Cathedral Square Police Kiosk

BU 1217-001 EQ2

Detailed Engineering Evaluation Quantitative Assessment Report

Christchurch City Council

Cathedral Square Police Kiosk Detailed Engineering Evaluation Quantitative Assessment Report

Cathedral Square, Christchurch
Christchurch City Council

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Contents

Executive Summary

Christchurch City Council appointed Opus International Consultants to carry out a detailed seismic assessment of the police kiosk in the northern half of Cathedral Square, Christchurch. The key outcome of this assessment was to ascertain the anticipated seismic performance of the structure and to compare this performance with current design standards.

Findings of the assessment are:

1. The seismic performance of the police kiosk exceeds 100%NBS. The building is therefore considered to be of low risk in accordance with the NZSEE 2006 Guidelines for *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*.

2. Liquefaction hazard at the site is considered to be low, therefore the current shallow foundations are considered appropriate.

It is recommended that the occupancy of the building be allowed to continue.

1 Introduction

Opus International Consultants Limited has been engaged by Christchurch City Council (CCC) to undertake a detailed seismic assessment of the police kiosk, located in the northern half of Cathedral Square, following the M6.3 Christchurch earthquake on 22 February 2011.

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

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

2 Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

We understand that CERA 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 (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011. This document sets out a methodology for both initial qualitative and detailed quantitative assessments.

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

1. The importance level and occupancy of the building.

2. The placard status and amount of damage.
3. The age and structural type of the building.
4. Consideration of any critical structural weaknesses.

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

2.2 Building Act

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

Section 112 - Alterations

This section requires that an existing building complies with the relevant sections of the Building Code to at least the extent that it did prior to the alteration.

This effectively means that a building cannot be weakened as a result of an alteration (including partial demolition).

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) is satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'.

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

Section 121 – Dangerous Buildings

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

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

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

Section 122 – Earthquake Prone Buildings

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

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

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

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

- The accessibility requirements of the Building Code;

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

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:

- 36% increase in the basic seismic design load for Christchurch (Z factor increased for 0.22 to 0.3)
- Increased serviceability requirements.

3 Earthquake Resistance Standards

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

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

Table 2.2 NZSEE Risk Classifications and Improvement Recommendations

<table>
<tr><th rowspan="2">Description</th><th rowspan="2">Grade</th><th rowspan="2">Risk</th><th rowspan="2">%NBS</th><th rowspan="2">Existing Building Structural Performance</th><th colspan="2">Improvement of Structural Performance</th></tr>
<tr><th>Legal Requirement</th><th>NZSEE Recommendation</th></tr>
<tr><td>Low Risk Building</td><td>A or B</td><td>Low</td><td>Above 67</td><td>Acceptable (improvement may be desirable)</td><td rowspan="2">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.</td><td>100%NBS desirable. Improvement should achieve at least 67%NBS</td></tr>
<tr><td>Moderate Risk Building</td><td>B or C</td><td>Moderate</td><td>34 to 66</td><td>Acceptable legally. Improvement recommended</td><td>Not recommended. Acceptable only in exceptional circumstances</td></tr>
<tr><td>High Risk Building</td><td>D or E</td><td>High</td><td>33 or lower</td><td>Unacceptable (Improvement required under Act)</td><td>Unacceptable</td><td>Unacceptable</td></tr>
</table>

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

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

4.1 Building Description

The Cathedral Square Police Kiosk is located in the northern half of Cathedral Square around 30m south-west from the intersection of Worcester and Colombo Streets in Central Christchurch. The building was constructed in 1973.

The kiosk is a single storey octagonal shaped reinforced concrete frame structure with a pitched timber roof. The perimeter wall segments are 3.8m long, and the peak roof height is 5.7m.

The building has rectangular 600x200mm precast concrete columns at each of the eight vertices. A rectangular 300x250mm concrete tension ring beam runs between the perimeter columns 2.4m above floor level. The roof has pitched glulam roof beams supporting timber rafters under 10mm thick plywood sheathing. At the centre of the roof, the pitched glulams are supported by a 100x100mm steel compression ring beam.

There are some partial and full height infill blockwork walls around the perimeter of the kiosk. The only full height blockwork wall is on the east face of the kiosk. All other perimeter faces have partial height blockwork. On the interior, there are also partial height blockwork partitions.

The foundation system consists of spread footings connected around the perimeter by 200mm thick cast-in-place reinforced concrete ground beams with varying depths. The ground beams have a single layer of reinforcing steel while the cast-in-place concrete spread footings are unreinforced. The slab-on-grade is 100mm thick mesh reinforced in-situ concrete.

Lateral load resistance is presumed to be provided by out-of-plane flexural cantilever action in the columns. It has been assumed that bending about the strong axis did not contribute to the lateral resistance of the kiosk. This is because there is only one dowel into the unreinforced concrete footing, so it did not appear that the flexural strength of the column could be developed at the base. In the weak direction, the columns are fixed on both sides by the perimeter ground beams. The point of fixity is taken at the top of the grade beam.

4.2 CBD Red Zone Cordon

Following the Lyttelton Earthquake of 22 February 2011, the central business district (CBD) suffered major damage to a large proportion of its building stock and so a central area of the city was cordoned off and closed to the public, forming what is known as the red zone. Some outskirts of the red zone cordon have now been lifted and Oxford Terrace is currently on the perimeter of the red zone. The red zone extent, as of 24 September 2012, is displayed below in Figure 2.

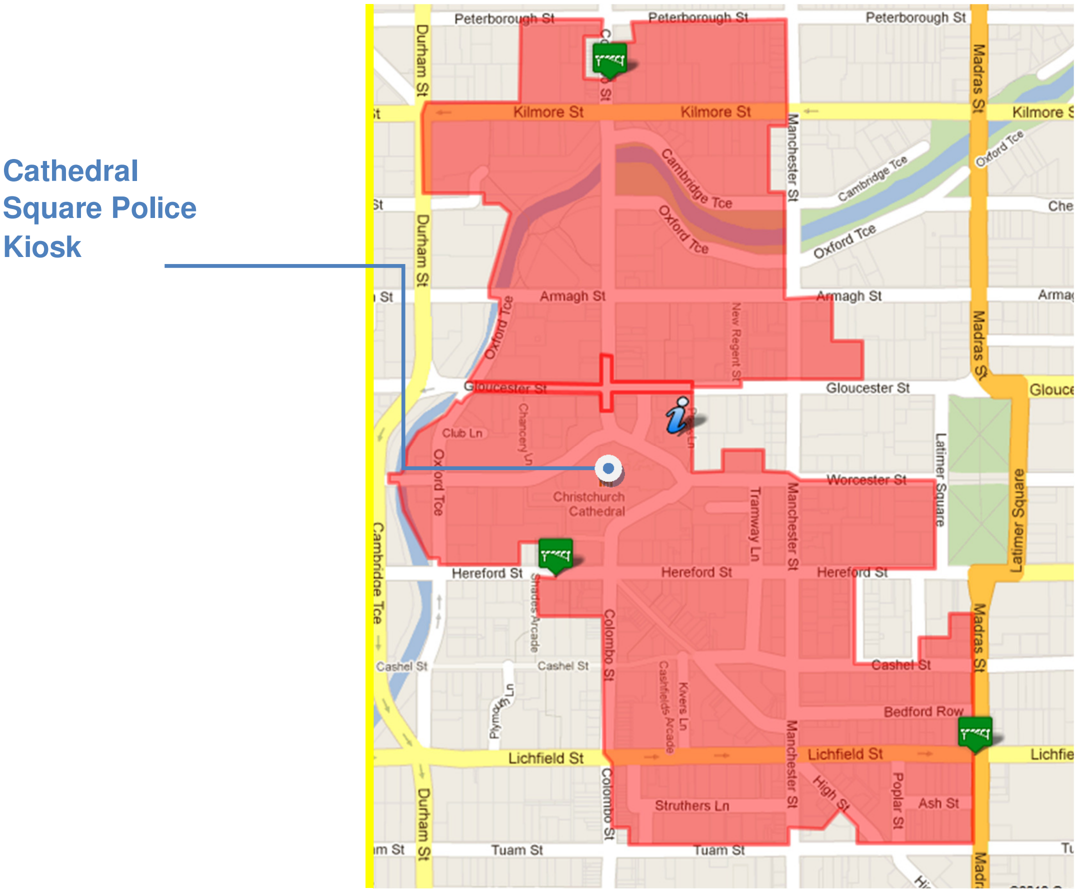


Figure 2: CBD Red Zone as at 24 September 2012

4.3 Inspection

An inspection was undertaken by Opus International Consultants on 7 December 2011. The inspection included external and internal visual inspections of all structural elements above foundation level, and areas of damage to structural and non-structural elements.

4.4 Original Documentation

Copies of the following construction drawings were provided by the CCC on 12 December 2011:

- Cathedral Square Redevelopment: CTB Inspectors Office, stamped 21 September 1973.

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

No design calculations were available.

5 Structural Damage

Only very minor damage was observed to the kiosk. The damage noted is as follows:

- Cracking at the gib wall intersection with the pitched roof.
- 10-20mm differential settlement in the ground floor slab in the southeast corner.

6 General Observations

The kiosk appears to have performed well during the earthquakes. Only very minor damage was noted to structural elements. The observed damage is consistent with the expected building performance following a review of the structural drawings and site investigations.

7 Detailed Seismic Assessment

The detailed seismic assessment has been based on the NZSEE 2006 [2] guidelines for the "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes" together with the Detailed Engineering Evaluation Procedure [3] (DEEP) document (draft) issued by the Structural Engineering Society (SESOC) on 19 July 2011.

7.1 Critical Structural Weaknesses

The term Critical Structural Weakness (CSW) refers to a component of a building that could contribute to increased levels of damage or cause premature collapse of a building. During the initial qualitative stage of the assessment the following potential CSW was identified:

- Limited ductility in the lateral force resisting system.

7.2 Quantitative Assessment Methodology

Hand calculations were performed to assess the %NBS for various design actions resulting from lateral loading. Because the building is expected to resist lateral load via cantilever action in the weak direction of the columns, the building is expected to remain nominally elastic. Lateral load demand was established in accordance with the static method in NZS1170.5, with an updated Z factor of 0.3 (B1/VM1). Based on the actions determined from the analyses, an assessment of the building capacities was made.

It was determined that weak axis bending in the columns controlled over strong axis bending in the columns due to the detailing at the column base. Sheet 2 of the foundation sheet shows only one dowel on one side of the column into the spread footing. Thus, the column can only resist flexural loads in one direction. However in the weak axis, ground beams frame into the column on either side, thus providing flexural rigidity. The point of fixity was taken to be the top of the ground beams.

For each direction of loading, four columns resist the lateral load. Figure 3 shows an example of loading in the north-south direction. In this case, two columns on the east and two columns on the west resist the lateral load. Columns were checked for flexure, shear, and drift.

In addition to the columns, there is one full height concrete masonry block wall on the east side of the kiosk. Due to the stiffness of this lateral element, we checked the flexural and shear capacity for the full base shear of the building.

The ring beam was checked to ensure that it could drag the lateral load into the lateral load resisting columns. The dowels from the ring beam to the column were checked for shear friction.

The moment from the columns is resisted by the ground beams on either side of the columns. The moment is then resolved into a tension and compression couple which is then taken into the spread footings below. The ground beams were checked for flexure and shear. The shear demand at the intersection of the ground beam with the column was checked against the shear friction capacity of the dowels.

The bearing pressure on the footings was determined by the resolving the lateral load moment on the grade beams into an axial load on the footing and adding in the dead loads from the roof. The moment and shear demand in the unreinforced concrete footing due to the bearing pressure was checked against the unreinforced concrete capacities.

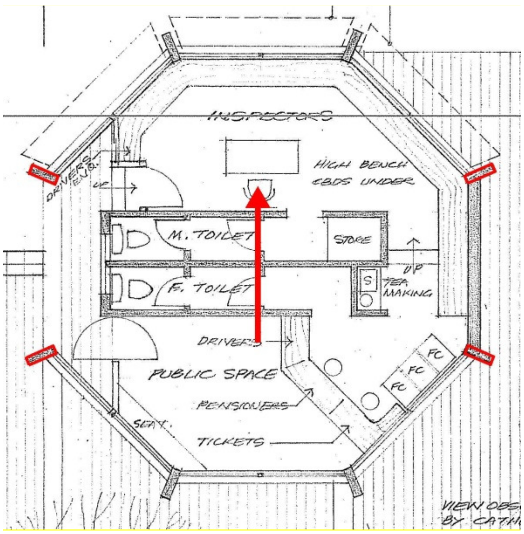


Figure 3: Lateral Load Distribution, North-South Direction

7.3 Limitations and Assumptions in Results

Our analysis and assessment is based on an assessment of the building in its undamaged state. Given the low level of damage to the building, this assumption is not un-conservative.

The results have been reported as a %NBS and the stated value is that obtained from our analysis and assessment. Despite the use of best national and international practice in this analysis and assessment, this value contains uncertainty due to the many assumptions and simplifications which are made during the assessment. These include:

- Simplifications made in the analysis, including boundary conditions such as foundation fixity.

- Assessments of material strengths based on limited drawings, specifications and site inspections
- The normal variation in material properties which change from batch to batch.
- Approximations made in the assessment of the capacity of each element, especially when considering the post-yield behaviour.

7.4 Assessment Results

The checks done on the lateral load carrying capacity indicate that all lateral load resisting elements have capacities greater than 100%NBS. Table 2 below has a summary of the findings.

Table 2: Summary of Seismic Performance

Structural Element/System	Failure Mode	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Limited ductility in the lateral load resisting system	A brittle failure in a lateral load resisting system can cause the structure to abruptly lose lateral load carrying capacity if the lateral load demand exceeds the yield limit. Each element in the lateral load path was checked assuming it needs to remain nominally elastic. All elements in the lateral load path have capacities exceeding the lateral load demand at the ultimate limit state.	No	>100%
Concrete Column	Check of the out-of-plane bending capacity for resistance to lateral loading.	No	>100%NBS
Concrete Column	Check of the shear capacity in weak axis of column for resistance to lateral loading.	No	>100%NBS
Full Height Concrete Blockwork Wall	Check of the shear capacity of blockwork wall for resistance to lateral loading.	No	>100%NBS
Full Height Concrete Blockwork Wall	Check of the bending capacity of blockwork wall for resistance to lateral loading.	No	>100%NBS
Ring Beam	Check of the tensile capacity for resistance to drag loading.	No	>100%NBS
Ring Beam	Check of the tensile capacity for resistance to roof gravity loading.	No	>100%NBS
Connection of Ring Beam to Column	Check of the shear friction capacity of the dowels for the drag load demand into the column.	No	>100%NBS

Structural Element/System	Failure Mode	Critical Structural Weakness and Collapse Hazard	% NBS based on calculated capacity
Concrete Grade Beam	Check of the bending capacity of grade beam for resistance to column overturning moment.	No	>100%NBS
Concrete Grade Beam	Check of the shear capacity of grade beam for resistance to the resultant couple from the column overturning moment.	No	>100%NBS
Concrete Grade Beam	Check of the shear friction capacity of the dowels into the precast concrete column for resistance to the resultant couple from the column overturning moment.	No	>100%NBS
Concrete Spread Footing	Check of the allowable bearing pressure for the axial load from the resultant couple in the grade beam due to the column overturning moment.	No	>100%NBS
Concrete Spread Footing	Check of the bending capacity of the unreinforced concrete footing.	No	>100%NBS
Concrete Spread Footing	Check of the shear capacity of the unreinforced concrete footing.	No	>100%NBS
Partial Height Concrete Blockwork Walls	Check of the flexural resistance for wall out-of-plane lateral loading.	No	>100%NBS

8 Summary of Geotechnical Appraisal

8.1 General

The 1:25 000 Geological Map of the Christchurch Urban Area Part Sheets M35 & M36 (Brown & Weber, 1992) indicates the site is underlain by dominantly Holocene-aged alluvial sand and silt over bank deposits. These deposits comprise firm to stiff clayey silt and loose to dense, fine to medium sand with local, interbedded subsurface gravel.

The groundwater level is typically high at 1 - 2.5m depth.

8.2 Liquefaction Potential

According to Figure 6 of the Technical Report “Foundations on Deep Alluvial Soils” Technical Report Prepared for the Canterbury Earthquakes Royal Commission, the high liquefaction zone from the 22 February 2011earthquake is located 200m to the north of the Cathedral Square Police Kiosk Building.

8.3 Conclusions

ECan well logs indicate the building is likely founded on a 3.7m to 11.5m thick layer of GRAVEL (medium dense) possibly overlain by a shallow layer of fine SAND up to 1.75m thick. The shallow foundations are likely within the gravel layer, which will provide some liquefaction resilience.

No differential settlement or evidence of liquefaction was observed during the site walkover, which reflects the expected ground conditions.

Based on the current external evidence, the existing shallow foundations are considered appropriate for the building in ULS and SLS seismic events.

8.4 Recommendations

No further site investigations are recommended at this stage.

9 Remedial Options

No remedial options are required.

10 Conclusions

a) The seismic performance of the police kiosk exceeds 100%NBS. The building is therefore considered to be of low risk in accordance with the NZSEE 2006 Guidelines for *Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*.

b) Liquefaction hazard at the site is considered to be low, therefore the current shallow foundations are considered appropriate.

11 Recommendations

a) It is recommended that the occupancy of the building be allowed to continue.

12 Limitations

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

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

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

13 References

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

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

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

Appendix 1 – Photographs

Police Kiosk – Cathedral Square		
No.	**Item description**	**Photo**
1.	View of south-west corner of kiosk.	
2.	View of north-east corner of kiosk.	
3.	Glulam rafter beam.	

4.	Connection of glulam rafter to precast column.	
5.	Interface of partial height blockwork walls and precast column.	
6.	Steel compression ring beam.	
7.	Cracking at the intersection of the partition wall with the ceiling.	

Appendix 2 – Geotechnical Appraisal

15 December 2011

Lindsay Fleming
Christchurch City Council
53 Hereford St
PO Box 237
Christchurch 8140

6-QUCCC.43/005SC

Dear Lindsay

Cathedral Square Police Kiosk - Geotechnical Desktop Appraisal

1. Introduction

The Cathedral Square Police Kiosk was subjected to severe ground shaking during the Darfield 2010 and Christchurch 2011 earthquakes and subsequent aftershocks. This report summarises the findings of a geotechnical desk study and site walkover completed by Opus International Consultants (Opus) for the Christchurch City Council (CCC) on 1 November 2011. This desk study assesses the ground conditions and performance of the building and identifies potential geotechnical hazards that may be present.

It is our understanding this is the first inspection by a Geotechnical Engineer following the earthquakes. A structural inspection was carried out by Opus on 12 October 2011.

2. Desktop Study

2.1 Site Description

The Police Kiosk is located on the northern half of Cathedral Square around 30m south west from the intersection of Worcester and Colombo Streets. The ground profile is flat, level with the surrounding streets and Cathedral Square area. All surfaces in the vicinity of the kiosk are paved or asphalted.

2.2 Regional Geology

The 1:25 000 Geological Map of the Christchurch Urban Area Part Sheets M35 & M36 (Brown & Weber, 1992) indicates the site is underlain by dominantly Holocene-aged alluvial sand and silt over bank deposits. These deposits comprise firm to stiff clayey silt and loose to dense, fine to medium sand with local, interbedded subsurface gravel.

The groundwater level is typically 1m - 2.5m below ground level (bgl).

2.3 Ground Conditions

Seven well logs were selected from the Environment Canterbury (ECan) website that are in close proximity to the Police Kiosk.

The following ground conditions are interpreted from the ECan logs near the kiosk building site:

Stratigraphy	Thickness (m)	Initial Depth Encountered From (m) bgl
Fine SAND	1.3 – 1.75	0
GRAVEL / Sandy GRAVEL	3.7 – 11.5	1.25 – 2.4
SILT / Fine SAND	14.9 – 16.8	6.5 - 10.7
Gravel (Riccarton)	-	24 – 25.6

Table 1 Interpreted Ground Conditions

The approximate locations of the boreholes relative to the Police Kiosk are shown on the attached Site Location Plan. The logs of the ECan borehole records are also included in Appendix A.

Groundwater is described in the logs as artesian but no exact water levels were found in these logs or others in the vicinity.

No CPT data was identified near the site.

2.4 Ground Damage

No evidence of liquefaction was observed in aerial photographs in the immediate vicinity of the Police Kiosk taken after the 4 September 2010 and 22 February 2011 earthquakes. According to Figure 6 of the Technical Report "Foundations on Deep Alluvial Soils" *Technical Report Prepared for the Canterbury Earthquakes Royal Commission,* the high liquefaction zone from the 22 February 2011earthquake is located approximately 200m north of the Cathedral Square Police Kiosk Building.

A walkover inspection of the exterior and interior of the building was completed by Emily Hodgkinson, an Opus Geotechnical Engineer on 3 November 2011.

There was no sign of liquefaction or significant differential settlement of the Police Kiosk observed during the walkover survey. The interior floor level in the eastern corner of the south east room in the kiosk appeared to be higher than the rest of the room by approximately 10mm to 20mm. There was no sign of differential settlement observed in the perimeter of the building foundation. The possible ground heave appears to be isolated and it is not conclusive if the heave is associated with liquefaction.

There appears to be no damage to the building has resulted from settlement or liquefaction. Lateral spreading is not considered to be a risk at this site.

2.5 Structural Drawings

Structural drawings of the police kiosk dated September 1973 have been obtained. The building is single level and comprises one octagonal structure in plan. The building is a reinforced concrete frame, with concrete wall frames, a concrete ring beam around the top of walls and a timber glulam beam roof structure.

The drawings indicate the internal walls and floor slab are supported on strip footings around 400mm deep and 100mm to 150mm wide. Shallow reinforced concrete piles around 500mm deep are located around the exterior wall of the building at the octagon vertices.

2.6 Liquefaction Hazard

The 2004 ECan Solid Facts Liquefaction Study indicates the area is designated as high liquefaction potential. According to this study, based on a low groundwater table, ground damage is expected to be low to moderate, indicating ground subsidence likely to be up to 300mm.

3.0 Conclusions

A geotechnical walkover inspection and appraisal of the Cathedral Square Police Kiosk was carried out on 2 November 2011. The expected ground conditions and liquefaction potential of the site have also been assessed.

The building is founded on shallow strip footings supporting the internal floor slab and walls with shallow piles around the exterior of the building at the octagon vertices.

ECan well logs indicate the building is likely to be founded on a fine sand layer, overlying a shallow layer of medium dense Gravels up to 11m thick. The gravel layer is expected to be underlay by Sand and Silt beds.

No differential settlement or evidence of liquefaction was observed during the site walkover.

Based on the performance of the building and expected ground conditions, the existing foundations are considered appropriate for the building in an Ultimate Limit State (ULS) seismic event.

4.0 Recommendations

Based on the performance in recent earthquakes, the existing shallow foundations are considered to be acceptable in terms of ULS and serviceability seismic loading .

No further site investigations are recommended at this stage.

Prepared By:	Reviewed By:
Emily Hodgkinson	Graham Brown
Geotechnical Engineer	Senior Geotechnical Engineer

Attachments:

Photos
Site Location Plan
Appendix A – ECan Borehole records

Photos of the Cathedral Square Police Kiosk Building taken 3 November 2011

Photograph 1. [redacted]

Photograph 2. [redacted]

CATHEDRAL SQUARE POLICE KIOSK & PUBLIC TOILETS - ECAN BOREHOLE GEOLOGY

E HODGKINSON
31/10/11

APPENDIX A: ECAN BOREHOLE LOGS

Borelog for well M35/7788

Gridref: M35:8070-4180 Accuracy : 3 (1=best, 4=worst)
Ground Level Altitude : 5.5 +MSD
Driller : Dynes Road Drilling
Drill Method : Cable Tool
Drill Depth : -10m Drill Date : 4/10/1997

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian	-0.50m	Asphalt basecoarse	fi
		-1.75m	Brown fine sand with minor silt	sp
		-2.50m	Brown fine to medium sand with minor to some fine to medium gravel	sp
		-3.25m	Brown gravelly sand. Fine to medium rounded gravel, fine to medium sand	sp
-5		-5.00m	Grey sandy gravel. Fine to medium rounded gravel, fine to medium sand, less sand with depth	sp
		-5.50m	Grey silt with some gravel. Fine to coarse rounded gravel, trace of wooden material	sp
		-7.25m	Grey silt with trace of wooden material & fine to medium rounded gravel. No gravel with depth	sp
		- 10.0m	Grey fine to medium sand, saturated	sp-ch

Borelog for well M35/11555 page 1 of 2

Gridref: M35:8069-4184 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 7.9 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -30m Drill Date : 26/10/2006

Depth(m)	Full Drillers Description	Formation Code
-0.50m	hard fill	fi
-1.30m	brown sand	sp
-2.40m	small/medium, well rounded, stained gravel	sp
-3.70m	small/medium, well rounded, stained, sandy gravel	sp
-8.00m	small/large, well rounded, blue, sandy gravel	sp
-8.10m	blue clay/silt	sp
-8.60m	small/large, rounded, blue, free gravel	sp
-9.10m	blue clay	sp
-9.80m	large, well rounded, blue, very free gravel	sp
- 10.2m	blue, medium/coarse sand	sp
- 11.1m	blue silt/clay	sp
- 12.8m	blue, silty sand with peat	sp
- 13.1m	blue sand and silt lumps and peat	sp
- 15.0m	blue sand	sp?

Scale(m): -5, -10

Borelog for well M35/11555 page 2 of 2

Gridref: M35:8069-4184 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 7.9 +MSD
Driller : McMillan Water Wells Ltd
Drill Method : Cable Tool
Drill Depth : -30m Drill Date : 26/10/2006

Environment Canterbury Regional Council

Scale(m): -20, -25

Water Level	Depth(m)	Full Drillers Description	Formation Code
	- 17.2m	blue sand	sp?
	- 17.6m	blue sand and peat	sp?
	- 19.0m	blue sand and sea shells	ch
	- 22.2m	blue clay/silt and sea shells	ch
	- 23.5m	blue clay/silt and peat	ch
	- 23.7m	blue clay/silt	ch
	- 23.9m	blue/brown clay/silt	ch
	- 24.1m	wood/peat	sp?
	- 24.5m	blue and brown, well rounded, free gravel (artesian conditions)	ri
	- 26.8m	poorly sorted, well rounded, very sandy, brown gravel (artesian conditions)	ri
	- 28.9m	poorly sorted, well rounded, sandy gravel (artesian conditions)	ri
	- 30.0m	brown sand and poorly sorted, well rounded gravel (artesian conditions)	ri

Borelog for well M35/16101

Gridref: M35:80545-41829 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 7.96 +MSD
Well name : CCC BorelogID 5484
Drill Method : Not Recorded
Drill Depth : -9.1m Drill Date : 1/01/1960

Depth(m)	Full Drillers Description	Formation Code
-2.10m	gravel fill	
-3.40m	brown gravel	
-4.60m	brown sand	
-8.20m	blue sand	
-8.50m	peaty clay	
-9.10m	sandy clay	

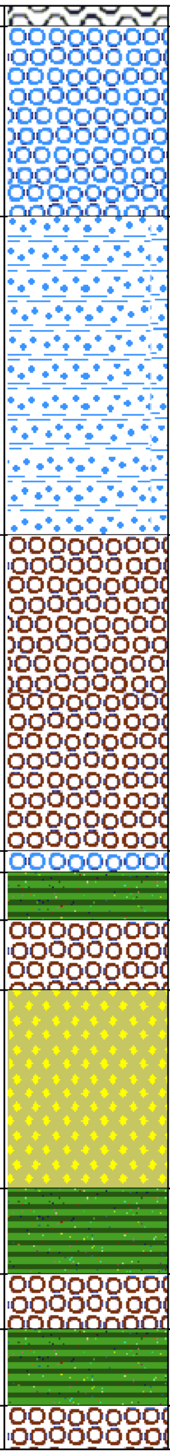
Scale(m): -1, -2, -3, -4, -5, -6, -7, -8, -9

Water Level

Borelog for well M35/1919 page 1 of 2

Gridref: M35:8054-4182 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.8 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -125m Drill Date : 13/09/1901

Water Level: Artesian



Depth(m)	Full Drillers Description	Formation Code
-0.89m	Soil	sp?
-9.10m	Blue shingle	sp?
- 22.9m	Blue sand & clay	ch
- 36.6m	Brown shingle	ri
- 37.5m	Blue shingle	ri
- 39.6m	Blue clay & peat	br
- 42.6m	Brown shingle	br
- 51.2m	Yellow sand	br
- 54.9m	Yellow clay & peat	br
- 57.3m	Brown shingle	li-1
- 60.6m	Blue clay peat & sand	li-2
- 62.5m	Brown shingle	li-2

Scale(m): -10, -20, -30, -40, -50, -60

Borelog for well M35/1919 page 2 of 2

Gridref: M35:8054-4182 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.8 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -125m Drill Date : 13/09/1901

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 64.6m	Brown shingle	li-2
	- 66.4m	Yellow clay & peat	li-2
	- 74.1m	Brown shingle	li-2
	- 75.9m	Yellow clay peat & sand	li-2
	- 81.7m	Brown shingle	li-3
	- 91.4m	Soft Yellow sand	he
	- 95.4m	Blue clay & sand	he
	- 97.5m	Yellow clay & sand	he
	- 103.6m	Brown shingle	bu
	- 106.7m	Yellow clay & sand	sh
	- 118.0m	Blue clay & sand	sh
	- 122.5m	Yellow clay peat & sand	sh
	- 125.0m	Brown shingle	wa

Scale(m): -70, -80, -90, -100, -110, -120

Borelog for well M35/1920

Gridref: M35:8053-4182 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 4.8 +MSD
Driller : Job Osborne (& Co/Ltd)
Drill Method : Hydraulic/Percussion
Drill Depth : -128.6m Drill Date : 9/11/1901

Environment Canterbury Regional Council

Water Level: Artesian

Depth(m)	Full Drillers Description	Formation Code
-5.80m	Grey sand & clay	sp?
- 10.7m	Blue shingle	sp?
- 25.6m	Blue clay & sand	ch
- 36.6m	Brown shingle	ri
- 38.1m	Brown sand	br
- 43.3m	Brown shingle	br
- 56.1m	Soft Yellow sand	br
- 61.6m	Brown shingle	li-1
- 77.4m	Blue clay & peat	li-2
- 82.9m	Brown shingle	li-3
- 95.1m	Soft Yellow sand	he
- 97.2m	Yellow clay & peat	he
- 103.0m	Brown shingle	bu
- 122.2m	Blue clay & sand	sh
- 126.2m	Yellow clay & sand	sh
- 129.6m	Brown shingle	wa

Borelog for well M35/1933 page 1 of 2

Gridref: M35:8070-4176 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 5.9 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -126.4m Drill Date :

Environment Canterbury Regional Council

Water Level: Artesian

Scale(m)	Depth(m)	Full Drillers Description	Formation Code
	-8.19m	Gravel	sp?
-10, -20	- 24.3m	Sandy clay	sp-ch
-30	- 35.9m	Gravel	ri
-40	- 40.2m	Clay (Peat at 37.4m)	br
	- 46.0m	Gravel	br
-50	- 50.5m	Sand	br
	- 53.3m	Sand & clay	br
	- 56.9m	Clay	br
	- 59.4m	Gravel	li-1
-60	- 62.4m	Clay (Peat at 60.9m)	li-1
	- 64.1m	Gravel	li-1

Borelog for well M35/1933 page 2 of 2

Gridref: M35:8070-4176 Accuracy : 4 (1=high, 5=low)
Ground Level Altitude : 5.9 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -126.4m Drill Date :

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	- 64.6m	Gravel	li-1
	- 67.0m	Sandy clay and peat	li-2
	- 68.5m	Clay	li-2
	- 75.2m	Gravel	li-2
	- 77.7m	Clay & peat	li-2
	- 79.2m	Gravel	li-3
	- 82.2m	Sand	he
	- 83.8m	Clay	he
	- 96.0m	Gravel	he
	- 98.4m	Sandy clay	he
	- 105.1m	Gravel	bu
	- 109.7m	Sand	sh
	- 120.3m	Sandy clay	sh
	- 121.9m	Gravel	wa
	- 124.0m	Clay	wa
	- 126.4m	Gravel, water level +10.6m	wa

Borelog for well M35/2220

Gridref: M35:8057-4182 Accuracy : 3 (1=high, 5=low)
Ground Level Altitude : 5 +MSD
Driller : not known
Drill Method : Unknown
Drill Depth : -23.7m Drill Date :

Scale(m)	Water Level	Depth(m)	Full Drillers Description	Formation Code
	Artesian		Sand & gravel	
-5				
-10				
-15				
-20		- 20.4m		sp?
			Silty clay	
		- 22.5m		ch
			Clay	ch
		- 22.8m		
			Sandy silt	
		- 23.4m		ch
			Gravel	
		- 24.1m		ri

Borelog for well M35/2723

Gridref: M35:805-418 Accuracy : 4 (1=best, 4=worst)
Ground Level Altitude : 5.45 +MSD
Driller : Ministry of Works
Drill Method : Cable Tool
Drill Depth : -34m Drill Date : 30/05/1983

Water Level	Depth(m)	Full Drillers Description	Formation Code
Artesian	-6.50m	Gravel up to 75mm becoming sandy from 4.5m wl 3.0m	sp?
	-7.50m	Grey silt	sp?
	- 18.5m	Fine Grey sand	ch
	- 23.3m	Grey silt	ch
	- 25.5m	Gravel, up to 150mm	ri
	- 26.5m	Grey sandy gravel	ri
	- 28.0m	Pea gravel, becoming rust stained	ri
	- 34.0m	Sandy gravel, up to 75mm	ri

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

Appendix 3 – CERA DEE Spreadsheet

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Cathedral Square Police Kiosk	Reviewer:	Alistair Boyce
	Unit / No: / Street	CPEng No:	209860
Building Address:	Cathedral Square	Company:	Opus International Consultants
Legal Description:		Company project number:	6QUCCC.43
		Company phone number:	03 363 5400
	Degrees / Min / Sec		
GPS south:		Date of submission:	16-Oct-12
GPS east:		Inspection Date:	7-Dec-11
		Revision:	Final
Building Unique Identifier (CCC):	BU 1217-001 EQ2	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	
Soil type:		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):	10.00

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):	
Storeys below ground			
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	5.70	height from ground to level of uppermost seismic mass (for IEP only) (m):	6
Floor footprint area (approx):			
Age of Building (years):	39	Date of design:	1965-1976
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	commercial	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):			
Importance level (to NZS1170.5):	IL2		

Gravity Structure

Gravity System:	frame system		
Roof:	timber framed	rafter type, purlin type and cladding	Timber
Floors:			
Beams:	timber	type	Glulam
Columns:	precast concrete	typical dimensions (mm x mm)	600x200
Walls:	partially filled concrete masonry	thickness (mm)	190

Lateral load resisting structure

Lateral system along:	other (note)	**Note: Define along and across in detailed report!**	describe system	Cantilevered columns
Ductility assumed, μ:	1.25			
Period along:	0.50	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	other (note)		describe system	Cantilevered columns
Ductility assumed, μ:	1.25			
Period across:	0.50	0.00	estimate or calculation?	
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations:

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

Non-structural elements

Stairs:			
Wall cladding:	exposed structure	describe	
Roof Cladding:	Other (specify)	describe	Butynol over plywood
Glazing:	aluminium frames		
Ceilings:			
Services(list):			

Available documentation

Architectural	full	original designer name/date	
Structural	full	original designer name/date	CTB Inspectors Office, September 1973
Mechanical	none	original designer name/date	
Electrical	none	original designer name/date	
Geotech report		original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:		Describe damage:	
Settlement:	0-25mm	notes (if applicable):	20mm settlement at south-east corner
Differential settlement:	0-1:350	notes (if applicable):	
Liquefaction:		notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:		notes (if applicable):	
Damage to area:		notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:		Describe how damage ratio arrived at:	
	Describe (summary):			
Across	Damage ratio:	#DIV/0!		
	Describe (summary):			

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

Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	yes	Describe:	Cracking of internal gib board walls

Recommendations

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

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):	0.5	0.5
(%NBS)nom from Fig 3.3:		

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
Note 2: for RC buildings designed between 1976-1984, use 1.2
Note 3: for buildngs designed prior to 1935 use 0.8, except in Wellington (1.0)

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

2.2 Near Fault Scaling Factor

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

	along	across
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**: 1.00

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:		
Ductility 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 — **%NBSb:** **#DIV/0!** **#DIV/0!**

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
3.5. Site Characteristics	insignificant	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

3.6. Other factors, Factor F

	Along	Across
For ≤ 3 storeys, max value =2.5, otherwise max value =1.5, no minimum		
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)	**0.00**	**0.00**
4.3 PAR x (%NBS)b: PAR x Baseline %NBS:	**#DIV/0!**	**#DIV/0!**
4.4 Percentage New Building Standard (%NBS), (before)		**#DIV/0!**

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