

Report

New Zealand Transport Agency Building Acoustic Mitigation Case Study

Prepared for New Zealand Transport Agency (Client)

By Beca Ltd (Beca)



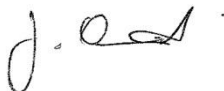
9 December 2013



Revision History

Revision Nº	Prepared By	Description	Date
A	Kade Motley	Final	9/12/2013

Document Acceptance

Action	Name	Signed	Date
Prepared by	Kade Motley		9/12/2013
Reviewed by	Albert Lombard		9/12/2013
Approved by	John Oscilowski		9/12/2013
on behalf of	Beca Ltd		

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2 Introduction

2.1 Background

The NZ Transport Agency (Transport Agency) has a Reverse Sensitivity Policy (NZ Transport Agency, 2007) to manage the effects of road-traffic noise and vibration with respect to new and altered houses and other noise sensitive activities built near existing state highways. Part of this policy is that the Transport Agency requests for rules to be included in District Plans under the Resource Management Act, which require new and altered buildings near roads to be designed to achieve road-traffic noise levels in bedrooms and living spaces that will not cause sleep disturbance or annoyance. The Transport Agency is often asked by Territorial Authorities what the typical cost of these requirements will be for residents.

In response to these requests, the Transport Agency have engaged Beca to outline and quantify what building modifications may be required to new homes affected by traffic noise in order to achieve internal noise levels that meet New Zealand Standard (NZS) 6806: 2010 “Acoustics – Road – Traffic Noise – New and Altered Roads.” This is the Standard of acoustic treatment the Transport Agency requires to mitigate the adverse effects.

2.2 Methodology

Beca adopted a three part approach to this study. Firstly in conjunction with the Transport Agency and Marshall Day Acoustics, a traffic noise level was determined which provided a baseline noise level for an acoustic mitigation solution. Three noise exposures were assessed based on the distance of the building from the noise source, this is discussed in further detail in section three.

Secondly, two notional building designs were selected for the study. The building designs were sought from a large house building company to be representative of typical homes being constructed in New Zealand in 2013. The designs are for a typical single storey home (three bedroom, 175 m²) and a typical double storey home (four bedroom, 225 m²). These were provided by A1 Homes NZ and can be found in appendix 1.

Finally, Marshall Day Acoustics completed an assessment of the two building designs at each of the three noise exposures outlined in stage 1. They then provided a sound insulation design for each exposure to achieve internal noise levels that meet NZS 6806:2010. The Marshall Day Acoustics design solution can be found in appendix 2. Beca then completed a cost assessment for Marshall Day’s design solution which can be found in appendix 3. The costs determined are the additional costs of including the mitigation as part of a new build house in 2013, and are not costs for retrofitting mitigation.

2.3 Ventilation

The acoustic design provided by Marshall Day is contingent on all doors and windows being closed in order to be effective. Therefore as part of the overall acoustic mitigation solution, mechanical ventilation will be required to maintain habitable indoor conditions.

Condensation Control Ltd has provided design advice for typical mechanical ventilation systems (appendix 4) which comply with the New Zealand Building Code and also allow for sufficient air circulation to cool the home during peak summer months as recommended in the draft ‘State Highway Guide to Acoustic Treatment of Buildings’ (New Zealand Transport Agency, 2012). The ventilation and air-conditioning rates are outlined in Table 1.

Table 1 – Ventilation Rates

Room Type	Fresh Ventilation Rate (Air Changes Per Hour) ¹	
	<i>Low Setting</i>	<i>High Setting</i>
Principle living areas	0.5 ± 0.1 ac / hr	min. 15 ac / hr
Other habitable areas	0.5 ± 0.1 ac / hr	min. 5 ac / hr

A heat recovery ventilation system has been used as a benchmark for the two building designs. Two different systems have been investigated and they have been designed to accommodate the above ventilation rates:

1. System 1 – Heat Recovery System (2-5 ac / hr) + Heat Pump, and
2. System 2 – Heat Recovery System (15 ac / hr).

System 1 is capable of providing ventilation rates at 2-5 ac / hr. This system has to be supplemented by a heat pump in order to provide sufficient cooling for the principle living area during peak summer temperatures.

System 2 is capable of providing ventilation rates at 15 ac / hr in the principle living area, this airflow is enough to sufficiently cool during peak summer temperatures and therefore does not require a heat pump.

¹ NZS 4303:1990 “Ventilation for Acceptable Indoor Air Quality” specifies a minimum of 0.35 ac / hr in living areas.

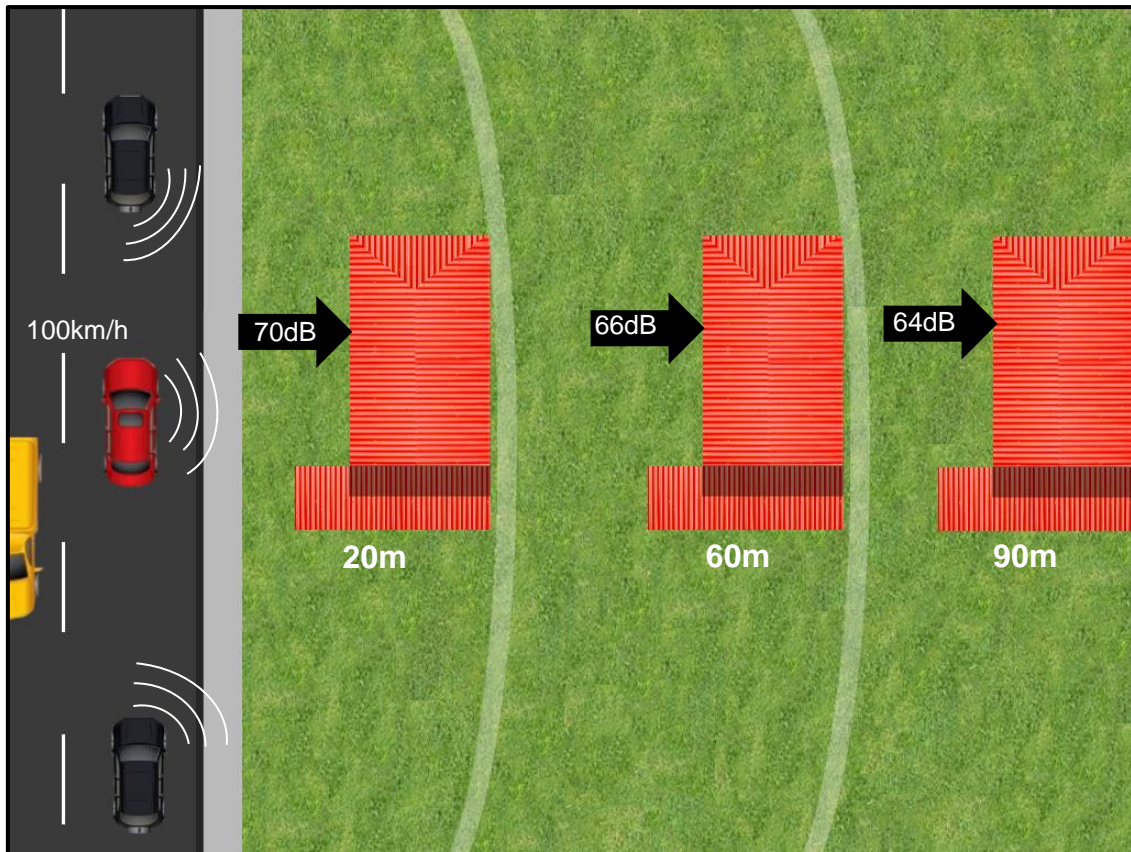
3 The Noise Exposures and Design Strategies

3.1 Assumptions

As part of this study Beca has made the following assumptions:

- The reference homes are located at three distances: 20m, 60m and 90m from the noise source. This is illustrated in Figure 1.
- At 20m, the traffic noise incident on the façade of the house is 70dB $L_{Aeq(24h)}$;
- At 60m, the traffic noise incident on the façade of the house is 66dB $L_{Aeq(24h)}$; and
- At 90m, the traffic noise incident on the façade of the house is 64dB $L_{Aeq(24h)}$.
- To produce these traffic noise levels with a speed of 100 km/h and 10% heavy goods vehicles, the annual average daily traffic (AADT) and road surfaces would be (other combinations could also result in the same noise levels):
 - AADT 9,000 on Grade 3/5 chipseal
 - AADT 30,000 on open graded porous asphalt OGPA-14, with 20% voids
- The main living room and most bedrooms face the road; this is the worst case scenario in regards to building orientation.
- There is no screening by other buildings, terrain or fences (noise levels and treatment would be reduced with screening).

Figure 1 – The Noise Exposures



3.2 Acoustic Mitigation Strategies

The closer the house is to the road, the higher the noise. As a result a greater engineering effort is required to prevent noise penetrations as the distance between the house and road reduces. Marshall Day Acoustics' subsequent mitigation strategies are three-fold:

- Additional interior plasterboard lining,
- Increased insulation rating for glazing units, and
- Additional wall / ceiling insulation.

The costs associated with these design changes are covered in the following section.

4 Resultant Design Costs

The following tables provide quantified costs for the construction modifications (as recommended by Marshall Day Acoustics Design Advise Da001) necessary to provide internal noise levels which are in accordance with NZS 6806:2010 and the costs associated with the necessary mechanical ventilation systems.

4.1 Construction Costs

The base prices for the single storey and two-storey houses are \$235,000 and \$332,000 respectively (2013). The prices outlined in the tables overleaf represent additions to the base price that are a result of the acoustic mitigation designs provided by Marshall Day Acoustics. Mechanical ventilation costs, discussed below, have been included in the breakdown also. For the purpose of the exercise; the lowest cost option (system 2) has been applied.

4.2 Mechanical Ventilation Costs

Table 2 outlines the costs associated with the two different ventilation systems. With the additional cost of the heat pump, system 1 is significantly more expensive than system 2.

Table 2 – Mechanical Ventilation Costs (2013)

System	Single Storey	Double Storey
1. Heat Recovery System (2 ac / hr) + Heat Pump	\$7,850	\$11,250
2. Heat Recovery System (15 ac / hr)	\$5,900	\$5,250

4.2.1 Construction Costs – Single Storey Home

Figure 2 - VH 175 Single-storey home. Image source: A1 Homes



Table 3 - Additional Costs to Base Price for Acoustic Mitigation Design (2013)

Single Storey (base price \$235,000)	Distance from Noise Source		
	20m	60m	90m
Living / Dining/ Kitchen	<u>\$7,126</u> Additional wall and ceiling lining, insulated glazing units	<u>\$1,908</u> Additional wall and ceiling lining, insulated glazing units	<u>\$1,000</u> Insulated glazing units on incident facade
Master Bedroom	<u>\$2,589</u> Additional wall and ceiling lining, insulated glazing units	<u>\$2,092</u> Additional wall and ceiling lining, insulated glazing units	-
Bedrooms 2 & 3	-	-	-
Roof	<u>\$2,285</u> Thicker exterior cladding	-	-
Ventilation*	\$5,900	\$5,900	\$5,900
Sub Total (excl. GST)**	\$21,900	\$11,900	\$7,900

*lowest cost option has been used

**includes overheads and contingencies

4.2.2 Construction Costs – Two Storey Home

Figure 3 - BH 225 Two-storey home. Image source: A1 Homes



Table 4 - Additional Costs to Base Price for Acoustic Mitigation Design (2013)

Double Storey (base price \$332,000)	Distance from Noise Source		
	20m	60m	90m
Lounge	<u>\$3,988</u> Additional wall and ceiling lining, insulated glazing units	<u>\$1,084</u> Additional ceiling lining, insulated glazing units	-
Family / Dining/ Kitchen	<u>\$7,195</u> Additional wall and ceiling lining, insulated glazing units	<u>\$1,092</u> Additional ceiling lining and insulated units	<u>\$1,000</u> Insulated glazing units
Master Bedroom	<u>\$2,437</u> Additional wall and ceiling lining, insulated glazing units	<u>\$380</u> Additional ceiling lining	-
Bedroom 2	<u>\$240</u> Additional ceiling lining	-	-
Bedrooms 3 & 4	<u>\$440</u> Additional ceiling lining	-	-
Study	<u>\$784</u> Additional wall lining and insulated glazing units	-	-
Roof	<u>\$1,916</u> Thicker exterior cladding	<u>\$2,444</u> Thicker exterior cladding	-
Ventilation*	\$5,250	\$5,250	\$5,250
Sub Total (excl. GST)**	\$27,250	\$12,250	\$7,250

5 Conclusion

This document outlines and quantifies the 2013 new build costs associated with modifying the design of a typical New Zealand residential 'new build' located near a highway to achieve internal noise levels that meet NZS 6806.

The closer the house is to the road, the higher the noise. Accordingly, as the house is located closer to the road, the cost for acoustic mitigation increases. Figure 4 demonstrates the costs expected for our benchmark homes as they are located at three different distances from the road.

Figure 4 – The costs associated with acoustic mitigation of our benchmark houses (2013)

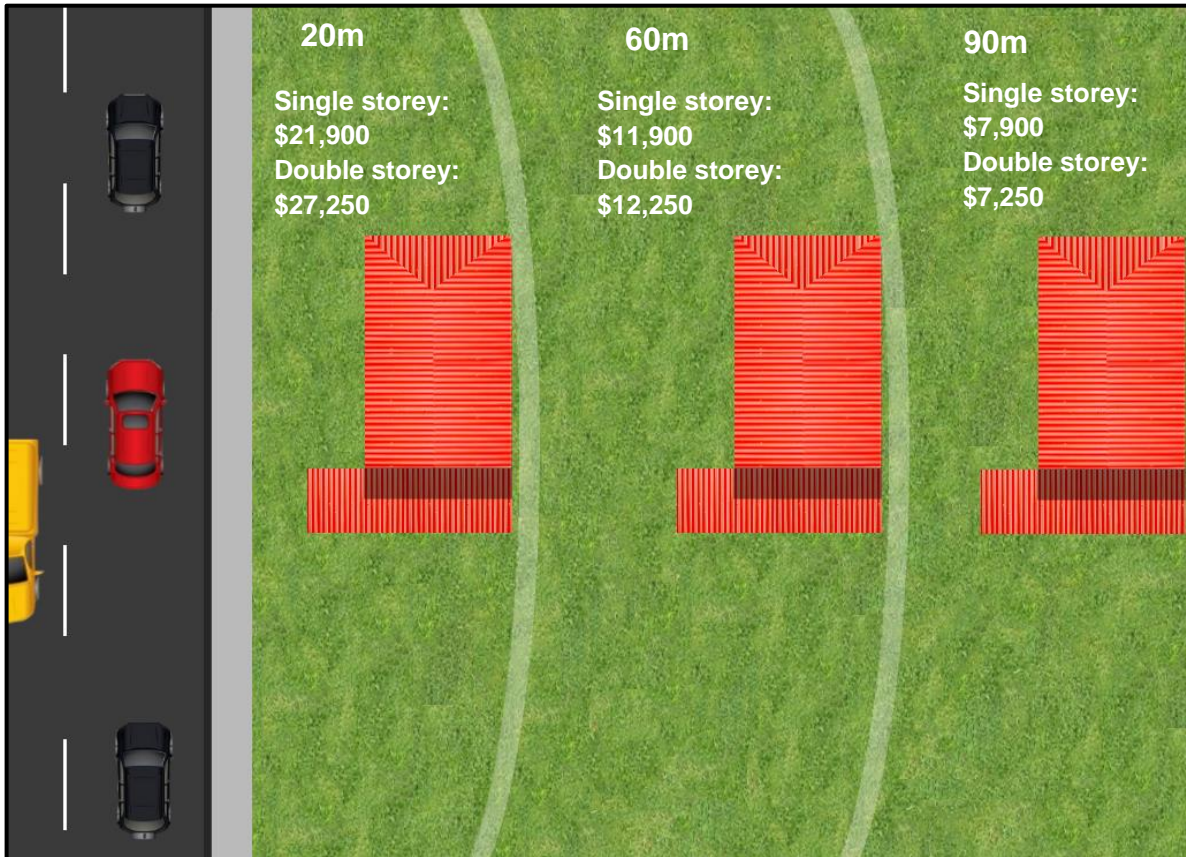


Table 5 illustrates the percentage of the acoustic design costs against the total costs (base build + acoustic design costs).

Table 5 – Cost of Acoustic Mitigation as a % of Total Costs (2013)

House	Distance from Noise Source					
	20m		60m		90m	
	Total cost	Acoustic Design as % of total cost	Total cost	Acoustic Design as % of total cost	Total cost	Acoustic Design as % of total cost
Single Storey	\$256,900	9%	\$246,900	5%	\$242,900	3%
Double Storey	\$359,250	8%	\$344,250	4%	\$339,250	2%

6 Bibliography

New Zealand Standards. (2010, April 29). NZS 6806:2010 Acoustics - Road-traffic noise - New and altered roads. New Zealand Standards.

New Zealand Transport Agency. (2012). *State Highway Guide to Acoustic Treatment of Buildings*. Wellington: New Zealand Transport Agency.

NZ Transport Agency. (2007). *Transit Planning Policy Manual Version 1 | Appendix 5D Reverse Sensitivity*.

Appendix 1 – A1 Benchmark House Designs

Floor

Concrete floor (see notes & details)

Cladding

240mm James Hardie Smooth weatherboard cladding

Roof

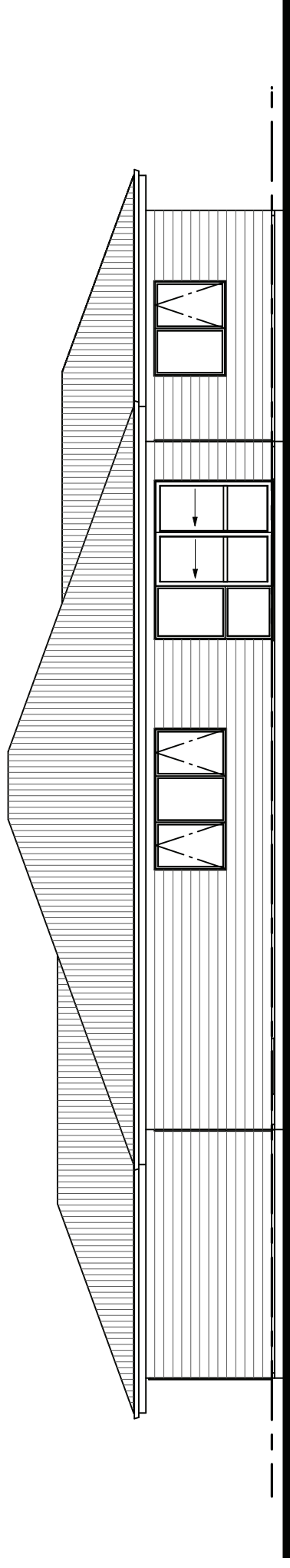
20° pitch. PCC Colorcote ZR8 or NZS Colorsteel Endura - corrugated profile

Fascia & Spouting

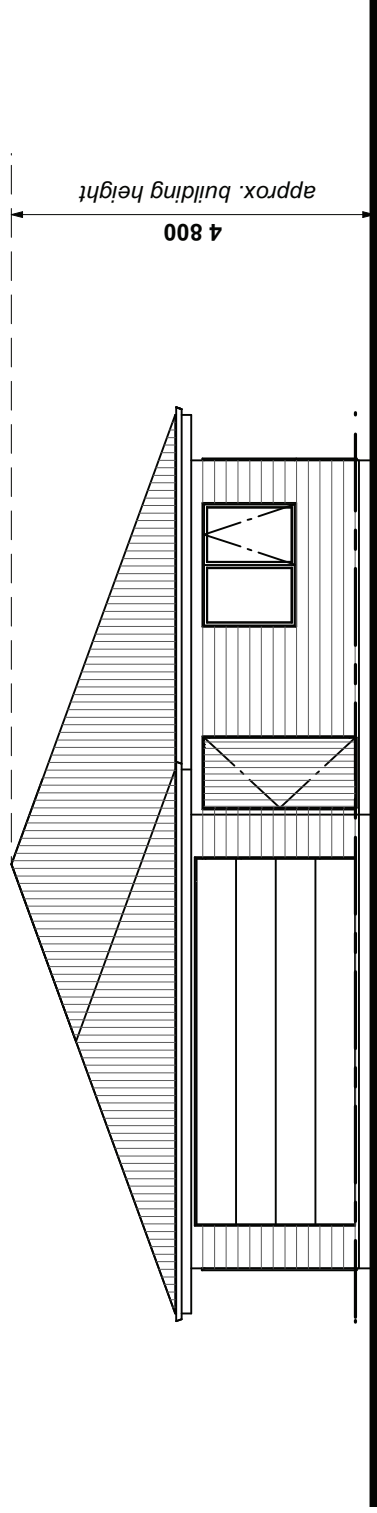
200x25pp fj fascica, Marley Stormcloud spouting system

Joinery

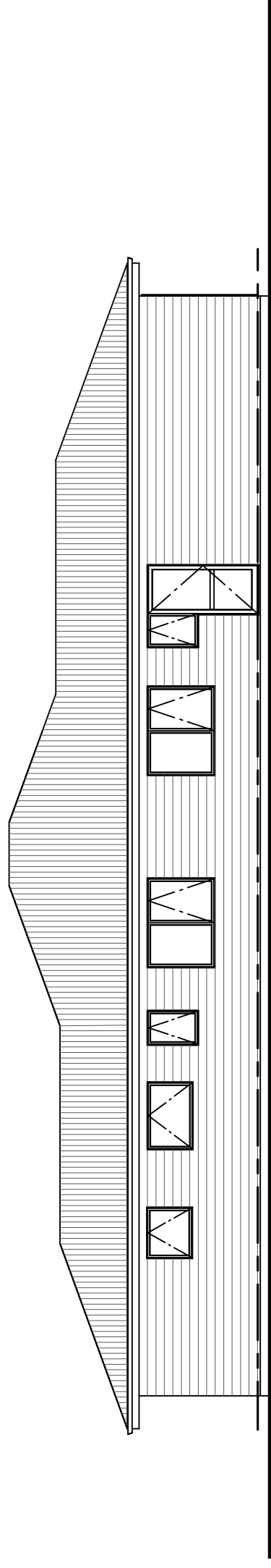
ASL Residential suite aluminium joinery



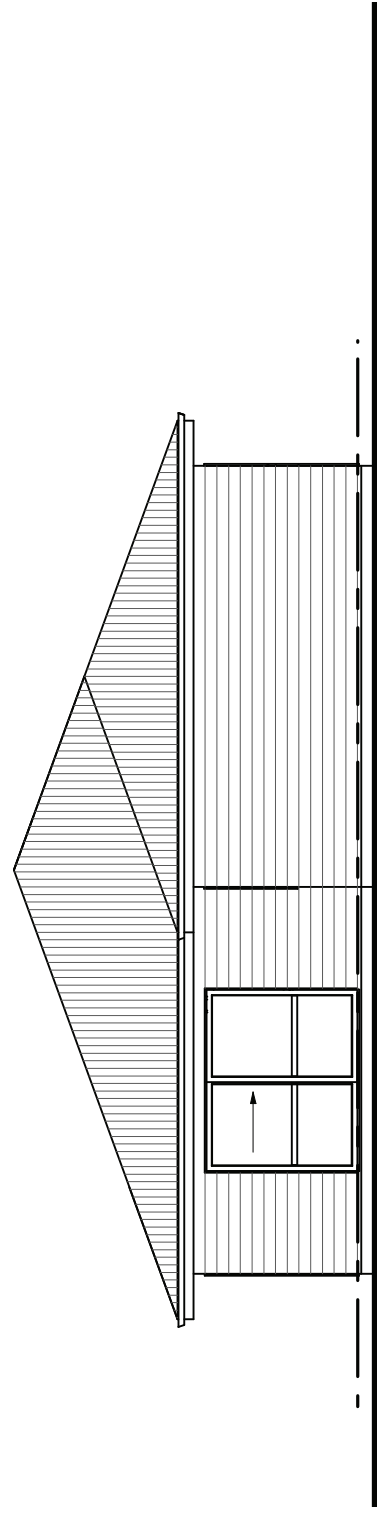
North



East



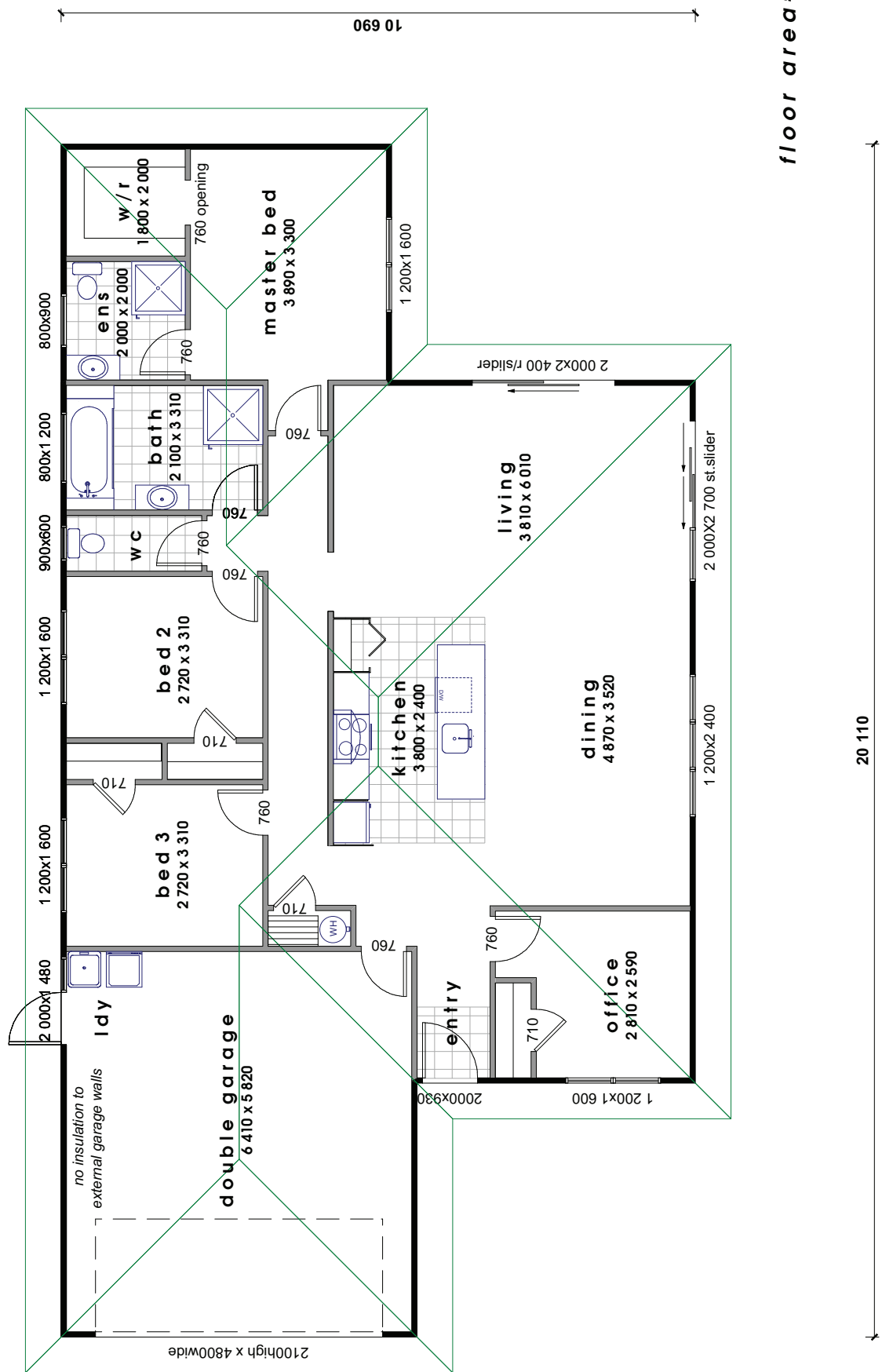
South



West

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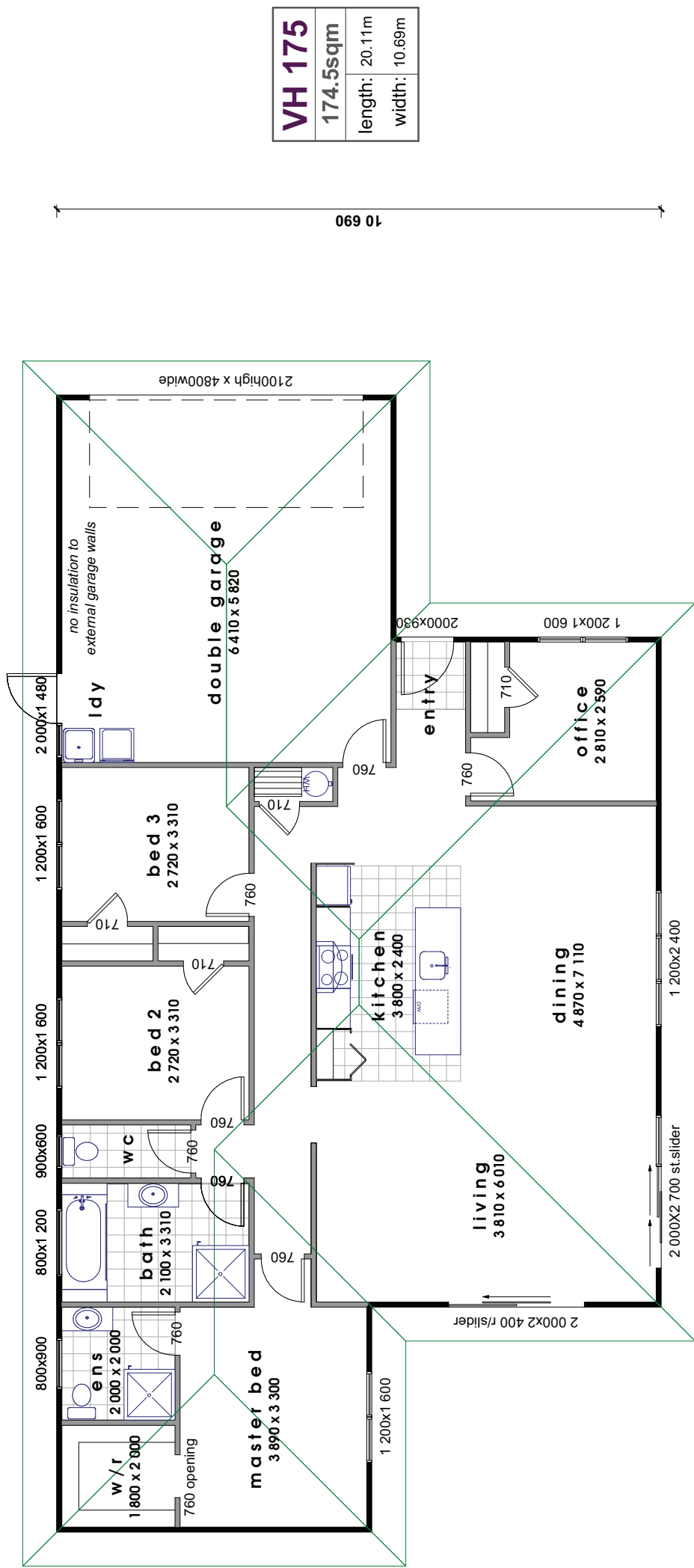
Plan:	VH175 std	Project No:	Sheet no:
Rev:	Scale: 1:100		A01
Date:	20.08.10	Drawn:	ND
		Call 0800 A1homes	2 1 4 6 6 3
		www.A1homes.co.nz	



VH 175
174.5sqm
length: 20.11m
width: 10.69m

floor area = 174.5sqm

Client Details:	Plan:	Project No:	Sheet no:
Pricing Plan	VH175 std		A07
Address:	Scale: 1:100	Rev:	Call 0800 A1homes
.....	Date: 20.08.10	Drawn: ND	2 1 4 6 6 3
			www.A1homes.co.nz



VH 175
174.5sqm
length: 20.11m
width: 10.69m

floor area = 174.5sqm

20 110

10 690

Client Details :
Pricing Plan
 Address:

Plan:	VH175 ^{std} _{Rev}	Project No:	Sheet no.:
Rev:	Scale: 1:100	SCHEME PLAN	A08
Date:	20.08.10	Drawn: ND	Call 0800 A1homes 2 1 4 6 6 3 www.A1homes.co.nz

Copyright 2010 A1 Homes NZ



North

Floor

Concrete floor (see notes & details)

Cladding

180mm James Hardie Linea w/board & AXON panel cladding

Roof

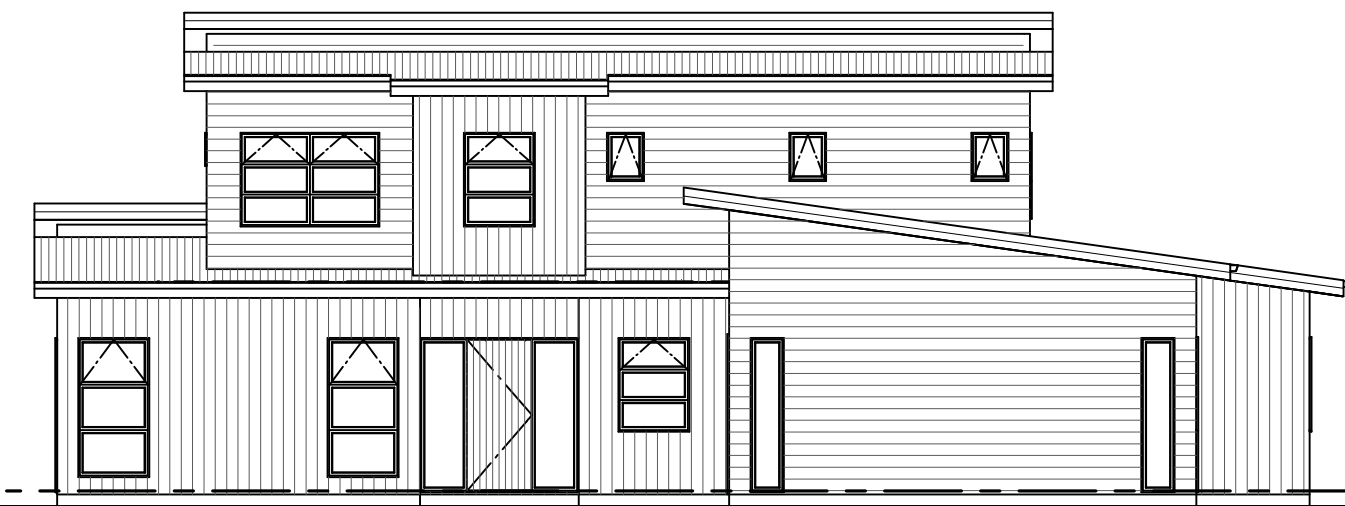
8° pitch. PCC Colorcote ZR8 or NZS Colorsteel Endura - corrugated profile

Fascia & Spouting

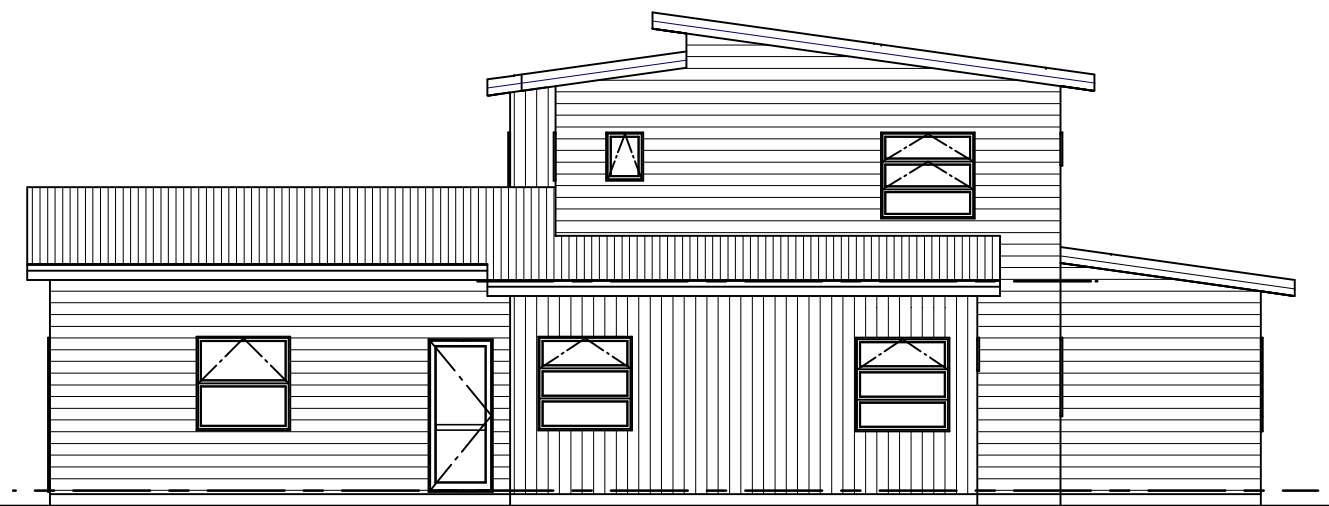
200x25pp fj fascia, Marley Stormcloud spouting system

Joinery

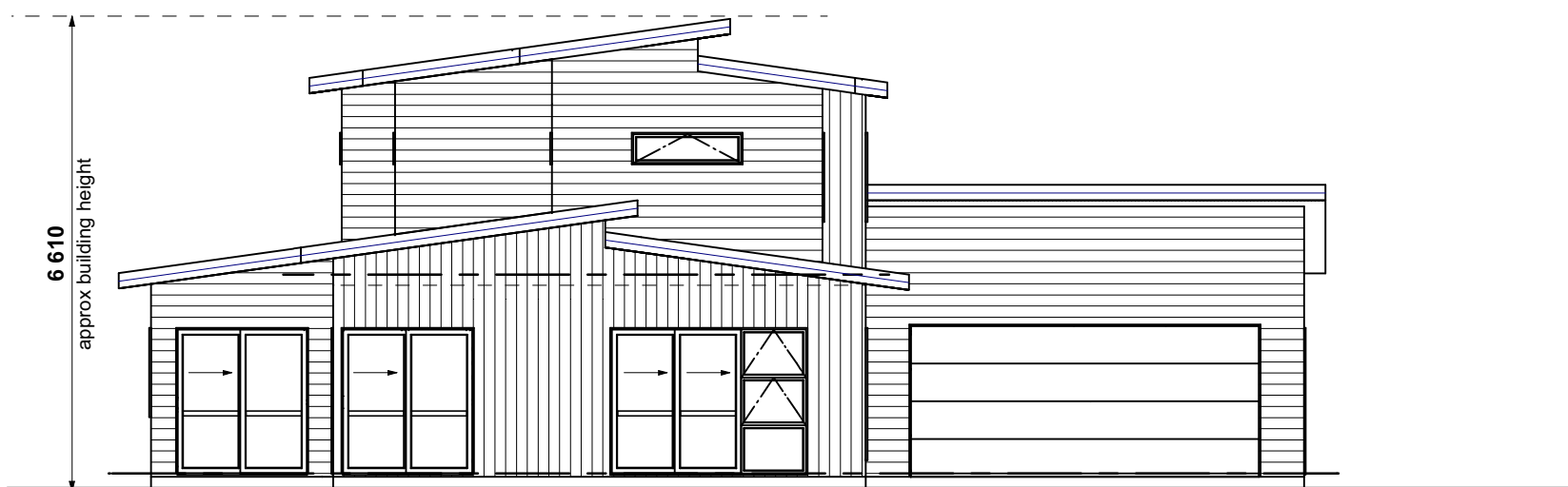
ASL Residential suite aluminium joinery



South



East

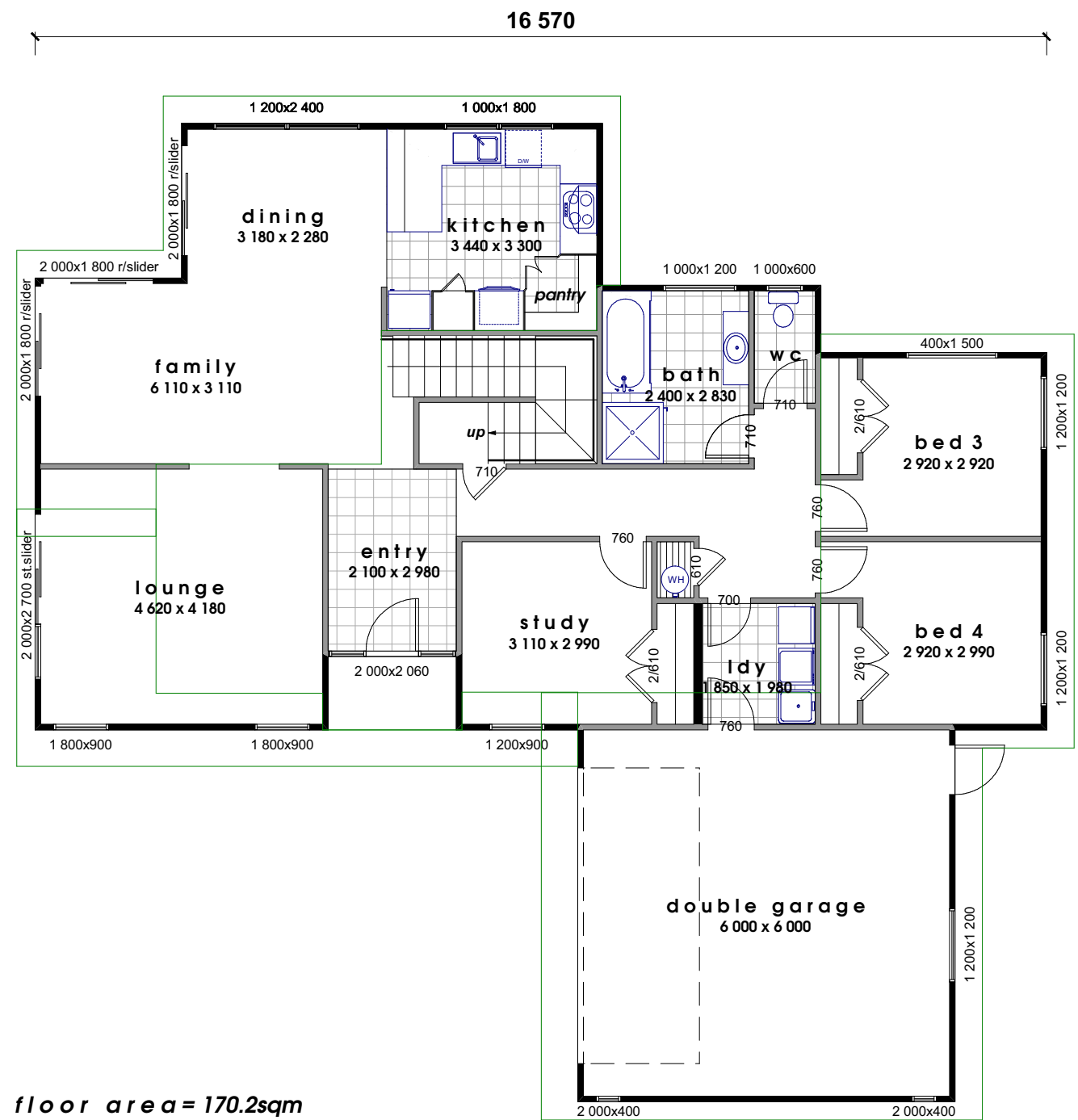


West

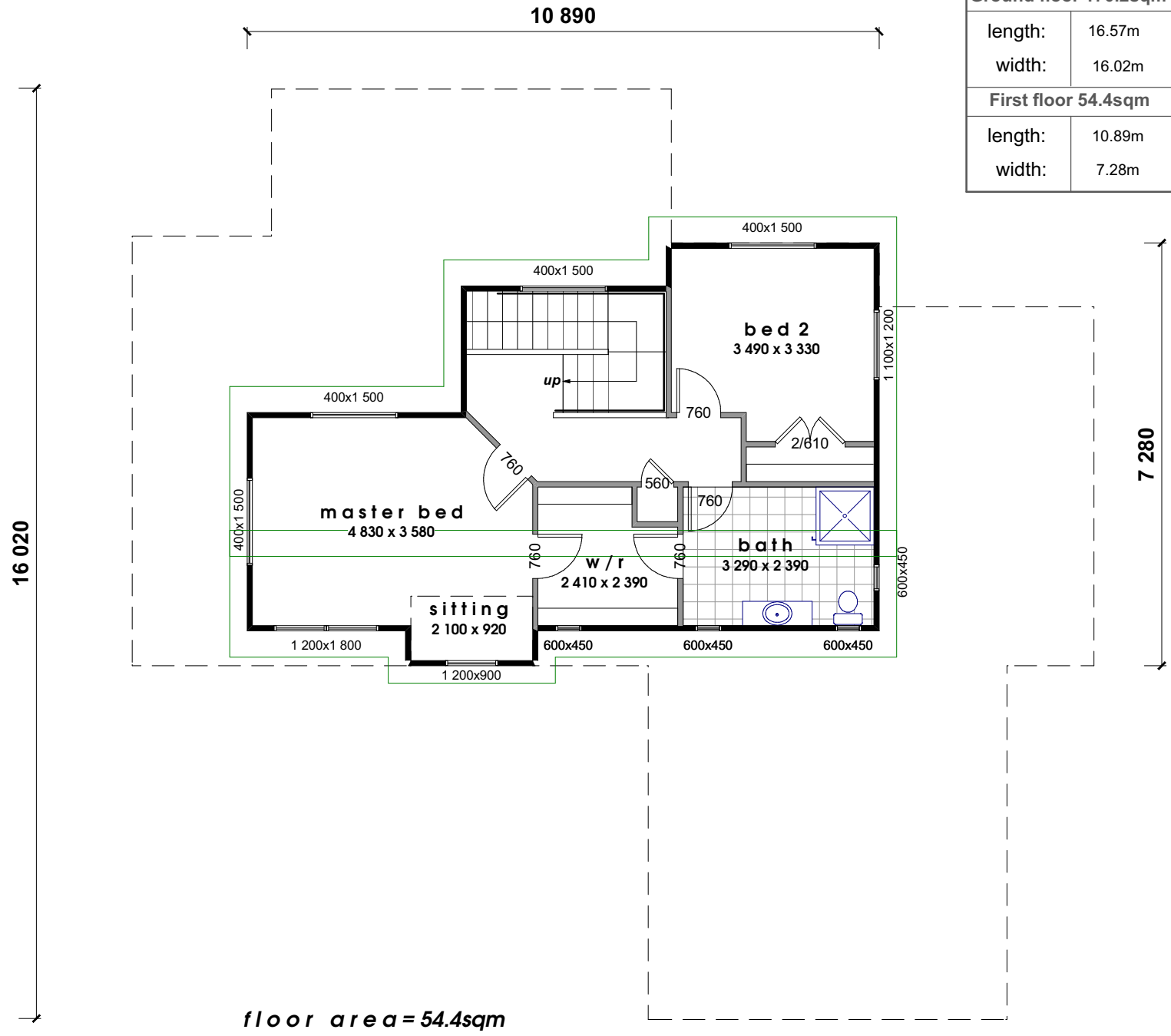
Copyright 2010 A1 Homes NZ

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Date: 12.08.10	Drawn: ND		2 1 4 6 6 3		
acdarchitecture.com				www.A1homes.co.nz		

BH 225	
Total 224.6sqm	
Ground floor 170.2sqm	
length:	16.57m
width:	16.02m
First floor 54.4sqm	
length:	10.89m
width:	7.28m



floor area = 170.2sqm
ground floor

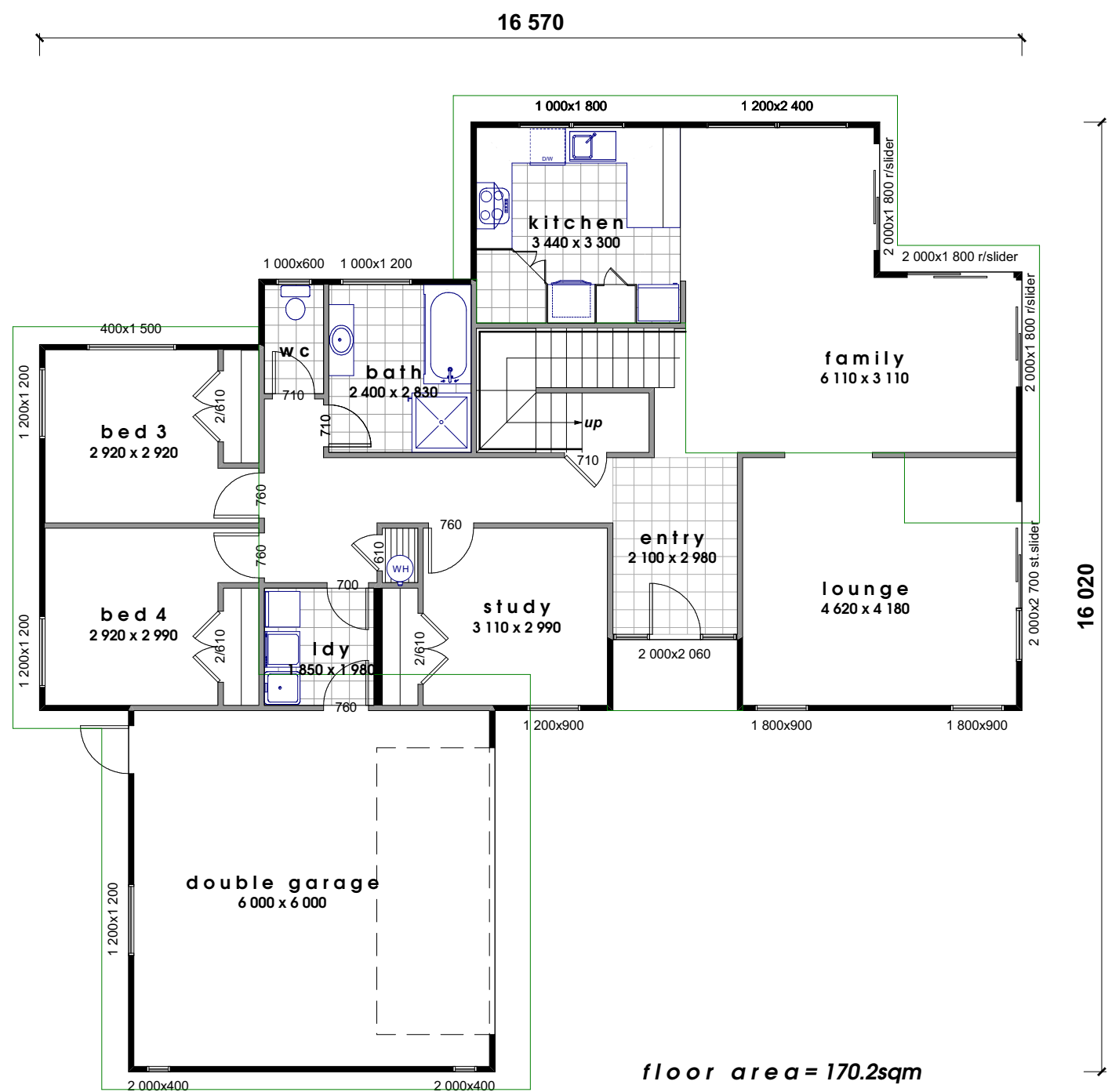


floor area = 54.4sqm
first floor

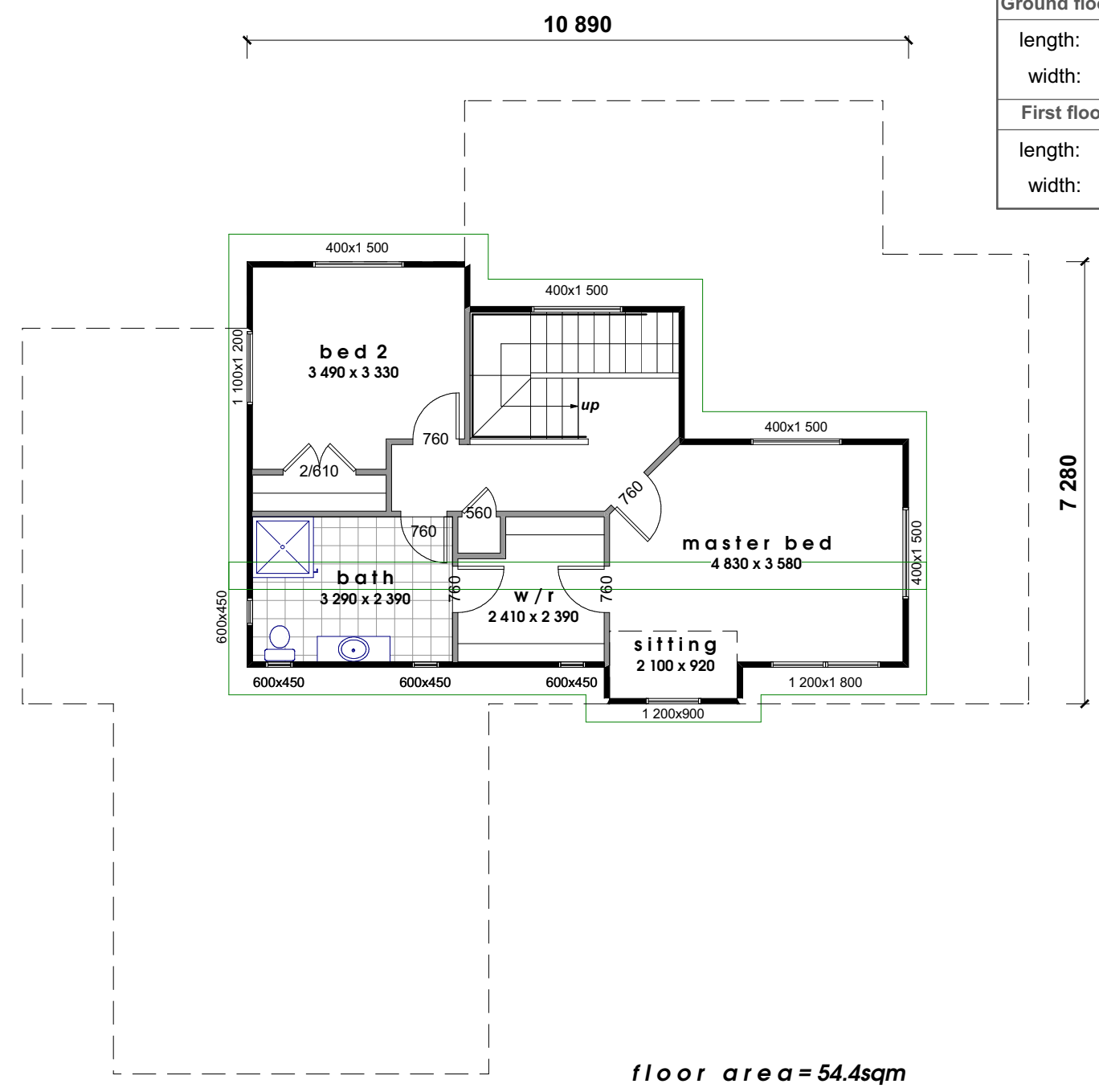
Copyright 2010 A1 Homes NZ

Client Details :		SCHEME PLAN		Plan :	Project No :	Sheet no :
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.....		Drawn: ND		2 1 4 6 6 3		www.A1homes.co.nz
.....		acdarchitecture.com				

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ground floor



first floor

Client Details :	SCHEME PLAN		Plan :	Project No:	Sheet no :
			BH225 std		A11
Address:	Rev:	Scale: 1:100	Call 0800 A1homes		
	Date: 12.08.10	Drawn: ND	2 1 4 6 6 3		
.....		acdarchitecture.com	www.A1homes.co.nz		

**Appendix 2 – Marshall Day
Acoustics Design Advise
Da001**

Project:	NZTA Building Sound Insulation	Document No.:	Da 001 r01		
To:	Beca	Date:	09 December 2013		
Attention:	Albert Lombard	Cross Reference:			
Delivery:		Project No.:	2013479W		
From:	Bill Wood	No. Pages:	15	Attachments:	No
SUBJECT	Traffic Noise Insulation Design				

As part of a study regarding the practicability, technical feasibility, and/or affordability of implementing noise insulation for houses constructed close to roading, Marshall Day Acoustics has been engaged by Beca to investigate required constructions to achieve the internal noise criterion of New Zealand Standard NZS 6806:2010 "Acoustics - Road-traffic noise - New and altered roads".

NZS 6806 sets out criteria for mitigating noise from new and altered roads. Section 6.1.2 (c) states that "Where it is inconsistent with the adoption of the best practicable option to achieve the criteria of Category A or B, and where internal noise levels of any habitable space would be greater than 45 dB $L_{Aeq(24\text{ hrs})}$, the criteria of Category C shall apply..."

The Category C internal noise criterion is 40 dB $L_{Aeq(24\text{ hrs})}$.

HOUSES CONSIDERED

Two generic house designs were considered for this study. These were provided by A1 Homes NZ and are as follows:

- VH175 std: single storey, 3 bedroom; and
- BH225 std: 2-storey, 4 bedroom.

TRAFFIC NOISE

Calculation Methodologies

A scenario of traffic flowing at 100 km/h, with a makeup of 10% heavy goods vehicles, was considered. Traffic noise levels were calculated using the CRTN UK *Calculation of Road Traffic Noise (1988)* method. This is a standard method of calculating traffic noise levels. The model used was that implemented on the NZTA website.

The transmission loss of the individual building elements was calculated using INSUL Version 7.0.10. The resulting noise level within each room was calculated using BS EN 12354-3: 2000 "Building Acoustics- Estimation of acoustic performance of buildings from the performance of elements Part 3 Airborne sound insulation against outdoor sound".

Traffic Flows

A 70 dB $L_{Aeq(24\text{ hrs})}$ traffic noise level incident on the façade of a house was selected as a typical, relatively high traffic noise scenario. At a distance of 20 metres from the road, this level would be produced by:

- AADT 9,000 on Grade 3/5 chipseal;
- AADT 12,000 on Grade 3 chipseal;
- AADT 14,000 on Grade 4 chipseal;
- AADT 30, 000 on open graded porous asphalt OGPA-14, with 20% voids.

Calculations were carried out assuming zero ground effect.

At greater distances, these same flows would produce;

- **66 dB $L_{Aeq(24\text{ hrs})}$** at 60m distance from the road; and
- **64 dB $L_{Aeq(24\text{ hrs})}$** at 90m distance from the road.

VH 175 STD SINGLE STOREY DWELLING

Following a review of the drawings supplied and discussions with A1 Homes Ltd personnel, we understand the construction to be as follows:

- Walls: exterior cladding James Hardie Smooth weatherboard cladding (13.7 kg/m^2)/90mm gap with batts installed between the nogs and dwangs/internal lining of 1x layer of 10mm Standard Gib;
- Glazing: double glazing, consisting of 4mm glass/11mm gap/4mm glass;
- Roof/ceiling: 0.4mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/1x layer of 13mm Standard Gib.

For the purposes of this study, it has been assumed that the road is located to the north of the house, so that the long wall of the living/dining/kitchen area is the most exposed façade (north elevation).

Living/Dining/Kitchen

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 47 dB $L_{Aeq(24\text{ hrs})}$. In order to meet the NZS 6806 Category C internal criterion of 40dB $L_{Aeq(24hr)}$, the following wall, roof and glazing constructions are required:

- All walls to the exterior: interior lining to be 2x 10mm Standard Gib (combined panel mass 27 kg/m^2);
- All glazing: 8.38 laminated glass/12mm gap/8.38mm laminated glass; or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36.
- Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib (combined panel mass 29 kg/m^2).

60m from Road: L_{pinc} 66 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 43 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if Category C was to be achieved, the required insulation is as follows:

- All walls to the exterior: interior lining to be 2x 10mm Standard Gib (combined panel mass 27 kg/m²);
- North glazing: 6mm/12mm gap/6mm glass;
- West glazing: as designed;
- Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

90m from Road: L_{pinc} 64 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 41 dB $L_{Aeq(24\text{ hrs})}$. If Category C was to be achieved here, the only required modification would be:

- North glazing: 6mm glass/12mm gap/6mm glass.

Master Bedroom

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 46 dB $L_{Aeq(24\text{ hrs})}$. In order to meet the NZS 6806 Category C internal criterion of 40dB $L_{Aeq(24hr)}$, the following wall, roof and glazing constructions are required:

- All walls to the exterior: interior lining to be 2x 13mm Standard Gib (combined panel mass 30 kg/m²);
- Glazing to be 8.38 laminated glass/12mm gap/8.38mm laminated glass; or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib (combined panel mass 29 kg/m²).

60m from Road: L_{pinc} 66 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 42 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the internal Category C criterion. However, if Category C was to be achieved, the required insulation is as follows:

- All walls to the exterior: interior lining to be 2x 10mm Gib (combined panel mass 26 kg/m²);
- Glazing to be 6mm/12mm gap/6mm glass;
- Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

90m from Road: L_{pinc} 64 dB $L_{Aeq(24\text{ hrs})}$:

With this room as designed, the internal noise level has been calculated as being 40 dB $L_{Aeq(24\text{ hrs})}$. Consequently no further insulation is required.

Bedrooms 2 and 3 (rear bedrooms)

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

These rooms have a measure of screening from the road. As designed, the internal noise level has been calculated as being 39 dB $L_{Aeq(24\text{ hrs})}$. Consequently no further insulation is required.

SUMMARY- VH 175 STD SINGLE STOREY DWELLING

For the purposes of specifying constructions, the above recommendations could usefully be summarised as follows. This may lead to over-design in some cases, but it may be preferable to an otherwise overly complex treatment specification. This summary is as follows:

20m from road:

- All interior linings to exposed façades to be 2x 13mm Standard Gib;
- All glazing to exposed façades to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling construction to be Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib.

60m from road:

- All interior linings to exposed façades to be 2x 10mm Gib;
- All glazing to exposed façades to be 6mm glass/12mm gap/6mm glass;
- Roof/ceiling construction to be Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib.

90m from road:

Walls and roof/ceiling as designed. Glazing to be 6mm glass/12mm gap/6mm glass.

BH 225 STD TWO-STOREY DWELLING

It has been assumed that the road is located to the west of the house, so that the western elevation walls of the lounge, family/dining/kitchen area, and the western wall of the master bedroom are the most exposed façades.

Following a review of the drawings supplied and discussions with A1 Homes Ltd personnel, we understand the construction to be as follows:

- Walls: exterior cladding a combination of James Hardie Linea weatherboard cladding (23.9 kg/m^2) and James Hardie Axon cladding (12.1 kg/m^2) /90mm gap with batts installed between the nogs and dwangs/internal lining of 1x layer of 10mm Standard Gib;
- Glazing: double glazing, consisting of 4mm glass/11mm gap/4mm glass;
- Roof/ceiling: 0.4mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/1x layer of 13mm Standard Gib.

In order to meet the NZS 6806 Category C criterion of $40\text{dB } L_{\text{Aeq}(24\text{hr})}$ inside all habitable spaces, the following wall, roof and glazing constructions are required for the external façades of habitable rooms:

Master Bedroom

20m from Road: L_{pinc} 70 dB $L_{\text{Aeq}(24 \text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as $45 \text{ dB } L_{\text{Aeq}(24 \text{ hrs})}$. In order to meet the NZS 6806 Category C internal criterion of $40\text{dB } L_{\text{Aeq}(24\text{hr})}$, the following wall, roof and glazing constructions are required:

- Walls: as designed, except interior linings to exposed façades of north facing and south facing walls to be 2x layers of 10mm Standard Gib (Linea wall combined panel mass 36 kg/m^2 ; Axon wall combined panel mass 25 kg/m^2);
- South glazing to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling construction to be: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib (combined panel mass 29 kg/m^2).

60m from Road: L_{pinc} 66 dB $L_{\text{Aeq}(24 \text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being $41 \text{ dB } L_{\text{Aeq}(24 \text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if this was to be considered, the only required modification would be:

- Roof/ceiling construction to be: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m^2).

90m from Road: L_{pinc} 64 dB $L_{Aeq(24\text{ hrs})}$:

With this room as designed, the internal noise level has been calculated as being 39 dB $L_{Aeq(24\text{ hrs})}$. Consequently no further insulation is required.

Bedroom 2

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 43 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if this was to be considered, the only required modification would be:

- Roof/ceiling construction to be: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

At distances of both 60m and 90m from the road, internal traffic noise levels in this room have been calculated as being less than 40 dB $L_{Aeq(24\text{ hrs})}$ with the house as designed. Consequently no additional insulation is required.

Lounge

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 46 dB $L_{Aeq(24\text{ hrs})}$. In order to meet the NZS 6806 Category C internal criterion of 40dB $L_{Aeq(24\text{ hr})}$, the following wall, roof and glazing constructions are required:

- Interior linings to exposed façades of all walls to be 2x layers of 10mm Standard Gib (combined panel mass 25 kg/m²);
- All glazing to be to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling construction to be: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib (combined panel mass 29 kg/m²).

60m from Road: L_{pinc} 66 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 42 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if this was to be considered, the required modifications would be:

- West glazing to be 6mm glass/12mm gap/6mm glass;
- Other glazing as designed;
- Roof/ceiling construction to be: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

90m from Road: L_{pinc} 64 dB $L_{Aeq(24\text{ hrs})}$:

With this room as designed, the internal noise level has been calculated as being 40 dB $L_{Aeq(24\text{ hrs})}$. Consequently no further insulation is required.

Family/Dining/Kitchen

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 47 dB $L_{Aeq(24\text{ hrs})}$. In order to meet the NZS 6806 Category C internal criterion of 40dB $L_{Aeq(24hr)}$, the following wall, roof and glazing constructions are required:

- Linea clad walls as designed;
- Interior linings to exterior Axon clad walls to be 2x layers of 10mm Standard Gib (combined panel mass 25 kg/m²);
- All glazing to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 35;
- Roof/ceiling construction to be 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib (combined panel mass 29 kg/m²).

60m from Road: L_{pinc} 66 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation implemented, the interior noise level has been calculated as being 43 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if this was to be considered, the required insulation is as follows:

- All walls as designed;
- West glazing to be 6mm glass/12mm gap/6mm glass;
- Other glazing as designed;
- Roof/ceiling to be 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

90m from Road: L_{pinc} 64 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 41 dB $L_{Aeq(24\text{ hrs})}$. If Category C was to be achieved here, the only required modification would be:

- West glazing: 6mm glass/12mm gap/6mm glass.

Bedrooms 3 and 4

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

These rooms have a measure of screening from the road. As designed, the internal noise level has been calculated as being 42 dB $L_{Aeq(24\text{ hrs})}$. This is below the NZS 6806 threshold for implementation of the Category C criterion. However, if this was to be considered, the required insulation is as follows:

- Walls: as designed;
- Glazing: as designed;
- Roof/ceiling to be 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib (combined panel mass 21 kg/m²).

60m and 90m from Road

At distances of both 60m and 90m from the road, internal traffic noise levels in this room have been calculated as being less than 40 dB $L_{Aeq(24\text{ hrs})}$ with the house as designed. Consequently no additional insulation is required.

Study

20m from Road: L_{pinc} 70 dB $L_{Aeq(24\text{ hrs})}$:

With no additional insulation, the internal traffic noise level has been calculated as 45 dB $L_{Aeq(24\text{ hrs})}$. In order to meet the NZS 6806 Category C criterion of 40dB $L_{Aeq(24\text{ hr})}$ inside all habitable spaces, the following wall, roof and glazing constructions are required for the external façades:

- Interior linings to external walls: 2x layers of 10mm Standard Gib (combined panel mass 25 kg/m²);
- Glazing to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling as designed.

60m and 90m from Road

At distances of both 60m and 90m from the road, internal traffic noise levels in this room have been calculated as being 40 dB $L_{Aeq(24\text{ hrs})}$ or less with the house as designed. Consequently no additional insulation is required.

SUMMARY- BH 225 STD TWO-STOREY DWELLING

For the purposes of specifying constructions, the above recommendations could usefully be summarised as follows. This may lead to over-design in some cases, but it may be preferable to an otherwise overly complex treatment specification. This summary is as follows:

20m from road:

- All interior linings to exposed façades to be 2x 10mm Standard Gib;
- All glazing to exposed façades to be 8.38 laminated glass/12mm gap/8.38mm laminated glass or other glazing system to give a performance of R_w+C_{tr} greater than or equal to 36;
- Roof/ceiling construction to be Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Noiseline Gib.

60m from road:

- All walls as designed;
- All glazing to façades facing the road to be 6mm glass/12mm gap/6mm glass;
- Other glazing as designed;
- Roof/ceiling construction to be Roof/ceiling: 0.55mm BMT corrugated steel/pitched roof with batts in the ceiling cavity/2x layers of 13mm Standard Gib.

90m from Road:

As designed, no additional treatment required.

GENERAL

Glazing

We note that some of the proposed glazing consists of openable sliding doors and windows. These are acceptable as long as the seals are properly installed and all meeting stiles/junctions perfectly mated, with an effectively snug fit. Not all such openable doors and windows are designed to have an effective seal.

Ventilation

Because the sound insulation as recommended in this Design Advice Da001 requires that all doors and windows are closed to be effective, mechanical ventilation will be required. This shall be designed to prevent additional noise break-in through the duct which would compromise the above sound insulation design.

Insulation Design

Please note that these design recommendations apply to the house designs as provided by Beca. Other designs may have variations aspects such as in room sizes, exterior cladding materials, glazing sizes, etc. These may in turn have an effect on any sound insulation design required to achieve the NZS 6806 Category C criterion of 40dB $L_{Aeq(24hr)}$ inside habitable spaces.

Traffic Noise

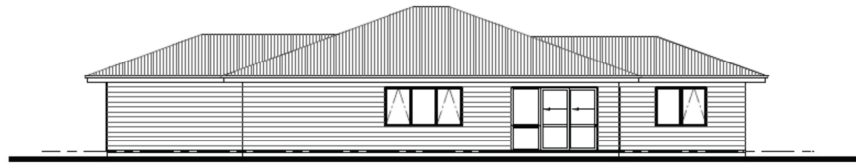
The design recommendations of this Design Advice relate only to the traffic noise levels as discussed. Higher traffic noise levels may require additional insulation design, and lower traffic noise levels may require less.

APPENDIX A GLOSSARY OF TERMINOLOGY

dB	<u>Decibel</u> The unit of sound level. Expressed as a logarithmic ratio of sound pressure P relative to a reference pressure of $P_r=20 \mu\text{Pa}$ i.e. $\text{dB} = 20 \times \log(P/P_r)$
dBA	The unit of sound level which has its frequency characteristics modified by a filter (A-weighted) so as to more closely approximate the frequency bias of the human ear.
A-weighting	The process by which noise levels are corrected to account for the non-linear frequency response of the human ear.
$L_{\text{Aeq}}(t)$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
Sound Insulation	When sound hits a surface, some of the sound energy travels through the material. 'Sound insulation' refers to ability of a material to stop sound travelling through it.
R_w	<u>Weighted Sound Reduction Index</u> A single number rating of the sound insulation performance of a specific building element. R_w is measured in a laboratory. R_w is commonly used by manufacturers to describe the sound insulation performance of building elements such as plasterboard and concrete.
C_{tr}	A sound insulation adjustment, commonly used with R_w and $D_{nT,w}$. C_{tr} adjusts for low frequency noise, like noise from trucks and subwoofers. C_{tr} values typically range from about -4 to about -12. This term is used to provide information about the acoustic performance at different frequencies, as part of a single number rating system.

APPENDIX B HOUSE DESIGN-SINGLE STOREY VH175 STD

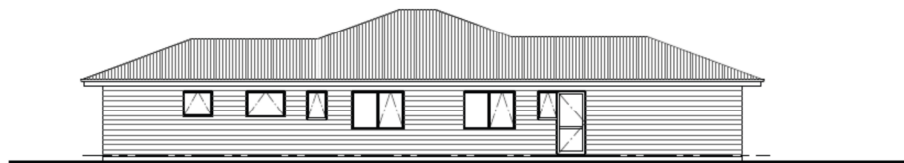
(Source: A1 Homes NZ; Copyright 2010)



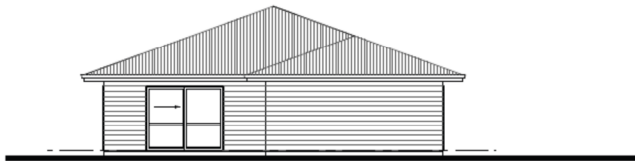
North



East



South



West



Floor
Concrete floor (see notes & details)

Cladding
240mm James Hardie Smooth weatherboard cladding

Roof
20° pitch, PCC Colorcote ZR8 or NZS Colorsteel Endura - corrugated profile

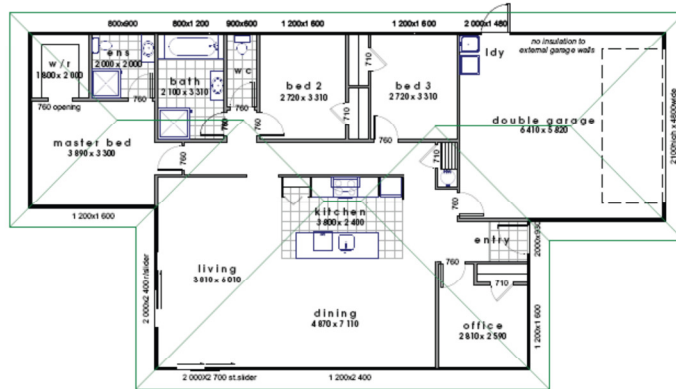
Fascia & Spouting
200x25pp fj fascia, Marley Stormcloud spouting system

Joinery
ASL Residential suite aluminium joinery



Client Details:		ELEVATIONS		Plan:	Project No:	Sheet No:
Pricing Plan		VH175 std		VH175 std		A01
Address:		Scale:	1:100	Call 0800 A1homes		
		Date:	20.08.10	214 683		
		Architect:	scdarchitecture	www.A1homes.co.nz		

Copyright 2010 A1 Homes NZ



VH 175
174.5sqm
length: 20.11m
width: 10.09m

floor area = 174.5sqm



Client Details:		Scheme Plan		Proj:	VH175.gld	Project No:	A08
Pricing Plan		Address:		Rev:	20.08.10	Scale:	1:100
Copyright 2010 A1 Homes NZ		Copyright 2010 A1 Homes NZ		Drawn:	ND	Call 0800 A1homes	2 14 663
				Architecture:		www.A1homes.co.nz	

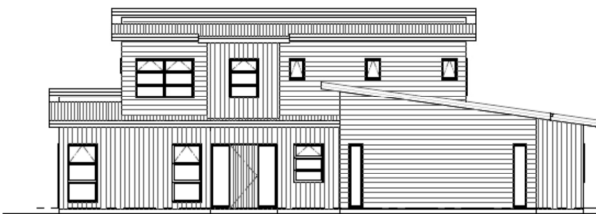
APPENDIX C HOUSE DESIGN – 2-STOREY BH225 STD

(Source: A1 Homes NZ; Copyright 2010)

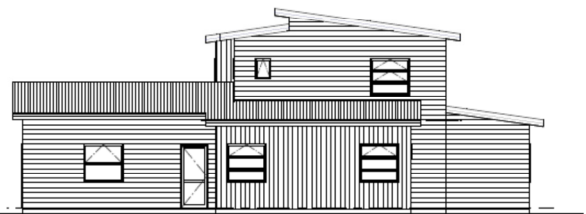


North

- Floor**
Concrete floor (see notes & details)
- Cladding**
180mm James Hardie Linea wboard & AXON panel cladding
- Roof**
8° pitch, PCC Colorsteel ZTR6 or NZS Colorsteel Endura - corrugated profile
- Fascia & Spouting**
200x25p p f fascia, Marley Stormcloud spouting system
- Joinery**
ASL Residential suite aluminium joinery



South



East



West

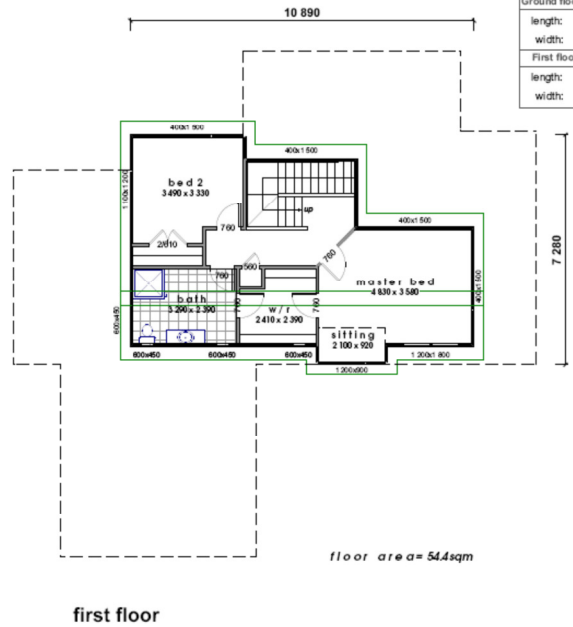
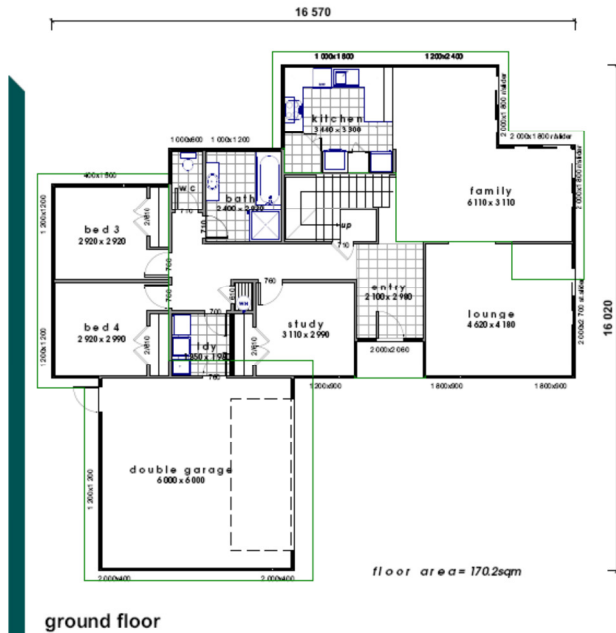
6 610
approx. cladding height



Copyright 2010 A1 Homes NZ

Client Details:		Plan: BH225 std	Project No: A01
ELEVATIONS		Rev: 1	Scale: 1:100
Date: 12.08.10	Drawn: ND	Call 0800 A1homes 2 14 6 6 3	
www.a1homes.co.nz		www.a1homes.co.nz	

BH 225	
Total 224.6sqm	
Ground floor 170.2sqm	
length:	16.57m
width:	16.02m
First floor 54.4sqm	
length:	10.89m
width:	7.28m



Client Details:		SCHEME PLAN		Rev:	Scale:	Proj No:	Proj No:
Address:		Date:	12.08.10	12.08.10	1:100	BH225_Std	A11
		Arch:	ND	ND	ND	ND	ND
		Call 0800 A1homes		www.A1homes.co.nz			

Appendix 3 – Beca Cost Estimate

Memorandum

To: Stephen Chiles

Date: 14 November 2013

From: Beca Ltd

Subject: NZTA Acoustic Mitigation Concept Design Estimate

1 Introduction

This estimate of construction costs for two generic A1Homes house designs have been prepared for New Zealand Transport Agency as part of the acoustic mitigation case study for houses built close to roads. The work is as summarised below;

- Implementing noise insulation to A1 Homes house type VH175 std: single storey 3 bedroom at various distances from the road
- Implementing noise insulation to A1 Homes house type BH225 std: 2 storey 4 bedroom at various distances from road

2 Executive Summary

With reference to the following estimate report and full detailed elemental estimate of construction costs, we summarise our estimate of construction works excluding GST as follows:

- | | |
|--|--------------|
| ■ VH175 std: single storey 3 bedroom 20m from road | \$251,000.00 |
| ■ VH175 std: single storey 3 bedroom 60m from road | \$241,000.00 |
| ■ VH175 std: single storey 3 bedroom 90m from road | \$237,000.00 |
| ■ BH225 std: two storey 4 bedroom 20m from road | \$354,000.00 |
| ■ BH225 std: two storey 4 bedroom 60m from road | \$339,000.00 |
| ■ BH225 std: two storey 4 bedroom 90m from road | \$334,000.00 |

These totals include the following contingency amounts:-

Estimating Contingency has been applied to additional noise insulation cost:

- | | |
|--|------------|
| ■ VH175 std: single storey 3 bedroom 20m from road | \$2,010.00 |
| ■ VH175 std: single storey 3 bedroom 60m from road | \$1,300.00 |
| ■ VH175 std: single storey 3 bedroom 90m from road | \$834.00 |
| ■ BH225 std: two storey 4 bedroom 20m from road | \$2,200.00 |
| ■ BH225 std: two storey 4 bedroom 60m from road | \$1,150.00 |
| ■ BH225 std: two storey 4 bedroom 90m from road | \$834.00 |

The Estimating Contingency is an allowance for residual cost risk including design development, omissions, construction risk, sundry measured items and assumptions made for construction details not shown.

The estimate is based upon rates and prices as at November 2013 and no allowance has been included for increases in labour, materials or plant beyond this date.

This estimate is based upon the Design Advice produced by Marshall Day Acoustics. However, please refer to clarifications, assumptions, a full list of exclusions, budget risks etc. that are included within the body of this estimate report.

It should be noted that the base price for the houses used in this estimate is as per A1 Homes website.

Please note that all values within this report and included in the attached Estimate Details are GST exclusive.

3 Basis of Estimate

The drawings / information relied upon to generate this estimate is summarised as follows;

A1Homes Scheme Plan VH175 std sheet A07 dated 20/08/2010

A1Homes Elevations VH175 std sheet A01 dated 20/08/2010

A1Homes Scheme Plan BH225 std sheet A10 dated 12/08/2010

A1Homes Elevations BH225 std sheet A10 dated 12/08/2010

Marshall Day Acoustics Design Advice dated 14/10/2013

House Base Price from A1Homes website

All work should be installed in accordance with the Building Code and manufacturer's instructions as applicable.

4 Estimate Summary

A summary of the estimate is included below, a full detailed breakdown is included at Appendix A.

Ref	Distance from road	Element of works	Single Storey	Double Storey
		Base Price	\$235,000	\$332,000
1.0	20m	Base Price +Noise Insulation	\$251,000	\$354,000
2.0	60m	Base Price +Noise Insulation	\$241,000	\$339,000
3.0	90m	Base Price +Noise Insulation	\$237,000	\$334,000

Note 1:- Preliminary & General has been applied to additional noise insulation cost.

Note 2:- Main Contractor (off-site) Overheads and Profit (OH&P) Margins have been applied to additional noise insulation cost.

Note 3:- Estimating/ Design Contingency sum has been applied to additional insulation cost.

5 Estimate Exclusions

Below we summarise items of work or likely project costs that are excluded from our estimate but that should be considered when establishing the likely project total budget;

5.1 General Estimate Exclusions

- Goods & Services Tax (GST)
- Construction escalation beyond date of report
- Finance / sales / marketing costs
- Legal / Accounting fees
- Professional fees
- Building & Resource consent fees and charges
- Cost of purchasing section
- Project Contingency

5.2 Project Specific Exclusions

- Drive way and Landscaping
- Ventilation

6 Assumptions and Clarifications

Suitable levels of health and safety management are required and have been included within the estimate rates.

7 Conclusion

The cost of each house type decreases with increase in distance from the road.

Appendix A

Estimate Details

GENERAL SUMMARY

COMPANY : Beca

PROJECT : Project- ACOUSTIC MITIGATION CASE STUDY

DATE : Thu 14 Nov 2013 04:25pm

SubTitle :

Bid Currency : New Zealand

CO	SECTION NAME	UNIT	QUANTITY	RATE	COST
1.0	VH175 STD SINGLE STOREY DWELLING 20M				251,000.00
2.0	VH175 STD SINGLE STOREY DWELLING 60M				241,000.00
3.0	VH175 STD SINGLE STOREY DWELLING 90M				237,000.00
4.0	BH225 STD 2 STOREY DWELLING 20M				354,000.00
5.0	BH225 STD 2 STOREY 60M FROM ROAD 60M				339,000.00
6.0	BH225 STD 2 STOREY 90M FROM ROAD 90M				334,000.00
TOTALS OF SELECTED SECTIONS					1,756,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	<u>VH 175 STD SINGLE STOREY DWELLING</u>				
	20m from road				
	<u>Base Price</u>				
1.00	A1 Built NSG Price - Price as per A1Homes website	Sum	1	212,929.00	212,929.00
1.01	Section	Sum	1	excluded	
1.02	Site Scrape - Price as per A1Homes website	Sum	1	3,000.00	3,000.00
1.03	Services to site - Price as per A1Homes website	Sum	1	10,000.00	10,000.00
1.04	Floor coverings - rate as per A Homes	m2	164	55.00	9,020.00
1.05	Council Fees	Sum	1	Excluded	
1.06	Drive Way and Landscaping	Sum	1	Excluded	
1.07	Sundries	Sum	1	51.00	51.00
	Subtotal **				235,000.00
	<u>Noise Insulation</u>				
	<u>Living/Dining/kitchen</u>				
1.08	2x Layers 10mm Standard Gib to walls in lieu of 1x Layer 10mm standard Gib allowed in the base price - Additional Cost	m2	24	18.00	432.00
1.09	Double glazing consisting of 8.38mm thick laminated glass on either side of the gap in lieu of 4mm thick glass on either side of gap allowed in base price - Additional Cost	m2	14	320.00	4,480.00
1.10	2 x layer of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price	m2	54	41.00	2,214.00
	<u>Master Bedroom</u>				
1.11	2x Layers 13mm Standard Gib to walls in lieu of 10mm Standard allowed in Base price - Additional Cost	m2	32	24.00	768.00
1.12	Double glazing consisting of 8.38 laminated glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price - additional cost	m2	3	320.00	960.00
1.13	2x layer of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	21	41.00	861.00
	<u>Bedroom 2 and 3</u>				
1.14	Insulation not required				

Section '1.0'-'VH175 STD SINGLE STOREY DWELLING 20M'

COMPANY : Beca

PROJECT : Project- ACOUSTIC MITIGATION CASE STUDY

DATE : Thu 14 Nov 2013 04:25pm

SubTitle :

Bid Currency : New Zealand

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	<u>Roof</u>				
1.15	0.55mm BMT corrugated sheet in lieu of 0.4mm BMT corrugated sheet allowed in base price - Additional Cost	m2	227	6.00	1,362.00
1.16	Sundries	Sum	1	923.00	923.00
	<u>Contractors OHP</u>				
1.17	Preliminaries & General (10%)	Sum	12,000	0.10	1,200.00
1.18	Margin (6.0%)	Sum	13,200	0.06	790.00
	<u>Contingencies</u>				
1.19	Estimating Contingency (10%)	Sum	13,990	0.10	1,400.00
1.20	Sundries	Sum	1	610.00	610.00
	Subtotal **				16,000.00
	Totals for Section '1.0'-'VH175 STD SINGLE STOREY DWELLING 20M'				251,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	<u>VH 175 STD SINGLE STOREY DWELLING</u>				
	60m from road				
	<u>Base Price</u>				
2.00	A1 Built NSG Price - Price as per A1Homes website	Sum	1	212,929.00	212,929.00
2.01	Section	Sum	1	excluded	
2.02	Site Scrape - Price as per A1Homes website	Sum	1	3,000.00	3,000.00
2.03	Services to site - Price as per A1Homes website	Sum	1	10,000.00	10,000.00
2.04	Floor coverings - rate as per A Homes	m2	164	55.00	9,020.00
2.05	Council Fees	Sum	1	Excluded	
2.06	Drive Way and Landscaping	Sum	1	Excluded	
2.07	Sundries	Sum	1	51.00	51.00
	Subtotal **				235,000.00
	<u>Noise Insulation</u>				
	<u>Living/Dining/kitchen</u>				
2.08	2x layers 10mm Standard Gib to walls in lieu of 1x 10mm Standard Gib allowed in base price	m2	24	18.00	432.00
2.09	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price -North glazing only - Additional Cost	m2	9	44.00	396.00
2.10	2 x layer of 13mm Gib standard to ceilings in lieu of 13mm Standard Gib allowed in base price	m2	54	20.00	1,080.00
	<u>Master Bedroom</u>				
2.11	2x Layers 10mm Standard Gib to walls in lieu of 10mm Standard allowed in Base price - Additional Cost	m2	32	18.00	576.00
2.12	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price - additional cost	m2	3	44.00	132.00
2.13	2 x layer of 13mm Gib Standard to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	21	20.00	420.00
2.14	Sundries	Sum	1	964.00	964.00
	<u>Bedroom 2 and 3</u>				

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
2.15	No further insulation required				
	<u>Contractors OHP</u>				
2.16	Preliminaries & General (10%)	Sum	4,000	0.10	400.00
2.17	Margin (6.0%)	Sum	4,400	0.07	300.00
	<u>Contingencies</u>				
2.18	Estimating Contingency (10%)	Sum	4,700	0.11	500.00
	Sundries	Sum	1	800.00	800.00
2.19	Subtotal **				6,000.00
	Totals for Section '2.0'-'VH175 STD SINGLE STOREY DWELLING 60M'				241,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	<u>VH 175 STD SINGLE STOREY DWELLING</u>				
	90m from road				
3.00	A1 Built NSG Price - Price as per A1Homes website	Sum	1	212,929.00	212,929.00
3.01	Section	Sum	1	excluded	
3.02	Site Scrape - Price as per A1Homes website	Sum	1	3,000.00	3,000.00
3.03	Services to site - Price as per A1Homes website	Sum	1	10,000.00	10,000.00
3.04	Floor coverings - rate as per A Homes	m2	164	55.00	9,020.00
3.05	Council Fees	Sum	1	Excluded	
3.06	Drive Way and Landscaping	Sum	1	Excluded	
3.07	Sundries	Sum	1	51.00	51.00
3.08	Subtotal **				235,000.00
	<u>Noise Insulation</u>				
	<u>Living/Dining/kitchen</u>				
3.09	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price -North glazing only - Additional Cost	m2	9	44.00	396.00
3.10	Sundries	Sum	1	604.00	604.00
	<u>Master Bed Room</u>				
3.11	No further insulation required				
	<u>Bedroom 2 and 3</u>				
3.12	No further insulation required				
	<u>Contractors OHP</u>				
3.13	Preliminaries & General (10%)	Sum	1,000	0.10	100.00
3.14	Margin (6.0%)	Sum	1,100	0.06	66.00
	<u>Contingencies</u>				
3.15	Estimating Contingency (10%)	Sum	1,166	0.10	120.00
3.16	Sundries	Sum	1	714.00	714.00
	Subtotal **				2,000.00
	Totals for Section '3.0'-'VH175 STD SINGLE STOREY DWELLING 90M'				237,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	BH225 STD TWO STOREY DWELLING				
	20m from road				
	<u>Base Price</u>				
4.00	A1 Built NSG Price - Price as per A1Homes website	Sum	1	309,015.00	309,015.00
4.01	Section	Sum	1	excluded	
4.02	Site Scrape - Price as per A1Homes website	Sum	1	3,000.00	3,000.00
4.03	Services to site - Price as per A1Homes website	Sum	1	10,000.00	10,000.00
4.04	Floor coverings - rate as per A1Homes website	m2	164	55.00	9,020.00
4.05	Council Fees	Sum	1	Excluded	
4.06	Drive Way & Landscaping	Sum	1	Excluded	
4.07	Sundries	Sum	1	965.00	965.00
	Subtotal **				332,000.00
	<u>Noise Insulation</u>				
	<u>Master Bedroom</u>				
4.08	2 x Layers 10mm Standard Gib to walls in lieu of 1x Layer 10mm Standard Gib allowed in the base price (North & South facing walls) - Additional Cost	m2	21	18.00	378.00
4.09	Double glazing consisting of 8.38 laminated glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price (South glazing) - Additional cost	m2	4	320.00	1,280.00
4.10	2 x layer of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	19	41.00	779.00
	<u>Bedroom 2</u>				
4.11	2 x layers of 13mm Gib standard to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	12	20.00	240.00
	<u>Lounge</u>				
4.12	2 x Layers 10mm Standard Gib to walls in lieu of 1x Layer 10mm Standard Gib allowed in the base price - Additional Cost	m2	16	18.00	288.00
4.13	Double glazing consisting of 8.38 laminated glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price - Additional cost	m2	9	320.00	2,880.00

Section '4.0'-'BH225 STD 2 STOREY DWELLING 20M '

COMPANY : Beca

PROJECT : Project- ACOUSTIC MITIGATION CASE STUDY

DATE : Thu 14 Nov 2013 04:25pm

SubTitle :

Bid Currency : New Zealand

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
4.14	2 x layer of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost <u>Family/Dining/Kitchen</u>	m2	20	41.00	820.00
4.15	2 x Layers 10mm Standard Gib to walls in lieu of 1x Layer 10mm Standard Gib allowed in the base price - Additional Cost	m2	31	18.00	558.00
4.16	Double glazing consisting of 8.38 laminated glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price - Additional cost	m2	16	320.00	5,120.00
4.17	2 x layer of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost <u>Bedroom 3 and 4</u>	m2	37	41.00	1,517.00
4.18	2 x layers of 13mm Gib standard to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost <u>Study</u>	m2	22	20.00	440.00
4.19	2 x Layers 10mm Standard Gib to walls in lieu of 1x Layer 10mm Standard Gib allowed in the base price - Additional Cost	m2	8	18.00	144.00
4.20	Double glazing consisting of 8.38 laminated glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price - Additional cost <u>Roof</u>	m2	2	320.00	640.00
4.21	0.55mm BMT corrugated sheet in lieu of 0.4mm BMT corrugated sheet allowed in base price - Additional Cost	m2	270	6.00	1,620.00
4.22	Sundries <u>Contractors OHP</u>	Sum	1	296.00	296.00
4.23	Preliminaries & General (10%)	Sum	17,000	0.10	1,700.00
4.24	Margin (6.0%) <u>Contingencies</u>	Sum	18,700	0.06	1,100.00
4.25	Estimating Contingency (10%)	Sum	19,800	0.10	2,000.00
4.26	Sundries	Sum	1	200.00	200.00
	Subtotal **				22,000.00
	Totals for Section '4.0'-'BH225 STD 2 STOREY DWELLING 20M '				354,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	BH225 STD TWO STOREY DWELLING				
	60m from road				
	Base Price				
5.00	A1 Built NSG Price - Price as per A1Homes website	Sum	1	309,015.00	309,015.00
5.01	Section	Sum	1	excluded	
5.02	Site Scrape - Price as per A1Homes website	Sum	1	3,000.00	3,000.00
5.03	Services to site - Price as per A1Homes website	Sum	1	10,000.00	10,000.00
5.04	Floor coverings - rate as per A1Homes website	m2	164	55.00	9,020.00
5.05	Council Fees	Sum	1	Excluded	
5.06	Drive Way & Landscaping	Sum	1	Excluded	
5.07	Sundries	Sum	1	965.00	965.00
	Subtotal **				332,000.00
	Noise Insulation				
	Master Bedroom				
5.08	2 x layers of 13mm Gib standard to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	19	20.00	380.00
	Bedroom 2				
5.09	No further insulation required				
	Lounge				
5.10	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price -West glazing only - Additional Cost	m2	6	44.00	264.00
5.11	2 x layers of 13mm Gib Noiseline to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	20	41.00	820.00
	Family/Dining/Kitchen				
5.12	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price -West glazing only - Additional	m2	8	44.00	352.00
5.13	2 x layer of 13mm Standard Gib to ceilings in lieu of 13mm Standard Gib allowed in base price - Additional Cost	m2	37	20.00	740.00
	Bedroom 3 and 4				

Section '5.0'-'BH225 STD 2 STOREY 60M FROM ROAD 60M'

COMPANY : Beca

PROJECT : Project- ACOUSTIC MITIGATION CASE STUDY

DATE : Thu 14 Nov 2013 04:25pm

SubTitle :

Bid Currency : New Zealand

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
5.14	No further insulation required <u>Study</u>				
5.15	No further insulation required <u>Roof</u>				
5.16	0.55mm BMT corrugated sheet in lieu of 0.4mm BMT corrugated sheet allowed in base price - Additional Cost	m2	270	6.00	1,620.00
5.17	Sundries <u>Contractors OHP</u>	Sum	1	824.00	824.00
5.18	Preliminaries & General (10%)	Sum	5,000	0.10	500.00
	Margin (6.0%)	Sum	5,500	0.06	350.00
	<u>Contingencies</u>				
5.19	Estimating Contingency (10%)	Sum	5,850	0.10	600.00
5.20	Sundries	Sum	1	550.00	550.00
	Subtotal **				7,000.00
	Totals for Section '5.0'-'BH225 STD 2 STOREY 60M FROM ROAD 60M'				339,000.00

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	BH225 STD TWO STOREY DWELLING				
	90m from road				
	<u>Base Price</u>				
6.00	A1 Built NSG Price - Price as per A1 Homes website	Sum	1	309,015.00	309,015.00
6.01	Section	Sum	1	excluded	
6.02	Site Scrape - Price as per A1 Homes website	Sum	1	3,000.00	3,000.00
6.03	Services to site - Price as per A1 Homes website	Sum	1	10,000.00	10,000.00
6.04	Floor coverings - rate as per A1 Homes website	m2	164	55.00	9,020.00
6.05	Council Fees	Sum	1	Excluded	
6.06	Drive Way & Landscaping	Sum	1	Excluded	
6.07	Sundries	Sum	1	965.00	965.00
	Subtotal **				332,000.00
	<u>Noise Insulation</u>				
	<u>Master Bedroom</u>				
6.08	No further insulation required				
	<u>Bedroom 2</u>				
6.09	No further insulation required				
	<u>Lounge</u>				
6.10	No further insulation required				
	<u>Family/Dining/Kitchen</u>				
6.11	Double glazing consisting of 6mm glass on either side of the gap in lieu of 4mm glass on either side of gap allowed in base price -West glazing only - Additional Cost	m2	8	44.00	352.00
6.12	Sundries	Sum	1	648.00	648.00
	<u>Bedroom 3 and 4</u>				
6.13	No further insulation required				
	<u>Study</u>				
6.14	No further insulation required				
	<u>Contractors OHP</u>				
6.15	Preliminaries & General (10%)	Sum	1,000	0.10	100.00
6.16	Margin (6.0%)	Sum	1,100	0.06	66.00

Section '6.0'-'BH225 STD 2 STOREY 90M FROM ROAD 90M'

COMPANY : Beca

PROJECT : Project- ACOUSTIC MITIGATION CASE STUDY

DATE : Thu 14 Nov 2013 04:25pm

SubTitle :

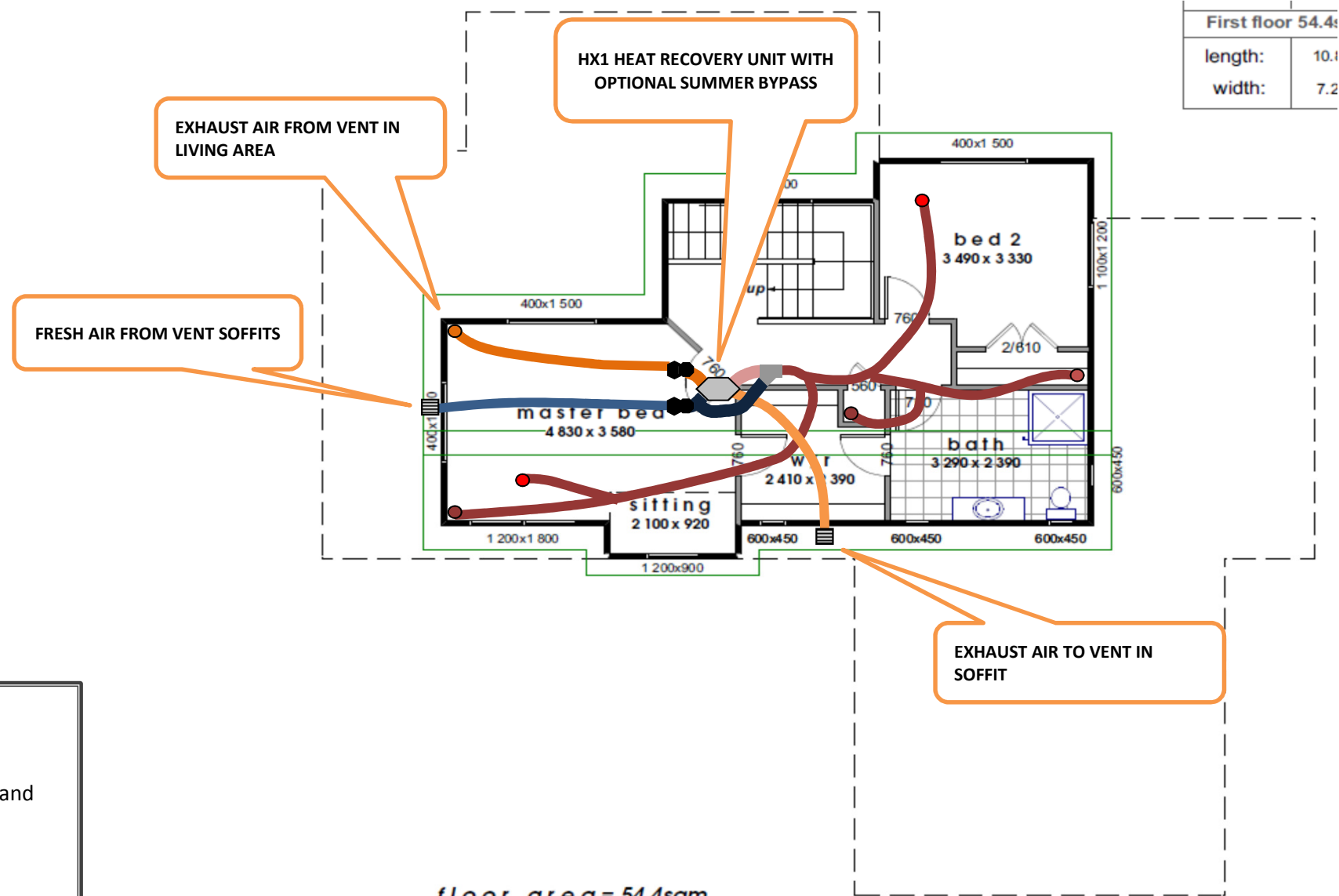
Bid Currency : New Zealand

BQREF	DESCRIPTION	UNIT	QTY	RATE	COST
	<u>Contingencies</u>				
6.17	Estimating Contingency (10%)	Sum	1,166	0.10	120.00
6.18	Sundries	Sum	1	714.00	714.00
	Subtotal **				2,000.00
	Totals for Section '6.0'-'BH225 STD 2 STOREY 90M FROM ROAD 90M'				334,000.00

**Appendix 4 – Condensation
Control Ltd Ventilation
Design**

MOISTUREMASTER HX HEAT RECOVERY VENTILATION SYSTEM WITH SUMMER BYPASS

PROPOSED LAYOUT PLAN For House C - BH225 - Upstairs



First floor 54.4sqm	
length:	10.1
width:	7.2

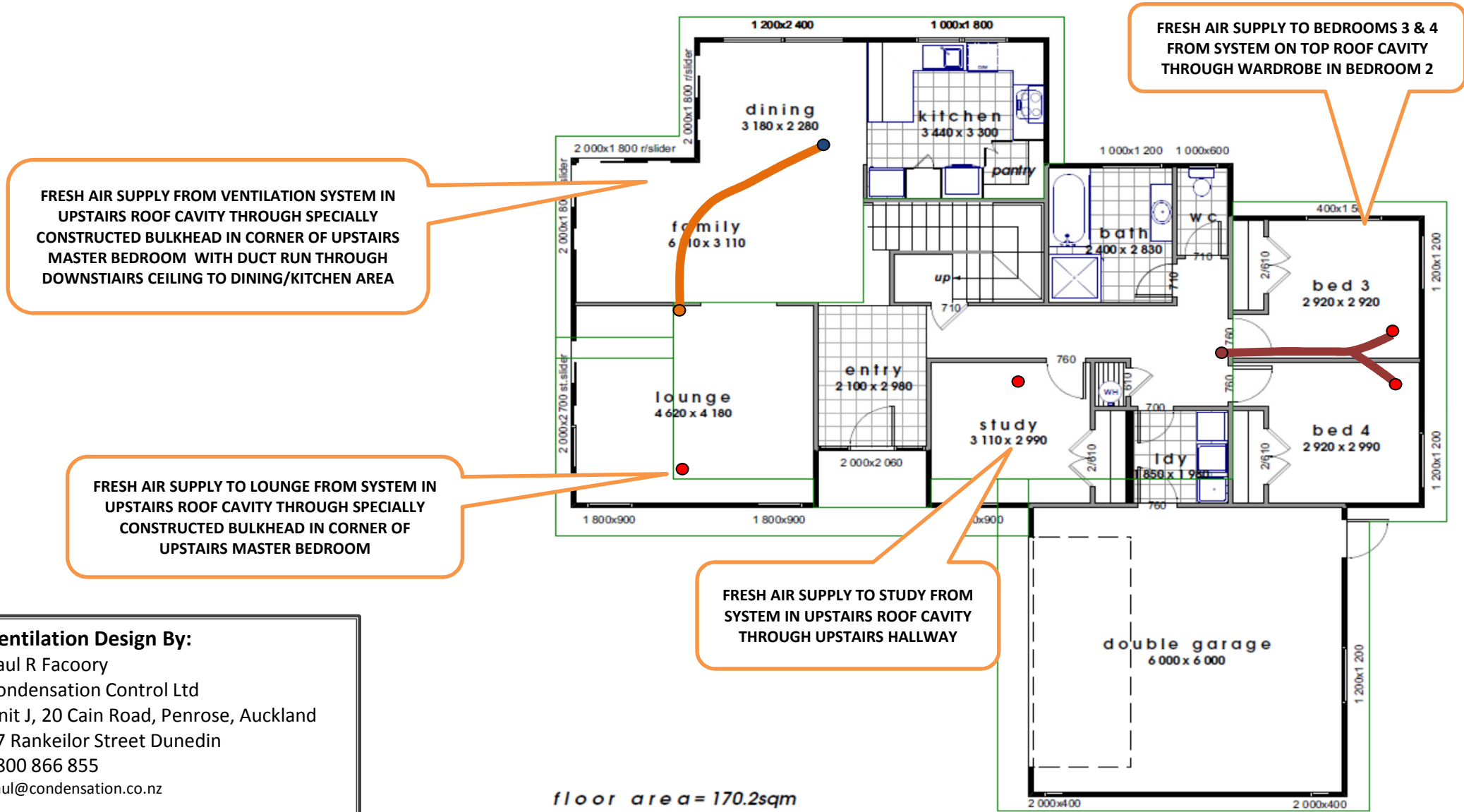
floor area = 54.4sqm

Ventilation Design By:
 Paul R Facoory
 Condensation Control Ltd
 Unit J, 20 Cain Road, Penrose, Auckland
 47 Rankeilor Street Dunedin
 0800 866 855
 paul@condensation.co.nz

LEGEND		Fan & Filter Cassette - Etaline 3 Speed		DL	Double Y Branch		Motorised Damper Unit		Fresh Outside Air In		
	Pure Air/Ozone		HX Heat Exchange Unit		Water to Air Exchange		Y BTO		Warm Fresh Air In		
	Exterior Intlet Grill		Fresh Air Supply Diffuser		Warm Air Exhaust Vent		Leg Branch		Warm Exhaust Air Out		

MOISTUREMASTER HX HEAT RECOVERY VENTILATION SYSTEM WITH SUMMER BYPASS

PROPOSED LAYOUT PLAN For House C - BH225 - Downstairs



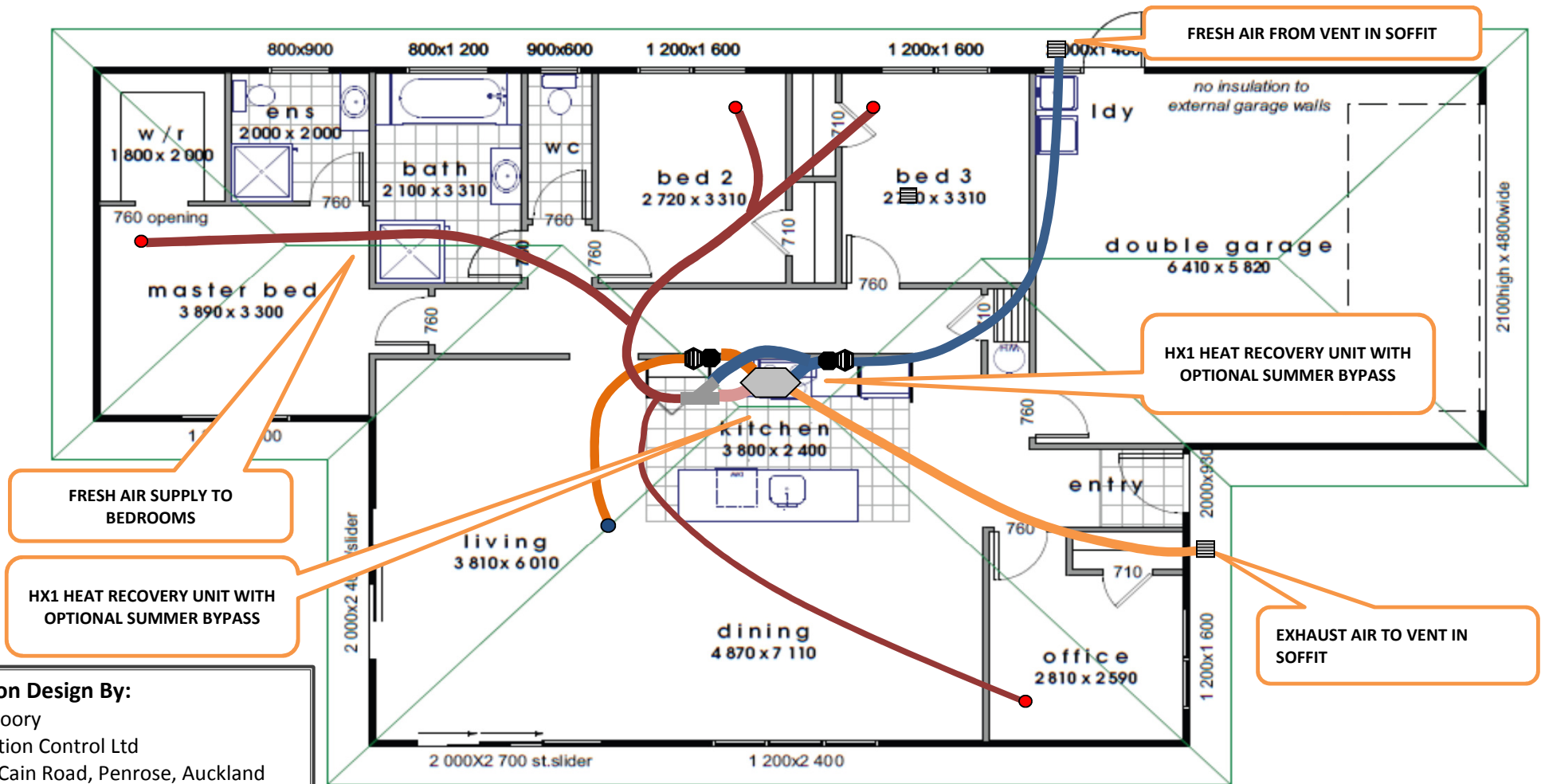
Ventilation Design By:

Paul R Facory
 Condensation Control Ltd
 Unit J, 20 Cain Road, Penrose, Auckland
 47 Rankeilor Street Dunedin
 0800 866 855
 paul@condensation.co.nz

LEGEND			Fan & Filter Cassette - Etaline 3 Speed		DL	Double Y Branch		Motorised Damper Unit		Fresh Outside Air In		Roof Supply	
	Pure Air/Ozone		HX Heat Exchange Unit		Water to Air Exchange		Y BTO		Warm Fresh Air In		Warm Exhaust Air Out		Roof Exhaust
	Exterior Inlet Grill		Fresh Air Supply Diffuser		Warm Air Exhaust Vent		Leg Branch						

MOISTUREMASTER HX HEAT RECOVERY VENTILATION SYSTEM WITH SUMMER BYPASS

PROPOSED LAYOUT PLAN For House B - VH175

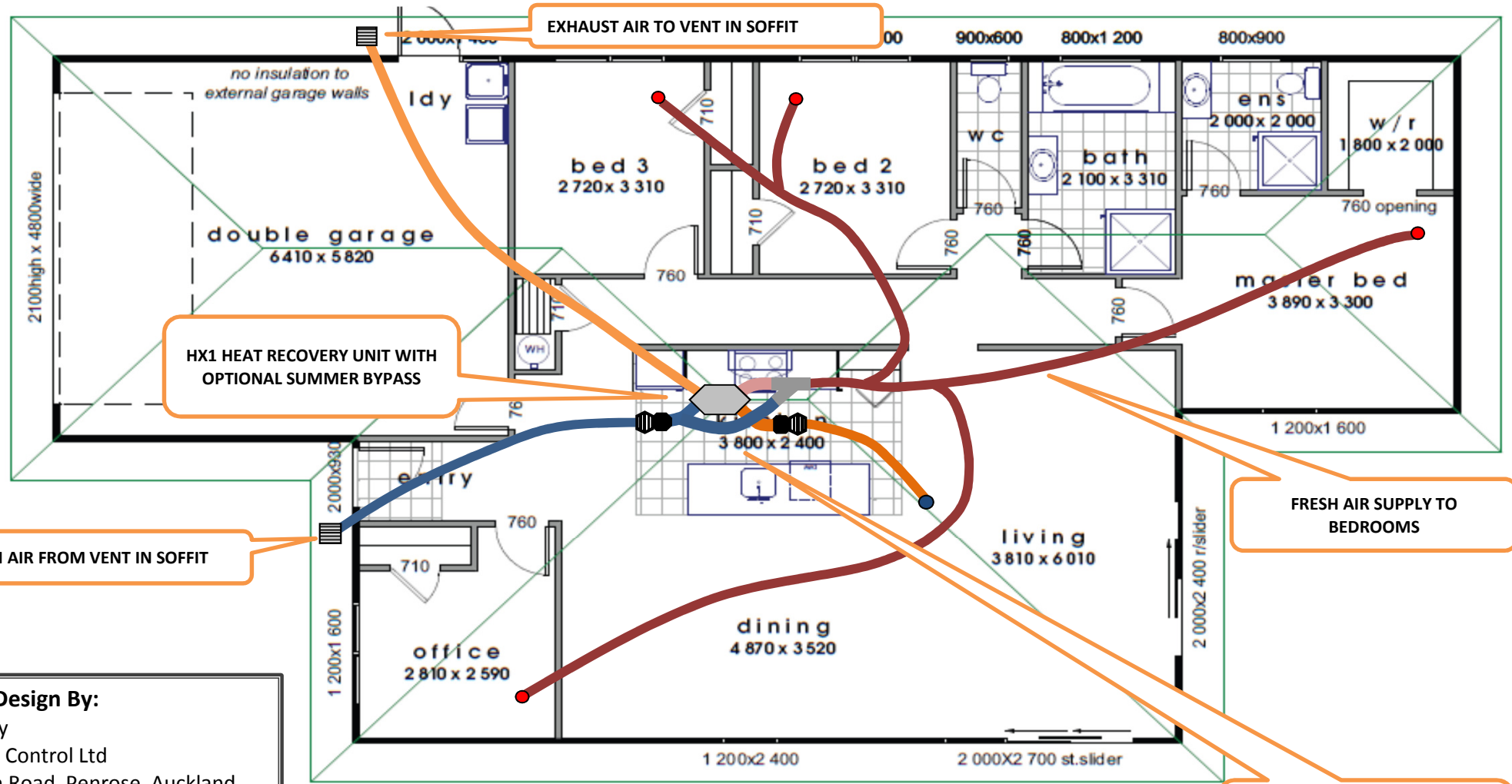


Ventilation Design By:
 Paul R Facory
 Condensation Control Ltd
 Unit J, 20 Cain Road, Penrose, Auckland
 47 Rankeilor Street Dunedin
 0800 866 855
 paul@condensation.co.nz

LEGEND		Fan & Filter Cassette - Etaline 3 Speed	DL Double Y Branch	Motorised Damper Unit	Fresh Outside Air In	Roof Supply	Roof Exhaust
Pure Air/Ozone	HX Heat Exchange Unit	Water to Air Exchange	Y Y BTO	Warm Fresh Air In			
Exterior Inlet Grill	Fesh Air Supply Diffuser	Warm Air Exhaust Vent	Leg Leg Branch	Warm Exhasut Air Out			

MOISTUREMASTER HX HEAT RECOVERY VENTILATION SYSTEM WITH SUMMER BYPASS

PROPOSED LAYOUT PLAN For House A - VH175



Ventilation Design By:

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 0800 866 855
 paul@condensation.co.nz

LEGEND			Fan & Filter Cassette - Etaline 3 Speed		DL	Double Y Branch		Motorised Damper Unit		Fresh Outside Air In		Roof Supply
	Pure Air/Ozone		HX Heat Exchange Unit		DL	Water to Air Exchange		Y BTO		Warm Fresh Air In		Roof Exhaust
	Exterior Inlet Grill		Fresh Air Supply Diffuser		DL	Warm Air Exhaust Vent		Leg Branch		Warm Exhaust Air Out		