DETAILED SEISMIC ASSESSMENT (QUANTITATIVE)

1473 MAIN NORTH ROAD WAIKUKU 7473

Sanderson China & Pottery

4th October 2022
JN 220173A

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1.0 EXECUTIVE SUMMARY

In response to a request by our client, Sanderson China & Pottery, as owner's representative of the building. Centraus Limited is pleased to present this report of our Detailed Seismic Assessment of the commercial buildings at 1473 Main North Road, Waikuku 7473. The Assessment was performed in order to evaluate the buildings and determine if any seismic vulnerabilities (critical structural weaknesses) in the seismic load resisting systems exist and provide recommendations for further action.

The subject site consists of two one-storey commercial buildings originally constructed in the 1920's, with later additions added in the 1940's and 1960's. The buildings consist of brick masonry walls and timber framed roofs with a concrete slab on grade foundation, (Type C). Previous strengthening works were performed on a portion of the buildings in 2012 by W2 Structural Engineering Limited. The strengthening works were emergency strengthening to an NBS% rating of 34%. To simplify the report, the two buildings on the site have been analysed as seven separate buildings. This allowed the portions of the buildings which had been strengthened to be analysed separately. Refer to Figure 1 in Section 3 of the report for a site plan displaying the seven separate building areas being analysed.

A Detailed Seismic Assessment (DSA) – Quantitative Method for these buildings was completed which concluded that the buildings are noted below and providing a classification of risk to the structures as outlined in the New Zealand Society of Earthquake Engineering's "Assessment and Improvement of the Structural Performances of Buildings in Earthquakes".

Our assessment confirms the following rating for each of the separate building areas on the site:

Building 1: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C
Building 2: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 3: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4A: >100%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4B: >100%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Building 5: 50%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Storage Building: 70%NBS Longitudinal, 15%NBS Transverse, *High Risk*, Grade E.

The buildings are currently in a sound condition and should provide full functionality of the building systems. Our review of the buildings has identified the existing roof diaphragms and its connections to the URM walls as critical structural issues in Building 4B and the Storage Building. The timber framed shear wall was also found to be a critical structural weakness in Building 5. The critical structural weaknesses could adversely affect the future performance of these buildings.

We, recommend the roof diaphragms are strengthen by the addition of a plywood or a Reid brace diaphragm being added to the roof. Roof diaphragms with large spans such as Building 4B should have the addition of an internal bracing element to reduce the diaphragms span. The internal bracing element added can be a brace frame, portal frame or shear wall, the appropriate bracing element should be selected to align with the future use of the building. The diaphragms connection to the URM walls can be strengthened by the addition of epoxy bolts either connecting the roof framing or cross brace diaphragm to the URM walls. The timber frame shear walls can be strengthened by the addition of plywood line with the appropriate nail spacing for the capacity required.

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2.0 SCOPE OF ENGAGEMENT

Centraus Limited has been engaged to undertake a Detailed Seismic Assessment of the buildings located at 1473 Main North Road, Waikuku 7473. The site consists of two one-storey URM commercial structures. Both buildings on site are occupied by the same tenant and are currently being used as pottery and china manufacturer/retail store.

This evaluation has been carried out in accordance with the "Guidance on Initial Engineering Evaluation of Earthquake Affected Buildings in Canterbury" prepared by the Engineering Advisory Group; dated 1 July 2017. The assessment is made with regard to Clause B1 – Structure of the New Zealand Building Code. No other building code clauses have been assessed by this report. This structural assessment is based upon review of noted materials and visual evidence and indications present at the time of inspection. The findings of this report may be subject to revision pending deterioration of elements from subsequent aftershocks or ground settlement.

As part of our assessment, we have not reviewed any of the original construction documents. However, were provided with the documents for the 34%NBS emergency strengthening works by W2 Structural Engineering LTD dated March 2012, as well as a previous detail engineering evaluation by Bond Few Civil Engineers LTD dated the 12th of August 2019 for the storage building on site.

The report is provided solely for use by the owners and shall not be relied on by any other parties without written approval from Centraus Limited.

3.0 BACKGROUND INFORMATION

The site at 1473 Main North Road, Waikuku 7473 consists of two one-storey brick unreinforced masonry buildings acting as commercial structures. Previous strengthening works were preformed to a portion of buildings in 2012 by W2 Structural Engineering LTD, bring this portion of the building up to 34%NBS. The two buildings on site have been analysed as seven separate building to account for the later additions to structural as well as the portion of the buildings which previous strengthening works has been conducted. The seven separate building areas have been described in Section 3.1 of this report, Figure 1 below displays a site plan with the seven separate building areas.

The subject site is positioned in a high seismic zone on the east coast on New Zealand's South Island. We inspected the property on 28th September 2022.

FIGURE 1 – BUILDING SITE LOCATION http://koordinates.com/layer/3185-christchurch-post-earthquake-aerial-photos-24-feb-2011/metadata/

3.1 BUILDING DESCRIPTION

The original council records were not available for our review, however previous strengthening plans and a detailed engineering evaluation report were available (as noted in 2.0). Each of the seven separate building areas as shown in Figure 1 are described below:

Building 1 is a one storey commercial structure assumed to be built in the 1920's and is currently used as storage space. The building consists of iron roofing on timber sarking supported on timber purlins and timber trusses. The roof structure is supported on tall unreinforced masonry walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 1 was part of the area which received seismic strengthening in 2012. The strengthening works involved the addition of timber braces supporting the URM walls out of plane as well as timber roof braces to strengthen the roof diaphragm. The footprint area for Building 1 is approximately 60 sqm.

Building 2 is a one storey commercial structure assumed to be built in the 1920's and is currently used as retail space. The building consists of iron roofing on timber sarking supported on timber purlins and timber trusses. The roof structure is supported on tall unreinforced masonry walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 2 was part of the area which received seismic strengthening in 2012. The strengthening works involved the addition of steel I-beam columns supporting the URM walls out of plane as well as timber roof braces to strengthen the roof diaphragm. The footprint area for Building 2 is approximately 60 sqm.

Building 3 is a one storey commercial structure assumed to be built in the 1920's and is currently used as retail space. The building consists of iron roofing on timber sarking supported on timber purlins and timber saw tooth trusses. The roof structure is supported on unreinforced masonry walls and timber framed walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 3 was part of the area which received seismic strengthening in 2012. The strengthening works involved the addition of timber braces to help support the buildings in plane lateral loads. The footprint area for Building 3 is approximately 500 sqm.

Building 4A is a one storey commercial structure assumed to be built in the 1940's and is currently used as a manufacturing space. The building consists of iron roofing on timber sarking supported on timber purlins and timber/steel trusses. The roof structure is supported on a combination of confined and unconfined unreinforced masonry walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 4A was part of the area which received seismic strengthening in 2012. The strengthening works involved the addition of timber braces to help support the buildings in plane lateral loads. The footprint area for Building 4A is approximately 400 sqm.

Building 4B is a one storey commercial structure assumed to be built in the 1940's and is currently used as a manufacturing space. The building consists of iron roofing on timber sarking supported on timber purlins and timber/steel trusses. The roof structure is supported on unreinforced masonry walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 4B was not strengthened during the strengthening works conducted in 2012. The footprint area for Building 4B is approximately 250 sqm.

Building 5 is a one storey commercial structure assumed to be built in the 1940's and is currently used as a manufacturer space. The building consists of iron roofing on timber sarking supported on timber purlins and timber trusses. The roof structure is supported on unreinforced masonry walls and timber framed walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). Building 5 was not strengthened during the strengthening works conducted in 2012. The footprint area for Building 4B is approximately 340 sqm.

The Storage Building is a one storey commercial structure assumed to be built in the 1960's and is currently used as storage space. The building consists of iron roofing on timber sarking supported on timber purlins and timber trusses. The roof structure is supported on unreinforced cavity masonry walls which are assumed to be sitting on a concrete grade beam foundation with a slab on grade base (Type C foundation). The Storage Building was not strengthened during the strengthening works conducted in 2012. The footprint area for the Storage Building is approximately 375 sqm.

There is a car park at the east side of the side with access from Main North Road. Refer to Figure 1 for the general site of the subject building.

Our report is based upon discussions with owner's representative and information as gathered at the site, no independent analysis has been performed. The inspection was limited to readily accessible areas of the property only. No intrusive investigations were completed.

3.2 Gravity Load Resisting System

Table 1 below outlines the gravity load resisting system for the subject buildings.

Building Portion	Description
Building 1	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber trusses. The roof trusses are supported on unreinforced brick masonry walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Building 2	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber trusses. The roof trusses are supported on unreinforced brick masonry walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Building 3	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber trusses. The roof trusses are supported on unreinforced brick masonry walls, timber framed walls and timber columns. The walls and columns are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Building 4A	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber/steel trusses. The roof trusses are supported on a combination of confined and unconfined unreinforced brick masonry walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Building 4B	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber/steel trusses. The roof trusses are supported on unreinforced brick masonry walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Building 5	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber trusses. The roof trusses are supported on unreinforced brick masonry walls and timber framed walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).
Storage Building	The gravity load resisting system consists of an iron roof on timber sarking supported on timber purlins and timber trusses. The roof trusses are supported on unreinforced brick masonry cavity walls. The walls are supported on an assumed concrete grade beam foundation with a slab on grade base (Type C Foundation).

Table 1 – Gravity Load Resisting Systems

3.3 LATERAL LOAD RESISTING SYSTEM

A building lateral load resisting system (LLRS) helps brace the structure against earthquake and wind loading. The lateral load resisting system for each of the seven building areas is described in Table 2 below.

Building Portion	Description
Building 1	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and timber roof brace diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal and transverse direction consists of URM shear walls and timber braces. The URM shear walls and timber braces transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Building 2	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and timber roof brace diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal and transverse direction consists of URM shear walls. The URM shear walls transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Building 3	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal direction consist of URM shear walls and the lateral bracing elements in the transverse direction consist of URM shear walls, timber framed shear walls and timber braces. The URM shear walls, timber framed shear walls and timber braces transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Building 4A	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal direction consists of a combination of confined and unconfined URM shear walls. The lateral bracing elements in the transverse direction consist of confined URM shear walls and timber braces. The URM shear walls and timber braces transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Building 4B	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in both the longitudinal and transverse direction consist of URM shear walls. The URM shear walls transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Building 5	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal direction consists of URM shear walls and the lateral bracing elements in the transverse direction consist of URM shear walls and timber framed shear walls. The URM shear walls and timber framed shear walls transfer the lateral load to the assumed concrete grade beam foundation below then into ground.
Storage Building	The lateral load resisting system consists of the lateral loads from the roof being picked up by the roofs sarking diaphragm and transferred to the lateral bracing elements. The lateral bracing elements in the longitudinal direction consists of URM cavity shear walls and the lateral bracing elements in the transverse direction consist of URM cavity shear walls and timber framed shear walls. The URM cavity shear walls and timber framed shear walls transfer the lateral load to the assumed concrete grade beam foundation below then into ground.

TABLE 2 – LATERAL LOAD RESISTING SYSTEMS

3.4 GEOTECHNICAL CONDITIONS AND FOUNDATION SYSTEM

The land in this area is not included in the Landcheck information as it is not near residential zoned. The site is noted as technical category N/A Urban. We do not have any other geotechnical notation on the site.

A review of the site did not note any observable settlement in the area of the buildings, parking lots or adjacent streets. These was no evidence noted of cracking or spreading of the existing joints in the exterior paving.

3.5 BUILDING CONDITION AND DAMAGE DESCRIPTION

We reviewed the site visually from the exterior and interior during the site visit in order to determine the nature and scope of the current building condition. During the course of our inspection, we did not observe any cracking or damages which could be considered earthquake damage that would affect the buildings structural capacities.

However, there was cracking through some of the concrete columns in Building 4A's confined masonry walls, refer to Figure 2 below. As the cracks were vertical cracks parallel with the longitudinal reinforcing in the concrete column, it is likely the cracking is due to induced stresses from the reinforcing expanding from rust. To ensure the damage doesn't become more significant leading to structural issues, the corroded steel should be repaired. Figure 3 below show a standard procedure to repair corroded reinforcing steel.

FIGURE 2 – BUILDING 4A CONCRETE COLUMN CRACKS

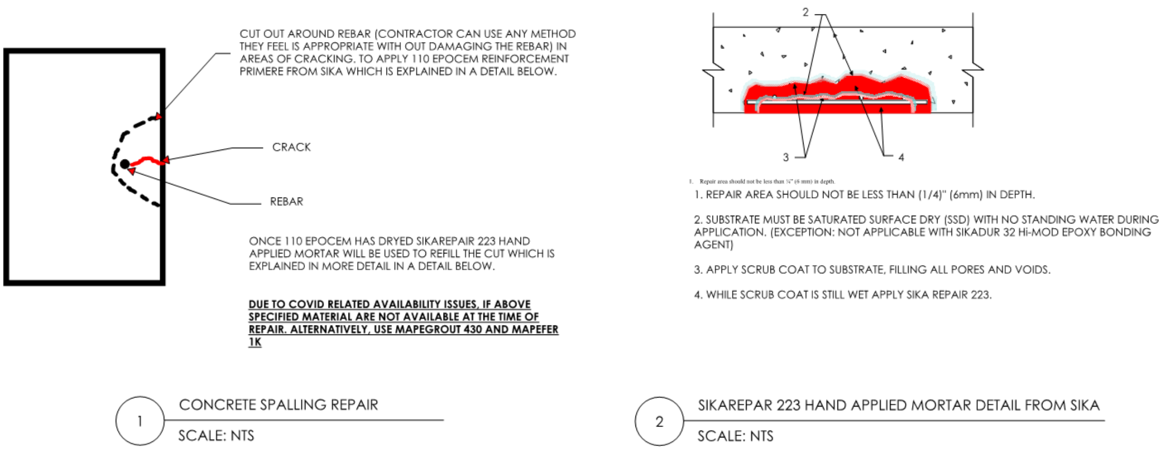

FIGURE 3 – REINFORCING CORROSION REPAIR

4.0 QUANTITATIVE ASSESSMENT

Our evaluation of the existing structures includes an assessment of specific building characteristics as gathered at the site. We have provided a Quantitative Assessment of the subject building, See Appendix B for a summary sheet of the Quantitative Assessment. We have reviewed the site as seven separate building areas built between the 1920's to the 1960's. It should be noted that most the building areas are joined together as noted in Figure 1.

In order to identify potential seismic deficiencies associated with the existing building, an analysis of key elements of the seismic force resisting system has been reviewed based on earthquake actions in accordance with the New Zealand Standard (NZS) 1170.5. Seismic vulnerabilities and Critical Structural Weaknesses (CSW's) associated with site and building characteristics have been considered in accordance with NZSEE's "Assessment and Improvement of the Structural Performance of Buildings in Earthquakes".

Portion	Loading direction and loaded element	%NBS Before earthquakes	%NBS After earthquakes
Building 1	Longitudinal Direction – URM Walls and Timber Braces	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
	Transverse Direction – URM Walls and Timber Braces	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
Building 2	Longitudinal Direction – URM Walls and Roof Diaphragm	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
	Transverse Direction – URM Walls and Roof Diaphragm	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
Building 3	Longitudinal Direction - Timber Braces	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
	Transverse Direction – Timber Braces	<34%	34% Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
Building 4A	Longitudinal Direction – URM Walls	>100%	>100% Assumed undamaged Structurally 34%

	Transverse Direction – Timber Braces	<34%	Structurally Strengthened to 34%NBS in 2012 by W2 LTD.
Building 4B	Longitudinal Direction – URM Walls and Roof Diaphragm	>100%	>100% Assumed undamaged Structurally
	Transverse Direction – Roof Diaphragm and End URM Wall	>20%	>20% Assumed undamaged Structurally
Building 5	Longitudinal Direction - URM Walls and Roof Diaphragm	>50%	>55% Assumed undamaged Structurally
	Transverse Direction – Timber Framed Shear Wall	>20%	>20% Assumed undamaged Structurally
Storage Building	Longitudinal Direction – URM Walls and Roof Diaphragm	>70%	>70% Assumed undamaged Structurally
	Transverse Direction – Timber Framed Shear Wall and Roof Diaphragm.	>15%	>15% Assumed undamaged Structurally

TABLE 3 – %NBS CHARACTERIZATIONS

The review concluded the following NBS% results for each of the buildings:

Building 1: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 2: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 3: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4A: >100%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4B: >100%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Building 5: 50%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Storage Building: 70%NBS Longitudinal, 15%NBS Transverse, *High Risk*, Grade E.

All the buildings have been reviewed with a ductility of 1.25 for the unreinforced brick masonry walls. The use of this ductility value is based upon previous reviews and studies of similar building performance in previous earthquakes. It should be noted that recommendations for new construction are to use a ductility factor of 1.25 for new design.

Using engineering judgement and acknowledging that the buildings are regular with redundancies of differing capacities and performance characteristics we would estimate a combined building rating to be estimated as a central risk estimate. This results in the overall ratings described above is as outlined in the New Zealand Society of Earthquake Engineering's "Assessment and Improvement of the Structural Performances of Buildings in Earthquakes".

Table 2.1: Grading system for earthquake risk

Percentage of New Building Standard (%NBS)	Letter grade	Relative risk (approx)	NZS 4203: 1976 or better	1965–76 No CSWs	1935–65 No CSWs	2/3 Chapter 8	Buildings with CSWs
>100	A+	< 1 time					
80–100	A	1–2 times					
67–80	B	2–5 times					
33–67	C	5–10 times					
20–33	D	10–25 times					
<20	E	> 25 times					

Note changes to the relative risk values have been made to line up with the values in Table C4.4.

Notes:

1) *%NBS* is the percentage new building standard score for a particular building
2) Values shown for *%NBS* for building groups are indicative only and will vary with location, assessed ductility, features. Many buildings may have been designed for more than the minimum requriements of the Standards of the day.
3) Letter grade is an indicator of likely performance in earthquake.
4) Relative risk (RR) is the ratio of probabilities that the ultimate strength will be exceeded in any given period of time, i.e. RR = (probability for existing building with *%NBS* value shown) ÷ (probability for building with 100*%NBS*).
5) CSW stands for critical structural weaknesses.

Table 2.2 NZSEE Risk Classifications and Improvement Recommendations

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

Improvement of Structural Performance	
Legal Requirement	NZSEE Recommendation
The Building Act sets no required level of structural improvement (unless change in use) This is for each TA to decide. Improvement is not limited to 34%NBS.	100%NBS desirable. Improvement should achieve at least 67%NBS
	Not recommended. Acceptable only in exceptional circumstances
Unacceptable	Unacceptable

* *Reprint from NZSEE, Assessment and Improvement of the Structural Performance of Buildings in Earthquakes*

4.1 CRITICAL STRUCTURAL WEAKNESS AND MITIGATION

The structural systems, in our opinion, have performed well and appears to be well built. At this point, we have inspected these buildings and have noted some CSW areas of concern. Each of the critical structural weaknesses noted with the proposed mitigation method is described below.

<u>Out of Plane Capacity of Tall Unreinforced Brick Masonry Walls</u>

Buildings 1 and 2 have tall URM brick walls which were previously strengthened to 34%NBS with the addition of timber braces and steel I-beam columns. To achieve a higher NBS% in these buildings, we recommend the existing timber braces are removed and a mid-height floor is installed. This would allow the existing space to be opened as the timber braces can be removed as well as extra floor space being added with the additional floor. The additional floor also acts as a mid-height diaphragm bracing the walls out of plane and drastically lowering the lateral loads on the roof diaphragm as an additional diaphragm has been added. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

Roof Diaphragm Capacity

Both buildings 4B and the storage building have the roof diaphragm as a critical structural issue as it is less than 34%NBS making the buildings earthquake prone. All the other buildings will require strengthening to their diaphragm if a higher NBS% wants to be achieved with the removal of the existing emergency strengthening to help open up the space. The existing roof diaphragms can be strengthened by the addition of a plywood or cross-brace diaphragm. The addition of internal bracing element to reduce the diaphragms span is another option. Internal brace frames, portal frames and shear walls can be used, we recommend the appropriate bracing element is selected to align with the desire future use of the building. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

Roof Diaphragm to Wall Connection Capacity

Both buildings 4B and the storage building have the roof diaphragm connections to the URM shear walls as a critical structural issue as it is less than 34%NBS making the buildings earthquake prone. All the other buildings will require strengthening to their diaphragm connections if a higher NBS% wants to be achieved with the removal of the existing emergency strengthening to help open up the space. The existing roof diaphragm connections to the URM walls can be strengthened by the addition of epoxy bolts connecting the roof diaphragms framing or cross brace wall bracket to the URM wall. The roof diaphragms connection to the URM brick wall is a typical failure mode for URM building in this era. The addition of improved diaphragm connection is a simple way to drastically strengthen and increase the performance of the building in a seismic event. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

Timber Framed Shear Wall Capacity

Building 5's timber framed shear wall is seen as a critical structural issue as it is less than 34%NBS making the building earthquake prone. Building 3's timber shear walls will also require strengthening if a higher NBS% wants to be achieved with the removal of the existing emergency strengthening to help open up the space. The existing timber framed shear walls is lined with Hardie board and is believed to be installed as an addition to the original construction to help separate the space. The timber framed shear walls can be strengthened by adding additional hold downs at the ends of the timber framed walls with plywood lining to create plywood shear walls. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

Brick Cavity Wall Brick Ties

The storage buildings unreinforced brick masonry walls are brick cavity walls. As the building was constructed in the 1960's, it is likely the steel wire brick ties tying the bricks together have corrosion away. Therefore, Helifix ties should be installed to tie the two layers of brick together strengthening the existing cavity URM walls for both out of plane and in plane loading. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

Two schematic plans have been created to determine what works would be required to strengthen the buildings and help with budget costing to conduct the works. A schematic to 34%NBS has been created with the previous strengthening works from W2 Structural Engineering LTD remaining. A second schematic has been conducted to 70%NBS with the removal of the previous strengthening works from W2 Structural Engineering LTD to help open up the buildings internal space for future use. Refer to Appendix D for schematic strengthening plans to 70%NBS and Appendix C for schematic strengthening plans to 34%NBS.

As a quantitative analysis of the buildings has been conducted no recommendation to perform further assessments to provide specific analysis for the building systems would be necessary or required, in our opinion.

5.0 CONCLUSIONS, OCCUPANCY AND RECOMMENDATIONS

The building has been designed to resist the seismic loading provided in the 1920's to 1960's. The lateral systems provided in the building are considered to be specific engineered design. The Z factor has been modified in 2011 in the Canterbury region from 0.22 to 0.3 indicating a 27% increase in design loading. The building contains most items which have a low ductility but due to the regular nature of the building can perform satisfactorily in future seismic events.

In our estimation the URM shear walls, timber framed shear walls and timber braces provide the main seismic path which provides a relatively low ductility performance. In our opinion, the buildings were found to have an NBS% rating as shown below:

Building 1: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 2: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 3: 34%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4A: >100%NBS Longitudinal, 34%NBS Transverse, *Moderate Risk*, Grade C.
Building 4B: >100%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Building 5: 50%NBS Longitudinal, 20%NBS Transverse, *High Risk*, Grade D.
Storage Building: 70%NBS Longitudinal, 15%NBS Transverse, *High Risk*, Grade E.

In our opinion, the buildings performed well in the recent seismic loading and behaved similar to more modern buildings with similar structural systems. As portions of the buildings are of *High Risk*, the anticipated performance will behave subpar to newly constructed buildings. Therefore, we recommend strengthening works are conducted to the building to help ensure the structure performs appropriately in future seismic events. As a quantitative analysis was conducted it is likely a more comprehensive analysis of the building won't provide a much higher rating than indicated.

At this point we propose that no limitations be placed upon occupation of the building.

Appendix A: Photos 28th September 2022

 Photo 1 – Site Front Elevation	 Photo 2 – Site Front Elevation
 Photo 3 – Building 1 Interior	 Photo 4 – Building 1 Interior
 Photo 5 – Building 1 Interior	 Photo 6 – Building 1 Interior

Photo 7 – Building 2 Interior

Photo 8 – Building 2 Interior

Photo 9 – Building 2 Interior

Photo 10 – Building 2 Interior

Photo 11 – Building 3 Interior

Photo 12 – Building 3 Interior


Photo 13 – Building 3 Interior


Photo 14 – Building 3 Interior


Photo 15 – Building 3 Interior


Photo 16 – Building 3 Interior


Photo 17 – Building 3 Interior


Photo 18 – Building 4A Interior


Photo 19 – Building 4A Interior


Photo 20 – Building 4A Interior


Photo 21 – Building 4B Interior


Photo 22 – Building 4B Interior


Photo 23 – Building 5 Interior

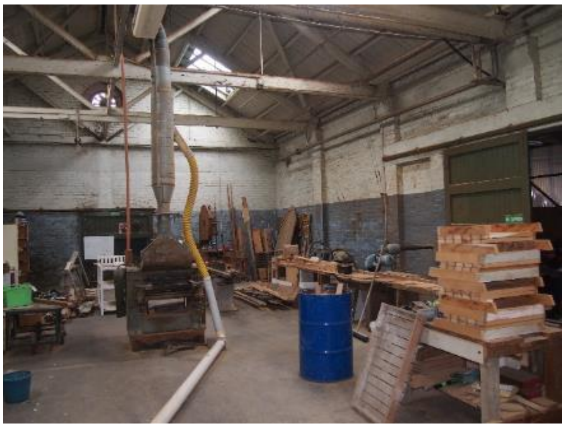
Photo 24 – Building 5 Interior


Photo 25 – Building 5 Interior


Photo 26 – Storage Building Exterior


Photo 27 – Storage Building Exterior

Photo 28 – Storage Building Interior


Photo 29 – Storage Building Interior

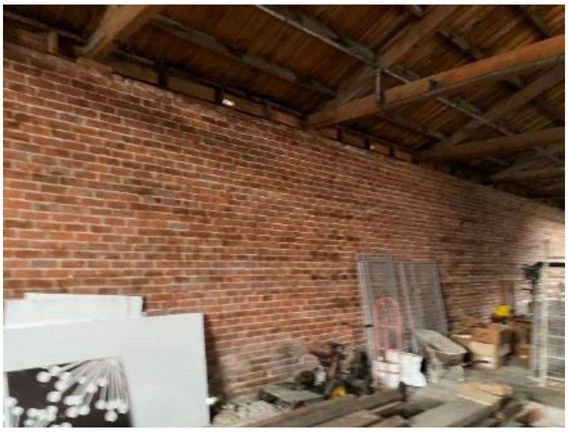
Photo 30 – Storage Building Interior

Appendix B: Assessment Summary Form

1473 Main North Road DSA Final

1. **Building Information**	
Building Name/ Description	1473 Main North Road
Street Address	1473 Main North Road, Waikuku 7473
Territorial Authority	Christchurch City Council
No. of Storeys	One Storey
Area of Typical Floor (approx.)	Main building approx. 1620sm. Storage building approx. 375sm.
Year of Design (approx.)	See attached Centraus report dated 4th October 2022
NZ Standards designed to	See attached Centraus report dated 4th October 2022 Background
Structural System including Foundations	See attached Centraus report dated 4th October 2022 Building Description
Does the building comprise a shared structural form or shares structural elements with any other adjacent titles?	No
Key features of ground profile and identified geohazards	See attached Centraus report dated 4th October 2022 Attached herewith - Geotechnical Investigation not undertaken – no information noted
Previous strengthening and/ or significant alteration	See attached Centraus report dated 4th October 2022 Previous strengthening works to a portion of the building to 34%NBS in 2012 by W2 Limited
Heritage Issues/ Status	None Noted
Other Relevant Information	Not Applicable

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1 | Page

2. Assessment Information	
Consulting Practice	Centraus Structural Engineers
CPEng Responsible, including: • Name • CPEng number • A statement of suitable skills and experience in the seismic assessment of existing buildings[1]	Michael King CPEng 1022085 30 years experience working with timber, concrete and reinforced and unreinforced masonry buildings in high seismic areas – California, Haiti and New Zealand.
Documentation reviewed, including: • date/ version of drawings/ calculations[2] • previous seismic assessments	See attached Centraus report dated 4th October 2022 Background
Geotechnical Report(s)	None Noted
Date(s) Building Inspected and extent of inspection	Physical inspection was undertaken on-site in 4th October 2022 and discussions with owner.
Description of any structural testing undertaken and results summary	None Noted
Previous Assessment Reports	None Noted
Other Relevant Information	None Noted

[1] This should include reference to the engineer's Practice Field being in Structural Engineering, and commentary on experience in seismic assessment and recent relevant training
[2] Or justification of assumptions if no drawings were able to be obtained

1473 Main North Road DSA Final

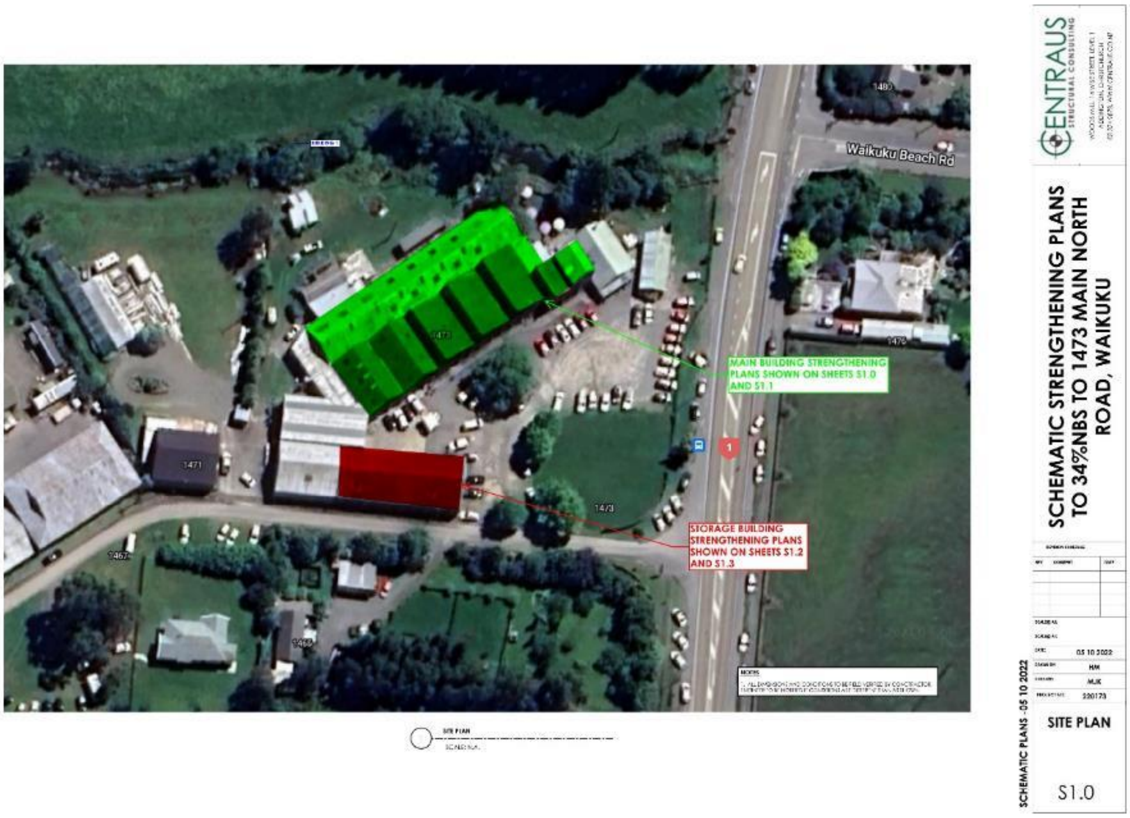
3. Summary of Engineering Assessment Methodology and Key Parameters Used	
Occupancy Type(s) and Importance Level	Fire Hazard Category 2
Site Subsoil Class	Type D
For an ISA:	N/A
Summary of how Part B was applied, including: • Key parameters such as μ, S_p and F factors • Any supplementary specific calculations	N/A
For a DSA:	Yes
Summary of how Part C was applied, including: • the analysis methodology(s) used from C2 • other sections of Part C applied	NZS1170.5 NZSEE Section C8
Other Relevant Information	None

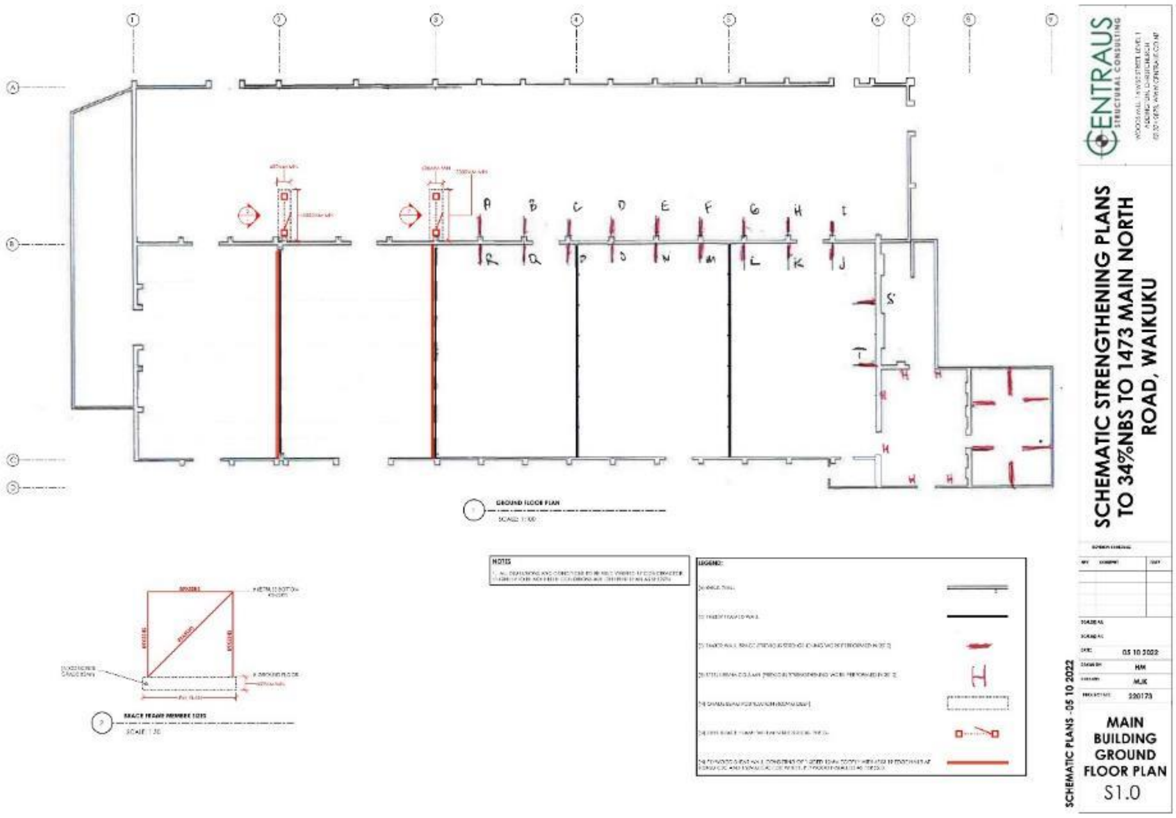
4. Assessment Outcomes		
Assessment Status (Draft or Final)	Final	
Assessed *%NBS* Rating	Building 1: 34%NBS Longitudinal, 34%NBS Transverse. Building 2: 34%NBS Longitudinal, 34%NBS Transverse. Building 3: 34%NBS Longitudinal, 34%NBS Transverse. Building 4A: >100%NBS Longitudinal, 34%NBS Transverse. Building 4B: >100%NBS Longitudinal, 20%NBS Transverse. Building 5: 50%NBS Longitudinal, 20%NBS Transverse. Storage Building: 70%NBS Longitudinal, 15%NBS Transverse.	
Seismic Grade and Relative Risk (from Table A3.1)	Building 1: Grade C. Building 2: Grade C. Building 3: Grade C. Building 4A: Grade C. Building 4B: Grade D. Building 5: Grade D. Storage Building: Grade E.	
<u>For an ISA:</u>		
Describe the Potential Critical Structural Weaknesses	N/A	
Does the result reflect the building's expected behaviour, or is more information/ analysis required?	N/A	
If the results of this ISA are being used for earthquake prone decision purposes, <u>and</u> elements rating <34*%NBS* have been identified:	**Engineering Statement of Structural Weaknesses and Location** N/A	***Mode of Failure and Physical Consequence* Statement(s)** N/A
<u>For a DSA:</u>		
Comment on the nature of Secondary Structural and Non-structural elements/ parts identified and assessed	None Noted.	
Describe the Governing Critical Structural Weakness	Building 4B, Building 5 and Storage Building – Roof Diaphragm, Roof Connections and Timber Frame Shear Wall	

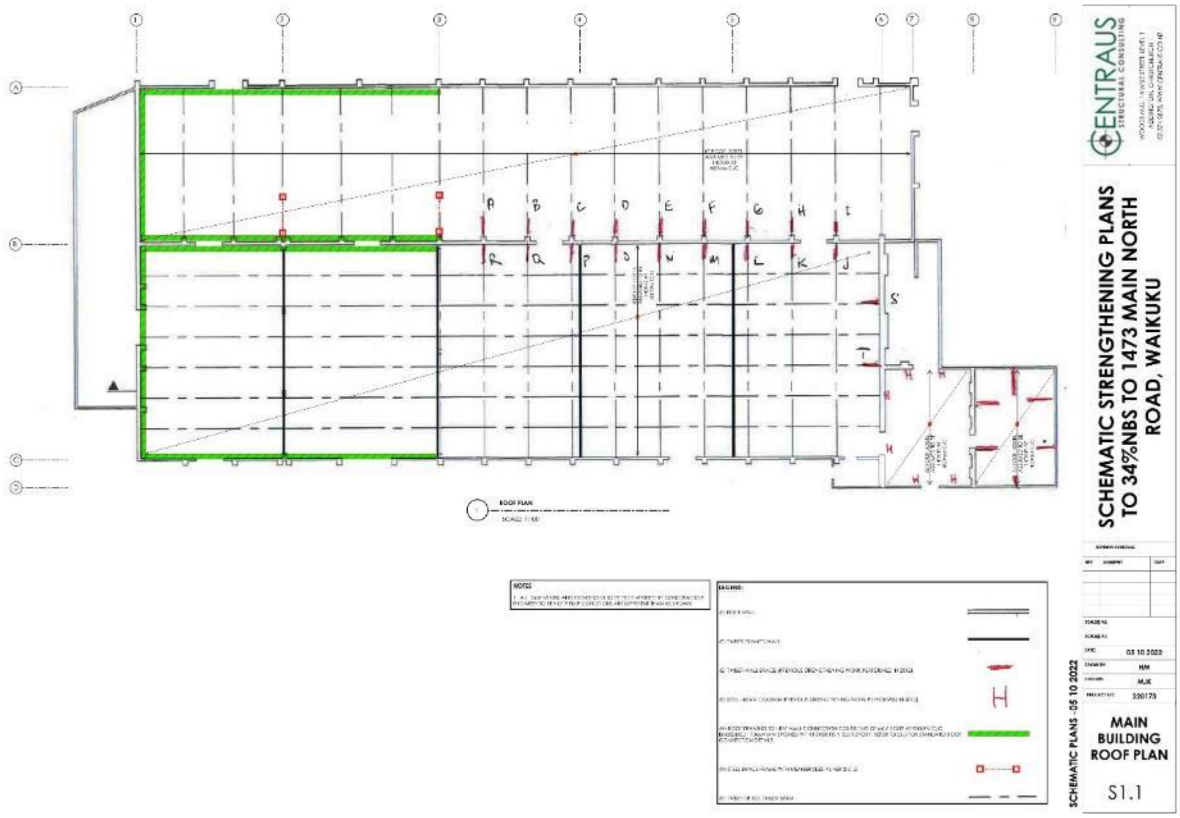
If the results of this DSA are being used for earthquake prone decision purposes, <u>and</u> elements rating <34%*NBS* have been identified (including Parts)[3]:	**Engineering Statement of Structural Weaknesses and Location** See above	***Mode of Failure and Physical Consequence* Statement(s)**
Recommendations (*optional for EPB purposes*)		

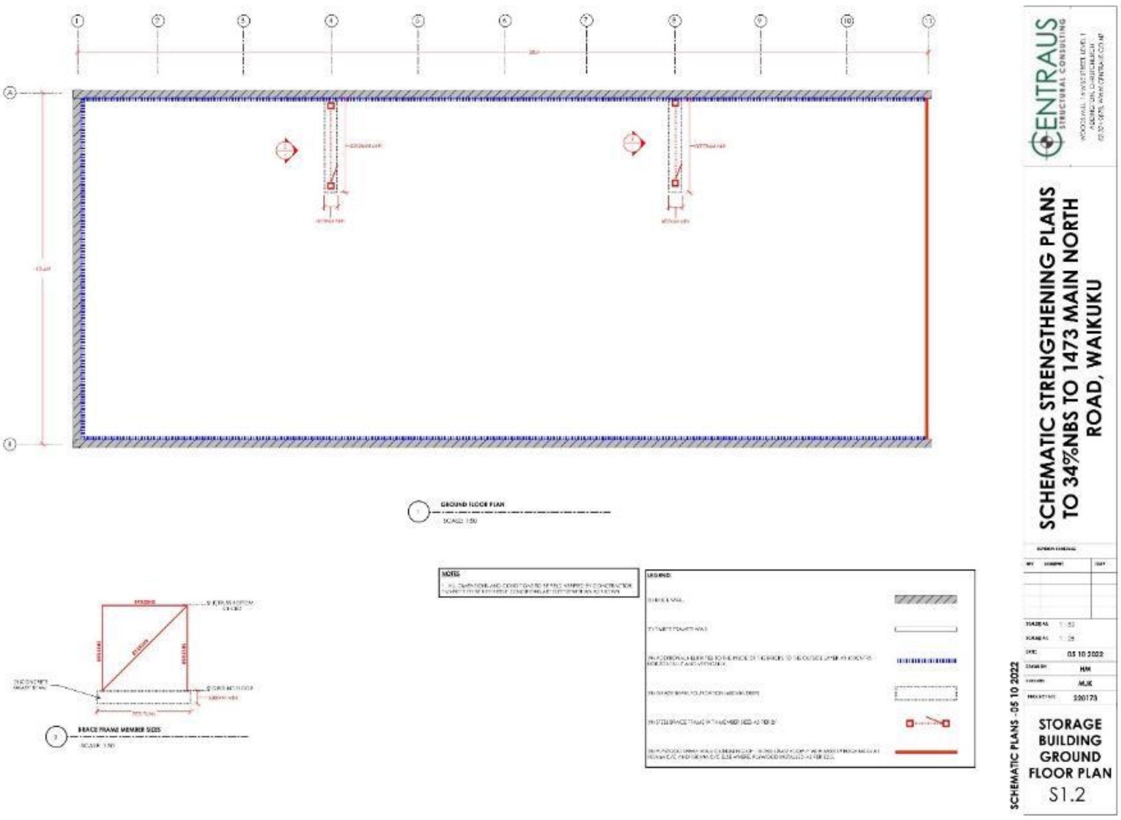
[3] If a building comprises a shared structural form or shares structural elements with other adjacent titles, information about the extent to which the low scoring elements affect, or do not affect the structure.

APPENDIX C: SCHEMATIC STRENGTHENING PLANS TO 34%NBS






CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 34%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
SCHEMATIC PLANS - 05 10 2022
05 10 2022
HM
MJK
220173
MAIN BUILDING ROOF PLAN
S1.1
ROOF PLAN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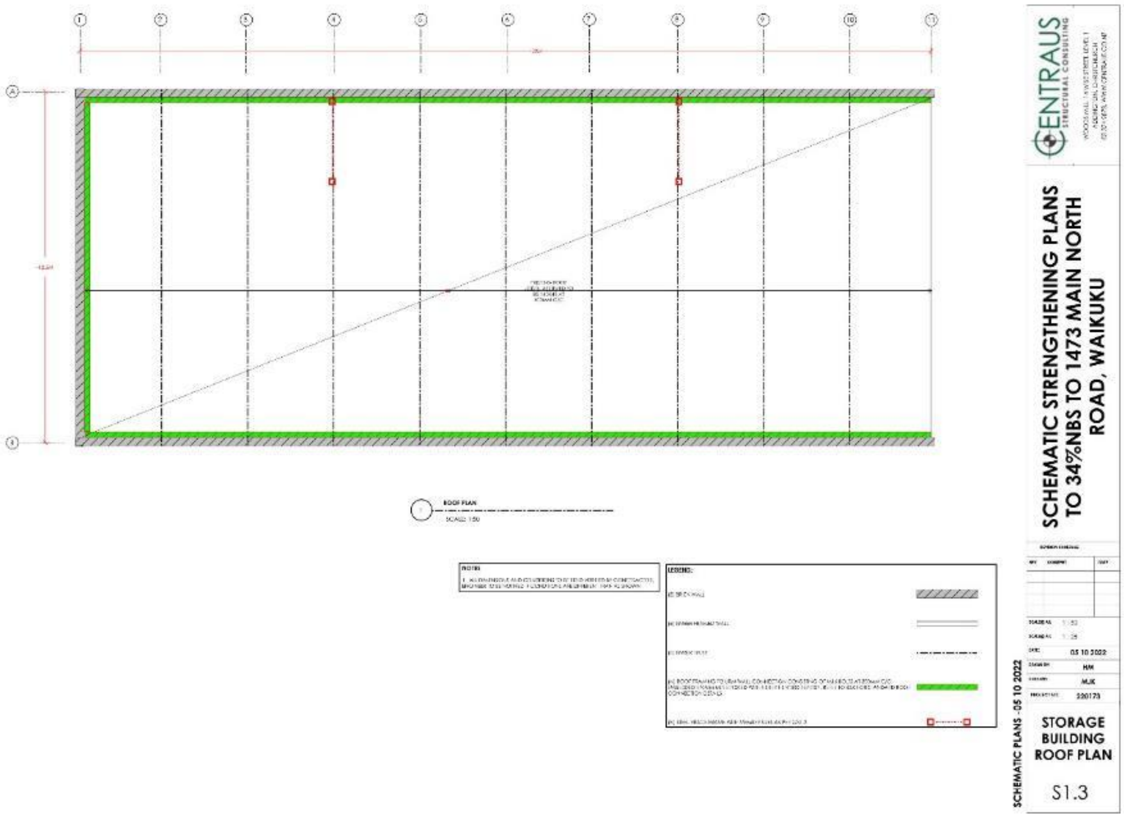
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 34%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
SCHEMATIC PLANS - 05 10 2022
05 10 2022
HM
MJK
220173
STORAGE BUILDING GROUND FLOOR PLAN
S1.2
GROUND FLOOR PLAN
BRACE FRAME MEMBER SIZES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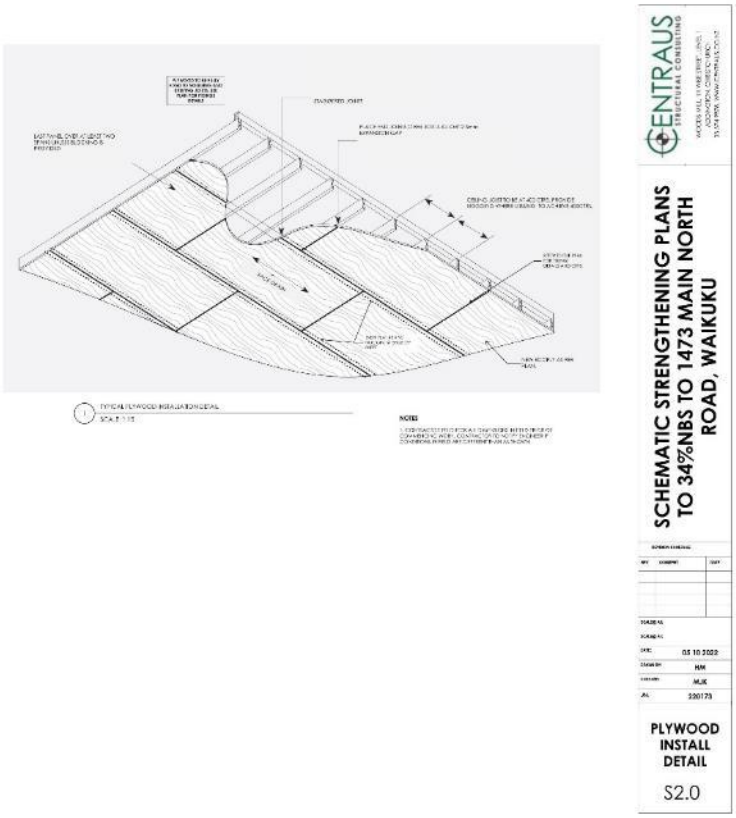
SCHEMATIC PLANS - 05 10 2022
05 10 2022
HM
MJK
220173
STORAGE BUILDING ROOF PLAN
S1.3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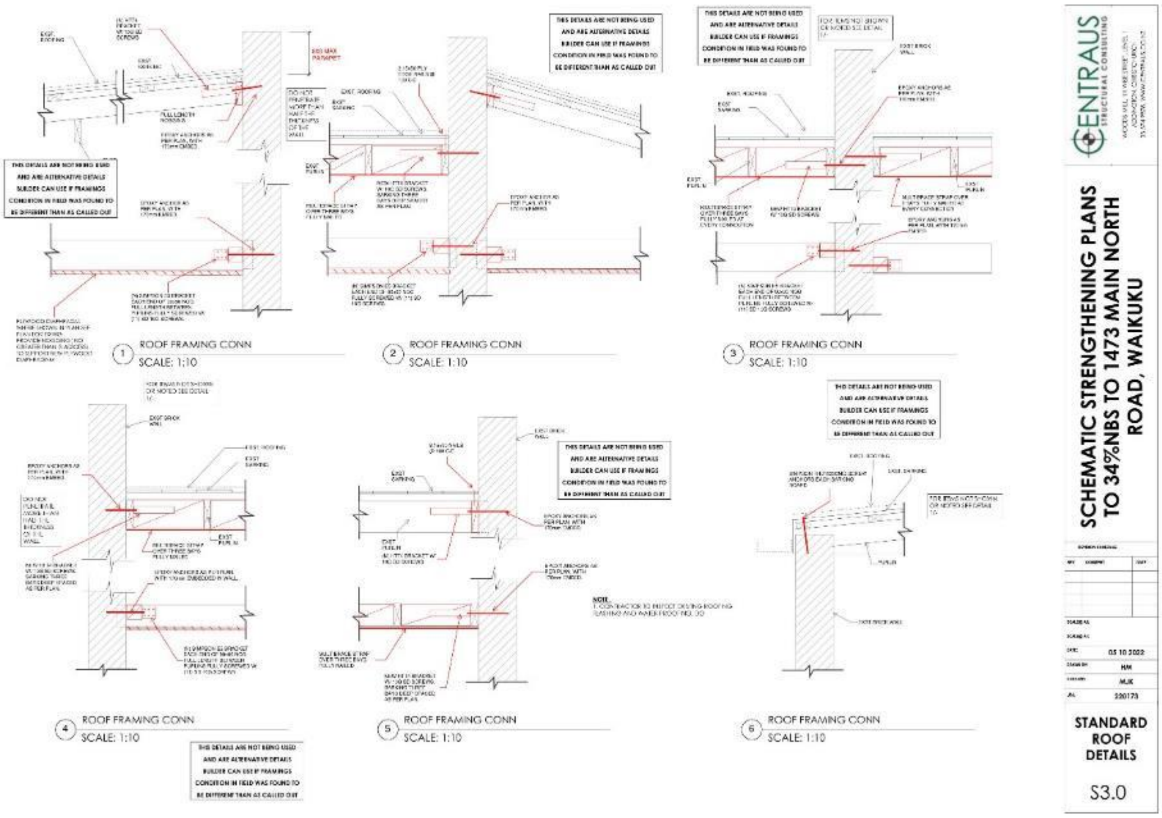
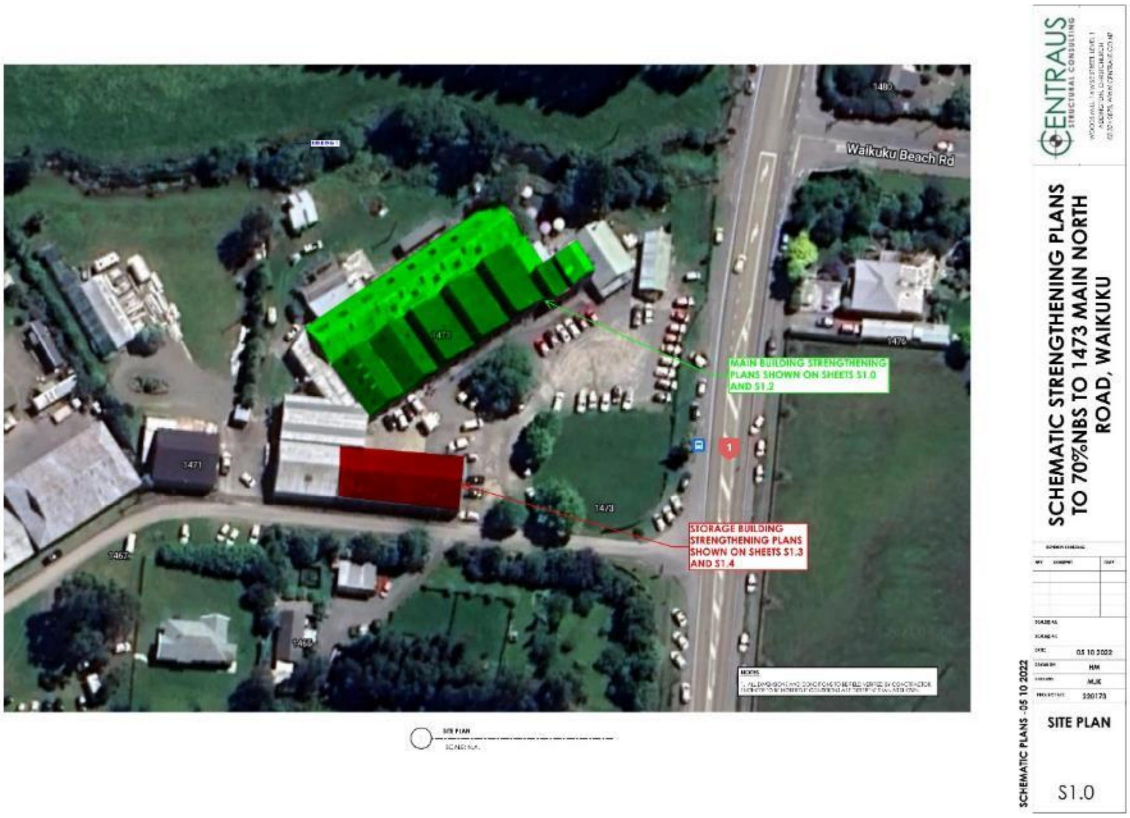
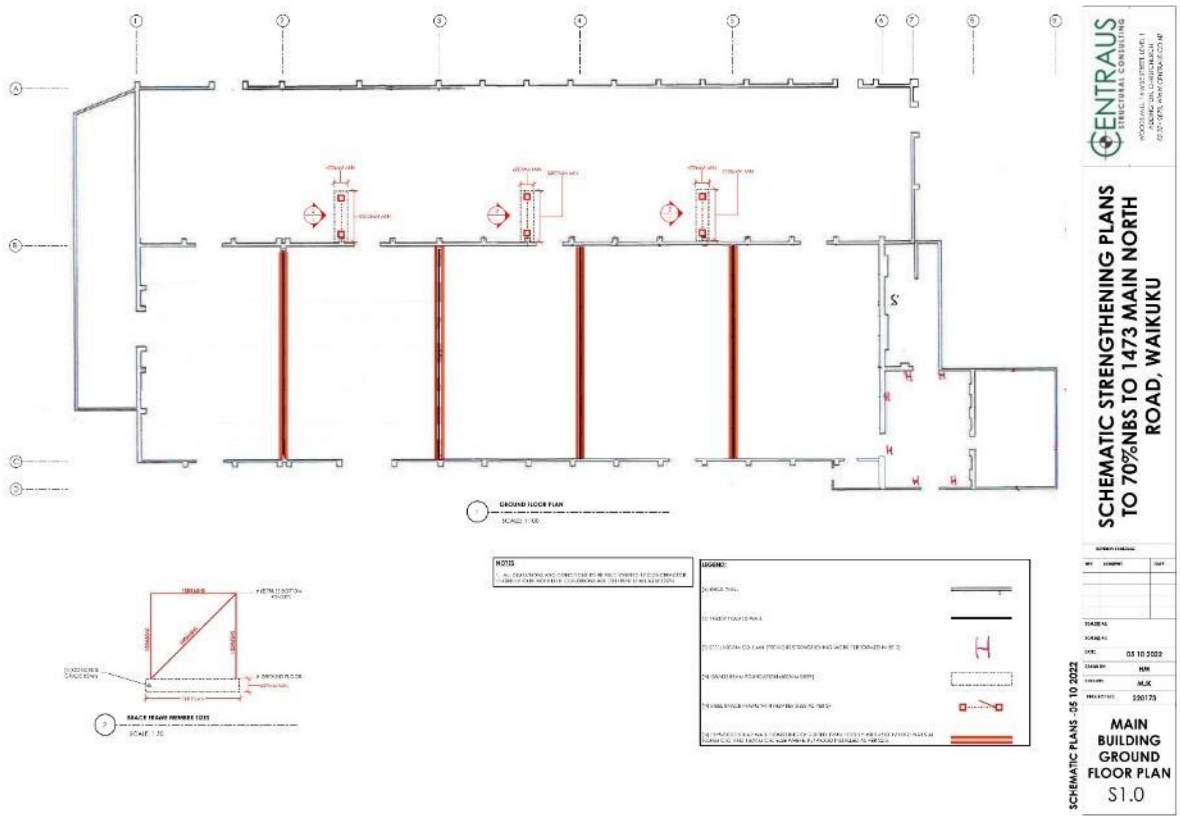
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 34%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
05 10 2022
HM
MJK
220173
PLYWOOD INSTALL DETAIL
S2.0

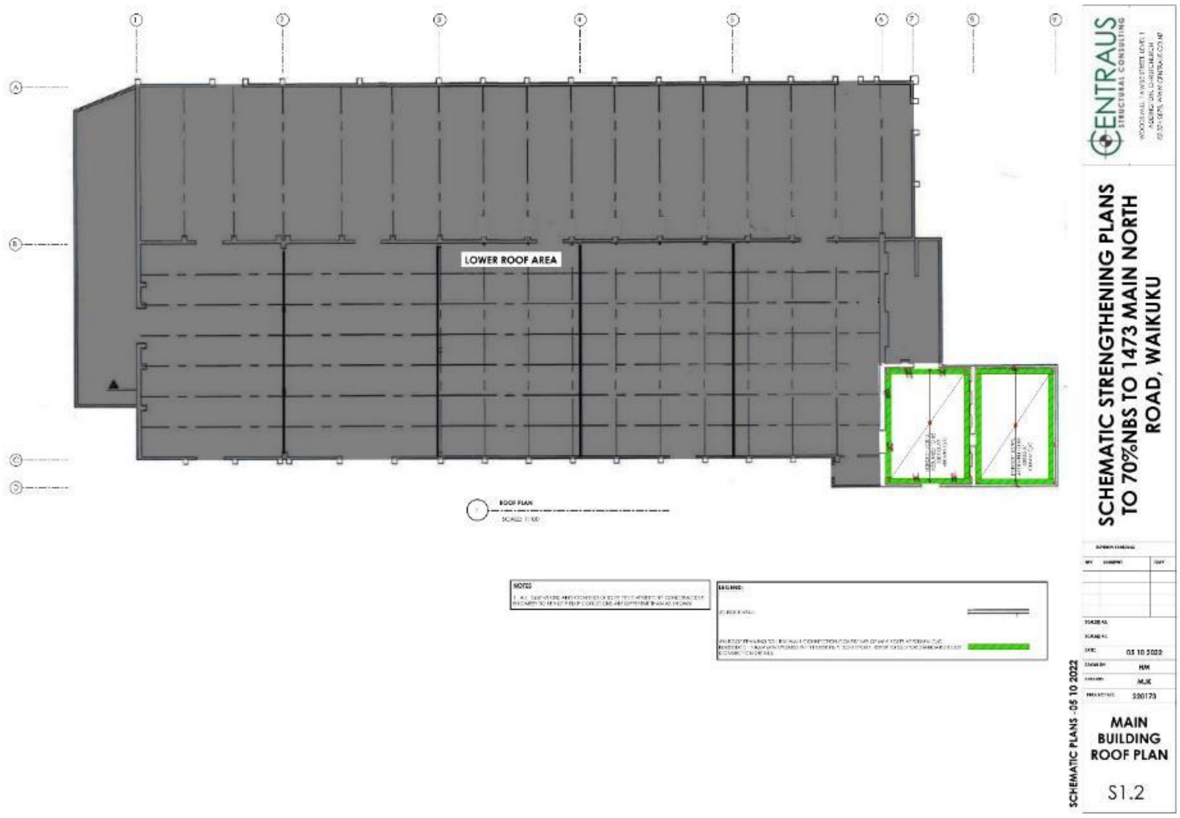

ROOF FRAMING CONN
SCALE: 1:10
THIS DETAILS ARE NOT BEING USED AND ARE ALTERNATIVE DETAILS BUILDER CAN USE IF FRAMINGS CONDITION IN FIELD WAS FOUND TO BE DIFFERENT THAN AS CALLED OUT
CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 34%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
STANDARD ROOF DETAILS
S3.0

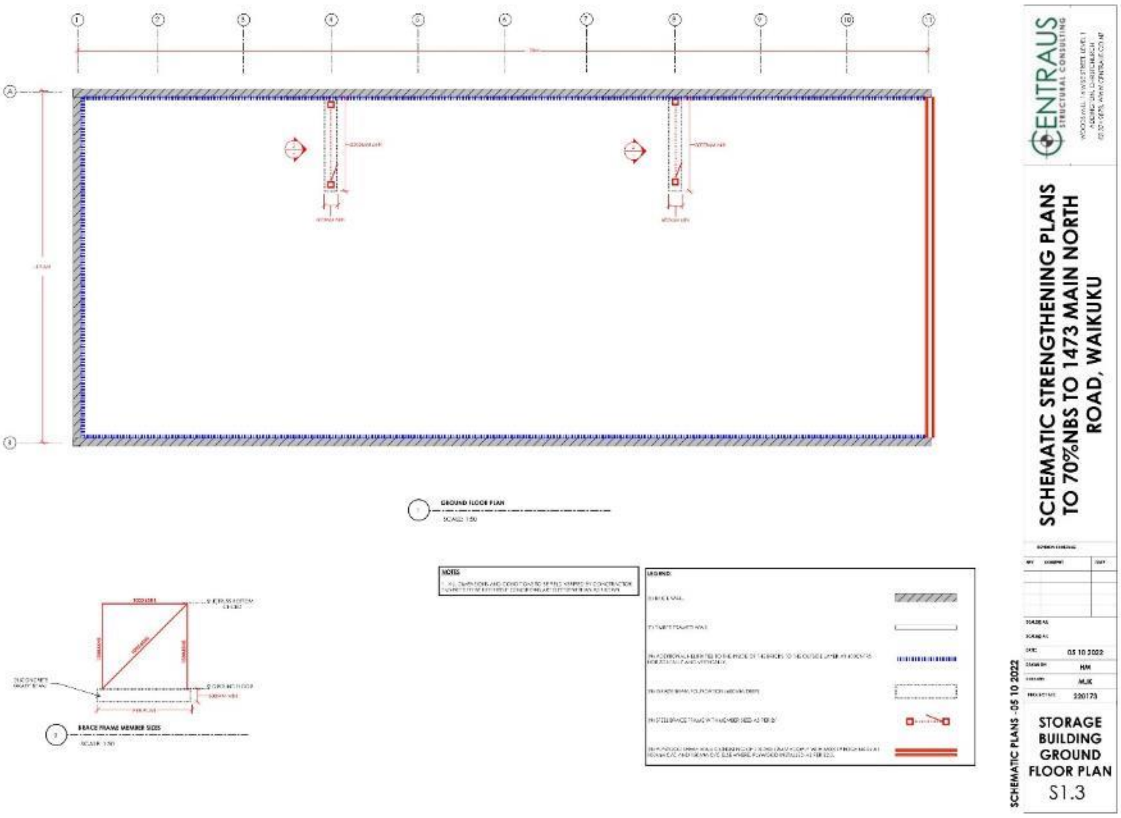
Appendix D: Schematic Strengthening Plans to 70%NBS

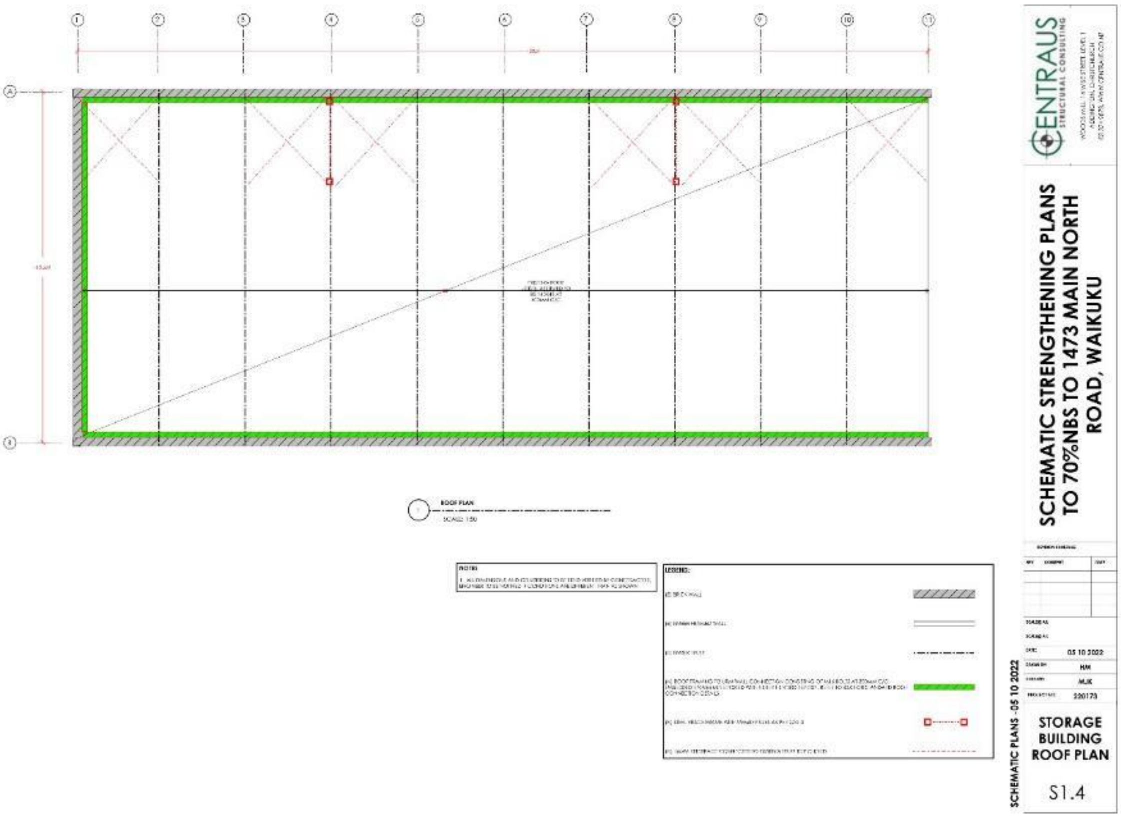


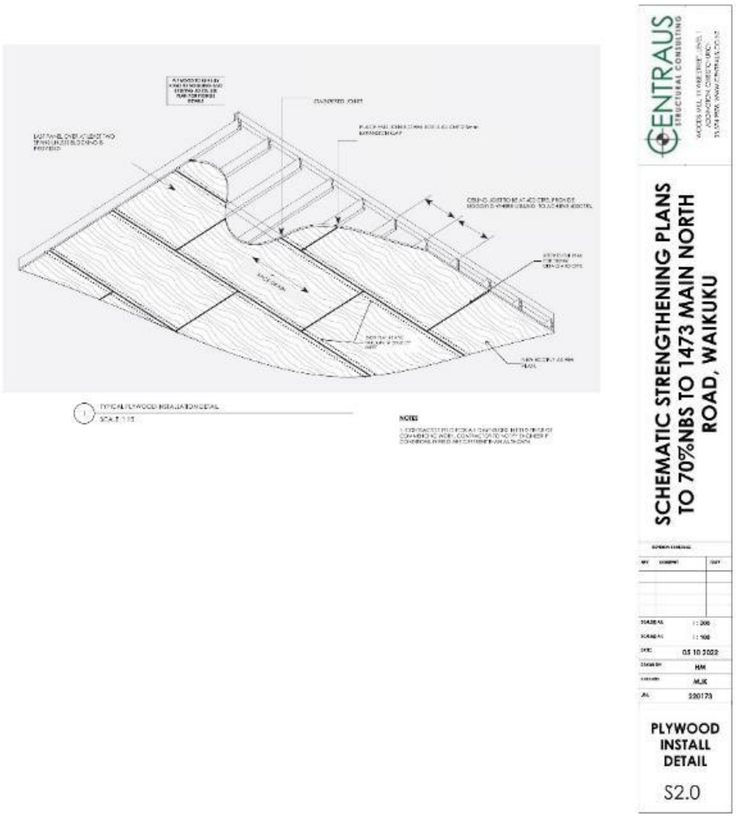


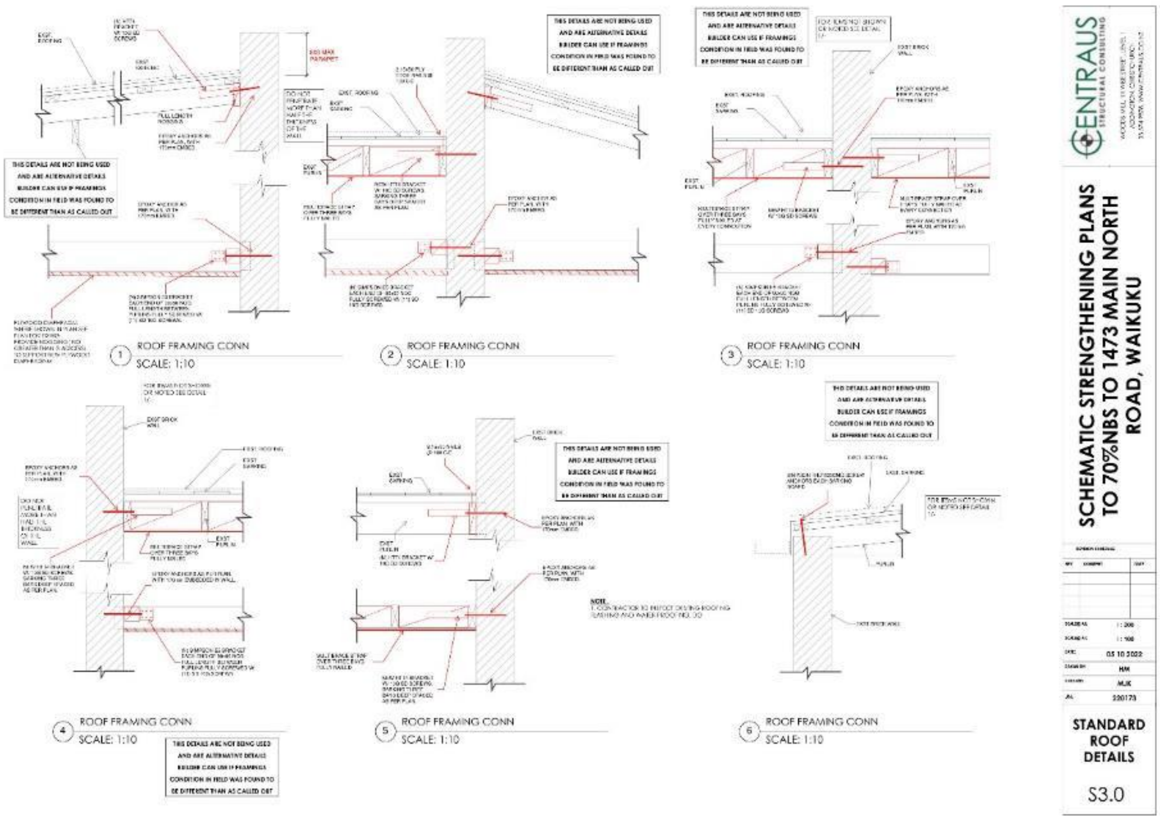

ROOF PLAN
CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
05 10 2022
HM
MJK
220173
MAIN BUILDING 1ST FLOOT AND LOWER ROOF PLAN
S1.1
SCHEMATIC PLANS - 05 10 2022


LOWER ROOF AREA
ROOF PLAN
CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
05 10 2022
HM
MJK
220173
MAIN BUILDING ROOF PLAN
S1.2
SCHEMATIC PLANS - 05 10 2022


GROUND FLOOR PLAN
SCALE 1:50
NOTES
LEGEND
SCALE 1:50
CENTRAUS STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
05 10 2022
HM
MJK
220173
STORAGE BUILDING GROUND FLOOR PLAN
S1.3
SCHEMATIC PLANS - 05 10 2022


ROOF PLAN
SCALE 1:50
NOTES
LEGEND
CENTRAUS STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
05 10 2022
HM
MJK
220173
STORAGE BUILDING ROOF PLAN
S1.4
SCHEMATIC PLANS - 05 10 2022


CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
PLYWOOD INSTALL DETAIL
S2.0


THIS DETAILS ARE NOT BEING USED AND ARE ALTERNATIVE DETAILS BUILDER CAN USE IF FRAMINGS CONDITION IN FIELD WAS FOUND TO BE DIFFERENT THAN AS CALLED OUT
1 ROOF FRAMING CONN
SCALE: 1:10
2 ROOF FRAMING CONN
SCALE: 1:10
3 ROOF FRAMING CONN
SCALE: 1:10
4 ROOF FRAMING CONN
SCALE: 1:10
5 ROOF FRAMING CONN
SCALE: 1:10
6 ROOF FRAMING CONN
SCALE: 1:10
CENTRAUS
STRUCTURAL CONSULTING
SCHEMATIC STRENGTHENING PLANS TO 70%NBS TO 1473 MAIN NORTH ROAD, WAIKUKU
STANDARD ROOF DETAILS
S3.0