**APPENDIX 1**
A3189945

Project Number: 6-DP444.00

# Anderson House Seismic Strengthening Investigations

14 July 2020

CONFIDENTIAL

# Summary Report

wsp

150 YEARS IN AOTEAROA

## Contact Details

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*Document Details:*

| | |
|---|---|
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*Reviewed by*
Simon Therkleson

*Approved for release by*
Mary Ann Halliday

## Document History and Status

| Revision | Date | Author | Reviewed by | Approved by | Status |
|---|---|---|---|---|---|
| A.1 | 22/06/2020 | T. Green,<br>M. A. Halliday | S. Therkleson | M.A. Halliday | DRAFT |
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| | | | | | |

## Revision Details

| Revision | Details |
|---|---|
| A.1 | Draft release for client comment |
| | |
| | |

# Contents

# 1 Introduction

WSP has been engaged by Invercargill City Council to provide professional engineering services for the investigation and seismic assessment of Anderson House located at Anderson Park, 91 McIvor Road, Waikiwi.

WSP have previously been engaged to carry out site inspections and prepare a Detailed Engineering Evaluation (DEE) in January 2014. The reported poor seismic performance led to the building being closed. A strengthening scheme to 67% NBS (IL2) was prepared and costed at the time of the evaluation.

WSP has now carried out further investigations and re-assessed the building using techniques that were not available in 2013, resulting in an increase in the expected seismic performance of select elements of the building and therefore changing some of the assumptions made in the DEE. The increase is due to changes in the New Zealand Society for Earthquake Engineering (NZSEE) assessment guidelines and legislation regarding earthquake prone buildings which have both been revised since 2014.

## 1.1 Background

A site visit and visual investigation of the building was completed by WSP with a contractor on the 4th June 2020 to open up key areas requested previously. Careful intrusive investigations were completed at the specified locations to confirm details that were unclear from the previous work. Investigations were limited to localised openings in the floor(s), wall(s) and ceilings(s) at first floor level.

The results of the site investigations indicate the following:

1. The condition of the concrete work appears to be very good, compared to other structures built during this time. It was found that there is reinforcement in the concrete which is unusual for a concrete structure of this age. Figure 1 below highlights the location of reinforcement (in red) which was identified along the back wall during the inspection.
2. The observed concrete is cast in-situ with clear formwork edges observed. There is no evidence to indicate that it is camerated concrete.
3. The T&G floor condition is very good, with only minor damage where penetrations for services have been opened.
4. The existing floor joists appear to be cast into the concrete walls which provide good shear transfer capacity however no ties or other fixings were observed which could provide tension capacity.
5. The chimneys appear to be well confined within the timber floor and roof framing at each level and have large concrete arched structures which assist with out of plane restraint at each floor level. However, there is only limited support above first floor ceiling level, and the chimneys pose a potential fall hazard.
6. There is one internal concrete dividing wall at first floor level which is supported on the timber floor which overloads the floor.
7. Some of the floor beams vary from what was previously assumed which has a minor impact on the strengthening scheme proposed previously.

*Figure 1: Approximate steel reinforcing in concrete veneer which was Identified during the site inspection*

# 2 Discussion

## 2.1 Secondary Timber Beam/Concrete Walls

The wall between the family room and the Guest room at first floor level is made of concrete. There is no wall or beam directly underneath. It has been cast on top of the tongue and groove flooring which is supported on timber floor joists. The ceiling under this floor is quite ornate with an expressed primary and secondary beam grid system that support the floor joists. An illustration of the location of the transverse concrete wall with reference to the primary and secondary beams is presented in Figure 2

Some levels were taken on the floor in the vicinity of the concrete wall. There is a pronounced displacement of about 15mm. This is depicted Figure 3. Calculations confirm that this displacement would be expected due to the load from the concrete wall.

The critical member in the flooring system is the secondary beams. The walls impose a large self-weight (dead load) on the timber flooring which exceeds the calculated capacity of the secondary beams. Further to this, in an earthquake, the walls impose an additional seismic reaction on the secondary beams which could require secondary mechanisms to form to support the wall. The imposed loading on the floor has resulted in a deflection of 15 mm, measured adjacently to one wall, over the course of the buildings design life.

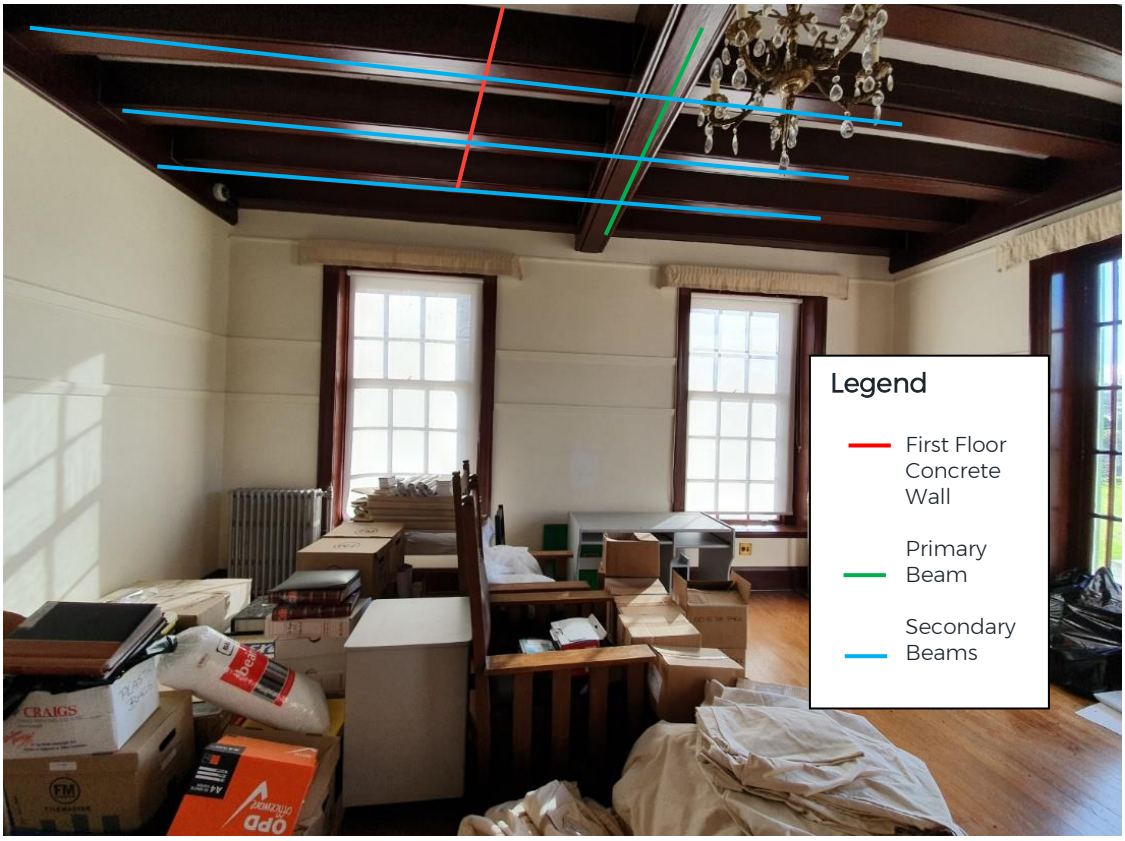


*Figure 2: Location of First Floor Concrete Wall Shown from Ground Floor*

*Figure 3: Displacement of Flooring Adjacent to Concrete Wall, Second Storey*

*Table 1: Loading compliance under different load cases*

| Load Case | Loading Standard Compliance |
|---|---|
| Seismic (Secondary Beam) | 74% NBS (IL2) |
| Gravity (Secondary Beam) | Live load on floor is limited to 0.31 kPa for code compliance. Future uses likely to require 3 kPa. |
| Seismic (Timber Joist) | 57% NBS (IL2) |
| Gravity (Timber Joist) | Sufficient capacity |

An assessment of one concrete wall on the timber flooring was completed to confirm that it was limiting the overall new build standard percentage (%NBS) for the building. Table 1 shows the relative NBS percentages for seismic and gravity loading scenarios and indicates that the flooring system has an overall limit of 57% NBS (IL2). The measured deflection of 15 mm is expected from the behaviour of timber floors. This deflection is in line with the relative calculated deflection of 19 mm, although, both deflections are significantly over the allowable limit of 10 mm as stated in the New Zealand loadings standard (AS/NZS 1170.1:2004).

The secondary beams are overloaded in the current condition for basic gravity loading and are not capable of resisting the minimum usable live load requirements stated in the New Zealand Building Code.

Strengthening the floor system would require installing new steel beams which will have significant impact on the heritage fabric. The preferred structural solution is to remove the concrete dividing walls and reinstate with a lightweight timber option finished to match the existing. This would significantly reduce the demand on the floor system and allow the floor to be used for general purposes. We consider that this is the easiest and most economical solution to improve the performance of the floor system.

## 2.2 Steel Floor Beams

There are a range of floor support beams which are visible from ground floor level, however most of them appear to be boxed in. The revised 67% NBS (IL2) strengthening scheme which was issued in 2019 before the current 2020 site investigations were based on the assumption that these beams were boxed in steel sections. The strengthening plans previously recommended have been updated to match the findings in the 2020 investigations. The first area of change is the floor beams located in the Billiard Room, which are highlighted in solid blues lines in Figure 4 below.

The investigations have shown that the steel beams in the Billiard Room are cast through the Gallery wall and protrude on the Gallery side of the wall. The beams appear to be well bonded to the wall and are considered to have sufficient pull out capacity to not require any additional strengthening.

The tie beams across the Gallery are confirmed to be reinforced concrete sections. There is no evidence of cracking at the interface with the Gallery walls which indicates that they are reinforced with ties extending into the concrete walls on each side. These are considered acceptable to transfer the external wall demands into the building without further strengthening.

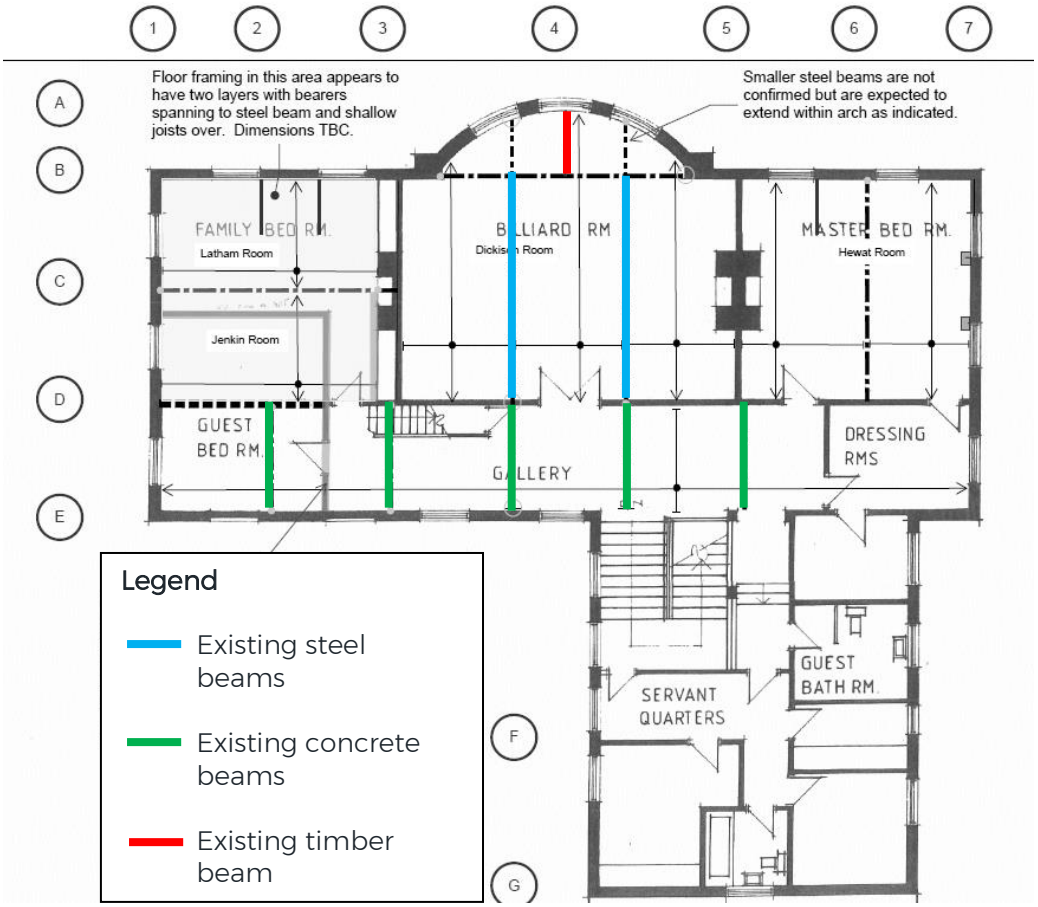


*Figure 4: First floor plan of Anderson House with floor beams highlighted*

## 2.3 Bay Window Floor Beam

There is an existing timber floor beam in the middle of the Bay Window area highlighted in red in Figure 4 which was previously unconfirmed. It was expected that there were steel beams in this area extending from the end of the highlighted blue beams. The existing timber beam requires strengthening of the end connections to ensure adequate capacity to achieve 67% NBS (IL2).

In addition, due to the existing beam being in the centre of the curve, further strengthening of the external wall on each side is required to reduce the span of the external wall. This will use the same methodology proposed for other areas with additional ties and timber blocking within the floor void.

## 2.4 Roof Structure

The site investigation were not able to observe an adequate connection between the roof structure (i.e. roof trusses) and the external concrete walls. This means that in an earthquake, the external walls are not restrained by the roof and the roof load is unable to be transferred down the structure.

Strengthening of the connection is relatively simple and will involve a fabricated steel bracket being installed at the end of each truss along the perimeter of the building to provide a lateral connection between the concrete walls and the roof trusses.

## 2.5 Chimney

There are currently four large brick chimneys around the building as highlighted in Figure 5 below. Two of these are located in the main wing and appear to be similar in terms of size and arrangement (1 and 2 in figure). The others are in the rear wing with one large chimney against the back wall, and the other small and slender chimney on the side of the rear wing (3 and 4 in figure).

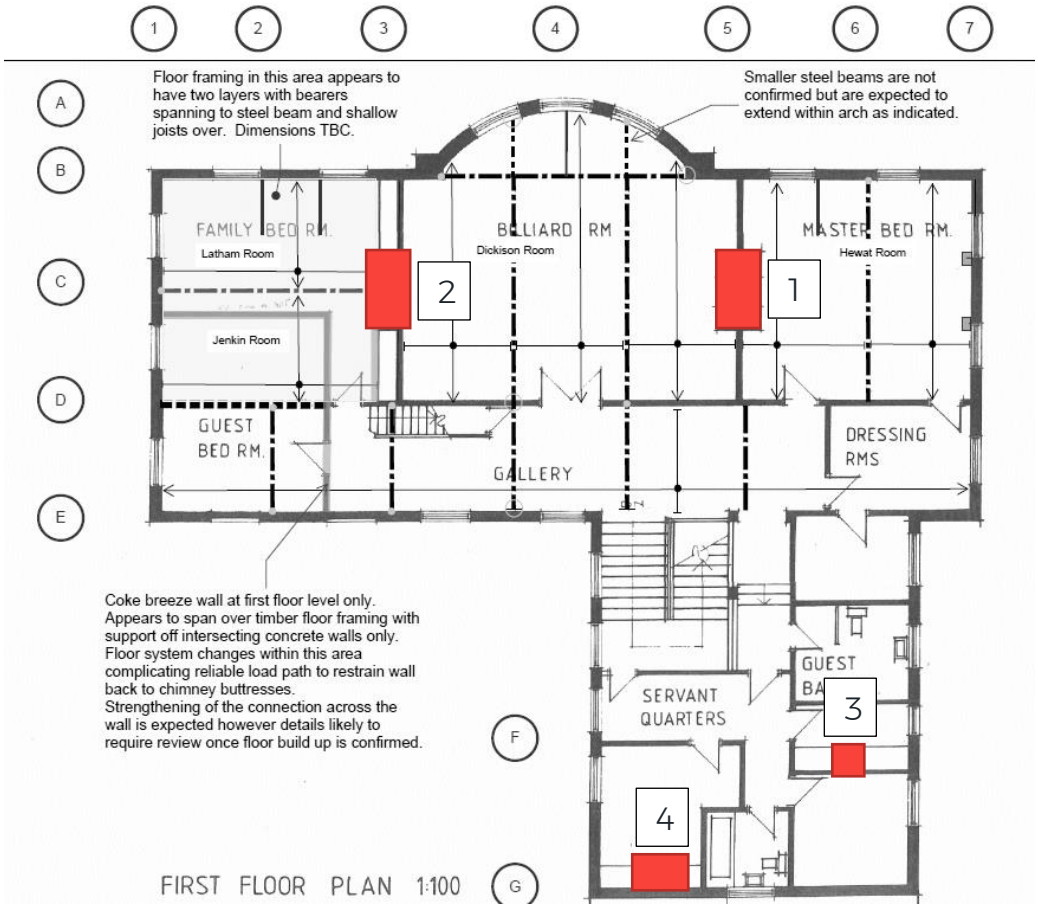


*Figure 5: Plan Layout of Anderson House with Floor Beams Highlighted*

Chimneys 1 and 2 in the main wing were found to be structurally sound below first floor ceiling level and are well tied into the adjacent timber framing. Above ceiling level, the large mass of the bricks are not as well restrained and pose a fall hazard. Should either of these chimneys collapse in a seismic event, they would cause significant damage to the heritage fabric of the building in addition to the life safety risk associated with falling bricks.

It is recommended that both Chimney 1 in the master bedroom and Chimney 2 in the family bedroom, be demolished down to first floor ceiling level and be replaced with a lightweight timber framed structure with lightweight plaster façade cladding. The timber structure is a cost-effective method to reduce the mass, while providing a plaster cladding system allows it to be shaped to maintain the heritage appearance and architectural aesthetic of the building.

Chimney 3 and Chimney 4 are located away from the apex of the roof nearer to the external walls while extending to the same height as Chimneys 1 and 2. This means that they both extend much further beyond the roof line and have effectively no restraint above first floor ceiling level.

It is recommended that chimneys 3 and 4 should be demolished down to first floor ceiling and not replaced. Due to the geometry of these chimneys a steel frame extending from at least first floor level would be required to reinstate them. This is achievable however we query whether the additional cost is warranted. We do not consider that these chimneys have the same heritage

value as Chimneys 1 and 2 and recommend that this proposal is discussed further with the heritage consultants and affected parties prior to acceptance.

### 2.6 Heritage

Anderson Park House is listed with Heritage New Zealand. All proposed works would require a resource consent which would include comment from Heritage New Zealand. The structural proposals recommended in this summary are simply the most expedient. We understand that previous discussions have included the idea of lightweight chimneys. The chimneys in the main part of the house can be reconstructed in timber to look like the existing relatively easily. This may also alleviate some of the problems in the area with water proofing. The idea of completely removing the chimneys to the south (3 and 4) may not be acceptable. However, the cost to keep these may exceed the cost of all the other strengthening work. In order for all parties to appreciate the variables the best way forward may be to have collaborative discussions before a decision is made regarding these chimneys.

## 3 Conclusions

WSP have carried out further site investigations in 2020 which have reinforced our opinion that the existing Anderson House is generally an extremely well-constructed building for the age and construction form with only local elements which do not perform adequately for modern seismic design procedures. The localised issues include the following:

1. The existing internal concrete dividing wall between the Family and Guest rooms. This concrete wall has been constructed on the suspended timber floor and overloads the floor beyond its acceptable capacity under self-weight gravity loads alone.
2. The floor to concrete wall connections around the perimeter in some areas, are insufficient to restrain the external concrete walls out of plane.
3. There does not appear to be a reliable connection to transfer seismic loads between the existing timber roof structure and external concrete walls.
4. The existing brick chimneys pose a fall hazard especially in the rear wing.

WSP have prepared a revised strengthening scheme to address the issues identified, which has been designed to achieve 67% NBS (IL2). This scheme is attached in Appendix A of this report. The scheme has been developed to best utilise the existing heritage elements, with only minimal impact on the high value timber flooring and other irreplaceable features. The design has been developed using sketches and mark-ups of available documentation to allow for further modifications should these be necessary to accommodate resource consent and future use requirements. We consider that this scheme can be best implemented in a practical manner with a competent contractor as it is expected that it will be necessary to adjust some details to suit individual conditions on site.

It is recommended that a Heritage Consultant be engaged to prepare a Conservation Plan and to provide input to the final design for the chimneys.

# 4 Disclaimers and Limitations

This report ('**Report**') has been prepared by WSP exclusively for Invercargill City Council ('**Client**') in relation to Anderson House Seismic Strengthening ('**Purpose**') and in accordance with the Short form Agreement with the Client dated 17 January 2020. The findings in this Report are based on and are subject to the assumptions specified in the Report and in the Offer of Services dated 17 January 2020]. WSP accepts no liability whatsoever for any reliance on or use of this Report, in whole or in part, for any use or purpose other than the Purpose or any use or reliance on the Report by any third party.

In preparing the Report, WSP has relied upon data, surveys, analyses, designs, plans and other information ('**Client Data'**) provided by or on behalf of the Client. Except as otherwise stated in the Report, WSP has not verified the accuracy or completeness of the Client Data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in this Report are based in whole or part on the Client Data, those conclusions are contingent upon the accuracy and completeness of the Client Data. WSP will not be liable in relation to incorrect conclusions or findings in the Report should any Client Data be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

# Appendix A
# 67% NBS (IL2) Seismic Strengthening Scheme

***Note:*** *The 'letter' of the Appendix is an automatic number, so you if you copy and paste the table, the 'letter' will automatically change.*

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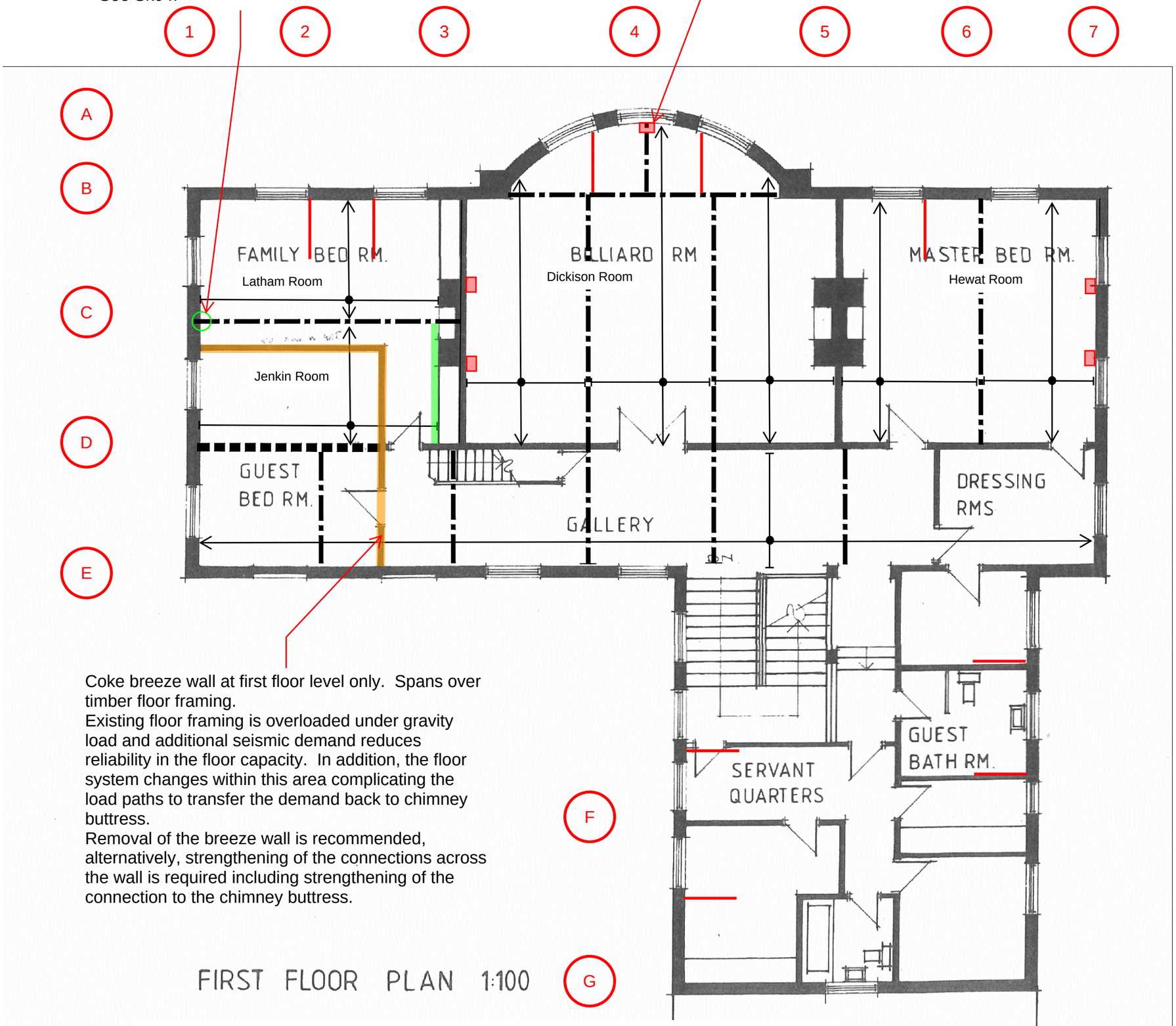
Timber beam requires strengthening with 2-M12 anchors into wall & 8-14g x 50mm long screws into timber beam through fabricated steel angle. See Sk04.

Timber beam requires strengthening of end connection similar to joist strengthening detail. See Sk01.




Coke breeze wall at first floor level only. Spans over timber floor framing.
Existing floor framing is overloaded under gravity load and additional seismic demand reduces reliability in the floor capacity. In addition, the floor system changes within this area complicating the load paths to transfer the demand back to chimney buttress.
Removal of the breeze wall is recommended, alternatively, strengthening of the connections across the wall is required including strengthening of the connection to the chimney buttress.

# First Floor Plan 67% NBS (IL2) Strengthening

LEGEND

- (E) Floor Support Beam
- (E) Floor Joist Span Direction
- (N) 50x0.91mm Multibrace Strap extending 1.5m into room as per detail Sk02.
- (N) Additional 10g-65mm long screw through floorboard to every third joist adjacent to wall.
- (N) Joist to Wall Connection improved as per detail Sk01.
- (N) Improve Connection as per detail Sk04.
- (N) Remove existing concrete wall and replace with lightweight timber to suit if required.

DOCUMENT CONTROL

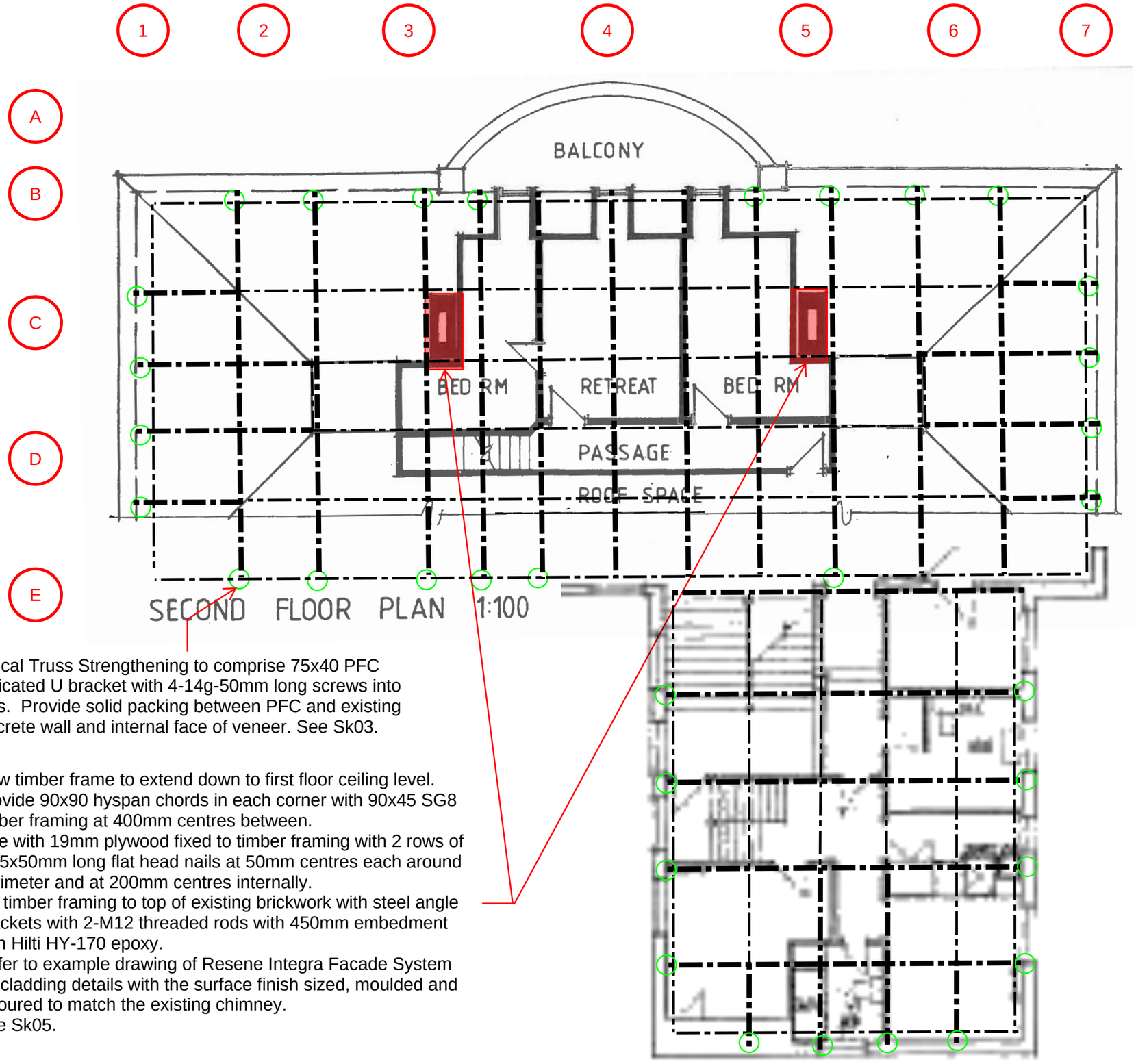
Date: 26 July 2020 Rev. 2

Sheet No. 1 of 8

Status: Developed Design

By: S. Therkleson (WSP)

Comments: NOT FOR CONSTRUCTION




Typical Truss Strengthening to comprise 75x40 PFC fabricated U bracket with 4-14g-50mm long screws into truss. Provide solid packing between PFC and existing concrete wall and internal face of veneer. See Sk03.

New timber frame to extend down to first floor ceiling level.
Provide 90x90 hyspan chords in each corner with 90x45 SG8 timber framing at 400mm centres between.
Line with 19mm plywood fixed to timber framing with 2 rows of 3.15x50mm long flat head nails at 50mm centres each around perimeter and at 200mm centres internally.
Fix timber framing to top of existing brickwork with steel angle brackets with 2-M12 threaded rods with 450mm embedment with Hilti HY-170 epoxy.
Refer to example drawing of Resene Integra Facade System for cladding details with the surface finish sized, moulded and coloured to match the existing chimney.
See Sk05.

# Roof Plan 67% NBS (IL2) Strengthening

LEGEND

(E) Roof Truss

(E) Under Purlin with rafters over.

(N) Demolish existing Chimney down to first floor ceiling level. Replace with 90x45 Hyspan framed chimney with lightweight Integra Facade system on 20mm cavity battens over 19mm plywood. Connections to existing to be confirmed once demolition of brickwork is complete.

(N) Improve Connection as per details. See Sk03.

DOCUMENT CONTROL

Date: 26 July 2020 Rev. 2

Sheet No. 2 of 8

Status: Developed Design

By: S. Therkleson (WSP)

Comments: NOT FOR CONSTRUCTION

# CALCULATION SHEET

Project/Task/File No: 6-DP444.00 ANDERSON HOUSE

Sheet No 3 of 8

Project Description: SK#01

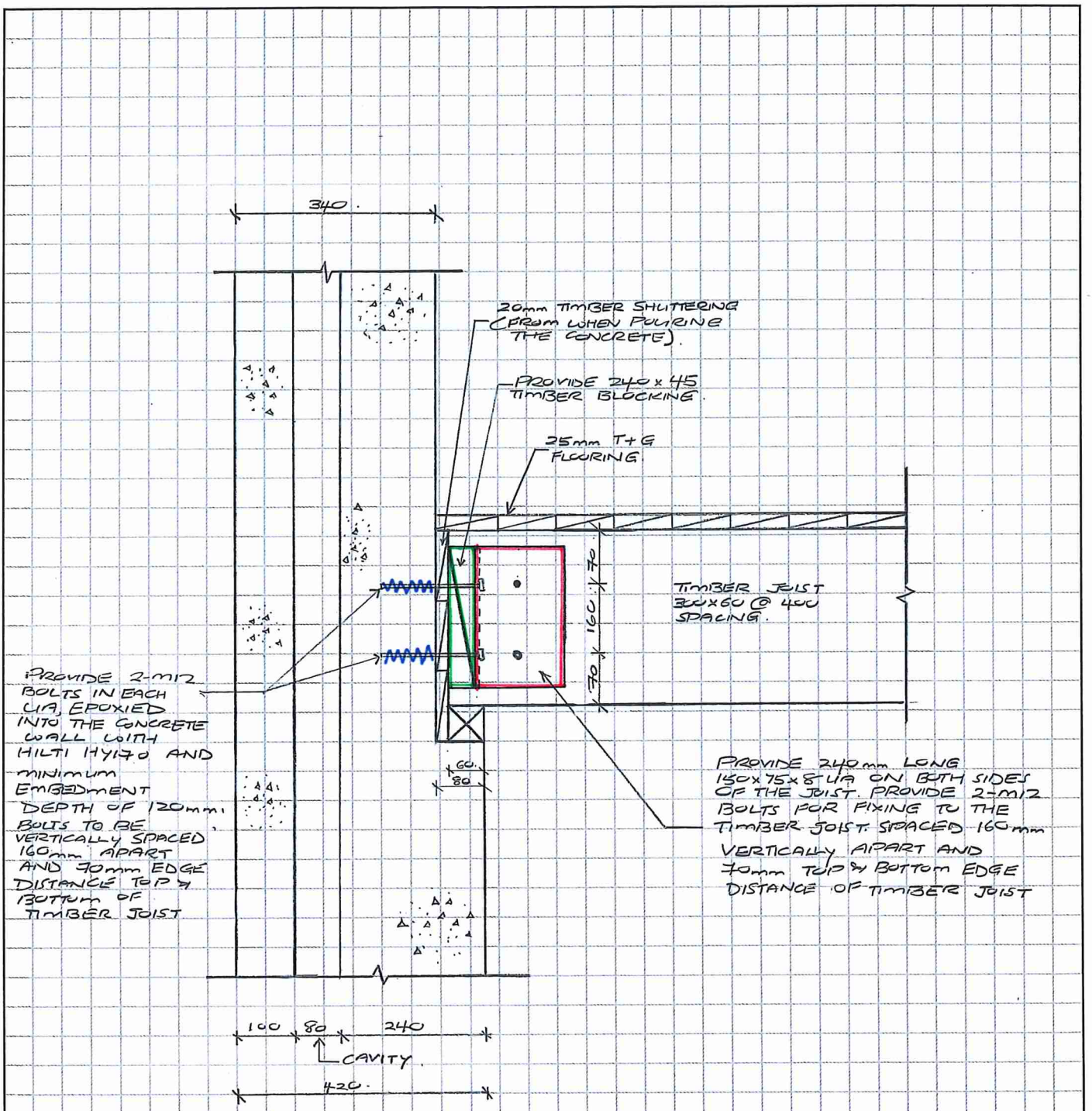
Office: Chch NND

Developed Design

Computed: 20 / 06 / 2020

NOT FOR CONSTRUCTION

Check: / /




FLOOR TO WALL CONNECTION
SECTION VIEW
Scale 1:10.

LEGEND.

- NEW STEEL ANGLE PLATE
- NEW TIMBER BLOCKING
- EPOXY INTO CONCRETE WALL

wsp | OPUS

# CALCULATION SHEET

| | | | |
|---|---|---|---|
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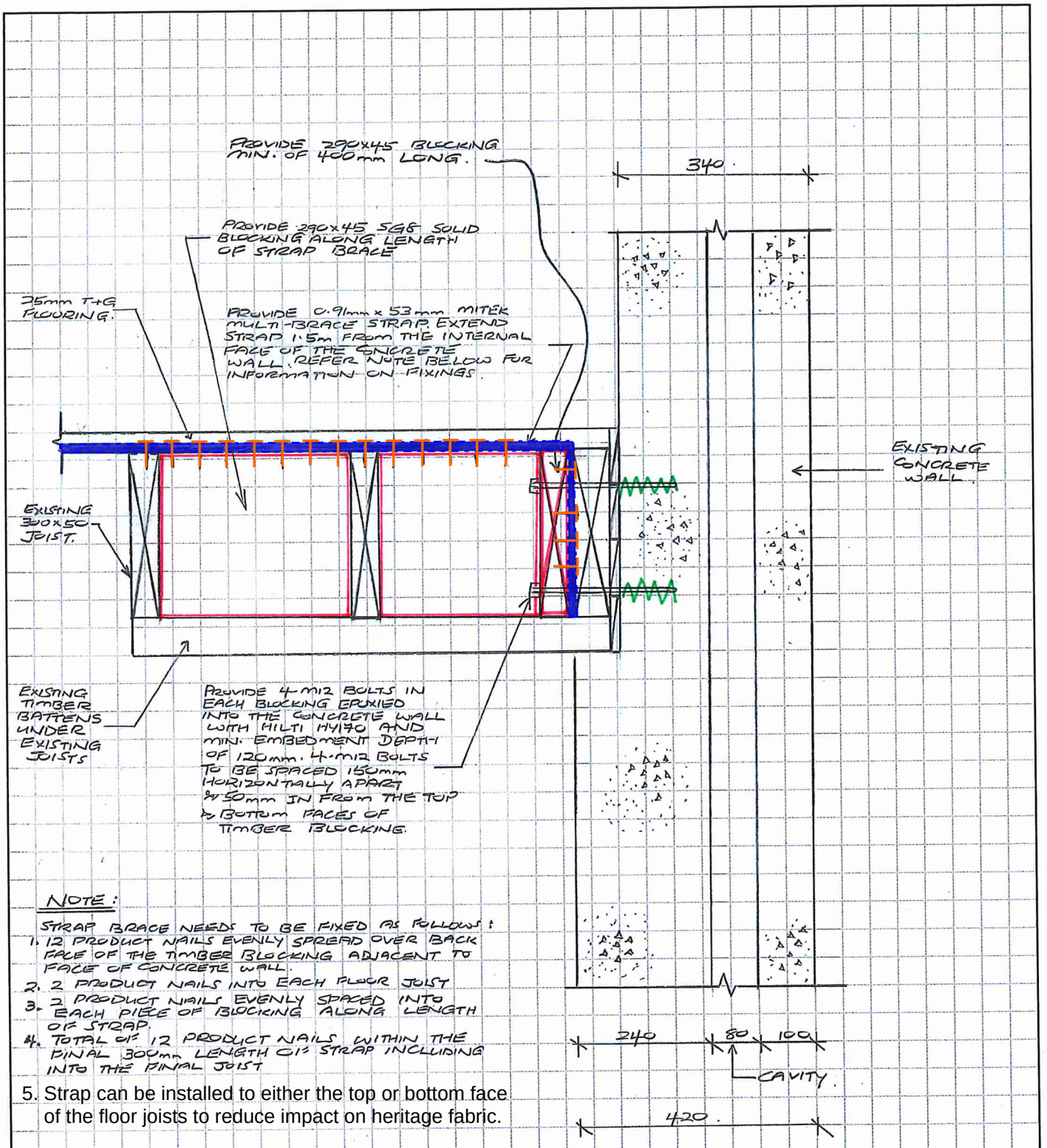


NOTE:

STRAP BRACE NEEDS TO BE FIXED AS FOLLOWS:

1. 12 PRODUCT NAILS EVENLY SPREAD OVER BACK FACE OF THE TIMBER BLOCKING ADJACENT TO FACE OF CONCRETE WALL.
2. 2 PRODUCT NAILS INTO EACH FLOOR JOIST
3. 2 PRODUCT NAILS EVENLY SPACED INTO EACH PIECE OF BLOCKING ALONG LENGTH OF STRAP.
4. TOTAL OF 12 PRODUCT NAILS WITHIN THE FINAL 300mm LENGTH OF STRAP INCLUDING INTO THE FINAL JOIST
5. Strap can be installed to either the top or bottom face of the floor joists to reduce impact on heritage fabric.

FLOOR TO WALL CONNECTION
SECTION VIEW
Scale 1:10

LEGEND

NEW MITEK MULTI-BRACE STRAP.

NEW BLOCKING/JOIST

EPOXY INTO CONCRETE WALL

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# CALCULATION SHEET

Project/Task/File No: 6-DP444.002
Project Description: ANDERSON HOUSE
SK #3 U2
ROOF TRUSS STRENGTHENING

Sheet No 5 of 8
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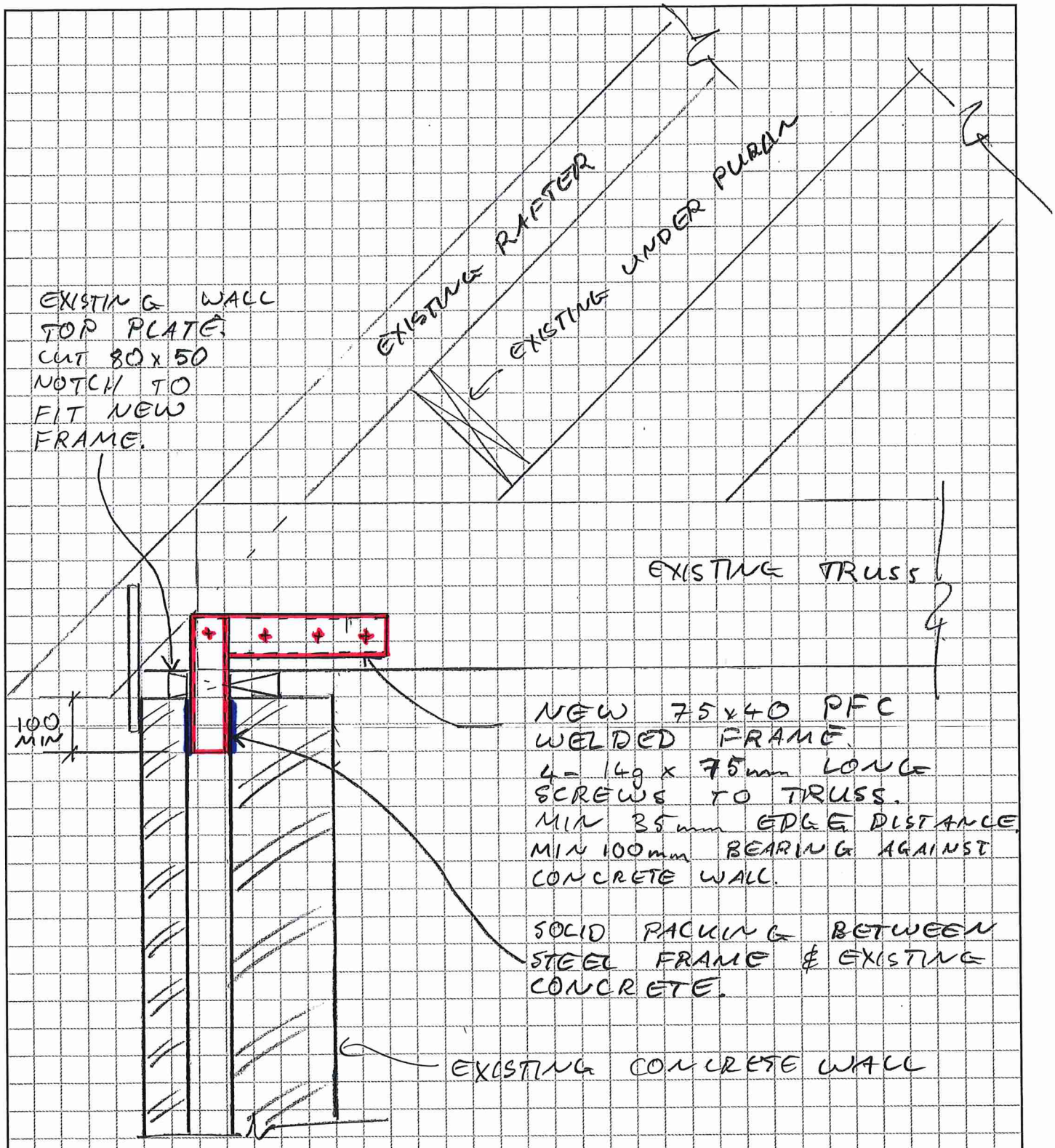
Computed: 8/7/2020
Check: / /




TYPICAL ROOF TRUSS – WALL CONNECTION

wsp | OPUS

CSF 400 (7/2000)

# CALCULATION SHEET

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|---|---|---|---|
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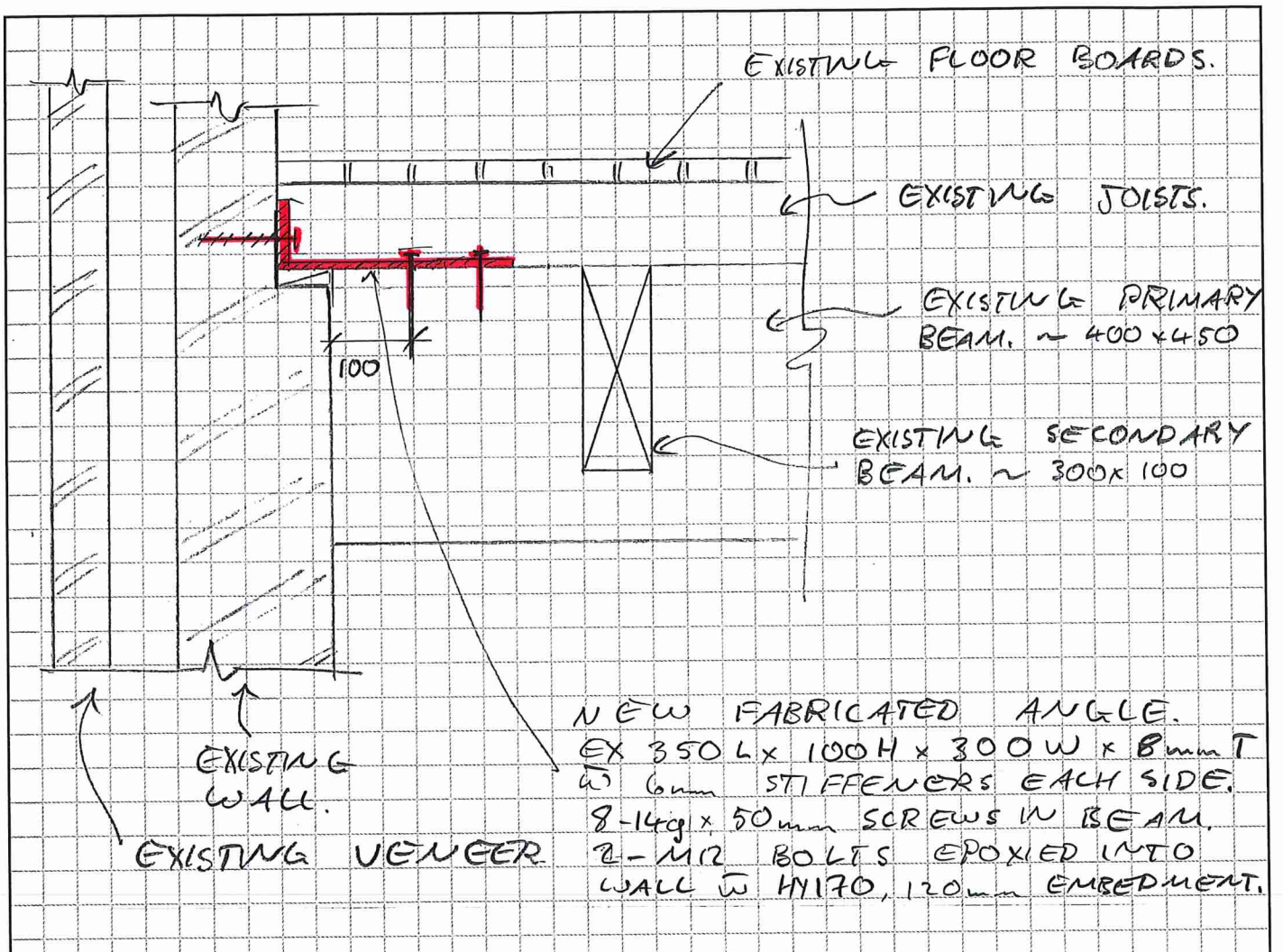
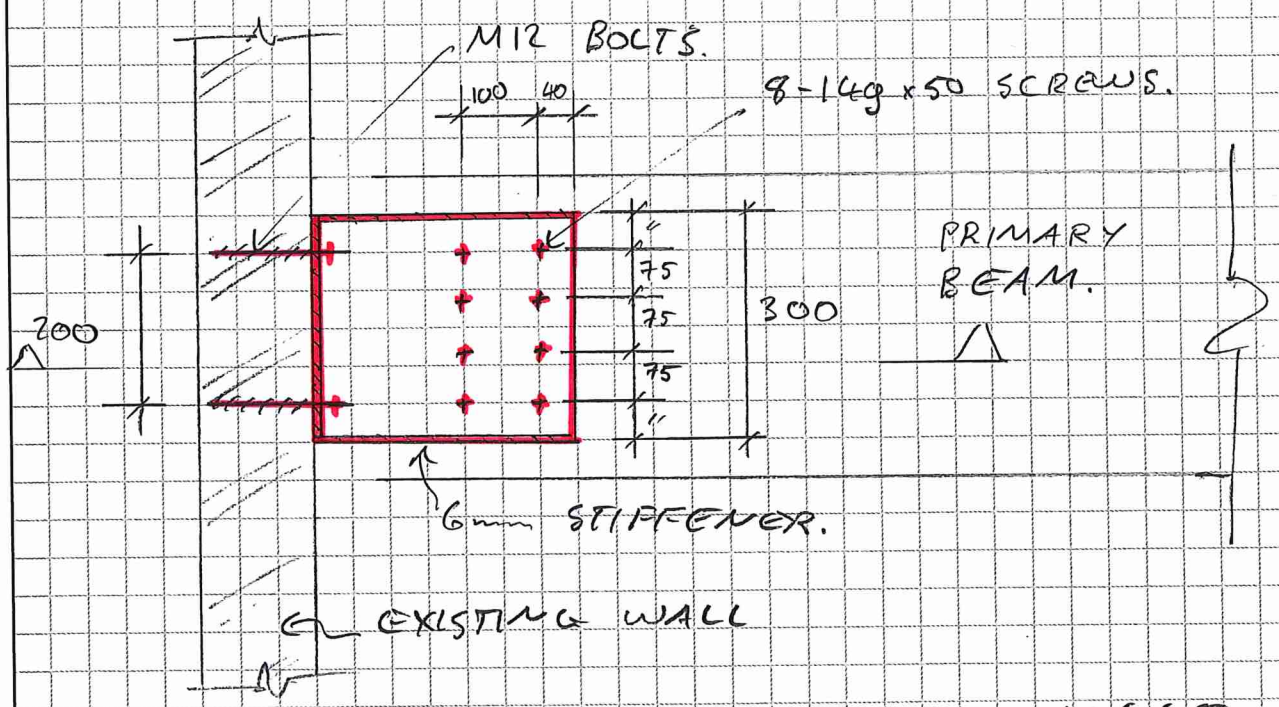
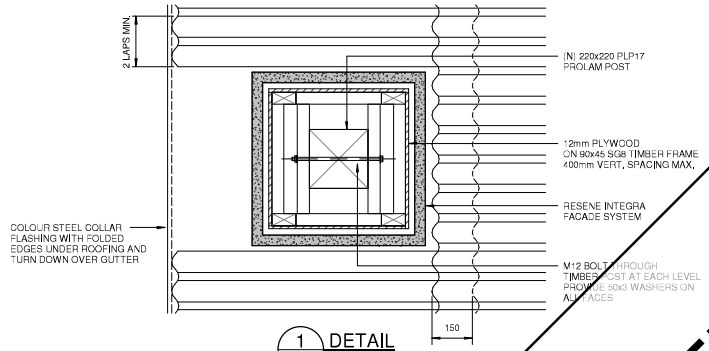
| | NOT FOR CONSTRUCTION | Check: | / / |




TIMBER BEAM STRENGTHENING ANGLE

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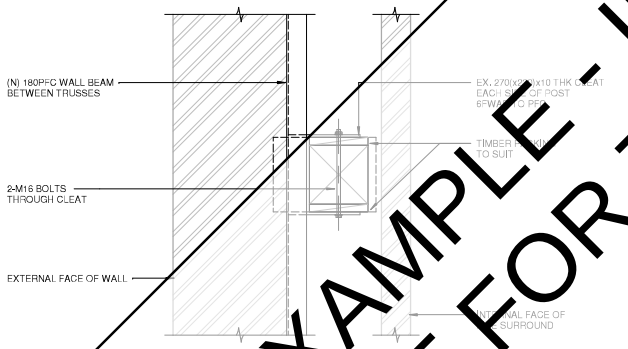
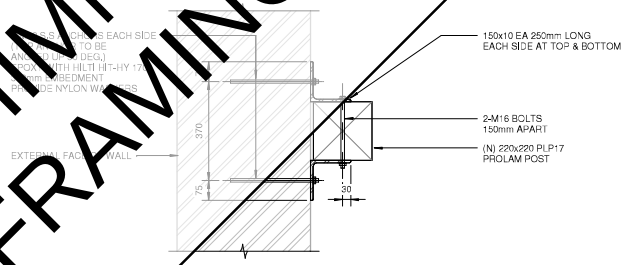



2 S210 DETAIL
SCALE

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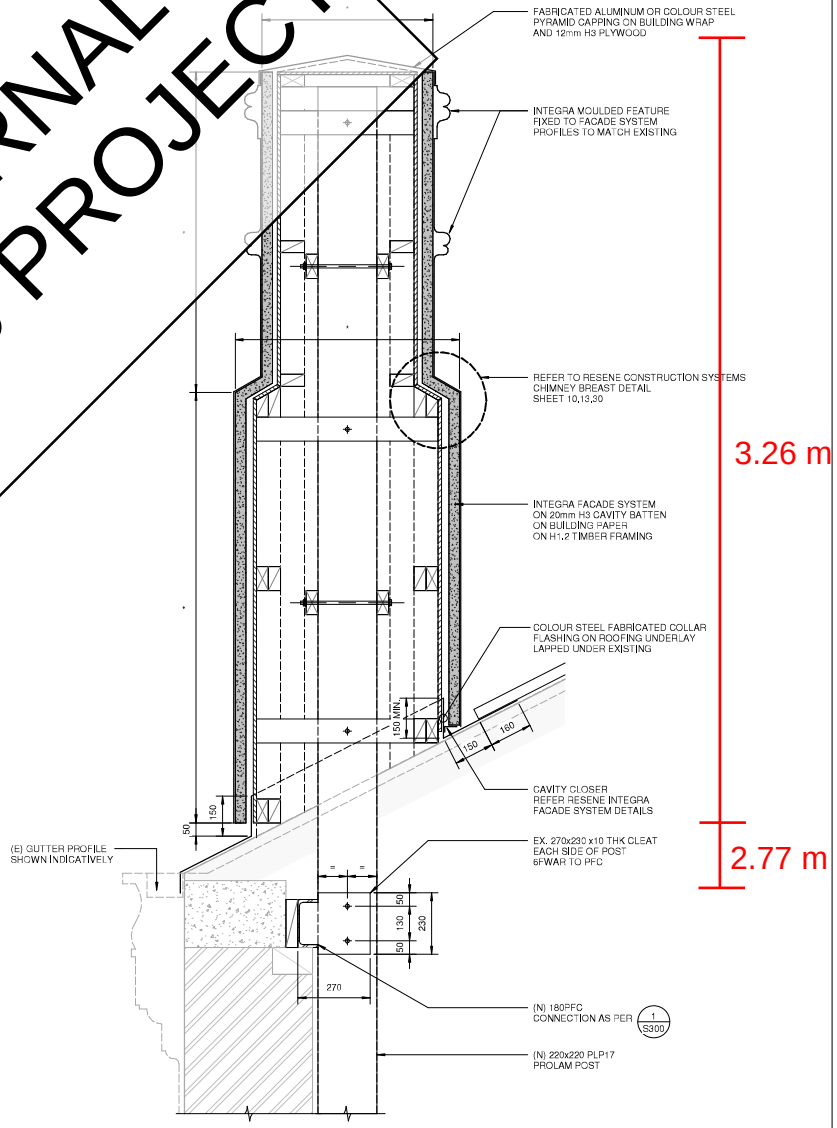



4 DETAIL
SCALE 1 : 10
CHIMNEY TYP. CROSS SECTION

## NOTES:

1. DO NOT SCALE.
2. CONTRACTOR TO CONFIRM ALL DIMENSIONS AND FEATURE PROFILES ON SITE AND AMEND TO MATCH EXISTING BEFORE REMOVAL OF CHIMNEY.

## LEGEND:

| | |
|---|---|
| (E) | DENOTES EXISTING |
| (N) | DENOTES NEW |
| * | CONFIRM DIMENSIONS |

| REVISION | AMENDMENT | APP | DATE |
|---|---|---|---|
| 1 | FOR CONSTRUCTION | JL | 10.09.2019 |

FOR CONSTRUCTION

[redacted]


wsp | OPUS
Christchurch Office
PO Box 1482
Christchurch 8140
New Zealand
+64 3 363 5400


| SCALE | ORIGINAL SIZE |
|---|---|
| As indicated @ A1 | A1 |

| DRAWN | DESIGNED | APPROVED |
|---|---|---|
| R.BONGALON | S.THERKLESON | J.LESTER |
| DRAWING VERIFIED | DESIGN VERIFIED | APPROVED DATE |
| S.THERKLESON | S.ONG | 10.09.2019 |

[redacted]

67% NBS (IL2) SEISMIC STRENGTHENING

TITLE
CONSTRUCTION DETAILS

[redacted]

STRUCTURAL

CHIMNEY EXAMPLE - INTERNAL FRAMING NOT FOR THIS PROJECT

| | |
|---|---|
| Sheet No | 8 of 8 |
| Office: | Chch SPT |
| Computed: | 19 / 06 / 2020 |
| Check: | / / |

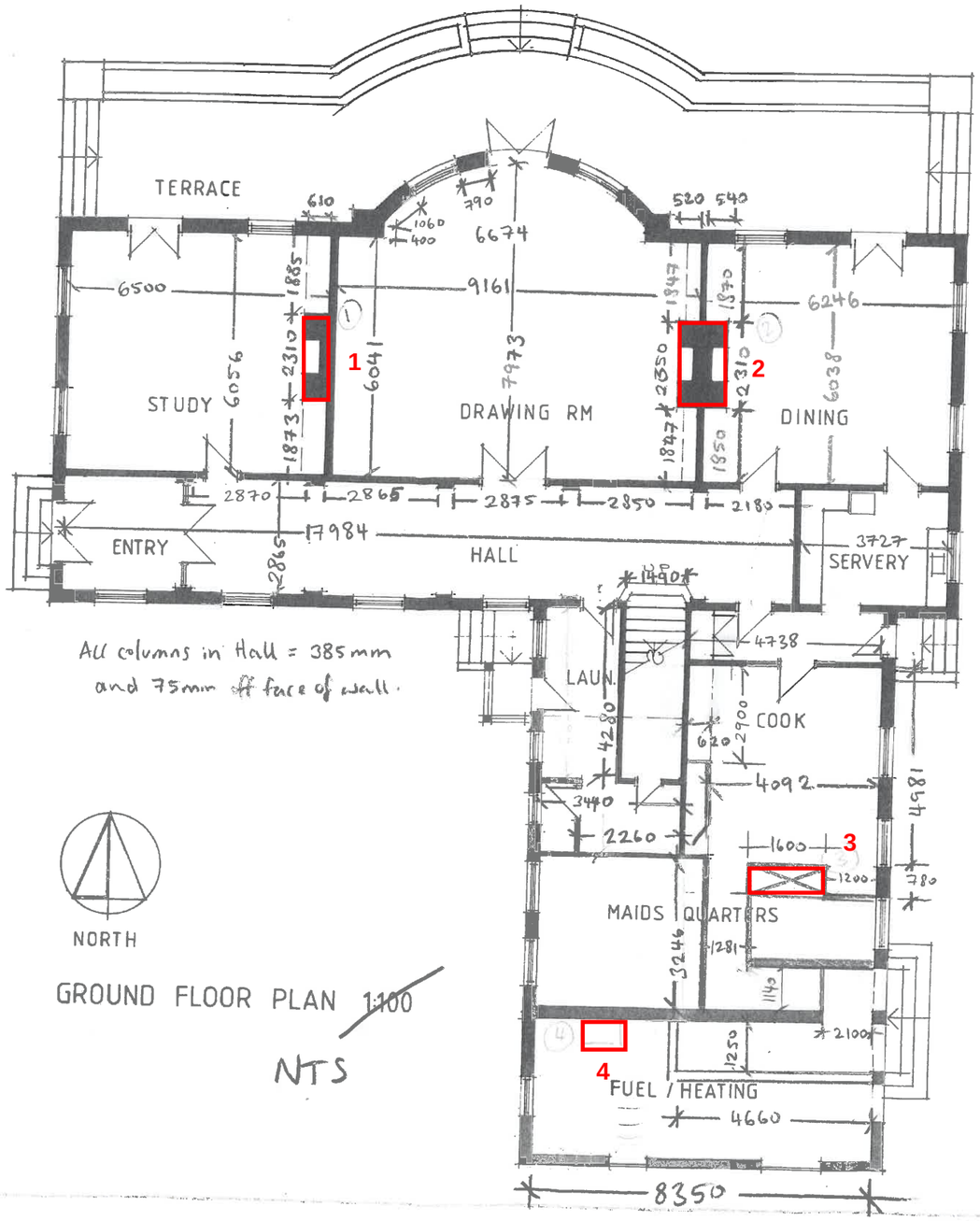
ANDERSON PARK

Former Residence, now Invercargill City Art Gallery.

Submission for New Zealand Institute Of Architects National Historical Award by Southland Members.

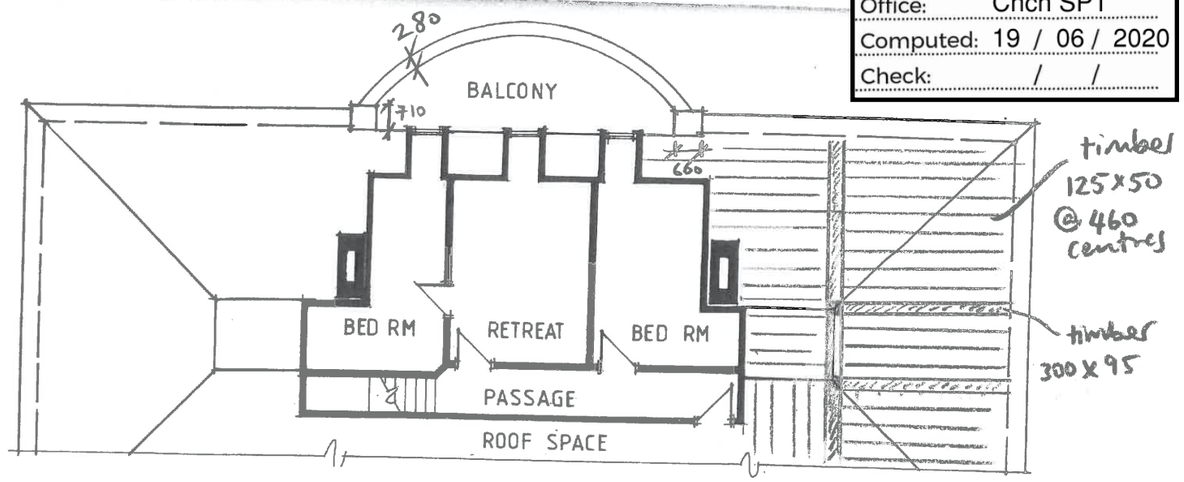
| | |
|---|---|
| Site: | 50 acre site Retreat Road, Invercargill |
| Client: | R.Anderson |
| Architect: | Cecil Wood, Christchurch |
| Designed: | 1923 |
| Completed: | 1925 |
| Cost: | £15,000.00 |

Bequeathed to Invercargill City Council 1951.



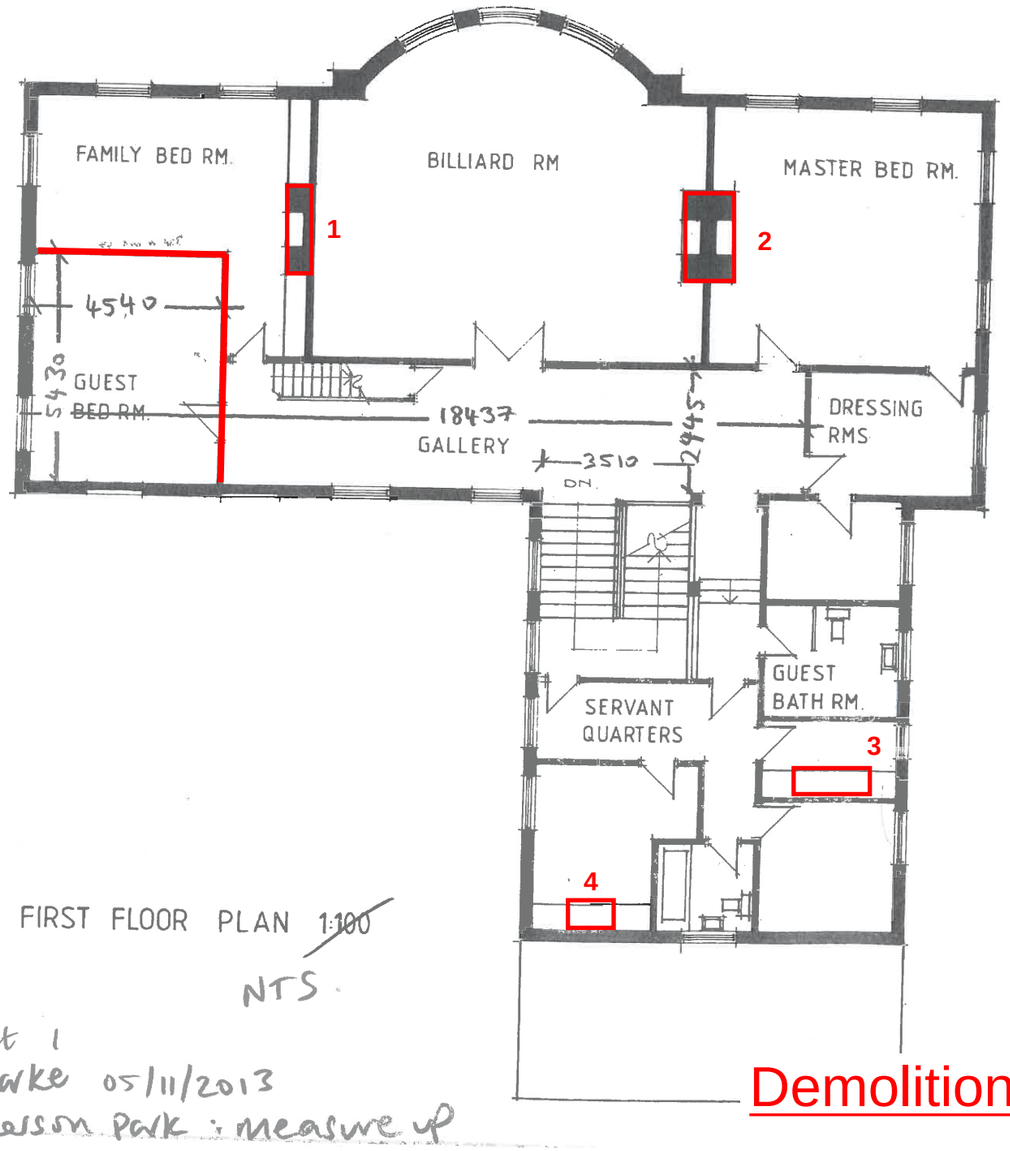

GROUND FLOOR PLAN ~~1:100~~

NTS




Roof framing detail. See photos.

SECOND FLOOR PLAN ~~1:100~~ NTS




FIRST FLOOR PLAN ~~1:100~~

NTS

sheet 1
R.Clarke 05/11/2013
Anderson Park : measure up

Demolition Plan