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Botanic Gardens Chemical Store
PRK 1566 BLDG 037
Detailed Engineering Evaluation

Qualitative Report

Version FINAL

7 Rolleston Avenue, Christchurch

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

Botanic Gardens Chemical Store
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Qualitative Report
Version FINAL

7 Rolleston Avenue, Christchurch

Christchurch City Council

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Date
13 February 2014

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Qualitative Report Summary

Botanic Gardens Chemical Store

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Detailed Engineering Evaluation

Qualitative Report - SUMMARY

Version FINAL

7 Rolleston Avenue, Christchurch

Background

This is a summary of the Qualitative report for the building structure, and is based in part on the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011, visual inspections on 6th July 2012 and available construction drawings.

Building Description

The Botanical Gardens Chemical Store is located at 7 Rolleston Avenue, Christchurch Central. The building was constructed in 1994.

The roof of the building is corrugated steel and translucent sheeting fixed to timber purlins. The purlins are supported by timber roof trusses. The trusses span between the external longitudinal front and rear walls. There is a plywood sheet ceiling fixed to the underside of the roof trusses in 2 of the rooms.

The majority of the walls are of reinforced concrete masonry construction. The rear wall of the building was constructed prior to the chemical store and is believed to be unfilled and unreinforced masonry. The transverse walls of the chemical store are tied into the rear wall using threaded tie rods. Internal walls are 15 series concrete blocks and external walls are 20 series concrete blocks. All walls are capped with a reinforced concrete ring beam.

Floors throughout the building are concrete slab on grade of varying thickness. Foundations are reinforced concrete strip footings under the masonry walls.

Key Damage Observed

- No damage was observed to the building during inspection.
- A portion of the original boundary wall, not directly connected to the Chemical Store building, has collapsed as a result of seismic actions.

Critical Structural Weaknesses

The following potential critical structural weaknesses have been identified in the structure.

- Liquefaction Potential (30% Reduction) 90% NBS

Indicative Building Strength (from IEP and CSW assessment)

Based on the information available, and using the NZSEE Initial Evaluation Procedure, the original capacity of the building has been assessed to be in the order of 90% NBS and post-earthquake capacity also in the order of 90% NBS. The building's post-earthquake capacity excluding critical structural weaknesses is in the order of 129% NBS.

The building has been assessed to have a seismic capacity in the order of 90% NBS and is therefore not considered potentially Earthquake Prone or Earthquake Risk.

Recommendations

As the building has been assessed to have a % NBS exceeding 67% NBS, it is deemed as neither potentially Earthquake Prone nor Earthquake Risk. It is recommended, as per Christchurch City Council's (CCC) policy regarding occupancy of potentially Earthquake Prone buildings, that the building can remain in use and does not require any further investigation or strengthening.

1. Background

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

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

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

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

At the time of this report, no intrusive site investigation, detailed analysis, or modelling of the building structure had been carried out. Construction drawings were made available, and these have been considered in our evaluation of the building. The building description below is based on a review of the drawings and our visual inspections.

2. Compliance

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

2.1 Canterbury Earthquake Recovery Authority (CERA)

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

Section 38 – Works

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

Section 51 – Requiring Structural Survey

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

We understand that CERA will require a detailed engineering evaluation to be carried out for all buildings (other than those exempt from the Earthquake Prone Building definition in the Building Act). It is anticipated that CERA will adopt the Detailed Engineering Evaluation Procedure document (draft) issued by the Structural Advisory Group on 19 July 2011. This document sets out a methodology for both qualitative and quantitative assessments.

The qualitative assessment is a desk-top and site inspection assessment. It is based on a thorough visual inspection of the building coupled with a review of available documentation such as drawings and specifications. The quantitative assessment involves analytical calculation of the buildings strength and may require non-destructive or destructive material testing, geotechnical testing and intrusive investigation.

It is anticipated that factors determining the extent of evaluation and strengthening level required will include:

- The importance level and occupancy of the building
- The placard status and amount of damage
- The age and structural type of the building
- Consideration of any critical structural weaknesses
- The extent of any earthquake damage

2.2 Building Act

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

Section 112 – Alterations

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

Section 115 – Change of Use

This section requires that the territorial authority (in this case Christchurch City Council (CCC)) be satisfied that the building with a new use complies with the relevant sections of the Building Code 'as near as is reasonably practicable'. Regarding seismic capacity 'as near as reasonably practicable' has previously been interpreted by CCC as achieving a minimum of 67% NBS however where practical achieving 100% NBS is desirable. The New Zealand Society for Earthquake Engineering (NZSEE) recommend a minimum of 67% NBS.

2.2.1 Section 121 – Dangerous Buildings

The definition of dangerous building in the Act was extended by the Canterbury Earthquake (Building Act) Order 2010, and it now defines a building as dangerous if:

- In the ordinary course of events (excluding the occurrence of an earthquake), the building is likely to cause injury or death or damage to other property; or
- In the event of fire, injury or death to any persons in the building or on other property is likely because of fire hazard or the occupancy of the building; or
- There is a risk that the building could collapse or otherwise cause injury or death as a result of earthquake shaking that is less than a 'moderate earthquake' (refer to Section 122 below); or
- There is a risk that that other property could collapse or otherwise cause injury or death; or
- A territorial authority has not been able to undertake an inspection to determine whether the building is dangerous.

Section 122 – Earthquake Prone Buildings

This section defines a building as earthquake prone if its ultimate capacity would be exceeded in a 'moderate earthquake' and it would be likely to collapse causing injury or death, or damage to other property. A moderate earthquake is defined by the building regulations as one that would generate ground shaking 33% of the shaking used to design an equivalent new building.

Section 124 – Powers of Territorial Authorities

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

Section 131 – Earthquake Prone Building Policy

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

2.3 Christchurch City Council Policy

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

The 2010 amendment includes the following:

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

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

We anticipate that any building with a capacity of less than 33% NBS (including consideration of critical structural weaknesses) will need to be strengthened to a target of 67% NBS of new building standard as recommended by the Policy.

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

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

2.4 Building Code

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

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

- Hazard Factor increased from 0.22 to 0.3 (36% increase in the basic seismic design load)
- Serviceability Return Period Factor increased from 0.25 to 0.33 (80% increase in the serviceability design loads when combined with the Hazard Factor increase)

The increase in the above factors has resulted in a reduction in the level of compliance of an existing building relative to a new building despite the capacity of the existing building not changing.

3. Earthquake Resistance Standards

For this assessment, the building's earthquake resistance is compared with the current New Zealand Building Code requirements for a new building constructed on the site. This is expressed as a percentage of new building standard (%NBS). The new building standard load requirements have been determined in accordance with the current earthquake loading standard (NZS 1170.5:2004 Structural design actions - Earthquake actions - New Zealand).

The likely capacity of this building has been derived in accordance with the New Zealand Society for Earthquake Engineering (NZSEE) guidelines 'Assessment and Improvement of the Structural Performance of Buildings in Earthquakes' (AISPBE), 2006. These guidelines provide an Initial Evaluation Procedure that assesses a buildings capacity based on a comparison of loading codes from when the building was designed and currently. It is a quick high-level procedure that can be used when undertaking a Qualitative analysis of a building. The guidelines also provide guidance on calculating a modified Ultimate Limit State capacity of the building which is much more accurate and can be used when undertaking a Quantitative analysis.

The New Zealand Society for Earthquake Engineering has proposed a way for classifying earthquake risk for existing buildings in terms of %NBS and this is shown in Figure 1 below.

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

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

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

Percentage of New Building Standard (%NBS)	Relative Risk (Approximate)
>100	<1 time
80-100	1-2 times
67-80	2-5 times
33-67	5-10 times
20-33	10-25 times
<20	>25 times

Table 1 %NBS compared to relative risk of failure

4. Building Description

4.1 General

The Botanical Gardens Chemical Store is located at 7 Rolleston Avenue, Christchurch Central. The building was constructed in 1994.

The roof of the building is corrugated steel and translucent sheeting fixed to 75 x 50mm timber purlins at 900mm centres. The purlins are supported by timber roof trusses at 975mm centres. The trusses span between the external longitudinal front and rear walls. There is a plywood sheet ceiling fixed to the underside of the roof trusses in the 2 northern rooms.

The majority of the walls are of reinforced concrete masonry construction. The rear wall of the building was constructed prior to the chemical store and is believed to be unfilled and unreinforced masonry. The transverse walls of the chemical store are tied into the rear wall using D16 threaded tie rods. Internal walls are 15 series concrete blocks and external walls are 20 series concrete blocks. All walls are capped with a reinforced concrete ring beam.

Floors throughout the building are concrete slab on grade of varying thickness. Foundations are reinforced concrete strip footings under the masonry walls.

The building is 7.8m in length, 4.5m in width and 3.6m in height.

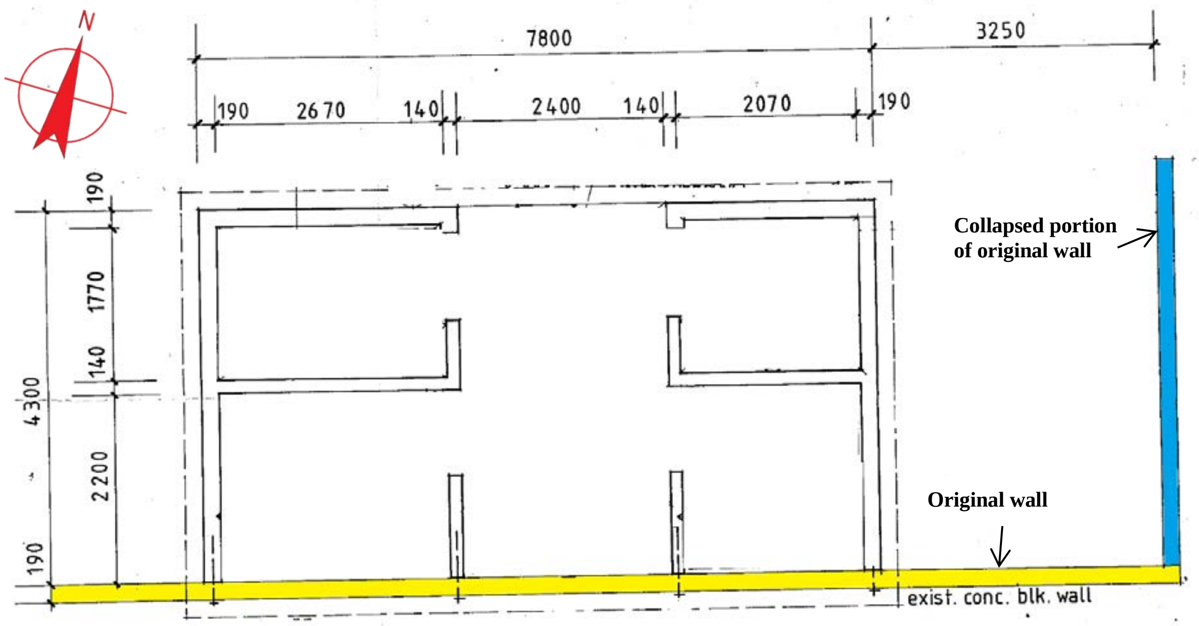


Figure 2 Plan Sketch Showing Key Structural Elements

4.2 Gravity Load Resisting System

Roof loads are transferred through the lightweight metal cladding to the timber purlins. The timber purlins transfer the gravity loads back to the supporting timber roof trusses. The roof trusses span between the external concrete masonry walls. Loads are transferred down through the external walls to the supporting foundations.

Loads on the internal walls are transferred directly through to the supporting concrete strip foundations.

4.3 Lateral Load Resisting System

The main resistance to lateral loads acting on the structure is provided by concrete blockwork walls in both the longitudinal and transverse directions, which transfer all building seismic loads from the roof through to the foundations. Out-of-plane seismic loads from the masonry walls are resisted by the 12mm diameter steel reinforcement bars, at 600mm centres, within the walls.

Roofing elements were clearly visible in the building. There was no evidence of in plane cross bracing or elements that would act as a bracing diaphragm.

5. Assessment

An inspection of the building was undertaken on the 6th of July 2012. Both the interior and exterior of the building were inspected. The main structural components of the roof of the building were all able to be viewed.

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

The %NBS score determined for this building has been based on the IEP procedure described by the NZSEE and based on the information obtained from visual observation of the building and available drawings.

6. Damage Assessment

6.1 Surrounding Buildings

The Chemical Store is located in the Botanic Gardens yard. To the north is the Potting Facility, and Glasshouses. To the east lie the Office Store, Office Library, Cycle Shelter and Irrigation Pump-house. Shear cracking was noted to the blockwork in the Office Library building and the Office Store building. Cracking was noted to several of the walls of the glass houses but the majority of these are not believed to be earthquake related.

6.2 Residual Displacements and General Observations

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

No damage was evident to the roof structure.

No cracking was noted to the perimeter strip footing.

A portion of the original wall has collapsed as a result of seismic actions.

6.3 Ground Damage

No ground damage was observed during the inspection of the site. Ground remediation works had taken place north of the building. These works included strengthening of the river banks. The river is situated approximately 40m to the north of the building. Any ground damage that may have been present was not identifiable as a result of the remediation work.

7. Critical Structural Weakness

7.1 Short Columns

No significant short columns are present in the structure.

7.2 Lift Shaft

The building does not contain a lift shaft.

7.3 Roof Bracing

Roof cross bracing was not seen in the building. Roof elements such as purlins and trusses were clearly visible and are expected to provide some minimal bracing to the roof structure along with the existing roof cladding.

7.4 Staircases

The building does not contain a staircase.

7.5 Site Characteristics

Liquefaction is regarded as a potential critical structural weakness based on the findings of the geotechnical report. For the purposes of the IEP assessment of the building and the determination of the %NBS score, the effects of potential liquefaction and lateral spreading on the performance of the building has been assessed as a 'significant' site characteristic in accordance with NZSEE guidelines.

8. Geotechnical Consideration

8.1 Site Description

The site is situated within a recreational reserve, in central Christchurch. It is relatively flat at approximately 8m above mean sea level. The structure is situated between 7m south of the Avon River, and 9.5km west of the coast (Pegasus Bay) at New Brighton.

8.2 Published Information on Ground Conditions

8.2.1 Published Geology

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

8.2.2 Environment Canterbury Logs

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

Table 2 ECan Borehole Summary

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

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

8.2.3 EQC Geotechnical Investigations

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

8.2.4 Land Zoning

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

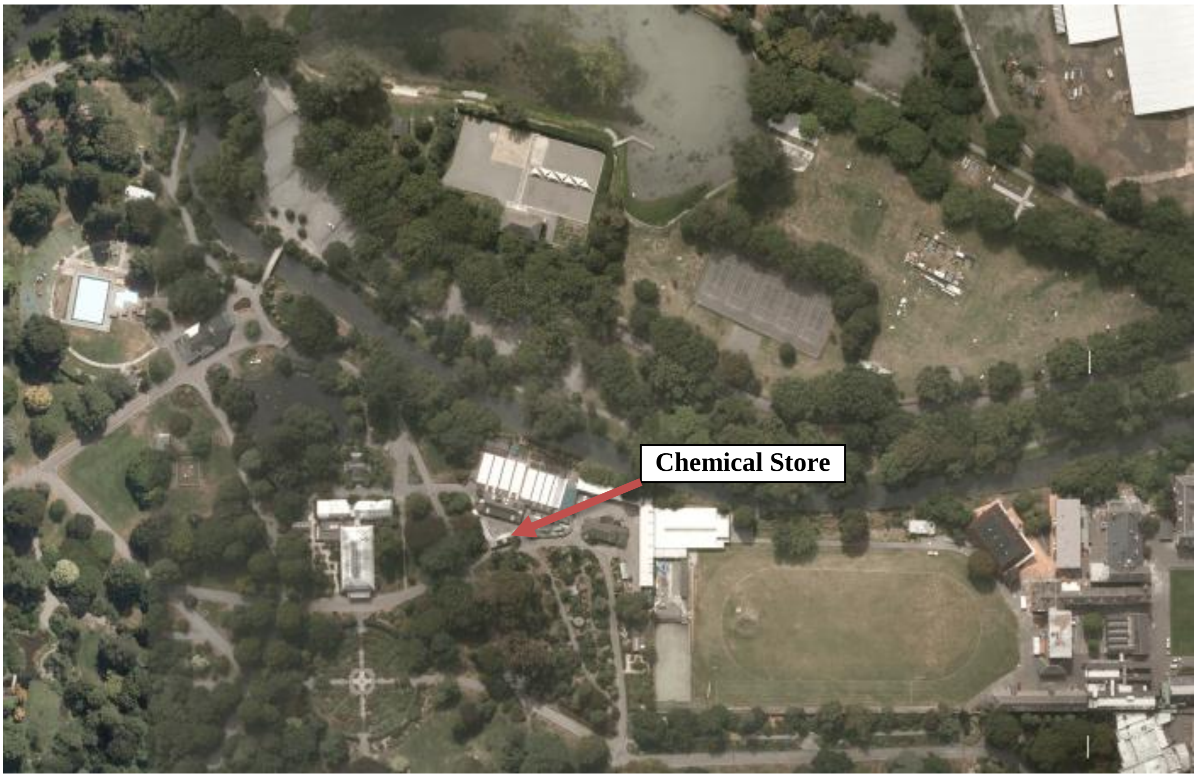
[1] Brown, L. J. and Weeber, J.H. 1992: Geology of the Christchurch Urban Area. Institute of Geological and Nuclear Sciences 1:25,000 Geological Map 1. Lower Hutt. Institute of Geological and Nuclear Sciences Limited.

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

8.2.5 Post February Aerial Photography

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

Figure 3 Post February 2011 Earthquake Aerial Photography[2]



8.2.6 Summary of Ground Conditions

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

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

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

8.3 Seismicity

8.3.1 Nearby Faults

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

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

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

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

8.3.2 Ground Shaking Hazard

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

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

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

8.4 Slope Failure and/or Rockfall Potential

Given the site's elevation and location in Central Christchurch, global slope instability is considered negligible. However, due to the site's proximity to the Avon River, it may be susceptible to lateral

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

[4] GNS Active Faults Database

spreading to the north. In addition, any localised retaining structures or embankments should be further investigated to determine the site-specific slope instability potential.

8.5 Liquefaction Potential

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

This liquefaction may propagate in the form of lateral spreading, given the site and structures' proximity to the Avon River.

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

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

8.6 Recommendations

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

Given the anticipated ground conditions and limited existing investigation in the vicinity of the site, we recommend that further investigation is conducted in the form of CPT investigations to a target depth of 20m bgl. Specific details regarding the number of tests can be confirmed at the commencement of the quantitative phase.

8.7 Conclusions & Summary

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

The site appears to be situated on stratified alluvial deposits, predominantly comprising gravel and sand, interlain by clay. Associated with this the site also has a moderate liquefaction potential, in particular where sands and/or silts are present. This liquefaction may propagate in the form of lateral spreading, given the site and structures' proximity to the Avon River.

It is recommended that intrusive investigation (piezocone CPT tests) be conducted. Specific details regarding the number of tests can be confirmed at the commencement of the quantitative phase.

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

9. Survey

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

10. Initial Capacity Assessment

10.1 % NBS Assessment

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

Item	%NBS
Building excluding CSW's	129%
Liquefaction Potential (30% Reduction)	90%

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

Following an IEP assessment, the building has been assessed as achieving 90% New Building Standard (NBS). Under the New Zealand Society for Earthquake Engineering (NZSEE) guidelines the building is not considered potentially Earthquake Prone or Earthquake Risk as it achieves greater than 67% NBS. This score has not been adjusted when considering damage to the structure as no significant damage was noted.

10.2 Seismic Parameters

The seismic design parameters based on current design requirements from NZS 1170:2002 and the NZBC clause B1 for this building are:

- Site soil class: D, NZS 1170.5:2004, Clause 3.1.3, Soft Soil
- Site hazard factor, Z = 0.3, NZBC, Clause B1 Structure, Amendment 11 effective from 1 August 2011
- Return period factor R_u = 0.5, NZS 1170.5:2004, Table 3.5, Importance level 1 structure with a 50 year design life.

An increased Z factor of 0.3 for Christchurch has been used in line with requirements from the Department of Building and Housing resulting in a reduced % NBS score.

10.3 Expected Structural Ductility Factor

A structural ductility factor of 1.25 has been assumed based on the structural system observed and the date of construction.

10.4 Discussion of Results

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

This building would have been designed to standards at the time, NZS 4203: 1992, that would have used design loads less than those required by the current loading standard and detailing requirements for ductile seismic behaviour that are present in the current standards. Liquefaction potential has reduced the % NBS by 30%. Based on the above factors combined with the increase in the hazard factor for Christchurch to 0.3 it is reasonable to expect the building would not achieve 100% NBS.

10.5 Occupancy

As the building has been assessed to have a % NBS exceeding 67% NBS, it is deemed as neither potentially Earthquake Prone nor Earthquake Risk. It is recommended, as per Christchurch City Council's (CCC) policy regarding occupancy of potentially Earthquake Prone buildings, that the building can remain in use and does not require any further investigation or strengthening.

11. Initial Conclusions

The building has been assessed to have a seismic capacity in the order of 90% NBS in accordance with the NZSEE guidelines. The building is deemed as neither potentially Earthquake Prone nor Earthquake Risk. It is recommended, as per Christchurch City Council's (CCC) policy regarding occupancy of potentially Earthquake Prone buildings, that the building can remain in use and does not require any further investigation or strengthening.

12. Recommendations

As the building has achieved greater than 67% NBS following a qualitative Detailed Engineering Evaluation of the building, no further assessment is required.

It is recommended, as per Christchurch City Council's (CCC) policy regarding occupancy of potentially Earthquake Prone buildings, that the building can remain in use and does not require any further investigation or strengthening.

13. Limitations

13.1 General

This report has been prepared subject to the following limitations:

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

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

13.2 Geotechnical Limitations

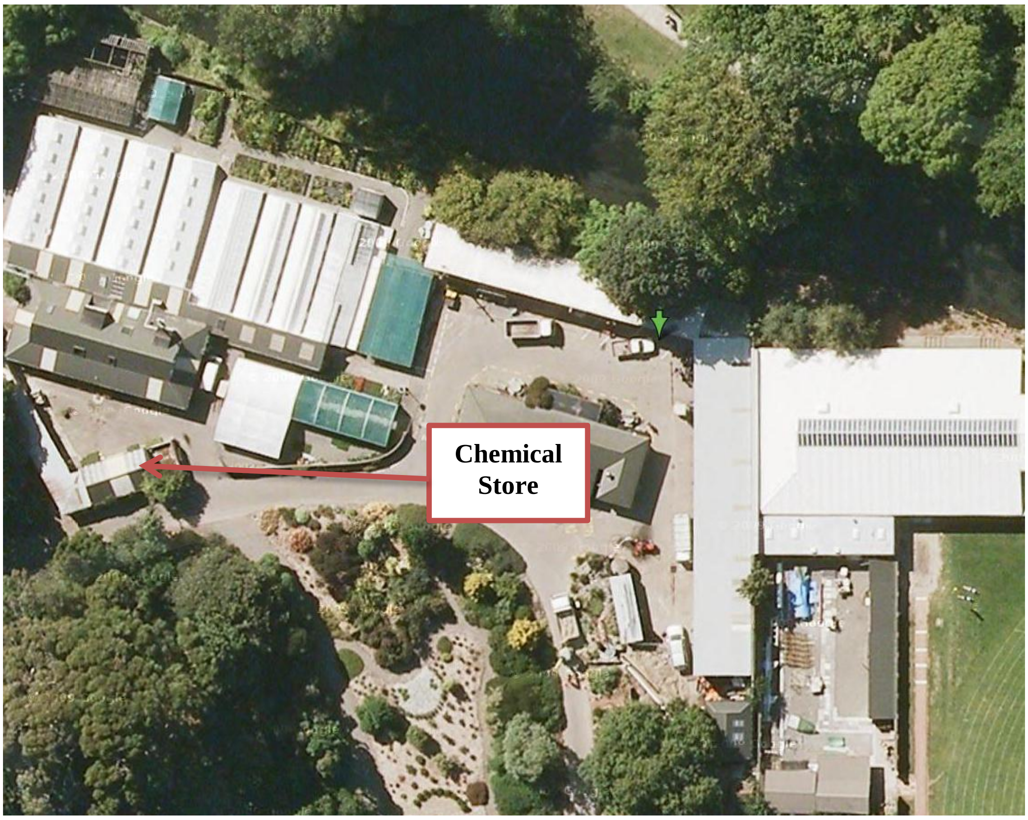
This report presents the results of a geotechnical appraisal prepared for the purpose of this commission, and for prepared solely for the use of Christchurch City Council and their advisors. The data and advice provided herein relate only to the project and structures described herein and must be reviewed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

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

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

Appendix A

Photographs



Photograph 1 Aerial photograph of site indicating the Chemical Store Building.

Photograph 2 Northern face of building (Front).

Photograph 3 The original southern wall of the building (Rear wall).

Photograph 4 The eastern face of the building.

Photograph 5 Timber roof trusses and purlins visible. No roof cross-bracing present.

Photograph 6 Plywood ceiling lining to the underside of one of the rooms. A reinforced concrete ring beam is clearly visible.

Photograph 7 Unfilled concrete masonry units of the collapsed portion of the original wall.

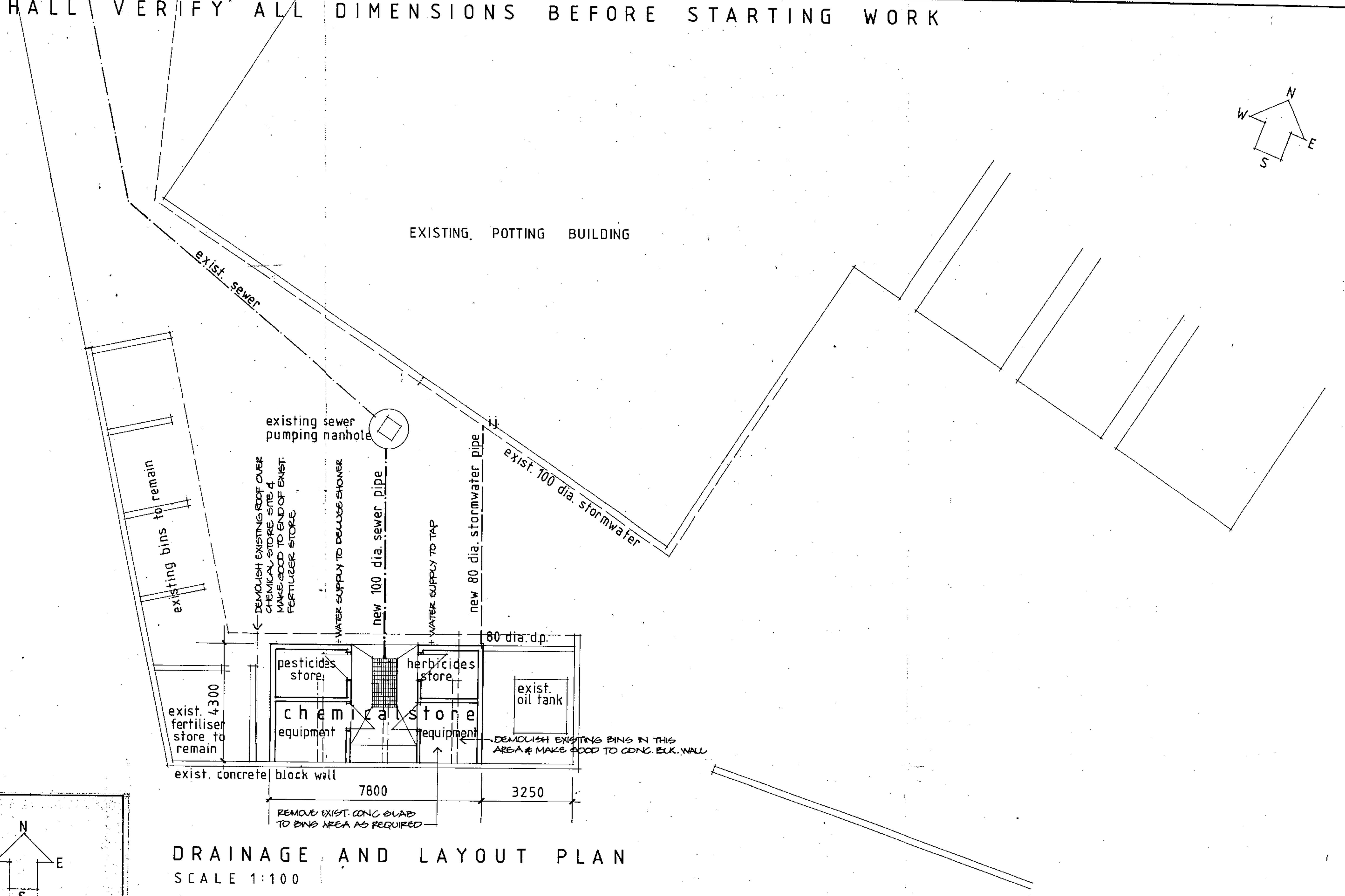
Photograph 8 Collapsed portion of the original wall.

Photograph 9 Cracking to original wall away from the chemical store.

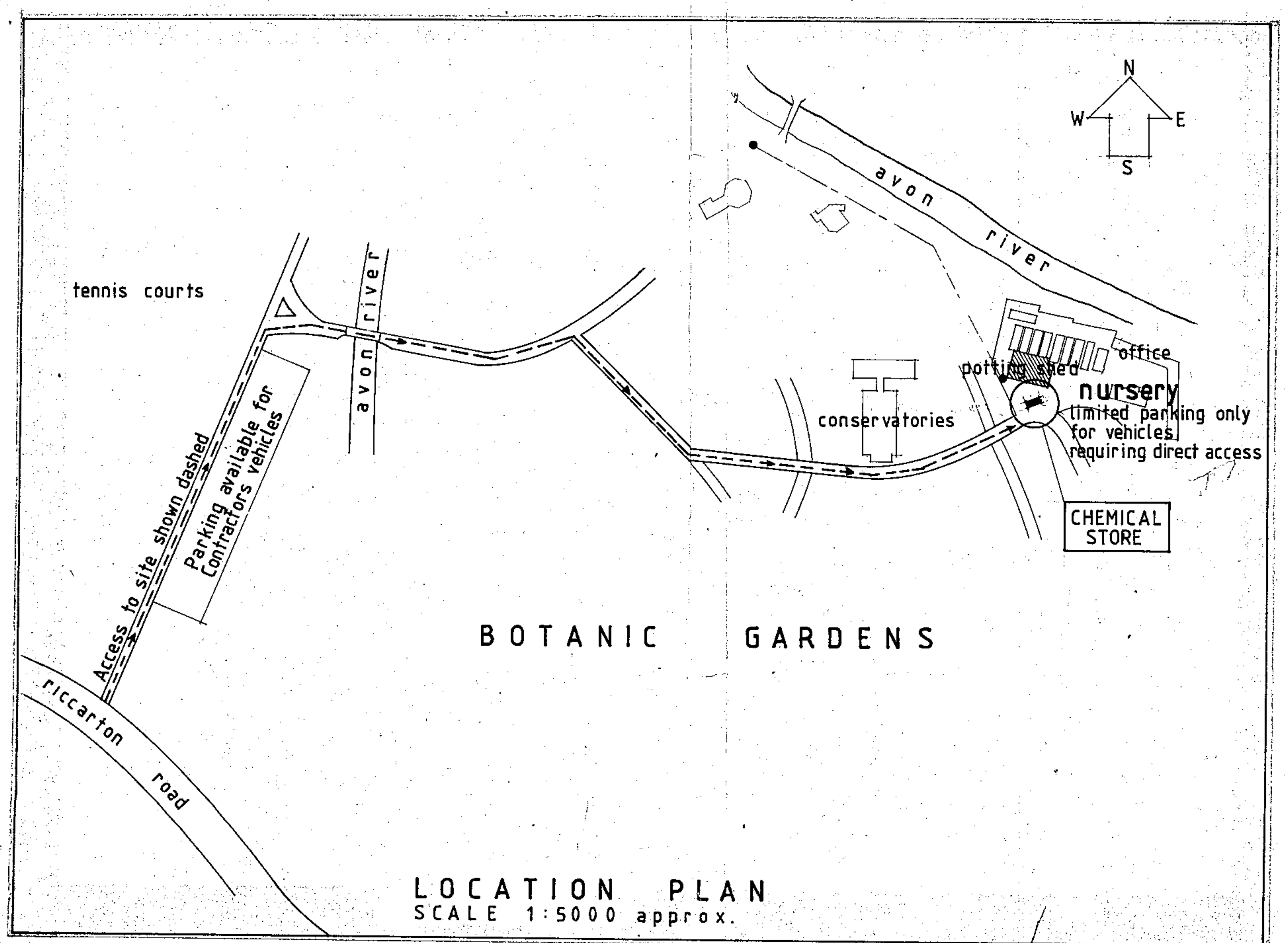
Appendix B

Existing Drawings

CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK



DRAINAGE AND LAYOUT PLAN
SCALE 1:100



LOCATION PLAN
SCALE 1:5000 approx.

All building work shall comply with the New Zealand Building Code notwithstanding any inconsistencies which may occur in the drawings and specifications.

CHRISTCHURCH CITY COUNCIL
MAY 1994
CONSENT DOCUMENT

FILE COPY

94004.090

(2)

CHRISTCHURCH CITY COUNCIL
P.I.M. APPLICATION
Rec'd 13 MAY 1994
Civic Offices
PROJECT No 94004090

DESIGN SERVICES UNIT		INITIALS	DATE			APPROVED	JOB TITLE	DRAWING TITLE	SCALES	C.N. 93/94-339
CHRISTCHURCH THE GARDEN CITY	DESIGNED			DATUM		/ /	NEW CHEMICAL STORE AT THE BOTANIC GARDENS	DRAINAGE AND LAYOUT PLAN	1:100	507.52
	DRAWN	M.KITT	MAY 94	BENCH MK.		DATE				
	TRACED			SURVEY FB						
	DRW. CHK.	G.F.H.	13/05/94	SURVEY LB						
	DES. CHK.			CONSTN. FB						
	INDEXED			CONSTN. LB		DESIGN SERVICES MANAGER				SHEET 1 OF 2

CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK

DESIGN SERVICES UNIT	INITIALS	DATE		APPROVED
CHRISTCHURCH THE GARDEN CITY — The city that shines				
DESIGNED			DATUM	/ / DATE
DRAWN	M.KITT	MAY 94	BENCH MK	
TRACED			SURVEY FB	
DRW. CHK.	G.F.H.	13/05/94	SURVEY LB	
DES. CHK.			CONSTN. FB	
INDEXED			CONSTN. LB	DESIGN SERVICES MANAGER

JOB TITLE
NEW CHEMICAL STORE AT THE BOTANIC GARDENS

DRAWING TITLE
PLAN, ELEVATIONS, AND CROSS SECION

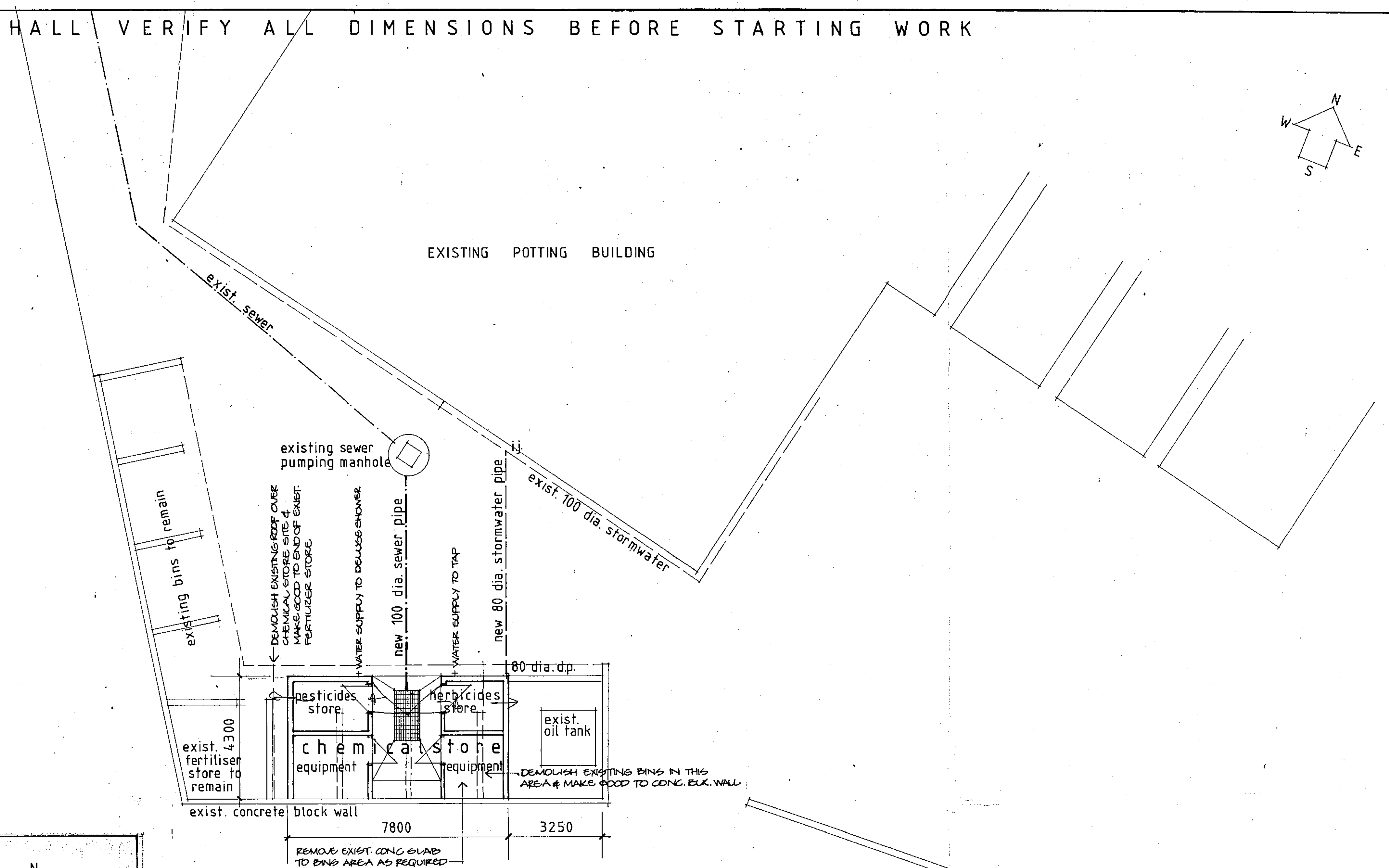
SCALES 1:50 1:20

C.N. 93/94-339

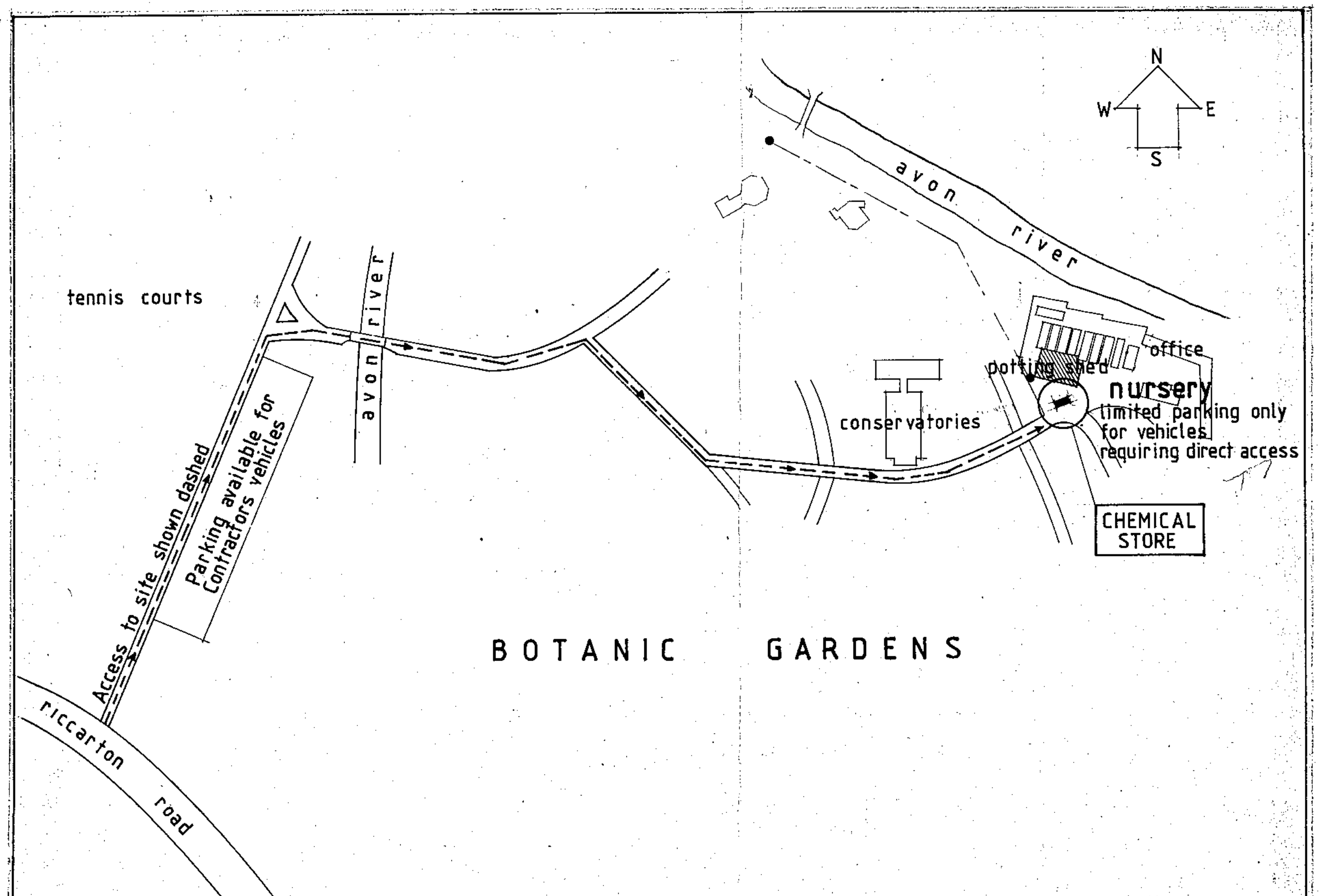
507.52

SHEET 2 OF 2

CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK



DRAINAGE AND LAYOUT PLAN
SCALE 1:100



LOCATION PLAN
SCALE 1:5000 approx.

CHRISTCHURCH CITY COUNCIL
P.I.M. APPLICATION
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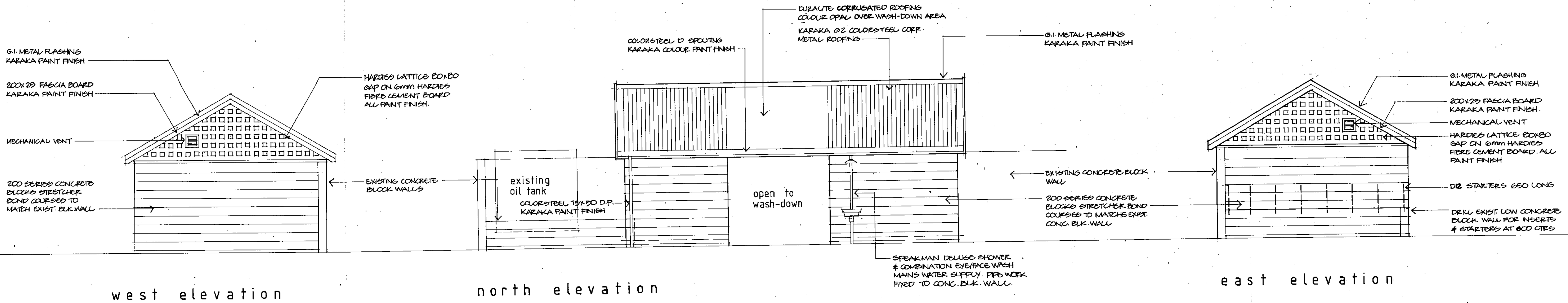
DESIGN SERVICES UNIT		INITIALS	DATE			APPROVED
CHRISTCHURCH THE GARDEN CITY The city that shines	DESIGNED			DATUM		/ /
	DRAWN	M.KITT	MAY 94	BENCH MK.		DATE
	TRACED			SURVEY FB		
	DRW. CHK.	G.F.H.	13/05/94	SURVEY LB		
	DES. CHK.			CONSTN. FB		
	INDEXED			CONSTN. LB		DESIGN SERVICES MANAGER

JOB TITLE	DRAWING TITLE	SCALES	C.N. 93/94-339
NEW CHEMICAL STORE AT THE BOTANIC GARDENS	DRAINAGE AND LAYOUT PLAN	1:100	507.52
			SHEET 1 OF 2

Original scale of millimetres 0 20 40 60 80 100

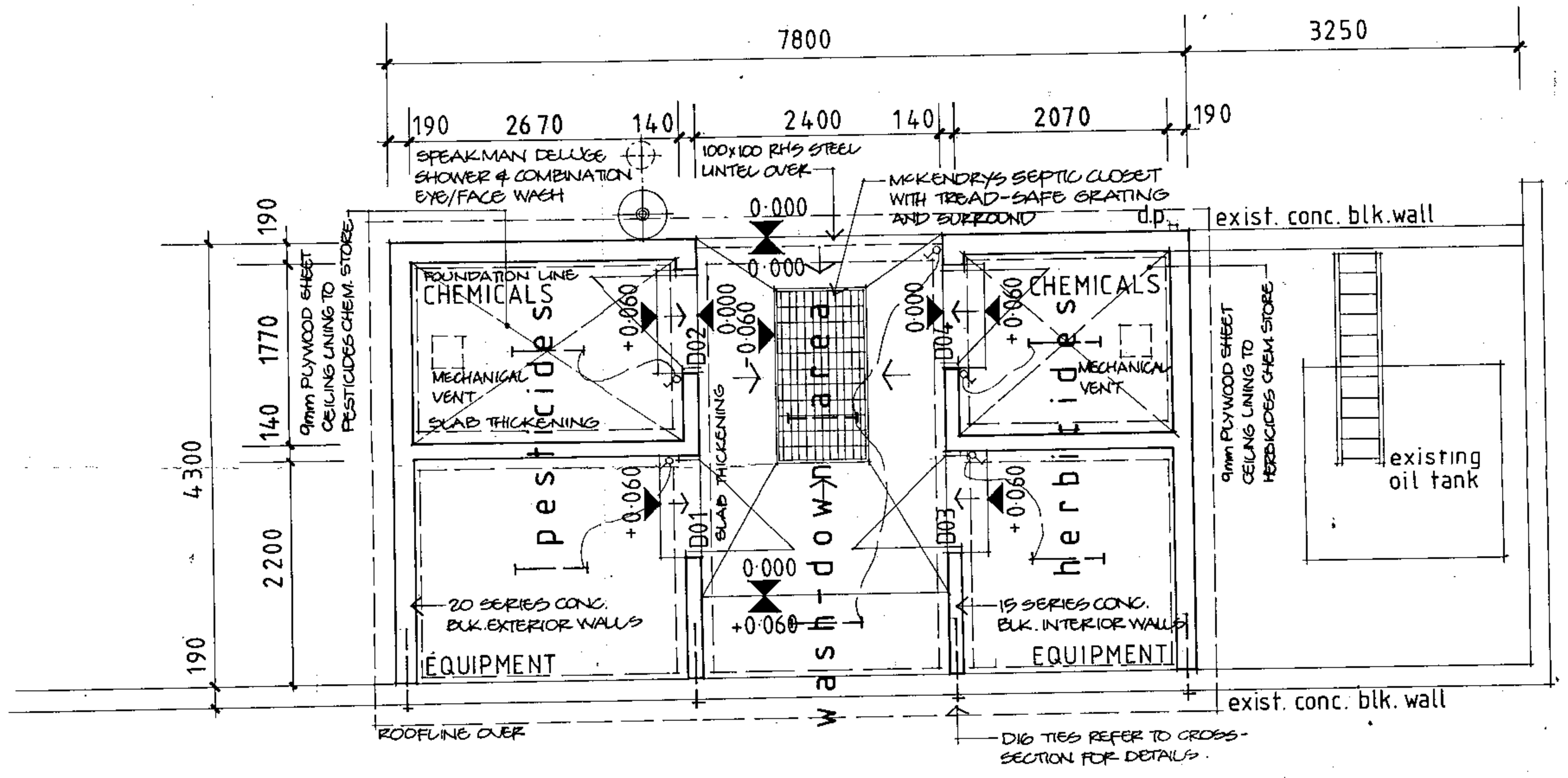
CONTRACTOR SHALL VERIFY ALL DIMENSIONS BEFORE STARTING WORK



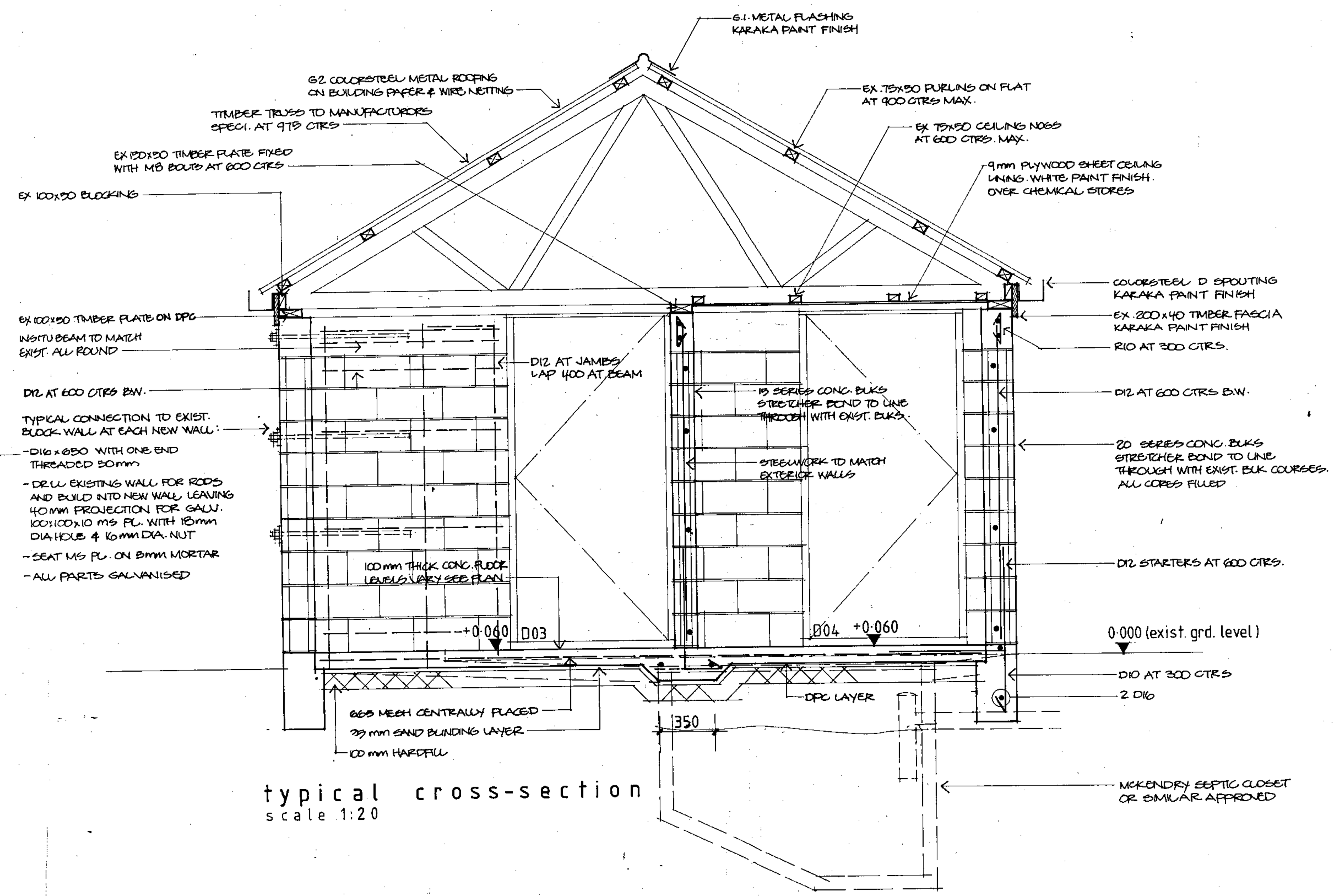
west elevation
scale 1:50

north elevation

east elevation



plan
scale 1:50



typical cross-section
scale 1:20

CHRISTCHURCH CITY COUNCIL
P.I.M. APPLICATION
Rec'd 13 MAY 1994
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DESIGN SERVICES UNIT		INITIALS	DATE			APPROVED
CHRISTCHURCH THE GARDEN CITY The city that shines	DESIGNED			DATUM		/ /
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DRAWING TITLE
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SCALES 1:50 1:20

C.N. 93/94-339
507.52
SHEET 2 OF 2

Original scale of millimetres 0 20 40 60 80 100

Appendix C

CERA Building Evaluation Form

Detailed Engineering Evaluation Summary Data V1.11

Location

Building Name:	Chemical Store	Reviewer:	Derek Chinn
	Unit / No: 7 / Street: Rolleston Avenue	CPEng No:	177243
Building Address:	7 Rolleston Avenue	Company:	GHD Ltd
Legal Description:		Company project number:	513090215
		Company phone number:	03 3780900
GPS south:	Degrees 43, Min 31, Sec 47.23	Date of submission:	13/02/2014
GPS east:	Degrees 172, Min 37, Sec 19.33	Inspection Date:	7/06/2012
		Revision:	Final
Building Unique Identifier (CCC):	PRK 1566 BLDG 037	Is there a full report with this summary?	yes

Site

Site slope:	flat	Max retaining height (m):	0
Soil type:	silty sand	Soil Profile (if available):	
Site Class (to NZS1170.5):	D		
Proximity to waterway (m, if <100m):	40	If Ground improvement on site, describe:	
Proximity to clifftop (m, if < 100m):			
Proximity to cliff base (m,if <100m):		Approx site elevation (m):	8.00

Building

No. of storeys above ground:	1 (single storey = 1)	Ground floor elevation (Absolute) (m):	8.00
Ground floor split?	no	Ground floor elevation above ground (m):	0.00
Storeys below ground	0		
Foundation type:	strip footings	if Foundation type is other, describe:	
Building height (m):	3.60	height from ground to level of uppermost seismic mass (for IEP only) (m):	2.5
Floor footprint area (approx):	48		
Age of Building (years):	18	Date of design:	1992-2004
Strengthening present?	no	If so, when (year)?	
		And what load level (%g)?	
Use (ground floor):	other (specify)	Brief strengthening description:	
Use (upper floors):			
Use notes (if required):	Storage of Chemicals		
Importance level (to NZS1170.5):	IL1		

Gravity Structure

Gravity System:	load bearing walls		
Roof:	timber truss	truss depth, purlin type and cladding	1.4m, 75x50 timber purlins, Metal roofing
Floors:	concrete flat slab	slab thickness (mm)	100
Beams:	none	overall depth x width (mm x mm)	
Columns:			
Walls:	fully filled concrete masonry	#N/A	

Lateral load resisting structure

Note: Define along and across in detailed report!

Lateral system along:	fully filled CMU			12
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	12
Period along:	0.10	0.00 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	
Lateral system across:	fully filled CMU			12.9
Ductility assumed, μ:	1.25		note total length of wall at ground (m):	12.9
Period across:	0.10	0.00 from parameters in sheet	estimate or calculation?	estimated
Total deflection (ULS) (mm):			estimate or calculation?	
maximum interstorey deflection (ULS) (mm):			estimate or calculation?	

Separations: (leave blank if not relevant)

north (mm):	
east (mm):	
south (mm):	
west (mm):	

Non-structural elements

Stairs:			
Wall cladding:			
Roof Cladding:	Metal	describe	G2 Colorsteel Metal Roofing
Glazing:			
Ceilings:			
Services(list):			

Available documentation

Architectural	partial	original designer name/date	Christchurch Design Services Unit, May 1994
Structural	partial	original designer name/date	Christchurch Design Services Unit, May 1994
Mechanical		original designer name/date	
Electrical		original designer name/date	
Geotech report		original designer name/date	

Damage

Site: (refer DEE Table 4-2)

Site performance:	Good	Describe damage:	
Settlement:	none observed	notes (if applicable):	
Differential settlement:	none observed	notes (if applicable):	
Liquefaction:	none apparent	notes (if applicable):	
Lateral Spread:	none apparent	notes (if applicable):	
Differential lateral spread:	none apparent	notes (if applicable):	
Ground cracks:	none apparent	notes (if applicable):	
Damage to area:	none apparent	notes (if applicable):	

Building:

	Current Placard Status:	green		
Along	Damage ratio:	0%	Describe how damage ratio arrived at:	
	Describe (summary):	No Damage		
Across	Damage ratio:	0%		
	Describe (summary):	No Damage		
Diaphragms	Damage?:	no	Describe:	
CSWs:	Damage?:	no	Describe:	
Pounding:	Damage?:	no	Describe:	
Non-structural:	Damage?:	no	Describe:	

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

Recommendations

	Level of repair/strengthening required:	none	Describe:	
	Building Consent required:	no	Describe:	
	Interim occupancy recommendations:	full occupancy	Describe:	
Along	Assessed %NBS before e'quakes:	90%	90% %NBS from IEP below	If IEP not used, please detail assessment methodology:
	Assessed %NBS after e'quakes:	90%		
Across	Assessed %NBS before e'quakes:	90%	90% %NBS from IEP below	
	Assessed %NBS after e'quakes:	90%		

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

Period of design of building (from above): 1992-2004

h_n from above: 2.5m

Seismic Zone, if designed between 1965 and 1992: B

not required for this age of building:

Design Soil type from NZS4203:1992, cl 4.6.2.2: b) Intermediate

	along	across
Period (from above):	0.1	0.1
(%NBS)nom from Fig 3.3:	22.3%	22.3%

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

	along	across
Final $(\%NBS)_{nom}$:	**22%**	**22%**

2.2 Near Fault Scaling Factor

	along	across
Near Fault scaling factor, from NZS1170.5, cl 3.1.6:		1.00
Near Fault scaling factor (1/N(T,D), **Factor A**:	1	1

2.3 Hazard Scaling Factor

Hazard factor Z for site from AS1170.5, Table 3.3:	0.30
Z_{1992}, from NZS4203:1992	0.8
Hazard scaling factor, **Factor B:**	2.666666667

2.4 Return Period Scaling Factor

Building Importance level (from above):	1
Return Period Scaling factor from Table 3.1, **Factor C**:	2.00

2.5 Ductility Scaling Factor

	along	across
Assessed ductility (less than max in Table 3.2)	1.25	1.25
Ductility scaling factor: =1 from 1976 onwards; or =k_μ, if pre-1976, fromTable 3.3:	1.00	1.00
Ductiity Scaling Factor, **Factor D**:	1.00	1.00

2.6 Structural Performance Scaling Factor:

Sp:	0.925	0.925
Structural Performance Scaling Factor **Factor E**:	1.081081081	1.081081081

2.7 Baseline %NBS, $(NBS\%)_b = (\%NBS)_{nom}$ x A x B x C x D x E **$\%NBS_b$:** **129%** **129%**

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

3.1. Plan Irregularity, factor A:	insignificant	1
3.2. Vertical irregularity, Factor B:	insignificant	1
3.3. Short columns, Factor C:	insignificant	1
3.4. Pounding potential Pounding effect D1, from Table to right		1.0
Height Difference effect D2, from Table to right		1.0
Therefore, Factor D:		1
3.5. Site Characteristics	significant	0.7

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

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

3.6. Other factors, Factor F

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

Detail Critical Structural Weaknesses: (refer to DEE Procedure section 6)
List any: Refer also section 6.3.1 of DEE for discussion of F factor modification for other critical structural weaknesses

3.7. Overall Performance Achievement ratio (PAR)	**0.70**	**0.70**
4.3 PAR x $(\%NBS)_b$: PAR x Baselline %NBS:	**90%**	**90%**
4.4 Percentage New Building Standard (%NBS), (before)		**90%**

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Final	Peter O'Brien	Kevan O'Brien		Derek Chinn		6/11/12
Final	Peter O'Brien	Kevan O'Brien		Donna Bridgeman		13/2/14