Wainoni Park Youth Activity Centre

BU 1264-002 EQ2

Detailed Engineering Evaluation

Quantitative Report

Christchurch City Council

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Wainoni Park Youth Activity Centre
Detailed Engineering Evaluation
Quantitative Report

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Reviewed by

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Wainoni Park Youth Activity Centre
BU 1264-002 EQ2

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final

Background
This is a summary of the quantitative report for the building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, a visual inspection on 01/03/12 and a dimension survey undertaken on 11/04/12.

Key Damage Observed

- Minor vertical hairline cracks at the junction of the Western addition and the flank wall of the main octagonal room.

The building otherwise appears to have performed adequately in the recent seismic events.

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 76%NBS.

This is above the target level of 67% NBS required by the CCC Earthquake Prone Building Policy.

Recommendations
It is recommended that:

a) In order to minimise further cracking at the junction between the main building and the Western addition during future seismic events consideration should be given to raking out the existing vertical joints between the two areas and installing a flexible sealant.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Wainoni Park Youth Activity Centre.

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.

Any building with a capacity of less than 34% of new building standard (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% as required by 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).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) 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 CCC as being 67% of the strength of an equivalent new building. 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.

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:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased from 0.22 to 0.3);
- 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.

<table>
<tr><th rowspan="2">Description</th><th rowspan="2">Grade</th><th rowspan="2">Risk</th><th rowspan="2">%NBS</th><th rowspan="2">Existing Building Structural Performance</th><th colspan="2">Improvement of Structural Performance</th></tr>
<tr><th>Legal Requirement</th><th>NZSEE Recommendation</th></tr>
<tr><td>Low Risk Building</td><td>A or B</td><td>Low</td><td>Above 67</td><td>Acceptable (improvement may be desirable)</td><td rowspan="2">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.</td><td>100%NBS desirable. Improvement should achieve at least 67%NBS</td></tr>
<tr><td>Moderate Risk Building</td><td>B or C</td><td>Moderate</td><td>34 to 66</td><td>Acceptable legally. Improvement recommended</td><td>Not recommended. Acceptable only in exceptional circumstances</td></tr>
<tr><td>High Risk Building</td><td>D or E</td><td>High</td><td>33 or lower</td><td>Unacceptable (Improvement required under Act)</td><td>Unacceptable</td><td>Unacceptable</td></tr>
</table>

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). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance 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, 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/Christchurch City Council 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.

[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 Wainoni Park Youth Activity Centre is a single storey structure consisting of a large octagonal central space (approximately 10m by 10m) with a small 2m by 3m kitchen addition to its Eastern flank and a larger 10m by 6m addition housing a boxing ring to the West. The building is approximately 22m long in the East-West direction and 9.8m wide in the North-South direction.

The roof over the main octagonal space is steeply pitched up to a central apex approximately 8m above the ground floor slab. A smaller steep roof over the kitchen addition extends to around 5m above the ground floor slab. The Western addition has a conventional duo-pitched roof, with hipped ends, and a ridge line at around 4.5m above ground floor level. All of the walls are constructed using reinforced concrete masonry blocks, with the exception of a single timber panel around the North-West entrance, and extend to a height of 2.4m above the ground floor slab.

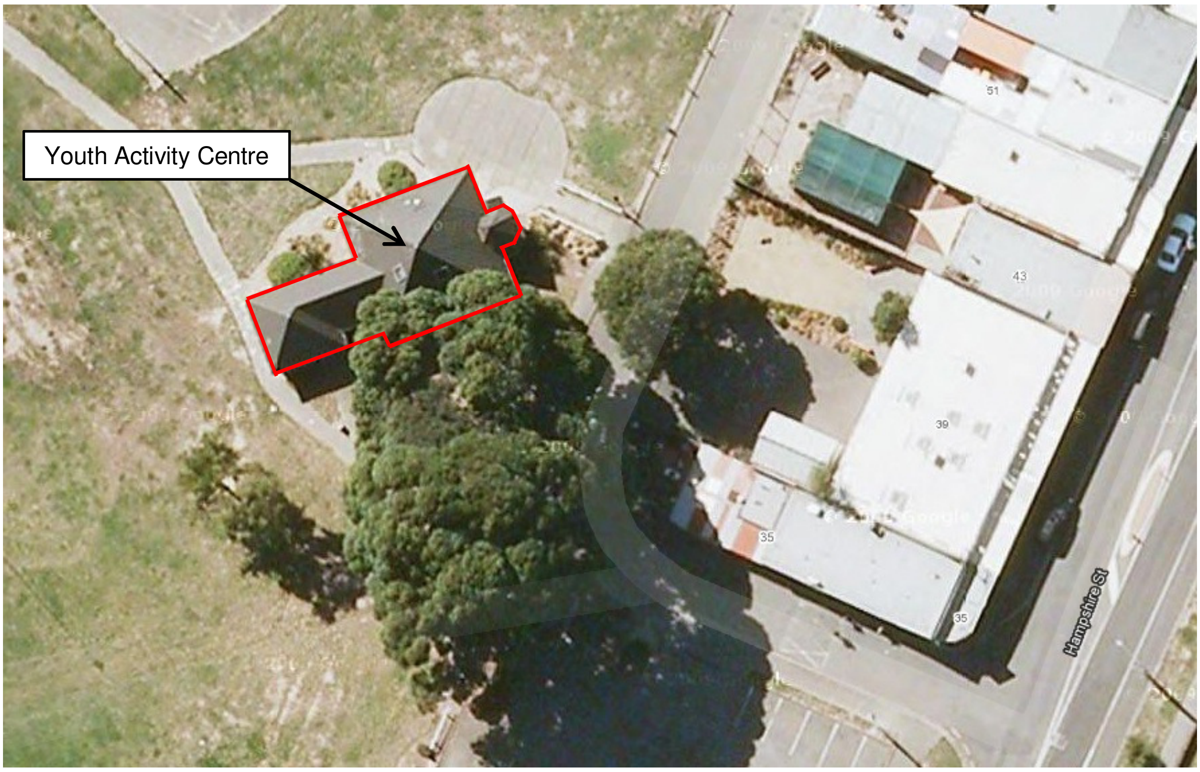


Figure 2: Site aerial photo. *Source: Google Earth*

The building is situated within a public park, behind Hampshire Street in the Eastern Suburbs of Christchurch. The site is relatively flat and open access is available around all four sides of the building.

No detailed construction drawings for the building have been located and its exact age is not known. However, the architectural appearance would suggest that it was built in the

1960s. The large addition to the West of the main octagonal space has been added as an extension to the original building at an unknown date in the past.

4.2 Gravity Load Resisting System

The roof to the main octagonal space consists of a series of eight radial timber trusses that extend out from a large, circular timber king post in the centre of the room. The trusses are fixed to the king post via bolted connections to a circular steel collar bracket with radial fins.

The main trusses are also fixed at their bearings with steel brackets bolted into the top of the masonry perimeter walls. The roof is sarked with Wood-Tek panels and finished with a lightweight profiled metal sheet externally.

The kitchen addition roof consists of a series of eight radial timber rafters in a lean-to arrangement at the central apex. Additional strutting is provided at third points down the rafter length and the whole roof is sarked with plywood and finished with the same lightweight profiled metal sheet as the main octagonal space.

The roof to the large Western addition is finished with plasterboard at ceiling level and could not be inspected. It is likely to consist of a series of timber trusses at regular centres with sarking to the underside of the roof sheets.

All of the load bearing walls to the perimeter of the original building, with the exception of a 2.8m long panel on the North-East corner, are constructed from 200 series masonry blocks and extend 2.4m above the ground floor.

The foundation detail is not known but the walls appear to be built directly off the ground bearing concrete slab which may be acting as raft or contain edge thickenings that act as shallow strip footings.

The Western extension is of a similar construction with 200 series masonry walls to 2.4m above ground level and a concrete ground bearing slab.

4.3 Lateral Load Resisting System

Lateral support for the roofs is provided through the numerous roof hips and sarking. Additional lateral support to the Western extension will be provided by the plasterboard ceiling acting as a diaphragm.

The main lateral support for the building is provided by the 200 series reinforced concrete masonry walls used throughout.

5 Survey

No copies of the original design calculations or structural drawings have been obtained for either the main building or the later Western addition.

A dimension survey of the building was undertaken by Opus International Consultants on 11 April 2012 and the resultant plan and elevations can be found in Appendix B of this report.

In order to accurately assess the building's seismic capacity an electronic cover meter was used to locate the steel reinforcement bars contained within the 200 series masonry walls that act as the main lateral load resisting system. From this it was determined that:

- Full height vertical bars are present in the walls of the main octagon at 600mm horizontal centres.
- No horizontal reinforcement is present in the main octagon except at the top of the walls (directly below the roof bearing) which acts as a bond beam.
- The reinforcement to the small kitchen addition at the east of the building consists of a full height vertical corner bar at each change of direction together with vertical starter bars at 600mm horizontal centres. These starter bars extend to a height of 600mm above the ground floor slab.
- A horizontal bar is also present at the top of the kitchen addition walls. The bar is positioned directly below the roof bearing and acts as a bond beam.
- The walls to the newer extension at the West of the building contain vertical and horizontal reinforcement at 600mm centres in both directions.

Opening up works were undertaken at one location to expose a vertical reinforcement bar contained within the walls. At this location it was found that a deformed bar, 12mm in diameter had been used. It has been assumed that a similar bar size has been used in the remainder of the building.

6 Damage Assessment

The building has suffered only minor damage as a result of the recent earthquake events and appears to have performed well under seismic conditions.

Some vertical hairline cracking was noted at the junction between original building and the later Western extension but in general the building appears to be in good condition.

7 Detailed Seismic Assessment

7.1 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.

No potential critical structural weaknesses have been identified in the building.

7.2 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 a nominally ductile reinforced masonry structure.

7.3 Detailed Seismic Assessment Results

A summary of the structural performance of the building is shown in the following table. 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	Failure mode and description of limiting criteria	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Walls in the East-West direction (longitudinal)	In-plane bending capacity of the reinforced masonry walls	No	>100%
	In-plane shear capacity of the reinforced masonry walls	No	>100%
	Out of plane bending capacity of the reinforced masonry walls	No	>100%
Walls in the North – South direction (transverse)	In-plane bending capacity of the reinforced masonry walls. Limited by large opening into kitchen addition on East flank.	No	76%
	In-plane shear capacity of the reinforced masonry walls along the building	No	>100%
	Out of plane bending capacity of the reinforced masonry walls	No	>100%
Roof (Main Building)	Capacity of the radial roof hips and sarking.	No	>100%
	Capacity of the roof to wall connections	No	>100%
	Capacity of the roof hips and ceiling level plasterboard diaphragm.	No	>100%
Foundations	Refer to separate Geotechnical Report	No	>100%

7.4 Discussion of Results

The building has a calculated capacity of 76% NBS. The capacity is limited by the large opening into the kitchen addition through the main Eastern flank wall of the building which reduces the length of masonry available to provide lateral load resistance in this area.

The capacities in the above table are based on the assumption that the masonry walls in the Western addition have been fully grouted. In the main building where only vertical bars have been provided it is assumed that the walls are partially grouted such that only the pockets containing a bar have been in-filled.

The capacity of the North elevation is dependent on the assumption that load can be transferred into the adjacent 4.4m long toilet wall panels.

7.5 Limitations and Assumptions in Results

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 limited drawings, specifications and site inspections;
- The normal variation in material properties which change from batch to batch;
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

8 Geotechnical Assessment

A separate geotechnical study of the site has been undertaken by Opus International Consultants and a copy of the resultant report can be found in Appendix C.

This report concludes that the existing foundations to the building are adequate but that there is a potential risk of differential settlement, in the region of 0-50mm, occurring in a future seismic event. Settlements of this magnitude are unlikely to cause significant structural distress to this building.

9 Conclusions and Recommendations

(a) The building has a calculated seismic capacity of 76%.

(b) As a result the building is classified as grade B, low risk and has a relative risk of failure of approximately 2 to 5 times that of building complying with current codes.

(c) This is above the target level of 67% NBS required by the CCC Earthquake Prone Building Policy.

(d) In order to minimise further cracking at the junction between the main building and the Western addition during future seismic events consideration should be given to raking out the existing vertical joints between the two areas and installing a flexible sealant.

10 Limitations

(a) This report is based on the dimension survey and limited opening up works undertaken by Opus International Consultants on 11 April 2012 together with the earlier visual inspection of 1 March 2012. No original structural drawings or calculations were available for the building and the effect of any construction detail not apparent during our inspections has not been included in the assessment.

(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.

11 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: Front (North Elevation)

Photo 2: Left Flank (East Elevation)

Photo 3: Rear (South Elevation)

Photo 4: Right Flank (West Elevation)

Photo 5: Typical Corner Detail

Photo 6: Overhang & Bracket to Main Roof

Photos 7&8: Cracking Between Original Building & Main Addition

Photo 9: South-West Corner of Main Addition (Internal View)

Photo 10: West Wall of Original Building (Internal View)

Photo 11: South Wall of Original Building (Internal View)

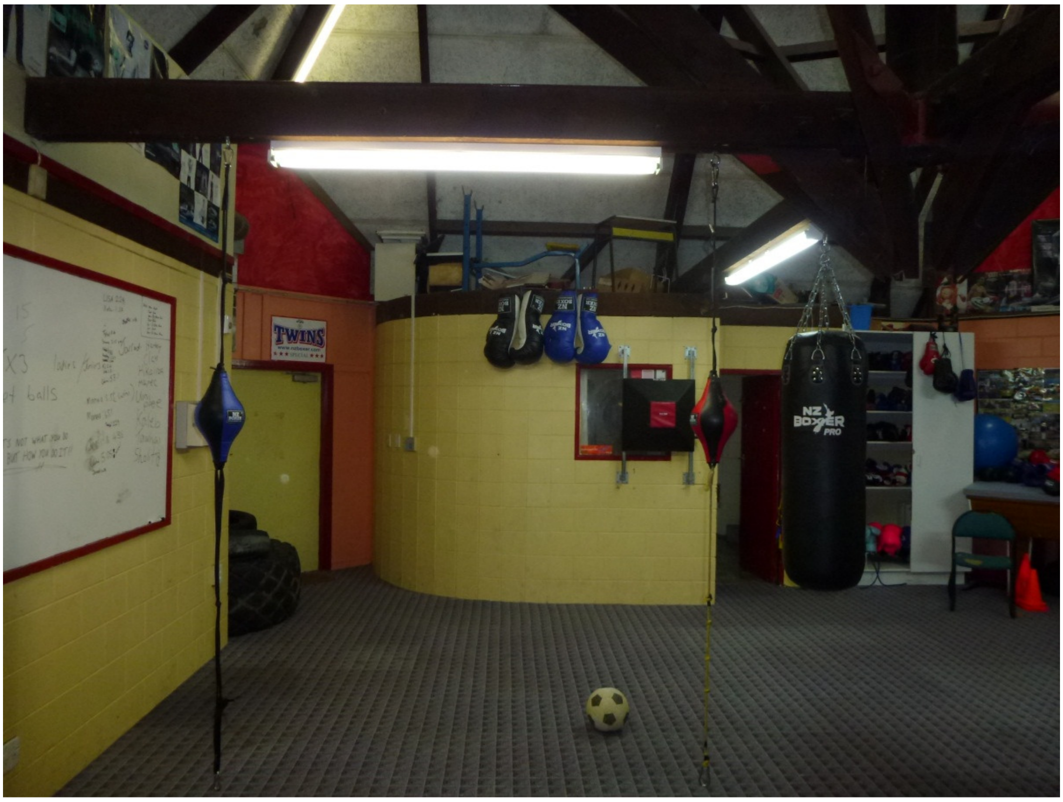


Photo 12: Eastern Flank Wall of Original Building (Internal View)

Photo 13: North Wall of Original Building (Internal View)

Photo 14: Entrance at North-East Corner of Original Building (Internal View)

Photo 15: South-West Corner of Original Building (Internal View)

Photo 16: Trussed Roof of Original Building

Photo 17&18: Trussed Roof of Original Building

Photo 19: Typical Roof Bearing (Internal View)

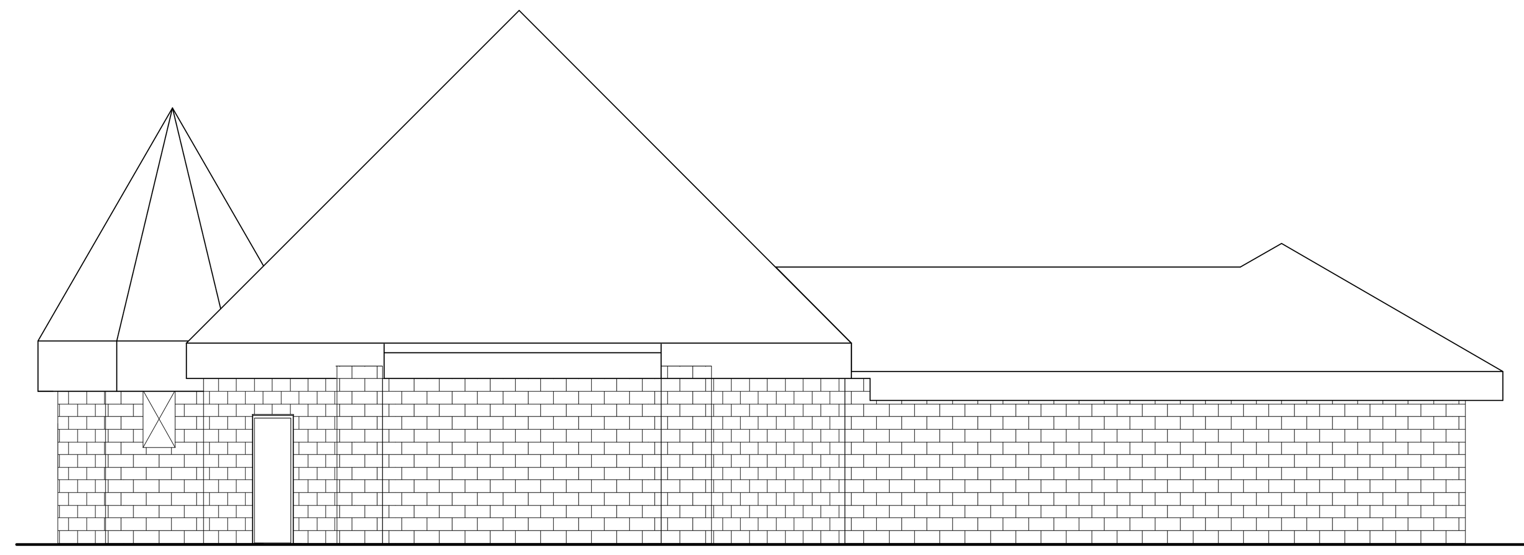
Photo 20: Typical Main Roof Truss Connection

Photo 21: Kitchen Addition (East) Main Roof

Photo 22: Junction between Kitchen Addition & Main Building

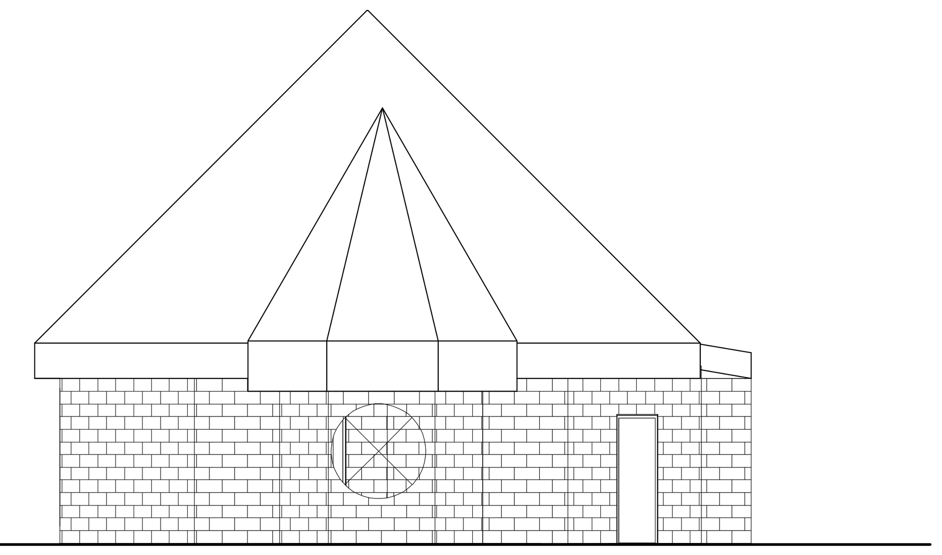
Photo 23: Confirmation of Main Vertical Reinforcement

Appendix B – Floor Plan



Elevation 1 - a

SCALE 1 : 100



Elevation 2 - a

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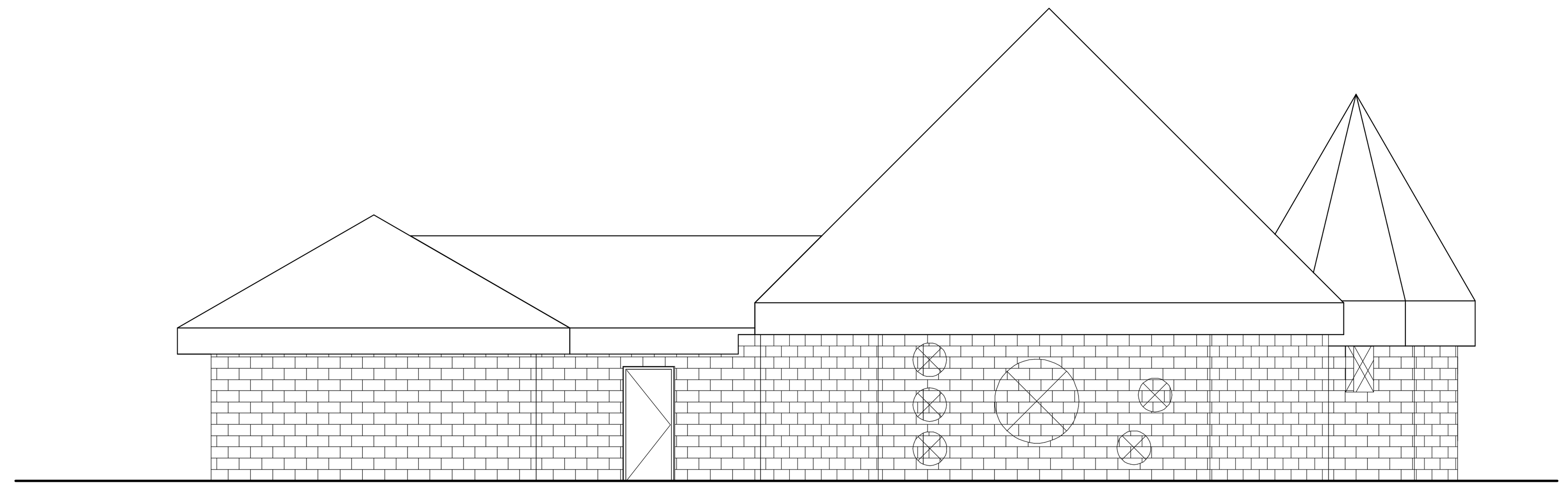

Elevation 3 - a

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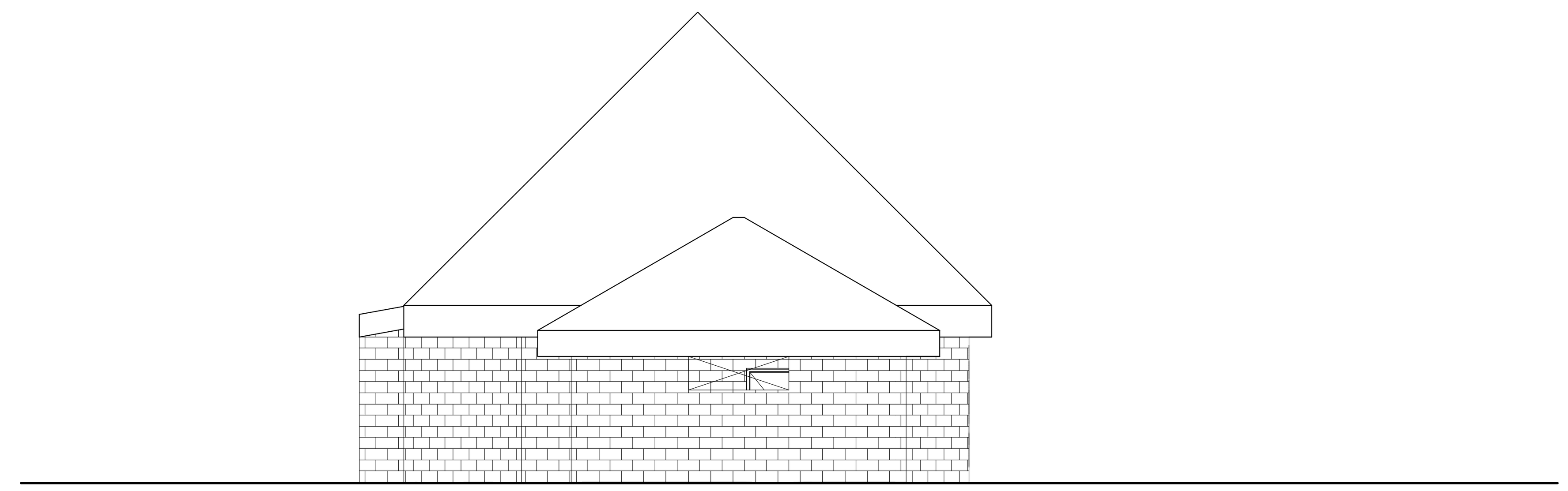

Elevation 4 - a

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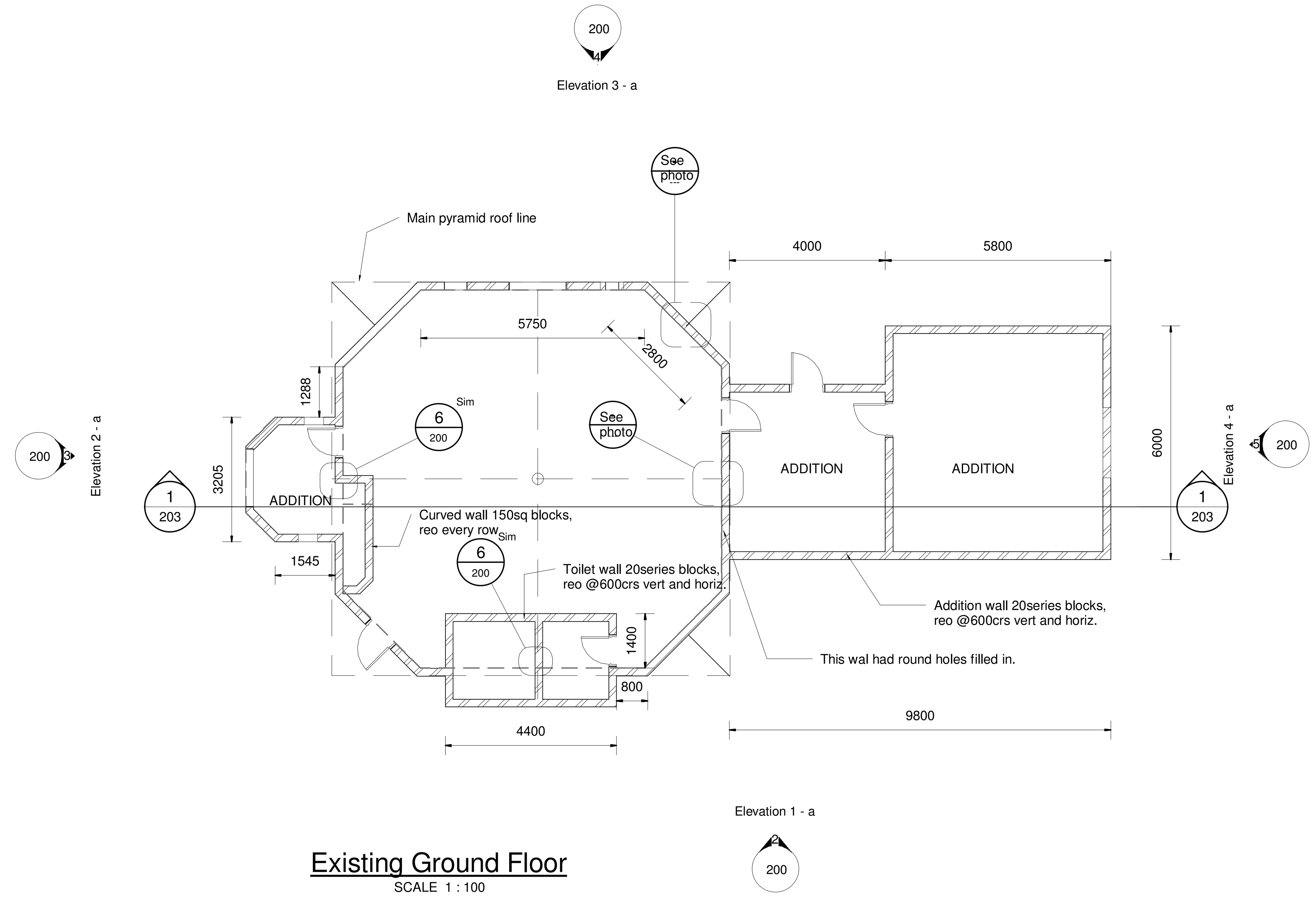

Existing Ground Floor

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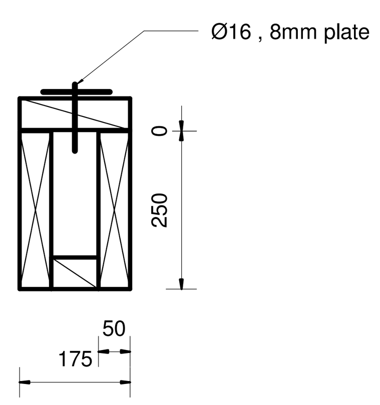

Kitchen beam

SCALE 1 : 10

PROJECT STATUS

Revision	Amendment	Approved	Revision Date

OPUS

Auckland Office
PO Box 5848,
Auckland 1010, New Zealand
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Drawn	Designed	Approved	Revision Date
Drawn By	Designer	Approver	Date

Project: Christchurch City Council
31 Hampshire st.
Wainoni Park Youth Activity Centre

Title: EXISTING FLOOR PLANS

Project No.	Scale	Drawing No.	Sheet No.	Revision
6-QUCCC-66	As indicated	6/1366/244	200	RA

Original sheet size A1 (841x594) Plot date: 16/04/2012 4:34:03 p.m. C:\Revit\Wainoni Park Youth Centre\Wainoni Park Youth Activity Centre_Structural(2012)_AS.rvt

Appendix C – Geotechnical Assessment

27 March 2012

Michael Sheffield
Christchurch City Council
PO Box 237
CHRISTCHURCH 8140

OPUS

6-QUCCC.66/025SC

Dear Michael

Geotechnical Desktop Study – Wainoni Park Youth Activity Centre

1. Introduction

This report summarises the findings of a geotechnical desktop study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council (CCC) at the above property on 21 March 2012. The Geotechnical desk study follows the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

The purpose of the geotechnical study is to assess the current ground conditions and the potential geotechnical hazards that may be present at the site, and determine whether further subsurface geotechnical investigations are necessary.

It is our understanding this is the first inspection by a Geotechnical Engineer of this property following the Canterbury Earthquake Sequence. A geotechnical desktop study of the adjacent building Wainoni Community Centre was completed for CCC in August 2011.

2. Desktop Study

2.1 Site Description

The Wainoni Park Youth Activity Centre is located at 31 Hampshire Street in the eastern suburbs of Christchurch. A car parking area is located to the south east of the centre and Wainoni Park surrounds the remainder of the building.

The building is a single storey structure with reinforced masonry walls and a timber frame roof structure. Though no detailed drawings for the foundations have been found, it is assumed that the foundations are likely to be shallow perimeter strip footings.

2.2 Structural Drawings

A search of CCC property files has not located any extracts from construction drawings.

No geotechnical reports or records of a ground condition assessment associated with the construction of the original building or additions have been identified.

2.4 Regional Geology

The published geological map of the area, (Geology of the Christchurch Urban Area 1:25,000, Brown and Weeber, 1992) indicates the site is underlain by sand of fixed and semi-fixed dunes and beaches.

A groundwater table depth of approximately 1m has been shown on the published map by Brown and Weeber (1992).

2.5 Expected Ground Conditions

A review of the Environmental Canterbury (ECan) Wells database showed two wells located within approximately 360 m of the property and one located approximately 420m of the site (refer to Site Location Plan and Appendix A).

Since the earthquake sequence commenced the Earthquake Commission (EQC) have completed Boreholes and CPT tests throughout the residential areas of Christchurch. Two CPT's are located within close proximity to the building. Three CPT's were commissioned by CCC as part of the geotechnical assessment for the Wainoni Community Centre, located 40m to the south east of the Youth Activity Centre (Refer to Site Investigation Plan and CPT Logs in Appendix C).

Material logs available from ECan wells and results of CPT testing have been used to infer the ground conditions at the site, as shown in Table 1 below.

Stratigraphy	Thickness	Depth Encountered from borelogs
TOPSOIL	0.5m	0
SAND	34.5m	0.5m
Sandy Gravels (Riccarton Formation)	-	35.4m – 37.7m

Table 1 Inferred Ground Conditions

All borehole logs record a ground water level varying between 2.8m and 5.5m below the ground.

2.6 Liquefaction Hazard

Examination of post-earthquake aerial photos confirmed evidence of liquefied soils ejected at the ground surface after the Magnitude 6.3 February 2011 event and also the June 2011 aftershock. It appears soils ejected from liquefaction occurred in Hampshire Street and in Wainoni Park. Refer to Wainoni Community Centre Geotechnical Desk Study for detailed observations of the site wide liquefaction.

The 2004 Environment Canterbury Solid Facts Liquefaction Study indicates the site is in an area designated as 'moderate liquefaction ground damage potential'. According to this study, based on a low groundwater table, ground damage is expected to be moderate and may be affected by 100-300mm of ground subsidence.

The Christchurch Earthquake Recovery Authority (CERA) last updated 10 February 2012 has classified 31 Hampshire Street and the surrounding residential properties as Green Zone, indicating repair and rebuilding process can begin. The maps that were released by the Department of Building and Housing (DBH) on 9 February 2012 indicate that the area surrounding the site is classified as Technical Category 2 (yellow), which indicates that minor to moderate land damage from liquefaction is possible in future significant earthquakes.

3. Site Walkover Inspection

A walkover inspection of the interior of the building and surrounding land was carried out by Andrei Cotiga, Opus Geotechnical Engineer on 22 March 2012. The following observations were made (refer to the Walkover Inspection Plan and Site Photographs attached to this report):

- Confirmed evidence of ejected liquefied sand on Hampshire Street and in the park;
- Hairline cracks at some of the corners of the building. Possibly due to seismic shaking (Refer Photograph 5 and 6);

4. Discussion

Minor cracking has occurred to the Wainoni Youth Activity Centre at 31 Hampshire Street due to the Canterbury Earthquake Sequence following the 4 September 2010 earthquake.

No obvious evidence of lateral spreading due to the recent earthquakes was observed on the property or adjoining properties. An internal inspection of the Youth Activity centre did not identify any evidence of differential settlement of the foundations, however no lever survey has been completed.

While liquefaction has occurred in close proximity to the site, it appears the existing foundations have performed adequately in recent earthquakes.

Detailed drawings of the foundations have not been located. Based on the walkover it is assumed that the foundations are strip foundations along the perimeter of the building and some of the interior walls. The existing foundations have performed satisfactorily and do not appear to have sustained damage from cracking from differential settlement. The existing foundations are considered appropriate for the building with CCC acceptance of potential differential settlement in the order of 0 to 50mm in a future seismic event.

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[1] indicates there is a 16% 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, dependent on the location of the earthquakes epicentre. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity

5. Recommendations

- Based on the building performance in recent earthquakes and adjacent CPT tests, the existing foundations should be acceptable in terms of future ultimate limit state (ULS) and serviceability limit state (SLS) loadings, although CCC will have to accept the risk for potential differential settlement in the order of 0 to 50mm in a future seismic event;

---

[1] GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 3 February 2012.

- No further geotechnical investigations or geotechnical assessments are considered necessary.

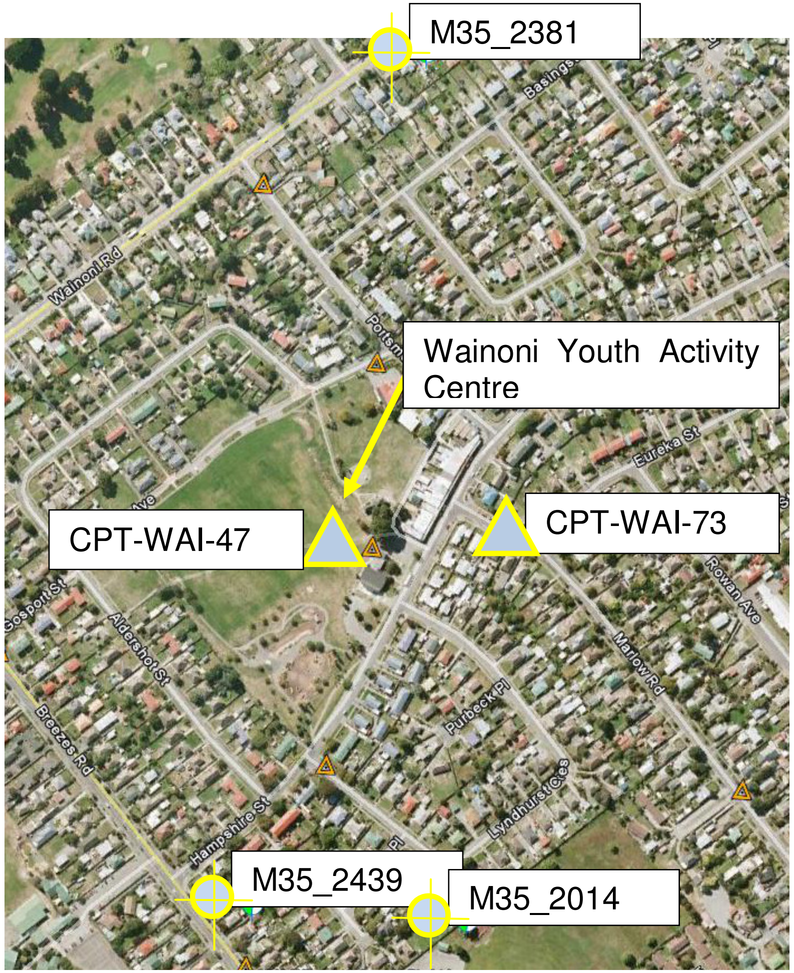
6. Limitation

This report has been prepared solely for the benefit of 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.

Prepared By:	Reviewed By:
Andrei Cotiga Geotechnical Engineer	Graham Brown Senior Geotechnical Engineer

<u>Figures:</u>
Site Location Plan
Walkover Inspection Plan
Site Photographs

<u>Appendices:</u>
Appendix A: Environment Canterbury Borehole Logs
Appendix B: EQC CPT Reports
Appendix C: CCC CPT Reports



Opus International Consultants Ltd. Christchurch Office 20 Moorhouse Ave PO Box 1482 Christchurch, New Zealand Tel: +64 3 363 5400 Fax: +64 3 365 7857	**Project:** 31 Hampshire Street Geotechnical Desktop Study **Project No.:** 6-QUCCC.66/025SC **Client:** Christchurch City Council	**Site Location Plan** **Completed by:** Andrei Cotiga on 21/03/2012 Civil/Geotechnical Engineer **Date Drawn:** 21/03/2012

OPUS
Opus International Consultants Ltd.
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project: 31 Hampshire Street
Geotechnical Desktop Study
Project No.: 6-QUCCC.66/025SC
Client: Christchurch City Council

Walkover Inspection Plan

Completed by: Andrei Cotiga on 21/03/2012
Civil/Geotechnical Engineer
Date Drawn: 21/03/2012


Photograph 1. Main entrance to building (East elevation)


Photograph 2. Northern elevation of the building

Photograph 3. Hairline crack in brick wall (does not extend into foundation)


Photograph 4. Western elevation of the building

Photograph 5. Southern side of the building

Photograph 6. Hairline cracking in brick wall (does not extend into foundation)

Appendix A:

Environment Canterbury Borehole Logs

Borelog for well M35/2014

Gridref: M35:859-436 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 3.9 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -81m Drill Date : 29/07/1914

Environment Canterbury Regional Council

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
- 32.3m	Sand	ch
- 37.7m	Clay	ch
- 50.2m	Blue shingle	ri
- 50.8m	Sand	br
- 52.7m	Clay	br
- 54.8m	Sand	br
- 66.7m	Blue clay & sand	br
- 73.1m	Blue shingle	li-1
- 78.0m	Clay	li-2
- 81.0m	Brown shingle	li-2

Scale(m): -10, -20, -30, -40, -50, -60, -70, -80

Borelog for well M35/2381

Gridref: M35:858-444 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 3.3 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -83.5m Drill Date : 9/08/1938

Environment Canterbury Regional Council

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
- 28.9m	Sand	ch
- 35.4m	Clay & peat	ch
- 44.1m	Blue gravel	ri
- 45.7m	Brown gravel	ri
- 60.3m	Blue sand	br
- 72.2m	Brown gravel	li-1 li-2
- 72.8m	Clay	li-2
- 74.7m	Blue sand	li-2
- 77.1m	Clay	li-2
- 78.3m	Peat	li-2
- 81.4m	Clay	li-2
- 83.6m	Brown gravel	li-2

Scale(m): -10, -20, -30, -40, -50, -60, -70, -80

Borelog for well M35/2439

Gridref: M35:857-436 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.3 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -79.9m Drill Date : 5/01/1922

Environment Canterbury Regional Council

Water Level: Artesian

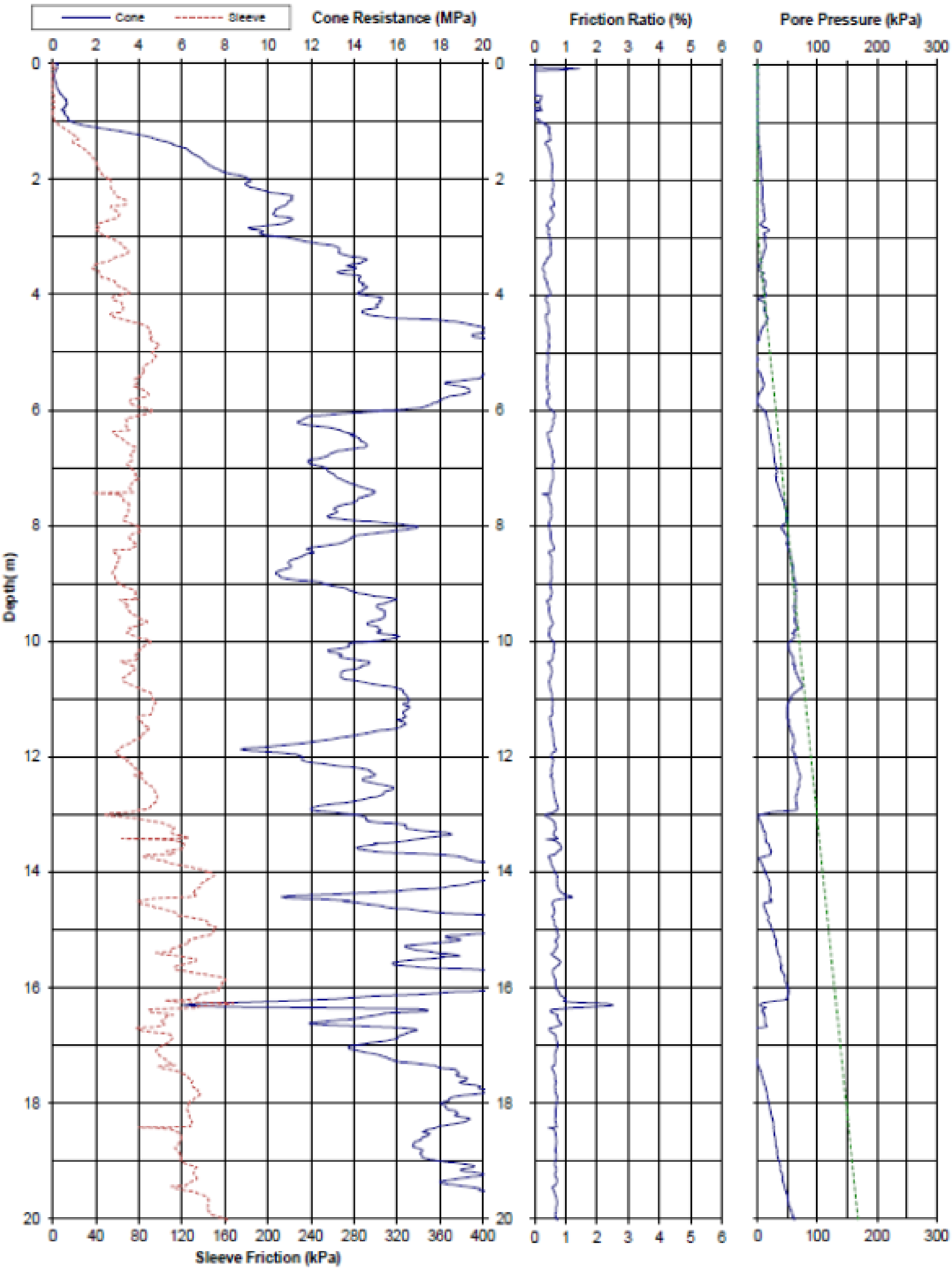
Depth(m)	Full Drillers Description	Formation Code
- 23.2m	Sand & clay	ch
- 30.4m	Blue sand & clay	ch
- 37.1m	Blue clay	ch
- 50.2m	Blue shingle	ri
- 59.4m	Blue sand & clay	br
- 63.1m	Blue clay	br
- 68.0m	Yellow clay & peat	br
- 75.0m	Brown shingle	li-1
- 77.7m	Yellow clay & peat	li-2
- 79.9m	Brown shingle	li-2

Scale(m): -10, -20, -30, -40, -50, -60, -70

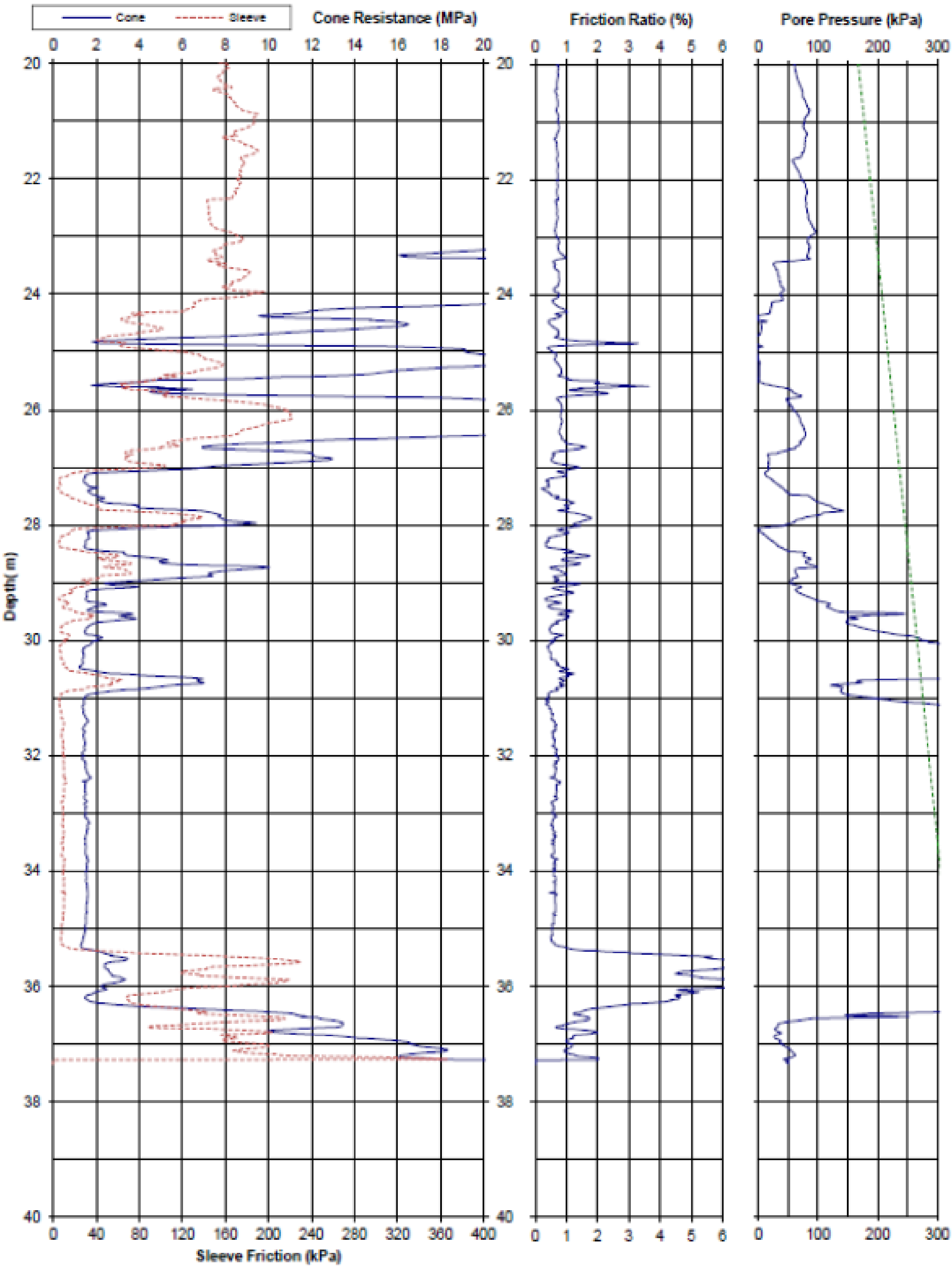
Appendix B:

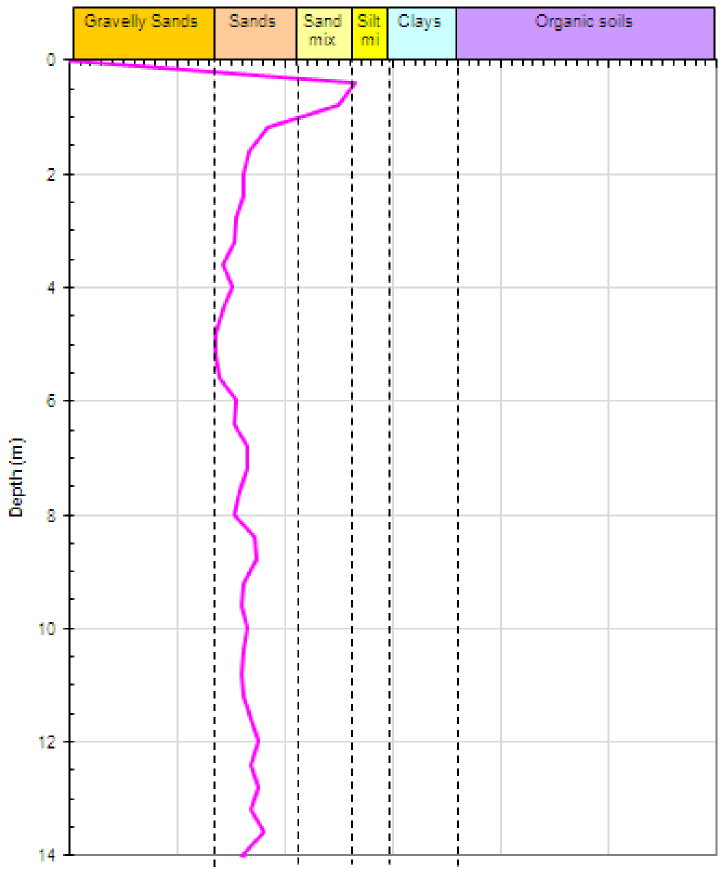
EQC CPT Report

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page: 1 of 2		CPT-WAI-47
Test Date:	1-Aug-2011	Location:	Wainoni	Operator:	Perry	
Pre-Drill:	1.2m	Assumed GWL:	2.9mBGL	Located By:	Survey GPS	
Position:	2485784.8mE	5743938.9mN	3.309mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



Project:	Christchurch 2011 Earthquake - EQC Ground Investigations					Page: 2 of 2	CPT-WAI-47
Test Date:	1-Aug-2011	Location:	Wainoni	Operator:	Perry		
Pre-Drill:	1.2m	Assumed GWL:	2.9mBGL	Located By:	Survey GPS		
Position:	2485784.8mE	5743938.9mN	3.309mRL	Coord. System:	NZMG & MSL		
Other Tests:				Comments:			



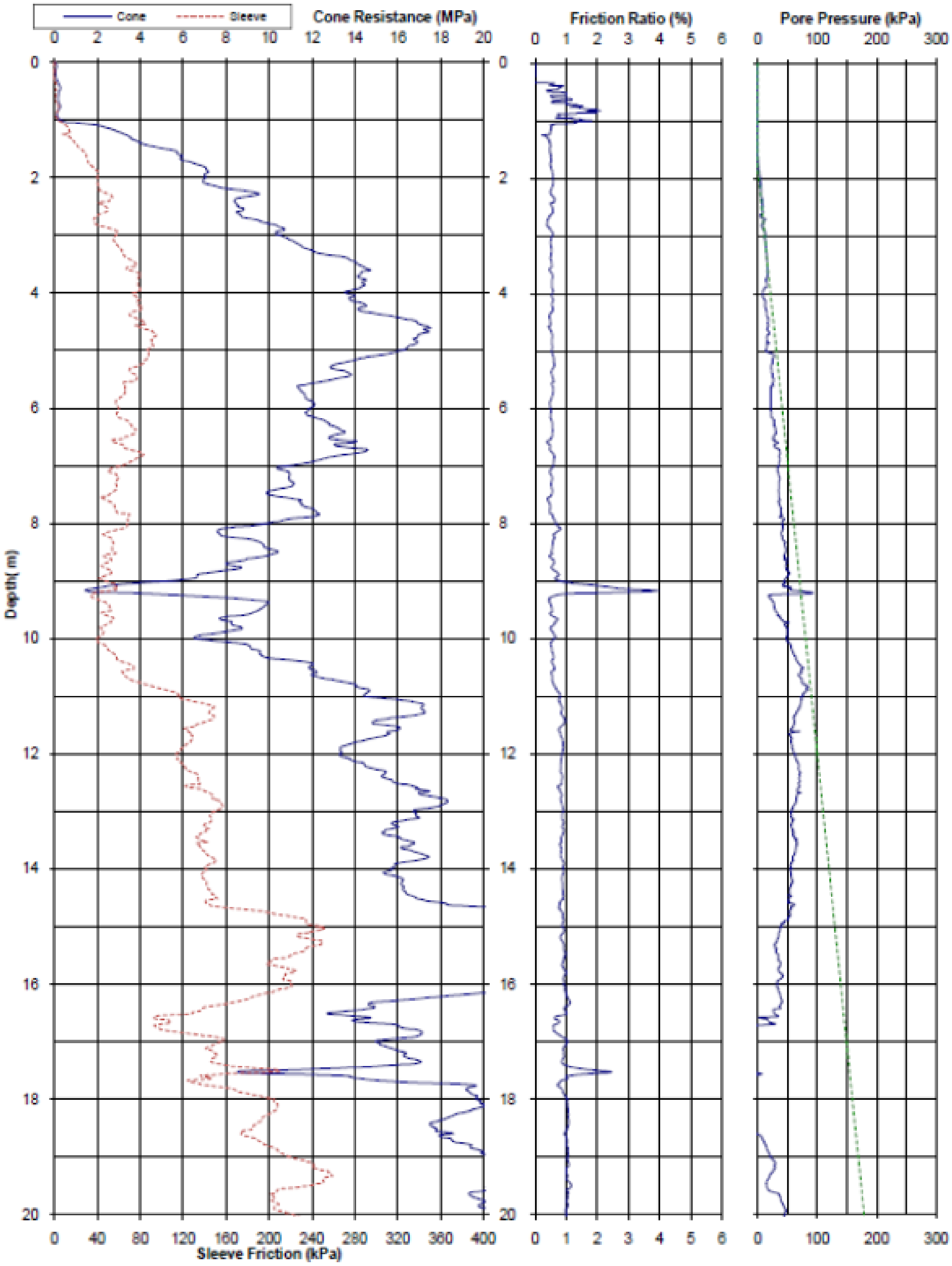


Project:	Wainoni Community Centre
Location:	31 Hampshire Street
Project number:	2-QUCCC.66
Analysis by:	Andrei Cotiga

CPT no:	CPT-WAI-47	GWL [m]:	2.9

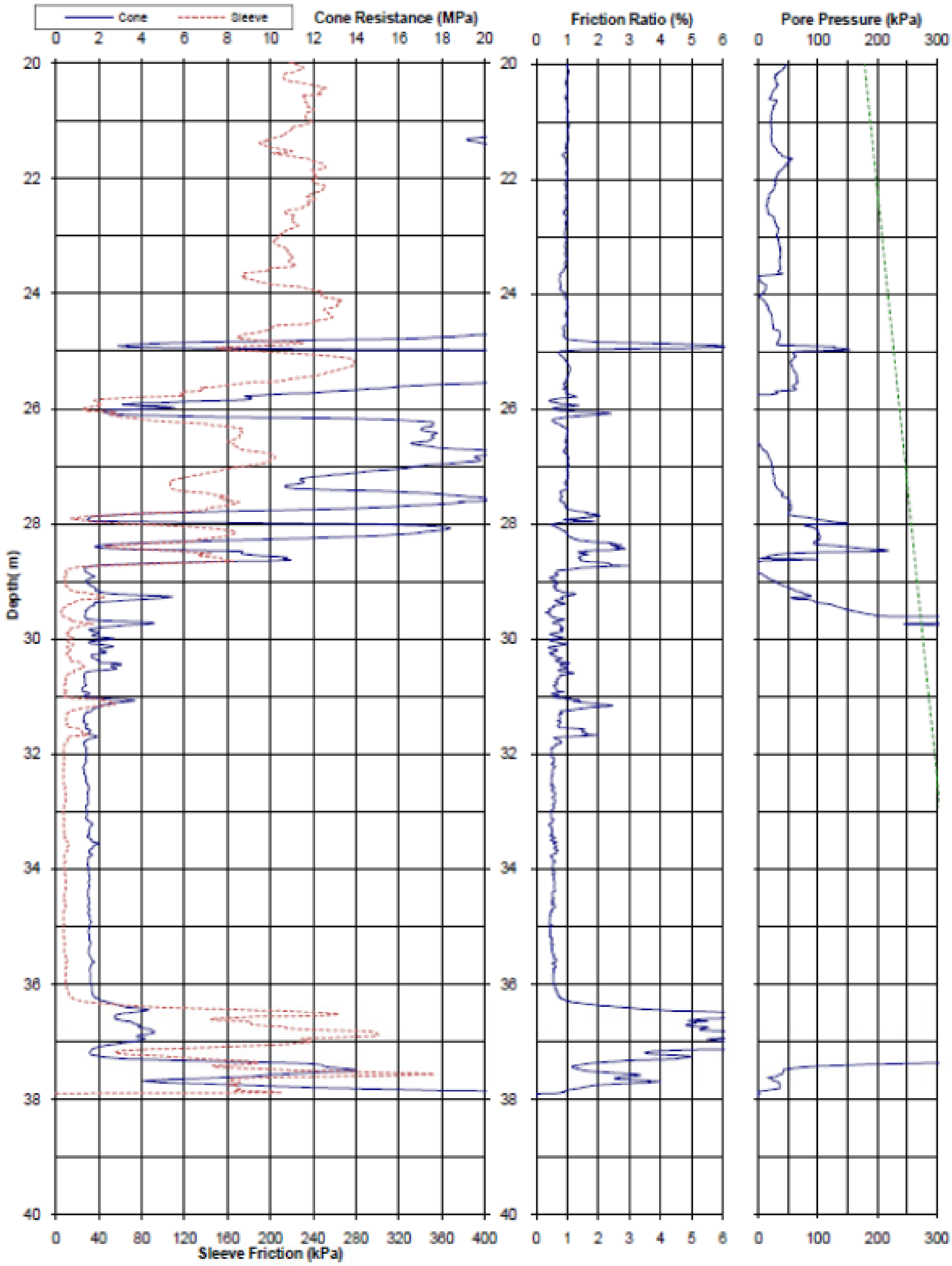
No	Depth [m]		Soil	I_c
	From:	To:		
1	0	0.8	Sand mix	2.00
2	0.8	19.59	Sand	1.48

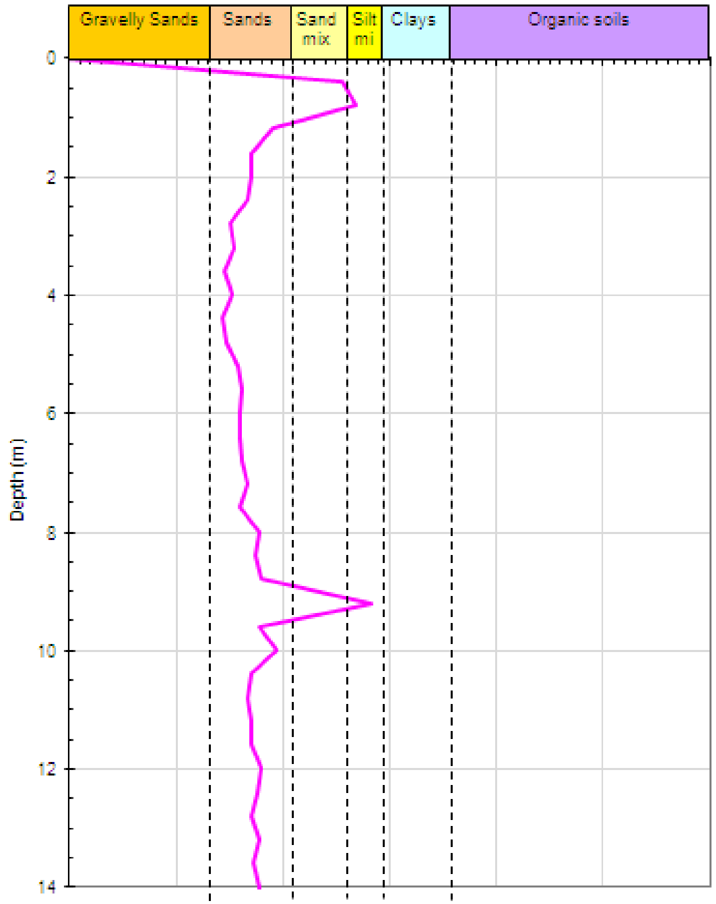
Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page: 1 of 2		CPT-WAI-73
Test Date:	5-Jul-2011	Location:	Wainoni	Operator:	Opus	
Pre-Drill:	1.2m	Assumed GWL:	1.8mBGL	Located By:	Survey GPS	
Position:	2485944.7mE	5743963.5mN	3.408mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



T+T Ref: 52000.3000 Printed: 12/08/2011 12:42 p.m. Template: CPT Graph Template v0.41.xls

Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page: 2 of 2		CPT-WAI-73
Test Date:	5-Jul-2011	Location:	Wainoni	Operator:	Opus	
Pre-Drill:	1.2m	Assumed GWL:	1.8mBGL	Located By:	Survey GPS	
Position:	2485944.7mE	5743963.5mN	3.408mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		





Project:	Wainoni Community Centre
Location:	31 Hampshire Street
Project number:	2-QUCCC.66
Analysis by:	Andrei Cotiga

CPT no:	CPT-WAI-73	GWL [m]:	1.8

No	Depth [m]		Soil	I_c
	From:	To:		
1	0	0.8	Silt mix	2.10
2	0.8	9.19	Sand	1.56
3	9.19	9.59	Silt mix	1.65
4	9.59	19.59	Sand	2.02

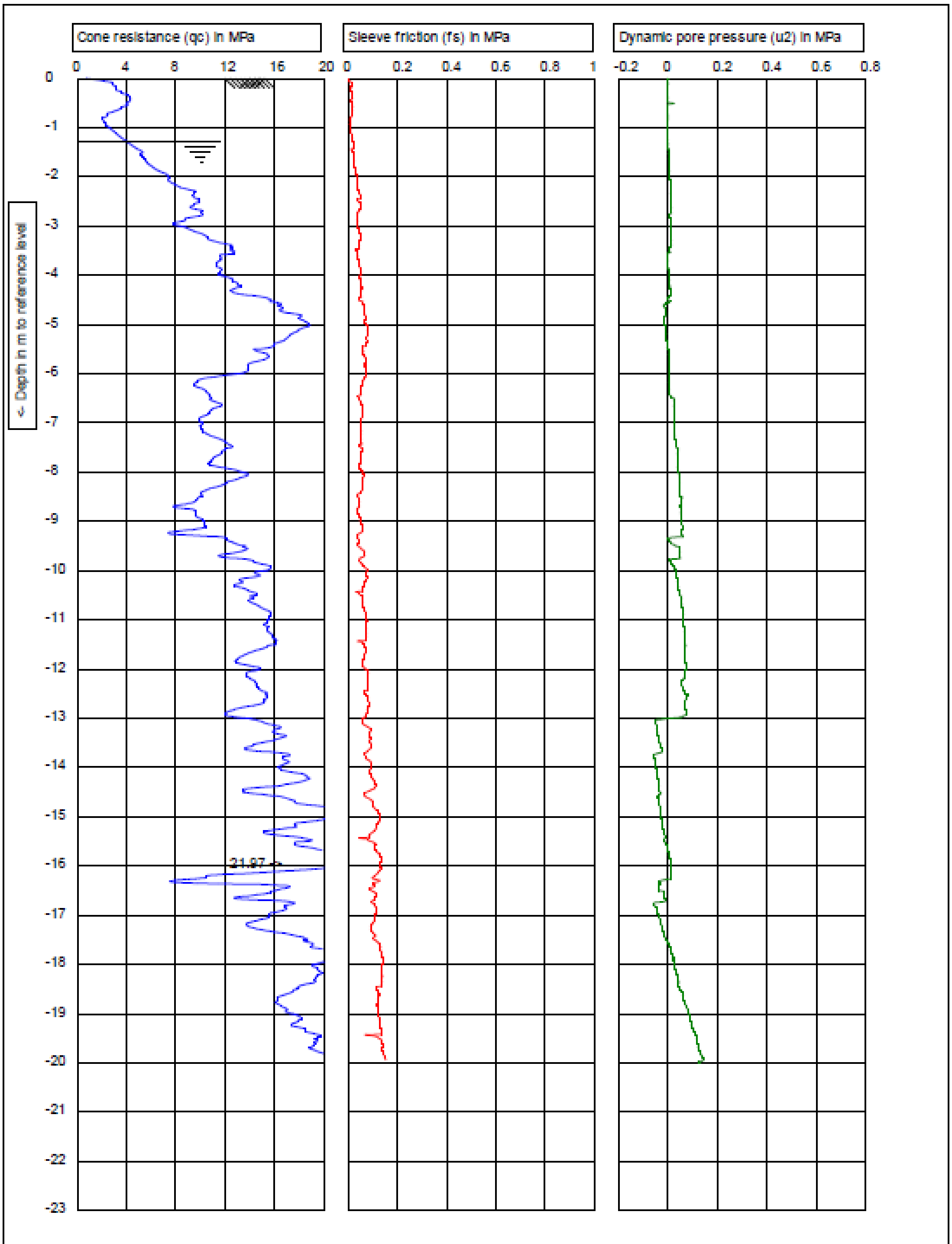
Appendix C:

CCC CPT Report

APPENDIX D

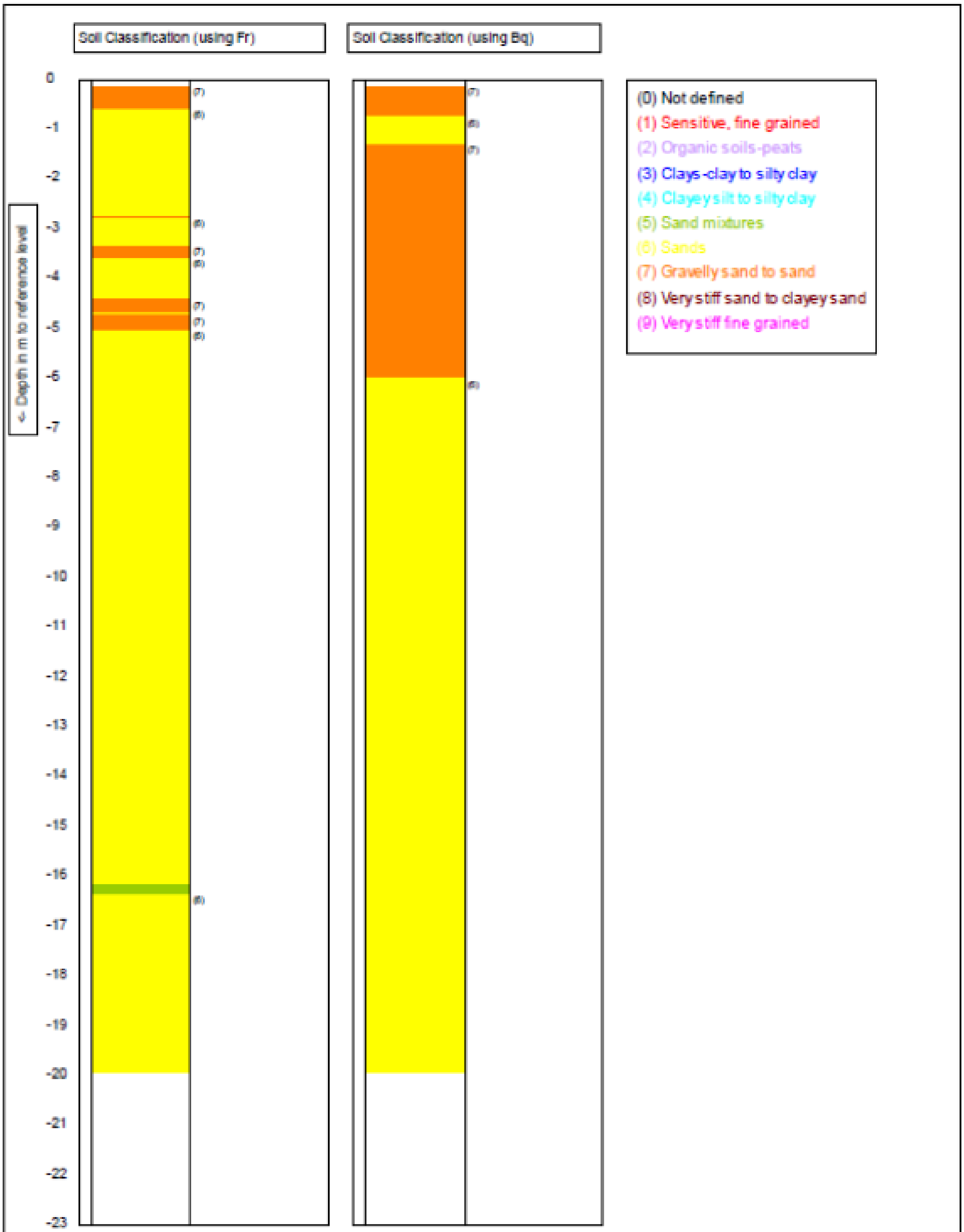
Figure 2 – Proposed Site Investigations

▲ - CPT ☐ - TP+HA

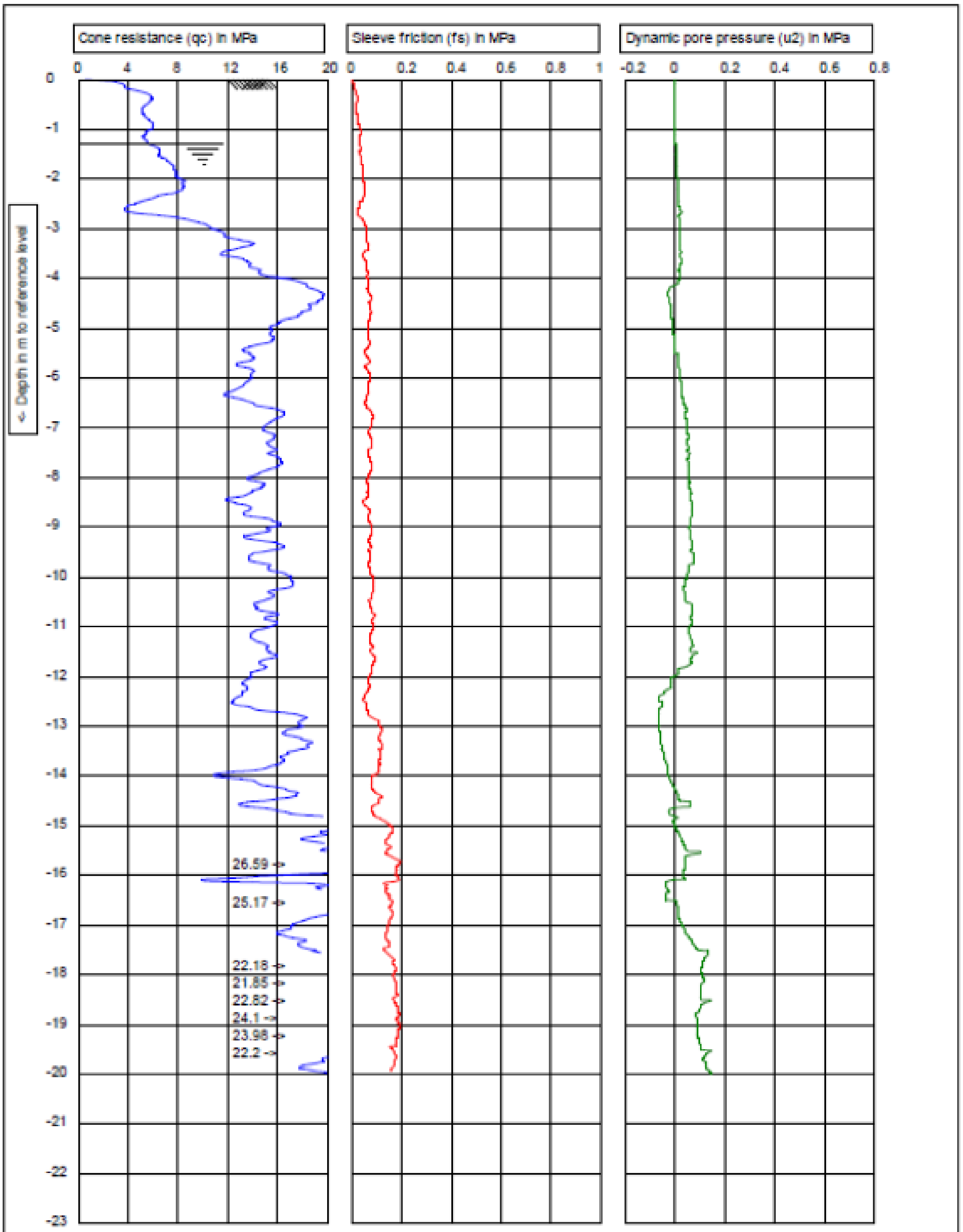


OPUS
HAMILTON LABORATORIES

Test according to A.S.T.M standard D-5778-95		Predrill :	0
G.L. 0	W.L.: -1.3	Date:	6/10/2011
Project:	Geotechnical Investigation	Cone no.:	C10CFIIP.C10021
Location:	Wainoni Community Centre	Project no.:	6-quccc.19
Position:		CPT no.:	CPT01 1/6

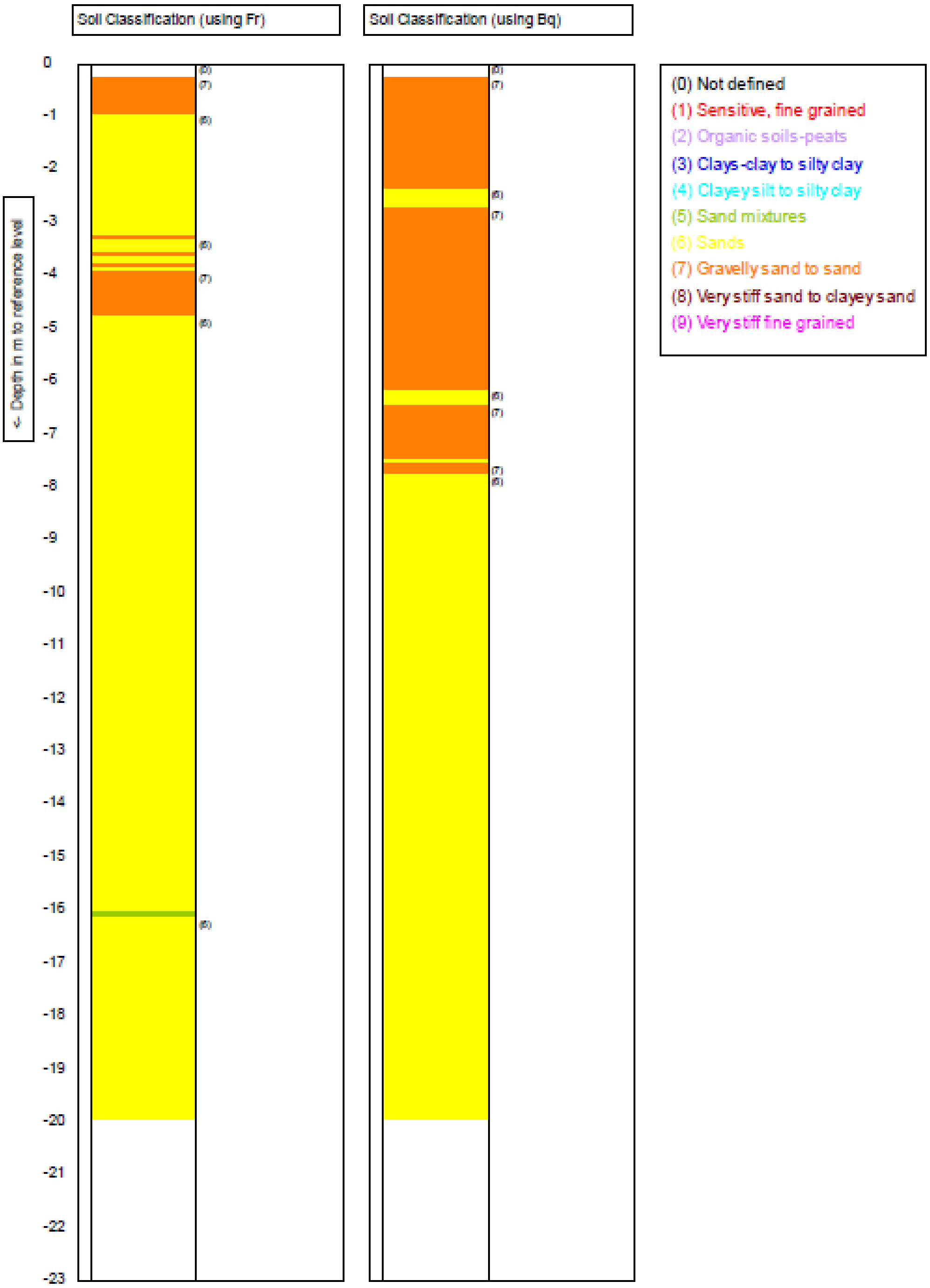


OPUS HAMILTON LABORATORIES	150 cm² 10 cm²	Test according to A.S.T.M standard D-5778-95	Predrill :	0
		G.L. 0 W.L.: -1.3	Date:	6/10/2011
	Project:	Geotechnical Investigation	Cone no.:	C10CFIIP.C10021
	Location:	Wainoni Community Centre	Project no.:	6-qucc c.19
	Position:		CPT no.:	CPT01 4/6



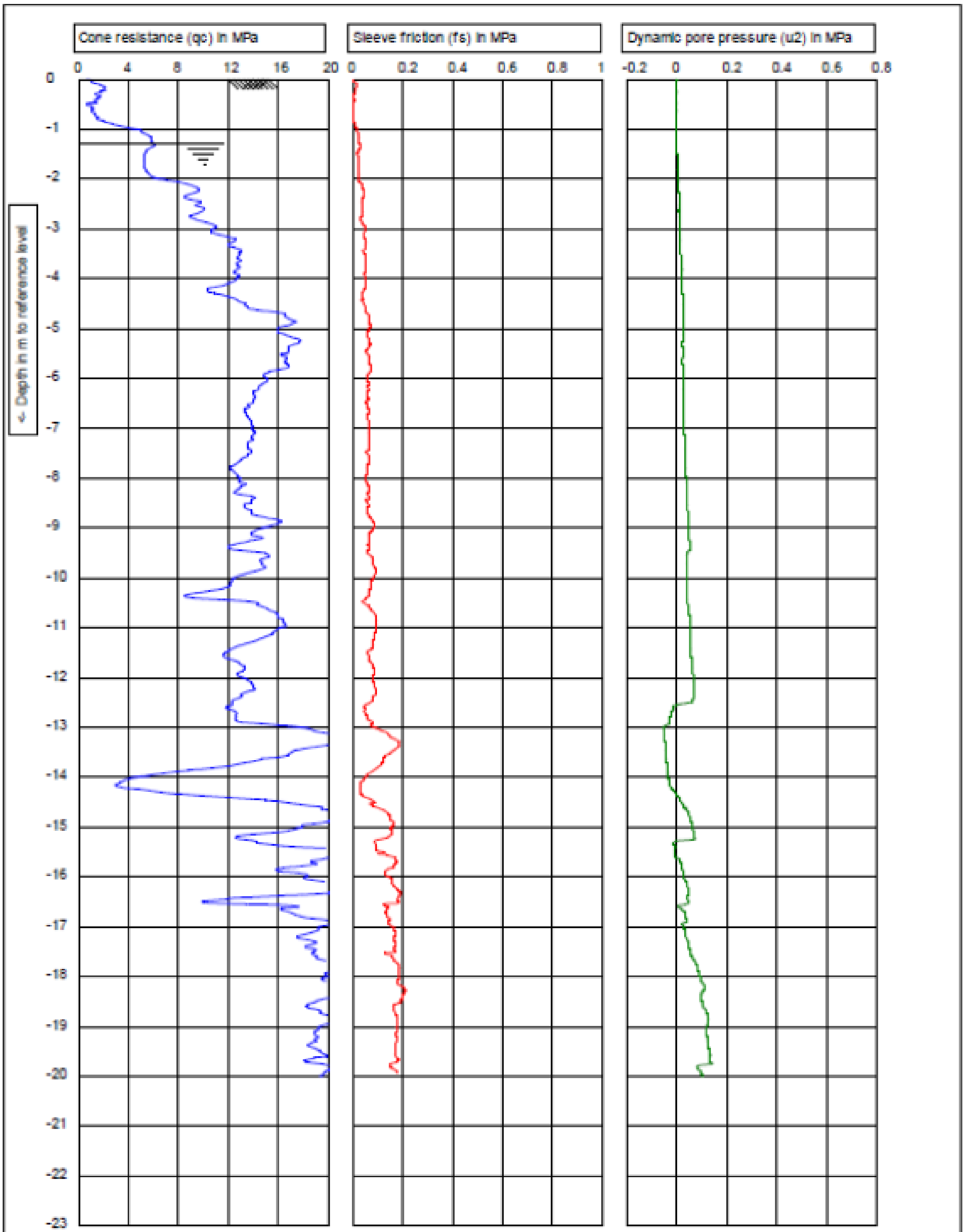
OPUS
HAMILTON LABORATORIES

Test according to A.S.T.M standard D-5778-95		Predrill :	0
G.L. 0	W.L.: -1.3	Date:	6/10/2011
Project:	Geotechnical Investigation	Cone no.:	C10CFIIP.C10021
Location:	Wainoni Community Centre	Project no.:	6-QUCCC.19
Position:		CPT no.:	CPT02 1/6



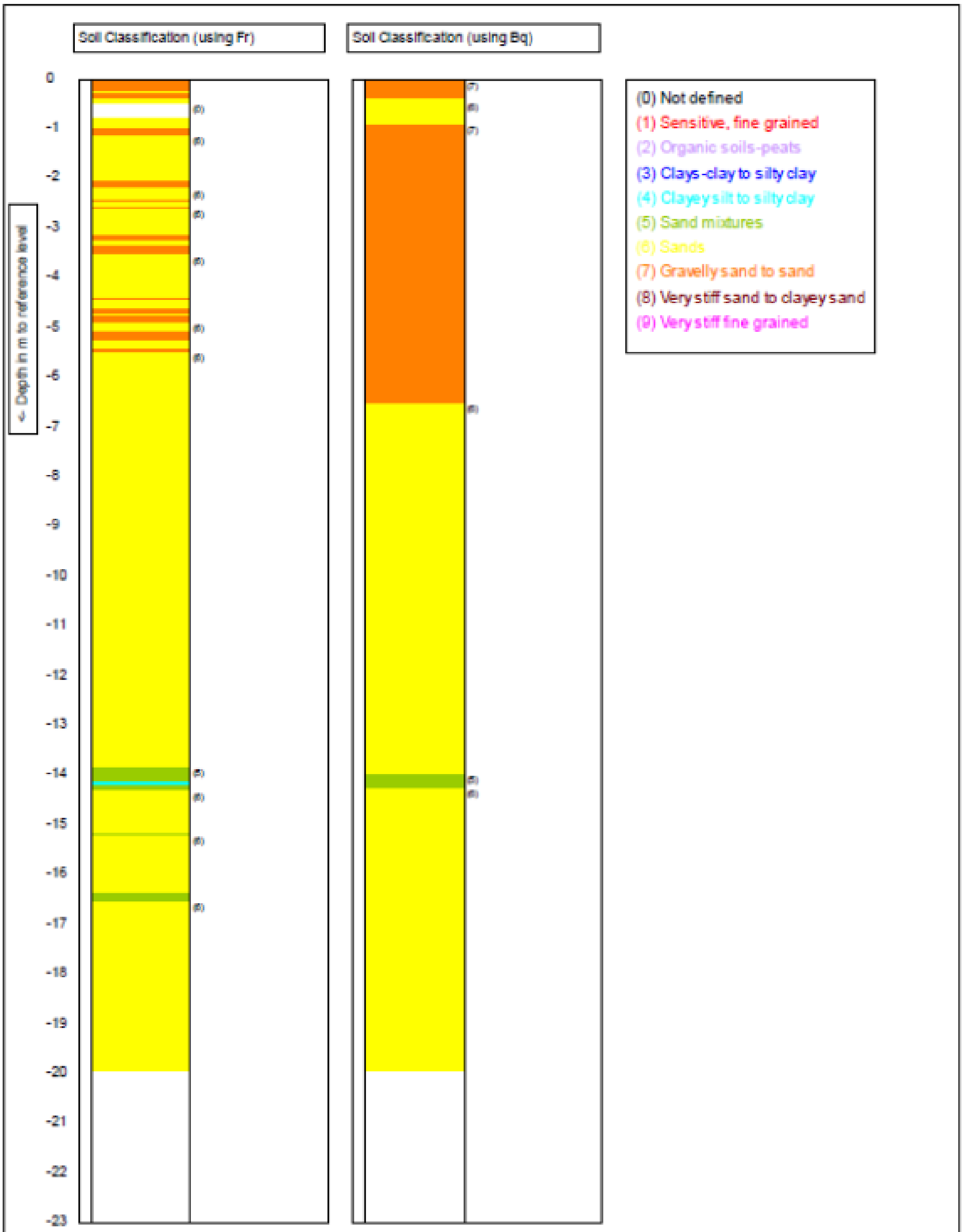
OPUS
HAMILTON LABORATORIES

150 cm² / 10 cm²	Test according to A.S.T.M standard D-5778-95	Predrill :	0
G.L. 0	W.L.: -1.3	Date:	6/10/2011
Project:	Geotechnical Investigation	Cone no.:	C10CFIIP.C10021
Location:	Wainoni Community Centre	Project no.:	6-QUCCC.19
Position:		CPT no.:	CPT02 4/6



OPUS
HAMILTON LABORATORIES

Test according to A.S.T.M standard D-5778-95		Predrill :	0
G.L. 0	W.L.: -1.3	Date:	6/10/2011
Project:	**Geotechnical Investigation**	Cone no.:	C10CFIIP.C10021
Location:	**Wainoni Community Centre**	Project no.:	6-QUCCC.19
Position:		CPT no.:	CPT03 1/6



HAMILTON LABORATORIES

Test according to A.S.T.M standard D-5778-95		Predrill :	0
G.L. 0	W.L.: -1.3	Date:	6/10/2011
Project:	**Geotechnical Investigation**	Cone no.:	C10CFIIP.C10021
Location:	**Wainoni Community Centre**	Project no.:	6-QUCCC.19
Position:		CPT no.:	CPT03 4/6

Appendix D – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Wainoni Park Activity Centre	Reviewer:	Dave Dekker
	Unit / No: / Street	CPEng No:	1003026
Building Address:	31 Hampshire Street	Company:	Opus International Consultants
Legal Description:		Company project number:	6-QUCCC-66
		Company phone number:	
	Degrees / Min / Sec		
GPS south:	43 / 30 / 40.00	Date of submission:	19-Nov-12
GPS east:	172 / 42 / 1.50	Inspection Date:	11-Apr-12
		Revision:	Final
Building Unique Identifier (CCC):	BU 1264-002 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:	silty sand	Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	
Ground floor split?	no	Ground floor elevation above ground (m):	0.10
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	7.00	height from ground to level of uppermost seismic mass (for IEP only) (m):	5
Floor footprint area (approx):	165		
Age of Building (years):	45	Date of design:	1935-1965
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	other (specify)	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	Leisure/Gymnasium		
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	3m, timber, metal sheet
Floors:	concrete flat slab	slab thickness (mm)	not known
Beams:			n/a
Columns:			n/a
Walls:	partially filled concrete masonry	thickness (mm)	190

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	partially filled CMU	note total length of wall at ground (m):	33m
Ductility assumed, μ:	1.25		
Period along:	0.40 ##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	
Lateral system across:	partially filled CMU	note total length of wall at ground (m):	20m
Ductility assumed, μ:	1.25		
Period across:	0.40 ##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):		estimate or calculation?	
maximum interstorey deflection (ULS) (mm):		estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			n/a
Wall cladding:	exposed structure	describe	main load bearing 200 series CMUs
Roof Cladding:	Metal	describe	metal sheet on WoodTek slabs
Glazing:	aluminium frames		
Ceilings:	plaster, fixed		
Services(list):			

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:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 m³/100m²	notes (if applicable):	
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:	0%	Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Minor vertical crack at wall junction b'ween portions of blo

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	Provide flexible sealant at wall junctions
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	100% ##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Pre-quake %NBS taken as matching DEE
	Assessed %NBS after e'quakes:	100%		
Across	Assessed %NBS before e'quakes:	76% ##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	76%		

OPUS