Christchurch City Council

Fred Price Courts Housing Complex BE 1323

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Fred Price Courts Housing Complex

Quantitative Assessment Report

76 Palmers Road, North Beach, Christchurch

Prepared By

Lachlan Howat
Graduate Structural Engineer

Opus International Consultants Ltd

Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre, Christchurch 8140
New Zealand

Telephone: +64 3 363 5400
Facsimile: +64 3 365 7858

Date: 30 April 2013
Reference: 6-QC128.00

Reviewed & Approved By

Mary Ann Halliday
Senior Structural Engineer
CPEng 67073

Status: Final

Summary

Fred Price Courts
BE 1323

Detailed Engineering Evaluation
Quantitative Report - Summary
Final

Background

This is a summary of the quantitative report for the Fred Price Courts Complex, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This assessment covers 19 identically constructed blocks containing 37 residential units and one community lounge.

Key Damage Observed

- Cracking to block veneers.
- Veneer fallen away from timber frames in some locations.
- Cracked internal linings above door frames and windows
- Floor slab settlement.

Critical Structural Weaknesses

No critical structural weaknesses were found in any of the buildings.

Indicative Building Strength

Based on available information and following a quantitative assessment, the original capacity of the building has been assessed to be 49% NBS along the building, as limited by the bracing available in the front wall of the units.

As the buildings have a capacity of between 33%NBS and 67%NBS it is considered to be a moderate earthquake risk building under the NZSEE classification system and has a relative risk of failure of 5-10 times that of a building constructed to the New Building Standard. Based on the form of construction and the seismic load resisting systems present we do not believe that the building has a high risk of collapse. It is therefore considered that there is not a high risk imposed to building occupants.

Recommendations

The following recommendations have been made for the site:

- Veneer ties checked for adequacy and corrosion.
- Check GIB nail spacing in all units and remediate as necessary.
- Strengthening options be developed to increase the seismic capacity of the buildings to at least 67%NBS.
- Investigate which units have piles.

- More level survey data will be required to assist the damage assessment for insurance.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council to undertake a detailed seismic assessment of Fred Price Courts, located at 76 Palmers Road, North Beach, Christchurch following the Canterbury earthquake sequence since September 2010.

The purpose of the assessment is to determine if the buildings on site are 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) [3] [4].

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 October 2011 following the Darfield Earthquake on 4 September 2010.

1. The policy includes the following:
2. A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
3. A strengthening target level of 67% of a new building for buildings that are Earthquake Prone;
4. A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
5. 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.

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

4 Building Descriptions

4.1 General

The Fred Price Courts complex was built in 1975 and consists of 37 residential units and one community lounge. All blocks, including the block with the community lounge, have identical superstructure construction. The foundation layouts of the blocks vary between blocks based on their location within the site. The location of the site relative to the Christchurch City CBD is shown in Figure 2.

Figure 2: Location of site relative to Christchurch City CBD (Sourced from Google maps).

The site layout and unit numbers are shown in Figure 3 and Figure 4 respectively.

Figure 3: Aerial view of Fred Price Courts (sourced from Google Earth)

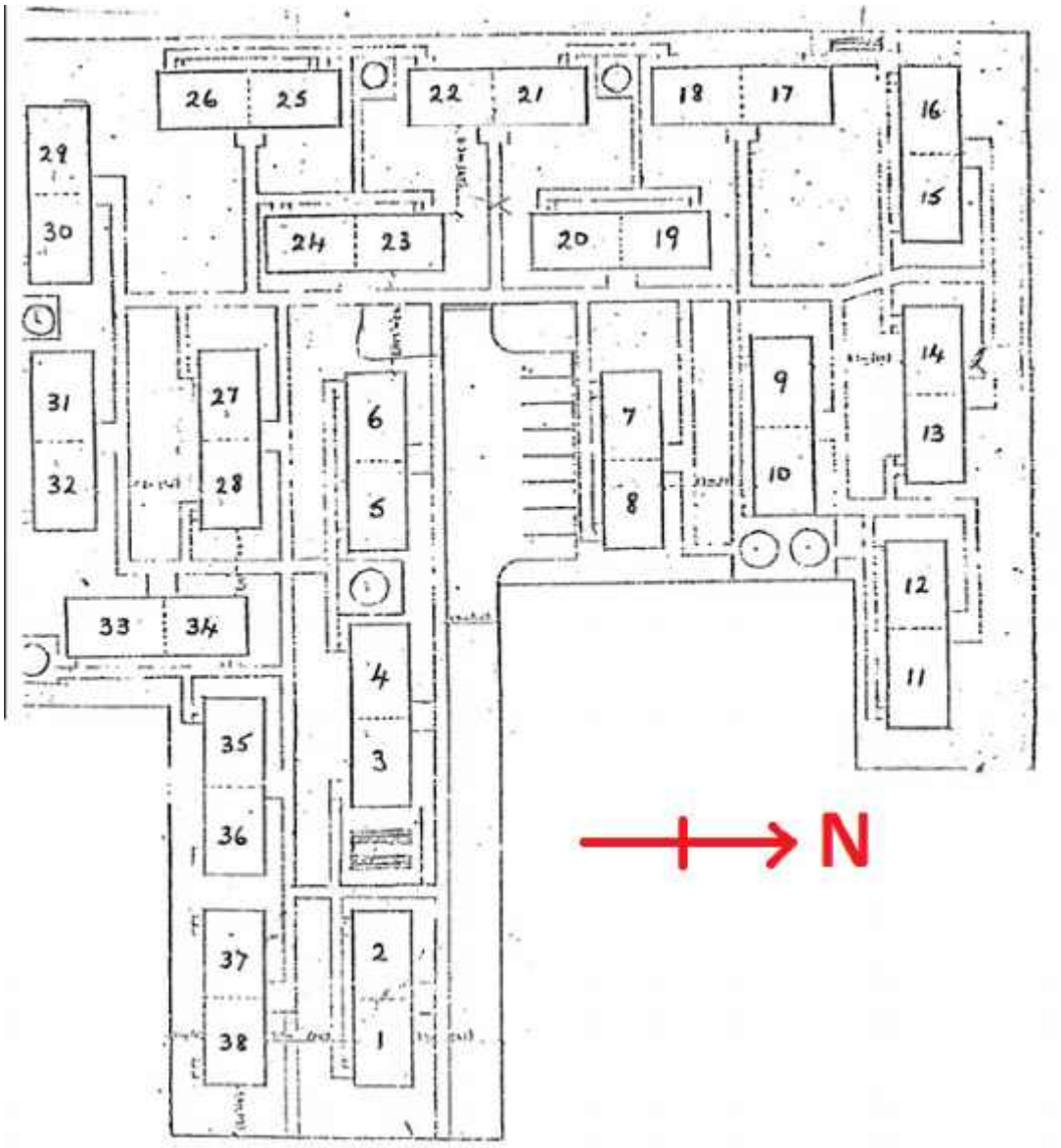


Figure 4: Site plan of Fred Price Courts.

Each unit is a single storey timber framed structure with Summerhill stone cladding and a timber trussed roof covered with concrete tiles. The units are separated by 200mm block masonry fire walls which consist of partially filled blockwork to the height of the roof ridge. The buildings are founded on various combinations of; reinforced concrete perimeter beams, bored piles and a 150mm thick hardfill layer. These combinations vary based on the location of each particular block. All units have a 100mm thick reinforced concrete slab on a damp proof course. A typical floor plan is shown in Figure 5; the lines used for bracing are shown in red.

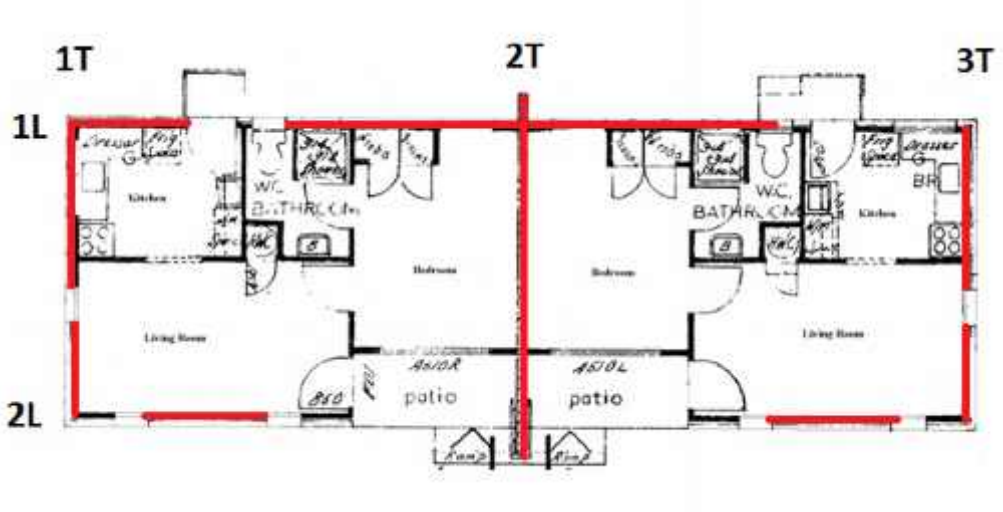


Figure 5: Typical floor plan of a block at Fred Price Courts (red lines indicate bracing lines)

Each block is approximately 16.5m long by 5.4m wide. The apex of the roof is 3.7m from ground level, with a ceiling height of 2.4m. All timber stud walls are lined with 9.5mm GIB board and external timber walls have a timber diagonal brace.

4.2 Gravity Load Resisting System

The roof structure consists of timber trusses covered with heavy concrete tile roofing. The roof trusses are supported by timber stud walls, which are 2.4m in height. The compartment blockwork wall is connected to the roof with 10mm bolts and provides fire separation between adjacent units.

All loadbearing walls and blockwork are constructed on shallow foundation beams. The ground floor construction consists of concrete slab-on-grade.

4.3 Seismic Load Resisting System

Seismic loads in both principal directions are resisted by braced timber stud walls lined with GIB board. The roof structure comprises of timber roof trusses, clad in concrete tiles, with timber braces spanning longitudinally between the trusses.

The partially filled compartment blockwall can be considered to provide resistance to transverse earthquake loads as the roof trusses adjacent to the block wall are bolted to the block wall at roof and ceiling level.

The concrete ground slabs are not tied to the foundation beams or the compartment walls.

4.4 Original Documentation

Copies of the following construction drawings were provided by CCC:

- 'Proposed Merritt-Beazley Cottages for the Elderly – Palmers Road – Christchurch' - 1975

Copies of the design calculations were not provided.

5 Survey

This report is based on site inspection records and photographic evidence. Site visits by Opus engineers included:

- A rapid assessment was carried out by an Opus Structural Engineer after the February earthquake.
- Site visits by Opus Structural Engineers on the 13th August 2012 and 4th April 2013.

6 Structural Damage

This section outlines the damage to the buildings that was observed during site visits. It is not intended to be a complete summary of the damage sustained by the buildings due to the earthquakes as some forms of damage may not be noticeable with only a visual inspection.

All units suffered minor damage to the internal wall linings, roofs and block veneer. The minor differential settlement caused damage to block veneers and caused the slabs to subside. Damage to the internal linings and veneers of the units is due to a combination of lateral earthquake movement and settlement.

The following damage was observed:

- Step cracking to block veneers.
- Units 25 and 37 had significant amounts of veneer blocks fall off in isolated locations.
- Floor settlement and sloping up to 12mm/m in isolated locations, generally more than 4mm/m throughout the site.
- Cracking in timber frame wall linings, particularly above door frames and windows.
- Cracks at junction between walls and ceilings.
- Minor tilting of the block fire walls. Maximum of 25mm over the whole wall in unit 8.

7 General Observations

The buildings appeared to have performed as reasonably expected during the earthquakes. They have suffered distributed amounts of minor to moderate damage which is consistent with the heavy nature of the cladding and the age of the buildings.

The spacing of GIB nails was checked in several locations throughout the site. This showed some locations had nail spacing of up to 450mm which is inadequate for bracing purposes. Due to the non-intrusive nature of the original survey, many other connection details could not be ascertained.

Deformation of the roofline was observed especially near the firewall. This has caused uplift of the tiles on the ridgeline and splitting of tiles throughout the roof.

The displacement of several veneer blocks indicates that the veneers may not be adequately tied to the timber frame. This could not be checked during site visits and may be due to:

- Inadequate spacing of ties.
- The existing ties have been compromised by corrosion, possibly due to the proximity of the site to a marine environment.

8 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [2] guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" together with the "Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury, Part 2 Evaluation Procedure" [3] draft document prepared by the Engineering Advisory Group on 19 July 2011, and the SESOC guidelines "Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes" [5] issued on 21 December 2011.

As all of the residential units have the same floor plan, the analysis was simplified by conducting the analysis only once and applying the results across all buildings.

8.1 Critical Structural Weaknesses

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 a building. No critical structural weaknesses were identified in the buildings.

8.2 Quantitative Assessment Methodology

The assessment assumptions and methodology have been included in Appendix 2. A brief summary follows:

Hand calculations were performed to determine seismic forces from the current building codes. These forces were distributed to walls by tributary area and relative rigidity. The capacities of the walls were calculated and used to estimate the % NBS. Where sections within the same block were constructed at separate times (such as extensions or alterations), they have been analysed separately.

8.3 Assessment

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

Table 2: Summary of Seismic Performance

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	% NBS based on calculated capacity.
All Units	Bracing capacity of the shear walls on the 'front face' of the building.	49%
	Bracing capacity of the shear walls on the 'rear face' of the building.	100%
	Bracing capacity of the shear walls on the 'end faces' of the building.	96%
	Bracing capacity of the shear walls on the 'fire wall' of the building.	70%

8.4 Discussion of Results

The buildings have a calculated capacity of 49% NBS, as limited by the bracing capacity of the timber frame walls on the front of the building, and is therefore classed as a moderate risk building in accordance with NZSEE guidelines.

Note that none of the buildings on site fall under the Earthquake Prone Buildings policy as they are all single storey residential buildings that contain no more than two units.

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 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 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.
- Construction is consistent with normal practise of the era in which constructed.

9 Summary of Geotechnical Appraisal

The Christchurch Earthquake Recovery Authority (CERA) has rezoned the "green" rebuild zones into various technical categories (TC). The property at Palmers Road has been zoned as TC3 "blue zone" (as shown in Figure 6), which is determined to be likely to suffer moderate to significant land damage from liquefaction in future significant earthquakes. Figure 6 illustrates the CERA technical category on their mapping service.

Figure 6: CERA Technical Categories Mapping (location starred)

Significant liquefaction damage has occurred at Fred Price Courts as a result of the 2010 and 2011 earthquake sequence. At the time of the 5 April 2013 inspection, evidence of ejected material and ground settlement was observed. The damage to pavements appears to be a result of differential settlement and uplift due to liquefaction heave. Minor cracking within the building footings was observed. The EQC maps showing areas of liquefaction interpreted from high resolution aerial photos indicate evidence of moderate to severe observed liquefaction on the site, or in the vicinity, after the June 2011 seismic event with minor observed liquefaction after the February and December 2011 seismic events.

The level survey results have been assessed and indicated large variations (up to 142mm) in floor level in Units 1, 2, 6-9, 31 and 32 in the Fred Price Courts complex. In accordance with the MBIE guidance (December 2012), these units will require a foundation re-level.

Boreholes and CPTs undertaken for EQC indicate the residential complex is likely to be founded on layers of loose to medium dense Sand overlying dense to very dense Sand from approximately 11.0-12.0m depth, with groundwater depths of approximately 1.5-2.1 m below ground level. Liquefaction typically occurs in recent (i.e. less than 10,000 years old), normally consolidated silts and sands beneath groundwater and is dependent on material density, grain size and soil composition. The liquefaction assessment identified liquefiable layers from 1 to 5m and 11.5 to 17.5m below ground

level from CPT 2892 and 5212. The subsurface ground profile together with the ground damage reported at the site during the recent earthquakes of 2010 and 2011, confirm that the site has a high risk of liquefaction.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the September 2010 earthquake. Recent advice (Geonet) indicates there is currently an 11% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. Such an event may cause liquefaction induced land damage similar to that experienced, dependent on the location of the earthquake's epicentre. This confirms that there is currently a risk of liquefaction and further differential settlement at Fred Price Courts. Refer to Desktop Geotechnical Report in Appendix 4.

10 Remedial Options

Any remedial options for increasing the seismic capacity above 67% NBS would need to address the capacity of the foundations and ensure that they can accommodate significant differential settlement.

Additional fixing of plasterboard (eg. adding nails so that the spacing between nails is 150mm) and the replacement of the heavy concrete roof with a lighter alternative are typical ways that the capacity of these structures can be increased.

11 Conclusions

As the building has a seismic capacity of 49%NBS it is considered to be a moderate earthquake risk building under the NZSEE classification system and has a relative risk of failure of 5-10 times that of a building constructed to the New Building Standard. Based on the form of construction and the seismic load resisting systems present we do not believe that the building has a high risk of collapse. It is therefore considered that there is not a high risk imposed to building occupants.

There are four units currently unoccupied. There is no evidence to suggest that they should remain so because of structural concerns.

- GIB nail spacing is inadequate for bracing in some locations.
- The block veneers pose a fall hazard as veneer ties may be inadequately spaced or may have suffered from corrosion due to their proximity to a marine environment.
- Based on the geotechnical appraisal, differential settlement as a result of liquefaction could result in further damage, similar in nature to that which has occurred in the recent earthquake sequence. However, based on the nature of construction, this is unlikely to result in the collapse of concrete ground beams.

12 Recommendations

The following recommendations have been made for the complex:

- Veneer ties checked for adequacy and corrosion.

- Check GIB nail spacing in all units and remediate as necessary.
- Strengthening options be developed to increase the seismic capacity of the buildings to at least 67%NBS.
- Investigate which units have piles.
- More level survey data will be required to assist the damage assessment for insurance.

13 Limitations

- This report is based on an inspection of the buildings and focuses on the structural damage resulting from the Canterbury Earthquake Sequence since September 20120 and its subsequent aftershocks only. Some non-structural damage may be described but this is not intended to be a complete list of damage to non-structural items.
- 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 this time.
- This report is prepared for the Christchurch City Council to assist in the assessment of any remedial works required for Fred Price Courts. It is not intended for any other party or purpose.

14 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 (2011), Practice Note – Design of Conventional Structural Systems Following Canterbury Earthquakes, Structural Engineering Society of New Zealand, 21 December 2011.

[6] DBH (2012), Guidance for engineers assessing the seismic performance of non-residential and multi-unit residential buildings in greater Christchurch, Department of Building and Housing, June 2012.

Appendix 1 - Photographs

Fred Price Courts		
No.	Item description	Photo
Residential Units		
1.	Typical Front Elevation	
2.	Typical Rear Elevation	

3.	Typical End Elevation 1	
4.	Typical End Elevation 2	
5.	Interior – Residents Lounge	

6.	Typical Roof Space	
7.	Typical Roof Space	
8.	Roof/Block wall connection	

9.	Roof/Block wall connection	
10.	Typical Internal Lining Damage	

11.	Typical Internal Lining Damage	
12.	Typical Internal Lining Damage	
13.	Typical Internal Lining Damage	

14.	450mm GIB Nail Spacing (Unit 32)	
15.	300mm GIB Nail Spacing (Unit 1)	

16.	450mm GIB Nail Spacing (Unit 3)	
17.	Temporary Veneer Bracing (Between units 36-37)	

18.	Veneer removed and covered	
19.	Veneer removed and covered -Unit 37	

20.	Veneer removed and covered -Unit 25	
21.	Typical step cracking in veneer	
22.	Typical veneer displacement	

23.	Damage to roof tiles	

Appendix 2 - Methodology and Assumptions

Seismic Parameters

As per NZS 1170.5:

- T < 0.4s (assumed)
- Soil: Category D
- Z = 0.3
- R = 1.0 (IL2, 50 year)
- N(T,D) = 1.0

For the analyses, a μ of 2 was assumed for the residents lounge and the residential units.

Analysis Procedure

The age and/or structural layout of the buildings meant that a rigid diaphragm assumption would be invalid for the ceiling diaphragms of all of the buildings. Base shears and capacities were therefore calculated based on tributary areas.

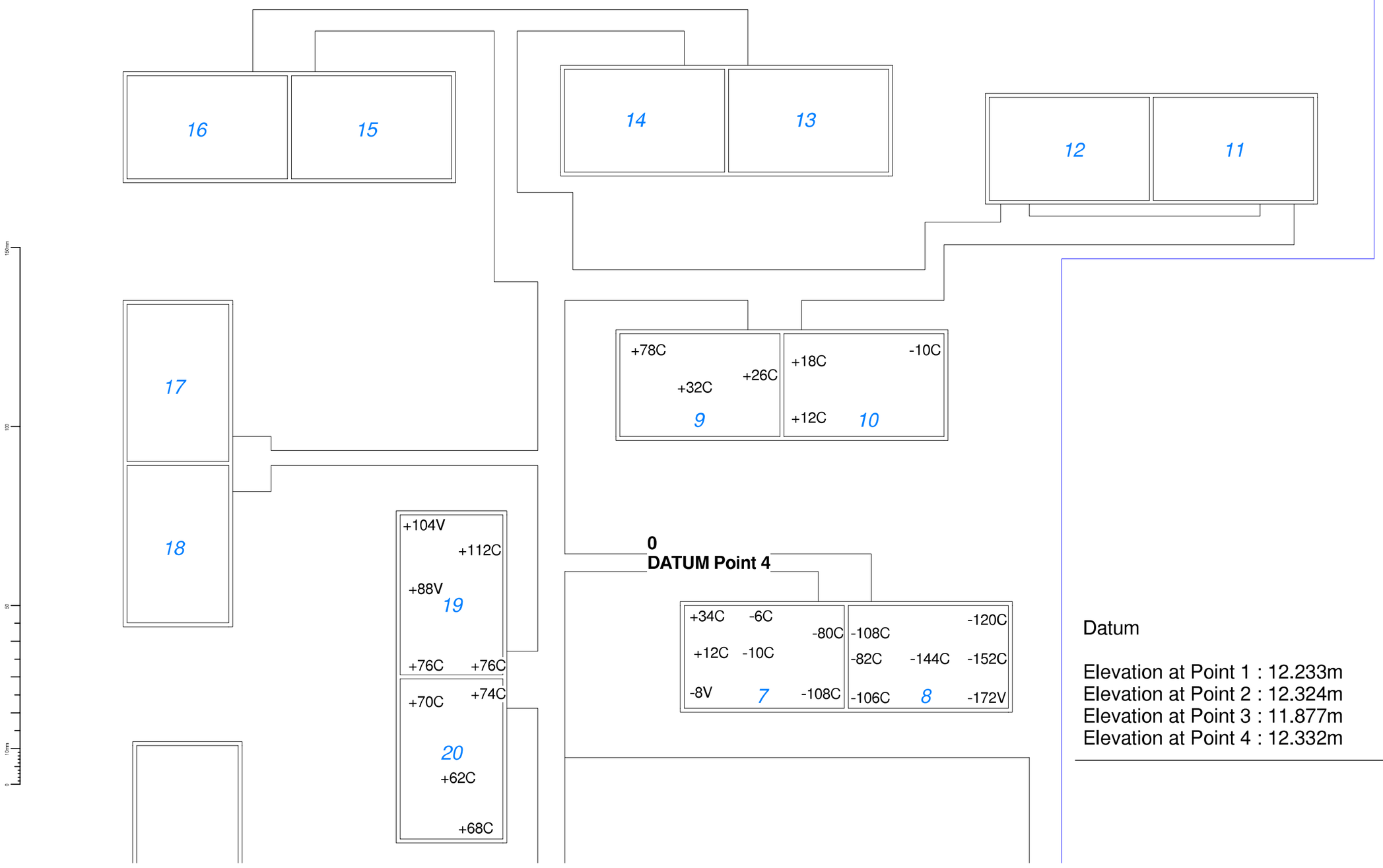
Capacities were based on the NZS 3604 approach where base shears are converted to bracing units (1 kN = 20 BU's) and the bracing capacities were found by assuming a certain BU/m rating for the walls along each line. Due to the unknown nature of the walls, the BU/m rating was taken as 60 BU/m for all timber walls with an aspect ratio (height : length) of less than 2:1. This was scaled down to 0 BU/m at an aspect ratio of 3.5:1 as per NZSEE guidelines. %NBS values were then found through the ratio of bracing demand to bracing capacity along each line; with the worst %NBS for each block being reported.

Additional Assumptions

Further assumptions about the seismic performance of the buildings were:

- Foundations and foundation connections had adequate capacity to resistance and transfer earthquake loads.
- Connections between all elements of the lateral load resisting systems are detailed to adequately transfer their loads sufficiently and are strong enough so as to not fail before the lateral load resisting elements.

Appendix 3 – Level Survey



Datum

Elevation at Point 1 : 12.233m
Elevation at Point 2 : 12.324m
Elevation at Point 3 : 11.877m
Elevation at Point 4 : 12.332m

Revision	Amendment	Approved	Revision Date

OPUS
Christchurch Office
+64 3 365 5400
PO Box 1482
Christchurch 8140
New Zealand

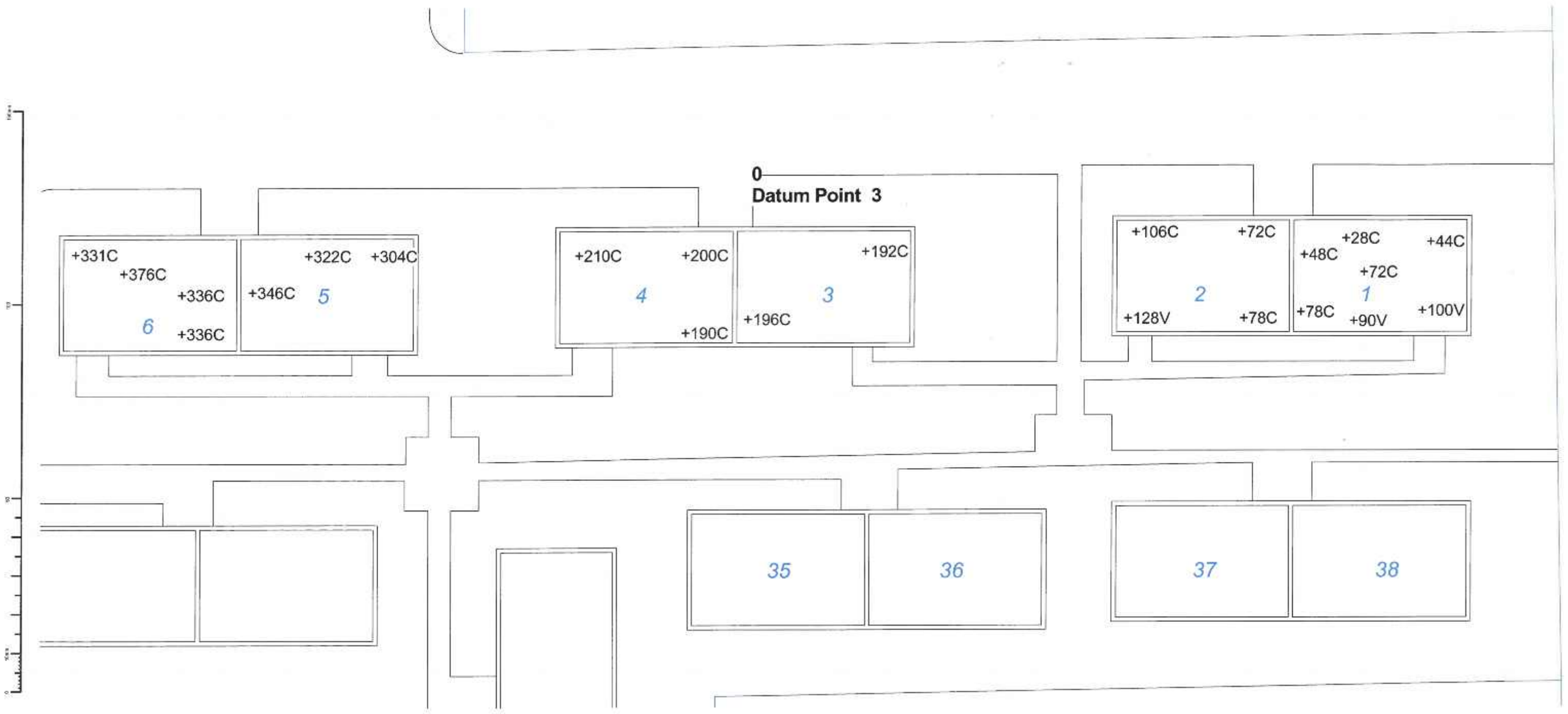
Drawn	Designed	Approved	Revision Date
Author	Designer	Approver	

Project
Fred Price Courts
76 Palmers Road
Level Survey

Title
units7-20

Project No.	Scale	Drawing No.	Sheet No.	Revision
	As indicated		A103	RA

Original sheet size A3 (420x297) Plot date: 22/04/2013 11:41:47 a.m. \\chwin01\Users$\chtpm0\document\CCC work\Fred Price Courts, Level Plan.rvt



Datum

Elevation at Point 1 : 12.233m
Elevation at Point 2 : 12.324m
Elevation at Point 3 : 11.877m
Elevation at Point 4 : 12.332m

Number	Amendment	Approved	Particulars Date

OPUS
Christchurch Office
+64 3 365 5400
PO Box 1482
Christchurch 8140
New Zealand

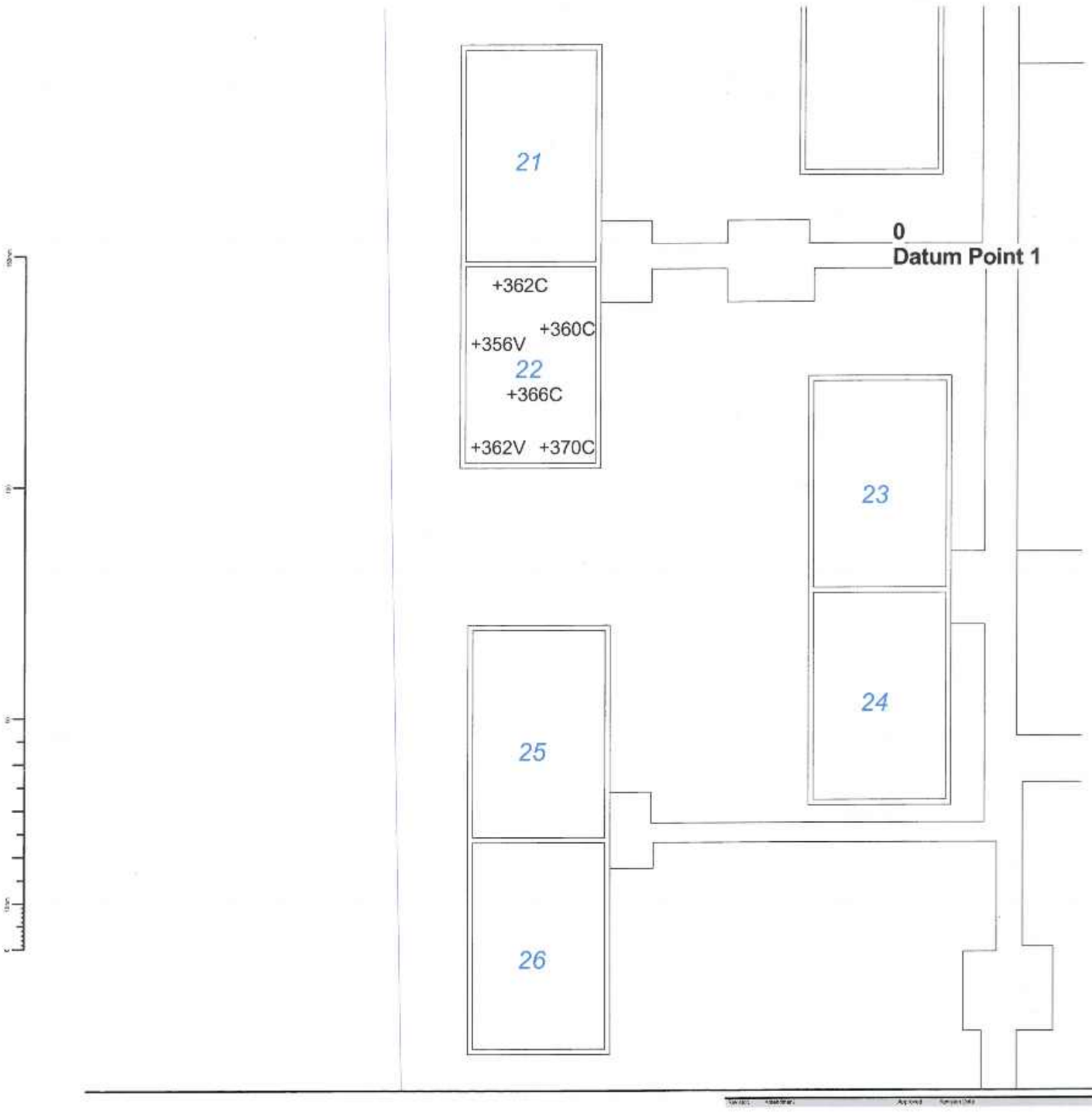
Drawn	Designed	Approved	Finalised Date
Author	Designer	Approver	

Project No.	Name	Drawing No.	Asset No.	Service Ctr
	As indicated		A102	RA

Project
Fred Price Courts
76 Palmers Road
Level Survey

Title
Units 1-6, 35-38

Original sheet size A3 (420x297) Plot date: 8/04/2013 9:41:10 a.m. \\chwin01\Users$\chtpm0\document\CCC work\Fred Price Courts, Level Plan.rvt



Datum

Elevation at Point 1 : 12.233m
Elevation at Point 2 : 12.324m
Elevation at Point 3 : 11.877m
Elevation at Point 4 : 12.332m

OPUS
Christchurch Office
+64 3 365 5400
PO Box 1482
Christchurch 8140
New Zealand

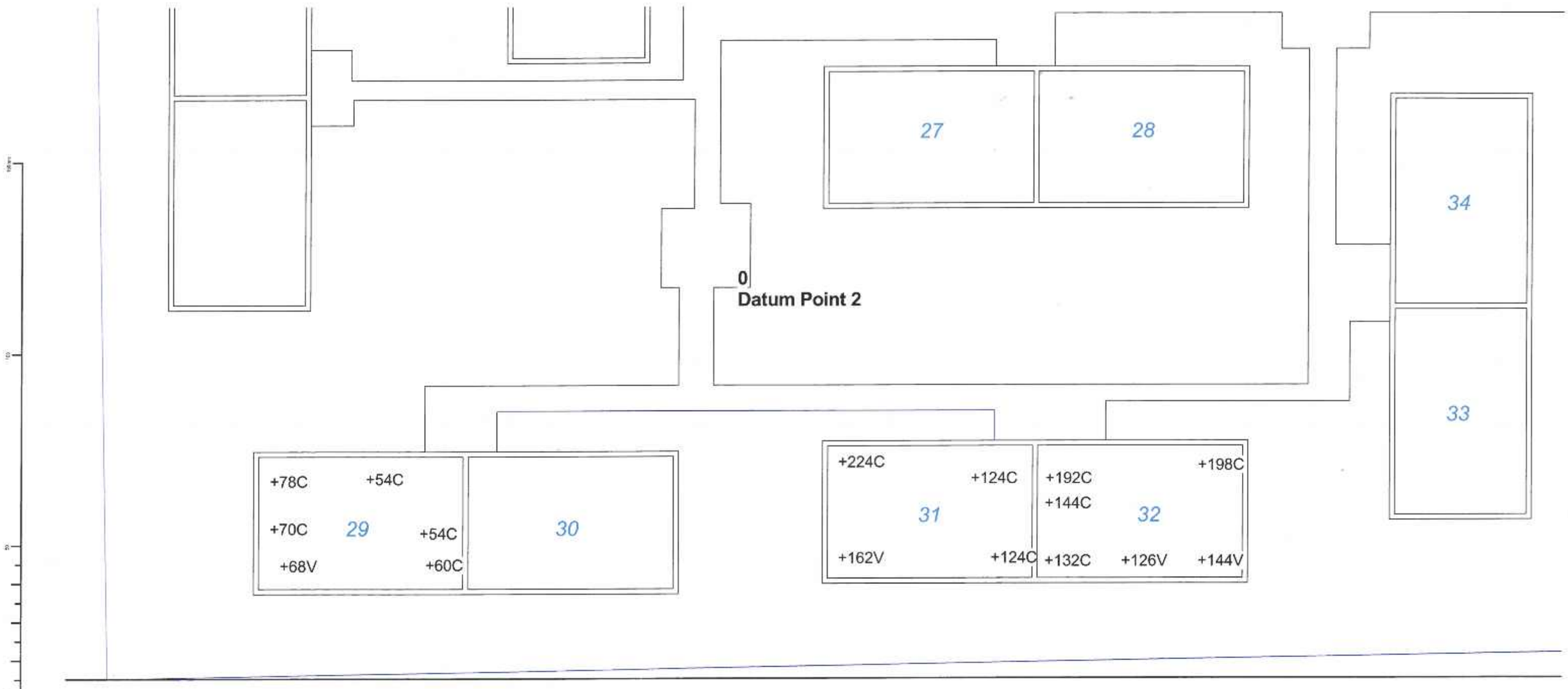
Project
Fred Price Courts
76 Palmers Road
Level Survey

Title
Units 21-26

Issue	Designed	Approved	Revision Date
Author	Designer	Approver	

Sheet No.	Scale	Drawing No.	Sheet No.	Version
	As indicated		A104	RA

Original sheet size A3 (420x297) Plot date: 5/04/2013 2:53:08 p.m. \\chwin01\Users$\chtpm0\document\CCC work\Fred Price Courts, Level Plan.rvt



Datum

Elevation at Point 1 : 12.233m
Elevation at Point 2 : 12.324m
Elevation at Point 3 : 11.877m
Elevation at Point 4 : 12.332m

OPUS
Christchurch Office
+64 3 365 5400
PO Box 1482
Christchurch 8140
New Zealand

Fred Price Courts
76 Palmers Road
Level Survey

Units 27-34

As indicated

A101 RA

Original sheet size A3 (420x297) Plot date: 5/04/2013 2:52:57 p.m. \\chwin01\Users$\chtpm0\document\CCC work\Fred Price Courts, Level Plan.rvt

Appendix 4 – Desktop Geotech

Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre, Christchurch 8140
New Zealand

t: +64 3 363 5400
f: +64 3 365 7858
w: www.opus.co.nz

24 April 2013

Christchurch City Council
C/- Opus International Consultants Ltd
PO Box 1482
Christchurch 8140
Attention: Geoff Bawden

6-QC128.00

Geotechnical Desk Study – Fred Price Courts

1. Introduction

Christchurch City Council has commissioned Opus International Consultants (Opus) to undertake a Geotechnical Desk Study and site walkover of the Fred Price Courts housing complex in New Brighton. The purpose of this study is to: collate existing subsoil information, undertake an appraisal of the potential geotechnical hazards at this site and determine whether further investigations are required. The site walkover was completed by Opus International Consultants on 4 April 2013.

This Geotechnical Desk 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 desk study has been undertaken without the benefit of any site specific investigations and is therefore preliminary in nature.

2. Desktop Study

2.1 Site Description

Fred Price Courts is located at 76 Palmers Road, New Brighton, 7.3km northeast of the centre of Christchurch; refer to Site Location Plan in Appendix B. The complex is bounded by residential areas to the north, south and west, and Palmers Road to the east.

The Fred Price Courts complex was built in 1975 and consists of 37 residential units and one community lounge; refer to Walkover Inspection Plan in Appendix C and Construction Details in Appendix D. Each block of two units has a simple rectangular floor plan and all are single storey timber framed structures with concrete block cladding and a timber trussed roof covered with heavy concrete tile roofing. The units are separated by 200mm block masonry party walls and are founded on concrete perimeter footings (230-250mm wide), founded at a depth not less than 300mm below ground level and a reinforced concrete slab (100mm thickness) on grade. The floor slab reinforcement does not appear to be tied to the footing reinforcement. Some of the foundations are considered to be equivalent to 'Type C2' in accordance with the Ministry of Business, Innovation and Employment (MBIE 2012) guidance. The foundation beneath the party wall is similar to that of the perimeter footings. The GL Evan's Inspection Report (Appendix D) indicates a number of buildings are supported on shallow piled foundations; bored piles (230-

250mm diameter at 1.4-1.5m c/c spacing) founded at depths of up to 1.2m below ground level. It is unclear from the documentation which units have been piled.

The ground profile is relatively flat and low lying. The ground surrounding the buildings is predominantly grassed surfaces with a concrete driveway leading into a car park, immediately north of Units 1-6.

2.2 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 of the Christchurch Formation with dominantly sand of fixed and semi-fixed dunes and beaches.

2.3 Expected Ground Conditions

The locations of Boreholes and Cone Penetrometer Tests (CPT) undertaken by the Earthquake Commission (EQC) have been reviewed. There have been twenty CPTs and two Boreholes conducted within approximately 50m of the site boundary. Refer to Site Location Plan in Appendix B and Surrounding Site Investigations in Appendix E.

Material logs available from the above sources have been used to infer the ground conditions at the site, as shown in Table 1 below.

Table 1: Inferred Ground Conditions

Stratigraphy	Thickness (m)	Depth Encountered (m)
Fine to medium SAND with trace Gravel (loose)	1.0-1.6	Surface
Fine to medium SAND with trace Silt (medium dense)	4.5-8.0	1.0-1.6
Fine to medium SAND (medium dense)	2.9-3.5	6.0-7.1
Fine to medium SAND with trace Silt (dense to very dense)	-	11.0-12.0

The Boreholes extended to 20m below ground level. Based on boreholes undertaken elsewhere in the New Brighton area, the Riccarton Gravel formation is expected to be encountered between 35 and 40m below ground level.

Groundwater depths of approximately 1.5 and 2.1 m below ground level have been interpreted from the EQC Borehole Logs. GNS Science indicates that the median depth to the groundwater surface at the site ranges from 0 to 2.0 m (Project Orbit, 2013).

2.4 Liquefaction Hazard

A liquefaction hazard study was conducted by the Canterbury Regional Council (ECan) in 2004 to identify areas of Christchurch susceptible to liquefaction during an earthquake. The northwestern half of Fred Price Courts is located on an area identified as having 'high liquefaction potential', for a low groundwater scenario.

Tonkin and Taylor Ltd (T&T Ltd), the Earthquake Commission's (EQC) geotechnical consultants, have prepared maps showing areas of liquefaction interpreted from high resolution aerial photos for the September 2010 earthquake and the aftershocks of February 2011, June 2011 and December 2011. The maps indicate evidence of moderate to severe observed liquefaction on the site, or in the vicinity, after the June 2011 seismic event and minor observed liquefaction after the

February and December 2011 seismic events. No evidence of surface expression of liquefaction was observed after the September 2010 earthquake.

Although there are no open watercourses or free surfaces within close proximity to the site, the EQC maps showing observed crack locations (refer to EQC Map Output in Appendix F) after the February 2011 seismic event, indicate that ground cracking (typically 10-50mm wide) occurred northwest of Fred Price Courts within 150m of the site boundary. This suggests that there is a potential risk of ground movement in a future seismic event.

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 expected ground performance in future large earthquakes.

The Ministry of Business, Innovation and Employment (MBIE) 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 MBIE guidance document (MBIE, 2012).

Fred Price Courts has been zoned as N/A-Urban Non-residential. However, the neighbouring residential properties have been zoned as Green-TC3, which indicates moderate land deformations are expected in future small to medium sized earthquakes and significant land deformations in a future moderate to large earthquake.

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

A preliminary liquefaction assessment has been completed using CLiq Software (Version 1.7, 2012) adopting the Idriss & Boulanger Method (2008) with settlements calculated using Zhang et al. (2002). Cone Penetrometer Tests (CPTs) form the basis for the prediction of liquefaction potential, with a Magnitude 7.5 earthquake considered, and earthquake groundwater depth of 1.0 m below ground level. The CLiq analysis was undertaken using four CPTs located within approximately 25m of the site boundary, as specified in Table 3 (refer to Site Location Plan in Appendix B).

Both the Serviceability and Ultimate Limit States have been assessed for an Importance Level 2 Structure (with Peak Ground Accelerations (PGAs) as specified in Table 3). The free field liquefaction induced subsidence estimates have been calculated over the complete test depth (typically 20m) and are presented in Table 2 (refer Appendix G for CLiq output). For comparison with MBIE (2012) guidelines the estimated settlement in the top 10m of the soil profile has also been presented.

Table 3: Estimated Liquefaction Induced Settlements

CPT	Event	Mag / PGA	Depth to Groundwater (m)	Estimated Settlement (mm)	Estimated Settlement in top 10m of soil profile (mm)
CPT 2892 (NNB-POD08-CPT16)	ULS	M7.5 / 0.35g	1.0	230	120
	SLS	M7.5 / 0.13g	1.0	30	30
CPT3909 (NNB-POD08-CPT658)	ULS	M7.5 / 0.35g	1.0	170	55
	SLS	M7.5 / 0.13g	1.0	15	10
CPT 6373 (NNB-POD08-CPT863)	ULS	M7.5 / 0.35g	1.0	155	80
	SLS	M7.5 / 0.13g	1.0	5	5
CPT 5212 (NBR-POD03-CPT07)	ULS	M7.5 / 0.35g	1.0	240	150
	SLS	M7.5 / 0.13g	1.0	45	45

Total liquefaction induced free field subsidence of up to 240mm has been predicted in a future ULS earthquake event, for a ground water depth of 1.0m. The total subsidence predicted to occur in the top 10m is greater than 100mm for CPT 2892 and 5212, which would indicate that the land in the western half of the site is comparable to MBIE Technical Category Three (TC3). Differential settlement is expected to occur due to variable thicknesses of liquefiable layers with expected differential settlements of up to 180mm, for a ULS earthquake event.

The Liquefaction Potential Index (LPI) is another tool used to identify the soil's susceptibility to liquefaction. This index weights the potential impact of the predicted liquefaction with the depth. Results obtained from the liquefaction analysis of CPT5212 indicate an LPI of 32 in a ULS seismic event. This categorises the site as a significant liquefaction risk.

3. Observations

A walkover site inspection of Fred Price Courts was carried out by an Opus Geotechnical Engineer on 4 April 2013. The following observations were made (refer to Walkover Inspection Plan in Appendix C):

- Spalling of concrete from the perimeter footing observed on the western side of Unit 2 (Photograph 1, Appendix A).
- Driveway surface in poor condition and evidence of sand boils observed, north of Units 1-6 (Photographs 2 and 3).
- Large cracks and broken sections of kerbing, north of Units 1-6 (Photograph 4).
- Cracking (5mm wide) observed in the footing in the southeast corner of Unit 1 (Photograph 5).
- Large cracks up to 5mm wide and 1.5m long were observed in the front porch slabs of most units. The cracks emanate from the Party wall footings (Photograph 6). The location of the cracked porch slabs is marked 'x' in the Walkover Inspection Plan in Appendix C.

- Separation of porch slab away from Party wall footing (by approximately 20mm, Photograph 7) and crack in slab (approximately 1m long and 20mm wide) observed along the northern side of Unit 32 (Photograph 8).
- Exposed concrete observed around drain where the ground may have settled (up to 20mm), at the northeastern corner of Unit 34 (Photographs 9) and western side of Unit 16.
- Cracking of porch slab (5mm wide x 1m long) and spalling of Party wall footing concrete observed on the northern side of Units 35 and 36 (Photographs 10).
- Sand boil observed in southwestern corner of site (Photographs 11).
- Surface evidence of up to 40 mm of differential settlement observed in the footpaths in the western half of the complex (Photograph 12).
- Large cracks across entire widths of many footpath slabs in the western half of the complex (Photograph 13) indicating differential settlement.
- Large sections of footpath slabs (approximately 10m long) along the southern sides of Units 7-10 appear to have undergone differential settlement (up to 40mm) as a result of liquefaction and now slope in a northerly direction towards the structure (Photograph 14).
- Moderate quantities of ejected liquefied material observed in the flower beds surrounding the residential units, particularly in the western half of the complex (Photograph 15).

4. Level Survey

A summary of the level survey undertaken by Opus Surveyors on 4 April 2013 at Fred Price Courts is given in Table 4. The units surveyed were those that appeared to have been the most damaged, based on a visual inspection by Opus Structural Engineers on 4 April 2013.

Unit no.	Maximum variation in floor level (mm)	Approximate distance between survey points (m)	Slope (%)	Direction of fall
1	72	7.0	1.0	Northwest
2	56	9.5	0.6	Northeast
3	4	9.5	0	-
4	20	9.5	0.2	Southeast
5	42	8.0	0.5	Northeast
6	45	5.0	0.9	Northwest
7	142	9.5	1.5	Southeast
8	90	8.0	1.1	Southeast
9	52	7.5	0.7	Southeast
10	28	7.5	0.4	East
19	36	7.0	0.5	South
20	12	5.5	0.2	South
22	14	7.0	0.2	Northwest
29	24	8.0	0.3	Southeast
31	100	7.5	1.3	East
32	72	6.0	1.2	Southwest

5. Discussion

All Units are constructed on concrete slab on grade type foundations. This is equivalent to Type C2 foundations in accordance with the MBIE (2012) guidance.

Significant liquefaction damage has occurred at Fred Price Courts as a result of the 2010 and 2011 earthquake sequence. At the time of the 5 April 2013 inspection, evidence of ejected material and ground settlement was observed. The damage to pavements appears to be a result of differential settlement and uplift due to liquefaction heave. Minor cracking within the building footings was observed. The EQC maps showing areas of liquefaction interpreted from high resolution aerial photos indicate evidence of moderate to severe observed liquefaction on the site, or in the vicinity, after the June 2011 seismic event with minor observed liquefaction after the February 2011 and December 2011 seismic events.

The level survey results have been assessed and indicated large variations (up to 142mm with slopes greater than 0.5%) in floor level in Units 1, 2, 6-9, 31 and 32 in the Fred Price Courts complex. In accordance with the MBIE guidance (December 2012), these units will require a foundation re-level.

Boreholes and CPTs undertaken for EQC indicate the residential complex is likely to be founded on layers of loose to medium dense Sand overlying dense to very dense Sand from approximately 11.0-12.0m depth, with groundwater depths of approximately 1.5-2.1 m below ground level. Liquefaction typically occurs in recent (i.e. less than 10,000 years old), normally consolidated silts and sands beneath groundwater and is dependent on material density, grain size and soil composition. The liquefaction assessment identified liquefiable layers from 1 to 5m and 11.5 to 17.5m below ground level from CPT 2892 and 5212. The subsurface ground profile together with the ground damage reported at the site during the recent earthquakes of 2010 and 2011, confirms that the site has a high risk of liquefaction.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the September 2010 earthquake. Recent advice (Geonet) indicates there is currently an 11% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. Such an event may cause liquefaction induced land damage similar to that experienced, dependent on the location of the earthquake's epicentre. This confirms that there is currently a risk of liquefaction and further differential settlement at Fred Price Courts.

6. Recommendations

It is recommended that in order to determine foundation repair options at Fred Price Courts, a site specific investigation is undertaken including CPTs, Hand Augers and Scalas. The site investigation will enable a site specific liquefaction assessment to be undertaken to identify the liquefiable layers to help determine conceptual repair and relevelling options.

The scope of the proposed site specific geotechnical investigations will be:

- A CPT to a depth of 20m in the centre of the site.
- Hand Auger and Scala tests should then be carried out to 3m depth or refusal.
- Assessment and reporting.
- Confirm which units are on piled foundations.

7. Limitation

This report has been prepared solely for the benefit of the Christchurch City Council as our client with respect to the particular brief given to us. Data or opinions in this desk study may not be used in other contexts, by any other party or for any other purpose.

It is recognised that the passage of time affects the information and assessment provided in this Document. Opus's opinions are based upon information that existed at the time of the production of this Desk 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.

8. 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 sheet + 104p.

Environment Canterbury, Canterbury Regional Council (ECan) website:

ECan 2004: The Soild Facts on Christchurch Liquefaction. Canterbury Regional Council, Christchurch, 1 sheet.

Project Orbit, 2011: Interagency/organisation collaboration portal for Christchurch recovery effort. https://canterburygeotechnicaldatabase.projectorbit.com/

GNS Science reporting on Geonet Website: http://www.geonet.org.nz/canterbury-quakes/aftershocks/ updated on 28 February 2013.

'Repairing and rebuilding houses affected by the Canterbury earthquakes': Ministry of Business, Innovation and Employment (December 2012).

Appendices:

Appendix A: Site Inspection Photographs
Appendix B: Site Location Plan
Appendix C: Walkover Inspection Plan
Appendix D: Construction Details
Appendix E: Surrounding Site Investigations
Appendix F: EQC Map Output
Appendix G: CLiq Liquefaction Analysis
Appendix H: Level Survey

Prepared By:

David Lally
Graduate Geotechnical Engineer

Reviewed By:

Graham Brown
Senior Geotechnical Engineer

Appendix A:
Site Inspection Photographs

Photograph 1: Spalling of concrete from the perimeter footing observed on the western side of Unit 2.

Photograph 2: View of driveway surface in poor condition, north of Units 1-6.

Photograph 3: Observed sand boil in driveway, north of Units 1-6.

Photograph 4: View of large cracks and broken sections of kerbing, north of Units 1-6 .

Photograph 5: View of cracking (5mm wide) observed in the footing in the southeast corner of Unit 1.

Photograph 6: View of large cracks up to 5mm wide and 1.5m long, observed in the front porch slabs of most units.

Photograph 7: View of separation of porch slab away from Party wall footing (by approximately 20mm) observed along the northern side of Unit 32.

Photograph 8: View of crack in slab (approximately 1m long and 20mm wide) observed along the northern side of Unit 32.

Photograph 9: View of exposed concrete observed around drain where the ground may have settled, at the northeastern corner of Unit 34.

Photograph 10: View of cracking of porch slab (5mm wide x 1m long) and spalling of Party wall footing concrete observed on the northern side of Units 35 and 36.

Photograph 11: View of sand boil observed in southwestern corner of site.

Photograph 12: View of surface evidence of up to 40mm of differential settlement observed in the footpaths in the western half of the complex.

Photograph 13: View of large crack across entire width of footpath slab, east of Units 21 and 22, indicating differential settlement.

Photograph 14: View of footpath slab (approximately 10m long) along the southern side of Units 9 and 10 that appeared to have undergone differential settlement (up to 40mm) as a result of liquefaction and now slopes in a northerly direction towards the structure.

Photograph 15: View of possible ejected liquefied material observed in the flower beds surrounding the residential units.

Photograph 16: View of front elevation of two units at Fred Price Court.

Photograph 17: View of ejected liquefied material (Photograph taken in March 2011).

Appendix B:
Site Location Plan

CPTs assessed for liquefaction potential.

0 100m

Approximate Scale:1 to 900 at A3

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 10/04/2013)

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

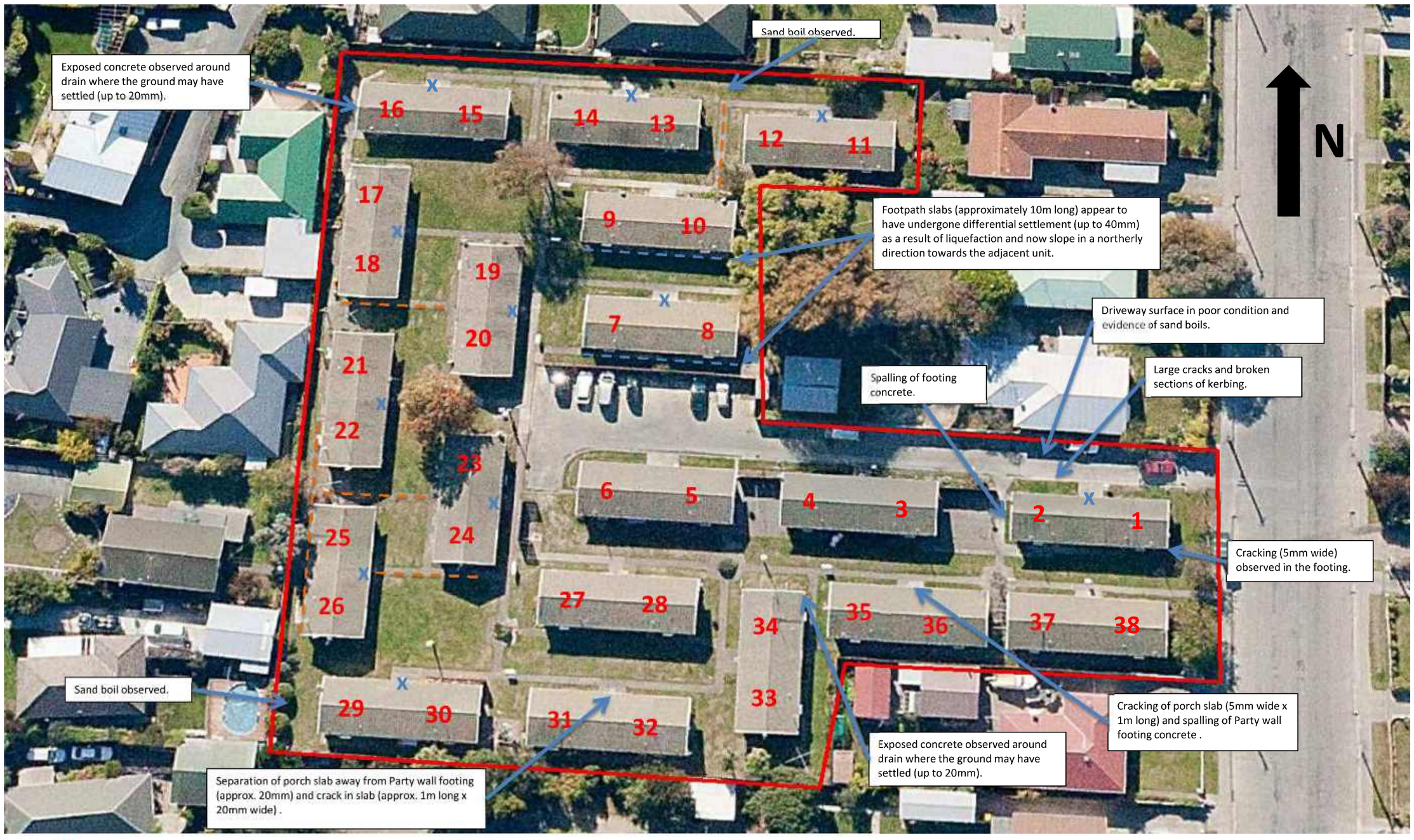
Project: Fred Price Courts, 76 Palmers Road, New Brighton
Project No.: 6-QC128.00/005SC
Client: Christchurch City Council

Site Location Plan

Drawn: Opus Geotechnical Engineer

Date: 10-Apr-13

Appendix C:
Walkover Inspection Plan



1-38: Residential Unit Numbers

x: Large cracks up to 5mm wide and 1.5m long in the front porch slabs, emanating from the Party wall footings.

Damaged footpaths - unlevel (up to 40 mm) and large cracking across slab width.

0 50m

Approximate Scale:1 to 500 at A3.

SOURCE: canterburyrecovery.projectorbit.com (Accessed on 10/04/2013)

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: Fred Price Courts, 76 Palmers Road, New Brighton
Project No.: 6-QC128.00/005SC
Client: Christchurch City Council

Walkover Inspection Plan

Drawn: Opus Geotechnical Engineer

Date: 10-Apr-13

Appendix D:
Construction details

1436.

73M6/35
Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date 4 November 75.

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 1)**

INVESTIGATION: DATE OF TESTS: 8/9/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material is brown sand filling compacted over organic and turf layer. Bearing capacity generally satisfactory except for organic layer at 1.0m depth.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm bars supported on piles dug through organic layer. Interior foundation 100mm concrete floor supported on bored piles at 1.4m c/c.

FOUNDATION AS BUILT: DATE INSPECTED: 9/9/75

1. Perimeter Beam
   (1) Base width 250 depth in ground 300
   Total height 630
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **bored** size **250mm dia**
   spacing **1.4m** depth **1.0-1.2m**
2. Interior Piles supported on **piles**
   size **250mm dia** depth **1.0-1.2m deep**
   spacing **1.4m c/c**
3. **Concrete Slab - Reinforced 100mm slab with 9mm rod over piles both ways.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date 4 November, 1975.

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 2)**

INVESTIGATION:

DATE OF TESTS: 27/5/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material is brown sand filling compacted over organic and turf layer. Bearing capacity generally satisfactory except for organic layer at 0.5 - 0.6m depth.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm bars supported on piles dug through organic layer. Interior foundation 100mm concrete floor supported on bored piles at 1.4m c/c.

FOUNDATION AS BUILT:

DATE INSPECTED: 4/9/75

1. Perimeter Beam
   (1) Base width **250** depth in ground **230**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **bored** size **230mm dia**
   spacing depth
2. Interior Piles supported on **piles bored**
   size **230mm dia** depth **0.75m**
   spacing **1.4m c/c bothways**
3. **Concrete Slab - Reinforced 100mm thick slab supported on bored piles at 1.4m c/c with 9mm rod on line of piles both ways.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

73M6/35

Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November, 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 3)**

INVESTIGATION: DATE OF TESTS: **29/7/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material is brown sand filling compacted over organic and turf layer. Bearing capacity generally satisfactory except for organic layer at 0.5 - 0.6m depth.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm bars supported on piles dug through organic layer. Interior foundation 100mm concrete floor supported on bored piles at 1.4m c/c.

FOUNDATION AS BUILT: DATE INSPECTED: **6/8/75**

1. Perimeter Beam
   (1) Base width **230** depth in ground **300**
   Total height **450**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **bored** size **250mm dia**
   spacing **1.5m** depth **0.8m**
2. Interior Piles supported on **piles bored**
   size **250mm dia** depth **0.8m**
   spacing **1.5m c/c**
3. **Concrete Slab - Reinforced 100mm slab supported on bored piles at 1.5m c/c with 9mm rod on line of piles both ways.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE
HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 4)**

INVESTIGATION: DATE OF TESTS: **29/7/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material is brown sand filling compacted over organic and turf layer. Bearing capacity generally satisfactory exceptfor organic layer at 0.2m - 0.35m deep.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm bars supported on piles dug through organic layer. Interior foundation 100mm concrete floor supported on bored piles at 1.4m c/c.

FOUNDATION AS BUILT: DATE INSPECTED: **4/8/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **230**
   Total height **500**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300** c/c
   (3) Piling - type **bored** size **230mm dia**
   spacing depth **0.25-0.4m**
2. Interior Piles supported on **N.A.** concrete floor on
   size depth **hardfill**
   spacing
3. **Concrete Slab - Reinforced concrete slab 100mm thick on hardfill.**

REMARKS: **Foundation beam under firewall similar to perimeter beam.**
After preliminary tests sand fill compacted with vibratory roller to satisfactory density.

G.L. Evans

73M6/35
Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road
Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November, 1975.**

INSPECTION CERTIFICATE
HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 5)**

INVESTIGATION:-- DATE OF TESTS: **Sept. 75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises 0.15m of brown sand filling on firm sand.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods; reinforced concrete slab on compacted hard fill.

FOUNDATION AS BUILT: DATE INSPECTED: 2/9/75

1. Perimeter Beam
   (1) Base width **250** depth in ground **230**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete Slab - reinforced 100mm thick on hard fill**

REMARKS: **Foundation beam under firewall similar to perimeter beam.**

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road
Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date 4 November 1975.

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: 76 Palmers Road (Unit 6)

INVESTIGATION: DATE OF TESTS: 8/9/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that site is partly filled with brown sand overlying turf & topsoil at 0.25 - 0.35m below which is firm sand.**

RECOMMENDED FOUNDATION:
Organic layer to be stripped and/or bored piles used where needed to support perimeter beam which is to be reinforced with 2-12mm rods.

FOUNDATION AS BUILT: DATE INSPECTED: 26/9/75

1. Perimeter Beam
   (1) Base width 250 depth in ground 250
   Total height 530
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **dug piles** ~~size~~ **at South end & under floor.**
   spacing **1.4m** depth **600mm**
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete Slab - reinforced and supported on dug piles at 1.4m c/c with a 12mm rod.**

REMARKS: **Foundation beam under firewall similar to perimeter beam.**

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E. M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road
Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 7)**

INVESTIGATION: DATE OF TESTS: **31/7/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises brown sand filling overlying firm material. Filling soft to 0.25 - 0.35m**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm rods. Reinforced concrete floor slab (100mm) on hard fill.

FOUNDATION AS BUILT: DATE INSPECTED: **5/8/75**

1. Perimeter Beam
   (1) Base width 250 depth in ground 230
   Total height 500
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **250mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete Slab - Reinforced with 666 mesh and supported on semi crushed hard filling.**

REMARKS: **Foundation beam under firewall similar to perimeter beam.**

G.L. Evans

Your ref. 73MG/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE
HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 8)**

INVESTIGATION: DATE OF TESTS: **31/7/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises brown sand filling overlying firm material. Filling soft to 0.25 - 0.35m**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods. Reinforced concrete floor slab (100mm) on hard fill.

FOUNDATION AS BUILT: DATE INSPECTED: **4/8/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **230**
   Total height **500**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced with 666 mesh and supported on semi-crushed compacted hard fill 230mm deep.**

REMARKS:

Foundation beam under firewall similar to perimeter beam, but 400-450mm deep in ground.

G.L. Evans

73M6/35

Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 9)**

INVESTIGATION: DATE OF TESTS: **8/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface layer comprises soft brown sand filling to depths of 0.3 - 0.4m below which is firm strata.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm rods, supported if required on short piles to firm strata concrete floor on hard fill.

FOUNDATION AS BUILT: DATE INSPECTED: **14/8/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **300**
   Total height **600**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **dug** size **250 x 250**
   spacing **1.4m** depth **to firm at 400-450**
2. Interior Piles supported on **n.a.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill 250mm thick.**

REMARKS: **Foundation beam under firewall similar to perimeter beam.**

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 10)**

INVESTIGATION: DATE OF TESTS: 5/8/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface layer comprises soft brown sand filling to depths of 0.25 - 0.35m below which is firm strata.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm rods; with concrete floor on hard filling.

FOUNDATION AS BUILT: DATE INSPECTED: 11/8/75

1. Perimeter Beam
   (1) Base width **230** depth in ground **280**
   Total height **500**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill 250mm thick.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 11)**

INVESTIGATION: DATE OF TESTS: 7/8/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises compacted brown sand soft to 0.3m deep and generally firm below this.**

RECOMMENDED FOUNDATION:

Perimeter beam at least 300mm deep, reinforced with 4-12mm rods and supported on hard filling.

FOUNDATION AS BUILT: DATE INSPECTED: 11/8/75

1. Perimeter Beam
   (1) Base width 230 depth in ground 400
   Total height 560
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - Reinforced and supported on hard fill.**

REMARKS:

Firewall foundation 230mm wide and 480mm deep with 4-12mm rods and stirrups of 6mm at 300mm c/c.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E. M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road
Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE
HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 12)**

INVESTIGATION: DATE OF TESTS: **7/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises compacted brown sand filling with soft layer down to 0.3 - 0.4m with deeper softness in S.E. corner.**

RECOMMENDED FOUNDATION:

Thorough saturation of foundation to complete compaction. Perimeter beam reinforced with 4-12mm rods.

FOUNDATION AS BUILT: DATE INSPECTED: **11/8/75**

1. Perimeter Beam
   (1) Base width **230** depth in ground **200**
   Total height **450**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on hardfill**

REMARKS:

Firewall foundation 230mm wide and 450 mm deep reinforced with 4-12mm rods.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 13)**

INVESTIGATION: DATE OF TESTS: 4/8/75

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material comprises compacted brown sand filling with a soft surface layer to 0.3 - 0.4m deep; firm below this.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods and supported on short dug piles if bottom not firm.

FOUNDATION AS BUILT: DATE INSPECTED: 6/8/75

1. Perimeter Beam
   (1) Base width **230** depth in ground **230-300**
   Total height
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **not used** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced 666 mesh and supported on partly crushed hardfill 230mm deep.**

REMARKS:

Firewall foundation 230mm wide and 300mm deep with 4-12mm rods.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E. M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road
Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE
HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 14)**

INVESTIGATION: DATE OF TESTS: **8/9/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material comprises compacted sand filling with good bearing capacity except at East end where there is a shallow layer of topsoil.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods and founded on firm base through topsoil.
Concrete floor supported on piles dug through topsoil at East end.

FOUNDATION AS BUILT: DATE INSPECTED: **8/9/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **300**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced with 665 mesh; supported on partly crushed hardfill 230mm thick and on dug piles at East end with 16mm dia rod over pile centres both ways.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

73M6/35
Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November, 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 15)**

INVESTIGATION: DATE OF TESTS: **15/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises shallow filling over turf and organic topsoil under which is firm sand.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm rods and founded on firm base below turf and topsoil. Organic material to be removed before hard filling for concrete floor.

FOUNDATION AS BUILT: DATE INSPECTED:

1. Perimeter Beam
   (1) Base width **250** depth in ground **300**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill.**

REMARKS:
Foundation beam under firewall similar to perimeter beam.

G.L. Evans

Your ref. 73M6/35

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E. M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmer Road (Unit 16)**

INVESTIGATION: DATE OF TESTS: **15/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises shallow sand filling on a turf layer overlying firm sand strata.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods and founded on firm base below turf and topsoil. Organic material to be removed before hard filling for concrete floor.

FOUNDATION AS BUILT: DATE INSPECTED: **18/8/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **300**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

73M6/35

Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 17)**

INVESTIGATION: DATE OF TESTS: **Sept. 75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **that subsurface material comprises compacted brown sand filling with satisfactory bearing capacity.**

RECOMMENDED FOUNDATION:
Perimeter beam reinforced with 4-12mm rods.
Concrete slab reinforced and supported on hardfilling.

FOUNDATION AS BUILT: DATE INSPECTED: **2/9/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **230**
   Total height **530**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill.**

REMARKS:
Foundation beam under firewall similar to perimeter beam.

G.L. Evans

73M6/35

Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 75.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 18)**

INVESTIGATION: DATE OF TESTS: **6/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material comprises compacted sand filling with satisfactory bearing capacity.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods.
Concrete slab reinforced and supported on hardfilling.

FOUNDATION AS BUILT: DATE INSPECTED: **6/8/75**

1. Perimeter Beam
   (1) Base width **230** depth in ground **350-400**
   Total height **500**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced and supported on partly crushed hardfill.**

REMARKS:

Foundation beam under firewall similar to perimeter beam.

G.L. Evans

73M6/35
Your ref.

G.L.Evans
B.Sc., M.E., D.I.C. (London) M.I.C.E.
M.N.Z.I.E. Registered Engineer
Consulting Civil Engineer
93D Riccarton Road

Phone 41-182
Box 8152 Riccarton
Christchurch 4
New Zealand

Date **4 November 1975.**

INSPECTION CERTIFICATE

HOUSE FOUNDATION

PROPERTY: **76 Palmers Road (Unit 19)**

INVESTIGATION: DATE OF TESTS: **6/8/75**

This certifies that the ground under or adjacent to the foundation on this property has been tested and the tests indicate **subsurface material comprises compacted sand filling with satisfactory bearing capacity.**

RECOMMENDED FOUNDATION:

Perimeter beam reinforced with 4-12mm rods.
Concrete slab reinforced and supported on hardfilling.

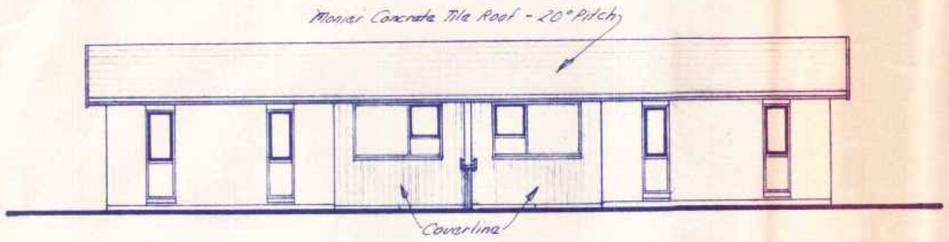
FOUNDATION AS BUILT: DATE INSPECTED: **6/8/75**

1. Perimeter Beam
   (1) Base width **250** depth in ground **300**
   Total height **500**
   (2) Reinforcing
   Main steel **4-12mm** dia rods
   Stirrups **6mm** dia at **300mm** c/c
   (3) Piling - type **N.A.** size
   spacing depth
2. Interior Piles supported on **N.A.**
   size depth
   spacing
3. **Concrete slab - reinforced 665 mesh and supported on partly crushed hardfill - 230mm thick.**

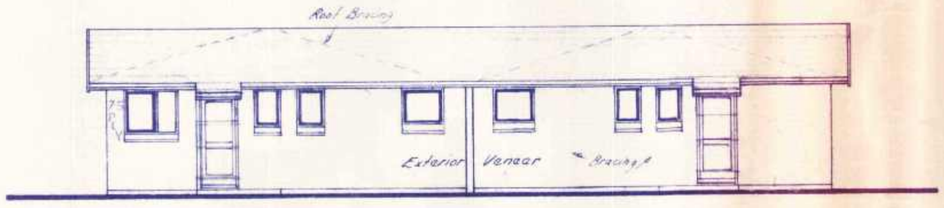
REMARKS:

Foundation beam under firewall similar to perimeter beam.

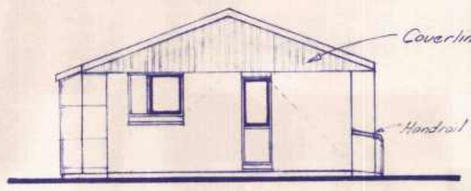
G.L. Evans



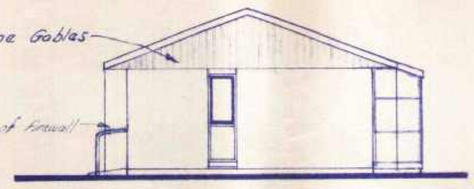
FRONT ELEVATION



REAR ELEVATION



SIDE ELEVATION



SIDE ELEVATION

WINDOW LINTEL SIZES

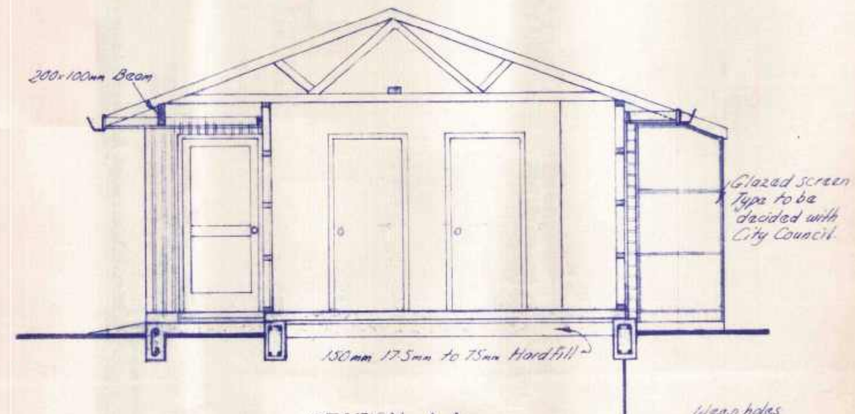
150 x 100mm	0 Up To	2130
200 x 100mm	2150 Up To	3040
250 x 100mm	3070 Up To	3520
300 x 100mm	3530 Up To	4250

SCHEDULE

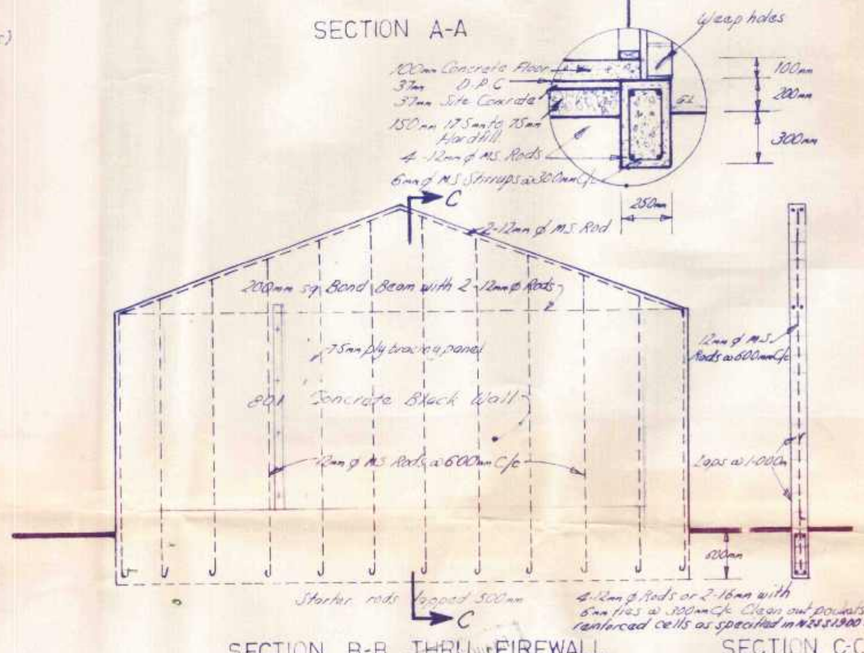
Monier Concrete Tile Roof
20° Pitch
Tile Battens (50x50mm)
Plate Trusses @ 900 mm C/c
Aryde Plates (Manufactured by M°Alpines)
94 x 47mm Top Plate
PVC Spouting
180 x 35mm Fascia
4.75 Alite 600mm Soffit
Veneer tied
37mm Cavity
94 x 47mm Studs @ 400mm C/c
94 x 35mm Brace
94 x 47mm Dwangs @ 600mm C/c
24G Galv brick ties
400mm Vertical
500 mm Horizontal
94 x 47mm Bottom plate
100mm Concrete Floor
Mesh N°665
D.P.C
37mm Site Concrete
4 - 12mm ϕ M.S. Rods
6mm ϕ M.S Stirrups @ 300mm C/c

ELECTRICAL SCHEDULE

6 Lights per unit
7 Power plugs per unit

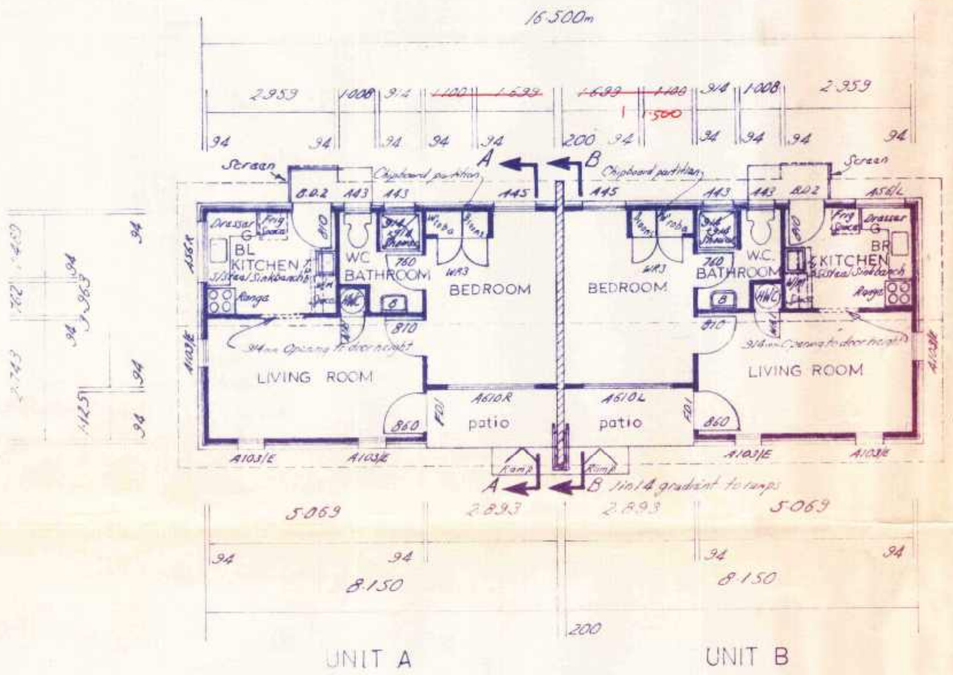


SECTION A-A



SECTION B-B THRU FIREWALL

SECTION C-C



UNIT A UNIT B

FLOOR PLAN

MARK 1

AMMENDED 30-7-75
AMMENDED 23-7-75

MB

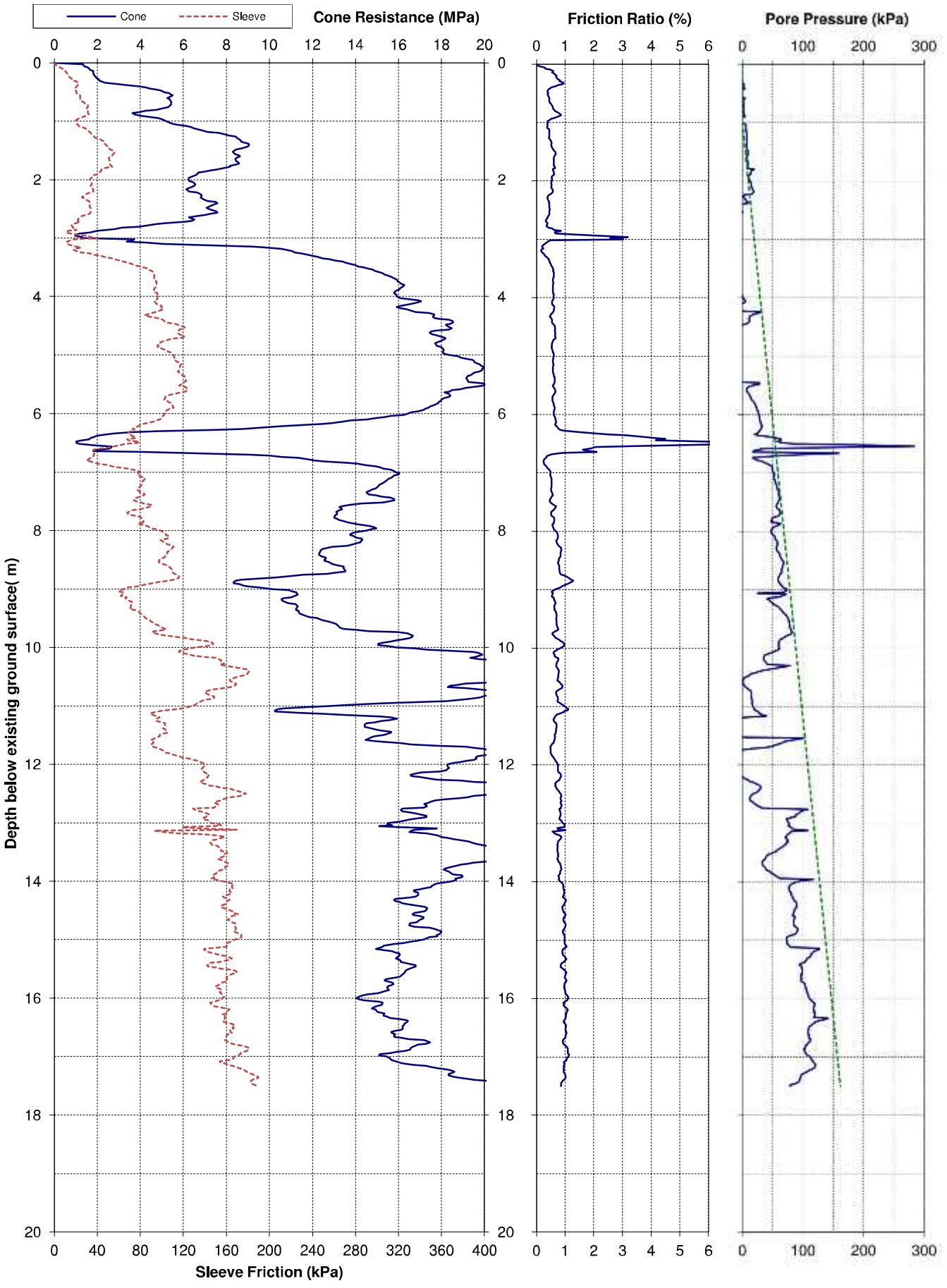
PROPOSED MERRITT - BEAZLEY COTTAGES FOR THE ELDERLY - PALMERS ROAD - CHRISTCHURCH

SCALE 1:100 1:50

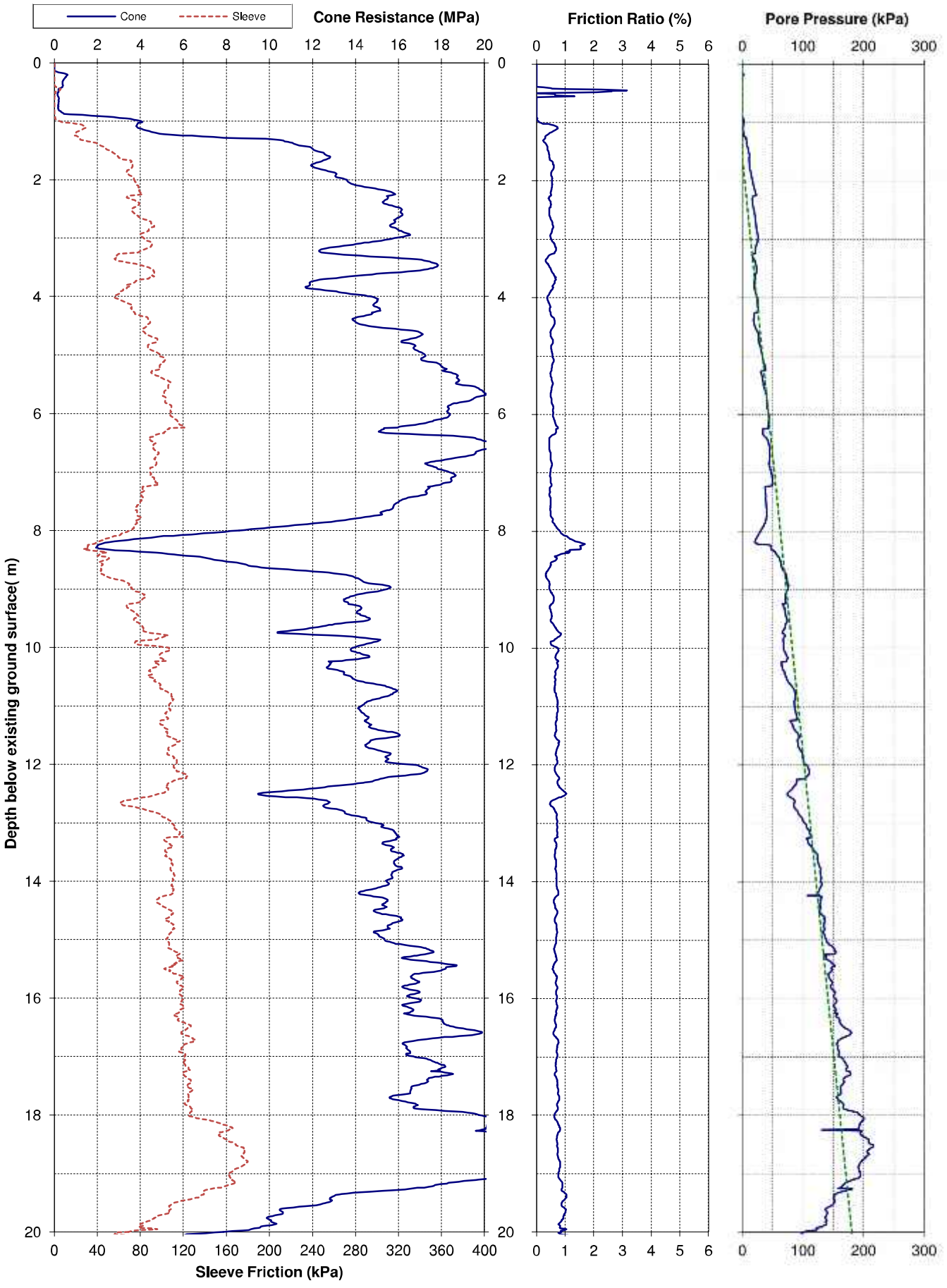
S4

Appendix E:
Surrounding Site Investigations

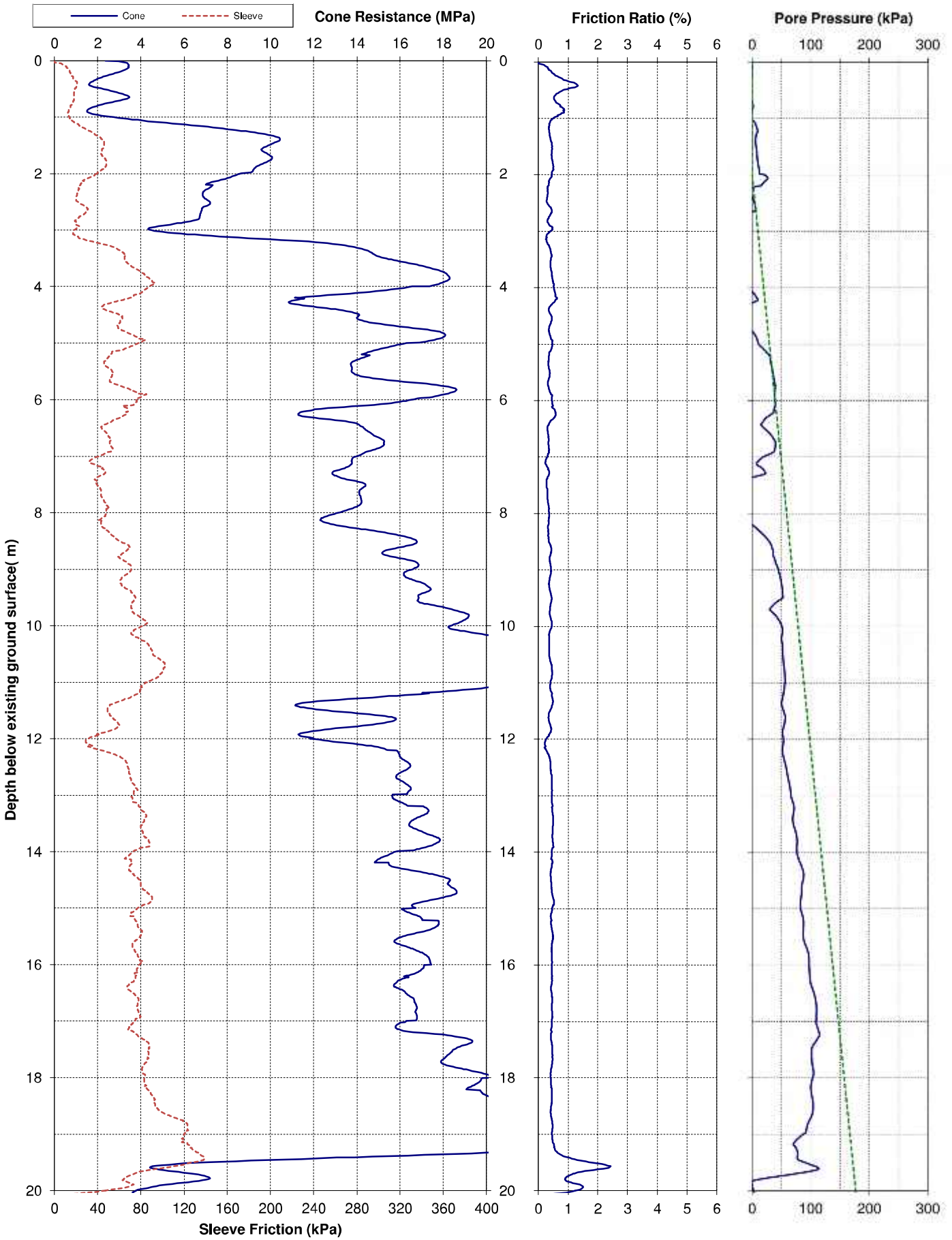
Project:	Christchurch TC3 Geotechnical Investigations				**Page:**	1 of 1	**NNB-POD08-CPT863**
Test Date:	21-Aug-2012	**Suburb:**	North New Brighton	**Operator:**	RDCL		
Pre-Drill:	0m	**Assumed GWL:**	1mBGL	**Located By:**	Survey GPS		
Position:	2486824.51mE	5745311.29mN	2.99mRL	**Coord. System:**	NZMG		
Address:	84 Palmers Rd			**Datum Reference:**	MSL (CCC 20/01/12 Datum -9.043)		



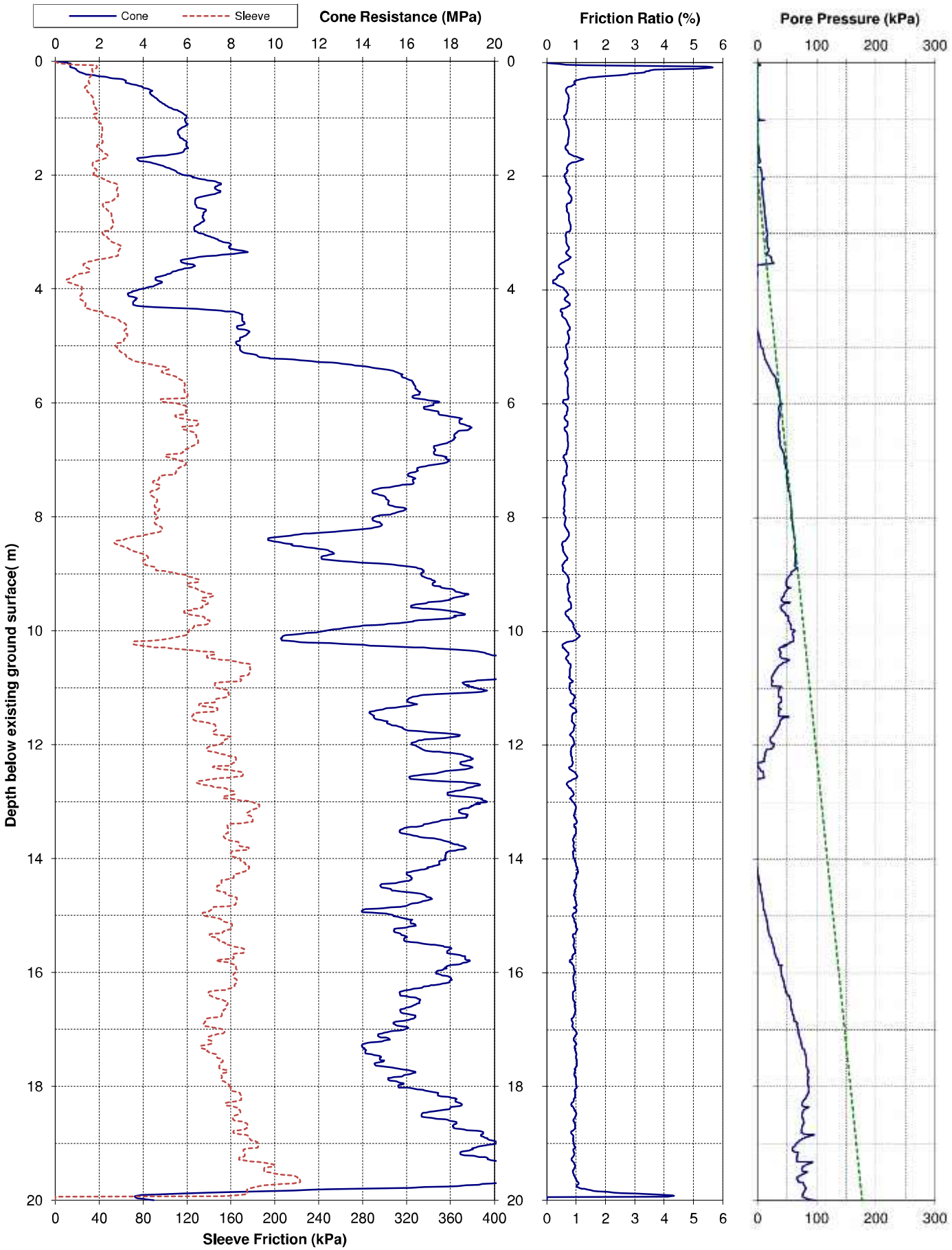
Project:	Christchurch TC3 Geotechnical Investigations				**Page:** 1 of 2	**NBR-POD03-CPT07**	
Test Date:	10-Aug-2012	**Suburb:**	New Brighton	**Operator:**	McMillan	EQC T+T	
Pre-Drill:	0.5m	**Assumed GWL:**	1.6mBGL	**Located By:**	Survey GPS		
Position:	2488239.87mE	5742566.89mN	1.87mRL	**Coord. System:**	NZMG		
Address:	2 Cromer Pl			**Datum Reference:**	MSL (CCC 20/01/12 Datum -9.043)		



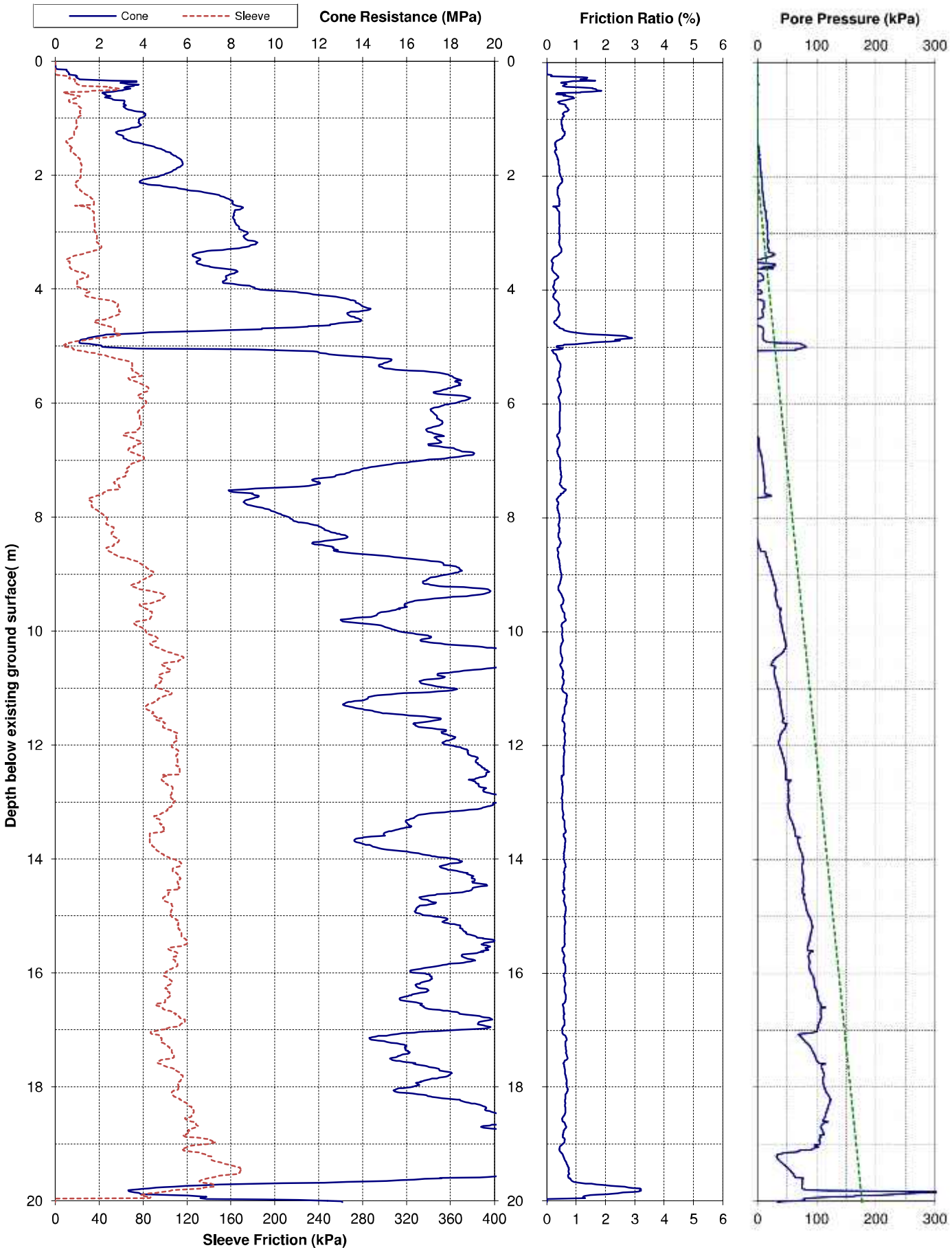
Project:	Christchurch TC3 Geotechnical Investigations			Page: 1 of 2	NNB-POD08-CPT658
Test Date:	20-Jul-2012	Suburb:	North New Brighton	Operator:	Pro-Drill
Pre-Drill:	0m	Assumed GWL:	2mBGL	Located By:	Survey GPS
Position:	2486818.18mE	5745368.56mN	3.02mRL	Coord. System:	NZMG
Address:	72 Palmers Rd			Datum Reference:	MSL (CCC 20/01/12 Datum -9.043)



Project:	Christchurch TC3 Geotechnical Investigations			Page: 1 of 1	NNB-POD08-CPT16
Test Date:	25-Jun-2012	Suburb:	North New Brighton	Operator:	Perry
Pre-Drill:	0m	Assumed GWL:	2mBGL	Located By:	Survey GPS
Position:	2486742.53mE	5745399.06mN	3.62mRL	Coord. System:	NZMG
Address:	36 Castletown Pl			Comments:	



Project:	Christchurch TC3 Geotechnical Investigations			Page: 1 of 2	NNB-POD08-CPT23
Test Date:	20-Jun-2012	Suburb:	North New Brighton	Operator:	Opus
Pre-Drill:	0.1m	Assumed GWL:	2mBGL	Located By:	Survey GPS
Position:	2486735.79mE	5745368.23mN	3.61mRL	Coord. System:	NZMG
Address:	36 Castletown Pl			Comments:	



TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH-02
Hole Location: NNB-POD9-BH02
(67 Palmers Road)
SHEET 1 OF 2

PROJECT: TC3 GROUND INVESTIGATIONS- POD9		LOCATION: NORTH NEW BRIGHTON	JOB No: 52003.000
CO-ORDINATES	5745358.51 mN 2486863.93 mE	DRILL TYPE: Sonic Vibration	HOLE STARTED: 23/5/12
		DRILL METHOD: Open Barrel/Std SPT	HOLE FINISHED: 23/5/12
R.L.	2.74 m		DRILLED BY: DCN
DATUM	NZMG, MSL (CCC 20/01/12 Datum -9.043m)	DRILL FLUID: N/A	LOGGED BY: MOSS-KW 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION / ROCK DESCRIPTION
CONCRETE																	CONCRETE.
HARDFILL & TOPSOIL																	Gravelly organic SILT with some sand, dark brown, moist, low plasticity, quick dilatency. Gravel is fine to coarse.
CHRISTCHURCH FORMATION (MARINE/ ESTUARINE)			100	OB				2			GM	M					
						*FC1.0	B		1		SP		MD				Fine SAND with trace silt, light greyish brown, medium dense, moist, poorly graded. 1
											ML		F				SILT with some sand, dark brown, firm, moist, low plasticity. Sand is fine to medium, poorly graded.
			100	SPT		4/5//4 2/5/14 N=25		1			SP		MD				Fine SAND with trace silt, light grey with brown mottling, medium dense, moist, poorly graded. 2
			100	OB				0	2		SP	W					Fine SAND, light grey, medium dense, wet, poorly graded.
			78	SPT		4/4//8 7/10/12 N=37		-1			SP		D				Fine to medium SAND with minor silt, light grey, dense, wet, poorly graded.
			100	OB		*FC4.0	B		4								3.35 to 3.5m- no recovery. 4
				SPT		3/4//5 6/9/12 N=32		-2									4.65 to 4.95m- no recovery.
			100	OB		*FC5.0	B	-	5								5
			27	SPT		3/4//5 7/10/12 N=34		-4	6								6.1 to 6.45m- no recovery. 6
			100	OB					7								6.45m- trace silt. 7
			66	SPT		1/2//5/6/6/8 N=25		-5					MD				7.1m- grey, silt absent. 7.5m- medium dense. 7.8 to 7.95m- no recovery.
			100	OB				-6	8								8
				SPT		2/4//6 7/10/11 N=34		-7	9				D				9.0m- dense. 9.15 to 9.45m- no recovery. 9
									10								

T+T DATATEMPLATE.GDT rcb

Log Scale 1:50

BORELOG 720016 NNB POD9.GPJ 31/7/12

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH-02
Hole Location: NNB-POD9-BH02
(67 Palmers Road)
SHEET 2 OF 2

PROJECT: TC3 GROUND INVESTIGATIONS- POD9		LOCATION: NORTH NEW BRIGHTON	JOB No: 52003.000
CO-ORDINATES	5745358.51 mN 2486863.93 mE	DRILL TYPE: Sonic Vibration	HOLE STARTED: 23/5/12
		DRILL METHOD: Open Barrel/Std SPT	HOLE FINISHED: 23/5/12
R.L.	2.74 m		DRILLED BY: DCN
DATUM	NZMG, MSL (CCC 20/01/12 Datum -9.043m)	DRILL FLUID: N/A	LOGGED BY: MOSS-KW 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm)	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (MARINE/ ESTUARINE)			100	OB				-8	11		SP	W	MD				Fine to medium SAND with trace silt, light grey, medium dense, wet, poorly graded.
			50	SPT		5/7//7 7/10/11 N=35											10.75 to 10.95m- no recovery.
			100	OB				-9	12								11
			5	SPT		7/6//10 11/14/15 for 65mm N=50		-10	1				VD				12.0m- very dense. 12.25 to 12.45m- no recovery.
			100	OB													12
			52	SPT		5/8//9 10/15/11 for 53mm N=45		-11	14								1
			100	OB				-12	15		SP		D				13.75 to 13.95m- no recovery.
			22	SPT		3/7//9 11/14/11 for 75mm N=45		-1	16								Fine to medium SAND with minor silt, light grey, dense, wet, poorly graded. Contains trace broken shells.
			100	OB							SP						14
				SPT		5/8//10 10/12/17 N=49		-14	17								15.1 to 15.45m- no recovery.
			100	OB				-15	18								15
			50	SPT		6/8//10 13/15/12 for35mm N>50		-16	19				VD				Fine to medium SAND, light grey, dense, wet, poorly graded. 15.55 to 16.0m- contains trace broken shells. 16.65 to 16.95m- no recovery. 18.0 to 18.25m- contains trace broken shells. 18.0m- very dense. 18.25 to 18.45m- no recovery. 18.5 to 19.95m- contains broken shells.
			100	OB													16
			100	SPT		4/6//9 11/10/12 N=42		-17	20								17
																	18
																	19
																	End of borehole at 19.95mbgl (target depth)

T+T DATATEMPLATE.GDT rcb

Log Scale 1:50

BORELOG 720016 NNB POD9.GPJ 31/7/12

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH-04
Hole Location: NNB-POD8-BH04
(22 Thurso Place
SHEET 1 OF 2

PROJECT: TC3 GROUND INVESTIGATIONS- POD8		LOCATION: NORTH NEW BRIGHTON	JOB No: 52003.000
CO-ORDINATES	5745310.58 mN 2486705.34 mE	DRILL TYPE: Sonic Vibration	HOLE STARTED: 27/4/12
		DRILL METHOD: Open Barrel/Std SPT	HOLE FINISHED: 1/5/12
R.L.	3.04 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: FT-GS 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) / COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (MARINE/ESTUARINE)			00	Hand Dug				3			SP	M	L			Fine to medium SAND with trace gravel, light brown, loose, moist, poorly graded. Gravel is fine to medium, subangular.
			00	OB				2								1.2m- light grey.
			00	SPT		6//8/10 N=18			2				MD			1.5m- medium dense. Gravel absent.
		▽	00	Open Barrel								S				2.0m- saturated.
			00	SPT		2//5/8 N=18		0	3							3.0m- light brown.
			00	Open Barrel		✱FC4.0	B		4							
			00	SPT		1//2/ N=8		-2	5		SP	S	L			Fine to medium SAND with trace silt, dark grey, loose, saturated, poorly graded.
			00	Open Barrel		✱FC5.5	B									
			00	SPT		3//6/5 N=		-3	6		SP	S	MD			Fine to medium SAND, dark grey, medium dense, saturated, poorly graded.
			00	Open Barrel		✱FC7.0	B	-4	7							
			00	SPT		2//2/8 N=10			8							
			00	Open Barrel		✱FC8.5	B		9				VD			9.0m- very dense.
			00	SPT		27//37/13 for 80mm N>50										
			00	OB		✱PSD9.5	B		10		SP	W				Fine to medium SAND with trace silt, grey, very dense, wet, poorly graded.

T+T DATATEMPLATE.GDT rcb

Log Scale 1:50

BORELOG 720016 NNB POD8.GPJ 17/7/12

TONKIN & TAYLOR LTD

BOREHOLE LOG

BOREHOLE No: BH-04
Hole Location: NNB-POD8-BH04
(22 Thurso Place
SHEET 2 OF 2

PROJECT: TC3 GROUND INVESTIGATIONS- POD8		LOCATION: NORTH NEW BRIGHTON	JOB No: 52003.000
CO-ORDINATES	5745310.58 mN 2486705.34 mE	DRILL TYPE: Sonic Vibration	HOLE STARTED: 27/4/12
		DRILL METHOD: Open Barrel/Std SPT	HOLE FINISHED: 1/5/12
R.L.	3.04 m		DRILLED BY: DCN
DATUM	NZMG	DRILL FLUID: N/A	LOGGED BY: FT-GS 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)	COMPRESSIVE STRENGTH (MPa)	DEFECT SPACING (mm	SOIL DESCRIPTION: Soil type, minor components, plasticity or particle size, colour. ROCK DESCRIPTION: Substance: Rock type, particle size, colour, minor components. Defects: Type, inclination, thickness, roughness, filling.
CHRISTCHURCH FORMATION (MARINE/ESTUARINE)			00	SPT		17//19/25 N=44		-7			SP	W	VD				Fine to medium SAND with minor silt, grey, very dense, wet, poorly graded.
			00	Open Barrel				-8			SP	S	D				Fine to medium SAND with some silt, dark grey, dense, saturated, poorly graded.
			00	SPT		10//24/26 for 145mm N>50		-9	12				VD				12.0m- very dense. - contains broken shells.
			0	Open Barrel				-10	13								12.45 to 13.5m- no recovery.
			00	SPT		16//17/27 N=44		-	14				D				13.5m- dense.
			00	Open Barrel													14.0m- silt absent.
			00	SPT		15//20/23 N=43		-12	15								
			00	Open Barrel				-13	16								
			00	SPT		11//15/23 N=38		-14	17								
			00	Open Barrel					18								
			00	SPT		12//15/24 N=49											
			00	Open Barrel					19								19.1m- some silt.
			0	SPT		3//3/4 N=7			20								19.5 to 19.95m- no recovery. Possible SPT disturbance. End of borehole at 19.95mbgl (target depth)

T+T DATATEMPLATE.GDT rcb

Appendix F:
EQC Map Output

0 200m

Approximate Scale: 1 to 2250 at A3.

SOURCE:canterburyrecovery.projectorbit.com (Accessed on 17/4/2013)

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: Fred Price Courts, 76 Palmers Road, New Brighton
Project No.: 6-QC128.00/005SC
Client: Christchurch City Council

EQC Observed Ground Cracking

Drawn: Opus Geotechnical Engineer

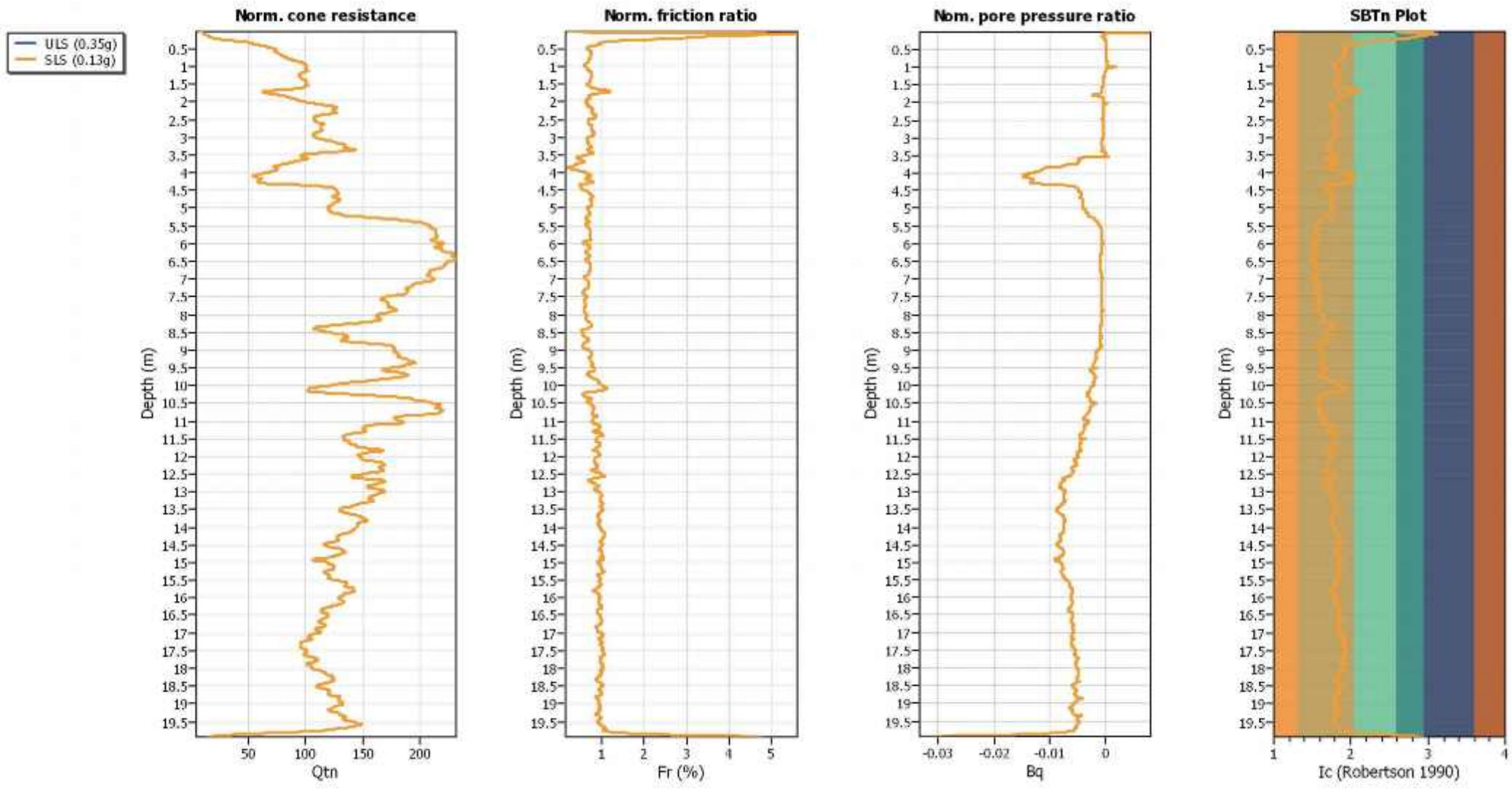
Date: 17-Apr-13

Appendix G:
CLiq Liquefaction Analysis

Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 2892 (NNB-POD08-CPT16)

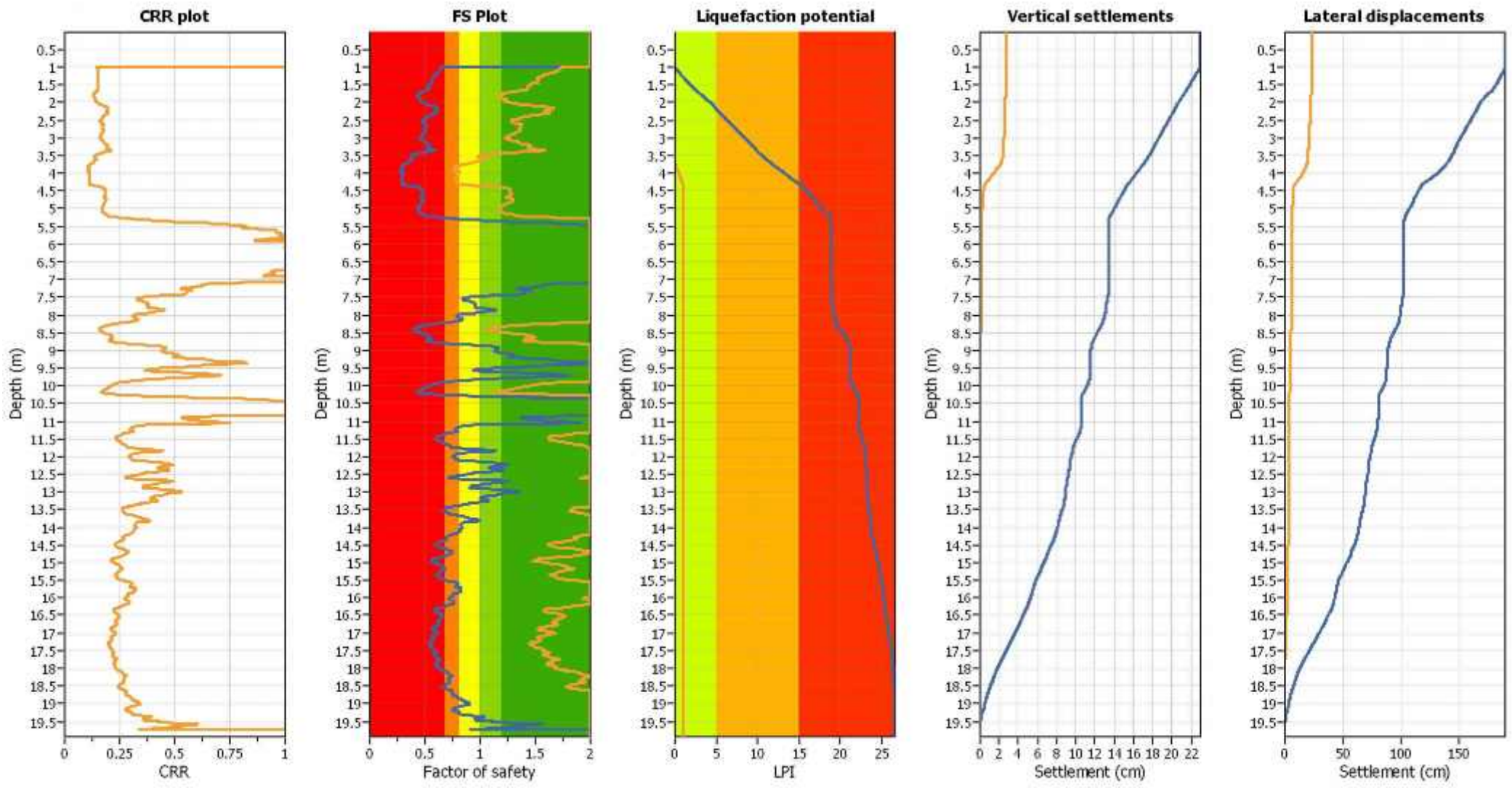
Overlay Normalized Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 2892 (NNB-POD08-CPT16)

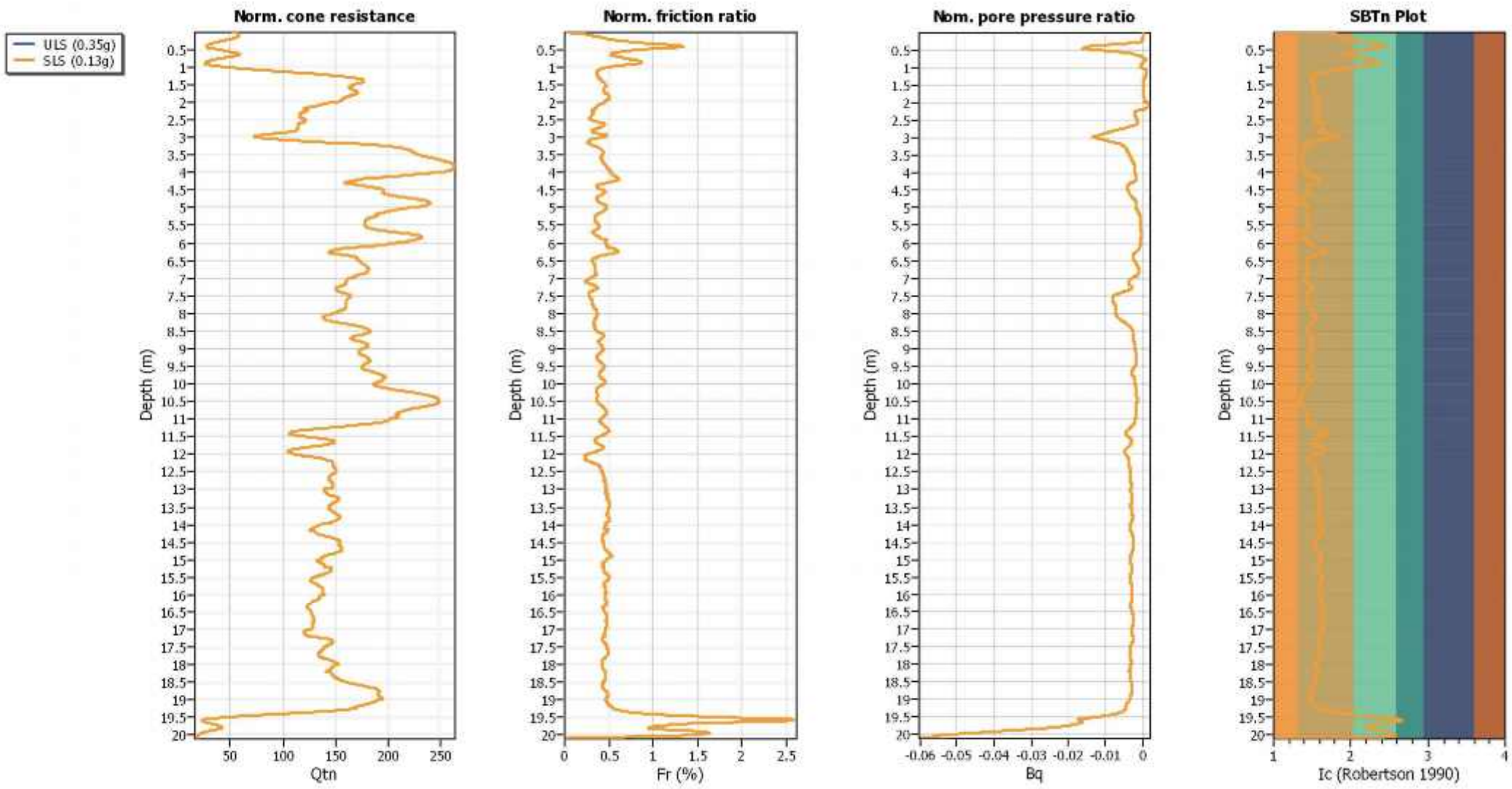
Overlay Cyclic Liquefaction Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT3909 (NNB-POD08-CPT658)

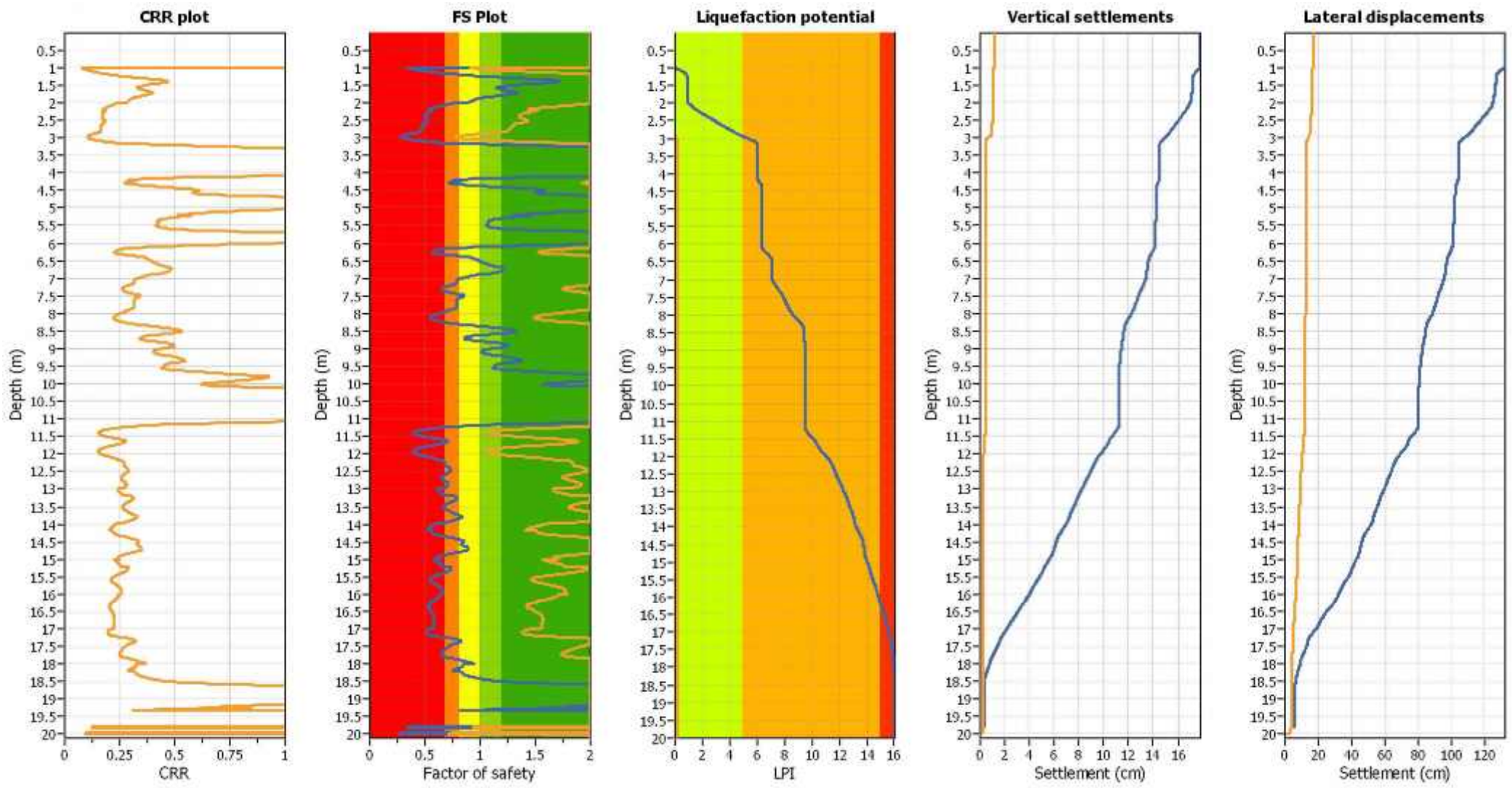
Overlay Normalized Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT3909 (NNB-POD08-CPT658)

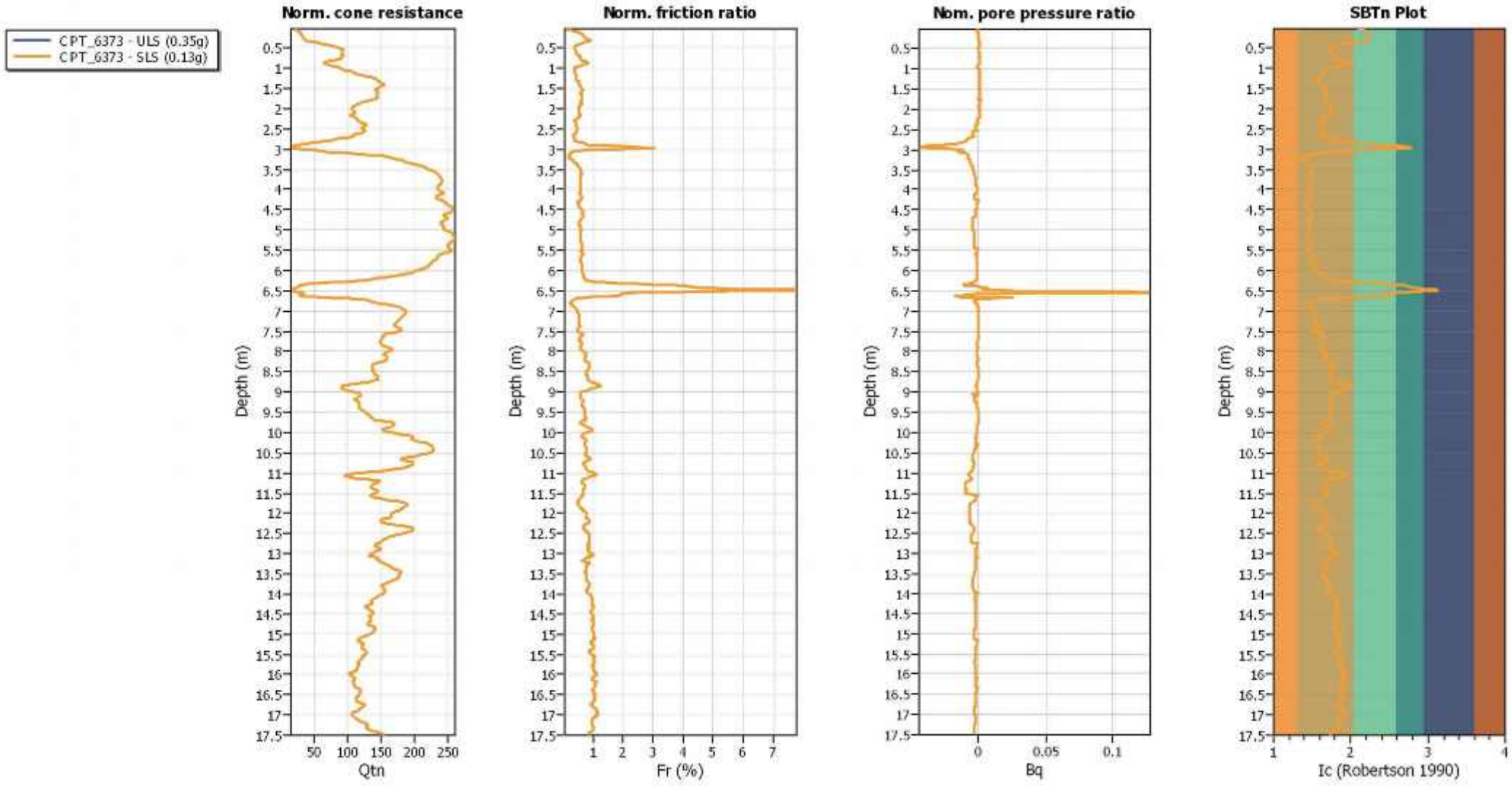
Overlay Cyclic Liquefaction Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 6373 (NNB-POD08-CPT863)

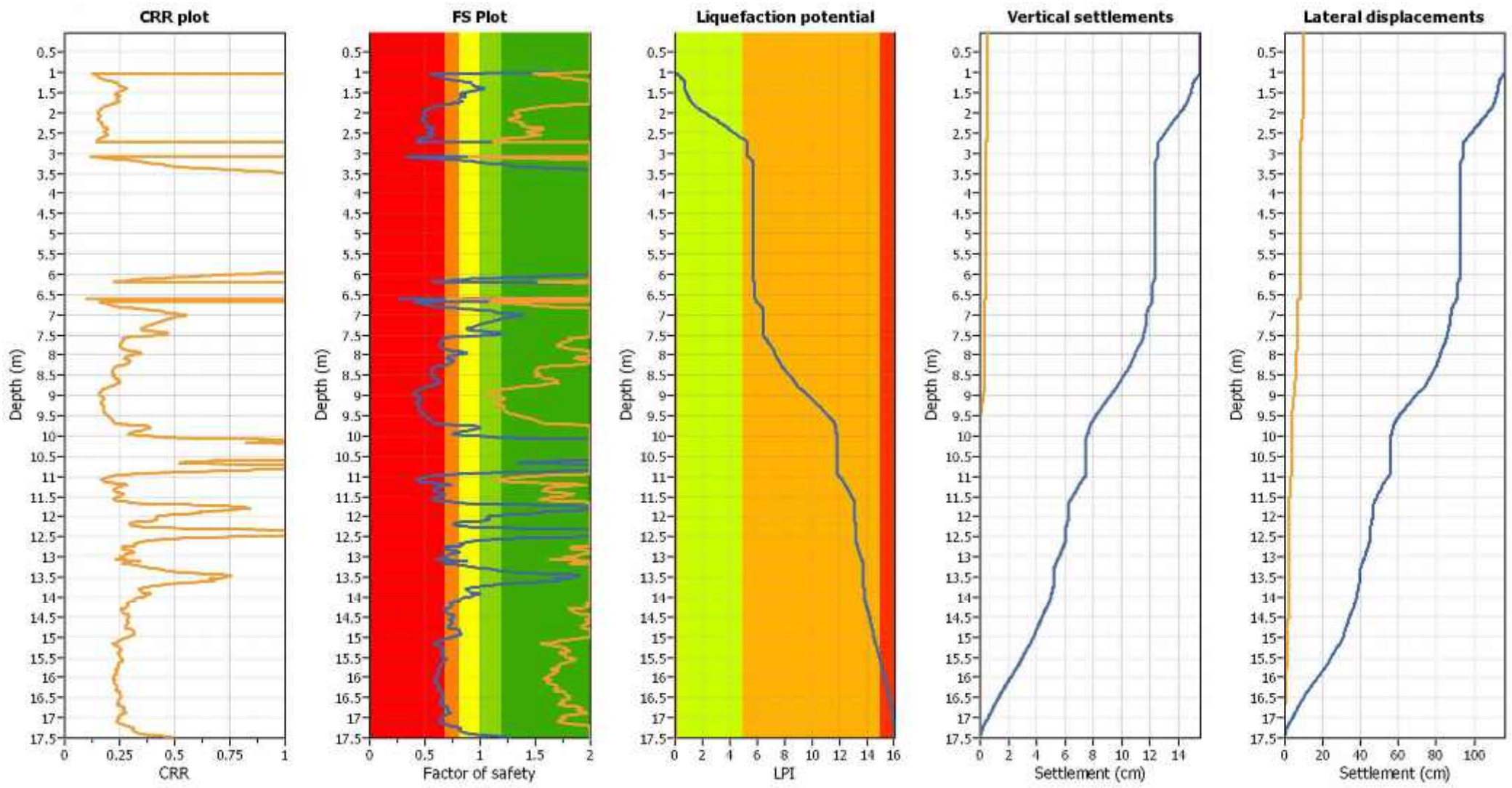
Overlay Normalized Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 6373 (NNB-POD08-CPT863)

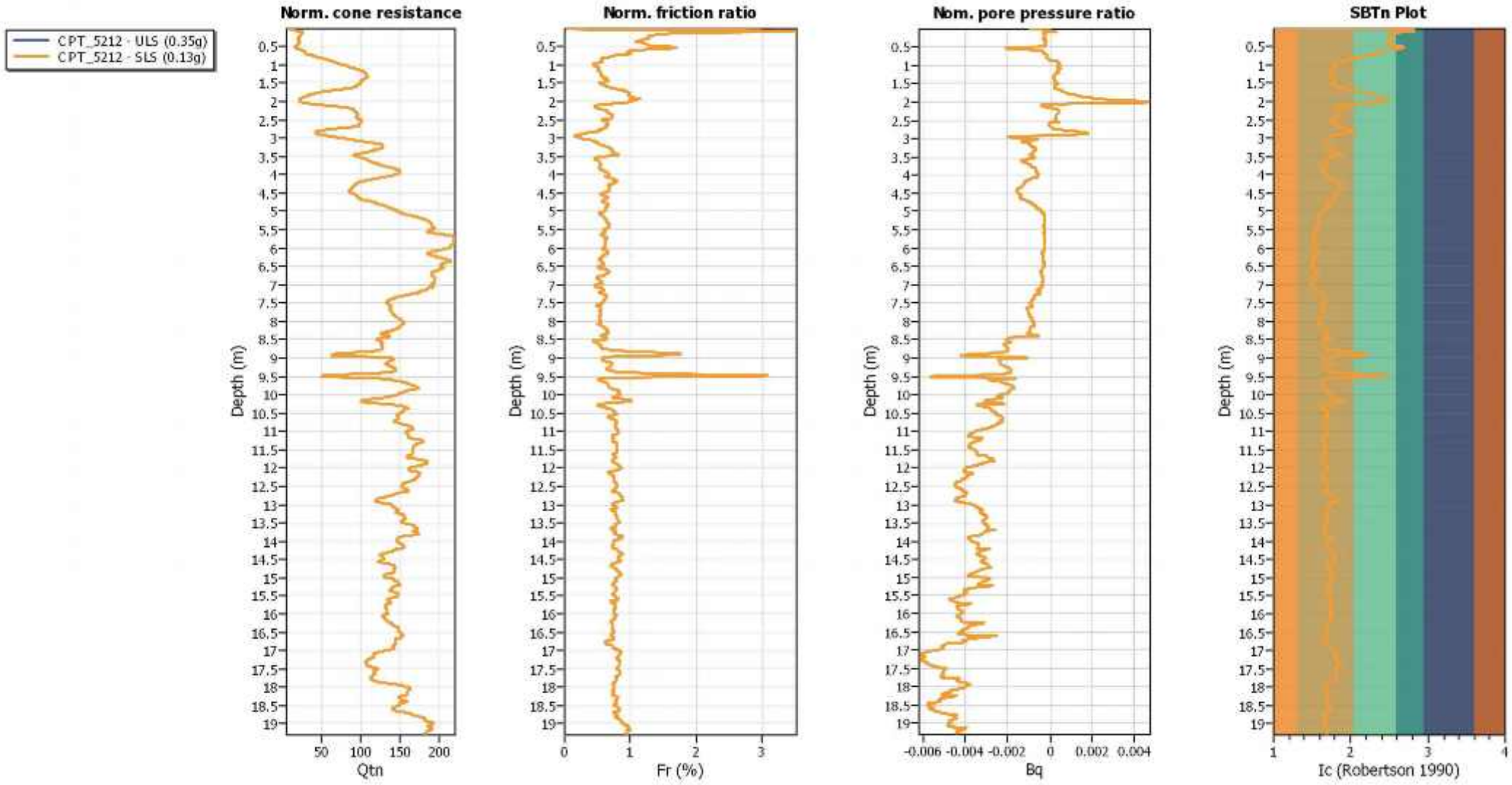
Overlay Cyclic Liquefaction Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 5212 (NBR-POD03-CPT07)

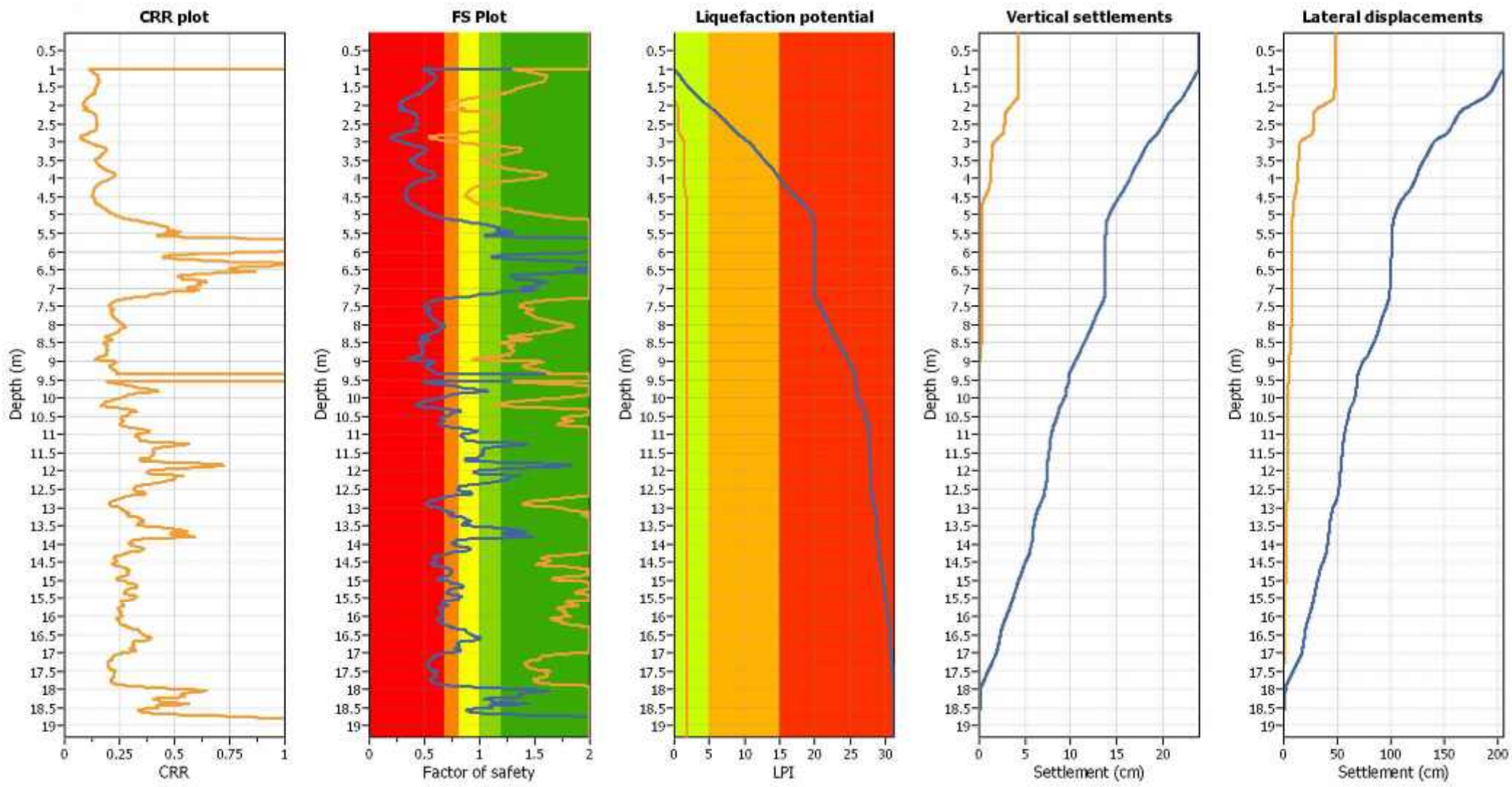
Overlay Normalized Plots



Opus International Consultants
20 Moorhouse Avenue
Christchurch

Project: Fred Price Courts - CPT 5212 (NBR-POD03-CPT07)

Overlay Cyclic Liquefaction Plots



Opus International Consultants Ltd
20 Moorhouse Avenue
PO Box 1482, Christchurch Mail Centre,
Christchurch 8140
New Zealand

t: +64 3 363 5400
f: +64 3 365 7858
w: www.opus.co.nz