Christchurch City Council

Reg Stillwell Place PRO 1320

Detailed Engineering Evaluation

Quantitative Assessment Report

Christchurch City Council

Reg Stillwell Place

Quantitative Assessment Report

189 Palmers Road, New Brighton

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Summary

Reg Stilwell Place
PRO 1320-001 to PRO 1320-008

Detailed Engineering Evaluation
Quantitative Report - SUMMARY
Final – Version Four

189 Palmers Road, New Brighton, Christchurch

Background

This is a summary of the quantitative report for the building structure, and is based on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections, and available drawings.

This report has been altered and reissued for the following reasons;

1. Drawings for the resident's lounge and garages were requested from Christchurch City Council and did not become available until after the release of the first version of this document.

2. Blocks C, D and E were initially classed as being identical, however further investigation has determined blocks D and E have significantly more capacity than block C due to existing damage and plan irregularity.

3. A non-intrusive method was devised and used by Opus International Consultants to check GIB nail spacing in the units. This allowed engineers to confirm the use of an increased level of ductility and strength in the analysis of these units.

4. Drawings were found that showed that unit 24 was strengthened in 2009 with Braceline GIB board.

Key Damage Observed

All block had cracking to plasterboard linings. Other damage observed includes:

General

a. Liquefaction induced differential movement is evident at the site surrounding the buildings.

Block A

b. Severe cracking of exterior concrete block veneer. Damage is most severe outside of unit 5. Noticeable settlement and rotation of the building. Cracking of the sides of concrete ground beam.

Block B

c. Severe cracking of exterior concrete block veneer. Damage is most severe outside of units 11 and 12. Some veneer block is out of plumb. Horizontal cracking of exterior block work propagates through interior gib lining. Noticeable settlement and rotation of the building. Cracking of perimeter ground beam.

Block C

d. Severe cracking of exterior concrete block veneer. Damage is most severe at the connection between the 2 halves of the building. Lateral separation between units 18 and 19. Gap at ground floor slab between units 18 and 19 indicative of ground movement. Longitudinal cracking along concrete footing to units 19 and 20.

Block F

e. Moderate cracking at exterior block veneer. Moderate cracking at interior lining.

Resident's Lounge

f. Minor to moderate cracking at exterior block veneer.

Critical Structural Weaknesses

Blocks A and B

a) Torsion: Ground floor concrete block wall between kitchen and bathroom is not connected to the first floor slab. As a result, the only lateral load resistance in the east-west direction comes from the wall piers along the south elevation resulting in a torsional response.

b) Pounding and separation between single-storey and two-storey portions: The two-storey portion and the single-storey portion are not structurally tied for lateral loading because the roof of the one-storey building does not align with the first floor of the two-storey building. As a result, they behave as separate structures and pounding can occur at the interface. Additionally, the roof of the single-storey structure relies on the two-storey building for gravity load support. Thus differential lateral movement from earthquake shaking could potentially lead to local loss of gravity support of the roof of the single storey portion.

Block C

a) Pounding and separation between eastern and western halves: There is a lateral offset at the midpoint of Block C. The roof diaphragm is not aligned at this offset thus the eastern half and the western half of the building behaves as two separate structures for seismic loading. Pounding can occur at the interface. Additionally, the roof structure of the two halves relies on the common wall for gravity support. Thus differential lateral movement from earthquake shaking of the two halves could potentially lead to local loss of gravity support.

Block F

a) Torsion: Ground floor concrete block wall between kitchen and bathroom is not connected to the first floor slab. As a result, the only lateral load resistance in the east-west direction comes from the wall piers along the south elevation resulting in a torsional response.

Indicative Building Strength (from quantitative assessment)

Based on the information available, and from undertaking a quantitative assessment, the indicative building strength is summarized in the table below:

Block	Indicative building strength	Comment
Blocks A and B	10% NBS	The buildings are considered earthquake prone
Blocks C and F	10 to 15% NBS	The buildings are considered earthquake prone

Block D	58% NBS	The building is considered to be moderate earthquake risk
Block E	68%NBS	The building is considered to be low earthquake risk
Resident's Lounge	46% NBS	The building is considered to be low to moderate earthquake risk
Garage (Block H)	65% NBS	The building is considered to be low or moderate earthquake risk.

Recommendations

a) Develop a strengthening works scheme to increase the seismic capacity of Blocks A through D, Block F and the residents lounge to at least 67%NBS; this will need to consider compliance with accessibility and fire requirements.

b) A quantity surveyor is engaged to determine the costs for strengthening the building.

c) It is recommended that Blocks D, E, H (Garage) and the Resident's Lounge can be occupied, given their low to moderate risk.

d) Due to potential falling hazard of the exterior block veneer, barricades are recommended or veneer be braced to protect pedestrians from falling hazards.

Contents

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the Reg Stilwell Place, located at 189 Palmers Road, New Brighton, Christchurch following the M6.3 Christchurch earthquake on 22 February 2011.

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

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

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

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

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.

3. The age and structural type of the building.

4. Consideration of any critical structural weaknesses.

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

2.2 Building Act

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

Section 112 - Alterations

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

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

Section 115 – Change of Use

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

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

Section 121 – Dangerous Buildings

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

1. In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
2. In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
3. There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
4. There is a risk that other property could collapse or otherwise cause injury or death; or

5. A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

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

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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

- The accessibility requirements of the Building Code.

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

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

2.4 Building Code

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

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

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

- Increased serviceability requirements.

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

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

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

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

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

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

3 Earthquake Resistance Standards

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

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

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

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

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

Table 1: %NBS compared to relative risk of failure

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

3.1 Minimum and Recommended Standards

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

3.1.1 Occupancy

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

3.1.2 Cordoning

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

3.1.3 Strengthening

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

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

3.1.4 Our Ethical Obligation

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

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

4 Background Information

4.1 Building Description

The Reg Stilwell Place Residential Housing Units are situated approximately 7km north east of Christchurch City at 189 Palmers Road, New Brighton. The housing development was constructed in the 1970's and comprises 34 units of single and double storey configuration The units are arranged into six blocks (Block A through F). There is also a single storey residents lounge and a single storey garage (Block H). Refer to the site plan in Figure 2 below.

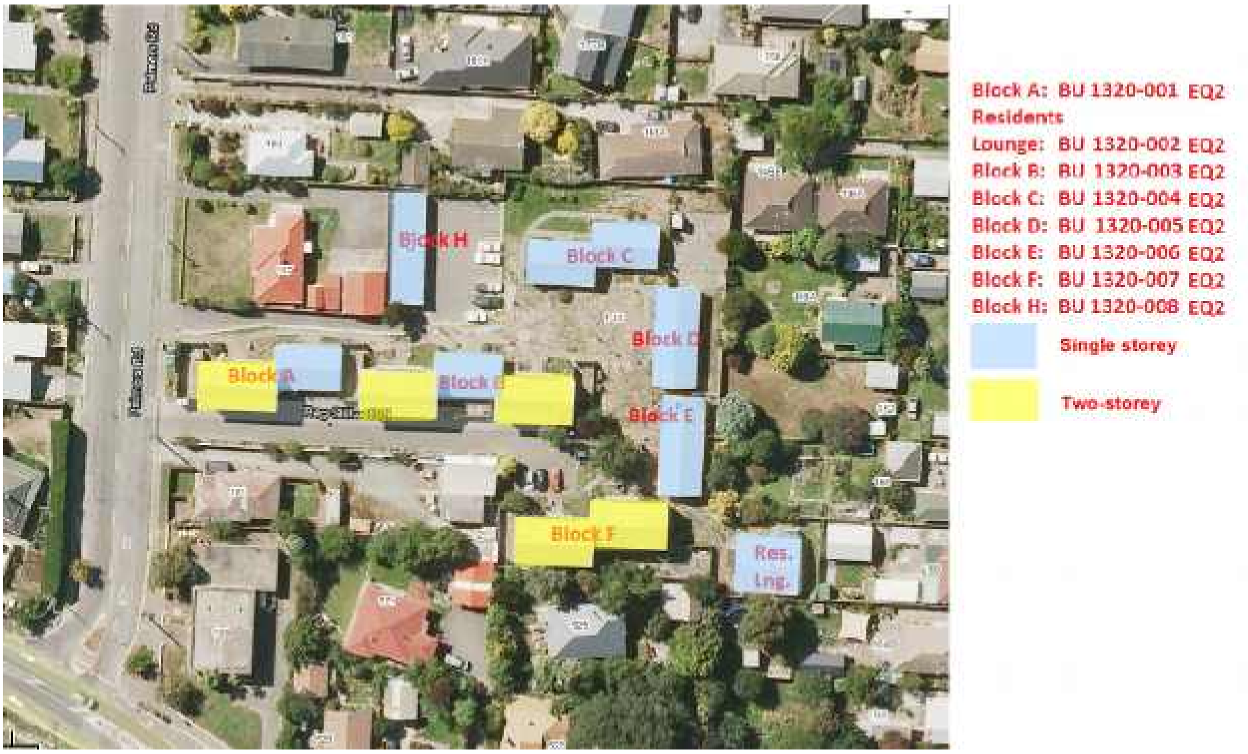


Figure 2: Site Plan (Source: Google Maps)

4.2 Residential Units (Blocks A through F)

The construction of the residential units (Block A through F) is similar with minor variation in terms of number of stories and units. Block A is double-storey at western half and single-storey at the eastern half and consists of 6 units. Block B consists of a single storey central portion sandwiched between two double storey portions and consists of 10 units. Block C is a single storey building with four units. Blocks D and E are identical single-storey buildings with three units each. Block F consists of two double-storey halves with total of 8 units.

All units within single-storey blocks (or single-storey portions of a block) have identical plans. All double-storey blocks (or double-storey portion of a block) have identical plans.

The roof framing of building Blocks A – E consist of 10mm thick plywood sarking on 50mm by 100mm timber purlins which are supported by gang nailed timber trusses. The trusses are supported by timber load bearing walls. For the two-storey buildings, the 1st floor slab consists of 100mm thick precast concrete rib slab with 64mm thick concrete topping. The topping is reinforced with 665 steel mesh. The 1st floor slab is supported by concrete masonry block walls.

The ground floors of all buildings consist of 100mm thick concrete slab on grade. The foundations typically consist of 700mm deep reinforced concrete ground beams under bearing walls and shear walls.

The exterior walls of all the buildings are cavity walls consisting of a 100 mm thick concrete block veneer. The veneer is backed by timber framed walls at the ground floor of single-storey buildings and 1st floor of 2-storey buildings. Whereas the backing for the veneer at ground floor of 2-storey buildings consists of partially filled concrete block walls.

There is no explicitly detailed roof diaphragm. The 10mm plywood sarking and 10mm gib board ceiling provides some diaphragm action to distribute the loads to the vertical lateral load resisting system. The 1st floor diaphragms for two-storey buildings consist of the concrete-topped precast concrete rib slab.

The lateral load resisting system for the single-storey buildings and the 1st floor of 2-storey buildings consist of a combination of concrete block walls and timber walls sheathed with 10mm "gib foil". The lateral load resisting system at the ground floor of two-storey buildings consists primarily of concrete block walls. The block walls are either 150mm or 200mm thick and are typically reinforced with 12.7mm diameter vertical bars at 800mm centres. The drawings do not show any horizontal reinforcements except below window openings. The cells of the block walls are typically filled only where reinforcement steel is present, except that the walls between units are fully filled. Concrete bond beams occur at the floor and roof levels of the block walls.

The E-W lateral load resisting system for the single-storey buildings Blocks D & E consists primarily of the concrete block party walls. The block walls are 200mm thick and are typically reinforced with 12.7mm diameter vertical bars at 600mm centres. The drawings only show any horizontal reinforcements in the bond beam at the top of the party wall. The cells of the block walls are only filled only where reinforcement steel is present, at 600mm centres. Concrete bond beams occur at the roof levels of the party block walls.

4.3 Resident's Lounge

The Resident's Lounge is a single storey building. The roof framing consists of timber rafters and beams supported on timber bearing walls. The walls are lined with Gib board with braces within the wall and some plywood panels. The exterior walls are similar to the residential units and are 90mm concrete block veneer.

4.4 Garage (Block H)

The garage (Block H) is a single storey concrete block wall structure that consists of six identical spaces separated by interior concrete block walls. The roof consists of timber purlins supported on the block walls. The lateral system consists of a long concrete block wall along the back of the garages, in between each garage, and 590mm wide concrete block piers between each garage roll-up door along the front elevation. Based on cover metre survey, the block walls are reinforced with 16mm diameter vertical bars at 600mm centres and 16mm horizontal bars at 1200mm centres.

A summary of the buildings within the site is provided in Table 2 below:

Table 2: Summary of Buildings

Block	# of Stories	# of Units	Approx. overall dim.	Plan area	Notes
Block A	1 and 2	Ground floor: 4; 1st floor: 2	6.9m by 25.4m	100 m^2	The eastern portion of Block A is single storey and is identical to central portion of Block B. The western portion of building A is two-storey and is identical to east and west portions of Block B.
Block B	1 and 2	Ground floor: 6; 1st floor: 4	6.9m by 39m	269 m^2	The eastern portion of Block A is single storey and is identical to central portion of Block B. The western portion of building A is two-storey and is identical to east and west portions of Block B.
Block C	1	Ground floor: 4	6.7m by 23.4m	157 m^2	Layout of each individual units are same as Block D and E
Block D	1	Ground floor: 3	6.7m by 17.6m	118 m^2	Blocks D is similar to E
Block E	1	Ground floor: 3	6.7m by 17.6m	118 m^2	Block E similar to D but unit 24 was rebuilt in 2009 due to fire damage
Block F	2	Ground floor: 4; 1st floor: 4	6.9m by 28m	193 m^2	
Residents Lounge	1	NA	10m by 11.1m	111 m^2	
Garage (Block H)	1	NA	6m by 20m	120 m^2	

5 Survey

5.1 Post 22 February 2011 Rapid Assessment

Opus International Consultants completed a Level 1 (external) Building Safety Evaluation on behalf of Civil Defence on 3 February 2011.

Opus International Consultants undertook a Level 2 (internal) inspection on 23 December 2011 on behalf of the Christchurch City Council.

We recommended barricades to be set up or veneer be braced to protect pedestrians from falling hazards.

5.2 Further Inspections

Additional site visits were undertaken by Opus International Consultants on 17 April 2012 and 30 April 2012.

Inspections included field measurements to determine existing construction of the residents lounge and garages.

Floor level surveys were performed on the ground floor and 1st floors of Blocks A, B and F. Additionally floor level survey was performed on the ground floor of Block C. The result of the survey is summarized in the geotechnical report included in Appendix 2. Verticality survey was performed at Blocks A, B and F. The results of the survey are included in Appendix 4.

5.3 Original Documentation

Copies of the following drawings were provided by CCC:

- June 1973 stamped consent drawings: Architectural drawings sheet 1 through 18
- 7 June 1973 stamped consent drawings: Structural sheet 1 through 4
- 8 April 1992 new resident's lounge drawings sheet 1 through 3
- March 2009 full drawings and bracing schedule was available for unit 24 which was rebuilt due to fire damage

Please note that we were NOT able to locate structural drawings for Block H (garage). Field investigation was performed to document the existing construction.

The drawings have been used to confirm the structural systems, investigate potential critical structural weaknesses (CSW's) and identify details which required particular attention.

No calculations were available for review.

6 General Observations

The buildings at Reg Stilwell Place have sustained moderate damage to structural elements, as well as some moderate to severe damage to non-structural elements. Following a review of the structural drawings and site investigations, the observed damage is generally consistent with the expected building performance, although some of the buildings have performed better than expected.

Key damage observed to structural and non-structural elements includes:

General

Liquefaction induced differential movement is evident at the site surrounding the buildings.

Block A

a) Severe cracking of exterior concrete block veneer. Damage is most severe outside of unit 5.

b) Cracking of interior lining.

c) Noticeable settlement and rotation of the building.

d) Cracking of the sides of concrete ground beam.

Block B

a) Severe cracking of exterior concrete block veneer. Damage is most severe outside of units 11 and 12.

b) Some veneer block is out of plumb.

c) Minor cracking of interior lining.

d) Horizontal cracking of exterior block work propagates through interior gib lining.

e) Noticeable settlement and rotation of the building.

f) Cracking of perimeter ground beam.

Block C

a) Severe cracking of exterior concrete block veneer. Damage is most severe at the connection between the 2 halves of the building.

b) Lateral separation between units 18 and 19.

c) Gap at ground floor slab between units 18 and 19 indicative of ground movement

d) Longitudinal cracking along concrete footing to Units 19 and 20.

Block D

a) Minor cracking at interior lining.

b) Visible ground movement and settlement.

Block E

a) Minor cracking at interior lining.

b) Visible ground movement and settlement.

Block F

a) Moderate cracking at exterior block veneer

b) Moderate cracking at interior lining.

Residents Lounge

a) Minor to moderate cracking at exterior block veneer.

Garage (Block H)

a) No damage was observed.

7 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" issued on 21 December 2011.

An initial qualitative assessment as outlined in the DEEP guidelines was not undertaken on this building prior to completing a detailed quantitative analysis. Identification of load paths, critical structural weaknesses and collapse hazards has been completed as part of the detailed quantitative analysis.

7.1 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. The following potential CSW's have been identified for the building and have been considered in the analysis.

Blocks A and B

a) Torsion: Ground floor concrete block wall between kitchen and bathroom is not connected to the first floor slab. As a result, the main lateral load resistance in the east-west direction comes from the wall piers along the south elevation resulting in a torsional response.

b) Pounding and separation between single-storey and two-storey portions: The two-storey portion and the single-storey portion are not structurally tied together for lateral loading because the roof of the one-storey portion is not aligned with the first floor of the two-storey building.. As a result, they behave as separate structures and pounding can occur at the interface. Additionally, the roof of the single-storey structure relies on the wall at the interface for gravity load support. Thus differential lateral movement from earthquake shaking could potentially lead to local loss of gravity support of the roof of the single storey portion.

Block C

a) Pounding and separation between eastern and western halves: There is a plan offset between the eastern and western halves of Block C. The roof diaphragm is not aligned at this offset thus the eastern half and the western half of the building behaves as two separate structures for seismic loading. Pounding can occur at the interface. Additionally, the roof structure of the two halves relies on the common wall for gravity support. Thus differential lateral movement from earthquake shaking of the two halves could potentially lead to local loss of gravity support.

Block F

c) Torsion: Ground floor concrete block wall between kitchen and bathroom is not connected to the first floor slab. As a result, the only lateral load resistance in the east-west direction comes from the wall piers along the south elevation resulting in a torsional response.

7.2 Quantitative Assessment Methodology

The assessment assumptions and methodology have been included in Appendix 3 of the report due to the technical nature of the content. A brief summary follows:

- A 3D model of the 2-storey buildings (2-storey portion of Blocks A, B and F) was created in ETABS, which is a finite element structural analysis programme.
- The single-storey buildings were checked by hand calculations.
- An equivalent static force analysis was carried out using the spectral values established from NZS1170.5, with an updated Z factor of 0.3 (B1/VM1). This analysis was used to establish the actions on the structural elements.
- The building was assessed as Importance Level 2.
- Based on the actions determined from the analysis, demand to capacity ratios (DCR's) were determined for each component in question. The highest DCR was then converted to a %NBS for the structure.

7.3 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. Therefore the current capacity of the building 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 drawings 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.

7.4 Quantitative Assessment

A summary of the structural performance of the building is shown in the tables below. Note that the values given represent the critical elements in the building, as these effectively define the building's capacity. As noted in Appendix A2.2 (Analysis Parameters), the building was analysed using a ductility factor (μ) equal to 1.25 due to partially reinforced block walls and timber walls that relies on gib sheathing to resist lateral load.

Modes of failure that do not govern the building's performance are not included in the table except as noted for cases where higher ductility factors have led to the component being classified as non-critical.

Table 3: Summary of Seismic Performance for Block A and B – μ = 1.25 (unless noted otherwise)

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Primary Components at 2-story portion (those that are required parts of the lateral resisting system)			
1st floor concrete block walls in north-south direction	Concrete block wall is adequate to resist code level forces in north-south direction loading	No	100%
1st floor timber walls (sheathed with gib foil) in north-south direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	10% - 20%
1st floor timber walls (sheathed with gib foil) in east-west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	< 10%

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Ground floor concrete block wall in the north-south direction	Concrete block wall is adequate to resist code level forces in north-south direction loading	No	100%
Ground floor concrete block wall in the east-west direction	Concrete block wall pier along south elevation is not capable to resist code level forces. Failure mode is in flexure.	Yes	25%
Topping slab at 1st floor (diaphragm)	Diaphragm is consists of 64mm thick concrete topping reinforced with 665 mesh. Maximum diaphragm shear occurs along the southern edge of the diaphragm where the concrete block wall along the south elevation provide majority of lateral load resistance for east west direction seismic load.	No	40%
Primary Components at 1-story portion (those that are required parts of the lateral resisting system)			
Concrete block wall in single-storey portion along north-south direction	Concrete block walls are adequate to resist code level forces	No	100%
Ground floor timber walls in single-storey portion in north-south direction	Timber walls sheathing with 10mm gib foil fails in shear.	No	40%
Ground floor timber walls in single-storey portion in east-west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	10 - 15%
Ceiling diaphragm of single story portion	10mm gib ceiling diaphragm does not have shear capacity to act as diaphragm to resist code lateral forces	No	40 - 50%
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			
Interface between 2-storey and 1-storey portions	The two-storey portion and the single-storey portion are not structurally tied for lateral loading because the roof of the one-storey building does not align with the first floor of the two-storey building.. As a result, they behave as separate structures and pounding can occur at the interface. Additionally, the roof of the single-storey structure relies on the two-storey building for gravity load support. Thus differential lateral movement from earthquake shaking could potentially lead to local loss of gravity support of the roof of the single storey portion.	Yes; potential local loss of gravity support	NA
Staircase	Stair case is in-situ concrete that is dowelled into 1st floor topping and slab intermediate landing. The staircase occurs between two relatively long concrete block walls. The inter-storey drift is expected to be low and the stair is expected to behave adequately	No	NA

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Out-of-plane support of ground floor block wall between kitchen and bathroom	Top of block wall is not connected to concrete slab above. Out of plane loading is resisted by block wall cantilever from foundation.	No	40 - 50%
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	NA

Table 4: Summary of Seismic Performance for Block C – $\mu = 1.25$ (unless noted otherwise)

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Primary Components (those that are required parts of the lateral resisting system)			
Concrete block wall in single-storey portion along north-south direction	Concrete block walls are adequate to resist code level forces	No	100%
Ground floor timber walls in single-storey portion along the north-south direction	Timber walls sheathing with 10mm gib foil fails in shear.	No	40%
Ground floor timber walls in single-storey portion along the east-west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	10 - 15%
Ceiling diaphragm of single story portion	10mm gib ceiling diaphragm does not have shear capacity to act as diaphragm to resist code lateral forces	No	40 - 50%
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Interface between eastern and western halves	There is a plan offset at the midpoint of Block C. The roof diaphragm is not aligned at this offset thus the eastern half and the western half of the building behaves as two separate structures for seismic loading. Separation and pounding can occur at the interface. This is evident from the damage to the exterior veneer adjacent to this interface. Additionally, the roof structure of the two halves relies on the common wall for gravity support. Thus differential lateral movement from earthquake shaking of the two halves could potentially lead to local loss of gravity support.	Yes; potential local loss of gravity support	NA
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	NA

Table 5: Summary of Seismic Performance for Block D – μ = 1.25 (unless noted otherwise)

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Primary Components (those that are required parts of the lateral resisting system)			
Concrete block along east west direction	Concrete block walls are adequate to resist code level forces	No	100%
Along the north-south direction	Timber walls sheathing with 10mm gib foil fails in shear.	No	58%
Along the east-west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	No	58%
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	NA

Table 6: Summary of Seismic Performance for Block E – $\mu = 1.25$ (unless noted otherwise)

Structural Element/System	**Failure mode or description of limiting criteria based on displacement capacity of critical element.**	**Critical Structural Weakness and Collapse Hazard**	**% NBS based on calculated capacity**
Primary Components (those that are required parts of the lateral resisting system)			
Concrete block along east west direction	Concrete block walls are adequate to resist code level forces	No	100%
Along the north-south direction	Timber walls sheathing with 10mm gib foil fails in shear.	No	68%
Along the east-west direction	Timber walls sheathing with 10mm gib foil and Braceline	No	100%
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	NA

Table 7: Summary of Seismic Performance for Block F – $\mu = 1.25$ (unless noted otherwise)

Structural Element/System	**Failure mode or description of limiting criteria based on displacement capacity of critical element.**	**Critical Structural Weakness and Collapse Hazard**	**% NBS based on calculated capacity**
Primary Components (those that are required parts of the lateral resisting system)			
1st floor concrete block walls in north-south direction	Concrete block wall is adequate to resist code level forces in north-south direction loading	No	100%
1st floor timber walls (sheathed with gib foil) in north-south direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	10% - 20%
1st floor timber walls (sheathed with gib foil) in east-west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	Yes	< 10%
Ground floor concrete block wall in the north-south direction	Concrete block wall is adequate to resist code level forces in north-south direction loading	No	100%
Ground floor concrete block wall in the east-west direction	Concrete block wall pier along south elevation is not capable to resist code level forces. Failure mode is in flexure.	Yes	25%

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Topping slab at 1st floor (diaphragm)	Diaphragm is consists of 64mm thick concrete topping reinforced with 665 mesh. Maximum diaphragm shear occurs along the southern edge of the diaphragm where the concrete block wall along the south elevation provide majority of lateral load resistance for east west direction seismic load.	No	40%
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			
Staircase	Stair case is in-situ concrete that is dowelled into 1st floor topping and slab intermediate landing. The staircase occurs between two relatively long concrete block walls. The inter-storey drift is expected to be low and the stair is expected to behave adequately	No	NA
Out-of-plane support of ground floor block wall between kitchen and bathroom	Top of block wall is not connected to concrete slab above. Out of plane loading is resisted by block wall cantilever from foundation.	No	40 - 50%
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	NA

Table 8: Summary of Seismic Performance for Residents Lounge – μ = 1.25 (unless noted otherwise)

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Primary Components (those that are required parts of the lateral resisting system)			
Timber walls (sheathed in gib foil) in the north-south direction	Timber walls sheathing with 10mm gib foil. Shear capacity is limited. Additionally, holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	No	70%
Timber walls (sheathed in gib foil) in the east west direction	Timber walls sheathing with 10mm gib foil. Holdowns are not present at end of walls thus their capacity to resist overturning is limited. Controlling mode of failure is overturning.	No	46%
Ceiling Diaphragm	Gib ceiling diaphragm does not have shear capacity to act as diaphragm to resist code lateral forces	No	50 – 60%

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Secondary Components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building under goes deformation due to earthquake loading)			
Exterior block veneer	Connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.	Yes	46%

Table 9: Summary of Seismic Performance for the Garage (Block H) – $\mu = 1.25$ (unless noted otherwise)

Structural Element/System	Failure mode or description of limiting criteria based on displacement capacity of critical element.	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Primary Components (those that are required parts of the lateral resisting system)			
Transverse block walls	Concrete block walls are adequate to resist code level forces. The stresses in the walls are low.	No	100%
Longitudinal block walls at back of garage	Concrete block walls are adequate to resist code level forces. The stresses in the wall are low.	No	100%
Block wall piers at the front of the garage	Flexural failure of block wall piers.	No	65%
Roof Diaphragm	The construction of the roof diaphragm is unknown. However, spans between block walls are relatively small, the diaphragm is expected to perform adequately	No	NA

7.5 Discussion

Based on our quantitative assessment, Blocks A, B, C and F have computed strength of less than 33% NBS. This is primarily due to limited overturning capacity of the gib-sheathed timber shear walls which do not have holddowns to resist overturning forces. The calculated overturning capacity of these walls are approximately 10-20% NBS for the residential units. Ground floor concrete block wall piers for block A, B, and F have capacities of approximately 25% NBS for east-west direction loading. There are also signs of separation and pounding for blocks A, B, and C where the interfaces between different portions of the buildings are not tied together. As highlighted in Tables 3 to 7 above, a number of other elements also have seismic capacities less than 33% NBS, and the buildings are therefore defined as being earthquake prone in accordance with the Building Act.

The lateral support for the exterior block veneers is unknown. Based on damage observed, the amount of damage to the block veneer indicates that they are likely not reinforced and poorly tied to the backup walls. Potential falling hazard exists thus barricades are recommended or veneer be braced to protect pedestrians from falling hazards.

The Garage (Block H) has a computed strength of 65%NBS and is considered to be low or moderate earthquake risk.

The single storey Blocks D, E, H (garage) and the residents lounge are considered safe to occupy, with capacities over 33% NBS.

8 Summary of Geotechnical Appraisal

8.1 General

Christchurch City Council commissioned Opus International Consultants to undertake a desktop study of the ground conditions beneath the buildings at Reg Stilwell Place. Geotechnical information herein is based on the findings of that study.

The buildings foundations are reinforced concrete perimeter strip footings founded 600mm to 900mm below the finished floor slab level. These foundations have settled differentially because of either densification of the underlying soil or liquefaction that has occurred at depth. A Site investigation was undertaken and a report written dated 7 March 2013. A summary of the main findings follow.

8.2 Liquefaction Potential

The ECan liquefaction study indicated the Reg Stilwell Place site possessed a high liquefaction ground damage potential during future seismic events. Post-earthquake aerials and observations have confirmed that significant volumes of liquefied soils were ejected at the site during the 4 September 2010, 22 February 2011 and 13 June 2011 earthquake events.

Residential properties on the southern boundary have been zoned "Red", indicating that the land is not practical to rebuild, repair or reoccupy, as the required improvements would be too difficult or costly to implement.

Observations of damage to the Reg Stilwell Residential Housing Units confirmed that liquefaction induced differential settlement has occurred at the site. The extent of settlement was quantified in a levels survey by OPUS which indicated between 40 and 120mm of differential settlement has occurred in the concrete floor slabs of the units in Blocks A, B, C & F.

Due to the proximity of the Avon River to Reg Stilwell Place and the height difference from floor level to river invert level, the site is considered to have lateral spreading potential. A detailed investigation and assessment of the lateral spreading potential for this site is recommended.

The buildings at the site are a similar structural form to a residential structure. Accordingly, recommendations in the Department of Building and Housing New Zealand guidance documents for repairing and rebuilding foundations in Technical Category 3 (DBH, 2012) are considered applicable for the buildings at this site. The guidance document indicates that for foundations comprising a reinforced concrete perimeter footing with a concrete floor slab which are out of level between 50mm to 150mm with cracks in the floor slab less than 3mm, a foundation re-level is required.

8.3 Summary

Reg Stillwell suffered moderate to major ground damage due to the recent seismic events. Surface evidence of liquefaction including sand boils and differential subsidence was observed around the site, with lateral spreading being observed south and west of the site towards the Avon River.

Differential settlement has caused significant damage to the majority of the structures at Reg Stillwell. All buildings are founded on concrete perimeter strip footings with slab on-grade floors that have not been tied together.

The foundations of the buildings at Reg Stillwell Residential Complex are not considered appropriate for this site based on the MBIE guidance document.

A liquefaction assessment predicts this building is likely to experience up to 200 mm of total free-field subsidence in a future ULS seismic event, where the expected differential settlements of approximately 100 to 150 mm can be expected in a ULS event and up to 70 mm in a SLS event.

Lateral spreading analysis suggests that there may be up to 300 mm of horizontal deformation towards the Avon River in a ULS event and up to 100 mm of lateral stretch of buildings, although this level of lateral spreading did not occur in the recent seismic events.

The expected future ground performance of Reg Stillwell is likely to perform similar to MBIE TC3, with moderate land deformations possible in a future small to medium sized (SLS) earthquake, and significant land deformations in a future moderate to large (ULS) earthquake.

A number of remedial options have been outlined based on whether the buildings are to remain or be rebuilt. Options include; re-levelling the existing foundations or rebuilding on enhanced foundations with consideration of lateral spreading potential and mitigation. Replacement of the concrete floor slabs is likely, following a re-level of the buildings.

Further site investigations and engineering evaluation would be required in the detailed design phase to determine the most appropriate liquefaction mitigation and foundation options, and the cost associated with these options.

The floor levels of some of the blocks are below the recommended interim floor level by the CCC but are above the 200 year Flood Level. This would need to be considered in the future remediation and utilization of this site.

8.4 Geotechnical Recommendations

For the Reg Stillwell site it is recommended that:

a) The selection of the most appropriate foundation option should consider the risks and long term exposure of this site to liquefaction induced subsidence and lateral spreading risk outlined in this assessment, comparing this with expected performance criteria.

b) Shallow re-levelling and repairing remedial schemes (Option L1) is not considered acceptable in a ULS seismic event without considering lateral spread remediation.

c) Underpinning the existing structure (Option L2) with piles or compacting grouting could provide an adequate low to moderate risk solution but may not be cost effective.

d) If replacement of the building on site is being considered, then low risk options including deep piled foundations or ground improvement (Options R1 and R2) and if possible location of the buildings in the north side of the site. This should provide a low risk/resilient structure but is likely to be relatively expensive.

e) Alternatively CCC could consider easily re-levellable foundation on a stabilised crust (Option R4).

f) In the long term, CCC should consider whether rebuilding on an alternative site may be more effective.

g) Allowance for significantly enhanced foundations and potentially lateral spreading mitigation should be made for any buildings that may be constructed on this site.

h) Further site investigation and specific analysis of the foundations would be required in the detailed design phase.

i) The final floor level of the re-levelled or re-built structure with respect to flood levels will need to be agreed with the CCC building consent team during the detailed design phase.

9 Remedial Options

The buildings requires repair and strengthening, with a target of increasing the seismic performance to as near as practicable to 100%NBS, and at least 67%NBS. A possible strengthening scheme to achieve this would include:

- Replace and/or strengthen gib sheathing at selected timber walls (applicable to Blocks A through F and residents lounge).

- Install hold-down anchors and strengthen timber members at ends of plywood shear walls. (Applicable to Blocks A through F and residents lounge).

- Install veneer ties to all exterior block veneers. (Applicable to Blocks A through F and residents lounge).

- Connect ground floor concrete block walls between kitchen and bathroom to 1st floor concrete slab above. (Applicable to Blocks A, B and F)

- Install secondary bearing wall to support roof framing along interface between single-storey and two-storey portions of Block A and B. Similarly, install secondary bearing wall to support roof framing along plan offset between eastern and western halves of Block C.

- Remove and replace selected block walls in east-west direction at ground level of Blocks A, B, and F with fully filled block walls with horizontal reinforcement or equivalent alternative.

- If the site is assessed to be the equivalent to the Department of Building and Housing New Zealand Technical Category 3 (DBH, 2011), then in accordance with the interim guidance document (DBH, 2012), a foundation re-level is recommended for the units at Reg Stilwell Place. However, more damage to the existing concrete slab foundations is likely in a future seismic event. Rebuilding with enhanced foundations (e.g. ribraft or piles) is considered more likely to be reinsurable and achieve building consent compliance.

10 Conclusions

Based on our quantitative assessment, Blocks A, B, C and F are considered earthquake prone. This is primarily due to the gib-sheathed timber shear walls having capacities of less than 33%NBS. Ground floor concrete block wall piers for block A, B, and F also have capacities less than 33%NBS for east-west direction loading. The single storey Blocks D and E, and the residents lounge are consider to be low or moderate earthquake risk, with capacities over 33% NBS. The Garage (Block H) has a computed strength of 65%NBS and is consider to be low or moderate earthquake risk. Factors limiting the %NBS of the buildings are summarized below:

a. The seismic performance of the primary components (those that are required parts of the lateral resisting system) are governed by:

   - The lateral system for single-storey buildings consist primarily of timber walls sheathed with 10mm gib foil. No hold-downs were provided at the end of the shear walls to resist overturning. The walls in the north-south direction of block D and E have computed strength of 58% NBS. The walls in the east-west direction of block C also have computed strength of 10 to 15% NBS. The walls in the east-west direction of the residents lounge have computed strength over 46% NBS.

- Similar to item "a" above, the lateral system for first floor of the two-storey buildings (Block A, B, and F) consists primarily of timber walls sheathed with 10mm gib foil. No hold-downs were provided at the end of the shear walls to resist overturning. The walls in the north-south direction have a computed strength of 10 to 20% NBS and the walls in the east-west direction have a computed strength of less than 10% NBS.
- The ground floor concrete block walls along the south elevations of Blocks A, B, and F are partially filled with no shear reinforcement and minimal reinforcement for flexure. These walls have computed strength of approximately 25% NBS.

b. The seismic performance of the secondary components (those that are not required parts of the lateral load resisting system but which must be able to maintain their gravity load capacity while the building undergoes deformation due to earthquake loading) are governed by:

- Exterior block veneer: connection between exterior block veneer and back-up wall is unknown. Whether the block veneer is reinforced is unknown. Based on observations from the field, the amount of damage to the veneer indicates that they are likely not reinforced and poorly tied to the back-up wall. Potential falling hazard exists.
- The two-storey portion and the single-storey portion of Blocks A and B are not tied together. The roof of the one-storey building does not align with the first floor of the two-storey building. As a result, they behave as separate structures and pounding can occur at the interface. Additionally, the roof of the single-storey structure relies on the two-storey building for gravity load support. Thus differential lateral movement from earthquake shaking could potentially lead to local loss of gravity support of the roof of the single storey portion.
- Similar to item "b" above, there is a lateral offset between the western and eastern halves of Block C. The roof diaphragm is not aligned at this offset thus the two halves behave as two separate structures for seismic loading. Pounding can occur at the interface. Additionally, the roof structure of the two halves relies on the common wall for gravity support. Thus differential lateral movement from earthquake shaking of the two halves could potentially lead to local loss of gravity support.

The buildings have a seismic capacity less than 34% NBS and are therefore defined as being earthquake prone in accordance with the Building Act. It is recommended that the buildings not be occupied given their earthquake prone building status.

The lateral support for the exterior block veneers is unknown. Based on damage observed, the amount of damage to the block veneer indicates that they are likely not reinforced and poorly tied to the backup walls. Potential falling hazard exists thus barricades are recommended or veneer be braced to protect pedestrians from falling hazards.

The ECan liquefaction study indicated the Reg Stilwell Place site possessed a high liquefaction ground damage potential during future seismic events. If the existing shallow foundations are retained, it is likely that in a future Serviceability Limit State (SLS) and Ultimate Limit State (ULS) earthquake, liquefaction induced settlement similar to that which has occurred at the site is likely. Additionally, due to the proximity of the Avon River to Reg Stilwell Place and the height difference from floor level to river invert level, the site is considered to have lateral spreading potential.

11 Recommendations

a) Develop a strengthening works scheme to increase the seismic capacity of the Blocks A through D, Block F and the residents lounge to at least 67%NBS; this will need to consider compliance with accessibility and fire requirements.

b) A quantity surveyor is engaged to determine the costs for strengthening the building.

c) It is recommended that Blocks D, E, H (garage) and the Resident's Lounge can be occupied, given their low to moderate risk.

d) Due to potential falling hazard of the exterior block veneer, barricades are recommended or veneer be braced to protect pedestrians from falling hazards.

12 Limitations

a) This report is based on an inspection of the structure of the buildings and focuses on the structural damage resulting from the 4 September 2010 Darfield Earthquake and the 22 February 2011 Canterbury Earthquake and aftershocks. Some non-structural damage is described but this is not intended to be a complete list of damage to non-structural items.

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

c) We were not able to locate structural drawings for the third floor addition thus we assumed the construction is similar to the original construction.

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

13 References

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

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

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

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

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

Appendix 1 – Photographs

Reg Stilwell Place – 189 Palmers Road		
No.	**Item description**	**Photo**
Block A		
1.	North elevation of Block A showing the two-storey portion	
2.	South elevation of Block A. Note the ejecta due to liquefaction at the pavement	

3.	Crack in gib board wall at unit 3	
4.	Separation between the 2-storey portion and the 1-storey portion	

5.	Severe cracking in block veneer outside of Unit 5	
6.	Vertical crack at sides of concrete ground beam	

Block B		
7.	North elevation of 2-storey portion of Block B. Identical to Block A	
8.	Temporary bracing for exterior block veneer at gables	

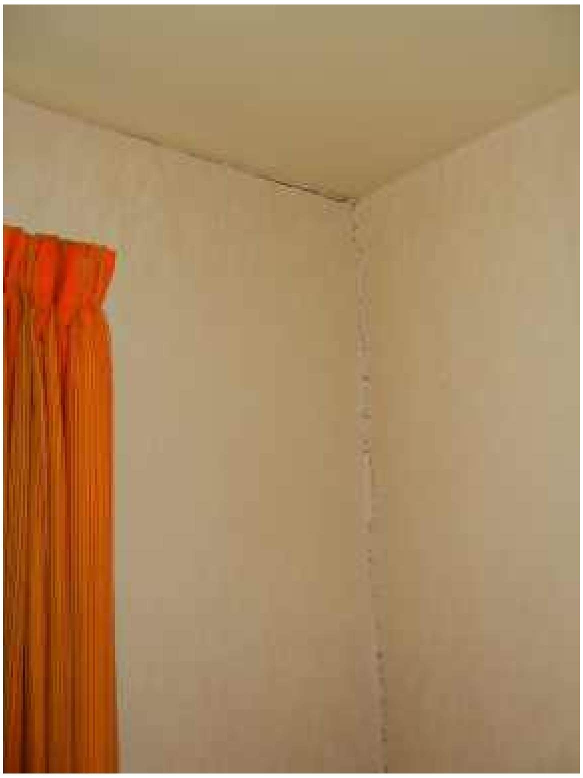
9.	Step cracking at veneer of single-storey portion. Veneer is leaning toward the interior of the unit		
10.	Vertical crack and out-of-plane offset in block veneer		

11.	15mm crack at veneer joints	
12.	Veneer leaning toward the interior of single story unit as evident in gap between soffit and face of veneer	

13.	Vertical crack of block veneer	
14.	Horizontal cracking in exterior blockwall propagates through into interior lining	

15.	Horizontal crack at top of lining	
16.	Vertical crack at sides of perimeter ground beam	

Block C		
17.	South elevation of block C	
18.	Severe step cracking of block veneer at Unit 18	

19.	Cracking of interior lining at Unit 18	
20.	Gap at slab on grade along base of partial wall between Unit 18 and 19	

21.	Temporary bracing of exterior block veneer in front of Unit 19	
22.	Separation between two halves of block C (between units 18 and 19	

23.	Separation of block veneer around window at Unit 20	
24.	Horizontal offset of exterior block veneer at Unit 20	

Block D		
25.	Minor cracking of interior linings at Unit 21	
26.	Minor cracking of interior linings at Unit 22	

Block E		
27.	Gap between footing and soil	
Block F		
28.	North elevation of Block F (identical to 2-storey portions of Block A and B)	

29.	Step cracking at exterior block veneer ground floor pier		
30.	Cracking of interior lining		

31.	Cracking of interior lining	
32.	Temporary bracing of exterior block veneer at gable	

Resident's Lounge		
33.	Front elevation of Residents Lounge	
34.	Step cracking at exterior block work	

35.		
	Garage (Block H)	
36.		

37.		

Appendix 2 – Quantitative Assessment Methodology and Assumptions

A3.1. Referenced Documents

- AS/NZS 1170.0:2002, *Structural design actions, Part 0: General principles,* Standards New Zealand.

- AS/NZS 1170.1:2002, *Structural design actions, Part 1: Permanent, imposed and other actions,* Standards New Zealand.

- NZS 1170.5:2004, *Structural design actions, Part 5: Earthquake actions – New Zealand,* Standards New Zealand.

- NZS 3101: Part 1: 2006, *Concrete Structures Standard, The Design of Concrete Structures,* Standards New Zealand.

- NZS 3101: Part 2: 2006, *Concrete Structures Standard, Commentary on the Design of Concrete Structures,* Standards New Zealand.

- NZBC, *Clause B1 Structure, Verification Method B1/VM1,* Department of Building and Housing.

- NZSEE: 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* New Zealand Society for Earthquake Engineering.

- 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.

- ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings,* Structural Engineering Institute of the American Society of Civil Engineers, 2007.

A3.2. Analysis Parameters

The following parameters are used for the seismic analysis:

- Site soil category — Cl. 3.1.3, NZS1170.5
  D (deep or soft soil)

- Seismic hazard factor — Cl. 2.2.14B, B1/VM1
  Z = 0.30

- Return period factor — Table 3.5, NZS1170.5
  R_u = 1.0 (*Importance* Level 2 structure, 50 year design life)

- Ductility factor — Cl. 2.6.1.2, NZS3101:2006
  μ = 2.0 for blocks D, E and Resident's Lounge
  μ = 1.25 (nominally ductile) for all other blocks

- Structural performance factor — Cl. 2.6.2.2, NZS3101:2006
  S_p = 0.925

- Material properties

Table A1: Analysis Material Properties

Masonry nominal compressive strength, f'_m (MPa) (1)	10
Mild reinforcing nominal yield strength, f_y (MPa) (2)	300
Timber wall sheathed with gib, fVn (kN/m)	2.1 per side

Notes:

1. Based on guidance from *NZSEE 2006*, probable reinforcement yield strength is based on a value of 1.08 times the nominal yield strength (Cl. 7.1.1)

- Effective section properties

Table A2: Effective section properties from NZS3101:2006

Table C6.6 – Effective section properties, I_e

Type of member	Ultimate limit state		Serviceability limit state		
	f_y = 300 MPa	f_y = 500 MPa	μ = 1.25	μ = 3	μ = 6
1 Beams					
(a) Rectangular ¶	0.40 I_g (use with E_{40}) §	0.32 I_g (use with E_{40}) §	I_g	0.7 I_g	0.40 I_g (use with E_{40})§
(b) T and L beams ¶	0.35 I_g (use with E_{40}) §	0.27 I_g (use with E_{40}) §	I_g	0.6 I_g	0.35 I_g (use with E_{40})§
2 Columns					
(a) $N^*/A_g f'_c > 0.5$	0.80 I_g (1.0 I_g)‡	0.80 I_g (1.0 I_g)‡	I_g	1.0 I_g	As for the ultimate limit state values in brackets
(b) $N^*/A_g f'_c = 0.2$	0.55 I_g (0.66 I_g)‡	0.50 I_g (0.66 I_g)‡	I_g	0.8 I_g	
(c) $N^*/A_g f'_c = 0.0$	0.40 I_g (0.45 I_g)‡	0.30 I_g (0.35 I_g)‡	I_g	0.7 I_g	
3 Walls ¶					
(a) $N^*/A_g f'_c = 0.2$	0.48 I_g	0.42 I_g	I_g	0.7 I_g	As for the ultimate limit state values
(b) $N^*/A_g f'_c = 0.1$	0.40 I_g	0.33 I_g	I_g	0.6 I_g	
(c) $N^*/A_g f'_c = 0.0$	0.32 I_g	0.25 I_g	I_g	0.5 I_g	
4 Diagonally reinforced coupling beams	0.6I_g for flexure Shear area, A_{shear}, as in text		I_g 1.5 A_{shear} for ULS	0.75 I_g 1.25 A_{shear} for ULS	As for ultimate limit state

NOTES –

(§) With these values the *E* value should be the elastic modulus for concrete with a strength of 40 MPa regardless of the actual concrete strength.

(‡) The values in brackets apply to columns which have a high level of protection against plastic hinge formation in the ultimate limit state.

(¶) For additional flexibility, within joint zones and for conventionally reinforced coupling beams refer to the text.

- Earthquake load combination — Cl. 4.2.2, AS/NZS1170.0

  $G + E_u + \Psi_E Q$

- Floor live loading — Table 3.1 Part G, AS/NZS1170.1

  Q = 1.5 kPa – General Areas

- Earthquake combination factor — Table 4.1, AS/NZS1170.0

  $\Psi_E = 0.3$

- Building seismic weight — Cl. 4.2, NZS1170.5

$W_t = G + \Psi_E Q$
$W_t = 944$ kN

A3.3. Assessment Methodology

<u>Static Analysis</u>

The seismic assessment was undertaken by completing static analysis for the building in accordance with NZS 1170.5:2004.

2-Story Buildings – Block A, B, and F

A 3D model was set up using the structural analysis program ETABS, and effective section properties for structural members were taken from Table A2 above. The floor diaphragms were modelled as flexible diaphragms.

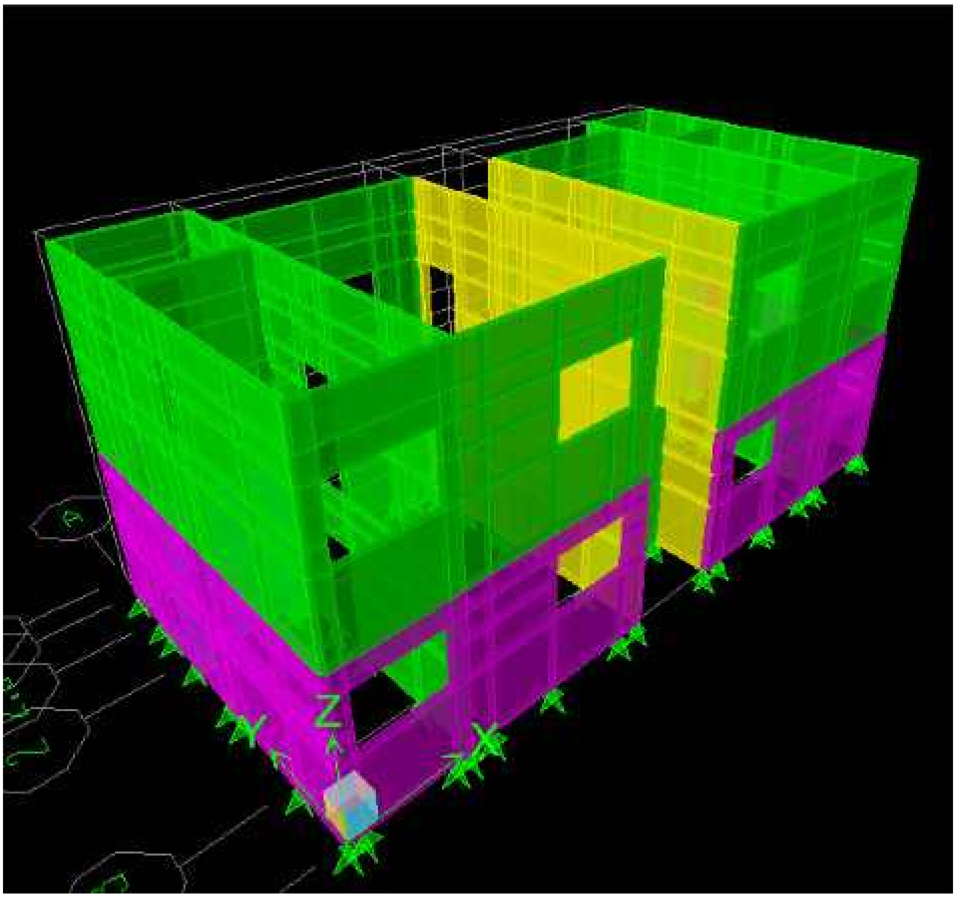


Figure A1: ETABS model of the 2-storey building

The fundamental building periods is based on T used = 0.24 sec. This

The base shears resulting from the equivalent static method are:

- V = 668 kN (E/W and N/S direction)

The building was analysed as having limited ductility (μ = 1.25) and the design actions were applied separately in each perpendicular direction, with 100% for the first axis plus 30% on the second axis, and then 30% on the first axis and 100% on the second axis, as required by NZS1170.5, Clause 5.3.1.2.

Single-storey buildings, Blocks A, B, C, D, E, Residents lounge, and Garage (Block H)

The single storey buildings were analysed by hand calculations

Element Demand to Capacity

Element force demands were extracted from the MRS analysis and compared to calculated capacities based on the material properties assumed in Table A1. The results of these demand to capacity checks are summarized in further detail in the report and reported as %NBS.

Appendix 3 – Geotechnical Appraisal

29 May 2012

Michael Sheffield
Christchurch City Council
PO Box 2522
Addington
CHRISTCHURCH 8140

6-QUCCC.84/85SC REV 1

Dear Michael

Reg Stillwell Place - Geotechnical Desktop Study

1. Introduction

The Christchurch City Council (CCC) has requested OPUS International Consultants (OPUS) provide a geotechnical desktop study and walkover inspection of the Reg Stillwell Place Residential Housing Units following the Canterbury Earthquake Sequence initiated by the 4 September 2010 earthquake.

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

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

2. Desktop Study

2.1 Site Description

The Reg Stillwell Place Residential Housing Units are situated approximately 7km north east of Christchurch City at 189 Palmers Road, New Brighton. It is a relatively flat site, approximately 180m north of the Avon River (refer Appendix A).

The housing development was constructed in the 1970's and comprises 34 units of single and double storey configuration.

2.2 Available Building Drawings

Construction drawings prepared by the Christchurch City Council of the Housing Development were sourced from the CCC property file (refer to Appendix B).

The drawings indicate the buildings are of timber framed construction, clad in concrete block veneer, with a corrugated iron roof. The buildings foundations are reinforced concrete perimeter strip footings founded 600mm to 900mm below the finished floor slab level, with a 100mm thick concrete floor slab reinforced with 1 layer of 668 mesh laid centrally on compacted hardfill.

2.3 Regional Geology

The published geological map of the area, (Brown et al, 1992) indicates the site is underlain predominantly by sand of fixed and semi-fixed dunes and beaches belonging to the Christchurch Formation. A groundwater table depth of approximately 1m has been shown on the published map (Brown et al, 1992).

2.4 Earthquake Commission Subsurface Investigations

Four Cone Penetrometer Tests (CPT's) have been completed within 200m of the site by Tonkin and Taylor, on behalf of the Earthquake Commission (EQC). The CPT's indicate soils comprise silty to clayey SAND/SILT from 0m to 1.4m, underlain by interbedded SAND and SILT layers down to 3.8m to 5.8m, before transitioning into clean sand to the end of the test at approximately 14m depth (Refer Appendix C).

2.5 Expected Ground Conditions

A review of the Environmental Canterbury Wells database (ECan, 2012) showed four wells located within approximately 50m of the property boundary (on the neighbouring property - refer to Appendix D). Material logs available from these wells in addition to the EQC CPT's 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 from (m) below ground
silty SAND/sandy SILT qc_{ave} = 0.5 MPa (0 to 1.0 MPa)	1.2-1.8	0
clayey SILT qc_{ave} = 1.0 MPa, (0.2 to 2.2 MPa)	1.8-4.4	1.2-1.4
SAND qc_{ave} = 12 MPa, (10 to 20 MPa)	28.6-29.7	3.0-5.8
PEAT/clayey SILT qc_{ave} = 2.0 MPa, (0.5 to 5 MPa)	4.2-6.7	31.6-35.5
GRAVELS (RICCARTON)	-	37.4-39.7

The groundwater level was recorded as 0.8m to 1.0m below ground in the borehole records.

2.6 Liquefaction Hazard

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

Examination of post-earthquake aerial photos taken by New Zealand Aerial Mapping (Project Orbit, 2012) identified evidence of significant quantities of liquefied soils ejected at the ground surface of the site after the 4 September 2010, 22 February 2011 and 13 June 2011 events.

The Tonkin and Taylor Reconnaissance (Project Orbit, 2012) also indicated evidence of liquefaction was observed at the site after the 4 September 2010, 22 February 2011 and 13 June 2011 events.

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

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

Table 2: Technical Categories based on Expected Land Performance

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

The property at Reg Stigwell Place has been zoned as N/A-Urban Non-residential, as it is not a residential dwelling. However, the neighbouring residential properties to the south of the site have been zoned as "Red" which is evaluated as not being practical to rebuild, repair or reoccupy. Properties to the north and east of the site have been zoned as Green-TC3 "blue zone", which is determined to have a moderate to significant risk of land damage due to liquefaction in future significant earthquakes.

The Avon River is approximately 180m south-east of the site and its invert is approximately 3m to 4m below the floor level of the residential Units at Reg Stillwell Place. The proximity of the Avon River and presence of liquefiable soils may result in lateral spread occurring at the site.

3. Site Walkover Inspection

A walkover inspection of the exterior of the building and surrounding land was carried out by an Opus Geotechnical Engineer on 30 April 2012. The following observations were made (refer to Site Photographs and Appendix F):

- Ejected sand due to liquefaction located throughout the entire site (refer photographs 3,4 & 10);
- Up to 20mm stepped cracking of concrete block work cladding in numerous units with partial instability of the block work (refer photographs 5 & 8);
- 1mm to 3mm cracks in concrete slab footing to numerous units (refer photographs 2 & 6);
- 20mm to 300mm depressions in asphalt access way and in lawn areas (refer photograph 4);
- Manhole floated by 40mm relative to the surrounding ground;
- Approximately 80mm of heave in the asphalt path in front of Block F (refer photograph 9);
- Numerous cracks in asphalt areas throughout the site;
- Undulating asphalt surface in car park area (refer photograph 3);
- Numerous cracks in concrete kerb to northern access way;

- Numerous cracks in asphalt surfacing to southern access way;
- Longitudinal cracking along concrete footing to Units 19 & 20, Block C (refer photograph 7).

4. Level Survey

A level survey was carried out by OPUS on 30 April 2012. The maximum differential settlement is summarised in Table 3 (refer Appendix G).

Table 3: Variation in Floor Slab Levels

Block	Unit	Differential Settlement (mm)[1,2]
A	1	90 (south)
A	3	80 (south)
B	7	100 (south-east)
B	9	110 (south-east)
B	13	40 (south-east)
B	15	40 (south-east)
C	17	40 (south)
C	18	80 (south-west)
C	19	90 (south-west)
C	20	50 (south-west)
F	27	120 (north-west)
F	29	90 (north-west)
F	31	120 (north)
F	33	90 (north-east)

Notes: (1) Floor slab levels rounded to nearest 10mm

(2) Direction of fall indicated in brackets

(3) Only units listed were surveyed.

5. Discussion

The ECan liquefaction study indicated the Reg Stillwell Place site possessed a high liquefaction ground damage potential during future seismic events. Post earthquake aerials and observations have confirmed that significant volumes of liquefied soils were ejected at the site during the 4 September 2010, 22 February 2011 and 13 June 2011 earthquake events.

Residential properties on the southern boundary have been zoned “Red”, indicating that the land is not practical to rebuild, repair or reoccupy, as the required improvements would be too difficult or costly to implement.

Observations of damage to the Reg Stillwell Residential Housing Units confirmed that liquefaction induced differential settlement has occurred at the site. The extent of settlement was quantified in a levels survey by OPUS which indicated between 40 and 120mm of differential settlement has occurred in the concrete floor slabs of the units in Blocks a, B, C & F.

Observed cracking of the concrete kerbs and asphalt surfaces throughout the site are predominantly perpendicular to the Avon River. Lateral spread ground cracking would be expected to be parallel to the Avon River. Significant ground heave has occurred, which is inferred to result from liquefied ejected soils accumulating under an impermeable surface, such as asphalt.

Due to the proximity of the Avon River to Reg Stillwell Place, the site is considered to have lateral spreading potential. A detailed investigation and assessment of the lateral spreading potential for this site is recommended. The site may also be at risk from flooding of the Avon River.

The buildings at the site are a similar structural form to a residential structure. Accordingly, recommendations in the Department of Building and Housing New Zealand guidance documents for repairing and rebuilding foundations in Technical Category 3 (DBH, 2012) are likely to be applicable for the buildings at this site. The guidance document indicates that for foundations comprising reinforced concrete perimeter footing and a concrete floor slab which are out of level between 50mm to 150mm, with cracks in the floor slab less than 3mm width; a foundation re-level is required.

GNS Science indicates an elevated risk of seismic activity is expected in the Canterbury region as a result of the earthquake sequence following the 4 September 2010 earthquake. Recent advice (Geonet, 2012) indicates there is a 15% probability of another Magnitude 6 or greater earthquake occurring in the next 12 months in the Canterbury region. This event may cause liquefaction induced land damage at the site similar to that experienced; dependent on the location of the earthquakes epicentre. This confirms that there is currently a significant risk of liquefaction and ground settlements occurring at the site. It is expected that the probability of occurrence is likely to decrease with time following periods of reduced seismic activity

If the existing shallow foundations are retained, it is likely that in a future Serviceability Limit State (SLS) and Ultimate Limit State (ULS) earthquake, liquefaction induced settlement similar to that which has been reported at the site may occur.

If the existing units are to be retained, a building consent will be necessary for remedial works. Deep investigations comprising at least 6 Cone Penetrometer Tests (CPT's) to a depth of 20m are recommended to be undertaken to enable a site wide liquefaction and lateral spreading assessment (refer Appendix H).

6. Recommendations

- Review of the flood risk to the site based on updated topographic surveys of the area and predicted flooding river levels is recommended;
- It is recommended that deep investigations comprising at least 6 Cone Penetrometer Tests to a depth of 20m be undertaken to enable a site wide liquefaction and lateral spread potential assessment;
- If the site is assessed to be the equivalent to the DBH Technical Category 3, in accordance with the interim guidance document, a foundation re-level is recommended for the units at Reg Stillwell Place. However, more damage to the existing concrete slab foundations is likely in a future seismic event. Rebuilding with enhanced foundations (e.g. ribraft or piles) is considered more likely to be re-insurable and achieve building consent compliance.

7. Limitation

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

It is recognised that the passage of time affects the information and assessment provided in this Document. The recommendations formed in this report are based upon information that existed at the time of production of the Desk top 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

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

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Project Orbit, *interagency/organisation collaboration portal for Christchurch recovery effort* (2012-last update) [Online] Available: https://canterburyrecovery.projectorbit.com/SitePages/Home.aspx [2012, May 15]

<u>Figures:</u>

Site Photographs

<u>List of Appendices:</u>

Appendix A: Site Location Plan

Appendix B: CCC Construction Drawings

Appendix C: Earthquake Commission Cone Penetrometer Test Results

Appendix D: Environment Canterbury Borehole Logs

Appendix E: Land Recovery Zones

Appendix F: Site Walkover Inspection Plan

Appendix G: OPUS Verticality Survey

Appendix H: Proposed CPT Site Plan

Appendix A:
Site Location Plan

Key:

EQC CPT

Ecan Borehole

SOURCE: 1) canterburyrecovery.projectorbit.com (Accessed on 15/05/12)
2) http://arcims.ecan.govt.nz/ecanmapping/ (Accessed on 15/05/12)

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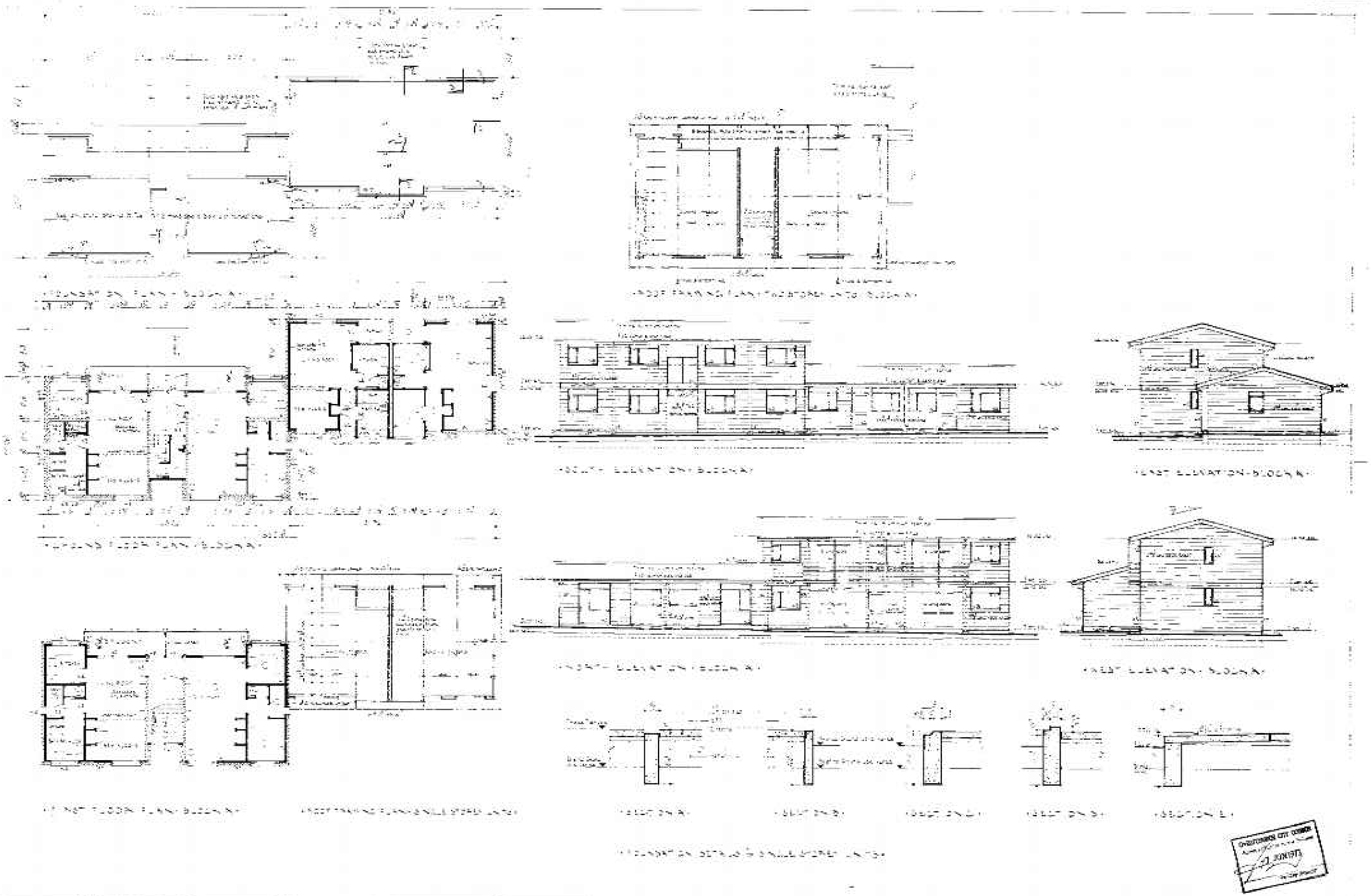
Project:	Reg Stillwell Place Geotechnical Desktop Study	**Site Location Plan**	
Project No:	6-QUCCC.84 85SC	**Drawn:**	15/05/2012
Client:	Christchurch City Council		

Appendix B:
CCC Construction Drawings

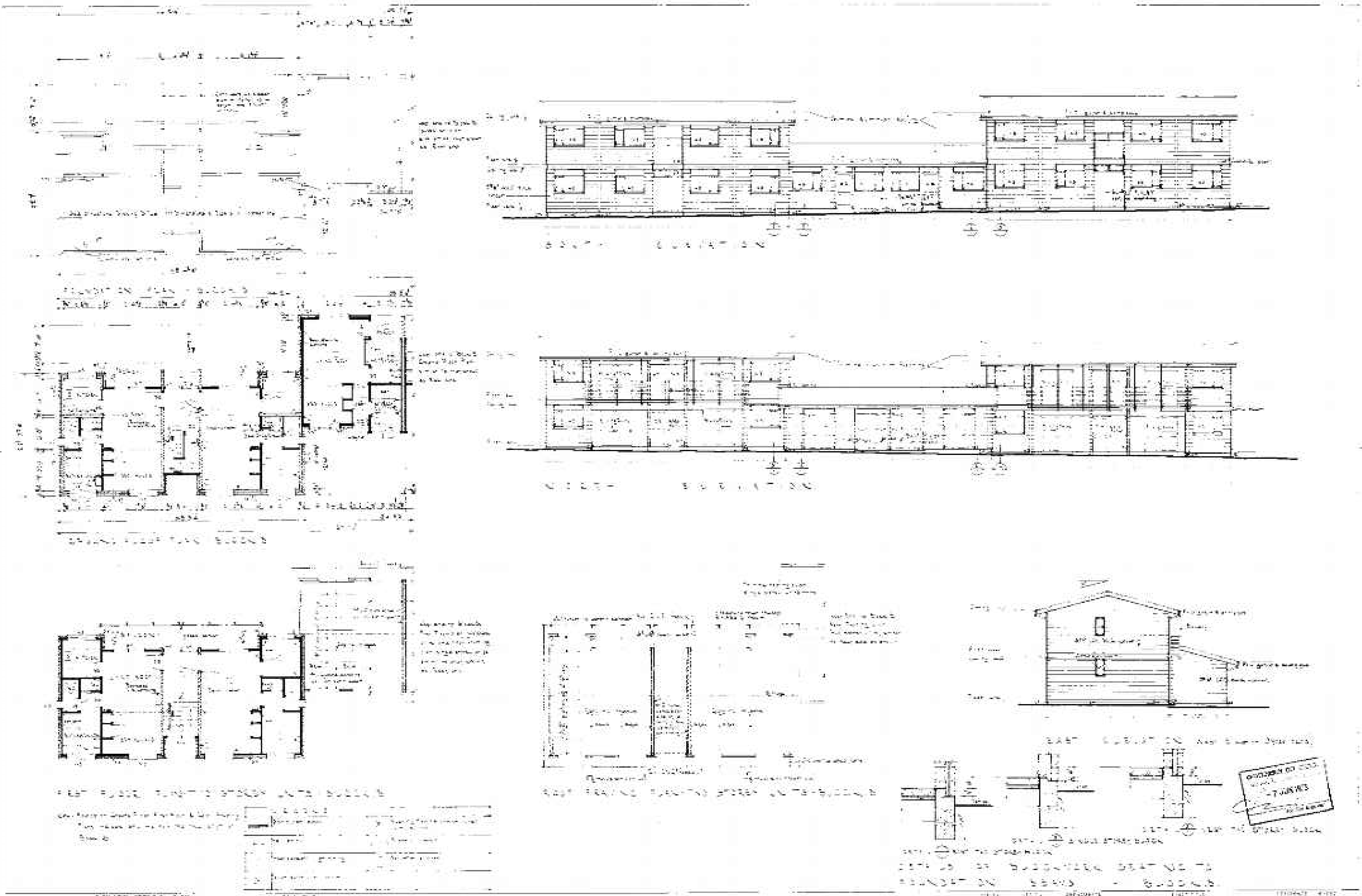


CHRISTCHURCH CITY COUNCIL

PALMERS ROAD PENSIONERS COTTAGES

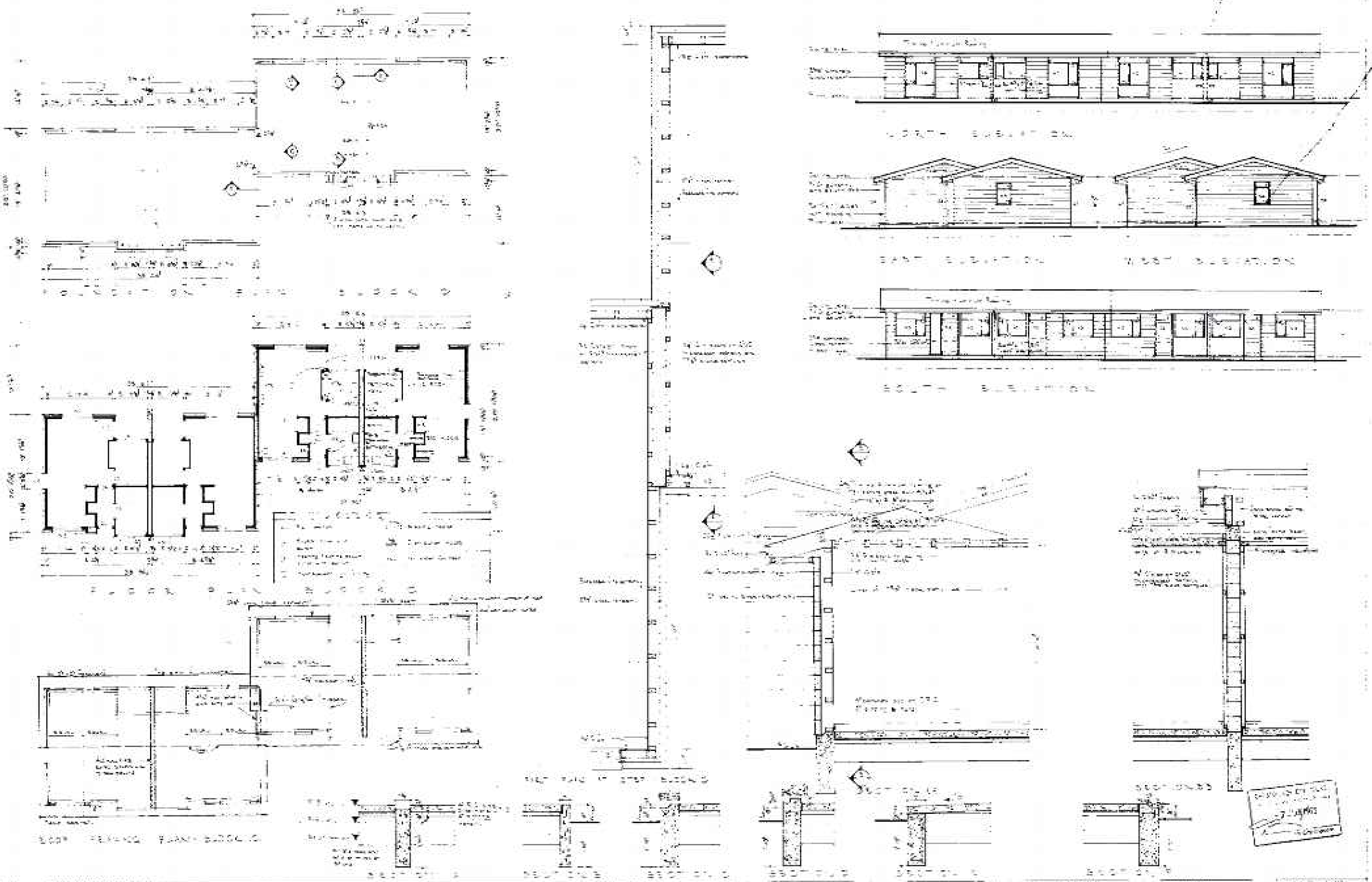
BLOCK A

3



CHRISTCHURCH CITY COUNCIL

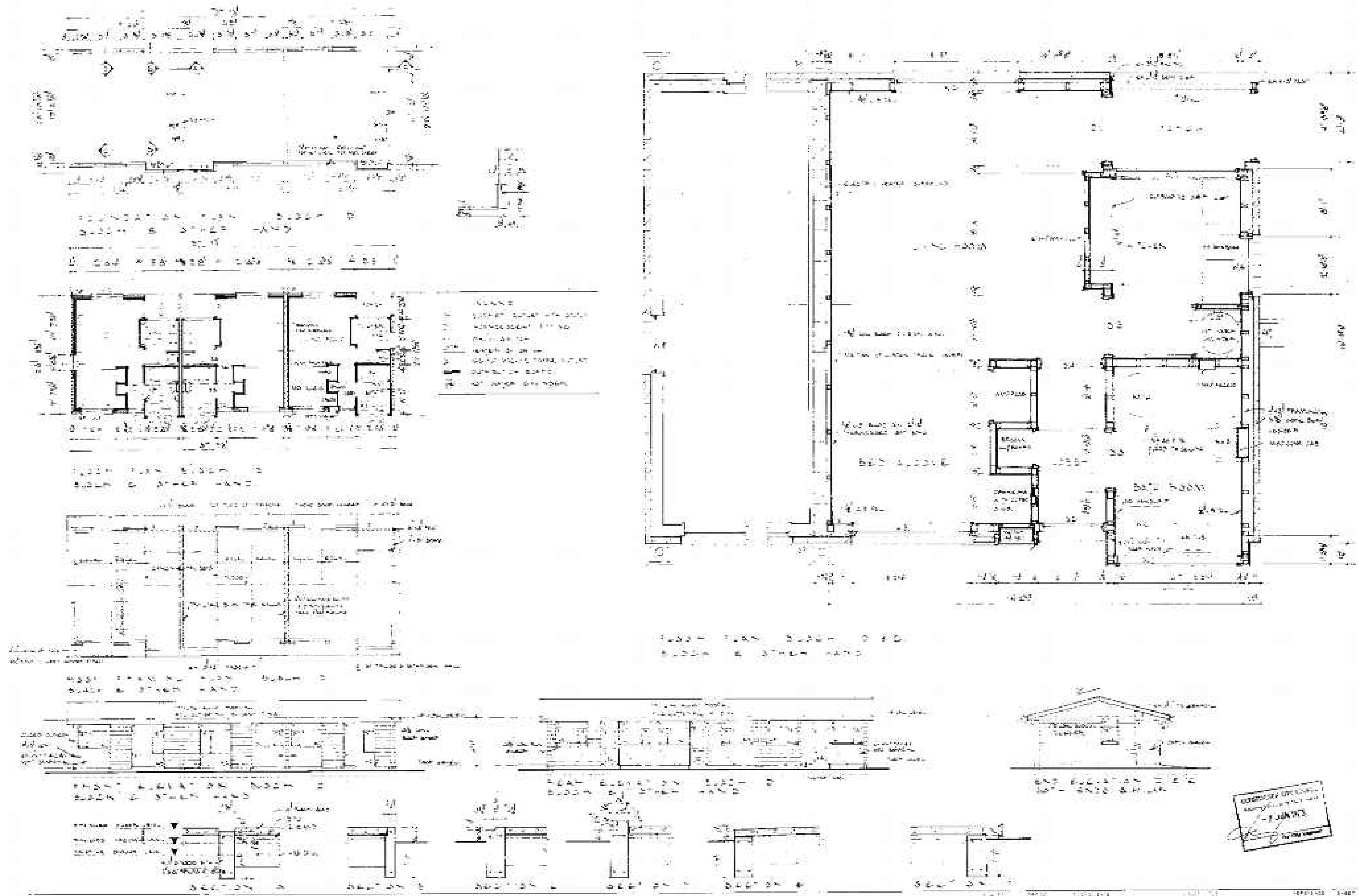
4



CHRISTCHURCH CITY COUNCIL

PALMERS ROAD PENSIONERS COTTAGES

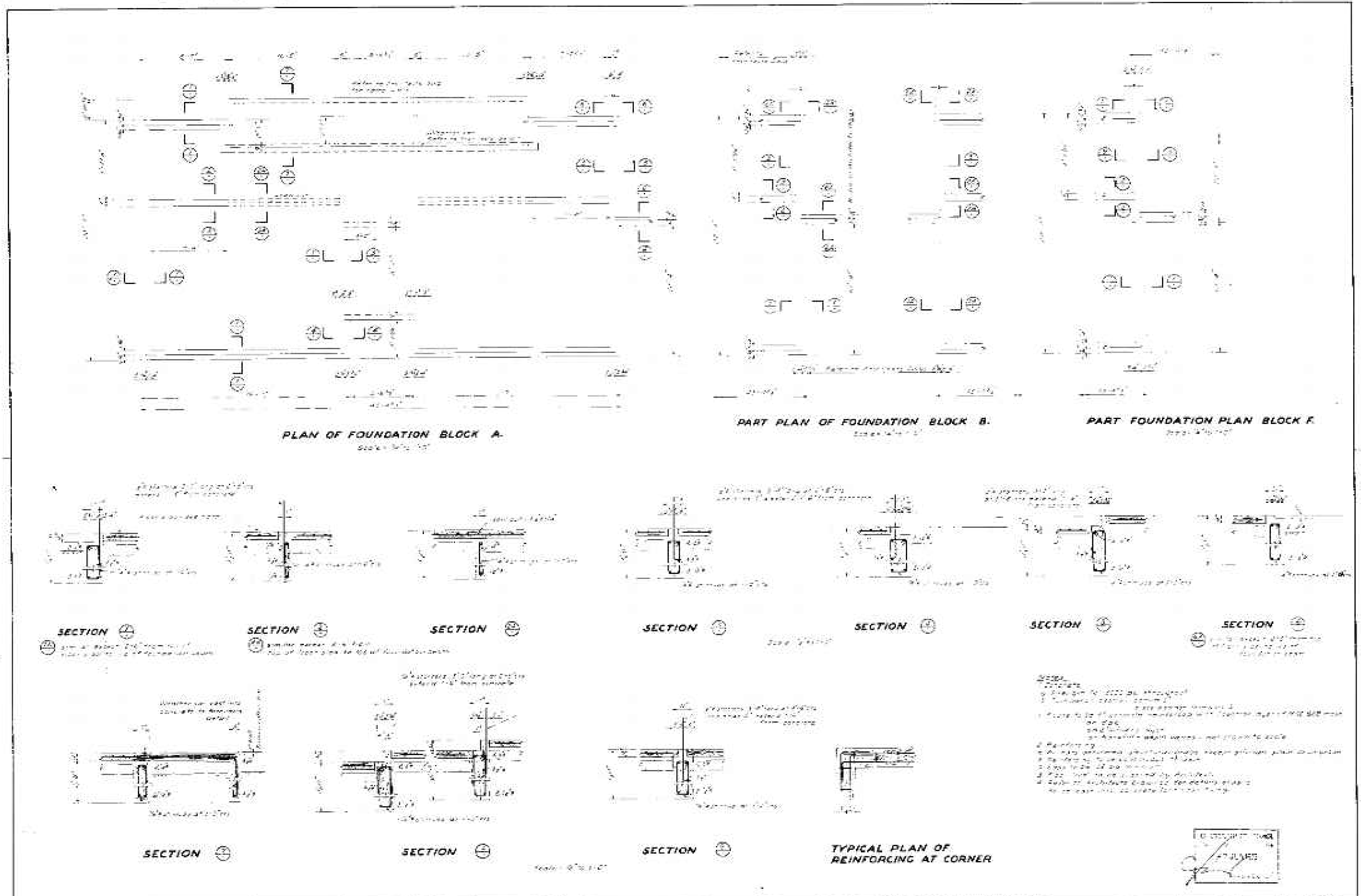
5



CHRISTCHURCH CITY COUNCIL

PALMERS ROAD PENSIONERS COTTAGES

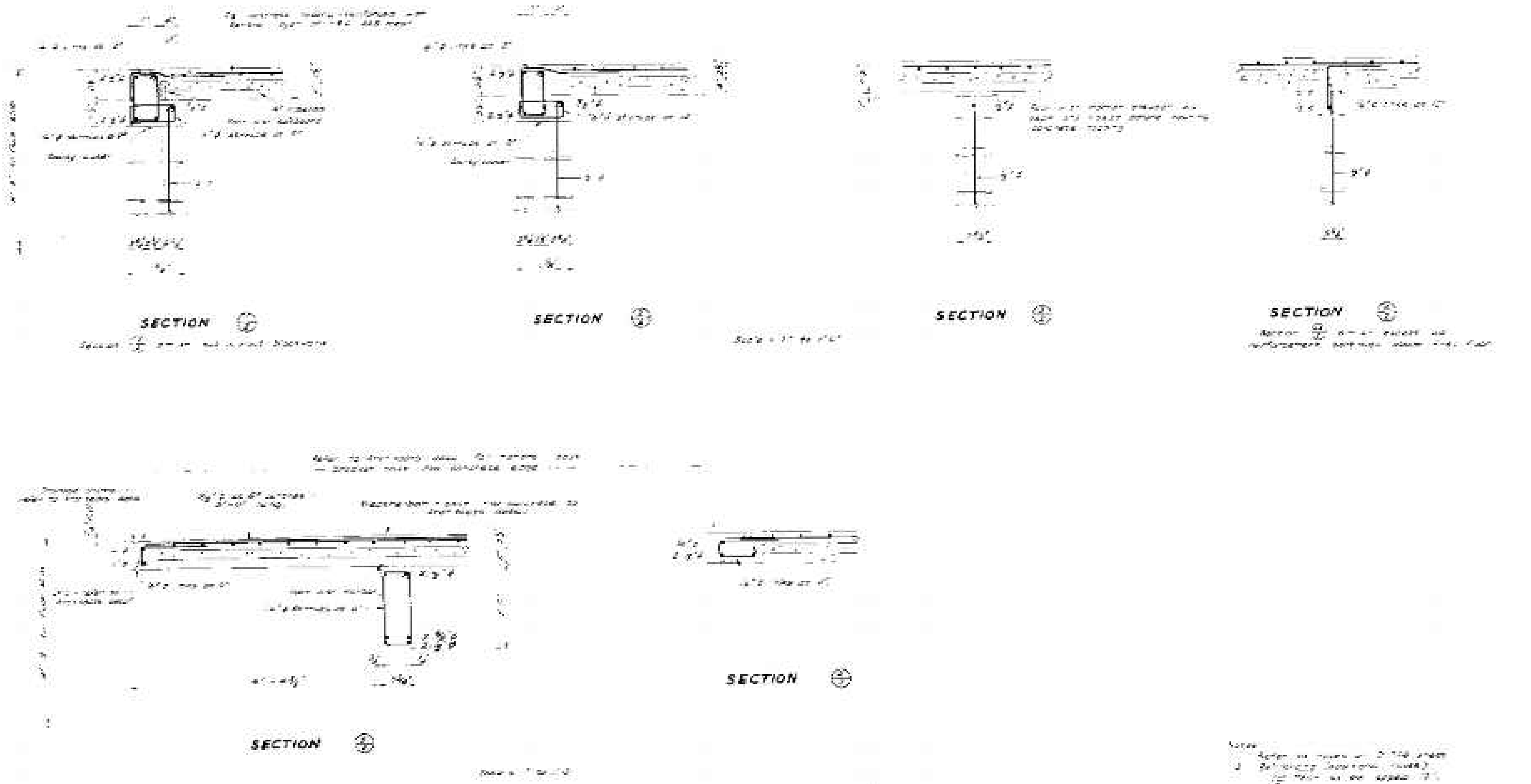
6



CHRISTCHURCH CITY COUNCIL — CITY ENGINEER'S DEPARTMENT

PALMERS ROAD PENSIONERS COTTAGES - DOUBLE STOREY UNITS
FOUNDATION DETAILS

D.1746



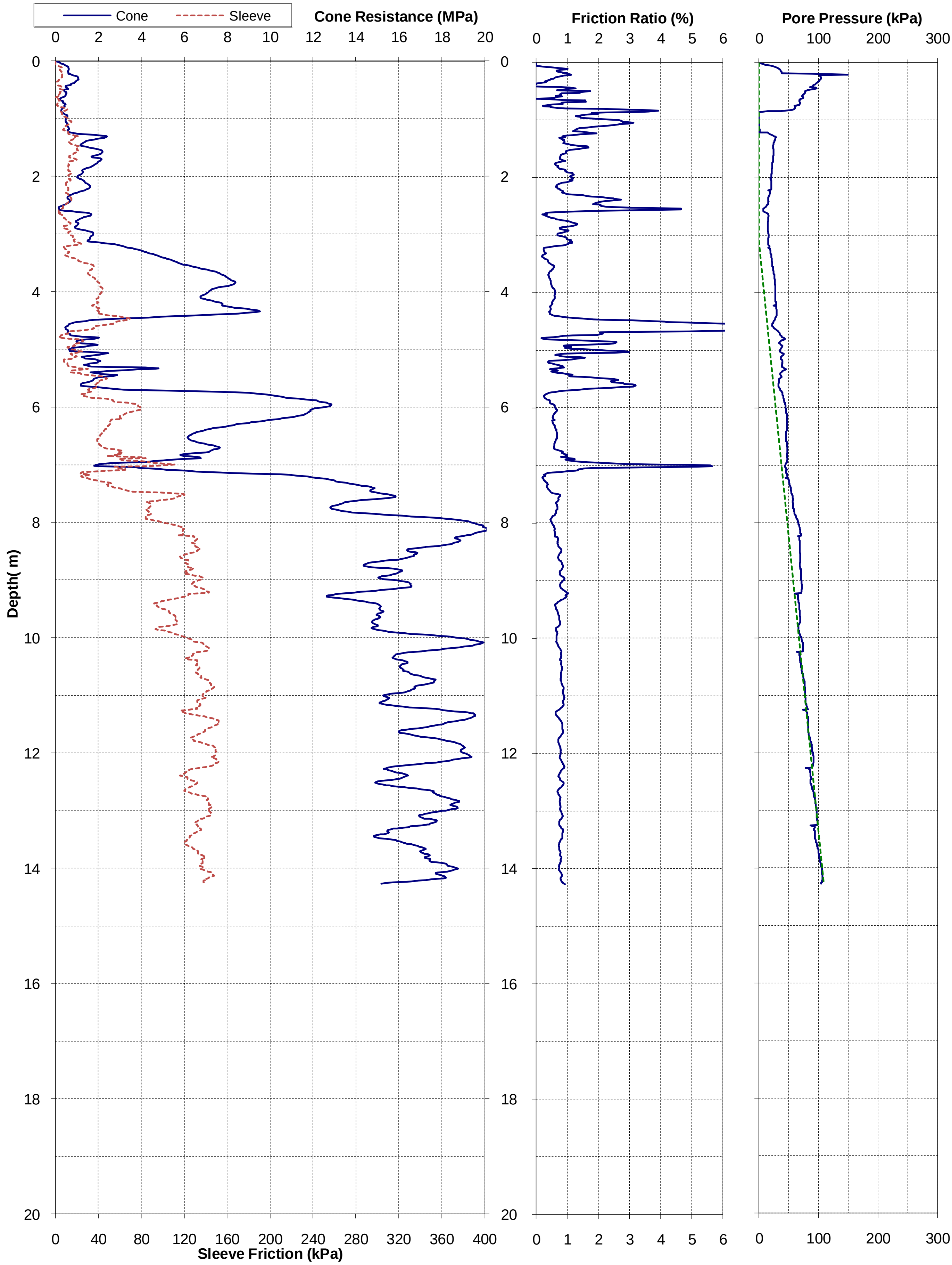
CHRISTCHURCH CITY COUNCIL — CITY ENGINEER'S DEPARTMENT

PALMERS ROAD PENSIONERS COTTAGES - DOUBLE STOREY UNITS
SECTIONS

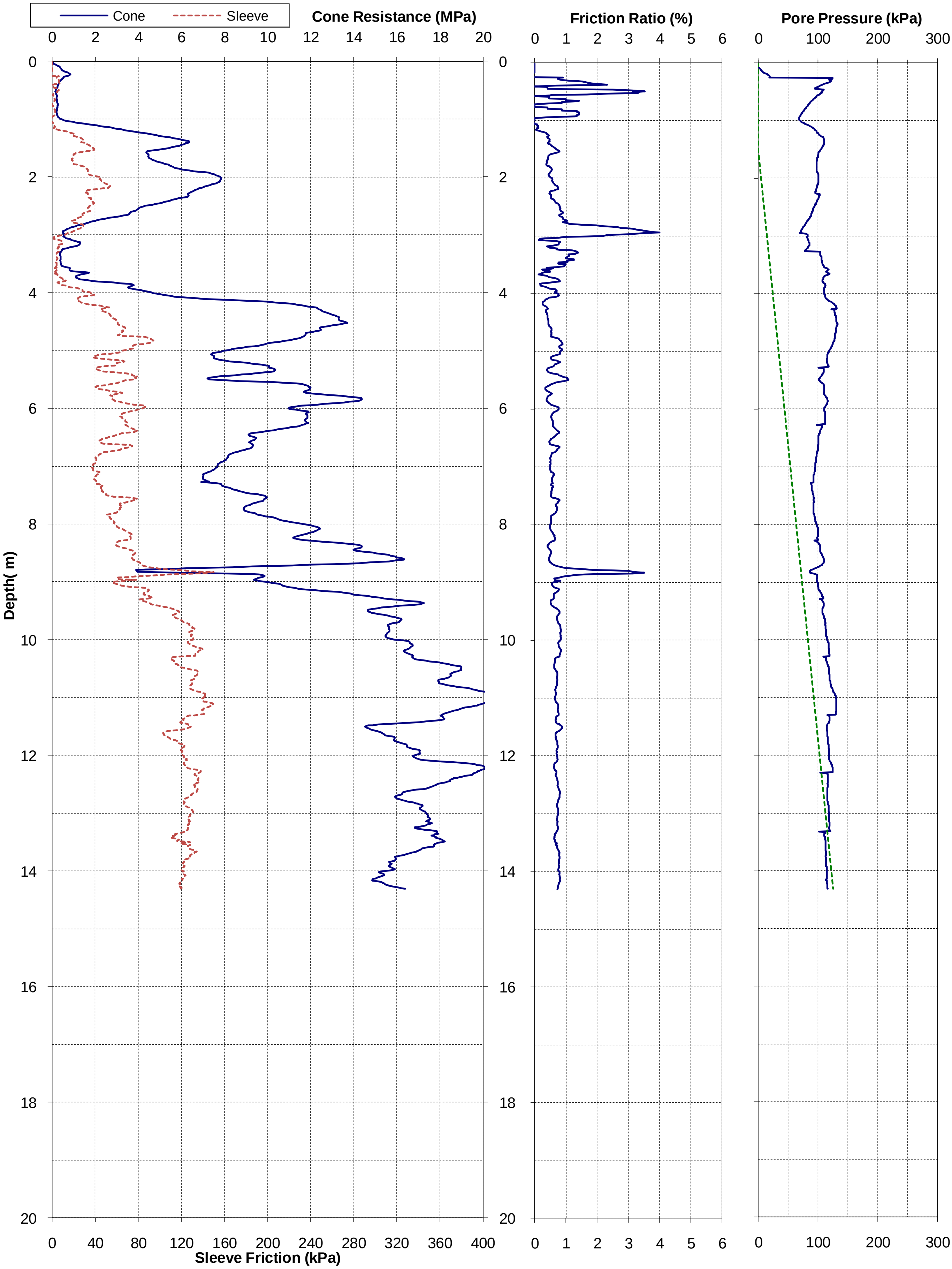
D.1746

Appendix C:
Earthquake Commission Cone Penetrometer Test Results

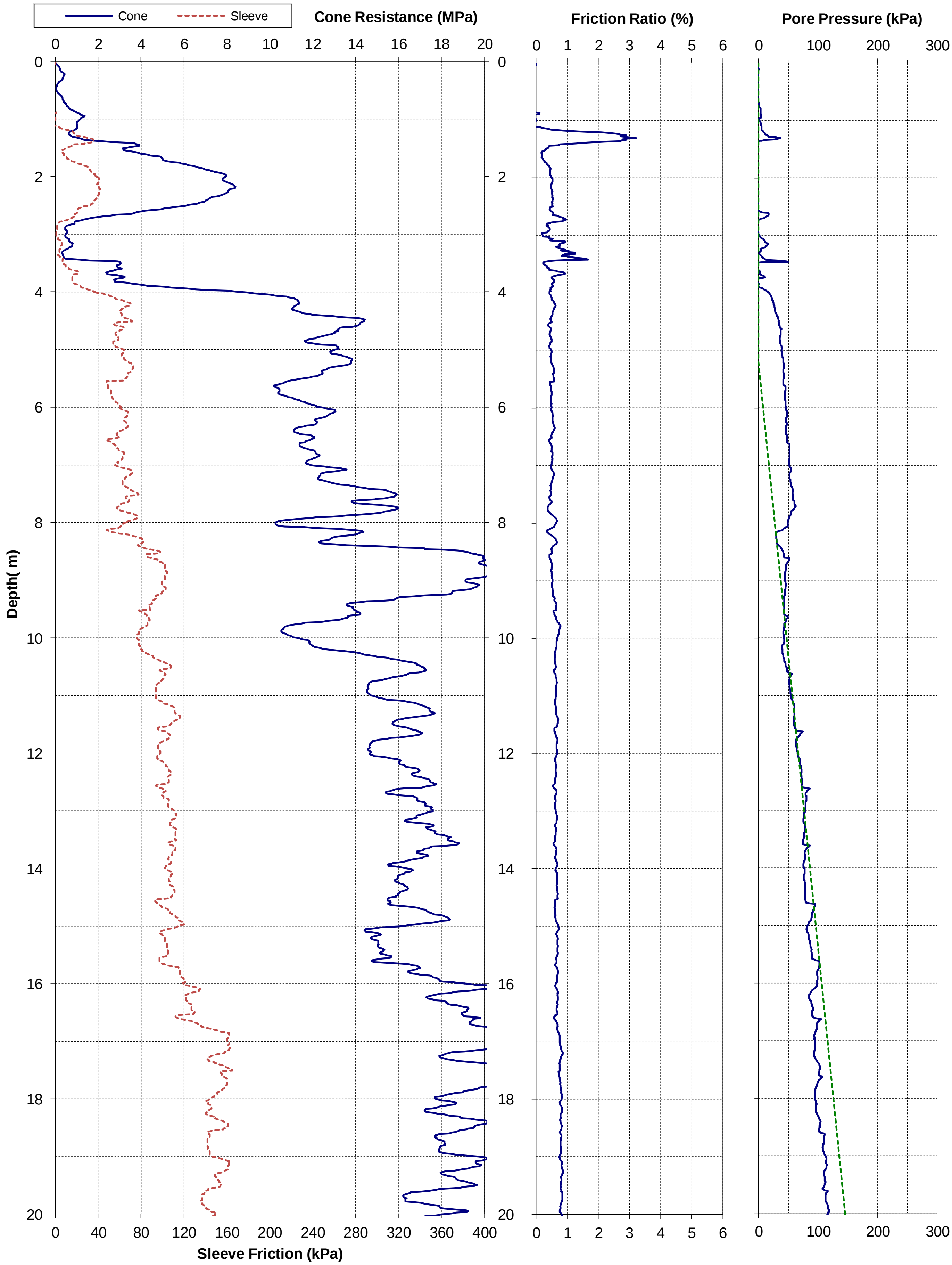
Project:	Darfield 2010 Earthquake - EQC Ground Investigations			**Page:** 1 of 1	**CPT-NBT-07**
Test Date:	27-Nov-2010	**Location:**	New Brighton	**Operator:**	McMillan
Pre-Drill:	1.2m	**Assumed GWL:**	3.1mBGL	**Located By:**	Survey GPS
Position:	2486769.7mE	5744668.4mN	1.59mRL	**Coord. System:**	NZMG & MSL
Other Tests:				**Comments:**	



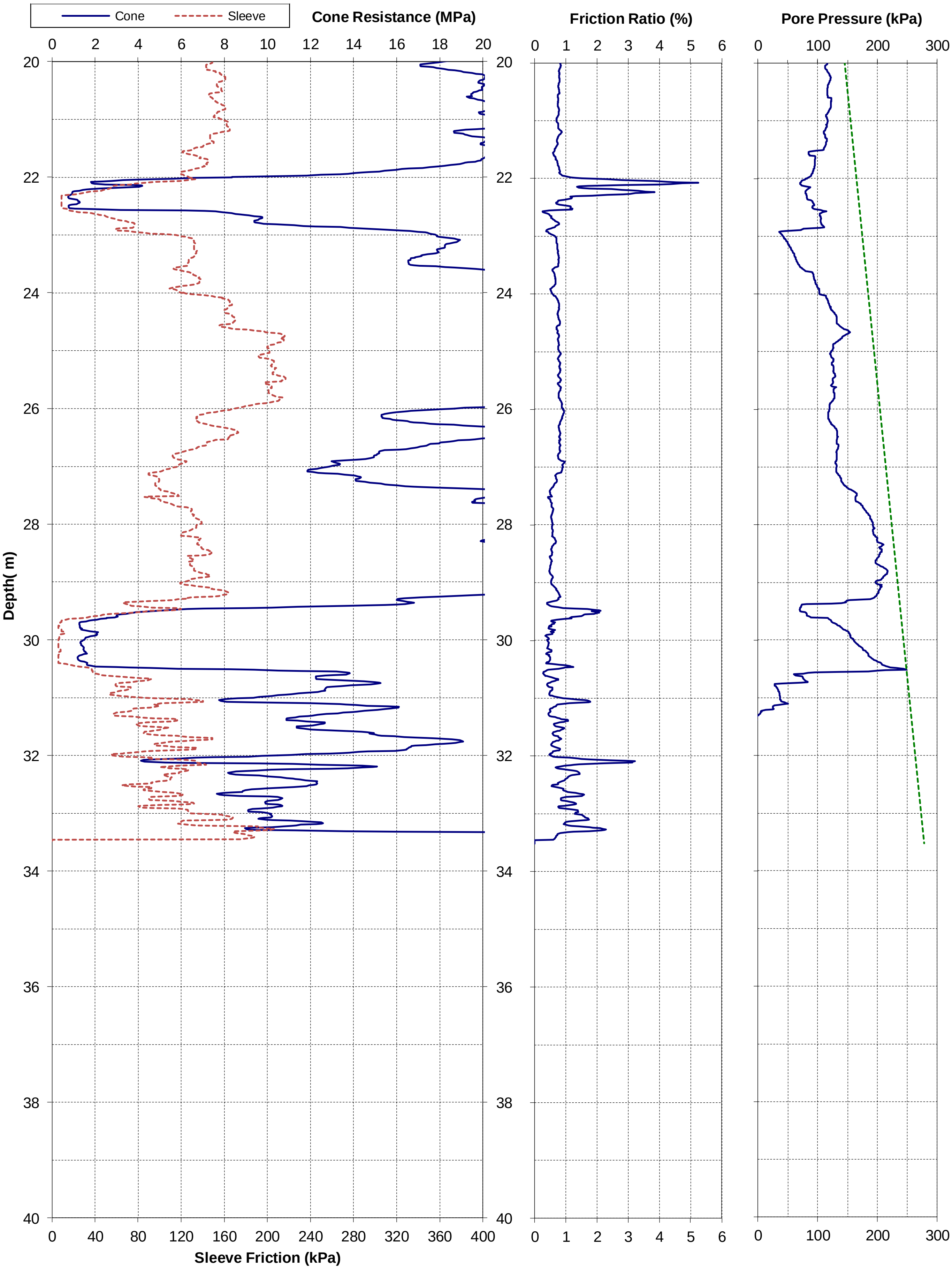
Project:	Darfield 2010 Earthquake - EQC Ground Investigations			Page:	1 of 1	CPT-NBT-08
Test Date:	27-Nov-2010	Location:	New Brighton	Operator:	McMillan	
Pre-Drill:	1.2m	Assumed GWL:	1.5mBGL	Located By:	Survey GPS	
Position:	2486821.6mE	5744921.7mN	2.26mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



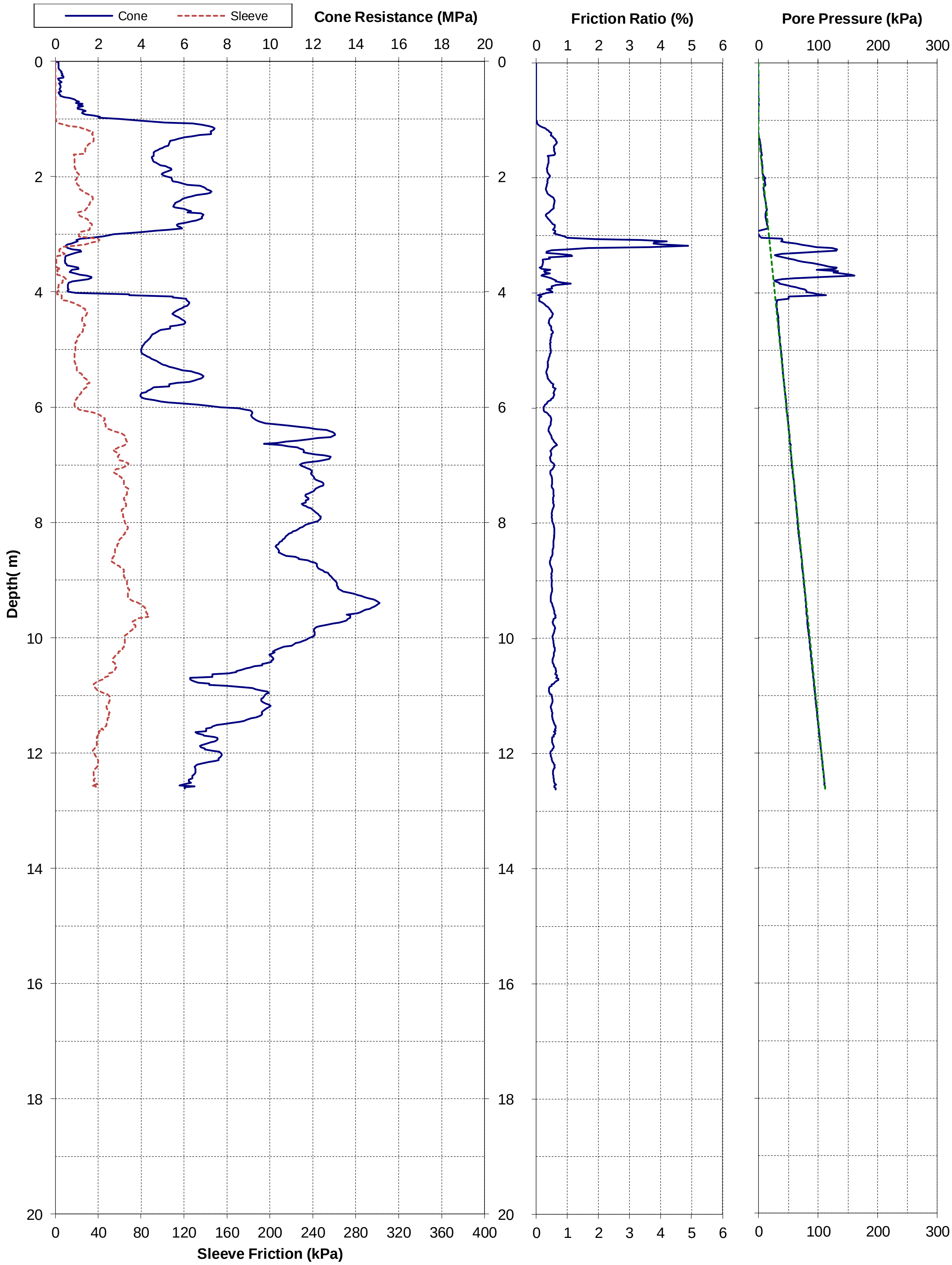
Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page:	1 of 2	CPT-NBT-28
Test Date:	4-Aug-2011	Location:	New Brighton	Operator:	Opus	
Pre-Drill:	1.2m	Assumed GWL:	5.2mBGL	Located By:	Survey GPS	
Position:	2487002.3mE	5744574.2mN	1.46mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page:	2 of 2	CPT-NBT-28
Test Date:	4-Aug-2011	Location:	New Brighton	Operator:	Opus	
Pre-Drill:	1.2m	Assumed GWL:	5.2mBGL	Located By:	Survey GPS	
Position:	2487002.3mE	5744574.2mN	1.46mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



Project:	Christchurch 2011 Earthquake - EQC Ground Investigations			Page:	1 of 1	CPT-NBT-30
Test Date:	10-Jun-2011	Location:	New Brighton	Operator:	Geotech	
Pre-Drill:	1.2m	Assumed GWL:	1.2mBGL	Located By:	Survey GPS	
Position:	2487025.5mE	5744805.2mN	2.2mRL	Coord. System:	NZMG & MSL	
Other Tests:				Comments:		



Appendix D:
Environment Canterbury Borehole Logs

Borelog for well M35/1871 page 1 of 2

Gridref: M35:86855-44667 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 2.39 +MSD
Driller : Stewart R H
Drill Method : Driven Pipe
Drill Depth : -103m Drill Date : 14/01/1952

Environment Canterbury Regional Council

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-1.20m	Sand	ch
	-3.00m	Blue clay	ch
	-9.10m	Blue sand & clay	ch
	- 27.1m	Grey sand & clay, some shells	ch
	- 31.7m	Blue sand & clay, some shells	ch
	- 32.3m	Blue clay	ch
	- 35.1m	Blue sand & some small stones	ch
	- 37.5m	Blue clay	ch
	- 38.4m	Peat	ch
	- 39.0m	Blue gravel & clay (Tight)	ri
	- 48.2m	Blue gravel (Some water)	ri
	- 49.1m	Brown sand & clay	br
	- 51.5m	Yellow clay	br

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

Borelog for well M35/1871 page 2 of 2

Gridref: M35:86855-44667 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 2.39 +MSD
Driller : Stewart R H
Drill Method : Driven Pipe
Drill Depth : -103m Drill Date : 14/01/1952

Environment Canterbury Regional Council

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 53.9m	Yellow clay	br
	- 61.0m	Yellow clay & sand	br
	- 66.4m	Blue clay & sand	br
	- 67.4m	Yellow clay & sand	br
	- 70.7m	Brown gravel, sand & clay (Tight)	li-1
	- 71.9m	Brown gravel & sand	li-1
	- 76.2m	Blue clay	li-2
	- 82.3m	Peat with clay & timber	li-2
	- 82.9m	Gravel, sand, & clay (Tight)	li-2
	- 87.8m	Brown gravel with clay & sand	li-2
	- 88.7m	Brown gravel	li-2
	- 89.3m	Yellow clay	li-2
	- 91.1m	Blue clay	li-2
	- 91.7m	Yellow clay	li-2
	- 92.0m	Yellow clay & some gravel	li-2
	- 103.0m	Brown gravel, sand & some clay	li-3

Scale(m): -60, -70, -80, -90, -100

Borelog for well M35/2132 page 1 of 3

Gridref: M35:86857-44695 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 3.95 +MSD
Driller : Stewart R H
Drill Method : Cable Tool
Drill Depth : -152.5m Drill Date : 21/10/1949

Environment Canterbury Regional Council

Depth(m)	Full Drillers Description	Formation Code
-1.20m	Surface sand	ch
-3.00m	Blue clay	ch
-9.10m	Blue sand & clay (Timber at 7.3m)	ch
- 27.1m	Grey sand & clay with shells	ch
- 31.6m	Blue sand & clay with shells	ch
- 32.2m	Blue sand & a few stones	ch
- 35.0m	Blue clay	ch
- 37.4m	Peat	ch
- 38.4m	Blue gravel & clay (Tight)	ri
- 39.0m	Blue gravel	ri
- 48.1m	Brown sand & clay	ri
- 49.0m	Yellow clay	br
- 50.8m	Yellow clay & sand	br

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

Water Level

Borelog for well M35/2132 page 2 of 3

Gridref: M35:86857-44695 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 3.95 +MSD
Driller : Stewart R H
Drill Method : Cable Tool
Drill Depth : -152.5m Drill Date : 21/10/1949

Environment Canterbury Regional Council

Depth(m)	Full Drillers Description	Formation Code
- 53.9m	Yellow clay & sand	br
- 60.9m	Blue clay & sand	br
- 66.4m	Yellow clay & sand	br
- 67.3m	Brown gravel, sand & clay (Tight)	li-1
- 70.7m	Brown gravel & sand	li-1
- 71.9m	Blue clay & sand	li-2
- 76.2m	Blue clay	li-2
- 82.2m	Peat with clay & timber	li-2
- 82.9m	Gravel sand & clay (Very tight)	li-2
- 84.4m	Brown gravel& sand (Tight)	li-2
- 90.2m	Brown gravel	li-2
- 91.7m	Blue clay	li-2
- 92.0m	Brown gravel & clay	li-3
- 101.7m	Brown gravel & sand	li-3

Scale(m): -60, -70, -80, -90, -100

Borelog for well M35/2132 page 3 of 3

Gridref: M35:86857-44695 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 3.95 +MSD
Driller : Stewart R H
Drill Method : Cable Tool
Drill Depth : -152.5m Drill Date : 21/10/1949

Environment Canterbury Regional Council

Depth(m)	Full Drillers Description	Formation Code
- 103.6m	Brown gravel & sand	li-3
- 109.7m	Brown sand & gravel	he
- 113.0m	Brown sand with some gravel and clay (Tight)	he
- 114.3m	Sandy clay (Hard)	he
- 115.5m	Yellow clay	he
- 121.3m	Brown gravel & sand	bu
- 122.5m	Sand, gravel & clay mixture	bu
- 124.0m	Yellow clay & sand	sh
- 127.4m	Blue clay & sand	sh
- 132.8m	Blue clay & sand	sh
- 135.3m	Brown sandy clay	sh
- 138.3m	Blue clay	sh
- 138.9m	Blue clay & fine Blue gravel	sh
- 141.1m	Yellow clay	sh
- 142.9m	Brown silty clay	sh
- 143.5m	Clay, sand & Brown gravel (Tight)	wa
- 152.4m	Brown gravel	wa
- 153.7m	Yellow clay	aq5

Scale(m): -110, -120, -130, -140, -150; Water Level

Borelog for well M35/2276 page 1 of 2

Gridref: M35:86858-44671 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 2.35 +MSD
Driller : Owner
Drill Method : Cable Tool
Drill Depth : -89.3m Drill Date : 6/06/1958

Environment Canterbury Regional Council

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
-0.30m	Fill	fi
-1.80m	Sand	ch
-5.50m	Blue silty clay & timber	ch
- 18.0m	Blue sand, some shells & clay 8.5 - 9.4m & shells & grit 17.1 - 18.0m	ch
- 18.3m	Blue clay & timber	ch
- 23.8m	Blue silty clay & timber	ch
- 24.7m	Blue silty clay & timber & shells	ch
- 27.4m	Blue silty clay & timber & sand	ch
- 33.5m	Blue silty clay & timber & sand & shells	ch
- 35.4m	Blue sand & some small stones	ch
- 37.5m	Blue clay, sand, stones & timber	ch
- 38.1m	Peat	ch
- 38.7m	Blue gravel & some clay	ri
- 44.7m	Blue gravel & some clay at 42.4m	ri

Scale(m): -5, -10, -15, -20, -25, -30, -35, -40

Borelog for well M35/2276 page 2 of 2

Gridref: M35:86858-44671 Accuracy : 2 (1=high, 5=low)
Ground Level Altitude : 2.35 +MSD
Driller : Owner
Drill Method : Cable Tool
Drill Depth : -89.3m Drill Date : 6/06/1958

Environment Canterbury Regional Council

Water Level: Artesian

Scale(m): -45, -50, -55, -60, -65, -70, -75, -80, -85

Depth(m)	Full Drillers Description	Formation Code
- 47.9m	Blue gravel & some clay at 42.4m	ri
- 49.7m	Brown sand & Yellow clay	br
- 50.9m	Blue clay	br
- 61.0m	Yellow clay & sand some grit 57.0m - 58.5m	br
- 66.4m	Blue silty clay	br
- 68.0m	Yellow sandy clay	br
- 70.4m	Brown gravel & sand, some clay (Tight)	li-1
- 71.9m	Brown gravel & sand	li-1
- 72.5m	Yellow clay & sand	li-2
- 81.7m	Blue clay with traces of peat & timber	li-2
- 82.3m	Clay	li-2
- 83.2m	Yellow clay & some gravel	li-2
- 89.3m	Brown gravel & sand, some clay to 87.8m	li-2

Borelog for well M35/2884

Gridref: M35:869-447 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 2.14 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -102.5m Drill Date : 26/10/1983

Environment Canterbury
Your regional council

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
-0.20m	Fill	ff
-1.40m	Sand	ch
-5.80m	Blue silty clay, some timber	ch
- 18.5m	Grey sand, some shells	ch
- 18.8m	Grey clay & sand	ch
- 26.8m	Grey clayey sand	ch
- 29.0m	Grey sand shells	ch
- 32.3m	Grey clay, sand, shells	ch
- 35.5m	Grey sand	ch
- 37.6m	Grey clay, sand, peat	ch
- 39.7m	Peat	ch
- 45.6m	Blue gravel, sand, (Tight patches)	ri
- 49.1m	Grey sand	br
- 49.8m	Sandy Grey clay	br
- 50.5m	Grey sand	br
- 50.8m	Sandy Grey clay	br
- 51.5m		

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

Borelog for well M35/2884 page 2 of 2

Gridref: M35:869-447 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 2.14 +MSD
Driller : A M Bisley & Co
Drill Method : Cable Tool
Drill Depth : -102.5m Drill Date : 26/10/1983

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
51.5m	Grey sand	br
	Yellow clay	
- 56.9m	Brown sand	br
- 57.5m	Sandy Yellow clay	br
- 61.0m	Blue clay	br
- 66.1m	Yellow clay	br
- 68.3m	Brown gravel, sand	br
- 71.9m	Blue gravel, sand	li-1
- 72.5m	Blue & Yellow clay	li-1 li-2
- 72.8m	Grey clay	
- 77.7m	Peaty clay	li-2
- 82.1m	Yellow clay & gravel (Tight)	li-2
- 84.2m	Brown gravel, sand	li-2
- 88.8m	Grey clay (Soft)	li-2
- 91.5m	Yellow clay (Hard)	li-2
- 92.7m	Brown gravel, Yellow clay	li-2
- 93.7m	Brown gravel, sand	li-3
- 102.5m		li-3

Scale(m): -60, -70, -80, -90, -100

Borelog for well M35/4925 page 1 of 2

Gridref: M35:8679-4466 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 2.1 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -97m Drill Date : 28/11/1986

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
-0.50m	Earth & mud	ch
-7.00m	Fine Blue sands	ch
-7.50m	Sea shells & fine Blue sand	ch
- 13.0m	Fine Blue sand	ch
- 29.0m	Fine Blue sand & small pieces of sea shells	ch
- 37.0m	Fine Blue sand & shells	ch
- 38.0m	Peat & wood	ch
- 46.5m	Medium sized Blue gravels	ri
- 49.0m	Grey sand & some gravel	br

Borelog for well M35/4925 page 2 of 2

Gridref: M35:8679-4466 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 2.1 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -97m Drill Date : 28/11/1986

Water Level: Artesian

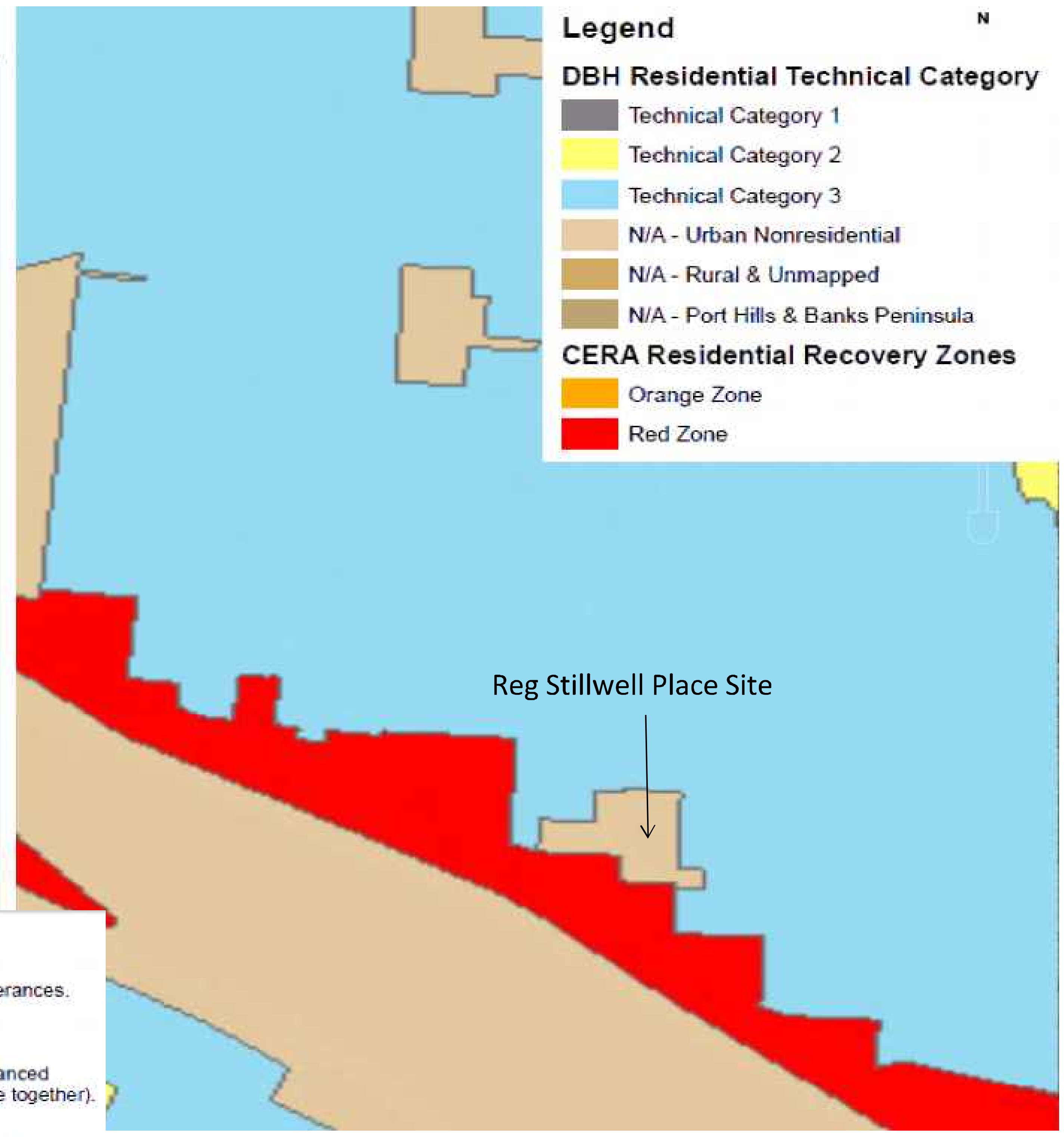
Depth(m)	Full Drillers Description	Formation Code
49.0m	Grey sand & some gravel	br
- 50.5m	Fine Blue & Grey sands	br
- 52.0m	Fine Brown sand	br
- 54.0m	Fine Brown sand & some clay	br
- 56.0m	Yellow clay	br
- 61.0m	Small gravels & sand	br
- 64.0m	Blue pug & Blue sand	br
- 65.0m	Blue pug	br
- 65.5m	Yellow silt	br
- 74.0m	Brown stained shingle & sand	li-1
- 77.5m	Grey pug	li-2
- 80.5m	Claybound gravels	li-2
- 87.8m	Rusty Brown stained gravels & sand	li-2
- 88.5m	Yellow clay	li-2
- 90.7m	Grey pug, some organic material	li-2
- 91.3m	(Hard) Yellow clay	li-2
- 94.4m	Brown gravels	li-3
- 97.0m	Free Brown gravels	li-3

Scale(m): -50, -55, -60, -65, -70, -75, -80, -85, -90, -95

Appendix E:
Land Recovery Zones

Greater Christchurch Land Information Map Legend

Colour code	Description and factors
Green	**Repair/Rebuild process can begin and normal insurance and consenting processes apply** • Insurers can continue claim settlements on repairs and rebuilds on individual properties - the insurance process will assess the practicability of repair or rebuilding, taking into account the requirements of the specific property. • Some land damage may be present that requires land repair or improvement. In some cases it may be beneficial for landowners to work together on land repair/improvement options. ***Residential Properties*** • Refer to LandCheck website www.landcheck.org.nz for information on your area. • The Department of Building and Housing (DBH) has guidance on house repairs and reconstruction – for more information refer to the DBH website http://www.dbh.govt.nz/canterbury-earthquake-residential-building. • For some properties, owners/insurers may need to arrange their own specific engineering assessment, including detailed site-specific geotechnical investigation and/or specific foundation design. ***Non-residential properties (eg, schools, health facilities, council assets, parks, and commercial/industrial areas)*** • Works may be undertaken with the appropriate advice from the local authority and specialist consultants and engineers. • Owners/insurers will need to arrange their own specific engineering assessment. This may include detailed site specific geotechnical investigation and/or specific foundation design.
Red	**Repair/rebuild process and/or reoccupation is not practical as required land repair, improvements or life-safety hazard mitigation works would be too difficult to implement, prolonged and disruptive for landowners** • Refer to LandCheck website www.landcheck.org.nz for information on your area and the Government offer to purchase the properties of insured residential property owners.



FOR RESIDENTIAL PURPOSES ONLY

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

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

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

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

SOURCE: 1) canterburyrecovery.projectorbit.com (Accessed on 15/05/12)
2) http://arcims.ecan.govt.nz/ecanmapping/ (Accessed on 15/05/12)

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PO Box 1482
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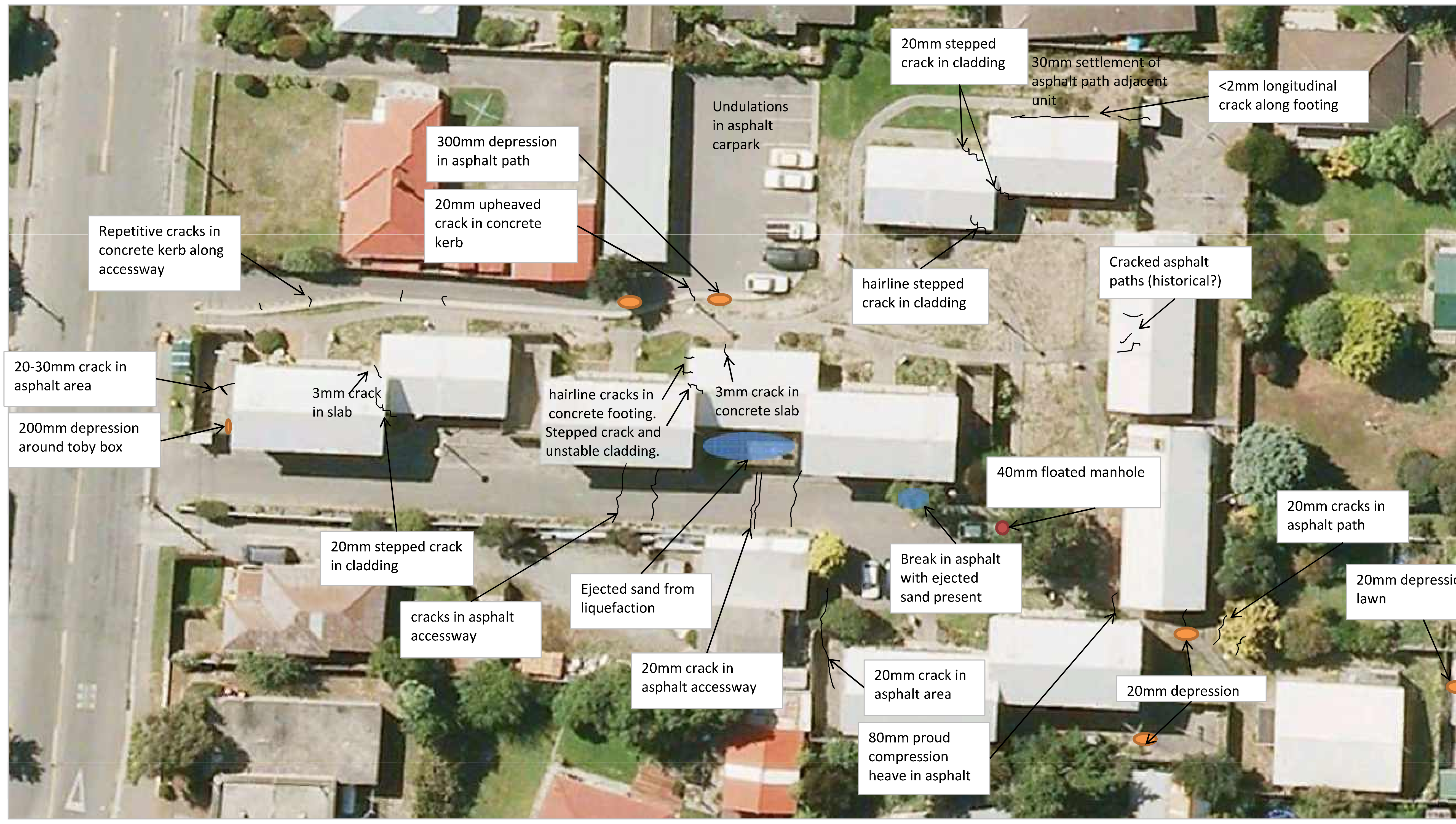
OPUS

Project: Reg Stillwell Place Geotechnical Desktop Study
Project No: 6-QUCCC.84 85SC
Client: Christchurch City Council

Land Recovery Zones

Drawn: 15/05/2012

Appendix F:
Site Walkover Inspection Plan



SOURCE: 1) canterburyrecovery.projectorbit.com (Accessed on 15/05/12)

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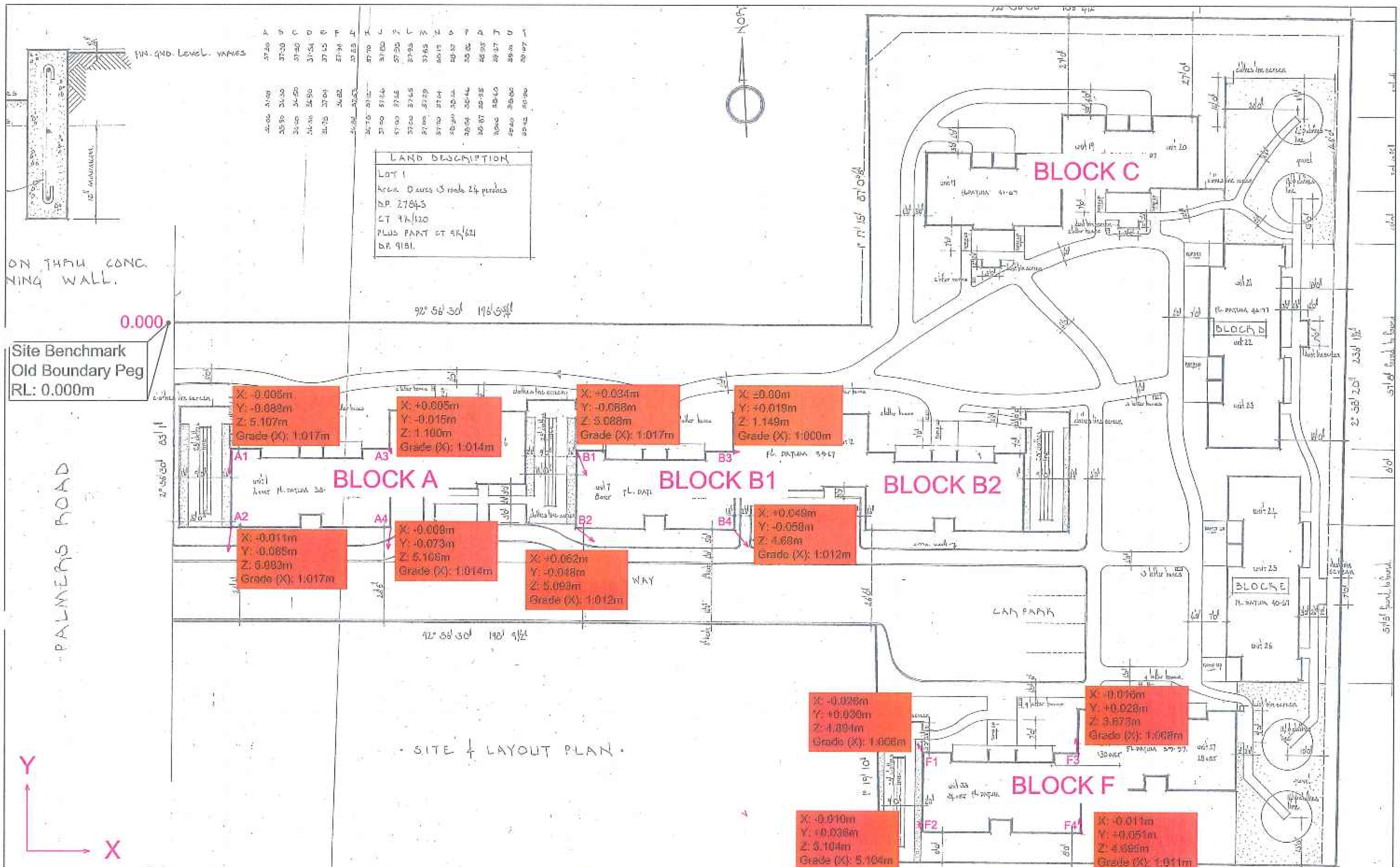
Project:	Reg Stillwell Place Geotechnical Desktop Study
Project No:	6-QUCCC.84 85SC
Client:	Christchurch City Council

Site Walkover Inspection Plan

Inspected:	30/04/2012
Drawn:	15/05/2012

Appendix G:
OPUS Verticality Survey



VERTICALITY ASSESSMENT NOTES:

Verticality is assessed by surveying features which would have been architecturally vertical at time of construction or pre quake.

Due to objects obscuring views at A3 and B3 the entire height of walls / features full vertical assessment was unable to be undertaken.

The results are shown in dx, dy, dz format for easy interpretation.
dz value shows the height over which the verticality assessment was undertaken.
The arrow shows the direction of the lean.

Coordinate and orientation datums are assumed and based on control established onsite. A site benchmark has been established on an old boundary peg located at the entrance way into Reg Stillwell Place and is shown on the plan.

OPUS
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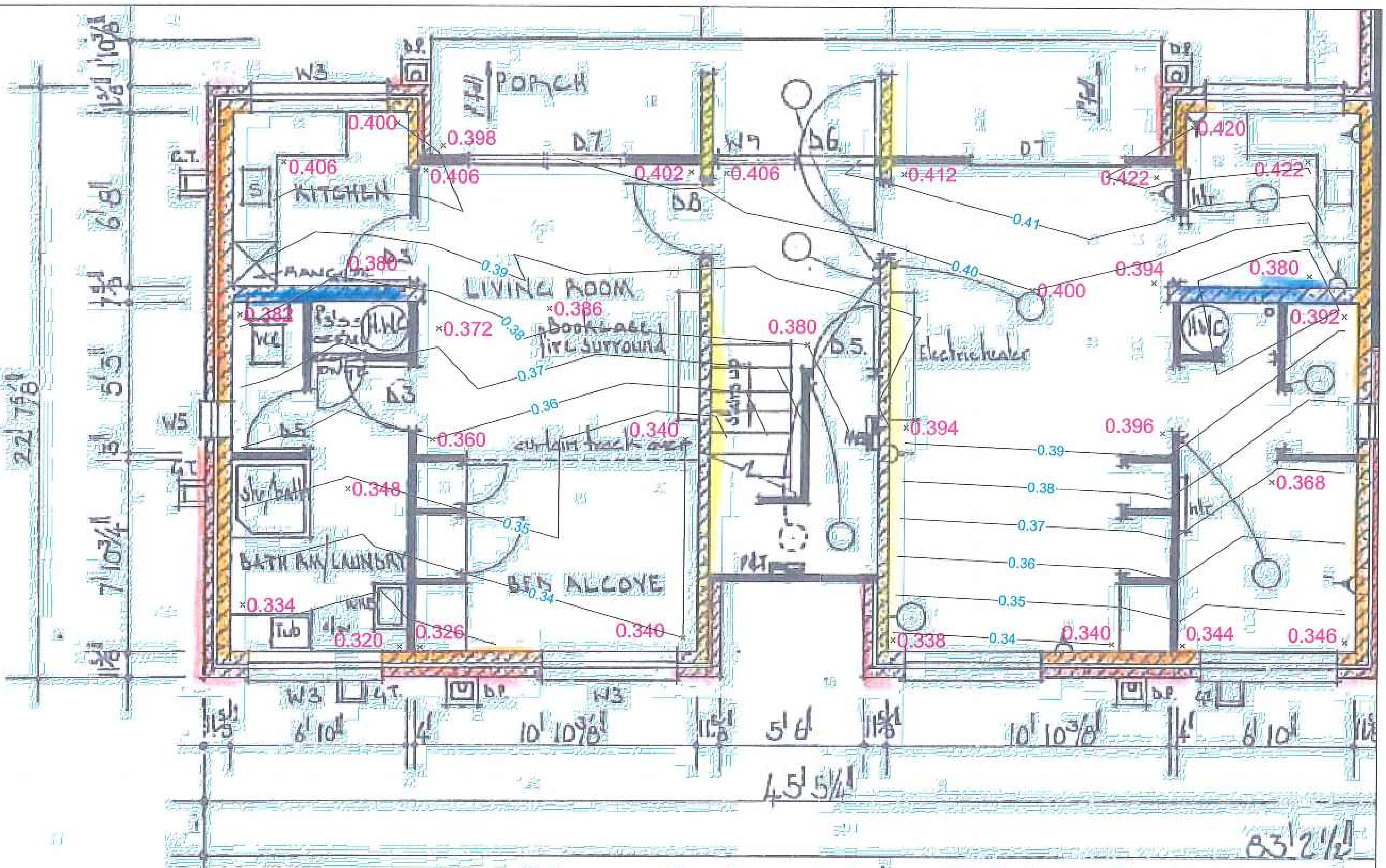
Project: Reg Stillwell Level Survey
Site Layout and Verticality

Drawn	Designed	Approved	Revision Date
J Moreira		B Bodiar	

Project No.	Scale	Drawing No.	Sheet No.	Revision
6QUCCC.84	N.T.S	6/1366/247/2604	1/10	R0

Original Sheet Size A1 [841x594] Plot Date 02/05/12 @ 15:10



GROUND FLOOR PLAN - BLOCK A

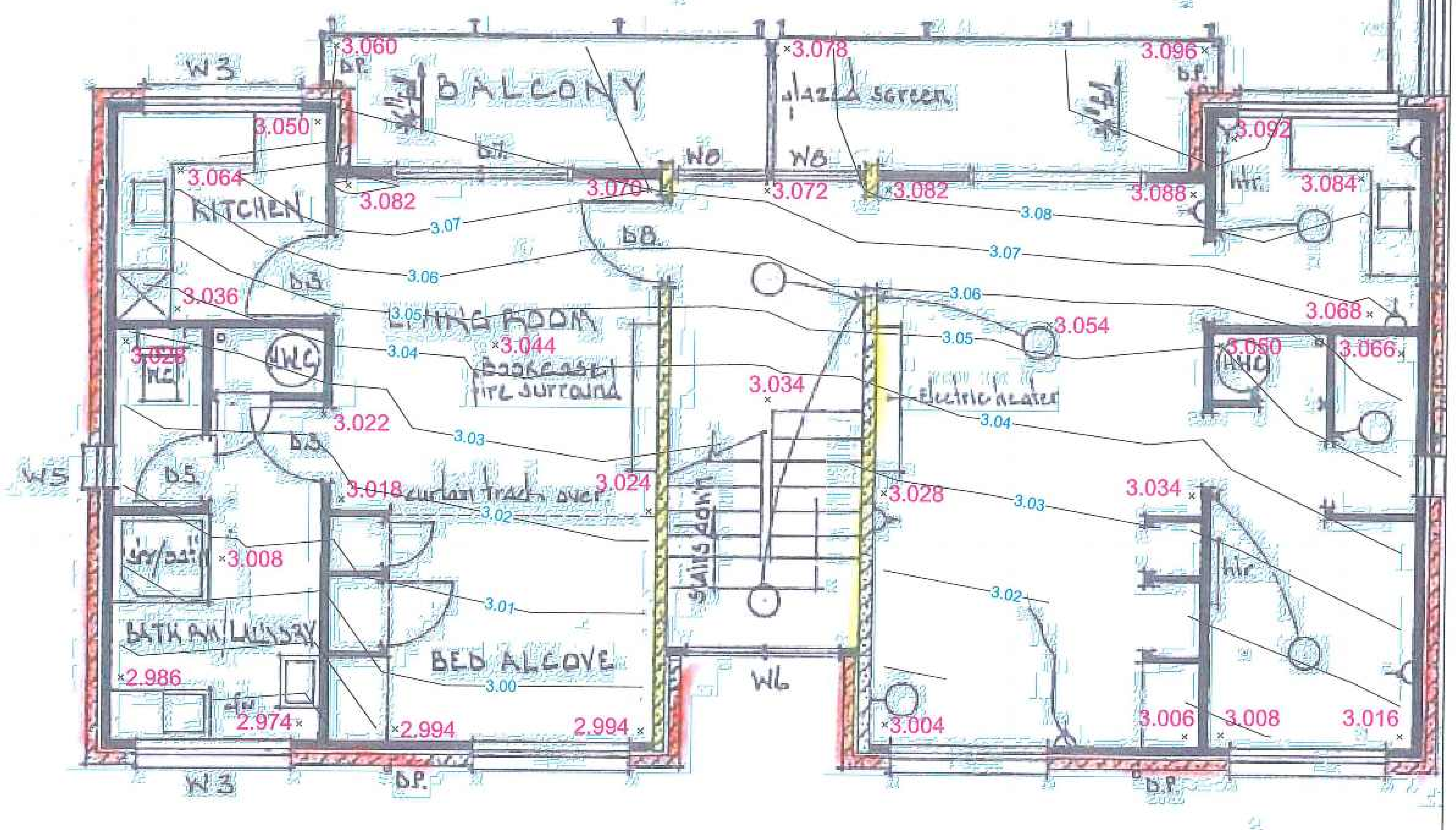
Revision	Amendment	Approved	Revision Date

OPUS
Christchurch Office
P O Box 1482
Christchurch 8140, New Zealand
+64 3 363 5400

Project: Reg Stillwell Level Survey
Block A (Ground Floor)

Drawn	Designed	Approved	Revision Date
J Morrow		B Becker	

Project No.	Scale	Drawing No.	Sheet No.	Revision
6QUCCC.81	N.T.S	6/1366/247/2604	2/10	R0



FIRST FLOOR PLAN · BLOCK A

Revision	Amendment	Approval	Revision Date

OPUS
Christchurch Office
P O Box 1482
Christchurch 8140, New Zealand
+64 3 363 5400

Drawn	Designed	Approved	Revision Date
J Morrow		S Becker	

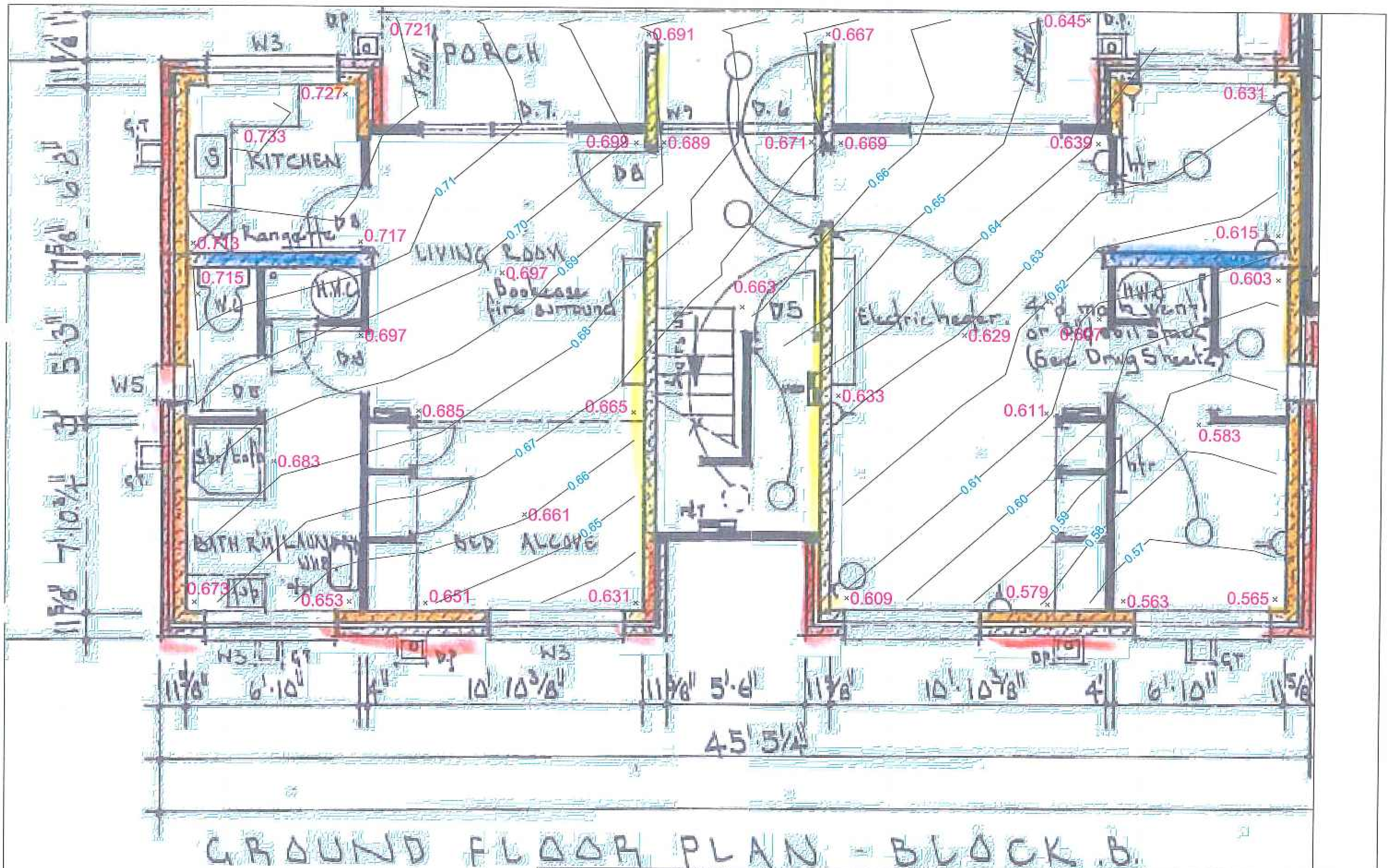
Project No.	Scale
6QUCCC.84	N.T.S

Project: Reg Stillwell Level Survey
Block A (First Floor)

Sheet:

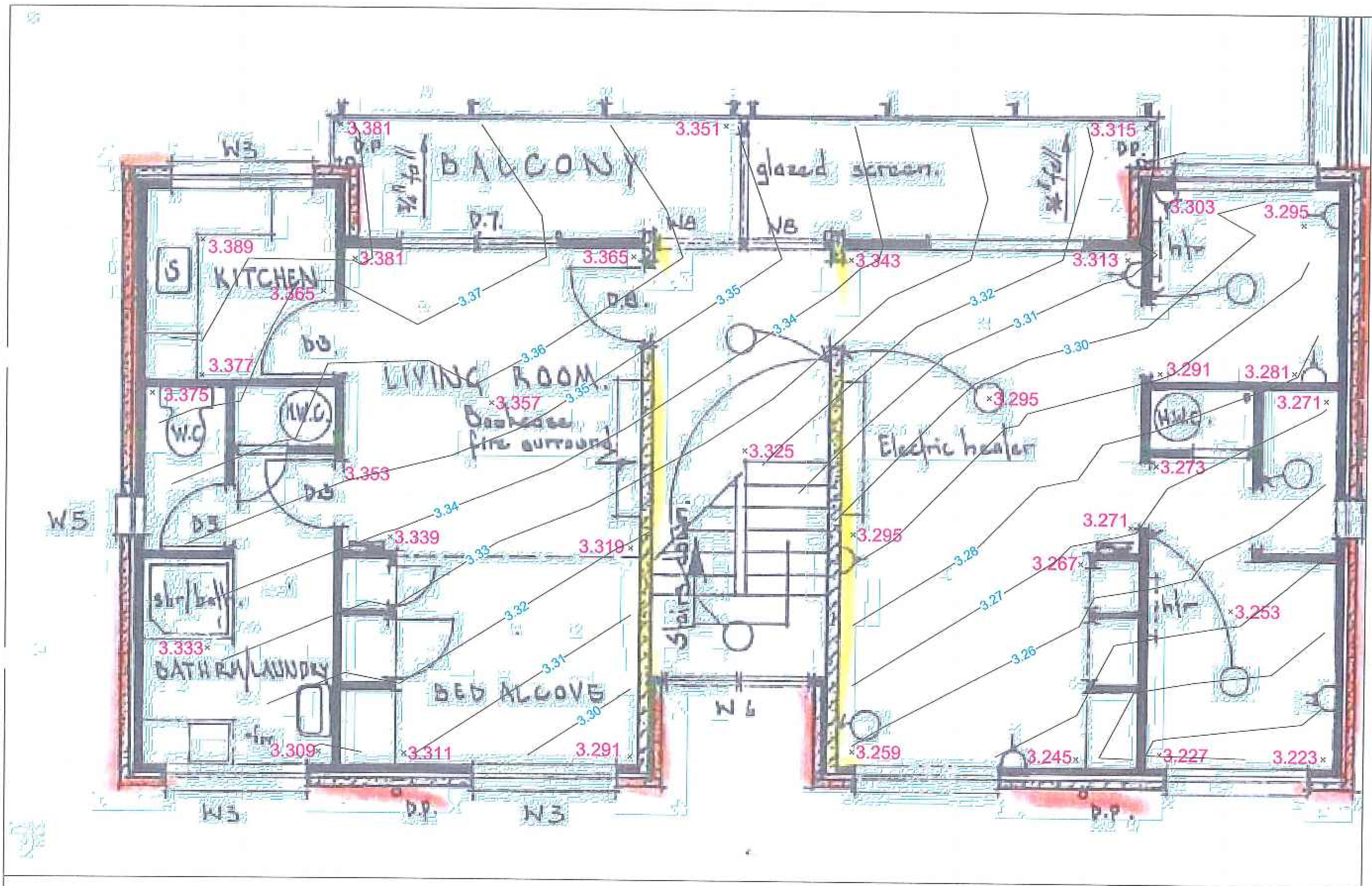
Drawing No.	Sheet No.	Revision
6/1366/247/2604	3/10	R0

Original Sheet Size A4 [297x210] Plot Date



GROUND FLOOR PLAN - BLOCK B.

OPUS Christchurch Office, P O Box 1482, Christchurch 8140, New Zealand, +64 3 363 5400	Project: Reg Stillwell Level Survey Block B1 (Ground Floor)
Drawn: J Morrow	Approved: S Becker
Project No: 6QUCCC.84	Scale: N.T.S
Drawing No: 6/1366/247/2604	Sheet No: 4/10
Revision: R0	



Revision	Amendment	Approved	Revision Date

OPUS
Christchurch Office
P O Box 1482
Christchurch 8140, New Zealand
+64 3 363 5400

Project: Reg Stillwell Level Survey
Block B1 (First floor)

Client:

Drawn	Designed	Approved	Revision Date
J Mcrnev		B Becker	

Project No.	Scale	Drawing No.	Sheet No.	Revision
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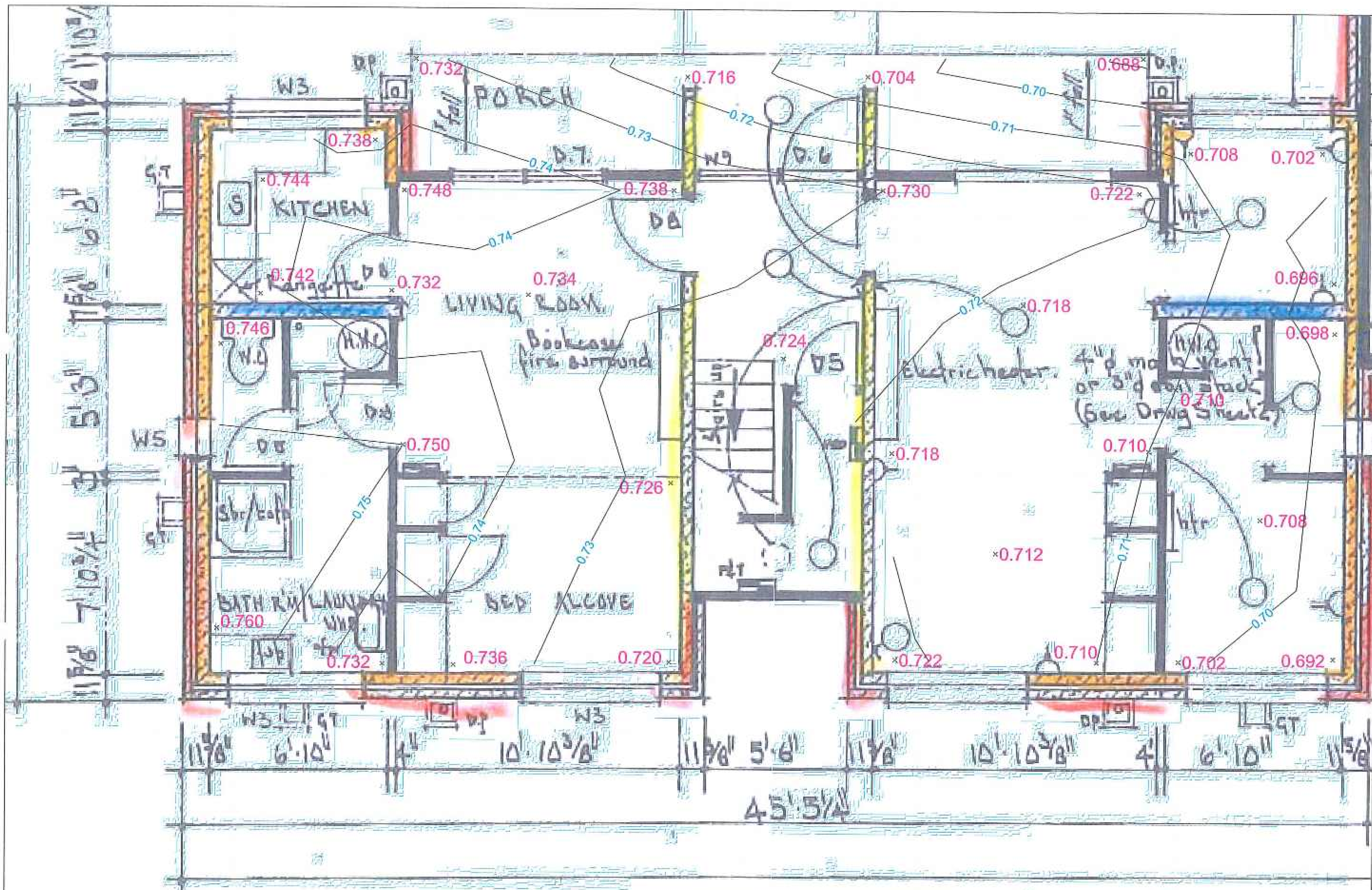

Christchurch Office
P O Box 1482
Christchurch 8140, New Zealand
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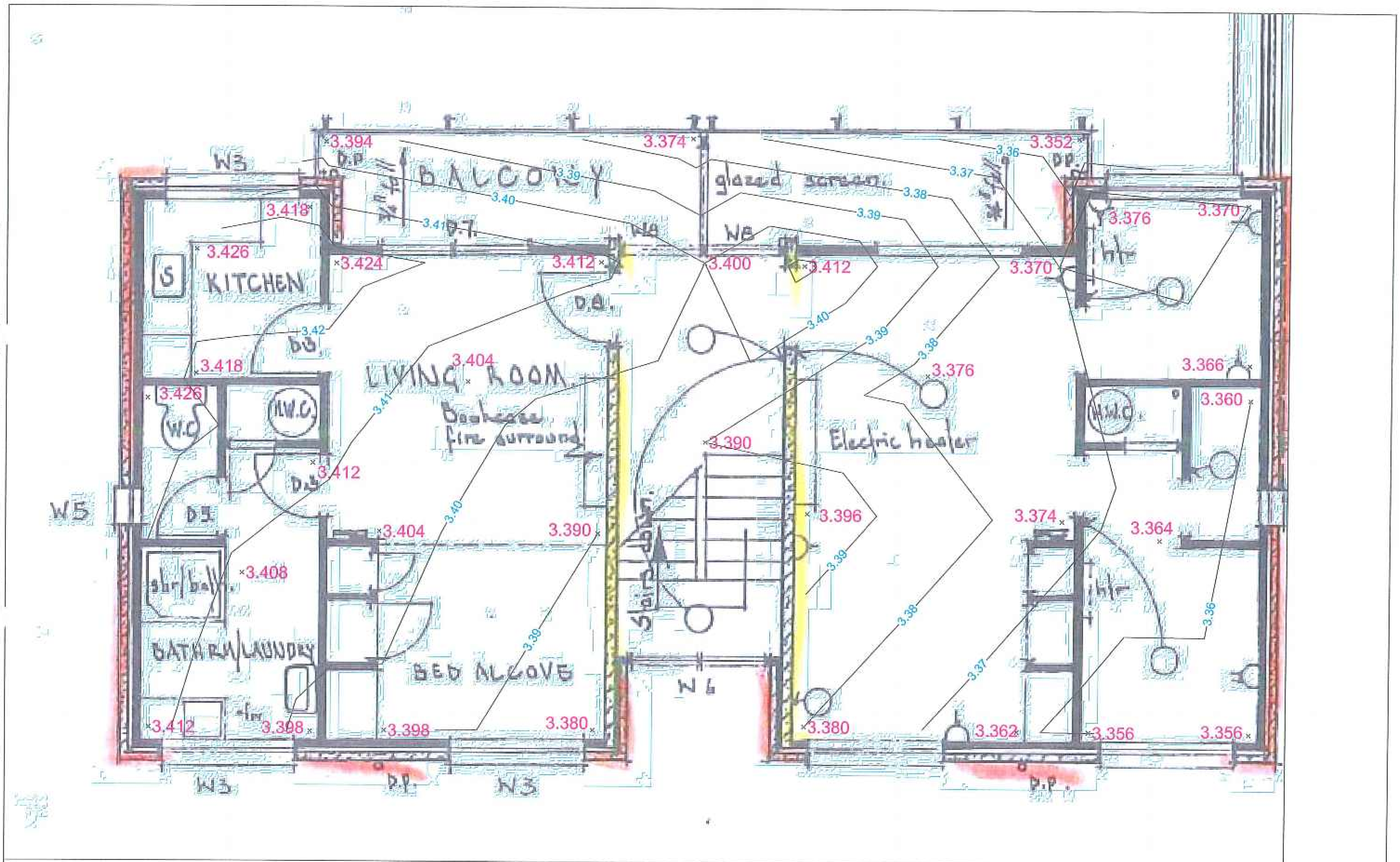
Project: Reg Stillwell Level Survey
Block B2 (Ground floor)

Sheet:

Drawn	Designed	Approved	Revision Date
J Morrow		G Becker	

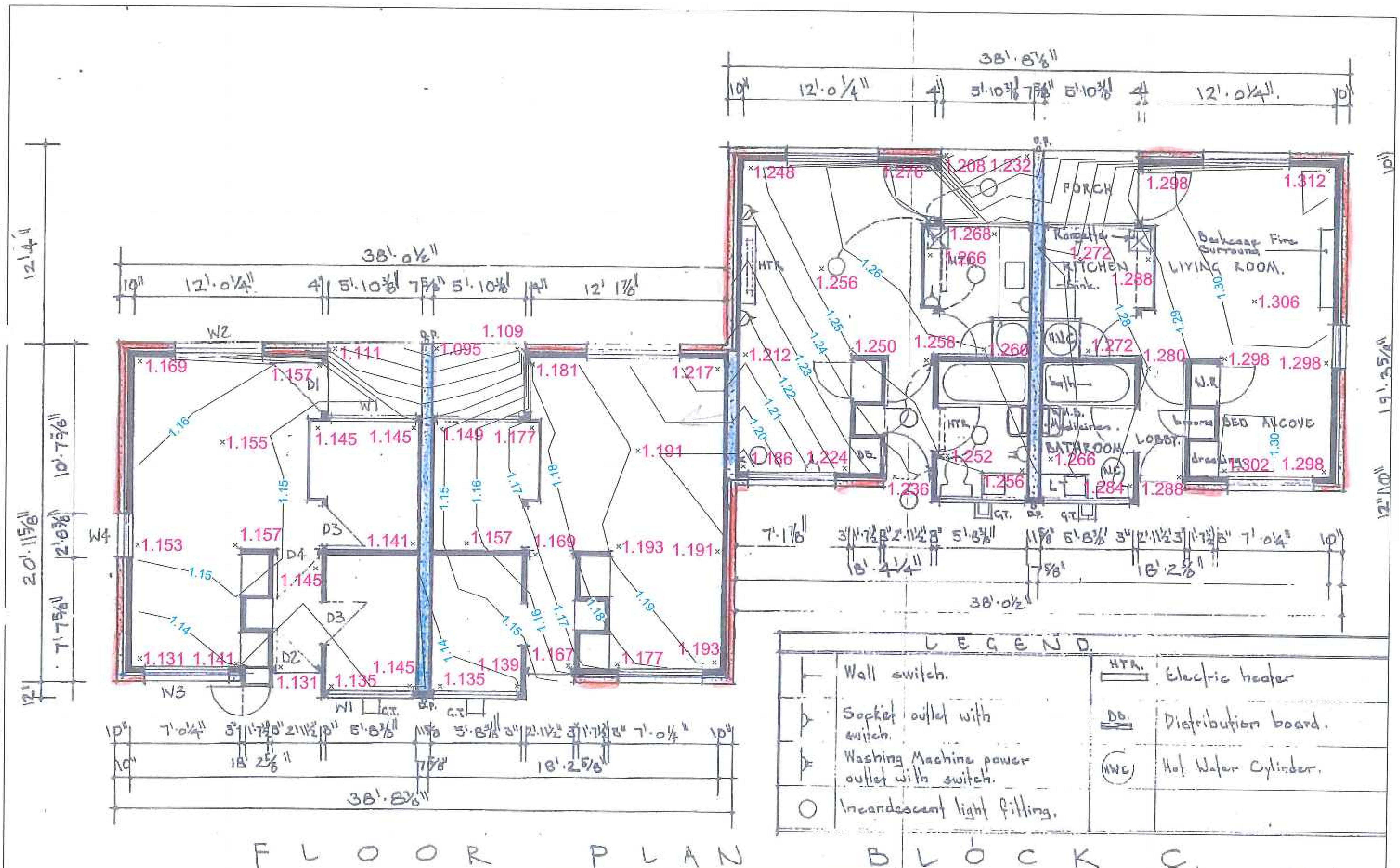
Project No.	Scale	Drawing No.	Sheet No.	Revision
6QUCCC.84	N.T.S	6/1366/247/2604	6/10	R0



Project	
Christchurch Office, P.O Box 1482, Christchurch 8140, New Zealand, +64 3 363 5400	Reg Stillwell Level Survey Block B2 (First floor)

Drawn	Designed	Approved	Revision Date
J Moncur		S Becker	

Project No.	Scale	Drawing No.	Sheet No.	Revision
6QUCCC.84	N.T.S	6/1366/247/2604	7/10	R0

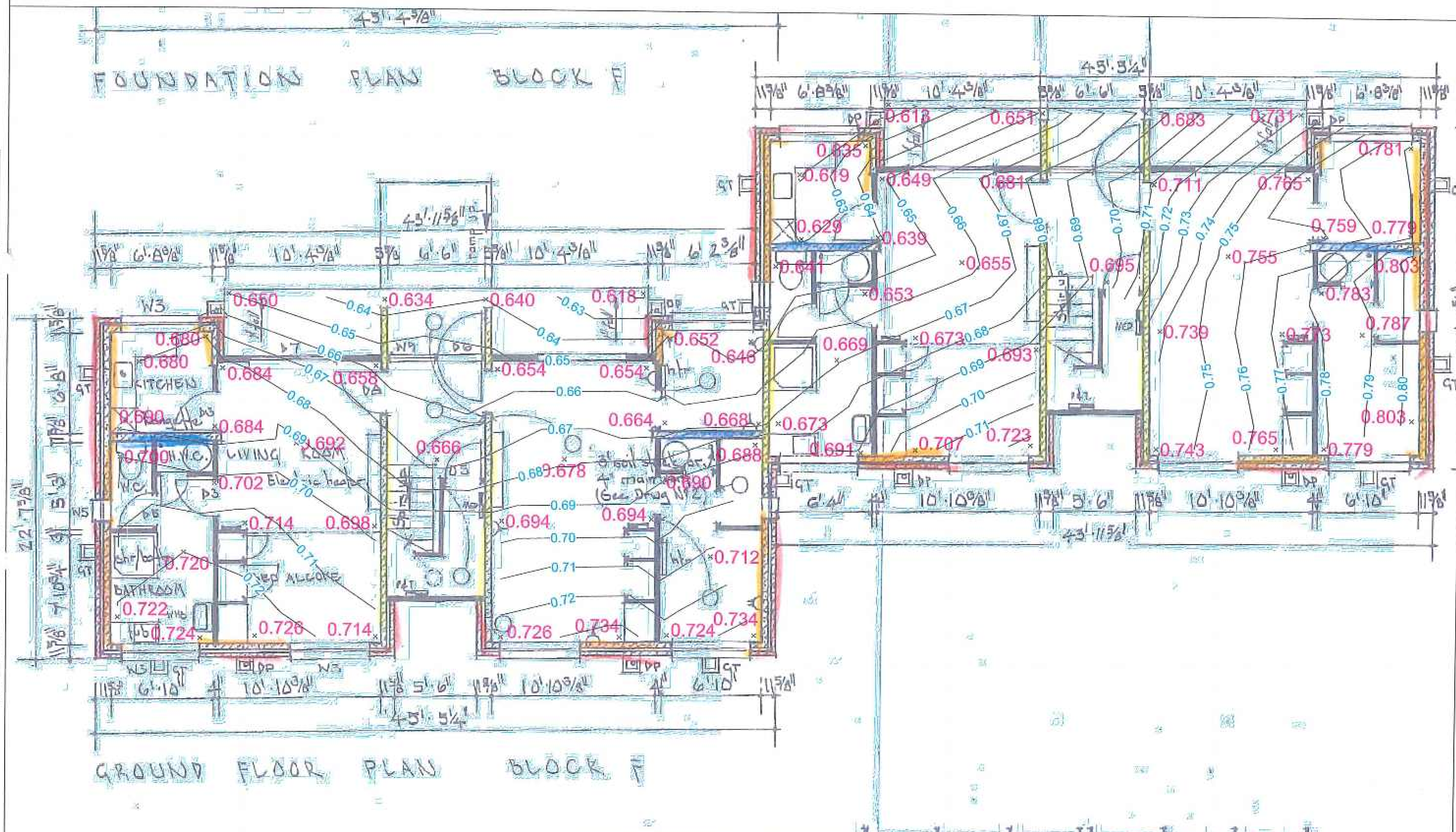


Christchurch Office
P O Box 1482
Christchurch 8140, New Zealand

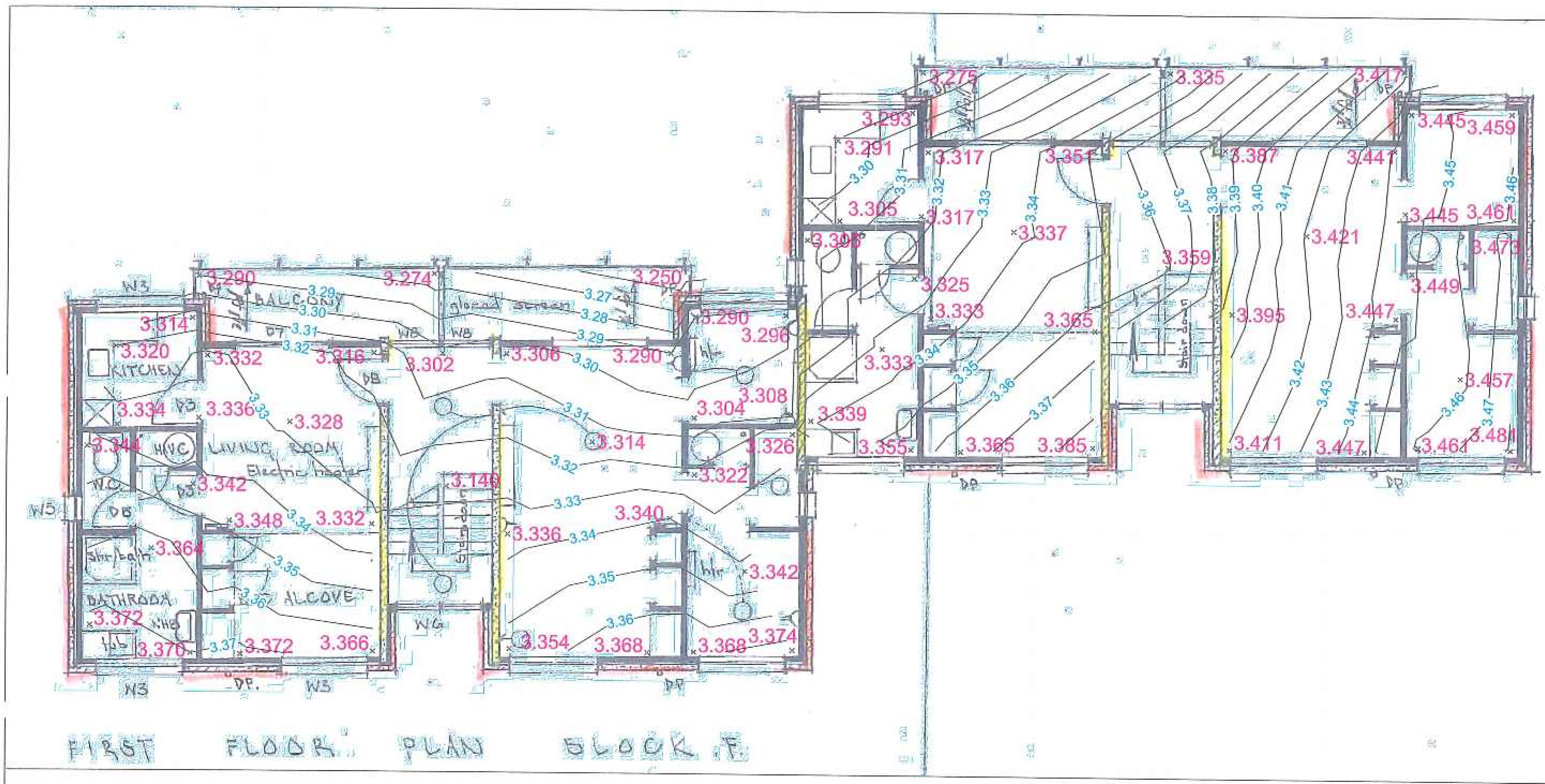
Project: Reg Stillwell Level Survey Block C

Drawn	Designed	Approved	Revision Date
J Morrow		S Booker	

Project No.	Scale	Drawing No.	Sheet No.	Revision
6QUCCC.84	N.T.S	6/1366/247/2604	8/10	R0



Christchurch Office P O Box 1482 Christchurch 8140, New Zealand +64 3 363 5400	Project: Reg Stillwell Level Survey Block F (Ground floor)	
Drawn: J Mcmnel	Approved: S Backer	
Project No: 6QUCCC.84	Scale: N.T.S	Drawing No: 6/1366/247/2604
Sheet No: 9/10	Revision: R0	



OPUS

Christchurch Office
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Drawn	Designed	Approved	Revision Date
J Marrow		S Becker	

Project No.	Scale
6QUCCC.84	N.T.S

Project: Reg Stillwell Level Survey
Block F (First floor)

Drawing No.	Sheet No.	Revision
6/1366/247/2604	10/10	R0

Appendix H:
Proposed CPT Site Plan

Key: ⊕ Cone Penetrometer Test Location

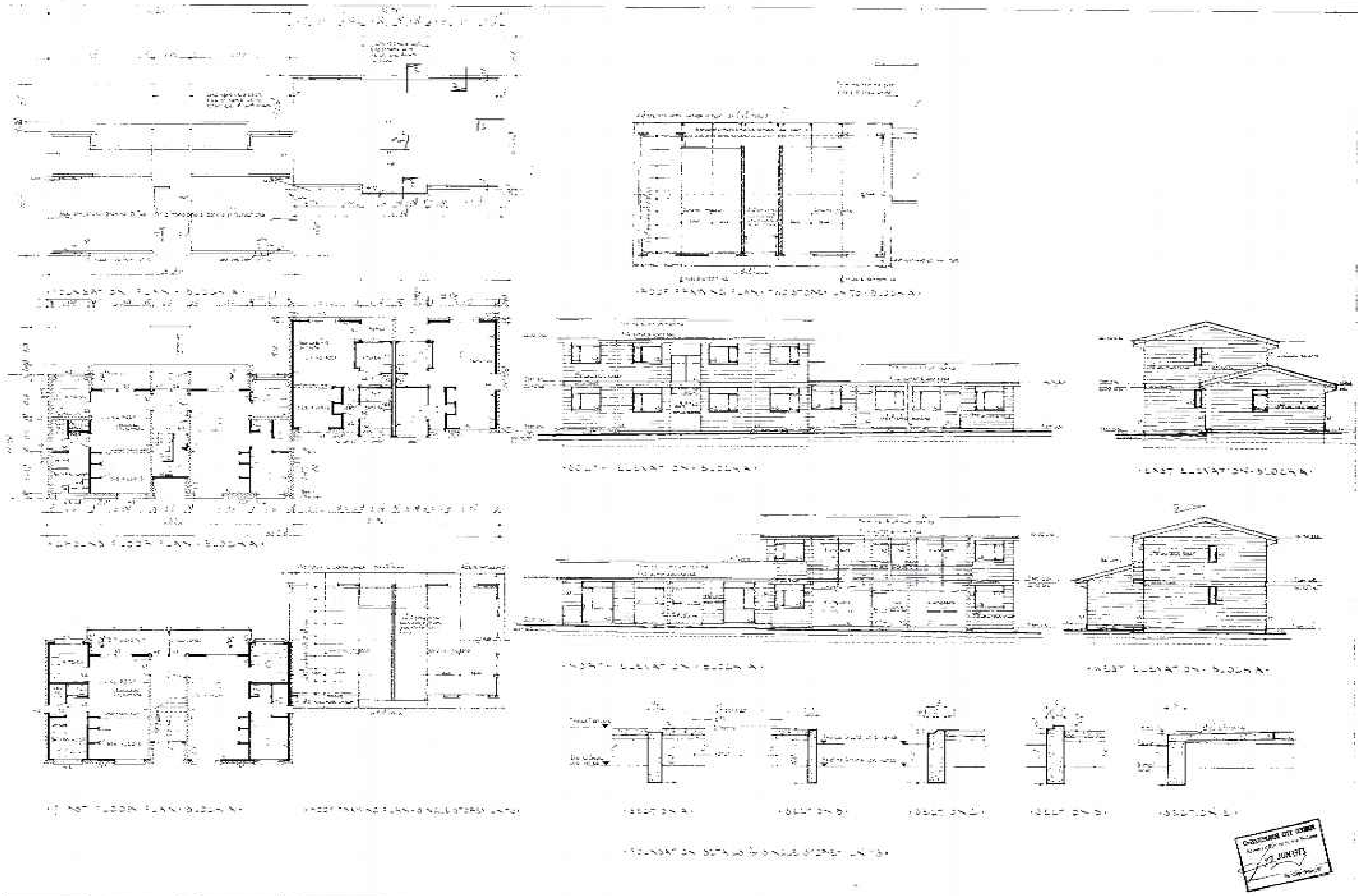
Opus International Consultants Ltd
Christchurch Office
20 Moorhouse Ave
PO Box 1482
Christchurch, New Zealand
Tel: +64 3 363 5400 Fax: +64 3 365 7857

Project:	Reg Stillwell Place Geotechnical Desktop Study
Project No:	6-QUCCC.84 85SC
Client:	Christchurch City Council

Proposed CPT Site Plan

Drawn: 28/05/2012

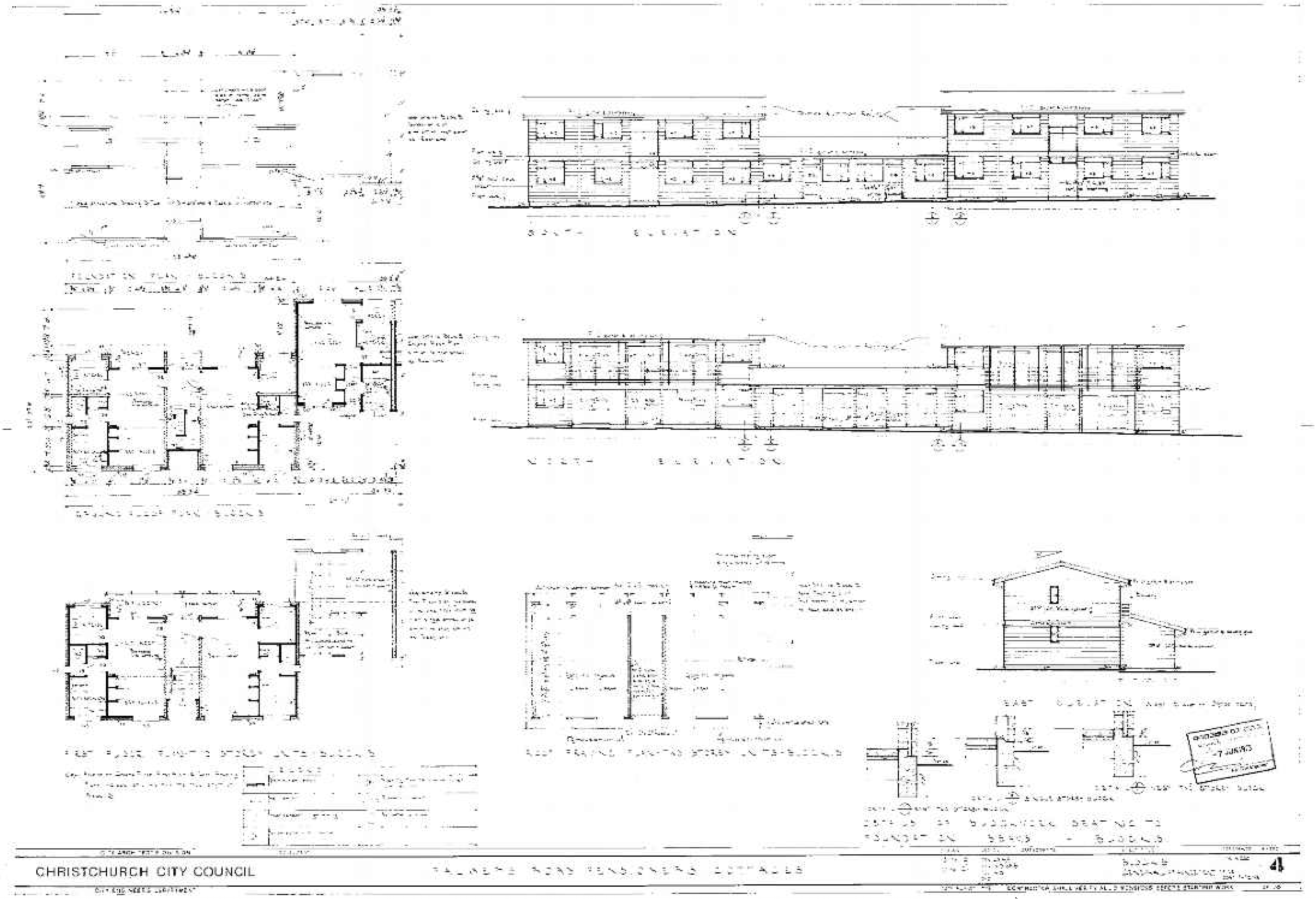
Appendix 4 – Drawings



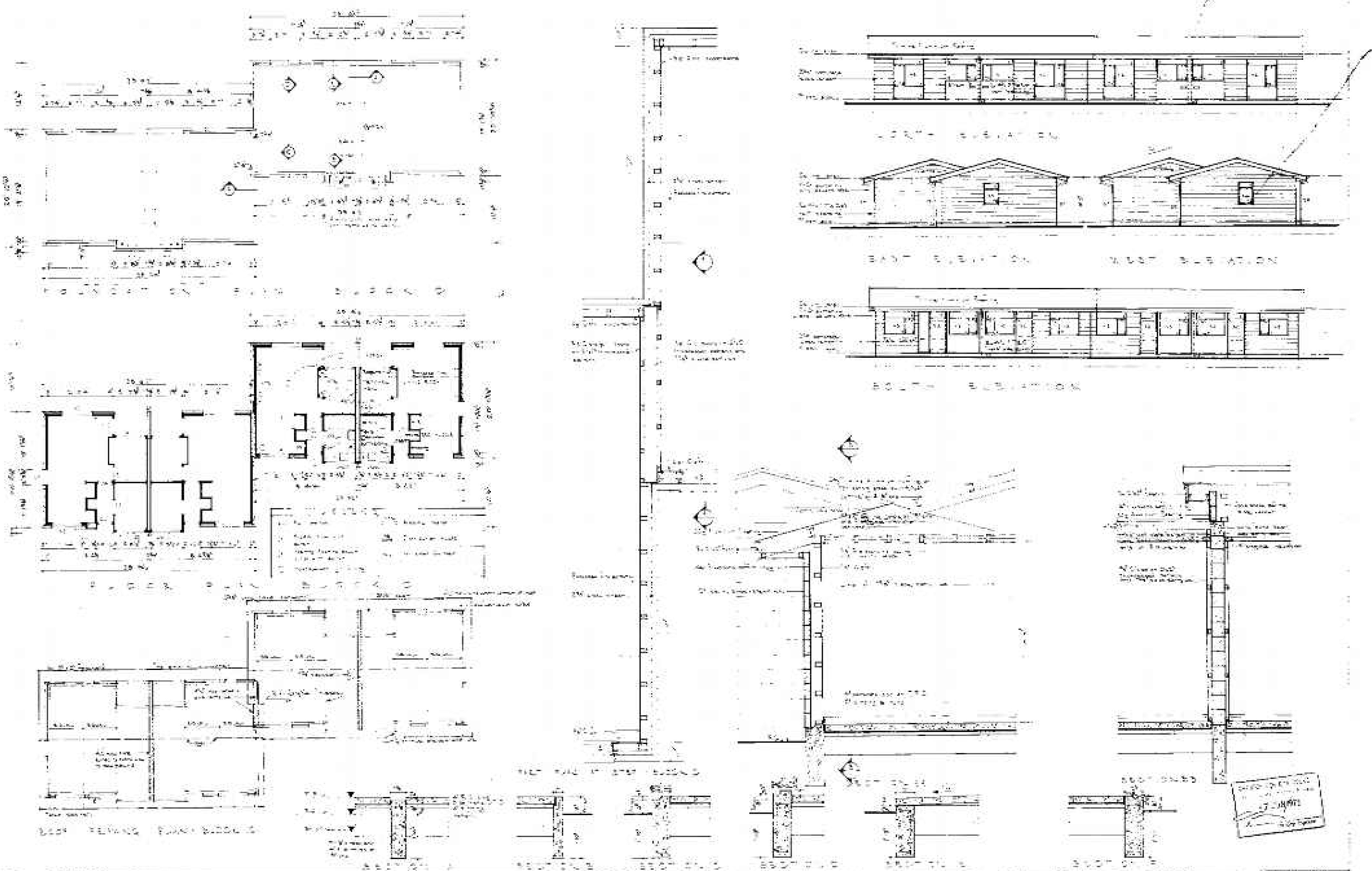
CHRISTCHURCH CITY COUNCIL

PALMERS ROAD PENSIONERS COTTAGES

3



SOUTH ELEVATION
NORTH ELEVATION
EAST ELEVATION
CHRISTCHURCH CITY COUNCIL
4



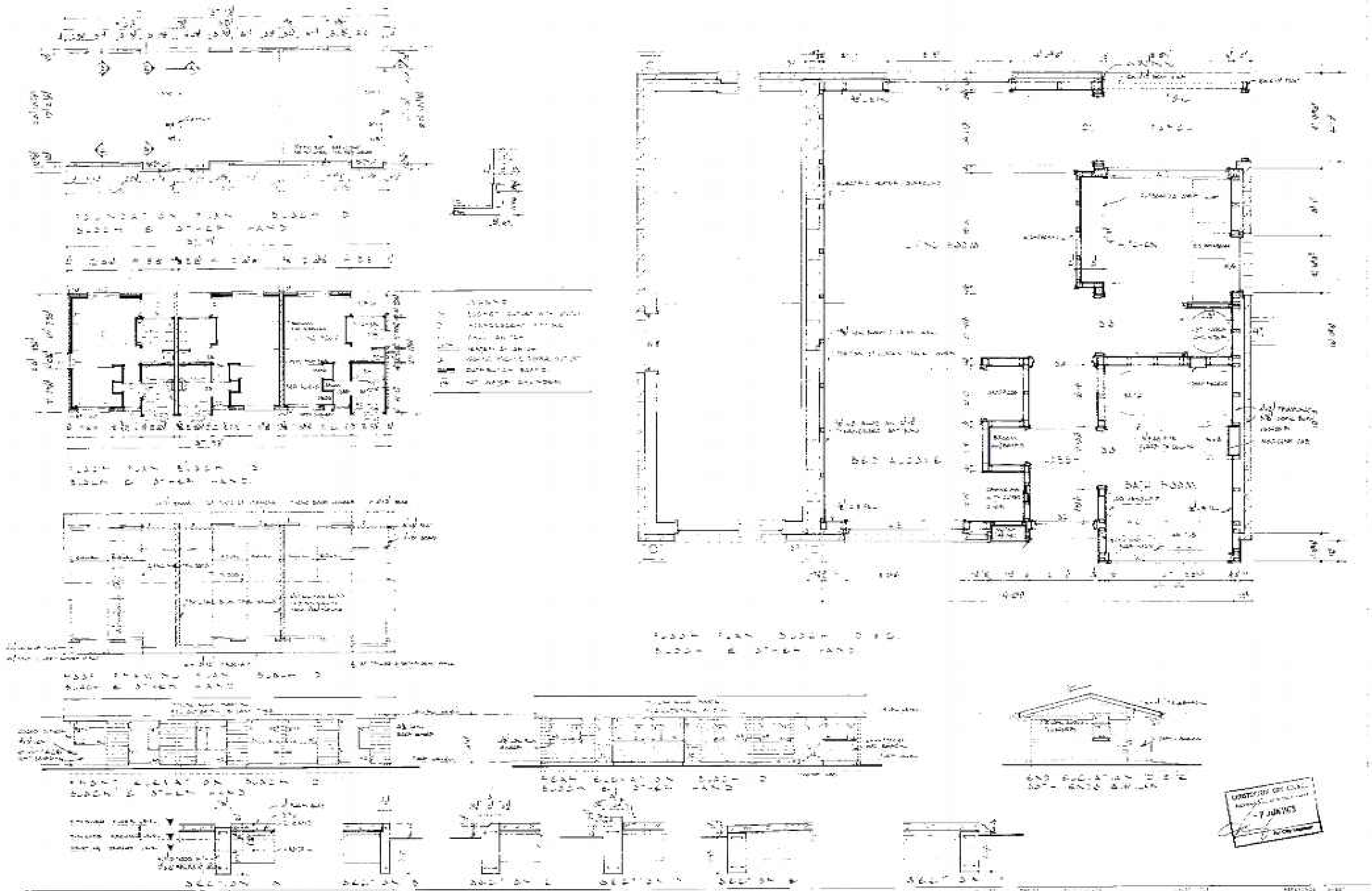
CITY ARCHITECT'S DIVISION

CHRISTCHURCH CITY COUNCIL

PALMERS ROAD PENSIONERS COTTAGES

CITY ENGINEER'S DEPARTMENT

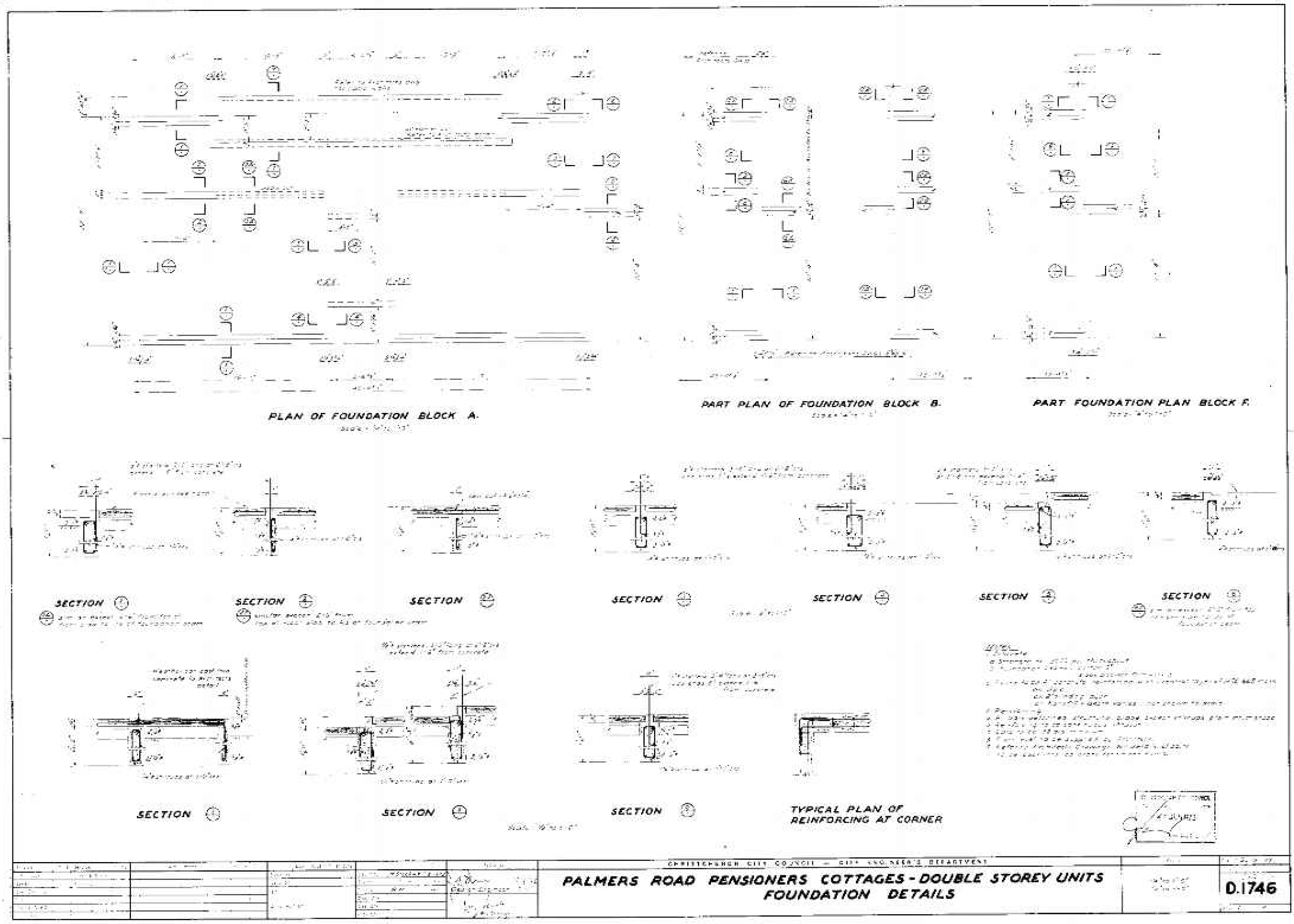
5



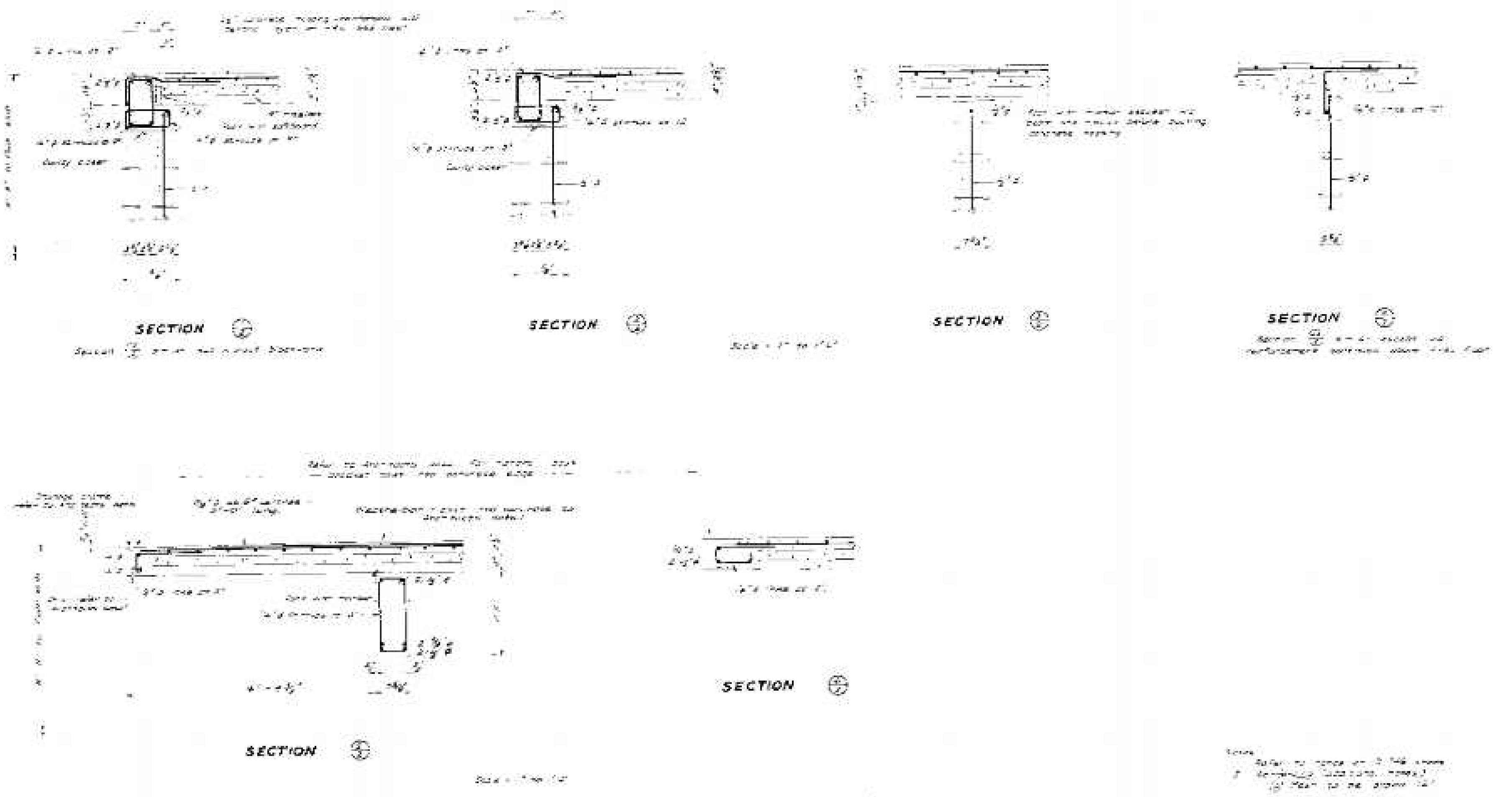
CHRISTCHURCH CITY COUNCIL

CITY ENGINEER'S DEPARTMENT

6



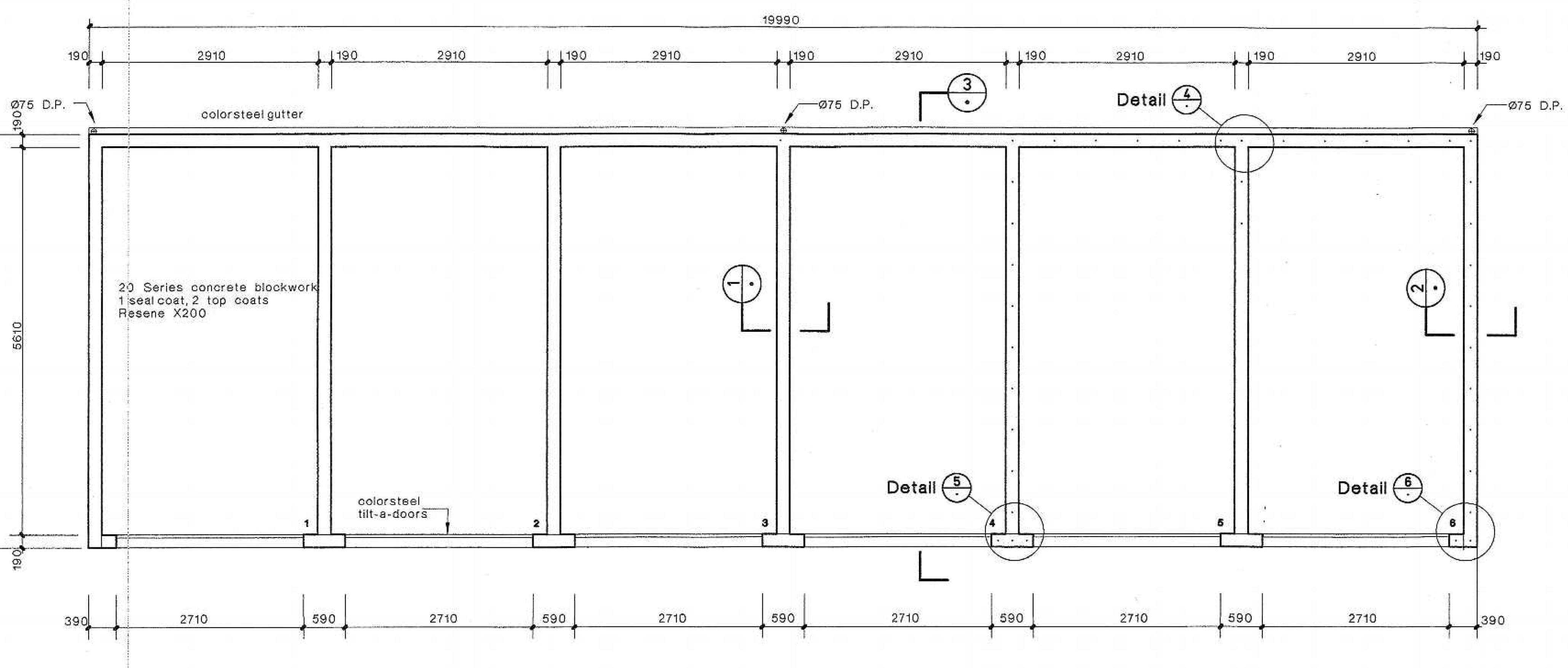
PLAN OF FOUNDATION BLOCK A.
PART PLAN OF FOUNDATION BLOCK B.
PART FOUNDATION PLAN BLOCK F.
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
SECTION
TYPICAL PLAN OF
REINFORCING AT CORNER
CHRISTCHURCH CITY COUNCIL — CITY ENGINEER'S DEPARTMENT
PALMERS ROAD PENSIONERS COTTAGES - DOUBLE STOREY UNITS
FOUNDATION DETAILS
D.1746



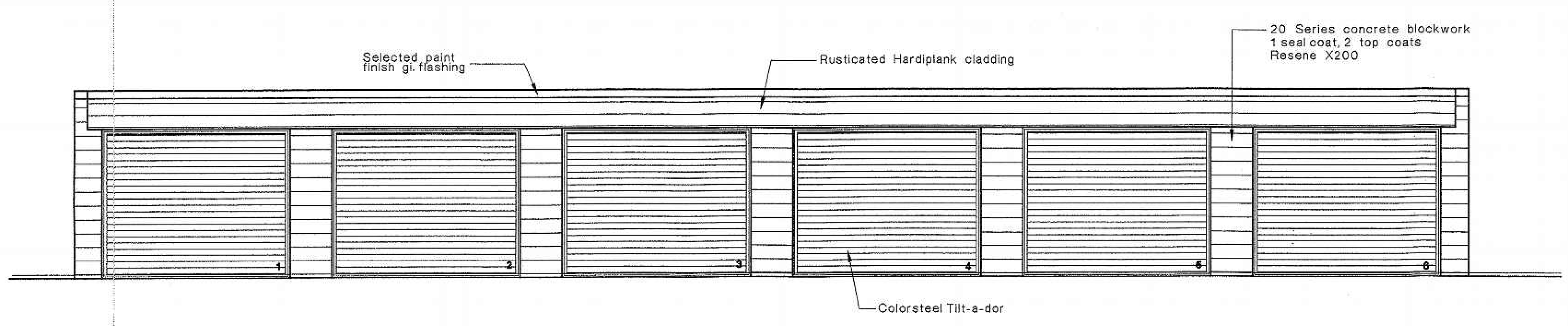
CHRISTCHURCH CITY COUNCIL — CITY ENGINEER'S DEPARTMENT

PALMERS ROAD PENSIONERS COTTAGES – DOUBLE STOREY UNITS
SECTIONS

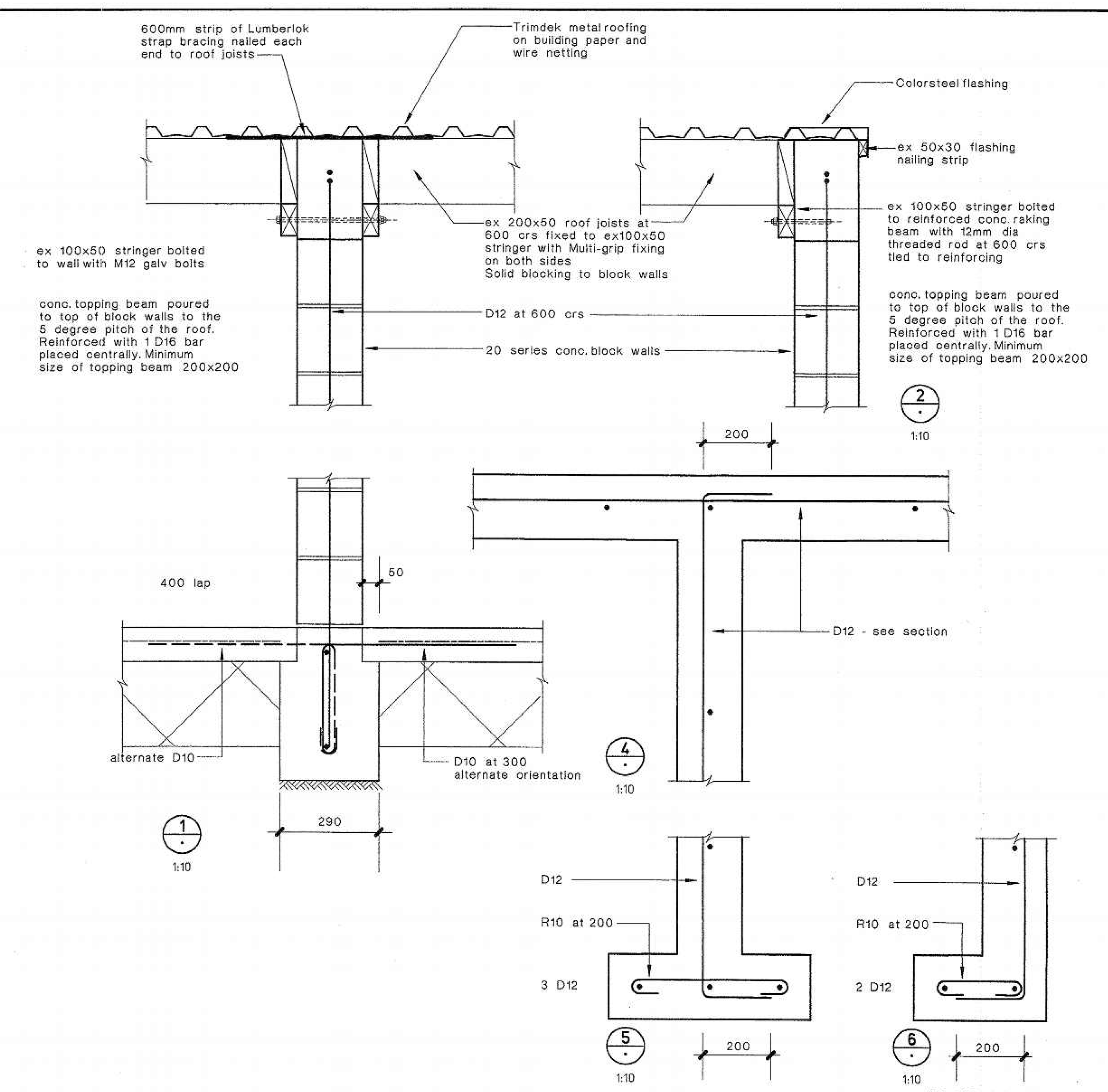
D.1746

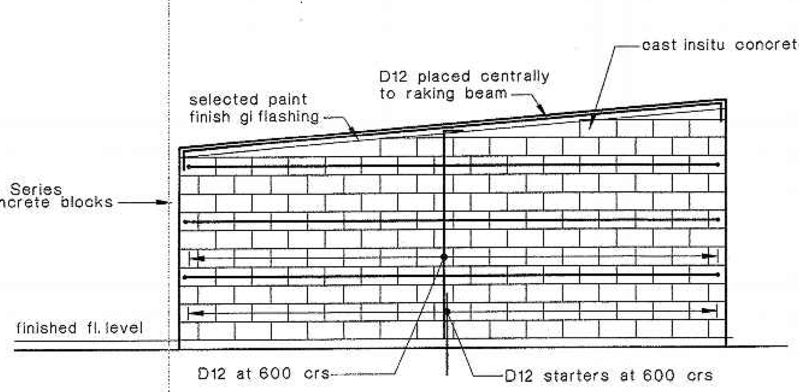


FLOOR PLAN Scale 1:50



FRONT ELEVATION Scale 1:50





END ELEVATION

NOTES

1) Concrete and Masonry

a) All concrete work to comply with the provisions of NZS 3109:1997, NZS 4210:1989 & related documents

b) Concrete strength f'c (28 days) >25Mpa

c) Block grout strength f'c = 20 Mpa, Spread = 450 +/- 50mm

d) All construction joints shall be Type B unless shown otherwise.

2) Reinforcing

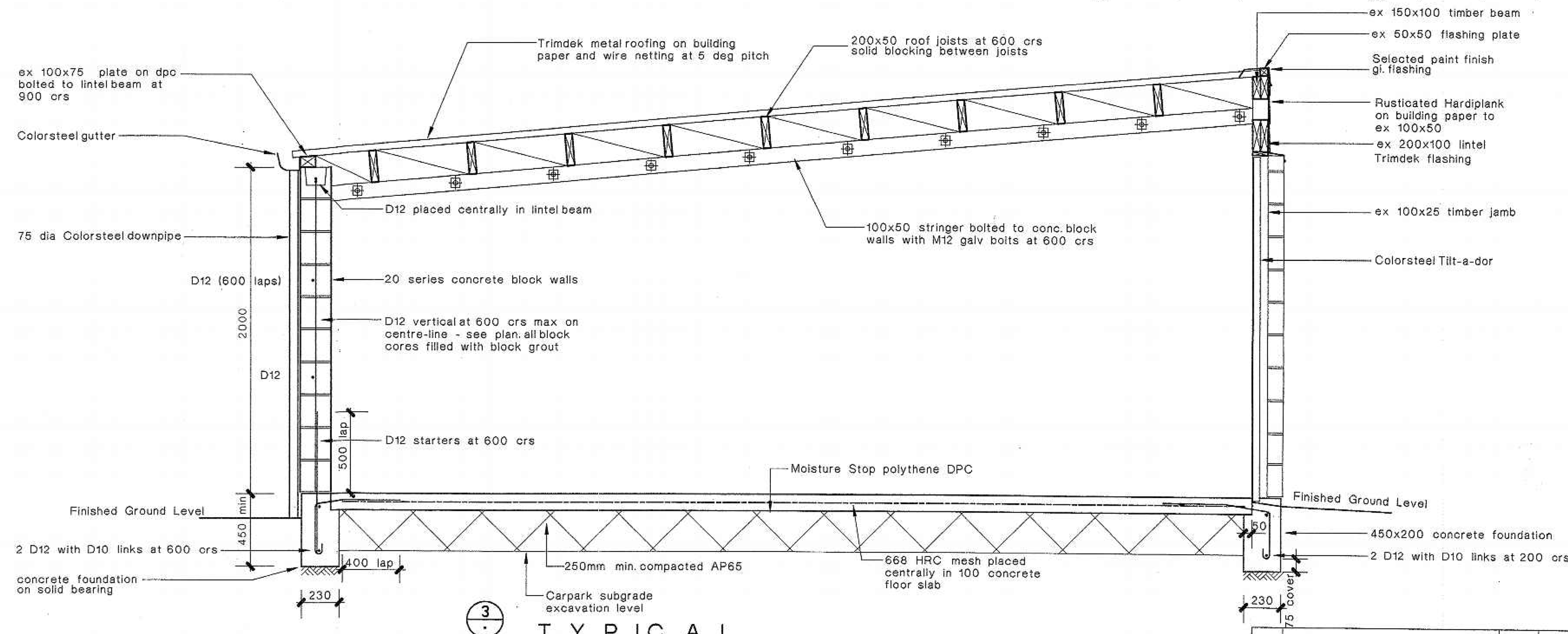
a) All reinforcing shall be in accordance with NZS 3109: 1997 & related documents

b) R denotes plain round bar Grade 300
D denotes deformed bar Grade 300

c) All bends in reinforcing to comply with NZS 3109:1997

d) Cover to reinforcing to be 50mm unless otherwise shown

e) Laps in reinforcing to be: (unless shown otherwise) D12 400mm, Mesh 300mm



TYPICAL 1:20

ISSUE	AMENDMENTS	APPD	DATE
A	Construction Issue		18/5/99

CITY DESIGN
CHRISTCHURCH THE GARDEN CITY
The city that shines

	NAME	SIGN.	DATE	
DESIGNED	SDS / MK			DATUM
DES REVIEW	D CLARK		18/5/99	BENCH MK.
DRAWN	M KITT			SURVEY FB
DRW. CHK.	SD SMITH			SURVEY LB
INDEXED	AD0088010GN	MAR 99		CONSTN. EB
				CONSTN. LB

APPROVED 18/5/99 DATE D.E.Street

JOB TITLE: REG STILLWELL PLACE SIX NEW GARAGES

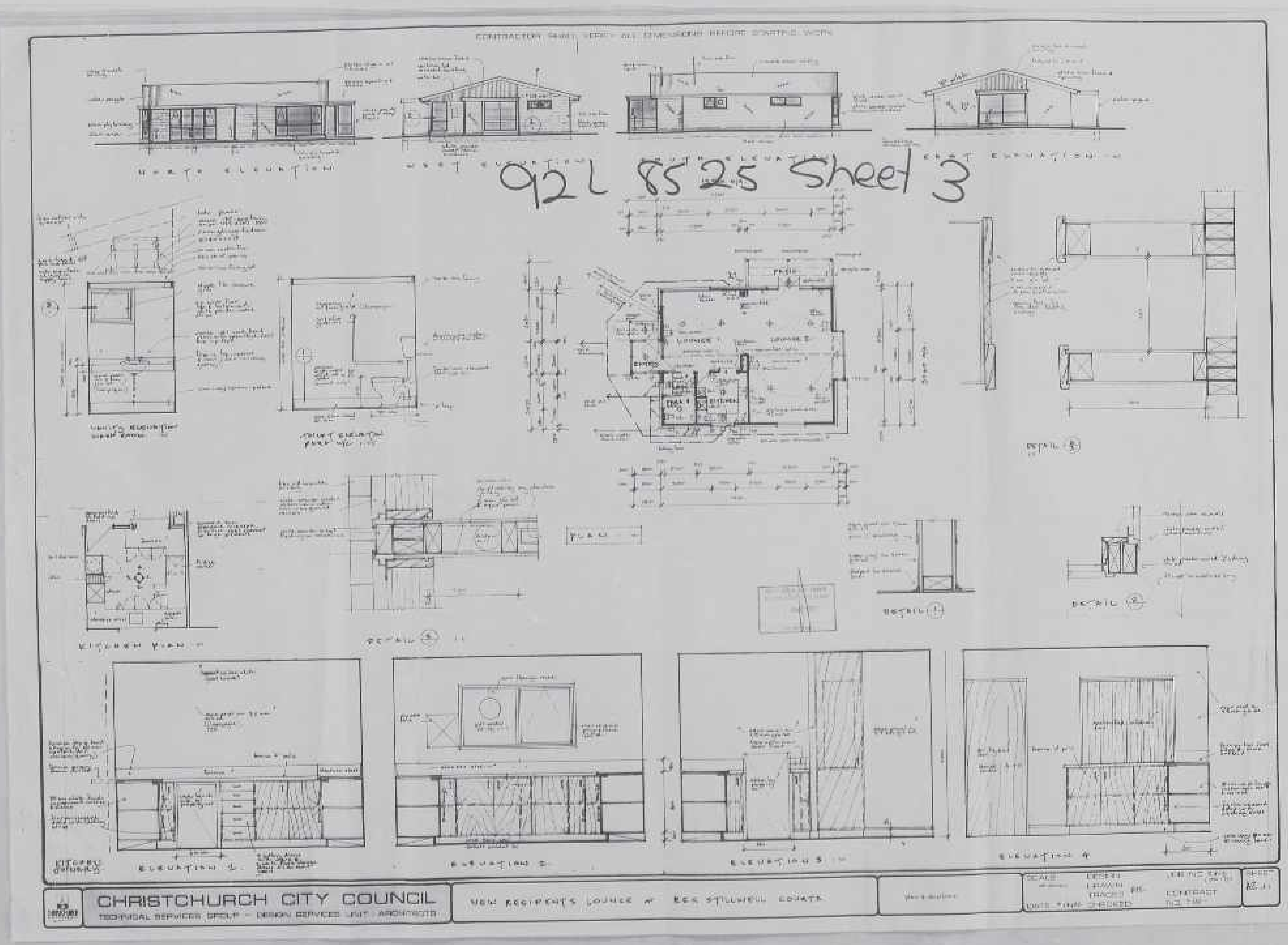
DRAWING TITLE: SITE PLAN, PLAN, ELEVATIONS AND CROSS SECTION

SCALES 1:50 1:20

C.N. 98/99-359

D7501

SHEET 1 OF 3


92L 8525 Sheet 3
CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK
NORTH ELEVATION
WEST ELEVATION
SOUTH ELEVATION
EAST ELEVATION
VANITY ELEVATION
TOILET ELEVATION
LOUNGE
PLAN
KITCHEN PLAN
DETAIL 1
DETAIL 2
DETAIL 3
ELEVATION 1
ELEVATION 2
ELEVATION 3
ELEVATION 4
KITCHEN JOINERY
CHRISTCHURCH CITY COUNCIL
TECHNICAL SERVICES GROUP - DESIGN SERVICES UNIT - ARCHITECTS
NEW RESIDENT'S LOUNGE AT ECK STILLWELL COURTS
SCALE
DESIGN
DRAWN
TRACED
CHECKED
DATE
CONTRACT
SHEET

Appendix 5 – CERA DEE Data Sheets

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block A	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	Reg Stillwell Place	Company:	Opus International
Legal Description:		Company project number:	6-QUCCC.84
		Company phone number:	03 3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	25/10/2013
GPS east:		Inspection Date:	23/12/2011
		Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-001	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	2	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	165			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	precast concrete with topping	unit type and depth (mm), topping	64mm topping, 100mm PC rib slab
Beams:	none	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	load bearing concrete	#N/A	

Lateral load resisting structure

Lateral system along:	concrete shear wall	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	4
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period along:	0.24	0.02 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	concrete shear wall		note total length of wall at ground (m):	24
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period across:	0.24	0.00 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	cast insitu	notes	
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 $m^2/100m^2$	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	red		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	yes	Describe:	torsion, lack of load transfer, pounding
Pounding:	Damage?:	yes	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening		Describe:	as described in report
	Building Consent required:	yes		Describe:	
	Interim occupancy recommendations:	do not occupy		Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative
	Assessed %NBS after:	10%			
Across	Assessed %NBS before:		##### %NBS from IEP below		
	Assessed %NBS after:	10%			

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block B		Reviewer:	Alistair Boyce
	Unit / No: / Street		CPEng No:	209860
Building Address:	Reg Stillwell Place		Company:	Opus International
Legal Description:			Company project number:	6-QUCCC.84
			Company phone number:	03 3635400
	Degrees / Min / Sec			
GPS south:			Date of submission:	25/10/2013
GPS east:			Inspection Date:	6/01/2012
			Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-003		Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	2	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	165			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	precast concrete with topping	unit type and depth (mm), topping	64mm topping, 100mm PC rib slab
Beams:	none	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	load bearing concrete	#N/A	

Lateral load resisting structure

Lateral system along:	concrete shear wall	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	4
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period along:	0.24	0.02 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	concrete shear wall		note total length of wall at ground (m):	24
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period across:	0.24	0.00 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	cast insitu	notes	
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m²/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	red		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	yes	Describe:	torsion, lack of load transfer, pounding
Pounding:	Damage?:	yes	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	as described in report
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative
	Assessed %NBS after:	10%		
Across	Assessed %NBS before:	##### %NBS from IEP below		
	Assessed %NBS after:	10%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block C			Reviewer:	Alistair Boyce
	Unit	No:	Street	CPEng No:	209860
Building Address:	Reg Stillwell Place			Company:	Opus International
Legal Description:				Company project number:	6-QUCCC.84
				Company phone number:	03 3635400
	Degrees	Min	Sec		
GPS south:				Date of submission:	25/10/2013
GPS east:				Inspection Date:	23/12/2011
				Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-004			Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	3
Floor footprint area (approx):	141			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	other (note)	describe sytem	
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period across:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m³/100m³	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	red		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	yes	Describe:	pounding
Pounding:	Damage?:	yes	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	as described in report
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	10%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	10%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block D		Reviewer:	Alistair Boyce
	Unit	No: Street	CPEng No:	209860
Building Address:	Reg Stillwell Place		Company:	Opus International
Legal Description:			Company project number:	6-QUCCC.84
			Company phone number:	03 3635400
	Degrees	Min Sec		
GPS south:			Date of submission:	25/10/2013
GPS east:			Inspection Date:	23/12/2011
			Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-005		Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	108			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	other (note)	describe sytem	64mm topping, 100mm PC rib slab
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period across:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m³/100m³	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	torsion, lack of load transfer, pounding
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	as described in report
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	58%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	58%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block E	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	Reg Stillwell Place	Company:	Opus International
Legal Description:		Company project number:	6-QUCCC.84
		Company phone number:	03 3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	25/10/2013
GPS east:		Inspection Date:	23/12/2011
		Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-006	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	108			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	other (note)	describe sytem	64mm topping, 100mm PC rib slab
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period along:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period across:		0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m²/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	torsion, lack of load transfer, pounding
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor non-structural	Describe:	as described in report
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	68%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	100%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Block F		Reviewer:	Alistair Boyce
	Unit No: Street		CPEng No:	209860
Building Address:	Reg Stillwell Place		Company:	Opus International
Legal Description:			Company project number:	6-QUCCC.84
			Company phone number:	03 3635400
	Degrees Min Sec			
GPS south:			Date of submission:	25/10/2013
GPS east:			Inspection Date:	23/12/2011
			Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-007		Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	2	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	185			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	precast concrete with topping	unit type and depth (mm), topping	64mm topping, 100mm PC rib slab
Beams:	none	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	load bearing concrete	#N/A	

Lateral load resisting structure

Lateral system along:	concrete shear wall	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	8
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period along:	0.24	0.01 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	concrete shear wall		note total length of wall at ground (m):	48
Ductility assumed, μ:	1.25		wall thickness (m):	150
Period across:	0.24	0.00 from parameters in sheet	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	cast insitu	notes	
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m²/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	yes	Describe:	torsion, lack of load transfer, pounding
Pounding:	Damage?:	yes	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	significant structural and strengthening	Describe:	as described in report
	Building Consent required:	yes	Describe:	
	Interim occupancy recommendations:	do not occupy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	10%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	10%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Garage	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	Reg Stillwell Place	Company:	Opus International
Legal Description:		Company project number:	6-QUCCC.84
		Company phone number:	03 3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	25/10/2013
GPS east:		Inspection Date:	23/12/2011
		Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-008	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	165			
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	other (note)	describe sytem	64mm topping, 100mm PC rib slab
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls	**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period along:	0.24	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period across:	0.24	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m²/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	Moderate to severe damage observed
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	as described in report
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	65%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	65%		

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Reg Stillwell - Residents lounge	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	Reg Stillwell Place	Company:	Opus International
Legal Description:		Company project number:	6-QUCCC.84
		Company phone number:	03 3635400
	Degrees / Min / Sec		
GPS south:		Date of submission:	25/10/2013
GPS east:		Inspection Date:	23/12/2011
		Revision:	Final V4
Building Unique Identifier (CCC):	PRO 1320-002	Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	0.00
Ground floor split?	no		Ground floor elevation above ground (m):	
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	3
Floor footprint area (approx):				
Age of Building (years):	39		Date of design:	1965-1976
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	multi-unit residential		Brief strengthening description:	
Use (upper floors):	multi-unit residential			
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	Timber purlins over gang nailed trusses
Floors:	other (note)	describe sytem	
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	
Columns:	other (note)	typical dimensions (mm x mm)	
Walls:	partially filled concrete masonry	thickness (mm)	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period along:	0.24	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	lightweight timber framed walls		note typical wall length (m)	
Ductility assumed, μ:	1.25			
Period across:	0.24	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:	other (specify)	describe	None
Wall cladding:	other heavy	describe	Concrete block veneer
Roof Cladding:	Metal	describe	
Glazing:	aluminium frames		
Ceilings:	strapped or direct fixed		gib ceiling
Services(list):			

Available documentation

Architectural	full	original designer name/date	Christchurch City Council
Structural	full	original designer name/date	Christchurch City Council
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:	Poor	Describe damage:	
Settlement:	0-25mm	notes (if applicable):	
Differential settlement:	1:150 or more	notes (if applicable):	
Liquefaction:	2-5 m²/100m²	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	20-100mm/20m	notes (if applicable):	
Damage to area:	moderate to substantial (1 in 5)	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	minor structural	Describe:	as described in report
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before:		##### %NBS from IEP below	If IEP not used, please detail assessment methodology: Quantitative
	Assessed %NBS after:	46%		
Across	Assessed %NBS before:		##### %NBS from IEP below	
	Assessed %NBS after:	46%		

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