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REPORT

Yachiyo Engineering Co Ltd.

**The Project for Improvement of
Equipment for Disaster Risk
Management in the Republic of Fiji**

Soils Investigation Report

Report prepared for:

Yachiyo Engineering Co Ltd.

Report prepared by:

Tonkin & Taylor International Ltd

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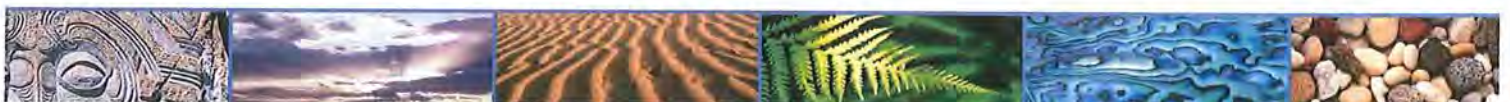


Table of contents

1	Introduction	1
1.1	General	1
1.2	Project Description	1
2	Site Description	1
3	Summary of Site Survey	2
4	Summary of Soils Investigation	2
4.1	General	2
4.2	Handauger and Scala Penetrometer Investigations	2
4.2.1	Site A - Fiji Meteorological Service, Nadi	3
4.2.2	Site B - Fiji Meteorological Service, Suva	3
4.2.3	Site C - Fiji Meteorological Service, Vatudamu	3
4.3	Geotechnical Laboratory Schedule	3
5	Subsurface Conditions	4
5.1	Geological Setting	4
5.2	Ground and Groundwater Conditions	4
5.2.1	Site A - Fiji Meteorological Service, Nadi	4
5.2.2	Site B - Fiji Meteorological Service, Suva	5
5.2.3	Site C - Fiji Meteorological Service, Vatudamu	6
6	Geotechnical Laboratory Testing Results	8
7	Discussion and Engineering Properties	9
7.1	Solid Density Range	9
7.1.1	Site A – Nadi Met office	9
7.1.2	Site B – Suva Met office	9
7.1.3	Site C – Vatudamu Met office	9
7.2	Effective Cohesion (c')	9
7.2.1	Site A – Nadi Met office	9
7.2.2	Site B – Suva Met office	9
7.2.3	Site C – Vatudamu Met office	10
7.3	Effective Internal Friction Angle (ϕ)	10
7.3.1	Site A – Nadi Met office	10
7.3.2	Site B – Suva Met office	10
7.3.3	Site C – Vatudamu Met office	10
7.4	Young's Modulus Range (E)	11
7.4.1	Site A – Nadi Met office	11
7.4.2	Site B – Suva Met office	11
7.4.3	Site C – Vatudamu Met office	12
7.5	Foundation Design	12
7.5.1	General	12
7.5.2	Site A – Nadi Met office	12
7.5.3	Site B – Suva Met office	13
7.5.4	Site C – Vatudamu Met office	13
7.6	Settlement	13
8	Applicability	14

- Appendix A: Contract of Soils Explorations**
- Appendix B: Topographical Survey and Geotechnical Investigation Location Plans**
- Appendix C: Investigation Logs and Geotechnical Laboratory Testing**

1 Introduction

1.1 General

Yachiyo Engineering Co. Ltd (YEC) engaged Tonkin & Taylor International Ltd (T&TI) to carry out the soils investigations for the project for improvement of equipment for disaster risk management at three Fiji Meteorological service (Met service) sites in the Republic of Fiji. The investigations were carried out at the Fiji Metrological services office in Nadi, Viti Levu, the Metrological services office in Suva, Viti Levu and at the metrological service outpost at Vatudamu, Vanua Levu. A topographical survey of the site in Nadi is to be undertaken by local surveyors, Cadastral Solutions Limited.

The investigations have been carried out in accordance with the “Contract of Topographical Survey and Soil Explorations” provided to T&TI by YEC (ref: Appendix A). The soils investigation consisted of 2 hand auger boreholes and 2 Scala penetrometer tests at the Met Service office in Nadi, 3 hand auger boreholes and 3 Scala penetrometer tests at the Met Service office in Suva and 2 hand auger bore holes along with 2 Scala penetrometer tests at Vatudamu. Laboratory testing of recovered soil samples from the three sites was also undertaken. This work scope was agreed with YEC. This report summarises the results of the soils investigation carried out at these three sites.

1.2 Project Description

The Republic of Fiji consists of 332 islands occupying over 18,300 square kilometres in the southern Pacific Ocean. The capital is Suva located on the main island of Viti Levu.

The project involves construction of various works at three separate sites, two on Viti Levu and one on Vanua Levu; a new wind profiler system at the site in Nadi (Viti Levu) and a new automatic weather station at Suva (Viti Levu) and Vatudamu (Vanua Levu). The works are part of the project for improvement of equipment for disaster risk management in the republic of Fiji.

2 Site Description

The first site (Site A) is located in Nadi, on the western coast of Viti Levu. The site is approximately 1km from Nadi Airport within the CAAFI Compound at the Fiji Meteorological service office. The site is relatively flat, consisting of several flat building platforms divided by small embankments. The property is currently occupied by a large office building and meteorological instruments including radar and satellite dishes. Several underground cables supplying power to the external equipment dissect the site, however the exact alignment of these is unknown.

The second site (Site B) is located in Suva, on the south eastern coast of Viti Levu. The site is approximately 2km from the centre of town and is located on Fletcher Road at the Fiji Meteorological Service office. The site is situated above the road on a flat site which is currently occupied by a concrete 3 storey office building and various weather monitoring equipment including wind masts and rain and temperature gauges. At the time of the site visit, construction of a new office building was underway to the rear of the existing office building.

The third site (Site C) is located at Vatudamu approximately 10 km from Labasa, on the northern coast of Vanua Levu. The site is at the top of a ridge line approximately 120m above sea level and is located approximately 400m from the Vodafone telecommunication tower. The site is sloping down from east to west, and there are several flat building platforms created during the construction of the site office. The site is surrounded by steep slopes to the north, south and west. The site is currently occupied by a small service building, water tanks, satellites and a radar tower. Access to the site is by 4WD only via an unmaintained gravel road. Exposed andesite rock

was present at ground level at some locations within the site boundaries. An underground septic tank of an unknown size is located in the western corner of the site at the approximate location of the proposed new construction.

A site plan of each location and topographic survey of Site A is attached in Appendix B.

3 Summary of Site Survey

A topographical survey of the Nadi Met office site was undertaken by local surveyors, Cadastral Solutions in January 2013 under the supervision of T&TI. Each site investigation location at the Nadi Met office was surveyed and the co-ordinates and reduced levels (RL'S) are presented in Appendix B. The topographic survey plans are also presented in Appendix B.T&TI. Two cross sections, A and B were also taken across the site and these are presented in Appendix B.

4 Summary of Soils Investigation

4.1 General

The soils investigations were carried out in January 2013 and the scope of work was completed in accordance with the "Contract of Topographical Survey and Soil Explorations" attached in Appendix A. All tests were terminated in hard ground.

The following tasks were completed for the soils investigation:

- Site A – Fiji Meteorological Service, Nadi
 - 2 No. Hand auger boreholes (BH1A – BH2A) to 3m below existing ground level
 - 2 No. Scala penetrometer tests (SC1A – SC2A) to 3m below existing ground level
- Site B – Fiji Meteorological Service, Suva
 - 3 No. Hand auger boreholes (BH1B – BH3B) to between 1 and 3m below existing ground level
 - 3 No. Scala penetrometer tests (SC1B – SC3B) to between 2 and 5m below existing ground level
- Site C – Fiji Meteorological Service, Vatudamu
 - 2 No. Hand auger boreholes (BH1C – BH2C) to between 1 and 2m below existing ground level
 - 2 No. Scala penetrometer tests (SC1C – SC2C) to between 2 and 4m below existing ground level

The subsections below present a summary of the investigation work and laboratory testing results. Site investigation logs are presented in Appendix C and laboratory testing results are presented in Appendix C.

4.2 Handauger and Scala Penetrometer Investigations

The soil investigation testing, including hand augered boreholes and Scala penetrometer tests, was undertaken over three days (7-9 January 2013) at the Met service office Nadi, Met service office Suva and Vatudamu. In-situ shear strength testing was carried out in the hand auger boreholes in cohesive materials using a calibrated pilcon shear vane and samples were taken for geotechnical laboratory testing. The subsurface soils were described in accordance with NZ Geotechnical Society guidelines and shear strengths are recorded on the borehole logs presented

in Appendix C. The Scala penetrometer provides continuous soil strength data until hard ground/refusal is achieved (8 to 10 blows per 50mm penetration). The results of the Scala penetrometer tests are included in Appendix C.

Correlations between Scala penetrometer test results and SPT 'N' values have been developed over a long period of time. The developed correlations are particularly relevant in granular soils.

4.2.1 Site A - Fiji Meteorological Service, Nadi

Two hand auger boreholes and two Scala penetrometer tests were completed at this site on 7th January 2013. The hand auger boreholes extended to a depth of 3m below existing ground level where hard clays were encountered. No groundwater was encountered in either borehole at the site. The Scala penetrometer tests were terminated at depths of 5m below ground level.

4.2.2 Site B - Fiji Meteorological Service, Suva

Three hand auger boreholes and three Scala penetrometer tests were completed at this site on 8th January 2013. Hand auger boreholes BH1B was drilled to a depth of 1.3m where it hit an obstruction and was terminated. The corresponding Scala penetrometer test SC1B was also terminated at 1.3m after hitting the same obstruction. Two further hand augers (BH2B and BH3B) were drilled to a depth of up to 3.0m below existing ground level. Groundwater was encountered between 1.9 and 2.3m below ground level. The Scala penetrometer tests (SC2B and SC3B) were terminated at depths of 5m below ground level.

4.2.3 Site C - Fiji Meteorological Service, Vatudamu

Two hand auger boreholes and two Scala penetrometer tests were completed at this site on 9th January 2013. The hand auger boreholes were drilled to a depth of up to 1.9m below existing ground level where rock was encountered. No ground water was encountered in any of the boreholes. The Scala penetrometer tests were terminated at depths of up to 3.7m due to encountered rock.

4.3 Geotechnical Laboratory Schedule

The recovered samples were brought back to Auckland and geotechnical laboratory testing was carried out by Geotechnics Ltd. The laboratory tests have been completed in full accordance with the relevant New Zealand standards, identified in the subsections below, and the laboratory is fully accredited with International Accreditation New Zealand (IANZ) registration.

The soil testing consisted of the following:

- Site A - Fiji Meteorological Service, Nadi
 - Moisture content (2 No.)
 - Particle size distribution (2 No.)
 - Soil density (2 No.)
- Site B - Fiji Meteorological Service, Suva
 - Moisture content (2 No.)
 - Particle size distribution (2 No.)
 - Soil density (2 No.)
- Site C - Fiji Meteorological Service, Vatudamu

- Moisture content (2 No.)
- Particle size distribution (2 No.)
- Soil density (2 No.)

5 Subsurface Conditions

5.1 Geological Setting

On the island of Viti Levu the published geology, geological studies in southwest Viti Levu¹ indicates Site A (Nadi) is underlain by conglomerates, tuff, limestone and maris, while the published geology of Suva² indicates Site B (Suva) is underlain by conglomerates and clay.

The geology of east-central Vanua Levu³ indicates Site C (Vatudamu) is underlain by Koroutari andesites consisting of andesite lavas, pyroclastic rocks and epiclastic breccias.

5.2 Ground and Groundwater Conditions

5.2.1 Site A - Fiji Meteorological Service, Nadi

The two hand auger boreholes across the building platform encountered very similar ground conditions and these are summarised in Table 1 below:

Table 1 – Summary of ground conditions

Depth (Below ground level)	Geological unit	Soil description	Soil undrained shear strength (kPa)
0.0m – 0.1m	Topsoil	SILT with some clay, light brown, dry, low plasticity	N/A
0.1m – 2.5m	Volcanic Tuff	CLAY with some silt, orange/red brown, very stiff to hard, dry, low plasticity	162 kPa to 210 kPa
2.5m - >3.0m	Residual soil	Clay with trace silt, red brown mottled white, hard, dry, low plasticity	210 ⁺ kPa

Groundwater was not encountered in either borehole during geotechnical investigations at this site.

¹ W.J Skiba 1964: Geological studies in southwest Viti Levu. Geological survey of Fiji

² P Ibbotson 1960: Geology of the Suva Area, Viti Levu. Geological survey Department, Suva Fiji

³ P Ibbotson 1969: The Geology of East-central Vanua Levu. Geological Survey of Fiji

Table 2 – Summary of Scala penetrometer results

Depth (Below ground level)	Average Scala Blows per 50mm	Soil Type	Inferred Strength	Equivalent SPT "N" values
0.5m	2	Cohesive	Very stiff	8
1.0m	3.5	Cohesive	Very stiff	12
1.5m	4	Cohesive	Very stiff	16
2.0m	6	Cohesive	Very stiff	24
2.5m	7.5	Cohesive	Very stiff	28
3.0m	9.5	Cohesive	Very stiff	36
3.5m	10	Cohesive	Dense	40 ⁺
4.0m	11.5	Cohesive	Dense	40 ⁺
4.5m	11	Cohesive	Dense	40 ⁺
5.0m	12	Cohesive	Dense	40 ⁺

The two Scala penetrometer tests SC1A – SC2A were terminated at depths of 5m below ground level. From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 2 below:

From the table above, it can be noted that the soil strength increases with depth at the site.

5.2.2 Site B - Fiji Meteorological Service, Suva

The 3 No. hand auger boreholes across the site generally encountered similar ground conditions and these are summarised in Table 3 below:

Table 3 – Summary of ground conditions

Depth (Below ground level)	Geological unit	Soil description	Soil undrained shear strength (kPa)
0.0m – 0.2m	Topsoil	Clayey SILT, dark brown, damp, moderately plastic	N/A
0.2m – 2.4m	Alluvial deposits	Clayey SILT with trace fine sand, orange brown, moist, moderately plastic. (BH1B hit an obstruction at 1.3m and was terminated)	45 kPa to 200 kPa

1.9-2.5m	Gravel	Fine to medium Gravel, grey, angular	N/A
>2.5m	Residual soil	Silty CLAY, red brown mottled white, plastic, wet	120-150kPa

N/A – not applicable

Groundwater was encountered at a depth of between 1.9 and 2.3m below ground level.

The three scala penetrometer tests SC1B – SC3B were terminated at depths of up to 5m below ground level (SC1B was terminated at 1.7m below ground level). From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 4 below:

Table 4 – Summary of Scala penetrometer results

Depth (Below ground level)	Average Scala Blows per 50mm	Soil Type	Inferred Strength	Equivalent SPT “N” values
0.5m	1.5	Cohesive	Stiff	4
1.0m	1	Cohesive	Stiff	4
1.5m	1.5	Cohesive	Very Stiff	4
2.0m	2	Cohesive	Very Stiff	8
2.5m	4	Cohesive	Very Stiff	16
3.0m	2.5	Cohesive	Very Stiff	8
3.5m	4	Cohesive	Medium dense	16
4.0m	5.5	Cohesive	Medium dense	20
4.5m	5.5	Cohesive	Medium dense	20
5.0m	7	Cohesive	Dense	28

From the table above, it can be noted that the soil strength increases with depth at the site.

5.2.3 Site C- Fiji Meteorological Service, Vatudamu

The 2 No. hand auger boreholes across the site encountered similar ground conditions and these are summarised in Table 5 below. The investigations did not extend to full depth as they met refusal on what is believed to be weathered andesite rock surface. A visual inspection identified exposed rock outcrops and large andesite boulders at ground surface on the surrounding slopes.

Table 5 – Summary of ground conditions

Depth (Below ground level)	Geological unit	Soil description	Soil undrained shear strength (kPa)
0.0m – 0.05m	Topsoil	Clayey SILT with fine to medium gravel, light brown, dry, non plastic	N/A
0.05m – 1.5m	Residual soil	CLAY trace silt, dark brown/red (maroon), medium plastic, dry	45kPa - 210kPa

N/A – not applicable

Groundwater was not encountered in either borehole during geotechnical investigations at this site.

The two Scala penetrometer tests SC1C – SC2C were terminated at depths of up to 3.7m below ground level. From this in-situ testing, we can assess the soil strengths at specific depths below the site. The Scala results and inferred soil strength are summarised in Table 6 below:

Table 6 – Summary of Scala penetrometer results

Depth (Below ground level)	Average Scala Blows per 50mm	Soil Type	Inferred Strength	Equivalent SPT "N" values
0.5m	1.5	Cohesive	Stiff	4
1.0m	1	Cohesive	Stiff	4
1.5m	4	Cohesive	Very stiff	16
2.0m	7	Cohesive	Very stiff	28
2.5m	14	Cohesive	Dense	40 ⁺
3.0m	15	Cohesive	Dense	40 ⁺
3.5m	16	Cohesive	Dense	40 ⁺
3.7m	20	Cohesive	Hard	40 ⁺

In addition, the borehole logs of the geotechnical investigations carried out for the design and construction of the Met service office and radar tower at Vatudamu have been provided to T&TI by Fiji Meteorological Service. The investigations for the office and radar tower were located to the east of the T&TI boreholes. However due to uncertainties in elevations and the extent of earthworks required for the construction of the radar tower and office the results of the geotechnical investigations from this project cannot be relied upon.

6 Geotechnical Laboratory Testing Results

A summary of the geotechnical laboratory testing results is presented in Table 7 below. A full set of the geotechnical testing data sheets is presented in Appendix C.

Table 7 – Summary of geotechnical testing

Sample Identification	Specific Gravity	Grain Size Analysis	Moisture Content
Nadi – HA1A (1.0m-1.2m)	2.84 t/m ³	silty CLAY with trace gravel	33.6%
Nadi – HA2A (2.1m-2.8m)	2.83 t/m ³	silty CLAY with some sand and trace gravel	35.6%
Suva – HA2B (1.9m-2.7m)	2.73 t/m ³	sandy SILT with some clay and trace of gravel	43.0%
Suva – HA3B (0.5m-0.7m)	2.74 t/m ³	clayey sandy SILT	32.6%
Vatudamu HA1C (0.4m- 0.5m)	2.82 t/m ³	SAND and SILT with some clay and trace of gravel	51.9%
Vatudamu – HA2C (1.0m- 1.2m)	2.82 t/m ³	silty SAND with minor clay and trace of gravel	55.5%

7 Discussion and Engineering Properties

Recommendations and opinions contained in this report are based upon data from:

- 2 No. hand auger boreholes and 2 No. Scala penetrometer tests at Fiji Meteorological Service, Nadi
- 3 No. hand auger boreholes and 3 No. Scala penetrometers tests at Fiji Meteorological Service, Suva
- 2 No. hand auger boreholes and 2 No. Scala penetrometer tests at Fiji Meteorological Service, Vatudamu

The nature and continuity of the subsoil away from the test locations is inferred, but it must be appreciated that actual conditions could vary from the assumed model.

From the results of the soils investigation, geotechnical laboratory testing and also using published empirical relationships, we have assessed the engineering properties for the underlying soils at the three sites for the designer's consideration in the following subsections.

Actual ground conditions should be confirmed by a person competent to judge whether the soils exposed in the foundation excavations are compatible with those described within this report.

7.1 Solid Density Range

7.1.1 Site A – Nadi Met office

The Volcanic Tuff deposits (1.0m-1.2m) can be assumed to have the following solid density:

$$\text{Solid Density} = 2.84 \text{ t/m}^3$$

The residual soils (2.1m-2.8m) can be assumed to have the following solid density:

$$\text{Solid Density range} = 2.83 \text{ t/m}^3$$

7.1.2 Site B – Suva Met office

The Alluvial deposits (0.2m to 2.4m) can be assumed to have the following solid densities:

$$\text{Solid Density range} = 2.73 \text{ to } 2.74 \text{ t/m}^3$$

7.1.3 Site C – Vatudamu Met office

The residual soils (0.05m to 1.5m) can be assumed to have the following solid density:

$$\text{Solid Density range} = 2.82 \text{ t/m}^3$$

7.2 Effective Cohesion (c')

7.2.1 Site A – Nadi Met office

The near surface materials (upper 2m) are cohesive and the assessed effective cohesion for design purposes, can be taken as:

$$c' \text{ (Effective Cohesion)} = 5 \text{ kPa}$$

7.2.2 Site B – Suva Met office

The near surface material provides some effective cohesion due to the cohesive nature of the soil but there is some sand present in the soil. A value of 2 kPa may be used for design.

$$c' \text{ (Effective Cohesion)} = 2 \text{ kPa}$$

7.2.3 Site C – Vatudamu Met office

The near surface material does not contain much fine silt and clay and therefore may behave like a granular soil. A value of 0 kPa may be used for design.

$$c' \text{ (Effective Cohesion)} = 0 \text{ kPa}$$

7.3 Effective Internal Friction Angle (ϕ)

7.3.1 Site A – Nadi Met office

The effective internal friction angle for the near surface material (clay) has been estimated using a correlation from the Scala penetrometer results. A value of 30° may be used as the effective internal friction angle for design.

$$\Phi \text{ (Effective internal friction angle)} = 30^\circ$$

7.3.2 Site B – Suva Met office

The effective internal friction angle for the near surface alluvium (clayey silt) has been estimated using a correlation from the Scala penetrometer and shear strength results. A value of 28° may be used as the effective internal friction angle for design.

$$\Phi \text{ (Effective internal friction angle)} = 28^\circ$$

7.3.3 Site C – Vatudamu Met office

The effective internal friction angle for the near residual soils has been estimated using a correlation from the Scala penetrometer and shear strength results. A value of 30° may be used as the effective internal friction angle for design.

$$\Phi \text{ (Effective internal friction angle)} = 30^\circ$$

7.4 Young's Modulus Range (E)

The soil stiffness or Young's Modulus, E has been calculated from a correlation with SPT N values (Bowles et al) derived from the available shear strength and Scala penetrometer readings. The table below gives the range of Young's Modulus values for varying depths.

7.4.1 Site A – Nadi Met office

Table 8 – Summary of Young's Modulus (E) with depth (cohesive soils only)

Depth (Below Ground level)	Shear strength (kPa)	Estimated Young's Modulus, E (MPa)
0.5 m	160	25
1.0 m	200+	32
1.5 m	200+	32
2.0 m	200+	32
2.5 m	200+	32
3.0 m	200+	32

7.4.2 Site B – Suva Met office

Table 9 – Summary of Young's Modulus (E) with depth (cohesive soils only)

Depth (Below Ground level)	Shear strength (kPa)	Estimated Young's Modulus, E (MPa)
0.5 m	80	12
1.0 m	100	15
1.5 m	190	30
2.0 m	160	25
2.5 m	90	13
3.0 m	120	20

7.4.3 Site C – Vatudamu Met office

Table 10 – Summary of Youngs Modulus (E) with depth (cohesive soils only)

Depth (Below Ground level)	Shear strength (kPa)	Estimated Young's Modulus, E (MPa)
0.5 m	70	9
1.0 m	150	23
1.5 m	190	30
2.0 m	160	25
2.5 m	90	14
3.0 m	120	20

7.5 Foundation Design

7.5.1 General

Following discussions with YEC, it is understood that either strip or pad foundations will be constructed for the three proposed equipment installations at Nadi, Suva or Vatudamu, providing the ground conditions are suitable.

The site investigation data has indicated that shallow foundations may be utilised at the three sites depending on actual loadings. We have provided bearing pressures at different depths in the upper 3m of subsoil.

We recommend using a strength reduction factor of 0.5 ($\phi_G = 0.5$) to give an ultimate limit state (ULS) bearing capacity, in accordance with New Zealand Design Standards (ref: NZS 1170). For serviceability limit state design we recommend a strength reduction factor of 0.33 ($\phi_G = 0.3$) to give an allowable bearing capacity.

7.5.2 Site A – Nadi Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

Strip or pad foundations would be constructed in the near surface volcanic tuff material. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 11 below.

Table 11 – Bearing pressures within the Volcanic Tuff deposits

Depth	Bearing Pressures					
	Shallow strip footings up to 1 m wide			Shallow isolated pad footings up to 2.5 m wide		
	<i>Allowable</i>	<i>ULS⁽¹⁾</i>	<i>Ultimate</i>	<i>Allowable</i>	<i>ULS⁽¹⁾</i>	<i>Ultimate</i>
0.5m	100kPa	150kPa	300kPa	120kPa	180kPa	360kPa

⁽¹⁾ ULS = Ultimate Limit State (ref. NZS1170)

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

7.5.3 Site B – Suva Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

The strip or pad foundations would be constructed in the near surface alluvial deposits. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 12 below.

Table 12 – Bearing pressures within the alluvial deposits

Depth	Bearing Pressures					
	Shallow strip footings up to 1 m wide			Shallow isolated pad footings up to 2.5 m wide		
	<i>Allowable</i>	<i>ULS</i>	<i>Ultimate</i>	<i>Allowable</i>	<i>ULS</i>	<i>Ultimate</i>
0.6m	100kPa	150kPa	300kPa	120kPa	180kPa	360kPa

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

7.5.4 Site C – Vatudamu Met office

We recommend that all foundations should be embedded at least 0.5m below finished ground level.

The strip or pad foundations would be constructed in the near surface Residual soils materials. Bearing capacities for this material based on the in situ testing undertaken are shown in Table 13 below.

Table 13 – Bearing pressures within the Residual soils

Depth	Bearing Pressures					
	Shallow strip footings up to 1 m wide			Shallow isolated pad footings up to 2.5 m wide		
	<i>Allowable</i>	<i>ULS</i>	<i>Ultimate</i>	<i>Allowable</i>	<i>ULS</i>	<i>Ultimate</i>
0.6m	100kPa	150kPa	300kPa	120kPa	180kPa	360kPa

We recommend that all foundation excavations are inspected and tested by a competent person to ensure the ground conditions and bearing capacities are similar to those encountered during this investigation.

7.6 Settlement

T&TI have not been provided with any vertical loads for the proposed structures. It is recommended that settlement analysis is carried out following completion of the detailed design of the new equipment.

8 Applicability

This report has been prepared for the benefit of YEC with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose without our prior review and agreement.

Tonkin & Taylor International Ltd

Environmental and Engineering Consultants

Report prepared by:

Authorised for Tonkin & Taylor International Ltd by:



Chris Thurlow

Geotechnical engineer






Chris Freer

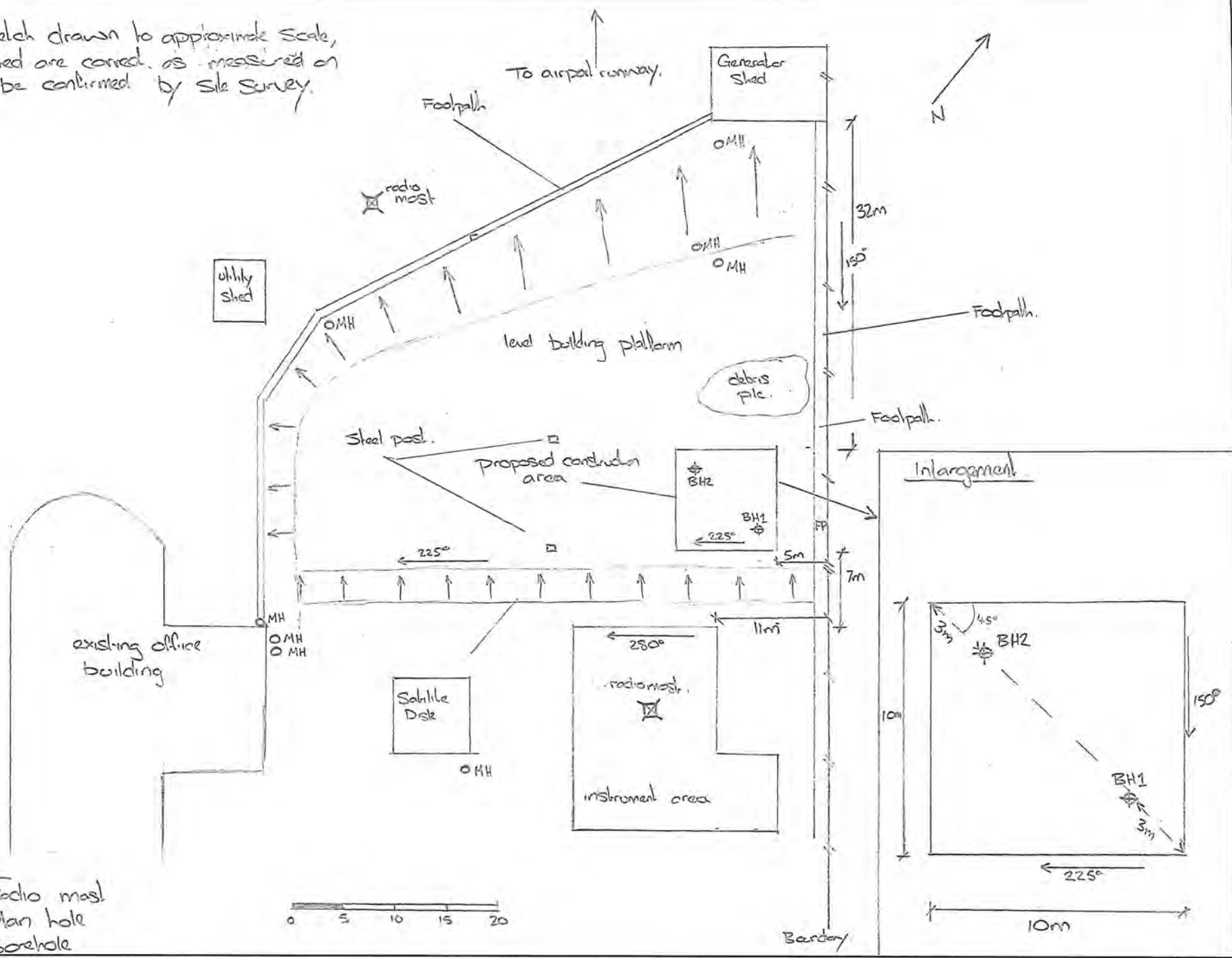
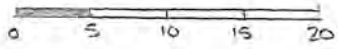
Project Director

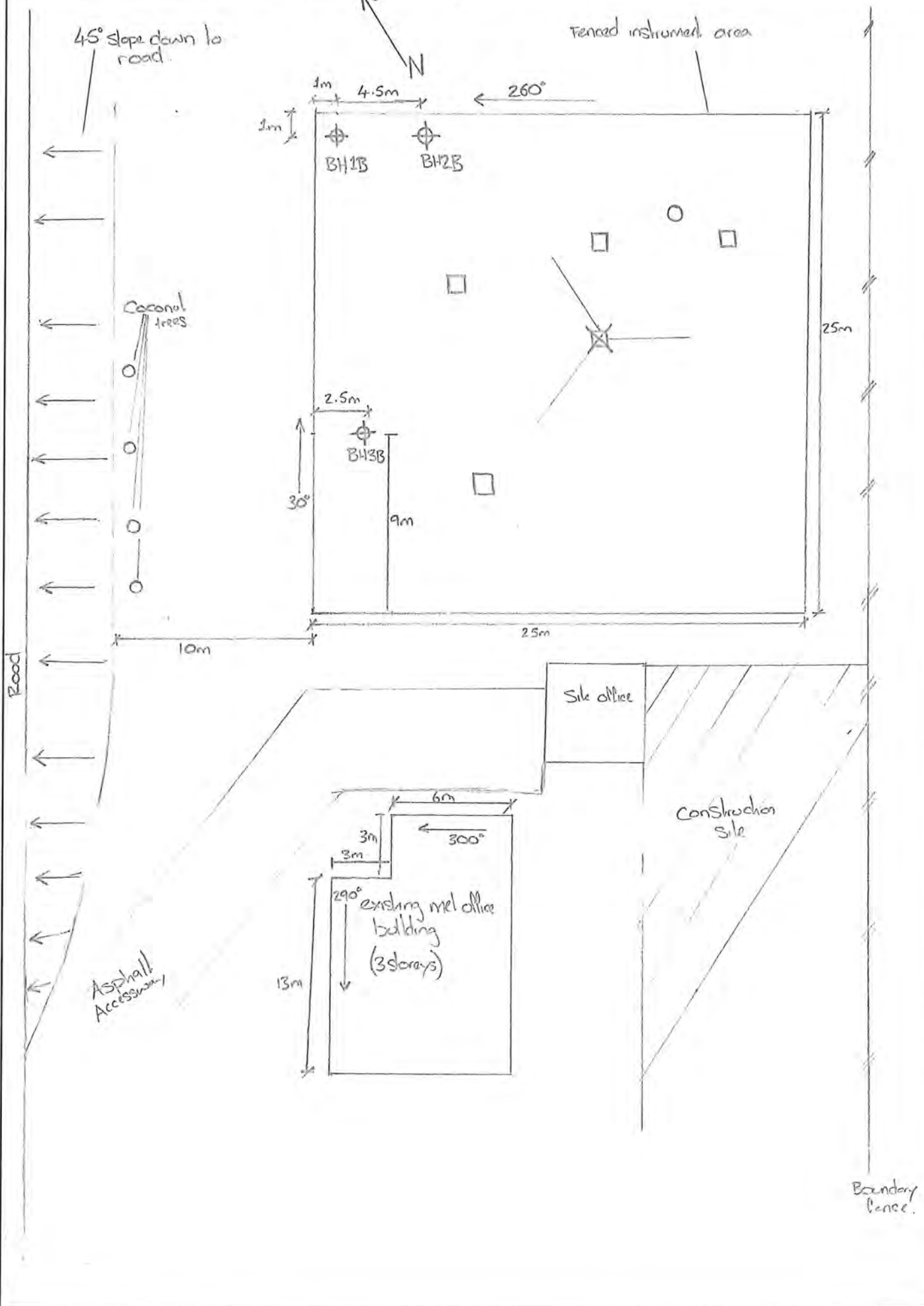
Appendix B:

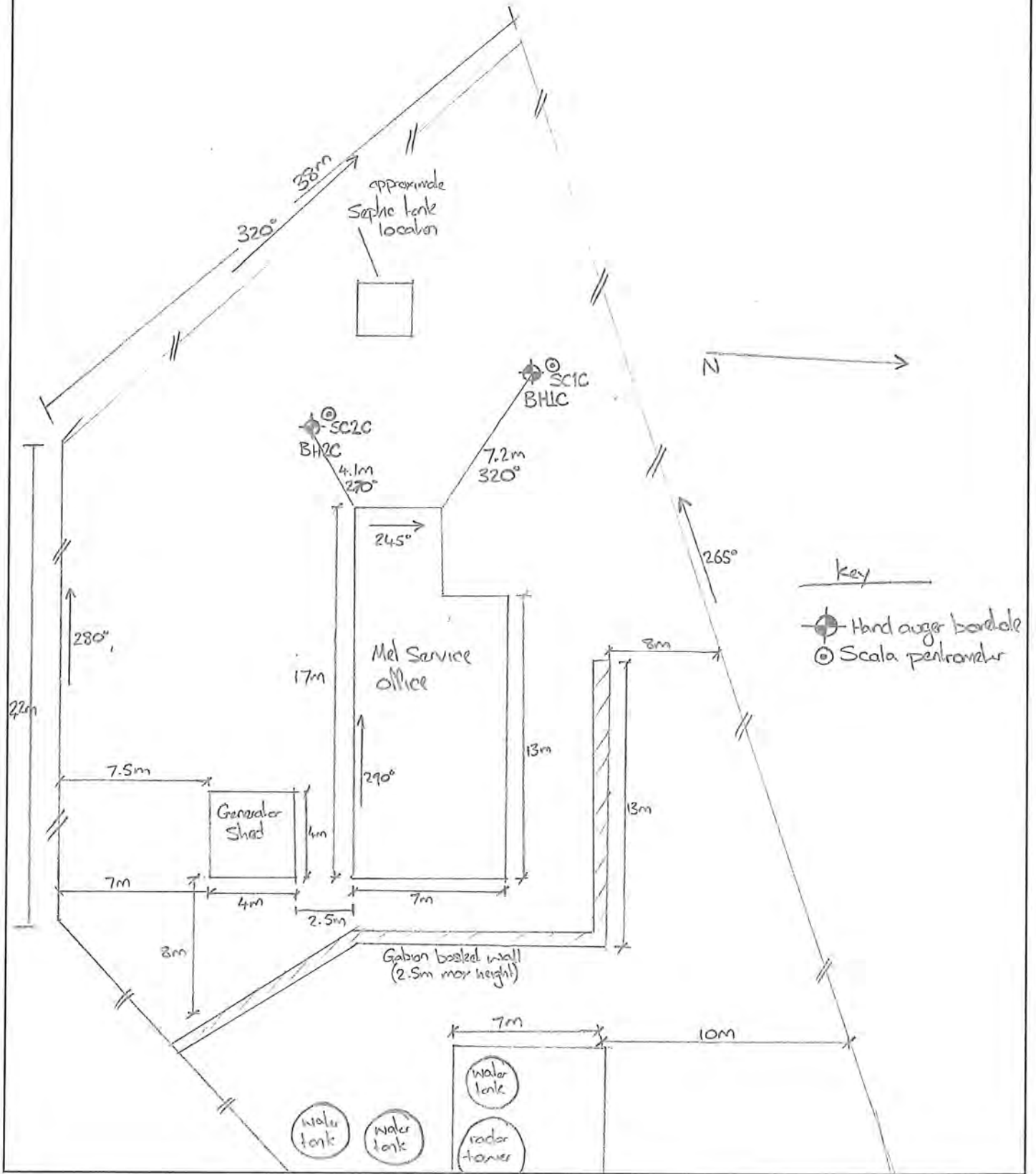
**Topographical Survey and Geotechnical
Investigation Location Plans**

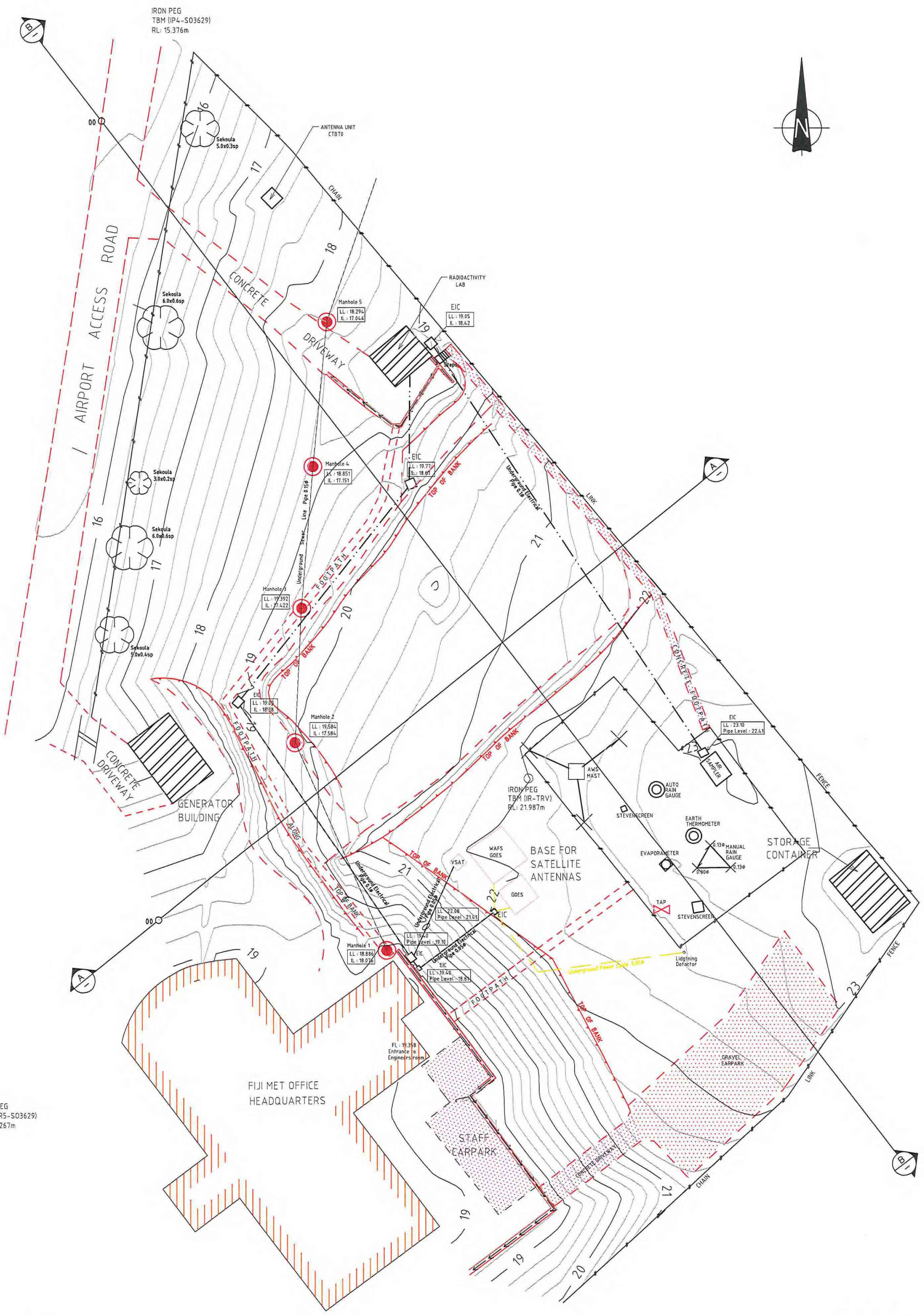
Note: Sketch drawn to approximate scale, bearings quoted are correct as measured on site. To be confirmed by site survey.

- Key**
-  Radio mast
 -  Man hole
 -  Borehole









A3 SCALE 1:500
0 5 10 15 20 25 (m)

ORIGINAL IN COLOUR

NOTES:
 1. Survey supplied by Cadastrals Surveyors, Planners and Development Consultants.
 2. Datum of survey: Fiji Map Grid Datum 1986
 3. Origin of survey: Approved survey plan S03629 (FMG).
 4. Level Datum: Mean sea level (Lands Dept) Datum.
 5. Origin of levels: Standard Survey Mark 3506 of S04242 RL: 27.064m (MSL) on Lands Department Triangulation Network.
 6. Survey Methodology: Grid and String Method.
 7. Contour Intervals: 0.25m (as required).
 8. Schedule of TBM description:

TBM Name	Easting Coord	Northing Coord	RL (MSL) Value
IP4 S03629	186 15 18.880	39 15532.920	15.379m
IR - TRAV	186 1567.680	39 15436.831	21.087m
IR5 S03629	186 1496.168	39 15393.511	16.287m

9. MH denotes Manholes.
 10. EIC denotes U/G Electrical Inspection Chambers.

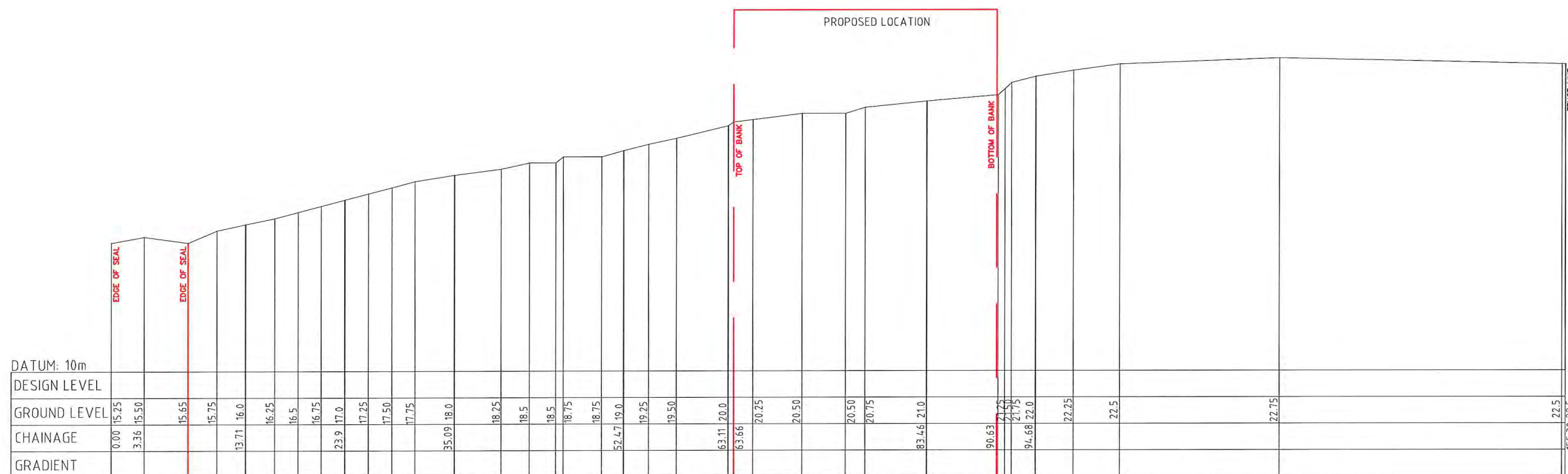
Tonkin & Taylor
 Environmental and Engineering Consultants
 105 Carlton Gore Road, Newmarket, Auckland
 www.tonkin.co.nz

DRAWN	KAH	Feb. 13
DRAFTING CHECKED		
APPROVED		
CADFILE :	\\750942-01.dwg	
SCALES (AT A3 SIZE)	1:500	
PROJECT No.	750942	

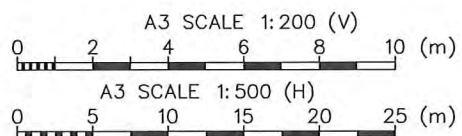
YACHIYO ENGINEERING CO LTD
 EQUIPMENT IMPROVEMENT FOR DISASTER RISK MANAGEMENT
 NADI MET SERVICE OFFICE, NADI, FIJI
 Topographical Survey

FIG. No. Figure 1. REV. 0

L:\750942\WorkingMaterial\CAD\DWG\750942-01.dwg F:\28/02/2013 1:50:00 p.m.



CROSS SECTION B-B
SCALE: 1:500 (H) 1:200 (V)



NOTES:
1. Cross Section supplied by Cadastrals Surveyors, Planners and Development Consultants.
Ref: CSL 1829 - C.S

<p>Tonkin & Taylor International Environmental and Engineering Consultants 105 Carlton Gore Road, Auckland, NEW ZEALAND www.tonkin.co.nz</p>	DRAWN	KAH	Feb. 13	<p>YACHIYO ENGINEERING CO LTD EQUIPMENT IMPROVEMENT FOR DISASTER RISK MANAGEMENT NADI MET SERVICE OFFICE, NADI, FIJI Cross Section B-B</p>	
	DRAFTING CHECKED				
	APPROVED				
	CADFILE :	\\750942-02.dwg			
	SCALES (AT A3 SIZE)	1: 500			
PROJECT No.	750942		FIG. No.	Figure 3	
				REV.	0

Appendix C: Investigation Logs and Geotechnical Laboratory Testing

- **Hand auger borehole logs**
- **Scala Penetrometer results**
- **Geotechnical Laboratory Testing**



BOREHOLE LOG

BOREHOLE No: BH1A
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES: DRILL TYPE: Hand Auger HOLE STARTED: 7/1/13
 DRILL METHOD: HA HOLE FINISHED: 7/1/13
 R.L.: DRILLED BY: CJT
 DATUM: DRILL FLUID: LOGGED BY: CJT CHECKED:

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.										SOIL DESCRIPTION									
TESTS										ROCK DESCRIPTION									
FLUID LOSS										Substance: Rock type, particle size, colour, minor components.									
WATER										Defects: Type, inclination, thickness, roughness, filling.									
CORE RECOVERY (%)										Soil type, minor components, plasticity or particle size, colour.									
METHOD										SHEAR STRENGTH (kPa)									
CASING										COMPRESSION STRENGTH (MPa)									
SAMPLES										DEFECT SPACING (mm)									
R.L. (m)										CLASSIFICATION SYMBOL									
DEPTH (m)										MOISTURE / WEATHERING CONDITION									
GRAPHIC LOG										STRENGTH/DENSITY CLASSIFICATION									
TOPSOIL										TOPSOIL, organic; light brown. Dry									
VOLCANIC TUFF										CLAY; red brown. Stiff, dry, non-plastic, low cohesion, crumbly									
										Some sand/fine gravel present									
										Fine gravelly material present (volcanic tuff)									
										1-1.2m: Sample collected for laboratory testing									
										CLAY, trace silt and sand; red brown with trace yellow. Dry, non-plastic, non-cohesive									
										2.1-2.4m: Sample collected for laboratory testing - poor recovery.									
RESIDUAL SOIL										CLAY; red brown mottled white. Dry, non-plastic, increased cohesion									
										END OF BOREHOLE AT 3m.									
										Unable to auger further due to soil stiffness.									

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH1B
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management				LOCATION: Met. Office, Valudamu				JOB No: 750942													
CO-ORDINATES:				DRILL TYPE: Hand Auger				HOLE STARTED: 8/1/13													
R.L.:				DRILL METHOD: HA				HOLE FINISHED: 8/1/13													
DATUM:				DRILL FLUID:				DRILLED BY: CJT													
								LOGGED BY: CJT													
								CHECKED:													
GEOLOGICAL				ENGINEERING DESCRIPTION																	
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.				FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION
																					Soil type, minor components, plasticity or particle size, colour.
																					ROCK DESCRIPTION
																					Substance: Rock type, particle size, colour, minor components.
																					Defects: Type, inclination, thickness, roughness, filling.
TOPSOIL							HAND AUGER														TOPSOIL, organic; dark brown. Damp
											0.5										Silty CLAY; brown/light orange. Damp, moderate plasticity, cohesive
											1.0										Becoming clayey SILT; brown/light orange. Damp, moderate plasticity, medium cohesion
																					SILT, some clay and sand; orange brown. Loosely packed, moist, moderate plasticity, crumbly
											1.5										END OF BOREHOLE AT 1.3m.
											2.0										Unable to penetrate - hit obstruction: Fine SAND/SILT, trace clay; orange brown. Damp, non-plastic, low cohesion
											2.5										
											3.0										
											3.5										
											4.0										

T-T DATA TEMPLATE.GDT amm



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH2A
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES: DRILL TYPE: Hand Auger HOLE STARTED: 7/1/13
 R.L.: DRILL METHOD: HA HOLE FINISHED: 7/1/13
 DATUM: DRILL FLUID: LOGGED BY: CJT CHECKED:

GEOLOGICAL		ENGINEERING DESCRIPTION																
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.	FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE / WEATHERING CONDITION	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSION STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION	
																	Soil type, minor components, plasticity or particle size, colour.	
ROCK DESCRIPTION																		
Substance: Rock type, particle size, colour, minor components.																		
Defects: Type, inclination, thickness, roughness, filling.																		
TOPSOIL																	TOPSOIL, organic; light brown. Dry	
VOLCANIC TUFF						● 108/16kPa			0.5								CLAY, with trace silt, trace gravel fragments; reddish brown. Dry, non-plastic, non-cohesive (possible volcanic material); gravel, coarse	
						● >140kPa											Becoming less silty	
						● >140kPa			1.0								Sample taken for testing	
						● >140kPa				1.5								
						● >140kPa				2.0								
						● >140kPa				2.5								Silty CLAY; reddish brown mottled white. Stiff, non-plastic
						● >140kPa				3.0								CLAY, with trace gravel; white mottled red. Cohesion increasing; gravel, fine
RESIDUAL SOIL						● 140/38kPa												
						● >140kPa											END OF BOREHOLE AT 3m.	

T-T DATATEMPLATE.GDT amm



TONKIN & TAYLOR LTD

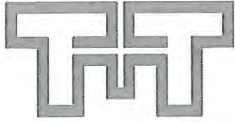
BOREHOLE LOG

BOREHOLE No: BH2C
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management										LOCATION: Met. Office, Valudamu										JOB No: 750942																			
CO-ORDINATES:										DRILL TYPE: Hand Auger										HOLE STARTED: 9/1/13																			
R.L.:										DRILL METHOD: HA										HOLE FINISHED: 9/1/13																			
DATUM:										DRILL FLUID:										LOGGED BY: CJT										CHECKED:									
GEOLOGICAL										ENGINEERING DESCRIPTION																													
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.										SOIL DESCRIPTION																													
FLUID LOSS										Soil type, minor components, plasticity or particle size, colour.																													
WATER										ROCK DESCRIPTION																													
CORE RECOVERY (%)										Substance: Rock type, particle size, colour, minor components.																													
METHOD										Defects: Type, inclination, thickness, roughness, filling.																													
CASING																																							
TESTS																																							
SAMPLES																																							
R.L. (m)																																							
DEPTH (m)																																							
GRAPHIC LOG																																							
CLASSIFICATION SYMBOL																																							
MOISTURE CONDITION																																							
WEATHERING																																							
STRENGTH/DENSITY																																							
CLASSIFICATION																																							
										SHEAR STRENGTH (kPa)																													
										10																													
										25																													
										50																													
										100																													
										200																													
										500																													
										1000																													
										2000																													
										COMPRESSION STRENGTH (MPa)																													
										5																													
										100																													
										250																													
										DEFECT SPACING (mm)																													
										50																													
										100																													
										200																													
										500																													
										1000																													
										2000																													
TOPSOIL										TOPSOIL, organic, coarse gravel; dark brown																													
RESIDUAL SOIL										Sand Silt with trace gravel and some clay.																													
										0.5																													
● 60/12kPa																																							
										1.0																													
● 30/10kPa																																							
										1.5																													
● >140kPa																																							
										2.0																													
● >140kPa																																							
										2.5																													
● >140kPa																																							
										3.0																													
● UTP																																							
WEATHERED ANDESITE ROCK										END OF BOREHOLE AT 1.9m.																													
										Top of rock.																													
										2.0																													
										2.5																													
										3.0																													
										3.5																													
										4.0																													

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TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH3B
Hole Location: Refer site plan.

SHEET 1 OF 1

PROJECT: Improvement of Equipment for Disaster Risk Management LOCATION: Met. Office, Valudamu JOB No: 750942

CO-ORDINATES: DRILL TYPE: Hand Auger HOLE STARTED: 8/1/13
R.L.: DRILL METHOD: HA HOLE FINISHED: 8/1/13
DATUM: DRILL FLUID: LOGGED BY: CJT CHECKED:

GEOLOGICAL		ENGINEERING DESCRIPTION																	
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.		FLUID LOSS	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	R.L. (m)	DEPTH (m)	GRAPHIC LOG	CLASSIFICATION SYMBOL	MOISTURE CONDITION	WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION
																			TOPSOIL, organic; dark brown. Moist
							• 45/20kPa			0.5									Silty CLAY, trace sand; brown orange. Moist, moderate plasticity
							• 102/35kPa												Clayey SILT, with trace sand; orange brown. Damp, low plasticity, low cohesion; sand, fine
							• 130/32kPa			1.0									
							• UTP			1.5									
							• UTP												
							• UTP			2.0									Fine to medium GRAVEL (5-20mm dia.); grey, angular
							• 130/15kPa												SILT, with some sand, some clay; white mottled red. Wet, non-plastic, cohesive; sand, fine
							• 100/45kPa			2.5									
							• 80/16kPa												
							• 85/20kPa			3.0									END OF BOREHOLE AT 3m.
										3.5									
										4									

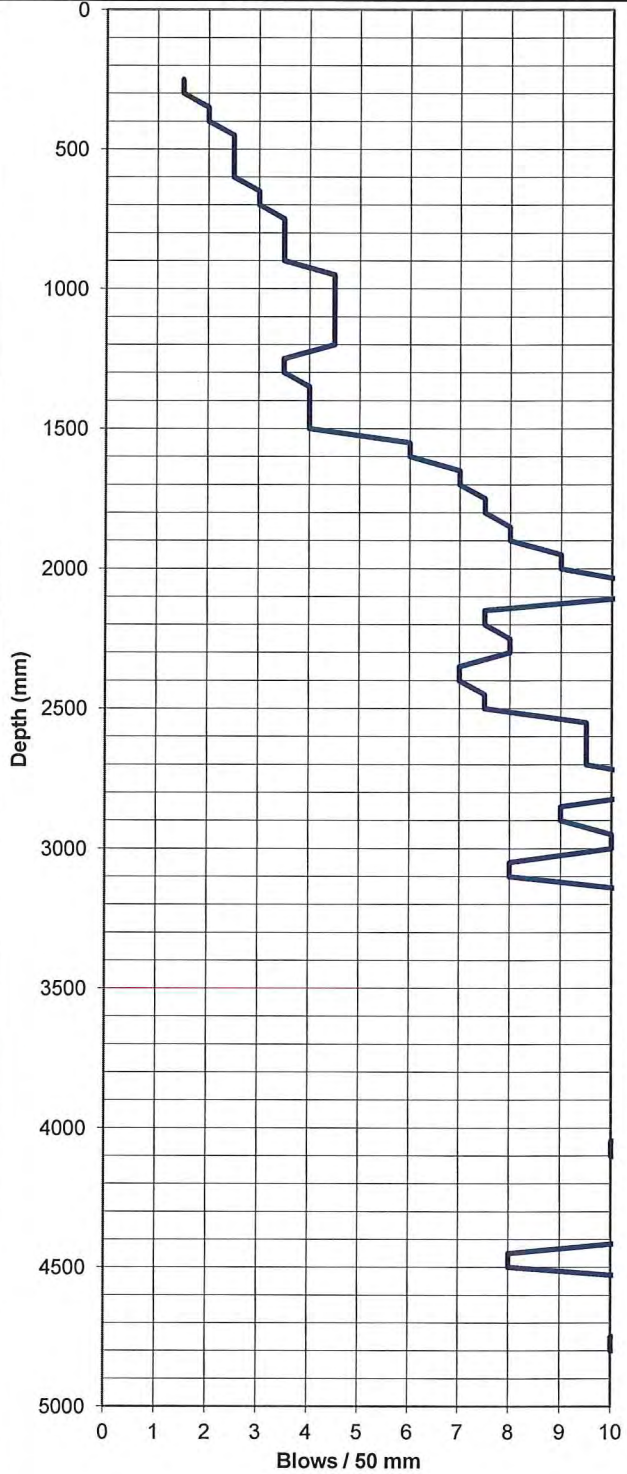
T-T DATATEMPLATE.GDT amm



TONKIN & TAYLOR
SCALA PENETROMETER LOG

Job No: 750942	Date: 7/01/2013	Test No. SC1A
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Nadi	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	9.5
100		2600	9.5
150		2650	9.5
200		2700	9.5
250	1.5	2750	11
300	1.5	2800	11
350	2	2850	9
400	2	2900	9
450	2.5	2950	10
500	2.5	3000	10
550	2.5	3050	8
600	2.5	3100	8
650	3	3150	10.5
700	3	3200	10.5
750	3.5	3250	11
800	3.5	3300	11
850	3.5	3350	12
900	3.5	3400	12
950	4.5	3450	11.5
1000	4.5	3500	11.5
1050	4.5	3550	12.5
1100	4.5	3600	12.5
1150	4.5	3650	12.5
1200	4.5	3700	12.5
1250	3.5	3750	12.5
1300	3.5	3800	12.5
1350	4	3850	11
1400	4	3900	11
1450	4	3950	11
1500	4	4000	11
1550	6	4050	10
1600	6	4100	10
1650	7	4150	11
1700	7	4200	11
1750	7.5	4250	12
1800	7.5	4300	12
1850	8	4350	11
1900	8	4400	11
1950	9	4450	8
2000	9	4500	8
2050	10.5	4550	11.5
2100	10.5	4600	11.5
2150	7.5	4650	13
2200	7.5	4700	13
2250	8	4750	10
2300	8	4800	10
2350	7	4850	14.5
2400	7	4900	14.5
2450	7.5	4950	14.5
2500	7.5	5000	14.5



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
TITLE Scala Penetrometer Test
REFERENCE No. 750942

January 2013

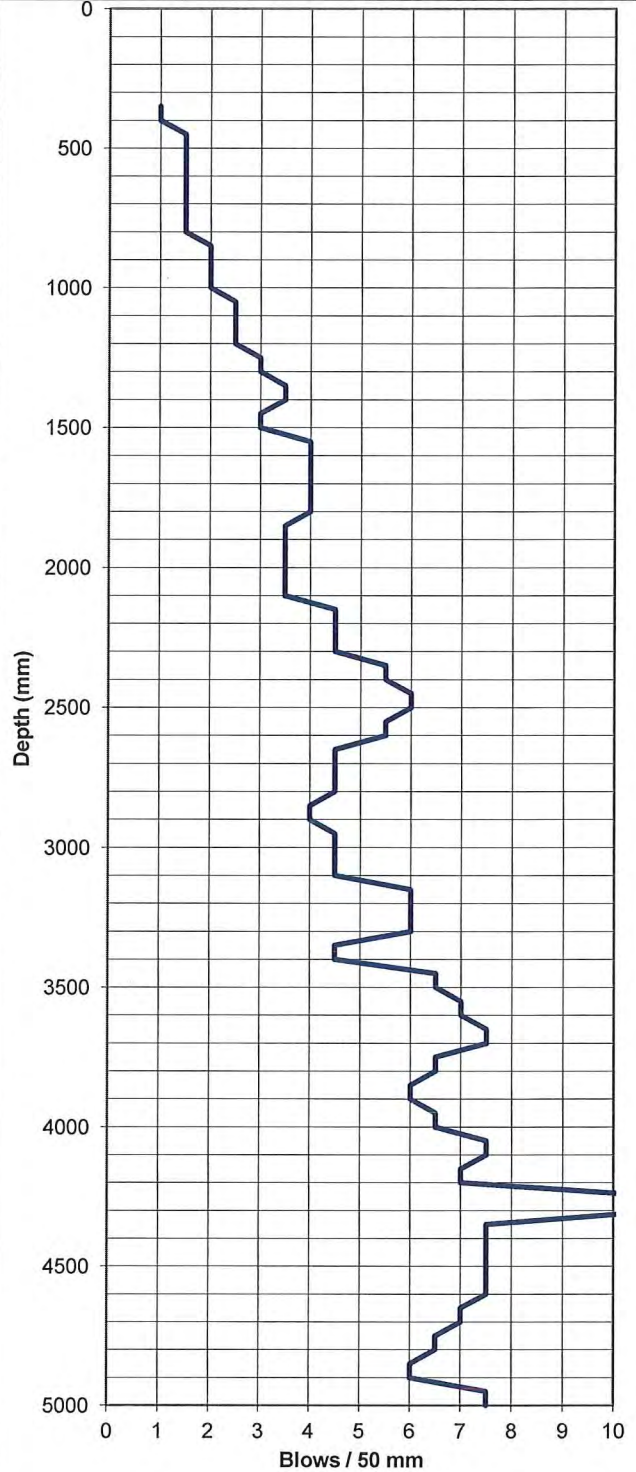
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TONKIN & TAYLOR
SCALA PENETROMETER LOG

Job No: 750942	Date: 7/01/2013	Test No. SC2A
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Nadi	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	5.5
100		2600	5.5
150		2650	4.5
200		2700	4.5
250		2750	4.5
300		2800	4.5
350	1	2850	4
400	1	2900	4
450	1.5	2950	4.5
500	1.5	3000	4.5
550	1.5	3050	4.5
600	1.5	3100	4.5
650	1.5	3150	6
700	1.5	3200	6
750	1.5	3250	6
800	1.5	3300	6
850	2	3350	4.5
900	2	3400	4.5
950	2	3450	6.5
1000	2	3500	6.5
1050	2.5	3550	7
1100	2.5	3600	7
1150	2.5	3650	7.5
1200	2.5	3700	7.5
1250	3	3750	6.5
1300	3	3800	6.5
1350	3.5	3850	6
1400	3.5	3900	6
1450	3	3950	6.5
1500	3	4000	6.5
1550	4	4050	7.5
1600	4	4100	7.5
1650	4	4150	7
1700	4	4200	7
1750	4	4250	11
1800	4	4300	11
1850	3.5	4350	7.5
1900	3.5	4400	7.5
1950	3.5	4450	7.5
2000	3.5	4500	7.5
2050	3.5	4550	7.5
2100	3.5	4600	7.5
2150	4.5	4650	7
2200	4.5	4700	7
2250	4.5	4750	6.5
2300	4.5	4800	6.5
2350	5.5	4850	6
2400	5.5	4900	6
2450	6	4950	7.5
2500	6	5000	7.5



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
TITLE Scala Penetrometer Test
REFERENCE No. 750942

January 2013

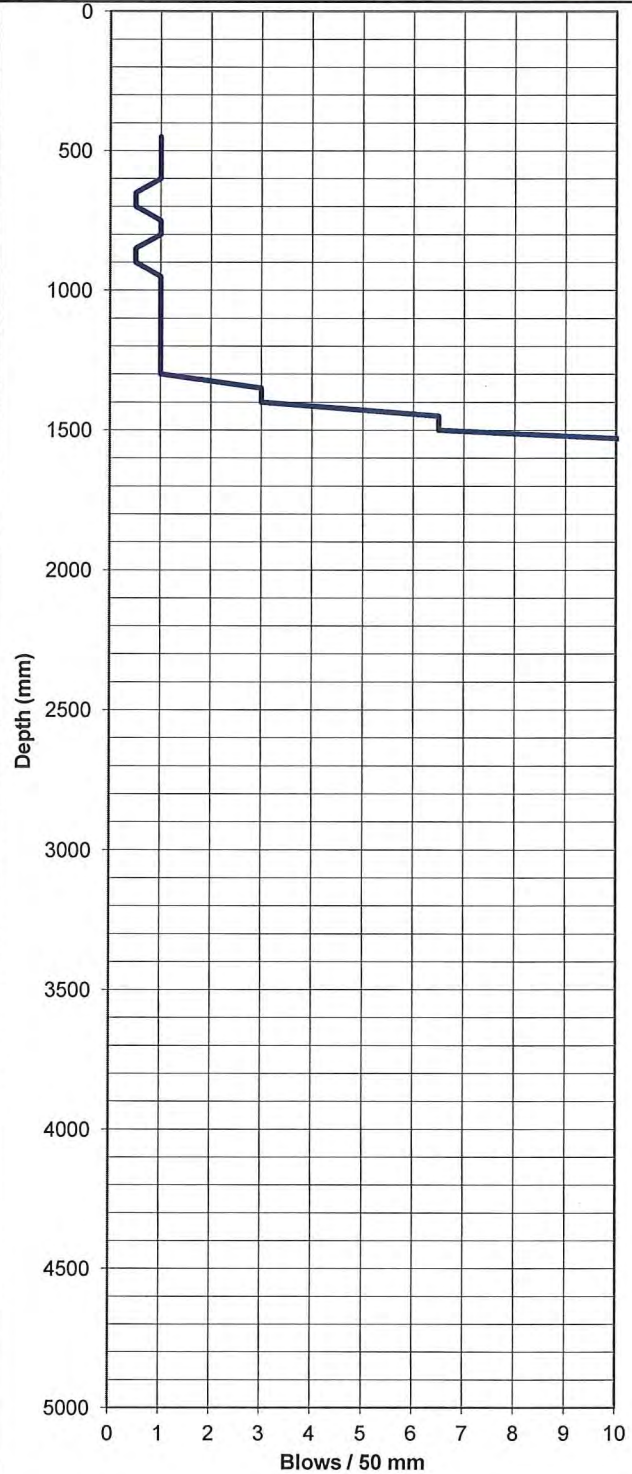
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SCALA PENETROMETER LOG

Job No: 750942	Date: 8/01/2013	Test No. SC1B
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Suva	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	
100		2600	
150		2650	
200		2700	
250		2750	
300		2800	
350		2850	
400		2900	
450	1	2950	
500	1	3000	
550	1	3050	
600	1	3100	
650	0.5	3150	
700	0.5	3200	
750	1	3250	
800	1	3300	
850	0.5	3350	
900	0.5	3400	
950	1	3450	
1000	1	3500	
1050	1	3550	
1100	1	3600	
1150	1	3650	
1200	1	3700	
1250	1	3750	
1300	1	3800	
1350	3	3850	
1400	3	3900	
1450	6.5	3950	
1500	6.5	4000	
1550	12.5	4050	
1600	12.5	4100	
1650	22	4150	
1700	22	4200	
1750		4250	
1800		4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
 TITLE Scala Penetrometer Test
 REFERENCE No. 750942

January 2013

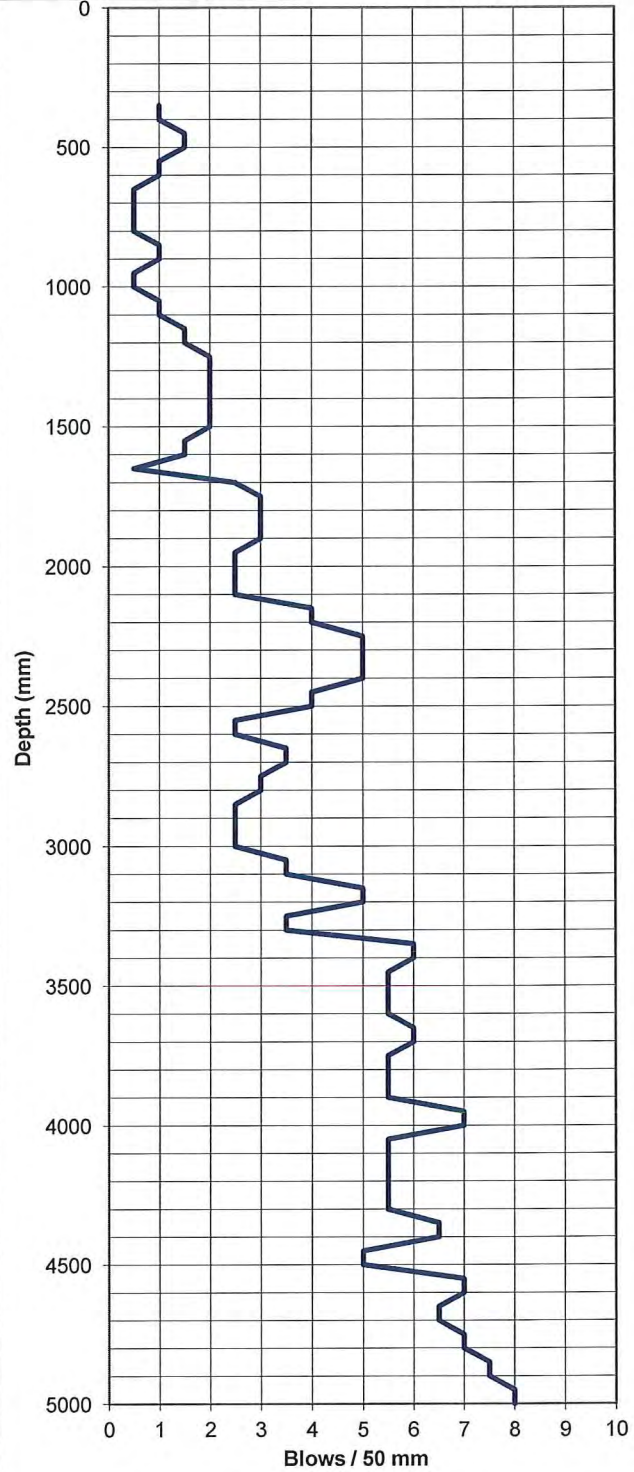
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TONKIN & TAYLOR
SCALA PENETROMETER LOG

Job No: 750942	Date: 8/01/2013	Test No. SC2B
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Nadi	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	2.5
100		2600	2.5
150		2650	3.5
200		2700	3.5
250		2750	3
300		2800	3
350	1	2850	2.5
400	1	2900	2.5
450	1.5	2950	2.5
500	1.5	3000	2.5
550	1	3050	3.5
600	1	3100	3.5
650	0.5	3150	5
700	0.5	3200	5
750	0.5	3250	3.5
800	0.5	3300	3.5
850	1	3350	6
900	1	3400	6
950	0.5	3450	5.5
1000	0.5	3500	5.5
1050	1	3550	5.5
1100	1	3600	5.5
1150	1.5	3650	6
1200	1.5	3700	6
1250	2	3750	5.5
1300	2	3800	5.5
1350	2	3850	5.5
1400	2	3900	5.5
1450	2	3950	7
1500	2	4000	7
1550	1.5	4050	5.5
1600	1.5	4100	5.5
1650	0.5	4150	5.5
1700	2.5	4200	5.5
1750	3	4250	5.5
1800	3	4300	5.5
1850	3	4350	6.5
1900	3	4400	6.5
1950	2.5	4450	5
2000	2.5	4500	5
2050	2.5	4550	7
2100	2.5	4600	7
2150	4	4650	6.5
2200	4	4700	6.5
2250	5	4750	7
2300	5	4800	7
2350	5	4850	7.5
2400	5	4900	7.5
2450	4	4950	8
2500	4	5000	8



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
TITLE Scala Penetrometer Test
REFERENCE No. 750942

January 2013

[1]



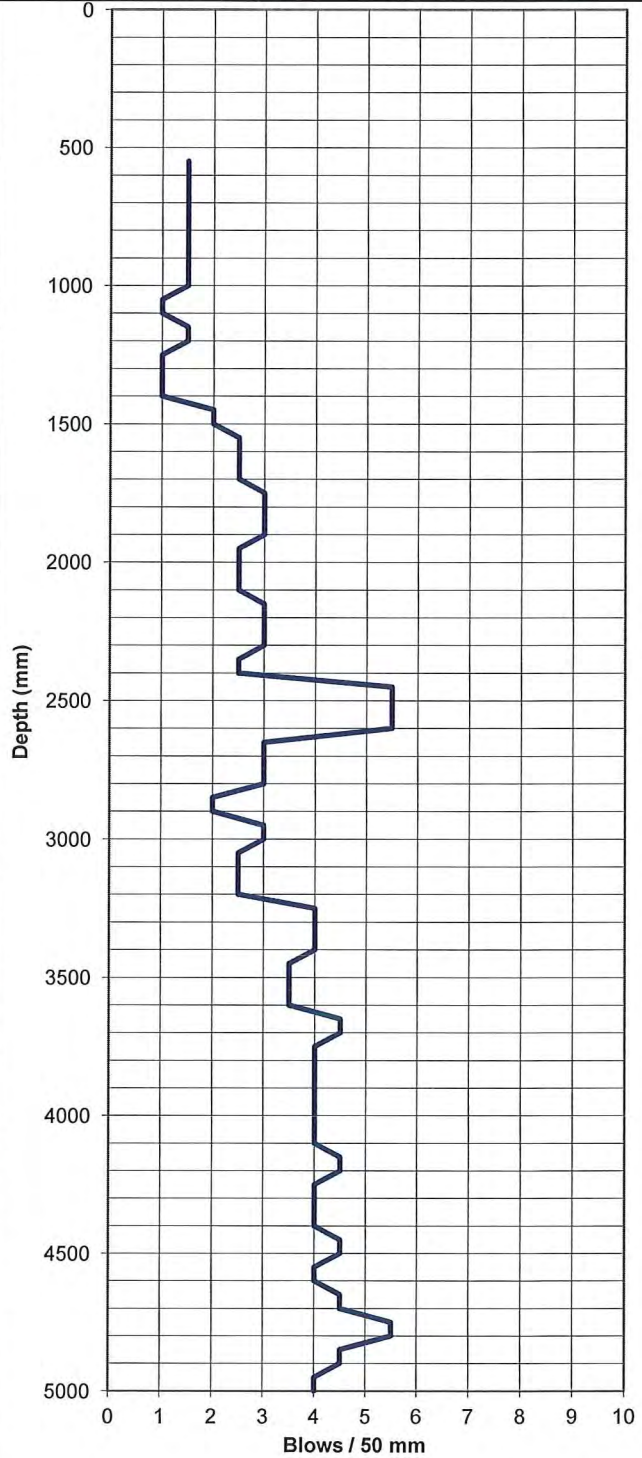
TONKIN & TAYLOR
SCALA PENETROMETER LOG

Job No: **750942**
Project: **Improvement of Equipment for Disaster Risk Management**
Location: **Met Office Suva**

Date: **8/01/2013**
Operated by: **CJT**
Logged by: **CJT**
Checked by: **ADP**

Test No. **SC3B**
Sheet **1**
of **1**

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	5.5
100		2600	5.5
150		2650	3
200		2700	3
250		2750	3
300		2800	3
350		2850	2
400		2900	2
450		2950	3
500		3000	3
550	1.5	3050	2.5
600	1.5	3100	2.5
650	1.5	3150	2.5
700	1.5	3200	2.5
750	1.5	3250	4
800	1.5	3300	4
850	1.5	3350	4
900	1.5	3400	4
950	1.5	3450	3.5
1000	1.5	3500	3.5
1050	1	3550	3.5
1100	1	3600	3.5
1150	1.5	3650	4.5
1200	1.5	3700	4.5
1250	1	3750	4
1300	1	3800	4
1350	1	3850	4
1400	1	3900	4
1450	2	3950	4
1500	2	4000	4
1550	2.5	4050	4
1600	2.5	4100	4
1650	2.5	4150	4.5
1700	2.5	4200	4.5
1750	3	4250	4
1800	3	4300	4
1850	3	4350	4
1900	3	4400	4
1950	2.5	4450	4.5
2000	2.5	4500	4.5
2050	2.5	4550	4
2100	2.5	4600	4
2150	3	4650	4.5
2200	3	4700	4.5
2250	3	4750	5.5
2300	3	4800	5.5
2350	2.5	4850	4.5
2400	2.5	4900	4.5
2450	5.5	4950	4
2500	5.5	5000	4



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



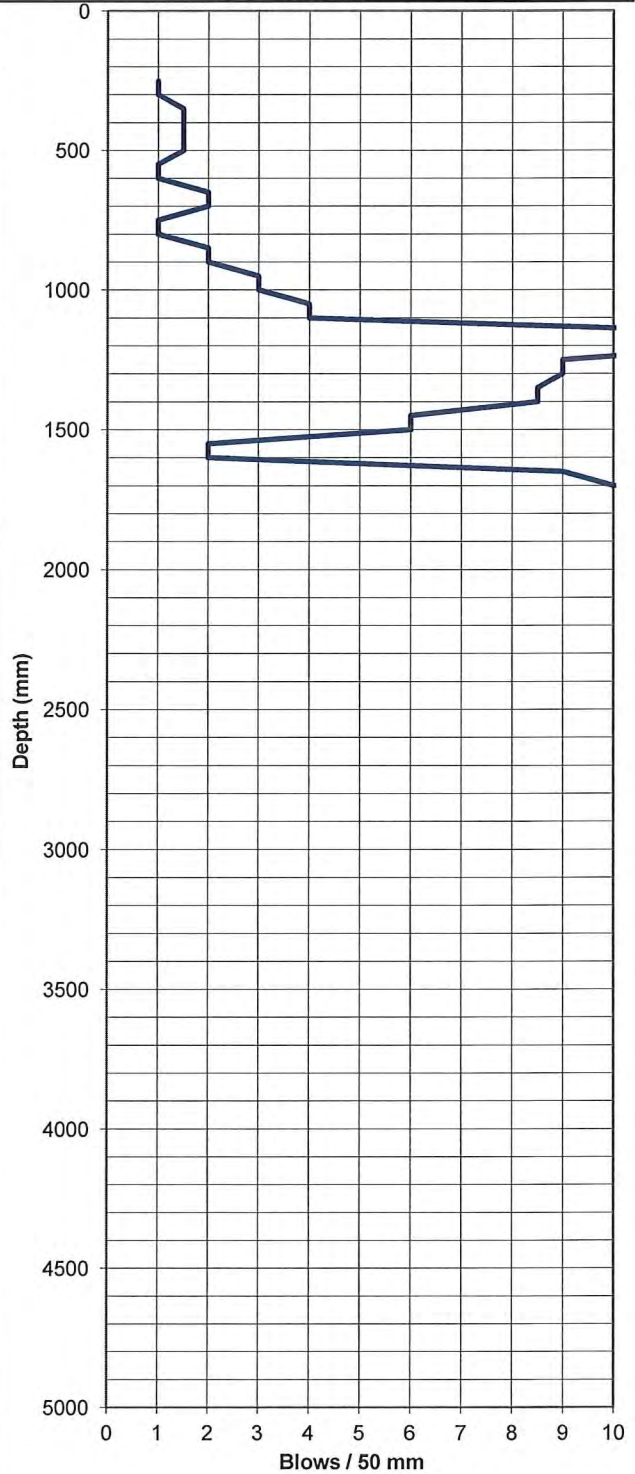
CLIENT Yachiyo Engineering
TITLE Scala Penetrometer Test
REFERENCE No. 750942



SCALA PENETROMETER LOG

Job No: 750942	Date: 9/01/2013	Test No. SC1C
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Vatudamu	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	
100		2600	
150		2650	
200		2700	
250	1	2750	
300	1	2800	
350	1.5	2850	
400	1.5	2900	
450	1.5	2950	
500	1.5	3000	
550	1	3050	
600	1	3100	
650	2	3150	
700	2	3200	
750	1	3250	
800	1	3300	
850	2	3350	
900	2	3400	
950	3	3450	
1000	3	3500	
1050	4	3550	
1100	4	3600	
1150	12	3650	
1200	13	3700	
1250	9	3750	
1300	9	3800	
1350	8.5	3850	
1400	8.5	3900	
1450	6	3950	
1500	6	4000	
1550	2	4050	
1600	2	4100	
1650	9	4150	
1700	10	4200	
1750	43	4250	
1800	25	4300	
1850		4350	
1900		4400	
1950		4450	
2000		4500	
2050		4550	
2100		4600	
2150		4650	
2200		4700	
2250		4750	
2300		4800	
2350		4850	
2400		4900	
2450		4950	
2500		5000	



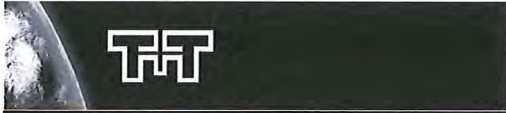
Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
 TITLE Scala Penetrometer Test
 REFERENCE No. 750942

January 2013

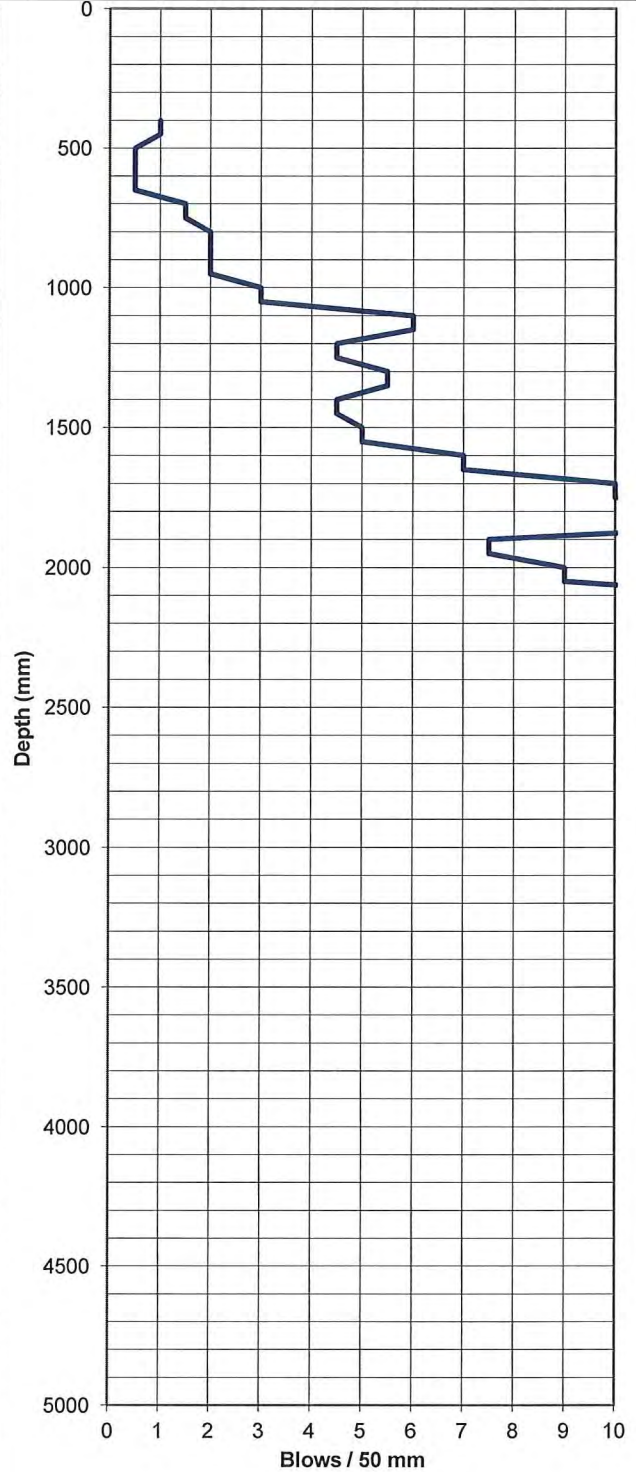
[1]



TONKIN & TAYLOR
SCALA PENETROMETER LOG

Job No: 750942	Date: 9/01/2013	Test No. SC2C
Project: Improvement of Equipment for Disaster Risk Management	Operated by: CJT	Sheet 1
Location: Met Office Nadi	Logged by: CJT	of 1
	Checked by: ADP	

mm Driven	No. of Blows	mm Driven	No. of Blows
50		2550	14.5
100		2600	14.5
150		2650	14.5
200		2700	117
250		2750	17
300		2800	16
350		2850	16
400	1	2900	15.5
450	1	2950	15.5
500	0.5	3000	14
550	0.5	3050	14
600	0.5	3100	15
650	0.5	3150	15
700	1.5	3200	14
750	1.5	3250	14
800	2	3300	17.5
850	2	3350	17.5
900	2	3400	15
950	2	3450	15
1000	3	3500	16.5
1050	3	3550	16.5
1100	6	3600	16.5
1150	6	3650	16.5
1200	4.5	3700	41
1250	4.5	3750	
1300	5.5	3800	
1350	5.5	3850	
1400	4.5	3900	
1450	4.5	3950	
1500	5	4000	
1550	5	4050	
1600	7	4100	
1650	7	4150	
1700	10	4200	
1750	10	4250	
1800	13	4300	
1850	13	4350	
1900	7.5	4400	
1950	7.5	4450	
2000	9	4500	
2050	9	4550	
2100	13	4600	
2150	13	4650	
2200	19	4700	
2250	19	4750	
2300	19	4800	
2350	19	4850	
2400	17.5	4900	
2450	17.5	4950	
2500	14.5	5000	



Test Method Used: NZS 4402:1988 Test 6.5.2 Dynamic Cone Penetrometer



CLIENT Yachiyo Engineering
TITLE Scala Penetrometer Test
REFERENCE No. 750942

January 2013

[1]



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Form No.: S4

Form Date: January 2004

File: P:\M11330\0072\Work\Materials\Water Content_s4.doc

Plate No.: _____ Page of _____ Your Job No.: 750942.000
 Site : Site A-Nadi Met Office, Site B-Suva Met Office and Site C-Vatudamu Met Office, Fiji Our Job No.: 615990.000
 Test Method Used: NZS 4402:1986 Test 2.1 Determination of Water Content

WATER CONTENT TEST RESULTS

Table 1: Water Content

Site:	Site A-Nadi Met Office, Fiji		Site B-Suva Met Office, Fiji		Site C-Vatudamu Met Office, Fiji	
BH No.:	1A	2A	2B	3B	1C	2C
Depth (m)	1.0-1.2	2.1-2.8	1.9-2.7	0.5-0.7	0.4-0.5	1.0-1.2
Water Content %	33.6	35.6	43.0	32.6	51.9	55.5

Remarks : The water content reported to the nearest 0.1 %.

Tested by: *ST*

Date: *27/2/13*

Checked by: *AJFG*

Date: *27/2/13*



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Form No.: 84

Form Date: January 2004

File: P:\81559\807\New\Matlab\SS-Density_Summary.doc

Plate No.: _____ Page of _____ Your Job No.: 750942.000

Site : Site A-Nadi Met Office, Site B-Suva Met Office and Site C-Vatudamu Met Office, Fiji Our Job No.: 615990.000

Test Method Used: NZS 4402:1986 Test 2.7.2 Determination of Solid Density of Soil Particles by Vacuum

SOLID DENSITY TEST RESULTS

Table 1: Solid Density

Site:	Site A-Nadi Met Office, Fiji		Site B-Suva Met Office, Fiji		Site C-Vatudamu Met Office, Fiji	
BH No.:	1A	2A	2B	3B	1C	2C
Depth (m)	1.0-1.2	2.1-2.8	1.9-2.7	0.5-0.7	0.4-0.5	1.0-1.2
Av.Solid Density (t/m ³)	2.84	2.83	2.73	2.74	2.82	2.82

Remarks : Solid density was performed on whole material.
The average solid density reported to the nearest 0.01 t/m³.

Tested by: *ST*

Date: *27/2/13*

Checked by: *AJFG*

Date: *27/2/13*



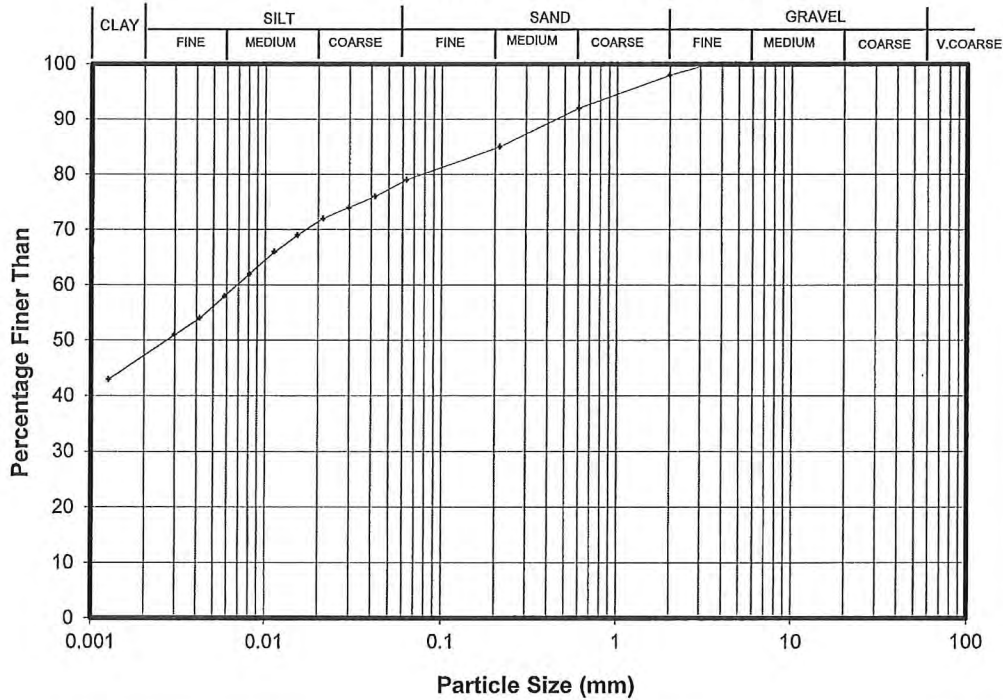
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Form No.: P6
Form Date: January 2004
File: P:\615990.000\Working material\BHIA_1.0-1.2m_hydo.xlsx

Plate No.: _____ Page of _____
Site: **Site A-Nadi Met Office, Fiji**
BH No.: **1A** Sample ID.: ---
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
Our Job No.: **615990.000**
Depth: **1.0-1.2 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	100		
3.35	100		
2.00	98		
0.600	92		
0.212	85		
0.063	79		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0418	76
0.0298	74
0.0212	72
0.0153	69
0.0113	66
0.0081	62
0.0058	58
0.0042	54
0.0030	51
0.0013	43

Sample history : As received.

Description: silty CLAY with some sand and trace of gravel, firm, red mixed with light grey/yellow, high plasticity.

Solid Density (Measured) : 2.84 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : ST

Date : 11/2/13

Checked by : MS

Date : 11/2/13



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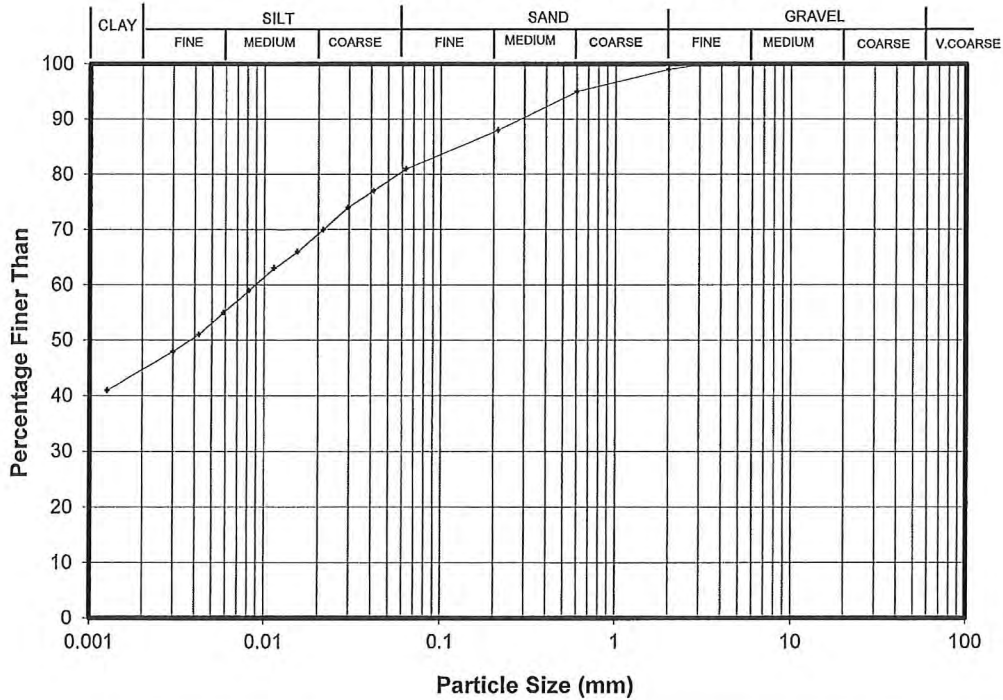
Form Date: January 2004

File: P:\615990.000\Working material\BH2A_2.1-2.8m_Hydro.xlsx

Plate No.: _____ Page of _____
Site: **Site A-Nadi Met Office, Fiji**
BH No.: **2A** Sample ID.: ---
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
Our Job No.: **615990.000**
Depth: **2.1-2.8 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	100		
3.35	100		
2.00	99		
0.600	95		
0.212	88		
0.063	81		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0412	77
0.0296	74
0.0213	70
0.0153	66
0.0114	63
0.0082	59
0.0059	55
0.0042	51
0.0030	48
0.0013	41

Sample history : As received.

Description: silty CLAY with some sand and trace of gravel, firm, red mixed with light grey, high plasticity.

Solid Density (Measured) : 2.83 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : **ST**

Date : **11/2/13**

Checked by : **MS**

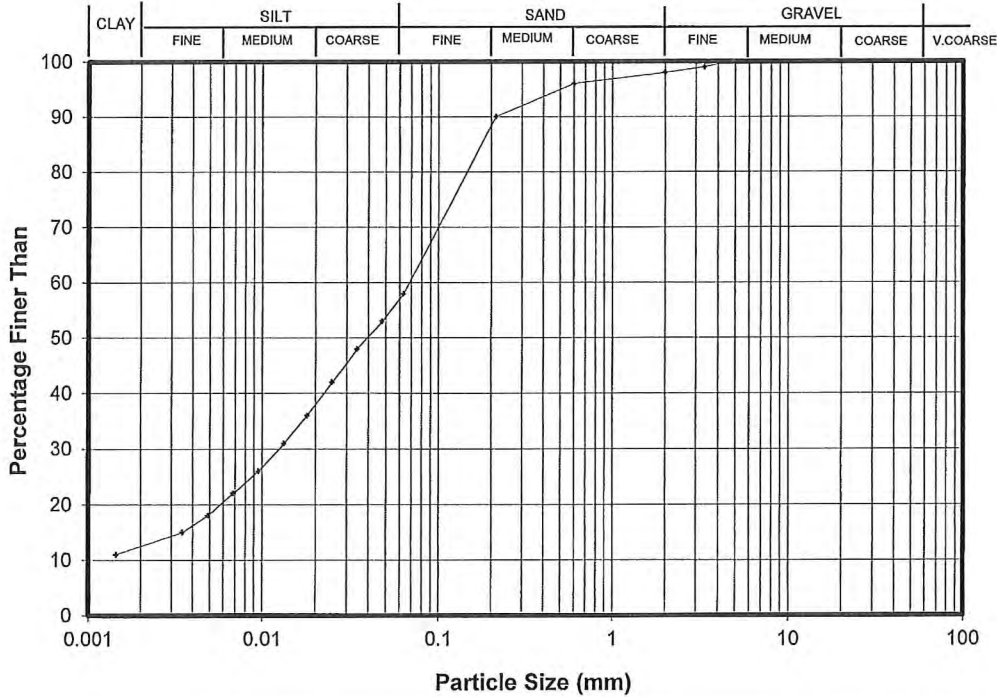
Date : **11/2/13**



Plate No.: _____ Page of _____
Site: **Site B - Suva Met Office, Fiji**
BH No.: **2B** Sample ID.: ---
Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
Our Job No.: **615990.000**
Depth: **1.9-2.7 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	100		
3.35	99		
2.00	98		
0.600	96		
0.212	90		
0.063	58		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0477	53
0.0344	48
0.0248	42
0.0179	36
0.0133	31
0.0095	26
0.0068	22
0.0049	18
0.0035	15
0.0014	11

Sample history : As received.

Description: sandy SILT with some clay and trace of gravel, firm, light yellowish brown mixed with light grey, mottled orange-dark red, medium-high plasticity, dilatant.

Solid Density (Measured) : 2.73 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : **ST**

Date : **27/2/13**

Checked by : **AJFG**

Date : **27/2/13**



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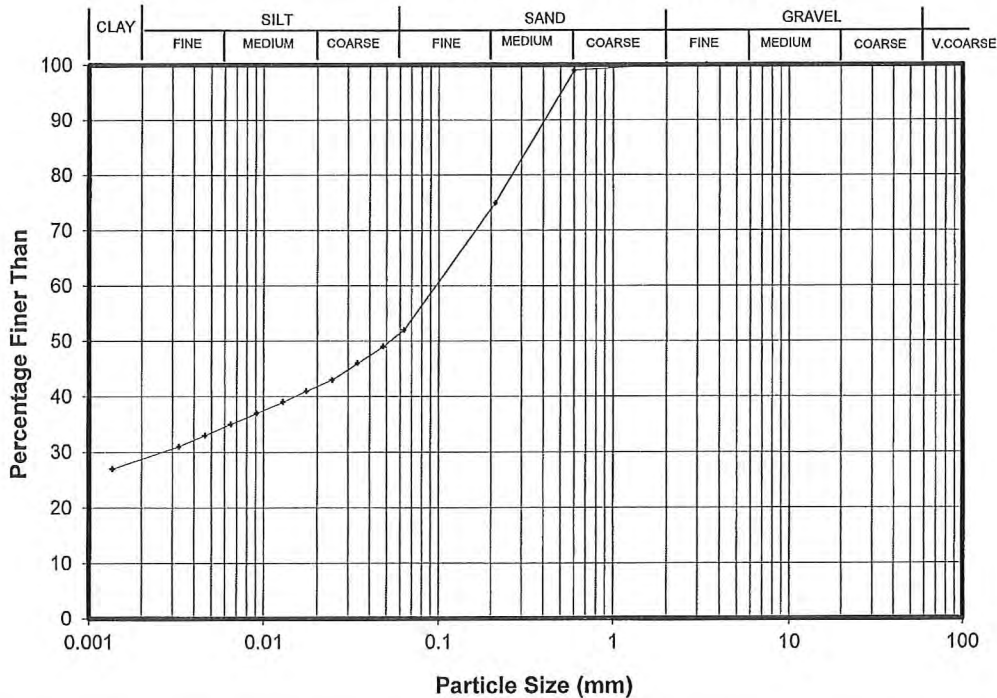
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File: P:\615990.000\Working materal\Site B_BH3B_0.5-0.7m_Hydro.xlsx

Plate No.: _____ Page of _____
 Site: **Site B - Suva Met Office, Fiji**
 BH No.: **3B** Sample ID.: ---
 Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
 Our Job No.: **615990.000**
 Depth: **0.5-0.7 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	---		
3.35	100		
2.00	100		
0.600	99		
0.212	75		
0.063	52		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0478	49
0.0341	46
0.0244	43
0.0174	41
0.0128	39
0.0091	37
0.0065	35
0.0046	33
0.0033	31
0.0014	27

Sample history : As received.

Description: clayey silty SAND, firm, light yellowish brown, mottled orange-red, medium-high plasticity, dilatant.

Solid Density (Measured) : 2.74 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : **ST**

Date : **27/2/13**

Checked by : **AJFG**

Date : **27/2/13**



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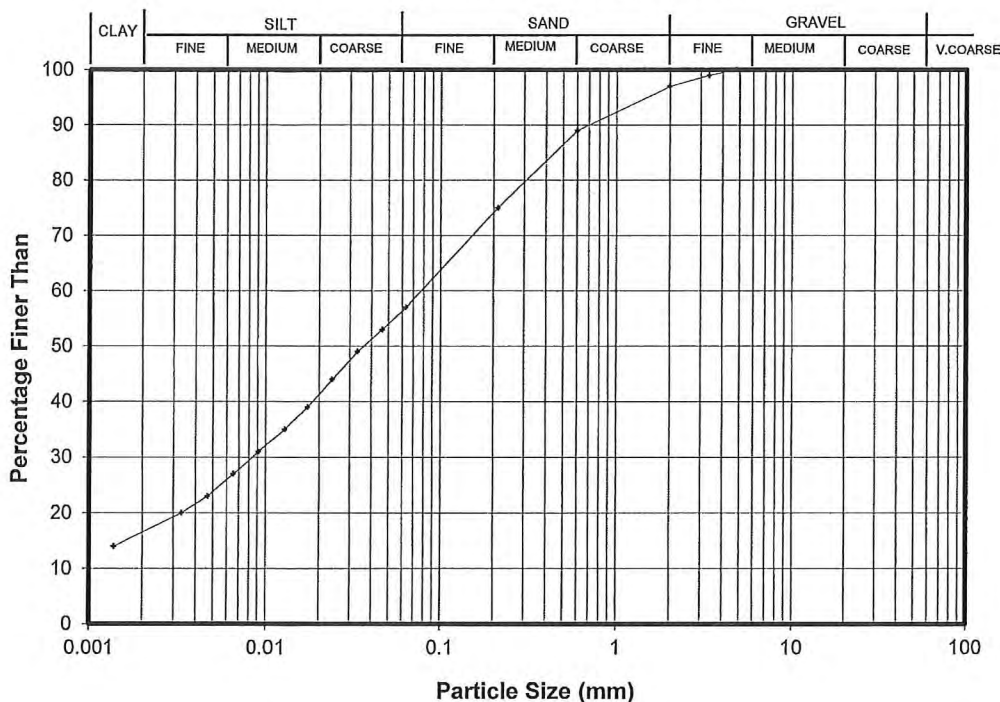
Form Date: January 2004

File: P:\615990.000\Working material\Site C_BH1C_0.4-0.5m_Hydro.xlsx

Plate No.: _____ Page of _____
 Site: **Site C - Vatudamu Met Office, Fiji**
 BH No.: **1C** Sample ID.: ---
 Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
 Our Job No.: **615990.000**
 Depth: **0.4-0.5 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	100		
3.35	99		
2.00	97		
0.600	89		
0.212	75		
0.063	57		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0461	53
0.0331	49
0.0238	44
0.0171	39
0.0127	35
0.0091	31
0.0065	27
0.0047	23
0.0033	20
0.0014	14

Sample history : As received.

Description: SAND-SILT with trace of gravel and some clay, firm, dark red, low to medium plasticity, dilatant.

Solid Density (Measured) : 2.82 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : **ST**

Date : **11/2/13**

Checked by : **MS**

Date : **11/2/13**



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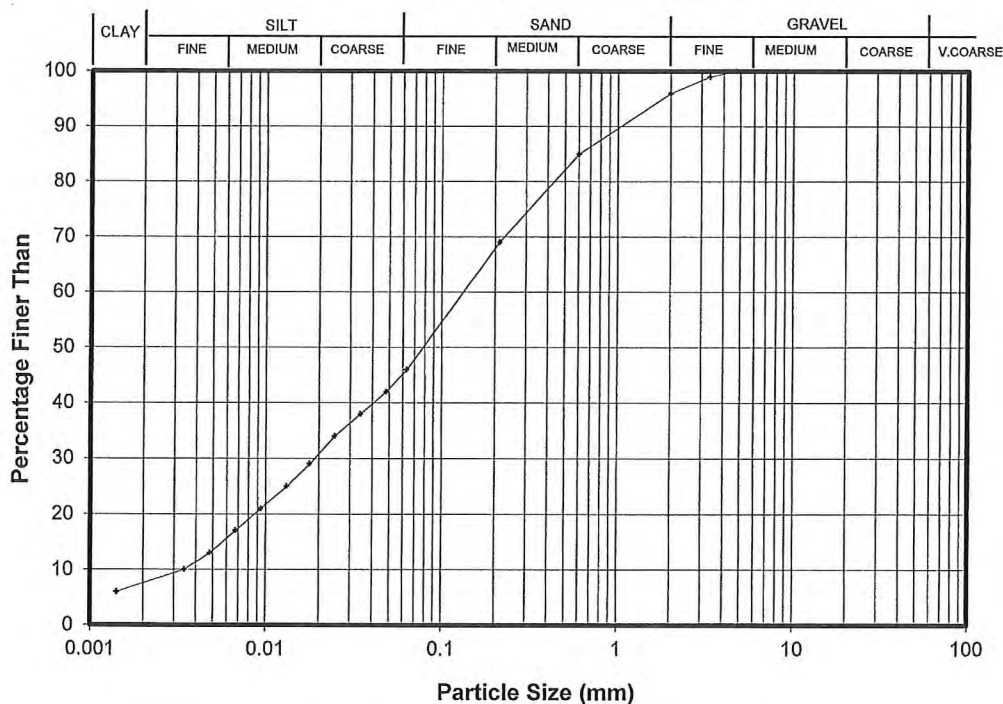
Form Date: January 2004

File: P:\615990.000\Working material\Site C_BH2C_1.0-1.2m_Hydro.xlsx

Plate No.: _____ Page of _____
 Site: **Site C - Vatudamu Met Office, Fiji**
 BH No.: **2C** Sample ID.: ---
 Test Method Used : NZS 4402:1986 Test 2.8.4 Hydrometer

Your Job No.: **750942.000**
 Our Job No.: **615990.000**
 Depth: **1.0-1.2 (m)**

PARTICLE SIZE ANALYSIS



Sieve (mm)	Total % Passing	Sieve (mm)	Total % Passing
4.75	100		
3.35	99		
2.00	96		
0.600	85		
0.212	69		
0.063	46		

Equivalent Particle Diameter D (mm)	% of Particles Finer than D
0.0480	42
0.0344	38
0.0246	34
0.0177	29
0.0131	25
0.0094	21
0.0067	17
0.0048	13
0.0034	10
0.0014	6

Sample history : As received.

Description: silty SAND with trace of gravel and minor clay, firm, red, low to medium plasticity, dilatant.

Solid Density (Measured) : 2.82 t/m³

Remarks : A sub sample was split from the original sample for hydrometer analysis. This sample was soaked with a dispersing agent (~2 hrs), then the mechanical shaker was used, until the material was brought into suspension, before proceeding with the test.

Suspension pH 8.0

The classification of gravel-sand-silt-clay components were described on the basis of particle size analysis.

Sample description is not IANZ endorsed.

Entered by : ST

Date : 11/2/13

Checked by : MS

Date : 11/2/13