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Botanic Gardens Office Library
PRK 1566 BLDG 029

Detailed Engineering Evaluation

Qualitative Report

Version FINAL

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Botanic Gardens Office Library
PRK 1566 BLDG 029

Detailed Engineering Evaluation
Qualitative Report
Version FINAL

7 Rolleston Avenue, Christchurch
Central

Christchurch City Council

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Date
17/09/13

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Qualitative Report Summary

Botanic Gardens Office Library

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Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version FINAL

7 Rolleston Avenue, Christchurch Central

Background

This is a summary of the Qualitative report for the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011 and visual inspections on 4 April 2012.

Building Description

The structure thought to be constructed in the 1950's with extensions to the north and east consists of a timber framed wall construction with brick veneer to the exterior. The timber framed hip roof consists of a lightweight metal cladding on timber purlins spanning between timber rafters. The rafters are exposed with timber sarking supporting the roof cladding. The timber framed internal wall linings consist of a mixture of plasterboard and hardboard. The flat roof dining area extension to the north side of the structure consists of a butynol roof on plywood supported by timber lintels supported on timber studs. The substructure to both the original building and extensions consists of timber joists on timber bearers supported by concrete piles internally and concrete strip footings to the external perimeter.

Key Damage Observed

- Shear cracking to brickwork veneer with temporary propping preventing potential collapse of veneer.

Critical Structural Weaknesses

No critical structural weaknesses were observed to the structure.

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the building's original capacity has been assessed to be in the order of 18% NBS. The buildings post-earthquake capacity excluding critical structural weaknesses as none were present is also in the order of 18% NBS. The building has been assessed to have a seismic capacity in the order of 18% NBS and is deemed to be potentially Earthquake Prone.

Recommendations

It is recommended that:

A quantitative assessment of the timber framed structure be undertaken to determine the seismic capacity due to the structure being regarded as potentially Earthquake Prone.

Based on the Christchurch City Council's policy, the building is deemed to be potentially Earthquake Prone as it did not achieve greater than 33% NBS. It is recommended that occupancy of the building is prohibited.

1. Background

GHD has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the Botanic Gardens Office Library.

This report is a Qualitative Assessment of the building structure, and is based in general on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011.

A qualitative assessment involves inspections of the building and a desktop review of existing structural and geotechnical information, including existing drawings and calculations, if available.

The purpose of the assessment is to determine the likely building performance and damage patterns, to identify any potential critical structural weaknesses or collapse hazards, and to make an initial assessment of the likely building strength in terms of percentage of new building standard (%NBS).

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. The building description is based on the visual inspection carried out on site and drawings available.

2. Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

This section enables the chief executive to require a building owner, insurer or mortgagee 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

2.2 Building Act

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

Section 112 – Alterations

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

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) 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.

2.2.1 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.

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.

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

Christchurch City Council adopted their Earthquake Prone, Dangerous and Insanitary Building Policy in 2006. This policy was amended immediately following the Darfield Earthquake 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;
- 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 33% 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.

2.4 Building Code

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

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

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

3. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The 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 1 below.

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

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

Table 1 compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% risk of exceedance in 50 years (i.e. 0.2% in the next year). It is noted that the current seismic risk in Christchurch results in a 6% risk of exceedance in the next year.

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

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The Office Library is located in the Botanic Gardens at 7 Rolleston Avenue, Christchurch Central. The original construction date of the structure is unknown but based on site observation it is thought to be in the 1950's with two extensions added in 1969. The adjacent office store was also constructed in 1969.

The site is located opposite the glasshouses to the west and adjacent to the office store on the north. The Avon River is located 30 m to the north of the structure.

The site is predominantly flat with insignificant variations in ground levels throughout.

The structure consists of timber framed wall construction with brick veneer to the exterior. The timber framed hip roof consists of a lightweight metal cladding on timber purlins spanning between timber rafters. The rafters are exposed with timber sarking supporting the roof cladding. The timber framed internal wall linings consist of a mixture of plasterboard and hardboard. The flat roof dining area extension to the north side of the structure consists of a butynol roof on plywood supported by timber lintels supported on timber studs.

The substructure to both the original building and extensions consists of timber joists on timber bearers supported by concrete piles internally and concrete strip footings to the external perimeter.

The dimensions of the building are approximately 22m long, 7.4m in width and 3m in height.

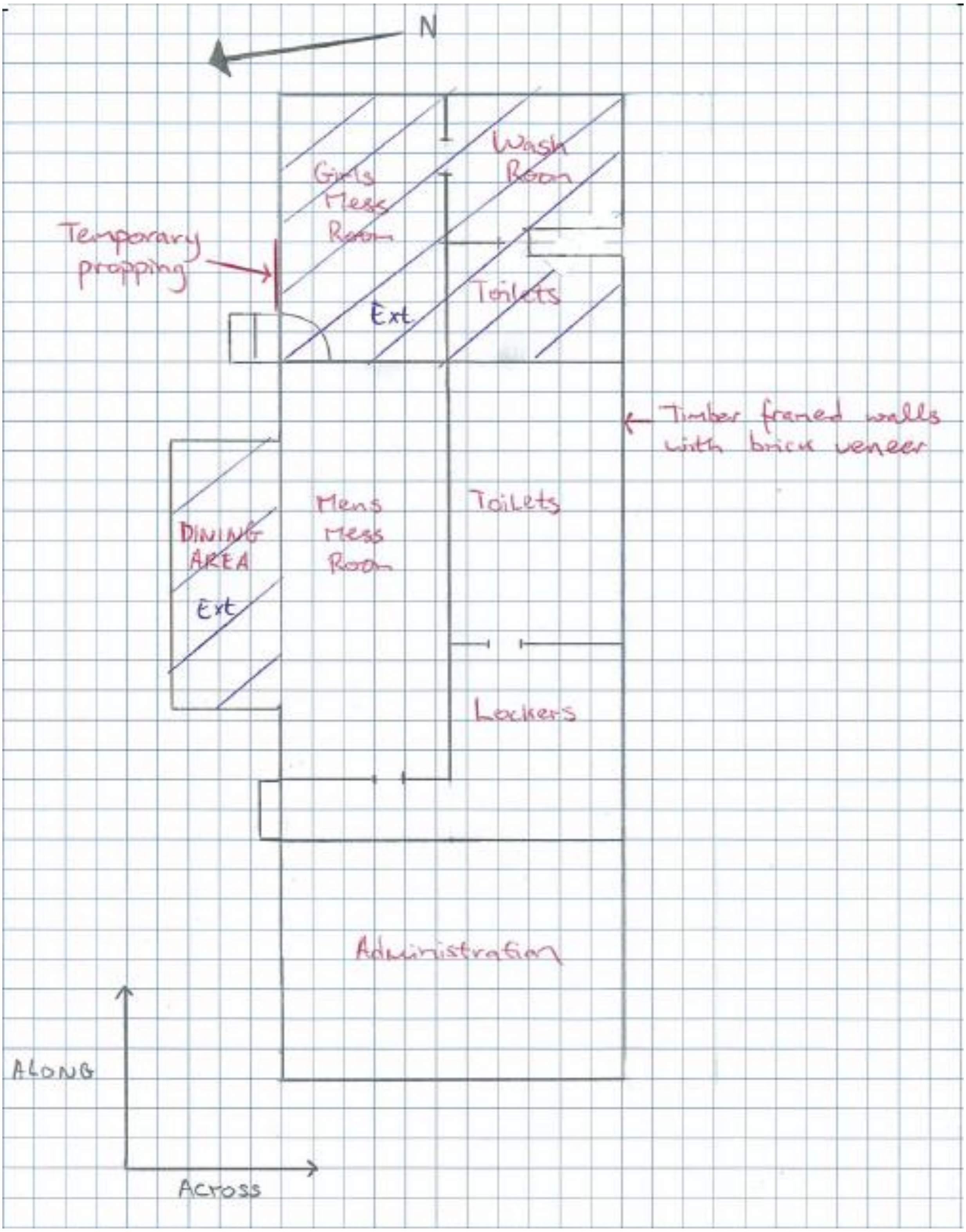


Figure 2 Plan Sketch Showing Key Structural Elements

4.2 Gravity Load Resisting System

The timber framed load bearing walls act as the gravity load resisting system for the building. Gravity loads from the roof are transferred through the timber purlins into the rafters and distributed out to the timber framed walls. The loads are then transferred down to the ground via the timber framed walls and concrete perimeter footings. The ground floor loads are supported by timber joists and bearers on concrete piles.

4.3 Lateral Load Resisting System

The lateral loads acting on the structure are resisted by the plasterboard and hardboard lined timber framed walls in both the short and long directions. The lateral load is transferred from the purlins into the rafters and out to the side walls and down to the concrete foundations. Some diaphragm action is expected from the timber sarking to the rafters, transferring the lateral roof load to the side walls and down to the ground via concrete foundations. Diaphragm action is also expected from the flat plywood roof.

5. Assessment

A visual inspection of the building was undertaken on 4 April 2012. Both the interior and exterior of the building were inspected. The building was observed to have a green placard in place. Most of the main structural components of the building were able to be viewed due to the exposed simple construction of the building.

The visual inspection consisted of observing the building to determine the structural systems and likely behaviour of the building during an earthquake. The site was assessed for damage, including observing the ground conditions, checking for damage in areas where damage would be expected for the structure type observed and noting general damage observed throughout the building in both structural and non-structural elements.

The %NBS score is determined using the IEP procedure described by the NZSEE which is based on the information obtained from visual observation of the building and a desktop review of the available structural and geotechnical information. Liquefaction was identified as a potential critical structural weaknesses thus reducing the overall %NBS.

6. Damage Assessment

6.1 Surrounding Buildings

The Office Library is located in the Botanic Gardens yard which is surrounded by green field areas and walkways. The structure is located opposite the glasshouses to the west and adjacent to the office store to the north. Minor staircase cracking was noted to the blockwork in the office store building.

6.2 Residual Displacements and General Observations

No residual displacements of the structure were noted during the inspection of the building.

No damage was evident to the roof structure.

No cracking was noted to the perimeter strip footing.

Shear cracking was observed to the exterior brickwork veneer possibly as a result of short column action. Temporary props have been erected to prevent further brickwork veneer collapse. (See photographs 5 and 7, Appendix A)

No damage was evident to the load bearing timber framed walls.

6.3 Ground Damage

No ground damage was observed during the inspection of the site.

7. Critical Structural Weakness

7.1 Short Columns

The building does not contain any significant short columns. The brickwork veneer collapse is possibly as a result of short column action. Refer photograph 7, Appendix A.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof

No critical structural weaknesses were observed in the roof structure. It is possible roof bracing exists but this could not be observed due to the presence of wall and ceiling linings. The timber sarking ceiling will act as a diaphragm to the structure.

7.4 Plan Irregularity

Plan irregularity potential exists to the north side extension due to the window openings. However this is not considered significant due to the adequate plywood roof diaphragm.

7.5 Staircases

The building does not contain a staircase.

7.6 Liquefaction

Liquefaction is possible on site however due to the nature of the structure (timber framed, single storey and on reinforced perimeter footings) it has been assessed as an ‘insignificant’ site characteristic in accordance with the NZSEE guidelines.

8. Geotechnical Consideration

8.1 Site Description

The site is situated within a recreational reserve, in central Christchurch. It is relatively flat at approximately 8m above mean sea level. The strucutres are situated between 50m and 100m south of the Avon River, and 9.5km west of the coast (Pegasus Bay) at New Brighton.

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

The geological map of the area[1] indicates that the site is underlain by Holocene alluvial soils of the Yaldhurst Member, sub-group of the Springston Formation, comprising alluvial sand and silt overbank deposits.

8.2.2 Environment Canterbury Logs

Information from Environment Canterbury (ECan) indicates that three boreholes are located within 200m of the site (see Table 2). Of these, two contained adequate lithographic logs. The site geology described in the logs is stratified gravel, sand, silt and clay. Also present are layers of peat between 20m and 40m bgl.

Table 2 ECan Borehole Summary

Bore Name	Log Depth	Groundwater	Distance & Direction from Site
M35/1936	100.9m	1.4m bgl	50m E of office buildings
M35/10619	104.5m	0.8m bgl	100m E of office buildings

It should be noted that the purpose of the boreholes the well logs are associated with, were sunk for groundwater extraction and not for geotechnical purposes. Therefore, the amount of material recovered and available for interpretation and recording will have been variable at best and may not be representative. The logs have been written by the well driller and not a geotechnical professional or to a standard. In addition strength data is not recorded.

8.2.3 EQC Geotechnical Investigations

The Earthquake Commission has not undertaken geotechnical testing in the area of the subject site.

8.2.4 Land Zoning

Canterbury Earthquake Recovery Authority (CERA) has published areas showing the Green Zone Technical Category in relation to the risk of future liquefaction and how these areas are expected to

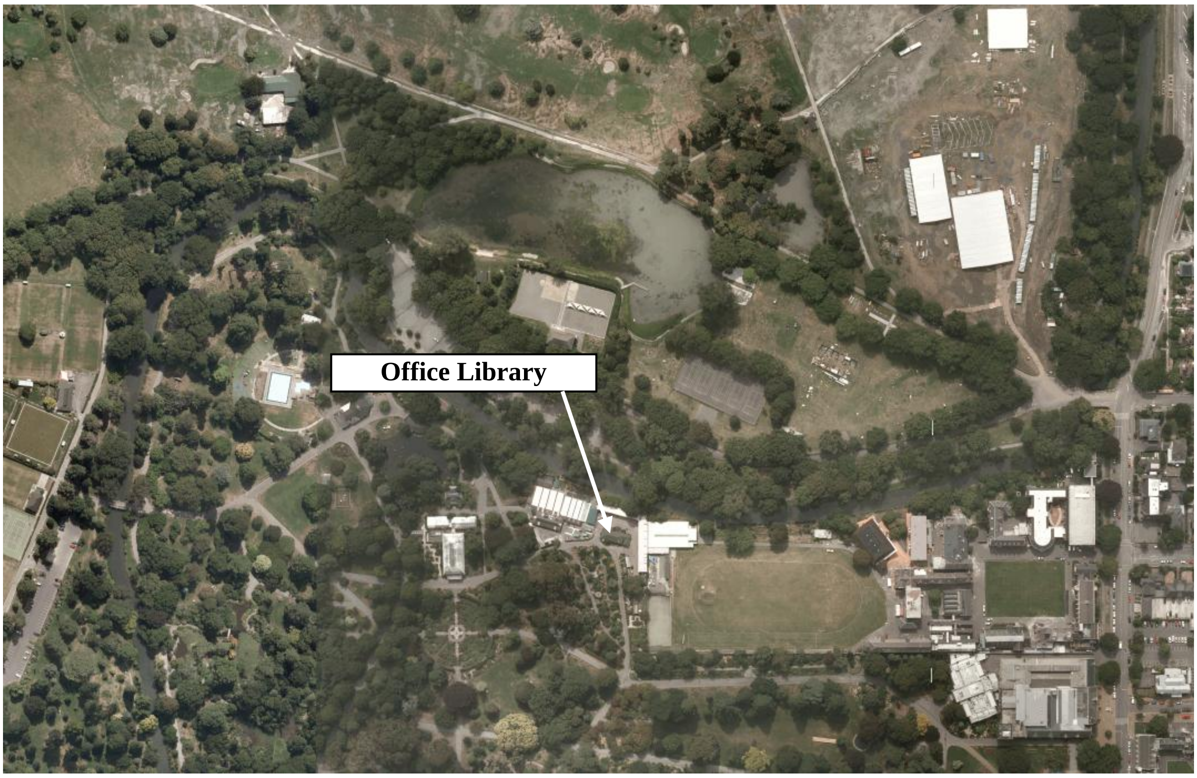
[1] Brown, L. J. and Weeber, J.H. 1992: Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. Lower Hutt. Institute of Geological and Nuclear Sciences Limited.

perform in future earthquakes. The site is classified as Technical Category N/A. This is due to the site not being classified as within a residential area.

8.2.5 Post February Aerial Photography

Aerial photography taken following the 22 February 2011 earthquake shows moderate amounts of liquefaction on the northern side of the Avon and in Victoria Lake, in the top-left and top-right corners of Figure 3. However, there is no evidence of liquefaction at the surface within the botanic gardens themselves.

Figure 3 Post February 2011 Earthquake Aerial Photography[2]



8.2.6 Summary of Ground Conditions

From the information presented above, the ground conditions underlying the site are anticipated to be alluvial deposits comprising multiple strata of gravel, sandy gravel and silt/clay. Occasional layers of peat are also anticipated to be present between 20 and 40m bgl.

The Avon River is immediately adjacent to the site, and hence groundwater levels are expected to be close to the surface.

[2] Aerial Photography Supplied by coordinates sourced from http://Coordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/

8.3 Seismicity

8.3.1 Nearby Faults

There are many faults in the Canterbury region, however only those considered most likely to have an adverse effect on the site are detailed below.

Table 3 Summary of Known Active Faults[3,4]

Known Active Fault	Distance from Site	Direction from Site	Max Likely Magnitude	Avg Recurrence Interval
Alpine Fault	120 km	NW	~8.3	~300 years
Greendale (2010) Fault	20 km	W	7.1	~15,000 years
Hope Fault	100 km	N	7.2~7.5	120~200 years
Kelly Fault	100 km	NW	7.2	150 years
Porters Pass Fault	55 km	NW	7.0	1100 years

Recent earthquakes since 22 February 2011 have identified the presence of a previously unmapped active fault system underneath Christchurch City and the Port Hills. Research and published information on this system is in development and not generally available. Average recurrence intervals are yet to be estimated.

8.3.2 Ground Shaking Hazard

This recent seismic activity has produced earthquakes of Magnitude 6.3 with peak ground accelerations (PGA) up to twice the acceleration due to gravity (2g) in some parts of the city and has resulted in widespread liquefaction throughout Christchurch.

New Zealand Standard NZS 1170.5:2004 quantifies the Seismic Hazard factor for Christchurch as 0.30, being in a moderate to high earthquake zone. This value has been provisionally upgraded recently (from 0.22) to reflect the seismicity hazard observed in the earthquakes since 4 September 2010.

Ground conditions are anticipated to comprise stratified alluvial deposits of varying density, and a 475-year PGA (peak ground acceleration) of ~0.4 (Stirling et al, 2002[4]). In addition, bedrock is anticipated to be in excess of 500m deep, and hence ground shaking is likely to be moderate to high.

8.4 Slope Failure and/or Rockfall Potential

Given the site's elevation and location in Central Christchurch, global slope instability is considered negligible. However, any localised retaining structures or embankments should be further investigated to determine the site-specific slope instability potential.

[3] Stirling, M.W, McVerry, G.H, and Berryman K.R. (2002) A New Seismic Hazard Model for New Zealand, Bulletin of the Seismological Society of America, Vol. 92 No. 5, pp 1878-1903, June 2002.

[4] GNS Active Faults Database

8.5 Liquefaction Potential

Due to the anticipated presence of alluvial deposits and evidence from the post-earthquake aerial photography, it is considered possible that liquefaction will occur at the site in layers where sands and silts are present.

However, due to the presence of gravel and clay layers, evidence may not necessarily propagate to the surface. This gives the site a moderate liquefaction potential.

Further investigation is recommended to better determine subsoil conditions. From this, a more comprehensive liquefaction assessment could be undertaken.

8.6 Recommendations

Given the anticipated ground conditions and limited existing investigation in the vicinity of the site, we recommend that further investigation is undertaken. Specifically, three CPT investigations should be conducted to a target depth of 20m bgl.

8.7 Conclusions & Summary

This assessment is based on a review of the geology and existing ground investigation information, and observations from the Christchurch earthquakes since 4 September 2010.

The site appears to be situated on stratified alluvial deposits, predominantly comprising gravel and sand, interlain by clay. Associated with this the site also has a moderate liquefaction potential, in particular where sands and/or silts are present.

It is recommended that intrusive investigation comprising of three piezocone CPT's be conducted.

A soil class of **D** (in accordance with NZS 1170.5:2004) should be adopted for the site.

9. Survey

No level or verticality surveys have been undertaken for this building at this stage.

10. Initial Capacity Assessment

10.1 % NBS Assessment

The seismic capacity of the building was assessed using the Initial Evaluation Procedure based on the information available. The building's capacity excluding critical structural weaknesses and the capacity of any identified weaknesses are expressed as a percentage of new building standard (%NBS) and are in the order of that shown below in Table 4. These capacities are subject to confirmation by a more detailed quantitative analysis.

Item	%NBS	
Direction of building	Along	Across
Building excluding CSW's	18	18

Table 4 Indicative Building and Critical Structural Weaknesses Capacities based on the NZSEE Initial Evaluation Procedure

Following an IEP assessment, the building has been assessed as achieving 18% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is considered potentially Earthquake Prone as it achieves below 33% NBS. This score has not been adjusted when considering damage to the structure as all damage observed was considered unlikely to adversely affect the load carrying capacity of the structural systems.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: D, NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 1.0, NZS 1170.5:2004, Table 3.5, Importance Level 2 structure with a 50 year design life.

Several key seismic parameters have influenced the %NBS score obtained from the IEP assessment. The building has been assessed as an Importance Level 2 building. An increased Z factor of 0.3 for Christchurch has been used in line with recommendations from the Department of Building and Housing recommendations. The site soil class D, for soft soils, has a negative effect on seismic capacity of the structure.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 2.0 has been assumed both along and across the structure based on the date of construction and lightweight timber framed walls.

10.4 Discussion of Results

The results obtained from the initial IEP assessment are consistent with those expected for a building of this age, importance level and construction type founded on Class D soils.

This building would have been designed to standards at the time that would have used design loads significantly less than those required by the current loading standard and detailing requirements for ductile seismic behaviour that are present in the current standards. These factors combined with the increase in the hazard factor for Christchurch to 0.3 it is reasonable to expect the building to be classified as potentially Earthquake Prone.

10.5 Occupancy

As the building has been assessed to have a % NBS not exceeding 33% NBS, it is deemed to be potentially Earthquake Prone. It is recommended as per Christchurch City Council's (CCC) policy, regarding occupancy of potentially Earthquake Prone buildings, that the structure is unoccupied pending further detailed assessment and strengthening.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 18% NBS and is deemed to be potentially Earthquake Prone in accordance with the NZSEE guidelines. In accordance with CCC policy to not occupy potentially Earthquake Prone buildings, it is recommended that the building is not occupied subject to further investigation and/or strengthening.

12. Recommendations

The damage to the building during recent seismic activity in Christchurch has only caused minor damage to the building, with cracking to the brick veneer the only damage noted.

As the building has achieved less than 33% NBS following a qualitative assessment of the building further quantitative assessment is recommended.

It is recommended that the tying of the brick veneer to the timber framed structure is investigated.

13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

- No intrusive structural investigations have been undertaken.
- No intrusive geotechnical investigations have been undertaken.
- No level or verticality surveys have been undertaken.
- No material testing has been undertaken.
- No calculations, other than those included as part of the IEP in the CERA Building Evaluation Report, have been undertaken. No modelling of the building for structural analysis purposes has been performed.

It is noted that this report has been prepared at the request of Christchurch City Council and is intended to be used for their purposes only. GHD accepts no responsibility for any other party or person who relies on the information contained in this report.

13.2 Geotechnical Limitations

This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and for prepared solely for the use of Christchurch City Council and their advisors. The data and advice provided herein relate only to the project and structures described herein and must be reviewed by a competent geotechnical engineer before being used for any other purpose. GHD Limited (GHD) accepts no responsibility for other use of the data.

The advice tendered in this report is based on a visual geotechnical appraisal. No subsurface investigations have been conducted. An assessment of the topographical land features have been made based on this information. It is emphasised that Geotechnical conditions may vary substantially across the site from where observations have been made. Subsurface conditions, including groundwater levels can change in a limited distance or time. In evaluation of this report cognisance should be taken of the limitations of this type of investigation.

An understanding of the geotechnical site conditions depends on the integration of many pieces of information, some regional, some site specific, some structure specific and some experienced based. Hence this report should not be altered, amended or abbreviated, issued in part and issued incomplete in any way without prior checking and approval by GHD. GHD accepts no responsibility for any circumstances, which arise from the issue of the report, which have been modified in any way as outlined above.

Appendix A

Photographs

Photograph 1: North and west facing elevations

Photograph 2: South and west facing elevations

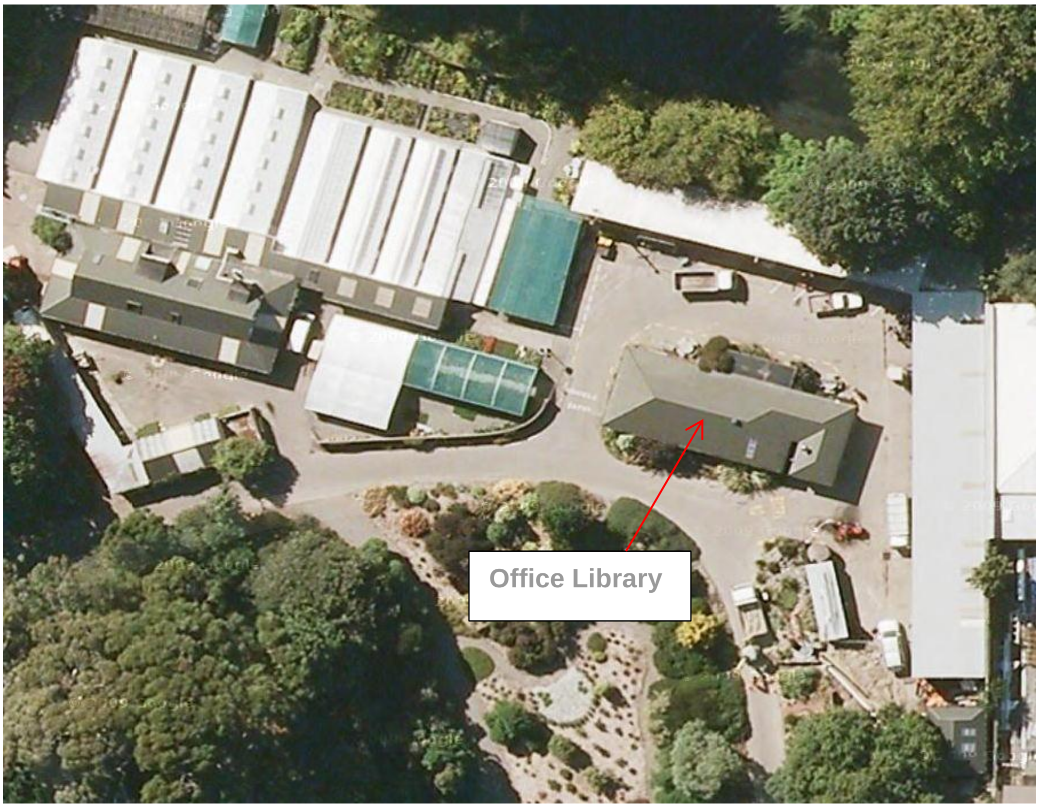
Photograph 3: Flat roof extension to the north side of the structure

Photograph 4: Internal view of north side extension

Photograph 5: Shear cracking to brickwork veneer located on south-east of the structure

Photograph 6: Timber sarking ceiling on exposed rafters

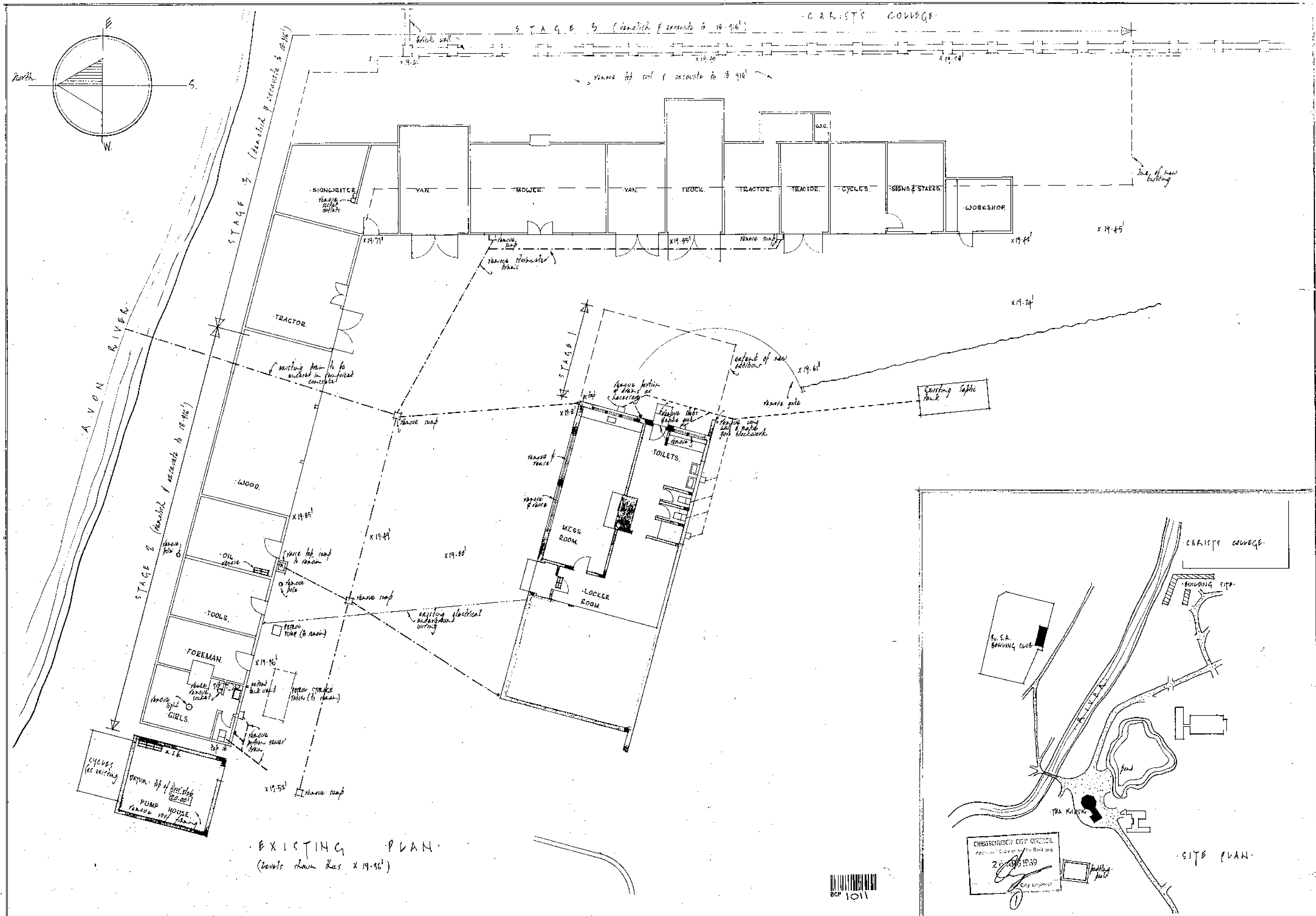
Photograph 7: Temporary propping to brickwork veneer on the north side of structure



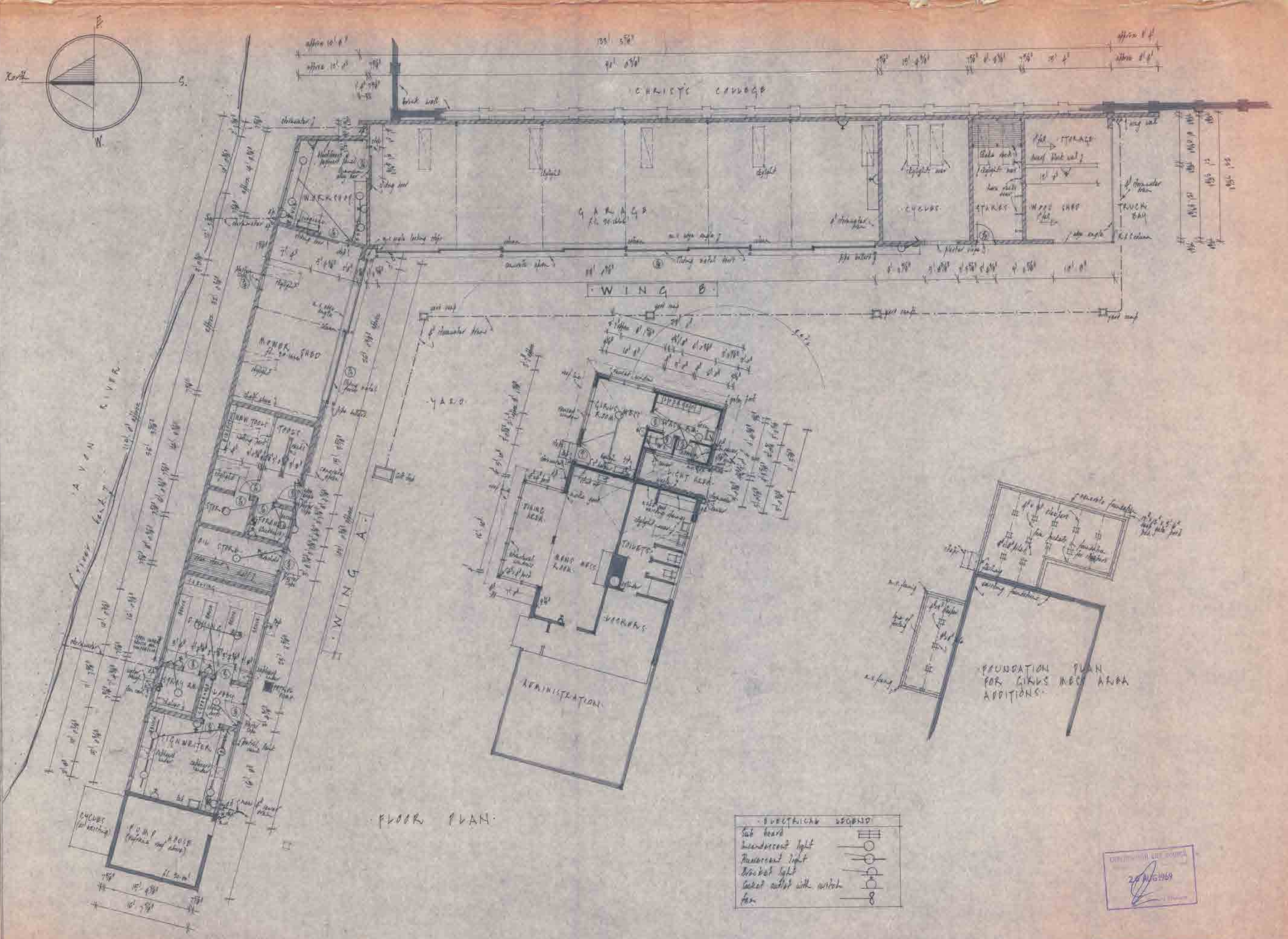
Photograph 8: Building location on site

Appendix B

Existing Drawings/Sketches



GERALD K. AUSTIN A.N.Z.I.A. Registered Architect 87 Victoria St. Christchurch Phone 80263	HARDIE & ANDERSON Consulting Engineers Christchurch	IMPLEMENT SHEDS & STAFF FACILITIES · BOTANIC GARDENS for the CHRISTCHURCH CITY COUNCIL	FILE No. 43/2	Existing plans showing drainage, levels, electrical fittings & demolition etc.	SCALES. Eight feet to One inch	SHEET No. 1 of 8	SET No. 12



GERALD W. AUSTIN A.N.Z.I.A. Registered Architect 87 Victoria St. Christchurch. Phone 40-215	HARDIE & ANDERSON Consulting Engineers Christchurch	IMPLEMENT SHEDS & STAFF FACILITIES · BOTANIC GARDENS for the CHRISTCHURCH CITY COUNCIL	FILE NO. 43/2	Floor & drainage plan Foundation plan mess additions Electrical plan	SCALES: Eight feet to one inch	SHEET NO. 2 of 8	SET NO. 12

GERALD K. AUSTIN, A.N.Z.I.A. Registered Architect 81 Victoria Street Christchurch Phone 66-215	HARDIE & ANDERSON Consulting Engineers Christchurch	IMPLEMENT SHEDS & STAFF FACILITIES - BOTANIC GARDENS for the CHRISTCHURCH CITY COUNCIL	File No. 43/C	Mess Additions - Stage 1. Joinery details	SCALES Eight feet to one inch, One foot to one inch, Eight full size.	SHEET No. 4 of 8	SET No. 12

Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Botanic Gardens Office Library			Reviewer:	Stephen Lee
		Unit / No:	Street	CPEng No:	1006840
Building Address:	7 Rolleston Avenue			Company:	GHD
Legal Description:				Company project number:	513059686
				Company phone number:	6433780900
	Degrees	Min	Sec		
GPS south:				Date of submission:	
GPS east:				Inspection Date:	04-04-12
				Revision:	Final
Building Unique Identifier (CCC):	PRK 1566 BLDG 029 EQ2			Is there a full report with this summary?	yes

Site

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

Building

No. of storeys above ground:	1	single storey = 1	Ground floor elevation (Absolute) (m):	
Ground floor split?	no		Ground floor elevation above ground (m):	2.50
Storeys below ground	0			
Foundation type:	strip footings		if Foundation type is other, describe:	Strip footings to perimeter with timber piles to internal floor
Building height (m):	3.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	2.25
Floor footprint area (approx):				
Age of Building (years):	62		Date of design:	1935-1965
Strengthening present?	no		If so, when (year)?	
			And what load level (%g)?	
Use (ground floor):	commercial		Brief strengthening description:	
Use (upper floors):				
Use notes (if required):				
Importance level (to NZS1170.5):	IL2			

<u>Gravity Structure</u>

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	rafters 100x50, purlins 75x50, metal cladding
Floors:	timber	joist depth and spacing (mm)	suspended timber floor 100mm spacing
Beams:			
Columns:			
Walls:			200

Lateral load resisting structure

Lateral system along:	lightweight timber framed walls		**Note: Define along and across in detailed report!**	note typical wall length (m)	
Ductility assumed, μ:	2.00				
Period along:	0.10	0.00		estimate or calculation?	estimated
Total deflection (ULS) (mm):				estimate or calculation?	
maximum interstorey deflection (ULS) (mm):				estimate or calculation?	
Lateral system across:	lightweight timber framed walls			note typical wall length (m)	
Ductility assumed, μ:	2.00				
Period across:	0.10	0.00		estimate or calculation?	estimated
Total deflection (ULS) (mm):				estimate or calculation?	
maximum interstorey deflection (ULS) (mm):				estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			No staircase
Wall cladding:	other light	describe	external brickwork veneer, internal timber hardboard
Roof Cladding:	Metal	describe	corrugated galvanised iron
Glazing:	timber frames		
Ceilings:			timber sarking
Services(list):			

Available documentation

Architectural	none	original designer name/date	
Structural	partial	original designer name/date	City Architects (CCC)
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report	none	original designer name/date	

Damage

Site:
(refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	0-2 $m^2/100m^3$	notes (if applicable):	Moderate Liquefaction potential
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:
	Describe (summary):		
Across	Damage ratio:	0%	
	Describe (summary):		
Diaphragms	Damage?:	no	Describe:
CSWs:	Damage?:	yes	Describe: Moderate Liquefaction Potential
Pounding:	Damage?:	no	Describe:
Non-structural:	Damage?:	yes	Describe: Cracking to brickwork veneer

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

Recommendations

	Level of repair/strengthening required:			Describe:
	Building Consent required:			Describe:
	Interim occupancy recommendations:	do not occupy		Describe:
Along	Assessed %NBS before:	18%	18% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after:	18%		
Across	Assessed %NBS before:	18%	18% %NBS from IEP below	
	Assessed %NBS after:	18%		

IEP **Use of this method is not mandatory - more detailed analysis may give a different answer, which would take precedence. Do not fill in fields if not using IEP.**

Period of design of building (from above): 1935-1965

h_n from above: 2.25m

Seismic Zone, if designed between 1965 and 1992: B

not required for this age of building

not required for this age of building

	along	across
Period (from above):	0.1	0.1
(%NBS)nom from Fig 3.3:	3.0%	3.0%

Note:1 for specifically design public buildings, to the code of the day: pre-1965 = 1.25; 1965-1976, Zone A =1.33; 1965-1976, Zone B = 1.2; all else 1.0	1.00
Note 2: for RC buildings designed between 1976-1984, use 1.2	1.0
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)	1.0

	along	across
Final $(\%NBS)_{nom}$:	**3%**	**3%**

2.2 Near Fault Scaling Factor

Near Fault scaling factor, from NZS1170.5, cl 3.1.6: 1.00

	along	across
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	0.30
Z_{1992}, from NZS4203:1992	
Hazard scaling factor, **Factor B:**	3.333333333

2.4 Return Period Scaling Factor

Building Importance level (from above):	2
Return Period Scaling factor from Table 3.1, **Factor C**:	1.00

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	2.00	2.00
Ductility scaling factor: =1 from 1976 onwards; or =k_μ, if pre-1976, fromTable 3.3:	1.57	1.57
Ductiity Scaling Factor, **Factor D**:	1.57	1.57

2.6 Structural Performance Scaling Factor:

Sp:	0.850	0.850
Structural Performance Scaling Factor **Factor E**:	1.176470588	1.176470588

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E

$\%NBS_b$:	**18%**	**18%**

Global Critical Structural Weaknesses: (refer to NZSEE IEP Table 3.4)

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1

3.4. Pounding potential

Pounding effect D1, from Table to right	1.0
Height Difference effect D2, from Table to right	1.0
Therefore, Factor D:	1

Table for selection of D1	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Alignment of floors within 20% of H	**0.7**	**0.8**	**1**
Alignment of floors not within 20% of H	**0.4**	**0.7**	**0.8**

Table for Selection of D2	Severe	Significant	Insignificant/none
Separation	0<sep<.005H	.005<sep<.01H	Sep>.01H
Height difference > 4 storeys	0.4	0.7	1
Height difference 2 to 4 storeys	0.7	0.9	1
Height difference < 2 storeys	1	1	1

3.5. Site Characteristics	insignificant	1

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max valule =1.5, no minimum	1.0	1.0
Rationale for choice of F factor, if not 1		

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)

List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR)	**1.00**	**1.00**
4.3 PAR x (%NBS)b: PAR x Baselline %NBS:	**18%**	**18%**
4.4 Percentage New Building Standard (%NBS), (before)		**18%**

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
DRAFT	Cormac Joy	Peter O Brien		Stephen Lee		20/04/12
FINAL	Cormac Joy	Peter O Brien		Donna Bridgman		17/09/13