Building improvements to raise house energy ratings from 5.0 stars

Overview of systematic AccuRate modelling for the Australian Building Codes Board

Data created by Tony Isaacs Consulting • Overview report by Constructive Concepts

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Executive Summary

To test the cost effectiveness of energy efficiency proposals based on a star rating target, it is first necessary to understand how building construction must change to reach the target. The ABCB office commissioned this study to catalogue construction changes that can improve ratings from 5 stars in half star steps and record their impact on annual heating and cooling loads. The results are a key input to the assessment of a proposed 6 star target. Additional analysis will be required to transform the load reductions into predicted savings in energy costs and greenhouse gas emissions.

The study covers 8 dwellings in 12 locations that span all State and Territory capitals and selected regional centres in the 8 BCA *climate zones*. The dwellings include single and double storey detached houses, a townhouse and an apartment. Their floor areas range from 90m² to 263m². Selection of climates has taken account of household numbers and load saving potential in candidate locations. Configuring dwellings for each half star step from 5 to 7 stars with variants for floor and wall types created 850 combinations of construction and climate. House energy ratings and changes in heating and cooling loads come from AccuRate v1.1.4.1, the latest commercial release of the software.

The building construction varied for better ratings include waffle slabs in place of slab on ground floors, insulation to subfloor walls, isolating of wall cavities from subfloor space and extra insulation to lower and upper floors, external and internal walls and to roofs and ceilings. Other adjustments affect glazing types, window sizes and opening areas, shading by eaves and external blinds, sealing of doors and windows and use of ceiling fans.

Tony Isaacs (of Tony Isaacs Consulting) prepared the dwelling configuration files, undertook the house energy ratings and compiled the record of results as a database with a user interface that allows side by side comparison of cases. Tony also provided indicative cost rates for the building improvements. Bruce Lightfoot (of Constructive Concepts) adapted the resource to ABCB's needs with summary information and prepared this commentary.

The cost rates in the database show the capital cost impacts of lifting ratings from 5 to 6 stars. In about 10% of cases, costs fall (by up to $2,600 with an average near $1,000). Such savings usually occur when window sizes are rationalised for better summer and winter performance. In the majority of cases, capital costs are increased by amounts ranging from $300 to $6,200. The average extra cost is around $2,300. Houses with timber floors provide the extremes of the range, producing the highest additional costs but also the largest saving. The costs effects do not have an obvious correlation with climate. Capital cost calculations are preliminary assessments to provide a common denominator for comparison of diverse construction changes. More elaborate calculations for a Regulation Impact Statement can be expected to show significant variations to these numbers.

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1.0 Aims

Proposals for energy efficiency provisions in the Building Code of Australia (BCA) must demonstrate their cost effectiveness within an agreed context. The Regulation Impact Statement (RIS) for the provisions introduced in BCA 2006 found them to be beneficial for a long term building owner. Their net cost during construction was calculated to be lower than the present value of the energy they could save. Proposals for BCA 2010 will be subject to similar examination of housing affordability but with more emphasis on benefits to the community. To assess benefits, it is first necessary to identify the cost of measures.

Estimating construction costs is relatively straightforward when energy efficiency is based on the prescriptive provisions of the BCA. The Acceptable Construction Practice of Volume Two describes literal forms of construction which can be measured and priced. When star rating determines compliance, the construction can be any workable combination of elements in the extensive materials libraries of house energy rating software. Many solutions are possible and defining an optimal arrangement calls for judgement and experimentation.

The ABCB office commissioned this study to catalogue the construction changes needed to improve house energy ratings from 5 stars in half star steps and record their impact on annual heating and cooling loads. The database of results will be a key input to assessing the impact of a 6 star target. Additional analysis will be needed to transform load reductions into probable energy cost savings and reductions in greenhouse gas emissions.

2.0 Method

The study examines 8 dwellings in 12 locations. The dwellings include single and double storey detached houses, a townhouse and an apartment. The locations span all State and Territory capitals and regional centres in the 8 BCA *climate zones*. (3.0 and 4.0 below discuss the basis of dwelling and climate selections.)

To provide context for the 6 star target, the dwellings are configured to achieve each of the half star rating steps from 5 to 7 stars. Most dwellings have separate configurations for timber and concrete slab on ground floors in all climates. Limited local variants have been created for concrete block and cavity brick external walls. The study consequently covers 850 combinations of construction and climate.

House energy ratings and changes to annual heating and cooling needs come from AccuRate v1.1.4.1. This is the latest commercial release of the software developed by CSIRO as the benchmark for second generation house energy rating tools. The Nationwide House Energy Rating Scheme (NatHERS) admits ratings from other software which has been formally accredited as producing similar results for defined buildings in specified locations. The two alternative packages with provisional accreditation are BERS Pro and FirstRate5. Both incorporate the AccuRate calculation engine and differ from the AccuRate package mainly in their user interfaces. The stringency of the software accreditation protocol should limit the scope for alternative software to affect substantially the findings of this study.

The study builds on a concept developed by Tony Isaacs (of Tony Isaacs Consulting) for the Department of Environment, Water, Heritage and the Arts (DEWHA). His prototype Energy Efficiency Ratings Calculator allowed side by side comparison of a dwelling's construction and thermal performance at any two rating levels between zero and 10 stars. The dwelling could be selected from a menu of 8 types but comparisons were available only for the Canberra climate.

Tony Isaacs has extended that work to the 12 climates chosen for this study with ratings in the range of 5 to 7 stars. Tony has prepared all of the necessary configuration files, undertaken the house energy ratings, recorded the construction details, assembled the results into the calculator interface (as an Excel file) and provided indicative cost rates for the improvements. The calculator and its underlying database are the principal resources developed by this investigation. Bruce Lightfoot (of Constructive Concepts) has adapted these resources to the ABCB's needs, compiled summaries of findings and prepared this commentary on the study.

3.0 Selection and configuration of dwellings

Since configuring dwellings for energy rating is labour intensive, the sample needs to be small but diverse enough to reflect the range of housing found in Australia. Such a representative set had already been developed for accrediting software alternatives to AccuRate. 8 examples had been selected from a short list of about 200 actual building designs submitted for building approval. These dwellings are illustrated below by Tony Isaacs. (Areas in the captions are total internal floor areas.)

House 01
single storey 165m²

House 04
single storey 232m²

House 08
double storey 263m²

House 09
double storey townhouse 90m²

House 10
double storey apartment 118m²

House 11
single storey 215m²

House 12
double storey 164m²

House 13
single storey 261m²

The irregular numbering of the houses reflects their order in the short list of candidates for accreditation use. This set has the advantages of having been well considered and further refined through use in software testing. The buildings include types found in urban, suburban, rural and coastal settings. They are documented in dimensioned CAD drawings with detailed specifications available in AccuRate project files. (The drawings are attached as Appendix A.)

Table 3.1 below summarises the floor, wall and roof constructions of the accreditation dwellings as they were actually built (or proposed for building approval). The table is divided between floor, wall and roof constructions.

Table 3.1: Default characteristics of accreditation dwellings

	dwelling	H01	H04	H08	H09	H10	H11	H12	H13
	type	detached	detached	detached	townhouse	apartment	detached	detached	detached
	storeys	single	single	double	double	double	single	double	single
element	area	165 m²	232 m²	263 m²	90 m²	118 m²	215 m²	164 m²	261 m²
slab on ground		✓	✓	✓	*ground*	•	*entry*	*ground*	•
timber floor - open		•	•	•	•	•	•	*upper*	✓
timber floor - enclosed		•	•	•	*upper*	•	✓	•	•
suspended concrete slab		•	•	✓	•	*both*	•	•	•
sheeted walls		✓	•	•	*gables*	•	✓	✓	•
weatherboard		•	•	*upper*	*upper*	*partial*	•	•	✓
brick veneer		•	•	•	*lower*	•	•	•	•
cavity brick		•	✓	✓	•	•	•	•	•
concrete block		•	•	•	•	•	•	•	•
AAC block		•	•	•	•	✓	•	•	•
steel roof		✓	•	•	✓	•	✓	✓	✓
tiled roof		•	✓	✓	•	•	•	•	•
insulated membrane		•	•	•	•	✓	•	•	•

Viewed as candidates for this study, the group noticeably lack examples of some common types of construction such as timber floors over enclosed bases or walls in concrete block. Brick veneer is confined to the ground floor of the townhouse (House 09). To address these omissions, the study uses the adjusted and expanded set of construction types listed in Table 3.2 below. Coloured cells in the table highlight changes to the default characteristics. The mention of particular locations means that the change applies only in those locations. The full range of climate locations selected for house energy modelling is discussed in 4.0 below.

Table 3.2: Construction types used for modelling

	dwelling	H01	H04	H08	H09	H10	H11	H12	H13
	type	detached	detached	detached	townhouse	apartment	detached	detached	detached
	storeys	single	single	double	double	double	single	double	single
element	area	165 m²	232 m²	263 m²	90 m²	118 m²	215 m²	164 m²	261 m²
slab on ground		✓	✓	✓	*ground*	•	✓	*ground*	✓
timber floor - open		•	•	•	•	•	•	*upper*	✓
timber floor - enclosed		✓	✓	*both*	*both*	•	✓	•	•
suspended concrete slab		•	•	•	•	*both*	•	•	•
sheeted walls		•	•	•	*gables*	•	•	•	•
weatherboard		•	•	*upper*	*upper*	•	•	*both*	✓
brick veneer		✓	✓	✓	*lower*	•	•	•	•
cavity brick		*Perth*	*Perth*	*Perth*	*Perth*	•	•	•	•
concrete block		*Darwin*	•	•	•	•	•	*ground*	•
precast concrete (~~AAC~~)		•	•	•	•	✓	•	•	•
steel roof		✓	*L'reach*	*D/B/L**	✓	•	✓	✓	✓
tiled roof		•	✓	✓	•	•	•	•	•
insulated membrane		•	•	•	•	✓	•	•	•

* *"D/B/L" refers to limited cases in Darwin, Brisbane and Longreach.*

Table 3.2 shows that most houses have modelling files for both slab and timber ground floors. The exceptions are House 10 (apartment) and House 12 (elevated beach house) where the alternatives are unlikely in practice. Cavity brick external walls replace brick veneer in Perth to reflect local practice. Internal walls in these cases are solid brick with plasterboard linings in place of the usual stud framed walls. House 01 in Darwin has alternatives for external walls in concrete block or weatherboard on stud frames. Brick veneer is used for House 01 in all locations other than Perth or Darwin. Roofs generally retain their default type but some tiled roofs have been changed to steel in Darwin, Brisbane and Longreach.

Table 3.3 below summarises the building elements varied and the range of changes made in pursuit of improved ratings. More details can be found in Appendices B and C which show fabric and glazing changes house by house and climate by climate.

Table 3.3: Range of construction variations modelled

element	treatment	range
slabs on ground	waffle slab in place of solid slab	yes/no
	tiles in place of carpet	varies
enclosed subfloors	subfloor wall insulation	nil - R2.5
	flashing to seal wall cavity from subfloor	yes/no
	insulation under floor	nil - R3.0
open subfloors	insulation under floor	nil - R4.0
floors over lower storeys	insulation under floor	nil or R2.5
external walls	wall insulation	nil - R2.5
internal walls	wall insulation	nil - R2.5
roof / ceiling	light roof colour	yes/no
	reflective foil under roof	yes/no
	roof / ceiling insulation	R1.0 - R4.5
	roof ventilation	low/med/high
glazing	improved glazing types	18 glazing types
	window area reductions	up to 30%
shading	eaves width	+ 750mm to - 3.7m
	adjustable external blinds	0 - 60% of window area
seals	window seals	sealed/unsealed
	door seals	sealed/unsealed
	exhaust fan seals	sealed/unsealed
ventilation	window opening area	0 - 90%
ceiling fans	1200 & 1400 diameter fans	nil - all habitable rooms

House energy ratings for the dwellings are assessed at their default orientations (as drawn in Appendix A and summarised in Table 3.4 below). These are the real world orientations used for design and building approval documentation. They refer to the wall facing the top of plan drawings. The walls contain significant proportions of the glazed areas in the dwelling and their orientations vary widely. As a result, a reasonable proportion of the selected dwellings present challenges for energy efficient design that reflect the diversity in the broader housing stock.

Table 3.4: Default orientations used for house energy ratings

orientation	H01	H04	H08	H09	H10	H11	H12	H13
nominal	ENE	North	ESE	NW	South	SE	South	North
offset from North	65°	8°	112°	325°	180°	135°	180°	0°

4.0 Selection of climates

AccuRate v1.1.4.1 lists 69 distinct Australian climates (called "climate zones" in the software interface but "climates" here to avoid confusion with the eight BCA *climate zones*.) The DEWHA procedure for accrediting alternative rating software requires testing in ten of these climates, "representing cool temperate, temperate, warm temperate, hot humid, tropical and hot arid zones and consideration of inland and coastal climates". The ten are listed below in the order of their BCA *climate zones*.

Table 4.1: Accreditation climates

NatHERS climate	State	BCA *climate zone*
33 Broome	WA	1
5 Townsville	QLD	1
10 Brisbane	QLD	2
19 Charleville	QLD	3
27 Mildura	VIC	4
17 Sydney	NSW	5
16 Adelaide	SA	5
13 Perth	WA	5
21 Melbourne	VIC	6
24 Canberra	ACT	7

The accreditation climates cover the more populous capital cities and selected regional centres but do not include locations in the Northern Territory, Tasmania or the BCA *alpine area* in *climate zone* 8. To provide wider national coverage, the ABCB modelling uses 12 climates. All capital cities are included by adding Hobart and substituting Darwin for Broome. Mascot and Moorabbin replace Sydney and Melbourne respectively on the basis of household numbers (which are discussed below). Longreach is considered more representative of BCA *climate zone* 3 than is Charleville. Cabramurra is included for BCA *climate zone* 8.

Table 4.2: Climates used in this study

NatHERS climate	State	BCA *climate zone*
1 **Darwin**	NT	**1**
5 **Townsville**	QLD	
10 **Brisbane**	QLD	**2**
3 **Longreach**	QLD	**3**
27 **Mildura**	VIC	**4**
56 **Mascot** (for Sydney)	NSW	**5**
16 **Adelaide**	SA	
13 **Perth**	WA	
62 **Moorabbin** (for Melbourne)	VIC	**6**
26 **Hobart**	TAS	**7**
24 **Canberra**	ACT	
25 **Alpine** (Cabramurra)	NSW	**8**

Household numbers in the selected climates

In 2008, DEWHA released a baseline study of estimated energy use in Australian households between 1986 and 2020. The study, prepared by Energy Efficient Strategies (EES), is available for download at *http://www.environment.gov.au/settlements/energyefficiency/buildings/publications/energyuse.html.*

Section 7.7.2 of the baseline study provides an analysis of current household numbers in each of the 69 NatHERS climates. Since AccuRate relies on postcodes to select the applicable climate, EES compared the AccuRate postcode listing with Australia Post statistics on private and business postal addresses. The report notes that Australia Post identified some 7.5 million private postal addresses in 2006. The Australian Bureau of Statistics (ABS) estimated approximately 8 million Australian households for the same year. This means that the postcode data cover about 93% of 2006 household numbers. The coverage is barely diminished by the omission of 0.8% of postcodes from the AccuRate climate allocation file.

EES points out that some postcode boundaries span up to three AccuRate climate regions. Although 88% of postcodes fall within a single climate region, 11% of postcodes span two regions and 1% span three. In these cases, EES divided household numbers evenly between the several regions, noting that the impact on overall heating and cooling load estimates is likely to be small.

The EES figures for household numbers indicate that the 12 selected climates account for just over half of all households in Australia. Table 4.3 below shows the relative significance of the selected locations nationally and within their respective States or Territories and BCA *climate zones*. Details for the Sydney East and Melbourne climates, which might be considered as alternative selections, are included (in grey italics) only for comparison with Mascot and Moorabbin. Their household numbers are not counted in the national totals below the table.

Table 4.3: Household numbers in selected climates

BCA zone	NatHERS climate	State	households	national %	State %	BCA zone %
1	1 **Darwin**	NT	48,016	0.6%	75%	21%
	5 **Townsville**	QLD	75,588	1.0%	5%	33%
2	10 **Brisbane**	QLD	798,533	10.8%	52%	63%
3	3 **Longreach**	QLD	15,730	0.2%	1%	19%
4	27 **Mildura**	VIC	111,731	1.5%	3%	33%
5	13 **Perth**	WA	423,911	5.7%	58%	16%
	16 **Adelaide**	SA	473,356	6.4%	81%	18%
	17 Sydney East	*NSW*	*237,373*	*3.2%*	*9%*	*9%*
	56 **Mascot** *(used for Sydney)*	NSW	862,814	11.6%	33%	33%
6	*21 Melbourne*	*VIC*	*161,549*	*2.2%*	*9%*	*7%*
	62 **Moorabbin** *(used for Melbourne)*	VIC	715,575	9.7%	42%	33%
7	24 **Canberra**	ACT	202,850	2.7%	100%	31%
	26 **Hobart**	TAS	80,941	1.1%	44%	12%
8	25 **Alpine** (Cabramurra)	NSW	33,551	0.5%	1%	60%
		national totals	***3,842,596***	***52%***		

The table identifies the east coast mainland capitals of Brisbane, Sydney (via Mascot) and Melbourne (via Moorabbin) as the major contributors to the national total. Perth and Adelaide each contain about half as many dwellings. Darwin, Canberra and Hobart have limited impact on national figures but are important within their own jurisdictions. The significance of the regional centres does not emerge until they viewed in relation to their BCA *climate zones*. Each of these contexts is illustrated in Figures 4.1-4.3 below.

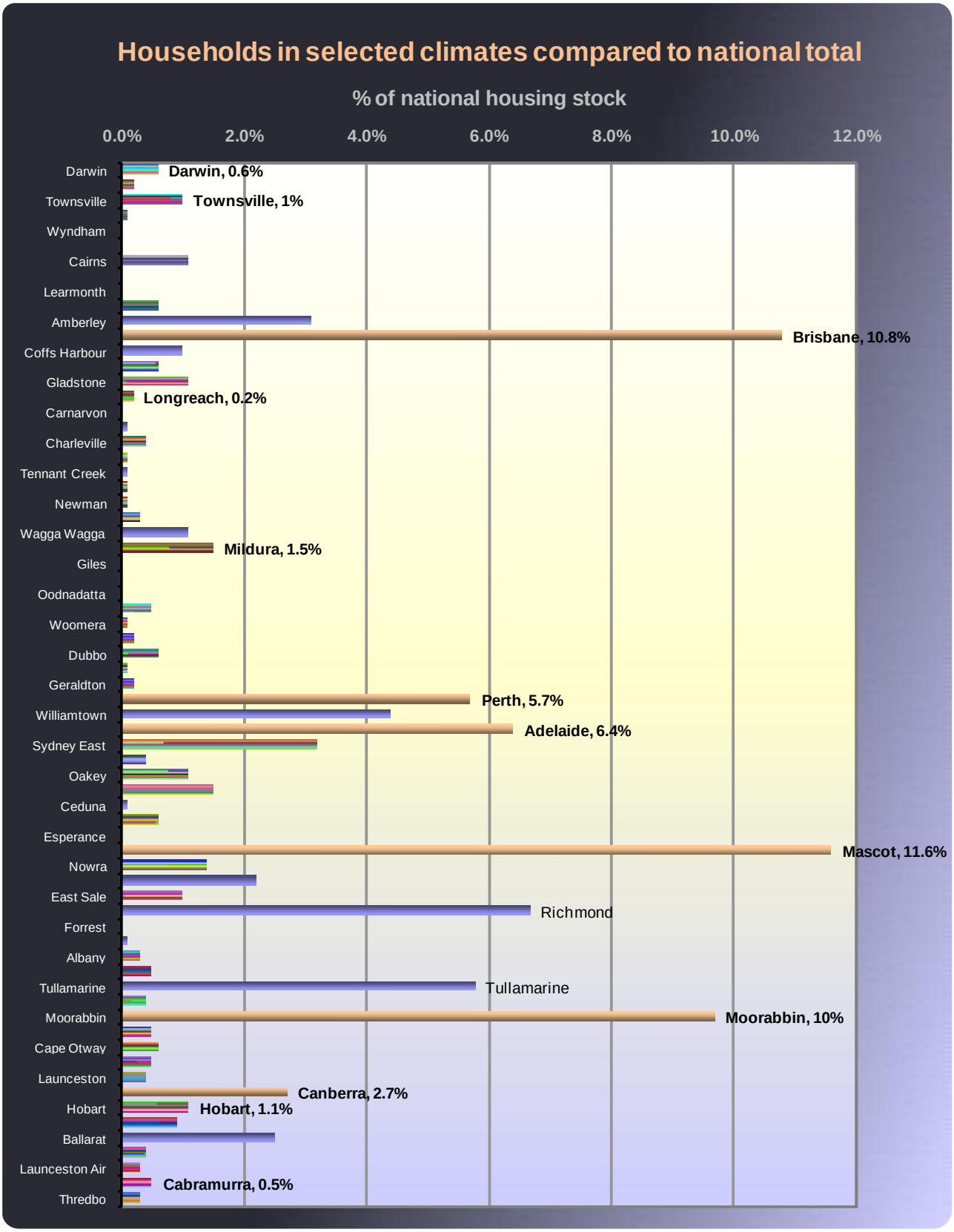


Figure 4.1: Percentage of national households present in selected NatHERS climates
Selected climates are shown in tan bars

The longer bars in Figure 4.1 highlight the concentration of households in 5 of the 12 climates selected for modelling. Brisbane, Perth, Adelaide, Mascot and Moorabbin contain more than 40% of the national housing stock. Richmond (Western Sydney) and Tullamarine (Melbourne) are the only comparably large centres not in the selection.

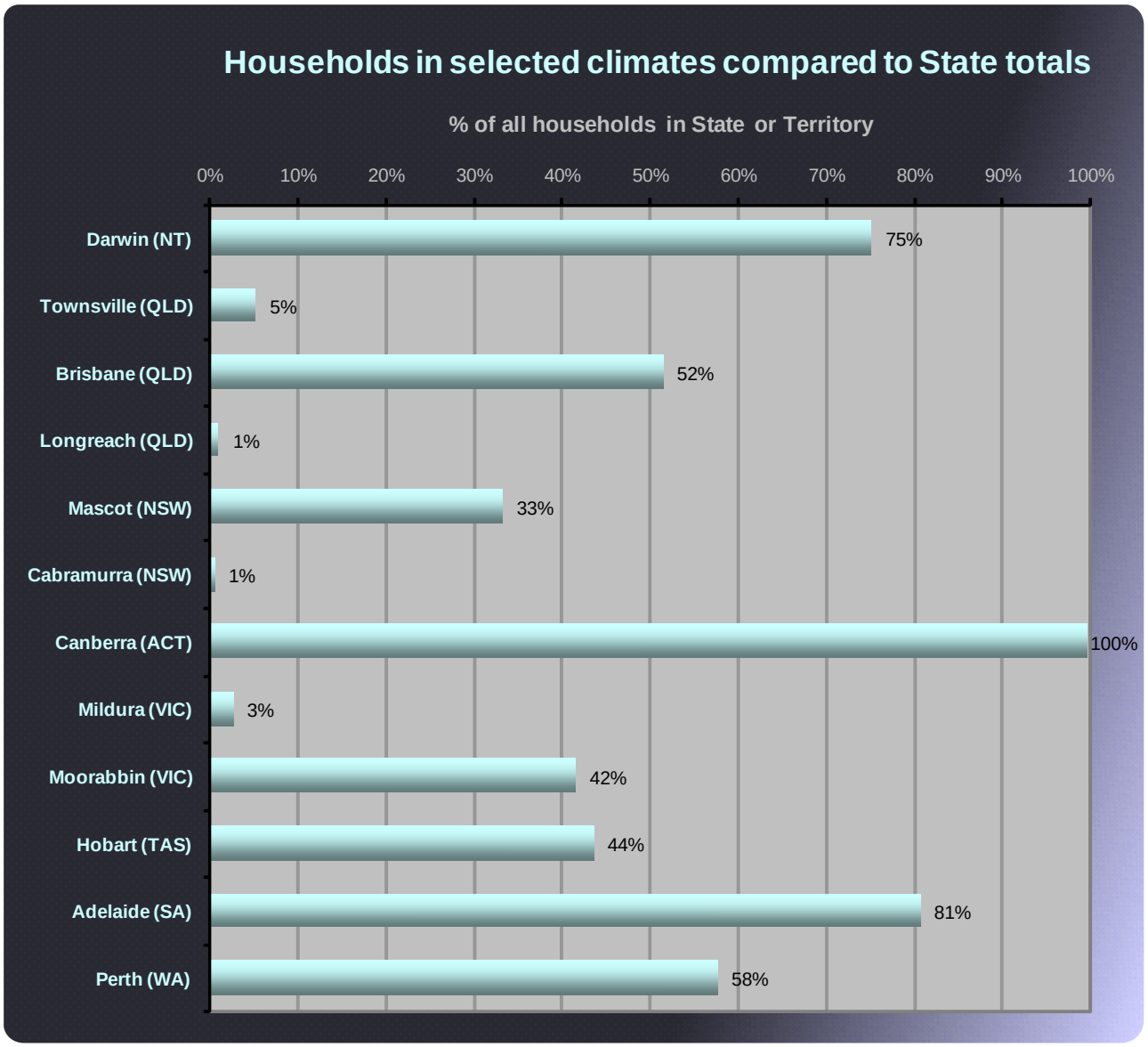


Figure 4.2: Percentage of State or Territory households present in selected NatHERS climates
Climates are listed in State order, working clockwise from the Northern Territory.

Figure 4.2 shows Darwin, Canberra and Hobart to have significant household concentrations within their own State or Territory contexts. Sydney (Mascot) and Melbourne (Moorabbin) appear less significant here than they do nationally because their larger metropolitan areas are divided between several NatHERS climates.

The smaller regional locations (Townsville, Longreach, Cabramurra and Mildura) are dominated by their capital cities. They are included to represent BCA *climate zones* not found in the capital cities (other than Darwin). When considered in comparison to their individual *climate zones*, their contribution to household numbers takes on another dimension. Tan bars in Figure 4.3 (below) show that Townsville, Mildura and Cabramurra account for 33-60% of the comparatively small numbers of dwellings in *climate zones* 1, 4 and 8 respectively. Only Brisbane, *in climate zone 2*, contains a greater share (63%) of total numbers. Longreach contains 19% of households in *climate zone* 3, the greatest share for any location other than Charleville. At 35%, Charleville's contribution is almost twice as large but its balance of heating and cooling needs is less characteristic of *climate zone* 3.

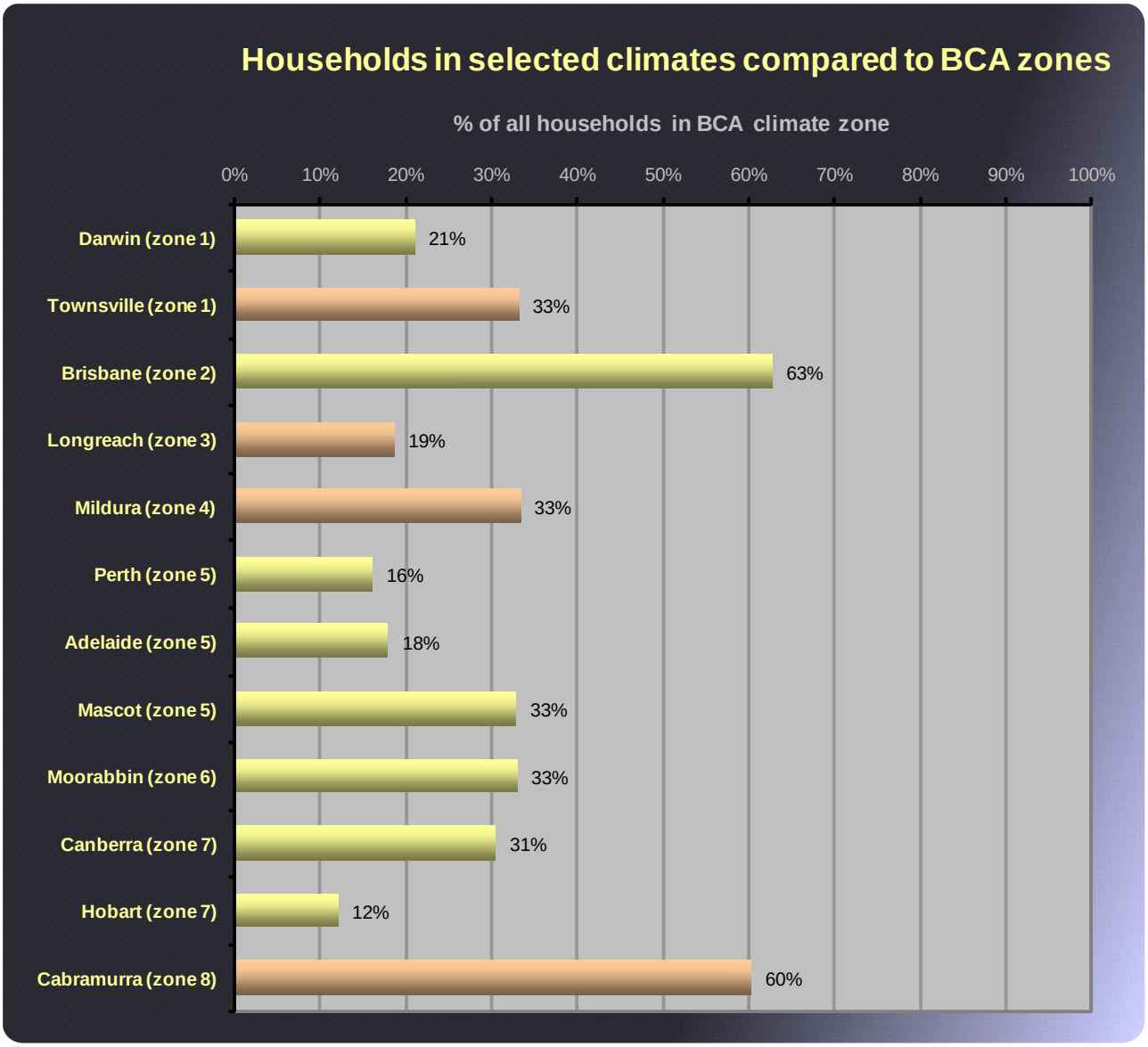


Figure 4.3: Percentage of BCA climate zone households present in selected NatHERS climates
Climates are listed in BCA climate zone order. Regional centres are distinguished by tan bars.

5.0 Potential benefits in each BCA *climate zone*

Although the 8 BCA *climate zones* do not form part of the NatHERS framework, they have been used in the past to vary star rating targets in different *zones*. BCA 2009 Volume One, for example, calls for multi unit apartments to achieve an average rating of 3.5 stars in *climate zones* 1-3 and 4 stars in *climate zones* 4-8. The BCA *climate zones* also provide a convenient means of categorising the spectrum of NatHERS climates and examining their differences. This section considers the potential benefits of improved ratings in the 12 selected climates and compares them with other climates in the same BCA *climate zone*.

House energy rating software simulates the thermal behaviour of a candidate building when it is occupied by a "standard family" and calculates heating and cooling needs for a typical year. Although AccuRate labels these results as "energy requirements", they do not directly measure energy consumption. Instead, they are annual "heat loads" or the total amount of heat energy which must be added to occupied spaces or removed from them to keep the "standard family" comfortable. Additional judgements and analysis are needed to convert reductions in heat loads into possible energy savings. 6.0 below outlines some of the considerations involved. Discussion here covers the heat load reductions that can be expected from better star ratings and how they vary for different NatHERS climates in the same BCA *climate zone*.

NatHERS gives each climate a unique star rating scale which recognises the degree of difficulty in staying comfortable in the climate and sets limits for the annual heat load at each star level. Figure 5.1 below charts the limits for all 69 climates. Striking features of these "star bands" are their variability at low star ratings and increasing convergence at higher ratings. The outer bands (at 0.5 stars) are highlighted in blue and red with their load limits labelled at each half star step.

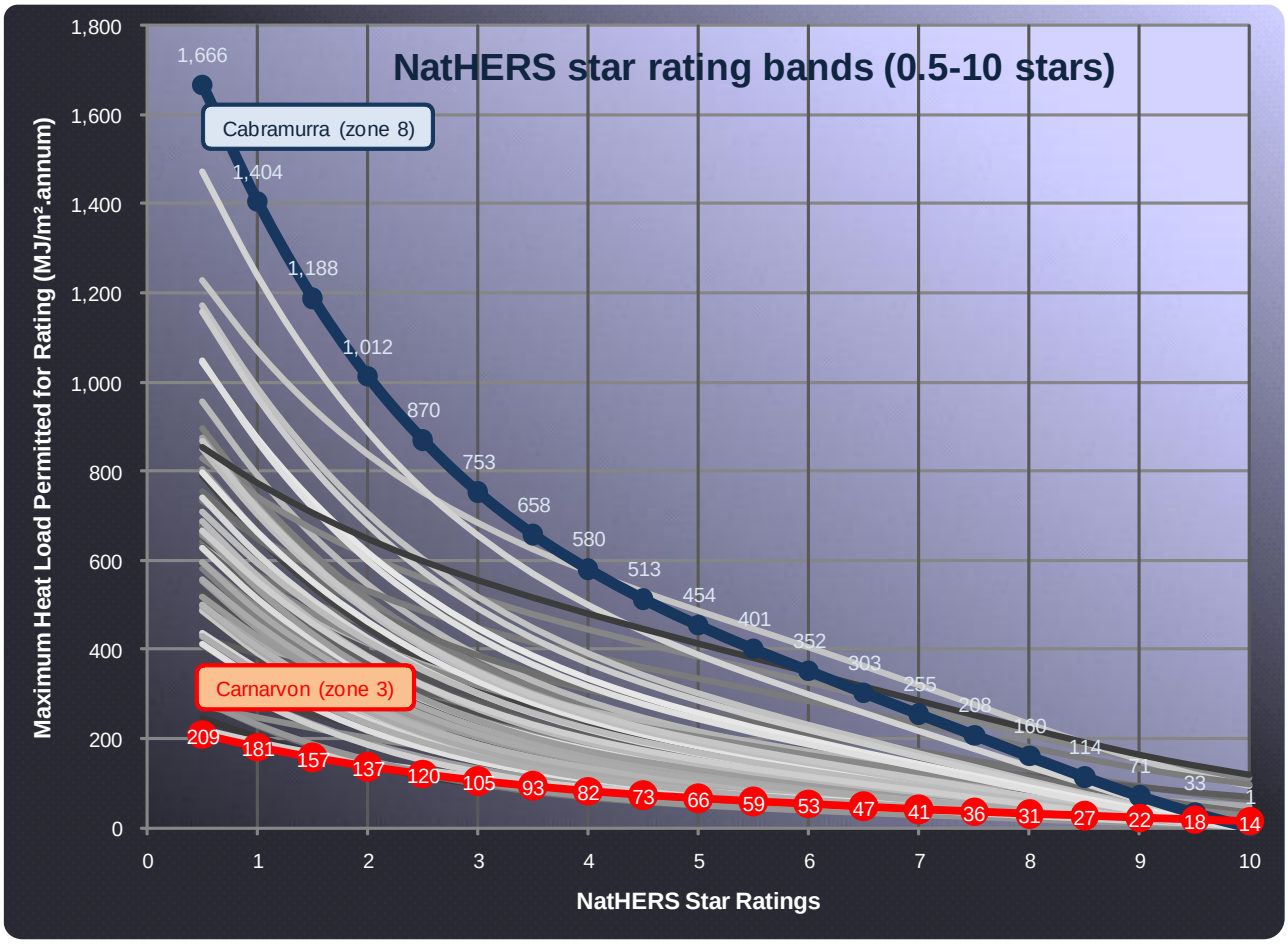


Figure 5.1: NatHERS star bands (heat load limits) for all 69 climates
Upper and lower bands (at 0.5 stars) are labelled to indicate the BCA climate zones involved

The portion of the star bands of interest to this study lies between 5 and 7 stars. The spread of load limits at the 5 star level is down to 30% of the range at the 0.5 star ratings level. At 7 stars, it is only 20% of the initial difference. Even so, improving a 5 star rating in Cabramurra to 6 stars delivers a much greater absolute load reduction than the same improvement in Carnarvon. When load reductions are eventually translated to energy cost savings for a cost/benefit analysis, they are likely to support greater expenditure on building improvements in Cabramurra than in Carnarvon.

Figure 5.2 below compares the potential load reductions from similar ratings improvements in the 12 selected climates. The vertical bars show the magnitude of the load reductions and their upper and lower ends indicate the load limits for 5 and 6 stars in the climate.

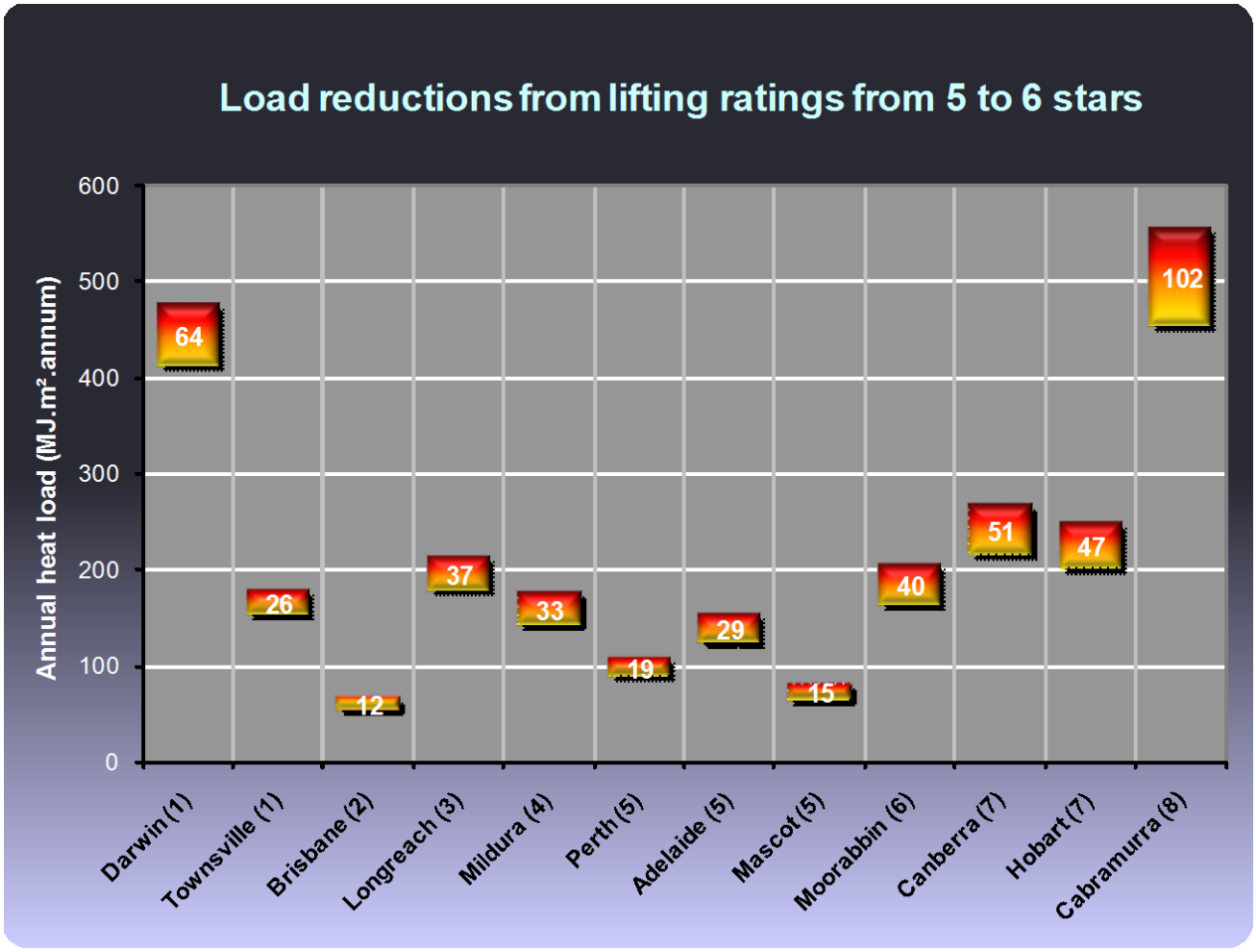


Figure 5.2: Annual heat load reductions in the 12 selected climates
Reductions are based on improving ratings from 5 to 6 stars. Climates are in order of BCA climate zones.

The greatest reductions are available in the hottest and coldest climates (Darwin and Thredbo) where the permitted loads are also highest. The reduction for the alpine climate is about 60% higher than for the tropical (in terms of megaJoules/m² of load saving).

Middle ranking reductions tend also to occur at intermediate load limits (in Longreach, Mildura, Moorabbin, Canberra and Hobart). Townsville limits fall within this group but its load reduction is smaller than any of them. Adelaide has lower load limits than the intermediate group but a greater load reduction than Townsville. Adelaide's companions in *climate zone* 5 (Perth and Mascot) have distinctly lower limits and load reductions.

Most notable are the limited load reductions available in Brisbane, Perth and Mascot. These values may constrain the scope for cost effective energy efficiency improvements in these climates.

Comparing the selected climates with others in the same BCA *climate zone* shows that potential load reductions vary significantly. Charts and tables on the following 8 pages summarise the various reductions needed in *climate zones* 1 - 8 to improve ratings from 5 to 6 stars. A "household weighted average" below each table apportions load savings according to the number of households present in each climate. Subject to achieving national and regional coverage, climate selection has aimed for locations with reductions near or below this average. Reductions projected from such locations will tend to be either "typical" or conservative.

The load reductions in the charts and tables apply only to dwellings of about 200m² because NatHERS adjusts the loads calculated for dwellings that are smaller or larger. A large house has proportionally less surface area than a small house of the same shape, reducing the opportunity for unwanted heat flows through floors, walls and roofs. Other things being equal, the large house will have a lower heat load per square metre and a higher NatHERS star rating. Recognising that larger houses will tend to use more energy in total, the area corrections allow smaller dwellings to have higher heat load rates than larger houses to achieve the same star rating.

AccuRate first calculates the actual heat load figures and then adjusts them before determining the star rating. The adjustments vary by climate and the net conditioned floor area (NCFA) of the dwelling. Table 5.1 below summarises the average level of adjustments for the selected dwellings in the selected climates. The NCFA figures in two rows at the top of the table show the range for the various configurations of each dwelling. Differing values in the lower row apply in only a handful of cases. Negative percentages (in red) show that AccuRate reduces calculated heat loads by these amounts before assigning star ratings.

Table 5.1: AccuRate area adjustments to actual heat loads before star rating

BCA zone	climate	H01	H04	H08	H09	H10	H11	H12	H13
		149 m²	207 m²	214 m²	82 m²	111 m²	200 m²	129 m²	220 m²
		145 m²	207 m²	221 m²	82 m²	111 m²	196 m²	129 m²	192 m²
1	Darwin	-3.5%	2.5%	3.0%	-14.4%	-5.1%	1.7%	-6.3%	2.7%
	Townsville	-4.1%	2.2%	3.0%	-15.9%	-5.7%	1.5%	-7.1%	3.1%
2	Brisbane	-7.4%	2.8%	4.3%	-22.0%	-8.7%	1.5%	-11.5%	4.5%
3	Longreach	-4.8%	2.8%	3.5%	-16.6%	-6.3%	1.9%	-8.0%	4.2%
4	Mildura	-7.5%	2.5%	3.5%	-20.3%	-8.2%	1.3%	-11.3%	4.3%
5	Perth	-7.5%	2.6%	3.6%	-20.2%	-8.3%	1.4%	-11.3%	4.4%
	Adelaide	-7.7%	2.7%	3.7%	-20.4%	-8.4%	1.4%	-11.5%	4.6%
	Sydney (Mascot)	-8.0%	2.8%	3.9%	-21.4%	-8.9%	1.5%	-12.1%	4.8%
6	Melbourne (Moorabbin)	-8.4%	2.1%	3.2%	-20.6%	-8.7%	0.8%	-12.2%	4.1%
7	Canberra	-7.6%	2.3%	3.2%	-19.6%	-8.1%	1.1%	-11.3%	4.1%
	Hobart	-8.1%	2.1%	3.1%	-20.0%	-8.5%	0.9%	-11.8%	4.0%
8	Alpine (Cabramurra)	-6.8%	2.0%	2.9%	-18.2%	-7.5%	1.0%	-10.2%	3.6%

Although House 11 has net conditioned floor area at the "neutral" 200m² level, it is still subject to minor adjustments. Tony Isaacs devised the original area adjustment equations and has confirmed that this result is consistent with expectations.

These adjustments mean that a 5-6 star rating improvement in Houses 01, 09, 10 and 12 will reduce heat loads by more than the values tabled below. The benefits range between 3% and 22%. Conversely, Houses 04, 08, 11 and 13 will deliver reductions that are smaller by between 1% and 5%. Other factors affecting load savings reported in the database are discussed in 6.0 below.

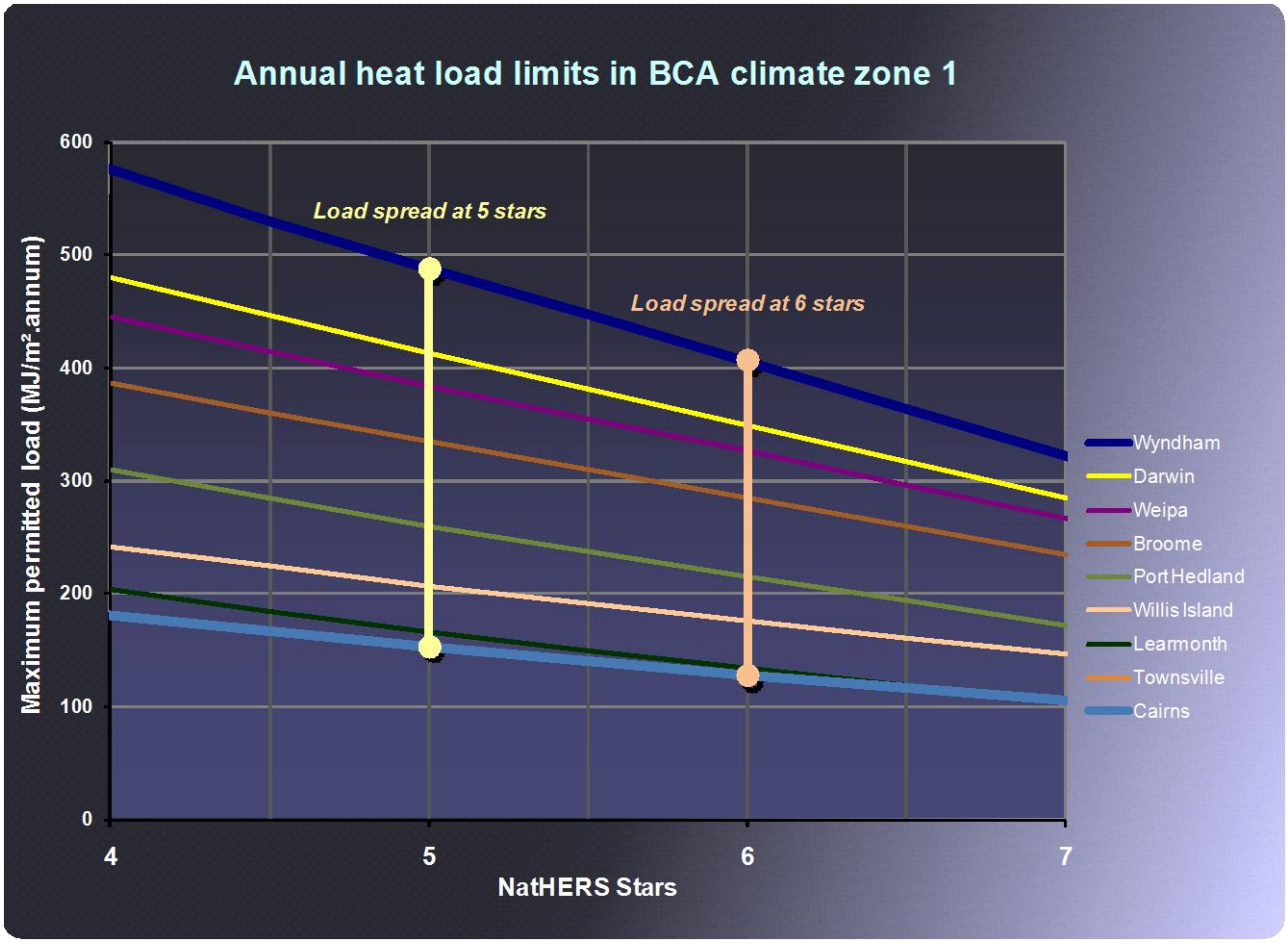


Figure 5.3: Load limits and potential reductions for NatHERS climates in BCA climate zone 1
(The Townsville star band on the chart is obscured by the very similar Cairns band.)
The difference between the highest and lowest 6 star load limits is 278 MJ/m².annum. The lowest limit is 32% of the highest.
Climates are listed below in the same order as on the chart. The two selected climates are in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
30 Wyndham	488	406	82	*1,891*
1 **Darwin**	413	349	**64**	*48,016*
29 Weipa	384	326	58	*4,656*
33 Broome	335	285	50	*1,863*
2 Port Hedland	260	215	45	*12,912*
31 Willis Island	207	176	31	*3,225*
34 Learmonth	166	134	32	*665*
5 **Townsville**	153	127	**26**	*75,588*
32 Cairns	153	128	25	*78,516*
	household weighted average …		*36*	*MJ/m².a*

Zone 1 observations

- The 9 NatHERS climates in *climate zone* 1 have a broader spread of 6 star load limits (in absolute terms) than in any other BCA *climate zone*.
- The two selected climates (Darwin and Townsville) encompass most of that range and have large shares of total household numbers.
- Cairns, the other populous centre in *climate zone* 1, has load limits nearly identical to Townsville.

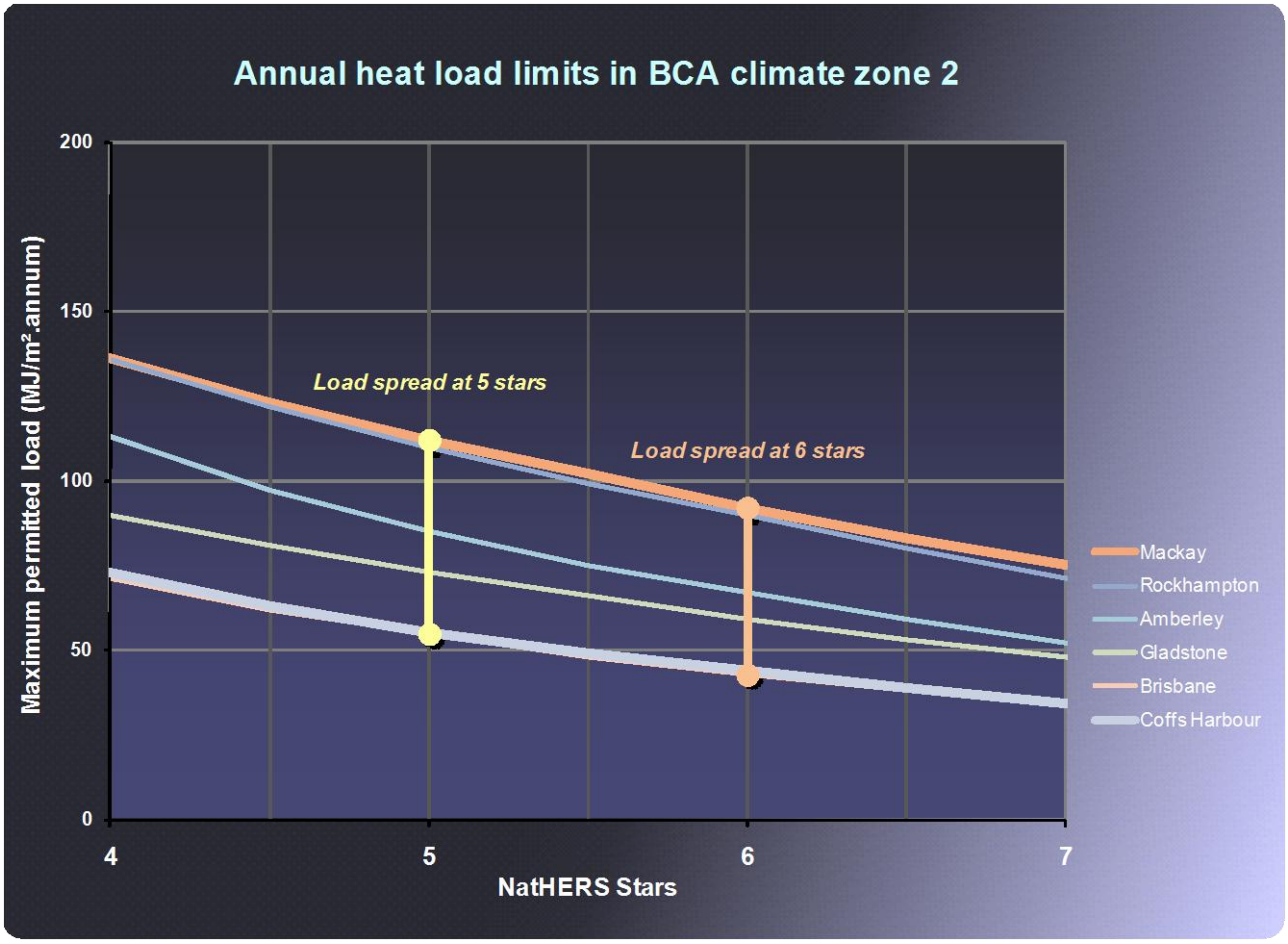


Figure 5.4: Load limits and potential reductions for NatHERS climates in BCA climate zone 2
(The Brisbane star band on the chart lies under the very similar Coffs Harbour band.)
The difference between the highest and lowest 6 star load limits is 48 MJ/m².annum. The lowest limit is 48% of the highest.
All climates are listed below in the same order as on the chart. The selected climate is in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
35 Mackay	112	92	20	*43,097*
7 Rockhampton	110	90	20	*44,956*
9 Amberley	85	67	18	*226,168*
36 Gladstone	73	59	14	*82,648*
10 **Brisbane**	55	43	**12**	*798,533*
11 Coffs Harbour	55	44	11	*75,508*
household weighted average …..			***14***	*MJ/m².a*

Zone 2 observations

- The 6 NatHERS climates in *climate zone* 2 have 6 star load limits which are among the lowest for all BCA *climate zones* and the narrowest spread of star bands in absolute terms.
- Brisbane has been selected as a capital city and for its dominant share of total household numbers. It also offers a 5-6 star load reduction below the weighted zone average (14 MJ/m².a) and near the lowest for *climate zone* 2.
- If buildings configured for Brisbane receive similar star ratings in other *climate zone* 2 locations, the load savings from building improvements will be greater than those predicted for Brisbane.

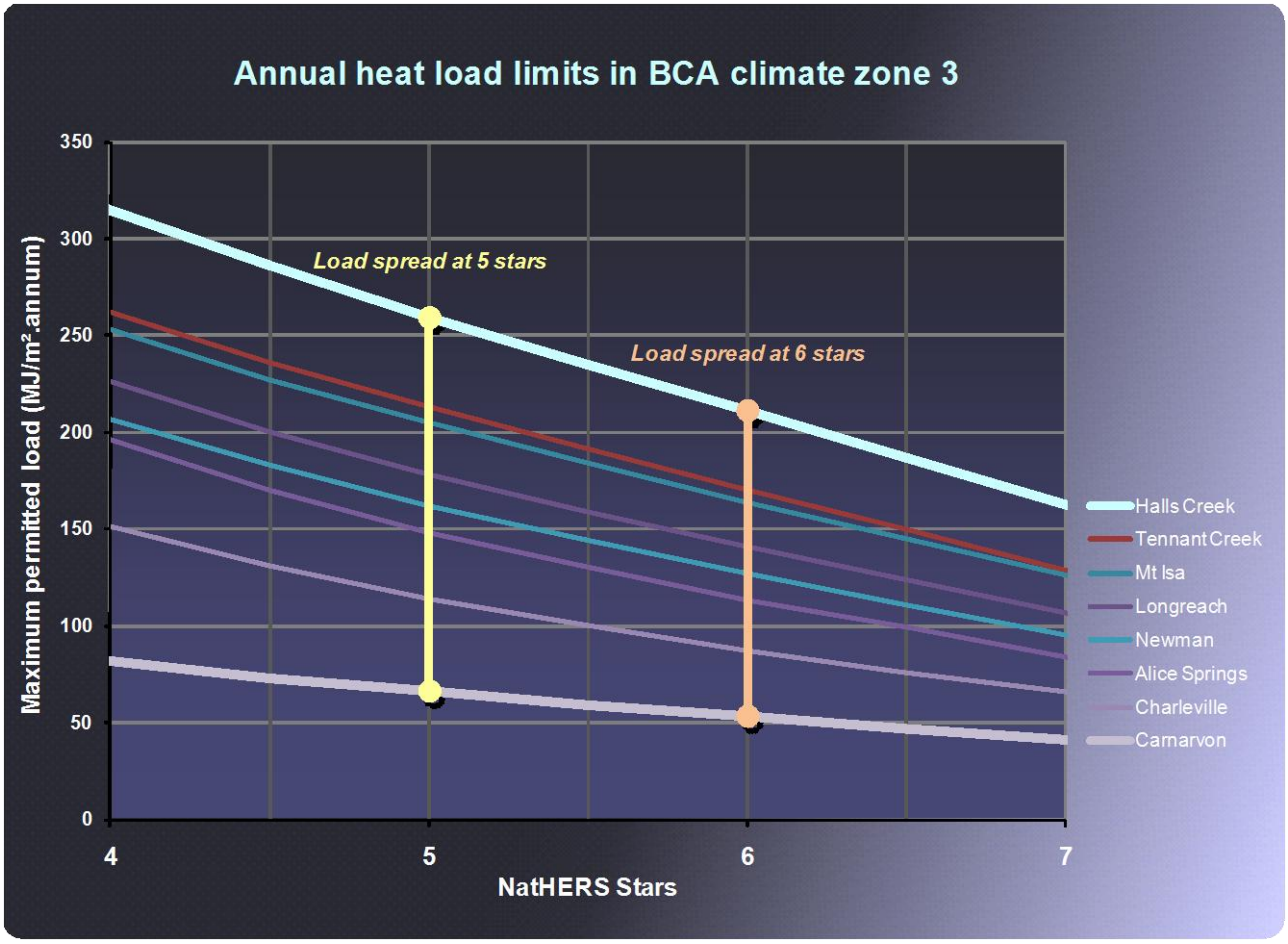


Figure 5.5: Load limits and potential reductions for NatHERS climates in BCA climate zone 3
The difference between the highest and lowest 6 star load limits is 158 MJ/m².annum. The lowest limit is 25% of the highest.
Climates are listed below in the same order as on the chart. The selected climate is in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
37 Halls Creek	259	211	48	*6,971*
38 Tennant Creek	213	170	43	*5,444*
39 Mt Isa	205	164	41	*10,065*
3 **Longreach**	178	141	**37**	*15,730*
40 Newman	162	127	35	*4,305*
6 Alice Springs	148	113	35	*10,477*
19 Charleville	114	87	27	*29,515*
4 Carnarvon	66	53	13	*1,376*
household weighted average …			***35***	*MJ/m².a*

Zone 3 observations

- The 8 NatHERS climates in BCA *climate zone* 3 have a wide spread in 6 star load limits (similar to *climate zone* 6) and high variability in percentage terms.
- The EES baseline study indicates that the outlying Halls Creek and Carnarvon climates have cooling needs distinctive from all other zone 3 locations. The populous centres of Alice Springs and Charleville have heating needs closer to those found in *climate zone* 4.
- Longreach has been selected as the most populous representative location with load reductions (37 MJ/m².a) near the weighted zone average. (35 MJ/m².a).

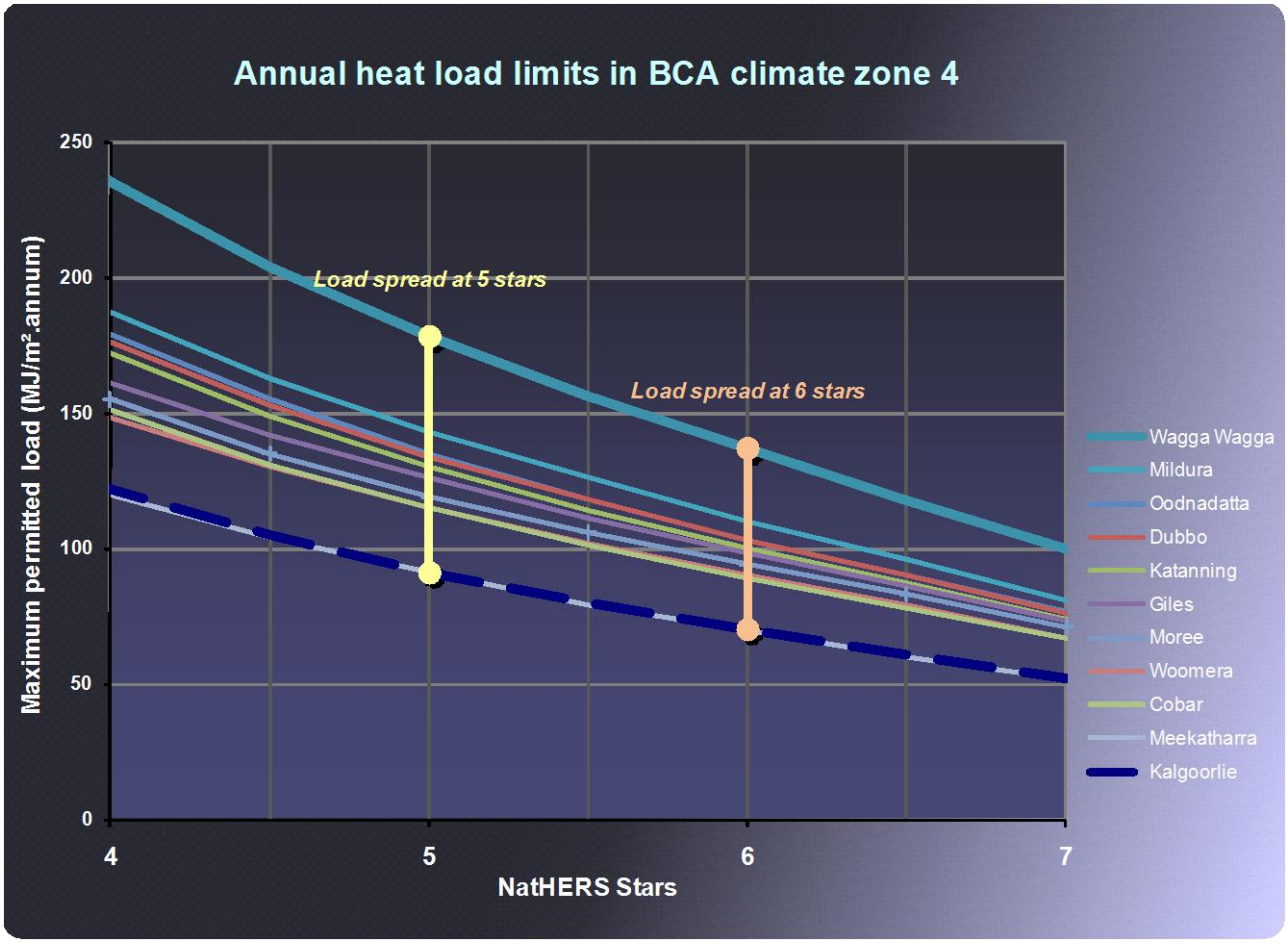


Figure 5.6: Load limits and potential reductions for NatHERS climates in BCA climate zone 4
The difference between the highest and lowest 6 star load limits is 67 MJ/m².annum. The lowest limit is 51% of the highest.
All climates are listed below in the same order as on the chart. The selected climate is in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
20 Wagga Wagga	178	137	41	*77,983*
27 **Mildura**	143	110	**33**	*111,731*
43 Oodnadatta	135	103	32	*1,704*
48 Dubbo	134	103	31	*42,594*
49 Katanning	130	100	30	*10,694*
41 Giles	126	98	28	*701*
8 Moree	119	94	25	*24,890*
45 Woomera	115	90	25	*8,402*
46 Cobar	115	89	26	*17,989*
42 Meekatharra	91	70	21	*3,162*
44 Kalgoorlie	91	70	21	*34,330*
household weighted average …..			***32***	*MJ/m².a*

Zone 4 observations

- The 11 NatHERS climates in *climate zone* 4 have a limited spread of 6 star load limits but Wagga Wagga appears distinctive at the top of the range as do Meekatharra and Kalgoorlie at the lower end.
- Among remaining locations, Mildura offers potential savings (33 MJ/m².a) just above the weighted zone average (32 MJ/m².a) which is influenced by Mildura's large share of household numbers.

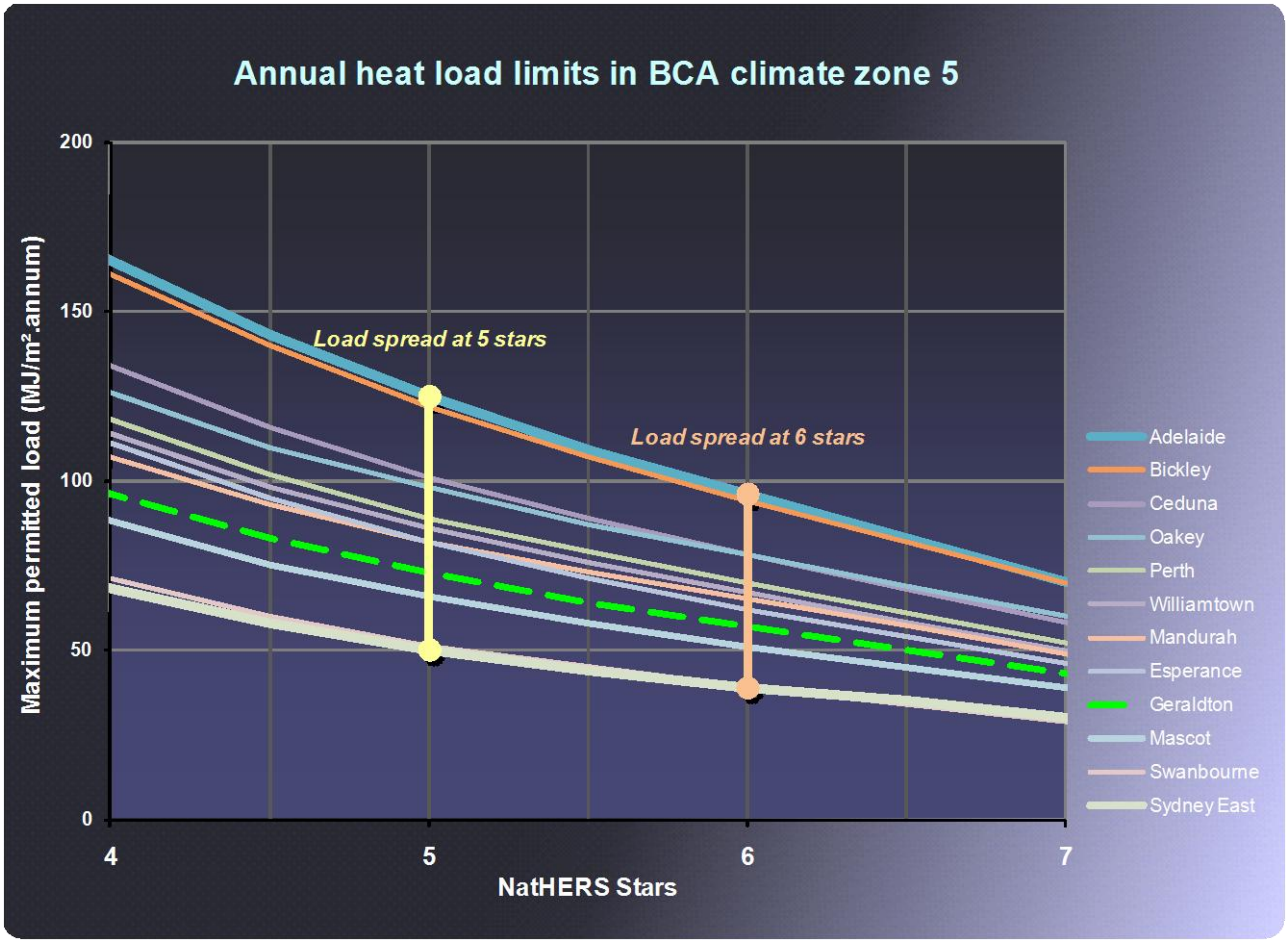


Figure 5.7: Load limits and potential reductions for NatHERS climates in BCA climate zone 5
The difference between the highest and lowest 6 star load limits is 57 MJ/m².annum. The lowest limit is 41% of the highest.
Climates are listed below in the same order as on the chart. The three selected climates are in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
16 **Adelaide**	125	96	**29**	*473,356*
47 Bickley	122	94	28	*32,505*
53 Ceduna	101	78	23	*10,266*
50 Oakey	98	78	20	*79,573*
13 **Perth**	89	70	**19**	*423,911*
15 Williamtown	86	67	19	*323,525*
54 Mandurah	82	65	17	*45,575*
55 Esperance	82	62	20	*3,035*
12 Geraldton	73	57	16	*13,653*
56 **Mascot**	66	51	**15**	*862,814*
52 Swanbourne	51	39	12	*110,909*
17 Sydney East	50	39	11	*237,373*
household weighted average …..			***19***	*MJ/m².a*

Zone 5 observations

- *Climate zone* 5 contains 12 NatHERS climates with a limited spread in 6 star load limits and 5-6 star load reductions. The load reduction in Sydney East is the smallest for any of the 69 NatHERS climates.
- Adelaide, Perth and Mascot (for Sydney) have been selected as capitals which also encompass most of the range of star bands and load reductions.

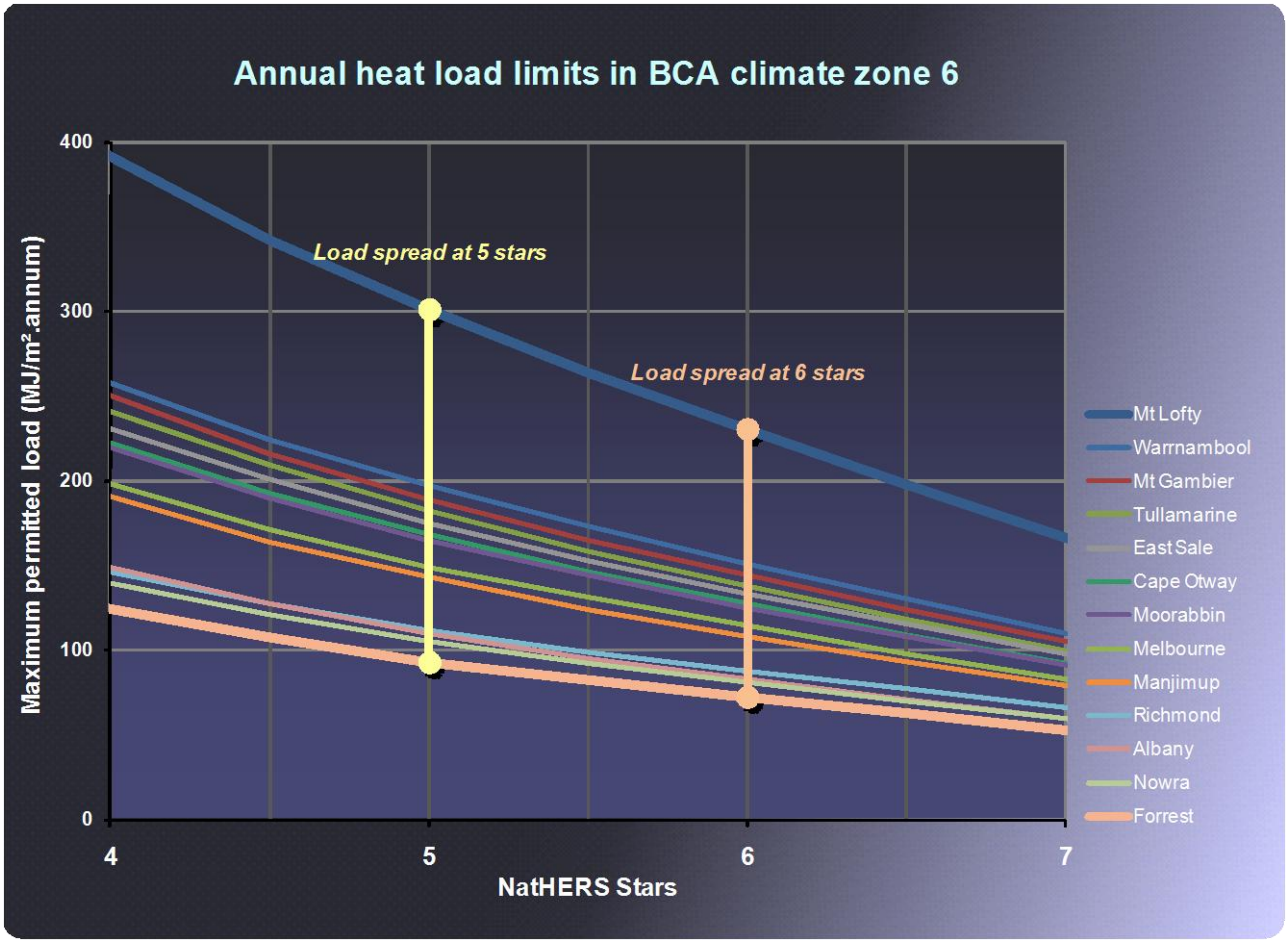


Figure 5.8: Load limits and potential reductions for NatHERS climates in BCA climate zone 6
The difference between the highest and lowest 6 star load limits is 158 MJ/m².annum. The lowest 6 star limit is 31% of the highest.
All climates are listed below in the same order as on the chart. The selected climate is in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
59 Mt Lofty	301	230	71	*35,797*
63 Warrnambool	197	151	46	*37,947*
61 Mt Gambier	189	144	45	*32,391*
60 Tullamarine	182	138	44	*429,539*
22 East Sale	175	133	42	*75,814*
64 Cape Otway	168	127	41	*43,040*
62 **Moorabbin**	165	125	**40**	*715,575*
21 Melbourne	149	114	35	*161,549*
57 Manjimup	143	108	35	*6,397*
28 Richmond	112	87	25	*494,369*
58 Albany	110	83	27	*24,192*
18 Nowra	105	81	24	*106,021*
51 Forrest	93	72	21	*14*
household weighted average …..			***37***	*MJ/m².a*

Zone 6 observations

- The 13 star bands in *climate zone* 6 vary more than in any other BCA *climate zone*. Mt Lofty load limits are notably distinct from others in *climate zone* 6.
- Moorabbin has been selected for its high share of household numbers, reflected in a 5-6 star load reduction close to the zone weighted average (37 MJ/m².a)

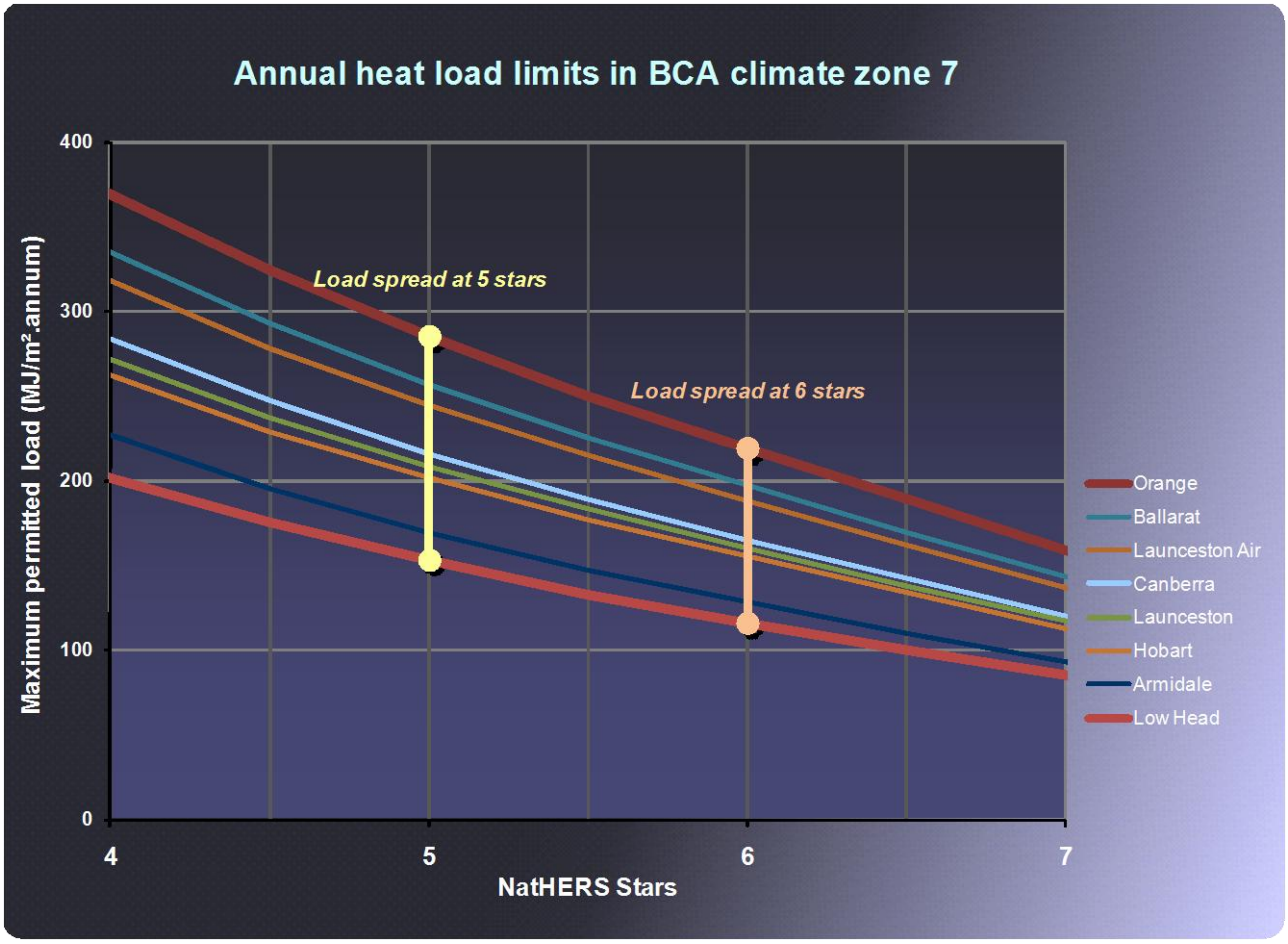


Figure 5.9: Load limits and potential reductions for NatHERS climates in BCA climate zone 7
The difference between the highest and lowest 6 star load limits is 103 MJ/m².annum. The lowest limit is 53% of the highest.
Climates are listed below in the same order as on the chart. The 2 selected climates are in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
65 Orange	285	219	66	*67,073*
66 Ballarat	257	197	60	*186,669*
68 Launceston Air	245	188	57	*22,142*
24 **Canberra**	216	165	**51**	*202,850*
23 Launceston	208	160	48	*31,518*
26 **Hobart**	202	155	**47**	*80,941*
14 Armidale	169	128	41	*39,548*
67 Low Head	153	116	37	*32,523*
household weighted average……			***53***	*MJ/m².a*

Zone 7 observations

- *Climate zone* 7 covers 8 NatHERS climates with a significant range of load limits.
- The two selected locations (Canberra and Hobart) have star bands in the middle of the range and have been selected as capital cities.
- Both have load savings below the weighted average for the zone (53 MJ/m².a).
- Load savings projected from Canberra and Hobart results will be bettered in the other populous centre (Ballarat) if houses yield similar ratings in that climate.

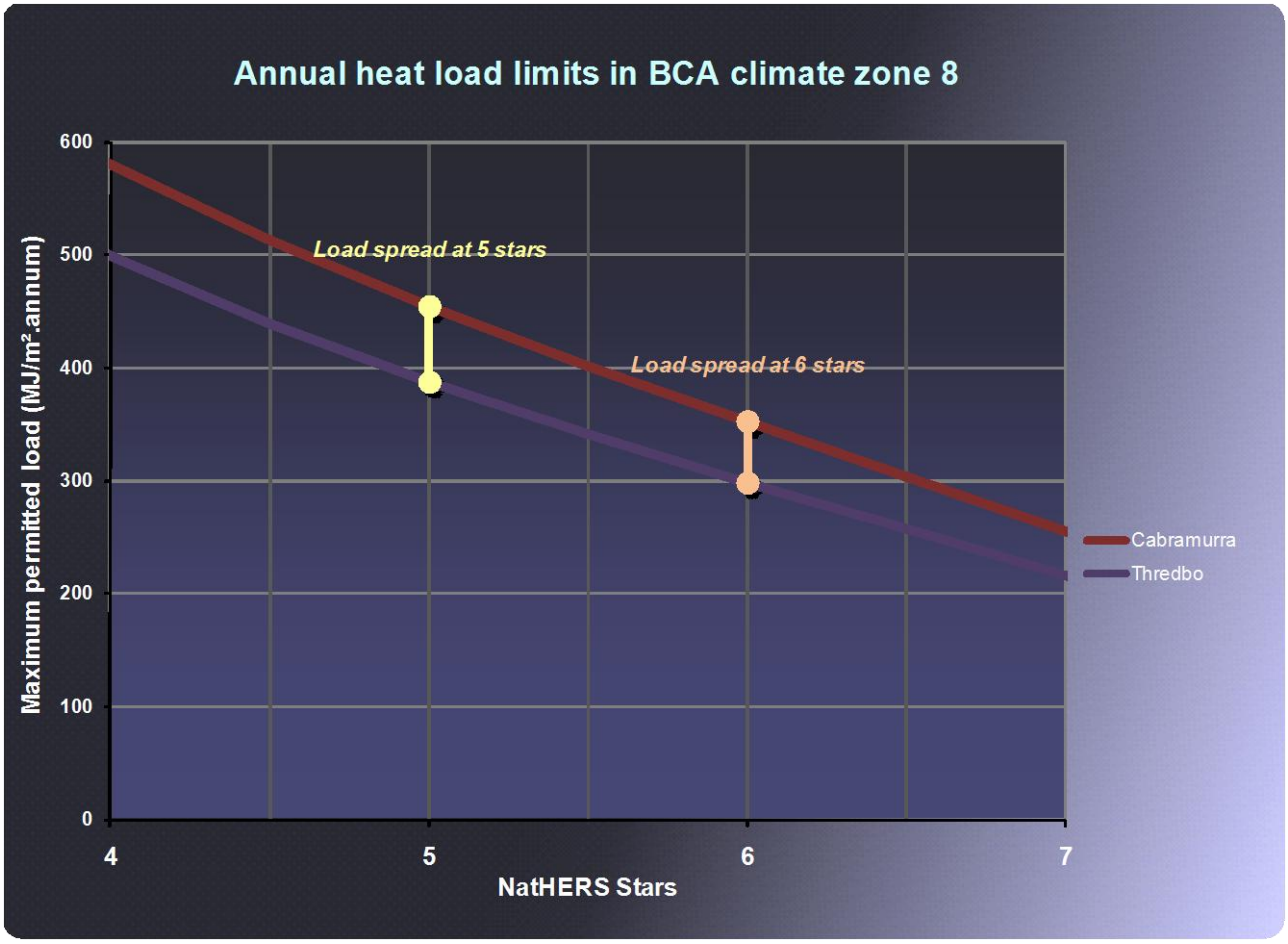


Figure 5.10: Load limits and potential reductions for NatHERS climates in BCA climate zone 8
The difference between 6 star load limits is 54 MJ/m².annum. The lower limit is 85% of the higher. Climates are listed below in the same order as on the chart. The selected climate is in bold font.

NatHERS climate	5 stars	6 stars	5-6 stars	houses
25 **Cabramurra**	454	352	**102**	*33,551*
69 Thredbo	387	298	89	*22,010*
household weighted average …..			***97***	*MJ/m².a*

Zone 8 observations

- *Climate zone* 8 contains just two NatHERS climates but their 5-6 star load reductions are closer (in percentage terms) than in any other BCA *climate zone*.
- The load reductions in both Cabramurra and Thredbo are the largest in absolute terms for any of the BCA *climate zones*.
- Thredbo has the smaller 5-6 star load reduction and lower household numbers.
- Cabramurra has been selected to represent *climate zone* 8 since it accounts for about 60% of household numbers in the zone.

6.0 Study outputs and their interpretation

The study has generated two sets of complementary data: a catalogue of graded improvements to building fabric and a list of their impacts on simulated annual heating and cooling needs. The improvements and their effects are matched through the calculator interface. The calculator has many potential uses but its central purpose in this study is to provide explicit data on construction and load changes to assist the cost/benefit analysis of a higher star rating target proposed for BCA Volume Two.

The database can be interrogated through the calculator interface, by directly filtering the data table or by creating cross tabbed summaries of the sort sampled in Appendices B-D. (Appendix B gives details of insulation levels in 6 star houses and Appendix C summarises glazing and shading arrangements. Appendix D provides indicative costs of construction changes.) The summaries are based on Excel pivot tables and charts. Such tables can display information for all ratings, a selected range of ratings or any single star level (within the 5-7 star range). Filtering the tables can also show only some climates or some dwellings, depending on the focus of the table.

The calculator allows side by side comparison of any two cases in the database. It is intended mainly for seeing how construction changes between two star rating levels of the same house in the same climate. In the context of current BCA proposals, this would involve selecting the 5 star configuration of a house in one column and its 6 star variant in the other. The calculator displays construction details, highlighting the differences between them, and the differential cost of the higher rating. The lower part of the calculator screen charts the changes in AccuRate's simulated heating and cooling loads and summarises the benefits to occupants' comfort if the house were free running. Comfort is expressed in terms of the hours per year above and below certain temperature thresholds. Figure 6.1 (on the following page) illustrates the calculator interface used in this mode.

The accreditation dwellings retain their irregular numbering (House 01, 04, 08, etc.) throughout the text of this report. In case this causes a misapprehension of missing cases, the calculator menu for selecting houses labels them in simple numerical order (1-8). Thumbnail images of the dwellings alongside the calculator are also intended to assist selection.

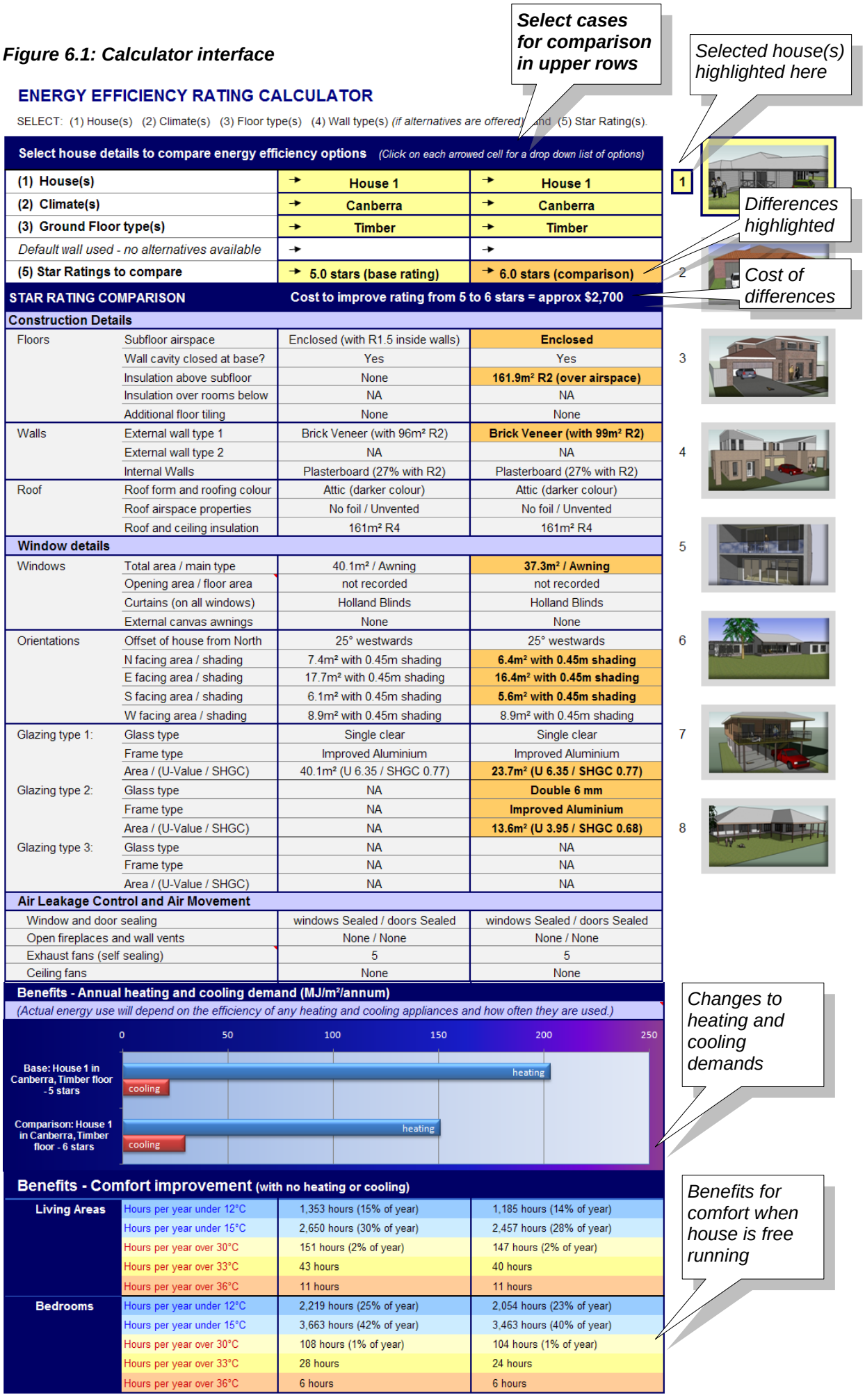
Other comparisons through the calculator could include:

- slab and timber floor variants of the same dwelling (at the same rating)
- alternative wall constructions (presently available only in Darwin)
- equally rated versions of the same dwelling in different climates
- different dwellings of the same rating in the same climate

In these alternative comparisons, the focus would be on differences in construction, calculated loads and comfort benefits. The calculator cannot display cost differences since the database does not have rates that span all of the variables involved.

The brief for this study did not require the evaluation of costs of construction changes. The calculator includes them as a convenient single measure of their impact. Cost rates embedded in the database and the methods of applying them should be reviewed before they are relied on for any use in Regulation Impact Statement calculations. Those calculations will need to accommodate factors not considered here and can be expected to show significant variations to figures in the appendices of this report.

Figure 6.1: Calculator interface



Other qualifications apply to interpreting data from this study:

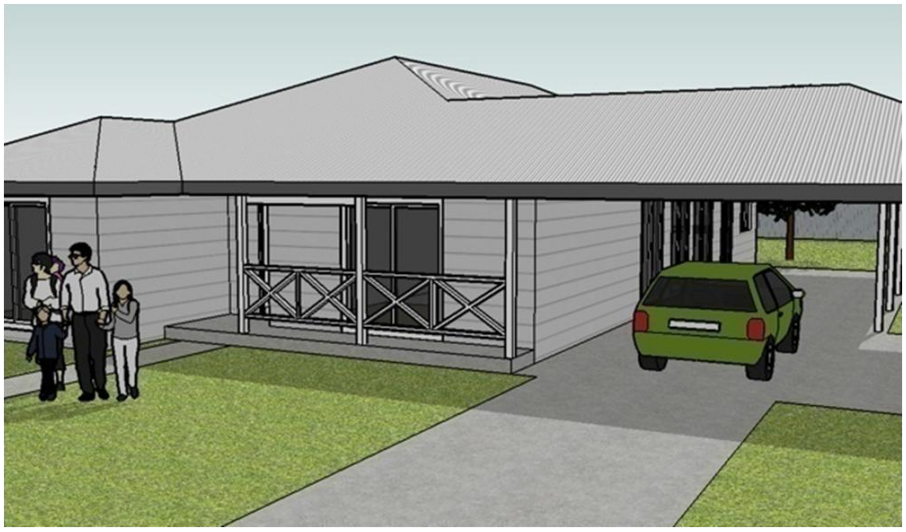
- The study uses a variety of buildings but the sample size is still small. The fabric configurations which achieve particular star levels apply only to the buildings considered in this study. The incremental changes may point to solutions for similar buildings but the benefits cannot be assumed to transfer equally.
- Although dwellings have been chosen for diversity, the study does not consider how representative they are of the national housing stock. The EES baseline study may provide useful insights for analysis of this issue.
- All BCA *climate zones* contain several NatHERS climate locations. A dwelling configured for a particular star rating in one location may receive a different rating in another location in the same *climate zone*.
- The practicalities of manually configuring 850 modelling files have prevented fine tuning of every case to match its nominal rating precisely. Decimal star ratings may vary from the nominal value by 0.1 or 0.2 stars in some cases. Tony Isaacs has managed this tolerance to ensure that it does not compound to distort the nominal half star steps. In any case, actual load changes are recorded in the database rather than nominal changes.
- Reporting actual load changes means that smaller dwellings will return greater benefits than suggested by the nominal rating improvement. Benefits recorded for larger dwellings will be smaller due to the area adjustments discussed in 5.0 above. This needs to be accounted for if extrapolating individual dwelling results to a housing stock of varied sizes.
- Calculated heating and cooling loads are based on AccuRate's default occupancy profile. The results will need adjustment for identifiable differences from real world behaviour. These may include different occupancy schedules and selective usage of any heating and cooling appliances. An alternative approach to transforming the default data would be to batch run the modelling files with modified profiles and settings. The EES baseline study may also inform this process.
- The construction changes listed in the database are intended to resemble the likely choices of an informed and experienced designer. There will, nevertheless, be other pathways to the same ratings which may be more economical and certainly many with greater costs.
- The listed benefits are basic inputs to a complex calculation which must address factors beyond the scope of this study. These include the proportion of sampled houses present in the housing stock, limited availability of heating and cooling appliances, their operating efficiencies, fuel sources, emissions intensity of fuels, future pricing of energy and carbon credits, impacts of emissions reductions measures and discounting to determine present worth, among others.

The calculator and database have been assembled in a single Excel file (currently in Office 2007 format) with a modular structure which can be readily adapted or elaborated for specific queries. The outline and examples here are brief because its capabilities will be best realised when applied to the specific needs of the Regulation Impact evaluation.

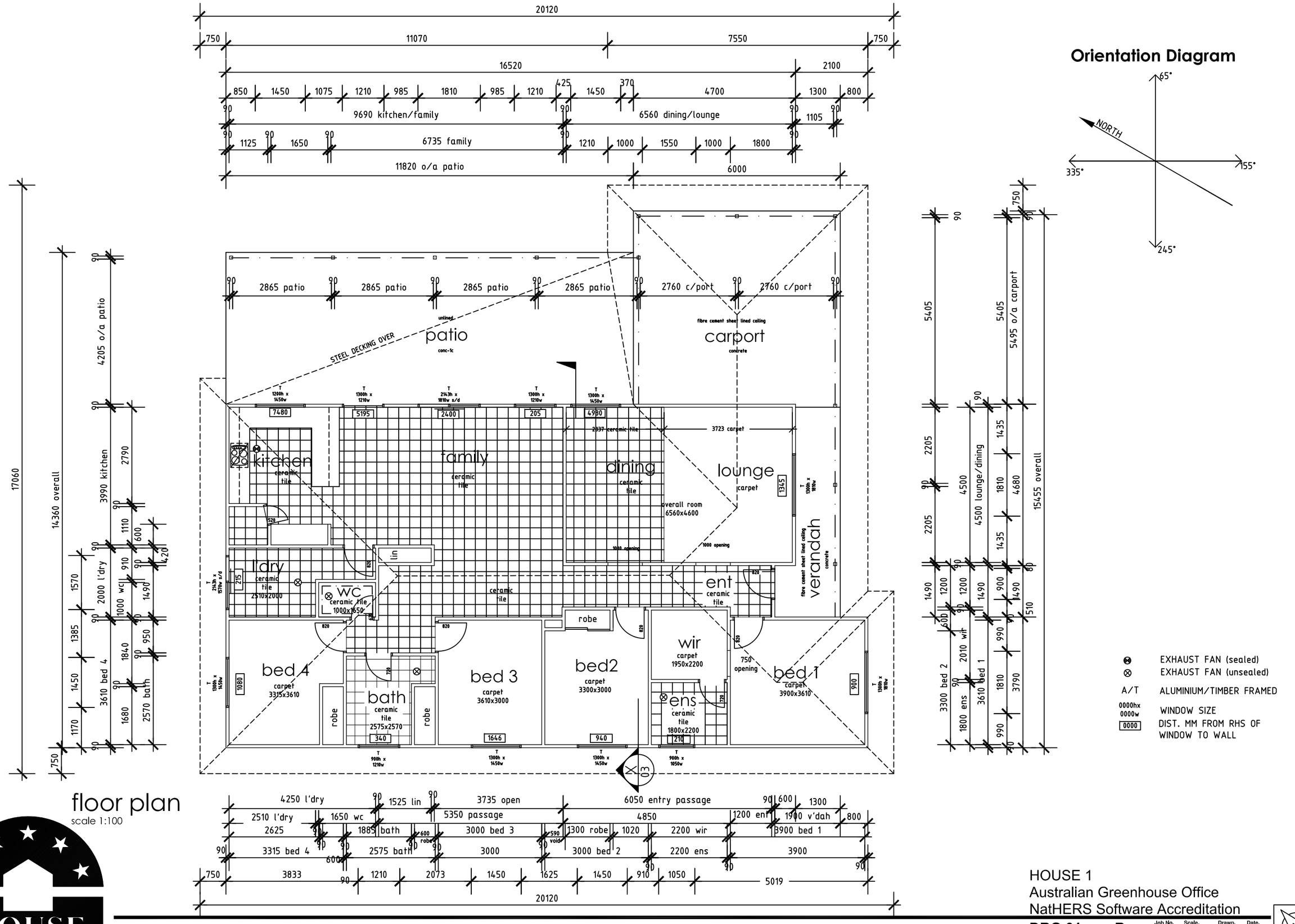
Appendix A: Dwellings selected for AccuRate modelling

3D illustrations by Tony Isaacs. 2D drawings supplied by the Department of Environment, Water, Heritage and the Arts

Appendix A.1: House 01



Single storey 165m²



Orientation Diagram

EXHAUST FAN (sealed)
EXHAUST FAN (unsealed)
A/T ALUMINIUM/TIMBER FRAMED
0000hx 0000w WINDOW SIZE
0000 DIST. MM FROM RHS OF WINDOW TO WALL

floor plan

scale 1:100

HOUSE ENERGY RATING

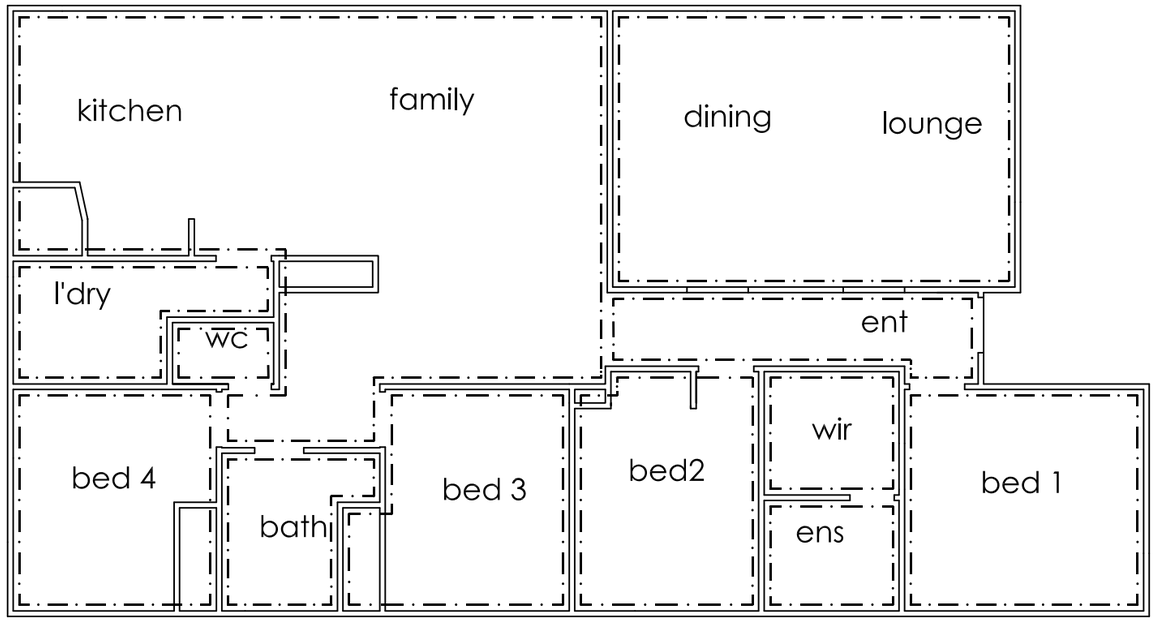
HOUSE 1
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 01 **B**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	08/08

GROUND FLOOR PLAN

Rev	Date	Issue
Rev	Date	Issue
Rev	Date	Issue
Rev	Date	Issue



zone diagram

scale 1:100

THERMAL ZONES

HOUSE
ENERGY RATING

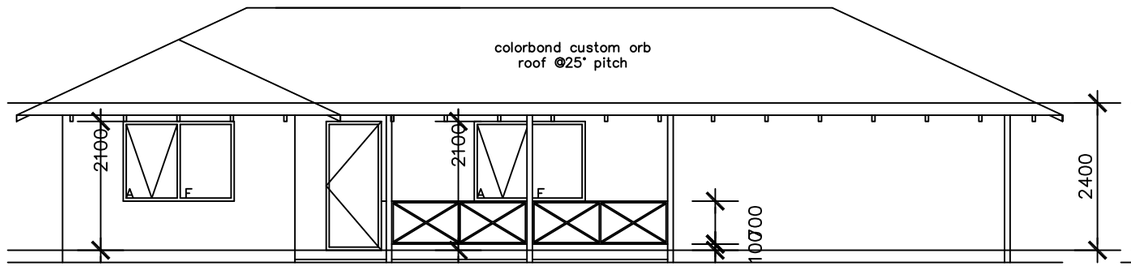
HOUSE 1
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 02 **A**

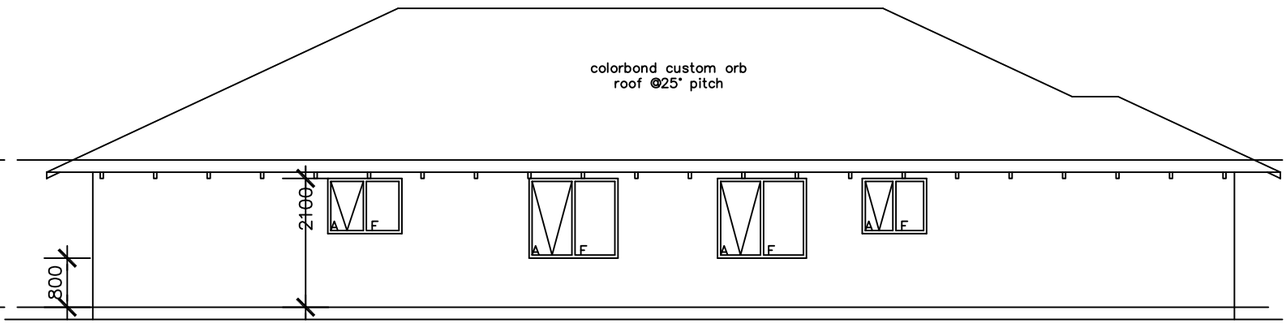
Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

THERMAL ZONES PLAN

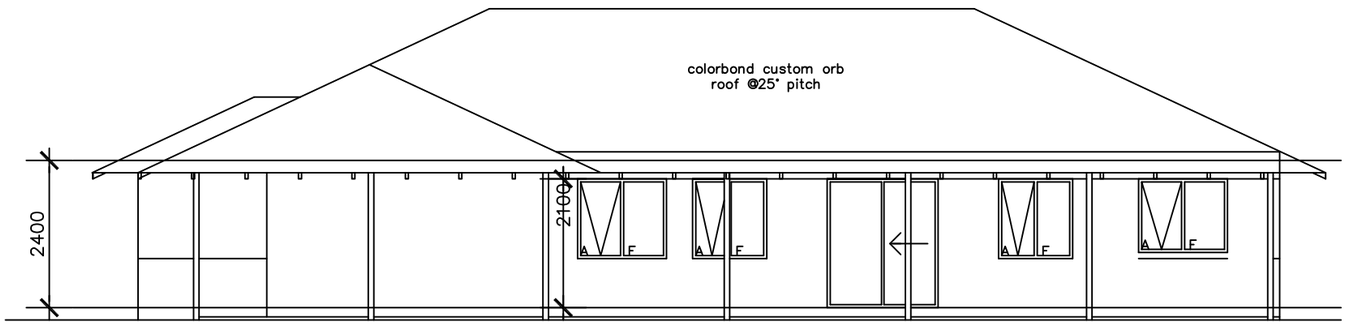
Rev	Date	Issue
B	01.11.07	RATING ISSUE
A	04.10.07	CLIENT ISSUE



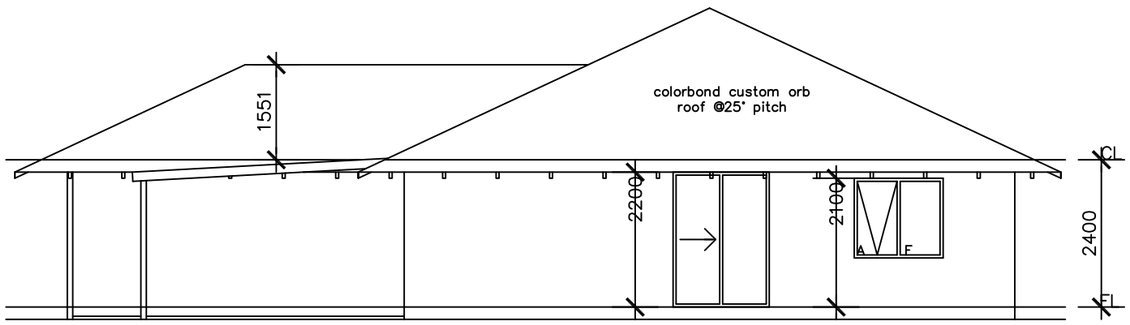
elevation 1 (front)
scale 1:100



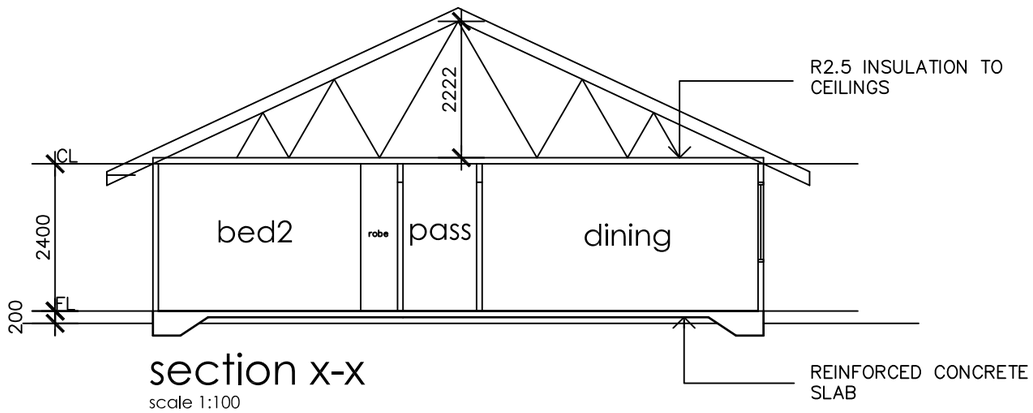
elevation 2 (side)
scale 1:100



elevation 4 (side)
scale 1:100



elevation 3 (rear)
scale 1:100



section x-x
scale 1:100

HOUSE ENERGY RATING

Single Storey 172m2, Slab FLoor
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 03 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

ELEVATIONS & SECTION

Rev	Date	Issue
P1	04/07	CLIENT ISSUE

Rev	Date	Issue

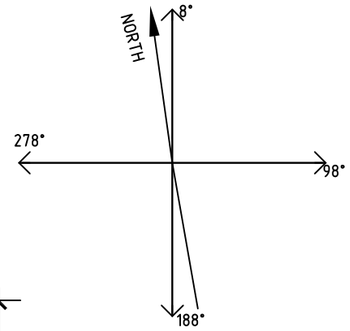
Rev	Date	Issue

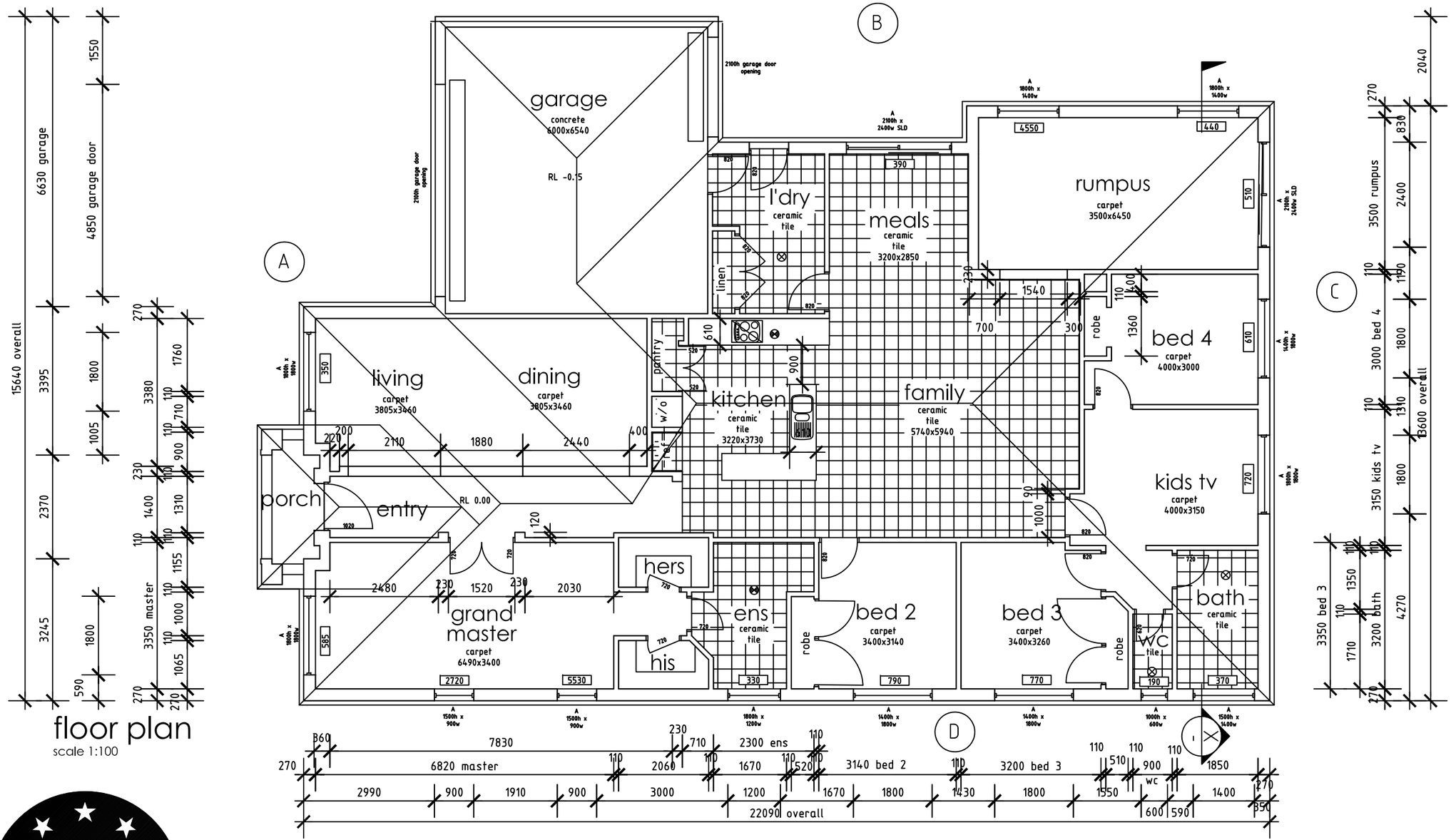
Rev	Date	Issue

Appendix A.2: *House 04*

Single storey 232m²

Orientation Diagram





floor plan
scale 1:100

⊗ EXHAUST FAN (sealed)
⊗ EXHAUST FAN (unsealed)
A/T ALUMINIUM/TIMBER FRAMED
0000hx 0000w WINDOW SIZE
0000 DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE
ENERGY RATING

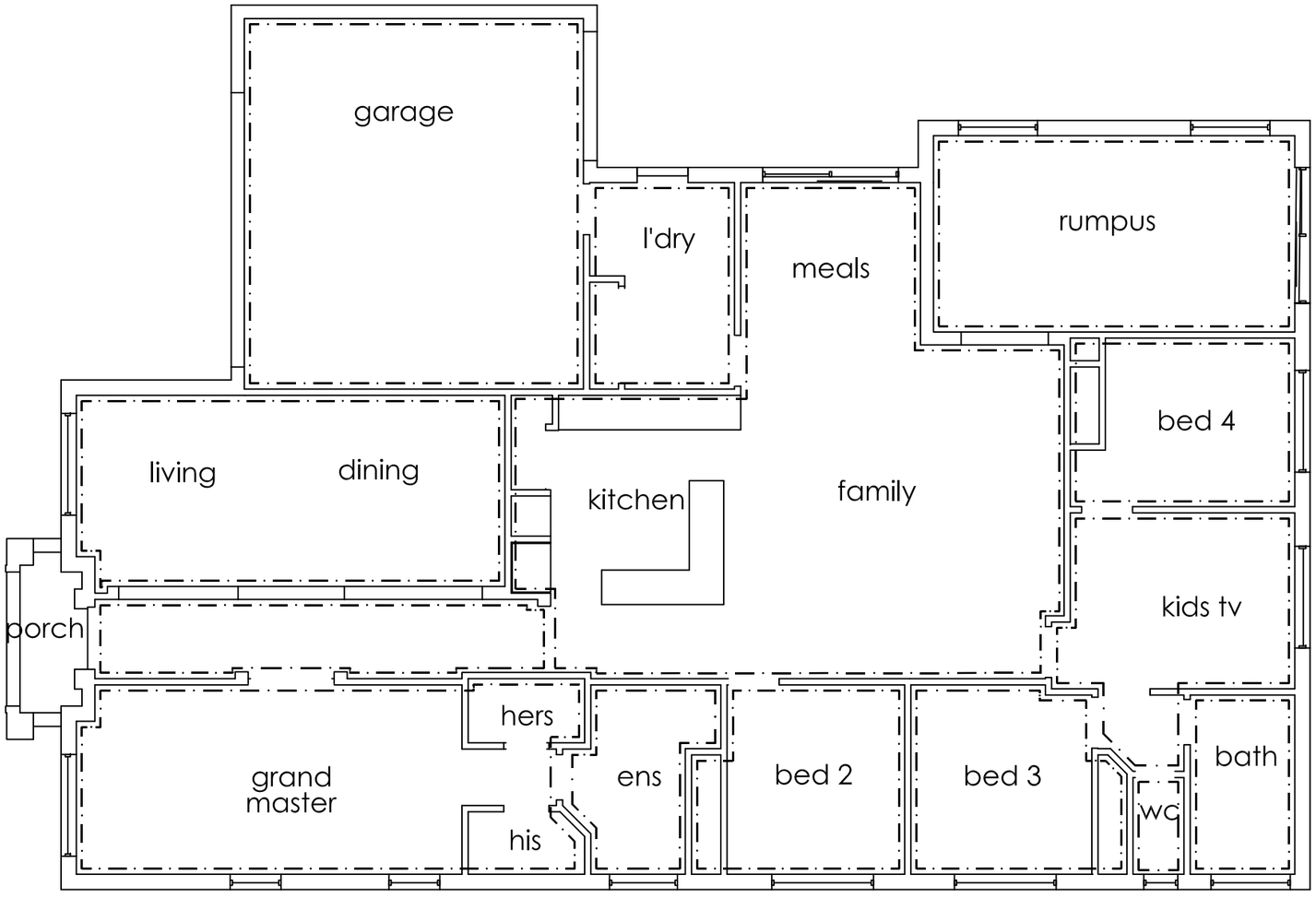
HOUSE 4
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 01 **B**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

GROUND FLOOR PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



zone diagram

scale 1:100

THERMAL ZONES

HOUSE
ENERGY RATING

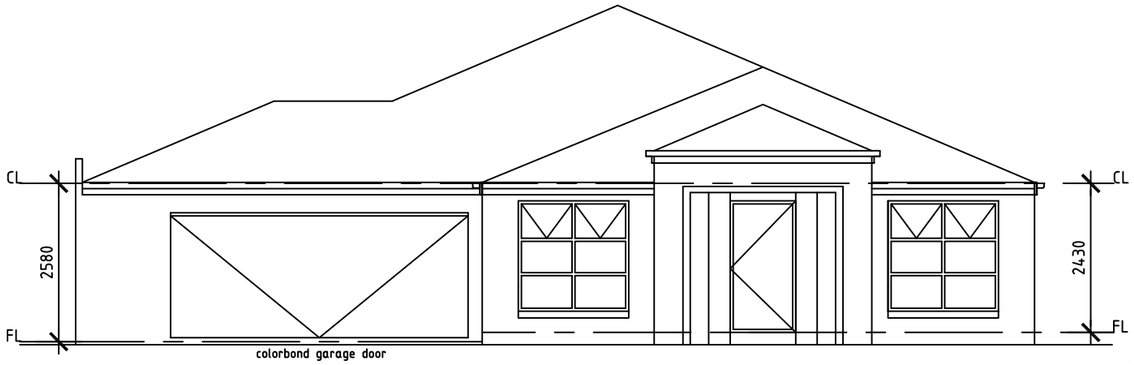
HOUSE 4
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 02 **A**

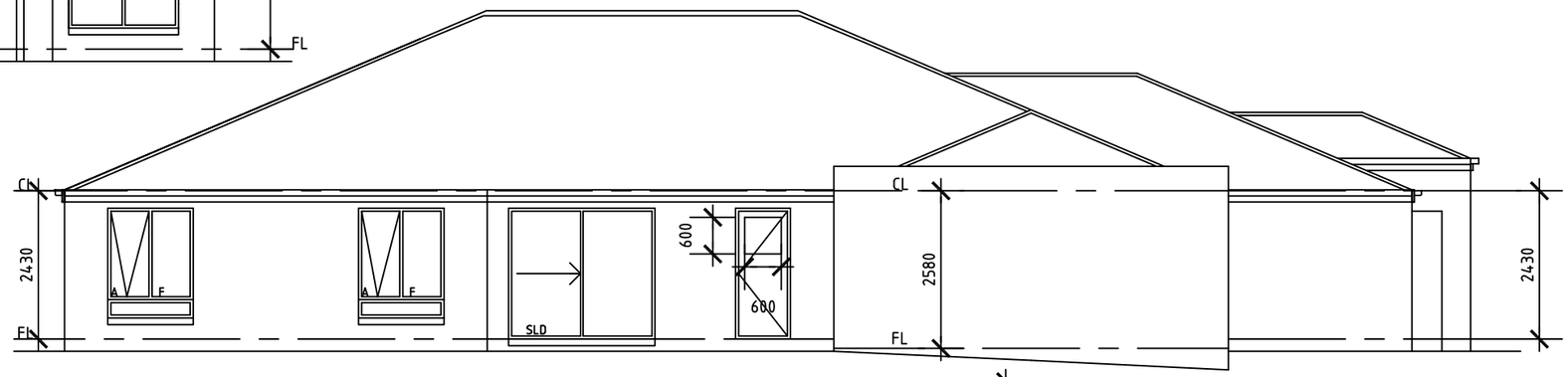
Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

THERMAL ZONES PLAN

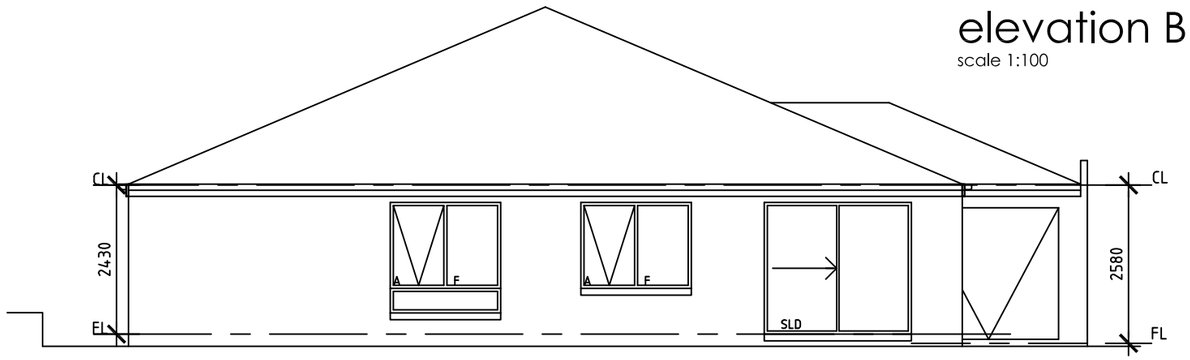
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



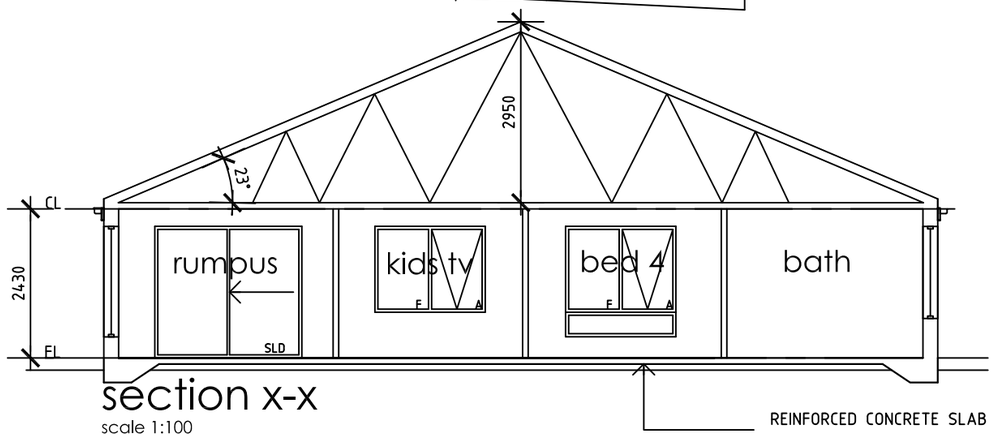
elevation A
scale 1:100



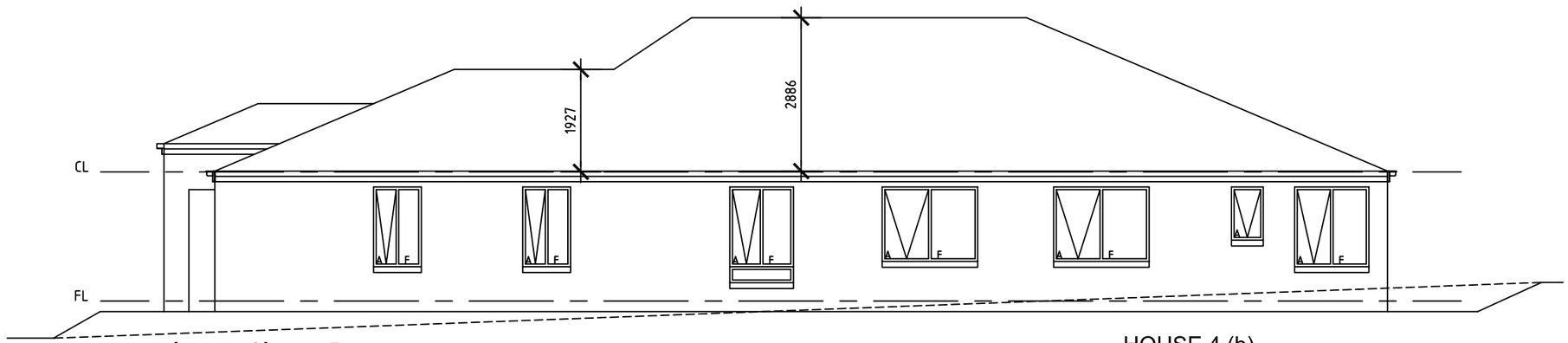
elevation B
scale 1:100



elevation C
scale 1:100



section x-x
scale 1:100



elevation D
scale 1:100

HOUSE
ENERGY RATING

HOUSE 4 (b)
Australian Greenhouse Office
NatHERS Software Accreditation

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ELEVATIONS & SECTION

Rev	Date	Issue

Rev	Date	Issue

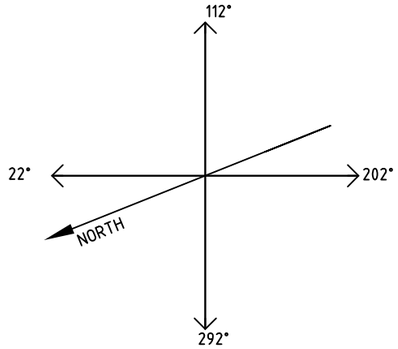
Rev	Date	Issue
B	01.11.07	RATING ISSUE

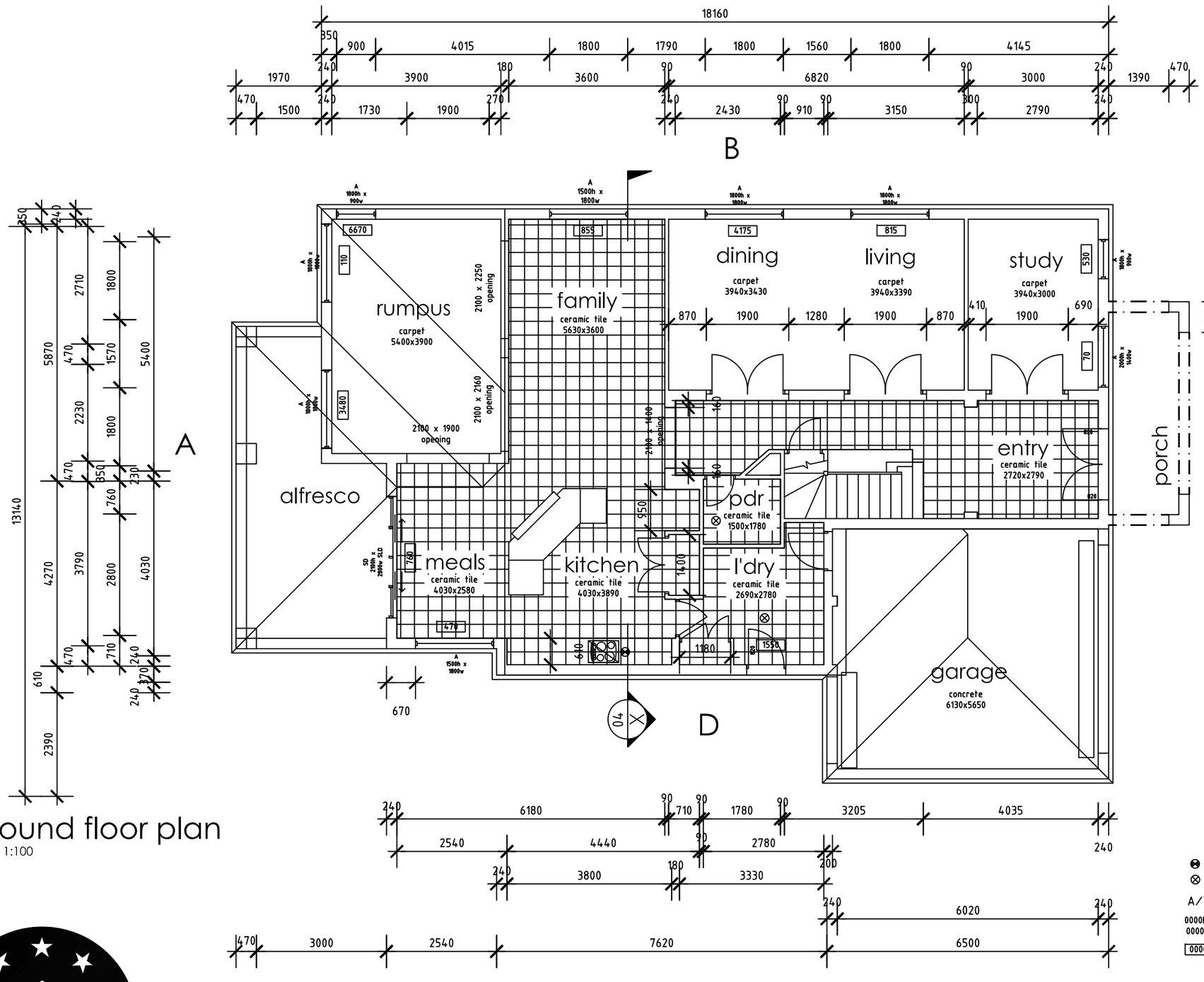
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix A.3: *House 08*

Double storey 263m²

Orientation Diagram





ground floor plan

scale 1:100

⊗	EXHAUST FAN (sealed)
⊗	EXHAUST FAN (unsealed)
A/T	ALUMINIUM/TIMBER FRAMED
0000hx 0000w	WINDOW SIZE
0000	DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE ENERGY RATING

HOUSE 8
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 01 **B**

Job No.	Scale.	Drawn.	Date.
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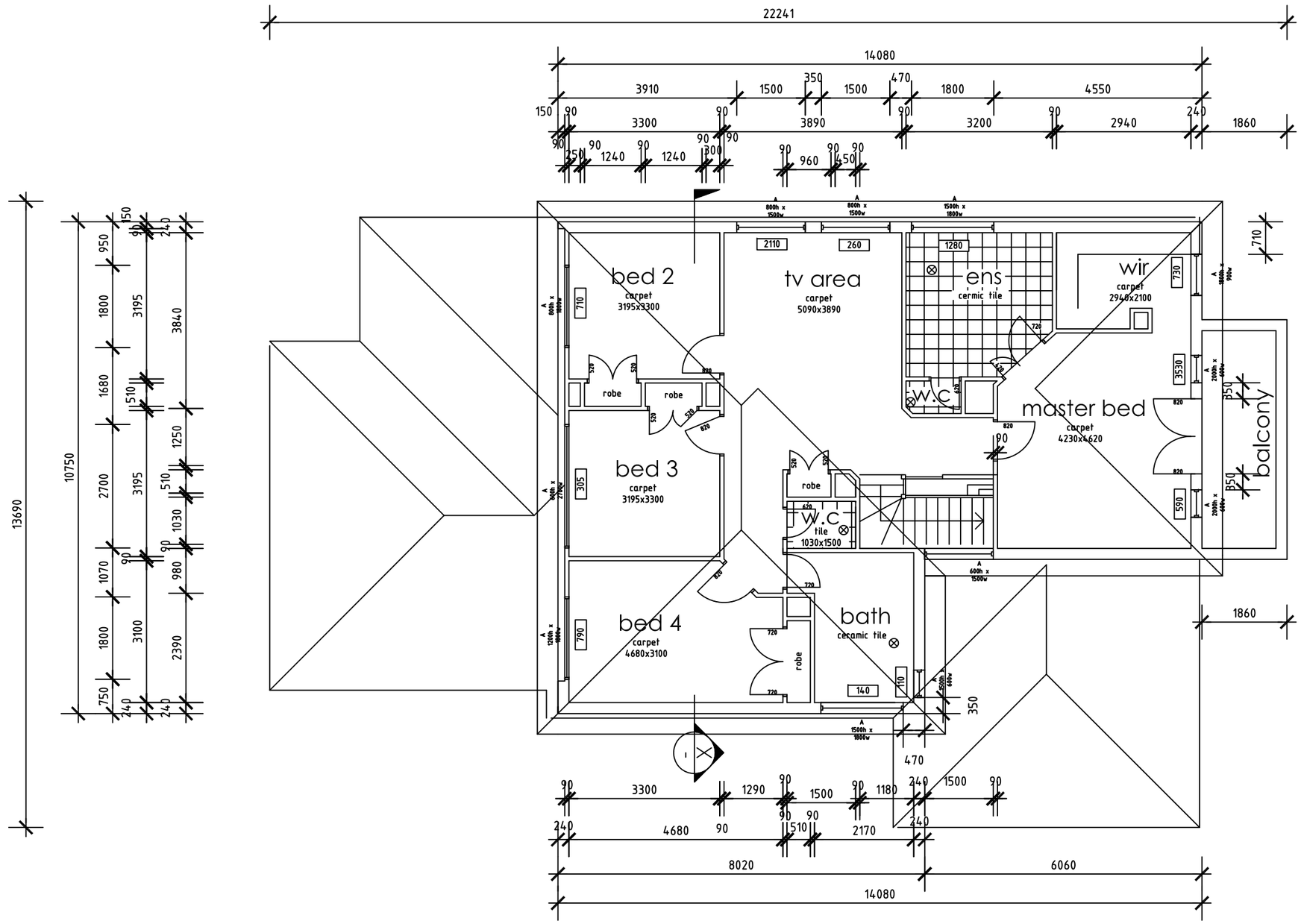
GROUND FLOOR PLAN

Rev	Date	Issue

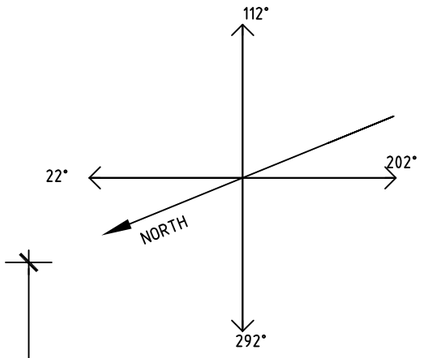
Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



Orientation Diagram



first floor plan

scale 1:100

⊗	EXHAUST FAN (sealed) EXHAUST FAN (unsealed)
A/T	ALUMINIUM/TIMBER FRAMED
0000hx 0000w	WINDOW SIZE
0000	DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE
ENERGY RATING

HOUSE 8
Australian Greenhouse Office
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DRG 02 **B**

Job No.	Scale.	Drawn.	Date.
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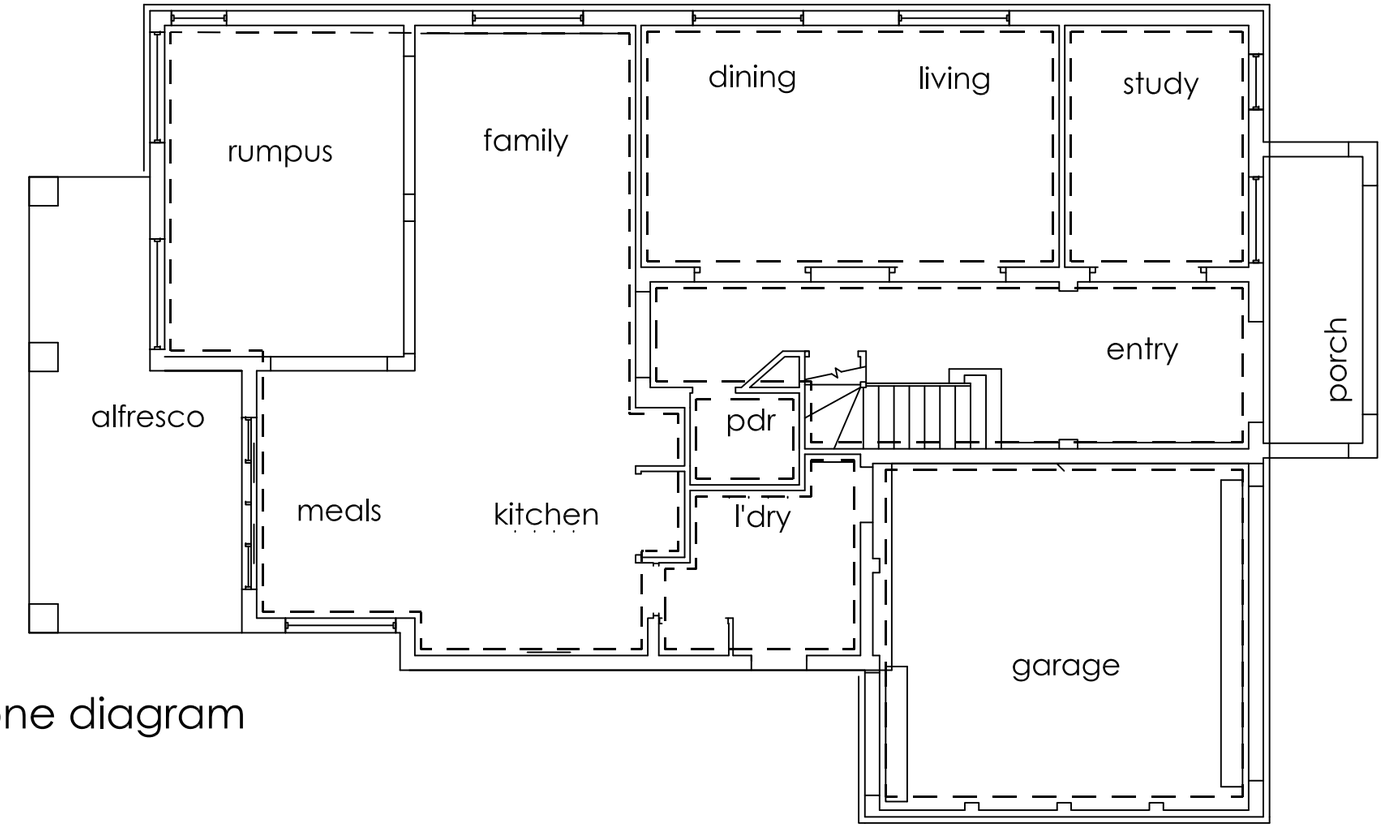
FIRST FLOOR PLAN

Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue

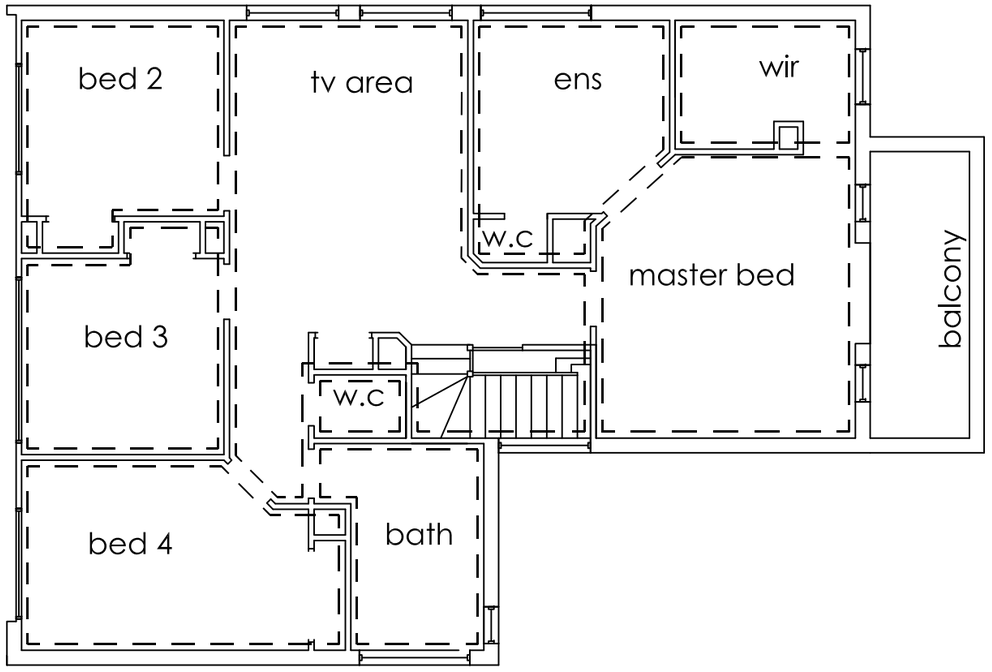
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



ground floor zone diagram

scale 1:100

THERMAL ZONES



first floor zone diagram

scale 1:100

THERMAL ZONES

HOUSE ENERGY RATING

HOUSE 8

Australian Greenhouse Office

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Job No.	Scale.	Drawn.	Date.
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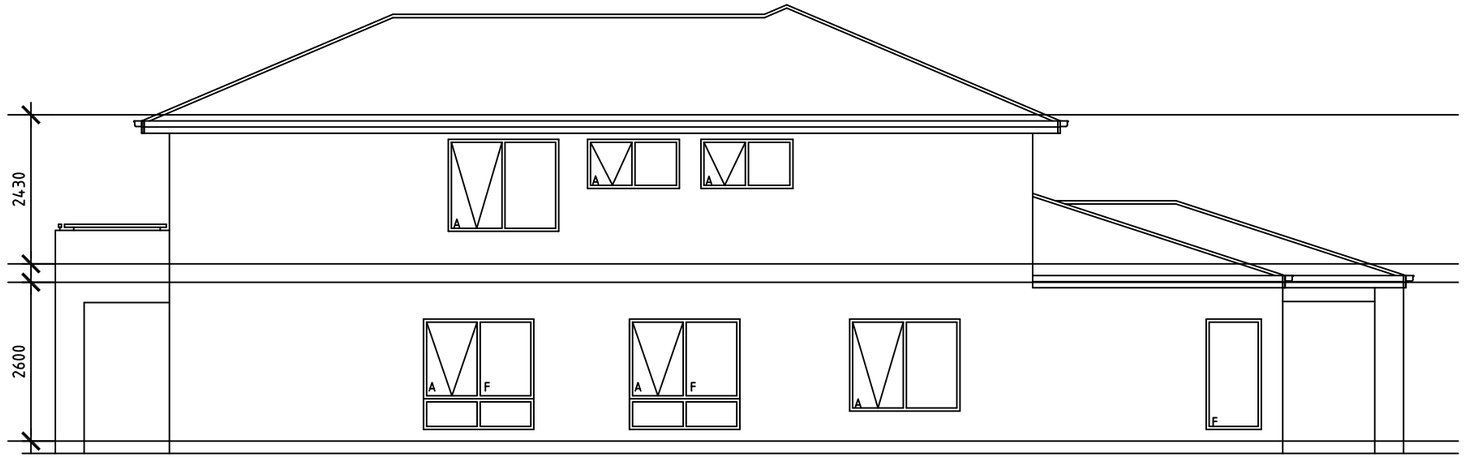
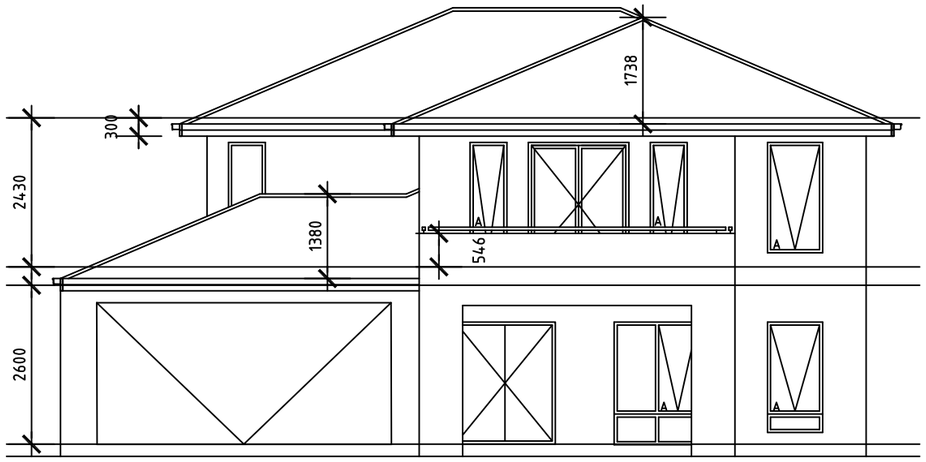
THERMAL ZONES PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

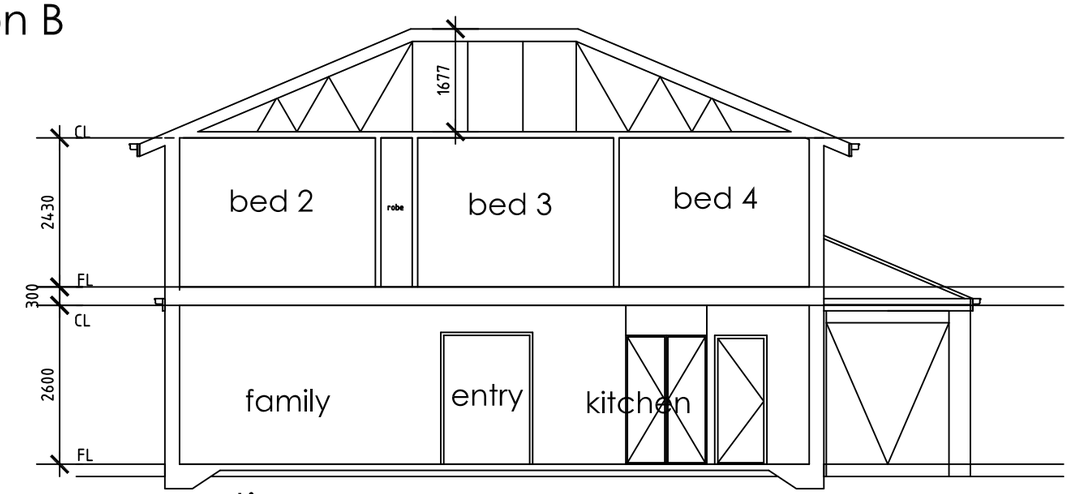
elevation A
scale 1:100



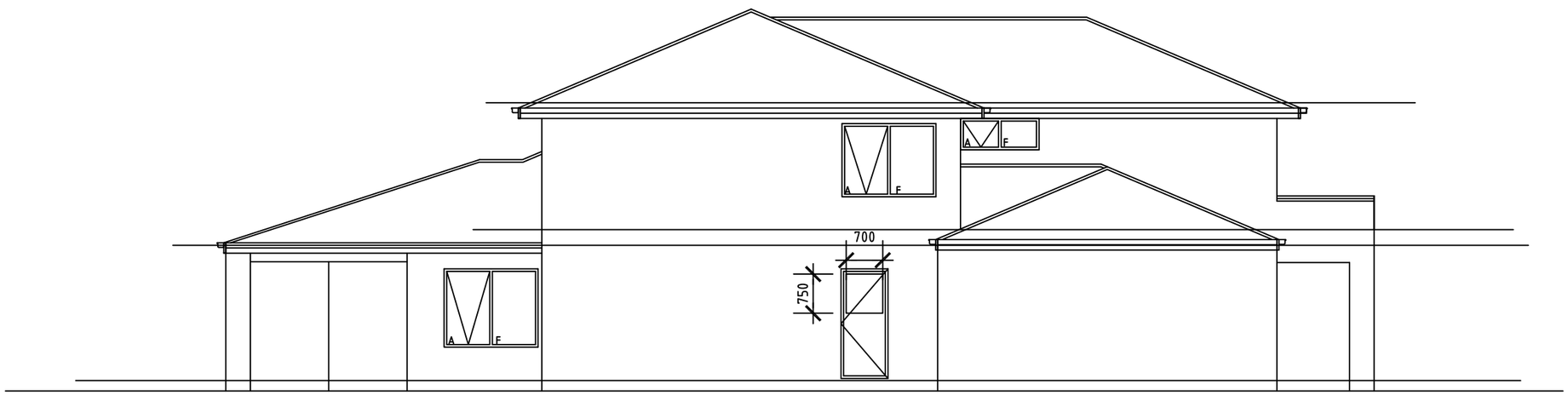
elevation B
scale 1:100



elevation C
scale 1:100



section x-x
scale 1:100



elevation D
scale 1:100

HOUSE
ENERGY RATING

HOUSE 8
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DRG 04 **A**

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ELEVATIONS & SECTION

Rev	Date	Issue

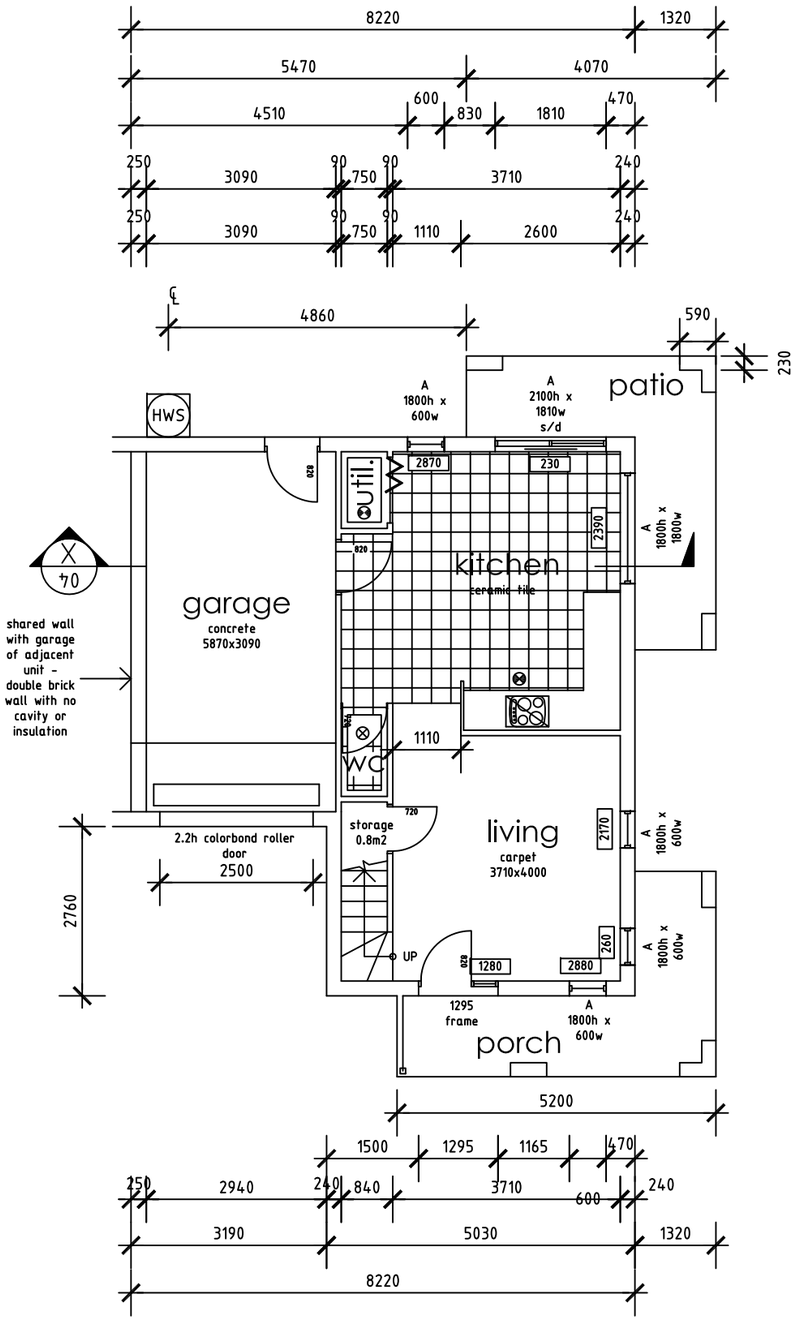
Rev	Date	Issue

Rev	Date	Issue

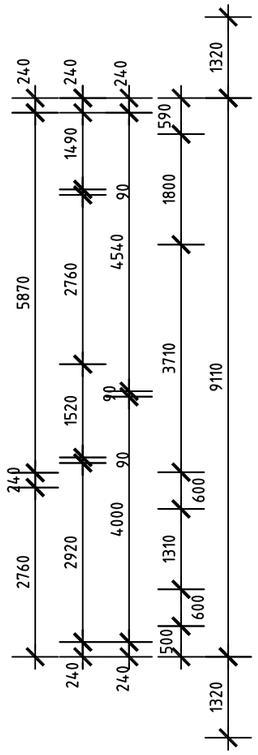
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix A.4: *House 09*

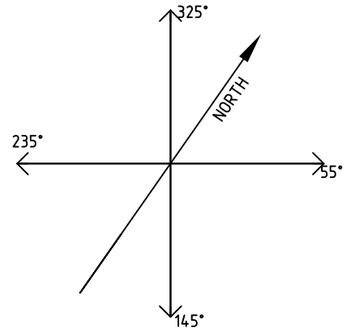
Double storey townhouse 90m²



ground floor plan
scale 1:100



Orientation Diagram



⊗	EXHAUST FAN (sealed)
⊗	EXHAUST FAN (unsealed)
A/T	ALUMINIUM/TIMBER FRAMED
0000hx 0000w	WINDOW SIZE
0000	DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE ENERGY RATING

HOUSE 9
Australian Greenhouse Office
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DRG 01 **A**

Job No.	Scale.	Drawn.	Date.
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GROUND FLOOR PLAN

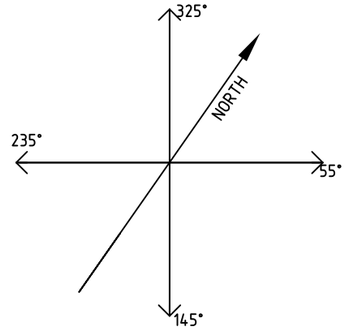
Rev	Date	Issue

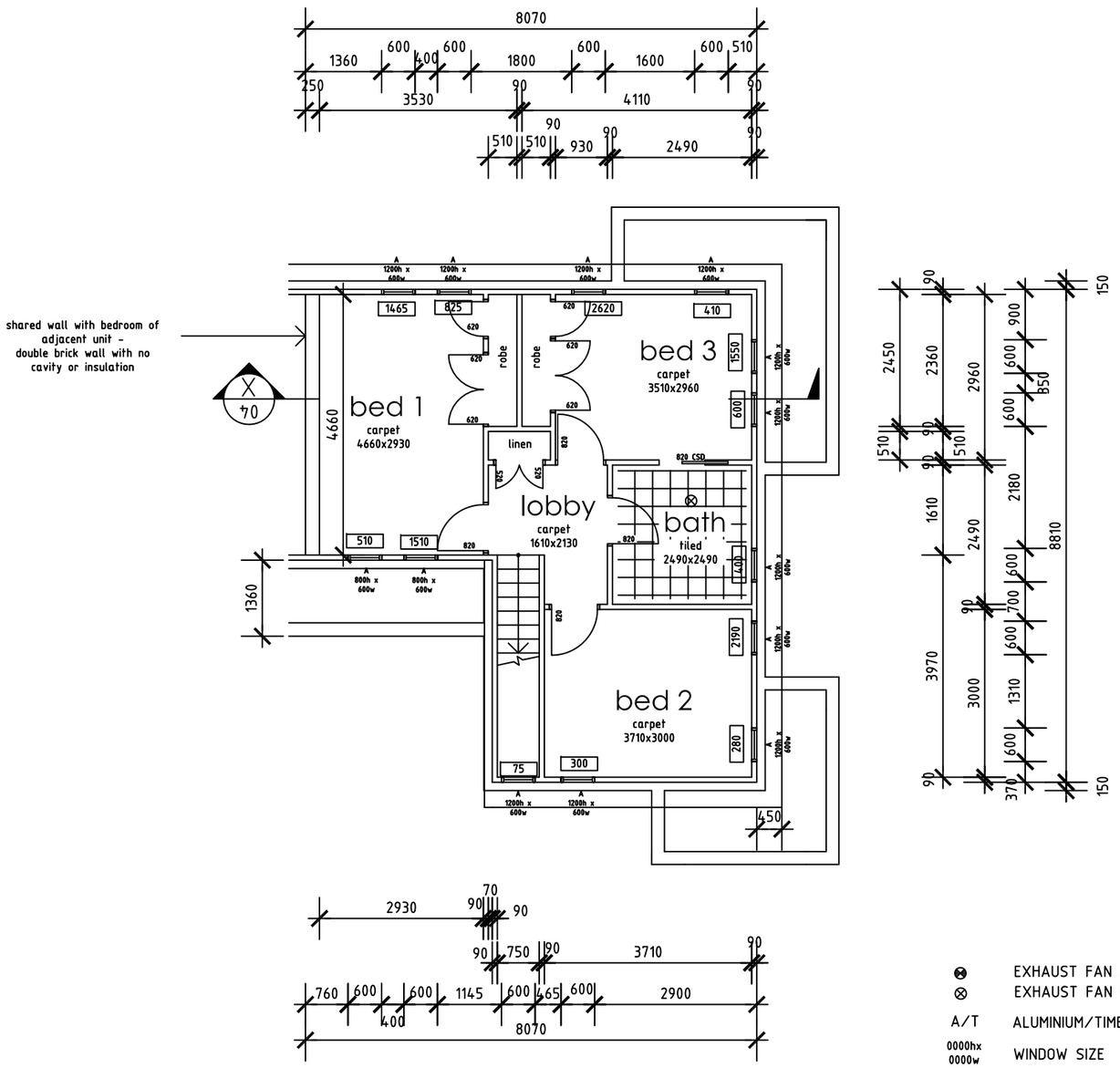
Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Orientation Diagram





⊗ EXHAUST FAN (sealed)
⊗ EXHAUST FAN (unsealed)
A/T ALUMINIUM/TIMBER FRAMED
0000hx 0000w WINDOW SIZE
0000 DIST. MM FROM RHS OF WINDOW TO WALL

first floor plan

scale 1:100

HOUSE ENERGY RATING

HOUSE 9
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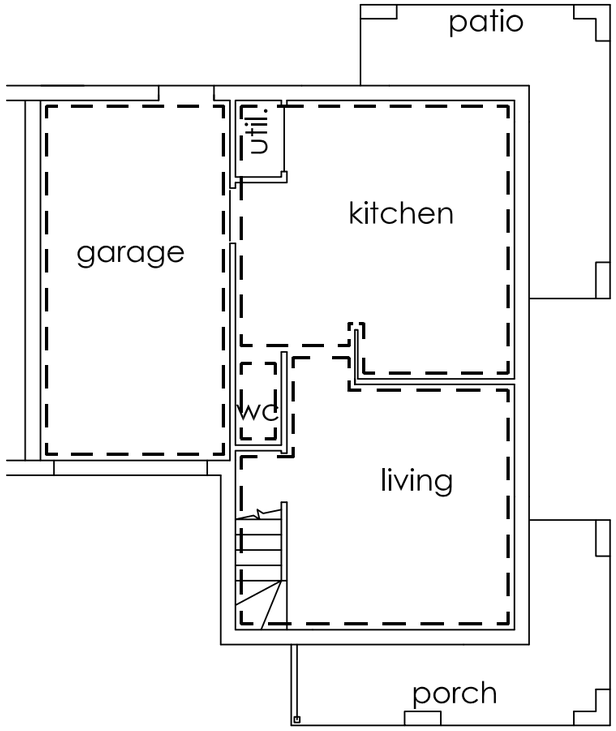
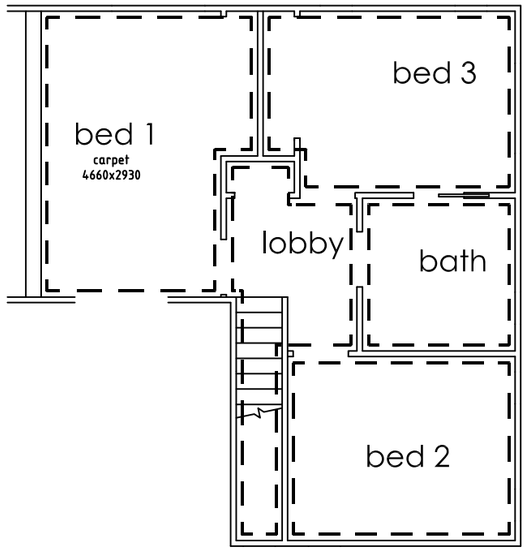
Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

FIRST FLOOR PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



ground floor zone diagram
scale 1:100



first floor zone diagram
scale 1:100

HOUSE
ENERGY RATING

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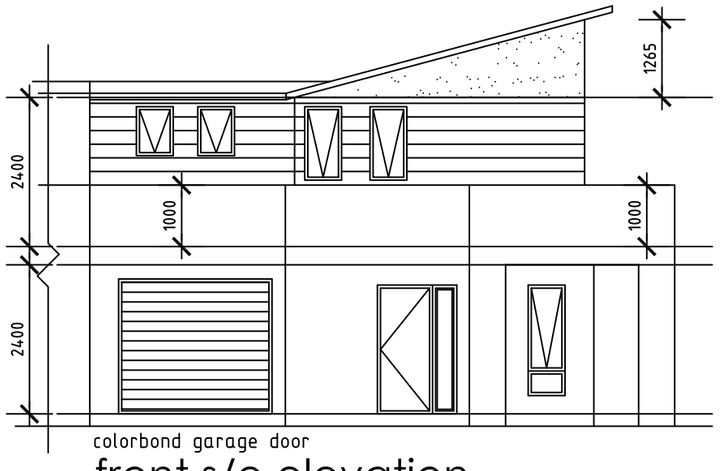
THERMAL ZONES PLAN

Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue

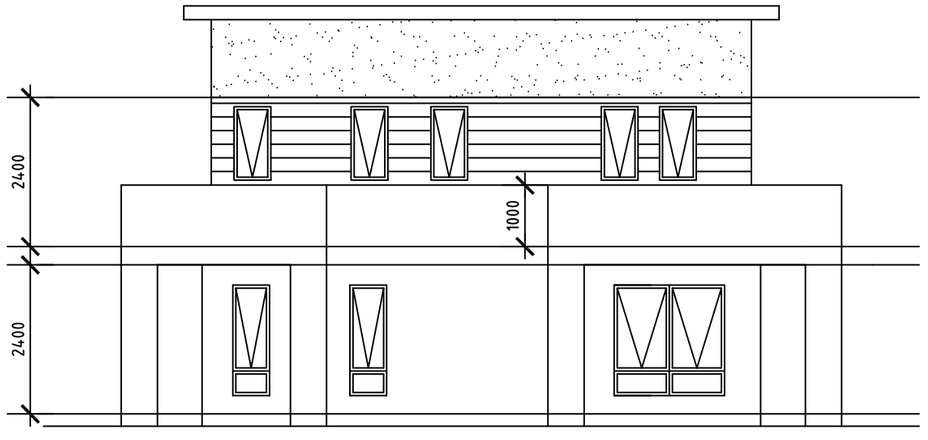
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



colorbond garage door

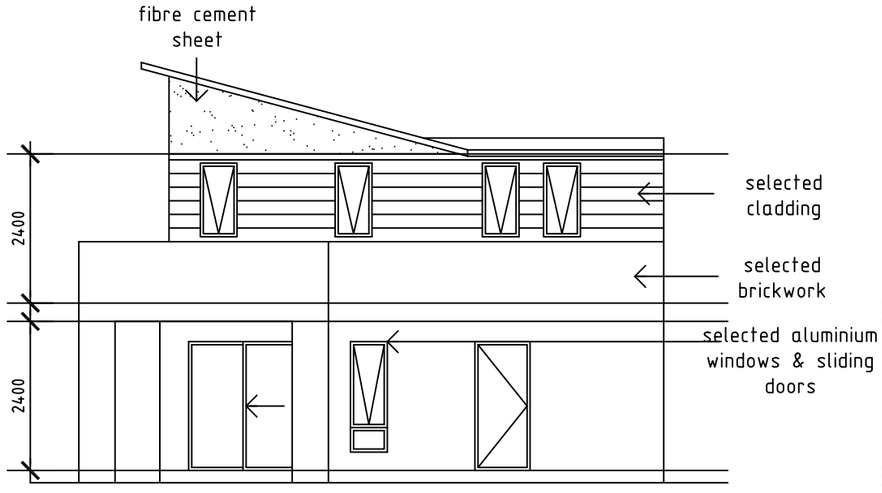
front s/e elevation

scale 1:100



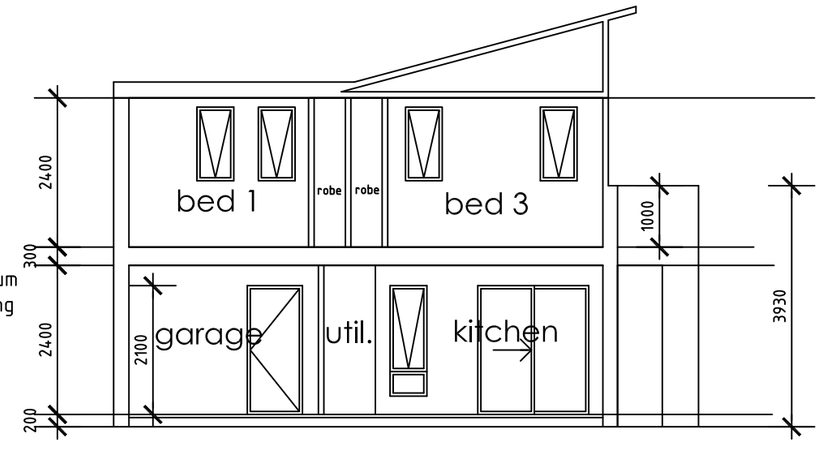
side n/e elevation

scale 1:100



rear n/w elevation

scale 1:100



section x-x

scale 1:100

HOUSE ENERGY RATING

HOUSE 9
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DRG 04 **A**

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ELEVATIONS & SECTION

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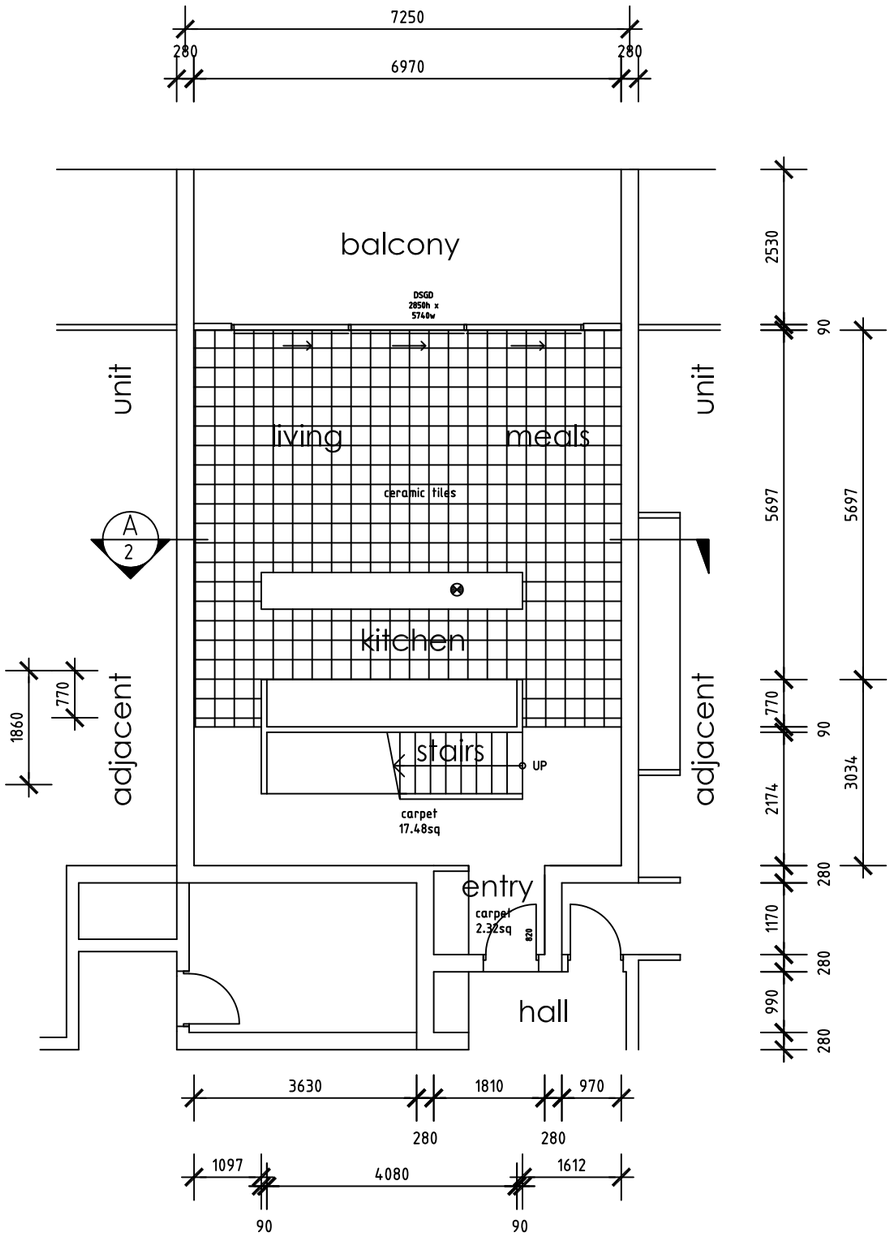
A	04.10.07	CLIENT ISSUE

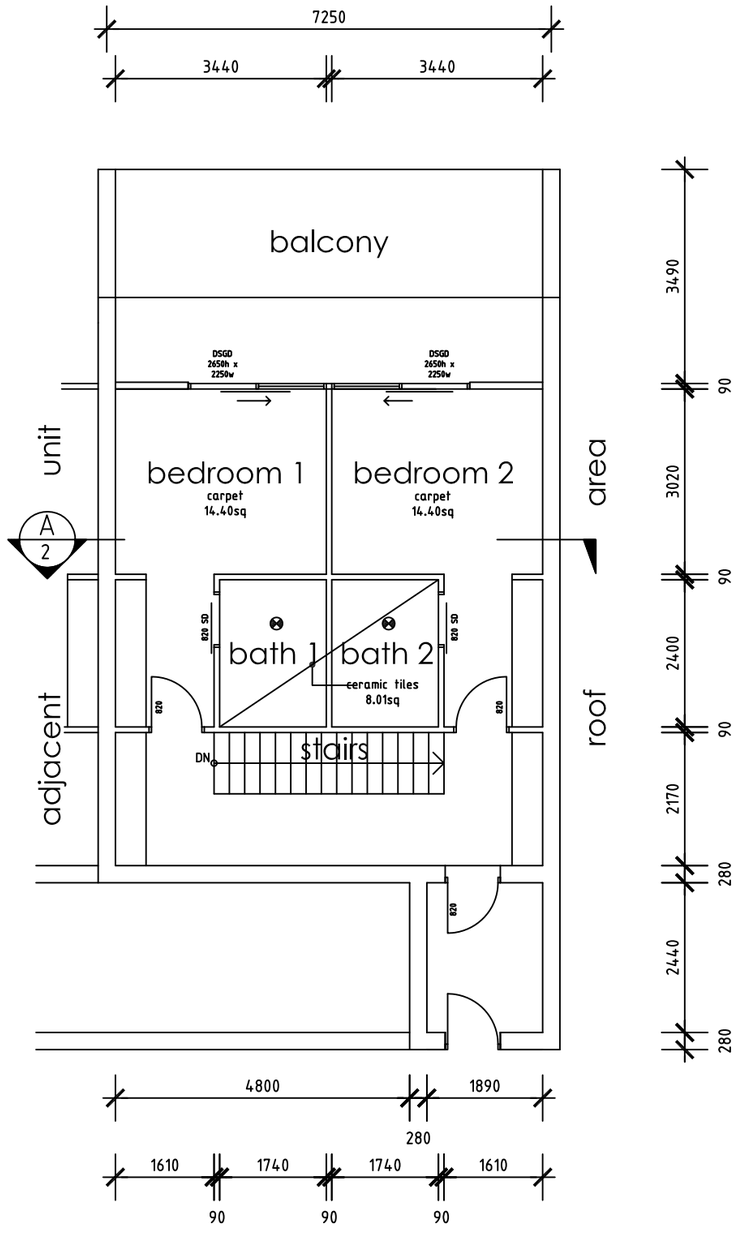
Appendix A.5: *House 10*

Double storey apartment 118m²



level 5 floor plan

scale 1:100



level 6 floor plan

scale 1:100

THERMAL ZONES

EXHAUST FAN (sealed)

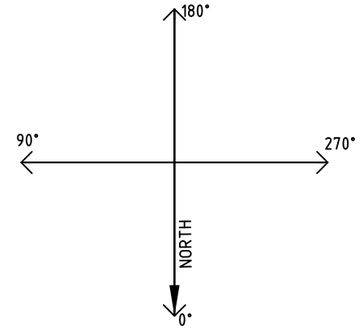
EXHAUST FAN (unsealed)

A ALUMINIUM FRAMED

0000hx 0000w WINDOW SIZE

0000 DIST. MM FROM RHS OF WINDOW TO WALL

Orientation Diagram



HOUSE ENERGY RATING

HOUSE 10
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DRG 01 **A**

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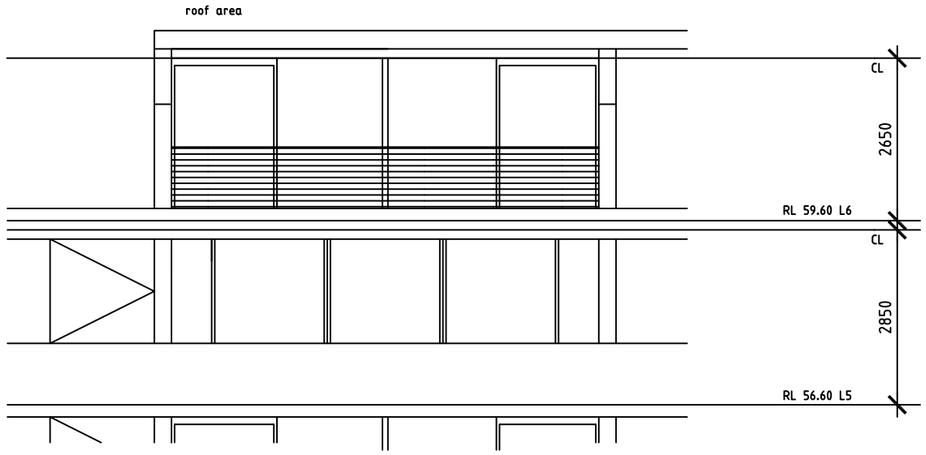
floor plans

Rev	Date	Issue

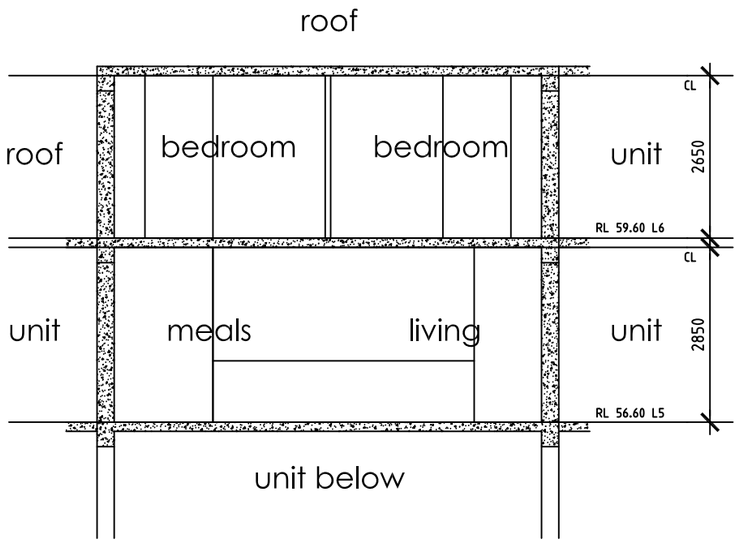
Rev	Date	Issue

Rev	Date	Issue

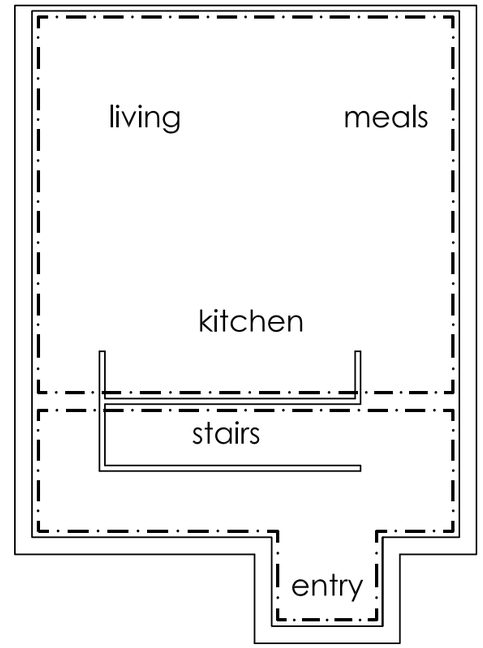
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



south elevation - part
scale 1:100

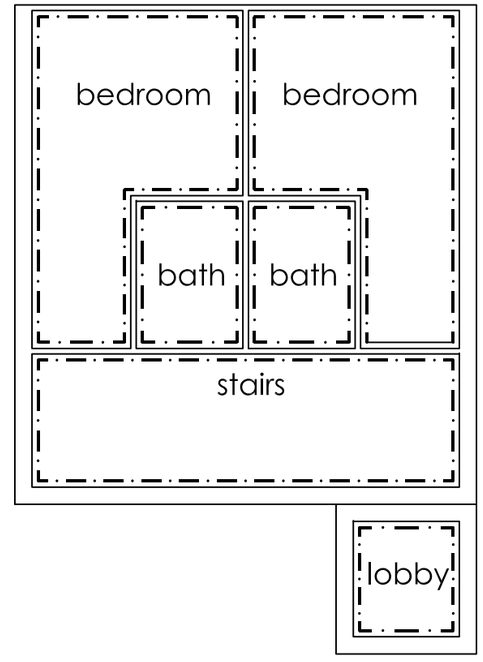


section A-A
scale 1:100



level 5 zone diagram
scale 1:100

thermal zones



level 6 zone diagram
scale 1:100

HOUSE
ENERGY RATING

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elevation, section & zone diagrams

Rev	Date	Issue

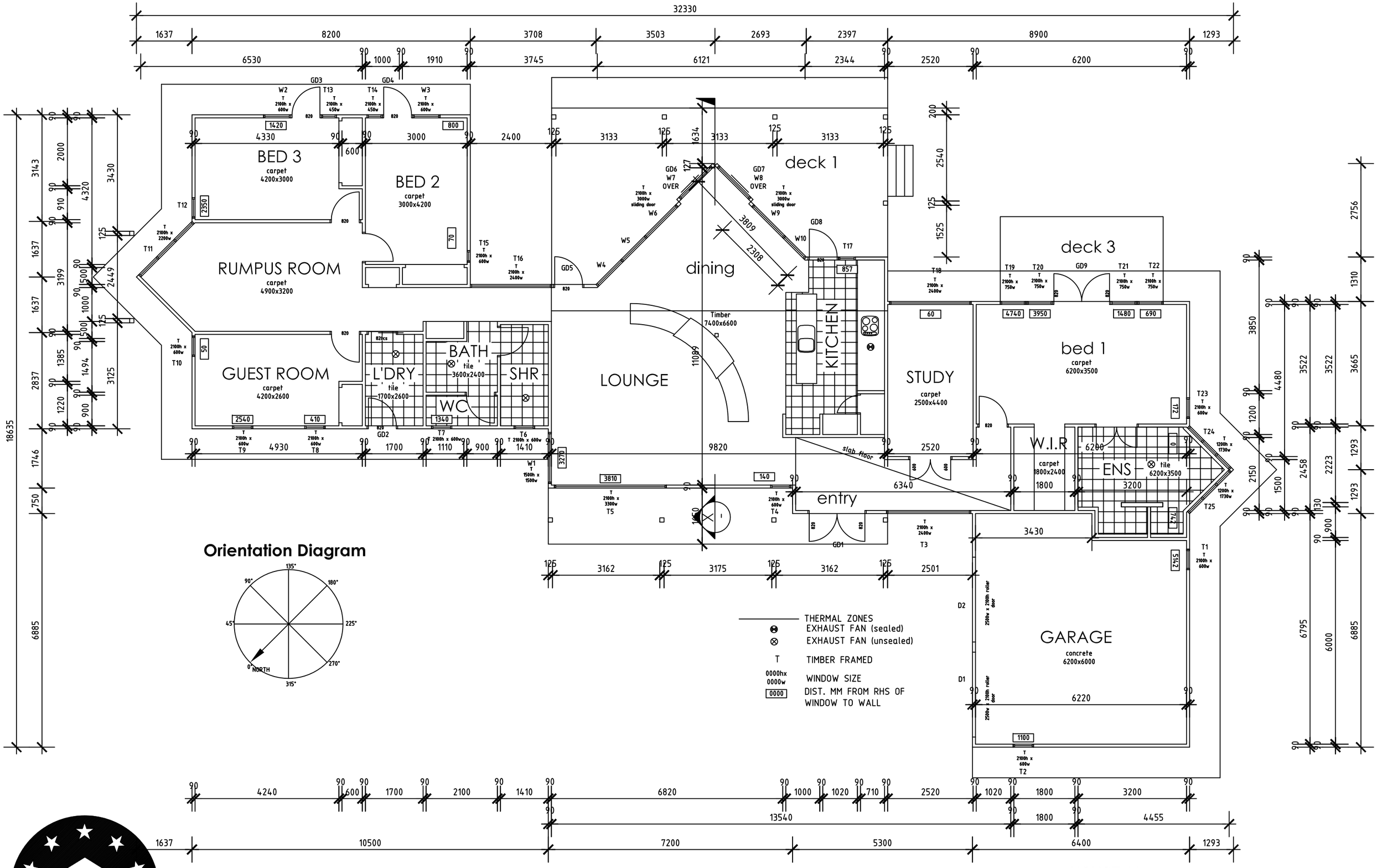
Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix A.6: *House 11*

Single storey 215m²



Orientation Diagram

HOUSE
ENERGY RATING

HOUSE 11
Australian Greenhouse Office
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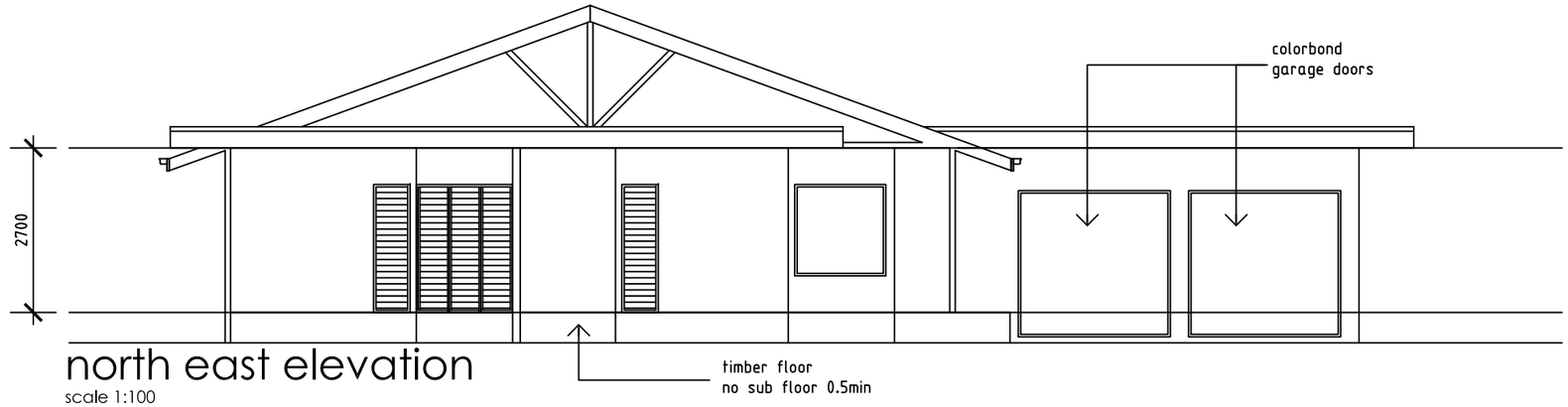
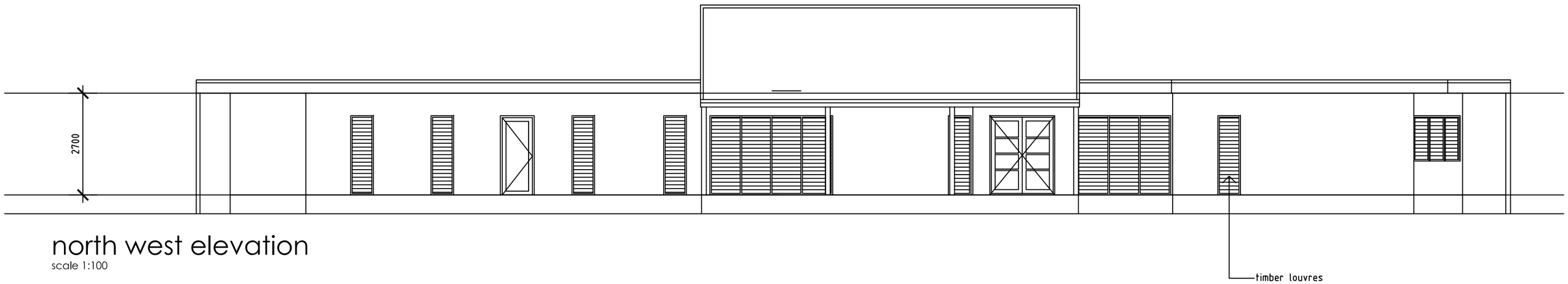
FLOOR PLAN

NORTH

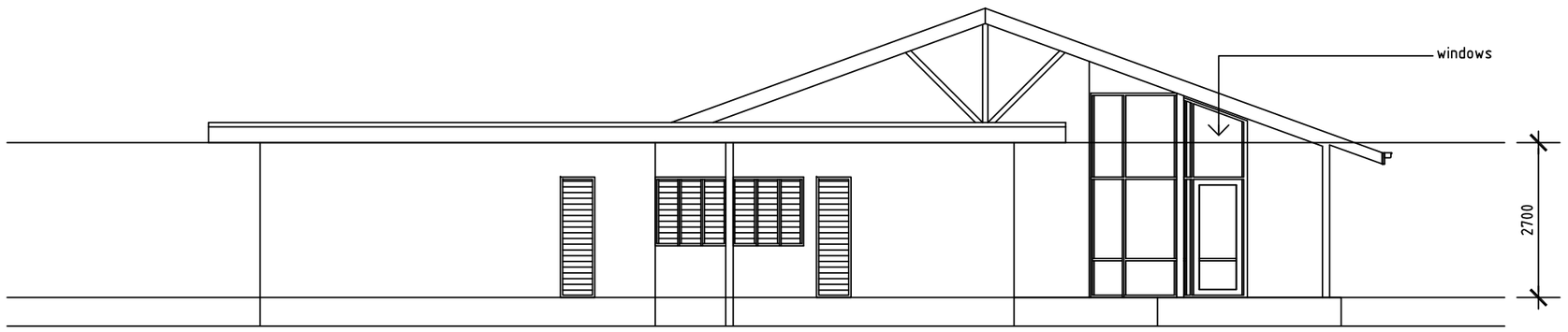
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



north east elevation
scale 1:100



north west elevation
scale 1:100



south west elevation
scale 1:100

HOUSE
ENERGY RATING

HOUSE 11
Australian Greenhouse Office
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Job No.	Scale.	Drawn.	Date.
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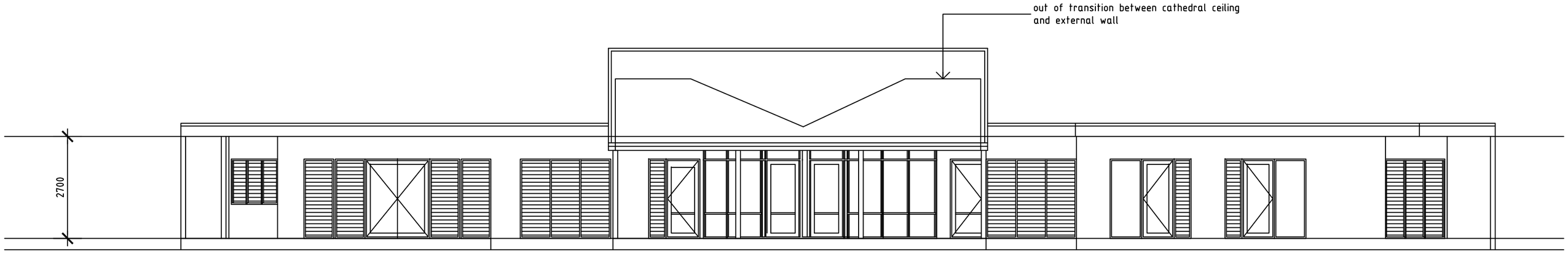
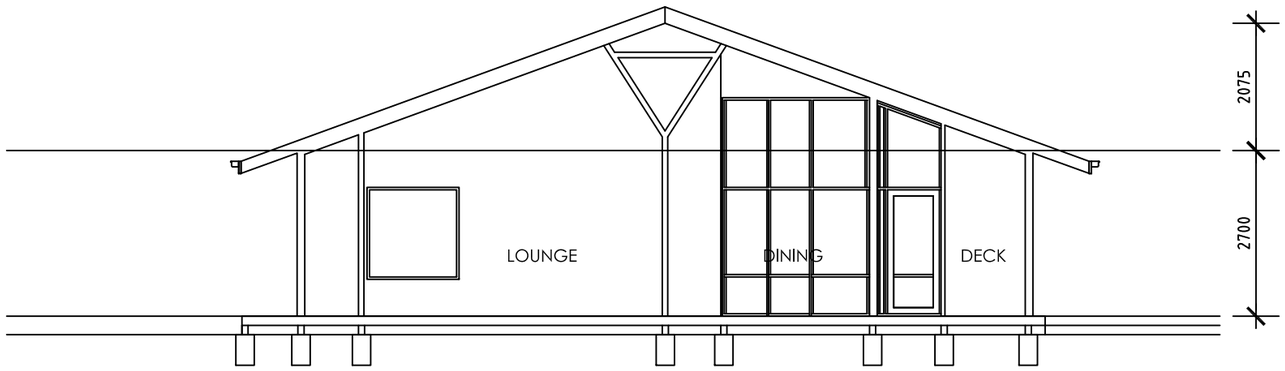
VARIATION ELEVATIONS

NORTH

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



south east elevation
scale 1:100



section x-x
scale 1:100

HOUSE
ENERGY RATING

HOUSE 11
DEWHA
NatHERS Software Accreditation

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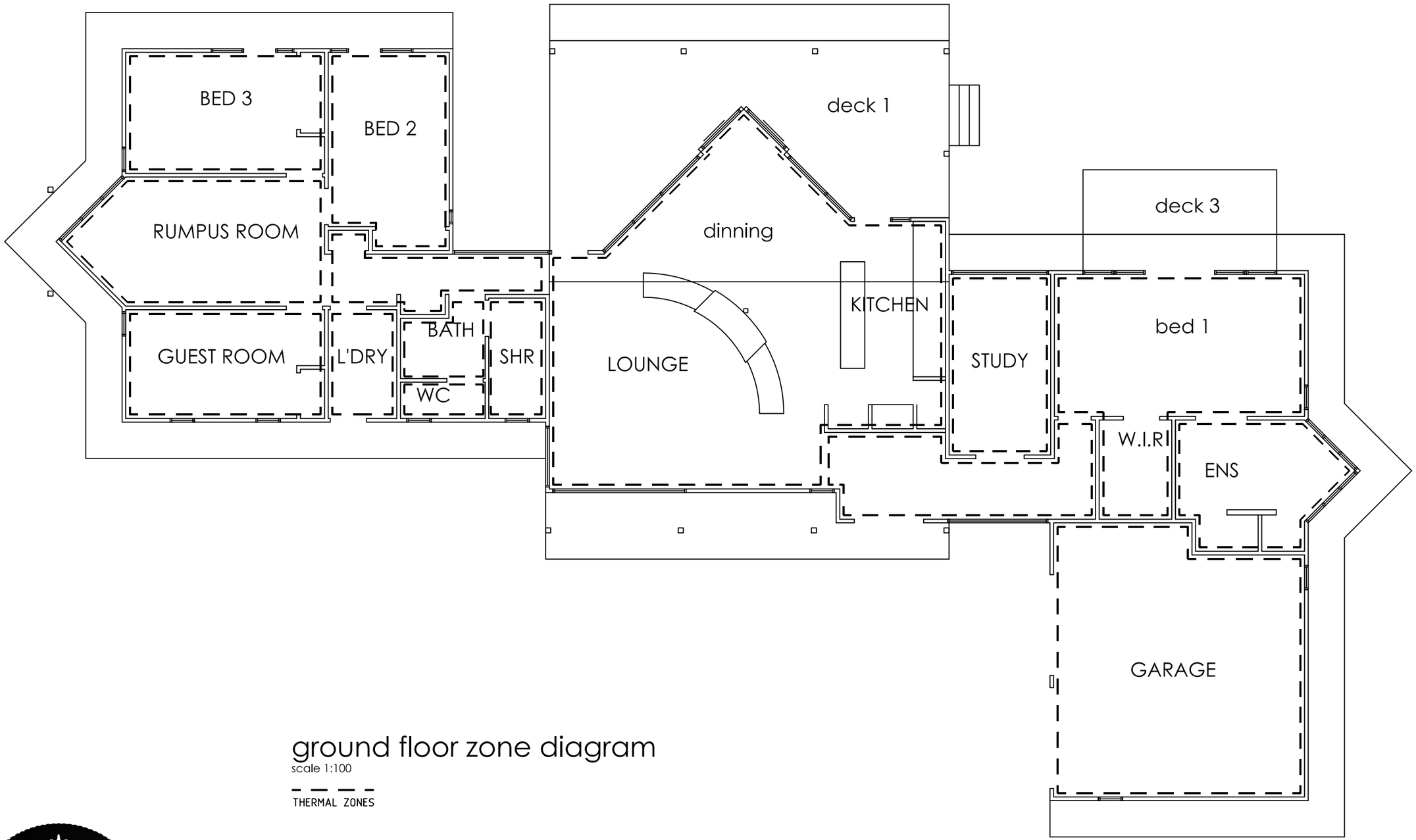
Variation 2 elevations and sections

NORTH

Rev	Date	Issue
P1	17.04.07	CLIENT ISSUE



ground floor zone diagram

scale 1:100

THERMAL ZONES

HOUSE ENERGY RATING

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Job No.	Scale.	Drawn.	Date.
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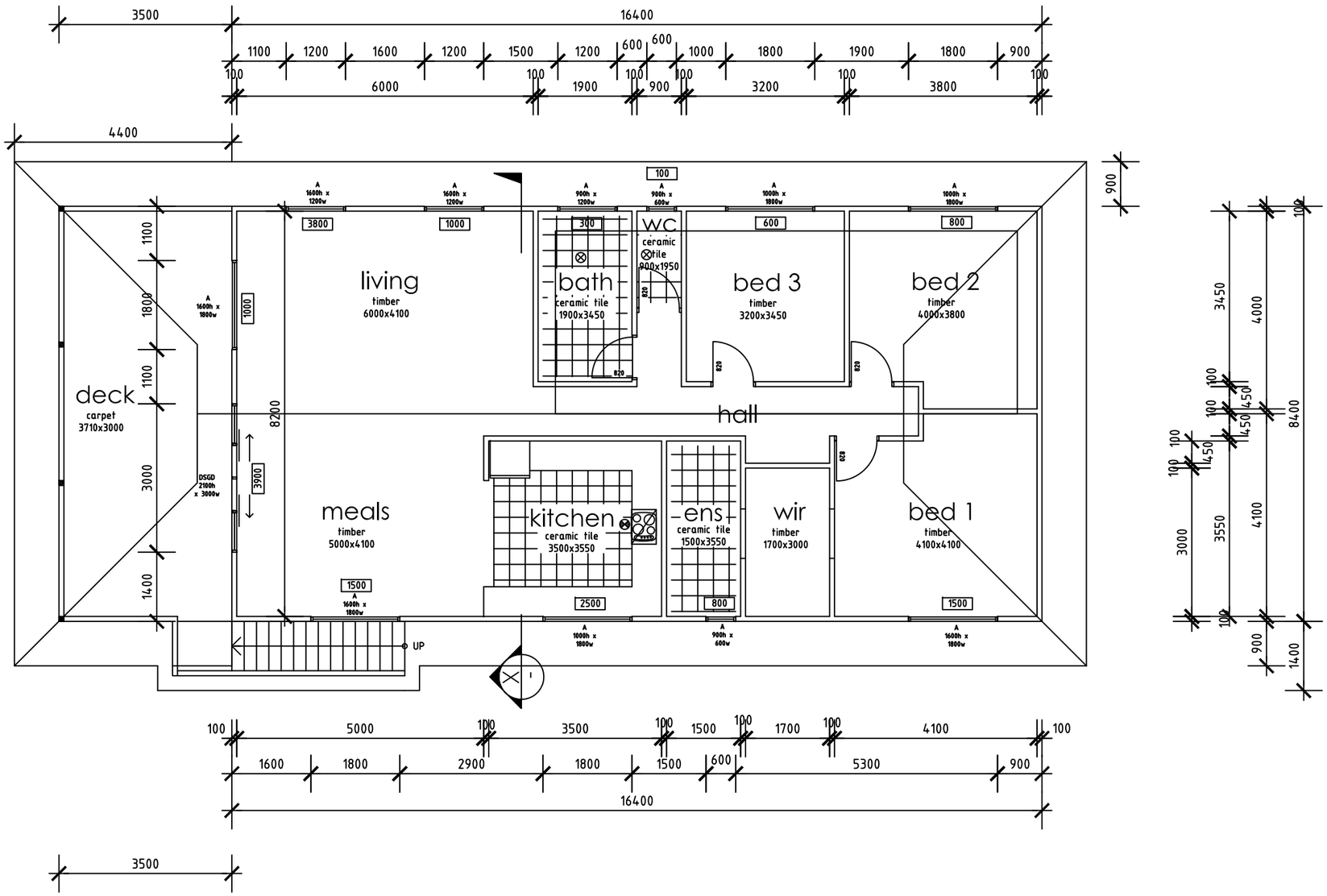
ZONE DIAGRAM

NORTH

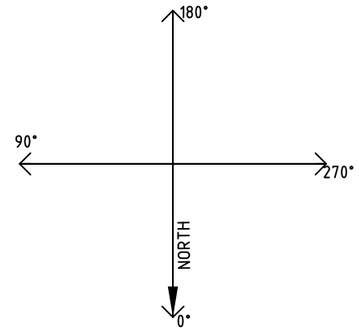
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix A.7: *House 12*

Double storey 117m²



Orientation Diagram



first floor plan

scale 1:100

⊗ EXHAUST FAN (sealed)
⊗ EXHAUST FAN (unsealed)
A/T ALUMINIUM/TIMBER FRAMED
0000hx 0000w WINDOW SIZE
0000 DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE ENERGY RATING

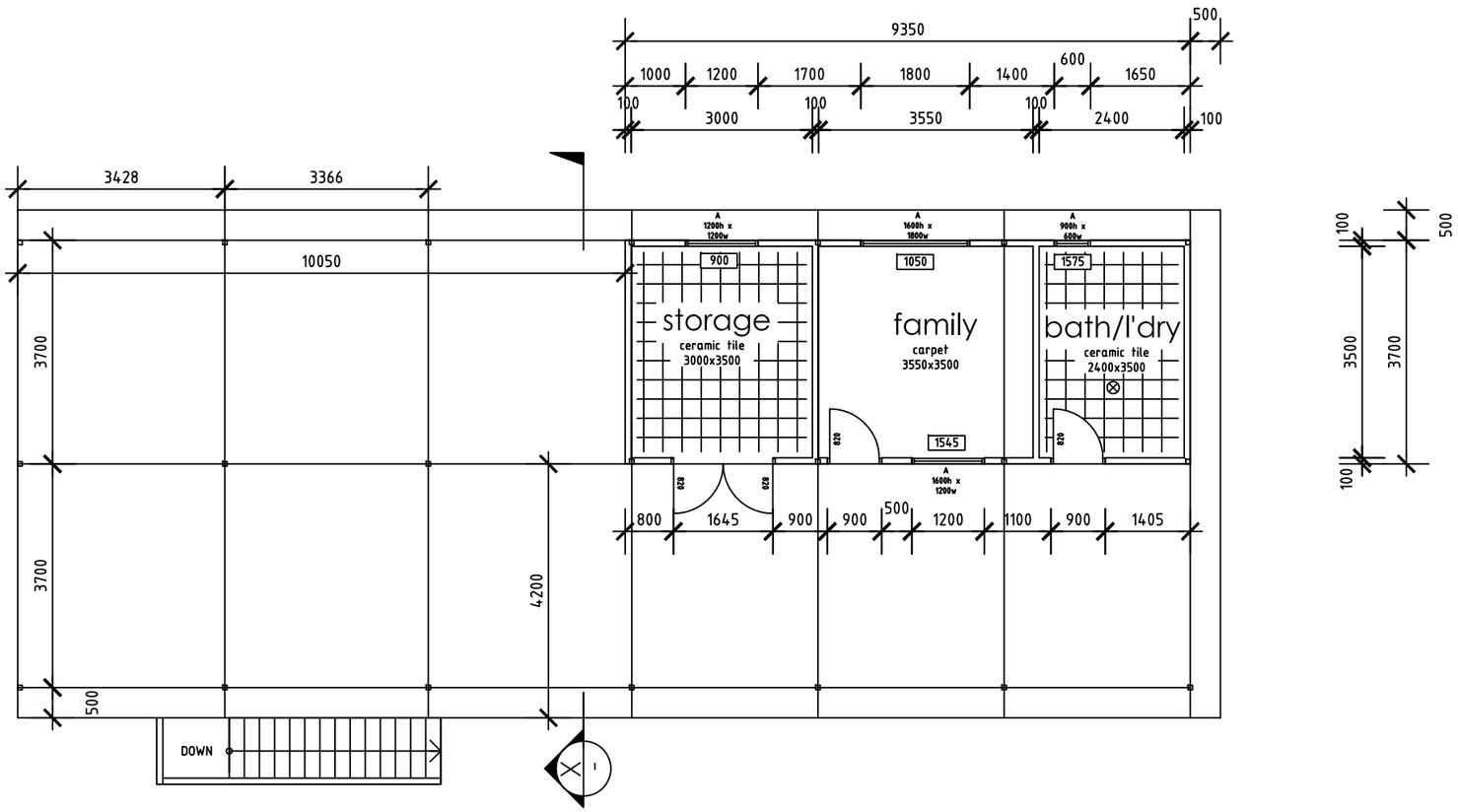
HOUSE 12
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 01 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

FIRST FLOOR PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



ground floor plan

scale 1:100

⊗ EXHAUST FAN (sealed)

⊗ EXHAUST FAN (unsealed)

A/T ALUMINIUM/TIMBER FRAMED

0000hx 0000w WINDOW SIZE

0000 DIST. MM FROM RHS OF WINDOW TO WALL

HOUSE ENERGY RATING

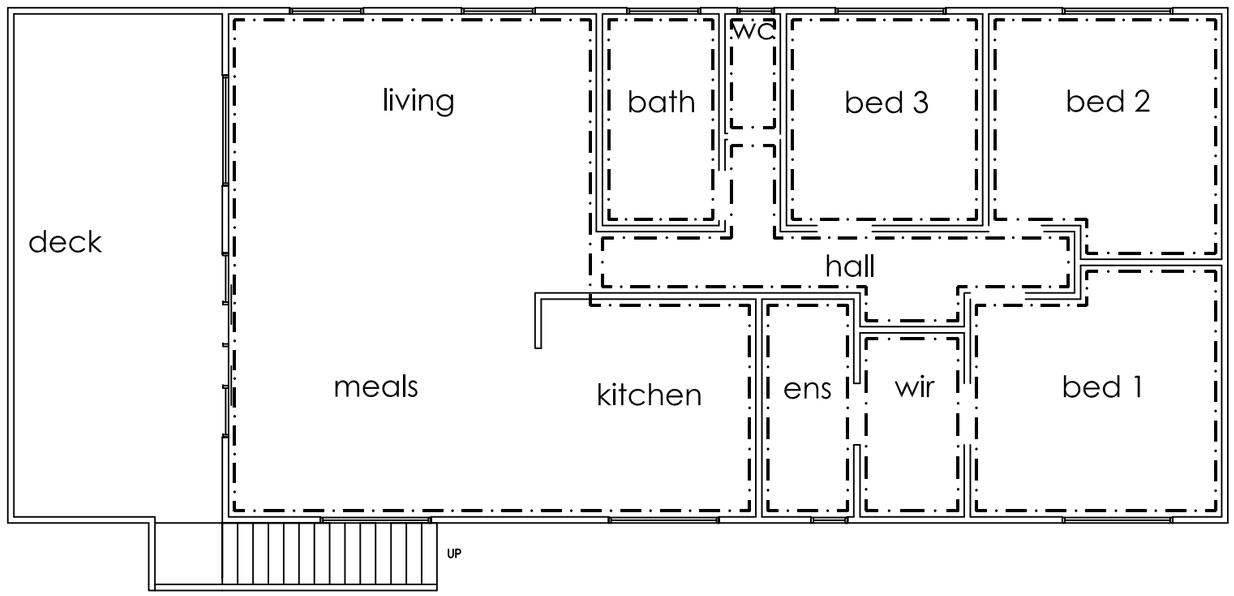
HOUSE 12
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 02 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

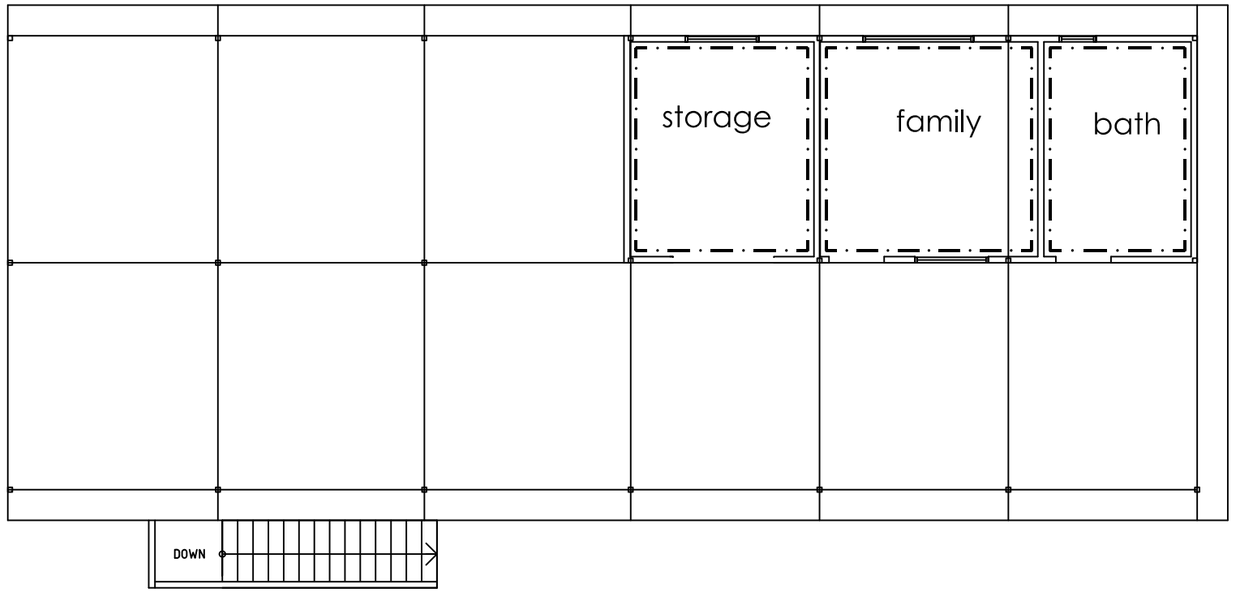
GROUND FLOOR PLAN PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



first floor zone diagram

scale 1:100



ground floor zone diagram

scale 1:100

HOUSE
ENERGY RATING

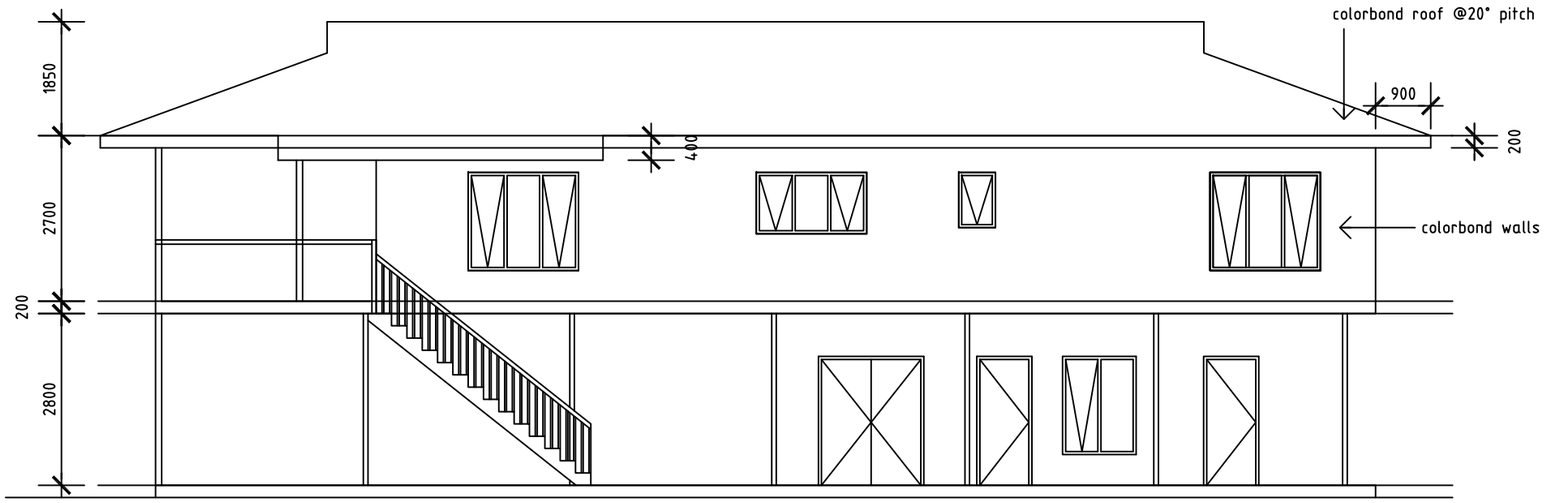
HOUSE 12
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 03 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

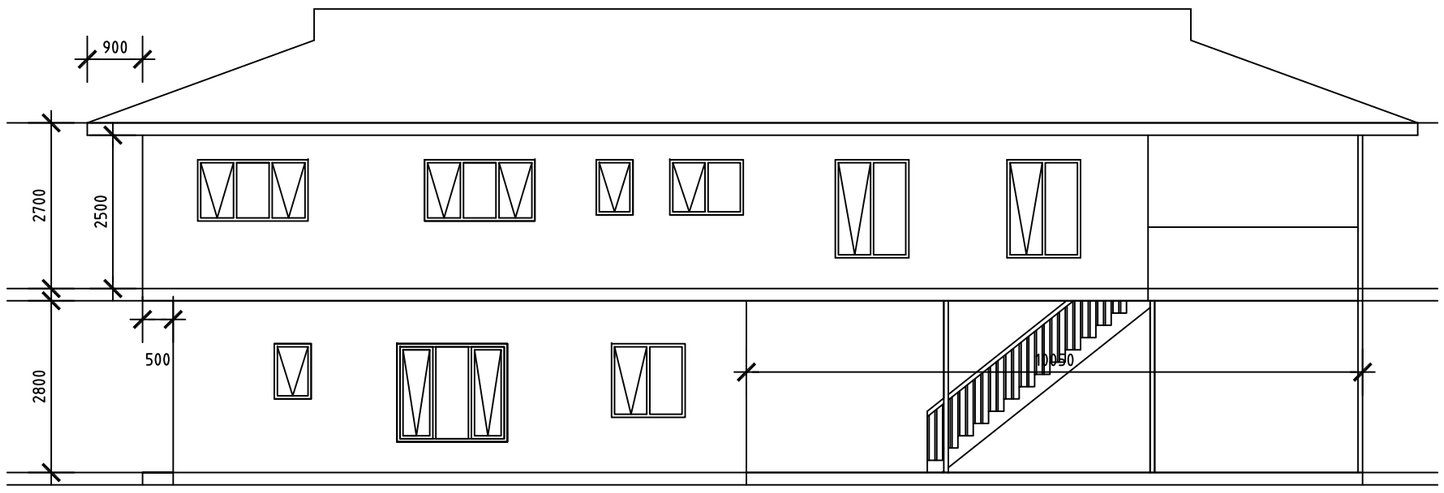
THERMAL ZONES PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



north elevation

scale 1:100



south elevation

scale 1:100

HOUSE
ENERGY RATING

HOUSE 12
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 04 **A**

Job No.	Scale.	Drawn.	Date.
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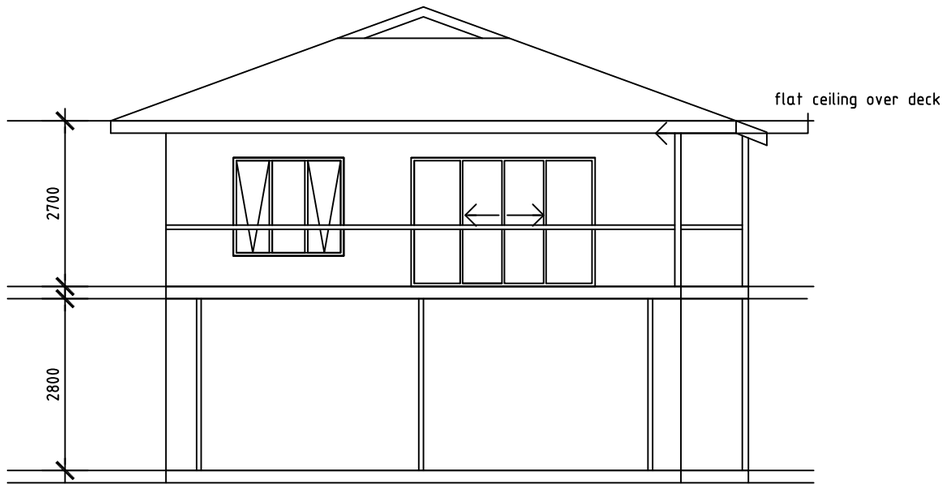
ELEVATIONS WINDOW VARIATIONS

Rev	Date	Issue

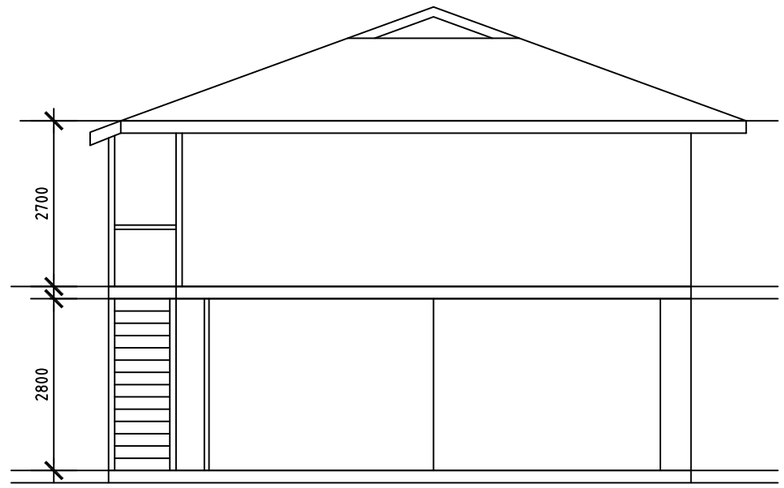
Rev	Date	Issue

Rev	Date	Issue

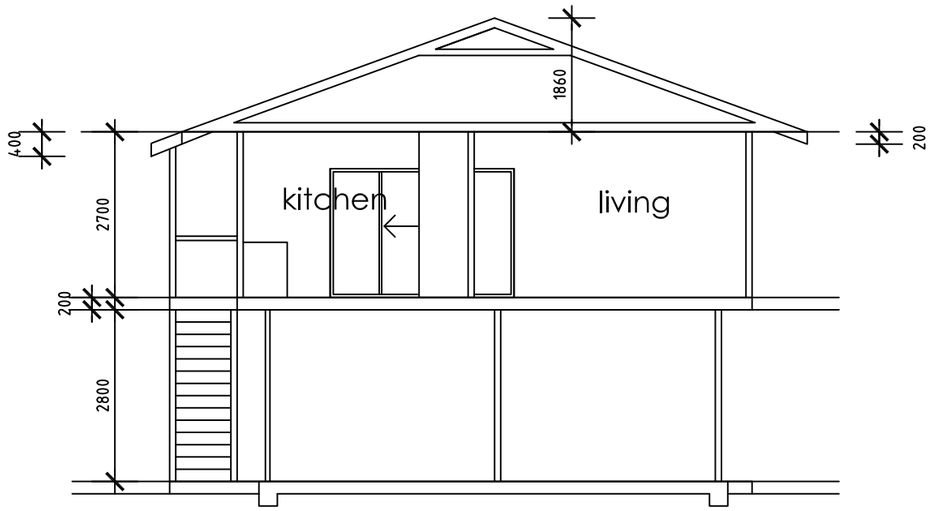
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



east elevation
scale 1:100



west elevation
scale 1:100



section x-x
scale 1:100

HOUSE
ENERGY RATING

HOUSE 12
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 05 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

ELEVATIONS & SECTION ALTERNATIVE

Rev	Date	Issue

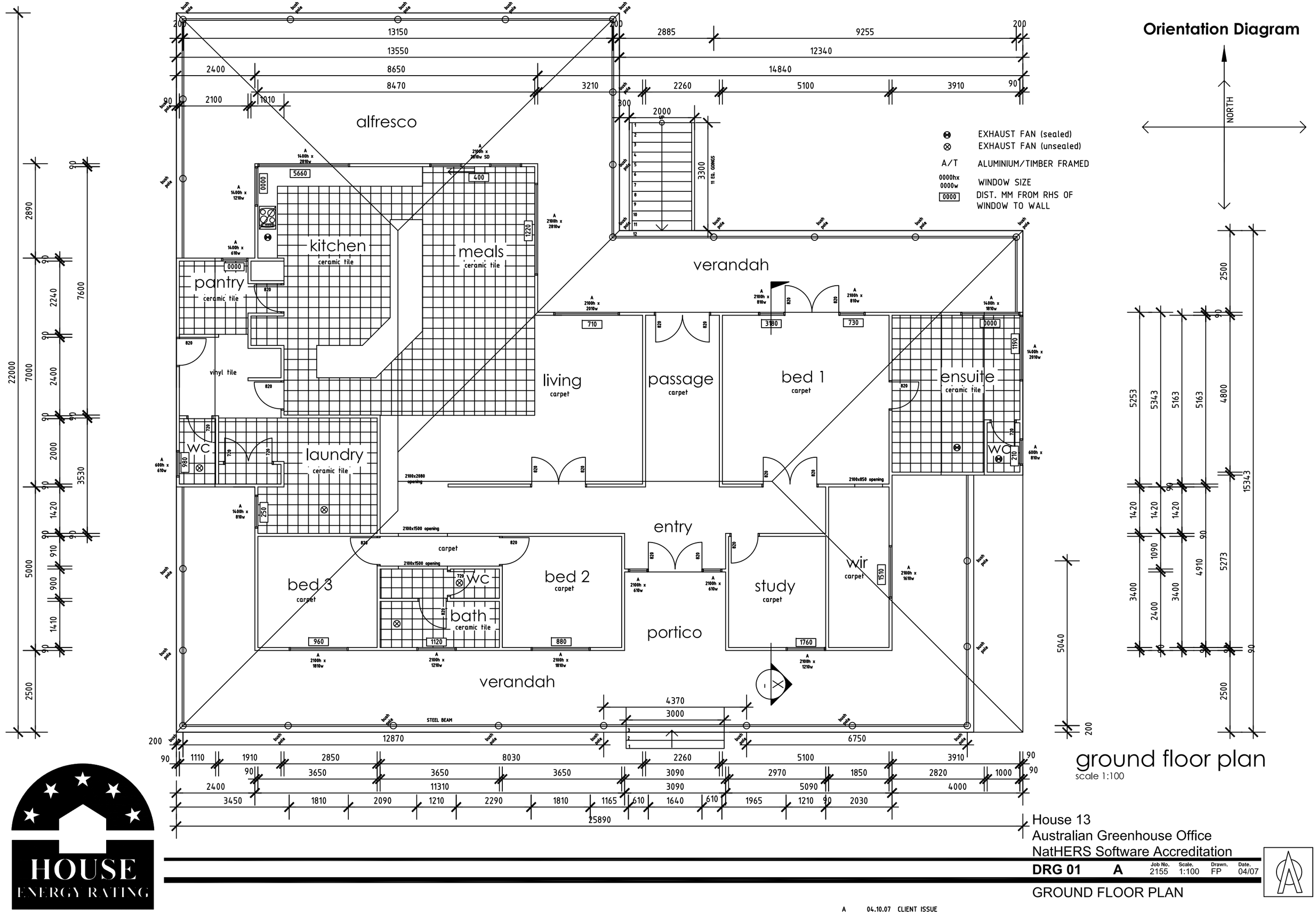
Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix A.8: *House 13*

Single storey 261m²



HOUSE ENERGY RATING

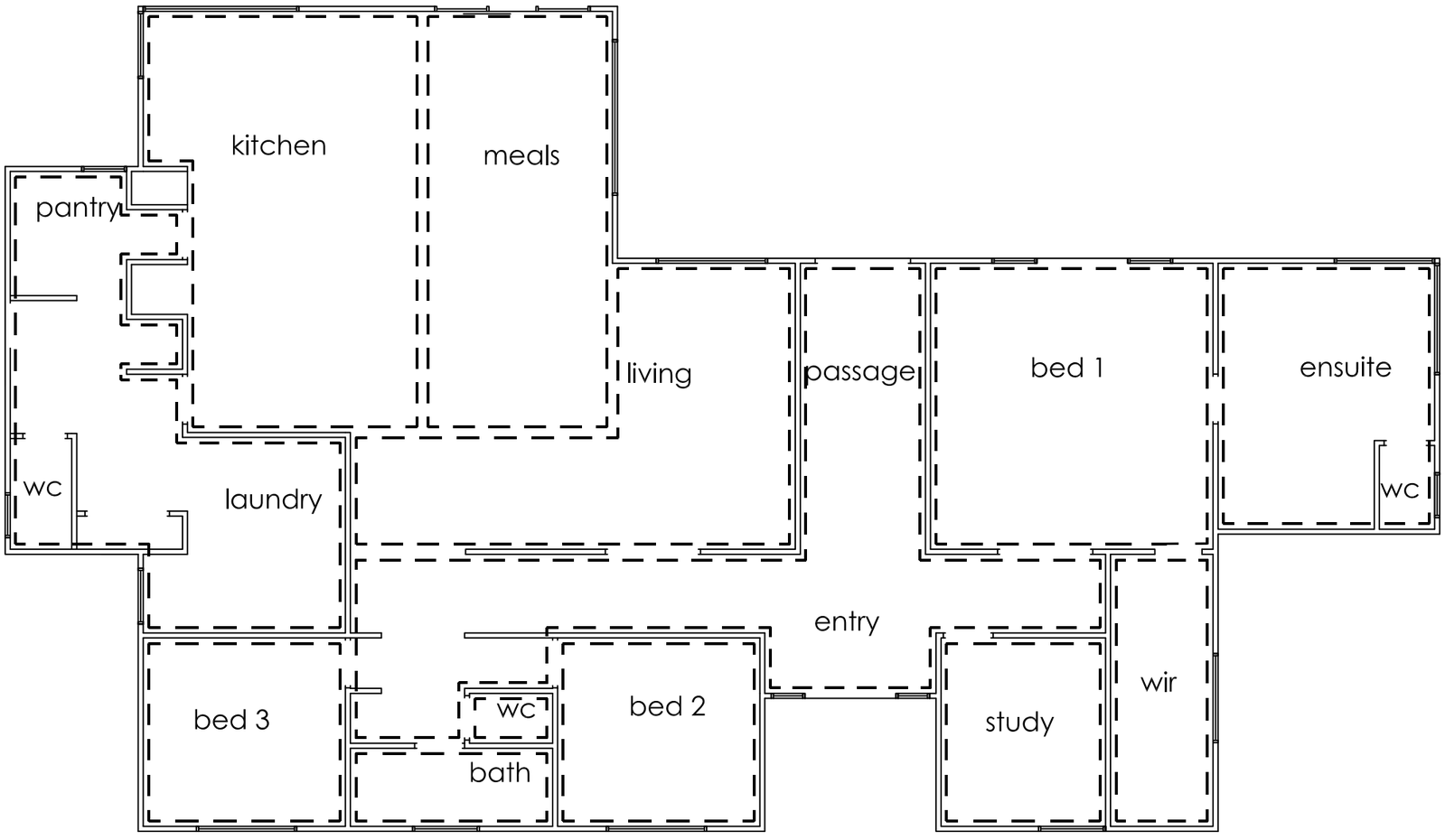
House 13
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 01 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

GROUND FLOOR PLAN

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



zone diagram

scale 1:100

HOUSE ENERGY RATING

House 13
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 02 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

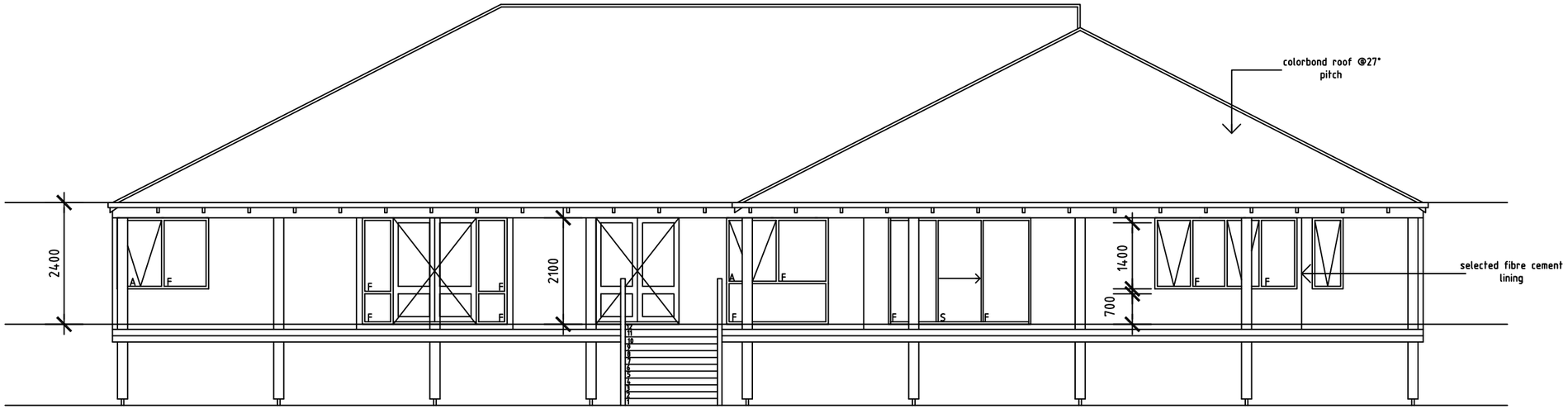
THERMAL ZONES PLAN

Rev	Date	Issue

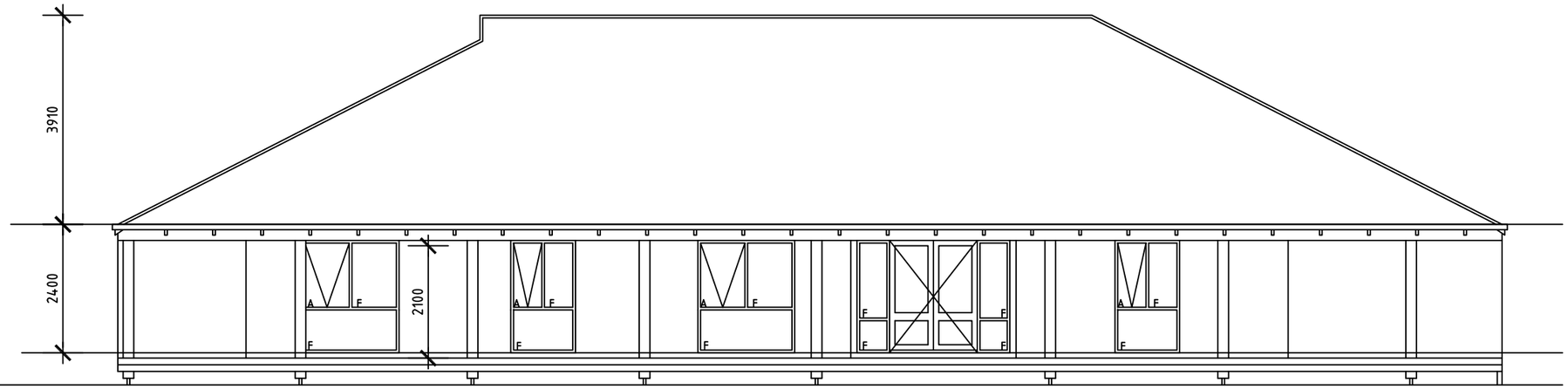
Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



north elevation
scale 1:100



south elevation
scale 1:100

HOUSE ENERGY RATING

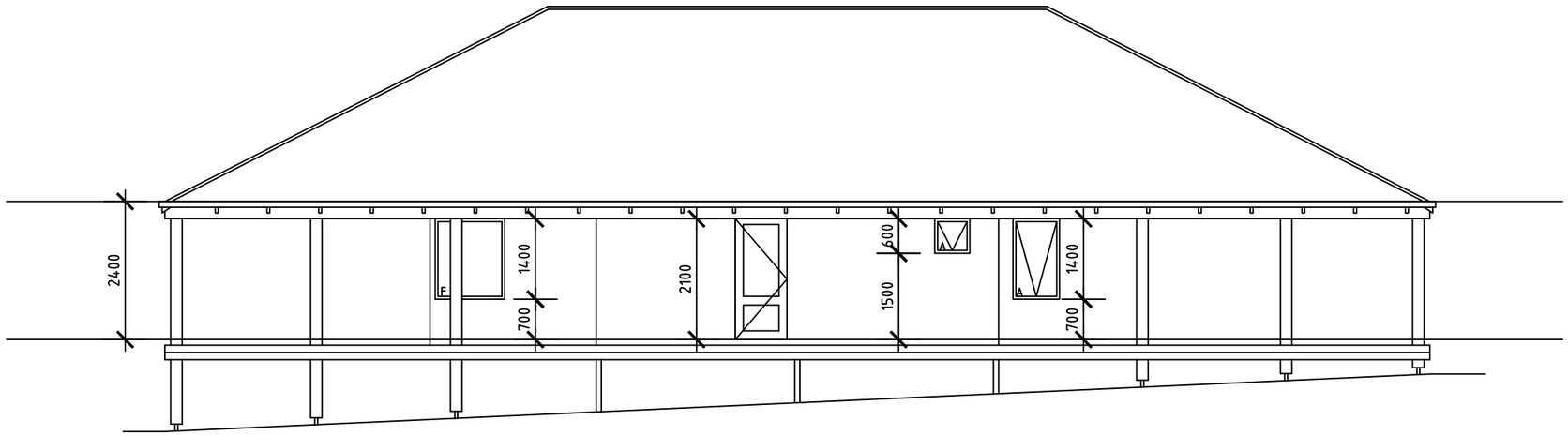
House 13
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 03 **A**

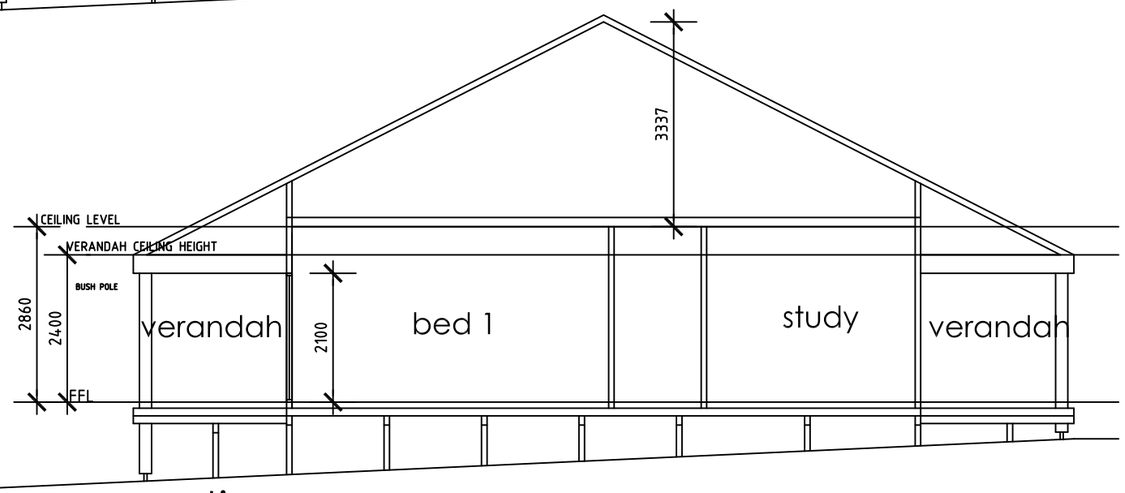
Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

ELEVATIONS

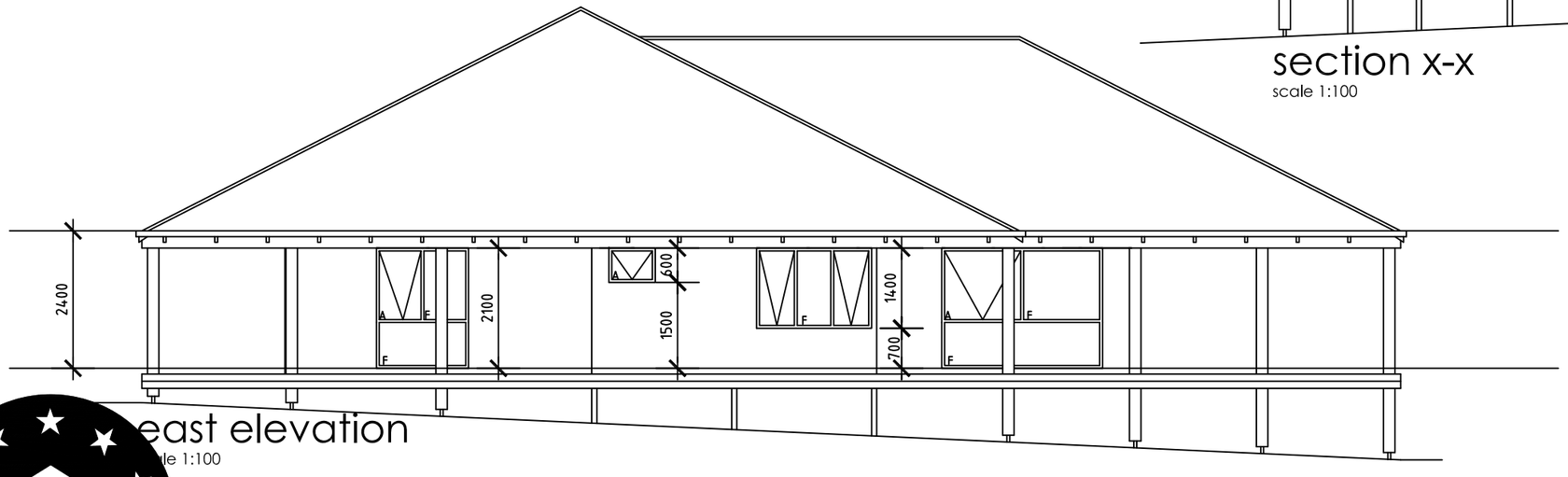
Rev	Date	Issue
A	04.10.07	CLIENT ISSUE



west elevation
scale 1:100



section x-x
scale 1:100



east elevation
scale 1:100

HOUSE ENERGY RATING

House 13
Australian Greenhouse Office
NatHERS Software Accreditation

DRG 04 **A**

Job No.	Scale.	Drawn.	Date.
2155	1:100	FP	04/07

ELEVATIONS
SECTION

Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue

Rev	Date	Issue
A	04.10.07	CLIENT ISSUE

Appendix B: Insulation in 6 star configurations

Introductory notes

The 8 tables in this appendix show the insulation added to floors, walls and roofs of dwellings with 6 star configurations. Resistance values refer to the insulating material alone rather than to the Total R-Value used in the BCA. AccuRate makes the necessary allowances for other construction materials, air spaces and reflective surfaces. They are also absolute values, not the incremental changes to the 5 star base cases. The insulation levels listed are not necessarily the optimal limits for their climates but were the appropriate choices in combination with other elements adjusted for economical energy efficiency.

Information is drawn from Excel pivot tables linked to the study database. The source tables can display insulation information for all ratings, a selected range of ratings or any single star level (within the 5-7 star range). In this appendix, only 6 star ratings are displayed.

Table colours vary to avoid confusion due to their similar layouts. In each table, houses are labelled on the left hand side with separate groups of rows below for their slab and timber floor variants. Applicable wall types are listed below each floor type in tables referring to floors and walls. The wall descriptors for external walls refer to the main walls of the dwellings. For House 12, these are the walls of the elevated upper floor. Tables referring to roof insulation have separate rows for each level of roof space ventilation. At the top of all tables, NatHERS climates appear in order of the 8 BCA *climate zones*. (Due to a limitation in Excel 2007's printing of pivot tables, column headings appear below tables carried over onto a second page.)

The body of each table shows both maximum and minimum added R-Values. These numbers always match, except in the final summary row, because the tables cover only the 6 star configurations. The maximum and minimum values have different formats to distinguish them. (Minimum values are non bold and lack the R prefix). Blank cells indicate that the particular form of construction does not exist in the database.

Additional notes above each table explain details relevant mainly to that table. Pages with tables are numbered only within the context of each appendix. Introductory pages for this and other appendices have numbers which refer to the whole document.

Fabric Table 1: Insulation added to walls of subfloor enclosure (R-Values)

Sublfoor walls of weatherboard walls are generally fibre cement clad.

Most likely insulation for subfloor walls (of all types) is expanded polystyrene (EPS) boards. R2 for EPS implies about 75mm thickness.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Walls	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab																								
Brick Cavity													**-**	-										
Brick Veneer			**-**	-	**-**	-	**-**	-	**-**	-	**-**	-			**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Concrete Block	**-**	-																						
Weatherboard	**-**	-																						
Timber																								
Brick Cavity													**R1**	1										
Brick Veneer			**-**	-	**R1**	1	**R1**	1	**R1**	1	**R1**	1			**R2**	2	**-**	-	**-**	-	**-**	-	**-**	-
Concrete Block	**-**	-																						
Weatherboard	**R1.5**	1.5																						
House 4																								
Slab																								
Brick Cavity													**-**	-										
Brick Veneer	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-			**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
Brick Cavity													**-**	-										
Brick Veneer	**R1**	1	**R1**	1	**R1**	1	**R1**	1	**R1.5**	1.5	**R1.5**	1.5			**R1.5**	1.5	**-**	-	**-**	-	**-**	-	**-**	-
House 8																								
Slab																								
Brick Cavity													**-**	-										
Brick Veneer	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-			**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
Brick Cavity													**R1**	1										
Brick Veneer	**R1.5**	1.5	**-**	-	**R1**	1	**R1.5**	1.5	**R2**	2	**R2**	2			**R1.5**	1.5	**-**	-	**-**	-	**-**	-	**-**	-

House 9																								
Slab																								
Brick Cavity													**-**	-										
Brick Veneer	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-			**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
Brick Cavity													**R1**	1										
Brick Veneer	**R1.5**	1.5	**-**	-	**R1**	1	**R1**	1	**R2**	2	**R2**	2			**R1.5**	1.5	**-**	-	**-**	-	**-**	-	**-**	-
House 10																								
Slab																								
Concrete Panel	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 11																								
Slab																								
Weatherboard	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
Weatherboard	**R2**	2	**R1**	1	**R1**	1	**R2**	2	**R2**	2	**R2**	2	**R1.5**	1.5	**R1.5**	1.5	**-**	-	**-**	-	**-**	-	**-**	-
House 12																								
Timber																								
Weatherboard	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 13																								
Slab																								
Weatherboard	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
Weatherboard	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
max/min R in climate	**R2**	**-**	**R1**	**-**	**R1**	**-**	**R2**	**-**	**R2**	**-**	**R2**	**-**	**R1.5**	**-**	**R2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 2: Insulation added to underside of main floor (R-Values)

Main floor is the ground floor except in the case of elevated House 12. (In House 12 it is the greater portion of the elevated floor that is not above ground floor rooms.)
Rows below the floor types show the type of subfloor enclosure (always NA for slabs).
R1 insulation to slab floors refers to uninsulated Waffle slab construction to which AccuRate awards an intrinsic R1.
House 10 (a mid level apartment with no insulated floors) is not shown.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Enclosure	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab																								
NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R1**	1	**R1**	1
Timber																								
Enclosed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R2**	2	**R2**	2	**R2**	2	**R2**	2
House 4																								
Slab																								
NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R1**	1	-	-
Timber																								
Enclosed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R2**	2	**R2**	2	**R2**	2	**R1.5**	1.5
House 8																								
Slab																								
NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R1**	1	**R1**	1
Timber																								
Enclosed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R2.5**	2.5	**R2.5**	2.5	**R1.5**	1.5	**R2.5**	2.5
House 9																								
Slab																								
NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R1**	1	**R1**	1	**R1**	1
Timber																								
Enclosed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R3**	3	**R3**	3	**R3**	3	**R3**	3
House 11																								
Slab																								
NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R1**	1	**R1**	1	**R1**	1
Timber																								
Enclosed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**R2**	2	**R2**	2	**R2**	2	**R2**	2

House 12																								
Timber																								
Elevated	**-**	-	**-**	-	**R2.5**	2.5	**R2.5**	2.5	**R3.5**	3.5	**R3.5**	3.5	**R3.5**	3.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
House 13																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**R1**	1	**R1**	1	**-**	-
Timber																								
Open	**-**	-	**R2.5**	2.5	**R2.5**	2.5	**R3.5**	3.5	**R3**	3	**R3**	3	**R3.5**	3.5	**R3**	3	**R3**	3	**R3**	3	**R3**	3	**R3**	3
max/min R in climate	**-**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R3.5**	**-**	**R3.5**	**-**	**R3.5**	**-**	**R3.5**	**-**	**R3**	**-**	**R3**	**-**	**R3**	**-**	**R3**	**1**	**R3**	**-**

repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 3: Insulation added to minor floor (R-Values)

Minor floor is the upper floor except in the case of elevated House 12, where it is the smaller portion of the elevated floor that is above ground floor rooms.
House 9 upper floor insulation is installed to only part of the floor in listed climates other than Longreach, Mildura and Adelaide.
House 10 (a mid level apartment with no insulated floors) is not shown.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Main Floor	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 4																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 8																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 9																								
Slab	-	-	-	-	-	-	-	-	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	-	-	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
House 11																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 12																								
Timber	-	-	-	-	-	-	-	-	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
House 13																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
max/min R in climate	-	-	-	-	-	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-	**R2.5**	-

Fabric Table 4: Insulation added to external walls of Wall Type 1 (R-Values)
Wall Type 1 is the dominant wall type which may occur on one or more storeys.
Any secondary wall type is shown in Fabric Table 5.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Walls	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab																								
Brick Cavity													-	-										
Brick Veneer			-	-	-	-	-	-	R2	2	R2	2			R2	2	R2	2	R2	2	R1.5	1.5	R2	2
Concrete Block	-	-																						
Weatherboard	-	-																						
Timber																								
Brick Cavity													-	-										
Brick Veneer			-	-	-	-	R2	2	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
Concrete Block	-	-																						
Weatherboard	-	-																						
House 4																								
Slab																								
Brick Cavity													-	-										
Brick Veneer	R2	2	-	-	-	-	-	-	R2	2	R2	2			-	-	R2	2	R2	2	R1.5	1.5	R2	2
Timber																								
Brick Cavity													-	-										
Brick Veneer	R2	2	-	-	-	-	-	-	R2	2	R2	2			-	-	R2	2	R2	2	R1.5	1.5	R2	2
House 8																								
Slab																								
Brick Cavity													-	-										
Brick Veneer	R2.5	2.5	-	-	R2	2	-	-	R2.5	2.5	R2.5	2.5			R2.5	2.5	R2.5	2.5	R2.5	2.5	R2.5	2.5	R2.5	2.5
Timber																								
Brick Cavity													R1	1										
Brick Veneer	R2.5	2.5	-	-	R2	2	R2.5	2.5	R2.5	2.5	R2.5	2.5			R2.5	2.5	R2.5	2.5	R2.5	2.5	R2.5	2.5	R2.5	2.5

House 9																								
Slab																								
Brick Cavity													**R1**	1										
Brick Veneer	**-**	-	**-**	-	**-**	-	**R2**	2	**R2**	2	**R2**	2			**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2
Timber																								
Brick Cavity													**R1**	1										
Brick Veneer	**R1.5**	1.5	**R1.5**	1.5	**-**	-	**R2**	2	**R2.5**	2.5	**R2.5**	2.5			**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
House 10																								
Slab																								
Concrete Panel	**-**	-	**-**	-	**-**	-	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2
House 11																								
Slab																								
Weatherboard	**-**	-	**-**	-	**R2**	2	**R2**	2	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
Timber																								
Weatherboard	**R2**	2	**-**	-	**R2**	2	**R2.5**	2.5	**R2**	2	**R2**	2	**R2**	2	**R2.5**	2.5	**R2**	2	**R2**	2	**R2**	2	**R2**	2
House 12																								
Timber																								
Weatherboard	**R2**	2	**-**	-	**R2**	2	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2**	2	**R2**	2	**R2.5**	2.5	**R2**	2	**R2**	2
House 13																								
Slab																								
Weatherboard	**-**	-	**-**	-	**-**	-	**-**	-	**R2**	2	**R2**	2	**R2**	2	**R1.5**	1.5	**R2**	2	**R2**	2	**R2**	2	**R2**	2
Timber																								
Weatherboard	**-**	-	**-**	-	**-**	-	**R2**	2	**R2**	2	**R2**	2	**R2.5**	2.5	**R2.5**	2.5	**R2**	2	**R2**	2	**R2**	2	**R2**	2
max/min R in climate	**R2.5**	**-**	**R1.5**	**-**	**R2**	**-**	**R2.5**	**2**	**R2.5**	**2**	**R2.5**	**2**	**R2.5**	**-**	**R2.5**	**1.5**	**R2.5**	**2**	**R2.5**	**2**	**R2.5**	**1.5**	**R2.5**	**2**

repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 5: Insulation added to external walls of Wall Type 2 (R-Values)

Wall type 2 is the secondary wall type and may occur on one or more storeys.

NA for the external wall type (in rows below the floor descriptor) indicates that the wall type is the same as for Wall type 1.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Walls	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
House 1																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 4																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 8																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 9																								
Slab																								
Weatherboard	**R2**	2	**-**	-	**R1.5**	1.5	**R2**	2	**R2**	2	**R2**	2	**-**	-	**R2**	2	**R2**	2	**R2**	2	**R2**	2	**R2**	2
Timber																								
Weatherboard	**R1.5**	1.5	**-**	-	**R1.5**	1.5	**R2**	2	**R2.5**	2.5	**R2.5**	2.5	**R1**	1	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5	**R2.5**	2.5
House 10																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-

House 11																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 12																								
Timber																								
Concrete Block	**-**	-	**-**	-	**R1**	1							**R2.5**	2.5			**R1**	1	**R2**	2	**R1**	1	**R1**	1
NA							**-**	-	**-**	-	**-**	-			**-**	-								
House 13																								
Slab																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber																								
NA	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
max/min R in climate	**R2**	**-**	**-**	**-**	**R1.5**	**-**	**R2**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**

repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 6: Insulation added to internal walls (R-Values)

The proportion of internal walls with insulation (to separate conditioned zones from unconditioned zones) varies from 4% to 61%.
Insulation to Houses 8 and 9 in Perth involves brick walls which are lined with plasterboard whether insulated or not.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Walls	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab																								
Brick													-	-										
Concrete Block	-	-																						
Plasterboard	-	-	-	-	-	-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-	-
Timber																								
Brick													-	-										
Concrete Block	-	-																						
Plasterboard	-	-	-	-	-	-	-	-	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
House 4																								
Slab																								
Brick													-	-										
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2			R2	2	-	-	R2	2	-	-	-	-
Timber																								
Brick													-	-										
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
House 8																								
Slab																								
Brick													-	-										
Plasterboard	R2	2	R2	2	R2	2	R2.5	2.5	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
Timber																								
Brick													R1	1										
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2			R2	2	-	-	-	-	-	-	-	-

House 9																								
Slab																								
Brick													-	-										
Plasterboard	-	-	-	-	-	-	R2	2	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
Timber																								
Brick													R1	1										
Plasterboard	R2	2	-	-	-	-	R2	2	R2	2	R2	2			R2	2	R2	2	R2	2	R2	2	R2	2
House 10																								
Slab																								
Plasterboard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 11																								
Slab																								
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2
Timber																								
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2.5	2.5	R2	2	R2	2	R2	2	R2	2	R2	2
House 12																								
Timber																								
Plasterboard	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2
House 13																								
Slab																								
Plasterboard	-	-	-	-	-	-	-	-	R2.5	2.5	R2.5	2.5	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2
Timber																								
Plasterboard	R2	2	-	-	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2	R2	2
max/min R in climate	**R2**	**-**	**R2**	**-**	**R2**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2.5**	**-**	**R2**	**-**	**R2**	**-**	**R2**	**-**	**R2**	**-**	**R2**	**-**
repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 7: Insulation added to roofs and ceilings (R-Values)

Roof space ventilation levels appear in rows below each floor type. Ventilation levels are listed in ascending order.
No ceilings in the 5-7 star range are uninsulated.
House 9 includes both roof and ceiling insulation.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Roof vent	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab																								
Standard	R2.5	2.5	R2.5	2.5	R4	4			R4	4	R4	4	R3	3	R4	4	R3.5	3.5	R4	4	R3	3	R4	4
Vented	R1.5	1.5					R4	4																
Timber																								
Standard									R4	4	R4	4	R3.5	3.5	R4	4	R4	4	R4	4	R4	4	R4	4
Well Vented	R4	2.5	R3	3	R3	3	R4	4																
House 4																								
Slab																								
Standard									R4	4	R4	4	R4	4	R3.5	3.5	R3.5	3.5	R4	4	R2.5	2.5	R3.5	3.5
Vented			R3.5	3.5	R3.5	3.5	R3.5	3.5																
Well Vented	R3.5	3.5																						
Timber																								
Standard	R3.5	3.5							R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R3.5	3.5	R4	4
Vented			R3.5	3.5	R3.5	3.5	R3.5	3.5																
House 8																								
Slab																								
Standard	R3.5	3.5	R3.5	3.5	R3.5	3.5			R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4
Vented							R3.5	3.5																
Timber																								
Standard			R3.5	3.5	R4	4			R4	4	R4	4					R4	4	R4	4	R3	3	R4	4
Vented							R4	4					R4	4	R4	4								
Well Vented	R3.5	3.5																						

House 9																								
Slab																								
Standard	R3.5	3.5	R3.5	3.5	R3.5	3.5			R3.5	3.5	R3.5	3.5	R4	4	R4	4	R3.5	3.5	R3.5	3.5	R3.5	3.5	R3.5	3.5
Vented							R4	4																
Timber																								
Standard	R3.5	3.5	R3.5	3.5	R3.5	3.5			R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R3.5	3.5
Vented							R4	4																
House 10																								
Slab																								
Standard	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4
House 11																								
Slab																								
Standard	R4	4	R3	3	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4
Timber																								
Standard	R4	4	R2.5	2.5	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4	R4	4
House 12																								
Timber																								
Vented	R2.5	2.5	R3	3	R4	4	R4	4	R4.5	4.5	R4.5	4.5	R4.5	4.5	R4	4	R4	4	R4	4	R4	4	R4	4
House 13																								
Slab																								
Standard			R1	1	R3	3	R4	4	R4	4	R4	4	R3	3	R4	4	R4	4	R4	4	R4	4	R4	4
Vented	R4	4																						
Timber																								
Standard	R4	4							R4	4	R4	4	R4.5	4.5	R4	4	R4	4	R4	4	R4	4	R4	4
Vented			R2.5	2.5	R4	4																		
Well Vented							R4	4																
max/min R in climate	**R4**	**1.5**	**R4**	**1**	**R4**	**3**	**R4**	**3.5**	**R4.5**	**3.5**	**R4.5**	**3.5**	**R4.5**	**3**	**R4**	**3.5**	**R4**	**3.5**	**R4**	**3.5**	**R4**	**2.5**	**R4**	**3.5**

repeated column headings	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Fabric Table 8: Reflective insulation in roof spaces and light coloured roof surfaces

Roof space ventilation levels appear in rows below each floor type. Ventilation levels are listed in ascending order.
The use of reflective foil in the attic or a light coloured roof cladding is indicated by "F" or "L" in the appropriate column.
Blank cells indicate that the particular configuration does not exist in the database.

Stars ..... **(All)**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor / Roof vent	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light
House 1																								
Slab																								
Standard	-	L	-	L	-	L	-	L	-	-	-	-	-	L	-	L	-	-	-	-	-	-	-	-
Vented	-	L					-	L																
Timber																								
Standard									-	-	-	-	-	L	-	L	-	-	-	-	-	-	-	-
Well Vented	-	L	-	L	-	L	-	L																
House 4																								
Slab																								
Standard									-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vented			-	-	-	-	-	L							-	-								
Well Vented	-	-																						
Timber																								
Standard	-	-							-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vented			-	-	-	-	F	L																
House 8																								
Slab																								
Standard	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vented							-	L																
Timber																								
Standard			-	-	-	L			-	-	-	-					-	-	-	-	-	-	-	-
Vented							-	L					-	-	-	-								
Well Vented	-	-																						

House 9																								
Slab																								
Standard	-	L	-	L	-	L			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vented							F	L																
Timber																								
Standard	-	L	-	L	-	L			-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vented							F	L																
House 10																								
Slab																								
Standard	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 11																								
Slab																								
Standard	-	L	-	L	-	L	-	L	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber																								
Standard	-	-	-	L	-	-	-	L	F	-	-	-	F	-	F	-	-	-	-	-	-	-	-	-
House 12																								
Timber																								
Vented	-	L	-	L	-	L	-	L	-	-	-	-	-	L	-	L	-	-	-	-	-	-	-	-
House 13																								
Slab																								
Standard	-	-	F	-	-	-	-	L	-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-
Vented	-	-			-	-																		
Timber																								
Standard	-	L			-	-			-	-	-	-	F	-	-	-	-	-	-	-	-	-	-	-
Vented			F	L	-	-																		
Well Vented							-	-																
used anywhere in climate	**-**	**L**	**F**	**L**	**-**	**L**	**F**	**L**	**F**	**-**	**-**	**-**	**F**	**L**	**F**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

repeated column headings	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light	Foil	Light
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
	1				**2**		**3**		**4**				**5**				**6**		**7**				**8**	

Appendix C: Glazing and shading arrangements in 6 star configurations

Introductory notes

The 5 tables in this appendix show details of glazing and shading arrangements adopted for 6 star ratings.

Table 1 shows the proportion of glazing in each dwelling at their 6 star configurations. Glazing extent is described as a percentage of net conditioned floor area. NCFA values are usually smaller than the "area of the floor of the storey" used in BCA Volume Two. Glazing ratios reported here will be higher than ratios calculated by the BCA measure. Two shades of purple fill mark cells in the table where double glazing makes up part or (in a few cases) all of the glazing area.

Table 2 extends Table 1 by quantifying the percentage of double glazing in the total glazing area. (The balance is single glazing which may be clear, tinted or low e, depending on the climate.) Table 3 summarises changes in glazing area, generally reductions, made to lift the rating from 5 stars. The use of higher performance glazing types would be an alternative to the area changes shown here, albeit with some cost effects.

Tables 4 and 5 show the extent of adjustable external blinds and the largest of changes made to eaves depths (if any).

Information is drawn from Excel pivot tables linked to the study database. The source tables can display glazing information for all ratings, a selected range of ratings or any single star level (within the 5-7 star range). In this appendix, only 6 star ratings are displayed.

Table colours vary to avoid confusion due to their similar layouts. In each table, houses are labelled on the left hand side with separate rows below for their Slab and Timber floor variants. At the top of all tables, NatHERS climates appear in order of the 8 BCA *climate zones*.

The body of each table shows both maximum and minimum values. These numbers always match, except in the final summary row, because the tables cover only the 6 star configurations. The maximum and minimum values have different formats to distinguish them. (Minimum values have lighter fonts without bold formatting). Dashes in cells indicate zero values.

Additional notes above each table explain details relevant mainly to that table. Pages with tables are numbered only within the context of each appendix. Introductory pages for this and other appendices have numbers which refer to the whole document.

Glazing Table 1: Glazing ratio (Total glazing area / Net Conditioned Floor Area)

Percentages shown are higher than those based on internal floor areas used in the BCA.
Colour fills in the maximum value cells highlight cases where double glazing is involved.
The darker fill indicates cases where all glazing is double glazed.
Minimum cases matching the maximum are in ghosted font. (In this table, showing only 6 star ratings, both values always match.)

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
House 1																								
Slab	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%	**26%**	26%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%
Timber	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%	**26%**	26%	**26%**	26%	**27%**	27%	**27%**	27%	**25%**	25%	**25%**	25%	**25%**	25%	**25%**	25%
House 4																								
Slab	**22%**	22%	**23%**	23%	**20%**	20%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%
Timber	**20%**	20%	**23%**	23%	**22%**	22%	**22%**	22%	**22%**	22%	**22%**	22%	**22%**	22%	**22%**	22%	**23%**	23%	**23%**	23%	**23%**	23%	**23%**	23%
House 8																								
Slab	**26%**	26%	**29%**	29%	**27%**	27%	**25%**	25%	**25%**	25%	**25%**	25%	**25%**	25%	**25%**	25%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%
Timber	**24%**	24%	**22%**	22%	**21%**	21%	**24%**	24%	**24%**	24%	**24%**	24%	**27%**	27%	**23%**	23%	**27%**	27%	**27%**	27%	**27%**	27%	**27%**	27%
House 9																								
Slab	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%	**28%**	28%	**28%**	28%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%
Timber	**34%**	34%	**34%**	34%	**34%**	34%	**31%**	31%	**28%**	28%	**28%**	28%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%	**34%**	34%
House 10																								
Slab	**41%**	41%	**36%**	36%	**36%**	36%	**41%**	41%	**41%**	41%	**41%**	41%	**39%**	39%	**32%**	32%	**41%**	41%	**41%**	41%	**41%**	41%	**41%**	41%
House 11																								
Slab	**34%**	34%	**41%**	41%	**39%**	39%	**36%**	36%	**31%**	31%	**31%**	31%	**27%**	27%	**32%**	32%	**33%**	33%	**33%**	33%	**33%**	33%	**33%**	33%
Timber	**38%**	38%	**37%**	37%	**33%**	33%	**27%**	27%	**27%**	27%	**27%**	27%	**24%**	24%	**26%**	26%	**35%**	35%	**34%**	34%	**35%**	35%	**35%**	35%
House 12																								
Timber	**26%**	26%	**26%**	26%	**25%**	25%	**25%**	25%	**24%**	24%	**24%**	24%	**23%**	23%	**22%**	22%	**26%**	26%	**26%**	26%	**26%**	26%	**26%**	26%
House 13																								
Slab	**33%**	33%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%	**29%**	29%
Timber	**24%**	24%	**29%**	29%	**24%**	24%	**23%**	23%	**24%**	24%	**24%**	24%	**22%**	22%	**22%**	22%	**24%**	24%	**24%**	24%	**24%**	24%	**24%**	24%
max / min in climate	**41%**	**20%**	**41%**	**22%**	**39%**	**20%**	**41%**	**22%**	**41%**	**22%**	**41%**	**22%**	**39%**	**22%**	**34%**	**22%**	**41%**	**23%**	**41%**	**23%**	**41%**	**23%**	**41%**	**23%**

Glazing Table 2: Percentage of double glazing (Double glazing area / Total glazing area)

Double glazing includes all types of insulated glazing units (IGUs) including high performance IGUs.
Cases with dashes have only single glazing, which may include clear, tinted or low e glass types.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
House 1																								
Slab	-	-	-	-	-	-	-	-	15%	15%	15%	15%	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	65%	65%	53%	53%	-	-	51%	51%	36%	36%	36%	36%	19%	19%	19%	19%
House 4																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	66%	66%	55%	55%	-	-	-	-	-	-	48%	48%	-	-	-	-
House 8																								
Slab	-	-	-	-	-	-	-	-	66%	66%	66%	66%	42%	42%	-	-	30%	30%	30%	30%	9%	9%	30%	30%
Timber	-	-	-	-	-	-	-	-	61%	61%	61%	61%	-	-	-	-	64%	64%	64%	64%	64%	64%	43%	43%
House 9																								
Slab	-	-	-	-	-	-	-	-	35%	35%	35%	35%	-	-	-	-	36%	36%	36%	36%	-	-	36%	36%
Timber	-	-	-	-	-	-	-	-	54%	54%	54%	54%	-	-	-	-	53%	53%	53%	53%	29%	29%	29%	29%
House 10																								
Slab	-	-	-	-	-	-	-	-	100%	100%	100%	100%	46%	46%	-	-	100%	100%	100%	100%	100%	100%	100%	100%
House 11																								
Slab	-	-	-	-	-	-	-	-	70%	70%	59%	59%	37%	37%	23%	23%	51%	51%	58%	58%	51%	51%	51%	51%
Timber	-	-	-	-	-	-	-	-	100%	100%	100%	100%	91%	91%	60%	60%	72%	72%	94%	94%	63%	63%	63%	63%
House 12																								
Timber	-	-	-	-	-	-	-	-	65%	65%	65%	65%	88%	88%	66%	66%	67%	67%	67%	67%	53%	53%	53%	53%
House 13																								
Slab	-	-	-	-	-	-	-	-	22%	22%	22%	22%	11%	11%	-	-	29%	29%	29%	29%	29%	29%	49%	49%
Timber	-	-	-	-	-	-	-	-	88%	88%	88%	88%	85%	85%	54%	54%	89%	89%	89%	89%	43%	43%	52%	52%
max in climate	-	-	-	-	-	-	-	-	100%	-	100%	-	91%	-	66%	-	100%	-	100%	-	100%	-	100%	-

Glazing Table 3: Percentage changes in total glazing area (from 5 star cases)

Glazing area reductions appear as negative values.

Since the table shows only 6 star ratings, maximum and minimum values in the table body always match.

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
House 1																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-5%	-5%	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-3%	-3%	-3%	-3%	-	-	-2%	-2%	-7%	-7%	-7%	-7%	-7%	-7%	-7%	-7%
House 4																								
Slab	-7%	-7%	-	-	-15%	-15%	-	-	-2%	-2%	-2%	-2%	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-8%	-8%	-5%	-5%	-	-	-	-	-	-	-3%	-3%	-	-	-	-	-	-	-	-
House 8																								
Slab	-10%	-10%	-	-	-7%	-7%	-5%	-5%	-6%	-6%	-6%	-6%	-	-	-2%	-2%	-	-	-	-	-	-	-	-
Timber	-10%	-10%	-	-	-3%	-3%	-7%	-7%	-8%	-8%	-8%	-8%	-	-	-12%	-12%	-	-	-	-	-	-	-	-
House 9																								
Slab	-	-	-	-	-	-	-	-	-18%	-18%	-18%	-18%	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-8%	-8%	-19%	-19%	-16%	-16%	-	-	-	-	-	-	-	-	-	-	-	-
House 10																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-17%	-17%	-	-	-	-	-	-	-	-
House 11																								
Slab	-12%	-12%	-14%	-14%	-19%	-19%	-	-	-12%	-12%	-12%	-12%	-12%	-12%	-9%	-9%	-11%	-11%	-11%	-11%	-11%	-11%	-11%	-11%
Timber	-10%	-10%	-	-	-13%	-13%	-	-	-1%	-1%	-1%	-1%	-4%	-4%	-2%	-2%	-	-	-1%	-1%	-	-	-	-
House 12																								
Timber	-	-	-	-	-5%	-5%	-2%	-2%	-7%	-7%	-7%	-7%	-	-	-10%	-10%	-	-	-	-	-	-	-	-
House 13																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-10%	-10%	-	-	-	-	-5%	-5%	-	-	-	-	-	-	-7%	-7%	-15%	-15%	-15%	-15%	-15%	-15%	-16%	-16%
max / min in climate	**-**	**-12%**	**-**	**-14%**	**-**	**-19%**	**-**	**-8%**	**-**	**-19%**	**-**	**-18%**	**-**	**-12%**	**-**	**-17%**	**-**	**-15%**	**-**	**-15%**	**-**	**-15%**	**-**	**-16%**

Glazing Table 4: Percentage of glazing with external blinds

External blinds are adjustable and capable of covering the entire area of each window.
AccuRate assumes that occupants will adjust the blinds to optimise comfort.

Stars **6**

	Zone																							
	1				**2**		**3**		**4**		**5**						**6**		**7**				**8**	
	Darwin		**Townsville**		**Brisbane**		**Longreach**		**Mildura**		**Adelaide**		**Perth**		**Sydney**		**Melbourne**		**Canberra**		**Hobart**		**Alpine**	
House / Floor	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**	**max**	**min**
House 1																								
Slab	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 4																								
Slab	**-**	-	**-**	-	**-**	-	**32%**	32%	**30%**	30%	**30%**	30%	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber	**8%**	8%	**13%**	13%	**24%**	24%	**28%**	28%	**25%**	25%	**25%**	25%	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
House 8																								
Slab	**21%**	21%	**22%**	22%	**24%**	24%	**33%**	33%	**-**	-	**-**	-	**-**	-	**15%**	15%	**-**	-	**-**	-	**-**	-	**-**	-
Timber	**-**	-	**-**	-	**32%**	32%	**28%**	28%	**40%**	40%	**29%**	29%	**24%**	24%	**33%**	33%	**-**	-	**-**	-	**-**	-	**-**	-
House 9																								
Slab	**-**	-	**-**	-	**13%**	13%	**13%**	13%	**-**	-	**-**	-	**13%**	13%	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber	**-**	-	**-**	-	**13%**	13%	**36%**	36%	**14%**	14%	**14%**	14%	**-**	-	**17%**	17%	**-**	-	**-**	-	**-**	-	**-**	-
House 10																								
Slab	**-**	-	**-**	-	**-**	-	**11%**	11%	**11%**	11%	**-**	-	**12%**	12%	**6%**	6%	**-**	-	**-**	-	**-**	-	**-**	-
House 11																								
Slab	**-**	-	**5%**	5%	**-**	-	**9%**	9%	**-**	-	**-**	-	**-**	-	**19%**	19%	**-**	-	**22%**	22%	**-**	-	**-**	-
Timber	**-**	-	**-**	-	**13%**	13%	**22%**	22%	**6%**	6%	**6%**	6%	**29%**	29%	**6%**	6%	**-**	-	**-**	-	**-**	-	**-**	-
House 12																								
Timber	**-**	-	**-**	-	**-**	-	**-**	-	**19%**	19%	**19%**	19%	**40%**	40%	**23%**	23%	**-**	-	**27%**	27%	**-**	-	**-**	-
House 13																								
Slab	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
Timber	**-**	-	**-**	-	**-**	-	**-**	-	**23%**	23%	**23%**	23%	**36%**	36%	**-**	-	**-**	-	**-**	-	**-**	-	**-**	-
max / min in climate	**21%**	**-**	**22%**	**-**	**32%**	**-**	**36%**	**-**	**40%**	**-**	**30%**	**-**	**40%**	**-**	**33%**	**-**	**-**	**-**	**27%**	**-**	**-**	**-**	**-**	**-**

Glazing Table 5: Maximum changes to eaves depths (from 5 star cases)

Values (in metres) show the largest changes made to eaves depth on any one orientation. Smaller changes may have been made to other orientations.
Negative values indicate reduced eaves depths.
The eaves depth for the upper floor was not varied in any configuration (other than the elevated main floor of House 12).

Stars **6**

	Zone																							
	1				2		3		4		5						6		7				8	
	Darwin		Townsville		Brisbane		Longreach		Mildura		Adelaide		Perth		Sydney		Melbourne		Canberra		Hobart		Alpine	
House / Floor	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min
House 1																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-3.50**	-3.50	**-0.30**	-0.30	**-0.30**	-0.30	**-0.30**	-0.30	**-0.30**	-0.30
Timber	**0.30**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 4																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 8																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-1.95**	-1.95	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 9																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 10																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 11																								
Slab	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
House 12																								
Timber	-	-	-	-	-	-	-	-	**0.75**	0.75	**0.75**	0.75	-	-	-	-	-	-	-	-	-	-	-	-
House 13																								
Slab	-	-	-	-	**-1.60**	-1.60	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Timber	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
max / min in climate	**0.30**	**-**	**-**	**-**	**-**	**-1.60**	**-**	**-**	**0.75**	**-**	**0.75**	**-**	**-**	**-**	**-**	**-3.50**	**-**	**-0.30**	**-**	**-0.30**	**-**	**-0.30**	**-**	**-0.30**

Appendix D: Indicative capital costs for 6 star configurations

Introductory notes

The brief for this study did not require the evaluation of costs of construction changes. The database includes preliminary cost rates as a common denominator between the diverse modifications needed to improve ratings. Tony Isaacs provided rates which Bruce Lightfoot has updated to 2009 Quarter 2 values by Building Price Index calculations. Additional rates come from Rawlinsons Australian Construction Handbook 2008, also indexed to 2009 Q2. More elaborate calculations for a Regulation Impact Statement can be expected to show significant variations to the costs reported here.

Tables 1 and 2 in Appendix D show how costs vary by dwelling type and by climate. A chart illustrates the climate based numbers in Table 2.

The cost rates in the database show the varying capital cost impacts of lifting ratings from 5 to 6 stars. In about 10% of cases, costs fall (by up to $2,600 and average about $1,000). Such savings usually occur when window sizes are rationalised for better summer and winter performance. In the majority of cases, costs are increased by amounts ranging from $300 to $6,200 or so. The average extra cost is around $2,300. Houses with timber floors provide the extremes of the range, producing the highest additional costs but also the largest saving. The cost effects do not have an obvious correlation with climate.

Information is drawn from Excel pivot tables linked to the study database. The source tables can display information for all ratings, a selected range of ratings or any single star level (within the 5-7 star range). In this appendix, only 6 star ratings are displayed. The source tables can also be filtered to show only some climates or some dwellings, depending on the focus of the table. All tables report maximum, minimum and average values separately for slab and timber floors. Unlike in preceding appendices, maximum and minimum values are not expected generally to match.

Additional notes above each table explain details relevant mainly to that table. Pages with tables are numbered only within the context of each appendix. Introductory pages for this and other appendices have numbers which refer to the whole document.

Costs Table 1: Indicative capital cost variations by house and floor type (for 5-6 star rating improvement)

Table 1 shows the range of indicative capital costs over all climates.
Differences between climates can be seen in Table 2.
Values are rounded to the nearest hundred dollars.
Negative values are capital cost savings (often due to reducing glazing areas).

Climate ..... (All)
Stars **6**

House	Floor					
	Slab			Timber		
	max	min	*avg*	max	min	*avg*
House 1	1,700	-1,300	*800*	3,300	600	*2,100*
House 4	4,500	-1,600	*1,400*	5,200	900	*2,900*
House 8	4,500	-1,300	*1,800*	4,400	-2,600	*2,100*
House 9	2,100	300	*1,100*	2,600	400	*1,700*
House 10	3,400	700	*2,500*			
House 11	3,700	-900	*1,200*	6,200	-1,300	*3,600*
House 12				2,700	900	*2,100*
House 13	4,600	-1,600	*1,800*	5,800	-1,300	*2,600*
max/min/avg	**4,600**	**-1,600**	***1,500***	**6,200**	**-2,600**	***2,400***


House 1


House 10


House 4


House 11


House 8


House 12


House 9


House 13

Costs Table 2: Capital cost variations by climate (for 5-6 star rating improvement)

Table 2 shows, for each location, the capital cost range for each dwelling type.

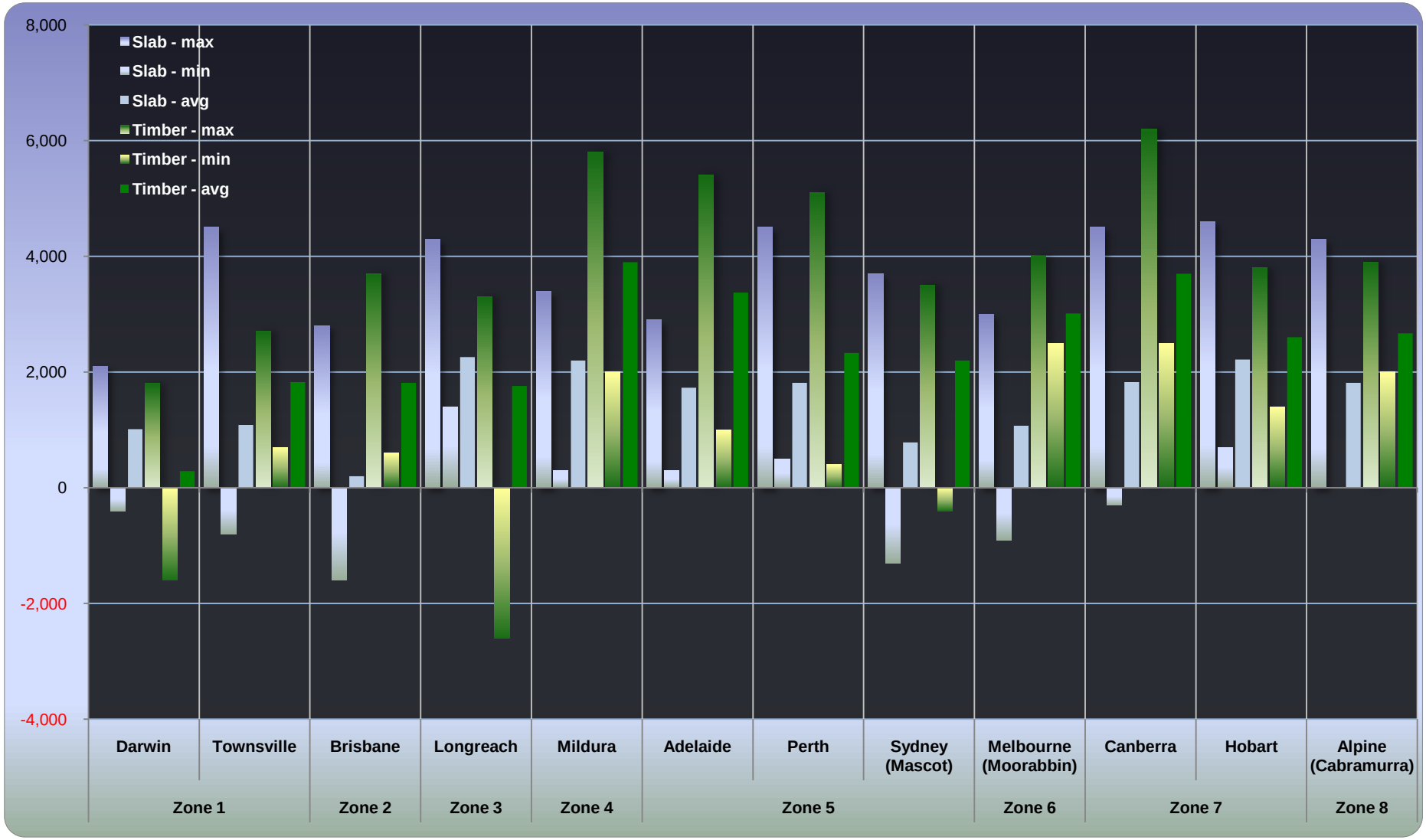
Values are rounded to the nearest hundred dollars.

House ..... (All)
Stars **6**

Location	Floor	Slab			Timber		
	max	min	*avg*	max	min	*avg*
Zone 1						
Darwin	2,100	-400	*1,000*	1,800	-1,600	*300*
Townsville	4,500	-800	*1,100*	2,700	700	*1,800*
Zone 2						
Brisbane	2,800	-1,600	*200*	3,700	600	*1,800*
Zone 3						
Longreach	4,300	1,400	*2,300*	3,300	-2,600	*1,800*
Zone 4						
Mildura	3,400	300	*2,200*	5,800	2,000	*3,900*
Zone 5						
Adelaide	2,900	300	*1,700*	5,400	1,000	*3,400*
Perth	4,500	500	*1,800*	5,100	400	*2,300*
Sydney (Mascot)	3,700	-1,300	*800*	3,500	-400	*2,200*
Zone 6						
Melbourne (Moorabbin)	3,000	-900	*1,100*	4,000	2,500	*3,000*
Zone 7						
Canberra	4,500	-300	*1,800*	6,200	2,500	*3,700*
Hobart	4,600	700	*2,200*	3,800	1,400	*2,600*
Zone 8						
Alpine (Cabramurra)	4,300	0	*1,800*	3,900	2,000	*2,700*
max/min/avg	**4,600**	**-1,600**	***1,500***	**6,200**	**-2,600**	***2,400***

Chart 2 (based on Costs Table 2): Capital cost variations by climate

Slab and timber floors have separate bars in the chart (see legend at top left).



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