Christchurch City Council

Richmond Park Pavilion
PRK 0671 BLDG 003 EQ2

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Richmond Park Pavilion

Quantitative Assessment Report

39 Medway Street, Christchurch

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Summary

Richmond Park Pavilion
PRK 06716 BLDG 003 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

39 Medway Street, Christchurch

Background

This is a summary of the quantitative report for the Richmond Park Pavilion building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 3 July and 3 September 2012 and calculations.

Key Damage Observed

Damage observed includes:

- multiple hairline cracks in the concrete slab forming the raised patio on the western side of the building;
- hairline crack in the concrete slab in the changing rooms;
- vertical cracks up to 1.5mm in the external concrete masonry eastern wall;
- crack in the ceiling seam of the northern part of the building; and
- cracking of lintel beams and window sills.

Critical Structural Weaknesses

No potential critical structural weaknesses have been identified.

Indicative Building Strength

Based on the information available, and from undertaking a quantitative assessment, the building's original capacity has been assessed to be 44%NBS along the building, limited by the out-of-plane bending capacity of the internal masonry cross walls due to the absence of a ceiling diaphragm to support the top of the wall.

As the occupancy levels and duration is likely to be low, based on the NZSEE guidelines included in Figure 1, the building can be classified as a moderate risk building and its normal occupancy should be unaffected.

Recommendations

The following recommendations are made:

(a) Carry out a levels survey to determine if the concrete floor slab has settled differentially and to quantify the magnitude of settlement.

(b) Strengthening schemes be developed to increase the seismic capacity of the building to at least 67%NBS.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Richmond Park Pavilion building, located at 39 Medway Street, Christchurch, following the Canterbury Earthquake Sequence since September 2010.

The purpose of the assessment is to determine if the building is classed as being earthquake prone in accordance with the Building Act 2004.

The seismic assessment and reporting have been undertaken based on the qualitative and quantitative procedures detailed in the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

2 Compliance

This section contains a brief summary of the requirements of the various statutes and authorities that control activities in relation to buildings in Christchurch at present.

2.1 Canterbury Earthquake Recovery Authority (CERA)

CERA was established on 28 March 2011 to take control of the recovery of Christchurch using powers established by the Canterbury Earthquake Recovery Act enacted on 18 April 2011. This act gives the Chief Executive Officer of CERA wide powers in relation to building safety, demolition and repair. Two relevant sections are:

Section 38 – Works

This section outlines a process in which the chief executive can give notice that a building is to be demolished and if the owner does not carry out the demolition, the chief executive can commission the demolition and recover the costs from the owner or by placing a charge on the owners' land.

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee to carry out a full structural survey before the building is re-occupied.

We understand that CERA require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). CERA have adopted the Detailed Engineering Evaluation Procedure (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

It is anticipated that a number of factors, including the following, will determine the extent of evaluation and strengthening level required:

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

Christchurch City Council requires any building with a capacity of less than 34% of New Building Standard (including consideration of critical structural weaknesses) to be strengthened to a target of 67% as required under the CCC Earthquake Prone Building Policy.

2.2 Building Act

Several sections of the Building Act are relevant when considering structural requirements:

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration. This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

The Earthquake Prone Building policy for the territorial authority shall apply as outlined in Section 2.3 of this report.

Section 115 – Change of Use

This section requires that the territorial authority is satisfied that the building with a new use complies with the relevant sections of the Building Code ‘as near as is reasonably practicable’.

This is typically interpreted by territorial authorities as being 67% of the strength of an equivalent new building or as near as practicable. This is also the minimum level recommended by the New Zealand Society for Earthquake Engineering (NZSEE).

Section 121 – Dangerous Buildings

This section was extended by the Canterbury Earthquake (Building Act) Order 2010, and defines a building as dangerous if:

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a ‘moderate earthquake’ (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or
5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone (EPB) if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property.

A moderate earthquake is defined by the building regulations as one that would generate loads 33% of those used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

This section gives the territorial authority the power to require strengthening work within specified timeframes or to close and prevent occupancy to any building defined as dangerous or earthquake prone.

Section 131 – Earthquake Prone Building Policy

This section requires the territorial authority to adopt a specific policy for earthquake prone, dangerous and insanitary buildings.

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake on 4 September 2010.

The 2010 amendment includes the following:

1. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
2. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
3. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
4. Repair works for buildings damaged by earthquakes will be required to comply with the above.

The council has stated their willingness to consider retrofit proposals on a case by case basis, considering the economic impact of such a retrofit.

If strengthening works are undertaken, a building consent will be required. A requirement of the consent will require upgrade of the building to comply 'as near as is reasonably practicable' with:

- The accessibility requirements of the Building Code.
- The fire requirements of the Building Code. This is likely to require a fire report to be submitted with the building consent application.

Where an application for a change of use of a building is made to Council, the building will be required to be strengthened to 67% of New Building Standard or as near as is reasonably practicable.

2.4 Building Code

The Building Code outlines performance standards for buildings and the Building Act requires that all new buildings comply with this code. Compliance Documents published by The Department of Building and Housing can be used to demonstrate compliance with the Building Code.

On 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

- increase in the basic seismic design load for the Canterbury earthquake region (Z factor increased to 0.3 equating to an increase of 36 – 47% depending on location within the region);
- Increased serviceability requirements.

2.5 Institution of Professional Engineers New Zealand (IPENZ) Code of Ethics

One of the core ethical values of professional engineers in New Zealand is the protection of life and safeguarding of people. The IPENZ Code of Ethics requires that:

Members shall recognise the need to protect life and to safeguard people, and in their engineering activities shall act to address this need.

1.1 Giving Priority to the safety and well-being of the community and having regard to this principle in assessing obligations to clients, employers and colleagues.

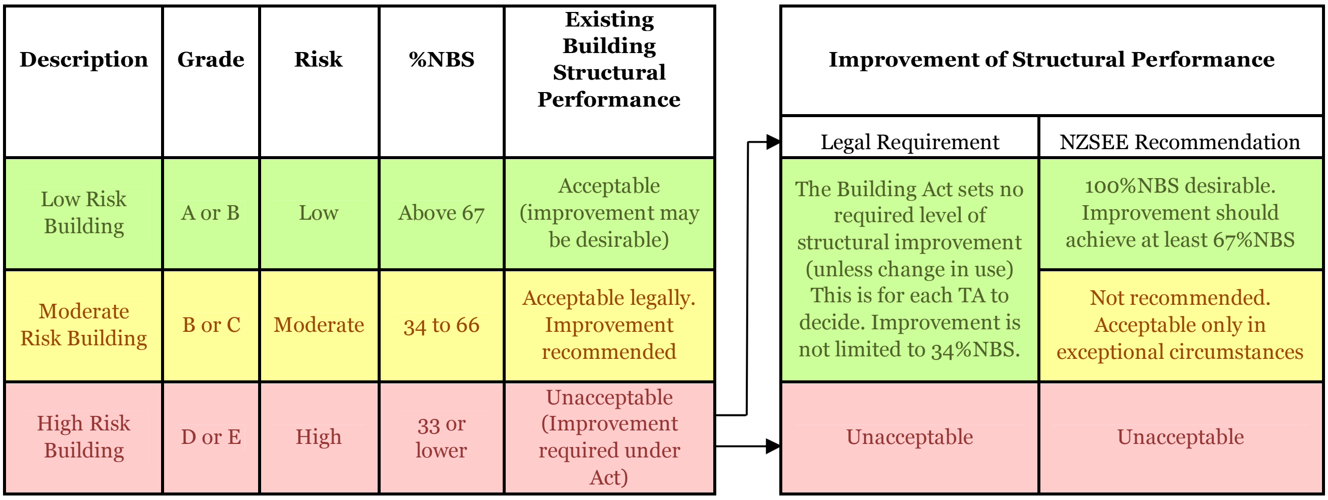
1.2 Ensuring that responsible steps are taken to minimise the risk of loss of life, injury or suffering which may result from your engineering activities, either directly or indirectly.

All recommendations on building occupancy and access must be made with these fundamental obligations in mind.

3 Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The loadings are in accordance with the current earthquake loading standard NZS1170.5 [1].

A generally accepted classification of earthquake risk for existing buildings in terms of %NBS that has been proposed by the NZSEE 2006 [2] is presented in Figure 1 below.



Description	Grade	Risk	%NBS	Existing Building Structural Performance	Improvement of Structural Performance	
					Legal Requirement	NZSEE Recommendation
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)	The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended		Not recommended. Acceptable only in exceptional circumstances
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement required under Act)	Unacceptable	Unacceptable

Figure 1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table 1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year).

Table 1: %NBS compared to relative risk of failure

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

3.1 Minimum and Recommended Standards

Based on governing policy and recent observations, Opus makes the following general recommendations:

3.1.1 Occupancy

The Canterbury Earthquake Order[1] in Council 16 September 2010, modified the meaning of "dangerous building" to include buildings that were identified as being EPB's. As a result of this, we would expect such a building would be issued with a Section 124 notice, by the Territorial Authority, or CERA acting on their behalf, once they are made aware of our assessment. Based on information received from CERA to date and from the DBH guidance document dated 12 June 2012 [6], this notice is likely to prohibit occupancy of the building (or parts thereof), until its seismic capacity is improved to the point that it is no longer considered an EPB.

3.1.2 Cordoning

Where there is an overhead falling hazard, or potential collapse hazard of the building, the areas of concern should be cordoned off in accordance with current CERA/territorial authority guidelines.

3.1.3 Strengthening

Industry guidelines (NZSEE 2006 [2]) strongly recommend that every effort be made to achieve improvement to at least 67%NBS. A strengthening solution to anything less than 67%NBS would not provide an adequate reduction to the level of risk.

It should be noted that full compliance with the current building code requires building strength of 100%NBS.

3.1.4 Our Ethical Obligation

In accordance with the IPENZ code of ethics, we have a duty of care to the public. This obligation requires us to identify and inform CERA of potentially dangerous buildings; this would include earthquake prone buildings.

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[1] This Order only applies to buildings within the Christchurch City, Selwyn District and Waimakariri District Councils authority

4 Building Description

4.1 General

The Richmond Park Pavilion building is a single storey structure with 200mm thick reinforced concrete masonry internal and external walls. The kitchen area in the northern part of the building has timber framed internal walls. The roof is comprised of a timber A-frame truss system spanning in the transverse direction, supporting timber sarking above and corrugated iron roof sheeting. The structure has a concrete slab on grade and is assumed to be a 1970s or 1980s construction.

The structure is located in Richmond Park and is primarily used as a sports pavilion, and changing room with toilet facilities.

The building structure is approximately 20.4m long in the north-south direction and approximately 5.4m in the east-west direction with a 1.3m wide veranda at the western and southern side. The height of the masonry walls are approximately 2.5m.

The northern part of the building has a ceiling lining, which is boxed down adjacent to the wall locations (refer to photos in Appendix A,) and tapers to create a high flat ceiling in the centre of the building. This ceiling lining is not expected to transfer horizontal loads due to the possibility of the joints failing at the tapered locations.

The building has no ceiling level linings or diaphragms in other parts of the building to provide restraint to the top of the internal cross walls.

Refer to Appendix B for the floor plan of the building.

4.2 Gravity Load Resisting System

The roof of the building structure is a lightweight corrugated roofing supported on A-frame timber trusses. The connection of the trusses to the timber top plate appears to be adequate. The timber top plate is bolted to the masonry wall.

The gravity loads are transferred to the foundation via the reinforced masonry walls.

4.3 Seismic Load Resisting System

Lateral support for the roof is provided by the sarked timber trusses and the reinforced masonry walls in the longitudinal direction (north-south) and transverse direction (east-west).

5 Survey

No copies of the original design calculations or drawings have been obtained for this building.

Opus has previously carried out level 1 Rapid assessment on the building on 14 April 2011, where a green placard (G2) was assigned.

We carried out site visits on 3 July and 3 September 2012 to identify the structural systems of the building and to note any critical structural weaknesses and any damage resulting from the February 2011 earthquake.

The building structure was inspected and measured. The presence of reinforcement within the concrete masonry walls has been confirmed through survey with a cover meter, giving a bar size of 10mm diameter.

Layout drawings were prepared by Opus. The layout drawings produced by Opus have been used to investigate potential critical structural weaknesses (CSW) wherever possible, and to identify details which require particular attention.

6 Damage Assessment

The building appears to have suffered only minor damage as a result of the recent earthquake events. The following damage has been noted:

6.1 Cracking

We observed the following cracks:

- multiple hairline cracks in the concrete slab forming the raised patio on the western side;
- hairline crack in the concrete slab in the changing rooms;
- a number of moderate vertical cracks (up to 1.5mm wide) on the eastern wall;
- cracks in the ceiling lining seam in the northern part of the building; and
- cracking of lintel beams and window sills.

7 General Observations

There was evidence of liquefaction around the building, with approximately 70mm vertical settlement of pavers adjacent to the raised patio. We were advised by the President of the Cricket Club that liquefaction also occurred inside the northern part of the building (this was not observed by Opus). The floor was newly carpeted in the northern part of the building at the time of inspection and therefore the extent of cracks or repairs (if any) could not be inspected.

Overall the building has performed well under the recent seismic conditions. The building has sustained little damage and continues to be fully operational.

Due to the non-intrusive nature of the original survey, many connection details could not be inspected.

8 Detailed Seismic Assessment

8.1 Critical Structural Weaknesses

As outlined in the Critical Structural Weakness and Collapse Hazards draft briefing document, issued by the Structural Engineering Society (SESOC) on 7 May 2011, the term 'Critical Structural

Weakness' (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of the building.

We have not identified any critical structural weaknesses in the building.

8.2 Seismic Coefficient Parameters

The seismic design parameters based on current design requirements from NZS1170.5:2004 and the NZBC clause B1 for this building are:

- Site soil class D, clause 3.1.3 NZS 1170.5: 2004.
- Site hazard factor, Z=0.3, B1/VM1 clause 2.2.14B.
- Return period factor R_u = 1.0 from Table 3.5, NZS 1170.5: 2004, for an Importance Level 2 structure with a 50 year design life.
- Ductility factor μ_{max} = 1.25 for the reinforced concrete masonry building.

8.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in Table 2. Note that the values given represent the worst performing elements in the building, as these effectively define the building's capacity. Other elements within the building may have significantly greater capacity when compared with the governing element.

Table 2: Summary of Seismic Performance

Structural Element/System	Description/Discussion	% NBS based on calculated capacity
External masonry walls in the E-W direction	In-plane shear and bending, and out-of-plane bending capacity	100%
External masonry walls in the N-S direction	In-plane shear and bending, and out -of-plane bending capacity	100%
Internal masonry walls	In-plane shear and bending capacity	100%
Internal masonry walls (N-S)	Out-of-plane bending capacity	44%

8.4 Discussion of Results

The building has a calculated capacity of greater than 33%NBS with the capacity being limited by the out-of-plane bending capacity of the internal masonry cross walls due to the absence of ceiling diaphragms providing support to the top of the walls. These masonry walls have been analysed as cantilevered walls.

The %NBS of the building is above the threshold limit for buildings classified as 'earthquake prone', which is effectively one third (33%) of the seismic performance specified in the current loading standard for new buildings, but below 67%NBS. The building falls under the category of being 'earthquake risk', with a moderate risk profile.

As the occupancy levels and duration is likely to be low, based on the NZSEE guidelines included in Figure 1, the building can be classified as a moderate risk building and its normal occupancy should be unaffected.

We have assumed that the connection of the trusses to the walls is adequate to allow transfer of lateral loads of at least those associated with the assessed %NBS lateral loading for the structure. This assumption is based on site visits and the performance of the building in recent seismic events.

The reinforcement spacing in the masonry wall was determined using a cover meter and found at 800mm centres for the external walls and 600mm centres for the internal walls. The reinforcement size was determined by the cover meter as 10mm diameter. It must be noted that reinforcement bars larger than 10mm diameter will produce a higher %NBS. Limited breakout of the masonry wall could be undertaken to accurately determine the size of the reinforcement and confirm this assessment.

8.5 Limitations and Assumptions in Results

The observed level of damage suffered by the buildings was deemed low enough to not affect their capacity. Therefore the analysis and assessment of the buildings was based on them being in an undamaged state. There may have been damage to the buildings that was unable to be observed during assessments that could cause the capacity of the buildings to be reduced; therefore the current capacity of the buildings may be lower than that stated.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- simplifications made in the analysis, including boundary conditions such as foundation fixity;
- assessments of material strengths based on the unavailability of drawings, and site inspections;
- the normal variation in material properties which change from batch to batch; and
- approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

9 Geotechnical Assessment

A summary of the Geotechnical Desktop Study for the site is shown in this section.

A full Geotechnical Desktop Study for the Richmond Park Pavilion Building, dated 25 June 2012, is attached in Appendix C.

9.1 Regional Geology

The published geological map of the area, (Brown & Webber, 1992) indicates the site is underlain predominantly by alluvial sand and silt overbank deposits belonging to the Yaldhurst Member of the Springston Formation. A groundwater table depth of approximately 1m has been shown on the published map.

9.2 Expected Ground Conditions

A review of the Environmental Canterbury Wells database (ECan, 2012) showed two wells located within approximately 150m of the pavilion. Material logs available from these wells, in addition to the EQC investigations, have been used to infer the ground conditions at the site as shown in Table 3 below.

Table 3: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered from (m) below ground
SILT/CLAY/SAND	3.2m to 4.4m	Surface
CLAY/SAND	15.0m to 28.6	Surface to 4.4m
Gravelly SAND	1.8m to 5.1m	6.5m to 11.6m
Riccarton GRAVEL Formation	-	25.9m to 28.6m

The groundwater level as recorded in the previous investigations is between 2.5m-2.8m bgl, however in the ECan boreholes, M35_1995 and M35_2282, artesian pressures were recorded in the Riccarton GRAVEL Formation.

9.3 Liquefaction Hazard Study

The Environment Canterbury Solid Facts Liquefaction Study (ECan, 2004) indicates the site is in an area designated as having 'high liquefaction ground damage potential'. According to this study, based on a low groundwater table, ground damage from liquefaction is expected to be significant and is likely to be affected by greater than 300mm of ground subsidence.

Examination of post-earthquake aerial photographs taken by New Zealand Aerial Mapping (Project Orbit, 2012) identified significant quantities of liquefied soils ejected at the ground surface of the site after the 22 February 2011, 13 June 2011 and 23 December 2011 events. No liquefied soils were ejected after the 4 September 2010 event.

The Tonkin and Taylor Reconnaissance (Project Orbit, 2012) also indicated evidence of liquefaction was observed at the site after the 22 February 2011 and 13 June 2011 events.

The land at Richmond Park has been zoned as N/A-Urban Non-residential, as it is not a residential dwelling. Neighbouring residential properties southeast of the site have been zoned as 'red' which is evaluated as not being practical to rebuild, repair or reoccupy. Properties to the north, south and west of the site have been zoned as Green-TC3 'blue zone', which is determined to have a moderate to significant risk of land damage due to liquefaction in future significant earthquakes.

The Pavilion is on relatively flat ground approximately 130m east of Dudley Stream; therefore the risk of lateral spreading affecting this location is low

9.4 Discussion and Recommendation of Geotechnical Assessment

Due to the 130m setback distance of the building to Dudley Stream, and the relatively flat topography, lateral spreading is not considered to be an issue. It is difficult to quantify global or differential settlement of the existing concrete floor slab of the Pavilion by visual inspection. It is recommended to complete a level survey to quantify the performance of the slab and foundations in the recent earthquake events.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet, 2012) indicates there is a 14% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause liquefaction induced land damage at the site similar to that experienced; dependent on the location of the earthquake's epicentre. This confirms that there is currently a significant risk of liquefaction and ground settlements occurring at the site. It is expected that the probability of recurrence is likely to decrease with time, following periods of reduced seismic activity.

The following works are recommended:

- A level survey is recommended to determine if the concrete floor slab has settled differentially, and to quantify the magnitude of settlement.
- Depending on the results of the level survey, further site specific investigations may be required.
- The existing foundations appear to have performed reasonably well. Provided the results of the level survey indicate the foundation has not settled beyond serviceability limits, further investigations are not deemed necessary and repair of the cracks in the slab can be carried out.

10 Conclusions

(a) The building has a seismic capacity of 44%NBS and is therefore classed as grade C, moderate risk and has a relative risk of failure of approximately 8 times that of a building complying with current codes.

(b) The seismic capacity is governed by the out-of-plane bending capacity of the internal masonry cross walls, due to the absence of ceiling diaphragm providing support to the top of the wall.

(c) As the occupancy levels and duration is likely to be low, based on the NZSEE guidelines included in Figure 1, the building can be classified as a moderate risk building and its normal occupancy should be unaffected.

11 Recommendations

(a) Carry out a levels survey to determine if the concrete floor slab has settled differentially and to quantify the magnitude of settlement.

(b) Strengthening schemes be developed to increase the seismic capacity of the building to at least 67%NBS.

12 Limitations

(a) This report is based on an inspection of the structure with a focus on the damage sustained from the 22 February 2011 Canterbury Earthquake and aftershocks only. Some non-structural damage is mentioned but this is not intended to be a comprehensive list of non-structural items.

(b) Our professional services are performed using a degree of care and skill normally exercised under similar circumstances by reputable consultants practicing in this field at the time.

(c) This report is prepared for the CCC to assist with assessing remedial works required for council buildings and facilities. It is not intended for any other party or purpose.

13 References

[1] NZS 1170.5: 2004, *Structural design actions, Part 5 Earthquake actions,* Standards New Zealand.

[2] NZSEE: 2006, *Assessment and improvement of the structural performance of buildings in earthquakes,* New Zealand Society for Earthquake Engineering.

[3] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure*, Draft Prepared by the Engineering Advisory Group, Revision 5, 19 July 2011.

[4] Engineering Advisory Group, *Guidance on Detailed Engineering Evaluation of Non-residential buildings, Part 3 Technical Guidance*, Draft Prepared by the Engineering Advisory Group, 13 December 2011.

[5] SESOC, *Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes*, Structural Engineering Society of New Zealand, 21 December 2011.

Appendix A – Photographs

Photo 1: Western wall.

Photo 2: Southern wall.

Photo 3: Northern wall.

Photo 4: Typical view of roof truss in toilet area.

Photo 5: Typical truss connection to top plate.

Photo 6: Typical view of the changing area and roof arrangement.

Photo 7: View of ceiling in the northern part of structure.

Photo 8: Cracking of ceiling seam.

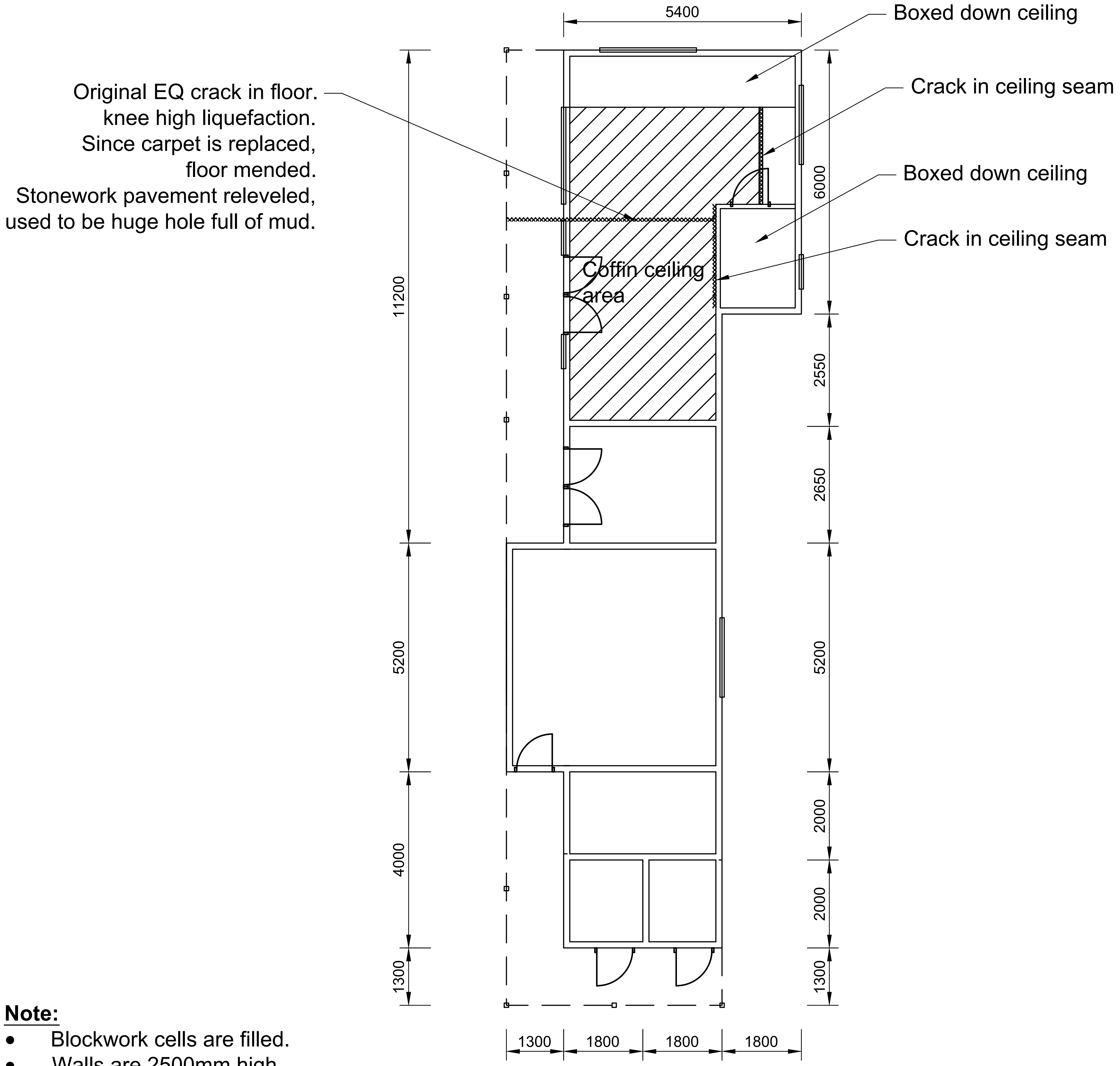
Photo 9: Cracks on slab on western side. Note settlement of paving due to liquefaction.

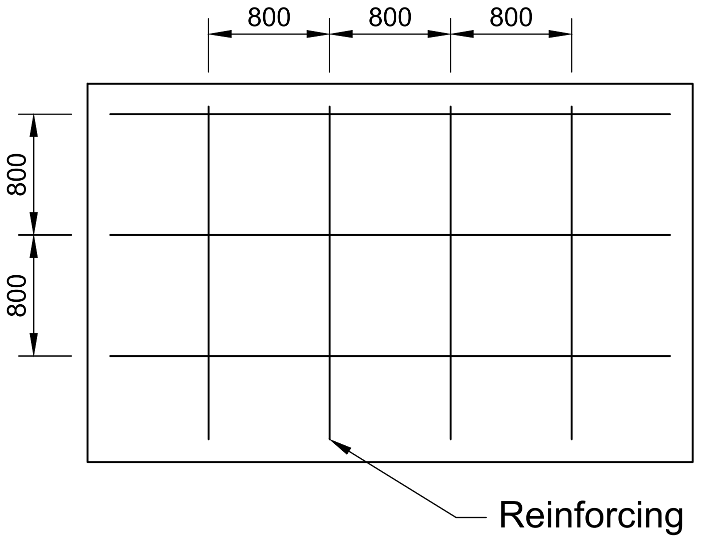
Photo 10: Vertical cracks on eastern wall (approx. 1.5mm wide).

Photo 11: Cracking of sill below window opening.

Photo 12: Vertical crack on wall.

Appendix B – Floor Plans





2 -

External Wall Reinforcing Detail

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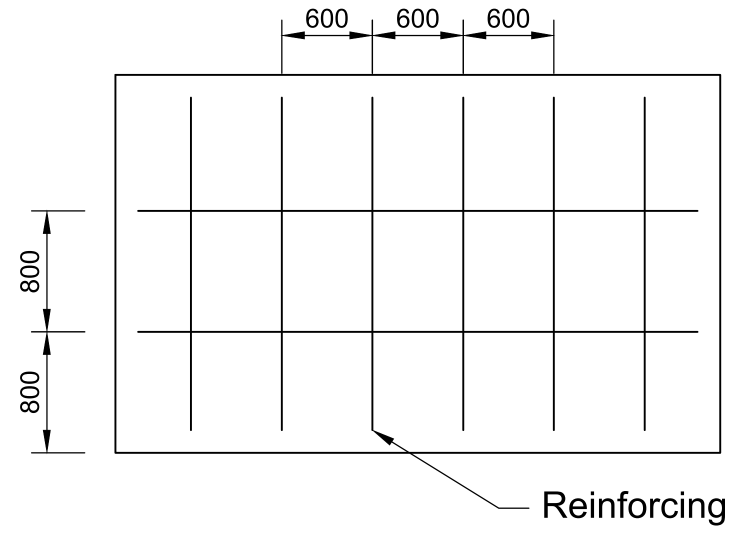

3 -

Internal Wall Reinforcing Detail

Scale: 1:50

Note:

- Blockwork cells are filled.
- Walls are 2500mm high.
- External walls are reinforced as shown on detail 2.
- Internal walls are reinforced as shown on detail 3.

1:1 @ A3 0 10 20 30 40 mm

Construction Details

Revision	Amendment	Approved	Revision Date

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A.S			19.09.2012

Project No. 6/1366/289/8602
Scale As Shown @ A3

Project
Christchurch City Council
Richmond, Christchurch 8013
Richmond Park Pavilion - Toilets

Sheet
Layout & Wall Reinforcing

Drawing No.	Sheet. No.	Revision
6-QUCC1.18	200	R0

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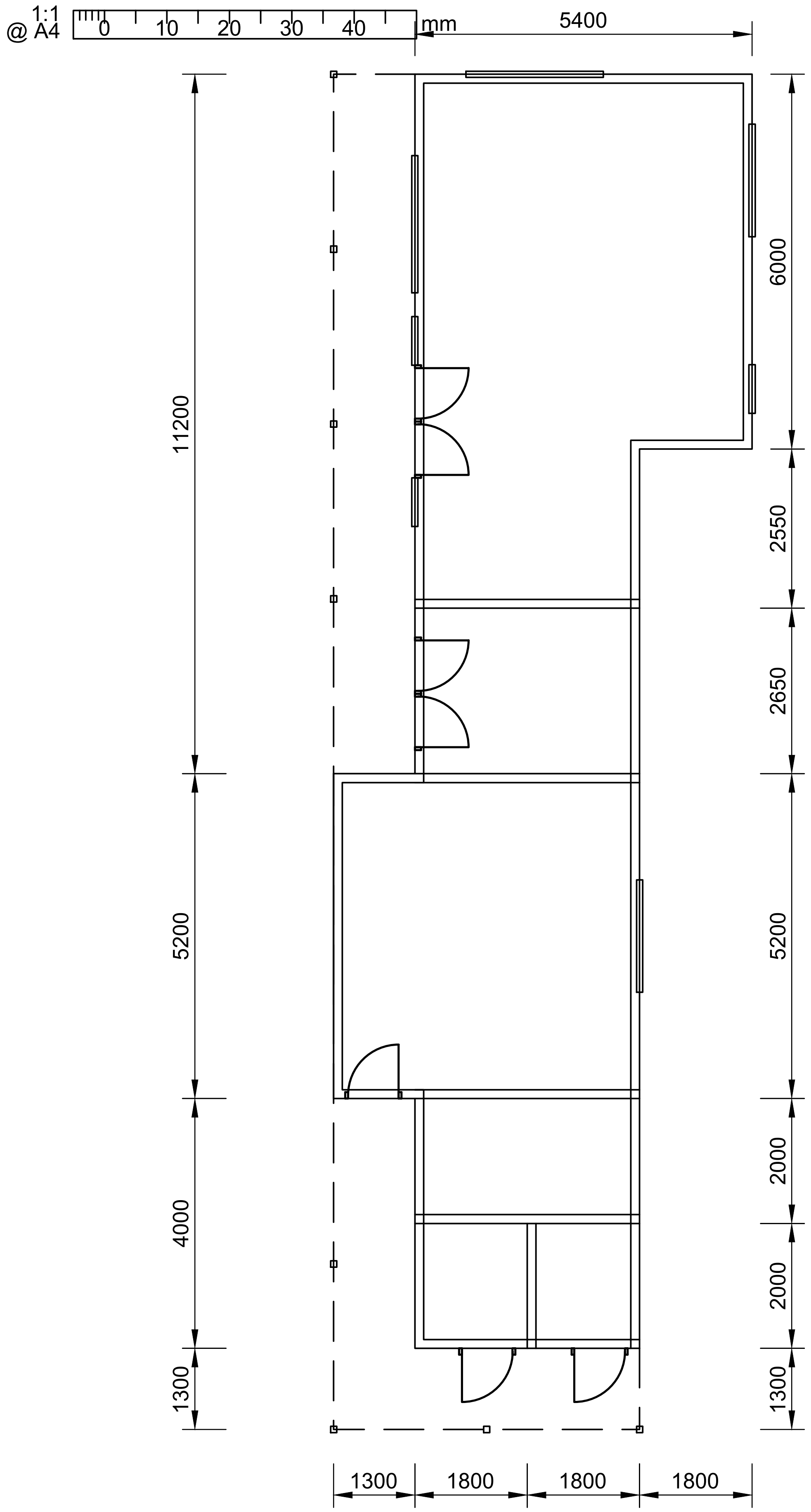

OPUS

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Project
Richmond Park Pavillion
Christchurch
####

Sheet
Existing plan
####

Revision	Amendment	Approved	Date

Drawn	Designed	Approved	Revision Date
			####

Project No.	Scale	Drawing No.	Sheet. No.	Revision
PRK 0671	1:100	####	201	####

Original Sheet Size A4 [210x297] Plot Date

Appendix C – Geotechnical Appraisal

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18 December 2012

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6-QUCCC1.18/005SC

Richmond Park Pavilion – Geotechnical Desktop Study

1. Introduction

The Christchurch City Council (CCC) has requested Opus International Consultants (Opus) to provide a Geotechnical Desktop Study and walkover inspection of the Richmond Park Pavilion following the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

The purpose of this Geotechnical Desktop Study is to collate existing subsoil information, assess the current ground conditions and the potential geotechnical hazards, and determine whether further subsurface geotechnical investigations are necessary.

This Geotechnical Desktop Study has been prepared in accordance with the Engineering Advisory Group's Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Revision 5, 19 July 2011.

This Geotechnical Desktop Study forms part of a Detailed Engineering Evaluation prepared by Opus and has been undertaken without the benefit of any site specific investigations and is therefore preliminary in its nature.

2. Desktop Study

2.1 Site Description

The Richmond Park Pavilion is situated in Richmond Park, 3km north east of the Christchurch Central Business District on relatively flat ground. The building is located approximately 130m west of Dudley Stream at its nearest point and is approximately 300m north of the Avon River.

Refer to the Site Location Plan in Appendix A.

2.2 Available Structural Drawings

No structural drawings were available for review at the time of preparing this report.

Based upon observations made during the site walkover inspection, the Richmond Park Pavilion appears to be a single storey building of concrete block construction, with timber roof trusses clad in corrugated iron sheets. The foundations appear to be a shallow perimeter strip footing with slab on grade.

2.3 Regional Geology

The published geological map of the area, (Brown & Webber, 1992) indicates the site is underlain predominantly by alluvial sand and silt overbank deposits belonging to the Yaldhurst Member of the Springston Formation. A groundwater level is approximately 1m below ground level (bgl) as shown on the Brown and Webber map.

2.4 Expected Ground Conditions

Four Cone Penetrometer Tests (CPT's) have been completed within 230m of the site by Tonkin and Taylor, on behalf of the Earthquake Commission (EQC). One borehole within 300m of the site has also been completed for the EQC.

A review of the Environmental Canterbury Wells database (ECan, 2012) showed two wells located within approximately 150m of the Richmond Park Pavilion. Material logs available from these wells in addition to the EQC investigations have been used to infer the ground conditions at the site as shown in Table 1 below.

Refer to Appendix B for the Previous Investigation logs.

Table 1: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered from (m) below ground
SILT/CLAY/SAND	3.2m to 4.4m	Surface
CLAY/SAND	15.0m to 28.6	Surface to 4.4m
Gravelly SAND	1.8m to 5.1m	6.5m to 11.6m
Riccarton GRAVEL Formation	-	25.9m to 28.6m

The groundwater level as recorded in the previous investigations is between 2.5m-2.8m bgl, however in the ECan boreholes, M35_1995 and M35_2282, artesian pressures were recorded in the Riccarton GRAVEL Formation.

2.5 Liquefaction Hazard

The Environment Canterbury Solid Facts Liquefaction Study (ECan, 2004) indicates the site is in an area designated as having 'High liquefaction ground damage potential'. According to this study, based on a low groundwater table, ground damage from liquefaction is expected to be significant and is likely to be affected by greater than 300mm of ground subsidence.

Examination of post-earthquake aerial photographs taken by New Zealand Aerial Mapping (Project Orbit, 2012) identified significant quantities of liquefied soils ejected at the ground surface of the site after the 22 February 2011, 13 June 2011 and 23 December 2011 events. No liquefied soils were ejected after the 4 September 2010 event. Refer to Appendix C for an aerial photo of the site taken post 22 February 2011 earthquake.

The Tonkin and Taylor Reconnaissance (Project Orbit, 2012) also indicated evidence of liquefaction was observed at the site after the 22 February 2011 and 13 June 2011 events.

Following the recent strong earthquakes in Canterbury, the Canterbury Earthquake Recovery Authority (CERA, 2012) has zoned land in the Greater Christchurch area according to its ground performance in future large earthquakes (refer Appendix C).

The Department of Building and Housing has sub-divided the CERA "Green" residential recovery zone land on the flat in Christchurch into technical categories. The three technical categories are summarised in Table 2 which has been adapted from the Department of Building and Housing guidance document (DBH, 2011).

Table 2: Technical Categories based on Expected Land Performance

Foundation Technical Category	Future land performance expected from liquefaction	Expected SLS land settlement	Expected ULS land settlement
TC 1	Negligible land deformations expected in a future small to medium sized earthquake and up to minor land deformations in a future moderate to large earthquake.	0-15 mm	0-25 mm
TC 2	Minor land deformations possible in a future small to medium sized earthquake and up to moderate land deformations in a future moderate to large earthquake.	0-50 mm	0-100 mm
TC 3	Moderate land deformations possible in a future small to medium sized earthquake and significant land deformations in a future moderate to large earthquake.	>50 mm	>100 mm

The land at Richmond Park has been zoned as N/A-Urban Non-residential, as it is not a residential dwelling. Neighbouring residential properties southeast of the site have been zoned as "Red" which is evaluated as not being practical to rebuild, repair or reoccupy. Properties to the north, south and west of the site have been zoned as Green-TC3 ("blue zone"), which is determined to have a moderate to significant risk of land damage due to liquefaction in future significant earthquakes.

The Richmond Park Pavilion is on relatively flat ground approximately 130m west of Dudley Stream; therefore the risk of lateral spreading affecting this location is low.

3. Site Walkover Inspection

A walkover inspection of the exterior of the Richmond Park Pavilion and surrounding land was carried out by an Opus Geotechnical Engineer. The following observations were made:

- Approximately 70mm of heave has occurred under the pavers adjacent to the raised patio on the western side of the building;
- Multiple hairline cracks in the concrete slab forming the raised patio on the western side of the building;
- Misaligned and tilting pavers;
- Hairline crack in the concrete slab of the changing rooms;
- A 1.5mm wide crack down the external concrete block wall on the eastern side of the building;
- Numerous areas of ejected liquefied silt/sand adjacent to the eastern, southern and western walls of the Pavilion;
- No evidence of lateral spreading was observed at the site.

Refer to Appendix D for the Site Walkover Plan.

4. Discussion

Past literature studies predicted that the land at Richmond Park has a high liquefaction ground damage potential during seismic events. Post-earthquake aerial photos and observations have confirmed that significant volumes of liquefied soils were ejected at the site during the 22 February 2011, 13 June 2011 and 23 December 2011 earthquake events.

Due to the 130m setback distance of the building from Dudley Stream and the relatively flat topography, lateral spreading is not considered to be an issue.

The Richmond Park Pavilion has sustained damage as a result of the Canterbury earthquake sequence commencing 4 September 2010. Minor cracking of the concrete floor slab and concrete block work has occurred. The Richmond Park Pavilion is of a similar structural form to a residential structure. Accordingly, recommendations in the Department of Building and Housing New Zealand guidance documents for repairing and rebuilding foundations in Technical Category 3 (DBH, 2012) are likely to be applicable for the building.

It is difficult to quantify the global or differential settlement of the existing concrete floor slab of the Richmond Park Pavilion by visual inspection. It is recommended to complete a level survey to quantify the performance of the slab and foundations in the recent earthquake events. The observed cracks in the concrete slab appear to be minor, however, if the existing shallow foundations are retained, it is likely that in a future Serviceability Limit State (SLS) and Ultimate Limit State (ULS) earthquake, liquefaction induced subsidence at the site may occur.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the Canterbury earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet, 2012) indicates there is a 12% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause liquefaction induced land damage at the site similar to that experienced, dependent on the location of the epicentre of the earthquake. This confirms that there is currently a significant risk of liquefaction and ground damage at the site. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity.

5. Recommendations

- A level survey is recommended to determine if the concrete floor slab has settled differentially, and to quantify the magnitude of settlement.
- Depending on the results of the level survey, further site specific investigations may be required.
- The existing foundations appear to have performed reasonably well. Provided the results of the level survey indicate the foundation has not settled beyond serviceability limits, further investigations are not deemed necessary and repair of the cracks in the slab can be carried out.

6. Limitation

This report has been prepared solely for the benefit of the Christchurch City Council as our client with respect to the brief. The reliance by other parties on the information or opinions contained in the report shall, without our prior review and agreement in writing, be at such parties' sole risk.

It is recognised that the passage of time affects the information and assessment provided in this Document. The recommendations formed in this report are based upon information that existed at the time of production of the Desktop Study. It is understood that the services provided allowed Opus to form no more than an opinion on the actual conditions of the site at the time the site was visited and cannot be used to assess the effect of any subsequent changes in the quality of the site, or its surroundings or any laws or regulations.

7. References

Brown, LJ; Webber, JH (1992). Geology of the Christchurch Urban Area. Scale 1:25,000. Institute of Geological and Nuclear Sciences geological map 1.

Canterbury Earthquake Recovery Authority (CERA). *Land Zone Map*. (2012-last update). [Online]. Available: http://www.rebuildchristchurch.co.nz/content/land-zone-map [2012, November 22]

Department of Building and Housing New Zealand (2011) *Revised guidance on repairing and rebuilding houses affected by the Canterbury earthquake sequence.*

Department of Building and Housing New Zealand (2012) *Appendix C: Interim guidance for repairing and rebuilding foundations in Technical Category 3.*

Environment Canterbury (ECan), Canterbury Regional Council (2004) *The Solid Facts on Christchurch Liquefaction.*

Environment Canterbury (ECan), Canterbury Regional Council, *Well Card Search* [Online], Available: http://ecan.govt.nz/services/online-services/tools-calculators/Pages/well-card.aspx [2012, November 22]

Geonet. *Canterbury region long-term probabilities* (14 November 2012-last update). [Online], Available: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ [2012, November 22]

Project Orbit, *Interagency/organisation collaboration portal for Christchurch recovery effort* (2012-last update) [Online] Available: https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx [2012, November 22]

Figures:

Site Photographs

List of Appendices:

Appendix A: Site Location Plan

Appendix B: Previous Investigations

Appendix C: CERA Land Recovery Zones

Appendix D: Site Walkover Inspection Plan

Photographs Richmond Park Pavilion.

Photograph 1. View of western and southern walls of Pavilion.

Photograph 2. Ejected silts and sands, looking towards the north.

Photograph 3. View along western wall, showing ejected silts and sands.

Photograph 4. View along eastern wall, showing ejected silts and sands.

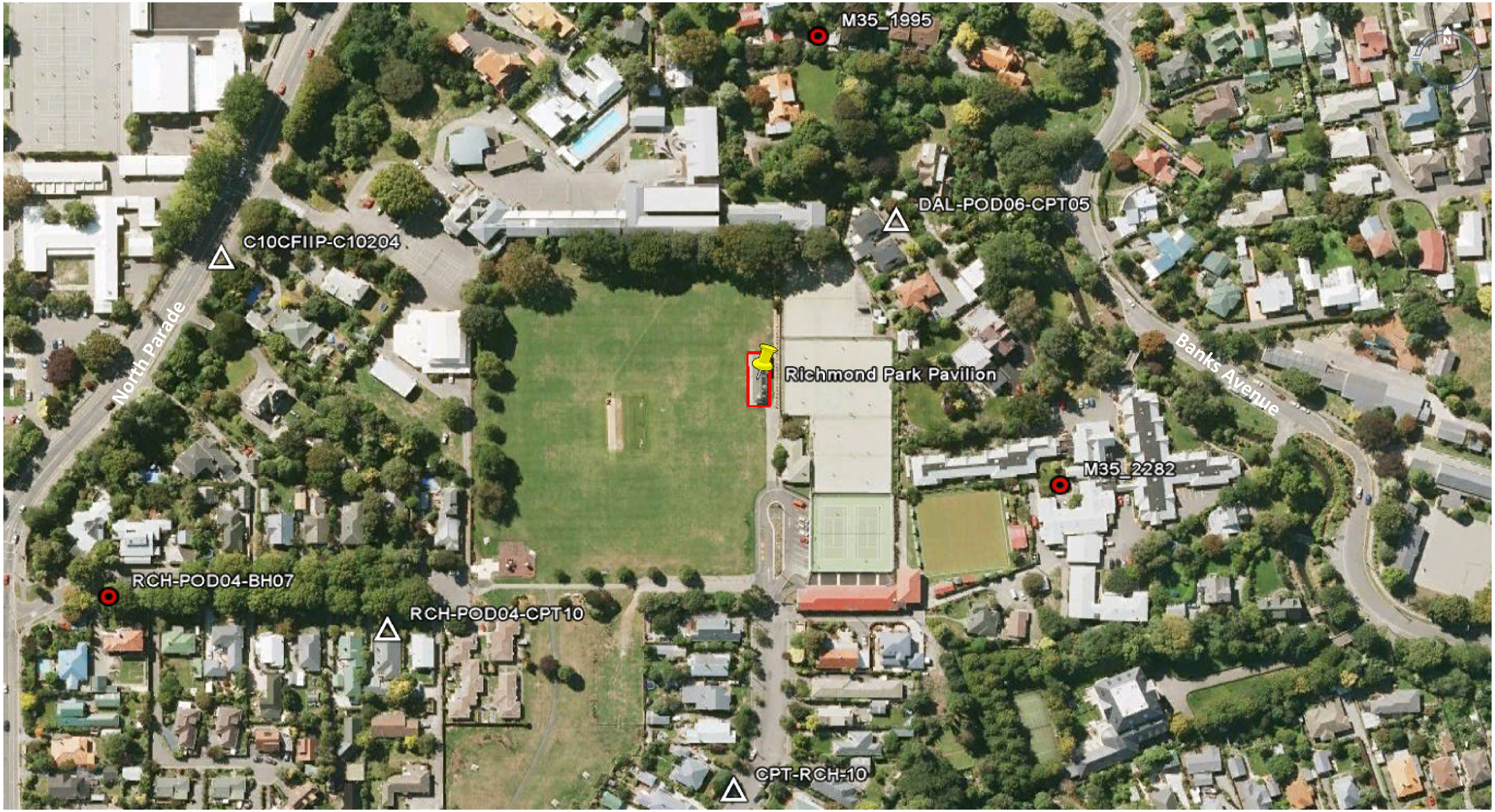
Photograph 5. 1.5mm wide crack in eastern external concrete block work.

Photograph 6. Approximately 70mm heave of the pavers adjacent to the raised patio (western side of pavilion).

Photograph 7. Typical hairline crack through concrete slab along raised patio.

Photograph 8. Hairline crack along concrete slab in changing rooms.

Appendix A:
Site Location Plan



KEY:

△ CPT Location

● Borehole Location

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 19/06/12)

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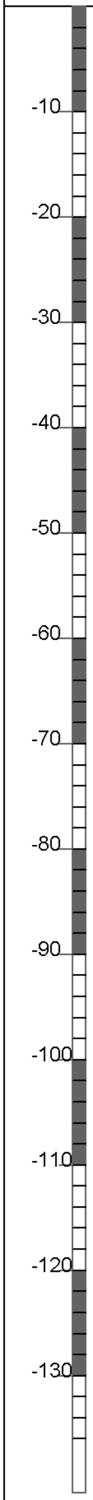
Project: Richmond Park Pavilion
Geotechnical Desktop Study
Project No: 6-QUCCC1.18
Client: Christchurch Ciy Council

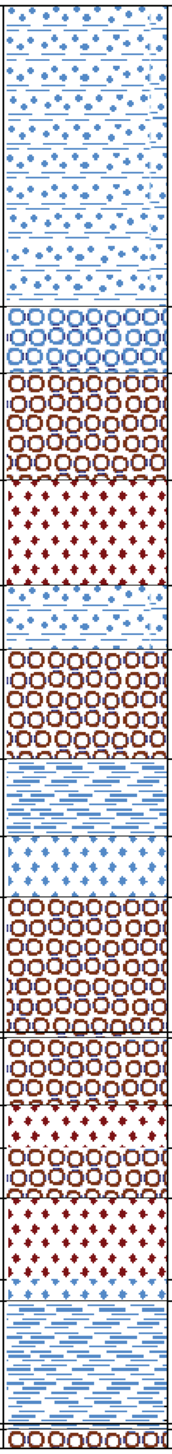
Site Location Plan

Appendix B:
Previous Investigations

Borelog for well M35/1995

Gridref: M35:829-440 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.4 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -137.1m Drill Date : 1/05/1926

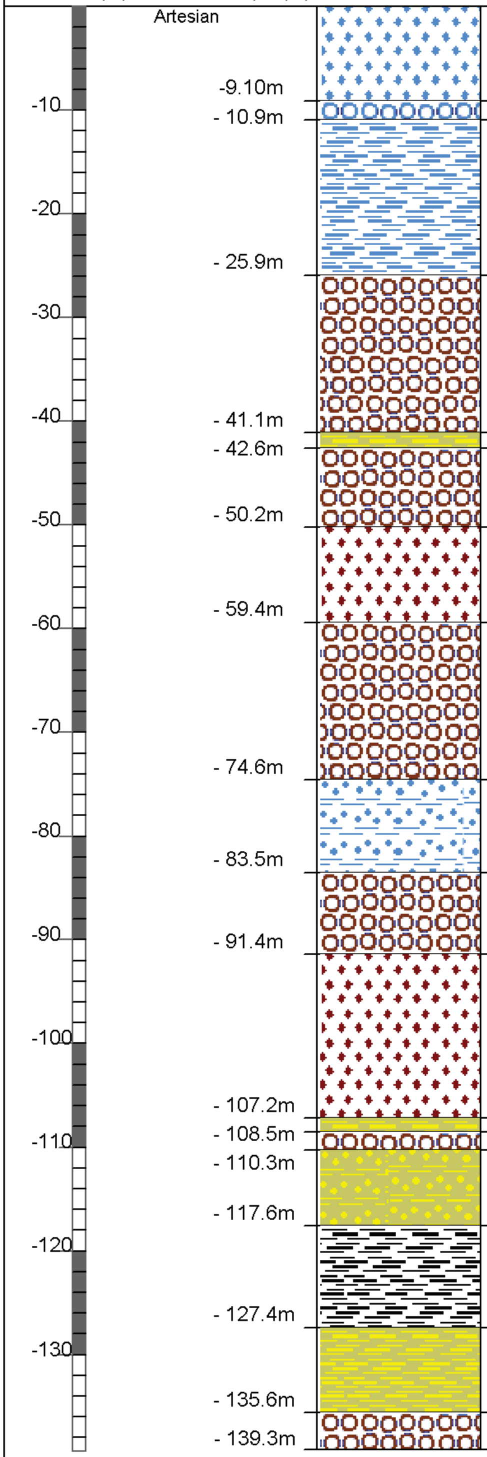




Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 28.6m	Blue clay and sand	sp-ch
	- 34.9m	Blue shingle - water at 32.3m rising 0.9m	ri
	- 45.1m	Brown shingle - water at 42.6m rising 0.9m	ri
	- 55.1m	Brown sand	br
	- 61.2m	Blue clay and sand	br
	- 71.6m	Brown shingle - water at 64.0m rising 4.8m	li-1
	- 78.9m	Blue clay	li-2
	- 84.7m	Blue sand	li-2
	- 97.5m	Brown shingle - water at 87.1m rising 5.7m	li-3
	- 98.1m	Brown sand	he
	- 104.5m	Brown shingle - water at 100.5m rising 5.7m	he
	- 108.5m	Brown sand	he
	- 113.3m	Brown shingle	bu
	- 121.0m	Brown sand	sh
	- 123.1m	Blue sand	sh
	- 134.7m	Blue clay	sh
	- 135.3m	Yellow clay	sh
	- 141.1m	Brown shingle - water flows 393m3/d and rises 9.4m	wa

Borelog for well M35/2282

Gridref: M35:830-438 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.3 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -139.2m Drill Date :



Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-9.10m	Blue sand	sp?
	- 10.9m	Blue shingle	sp?
	- 25.9m	Blue clay	ch
	- 41.1m	Brown shingle, water rises 1.5m	ri
	- 42.6m	Yellow clay	br
	- 50.2m	Brown shingle	br
	- 59.4m	Brown sand	br
	- 74.6m	Brown shingle water rise 5.1m	li-1
	- 83.5m	Blue clay & sand	li-2
	- 91.4m	Brown shingle water rise 6.0m	li-3
	- 107.2m	Brown sand	he
	- 108.5m	Yellow clay	he
	- 110.3m	Brown shingle water rise 7.9m	bu
	- 117.6m	Yellow clay & sand	sh
	- 127.4m	Clay	sh
	- 135.6m	Stiff Yellow clay	sh
	- 139.3m	Brown shingle water flows at 1310.0m3/d at surface & rises 10.2m	wa

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH-07
Hole Location:
RCH-POD04-BH07
(8 Poulton Avenue)
SHEET 1 OF 2

PROJECT: CHCH TC3 GEOTECHNICAL INVESTIGATION
LOCATION: RICHMOND
JOB No: 52003.000

CO-ORDINATES: 5743747.25 mN
2482608.21 mE
R.L.: 3.78 m
DATUM: NZMG, MSL (CCC 20/01/12 Datum -9.043m)
DRILL TYPE: Roto-Sonic
DRILL METHOD: PQDT/Auto SPT
DRILL FLUID: LP2000
HOLE STARTED: 11/7/12
HOLE FINISHED: 11/7/12
DRILLED BY: Pro-Drill
LOGGED BY: EC-PLS
CHECKED: BMcD

GEOLOGICAL

GEOLOGICAL UNIT, GENERIC NAME, ORIGIN, MINERAL COMPOSITION.
ASPHALT
FILL
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)

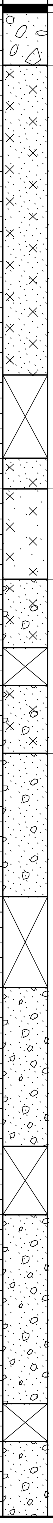
CORE RECOVERY (%)	METHOD	TESTS	SAMPLES
100	PQDT		
100	SPT	1/2//1/2/2/2 N=7	
48	PQDT	*FC2.2	B
100	SPT	2/3//1/1/2/1 N=5	
76	PQDT		
100	SPT	*PSD4.5 1/2//4/5/5/5 N=19	
100	SPT	4/7//5/5/7/7 N=24	
48	PQDT		
100	SPT	5/5//6/7/8/9 N=30	
57	PQDT		
100	SPT	5/6//8/8/9/6 N=31	
76	PQDT		
100	SPT	4/7// 9/10/12/13 N=44	

WATER: ▼ (approx. 2.3 m)

R.L. (m): 3, 2, 1, 0, -1, -2, -3, -4, -5, -6

DEPTH (m): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10

ENGINEERING DESCRIPTION



CLASSIFICATION SYMBOL	MOISTURE CONDITION / WEATHERING	STRENGTH/DENSITY CLASSIFICATION	SOIL DESCRIPTION
			ASPHALT.
GW	M		Sandy fine to coarse GRAVEL, grey, subrounded to rounded, moist, well graded. Sand is fine to coarse.
SM			Silty fine to medium SAND, light brown, moist, poorly graded.
		L	1.5m- brownish grey with orange mottles, loose.
	S		2.3m- grey, saturated. 2.45 to 3.0m- no recovery.
ML		F	SILT with trace sand, grey, firm, saturated, low plasticity. Sand is fine to medium.
SP		L	Fine to medium SAND with minor silt and gravel, grey, loose, saturated, poorly graded. 4.25 to 4.5m- no recovery.
		MD	4.5m- medium dense.
SW			Fine to coarse SAND with trace gravel, grey, medium dense, saturated, well graded. Gravel is fine to medium, rounded. 5.9 to 6.5m- no recovery.
			Gravelly fine to coarse SAND, grey, medium dense, saturated, well graded. Gravel is fine to coarse, rounded. 7.55 to 8.0m- no recovery.
		D	8.0m- dense. 9.25 to 9.50m- no recovery

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BOREHOLE LOG

BOREHOLE No: BH-07
Hole Location:
RCH-POD04-BH07
(8 Poulton Avenue)
SHEET 2 OF 2

PROJECT: CHCH TC3 GEOTECHNICAL INVESTIGATION	LOCATION: RICHMOND	JOB No: 52003.000

CO-ORDINATES	5743747.25 mN 2482608.21 mE	DRILL TYPE: Roto-Sonic	HOLE STARTED: 11/7/12 HOLE FINISHED: 11/7/12
R.L.	3.78 m	DRILL METHOD: PQDT/Auto SPT	DRILLED BY: Pro-Drill
DATUM	NZMG, MSL (CCC 20/01/12 Datum -9.043m)	DRILL FLUID: LP2000	LOGGED BY: EC-PLS CHECKED: BMcD

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) 10 25 50 100 200 | COMPRESSIVE STRENGTH (MPa) 1 5 20 50 100 250 | DEFECT SPACING (mm) 50 250 1000 2000

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.

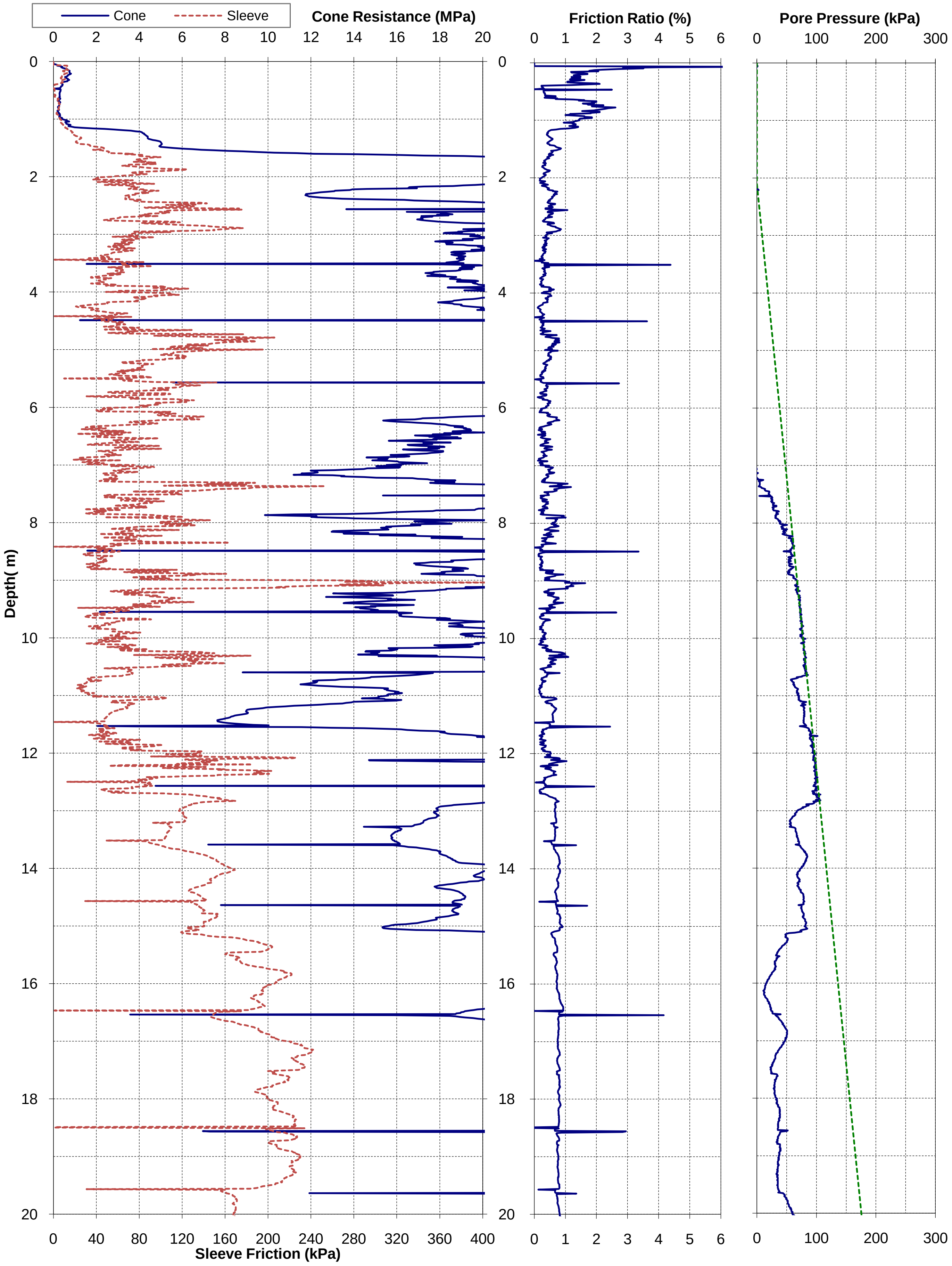
GEOLOGICAL UNIT	CORE RECOVERY (%)	METHOD	TESTS	SAMPLES	DEPTH (m)	CLASSIFICATION SYMBOL	MOISTURE CONDITION	STRENGTH/DENSITY CLASSIFICATION	DESCRIPTION
YALDHURST MEMBER OF THE SPRINGSTON FORMATION (ALLUVIAL)	38	PQDT			10.0–11.0	SW	S	D	Gravelly fine to coarse SAND, grey, dense, saturated, well graded. Gravel is fine to coarse, rounded. 10.35 to 11.0m- no recovery.
	100	SPT	9/10// 15/21/14 for 70mm N>50		11.0–11.45			VD	11.0m- very dense.
CHRISTCHURCH FORMATION (MARINE/ ESTUARINE)	62	PQDT			11.45–12.5	SP			Fine to medium SAND with trace gravel, grey, very dense, saturated, poorly graded. Gravel is fine. 12.0 to 12.4m- no recovery.
					12.4				Fine to medium SAND with minor silt, grey, very dense, saturated, poorly graded.
	100	SPT	4/7//10/ 14/15/11 for 55mm *N>50 FC13.0	B	12.5–12.95				
	76	PQDT			12.95–14.0				13.75 to 14.0m- no recovery.
	100	SPT	6/7// 20/20/10 for 45mm N>50		14.0–14.45				
	76	PQDT	*FC15.0	B	14.45–15.5				15.0m- trace silt 15.25 to 15.5m- no recovery.
	78	SPT	9/16// 18/22/10 for 45mm N>50		15.5–16.0				15.85 to 16.0m- no recovery.
	100	PQDT			16.0–17.0				
	100	SPT	4/5//9/ 11/15/15 N=50 *FC17.5	B	17.0–17.45			D	17.0m- dense. 17.45m- some silt.
	52	PQDT			17.45–18.5				18.0 to 18.5m- no recovery.
	100	SPT	2/4//8/ 12/13/17 for 75mm N>50		18.5–18.95			VD	18.5m- very dense.
	52	PQDT			18.95–20.0				19.5 to 20.0m- no recovery. End of borehole at 20.0mbgl (target depth)

R.L. (m): -7, -8, -9, -10, -11, -12, -13, -14, -15, -16

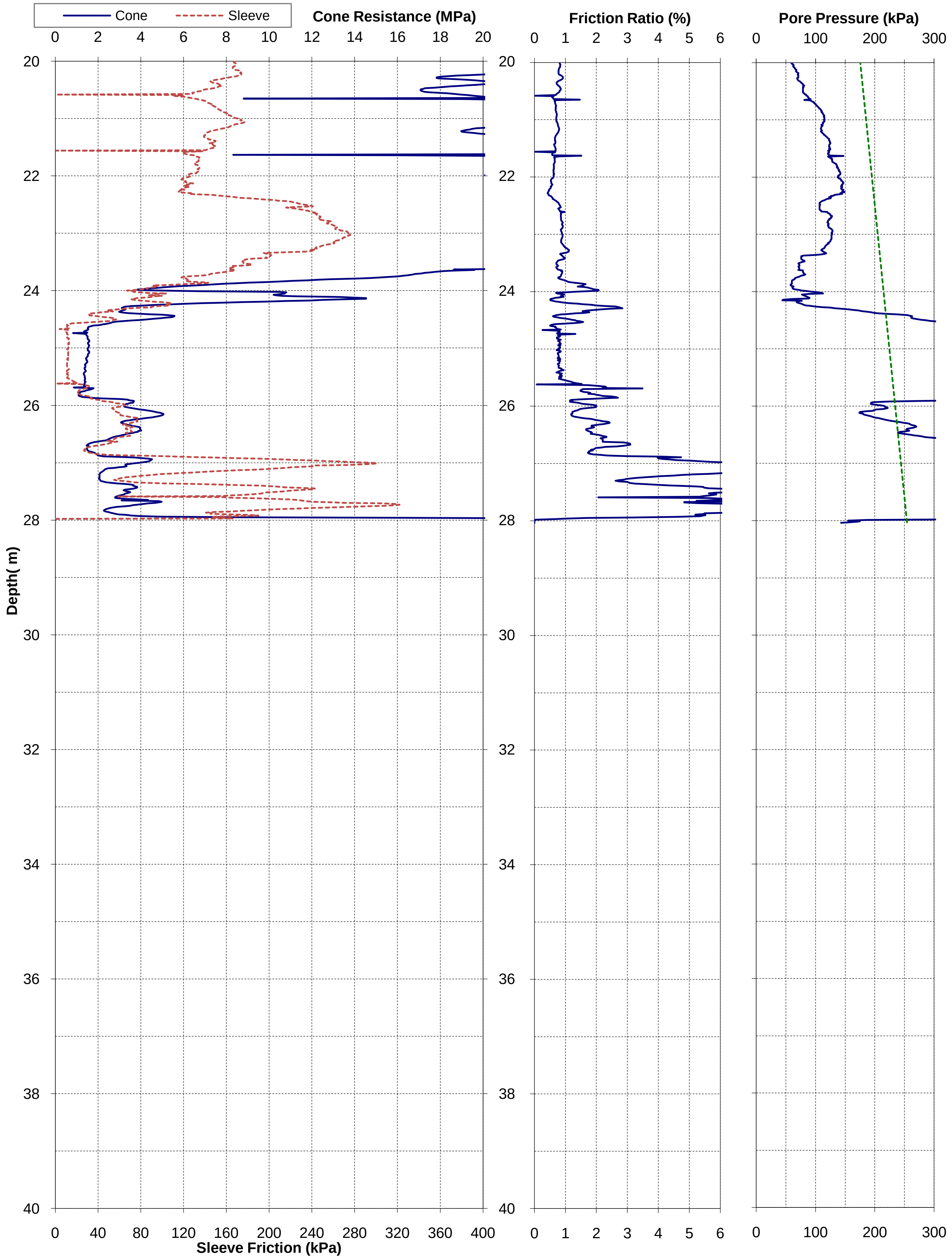
DEPTH (m): 11, 12, 13, 14, 15, 16, 17, 18, 19, 20

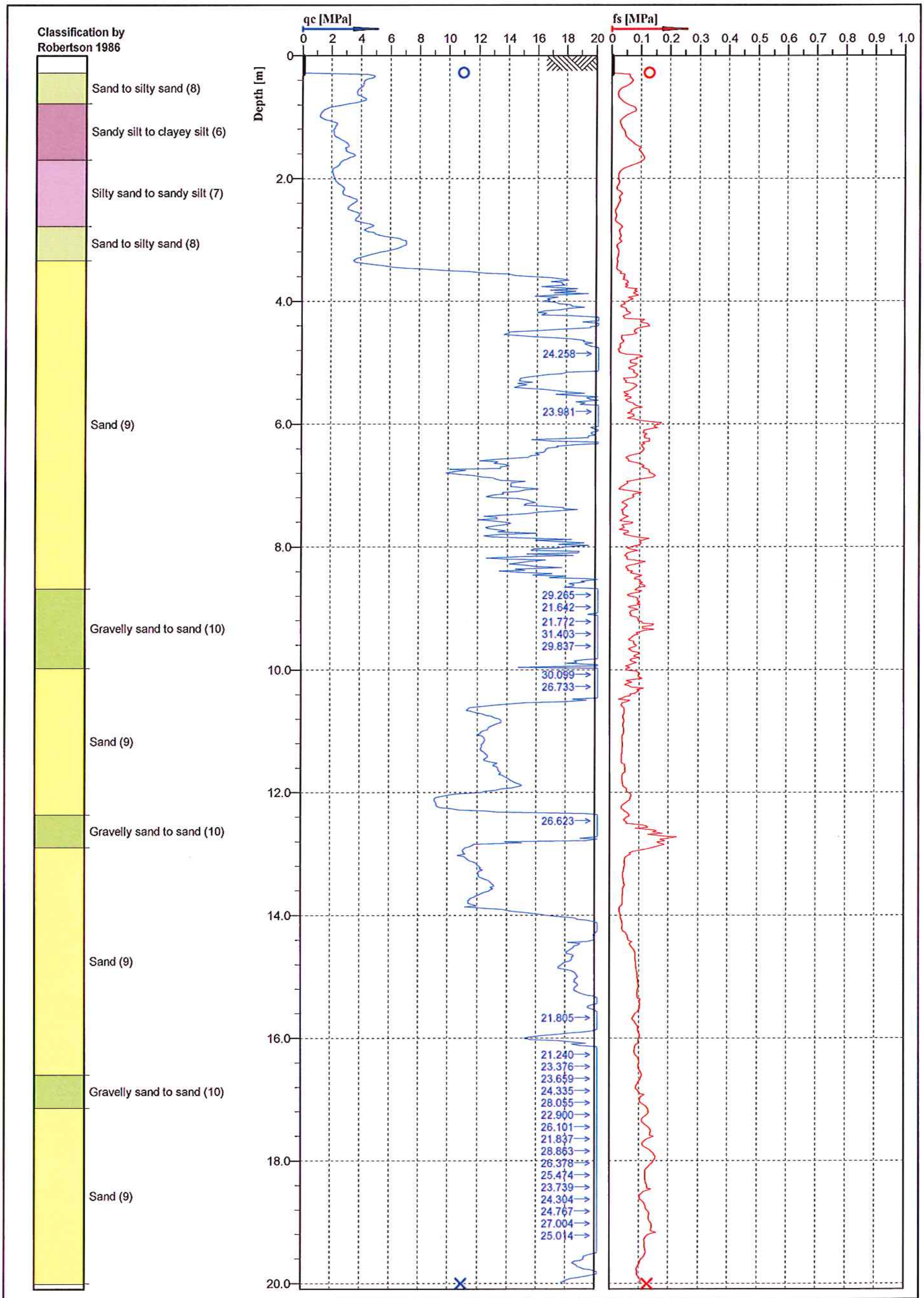
T+T DATATEMPLATE.GDT RCB

Project:	Darfield 2010 Earthquake - EQC Ground Investigations			**Page:**	1 of 2	**CPT-RCH-10**
Test Date:	3-Dec-2010	**Location:**	Richmond	**Operator:**	Perry	
Pre-Drill:	1.2m	**Assumed GWL:**	2.1mBGL	**Located By:**	Survey GPS	
Position:	2482865.9mE	5743661.9mN	3.27mRL	**Coord. System:**	NZMG & MSL	
Other Tests:				**Comments:**		



Project:	Darfield 2010 Earthquake - EQC Ground Investigations			**Page:** 2 of 2	**CPT-RCH-10**
Test Date:	3-Dec-2010	**Location:**	Richmond	**Operator:**	Perry
Pre-Drill:	1.2m	**Assumed GWL:**	2.1mBGL	**Located By:**	Survey GPS
Position:	2482865.9mE	5743661.9mN	3.27mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	



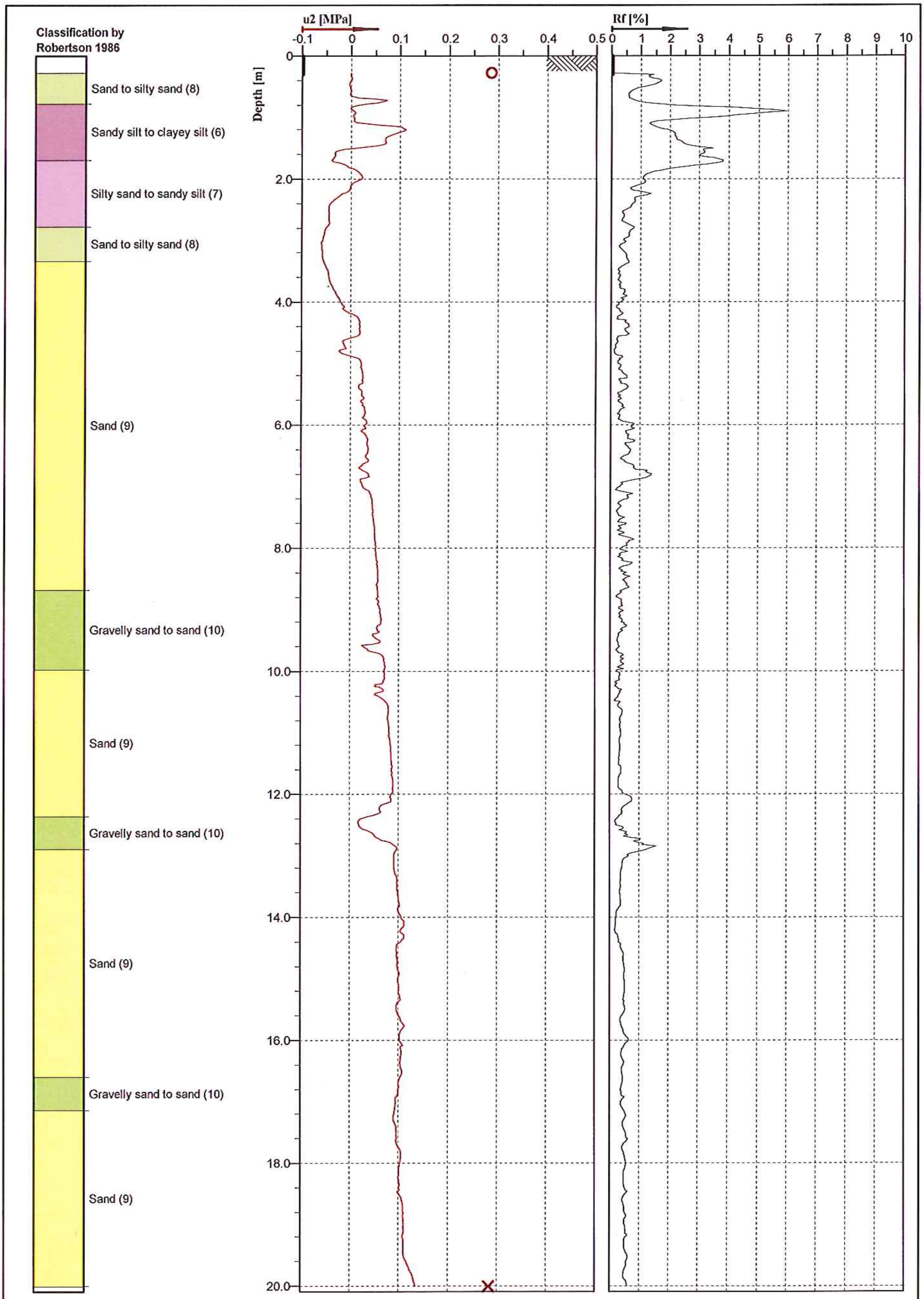


U2

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

Cone No: 4494
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: DAL-POD06-CPT05	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 1
Project ID:	Client: EQC	Date: 29/08/2012	Scale: 1 : 82
Project: 42 BANKS AVE		Page: 1/1	Fig:
E1572929 N5182303		File: DAL-POD06-CPT05.cpt	

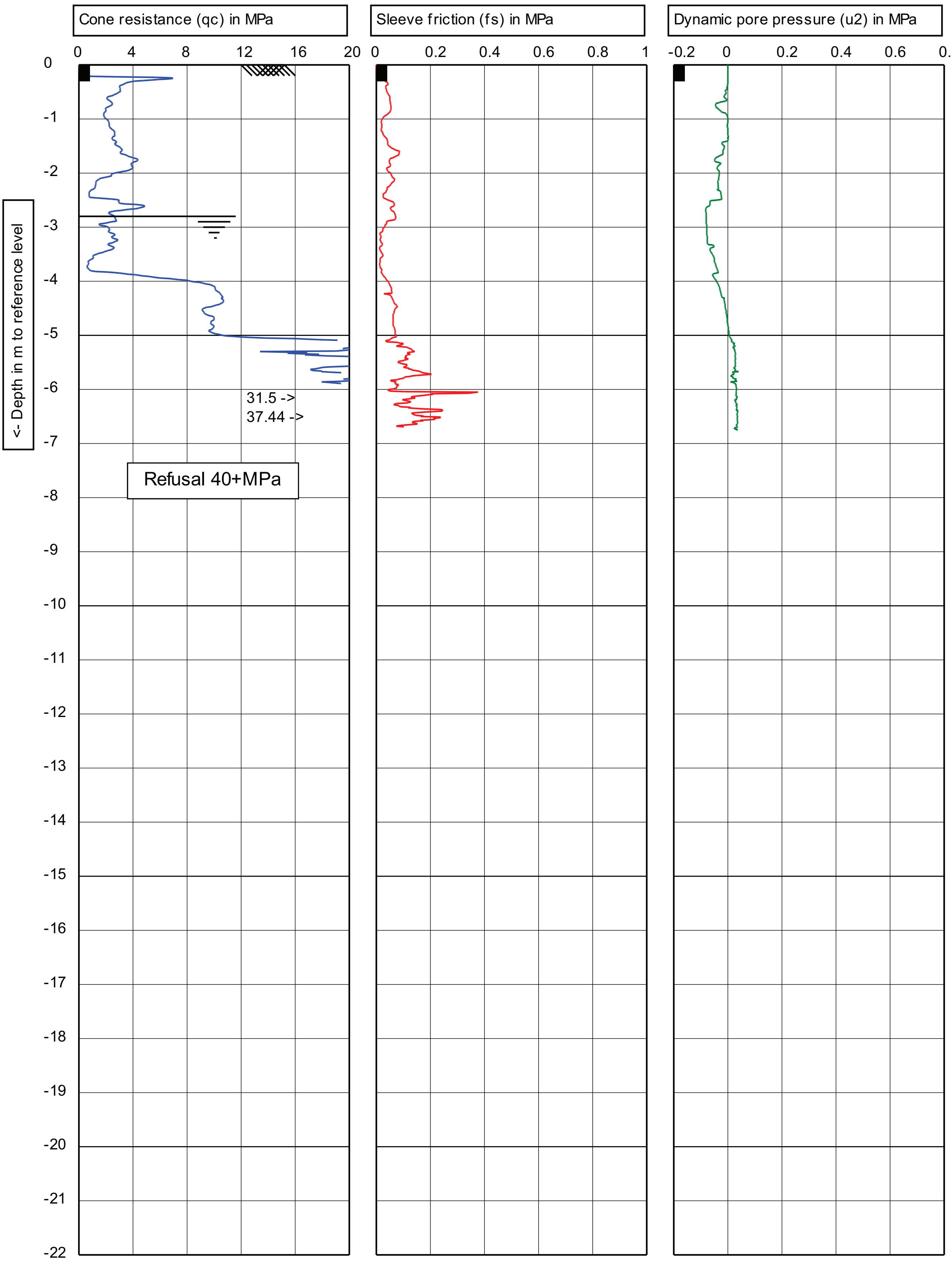


U2

PRO-DRILL
SPECIALIST DRILLING ENGINEERS

Cone No: 4494
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: DAL-POD06-CPT05	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 1
Project ID:	Client: EQC	Date: 29/08/2012	Scale: 1 : 82
Project: 42 BANKS AVE		Page: 1/1	Fig:
E1572929 N5182303		File: DAL-POD06-CPT05.cpt	



OPUS
HAMILTON LABORATORY

u2
150 cm²
10 cm²

Test according to A.S.T.M standard D-5778-07

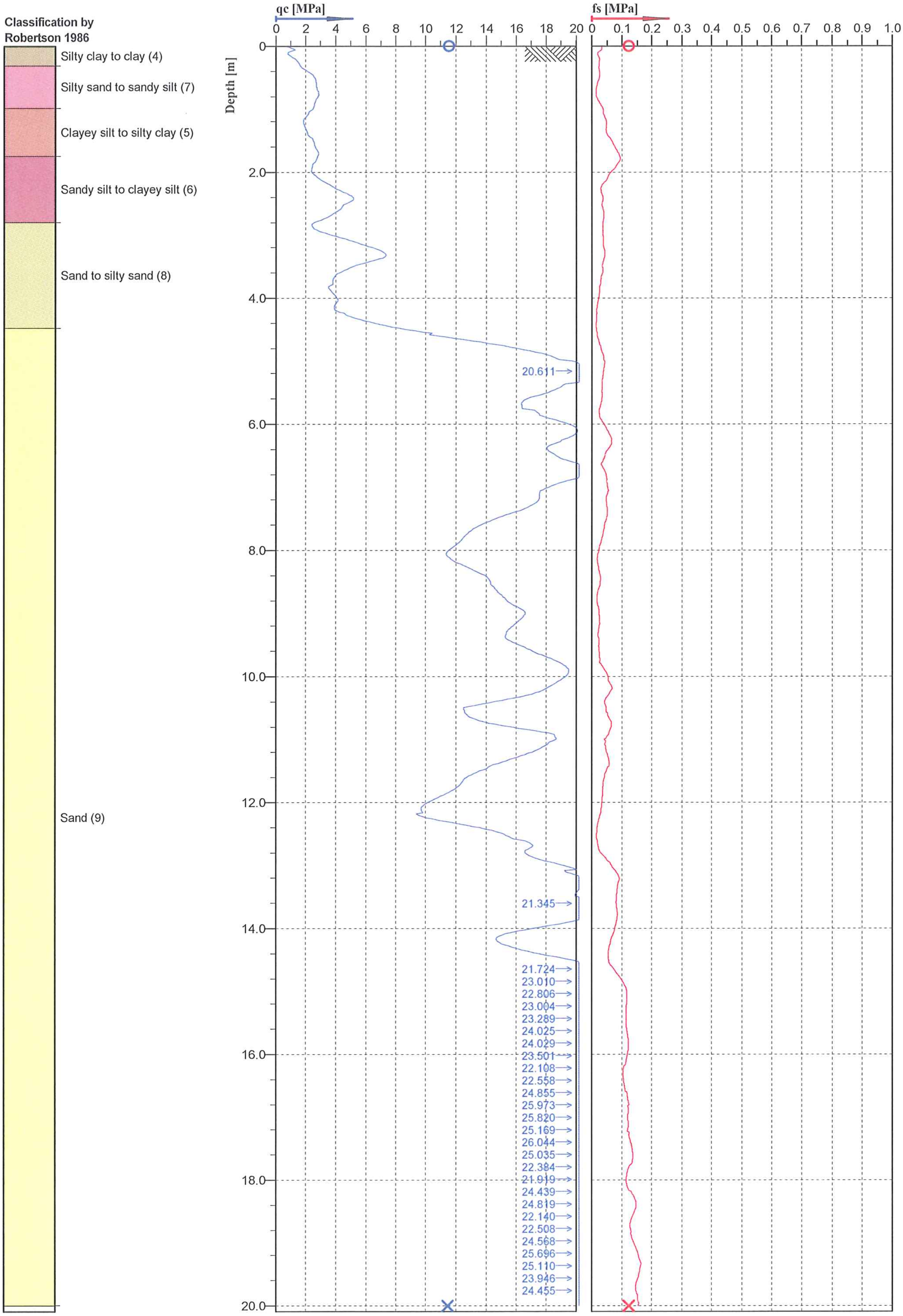
G.L. **0**

W.L.: **-2.8**

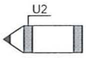
Project: **Geotechnical Investigation**
Location: **GPS:E1572664 N5182295**
Position:

Predrill :	**0.3**
Date:	**2/08/2012**
Cone no.:	**C10CFIIP.C10204**
Project no.:	**2-68292.12_027**
CPT no.:	**RCH-POD04-CPT45** **1/6**

CPTask V1.20

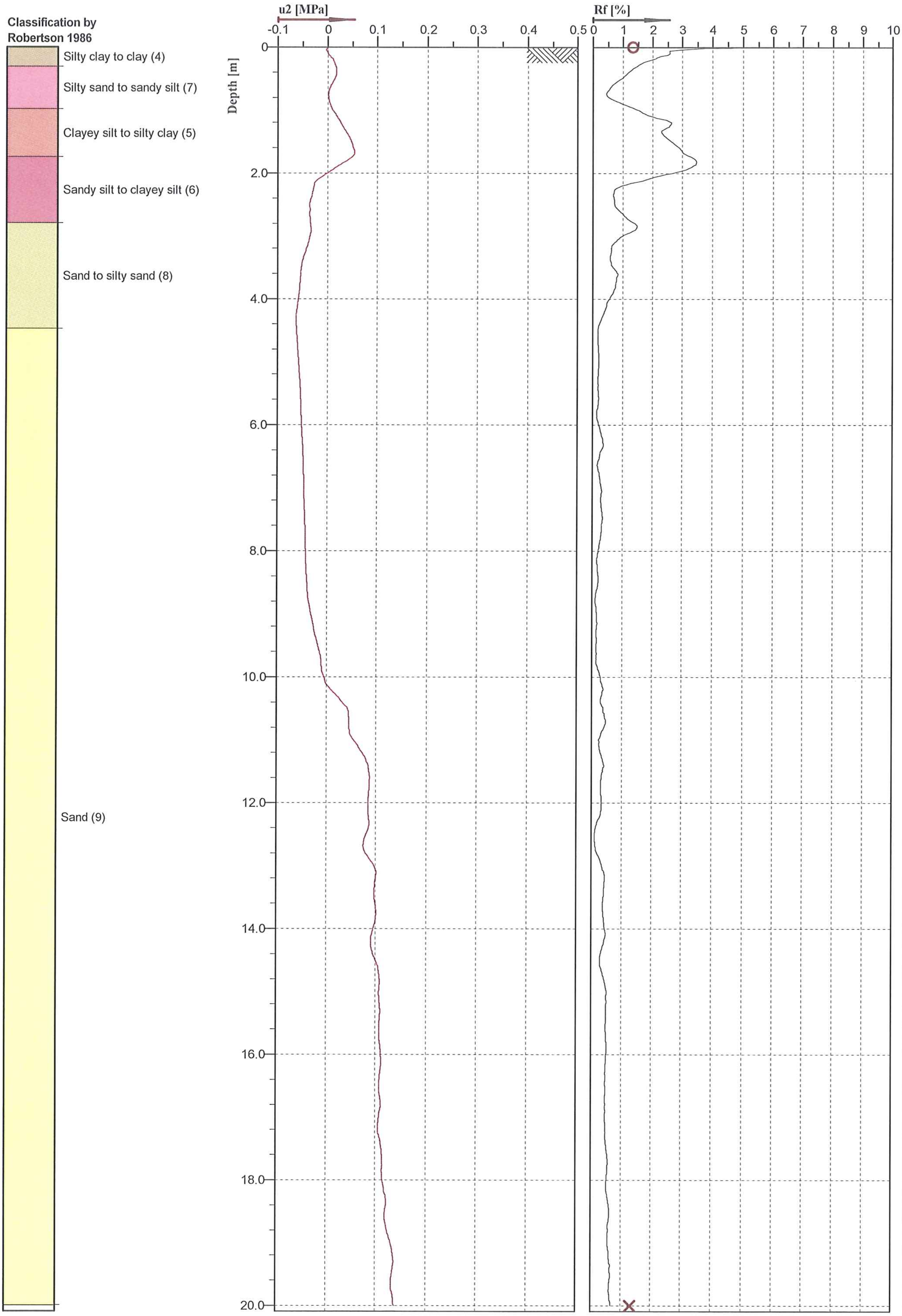


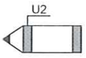
PRO-DRILL
SPECIALIST DRILLING ENGINEERS



Cone No: 4486
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: RCH-POD04-CPT10	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 1
Project ID:	Client: EQC	Date: 25/07/2012	Scale: 1 : 82
Project: 32POULTONAVE		Page: 1/1	Fig:
		File: RCH-POD04-CPT10.010	





PRO-DRILL
SPECIALIST DRILLING ENGINEERS

Cone No: 4486
Tip area [cm2]: 10
Sleeve area [cm2]: 150

Location: RCH-POD04-CPT10	Position: X: 0.00 m, Y: 0.00 m	Ground level: 0.00	Test no: 1
Project ID:	Client: EQC	Date: 25/07/2012	Scale: 1 : 82
Project: 32POULTONAVE		Page: 1/1	Fig:
		File: RCH-POD04-CPT10.010	

Appendix C:
CERA Land Recovery Zones
Post 22 February 2011 Earthquake Aerial Photo

Legend

DBH Residential Technical Category

⬛ Technical Category 1
🟨 Technical Category 2
🟦 Technical Category 3
🟫 N/A - Urban Nonresidential
🟫 N/A - Rural & Unmapped
🟫 N/A - Port Hills & Banks Peninsula

CERA Residential Recovery Zones

🟧 Orange Zone
🟥 Red Zone

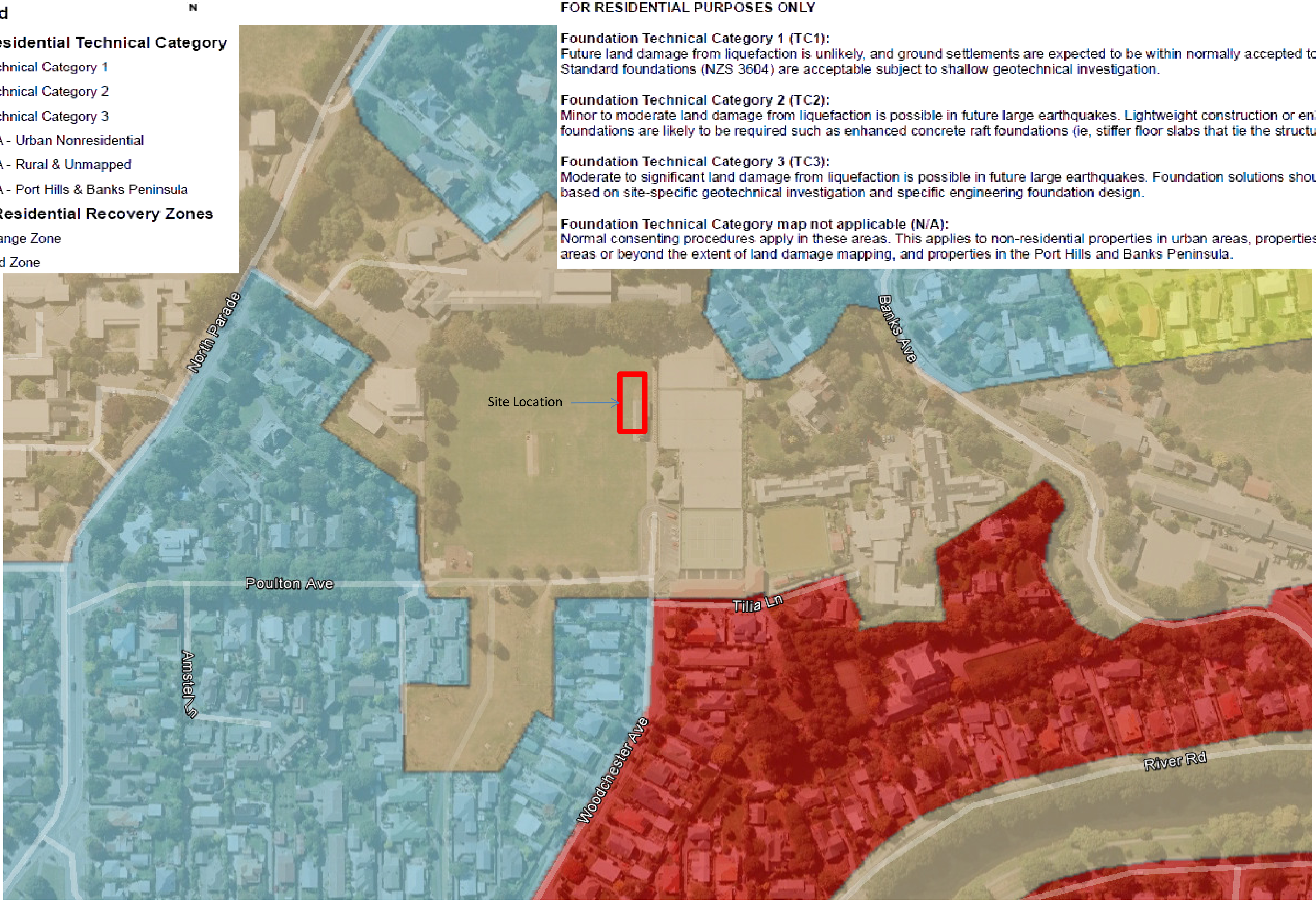
FOR RESIDENTIAL PURPOSES ONLY

Foundation Technical Category 1 (TC1):
Future land damage from liquefaction is unlikely, and ground settlements are expected to be within normally accepted tolerances. Standard foundations (NZS 3604) are acceptable subject to shallow geotechnical investigation.

Foundation Technical Category 2 (TC2):
Minor to moderate land damage from liquefaction is possible in future large earthquakes. Lightweight construction or enhanced foundations are likely to be required such as enhanced concrete raft foundations (ie, stiffer floor slabs that tie the structure together).

Foundation Technical Category 3 (TC3):
Moderate to significant land damage from liquefaction is possible in future large earthquakes. Foundation solutions should be based on site-specific geotechnical investigation and specific engineering foundation design.

Foundation Technical Category map not applicable (N/A):
Normal consenting procedures apply in these areas. This applies to non-residential properties in urban areas, properties in rural areas or beyond the extent of land damage mapping, and properties in the Port Hills and Banks Peninsula.



SOURCE: canterburyrecovery.projectorbit.com (Accessed on 19/06/12)

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Project: Richmond Park Pavilion
Geotechnical Desktop Study
Project No.: 6-QUCCC1.18
Client: Christchurch Ciy Council

CERA Land Damage Map

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 19/06/12)

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Geotechnical Desktop Study
Project No.: 6-QUCCC1.18
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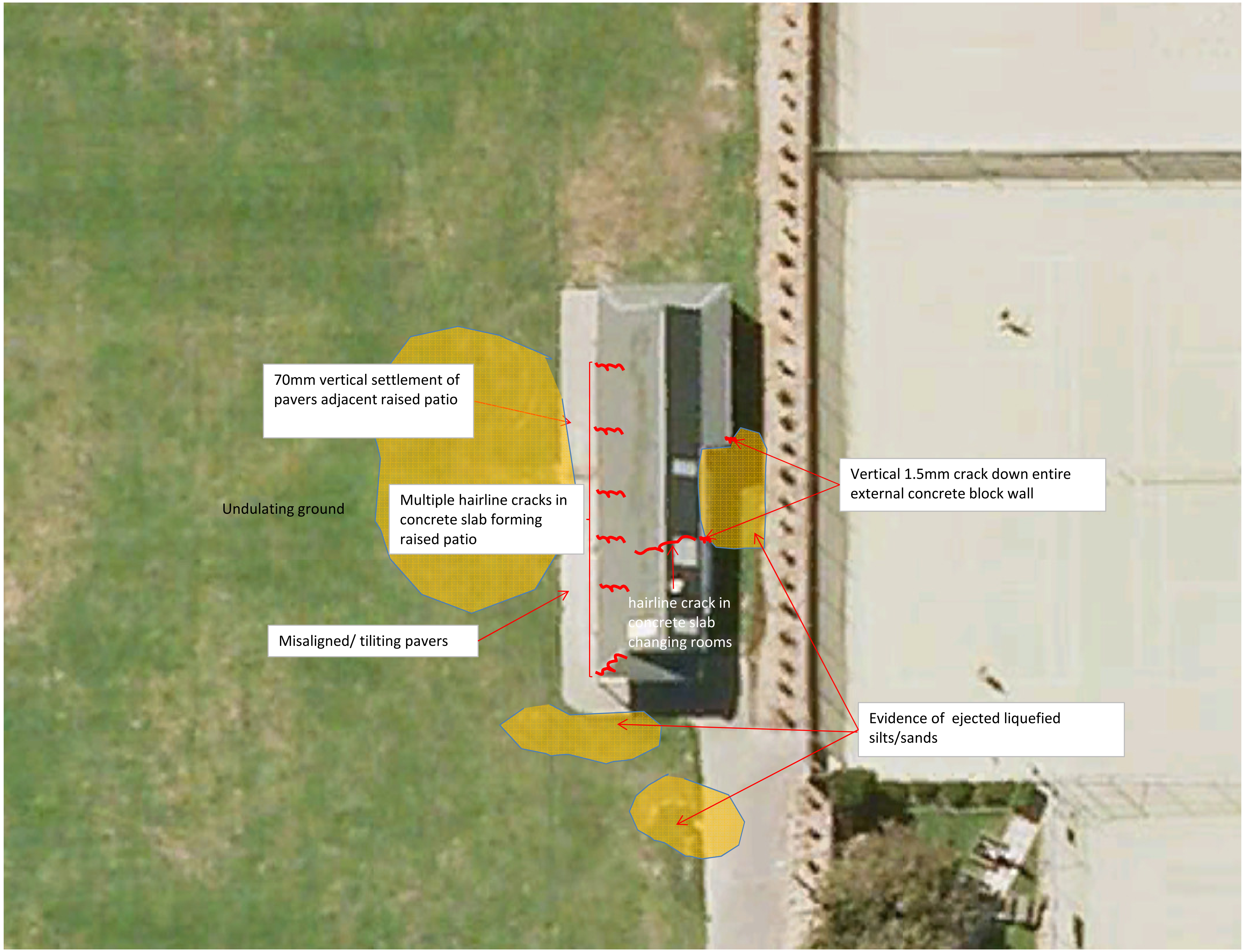
Aerial of Liquefaction Damage Post 22 Feburary Earthquake

Appendix D:
Site Walkover Inspection Plan



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Site Walkover Plan

Appendix D – CERA DEE Datasheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name: Richmond Park Pavilion
Unit No: Street
Building Address: 39 Medway Street, Christchurch
Legal Description:
Degrees Min Sec
GPS south:
GPS east:
Building Unique Identifier (CCC): PRK_0671_BLDG_003 EQ2

Reviewer: Dave Dekker
CPEng No: 1003026
Company: Opus International Consultants Ltd
Company project number: 6-QUCC1.18
Company phone number: 07 834 1897
Date of submission: 4-Feb-13
Inspection Date: 3-Sep-12
Revision: Final
Is there a full report with this summary? yes

Site

Site slope: flat
Soil type: mixed
Site Class (to NZS1170.5): D
Proximity to waterway (m, if <100m):
Proximity to clifftop (m, if < 100m):
Proximity to cliff base (m,if <100m):

Max retaining height (m):
Soil Profile (if available):
If Ground improvement on site, describe:
Approx site elevation (m):

Building

No. of storeys above ground: 1 single storey = 1
Ground floor split? no
Storeys below ground
Foundation type: other (describe)
Building height (m): 2.50
Floor footprint area (approx): 117
Age of Building (years):

Ground floor elevation (Absolute) (m):
Ground floor elevation above ground (m):
if Foundation type is other, describe: slab on grade and assumed to have strip foundation
height from ground to level of uppermost seismic mass (for IEP only) (m): 2.5
Date of design:

Strengthening present? no
If so, when (year)?
And what load level (%g)?
Brief strengthening description:

Use (ground floor): public
Use (upper floors):
Use notes (if required):
Importance level (to NZS1170.5): IL2

Gravity Structure

Gravity System: load bearing walls
Roof: timber truss
Floors: concrete flat slab
Beams: none
Columns: load bearing walls
Walls: fully filled concrete masonry

truss depth, purlin type and cladding
slab thickness (mm)
overall depth x width (mm x mm)
typical dimensions (mm x mm)
#N/A

Lateral load resisting structure

Lateral system along: fully filled CMU
Ductility assumed, μ: 1.25
Period along: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

Note: Define along and across in detailed report!

note total length of wall at ground (m):
wall thickness (m): 190mm
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Lateral system across: fully filled CMU
Ductility assumed, μ: 1.25
Period across: 0.40 ##### enter height above at H31
Total deflection (ULS) (mm):
maximum interstorey deflection (ULS) (mm):

note total length of wall at ground (m):
wall thickness (m): 190mm
estimate or calculation? estimated
estimate or calculation?
estimate or calculation?

Separations:

north (mm): leave blank if not relevant
east (mm):
south (mm):
west (mm):

Non-structural elements

Stairs:
Wall cladding:
Roof Cladding: Metal
Glazing: aluminium frames
Ceilings:
Services(list):

describe

Available documentation

Architectural none original designer name/date
Structural none original designer name/date
Mechanical none original designer name/date
Electrical none original designer name/date
Geotech report none original designer name/date

Damage

Site:
(refer DEE Table 4-2)

Site performance: good
Describe damage: cracking of wall, lintel beam, window sills and ground slab

Settlement: 25-100m notes (if applicable): 70mm settlement of surrrounding pavings
Differential settlement: none observed notes (if applicable): survey recommended to confirm this
Liquefaction: 2-5 m²/100m³ notes (if applicable): estimated
Lateral Spread: none apparent notes (if applicable):
Differential lateral spread: none apparent notes (if applicable):
Ground cracks: none apparent notes (if applicable):
Damage to area: slight notes (if applicable):

Building:

Current Placard Status: green

Along Damage ratio: 100%
Describe (summary):
Describe how damage ratio arrived at:

Across Damage ratio:
Describe (summary):

$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Diaphragms Damage?: Describe:
CSWs: Damage?: Describe:
Pounding: Damage?: Describe:
Non-structural: Damage?: Describe:

Recommendations

Level of repair/strengthening required: minor structural
Building Consent required: yes
Interim occupancy recommendations: full occupancy

Describe: Install ceiling diaphragm or other restraint to top of wall
Describe:
Describe:

Along Assessed %NBS before: 44% ##### %NBS from IEP below
Assessed %NBS after:

If IEP not used, please detail assessment methodology:

Across Assessed %NBS before: 100% ##### %NBS from IEP below
Assessed %NBS after:

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