



# Liquefaction Assessment Report

1-42 Roxburgh Crescent, Palmerston North

Prepared for  
Palmerston North City Council

Prepared by  
Tonkin & Taylor Ltd

Date  
April 2020

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## Document Control

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## Liquefaction Assessment Summary

LIQUEFACTION ASSESSMENT SUMMARY	
<p>This liquefaction assessment has been undertaken in general accordance with the guidance document 'Assessment of liquefaction-Induced Ground Damage to Inform Planning Processes' published by the Ministry of Business, Innovation and Employment in 2017.</p> <p><a href="https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land/">https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land/</a></p>	
Client	Palmerston North City Council (PNCC)
Assessment undertaken by	Tonkin & Taylor Ltd, 2 Hunter Street, Wellington 6011
Report date	April 2020
Extent of the study	Roxburgh Crescent site area (refer Figure A1):
Intended RMA planning and consenting purposes	Inform PNCC of liquefaction risks associated with site as part of plan change
Other intended purposes	Inform future liquefaction assessment work required to develop Roxburgh Crescent site
Level of detail	Level C (Detailed area-wide assessment)
Notes regarding base information	<ul style="list-style-type: none"> <li>- The assessment included geotechnical investigations undertaken by Tonkin &amp; Taylor including machine drilled boreholes and Cone Penetration Tests (CPT). A summary of the investigation data is presented in Appendix B</li> <li>- Depth to groundwater was based on groundwater encountered within investigations, Horizons Regional Council groundwater database, and observation of surface water such as lakes and rivers</li> </ul>
Other notes	

# 1 Introduction

## 1.1 General

Tonkin & Taylor Ltd (T+T) was engaged by Palmerston North City Council (PNCC) to undertake a liquefaction assessment of the proposed development area at Roxburgh Crescent.

The work was undertaken in accordance with our proposal dated 21 November 2018.

T+T completed site specific geotechnical investigations to characterise the subsoil conditions and complete the liquefaction and lateral spreading assessment. These investigations are described in Section 2.4 below.

The liquefaction analysis and assessment included the following:

- Identify liquefaction vulnerability across the site.
- Assess lateral spreading hazard across the site.
- Identify liquefaction and lateral spreading constraints relevant for infrastructure and residential development.
- Identify appropriate ground improvement measures and/or foundations for developments in order to mitigate the consequences of liquefaction.

## 1.2 Intended purpose of assessment

This liquefaction assessment is to inform council of risks associated with liquefaction and lateral spreading at the site as part of a plan change to rezone the site from industrial to residential.

Other intended purposes of this report are to inform future liquefaction assessment work which may be required to develop the Roxburgh Crescent site. In addition, this report indicates potential strategies which may be used during development of the Roxburgh Crescent site to mitigate liquefaction and lateral spreading hazard.

## 1.3 Assessment methodology

This liquefaction assessment has been undertaken following the recommendations of the Ministry of Business Innovation & Employment (MBIE) Planning and Engineering Guidance for Potentially Liquefaction-Prone Land<sup>1</sup>. The assessment is based on an understanding of the area wide geology, regional groundwater regime, site specific geotechnical investigations undertaken by T+T, and site specific groundwater readings.

The liquefaction assessment is considered to be a Level C “*Detailed area-wide assessment*” based on the density of T+T’s site specific geotechnical investigations works. Earthquakes scenarios for return periods of 25-year, 100-year, and 500-year levels of earthquake shaking specific to each site were used. The specific outcomes of the liquefaction assessment for the site are detailed in the following sections.

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<sup>1</sup> MBIE (September 2017) *Planning and Engineering Guidance for Potentially Liquefaction-prone Land*  
<https://www.building.govt.nz/building-code-compliance/b-stability/b1-structure/planning-engineering-liquefaction-land/>

## 1.4 Liquefaction vulnerability categories

The Roxburgh Crescent site has been categorised as **Liquefaction Damage Is Unlikely** as described in Table 4.4 of the MBIE guidance document<sup>1</sup>, which is presented in Table 1 below.

Changes in geology, variations in ground surface level, or variations in groundwater level over the site are expected to alter the sites liquefaction vulnerability. Any significant variations in these parameters, identified during our liquefaction assessment, have been further discussed in Section 3 liquefaction assessment.

**Table 1: Performance criteria for determining the liquefaction vulnerability category – from MBIE guidance document Table 4.4.**

LIQUEFACTION CATEGORY IS UNDETERMINED			
A liquefaction vulnerability category has not been assigned at this stage, either because a liquefaction assessment has not been undertaken for this area, or there is not enough information to determine the appropriate category with the required level of confidence.			
<b>LIQUEFACTION DAMAGE IS UNLIKELY</b> There is a probability of more than 85 percent that liquefaction-induced ground damage will be <b>None to Minor</b> for 500-year shaking.  At this stage there is not enough information to distinguish between <b>Very Low</b> and <b>Low</b> . More detailed assessment would be required to assign a more specific liquefaction category.		<b>LIQUEFACTION DAMAGE IS POSSIBLE</b> There is a probability of more than 15 percent that liquefaction-induced ground damage will be <b>Minor to Moderate</b> (or more) for 500-year shaking.  At this stage there is not enough information to distinguish between <b>Medium</b> and <b>High</b> . More detailed assessment would be required to assign a more specific liquefaction category.	
<b>Very Low Liquefaction Vulnerability</b>  There is a probability of more than 99 percent that liquefaction-induced ground damage will be <b>None to Minor</b> for 500-year shaking.	<b>Low Liquefaction Vulnerability</b>  There is a probability of more than 85 percent that liquefaction-induced ground damage will be <b>None to Minor</b> for 500-year shaking.	<b>Medium Liquefaction Vulnerability</b>  There is a probability of more than 50 percent that liquefaction-induced ground damage will be: <b>Minor to Moderate</b> (or less) for 500-year shaking; and <b>None to Minor</b> for 100-year shaking.	<b>High Liquefaction Vulnerability</b>  There is a probability of more than 50 percent that liquefaction-induced ground damage will be: <b>Moderate to Severe</b> for 500-year shaking; and/or <b>Minor to Moderate</b> (or more) for 100-year shaking.



## 2 Site description and subsurface conditions

### 2.1 Site description

The site is located in the south east of Palmerston North along Roxburgh Crescent. It is bordered to the west by Ruahine Street, to the north and east by Fitzroy Bend Reserve and Roxburgh Crescent Reserve and to the south by residential dwellings off Tilbury Avenue. The approximate site boundary is shown on Figure 1 below.

The site is generally flat with reduced levels typically between 33 to 34 m R.L. Approximately 100 m east of the site is the Manawatu River. The east side of the site perimeter is adjacent to the Manawatu River flood stopbanks.

Industrial developments cover the majority of the site with a large portion utilised by Higgins Ltd. The site spans 36 legal titles.



Figure 1 - Aerial photograph with approximate site boundary

### 2.2 Published geology

The published geological map of the area<sup>2</sup> indicates that the site is underlain by Holocene river deposits consisting of alluvial gravel, sand, silt, mud and clay with localised peat. Holocene deposits are less than 12,000 years old.

<sup>2</sup> Lee, J.M., Begg, J.G. (compilers) 2002: *Geology of the Wairarapa area*. Institute of Geological & Nuclear Sciences 1:250,000 geological map 11. 1 sheet + 66 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

## 2.3 Existing investigations

Data available on the New Zealand Geotechnical Database (NZGD) and T+T Geotechnical Database (TTGD) indicate three relevant investigations in the area which have similar geomorphological and geological significance:

- Hokowhitu Campus geotechnical investigations conducted by T+T for PNCC (T+T Ref: 85442.0040), and again for Wallace Development Company Ltd (T+T Ref: 1004625.0010), located approximately 1.5km southwest of the site.
- Napier road geotechnical investigation conducted by T+T for PNCC (T+T Ref: 85442.0040), located approximately 2.5km north of the site.
- 109 Fitzherbert Avenue geotechnical investigation conducted by Miyamoto for Wallace Development Company Ltd, located approximately 2.5km west of the site.

## 2.4 T+T geotechnical investigations

### 2.4.1 General

T+T completed site specific geotechnical investigations comprising:

- Three (3) machine drilled boreholes;
- Six (6) Cone Penetration Tests (CPTs);
- One (1) standpipe piezometer; and,
- Three (3) Particle Size Distribution (PSD) laboratory tests on recovered soil samples.

Detailed descriptions of T+T's site specific geotechnical investigations are presented in Sections 2.4.2 to 2.4.5 below.

Geotechnical investigations have been undertaken at six locations over the site, with three of the CPT investigations undertaken adjacent to machine drilled borehole locations. This corresponds with an investigation density of approximately 1.2 investigations per hectare. Table 3.3 of the MBIE guidance<sup>1</sup> recommends an average investigation density, for a Level C (*Detailed area-wide assessment*) liquefaction assessment, of 0.1 to 4 investigations per hectare with a minimum of 5 investigations for sites larger than 1 hectare. Our investigation density falls within the midrange of the MBIE guidance<sup>1</sup> investigation density for a Level C (*Detailed area-wide assessment*) liquefaction assessment.

Typical geologic cross-sections based on T+T's completed site specific geotechnical investigations are presented in Figure A1 – A5, Appendix A.

### 2.4.2 Machine drilled boreholes

Three (3) machine drilled boreholes were undertaken using a sonic-rotary coring drilling rig, supplied and operated by Pro-Drill. The boreholes were HQ3 triple tube cored down to 10.6m below ground level (bgl). Standard Penetration Tests (SPT) were carried out at 1.5m intervals within the machine drilled borehole to a final depth of 11.05m bgl.

All drilling works were completed under the full time supervision of an engineering geologist from T+T. The recovered drill core was photographed and logged to NZGS 'Field Description of Soil and Rock' guidelines.

The borehole investigation locations are presented in Figure 1, Appendix A. A summary of borehole investigations completed by T+T is presented in Table B1, Appendix B. Borehole logs and core photographs are presented in Appendix B.



### 2.4.3 Cone Penetration Tests

Six (6) CPTs were undertaken by Pro-Drill on 18 to 19 December 2018. Five of the CPTs refused at depths of between 0.48 to 5.18m bgl. The sixth CPT labelled CPT-03 failed to achieve sufficient anchoring to advance the CPT and was abandoned.

The CPT locations are presented in Figure 1, Appendix A. A summary of CPT investigations completed by T+T is presented in Table B2, Appendix B. CPT logs are appended in Appendix B.

### 2.4.4 Groundwater monitoring

One (1) standpipe piezometer was installed within the machine drilled borehole BH-02 to a depth of 10m bgl. Standpipe piezometers are used to monitor groundwater levels.

Groundwater levels were recorded following completion of each machine drilled borehole and within the standpipe piezometer. Groundwater levels were recorded at between 7.3 and 8.55m bgl which is at a level of between 24.45 to 25.85m R.L.

Groundwater level is expected to be closely tied to the water level within the Manawatu River, which runs approximately 100m to the east. River level reduced level is estimated to be typically between 25 to 26 m R.L.

A preliminary review of Manawatu River level monitoring data from the previous 12 months, available from Horizons Regional Council<sup>3</sup>, indicates that river water levels are typically elevated for only short periods of time. Nearby groundwater well records, also available from Horizons Regional Council, show a slow groundwater response over time and the change in groundwater level is approximately 1m over the previous 12 months. Standpipe piezometer details are summarised in Table B3, Appendix B and groundwater level records are summarised in Table B4, Appendix B.

### 2.4.5 Laboratory testing

Three (3) Particle Size Distribution (PSD) laboratory tests were undertaken on samples collected from machine drilled boreholes. One sample was tested from each borehole. Samples were tested at the Geotechnics laboratory using test method NZS 4402:1986 Test 2.8.1 (Wet Sieve).

Laboratory test are summarised in Table B5, Appendix B and laboratory test results are presented in Appendix B.

## 2.5 Site subsoil profile

The generalised site subsoil profile identified in T+T's geotechnical investigations comprises:

- 1.5 – 2.25m of loose SAND and silty SAND; overlying,
- Medium dense to very dense sandy GRAVEL.

Layers of medium dense to dense gravelly SAND up to approximately 1m thick were identified between 6 and 10.5m depth within the sandy GRAVEL layer in BH-01 and BH-02. These layers do not appear to be continuous over the site.

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<sup>3</sup> [Horizons.govt.nz/environment-data](https://www.horizons.govt.nz/environment-data)

### 3 Liquefaction Assessment

#### 3.1 Liquefaction susceptibility

The site is assigned a liquefaction vulnerability category of **Liquefaction Damage is Unlikely**. The liquefaction assessment is considered to be a Level C “Detailed area-wide assessment” based on the density of T+T’s site specific geotechnical investigations works.

This liquefaction category corresponds to a probability of more than 85 percent that liquefaction-induced ground damage will be **None** to **Minor** for 500-year shaking. At this stage there is not enough information to distinguish between **Very Low** and **Low** liquefaction vulnerability; however the site may be conservatively assigned a **Low** liquefaction vulnerability categorisation. A more detailed assessment would be required to assign a **Very Low** liquefaction vulnerability category.

Key factors contributing to this liquefaction vulnerability assessment include:

- Depth to groundwater measured at more than 7m bgl;
- Principal geologic unit is Holocene age (less than 11,000 years); and,
- Thick sandy gravel layer underlying the site.

Table 4.3 of the MBIE guidance<sup>1</sup> provided semi-quantitative screening criteria for identifying land where liquefaction induced ground surface damage is unlikely. For Holocene age soil deposits (less than 11,000 years old) a liquefaction vulnerability category of Liquefaction Damage is Unlikely can be assigned if depth to groundwater is more than 6m.

The medium dense to dense gravelly sand layers identified within the machine drilled boreholes between depth of 6 and 10.5m may be liquefiable if below the ground water table. Due to the depth of these potentially liquefiable soils, and the thickness and density of the overlying sandy gravel crust, liquefaction damage at the ground surface is expected to be **None** to **Minor** for 500-year shaking.

All CPT investigations refused within the sandy gravel layer at the site. This is above the site groundwater level. As CPT investigations did not encounter the gravelly sand layers identified within the sandy gravel layer no quantitative liquefaction triggering and consequences assessment is currently possible. If a quantitative liquefaction triggering and consequences assessment is desired then additional CPT investigations targeted to the potentially liquefiable sand layers would be required. These CPT locations would have to be pre-drilled through the overlying sandy gravel to prevent refusal of CPT investigations above the target soil layer.

#### 3.2 Lateral spreading assessment

No lateral spreading hazard is expected to be present at this site.

Simple geomorphic screening for lateral spreading in Section 4.4.2 of the MBIE guidance<sup>1</sup> suggests that if the site is determined to have a liquefaction vulnerability category of **Liquefaction Damage is Unlikely** then lateral spreading is usually also unlikely. Lateral spreading may still occur if a thin liquefiable layer is present which allows the overlying material to slide towards the free face.

Free faces which may contribute to lateral spreading risk at the Roxburgh Crescent site include:

- Manawatu River bank, located approximately 100m to the east; and,
- The terrace formed between Roxburgh Crescent site and Fitzroy Bend Reserve, located immediately to the north and northeast of the site.

Both free faces near the site are greater than 2m high. Section 4.4.2 of the MBIE guidance<sup>1</sup> suggests that for, free face heights of greater than 2m, land within 200m of the free face should be given careful consideration for lateral spreading risk. The majority of the north and west of the site is within 200m of a free face.

Indicative geologic cross sections, Figure A2 and A3 in Appendix A, show that at the Fitzroy Bend Reserve free face location no sandy lenses have been identified below the groundwater table. The absence of continuous liquefiable soil layers at this location suggests that lateral spreading is unlikely to develop at the Fitzroy Bend Reserve free face.

Indicative geologic cross section, Figure A4 in Appendix A, shows a potentially liquefiable gravelly sand layer located below the groundwater table in BH-02. We have not assessed liquefaction potential outside the property boundary; however, if this potentially liquefiable gravelly sand layer is continuous between the site and the Manawatu River free face lateral spreading could occur at this location. Based on the other currently available geotechnical investigations and the geologic deposition environment we consider that it is unlikely that this potentially liquefiable sandy layer is continuous.

If a more detailed assessment of lateral spreading risk in this area is desired then additional geotechnical investigations would be required. These investigations are expected to comprise machine drilled boreholes or CPT with predrilling through the dense gravel layers.

The southern extent of the Roxburgh Crescent site does not have liquefiable soil layers below the water table identified in the currently available geotechnical investigations, see Figure A5, Appendix A.

### **3.3 Key uncertainties**

The key uncertainties associated with our liquefaction assessment are variation in regional groundwater depth over time and continuity of potentially liquefiable sand layers over the site.

Groundwater levels measured at the site appear to correspond to the water level in the Manawatu River. Elevated river water levels are expected to raise groundwater levels at the site. A preliminary review of Manawatu River level monitoring data from the previous 12 months, available from Horizons Regional Council<sup>3</sup>, indicates that river water levels are typically elevated for only short periods of time.

An elevated site groundwater level may increase the site liquefaction vulnerability; however, any increased liquefaction vulnerability would only be present while groundwater levels were elevated. An earthquake event occurring at the same time as groundwater levels are elevated is unlikely. If a more detailed assessment of risks associated with variation in regional groundwater level is desired then long term site specific groundwater monitoring is expected to be required.

Potentially liquefiable sand layers have been identified within two machine drilled boreholes. If these soil layers are continuous between the site and a free face lateral spreading may occur. Currently available geotechnical investigations suggest that potentially liquefiable sand layers are not continuous. A more detailed assessment of the potentially liquefiable sand layers would require additional geotechnical investigations to be completed.

#### 4 Site development considerations

The Roxburgh Crescent site has been classified into the liquefaction vulnerability category of ***Liquefaction Damage is Unlikely*** and no lateral spreading hazard is expected to be present at the site. As such, no additional measures to reduce liquefaction or lateral spreading risk are expected to be required for development of the site.

All normal requirements for earthworks and building design still apply (e.g. as stated in NZS 3604). Additional site specific geotechnical investigations may be required during development to confirm soil characteristics and strength parameters to inform building foundation design.

## 5 Applicability

This report has been prepared for the exclusive use of our client Palmerston North City 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.

We understand and agree that this report will be used by Palmerston North City Council in undertaking its regulatory functions in connection with a plan change to rezone the site from industrial to residential.

Tonkin & Taylor Ltd

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.....  
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Geotechnical Engineer

Report reviewed by:



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Christopher Sandoval  
Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:

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Mike Jacka  
Project Director

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## Appendix A: Figures

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**LEGEND**

- BOREHOLE LOCATION
- CPT LOCATION NOTE; CPT-03 NOT CONDUCTED DUE TO ANCHOR FAILURE

APPROXIMATE SCALE

0 10 20 30 40 50m

**NOTES:**

1. GROUND PROFILE BASED ON CONTOURS AND IS APPROXIMATE ONLY.
2. GEOLOGY MARKED ON THIS SECTION IS BASED ON THE LIMITED AVAILABLE INVESTIGATION DATA AS SHOWN. ACTUAL GROUND CONDITIONS MAY DIFFER FROM THE ASSUMED MODEL.
3. PROPERTY BOUNDARY BASED ON LINZ AND IS APPROXIMATE ONLY.

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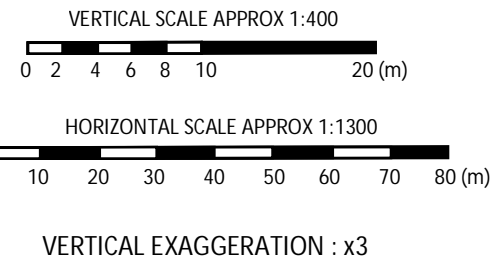
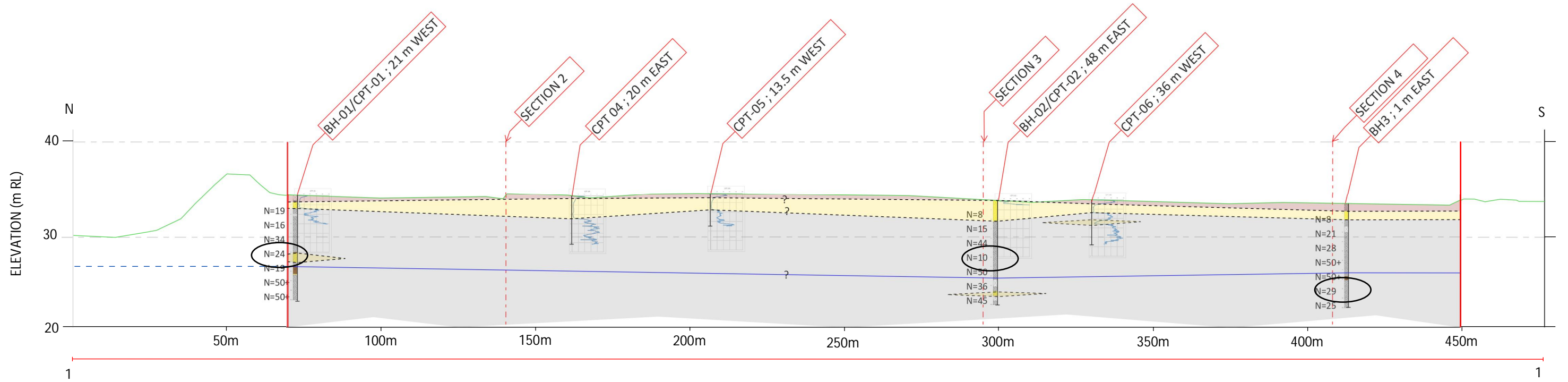
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APPROVED	MES	Sep 19
FILE: 85442.0090		
APPROX. SCALE (AT A3 SIZE)		
NTS		
PROJECT No.	85442.0090	

**AERIAL VIEW OF CROSS SECTIONS**  
**PALMERSTON NORTH CITY COUNCIL**  
**ROXBURGH CRESCENT, PALMERSTON NORTH**

FIG. No. **FIGURE A1**

REV. 1





**LEGEND**

- TOPSOIL / FILL:** FINE TO COARSE SANDY GRAVEL.
- ALLUVIAL SAND DEPOSITS:** FINE SAND MEDIUM DENSE.
- ALLUVIAL GRAVEL DEPOSITS:** FINE TO COARSE GRAVEL, SOME SAND, MEDIUM TO VERY DENSE. OCCASIONAL LOGS.
- GEOLOGICAL BOUNDARY:** INFERRED BETWEEN BOREHOLES.
- SITE BOUNDARY**
- WATER LEVEL:** INFERRED BETWEEN BOREHOLES.

**NOTES:**

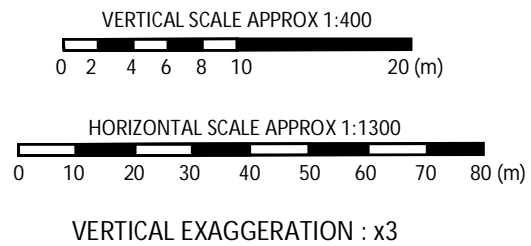
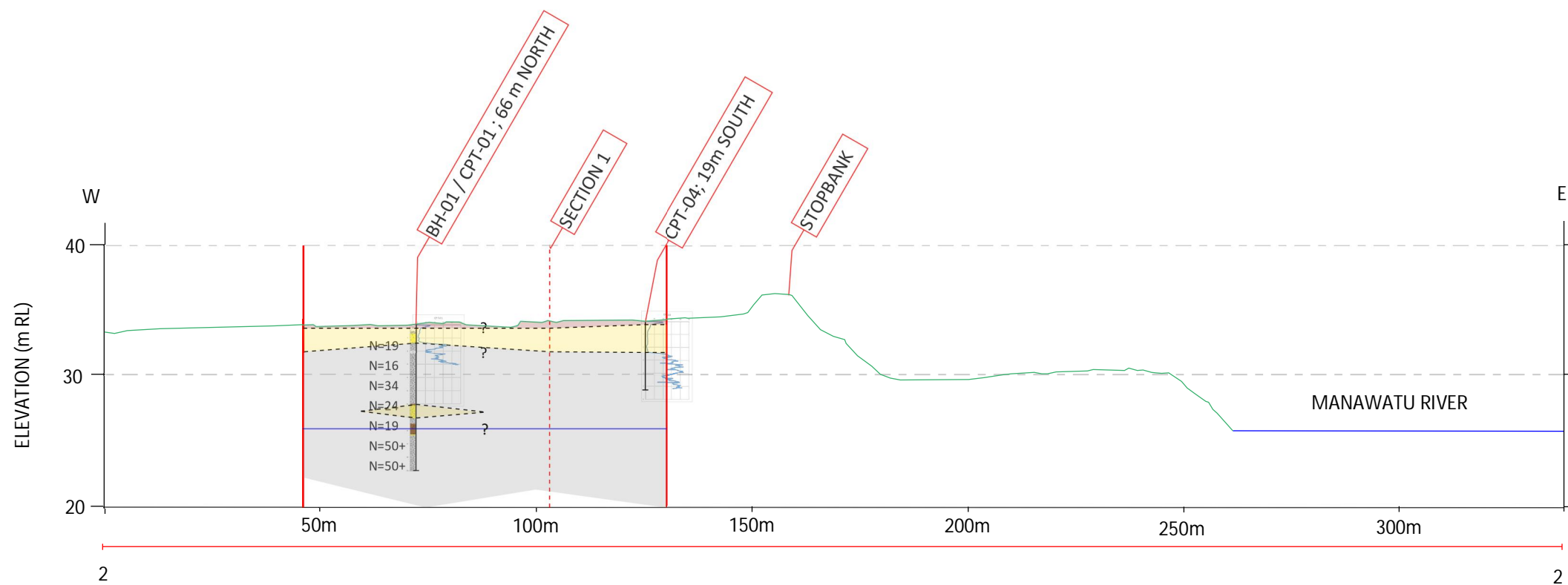
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**CROSS SECTION 1**  
**PALMERSTON NORTH CITY COUNCIL**  
 ROXBURGH CRESCENT, PALMERSTON NORTH

FIG. No. **FIGURE A2** REV. 1



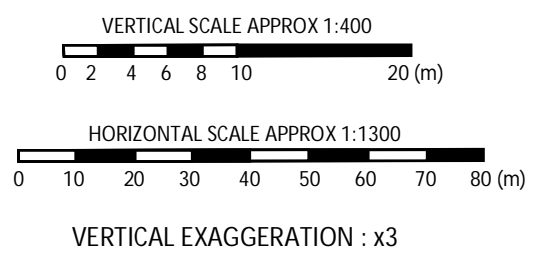
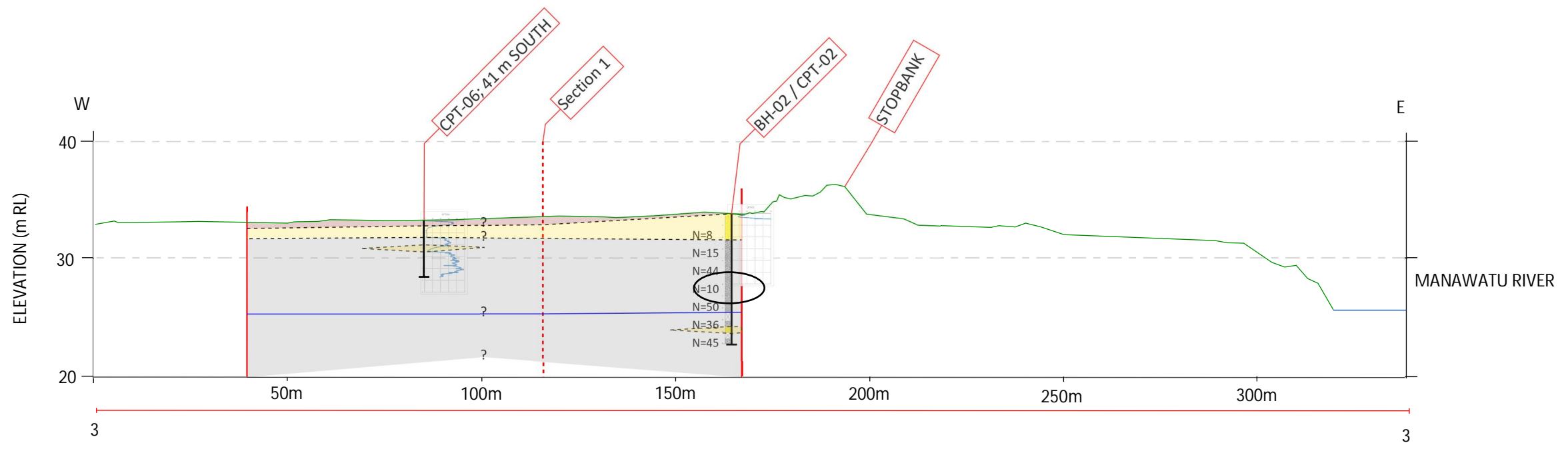
LEGEND	
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	ALLUVIAL SAND DEPOSITS: FINE SAND MEDIUM DENSE.
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	SITE BOUNDARY
	WATER LEVEL: INFERRED BETWEEN BOREHOLES.

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<b>CROSS SECTION 2</b>	
PALMERSTON NORTH CITY COUNCIL	
ROXBURGH CRESCENT, PALMERSTON NORTH	
FIG. No.	FIGURE A3
REV.	1



LEGEND	
	TOPSOIL / FILL: FINE TO COARSE SANDY GRAVEL.
	ALLUVIAL SAND DEPOSITS: FINE SAND MEDIUM DENSE.
	ALLUVIAL GRAVEL DEPOSITS: FINE TO COARSE GRAVEL, SOME SAND, MEDIUM TO VERY DENSE. OCCASIONAL LOGS.
	GEOLOGICAL BOUNDARY: INFERRED BETWEEN BOREHOLES.
	SITE BOUNDARY
	WATER LEVEL: INFERRED BETWEEN BOREHOLES.

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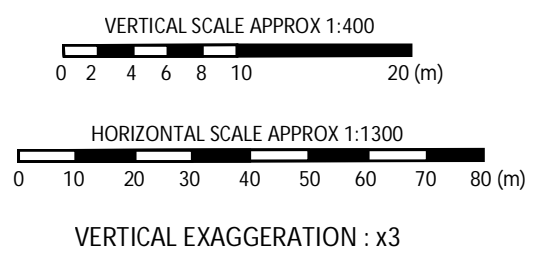
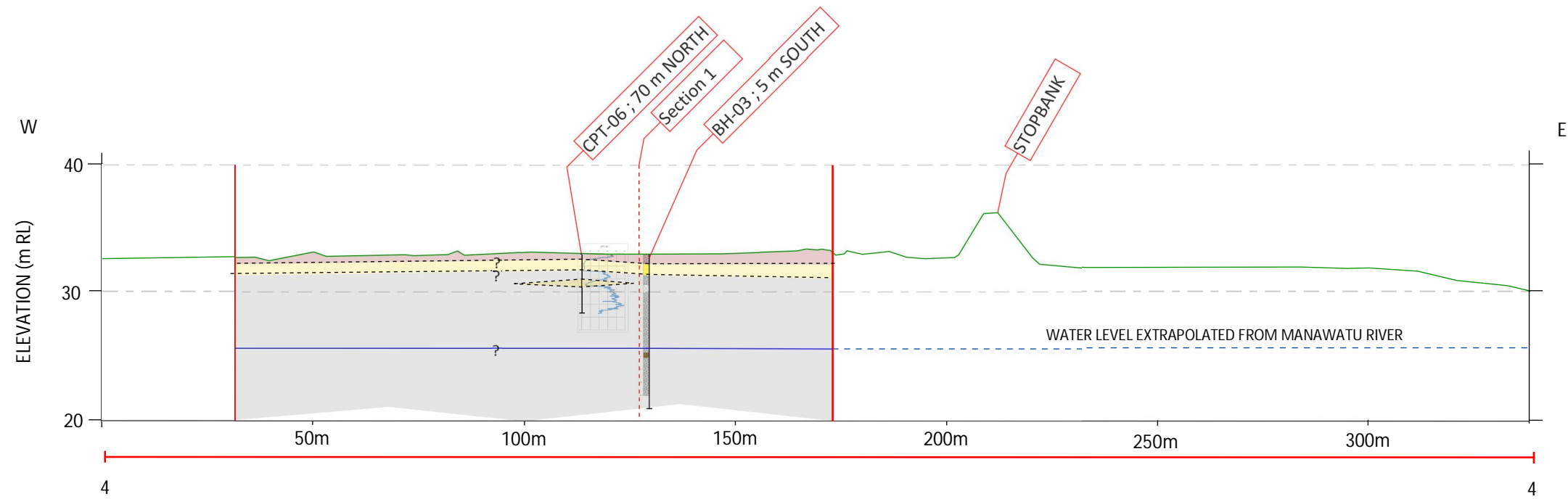
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**CROSS SECTION 3**  
**PALMERSTON NORTH CITY COUNCIL**  
**ROXBURGH CRESCENT, PALMERSTON NORTH**

FIG. No. FIGURE A4

REV. 1



LEGEND	
	TOPSOIL / FILL: FINE TO COARSE SANDY GRAVEL.
	ALLUVIAL SAND DEPOSITS: FINE SAND MEDIUM DENSE.
	ALLUVIAL GRAVEL DEPOSITS: FINE TO COARSE GRAVEL, SOME SAND, MEDIUM TO VERY DENSE. OCCASIONAL LOGS.
	GEOLOGICAL BOUNDARY: INFERRED BETWEEN BOREHOLES.
	SITE BOUNDARY
	WATER LEVEL: INFERRED BETWEEN BOREHOLES.

**NOTES:**  
 1. GROUND PROFILE BASED ON CONTOURS AND IS APPROXIMATE ONLY.  
 2. GEOLOGY MARKED ON THIS SECTION IS BASED ON THE LIMITED AVAILABLE INVESTIGATION DATA AS SHOWN. ACTUAL GROUND CONDITIONS MAY DIFFER FROM THE ASSUMED MODEL.  
 3. PROPERTY BOUNDARY BASED ON LINZ AND IS APPROXIMATE ONLY.

**Tonkin + Taylor**  
 Environmental & Engineering Consultants  
 2 Hunter Street, Wellington, New Zealand  
 www.tonkintaylor.co.nz

DRAWN	EJWL	Jan 19
DRAFTING CHECKED	WYHU	Sep 19
APPROVED	MES	Sep 19
FILE: 85442.0090		
APPROX. SCALE (AT A3 SIZE) 1:1300 (HORIZONTAL)		
PROJECT No.	85442.0090	

**CROSS SECTION 4**  
**PALMERSTON NORTH CITY COUNCIL**  
**ROXBURGH CRESCENT, PALMERSTON NORTH**

FIG. No.	FIGURE A5	REV.	1
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## Appendix B: Geotechnical investigations

### B1 Machine Drilled Borehole

Table B1: Summary of machine drilled boreholes

BH ID	Location (NZTM)		Ground Surface Elevation (m R.L.)	Depth (m bgl)
	Easting (m)	Northing (m)		
BH-01	1824516.8	5529090.5	33.5	11.05
BH-02	1824614.7	5528873.9	33.0	11.05
BH-03	1824583.6	5528754.2	33.0	11.05

### B2 Cone Penetration Test

Table B2: Summary of CPTs

CPT ID	Location (NZTM)		Ground Surface Elevation (m R.L.)	Termination depth (m bgl)	Reason for termination
	Easting (m)	Northing (m)			
CPT-01	1824514.7	5529090.8	33.8	3.03	Cone resistance exceeds 20 MPa
CPT-02	1824616.0	5528874.6	33.8	0.48	Cone resistance exceeds 20 MPa
CPT-03	1824585.9	5528753.6	33.0	-	Reaction augers pulled (abandoned)
CPT-04	1824569.1	5529006.1	34.1	5.18	Cone resistance exceeds 20 MPa
CPT-05	1824542.1	5528957.1	33.6	3.49	Reaction augers pulled
CPT-06	1824535.6	5528831.7	33.3	4.72	Cone resistance exceeds 20 MPa

### B3 Groundwater Monitoring

Table B3: Piezometer details

Borehole ID	Collar Level (m R.L.)	Installation depth (m)	Type	Geological Unit over screened depth
BH-02	33.0	10	Standpipe	Holocene Alluvial Gravel



**Table B4: Groundwater levels**

<b>Borehole ID</b>	<b>Date of groundwater measurement</b>	<b>Groundwater depth (m bgl)</b>	<b>Estimated groundwater level (m R.L.)</b>
BH-01	18/12/2018	7.65	25.85
BH-02	18/12/2018	8.25	24.75
BH-02 Piezometer	31/01/2019	8.55	24.45
BH-03	17/12/2018	7.3	25.7

## **B4 Laboratory Tests**

**Table B5: Groundwater levels**

<b>Borehole No.</b>	<b>Sample Depth (m bgl)</b>	<b>Top of sample level (m R.L.)</b>	<b>Test Type</b>
BH01	3.5-3.8	30.0	PSD < 19mm
BH02	6.5-6.8	26.5	PSD < 19mm
BH03	3.5-3.8	29.5	PSD <19mm

# BOREHOLE LOG

BOREHOLE No.: **BH-01**

Hole Location: 40 Roxburgh Crescent, western side of building

SHEET: 1 OF 2

PROJECT: PNCC Roxburgh Crescent	LOCATION: Roxburgh Crescent, Palmerston North JOB No.: 85442.0090			
CO-ORDINATES: 5529096.03 mN (NZTM2000) 1824514.51 mE	DRILL TYPE: Mito 8	HOLE STARTED: 18/12/2018		
R.L.: 33.50m	DRILL METHOD: SNC	HOLE FINISHED: 18/12/2018		
DATUM: NZVD2016	DRILL FLUID: WATER	DRILLED BY: ProDrill	LOGGED BY: EJWL	CHECKED: PAWR

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION										Description and Additional Observations									
FLUID LOSS (%)										DEFECT SPACING (cm)									
WATER										20 40 60 80 100 120 140 160 180 200									
CORE RECOVERY (%)										1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20									
METHOD										20 40 60 80 100 120 140 160 180 200									
CASING										20 40 60 80 100 120 140 160 180 200									
TESTS										20 40 60 80 100 120 140 160 180 200									
SAMPLES										20 40 60 80 100 120 140 160 180 200									
RL (m)										20 40 60 80 100 120 140 160 180 200									
DEPTH (m)										20 40 60 80 100 120 140 160 180 200									
GRAPHIC LOG										20 40 60 80 100 120 140 160 180 200									
MOISTURE CONDITION WEATHERING										20 40 60 80 100 120 140 160 180 200									
STRENGTH/DENSITY CLASSIFICATION										20 40 60 80 100 120 140 160 180 200									
SHEAR STRENGTH (kPa)										20 40 60 80 100 120 140 160 180 200									
COMPRESSION STRENGTH (MPa)										20 40 60 80 100 120 140 160 180 200									
Fill										No recovery									
BH-01 0.5-0.6 @ 0.5m BH-01 0.6-0.7 @ 0.6m										Silty GRAVEL (GW); brown . Moist, well graded; gravel, fine to coarse, angular to rounded, slightly weathered, Sandstone; loosely packed. Silty SAND (SP); orange brown. Moist, uniformly graded; sand, fine, loosely packed.									
5/6 5/4 5/5 N=19										Sandy GRAVEL (GP); brownish grey. Medium dense, moist, poorly graded; gravel, fine to coarse, angular subrounded, slightly weathered; sand, fine to coarse, subangular.									
no recovery										no recovery									
76										Sandy GRAVEL (GW), trace cobbles; grey . Medium dense, moist, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered, Sandstone; sand, fine to coarse, subangular; cobbles, subangular, up to 70mm, slightly weathered, Sandstone.									
4/4 4/4 4/4 N=16										Sandy GRAVEL (GW); brownish grey. Medium dense, moist, well graded; gravel, fine to coarse, angular to subangular, moderately weathered, Sandstone; sand, fine to coarse.									
BH-01 3.5 @ 3.5m PSD										Sandy GRAVEL (GW); grey . Medium dense, moist, well graded; gravel, fine to coarse, angular subrounded, slightly weathered, Sandstone; sand, fine to coarse.									
100										4.30m: minor silt; trace cobbles, subrounded to rounded, sandstone, up to 70mm 4.50m: Dense									
8/9 6/8 8/12 N=34																			
Alluvial Deposits																			

COMMENTS: SPT Hammer Energy Transfer Ratio 87.4% (Pile Dynamics Inc. 5/4/2018) | PSD sample tested by Geotechnics Ltd (ID S19WN000034)

Hole Depth  
11.05m  
Scale 1:30



PROJECT: PNCC Roxburgh Crescent	LOCATION: Roxburgh Crescent, Palmerston North JOB No.: 85442.0090
CO-ORDINATES: 5528876.54 mN (NZTM2000) 1824612.69 mE	DRILL TYPE: Mito 8
R.L.: 33.00m	DRILL METHOD: SNC
DATUM: NZVD2016	DRILL FLUID: WATER
	HOLE STARTED: 17/12/2018
	HOLE FINISHED: 18/12/2018
	DRILLED BY: ProDrill
	LOGGED BY: EJWL
	CHECKED: PAWR

GEOLOGICAL		ENGINEERING DESCRIPTION																
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION		FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (cm)	Description and Additional Observations	
Alluvial Deposits				100	SNC		BH-02 0.1-0.2 @ 0.1m					M					Silty SAND (SM); greenish grey. Moist, uniformly graded, non-plastic; sand, fine, Loosely packed.	
				100	SNC		BH-02 0.4-0.5 @ 0.4m					L					SAND (SP), minor silt, trace gravel; brownish grey. Loose, moist, uniformly graded; sand, fine; gravel, fine to coarse, subrounded rounded, moderately weathered, Sandstone.	
				100	SPT		2/2 2/2 2/2 N=8		32	1								
				100	SNC				31	2			MD					GRAVEL (GW), some sand; grey . Medium dense, moist, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; sand, fine to coarse, subangular.  2.25m: single cobble 90mm, subangular, sandstone
				100	SPT		5/4 3/3 5/4 N=15		30	3			D					GRAVEL (GP), some cobbles; grey . Medium dense, moist, poorly graded; gravel, medium to coarse, subangular to rounded, slightly weathered, Sandstone; cobbles, subrounded to rounded, up to 80mm, slightly weathered, Sandstone.
		100	SNC				29	4									GRAVEL (GW), some sand, trace silt; grey . Dense, moist, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered, Sandstone; sand, fine to coarse, subangular.	
		100	SPT		7/8 9/8 12/15 N=44		28	5			MD						Sandy GRAVEL (GW); reddish grey. Medium dense, moist, well graded; gravel, fine to coarse, angular to rounded, slightly weathered to moderately weathered; sand, fine to coarse, subangular to angular; iron panning. GRAVEL (GW), some sand, trace cobbles; grey .	

COMMENTS: SPT Hammer Energy Transfer Ratio 87.4% (Pile Dynamics Inc. 5/4/2018) | Standpipe Piezometer installed (18/12/2018); blank 0-1 mbgl; slotted 1-10 mbgl; Flush toby triangle key lock | PSD sample tested by Geotechnics Ltd (S19WN000035)

Hole Depth 11.05m  
Scale 1:30

BoreLog - 1/03/2019 9:00:39 AM - Produced with Core-GS by GeRoc

PROJECT: PNCC Roxburgh Crescent	LOCATION: Roxburgh Crescent, Palmerston North	JOB No.: 85442.0090
CO-ORDINATES: 5528876.54 mN (NZTM2000) 1824612.69 mE	DRILL TYPE: Mito 8	HOLE STARTED: 17/12/2018
R.L.: 33.00m	DRILL METHOD: SNC	HOLE FINISHED: 18/12/2018
DATUM: NZVD2016	DRILL FLUID: WATER	LOGGED BY: EJWL CHECKED: PAWR

GEOLOGICAL										ENGINEERING DESCRIPTION									
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION										Description and Additional Observations									
WATER										MOISTURE CONDITION / WEATHERING									
CORE RECOVERY (%)										STRENGTH/DENSITY CLASSIFICATION									
METHOD										SHEAR STRENGTH (kPa)									
CASING										COMPRESSIVE STRENGTH (MPa)									
TESTS										DEFECT SPACING (cm)									
SAMPLES										GRAPHIC LOG									
RL (m)										DEPTH (m)									
31/07/2018, 18/12/2018 casing in										31/07/2018, 18/12/2018 casing in									
Peizo										Peizo									
4/3										4/3									
4/3										4/3									
2/1										2/1									
N=10										N=10									
BH-02 6.5 @ 6.5m PSD										BH-02 6.5 @ 6.5m PSD									
26										26									
7										7									
20/20										20/20									
16/17										16/17									
17 for 45mm										17 for 45mm									
N>=50										N>=50									
25										25									
8										8									
M										M									
VD										VD									
47										47									
SNC										SNC									
no recovery										no recovery									
24										24									
9										9									
6/7										6/7									
9/10										9/10									
10/7										10/7									
N=36										N=36									
W										W									
D										D									
47										47									
SNC										SNC									
No recovery										No recovery									
7/9										7/9									
12/111										12/111									
12/10										12/10									
N>=50										N>=50									
VD										VD									
22										22									
11										11									
GRAVEL (GW), minor sand. Very dense, wet; gravel, fine to coarse, subangular, slightly weathered, Sandstone; sand, fine to coarse, angular.										GRAVEL (GW), minor sand. Very dense, wet; gravel, fine to coarse, subangular, slightly weathered, Sandstone; sand, fine to coarse, angular.									
11.05m: Target depth										11.05m: Target depth									

COMMENTS: SPT Hammer Energy Transfer Ratio 87.4% (Pile Dynamics Inc. 5/4/2018) | Standpipe Piezometer installed (18/12/2018); blank 0-1 mbgl; slotted 1-10 mbgl; Flush toby triangle key lock | PSD sample tested by Geotechnics Ltd (S19WN000035)

Hole Depth 11.05m  
Scale 1:30

BoreLog - 1/03/2019 9:00:39 AM - Produced with Core-GS by GeRoc

# BOREHOLE LOG

**BOREHOLE No.: BH-03**  
**Hole Location:** Higgins yard, southern end  
 SHEET: 1 OF 2

PROJECT: PNCC Roxburgh Crescent	LOCATION: Roxburgh Crescent, Palmerston North JOB No.: 85442.0090
CO-ORDINATES: 5528762.88 mN (NZTM2000) 1824579.63 mE	DRILL TYPE: Mito 8
R.L.: 33.00m	DRILL METHOD: SNC
DATUM: NZVD2016	DRILL FLUID: WATER
	HOLE STARTED: 17/12/2018
	HOLE FINISHED: 17/12/2018
	DRILLED BY: ProDrill
	LOGGED BY: EJWL
	CHECKED: PAWR

GEOLOGICAL		ENGINEERING DESCRIPTION															
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION		FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (cm)	Description and Additional Observations
Fill				100	SNC		BH-03 0.05-0.15 @ 0.1m BH-03 0.1-0.2 @ 0.1m BH-03 0.4-0.5 @ 0.4m BH-03 0.5-0.6 @ 0.5m					D					Sandy GRAVEL (GW), minor silt; dark grey. Dry, well graded; gravel, fine to coarse, subangular rounded, slightly weathered, Sandstone, loosely packed; sand, fine to coarse.
				100	SNC				32	1		M	St				0.75m: Single gravel with yellow paint. SAND (SP), trace silt; orange brown. Loose, moist, uniformly graded; sand, fine.
				100	SPT		2/3 3/3 1/2 N=9						L				Sandy GRAVEL (GW), trace cobbles; grey . Loose, moist, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; cobbles, subangular to rounded, up to 70mm, slightly weathered to moderately weathered, Sandstone.
				42	SNC					31	2						No recovery -Cobble in drill bit
	Alluvial Deposits				100	SPT		4/4 4/5 5/7 N=21					M	MD			
				100	SNC		BH-03 3.5-3.8 @ 3.5m PSD										
				100	SPT		7/7 7/9 5/7 N=28										GRAVEL (GW), trace sand and cobbles; grey . Medium dense, moist, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; sand, coarse, cobbles, subangular, up to 70mm, slightly weathered, Sandstone.
									28	5							Sandy GRAVEL (GW); grey . Medium dense, moist; gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; sand, fine to coarse, Subangular.

COMMENTS: SPT Hammer Energy Transfer Ratio 87.4% (Pile Dynamics Inc. 5/4/2018) | PSD sample tested by Geotechnics Ltd (S19WN000035)

Hole Depth 11.05m  
 Scale 1:30



PROJECT: PNCC Roxburgh Crescent	LOCATION: Roxburgh Crescent, Palmerston North JOB No.: 85442.0090		
CO-ORDINATES: 5528762.88 mN (NZTM2000) 1824579.63 mE	DRILL TYPE: Mito 8	HOLE STARTED: 17/12/2018	
R.L.: 33.00m	DRILL METHOD: SNC	HOLE FINISHED: 17/12/2018	
DATUM: NZVD2016	DRILL FLUID: WATER	LOGGED BY: EJWL	CHECKED: PAWR

GEOLOGICAL		ENGINEERING DESCRIPTION																
GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MATERIAL COMPOSITION		FLUID LOSS (%)	WATER	CORE RECOVERY (%)	METHOD	CASING	TESTS	SAMPLES	RL (m)	DEPTH (m)	GRAPHIC LOG	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SHEAR STRENGTH (kPa)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (cm)	Description and Additional Observations	
Alluvial Deposits				100	SNC		9/17 18/18 14 for 65mm N>=50		26	7	[Symbol]	VD					[CONT] Sandy GRAVEL (GW); grey . Medium dense, moist, gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; sand, fine to coarse, Subangular.	
			17/12/2018	100	SNC							W					7.50m: Wet.	
				100	SPT		11/23 29/17 4 for 5mm N>=50		25	8	[Symbol]	MD					WOOD, log.	
				100	SNC													GRAVEL (GW), some sand, trace cobbles; grey . Medium dense, wet, well graded; gravel, fine to coarse, subangular to rounded, slightly weathered to moderately weathered, Sandstone; sand, fine to coarse, subangular; cobbles, subrounded to rounded, up to 70mm, slightly weathered, Sandstone.
				100	SPT		10/7 6/7 8/8 N=29		24	9	[Symbol]							
				100	SNC					23	10	[Symbol]						
				100	SPT		5/5 7/7 6/5 N=25		22	11	[Symbol]							11.05m: Target depth

COMMENTS: SPT Hammer Energy Transfer Ratio 87.4% (Pile Dynamics Inc. 5/4/2018) | PSD sample tested by Geotechnics Ltd (S19WN000035)

Hole Depth  
11.05m  
Scale 1:30

BoreLog - 1/03/2019 9:00:45 AM - Produced with Core-GS by GeRoc



# CONE PENETRATION TEST LOG

CPT No.:

CPT-01

SHEET: 1 OF 1

DRILLED BY:

LOGGED BY: EJWL

CHECKED: RSP

TEST DATE: 18/12/2018

CONTRACTOR: 409

PROJECT: PNCC Roxburgh Crescent

JOB No.: 85442.0090

LOCATION: Roxburgh Crescent, Palmerston North

CO-ORDINATES: 5529090.77 mN  
(NZTM2000) 1824514.71 mE

R.L. GROUND: 33.80m

DATUM: NZVD2016

DIRECTION:

ANGLE FROM HORIZ.:



Remarks Point imported from TTGD

Hole Depth  
3.03m

Scale 1:50

CPT Log: Generated with Core-GS by Geroc; 1/03/2019 9:00:16 AM

Rev.: A



# CONE PENETRATION TEST LOG

CPT No.:

## CPT-02

SHEET: 1 OF 1

DRILLED BY:

LOGGED BY: EJWL

CHECKED: RSP

TEST DATE: 18/12/2018

CONTRACTOR: 409

PROJECT: PNCC Roxburgh Crescent

JOB No.: 85442.0090

LOCATION: Roxburgh Crescent, Palmerston North

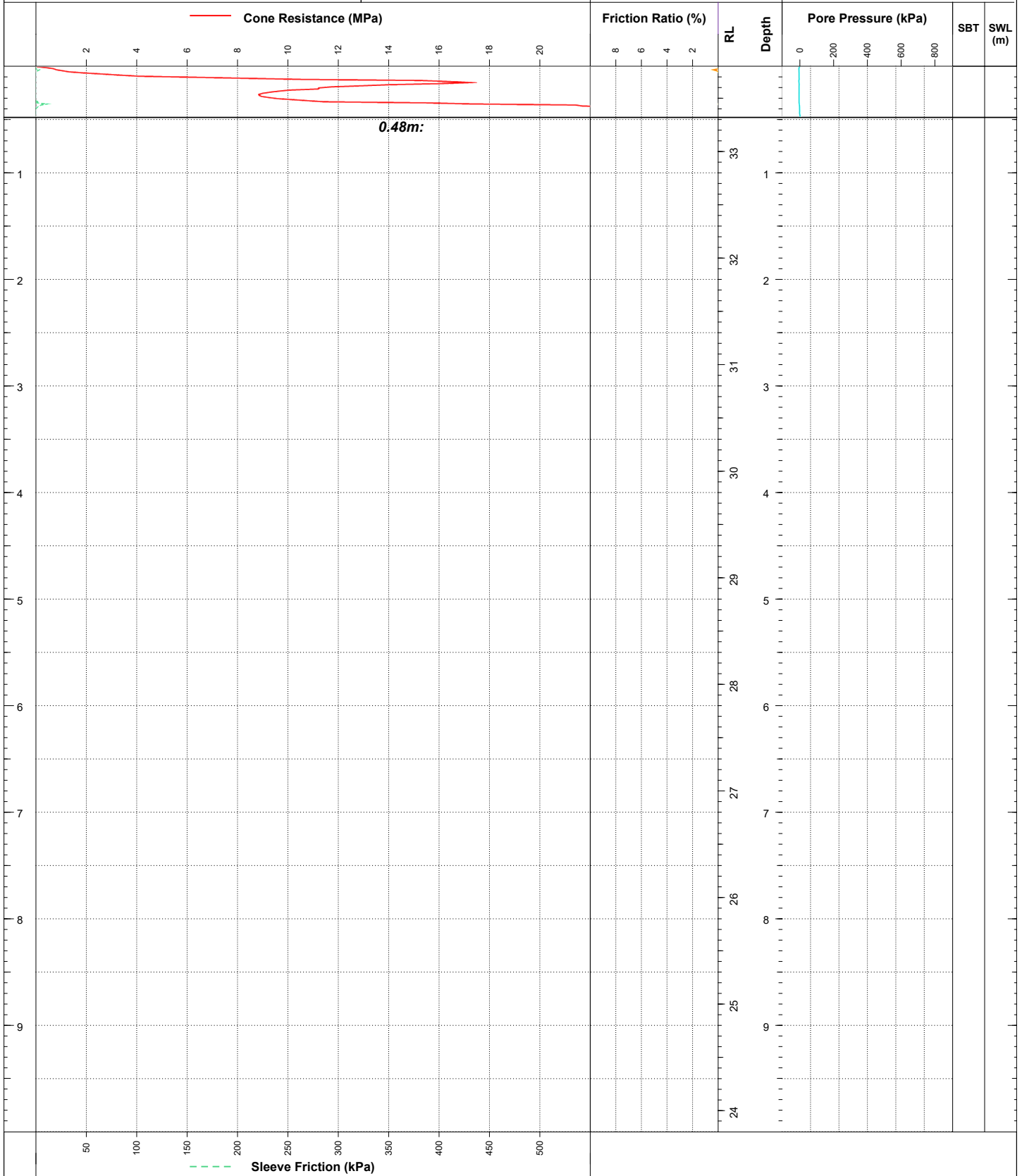
CO-ORDINATES: 5528874.61 mN  
(NZTM2000) 1824615.97 mE

R.L. GROUND: 33.80m

DATUM: NZVD2016

DIRECTION:

ANGLE FROM HORIZ.:



Remarks Point imported from TTGD

Hole Depth  
0.48m

Scale 1:50

CPT Log: Generated with Core-GS by Geroc; 1/03/2019 9:00:20 AM

Rev.: A



# CONE PENETRATION TEST LOG

CPT No.:

CPT-04

SHEET: 1 OF 1

DRILLED BY:

LOGGED BY: EJWL

CHECKED: RSP

TEST DATE: 19/12/2018

CONTRACTOR: 409

PROJECT: PNCC Roxburgh Crescent

JOB No.: 85442.0090

LOCATION: Roxburgh Crescent, Palmerston North

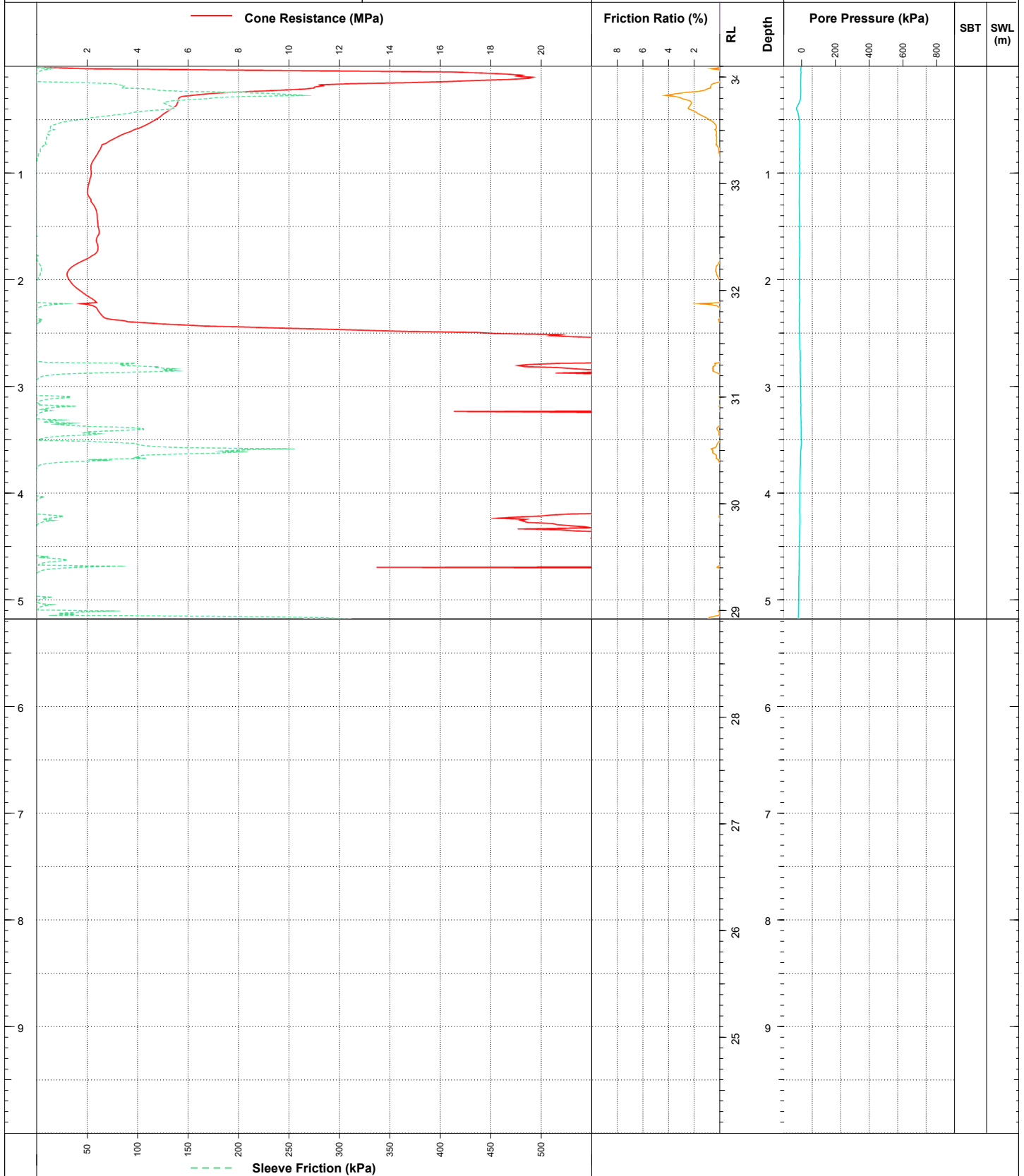
CO-ORDINATES: 5529006.14 mN  
(NZTM2000) 1824569.06 mE

R.L. GROUND: 34.10m

DATUM: NZVD2016

DIRECTION:

ANGLE FROM HORIZ.:



Remarks Point imported from TTGD

Hole Depth  
5.18m

Scale 1:50

CPT Log: Generated with Core-GS by Geroc; 1/03/2019 9:00:22 AM

Rev.: A



# CONE PENETRATION TEST LOG

CPT No.:

CPT-05

SHEET: 1 OF 1

DRILLED BY:

LOGGED BY: EJWL

CHECKED: RSP

TEST DATE: 19/12/2018

CONTRACTOR: 409

PROJECT: PNCC Roxburgh Crescent

JOB No.: 85442.0090

LOCATION: Roxburgh Crescent, Palmerston North

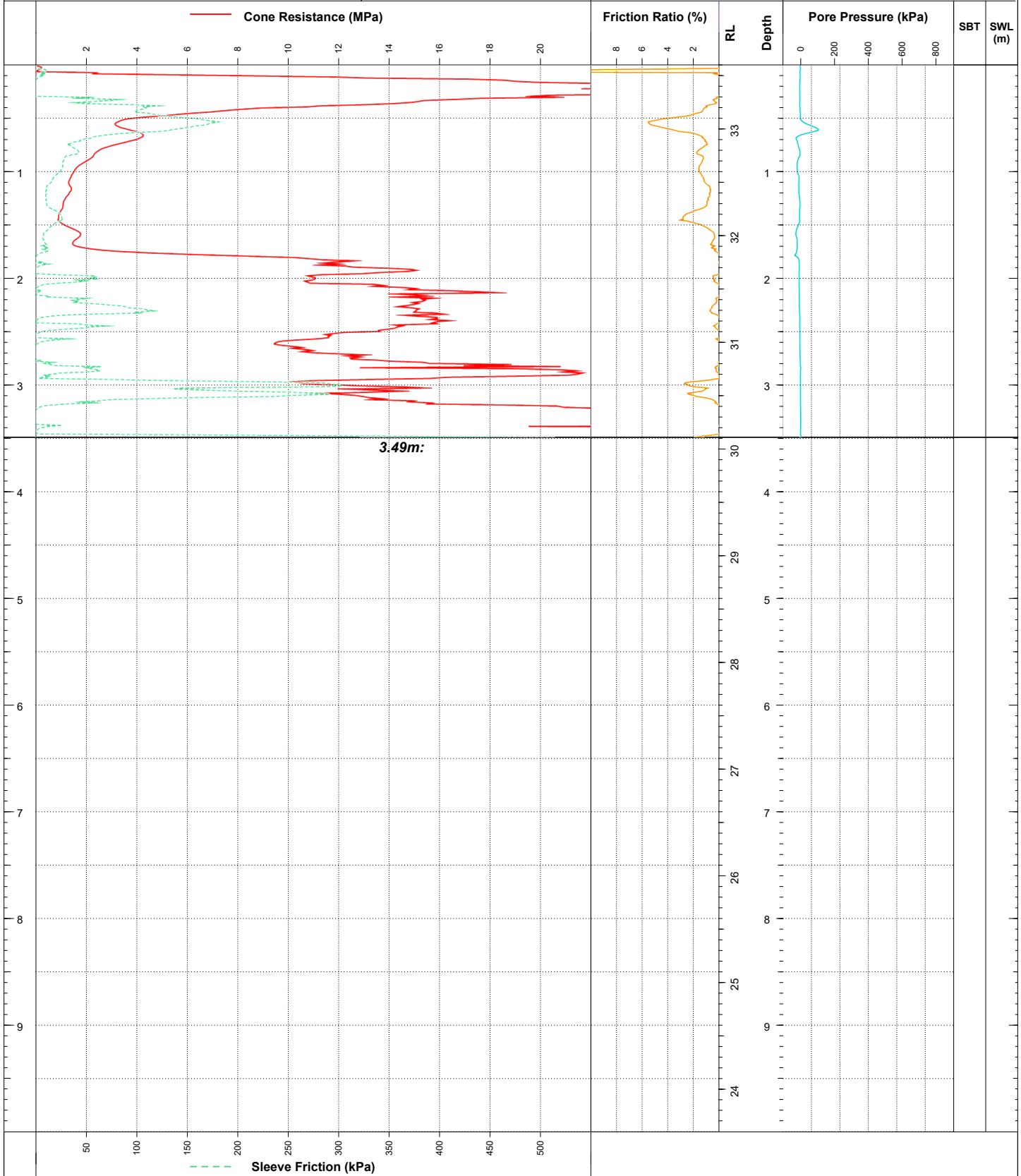
CO-ORDINATES: 5528957.10 mN  
(NZTM2000) 1824542.06 mE

R.L. GROUND: 33.60m

DATUM: NZVD2016

DIRECTION:

ANGLE FROM HORIZ.:



Remarks Point imported from TTGD

Hole Depth  
3.49m

Scale 1:50

CPT Log: Generated with Core-GS by Geroc; 1/03/2019 9:00:25 AM

Rev.: A



# CONE PENETRATION TEST LOG

CPT No.:

CPT-06

SHEET: 1 OF 1

DRILLED BY:

LOGGED BY: EJWL

CHECKED: RSP

TEST DATE: 19/12/2018

CONTRACTOR: 409

PROJECT: PNCC Roxburgh Crescent

JOB No.: 85442.0090

LOCATION: Roxburgh Crescent, Palmerston North

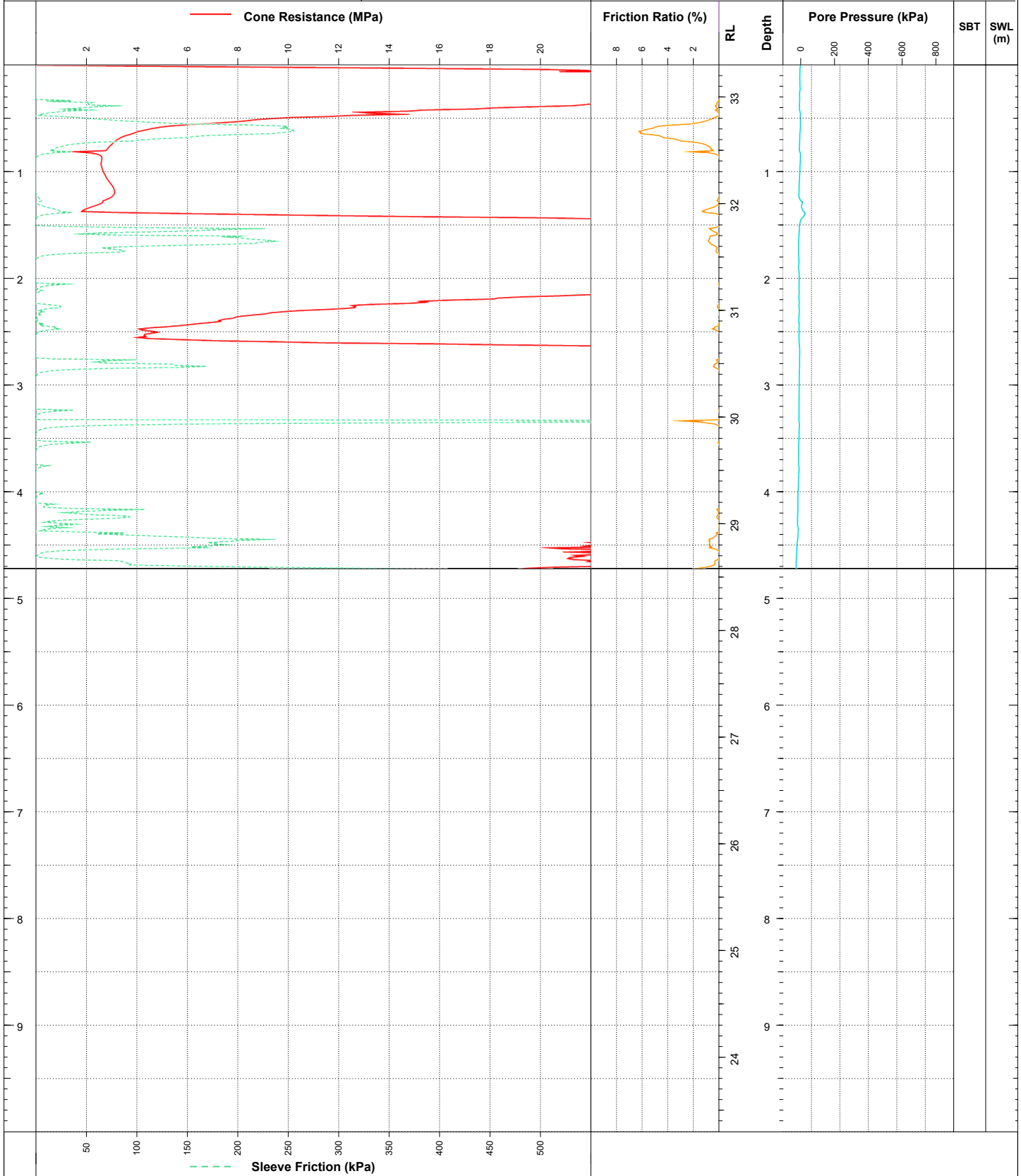
CO-ORDINATES: 5528831.66 mN  
(NZTM2000) 1824535.57 mE

R.L. GROUND: 33.30m

DATUM: NZVD2016

DIRECTION:

ANGLE FROM HORIZ.:



Remarks Point imported from TTGD

Hole Depth  
4.72m

Scale 1:50

CPT Log: Generated with Core-GS by Geroc; 1/03/2019 9:00:28 AM

Rev.: A





Our Ref: 1009594.0.0.0/REP1  
Customer Ref: 85442.009  
20 February 2019

Tonkin & Taylor Limited  
PO Box 5271  
Auckland  
1141

Attention: Enzo Liddle

Dear Enzo

### Roxburgh Crescent 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.

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:


Authorised for Geotechnics by:

.....  
  
James Green  
Construction Materials Technician

.....  
Paul Burton  
Project Director



Report checked by:

.....  
  
Alan Benton  
Wellington Manager

20-Feb-19  
t:\geotechnicsgroup\projects\1009495\workingmaterial\20190220.jmg.1009495.rep1.docx



Level 4, ASB Bank Tower  
2 Hunter Street  
Wellington 6011  
New Zealand  
p: +64 4 381 8584

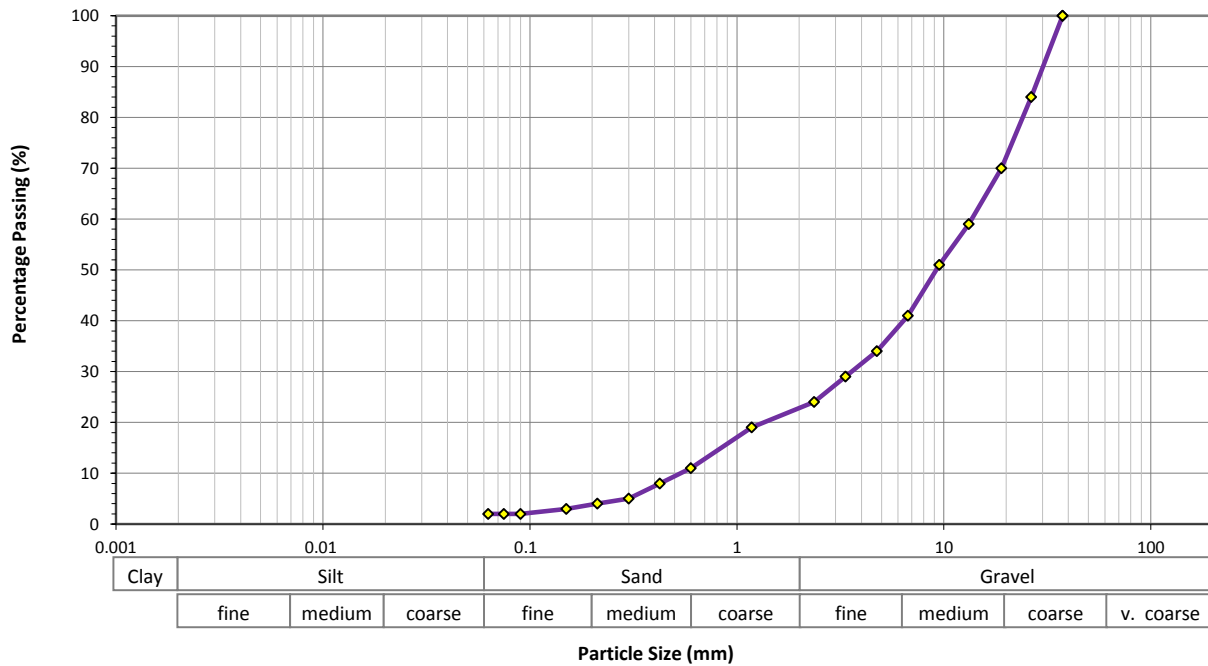
Geotechnics Project Number 1009495  
QESTLab Work Order ID W19WN-0002  
Customer Project ID 85442.0090

## Determination of the Particle Size Distribution - NZS 4402:1986 Test 2.8.1 (Wet Sieve)

### TEST DETAILS

<b>LOCATION</b>	<b>Description</b>	Roxburgh Crescent		
	<b>Data</b>	N/A		
<b>SAMPLE</b>	<b>Geotechnics ID</b>	S19WN000034		
	<b>Reference</b>	BH01_3.5-3.8m	<b>Top Depth</b>	3.5m
	<b>Sampled By</b>	Others, Tested As Received	<b>Bottom Depth</b>	3.8m
	<b>Description</b>	Sandy fine to coarse GRAVEL, with trace silt; grey. Moist; well graded. Sand, fine to coarse.		
<b>SPECIMEN</b>	<b>Reference</b>	<b>Depth</b>		
	<b>Description</b>			

### TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	84	4.75	34	0.300	5
100	-	19.0	70	3.35	29	0.212	4
75.0	-	16.0	-	2.36	24	0.150	3
63.0	-	13.2	59	1.18	19	0.090	2
53.0	-	9.50	51	0.600	11	0.075	2
37.5	100	6.70	41	0.425	8	0.063	2

### TEST REMARKS

- The material used for testing was natural, fraction passing a 19mm sieve.
- The sampling is not covered under our scope of IANZ accreditation.
- The percentage passing the <0.063mm was obtained by difference.
- Unable to be accredited due to insufficient sample mass.

Approved By Alan Benton

Date 18/02/2019



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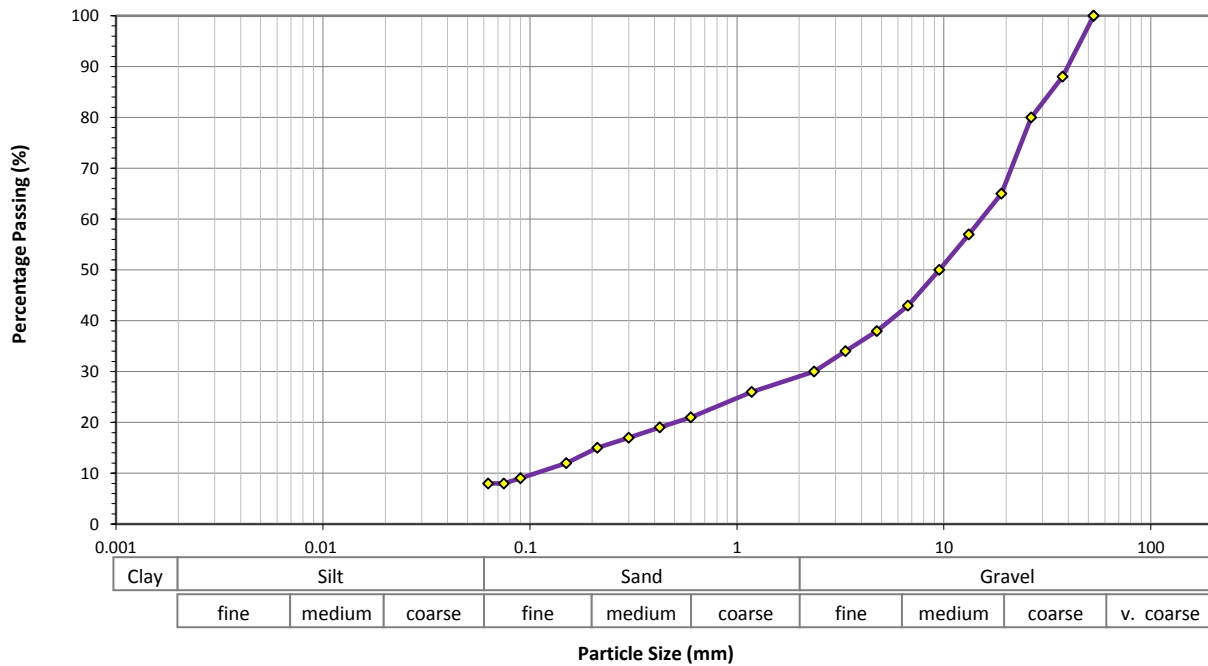
Geotechnics Project Number 1009495  
QESTLab Work Order ID W19WN-0002  
Customer Project ID 85442.0090

## Determination of the Particle Size Distribution - NZS 4402:1986 Test 2.8.1 (Wet Sieve)

### TEST DETAILS

<b>LOCATION</b>	<b>Description</b>	Roxburgh Crescent		
	<b>Data</b>	N/A		
<b>SAMPLE</b>	<b>Geotechnics ID</b>	S19WN000035		
	<b>Reference</b>	BH02_6.5-6.8m	<b>Top Depth</b>	6.5m
	<b>Sampled By</b>	Others, Tested As Received	<b>Bottom Depth</b>	6.8m
	<b>Description</b>	Sandy fine to coarse GRAVEL, with minor silt; grey. Moist; well graded. Sand, fine to coarse.		
<b>SPECIMEN</b>	<b>Reference</b>	<b>Depth</b>		
	<b>Description</b>			

### TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	80	4.75	38	0.300	17
100	-	19.0	65	3.35	34	0.212	15
75.0	-	16.0	-	2.36	30	0.150	12
63.0	-	13.2	57	1.18	26	0.090	9
53.0	100	9.50	50	0.600	21	0.075	8
37.5	88	6.70	43	0.425	19	0.063	8

### TEST REMARKS

- The material used for testing was natural, fraction passing a 19mm sieve.
- The sampling is not covered under our scope of IANZ accreditation.
- The percentage passing the <0.063mm was obtained by difference.
- Unable to be accredited due to insufficient sample mass.

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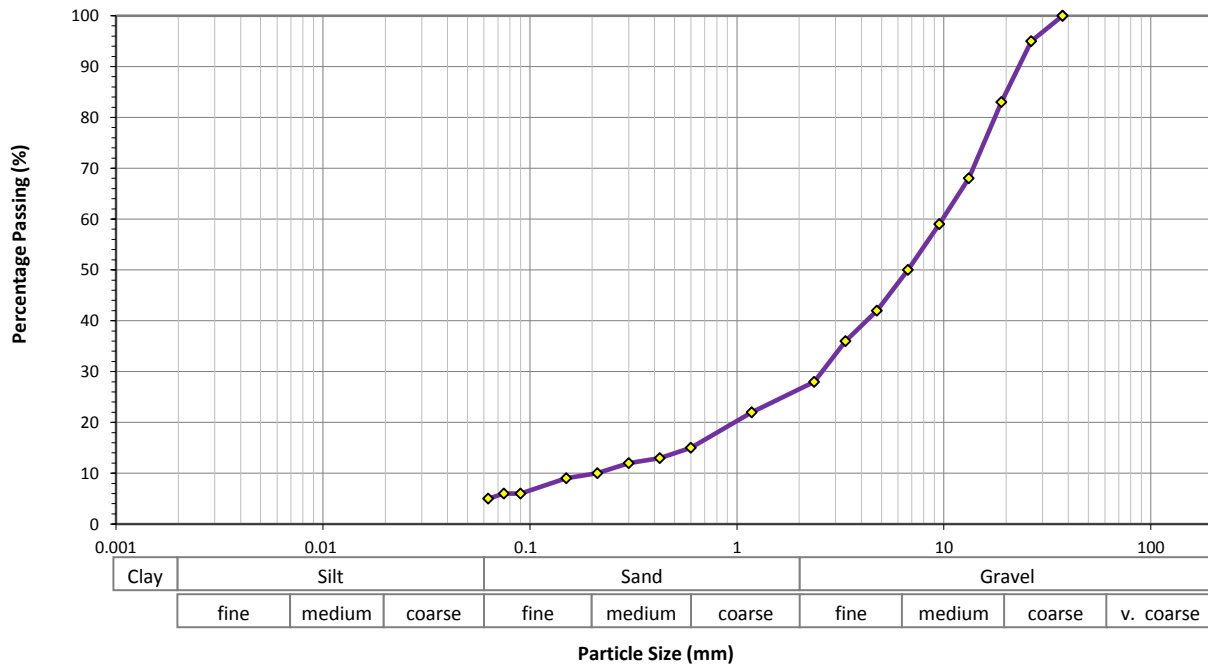
Geotechnics Project Number 1009495  
QESTLab Work Order ID W19WN-0002  
Customer Project ID 85442.0090

## Determination of the Particle Size Distribution - NZS 4402:1986 Test 2.8.1 (Wet Sieve)

### TEST DETAILS

<b>LOCATION</b>	<b>Description</b>	Roxburgh Crescent		
	<b>Data</b>	N/A		
<b>SAMPLE</b>	<b>Geotechnics ID</b>	S19WN000036		
	<b>Reference</b>	BH03_3.5-3.8m	<b>Top Depth</b>	3.5m
	<b>Sampled By</b>	Others, Tested As Received	<b>Bottom Depth</b>	3.8m
	<b>Description</b>	Sandy fine to coarse GRAVEL, with trace silt; grey. Moist; well graded. Sand, fine to coarse.		
<b>SPECIMEN</b>	<b>Reference</b>	<b>Depth</b>		
	<b>Description</b>			

### TEST RESULTS



Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)	Sieve Size (mm)	Percentage Passing (%)
150	-	26.5	95	4.75	42	0.300	12
100	-	19.0	83	3.35	36	0.212	10
75.0	-	16.0	-	2.36	28	0.150	9
63.0	-	13.2	68	1.18	22	0.090	6
53.0	-	9.50	59	0.600	15	0.075	6
37.5	100	6.70	50	0.425	13	0.063	5

### TEST REMARKS

- The material used for testing was natural, fraction passing a 19mm sieve.
- The sampling is not covered under our scope of IANZ accreditation.
- The percentage passing the <0.063mm was obtained by difference.
- Unable to be accredited due to insufficient sample mass.

Approved By Alan Benton

Date 18/02/2019

