



# Detailed Seismic Assessment

**Waitomo District Council –Administrative Building**

Waitomo District Council

03 March 2023

→ **The Power of Commitment**

<b>Project name</b>		WDC Offices Queen Street - Revised Scheme					
<b>Document title</b>		Detailed Seismic Assessment   Waitomo District Council –Administrative Building					
<b>Project number</b>		12545999					
<b>File name</b>		12545999-RPT-DSA Report for WDC Administrative Building					
Status Code	Revision	Author	Reviewer		Approved for issue		
			Name	Signature	Name	Signature	Date
S4	0	Sandeep Barwal	Ericson Encina		Alex Vindel		03/03/23

**GHD Limited**

52 The Square, Level 2

Palmerston North, Manawatu 4410, New Zealand

T +64 6 353 1800 | F +64 6 353 1801 | E palmmail@ghd.com | [ghd.com](http://ghd.com)

© GHD 2023

This document is and shall remain the property of GHD. The document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. Unauthorised use of this document in any form whatsoever is prohibited.

# Executive summary

The client - Waitomo District Council (WDC) - engaged GHD to undertake a Detailed Seismic Assessment of the existing administrative building located at 15 Queen Street, Te Kuiti, Waitomo, to better understand the likely seismic performance of the building against seismic events.

The Detailed Seismic Assessment (DSA) is a detailed assessment that focuses on to assess the structural load paths of the building, the capacities of the structural elements, the likely inelastic mechanisms, the global building response to earthquake shaking and the earthquake rating for the building. The detailed procedures for the assessment are intended to provide a more reliable and consistent outcome than is available from the Initial Seismic Assessment (ISA). The focus of the DSA is to achieve an understanding of the likely behaviour of the building in earthquakes by quantifying the strength and deformation capacities of the various structural elements, by checking the building's structural integrity against the loads/deformations (demands) that would be used for the design of a similar building on the same site.

The results of the Detailed Seismic Assessment of the existing building indicated a building score of **15%NBS(IL4) Grade E**. Grade E buildings represent a risk to occupant's equivalent to more than 25 times that expected for an equivalent new building, indicating a high-risk exposure to life-safety issues. The building score is below the 67%NBS threshold for Earthquake Risk buildings and also below 34%NBS threshold for Earthquake Prone Buildings.

The Critical Structural Weaknesses (CSWs) controlling the building's score are the timber braced walls in the Ground floor, closely followed by the timber braced walls in the First floor and the First floor timber diaphragm. Also, in line with Part C2G of the MBIE Assessment Guidelines, the timber walls and diaphragm are identified as Severe Structural Weaknesses (SSW) because their failure could lead to the collapse of the building.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.2 and the assumptions and qualifications contained throughout this report.

# Contents

<b>1. Introduction</b>	<b>1</b>
1.1 Background	1
1.2 Scope and deliverables	2
1.3 Assumptions and limitations	2
<b>2. Building investigation</b>	<b>3</b>
2.1 Available documents	3
2.2 Site inspection	3
2.3 Building description	4
<b>3. Assessment methodology</b>	<b>9</b>
3.1 Standards and guidelines	9
3.2 Seismic assessment philosophy	9
3.3 Seismic restraint of SSNS items	10
3.4 Seismic assessment requirements	10
3.3.1 Limit state design and loading	10
3.3.2 Assessment parameters	11
3.3.3 Building design life	11
3.3.4 Building importance level and annual probability of exceedance	11
3.5 Structural analysis	12
3.5.1 Analysis description and materials	12
3.5.2 Assessment of roof and floor system	13
3.5.3 Assessment of block walls	13
3.5.4 Assessment of timber walls	14
3.5.5 Assessment of the foundation system	14
<b>4. Assessment results</b>	<b>14</b>
<b>5. DSA summary and recommendations</b>	<b>15</b>

## Table index

Table 2.1: Available documents	3
Table 2.2: Building description and structural features	4
Table 3.1: Relative Earthquake Risk (from Table A3.1 of the MBIE Guidelines)	10
Table 3.2: Design dead and live loads	11
Table 3.3: General seismic factors	12
Table 3.4: Material properties used in the assessment	12
Table 4.1: Summary of assessment results for key structural elements	14



## Figure index

Figure 1.1: Aerial view of the building (Source: <a href="http://maps.waitomo.govt.nz">http://maps.waitomo.govt.nz</a> )	1
Figure 2.1: Building Geometry	5
Figure 2.2: Cross section of the Retaining Block Wall	6
Figure 2.3: Roof structural details	6
Figure 2.4: Floor structural details	7
Figure 2.5: Structural system	8
Figure 3.1: Qualitative Risk Classification	10
Figure 3.2 Etabs block wall model	13

## Appendix index

<b>Appendix – A</b>	<b>Building Plans</b>
<b>Appendix – B</b>	<b>Concept Strengthening Plans</b>
<b>Appendix – C</b>	<b>Geotechnical Report</b>

# 1. Introduction

## 1.1 Background

GHD has been engaged by the Waitomo District Council (WDC) to carry out a Detailed Seismic Assessment (DSA) of the existing administrative building located at 15 Queen Street, Te Kuiti, Waitomo as an Importance Level 4 structure.

The purpose of this assessment is to provide the client the expected structural performance of the existing building relative to the current Building Code requirements in terms of the percentage New Building Standard (%NBS).

The structure to be assessed is shown in orange in Figure 1.1.



**Figure 1.1: Aerial view of the building (Source: <http://maps.waitomo.govt.nz>)**

## 1.2 Scope and deliverables

The agreed scope of works of the DSA comprises the following:

1. Obtain property file folder held at the Waitomo District Council and perform a desktop review.
2. Perform an external and internal visual inspection of the structure.
3. Perform detailed assessment of the building.
4. Prepare the DSA report advising the outcome of the assessment.

The deliverables include:

1. A DSA report for client's review and comment
2. High-level Concept strengthening plans.

The report also includes the existing building plans (Refer Appendix A) and the geotechnical report (Refer Appendix C).

## 1.3 Assumptions and limitations

### Assumptions:

1. In this report it was assumed that the building was built following the documentation presented in section 2.1 with the alterations – if any – observed during the site inspection as noted in section 2.2.
2. A small part of the structural drawings are missing, and so some assumptions related to connections were made.
3. The thickness of the particle board at first floor level is assumed to be 15 mm as the information was not in the available plan set.

### Limitations:

1. *This report has been prepared by GHD for Waitomo District Council and may only be used and relied on by Waitomo District Council for the purpose agreed between GHD and Waitomo District Council as set out in section 1.2 of this report.*
2. *GHD otherwise disclaims responsibility to any person other than Waitomo District Council 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 conditions encountered and information reviewed at the date of preparation of the report. GHD has 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 this report. GHD disclaims liability arising from any of the assumptions being incorrect.*
6. *GHD has prepared this report on the basis of information provided by others which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.*

## 2. Building investigation

### 2.1 Available documents

A desktop review of the information provided by the Client and the property file folder was completed for the building. The useful documents and a short description are provided in Table 2.1.

*Table 2.1: Available documents*

Year	Author	Description
1985	Ministry of works and Development	Part set of the original structural drawings numbered 201, 202, 205 to 209, 210, 211
1985	Ministry of works and Development	Original Architectural drawings numbered 101 to 105
2017	Mark T Mitchell Ltd	Soil investigation, Geotechnical assessment for site subsoil class and Liquefaction potential

### 2.2 Site inspection

A visual internal and external site inspection was carried out on 1 May 2019. During the site inspection all areas were generally accessible and recorded by GHD where appropriate.

During the site inspection, GHD found the following alterations with respect to the original as-built drawings:

- Removal of bracing walls at gridline 2 between gridlines A and D at the reception area of the ground floor. In addition, the supporting steel column on Grid B was also 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.
- At the upper floor, timber framed walls with a second layer of GIB panel have been added in the office room located in the front area bounded between gridlines 2~3 and A~B.
- A segment of bracing panel at the intersection of gridlines E and 1 was shortened.

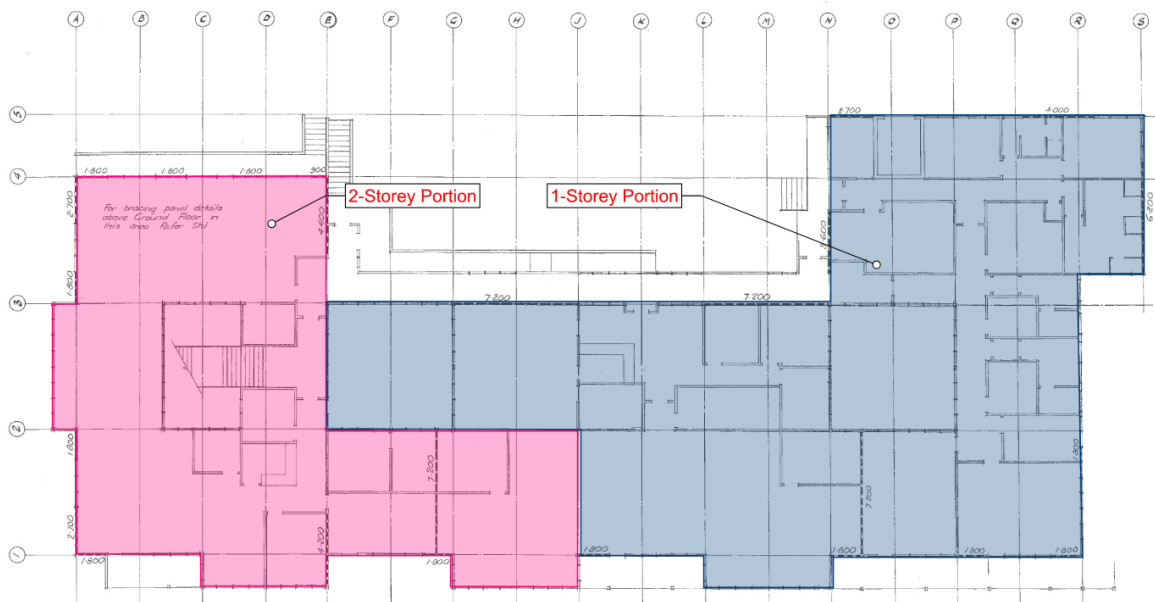
## 2.3 Building description

The description of the building and key structural features that may influence the response of the building is presented Table 2.2.

*Table 2.2: Building description and structural features*

General			
<b>Territorial Authority</b>	Waitomo District Council		
<b>Year of Design</b>	1985		
<b>Heritage Status</b>	None, the building is not listed in <a href="http://www.heritage.org.nz">www.heritage.org.nz</a>		
Building Description			
<b>No. of Storeys</b>	2	<b>Area of Typical Floor</b>	Approx. 1150 m <sup>2</sup>
<b>General Building Geometry</b>	<ul style="list-style-type: none"> <li>The building is mainly a timber structure that comprises a two-storey portion and a single storey portion constructed as a single building with no seismic gap between them. (Figure 2.1).</li> <li>The difference in height between the portions is addressed by a retaining block wall (Figure 2.2).</li> <li>In addition to this vertical irregularity, the building's footprint also presents a somewhat irregular shape (Figure 2.1).</li> </ul>		
<b>Roof System</b>	<ul style="list-style-type: none"> <li>Light weight steel roofing installed over plywood sheets that are supported on purlins over the timber trusses (Figure 2.3).</li> <li>Plywood sheets are used as bracing elements to control displacements and provide load paths (Figure 2.3).</li> </ul>		
<b>Floor System</b>	<ul style="list-style-type: none"> <li>The floor system consists of particle boards over timber joists, which in turn are supported by timber posts and bearers in the 1-storey portion, and by steel beams and columns in the 2-storey portion (Figure 2.4).</li> <li>The ground floor for the 2-storey portion has a slab-on-grade over a DPC on hardfill.</li> </ul>		
<b>Gravity Structural System</b>	<ul style="list-style-type: none"> <li>The gravity system of the structure is composed of timber roof trusses, timber floor joists, steel beams, load bearing timber walls and reinforced concrete block walls.</li> </ul>		
<b>Foundation System</b>	<ul style="list-style-type: none"> <li>The foundation system for the 1-storey portion comprises <math>\phi 150</math>mm timber piles at 1800 mm c/c and strip beam footings for the periphery walls (Figure 2.4).</li> <li>The foundation system for the 2-storey portion comprises strip and pad footings below walls and columns respectively.</li> </ul>		
<b>Lateral Load Resisting System (LLRS)</b>	<ul style="list-style-type: none"> <li>The lateral load resisting system is composed of framed timber walls with plywood panels. It is worth noting that the retaining block wall also participates resisting lateral loads (Figure 2.5).</li> </ul>		
<b>Structural Elements Shared with Adjacent Titles</b>	N/A		
<b>Ground Profile and Identified Geohazards</b>	<ul style="list-style-type: none"> <li>Levelled land on both sides of the retaining walls with gentle slope.</li> <li>No liquefaction risk as per Geotechnical report.</li> </ul>		

Previous Strengthening and/or Significant Alteration	<ul style="list-style-type: none"> <li>No previous structural strengthening was found in the property files.</li> </ul>
Other Relevant Information	N/A



(a) Building footprint and areas



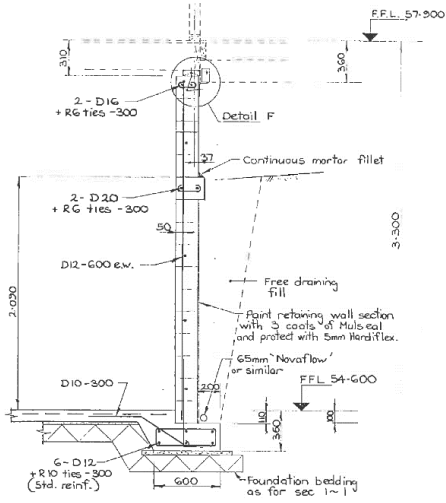
(b) 2-storey portion



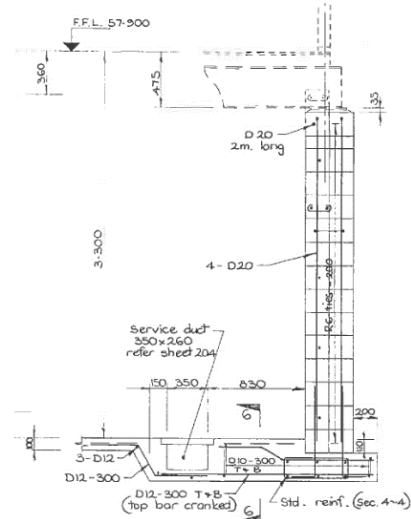
(c) 1-storey portion

**Figure 2.1: Building Geometry**



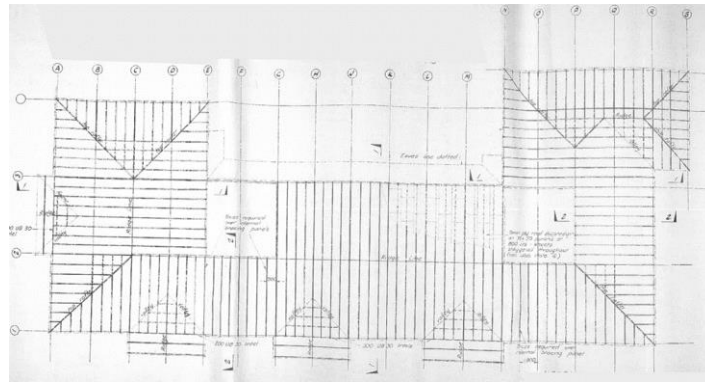


(a) Block Wall cross-section

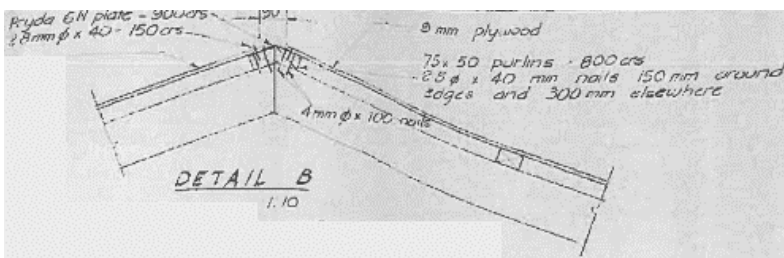


(b) Block Wall Pilaster cross-section

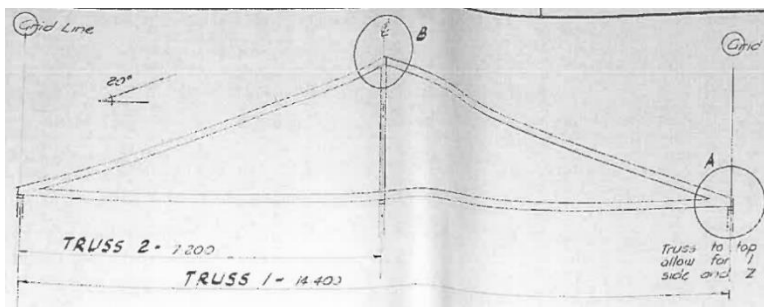
**Figure 2.2: Cross section of the Retaining Block Wall**



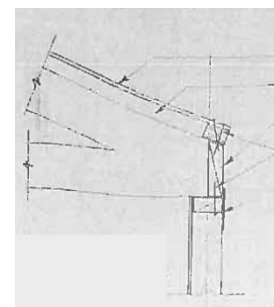
(a) Roof Layout Plan



(b) Detail at the apex of the truss

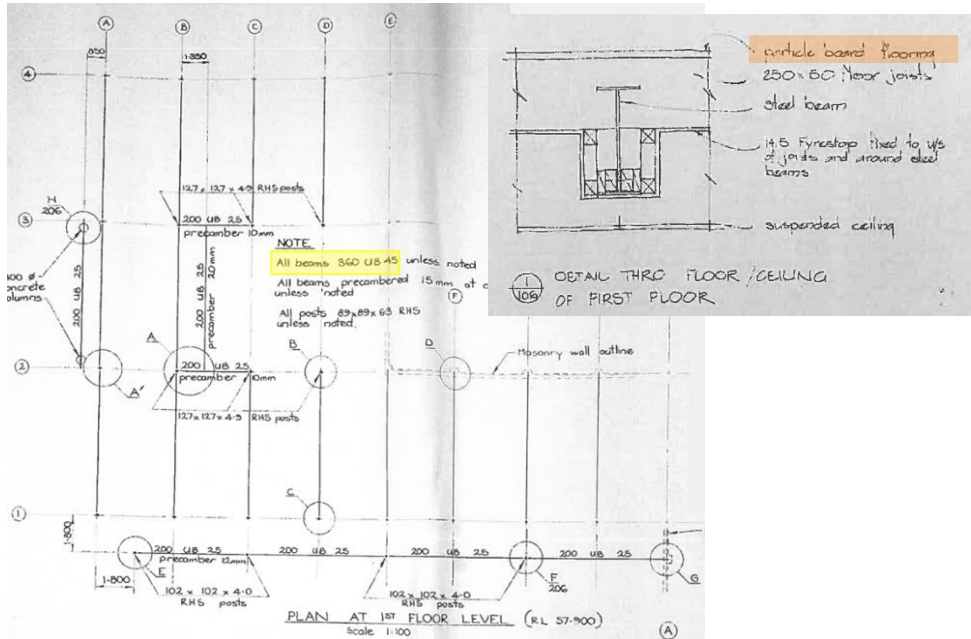


(c) Roof timber truss

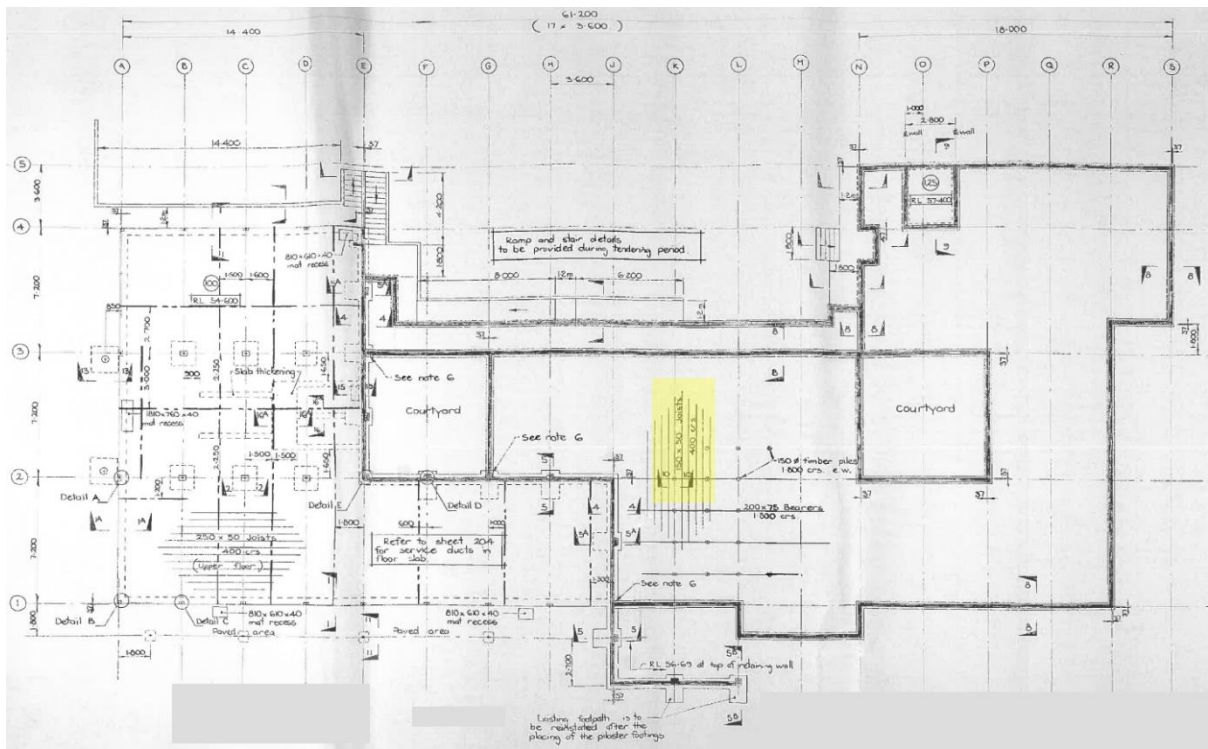


(d) Support of the truss

**Figure 2.3: Roof structural details**

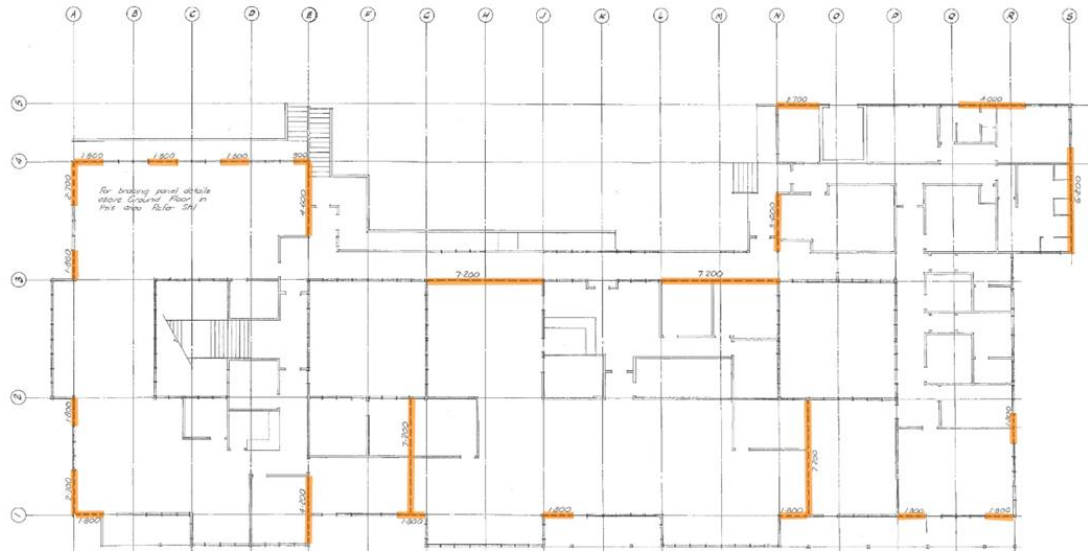


(a) First storey framing plan of the 2-storey portion

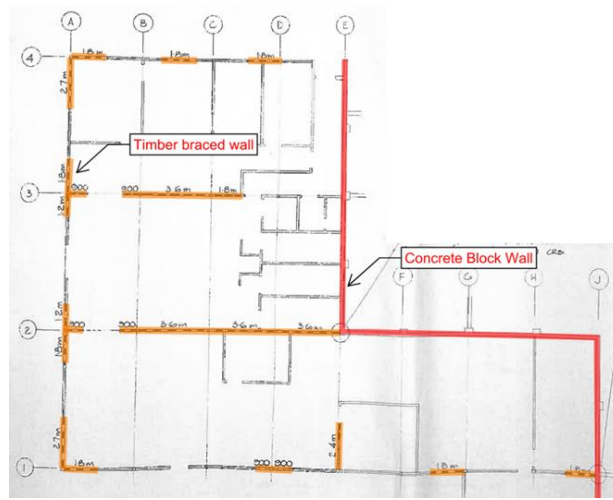


(b) Ground storey framing plan and foundation plan for 1-storey portion

**Figure 2.4: Floor structural details**



(a) Existing bracing timber walls on the First Floor



(b) Existing bracing timber walls and blockwall (retaining) on the Ground Floor

**Figure 2.5: Structural system**

## 3. Assessment methodology

### 3.1 Standards and guidelines

The building has been assessed to the current New Zealand Seismic Assessment guidelines and NZ standards. Other international standards and guidelines were also used where it was deemed necessary. The standards and guidelines that were used are listed below:

Name	Title
MBIE Guidelines	The Detailed Seismic Assessment of Existing Buildings (July 2017)
AS/NZS 1170.0:2002	General Principles
AS/NZS 1170.1:2002	Structural Design Actions NZS 1170.5:2004
NZS 3101:2006	Concrete Structures
NZS 3603: 1993	Timber Structures Standard

The MBIE (Ministry of Business, Innovation and Employment) Seismic Assessment Guidelines published in the EQ Assess webpage were the basis for the Detailed Seismic Assessment. These guidelines are referred to as the 'MBIE Guidelines' throughout the report. The specific sections used are as follows:

Name	Title
Part A	Assessment Objectives and Principles Part C
Part C	Detailed Seismic Assessment
	Section C1 General Issues
	Section C2 Assessment procedures and Analysis Techniques Section
	Section C3 Earthquake demands
	Section C4 Geotechnical Considerations Section
	Section C5 Concrete Buildings
	Section C9 Timber Buildings

### 3.2 Seismic assessment philosophy

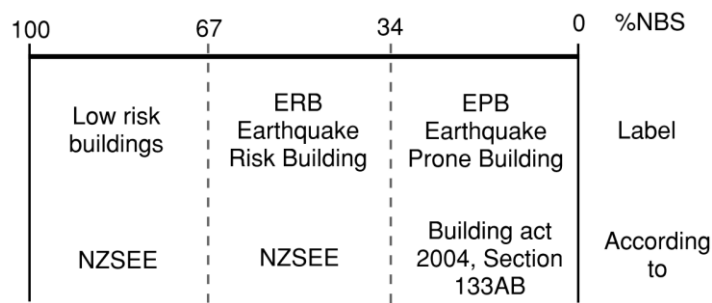
The current adopted philosophy in New Zealand for a seismic assessment and improvement is to compare the building's Ultimate Limit State (ULS) earthquake resistance with the current New Zealand Building Code requirements for a new building constructed on the same site. The seismic rating of the building is then expressed as a percentage of New Building Standard (%NBS).

The New Zealand Society for Earthquake Engineering (NZSEE) has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is detailed in Table 3.1. The table is the basis of a proposed grading system for existing buildings. Accordingly, occupants in *Earthquake Prone* buildings (less than 34% NBS) are exposed to more than 10 times the risk that they would be in a similar new building. For buildings that are potentially *Earthquake Risk* (less than 67% NBS), the risk is at least 5 times greater than that of an equivalent new building. Descriptions of the life-safety risk can be assigned to the building grades as shown in Table 3.1.

*Table 3.1: Relative Earthquake Risk (from Table A3.1 of the MBIE Guidelines)*

Percentage of New Building Standard (%NBS)	Building Score	Approximate Risk Relative to a New Building	Life-safety Risk Description
>100	A+	Less than or comparable to	Low risk
80-100	A	1 to 2 times greater	Low risk
67-79	B	2 to 5 times greater	Low to Medium risk
34-66	C	5 to 10 times greater	Medium risk
20-33	D	10 to 25 times greater	High risk
<20	E	25 times greater	Very high risk

In addition to this classification, it is worth mentioning the Qualitative Risk Classification commonly used. This is shown in Figure 3.1, and represents a combination of the language used by the Building Act 2004 Section 133AB and NZSEE as described in the NZ Assessment Guidelines – Part A.



*Figure 3.1: Qualitative Risk Classification*

### 3.3 Seismic restraint of SSNS items

During an earthquake, the safety of people can be put at risk due to secondary and non-structural (SSNS) items falling on them. These items should be adequately seismically restrained, where possible, to the NZS 4219:2009 “The Seismic Performance of Engineering Systems in Buildings”.

At this stage, GHD has no available information about the secondary and non-structural elements in the subject building, neither were they observed in the site inspection other than the main stairs. However, due to the size and occupancy type of the building it is considered that no SSNS poses a life safety risk for the building occupants.

### 3.4 Seismic assessment requirements

#### 3.3.1 Limit state design and loading

The seismic assessment of the subject building was undertaken to the Ultimate Limit State (ULS), as defined in AS/NZS1170.0. The ULS design level allows the structure to exhibit damage but requires the collapse of the structure to be prevented in addition to other life safety requirements. The ULS design level also requires designers to avoid damage that can cause SNSS systems necessary for building evacuation to be non-operational.

The reliable structural ductility was set as  $\mu = 2.0$  for timber structural elements and  $\mu = 1.0$  for concrete walls & footings. The following ULS load cases were considered during the analysis of the structure.

- $G + \psi_e \cdot Q + E_u$

A full gravity, wind and snow analysis of the existing structure is outside the scope of the DSA and has not been performed.

### 3.3.2 Assessment parameters

All gravity loads were derived based on AS/NZS1170.0 or as otherwise noted within the calculations. All seismic loads were derived based on NZS 1170.5. The summary of design loads and general seismic factors are presented in Table 3.2 and Table 3.3 respectively. All gravity loads were calculated using a gravity acceleration of  $9.81\text{m/s}^2$ .

### 3.3.3 Building design life

The building design life is assumed to be 50 years in accordance with clause B2 of the New Zealand Building Code.

### 3.3.4 Building importance level and annual probability of exceedance

As requested by the client and in line with AS/NZS1170.0 Clause 3.3, this building is currently considered to be an Importance Level (IL) 4 structure. IL4 structures include buildings that are *post-disaster structures (post disaster functions or dangerous activities)*. This has been defined in AS/NZS1170 as *High consequence for loss of human life, or very great economic, social or environmental consequences*.

In accordance with Table 3.3 of AS/NZS 1170.0 and with reference to the Building Importance Level, this building has been assessed with 1/2500 annual probability of exceedance and Return Period Factor,  $R_u$  of 1.8.

**Table 3.2: Design dead and live loads**

Type of Load	Load Name	Load Magnitude
<b>Permanent load</b>	Self-weight concrete elements	24 kN/m <sup>3</sup>
	Concrete block wall (fully filled)	3.65 kPa
	Roof	0.50 kPa
	Floor	0.55 kPa
	Timber wall (External)	0.35 kPa
	Timber wall (Internal)	0.25 kPa
<b>Imposed</b>	Roof	0.25 kPa
	Floor	3.00 kPa



**Table 3.3: General seismic factors**

Seismic Factor Coefficient	Document used	Selected Value										
Ductility Factor ( $\mu$ )	NZS1170.5, Cl. 4.3	$\mu = 2.0$ for Timber elements $\mu = 1.0$ for Concrete walls and footings										
Structural Performance Factor ( $S_p$ )	NZS3101 Cl2.6.2.2.	$S_p = 0.7$ for timber elements $S_p = 0.9$ for concrete elements										
Soil Type	NZS1170.5, Cl. 3.1.3	C										
Hazard Factor (Z)	NZS1170.5, Table 3.3	Z = 0.18										
Earthquake combination factor	NZS1170.5, Cl. 4.2	<table border="0"> <tr> <td><math>\Psi_E</math></td> <td>Description</td> </tr> <tr> <td>0.15</td> <td>Reducible floor</td> </tr> <tr> <td>0.3</td> <td>Non reducible floor</td> </tr> <tr> <td>0.6</td> <td>Non reducible storage</td> </tr> <tr> <td>0</td> <td>Roof</td> </tr> </table>	$\Psi_E$	Description	0.15	Reducible floor	0.3	Non reducible floor	0.6	Non reducible storage	0	Roof
$\Psi_E$	Description											
0.15	Reducible floor											
0.3	Non reducible floor											
0.6	Non reducible storage											
0	Roof											
Near-Fault Factor N(T,D)	NZS1170.5, Cl.3.16	N(T,D) = 1.0										
Return Period Factor ( $R_u$ )	NZS1170.5, Cl.3.15	$R_u = 1.8$										

## 3.5 Structural analysis

### 3.5.1 Analysis description and materials

The building was analysed with a mix of hand calculations and three-dimensional (3D) modelling. The soil retaining demands of the blockwalls were determined using a 3D numerical model in the software CSi Etabs, while its in-plane demands and the demands of the rest of the structure (timber and steel) were analysed based on hand calculations.

The Equivalent Static Method (ESM) in NZS1170.5 was used to determine the seismic load demands in the structure, while the MBIE Geotechnical Modules 1 and 6 were used to determine the load demands on the retaining wall. The loads resulting from the interaction between the retaining wall and the rest of the structure were manually added to the structural demands calculated by the ESM and applied to the affected elements. It should be noted that despite the building is classified as irregular by NZS1170.5, the ESM was used as it was considered to provide a conservative case scenario for the seismic loading of this particular building.

The material strengths were obtained from the structural plans and the indications from the MBIE Guidelines. These are shown in Table 3.4.

**Table 3.4: Material properties used in the assessment**

Material	Property	Strength
Concrete	Probable compression strength, $f_c$	30 MPa
Block wall	Probable compression strength, $f_c$	12 MPa
Reinforcement	Probable yield strength, $f_{yp}$	297 MPa

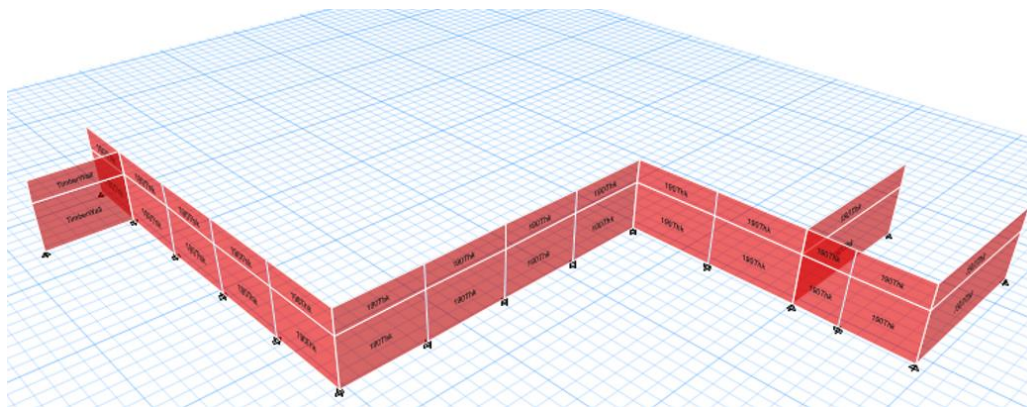
## 3.5.2 Assessment of roof and floor system

The diaphragms for the roof as well as for the floor were assessed using the girder analogy in NZS3603. Shear forces are resisted by the diaphragm panels and are assumed constant along the diaphragm depth. Bending moments are resisted by the chord elements (steel beams / floor joist / wall timber top plate) acting in tension and compression. Panel shear is transferred to timber braced walls and block walls via collector elements and in some cases direct connections.

## 3.5.3 Assessment of block walls

The block walls have a double function in this building, to retain soil (out-of-plane behaviour) and to be part of the bracing system (in-plane behaviour). For the assessment of the soil retaining behaviour the walls were analysed using a three-dimensional (3D) numerical model as previously described. The model was created in such a way that closely represents the geometry, dimension and cross sections shown in the building plans.

The model represented the walls with shell elements and the pilasters with frame elements. The materials were linear elastic isotropic materials. Loading was applied by using uniform and non-uniform load patterns. Figure 3.2 shows a graphical representation of the 3D analysis model for the block walls.



*Figure 3.2 Etabs block wall model*

The assessment was performed based on a progressive assumption-verification basis as described below:

### Step 1:

Assumption: retaining wall system (wall-foundation) resist forces by cantilever action with wall top displacement less than 0.4%h.

Verification: From an elastic analysis the wall displaces less than 0.4%, however it doesn't have enough capacity. So, the top of the wall will push against the floor diaphragm.

Action: Due to the expected displacements the retaining wall will push against the floor diaphragm. So, the load from wall top will be transferred to the structure. This changes the support condition to fixed base - pinned top.

### Step 2:

Assumption: Floor system props top of the wall driving the forces to the braced timber walls/ block walls (in-plane).

Verification: Retaining wall is verified as fixed base - pinned top. The wall is not strong enough. The diaphragm is not strong enough.

Action: the element is recognised as a structural weakness and requires strengthening

### 3.5.4 Assessment of timber walls

The assessment of the timber braced walls was conducted in accordance with the MBIE Guidelines and NZS 3603. The lateral capacity was determined based on the length of the bracing walls and the capacity per meter run.

### 3.5.5 Assessment of the foundation system

The assessment of the foundation system was conducted in accordance with the recommendations in the MBIE Guidelines. The soil bearing capacity for the seismic cases were checked for the relevant elements.

## 4. Assessment results

The results of the Detailed Seismic Assessment indicate that the overall earthquake rating of the administrative building is **15%NBS(IL4) Grade E**. Grade E buildings represent more than 25 times greater risk compared to that expected from an equivalent new building, indicating a high-risk exposure to life-safety. Key results are summarised in Table 4.1.

**Table 4.1: Summary of assessment results for key structural elements**

ID	Element	%NBS(IL4)	Location, mode of failure and engineering statement of structural weaknesses
1	Timber braced walls (Ground Floor)	15%	<b>Critical Structural Weakness (CSW) – High risk to life-safety should a large earthquake occur</b> Location: Timber walls on ground floor Mode of failure: Shear failure of the wall which is a combination of over-turning of the panels; bending of the studs; connection failure; and pull-out of the studs
2	Timber braced walls (First Floor)	20%	<b>Structural Weakness (SW) – High risk to life-safety should a large earthquake occur</b> Location: Timber walls on first floor Mode of failure: Shear failure of the wall which is a combination of over-turning of the panels; bending of the studs; connection failure; and pull-out of the studs
3	Floor Diaphragm	25%	<b>Structural Weakness (SW) – High risk to life-safety should a large earthquake occur</b> Location: First Floor Mode of failure: Pull out failure of the bolts from the concrete block pilaster
4	Concrete block walls	40%	<b>Structural Weakness (SW) – Medium risk to life-safety</b> Location: ground level along gridlines E, 2 and J Mode of failure: Flexural failure of the walls

Notes:

The acronyms' description below are a short version of the comprehensive descriptions provided in clauses A6.6, C1.5.3.1 and C2G of the MBIE Seismic Assessment Guidelines

SW: An SW is any element that scores less than 100%NBS.

CSW: is the lowest scoring element(s) among the identified SWs

SSW: is an element or system that have little margin after their %NBS is reached and has a step-change brittle behaviour.

While several elements were identified as structural weaknesses (SW) in the assessment, the Critical Structural Weaknesses (CSWs) controlling the building's score are the timber braced walls in the Ground floor, closely followed by the timber braced walls in the First floor and the first floor timber diaphragm.

In line with Part C2G of the MBIE Assessment Guidelines, the timber walls and diaphragm are identified as Severe Structural Weaknesses (SSW) because their failure could lead to the collapse of the building.

The following items have not been assessed in this document due to lack of information:

- Connections to the top plate of the walls
- Secondary structural and non-structural elements (however see 3.3)

## 5. DSA summary and recommendations

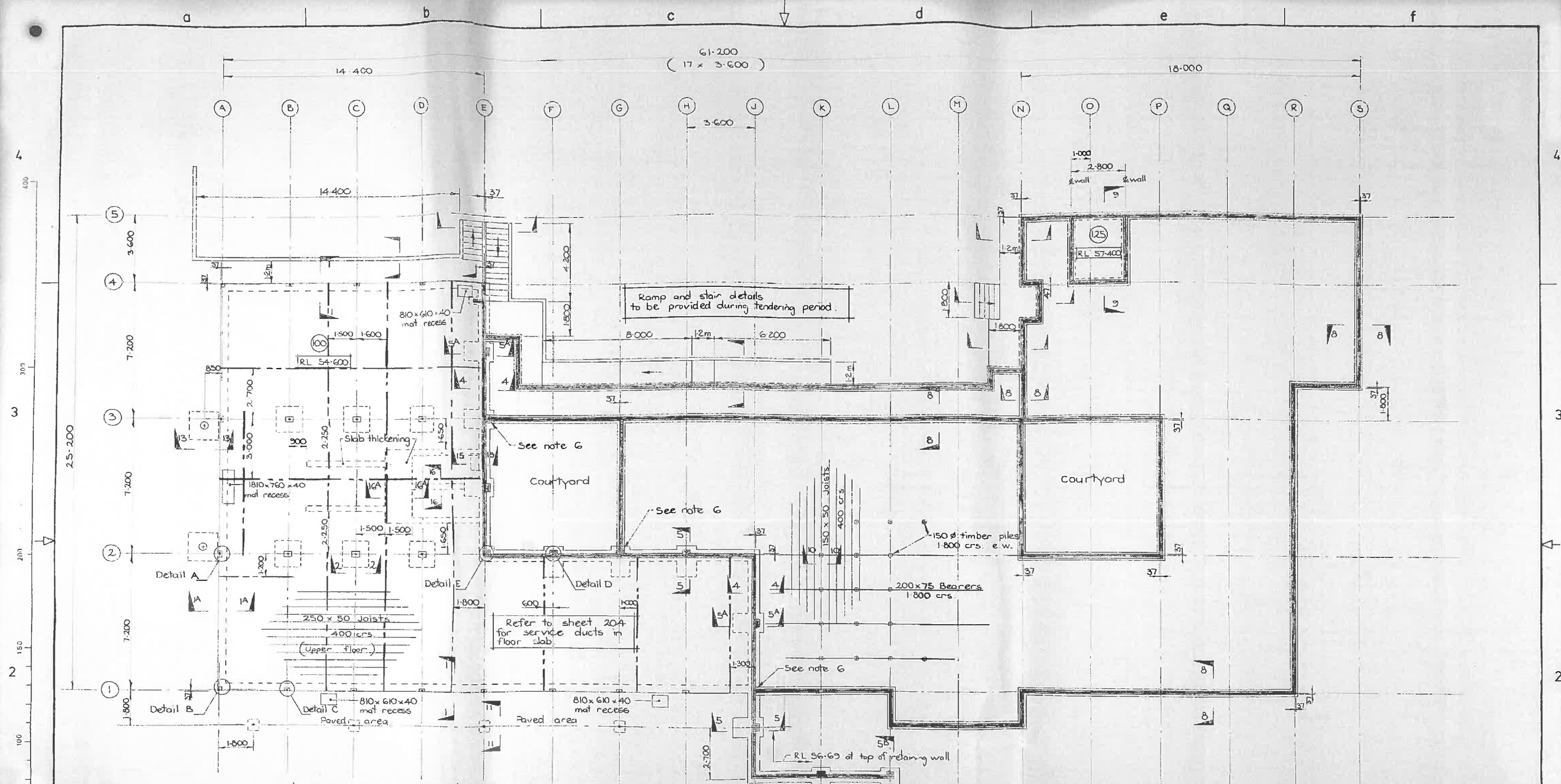
The results of the Detailed Seismic Assessment indicates that the overall earthquake rating of the administrative building is **15%NBS(IL4) Grade E**. This score is below the 67%NBS threshold for Earthquake Risk buildings and also below the 34%NBS threshold for Earthquake Prone Buildings.

Based on the findings and assessed %NBS score, in conjunction with the requirements of the building Act 2004, this building must be retrofitted to at least 34%NBS. However, and in line with WDC request, it is recommended that the building is strengthened to 100%NBS(IL4) so it can comply with the intended post-disaster use.

A high-level concept strengthening scheme was prepared and it is attached to this report in Appendix B. It should be noted that the strengthening scheme is indicative in nature and is not a fully developed design.

# Appendix A

## Building Plans



- NOTES**
- Concrete strength to be 20 MPa min of 28 days
  - Place DPC, site concrete, sand and handfill under all foundations as shown typically on sections 1-1 + 6-6
  - Sawcut positions are shown --- Cuts are to be 25 mm deep and made not more than 36 hours after placing conc. At not less than 28 days, clean out and fill with sand/cement at 3:1, dampen and finish smooth. Refer also to sheet 204 for saw cut positions
  - For sections and details refer to sheets 202 + 203.
  - Column recesses in floor slab are to be grout filled after columns are levelled and squared.
  - Provide starters from retaining wall to tie in single story perimeter wall.
  - Provide weather bars to external doors.

Refer to detail C sheet 207 - anchor bars set into concrete floor slab

Existing footpath is to be reinstated after the placing of the plaster footings

- Ventilation blocks to be placed in perimeter masonry wall as per NZS 3604 section 4.1.2. Architect to determine location but must be kept clear of wall reinforcement.
- Control joints are to be placed in masonry walls at max centres of 7.2m. Refer to sheet 211

ORIGINAL SIZE A 1	DESIGNED	BY	CHECKED	DATE	R. L. PRESTON CHIEF CIVIL ENGINEER	Ministry of Works and Development CIVIL ENGINEERING HAMILTON STRUCTURAL DESIGN OFFICE TG. SHADWELL Commissioner	G.O.A.B. - TE KUITI DEPARTMENTAL BUILDING FLOOR PLAN	ORIGINAL SCALES	1:100	FILE	
	DRAWN	C.H.	R.P.M.	8/95	T. N. MITCHELL CHIEF STRUCTURAL ENGINEER			WAR. 4A077			
	SUPERVISED				APPROVED			JOB	CODE	SHEET	REVISION
	COORD. CHK.							2/850/1	7202	201	
AMENDMENTS	BY	APPD.	DATE								



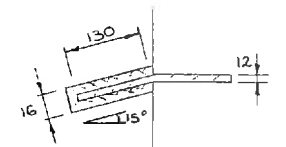
a b c d e f

NOTES

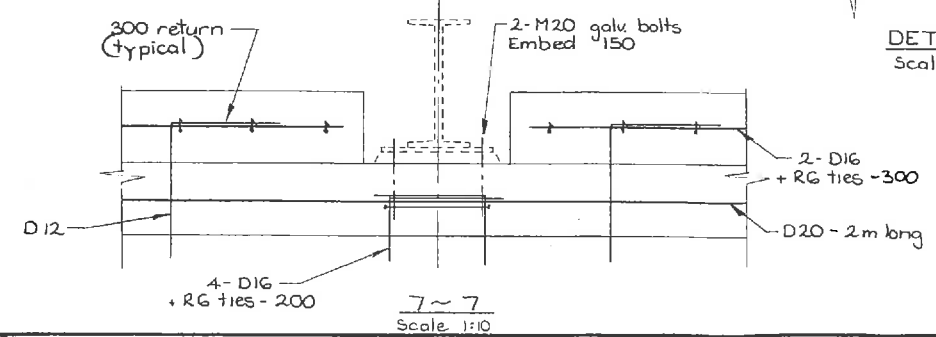
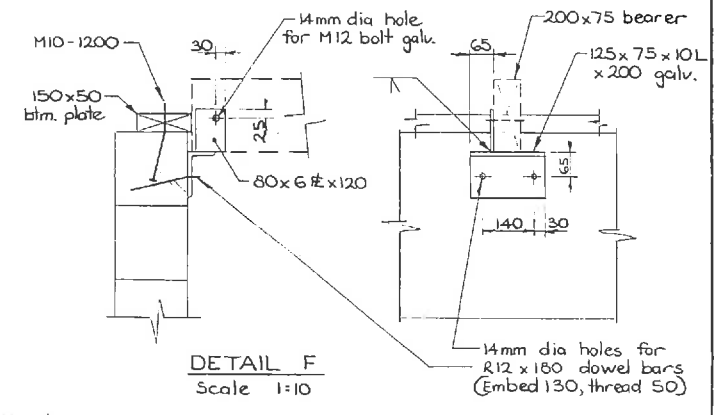
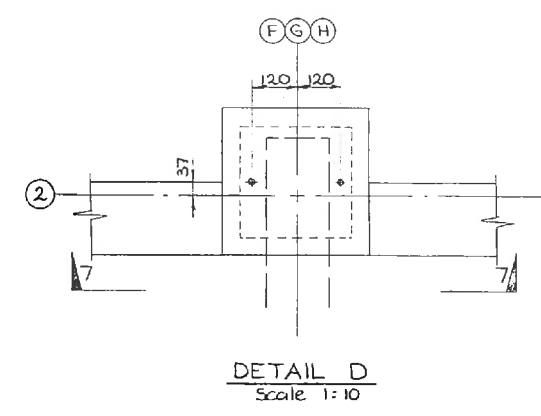
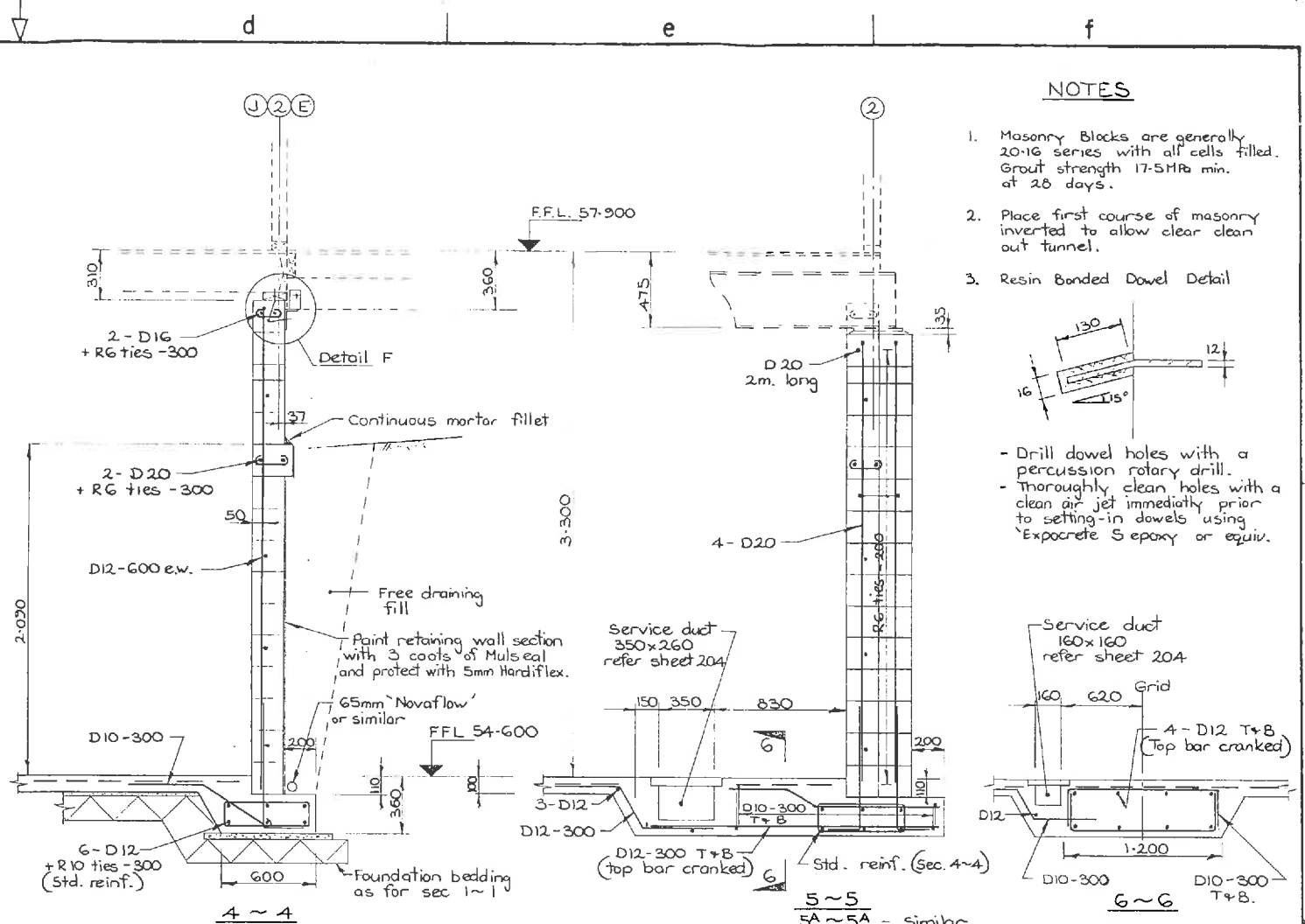
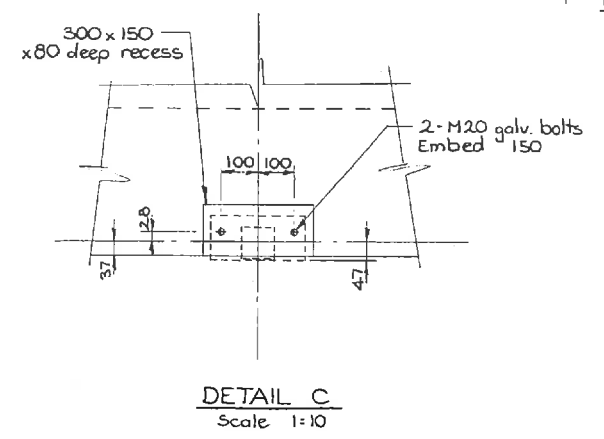
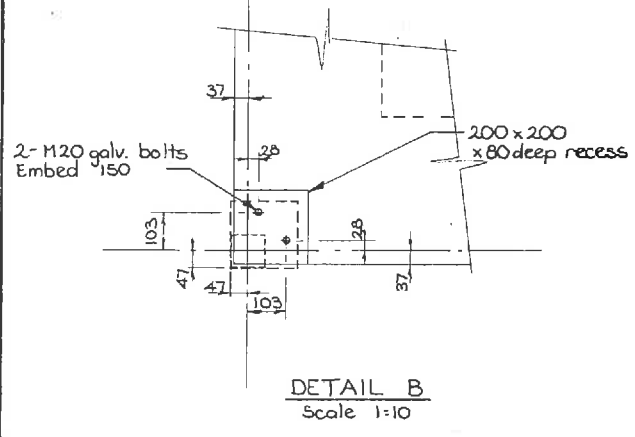
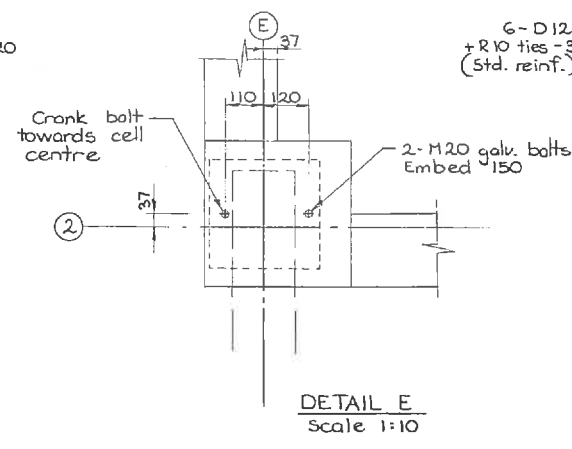
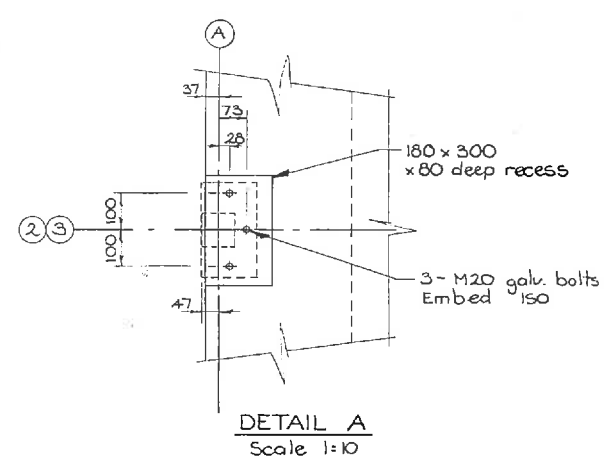
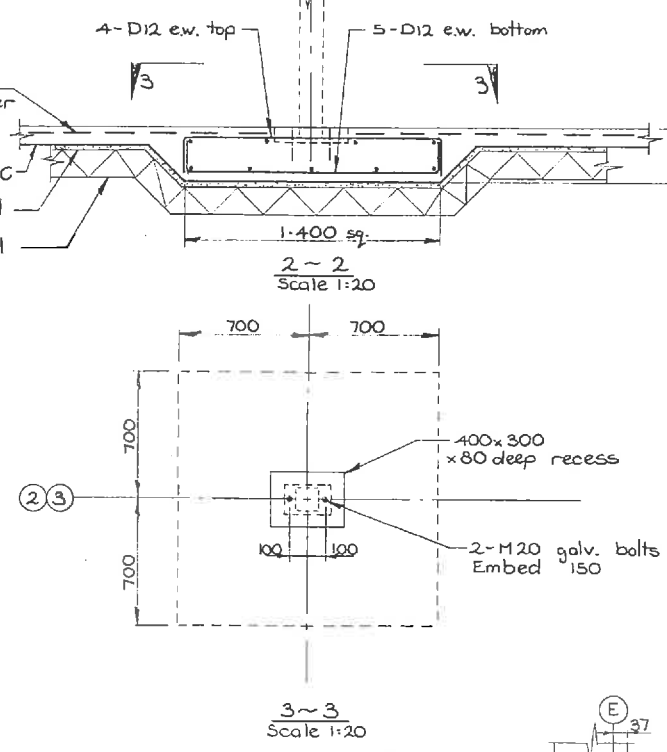
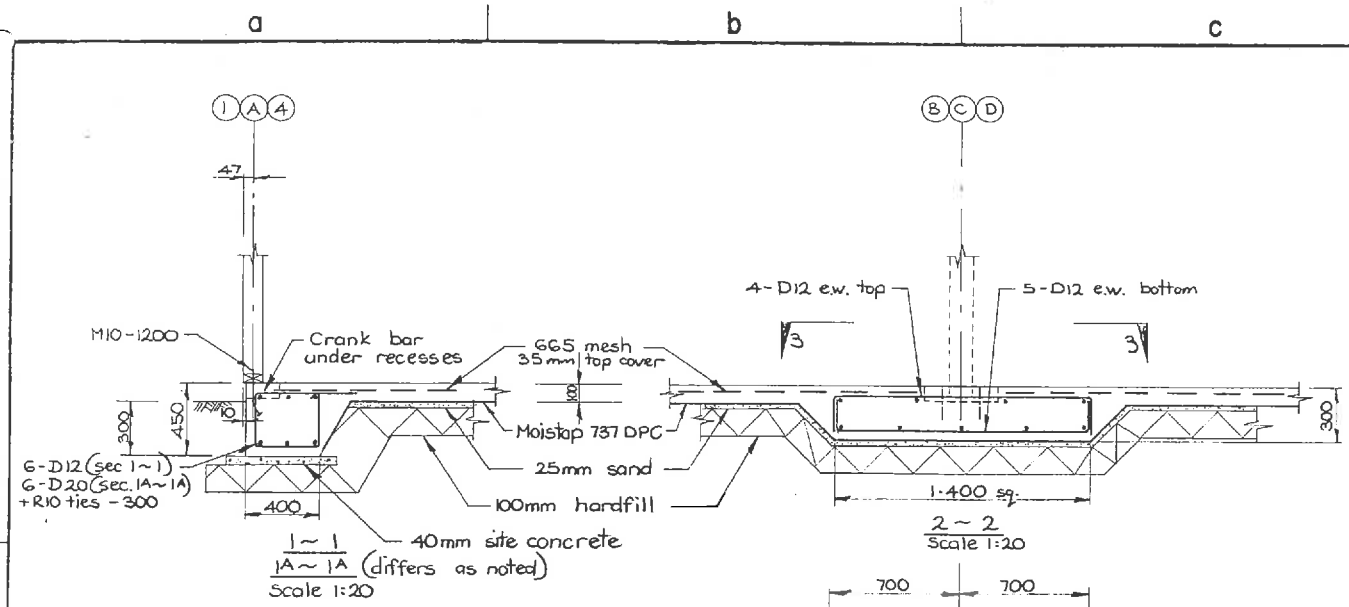
1. Masonry Blocks are generally 20-16 series with all cells filled. Grout strength 17.5MPa min. at 28 days.

2. Place first course of masonry inverted to allow clear out tunnel.

3. Resin Bonded Dowel Detail

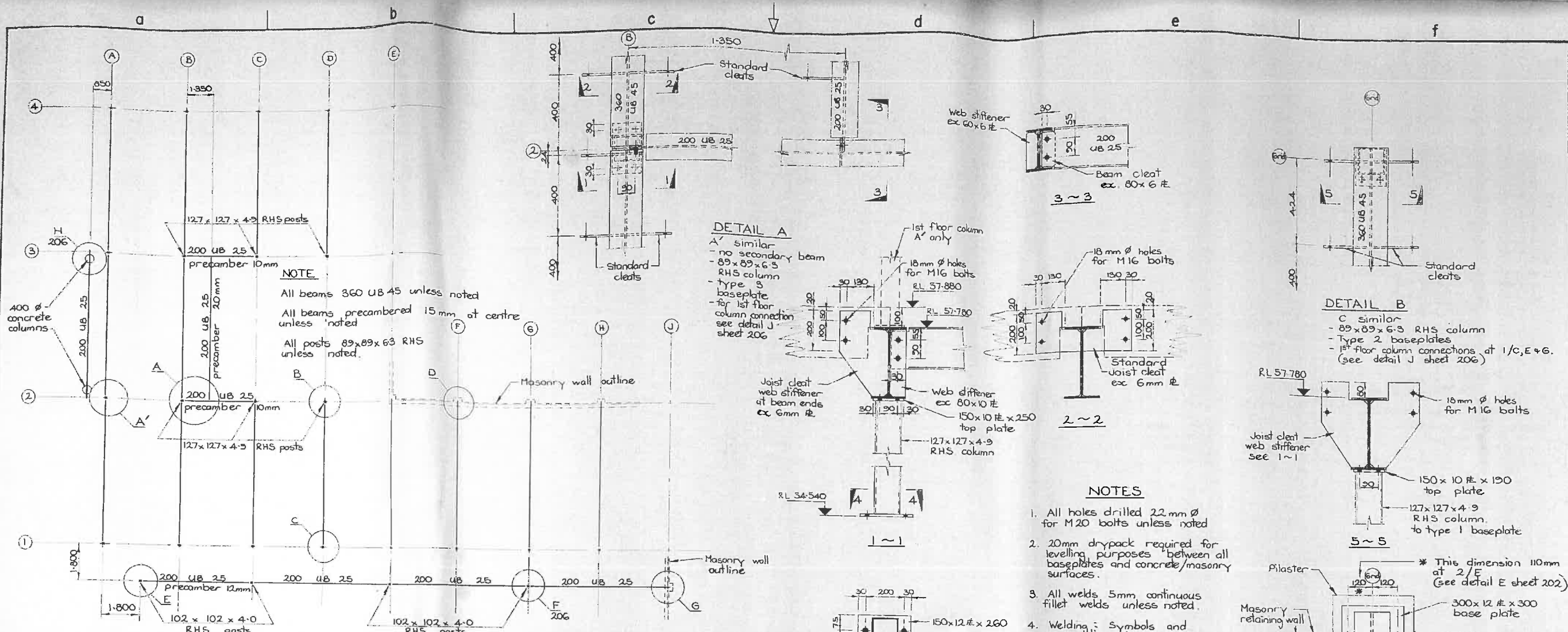


- Drill dowel holes with a percussion rotary drill.  
- Thoroughly clean holes with a clean air jet immediately prior to setting-in dowels using Expocrete S epoxy or equiv.



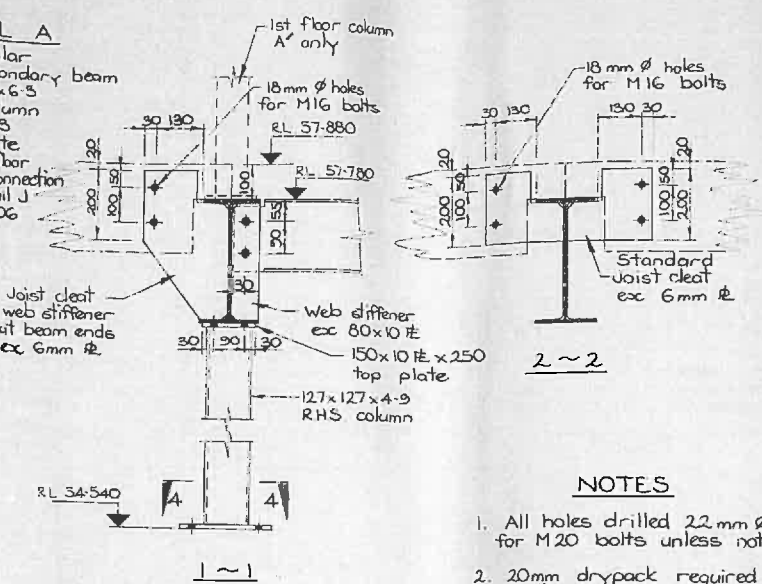
5A-5A - Similar  
1. Delete duct in footing and extend top D12 reinforcement.  
2. Full height masonry.  
5B-5B - Similar but R.L. at top of wall is 56-69.

ORIGINAL SIZE A1	BY	CHECKED	DATE	R. L. PRESTON CHIEF CIVIL ENGINEER	Ministry of Works and Development	G. O. A. B. - TE KUITI DEPARTMENTAL BUILDING FOUNDATION & RETAINING WALL DETAILS	ORIGINAL SCALES	1:10 & 1:20	FILE				
	Designed	<i>[Signature]</i>	8/85				T. N. MITCHELL, CHIEF STRUCTURAL ENGINEER	CIVIL ENGINEERING HAMILTON	WAR. 4A077	JOB	CODE	SHEET	REVISION
	Drawn	<i>[Signature]</i>	8/85				APPROVED	STRUCTURAL DESIGN OFFICE	2/850/1	7202	202		
	Supervised	<i>[Signature]</i>					T. G. SHADWELL, Commissioner						
	Co-ord. chkr. Recommended	<i>[Signature]</i>											
AMENDMENTS		BY	APPD.	DATE									



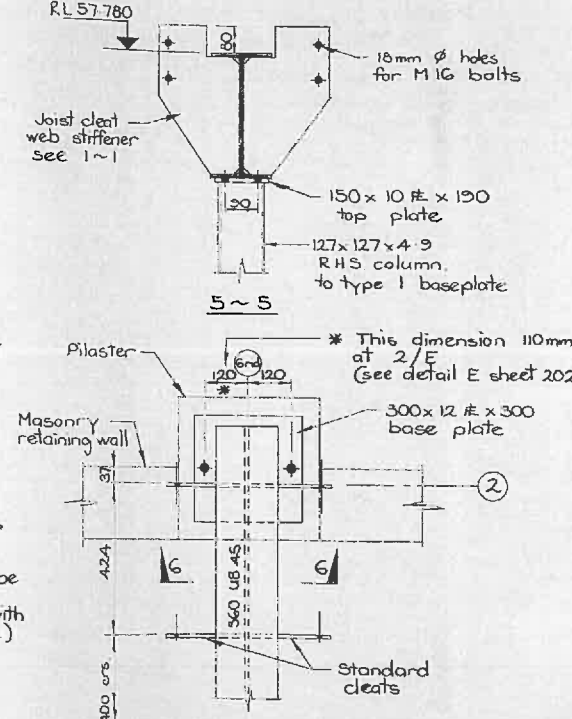
**DETAIL A**

A' similar  
 - no secondary beam  
 - 89 x 89 x 6.3 RHS column  
 - type 3 baseplate  
 - for 1st floor column connection see detail J sheet 206



**DETAIL B**

C similar  
 - 89 x 89 x 6.3 RHS column  
 - Type 2 baseplates  
 - 1st floor column connections at 1/C, E + G. (see detail J sheet 206)

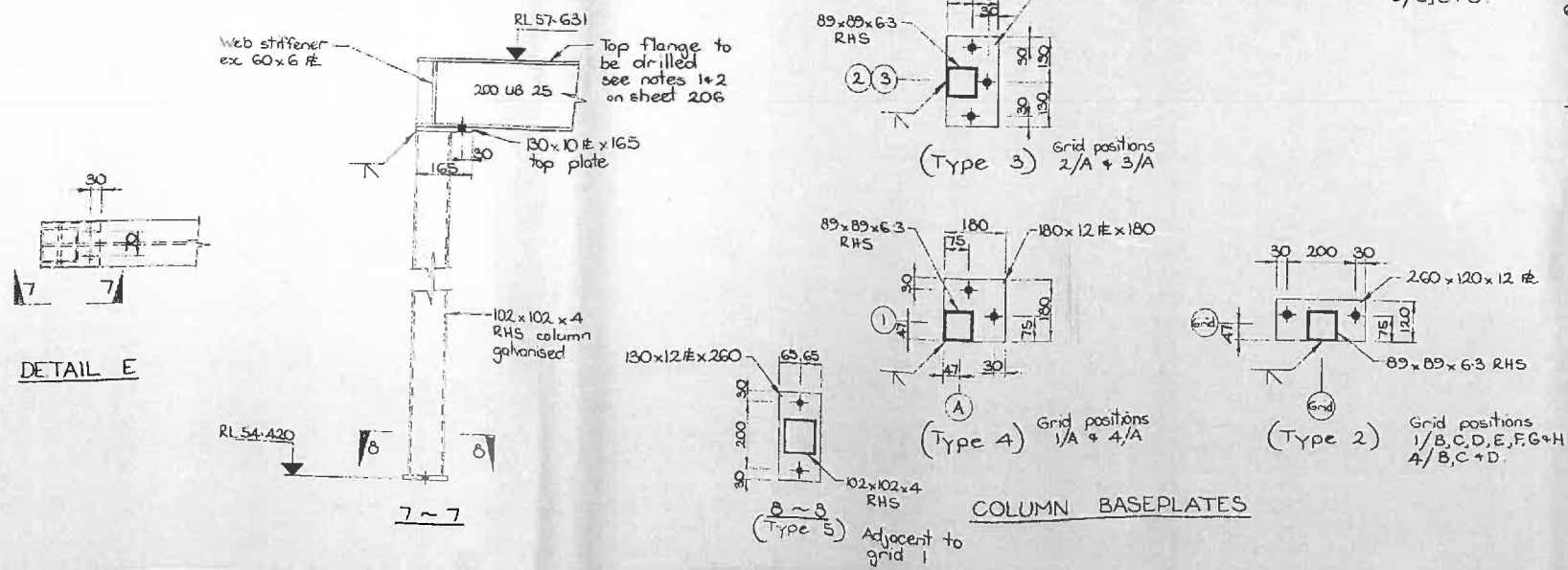


**NOTES**

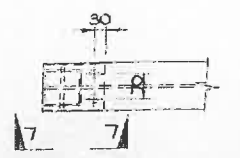
- All holes drilled 22mm  $\phi$  for M20 bolts unless noted.
- 20mm drypack required for levelling purposes between all baseplates and concrete/masonry surfaces.
- All welds 5mm continuous fillet welds unless noted.
- Welding: Symbols and preparation to C.D. 301.
- All nuts, bolts, washers and 102 x 102 x 4 RHS exterior columns to be supplied galvanised.
- Surface Finish: Steelwork to be blast cleaned to C.D 305 grade Sa 2 1/2 and painted with inorganic zinc silicate (C.D. 502) to 75  $\mu$ m.
- Damaged galvanised steelwork to be repaired with organic zinc epoxy to 75  $\mu$ m.

**PLAN AT 1ST FLOOR LEVEL (RL 57-900)**  
 Scale 1:100

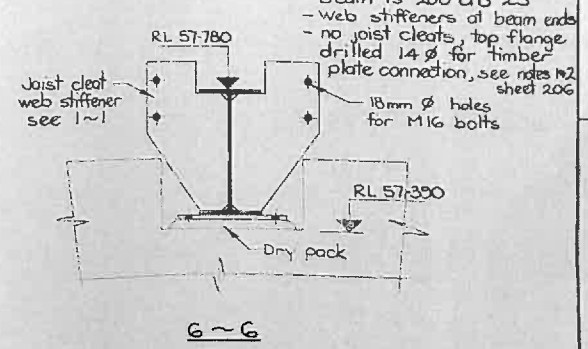
**COLUMN BASEPLATES**



**DETAIL E**



**DETAIL D**



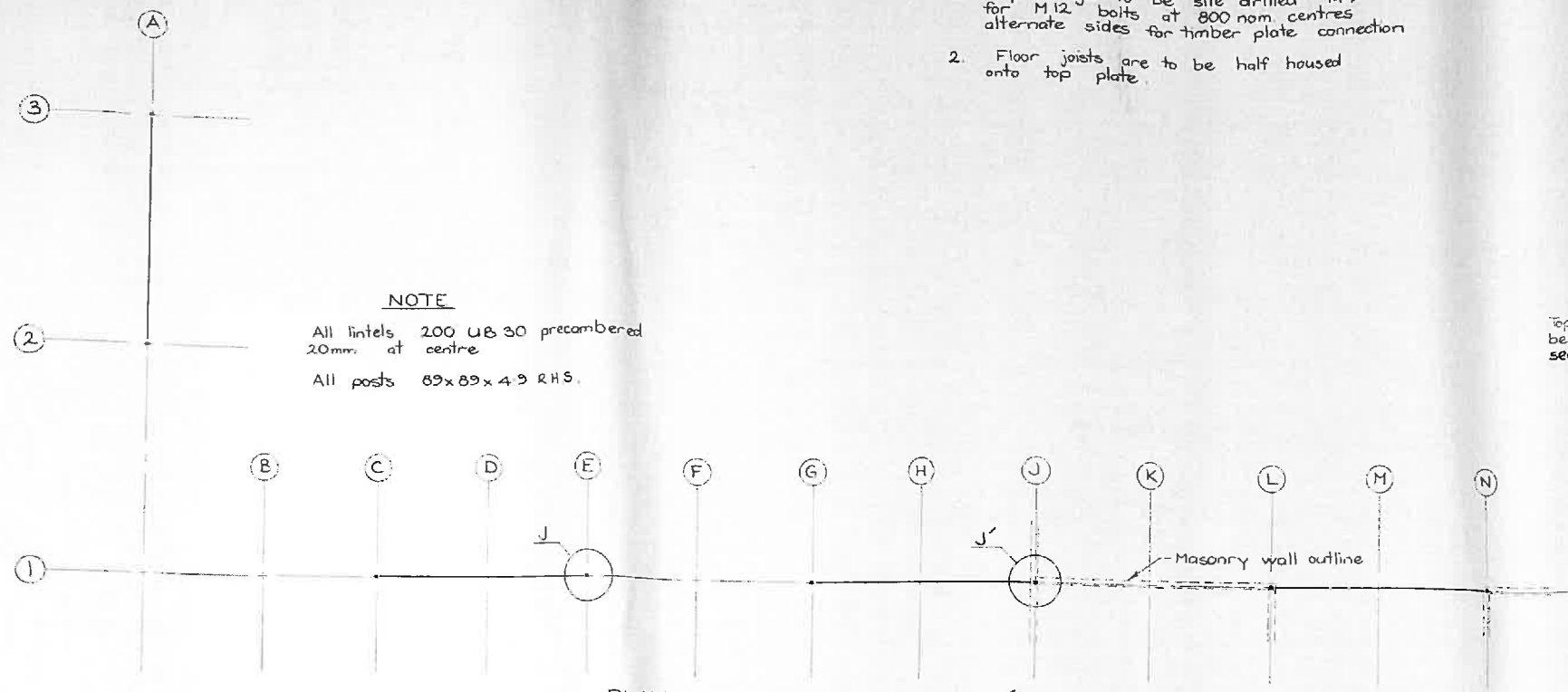
ORIGINAL SIZE A 1	Designed	BY	CHECKED	DATE	R. L. PRESTON CHIEF CIVIL ENGINEER  T. N. MITCHELL CHIEF STRUCTURAL ENGINEER APPROVED	Ministry of Works and Development CIVIL ENGINEERING HAMILTON STRUCTURAL DESIGN OFFICE T. G. SHADWELL Commissioner	G.O.A.B. - TE KUITI DEPARTMENTAL BUILDING STEELWORK DETAILS	ORIGINAL SCALES	1:10	FILE		
	Drawn			10/95				W.A.R. 4A077	JOB	CODE	SHEET	REVISION
	Supervised								2/850/1	7202	205	
	Co-ord. Chk.											
AMENDMENTS		BY	APPD.	DATE								

**NOTES**

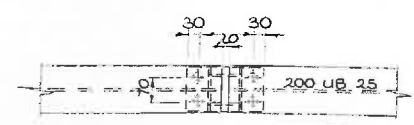
1. Top flange to be site drilled 14 # for M12 bolts at 800 nom centres alternate sides for timber plate connection
2. Floor joists are to be half housed onto top plate

**NOTE**

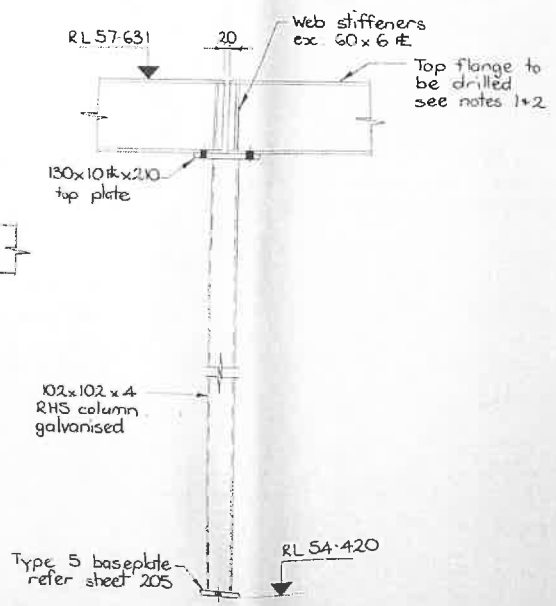
All lintels 200 UB 30 precombined 20mm at centre  
 All posts 89x89x4.9 RHS



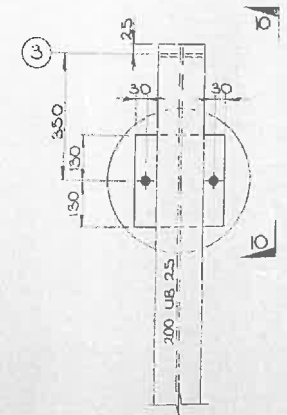
PLAN AT LINTEL LEVEL (RL 60-703)  
 Scale 1:100



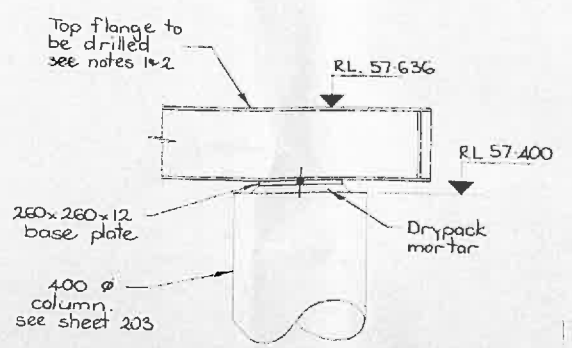
DETAIL F  
 From sheet 205



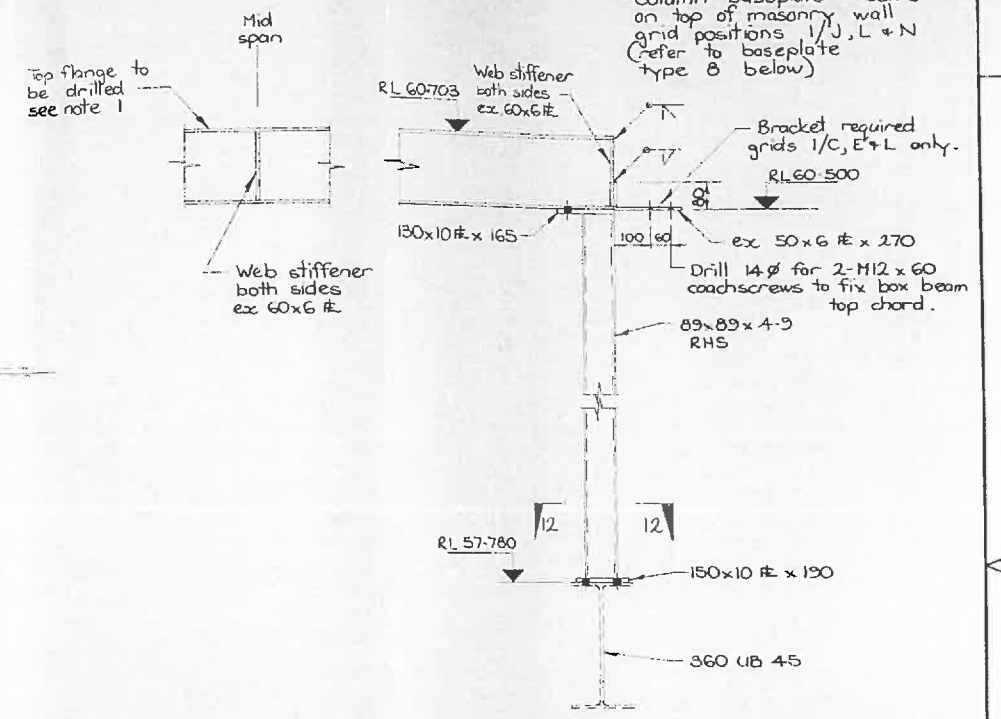
DETAIL G  
 From sheet 205



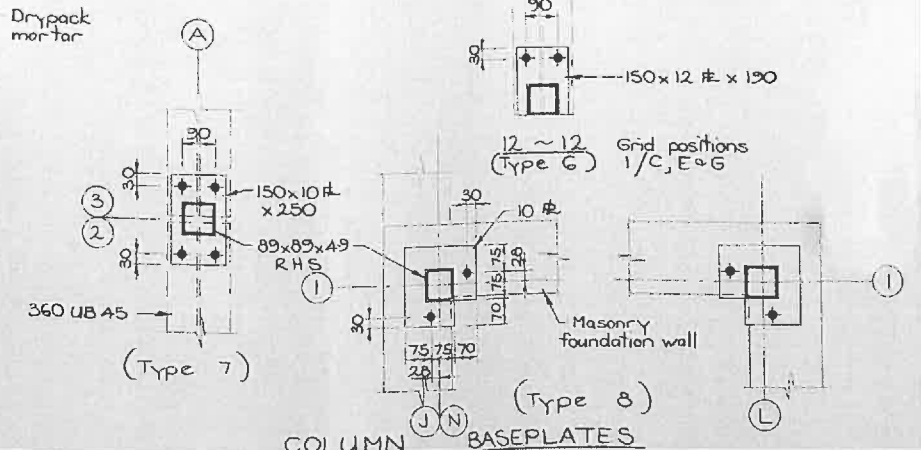
DETAIL H  
 From sheet 205



DETAIL I  
 From sheet 205



DETAIL J  
 From sheet 205



COLUMN BASEPLATES

AMENDMENTS	BY	APPD.	DATE

R. L. PRESTON  
 CHIEF CIVIL ENGINEER

T. N. MITCHELL  
 CHIEF STRUCTURAL ENGINEER

TG SHADWELL  
 Commissioner

Ministry of Works and Development  
 CIVIL ENGINEERING HAMILTON  
 STRUCTURAL DESIGN OFFICE

G.O.A.B. - TE KUITI  
 DEPARTMENTAL BUILDING  
 STEELWORK DETAILS

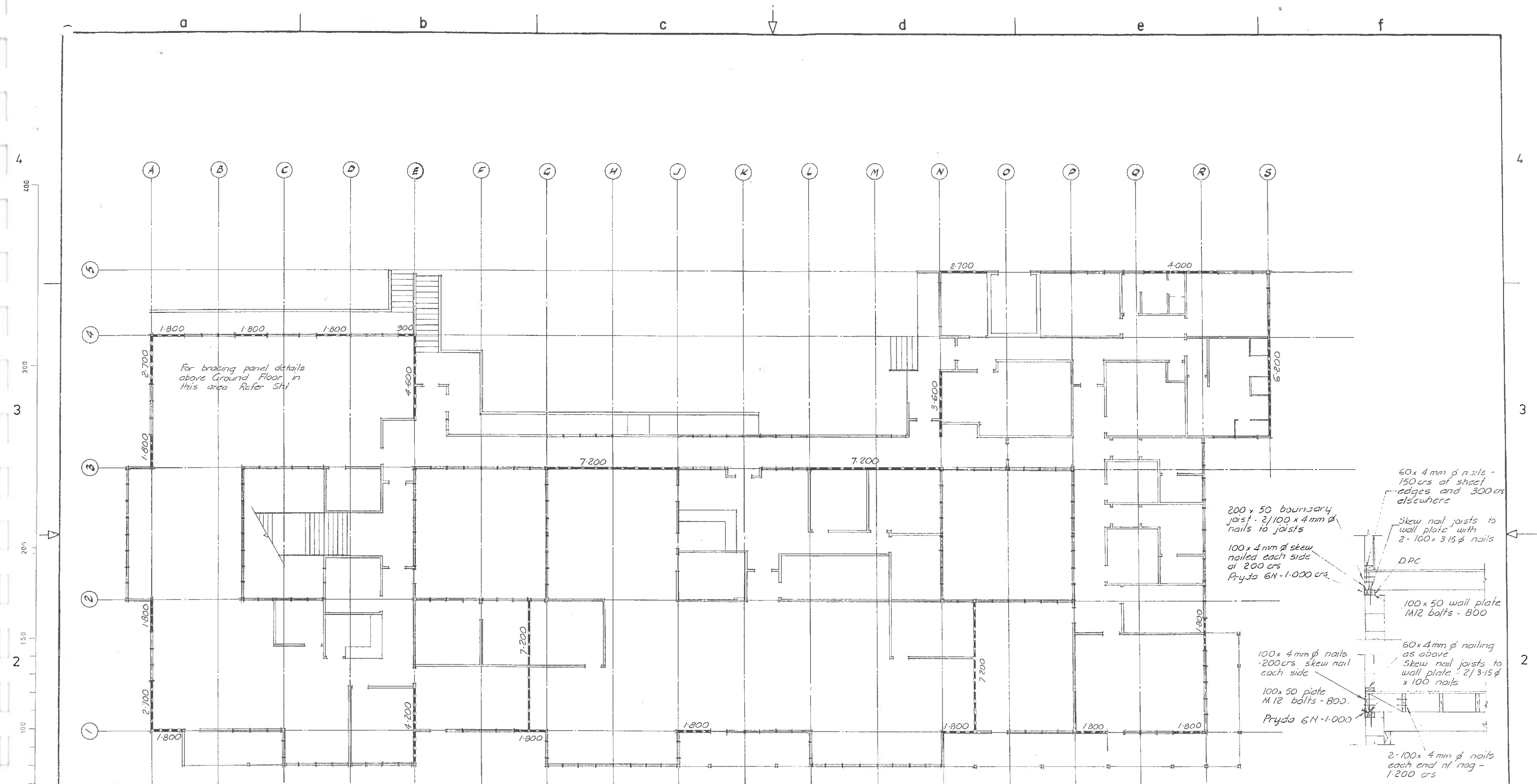
ORIGINAL SCALES 1:10	FILE
W.A.R. 4A077	
JOB 2/850/1	CODE 7202
SHEET 206	REVISION

ORIGINAL SIZE A1

ORIGINAL SIZE A1  
 Whole numbers = mm  
 Decimised expressions = m unless indicated otherwise



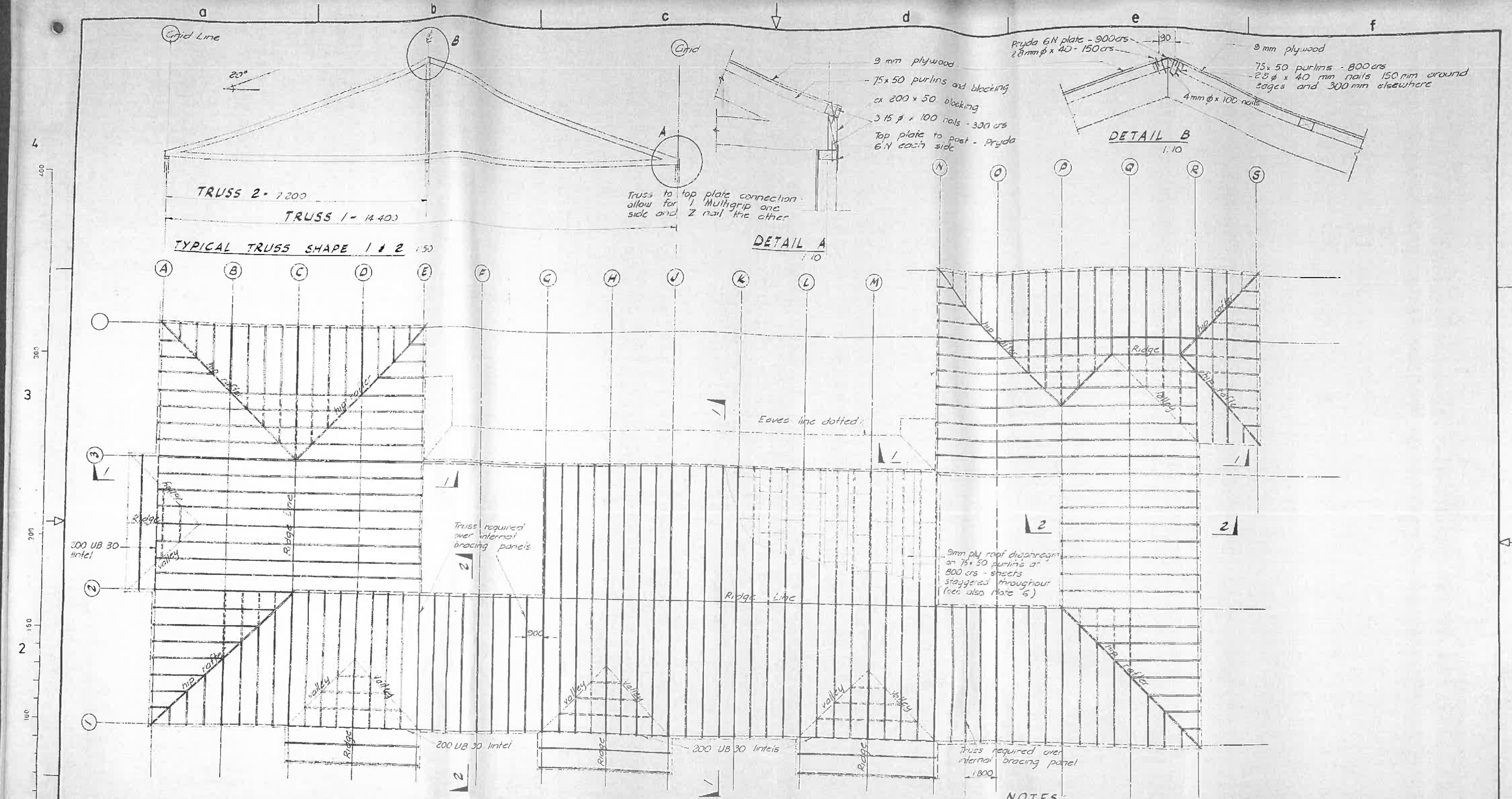




**DIAPHRAGM FLOOR FIXING**  
1:20

- NOTE:-**
1. All bracing panels to be 9 mm plywood - 100 x 100 post each end
  2. For Ground Floor bracing plan - refer Sheet 207
  3. For further bracing panel fixing details - refer Sheet 207

ORIGINAL SIZE A1	DESIGN	BY	CHECKED	DATE	R. L. PRESTON CHIEF CIVIL ENGINEER	 Ministry of Works and Development CIVIL ENGINEERING HAMILTON STRUCTURAL DESIGN OFFICE T.G. SHADWELL Commissioner	G.O.A.B. TE KUITI DEPARTMENTAL BUILDING  BRACING PLAN	ORIGINAL SCALES	1:100	1:20	FILE	
	DRAWN	BY	CHECKED	DATE				T. N. MITCHELL CHIEF STRUCTURAL ENGINEER	4A077			
	DRG. SUP.	BY	CHECKED	DATE				APPROVED:	JOB	CODE	SHEET	REVISION
	COORD. CHK.	BY	CHECKED	DATE				RECOMMENDED:	2185011	7202	208	
AMENDMENTS		BY	APPD.	DATE								



TRUSS LAYOUT PLAN  
1:100

NOTES

- 1 Contractor to verify all dimensions on site before fabrication
- 2 Trusses at 900 crs are indicative only. Trusses and nail plates to be designed by the Manufacturer as per the Specification
- 3 Trusses fixed to top plate with Multigrip one side and 1 Z type nail the other side
- 4 9mm ply roof diaphragm fixed to purlins with 2.8 phi x 40 mm nails at 150 mm around sheet edges and 300 mm at intermediate supports
- 5 All framing, noggling, packing to be in accordance with NZS 3604
- 6 Ply sheets to be fully supported around edges nog 75 x 50 crs required

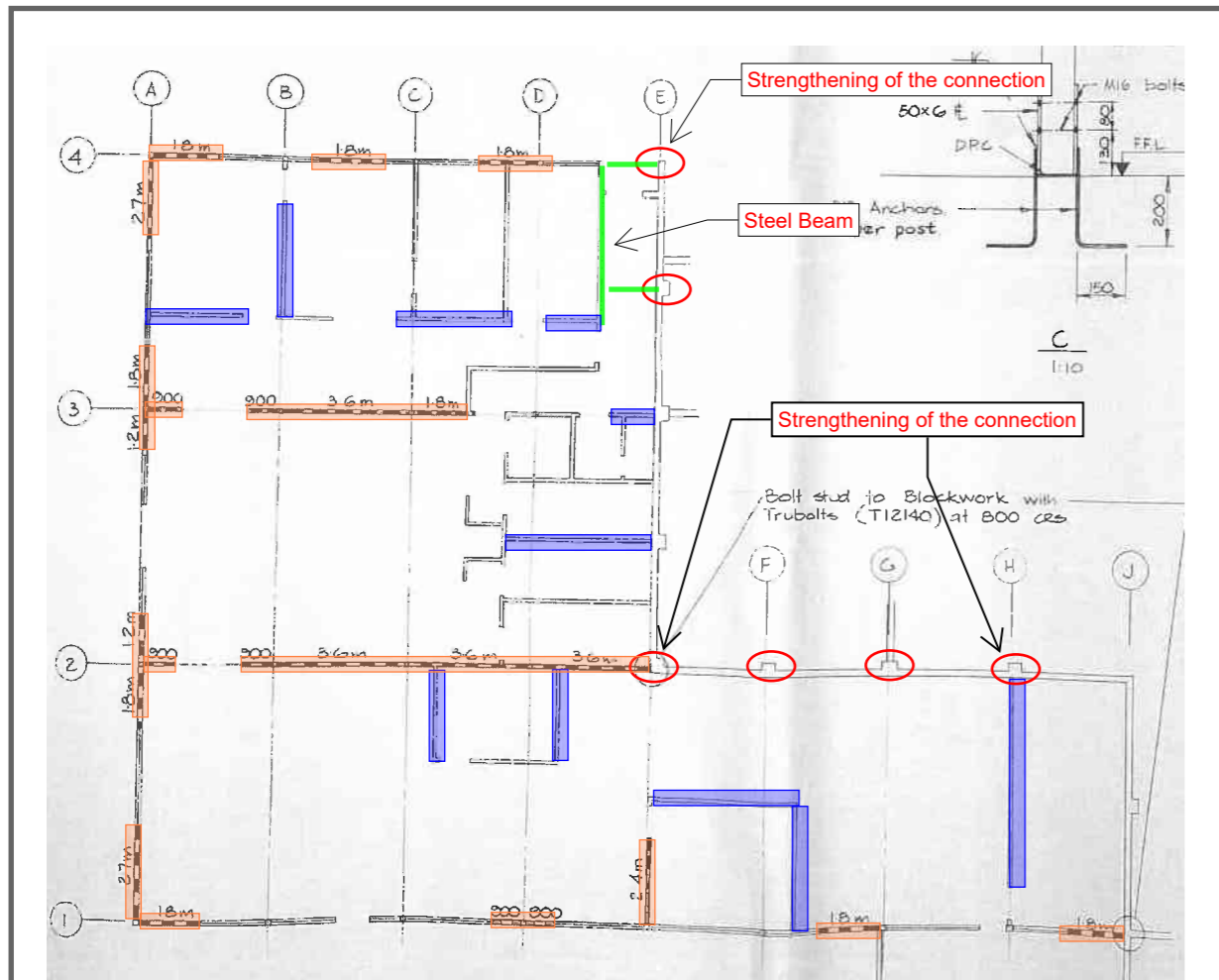
ORIGINAL SIZE A1	DESIGN	BY	CHECKED	DATE	R. L. PRESTON CHIEF CIVIL ENGINEER	Ministry of Works and Development	G.O.A.B. TE KUITI DEPARTMENTAL BUILDING	ORIGINAL SCALE	FILE		
	DRAWN			9-85				T. N. MITCHELL CHIEF STRUCTURAL ENGINEER	CIVIL ENGINEERING HAMILTON STRUCTURAL DESIGN OFFICE	1:100	4A077
	DRG SUP			10-85	APPROVED	Commissioner	TRUSS LAYOUT	JOB	CODE	SHEET	REVISION
	COORDCHK							2/850/1	7202	209	
	RECOMMENDED										
AMENDMENTS	BY	APPD.	DATE								



# Appendix B

## Concept Strengthening Plans

# Concept Strengthening Plan

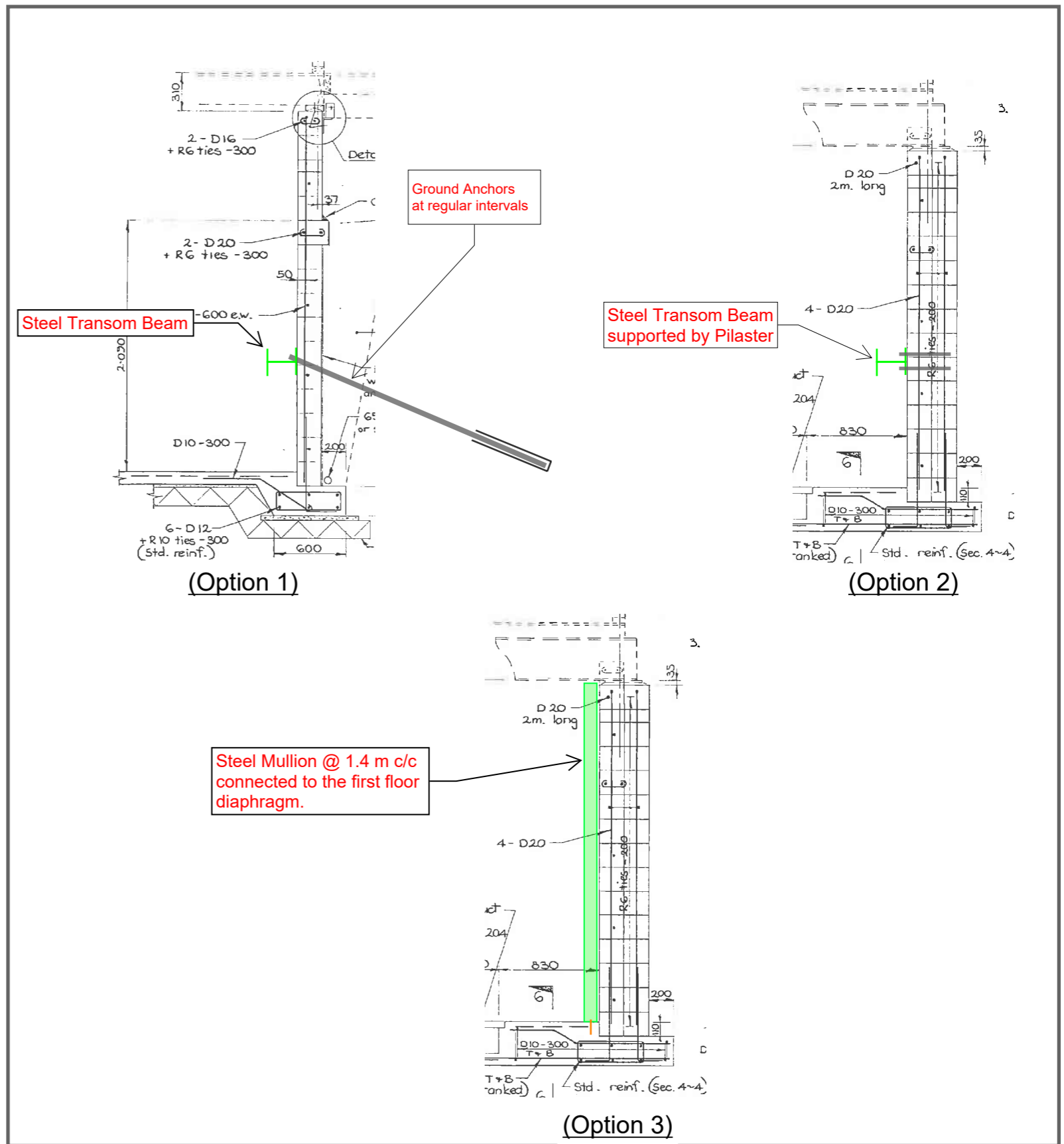


Ground Floor Strengthening Plan

- - Strengthening of Existing bracing Elements by replacing the current lining with new GIB lining
- - Strengthening of Existing full height walls by new GIB lining
- - New Steel Beam

### Notes:

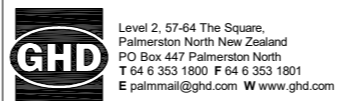
- Fix the existing roof ply board with additional 3.15 mm dia nails at 150 c/c at edges of the ply.



Strengthening of Block walls

SCALE: NTS

Rev	Description	Checked	Approved	Date
A	PRELIMINARY STRENGTHENING PLAN	EE	AV	23.02.23
Author	SB	Drafting Check	EE	
Designer	SB	Design Check	EE	



GHD Pty Ltd  
 Conditions of Use: This document may only be used by GHD's client (and any other person who GHD has agreed can use this document) for the purpose for which it was prepared and must not be used by any other person or for any other purpose.



Project No.  
12545999

Client	Waitomo District Council
Project	WDC Administrative Building
Status	PRELIMINARY DESIGN

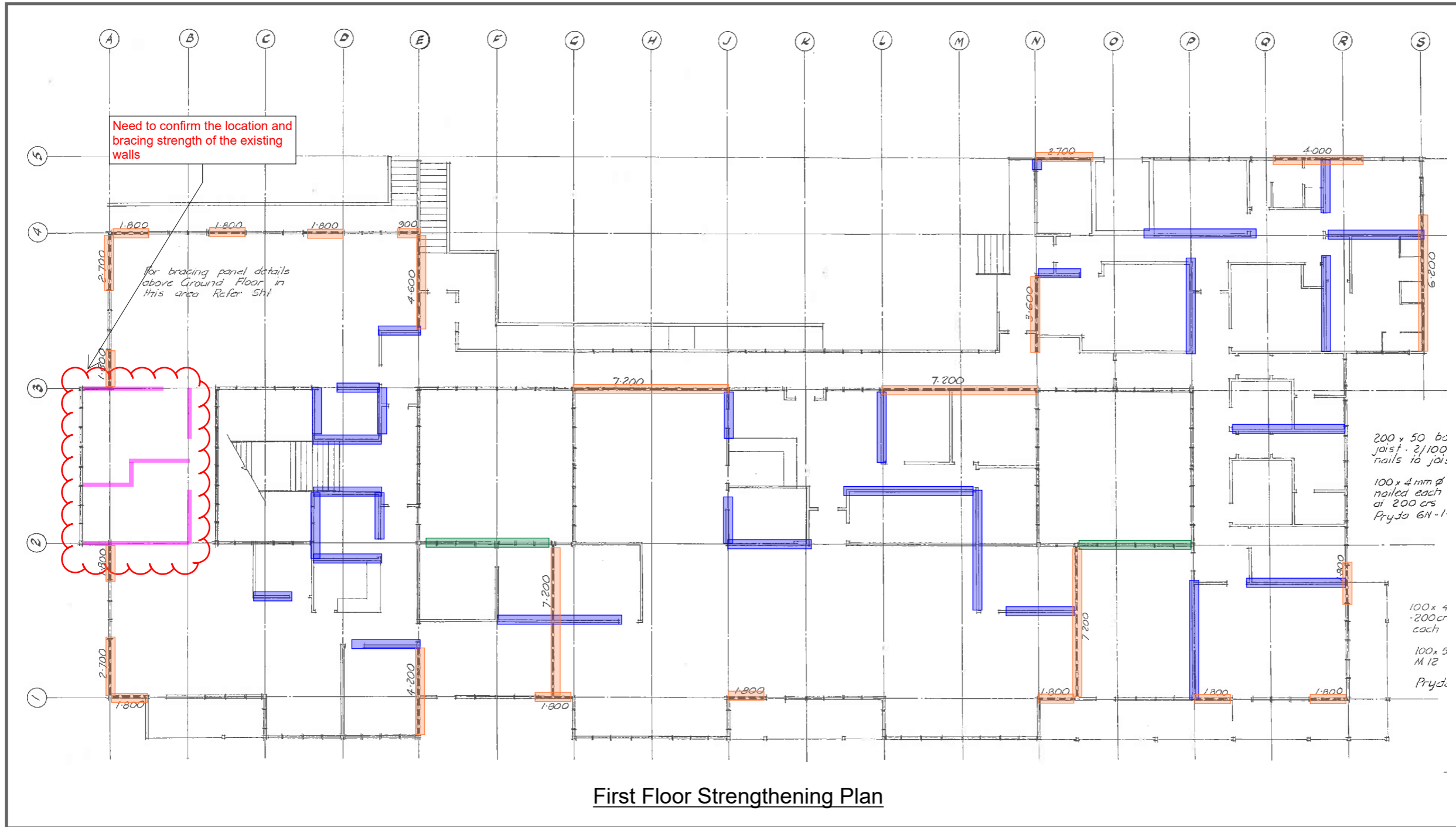
Drawing Title	Preliminary Strengthening Plan
Status	S0
Drawing No.	12545999-SKT-STR-001

Size  
A3  
Rev  
A

# Concept Strengthening Plan

- Strengthening of Existing bracing Elements by replacing the current lining with new GIB lining
- Strengthening of Existing full height walls by new GIB lining

- New GIB braced walls



## Notes:

-As the connection details for the existing particle board with the timber walls/ concrete block walls at first floor are missing in the existing drawings, the extent and detail for the strengthening of the diaphragm can only be determined following inspection of the existing connections.

SCALE: NTS

Rev	Description	Checked	Approved	Date
A	PRELIMINARY STRENGTHENING PLAN	EE	AV	23.02.23
Author	SB	Drafting Check	EE	
Designer	SB	Design Check	EE	

**GHD**  
Level 2, 57-64 The Square,  
Palmerston North New Zealand  
PO Box 447 Palmerston North  
T 64 6 353 1800 F 64 6 353 1801  
E palmmail@ghd.com W www.ghd.com



Client **Waitomo District Council**

Project **WDC Administrative Building**

Status **PRELIMINARY DESIGN**

Drawing Title **Preliminary Strengthening Plan**

Status Code **S0**

12545999-SKT-STR-002

Size **A3**  
Rev **A**

# Appendix C

## Geotechnical Report

# Mark T Mitchell Ltd

---

Consulting Geotechnical Engineers

1150 Victoria Street  
P O Box 9123  
Hamilton 3240  
New Zealand  
Telephone 07 838 3119  
Facsimile 07 839 3125  
email: [mtm@geocon.co.nz](mailto:mtm@geocon.co.nz)

Ref: W – 15387.7  
5 October, 2017

Waitomo District Council  
c/- Design Management Consultants Ltd  
PO Box 5254  
Hamilton 3242

Attention: Lyall Green

Dear Sirs,

**Re: Soils Investigation, Geotechnical Assessment for Site Subsoil Class and Liquefaction Potential  
Waitomo District Council Building – Queen Street, Te Kuiti**

In accordance with your request, we have carried out a Soils Investigation and Geotechnical Assessment of the above referenced property. The purpose of our investigation and assessment was to determine and evaluate the subsurface conditions within the property and provide a structural assessment of the Waitomo District Council building.

Our associate company, Geocon Geotechnical Ltd has carried out soil testing of the proposed building site area and the results of that testing are presented in the attached Geocon report dated 21 August, 2017.

## **1. Site Information**

The near level, industrial site is accessed from the south-eastern side of Queen Street, Te Kuiti. An existing commercial building for Waitomo District Council with a carpark at the rear of the building are located as shown on the attached Geocon Site Plan.

## **2. Soil Conditions**

### **2.1 Local Geology**

The Waitomo District Council building is founded on a deposit known as the Ongatiti Formation. The Ongatiti Formation is understood to have been deposited as variably-welded ignimbrites and airfall ash deposits, and as such typically show a broad range of strengths. These soils in their weathered form typically consist of pumiceous silts and clays with weathered vitrophyric pumice inclusions.

The soils underlying the ignimbrite deposits are mapped by GNS (QMAP, 2005) as early Miocene Taumatamaire Formation, being a massive to weakly bedded calcareous mudstone of the Mahoenui Group.



## 2.2 Subsoil Classification

The Australian/NZ Standard AS/NZS 1170.5:2004: *Part 4: Earthquake Loads* provides a subsoil classification as a means to assess the susceptibility of subsoils to amplify seismic waves arising from motions of the underlying bedrock.

In terms of alluvial deposits, such as occur within Te Kuiti, where the depth to Ignimbrite or mudstone is shallow, the soils are classified as *Class C; Shallow soil*. But within the central part of the Te Kuiti valley, the depth to rock may be in the order of 40 metres, in which case the subsoil classification is *Class D: Deep soil types*.

The results of the Cone Penetrometer Tests carried out at this site (refer to Geocon Report Figs. B-1A to B-2B) indicate effective refusal at depths of 9.0m and 15.0m respectively.

In terms of AS/NZ 1170.5: 2004, Part 5 the Site Subsoil Class is *Class C; Shallow soil types*

## 3. Liquefaction Potential Assessment

### 3.1. Cone Penetrometer Testing

The site investigations included two Cone Penetrometer Tests (CPT) to depths of 9 and 15 metres that were carried out by Opus International Consultants Ltd. The results of these tests are presented on Figs. B-1A, B-1B, B-2A and B-2B.

### 3.2. Assumed Groundwater Levels

Groundwater was detected in CPT Nos. 1 and 2 at a depth of 2.2 and 2.1 metres respectively. The liquefaction analyses described below have assumed groundwater level to be present at these indicated depths. Within a liquefaction assessment, the location of the groundwater level is critical, as liquefaction will only occur within soils located below the groundwater level.

Ground settlement in response to earthquake-related ground vibrations will also occur in any loose soils that are located above groundwater levels, but that situation does not normally form part of a liquefaction assessment

### 3.3 Liquefaction Assessment - Ultimate (ULS) and Serviceability Limit (SLS) States

The New Zealand design loads code NZS 1170 defines two design conditions which need to be assessed for the purpose of liquefaction assessment.

- ULS – Ultimate Limit State is concerned with ground damage associated with a 500-year earthquake event, and all commercial buildings such as this one are to be designed to avoid collapse and potential loss of life.
- SLS – Serviceability Limit State is concerned with ground damage associated with smaller earthquakes with a return period of 25 years. Buildings and their non-structural components are to be designed to withstand permanent damage for a 25-year event.

In addition, our analyses include an intermediate state, based on a 100-year return period earthquake event, with a typically assumed design life for most buildings being in the range of 50 to 100 years.

For the subject site, peak ground acceleration (PGA) for SLS and ULS are determined to be 0.05g and 0.21g respectively and 0.10g for the 100-year event. Earthquake magnitude is determined to be 6.0, in accordance with New Zealand Geotechnical Society and MIBE Guidelines for Earthquake Geotechnical Engineering Practice in NZ: Module 1 (2016).

### 3.4 Liquefaction Assessment Method

The liquefaction assessment was carried out in accordance with the Idriss and Boulanger (2014) Method.

For this method the CPT database has been updated adding data from more recent earthquakes, with a significant number of liquefaction case histories from the Canterbury Earthquake Sequence (50 in total) being added to the dataset. In addition, some of the older case studies have been re-examined.

### 3.5 Liquefaction Assessment Results

Liquefaction studies were carried out for the soil profiles of CPT-01 and CPT-02 and results are attached in a series of figures (Figs C-1 to C-8), with the Basic Data presented as the front page of each set.

#### 3.5.1 Analyses for SLS Event

- All FS plots (Factor of safety plots) for the SLS event show zero potential for liquefaction under a 25-year return period seismic event. Refer to Figs. C-2 and C-6.

#### 3.5.2 Analyses for 100-year Event

- The FS plots for the 100-year return period seismic event show associated ground settlements are expected to be in the order of between 1 to 4mm and lateral displacement values to be moderate. Refer to Figs. C-3 and C-7.
- However as the site is near-level, the predicted lateral displacement values do not apply to this site.
- Therefore no special construction works will be required to mitigate the potential effects of a seismic event of this return period.

#### 3.5.3 Analyses for ULS Event

- The FS plots for the ULS (extreme) event show associated ground settlements are expected to be in the order of between 40mm to 110mm and lateral displacement values to be moderate to high. Refer to Figs. C-4 and C-8.
- There is a moderate probability of liquefaction under a seismic event of this return period, this being on account of the presence of interbedded, low-strength silt and sand soils located at depths of between 4.0 to 9.5 metres below ground level.
- These results also indicate that no special construction works will be required to mitigate the potential effects of ULS seismic event at this site, apart from for building egress considerations.
- The ULS event is assessed primarily to ensure that the structure is designed to ensure that egress from the building is available in the event of the as-calculated ground settlements occurring.





### 3.6 Recommendations – Liquefaction Mitigation

The results of our studies indicates that site liquefaction is not expected to occur for the SLS (25-year return period) and that the effects of site liquefaction from the 100-year and 500-year events is expected to be minimal.

Therefore we advise there is no requirement to use deepened piles or other ground improvement measures are required to mitigate the effects of earthquake-related ground movements.

Yours faithfully

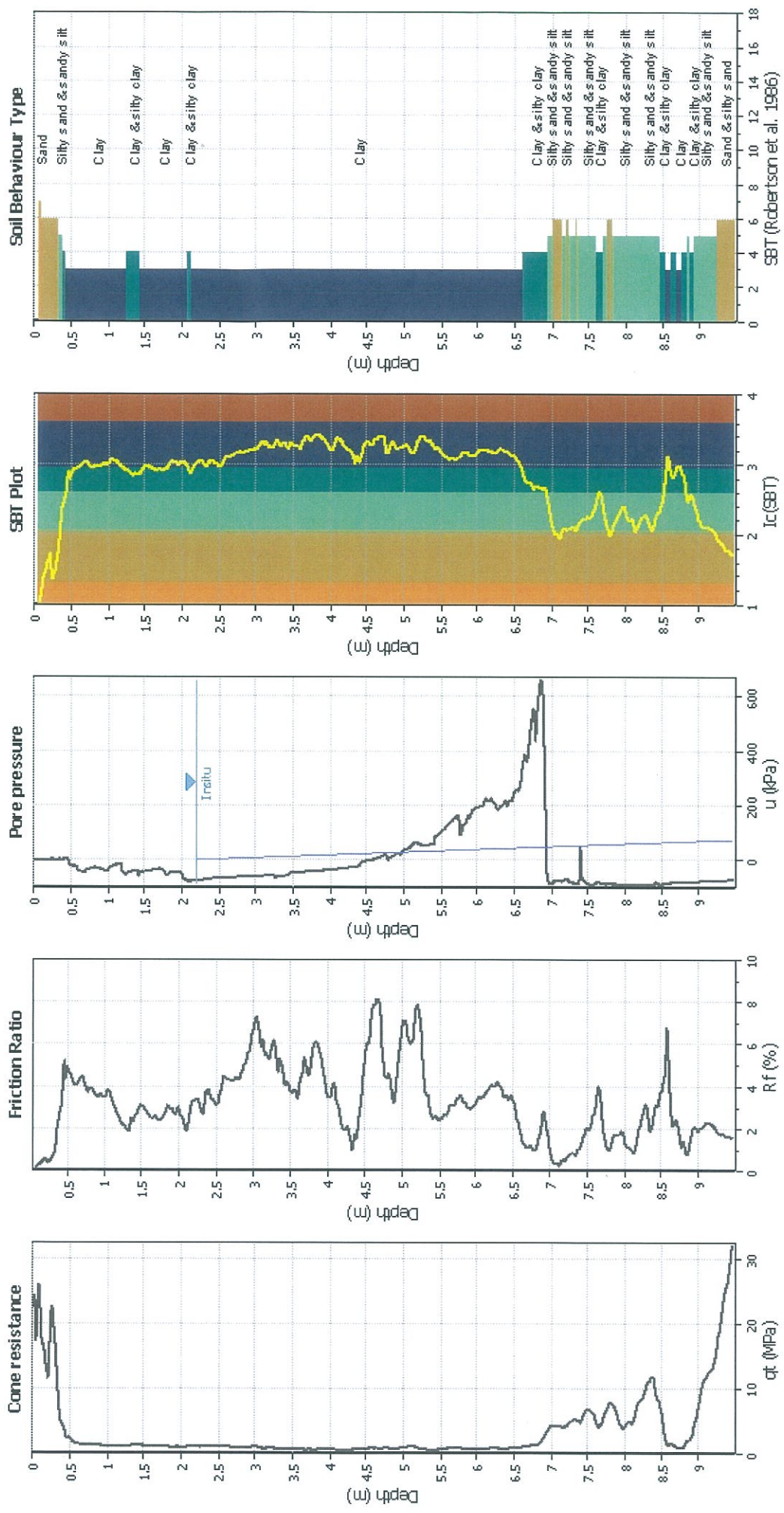
**Mark T Mitchell Ltd**



Mark T Mitchell  
Director



### CPT basic interpretation plo



### Input parameters and analysis data

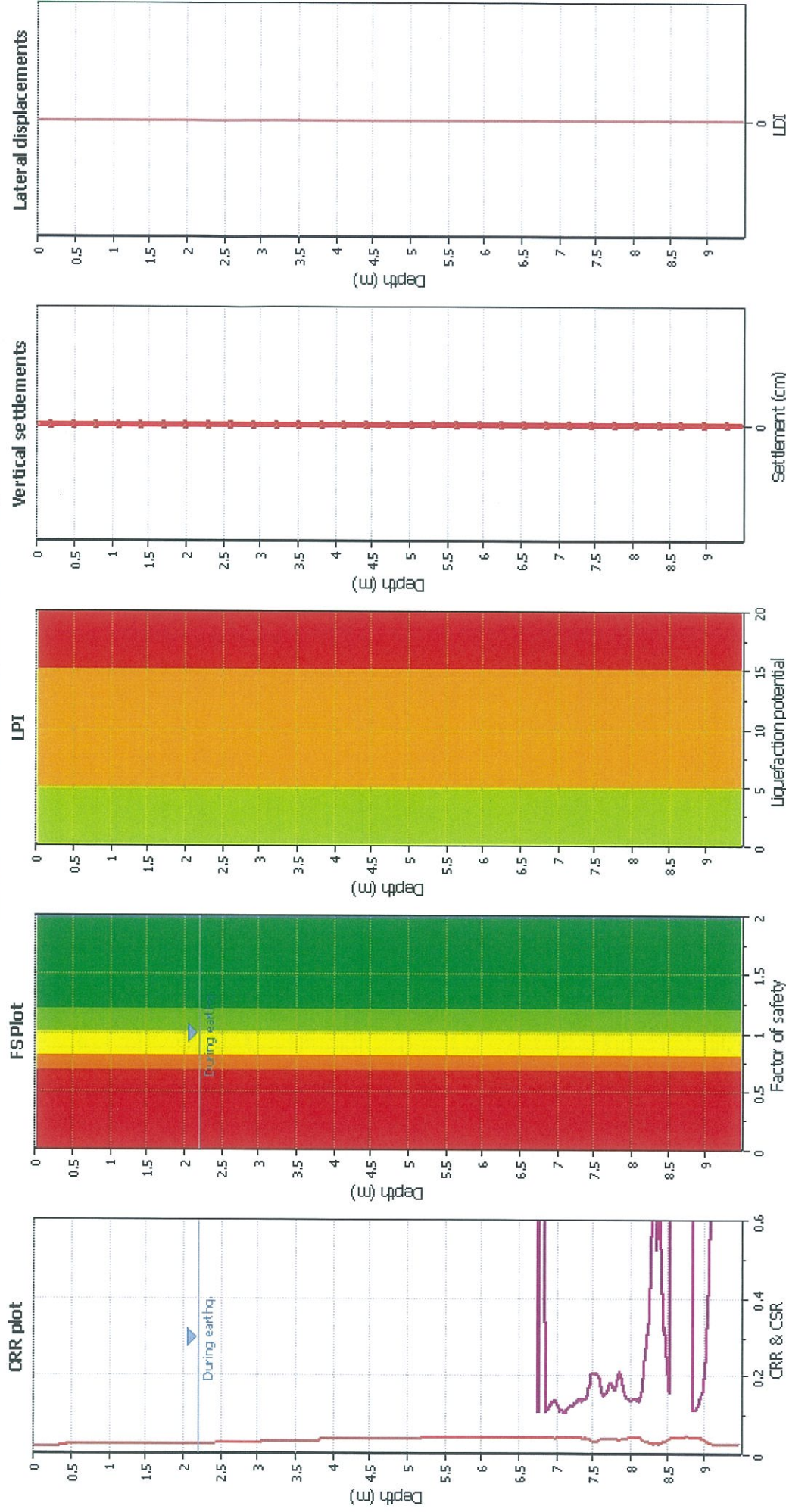
Analysis method:	B&I (2014)	Depth to GW (erthq.):	2.20 m	Fill weight:	N/A
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>v</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.10	Use fill:	No	Limit depth applied:	No
Depth to water table (insttu):	2.20 m	Fill height:	N/A	Limit depth:	N/A

### SBT legend

- 1. Sensitive fine grained
- 2. Organic material
- 3. Clay to silty clay
- 4. Clayey silt to silty
- 5. Silty sand to sandy silt
- 6. Clean sand to silty sand
- 7. Gravely sand to sand
- 8. Very stiff sand to
- 9. Very stiff fine grained



### Liquefaction analysis overall plot



#### Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.05  
 Depth to water table (instu): 2.20 m

Depth to GW (earthq.): 2.20 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition detect. applied: No  
 $K_c$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: No  
 Limit depth: N/A

#### F.S. color scheme

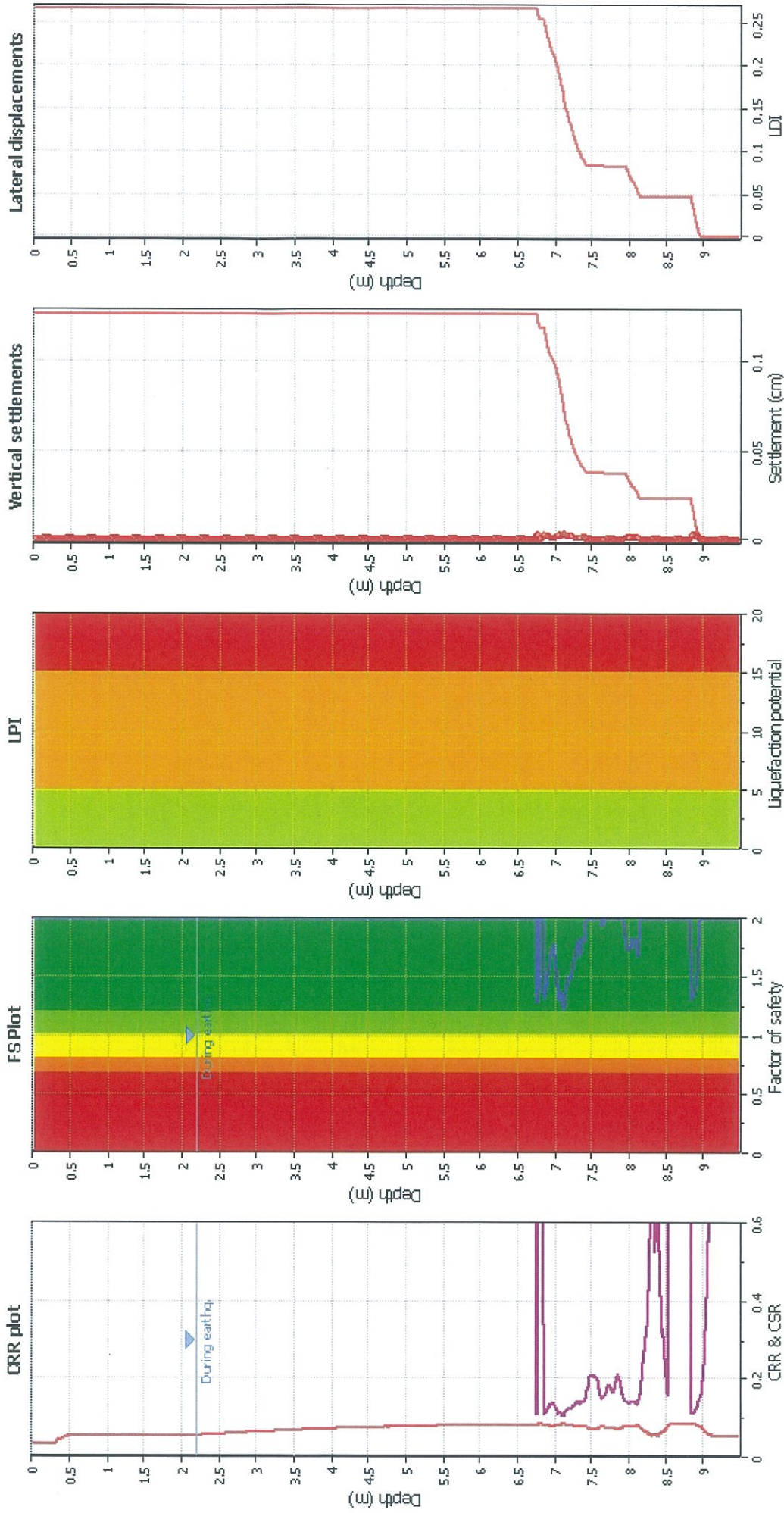
Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liq. are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk



### Liquefaction analysis overall plot



#### Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on I<sub>c</sub> value  
 Earthquake magnitude M<sub>w</sub>: 6.00  
 Peak ground acceleration: 0.10  
 Depth to water table (instu): 2.20 m

Depth to GW (earthq.): 2.20 m  
 Average results interval: 3  
 I<sub>c</sub> cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition detect. applied: No  
 K<sub>c</sub> applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: No  
 Limit depth: N/A

**F.S. color scheme**

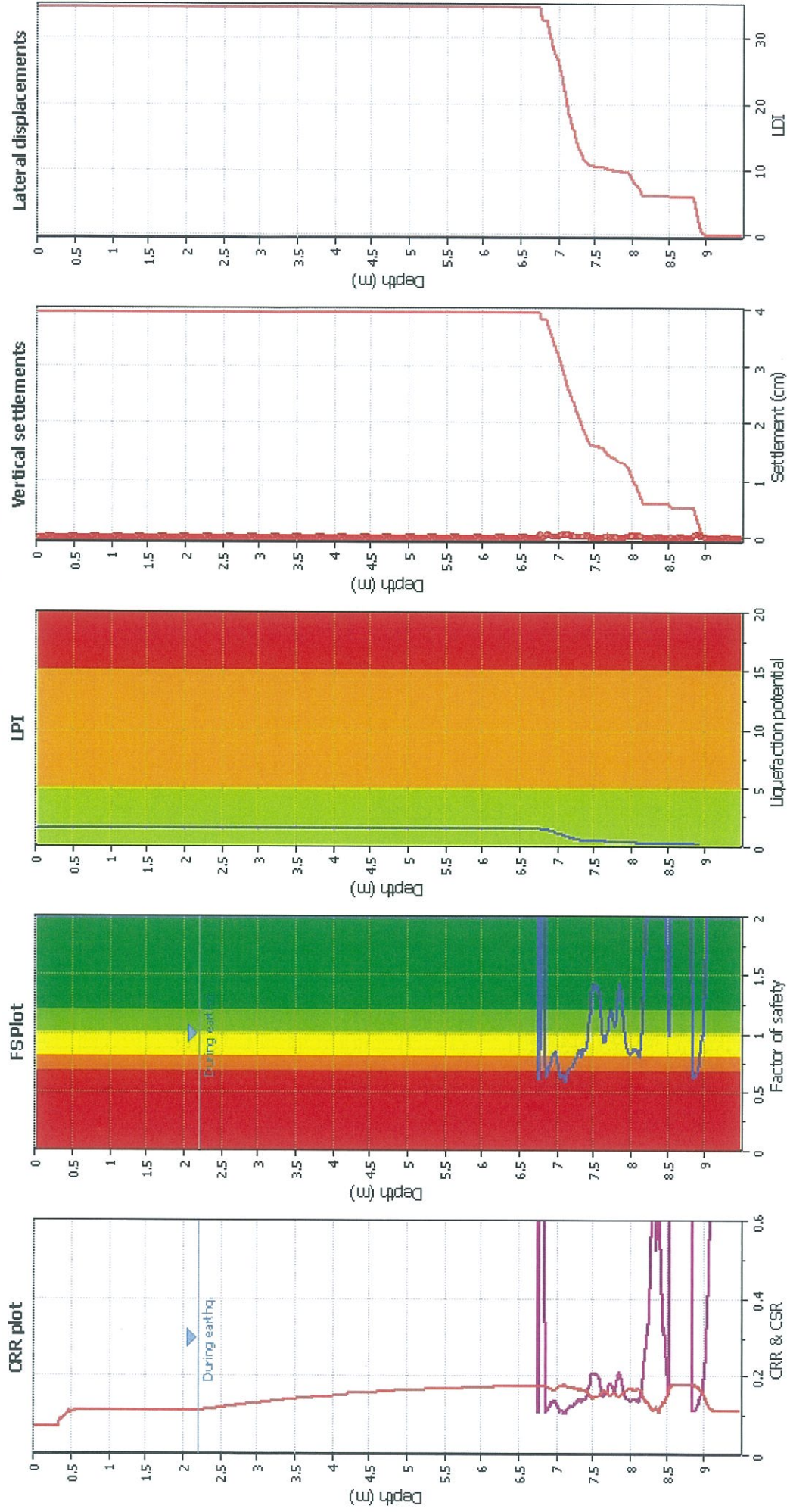
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk



### Liquefaction analysis overall plot



#### Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.21  
 Depth to water table (insttu): 2.20 m

Depth to GW (erthq.): 2.20 m  
 Average results interval: 3  
 Ic cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: No  
 Limit depth: N/A

#### F.S. color scheme

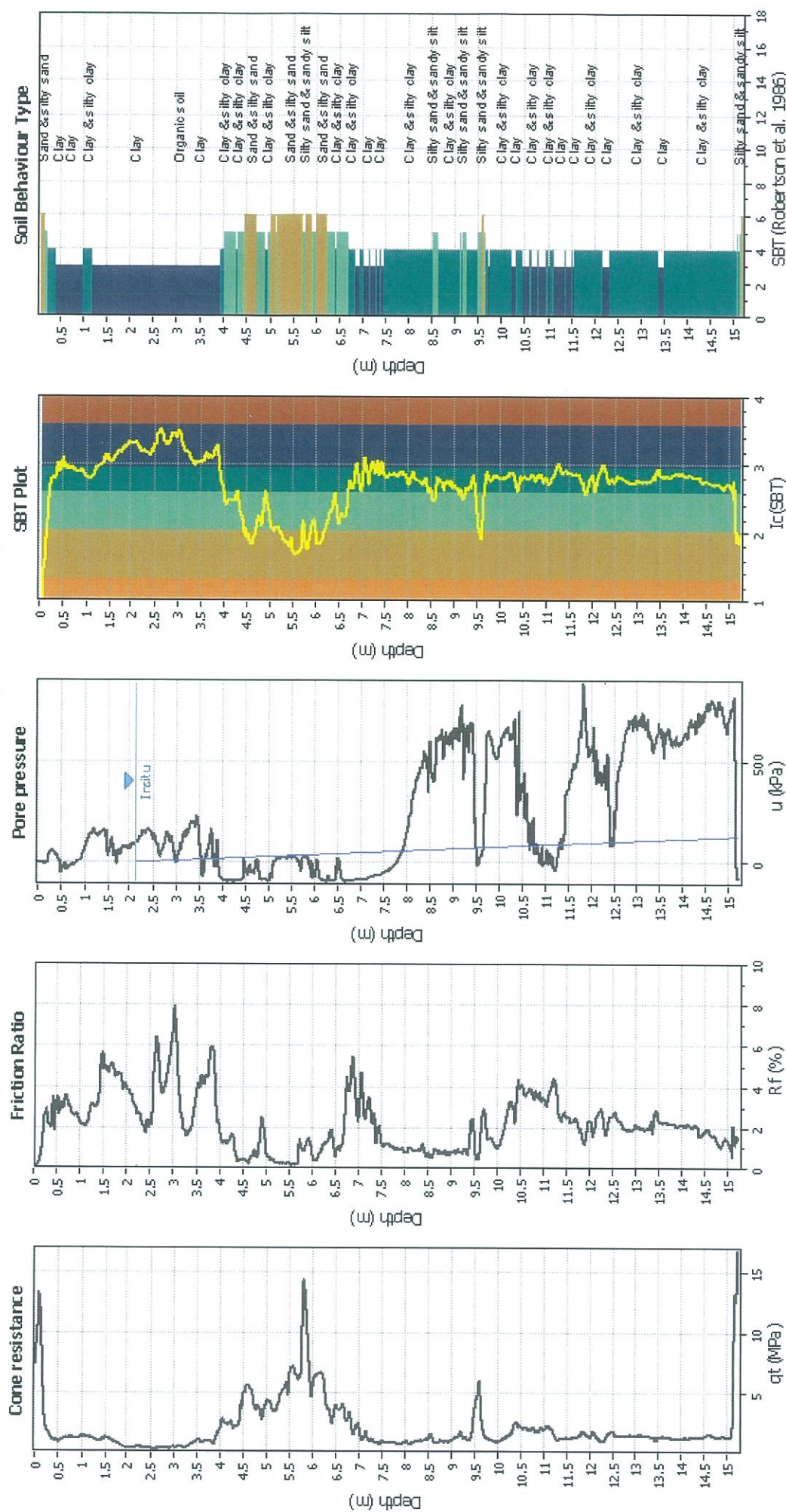
Almost certain it will liquefy  
 Very likely to liquefy  
 Liquefaction and no liq. are equally likely  
 Unlikely to liquefy  
 Almost certain it will not liquefy

#### LPI color scheme

Very high risk  
 High risk  
 Low risk



### CPT basic interpretation plo



### Input parameters and analysis data

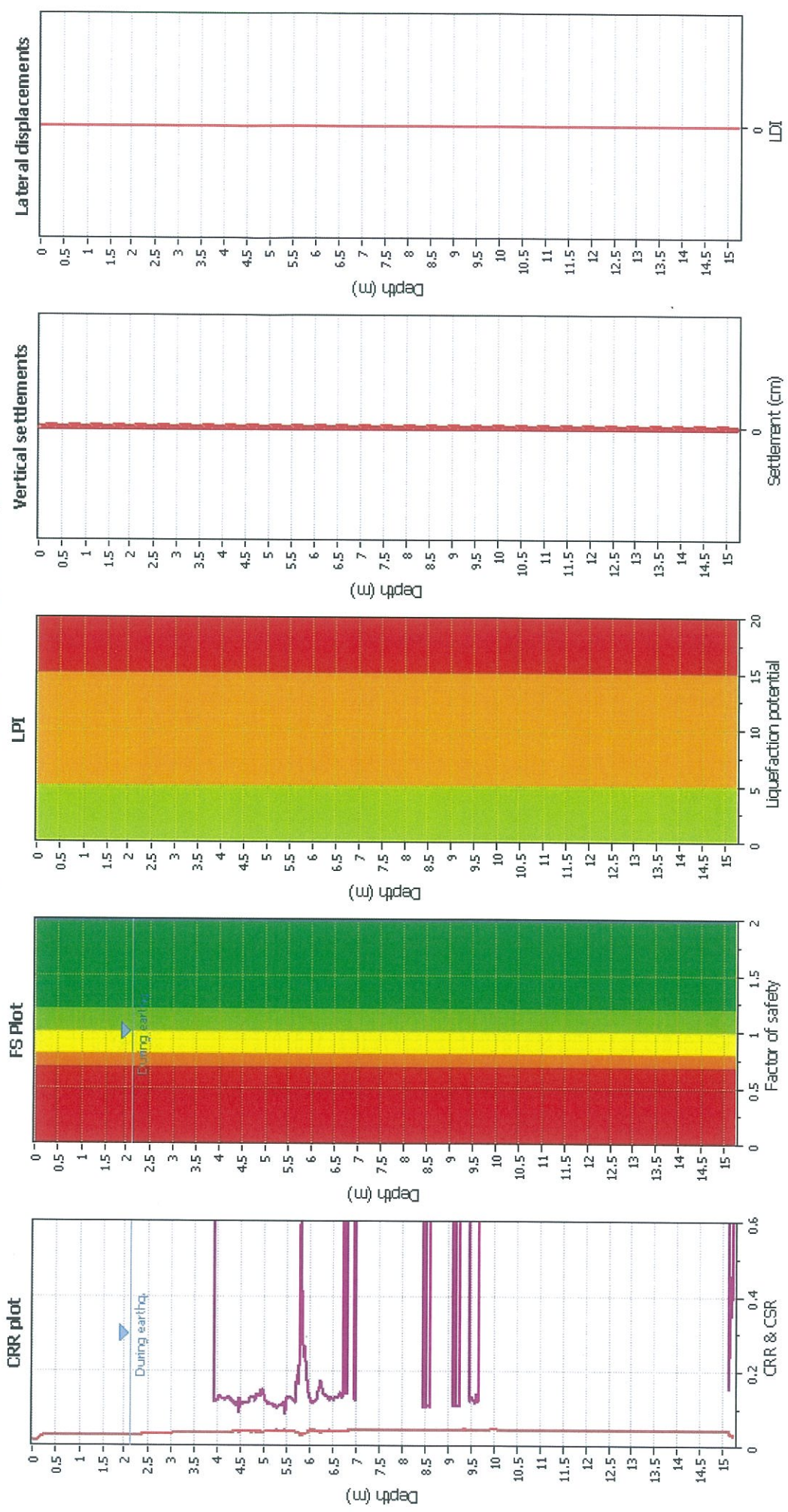
Analysis method:	B&I (2014)	Fill weight:	N/A
Fines correction method:	B&I (2014)	Transition detect. applied:	No
Points to test:	Based on Ic value	K <sub>c</sub> applied:	Yes
Earthquake magnitude M <sub>w</sub> :	6.00	Clay like behavior applied:	Sands only
Peak ground acceleration:	0.21	Limit depth applied:	No
Depth to water table (instu):	2.10 m	Limit depth:	N/A
Depth to GW (erthq.):	2.10 m		
Average results interval:	3		
Ic cut-off value:	2.60		
Unit weight calculation:	Based on SBT		
Use fill:	No		
Fill height:	N/A		

### SBT legend

1. Sensitive fine grained	4. Clayey silt to silty	7. Gravely sand to sand
2. Organic material	5. Silty sand to sandy silt	8. Very stiff sand to
3. Clay to silty clay	6. Clean sand to silty sand	9. Very stiff fine grained



### Liquefaction analysis overall plot



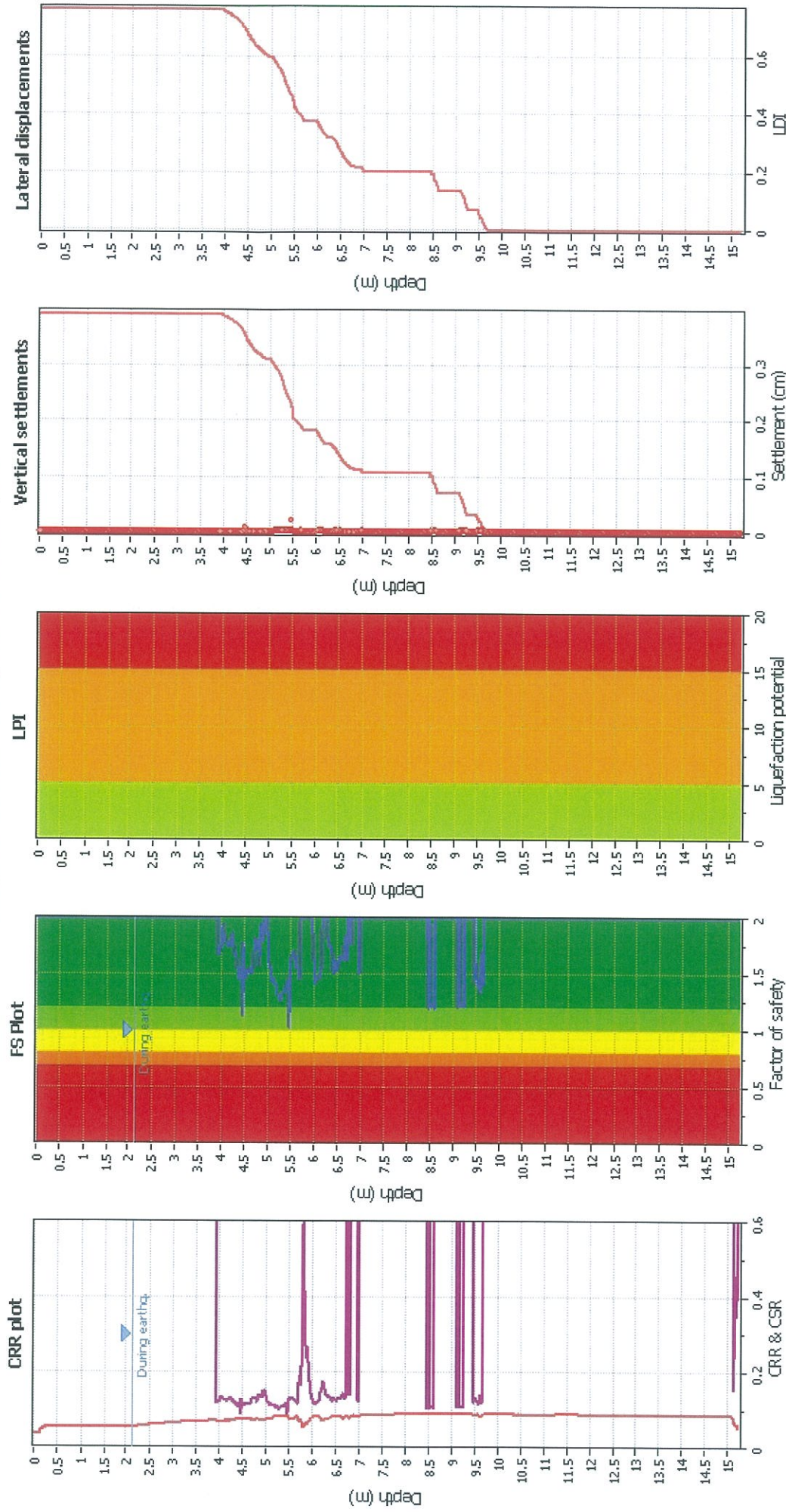
#### Input parameters and analysis data

Analysis method:	B&I (2014)	Depth to GWL (earthq.):	2.10 m	Fill weight:	N/A	F.S. color scheme	Almost certain it will not liquefy
Fines correction method:	B&I (2014)	Average results interval:	3	Transition detect. applied:	No	LPI color scheme	Very high risk
Points to test:	Based on Ic value	Ic cut-off value:	2.60	K <sub>0</sub> applied:	Yes		High risk
Earthquake magnitude M <sub>w</sub> :	6.00	Unit weight calculation:	Based on SBT	Clay like behavior applied:	Sands only		Low risk
Peak ground acceleration:	0.05	Use fill:	No	Limit depth applied:	No		
Depth to water table (insttu):	2.10 m	Fill height:	N/A	Limit depth:	N/A		

CPT2 PGA = 0.05 SLS Fig. C-6



### Liquefaction analysis overall plot



#### Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on  $I_c$  value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.10  
 Depth to water table (instu): 2.10 m

Depth to GW (earthq.): 2.10 m  
 Average results interval: 3  
 $I_c$  cut-off value: 2.60  
 Unit weight calculation: Based on SBT  
 Use fill: No  
 Fill height: N/A

Fill weight: N/A  
 Transition detect. applied: No  
 $K_0$  applied: Yes  
 Clay like behavior applied: Sands only  
 Limit depth applied: No  
 Limit depth: N/A

**F.S. color scheme**

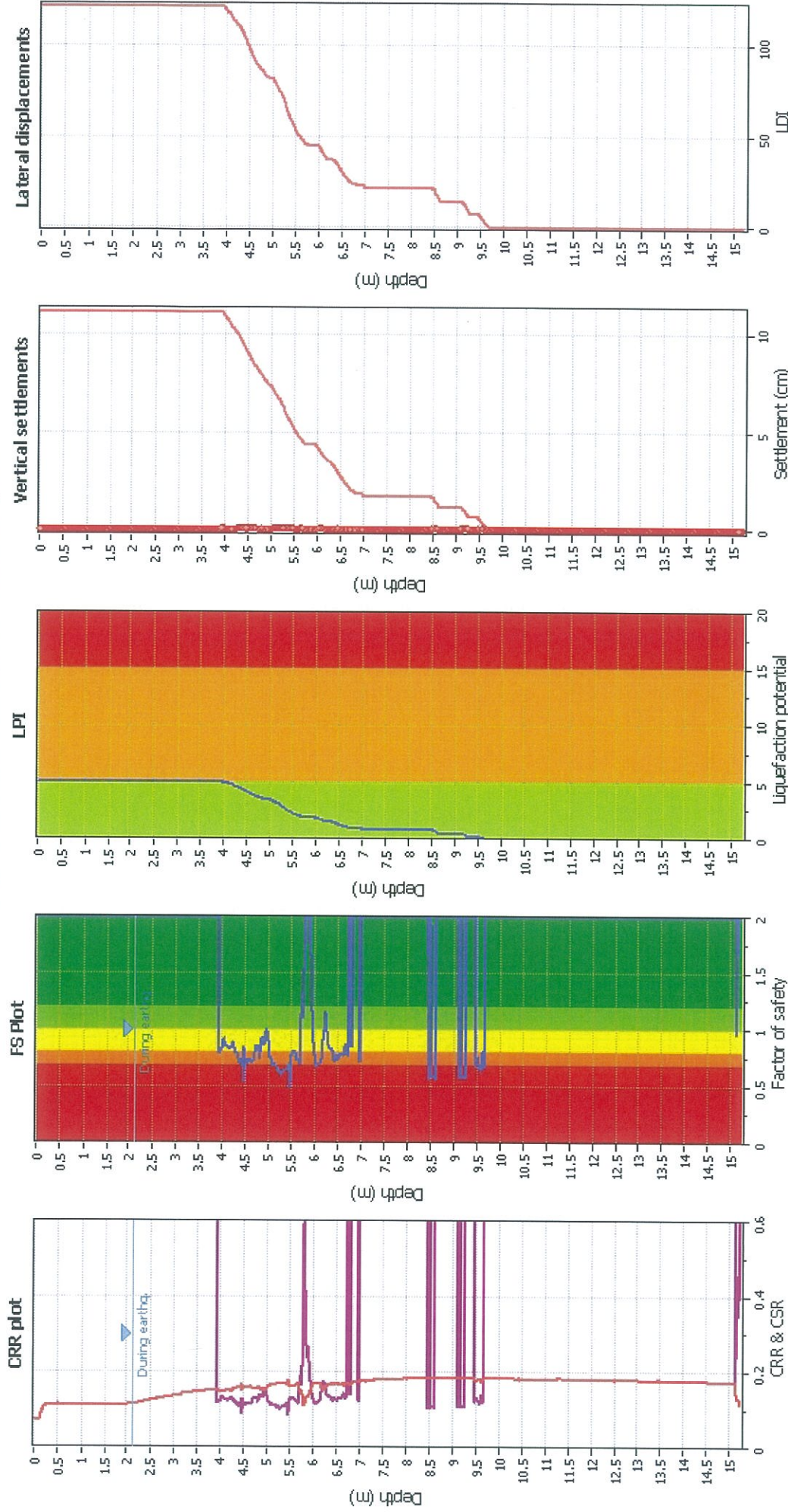
- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlikely to liquefy
- Almost certain it will not liquefy

**LPI color scheme**

- Very high risk
- High risk
- Low risk



### Liquefaction analysis overall plot



#### Input parameters and analysis data

Analysis method: B&I (2014)  
 Fines correction method: B&I (2014)  
 Points to test: Based on Ic value  
 Earthquake magnitude  $M_w$ : 6.00  
 Peak ground acceleration: 0.21  
 Depth to water table (insttu): 2.10 m

Depth to GW (earthq.): 2.10 m

Average results interval: 3

Ic cut-off value: 2.60

Unit weight calculation: Based on SBT

Use fill: No

Fill height: N/A

Fill weight: N/A

Transition detect. applied: No

$K_c$  applied: Yes

Clay like behavior applied: Sands only

Limit depth applied: No

Limit depth: N/A

#### F.S. color scheme

- Almost certain it will liquefy
- Very likely to liquefy
- Liquefaction and no liq. are equally likely
- Unlike to liquefy
- Almost certain it will not liquefy

#### LPI color scheme

- Very high risk
- High risk
- Low risk



# *Geocon Geotechnical Ltd*

---

Geotechnical Engineers

1150 Victoria Street  
PO Box 9123  
Hamilton, New Zealand  
Facsimile 07 839 3125  
Telephone 07 838 3119  
email:kevin@geocon.co.nz

Ref: G-15387.1  
4 September, 2017

Waitomo District Council  
c/- Mark T Mitchell Ltd  
Consulting Geotechnical Engineers  
P O Box 9123  
Hamilton 3240

Attention: Lyall Green

Dear Sir,

**Re: Site Investigation for Soil Classification  
Waitomo District Council, Queen Street, Te Kuiti**

In accordance with your request, we have carried out a Site Investigation at the above referenced property. The purpose of our studies was to determine the soils for the proposed structural assessment of the existing Waitomo District Council building.

The following report is based on site conditions as observed during a site investigation carried out by our geologists on 21 August, 2017 and Cone Penetrometer testing (CPT) completed by Opus International Consultants (NZ) (OPUS) Ltd on 21 August, 2017.

The near level, commercial site is accessed from the south-eastern side of Queen Street, Te Kuiti. An existing building used by Waitomo District Council with a carpark at the rear are located as shown on the attached Site Plan, Drawing No. 15387-01.

The results of the investigation are as follows:

## **1. Geomorphology and Geology**

The natural soils encountered at the test locations consist primarily of a deposit known as the Ongatiti Formation. The Ongatiti Formation is understood to have been deposited as variably-welded ignimbrites and airfall ash deposits, and as such typically show a broad range of strengths. These soils in their weathered form typically consist of pumiceous silts and clays with weathered vitrophyric pumice inclusions.

The soils underlying the ignimbrite deposits are mapped by GNS (QMAP, 2005) as early Miocene Taumatamaire Formation, being a massive to weakly bedded calcareous mudstone of the Mahoenui Group.

## **2. Field Investigation**

The subsurface conditions at the site were investigated by drilling two machine-auger borings together with Scala Penetrometer probes and *in-situ* shear vanes at the locations shown on the Site Plan. The Bore Holes are designated Nos. 1 and 2 with the Bore Hole Logs and associated test results presented on Figs. A-1 and 2.

The purpose of the borings and associated testing was to provide guidance as to the general subsurface soil profile, variability and relative density of soils within the proposed building areas. Actual conditions may vary across these areas however, and in some locations may differ slightly from those as described below.

Two, CPT's were carried out by OPUS and their locations are also shown on Site Plan. The CPT logs are designated CPT Nos. 1 and 2 and the results are presented on Figs B-1 and 2.

### **3. Subsurface Conditions**

The near-surface soil conditions at the site, as revealed by the bore holes, consist of 300mm of BASECOURSE overlying alternating layers of stiff to very stiff, pumiceous slightly clayey or clayey SILT, and stiff to very stiff, silty CLAY (Ongatiti Formation) to at least the base of the 6.0 metre deep bore holes.

Groundwater was encountered at 2.2 to 2.3 metres deep within the bore holes at the time of the site investigation.

Yours faithfully,

**Geocon Geotechnical Ltd.**



Josh Moir  
Engineering Geologist

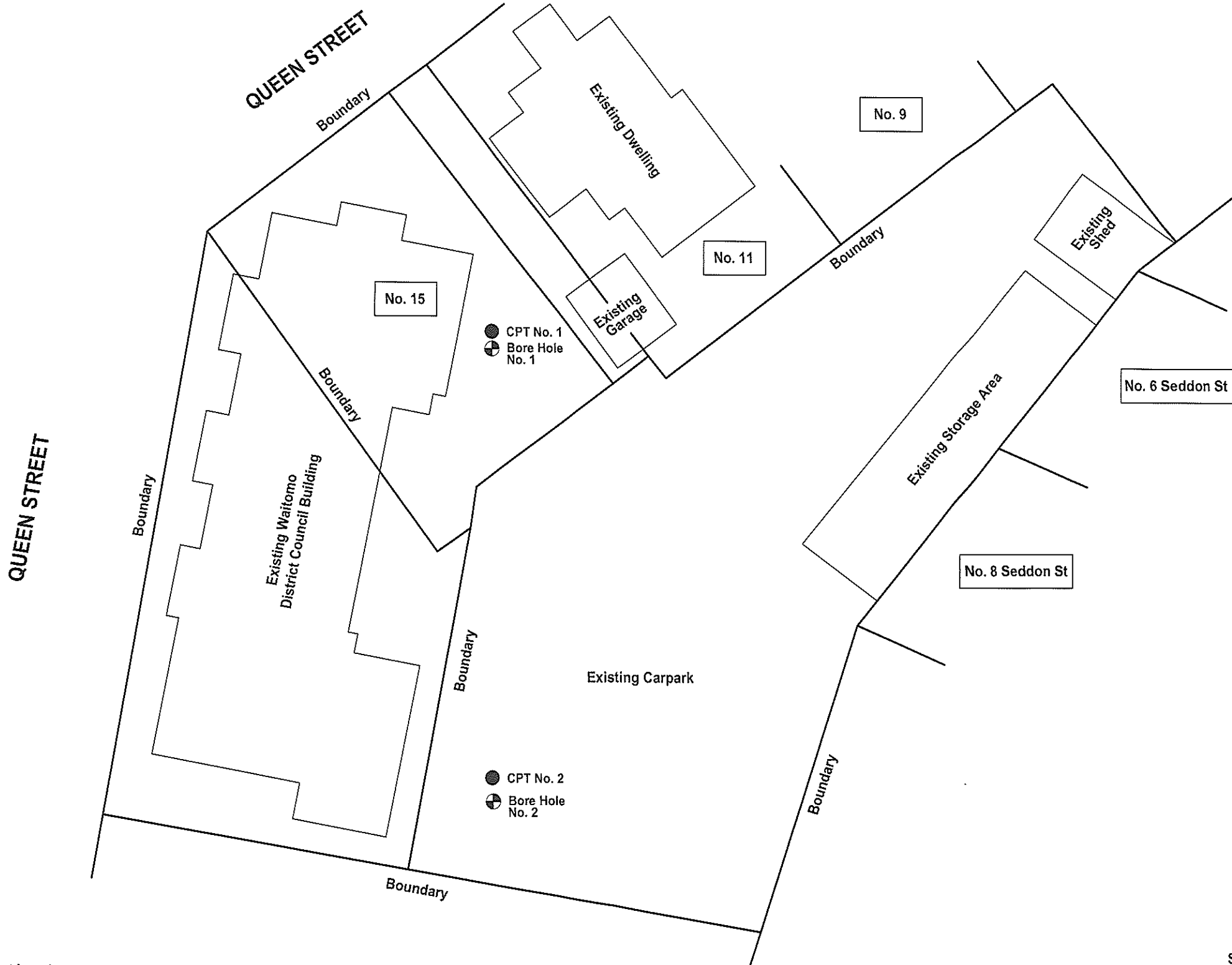
Approved by:



Geraint Walters  
Operations Manager

NOTE:

1. This drawing is reproduced from aerial imagery prepared by Waitomo District Council Intramaps.
2. All areas and distances where shown are subject to survey.



LEGEND

- ⊕ denotes Bore Hole locations
- " Cone Penetrometer Test locations

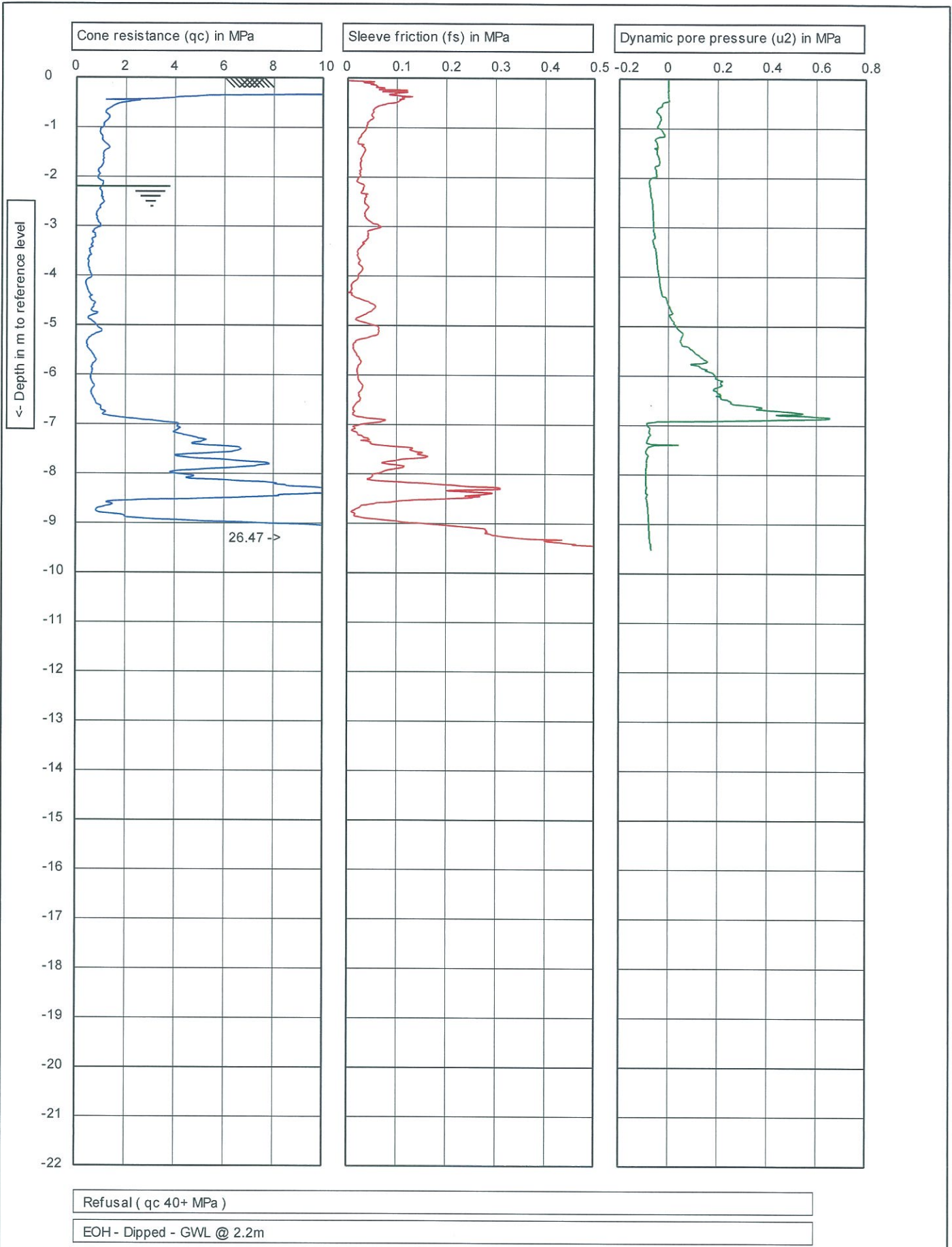
SCALE 1:500





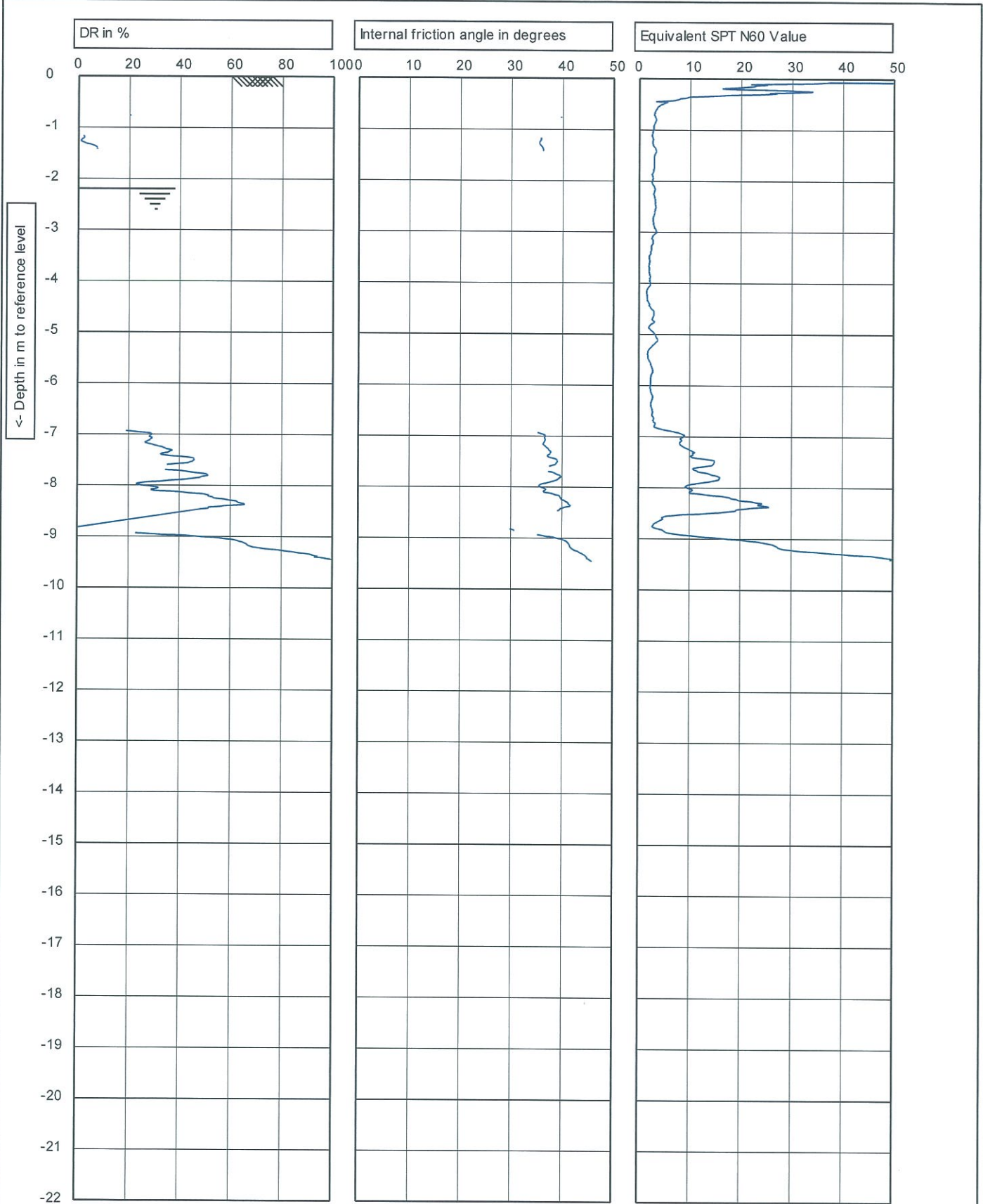
GRAPHIC LOG	BORE HOLE LOG No. 2		DEPTH (metres)	GEOLOGICAL FORMATION	VANE SHEAR STRENGTH - kPa (In-situ/Remoulded)	SCALA PENETROMETER (blows/100mm)										PIEZOMETER / WATER LEVEL					
	SOIL DESCRIPTION					1	2	3	4	5	6	7	8	9	10						
		BASECOURSE.		B/C																	
		SILT with trace clay. Very stiff, moist, pumiceous, low plasticity, light brown. Becoming firm @ 0.6 metres.	1	Ongatiti Formation	100/24																
					40/2																
					38/4																
					42/6																
					78/18																
		clayey SILT. Stiff, moist, pumiceous, highly plastic, slightly iron stained, light greyish brown. Becoming silty CLAY @ 1.5 metres. " wet @ 3.0 metres.	2		78/28																
				80/34																	
	SILT with some clay. Very stiff, moist to wet, light yellowish brown. Containing pumiceous gravels and lithics.	3		84/30																	
				86/40																	
	silty CLAY. Stiff, moist, highly plastic, reddish orange with light grey mottling.	4		92/14																	
				90/16																	
	clayey SILT. Stiff, moist to wet, light grey and brown. Containing pumiceous gravels and dark red and black lithics.	5		82/24																	
				86/36																	
				90/42																	
			6																		
	Bottom of Bore Hole completed 21/08/17																				
<b>NOTES</b> - The stratification lines represent the approximate boundary between soil types and the transition may be gradual. - Vane shear values shown are as-recorded in the field, to which a calibration factor from Geotechnics Vane 1432 of 1.558 should be applied to attain Undrained Shear Strength (kPa). - Scala test was carried out in 1.0 metre depth increments.																					
JOB NAME: <u>WAITOMO DISTRICT COUNCIL</u> JOB LOCATION: <u>Waitomo District Council, Queen Street, Te Kuiti</u> JOB NUMBER: <u>W-15387</u>				DRILL METHOD: <u>Machine Auger</u> RIG: <u>Hilux</u> DRILLER: <u>JZ</u>				LOGGED: <u>JM</u> PLOTTED: <u>JM</u> DATE LOGGED: <u>21/08/17</u> CHECKED: <u>SW</u>													
<b>Geocon Geotechnical Ltd</b> Geotechnical Engineers 1150 Victoria Street, P.O. Box 9123, Hamilton				<b>BORE HOLE LOG</b>				<b>BORE HOLE No. 2</b> LOCATION: <u>Refer Site Plan</u> RL (m): SHEET: 1 OF 1    Fig. No. A-2													





	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill: 0.00 m Pre drilled
	G.L.: 0.00 m MSL	W.L.: -2.20 m	Date: 21/08/2017
Project: Waitomo District Council	Cone no.: C10CFIP.C15215		
Location: Queen St - Te Kuiti	Project no.: 2-68002.00_HA1773		
Position: 1789213, 5754520 NZTM	CPT no.: 01	1/6	

CPT1 Fig. B-1A

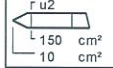


Refusal (qc 40+ MPa)

EOH - Dipped - GWL @ 2.2m



Graphs on this page are not IANZ accredited

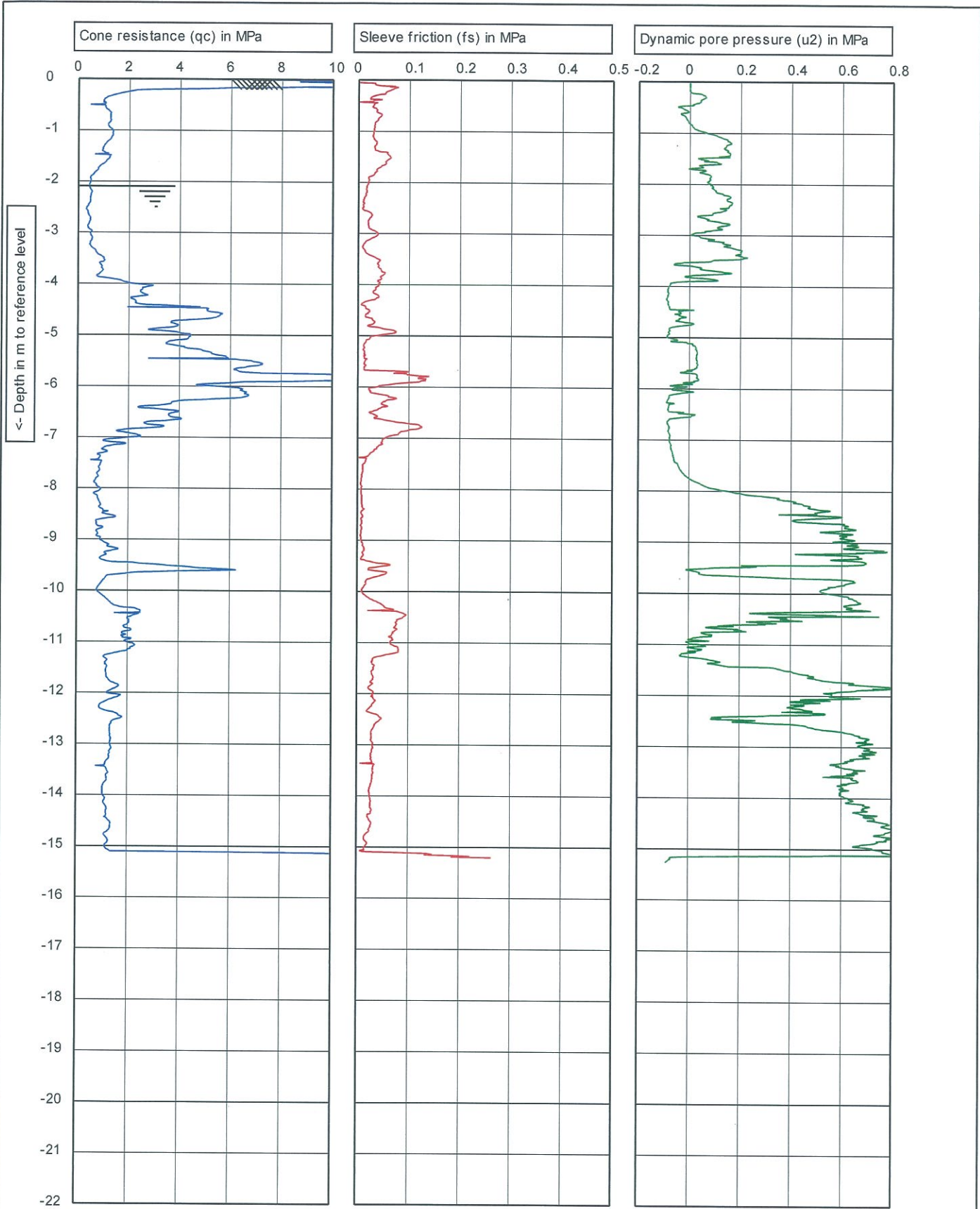


Test according ASTM D5778-12 & ISO 22476-1:2012  
 G.L.: 0.00 m MSL | W.L.: -2.20 m

Project: **Waitomo District Council**  
 Location: **Queen St - Te Kuiti**  
 Position: **1789213, 5754520 NZTM**

Predrill:	0.00 m Predrilled
Date:	21/08/2017
Cone no.:	C10CFIP.C15215
Project no.:	2-68002.00_HA1773
CPT no.:	01

CPT1 Fig. B-1B



Refusal ( qc 40+ MPa )

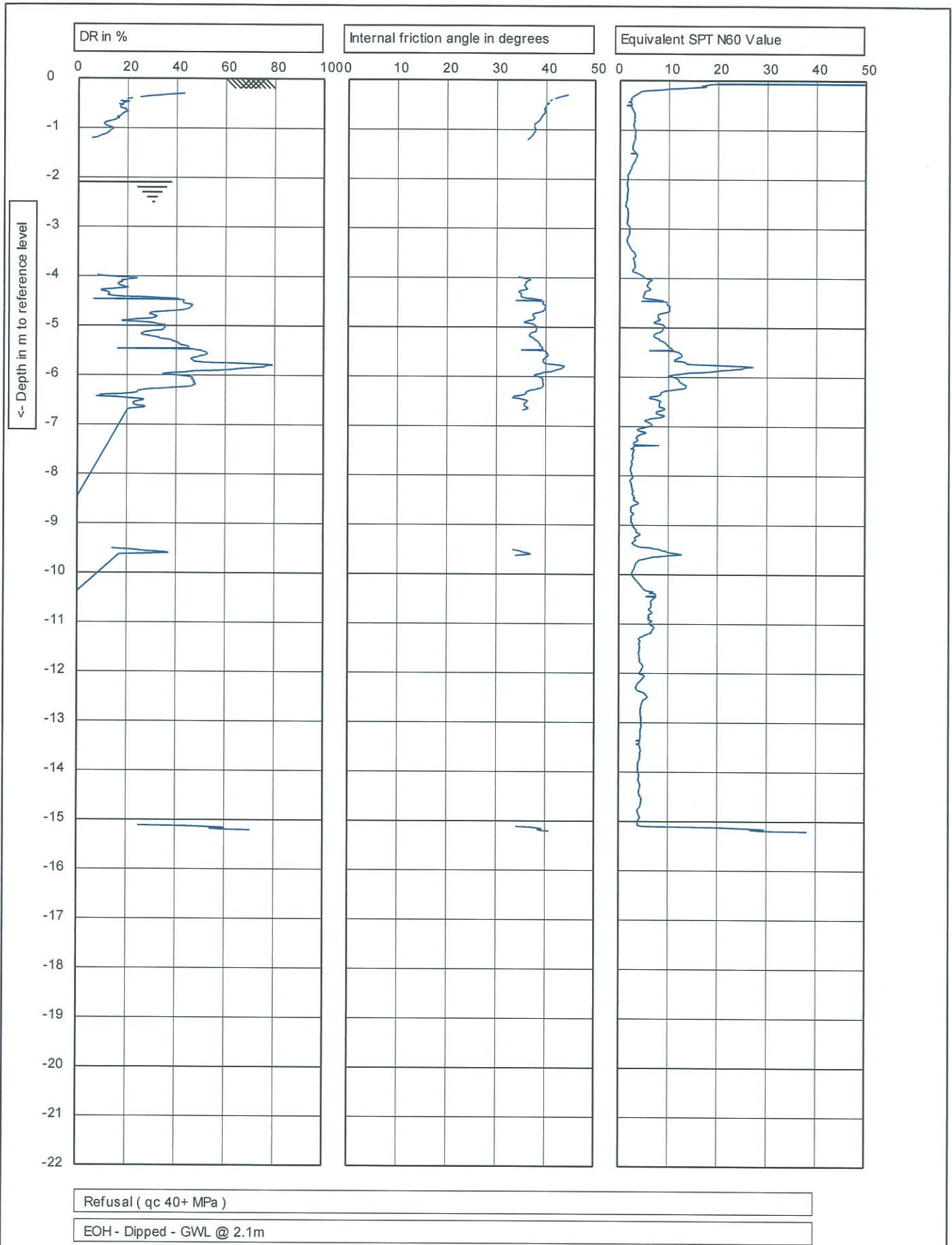
EOH - Dipped - GWL @ 2.1m

**OPUS**  
**IANZ** ACCREDITED LABORATORY  
 Graphs indicated as not accredited are outside the scope of the laboratory's accreditation

	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill: <b>0.00 m Predrilled</b>
	G.L.: <b>0.00 m MSL</b>	W.L.: <b>-2.10 m</b>	Date: <b>21/08/2017</b>
Project: <b>Waitomo District Council</b>	Cone no.: <b>C10CFIP.C15215</b>		Project no.: <b>2-68002.00_HA1773</b>
Location: <b>Queen St - Te Kuiti</b>	CPT no.: <b>02</b>		
Position: <b>1789210, 5754472 NZTM</b>			

CPT2 Fig. B-2A





1.45  
 Graphs on this page are not IANZ accredited

	Test according ASTM D5778-12 & ISO 22476-1:2012		Predrill: 0.00 m Pre drilled
	G.L.: 0.00 m MSL	W.L.: -2.10 m	Date: 21/08/2017
Project: Waitomo District Council			Cone no.: C10CFIP.C15215
Location: Queen St - Te Kuiti			Project no.: 2-68002.00_HA1773
Position: 1789210, 5754472 NZTM			CPT no.: 02
			5/6

CPT2 Fig. B-2B





[ghd.com](http://ghd.com)

→ **The Power of Commitment**