boreholes the water level data was collected using a manual dip tape after removal of the bailer. Water level recovery was too rapid at BC7 and BC9 to collect enough data in 2009. Additional slug testing was completed in 2018 to verify the 2009 results.

The permeability at each monitoring well has been calculated from the slug test data using both the Hvorslev and Bouwer - Rice methods. The results for the selected methods are in good agreement at each monitoring well. The permeability calculated for BC6 and adopted for BC7 and BC9 is similar to that reported for fine to medium sands[12]. The permeability reported for each of BC6, BC7, and BC9 is an order of magnitude greater than the permeability calculated at each of the other three monitoring wells in Area C.

Table 5.2 summarises the 2009 and 2018 slug test data. Slug test results are provided in Appendix F.

[10] Omarunui Landfill – Area D. Progress Report No. 3". T&T report for Hastings District Council, December 2005

[11] Alison, J.D and Allison, T. L. (2005), "Partition Coefficients for Metals in Surface Water, Soil, and Waste" USEPA, reference number EPA/600/R-05/074.

[12] Kruseman G.P. & de Ridder N.A. (1994) Analysis and Evaluation of Pumping Test Data (2nd ed.). International Institute for Land Reclamation and Improvement, The Netherlands.

Table 5.2: Summary of slug test data

Borehole	Screened Interval (m bgl)	Lithology tested	Permeability (Hvorslev) (K) (m/s)	Permeability (Bouwer-Rice) (K) (m/s)
BC6	7 – 10	LST/SST	8.6×10^{-5}	6.6×10^{-5}
BC7*	37.5-43.5	SST	5.0×10^{-5}	5.0×10^{-5}
BC9 (2009)*	50-56	SST	5.0×10^{-5}	5.0×10^{-5}
BC7A	24.8-27.8	LST/SST	-	1.95×10^{-6}
BC9 (2018) Falling head	50-56	SST	-	1.7×10^{-4}
BC9 (2018) Rising head	50-56	SST	-	4.1×10^{-5}
BC10	56-59	SST	-	9.5×10^{-3}

Note: * Permeability inferred based on speed of recovery to static groundwater level.

5.2.2 Rock mass permeability testing

Several borehole packer tests were carried out in the 2009 investigations with the objective of obtaining an indication of in-situ permeability values at the finished base level of the proposed landfill extension. Packer testing from 2009 is summarised in Table 5.3 below. Packer test data sheets are presented in Appendix F.

Table 5.3: Summary of Packer test data

Borehole	Final Depth (m)	Test Interval (m bgl)	Test Interval (m RL)	Lithology tested	Permeability (k) (m/s)
BC5	60	5.2 - 7.0	70.4 - 72.2	5.2-6.0m LST; 6.0-7.0m SST	7.52×10^{-6}
BC8	38.5	25.2 - 27.0	24.3 - 26.1	5.2-5.4m SST; 5.4-7.0 LST	6.54×10^{-7}

The above results show that, in general, the materials tested have variable permeability. The permeability of the sandstone and limestone units will vary greatly, due to the lateral variability of the unit (e.g. degree of cementation, shell and sand content variations, rubbly layers, and joints), and the presence (or absence) of dissolution cavities.

5.2.3 Overall rock mass permeability

The rock mass at the site is strongly layered with variably cemented and fractured limestone and sandstone. It is expected that within the sequence there is likely to be strong contrast between vertical and horizontal permeability, especially where uncemented sands and/or fractured limestone beds occur within a layered sequence of less permeable silty sandstone and/or siltstone. Furthermore, rock mass permeability can be expected to be one to two orders of magnitude higher where interconnected dissolution cavities are present within limestone units or within the uncemented sand lenses.

In general, we consider that the permeability testing undertaken did not encounter a highly fractured rock mass. Overall, we consider that in situ rock mass permeability in the limestone units or clean sand may be locally as high as 1 x 10^{-4} to 1 x 10^{-6} m/s where solution cavities are present.

5.3 Slope stability

5.3.1 General

The development of the landfill will require a significant amount of excavation to the centre and east of Area B. Further cut backs are proposed around the margins of the valley. The development of the temporary landfill excavation will require the excavation of cut slopes up to 50 m high. The proposed slopes within the landfill footprint are designed at a typical grade of 1V:3H, however the upper slopes of the eastern highwall will require steeper cuts at 1V:2H due to the proximity of the property boundary.

5.3.2 Slope stability modelling

Slope stability has been modelled using Slope/W, a limit equilibrium software package with the geological profiles based on the geological sections provided in Appendix A.

Analysis has been undertaken for the eastern highwall where the steepest slope (and highest) is proposed and for the permanent toe bund at the base of the landfill. The western highwall is proposed to be cut back at a shallower angle than the present slope, and we consider this slope is likely to perform adequately and a specific slope assessment was not required.

5.3.3 Slope stability results

5.3.3.1 Eastern Highwall

An assessment along Cross Section 3, Appendix A was completed based on BC13 & BC14. Table 5.4 summarises the results for this section. The slope assessment was undertaken to model the slope on completion of the excavation ignoring the buttressing effects of the backfilled refuse. Long term slope stability, following refuse placement, is expected to be higher for this scenario.

Table 5.4: Eastern Highwall Slope W results

Analysis Case	Target FoS	Calculated FoS
Static Conditions	1.5	2.47
Elevated Groundwater Conditions	1.3	2.19
Seismic Conditions	1.0	1.02

The slope modelling indicates that the proposed eastern cut slope meets the required factors of safety.

5.3.3.2 Toe Bund

A permanent toe bund is to be formed at the base of Area B to provide a stable base to contain the refuse to the south of the bund. A starter bund will be constructed to enable phase 1 of construction to begin, which will then become incorporated into the final bund design. The permanent toe bund will be constructed at the northern end of Area B and will be constructed to an elevation of RL35 m. A 7m high bund was initially proposed for the design, however this is unlikely to meet the seismic stability required and the bund height has been subsequently proposed to be raised to 10m total height (excluding shear key).

Table 5.5 summarises the results of these analyses.

Table 5.5: Toe bund stability assessment results

Analysis Case	Target FoS	Calculated FoS
Static Conditions (7 m high bund)	1.5	2.09
Elevated Leachate Conditions (7 m high bund)	1.3	1.71
ULS Seismic Conditions (7 m high bund)	1.0	0.69
ULS Seismic Conditions- Larger Bund (10 m high)	1.0	0.78
ULS Conditions –10 m high bund with intermediate bund and failure along liner	1.0	0.69
ULS Conditions -10 m high bund failure along liner (Yield Acceleration for FoS 1.0= 0.26g)	1.0	1.02

The analyses indicate that a 7 m high bund would meet the design requirements for the static case. However, the seismic design requirements for a 7 m high toe bund are difficult to meet due to the high seismic coefficient of the Hawkes Bay area. We have recommended increasing the bund height to 10 m to provide greater resisting force at the toe of the slope, and limit estimated seismic displacements to less than about 50mm under the ULS case (refer section 5.3.3.3 below).

We note that the design analyses are likely to be conservative as the analyses do not account for 3D buttressing effects of the valley sides, which would be expected to provide significant lateral support to any potential failure scenario. Final design of the bunds will be undertaken at the detailed design stage, at which time the stability modelling should be assessed in detail with the final landfill design.

Analyses outputs are provided in Appendix E.

5.3.3.3 Seismic displacements

Displacements under a ULS seismic case along the liner and toe bund in the scenario are expected to range from 10 to 50 mm based on various methodologies (Jibson, 2007 and Rathje and Saygili, 2009).

We recommend that the following considerations are made to provide adequate stability under the seismic slope stability case:

- Construct the height of the bund to have a minimum crest level of RL 35 m;
- Construct the bund to have a minimum width of 50 m at the base;
- Excavate the alluvium below the base of the toe bund; and
- Include an intermediate bund upslope of the toe bund to increase the shear resistance across the lower liner surface. This will essentially require the starter bund to remain in place during subsequent refuse placement and landfill construction.

5.3.4 Erosion control and mitigation

Whilst deep seated instability is unlikely to affect the proposed landfill slopes, surficial rilling and erosion of exposed slopes will need to be mitigated. Following excavation, exposed slopes should be

immediately hydroseeded or top soiled to limit erosion. Additional erosion protection, including geotextile, e.g. erosion matting, may be required where soil cover is thicker or colluvium is exposed.

5.4 Earthworks

5.4.1 General

The creation of the Area B landfill extension will require large volumes of excavation (approx. 800,000 m^3) to form the basegrade layer at approximately RL30 m. The bulk of the excavation will occur around the central spur in Area B. We anticipate the majority of this material will be interbedded limestone and sandstone rock which was encountered in BC13 and our recent test pits.

The southern, western and eastern slopes of Area B will be laid back to 1V:3H slopes except the eastern highwall, which is to be cut steeper (approx. 1V:2H) due to boundary constraints.

5.4.2 Excavation

Excavation of the sandstone units along the valley sides is expected to be relatively straightforward due to their low material strength. However, some harder cemented zones were encountered during the construction of the Area D landfill, and their presence within Area B should be expected. Some ripping of these zones may be required.

Excavation of the more heavily cemented limestone units may be harder in places. The limestone is variable and contains layers of sand which would provide planes to allow dislodgement of blocks during excavation. The limestone units would most likely require some ripping, depending on the earthworks plant available. The use of pneumatic picks may be necessary locally but it is considered that blasting is not likely to be required.

The colluvium that aprons the lower half of the slopes and the gullies is expected to be relatively easy to excavate. However, the top 1 m to 1.5 m is relatively dense due to soil leaching and may not be suitable for excavation with small plant (e.g. <10 tonne excavators).

It is anticipated that the gully alluvium in the centre of the site is to be removed prior to construction of the landfill. Our CPT testing indicated that this unit is up to 9 m thick and variable in strength and composition. It may be possible to form cut slopes up to 1V: 2H in the alluvium, however this may prove impractical as the gullies are narrow and steep. Complete removal of this unit may be the best option. Groundwater controls will be required (i.e. continuous pumping) as the groundwater level was typically encountered at 3 to 4 m below ground level in the central gully. It may be necessary to provide temporary support for the toe bund excavations with sheet piles or similar systems. This will be confirmed at the detailed design stage.

If groundwater seepage or springs are encountered in cut faces, these will need to be controlled with subsoil drainage and erosion carefully managed.

5.4.3 Foundation preparation

Some areas have a thin colluvial cover up to 0.5 m thick which contains organic topsoil pockets deposited by shallow land-slippage of the overlying slope. These materials, identified by their dark brown colouring, should be removed prior to preparation of landfill basegrade or liner placement.

The foundations for all earth fills including the bunds will need to be keyed (shear key) into competent natural ground for slope stability purposes (e.g. sandstone or limestone rock). Any low strength or compressible materials within the bund foundation footprint should be completely removed. This may require excavations up to 8 m deep in the permanent bund location. Excavations will need to be dewatered to ensure the shear key foundation can be compacted appropriately.

An alternative to a shear key in the toe bund location would be to construct a series of Stone Columns, Soil Mixed Columns or Rammed Aggregate Piers (RAPs) comprising compacted aggregates or cement mixing to provide adequate stability against a failure through the underlying alluvium. Geotechnical design of the toe bund foundations should be confirmed during detailed design.

To prevent potentially very sharp differential settlements (500 mm over 10 m worst case) along the extent of the narrow alluvial gullies we have proposed that the alluvium in these locations is removed and replaced with site won engineered fill.

Some of these materials may be suitable for reuse as engineered fill, otherwise could be placed as non-engineered buttress fill or landscaping materials outside of the footprint area. Alternatively, used as topsoil or daily cover material once dried and conditioned.

5.4.4 Settlement of landfill liner (Southern portion of Area B)

5.4.4.1 Background

The southern portion of Area B including the previously backfilled borrow area (non-engineered fill) will be eventually overlain by 20 to 25 m of refuse in the final design (Refer DWG 1000647.1000-05 in Appendix A). We understand this backfill material is to remain in place during landfill construction as it unlikely to be suitable for re use as liner (it was considered unsuitable for Area D).

Static settlement of this material is considered likely under the surcharge load of the refuse. There is likely to be differential settlement at the margin of the existing backfill with the refuse surcharge above, which may have an adverse effect on the proposed landfill liner placed above. Ground improvement work is recommended to minimise the amount of differential settlement at the margin of the existing fill area and mitigate deformation of the proposed liner system.

The underlying non engineered fill soils in the backfilled area are variable in nature but comprise sands, silts and minor organics with the CPT investigations confirming a variable strength. Cone resistances ranged from 1 to 2 MPa with occasional lenses of much denser material. SPT tests within the fill material ranged from 4 to 25 blows/300mm in BC7 (2008).

Figure 5.1 below shows the borrow area during excavation in November 2005.

Figure 5.1: 2005 Aerial photograph showing the extent of the borrow area excavation and resulting buried highwall

A preliminary assessment of likely settlements has been undertaken using the CPT data (where the CPTs did not encountered shallow refusal) and historical borehole data. The analyses has assumed a

uniform load of 250 kPa (i.e. 18 to 20m of 14 kNm^3 refuse). A summary of estimated settlements is shown in Table 5.6 below:

Table 5.6: Summary of CPT based settlements (former borrow area)

CPT Number	Thickness of fill	Estimated settlements (mm)
CPT12	7	<100
CPT13	13	100-120
CPT15	11.5	100-150
CPT16	17	100-120
CPT23	10	800-850

5.4.4.2 Settlement mitigation and monitoring

During construction we recommend that the construction of a landfill in this area is raised progressively at no more than 1 m per month to limit sharp static and differential settlements. The margins of the backfilled area will require further investigation to delineate the contact with the underlying natural ground.

For preliminary design, we recommend that these higher risk margin areas should be cut back and benched down into natural ground within the upper 5 m, at a maximum 1V:3H batter angle, to mitigate potential differential settlements and transition the expected settlements more gently across this interface. The resulting excavation should be backfilled with engineered fill placed to the specification in Section 5.4.5. Geogrids could be incorporated into the engineered fill to stiffen this crust of material over the non-engineered fill below.

It is recommended that a number of settlement plates are installed to monitor the response of the fill following completion of the engineering raft and initial filling. This should be complemented with a profilometer (horizontal settlement profile) and extensometers (vertical settlement profile) installed prior to construction.

Monitoring of a trail load over a 6 month period (following construction of the engineered fill crust) is recommended in order to confirm our assumptions and the response of the non-engineered fill to loading.

5.4.5 Bulk/Structural fill

Both the sandstone and the siltstone materials are likely to be suitable for bulk and structural fill (e.g. the toe bund construction). The lower permeability properties of the siltstone units means that they may also be preferentially used for liner construction. The toe bund in Area D was constructed from predominantly sandstone material and the strength specification was readily achieved.

Crushed shelly limestone material could provide for higher strength fill material (f ’ = 40º to 45°) if required but may be limited in volume. It may be useful for haul road surfacing during construction but should not be used as a drainage material.

Some of the colluvium and the alluvium may be suitable for re use as structural fill, low permeability liner construction or daily cover within the operational landfill. Conditioning (drying) of the colluvial and alluvial materials will probably be required where they naturally occur wet of optimum moisture content, particularly during winter.

Unsuitable materials (“unsuitables”) are present within the footprint area of the proposed landfill extension, and comprise topsoil, some alluvium and stock pond sediment. The alluvium and pond

sediment should be cut to waste and any topsoil stockpiled for future site rehabilitation works. The volume of unsuitables is expected to be relatively small.

Bulk bag samples were collected from the 2018 test pits for compaction testing. Table 5.7 below presents the results of the testing and an assessment of suitability of these materials as bulk fill.

Table 5.7: Summary of compaction test results

Investigation ID	Depth (m)	Material Type	Natural Moisture Content (%)	Optimum Moisture Content (%)	MC-OMC (%)	Suitability of re-use (Y/N)
TP1	1.0	Weathered sandstone	12.9	10	2.9	Y
TP2	1.0	Weathered sandstone	14.2	14	0.2	Y
TP2	2.0	Weathered sandstone	11.1	14	-2.9	Y
TP3	1.0-1.2	Silty sand	19.7	16	3.7	Y
TP3	2.5	Silty sand	25.1	19	6.1	Marginal
TP3	4.5	Weathered sandstone	13.4	14	0.6	Y
TP4	3.0	Weathered sandstone	19.3	19	0.3	Y
TP6	1.2	Weathered sandstone	21.7	18	3.7	Y
TP7	1.0	Weathered sandstone	20.1	18	3.1	Y
TP7	2.8	Weathered sandstone	20	20	-	Y

Assuming that the bulk/structural fill is likely to be sourced from the weathered sandstone units. The preliminary compaction control criteria for placement of new fill is as follows. A detailed earthworks and subsoil drain specification should be prepared to accompany detailed design. We anticipate that the site won sandy silts and silty sands will be sensitive to reworking and moisture content.

Bulk Structural Fill (Granular site won material-Weathered sandstone):

Density (measured by in nuclear densometer testing)

Average value of any 10 consecutive tests not less than 95% of MDD
Minimum single value 90% of MDD

Scala penetrometer testing >3 blows per 50mm
Clegg impact testing (CIV) CIV >20

Air Voids (measured by in nuclear densometer testing)

Average value of any 10 consecutive tests not greater than 8%
Maximum single value 10%

Liner material (Cohesive material):

Shear strength (Measured by hand held shear vane)

Average value of any 10 consecutive tests not less than 130kPa

Minimum single value 120kPa

Air Voids (measured by in nuclear densometer testing)

Average value of any 10 consecutive tests not greater than 6%

Maximum single value 8%

This specification has been set to enable a high strength toe bund to be constructed in Area B. High strength fill will greatly assist the seismic stability of the toe bund slopes.

6 Landfill Liner construction

The selection and design of the landfill liner system is described in the accompanying engineering report. It is proposed that the liner system will comprise a geomembrane liner overlying a Geosynthetic Clay liner (GCL) and 600 mm of compacted cohesive fill ($K \leq 1x10^{-7}$ m/s).

Generally, this cohesive fill will be selected finer grained soils sourced from excavation within the footprint of Area B but may require the establishment of borrow areas in Area C or the wider site. Recent works at the site have utilised imported fill from sites within Hawkes Bay. External borrow sites will need to be validated prior to importation of materials.

Laboratory permeability test data sheets are presented in Appendix E, and summary results of the testing are presented below in Table 6.1. The extent of this resource should be further quantified with a more detailed test pit and laboratory testing investigation.

Table 6.1: Permeability test results for selected soils

TP / BH number	Depth (m bgl)	Lithology	Sample Type	Permeability (m/s)
BC 1	13.5	Weakly cemented Sandstone	Remoulded bulk sample	1.1×10^{-6}
BC 5	6.2	Sandstone	Undisturbed HQ core sample	2.6×10^{-8}
TP 13	1.3	Clayey Silt	Remoulded bulk sample	9.4×10^{-11}
TP 18	1.8	Clay (Colluvium)	Remoulded bulk sample	5.6×10^{-9}
TP 21	1.2	Siltstone	Remoulded bulk sample	1.6×10^{-9}
TP 23	1.2	Siltstone	Remoulded bulk sample	5.4×10^{-7}

Other suitable soils comprise selected finer grained sandstone soils and the gully alluvium present at the base of Area B. The erodibility and sensitivity of these soils made them difficult to place during construction of the liner in Area D, and care will need to be taken for placing these materials to minimise the need for re-work. Gully alluvium would need to be dried and conditioned for it to be suitable as liner fill and any organics removed from this material.

6.1.1 Leachate drainage layer

The site materials are not suitable for use as a leachate drainage layer. Where required, as part of the design, imported river gravels should be placed above the geomembrane liner to provide for leachate drainage and liner protection. Crushed angular aggregate may be required for drainage layers on the side slopes of the proposed landfill cells.

6.1.2 Suitability of site soils for final cap

Once the landfill reaches its final levels, a final cap could consist of about 1m thickness of site won fill that will need to be placed, covered with topsoil and vegetated.

Because the climate at the location of the site is semi-arid (approximately 800 mm of annual rainfall and high evapotranspiration), a capillary barrier design for the final cap is considered appropriate to restrict percolation into the waste.

For the capillary cap, sandstone, colluvium, and alluvium won at the site can be used cost-effectively. Site specific sampling, to confirm permeabilities would be required prior to construction of final cap areas.

7 Conclusions and recommendations

7.1 General

Hastings District Council (HDC) commissioned T+T to investigate the potential for development of the north eastern valley at Omarunui Landfill (known as Area B) for use for future solid waste landfilling.

This valley is steeply sided and comprises a number of narrow gullies with ridgelines encircling the perimeter of Area B.

T+T undertook geotechnical investigations across Areas B and C in 2009 to assess ground conditions and the feasibility of the site for future use within the landfill complex. Subsequent investigations have been completed in 2018 to target specific features within the proposed landfill footprint.

The key landfill design features of Area B include:

- Bulk earthworks to remove approximately 800,000 m^3 of material from the centre of Area B and placement of about 90,000 m^3 of fill;
- A steep cut along the eastern boundary of the site and laying back of the northern and western slopes;
- Construction of a starter bund in the centre of Area B;
- Construction of a permanent toe bund at the northern end of Area B;
- A final landfill up to RL80 m (approximately 50 m deep); and
- Associated leachate and stormwater management systems.

7.2 Conclusions

We consider that it would be geotechnically feasible to develop Area B as an extension to the existing landfill on the Omarunui site. Our assessment has identified the following geotechnical constraints:

1 Erosion of batter slopes will need to be managed by hydroseeding and/or placement of erosion matting following excavation;

2 The toe bund profile can be designed to provide overall seismic stability combined with the construction of an intermediate bund. Slope displacements under a ULS seismic event are not expected to exceed about 50 mm;

3 The former borrow area at the southern end of Area B was backfilled with non-engineered fill during the period 2005 to 2012. The depth of this backfill varies up to 22 m and includes a sharp slope gradient over a former highwall under the current access road. Differential settlement across the former highwall under the loading of the final landfill could cause differential settlement and result in damage and tearing of the liner.

4 To mitigate differential settlement, it is recommended that the margins of this area be cut down 5 m and laid back at a slope of 1V:3H, with the resulting excavation backfilled with engineered fill. Settlement of this area will need to be monitored during construction and filling.

5 The alluvium within the landfill footprint should be removed to prevent sharp differential settlements over the narrow gully features.

6 There appears to be a deficiency of finer grained materials that are suitable for use as liner on site. This will require reliance on geosynthetic liner components as described in the accompanying engineering report. Importation of suitable cohesive materials may be required and should be reviewed during design and construction.

7 Groundwater is typically below final basegrade level (RL 30 m) although some perched groundwater was encountered between RL35 to 40 m. Subsoils drains will need to be installed where groundwater is encountered within exposed cut faces.

8 Subsurface geological features will need to be logged during construction by a qualified geologist to identify any geological features not identified in the 2009 and 2018 investigations.

7.3 Recommendations

- Carry out additional ground investigations (test pitting and sampling) for detailed earthworks design, and in the wider land holding, if required, to source suitable soils for construction of the compacted soil layer beneath the liner;
- Earthworks should include keying into competent rock for landfill side slopes and toe bunds and subsoil drainage, where required;
- A detailed construction methodology will be required to ensure that the proposed earthworks are staged and carried out in a manner that will not contribute to slope instability;
- The design of earthworks and slope re-profiling to provide the landfill profile should be reviewed by a Chartered Professional Engineer practicing in geotechnical engineering or an experienced Engineering Geologist. Earthworks construction should be monitored by an experienced Geotechnical Engineer or Engineering Geologist;
- On satisfactory completion of earthworks the Geotechnical Engineer or Engineering Geologist should submit a completion report and appropriate land use and earthfill suitability statements;
- All earthworks should be carried out in accordance with NZS4431:1989 and specifications prepared or reviewed by a geotechnical professional. All fill foundations should be stripped, benched and drained;
- An erosion and stormwater control plan must be prepared prior to the commencement of earthworks and should specify measures to avoid adverse offsite effects arising from the construction works.

8 Applicability

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

During excavation and construction, the site should be examined by an engineer competent to judge whether the exposed subsoils are compatible with the inferred conditions on which the report has been based. We would be pleased to provide this service to you and believe your project would benefit from the continuity. However, it is important that we be contacted if there is any variation in subsoil conditions from those described in the report.

Tonkin & Taylor Ltd

Report prepared by:

.....

Jamie Yule
Engineering Geologist

Report reviewed by:

.....

Tim Coote
Senior Engineering Geologist

Authorised for Tonkin & Taylor Ltd by:

.....

Tony Bryce
Project Director

JWY
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Appendix A: Figures

- Drawing 1 –Drawing List
- Drawing 2 – Site overview
- Drawing 3 – Site Investigation Plan
- Drawing 4 – Site Geological map
- Drawing 5 – Landfill Design Contours
- Drawing 6 – Stage 1 Earthworks plan
- Drawing 7 – Stage 2 Earthworks plan
- Drawing 8 – Stage 3 Earthworks plan
- Drawing 9 – Stage 4 Earthworks plan
- Drawing 10 – Geological cross section 1
- Drawing 11- Geological cross section 2
- Drawing 12– Geological cross section 3
- Drawing 13- Geological cross section 4
- Drawing 14- Toe bund construction section

HASTINGS DISTRICT COUNCIL
OMARUNUI LADFILL
AREA B DEVELOPMENT
Resource Consent Issue

DRAWING	Rev	Title
GENERAL		
● 1000647.1000-01	1	Drawing List and Site Location Plan
● 1000647.1000-02	1	Site Layout Plan
PLANS		
● 1000647.1000-03	1	Site Investigation Plan
● 1000647.1000-04	1	Gelogical Site Plan
● 1000647.1000-05	1	Proposed Area B Design
● 1000647.1000-06	1	Construction Sequence Stage 1
● 1000647.1000-07	1	Construction Sequence Stage 2
● 1000647.1000-08	1	Construction Sequence Stage 3
● 1000647.1000-09	1	Construction Sequence Stage 4
SECTIONS		
● 1000647.1000-10	1	Geological Cross Section 1
● 1000647.1000-11	1	Geological Cross Section 2
● 1000647.1000-12	1	Geological Cross Section 3
● 1000647.1000-13	1	Geological Cross Section 4
● 1000647.1000-14	1	Cross Section Showing Toe Bund Construction

NOTE: Topomap sourced from Linz Data Service, licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence (CC BY 3.0 NZ)

LOCATION PLAN
1: 25000

● Denotes drawing this issue: 2/10/2018

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

1	Resource Consent Issue		
REVISION DESCRIPTION		BY	DATE
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HASTINGS DISTRICT COUNCIL

OMARUNUI LANDFILL

AREA B DELEVOPMENT
Drawing List and
Site Location Plan

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE)
AS SHOWN

DWG. No. 1000647.1000-01

REV. 1

NOTES :
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2. Lidar information supplied by Hastings District Council, February 2008.
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SP1
SP2
SP3
FUTURE AREA C
AREA A
AREA B
AREA D
AREA E
Stock watering pond
Sediment Treatment Pond
Stock watering pond
Stock watering pond
Borrow areas for Area D construction
Extent of Liner
Proposed Cut Edge
Water tanks
"Quarry" borrow area for Area A construction – now backfilled
Viewing platform and bus parking area
Existing topsoil stockpile
Footprint Area A
Existing wheel wash
Existing service area
To weigh bridge and Omarunui Road
Fire Fighting water supply
LFG Flare
Stormwater pond Area D
Leachate pond Area A & D
Stormwater ponds Area A

LEGEND
- Existing Ground Contour (10m Interval)
- Existing Ground Contour (5m Interval)
- Access Road
- Proposed Cut (5m)
- Property Ownership Boundary
- Extent of Stockpile Areas
- Extent of Liner Area B
- Extent of Future Liner Area C
- Extent of Liner Area E Clean Fill
- Existing Landfill Footprint

ORIGINAL IN COLOUR
A3 SCALE 1:5000
0 50 100 150 200 250 (m)

DRAWING STATUS: RESOURCE CONSENT ISSUE

REVISION	DESCRIPTION	BY	DATE
1	Resource Consent Issue		

DESIGNED :	JWY	Oct. 18
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OMARUNUI LANDFILL

AREA B DELEVOPMENT
Site Layout Plan

SCALES (AT A3 SIZE) 1:5000

DWG. No. 1000647.1000-02

REV. 1

AREA C

AREA B

Non-engineered fill below this area. May be excavated to create additional air space

LEGEND

- Extent of Site B
- Extent of Site C
- Existing Contour (10m)
- Existing Contour (5m)
- Property Boundary
- Access Road – Existing
- BC8 — Tonkin & Taylor Ltd Borehole Location (2009)
- TP22 — Tonkin & Taylor Ltd Test Pit Location (2009)
- BC3 — Tonkin & Taylor Ltd Monitoring Well Location (2009)
- BH7 — Tonkin & Taylor Ltd Borehole Location (2018)
- CPT2 — Tonkin & Taylor Ltd Cone Penetrometer Test Location (2018)
- TP22 — Tonkin & Taylor Ltd Test Pit Location (2018)
- BC14 — Tonkin & Taylor Ltd Monitoring Well Location (2018)
- BH10 — Monitoring Well Location By Others (date unknown)

A3 SCALE 1: 2000
0 20 40 60 80 100 (m)

ORIGINAL IN COLOUR

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OMARUNUI LANDFILL

AREA B DELEVOPMENT Site Investigation Plan

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE)
1: 2000

DWG. No. 1000647.1000-03

REV. 1

AREA C

AREA B

Non-engineered fill below this area. May be excavated to create additional air space

LEGEND

- Extent of Site B
- Extent of Site C
- Property Boundary
- Existing Contour (10m)
- Existing Contour (5m)
- Access Road – Existing
- BC8 — Tonkin & Taylor Ltd Borehole Location (2009)
- TP22 — Tonkin & Taylor Ltd Test Pit Location (2009)
- BC3 — Tonkin & Taylor Ltd Monitoring Well Location (2009)
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- BH10 — Monitoring Well Location By Others (date unknown)

A3 SCALE 1:2000
0 20 40 60 80 100 (m)

ORIGINAL IN COLOUR

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GEOLOGICAL LEGEND:

- Sandstone
- Limestone
- Siltstone

(Petane Group (Pleistocene))

- Alluvium
- Fill
- Dam/pond
- 60 (dip and dip direction) Fault (observed)
- Fault (inferred)
- Strata dip (dip in degrees)

1	Resource Consent Issue		

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OMARUNUI LANDFILL

AREA B DELEVOPMENT
Gelogical Site Plan

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE)
1:2000

DWG. No. 1000647.1000-04

REV. 1

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AREA C

AREA B

Stock watering pond

Water Tanks

Existing Access Road

Non-engineered fill below this area. May be excavated to create additional air space

LEGEND

- Extent of Site B
- Extent of Site C
- Existing Contour (10m)
- Existing Contour (5m)
- Property Boundary
- Access Road – Existing
- 60 Finished Ground Contour (10m)
- Finished Ground Contour (5m)
- BC8 Tonkin & Taylor Ltd Borehole Location(2009)
- TP22 Tonkin & Taylor Ltd Test pit location (2009)
- BC3 Tonkin & Taylor Ltd Monitoring Well Location(2009)
- BH7 Tonkin & Taylor Ltd Borehole Location (2018)
- CPT2 Tonkin & Taylor Ltd Cone Penetrometer Test Location (2018)
- TP22 Tonkin & Taylor Ltd Test Pit Location (2018)
- BC14 Tonkin & Taylor Ltd Monitoring Well Location (2018)
- BH10 Monitoring Well Location By Others (date unknown)

A3 SCALE 1:2000
0 20 40 60 80 100 (m)

ORIGINAL IN COLOUR

1	Resource Consent Issue		

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OMARUNUI LANDFILL

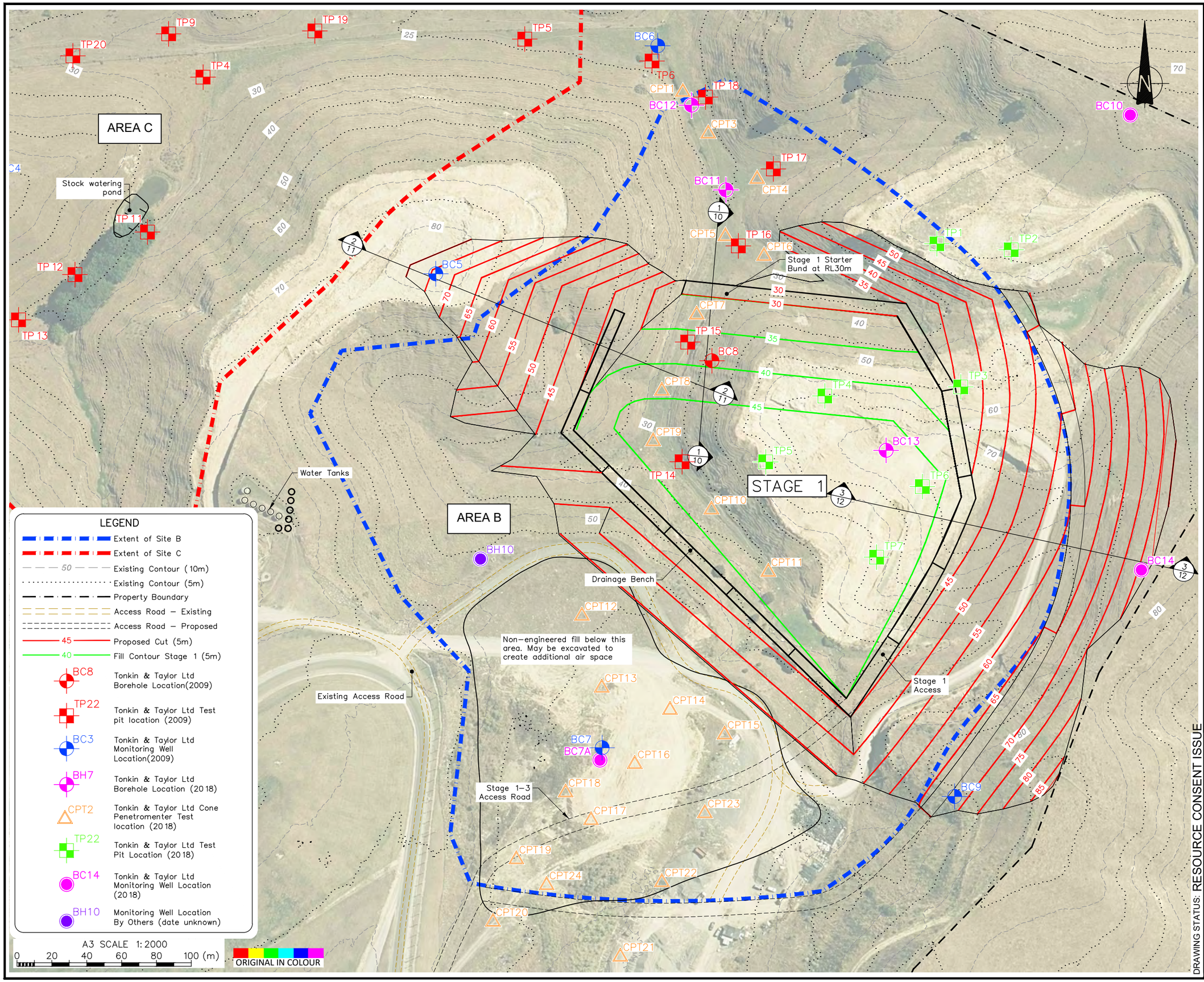
AREA B DELEVOPMENT
Proposed
Area B Design

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE)
1:2000

DWG. No. 1000647.1000-05

REV. 1



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OMARUNUI LANDFILL

AREA B DELEVOPMENT Construction Sequence Stage 1

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE) 1: 2000

DWG. No. 1000647.1000–06

REV. 1

AREA C

AREA B

STAGE 2

Permanent Starter Bund

Stock watering pond

Water Tanks

Drainage Bench

Existing Access Road

Stage 1–3 Access Road

Stage 2 Access

Non–engineered fill below this area. May be excavated to create additional air space

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP9 TP11 TP12 TP13 TP14 TP15 TP16 TP17 TP18 TP19 TP20

BC5 BC6 BC7 BC7A BC8 BC9 BC10 BC11 BC12 BC13 BC14

BH10

CPT1 CPT2 CPT3 CPT4 CPT5 CPT6 CPT7 CPT8 CPT9 CPT10 CPT11 CPT12 CPT13 CPT14 CPT15 CPT16 CPT17 CPT18 CPT19 CPT20 CPT21 CPT22 CPT23 CPT24

LEGEND

- Extent of Site B
- Extent of Site C
- 50 — Existing Contour (10m)
- Existing Contour (5m)
- Property Boundary
- Access Road – Existing
- Access Road – Proposed
- 45 — Proposed Cut (5m)
- 40 — Fill Contour Stage 2 (5m)
- BC8 — Tonkin & Taylor Ltd Borehole Location(2009)
- TP22 — Tonkin & Taylor Ltd Test pit location (2009)
- BC3 — Tonkin & Taylor Ltd Monitoring Well Location(2009)
- BH7 — Tonkin & Taylor Ltd Borehole Location (2018)
- CPT2 — Tonkin & Taylor Ltd Cone Penetrometer Test Location (2018)
- TP22 — Tonkin & Taylor Ltd Test Pit Location (2018)
- BC14 — Tonkin & Taylor Ltd Monitoring Well Location (2018)
- BH10 — Monitoring Well Location By Others (date unknown)

A3 SCALE 1:2000
0 20 40 60 80 100 (m)

ORIGINAL IN COLOUR

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HASTINGS DISTRICT COUNCIL

OMARUNUI LANDFILL

AREA B DELEVOPMENT
Construction Sequence
Stage 2

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE)
1:2000

DWG. No. 1000647.1000–07

REV. 1

AREA C

AREA B

STAGE 3

Stock watering pond

Water Tanks

Drainage Bench

Non-engineered fill below this area. May be excavated to create additional air space

Existing Access Road

Stage 1-3 Access Road

Permanent Access Road

TP9 TP19 TP5 TP20 TP4 TP11 TP12 TP13 TP6 TP18 TP17 TP16 TP1 TP2 TP15 TP3 TP14 TP7

BC6 BC12 BC10 BC11 BC5 BC8 BC13 BC7 BC7A BC9 BH10 BC14

CPT1 CPT3 CPT4 CPT5 CPT6 CPT7 CPT8 CPT9 CPT10 CPT11 CPT12 CPT13 CPT14 CPT15 CPT16 CPT18 CPT17 CPT23 CPT19 CPT24 CPT22 CPT20 CPT21

25 30 40 50 60 70 80 35 45 55 65 75

LEGEND

- Extent of Site B
- Extent of Site C
- 50 — Existing Contour (10m)
- Existing Contour (5m)
- Property Boundary
- Access Road – Existing
- Access Road – Proposed
- 45 — Proposed Cut (5m)
- 40 — Fill Contour Stage 3 (5m)
- BC8 — Tonkin & Taylor Ltd Borehole Location(2009)
- TP22 — Tonkin & Taylor Ltd Test pit location (2009)
- BC3 — Tonkin & Taylor Ltd Monitoring Well Location(2009)
- BH7 — Tonkin & Taylor Ltd Borehole Location (2018)
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- TP22 — Tonkin & Taylor Ltd Test Pit Location (2018)
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A3 SCALE 1:2000

0 20 40 60 80 100 (m)

ORIGINAL IN COLOUR

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HASTINGS DISTRICT COUNCIL

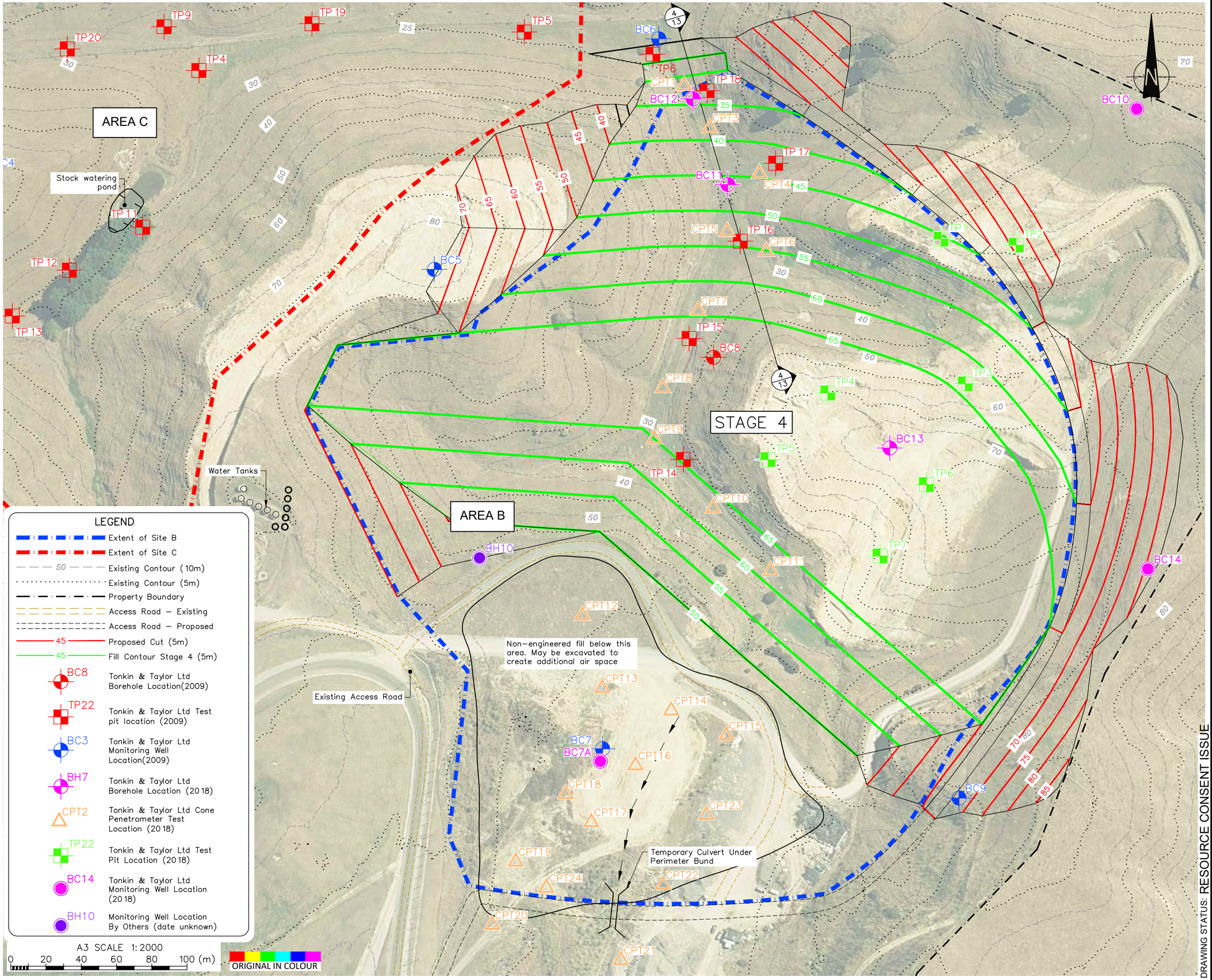
OMARUNUI LANDFILL

AREA B DELEVOPMENT Construction Sequence Stage 3

SCALES (AT A3 SIZE) 1:2000

DWG. No. 1000647.1000-08

REV. 1



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Tel. (09) 355 6000 Fax. (09) 307 0265
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DRAWING STATUS: RESOURCE CONSENT ISSUE

HASTINGS DISTRICT COUNCIL

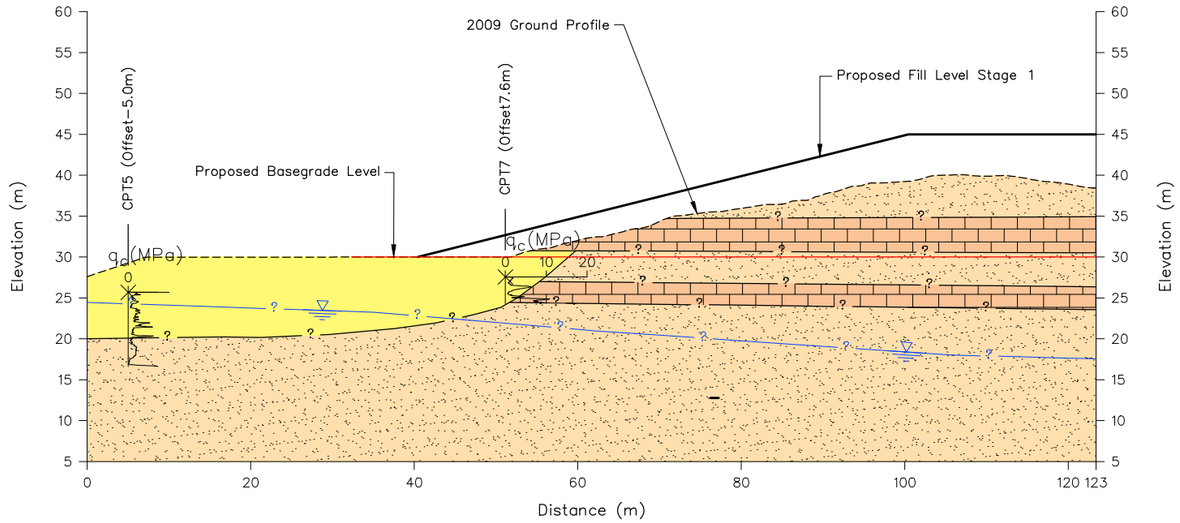
OMARUNUI LANDFILL

AREA B DELEVOPMENT
Construction Sequence
Stage 4

SCALES (AT A3 SIZE)
1: 2000

DWG. No. 1000647.1000-09

REV. 1



SECTION 1/06
SCALE 1:750

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

LEGEND

- 2009 Ground Profile
- Inferred Geological Boundary
- Inferred Groundwater Level
- Proposed Baseline Layer
- Fill
- Gully Alluvium
- Petane Formation
  - Limestone
  - Sandstone
  - Uncemented Sands
  - Siltstone/Sandstone
- Piezometer screen and groundwater level

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

REVISION	DESCRIPTION	BY	DATE
1	Resource Consent Issue		
	DESIGNED :	JWY	Oct. 18
	DRAWN :	JC	Oct. 18
	DESIGN CHECKED :		
	DRAFTING CHECKED :		

REFERENCE :

CADFILE : \\1000647.1000-10_14.dwg

APPROVED :

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HASTINGS DISTRICT COUNCIL

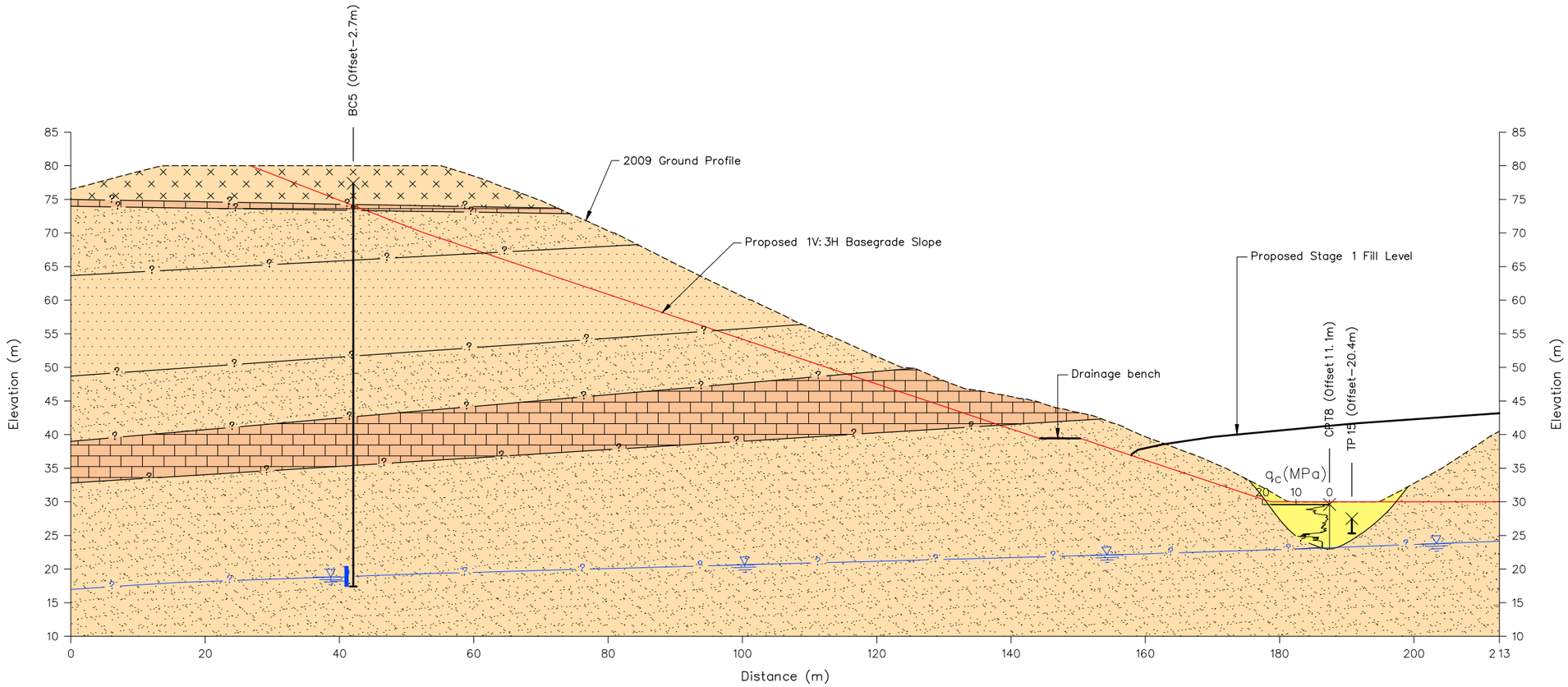
OMARUNUI LANDFILL

AREA B DELEVOPMENT
Geological
Cross Section 1

SCALES (AT A3 SIZE)
1:750

DWG. No. 1000647.1000-10

REV. 1



SECTION 2
SCALE 1:750 06

LEGEND

- 2009 Ground Profile
- Inferred Geological Boundary
- Inferred Groundwater Level
- Proposed Baseline Layer
- Fill
- Gully Alluvium
- Petane Formation
  - Limestone
  - Sandstone
  - Uncemented Sands
  - Siltstone/Sandstone
- Piezometer screen and groundwater level

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

REVISION	DESCRIPTION	BY	DATE
1	Resource Consent Issue		

DESIGNED :	JWY	Oct. 18
DRAWN :	JC	Oct. 18
DESIGN CHECKED :		
DRAFTING CHECKED :		

REFERENCE :

CADFILE : \\1000647.1000–10_14.dwg

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HASTINGS DISTRICT COUNCIL

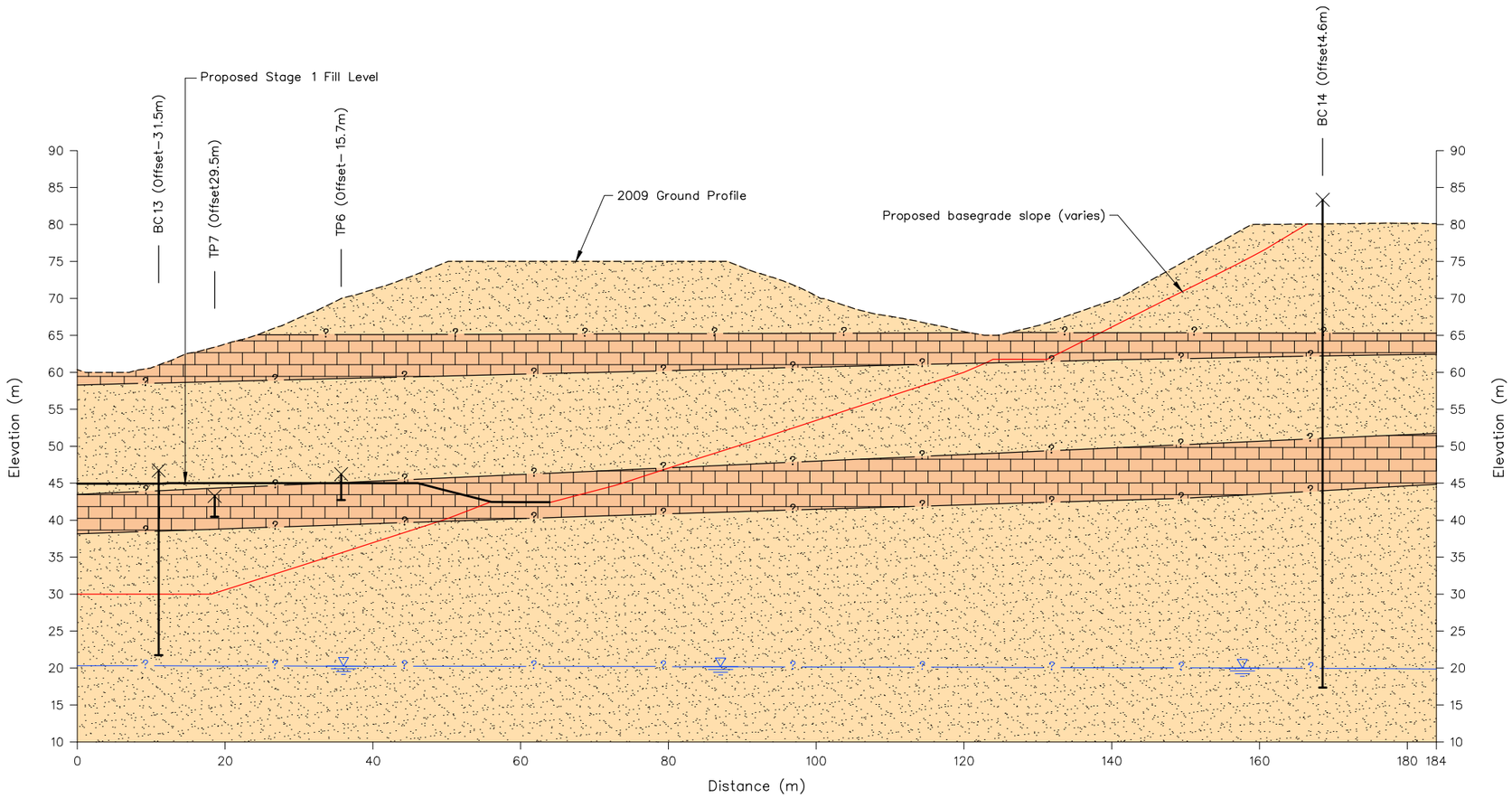
OMARUNUI LANDFILL

AREA B DELEVOPMENT
Geological
Cross Section 2

SCALES (AT A3 SIZE)
1:750

DWG. No. 1000647.1000–11

REV. 1



SECTION 3
SCALE 1:750 06

LEGEND

- 2009 Ground Profile
- Inferred Geological Boundary
- Inferred Groundwater Level
- Proposed Baseline Layer
- Fill
- Gully Alluvium
- Petane Formation
  - Limestone
  - Sandstone
  - Uncemented Sands
  - Siltstone/Sandstone
- Piezometer screen and groundwater level

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

1	Resource Consent Issue		
REVISION DESCRIPTION		BY	DATE
DESIGNED :		JWY	Oct. 18
DRAWN :		JC	Oct. 18
DESIGN CHECKED :			
DRAFTING CHECKED :			

REFERENCE :

CADFILE : \\1000647.1000–10_14.dwg

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HASTINGS DISTRICT COUNCIL

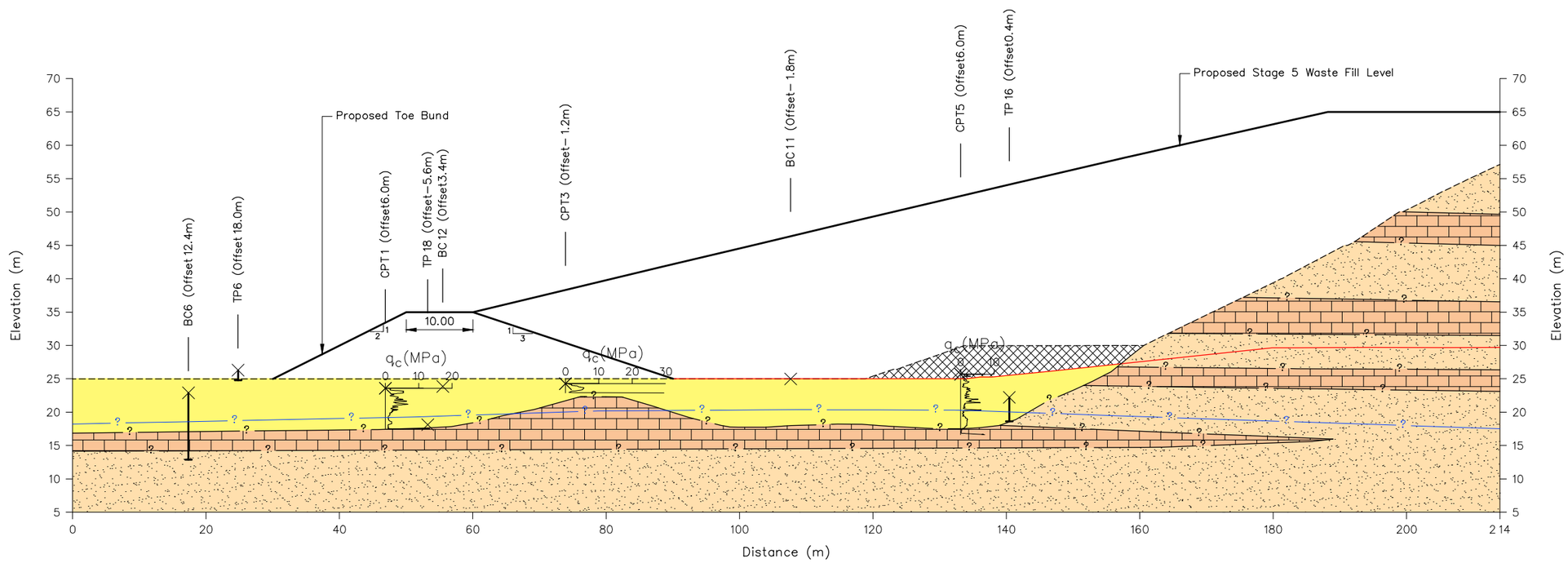
OMARUNUI LANDFILL

AREA B DELEVOPMENT
Geological
Cross Section 3

SCALES (AT A3 SIZE)
1: 750

DWG. No. 1000647.1000–12

REV. 1



SECTION 4
SCALE 1:750 09

LEGEND

- 2009 Ground Profile
- Inferred Geological Boundary
- Inferred Groundwater Level
- Proposed Baseline Layer
- Fill
- Gully Alluvium
- Petane Formation
  - Limestone
  - Sandstone
  - Uncemented Sands
  - Siltstone/Sandstone
- Piezometer screen and groundwater level

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

REVISION	DESCRIPTION	BY	DATE
1	Resource Consent Issue		
	DESIGNED :	JWY	Oct. 18
	DRAWN :	JC	Oct. 18
	DESIGN CHECKED :		
	DRAFTING CHECKED :		

REFERENCE :

CADFILE : \\1000647.1000-10_14.dwg

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HASTINGS DISTRICT COUNCIL

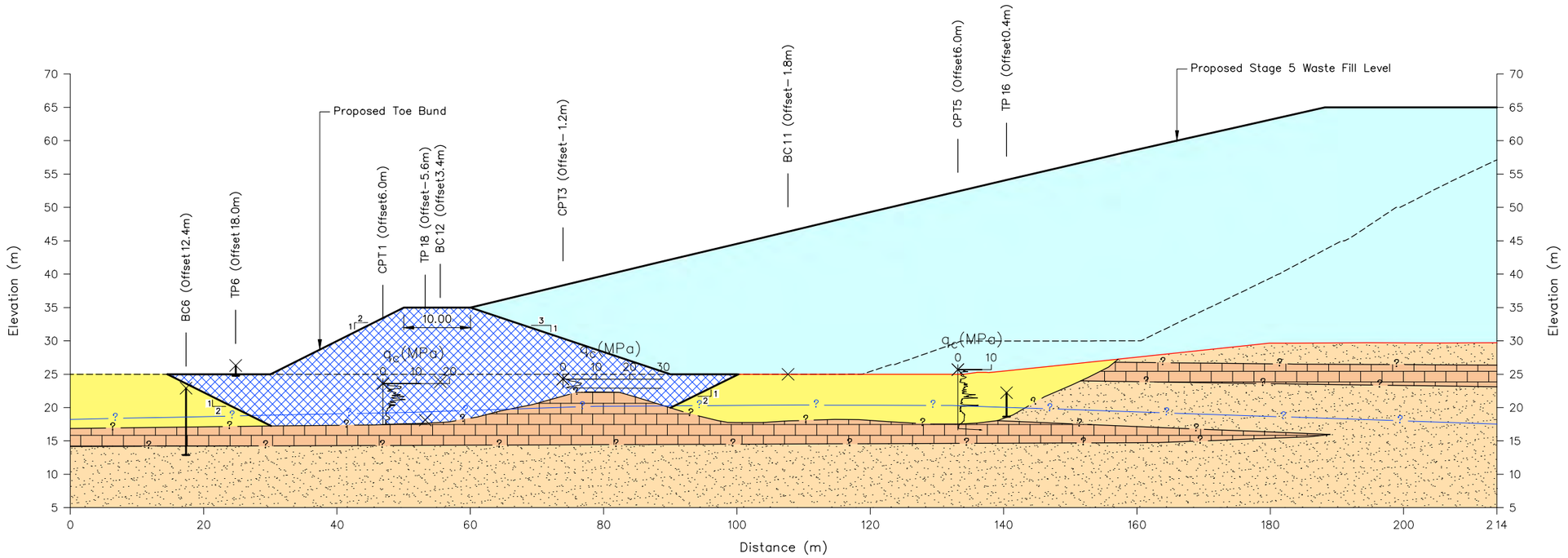
OMARUNUI LANDFILL

AREA B DELEVOPMENT
Geological
Cross Section 4

SCALES (AT A3 SIZE)
1: 750

DWG. No. 1000647.1000-13

REV. 1



SECTION 4/09
SCALE 1:750

LEGEND

- 2009 Ground Profile
- Inferred Geological Boundary
- Inferred Groundwater Level
- Proposed Baseline Layer
- Proposed Refuse
- Proposed Engineered Fill & Shear key
- Gully Alluvium

Petane Formation

- Limestone
- Sandstone
- Uncemented Sands
- Siltstone/Sandstone
- Piezometer screen and groundwater level

A3 SCALE 1:750
0 5 10 15 20 25 30 35 40 (m)

NOTES :
1. All dimensions are in millimetres unless noted otherwise.

1	Resource Consent Issue		
REVISION	DESCRIPTION	BY	DATE
DESIGNED :		JWY	Oct. 18
DRAWN :		MIGU	Oct. 18
DESIGN CHECKED :			
DRAFTING CHECKED :			

REFERENCE :

CADFILE : \\1000647.1000–10_14.dwg

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HASTINGS DISTRICT COUNCIL

OMARUNUI LANDFILL

AREA B DELEVOPMENT
Cross Section Showing
Toe Bund Construction

DRAWING STATUS: RESOURCE CONSENT ISSUE

SCALES (AT A3 SIZE) 1:750

DWG. No. 1000647.1000–14

REV. 1

Appendix B: Historic ground investigation results

- 2009 Machine borehole logs BC5,6,7 and 9
- 2009 Trial pit logs- TP14-18
- 2009 Packer test sheets
- 2009 Slug test sheets

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711979.4 mN, 309595.9 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 3/3/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 13/3/09

DIRECTION: ° | R.L. GROUND: 77.40 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: 77.90 m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW, SW, MW, HW)	ROCK STRENGTH (R4, R3, R2, R1, R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3, 10, 30, 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50, 10, 5, 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25, 50, 75)	CORE BOX	RL (m)
SANDSTONE	SILTSTONE, sandy, in thin beds, extremely weak, light brown, thin beds <50mm							1									77
	SAND, medium dense, very weakly cemented, fine, red/brown, crumbles in hands, Limestone fragments (<2mm) increasing depth, light grey																76
	No Recovery							2									
LIMESTONE	LIMESTONE, silicified, bioclastic, moderately strong to weak, ~10% secondary porosity, light grey/white												3/03/2009				75
	No Recovery							3									
	LIMESTONE, silicified, bioclastic, moderately strong to weak, ~10% secondary porosity, light grey/white																74
	No Recovery															Box 1	
SANDSTONE	SAND, light brown, medium dense, fine, very weakly cemented							4									73
	No Recovery																
	SAND, light brown, medium dense, fine, very weakly cemented							5				Numerous cross-cutting FeSt joints, 15-30°, IR, R, O.		29			72
	No Recovery																
	SAND, light brown, medium dense, fine, very weakly cemented							6				5J 10-20°, IR, VR, O, CN					71
								7				Jointed Sandstone, IR, R, O, slightly FeSt, no dominant orientations.		27		Box 2	
	SANDSTONE, light grey, fine sand, cemented							8									70
														28			
	No Recovery							9									69
												Sandstone slightly weathered, red staining.		67			68
								10								Box 3	

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711979.4 mN, 309595.9 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 3/3/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 13/3/09

DIRECTION: ° | R.L. GROUND: 77.40 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: 77.90 m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
SANDSTONE	SANDSTONE, fine, grey, weakly cemented SAND, medium dense, fine, red/brown mottled grey, cemented in patches, extremely weak; typically crumbles in hands with pressure							11 12 13 14 15 16 17 18 19 20				J10-25°, IR, VR, T-O, CN, very weakly cemented sand, drill-induced breaks.		90 90 87 100 90 100			Box 3 Box 4 Box 5 Box 6 Box 7	67 66 65 64 63 62 61 60 59 58

jkk

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711979.4 mN 309595.9 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 3/3/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 13/3/09

DIRECTION: ° | R.L. GROUND: 77.40 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: 77.90 m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
SANDSTONE	SAND, red/brown mottled grey, fine, poor grading, medium dense, weakly cemented in patches							21					4/03/2009	100			Box 7	57
	- becoming grey, unweathered, fine SAND							22						100				56
	- medium dense							23						100			Box 8	55
	SILTSTONE, dark grey/blue, well cemented, laminated, laminae <20mm							24				B3-5°, IR, R, T, CN		100				54
	SAND, medium dense, fine, poor grading, very weakly cemented, orange SANDSTONE, orange, fine, cemented, very weak, abundant shell fragments							25						90			Box 9	53
	- no shell fragments, weak, well cemented, grey mottled orange							26						100				52
								27				B6°, IR, VR, O, FeSt		100				51
								28				FeSt joints ~70°, IR, VR, O, FeSt		95			Box 10	50
								29						95				49
								30									Box 11	48

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711979.4 mN 309595.9 mE	DRILL TYPE: HQ Wireline DATUM: HB Circuit 1949	HOLE STARTED: 3/3/09 HOLE FINISHED: 13/3/09
DIRECTION: °	R.L. GROUND: 77.40 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 77.90 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS
SANDSTONE	SANDSTONE, orange mottled grey, fine, cemented	Bed partings, sub-horizontal, R, O, FeSt.
	- becoming very weakly cemented, dense to very dense sand, orange, fine	
	- well cemented, moderately strong, light grey	Bed partings, sub-horizontal, R, IR, T, CN.
	- slightly silty, orange/brown	
LIMESTONE	LIMESTONE, light grey/white, bioclastic, silicified, moderately strong, secondary porosity <10%	Numerous bed partings, 0-15°, IR, VR, O, CN.

ROCK WEATHERING: UW SW MW HW
ROCK STRENGTH: R4 R3 R2 R1 R0
PT LOAD / UCS TEST (MPa)
CORE LOSS / LIFT (%): 3 10 30 100
METHOD, CORE & CASING
TEST SYMBOL
DEPTH (m): 31 32 33 34 35 36 37 38 39 40
GRAPHIC LOG
DEFECT LOG
FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1
DATE / DEPTH: 5/03/2009
RQD (%): 100 100 100 100 77 22 37
WATER
DRILL WATER LOSS (%): 25 50 75
CORE BOX RL (m): Box 11 47 46 Box 12 45 44 Box 13 43 42 41 Box 14 40 39 Box 15 38

jkk

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

SHEET 5 OF 6

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711979.4 mN 309595.9 mE	DRILL TYPE: HQ Wireline DATUM: HB Circuit 1949	HOLE STARTED: 3/3/09 HOLE FINISHED: 13/3/09
DIRECTION: °	R.L. GROUND: 77.40 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 77.90 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);
LIMESTONE	LIMESTONE, light grey/white, silicified, bioclastic, <10% porosity - SANDSTONE bed, weakly cemented, fine to medium and, minor shell fragements <3mm
SANDSTONE	SANDSTONE, orange, fine, weakly cemented, massive, crumbles in hands under pressure - more cemented, very weak, light orange
	Silty SANDSTONE, dark grey/blue, very weak, common shell fragments (<10%), fine sand

ROCK WEATHERING: UW SW MW HW

ROCK STRENGTH: R4 R3 R2 R1 R0

PT LOAD / UCS TEST (MPa)

CORE LOSS / LIFT (%): 3 10 30 100

METHOD, CORE & CASING

TEST SYMBOL

DEPTH (m): 41 42 43 44 45 46 47 48 49 50

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

J35°, IR, R, T, CN

3J10-20°, IR, R, O, CN

J13°, IR, R, T, CN

DATE / DEPTH: 6/03/2009

RQD (%): 81 100 100 100 100 100

WATER

DRILL WATER LOSS (%): 25 50 75

CORE BOX: Box 15 Box 16 Box 17 Box 18

RL (m): 37 36 35 34 33 32 31 30 29 28

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC5
Hole Location: Valley B/C

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711979.4 mN, 309595.9 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 3/3/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 13/3/09

DIRECTION: ° | R.L. GROUND: 77.40 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: 77.90 m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS
SANDSTONE	Silty SANDSTONE, dark blue/grey, minor white shell fragments, cemented, fine sand	J22°, IR, VR, O, CN
	LIMESTONE, bioclastic, silicified, light orange mottled grey, porosity ~5%	Numerous sub-horizontal joints, 0-15°, IR, VR, O, CN.
	SANDSTONE, orange, fine, weakly cemented, crumbles in hands under pressure	Planar bed partings 0-5°, R, T, CN spaced 20-80mm apart.
	- well cemented bed, weak	
	- becoming fine to medium Sandstone, well cemented	Numerous sub-horizontal partings, B0-10°, IR, VR, T-O, FeSt
	- becoming fine, poor grading	
	- 100mm thick uncemented SAND layers, fine, orange, crumbles in hands	
	SAND, orange/brown, fine, massive, very weakly cemented	
	- becoming fine to medium SANDSTONE, orange, well cemented, minor white shell fragmets <2mm **END OF BOREHOLE AT 60m.** Monitoring well installed. Screen from 57-60m b.g.l.	Softened/fractured zone, IR joints, VR, O, CN.

ROCK WEATHERING: UW, SW, MW, HW

ROCK STRENGTH: R4, R3, R2, R1, R0

PT LOAD / UCS TEST (MPa)

CORE LOSS / LIFT (%): 3, 10, 30, 100

METHOD, CORE & CASING

TEST SYMBOL

DEPTH (m): 51, 52, 53, 54, 55, 56, 57, 58, 59

GRAPHIC LOG

DEFECT LOG

FRACTURE LOG spacing of natural fractures (cm): 50, 10, 5, 1

DATE / DEPTH: 10/03/2009

RQD (%): 95, 64, 32, 23, 35, 100, 59

WATER: 20/3/09

DRILL WATER LOSS (%): 25, 50, 75

CORE BOX RL (m): 27, 26, 25, Box 19, 24, 23, 22, Box 20, 21, 20, 19, Box 21, 18, Box 22

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC6
Hole Location: Valley B/C

SHEET 1 OF 2

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 712110. mN
309723.2 mE

DIRECTION: °

ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 22.90 m
R.L. COLLAR: 23.30 m

HOLE STARTED: 10/3/09
HOLE FINISHED: 10/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING	ROCK STRENGTH	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%)	CORE BOX RL (m)
TOPSOIL	SILT, trace of clay, dark brown/black, common rootlets	UW SW MW HW	R4 R3 R2 R1 R0		3 10 30 100						50 10 5 1				26 50 75	
Weathered SILTSTONE	No Recovery					HQ3		1								22
	Sandy SILT, trace of clay, fine sand, firm to stiff, low plasticity, grey mottled orange			2 3 2 N=5				2								21
	No Recovery							3								Box 1 20
	- becoming firm, minor clay			30/10 kPa		HQ3		4						20/3/09		19
	No Recovery			50/14 kPa				5								18
LIMESTONE	LIMESTONE, grey mottled orange, silicified, bioclastic, moderately strong, 10-15% secondary dissolution porosity			4 5 17 N=22				6								Box 2 17
	No Recovery							7								16
	LIMESTONE, grey mottled orange, silicified, bioclastic, moderately strong, 10-15% secondary dissolution porosity					HQ3		8								15
SANDSTONE	SANDSTONE, fine, well cemented, light orange															
	No Recovery							9								14
	- becoming less cemented, dense sand, fine, light orange			27 50 for 110mm N>50		HQ3		10					10/03/2009			Box 3 13

jkk

Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC6
Hole Location: Valley B/C

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 712110. mN
309723.2 mE

DIRECTION: °

ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 22.90 m
R.L. COLLAR: 23.30 m

HOLE STARTED: 10/3/09
HOLE FINISHED: 10/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
	No Recovery							11								12
	END OF BOREHOLE AT 10m.							12								11
	Monitoring well installed. Screen from 7-10m.							13								10
								14								9
								15								8
								16								7
								17								6
								18								5
								19								4
																3

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC7
Hole Location: Valley B

SHEET 1 OF 5

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711707.6 mN, 309691.3 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 60.21 m
R.L. COLLAR: 60.71 m

HOLE STARTED: 24/2/09
HOLE FINISHED: 26/2/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
FILL	SAND, light grey, fine to medium grained, loose, some fine gravel clasts (<5%, white)							0									60
	No Recovery							1									59
	SAND, silty, trace of clay, stiff, becoming more sandy with depth - becoming lihgt grey, loose to medium dense							2									58
	No Recovery							3									57
	Silty SAND, minor gravel, light grey mottled brown, limestone clasts <15mm, rounded greywacke clasts <10mm, medium dense			6 8 8 N=16				4									56
	No Recovery							5								Box 1	55
	SAND, dark grey, greywacke clasts becoming more common with depth (<10mm rounded), medium dense Gravelly SAND, light grey, white shell fragments <30mm, loose, unsorted							6									54
	No Recovery							7									53
	Sandy SILT, trace of clay, dark brown, firm, low plasticity			3 7 9 N=16				8								Box 2	52
	No Recovery							9									51
	- becoming light brown sandy SILT, low plasticity, trace of clay, firm, Limestone clasts <30mm, angular							10								Box 3	
	No Recovery																
	Gravelly SAND, minor silt, grey/blue, loose; rounded greywacke clasts <30mm			3 2 2 N=4													
	No Recovery																

Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC7
Hole Location: Valley B

SHEET 2 OF 5

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711707.6 mN, 309691.3 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 60.21 m
R.L. COLLAR: 60.71 m

HOLE STARTED: 24/2/09
HOLE FINISHED: 26/2/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);
FILL	No Recovery
	Sandy SILT, minor greywacke gravels, medium dense, light brown, some minor fragments of plastic at 11.7m
	No Recovery
	Clayey SILT, dark brown/black, organic rich, firm becoming stiff with depth, rootlets throughout, low plasticity
	- becoming light brown, no organics and clay, sandy, medium dense to dense, weakly cemented
	- becoming silty SAND, light brown, minor rounded greywacke gravel clasts (<15mm)
	No Recovery
	Silty SAND, brown, loose to medium dense, fine grained, streaked blue in patches with faint limonite staining

ROCK WEATHERING: UW SW MW HW
ROCK STRENGTH: R4 R3 R2 R1 R0
PT LOAD / UCS TEST (MPa): 10 13 12 N=25; 4 4 5 N=9; 5 6 9 N=15
CORE LOSS / LIFT (%): 3 10 30 100
METHOD, CORE & CASING
TEST SYMBOL
DEPTH (m): 11 12 13 14 15 16 17 18 19 20
GRAPHIC LOG
DEFECT LOG
FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

DATE / DEPTH: 24/02/2009
RQD (%)
WATER: 25/2/09 (am)
DRILL WATER LOSS (%): 25 50 75
CORE BOX RL (m): 50 49 48 47 46 45 44 43 42 41
Box 3 Box 4 Box 5

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Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC7
Hole Location: Valley B

SHEET 3 OF 5

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711707.6 mN, 309691.3 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 24/2/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 26/2/09

DIRECTION: ° | R.L. GROUND: 60.21 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: 60.71 m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
FILL	Silty SAND, brown streaked blue and rusty red, loose, fine sand																40
Weathered SANDSTONE	SAND, fine, loose, orange			35 50 for 100mm N>50				21								Box 5	39
SANDSTONE	SANDSTONE, light orange, fine sand, poor grading, extremely weak, patchily cemented, loose uncemented sand layers <300mm							22									38
	No Recovery							23									37
	SANDSTONE, light orange, fine sand, orange mottles, poor grading							24				J12°, IR, R, T, FeSt J20°, IR, VR, O, FeSt				Box 6	36
								25				J10°, SC, VR, O, CN					35
	Silty SANDSTONE, some shelly layers, well cemented (lime), lime content increasing with depth							26				J20°, PL, R, T, CN					34
LIMESTONE	LIMESTONE, dark grey/blue, weak to moderately strong, rare shell fragments, well cemented							27				J52°, PL, VR, O, CN				Box 7	33
								28									32
	- FeSt sand layer, loose, wet, medium sand							29									31
	LIMESTONE, dark blue mottled orange/red, silicified bioclastic Limestone, 20-30% dissolution porosity, cavities <30mm, slightly weathered							30				Numerous breaks along bed planes, beds spaced 10-80mm apart. Joints typically open and FeSt.				Box 8	

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Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC7
Hole Location: Valley B

SHEET 4 OF 5

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711707.6 mN 309691.3 mE	DRILL TYPE: HQ Wireline	HOLE STARTED: 24/2/09
	DATUM: HB Circuit 1949	HOLE FINISHED: 26/2/09
DIRECTION: °	R.L. GROUND: 60.21 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 60.71 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
LIMESTONE	LIMESTONE, silicified, bioclastic, dark blue/grey, cavities <30mm, well cemented, sub-horizontal bedding, cavities typically <10mm							31						7			Box 8 30 29
								32						13			28
	SANDSTONE, very weakly cemented, fine, dark brown/orange							33									Box 9 27
	LIMESTONE, silicified, bioclastic													47			26
SANDSTONE	SAND, dark brown/red, fine sand, loose, uncemented							34									
	LIMESTONE, silicified, bioclastic																
	SAND, dark brown/red, fine sand, loose, uncemented							35						100			25
								36									Box 10 24
	LIMESTONE, silicified, bioclastic																
	SANDSTONE, light orange, fine to medium sand, cemented							37					Numerous sub-horizontal bedding - parallel defects. Typically rough, open and FeSt.	39			23
								38						54			22
	- becoming weak, more heavily cemented, visibly porous, 10-20% primary porosity							39									Box 11 21
								40						49			Box 12

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Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC7
Hole Location: Valley B

SHEET 5 OF 5

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711707.6 mN, 309691.3 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 60.21 m
R.L. COLLAR: 60.71 m

HOLE STARTED: 24/2/09
HOLE FINISHED: 26/2/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
SANDSTONE	SANDSTONE, light orange, fine to medium sand, cemented, weak to extremely weak							41				Numerous sub-horizontal bed partings, R, O, FeSt.	25/02/2009	43	20/3		Box 12	20
								42						39				19
								43										18
	END OF BOREHOLE AT 43.5m. Monitoring well installed. Screen from 43.5 to 37.5m.							44									Box 13	17
								45										16
								46										15
								47										14
								48										13
								49										12
																		11

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Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC8
Hole Location: Valley B

SHEET 1 OF 4

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711912.26 mN, 309779.36 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 51.31 m
R.L. COLLAR: m

HOLE STARTED: 13/3/09
HOLE FINISHED: 16/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW, SW, MW, HW)	ROCK STRENGTH (R4, R3, R2, R1, R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3, 10, 30, 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50, 10, 5, 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25, 50, 75)	CORE BOX	RL (m)
LIMESTONE	SAND, fine to coarse, abundant shell fragments becoming more cemented/less sandy with depth LIMESTONE, light grey, bioclastic, silicified, moderately strong							0				Well jointed Limestone, spacing <100mm, VR, O, CN, IR, 0-25°					51
	No Recovery																
	LIMESTONE, as at 0.5m, up to 10% secondary porosity (dissolved sbells), laminated fabric							1						9			50
	No Recovery																
	LIMESTONE, as at 0.5m, shells up to 40mm long SILSTONE bed, grey, laminated fabric, weak, cleaves along sub-horizontal bedding							2						13	13/3/09		49
	No Recovery																
	LIMESTONE, light grey, bioclastic, silicified, moderately strong							3								Box 1	48
	No Recovery													21			47
	LIMESTONE, light grey, bioclastic, silicified, moderately strong							4									
	No Recovery													0			46
	LIMESTONE, sandy matrix, weak, fine sand content increasing with depth, less well cemented, shell content decreasing							5				J80°, IR, R, O, CN		0			45
	No Recovery																
SANDSTONE	SANDSTONE, light orange, fine, variably cemented, extremely weak to weak							6				Bed partings, sub-horizontal, 0-10°, PL, R, T, CN		0				44
	No Recovery							7									
	SANDSTONE, light orange, fine, variably cemented, extremely weak to weak							8						64		Box 2	43
								9									
								10						100			42

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TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC8
Hole Location: Valley B

SHEET 2 OF 4

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711912.26 mN
309779.36 mE

DIRECTION: °

ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 51.31 m
R.L. COLLAR: m

HOLE STARTED: 13/3/09
HOLE FINISHED: 16/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE

ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);
SANDSTONE	SANDSTONE, light orange, fine
	- becoming more cemented, weak to very weak
	- becoming shelly, fragments <30mm, white Sandstone is well cemented
	- becoming carbonate cemented silty SANDSTONE, minor shells, light blue/grey
	- 30mm lime clay seam, soft, moderate plasticity, no SL visible
LIMESTONE	LIMESTONE, grey mottled orange/red, bioclastic, silicified, slightly weathered
	- becoming light grey, orange/red mottling decreasing with depth, unweathered

ROCK WEATHERING: UW, SW, MW, HW
ROCK STRENGTH: R4, R3, R2, R1, R0
PT LOAD / UCS TEST (MPa)
CORE LOSS / LIFT (%): 3, 10, 30, 100
METHOD, CORE & CASING
TEST SYMBOL
DEPTH (m): 11, 12, 13, 14, 15, 16, 17, 18, 19, 20
GRAPHIC LOG
DEFECT LOG
FRACTURE LOG spacing of natural fractures (cm): 50, 10, 5, 1

SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS

DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING

ANGLES ARE NORMAL TO CORE AXIS

Sub-horizontal breaks along incipient planes of weakness (bedding), 0-20°, IR-PL, R, T, CN

J28°, IR, VR, T, CN

J40°, IR, VR, T, CN

J57°, PL, R, O, CN

Bed partings 0-10°, PL, SM, T, CN

J60°, IR, R, O, CN

DATE / DEPTH
RQD (%): 100, 83, 87, 95, 50, 42, 85, 72
WATER: 14/3/09
DRILL WATER LOSS (%): 25, 50, 75
CORE BOX
RL (m): 41, 40, 39, 38, 37, 36, 35, 34, 33, 32
Box 3, Box 4, Box 5, Box 6

jkk

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC8
Hole Location: Valley B

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711912.26 mN, 309779.36 mE | DRILL TYPE: HQ Wireline | HOLE STARTED: 13/3/09

DATUM: HB Circuit 1949 | HOLE FINISHED: 16/3/09

DIRECTION: ° | R.L. GROUND: 51.31 m | DRILLED BY: Boart Longyear

ANGLE FROM HORIZ.: -90.00 ° | R.L. COLLAR: m | LOGGED BY: JKK | CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS
LST	LIMESTONE, light grey, bioclastic, silicified, moderately strong	
SANDSTONE	SANDSTONE, orange, fine, weakly cemented, 50-100mm thick cemented sandstone beds, light blue/grey, weak to moderately strong, 2-3 beds in top 1m	Cleaves along incipient planes of weakness - bedding planes, 0-10°, IR, R, T, CN
	No Recovery	
	SANDSTONE, orange, fine, weakly cemented, 50-100mm thick cemented sandstone beds, light blue/grey, weak to moderately strong	
	No Recovery	
	SANDSTONE, orange, fine, weakly cemented, 50-100mm thick cemented sandstone beds, light blue/grey, weak to moderately strong	
LIMESTONE	LIMESTONE, light grey mottled light orange, bioclastic, silicified, moderately strong, laminated fabric, <5% porosity (secondary macroporosity)	
SANDSTONE	SANDSTONE, fine to medium grain size decreasing with depth, orange, weakly cemented	
	No Recovery	
	SANDSTONE, orange, fine, weakly cemented, 50-100mm thick cemented sandstone beds, light blue/grey, weak to moderately strong	
	No Recovery	
	SANDSTONE, orange, fine, weakly cemented, 50-100mm thick cemented sandstone beds, light blue/grey, weak to	

ROCK WEATHERING: UW SW MW HW | ROCK STRENGTH: R4 R3 R2 R1 R0 | PT LOAD / UCS TEST (MPa) | CORE LOSS / LIFT (%): 3 10 30 100 | METHOD, CORE & CASING | TEST SYMBOL | DEPTH (m): 21 22 23 24 25 26 27 28 29 30 | GRAPHIC LOG | DEFECT LOG | FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1

DATE / DEPTH | RQD (%): 89 69 76 85 91 73 80 65 | WATER | DRILL WATER LOSS (%): 25 50 75 | CORE BOX RL (m): 31 30 29 28 27 26 25 24 23 22; Box 7; Box 8; Box 9

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TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC8
Hole Location: Valley B

SHEET 4 OF 4

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711912.26 mN, 309779.36 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 51.31 m
R.L. COLLAR: m

HOLE STARTED: 13/3/09
HOLE FINISHED: 16/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
SANDSTONE	moderately strong SANDSTONE, orange, fine, weakly cemented, beds typically 50-150mm thick							31						83	15/3/09		Box 10	21
								32						92				19
								33						100				18
								34									Box 11	17
								35						100				16
								36						100				15
								37									Box 12	14
								38					16/03/2009	100			Box 13	13
	END OF BOREHOLE AT 38.5m. No monitoring well installed. Hole backfilled. Packer test performed at 27.5 to 24.5m.							39										12

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DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711679.65 mN 309893.48 mE	DRILL TYPE: HQ Wireline	HOLE STARTED: 28/2/09
	DATUM: HB Circuit 1949	HOLE FINISHED: 3/3/09
DIRECTION: °	R.L. GROUND: 70.18 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 70.68 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
	Silty SAND, fine, loose to medium dense, brown, becoming more silty with depth																70
	Gravel layer, clasts angular <20mm																
	SILT, trace of sand and clay, low plasticity, stiff, light brown mottled orange					HQ Wireline		1									69
								2									68
				16 22 28 for 110mm N>50				3									Box 1 67
								4									66
	- becoming cream/white, weathered SANDSTONE, medium dense, fine sand																
SST	SANDSTONE, light grey mottled orange, fine to medium sand, well cemented, weak to very weak, rare shell fragments, thinly bedded, beds 5-20mm thick							5				Numerous sub-horizontal bed plane partings, commonly FeSt, rough, open.					65 Box 2
LIMESTONE	LIMESTONE, light grey mottled orange, well cemented, silicified bioclastic Limestone, common bivalve shells, dissolution secondary porosity <10%							6						0			64
	No Recovery							7									63
	LIMESTONE, light grey mottled orange, well cemented, silicified bioclastic Limestone, common bivalve shells, dissolution secondary porosity <10%																
SANDSTONE	SAND, dense, very weakly cemented, fine sand, grey							8						0			62
	No Recovery												28/02/2009				
	SAND, dense, very weakly cemented, fine sand, grey							9						0			61 Box 3
								10									Box 4

jkk

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DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

SHEET 2 OF 6

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711679.65 mN, 309893.48 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 70.18 m
R.L. COLLAR: 70.68 m

HOLE STARTED: 28/2/09
HOLE FINISHED: 3/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX	RL (m)
SANDSTONE	No Recovery							11						0			60
	SAND, grey, fine, dense, very weakly cemented																
	No Recovery							12						0			59
	- 100mm thick silicified bioclastic LIMESTONE layer, weak							13						100			58
	- cemented fine SANDSTONE, light grey, 400mm thick SAND, dense, light orange/grey, fine							14						100		Box 4	57
								15				FeSt bed partings, sub-horizontal, rough, tight.		100			56
								16						100		Box 5	55
								17						100			54
								18						100			53
								19						100		Box 6	52
	- becoming dark orange, common white shell fragments, more cemented, very							20						100		Box 7	51

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Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

SHEET 3 OF 6

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711679.65 mN, 309893.48 mE
DIRECTION: °
ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 70.18 m
R.L. COLLAR: 70.68 m

HOLE STARTED: 28/2/09
HOLE FINISHED: 3/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS; DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING; ANGLES ARE NORMAL TO CORE AXIS
LIMESTONE	weak SANDSTONE, shell fragments common, dark orange, fine to medium sand, well cemented, shells becoming more abundant with depth	Sub-horizontal bed partings, R, FeSt, T.
	LIMESTONE, blue, well cemented crystalline matrix, abundant shells	
	SANDSTONE, orange, fine to medium, well cemented	
	LIMESTONE, blue, crystalline matrix, well cemented, common shell fragments	
	SANDSTONE, common shell fragments, shell beds common <100mm thick, well cemented, dark orange, fine to coarse sand, well graded	
	- abundant shell fragments, well cemented, laminated fabric visible	
	- 150mm thick blue crystalline LIMESTONE layer, well cemented, laminated fabric visible	Numerous bed partings, sub-horizontal, FeSt, T, R-VR.
	- 150mm layer of LIMESTONE, blue, crystalline	
SANDSTONE	SAND, dark orange, no shell fragments, fine sand, very weakly cemented, dense, crumbles in hands	
	- 300mm well cemented SANDSTONE bed, fine to medium sand, well graded	

ROCK WEATHERING: UW SW MW HW
ROCK STRENGTH: R4 R3 R2 R1 R0
PT LOAD / UCS TEST (MPa)
CORE LOSS / LIFT (%): 3 10 30 100
METHOD, CORE & CASING
TEST SYMBOL
DEPTH (m): 21 22 23 24 25 26 27 28 29 30
GRAPHIC LOG
DEFECT LOG
FRACTURE LOG spacing of natural fractures (cm): 50 10 5 1
DATE / DEPTH
RQD (%): 100 100 10 30 48 87 89
WATER
DRILL WATER LOSS (%): 25 50 75
CORE BOX: Box 7 Box 8 Box 9 Box 10
RL (m): 50 49 48 47 46 45 44 43 42 41

JKK

Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711679.65 mN 309893.48 mE	DRILL TYPE: HQ Wireline	HOLE STARTED: 28/2/09
	DATUM: HB Circuit 1949	HOLE FINISHED: 3/3/09
DIRECTION: °	R.L. GROUND: 70.18 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 70.68 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
SANDSTONE	SAND, dense, fine, orange, poorly graded, crumbles in hands							31								Box 10 40
	Cemented SANDSTONE, weak, fine sand, blue/grey													100		
	SAND, becoming more coarse with depth, more cemented							32								Box 11 39
	SANDSTONE, abundant shell fragments, silicified, weak							33					1/03/2009	90		38
								34						68		37
								35						100		Box 12 36
	LIMESTONE bed, moderately strong, blue/grey, well cemented							36						88		35
								37						100		34
	SANDSTONE, weakly cemented, extremely weak, dark orange, fine to medium sand							38						100		Box 13 33
								39						92		32
								40								31

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Log Scale 1:50

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

SHEET 5 OF 6

PROJECT: Omaranui Landfill	LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES 711679.65 mN 309893.48 mE	DRILL TYPE: HQ Wireline	HOLE STARTED: 28/2/09
	DATUM: HB Circuit 1949	HOLE FINISHED: 3/3/09
DIRECTION: °	R.L. GROUND: 70.18 m	DRILLED BY: Boart Longyear
ANGLE FROM HORIZ.: -90.00 °	R.L. COLLAR: 70.68 m	LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
SANDSTONE	SANDSTONE, fine to medium sand, weakly cemented, orange/brown, extremely weak							41				J28°, PL, R, T, FeSt.		93		30
								42								29
																Box 14 28
	Blue/grey crystalline LIMESTONE bed							43						65		27
								44								26
								45						72		Box 15 25
								46						80		24
												Bed planes 20-50mm apart, R, T, CN.				
	Blue/grey crystalline LIMESTONE bed							47						100		23
								48								Box 16 22
								49						90		21
								50					2/03/2009			Box 17

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Log Scale 1:50

ROCKLG 23610.100R.GPJ 9/4/09

TONKIN & TAYLOR LTD

DRILL HOLE LOG

BOREHOLE No: BC9
Hole Location: Valley B

SHEET 6 OF 6

PROJECT: Omaranui Landfill | LOCATION: Omaranui | JOB No: 23610.100

CO-ORDINATES 711679.65 mN
309893.48 mE

DIRECTION: °

ANGLE FROM HORIZ.: -90.00 °

DRILL TYPE: HQ Wireline
DATUM: HB Circuit 1949
R.L. GROUND: 70.18 m
R.L. COLLAR: 70.68 m

HOLE STARTED: 28/2/09
HOLE FINISHED: 3/3/09
DRILLED BY: Boart Longyear
LOGGED BY: JKK CHECKED: STMM

DESCRIPTION OF CORE | ROCK DEFECTS

GEOLOGICAL UNIT	ROCK OR SOIL TYPE, WEATHERING, HARDNESS, STRENGTH, COLOUR, LITHOLOGICAL FEATURES (bedding, cement, foliation, mineralogy, texture, etc...);	ROCK WEATHERING (UW SW MW HW)	ROCK STRENGTH (R4 R3 R2 R1 R0)	PT LOAD / UCS TEST (MPa)	CORE LOSS / LIFT (%) (3 10 30 100)	METHOD, CORE & CASING	TEST SYMBOL	DEPTH (m)	GRAPHIC LOG	DEFECT LOG	FRACTURE LOG spacing of natural fractures (cm) (50 10 5 1)	SIGNIFICANT JOINTS, BEDDING, CRUSHED AND SHEARED ZONES/SEAMS DEFECT TYPE, SHAPE, ROUGHNESS, APERTURE, INFILLING, SPACING ANGLES ARE NORMAL TO CORE AXIS	DATE / DEPTH	RQD (%)	WATER	DRILL WATER LOSS (%) (25 50 75)	CORE BOX RL (m)
SANDSTONE	SANDSTONE, very weakly cemented, fine sand, orange/brown, crumbles in hands with firm pressure							51						100	20/3	Box 17 19
								52						100		18
								53						100		17
								54								Box 18 16
	- some shell fragments, increasing with depth							55						100		15
	END OF BOREHOLE AT 56m. Monitoring well installed. Screen from 56 to 50m b.g.l.							56								Box 19 14
								57								13
								58								12
								59								11

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Log Scale 1:50

TONKIN & TAYLOR LTD

EXCAVATION LOG

BOREHOLE No: TP6
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES: 712101.29 mN 309719.91 mE		EXPOSURE TYPE: Test Pit	EXCAV. STARTED: 4/3/09
		EQUIPMENT: 20 tonne excavator	EXCAV FINISHED: 4/3/09
R.L. 26.3 m		OPERATOR: Lizettes	LOGGED BY: PJH
DATUM HB Circuit 1949		DIMENSIONS: 1.5 x 1 x 2m	CHECKED BY: JKK

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				26 / 0			SILT, dark brown	Mst			TOPSOIL	
							SILT, hard, pale grey, dry	D			COLLUVIUM	
							SILT, dark brown				TOPSOIL	
				25 / 1			SAND, silty, mottled orange brown, moist, with limestone fragments - limestone rock, white-grey, sandy/shell of varying proportions, but sand is major constituent	Mst			LIMESTONE/SHELLY SANDSTONE	
				24 / 2			Depth to Limestone increasing from base of slope. **END OF TEST PIT AT 1.5m.**					
				23 / 3								
				22 / 4								

SKETCH

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EXCAVATION LOG

BOREHOLE No: TP19
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES: 712118.54 mN 309526.53 mE		EXPOSURE TYPE: Test Pit	EXCAV. STARTED: 27/3/09
		EQUIPMENT: 20 Tonne Excavator	EXCAV FINISHED: 27/3/09
R.L. 26.74 m		OPERATOR: Lizettes	LOGGED BY: JKK
DATUM HB Circuit 1949		DIMENSIONS:	CHECKED BY: STMM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				26	0			TOPSOIL	Mst	MD		TOPSOIL	
								SAND (fine), slightly silty, medium dense, light orange	D			ALLUVIUM	
			● 109/35kPa	25	1			- becoming slightly clayey, low plasticity, fine sand decreasing with depth		St/VSt		SILTSTONE?	
					2			SILT, clayey, grey mottled orange					
				24				- wood fragments (black)					
					3			- clay content increasing					
				23					W				
					4								
				22				**END OF TEST PIT AT 5.0m.**					

SKETCH

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EXCAVATION LOG

BOREHOLE No: TP20
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES: 712104.32 mN 309387.79 mE		EXPOSURE TYPE: Test Pit	EXCAV. STARTED: 27/3/09
		EQUIPMENT: 20 Tonne Excavator	EXCAV FINISHED: 27/3/09
R.L. 29.83 m		OPERATOR: Lizettes	LOGGED BY: JKK
DATUM HB Circuit 1949		DIMENSIONS:	CHECKED BY: STMM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m) / DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				29 / 0			TOPSOIL	D			TOPSOIL	
							SAND (fine), silty, grey		D		ALLUVIUM	
							- 100mm rounded greywacke GRAVEL layer				TOPSOIL	
							SILT, sandy, trace of clay, light grey mottled light orange		St/VSt		Residual SILTSTONE	
			●137/45kPa	28 / 1				Mst				
							- becoming more clayey, firm, orange, low plasticity		F			
				27 / 2								
							SAND (fine), silty, medium dense to dense, light orange, FeSt common	W	MD/D			
				26 / 3								
				25 / 4			**END OF TEST PIT AT 4.6m.**					

SKETCH

TONKIN & TAYLOR LTD

EXCAVATION LOG

BOREHOLE No: TP21
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES: 712213.68 mN 309620.66 mE		EXPOSURE TYPE: Test Pit	EXCAV. STARTED: 27/3/09
		EQUIPMENT: 20 Tonne Excavator	EXCAV FINISHED: 27/3/09
R.L. 58.59 m		OPERATOR: Lizettes	LOGGED BY: JKK
DATUM HB Circuit 1949		DIMENSIONS:	CHECKED BY: STMM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
								TOPSOIL	D	F		TOPSOIL	
				58	1			SILTSTONE, grey mottled orange, becoming less weathered with depth, extremely weak		EW		SILTSTONE	
				57									
					2			**END OF TEST PIT AT 1.8m.**					
				56									
					3								
				55									
					4								
				54									

SKETCH

Log Scale 1:41.6666666666667

EXCAVLOG 23610.100.GPJ 30/10/09

TONKIN & TAYLOR LTD

EXCAVATION LOG

BOREHOLE No: TP22
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui		JOB No: 23610.100	
CO-ORDINATES:	712192.03 mN 309684.74 mE	EXPOSURE TYPE:	Test Pit	EXCAV. STARTED:	27/3/09
		EQUIPMENT:	20 Tonne Excavator	EXCAV FINISHED:	27/3/09
R.L.	48.88 m	OPERATOR:	Lizettes	LOGGED BY:	JKK
DATUM	HB Circuit 1949	DIMENSIONS:		CHECKED BY:	STMM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
								TOPSOIL	Mst	F		TOPSOIL	
			● UTP	48	1			SILTSTONE, light orange, moderately weathered, extremely weak, trace of sand	D	VW		SILTSTONE	
				47	2			**END OF TEST PIT AT 1.2m.** Hard digging.					
				46	3								
				45	4								
				44									

SKETCH

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EXCAVATION LOG

BOREHOLE No: TP23
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui		JOB No: 23610.100	
CO-ORDINATES:	712266.41 mN 309361.86 mE	EXPOSURE TYPE:	Test Pit	EXCAV. STARTED:	27/3/09
		EQUIPMENT:	20 Tonne Excavator	EXCAV FINISHED:	27/3/09
R.L.	89.1 m	OPERATOR:	Lizettes	LOGGED BY:	JKK
DATUM	HB Circuit 1949	DIMENSIONS:		CHECKED BY:	STMM

EXCAVATION TESTS				ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				89				TOPSOIL	D	F		TOPSOIL	
								SILTSTONE, light orange, extremely to very weak, trace of sand		VWk		SILTSTONE	
				88	1								
								END OF TEST PIT AT 1.3m.					
				87	2								
				86	3								
				85	4								

SKETCH

TONKIN & TAYLOR LTD

EXCAVATION LOG

BOREHOLE No: TP24
Location: Refer to site plan.

SHEET 1 OF 1

PROJECT: Geotechnical Investigations		LOCATION: Omaranui	JOB No: 23610.100
CO-ORDINATES: 712276.37 mN 309276.52 mE		EXPOSURE TYPE: Test Pit	EXCAV. STARTED: 27/3/09
		EQUIPMENT: 20 Tonne Excavator	EXCAV FINISHED: 27/3/09
R.L. 89.61 m		OPERATOR: Lizettes	LOGGED BY: JKK
DATUM HB Circuit 1949		DIMENSIONS:	CHECKED BY: STMM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION 1 2 3	SUPPORT	WATER	SAMPLES, TESTS	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH / DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	ORIGIN TYPE, MINERAL COMPOSITION, DEFECTS, STRUCTURE	UNIT
				89	0			TOPSOIL	D	F		TOPSOIL	
								SAND, gravelly, loose to medium dense, light grey/cream, pumiceous clasts <3mm		MD		PUMICE LAYER	
								SILTSTONE, light orange, extremely weak		EWk		MW SILTSTONE	
				88	1								
				87	2			**END OF TEST PIT AT 1.3m.**					
				86	3								
				85	4								

SKETCH

Log Scale 1:41.6666666666667

EXCAVLOG 23610.100.GPJ 30/10/09

Appendix C: Recent geotechnical investigation results

- 2018 Machine borehole logs BC7A, BC10-14
- 2018 CPT tests CPT1, 3-24
- 2018 Trial Pit logs- Area B TP1-7
- 2018 Core photography

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC10

SHEET: 1 OF 7

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m

R.L. COLLAR: 78.80m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 20/02/2018

FINISH DATE: 16/03/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	No recovery 0-0.65m						78	0										
	Highly weathered dark brown fine SANDSTONE, very weak, well cemented. Slightly calcareous with minor dissolution voids			HQTT	56			1				8	0.75m: BF, 15° dip, UN, R 0.90m: BF, 18° dip, UN, R 1.05m: BF, 6° dip, UN, R 1.25m: J, 75° dip, UN, R					
				HQTT	100		77	2				29	1.85m: J, 80° dip, UN, R					
				HQTT	66		76	3				0	2.25 - 3.00m: BZ					
	Highly weathered dark brown fine SANDSTONE crushed and recovered as Silty SAND with some gravel			HQTT	100		75	4				6	3.20m: J, 30° dip, UN, R					Box 1, 0.0-3.8m
	Highly weathered dark brown SANDSTONE, crushed and recovered as gravels																	
	Sandy SILT, trace clay; dark brown. Hard, dry, low plasticity. [CW SANDSTONE]																	
	No recovery 4.5-4.9m						74	5				0						
	Fine SAND, some silt; dark brown. Tightly packed, uniformly graded. [HW-CW SANDSTONE]			HQTT	73													
	No recovery 6-7.2m			HQTT	30		73	6				0						
	Interbedded layers of dark brown loose fine SAND with extremely weak light grey SILTSTONE																	
	No recovery 7.5-8.75m			HQTT	16		72	7				0						
	Interbedded sand and siltstone as above						71	8				0						
	No recovery 9-10.5m						70	9				0						
							69											

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC10

SHEET: 2 OF 7

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m
R.L. COLLAR: 78.80m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/02/2018
FINISH DATE: 16/03/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Sampling Method	Core Recovery (%)	RL (m)	Depth (m)	RQD (%)	Description & Additional Observations
		HQTT	0			0	
Petane Formation	Fine SAND, minor silt; light greyish brown. Tightly packed, uniformly graded.	HQTT	100				
	Fine SAND, some silt; light brown. Tightly packed, uniformly graded.	HQTT	100				
		HQTT	100				
	Highly weathered dark orange brown SANDSTONE, extremely to very weak	HQTT	100			0	14.80m: BF, 6° dip, UN, R 15.00m: J, 48° dip, UN, R, N, CN
	16.20 - 16.40m: Fine uncemented sand layer	HQTT	53			20	
	Moderately weathered dark grey SILTSTONE, weak with limestone nodules.						16.40m: BF, 4° dip, PL, SM 16.45m: BF, 4° dip, PL, SM
	Slightly weathered dark grey stained brown LIMESTONE, very weak to weak, with 10-20% voids. Coquina shell (coarse). Weakly cemented.	HQTT	66			16	16.75m: DD 16.80m: DD 16.95m: DD
	Slightly weathered dark brown sandy LIMESTONE, weak, with 20-30% voids. Broken with fine to coarse sand and shells. *18.00m:* becoming broken into 50-90mm pieces *18.30 - 18.35m:* Weak SILSTONE lense 50mm thick	HQTT	66			6	17.60 - 17.90m: BZ
						0	

Rock Weathering: UW, SW, MW, HW, CW
Rock Strength: ES, VS, S, MS, W, VW, EW
Defect Log
Fracture Spacing (mm): 2000, 600, 200, 60, 20
Fluid Loss (%): 25, 50, 75
Water Level
Casing
Installation: Box 2, 3.8-11.0m; Box 3, 11.0-13.8m; Box 4, 13.8-17.9m
Core Box No

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC10

SHEET: 3 OF 7

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m
R.L. COLLAR: 78.80m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/02/2018
FINISH DATE: 16/03/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark brown sandy LIMESTONE, weak, with 20-30% voids. Broken with fine to coarse sand and shells. *20.10m:* Limestone (broken) with voids as above			HQTT	73		58	21				0						
				HQTT	46		57	22				0						Box 5, 17.9-22.5m
	No recovery 22.5-23.4			HQTT	40		56	23				16						
	Limestone as above *23.60 - 23.80m:* Sandstone lense-200mm thick, weak, well cemented						55	24					23.90 - 24.00m: BZ					
	No recovery 24-24.7m			HQTT	53		54	25				0	24.70 - 24.85m: BZ 24.90m: BF, 4° dip, UN, SM		08/03/2018			
	Limestone as above *24.85 - 24.90m:* Interbedded sandstone siltstone lense-50mm thick						53	26										
	Slightly weathered dark greyish brown fine SANDSTONE, very weak			HQTT	86		52	27				48	26.70m: BF, 20° dip, UN, R, N, CN 26.90m: DD 27.00m: DD 27.10m: DD					
	Slightly weathered dark brown fine SANDSTONE, extremely weak-very weak, weakly cemented						51	28				32	27.40 - 27.50m: BZ 27.60m: J, 60° dip, ST, R 27.90m: J, 45° dip, UN, R 28.05m: BF, 10° dip, PL, R					
	Slightly weathered dark brown fine to medium SANDSTONE, very weak, well cemented			HQTT	100								28.40m: DD 28.45m: DD					Box 6, 22.5-27.2m
	Slightly weathered dark brown fine SANDSTONE, extremely weak, very weakly cemented.			HQTT	89		50	29				16	28.50 - 30.00m: DD, regular breaks in weakly cemented weathered rock (5-10 cm spacing)					
							49											

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC10

SHEET: 4 OF 7

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m

R.L. COLLAR: 78.80m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 20/02/2018

FINISH DATE: 16/03/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Sampling Method	Core Recovery (%)	RL (m)	Depth (m)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations
Petane Formation	Slightly weathered dark brown calcareous SANDSTONE, very weak	HQTT	100	48	31	41	30.15m: DD
	Slightly weathered dark brown SANDSTONE, weak, well cemented						30.80m: DD
	Slightly weathered dark brown SANDSTONE with occasional siltstone beds, very weak						31.05m: DD 31.15m: J, 30° dip, UN, R 31.40m: DD
	Interbedded grey and brown slightly to moderately weathered weak SILSTONE with highly weathered weakly cemented fine SANDSTONE	HQTT	100	47	32	40	31.50 - 33.00m: DD, Regular drilling breaks at 50-100mm intervals
	Slightly weathered dark brown sandy LIMESTONE, very weak to weak	HQTT	100	46	33	73	33.00 - 33.05m: BZ 33.30m: DD
	Slightly weathered light grey shelly LIMESTONE, weak, well cemented. Coquina shell with 5-10% voids			45	34		33.70 - 33.90m: BZ
	Slightly weathered dark brown broken sandy LIMESTONE, very weak to weak, layered with uncemented zones and cemented calcite lenses	HQTT	90	44	35	31	35.00m: BF, 6° dip, UN, R 35.20m: BZ
	Slightly weathered dark brown shelly medium SANDSTONE, very weak			43	36		35.40m: BZ 35.80m: DD 35.90m: DD
	Slightly weathered dark brown sandy LIMESTONE, very weak with occasional light grey cemented bands. 2-5% voids,	HQTT	93	42	37	28	36.00 - 36.30m: DD, broken and recovered as gravels 36.45m: DD 36.50 - 36.80m: BZ 36.80m: BF, 10° dip, UN, R
		HQTT	80	41	38	42	37.40m: DD 37.55m: DD 37.70m: DD 37.85m: DD 38.05m: BF, 12° dip, UN, R
	Slightly weathered dark brown fine SANDSTONE, very weak interbedded with uncemented medium SAND lenses.			40	39	0	38.40 - 39.00m: DD, Multiple drilling breaks in 50-100mm intervals 39.00 - 39.10m: BZ
				39			

Rock Weathering: UW, EW, HW, MW, HW, CW

Rock Strength: ES, VS, S, MS, W, VW, EW

Graphic Log

Defect Log

Fracture Spacing (mm): 2000, 600, 200, 60, 20

Testing

Fluid Loss (%): 25, 50, 75

Water Level

Casing

Installation: Box 7, 27.3-30.4m; Box 8, 30.4-33.4m; Box 9, 33.4-36.3m; Box 10, 36.3-39.6m

Core Box No

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC10

SHEET: 5 OF 7

PROJECT: Omarunui Landfill Valley B	CO-ORDINATES: 812252.40 N (HAWKTM2000) 410035.90 E	R.L. GROUND: 78.80m
JOB No.: 1000647.1000		R.L. COLLAR: 78.80m
LOCATION: Northeastern corner of site	DIRECTION:	DATUM: NAPIHT1962
	ANGLE FROM HORIZ.: -90°	SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/02/2018
FINISH DATE: 16/03/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark brown fine SANDSTONE, very weak interbedded with uncemented medium SAND lenses. *40.60m:* Shelly Limestone bed			HQTT	100		38	41				0	40.60m: DD 40.70m: DD					
	Fine to medium SAND, trace silt; dark brown. Dense, uncemented with rare sandstone cemented lenses			HQTT	100		37	42				0	41.50m: J, 45° dip, UN, R					
	Slightly weathered dark brown fine to medium SANDSTONE. very weak			HQTT	90		36	43				38	42.70m: DD 42.90m: DD 43.10m: DD					Box 11, 39.6-42.6m
	Fine to medium shelly SAND; brown, tightly packed, uncemented interbedded with weak SILSTONE and SANDSTONE, dark brown			HQTT	96		35	44				15						
				HQTT	100		34	45										Box 12, 42.6-45.8m
	Borehole wash drilled to 60m from this point. Core barrel becoming stuck due to uncemented sands gripping casing. Roller bit advanced ahead of HQ casing. Material from cuttings typically uncemented sand lenses with occasional clasts of limestone.						33	46										
							32	47										
							31	48										
							30	49										
							29											

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC10

SHEET: 6 OF 7

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m

R.L. COLLAR: 78.80m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 20/02/2018

FINISH DATE: 16/03/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Borehole wash drilled to 60m from this point. Core barrel becoming stuck due to uncemented sands gripping casing. Roller bit advanced ahead of HQ casing. Material from cuttings typically uncemented sand lenses with occasional clasts of limestone.	UW SW MW HW CW	ES VS S MS W VW EW	W	0		28 27 26 25 24 23 22 21 20 19	51 52 53 54 55 56 57 58 59			2000 600 200 60 20			25 50 75	20/04/2018			

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC10

SHEET: 7 OF 7

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Northeastern corner of site

CO-ORDINATES: 812252.40 N, 410035.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 78.80m

R.L. COLLAR: 78.80m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 20/02/2018

FINISH DATE: 16/03/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE	Rock Weathering (UW, SW, MW, HW, CW)	Rock Strength (ES, VS, S, MS, M, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m) / Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
	SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation																

60m: Target depth

COMMENTS: Casing stuck on first attempt due to uncemented sands collapsing around drill rods. Wash drilled hole advanced next to cored hole in upper 45m.

Hole Depth 60m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC11

SHEET: 1 OF 2

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Bottom of valley B

CO-ORDINATES: 812211.70 N, 409786.50 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 25.00m

R.L. COLLAR: 25.00m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Mark

LOGGED BY: JWY

CHECKED: CWM

START DATE: 26/02/2018

FINISH DATE: 26/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Holocene Alluvial Deposits	No recovery 0-0.3m						24	1										
	Sandy Organic SILT; dark blackish brown. Firm to stiff, dry, non-plastic *1.20 - 1.30m:* Peat lense 1.2-1.3m			HQTT	80													
	Silty fine SAND, rare organics; light greyish brown. Loose, moist, uniformly graded.			SPT	100	1/2, 1/2, 2/1, **N=6**	23	2										
				HQTT	83													
	Fine to Medium SAND, some silt; dark brown. Very loose, wet, uniformly graded.			SPT	100	1/0, 0/0, 1/0, **N=1**	22	3							26/02/2018			
	Sandy SILT, minor clay; dark brown. Soft-Firm, low to moderate plasticity.			HQTT	100		21	4							27/02/2018			
				SPT	100	0/1, 0/1, 1/0, **N=2**												
	Sandy SILT, minor clay; dark bluish grey. Firm, wet, low to moderate plasticity			HQTT	100		20	5										
	Sandy SILT, trace clay; dark greyish brown. Firm, wet, low plasticity			SPT	100	1/1, 1/1, 2/1, **N=5**	19	6										
	No recovery 6.45-6.88m			HQTT	54													
	Sandy SILT as above						18	7										
	Sandy SILT, minor clay; dark brown. Firm, wet, moderate plasticity.			SPT	100	0/1, 1/1, 1/2, **N=5**												
Petane Formation	Completely weathered dark brown medium SANDSTONE, extremely weak (recovered as dense medium SAND)			HQTT	85		17	8										
				SPT	100	3/6, 8/8, 7/9, **N=32**	16	9				0						
	No recovery 9.45-10m																	

Box 1. 0.0-3.8m

Box 2. 3.8-8.0m

COMMENTS: Backfilled on completion

Hole Depth 12.19m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC11

SHEET: 2 OF 2

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Bottom of valley B

CO-ORDINATES: 812211.70 N, 409786.50 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 25.00m

R.L. COLLAR: 25.00m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Mark

LOGGED BY: JWY

CHECKED: CWM

START DATE: 26/02/2018

FINISH DATE: 26/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark brown fine to medium SANDSTONE, extremely weak, weakly cemented			HQTT	47							0						
	No recovery 10.6-11.6m			HQTT	28	12/13 for 30mm **N>=50**	14	11				0	10.50 - 12.00m: , Broken in 100 mm pieces along thin interbeds					
	SW SANDSTONE as above			SPT	78	8/14 20 for 40mm **N>=50**	13	12										Box 3, 8.0-12.2m
	12.19m: Target depth						12	13										
							11	14										
							10	15										
							9	16										
							8	17										
							7	18										
							6	19										

COMMENTS: Backfilled on completion

Hole Depth 12.19m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC12

SHEET: 1 OF 2

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Bottom of Valley B

CO-ORDINATES: 812260.20 N, 409766.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 23.90m

R.L. COLLAR: 23.90m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Mark

LOGGED BY: JWY

CHECKED: CWM

START DATE: 26/02/2018

FINISH DATE: 27/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	RQD (%)
Holocene Alluvial Deposits	No recovery 0-0.25m						
	Organic SILT, minor fine sand; dark blackish brown. Stiff, moist, non-plastic	HQTT	83		23	1	
	SILT, some fine sand, minor organics and clay; dark brown. Stiff, dry, low to moderate plasticity						
	Amorphous PEAT; dark black. Stiff, dry, non plastic						
	Sandy SILT, minor clay; dark brown. Stiff, dry, low to moderate plasticity	SPT	88	2/1 2/2 2/2 N=8	22	2	
	1.30 - 1.50m: organic layer 1.3-1.5m						
	Silty fine to medium SAND; dark brown. Loose, wet, uniformly graded.	HQTT	83		21	3	
		SPT	84	1/2 1/2 3/2 N=8			
	3.50 - 3.85m: becomes with minor fine gravel and coarse sand, becoming well graded,						
	Silty fine SAND; dark brownish grey. Loose, wet, uniformly graded.	HQTT	76		20	4	
		SPT	100	0/2 1/0 1/2 N=4	19	5	
	No recovery 4.95-5.15m						
	Silty fine SAND; dark bluish grey. Loose, wet, uniformly graded.	HQTT	78		18	6	
		SPT	88	1/0 1/1 0/1 N=3			
	No recovery 6.45-6.75m						16
	Silty fine SAND as above	HQTT	74		17	7	
	7.25m: organic silt layer-dark brown (Paleosol)						
Petane Formation	Slightly to moderately weathered dark brown sandy LIMESTONE, very weak to weak, with infilled fractures of gravelly sand and silt.	SPT	100	5/5 7/23 16/4 for 30mm N>=50	16	8	
		HQTT	93		15	9	
		SPT	100	10/23 18/11 10/11 for 60mm N>=50			
	No recovery 9.44-9.8m				14		18
	Sandy LIMESTONE; as below						

ROCK DEFECTS: Defect Log; Fracture Spacing (mm) (2000, 600, 200, 60, 20)

Description & Additional Observations

Fluid Loss (%) (25, 50, 75)

Water Level: 27/02/2018

Casing

Installation: Box 1, 0.0-3.9m; Box 2, 3.9-8.3m

Core Box No

COMMENTS: Backfilled on completion

Hole Depth 10.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC12

SHEET: 2 OF 2

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Bottom of Valley B

CO-ORDINATES: 812260.20 N, 409766.90 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 23.90m

R.L. COLLAR: 23.90m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Mark

LOGGED BY: JWY

CHECKED: CWM

START DATE: 26/02/2018

FINISH DATE: 27/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly to moderately weathered dark brown sandy LIMESTONE, very weak to weak, with infilled fractures of gravelly sand and silt.	UW SW MW HW CW	ES VS S MS W VW EW	HQTT	66						2000 600 200 60 20	18		25 50 75				Box 3, 8.3-10.5m
	Completely weathered dark brown fine to medium SANDSTONE, extremely weak and cemented																	
	10.5m: Target depth																	

COMMENTS: Backfilled on completion

Hole Depth 10.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC13

SHEET: 1 OF 3

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Centre of Valley B

CO-ORDINATES: 812062.08 N, 409886.59 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 46.74m
R.L. COLLAR: 46.74m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 18/04/2018
FINISH DATE: 19/04/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	No recovery 0-0.3m																	
	Slightly weathered dark brown fine SANDSTONE, extremely to very weak, with lenses of uncemented sand *0.50 - 0.70m:* Lense of uncemented sand 200mm thick			HQTT	80		46	0				23	0.40m: BF, 3° dip, UN, R, N, CN 0.80m: DD 0.85m: DD					
				SPT	100	18/19 18/21 11 for 35mm **N>=50**	45	1										
	No recovery 1.85-2.15m																	
	Fine to medium SAND, dark greyish brown. Very dense, uncemented, uniformly graded. *2.70 - 2.80m:* Sandstone lense 100mm thick			HQTT	68		44	2				8						
	Slightly weathered brown fine to medium SANDSTONE, very weak, well cemented.			SPT	106	17/22 21/24 5 for 10mm **N>=50**	43	3										
				HQTT	100			4				67	3.60m: DD 3.80m: BF, 7° dip, UN, R, N, CN 4.25 - 4.45m: BZ, broken zone possibly drill induced					Box 1, 0.0-4.1m
				SPT	100	10/15 25/25 for 65mm **N>=50**	42	4										
	No recovery 4.79-4.95																	
	Slightly weathered brown broken fine SANDSTONE, extremely to very weak			HQTT	86		41	5				37	4.95 - 5.25m: BZ, irregular breaks every 50mm with uncemented sand infill 5.50m: BF, 4° dip, UN, R, N, CN 5.55m: BF, 5° dip, UN, R, N, CN 5.60m: DD 5.80m: DD					
	Slightly weathered dark greyish brown fine SANDSTONE, very weak to weak, rare limestone interbeds and shell clasts *7.20m:* concretionary layer-weak			HQTT	100		40	6				96	6.25m: DD 6.37m: DD 6.64m: BF, 3° dip, UN, R, MN, CN 6.90m: BF, 5° dip, UN, R, MN, shell bed along bedding 7.12m: DD					Box 2, 4.1-7.2m
	Slightly weathered brown shelly fine SANDSTONE, extremely to very weak, broken			HQTT	100		39	7				60	7.40m: DD 7.60m: BF, 6° dip, UN, R, N, CN 7.70 - 8.20m: BZ, Frequent breaks every 30mm					
	Slightly weathered fine to medium calcareous SANDSTONE, weak, well cemented with bands of concretionary limestone *9.16 - 9.40m:* Limestone band, well cemented						38	8					8.50m: DD 8.75m: DD					
							37	9				81	9.25m: BF, 6° dip, UN, R, N, CN 9.40m: BZ					
	Slightly weathered sandy LIMESTONE; as below												9.80m: BF, 4° dip, UN, R, MN,					

COMMENTS: Borehole grouted with bentonite/cement mix on completion.

Hole Depth 25.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:08 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC13

SHEET: 2 OF 3

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Centre of Valley B

CO-ORDINATES: 812062.08 N, 409886.59 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 46.74m
R.L. COLLAR: 46.74m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 18/04/2018
FINISH DATE: 19/04/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark brown sandy LIMESTONE, very weak, broken with medium to coarse sand sized shell fragments			HQTT	100							81	CN 10.20m: DD 10.40m: DD 10.55m: DD					
	Slightly weathered dark brown shelly fine to medium SANDSTONE, extremely weak, very weakly cemented *11.30 - 11.80m:* Sand lense 500mm thick- uncemented, fine grained			HQTT	95		36 35	11 12				0						
	Slightly weathered dark greyish brown sandy LIMESTONE, extremely to very weak, broken			HQTT	100		34 33	13 14				14	10.60 - 13.00m: BZ, Core breaking along small bedding planes, very weakly cemented and easily disturbed by drilling 13.00m: BF, 6° dip, PL, R, N, CN					Box 4, 10.1-13.1m
	Slightly weathered dark brown calcareous fine SANDSTONE, weak, well cemented			HQTT	100		32	15				10	13.10 - 14.80m: BZ, Core is highly disturbed with very broken appearance, may be drilling induced					
	Fine SAND, minor medium sand, trace shell fragments; dark brown. very dense, uncemented, uniformly graded			HQTT	100		31 30	16 17				16 0	14.80 - 15.00m: J, 60° dip, UN, R, MN, CN 15.05 - 15.10m: J, 60° dip, UN, R, N, Calcite infill along joint					Box 5, 13.1-16.0m
	Slightly weathered broken sandy LIMESTONE, extremely weak, weakly cemented			HQTT	90 100		29 28	18 19				10	18.10 - 19.10m: BZ, Core is highly disturbed with regular breaks, may be drilling induced					Box 6, 16.0-19.1m
	Slightly weathered dark greyish brown fine to medium SANDSTONE, extremely to very weak, very weakly cemented						27					13	19.10 - 19.50m: DD, Multiple drilling breaks in fractured limestone					

COMMENTS: Borehole grouted with bentonite/cement mix on completion.

Hole Depth 25.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC13

SHEET: 3 OF 3

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Centre of Valley B

CO-ORDINATES: 812062.08 N, 409886.59 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 46.74m
R.L. COLLAR: 46.74m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 18/04/2018
FINISH DATE: 19/04/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark greyish brown fine to medium SANDSTONE, extremely to very weak, very weakly cemented 20.80 - 20.90m: Sand lense, uncemented *21.10 - 21.30m:* sand lense, uncemented *21.50m:* sand lense			HQTT	93		26 21					13	19.50 - 22.20m: BZ, core parting along multiple drilling breaks 21.70m: BF, 14° dip, UN, R, T, CN 21.80m: J, 23° dip, PL, R, N, CN 22.05m: J, 40° dip, UN, R, N, CN					
	Slightly weathered medium SANDSTONE, very weak, weakly cemented *22.90 - 23.00m:* Sand lense, uncemented			HQTT	100		25 22					29	22.20 - 22.50m: DD, multiple drilling breaks 22.60m: BF, 6° dip, UN, R, N, CN 22.65m: BF, 4° dip, UN, R, N, CN 22.75m: BF, 8° dip, UN, R, N, CN 23.30m: DD					Box 7, 19.1-22.2m
	Fine to medium SAND, trace shell fragments; dark brown. Very dense, uncemented, uniformly graded			HQTT	94		23 24					56	23.65m: BF, 3° dip, UN, R, N, CN					
	Slightly weathered dark brown thinly bedded fine SANDSTONE, extremely to very weak, weakly cemented			HQTT	100		22 25					0	24.05m: DD 24.70 - 25.30m: BF, 4° dip, Multiple bedding fractures, spaced 30-50mm					
	25.5m: Target depth						21 26 20 27 19 28 18 29 17						25.40m: BF, 6° dip, UN, R, N, CN					

COMMENTS: Borehole grouted with bentonite/cement mix on completion.

Hole Depth 25.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC14

SHEET: 1 OF 7

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N, 410032.96 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m

R.L. COLLAR: 83.34m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 20/04/2018

FINISH DATE: 27/04/2018

CONTRACTOR: Geotech Drilling Ltd

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW, EW, HW, MW, CW, DW)	Rock Strength (ES, VS, S, MS, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Petane Formation	Silty brown TOPSOIL, stiff, moist			HQTT	100		83		TS									
	SILT, minor fine sand; dark brown. Very stiff, moist, low plasticity.							1										
	Silty SAND, trace clay; dark brown. medium dense, uniformly graded [HW Sandstone]			SPT	100	6/6 6/5 5/5 **N=21**	82											
	SILT, minor fine sand and fine gravel, trace clay; dark brown. Very stiff, low plasticity			HQTT	80			2										
				SPT	100	3/3 3/4 3/5 **N=15**	81											
	Moderately weathered dark brown fine to medium SANDSTONE. Extremely to very weak. Weakly cemented.			HQTT	100			3										
	Intebedded moderately weathered fine to mediumSANDSTONE and thin, infrequent SILTSTONE beds, spaced 400mm apart, extremely weak and often recovered as uncemented sand *4.95 - 5.30m:* Sand lense *5.40 - 5.60m:* Sand lense uncemented			SPT	100	9/22 24/24 2 for 4mm **N>=50**	80					47							
				HQTT	100			4										
	6.20 - 6.70m: Weak uncemented sands *6.25 - 6.70m:* sand lense uncemented						79											
	Fine to medium SAND, dark greyish brown. Tightly packed, uniformly graded.			HQTT	86			5										
	Slightly to moderately weathered dark greyish brown fine to medium SANDSTONE, extremely to very weak, weakly cemented						78					0						
				HQTT	98			6										
							77						7.50m: DD, 70° dip					
								7					7.80 - 8.00m: J, 65° dip, ST, R, N, CN 7.90m: J, 35° dip, UN, R, N, CN 8.20m: DD					
							76					58	8.50m: BF, 4° dip, PL, R, N, CN 8.60m: BF, 3° dip, PL, R, N, CN 8.80m: DD					
								8										
							75						9.00 - 9.30m: DD, Multiple drilling breaks 9.50m: J, 40° dip, UN, R, N, CN 9.60 - 9.80m: DD, Multiple drilling breaks					
								9				36						
							74											

Box 1, 0.0-3.7m

Box 2, 3.7-6.7m

Box 3, 6.7-10.0m

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC14

SHEET: 2 OF 7

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N, 410032.96 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly to moderately weathered dark greyish brown fine to medium SANDSTONE, extremely to very weak, weakly cemented			HQTT	96		73	10				36	10.15m: BF, 15° dip, UN, R, N, CN 10.20m: DD					
				HQTT	98		72	11				64	11.15m: DD					
	Moderately weathered light cream grey SILSTONE, extremely weak, very weakly cemented																	
	Medium to Coarse Shelly SAND; dark brown. Tightly packed, well graded.			HQTT	100		71	12				23	12.30m: BF, 7° dip, PL, R, T, CN 12.40m: BF, 4° dip, PL, R, N, CN 12.45m: BF, 3° dip, PL, R, N, CN 12.60m: BF, 4° dip, PL, R, N, CN 12.80m: DD					Box 4, 10.0-13.0m
	Slightly weathered light brownish grey sandy shelly LIMESTONE, very weak, well cemented with frequent broken zones							13										
	14.00 - 14.50m: Shelly sand bed, uncemented			HQTT	100		70	14				0	13.00 - 16.00m: BZ, Core completely broken and parting along small fractures, very weakly cemented with sandy uncemented beds					
	14.40 - 14.90m: Shelly sand bed, uncemented							15										
	15.10 - 15.80m: broken zone of shelly sand beds, very weakly cemented			HQTT	100		69	16				16	16.20m: DD 16.30 - 16.40m: BZ					Box 5, 13.0-16.0m
	Interbedded dark brown medium uncemented SAND with fine slightly weathered light greyish brown SANDSTONE, very weak, well cemented			HQTT	93		68	17				30	16.65m: DD 16.75m: BF, 8° dip, PL, R, N, CN 16.85m: DD 17.00m: BF, 6° dip, UN, R, MN, CN 17.55m: BF, 7° dip, UN, R, N, CN 17.80m: DD					
				HQTT	100		67	18				32	18.00m: DD 18.05m: BF, 8° dip, UN, R, MN, CN 18.20m: DD 18.30m: BF, 10° dip, PL, R, N, CN 18.60m: BF, 8° dip, UN, R, N, CN 18.70 - 18.80m: DD					Box 6, 16.0-19.0m
	19.60 - 19.80m: Uncemented sand lense						66	19				16	19.30m: BF, 12° dip, UN, R, N, CN					
							65											
							64											

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC14

SHEET: 3 OF 7

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N, 410032.96 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)
Petane Formation	Slightly weathered dark brown SANDSTONE, extremely to very weak, lenses of uncemented sands *20.60 - 21.00m:* Uncemented sand lense
	Highly weathered dark brown fine SANDSTONE, very weak [Weathered out to a hard sandy silt in places]
	Moderately weathered dark reddish brown LIMESTONE, very weak, broken and uncemented in places *29.85 - 30.00m:* broken shelly sand lense

Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log
UW SW MW HW CW	ES VS S MS W VW EW	HQTT	93		63		
		HQTT	100		62	21	
		HQTT	100		61	22	
		HQTT	100		60	23	
		HQTT	93		59	24	
		HQTT	100		58	25	
		HQTT	100		57	26	
		HQTT	100		56	27	
		HQTT	100		55	28	
					54	29	

ROCK DEFECTS

Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations
		16	20.05m: BF, 8° dip, PL, R, N, CN
		53	21.55m: BF, 14° dip, UN, R, N, CN 21.60m: J, 45° dip, UN, R, MN, CN 22.15m: DD 22.40m: DD
		63	22.70m: BF, 7° dip, UN, R, N, CN 22.80m: DD 23.00m: BF, 6° dip, PL, R, N, CN 23.60m: BF, 8° dip, UN, R, N, CN 23.85m: DD 23.90m: BF, 10° dip, UN, R, N, CN 24.26m: DD 24.30m: DD 24.70m: DD
		89	25.70m: DD 25.90m: BF, 6° dip, UN, R, N, CN 26.45m: DD 26.70m: DD 26.90m: DD
		48	27.15 - 27.30m: BZ 27.60m: DD 27.75m: DD 27.90m: DD 28.10m: DD 28.40m: DD
		56	28.95m: BF, 8° dip, UN, R, N, CN 29.00 - 29.10m: BZ 29.30m: BF, 7° dip, UN, R, N, CN 29.45m: DD 29.70 - 30.00m: BZ

Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
				Box 7, 19.0-22.0m
				Box 8, 22.0-25.0m
				Box 9, 25.0-28.0m

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC14

SHEET: 4 OF 7

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N, 410032.96 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark brownish grey LIMESTONE, slightly sandy, very weak to weak			HQTT	100		53	30				66	29.85m: DD 30.10m: DD 30.20m: DD 30.40 - 30.65m: J, 80° dip, UN, R, MN, CN 31.10m: BF, 6° dip, UN, R, N, CN 31.40m: DD					Box 10, 28.0-31.0m
				HQTT	100		52	31										
	Slightly weathered dark greyish brown fine to medium SANDSTONE, very weak to weak, occasional uncemented lenses			HQTT	100		51	32				57	31.60m: DD 31.70m: DD 32.00m: BF, 8° dip, UN, R, N, CN 32.05 - 32.20m: BZ 32.25m: BF, 10° dip, UN, R, N, CN 32.40m: J, 88° dip, UN, R, MN, CN 32.55m: BF, 5° dip, UN, R, N, CN					
				HQTT	100		50	33				28	32.60m: DD 32.85m: DD 33.05m: BF, 18° dip, PL, R, N, CN 33.20m: DD 33.40 - 34.00m: BZ 34.10m: DD 34.20 - 34.25m: BZ					Box 11, 31.0-34.0m
				HQTT	100		49	34										
	Fine to medium SAND; dark brown. Very dense, uncemented, uniformly graded			HQTT	86		48	35				52	34.55m: DD 34.75m: DD 34.88m: BF, 8° dip, PL, R, N, CN 35.10m: BF, 6° dip, UN, R, N, CN 35.30m: DD 35.50m: BF, 8° dip, PL, R, N, CN 35.70m: BF, 8° dip, PL, R, N, CN 35.80m: DD 35.95m: BF, 6° dip, UN, R, N, CN 36.08m: DD		▼			
				HQTT	86		47	36										
	Slightly weathered dark brown SANDSTONE, very weak			HQTT	100		46	37				16	37.85m: DD 38.00m: BF, 8° dip, PL, R, N, CN 38.20m: BF, 12° dip, UN, R, N, CN 38.55m: DD 38.70m: BF, 13° dip, PL, R, N, CN					Box 12, 34.0-37.0m
	Slightly weathered dark brown SANDSTONE, very weak to weak, with occasional uncemented sand lenses *39.60 - 39.70m:* Thin limestone bed 100m thick						45	38										
							44	39				46						
												50	39.35m: BF, 8° dip, UN, R, N, CN 39.70m: BF, 8° dip, PL, R, N, CN					

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:09 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: **BC14**

SHEET: 5 OF 7

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: (HAWKTM2000) 811993.50 N 410032.96 E
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT: Petane Formation

DESCRIPTION OF CORE

SOIL: Classification, colour, consistency / density, moisture, plasticity
ROCK: Weathering, colour, fabric, name, strength, cementation

Rock Weathering (UW SW MW HW CW) | Rock Strength (ES VS S MS W VW EW) | Sampling Method | Core Recovery (%) | Testing | RL (m) | Depth (m) | Graphic Log | Defect Log | Fracture Spacing (mm) (2000 600 200 60 20) | RQD (%) | Description & Additional Observations | Fluid Loss (%) (25 50 75) | Water Level | Casing | Installation | Core Box No

Slightly weathered dark brown SANDSTONE, very weak to weak, with occasional uncemented sand lenses

46.85 - 47.15m: Sand lense, uncemented

Fine to medium SAND with lenses of cemented SANDSTONE, minor shells; dark brown. Very dense, uncemented, uniformly graded

49.20 - 49.40m: weak sandstone layer- well cemented

Slightly weathered dark greyish brown fine SANDSTONE, very weak to weak

Sampling Method	Core Recovery (%)	RQD (%)
HQTT	90	50
HQTT	100	100
HQTT	100	93
HQTT	100	46
HQTT	96	55
HQTT	100	60
HQTT	100	56
		86

RL (m): 43, 42, 41, 40, 39, 38, 37, 36, 35, 34
Depth (m): 41, 42, 43, 44, 45, 46, 47, 48, 49

Description & Additional Observations:

39.90m: DD
40.27m: DD
40.65m: BF, 6° dip, UN, R, N, CN
40.95m: BF, 8° dip, PL, R, N, CN
41.10m: BF, 5° dip, PL, R, N, CN
41.50m: DD
41.70m: BF, 9° dip, UN, R, MN, CN
41.92m: BF, 16° dip, PL, R, N, CN
42.16m: DD
42.30m: DD
42.45m: BF, 6° dip, PL, R, N, CN
42.55m: BF, 10° dip, PL, R, N, CN
42.70m: BF, 9° dip, UN, R, N, CN
42.90m: DD
43.05m: BF, 11° dip, PL, R, N, CN
43.70m: BF, 8° dip, PL, R, N, CN
44.00 - 44.50m: BZ
44.60 - 44.85m: J, 85° dip, UN, R, MN, CN
44.80 - 45.00m: DD
45.20m: DD
45.50m: DD
46.05m: DD
46.65m: DD
47.40m: BF, 6° dip, UN, R, N, CN
47.70m: DD
49.60m: DD
49.75m: DD

Core Box No: Box 14, 40.2-43.2m; Box 15, 43.2-46.2m; Box 16, 46.2-49.3m

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC14

SHEET: 6 OF 7

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N, 410032.96 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm)	RQD (%)	Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Petane Formation	Slightly weathered dark greyish brown fine SANDSTONE, very weak to weak Slightly weathered dark greyish brown SANDSTONE (fine to medium), extremely weak to very weak, occasional uncemented lenses			HQTT	100			33				86	50.20m: DD 50.75m: BF, 8° dip, UN, R, N, CN					
				HQTT	100			51					51.30m: BF, 4° dip, UN, R, T, CN 51.55m: DD					
								32				53	51.75m: DD 51.80m: BF, 6° dip, PL, R, N, CN 52.10m: BF, 4° dip, PL, R, N, CN					Box 17, 49.0-52.2m
				HQTT	100			52					52.20 - 52.50m: BZ					
								31					52.70m: DD 52.75m: BF, 10° dip, UN, R, N, CN					
				HQTT	100			53				36	53.00m: DD 53.10m: BF, 9° dip, PL, R, N, CN					
								30					53.50m: DD 53.55m: BF, 8° dip, PL, R, N, CN 53.62m: BF, 7° dip, UN, R, N, CN					
	Fine to medium SAND; light greyish brown. Very dense, unicormly graded, uncemented							54					53.75m: BF, 36° dip, PL, R, N, CN 53.85m: J, 40° dip, UN, R, N, CN 54.10m: DD					
				HQTT	100			29				0						
	Slightly weathered brown fine SANDSTONE, extremely to very weak							55					55.00m: J, 29° dip, UN, R, N, CN					Box 18, 52.5-55.2m
				HQTT	93			28					55.55m: DD					
								56				53	56.10m: BF, 7° dip, PL, R, N, CN					
	56.70 - 57.00m: extremely weak- very weakly cemented sandstone			HQTT	100			27					56.70m: DD 56.80m: DD					
								57					57.10m: DD					
								26				56	57.50m: DD					
								58					58.20m: DD					Box 19, 55.2-58.4m
	Slightly weathered dark brown fine SANDSTONE, very weak, occasional shells			HQTT	98			25				86	58.75m: BF, 7° dip, PL, R, N, CN					
								59					59.10m: DD 59.40m: DD 59.55m: BF, 10° dip, PL, R, N, CN					
								24					59.70m: BF, 8° dip, PL, R, N, CN					

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

Tonkin+Taylor

BOREHOLE No.: BC14

SHEET: 7 OF 7

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 20/04/2018
FINISH DATE: 27/04/2018
CONTRACTOR: Geotech Drilling Ltd

PROJECT: Omarunui Landfill Valley B
JOB No.: 1000647.1000
LOCATION: Top of Eastern ridgeline

CO-ORDINATES: 811993.50 N 410032.96 E (HAWKTM2000)
DIRECTION:
ANGLE FROM HORIZ.: -90°

R.L. GROUND: 83.34m
R.L. COLLAR: 83.34m
DATUM: NAPIHT1962
SURVEY: Total Station\Surveyed

GEOLOGICAL UNIT | DESCRIPTION OF CORE | Rock Weathering | Rock Strength | Sampling Method | Core Recovery (%) | Testing | RL (m) | Depth (m) | Graphic Log | Defect Log | Fracture Spacing (mm) | RQD (%) | Description & Additional Observations | Fluid Loss (%) | Water Level | Casing | Installation | Core Box No

SOIL: Classification, colour, consistency / density, moisture, plasticity
ROCK: Weathering, colour, fabric, name, strength, cementation

Petane Formation

Slightly weathered dark brown fine SANDSTONE, very weak, occasional shells

Slightly weathered light brownish grey fine SANDSTONE, very weak, very weakly cemented

Unweathered dark bluish grey fine to medium SANDSTONE, weak, well cemented

66m: Target depth

Sampling Method	Core Recovery (%)	RQD (%)
HQTT	100	100
HQTT	96	93
HQTT	97	73
HQTT	80	46

Depth (m): 23, 22, 21, 20, 19, 18, 17, 16, 15, 14; 61, 62, 63, 64, 65, 66, 67, 68, 69

Description & Additional Observations:
60.40m: BF, 6° dip, PL, R, N, CN
60.60m: DD
61.05m: DD
61.25m: DD
61.75m: DD
62.40m: DD
62.60m: DD
62.80m: BF, 12° dip, PL, R, N, CN
63.25m: DD
63.77m: BF, 17° dip, PL, R, N, CN
64.10m: BF, 12° dip, PL, R, N, CN
64.35m: DD
65.00m: DD
65.60m: BZ

Core Box No: Box 20, 58.4-61.4m; Box 21, 61.4-64.5m; Box 22, 64.5-66.0m

COMMENTS: Single standpipe installed on completion. Boehole dry until 49m during drilling.

Hole Depth 66m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC7A

SHEET: 1 OF 3

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Fill pad at southern end of Valley B

CO-ORDINATES: 811884.70 N, 409714.20 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 58.10m

R.L. COLLAR: 58.10m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 19/02/2018

FINISH DATE: 20/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering	Rock Strength	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	ROCK DEFECTS: Fracture Spacing (mm)	ROCK DEFECTS: RQD (%)	ROCK DEFECTS: Description & Additional Observations	Fluid Loss (%)	Water Level	Casing	Installation	Core Box No
Fill	Fine SAND, with minor silt and gravels, grey						58	0										
	Fine SAND, with limestone gravels and shell inclusions, dark bluish grey.						57	1				0			20/02/2018: Post drilling			
							56	2										
							55	3										
							54	4										
							53	5										
							52	6										
							51	7										
							50	8										
							49	9										

COMMENTS: Wash drilled to reinstall monitoring well that was destroyed during earthworks. Logged from drill cuttings

Hole Depth 28.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC7A

SHEET: 2 OF 3

Tonkin+Taylor

PROJECT: Omarunui Landfill Valley B

JOB No.: 1000647.1000

LOCATION: Fill pad at southern end of Valley B

CO-ORDINATES: 811884.70 N, 409714.20 E (HAWKTM2000)

DIRECTION:

ANGLE FROM HORIZ.: -90°

R.L. GROUND: 58.10m

R.L. COLLAR: 58.10m

DATUM: NAPIHT1962

SURVEY: Total Station\Surveyed

DRILLED BY: Shawn

LOGGED BY: JWY

CHECKED: CWM

START DATE: 19/02/2018

FINISH DATE: 20/02/2018

CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE SOIL: Classification, colour, consistency / density, moisture, plasticity ROCK: Weathering, colour, fabric, name, strength, cementation	Rock Weathering (UW, SW, MW, HW, CW)	Rock Strength (ES, VS, S, MS, M, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Fill	Fine SAND, with limestone gravels and shell inclusions, dark bluish grey.						48	10										
							47	11										
	Silty fine SAND with limestone gravels, organics and rootlets. Dark brownish grey.						46	12										
							45	13										
							44	14										
							43	15				0						
	Fine SAND, with gravels and shell inclusions, bluish grey						42	16										
							41	17										
							40	18										
Pātaka Formation	Dark brown slightly weathered calcareous SANDSTONE, very weak						39	19							18; Following pi			

COMMENTS: Wash drilled to reinstall monitoring well that was destroyed during earthworks. Logged from drill cuttings

Hole Depth 28.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BOREHOLE LOG

BOREHOLE No.: BC7A

SHEET: 3 OF 3

PROJECT: Omarunui Landfill Valley B	CO-ORDINATES: 811884.70 N, 409714.20 E (HAWKTM2000)	R.L. GROUND: 58.10m
JOB No.: 1000647.1000	DIRECTION:	R.L. COLLAR: 58.10m
LOCATION: Fill pad at southern end of Valley B	ANGLE FROM HORIZ.: -90°	DATUM: NAPIHT1962
		SURVEY: Total Station\Surveyed

DRILLED BY: Shawn
LOGGED BY: JWY
CHECKED: CWM
START DATE: 19/02/2018
FINISH DATE: 20/02/2018
CONTRACTOR: Geotech Drilling .

GEOLOGICAL UNIT	DESCRIPTION OF CORE (SOIL: Classification, colour, consistency / density, moisture, plasticity; ROCK: Weathering, colour, fabric, name, strength, cementation)	Rock Weathering (UW, EW, HW, MW, HW, CW, DW)	Rock Strength (ES, VS, S, MS, M, W, VW, EW)	Sampling Method	Core Recovery (%)	Testing	RL (m)	Depth (m)	Graphic Log	ROCK DEFECTS: Defect Log	Fracture Spacing (mm) (2000, 600, 200, 60, 20)	RQD (%)	Description & Additional Observations	Fluid Loss (%) (25, 50, 75)	Water Level	Casing	Installation	Core Box No
Petane Formation	Dark brown slightly weathered calcareous SANDSTONE, very weak			W	0		37	21				0			09/03/2018; 2 weeks post drilling			
	Greyish brown calcareous slightly weathered SANDSTONE						36	22										
							35	23										
							34	24										
	Dark grey slightly weathered shelly coquina LIMESTONE with bands of sandstone						33	25										
							32	26										
							31	27										
							30	28										
	28.5m: Target depth						29	29										

COMMENTS: Wash drilled to reinstall monitoring well that was destroyed during earthworks. Logged from drill cuttings

Hole Depth 28.5m

Scale 1:50

Rev.: A

General Log - 21/05/2018 3:19:10 PM - Produced with Core-GS by GeRoc

BC10- Box 1 0-3.75m

BC10- Box 2 3.75-11m

BC10- Box 3 11-13.8m

BC10- Box 4 13.8-17.9

BC10- Box 5 17.9-22.5m

BC10- Box 6 22.5-27.2m

BC10- Box 7 27.2-30.4m

BC10- Box 8 30.4-33.35m

BC10- Box 9 33.35-36.3m

BC10- Box 10 36.3-39.6m

BC10- Box 11 39.6-42.6m

BC10- Box 12 426.-45.8m

BC11- Box 1 0.0-3.8m

BC11- Box 2 3.8-7.95m

BC11- Box 3 3.8-7.95m

BC12- Box 1 0.0-3.85m

BC12- Box 2 3.85-8.33m

BC12- Box 3 8.33-10.5m

BC13- Box 1 0.0-4.5m

BC13- Box 2 4.05-7.2m

BC13- Box 3 7.2-10.1m

BC13- Box 4 10.1-13.1m

BC13- Box 5 13.1-16m

BC13- Box 6 16-19.1m

BC13- Box 7 19.1-22.2m

BC13- Box 8 22.2-25.3m

BC13- Box 9 25.3-25.5m

BC14- Box 1 0.0-3.65m

BC14- Box 2 3.65-6.7m

BC14- Box 3 6.7-10.0m

BC14- Box 4 10.0-13.3m

BC14- Box 5 13.0-16.0m

BC14- Box 6 16.0-19.0m

BC14- Box 7 19.0-22.0m

BC14- Box 8 22.0-25.0m

BC14- Box 9 25.0-28.0m

BC14- Box 10 28.0-31.0m

BC14- Box 11 31.0-34.0m

BC14- Box 12 34.0-37.0m

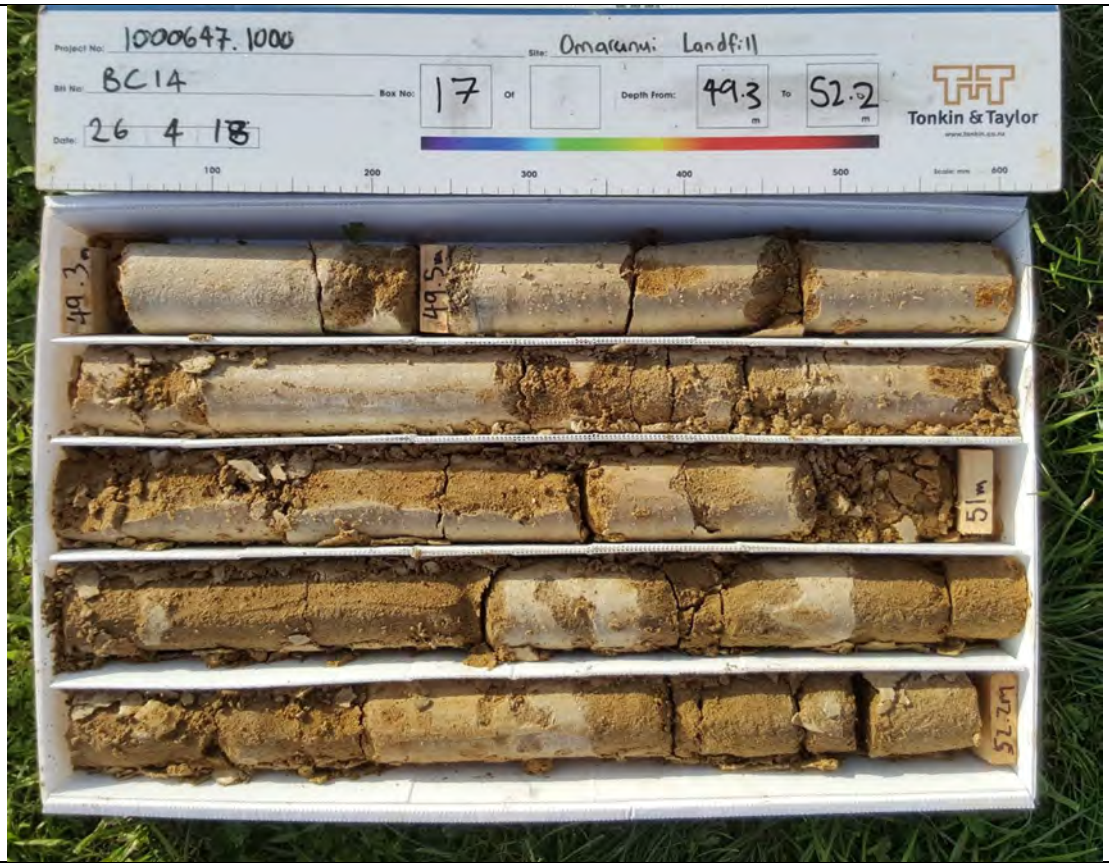
BC14- Box 13 37.0-40.2m

BC14- Box 14 40.2-43.2m

BC14- Box 15 43.2-46.2m

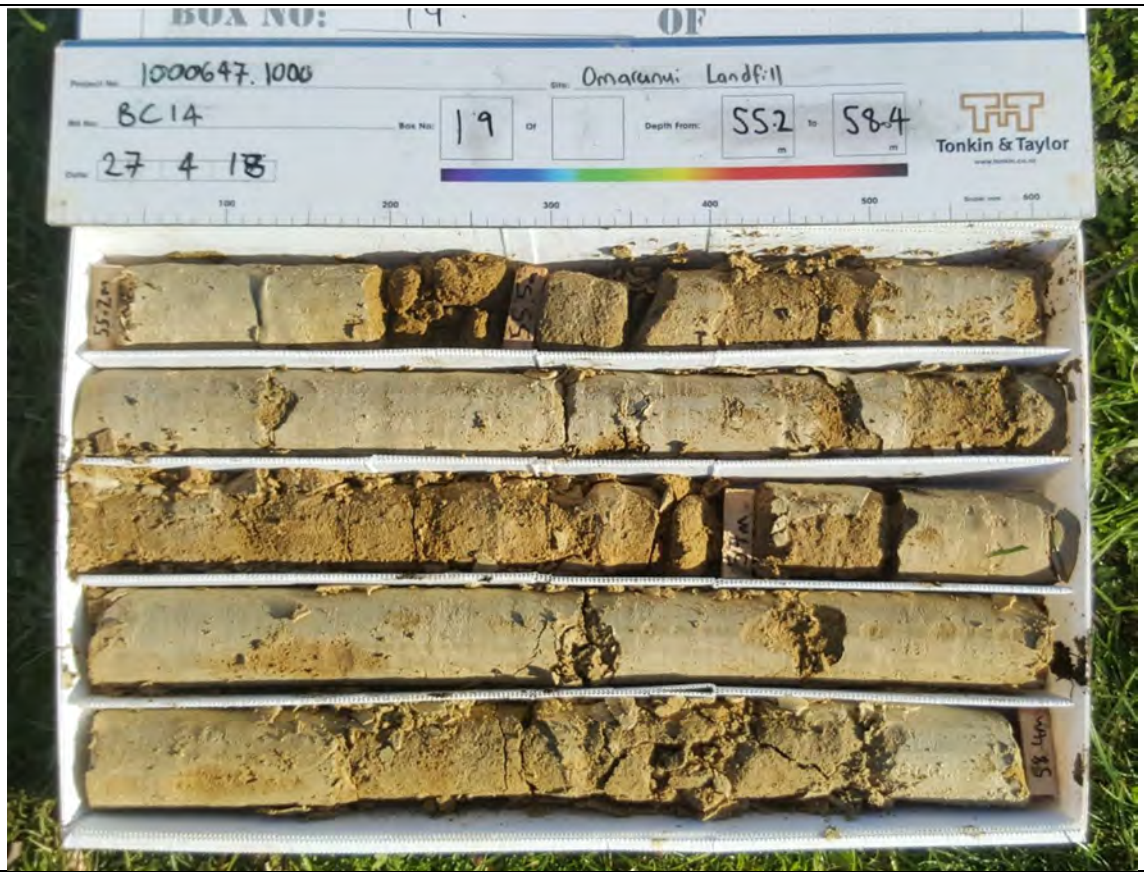
BC14- Box 16 46.2-49.3m

BC14- Box 17 49.3-52.2m



BC14- Box 18 52.2-55.2m

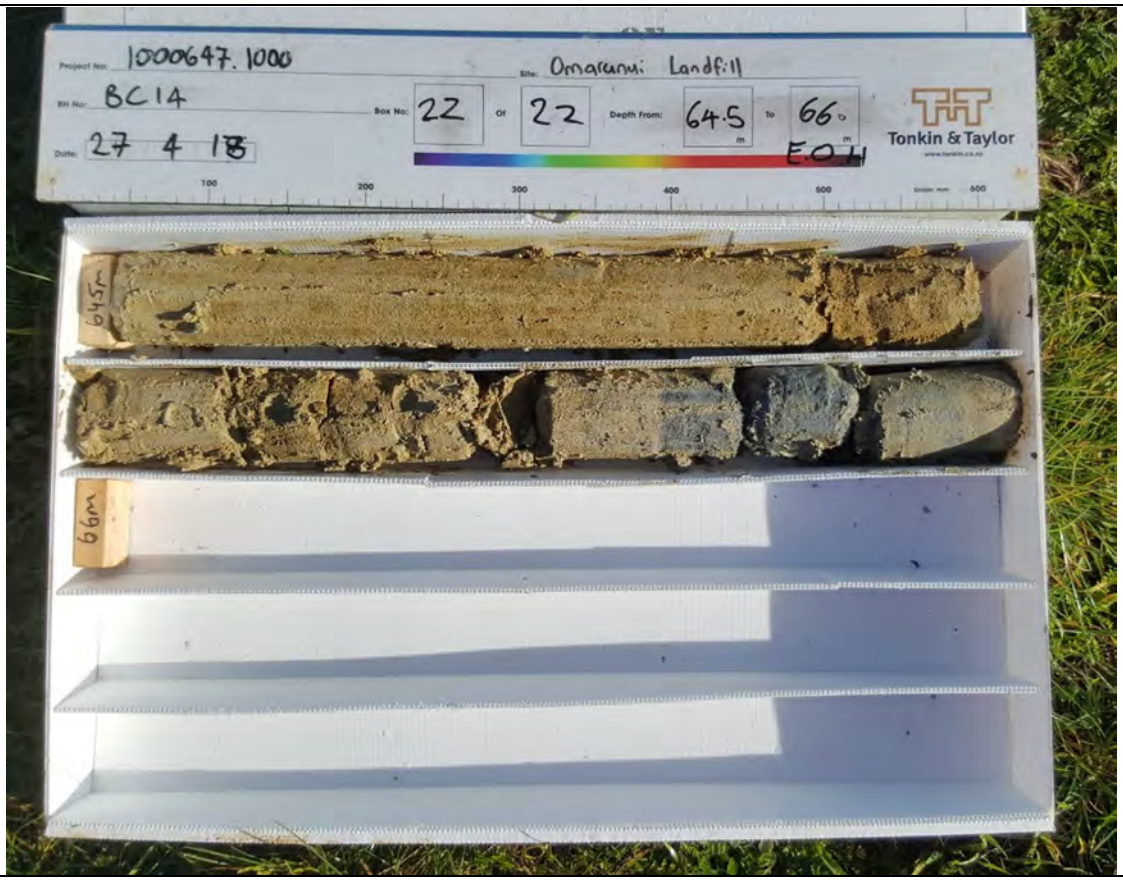
BC14- Box 19 55.2-58.4m



BC14- Box 20 58.4-61.4m

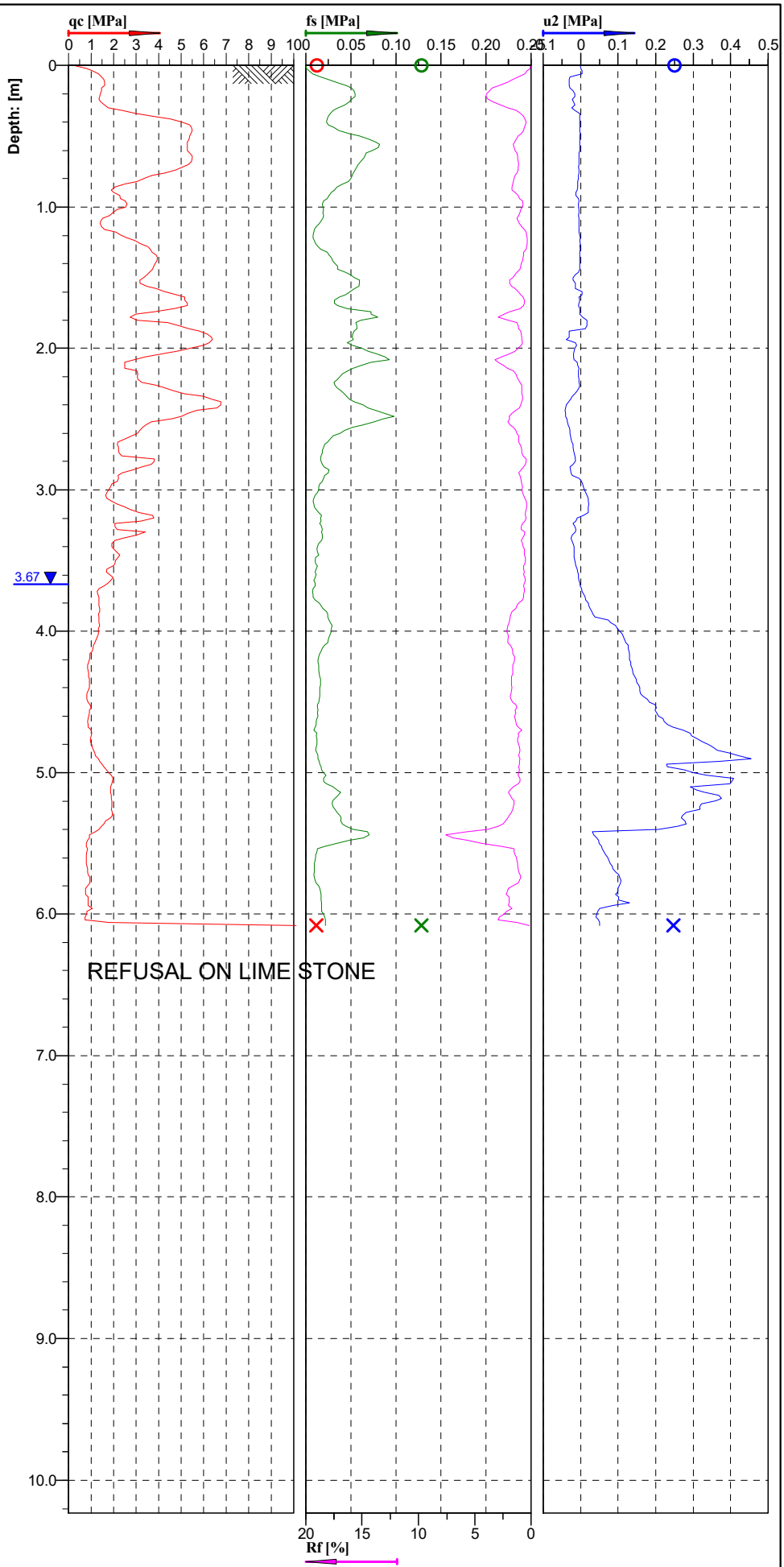
BC14- Box 21 61.4-64.5m

BC14- Box 21 61.4-64.5m



Classification by Robertson 1986

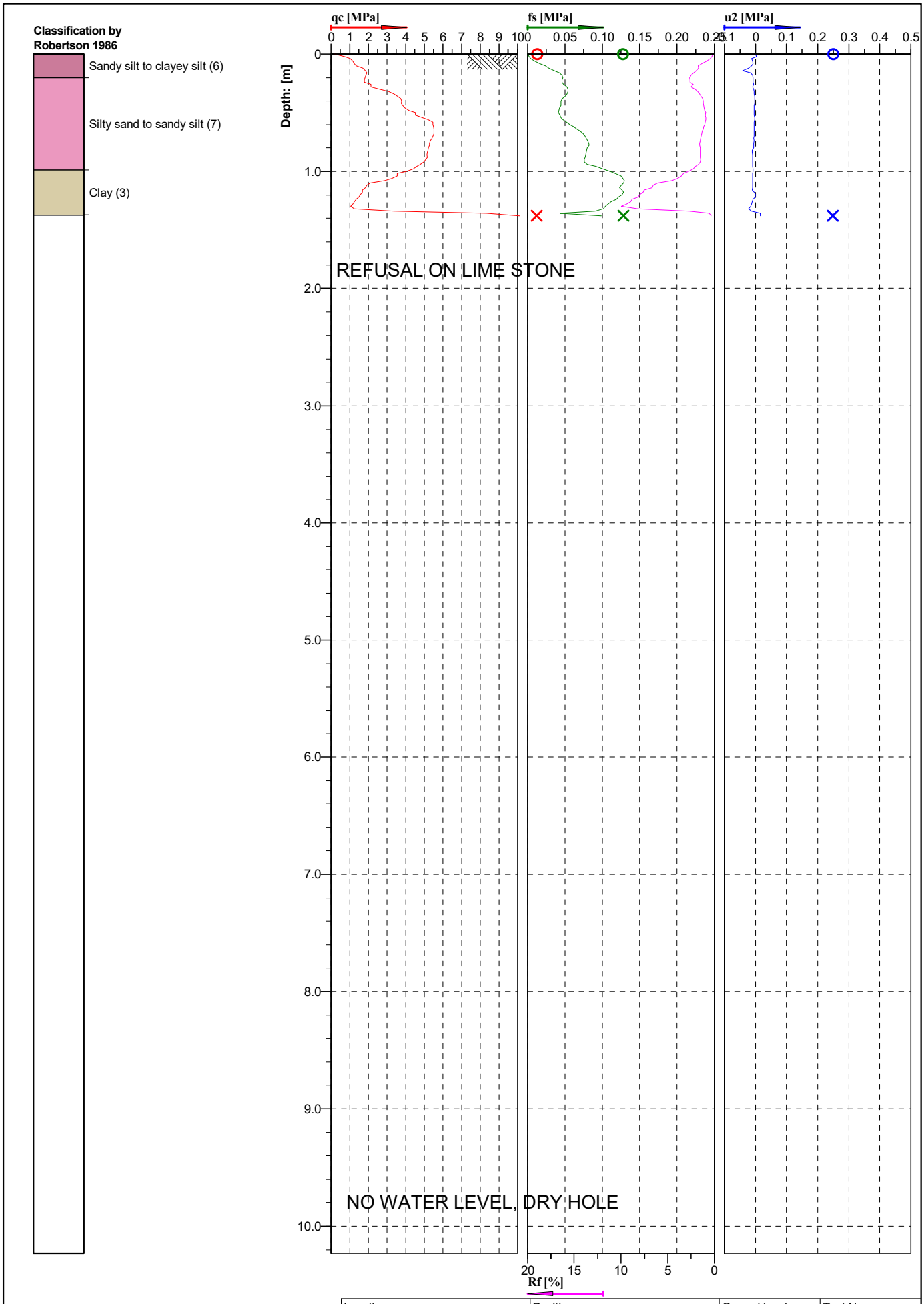
- Sandy silt to clayey silt (6)
- Sand to silty sand (8)
- Silty sand to sandy silt (7)
- Sandy silt to clayey silt (6)
- Silty sand to sandy silt (7)
- Sand to silty sand (8)
- Silty sand to sandy silt (7)
- Sandy silt to clayey silt (6)
- Silty sand to sandy silt (7)
- Sandy silt to clayey silt (6)
- Clayey silt to silty clay (5)
- Sandy silt to clayey silt (6)
- Clayey silt to silty clay (5)



GEOTECH DRILLING

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT01
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54029 E 176.78719		File: CPT01.cpt	

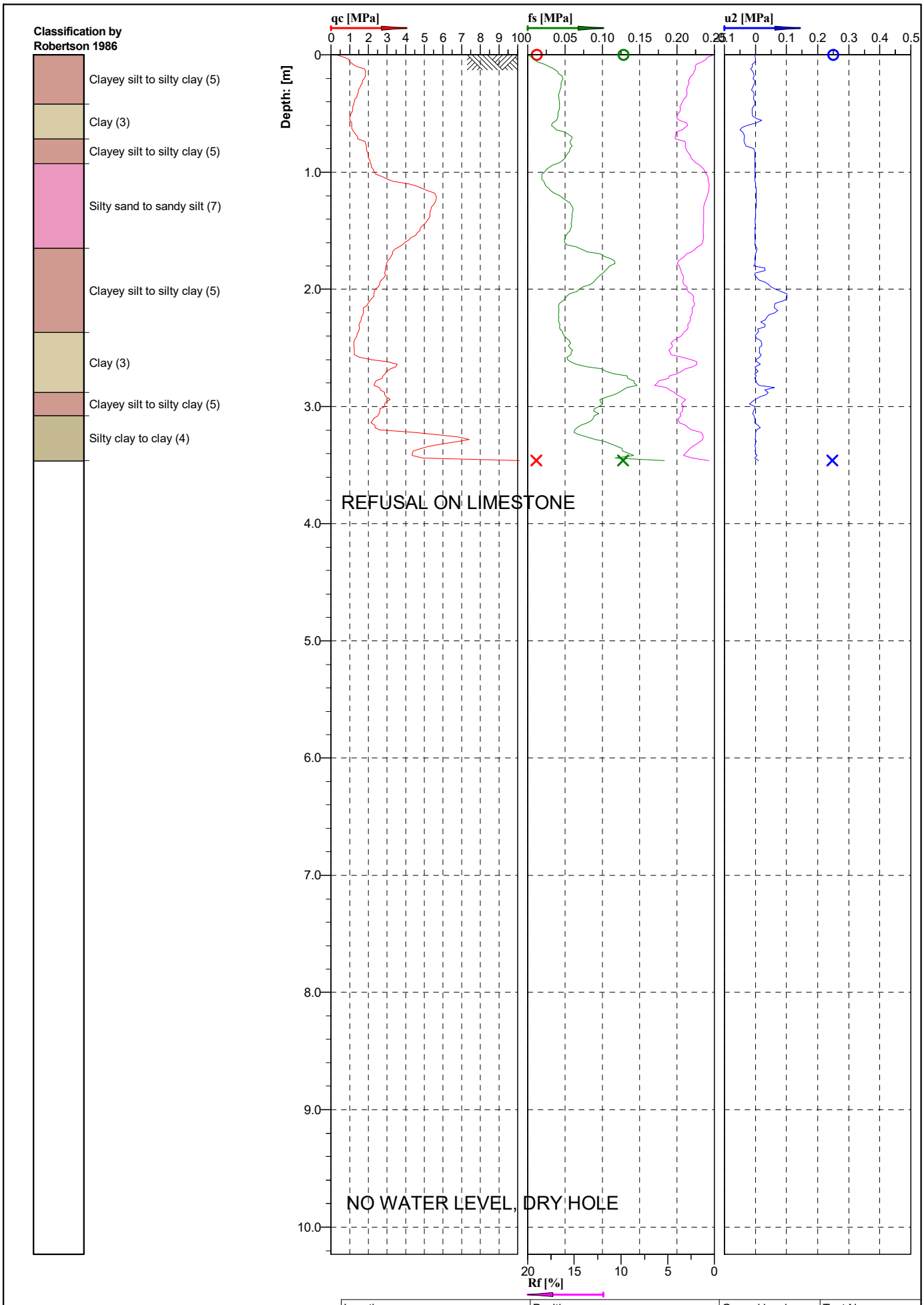


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT03
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54052 E 176.78732		File: CPT03.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

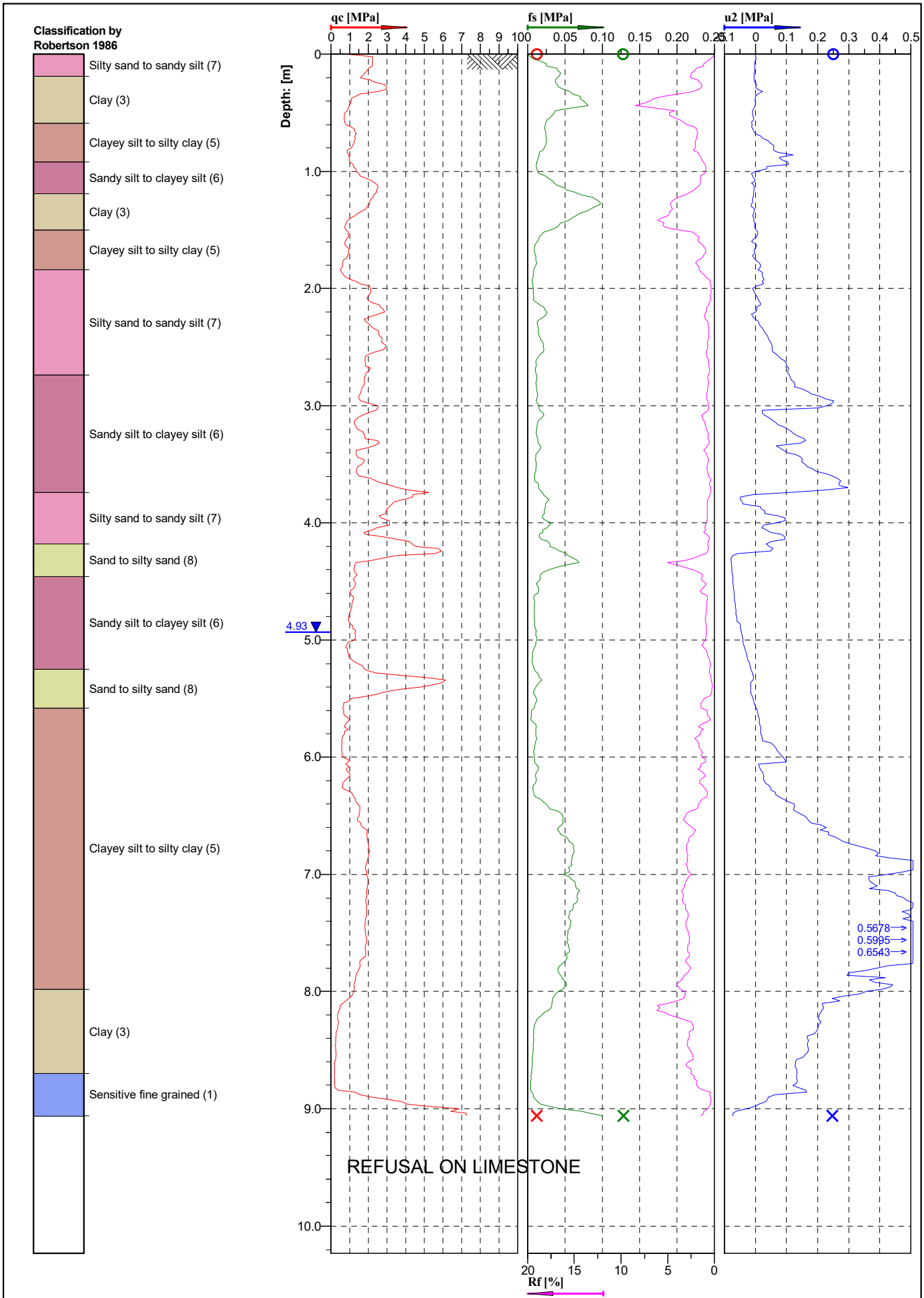


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT04
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54076 E 176.78767		File: CPT04.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

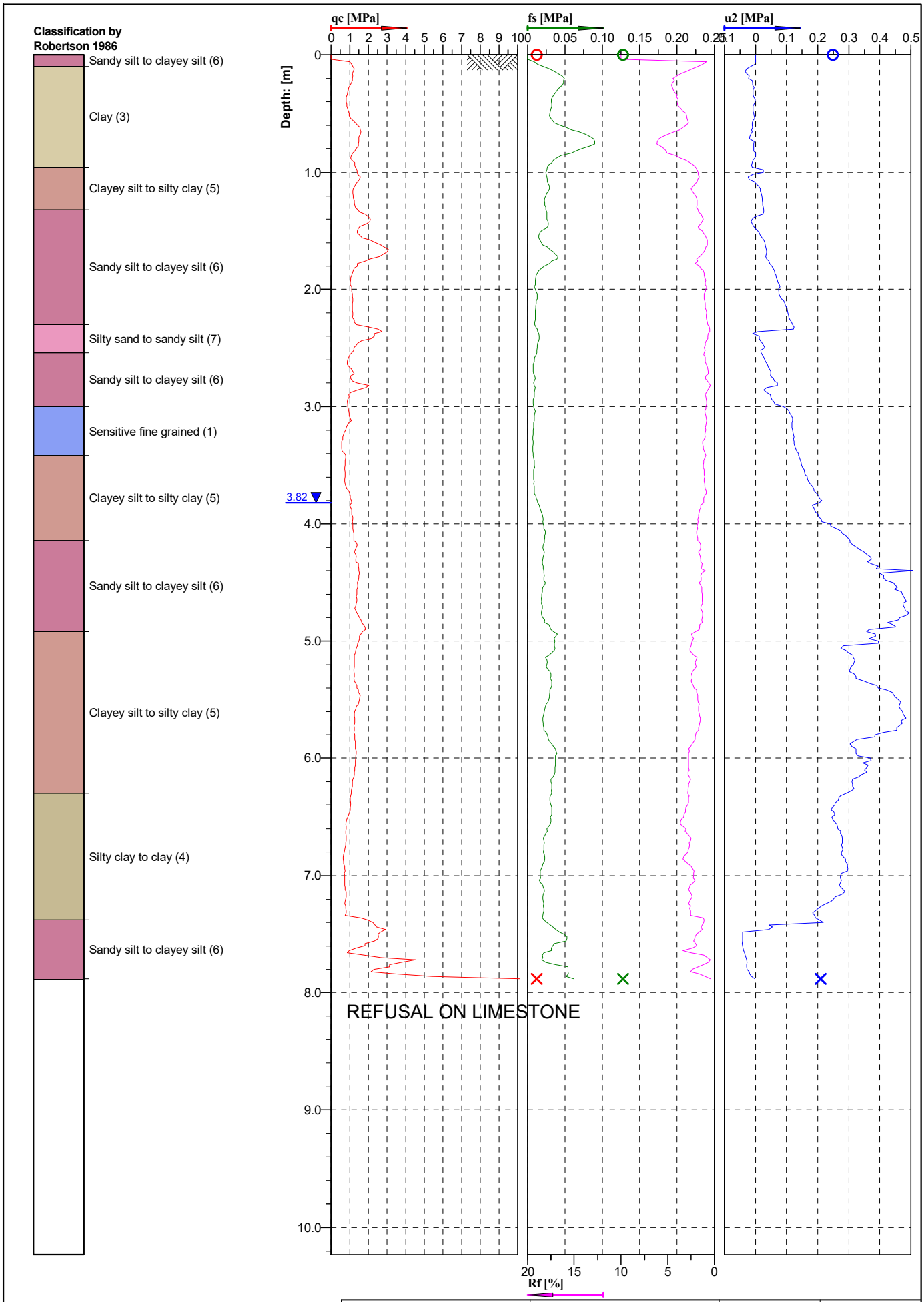


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT05
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54103 E 176.78745		File: CPT05.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

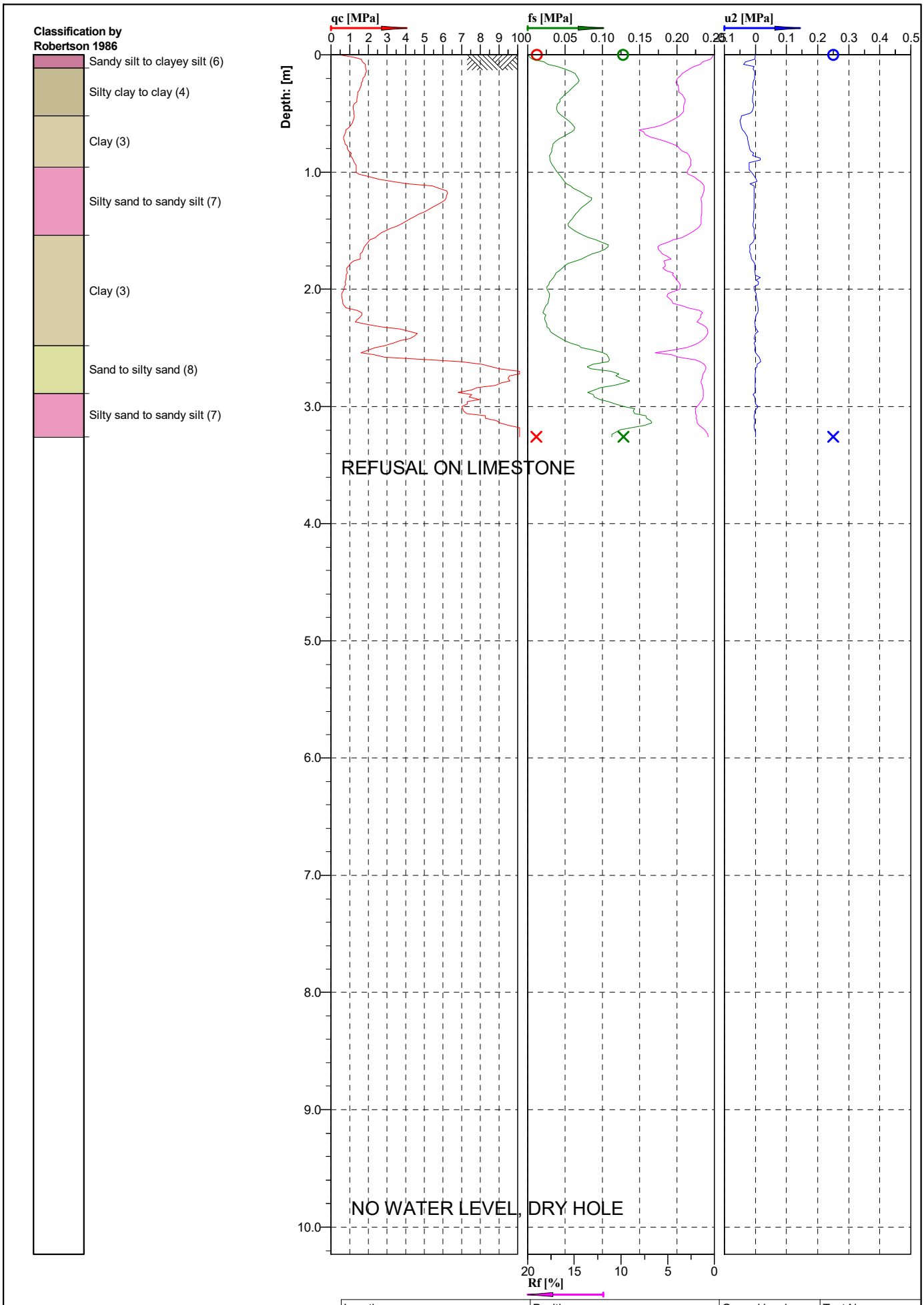


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT06
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54113 E 176.78772		File: CPT06.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

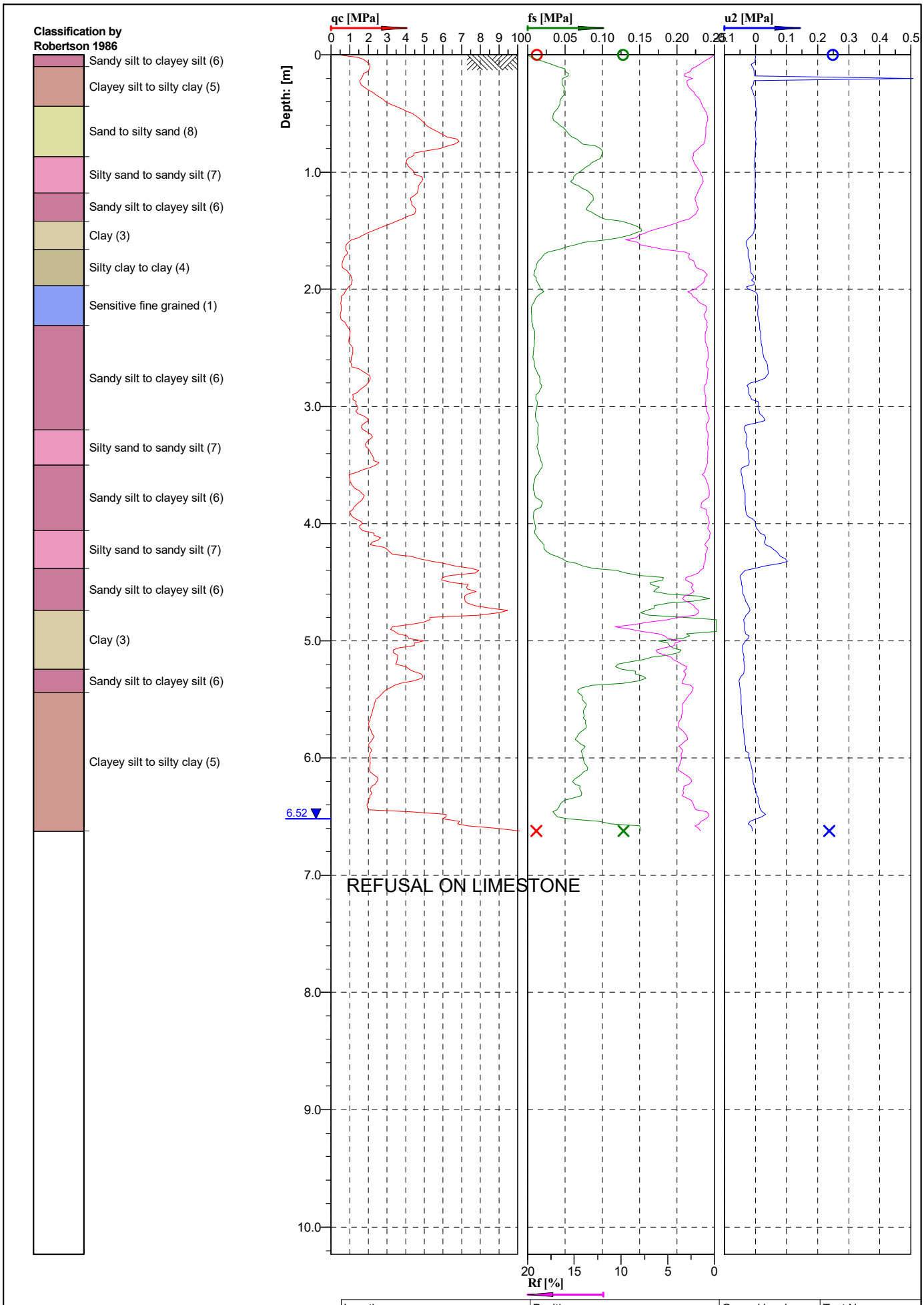


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT07
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54143 E 176.78726		File: CPT07.cpt	

GEOTECH DRILLING

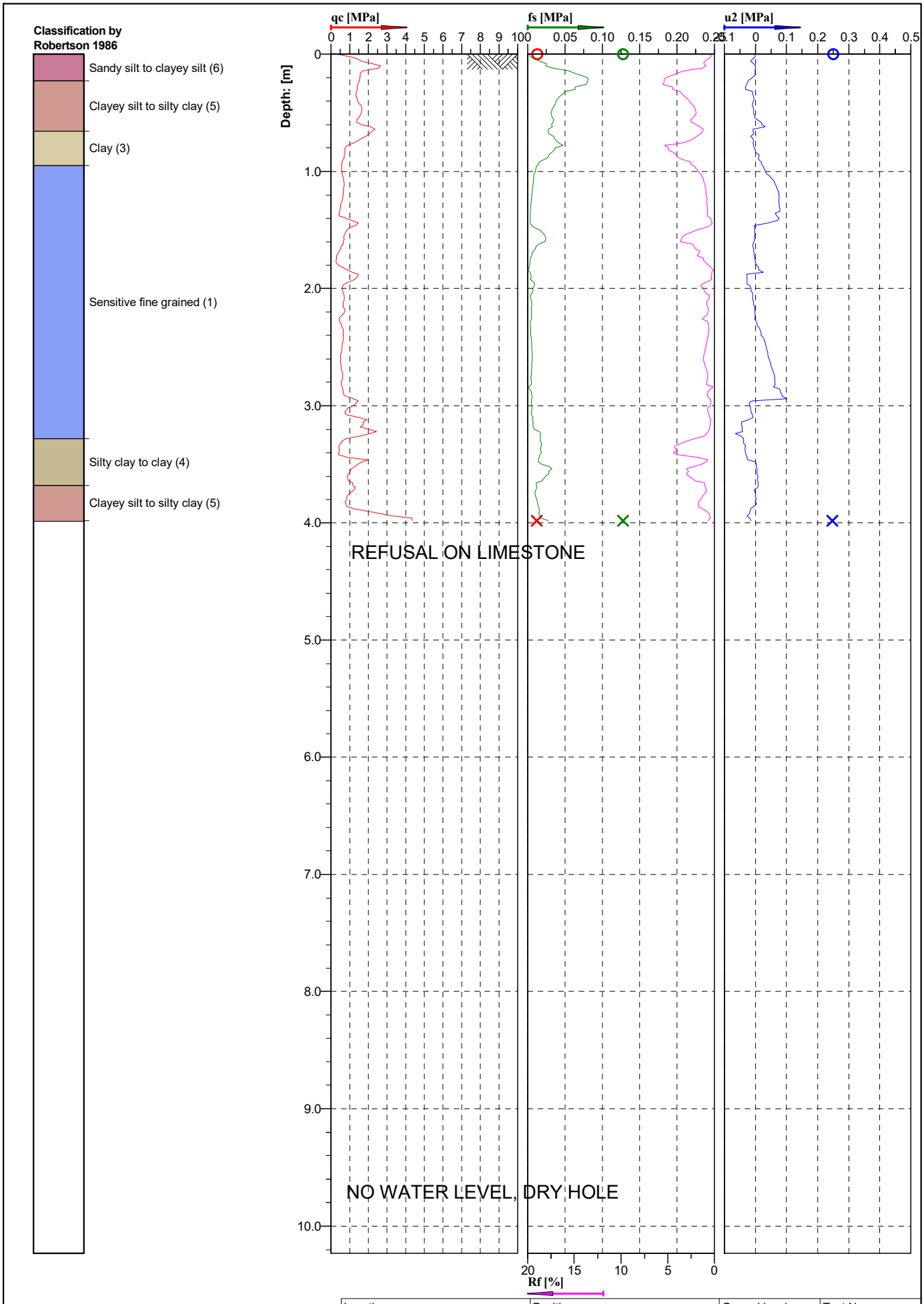
u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150



Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT08
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54182 E 176.78700		File: CPT08.cpt	

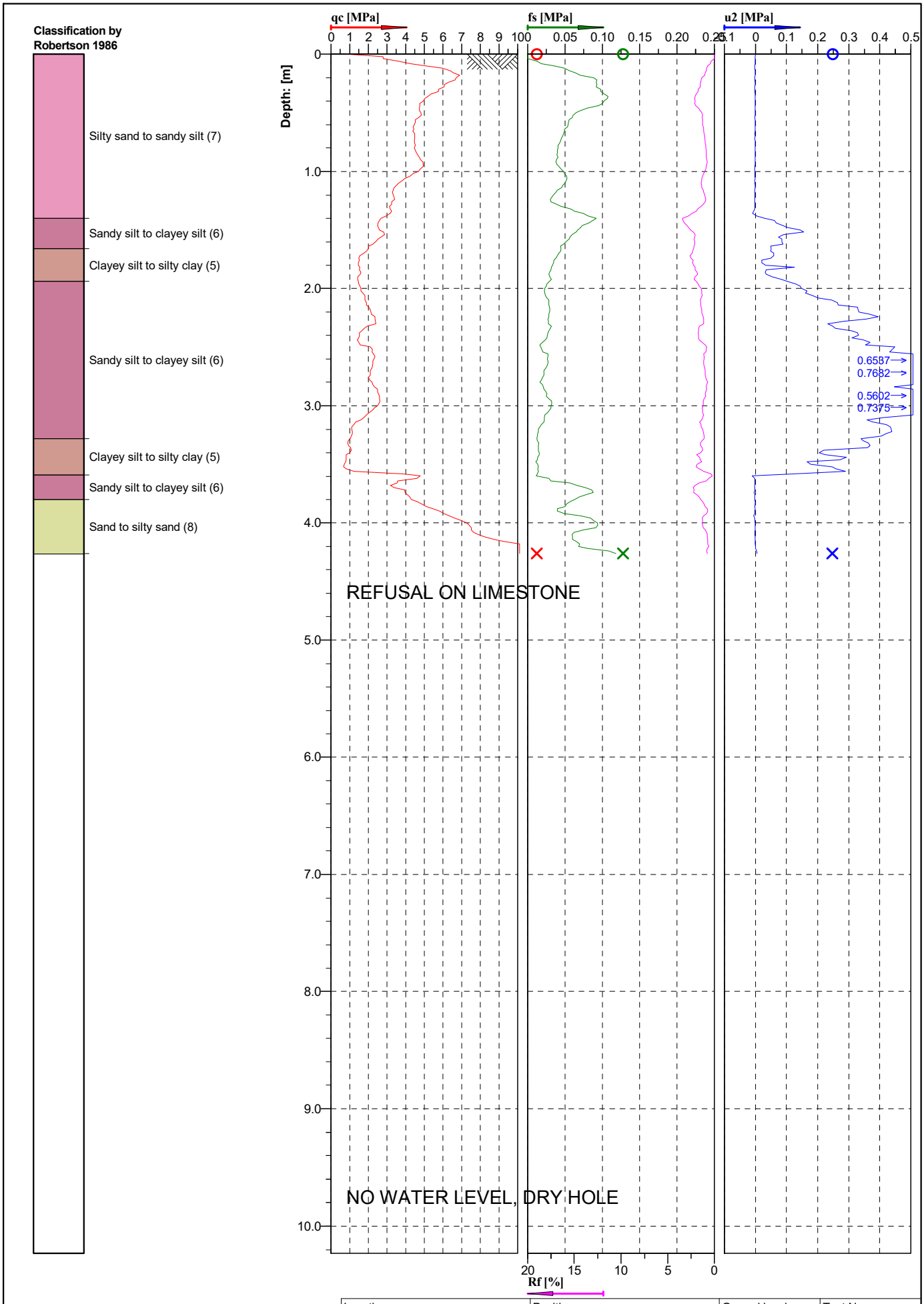


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT09
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54212 E 176.78702		File: CPT09.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

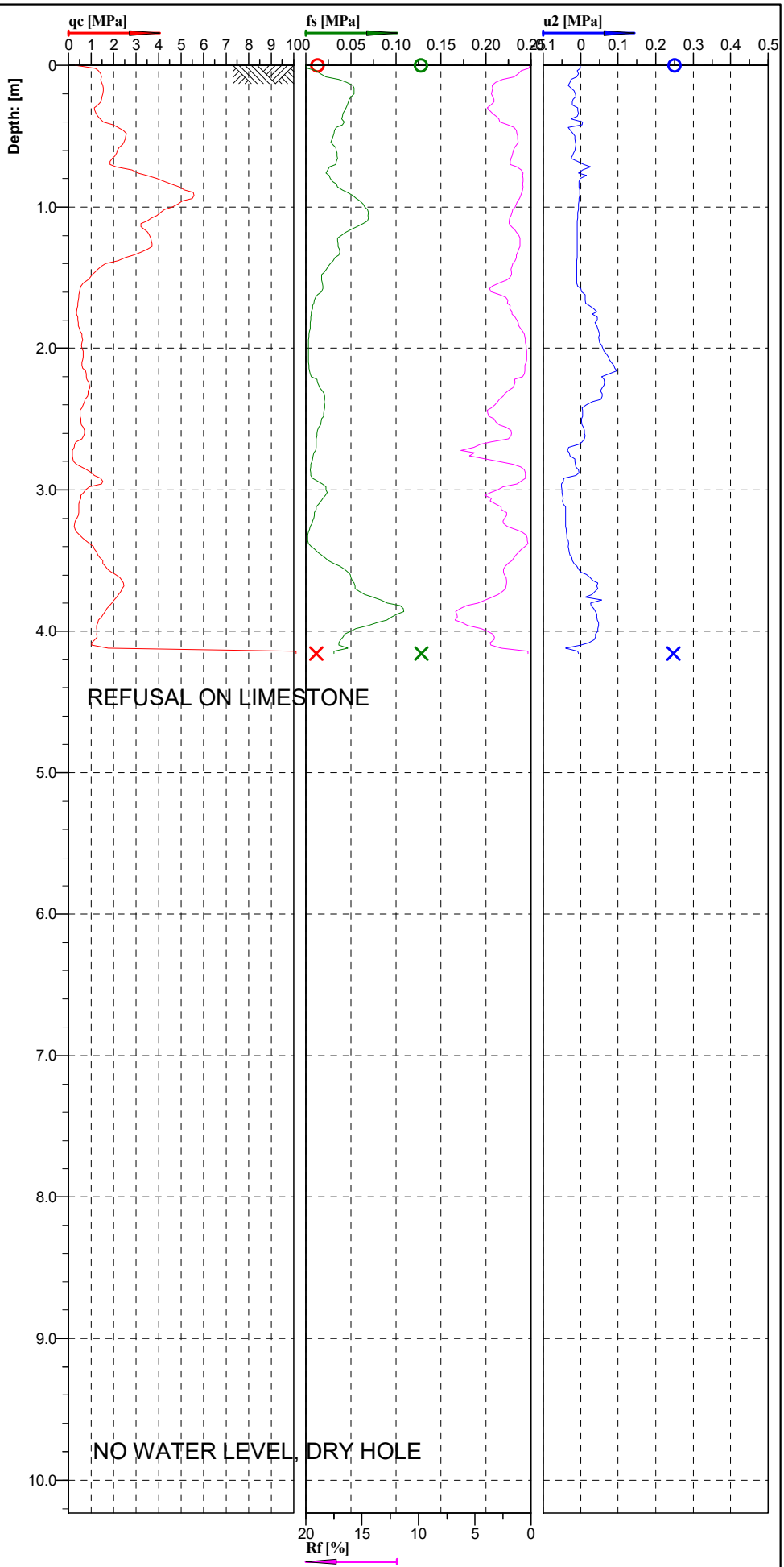


Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT10
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54244 E 176.78737		File: CPT10.cpt	

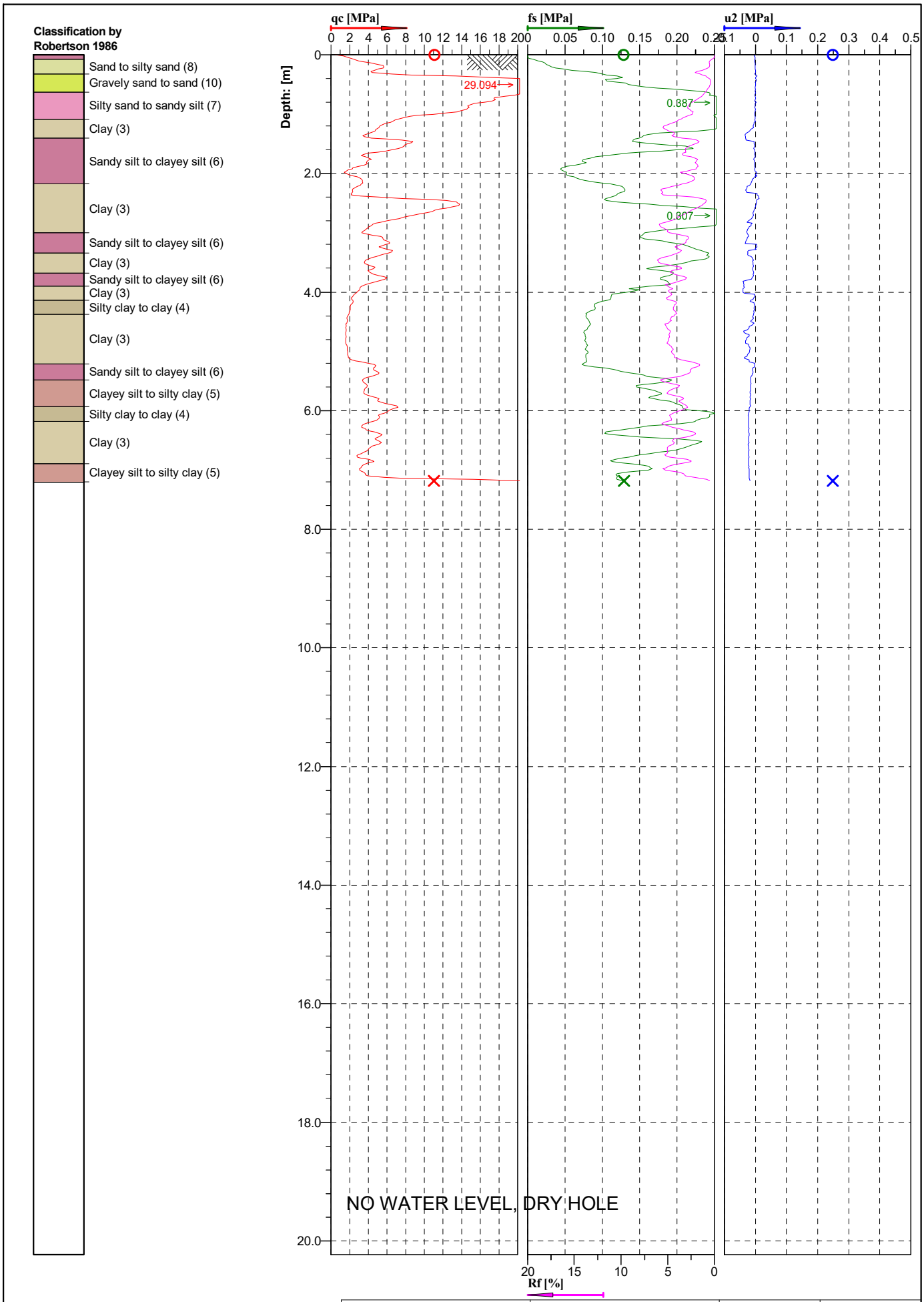
Classification by Robertson 1986

- Sandy silt to clayey silt (6)
- Silty clay to clay (4)
- Sandy silt to clayey silt (6)
- Sand to silty sand (8)
- Silty sand to sandy silt (7)
- Sensitive fine grained (1)
- Clay (3)
- Sensitive fine grained (1)
- Sandy silt to clayey silt (6)
- Clay (3)



Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT11
Project ID:	Client: TONKIN & TAYLOR LTD	Date: 14/03/2018	Scale: 1 : 43
Project: OMARUNUI LANDFILL		Page: 1/1	Fig.:
S 39.54274 E 176.78775		File: CPT11.cpt	

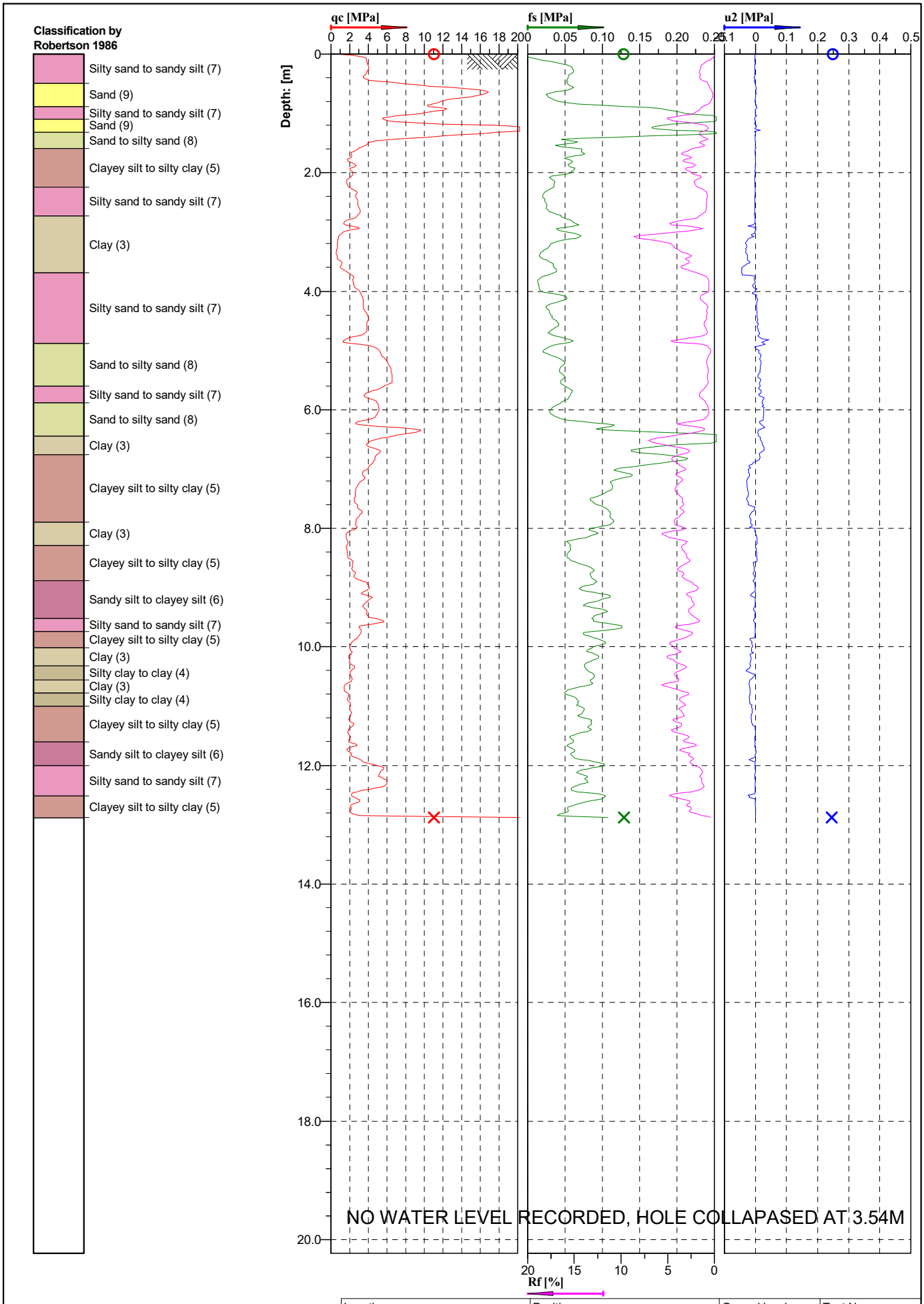


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT12
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54300 E 176.78662		File: CPT12.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

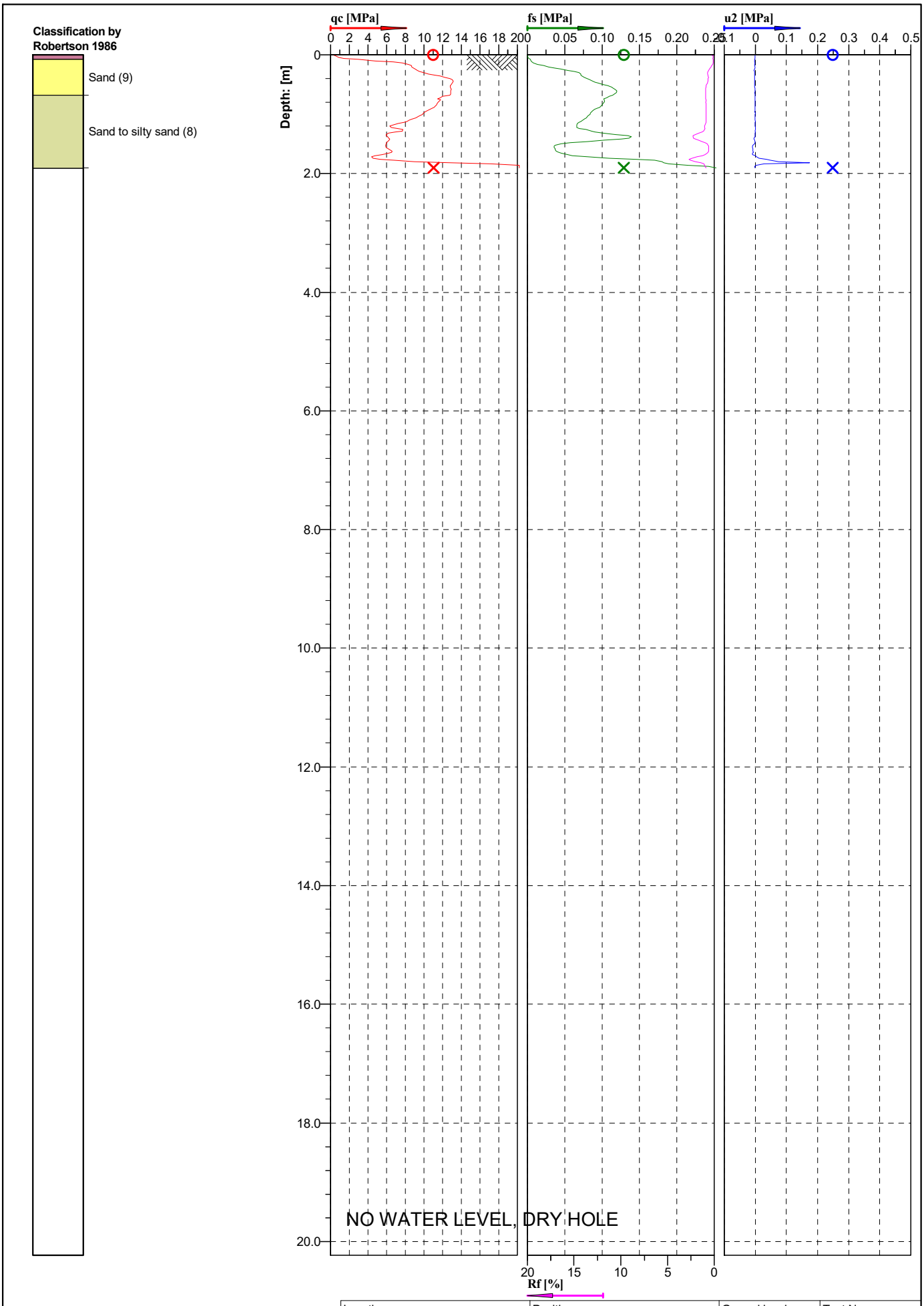


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT13
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54338 E 176.78673		File: CPT13.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

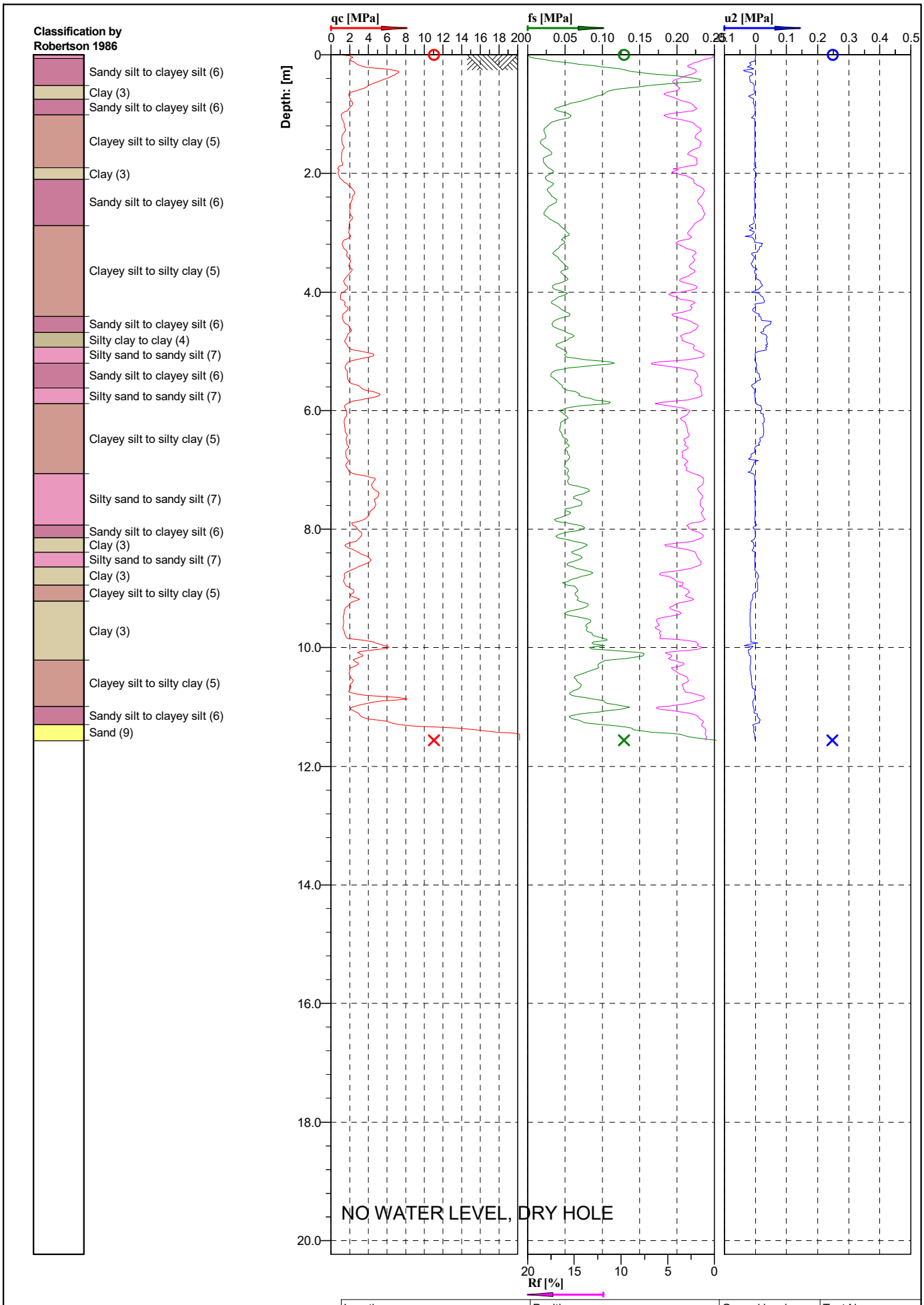


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT14
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54348E 176.78717		File: CPT14.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

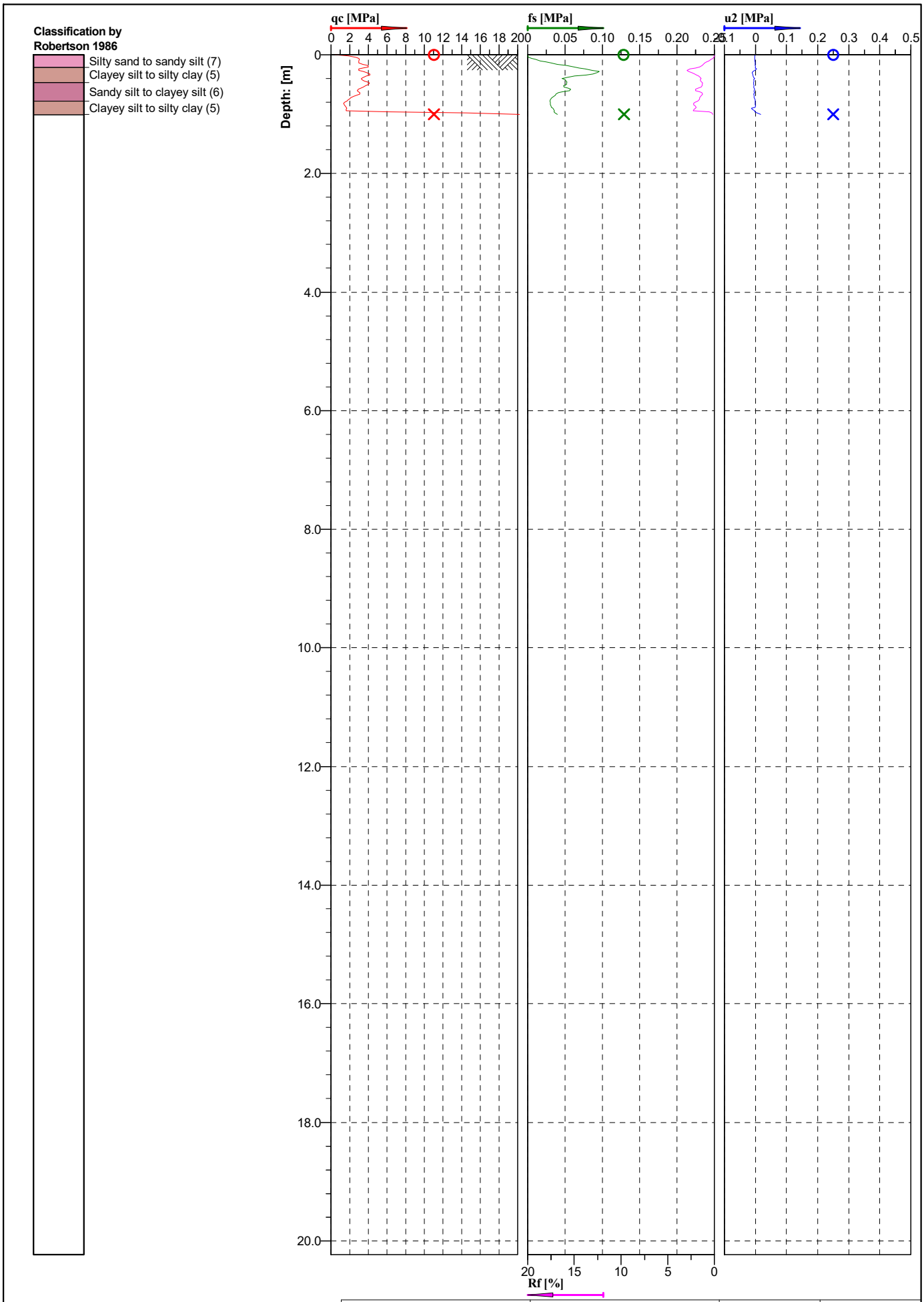


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT15
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54362 E 176.78757		File: CPT15.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

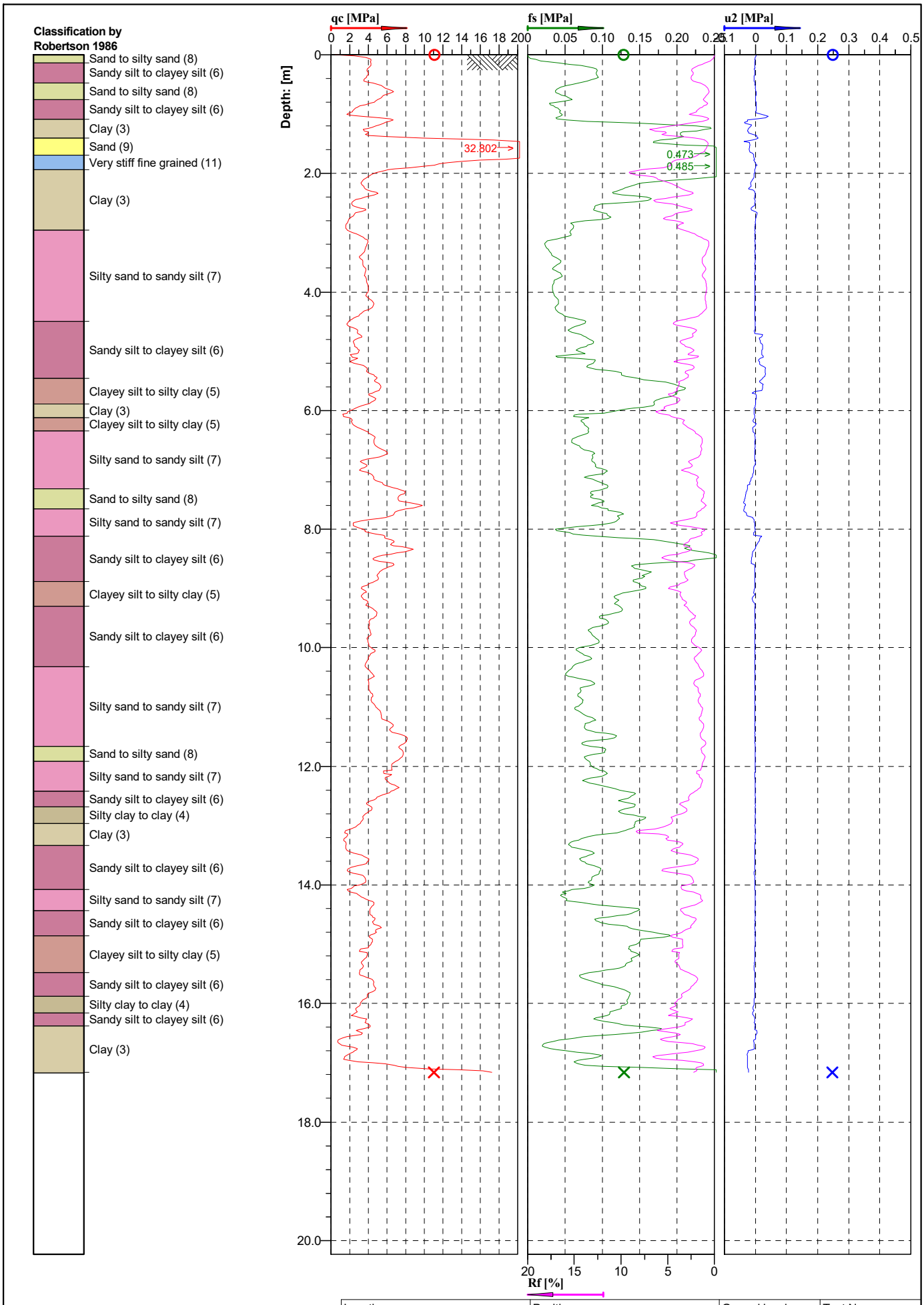


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT16
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54376 E 176.78694		File: CPT16.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150



Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT16A
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54376 E 176.78694		File: CPT16A.cpt	

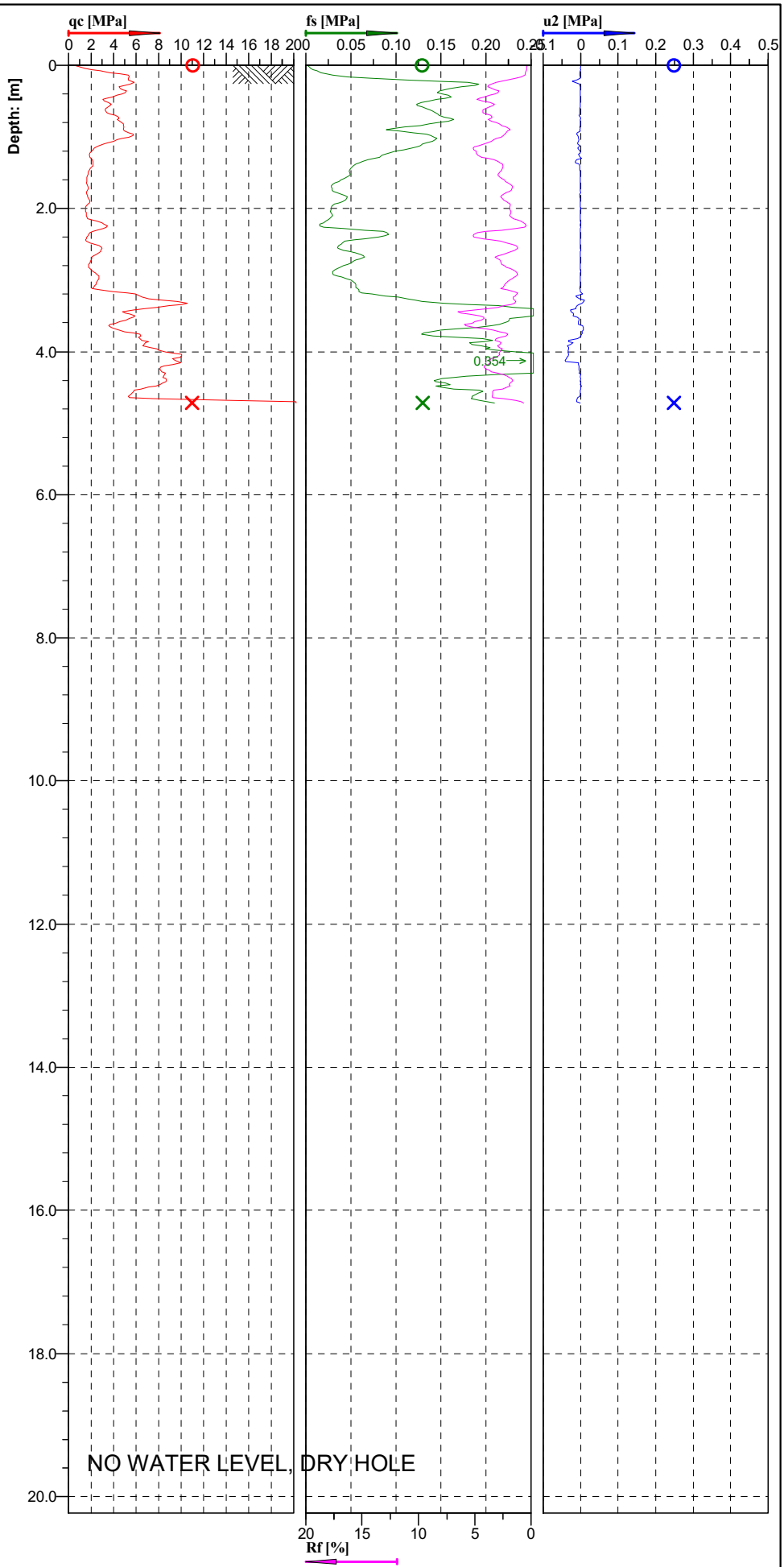
GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Classification by Robertson 1986

- Sandy silt to clayey silt (6)
- Silty clay to clay (4)
- Sandy silt to clayey silt (6)
- Clay (3)
- Clayey silt to silty clay (5)
- Sandy silt to clayey silt (6)
- Clay (3)
- Clayey silt to silty clay (5)
- Sandy silt to clayey silt (6)
- Silty sand to sandy silt (7)
- Clay (3)
- Sandy silt to clayey silt (6)
- Silty sand to sandy silt (7)

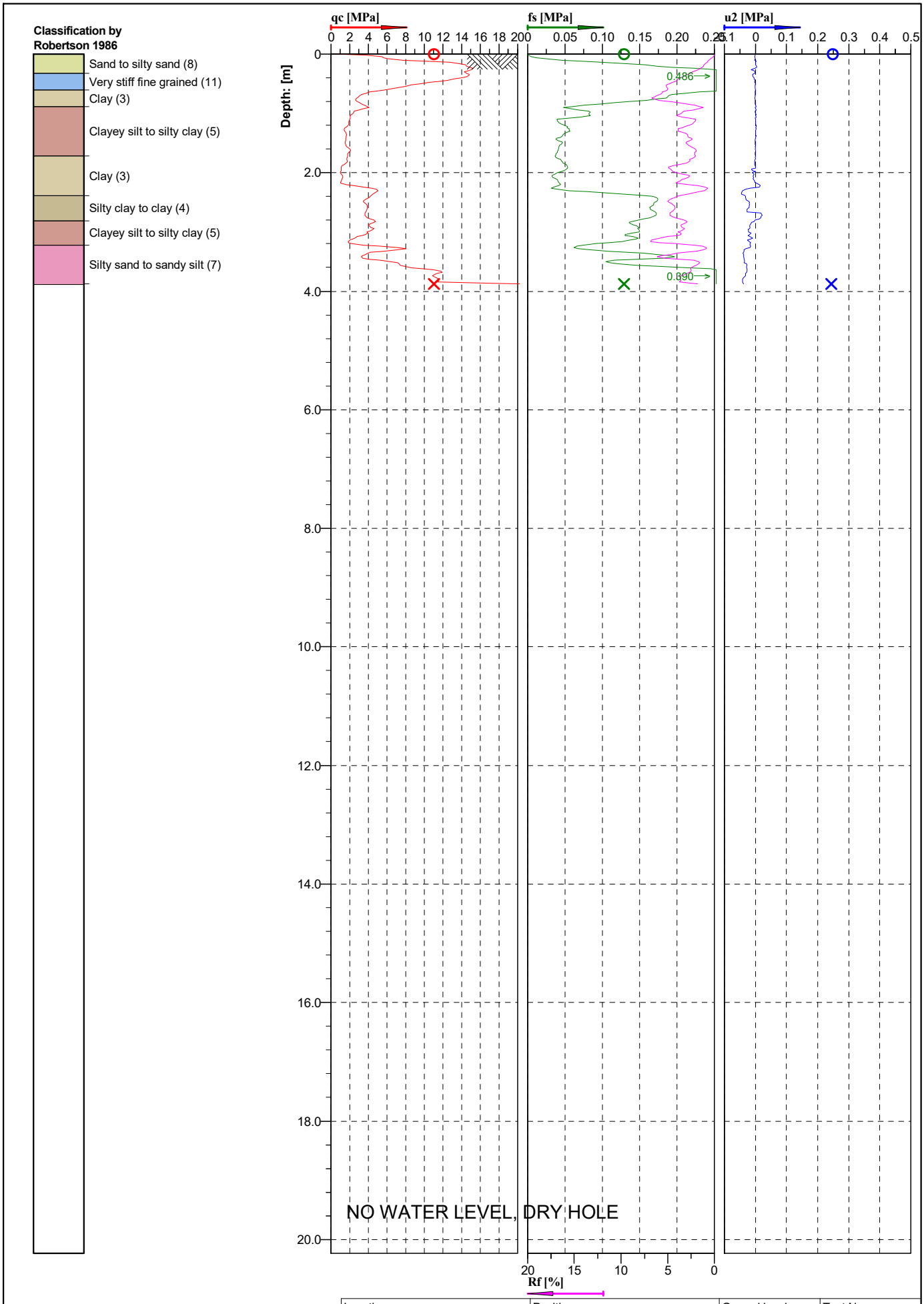


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT17
Project ID: 1000647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54403 E 176.78668		File: CPT17.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

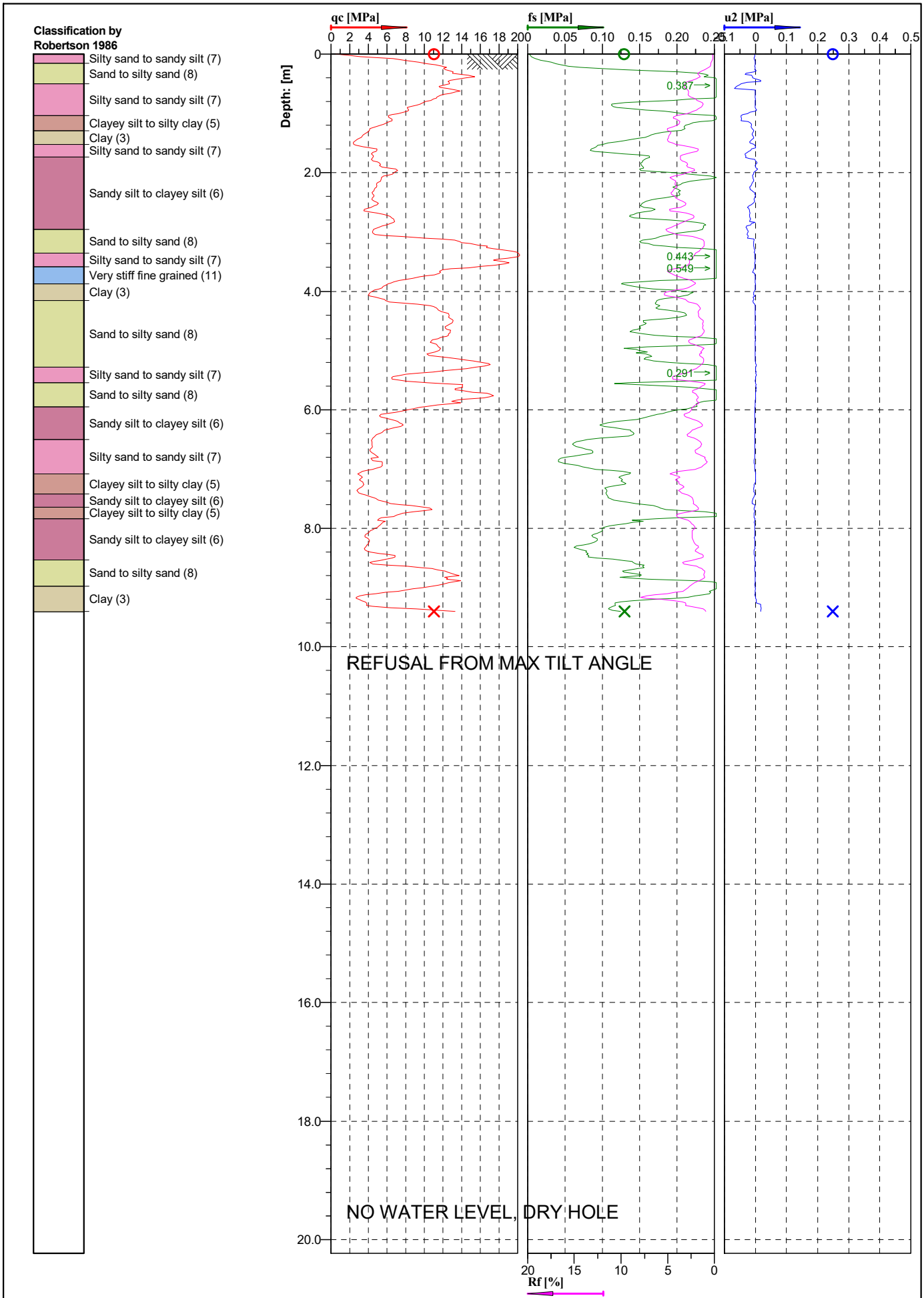


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT18
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54391 E 176.78648		File: CPT18.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

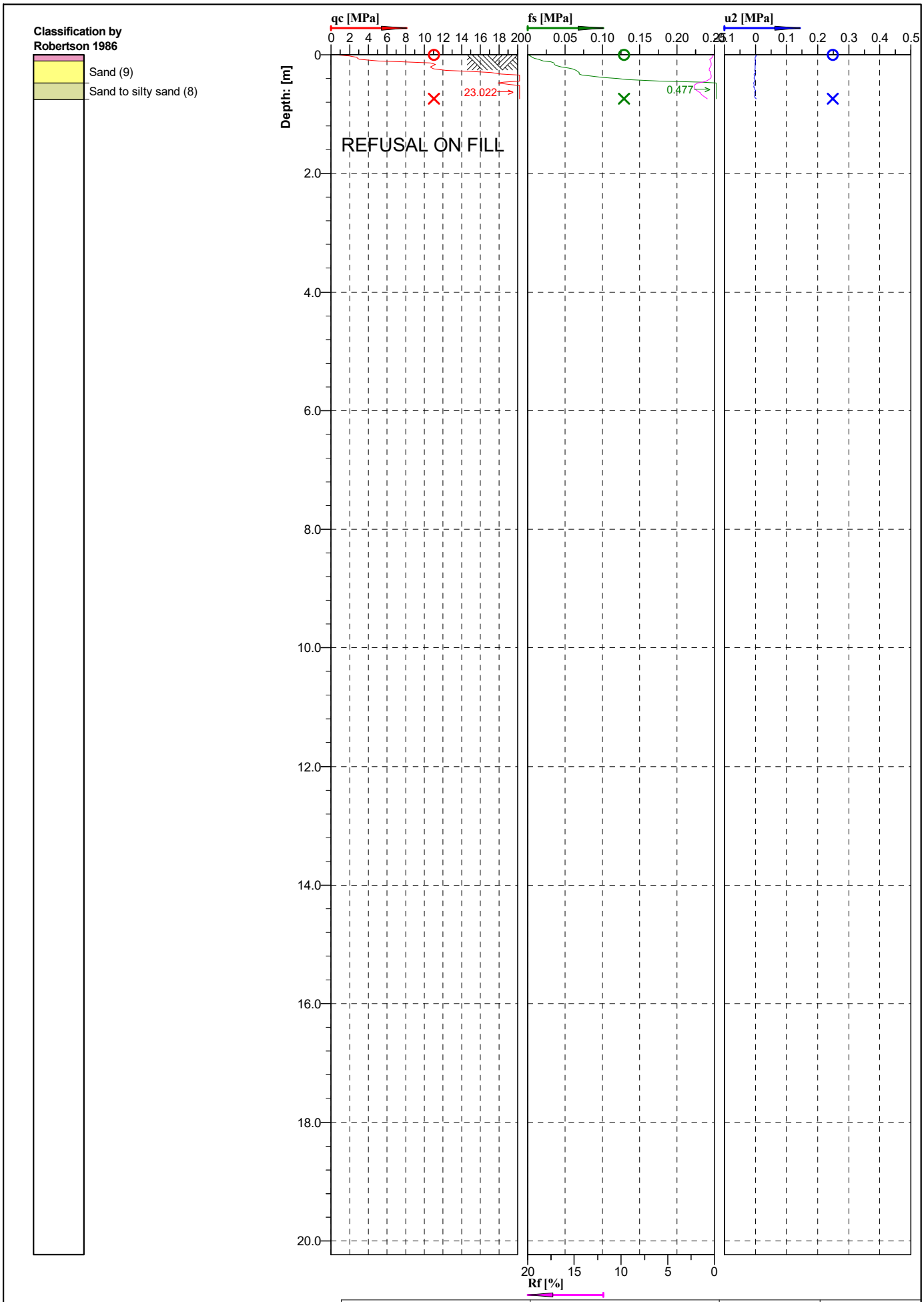


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT19
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54424 E 176.78616		File: CPT19.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

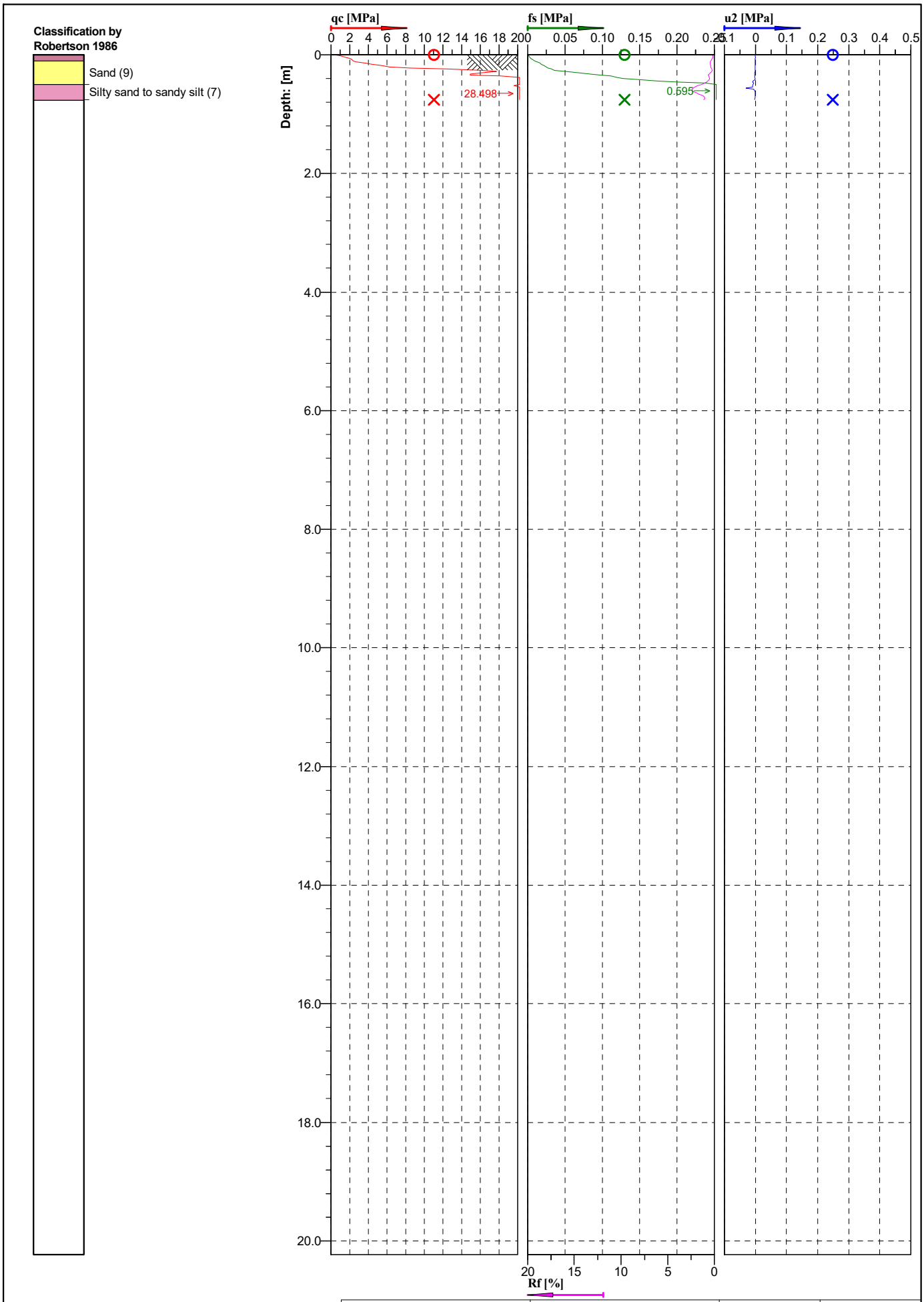


Location:	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT20
Project ID:	Client:	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LAND		Page: 1/1	Fig.:
		File: CPT20.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

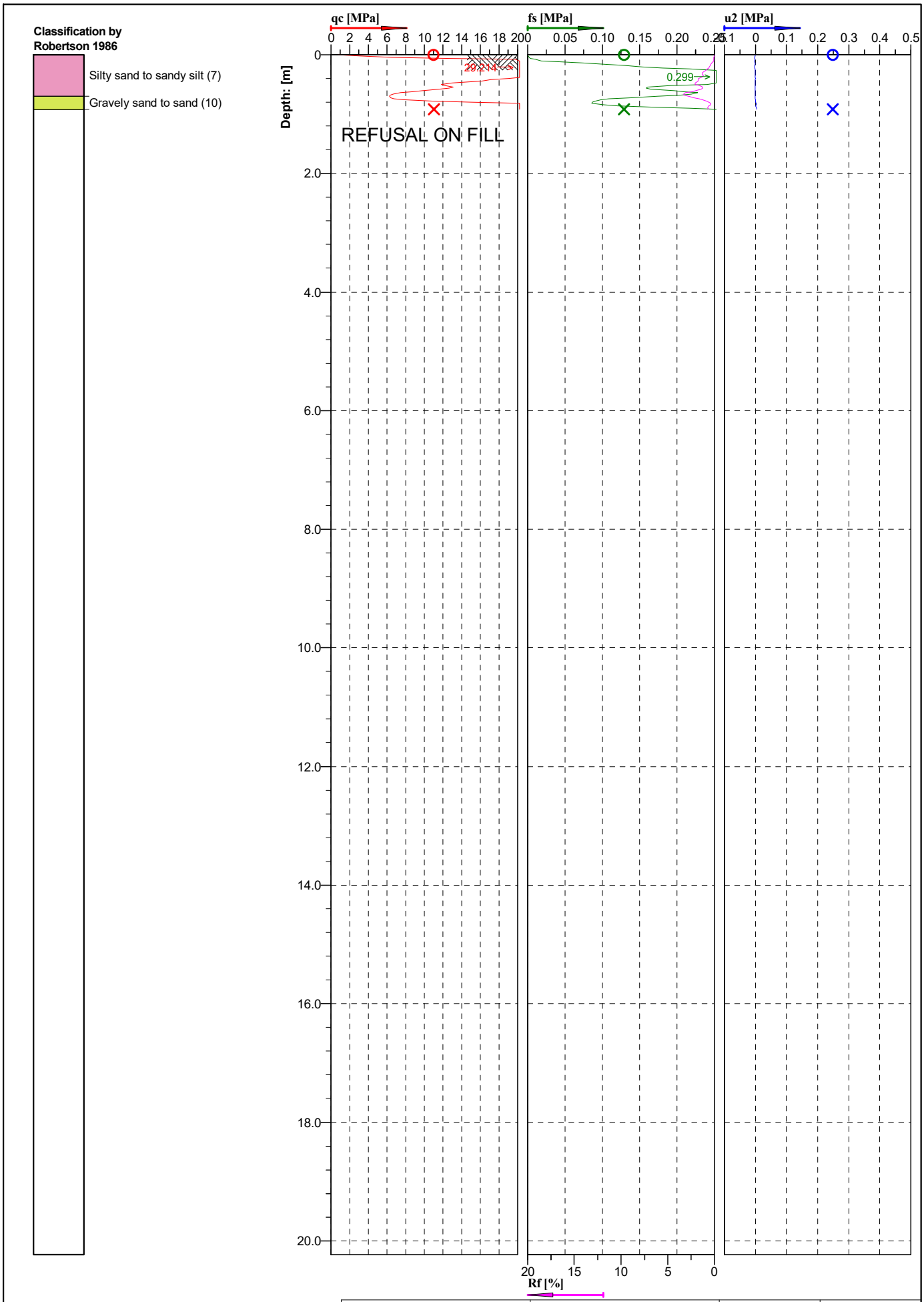


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT20A
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54458 E 176.78604		File: CPT20A.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

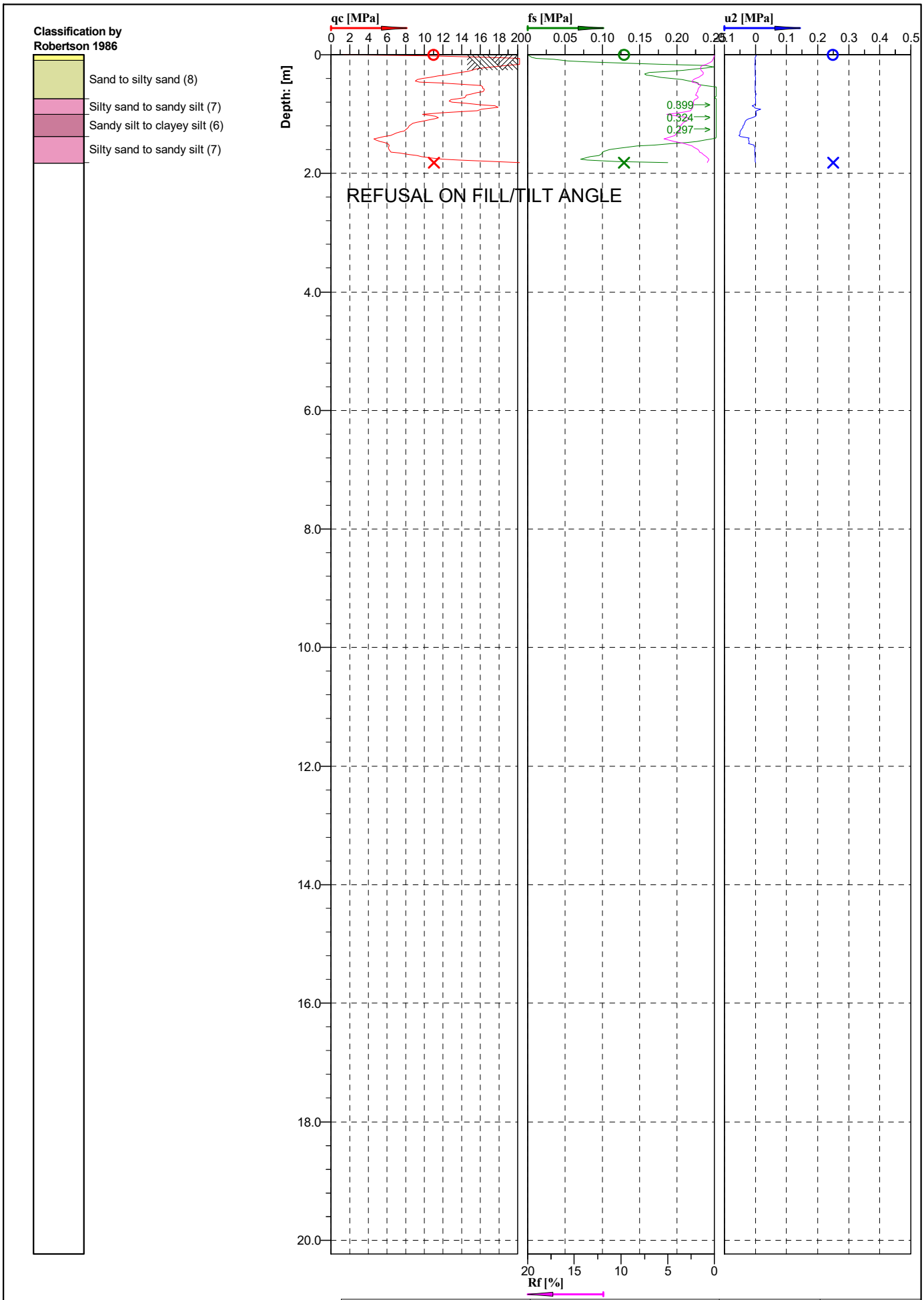


Location:	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT21
Project ID:	Client:	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LAND		Page: 1/1	Fig.:
		File: CPT21.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

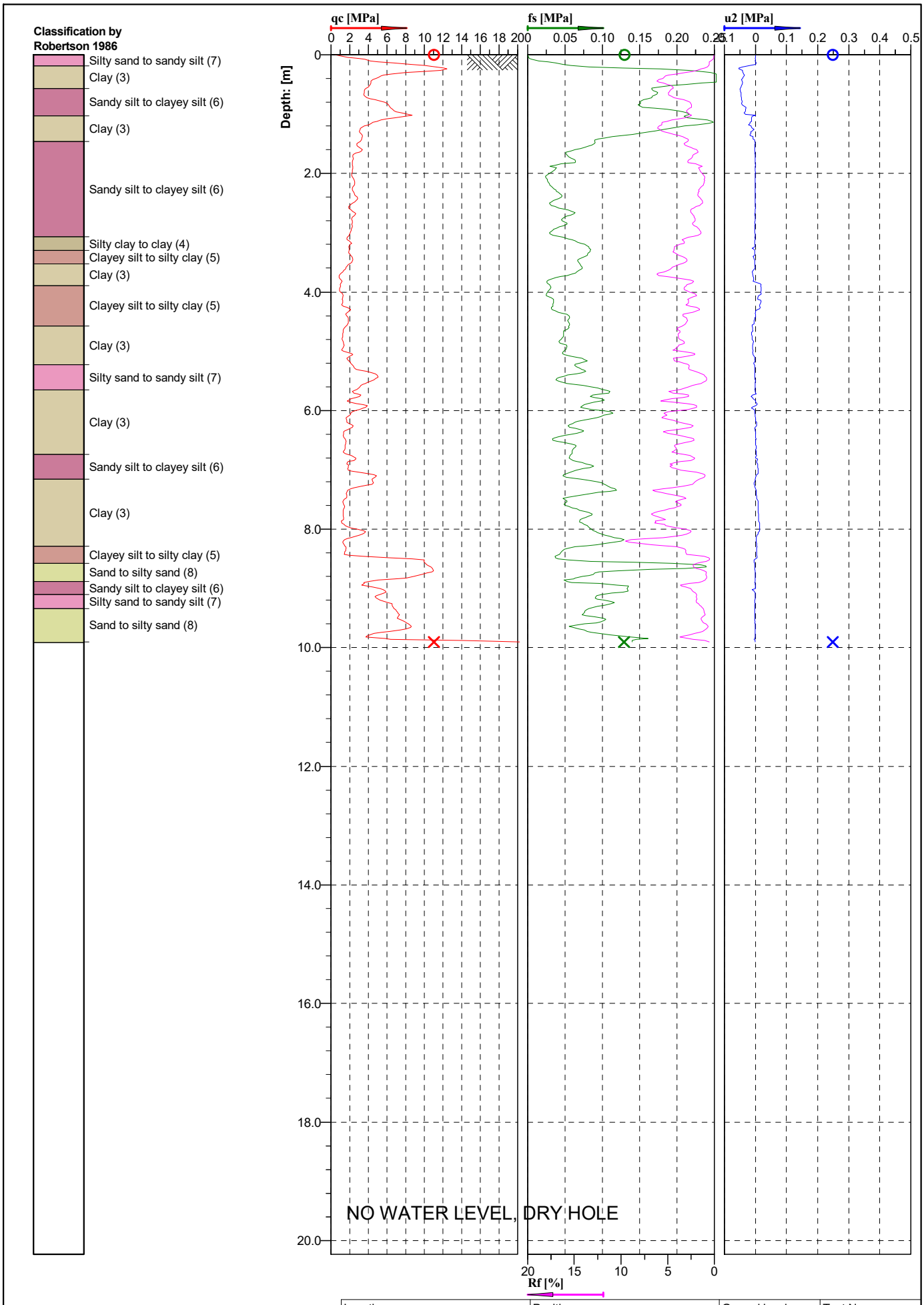


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT22
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54437 E 176.78712		File: CPT22.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

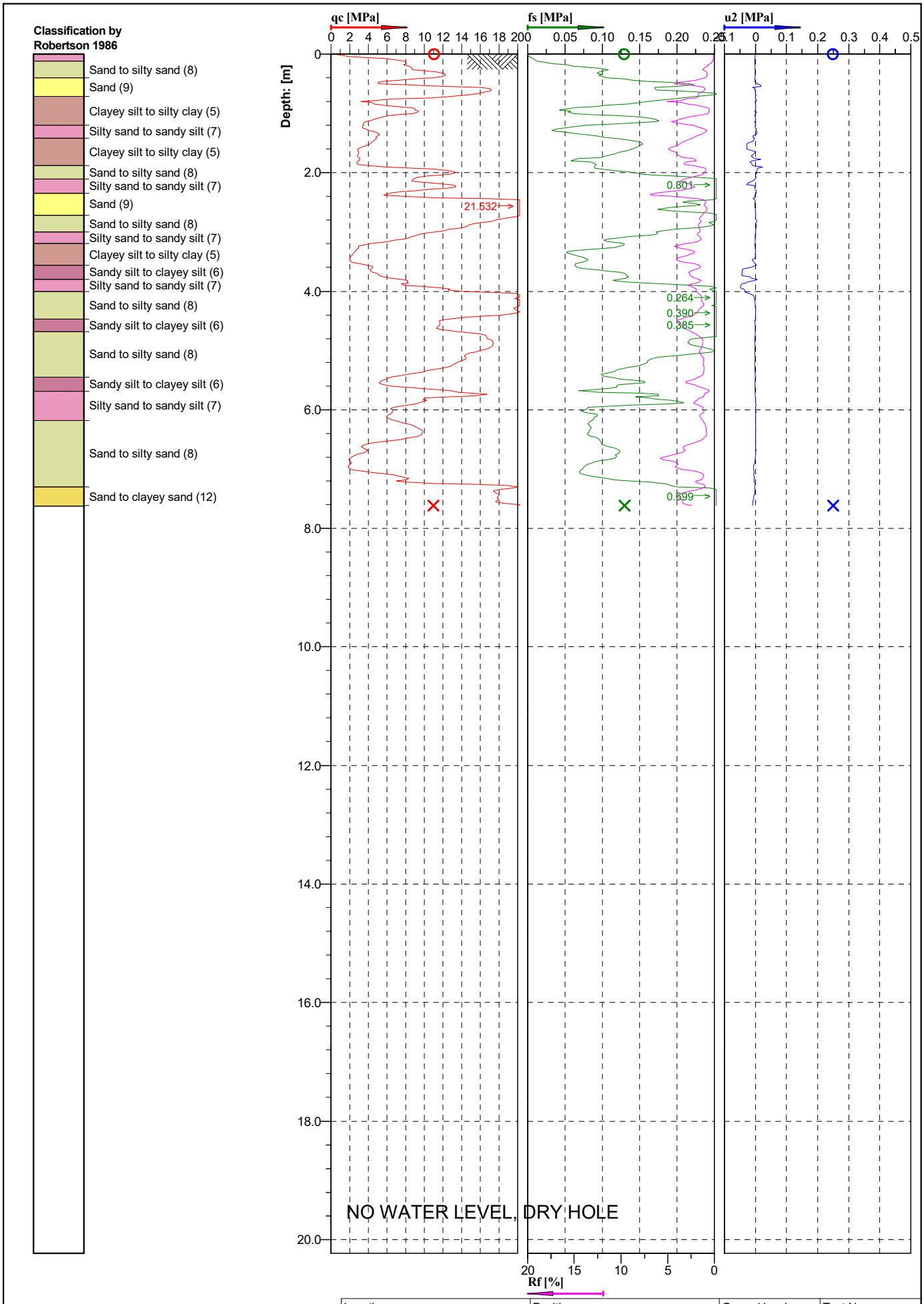


Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT23
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54396 E 176.78745		File: CPT23.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150



Location: NAPIER	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test No.: CPT24
Project ID: 100647.1000	Client: TONKIN & TAYLOR LTD	Date: 20/04/2018	Scale: 1 : 85
Project: NAPIER LANDFILL		Page: 1/1	Fig.:
S 39.54437 E 176.78636		File: CPT24.cpt	

GEOTECH DRILLING

u2

Cone No: 4870
Tip area [cm2]: 10
Sleeve area [cm2]: 150

EXCAVATION LOG

Excavation Id.: **Area B-TP1**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B	LOCATION: Omaranui Landfill, Hawkes Bay	JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812180.50 N 409915.70 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	27/04/2018
		EQUIPMENT:	14 T Ex	EXCAV. FINISHED:	27/04/2018
R.L.:	56.29m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	5m by 3m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION (-1 -2 -3)	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) (10 25 50 100 200)	DEFECTS, STRUCTURE, COMMENTS	UNIT
		DRY 27/04/2018	Sample BS1 @ 1.0m		56	0.5		Slightly weathered dark brown fine SANDSTONE and sandy LIMESTONE, very weak to weak, rare shell beds	D / SW				Petane Formation
			Sample BS2 @ 2.0m		55	1.0							
					54	1.5							
						2.0							
			Sample BS3 @ 2.9m		53	2.5		2.9m: Target depth					
						3.0							
						3.5							

SKETCH / PHOTO:

COMMENTS: Pit dry on Completion

Hole Depth 2.9m

Scale 1:33

Rev.: A

Excavation - 29/05/2018 12:09:21 PM - Produced with Core-GS by GeRoc

EXCAVATION LOG

Excavation Id.: **Area B-TP2**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B | LOCATION: Omaranui Landfill, Hawkes Bay | JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812177.20 N 409958.30 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	27/04/2018
		EQUIPMENT:	14T Ex	EXCAV. FINISHED:	27/04/2018
R.L.:	57.62m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	5.5m by 2.5m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION (-1 -2 -3)	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE \ WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) (10 25 50 100 200)	DEFECTS, STRUCTURE, COMMENTS	UNIT
		DRY 27/04/2018	Sample BS1 @ 3.8m		57	0.5		Slightly weathered light greyish brown sandy LIMESTONE, very weak to weak. [Ripper blade required to excavate] Weakly cemented	D / SW				Petane Formation
					56	1.0							
						1.5							
					55	2.0							
						2.5							
					54	3.0		Slightly weathered brown slightly shelly fine SANDSTONE, very weak					
						3.5							
						4.0		4m: Target depth					
					53	4.5							

SKETCH / PHOTO:

COMMENTS: Pit dry on Completion

Hole Depth 4m

Scale 1:42

Rev.: A

Excavation - 29/05/2018 12:09:21 PM - Produced with Core-GS by GeRoc

EXCAVATION LOG

Excavation Id.: **Area B-TP3**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B | LOCATION: Omaranui Landfill, Hawkes Bay | JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812098.50 N 409929.40 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	26/04/2017
		EQUIPMENT:	14 T Ex	EXCAV. FINISHED:	26/04/2017
R.L.:	53.11m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	5.5m by 4m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE \ WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
-1 -2 -3					53	0.5		SILT, some fine sand and minor clay; brown. Stiff, moist, low to moderate plasticity	M / CW	St	10 25 50 100 200		
			Sample BS1 @ 0.8m			1.0							
					52			SILT, some fine sand, trace clay; brown. Stiff, moist-wet, low plasticity.	M-W / HW-CW				
			Sample BS2 @ 2.2m			1.5							
					51	2.0							
						2.5		Highly weathered sandstone-recvoered as Sandy SILT with some gravels, minor clay; dark brown, wet, low plasticity.	W / HW				
		▼			50	3.0							
						3.5							
						4.0							
			Sample BS3 @ 4.3m		49								Petane Formation
						4.5		4.5m: Target depth					

SKETCH / PHOTO:

COMMENTS:

Hole Depth 4.5m

Scale 1:42

Rev.: A

Excavation - 29/05/2018 12:09:22 PM - Produced with Core-GS by GeRoc v3.11

EXCAVATION LOG

Excavation Id.: **Area B-TP4**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B	LOCATION: Omaranui Landfill, Hawkes Bay	JOB No.: 1000647.1000
CO-ORDINATES: 812093.30 N (HAWKTM2000) 409851.50 E	EXPOSURE METHOD: TP	EXCAV. STARTED: 26/04/2018
	EQUIPMENT: 14T Ex	EXCAV. FINISHED: 26/04/2018
R.L.: 49.32m	OPERATOR: Fulton Hogan	LOGGED BY: JWY
DATUM: NAPIHT1962	DIMENSIONS: 4.5m by 2.5m	CHECKED BY: CWM

EXCAVATION TESTS					ENGINEERING DESCRIPTION						GEOLOGICAL	
PENETRATION -1 -2 -3	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) 10 25 50 100 200	DEFECTS, STRUCTURE, COMMENTS	UNIT
		DRY 26/04/2018	Sample BS1 @ 2.8m		49	0.5		Sightly weathered dark brown SANDSTONE, occasional limestone layers and shell beds, very weak	D / SW				Petane Formation
					48	1.0							
						1.5							
					47	2.0							
						2.5							
						3.0		Slightly weathered greyish brown sandy coquina LIMESTONE, very weak to weak. Weakly cemented					
					46	3.5							
						4.0		4m: Target depth					
					45	4.5							

SKETCH / PHOTO:

COMMENTS: Pit dry on Completion

Hole Depth 4m

Scale 1:42

Rev.: A

Excavation - 29/05/2018 12:09:22 PM - Produced with Core-GS by GeRoc

EXCAVATION LOG

Excavation Id.: **Area B-TP5**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B | LOCATION: Omaranui Landfill, Hawkes Bay | JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812055.50 N 409817.60 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	26/04/2018
		EQUIPMENT:	14 T Ex	EXCAV. FINISHED:	26/04/2018
R.L.:	49.10m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	3m by 2m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
-1 -2 -3		DRY 26/04/2018			49	0.5		Slightly to unweathered dark greenish grey and brown LIMESTONE, weak to moderately strong,very well cemented- [difficult to rip with 14 T excavator]	D / UW-SW		10 25 50 100 200		Petane Formation
					48	1.0		1m: Target depth					
					47	1.5							
						2.0							
					46	2.5							
						3.0							
						3.5							

SKETCH / PHOTO:

COMMENTS: Pit dry on Completion

Hole Depth 1m

Scale 1:33

Rev.: A

Excavation - 29/05/2018 12:09:22 PM - Produced with Core-GS by GeRoc

EXCAVATION LOG

Excavation Id.: **Area B-TP6**

Hole Location: Centre of Area B

SHEET: 1 OF 1

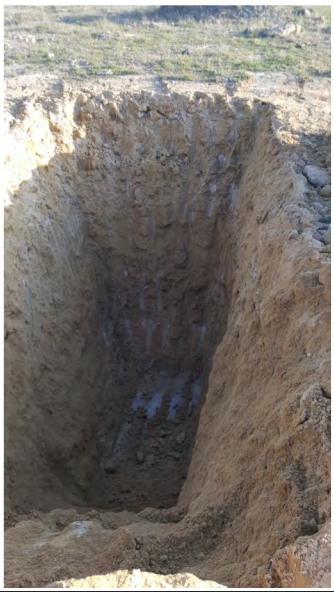
PROJECT: Omarunui Landfill Valley B | LOCATION: Omaranui Landfill, Hawkes Bay | JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812041.40 N 409907.40 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	26/04/2018
		EQUIPMENT:	14 T Ex	EXCAV. FINISHED:	26/04/2018
R.L.:	46.23m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	5m by 5m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa)	DEFECTS, STRUCTURE, COMMENTS	UNIT
-1 -2 -3		▼	Sample BS1 @ 0.8m		46	0.5		Slightly weathered greyish brown fine SANDSTONE with occasional bands of limestone, very weak	D / SW		10 25 50 100 200		
					45	1.0		Slightly weathered greyish brown sandy LIMESTONE, very weak to weak. Weakly cemented. [Ripped with single blade]	M / SW				Petane Formation
			Sample BS2 @ 2.0m		44	1.5							
						2.0							
			Sample Bs3 @ 3.0m		43	2.5							
						3.0							
						3.5		3.5m: Target depth					

SKETCH / PHOTO:



COMMENTS:

Hole Depth 3.5m

Scale 1:33

Rev.: A

Excavation - 29/05/2018 12:09:22 PM - Produced with Core-GS by GeRoc

EXCAVATION LOG

Excavation Id.: **Area B-TP7**

Hole Location: Centre of Area B

SHEET: 1 OF 1

PROJECT: Omarunui Landfill Valley B | LOCATION: Omaranui Landfill, Hawkes Bay | JOB No.: 1000647.1000

CO-ORDINATES: (HAWKTM2000)	812000.90 N 409881.10 E	EXPOSURE METHOD:	TP	EXCAV. STARTED:	26/04/2018
		EQUIPMENT:	14 T Ex	EXCAV. FINISHED:	26/04/2018
R.L.:	43.26m	OPERATOR:	Fulton Hogan	LOGGED BY:	JWY
DATUM:	NAPIHT1962	DIMENSIONS:	5.2m by 2.2m	CHECKED BY:	CWM

EXCAVATION TESTS | ENGINEERING DESCRIPTION | GEOLOGICAL

PENETRATION (-1 -2 -3)	SUPPORT	WATER	SAMPLES, TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	SOIL NAME, PLASTICITY OR PARTICLE SIZE CHARACTERISTICS, COLOUR, SECONDARY AND MINOR COMPONENTS	MOISTURE CONDITION \ WEATHERING	STRENGTH/DENSITY CLASSIFICATION	ESTIMATED SHEAR STRENGTH (kPa) (10 25 50 100 200)	DEFECTS, STRUCTURE, COMMENTS	UNIT
		DRY 26/04/2018	Sample BS1 @ 0.9m		43	0.5		Slightly weathered brown fine SANDSTONE, rare shells, very weak. Breaks down to silty fine sand when disturbed. [Difficult to excavate with 14 T excavator]	D / SW				Petane Formation
			Sample BS2 @ 2.6m		42	1.0							
						1.5							
					41	2.0							
						2.5							
						3.0		2.8m: Target depth					
					40	3.5							

SKETCH / PHOTO:

COMMENTS: Pit dry on completion

Hole Depth 2.8m

Scale 1:33

Rev.: A

Excavation - 29/05/2018 12:09:23 PM - Produced with Core-GS by GeRoc

Appendix D: Geotechnical laboratory test results

- 2009 Permeability tests
- 2018 UCS Testing
- 2018 Triaxial testing

GEOTECHNICS

Our Ref: 1006993.0000/Rep1
Customer Ref: 1000647.1000
6 July 2018

Tonkin + Taylor
PO Box 5271
Wellesley Street
Auckland 1141

Attention: Jamie Yule

Dear Mr. Yule

Omarunui Landfill - Area B Consent

Laboratory Test Report

Samples from the above mentioned site have been tested as received according to your instructions. Test results are included in this report.

Samples not destroyed during testing will be retained for one month from the date of this report before being discarded.

Descriptions are enclosed for your information, but are not covered under the IANZ endorsement of this report.

Please reproduce this report in full when transmitting to others or including in internal reports.

If we can be of any further assistance, feel free to get in touch. Contact details are provided at the bottom of this page.

GEOTECHNICS LTD

Report prepared by:

.....
Helen Wang
Triaxial Laboratory Manager
Approved Signatory

Authorised for Geotechnics by:

.....
Victor O'Connor
Project Director

Report checked by:

.....
Victor O'Connor
Managing Director

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

9-Jul-18
t:\geotechnicsgroup\projects\1006993\issueddocuments\20180706 omarunui area b consent -yhw.rep1.docx

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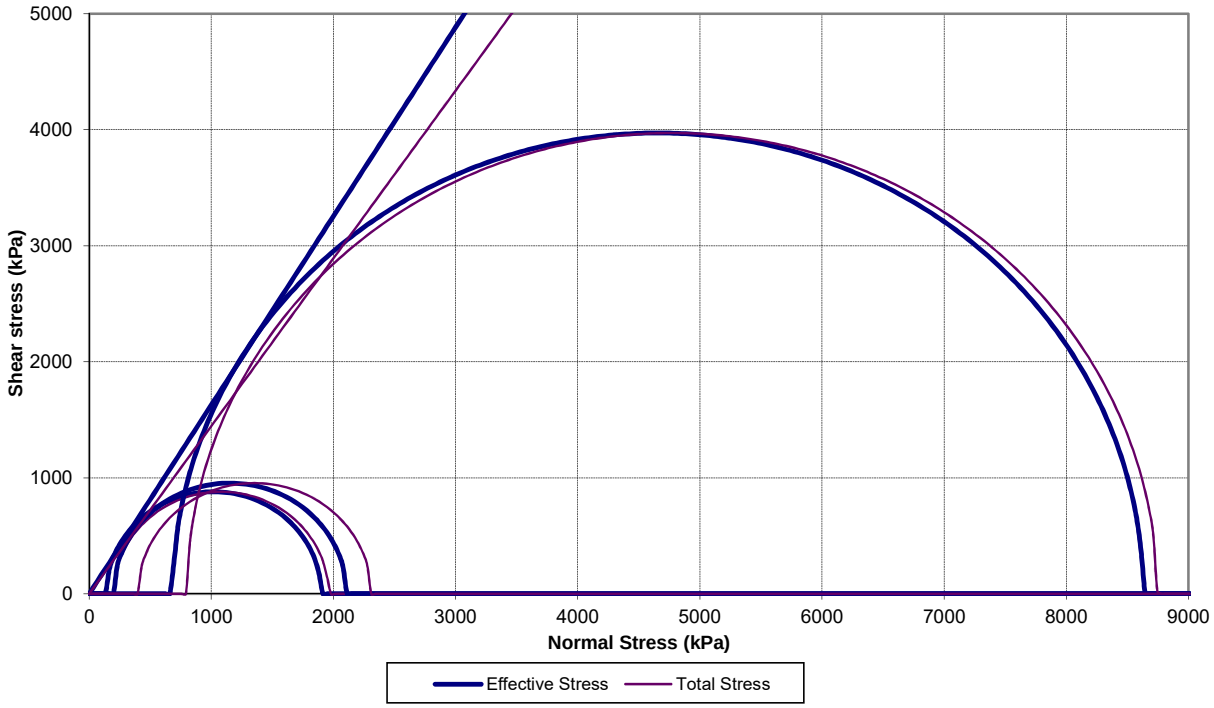
w. www.geotechnics.co.nz

Site: Omarunui Landfill Area B Consent | Your Project ID: 1000647.1000 | Project ID: 1006993.0000
Location ID: BC14 | Sample Ref.: | Depth: 21.41 -- 25.88 (m)
Test method used: BS1377:Part 8:1990:Clause 5 Saturation | BS1377:Part 8:1990:Clause 6 Consolidation
BS1377:Part 8:1990:Clause 7 Consolidated-undrained triaxial compression test with pore pressure measurement
NZS 4402:1986 Test 2.1 Determination of Water Content

CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST (3 STAGES)

MOHR CIRCLES OF TOTAL AND EFFECTIVE STRESSES



	Specimen 1	Specimen 2	Specimen 3	
Borehole Number:	BC14	BC14	BC14	
Sample Number:				
Depth:	21.41 -- 21.53	24.26 -- 24.48	25.76 -- 25.88	m
Initial Sample Height:	126.26	121.71	121.52	mm
Initial Sample Diameter:	61.04	61.51	61.30	mm
Initial Water Content:	14.0	19.5	8.6	%
Initial Bulk Density:	2.09	2.06	2.26	t/m³
Initial Dry Density:	1.83	1.72	2.08	t/m³
Final Water Content:	16.6	20.1	9.7	%
Initial B Value:	4	0	0	%
B Value before Consolidation:	96	94	96	%

	Consolidation Stage			Failure Values					
	Cell Pressure (kPa)	Back Pressure (kPa)	Eff. Consol. Stress (kPa)	Deviator Stress (kPa)	Pore Pressure Change During Shearing δμ (kPa)	Effective Principal Stress (kPa) Major σ1'	Minor σ3'	Vertical Strain (%)	Test Speed (mm/min)
SPECIMEN 1	650	450	200	1759.81	60.6	1899.21	139.40	0.45	0.020
SPECIMEN 2	700	300	400	1908.59	201.7	2106.89	198.30	0.73	0.023
SPECIMEN 3	1100	300	800	7945.09	115.6	8629.49	684.40	1.27	0.020

		Total			Effective	
Angle of Frictional Resistance:	ϕ =	55	°	ϕ' =	58	°
Cohesion:	c =	0	kPa	c' =	0	kPa
Linear Regression Coefficient:	r =	0.998		r =	1.000	

Sample History: Undisturbed core trimmed at natural water content.

Soil description: Specimen 1: Brown, extremely weak to very weak SANDSTONE with minor sand.
Specimen 2: Brown, extremely weak to very weak SANDSTONE with minor to some sand.
Specimen 3: Brown, weak to very weak SANDSTONE.

Failure Mode: Specimen1: Planar | Specimen 2: Planar | Specimen 3: Planar

Test Remarks: The sample was saturated by increments of cell pressure and back pressure.
Failure for each stage was determined by the maximum effective stress ratio.
Strength parameters have been derived by using a linear regression fitting method. Total and Effective Cohesion C and C' derived were negative, and therefore were both forced to be zero with ø and ø' recalculated.
The third specimen was much stronger than the first and second specimens, which resulted in a very high friction angle derived from Mohr–Coulomb envelope for both effective and total strengths..

Entered by: | Date: 28/05/18 | Checked by: MH | Date: 6/07/18

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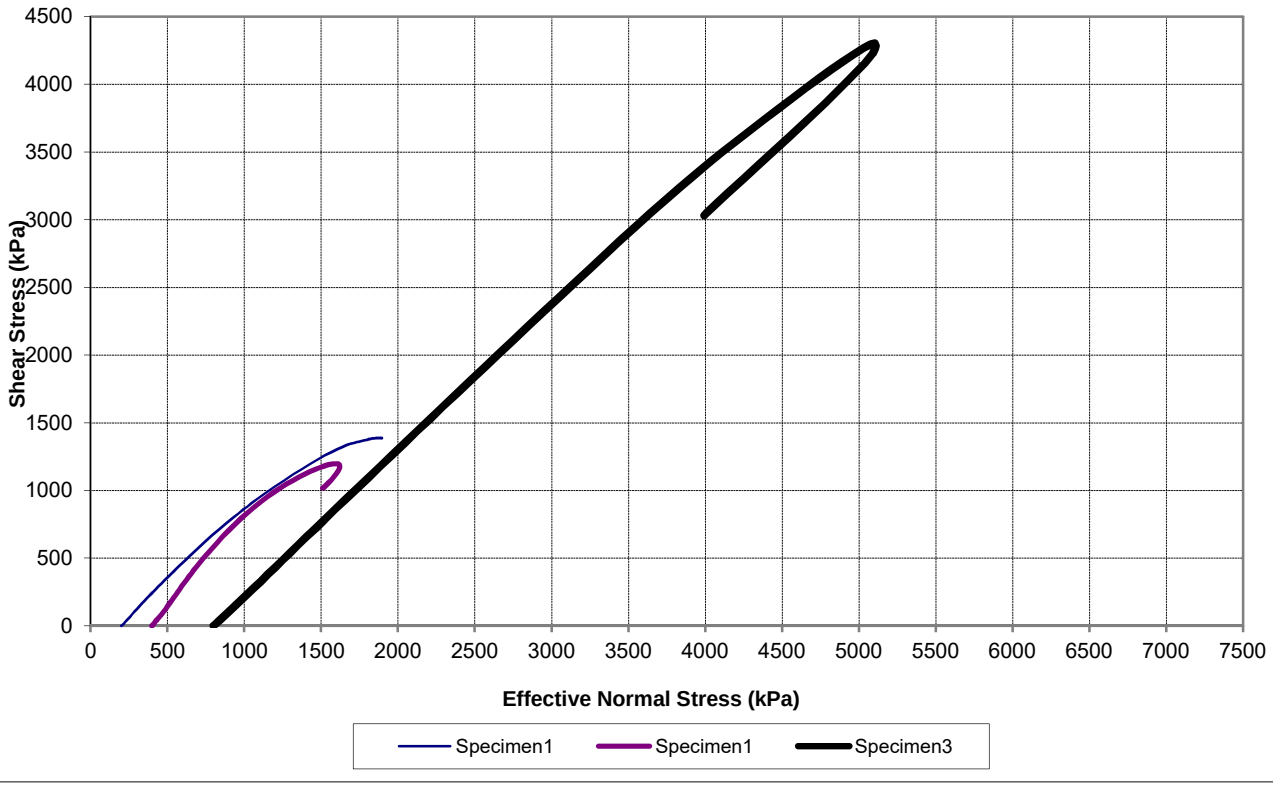
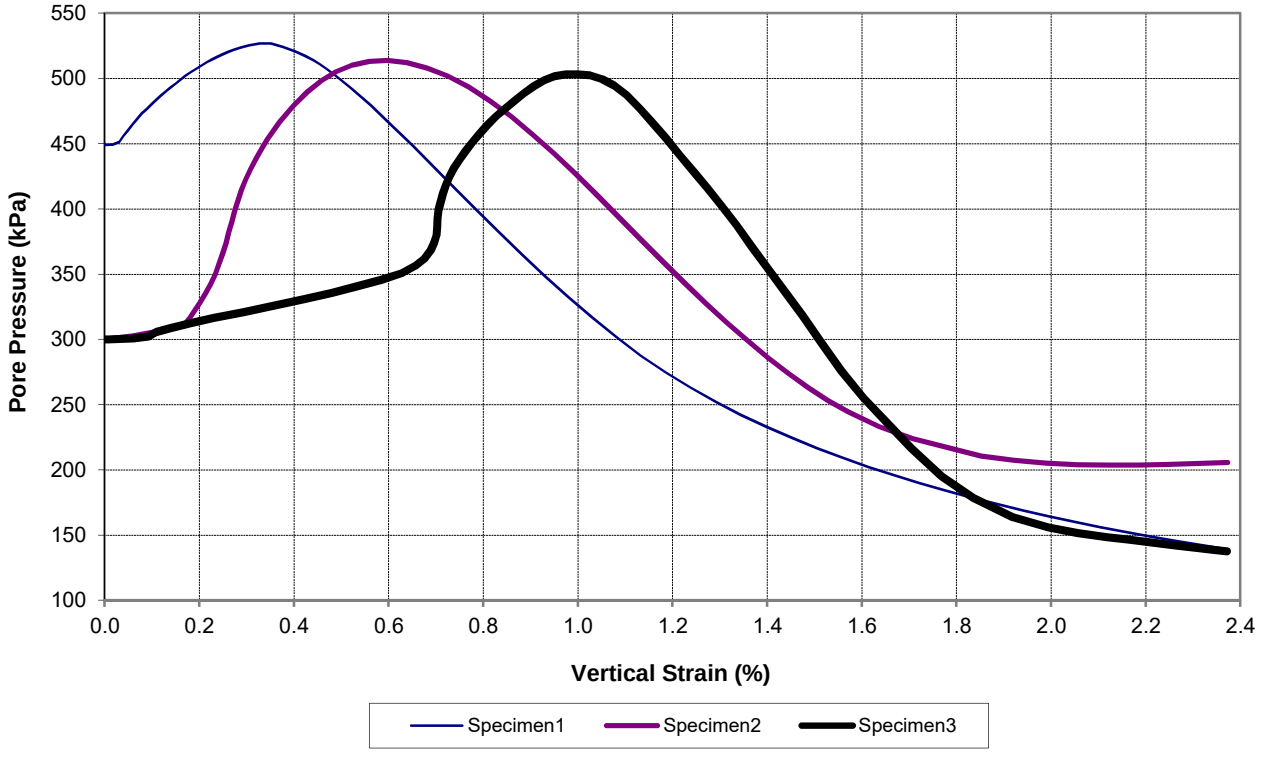
Site: Omarunui Landfill Area B Consent | Your Project ID: 1000647.1000 | Project ID: 1006993.0000
Location ID: BC14 | Sample Ref.: | Depth: 21.41 -- 25.88 (m)

GRAPHS

STRESS PATH



PORE PRESSURE Vs VERTICAL STRAIN



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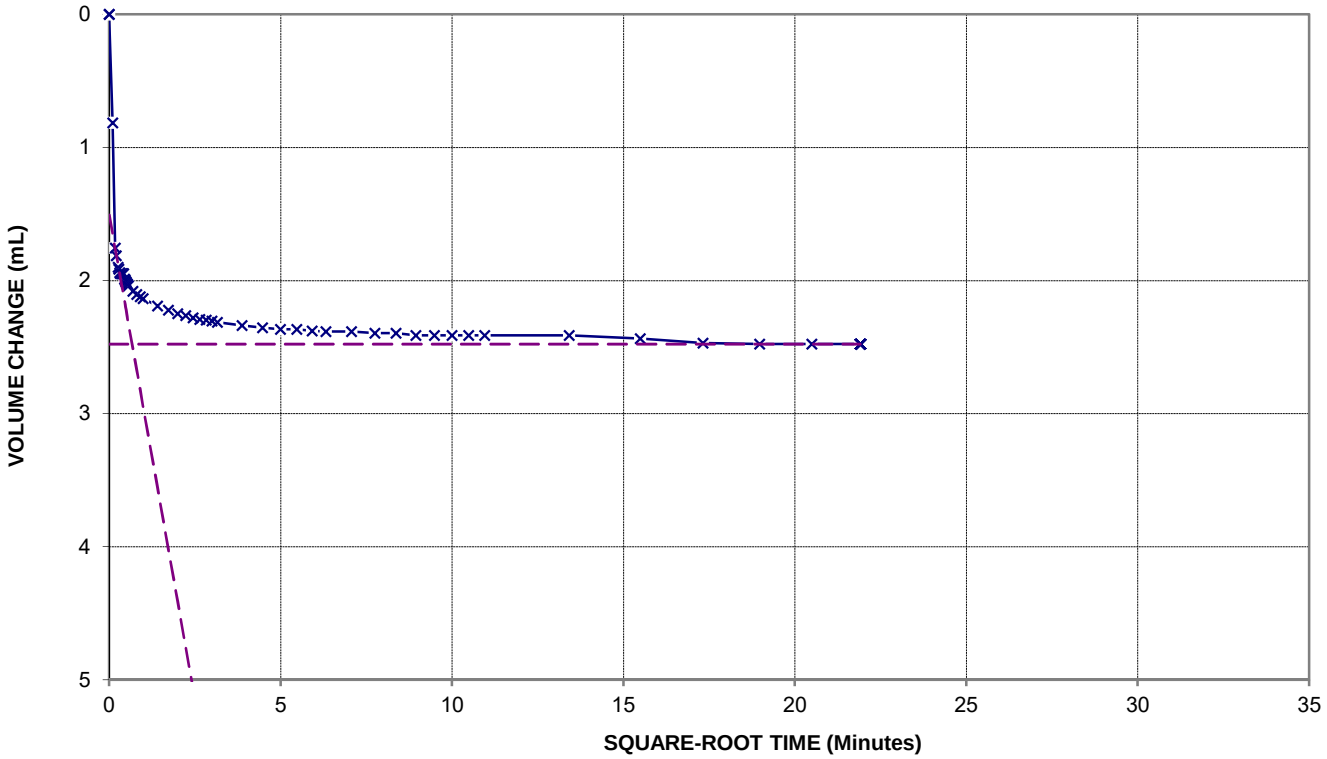
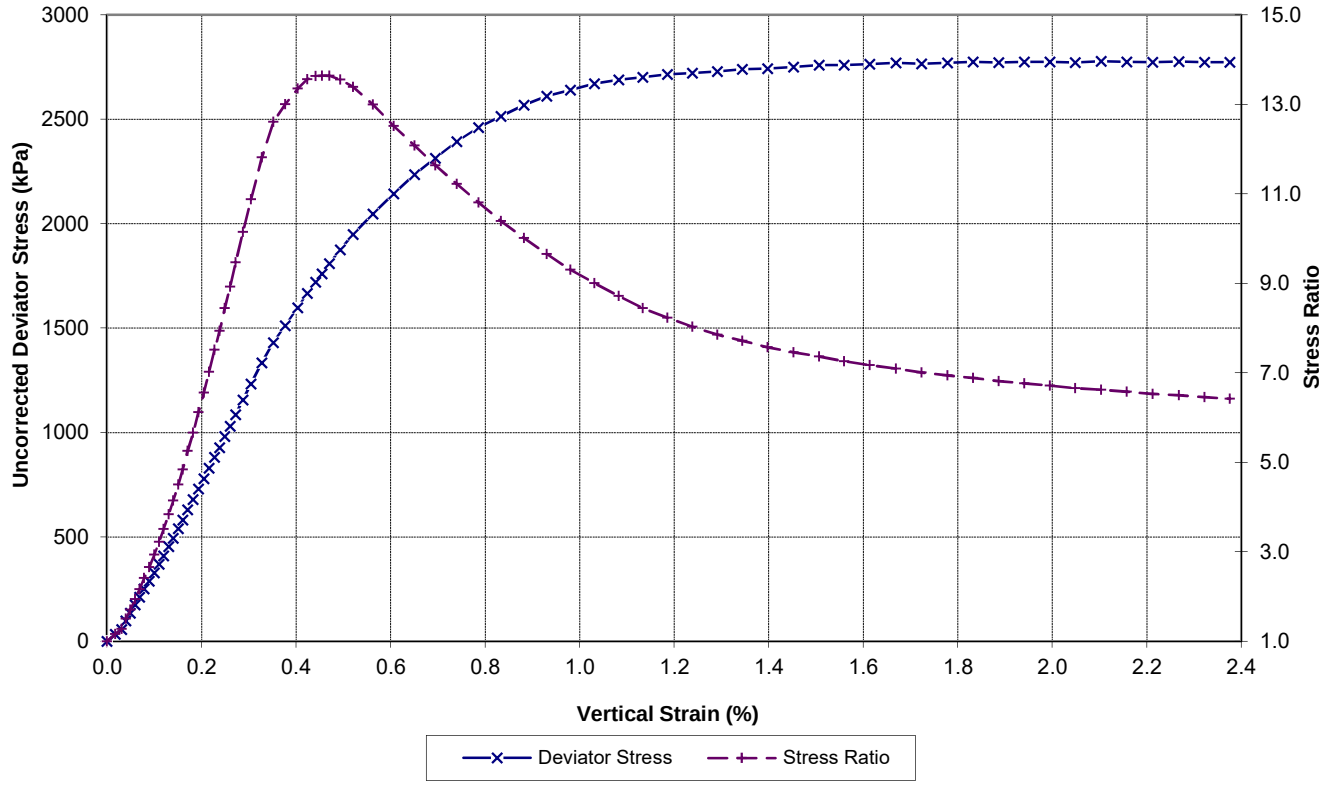
Site: Omarunui Landfill Area B Consent Your Project ID: 1000647.1000 Project ID: 1006993.0000
Location ID: BC14 Sample Ref.: Depth: 21.41 -- 21.53 (m)

SPECIMEN 1 GRAPHS

CONSOLIDATION



STRESS-STRAIN CURVE



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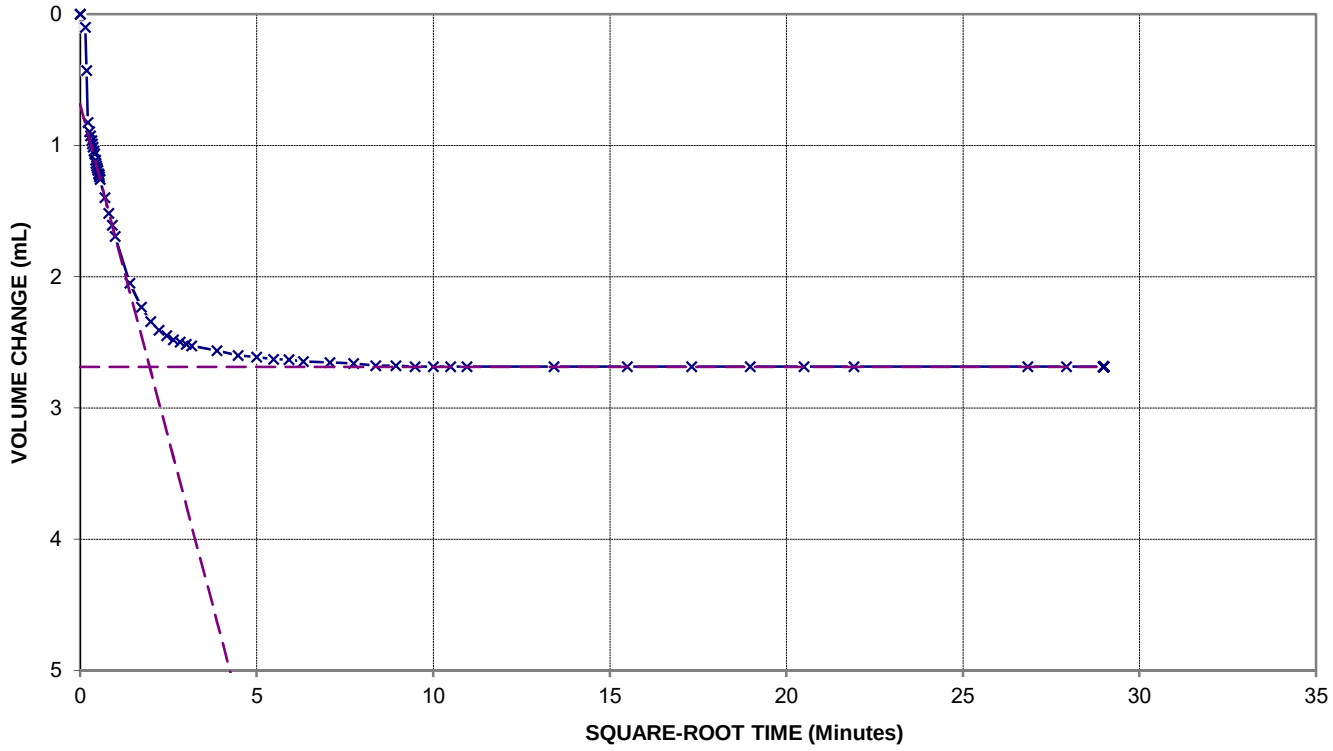
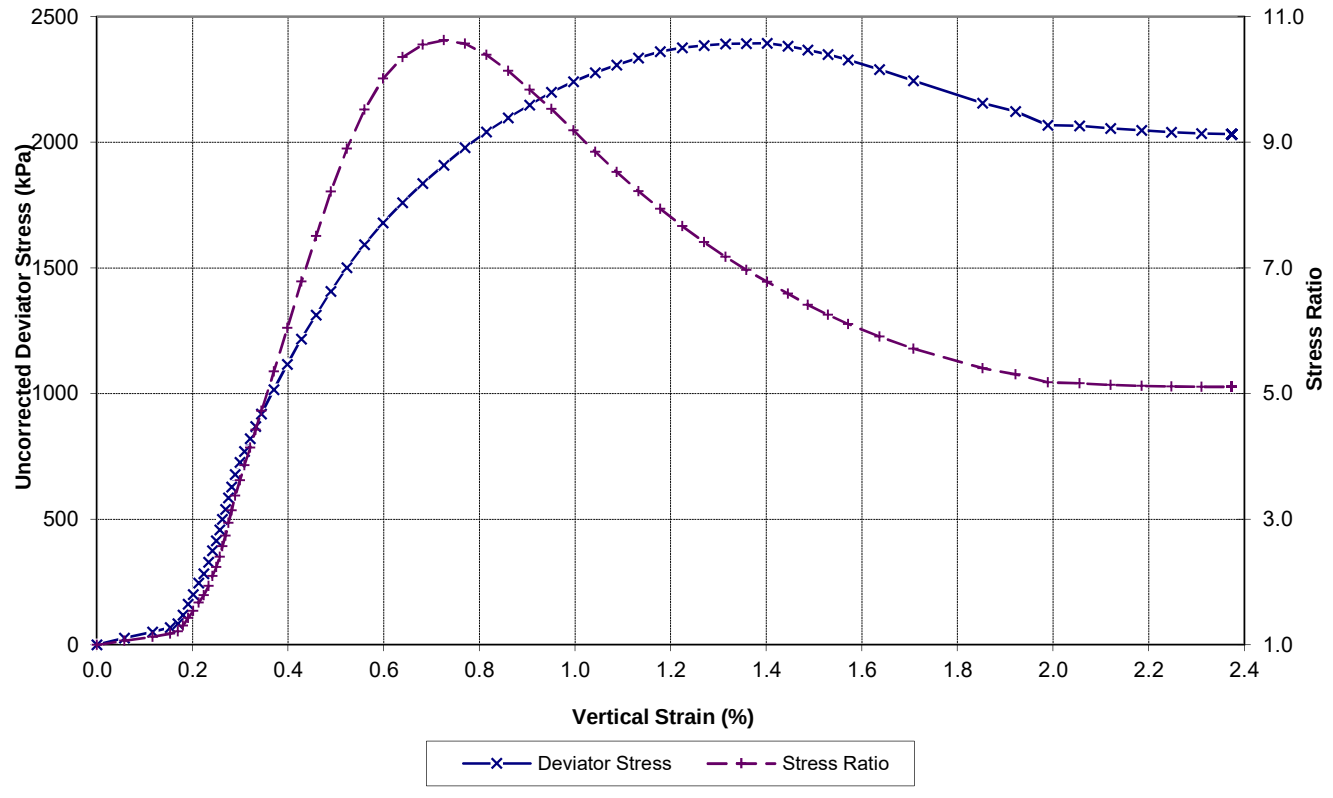
Site: Omarunui Landfill Area B Consent | Your Project ID: 1000647.1000 | Project ID: 1006993.0000
Location ID: BC14 | Sample Ref.: | Depth: 21.41 -- 21.53 (m)

SPECIMEN 2 GRAPHS

CONSOLIDATION



STRESS-STRAIN CURVE



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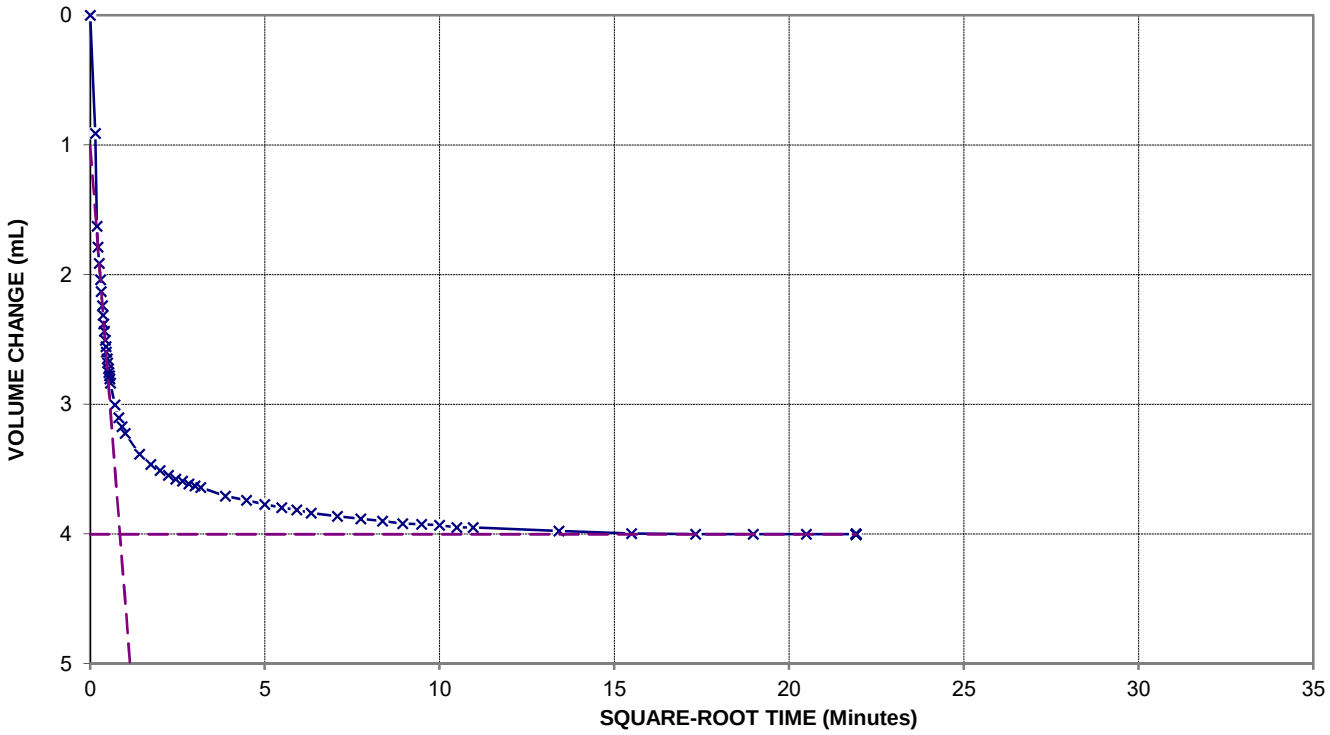
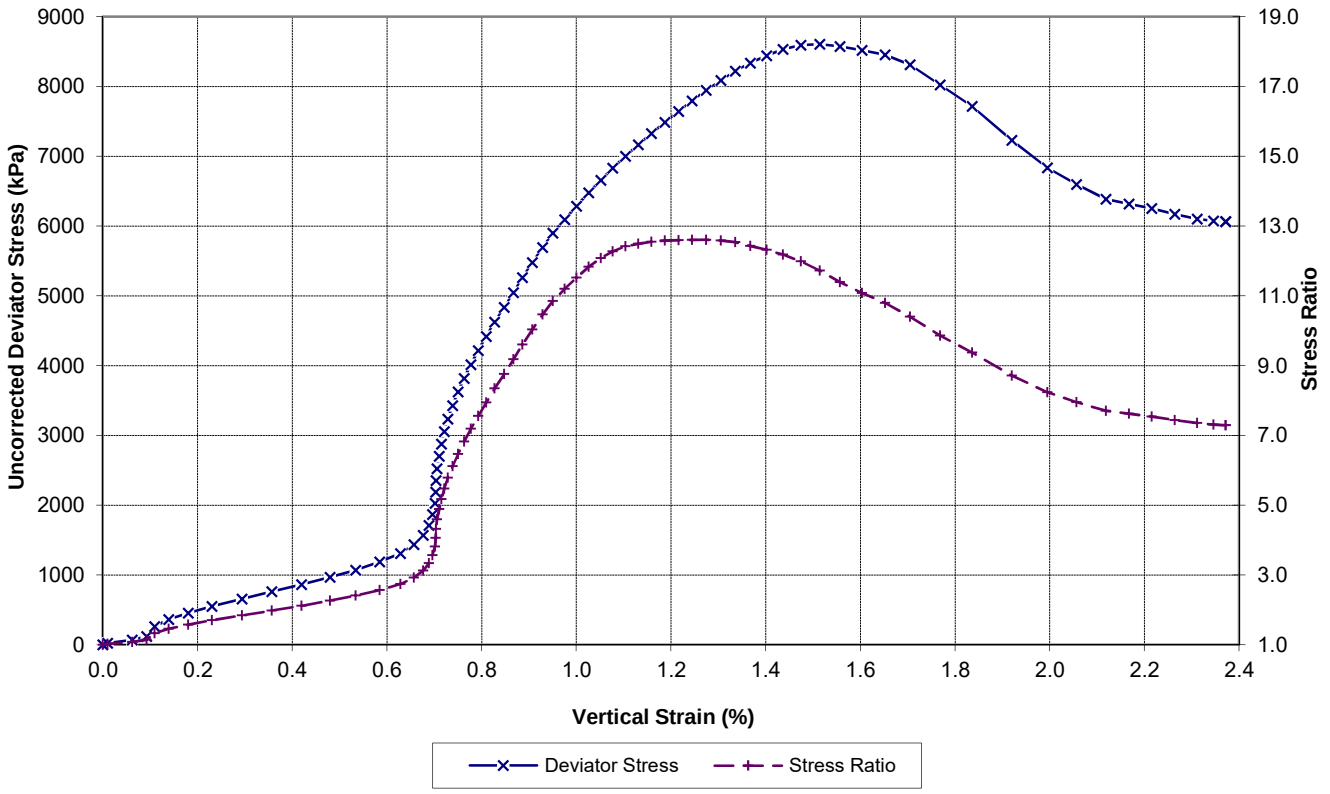
Site: Omarunui Landfill Area B Consent | Your Project ID: 1000647.1000 | Project ID: 1006993.0000
Location ID: BC14 | Sample Ref.: | Depth: 25.76 -- 25.88 (m)

SPECIMEN 3 GRAPHS

CONSOLIDATION



STRESS-STRAIN CURVE



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Form No.:	PT1
Form Date:	Oct 2002
P:\614993\WorkingMaterial\Summary.xlsx	

Your Ref. No.: 23610.100 Page of

Site: Omarunui Job No.: 614993.000

Test Method Used: BS 1377 : Part 6 : 1990 : Test 6 Constant Head Permeability Test in a Triaxial Cell

SUMMARY OF PERMEABILITY RESULTS

BOREHOLE / TEST PIT No.			BC5
SAMPLE No.			1
DEPTH			--
SAMPLE HISTORY			Undisturbed
SAMPLE PARAMETERS	Height	(mm)	71.21
	Diameter	(mm)	60.60
	Sample mass	(g)	417.38
	Initial bulk density	(t/m³)	2.03
	Initial dry density	(t/m³)	1.70
	Initial water content	(%)	19.4
	Final water content	(%)	20.7
	Final bulk density	(t/m³)	2.04
	Saturation at test (B)*	(%)	92
TESTING CONDITION	Mean effective stress	(kPa)	75
	Head difference	(kPa)	50
	Hydraulic gradient		72
COEFFICIENT OF PERMEABILITY AT 20 °C		(m/s)	**2.61E-08**

COMMENTS: *: Samples were saturated by increments of cell pressure and back pressure

Entered by: Date: 29/04/09 Checked by: Date: 29/04/09

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Form No.:	PT1
Form Date:	Oct 2002

P:\614993\614993.001\WorkingMaterial\Summary.xlsx

Your Ref. No.: 23610.100 Page of

Site: Omarunui Rd, Hastings, Hawkes Bay Job No.: 614993.001

Test Method Used: BS 1377 : Part 6 : 1990 : Test 6 Constant Head Permeability Test in a Triaxial Cell

SUMMARY OF PERMEABILITY RESULTS

BOREHOLE / TEST PIT No.			BC1	TP13	TP18
SAMPLE No.			1	1	1
DEPTH			13.5	1.3	1.8
SAMPLE HISTORY			Remoulded	Remoulded	Remoulded
TARGET VALUES	Target Moisture Content	(%)	Samples were remoulded at natural moisture content with NZ Standard Compaction effort.		
	Target Dry Density	(t/m³)			
SAMPLE PARAMETERS	Height	(mm)	115.04	115.04	115.04
	Diameter	(mm)	105.07	105.07	105.07
	Sample mass	(g)	1970.00	2001.00	1649.00
	Initial bulk density	(t/m³)	1.98	2.01	1.65
	Initial dry density	(t/m³)	1.58	1.63	1.51
	Initial water content	(%)	25.3	23.0	9.5
	Final water content	(%)	21.4	20.9	25.8
	Final bulk density	(t/m³)	2.08	2.01	1.82
	Saturation at test (B)*	(%)	96	94	92
TESTING CONDITION	Mean effective stress	(kPa)	30	75	75
	Head difference	(kPa)	20	50	50
	Hydraulic gradient		18	44	44
COEFFICIENT OF PERMEABILITY AT 20 °C		(m/s)	**1.10E-06**	**9.41E-11**	**5.60E-09**
BOREHOLE / TEST PIT No.			TP21	TP23	--
SAMPLE No.			1	1	--
DEPTH			1.2	1.2	--
SAMPLE HISTORY			Remoulded	Remoulded	--
TARGET VALUES	Target Moisture Content	(%)	Samples were remoulded at natural moilsture content with NZ Standard Compaction effort		--
	Target Dry Density	(t/m³)			--
SAMPLE PARAMETERS	Height	(mm)	115.04	115.04	--
	Diameter	(mm)	105.07	105.07	--
	Sample mass	(g)	1910.00	1767.00	--
	Initial bulk density	(t/m³)	1.91	1.77	--
	Initial dry density	(t/m³)	1.65	1.58	--
	Initial water content	(%)	16.3	11.9	--
	Final water content	(%)	22.6	23.7	--
	Final bulk density	(t/m³)	1.99	1.91	--
	Saturation at test (B)*	(%)	94	92	--
TESTING CONDITION	Mean effective stress	(kPa)	75	75	--
	Head difference	(kPa)	50	50	--
	Hydraulic gradient		44	44	--
COEFFICIENT OF PERMEABILITY AT 20 °C		(m/s)	**1.61E-09**	**5.37E-07**	--

COMMENTS: *: Samples were saturated by increments of cell pressure and back pressure

Entered by: Date: 5/05/09 Checked by: PL Date: 5/5/09

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Form No.:	PT1
Form Date:	Oct 2002
P:\614619\614619.004\WorkingMaterial\Summary.xlsx	

Your Ref. No.: 23668 Page of

Site: Omarunui Rd, Hastings, Hawkes Bay Job No.: 614619.004

Test Method Used: BS 1377 : Part 6 : 1990 : Test 6 Constant Head Permeability Test in a Triaxial Cell

SUMMARY OF PERMEABILITY RESULTS

BOREHOLE / TEST PIT No.			--	--
SAMPLE No.			1	2
DEPTH			--	--
SAMPLE HISTORY			Remoulded	Remoulded
TARGET VALUES	Target Moisture Content	(%)	Samples were remoulded at their natural moisture content with NZ Standard Compaction effort.	
	Target Dry Density	(t/m³)		
SAMPLE PARAMETERS	Height	(mm)	115.04	115.04
	Diameter	(mm)	105.07	105.07
	Sample mass	(g)	1996.00	1983.00
	Initial bulk density	(t/m³)	2.00	1.99
	Initial dry density	(t/m³)	1.62	1.68
	Initial water content	(%)	21.2	18.2
	Final water content	(%)	23.3	22.5
	Final bulk density	(t/m³)	2.02	2.03
	Saturation at test (B)*	(%)	94	92
TESTING CONDITION	Mean effective stress	(kPa)	75	75
	Head difference	(kPa)	50	50
	Hydraulic gradient		44	44
COEFFICIENT OF PERMEABILITY AT 20 °C		(m/s)	**1.68E-07**	**2.33E-07**

COMMENTS: *: Samples were saturated by increments of cell pressure and back pressure

Entered by: Um Date: 29/04/09 Checked by: DH Date: 29/04/09

UNCONFINED COMPRESSIVE STRENGTH TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**May-18**
Sampling method :	**Drill Core**
Sample description :	**Soft Rock**

Project No :	**2-L0065.09**
Lab Ref No :	**NA 1591**
Client Ref No :	

Test Results

Borehole ID	Depth (m)	Bulk Density (t/m3)	UCS Strength (Mpa)
BC13	3.5 - 3.7	2.089	2.20
BC13	6.9 - 7.1	2.074	2.68
BC14	10.2 - 10.4	2.107	2.76
BC14	29	2.03	4.84
BC14	30.1 - 30.35	2.139	3.43
BC14	32.8 - 32.93	2.36	20.60
BC14	34.55 - 35.7	2.388	23.19

Date tested : 18/05/18
Date reported : 25/05/18

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Approved

Designation : ***Laboratory Manager***
Date : 25/05/18

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Napier Laboratory
Quality Management Systems Certified to ISO 9001

90 Prebensen Drive
Private Bag 6019, Hawkes Bay Mail Centre, Napier 4142, New Zealand

Telephone +64 6 833 5590
Website www.wsp-opus.co.nz

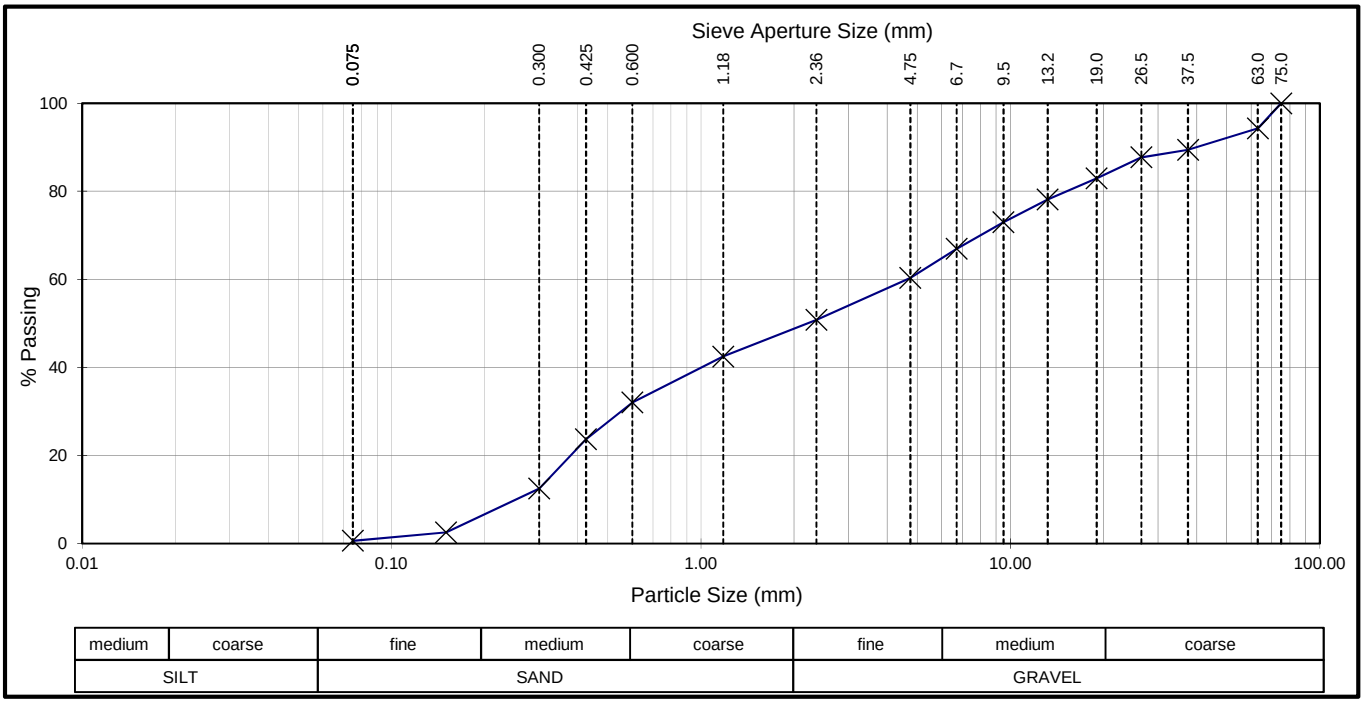
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Sand & Gravel**
Sample condition	**Moist**
Test Pit No:	**01**
Depth (m) :	**1.0m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA1591 / 1**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	**100**	19.00	**83**	4.75	**60**	0.425	**24**
63.00	**94**	13.20	**78**	2.36	**51**	0.300	**12**
37.50	**89**	9.50	**73**	1.18	**42**	0.150	**3**
26.50	**88**	6.70	**67**	0.600	**32**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 03/05/18
Date reported : 25/05/18

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Approved

Designation : ***Laboratory Manager***
Date : 25/05/18

WSP Opus
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Telephone +64 6 833 5590
Website www.wsp-opus.co.nz

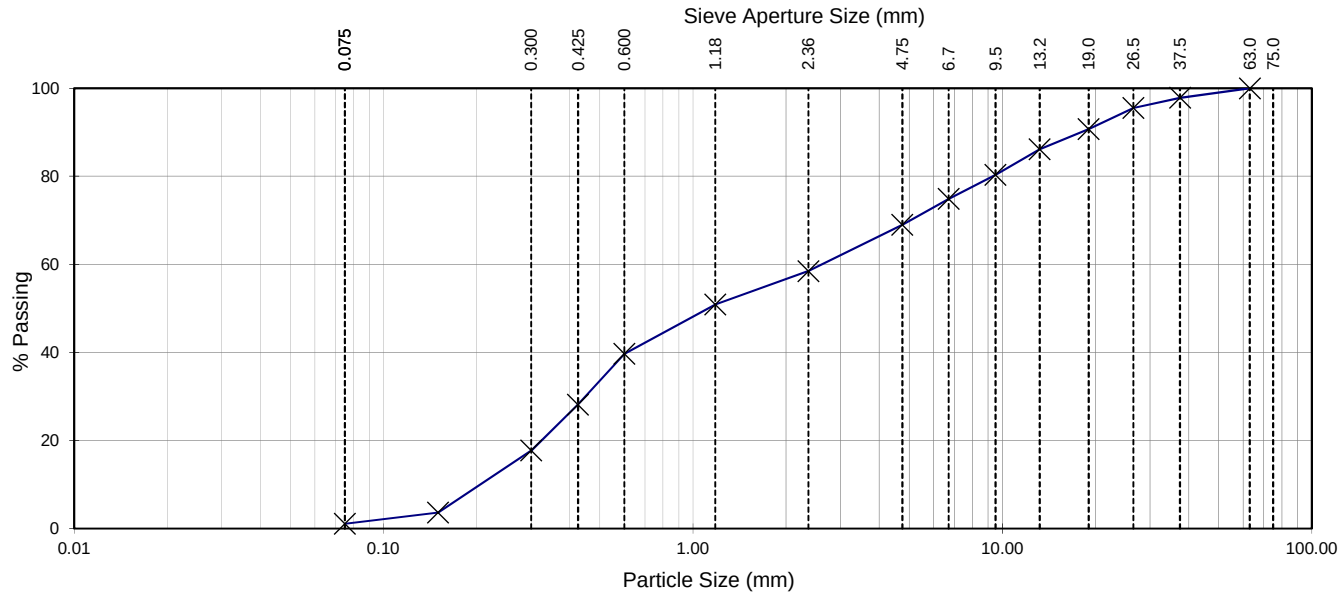
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Gravelly Sand**
Sample condition	**Moist**
Test Pit No:	**TP 02**
Depth (m) :	**1m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 2**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	**91**	4.75	**69**	0.425	**28**
63.00	**100**	13.20	**86**	2.36	**58**	0.300	**18**
37.50	**98**	9.50	**80**	1.18	**51**	0.150	**4**
26.50	**96**	6.70	**75**	0.600	**40**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 03/05/18
Date reported : 25/05/18

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Approved

Designation : ***Laboratory Manager***
Date : 25/05/18

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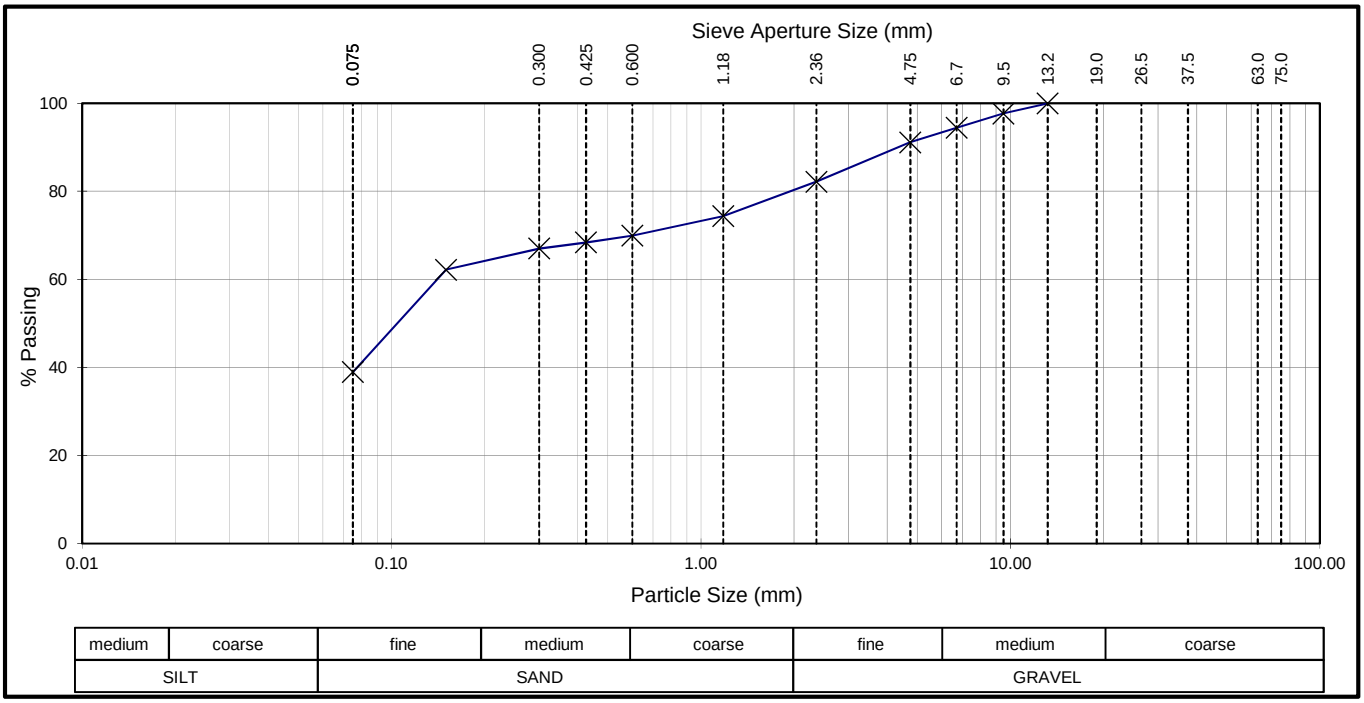
WET SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Silty Sand wih some Gravel**
Sample condition	**Wet**
Teest Pit No:	**TP 03**
Depth (m) :	**1.0-1.2m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 10**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	**91**	0.425	**68**
63.00	-	13.20	**100**	2.36	**82**	0.300	**67**
37.50	-	9.50	**98**	1.18	**74**	0.150	**62**
26.50	-	6.70	**94**	0.600	**70**	0.075	**39**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: Fraction tested: Whole Soil Dispersant Used: ***Fraction passing finest sieve is by difference.***

Date tested :

Date reported : 25/05/18

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Designation : ***Laboratory Manager***

Date : 25/05/18

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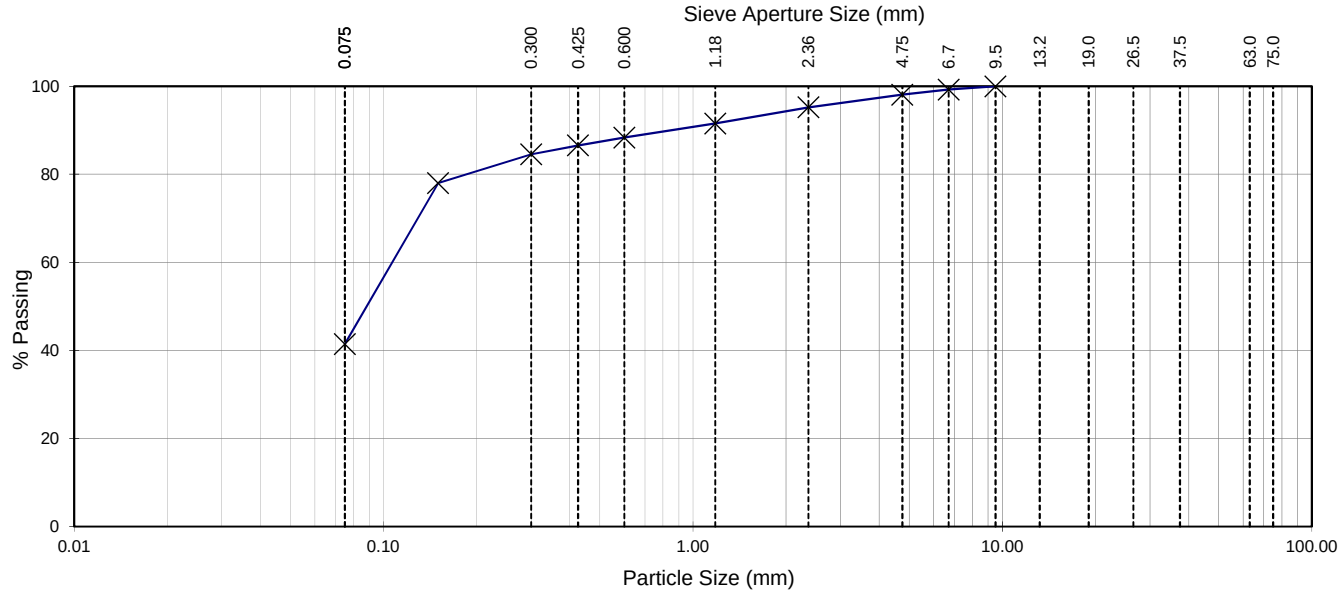
WET SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Silty Sand - trace of Gravel**
Sample condition	**Wet**
Test Pit No:	**TP 03**
Depth (m) :	**2.5m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 9**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	-	4.75	**98**	0.425	**87**
63.00	-	13.20	-	2.36	**95**	0.300	**85**
37.50	-	9.50	**100**	1.18	**92**	0.150	**78**
26.50	-	6.70	**99**	0.600	**88**	0.075	**41**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.1	History: Fraction tested: Whole Soil Dispersant Used: ***Fraction passing finest sieve is by difference.***

Date tested : 16/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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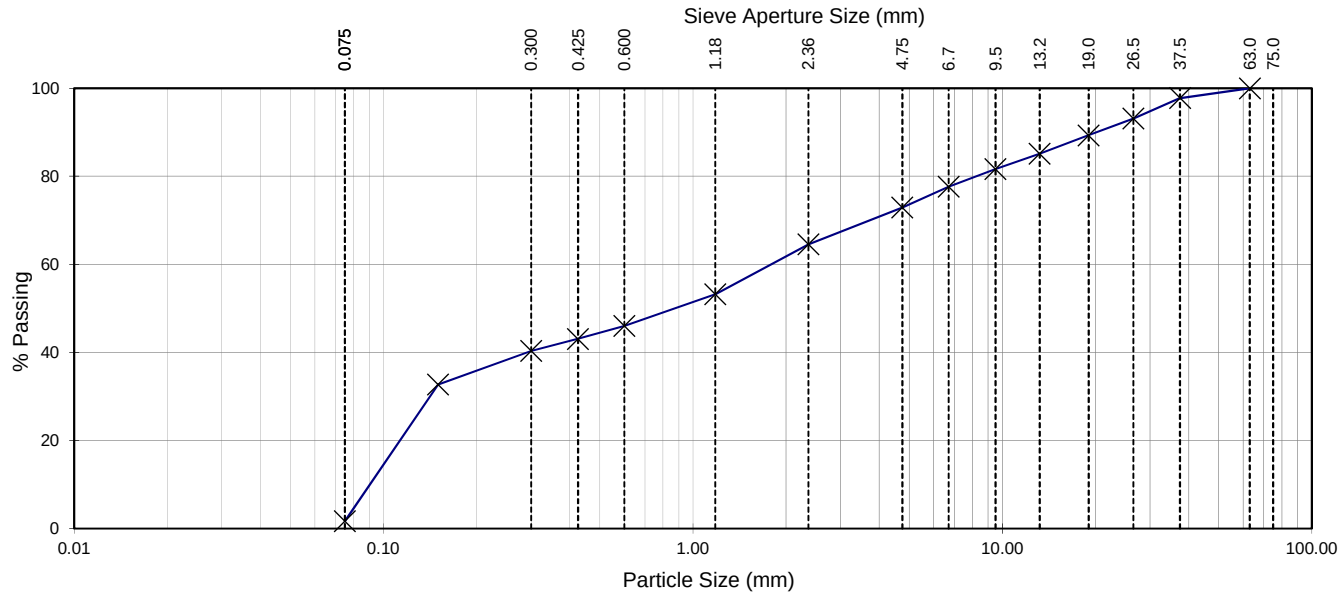
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Gravelly Sand**
Sample condition	**Moist**
Test Pit No:	**TP 03**
Depth (m) :	**4.5m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 8**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	89	4.75	**73**	0.425	**43**
63.00	**100**	13.20	85	2.36	**65**	0.300	**40**
37.50	**98**	9.50	82	1.18	**53**	0.150	**33**
26.50	**93**	6.70	78	0.600	**46**	0.075	**2**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 16/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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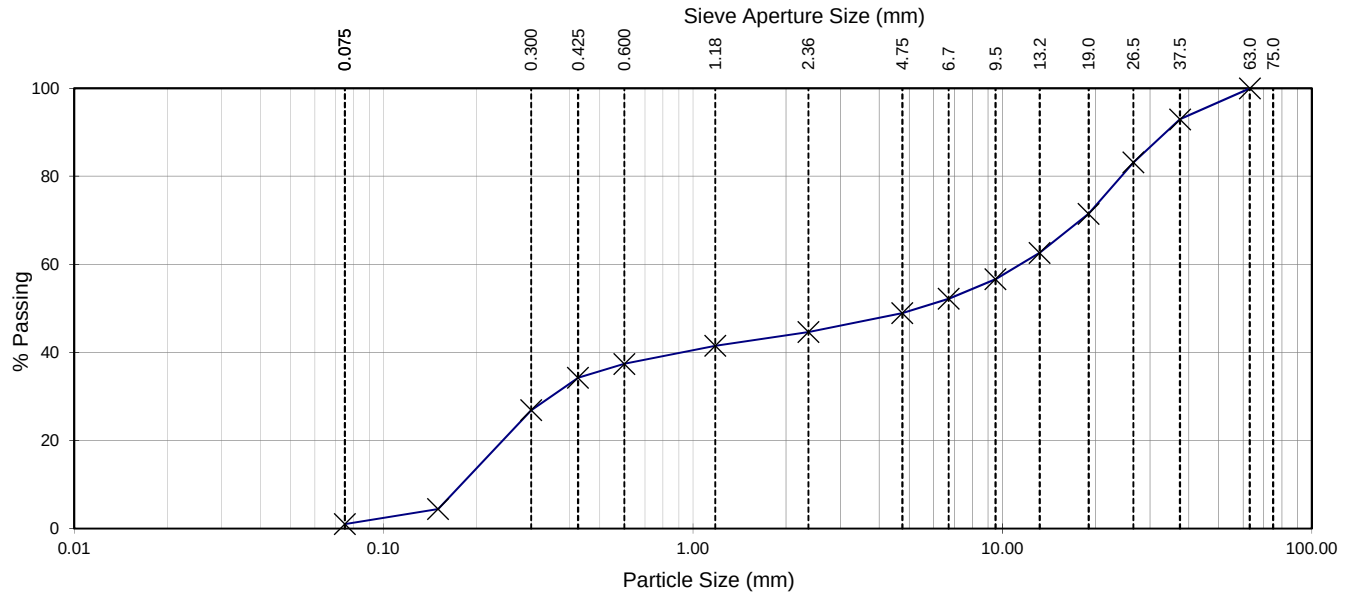
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Sandy Gravel**
Sample condition	**Moist**
Test Pit No:	**TP 04**
Depth (m) :	**3m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 4**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	**72**	4.75	**49**	0.425	**34**
63.00	**100**	13.20	**63**	2.36	**45**	0.300	**27**
37.50	**93**	9.50	**57**	1.18	**41**	0.150	**4**
26.50	**83**	6.70	**52**	0.600	**37**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 09/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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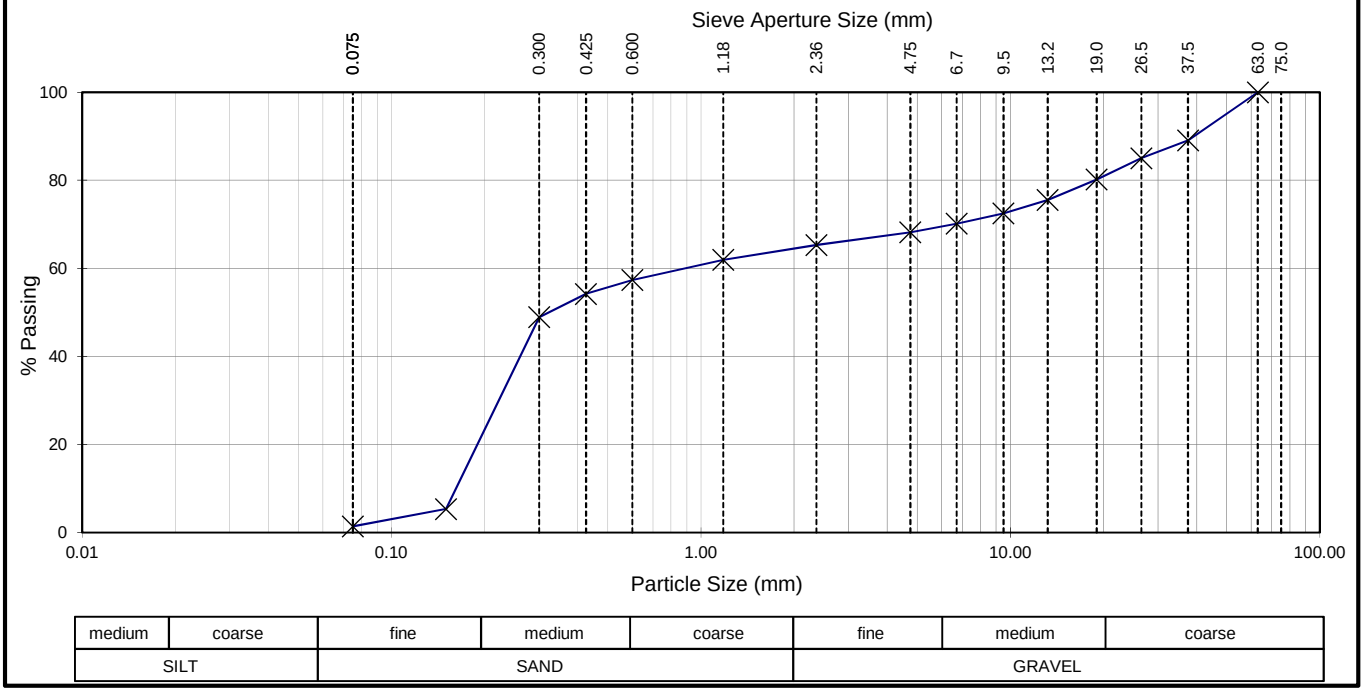
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Sandy Gravel**
Sample condition	**Moist**
Test Pit No:	**TP 06**
Depth (m) :	**1.2m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 5**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	**80**	4.75	**68**	0.425	**54**
63.00	**100**	13.20	**76**	2.36	**65**	0.300	**49**
37.50	**89**	9.50	**73**	1.18	**62**	0.150	**5**
26.50	**85**	6.70	**70**	0.600	**57**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 14/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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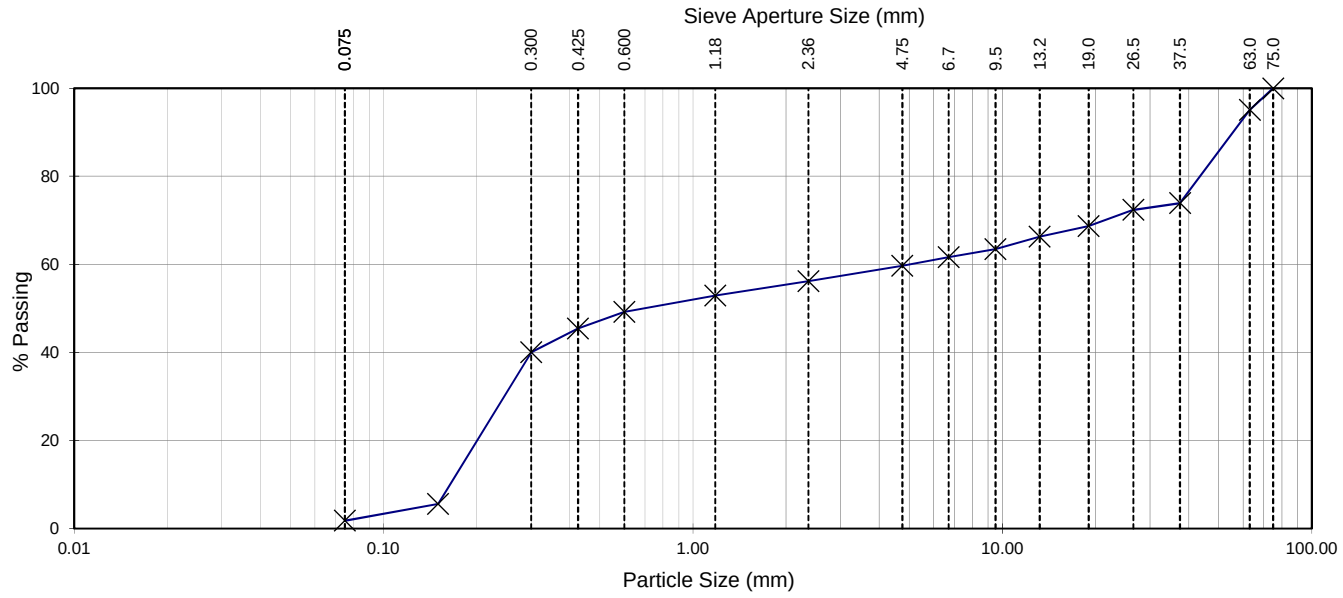
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Gravelly Sand**
Sample condition	**Wet**
Test Pit No:	**TP 07**
Depth (m) :	**1.0m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 6**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	**100**	19.00	**69**	4.75	**60**	0.425	**45**
63.00	**95**	13.20	**66**	2.36	**56**	0.300	**40**
37.50	**74**	9.50	**63**	1.18	**53**	0.150	**6**
26.50	**72**	6.70	**62**	0.600	**49**	0.075	**2**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 14/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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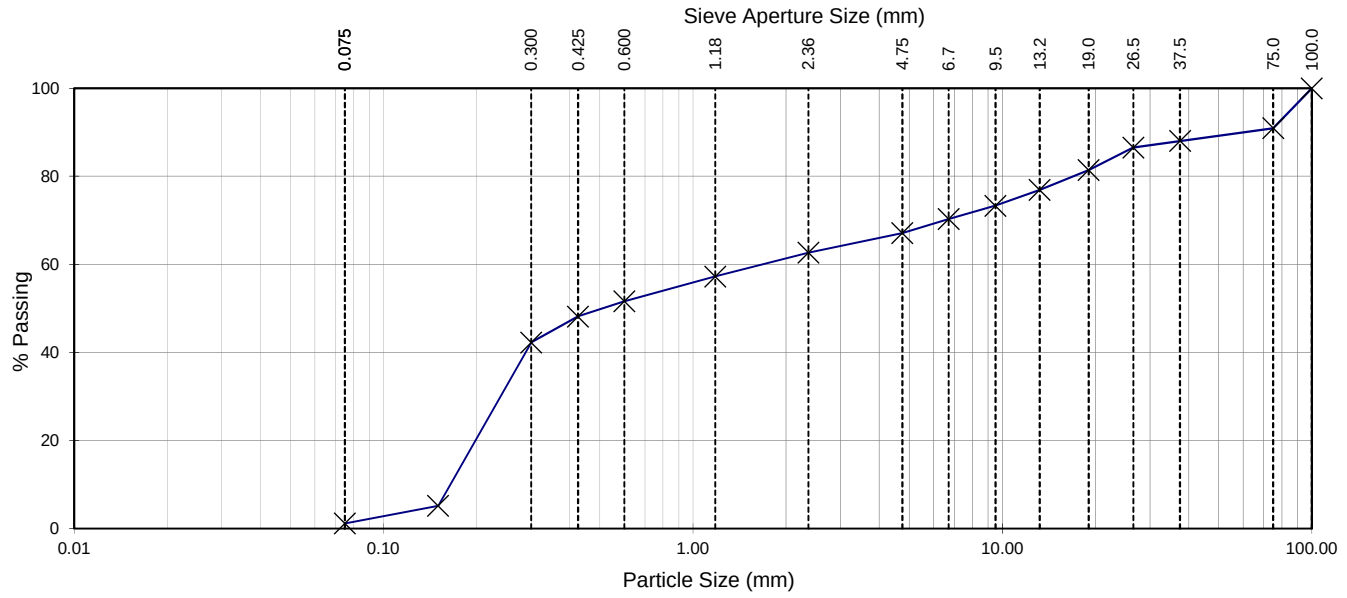
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Gravelly Sand**
Sample condition	**Wet**
Test Pit No:	**TP 07**
Depth (m) :	**2.8m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 7**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
100.00	**100**	19.00	**81**	4.75	**67**	0.425	**48**
75.00	**91**	13.20	**77**	2.36	**63**	0.300	**42**
37.50	**88**	9.50	**73**	1.18	**57**	0.150	**5**
26.50	**87**	6.70	**70**	0.600	**52**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 14/05/18
Date reported : 25/05/18

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Designation : ***Laboratory Manager***
Date : 25/05/18

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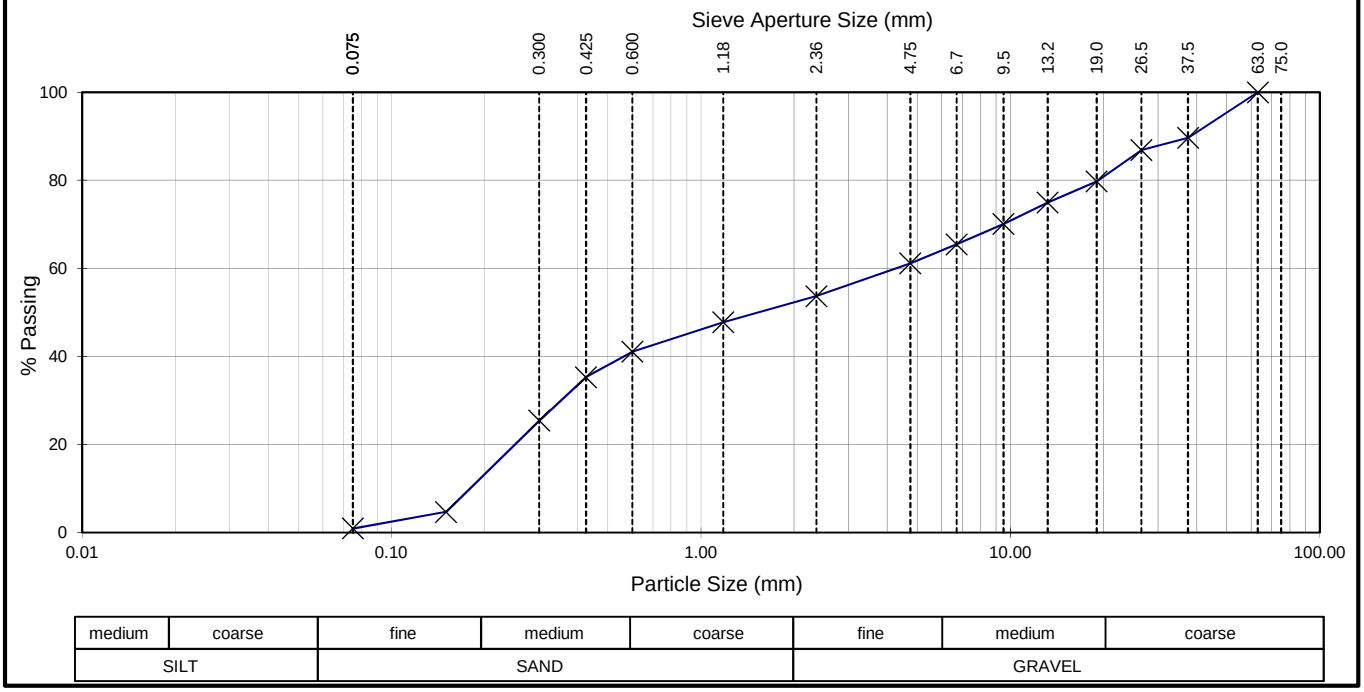
DRY SIEVE ANALYSIS
TEST REPORT

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**3/05/2018**
Sampling method :	**Excavated Pits**
Sample description :	**Gravelly Sand**
Sample condition	**Moist**
Test Pit No:	**TP 02**
Depth (m) :	**2m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA 1591 / 3**
Client Ref No :	

Sieve Analysis

Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing	Size (mm)	% Passing
75.00	-	19.00	**80**	4.75	**61**	0.425	**35**
63.00	**100**	13.20	**75**	2.36	**54**	0.300	**25**
37.50	**90**	9.50	**70**	1.18	**48**	0.150	**5**
26.50	**87**	6.70	**65**	0.600	**41**	0.075	**1**



Test Method	Notes
NZS 4407 : 2015 Test 3.8.2	History: Fraction tested: Whole Soil Dispersant Used:

Date tested : 08/05/18
Date reported : 25/05/18

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Approved

Designation : ***Laboratory Manager***
Date : 25/05/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

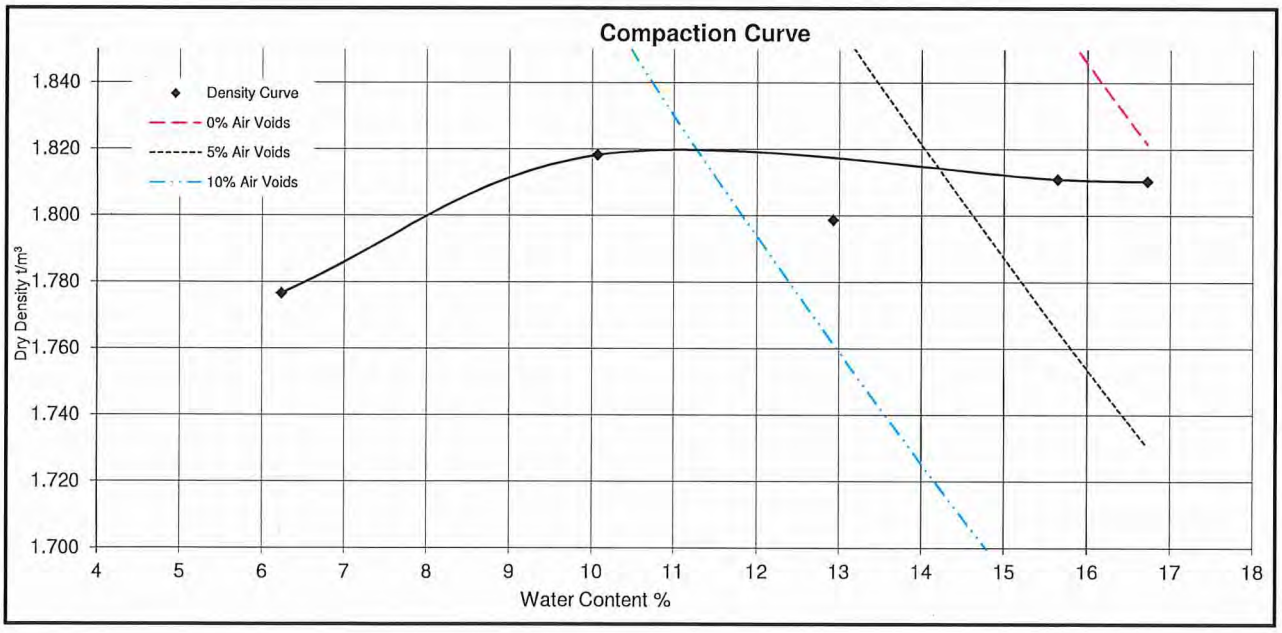
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Sand & Gravel**
Sample condition :	**Wet**
Solid density :	**2.62 t/m³ (Tested)**
Source :	**TP 1 @ 1.0m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA1591/1**
Client Ref No :	

Test Results

Maximum dry density	**1.82**	t/m³	Natural water content	12.9	%
Optimum water content	**10**	%	Fraction tested	Passing 19.00	

Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.887	2.001	2.031	2.094	2.113		
Water content	%	6.2	10.1	12.9	15.6	16.7		
Dry density	t/m³	1.777	1.818	1.799	1.811	1.810		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 08/05/18
Date reported : 05/06/18

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Designation : *Laboratory Manager*
Date : 05/06/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

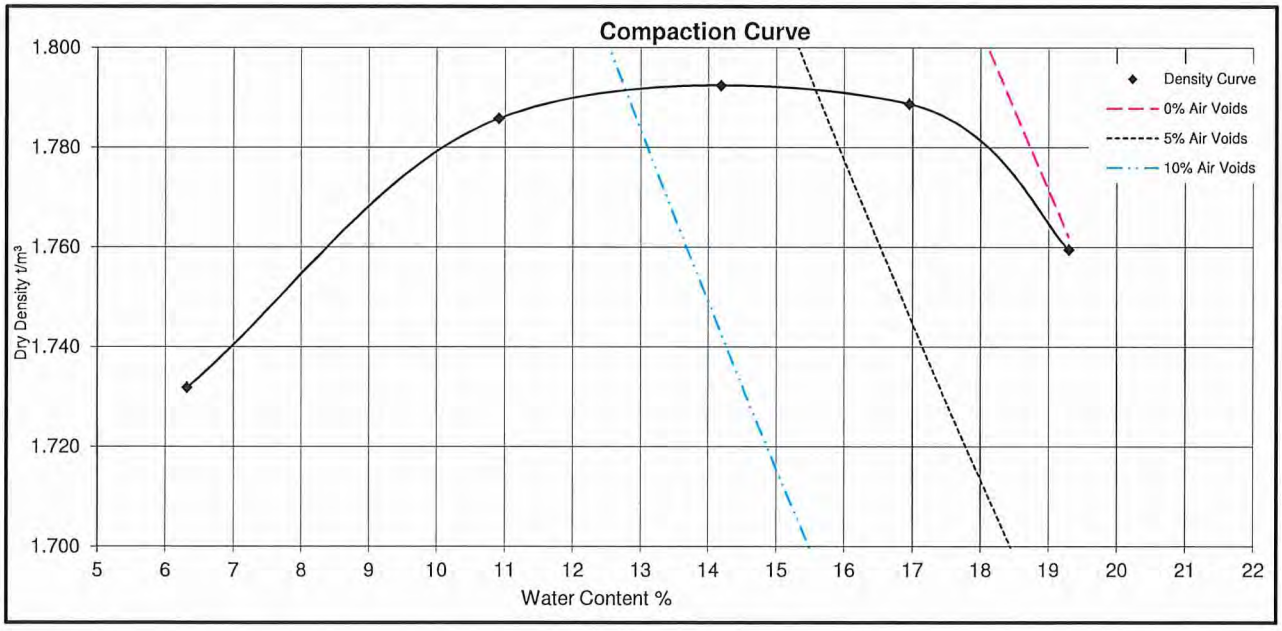
WSP | OPUS

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Gravelly Sand**
Sample condition :	**Damp**
Solid density :	**2.67 t/m³ (Tested)**
Source :	**TP 02 @ 1m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA1591/2**
Client Ref No :	

Test Results

Maximum dry density		**1.79**	t/m³		Natural water content	14.2	%	
Optimum water content		**14**	%		Fraction tested	Passing 19.00mm		
Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.841	1.981	2.047	2.092	2.099		
Water content	%	6.3	10.9	14.2	16.9	19.3		
Dry density	t/m³	1.732	1.786	1.792	1.789	1.759		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 08/05/18
Date reported : 05/06/18

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Designation : *Laboratory Manager*
Date : 05/06/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

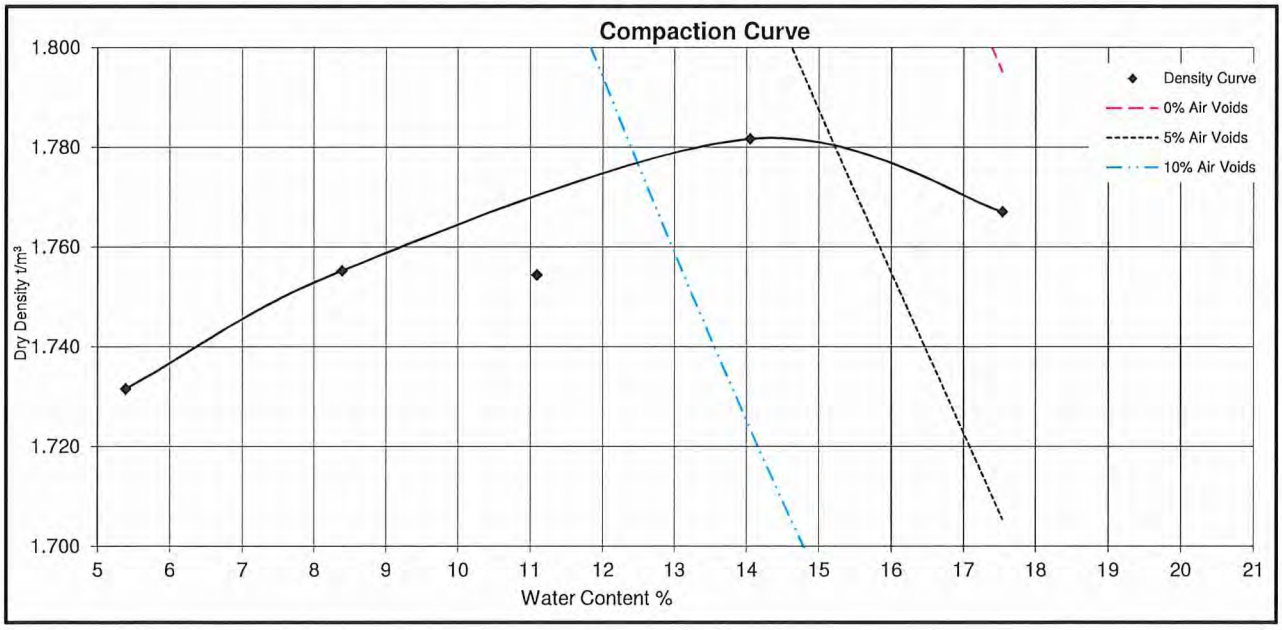
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Gravelly Sand**
Sample condition :	**Damp**
Solid density :	**2.62 t/m³ (Tested)**
Source :	**TP 02 @ 2m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 3**
Client Ref No :	

Test Results

Maximum dry density	**1.78**	t/m³	Natural water content	11.1	%		
Optimum water content	**14**	%	Fraction tested	Passing 19.00mm			

Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.825	1.902	1.949	2.032	2.077		
Water content	%	5.4	8.4	11.1	14.0	17.5		
Dry density	t/m³	1.732	1.755	1.754	1.782	1.767		
Sample condition						Seep		



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 08/05/18
Date reported : 05/06/18

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Approved

Designation : *Laboratory Manager*
Date : 05/06/18

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Telephone +64 6 833 5590
Website www.wsp-opus.co.nz

DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

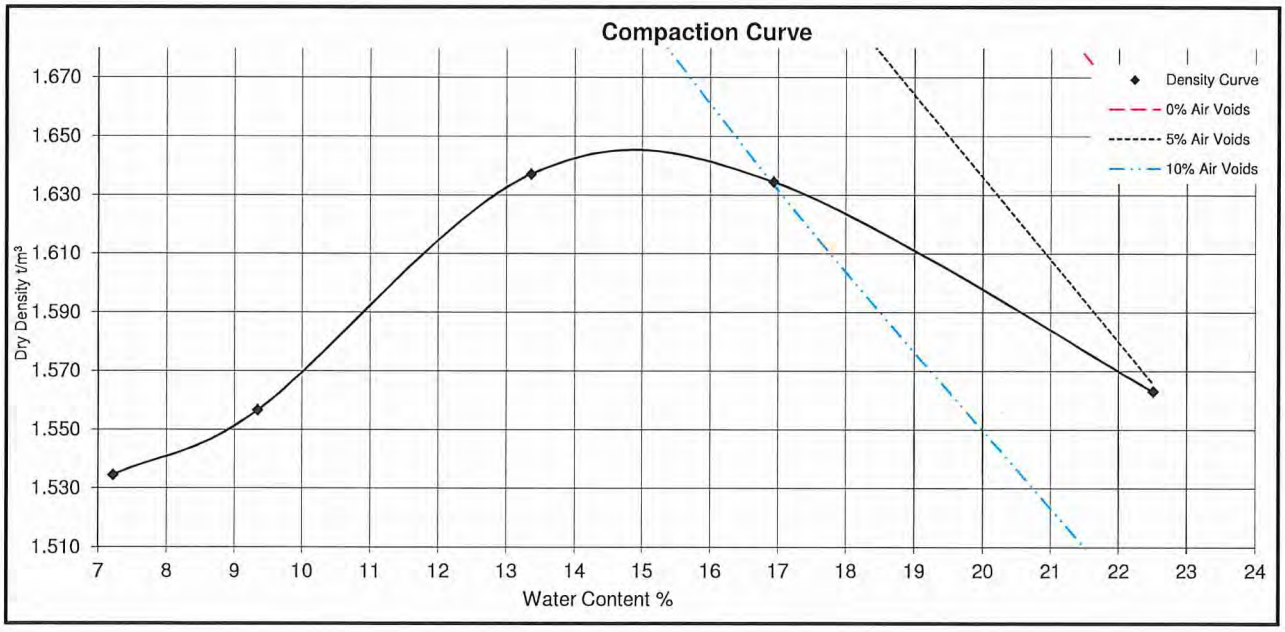
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Gravelly Sand**
Sample condition :	**Damp**
Solid density :	**2.62 t/m³ (Tested)**
Source :	**TP 03 @ 4.5m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA 1591/8**
Client Ref No :	

Test Results

Maximum dry density	**1.64**	t/m³	Natural water content	-	%
Optimum water content	**14**	%	Fraction tested	Passing 19.00mm	

Sample ID		Dry	-4	-3	-2	-1		
Bulk density	t/m³	1.645	1.702	1.856	1.911	1.915		
Water content	%	7.2	9.3	13.4	16.9	22.5		
Dry density	t/m³	1.535	1.557	1.637	1.634	1.563		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 16/05/18
Date reported : 25/05/18

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Approved

Designation : *Laboratory Manager*
Date : 25/05/18

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Website www.wsp-opus.co.nz

DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

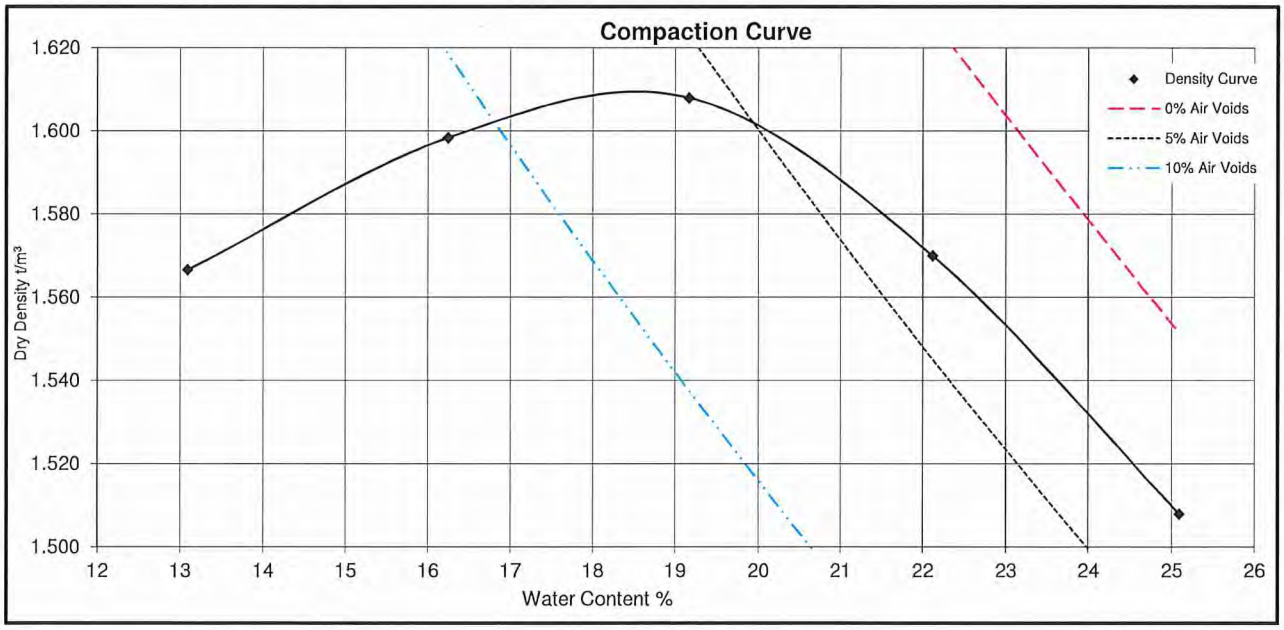
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Silty Sand with trace Gravel**
Sample condition :	**Wet**
Solid density :	**2.54 t/m³ (Tested)**
Source :	**TP 03 @ 2.5m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA1591 / 9**
Client Ref No :	

Test Results

Maximum dry density	**1.61**	t/m³	Natural water content	25.1	%
Optimum water content	**19**	%	Fraction tested	Whole Soil	

Sample ID		-12	-9	-6	-3	NAT		
Bulk density	t/m³	1.772	1.858	1.916	1.917	1.886		
Water content	%	13.1	16.2	19.2	22.1	25.1		
Dry density	t/m³	1.567	1.598	1.608	1.570	1.508		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 18/05/18
Date reported : 25/05/18

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Designation : *Laboratory Manager*
Date : 25/05/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

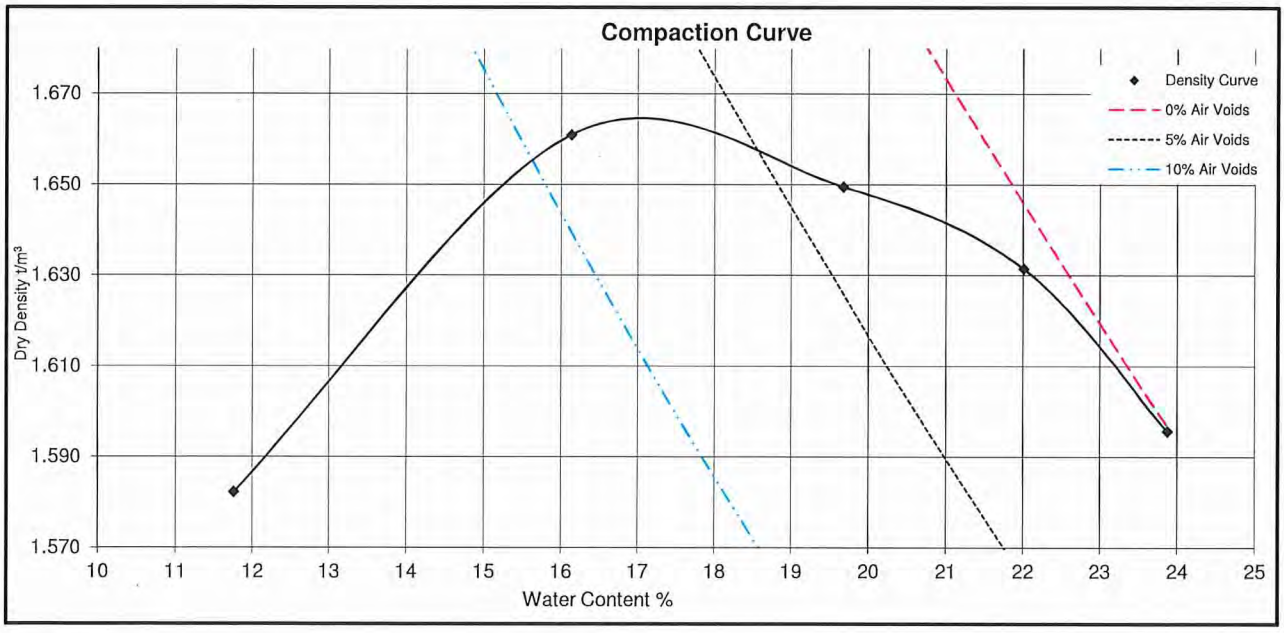
WSP | OPUS

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Silty Sand with some Gravel**
Sample condition :	**Damp**
Solid density :	**2.58 t/m³ (Tested)**
Source :	**TP 03 @ 1.0-1.2m**

Project No :	**2-L0065.09 / 001NL**
Lab Ref No :	**NA1591 / 10**
Client Ref No :	

Test Results

Maximum dry density		**1.66**	t/m³		Natural water content	19.7	%	
Optimum water content		**16**	%		Fraction tested	Whole Soil		
Sample ID		-2	-1	Nat	1	2		
Bulk density	t/m³	1.768	1.929	1.974	1.991	1.977		
Water content	%	11.8	16.1	19.7	22.0	23.9		
Dry density	t/m³	1.582	1.661	1.650	1.631	1.596		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 18/05/18
Date reported : 25/05/18

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Designation : *Laboratory Manager*
Date : 25/05/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

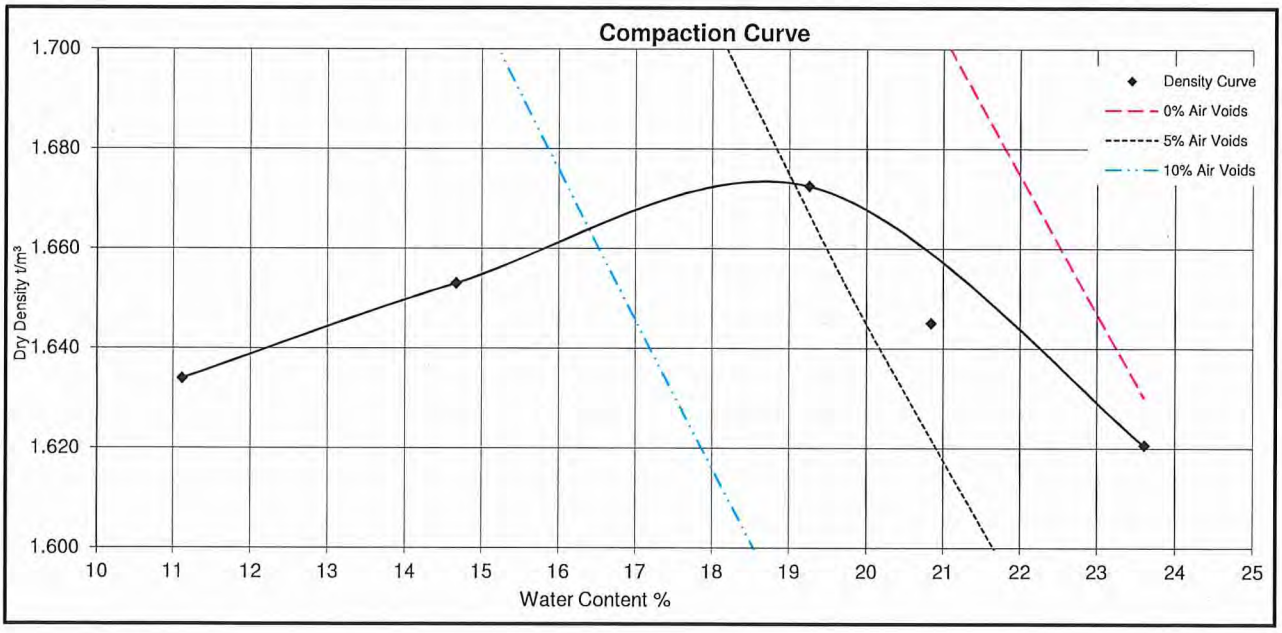
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Sandy Gravel**
Sample condition :	**Damp**
Solid density :	**2.65 t/m³ (Tested)**
Source :	**TP 4 @ 3.0m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA 1591/ 4**
Client Ref No :	

Test Results

Maximum dry density	**1.67**	t/m³	Natural water content	19.3	%	
Optimum water content	**19**	%	Fraction tested	Passing 19.00mm		

Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.816	1.896	1.995	1.988	2.003		
Water content	%	11.1	14.7	19.3	20.8	23.6		
Dry density	t/m³	1.634	1.653	1.673	1.645	1.621		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 09/05/18
Date reported : 23/05/18

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Approved

Designation : *Laboratory Manager*
Date : 23/05/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

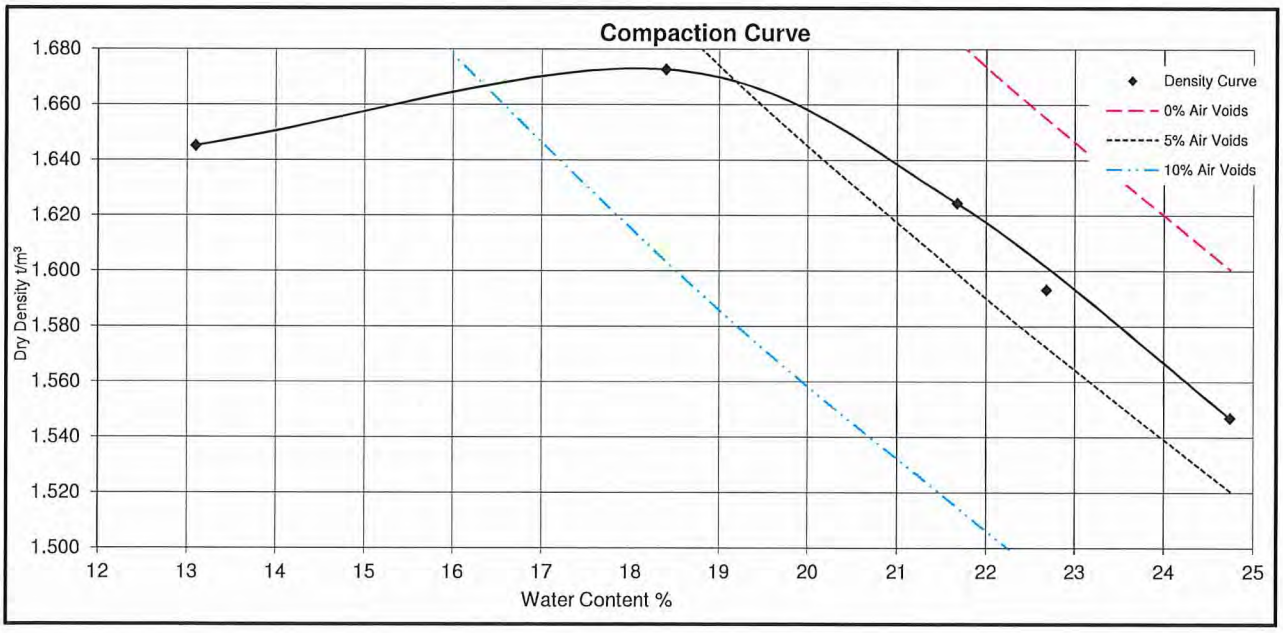
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Sandy Gravel**
Sample condition :	**Damp**
Solid density :	**2.65 t/m³ (Tested)**
Source :	**TP 06 @ 1.2m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA1591-5**
Client Ref No :	

Test Results

Maximum dry density	**1.67**	t/m³	Natural water content	21.7	%
Optimum water content	**18**	%	Fraction tested	Passing 19.00mm	

Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.861	1.980	1.976	1.955	1.930		
Water content	%	13.1	18.4	21.7	22.7	24.7		
Dry density	t/m³	1.645	1.673	1.624	1.593	1.547		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 10/05/18
Date reported : 05/06/18

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Approved

Designation : *Laboratory Manager*
Date : 05/06/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

WSP | OPUS

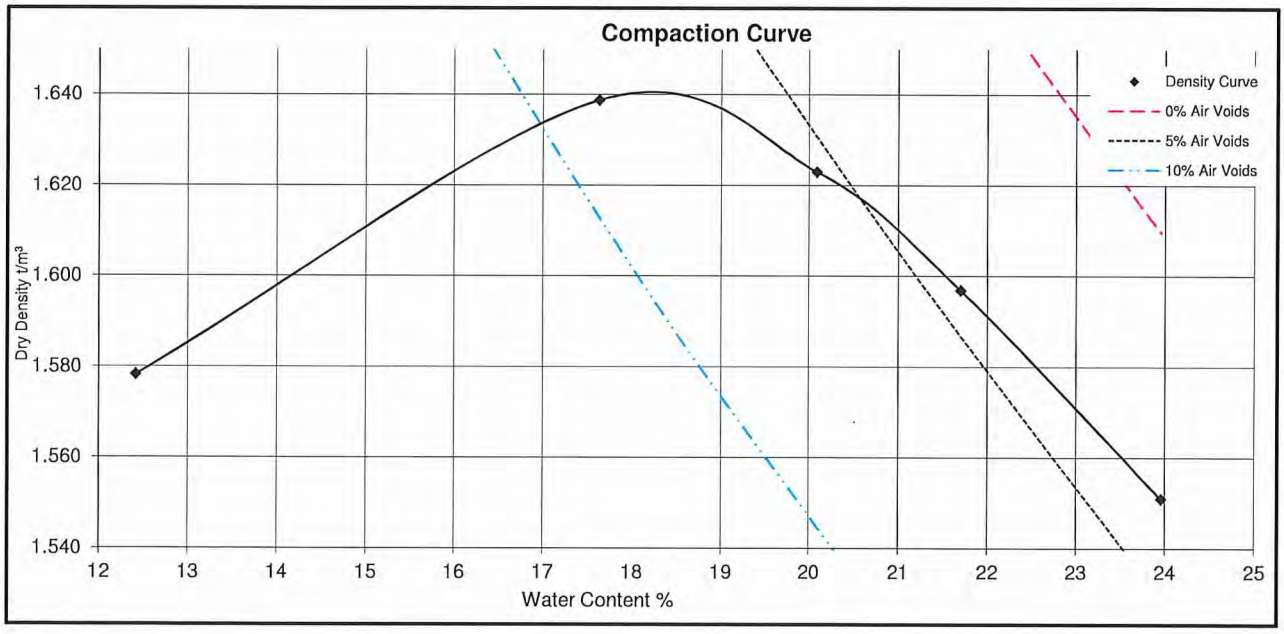
Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Gravelly Sand**
Sample condition :	**Wet**
Solid density :	**2.62 t/m³ (Tested)**
Source :	**TP 7 @ 1.0m**

Project No :	**2-L0065.09**
Lab Ref No :	**NA 1591- 6**
Client Ref No :	

Test Results

Maximum dry density	**1.64**	t/m³	Natural water content	20.1	%
Optimum water content	**18**	%	Fraction tested	Passing 19.00	

Sample ID		-2	-1	Nat	1	2		
Bulk density	t/m³	1.774	1.928	1.949	1.943	1.923		
Water content	%	12.4	17.6	20.1	21.7	24.0		
Dry density	t/m³	1.578	1.639	1.623	1.597	1.551		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 10/05/18
Date reported : 05/06/18

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Approved

Designation : *Laboratory Manager*
Date : 05/06/18

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DRY DENSITY / WATER CONTENT RELATIONSHIP
STANDARD COMPACTION

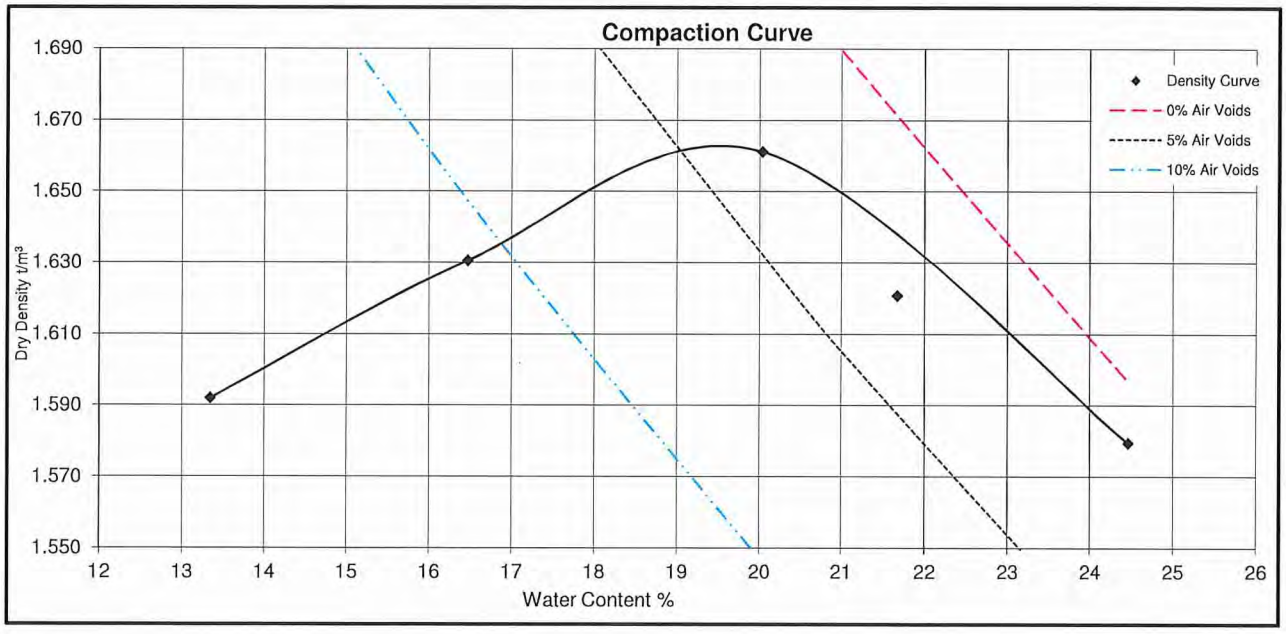
WSP | OPUS

Project :	**Omarunui Landfill - Area B**
Location :	**Taradale**
Client :	**Tonkin & Taylor**
Contractor :	**Tonkin & Taylor**
Sampled by :	**Jamie Yule**
Date sampled :	**03/05/18**
Sampling method :	**Excavated Pit**
Sample description :	**Gravelly Sand**
Sample condition :	**Damp**
Solid density :	**2.62 t/m³ (Tested)**
Source :	**TP 7 @2.8m**

Project No :	**2-L0065.09/ 001NL**
Lab Ref No :	**NA 1591 / 7**
Client Ref No :	

Test Results

Maximum dry density		**1.66**	t/m³		Natural water content	-	%	
Optimum water content		**20**	%		Fraction tested	Passing 19.00mm		
Sample ID		-2	-1	NAT	1	2		
Bulk density	t/m³	1.804	1.899	1.994	1.972	1.966		
Water content	%	13.3	16.5	20.0	21.7	24.5		
Dry density	t/m³	1.592	1.631	1.661	1.621	1.579		
Sample condition								



Test Methods		Notes
Compaction	NZS 4402 : 1986 Test 4.1.1 (Standard)	

Date tested : 16/05/18
Date reported : 23/05/18

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Approved

Designation : *Laboratory Manager*
Date : 23/05/18

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Appendix E: Slope stability modelling outputs

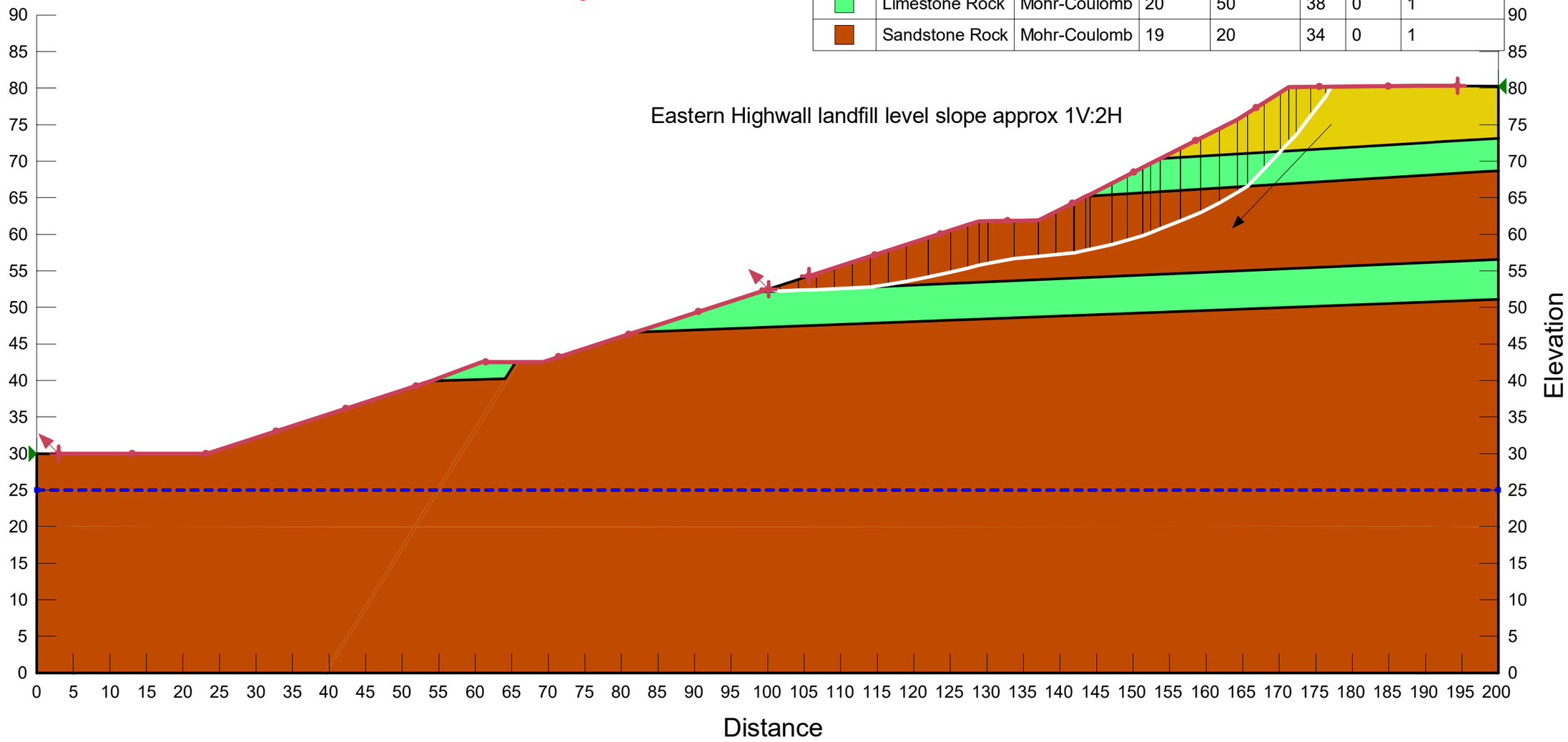
- Eastern highwall Section
- Toe bund section

Name: 1) Eastern Highwall stability- Static
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)
Horz Seismic Coef.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	HW Sandstone	Mohr-Coulomb	18	6	30	0	1
	Limestone Rock	Mohr-Coulomb	20	50	38	0	1
	Sandstone Rock	Mohr-Coulomb	19	20	34	0	1

2.47

Eastern Highwall landfill level slope approx 1V:2H



Tonkin+Taylor

HASTINGS DISTRICT COUNCIL

Omaranui Landfill Geotechnical Design Area B

1) Eastern Highwall stability- Static
Eastern Highwall Analysis.gsz
11/06/2018

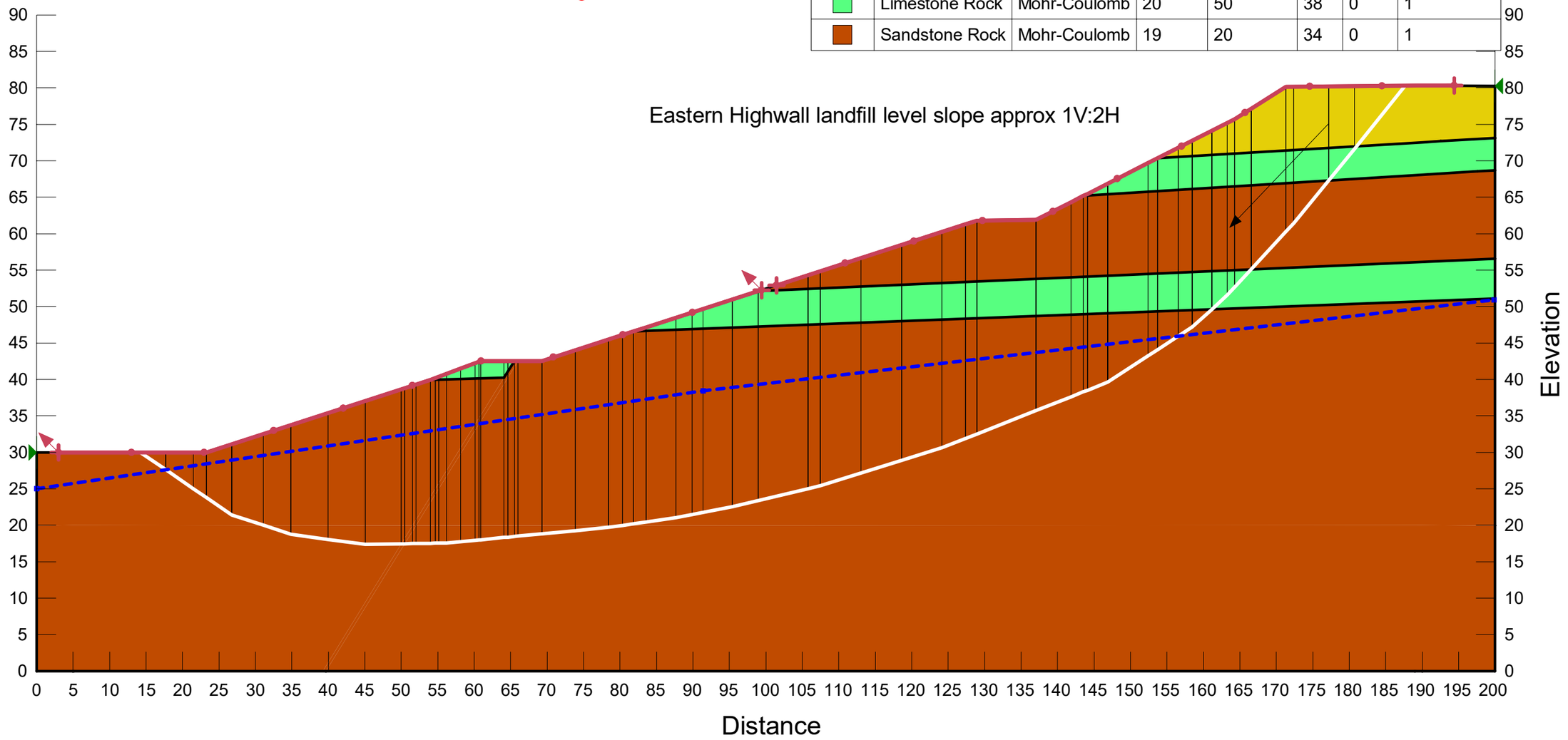
Analysed By: JWY
Checked By:

Scale
1:600

Name: 2) Eastern Highwall Stability- High GW
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)
Horz Seismic Coef.:

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	HW Sandstone	Mohr-Coulomb	18	6	30	0	1
	Limestone Rock	Mohr-Coulomb	20	50	38	0	1
	Sandstone Rock	Mohr-Coulomb	19	20	34	0	1

2.19

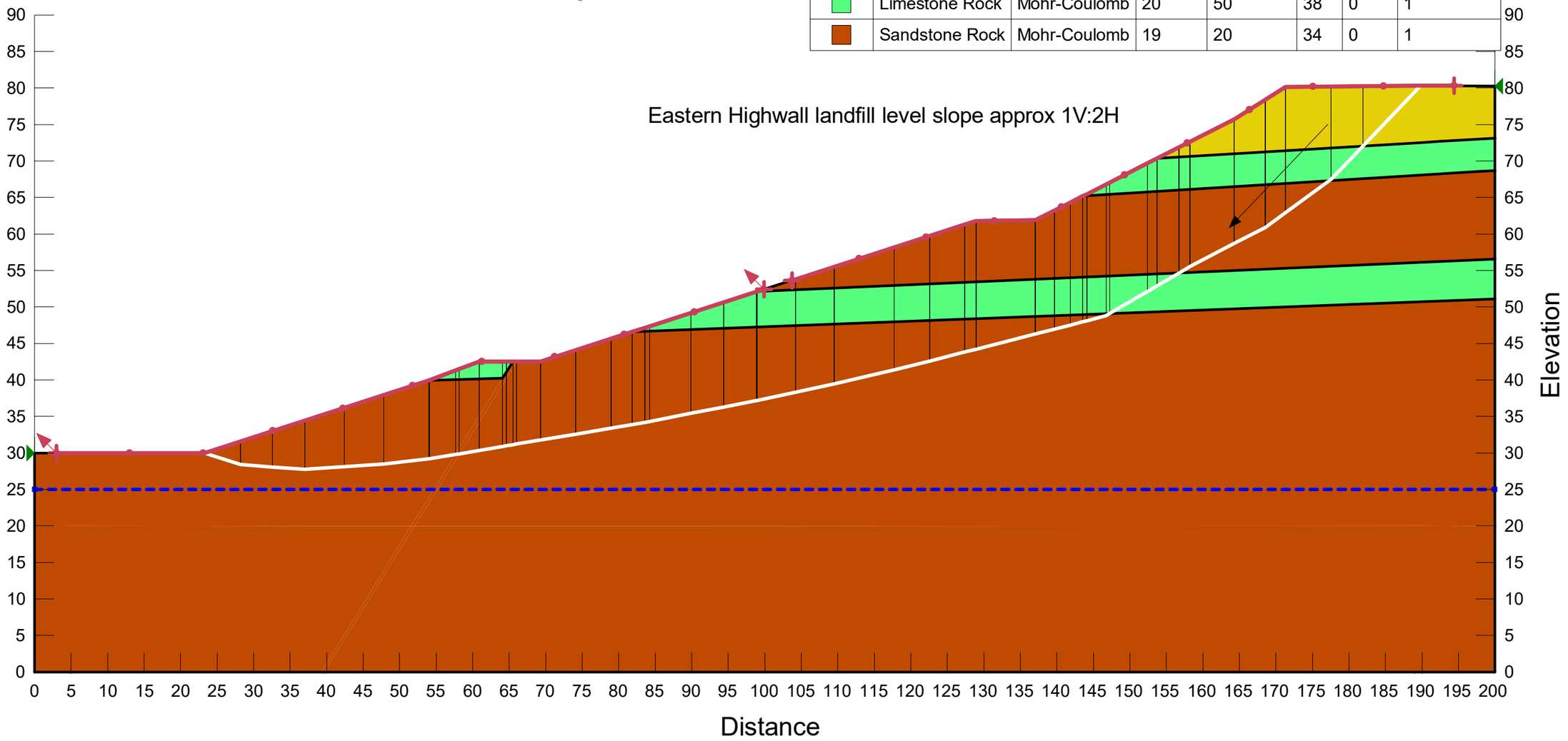


Tonkin+Taylor / HASTINGS DISTRICT COUNCIL	**Omaranui Landfill Geotechnical Design Area B**	2) Eastern Highwall Stability- High GW Eastern Highwall Analysis.gsz 11/06/2018	Analysed By: JWY Checked By: Scale 1:600

Name: 4) Eastern Highwall Stability- ULS Seismic
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)
Horz Seismic Coef.: 0.42

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	HW Sandstone	Mohr-Coulomb	18	6	30	0	1
	Limestone Rock	Mohr-Coulomb	20	50	38	0	1
	Sandstone Rock	Mohr-Coulomb	19	20	34	0	1

1.02



Tonkin+Taylor

HASTINGS DISTRICT COUNCIL

Omaranui Landfill Geotechnical Design Area B

4) Eastern Highwall Stability- ULS Seismic
Eastern Highwall Analysis.gsz
11/06/2018

Analysed By: JWY
Checked By:

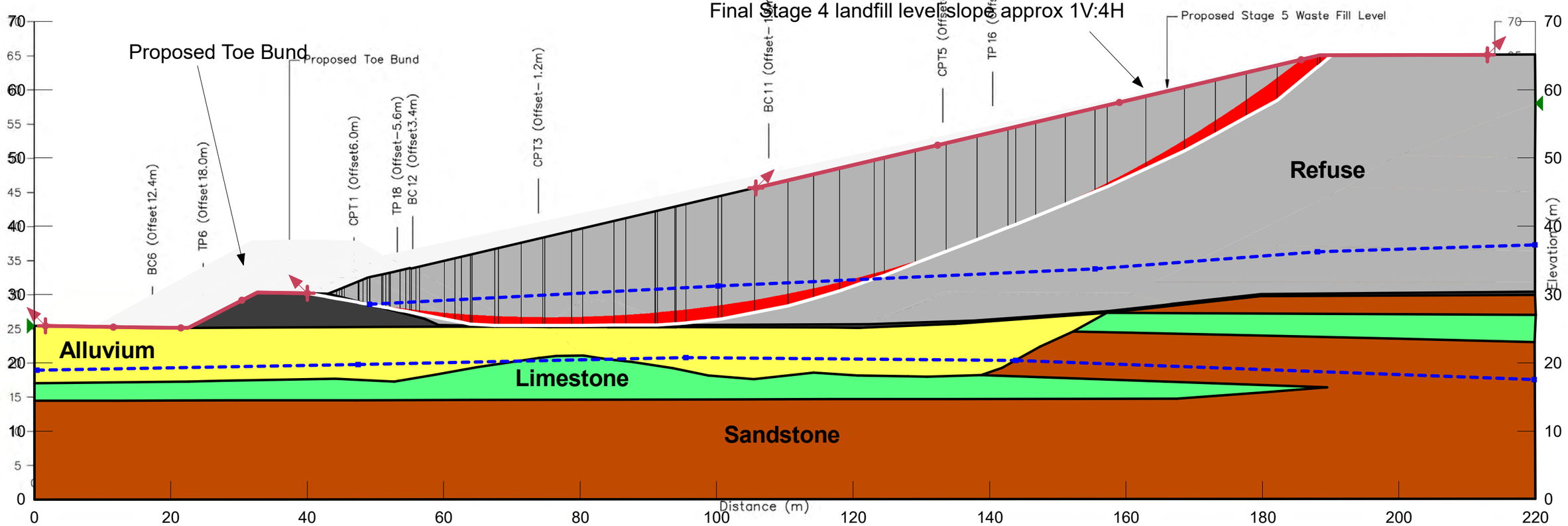
Scale
1:600

Name: 1) Toe bund stability- Static
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	Alluvium	Mohr-Coulomb	17	0	28	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	2
	Liner (Textured)	Mohr-Coulomb	18	0	25	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	2

2.09

Final Stage 4 landfill level slope approx 1V:4H

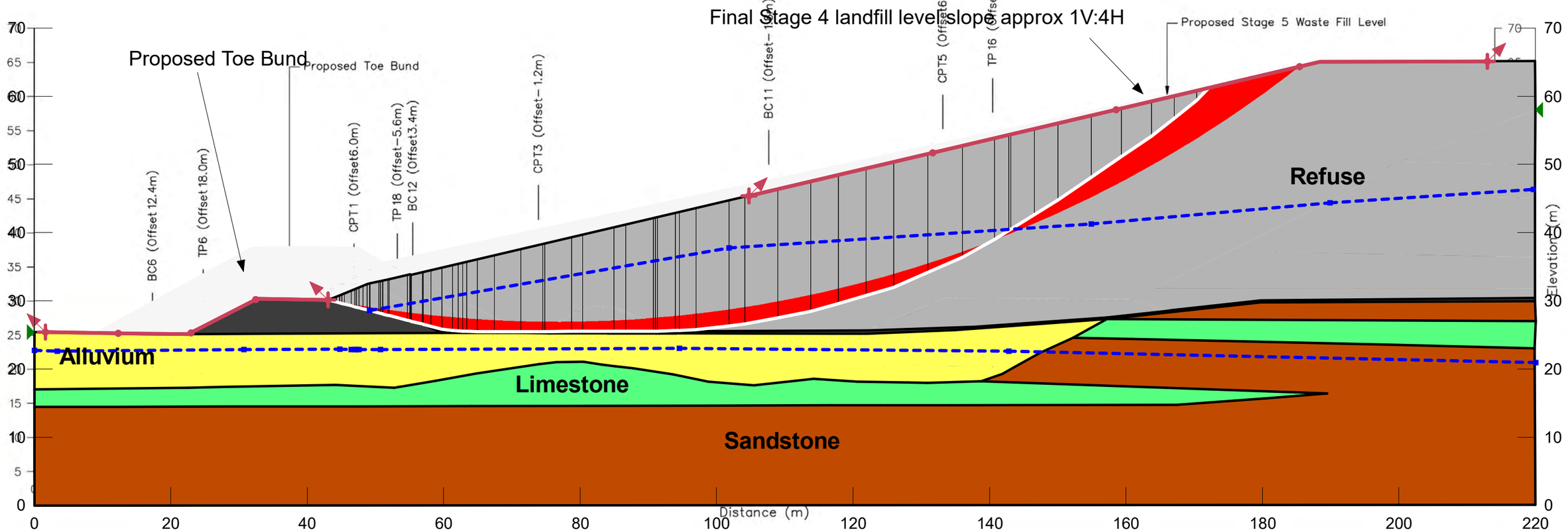


Tonkin+Taylor	HASTINGS DISTRICT COUNCIL	**Omaranui Landfill Geotechnical Design Area B**	1) Toe bund stability- Static 2020 update Toe Bund Analysis.gsz 20/05/2020
			Analysed By: JWY Checked By: NBK Scale 1:596

Name: 2) Toe Bund Stability- Elevated Leachate
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	Alluvium	Mohr-Coulomb	17	0	28	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	2
	Liner (Textured)	Mohr-Coulomb	18	0	25	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	2

1.71



Distance

Tonkin+Taylor

HASTINGS DISTRICT COUNCIL

Omaranui Landfill Geotechnical Design Area B

2) Toe Bund Stability- Elevated Leachate

2020 update Toe Bund Analysis.gsz

20/05/2020

Analysed By: JWY
Checked By: NBK

Scale

1:596

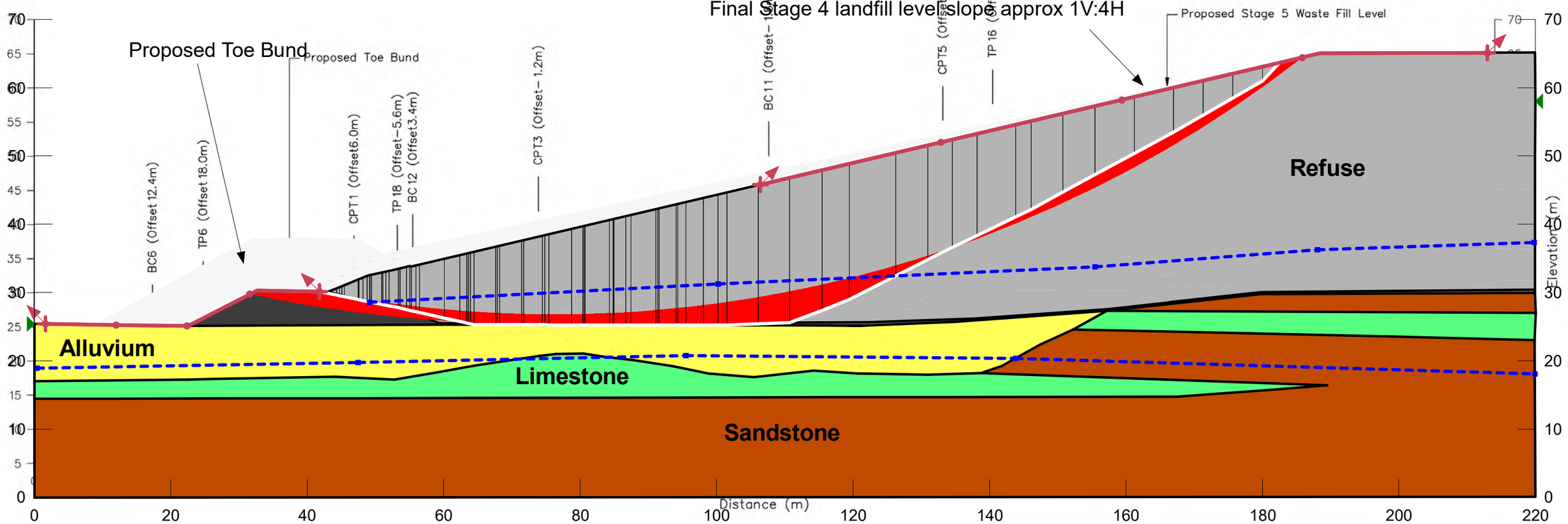
Name: 3) Toe Bund Stability- ULS Seismic
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: Effective Stress Strengths

Horz Seismic Coef.: 0.41

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Cohesion R (kPa)	Phi R (°)	Piezomet Line
	Alluvium	Mohr-Coulomb	17	0	28	0	0	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	0	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	0	0	2
	Liner (Post Peak)	Mohr-Coulomb	18	0	16	0	0	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	0	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	0	0	2

0.69

Final Stage 4 landfill level slope approx 1V:4H



Distance

Tonkin+Taylor

HASTINGS DISTRICT COUNCIL

Omaranui Landfill Geotechnical Design Area B

3) Toe Bund Stability- ULS Seismic
2020 update Toe Bund Analysis.gsz
20/05/2020

Analysed By: JWY
Checked By: NBK

Scale
1:596

Name: 4 REV1) Slope Stability- ULS seismic Larger Bund
Method: Morgenstern-Price
Slip Surface Option: Entry and Exit
Staged Pseudo Static Analysis Option: (none)

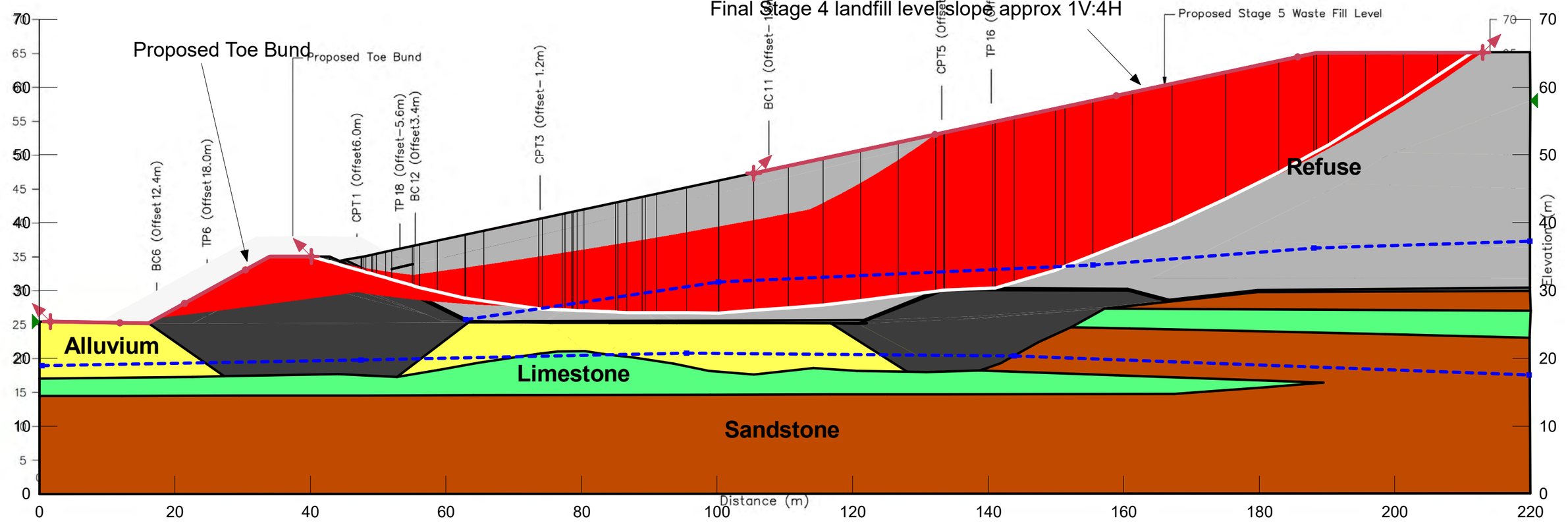
Horz Seismic Coef.: 0.41

Horz Seismic Coef.: 0.41

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	Alluvium	Mohr-Coulomb	17	0	28	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	2
	Liner (Post Peak)	Mohr-Coulomb	18	0	16	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	2

0.78

Final Stage 4 landfill level slope approx 1V:4H



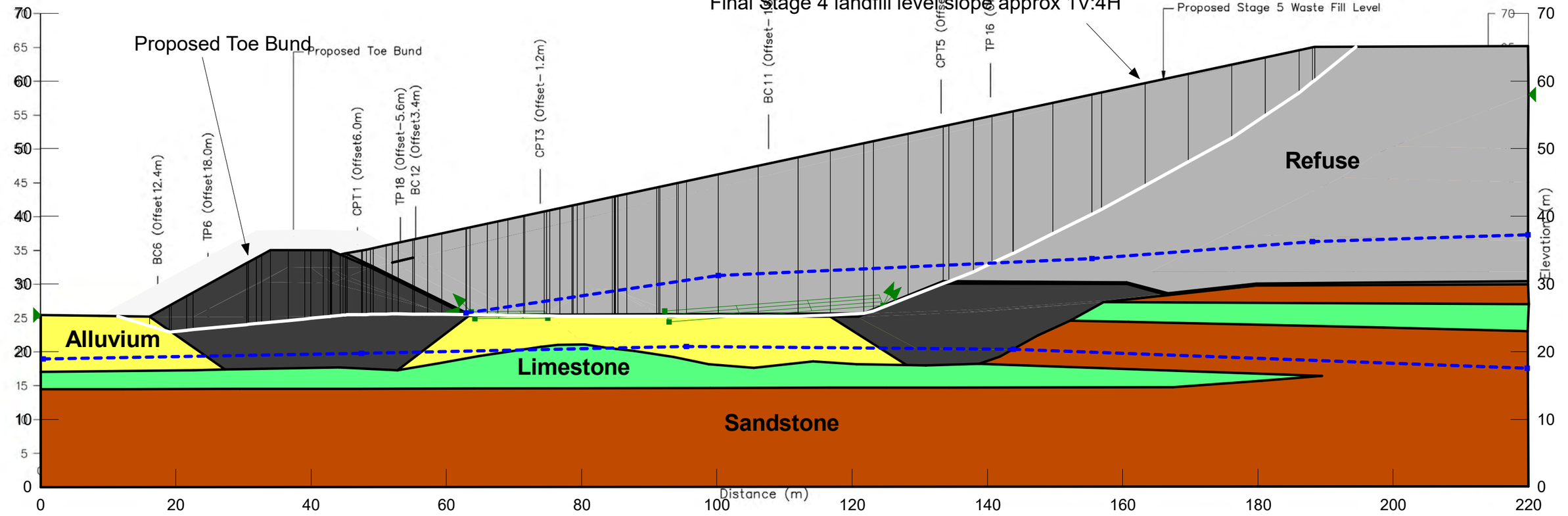
Distance

Tonkin+Taylor	HASTINGS DISTRICT COUNCIL	**Omaranui Landfill Geotechnical Design Area B**	4 REV1) Slope Stability- ULS seismic Larger Bund 2020 update Toe Bund Analysis.gsz 20/05/2020	Analysed By: JWY Checked By: NBK Scale 1:596

Name: 5 REV1) Slope Stability- Larger Bund Basal slide
Method: Morgenstern-Price
Slip Surface Option: Block
Staged Pseudo Static Analysis Option: (none)

Horz Seismic Coef.: 0.41

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	Alluvium	Mohr-Coulomb	17	0	28	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	2
	Liner (Post Peak)	Mohr-Coulomb	18	0	16	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	2



Distance

Tonkin+Taylor	HASTINGS DISTRICT COUNCIL	**Omaranui Landfill Geotechnical Design Area B**	5 REV1) Slope Stability- Larger Bund Basal slide 2020 update Toe Bund Analysis.gsz 20/05/2020	Analysed By: JWY Checked By: NBK Scale 1:596

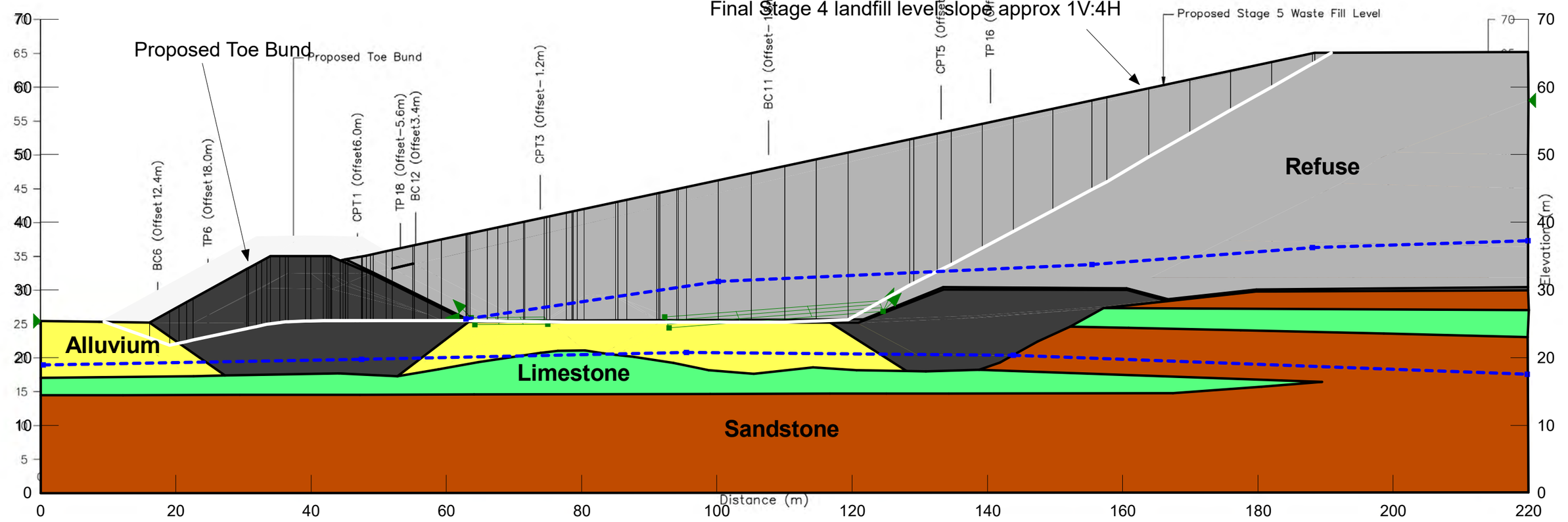
Name: 6 REV1) Slope Stability- Larger Bund Basal slide Yield
Method: Morgenstern-Price
Slip Surface Option: Block
Staged Pseudo Static Analysis Option: (none)

Horz Seismic Coef.: 0.26

Color	Name	Model	Unit Weight (kN/m³)	Cohesion' (kPa)	Phi' (°)	Phi-B (°)	Piezometric Line
	Alluvium	Mohr-Coulomb	17	0	28	0	1
	Engineered Fill (cohesive)	Mohr-Coulomb	18	5	32	0	2
	Limestone Rock	Mohr-Coulomb	18	20	40	0	2
	Liner (Post Peak)	Mohr-Coulomb	18	0	16	0	1
	Refuse	Mohr-Coulomb	14	5	25	0	2
	Sandstone Rock	Mohr-Coulomb	18	10	35	0	2

1.02

Final Stage 4 landfill level slope approx 1V:4H



Distance

Tonkin+Taylor	HASTINGS DISTRICT COUNCIL	**Omaranui Landfill Geotechnical Design Area B**	6 REV1) Slope Stability- Larger Bund Basal slide Yield 2020 update Toe Bund Analysis.gsz 20/05/2020	Analysed By: JWY Checked By: NBK Scale 1:596

Appendix F: In Situ Testing results

- Slug test results (2009/2018)
- Packer Testing Results

TONKIN & TAYLOR LTD
105 CARLTON GORE ROAD NEWMARKET AUCKLAND NEW ZEALAND
TELEPHONE (09) 3556000 FAX (09) 3070265

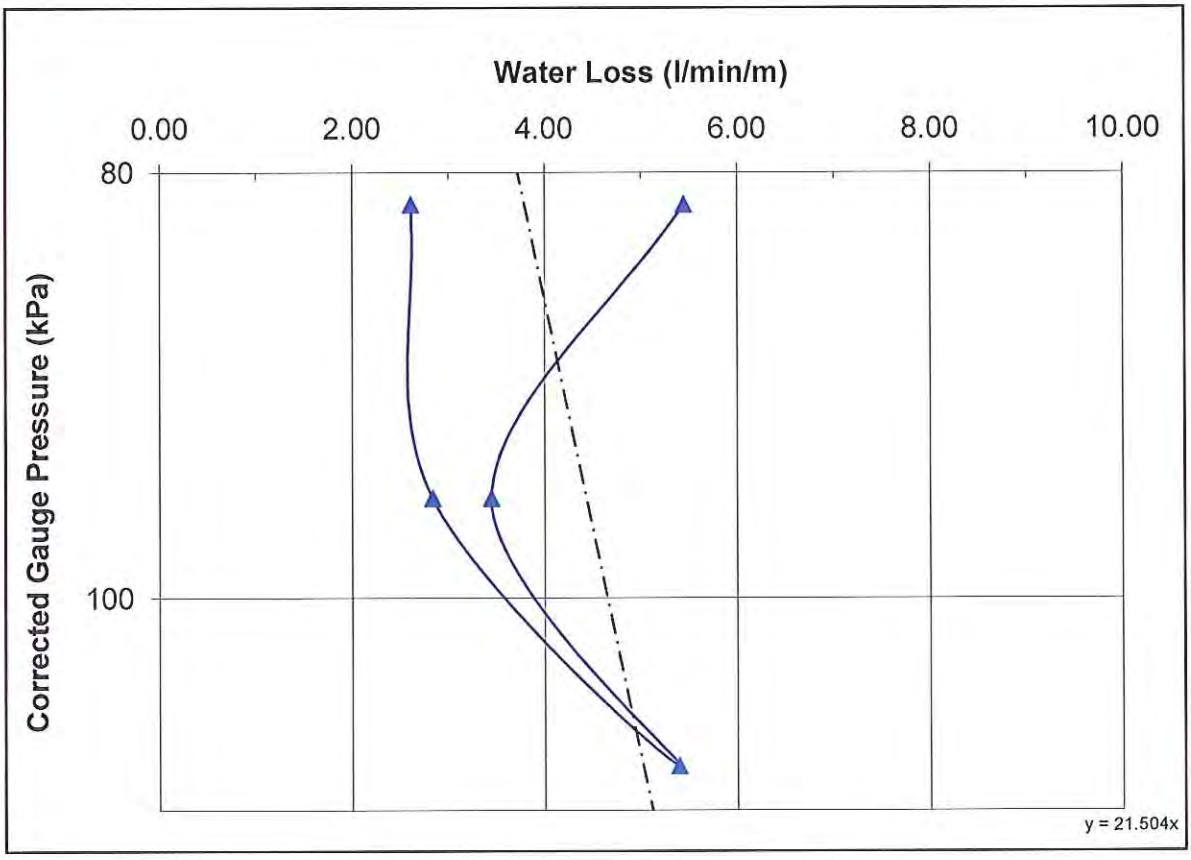
BOREHOLE PACKER TEST

Job No: *23610.1* Date: *28/06/2000*
Project: *Omarunui Landfill* Operated by: *JKK*
Location: *Napier/Hastings* Logged by: *JKK*
Packer type: Checked by:

BH No.: ***BC5***
Test unit: Limestone/Sandstone

GW depth: Guage height: 0.6
Depth from 5.2 to 7 Test length: 1.8 Mid point: 6.1

Guage pressure (kPa)	Flow (l)	Duration of test (min)	Flow rate (l/min)	Headloss (kPa)	Corrected pressure (kPa)	Water loss (l/min/m)	Comments
13.8	98	10.00	9.80	0.00	82	5.44	
27.6	62	10.00	6.20	0.00	95	3.44	
40.2	97	10.00	9.70	0.00	108	5.39	
27.6	51	10.00	5.10	0.00	95	2.83	
13.8	47	10.00	4.70	0.00	82	2.61	



Permeability 46.50 Lugeons

TONKIN & TAYLOR LTD
105 CARLTON GORE ROAD NEWMARKET AUCKLAND NEW ZEALAND
TELEPHONE (09) 3556000 FAX (09) 3070265

BOREHOLE PACKER TEST

Job No: *23610.1*
Project: *Omarunui Landfill*
Location: *Napier/Hastings*
Packer type:

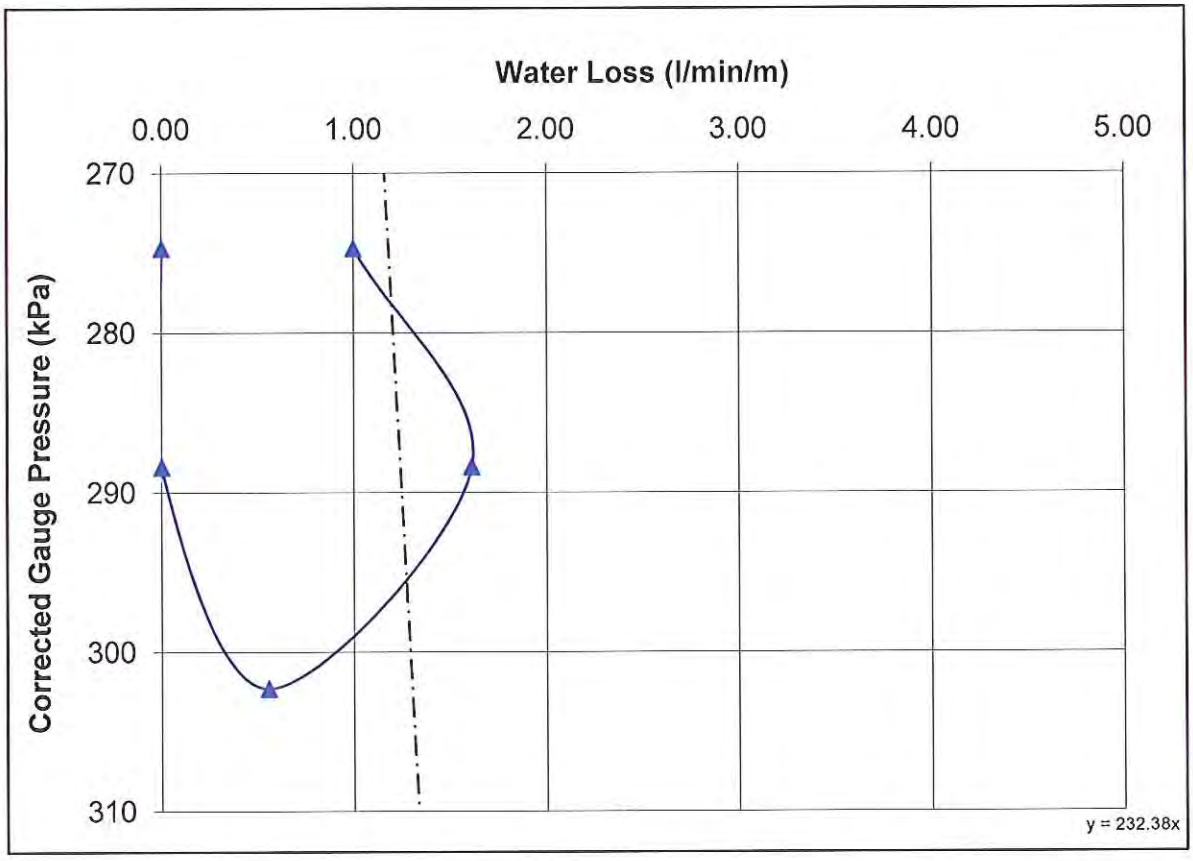
Date: *28/06/2000*
Operated by: *JKK*
Logged by: *JKK*
Checked by:

BH No.: ***BC8***
Test unit: Limestone/Sandstone

GW depth:
Depth from 25.2 to 27

Guage height: 0.5
Test length: 1.8
Mid point: 26.1

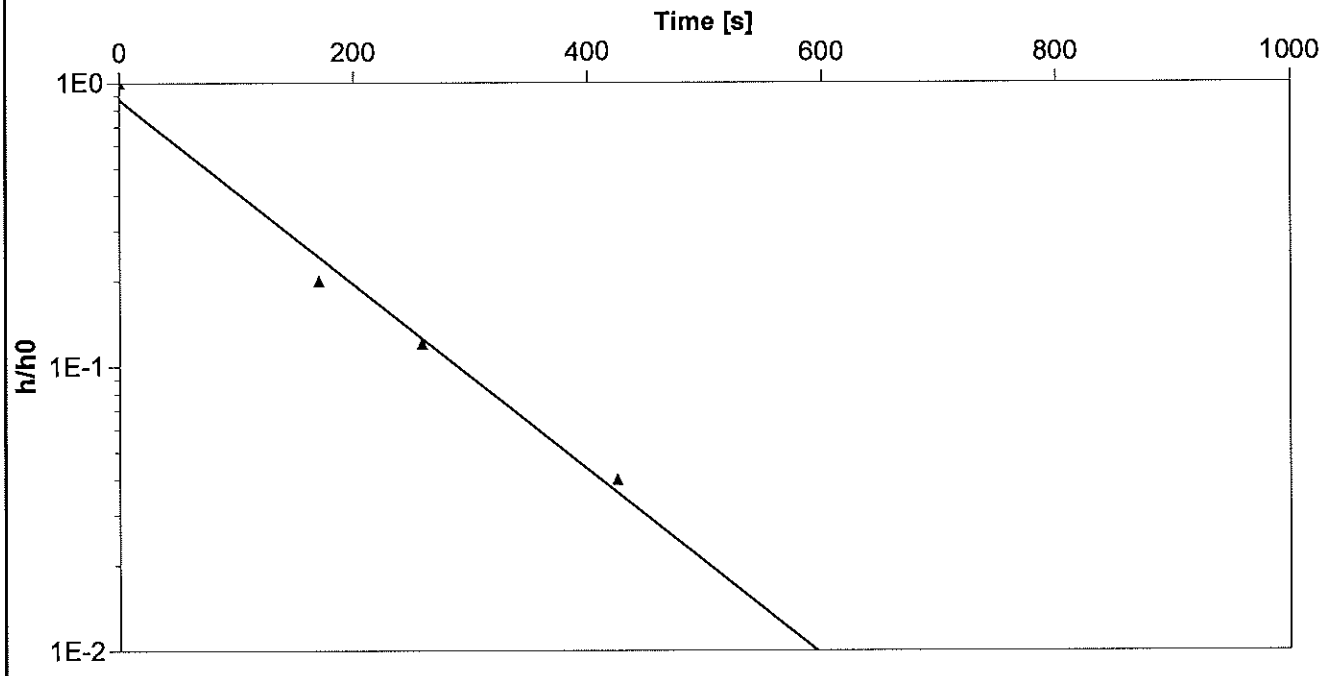
Guage pressure (kPa)	Flow (l)	Duration of test (min)	Flow rate (l/min)	Headloss (kPa)	Corrected pressure (kPa)	Water loss (l/min/m)	Comments
13.8	18	10.00	1.80	0.00	275	1.00	
27.5	29	10.00	2.90	0.00	288	1.61	
41.4	10	10.00	1.00	0.00	302	0.56	
27.5	0	10.00	0.00	0.00	288	0.00	
13.8	0	10.00	0.00	0.00	275	0.00	



Permeability 4.30 Lugeons

Tonkin & Taylor	Tonkin & Taylor Ltd 105 Carlton Gore Road Newmarket Auckland P O Box 5271 Wellesley Street Auckland NEW ZEALAND	**Slug Test Analysis Report**
		Project: Omarunui
		Number: 23610.100
		Client: Hastings District Council

Location: Omarunui Valleys B & C	Slug Test: Slug Test BC5	Test Well: BC5
Test conducted by: Jason Kelly		Test date: 13/05/09
Analysis performed by: TIR	Hvorslev	Analysis date: 14/05/09
Aquifer Thickness: 10.00 m		

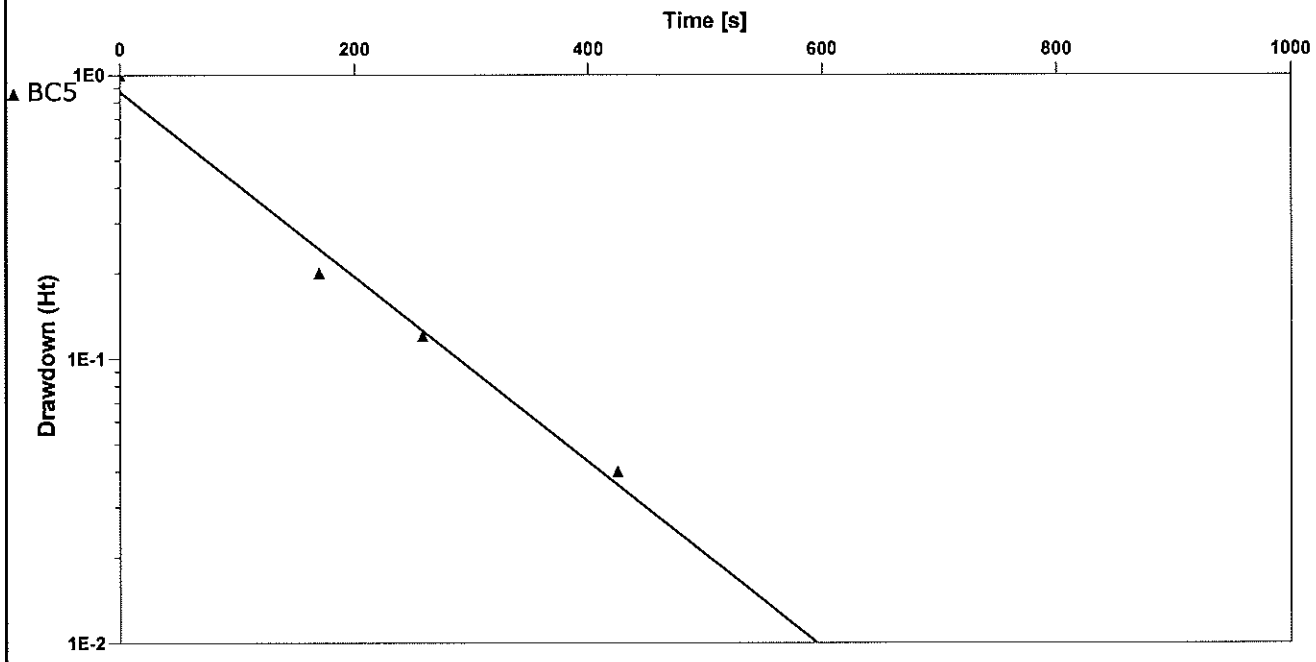


Calculation after Hvorslev

Observation well	Hydraulic Conductivity [m/d]	
BC5	4.03×10^{-1}	

Tonkin & Taylor	Tonkin & Taylor Ltd 105 Carlton Gore Road Newmarket Auckland P O Box 5271 Wellesley Street Auckland NEW ZEALAND	**Slug Test Analysis Report** Project: Omarunui Number: 23610.100 Client: Hastings District Council

Location: Omarunui Valleys B & C	Slug Test: Slug Test BC5	Test Well: BC5
Test conducted by: Jason Kelly		Test date: 13/05/09
Analysis performed by: TIR	Bouwer and Rice	Analysis date: 15/05/09
Aquifer Thickness: 10.00 m		

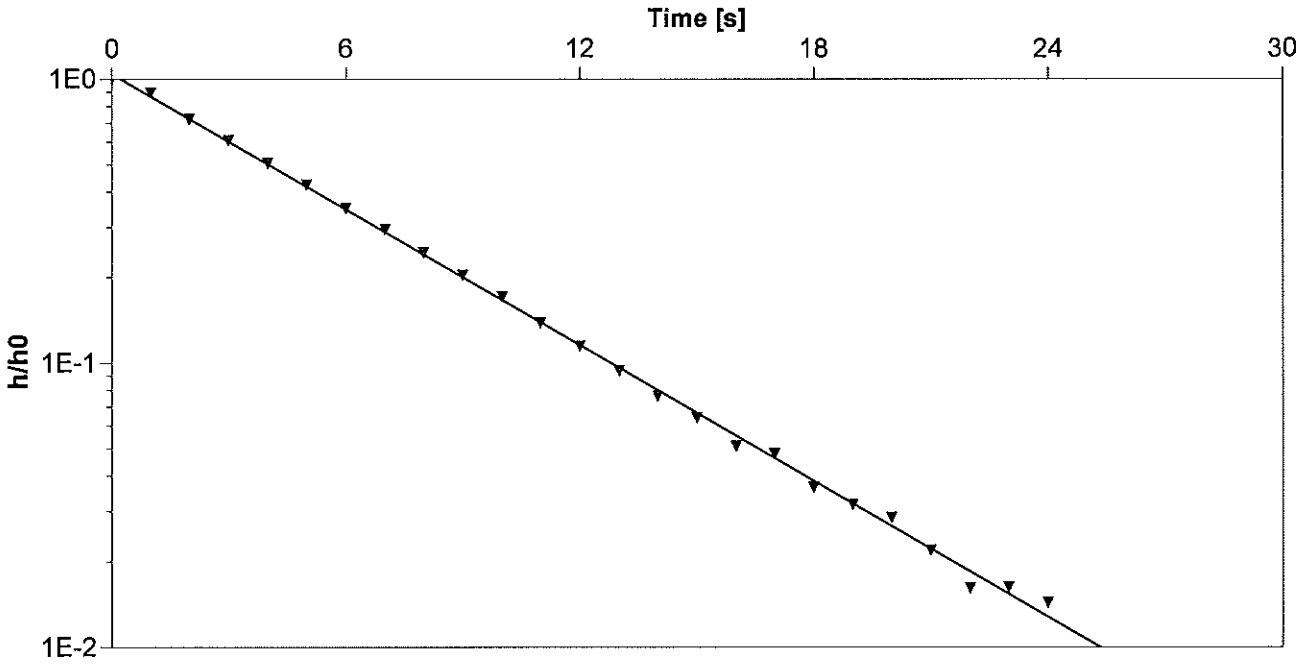


Calculation after Bouwer & Rice

Observation well	Hydraulic Conductivity [m/d]	
BC5	3.09×10^{-1}	

Tonkin & Taylor	Tonkin & Taylor Ltd 105 Carlton Gore Road Newmarket Auckland P O Box 5271 Wellesley Street Auckland NEW ZEALAND	**Slug Test Analysis Report** Project: Omarunui Number: 23610.100 Client: Hastings District Council

Location: Omarunui Valleys B & C	Slug Test: Slug Test BC6	Test Well: BC6
Test conducted by: Jason Kelly		Test date: 13/05/09
Analysis performed by: TIR	Hvorslev	Analysis date: 14/05/09
Aquifer Thickness: 10.00 m		

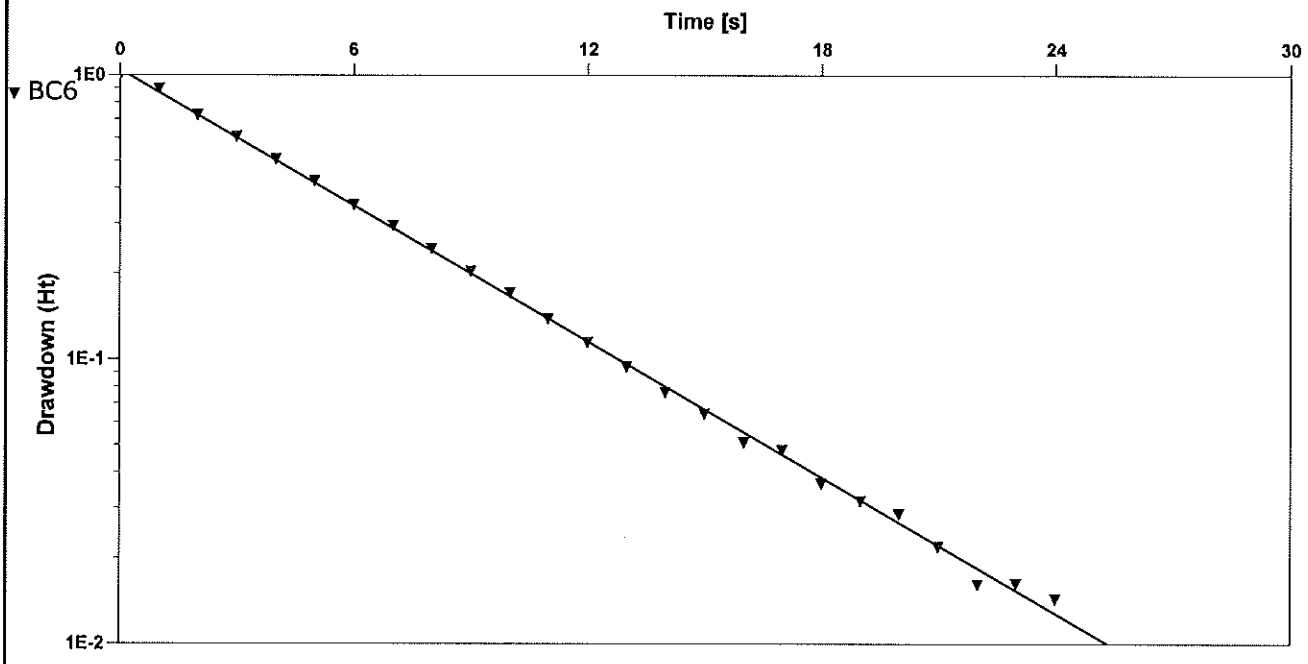


Calculation after Hvorslev

Observation well	Hydraulic Conductivity [m/d]	
BC6	7.41×10^{0}	

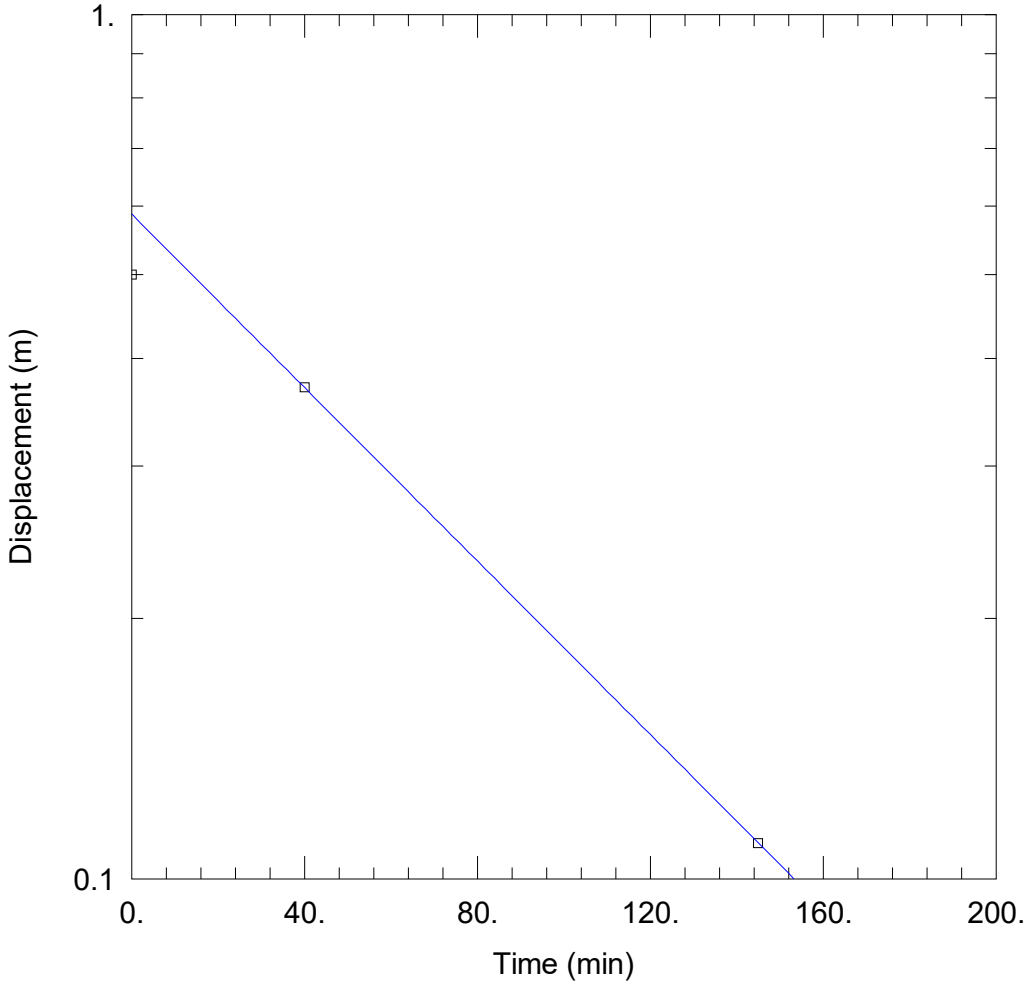
Tonkin & Taylor	Tonkin & Taylor Ltd 105 Carlton Gore Road Newmarket Auckland P O Box 5271 Wellesley Street Auckland NEW ZEALAND	**Slug Test Analysis Report** Project: Omarunui Number: 23610.100 Client: Hastings District Council

Location: Omarunui Valleys B & C	Slug Test: Slug Test BC6	Test Well: BC6
Test conducted by: Jason Kelly		Test date: 13/05/09
Analysis performed by: TIR	Bouwer and Rice	Analysis date: 14/05/09
Aquifer Thickness: 10.00 m		



Calculation after Bouwer & Rice

Observation well	Hydraulic Conductivity [m/d]	
BC6	5.71×10^{0}	



WELL TEST ANALYSIS

Data Set: P:\1000647\1000647.1000\WorkingMaterial\Hydrogeology\BC7ASlugTest.aqt
Date: 08/24/18 Time: 17:20:40

PROJECT INFORMATION

Company: Tonkin & Taylor Ltd
Client: Hastings District Council
Project: 1000647.1000
Location: Omarunui Landfill Area B
Test Well: BC7A
Test Date: June 2018

AQUIFER DATA

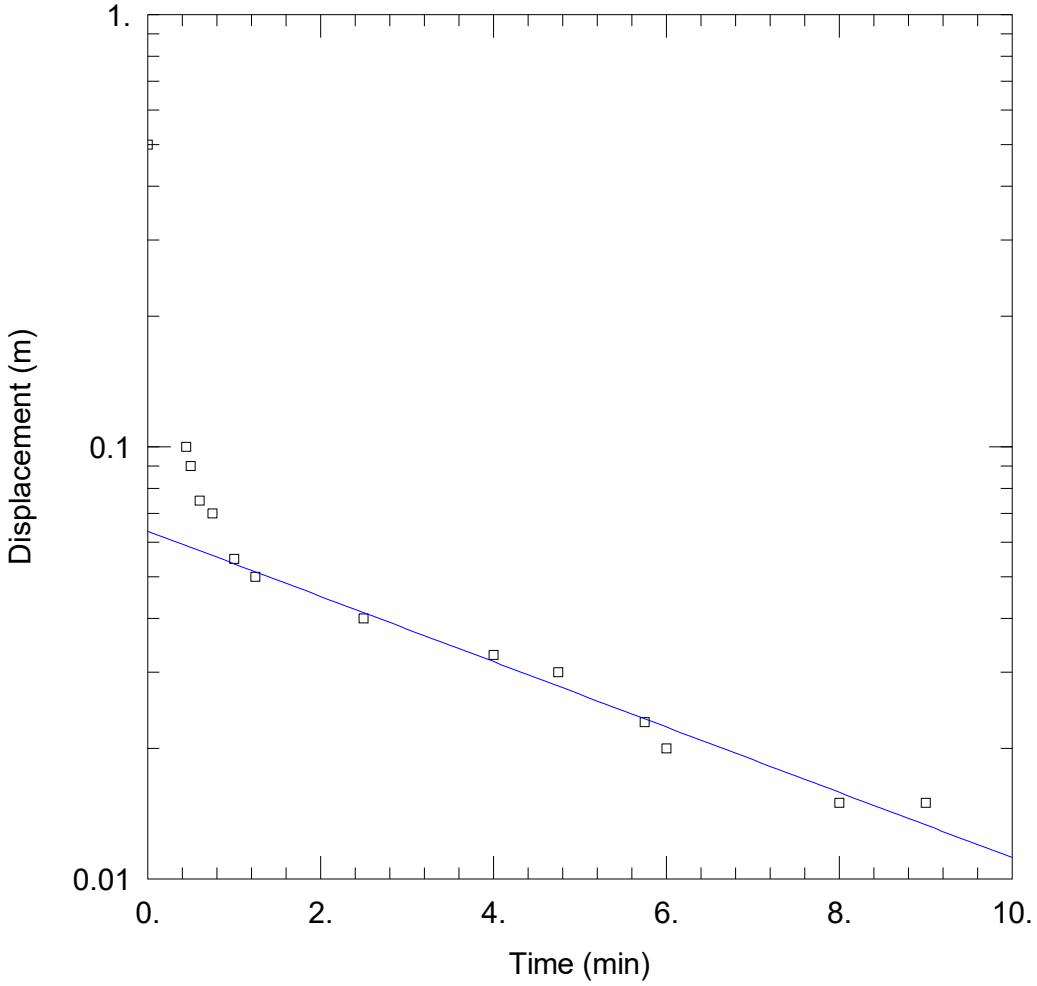
Saturated Thickness: 8.3 m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BC7A)

Initial Displacement: 0.5 m
Static Water Column Height: 6.44 m
Total Well Penetration Depth: 27.8 m
Screen Length: 3. m
Casing Radius: 0.025 m
Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.002808 m/day
y0 = 0.5873 m



WELL TEST ANALYSIS

Data Set: P:\1000647\1000647.1000\WorkingMaterial\Hydrogeology\BC9FallingHeadSlugTest.aqt
Date: 08/24/18 Time: 17:20:19

PROJECT INFORMATION

Company: Tonkin & Taylor Ltd
Client: Hastings District Council
Project: 1000647.1000
Location: Omarunui Landfill Area B
Test Well: BC9
Test Date: June 2018

AQUIFER DATA

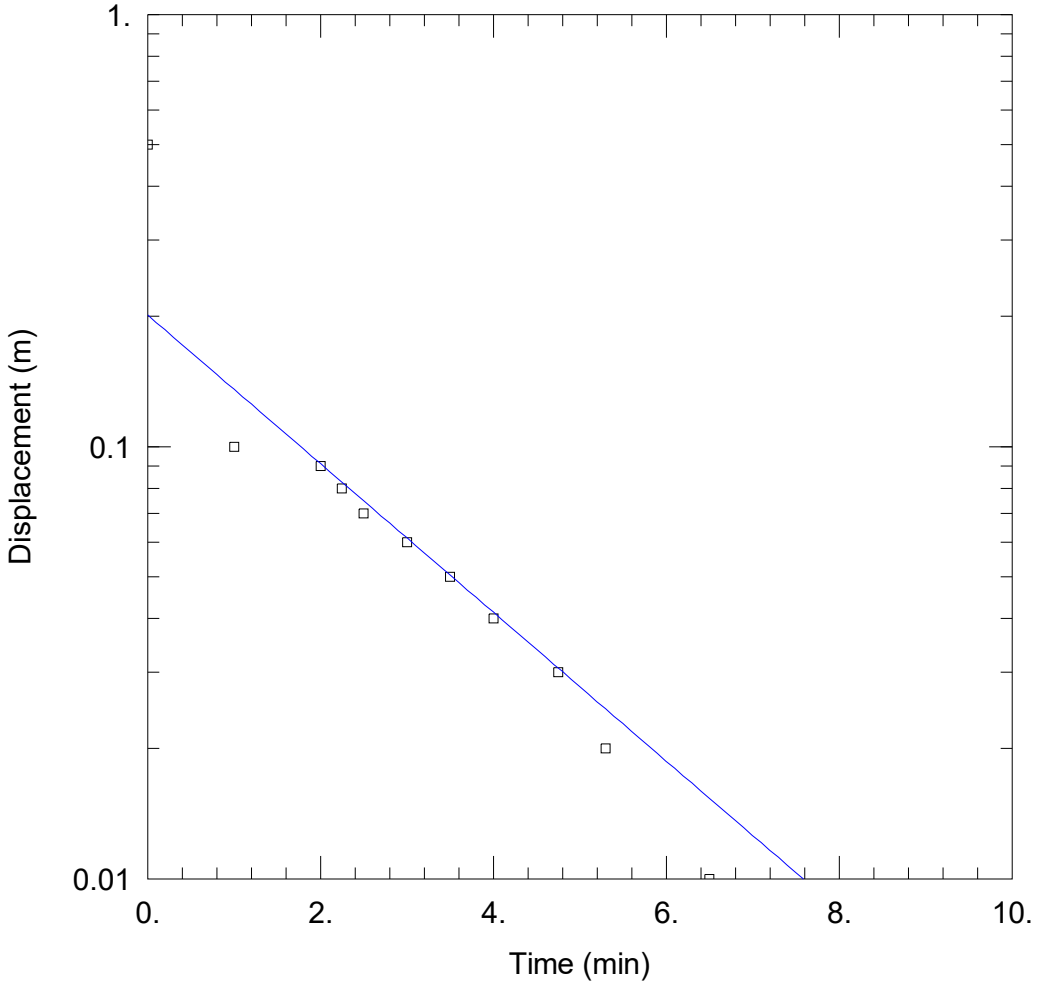
Saturated Thickness: 10. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BC9)

Initial Displacement: 0.5 m
Static Water Column Height: 53.98 m
Total Well Penetration Depth: 56.46 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.02393 m/day
y0 = 0.06373 m



WELL TEST ANALYSIS

Data Set: P:\1000647\1000647.1000\WorkingMaterial\Hydrogeology\BC9SlugTest.aqt
Date: 08/24/18 Time: 17:19:54

PROJECT INFORMATION

Company: Tonkin & Taylor Ltd
Client: Hastings District Council
Project: 1000647.1000
Location: Omarunui Landfill Area B
Test Well: BC9
Test Date: June 2018

AQUIFER DATA

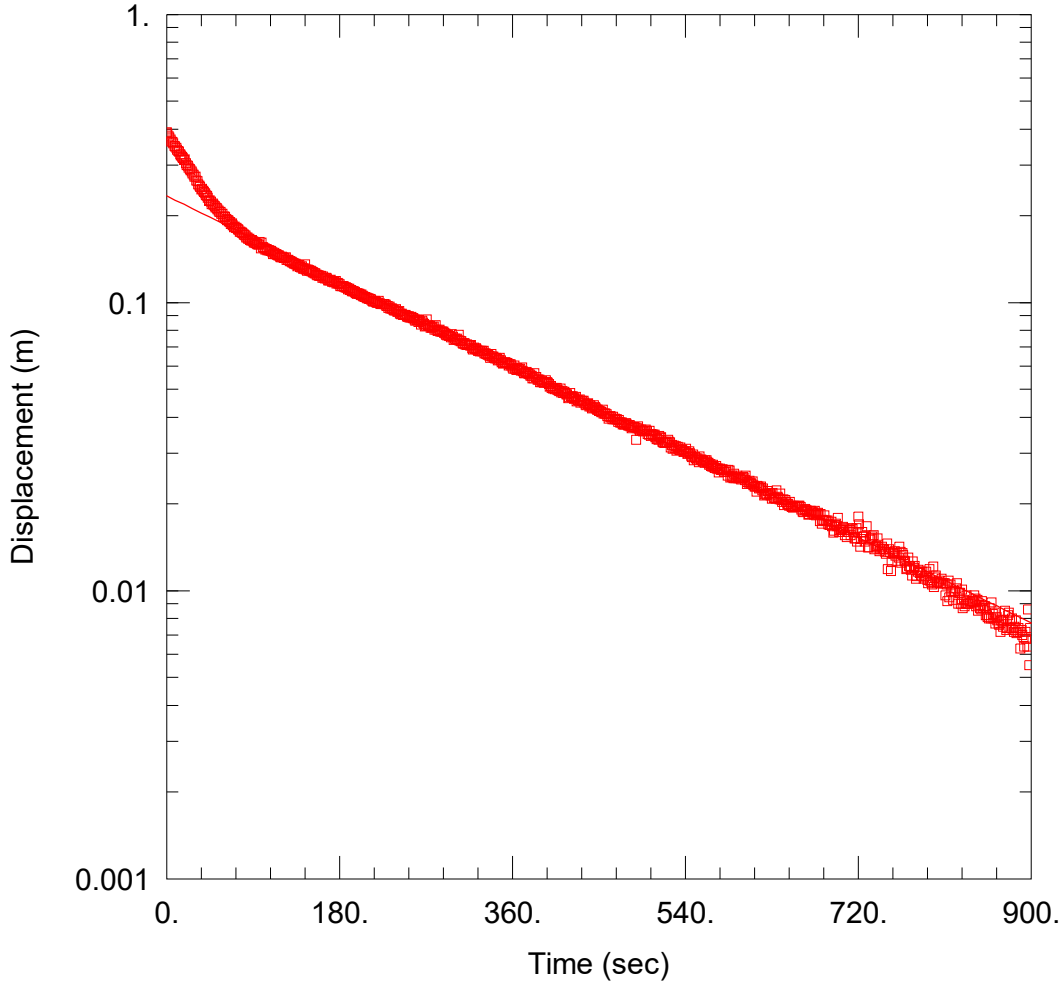
Saturated Thickness: 10. m
Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (BC9)

Initial Displacement: 0.5 m
Static Water Column Height: 0. m
Total Well Penetration Depth: 56.46 m
Screen Length: 6. m
Casing Radius: 0.025 m
Well Radius: 0.048 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Hvorslev
K = 0.05902 m/day
y0 = 0.2015 m



SLUG TESTING

Data Set: P:\1000647\1000647.1000\WorkingMaterial\Hydrogeology\BC10SlugTest.aqt
Date: 08/24/18 Time: 17:19:08

PROJECT INFORMATION

Company: Tonkin & Taylor Ltd
Client: Hastings District Council
Project: 1000649.1000
Location: Omarunui Area B
Test Well: BC10
Test Date: 6 June 2018

AQUIFER DATA

Saturated Thickness: 10. m
Anisotropy Ratio (Kz/Kr): 0.1

WELL DATA (BC10)

Initial Displacement: 0.39 m
Total Well Penetration Depth: 1.67 m
Casing Radius: 0.025 m
Static Water Column Height: 1.67 m
Screen Length: 1.67 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2278 m/day
y0 = 0.2344 m

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