CHRISTCHURCH CITY COUNCIL
BU 3522-001 EQ2
Lyttelton Library
18 Canterbury St, Lyttelton

QUANTITATIVE ASSESSMENT REPORT

FINAL

- Revision C
- 13 September 2013

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Contents

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	Signature	Date	Name	Title
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1. Executive Summary

1.1. Background

A quantitative Detailed Engineering Evaluation was carried out on the building located at 18 Canterbury Street, Lyttelton. An aerial photograph illustrating the area is shown below in Figure 1. Detailed descriptions outlining the building's age and construction type is given in Section 5 of this report.

Figure 1 Aerial Photograph of Lyttelton Library

This Quantitative report for the building structure is based on the Engineering Advisory Group's Guidance[1], visual inspections on 02 April 2012 and 15 October 2012, intrusive investigation on 29 May 2013 and available architectural drawings by Hall & MacKenzie dated August 1974.

[1] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury*

1.2. Key Damage Observed

Key damage observed includes:-

- Cracking of concrete shear walls both internally (the most critical location being the cracking in the wall in the vicinity of the timber truss support ner the grid intersection D/5) and externally.
- Potential partial failure of the retaining wall which supports the pavement outside the building. Please note that this refers to the retainng wall that, according to the drawings, pre-existed and it is an additional wall to the basement wall of the library building.
- Horizontal differential movement between two parts of the stepped roof which has caused the infill roof and walls between them to separate from the adjacent structures.
- During our initial inspection on 2 April 2012, one diagonal member of the timber roof truss was noted to have a crack near the end. During our next inspectin on 15 October 2013, this member was found to be replaced by a new member of similar specification. We found the new member being sufficient for its purpose and therefore have not accounted for the reduction of the roof truss capacity in the quantitative assessment.
- The building appears to have settled relative to the ground bearing floor slab leaving the floor slab significantly damaged with large cracks approaching 5 to 10mm wide.

Unless noted otherwise it is thought likely that all of the noted damage was as a direct cause of the earthquakes.

1.3. Critical Structural Weaknesses

No critical structural weaknesses have been discovered.

1.4. Building Capacity

The calculated capacity of the building, is of the order of 43% NBS and therefore the building is classed as a ‘Moderate Risk Building’ according to the NZSEE guidelines.

None of the damages observed has been evaluated as having influence on the building stability. It is expected that the building performance is similar as it was before the earthquakes.

The critical elements in the building with a low capacity are the foundations (bearing failure) and the capacity of the roof diaphragm and trusses to carry earthquake induced compression loads. Neither of these ‘failures’ are likely to result in an immediate collapse of the building due to moderate earthquake shaking, rather damage to building elements and redistribution of loads.

1.5. Conclusions and Recommendations

- There is no damage to the building that would cause it to be unsafe to occupy.
- Barriers around the building are not necessary.
- Remedial works to all areas noted in section 5.4 are completed as soon as reasonably practicable.
- Strengthening to 67% NBS should be investigated in due course

2. Introduction

Sinclair Knight Merz was engaged by Christchurch City Council to carry out a Quantitative Detailed Engineering Evaluation of Lyttelton Library located at 18 Canterbury Street, Lyttelton.

The scope of this quantitative analysis comprises:

- Analysis of the seismic load carrying capacity of the building compared with current seismic loading requirements expressed as a percentage of new building standard (%NBS). It should be noted that this analysis considers the building in its damaged state where appropriate.
- Identification of any critical structural weaknesses which may exist in the building and include these in the assessed capacity of the structure.
- Preparation of a summary report outlining the areas of concern in the building.

The recommendations from the Engineering Advisory Group[2] were followed to assess the likely performance of the structures in a seismic event relative to the New Building Standard (NBS). 100% NBS is equivalent to the strength of a building that fully complies with current codes. This includes a recent increase of the Christchurch seismic hazard factor from 0.22 to 0.3[3].

At the time of this report some architectural drawings by Hall & MacKenzie dated August 1974 were made available see Appendix D, an intrusive investigation to confirm foundation sizes, truss connections and masonry wall reinforcement was completed. A cover meter survey to obtain an indicative reinforcement layouts was also done, refer to Appendix B. These have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

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[2] EAG 2011, *Guidance on Detailed Engineering Evaluation of Earthquake Affected Non-residential Buildings in Canterbury - Draft*, p 10

[3] http://www.dbh.govt.nz/seismicity-info

3. Compliance

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

3.1. Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

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

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses

- The extent of any earthquake damage

3.2. Building Act

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

3.2.1. Section 112 – Alterations

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

3.2.2. Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67%NBS however where practical achieving 100%NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67%NBS.

3.2.3. Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

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

3.2.4. Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

3.2.5. Section 124 – Powers of Territorial Authorities

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

3.2.6. Section 131 – Earthquake Prone Building Policy

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

3.3. Christchurch City Council Policy

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

The 2010 amendment includes the following:

- A process for identifying, categorising and prioritising Earthquake Prone Buildings, commencing on 1 July 2012;
- A strengthening target level of 67% of a new building for buildings that are Earthquake Prone. Council recognises that it may not be practicable for some repairs to meet that target. The council will work closely with building owners to achieve sensible, safe outcomes;
- A timeframe of 15-30 years for Earthquake Prone Buildings to be strengthened; and,
- Repair works for buildings damaged by earthquakes will be required to comply with the above.

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

We anticipate that any building with a capacity of less than 34%NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67%NBS of new building standard as recommended by the Policy.

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

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

3.4. Building Code

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

After the February Earthquake, on 19 May 2011, Compliance Document B1: Structure was amended to include increased seismic design requirements for Canterbury as follows:

a) Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)

b) Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

4. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 2 below.

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

- **Figure 2: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines**

Table 1 below provides an indication of the risk of failure for an existing building with a given percentage NBS, relative to the risk of failure for a new building that has been designed to meet current Building Code criteria (the annual probability of exceedance specified by current earthquake design standards for a building of 'normal' importance is 1/500, or 0.2% in the next year, which is equivalent to 10% probability of exceedance in the next 50 years).

- **Table 1: %NBS compared to relative risk of failure**

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

4.1. The Detailed Engineering Evaluation (DEE) process

The DEE is a procedure written by the Department of Building and Housing's Engineering Advisory Group and grades buildings according to their likely performance in a seismic event. The procedure is not yet recognised by the NZ Building Code but is widely used and recognised by the Christchurch City Council as the preferred method for preliminary seismic investigations of buildings[4].

The procedure of the DEE is as follows:

1) Qualitative assessment procedure
   a) Determine the building's status following any rapid assessment that have been done
   b) Review any existing documentation that is available. This will give the engineer an understanding of how the building is expected to behave. If no documentation is available, site measurements may be required
   c) Review the foundations and any geotechnical information available. This will include determining the zoning of the land and the likely soil behaviour, a site investigation may be required
   d) Investigate possible Critical Structural Weaknesses (CSW) or collapse hazards
   e) Assess the original and post earthquake strength of the building (this assessment is subsequently superseded by the quantitative assessment)
2) Quantitative procedure
   a) Carry out a geotechnical investigation if required by the qualitative assessment
   b) Analyse the building according to current building codes and standards. Analysis accounts for damage to the building.

The DEE assessment ranks buildings according to how well they are likely to perform relative to a new building designed to current earthquake standards, as shown in Table 2. The building rank is

[4] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

indicated by the percent of the required New Building Standard (%NBS) strength that the building is considered to have. Earthquake prone buildings are defined as having less than 34 %NBS strength which correlates to an increased risk of approximately 20 times that of 100% NBS[5]. Buildings that are identified to be earthquake prone are required by law to be strengthened within 30 years of the owner being notified that the building is potentially earthquake prone[6].

- **Table 2: DEE Risk classifications**

Description	Grade	Risk	%NBS	Structural performance
Low risk building	A+	Low	> 100	Acceptable. Improvement may be desirable.
	A		100 to 80	
	B		80 to 67	
Moderate risk building	C	Moderate	67 to 33	Acceptable legally. Improvement recommended.
High risk building	D	High	33 to 20	Unacceptable. Improvement required.
	E		< 20	

The DEE method rates buildings based on the plans (if available) and other information known about the building and some more subjective parameters associated with how the building is detailed and so it is possible that %NBS derived from different engineers may differ.

This assessment describes only the likely seismic Ultimate Limit State (ULS) performance of the building. The ULS is the level of earthquake that can be resisted by the building without catastrophic failure.

The relevant current design standards and codes of practice pertinent to determining %NBS of building structures are primarily:

- AS/NZS 1170 Structural Design Actions
- NZS 3101:2006 Concrete Structures Standard
- NZS 3404:1997 Steel Structures Standard
- NZS 3603:1993 Timber Structures Standard

[5] NZSEE 2006, *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes,* p 2-2
[6] http://resources.ccc.govt.nz/files/EarthquakeProneDangerousAndInsanitaryBuildingsPolicy2010.pdf

5. Building Details

5.1. Building description

The building is generally a two storey structure which is used as a public library and temporary service centre with a small third storey area housing lift engine. It was originally designed as a post office and is constructed from reinforced concrete walls with a light weight roof on timber trusses and timber and steel beams. The first floor structure is constructed from in-situ concrete with occasional down-stand beams. Based on the intrustive investigations the foundations of the building are concrete strip footings. The floor in the basement is an 150mm thick, unreinforced concrete slab.

The architectural drawings indicate external retaining walls to the North and West of the building.

5.2. Gravity load resisting system

At the roof level the gravitational loads are transferred into structural concrete walls and timber beams through timber roof trusses spanning typically in west-east direction.

Floor weight (London street level) and related gravitational loads are transferred into structural concrete walls via in-situ 175mm deep concrete slabs spanning in two directions.

The ground floor is a concrete slab on grade.

Weight of concrete structural walls (typically 200mm thick) and applied loads are transferred into concrete strip footing and resisted by sub-soil.

For the purposes of this analysis the basement walls to the north, east and west sides of the building are thought to retain the pavements and associated fill adjacent to the building (since the existence and capacity of other retaining structures is rather uncertain and cannot be relied upon).

5.3. Seismic Load Resisting system

Lateral loads at roof level are distributed to the supporting shear walls by action of the roof diaphragms (25mm thick timber sarking). The diaphragms are at two levels (top of truss level and bottom of truss level) and the roof diaphragm levels vary over the plan of the building.

Lateral loads at 1st floor level (London Street level) are distributed to supporting shear walls by diaphragm action of 175mm thick in-situ concrete floor slab.

Lateral loads at ground level (basement) have been omitted from consideration of seismic assessment. It is assumed that horizontal forces will be resisted by friction between ground bearing slab and ground below.

Horizontal forces are transferred to foundation level by means of concrete walls acting as shear walls.

Horizontal forces at foundation level are resisted by friction and ground pressures between the surrounding soil and foundations.

5.4. Building Damage

SKM undertook an inspection on 2 April 2012. The following areas of damage were observed during the time of the inspection:

1) Minor cracking to the bed joints of concrete block walls (internal walls at basement level).
2) Cracking of concrete shear walls both internally - the most critical location being the cracking in the wall in the vicinity of the timber truss support ner the grid intersection D/5 (refer to photos 22-28) and externally refer to photos 29, 30, 33, 36, 37, 39, 44, 47 and 48. In addition there is an area of concrete roof within the stair core which has minor cracking, refer to photo 45. Where wall coverings exist these should be removed so that the level of damage of the covered wall can be determined, if any cracks exist which are larger than 0.5mm in width notify the engineer who will inspect and advise an appropriate course of action.
3) Widespread cracking of plasterboard walls and ceiling including junctions between plasterboard and different materials (most notably concrete shear walls). Refer to photos 40, 41 and 42. Where wall coverings exist these should be removed so that the level of damage of the covered wall can be determined and the appropriate steps taken.
4) Minor settlement is apparent due to the levels differences in the paving adjacent to the building. The architectural drawings appear to indicate an existing retaining wall in front of the building which supports the footpath in front of the building. If this retaining wall is of the same age as the retaining wall in front of the adjacent Service Centre building then the footpath settlement which is noted further later in this report may indicate that the wall has started to fail and full collapse may be of concern and so further investigation of the existing retaining wall should be undertaken. Refer to photo 32.
5) Cracking between adjacent materials – for example movement between concrete walls and window frames and concrete walls and adjacent plaster board linings. Refer photos 31 and 43.
6) Horizontal differential movement between two parts of the stepped roof which has caused the infill roof and walls between the roof steps to separate from the adjacent structures. Refer to photos 34 and 35.
7) During our initial inspection on 2 April 2012, one diagonal member of the timber roof truss was noted to have a crack near the end (refer to photo 38) and we recommended that the member is replaced. During our next inspectin on 15 October 2013, this member was found to be replaced by a new member of similar specification. We found the new member being

sufficient for its purpose and therefore have not accounted for the reduction of the roof truss capacity in the quantitative assessment.

8) The building appears to have settled relative to the ground bearing floor slab leaving the floor slab significantly damaged with large cracks approaching 5 to 10mm wide, refer to photo 47.

During our reinspection on 15 October 2012, the occupants reported that some of the cracks (especially around the damage in the area near D/5 – PHOTO 24-28) regularly release dust, which led to the concern that the damage may have been deteriorating as a result of ongoing settlements. Subsequent monitoring of the cracking has confirmed that there is no ongoing deterioration, but repair is recommended. The crack monitoring report is attached as Appendix F.

- SKM recommended that the west end of the truss on grid line 5 was temporarily propped as detailed in Appendix C – Temporary propping of truss at D/5. of this report until remedial measures are completed. Detail of the propping was issued in advance of this report by email to Chrsitchurch City Council on 13 February 2013. SKM has inspected the installation of the propping.

6. Available Information and Assumptions

6.1. Available Information

Following our inspection on the 15 October 2012 SKM carried out undertaken a Quantitative Detailed Engineering Evaluation using the following information:

- Architectural drawings of the building dated April 1974 by Hall & MacKenzie. The drawings however doesn`t cover the basement area between grid lines 3-12 (Appendix D)
- SKM site measurements and inspection findings for the building.
- SKM site inspection focused on detection of reinforcement in concrete walls and intrusive inspection focused on foundation sizes and truss connections,refer to Appendix B.

6.2. Survey and Intrusive Investigation

No levels or verticality survey was considered necessary for this report.

An intrusive investigation was completed to confirm a sample of foundation sizes, wall reinforcement and truss connections. The following investigations were done:

- In two basement walls the concrete was carefully broken out to reveal reinforcement, this allowed the diameter, spacing and cover of the reinforcement to be confirmed. At B1, reinforcement was found to be, D12's at 300 mm crs horizontally, D12's at 150 mm crs vertically on the outside face and D20's at 150 mm crs vertically on the inside face of the wall. At B2, the reinforcement was revealed to the first layer on the inside face of the wall and showed D12's at 150 mm crs horizontally, D20's at 150 mm vertically. Locations of B1 and B2 can be found in Appendix B.
- In three locations the foundations were carefully excavated around to reveal the size of the footings, each footing was only excavated on one side and assumed to be the same size on the other side of the wall. At F1, the footing size is 900 mm wide and 800 mm deep. At F2, the footing size is 600 mm deep and 1500 mm wide. At F3, the footing changed sizes around the corner, the footing up to gridline 11 is 700 mm deep and 900 mm wide and changes to 1000 mm deep and 600mm wide. In two of these foundations the concrete was carefully broken out on the top to reveal the reinforcement diameter, spacing and cover, this was typically D16 bars with R8 or R10 stirrups at 300 mm crs. For locations of F1, F2, F3 and their photos refer to Appendix B.
- Shear vane testing was done in the same foundation areas to confirm the bearing capacity of the soil insitu. The Ultimate bearing capacity found is 500kPa, this is a conservative value but without confirmation of the depth to the rock head this value will be used. Refer to Appendix E for further details.

- In two locations the connection details between the timber trusses and their supports were established. In the first location, C1 the concrete was broken out to confirm the embedment and size of the connecting bolts. The bolts were found to be M20 U bolts with 30mm cover and 250 mm spacing. At C2, the wall linings were removed to reveal a 125 x 75 SHS steel post and its connection of 2 / M20 bolts between the 6mm thick steel plate bracket supporting the timber truss and the steel post. For locations and photos please refer to Appendix B.
- The grade of timber material used in the trusses and the connection of the diaphragms to the perimeter supports could not be confirmed during the intrusive investigations. The problem was consulted with number of major timber merchants in New Zealand with the outcome that the timber grade used for the constrction was most likely “No 1 framing” (i.e. same as the grade used in the quantitative calculations). Testing of timber samples was also considered. This would be possible in theory, but highly inpracticable in subject situation as it would involve collection of large number of samples and extensive temporary propping, making the process economically not viable compare to strengthening.

For further information please refer to Appendix B – Intrusive Investigation.

Crack monitoring of the damaged and most critical areas within the library was undertaken within the period from 27 February 2013 until 9 July 2013. Four cracks out of 35 that were monitored were found to have notable change in order of ±0.5mm that occurred between the initial visit in February and second visit in March 2013. None of these cracks and no other monitored cracks were found to significantly change since March 2013. Refer to Appendix F – SKM Crack Monitoring Report dated 17/07/12 for further details.

6.3. Design Criteria and Assumptions

The following design criteria and assumptions made in undertaking the assessment include:

- The building was built according to the drawings and according to good practice at the time. We have reviewed the building and from our visual inspection the structure appears to be built in accordance with the drawings.
- The soil on site is class C as described in AS/NZS1170.5:2004, Clause 3.1.3, Shallow Soil. This is an assumption based on the desktop study. The ultimate bearing capacity on site is in order of 500kPa (original estimate from desktop study of 220kPa has been updated to reflect actual depth of foundations – i.e. effect of overburden pressure. For more information please refer to Appendix E – SKM Geotechnical Interpretive Report dated 4/07/12).
- 50 year design life.
- Structure Importance Level 2. This level of importance is described as ‘normal’ with medium or considerable consequence for loss of human life, or considerable economic, social or environmental consequence of failure.

- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- The following criteria were used for the assessment of the building:

North-south direction	East-west direction
Period, T = 0.4s	Period, T = 0.4s
Ductility, μ = 1.25	Ductility, μ = 1.25
Cd(T) = 0.71	Cd(T) = 0.71

- The following material properties were estimated and used in the analyses:

Table 3: Material Properties

Material	Nominal Strength	Structural Performance Factor
Structural Steel	f_y = 250MPa	S_p = 0.9
Concrete	f_c' = 30MPa	S_p = 0.9
Reinforcing steel	f_y = 250MPa	
Timber	“No 1 Framing”	S_p = 1.0

- No panel joints were found in the concrete walls - it has been assumed that the walls were cast in-situ.
- The reinforcement in the walls has been assumed as single layer throughout. The reinforcement scanning results support this assumption.
- The diameter and spacing of reinforcement in walls has been assumed as follows where not possible to establish information from cover meter reading:
  - Vertical reinforcement - 16mm diameter bars @ 300mm centres
  - Horizontal reinforcement - 16mm diameter bars @ 300mm centres
- A sample of foundations were measured during the intrusive investigation and these sizes were applied to other similar foundations around the building. It is also assumed that the foundations have the following properties:
  - Material: Concrete grade 30MPa;
  - Reinforcement: No reinforcement (however some may exist)
- It is assumed that the timber roof diaphragm (sarking) is effective as a semi-rigid diaphragm distributing loads between supporting elements for loads in the X (east-west direction), i.e. for loads perpendicular to the span of the sarking boards. In the Y (north-south) direction the sarking will be a flexible diaphragm at best, so we have assumed that the timber trusses carry the lateral load in out of plane bending. These assumptions are supported by the results of our limited intrusive investigations.
- The detailed engineering evaluation is a post construction evaluation therefore it has the following limitations:

- It is not likely to pick up on any concealed construction errors (if they exist).
- Other issues that could affect the performance of the building such as corrosion of metallic elements and modifications to the structure will not be identified unless they are visible and have been specifically mentioned in this report.
- The detailed engineering evaluation deals only with the structural aspects of the building. Other aspects such as building services are not covered.

7. Results and Discussion

7.1. Critical structural weaknesses and collapse hazards

No critical structural weaknesses have been identified in this building.

While not a collapse hazard, the damage to the concrete walls near the intersection of gridlines D/5 is such that propping has be installed as a precaution until repairs are complete. For details of propping refer to Appendix C of this report and for repair process refer to Section 5.4

7.2. Analysis Results

The equivalent static method as defined in NZS1170.5, clause 6.2, was used to calculate the appropriate seismic loads to apply to the building in order to analyse the response of the building and calculate the capacity.

The results of the analysis are reported in the following table, expressed as %NBS. The results below are calculated for the building in its damaged state and have been broken down into seismic resisting elements, locations and actions as appropriate.

- **Table 4: DEE Results**

Seismic Resisting Element	Action	Note / Worst case	Seismic Rating %NBS
Basement walls	Dimensional Check	Some walls fail to comply with requirements of current code	N/A
	In-plane bending + Axial Load	Wall 617 / Combination 174	>100%
	Stability - buckling	Wall 631 / Combination 113	52%
	Shear	Wall 619 / Combination 164	92%
	Out-of-plane bending + Axial Load	Wall 622 / Combination 154	>100%
Shear walls at 1st floor level (London Street)	Dimensional Check	Some walls fail to comply with requirements of current code	N/A
	In-plane bending + Axial Load	Wall 494 / Combination 123	70%
	Stability - buckling	Wall 518 / Combination 123	80%
	Shear	Wall 1306 / Combination 154	>100%
Foundations	Ground bearing pressure	Foundation sizes assumed after some trial pits	43%
	Shear due to ground pressure in strip footing	Foundation sizes assumed after some trial pits	>100%
	Sliding	Overall sliding resistance of the building	97%
Floor diaphragm	Tensile and compression stresses	Tension failure near grid N/2 for Combination 154	83%

Seismic Resisting Element	Action	Note / Worst case	Seismic Rating %NBS
Roof diaphragm	Direction X	Perpendicular to roof sarking span	>100%
	Direction Y	Parallel to roof sarking (resistance of top chord,truss T3 in bending about minor axis)	55%

7.3. Discussion

The capacity of the building has been calculated as 43% NBS The critical elements in the building with a low capacity are the foundations (bearing failure) and the capacity of the roof diaphragm and trusses to carry earthquake induced loads. Neither of these 'failures' are likely to result in a collapse of the building, rather damage to building elements and redistribution of loads.

None of the damages observed has been evaluated as having influence on the building stability. It is expected that the building performance is similar as it was before the earthquakes.

The crack monitoring (refer to Appendix F – SKM Crack Monitoring Report dated 17/07/12) suggests there has been a localised bearing failure which has allowed some differential movement causing cracking in the slab. This appears to have stabilised over time. In the event of another earthquake the building has the potential for further localised bearing failures, but this is unlikely to cause the building to collapse. The intrusive investigations were completed in three locations to reveal foundation dimensions and these have been extrapolated around the building as appropriate assuming that similar foundation details were used throughout. The limiting value of 43%NBS comes from a foundation that has not been exposed, so the parameters used may or may not be conservative.

We have assumed that in the north – south direction there is no connection between the roof diaphragm and the supporting walls. This means that the seismic roof load is resisted by the out of plane bending of the trusses. The truss chord members were not primarily designed for diaphragm loading, hence their low capacity at 55% NBS.

The low capacity of the timber members is also because of the unknown timber material and strength properties. The values used for the design of the trusses in 1974 are unknown and the intrusive investigation was not conclusive. We are guided by the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006 which states that using material properties and strengths that were specificed in the original design are not appropriate for the use in assessment procedures. There is no certainty around the timber strength properties designed in

1974 and hence the properties from the latest NZS 3603:1993, Timber Structures Standard have been used in the assessment. This is likely to be conservative.

The repairs to the truss members were not included in this calculation as the damage to these truss members and repairs will not change the %NBS.

We consider that continued use and occupancy of the building is reasonable since the damage to the building has limited impact on the seismic capacity and there are no immediate collapse hazards.

Repairs to cracked concrete (Damage item 2) and the structural framework supporting the roof and ceiling in the area approximately outlined by grid lines 4-5/A-P should be carried out as soon as practicable. Temporary propping to the end of the timber truss at D/5 and the temporary propping to the ceiling on grid line 4/N-O shall remain in place until the repairs to these areas are completed. Removing these proppings in advance of the repairs would result in potential collapse hazard and reduction of the building safety and thus its capacity that was calculated in this quantitative assessment.

Notwithstanding the above, the building occupier may wish to evaluate the use and occupancy of the building the basis of the limiting building capacity summarised above in Table 4.

8. Conclusions and Recommendations

SKM carried out a quantitative DEE of library building located at 18 Canterbury Street, Lyttelton. The building capacity has been assessed as 43%NBS and is limited by the bearing capacity of some of the foundations. Bearing failure would result in excessive settlement and structural damage, but is unlikely to lead directly to collapse.

The building is unlikely to collapse due to moderate earthquake shaking and there are no immediate collapse hazards, so continued occupancy and use of the building is appropriate.

It is recommended that:

- .
- Barriers around the building are not necessary.
- Remedial works to all areas noted in section 5.4 are completed as soon as reasonably practicable.
- Strengthening to 67% NBS should be investigated in due course

9. Limitation Statement

This report has been prepared on behalf of, and for the exclusive use of, SKM's client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and the Client. It is not possible to make a proper assessment of this report without a clear understanding of the terms of engagement under which it has been prepared, including the scope of the instructions and directions given to, and the assumptions made by, SKM. The report may not address issues which would need to be considered for another party if that party's particular circumstances, requirements and experience were known and, further, may make assumptions about matters of which a third party is not aware. No responsibility or liability to any third party is accepted for any loss or damage whatsoever arising out of the use of or reliance on this report by any third party.

Without limiting any of the above, in the event of any liability, SKM's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited in as set out in the terms of the engagement with the Client.

It is not within SKM's scope or responsibility to identify the presence of asbestos, nor the responsibility of SKM to identify possible sources of asbestos. Therefore for any property pre-dating 1989, the presence of asbestos materials should be considered when costing remedial measures or possible demolition.

Should there be any further significant earthquake event, of a magnitude 5 or greater, it will be necessary to conduct a follow-up investigation, as the observations, conclusions and recommendations of this report may no longer apply Earthquake of a lower magnitude may also cause damage, and SKM should be advised immediately if further damage is visible or suspected.

10. Site Inspection Report Photos

PHOTO 1: Exterior view of the property

PHOTO 2: Exterior view of the property

PHOTO 3: Exterior view of the property

PHOTO 4: Exterior view of the property

PHOTO 5: Exterior view of the property

PHOTO 6: Exterior view of the property

	
PHOTO 7: Exterior view of the property	PHOTO 8: Exterior view of the property

PHOTO 9: Exterior view of the property – roof from the top of the lift shaft

	
PHOTO 10: Roof trusses in the library (T1 & T2)	PHOTO 11: Roof trusses in the library (T1 & T2)
	
PHOTO 12: Roof trusses in the library (T1 & T2)	PHOTO 13: Roof trusses in the library – detail on supporting brackets

	
PHOTO 14: Roof trusses in the library – (T6 & T7)	PHOTO 15: Timber beam in the library supporting roof trusses.
	
PHOTO 16: Roof trusses in the library – (T6 & T7)	PHOTO 17: Temporary propping of the ceiling on grid line 4.

PHOTO 18: Temporary propping of the ceiling on grid line 4.

PHOTO 19: Temporary propping of the ceiling on grid line 4.

PHOTO 20: Roof Truss (T3) to the left

PHOTO 21: Roof Truss (T3) to the left

PHOTO 22: Supporting bracket to rrof truss T3 – grid D/5

PHOTO 23: Roof Truss (T3)

PHOTO 24: Cracking in concrete walls near D/5 (view from the library)

PHOTO 25: Cracking in concrete walls near D/5 (view from the library)

PHOTO 26: Cracking in concrete walls near D/5 (view from the library) – Truss T3 enclosed in the ceiling space

PHOTO 27: Dust coming out of the supporting bracket of roof truss T2

PHOTO 28: Cracking in concrete walls near D/5 (view from the office) – cracking appeared at the location of truss support attached from the other side of the wall)

PHOTO 29: Typical external cracking of concrete shear walls

PHOTO 30: Typical external cracking of concrete shear walls

PHOTO 31: Seperation of window frames from surrounding structure

PHOTO 32: View of visible settlement between the structure and the adjacent paving

PHOTO 33: Typical external cracking of concrete shear walls

PHOTO 34: View of differential movement between adjacent roof structures.

PHOTO 35: View of differential movement between adjacent roof structures.

	
PHOTO 36: Typical external cracking of concrete shear walls	PHOTO 37: Typical external cracking of concrete shear walls

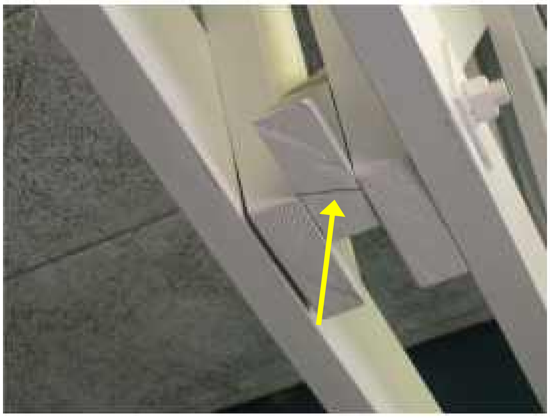



PHOTO 38: Crack in timber truss diagonal	PHOTO 39: Typical internal cracking of concrete shear walls
	
PHOTO 40: Typical plasterboard ceiling cracking	PHOTO 41: Typical plasterboard ceiling cracking

	
PHOTO 42: Typical plasterboard ceiling cracking with previous making safe work	PHOTO 43: Typical plasterboard wall cracking adjacent to concrete wall
	
PHOTO 44: Typical internal cracking of concrete shear walls	PHOTO 45: Cracking of concrete roof in stair core

PHOTO 46: Typical cracking of concrete slab on grade

PHOTO 47: Typical internal cracking of concrete shear walls. Wide spread in this location.

PHOTO 48: Typical internal cracking of concrete shear walls.

11. Appendix A – CERA Standardised Report Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Lyttelton Library	Reviewer:	James Carter
	Unit / No: / Street	CPEng No:	1017648
Building Address:	18 Canterbury Street, Lyttelton	Company:	Sinclair Knight Merz
Legal Description:		Company project number:	ZB01276.49
		Company phone number:	03 940 4900
	Degrees / Min / Sec		
GPS south:	43 / 36 / 9.50	Date of submission:	18/09/2013
GPS east:	172 / 43 / 14.50	Inspection Date:	15/10/2012
		Revision:	C
Building Unique Identifier (CCC):	PRO 3522 B001	Is there a full report with this summary?	yes

Site

Site slope:	slope < 1in 10	Max retaining height (m):	4
Soil type:	mixed	Soil Profile (if available):	basalt or man made fill
Site Class (to NZS1170.5):	C		
Proximity to waterway (m, if <100m):		If Ground improvement on site, describe:	None
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	30.00

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m): 20.00
Ground floor split?	no		Ground floor elevation above ground (m): 0.10
Storeys below ground	1		
Foundation type:	strip footings		if Foundation type is other, describe:
Building height (m):	7.50		height from ground to level of uppermost seismic mass (for IEP only) (m):
Floor footprint area (approx):	450		
Age of Building (years):	40		Date of design: 1965-1976
Strengthening present?	no		If so, when (year)?
			And what load level (%g)?
Use (ground floor):	other (specify)		Brief strengthening description:
Use (upper floors):	public		
Use notes (if required):	Storage only at ground level		
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	Truss depth 1.3m
Floors:	concrete flat slab	slab thickness (mm)	175
Beams:	cast-insitu concrete	overall depth x width (mm x mm)	unknown
Columns:			
Walls:	load bearing concrete	thickness (mm)	200

Lateral load resisting structure

Lateral system along:	concrete shear wall	**Note: Define along and across in detailed report!**	note total length of wall at ground (m):	
Ductility assumed, μ:	1.25		wall thickness (m):	0.2
Period along:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated
Lateral system across:	concrete shear wall		note total length of wall at ground (m):	
Ductility assumed, μ:	1.25		wall thickness (m):	0.2
Period across:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	estimated
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	estimated

Separations:

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

Non-structural elements

Stairs:	cast insitu	notes	No drift details allowed but no visible damage
Wall cladding:	other heavy	describe	RC concrete walls
Roof Cladding:	Metal	describe	metal sheeting on timber sarking
Glazing:			
Ceilings:	fibrous plaster, fixed		
Services(list):			

Available documentation

Architectural	partial	original designer name/date	Hall & Mackenzie Registered Architects (west of basement not on the drawings)
Structural	none	original designer name/date	
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	partial	original designer name/date	SKM geotech desk study, May 2012

Damage

Site: (refer DEE Table 4-2)

Site performance:	No liquefaction visible, evidence of minor settlement	Describe damage:	Minor settlement visible when comparing pavings with building
Settlement:	0-25mm	notes (if applicable):	Only noted in differential between paving and building
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	Little damage that affects the overall capacity of the building - refer to report for details.
	Describe (summary):	Damage insignificant in building capacity		
Across	Damage ratio:	0%		
	Describe (summary):	Damage insignificant in building capacity		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	damage to finishes and plaster work

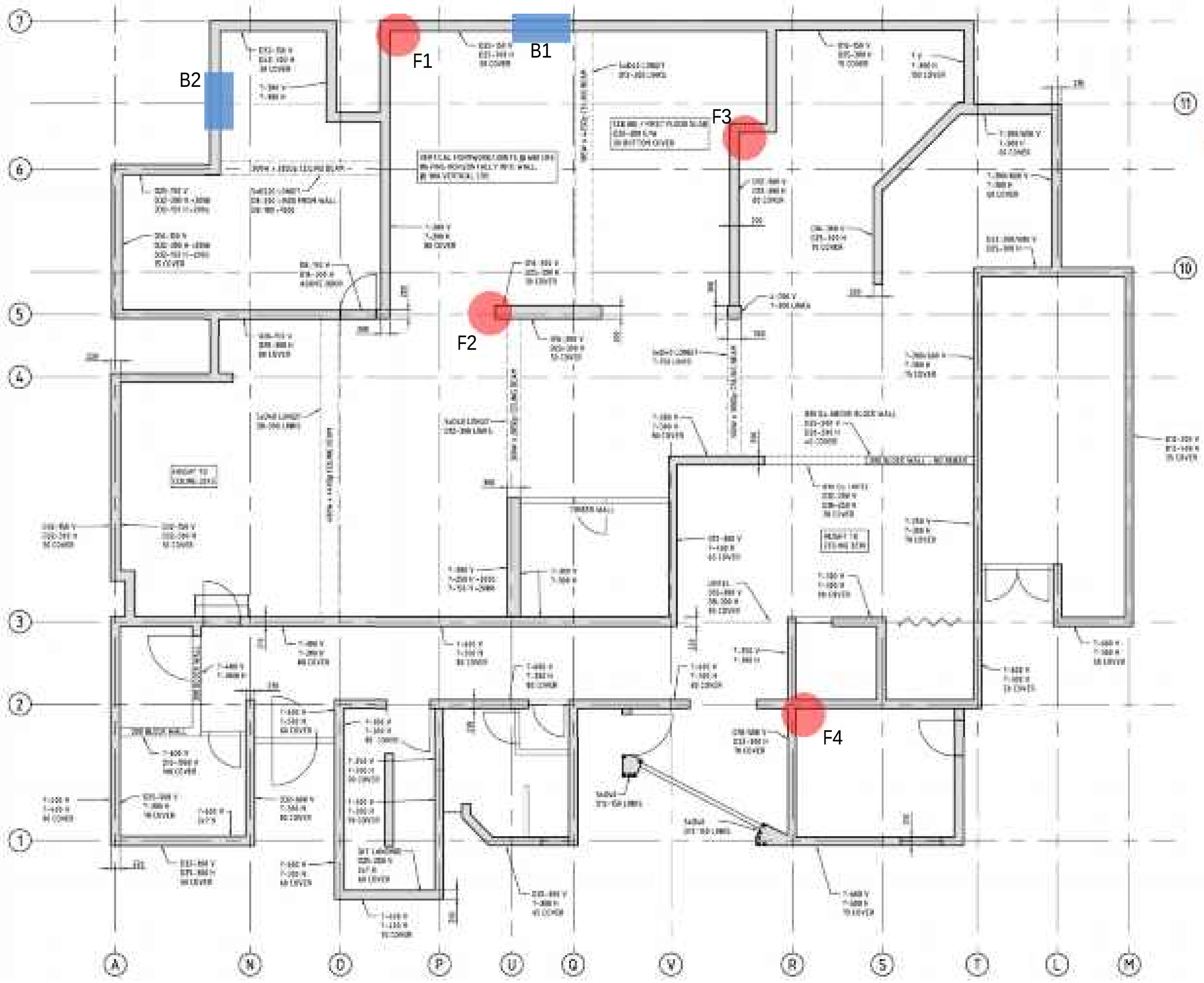
$$Damage\_Ratio = \frac{(\%NBS\,(before) - \%NBS\,(after))}{\%NBS\,(before)}$$

Recommendations

Level of repair/strengthening required:	significant structural	Describe:	As in detailed report
Building Consent required:	yes	Describe:	Repairs to cracks in concrete elements
Interim occupancy recommendations:	full occupancy	Describe:	Prop to truss in place untile repairs completed

Along	Assessed %NBS before:	43%	%NBS from IEP below	If IEP not used, please detail assessment methodology:	Detailed quantitative assessment
	Assessed %NBS after:	43%			
Across	Assessed %NBS before:	43%	%NBS from IEP below		
	Assessed %NBS after:	43%			

12. Appendix B – Intrusive Investigation



General notes:

1) All materials should be applied according to manufacturer`s instructions.

PROPOSED INTRUSIVE INVESTIGATIONS:
(see locations on floor plans)

B1 Confirm reinforcement in perimeter basement walls potentially acting as retaining walls:
- Break out concrete cover at given locations to establish diameter, spacing and cover.
- Reinstate using non-shrink grout (min 30MPa) & repaint to match surroundings.
- See "Intrusive Investigation – Sketch 1" for further details.

F1 Establish size of foundations and their reinforcement
- Excavations at given locations to establish size of foundations (width/depth).
- Carry out shear vane testing to obtain shearing resistance of the supporting ground (estimated fee for 4No locations is in order of $1000) – do before any other tasks listed below.
- Break out concrete cover to establish size of reinforcement and position – probably occurs at bottom face of the foundation.
- Reinstate footing using non-shrink grout (min 30MPa)
- Reinstate slab on compacted fill using concrete (min 30MPa) with 663 mesh (allow for overlap with existing mesh)
- See "Intrusive Investigation – Sketch 2" for further details.

Locations to be typically in the corner of two walls to cover 2 No foundations within one trial pit.

DRAWING STATUS
ISSUED FOR COSTING ONLY

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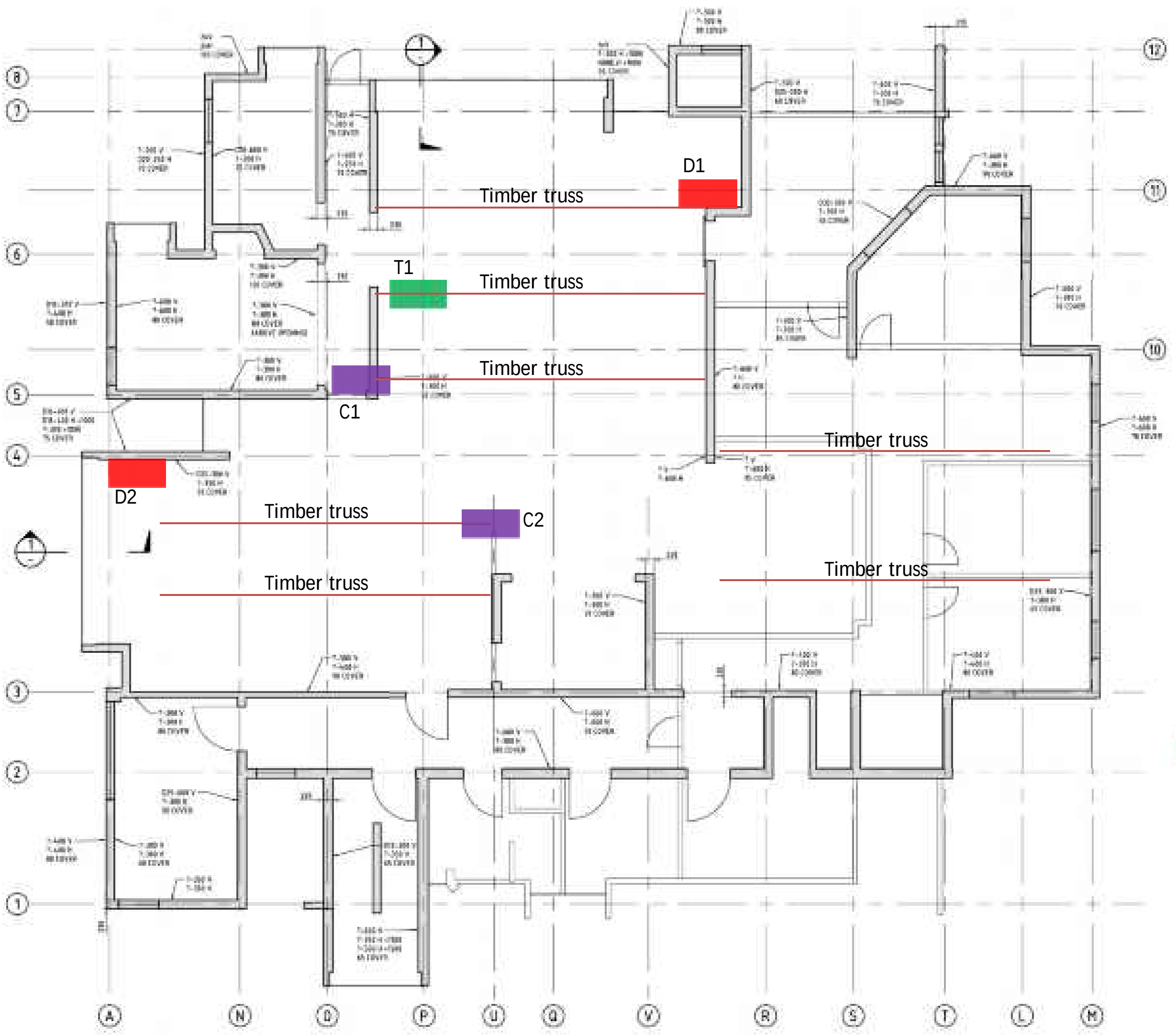
CLIENT
CHRISTCHURCH CITY COUNCIL

PROJECT
ZB01276.049-CCC – BU 3522-001 EQ2
Lyttleton Library, 18 Canterbury Street, Lyttleton

DRAWN BY	Tomas Bilek 06 March 2013	CHECKED BY	James Carter 06 March 2013

TITLE
PROPOSED INTRUSIVE INVESTIGATION
BASEMENT

SCALE	DRAWING No	REV
NTS	ZB01276.049-SK-001	R0



General notes:

1) All materials should be applied according to manufacturer`s instructions.

PROPOSED INTRUSIVE INVESTIGATIONS:
(see locations on floor plans)

D1 Establish connection detail between roof diaphragm and surrounding walls
- Check on-going roof leakage at location D2
- Remove ceiling panels at given locations to establish relationship and fixings.
- Reinstate ceiling

C1 Establish connection details between the steel brackets supporting timber trusses:
- Provide temporary propping to the end of the truss – refer to "Intrusive Investigation - Sketch 3"
- Break out of concrete / linings to establish connectivity/ embedment details of the bolts connecting the bracket to the wall at given locations).
- Reinstate damaged areas

Note for location C2: Inspection of this location will be required if supporting structural configuration differ from one at C1 (i.e. If structure supporting steel bracket is not a concrete wall similar to wall at C1). Remove linings at C2 and inspect before commencement of the works. Should the intrusive investigation at C2 be put forward, propping down to basement level will likely be required.

T1 Establish grade of timber material used for construction of trusses - by visual grading (or testing).

DRAWING STATUS
ISSUED FOR COSTING ONLY

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Web: www.globalskm.com

CLIENT: CHRISTCHURCH CITY COUNCIL

PROJECT: ZB01276.049-CCC – BU 3522-001 EQ2
Lyttleton Library, 18 Canterbury Street, Lyttleton

DRAWN BY	Tomas Bilek 20 May 2013	CHECKED BY	James Carter 06 March 2013

TITLE: PROPOSED INTRUSIVE INVESTIGATION LIBRARY

	DRAWING No	REV
NTS	ZB01276.049-SK-002	R1

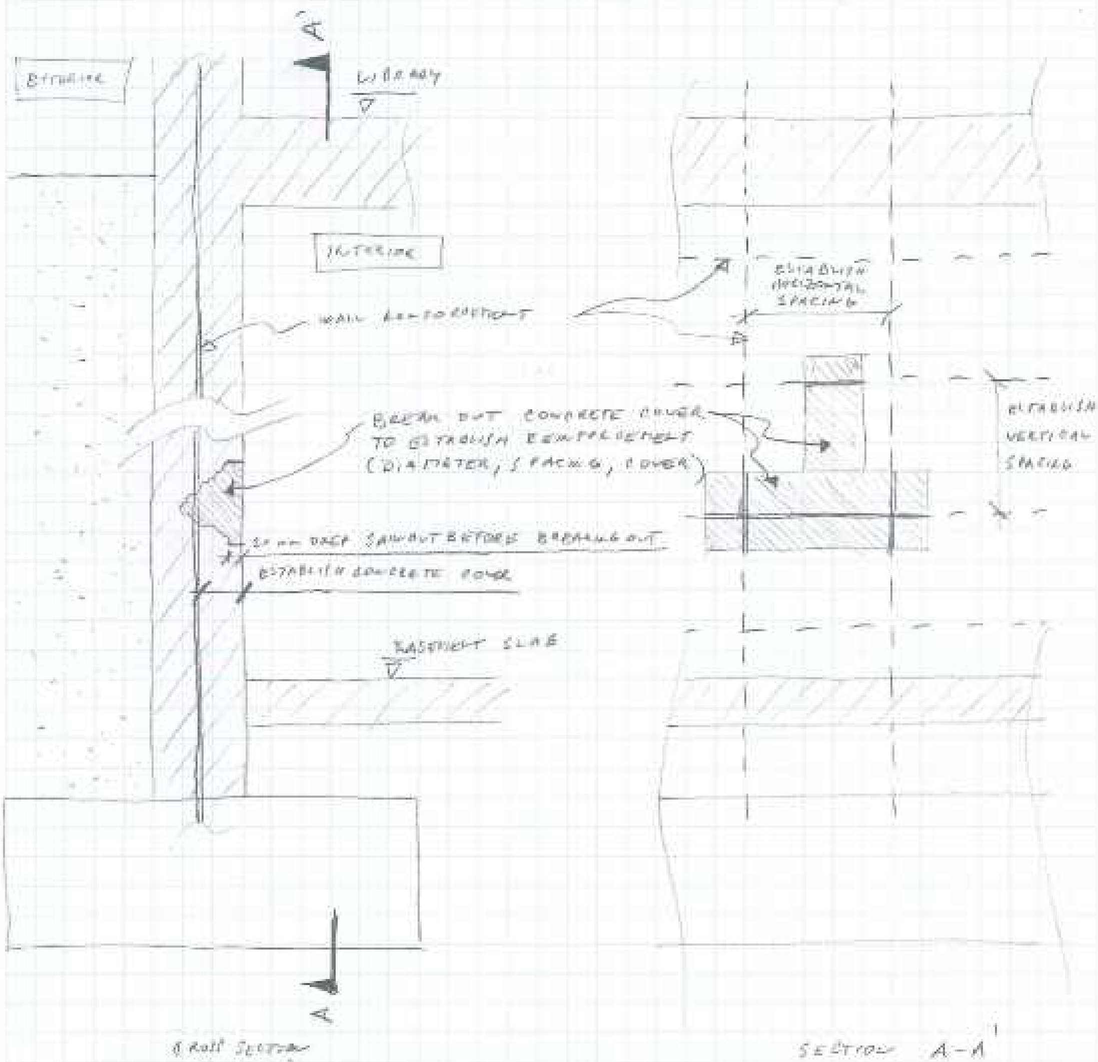
SKM

Job No. 2601276049
Calc. Series INTRUSIVES
Client CCC
Page 1
Job Name LYTTELTON LIBRARY
By TB
Calcs Title INTRUSIVE INVESTIGATION – SKETCH 1
Date 5/3/2013

B1 – B2

CONFIRM REINFORCEMENT IN PERIMETER BASEMENT WALLS

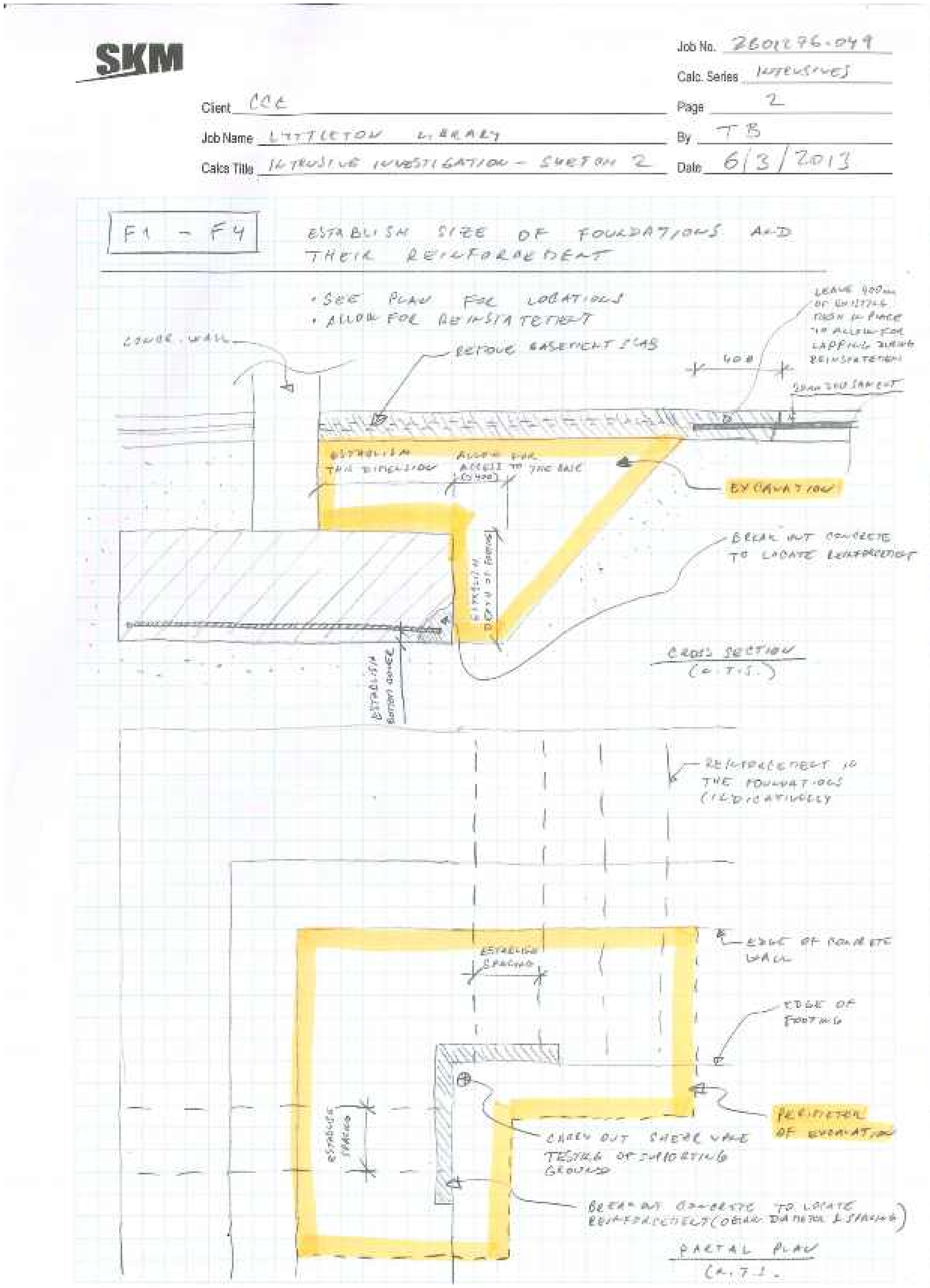
- SEE PLAN FOR LOCATIONS



CROSS SECTION (N.T.S.)

SECTION A–A' (N.T.S.)

- REINSTATE USING NON-SHRINK GROUT (SUCH AS SIKA MONO-TOP 412N) INSTALLED AS PER MANUFACTURER'S INSTRUCTIONS & REPAINT TO MATCH SURROUNDINGS

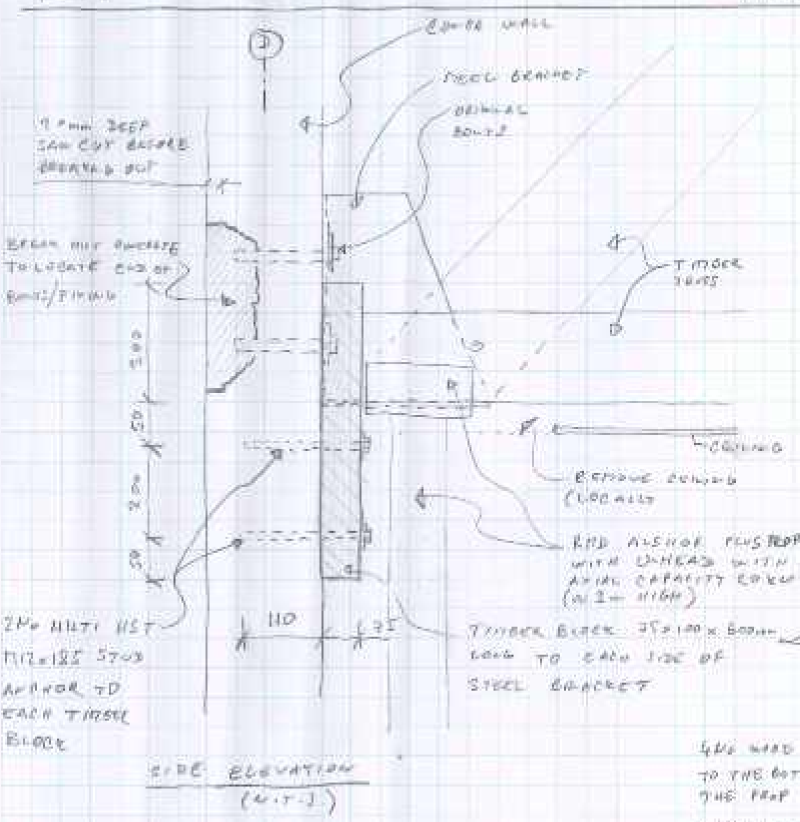

Job No. 2601276-049
Calc. Series INTRUSIVES
Client CCC
Page 2
Job Name LYTTELTON LIBRARY
By TB
Calcs Title INTRUSIVE INVESTIGATION - SHEET No 2
Date 6/3/2013
F1 - F4
ESTABLISH SIZE OF FOUNDATIONS AND THEIR REINFORCEMENT
• SEE PLAN FOR LOCATIONS
• ALLOW FOR REINSTATEMENT
REMOVE BASEMENT SLAB
EXCAVATION
BREAK OUT CONCRETE TO LOCATE REINFORCEMENT
CROSS SECTION
REINFORCEMENT IN THE FOUNDATIONS (INDICATIVELY)
EDGE OF CONCRETE WALL
EDGE OF FOOTING
PERIMETER OF EXCAVATION
CARRY OUT SHEAR VANE TESTING OF SUPPORTING GROUND
PARTIAL PLAN

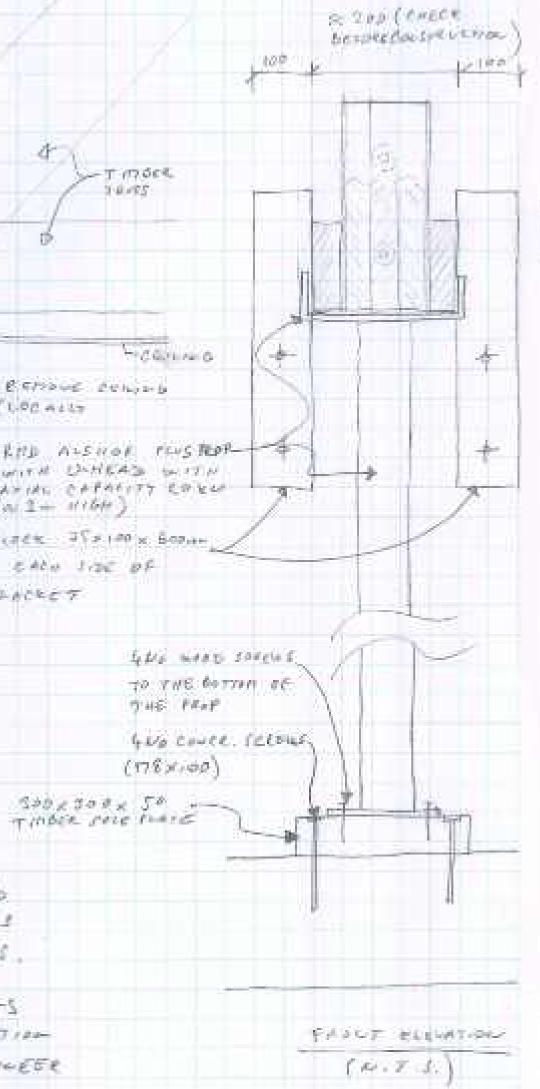
SKM

Client: CCC
Job Name: LYTTELTON LIBRARY
Calcs Title: INTRUSIVE INVESTIGATION - SKETCH 3

Job No. ZB01276.049
Calc. Series: INTRUSIVES
Page: 3
By: TB
Date: 6/3/2013

C1 ESTABLISH CONNECTION DETAILS TO STEEL BRACKETS SUPPORTING TIMBER TRUSSES





REINSTATEMENT

1) ALLOW FOR USING NON-SHRINK GROUT (SUCH AS SIKA MONOTOP 412 NZ) INSTALLED AS PER MANUFACTURER'S INSTRUCTIONS & REPAINT TO MATCH SURROUNDINGS.

2) REINSTATEMENT OF BOLT EMBEDMENTS IS TO BE ADVISED ON UPON COMPLETION OF INSPECTION BY STRUCTURAL ENGINEER

IMPORTANT NOTE!

1) CHECK DIMENSIONS OF U-HEAD AGAINST WIDTH OF BRACKET BEFORE CONSTRUCTION.

2) TOP HEAD OF PROP MUST BE FIXED TO THE TRUSS/BRACKET BY MEANS OF TIMBER SCREWS OR STRAPPING (TO MAINTAIN ITS POSITION DURING EARTHQUAKES)

Intrusive Investigation 24 May 2013 Thumbs

	
http://dmca.skmconsulting.com/sites/ZB01276/DmcaConsult/ZB01276.049.BU_3522/Photos/2013-05-24.Intrusive.01.JPG	http://dmca.skmconsulting.com/sites/ZB01276/DmcaConsult/ZB01276.049.BU_3522/Photos/2013-05-24.Intrusive.02.JPG
	
http://dmca.skmconsulting.com/sites/ZB01276/DmcaConsult/ZB01276.049.BU_3522/Photos/2013-05-24.Intrusive.03.JPG	

Intrusive Investigation of Lyttelton Library, 30 May, 2013, Thumbs

	
http://dmca.skmconsulting.com/sites/ZB01276/DmcaConsult/ZB01276.049.BU_3522/Photos/2013-05-30.Intrusive.01.JPG	http://dmca.skmconsulting.com/sites/ZB01276/DmcaConsult/ZB01276.049.BU_3522/Photos/2013-05-30.Intrusive.02.JPG
	
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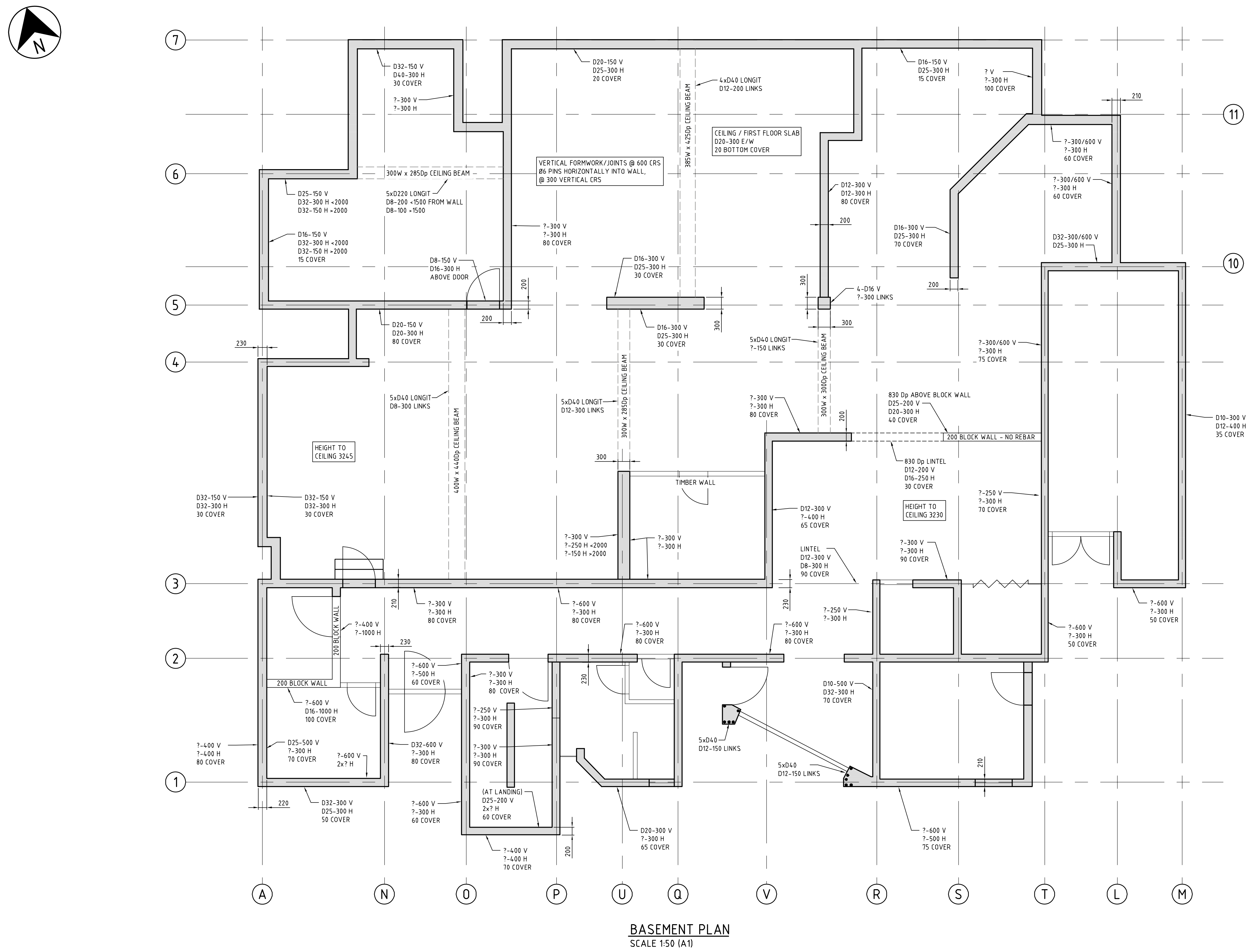

NOTES

1. TO BE READ IN CONJUNCTION WITH ARCHITECTS PLANS & DETAIL DRAWINGS.
2. REINFORCING DIAMETERS ARE NOT TO BE TAKEN LITERALLY. USE REASONABLE REINFORCING SIZES IF PRINTED SIZE IS NOT AS ANTICIPATED.

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Web: www.skmconsulting.com

CLIENT: CCC

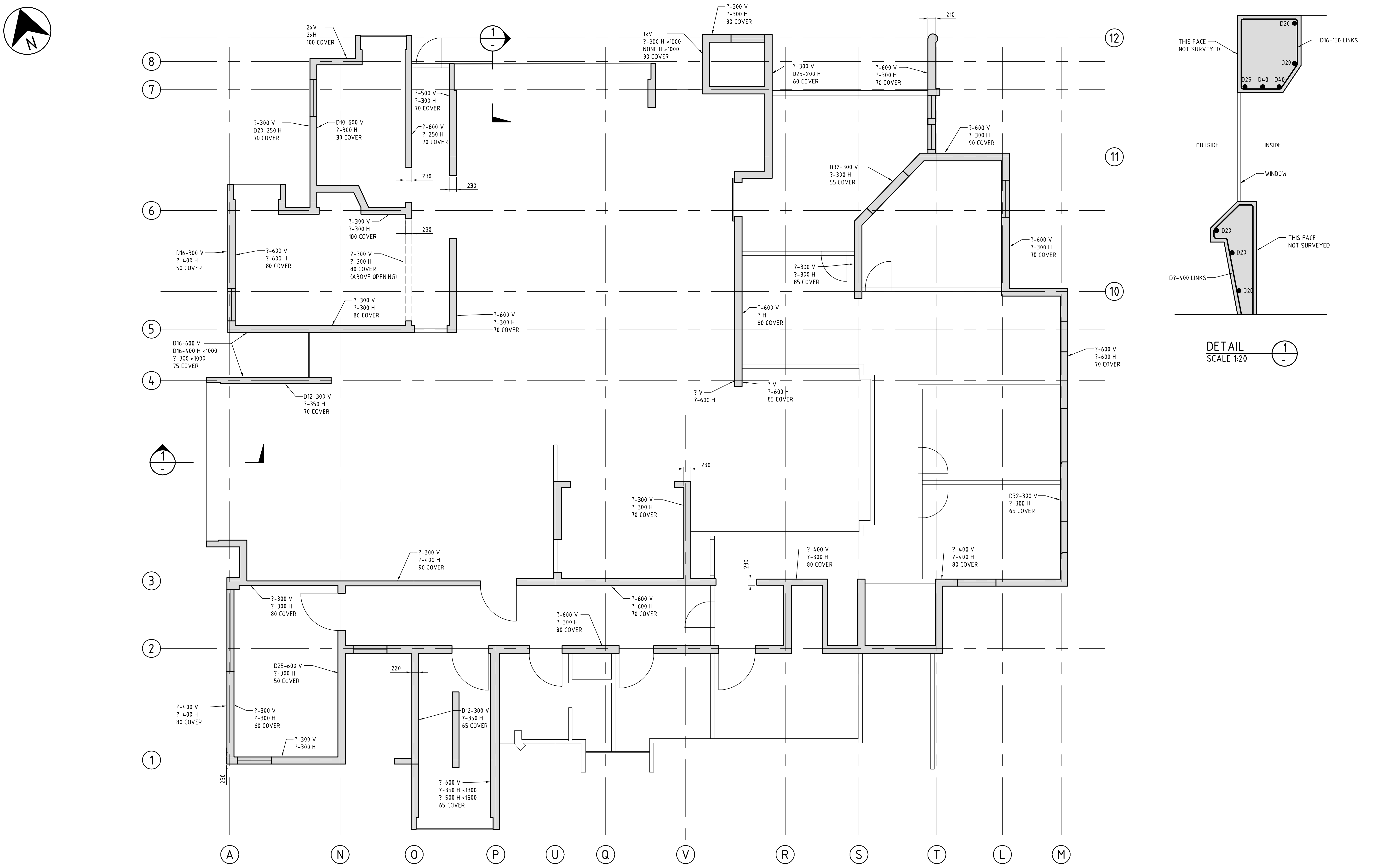
PROJECT: BUILDING SURVEY
LONDON RD, LYTTELTON, CHRISTCHURCH

DRAWN	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
MF		NMC	MWF
DESIGNED	DESIGN REVIEW		

TITLE: LYTTELTON LIBRARY
BASEMENT PLAN

SCALE	PROJECT No	DRAWING No	AMDT
1:50 (A1)	ZB01276	S05	A

A1



GROUND FLOOR PLAN
SCALE 1:50 (A1)

No	DATE	DESIGN REVIEW	REV'D P.MGR	APP'D P.DIR	AMENDMENT
-					
-					
-					
-					
-					
-					

REF.	DRAWING NUMBER	REFERENCE DRAWING TITLE
-		
-		
-		
-		
-		
-		

CLIENT APPROVAL

SKM
Sinclair Knight Merz Ltd
142 Sherborne Street
Christchurch
NEW ZEALAND
Tel: +64 3 940 4900
Fax: +64 3 940 4901
Web: www.skmconsulting.com

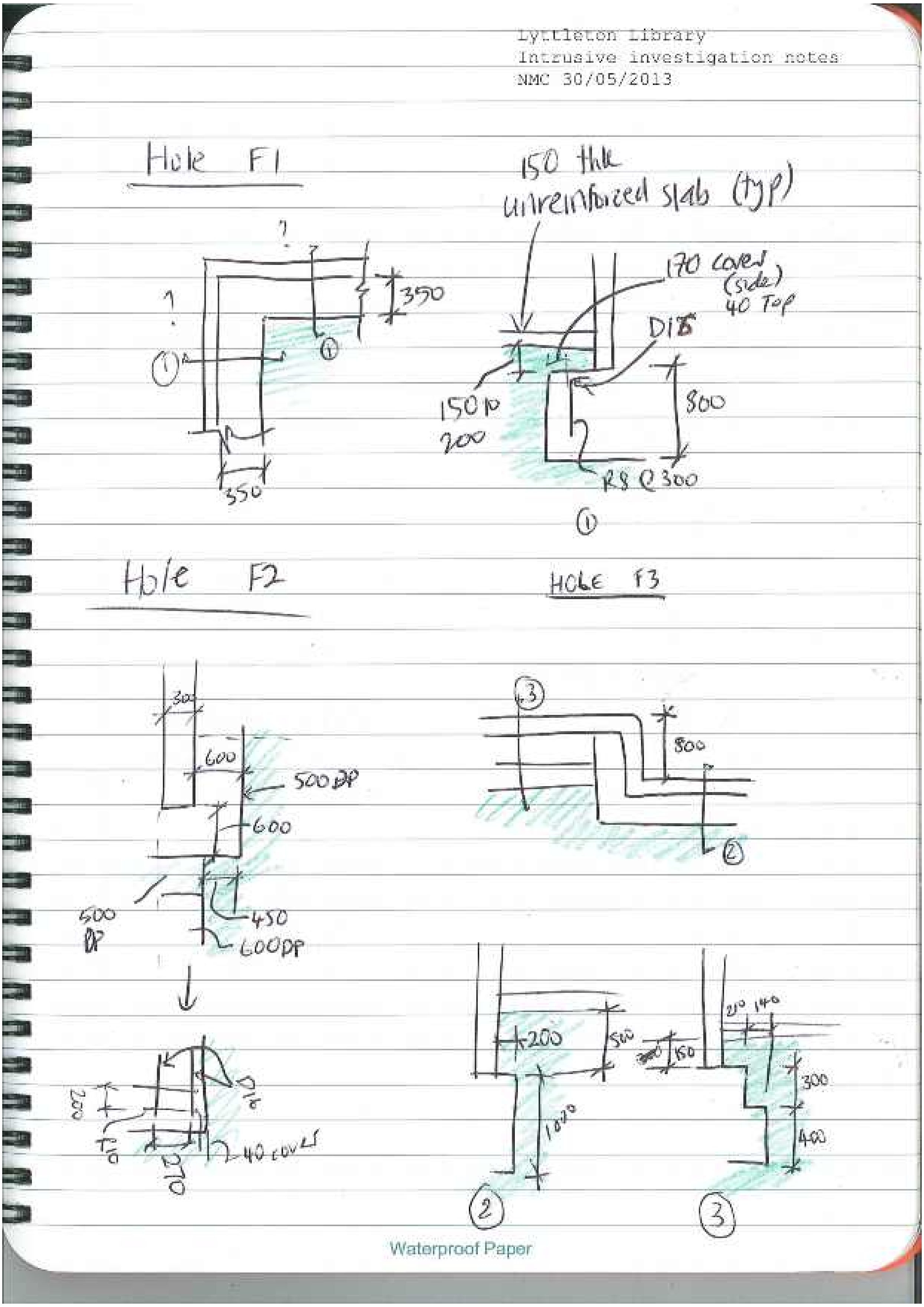
CLIENT: CCC
PROJECT: BUILDING SURVEY
LONDON RD, LYTTELTON, CHRISTCHURCH

DRAWN	DRAFTING CHECK	REVIEWED PROJECT MANAGER	APPROVED PROJECT DIRECTOR
MF		NMC	MWF
DESIGNED	DESIGN REVIEW		

TITLE: LYTTELTON LIBRARY
GROUND FLOOR PLAN

SCALE	PROJECT No	DRAWING No	AMDT
1:50 (A1)	ZB01276	S06	A

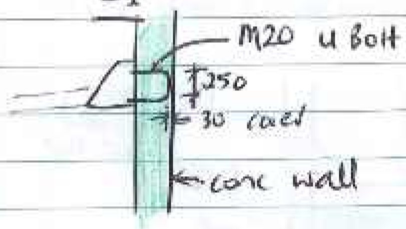
A1


Lyttleton Library
Intrusive investigation notes
NMC 30/05/2013
Hole F1
150 thk
unreinforced slab (typ)
350
350
170 cover (side)
40 Top
D16
150 to
200
800
R8 @ 300
Hole F2
HOLE F3
500 DP
600
600
450
600 DP
500 DP
800
200
500
150
300
400
40 cover
270
Waterproof Paper

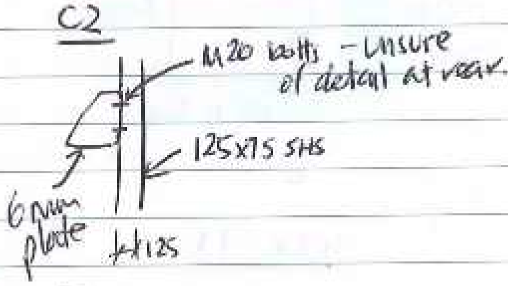
Lyttleton Library
Intrusive investigation notes
NMC 30/05/2013

Truss connections

C1



C2



D1

D2 - contractor confirmed that roofing is compromised.

T1 - Nothing provided. Suggest No 1 framing is used

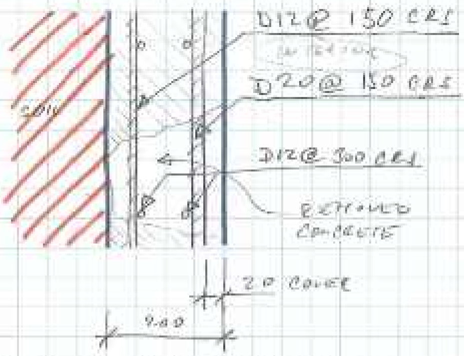
SKM

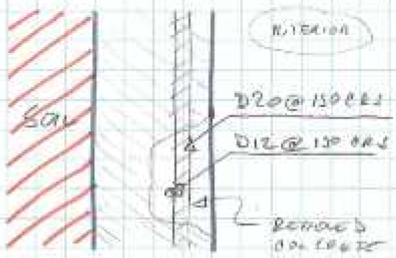
Job No. 2B01276.049
Calc. Series
Client CCC
Page 1
Job Name LYTTELTON LIBRARY
By TB
Calcs Title INTRUSIVE INVESTIGATION
Date 23/05/2013

REINFORCEMENT IN BASEMENT WALLS

SEE 2B01276.049-SK-001 REV 0 (ISSUED ON 6 MARCH 2013) FOR LOCATION PLAN

FOLLOWING DETAILS HAVE BEEN ESTABLISHED





SEE PHOTO 2013-05-24, INTRUSIVE, 02 IN APPENDIX B

LOCATION B1
VERT. SECTION
(N.T.S.)

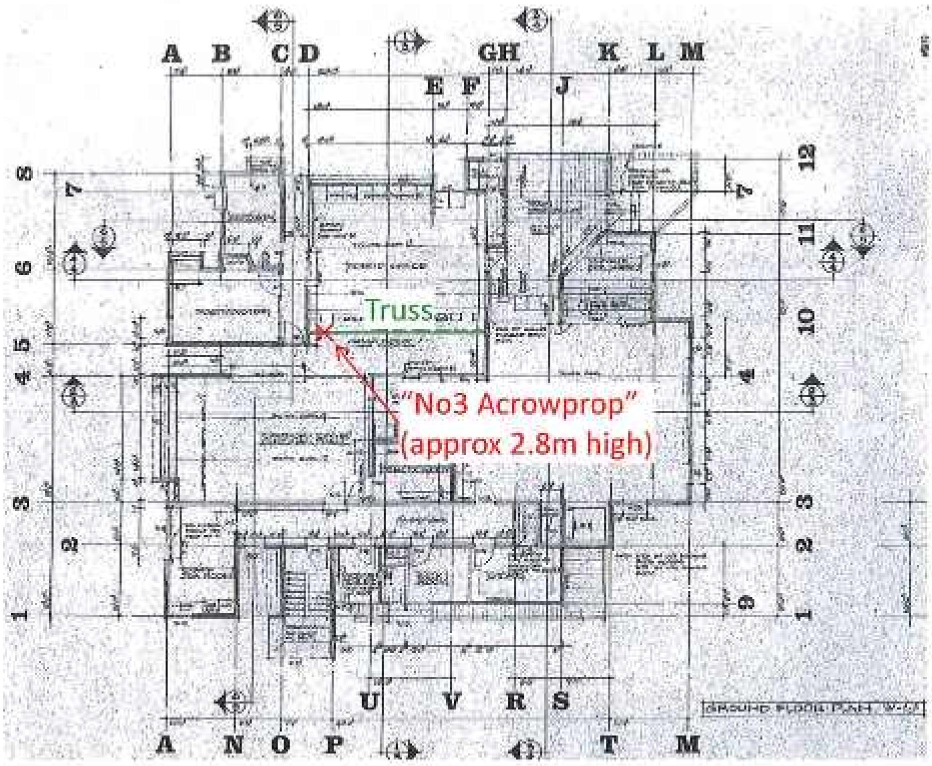
LOCATION B2
VERT. SECTION
(N.T.S.)

13. Appendix C – Temporary propping of truss at D/5.

SKM

		Job No.	ZB01276.049
		Calc Series	
Client	CCC	Page	
Job Name	Lyttleton Library	By	Tomas Bilek
Calcs Title	Temporary propping of Truss near D/5	Date	13 February 2013

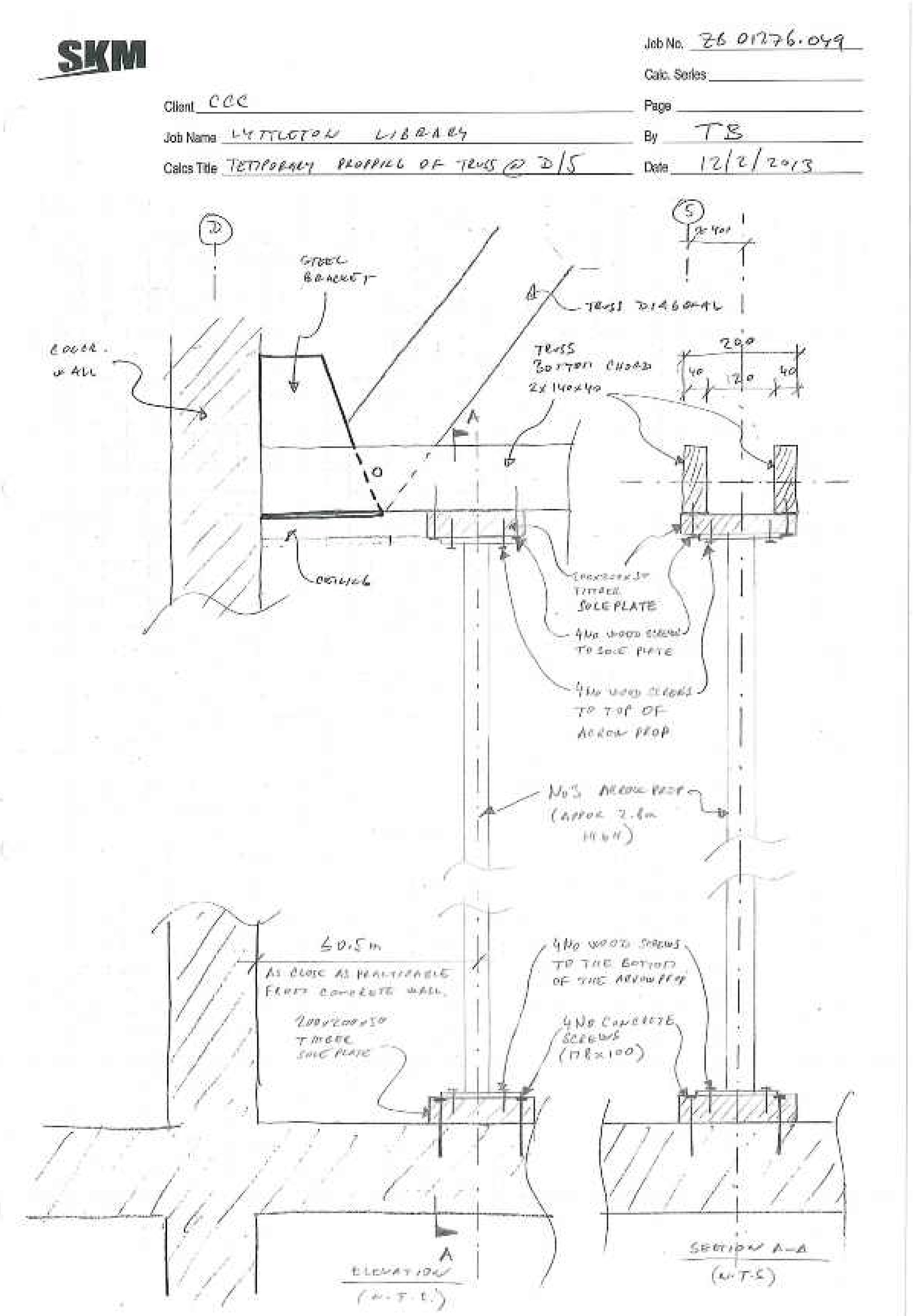
Location of the prop shown on plan of the ground floor (library)



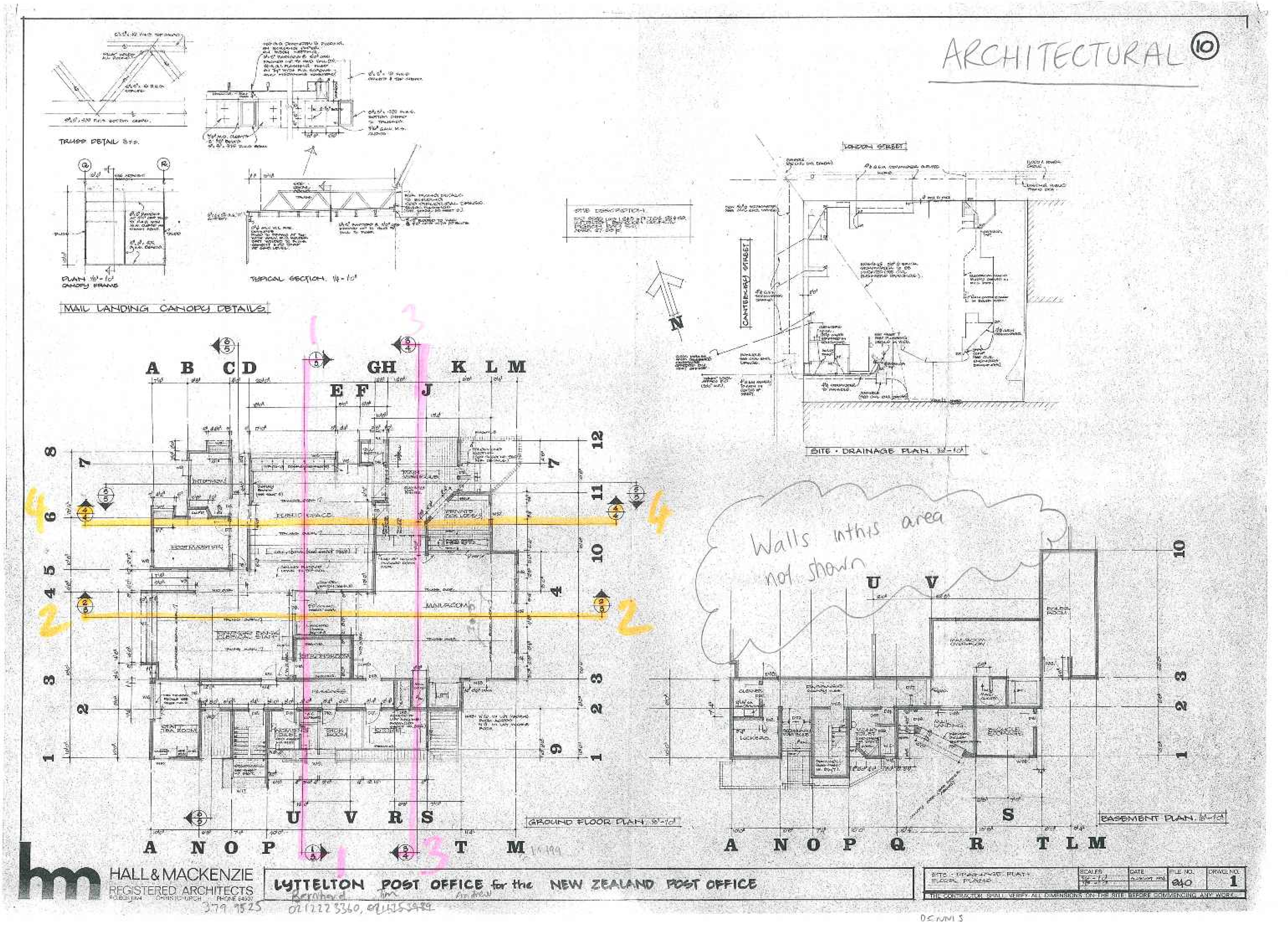
Install one "No 3 Acrowprop" at the location D/5 as marked on the above plan. The prop shall provide alternative support to the west end of the truss and transfer the load to the concrete floor slab below.

Prop shall be positioned at the centreline of the truss and as close to the concrete wall on grid line D as practicable, but not further than 0.5m.

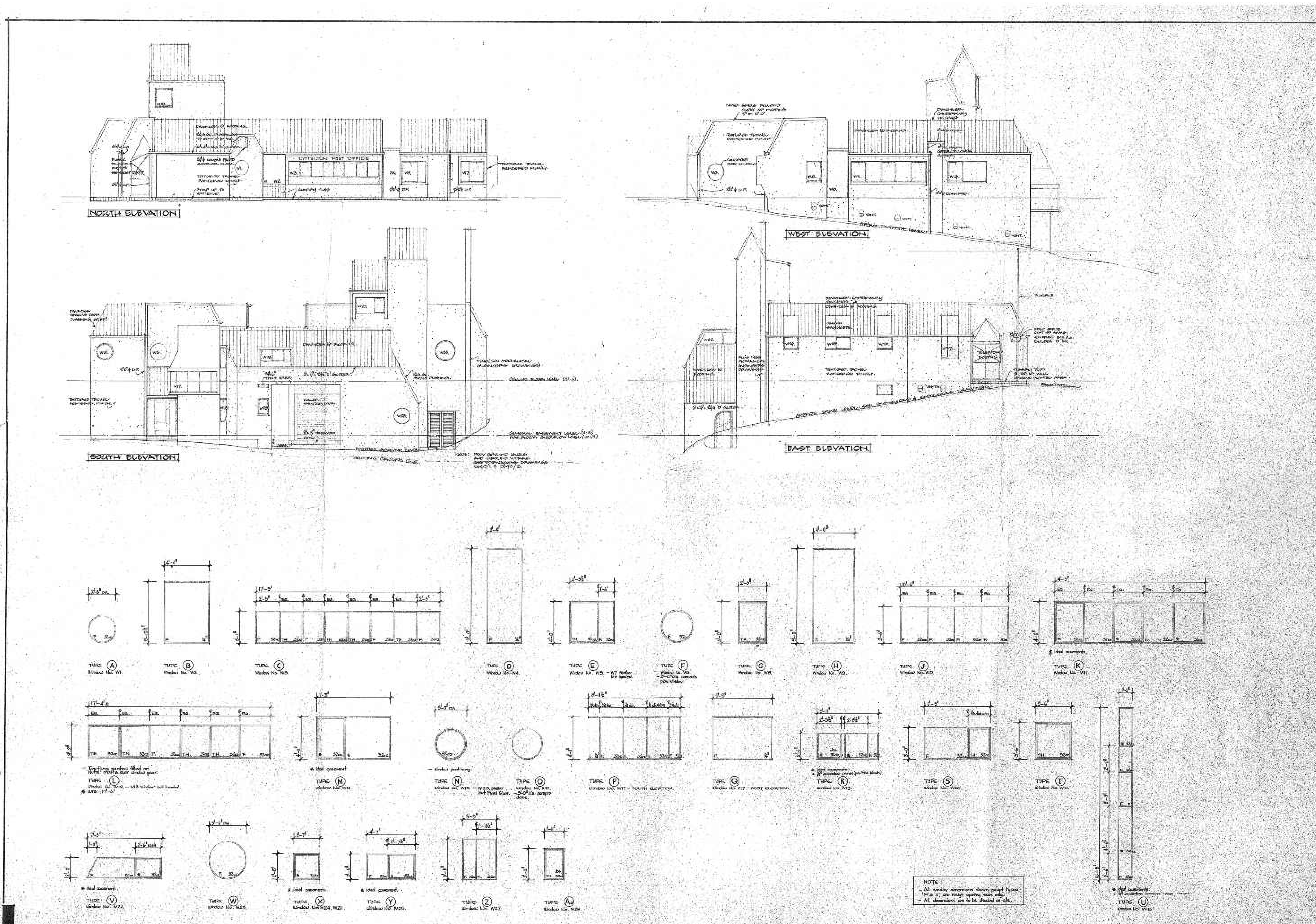
Top and bottom of the prop shall be secured against sliding by means of fixing – see following page for more details.


SKM
Job No. ZB 01276.049
Calc. Series
Page
By TB
Date 12/2/2013
Client CCC
Job Name LYTTELTON LIBRARY
Calcs Title TEMPORARY PROPPING OF TRUSS @ D/5
D
5
STEEL BRACKET
TRUSS DIAGONAL
COLCR. WALL
TRUSS BOTTOM CHORD 2x 140x40
200
40
120
40
CEILING
SOLE PLATE
4No WOOD SCREWS TO SOLE PLATE
4No WOOD SCREWS TO TOP OF ACROW PROP
No 3 ACROW PROP (APPROX 2.8m HIGH)
4No WOOD SCREWS TO THE BOTTOM OF THE ACROW PROP
AS CLOSE AS PRACTICABLE FROM CONCRETE WALL.
TIMBER SOLE PLATE
4No CONCRETE SCREWS (M8x100)
ELEVATION (N.T.S.)
SECTION A-A (N.T.S)

14. Appendix D – Architect`s drawings (1974)



ARCHITECTURAL 10
TRUSS DETAIL 3TS.
PLAN 1/2"-1'0" CANOPY FRAME
TYPICAL SECTION. 1/2"-1'0"
MAIL LANDING CANOPY DETAILS
LONDON STREET
CANTERBURY STREET
N
SITE DESCRIPTION
SITE · DRAINAGE PLAN.
Walls in this area not shown
POSTMASTER
MAILROOM
GROUND FLOOR PLAN.
BASEMENT PLAN.
A B C D E F G H J K L M
A N O P U V R S T M
A N O P Q R T L M
U V
S
HALL & MACKENZIE
REGISTERED ARCHITECTS
CHRISTCHURCH PHONE
379 9525
Bernhard
Tim
Andrew
0212223360, 0211253989
LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE
SCALES
DATE
FILE NO.
840
DRWG. NO.
1
THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK.
DENNIS

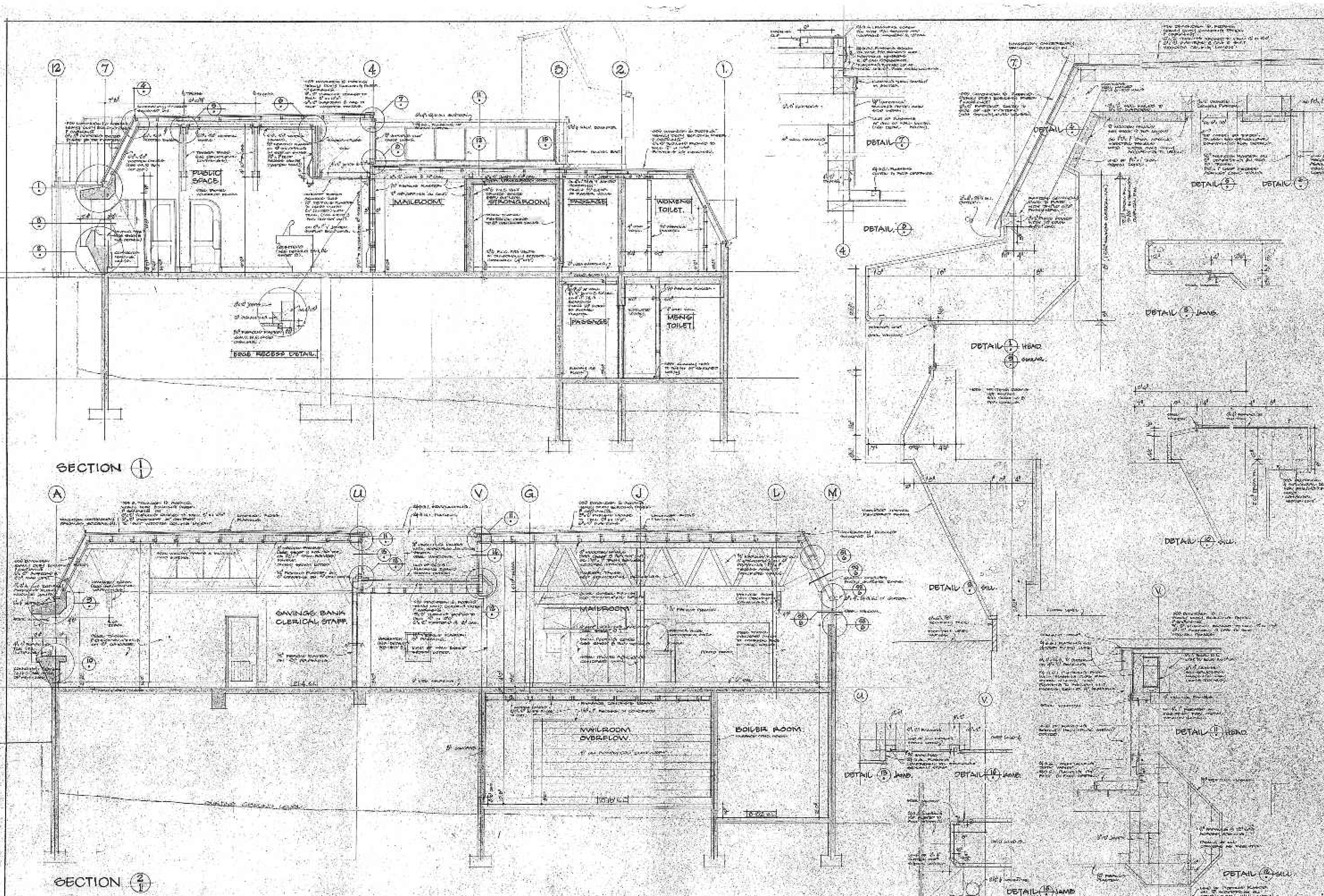


HALL & MACKENZIE
REGISTERED ARCHITECTS
P.O.BOX 1186 CHRISTCHURCH PHONE 64007

LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE

ELEVATIONS WINDOW SCHEDULE	SCALES	DATE	FILE NO.	DRWG. NO.
		AUGUST 197?	940	2

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK

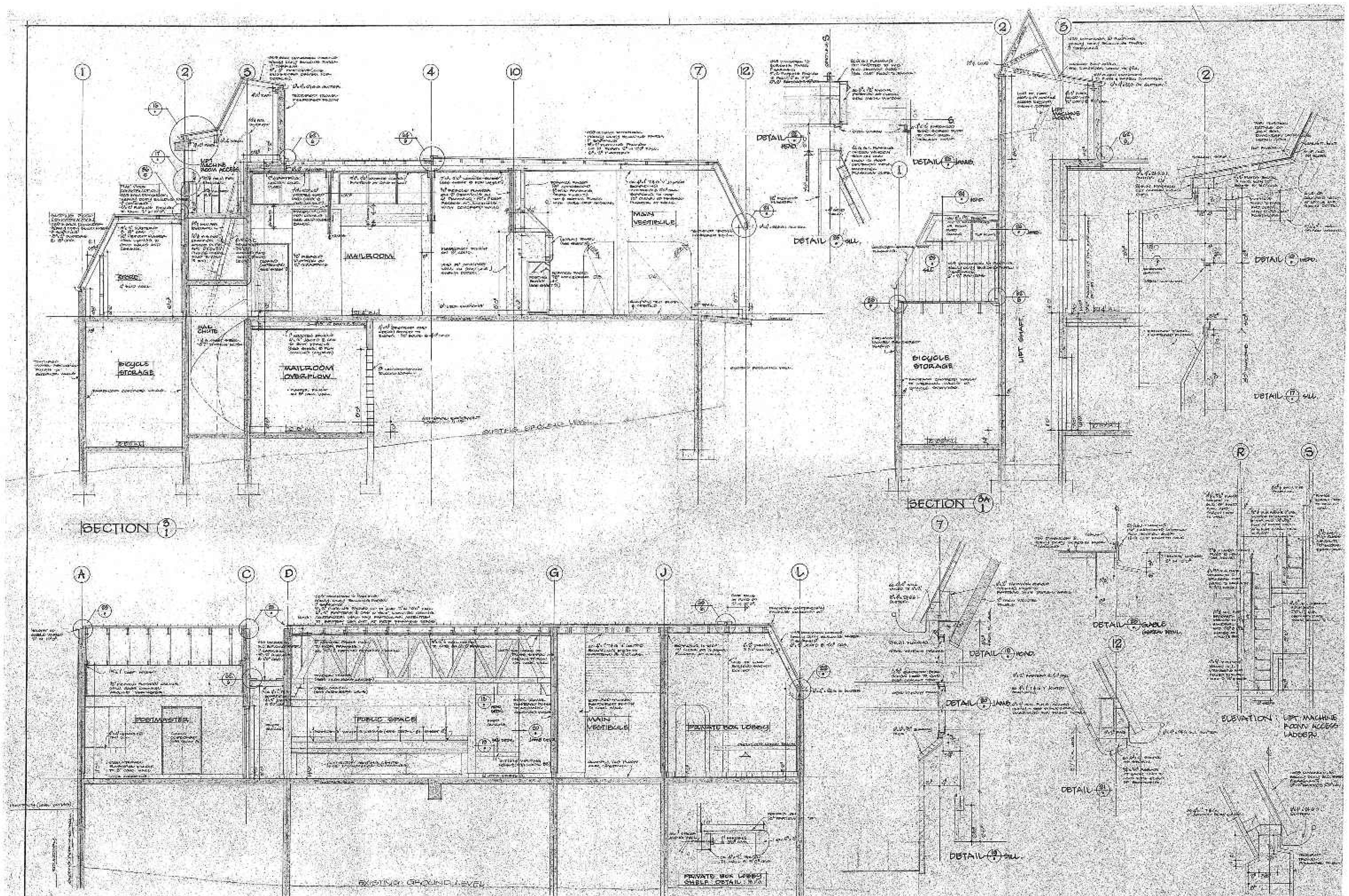


HALL & MACKENZIE
REGISTERED ARCHITECTS
P.O. BOX 1996 CHRISTCHURCH PHONE 84907

LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE

SECTIONS DETAILS	SCALES	DATE	FILE NO.	DRWG. NO.
		AUGUST 1976	940	3

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK



SECTION

HALL & MACKENZIE
REGISTERED ARCHITECTS
CHRISTCHURCH

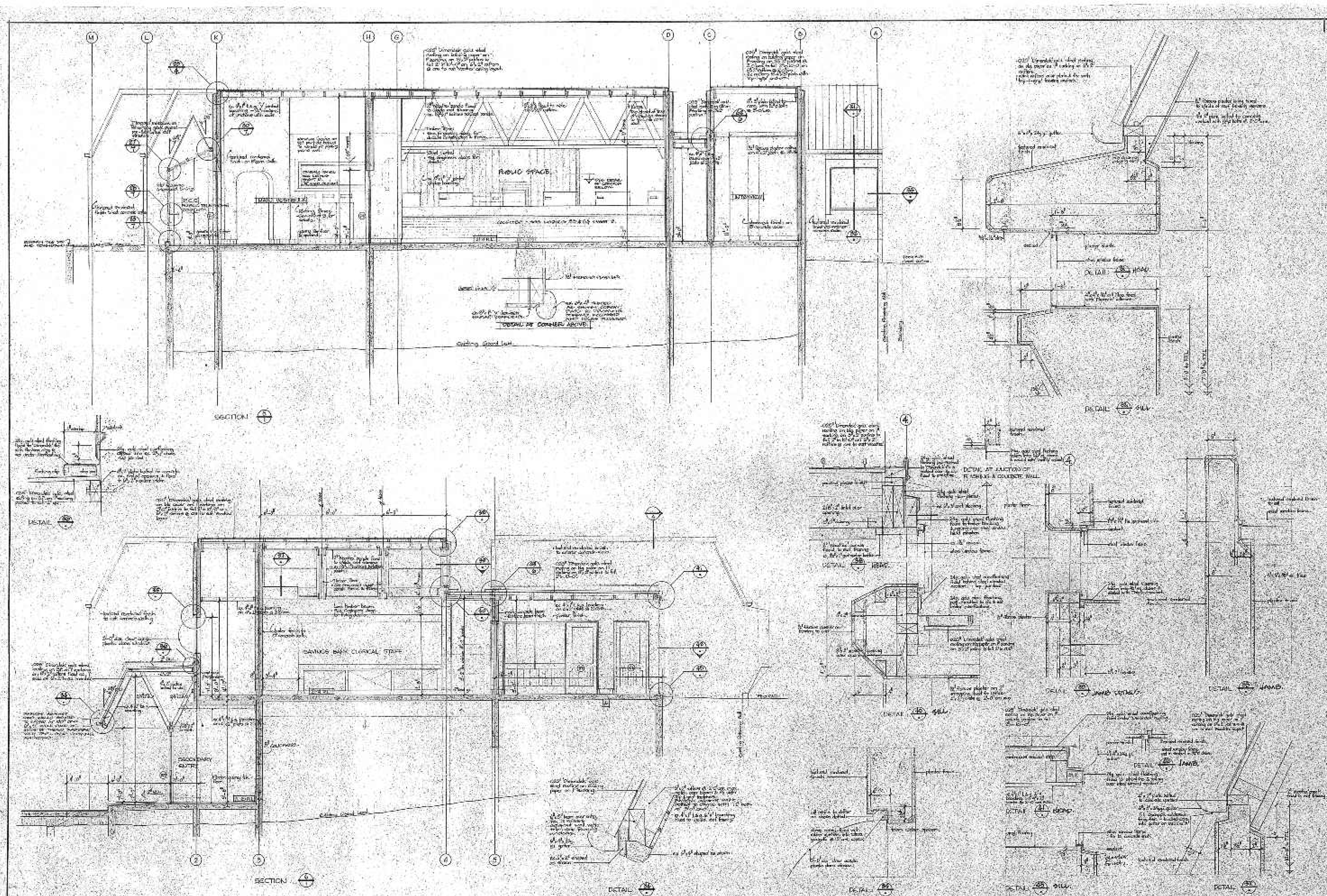
LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE

SECTIONS DETAILS

FILE NO. 940

DRWG. NO. 4

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK

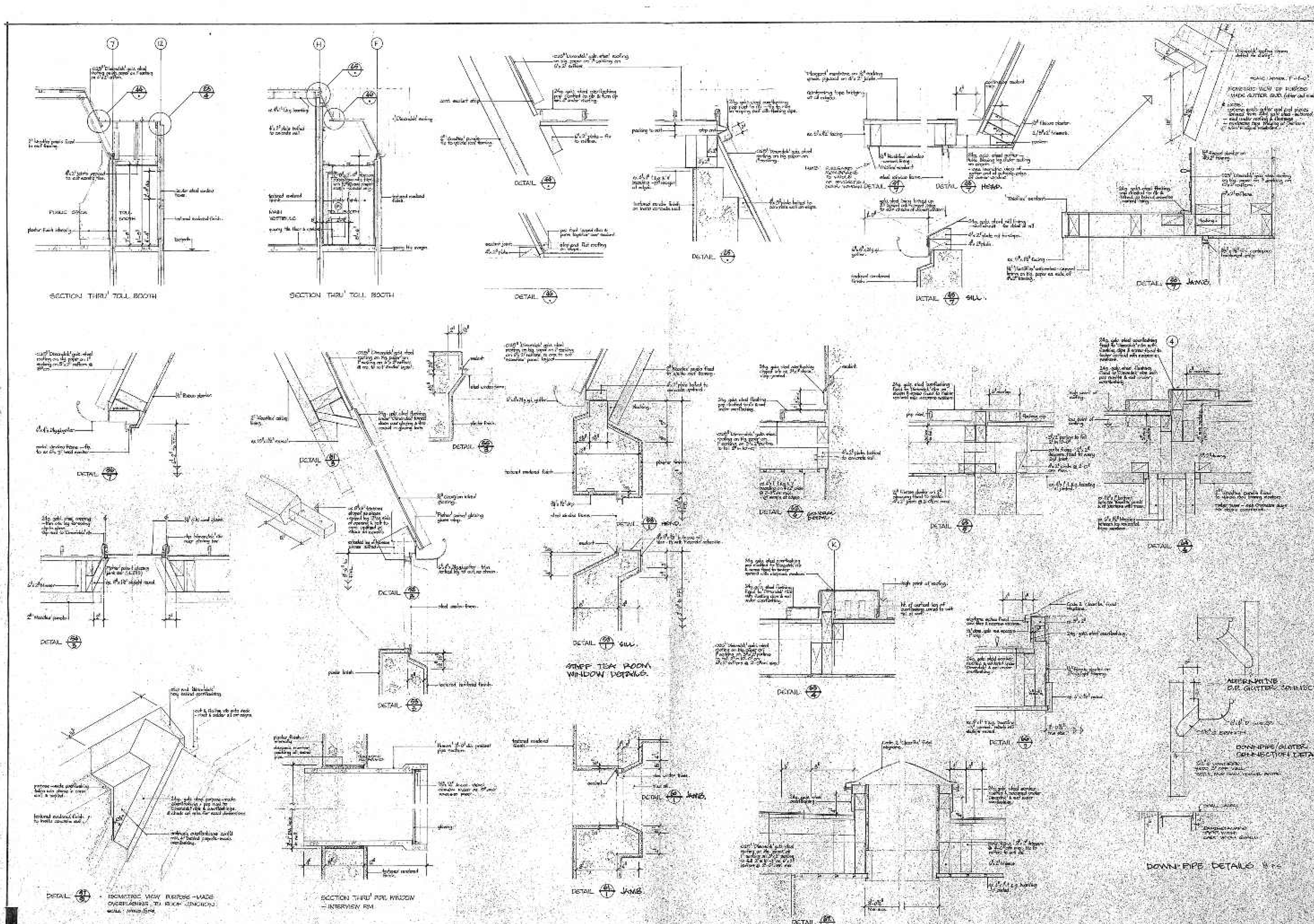


HALL & MACKENZIE
REGISTERED ARCHITECTS
P.O.BOX 1944 CHRISTCHURCH PHONE 64007

LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE.

SECTIONS DETAILS	SCALES	DATE	FILE NO. 940	DRWG. NO. 5

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK.



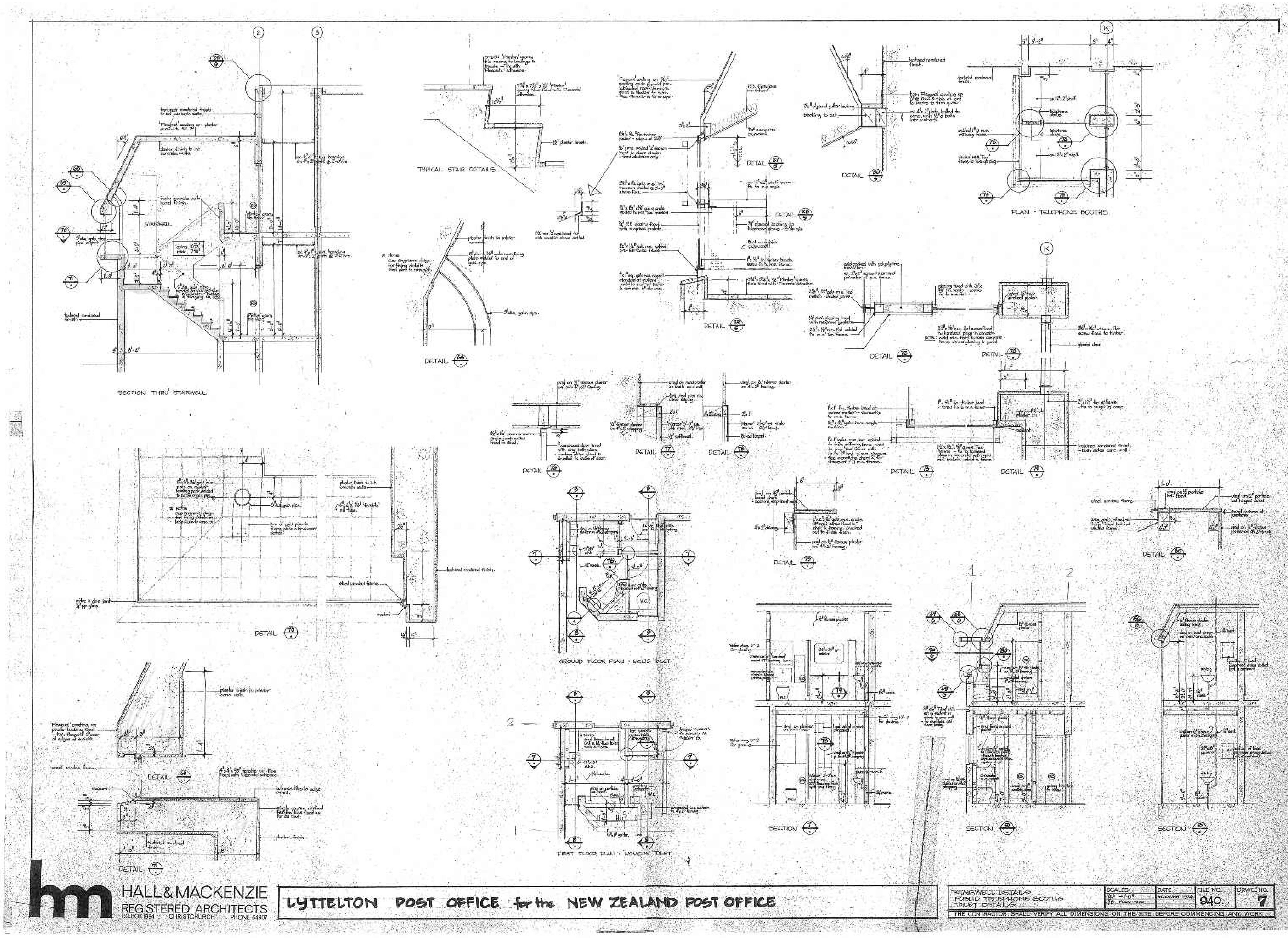
HALL & MACKENZIE
REGISTERED ARCHITECTS
P.O. BOX 1904 CHRISTCHURCH PHONE 64907

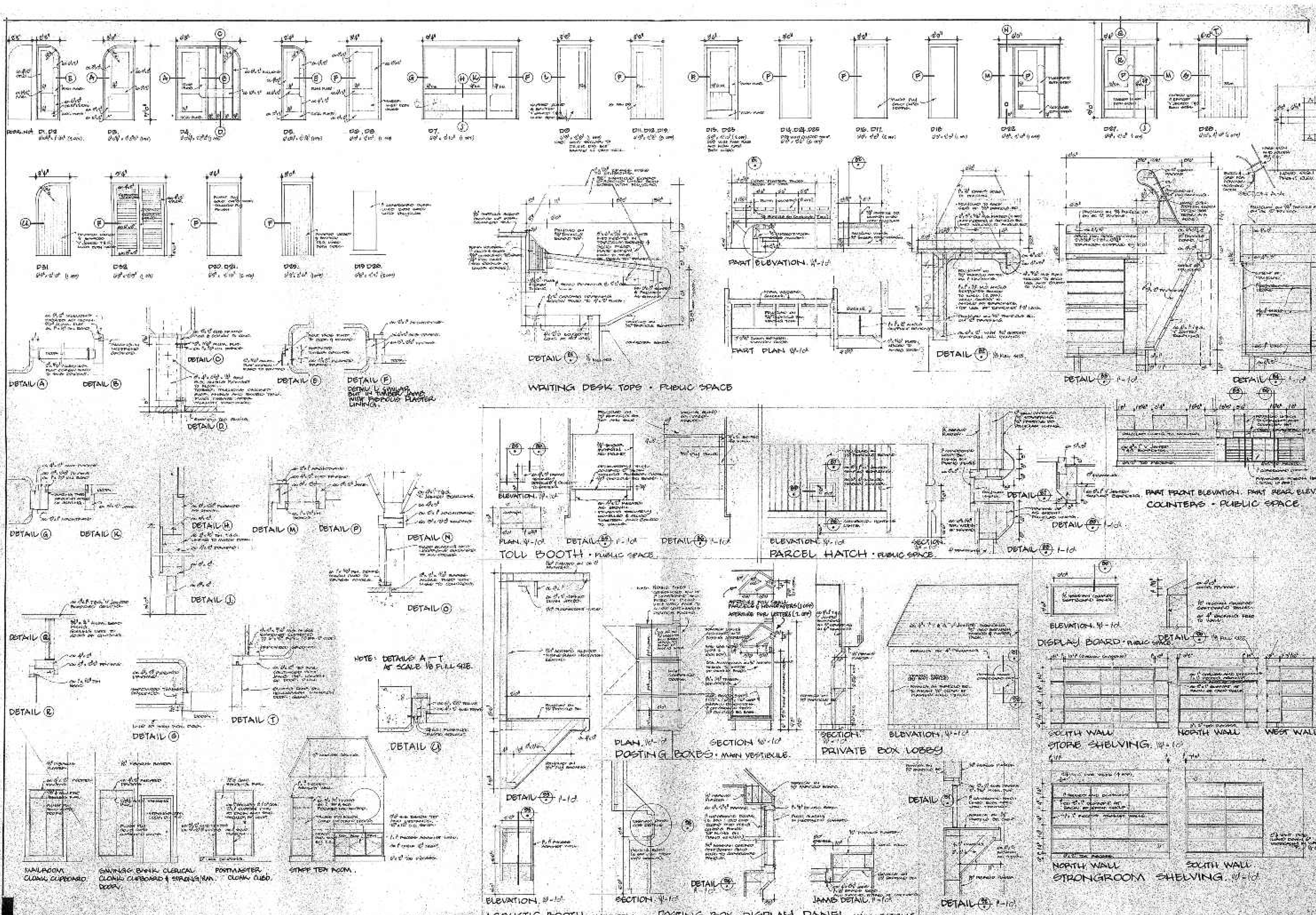
LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE

TOLL BOOTH SECTIONS
MISCELLANEOUS DETAILS

SCALES	DATE	JOB NO.	DRWG. NO.
[illegible]	[illegible]	940	6

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK.


SECTION THRU' STAIRWELL
TYPICAL STAIR DETAILS
PLAN - TELEPHONE BOOTHS
GROUND FLOOR PLAN - MEN'S TOILET
FIRST FLOOR PLAN - WOMEN'S TOILET
DETAIL
SECTION
hm HALL&MACKENZIE
REGISTERED ARCHITECTS
CHRISTCHURCH
LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE
STAIRWELL DETAILS
PUBLIC TELEPHONE BOOTHS
TOILET DETAILS
SCALES
DATE
FILE NO.
940
DRWG. NO.
7
THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK.



HALL & MACKENZIE
REGISTERED ARCHITECTS
P.O. BOX 984 CHRISTCHURCH PHONE 6-907

LYTTELTON POST OFFICE for the NEW ZEALAND POST OFFICE.

DOOR SCHEDULE & DETAILS JOINERY DETAILS	SCALES: AS SHOWN	DATE: AUGUST 1932	FILE NO. 940	DRWG. NO. 8

THE CONTRACTOR SHALL VERIFY ALL DIMENSIONS ON THE SITE BEFORE COMMENCING ANY WORK.

15. Appendix E – SKM Geotechnical Interpretive Report dated 4/07/12

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	04/07/2013	C Watts	N Calvert	04/07/2013	Draft for Client Approval

Distribution of copies

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A	1	1	Christchurch City Council

Printed:	4 July 2013
Last saved:	4 July 2013 04:41 PM
File name:	PRO 3522 B001 Lyttelton Library Geotechnical InterpretiveReport Draft.docx
Author:	Jon Rabey
Project manager:	Alex Martin
Name of organisation:	Christchurch City Council
Name of project:	CCC Structural Panel
Name of document:	Lyttelton Library Geotechnical Interpretative Report
Document version:	A
Project number:	ZB01276.049

15.1. Introduction

SKM has been commissioned by Christchurch City Council (CCC) to undertake a geotechnical investigation to provide a bearing capacity to be used in a quantitative Detailed Engineering Evaluation (DEE). The following work has been completed:

- 3 scala penetrometer tests in inspection pits on the basement floor of Lyttelton Library.
- Preparation of a geotechnical interpretative report confirming the bearing capacity at the site to be used in quantitative DEE.

15.2. Site description

The site is located at 18 Canterbury Street, Lyttelton on the corner of Canterbury Street and London Street. The site has been cut into a southwards facing slope.

- **Figure 1 – Site Location (Source: SKM Internal System)**

15.3. Existing information

15.3.1. Investigation by third parties

A search of existing information was undertaken. Available map data shows that no boreholes or Cone Penetration Tests (CPTs) have been undertaken previously on the site or if they have, they are not publically available.

15.3.2. Regional geology

The 1:250,000 geological map of the Christchurch area[7] indicates that the site is underlain by basalt which is overlain by a variable thickness of loess.

15.4. Geotechnical investigation

15.4.1. General

The geotechnical investigation included 3 scala penetrometer tests to effective refusal (8 blows or more for 50 mm penetration). Each test was conducted at the base of a foundation excavation pit.

15.4.2. Methodology

15.4.2.1. Scala penetrometer tests

The 3 scala penetrometer tests referred to in section 4.1 above are detailed in Table 1 below.

- **Table 1 – Scala penetrometer summary**

Foundation excavation pit ref.	Foundation excavation pit depth (m)	Depth of DCP test (m)	Final depth below floor level (mbgl)
F1	1.0	1.3	2.3
F2	1.0	1.15	2.15
F3	1.5	1.8	3.3

NB – DCP test was undertaken at base of foundation excavation pit

[7] Forsyth, P.J., Barrell, D.J.A., Jongens, R. (compilers) (2008). *Geology of the Christchurch area. Institute of Geological and Nuclear Sciences 1:250,000 geological map 16. 1 sheet + 67 p.* Lower Hutt, New Zealand: Institute of Geological and Nuclear Sciences Ltd.

15.5. Geotechnical interpretation / considerations

15.5.1. Bearing capacity

An assessment of the bearing capacity of the shallow soils can be carried out based on the findings of the scala penetrometer results and in particular the plots of blow counts with depth. The majority of scala results show blows equal to and in excess of 8 which indicates an ultimate bearing capacity of at least 500kPa[8]. It is expected that these results are due to the Dynamic Cone Penetrometer (DCP) encountering weathered basalt rock. However, man-made fill could also provide similar DCP results. Sampling would be required to confirm basalt bedrock underneath the building.

15.6. Conclusions

- DCP results indicate that the building is most likely underlain by basalt or man-made fill with an ultimate bearing capacity of approximately 500 kPa. It is possible that the ultimate bearing capacity is higher than this but this can only be confirmed by additional testing (i.e. borehole with sampling).
- The site has been evaluated as Class C due to the inferred geology of loess underlain by basalt. It is expected that when the building was constructed the layer of loess was removed and the building founded on basalt or man-made fill.

[8] Stockwell, M. J. (1977). Determination of allowable bearing pressure under small structures. *New Zealand Engineering*, 32(6), 132-134.

15.7. Limitations

This report is project specific. It was prepared to address geotechnical issues relating to the specific site in accordance with the scope of works as defined in the contract between SKM and our Client. This report has been prepared on behalf of, and for the exclusive use of, our Client, and is subject to, and issued in accordance with, the provisions of the contract between SKM and our Client. The findings presented in this report should not be applied to another site or another development within the same site without consulting SKM.

Geotechnical conditions can change and will vary across any site and between investigation locations. The findings of this geotechnical report reflect the geotechnical conditions at the identified locations and at the time of the investigation. If this report is being referenced after some period of time has elapsed since it was drafted then it is recommended that SKM be consulted regarding the current validity of this report.

All of the ground conditions that exist at the site may have been identified in this report. All reports and conclusions that deal with sub-surface conditions are based on interpretation and judgement and as a result have uncertainty attached to them. You should be aware that this report contains interpretations and conclusions which are uncertain due to the nature of the investigations. Sampling techniques, by definition, cannot determine the conditions between the sample points and so this report cannot be taken to be a full representation of the sub-surface conditions. This report only provides an indication of the likely sub surface conditions. No study or investigation can eliminate every risk and conclusively identify all the ground conditions within a site.

This report is based on assumptions that the site conditions as revealed through sampling are indicative of conditions throughout the site. The findings are the result of standard assessment techniques used in accordance with normal practices and standards, and they represent a reasonable interpretation of the current conditions on the site.

This report should be read in full and no excerpts are to be taken as representative of the findings. It must not be copied in parts, have parts removed, redrawn or otherwise altered without the written consent of SKM.

16. Appendix F – SKM Crack Monitoring Report dated 17/07/12

CHRISTCHURCH CITY COUNCIL

BU 3522-001 EQ2
Lyttelton Library
18 Canterbury St, Lyttelton

CRACK MONITORING REPORT

DRAFT

- A
- 17 July 2013

CHRISTCHURCH CITY COUNCIL
BU 3522-001 EQ2
Lyttelton Library
18 Canterbury St, Lyttelton

CRACK MONITORING REPORT

DRAFT

- A
- 17 July 2013

DRAFT

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Contents

Document history and status

Revision	Date issued	Reviewed by	Approved by	Date approved	Revision type
A	17/07/2013	N Calvert	A Martin	17/07/2013	Draft for Client Approval

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Revision	Copy no	Quantity	Issued to
A	1	1	Christchurch City Council

Printed:	17 July 2013
Last saved:	11 July 2013 02:31 PM
File name:	PRO 3522 B001 Lyttelton Library Crack Monitoring Report Draft.docx
Author:	Tomas Bilek
Project manager:	Alex Martin
Name of organisation:	Christchurch City Council
Name of project:	CCC Structural Panel
Name of document:	Crack Monitoring Report
Document version:	A
Project number:	ZB01276.049

1. Introduction

SKM was commissioned by the Christchurch City Council (CCC) to undertake a quantitative detailed engineering evaluation of the building located at 18 Canterbury Street, Lyttelton. This evaluation entailed, inter alia, conducting two visual inspections of the building, on 02 April 2012 and 15 October 2012. During the second of these inspections, the occupants reported that some of the cracks (especially around the damage in the area near D/5) regularly release dust, which led to the concern that the damage may have been deteriorating as a result of on-going settlements.

These concerns were relayed to CCC, and it was decided to undertake a crack monitoring exercise, in parallel to the quantitative detailed engineering evaluation, reporting the findings to CCC by email as the monitoring proceeded. This report summarises the results of the crack monitoring.

2. Methodology

Crack measurement was conducted on site on five occasions, with each inspection approximately one month apart. During the first inspection, on 27 February 2013 - 33 locations were selected for measurement; 12 within the public library area on the ground floor and 21 in the basement. The locations of these cracks are indicated in Appendix A.

Shortly before the third visit, the library manager identified two (reportedly fresh) cracks and asked that they be added to the monitoring schedule. The locations of these cracks are indicated in Appendix B.

The monitoring comprised of establishing the locations by marking them with a black line running across the crack and subsequent reading of the crack widths (and crack steps where of concern) using a micrometre with magnifying glass and accuracy of 0.1mm.

3. Results

SKM visited the site on 27 February 2013, 27 March 2013, 22 April 2013, 22 May 2013 and upon completion of intrusive investigation works on 9 July 2013. The measurements taken on these visits are shown in Table 1 below.

Table 1: Summary of measured results

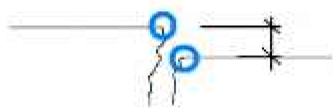
1.0	Green = decrease	1.0	Red = increase	R	Grey = mark rubbed out

	Crack No.	27/02/2013		27/03/2013		22/04/2013		22/05/2013		9/07/2013 (post intrusive investigation)		Overal change between 27/02 & 09/07/2013		
		Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Notes
LIBRARY	1	0.4	-	0.3	-	0.2	-	0.2	-	0.2	-	0.2		insignificant change
	2	0.2	1.8	0.2	1.8	0.2	1.8	0.2	1.8	R	R	0.0	0	
	3	1.1	-	1.0	-	1.0	-	1.0	-	1.0	-	0.1		
	4	1.1	-	1.0	-	1.0	-	1.0	-	1.0	-	0.1		
	5	1.6	-	1.5	-	1.6	-	1.6	-	1.6	-	0.0		
	6	1.3	-	1.3	-	1.3	-	1.3	-	1.3	-	0.0		
	7	2.2	-	2.2	-	2.1	-	2.1	-	2.1	-	0.1		
	8	4.9	-	4.5	-	4.5	-	4.5	-	4.5	-	0.4		within gib ceiling
	9	0.5	2.2	0.3	2.0	0.3	2.0	0.3	2.0	0.3	2.0	0.2	0.2	insignificant change
	10	0.4	-	0.3	-	0.3	-	0.4	-	0.4	-	0.0		
	11	0.3	-	0.3	-	0.3	-	0.2	-	0.2	-	0.1		
	12	0.2	-	0.2	-	0.2	-	0.2	-	0.2	-	0.0		
BASEMENT	13	3.6	2.0	4.0	2.0	4.0	2.0	4.0	2.0	4.0	2.0	-0.4	0	moved in March then stopped.
	14	3.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	R	R	-0.5	0	
	15	3.5	2.0	3.7	2.0	3.7	2.0	3.7	2.0	3.7	2.0	-0.2	0	insignificant change
	16	1.1	-	1.1	-	1.1	-	1.1	-	1.1	-	0.0		
	17	5.3	2.0	5.0	2.0	5.0	2.0	5.0	2.0	5.0	2.0	0.3	0	as per 13
	18	6.2	-	6.2	-	6.2	-	6.2	-	6.3	-	-0.1		insignificant change
	19	2.2	1.0	2.2	1.0	2.3	1.0	2.2	1.0	2.2	1.0	0.0	0	
	20	3.0	2.0	3.0	2.0	3.0	2.0	3.0	2.0	3.0	2.0	0.0	0	
	21	1.2	-	1.3	-	1.2	-	1.2	-	1.2	-	0.0		
	22	1.1	0.5	1.2	0.5	1.3	0.5	1.3	0.5	R	R	-0.2	0	
	23	0.4	-	0.3	-	0.4	-	0.4	-	0.4	-	0.0		
	24	0.4	-	0.4	-	0.4	-	0.4	-	0.4	-	0.0		
	25	0.2	-	0.3	-	0.3	-	0.3	-	0.3	-	-0.1		
	26	0.4	-	0.4	-	0.4	-	0.4	-	0.4	-	0.0		
	27	0.6	-	0.5	-	0.5	-	0.5	-	0.5	-	0.1		
	28	0.2	-	0.2	-	0.2	-	0.2	-	0.2	-	0.0		
	29	0.4	-	0.4	-	0.4	-	0.4	-	0.4	-	0.0		
	30	0.6	-	0.5	-	0.5	-	0.5	-	0.5	-	0.1		
	31	0.3	-	0.2	-	0.2	-	0.2	-	0.2	-	0.1		
	32	0.3	-	0.3	-	0.3	-	0.3	-	0.3	-	0.0		
	33	0.2		0.2	-	0.2	-	0.2	-	0.2	-	0.0		
LIB.	34	-	-	-	-	0.4	-	0.4	-	0.4	-	0		
	35	-	-	-	-	0.7	-	0.7	-	0.7	-	0		

Crack width reading:
measure distance between red circles (top of the marks)

VIEW AT CRACK

Crack step reading:
measure distance between blue circles (centreline of marks)



SECTION THROUGH CRACK

4. Discussion

Most of the change recorded is considered to be insignificant, and likely within the margin of error of the measuring tools used. Only four cracks were found to have notable change, being cracks 8, 13, 14 and 17.

Crack 8 was found to have decreased by 0.4mm. This crack is located within a ceiling that suffered serious cracking. The structure providing support to the ceiling panels is of a relatively flexible nature and such movement can be expected to occur as a result of natural movements occurring within the structure. Temporary propping to this area has been installed to prevent further deterioration until the repair/partial reconstruction of the ceiling is undertaken.

Cracks 13, 14 and 17 were found to have increased by 0.4mm, increased by 0.5mm and decreased by 0.3mm respectively. It is noted that all of this movement occurred in March (i.e. at the beginning of the monitoring period) and appears to have stopped.

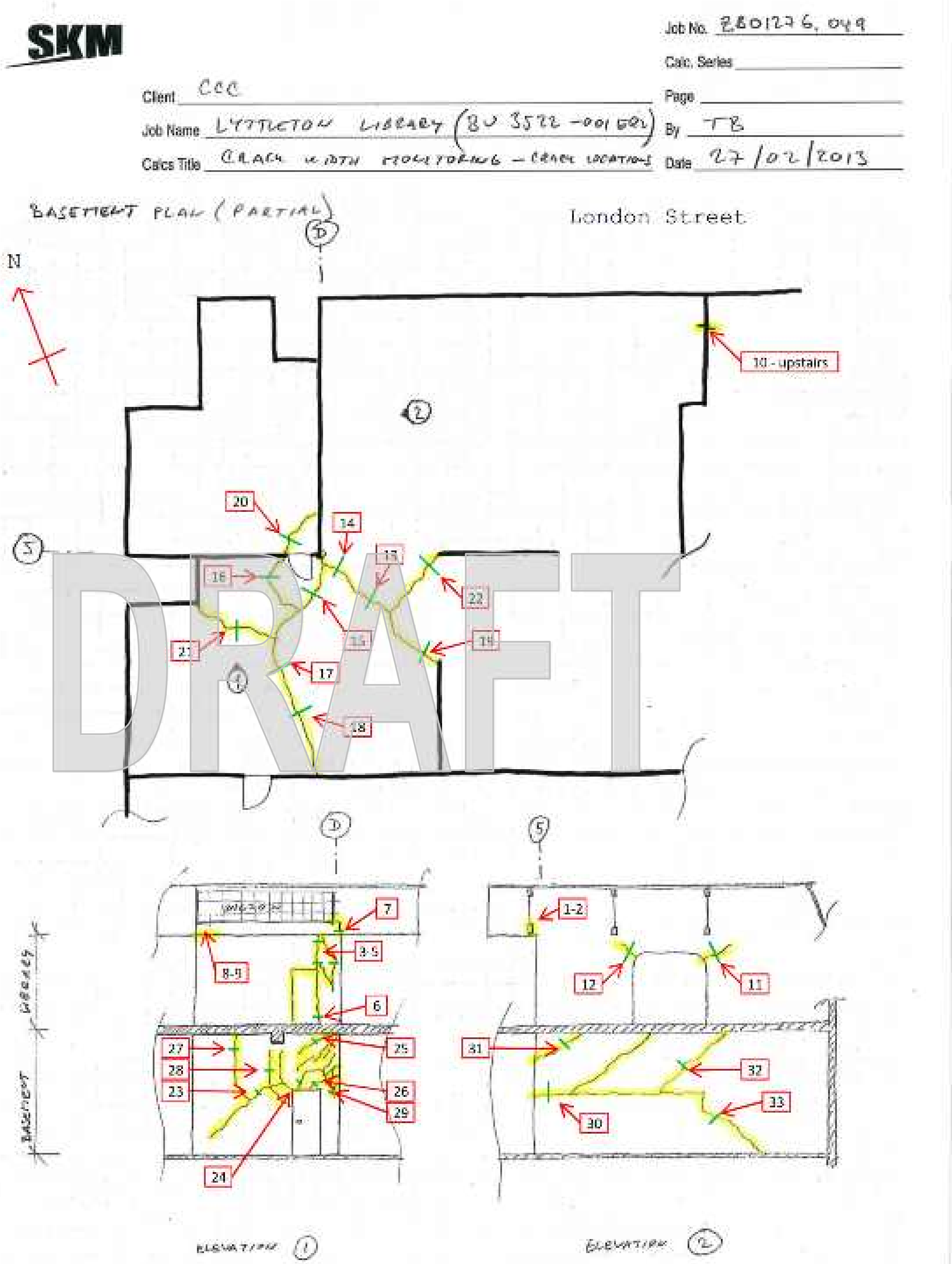
The final measurements undertaken upon completion of the intrusive investigation indicate that the building has not been affected during the works. 3 No marks (#2, #14 & #22) were found to have been rubbed out during the works and we were unable to take measurements at these locations.

5. Conclusion

Crack monitoring of the damaged and most critical areas within the library was undertaken over the period from 27 February 2013 until 9 July 2013. Four cracks out of 35 that were monitored were found to have a change in the order of ±0.5mm that occurred between the initial visit in February and second visit in March 2013. None of these cracks and no other monitored cracks were found to significantly change since March 2013 and we therefore recommend ceasing the monitoring as the cracks appear to be relatively stable and do not appear to be moving.

We do not believe that the cracking indicates a collapse risk and hence the cracking does not impact on the building safety.

Appendix A Crack Locations



Appendix B Cracks in concrete lintel

SKM

Job No. ZB01276.049
Calc. Series
Page
Client CCC
Job Name LYTTELTON LIBRARY (BU 3522-001 EQ2)
By TB
Calcs Title CRACK WIDTH MONITORING - CRACK LOC.
Date 22/4/2013

- FIRST PLAN ISSUED ON 27/02/2013
- TWO NEW LOCATIONS HAVE BEEN ADDED ON 22/4/2013

LIBRARY PLAN (PARTIAL)

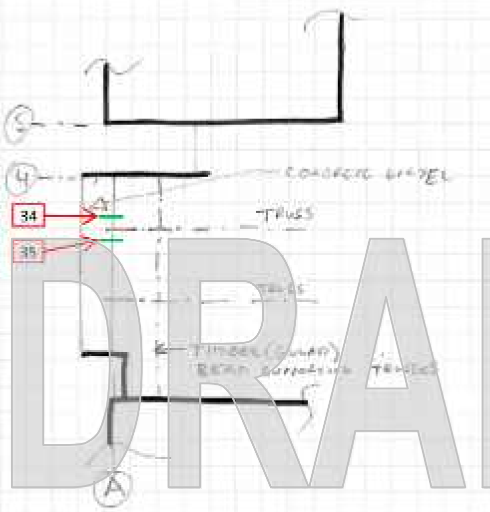


Photo of crack monitoring locations 34 & 35

General view on concrete lintel

Appendix C Emails

C.1 Email, SKM to Carissa Ptacek, 27/2/13

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Wednesday, 27 February 2013 3:33 PM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); 'Sutherland, Di'
Subject: Lyttelton Library - Crack monitoring
Attachments: Lyttleton Library - crack width monitoring_0.pdf

Carissa,

Attached is the crack report showing the starting readings for each crack. As per our email we will monitor the cracks on a monthly basis and report following each inspection. As you can see we have chosen to monitor 33 locations which we feel provides a better indication of the ongoing movement.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
Mb: +64 (0) 21 757 549
142 Sherborne Street
PO Box 21011 Christchurch

Inspection note

Sheet No.	Rev.
1	0

Contract	CCC - Lyttleton Library (BU 3522 - 001 EQ2)
Part of Structure	Crack Width Monitoring

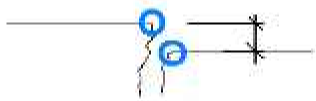
Contract No.	ZB01276.049
Date	27 Feb 13
Inspector	TB

	Crack No.	27/02/2013		27/03/2013 (t.b.c.)		24/04/2013 (t.b.c.)		22/05/2013 (t.b.c.)	
		Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]
LIBRARY	1	0.4	-						
	2	0.2	1.8						
	3	1.1	-						
	4	1.1	-						
	5	1.6	-						
	6	1.3	-						
	7	2.2	-						
	8	4.9	-						
	9	0.5	2.2						
	10	0.4	-						
	11	0.3	-						
	12	0.2	-						
BASEMENT	13	3.6	2.0						
	14	3.0	3.5						
	15	3.5	2.0						
	16	1.1	-						
	17	5.3	2.0						
	18	6.2	-						
	19	2.2	1.0						
	20	3.0	2.0						
	21	1.2	-						
	22	1.1	0.5						
	23	0.4	-						
	24	0.4	-						
	25	0.2	-						
	26	0.4	-						
	27	0.6	-						
	28	0.2	-						
	29	0.4	-						
	30	0.6	-						
	31	0.3	-						
	32	0.3	-						
	33	0.2							

Crack width reading:
measure distance between red circles (top of the marks)

VIEW AT CRACK

Crack step reading:
measure distance between blue circles (centreline of marks)



SECTION THROUGH CRACK

Filename : Lyttleton Library - crack width monitoring_0.xlsx 27/02/2013

Page : **1 of 1**

C.2 Email, SKM to Carissa Ptacek, 28/2/13

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Thursday, 28 February 2013 7:54 AM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); 'Sutherland, Di';" Penrice, Mark
Subject: Lyttelton Library - Crack monitoring
Attachments: Cracking in basement slab and walls near D-5 - with numbers (27-02-2013).pdf

Carissa,

Sketch attached. The reason for adding additional locations (which is more locations not more cracks) is to ensure we capture what is going on – at this time we are unsure of the direction of the movement and hence the likely movement of the cracks is unknown. The addition of more cracks ensures that we will not miss any movement and allow us to interpret the information more accurately.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
Mb: +64 (0) 21 757 549
142 Sherborne Street
PO Box 21011 Christchurch

From: Ptacek, Carissa [mailto:Carissa.Ptacek@ccc.govt.nz]
Sent: Wednesday, 27 February 2013 4:23 PM
To: Calvert, Nick M (SKM)
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di; Penrice, Mark
Subject: RE: Lyttelton Library - Crack monitoring

Hello Nick,

Thank you for the report. Would it be possible to provide a site map of the locations so we can track where in the building the monitoring stations are located?

I've reread your initial assessment that 10 cracks would be monitored can you send a quick note explaining why the increase in monitoring has happened or give me a call? Also, can you clarify if this is 33 cracks or 33 monitoring locations (i.e. multiple locations along a crack).

Thanks for your work on this.

Cheers,
Carissa

Carissa Ptacek
Project Manager
Christchurch City Council
M: 027 254 4038
DDI: (03) 941 8805

http://www.ccc.govt.nz/

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Wednesday, 27 February 2013 3:33 PM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di
Subject: Lyttelton Library - Crack monitoring

Carissa,

Attached is the crack report showing the starting readings for each crack. As per our email we will monitor the cracks on a monthly basis and report following each inspection. As you can see we have chosen to monitor 33 locations which we feel provides a better indication of the ongoing movement.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
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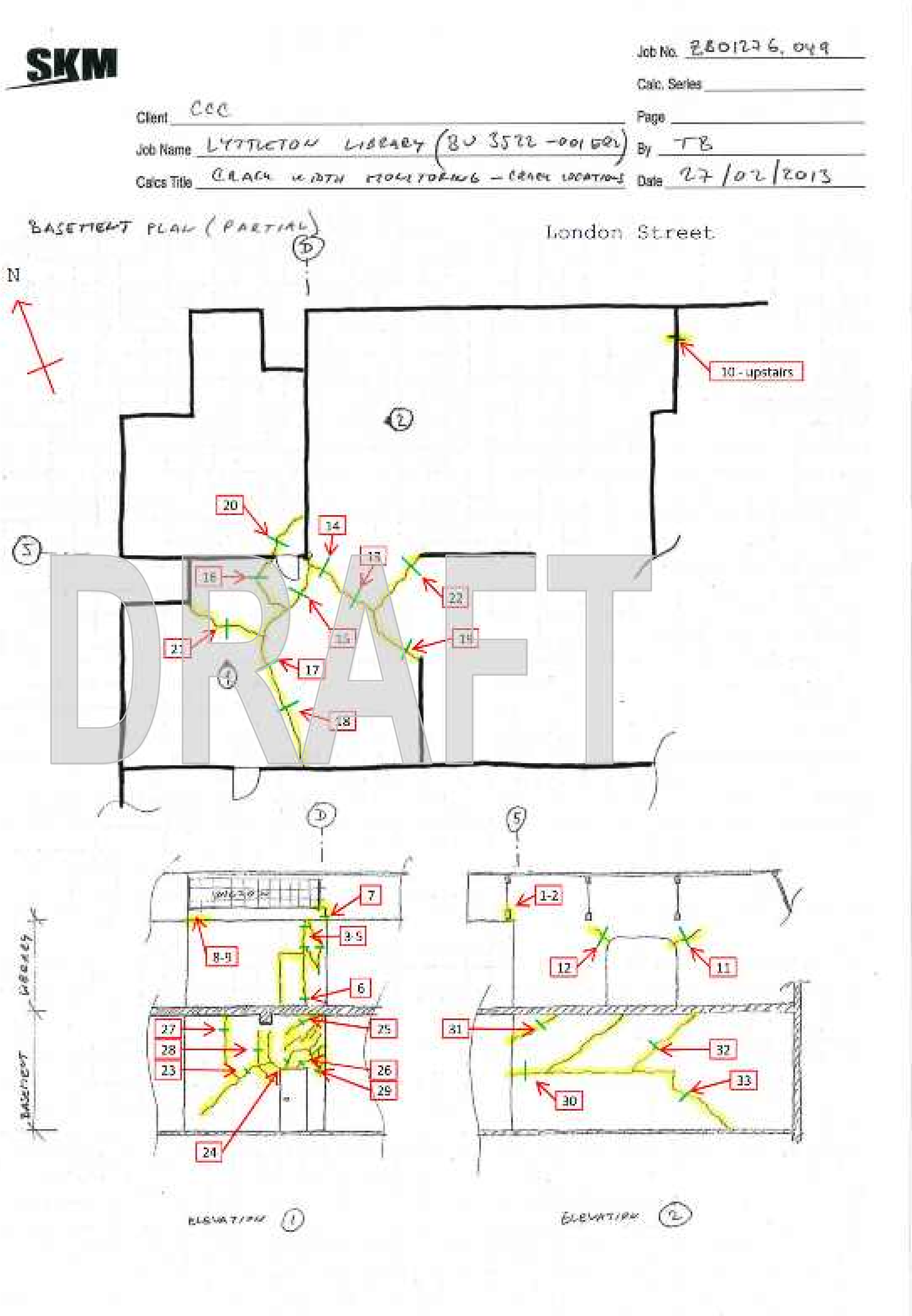
142 Sherborne Street
PO Box 21011 Christchurch


SKM
Job No. 2801276, 049
Calc. Series
Client CCC
Page
Job Name LYTTELTON LIBRARY (BU 3522 -001 EQ2)
By TB
Calcs Title CRACK WIDTH MONITORING - CRACK LOCATIONS
Date 27/02/2013
BASEMENT PLAN (PARTIAL)
London Street
N
10 - upstairs
20
14
13
16
22
21
15
19
17
18
7
1-2
3-5
8-9
12
11
6
27
25
31
28
32
23
26
29
33
30
24
ELEVATION 1
ELEVATION 2
LIBRARY
BASEMENT
DRAFT

C.3 Email, SKM to Carissa Ptacek, 3/4/13

From: Martin, Alex (SKM) [mailto:AMartin@globalskm.com]
Sent: Wednesday, 3 April 2013 12:01 PM
To: Ptacek, Carissa
Cc:
Subject: FW: Lyttelton Library - cracks
Attachments: Lyttleton Library - crack width monitoring_1.pdf

Hi Carissa,

As I suspected, it was sitting in my drafts folder!

Apologies.

Alex

From: Bilek, Tomas (SKM)
Sent: Wednesday, 27 March 2013 1:55 PM
To: Calvert, Nick M (SKM)
Cc: Martin, Alexandra (SKM)
Subject: RE: Lyttelton Library - Crack monitoring

Hi Nick

Attached is the result of my first re-visit of the monitored cracks.

Regards,

Tomas Bilek
Structural Engineer

Sinclair Knight Merz
142 Sherborne Street, St Albans, Christchurch, 8014, New Zealand
PO Box 21011, Edgeware, Christchurch, 8143, New Zealand
D +64 3 940 4920 T +64 3 940 4900 F +64 3 940 4901 M +64 2 180 2395 E TBilek@globalskm.com
www.globalskm.com

From: Calvert, Nick M (SKM)
Sent: Thursday, 28 February 2013 9:37 AM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di; Penrice, Mark
Subject: RE: Lyttelton Library - Crack monitoring

Carissa,

Added as requested.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
Mb: +64 (0) 21 757 549
142 Sherborne Street
PO Box 21011 Christchurch

From: Ptacek, Carissa [mailto:Carissa.Ptacek@ccc.govt.nz]
Sent: Thursday, 28 February 2013 9:29 AM
To: Calvert, Nick M (SKM)
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di; Penrice, Mark
Subject: RE: Lyttelton Library - Crack monitoring

Sorry to be a nuisance Nick, I have one more request.

Since these documents will be used not only for the short term but as historic records can you put a reference cardinal direction and/or street references on the sketch?

Thank you

Carissa

Carissa Ptacek
Project Manager
Christchurch City Council
M: 027 254 4038
DDI: (03) 941 8805

http://www.ccc.govt.nz/

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Thursday, 28 February 2013 7:54 AM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di; Penrice, Mark
Subject: RE: Lyttelton Library - Crack monitoring

Carissa,

Sketch attached. The reason for adding additional locations (which is more locations not more cracks) is to ensure we capture what is going on – at this time we are unsure of the direction of the movement and hence the likely movement of the cracks is unknown. The addition of more cracks ensures that we will not miss any movement and allow us to interpret the information more accurately.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

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142 Sherborne Street
PO Box 21011 Christchurch

From: Ptacek, Carissa [mailto:Carissa.Ptacek@ccc.govt.nz]
Sent: Wednesday, 27 February 2013 4:23 PM
To: Calvert, Nick M (SKM)
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di; Penrice, Mark
Subject: RE: Lyttelton Library - Crack monitoring

Hello Nick,

Thank you for the report. Would it be possible to provide a site map of the locations so we can track where in the building the monitoring stations are located?

I've reread your initial assessment that 10 cracks would be monitored can you send a quick note explaining why the increase in monitoring has happened or give me a call? Also, can you clarify if this is 33 cracks or 33 monitoring locations (i.e. multiple locations along a crack).

Thanks for your work on this.

Cheers,
Carissa

Carissa Ptacek
Project Manager
Christchurch City Council
M: 027 254 4038
DDI: (03) 941 8805

http://www.ccc.govt.nz/

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Sent: Wednesday, 27 February 2013 3:33 PM
To: Ptacek, Carissa
Cc: Sheffield, Michael; Bilek, Tomas (SKM); Martin, Alexandra (SKM); Sutherland, Di
Subject: Lyttelton Library - Crack monitoring

Carissa,

Attached is the crack report showing the starting readings for each crack. As per our email we will monitor the cracks on a monthly basis and report following each inspection. As you can see we have chosen to monitor 33 locations which we feel provides a better indication of the ongoing movement.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

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PO Box 21011 Christchurch

Inspection note

Sheet No.	1
Rev.	1

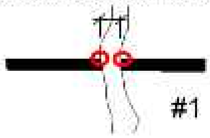
Contract	CCC - Lyttleton Library (BU 3522 - 001 EQ2)
Part of Structure	Crack Width Monitoring

Contract No.	ZB01276.049
Date	27 Mar 13
Inspector	TB

1.0	Green = decrease	1.0	Red = increase

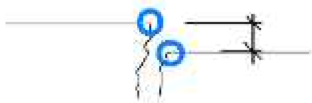
	Crack No.	27/02/2013		27/03/2013		24/04/2013 (t.b.c.)		22/05/2013 (t.b.c.)	
		Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]
LIBRARY	1	0.4	-	0.3	-				
	2	0.2	1.8	0.2	1.8				
	3	1.1	-	1.0	-				
	4	1.1	-	1.0	-				
	5	1.6	-	1.5	-				
	6	1.3	-	1.3	-				
	7	2.2	-	2.2	-				
	8	4.9	-	4.5	-				
	9	0.5	2.2	0.3	2.0				
	10	0.4	-	0.3	-				
	11	0.3	-	0.3	-				
	12	0.2	-	0.2	-				
BASEMENT	13	3.6	2.0	4.0	2.0				
	14	3.0	3.5	3.5	3.5				
	15	3.5	2.0	3.7	2.0				
	16	1.1	-	1.1	-				
	17	5.3	2.0	5.0	2.0				
	18	6.2	-	6.2	-				
	19	2.2	1.0	2.2	1.0				
	20	3.0	2.0	3.0	2.0				
	21	1.2	-	1.3	-				
	22	1.1	0.5	1.2	0.5				
	23	0.4	-	0.3	-				
	24	0.4	-	0.4	-				
	25	0.2	-	0.3	-				
	26	0.4	-	0.4	-				
	27	0.6	-	0.5	-				
	28	0.2	-	0.2	-				
	29	0.4	-	0.4	-				
	30	0.6	-	0.5	-				
	31	0.3	-	0.2	-				
	32	0.3	-	0.3	-				
	33	0.2		0.2	-				

Crack width reading:
measure distance between red circles (top of the marks)



VIEW AT CRACK

Crack step reading:
measure distance between blue circles (centreline of marks)



SECTION THROUGH CRACK

Filename : Lyttleton Library - crack width monitoring_1.xlsx 27/03/2013

Page : **1 of 1**

C.4 Email, SKM to Carissa Ptacek, 24/4/13

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Wednesday, 24 April 2013 9:43 AM
To: Ptacek, Carissa
Cc: Martin, Alexandra (SKM); 'Sutherland, Di';
Subject: FW: Lyttelton Library - cracks
Attachments: Lyttleton Library - crack width monitoring_2.pdf; Cracks in concrete lintel at near A-4 (22-04-2013).pdf

Carissa,

Attached further crack monitoring report. As you can see most of the cracks are holding pretty steady and we will carry out the final monitoring next month and then likely stop monitoring as the cracks appear to be staying pretty consistent (within the margin or measuring error).

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
Mb: +64 (0) 21 757 549
142 Sherborne Street
PO Box 21011 Christchurch

From: Bilek, Tomas (SKM)
Sent: Wednesday, 24 April 2013 9:32 AM
To: Calvert, Nick M (SKM)
Cc: Martin, Alexandra (SKM)
Subject: RE: Lyttelton Library - cracks

Hi Nick,

Attached is updated table with crack widths including two new locations in the concrete lintel at the junction with end of timber truss (i.e. new crack). The truss is not being supported of this lintel so this crack is not of structural importance (in fact I think there should be a movement joint to avoid this sort of cracking to happen).

I also created additional crack location sketch.

Cheers

Tom

Tomas Bilek
Structural Engineer

Sinclair Knight Merz
142 Sherborne Street, St Albans, Christchurch, 8014, New Zealand
PO Box 21011, Edgeware, Christchurch, 8143, New Zealand
D +64 3 940 4920 T +64 3 940 4900 F +64 3 940 4901 M +64 2 180 2395 E TBilek@globalskm.com
www.globalskm.com

Inspection note

Sheet No.	1	Rev.	2

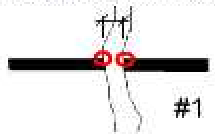
Contract	CCC - Lyttelton Library (BU 3522 - 001 EQ2)
Part of Structure	Crack Width Monitoring

Contract No.	ZB01276.049
Date	22 Apr 13
Inspector	TB

1.0	Green = decrease	1.0	Red = increase

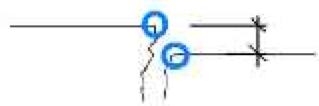
	Crack No.	27/02/2013		27/03/2013		22/04/2013		22/05/2013 (t.b.c.)	
		Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]	Crack width [mm]	Step in crack [mm]
LIBRARY	1	0.4	-	0.3	-	0.2			
	2	0.2	1.8	0.2	1.8	0.2	1.8		
	3	1.1	-	1.0	-	1.0			
	4	1.1	-	1.0	-	1.0			
	5	1.6	-	1.5	-	1.6			
	6	1.3	-	1.3	-	1.3			
	7	2.2	-	2.2	-	2.1			
	8	4.9	-	4.5	-	4.5			
	9	0.5	2.2	0.3	2.0	0.3	2.0		
	10	0.4	-	0.3	-	0.3			
	11	0.3	-	0.3	-	0.3			
	12	0.2	-	0.2	-	0.2			
BASEMENT	13	3.6	2.0	4.0	2.0	4.0	2.0		
	14	3.0	3.5	3.5	3.5	3.5	3.5		
	15	3.5	2.0	3.7	2.0	3.7	2.0		
	16	1.1	-	1.1	-	1.1			
	17	5.3	2.0	5.0	2.0	5.0	2.0		
	18	6.2	-	6.2	-	6.2			
	19	2.2	1.0	2.2	1.0	2.3			
	20	3.0	2.0	3.0	2.0	3.0	2.0		
	21	1.2	-	1.3	-	1.2			
	22	1.1	0.5	1.2	0.5	1.3	0.5		
	23	0.4	-	0.3	-	0.4			
	24	0.4	-	0.4	-	0.4			
	25	0.2	-	0.3	-	0.3			
	26	0.4	-	0.4	-	0.4			
	27	0.6	-	0.5	-	0.5			
	28	0.2	-	0.2	-	0.2			
	29	0.4	-	0.4	-	0.4			
	30	0.6	-	0.5	-	0.5			
	31	0.3	-	0.2	-	0.2			
	32	0.3	-	0.3	-	0.3			
	33	0.2		0.2	-	0.2			
LIB.	34	-	-	-	-	0.4			
	35	-	-	-	-	0.7			

Crack width reading:
measure distance between red circles (top of the marks)



VIEW AT CRACK

Crack step reading:
measure distance between blue circles (centreline of marks)



SECTION THROUGH CRACK

Filename : Lyttelton Library - crack width monitoring_2.xlsx 24/04/2013

Page : **1 of 1**

SKM

Job No. ZB01276.049
Calc. Series
Page
By TB

Client CCC
Job Name LYTTELTON LIBRARY (BU 3522-001 EQ2)
Calcs Title CRACK WIDTH MONITORING - CRACK LOC.
Date 22/4/2013

- FIRST PLAN ISSUED ON 27/02/2013
- TWO NEW LOCATIONS HAVE BEEN ADDED ON 22/4/2013

LIBRARY PLAN (PARTIAL)

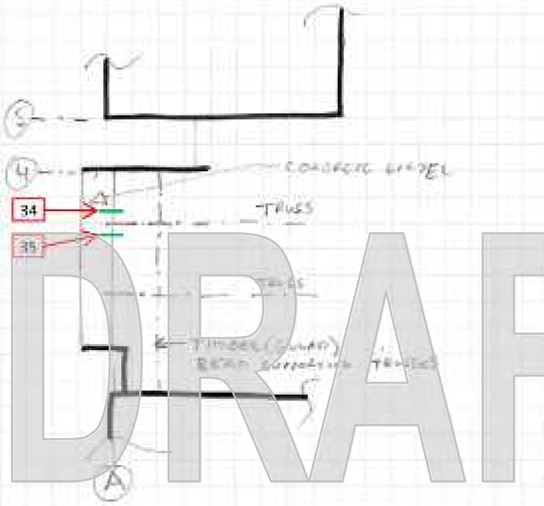


Photo of crack monitoring locations 34 & 35

General view on concrete lintel

C.5 Email, SKM to Carissa Ptacek, 23/5/13

From: Calvert, Nick M (SKM) [mailto:NCalvert@globalskm.com]
Sent: Thursday, 23 May 2013 7:37 AM
To: Ptacek, Carissa
Cc: Martin, Alexandra (SKM); Bilek, Tomas (SKM)
Subject: Lyttelton Library - cracks
Attachments: Lyttelton Library - crack width monitoring_3.pdf

Carissa,

Attached is our report for the crack monitoring at Lyttelton Library. We will carry out one more measure following the intrusive investigations and make a recommendation at that time. If no intrusives were happening our recommendation now would be to cease monitoring as the cracks appear to be relatively stable and not causing a collapse risk.

Regards,

Nick

Nick Calvert
Project Manager & Senior Structural Engineer
BE (Hons) Structural, CPEng, MIPENZ

SINCLAIR KNIGHT MERZ
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SKM

Inspection note

Sheet No.	Rev.
1	3

Contract	CCC - Lyttelton Library (BU 3522 - 001 EQ2)
Part of Structure	Crack Width Monitoring 27/02 - 22/05 /2013

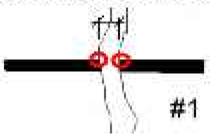
Contract No.	ZB01276.049
Date	22 May 13
Inspector	TB

1.0	Green = decrease	1.0	Red = increase

	Crack No.	27/02/2013 Crack width [mm]	27/02/2013 Step in crack [mm]	27/03/2013 Crack width [mm]	27/03/2013 Step in crack [mm]	22/04/2013 Crack width [mm]	22/04/2013 Step in crack [mm]	22/05/2013 Crack width [mm]	22/05/2013 Step in crack [mm]	Overal change between 27/02 & 22/05/2013 Crack width [mm]	Overal change Step in crack [mm]	Notes
LIBRARY	1	0.4	-	0.3	-	0.2	-	0.2	-	0.2		
	2	0.2	1.8	0.2	1.8	0.2	1.8	0.2	1.8	0	0	
	3	1.1	-	1.0	-	1.0	-	1.0	-	0.1		
	4	1.1	-	1.0	-	1.0	-	1.0	-	0.1		Insignificant change
	5	1.6	-	1.5	-	1.6	-	1.6	-	0		
	6	1.3	-	1.3	-	1.3	-	1.3	-	0		
	7	2.2	-	2.2	-	2.1	-	2.1	-	0.1		
	8	4.9	-	4.5	-	4.5	-	4.5	-	0.4		within seriously damaged ceiling
	9	0.5	2.2	0.3	2.0	0.3	2.0	0.3	2.0	0.2	0.2	
	10	0.4	-	0.3	-	0.3	-	0.4	-	0		Insignificant change
	11	0.3	-	0.3	-	0.3	-	0.2	-	0.1		
	12	0.2	-	0.2	-	0.2	-	0.2	-	0		
BASEMENT	13	3.6	2.0	4.0	2.0	4.0	2.0	4.0	2.0	-0.4	0	moved in March then stopped.
	14	3.0	3.5	3.5	3.5	3.5	3.5	3.5	3.5	-0.5	0	
	15	3.5	2.0	3.7	2.0	3.7	2.0	3.7	2.0	-0.2	0	Insignificant change
	16	1.1	-	1.1	-	1.1	-	1.1	-	0		
	17	5.3	2.0	5.0	2.0	5.0	2.0	5.0	2.0	0.3	0	as per 13
	18	6.2	-	6.2	-	6.2	-	6.2	-	0		
	19	2.2	1.0	2.2	1.0	2.3	1.0	2.2	1.0	0	0	
	20	3.0	2.0	3.0	2.0	3.0	2.0	3.0	2.0	0	0	
	21	1.2	-	1.3	-	1.2	-	1.2	-	0		
	22	1.1	0.5	1.2	0.5	1.3	0.5	1.3	0.5	-0.2	0	
	23	0.4	-	0.3	-	0.4	-	0.4	-	0		
	24	0.4	-	0.4	-	0.4	-	0.4	-	0		
	25	0.2	-	0.3	-	0.3	-	0.3	-	-0.1		
	26	0.4	-	0.4	-	0.4	-	0.4	-	0		Insignificant change
	27	0.6	-	0.5	-	0.5	-	0.5	-	0.1		
	28	0.2	-	0.2	-	0.2	-	0.2	-	0		
	29	0.4	-	0.4	-	0.4	-	0.4	-	0		
	30	0.6	-	0.5	-	0.5	-	0.5	-	0.1		
	31	0.3	-	0.2	-	0.2	-	0.2	-	0.1		
	32	0.3	-	0.3	-	0.3	-	0.3	-	0		
	33	0.2		0.2	-	0.2	-	0.2	-	0		
LIB.	34	-	-	-	-	0.4	-	0.4	-	0		
	35	-	-	-	-	0.7	-	0.7	-	0		

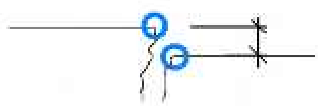
DRAFT

Crack width reading:
measure distance between red circles (top of the marks)



VIEW AT CRACK

Crack step reading:
measure distance between blue circles (centreline of marks)



SECTION THROUGH CRACK

Filename : Lyttelton Library - crack width monitoring_3 22/05/2013

Page : **1 of 1**

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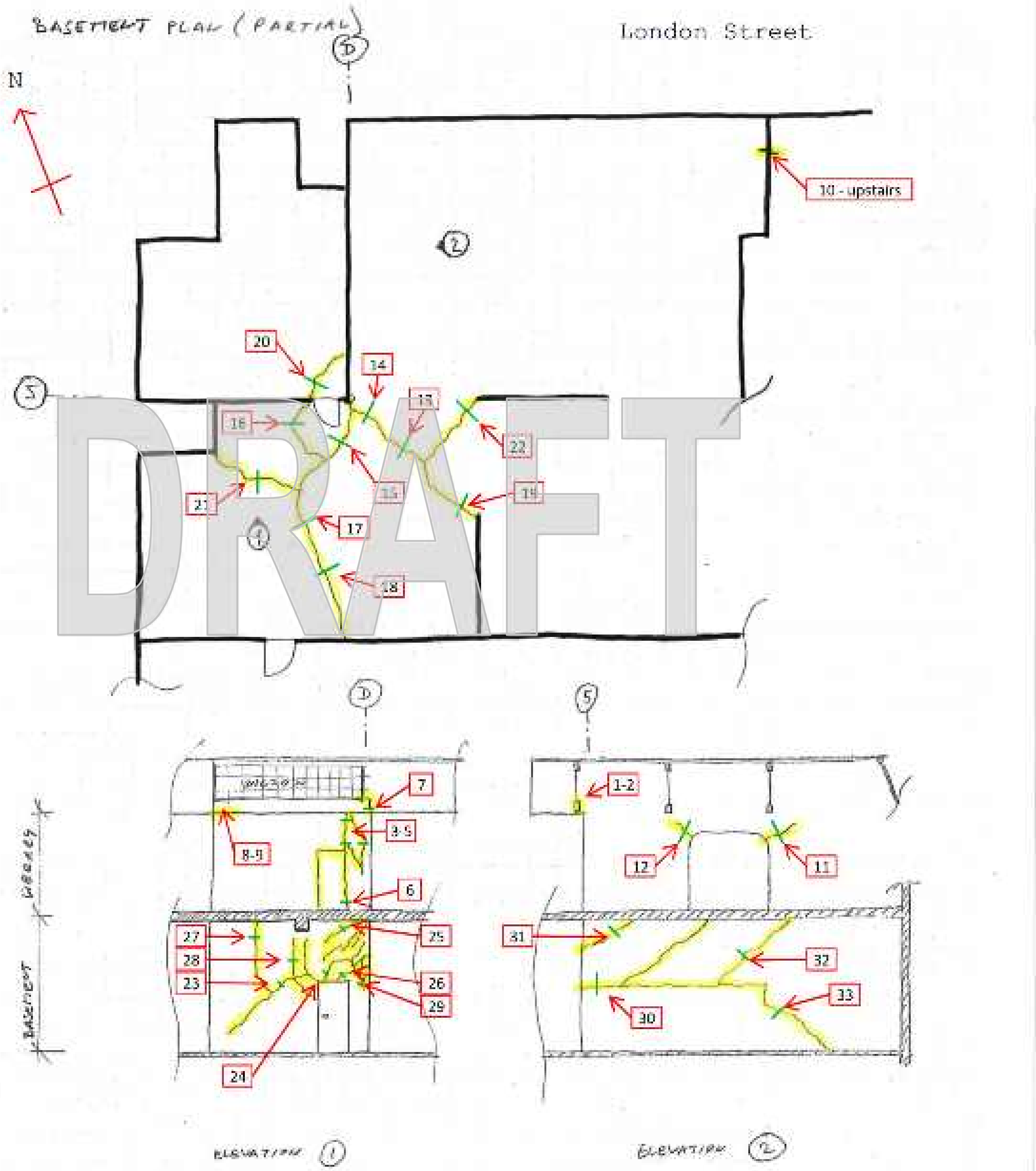
Job No. 2801276, 049
Calc. Series
Client CCC
Page
Job Name LYTTELTON LIBRARY (BU 3522 -001 EQ2)
By TB
Calcs Title CRACK WIDTH MONITORING – CRACK LOCATIONS
Date 27/02/2013



Job No. ZB01276.049

Calc. Series

Client CCC

Page

Job Name LYTTLETON LIBRARY (BU 3522-001 EQ2)

By TB

Calcs Title CRACK WIDTH MONITORING – CRACK LOC.

Date 22/4/2013

- FIRST PLAN ISSUED ON 27/02/2013
- TWO NEW LOCATIONS HAVE BEEN ADDED ON 22/4/2013

LIBRARY PLAN (PARTIAL)

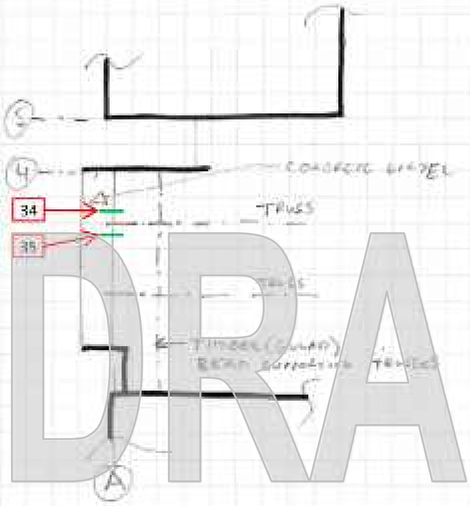


Photo of crack monitoring locations 34 & 35

General view on concrete lintel