

## REPORT

STRUCTURAL AND CIVIL ENGINEERS

78- 82 BYRON ST

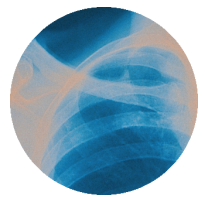
BUILDING A

PREPARED FOR

STEWART FAMILY TRUST

111702

JUNE 2014





78 BYRON ST – DETAILED SEISMIC ASSESSMENT REPORT  
BUILDING A – SHEER ADVENTURE WORKSHOP

Prepared For:  
STEWART FAMILY TRUST

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## EXECUTIVE SUMMARY

This report covers the structural damage sustained by the Sheer Adventure Workshop building at 78 Byron St, as a result of the series of earthquakes including the Darfield Earthquake that struck at 4:36am on 4<sup>th</sup> September, 2010 and the Lyttelton Earthquake that struck at 12.51 pm on the 22<sup>nd</sup> of February, 2011. The Sheer Adventure Workshop building consists of the original western warehouse structure and the eastern lean-to addition.

The lateral capacity of the building in the east-west direction prior to the earthquakes was found to be approximately 35% of current code. The capacity in the east-west direction was limited by the combined axial loading and bending capacity of the steel portal frames. The lateral capacity of the building in the north-south direction was found to be approximately 70% of current code and was limited by shear in the central ungrouted concrete block infill walls. The external wing-wall extension in the northwest corner of the original structure was found to be 15% of current code and was limited by the out-of-plane capacity of the wall at its base.

The level of shaking experienced at the site is estimated from the Geonet strong motion data recorded at monitoring sites around Christchurch and is related to the fundamental periods of the building for the Lyttelton Earthquake. Given the strong motion data available, it is likely that this earthquake produced accelerations significantly in excess of the design spectra for this building.

Preliminary and detailed observations have been made of the damage sustained as a result of the earthquakes. This report summarises the findings of these detailed observations and provides recommendations regarding the repair work required.

General damage observed consists of cracking and differential settlement of the concrete slab, diagonal cracking along the mortar joints of the concrete masonry unit block walls throughout the original western structure, and failure of a roof bracing strap.

As a result of the earthquakes the building's capacity has likely been reduced in the north-south direction due to diagonal cracking along mortar joints in some of the infill wall panels. The remaining uncracked panels provide the residual lateral capacity in the north-south direction and we estimate the remaining capacity to be greater than 33% of current code. The building's capacity in the east-west direction remains at approximately 35% of current code. The wing-wall extension in the northwest corner of the original structure remains at 15% of current code.

Repairs are recommended in the report and include repairing and repointing of the concrete blockwork and infill wall mortar joints, repair of spalled concrete at portal column bases and beam joints, removing and replacing the slab-on-grade in approximately 40% of the building, and replacing the failed roof bracing tension strap. Note that replacement of slab sections and wall repairs may require the tenants to relocate equipment and operations to the unaffected areas of the building. The northwest wing wall extension should be deconstructed. A fire engineer should be engaged to determine if the wall needs to be replaced. If so, the new wall should be designed for 100% of current loading standard.

Following the repairs recommended herein, the lateral load resisting performance of the building will be restored to its pre-earthquake condition. As noted above, this capacity is

limited by the capacity of the steel portal frames in the east-west direction (35% DBE) and the capacity of the infill walls in the north-south direction (70% DBE).

The following further investigations are recommended to confirm analysis assumptions and complete observations of areas of potential damage:

- To confirm foundation assumptions, a geotechnical report should be completed for the site.
- One location of the slab should be broken up along the internal north-south running block wall to confirm block wall foundation and steel portal frame column foundation assumptions.
- The concrete encasement around the steel portal frame column should be broken out at the slab level and the beam-column joint level at several locations to determine if any damage has occurred to the steel portal frames.

All locations should be confirmed with the engineer prior to implementation of any destructive investigations.

This report is considered a live document and will be updated throughout the course of the project with the final report issued once the repairs have been completed.



## 1. INTRODUCTION

Holmes Consulting Group has been engaged by the Stewart Family Trust to complete a structural review following the Canterbury Earthquakes.

The Darfield Earthquake of 4:36am on 4<sup>th</sup> September, 2010 and the Lyttelton Earthquake of 12.51 pm on 22<sup>nd</sup> of February, 2011 have subjected the building to strong ground motions which significantly exceed the full design earthquake load for buildings of this nature. Consequently it is important that a full evaluation is performed.

### 1.1 PURPOSE

The purpose of this study was to:

- review the impact of the earthquakes on the building
- determine the seismic capacity of the building
- map typical damage around the building
- identify those items requiring repairs or replacement
- specify concept repairs to comply with Christchurch City Council regulations

The overall objective is to ensure that the building is repaired and opened for tenants in as timely and smooth a fashion as possible.

### 1.2 SCOPE OF WORK

The CERA detailed engineering evaluation procedure is currently in draft form and specific requirements for re-occupation of buildings or applications for Building Consents are not yet certain. As such, this report covers the following scope:-

- Review the available structural drawings to determine the building structural systems and predict areas of likely damage.
- Inspect a sufficient amount of the building structure to be able to make a determination of the behaviour of the building in the earthquake, and to map damage to the structure.
- Repair of damage caused directly by the earthquake.
- Adoption of the new loadings standard ( $Z=0.3$ ).
- Assessment of Critical Collapse Hazards.
- Prepare a report detailing the proposed repairs required including extent and details.

The likely extent of repairs outlined herein is based on our observations described herein and does not consider any potential changes to the minimum design load levels other than those described above. Further repairs may also be identified during the course of conducting detailed observations.

It should be noted that even after the detailed observations and analysis outlined above, it is difficult to accurately quantify the residual capacity remaining in the structure following this significant earthquake. As such, it is likely that we may never be able to categorically state that the building is as good as it was before the earthquake.

### 1.3 LIMITATIONS

Findings presented as a part of this project are for the sole use of the Stewart Family Trust, its insurer, and the Christchurch City Council in its evaluation of the subject property. The findings are not intended for use by other parties, and may not contain sufficient information for the purposes of other parties or other uses.

Our observations have been visual only and limited to representative samples, as described in our record of observations. Our observations have been restricted to structural aspects only. Waterproofing elements, electrical and mechanical equipment, fire protection and safety systems, service connections, water supplies and sanitary fittings have not been inspected or reviewed, and secondary elements such as windows and fittings have not generally been reviewed.

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. No other warranty, expressed or implied, is made as to the professional advice presented in this report.





## 2. STATUTORY REQUIREMENTS

### 2.1 BUILDING ACT

When dealing with existing buildings there are a number of relevant sections of the Building Act [1] that need to be considered in relation to the building's structure and strength.

#### Section 112 - Alterations to Existing Buildings

Section 112 of the Building Act requires that a building subject to an alteration continue to comply with the relevant provisions of the Building Code to at least the same extent as before the alteration.

Essentially this section means that the building may not be made any weaker than it was, as a result of any alteration.

#### Section 122 – Meaning of Earthquake Prone Building

Section 122 of the Building Act 2004 deems a building to be earthquake prone if its ultimate capacity (strength) would be exceeded in a “moderate earthquake” and it would be likely to collapse causing injury or death, or damage to other property.

The Building Regulations (2005) define a moderate earthquake as one that would generate loads 33% as strong as those used to design an equivalent new building.

#### Section 124 – Powers of Territorial Authorities

If a building is found to be earthquake prone, the territorial authority has the power under section 124 of the Building Act to require strengthening work to be carried out, or to close the building and prevent occupancy.

#### Section 131 – Earthquake Prone Building Policy

Section 131 of the Building Act requires all territorial authorities to adopt a specific policy on dangerous, earthquake prone, and unsanitary buildings.

### 2.2 BUILDING CODE

The Building Act requires all new building work to comply with the New Zealand Building Code [2] which outlines the performance standards required for new building work. The Department of Building and Housing also publishes Compliance Documents which may be used to establish compliance with the Building Code.

Following the Lyttelton Earthquake, an amendment to the Compliance Document B1 Structure was published on the 19<sup>th</sup> May, 2011. This amendment contained changes to the seismic design loads for Canterbury including:-

- 36% increase in the basic seismic design load (Z) for Christchurch (new Z=0.3)
- 85% increase in the basic seismic design load (Z) for Akaroa (new Z=0.3)
- Increased serviceability limitations for new buildings

As a result, a building constructed last year to comply with the Building Code could now have a capacity of just 73% of the new load levels.

## 2.3 CHRISTCHURCH CITY COUNCIL POLICY

In 2006 the Christchurch City Council (CCC) adopted their Earthquake-Prone, Dangerous and Insanitary Building Policy [3], which was subsequently amended (under urgency) following the 4<sup>th</sup> September 2010 Darfield Earthquake.

The 2010 amendment outlines a process of identifying Earthquake Prone Buildings due to commence from 1 July 2012. Owners of Earthquake Prone Buildings identified through this process would have between 15-30 years to strengthen the building to a target of 67% of current code as outlined in Section 2.3.3.

### Section 2.3.3 – Taking Action on Earthquake-prone Buildings

... As noted in section 2.3.1 of this Policy, the Council will determine the level of strengthening required to reduce or remove the danger on a building-by-building basis. It will be guided by the Recommendations of the New Zealand Society of Earthquake Engineers that 67% of Full Code Levels is a reasonable target level of strengthening to reduce the risk posed by existing buildings...

The CCC's 2010 policy also includes the following section covering the repair of buildings damaged by an earthquake:

### Section 2.3.6 – Buildings Damaged by an Earthquake

Buildings may suffer damage in a seismic event. Applications for a building consent for repairs will be required to ensure structural strength. The Council will follow sections 2.3.1 and 2.3.3 of this Policy in determining the level of strengthening required for each building.

If a building consent application for repairs is not made and/or the repair work is not completed within a timeframe that the Council considers reasonable the Council reserves the right to serve notice under section 124(1) of the Building Act 2004 to require the work to be done.

The judgement of a recent case before the High Court of New Zealand (CIV 2012-409-2444 [2013] NZHC 51) states that "...territorial authorities may not use section 124 notices to advance a policy of increasing building capacity to a level above 34% of the NBS. However, they are not prevented from requiring work to reduce or remove specific vulnerabilities capable of causing injury, death or property damage where the subject building is also under 34% of the NBS"

While strengthening earthquake prone buildings to levels above 34% is desirable and recommended, this judgement indicates that the Christchurch City Council does not have the authority to require earthquake prone buildings to be strengthened beyond 34% of the NBS.

## 2.4 CANTERBURY EARTHQUAKE RECOVERY AUTHORITY (CERA)

The Canterbury Earthquake Recovery Authority (CERA) was established on 28<sup>th</sup> March, 2011 to take responsibility for the recovery of Christchurch by means of the Canterbury Earthquake Recovery Act 2011 [4] which was passed on 18 April, 2011. Under this act, the CEO (of the Canterbury Earthquake Recovery Agency, CERA) has wide powers in respect of verifying building safety and requiring demolition or repairs. Particularly relevant sections are;

### Section 38 – Works

- (4) If the chief executive gives written notice to an owner of a building, structure, or other erection on or under land that demolition work is to be carried out there, -
  - (a) the owner must give notice to the chief executive within 10 days after the chief executive's notice is given stating whether or not the owner intends to carry out the works and, if the owner intends to do so, specifying a time within which the works will be carried out; and
  - (b) if the owner fails to give notice under paragraph (a) or the chief executive is not satisfied with the time specified, or the works are not carried out in the time specified or otherwise agreed, then –
    - (i) the chief executive may commission the carrying out of the works; and
    - (ii) in the case of the demolition of a building to which section 40(1) or (2) refers, the chief executive may recover the costs of carrying out the work from the owner of the dangerous building in question; and
    - (iii) the amount recoverable becomes a charge on the land on which the work was carried out.

### Section 51 – Requiring Structural Survey

The chief executive may require any owner, insurer, or mortgagee of a building that he or she considers has or may have experienced structural change in the Canterbury earthquakes to carry out a full structural survey of the building before it is re-occupied for business or accommodation by the owner, a tenant, or any member of the public.

With regard to Section 51, we understand that it is likely that CERA will require a detailed engineering evaluation to be carried out for all buildings not exempt from the Earthquake Prone Building Legislation. At this stage it is not clear whether the detailed evaluation will be required prior to re-occupation.

CERA has recently published a draft procedure for the detailed engineering evaluation. Depending on the outcome of an initial qualitative assessment for a building, a further detailed quantitative assessment may be required. In addition to repair of earthquake damage, strengthening may be required in order to achieve compliance with the performance levels outlined in this evaluation procedure.

Typically the evaluation procedure defaults to achieving the minimum standard set out by the Earthquake Prone Building legislation, which has generally been accepted as achieving an ultimate limit state capacity equivalent to at least 33% current code.

### 3. PRE-EARTHQUAKE BUILDING CONDITION



This section discusses the form and capacity of the building prior to the Canterbury Earthquakes. The Sheer Adventures Workshop building at 78 Byron Street was constructed in two different time periods. The main structure was constructed in the 1960's with an addition along the eastern side of the building constructed in 1988. The original structural design for the 1988 addition was completed by Buchanan and Fletcher Ltd. Designers of the 1960's section are unknown. The street facing side of the structure is shown in Figure 3-1.

The information available for the review included the structural drawings for the eastern addition. Construction documents for the original warehouse structure were not available. A geotechnical assessment has not been conducted for this site at the time of this report.



Figure 3-1: Sheer Adventure Workshop – 78 Byron St

#### 3.1 BUILDING FORM

The Sheer Adventure Workshop overall building footprint is approximately 28 m by 26 m. The building is composed of two sections built in separate time periods. The building is located adjacent to buildings on its eastern and southern elevations. The building is structurally separate from the neighbouring buildings. There may be some small separation gap between the buildings, however existing external façade elements and internal linings prevented the

direct observation of the gap. There was originally a link (door opening) between the eastern addition and the building to the south. This has since been filled in with a fire rated concrete block wall. The block wall appears to be attached to the southern building and separated from this building. The overall building footprint is illustrated in Figure 3-2.

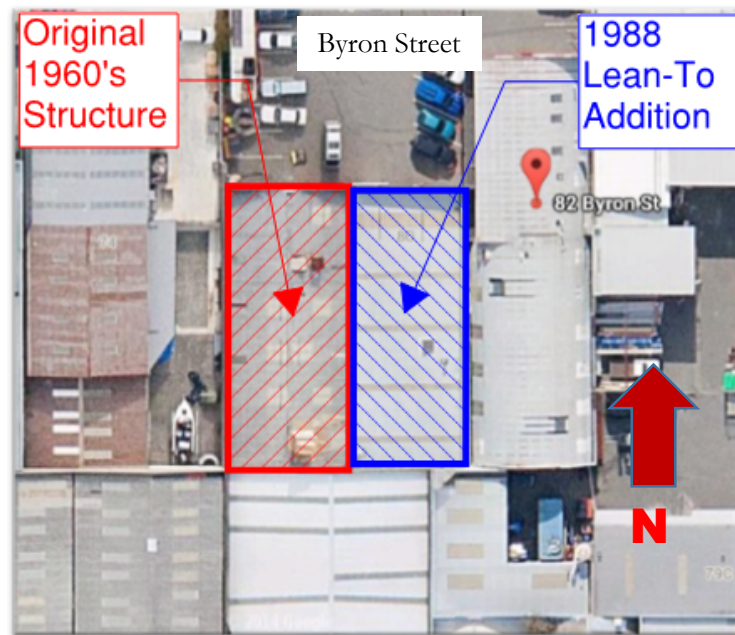


Figure 3-2: Sheer Adventure Workshop – Original Structure and Eastern Addition

The original structure, the western section, was designed and constructed in the 1960's (Figures 3-3 and 3-4). The building was likely designed to predecessor standards of the current NZ Building Code, comprising principally NZS1900:1965. The building is a single story structure, with an internal timber framed mezzanine at the north end of the building. The structure is an open warehouse with steel portal frames running across the building in the east-west direction. The portal frames are composed of I-sections with the columns encased in concrete. Infill walls around the west, south, and original 1960's eastern perimeter of the building are constructed of ungrouted concrete blockwork. There is a solid bond beam along the top of these walls that appears to be reinforced concrete. The roof is composed of diagonal sarking on timber framing with numerous skylights. There is no foundation information available to review however given the type of building and damage observed, the likely construction is concrete slab on grade with shallow pads under portal legs and shallow strip foundations under the walls.

The lean-to addition, the eastern section, was designed and constructed in 1988 (Figures 3-3 and 3-5). This addition was likely designed to the NZS4203 (1984) loadings standard. The structure consists of glulam cantilevered L-shaped frames which span in the east-west direction and are pinned to the original structure's reinforced concrete bond beam. The roof is composed of light gage metal roofing and insulation supported by timber purlins. The south, north, and east walls are composed of light timber framing. A connection doorway to the building adjacent to the south wall has been in-filled with a grout filled concrete block wall. The wall appears to be tied into the structural concrete blockwork walls of the adjacent structure, and are therefore not a part of this building. There is a short height timber framed mezzanine at the north end.

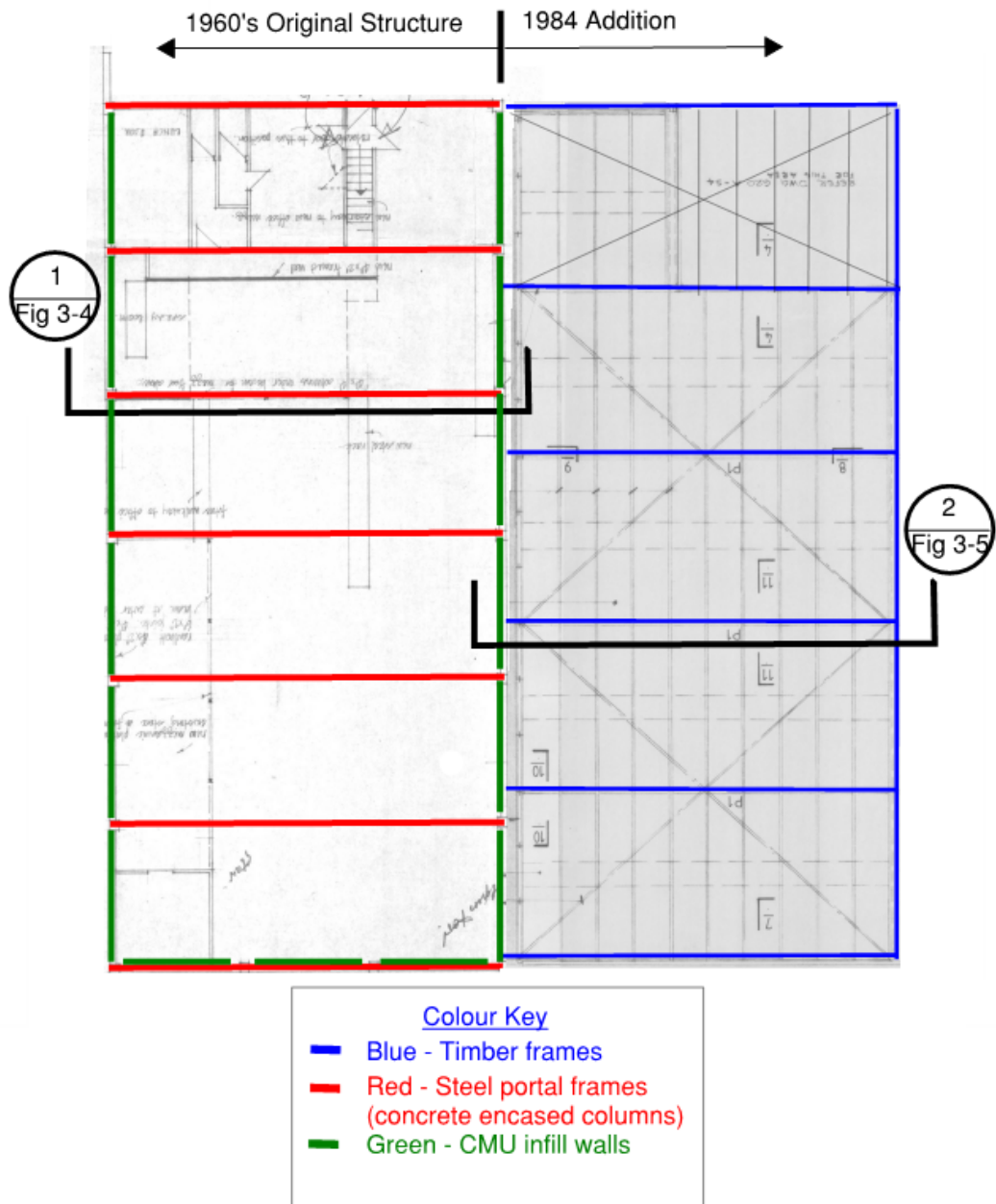


Figure 3-3: Sheer Adventure Workshop – Plan View of Building

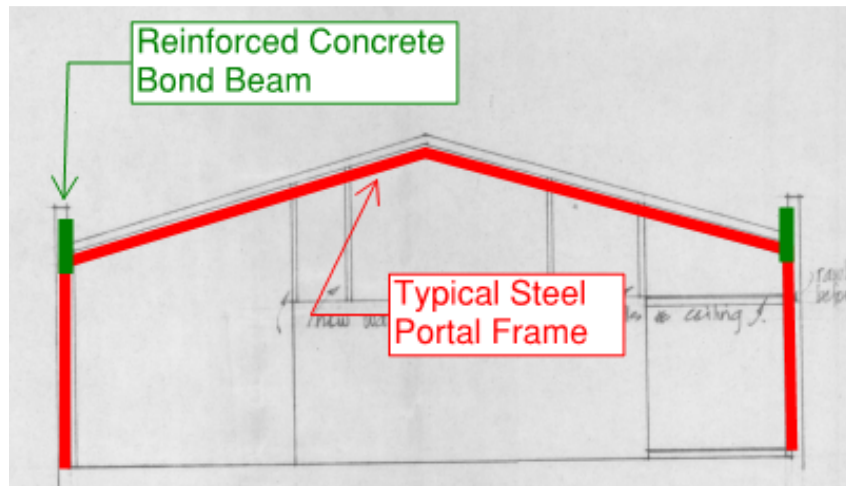


Figure 3-4: Section 1 - 1960's Original Steel Building Cross Section

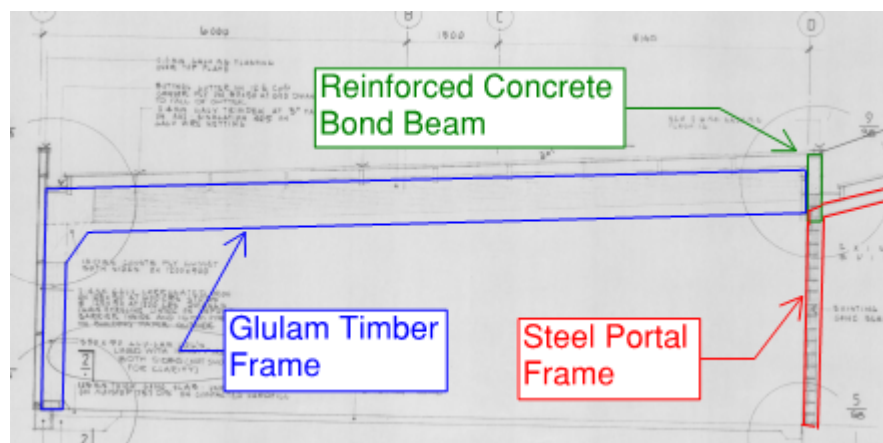


Figure 3-5: Section 2 - 1980's Eastern Addition

### 3.2 LATERAL LOAD RESISTING SYSTEM

In the east-west (across) direction lateral loads for the original structure at the roof level are distributed by the diagonal timber sarking and are resisted, typically, by the steel portal frames. Lateral loads at the roof level from the eastern lean-to addition are distributed to the timber glulam frames via the purlins. The lateral loads from the walls are transferred directly to the timber glulam frames. The timber glulam frames in the addition and the original steel portal frames are connected by the concrete bond beam of the original structure. The timber glulam frames and original steel portal frames are offset, as shown in Figure 3-3. Lateral loads are resisted by a combination of frame action in the glulam frame and the steel portal frames.

In the north-south direction in the original structure, lateral loads at the roof level are distributed by diagonal timber sarking to the reinforced concrete bond beam and resisted by the ungrouted concrete block infill walls between the portal frames. Lateral loads at the roof level of the lean-to addition are distributed by tension only steel strap bracing to the gib lined timber wall along the western edge of the building and to the reinforced concrete bond beam in the centre of the building. Lateral loads are resisted by the gib lined timber perimeter wall and the ungrouted concrete block infill walls below the reinforced concrete bond beam.



### 3.3 PRE-EARTHQUAKE BUILDING CAPACITY – DIRECT CODE COMPARISON

The original structure, the western building, was likely designed to the NZS1900:1965 loadings standard. The eastern addition, constructed in 1988, was likely designed to the NZS4203 (1984) loadings standard. Both standards have been replaced by NZS1170.5:2004 [8]. The recent amendment to the Building Code has further increased the load levels defined in NZS1170.

Based upon building occupancy, the Sheer Adventures Workshop has been considered as an Importance Level 2 (IL2) building in accordance with NZS1170.5:2004 [8]. For a building design life of 50 years, the associated return period of the Design Base Earthquake (DBE) is 500 years. Per the loadings standard for a warehouse structure as prescribed in this code (no post-disaster or special function), the risk factor for design is taken as  $R=1.0$ . The sub soil for the entire site has been assumed to be Soil Type D in accordance with NZS1170, which is typical of this location in Christchurch. The fundamental period of the structure was assumed to be 0.4s for out-of-plane and in-plane ungrouted concrete block walls. The fundamental period of the steel portal frame with lean-to frame addition was estimated with the Raleigh method to be approximately 1.0s.

Based upon the information available, we have assumed the following levels of ductility:

- in-plane lateral loads for frames – nominally ductile,  $\mu=1.25$
- in-plane lateral loads for ungrouted concrete block walls – elastic,  $\mu=1.0$
- Out-of-plane lateral loads for ungrouted concrete block walls – elastic,  $\mu=1.0$

Comparisons of the load levels represented by the original loading standards to the current loading standard are plotted below for a building fundamental period of 0.4s. The seismic design loads from NZS1900:1965 are approximately 15% of current design loads. Seismic loads from NZS4203(1984) are approximately 35% of current design loads.

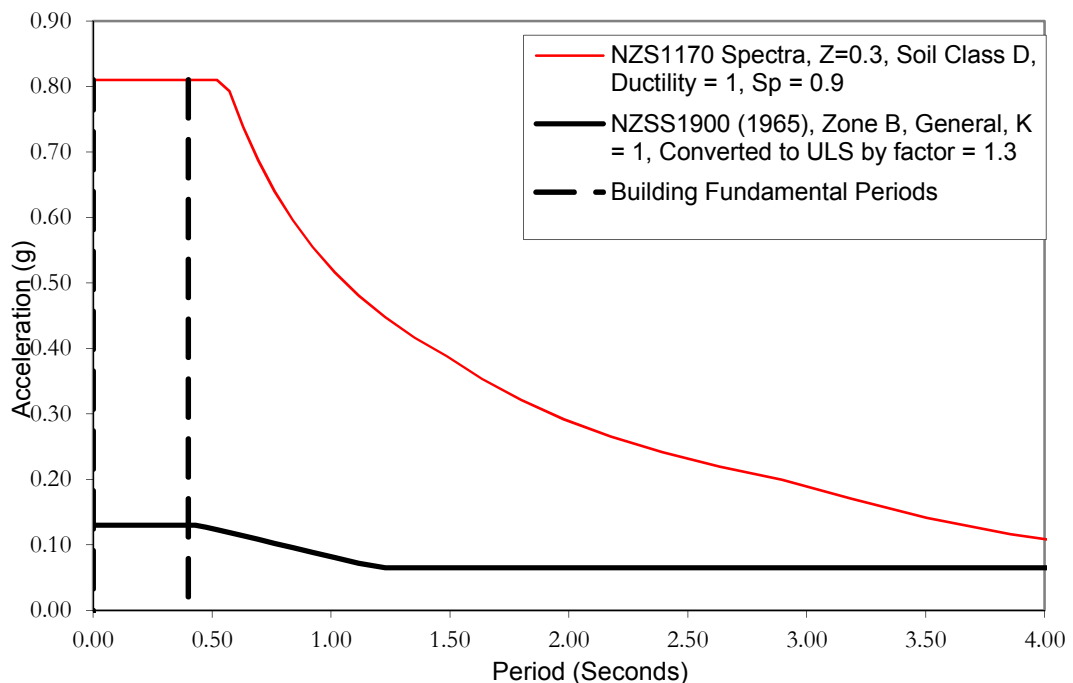


Figure 3-6: Comparison of Design Codes (NZSS1900 to NZS1170)



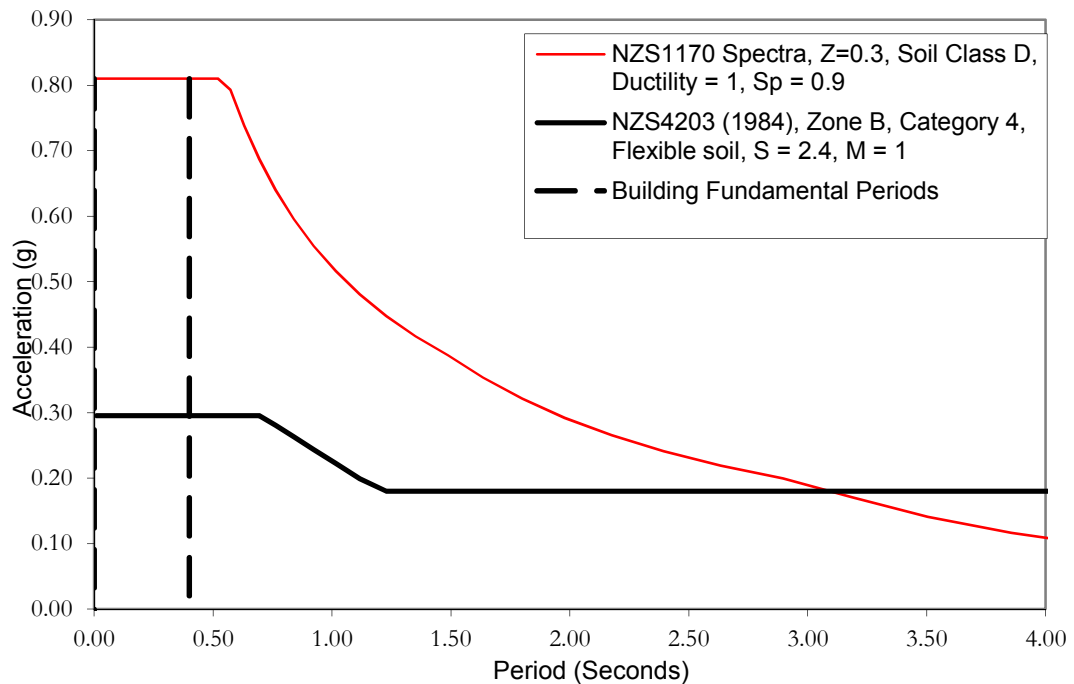


Figure 3-7: Comparison of Design Codes (NZS4203 to NZS1170)

### 3.4 PRE-EARTHQUAKE BUILDING CAPACITY – EQUIVALENT STATIC ANALYSIS TO NZS1170.5 (2004)

In addition to the direct code comparison provided above, an equivalent static analysis to NZS1170.5:2004 has been carried out to gain a better understanding of the buildings capacity when compared to current loading standards. The equivalent static analysis was carried out based upon the original construction documents available, incorporating on-site measurements and as-built observations.

The probable capacities have been calculated using the *New Zealand Society for Earthquake Engineering Guidelines for the Assessment of the Structural Performance of Buildings in Earthquakes* – NZSEE 2006 [13]. The guidelines allow some relaxation of the requirements for existing buildings when compared to what would be required for a new building. As a result existing buildings shown to achieve 100% of current code loading may not achieve the same level of seismic performance as a new building designed to achieve minimum compliance with the building code.

Account is also made of critical structural weaknesses. Critical structural weaknesses (CSW) are details, configurations, and building or site characteristics that could lead to increased damage levels in a building or the premature failure or collapse of all or part of a building.

To provide a comparison for each of the primary lateral components, the relative capacity of the elements have been assessed as a percentage of the demand imposed by the current loading code Design Basis Earthquake, and have been expressed as a %DBE. This includes checks for both strength and deflection requirements.

The demand on the various structural elements of the system were determined by performing a three dimensional analysis on the main framing elements. A three-dimensional model was constructed and analysed in an analysis program based on information contained on the available construction drawings and from on-site measurements. Based on the time period and

type of building construction, some fixity in the portal frame foundations was assumed in the model.

To determine the design loads imposed by the current loading standard, the building natural periods were estimated to be 0.4s in the north-south direction and approximately 1.0s in the east-west direction. The fundamental period in the east-west direction was determined using the Raleigh Method described in the loading standard. From the structure's natural period and ductility, as listed in Section 3.3, the loading demand imposed by the current standard was determined and applied to the analysis model. The demand on the various structural components was obtained from the analysis results and compared to the calculated capacities to determine the %DBE of each element.

The calculated seismic capacity in the east-west direction of the Sheer Adventures Workshop is approximately 35% DBE. The limiting elements in the structure are the east-west steel and glulam portal frames. The table below outlines the capacities of various elements in the structure.

The limiting factor in the north-south direction for the capacity of the Sheer Adventures workshop is the central ungrouted concrete block work infill walls which are at 70% DBE and limited by sliding shear of the infill walls.

Due to the flexible nature of the portal frames, large deflections are likely to occur, especially in at the western edge of the building. If the seismic gap with the adjacent building is insufficient, pounding is likely to occur.

To the north of the western concrete masonry wall of the original warehouse structure there is an extension of the concrete masonry block wall that appears to cantilever from the ground. There does not appear to be any dowel connection between the original wall and the extension. Assuming the wall is fully grouted with minimum reinforcement, the wall is at approximately 15% DBE and limited by out-of-plane loading.

Table 3-1: 78 Sheer Adventure Workshop – Seismic Assessment %DBE

| <b>Building Element</b>                                       | <b>%DBE (IL2)</b> | <b>Comments</b>                                                                         |
|---------------------------------------------------------------|-------------------|-----------------------------------------------------------------------------------------|
| Ceiling Diaphragm – NS<br>- EW                                | 100<br>100        | Diagonal sheathing in west side of building                                             |
| Ceiling Tension Strap Bracing                                 | 95                | Bracing is limited by tensile capacity                                                  |
| GluLam Portal Frames                                          | 35                | Glulam frame is limited by combined bending and axial loading in the column             |
| Steel Portal Frames                                           | 35                | Steel portal frame is limited by combined bending and axial loading in beam element     |
| Gib lined timber framed wall                                  | 70                | Capacity limited by nail slip                                                           |
| Concrete Bond Beam                                            | 50                | Capacity limited by out-of-plane flexural capacity due to assumed reinforcement layout. |
| UngROUTED concrete masonry block infill walls – in plane      | 70                | Capacity limited by sliding shear                                                       |
| UngROUTED Concrete masonry block infill walls – face loading. | 65                | Capacity is limited by south wall block wall spanning between ground and roof           |
| External Concrete Masonry Block wall – face loading           | 15                | Capacity is limited by moment capacity at base of cantilevered wall                     |



## 4. EARTHQUAKE EVALUATION

### 4.1 EARTHQUAKE SHAKING EXPERIENCED AT THE SITE

The Geonet Project, run by EQC and GNS Science, maintains the New Zealand National Seismograph Network which consists of a series of strong motion seismometers set up around New Zealand. The following image shows the location of the four closest monitoring stations to the building.

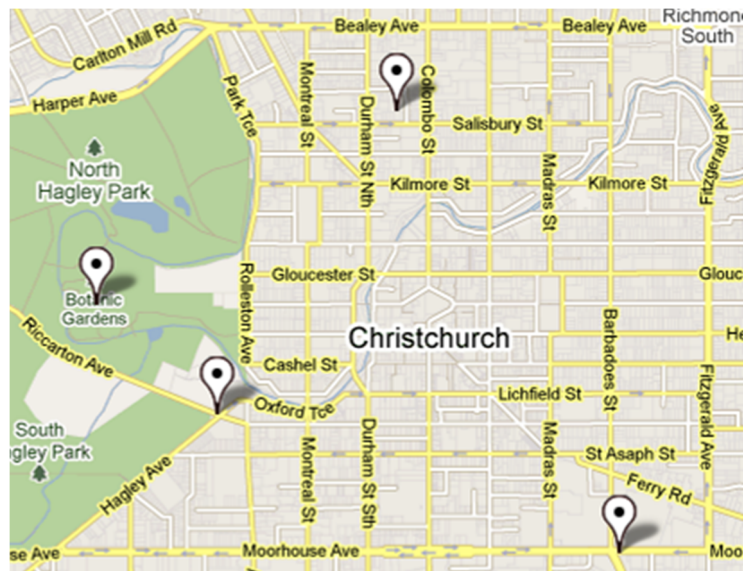


Figure 4-1: Location of Nearby Monitoring Stations

The strong motion shaking data resulting from the Darfield and the Lyttelton Earthquakes has been downloaded from these monitoring stations and processed to obtain acceleration response spectra (a response spectra essentially defines the peak response for a building subjected to the ground shaking, as a function of its fundamental period).

The accelerations recorded from the Lyttelton Earthquake are generally larger than those from the Darfield Earthquake, therefore these are presented and discussed in this section.

The following graphs plot the acceleration response spectra processed from the Geonet monitoring stations for the initial main shock of the Lyttelton Earthquake at 12:51pm on the 22<sup>nd</sup> February, as well as the elastic design spectra (NZS1170) for a new building constructed on the site. For reference the fundamental period of the building has been plotted on the graphs of the North-South and West-East directions respectively.

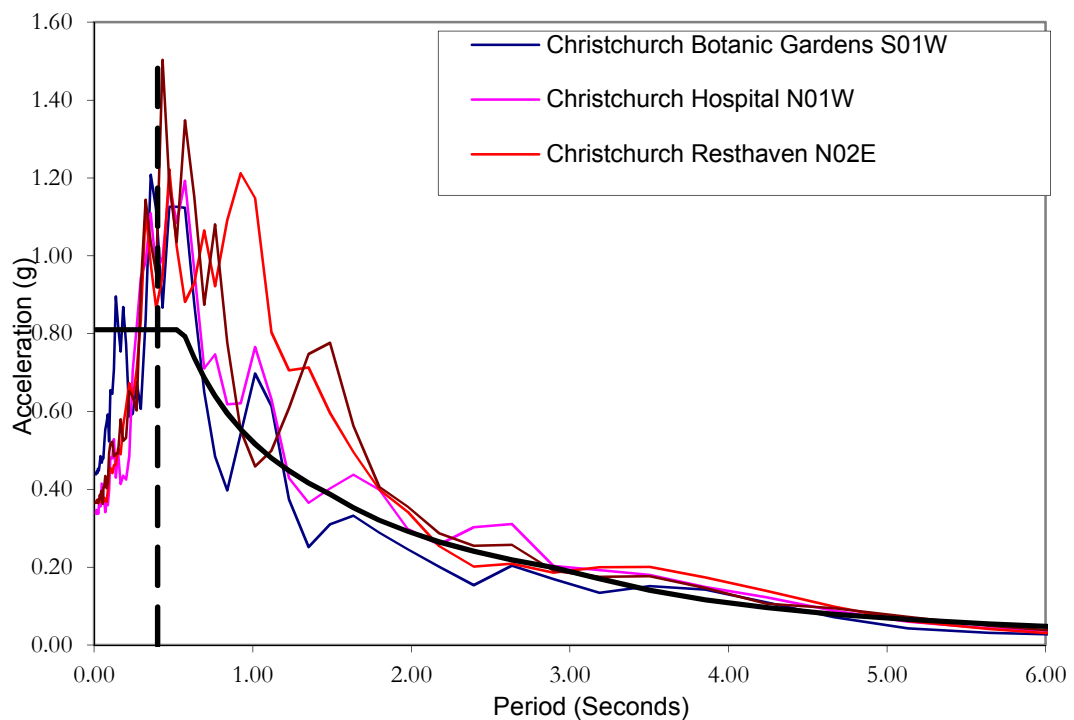


Figure 4-2: 5% Damped Spectra – North-South

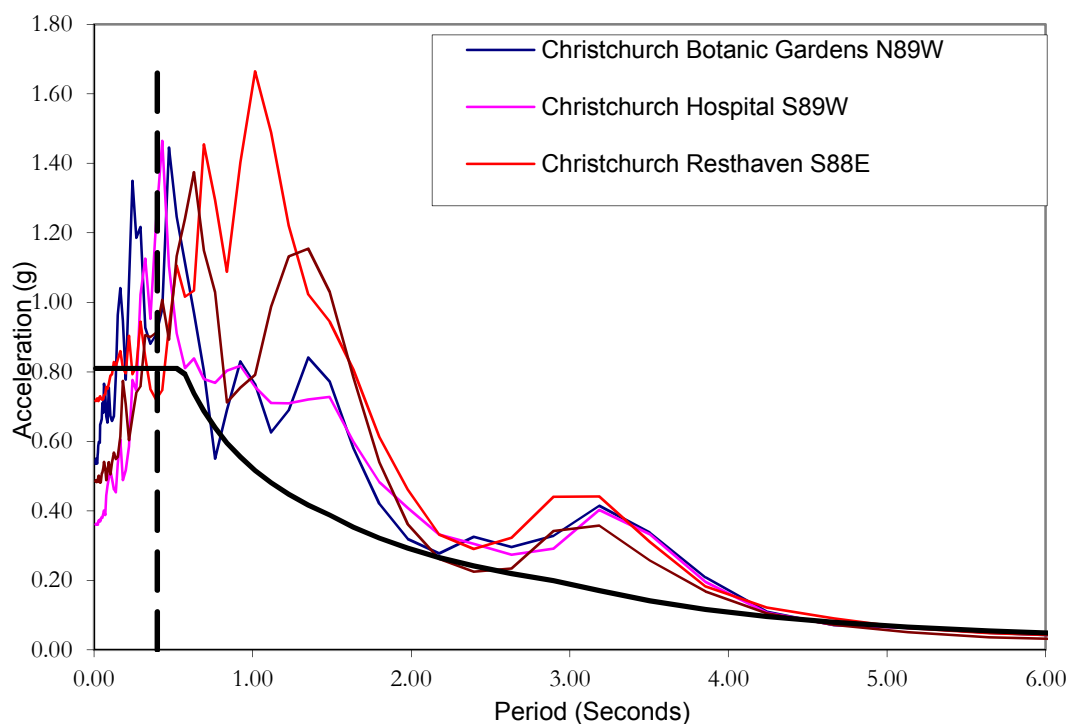


Figure 4-3: 5% Damped Spectra – East-West

It is apparent that in both directions there is significant variation in the shaking experienced at the different monitoring sites. This is due to the highly variable ground conditions around Christchurch.

The Shear Adventure Workshop building has been determined to have a fundamental period to less than 0.4 seconds (north-south) and (east-west). Based on the strong motion data downloaded, it is likely that the earthquake produced accelerations significantly in excess of the design spectra for this building.

Modern office buildings, typically designed to an importance level of 2 (IL2), are designed to resist an earthquake with a return period of 500 years at the Ultimate Limit State (ULS). The magnitude of the ground accelerations recorded in the CBD are in the order of 150% to 200% of the current design code at the time of the earthquake, and are some of the strongest ever recorded in the world. This intensity of shaking is roughly equivalent to an earthquake in Christchurch having a return period of 2500 years, deemed to be the Maximum Credible Event (MCE). At this level of shaking, modern buildings designed to the current codes in place at the time are expected to be at the point of collapse.

However it should also be noted that this earthquake was relatively short in terms of the strong shaking produced. The following plot of the earthquake record from the Christchurch Hospital monitoring station at 12:51 pm on the 22<sup>nd</sup> of February shows that the strong motion only lasted for a duration of approximately 5-10 seconds.

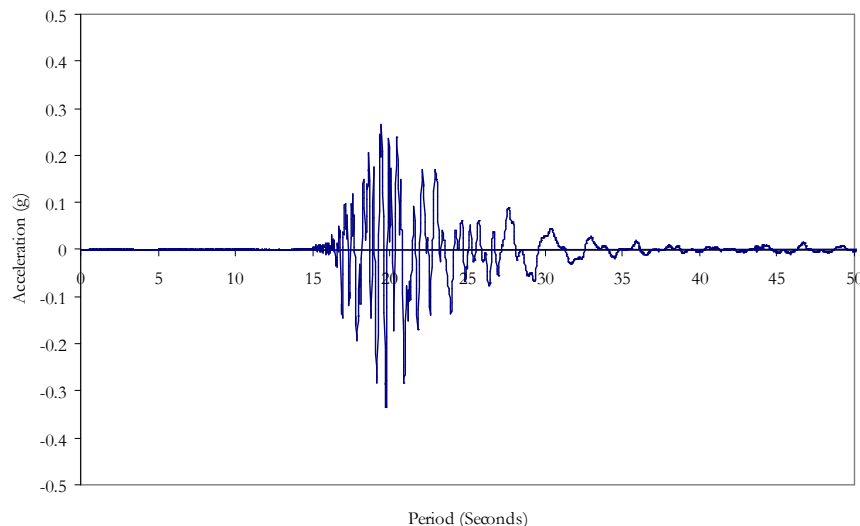


Figure 4-4: Earthquake Record from Christchurch Hospital Site

Because of this the building has only gone through a limited number of inelastic cycles. A full design earthquake for Christchurch (eg rupture of the Alpine Fault) is expected to have a significantly longer record of shaking, although the accelerations are not expected to be as strong. As an indication, rupture of the Alpine Fault is expected to contain in excess of 60 seconds of strong motion.

Due to the highly variable ground conditions around Christchurch, it is impossible to determine what the actual shaking experienced at the site was. However, based on the data described above it is likely that the shaking experienced by the building could have exceeded the current code design spectra for the building

## 4.2 PRELIMINARY INVESTIGATIONS

Preliminary investigations have been undertaken to ascertain areas of the building likely to be subject to damage, and therefore requiring specific attention during the detailed assessment. The areas identified for detailed inspection have been selected based on:-

- typical damage expected for buildings of this form;
- a review of the original drawings [6];
- review work undertaken to date;
- damage observed following the earthquakes.

In conjunction with a review of the structural drawings and previous damage review associated with this building the following areas were identified for potential damage:-

- Cracking of concrete block work wall mortar joints
- Distress at portal frame moment connections
- Differential settlement and lateral spreading of slab on grade
- Differential settlement and lateral spreading of walls and foundations

#### 4.3 SUMMARY OF BUILDING DAMAGE

The following is a summary of the structural damage observed.

- In plane diagonal cracking along concrete block wall mortar joints
- Cracking along slab construction joints
- Differential settlement and lateral spreading of slab on grade
- Out of vertical walls at central block work wall and southern wall of eastern structure
- Broken tension only strap cross bracing in eastern structure

#### 4.4 FURTHER INVESTIGATIONS REQUIRED

No geotechnical information is available for the building site. A geotechnical report should be completed to assess the ground conditions at the site.

Destructive investigations should be conducted to examine the condition of the steel portal frame beam to column connections ensure no damage occurred.

The connection between the reinforced bond beam and the steel portal frames as well as the steel portal frame foundations should be exposed and observed to confirm analysis assumptions.



## 5. DAMAGE OBSERVED & REPAIRS REQUIRED

### 5.1 TYPICAL DAMAGE OBSERVED & REPAIRS REQUIRED

Table 5-1 provides a photographic summary of the observed damage and typical repairs required. The table should be read in conjunction with Appendix A – Damage Photo Location Map and Appendix B – Record of Observations. The Repair Specification is attached in Appendix D.

Generally the aim of the repair work indicated is to restore the structure to its pre-earthquake state as far as practicable. Specifically the repair work described herein does not include the strengthening required to comply with the relevant regulations outlined in Section 2. It should be noted that more damage may be identified during the repair works and (if required) additional repair details will be specified accordingly.

The damage outlined herein does not include the necessary repair or replacement of architectural items, services, etc, or the removal of such items necessary to carry out structural observations. We recommend appropriate professionals be engaged to carry out scoping of these non-structural works.



Table 5-1: 78 Sheer Adventure Workshop - Photographic Summary of Primary Damage Observed & Repairs Required

| Damaged Item                                            | Location                           | Example                                                                             | Recommended Repair                                                                                                       |
|---------------------------------------------------------|------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1. Slab on Grade                                        |                                    |                                                                                     |                                                                                                                          |
| 1.1. Cracking and spreading at slab construction joints | South section of eastern structure |   | Chase channels each side of crack and install dowels across crack to prevent future lateral spreading of slab.           |
| 1.2. Differential settlement of slab                    | South section of eastern structure |  | Remove section of slab that has lifted. Re-level ground. Install new slab with epoxy dowels into adjacent slab sections. |

| Damaged Item                                                              | Location                                                                                       | Example                                                                             | Recommended Repair                                                                                                       |
|---------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.3. Differential settlement of slab                                      | Southern wall at internal wall junction with slab in eastern structure.                        |   | Remove section of slab that has lifted. Re-level ground. Install new slab with epoxy dowels into adjacent slab sections. |
| 2. Concrete Block Infill Walls                                            |                                                                                                |                                                                                     |                                                                                                                          |
| 2.1. Diagonal cracking along mortar joints in concrete block infill walls | Occurs along the west, south, and east walls of the original factory building (west structure) |  | Repair and repoint all mortar joint cracks from both the inside and outer faces.                                         |

| Damaged Item                                                                                   | Location                                                    | Example                                                                             | Recommended Repair                                                                                                                                                         |
|------------------------------------------------------------------------------------------------|-------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.2. Vertical cracking in concrete block work wall                                             | Occurs in north section of west wall                        |   | Remove and replace cracked concrete blocks. Repair and repoint cracked mortar joints.                                                                                      |
| 2.3. External concrete block wing wall extension has moved creating a gap in the upper portion | External concrete wing wall at northwest corner of building |  | Remove wing-wall extension or strengthen for face loads. Provide temporary propping while the fire requirements are confirmed and the solution for the wall is determined. |

| Damaged Item                                                           | Location                                              | Example                                                                             | Recommended Repair                                                                                                                                                            |
|------------------------------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. Western structure portal frames                                     |                                                       |                                                                                     |                                                                                                                                                                               |
| 3.1. Cracking and spalling of concrete column to steel beam connection | Top of west portal frame column at west boundary wall |   | Remove concrete and observe beam to column connection to ensure no signs of distress. If no signs of distress, repair concrete encasement of column per repair specification. |
| 3.2. Cracking and spalling of concrete column at slab level            | Occurs at several locations in the western structure  |   | Remove concrete and observe column at base to ensure no signs of distress. If no signs of distress, repair concrete encasement of column per repair specification.            |
| 4. Roof                                                                |                                                       |                                                                                     |                                                                                                                                                                               |
| 4.1. Broken roof tension strap                                         | Eastern structure                                     |  | Replace broken strapping. Refer to Section 5.2.                                                                                                                               |

## 5.2 ROOF TENSION STRAP CROSS BRACING

In the eastern lean-to addition, a roof tension strap cross bracing member has failed in tension and snapped apart. This is likely due to the difference in stiffness of the eastern gib lined timber framed wall and the internal concrete blockwork infill walls. As determined in section 3, the capacity of the tension strap bracing is at 95% DBE.

The strap brace should be replaced. To improve the performance of the structure in future seismic events, the gib wall along the eastern boundary should be stiffened with additional bracing or additional strap bracing should be installed.

## 5.3 NORTHWEST WING WALL

In the northwest corner of the original 1960's warehouse structure, a concrete masonry block wall wing wall extension has, at some point, been added along the western boundary wall. This wall does not appear to be tied to the original wall or concrete bond beam and cantilevers from ground level. The out-of-plane capacity of the wall is 15% DBE. There are signs of lateral movement at the base of the wall and along the joint with the original wing wall end.

The wall extension may have been installed due to fire requirements. Temporarily prop the wall until the fire requirements are investigated and a strengthening solution can be determined.

## 5.4 DIFFERENTIAL SETTLEMENT REMEDIATION

In addition to the damage and repairs outlined in Table 5-1, differential settlement of the slab and foundations was identified onsite and in the levels survey. From the levels survey, the slab-on-grade and walls appear to have settled in the earthquake. The general pattern of settlement inside the western half of the building is settlement of the external wall foundations relative to the internal slab causing bowing in the slab. This is likely due to the heavier loads carried by the perimeter walls. The differential settlement along the wall foundations is typically less than 20mm. The differential settlement between the slab and the wall foundations is generally 35 mm or less. There is a high spot in the centre of the western half of the building.

In the eastern half of the building, settlement was generally relatively even throughout the interior with low spots at the south and north ends of the building. This is likely due to the light weight timber construction of the addition.

Slopes, throughout the building, are typically around 0.50% (1:200). In a localised area towards the south of the eastern lean-to addition, the slope is approximately 0.8% (1:130). Near this location, the slab has cracked along a construction joint. The differential settlement across the construction joint is approximately 10 mm.

### 5.4.1 Repair Work to Return the Building to Original Level

Based on these observations, the settlements affecting the foundations and walls may be acceptable and not require re-levelling. The bowing in the ground floor slab can be addressed by locally demolishing and replacing the existing slab-on-grade. The areas of slab to be replaced include the southern end of both the western and eastern parts of the building as well as the northern area of the eastern half of the building. Refer to Appendix C for the extent of slab replacement.

The existing slab-on-grade to be demolished should be replaced with a new 125mm slab on DPM on sand binding on 150 mm of compacted hard fill. Allow for reinforcing in the slab of 12mm diameter deformed reinforcing bars at 300mm centres each way. The demolition is to

be such that the dowels connecting the foundation beam to the slab remain in place and are cast into the new slab. Allow to epoxy inject D12 starters at 300 mm into the existing slab and foundations around the perimeter of the new slab.

Note that this option will return the structure to its pre-earthquake level and lateral capacity, but does not address the mitigation or prevention of differential settlements occurring in future seismic events. Differential settlements could reduce the lateral capacity of the structure. However, as indicated above, there has not been significant differential settlement between existing foundations in recent events. The mitigation of future differential settlement should be considered in any future strengthening scheme.



## 6. POST-EARTHQUAKE BUILDING CAPACITY

### 6.1 POST-EARTHQUAKE BUILDING CAPACITY

In its damaged state following the earthquakes, we consider the Sheer Adventures workshop to have no reduction in gravity load resistance. The overall lateral load resisting capacity of the building in the north-south direction has been affected due to the snapping of the eastern roof tension strap bracing and due to diagonal cracking along the mortar joints of the ungrouted concrete blockwork infill walls. The roof tension strap bracing that has snapped has reduced the roof bracing capacity from 95% to 75% DBE. Diagonal cracking along the mortar joints of the concrete blockwork walls has reduced the lateral load resisting capacity of the walls to approximately 35% DBE. This has been determined by considering the blockwork infill wall panels that remain uncracked as well as accounting for some contributions to capacity from the damaged walls per NZSEE 2006. Distribution via the reinforced concrete bond beam of the lateral loads to undamaged infill wall segments is likely to occur.

The overall lateral load resisting capacity of the building in the east-west direction has not been significantly reduced due to the damage observed after the earthquakes.

Following the recommended repair of the structural damage, the lateral load resisting performance of the structure will be restored. The capacity of the primary structural system in the east-west direction will be approximately 35% of DBE and in the north-south direction will be 75% DBE.

Following the recommended repair of the consequential damage the durability performance of the structure should be restored. However this should continue to be monitored throughout the life of the building to ensure that the sealants are maintained to prevent moisture penetration, and that any future cracking is repaired.



## 7. REFERENCES

- 1 *Building Act 2004*, New Zealand Government
- 2 *New Zealand Building Code*, New Zealand Government
- 3 *Earthquake-Prone Dangerous and Insanitary Buildings Policy 2010*, Christchurch City Council, 2010
- 4 *The Canterbury Earthquake Recovery Act 2011*
- 5 78-82 Byron Street – EQ Damage and Repair, Structex, September 2013
- 6 Temporary Warehouse 82 Byron St Christchurch, Holmes, Wood & Poole, April 1975
- 7 Survey Report for Building Survey at 78 & 82 Byron St, Christchurch, Staig & Smith, August 2013
- 8 *Structural Design Actions part 5: Earthquake Actions – New Zealand*, NZS 1170.5:2004, Standards New Zealand, 2004
- 9 *Timber Framed Buildings*, NZS 3604:2011, Standards New Zealand, 2011
- 10 *Steel Structures Standard*, NZS 3404:1997, Standards New Zealand, 1997
- 11 *Timber Structures Standard*, NZS 3603:1993, Standards New Zealand 1993
- 12 *Design of Reinforced Concrete Masonry Structures*, NZS 4230:2004, Standards New Zealand, 2004
- 13 *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*, NZSEE-2006, New Zealand Society for Earthquake engineering, 2006





# APPENDIX A

Damage Map



Project Name: *78 Byron Street DEE Building A*

Project No: *111702*

Calcs By: *DJH*

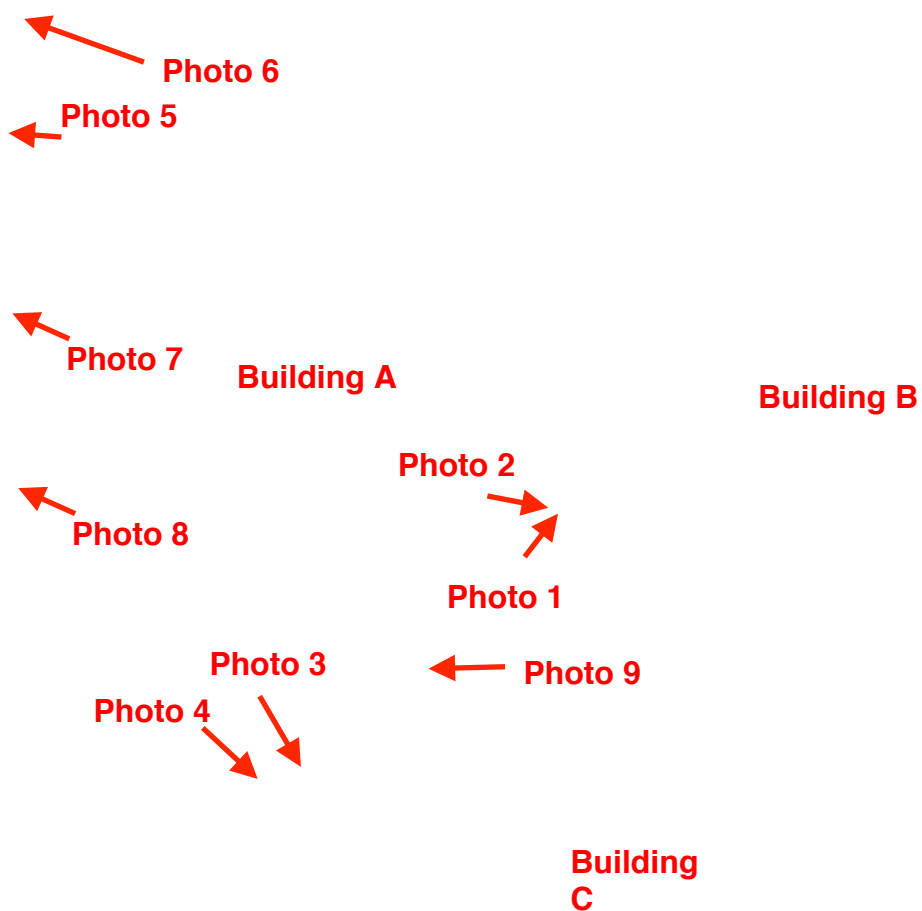
Date: *24/06/14*

Sketch No: *APA-SK01*

Page No: *1*

Revision: *1*

CALCS / SKETCHES



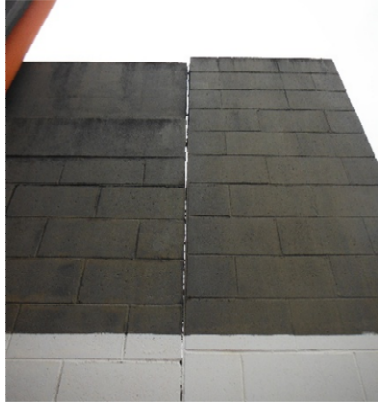


# APPENDIX B

Record of Observations

| Damaged Item                                            | Location                                                                 | Example                                                                             | Recommended Repair                                                                                                       |
|---------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1. Slab on Grade                                        |                                                                          |                                                                                     |                                                                                                                          |
| 1.1. Cracking and spreading at slab construction joints | <p>South section of eastern structure</p> <p>See damage map photo 1.</p> |   | Chase channels each side of crack and install dowels across crack to prevent future lateral spreading of slab.           |
| 1.2. Differential settlement of slab                    | <p>South section of eastern structure</p> <p>See damage map photo 2.</p> |  | Remove section of slab that has lifted. Re-level ground. Install new slab with epoxy dowels into adjacent slab sections. |

| Damaged Item                                                              | Location                                                                                                                      | Example                                                                             | Recommended Repair                                                                                                       |
|---------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------|
| 1.3. Differential settlement of slab                                      | Southern wall at internal wall junction with slab in eastern structure.<br><br>See damage map photo 3.                        |   | Remove section of slab that has lifted. Re-level ground. Install new slab with epoxy dowels into adjacent slab sections. |
| 2. Concrete Block Infill Walls                                            |                                                                                                                               |                                                                                     |                                                                                                                          |
| 2.1. Diagonal cracking along mortar joints in concrete block infill walls | Occurs along the west, south, and east walls of the original factory building (west structure)<br><br>See damage map photo 4. |  | Repair and repoint all mortar joint cracks from both the inside and outer faces.                                         |

| Damaged Item                                                                                   | Location                                                                                   | Example                                                                             | Recommended Repair                                                                                                                                                         |
|------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2.2. Vertical cracking in concrete block work wall                                             | Occurs in north section of west wall<br><br>See damage map photo 5.                        |   | Remove and replace cracked concrete blocks. Repair and repoint cracked mortar joints.                                                                                      |
| 2.3. External concrete block wing wall extension has moved creating a gap in the upper portion | External concrete wing wall at northwest corner of building<br><br>See damage map photo 6. |  | Remove wing-wall extension or strengthen for face loads. Provide temporary propping while the fire requirements are confirmed and the solution for the wall is determined. |

| Damaged Item                                                           | Location                                                                             | Example                                                                             | Recommended Repair                                                                                                                                                            |
|------------------------------------------------------------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3. Western structure portal frames                                     |                                                                                      |                                                                                     |                                                                                                                                                                               |
| 3.1. Cracking and spalling of concrete column to steel beam connection | Top of west portal frame column at west boundary wall<br><br>See damage map photo 7. |   | Remove concrete and observe beam to column connection to ensure no signs of distress. If no signs of distress, repair concrete encasement of column per repair specification. |
| 3.2. Cracking and spalling of concrete column at slab level            | Occurs at several locations in the western structure<br><br>See damage map photo 8.  |   | Remove concrete and observe column at base to ensure no signs of distress. If no signs of distress, repair concrete encasement of column per repair specification.            |
| 4. Roof                                                                |                                                                                      |                                                                                     |                                                                                                                                                                               |
| 4.1. Broken roof tension strap                                         | Eastern structure<br><br>See damage map photo 9.                                     |  | Replace broken strapping.                                                                                                                                                     |



# APPENDIX C

## Conceptual Repair Plan





Project Name: **78 Byron Street DEE - Building A**

Project No: **111702**

Calcs By: **DJH**

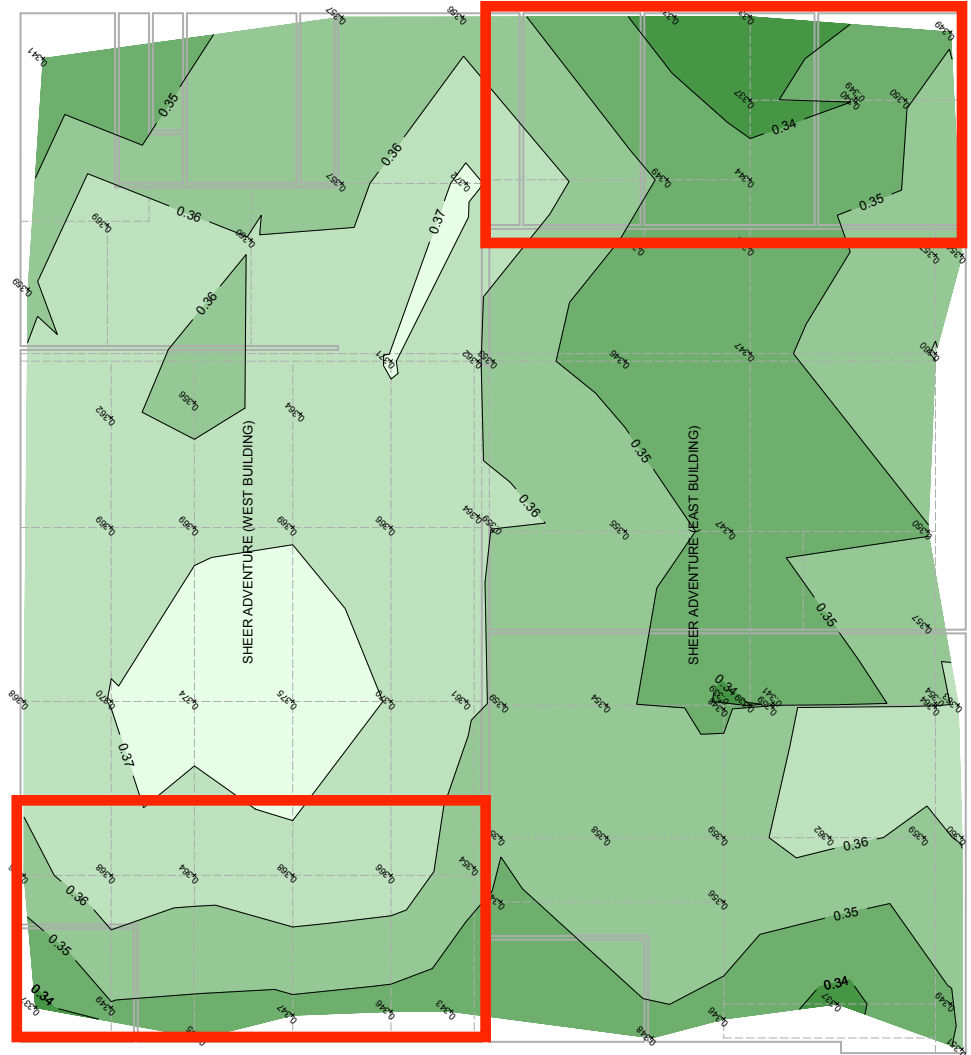
Date: **24/06/14**

Sketch No: **APC-SK01**

Page No: **1**

Revision: **1**

CALCS/SKETCHES



- Area of slab to be broken out and replaced with D12 starters epoxied into existing slab or foundations/walls to remain.



# APPENDIX D

Building Alignment Survey



## SURVEY REPORT FOR BUILDING SURVEY AT 78 & 82 BYRON ST, CHRISTCHURCH

### Introduction

Staic and Smith Ltd were engaged to carry out a survey of the buildings at 78 & 82 Byron St. The site comprises four individual buildings; the eastern and south-eastern buildings are tenanted by Socks Pacific and the two western buildings are tenanted by Sheer Adventure.



*Diagram of the buildings surveyed.*

The aim of the survey was to measure the building following the recent significant earthquakes in Christchurch.

The work involved surveying the following elements:

- Floor levels and gradients
- Internal column verticality

Following the survey, a set of plans have been prepared detailing the results from the survey.

### Methodology

The survey was carried out on the 28<sup>th</sup> and 29<sup>th</sup> August 2013.

#### Levels

Levels were surveyed with a Leica 150M Sprinter Digital Level (SN 2111297). This instrument has a measuring standard deviation of 0.6mm (electronic) and 1.2mm (optical) at 30m. Closed level loops were observed. Levels were positioned relative to the walls. In the Socks Pacific showroom the level positions were based on a grid using



the portals and concrete slabs. In the remainder of the Socks Pacific the level positions were based on a 3x3 grid on each individual concrete slab. In the Sheer Adventure buildings the level positions were based on the concrete slab edges.

Contours have been provided at 10mm (0.01m) intervals.

Assumed datums have been used for the level surveys and origin marks are shown and labelled on the plans.

Any noticeable cracks or steps in the slab were surveyed and have been shown on the plan. The thickness of the different floor coverings was measured and levels have been adjusted so that all levels are in terms of the concrete surface.

#### Verticality Alignment

Verticality measurements were made with a Leica TCRP 1202 Robotic Total Station (SN 227215). This instrument has measuring standard deviations of 2" for angle and 2mm+2ppm for prism distance and 3mm+2ppm for reflectorless distance.

Measurements were made directly onto the walls/columns using reflectorless EDM measurements from the total station. The top and bottom of the columns/walls were measured wherever practical.

#### **Analysis**

##### Socks Pacific Northern Building

The floor contours and levels indicate that the central part of the floor is generally lower than the outside of the floor, with particularly low areas seen at the central southern, central middle and central northern parts of the floor. There are noticeably high areas at the central western and central eastern parts of the floor. Note the very outer edge of the floor, which is outside the main floor slabs, drops away significantly.

The floor slope plan shows maximum slopes adjacent cracks and on the outer edge of the floor as expected. Large areas of the floor, mainly in the outer areas, have gradients of 0.5% or more.

No verticality measurements were made in this building.

##### Socks Pacific Southern Building

The floor contours and levels indicate that the central part of the floor is generally higher than the outside of the floor. There is a noticeably low area at the south-eastern corner of the floor.

The floor slope plan shows that the majority of the floor has gradients of 0.5% or more, particularly the southern part of the floor.

The verticality values show maximum deviations from vertical near the southeast and southwest corners of the building.

##### Sheer Adventure Eastern Building

The floor contours and levels indicate that the central part of the floor is generally higher than the outside of the floor, as well as low spots on the central northern and central southern edges of the floor. There is a noticeably high area near the south eastern corner of the floor.





The floor slope plan shows maximum slopes adjacent cracks as expected. Isolated areas of the floor, mainly in the outer areas, have gradients of 0.5% or more.

The verticality values show significant deviations from vertical on the eastern wall of the building. Note that this wall, including the columns, is lined so measurements have not been made directly to the structural elements.

#### Sheer Adventure Western Building

The floor contours and levels indicate that the central part of the floor is generally lower than the outside of the floor. The southern edge and north-western corner of the floor are noticeably lower than the rest of the floor.

The floor slope plan shows maximum slopes at the interface to the adjacent building to the east. The southern and northern areas of the floor generally have gradients of 0.5% or more.

The verticality values show significant deviations from vertical on the southern end of the eastern wall and along the southern wall.

#### **Conclusion**

The survey was successfully carried out and plans drafted showing graphically the results of the survey. The plans show areas that deviated from level and verticality. The plans and report can be used to assist further structural analysis of the building.

Report Prepared by

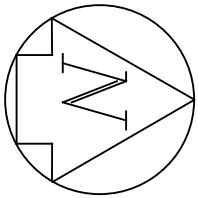
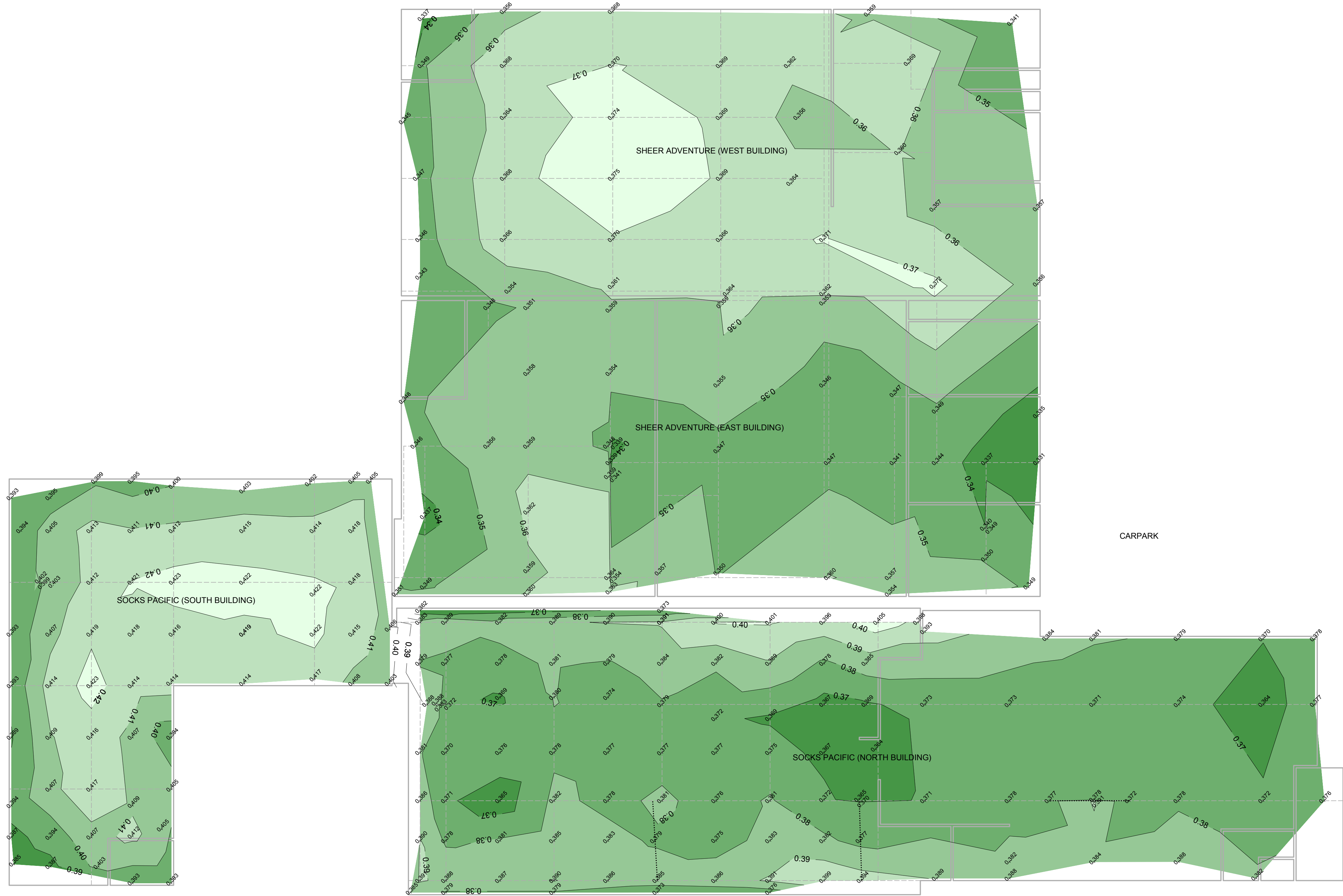
**STAIG AND SMITH LTD**

A handwritten signature in black ink, appearing to read 'Ephraim Jacobsen', located below the company name.

Ephraim Jacobsen  
Licensed Cadastral Surveyor

DO NOT SCALE

ORIGINAL SIZE A1



BYRON ST

SURVEY BENCHMARK  
NAIL 1  
RL 0.000m

#### Notes

- (1) VERIFY ALL DIMENSIONS ON SITE.
- (2) DO NOT SCALE FROM DRAWING.
- (3) LEVELS IN TERMS OF: ASSUMED DATUM  
ORIGIN OF LEVELS: SURVEY BENCHMARK NAIL 1  
(IN ASPHALT ON WEST SIDE OF EASTERN ENTRANCE)  
RL 0.000m
- (4) ORIENTATION IS APPROXIMATE ONLY AND IS NOT IN  
TERMS OF TRUE NORTH.
- (5) THE FLOOR PLAN HAS BEEN OBTAINED FROM ON-SITE  
MEASUREUP. THE WALL LAYOUT IS INDICATIVE ONLY  
AND MUST NOT BE USED FOR STRUCTURAL ANALYSIS.
- (6) LEVELS WERE TAKEN ON THE CONCRETE FLOOR SURFACE.  
WHERE A CARPET OR VINYL SURFACE WAS PRESENT,  
LEVELS WERE ADJUSTED FOR THE COVERING THICKNESS.
- (7) THE COLUMN/WALL VERTICALITY ARROWS SHOW THE  
DIRECTION OF THE TOP OF THE COLUMN/WALL RELATIVE  
TO THE BOTTOM.
- (8) THE COLUMN/WALL VERTICALITY ARROWS SHOW THE  
DIRECTION OF THE TOP OF THE COLUMN/WALL RELATIVE  
TO THE BOTTOM.
- (9) VERTICALITY DEVIATIONS ARE FOR CONCRETE  
WALLS, UNLESS STATED OTHERWISE.
- (10) FIELDWORK CARRIED OUT ON 28TH-29TH AUGUST 2013.

ISO CONTOUR LEGEND - INTERVAL 0.010M



#### KEY

- \*\*\*\*\* STEP/CRACK IN CONCRETE SLAB
- - - - - EDGE OF CONCRETE SLAB
- - - - - TOP OF BANK (TB)
- 42.5 - - - EXISTING CONTOURS
- ===== BUILDING WALL
- ⊗ TREE
- ✕ SPOT HEIGHT
- ⊕ STREET LIGHT
- ⊞ POWER BOX
- ⊙ TELEPHONE UPSTAND
- ⊞ HYDRANT
- ⊞ WATER VALVE
- ⊞ WATER METER
- ⊞ MANHOLE
- ⊞ SANITARY SEWER MANHOLE (SSMH)
- ⊞ STORMWATER MANHOLE (SWMH)
- ⊞ STANDARD SUMP
- ⊞ YARD SUMP
- INVERT
- ⊞ FENCE
- ⊞ GATE
- V — POWER LINE

AMENDMENT

DATE



STAIG & SMITH LTD

12 Bealey Avenue  
Christchurch

Ph: 0800 807 818

Fax: 03 548 4427

e-mail: enquiries@staigsmith.co.nz

SURVEYING-PLANNING-ENGINEERING-RESOURCE MANAGEMENT

Design:

Drawn: EDJ

Checked: SO

Approved: SO

Issue Date: 10 Sept 2013

Job Title

Structex Harvard Ltd  
78 & 82 Byron St  
Christchurch

Drawing Title

Floor Level Plan

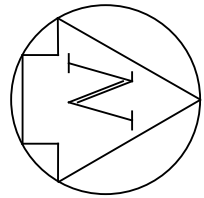
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Issue. 1

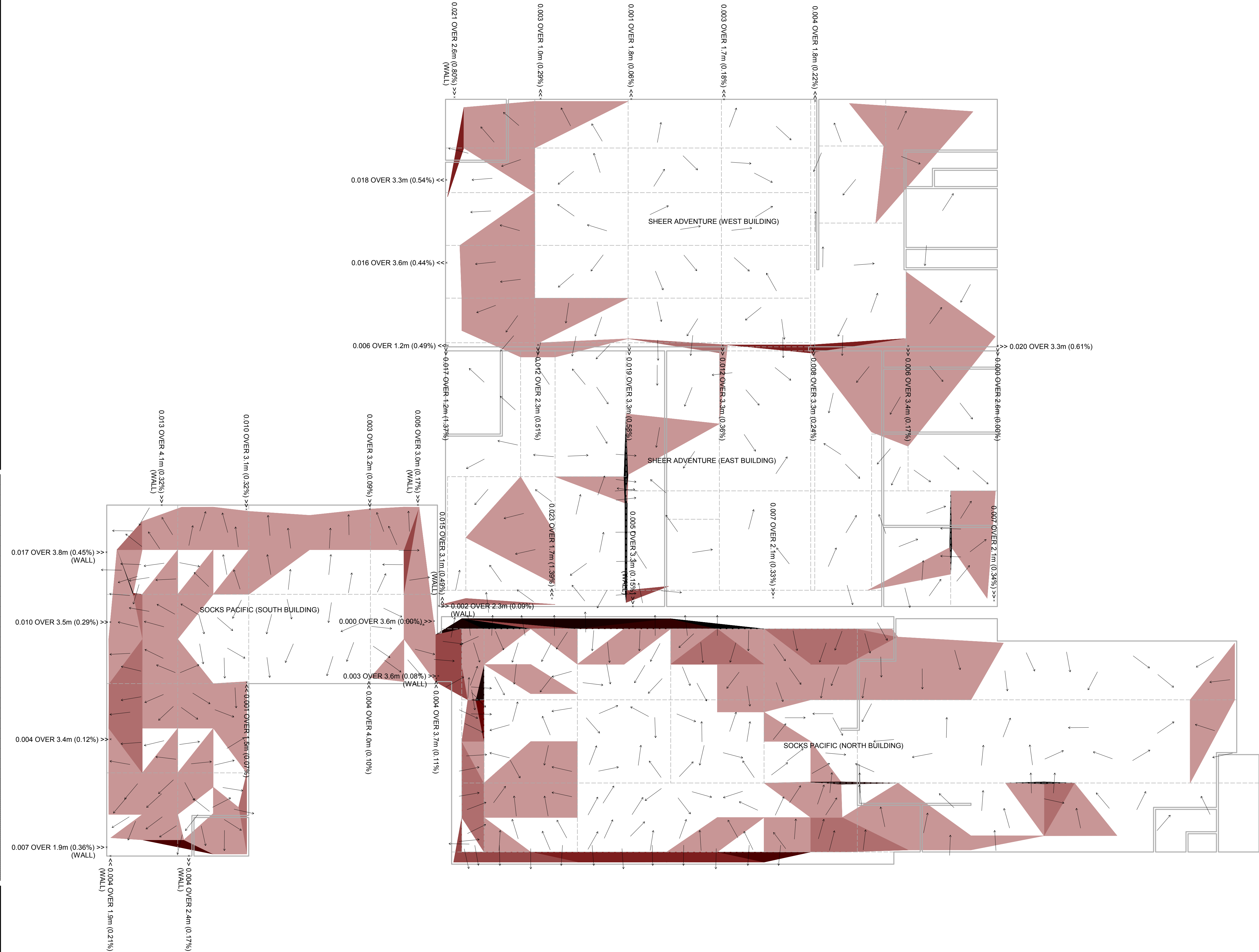
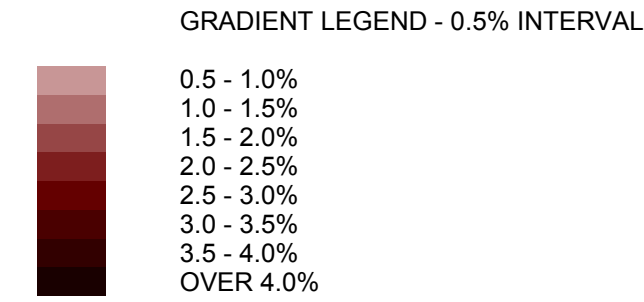
Job No: 11417

Sheet 1 of 2





- Notes**
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  - (2) DO NOT SCALE FROM DRAWING.
  - (3) LEVELS IN TERMS OF: ASSUMED DATUM  
ORIGIN OF LEVELS: SURVEY BENCHMARK NAIL 1  
(IN ASPHALT ON WEST SIDE OF EASTERN ENTRANCE)  
RL 0.000m
  - (4) ORIENTATION IS APPROXIMATE ONLY AND IS NOT IN TERMS OF TRUE NORTH.
  - (5) THE FLOOR PLAN HAS BEEN OBTAINED FROM ON-SITE MEASUREUP. THE WALL LAYOUT IS INDICATIVE ONLY AND MUST NOT BE USED FOR STRUCTURAL ANALYSIS.
  - (6) LEVELS WERE TAKEN ON THE CONCRETE FLOOR SURFACE. WHERE A CARPET OR VINYL SURFACE WAS PRESENT, LEVELS WERE ADJUSTED FOR THE COVERING THICKNESS.
  - (7) THE COLUMN/WALL VERTICALITY ARROWS SHOW THE DIRECTION OF THE TOP OF THE COLUMN/WALL RELATIVE TO THE BOTTOM.
  - (8) VERTICALITY DEVIATIONS ARE FOR CONCRETE WALLS, UNLESS STATED OTHERWISE.
  - (9) FIELDWORK CARRIED OUT ON 28TH-29TH AUGUST 2013.



AMENDMENT DATE



STAIG & SMITH LTD

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Christchurch

Ph: 0800 807 818  
Fax: 03 548 4427  
e-mail: enquiries@staigsmith.co.nz

SURVEYING-PLANNING-ENGINEERING-RESOURCE MANAGEMENT

|                          |  |
|--------------------------|--|
| Design:                  |  |
| Drawn: EDJ               |  |
| Checked: SO              |  |
| Approved: SO             |  |
| Issue Date: 10 Sept 2013 |  |

Job Title

**Structex Harvard Ltd  
78 & 82 Byron St  
Christchurch**

Drawing Title

**Floor Slope and  
Column Verticality Plan**

|                    |              |
|--------------------|--------------|
| Scale: 1:100 at A1 | Issue. 1     |
| Job No: 11417      | Sheet 2 of 2 |



# APPENDIX E

Repair Specification





## 1. POST-EARTHQUAKE DAMAGE REPAIR

### 1.1 PRELIMINARY

Refer to the Preliminary and General Clauses of this Specification and to the General Conditions of Contract which are equally binding on all trades. This section of the Specification shall be read in conjunction with all other sections.

### 1.2 SCOPE

This Section consists of:-

1. Damage surveys.
2. Repair of cracks in reinforced concrete and blockwork.
3. Repair of concrete spalling.
4. Repair of cracks in unreinforced masonry.
5. Grouting of reinforcing bars and anchors into unreinforced masonry.

### 1.3 RELATED DOCUMENTS

In this section of the Specification reference is made to the latest revisions of the following documents:

|                               |                                                                                        |         |
|-------------------------------|----------------------------------------------------------------------------------------|---------|
| The New Zealand Building Code |                                                                                        | (BIA)   |
| NZS 3103:1991                 | Specification for sands for mortars and plasters                                       | (SCNZ)  |
| NZS 3104:2003                 | Specification for Concrete Production                                                  | (SCNZ)  |
| NZS 3109:1997                 | Specification for Concrete Construction                                                | (SCNZ)  |
| NZS 3112.4:1986               | Methods of test for concrete<br>Tests relating to grout                                | (SCNZ)  |
| NZS 3121:1986                 | Specification for water and aggregate for concrete                                     | (SANZ)  |
| NZS 4210:2001                 | Code of Practice for Masonry<br>Construction: Materials and Workmanship                | (SANZ)  |
| BS EN 459-1:2010              | Building Limes Part 1: Definitions, Specifications<br>and Conformity Criteria          | (BS EN) |
| BS EN 1052-3:2002             | Determination of Initial Shear Strength                                                | (BS EN) |
| BS EN 459-2:2010              | Building Limes Part 2: Test Methods                                                    | (BS EN) |
| NZSEE                         | Assessment & Improvement of the Structural<br>Performance of Buildings in Earthquakes. | (NZSEE) |

|                |                                                                                 |        |
|----------------|---------------------------------------------------------------------------------|--------|
| ASTM C 109-08  | Standard Test Methods for Compressive Strength of Hydraulic Cement Mortars.     | (ASTM) |
| ASTM C 1314-10 | Standard Test Methods for Compressive Strength of Masonry Prisms.               | (ASTM) |
| ASTM E488-90   | Standard Test Methods for Strength of Anchors In Concrete and Masonry Elements. | (ASTM) |

## 1.4 QUALITY ASSURANCE

### 1.4.1 General

It is the Contractor's responsibility to ensure that all work associated with this part of the contract is performed in accordance with the plans and specifications.

The Contractor's quality assurance procedures should encompass, but are not limited to, the following items:

1. Photographic record of damage observed
2. Recording of repairs completed
3. Daily recording of materials used
4. Mixing of epoxy/mortar/grout
5. Substrate surface preparation
6. Application of repair systems
7. Anchor hole location and embedment depth
8. Anchor and reinforcing steel placement
9. Testing frequency and reporting

The Contractor shall advise the Engineer in writing of the name of a suitably qualified and experienced representative to be responsible for ensuring that quality assurance procedures are being followed, prior to commencement on site.

Masonry shall be erected only under the direction of a Registered Mason specialising in the laying of masonry units. Before work commences on site, the Contractor shall advise the Engineer, in writing, the name of the Registered Mason who will be responsible for the masonry construction.

From time to time the Engineer may elect to audit the quality records. They shall be kept up to date and be made available for audit by the Engineer at all times during the construction of this project.

If so instructed, the Contractor shall forward copies of all or part of the records to the Engineer.

### 1.4.2 Inspection

The Engineer will review construction. Prior to grouting of anchor holes, the Engineer or his representative shall be notified and a reasonable opportunity given him to inspect prepared anchor holes.

Where necessary, the Engineer's instructions shall be carried out before grouting commences.

#### 1.4.3 Producer Statement – Construction (PS3)

When the works are sufficiently complete that they are ready for application to the Territorial Authority for a Code Compliance Certificate, or otherwise at key handover dates for particular sections of the works, the nominated representative responsible for the quality assurance procedures for the Damage Repair will be required to certify to the main Contractor that all Damage Repair work has been carried out in full accordance with all Contract Documents and Contract Instructions in the form of a Producer Statement - Construction. This statement will be required to be completed prior to the issue of the Producer Statement – Construction Review by the Engineer for the whole or sections of the works as appropriate.

No Practical Completion Certificate shall be issued until such time as all the Producer Statements for the relevant section of the works have been received.

#### 1.5 TESTING

The Contractor shall provide evidence of material compliance with the required testing as defined in this section of the Specification.

##### 1.5.1 Mortar for Reinforced Concrete Blockwork

The Contractor shall provide evidence of testing for the following:

###### 1. Mortar Compression Strength

Allow to test mortar compressive strength in accordance with NZS 4210:2001. Each test shall consist of a minimum of 3 specimens. Testing frequency shall be as follows:

- (i) Test to be carried out for every 450 sq.m of wall constructed (measured on one face only) to be tested at an age of 28 days.

###### 2. Masonry to Mortar Bond Strength

Allow to test masonry to mortar bond strength in accordance with NZS 4210:2001. Each test shall consist of a minimum of 3 specimens. Testing frequency shall be as follows:

- (i) Test to be carried out for every 450 sq.m of wall constructed (measured on one face only) to be tested at an age of 7 days.

##### 1.5.2 Unreinforced Masonry with Lime Mortar

The Contractor shall provide evidence of testing for the following:

###### 1. Lime Chemical Requirements

Prior to the commencement of work allow to test the carbon dioxide content of the lime in accordance with Section 5.5 or 5.4 of BS EN 459-2:2010.

###### 2. Soundness of Slaked Lime

Prior to the commencement of work allow to test soundness of slaked lime in accordance with Section 6.4.4 of BS EN 459-2:2010. Each test shall consist of a minimum of 3 specimens.

###### 3. Mortar Compression Strength

Allow to test mortar compressive strength in accordance with ASTM C 109-08 (2008) except that the samples shall be left to cure at a temperature of  $24 \pm 8$  deg C and a relative humidity of less than 80%. Each test shall consist of a minimum of 3 specimens. Testing frequency shall be as follows:

- (ii) Specimens prepared for testing prior to the commencement of works, to be tested at an age of 7, 28, 90, 180 and 360 days (total 15 specimens to be prepared).
- (iii) Specimens prepared for every 50 sq.m of wall constructed (measured on one face only) to be tested at an age of 7 and 28 days.

#### 4. Masonry Compression Strength

Prior to the commencement of work allow to test masonry compressive strength in accordance with ASTM C 1314-10 (2010) except that the samples shall be left to cure at a temperature of  $24 \pm 8$  deg C and a relative humidity of less than 80%. Each test shall consist of a minimum of 3 specimens. Testing frequency shall be as follows:

- (i) Specimens prepared for testing prior to the commencement of works, to be tested at an age of 7, 28, 90, 180 and 360 days (total 15 specimens to be prepared).

#### 5. Masonry Bed-Joint Shear Strength

Prior to the commencement of work allow to test initial masonry shear strength in accordance with BS EN 1052-3:2002. Each test shall consist of a minimum of 9 specimens as detailed in BS EN 1052-3:2002. Testing frequency shall be as follows:

- (i) Specimens prepared for testing prior to the commencement of works, to be tested at an age of 28, 90, 180 and 360 days (total 12 specimens to be prepared).

#### Variation of Materials

If the repair works consist of structural elements with more than one type of masonry unit (i.e. red brick and Halswell Stone) the testing detailed above for masonry compressive strength and bed-joint shear strength shall be repeated for each masonry unit type.

Further tests shall be carried out if, and immediately when, the supply of the constituent materials varies during construction with at least three specimens per test. Tests shall also be conducted when requested by the Engineer.

The results of all tests shall be submitted upon request to the Engineer for review.

### 1.5.3 Unreinforced Masonry with Cement-Lime Mortar

The Contractor shall provide evidence of testing for the following:

#### 1. Mortar Compression Strength

Allow to test mortar compressive strength in accordance with Appendix 2.A of NZS 4210. Each test shall consist of a minimum of 3 specimens. Testing frequency shall be as follows:

- (i) Specimens prepared for testing prior to the commencement of works, to be tested at an age of 7, 28 and 90 days (total 9 specimens to be prepared).
- (ii) Specimens prepared for every 50 sq.m of wall constructed (measured on one face only) to be tested at an age of 7 and 28 days (6 specimens to be prepared for every 50 sq.m).

#### 2. Masonry Bed-Joint Shear Strength

Prior to the commencement of work allow to test initial masonry shear strength in accordance with BS EN 1052-3:2002. Each test shall consist of a minimum of 9 specimens. Testing frequency shall be as follows:

- (i) Specimens prepared for testing prior to the commencement of works, to be tested at an age of 28 and 90 days (total 18 specimens to be prepared).

#### Variation of Materials

If the repair works consist of structural elements with more than one type of masonry unit (i.e. red brick and Halswell Stone) the testing detailed above for masonry compressive strength and bed-joint shear strength shall be repeated for each masonry unit type.

Further tests shall be carried out if, and immediately when, the supply of the constituent materials varies during construction with at least three specimens per test. Tests shall also be conducted when requested by the Engineer.

The results of all tests shall be submitted upon request to the Engineer for review.

### 1.6 SAFETY

The Contractor shall conform fully both on and off site with the provisions of the New Zealand Building Code in all matters related to construction safety, in particular with approved documents F1 (Hazardous Agents on Site), F2 (Hazardous Building Materials), F4 (Safety from Falling) and F5 (Construction and Demolition Hazards).

### 1.7 MATERIALS AND WORKMANSHIP

#### 1.7.1 Materials

The Contractor shall adhere to all requirements of NZS 3104, NZS 3109 and NZS 4210, except where specified otherwise herein or instructed otherwise by the Engineer. A copy of this standard shall be kept on the site and relevant parts read with the following Clauses of this Specification.

Materials to be used in conjunction with brick or stone masonry shall be selected to minimise the effects of efflorescence.

The Engineer may approve equivalent products that satisfy all of the requirements and show equality to the systems specified herein. Approval for the equivalent system shall be sought prior to submission of tender, refer also to the Submittals section below

#### 1.7.2 Workmanship

All work shall be carried out by licensed applicators of the material manufacturer's.

Undertake all preparatory work necessary prior to application of the specified system to ensure proper bond and clean, true surfaces in the finished work.

All materials shall be mixed and applied in accordance with best trade practice and applied by skilled applicators to the manufacturer's recommendations.

All adjoining work shall be adequately protected during mixing and application and utmost care shall be taken not to damage surrounding fixtures and fittings. All damage consequent upon this operation shall be completely made good.

Remove debris at regular intervals and leave the completed work free from defects of all kinds.

#### 1.7.3 Completion

Clean all adjoining surfaces and fittings of any paint contamination. Replace all hardware without damage to it or the adjoining surface. Take away from the site all painting materials, equipment and rubbish leaving the surrounding area clean, tidy and undamaged.

### 1.8 DAMAGE SURVEYS

We have undertaken an initial assessment that has identified general forms of damage and repairs required. We have not been able to expose all critical elements for observation, nor have we conducted a detailed survey identifying each individual crack. At the request of the engineer the Contractor shall expose areas of the structure, in order to enable detailed observations to be made of critical areas.

The Drawings provide specific details of the primary structural repairs required. Repairs of more minor damage (such as cracking and spalling of concrete) shall be undertaken by the Contractor in accordance with this Specification, under the direction of the Engineer.

#### 1.8.1 Crack Damage

The Contractor shall identify cracks to be repaired following the methodologies outlined in the following sections of this Specification. Following preparation but prior to epoxy injection or grouting, the Contractor shall contact the Engineer to arrange an inspection of the area to be repaired.

Cracks are to be repaired in various elements as identified in site reports or on structural drawings.

Records should be kept of repaired cracks and should include details of:-

1. Location
2. Crack width
3. Crack length
4. Volume of material (epoxy/grout) used

#### 1.8.2 Spalling Damage

The Contractor shall identify areas of spalled concrete to be repaired following the methodologies outlined in the following sections of this Specification. Following preparation but prior to application of the repair mortar, the Contractor shall contact the Engineer to arrange an inspection of the area to be repaired.

Spalled concrete is to be repaired in various elements as identified in site reports or on structural drawings.

Records should be kept of repaired spalling and should include details of:-

1. Location
2. Approximate spalled area
3. Volume of material (repair mortar) used

#### 1.8.3 Verticality Survey

At the request of the Engineer, the Contractor shall undertake a verticality survey of the target building. The verticality survey shall ascertain whether there is any residual displacement or twist of the building. The Contractor shall submit their proposed methodology to the Engineer for approval prior to undertaking the survey.

### 1.9 REPAIR OF CRACKS IN REINFORCED CONCRETE AND BLOCKWORK

The following sections of the Specification detail the procedures to be followed when repairing cracks in reinforced concrete and reinforced concrete blockwork.

Cracks less than 0.2mm wide are considered to be superficial and do not require specific structural repair.

#### 1.9.1 Repair of Hairline Cracks (< 2mm)

Where possible at the direction of the Engineer, cracks between 0.2mm and 2mm shall be repaired by injection of epoxy resin.

Where access to seal around the element being repaired is possible, repair the crack using a low viscosity epoxy resin such as Sikadur Injectokit – LV or Sikadur 52.

Where access is not possible to prevent grout loss, repair the crack with a thixotropic epoxy resin such as Sikadur Injectokit – TH.

Seal and prepare the surface being repaired and inject the epoxy resin in accordance with the manufacturers instructions.

Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

#### 1.9.2 Repair of Large Cracks (< 5mm)

Where possible at the direction of the Engineer, cracks between 2mm and 5mm shall be repaired by injection of Sikadur 52.

Seal and prepare the surface being repaired and inject the epoxy resin in accordance with the manufacturers instructions.

Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

#### 1.9.3 Repair of Very Large Cracks (> 5mm)

Advise the Engineer of any cracks larger than 5mm in width.

If the Engineer does not require any specific repair detail, cracks larger than 5mm shall be repaired by injection of Sikadur 42 / Sika Grout 212.

Seal and prepare the surface being repaired and inject the epoxy resin / cementitious grout in accordance with the manufacturers instructions.

Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

#### 1.9.4 Repair of Reinforced Concrete Blockwork Mortar Joints

Repair mortar shall conform to NZS 4210, clause 2.2. Mortar shall have a 28 day compressive strength of at least 12.5 MPa. The 7 day masonry to mortar bond strength shall not be less than 200kPa. Sand shall comply with NZS 3103 with chloride levels not exceeding 0.04% by dry weight of sand. Appearance of new mortar shall match the existing. The contractor shall submit to the Engineer a mix design for the mortar prior to commencing work.

Damaged mortar beds shall be raked out to a minimum depth of 25 mm and re-pointed. Pointing shall be undertaken to match existing.

The Contractor shall carry out material testing as required in Section 1.5.

### 1.10 REPAIR OF CONCRETE SPALLING

The following sections of the Specification detail the procedures to be followed when repairing spalled concrete.

#### 1.10.1 Repair of Shallow Spalling (<40mm thick)

At the direction of the Engineer break back to sound concrete. The depth of breakout on the edge of any repair area shall be a minimum of 10 mm and feather edges will not be accepted. To achieve this, the perimeter of the area to be repaired shall first be cut to a depth of 10 mm using a suitable tool.

Clean any exposed reinforcing using a wire brush. Prepare the exposed concrete surface and reinforcing in accordance with the manufacturers instructions, applying a primer such as Sika Monotop Primer as required.

Build up the required concrete profile using a high strength repair mortar, such as Sika Monotop Structural Mortar, and finish in accordance with the manufacturers instructions.

Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

#### 1.10.2 Repair of Moderate Spalling (<80mm thick)

At the direction of the Engineer break back to sound concrete. The depth of breakout on the edge of any repair area shall be a minimum of 10 mm and feather edges will not be accepted. To achieve this, the perimeter of the area to be repaired shall first be cut to a depth of 10 mm using a suitable tool.

Clean any exposed reinforcing using a wire brush. Prepare the exposed concrete surface and reinforcing in accordance with the manufacturers instructions, applying a primer such as Sika Monotop Primer as required.

Build up the required concrete profile using a high build repair mortar, such as Sika Monotop High Build Mortar, and finish in accordance with the manufacturers instructions.



Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

#### 1.10.3 Repair of Deep Spalling (>80mm thick)

At the direction of the Engineer break back to sound concrete. The depth of breakout on the edge of any repair area shall be a minimum of 10 mm and feather edges will not be accepted. To achieve this, the perimeter of the area to be repaired shall first be cut to a depth of 10 mm using a suitable tool.

Clean any exposed reinforcing using a wire brush. Prepare the exposed concrete surface and reinforcing in accordance with the manufacturers instructions.

Box and pour to the required concrete profile using a flowable repair mortar, such as Sika Monotop Microconcrete, and finish in accordance with the manufacturers instructions.

Alternative products of equivalent properties may be acceptable but must be submitted to the Engineer for approval at the time of tender.

### 1.11 REPAIR OF CRACKS IN UNREINFORCED MASONRY

The following sections of the Specification detail the procedures to be followed when repairing cracks in unreinforced masonry. The Contractor shall adhere to all requirements of NZS 4210, except where specified otherwise herein or instructed otherwise by the Engineer.

#### 1.11.1 Unreinforced Masonry with Lime Mortar

At the direction of the Engineer, replace or repair cracked masonry units. New brick or stone masonry units shall be selected to match colour, density and texture of the existing.

Repair mortar shall be lime mortar to match the existing. Lime mortar shall be composed of aged slacked lime (lime putty), sand and water. The prescribed ratio of lime to sand shall be 1:3. Alternate mix designs may be used with the approval of the Engineer. Repair mortar should be batch mixed.

Lime used shall meet the requirements of BS 890:1995 and shall be slaked for a minimum of 3 months. Acceptable suppliers include:

1. Historic Building Conservation  
18 Soper Road  
Wingatui  
Dunedin  
03 489 0930

Alternate suppliers may be used with the approval of the Engineer.

Sand shall be Class A sand as defined in NZS 3103 with chloride levels not exceeding 0.04% by dry weight of sand.

Alkaline resistant mineral oxides can be added to enable colour matching. Dosage rates of mineral oxides shall be limited such that they do not cause a reduction in mortar strength.

No cement products, modern additives or plasticisers are to be added to the mix unless approved by the Engineer.

The contractor shall submit to the Engineer a mix design for lime mortar prior to commencing work.

Masonry repairs shall be cured in accordance with NZS 4210, Sections 2.18 and 2.19.

The Contractor shall carry out material testing as required in Section 1.5.

#### 1.11.2 Unreinforced Masonry with Cement-Lime Mortar

Repair of unreinforced masonry with cement-lime mortar shall be undertaken in accordance with NZS 4210.

At the direction of the Engineer, replace or repair cracked masonry units. New brick or stone masonry units shall be selected to match existing. Damaged mortar beds shall be raked out to a minimum depth of 25 mm and re-pointed. Pointing shall be undertaken to match existing.

Repair mortar shall be cement-lime mortar to match the existing. Mortar shall be composed of Portland cement, hydrated lime, sand and water, and shall be Durability Class M2 mortar as defined in Table 2.1 of NZS 4210.

Mortar shall have a 28 day compressive strength of at least 5 MPa. The 28 day masonry to mortar bond strength shall not be less than 200kPa.

Building lime shall comply with BS EN 459-1:20101 and shall be slaked with water to form hydrated lime before use in mortar. Sand shall be Class A sand as defined in NZS 3103 with chloride levels not exceeding 0.04% by dry weight of sand.

Repair mortar should be batch mixed. Hydrated lime shall not be omitted from the mix unless approved by the Engineer. Alkaline resistant mineral oxides can be added in accordance with NZS 4210 to enable colour matching.

The contractor shall submit to the Engineer a mix design for the mortar prior to commencing work.

Masonry repairs shall be cured in accordance with NZS 4210, Sections 2.18 and 2.19.

The Contractor shall carry out material testing as required in Section 1.5.

#### 1.12 GROUT INJECTION OF CRACKS AND OPEN JOINTS IN UNREINFORCED MASONRY

The following sections of the Specification detail the procedures to be followed when repairing cracks in unreinforced masonry.

At the direction of the Engineer, replace or repair cracked masonry units. New brick or stone masonry units shall be selected to match colour, density and texture of the existing.

##### 1.12.1 Materials

Grout shall be Centricrete MV or approved alternative.

Repair mortar shall be as specified in Section 1.10.

### 1.12.2 Methodology

Rake open joint to adequate depth to remove any loose mortar, but no less than 25 mm.

Flush joint, surfaces and cracks with clean water. Loose bricks shall be removed and reset with mortar

Injection holes are to be drilled at header joints or cracked brick, through to the inner wythe in each course. Bleed tubes shall be provided as required to ensure that any trapped air can escape. Flush bleed holes with water. Pressure inject grout to bond cracks in accordance with the manufacturers recommendations.

Re-point holes and open joints. Pointing shall be undertaken to match existing.

## 1.13 GROUTING OF BARS INTO UNREINFORCED MASONRY

The following sections of the Specification detail the procedures to be followed when grouting threaded rod and reinforcing bars into unreinforced masonry.

### 1.13.1 Shallow Embedment (< 750mm)

Grout shall be either non-shrink cement or epoxy based and shall be prepared in accordance with the manufacturers specifications. Acceptable products include:

1. Hilti HY150
2. Hilti CM 651
3. Sika Sikadur 52
4. Sika Grout 212
5. Ramset Epcon C6 (brick masonry only)
6. Ramset Premier Grout MP

The Contractor shall submit details of the proposed grout and grouting procedure to the Engineer for approval prior to the start of construction.

Anchor hole diameters are detailed in Table 1.

**Table 1 Hole Diameters**

| Anchor<br>Size<br><br>(mm) | Hole Diameter (mm)                        |                                                          |
|----------------------------|-------------------------------------------|----------------------------------------------------------|
|                            | Hilti HY150 /<br>Sikadur 52 /<br>Epcon C6 | Hilti CM 651 /<br>Sika Grout 212/<br>Premier Grout<br>MP |
| 10                         | 12                                        | 20                                                       |
| 12                         | 14                                        | 24                                                       |
| 16                         | 18                                        | 32                                                       |
| 20                         | 22                                        | 40                                                       |
| 25                         | 27                                        | 50                                                       |

Holes shall be drilled using hammer drills and must be dry prior to filling with grout.

All holes shall be cleaned out using a stiff bristled wire bottlebrush and a compressed air source (with no oil bottle in the line) so that all dust and debris are removed from the side of the hole.

When this has been completed the Contractor is to notify the Engineer for inspection of the holes prior to placement of bars and grout.

The holes shall be partially filled with grout prior to inserting the reinforcing bar. Holes shall be filled from the bottom up (rather than pouring from the top). When a wall cavity is encountered, use a proprietary mesh anchor sleeve to bridge the cavity.

Bars shall be placed in the holes, given one turn to expel air voids and shall be fully supported (if necessary) and left undisturbed for at least 24 hours. After 24 hours horizontal bars installed at 15 degree slope can be bent horizontal.

After the bars have been placed in position, ensure that the grout fills the hole to the surface of the substrate. Top up holes if necessary.

The grouts shall be used strictly in accordance with the manufacturer's instructions.

When it is intended that the anchor be concealed in the completed state the bar shall be recessed a minimum of 35 mm beyond the exposed face of the masonry. Close the hole by mixing dust salvaged from the drill hole with a weakly cementitious mortar (eg Sika 212) and plug the hole to match existing.

#### 1.13.2 Deep Embedment (> 750mm Vertical)

This section of the Specification details the procedure to be followed when grouting vertical bars into masonry walls. Grout shall be either non-shrink cement or epoxy based and shall be prepared in accordance with the manufactures specifications. Acceptable products for grouting include:

1. Hilti RE500
2. Sika Sikadur 52
3. Sika Grout 212
4. Ramset Epcon C6
5. Ramset Premier Grout MP

The Contractor shall submit details of the proposed grout and grouting procedure to the Engineer for approval prior to the start of construction.

Anchor hole diameters are detailed in Table 2.

**Table 2 Hole Diameters**

| Anchor<br>Size<br><br>(mm) | Hole Diameter (mm)                       |                                            |
|----------------------------|------------------------------------------|--------------------------------------------|
|                            | Hilti RE500 /<br>Sikadur 52/<br>Epcon C6 | Sika Grout 212/<br><br>Premier Grout<br>MP |
| 10                         | 12                                       | 20                                         |
| 12                         | 14                                       | 24                                         |
| 16                         | 18                                       | 32                                         |
| 20                         | 22                                       | 40                                         |
| 25                         | 27                                       | 50                                         |

Holes may be drilled using hammer or core drills and must be dry prior to filling with grout.

If the brick wall is suspected to contain cavities that might cause significant grout loss the hole can be filled with expandable builders filler and re-drilled at 2mm oversize to remove the filler from the walls of the hole.

All holes shall be cleaned out using a stiff bristled wire bottlebrush and a compressed air source (with no oil bottle in the line) so that all dust and debris are removed from the side of the hole.

When this has been completed the Contractor is to notify the Engineer for inspection of the holes prior to placement of bars and grout.

The holes shall be partially filled with grout prior to inserting the reinforcing bar. Holes shall be filled from the bottom up (rather than pouring from the top). Grouting shall be conducted with a maximum lift height of 1.5m.

Bars shall be placed in the holes, given one turn to expel air voids and shall be fully supported (if necessary) and left undisturbed for at least 24 hours.

After the bars have been placed in position, ensure that the grout fills the hole to the surface of the substrate. Top up holes if necessary.

The grouts shall be used strictly in accordance with the manufacturer's instructions.

#### 1.13.3 Control Tests – Grouted Anchors & Reinforcing Bars

Shallow embedment anchors installed in accordance with Section 1.11.1 above shall be tested in accordance with the following:

##### Torque Testing

One quarter of all new tension anchor bolts and reinforcing bars embedded in unreinforced masonry walls shall be tested using a torque calibrated wrench to the following minimum torques,

|                               |       |
|-------------------------------|-------|
| 12mm diameter anchors or bars | 54Nm  |
| 16mm diameter anchors or bars | 68Nm  |
| 20mm diameter anchors or bars | 100Nm |

No slippage shall occur under the above torques.

##### Direct Tension Testing

A minimum of five direct tension tests shall be undertaken for each anchor size specified on the Structural Drawings. The load testing shall be undertaken as follows:

The masonry wall should support the test apparatus. The distance between the anchor and the test apparatus support should not be less than the wall thickness.

The tension test load reported should be the load recorded at 3 mm relative movement of the anchor and the adjacent masonry surface. For the testing of existing anchors, a preload of 1.5 kN shall be applied prior to establishing a datum for recording elongation.

##### Reports

Results of all tests shall be reported. The report shall include the test results as related to anchor size and type, location, embedment depth, wall thickness and joist orientation.

## 1.14 GROUTING OF TIES INTO UNREINFORCED MASONRY PIERS

The following sections of the Specification detail the procedures to be followed when grouting galvanised threaded rod into unreinforced masonry piers.

Grout shall be Sika 212 or approved alternative. Anchor hole diameters are detailed in Table 3. When steel plate washers are required a rebate shall be formed at each end to ensure at least 35 mm cover is provided to the end of the threaded rod.

**Table 3 Hole Diameters**

| Anchor Size (mm) | Hole Diameter (mm) |
|------------------|--------------------|
| 10               | 20                 |
| 12               | 24                 |
| 16               | 32                 |
| 20               | 40                 |
| 25               | 50                 |

All holes shall be cleaned out using clean water so that all dust and debris are removed from the side of the hole.

When this has been completed the Contractor is to notify the Engineer for inspection of the holes prior to placement of bars and grout.

Injection holes are drilled through to the anchor hole. Bleed tubes shall be provided as required to ensure that any trapped air can escape. Flush bleed holes with water. Insert threaded rod into hole. Install plate washers with high strength grout behind. Attempt to close cracks in the unreinforced masonry piers by tightening the nuts.

When all threaded rods have been installed and tightened pressure inject grout the anchor holes in accordance with the manufacturers recommendations.

When it is intended that the threaded rod be concealed in the completed state the threaded rod, plate washer and nut shall be recessed a minimum of 35 mm beyond the exposed face of the masonry. Close the hole by mixing dust salvaged from the drill hole with a weakly cementitious mortar (eg Sika 212) and plug the hole to match existing.

## 1.15 RECONSTRUCTION OF UNREINFORCED MASONRY WALLS

The following sections of the Specification detail the procedures to be followed when rebuilding whole or parts of unreinforced masonry walls. The Contractor shall adhere to all requirements of NZS 4210, except where specified otherwise herein or instructed otherwise by the Engineer.

### 1.15.1 Unreinforced Masonry with Lime Mortar

At the direction of the Engineer, demolish and rebuild unreinforced masonry walls. New brick or stone masonry units shall be selected to match colour, density and texture of the existing.

Mortar shall be lime mortar to match the existing. Lime mortar shall be composed of aged slacked lime (lime putty), sand and water. The prescribed ratio of lime to sand shall be 1:3.

Alternate mix designs may be used with the approval of the Engineer. Repair mortar should be batch mixed.

Lime used shall meet the requirements of BS EN 459-2:010 for air lime and shall be slaked for a minimum of 3 months. Acceptable suppliers include:

1. Historic Building Conservation  
18 Soper Road  
Wingatui  
Dunedin  
03 489 0930

Alternate suppliers may be used with the approval of the Engineer.

Sand shall be Class A sand as defined in NZS 3103 with chloride levels not exceeding 0.04% by dry weight of sand.

Alkaline resistant mineral oxides can be added to enable colour matching. Dosage rates of mineral oxides shall be limited such that they do not cause a reduction in mortar strength.

No cement products, modern additives or plasticisers are to be added to the mix unless approved by the Engineer.

The contractor shall submit to the Engineer a mix design for lime mortar prior to commencing work.

Masonry repairs shall be cured in accordance with NZS 4210, Sections 2.18 and 2.19.

If the wall is a veneer, install Type B Heavy Duty (EH) veneer ties at 600mm c/s horizontally, 400mm vertically each way unless noted otherwise.

The Contractor shall carry out material testing as required in Section 1.5.

#### 1.15.2 Unreinforced Masonry with Cement-Lime Mortar

Reconstruction of unreinforced masonry walls with cement-lime mortar shall be undertaken in accordance with NZS 4210.

At the direction of the Engineer, demolish and rebuild unreinforced masonry walls, replacing or repairing cracked masonry units. New brick or stone masonry units shall be selected to match existing.

Mortar shall be cement-lime mortar to match the existing. Mortar shall be composed of Portland cement, hydrated lime, sand and water, and shall be Durability Class M2 mortar as defined in Table 2.1 of NZS 4210.

Repair mortar should be batch mixed. Hydrated lime shall not be omitted from the mix unless approved by the Engineer.

Building lime shall comply with BS EN 459-1:2010 and shall be slaked with water to form hydrated lime before use in mortar.

Sand shall be Class A sand as defined in NZS 3103 with chloride levels not exceeding 0.04% by dry weight of sand.

Alkaline resistant mineral oxides can be added in accordance with NZS 4210 to enable colour matching.

The contractor shall submit to the Engineer a mix design for the mortar prior to commencing work.

Masonry repairs shall be cured in accordance with NZS 4210, Sections 2.18 and 2.19.

If the wall is a veneer, install Type B Heavy Duty (EH) veneer ties at 600mm crs horizontally, 400mm vertically each way unless noted otherwise.

The Contractor shall carry out material testing as required in Section 1.5.

#### 1.16 COORDINATION

The Contractor shall coordinate all associated trades so as to ensure the correct finished relationship, both as to dimensions, details, and finishes, between concrete repair work and all other trades, in particular finishing trades who will be working in the same areas.

#### 1.17 SUBMITTALS

The Contractor shall supply the following documentation for review, at least 10 days prior to installation of the system:

A complete list of proposed materials for the system, including the following areas and clearly identifying any proposed variances from this specification:

1. Repair product
2. Primer / filler
3. Fire resistant coating
4. Protective coating

The individual component materials proposed for the system must be confirmed by the manufacturers to be mutually compatible.

The manufacturer must be able to demonstrate compliance with the Materials section of this specification above.

The manufacturer must also be able to provide supporting evidence of adequate testing of the performance of the proposed system, to the satisfaction of the Engineer.

A complete methodology shall be provided for the system, addressing the following areas and clearly identifying any proposed variances from this specification:

1. Substrate surface preparation
2. Mixing of epoxy / grout
3. Application method
4. Curing method
5. Testing of samples





**ENGCO**  
Consulting Engineers

**GEOTECHNICAL REPORT FOR PROPOSED COMMERCIAL BUILDING  
83 BYRON ST, SYDENHAM, CHRISTCHURCH**



**Project Reference No: 16363**

**Prepared for: Spaghetti Junction Ltd**

**Date: 11/11/2016**

| Project Summary  |            |                        |                          |          |
|------------------|------------|------------------------|--------------------------|----------|
| Report Title     |            | Geotechnical Report    |                          |          |
| ENGCO Project No |            | 16363                  |                          |          |
| Client           |            | Spaghetti Junction Ltd |                          |          |
| Rev              | Date       | Details                | Prepared by              | Approver |
| 0                | 25/11/2016 | Draft for review       | Ragulan Kanapathippillai |          |
| 1                | 30.01.2017 | For Consent            | Ragulan Kanapathippillai | AL       |

| Approval      |                          |                                       |                                                                                       |
|---------------|--------------------------|---------------------------------------|---------------------------------------------------------------------------------------|
| Action        | Name                     | Title                                 | Signature                                                                             |
| Prepared by   | Ragulan Kanapathippillai | Geotechnical Engineer                 |  |
| Reviewed by   | Dave Brierley            | Technical Director<br>CPEng No 225268 |  |
| Authorised by | Andrew Lind              | Director<br>CPEng No. 1019507         |  |

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**Appendix 3- Shallow Geotechnical Investigation Results**

# I INTRODUCTION

The Engineering Company Limited (ENGCO) was requested by Spaghetti Junction Ltd, to undertake a geotechnical assessment for the proposed warehouse building with offices at 83 Byron Street, Sydenham, Christchurch. Refer to Figure I for a plan of the proposed development area. This report evaluates the surface and subsurface conditions of the site and provides preliminary geotechnical recommendations for the proposed building foundations, with reference to Ministry of Business, Innovation and Employment (MBIE) Guidance, and building codes, as appropriate.

Our scope of works included the following:

- Desktop study of relevant, publicly available geotechnical and geological publications;
- Organizing deep geotechnical investigation, comprising Piezocone Penetration Tests (CPTu), Dynamic Cone Penetrometers (DCP) and Hand Augers (HA);
- An assessment of liquefaction potential for the site;
- Preparation of this report, outlining our findings on the ground conditions and including geotechnical advice on foundation conditions and ground remediation if necessary;
- Preliminary foundation recommendations for the proposed warehouse building;

## 2 SITE DETAILS

### 2.1 Site description

The site 83 Byron Street, Sydenham is located approximately 1.5k southeast of Christchurch city centre. The vacant site is surrounded by commercial buildings. At the time of our investigation, the site was cleared, the contour was generally flat and the site was occupied by a number of containers.

### 2.2 MBIE land zoning

The site is classified as a non-residential site and the current liquefaction severity land classification for this site, according to Canterbury Earthquake Recovery Authority (CERA) maps, is “N/A-Urban Non-Residential”. A plan of the site location is provided in Figure 2.

### 2.3 Regional Geology and Seismicity

The geological map of the area indicates that the site has surface geology consisting of “*Dominantly alluvial sand and silt overbank deposits*”.

### 2.4 Flood hazard

Ground levels have changed across Christchurch as a result of the Canterbury earthquake sequence. Minimum floor elevation requirements for any rebuild at the site should be confirmed with the Christchurch City

Council to inform the design and construction processes. At the time of writing this report, there was no publically available information regarding the final floor level for the commercial building development proposed.

## 2.5 Hazardous Activities and Industries List

The ECAN contaminated land registry indicates that the site contained an underground storage tank which was removed in 2011. It should be noted that contaminated land assessment is outside the scope of this report.

## 2.6 Liquefaction and Lateral Spreading

### 2.6.1 Observed performance

A site walkover was performed by ENGCO on 31<sup>st</sup> October 2016. During the inspection, there was no evidence of any earthquake-induced land deformation remaining onsite. A summary of our desktop assessment and site walkover is provided below;

The “EQC Liquefaction Interpreted from Aerial Photography” map layers indicate that the property is located within an area where moderate to severe liquefaction was observed, following the June 2011 earthquake, and minor liquefaction was observed following the December 2011 earthquake. No liquefaction was observed following the September 2010 or February 2011 Earthquake.

The “EQC Liquefaction and Lateral Spreading Observations” map indicates no ground cracking or ejected liquefied material were reported at the site, following the February 2011 earthquake event. The road observation indicates no ejected liquefied material observed, after the June 2011 earthquake.

The “EQC Observed Ground Crack Locations” map indicates there were no ground cracks observed near the site, following the February 2011 earthquake.

## 3 FIELDWORK SUMMARY

### 3.1 Site Investigation

On behalf of ENGCO, Land Test Ltd carried out two Piezocone Penetration Tests (CPTu), four Dynamic Cone Penetrometer Tests (DCPs) and two Hand Augur Tests (HAs) on 31<sup>st</sup> October 2016. In addition, another CPT test was carried out on 15<sup>th</sup> November 2016. These deep investigations were carried out under the supervision of ENGCO’s Engineer. The results of both deep and shallow investigations are summarized in Table 1.

**Table 1: Location and Depth of Investigations**

| Test No | Investigations Type                    | Depth (m) |
|---------|----------------------------------------|-----------|
| 1       | Piezocone Penetration Tests (CPTu 1)   | 15m bgl   |
| 2       | Piezocone Penetration Tests (CPTu 2)   | 15m bgl   |
| 3       | Dynamic Cone Penetrometer (DCP1 & HA1) | 2.0m bgl  |
| 4       | Dynamic Cone Penetrometer (DCP2 & HA2) | 2.0m bgl  |
| 5       | Dynamic Cone Penetrometer (DCP3)       | 2.0m bgl  |
| 6       | Dynamic Cone Penetrometer (DCP4)       | 2.0m bgl  |

The locations of the DCP, HA and CPTu tests are shown on Figure 3, and the results are attached in Appendix 2.

### 3.2 Shallow Ground Condition

The shallow ground conditions encountered during the investigation have been interpreted from the HAs and DCPs. The subsurface conditions encountered are considered to be generally consistent with published geological information.

The inferred shallow ground condition from specific Hand Augers (HA) are provided in Table 2.

**Table 2: Inferred soil profile from Test Pits**

| HA1             | HA2             | Summary of Soil Type |
|-----------------|-----------------|----------------------|
| 0 to 0.3m bgl   | 0 to 0.3m bgl   | Sandy GRAVEL (FILL)  |
| 0.3 to 2.0m bgl | 0.3 to 2.0m bgl | Clayey SILT          |

### 3.3 Groundwater Regime

Groundwater was not encountered during the shallow investigation at this site, in October 2016. The GNS ground water elevation model indicates that the water table may vary between 0.0m and 1.0m bgl at this site. It should be noted that the ground water level may vary, seasonally.

For liquefaction analysis purposes, an in-situ groundwater depth of 2.0m bgl and a design groundwater level of 0.5m bgl were adopted.

### 3.4 Site subsoil class

In accordance with NZS1170.5, Section 3.1.3, site subsoil classification “*Class D – Deep or soft soil sites*” may be assumed for this site.

### 3.6 Deep Ground Condition

Based on the existing geotechnical information, the site-specific geotechnical investigation undertaken by ENGCO and the review of published information, the following ground model for the site has been inferred, as outlined in Table 3.

**Table 3: Inferred geological model**

| Soil Layer | Depth range(m bgl) | Soil Description                           |
|------------|--------------------|--------------------------------------------|
| Layer 1    | 0.0 to 6.0         | Clay & silty clay                          |
| Layer 2    | 0.6 to 16.5        | Sand & silty sand                          |
| Layer 3    | 16.5 to 24.5       | Clay & silty clay, Silty sand & sandy silt |
| Layer 4    | 24.5 to 24.7       | Silty sand & sandy silt, Gravel            |

## 4 EARTHQUAKE- INDUCED GROUND DEFORMATION

### 4.1 Predicted vertical deformation

Assessment of earthquake-induced ground deformation at the site has been carried out in accordance with MBIE Guidance, using proprietary liquefaction assessment software. The derivation of the procedures has been based on a conservative approach to give estimates of deformation that may be experienced in the earthquake scenarios at a free-field site, i.e. one with no building present, and not subject to lateral spreading. The results of this analysis are summarized in Table 4.

**Table 4: Estimated Total "Free-Field "Ground Surface Settlement from CPT and BH results**

| Earthquake Scenario | Moment Magnitude (Mw) | Peak Ground Acceleration(PGA,(m/s <sup>2</sup> )) | Settlement to tested depth (mm) | MBIE "Index Value"(settlement in Upper 10m) (mm) |
|---------------------|-----------------------|---------------------------------------------------|---------------------------------|--------------------------------------------------|
| SLS1                | 7.5                   | 0.13                                              | 65 - 90                         | 55 - 80                                          |
| SLS2                | 6.0                   | 0.19                                              | 75 - 100                        | 60 - 90                                          |
| ULS                 | 7.5                   | 0.35                                              | 155 - 165                       | 90 - 115                                         |

The liquefaction assessment results are provided in Appendix 2.

The analysis results indicates that a non-liquefiable soil layer is located between 3.0m bgl and 7.0m bgl, under ULS conditions.

### 4.2 Assessed lateral deformation

Following the procedure outlined in Section 12.2 of the MBIE Guidance, an assessment of the global lateral movement of the site and lateral stretch across the site has been undertaken and the results are outlined in Table 5.

**Table 5: Assessed lateral deformation at the site**

|                                                       |                                     |
|-------------------------------------------------------|-------------------------------------|
| Assessed global lateral movement category of the site | Minor to moderate (less than 300mm) |
| Assessed lateral stretch category of the site         | Minor to moderate (less than 200mm) |

Based on the Canterbury Geotechnical database (CGD) horizontal ground movement data, the site is categorized as being subject to minor to moderate global lateral movement. Site observations and subsequent analyses show that the site has been 'sufficiently tested at SLS' to a significant degree, and that a minor global lateral movement category is appropriate for this site.

We consider the risk of lateral spreading, as a result of liquefaction at this site, to be low, as there are no major cracks due to earthquake events (based on desktop studies). We consider that the risk of lateral stretch is in the minor to moderate category as there were no significant ground cracks identified at the site.

## 5 FOUNDATION RECOMMENDATION FOR THE DEVELOPMENT

### 5.1 Design considerations

At the time of preparation of this report, the anticipated foundation loads from the proposed structures were not known to ENGCO, but have been assumed to be based on a single level, heavyweight warehouse building. Due to the liquefaction risk at this site, conventional shallow foundations are not recommended.

A specifically designed, piled foundations is a viable solution for the proposed building. The piles would need to be founded at a depth of 12.5m bgl. It should be noted that pile driving operations can cause vibration to adjacent buildings and suitable pile installation methods should be considered for the pile driving, including the potential use of screw piles. The piled foundation solution would require minimal excavation, as the structural loads would be transferred through the piles. It should be noted that the soil layer between 12m and 16m bgl has sufficient bearing capacity (>15MPa) and thickness, to resist superstructure loads, under SLS earthquake conditions.

The design of the building structure and foundations must be carried out to ensure that, as a minimum, SLS and ULS Building Code performance requirement are fulfilled (e.g. low probability of causing loss of amenity through undue deformation, for SLS events, and low probability of rupturing, becoming unstable, losing equilibrium or collapsing, for ULS events).



## 6. Construction Observation

### 6.1 Pavement Areas

It is generally advisable that any un-engineered fill or unsuitable material be removed from under any pavement areas, prior to construction, and replaced with compacted granular fill. However, based upon our assessment, the density of existing soils may be adequate for the support of access ways.

### 6.2 Underground Services

Flexible connections should be constructed where all service drains and ducts enter/exit the concrete floor slabs. Service trench backfill within 1.5m of the buildings is to comprise well graded crushed stone aggregate (i.e. CAP 20), compacted from the surface only.

### 6.3 Storm water

Concentrated storm water flows from all impermeable areas must be collected and carried in sealed pipes to the Council system. Uncontrolled storm water flows must not be allowed to run onto or saturate the ground so as to adversely affect foundation performance, both statically and during future seismic activity (liquefaction potential and liquefaction induced settlement are both increased with a higher groundwater table, resulting from uncontrolled disposal of storm water).

## 7 Limitations and Restrictions on Building Consents

### 7.1 Construction of building on land subject to natural hazards

In terms of Section 71 of the Building Act 2004, Christchurch City Council has an obligation to consider the following matters, and to refuse consent unless satisfied that measures have been or will be taken to remedy identified hazards:

- Erosion, including surface and subsurface erosion, associated with water and wind;
- Falling debris, including rockfall that could impact the site from upslope sources;
- Subsidence, which involves the removal of underlying support by natural or artificial means;
- Slippage, which is defined as the downslope transfer of materials by sliding and/or flowage;
- Inundation, including flooding, overland flow, storm surge, tidal effects, and ponding.

Provided adequate stormwater drainage is in place, erosion is not considered an issue at this site.

As the site is situated on the flat, falling debris is not an issue. Due to the moderate to high potential for soils to liquefy at ULS levels of seismic shaking beneath the site, minor to moderate subsidence could occur during an earthquake event. Provided a foundation system per the recommendations of this report (Section 5.0) is constructed, we consider the proposed foundation system will comply with MBIE industrial building guidance performance criteria. There are no other potential subsidence and/or settlement processes that could

adversely affect the foundation system. The site is far removed from any free edge or major waterway. In terms of slippage, lateral movement is considered to be consistent with the minor category during a ULS seismic event. ENGCO is satisfied that there are no geotechnical issues pertaining to Section 71 of the Building Act 2004 that cannot be addressed by appropriate foundation design and drainage on the site.

## 8 REFERENCES

- 1) Ministry of Business, Innovation and Employment (MBIE) 2012. Repairing and rebuilding houses affected by the Canterbury earthquakes. Ministry of Business, Innovation and Employment. Available from: <http://www.building.govt.nz/guidance-on-repairs-after-earthquake>.
- 2) Ministry of Business, Innovation and Employment (MBIE) 2014. Clarifications and updates to the Guidance 'Repairing and rebuilding houses affected by the Canterbury earthquakes'. Issue 7.
- 3) Forsyth, P.J.; Barrell, D.J.A; Jongens, R. 2008: Sheet 16 - Geology of the Christchurch Area 1:250,000. Institute of Geological and Nuclear Sciences, Lower Hutt.
- 4) <http://llur.ecan.govt.nz>
- 5) Canterbury Geotechnical Database. EQC Liquefaction Interpreted from Aerial Photography. Map layer CGD0200 – 11 Feb 2013
- 6) Canterbury Geotechnical Database. EQC Liquefaction and Lateral Spreading Observations. Map layer CGD0300 – 11 Feb 2013
- 7) Canterbury Geotechnical Database. EQC Observed Ground Crack Locations. Map layer CGD0400 – 23 Jul 2012
- 8) van Ballegooy, S., Wentz, F. J. & Boulanger, R. W. 2015c. Evaluation of a CPT-based liquefaction procedure at regional scale. Soil Dynamics and Earthquake Engineering, Special Issue: Liquefaction in New Zealand and Japan
- 9) Boulanger, R. W. & Idriss, I. M. 2014. CPT and SPT based liquefaction triggering procedures. (Report No. UCD/CGM-14/01). Center for Geotechnical Modelling, Department of Civil and Environmental Engineering, University of California, Davis, CA
- 10) Robertson and Wride, 1998. Evaluating cyclic liquefaction potential using the cone penetration test. Canadian Geotechnical Journal, Vol. 35, pp. 442 – 459
- 11) Zhang, G., Robertson, P. K., & Brachman, R. W. I. (2002). Estimating liquefaction induced ground

settlements from CPT for level ground, Canadian Geotechnical Journal, 39, 1168–80

12) Ministry of Business, Innovation and Employment (MBIE) 2015. Repairing and rebuilding houses affected by the Canterbury earthquakes - Section 15.3 Updated guidance on site ground improvement, Christchurch.

## 9 LIMITATIONS

### 9.1 General

This report, prepared by ENGCO, at the request of our Client, is exclusively for our Client's use, is not to be relied upon by any other person, and is strictly limited to the matters herein.

No responsibility or liability to any third party is accepted for any loss or damages whatsoever arising out of the use of or reliance on this report by any third party, outside of our Client. Nor may the report be used for any other property than the one specified.

The report and its contents are not to be quoted or published without ENGCO's consent.

### 9.2 Geotechnical

The conclusions of the report are based on the interpretation of a limited number of tests at specific locations, and information gathered from nearby sites and other sources. It shall not be relied upon for any other purpose. The reliance by other parties on the information or opinions contained in this report shall, without our prior review and agreement in writing, be at such parties' sole risk. ENGCO will not accept liability for global stability issues on this site where investigation on a single lot could not reasonably assess the global stability issues.

During excavation and construction, the site should be examined by a Geotechnical Engineer to judge whether the exposed subsoils are compatible with the inferred conditions. It is possible that the nature of the exposed subsoils may require further investigation and the modification of the design based on this report. In any event, it is essential that ENGCO is notified if there is any variation in subsoil conditions from those described in the report, as it may affect the design parameters recommended in the report. There is no investigation, which is thorough enough to preclude the presence of materials at the site, which presently, or in the future, may be considered hazardous.

Should you require any further information, please contact the ENGCO office on 03 366 7955



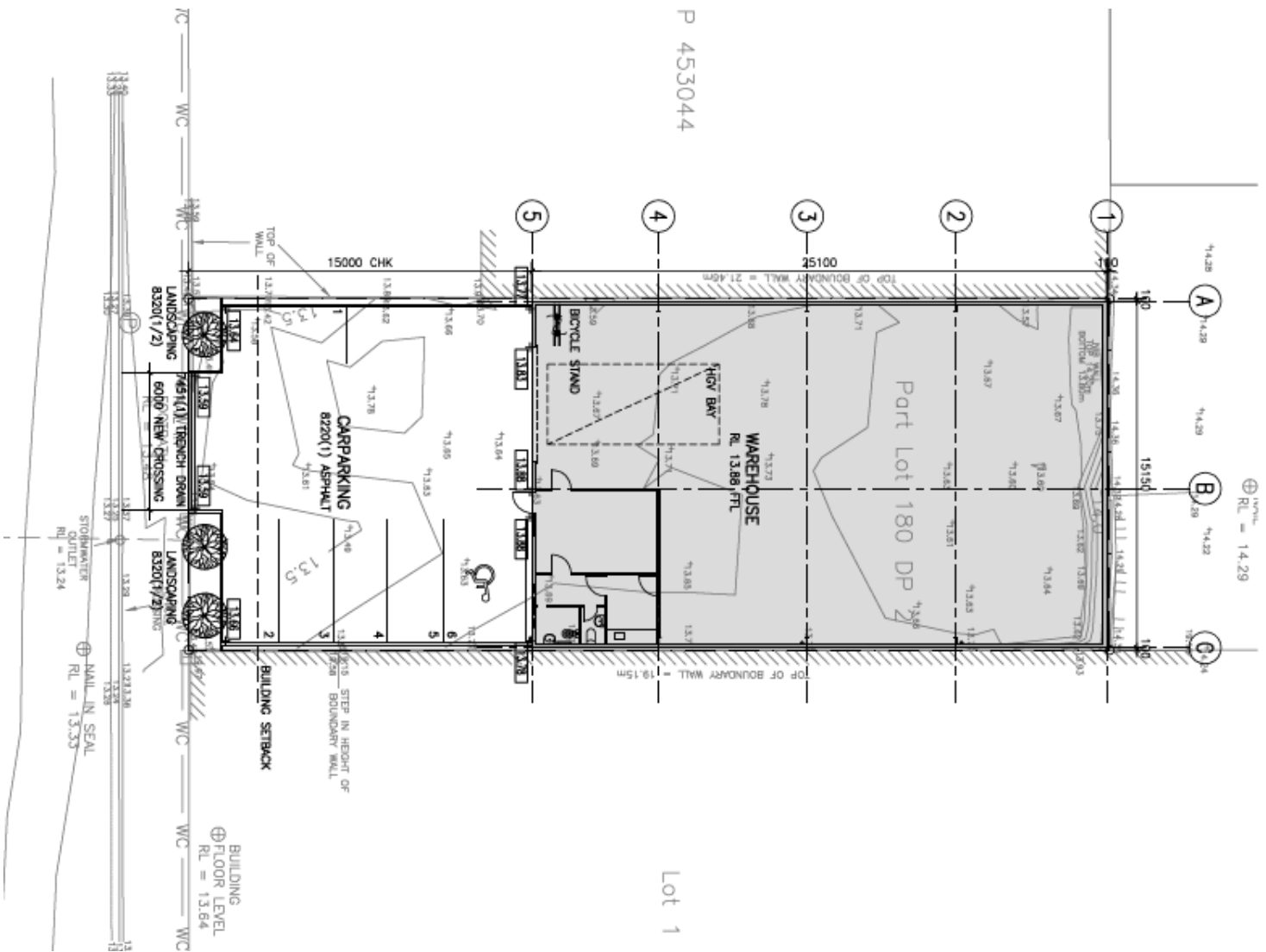
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Consulting Engineers

# Appendix I

Figure 1- Site location plan

Figure 2- Site Location plan Showing MBIE Technical Category Map

Figure 3- Field Investigation Location



P 453044

Lot 1

|                                                                                     |            |       |      |            |           |                                  |
|-------------------------------------------------------------------------------------|------------|-------|------|------------|-----------|----------------------------------|
|  | Figure     | I     | Date | 23/11/2016 | Title     | Site boundary & Development Area |
|                                                                                     | Project No | I6363 |      |            | Reference | N/A                              |

# 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):

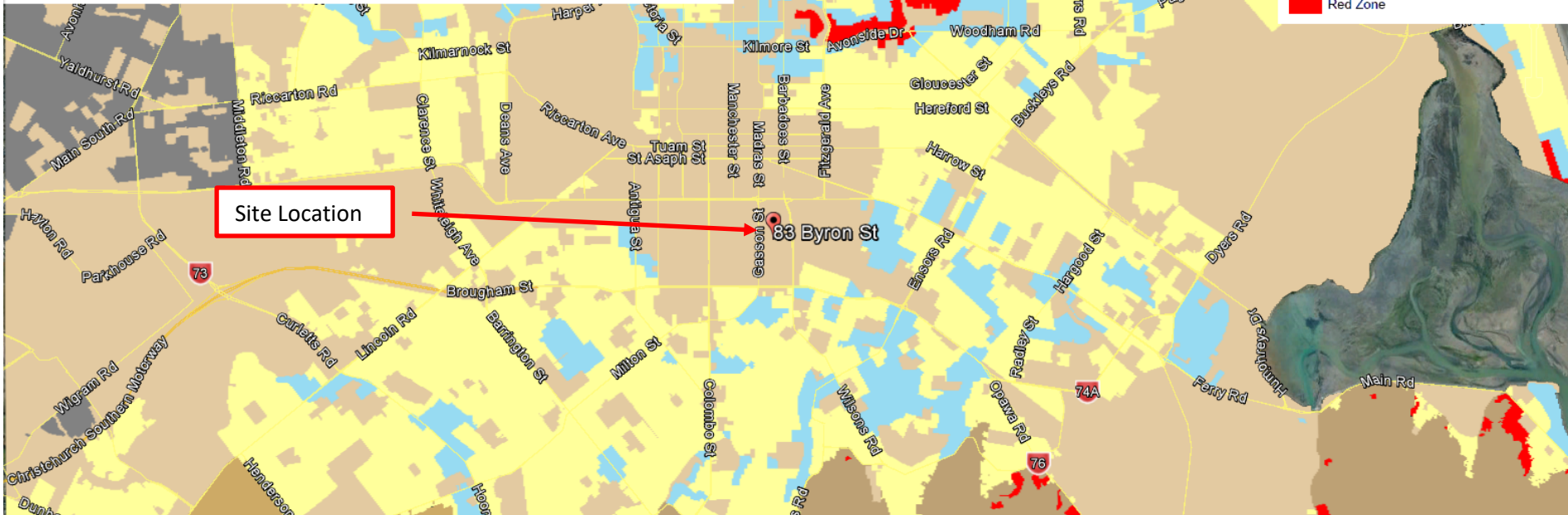
Minor to moderate land damage from liquefaction is possible in future large earthquakes. Lightweight construction or enhanced foundations are likely to be required such as enhanced concrete raft foundations (ie, stiffer floor slabs that tie the structure together).

## Foundation Technical Category 3 (TC3):

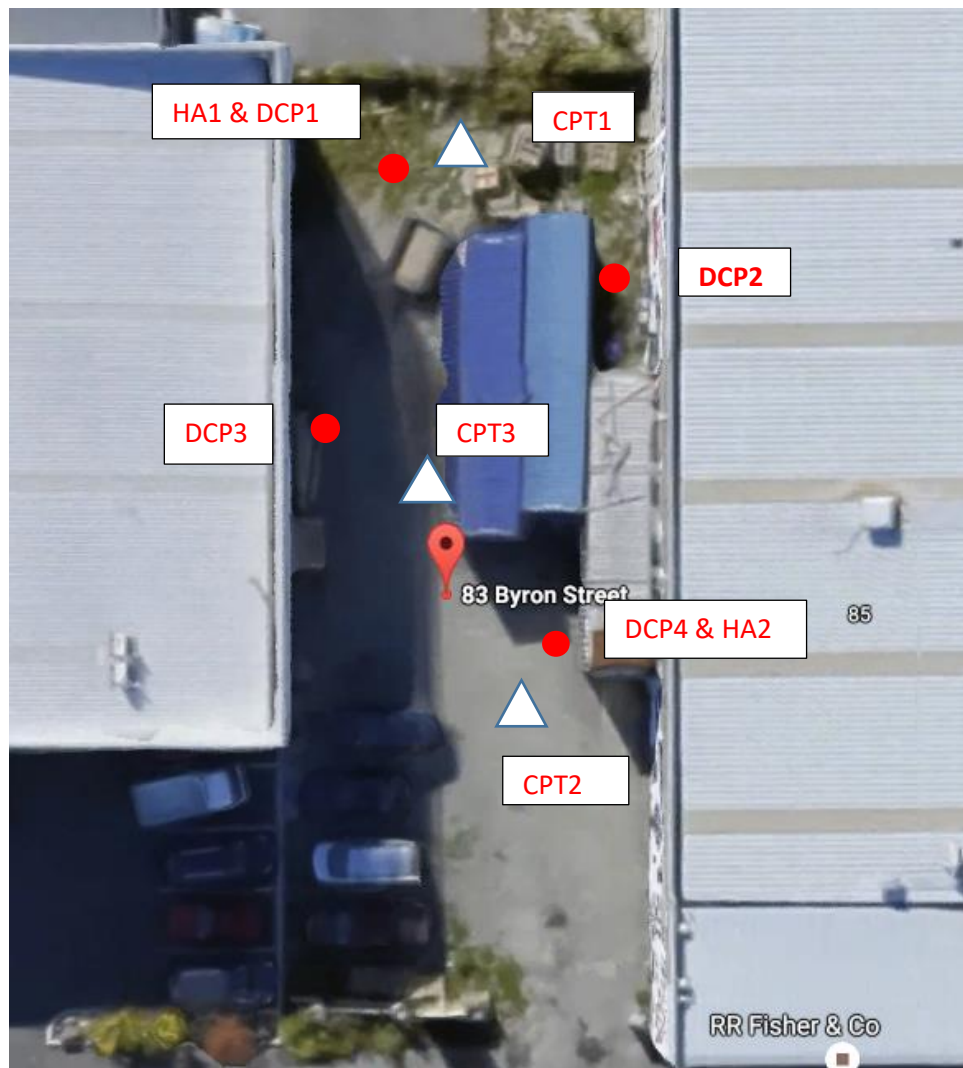
Moderate to significant land damage from liquefaction is possible in future large earthquakes. Foundation solutions should be based on site-specific geotechnical investigation and specific engineering foundation design.

## 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.



|            |       |      |            |           |                                                      |
|------------|-------|------|------------|-----------|------------------------------------------------------|
| Figure     | 2     | Date | 23/11/2016 | Title     | Site Location Plan showing MBIE Technical Categories |
| Project No | 16363 |      |            | Reference | Canterbury Geotechnical Database.                    |



|                                                                                     |            |       |      |            |           |                               |
|-------------------------------------------------------------------------------------|------------|-------|------|------------|-----------|-------------------------------|
|  | Figure     | 3     | Date | 23/11/2016 | Title     | Field Investigation Locations |
|                                                                                     | Project No | 16363 |      |            | Reference | N/A                           |





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# Appendix 2

Liquefaction Assessment Results

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.13              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.13              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.13              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 6.00              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.19              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 6.00              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.19              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 6.00              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.19              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.35              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |



Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.35              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |

Liquefaction analysis overall plots

Input parameters and analysis data

|                   |                           |              |            |
|-------------------|---------------------------|--------------|------------|
| B&I (2014)        | Depth to GWT (erthq.):    | 0.50 m       | N/A        |
| B&I (2014)        | Average results interval: | 3            | Yes        |
| Based on Ic value | Ic cut-off value:         | 2.60         | Yes        |
| 7.50              | Unit weight calculation:  | Based on SBT | Sands only |
| 0.35              | Use fill:                 | No           | No         |
| 2.00 m            | Fill height:              | N/A          | N/A        |

F.S. color scheme

|                                                                                       |                                             |
|---------------------------------------------------------------------------------------|---------------------------------------------|
|  | Almost certain it will liquefy              |
|  | Very likely to liquefy                      |
|  | Liquefaction and no liq. are equally likely |
|  | Unlike to liquefy                           |
|  | Almost certain it will not liquefy          |

LSN color scheme

|                                                                                       |                                         |
|---------------------------------------------------------------------------------------|-----------------------------------------|
|  | Severe damage                           |
|  | Major expression of liquefaction        |
|  | Moderate to severe exp. of liquefaction |
|  | Moderate expression of liquefaction     |
|  | Minor expression of liquefaction        |
|  | Little to no expression of liquefaction |



**ENGCO**  
Consulting Engineers

# Appendix 3

Shallow Geotechnical Investigation Results

# HAND AUGER & SCALA LOG

Job Number: 16412

Client: ENGCO  
Project: 83 Byron Street

Test Label: DCP02

Site Location: 83 Byron Street, Christchurch

Test Date: 31/10/2016

Coordinates: -43.542160, 172.644481 (WGS84)

Groundwater Level: Not encountered

Operator: Logan Allan

Logger: Jozef Knottenbelt

Hole Depth: 2m

Surface Conditions: Grass

| Hand Auger<br>Geological Interpretation | Legend | Water                       | Depth (m) | Scala Penetrometer<br>(Blows / 100mm) |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|-----------------------------------------|--------|-----------------------------|-----------|---------------------------------------|---|---|---|----|----|----|----|----|--|--|----|----|----|----|
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           | 2                                     | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |  |  |    |    |    |    |
|                                         |        | Groundwater Not Encountered |           |                                       |   | 7 |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           | 2                                     |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           | 2                                     |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       | 4 |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             | 0.5       |                                       | 3 |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           | 2                                     |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       | 4 |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   | 7 |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             | 1.0       |                                       |   |   | 8 |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   | 11 |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    | 15 |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    | 18 |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  | 20 |    |    |    |
|                                         |        |                             | 1.5       |                                       |   |   |   |    |    |    |    |    |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    | 18 |  |  |    |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  | 20 |    |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  |    | 19 |    |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  |    |    | 16 |    |
|                                         |        |                             |           |                                       |   |   |   |    |    |    |    |    |  |  |    |    |    | 20 |

## Remarks

Testing carried out to New Zealand Standard 4402:1986 (Test 6.5.2.1988)

# HAND AUGER & SCALA LOG

Job Number: 16412

Client: ENGCO  
Project: 83 Byron Street

Test Label: DCP03

Site Location: 83 Byron Street, Christchurch

Test Date: 31/10/2016

Coordinates: -43.542241, 172.644351 (WGS84)

Groundwater Level: Not encountered

Operator: Logan Allan

Logger: Jozef Knottenbelt

Hole Depth: 2m

Surface Conditions: Gravel

| Hand Auger<br>Geological Interpretation |  |                             | Legend | Water | Depth (m) | Scala Penetrometer<br>(Blows / 100mm) |   |   |   |    |    |    |    |    |  |  |  |  |  |
|-----------------------------------------|--|-----------------------------|--------|-------|-----------|---------------------------------------|---|---|---|----|----|----|----|----|--|--|--|--|--|
|                                         |  |                             |        |       |           | 2                                     | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |  |  |  |  |  |
|                                         |  | Groundwater Not Encountered |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |
|                                         |  |                             |        |       |           |                                       |   |   |   |    |    |    |    |    |  |  |  |  |  |

## Remarks

Testing carried out to New Zealand Standard 4402:1986 (Test 6.5.2.1988)

# HAND AUGER & SCALA LOG

Job Number: 16412

Client: ENGCO  
Project: 83 Byron Street

Test Label: HA01/SP01

Site Location: 83 Byron Street, Christchurch  
Test Date: 31/10/2016  
Coordinates: -43.542137, 172.644341 (WGS84)  
Groundwater Level: Not encountered

Operator: Logan Allan  
Logger: Jozef Knottenbelt  
Hole Depth: 2m  
Surface Conditions: Grass

| Hand Auger<br>Geological Interpretation                                                                                         | Legend | Water                       | Depth (m) | Scala Penetrometer<br>(Blows / 100mm) |   |   |   |    |    |    |    |    |       |
|---------------------------------------------------------------------------------------------------------------------------------|--------|-----------------------------|-----------|---------------------------------------|---|---|---|----|----|----|----|----|-------|
|                                                                                                                                 |        |                             |           | 2                                     | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |       |
| Sandy Gravelly SILT; with minor tiles and trace brick, dark brown/black, medium dense to very dense, damp, grey clasts(rounded) |        | Groundwater Not Encountered |           |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   |   | 8 |    |    |    |    |    |       |
| Sandy SILT; blue/grey with orange mottles, dense, damp, low plasticity                                                          |        |                             |           |                                       |   |   |   |    |    |    |    |    | 28 >> |
|                                                                                                                                 |        |                             |           |                                       |   |   |   | 9  |    |    |    |    |       |
| SILT; black with orange mottles, loose, damp, moderate plasticity                                                               |        |                             |           |                                       | 3 |   |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             | 0.5       |                                       | 3 |   |   |    |    |    |    |    |       |
| clayey SILT; green/blue, medium dense, damp, high plasticity                                                                    |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
| clayey SILT; grey/blue with orange mottles, medium dense, damp, high plasticity                                                 |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   | 5 |   |    |    |    |    |    |       |
| clayey SILT; grey/blue with orange mottles, medium dense to dense, wet, high plasticity                                         |        |                             | 1.0       |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   |   |   | 10 |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   |   |   | 9  |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   |   | 7 |    |    |    |    |    |       |
|                                                                                                                                 |        |                             | 1.5       |                                       |   |   | 7 |    |    |    |    |    |       |
| clayey SILT; grey/blue, medium dense, wet, high plasticity                                                                      |        |                             |           |                                       |   |   | 7 |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
|                                                                                                                                 |        |                             |           |                                       |   | 6 |   |    |    |    |    |    |       |
| clayey SILT; grey/blue, medium dense, saturated, high plasticity,                                                               |        |                             |           |                                       |   |   | 7 |    |    |    |    |    |       |

## Remarks

Testing carried out to New Zealand Standard 4402:1986 (Test 6.5.2.1988)

# HAND AUGER & SCALA LOG

Job Number: 16412

Client: ENGCO  
Project: 83 Byron Street

Test Label: HA02/DCP04

Site Location: 83 Byron Street, Christchurch  
Test Date: 31/10/2016  
Coordinates: -43.542315, 172.644489 (WGS84)  
Groundwater Level: Not encountered

Operator: Jozef Knottenbelt  
Logger: Logan Allan  
Hole Depth: 2m  
Surface Conditions: Gravel

| Hand Auger<br>Geological Interpretation                                               | Legend | Water                       | Depth (m) | Scala Penetrometer<br>(Blows / 100mm) |   |   |   |    |    |    |    |    |    |
|---------------------------------------------------------------------------------------|--------|-----------------------------|-----------|---------------------------------------|---|---|---|----|----|----|----|----|----|
|                                                                                       |        |                             |           | 2                                     | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |    |
| Sandy GRAVEL; Grey clasts brown matrix, very dense, damp, rounded clasts, well graded |        | Groundwater Not Encountered |           |                                       |   |   |   |    |    |    |    |    |    |
| SILT; dark brown/black, medium dense, moist, plastic                                  |        |                             |           |                                       |   |   |   |    |    |    |    |    | 19 |
|                                                                                       |        |                             |           |                                       | 4 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             | 0.5       |                                       | 4 |   |   |    |    |    |    |    |    |
| SILT; blue/grey, medium dense, moist, high plasticity                                 |        |                             |           |                                       | 3 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 5 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
| SILT; light brown, dense, moist, high plasticity                                      |        |                             | 1.0       |                                       |   | 7 |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       |   | 7 |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       |   | 7 |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       |   | 7 |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       |   |   |   | 10 |    |    |    |    |    |
|                                                                                       |        |                             | 1.5       |                                       |   |   | 8 |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
| SILT; light brown, dense, wet, high plasticity                                        |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |
|                                                                                       |        |                             |           |                                       | 6 |   |   |    |    |    |    |    |    |

## Remarks

Testing carried out to New Zealand Standard 4402:1986 (Test 6.5.2.1988)

Scalar prehole to 0.3m

**From:** Nigel Walsh [info@mecserve.co.nz](mailto:info@mecserve.co.nz)  
**Subject:** RE: Attention Nigel Ventilation commissioning PS1 & PS4  
**Date:** 25 July 2017 3:37 pm  
**To:** Adrian [adrian@architecturaldesigngroup.co.nz](mailto:adrian@architecturaldesigngroup.co.nz)

---

Hi Adrian

Yes we are able to submit a PS1 and PS4 for this project.

We would estimate a cost of \$450.00 to \$550.00 +GST

Regards



---

**From:** Adrian [<mailto:adrian@architecturaldesigngroup.co.nz>]  
**Sent:** Monday, July 24, 2017 9:09 AM  
**To:** [info@mecserve.co.nz](mailto:info@mecserve.co.nz)  
**Subject:** Attention Nigel Ventilation commissioning PS1 & PS4

Hi Nigel,

My name is Adrian, I am a architectural technician for ADG here in Tauranga, further to our conversation on the phone today. I have received an RFI from Christchurch City Council (see below) for a project we are working on in Byron Street, Sydenham, Christchurch.

**Specialist Review : Mechanical Ventilation (Nick Waddington - 7/4/17)**

SER - 001 The specialist services reviewer of this application requires the following additional information:

Please provide PS1 (Design) and associated design details, showing Compliance with Clauses G4 and H1.3.6 of the New Zealand Building Code. Also, a schedule of inspections to be

undertaken by the engineer with confirmation that 'as built' drawings and a PS4 will be provided on successful commissioning of the ventilation systems. Response received 12/7/17

does not address RFI.

I have attached related consent drawings for your use in calculating volumes etc the ablution rooms are quite small and have no window.

The meeting room and other office that have sky lights are 24 and 22% for natural ventilation



Basically I will need conformation for Council that you are able to issue a PS1 and a schedule of inspection, as built drawings and PS4 when commissioning is completed. Ventilation units Specification attached to this email also.

Our client would like some idea of costs before proceeding if possible.

Thanks

Regards,  
Adrian

Consenting & Compliance Group

# Producer statement design (PS1)

**To be completed by the design professional who has been engaged to provide a PS1**

Author name:

Nigel Walsh

Author company:

Mecserve Ltd

Site address:

80 Byron Street

Legal description:

Engaged by:

Architectural Design Group

To provide design services in respect of: ☒ part ☐ all

*(describe work)*

Design for toilet extraction for disabled toilet and stanard toilet. Meeting rooms and other office natural ventilation.

NZBC clauses:

*[select as applicable]*

- |                                        |                                        |                             |                             |                             |                             |                              |                              |                              |                              |                              |                              |
|----------------------------------------|----------------------------------------|-----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|------------------------------|
| <input type="checkbox"/> B1            | <input checked="" type="checkbox"/> B2 | <input type="checkbox"/> C1 | <input type="checkbox"/> C2 | <input type="checkbox"/> C3 | <input type="checkbox"/> C4 | <input type="checkbox"/> C5  | <input type="checkbox"/> C6  | <input type="checkbox"/> D1  | <input type="checkbox"/> D2  | <input type="checkbox"/> E1  | <input type="checkbox"/> E2  |
| <input type="checkbox"/> E3            | <input type="checkbox"/> F1            | <input type="checkbox"/> F2 | <input type="checkbox"/> F3 | <input type="checkbox"/> F4 | <input type="checkbox"/> F5 | <input type="checkbox"/> F6  | <input type="checkbox"/> F7  | <input type="checkbox"/> F8  | <input type="checkbox"/> G1  | <input type="checkbox"/> G2  | <input type="checkbox"/> G3  |
| <input checked="" type="checkbox"/> G4 | <input type="checkbox"/> G5            | <input type="checkbox"/> G6 | <input type="checkbox"/> G7 | <input type="checkbox"/> G8 | <input type="checkbox"/> G9 | <input type="checkbox"/> G10 | <input type="checkbox"/> G11 | <input type="checkbox"/> G12 | <input type="checkbox"/> G13 | <input type="checkbox"/> G14 | <input type="checkbox"/> G15 |
| <input type="checkbox"/> H1            |                                        |                             |                             |                             |                             |                              |                              |                              |                              |                              |                              |

NB: All statements must include B2

The design has been prepared in accordance with:

☒ Approved documents issued by the Ministry of Business, Innovation and Employment *(verification method / acceptable solution)*

G4 and H1.3.6 of the New Zealand building code.

☐ Alternative solution *(attach schedule if required)*

The proposed building work covered by this producer statement design is described on the drawings referenced below, together with the specifications and other documents set out in the schedule attached to this statement:

Drawing title:

Proposed Additions  
80 Byron Street  
Christchurch  
For Clip and Climb

Drawing numbers:

A4 A6

The producer statement is subject to:

(i) Site verification of the following design assumptions:

The size of the toilets and offices doe not increase in cubic mtrs. Increase in maxium occupancy and intended use.

(ii) All proprietary products meeting their performance specification requirements

I believe on reasonable grounds that the proposed building work, will comply with the relevant provisions of the Building Code if constructed in accordance with the drawings, specifications and other documents provided or listed with this statement.

I understand that the Council may rely on this producer statement for the purposes of establishing compliance with the relevant provisions of the Building Act 2004, Building Regulations and Building Code. I confirm that I hold a current policy of professional indemnity insurance to the value required by the Council.

Construction monitoring is: ☒ Not required ☐ Required

If required, please list below:

|  |
|--|
|  |
|--|

(Agreement must be attached)

Signature:



Date:

26/7/17

☐ ACENZ

☐ IPENZ

☐ CPENG

☐ NZIA

☒ Other (specify):

IRACE

1127

(Membership number)

Practice Area:

Canterbury /Westland

Address:

60 Aikmans Road Christchurch

Postcode:

8104

Phone:

03 3554840

Fax:

03 3664221

Mobile:

0274335593

Email:

inf@mecserve.co.nz

Comments:

|  |
|--|
|  |
|--|

**From:** Robert Warner [robert.warner@cosgroves.com](mailto:robert.warner@cosgroves.com)   
**Subject:** RE: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 revised - Fire  
**Date:** 18 July 2017 12:33 pm  
**To:** Adrian [adrian@architecturaldesigngroup.co.nz](mailto:adrian@architecturaldesigngroup.co.nz)  
**Cc:** Nick Chen [nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com), [jt@clipnclimb.com](mailto:jt@clipnclimb.com)

---

Hi Adrian,

Following your discussions with our Nick Chen yesterday, please find attached Emergency Lighting design and documentation for the above Consent application, for your information and use, inclusive of Ps1-Design Producer statement and PN22 Fire Coordination statement.

Attached also is a pro forma 'PS3-Construction' producer statement, for use by the successful electrical contractor, in the case they do not have their own form.

Once the installation is completed we should be notified and an inspection, witness test and sign off with PS4 issue can then be programmed. The electrical contractor will need to provide supporting documents at completion inclusive of: their Certificate of Compliance and PS3 producer statement, along with a completed test sheet (pro forma included) and a marked up "As Built" plan.

Should you have any queries or seek additional clarification please contact us to discuss.

Regards,

**Robert Warner** | Senior Engineer (Electrical)

Cosgroves Ltd | Level 3, ASB House, 518 Colombo Street | PO Box 842, Christchurch 8140

**T** +64 3 377 8600 | **M** +64 27 382 8323 | **DDI** +64 3 378 3819 | **W** [www.cosgroves.com](http://www.cosgroves.com)



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---

**From:** Nick Chen [<mailto:nick.chen@cosgroves.com>]  
**Sent:** Monday, 17 July 2017 9:35 a.m.  
**To:** 'Adrian' <[adrian@architecturaldesigngroup.co.nz](mailto:adrian@architecturaldesigngroup.co.nz)>  
**Cc:** Robert Warner <[robert.warner@cosgroves.com](mailto:robert.warner@cosgroves.com)>  
**Subject:** FW: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 revised - Fire

Hi Adrian,

We will endeavour to send the emergency lighting and exit sign design docs to you tomorrow. Thanks

Kind Regards

Nick Chen  
BE(Hon), ME(Fire), CPEng, MIPENZ  
Senior Fire Engineer  
Cosgroves Ltd  
03 377 8600  
027 520 9292

---

**From:** Adrian [<mailto:adrian@architecturaldesigngroup.co.nz>]  
**Sent:** Monday, 17 July 2017 9:11 AM  
**To:** Nick Chen <[nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com)>  
**Subject:** Re: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 revised - Fire

Hi Nick,  
do you have any ETA for the emergency lighting design?

Regards,  
Adrian



All information contained in this email and any files transmitted with it are confidential. If you are not the intended recipient you must not use, disclose copy or distribute the information contained in it. If you have received this message in error, please notify the sender and delete it from your system. Every effort is made to ensure these emails are free from viruses; however this cannot be guaranteed. PLEASE CONSIDER THE ENVIRONMENT BEFORE PRINTING THIS EMAIL

On 14/07/2017, at 1:22 pm, Nick Chen <[nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com)> wrote:

Hi Adrian,

I wonder what have made them change their mind on FIR-005? Did you talk to them or they have come to sense and realised they are wrong?

Kind Regards

Nick Chen  
BE(Hon), ME(Fire), CPEng, MIPENZ  
Senior Fire Engineer  
Cosgroves Ltd  
03 377 8600  
027 520 9292

---

**From:** Adrian [<mailto:adrian@architecturaldesigngroup.co.nz>]  
**Sent:** Friday, 14 July 2017 1:16 PM  
**To:** Nick Chen <[nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com)>  
**Cc:** John Targett <[jt@clipnclimb.com](mailto:jt@clipnclimb.com)>  
**Subject:** Fwd: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 revised - Fire

Hi Guys,  
trying to forward you the email from Jonathan but it didn't include the amended RFI list, i've attached it as a PDF so you get it this time for your records.

Regards,  
Adrian





Em Ltg  
Docs\_CC1...8.07.17.pdf



## MEMO

**To:** Architectural Design Group - Adrian  
**CC:** John Targett – Clip n Climb International  
**From:** Robert Warner  
**File Ref:** CC16175 E  
**Date:** 18.07.17  
**Re:** EQ strengthening & Proposed Office, 80 Byron Street, Christchurch –  
Emergency Lighting

---

Dear Sir,

We have reviewed the emergency lighting requirements for the above job and enclose the following documents:

1. PDF generated sketch drawing, referenced CC16175-EL.01, indicating the locations of emergency luminaires and emergency switching. Complete with accompanying Document Transfer sheet, applicable Legend and separately attached, drawing notes specification sheets, indicating the typical emergency luminaires and emergency switching Lighting control diagram.
2. Specification clauses to be inserted within your specification that specify the installation methods, connection details, test log books, maintenance etc. of the emergency lighting installation. Please Note: Luminaire Schedule has been detailed on the layout drawing and is the minimum expectation specified emergency exit luminaires and fittings.
3. PS1 – Design Producer Statement and Fire Coordination Statement which must be attached/enclosed in final Consent submission package
4. PS3 – Construction Producer Statement and Emergency lighting Test sheet for the installation Contractor's use as appropriate

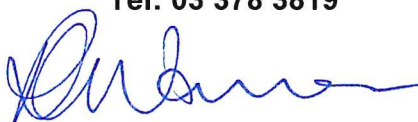
Note: Emergency lighting design and luminaires as shown on the drawings meets the minimum requirement for emergency lighting under the relevant NZ Building Codes. The client may wish to provide further emergency lighting above and beyond this minimum requirement.

If you have any further questions or queries regarding this project, please contact us.

Kind regards,

**Robert Warner**  
**Cosgroves**

**Tel: 03 378 3819**



## PRODUCER STATEMENT – PS1 – DESIGN

(Guidance notes on the use of this form are printed on page 2)

**ISSUED BY:**.....COSGROVES LIMITED.....  
 (Design Firm)

**TO:**.....CLIP n CLIMB INTERNATIONAL c/- ARCHITECTURAL DESIGN GROUP.....  
 (Owner/Developer)

**TO BE SUPPLIED TO:**...CHRISTCHURCH CITY COUNCIL.....  
 (Building Consent Authority)

**IN RESPECT OF:**.....EMERGENCY LIGHTING & EXIT SIGNAGE DESIGN & DOCUMENTS.....  
 (Description of Building Work)

**AT:**... EQ STRENGTHENING & PROPOSED OFFICE, 80 BYRON STREET, CHRISTCHURCH.....  
 (Address)

.....**LOT**...1...**DP** .....449853..... **SO** .....

We have been engaged by the owner/developer referred to above to provide EMERGENCY LIGHTING & EXIT SIGNAGE DESIGN AND DOCUMENTATION....services in respect of the requirements of  
 (Extent of Engagement)

Clause(s) .....F6 & F8 (Part).....of the Building Code for

All ☒ or Part only ☐ (as specified in the attachment to this statement), of the proposed building work.

The design carried out by us has been prepared in accordance with:

☒ Compliance Documents issued by the Ministry of Business, Innovation & Employment...NZBC F6/AS1 & F8/AS1 (Part).....or

(verification method / acceptable solution)

☐ Alternative solution as per the attached schedule.....

The proposed building work covered by this producer statement is described on the drawings titled EQ STRENGTHENING & PROPOSED OFFICE, 78 BYRON ST., CHRISTCHURCH – EMERGENCY LIGHTING LAYOUT

.....and numbered .....CC16175-EL.01 .....

together with the specification, and other documents set out in the schedule attached to this statement.

**On behalf of the Design Firm, and subject to:**

(i) Site verification of the following design assumptions .....NONE.....

(ii) All proprietary products meeting their performance specification requirements;

I **believe on reasonable grounds** that a) the building, if constructed in accordance with the drawings, specifications, and other documents provided or listed in the attached schedule, will comply with the relevant provisions of the Building Code and that b), the persons who have undertaken the design have the necessary competency to do so. I also recommend the following level of construction monitoring/observation:

☐ CM1 ☒ CM2 ☐ CM3 ☐ CM4 ☐ CM5 (Engineering Categories) Or ☐ as per agreement with owner/developer (Architectural)

I, **STEPHEN PAGE** am: ☒ CPEng 216143 #  
 (Name of Design Professional)

☐ Reg Arch ..... #

I am a Member of : ☒ IPENZ ☐ NZIA and hold the following qualifications: B.E. (ELEC) The Design Firm issuing this statement holds a current policy of Professional Indemnity Insurance no less than \$200,000\*.

The Design Firm is a member of ACENZ: ☒

**SIGNED BY** ...STEPHEN PAGE..... **ON BEHALF OF** ...COSGROVES LIMITED...  
 (Design Firm)

**Date:** 18th JULY 2017 ..... (signature).....

*Note: This statement shall only be relied upon by the Building Consent Authority named above. Liability under this statement accrues to the Design Firm only. The total maximum amount of damages payable arising from this statement and all other statements provided to the Building Consent Authority in relation to this building work, whether in contract, tort or otherwise (including negligence), is limited to the sum of \$200,000\*.*

This form is to accompany **Form 2 of the Building (Forms) Regulations 2004** for the application of a Building Consent.

THIS FORM AND ITS CONDITIONS ARE COPYRIGHT TO ACENZ, IPENZ AND NZIA



**Fire Design Coordination Statement for Electrical Services**  
(in accordance with IPENZ Practice Note 22)



PROJECT: EQ Strengthening & Proposed Office – 80 Byron Street, Christchurch  
JOB NO: CC16175 E

**STATEMENT OF COORDINATION:**

This Design Coordination Statement is to be provided to the Building Consent Authority, and is intended to accompany the documents submitted in the building consent application.

The Fire Report, rev B, prepared by Cosgroves Ltd, for New Tyre Workshop, 7 Shirley Road, Christchurch, issued 07.11.16 has been reviewed by Cosgroves Ltd – Electrical Engineer.

We believe on reasonable grounds that the relevant elements of the associated Report detailed above have been incorporated into our design of the electrical services systems proposed, as described on COSGROVES' drawings titled EQ Strengthening & Proposed Office, 78 Byron Street, Christchurch –*Emergency Lighting Layout, referenced CC16175-EL.01 Issue A and dated 18.07.17*, together with the specification issued by Cosgroves Ltd.

**SIGNED BY:**  **ON BEHALF OF:** Cosgroves Ltd

**NAME:** Robert Warner

**POSITION:** Senior Electrical Engineer

**DATE:** 18<sup>th</sup> July 2017

# DOCUMENT TRANSFER ELECTRICAL SERVICES

PROJECT: EQ Strengthening & Proposed Office  
80 Byron Street, Christchurch  
**Emergency Lighting**

FILE No: CC16175 E

DATE: 18<sup>th</sup> July 2017

SHEET: 1 of 1

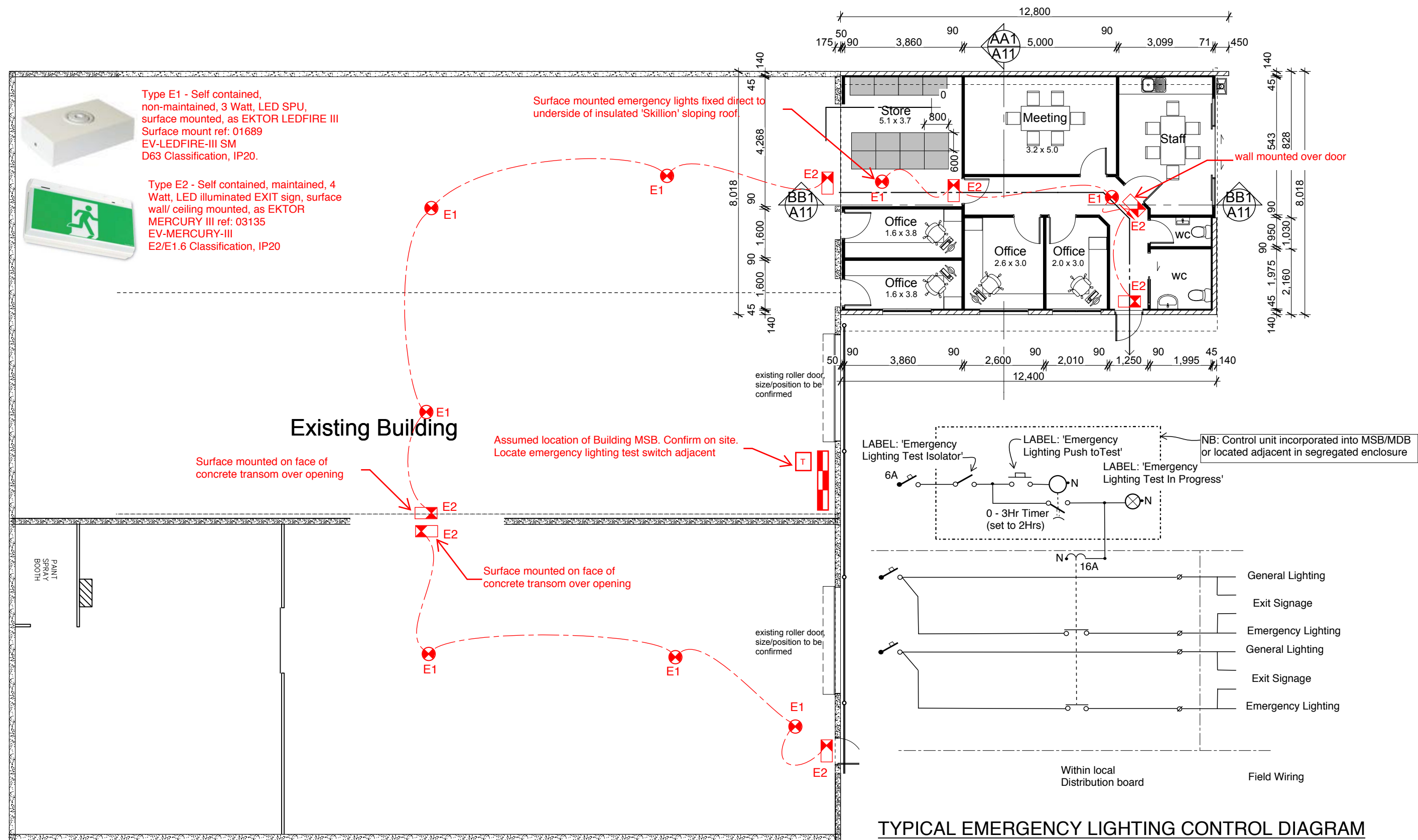
|           |     |  |  |  |  |  |
|-----------|-----|--|--|--|--|--|
| Day       | 18  |  |  |  |  |  |
| Month     | 07  |  |  |  |  |  |
| Year      | 17  |  |  |  |  |  |
| Issued by | rlw |  |  |  |  |  |

| Drawing       | Sheet | Description               | Revision |  |  |  |  |  |
|---------------|-------|---------------------------|----------|--|--|--|--|--|
| CC16175-EL.01 | A3    | Emergency Lighting Layout | A        |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |
|               |       |                           |          |  |  |  |  |  |

| Other Documents Enclosed                        | Issue |  |  |  |  |  |
|-------------------------------------------------|-------|--|--|--|--|--|
| PS1 – Design Producer Statement                 | 0     |  |  |  |  |  |
| Specifications Sheet                            | 0     |  |  |  |  |  |
| PS3 – Construction (pro forma)                  | 0     |  |  |  |  |  |
| Emergency Lighting Test & Log Sheet (pro forma) | 0     |  |  |  |  |  |
| Schedule of Notes                               | 0     |  |  |  |  |  |
| Fire Coordination Statement                     | 0     |  |  |  |  |  |

| Distribution               | Attention    | No of Copies Distributed |  |  |  |  |  |
|----------------------------|--------------|--------------------------|--|--|--|--|--|
| Clip n Climb International | John Targett | 1 x PDF                  |  |  |  |  |  |
| Architectural Design Group | Adrian       | 1 x PDF                  |  |  |  |  |  |
|                            |              |                          |  |  |  |  |  |

| Reason for Issue |                |     |  |  |  |  |
|------------------|----------------|-----|--|--|--|--|
| P Preliminary    | R Revision     |     |  |  |  |  |
| N Consent        | I Information  | N/I |  |  |  |  |
| Q As Requested   | C Construction | Q   |  |  |  |  |
| T Tender         | S Schedule     |     |  |  |  |  |



| Symbol | Description                                         |
|--------|-----------------------------------------------------|
|        | New emergency luminaire (surface/recessed)          |
|        | New illuminated EXIT sign (Directional as required) |
|        | Main switchboard -MSB                               |
|        | Emergency lighting test point at MSB                |
|        | emergency circuiting line                           |

**NOTES:**  
This drawing to be read in conjunction with the separately attached 'Notes' & 'Specifications' sheets

|                                                                                                                                              |               |          |                                                                                                                                                                                                                                                 |                                                                                           |                                                  |                                   |                |          |
|----------------------------------------------------------------------------------------------------------------------------------------------|---------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------|-----------------------------------|----------------|----------|
| CHECK ALL INFORMATION ON SITE PRIOR TO COMMENCING WORK. READ IN CONJUNCTION WITH THE SPECIFICATION AND OTHER RELEVANT DRAWINGS AND DOCUMENTS |               |          | <br><b>cosgroves</b><br><small>First Floor, 99 Tuam St. PO Box 842<br/>Christchurch, New Zealand. Ph. (03) 377 8800<br/>Email: admin@cosgroves.com</small> | PROJECT<br><br>EQ STRENGTHENING &<br>PROPOSED OFFICE,<br>80 BYRON STREET,<br>CHRISTCHURCH | SHEET TITLE:<br><br>EMERGENCY LIGHTING<br>LAYOUT | <b>CONSENT</b>                    |                |          |
|                                                                                                                                              |               |          |                                                                                                                                                                                                                                                 |                                                                                           |                                                  | DESIGNED: RLW                     | DATE: 18.07.17 | ISSUE: A |
|                                                                                                                                              |               |          |                                                                                                                                                                                                                                                 |                                                                                           |                                                  | DRAWN: RLW                        | SCALE: NTS     |          |
| A                                                                                                                                            | CONSENT ISSUE | 18.07.17 |                                                                                                                                                                                                                                                 |                                                                                           |                                                  | SHEET No:<br><b>CC16175-EL.01</b> |                |          |
| ISSUE                                                                                                                                        | AMENDMENT     | DATE     |                                                                                                                                                                                                                                                 |                                                                                           |                                                  |                                   |                |          |

Emergency Lighting Notes - To be read in conjunction with the Layout Drawing referenced CC16175-EL.01 and the Specification clauses.

1. New illuminated Exit signs shall be located centrally over exit ways, and be mounted no less than 2m AFL and no more than 2.7m AFL in full compliance with the manufacturers technical specifications attached.
2. The Electrical Contractor shall supply and install emergency self-contained battery luminaires and circuit cables to comply with the requirements of NZBC F6 (including AS2293 parts 1 and 3: 2005), NZBC G9 (in part), AS/NZS 60598.2.22: 2005 and AS/NZS 2293.2: 1995. The system shall comprise a single point system utilising Maintained (M), non-maintained (NM) or sustained (S) as defined in AS2293:2005 parts 1 and 3 and AS/NZS 60598.2.22: 2005.
3. All emergency fittings to be controlled via an installed common test & maintenance switch facility (refer to Specification and AS/NZS 2293 for further information). Test and maintenance switch should be located adjacent or incorporated into the front panel of the MSB,
4. Post installation, the installing Contractor shall measure the illuminance levels achieved in accordance with Appendix B of AS/NZS 1680.1 or, verify the installation has been installed in accordance with the minimum spacing's recommended in the manufacturers' spacing's tables, & ensure the additional luminaires are incorporated into a site specific Test Log Book & Maintenance Schedule.
5. Locations and selection of Emergency luminaires and Illuminated Exit signs are designed in accordance with manufacturers' recommended mounting heights and spacing's to meet the requirements of AS/NZS 2293: and NZBC Clause F6/AS1 and F8/AS1 (in part). Any major deviations from the locations indicated must be in compliance with stated manufacturers spacing at the relevant mounting heights. Any deviations from the manufacturers' units specified must be provided with alternative justification to satisfy the requirements of F6/AS1 & F8/AS1 (in part). The final locations incorporating any minor deviations shall be confirmed on site to suit the prevailing site conditions.
6. Luminaires shall connect to the existing emergency lighting test facility.
7. Emergency Luminaires shall be controlled in connection with the monitoring of the existing relevant local lighting circuit MCB's.

## CC16175 E - EMERGENCY LIGHTING – SPECIFICATION CLAUSES

The Electrical Contractor shall supply and install emergency self-contained battery luminaires and circuit cables to comply with the requirements of NZBC F6 (including AS2293 parts 1 and 3: 2005), NZBC G9 (in part), AS/NZS 60598.2.22:2005 and AS/NZS 2293.2:1995. The system shall comprise a single point system utilising non-maintained (NM) and (M) Maintained as defined in AS/NZS 2293.

Illuminated exit signs shall be fitted to all doors leading to the exit ways and shall be installed as shown on the drawings. Final coordination shall be carried out on site to suit the prevailing site conditions.

Emergency luminaires shall be supplied from the live side of the essential lighting circuit supplying general lighting in the area concerned. Emergency luminaires shall only be looped together where indicated. Provide all relays and automatic resetting test switch/timer controls associated with the group test facility as required by the Standards. All test initiation devices and indicators shall be panel mounted on the door of the associated controls cabinet, provide all necessary labelling. Provide manual cancel facility at same location in order that batteries are not unduly discharged.

**Self Contained Maintained Luminaires:** Self Contained Maintained units shall comprise single lamp luminaires or signs, the principle of operation shall be that under normal conditions the lamp shall be illuminated via the mains and in the event of a power failure or under test conditions via its integral battery system.

**Self Contained Non-Maintained Luminaires:** Self Contained Non Maintained units shall comprise single lamp luminaires or signs, the principle of operation shall be that under normal conditions the lamp shall be either extinguished or illuminated in conjunction with the general lighting (as specified) and in the event of a power failure or under test conditions via its integral battery system.

Emergency lights shall be rated for two-hour duration. Batteries shall be sealed non-venting high temperature Lithium Iron Phosphate type, suitable for operating lamp at its rated output for 2 hours. Lead acid or Nickel Cadmium or Nickel Hydride type batteries will not be accepted. Battery life shall be at least 3 years when operating under normal conditions at an ambient temperature of 25 degrees Celsius and subjected to charging and discharging at 6 monthly intervals.

All Emergency lights shall be an approved classified type, as required by AS/NZS 2293, and certificates for each luminaire (stating compliance with AS/NZS 2293) shall be provided on request.

All emergency lights shall have a Red LED indicator and local test switch, as specified within AS/NZS 2293. Provide protection of the inverter system against damage in the event of failure, removal or replacement of lamp, while in normal operation. All exit fittings shall be complete with 'Exit' labels and arrows as necessary to indicate the direction of exit

Individual lighting MCB's which are associated with the Emergency Lighting System shall be fitted with an engraved label (red on white) with lettering:

INTERRUPTING SUPPLY WILL DISCHARGE  
EMERGENCY LIGHTING BATTERIES.

The test facility shall be similarly labelled:

EMERGENCY LIGHTING TEST

An operating and maintenance manual in a durable A4 hard-bound cover shall be provided for the emergency lighting installation, in addition to the test procedures and maintenance procedures this document shall incorporate test record sheets for each emergency luminaire and a copy of the lighting drawings cross referencing the emergency luminaires indicated on the drawings with the test record sheets.

The operating and maintenance manual shall be kept on the premises at all times, or at such other locations as may be approved by the inspecting authority.

The system shall be fully tested on completion.

## Emergency Lighting Test Record Sheet

### Single Point System

|                                                                                                                                   |                                                                                                                                                     |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Building</b><br><b>Owner:</b> .....<br><b>Address:</b> .....<br>.....<br>.....<br><b>Building</b><br><b>Description:</b> ..... | <b>Installation Engineer / Inspector:</b> .....<br><b>Installation Date:</b> .....<br><b>Telephone:</b> .....<br><br><b>Area Description:</b> ..... |
|-----------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|

[illegible]

[illegible]

**From:** Nick Chen [nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com)  
**Subject:** RE: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 - Fire  
**Date:** 13 July 2017 2:38 pm  
**To:** Adrian [adrian@architecturaldesigngroup.co.nz](mailto:adrian@architecturaldesigngroup.co.nz)

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Hi Adrian,

Could you please send a copy of your latest architectural drawing set and structural design documentation for coordination? Council may request a coordination statement prepared in accordance with IPENZ Practice Note 22. But we will see how it goes first with the below response.

Below is my suggested response to NZFS.

- 1.1 Please refer attached photo for the opening between two spaces and there is no sliding door.
- 1.2 a: The external fire rated wall is of concrete construction and the structural engineer's design calculation should provide information on achieving the required fire rating and meet with post-fire structural stability requirements.  
  
b: The coordination of the fire safety requirements between the fire design and architectural & structural engineer has occurred.

Kind Regards

Nick Chen  
BE(Hon), ME(Fire), CPEng, MIPENZ  
Senior Fire Engineer  
Cosgroves Ltd  
03 377 8600  
027 520 9292

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**From:** Adrian [<mailto:adrian@architecturaldesigngroup.co.nz>]  
**Sent:** Thursday, 13 July 2017 9:11 AM  
**To:** Nick Chen <[nick.chen@cosgroves.com](mailto:nick.chen@cosgroves.com)>  
**Subject:** Fwd: BCN/2017/2013- Processing - RFI update (FIR-0xx only) V3 - Fire

Hi Nick,

it would appear that the Christchurch City Council are not prepared to accept your interpretation of the Fire Code can you deal with these Requests for Information and get back to me on who is handling the emergency lighting and installation.  
I will handle FIR 031, I was under the impression that there was only the one lock that needed to be noted as i would of thought that all new hardware would be to the requirements in the fire report, but i will put a hardware schedule together send it to them

Regards,  
Adrian





