Spencer Park Surf Club

Quantitative Engineering Evaluation

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Prepared for:

Christchurch City Council

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Document prepared by:

Aurecon New Zealand Limited
Level 2, 518 Colombo Street
Christchurch 8011
PO Box 1061
Christchurch 8140
New Zealand

T +64 3 375 0761
F +64 3 379 6955
E christchurch@aurecongroup.com
W aurecongroup.com

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Approval			
Author Signature		Approver Signature	
Name	Alan Williams	Name	Luis Castillo
Title	Structural Engineer	Title	Senior Structural Engineer

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Executive Summary

This is a summary of the Quantitative Engineering Evaluation for the Spencer Park Surf Club building and is based on the Detailed Engineering Evaluation Procedure document issued by the Engineering Advisory Group on 19 July 2011, visual inspections, available structural documentation and summary calculations as appropriate.

Building Details	**Name**	Spencer Park Surf Club			
Building Location ID	PRK 2971 BLDG 001			**Multiple Building Site**	Y
Building Address	100 Heyders Road, Spencerville			**No. of residential units**	0
Soil Technical Category	N/A	**Importance Level**	2	**Approx. Year Built**	1960s
Approx. Footprint (m^2)	170	**Storeys above ground**	2	**Storeys below ground**	0
Type of Construction	Timber framed roof with colour steel cladding, lined timber framed walls on the upper storey, timber framed upper floor, concrete masonry walls on the lower storey, and concrete slab on grade ground floor on hard fill.				

Quantitative L5 Report Results Summary

Building in Use	Y	The Spencer Park Surf Club is currently in use.
Suitable for Continued Use	Y	The Spencer Park Surf Club is suitable for continued use.
Key Damage Summary	Y	Refer to summary of building damage Section 3.1 report body.
Critical Structural Weaknesses (CSW)	N	No critical structural weaknesses were identified.
Levels Survey Results	Y	Variations in floor levels were within acceptable limits.
Building %NBS From Analysis	39%	Based on an analysis of structural capacity and seismic loads.

Approval

Author Signature		**Approver Signature**	
Name	Alan Williams	**Name**	Luis Castillo
Title	Structural Engineer	**Title**	Senior Structural Engineer

1 Introduction

1.1 General

On 28 January 2013 Aurecon engineers visited the Spencer Park Surf Club to inspect the building prior to carrying out a quantitative assessment of the building strength on behalf of Christchurch City Council. Detailed visual inspections were carried out to assess the damage caused by the earthquakes on 4 September 2010, 22 February 2011, 13 June 2011, 23 December 2011 and related aftershocks.

The scope of work included:

- Assessment of the nature and extent of the building damage.
- Visual assessment of the building structure, including connection details and consideration of critical structural weaknesses.
- A detailed calculation of the lateral strength of the structure and comparison with the New Building Standard (%NBS).

This report outlines the results of our Quantitative Assessment of the Spencer Park Surf Club and is based on the Detailed Engineering Evaluation Procedure document issued by the Structural Advisory Group on 19 July 2011, visual inspections, available structural documentation and summary calculations as appropriate.

1.2 Previous Assessments

A Qualitative Level 4 assessment has been carried out by Aurecon. The report, dated 11 January 2013, estimated the %NBS for the spencer park surf club as 66%. This value was calculated using nominal values for the building seismic weight and strength of the structural elements.

The value found in this Quantitative L5 assessment is lower than that found in the Qualitative L4 assessment. This difference is due to the more detailed calculations carried out for this report, including actual values for the building seismic weight and structural strength. These are discussed in further detail in Section 5 of this report.

2 Description of the Building

2.1 Building Age and Configuration

The Spencer Park Surf Club is a two-storey building with concrete masonry walls forming the lower storey and lined timber framed walls on the upper storey. The first floor is of timber construction. Originally built in the 1960s, the building was once a single storey ablutions and amenities block before the newer detached toilet block (not covered in this report) to the south west was built in 2000. There have been several additions since the completion of the original single storey concrete masonry ablutions and amenities block, namely:

- The addition of the timber framed upper floor in the 1970s;
- The addition of the balcony in 1989;
- The extensions to the inflatable rescue boat shed in 1994; and
- The reconfiguration of the concrete masonry walls in the western end of the building on completion of the new detached toilet block in 2000.

The building has a concrete slab on grade foundation with, we assume, local thickenings for load bearing elements.

The approximate footprint of the surf club is 170 square metres while the approximate floor area is 250 square metres. The building is considered as an 'Importance Level 2 Structure' in accordance with NZS 1170 Part 0: 2002.

2.2 Building Structural Systems Vertical and Horizontal

The Spencer Park Surf Club has well defined gravity and seismic load paths.

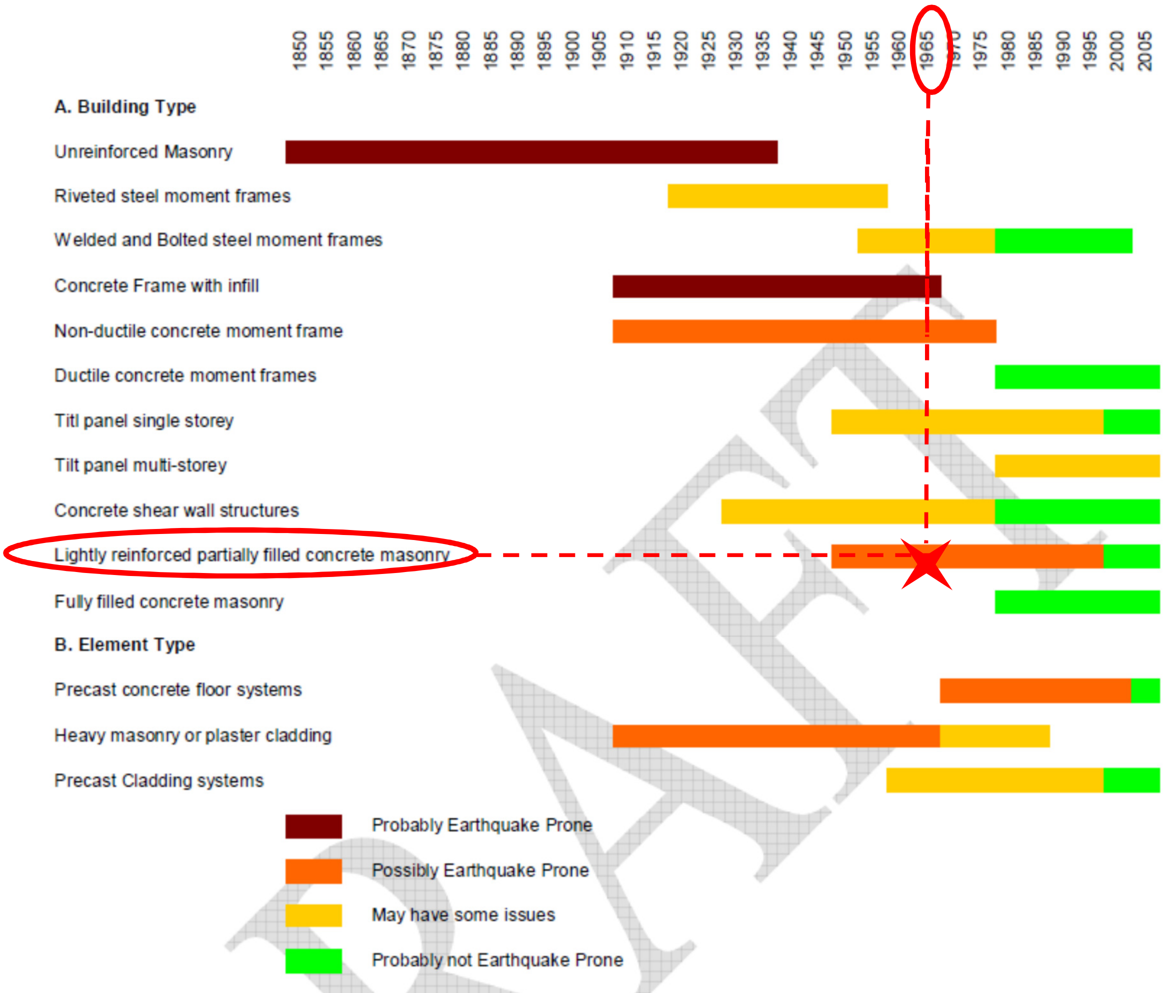
The gravity loads from the timber framed roof are supported on the lined timber framed walls. The upper storey walls are supported on the lower masonry walls and the timber floor which is braced with metal braces. The gravity loads are then transferred into the concrete slab foundations via the concrete masonry walls on the lower floor.

The lateral loads in both principal directions (i.e. along and across direction) are resisted by the lined timber framed walls and the sloping roof on the upper floor and the concrete masonry walls on the lower floor.

2.3 Reference Building Type

The Spencer Park Surf Club is a typical two-storey building with a generic concrete masonry wall lower floor and a lined timber framed wall upper floor. The upper floor is of lightweight construction and is ductile in nature, qualities which attract relatively low seismic loads. The lower floor on the other hand is stiffer, which attract greater seismic demands but limits inter-storey drifts and provides good torsional stability.

A general overview of the reference building type, construction era and likely earthquake risk is presented in the figure shown on the next page. According to this, the Spencer Park Surf Club is classified as possibly earthquake prone.



As noted by Buchanan et al in the 'Performance of Houses during the Christchurch Earthquake of 22 February 2011', timber framed buildings have generally performed 'very well' in the earthquake. Severe damage was usually due to loss of functionality of doors and windows rather than structural collapse.

On the other hand, the concrete masonry wall buildings showed a range of seismic performances. Depending on the level of reinforcement and grouting, the performance varied from 'poor' for unreinforced and un-grouted concrete masonry wall to 'very well' for fully reinforced and grouted concrete masonry walls. According to Buchanan et al, of particular concern was the apparent failure of the bond between the brick and the mortar due to the rapid loss of moisture of the mortar post construction. This is manifested as step cracking in the mortar joints.

2.4 Building Foundation System and Soil Conditions

The Spencer Park Surf Club has a concrete slab on grade foundation with local thickenings for load bearing elements. The land surrounding the surf club was classified as 'urban non-residential' according to the Department of Housing and Building's Technical Classes dated 18 May 2012. It is of note that the residential properties to the immediate east were classified at 'Technical Category 3' or 'TC3' and according to CERA, 'may suffer moderate to significant liquefaction in future significant earthquakes'. It is further noted that the Surf Club building is located on historical sand dunes, which in New Brighton and other areas have not liquefied to the same extent as land immediately inland of the dune line.

2.5 Available Structural Documentation and Inspection Priorities

No original architectural or structural drawings were available for the Spencer Park Surf Club. The only drawings and documentation available in the council files were for:-

- The addition of the balcony in 1989;
- The extensions to the inflatable rescue boat shed in 1994, and
- The reconfiguration of the concrete masonry walls in the western end of the building on completion of the new detached toilet block in 2000.

The inspection priorities related to a review of potential damage to foundations and consideration of wall bracing adequacy.

2.6 Available Survey Information

A floor level survey was undertaken to establish the level of unevenness across the floors. The results of the survey are presented on the attached sketch in Appendix A. All of the levels were taken on top of the existing floor coverings which may have introduced some margin of error.

The Department of Building and Housing (DBH) published the 'Revised Guidance on Repairing and Rebuilding Houses Affected by the Canterbury Earthquake Sequence' in November 2011, which recommends some form of re-levelling or rebuilding of the floor

1. If the slope is greater than 0.5% for any two points more than 2m apart, or
2. If the variation in level over the floor plan is greater than 50mm, or
3. If there is significant cracking of the floor.

It is important to note that these figures are recommendations and are only intended to be applied to residential buildings. However, they provide useful guidance in determining acceptable floor level variations.

Although the floor levels were not within the recommended tolerances stated above, they are deemed to be acceptable nonetheless given the nature of the building's construction.

3 Structural Investigation

3.1 Summary of Building Damage

The Spencer Park Surf Club was in use at the time of the damage assessment. There was no seismic related damage noted. However, there were a few age related damages noted:-

- The balcony in the North East does not drain properly, rather water accumulates by the balcony door, this is supported by the levels survey;
- Concrete spalling on the top of the Northern concrete masonry wall interior; and
- Impact damage to the face shell at about mid height on the Northern concrete masonry wall interior.

3.2 Record of Intrusive Investigation

There were no noted signs of seismic damage and therefore, an intrusive investigation was neither warranted nor undertaken for Spencer Park Surf Club.

3.3 Damage Discussion

There were no signs of seismic damage noted to the Spencer Park Surf Club. This is in line with the low levels of damage observed to the majority of the lightly reinforced concrete masonry and lined timber framed building stock following the Canterbury earthquake sequence.

4 Building Review Summary

4.1 Building Review Statement

As noted above no intrusive investigations were undertaken on the Spencer Park Surf Club building. Despite the lack of original architectural and structural drawings, the generic nature of the building allowed for most of the primary structure to be assessed for damage.

A HILTI reinforcement locator was used to measure reinforcement spacing at representative locations in the masonry walls of the lower storey.

4.2 Critical Structural Weaknesses

No specific critical structural weaknesses were identified as part of the building qualitative assessment.

5 Building Strength (Refer to Appendix C for background information)

5.1 General

The Spencer Park Surf Club is, as described above, a two-storey building with concrete masonry walls forming the lower storey and lined timber framed walls on the upper storey. Buildings of this nature have typically performed well in the Canterbury earthquake sequence.

5.2 Percentage NBS Assessment

The damage to the building is considered to have minimal impact on the strength of the building and so the strength assessment of the building has been based on the undamaged structure.

The seismic demand for the Spencer Park Surf Club has been calculated based on NZS 1170:2002. The capacity of the structure has been calculated from the NZ Society for Earthquake Engineering (NZSEE) guidelines on assumed strengths of existing materials

Despite the use of best practice in this analysis and assessment, the values are uncertain due to the assumptions and simplifications which were made during the assessment (Refer to Appendix B for the assumptions).

The strength of the building was assessed in the two major orthogonal directions: longitudinally in the east-west direction (referenced as "along" in the CERA DEE Spreadsheet in Appendix D) and transversally in the north-south direction (referenced as "across" in the CERA DEE Spreadsheet). The critical elements of the structure were identified and the strength of each element calculated as a percentage NBS.

Table 1: Parameters used in the Seismic Assessment

Seismic Parameter	Quantity	Comment/Reference
Site Soil Class	D	NZS 1170.5:2004, Clause 3.1.3, Deep or Soft Soil.
Site Hazard Factor, Z	0.30	Department of Building and Housing Info Sheet on Seismicity Changes (Effective 19 May 2011).
Return period Factor, R_u	1.00	NZS 1170.5:2004, Table 3.5, Importance Level 2 with a 50 year Design Life.
Ductility Factor in the along Direction, μ	1.25	Lightly reinforced concrete masonry walls.
Ductility Factor in the across Direction, μ	1.25	Lightly reinforced concrete masonry walls.

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5.2.1 Upper Storey - Timber Structure

The lateral load resisting elements in the upper storey structure are the timber framed walls with hardi-board cladding. Additional lateral resistance is provided by the sloping roof sections on either side of the central hall. These roof sections act as additional diaphragms in the longitudinal direction, and tension and compression props in the transverse direction.

The layout of the upper storey is largely symmetrical in both directions.

The lateral forces in the timber walls are transferred to the supporting masonry walls below by the timber floor diaphragms. Steel bracing elements and timber floor beams assist this load transfer.

The limiting calculated strength of the building in this direction is 100% NBS. Strengths for the individual elements are as follows:

Table 2: Summary of Calculated Building Capacity Upper Storey

Longitudinal direction		
Load Resisting Element	**Failure Mode**	**% NBS**
Roof diaphragm and roof beams	Bending failure of the timber beams	100% NBS
Wall diaphragms	Shear failure	100% NBS
Floor Diaphragms	In-Plane Shear	100% NBS
Floor diaphragm connection to lower storey	In-Plane Shear	100% NBS

Transverse direction		
Load Resisting Element	**Failure Mode**	**% NBS**
Roof diaphragm and roof beams	Bending failure of the timber beams	100% NBS
Wall diaphragms	Shear failure	100% NBS
Floor Diaphragms	In-Plane Shear	100% NBS

5.2.2 Lower Storey - Reinforced Masonry Storey

The lateral load resisting elements in the lower storey are the concrete masonry walls. The walls are generally 200 series in-filled reinforced masonry block walls. The layout of the walls in plan is largely symmetrical in the longitudinal direction.

In the transverse direction, the walls are concentrated at the western end of the building – the eastern end of the building contains long spaces for watercraft. Due to this, the eastern-most exterior wall carries the seismic weight of one third of the building. In addition, this wall is pierced by three large door openings, reducing the available length of the walls and their lateral capacity. These walls are the critical structural elements. The seismic weight contributing to the lateral load on these walls was under-estimated by the qualitative assessment and is the reason for the reduced capacity identified in this report.

The limiting calculated strength of the lower storey of the building is 39% NBS. Strengths for the individual elements are as follows:

Table 3: Summary of Calculated Building Capacity Lower Storey

Longitudinal direction		
Load Resisting Element	**Failure Mode**	**% NBS**
Reinforced masonry walls	Wall Shear	100% NBS
Reinforced masonry walls	Wall Flexure	39% NBS

Transverse direction		
Load Resisting Element	**Failure Mode**	**% NBS**
Reinforced masonry walls	Wall Shear	100% NBS
Reinforced masonry walls	Wall Flexure	99% NBS

The assumptions are described in Appendix B

5.3 Foundations

The foundation system is a slab on grade, which is assumed to have local thickenings to transfer wall loads to the subgrade soils. There is no observable indication of structural damage to the foundations, other than slight differential settlement. It is likely that the strength of the foundations is adequate to meet the current NBS.

5.4 Results Discussion

The findings of the bracing check correspond well with the level of damage noted from the damage assessment. Overall the surf club has demonstrated good seismic performance, and the majority of the structural elements in the building have a calculated capacity of 67% NBS or higher.

The major factors that contribute to the low %NBS calculated are:

- The high seismic load and low flexural capacity of the short masonry walls on Grid Line 2. This is a specific issue and does not reflect the general capacity of the structure.

Should it be desired to strengthen the building to a minimum of 67%NBS, possible strengthening solutions are (but not limited to):

- Addition of steel bracing frames and transfer beams to supplement the lateral capacity of the masonry walls on Grid Line 5

Any strengthening and repair works will need to be designed and supervised by a structural chartered professional engineer and undertaken by a licensed building practitioner.

6 Conclusions and Recommendations

An assessment of the Spencer Park Surf Club building has established the following:

- Observed damage to the building is minor and of little structural significance
- No critical structural weaknesses were found in the building.
- The building strength is estimated at approximately 39%NBS, limited by the calculated lateral capacity of the lower storey masonry walls on grid line 5.
- The building is unlikely to exhibit a brittle failure mode

Given these findings, the Spencer Park Surf Club building is classified as an Earthquake Risk building.

The NZ Society for Earthquake Engineering has assessed relative building risk against building strength in relation to seismic events. They are of the view that a building with a seismic strength of 20%NBS poses a risk that is 25 times greater than the risk posed by a new building (100%NBS).

The building is considered to be **suitable for continued use.**

As the floor levels of the Spencer Park Surf Club were within tolerable limits, **a geotechnical investigation is currently not considered necessary.**

7 Explanatory Statement

The inspections of the building discussed in this report have been undertaken to assess structural earthquake damage. No analysis has been undertaken to assess the strength of the building or to determine whether or not it complies with the relevant building codes, except to the extent that Aurecon expressly indicates otherwise in the report. Aurecon has not made any assessment of structural stability or building safety in connection with future aftershocks or earthquakes – which have the potential to damage the building and to jeopardise the safety of those either inside or adjacent to the building, except to the extent that Aurecon expressly indicates otherwise in the report.

This report is necessarily limited by the restricted ability to carry out inspections due to potential structural instabilities/safety considerations, and the time available to carry out such inspections. The report does not address defects that are not reasonably discoverable on visual inspection, including defects in inaccessible places and latent defects. Where site inspections were made, they were restricted to external inspections and, where practicable, limited internal visual inspections.

To carry out the structural review, existing building drawings were obtained from the Christchurch City Council records. We have assumed that the building has been constructed in accordance with the drawings.

While this report may assist the client in assessing whether the building should be strengthened, that decision is the sole responsibility of the client.

This review has been prepared by Aurecon at the request of its client and is exclusively for the client's use. It is not possible to make a proper assessment of this review 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 Aurecon. The report will 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, Aurecon's liability, whether under the law of contract, tort, statute, equity or otherwise, is limited as set out in the terms of the engagement with the client.

Appendices

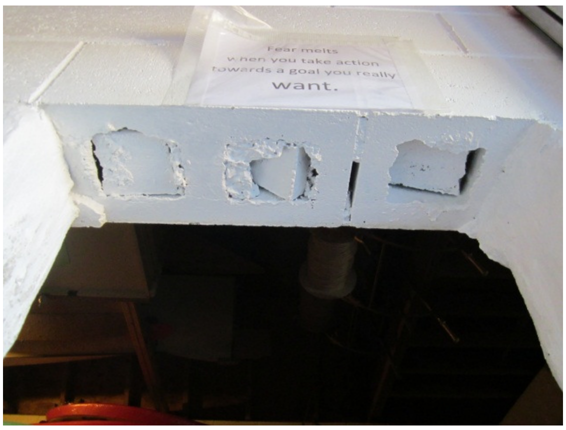
Appendix A

Site Map, Photos Structural Layout and Floor Level Surveys

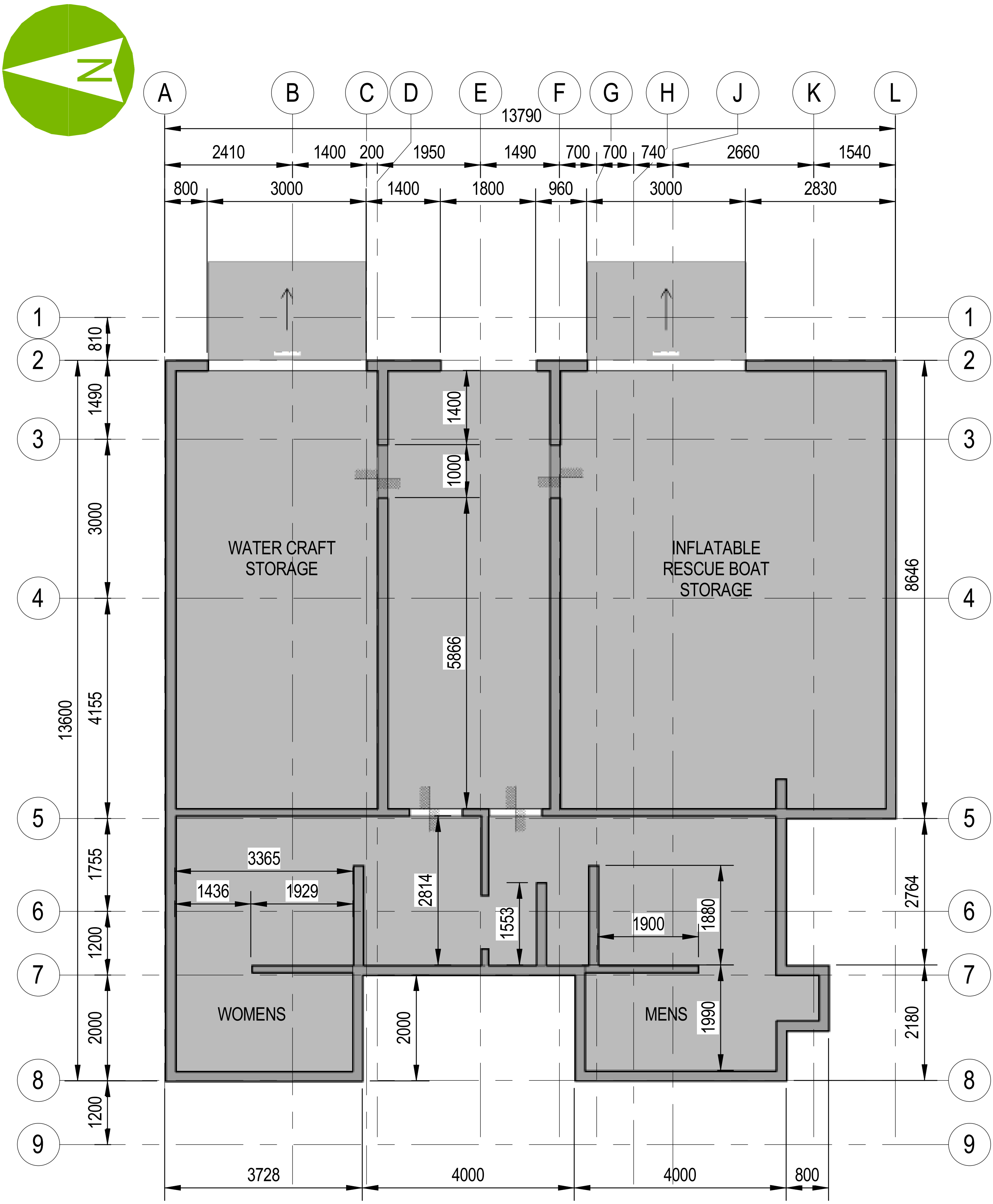
28 January 2013 – Spencer Park Surf Club Site Photographs

Eastern elevation of the Spencer Park Surf Club.	
Western elevation of the Spencer Park Surf Club.	

Exterior view of the first floor deck.	
Interior view of the kitchen on the upper floor.	
Interior view of the timber framed roof on the upper floor	
Interior view of the first aid room as well as the access hatch to the lower floor.	

Interior view of the first aid room on the upper floor.	
The timber floor structure - note steel bracing to underside of timber floor joists.	
The access stairs between the lower and upper floors.	
Underside of the opening between the storage rooms. The 'biscuits' indicate that the wall above is at least partially filled.	

Interior view showing that the concrete slab on grade of the storage sheds are approximately 400 mm above ground level.	
Interface showing the 1994 extension (left) and the original concrete masonry wall (right) in the inflatable rescue boat shed.	
Non seismic related damage - concrete spalling on the top of the Northern concrete masonry wall interior.	
Non-seismic related damage - impact damage to the face shell at about mid height on the Northern concrete masonry wall interior.	



LEGEND:

INDICATES CONSTRUCTED DIFFERENCE OF ELEVATION IN SLAB

INDICATES BLOCKWORK WALL

GROUND

1 : 100

15/02/2013 12:28:56 p.m.

aurecon

CLIENT

Christchurch City Council

REV	DATE	REVISION DETAILS	APPROVAL
A	15.02.13	ISSUED FOR INFORMATION	L.CASTILLO

DRAWN	DESIGNED
D.LAKE	C.BONG

CHECKED: L.CASTILLO

APPROVED: L.CASTILLO DATE

PROJECT: SPENCER PARK SURF LIFE SAVING BUILDING CHRISTCHURCH

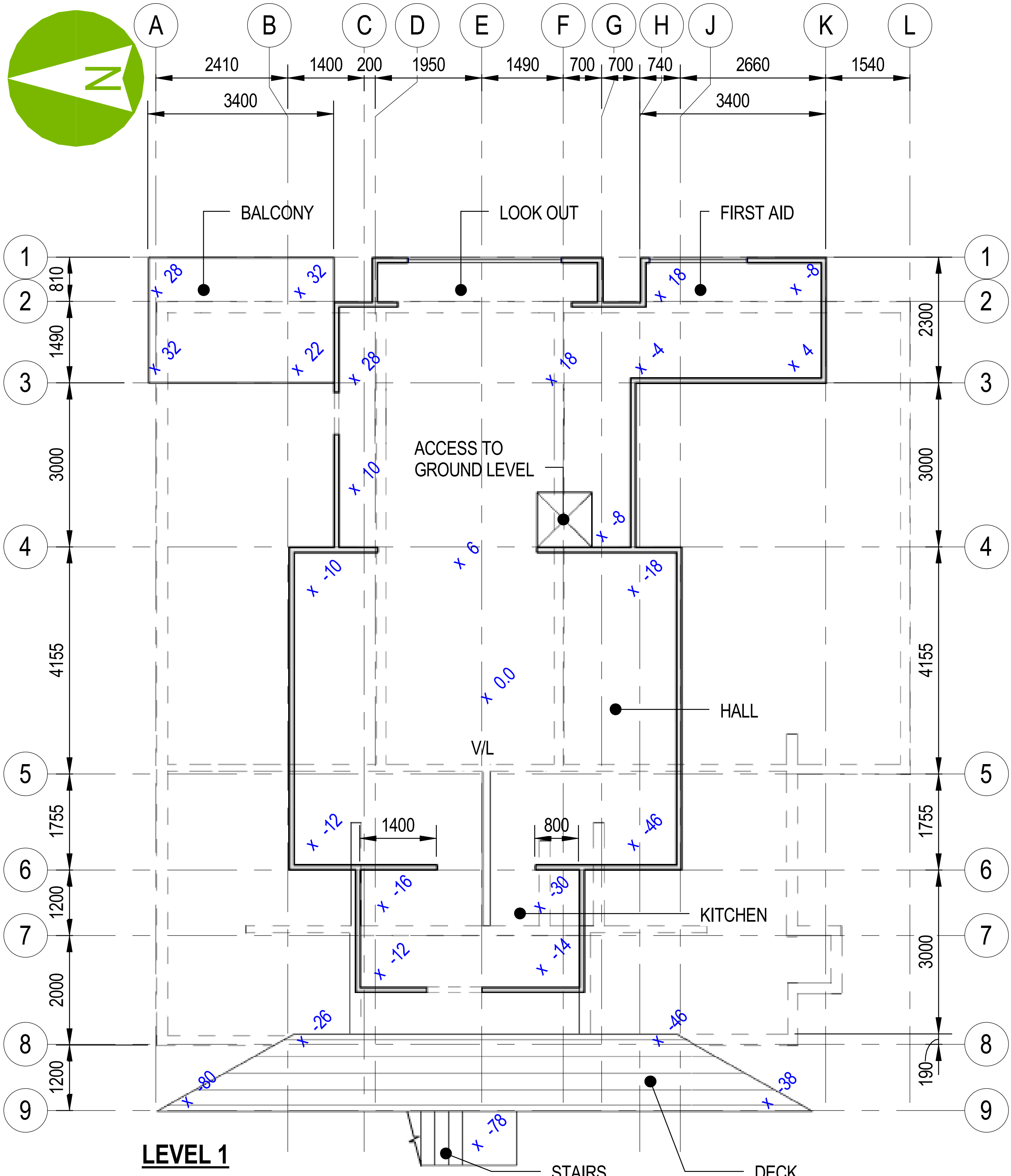
TITLE: GROUND LEVEL STRUCTURAL LAYOUT

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT No. 228701

SCALE 1 : 100 | SIZE A4

DRAWING No. S-24-00 | REV A



LEVEL 1

1 : 100

MAXIMUM VARIATION ACROSS LEVEL 1 = 46mm (SAME FLOOR COVERING)

LEGEND:

C=	CONCRETE
CP=	CARPET
TB=	TIMBER FLOOR
V/L=	VINYL / LINOLEUM
0.0 =	REFERENCE POINT
⊏ ⊐ ⊏ ⊐	INDICATES WALLS OF LEVEL BELOW, REFER S-24-00 FOR INFORMATION

NOTES:

1. FLOOR PLANS AND DIMENSIONS ARE APPROXIMATE ONLY
2. FLOOR LEVEL SURVEY CARRIED OUT ON 02/07/2012.

15/02/2013 12:28:56 p.m.

aurecon

CLIENT

Christchurch City Council

REV	DATE	REVISION DETAILS	APPROVAL
A	15.02.13	ISSUED FOR INFORMATION	L.CASTILLO

DRAWN	T.DOWN
DESIGNED	C.BONG
CHECKED	L.CASTILLO
APPROVED	L.CASTILLO
DATE	

PROJECT: SPENCER PARK SURF LIFE SAVING BUILDING CHRISTCHURCH

TITLE: LEVEL 1 FLOOR LEVEL SURVEY

PRELIMINARY NOT FOR CONSTRUCTION

PROJECT No.	228701
SCALE	1 : 100
SIZE	A4
DRAWING No.	S-24-01
REV	A

Appendix B

References

1. Department of Building and Housing (DBH), “Revised Guidance on Repairing and Rebuilding Houses Affected by the Canterbury Earthquake Sequence”, November 2011

2. New Zealand Society for Earthquake Engineering (NZSEE), “Assessment and Improvement of the Structural Performance of Buildings in Earthquakes”, April 2012

3. Standards New Zealand, “AS/NZS 1170 Part 0, Structural Design Actions: General Principles”, 2002

4. Standards New Zealand, “AS/NZS 1170 Part 1, Structural Design Actions: Permanent, imposed and other actions”, 2002

5. Standards New Zealand, “NZS 1170 Part 5, Structural Design Actions: Earthquake Actions – New Zealand”, 2004

6. Standards New Zealand, “NZS 3101 Part 1, The Design of Concrete Structures”, 2006

7. Standards New Zealand, “NZS 3404 Part 1, Steel Structures Standard”, 1997

8. Standards New Zealand, “NZS 3606, Timber Structures Standard”, 1993

9. Standards New Zealand, “NZS 3604, Timber Framed Structures”, 2011

10. Standards New Zealand, “NZS 4229, Concrete Masonry Buildings Not Requiring Specific Engineering Design”, 1999

11. Standards New Zealand, “NZS 4230, Design of Reinforced Concrete Masonry Structures”, 2004

Assumptions

The following table resume the assumptions made in order to complete calculations.

Table 1: Assumptions made

Assumptions	Description of the assumptions	Values
Dead load contributing in seismic calculations. **Upper Storey**	Timber framed walls: 0.3 kPa Timber framed roof inc. ceiling: 0.5 kPa	
Dead load contributing in seismic calculations. **Lower Storey**	Floor dead load: 0.5 kPa Superimposed dead load: 0.25 kPa Live Load: 2.0 kPa	
f_y of all reinforcing bars.		275 Mpa
f_y of all steel sections.		275 Mpa
Ductility Factor for the reinforced masonry walls, μ	Nominally ductile design assumed for the masonry walls.	1.25
Ductility Factor for timber frame walls	A ductility of 3 is assumed for the timber framed walls of the upper storey.	3
Size of reinforcing bars in the Main Hall concrete panels.	Size of reinforcing bars in the concrete masonry walls of the lower storey. 12mm is likely to be the minimum diameter used in the construction.	12 mm at 900 mm c/c each direction

Appendix C
Strength Assessment Explanation

New building standard (NBS)

New building standard (NBS) is the term used with reference to the earthquake standard that would apply to a new building of similar type and use if the building was designed to meet the latest design Codes of Practice. If the strength of a building is less than this level, then its strength is expressed as a percentage of NBS.

Earthquake Prone Buildings

A building can be considered to be earthquake prone if its strength is less than one third of the strength to which an equivalent new building would be designed, that is, less than 33%NBS (as defined by the New Zealand Building Act). If the building strength exceeds 33%NBS but is less than 67%NBS the building is considered at risk.

Christchurch City Council Earthquake Prone Building Policy 2010

The Christchurch City Council (CCC) already had in place an Earthquake Prone Building Policy (EPB Policy) requiring all earthquake-prone buildings to be strengthened within a timeframe varying from 15 to 30 years. The level to which the buildings were required to be strengthened was 33%NBS.

As a result of the 4 September 2010 Canterbury earthquake the CCC raised the level that a building was required to be strengthened to from 33% to 67% NBS but qualified this as a target level and noted that the actual strengthening level for each building will be determined in conjunction with the owners on a building-by-building basis. Factors that will be taken into account by the Council in determining the strengthening level include the cost of strengthening, the use to which the building is put, the level of danger posed by the building, and the extent of damage and repair involved.

Irrespective of strengthening level, the threshold level that triggers a requirement to strengthen is 33%NBS.

As part of any building consent application fire and disabled access provisions will need to be assessed.

Christchurch Seismicity

The level of seismicity within the current New Zealand loading code (AS/NZS 1170) is related to the seismic zone factor. The zone factor varies depending on the location of the building within NZ. Prior to the 22nd February 2011 earthquake the zone factor for Christchurch was 0.22. Following the earthquake the seismic zone factor (level of seismicity) in the Christchurch and surrounding areas has been increased to 0.3. This is a 36% increase.

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 C1 below.

Description	Grade	Risk	%NBS	Existing Building Structural Performance
Low Risk Building	A or B	Low	Above 67	Acceptable (improvement may be desirable)
Moderate Risk Building	B or C	Moderate	34 to 66	Acceptable legally. Improvement recommended
High Risk Building	D or E	High	33 or lower	Unacceptable (Improvement

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
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
	Not recommended. Acceptable only in exceptional circumstances
Unacceptable	Unacceptable

Figure C1: NZSEE Risk Classifications Extracted from table 2.2 of the NZSEE 2006 AISPBE Guidelines

Table C1 below compares the percentage NBS to the relative risk of the building failing in a seismic event with a 10% probability 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% probability of exceedance in the next year.

Table C1: Relative Risk of Building Failure In A

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

Appendix D
Background and Legal Framework

Background

Aurecon has been engaged by the Christchurch City Council (CCC) to undertake a detailed engineering evaluation of the building

This report is a Qualitative Assessment of the building structure, and is based 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. Construction drawings were made available, and 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.

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.

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

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.

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.

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.

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.

Appendix E
Standard Reporting Spread Sheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Spencer Park Surf Club		Reviewer:	Lee Howard
	Unit / No: / Street		CPEng No:	1008889
Building Address:	110 Heyders Road		Company:	Aurecon
Legal Description:	Lot 1 DP 44484		Company project number:	228701
	Degrees / Min / Sec		Company phone number:	03 375 0761
GPS south:	43 / 25 / 55.81		Date of submission:	Jun-13
GPS east:	172 / 42 / 46.29		Inspection Date:	Jan-13
			Revision:	2
Building Unique Identifier (CCC):	PRK 2971 BLDG 001		Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0.4
Soil type:	mixed	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):	0.00

Building

No. of storeys above ground:	2	single storey = 1	Ground floor elevation (Absolute) (m):	0.40
Ground floor split?	no		Ground floor elevation above ground (m):	0.40
Storeys below ground	0			
Foundation type:	mat slab		if Foundation type is other, describe:	
Building height (m):	6.00		height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):	170			
Age of Building (years):	50		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):	other (specify)			
Use notes (if required):	surf club			
Importance level (to NZS1170.5):	IL2			

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber framed	rafter type, purlin type and cladding	
Floors:	timber	joist depth and spacing (mm)	concrete ground floor, timber first floor
Beams:	timber	type	
Columns:			concrete masonry walls ground floor, lined timber framed walls first floor
Walls:	partially filled concrete masonry	thickness (mm)	190

Lateral load resisting structure

Lateral system along:	partially filled CMU	**Note: Define along and across in detailed report!**		CMU G floor, timber framed 1st floor
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	
Period along:	0.40	##### enter height above at H31	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	partially filled CMU			CMU G floor, timber framed 1st floor
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	
Period across:	0.40	##### enter height above at H31	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:	timber	describe supports	fixed
Wall cladding:	other light	describe	CMU walls on G floor were painted, timber framed walls or
Roof Cladding:	Metal	describe	colour steel
Glazing:	timber frames		
Ceilings:	plaster, fixed		
Services(list):			

Available documentation

Architectural	none	original designer name/date	
Structural	none	original designer name/date	
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:	Good	Describe damage:	none noted
Settlement:	none observed	notes (if applicable):	
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:	
	Describe (summary):			
Across	Damage ratio:	0%		
	Describe (summary):			
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	none		Describe:	
	Building Consent required:	no		Describe:	
	Interim occupancy recommendations:	full occupancy		Describe:	
Along	Assessed %NBS before e'quakes:	100%	##### %NBS from IEP below	If IEP not used, please detail assessment methodology:	Quantitative
	Assessed %NBS after e'quakes:	100%			
Across	Assessed %NBS before e'quakes:	39%	##### %NBS from IEP below		
	Assessed %NBS after e'quakes:	39%			

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): 1965-1976 h_n from above: 6m

Seismic Zone, if designed between 1965 and 1992: not required for this age of building / not required for this age of building

	along	across
Period (from above):	0.4	0.4
(%NBS)nom from Fig 3.3:	0.0%	0.0%
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		1.20
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

	along	across
Final (%NBS)nom:	**0%**	**0%**

2.2 Near Fault Scaling Factor

	along	across
Near Fault scaling factor, from NZS1170.5, cl 3.1.6:		
Near Fault scaling factor (1/N(T,D), **Factor A**:	#DIV/0!	#DIV/0!

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	
Z_{1992}, from NZS4203:1992	
Hazard scaling factor, **Factor B:**	#DIV/0!

2.4 Return Period Scaling Factor

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

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)		
Ductility scaling factor: =1 from 1976 onwards; or =kμ, if pre-1976, fromTable 3.3:		
Ductiity Scaling Factor, **Factor D**:	0.00	0.00

2.6 Structural Performance Scaling Factor:

Sp:		
Structural Performance Scaling Factor **Factor E**:	#DIV/0!	#DIV/0!

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

$\%NBS_b$:	**#DIV/0!**	**#DIV/0!**

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

3.1. Plan Irregularity, factor A:	1
3.2. Vertical irregularity, Factor B:	1
3.3. Short columns, Factor C:	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	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:	**#DIV/0!**	**#DIV/0!**
4.4 Percentage New Building Standard (%NBS), (before)			**#DIV/0!**

Aurecon New Zealand Limited
Level 2, 518 Colombo Street
Christchurch 8011
PO Box 1061
Christchurch 8140
New Zealand

T +64 3 375 0761
F +64 3 379 6955
E christchurch@aurecongroup.com
W aurecongroup.com