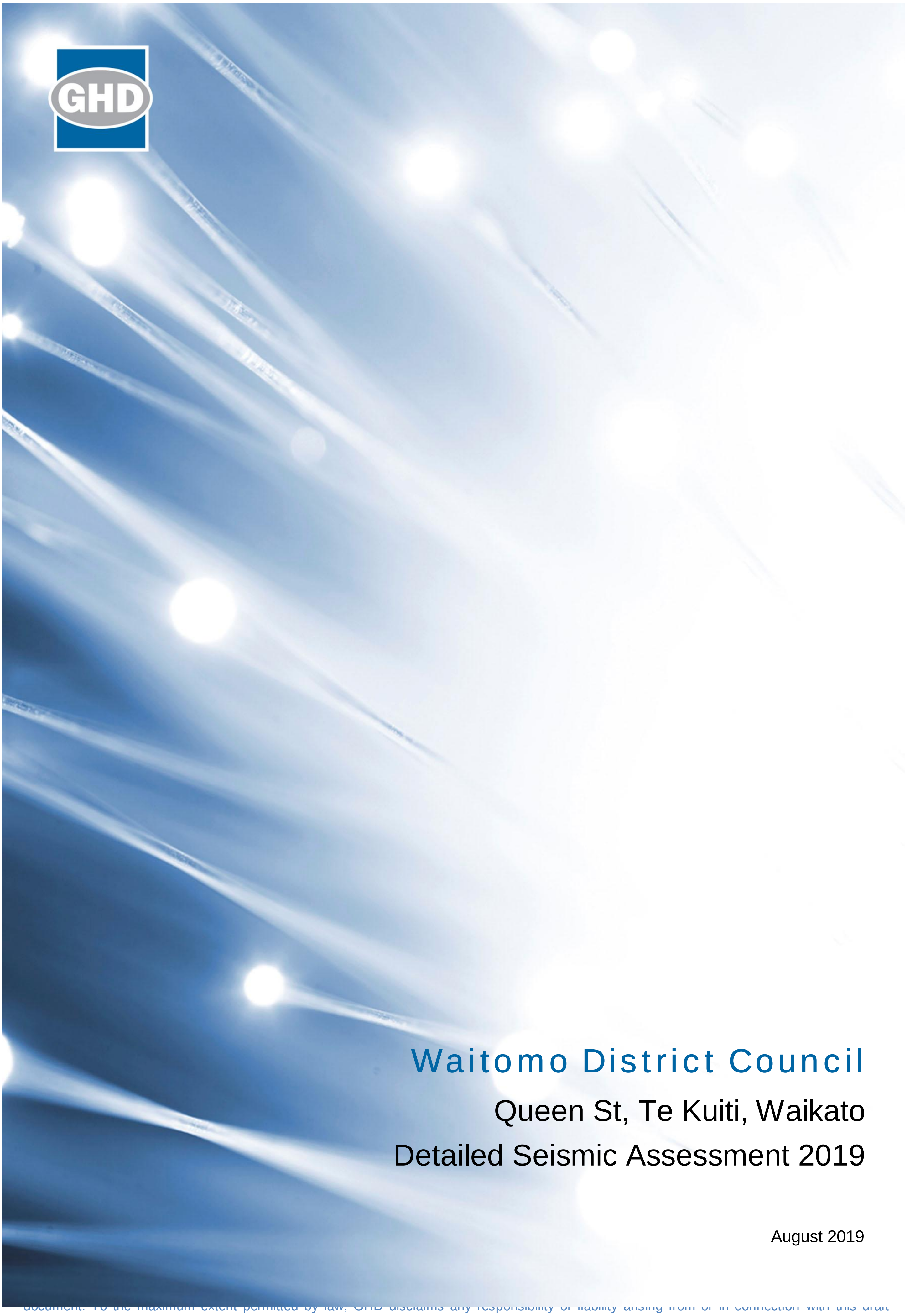

Waitomo District Council

Queen St, Te Kuiti, Waikato

Detailed Seismic Assessment 2019

August 2019

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Appendices

1. Background

An initial seismic assessment (ISA) of the structure at Queen St, Te Kuiti was conducted on 1 May 2019, by GHD. From structural drawings provided, it is understood that this two storey structure was designed in 1985. Some minor wall layout alterations have been undertaken however the structural drawings did not indicate a date of alteration.

The scope of this Detailed Seismic Assessment is limited to the double-storey portion of the Waitomo District Council Administration building, with the ISA indicating the single storey building section to be performing at 100%NBS. See Figure 2 and Figure 3 below in Section 5 for a plan view of the scope area.

2. Building Description

Sources of information on the building include available structural drawings of the original structure and recent alterations done on the structure regarding demolition of ground floor walls and addition of first floor partitions. A site inspection provided photos of the structure as it stands presently.

The building is a two-storey structure. The two level portion of the building consists of approximately 40% of the total floor area at the front and the remaining area is single storey at the rear. The approximate footprint of the two-level portion and single-level portion is 29 m x 21 m and 62 m x 27 m respectively.

Figure 1: Waitomo District Council Building (Google Maps Image)

The gravity load resisting system of the structure is comprised of steel beams to support the lightweight timber roof and floor systems, and steel columns founded on shallow pad foundations. The partition walls consist of timber frames and plywood bracing panels which act as the lateral load resisting system. The recessed double-storey portion (ground floor) has a 20 series reinforced blockwall around the perimeter that retains the soil beneath the upper single-level at the rear of the building.

The building has two sets of stairs both of which are assumed to be timber construction – there are no as-built drawings to confirm this assumption. The main staircase is located at the ground floor entrance and the other is located at the rear.

The ceiling systems are all lightweight suspended ceilings. Services are located within ceiling space and are mainly comprising of air conditioning ducting, wiring and possibly plumbing. Seismic restraint of non-structural systems have not been addressed as part of this assessment.

3. Lateral Load Resisting System

According to the as-built drawings, the bracing panels are distributed across both longitudinal and transverse directions. The panels are 9.0 mm thick plywood bracing (Grade D). The plywood bracing panels are fixed to interior faces of the exterior walls. It is assumed that the upper and lower floor systems act as a rigid diaphragm that transfers lateral loads to bracing panels then down to foundations by cantilever action.

In addition to the plywood panels, the blockwall running along the perimeter of the ground floor provides lateral load resisting capacity to the lower floor within the double-storey portion of the building.

4. Assessment Process

The assessment for this structure has involved the following:

- Review of the existing plans and the as-built drawings provided by Waitomo District Council;
- A site inspection to determine the plans are representative of current building conditions and layout; and
- Undertaking detailed analysis to determine the seismic strength of the building in accordance with the current New Zealand design and material standards to estimate the extent of the building's compliance with current building code requirements.

5. Building and Site Description

Table 1 Building and Site Description

Building	Description
Number of Storeys	2
Gross Floor Area (m^2)	Ground Floor: 415 m^2 First Floor: 1290 m^2
Year of Design (approximate)	1985
Current use	Office Space
Importance Level (IL)	IL 4
Structural Alterations	During the site inspection, GHD found the following changes / alterations from the original as-built drawings: 1. Removal of bracing walls at gridline 2 – (A~D) at the reception area of the ground floor. In addition, the supporting steel column has been removed. It appears from bulkhead framing that the beam has been retrofitted for a deeper longer spanning member during the column removal, however this could not be confirmed on site;

	2. At the upper floor, timber framed walls with a 2nd layer of GIB panel have been added in the office room located in the front area gridline 2~3 / A~B; 3. A segment of bracing panel at gridline E/1 has been shortened.
Basement	None
Gravity Load Resisting System	Gravity loads from the roof are supported on timber purlins and trusses which then span to steel roof beams and timber framed walls. The timber floor is also supported on a masonry wall and steel beams which are supported on steel columns. The columns transfer loads to shallow pad foundations.
Lateral Load Resisting System	Longitude and Transverse Directions: Upper floor: Lateral loads are resisted by 9 mm thick Plywood Bracing Panels (Grade D) fixed at 150 mm centres with 3.15 mm diameter nails along sheet edges, 300mm centres elsewhere. The walls transfer in-plane lateral loads via ceiling diaphragm into the floor system then into foundations. Lower floor: Lateral loads are resisted by 9 mm thick Plywood Bracing Panels (Grade D) fixed at 150 mm centres with 3.15 mm diameter nails along sheet edges, 300mm centres elsewhere. The walls transfer in-plane lateral loads into the floor diaphragm system then into foundations. Additionally, a 20 series masonry wall is positioned around the rear perimeter of the lower floor to retain the soil beneath the single-level portion of the upper floor. This masonry wall contributes lateral load resisting capability in both directions.
Wall/Cladding/Roof System	Colorsteel corrugated roofing on lightweight timber purlins.
Floor System	Steel bearers (beams), timber joists and plywood timber flooring.
Foundation System	Steel columns are supported by the shallow pad foundation. The blockwall retaining wall is supported on a strip foundation.
Geotechnical Considerations	Based on a Soil Investigation Report prepared by Mark T Mitchell Ltd on 5 October 2017, the building is found to be sitting on shallow soil of Subsoil Class C in accordance with NZS1170.5:2004

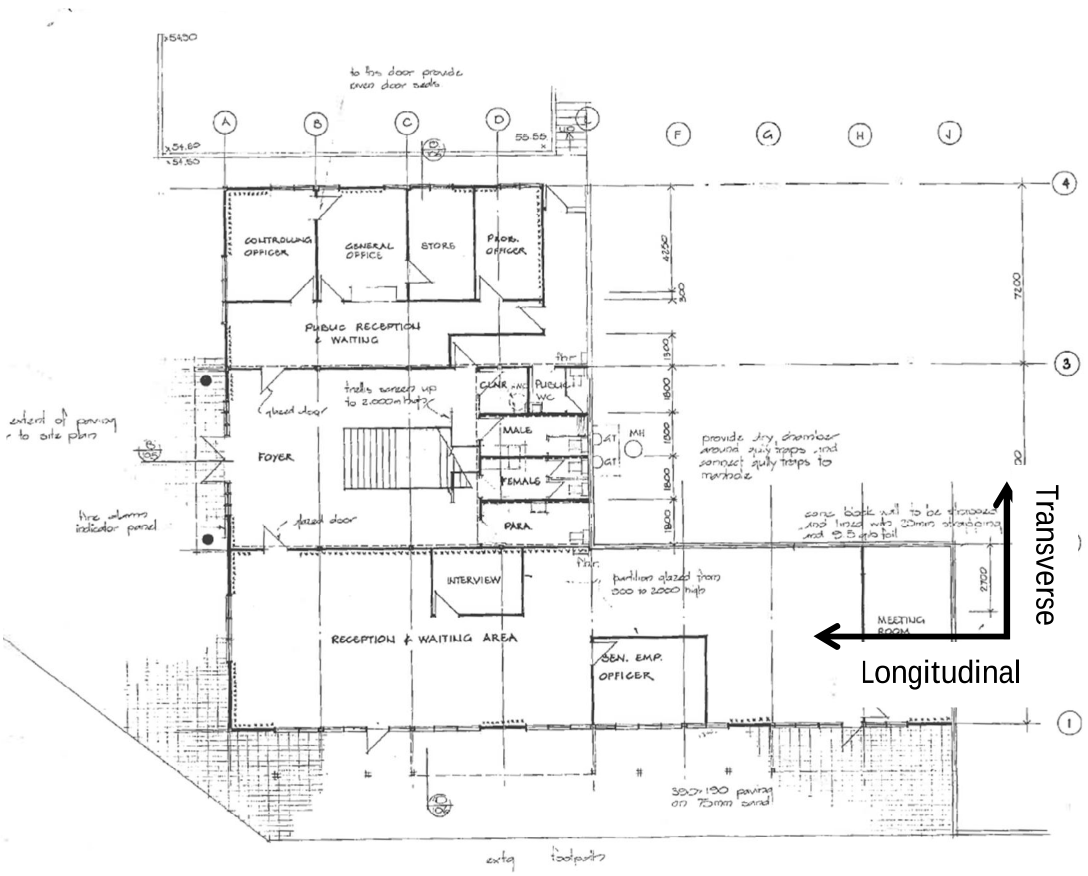


Figure 2: Original 1985 Lower Floor Layout

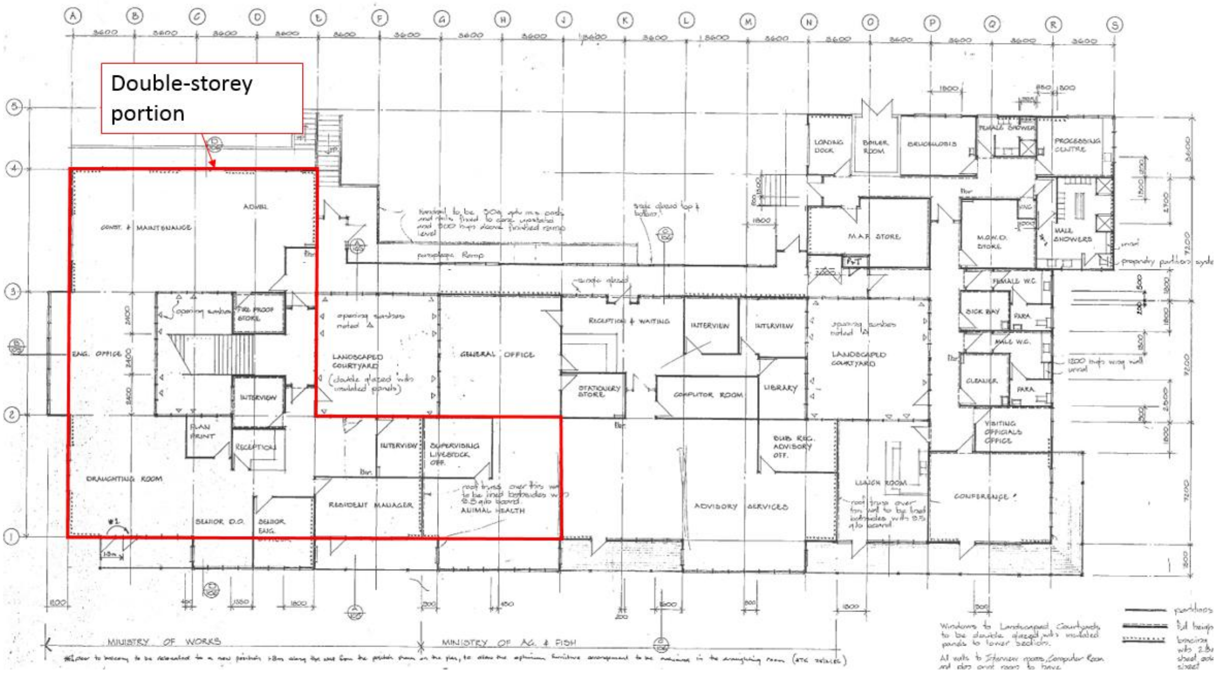


Figure 3: Original 1985 Upper Floor Layout

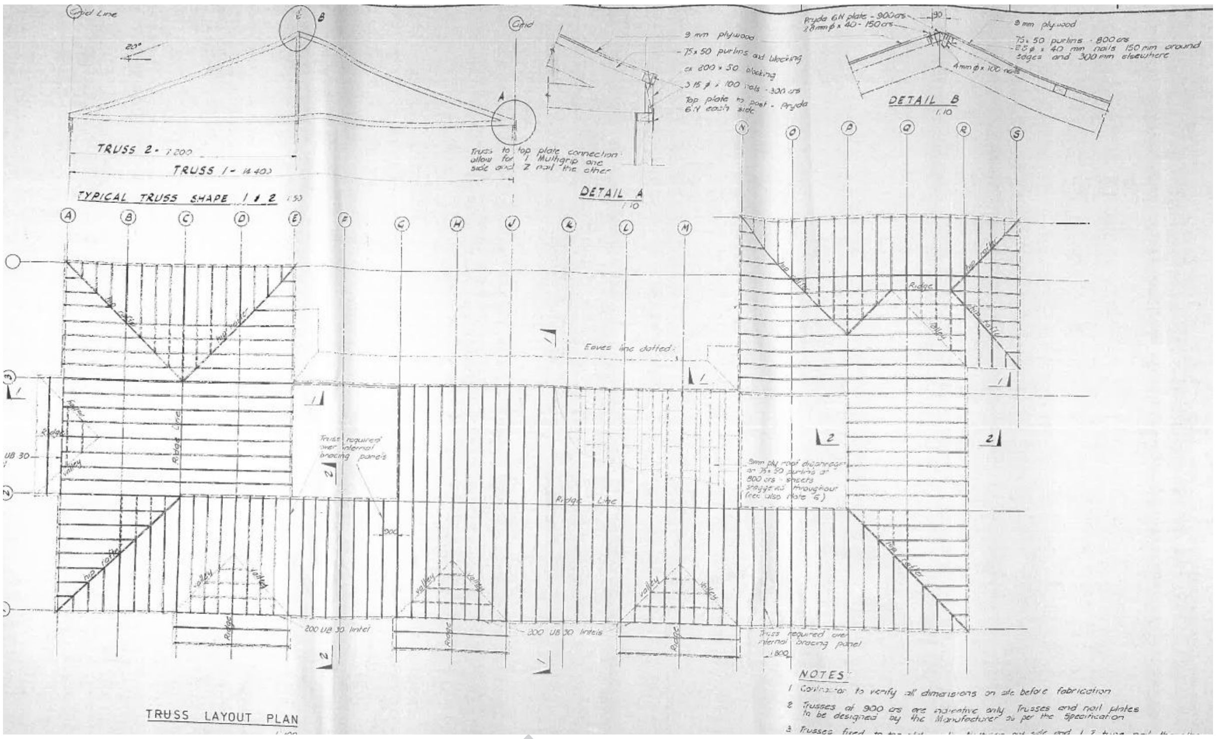


Figure 4: Original 1985 Roof Plan

6. Seismic Assessment of the Building

6.1 Analysis Methodology

The building plans indicate the building was designed in 1985. Seismic loading would have been considered in the design of the structure. The seismic loading code at the time was NZS 4203:1984.

The building's seismic capacity has been assessed in accordance with NZS 3604: 2011 and NZSEE guidelines on the Assessment and Improvement of the Structural Performance of Buildings in Earthquakes. The seismic capacity is measured as a percentage of New Building Standard (%NBS), the standard to which a new building must perform in terms of current design codes and standards. The seismic demands on the structure were calculated using NZS 3604:2011.

An equivalent static method of assessment was carried out for both the longitudinal and transverse directions. The structure is considered regular in shape and loading.

6.2 Intrusive Investigations

None required. The seismic resisting system is accessible without the need for intrusive investigations.

6.3 Assessment Criteria and Building Properties Assumptions

6.3.1 Seismic Assessment Parameters

Seismic loads were applied based on criteria specified by the New Zealand Standards (NZS1170.5:2004) and The Seismic Assessment of Existing Building (Technical Guidelines for Engineering Assessments). The seismic design parameters are as tabulated below:

Seismic Parameter	Value
Site Subsoil Classification	C
Hazard factor, Z (Table 3.3, NZS 1170.5:2004)	0.18
Annual Probability of Exceedance (Table 3.3, NZS 1170.0:2002)	1/2500 (ULS) 1/25 (SLS)
Return Period Factor, Ru (Table 3.5, NZS 1170.5:2004)	1.8
Return Period Factor, Rs (Table 3.5, NZS 1170.5:2004)	0.25
Ductility Factor	3
Strength reduction factor for Steel Flexure strength reduction factor for Concrete Strength reduction factor for Timber	1 1 1

6.3.2 Material Properties

Material properties were assigned based on the available drawings, design calculations and criteria defined by the NZSEE publication "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' for the reinforced concrete and steel properties and has been adopted for this seismic assessment.

Masonry Walls	f'm = 17.5 MPa
Concrete	f'c = 1.5 x 20 = 30 MPa
Reinforcing Steel	fy = 275 x 1.08 = 300 MPa
Timber	Grade D = Type F11

These parameters were used in determining the sufficiency of the blockwall retaining wall along the perimeter of the ground floor and the bracing capacity of the existing plywood bracing panels.

6.3.3 Soil Conditions

The ultimate bearing capacity is assumed to be 300kPa. The strength reduction factor is 0.5 and 0.8 for gravity load case and seismic load case respectively.

6.3.4 Seismic Capacity Assessment

The following table summarises the calculated %NBS capacity for the various seismic resisting elements in the building based on the detailed seismic analysis.

Floor	Direction	Shear (%NBS)	NZSEE Risk Classification
Upper Floor	Longitude	**41%**	Medium Risk
	Transverse	**40%**	Medium Risk
Lower Floor	Longitude	100%	Low Risk
	Transverse	100%	Low Risk
Floor Diaphragm	Both	100%	Low Risk
Ceiling Diaphragm	Both	100%	Low Risk
Blockwall Element	**Shear Strength (%NBS)**	**Flexural Strength (%NBS)**	**NZSEE Risk Classification**
Wall	100%	**59%**	Medium Risk
Bond Beam	**52%**	92%	Medium Risk
Column	100%	100%	Low Risk
Blockwall Element	**Bearing (%NBS)**		**NZSEE Risk Classification**
Wall Foundation	100%		Low Risk
Column Foundation	100%		Low Risk
	Overall %NBS = 40% (IL4)		**Medium Risk**

Note: The stability and sliding of the wall / column foundations was not checked. The respective foundations are tied into the ground slab. By inspection, the ground slab is considered to provide adequate sliding resistance and resistance to overturning.

The assessment confirms that the structure achieved an overall calculated seismic capacity of

40% NBS (IL4).

The main structural weakness of this building is considered to be the type and number of bracing panels in the upper and lower floor of the double-storey portion of the building. The panels are 9 mm Plywood (Grade D) fixed at 300 mm centres with 3.15 mm diameter nails. The bracing capacity of these panels does not satisfy the seismic demand imposed upon the building at both the upper and lower floor, in both the longitudinal and transverse directions.

The upper floor obtains %NBS scores of 41% and 40% in the longitudinal and transverse directions respectively. The lower floor %NBS scores are improved from 22% and 12% to 100% in the longitudinal and transverse directions respectively. The increase to 100% NBS is due to the blockwall retaining wall which runs along the perimeter of the lower floor. This blockwall contributes significant bracing capacity in both directions. In the absence of this blockwall, the bracing panels alone would not satisfy the seismic demands on the building to a degree of obtaining a 'very high risk' score.

Another structural weakness of the building is the blockwall retaining wall that runs along the rear perimeter of the ground floor. The wall obtained a score of 59% NBS for flexure and the bond beam scored 52% for shear. In the event of a seismic event, it is likely the wall will fail in flexure and the bond beam in shear.

In summary, the type and number of bracing panels in the upper floor are considered to be the main structural weakness. It is unlikely that this weakness will create a life safety risk in the event of an earthquake. Rather, it will most likely leave the upper floor damaged and unusable during and following a seismic event.

A score of 40% NBS corresponds to a "Grade C" building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) building grading scheme, as per the following table:

Table 1: Relative Earthquake Risk

Building Grade	Percentage of New Building Strength (%NBS)	Approx. Risk Relative to a New Building	Life-safety Risk Description
A+	>100	<1	low risk
A	80 to 100	1 to 2 times	low risk
B	67 to 79	2 to 5 times	low or medium risk
C	34 to 66	5 to 10 times	medium risk
D	20 to 33	10 to 25 times	high risk
E	<20	more than 25 times	very high risk

7. Seismic Strengthening

7.1 Suggested Improvement

The building has a calculated seismic capacity of 40%NBS which is more than the legislative minimum requirement of 33% NBS seismic capacity. However, it is recommended by the New Zealand Society of Earthquake Engineers to improve that to as close as possible to the New Building Standard which is at least above the 67% NBS threshold.

7.2 Strengthening Scheme

It is recommended to improve the building seismic capacity to 67% NBS or above, as per NZSEE recommendations.

GHD recommends strengthening by two methods:

(1) Replace all existing plywood bracing panels with GIB BL1-H bracing panels to provide sufficient lateral load resistance for an IL 4 building.

(2) Install a 100 UC steel beam at mid-height of the blockwall retaining wall to improve the flexural and shear strength of the wall elements.

7.2.1 Bracing Panel Strengthening

To strengthen the structure in both the along and across directions, GHD recommends replacing all existing Plywood bracing panels with GIB Bracing Panels (type BL1-H). The proposed installation locations for the ground floor and upper floor are shown in Figure 5 and Figure 6 respectively.

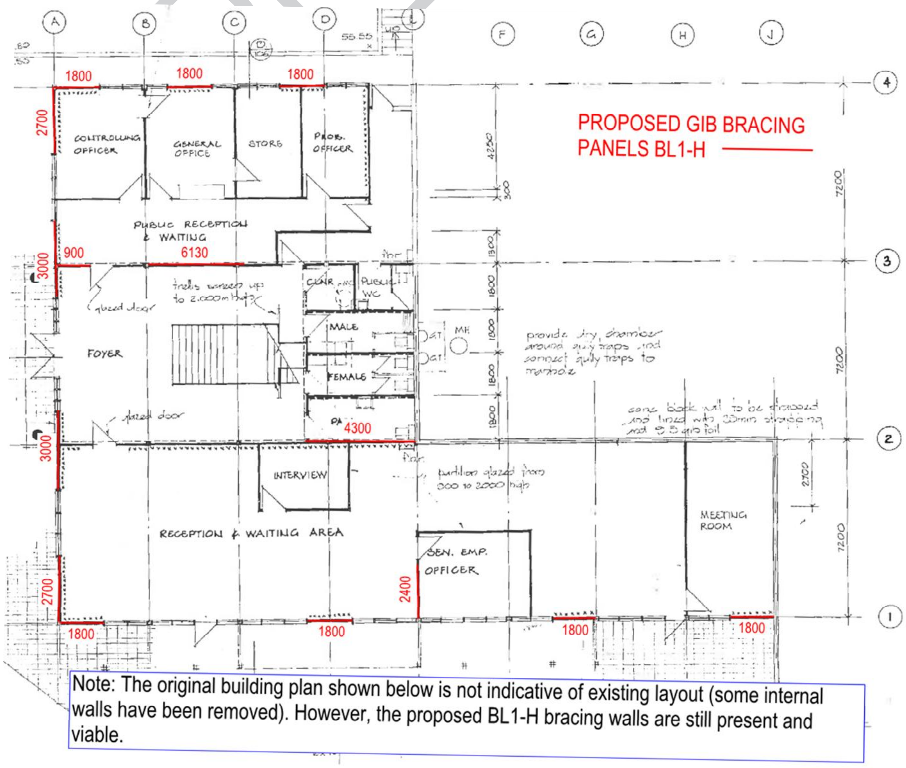


Figure 5: Ground Floor GIB Strengthening Plan

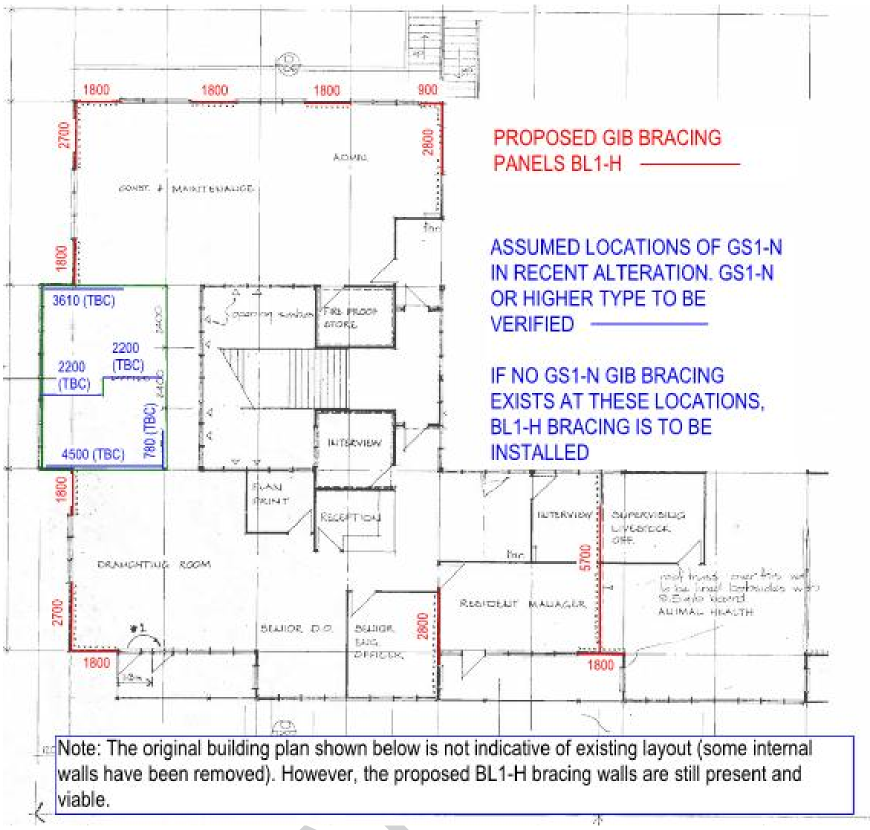


Figure 6: Upper Floor GIB Strengthening Plan

In addition to replacing all existing panels with BL1-H as shown above, it is recommended that the upper floor office walls constructed in the most recent alterations are verified to have GS1-N bracing panels (or higher capacity type). See Figure 7 for locational context.

If there are no bracing panels along these walls, it is recommended that BL1-H GIB panels are installed as shown in blue above in Figure 6.

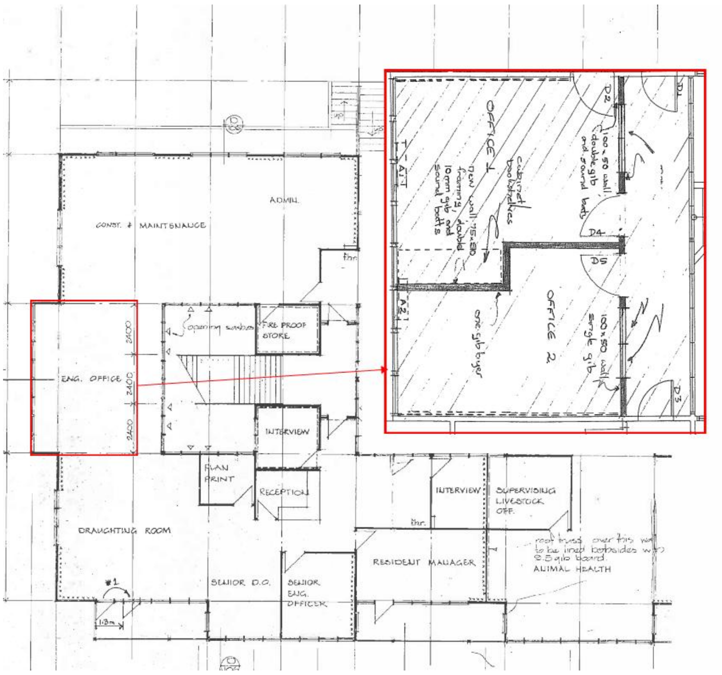
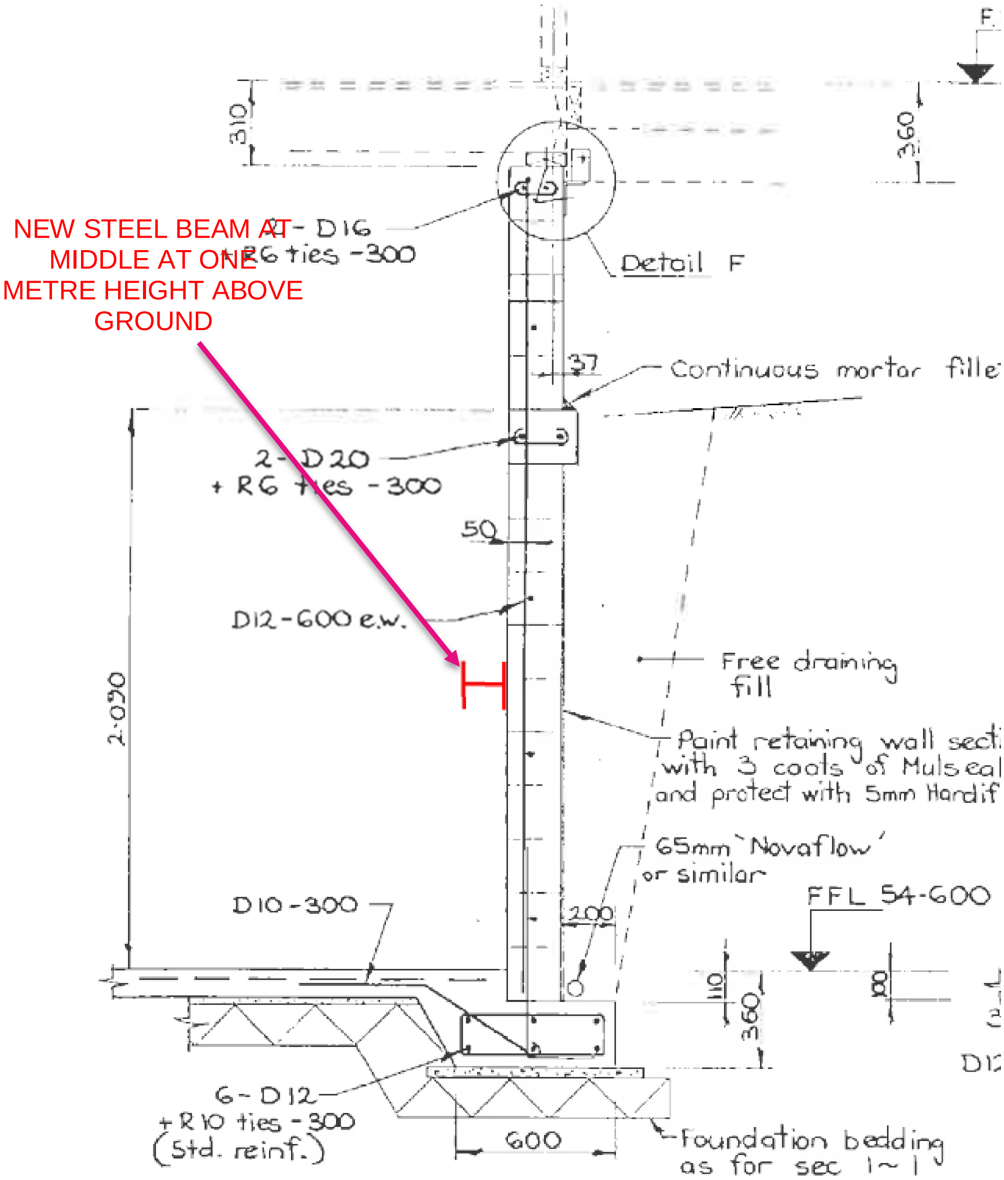


Figure 7: Undated office wall alterations

Note: The image outlined in red above was provided to GHD by WDA. It an undated alteration plan and did not appear to belong to a larger drawing set. The additional walls shown in this alteration plan were visibly verified to exist on site. The dimensions will need to be verified on site to confirm those dimensions shown in blue scaled by GHD in Figure 6*.*

7.2.2 Blockwall Strengthening

To strengthen the blockwall retaining wall elements, installation of a 150 UC steel member along the wall at mid-height between the bond beam and the wall foundation can be done. See Figure 8 below. The effect of providing an additional steel support along the wall will bring the %NBS score to above 67% for both wall element shear and flexural capacity.



7.3 Rough Order of Cost Estimate

A rough order of cost estimate for the suggested strengthening options above is given below.

The rough order of cost estimates DO include the costs associated with any consequential works associated with the strengthening works (such as making good existing finishes and the like). The costs DO NOT include the following:

- Building Consent Fees
- Consultancy fees
- Other costs associated with an upgrade to the building that may be considered if a seismic strengthening project was to proceed
- Cost escalations

A more accurate cost estimate can be developed after completing a detailed design for the suggested structural improvements and with the engagement of a qualified builder and/or quantity surveyor.

Criteria	Response
Rough Order Cost (ROC) Strengthening (±40%)	$70,000
%NBS following strengthening	70%
Timeframe to complete strengthening works	1 month
Can the building be occupied during strengthening works	Yes, partially occupied during strengthening works.

A more detailed design will need to be undertaken to further develop the suggested seismic improvements. The rough order of cost estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare this preliminary estimate. GHD does not represent, warrant or guarantee that the works/project can or will be undertaken at a cost which is the same or less than the rough order of cost estimate.

8. Conclusions and Recommendation

8.1 Conclusions

The building achieves an overall seismic capacity of **40%NBS** (IL4) when considered as an Importance Level 4 building. A score of 40% NBS corresponds to a “Grade C” building as defined by the New Zealand Society for Earthquake Engineering (NZSEE) and is given a life-safety risk of description of “medium risk”. It is recommended by the New Zealand Society of Earthquake Engineers to improve the seismic performance of a building to as close as possible to the New Building Standard which is at least above the 67% NBS threshold

8.2 Recommendations

Seismic improvements have been suggested to achieve a minimum seismic capacity of 67%NBS. These include replacing plywood bracing panels with GIB BL1-H bracing panels as well as installation of a steel beam along the blockwall retaining wall. A rough order of cost estimate for these improvements has been established.

A detailed design will need to be undertaken to further develop the suggested seismic improvements and provide more cost certainty. Upon completion of design documentation a building consent application will need to be lodged and approved prior to the installation of the suggested seismic improvements.

9. Limitations of this Report

1. *This report has been prepared by GHD for Waitomo District Council (WDC) and may only be used and relied on for the purpose agreed between GHD and WDC as set out in our proposal.*
2. *GHD otherwise disclaims responsibility to any person other than WDC arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.*
3. *The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.*
4. *The opinions, conclusions and any recommendations in this report are based on the actual conditions encountered and information reviewed at the date of preparation of the report. GHD accepts no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.*
5. *The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in Section 6 of this report. GHD disclaims liability arising from any of the assumptions being incorrect.*
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9. *Where rough order of cost estimates are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.*
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11. *Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.*
12. *Site conditions may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.*

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Appendices

Appendix A – Calculation Report

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Document Status

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