

## Appendix 3: Dwelling Reports 1-20

### Dwelling Report Guide

#### General Information

The 20 dwelling reports are ordered as follows:

Dwellings 1-6: Single storey detached house;  
Dwellings 7-12: Double storey detached house;  
Dwellings 13-14: Semi-detached houses with one shared walls;  
Dwellings 15-16: Semi-detached houses with two shared walls;  
Dwellings 17-18: Apartment located on the corner of an apartment block;  
Dwellings 19-20: Apartment located in the middle of an apartment block.

In each capital city the dwellings were modelled in four orientations. The direction of the front door is used to describe the orientation of all dwellings, except for the apartments in which the main glazing determines the orientation.

Unless otherwise specified all original dwelling designs were modelled with aluminium framed windows, no external shading devices to windows, plasterboard lining to internal walls and medium roof colour with solar absorptance of 50%. For detailed information about other modelling assumptions refer to *Methodology: Modelling Techniques and Assumptions*.

Star rating results for redesigned dwellings are presented in a table that includes all capital cities, together with total redesigned cost and cost saving compared to the original dwelling. The table also includes star rating change, which is a comparison of the original star rating in the *same* orientation, not the star rating for the worst orientation.

#### Capital City Climate Types and Required Star Ratings

The table below shows the eight capital cities in which each dwelling design has been assessed, together with their climate type, initial star rating requirement and redesign star rating requirement for each city.

**Table 1: Climate type category assumptions and original and redesigned star rating requirement for each capital city.**

Capital City	Climate type	Initial required star rating	Required star rating after redesign
Darwin	Hot	5	6
Brisbane	Temperate	5	6
Perth	Temperate	5	6
Sydney	Temperate	5	6
Adelaide	Temperate	6	6
Canberra	Cold	6	6
Melbourne	Cold	5	6
Hobart	Cold	5	6

## Redesigned Specification Tables

Where there is a change from the initial specifications, the table of revised specifications will show it in **red** if it increases the estimated cost, **green** if it decreases the estimated cost, and **blue** if it has little to no impact on cost. An example of this is provided below (Table 2).

**Table 2: Example specification table for redesigned dwelling where green specifications indicate a cost decrease compared to the initial dwelling specifications, blue indicates a no-net cost change and red indicates a cost increase.**

Capital City	Glazing	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Floor covering change	CSOG
Darwin	3mm clear	0.3	Yes	30	Vinyl	normal

In the example above, four of the six specifications in Darwin are changing. The glazing is changing to 3mm clear, which is expected to decrease the estimated cost; the eave width is changing to 0.3m, which is expected to decrease the estimated cost; the roof solar absorptance is changing to 30%, which is expected to have a negligible impact on the estimated cost, and; the floor covering is changing to vinyl, which is expected to increase the estimated cost.

## Redesigned Floor Plans

Some redesigned changes are not shown in the specification table, but are shown on the redesigned floor plans only and these include: whirly birds to the roof space; ceiling fans; internal doors; external wall construction types; window size and location; internal partition rearrangement; shading structures. There are also several changes that are detailed in the redesigned dwelling specification table, but for which it was also necessary to show on the redesigned floor plan and these are floor coverings and eave widths.

All of the above detailed redesign changes are shown on the floor plans in **red** with a **blue** number immediately adjacent to the change. Each number corresponds to a brief description of the redesigned change in a legend below each redesigned plan.

## Dwelling 1: Review of Original Dwelling Design in All Capital Cities



**Table 1.1: Summary of Dwelling 1 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	2	-	3	2

**Table 1.2: Dwelling 1 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	31
Living/ Kitchen	Yes	59
Bedrooms	Yes	59
Corridor	Yes	13
Main Bathroom & Laundry	No	7
Garage	No	35
Verandah	No	19
TOTAL		223



**Figure 1.1: Dwelling 1 floor plan for original design.**

### Dwelling Description

A large single storey project home with a total floor area of 223m<sup>2</sup>, Dwelling 1 has four bedrooms, an open-plan family and kitchen area, and separate living and dining rooms. The external walls are of typical brick veneer construction with a metal hip roof at 25.0 degree pitch. The glazing is evenly distributed across the four facades with the front and rear facades having an increased level of glazing. The window to floor area ratio is approximately 18%. The front façade features a bay window, left of the main entry. Approximately half of the dwelling has 0.45m eaves with a 1.2m verandah wrapping around a high proportion of the front and right facades.

### Initial Specifications and Star Rating Results

Tables 1.1 and 1.2 describe the zoning of Dwelling 1, while Table 1.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 1.4, with Table 1.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 1.3: Dwelling 1 construction details.

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	Concrete slab on ground
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Metal deck
Eave	-	0.45m

Table 1.4: Specifications for original design of Dwelling 1 in each capital city.

Capital City	Glazing	Roof insulation	Insulation					
			House			Garage		
			Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	5mm Evergreen	Yes	R2.0	R1.5	None	None	None	R1.5
Brisbane	5mm Evergreen	Yes	R2.0	R1.5	None	None	None	R1.5
Perth	3mm clear	Yes	R4.0	R2.0	None	None	None	R2.0
Sydney	3mm clear	None	R3.5	R2.0	None	None	None	R2.0
Adelaide	3mm clear	None	R4.0	R2.0	None	None	None	R2.0
Canberra	3mm clear	None	R4.0	R2.5	None	None	None	R2.0
Melbourne	3mm clear	None	R4.0	R2.0	None	None	None	R2.0
Hobart	3mm clear	None	R4.0	R2.0	None	None	None	R2.0

**Table 1.5: Star rating in four cardinal orientations and cost for original design of Dwelling 1 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	372,992	5.7	5.3	5.3	5.1
Brisbane	410,923	4.9	5.2	6.1	5.2
Perth	385,169	5.4	4.9	5.6	5.4
Sydney	333,265	5.2	4.9	5.6	5.3
Adelaide	311,835	5.7	5.4	5.8	5.7
Canberra	306,246	5.4	5.4	5.9	5.6
Melbourne	296,243	5.4	5.5	5.9	5.6
Hobart	305,598	5.4	5.7	6.1	5.7

### Performance of Original Design

Dwelling 1 has a variation of 0.4 to 0.7 stars between orientations in most locations. Brisbane displays the largest variation in results between orientations, with a variation of 1.2 stars between the front door facing south and north.

In most climates, the dwelling achieves the highest star rating with the front door facing south, but this is not true of Darwin, where the dwelling achieves a higher star rating with the front door facing north. The orientation with the lowest result is with the front door facing west in Darwin, and the front door facing north in Brisbane. The other temperate climates have lower results with the front door facing east, while the front door facing north results in lower ratings in the cold climates.

The dwelling achieves better results in Adelaide and the colder climates, as the front shading is offset by large heat gains through the rear glazing. The reverse is true of the other temperate and hot climates, where these heat gains result in a reduced star rating.

## Review of Redesigned Dwelling in All Capital Cities

### Redesign Summary

Dwelling 1 has been redesigned with the front door facing north in Darwin, and the front door facing south in all other locations. These orientations provide more opportunity to move windows to optimal locations, and decrease the east- and west-facing glazing.

In Darwin, windows to Bed 3, Bed 4 and Dining have all been moved to the south-facing wall to minimise solar heat gain. The flooring of the main living and Dining areas has been changed to vinyl to maximise thermal mass benefits from the concrete slab on ground in daytime occupied living areas. In addition, an internal door has been included between the Family area and corridor to reduce the total conditioned area by 13m<sup>2</sup> and change the corridor into an unconditioned zone for modelling purposes (refer to Table 1.2 for conditioned area reduction). Eaves have been added to the southern Dining facade adjacent to the Kitchen, to help reduce solar heat gains to this area.

In temperate climates the same glazing change have been made to Bed 3, Bed 4 and Dining as in Darwin, but as the dwelling was redesigned in the opposite orientation windows have been moved to the north to improve passive heating in winter.

In the cold climates, the floor coverings have not been changed and instead the Family window has been reduced, or removed. This helps to reduce heat loss through the large amount of glazing to the main living area. The glazing changes to Bed 3, Bed 4 and Dining are the same as the temperate climates. The door between the Family area and passageway has been included, and the eaves reduced to 0.3m, to let in more sunlight. They have been extended to the Dining area to cut down on any possible overheating in summer.

### Revised Specifications and Star Rating Results

Tables 1.6.1 and 1.6.2 show the final specifications for the dwelling and Table 1.7 shows the glazing comparison between the initial and redesigned dwelling. Table 1.8 shows the star rating results and cost savings.

**Table 1.6.1: Specifications for redesigned Dwelling 1 in each capital city.**

Capital City	Glazing	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Floor covering change
Darwin	3mm clear	0.3	Yes	30	Vinyl
Brisbane	3mm clear	0.3	None	30	Vinyl
Perth	3mm clear	0.3	None	30	Vinyl
Sydney	3mm clear	0.3	None	30	Vinyl
Adelaide	3mm clear	0.3	None	30	Vinyl
Canberra	3mm clear	0.3	None	85	None
Melbourne	3mm clear	0.3	None	50-85	None
Hobart	3mm clear	0.3	None	85	None

Table 1.6.2: Specifications for redesigned Dwelling 1 in each capital city (continued).

Capital City	Insulation					
		House			Garage	
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2	R1.5	None	None	None	None
Brisbane	R2	R1.5	None	None	None	None
Perth	R3.5	R1.5	None	None	None	None
Sydney	R3.5	R2.0	None	None	None	None
Adelaide	R2.5	R1.5	None	None	None	None
Canberra	R3.5	R2	None	None	None	None
Melbourne	R3.5	R1.5	None	None	None	None
Hobart	R3.0	R1.5	None	None	None	None

Table 1.7: Glazing comparison between initial design and redesign for Dwelling 1.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	No window changes		
Brisbane	No window changes		
Perth	No window changes		
Sydney	No window changes		
Adelaide	No window changes		
Canberra	18.4	16.2	11.7
Melbourne	18.4	17.6	4.1
Hobart	No window changes		



**Table 1.8: Redesigned Dwelling 1 star rating and cost comparison in selected orientations in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	362,582	10,410	2.8	North	6.2	0.5
Brisbane	397,375	13,548	3.3	South	7.2	1.1
Perth	377,248	7,921	2.1	South	6.3	0.7
Sydney	328,586	4,679	1.4	South	6.2	0.6
Adelaide	306,334	5,501	1.8	South	6.2	0.4
Canberra	299,206	7,040	2.3	South	6.1	0.2
Melbourne	289,917	6,326	2.1	South	6.1	0.2
Hobart	299,257	6,341	2.1	South	6.0	-0.1

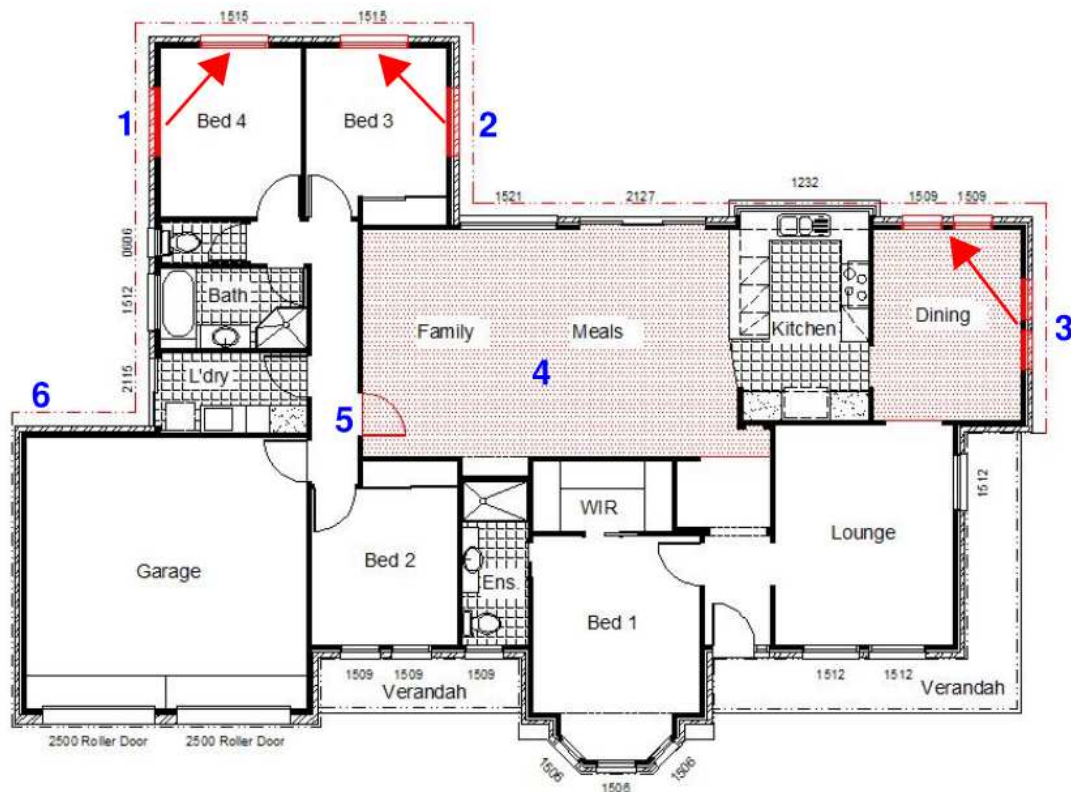
### Performance of Redesigned Dwelling

The positive effect of these changes in Darwin amounts to half a star, as the window relocation has cut down the cooling load to the dwelling. This also equates to a saving of 2.8% of the initial price.

Brisbane shows the most impressive improvement in star rating and cost, gaining 1.1 stars and saving over 3% of the initial cost. Brisbane benefits from a reduced cooling and a reduced heating load.

The other temperate climates all have impressive cost savings, of 1.4% to 2.3%. The general improvement in star rating in these locations is less than a full star.

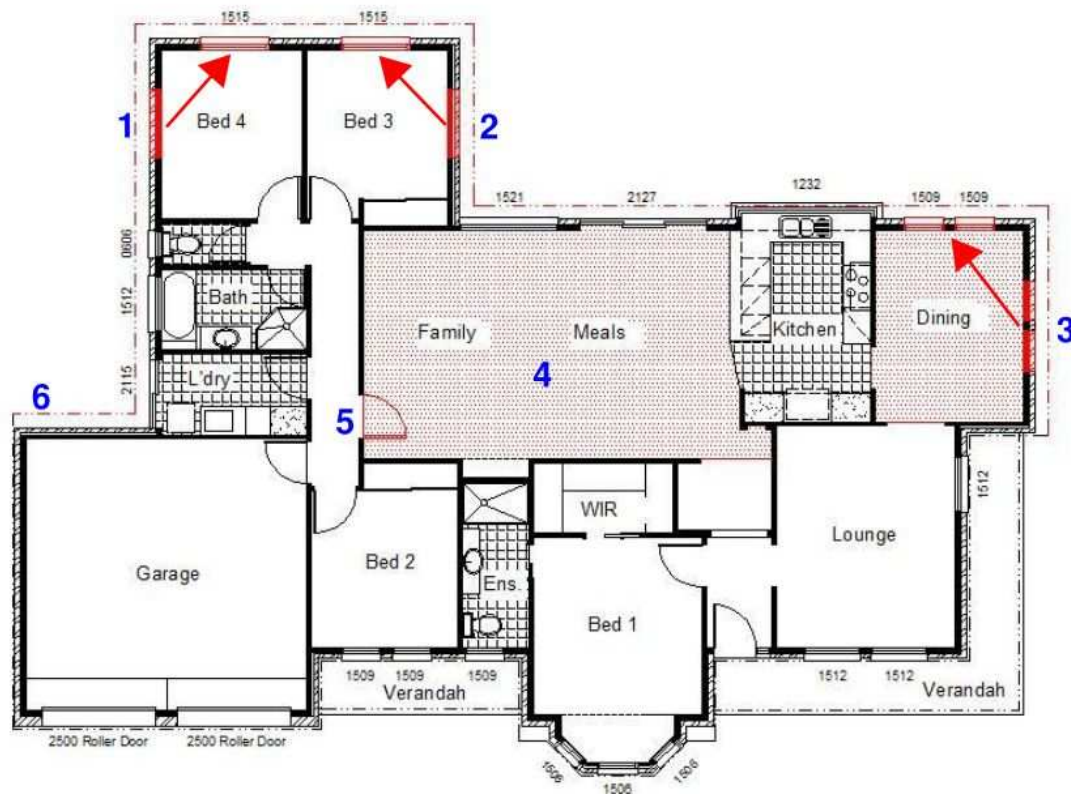
The cold climates experience a much smaller increase in star rating, especially in Hobart, where the rating has been reduced by 0.1 of a star. The benefit of the redesign in this example is the cost saving, while the performance of the dwelling has remained much the same. The star ratings have been increased by a little more in Canberra and Melbourne, where glazing was reduced.



1. Move Bedroom 4 window from eastern to southern facade.
2. Move Bedroom 3 window from western to southern facade.
3. Move two dining room windows from western to southern facade.
4. Change floor covering in Family/Meals and Dining from carpet to vinyl tiles.
5. Add internal door between corridor and Family/Meals.
6. Reduce eaves from 0.45m to 0.3m.



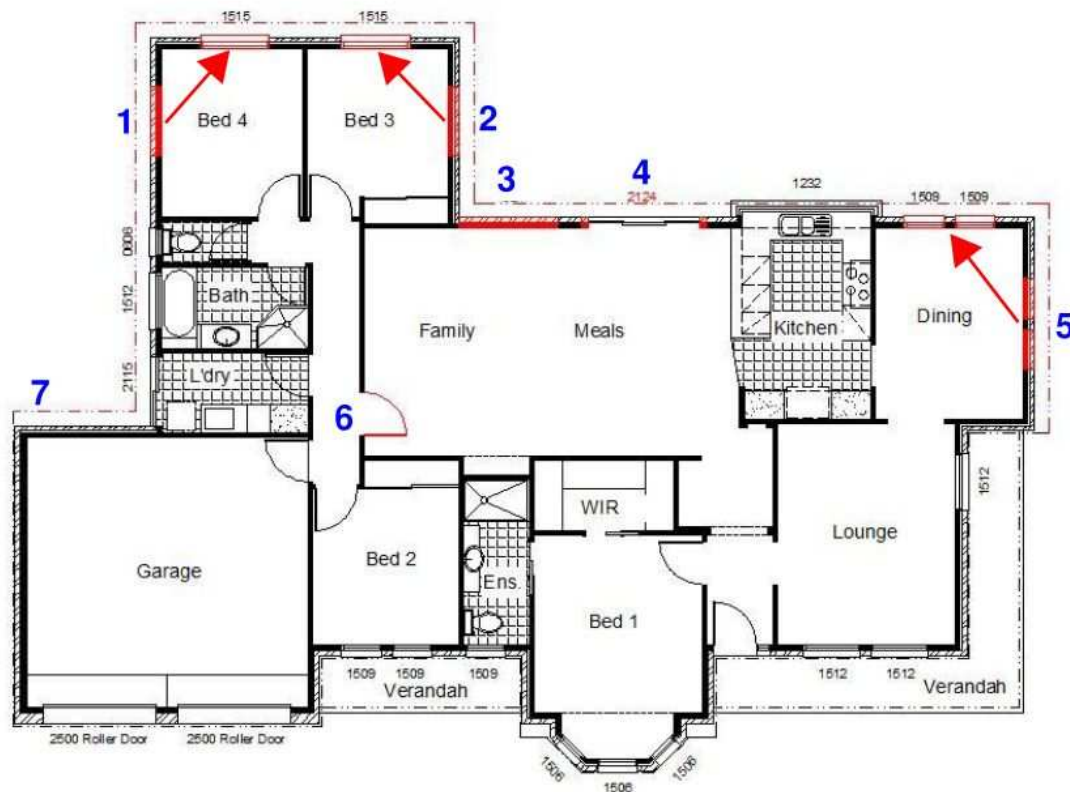
**Figure 1.3: Redesigned floor plan for Dwelling 1 in Darwin.**



1. Move Bedroom 4 window from western to northern facade.
2. Move Bedroom 3 window from eastern to northern facade.
3. Move two dining room windows from eastern to northern facade.
4. Change floor covering in Family/Meals and Dining from carpet to vinyl tiles.
5. Add internal door between corridor and Family/Meals.
6. Reduce eaves from 0.45m to 0.3m.



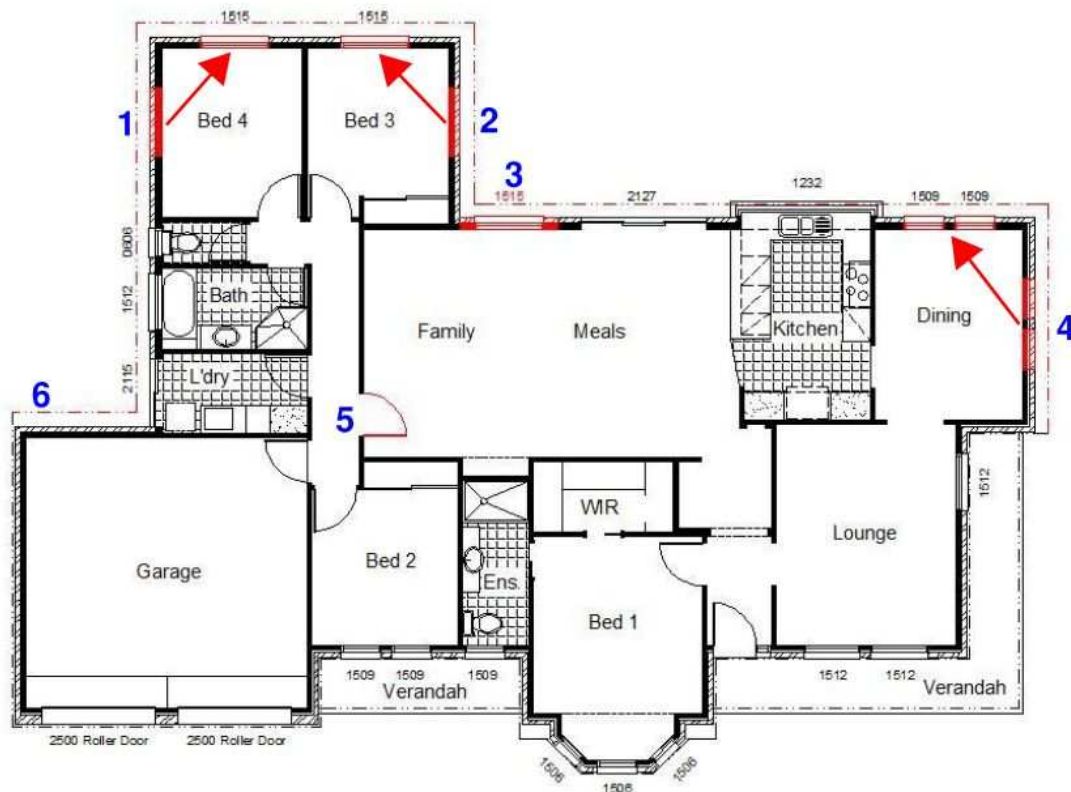
**Figure 1.4: Redesigned floor plan for Dwelling 1 in temperate climates.**



1. Move Bedroom 4 window from western to northern facade.
2. Move Bedroom 3 window from eastern to northern facade.
3. Remove 1.5x2.1m window on northern facade to Family/Meals.
4. Reduce Meals sliding door on northern facade from 2.7m to 2.4m wide.
5. Move two dining room windows from eastern to northern facade.
6. Add internal door between corridor and Family/Meals.
7. Reduce eaves from 0.45m to 0.3m.



Figure 1.5: Redesigned floor plan for Dwelling 1 in Canberra.



1. Move Bedroom 4 window from western to northern facade.
2. Move Bedroom 3 window from eastern to northern facade.
3. Reduce Family window on northern facade from 2.1m to 1.5m wide.
4. Move two dining room windows from eastern to northern facade.
5. Add internal door between corridor and Family/Meals.
6. Reduce eaves from 0.45m to 0.3m.



**Figure 1.6: Redesigned floor plan for Dwelling 1 in Melbourne.**





1. Move Bedroom 4 window from western to northern facade.
2. Move Bedroom 3 window from eastern to northern facade.
3. Move two dining room windows from eastern to northern facade.
4. Add internal door between corridor and Family/Meals.
5. Reduce eaves from 0.45m to 0.3m.



Figure 1.7: Redesigned floor plan for Dwelling 1 in Hobart.

## Dwelling 2: Review of Original Dwelling Design in All Capital Cities

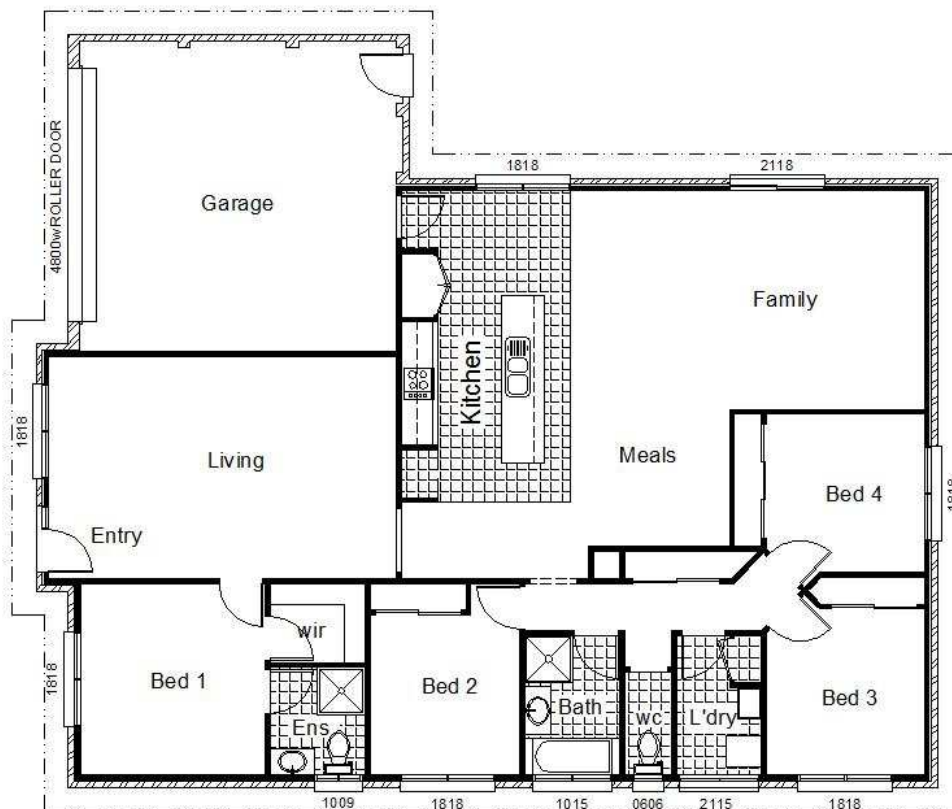


**Table 2.1: Summary of Dwelling 2 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	2	-	2	2

**Table 2.2: Dwelling 2 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	27
Living/ Kitchen	Yes	59
Bedrooms	Yes	51
Corridor	Yes	7
Main Bathroom & Laundry	No	11
Garage	No	34
	TOTAL	189



**Figure 2.1: Dwelling 2 floor plan for original design.**

### Dwelling Description

A compact single storey dwelling with four bedrooms and an open-plan living, dining and kitchen area towards the rear of the dwelling and separate living and entry areas. The external walls are of typical brick veneer construction with a metal hip roof at a 22.5 degree pitch. Dwelling 2 has an even distribution of glazing across three of the facades, with less glazing to the rear of the dwelling. The window to floor area ratio (including the Garage floor area) is 16%. The whole dwelling has 0.45m eaves.

### Initial Specifications and Star Rating Results

Tables 2.1 and 2.2 describe the zoning of Dwelling 2, while Table 2.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 2.4, with Table 2.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.



Table 2.3: Dwelling 2 construction details.

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	CSOG
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	-	0.45m

Table 2.4: Specifications for original design of Dwelling 2 in each capital city.

Capital City	Glazing	Roof sisalation	Insulation					
			House			Garage		
			Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	5mm Evergreen	Yes	R3.5	R1.5	None	None	None	R2.0
Brisbane	3mm clear	None	R3.5	R1.5	None	R3.5	R1.5	None
Perth	3mm clear	None	R3.5	R2.0	None	None	None	R1.5
Sydney	3mm clear	None	R3.5	R1.5	None	None	None	R1.5
Adelaide	3mm clear	None	R4.0	R2.0	None	None	None	R2.0
Canberra	3mm clear	None	R4.0	R2.0	None	None	None	R2.0
Melbourne	3mm clear	None	R4.0	R2.0	None	None	None	R2.0
Hobart	3mm clear	None	R4.0	R2.5	None	None	None	R2.0

Table 2.5: Star rating in four cardinal orientations and cost for original design of Dwelling 2 in each capital city (orientation according to direction of front door).

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	266,913	5.8	5.9	5.9	6.1
Brisbane	288,505	6.4	6.0	5.1	5.7
Perth	272,341	6.1	6.5	6.0	6.2
Sydney	236,649	6.4	6.5	5.9	6.3
Adelaide	221,809	6.7	6.9	6.5	6.8
Canberra	218,069	6.6	6.5	6.3	6.6
Melbourne	210,719	6.6	6.5	6.3	6.6
Hobart	217,616	6.7	6.6	6.5	6.7

### **Performance of Original Design**

Dwelling 2 achieves 6 stars in at least one orientation in all locations. The variation between orientations ranges from 0.2 to 0.7 stars, with the largest variation occurring in Brisbane.

The lowest star ratings occur when the front door is facing south. This results in the least possible amount of north-facing glazing. The highest rating orientation changes depending on climate type.

When located in Darwin, Dwelling 2 requires 5mm Evergreen glazing to the windows to achieve the required rating in all orientations. This is due to too much heat gain from a lack of shading.

In Brisbane, the dwelling achieves higher star ratings in the orientations where the living areas are facing south and west, which minimises heat gains. In the other temperate climates the dwelling performs well with the front door facing east.

In the cold climates, the dwelling is achieving higher ratings than in the other climates. When the front door is facing north or west the dwelling achieves better results due to the main living areas having north-facing glazing. This maximises solar heat gains through the colder months to keep the dwelling warm.

### **Review of Redesigned Dwelling in All Capital Cities**

#### **Redesign Summary**

Dwelling 2 was redesigned with the front door facing south, as this provided the lowest initial star ratings.

In all locations, the Bed 3 window and the family room sliding door were moved to the northern facade to increase northern exposure. The Bed 2 window was reduced from 1.8m high to 1.5m high to reduce the east facing window area. The eaves were reduced from 0.45m to 0.3m to reduce construction costs.

In Darwin, additional changes were required. The floor covering was changed from carpet through the family/meals area to vinyl tiles to make use of the concrete floor for passive cooling. Ceiling fans were added to the main living areas to increase air movement to cool the dwelling.

#### **Revised Specifications and Star Rating Results**

Tables 2.6.1 and 2.6.2 show the final specifications for the dwelling and Table 2.7 shows the glazing comparison between the initial and redesigned dwelling. Table 2.8 shows the star rating results and cost savings.

**Table 2.6.1: Specifications for redesigned Dwelling 2 in each capital city.**

Capital City	Glazing	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Floor covering change	CSOG
Darwin	3mm clear	0.3	Yes	30	Vinyl	normal
Brisbane	3mm clear	0.3	No	30	None	normal
Perth	3mm clear	0.3	No	30	None	normal
Sydney	3mm clear	0.3	No	30	None	normal
Adelaide	3mm clear	0.3	No	30-50	None	normal
Canberra	3mm clear	0.3	No	50-85	None	Polystyrene core
Melbourne	3mm clear	0.3	No	85	None	Polystyrene core
Hobart	3mm clear	0.3	No	85	None	Polystyrene core

**Table 2.6.2: Specifications for redesigned Dwelling 2 in each capital city (continued).**

Capital City	Insulation					
	House			Garage		
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	None
Brisbane	R3.5	R1.5	None	None	None	None
Perth	R3.5	R1.5	None	None	None	R1.5
Sydney	R3.5	R1.5	None	None	None	None
Adelaide	R3.5	R1.5	None	None	None	R1.5
Canberra	R3.5	R2.0	None	None	None	R2.0
Melbourne	R3.5	R2.0	None	None	None	R2.0
Hobart	R3.5	R2.0	None	None	None	R2.0

**Table 2.7: Glazing comparison between initial design and redesign for Dwelling 2.**

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	15.9	15.3	3.6
Brisbane	15.9	15.3	3.6
Perth	15.9	15.3	3.6
Sydney	15.9	15.3	3.6
Adelaide	15.9	15.3	3.6
Canberra	15.9	15.3	3.6
Melbourne	15.9	15.3	3.6
Hobart	15.9	15.3	3.6

**Table 2.8: Redesigned Dwelling 2 star rating and cost comparison in selected orientation in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	259,937	7,878	3.0	South	6.3	0.4
Brisbane	283,964	4,656	1.6	South	6.4	1.3
Perth	268,976	3,110	1.1	South	6.5	0.5
Sydney	233,724	2,703	1.1	South	6.2	0.3
Adelaide	218,680	2,922	1.3	South	6.7	0.2
Canberra	214,854	2,588	1.2	South	6.9	0.6
Melbourne	208,030	2,491	1.2	South	7.1	0.8
Hobart	214,600	2,813	1.3	South	7.4	0.9

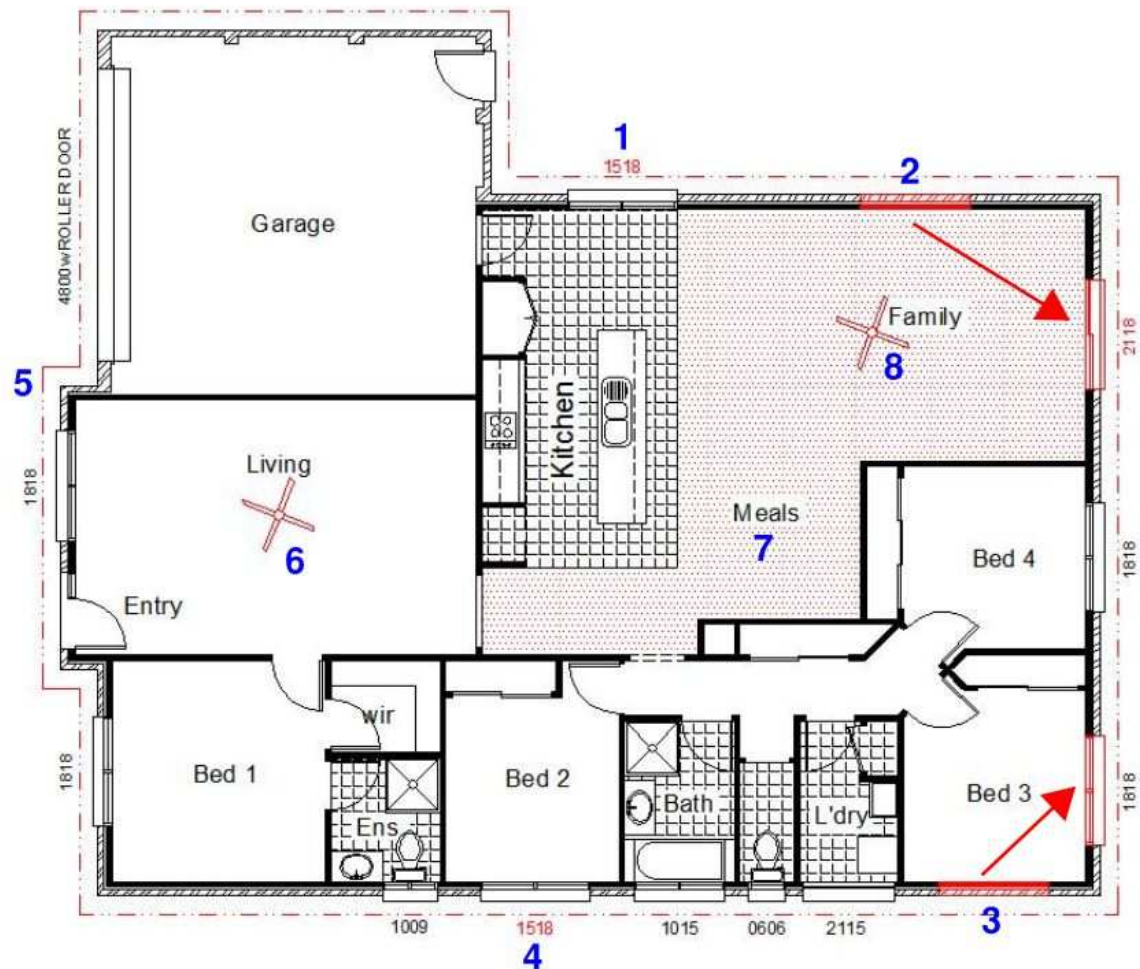
### Performance of Redesigned Dwelling

The largest benefit from the redesign can be seen in Brisbane, where the star rating increased from 5.1 to 6.4 stars. These changes have also resulted in a cost saving of 1.6% of the initial design cost. The star rating in Darwin increased by 0.4 of a star, and the redesign cost saving is 3.0%. This is the largest cost saving, and is due to the removal of the Evergreen glazing included in the initial specification.

In Perth and Sydney, the star rating increased by 0.5 to 0.6 stars, with a cost saving of 1.1%. Adelaide had a lower star rating increase (of 0.2 of a star), with a high cost saving (of 1.3%), as more cost-saving than energy-saving changes were made in the redesign process.

In the cold climates, it was found that polystyrene core concrete slab improved the star rating by 0.6 stars in Canberra and Melbourne and 1 star in Hobart.

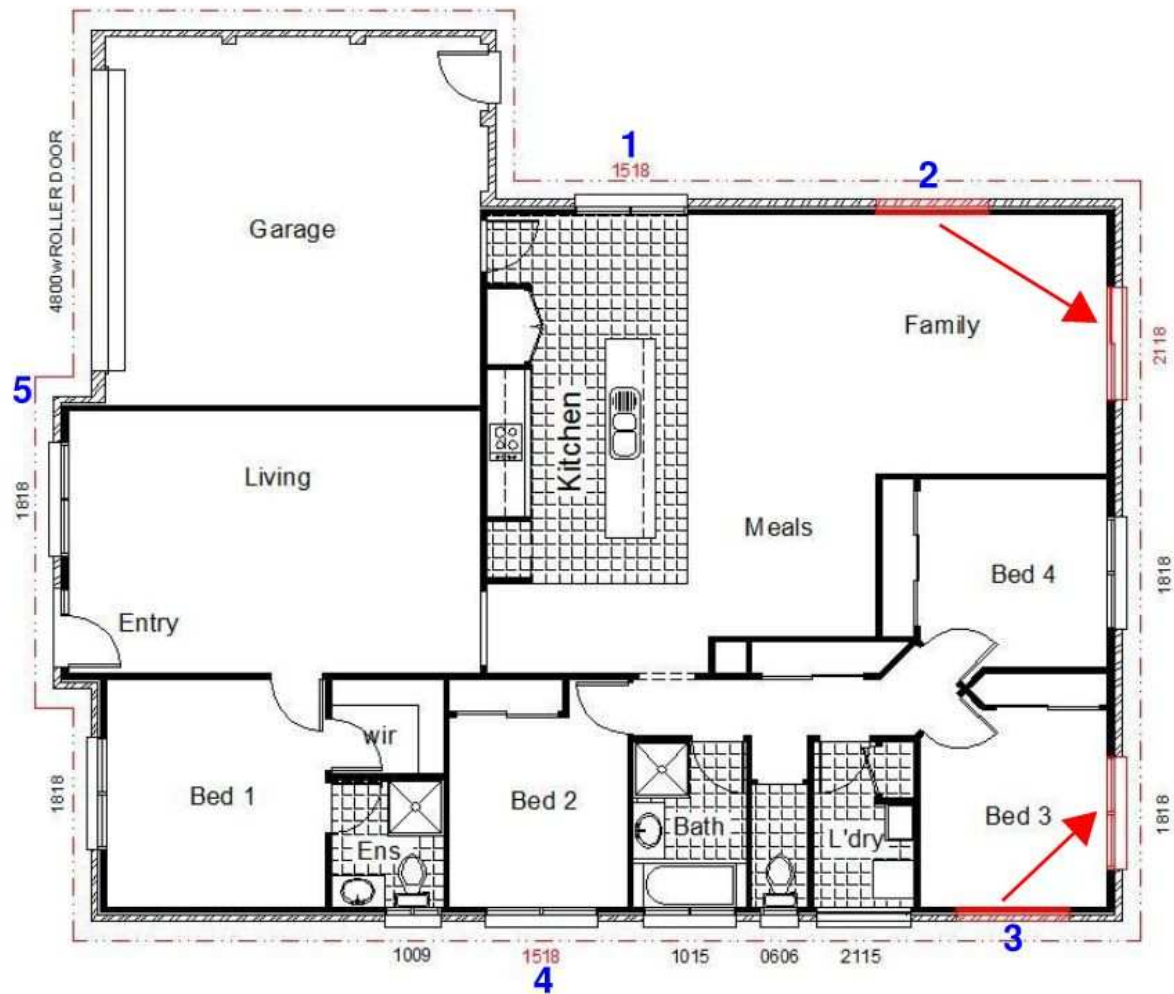
As this dwelling was already achieving 6-stars in at least one orientation in all locations, the benefits of redesigning the dwelling can be seen in the reduction in construction costs. Design changes, such as the glazing reduction to all locations (see Table 2.7) reduced insulation requirements in all capital cities which contributed to cost savings achieved in all capital cities.



1. Reduce Kitchen window from 1.8m high to 1.5m high.
2. Move Family glass door from western to northern facade.
3. Move Bed 3 window from eastern to northern facade.
4. Reduce Bed 2 window from 1.8m high to 1.5m high.
5. Reduce eave width from 0.45m to 0.3m
6. Add 1200mm ceiling fan to Living.
7. Change floor covering in Family/Meals from carpet to vinyl tiles.
8. Add 1200mm ceiling fan to Family.



Figure 2.2: Redesigned floor plan for Dwelling 2 in Darwin.



1. Reduce Kitchen window height from 1.8m to 1.5m.
2. Move Family window from western to northern facade.
3. Move Bed 3 window from eastern to northern facade.
4. Reduce Bed 2 window height from 1.8m to 1.5m.
5. Reduce eave width from 0.45m to 0.3m.



Figure 2.3: Redesigned Dwelling 2 in all capital cities except Darwin.



### Dwelling 3: Review of Original Dwelling Design in All Capital Cities

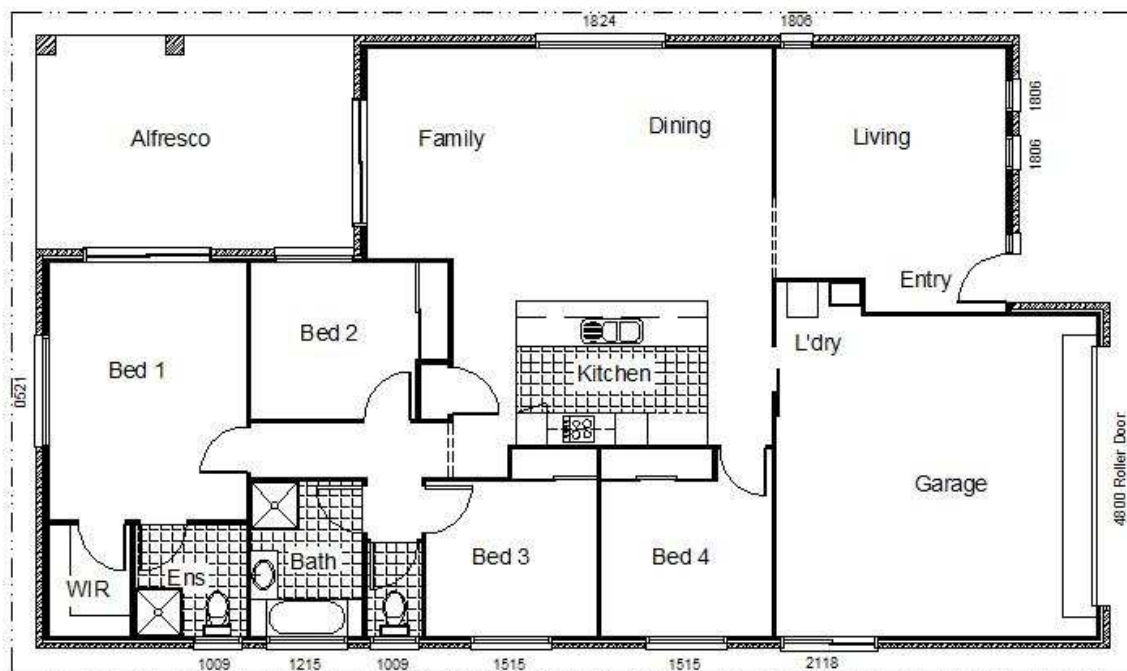


**Table 3.1: Summary of Dwelling 3 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	2	-	2	2

**Table 3.2: Dwelling 3 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	20
Living/ Kitchen	Yes	56
Bedrooms	Yes	57
Main Bathroom & Laundry	No	8
Garage	No	89
Verandah	No	22
	TOTAL	252



**Figure 3.1: Dwelling 3 floor plan for original design.**

### Dwelling Description

This single storey detached dwelling is the second largest of this dwelling type to be included in the study. The external walls are of typical brick veneer construction, while the roof is made of concrete tiles with a 20.1 degree pitch. The glazing is evenly distributed across the rear and side facades, but there is less glazing to the front facade, which is dominated by the double garage. The window to floor area ratio is approximately 15%. The dwelling has 0.6m eaves, with a shaded alfresco to the rear, and 1.1m shading to the front living windows.

### Initial Specifications and Star Rating Results

Tables 3.1 and 3.2 describe the zoning of Dwelling 3, while Table 3.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 3.4, with Table 3.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.



Table 3.3: Dwelling 3 construction details.

Construction	Type	Details
Ceiling height	-	2.4m
Floors	-	CSOG
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Concrete tiles
Eaves	-	0.6m

Table 3.4: Specifications for original design of Dwelling 3 in each capital city.

Capital City	Glazing	Roof insulation	Insulation					
			Ceiling	House		Garage		
				External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	3mm clear	Yes	R2.0	Double foil	None	None	None	R1.5
Brisbane	3mm clear	Yes	R2.0	Double foil	None	None	None	R1.5
Perth	3mm clear	No	R3.5	R1.5	None	None	None	R1.5
Sydney	3mm clear	No	R3.5	R1.5	None	None	None	R1.5
Adelaide	3mm clear	No	R4.0	R2.0	None	None	None	R2.0
Canberra	6.38mm ComfortPlus Neutral	No	R4.0	R2.5	None	None	None	R2.0
Melbourne	3mm clear	No	R4.0	R2.0	None	None	None	R1.5
Hobart	3mm clear	No	R4.0	R2.0	None	None	None	R2.0

Table 3.5: Star rating in four cardinal orientations and cost for original design of Dwelling 3 in each capital city (orientation according to direction of front door).

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	275,265	5.9	6.2	6.0	6.3
Brisbane	303,258	5.1	6.2	6.4	5.8
Perth	286,330	5.4	5.9	5.6	5.7
Sydney	249,084	5.4	5.9	5.6	5.7
Adelaide	233,448	6.0	6.3	6.0	6.2
Canberra	229,631	5.9	6.1	5.8	5.7
Melbourne	221,710	5.7	5.9	5.6	5.4
Hobart	228,779	5.8	6.0	5.7	5.4

### **Performance of Original Design**

Dwelling 2 shows a variation of no more than 0.6 stars between orientations in most locations. Brisbane, however, has a difference of 1.3 stars between the north and south orientations.

In all capital cities except for Darwin and Brisbane, the dwelling achieves the highest star rating when the front door is facing east. In this orientation, most of the glazing to the main living areas is facing north.

In Darwin, the optimal orientation is with the front door facing west and most of the living area glazing facing south, which minimises the amount of sunlight the dwelling gets year round.

Brisbane achieves a higher rating with the front door facing south, where it has a large amount of shaded north-facing glazing to the Family and Bed 1 areas, but also receives some solar heat gains through the east-facing Dining window.

Having the front door to the north results in the lowest star ratings for most locations, as this minimises the amount of north-facing glazing to the dwelling, and maximises west-facing glazing to the main living areas. In the cold climates, having the front door to the west results in the lowest star rating, as this makes most of the main living area glazing south-facing, minimising heat gains and maximising heat loss.

### **Review of Redesigned Dwelling in All Capital Cities**

#### **Redesign Summary**

Due to its high initial star ratings, Dwelling 3 has only been redesigned for improved performance in Perth and Sydney, and the three colder climates.

In Perth and Sydney, Dwelling 3 has been redesigned with the front door facing north, as this orientation is the lowest rating in both locations. The locations of the main living area and bedrooms have been exchanged, to maximise east-facing glazing to the main living area, and minimise west-facing. The Alfresco to the rear has been removed to increase solar heat gains through the Family and Bed 1 sliding doors. The eaves have been reduced to increase solar heat gains, and the Family and Dining area flooring has been changed to vinyl. Internal wall insulation has also been added to stop heat transfer between different areas of the dwelling.

Redesign in the colder climates has been undertaken with the front door facing west, as this orientation is the lowest rating for all three locations. As with Perth and Sydney, the location of the main living area and bedrooms has been exchanged, in order to maximise north-facing glazing to the main living area, and minimise the south-facing glazing. The Alfresco has been removed, and the eaves have been reduced. The eaves have been removed from the south- and north-facing walls. The insulation has not been increased from the initial specifications, but the slab has been changed to an insulative polystyrene core concrete construction.

#### **Revised Specifications and Star Rating Results**

Tables 3.6.1 and 3.6.2 show the final specifications for the dwelling and Table 3.7 shows the star rating results and cost savings.

Table 3.6.1: Specifications for redesigned Dwelling 3 in each capital city.

Capital City	Glazing	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Concrete slab type	Floor covering change
Darwin	Not redesigned					
Brisbane	Not redesigned					
Perth	3mm clear	0.3	None	30	Normal	Vinyl
Sydney	3mm clear	0.3	None	30	Normal	Vinyl
Adelaide	Not redesigned					
Canberra	3mm clear	None	None	50	Polystyrene core	None
Melbourne	3mm clear	None	None	50-85	Polystyrene core	None
Hobart	3mm clear	None	None	85	Polystyrene core	None

Table 3.6.2: Specifications for redesigned Dwelling 3 in each capital city (continued).

Capital City	Insulation						
	House				Garage		
	Ceiling	External walls	Internal walls	Wet area internal walls	Ceiling	External walls	Internal walls to house
Darwin	Not redesigned						
Brisbane	Not redesigned						
Perth	R3.5	R1.5	None	R2.0	None	None	R2.0
Sydney	R3.5	R1.5	None	R2.0	None	None	R2.0
Adelaide	Not redesigned						
Canberra	R3.5	R2.0	None	None	None	None	None
Melbourne	R3.5	R2.0	None	None	None	None	None
Hobart	R3.5	R2.0	None	None	None	None	None

**Table 3.7: Redesigned Dwelling 3 star rating and cost comparison in selected orientations in each capital city.**

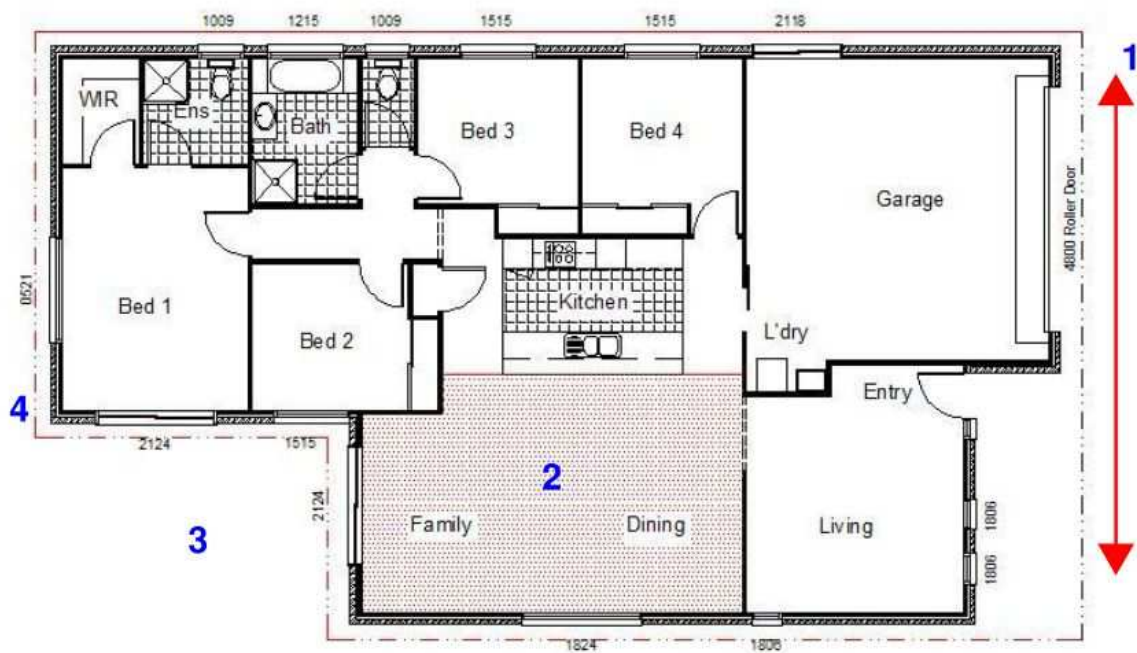
Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	Not redesigned					
Brisbane	Not redesigned					
Perth	282,322	4,008	1.4	North	6.6	0.7
Sydney	245,598	3,486	1.4	North	6.2	1.1
Adelaide	Not redesigned					
Canberra	223,198	6,433	2.8	West	6.2	0.5
Melbourne	216,101	5,609	2.5	West	6.4	1.0
Hobart	222,925	5,854	2.6	West	6.8	1.4

### Performance of Redesigned Dwelling

In Sydney and Perth, the effect of the redesign equates to savings of 1.4% of the initial design cost in conjunction with star rating increases of 0.8 and 1.2 respectively.

In the colder climates, the large reductions in shading and addition of polystyrene core concrete flooring system have resulted in significant star rating improvements, particularly in Hobart. As with Perth and Sydney Dwelling 3 was redesigned to improve energy efficiency and reduce construction costs, although a larger cost saving was achieved in these capital cities at 2.5% or more. In Canberra, which was required to achieve a higher star rating for the initial design than the other cold climates, the star rating increase was lower at 0.5 stars, however the percentage cost saving was higher at 2.8%.

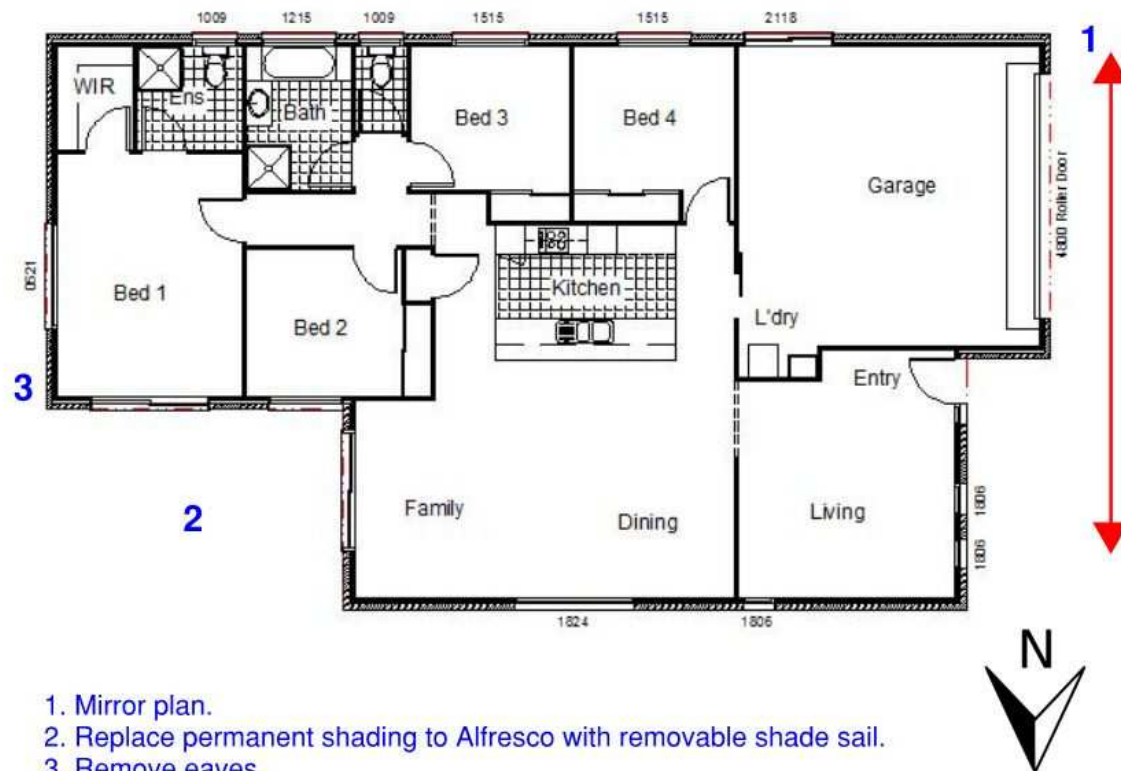
Glazing reductions were not made as part of the redesign of this dwelling in any of the capital cities.



1. Mirror plan.
2. Change floor covering in Family and Dining from carpet to vinyl.
3. Replace permanent shading to Alfresco with removable shade sail.
4. Reduce eave width from 0.6m to 0.3m.



Figure 3.2: Redesigned floor plan for Dwelling 3 in Perth and Sydney.



**Figure 3.3: Redesigned floor plan for Dwelling 3 in cold climates (Canberra, Melbourne and Hobart).**

## Dwelling 4: Review of Original Dwelling Design in All Capital Cities



**Table 4.1: Summary of Dwelling 4 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	2	1	2	3

**Table 4.2: Dwelling 4 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	24
Living/ Kitchen	Yes	81
Bedrooms	Yes	70
Corridor/Activity/Office	Yes	38
Main Bathroom & Laundry	No	16
Garage	No	53
Verandah	No	22
	TOTAL	304



**Figure 4.1: Dwelling 4 floor plan for original design.**

### Dwelling Description

With a total floor area (including Garage and Alfresco) of more than 300m<sup>2</sup>, Dwelling 4 is the largest single storey detached dwelling to be included in this study. It has four bedrooms, an open plan family/dining and kitchen, with an attached home theatre area, as well as an office off the entry, and an activity/study area. The external walls are of brick cavity construction and the roof is tiled, on a pitch of 25 degrees. The glazing is evenly distributed across the four facades, with all main living area glazing facing to the rear and to the left-hand side. The window to floor area ratio is approximately 21%. The dwelling has 0.45m eaves, which are reduced around the garage, and it also has an alfresco area to the rear, accessible through the home theatre and family areas.

### Initial Specifications and Star Rating Results

Tables 4.1 and 4.2 describe the zoning of Dwelling 4, while Table 4.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 4.4.1 and Table 4.4.2, with Table 4.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.



**Table 4.3: Dwelling 4 construction details.**

Construction	Type	Details
Ceiling height	-	2.4m
Floors	-	CSOG
External walls	-	Double brick: 110mm brick + air gap + 110mm brick + 10mm plasterboard
Internal walls	-	Single brick: 10mm plasterboard + 110mm brick + 10mm plasterboard
Window frames	-	Cedar to front facade, alum elsewhere
	-	Aluminium everywhere else
Roof	-	Metal deck
Eaves	-	0.45m

**Table 4.4.1: Specifications for original design of Dwelling 4 in each capital city.**

Capital City	Glazing	Roof insulation
Darwin	Alum 5mm Evergreen Cedar 6.38mm ComfortPlus Neutral	Yes
Brisbane	Alum 5mm Evergreen Cedar 6.38mm CP Neutral	Yes
Perth	Alum 3mm clear Cedar 3mm clear	No
Sydney	Alum 3mm clear Cedar 3mm clear	No
Adelaide	Alum 6.38mm CP Neutral Cedar 6.38mm CP Neutral	Yes
Canberra	Cedar 4mm clear/8mm air/4mm Energy Advantage Low E Cedar 3mm clear/6mm air/3mm clear (to front facade)	Yes
Melbourne	Alum 3mm clear Cedar 3mm clear	No
Hobart	Alum 6.38mm CP Neutral Cedar 3mm clear	No

**Table 4.4.2: Specifications for original design of Dwelling 4 in each capital city (continued).**

Capital City	Insulation					
		House			Garage	
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R3.5	Double-sided foil	None	R3.5	Double-sided foil	None
Brisbane	R3.5	Double-sided foil	None	R3.5	Double-sided foil	None
Perth	R3.5	Double-sided foil	None	R3.5	Double-sided foil	None
Sydney	R3.5	Double-sided foil	None	None	Double-sided foil	None
Adelaide	R3.5	Double-sided foil	None	R3.5	Double-sided foil	None
Canberra	R4.0	Double-sided foil	None	R4.0	Double-sided foil	None
Melbourne	R3.5	Double-sided foil	None	R3.5	Double-sided foil	None
Hobart	R4.0	Double-sided foil	None	R4.0	Double-sided foil	None

**Table 4.5: Star rating in four cardinal orientations and cost for original design of Dwelling 4 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	506,878	5.5	5.1	5.2	5.1
Brisbane	558,425	5.4	4.3	5.4	5.3
Perth	510,904	5.4	5.1	5.7	5.1
Sydney	443,419	4.8	4.9	5.4	4.9
Adelaide	429,557	5.4	5.5	5.8	5.4
Canberra	429,034	5.8	5.9	6.4	5.9
Melbourne	394,600	4.4	4.6	4.8	4.4
Hobart	407,702	4.3	4.6	4.8	4.4

### **Performance of Original Design**

Dwelling 4 shows moderate variation in star rating between different orientations in each capital city, with the largest variation being 1.1 stars between the north and east orientations in Brisbane. For the most part, however, the variation between orientations is no more than 0.6 stars.

The dwelling achieves higher ratings when the front door is facing south for most locations. The majority of the main living area glazing is at the rear of the dwelling, so having this facing north provides thermal benefits in most locations. The exceptions to this trend are Darwin which performs better with the front door facing north to minimise heat gains, and Brisbane which performs equally well with the front door facing north and south.

Perth, Sydney, Melbourne and Hobart have been rated with standard single glazing throughout, resulting in lower star ratings. All the other locations required some form of improved glazing to achieve the minimum star rating requirement, including Canberra which required a Low E double glazed system.

There is no strong trend in the lowest achieving performing orientation. In general though, the colder locations achieve lower star ratings when the front door faces north, while the same is true of the warmer locations when the front door faces east or west.

### **Review of Redesigned Dwelling in All Capital Cities**

#### **Redesign Summary**

The redesign has been undertaken with the front door facing south in all locations, as this generally provided the highest rating results.

In Darwin, the glazing has been changed from a 5mm Evergreen system to standard 3mm clear glazing. The floor covering has been changed to vinyl and ceiling fans have been included to Bed 1 and the Living/Dining area, to create air flow throughout the dwelling. The roof has been changed to a lighter colour to stop the dwelling from absorbing heat during the day and releasing back into the dwelling at night. Brisbane has the same changes, without sisalation and with a reduction in eave width to cut costs.

In Perth, eave width has been reduced to save costs and ensure sunlight can enter during winter. The lighter roof colour reflects summer heat and in doing so reduces the cooling load in summer.

In the other temperate climates, the change from a high performance to a standard 3mm clear glazing system has been offset by vinyl flooring to the living areas, eave width reduction and some increases to insulation.

The cold locations have all been changed to a polystyrene core floor construction to maximise the insulative effect of the flooring. The glazing to the Living, Dining and Home Theatre areas has been reduced in order to minimise heat loss through these large glazed areas during winter.

#### **Revised Specifications and Star Rating Results**

Tables 4.6.1 and 4.6.2 show the final specifications for the dwelling and Table 4.7 shows the glazing comparison between the initial and redesigned dwelling. Table 4.8 shows the star rating results and cost savings.

Table 4.6.1: Specifications for redesigned Dwelling 4 in each capital city.

Capital City	Glazing	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Concrete slab type	Floor covering change
Darwin	3mm clear	0.45	Yes	30	Normal	Vinyl
Brisbane	3mm clear	0.3	None	30	Normal	Vinyl
Perth	3mm clear	0.3	None	30	Normal	None
Sydney	3mm clear	0.3	None	30	Normal	Vinyl
Adelaide	3mm clear	0.3	None	30-50	Normal	Vinyl
Canberra	3mm clear	0.3	None	50-85	Polystyrene core	None
Melbourne	3mm clear	0.3	None	85	Polystyrene core	None
Hobart	3mm clear	0.3	None	85	Polystyrene core	None

Table 4.6.2: Specifications for redesigned Dwelling 4 in each capital city (continued).

Capital City	Insulation					
	Ceiling	House		Ceiling	Garage	
		External walls	Internal walls		External walls	Internal walls to house
Darwin	R3.5	R1.5	None	None	None	None
Brisbane	R3.5	R2.0	None	None	None	None
Perth	R4.0	R1.5	None	R4.0	None	None
Sydney	R3.5	R1.5	None	R3.5	None	None
Adelaide	R3.5	R1.5	None	R3.5	None	None
Canberra	R3.5	R2.0	None	R3.5	None	None
Melbourne	R3.5	R2.0	None	R3.5	None	None
Hobart	R3.5	R2.0	None	R3.5	None	None

**Table 4.7: Glazing comparison between initial design and redesign for Dwelling 4.**

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	No window changes		
Brisbane	No window changes		
Perth	No window changes		
Sydney	No window changes		
Adelaide	No window changes		
Canberra	21.5	17.2	19.9
Melbourne	21.5	17.2	19.9
Hobart	21.5	17.2	19.9

**Table 4.8: Redesigned Dwelling 4 star rating and cost comparison in selected orientation in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	498,279	8,599	1.7	South	6.0	0.8
Brisbane	541,867	16,558	3.0	South	6.1	0.7
Perth	504,470	6,434	1.3	South	6.1	0.4
Sydney	438,303	5,116	1.2	South	6.1	0.7
Adelaide	418,066	11,491	2.7	South	6.1	0.3
Canberra	408,159	20,875	4.9	South	6.3	0.7
Melbourne	388,576	6,024	1.5	South	6.2	1.4
Hobart	400,890	6,812	1.7	South	6.3	1.6

### Performance of Redesigned Dwelling

In all capital cities the redesign changes resulted in construction costs savings, which were between 1.2 and 4.9%, and a star rating increase ranging from 0.3 to 1.6 stars.

The highest cost saving was achieved in Canberra which was almost 5% of the initial cost due to the use of single glazing instead of double. The change in glazing has been offset with cheaper design changes. Adelaide and Brisbane also have large cost savings as a result of a change in glazing, but the star rating increase in Adelaide was only 0.3 stars, with Brisbane increasing by 0.7 stars.

The cold climate zones were all redesigned with a glazing reduction of almost 20%, and this has resulted in much higher star ratings in all three colder locations.

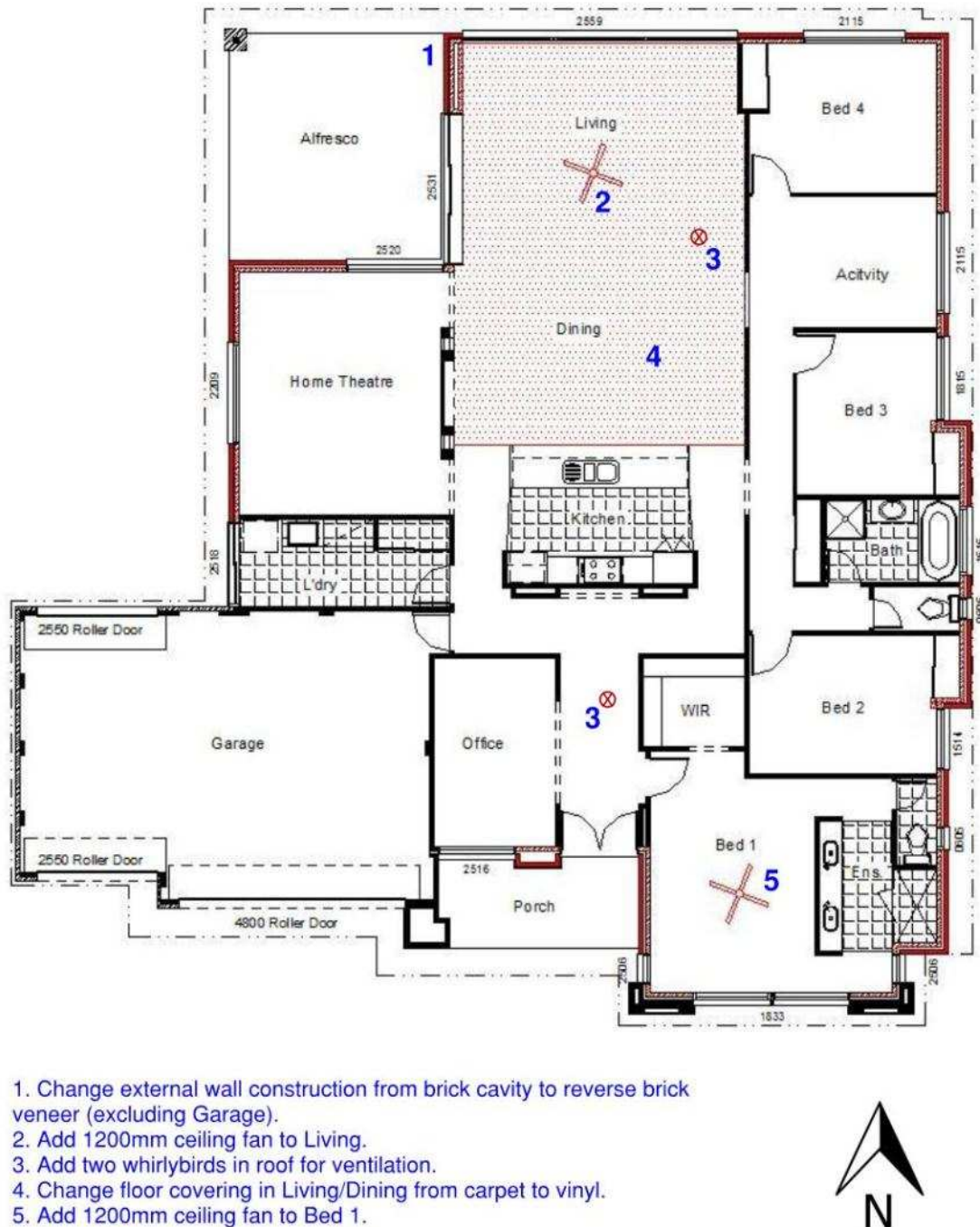


Figure 4.2: Redesigned floor plans for Dwelling 4 in Darwin.

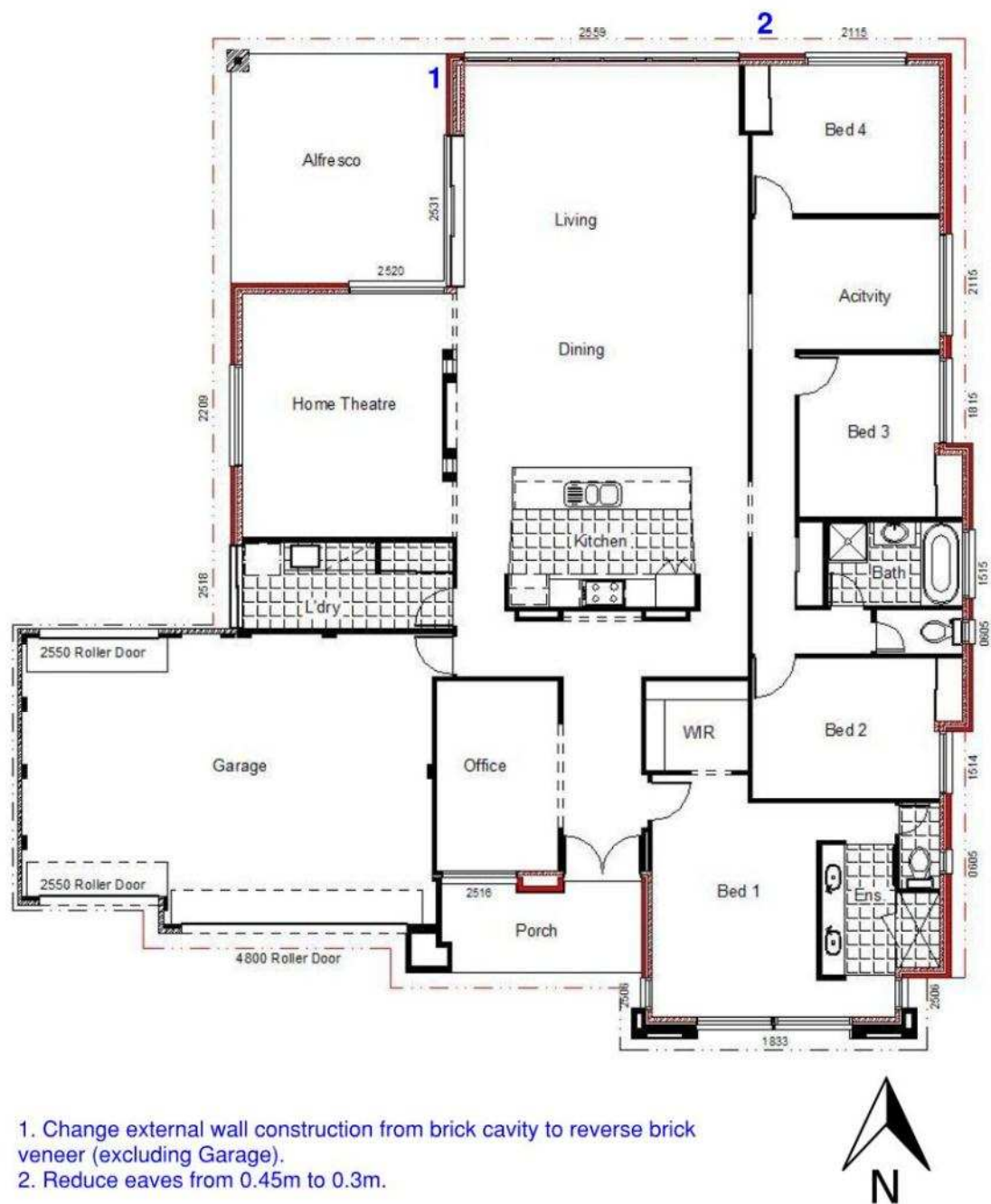


Figure 4.3: Redesigned floor plans for Dwelling 4 in Perth.





**Figure 4.4: Redesigned floor plans for Dwelling 4 in temperate climates except Perth (Brisbane, Sydney and Adelaide).**





**Figure 4.5: Redesigned floor plans for Dwelling 4 in cold climates (Canberra, Melbourne and Hobart).**

## Dwelling 5: Review of Original Dwelling Design in All Capital Cities

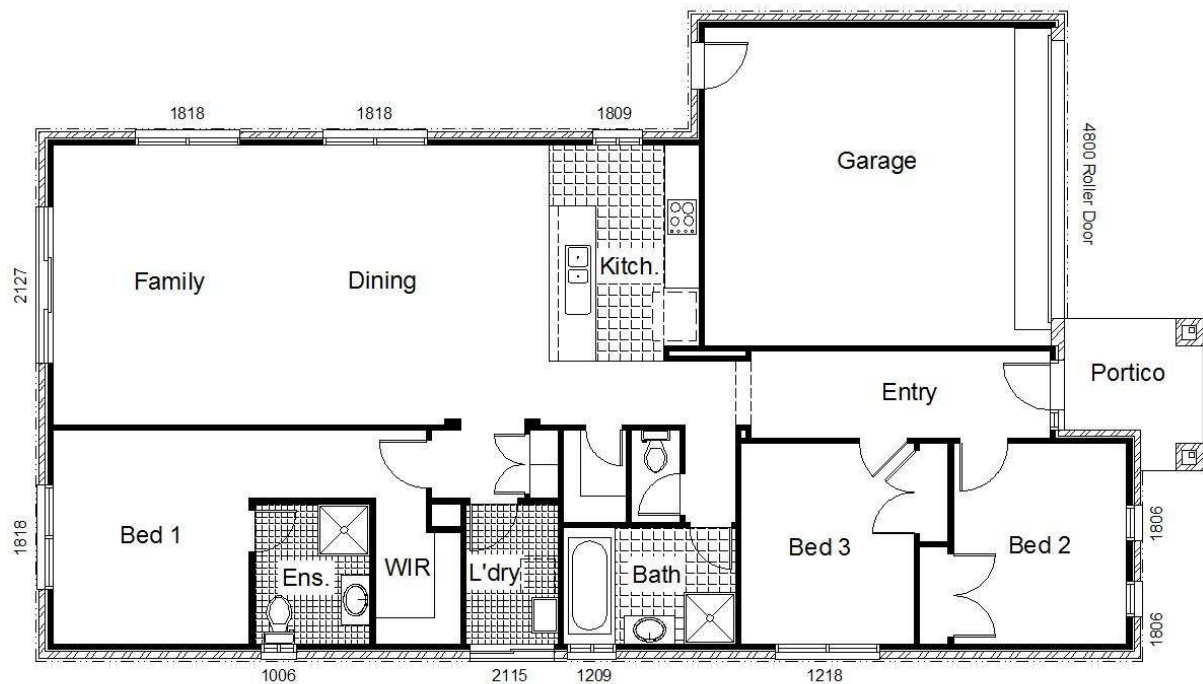


**Table 5.1: Summary of Dwelling 5 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	-	1	2

**Table 5.2: Dwelling 5 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living/ Kitchen	Yes	61
Bedrooms	Yes	48
Corridor	Yes	8
Main Bathroom & Laundry	No	18
Garage	No	33
Verandah	No	5
	TOTAL	173



**Figure 5.1: Dwelling 5 floor plan for original design.**

### Dwelling Description

With a total area of 173m<sup>2</sup>, Dwelling 5 is a compact single storey, and the second smallest of this dwelling type to be included in this study. It has three bedrooms and an open-plan living, dining and kitchen area towards the rear of the dwelling. The external walls are of typical brick veneer construction with a metal hip roof at a 25 degree pitch. The dwelling has an even distribution of glazing across three facades with the front facade having less glazing. The window to floor area ratio (including Garage floor area) is 17%. The majority of the dwelling does not have eaves except for the front, where there is a portico and 0.45m eaves to approximately half of the front facade.

### Initial Specifications and Star Rating Results

Tables 5.1 and 5.2 describe the zoning of Dwelling 5, while Table 5.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 5.4.1 and Table 5.4.2, with Table 5.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 5.3: Dwelling 5 construction details.

Construction	Type	Details
Ceiling height	House	2.4m
Floors	-	CSOG
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	To front facade	None

Table 5.4.1: Specifications for original design of Dwelling 5 in each capital city.

Capital City	Glazing	Roller shutters	Roof sisalation
Darwin	3mm clear	Yes	Yes
Brisbane	3mm clear	Yes	Yes
Perth	3mm clear	No	No
Sydney	3mm clear	No	No
Adelaide	3mm clear	No	No
Canberra	3mm clear	No	No
Melbourne	3mm clear	No	No
Hobart	3mm clear	No	No

Table 5.4.2: Specifications for original design of Dwelling 5 in each capital city (continued).

Capital City	Insulation					
	House			Garage		
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	R1.5
Brisbane	R2.0	R1.5	None	None	None	R1.5
Perth	R2.0	R2.0	None	R2.0	None	R2.0
Sydney	R4.0	R2.0	None	None	None	R2.0
Adelaide	R4.0	R2.5	None	R4.0	None	R2.0
Canberra	R4.0	R2.5	None	None	None	R2.0
Melbourne	R4.0	R2.0	None	None	None	R2.0
Hobart	R4.0	R2.0	None	None	None	R2.0

**Table 5.5: Star rating in four cardinal orientations and cost for original design of Dwelling 5 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	276,632	5.3	5.2	5.0	5.3
Brisbane	304,764	4.6	4.2	4.7	5.6
Perth	282,115	5.1	4.8	4.7	5.5
Sydney	244,173	5.0	4.8	5.0	5.6
Adelaide	230,710	6.1	5.8	5.8	6.2
Canberra	224,173	5.6	5.9	6.2	5.9
Melbourne	218,314	5.9	6.0	6.2	6.2
Hobart	225,208	6.1	6.3	6.6	6.3

### Performance of Original Design

In general, Dwelling 5 shows a variation of between 0.3 and 0.8 stars across the four orientations for seven of the capital cities. Brisbane is a clear outlier with a variation of 1.4 stars between the east and west orientations.

There are no strong trends in the performance of orientations, however the hot and temperate climate generally achieve the highest star ratings in the west orientation. This is due to the living area having a large proportion of glazing, and in the other orientations it is gaining too much solar heat. When the dwelling is in the west orientation the living area glazing is facing east and south, reducing solar gains. There is no trend in the cool climate results.

In the hot and temperate locations the absence of eaves is causing lower star ratings. However in Darwin and Brisbane the glazing is shaded as roller shutters have been included. In the hotter climates this design limitation is compounded by limited cross-flow ventilation. The dwelling is performing well in Adelaide, however, where it has better insulation levels.

In the colder locations, the lack of shading is maximising solar heat gains, and the small window area means that not too much heat is lost through the glazing during winter.

### Review of Redesigned Dwelling in All Capital Cities

#### Redesign Summary

Dwelling 5 has been redesigned with the front door facing east in all capital cities. Also in all capital cities this dwelling was redesigned to include an internal door to separate the corridor from the conditioned zones and in doing so reduce the total conditioned area by 7.9m.

In the hot and temperate locations, the locations of Bed 1 and the main living area have been exchanged. This means that the main living has south and west-facing glazing, while the Bed 1 window is moved to the north-facing wall.

Reversing the living areas is beneficial in a dwelling without eaves to increase the amount of south-facing glazing to the main living areas, ensuring that they are getting the least amount of sunlight possible year-round.

Due to the fact that the original design already achieved six stars in the cold climates, limited redesign was undertaken in Canberra, Melbourne and Hobart. Apart from specification changes and addition of the internal door to the corridor, the only redesign changes in these cities involved slight glazing reductions, glazing re-orientation and the addition of polystyrene core to the concrete slab on ground.

### Revised Specifications and Star Rating Results

Tables 5.6.1 and 5.6.2 show the final specifications for the dwelling and Table 5.7 shows the glazing comparison between the initial and redesigned dwelling. Table 5.8 shows the star rating results and cost savings.

**Table 5.6.1: Specifications for redesigned Dwelling 5 in each capital city.**

Capital City	Glazing	Roller shutters	Roof insulation	Concrete slab type	Roof solar absorptance %	Floor covering change
Darwin	3mm clear	No	Yes	Normal	30	Vinyl
Brisbane	3mm clear	No	Yes	Normal	30	None
Perth	3mm clear	No	No	Normal	30	None
Sydney	3mm clear	No	No	Normal	30	None
Adelaide	3mm clear	No	No	Normal	30-50	None
Canberra	3mm clear	No	No	Polystyrene core	50-85	None
Melbourne	3mm clear	No	No	Polystyrene core	85	None
Hobart	3mm clear	No	No	Polystyrene core	85	None

Table 5.6.2: Specifications for redesigned Dwelling 5 in each capital city (continued).

Capital City	Insulation					
	House			Garage		
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	None
Brisbane	R3.5	R2.0	None	None	None	None
Perth	R3.5	R1.5	None	None	None	None
Sydney	R3.5	R1.5	None	None	None	None
Adelaide	R3.5	R1.5	None	None	None	None
Canberra	R3.5	R2.0	None	None	None	None
Melbourne	R3.5	R2.0	None	None	None	None
Hobart	R3.5	R2.0	None	None	None	None

Table 5.7: Glazing comparison between initial design and redesign for Dwelling 5.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	16.6	15.5	6.8
Brisbane	16.6	15.5	6.8
Perth	16.6	15.5	6.8
Sydney	16.6	15.5	6.8
Adelaide	16.6	15.5	6.8
Canberra	16.6	15.5	6.8
Melbourne	16.6	15.5	6.8
Hobart	16.6	15.5	6.8



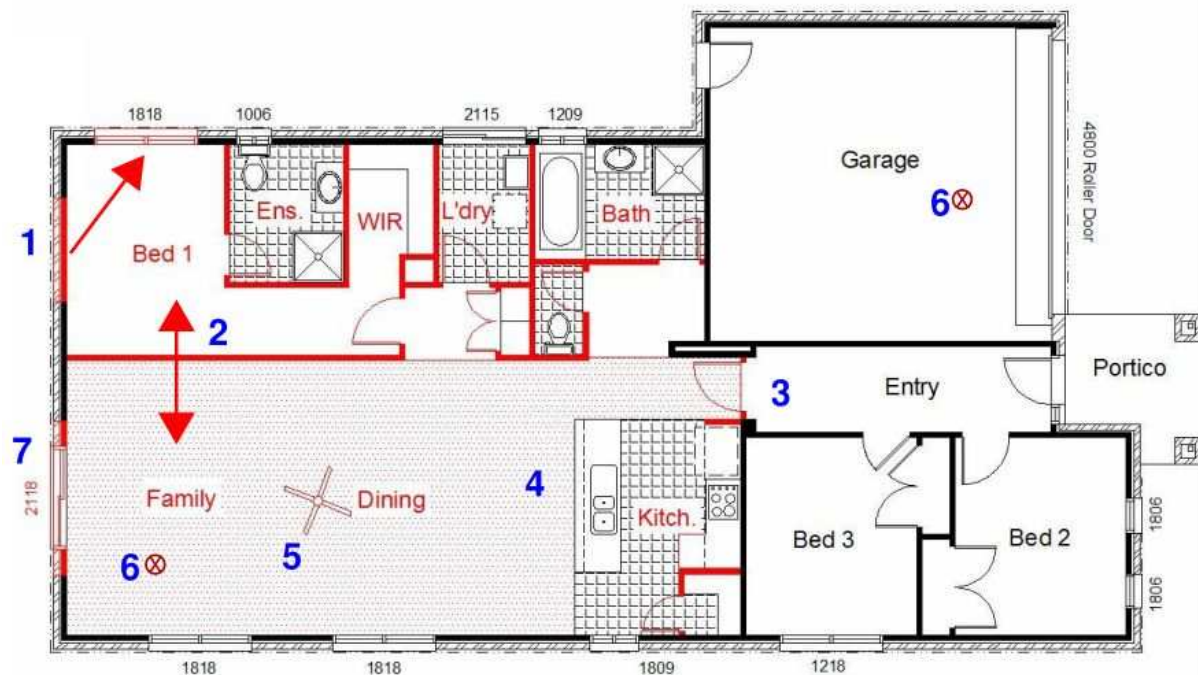
**Table 5.8: Redesigned Dwelling 5 star rating and cost comparison in selected orientation in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	270,688	5,944	2.2	East	6.2	1.0
Brisbane	293,739	11,025	3.6	East	6.9	2.7
Perth	281,940	175	0.1	East	6.2	1.4
Sydney	243,548	625	0.3	East	6.3	1.5
Adelaide	229,220	1,490	0.7	East	6.4	0.6
Canberra	223,600	573	0.3	East	6.4	0.5
Melbourne	218,015	299	0.1	East	6.6	0.6
Hobart	224,900	308	0.1	East	7.2	0.9

### Performance of Redesigned Dwelling

The Dwelling 5 redesign saves money in all locations, but only a small amount. The cost saving is under 1% of the original design cost in all locations except Darwin and Brisbane, which have overall cost saving of 2.2 and 3.6% respectively. Brisbane also has the largest star rating increase at 2.7 stars.

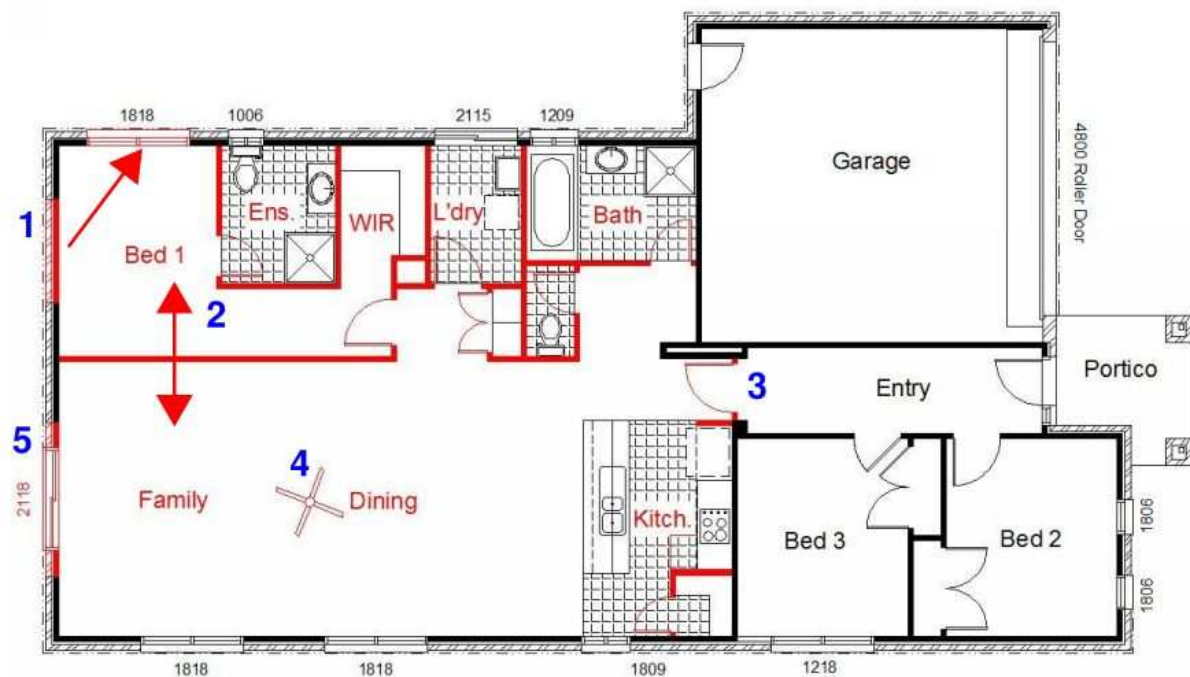
In general the increase in star rating as a result of the redesign process is high in all capital cities, with Darwin, Brisbane, Perth and Sydney all achieving an increase of 1 star or more. Exchanging the Bed 1 and main living area locations has proven to be a cost neutral and energy saving change in all the hot and temperate climates. The glazing reduction of almost 7% to all locations has also had a positive impact. The cold climates primarily benefitted from the change to a polystyrene core concrete slab.



1. Move Bed 1 window from western to northern facade.
2. Move internal zones by replacing the Family/ Dining and Kitchen with Bed 1, Ensuite, WIR, Laundry, WC and Bath.
3. Add hinged door to Entry corridor.
4. Change floor covering in Family/Dining from carpet to vinyl.
5. Add 1200mm ceiling fan to Family/Dining.
6. Add two whirlybirds in roof for ventilation.
7. Reduce Family sliding door from 2.7m to 1.8m wide.



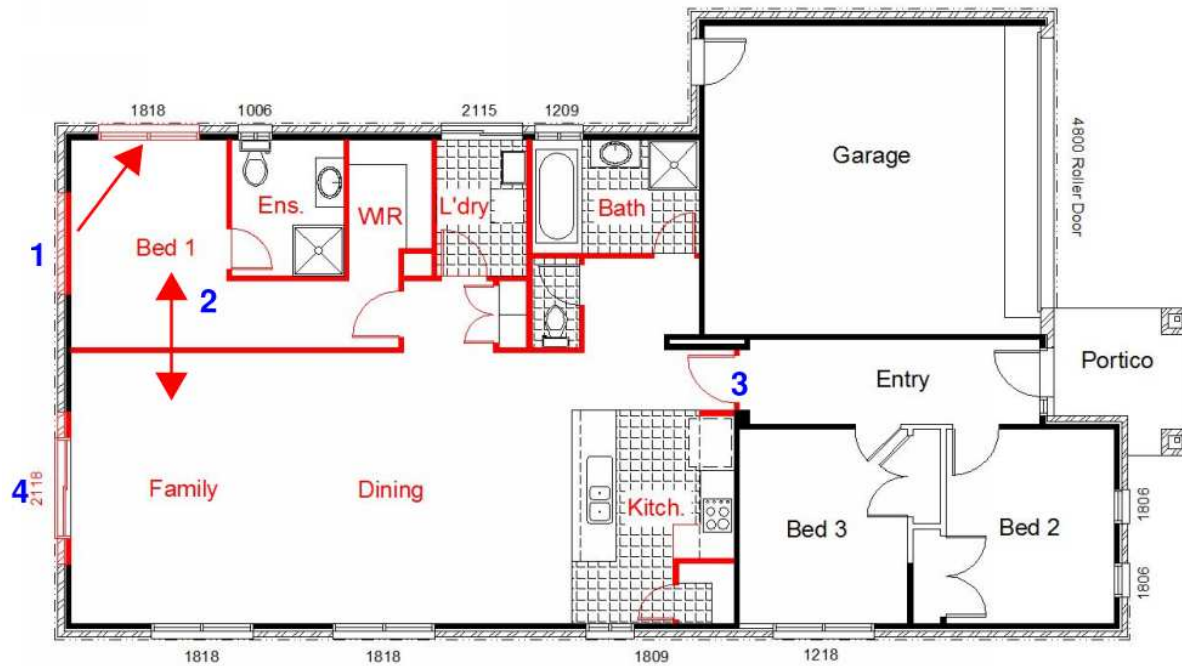
Figure 5.2: Redesigned floor plan for Dwelling 5 in Darwin.



1. Move Bed 1 window from western to northern facade.
2. Move internal zones by replacing the Family/ Dining and Kitchen with Bed 1, Ensuite, WIR, Laundry, WC and Bath.
3. Add hinged door to Entry corridor.
4. Add 1200mm ceiling fan to Family/Dining.
5. Reduce Family sliding door from 2.7m to 1.8m wide.



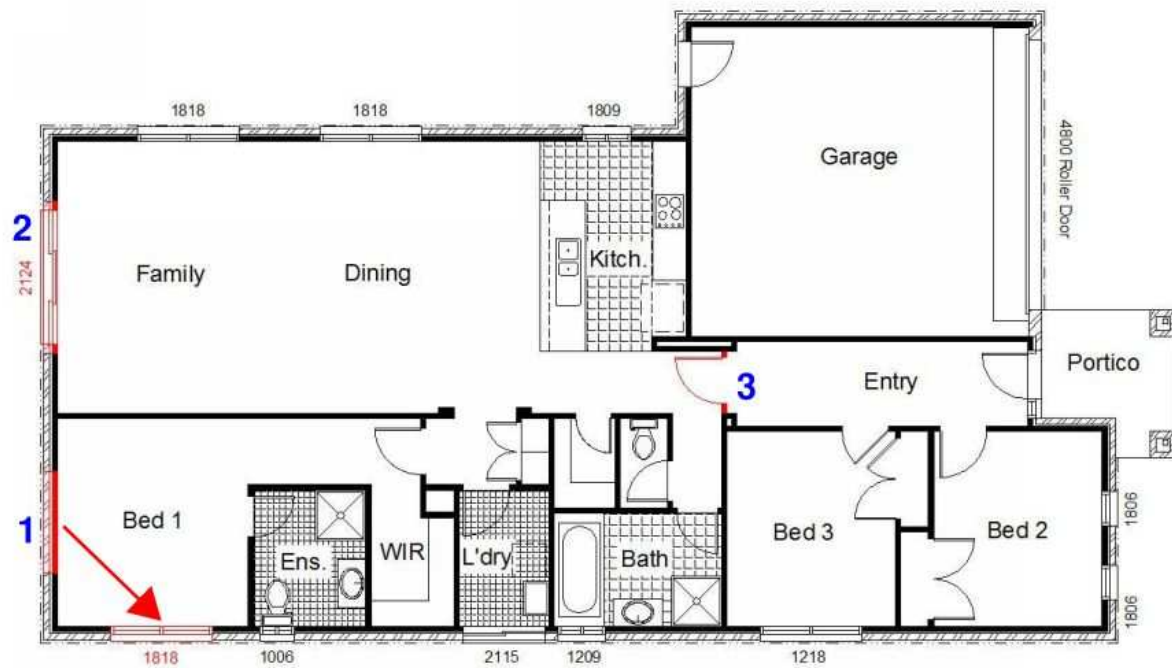
Figure 5.3: Redesigned floor plan for Dwelling 5 in Brisbane.



1. Move Bed 1 window from western to northern facade.
2. Move internal zones by replacing the Family/ Dining and Kitchen with Bed 1, Ensuite, WIR, Laundry, WC and Bath.
3. Add hinged door to Entry corridor.
4. Reduce Family sliding door from 2.7m to 1.8m wide.



**Figure 5.4: Redesigned floor plan for Dwelling 5 in Perth, Sydney and Adelaide.**



1. Move Bed 1 window from western to southern facade.
2. Reduce Family sliding door from 2.7m to 1.8m wide.
3. Add hinged door to Entry corridor.



Figure 5.5: Redesigned floor plan for Dwelling 5 in Canberra, Melbourne and Hobart.

## Dwelling 6: Review of Original Dwelling Design in All Capital Cities



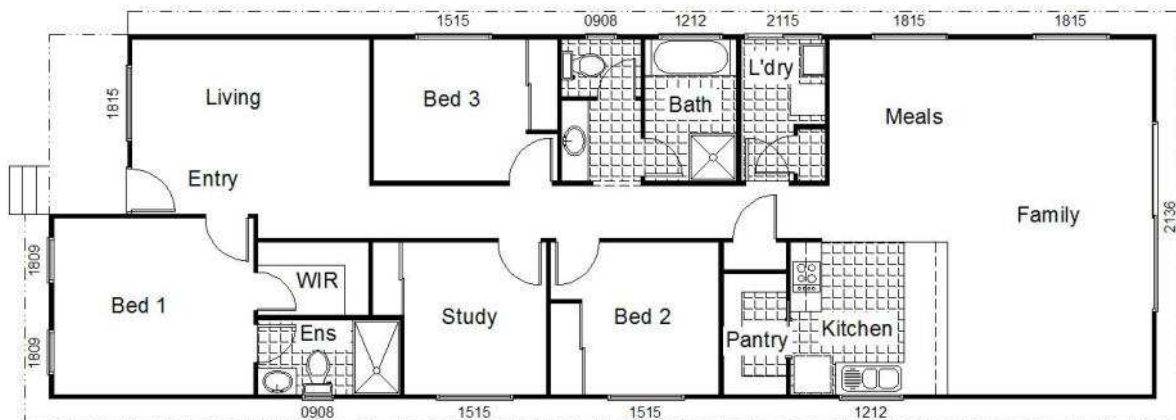
**Table 6.1: Summary of Dwelling 6 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	1	2	-

**Table 6.2: Dwelling 6 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	15
Living/ Kitchen	Yes	43
Bedrooms	Yes	36
Corridor	Yes	17
Main Bathroom & Laundry	No	10
Verandah	No	5
	TOTAL	126





**Figure 6.1: Dwelling 6 floor plan for original design.**

### Dwelling Description

An elongated single storey with suspended timber floor, Dwelling 6 has three bedrooms, a study and an open-plan living, dining and kitchen area towards the rear of the dwelling and a separate living area at the front of the dwelling. Dwelling 6 is the smallest single storey design in this study. The external walls are of weatherboard construction with a metal hip roof at 17.5 degree pitch. The two longer facades have an even distribution of glazing while the short front and rear facades have significant sliding doors and windows. The window to floor area ratio is 26%. The dwelling has 0.3m eaves with a gable end and verandah at the front.

### Initial Specifications and Star Rating Results

Tables 6.1 and 6.2 describe the zoning of Dwelling 6, while Table 6.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 6.4.1 and Table 6.4.2, with Table 6.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.



**Table 6.3: Dwelling 6 construction details.**

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	Timber
External walls	-	Weatherboard: 10mm weatherboard + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	-	0.3m

**Table 6.4.1: Specifications for original design of Dwelling 6 in each capital city.**

Capital City	Glazing	Roof insulation	Awning shading
Darwin	Alum 6.38mm ComfortPlus Neutral	Yes	Yes
Brisbane	Alum 4mm clear/8mm air/4mm Energy Advantage Low E	Yes	Yes
Perth	Cedar 4mm clear/8mm air/4mm Energy Advantage Low E	No	Yes
Sydney	Cedar 3mm clear/6mm air/3mm clear	Yes	Yes
Adelaide	Cedar 4mm clear/8mm air/4mm Energy Advantage Low E	Yes	Yes
Canberra	Cedar 4mm clear/8mm air/4mm Energy Advantage Low E	Yes	Yes
Melbourne	Cedar 6.38mm ComfortPlus Neutral	Yes	No
Hobart	Alum 3mm clear	No	No

**Table 6.4.2: Specifications for original design of Dwelling 6 in each capital city (continued).**

Capital City	Insulation				
	Ceiling	Roof blanket	External walls	Internal walls	Under floor
Darwin	R3.5	None	R2.0	R2.0	R1.5
Brisbane	R3.5	None	R2.0	R2.0	R1.5
Perth	R4.0	R2.0	R2.5	R2.0	R1.5
Sydney	R4.0	R2.0	R2.5	R2.0	R1.5
Adelaide	R4.0	R2.0	R2.5	R2.0	R1.5
Canberra	R4.0	R2.0	R2.5	R2.0	R1.5
Melbourne	R4.0	None	R2.0	R2.0	R1.5
Hobart	R3.5	None	R1.5	None	R1.5

**Table 6.5: Star rating in four cardinal orientations and cost for original design of Dwelling 6 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	249,895	5.3	5.6	5.5	5.6
Brisbane	281,428	4.6	4.2	4.4	5.1
Perth	264,613	5.2	5.3	5.1	5.4
Sydney	231,051	4.9	4.9	4.8	5.1
Adelaide	217,112	5.7	5.8	5.6	5.9
Canberra	213,043	5.6	5.6	5.6	5.8
Melbourne	200,344	4.7	4.7	4.8	4.9
Hobart	194,166	5.4	5.1	5.2	5.4

### Performance of Original Design

There is not a lot of variation between the different orientations within each location for this dwelling. The well-dispersed glazing across the four facades means that orientation changes do not make a large impact on the rating.

The dwelling does achieve higher star ratings with the front door facing west in all locations, as this minimises the amount of west-facing glazing, and gives the main living areas a large amount of north-facing glazing. Darwin, however, rates higher with the front door facing east.

The dwelling achieves lower ratings with the front door facing east in colder climates, as the large sliding door to the family is facing west and losing a substantial amount of heat and there is minimal north glazing through which to gain heat. In Darwin, the dwelling achieves a lower star rating with the front door facing north, as this orientation increases the east and west glazing to the dwelling increasing unwanted heat gains.

In almost every location the dwelling requires double glazing and maximum insulation levels in external walls, floors and ceilings to combat heat loss and heat gain. The dwelling has lower star ratings in the locations where there is a need for both heating and cooling.

### Review of Redesigned Dwelling in All Capital Cities

#### Redesign Summary

The dwelling has been redesigned with the front door facing west in all locations. Due to the very poor performance of the original dwelling, this orientation was selected for redesign because it was the highest rating orientation in all locations.

In Darwin, the dwelling has been redesigned with the west-facing Bed 1 windows moved to the south facade to cut down on heat gains through this glazing. Ceiling fans have been included to the Living, Meals and Family areas, along with ventilators to the roof. The main living area sliding door has been moved to the south facade, to cut down on heat gains. The eaves have also been extended to 0.6m all the way around the dwelling.

In Adelaide, the dwelling has been redesigned with the front Living window moved to the north-facing facade. The Study and Bed 3 have been swapped over, so that the day-time occupied Study has better comfort levels. The west-facing sliding door has been reduced, to cut down on heat gains during summer and reduce the area for heat loss during winter.

The other temperate climates have the same changes as Adelaide, in addition to ceiling fans to the Living and Meals/Family area, vinyl to the Meals/Family floor and 0.6m eaves throughout. This is due to the fact that Brisbane, Perth and Sydney require more reductions in heat gains.

### Revised Specifications and Star Rating Results

Tables 6.6.1 and 6.6.2 show the final specifications for the dwelling and Table 6.7 shows the glazing comparison between the initial and redesigned dwelling. Table 6.8 shows the star rating results and cost savings.

**Table 6.6.1: Specifications for redesigned Dwelling 6 in each capital city.**

Capital City	Glazing	Window reduction (%)	Awning	Eave width (m)	Roof insulation	Roof solar absorptance (%)	Floor covering change
Darwin	Alum 5mm Evergreen	No	No	0.6	Yes	30	None
Brisbane	Alum 5mm Evergreen	10	All Bed 1 & Fam/ Mls	0.6	Yes	30	Vinyl
Perth	Cedar 6.38mm ComfortPlu s Neutral	10	All Bed 1 & Fam/ Mls	0.6	Yes	30	Vinyl
Sydney	Cedar 6.38mm ComfortPlu s Neutral	10	All Bed 1 & Fam/ Mls	0.6	Yes	30	Vinyl
Adelaide	Cedar 6.38mm ComfortPlu s Neutral	No	All Bed 1 & Fam/ Mls	0.3	Yes	30	None
Canberra	Alum 3mm clear	No	No	0.3	No	50-85	None
Melbourne	Alum 3mm clear	No	No	0.3	No	50-85	None
Hobart	Alum 3mm clear	No	No	0.3	No	85	None

Table 6.6.2: Specifications for redesigned Dwelling 6 in each capital city (continued).

Capital City	External wall construction	Subfloor Type	Wall solar absorptance (%)
Darwin	Weatherboard	Very Open	30
Brisbane	Weatherboard	Normal	50
Perth	Weatherboard	Normal	50
Sydney	Weatherboard	Normal	50-85
Adelaide	Weatherboard	Normal	50-85
Canberra	Expanded polystyrene	Normal	85
Melbourne	Expanded polystyrene	Normal	85
Hobart	Expanded polystyrene	Normal	85

Table 6.6.3: Specifications for redesigned Dwelling 6 in each capital city (continued).

Ceiling	Insulation			
	External walls	Internal walls except wet walls	Internal wet walls	Under floor
R3.5	R2.0	None	R1.5	None
R4.0	R2.5	None	R2.0	R2.0
R4.0	R2.5	None	R2.0	R2.0
R4.0	R2.0	None	R2.0	R2.0
R4.0	R2.0	None	R2.0	R2.0
R3.5	R2.0	None	R2.0	R2.0
R3.5	R2.0	None	R2.0	R2.0
R3.5	R2.0	None	None	R2.0

Table 6.7: Glazing comparison between initial design and redesign for Dwelling 6.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	26.2	24.2	7.9
Brisbane	26.2	21.8	17.1
Perth	26.2	21.8	17.1
Sydney	26.2	21.8	17.1
Adelaide	26.2	24.2	7.9
Canberra	26.2	23.8	9.5
Melbourne	26.2	23.8	9.5
Hobart	26.2	23.8	9.5

**Table 6.8: Redesigned Dwelling 8 star rating and cost comparison in selected orientations in each capital city.**

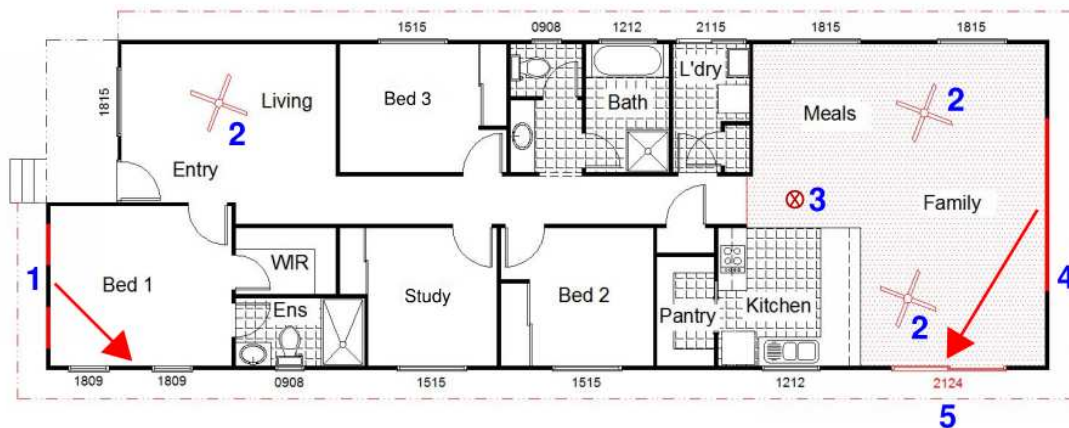
Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	250,766	-871	-0.4	West	6.0	0.4
Brisbane	271,777	9,651	3.4	West	6.0	0.9
Perth	255,762	8,851	3.3	West	6.0	0.6
Sydney	223,332	7,719	3.3	West	6.1	1.0
Adelaide	209,439	7,673	3.5	West	6.1	0.2
Canberra	200,241	12,802	6.0	West	6.1	0.3
Melbourne	193,570	6,774	3.4	West	6.1	1.2
Hobart	197,500	-3,334	-1.7	West	6.6	1.2

### Performance of Redesigned Dwelling

In most capital cities, construction costs decreased with increased energy efficiency for the redesigned dwelling. This is also due to the 7.9% to 17.1% reduction in glazing to all locations.

Cost savings ranged from 3.3% of the initial design cost in Perth and Sydney, to 6.0% in Canberra, with a 0.3 star increase.

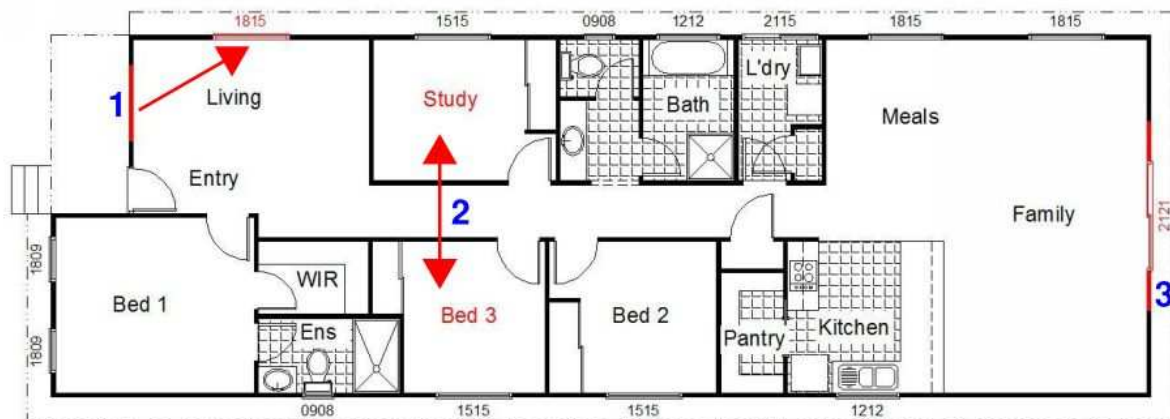
The only locations that did not achieve a cost saving for the redesigned dwelling were Darwin and Hobart. In Darwin a 0.4 star increase was associated with a very small cost, while in Hobart the star rating increased by 1.2 stars for an added cost of 1.7% of the initial design cost.



1. Bed 1 windows re-orientated to the southern facade.
2. Addition of 1.2m diameter ceiling fans to living, meals and family.
3. Roof ventilator to roof space.
4. Reduction of width of family door from 3.6m to 2.4m and moved to southern facade.
5. 0.6m eaves to whole house except for gable ends.



Figure 6.2: Redesigned floor plan for Dwelling 6 in Darwin.



1. Living windows moved to northern facade.
2. Move internal zones by replacing the study with Bed 3.
3. Reduction of width of family door from 3.6m to 2.4m and moved to southern facade.



Figure 6.3: Redesigned floor plan for Dwelling 6 in Adelaide.



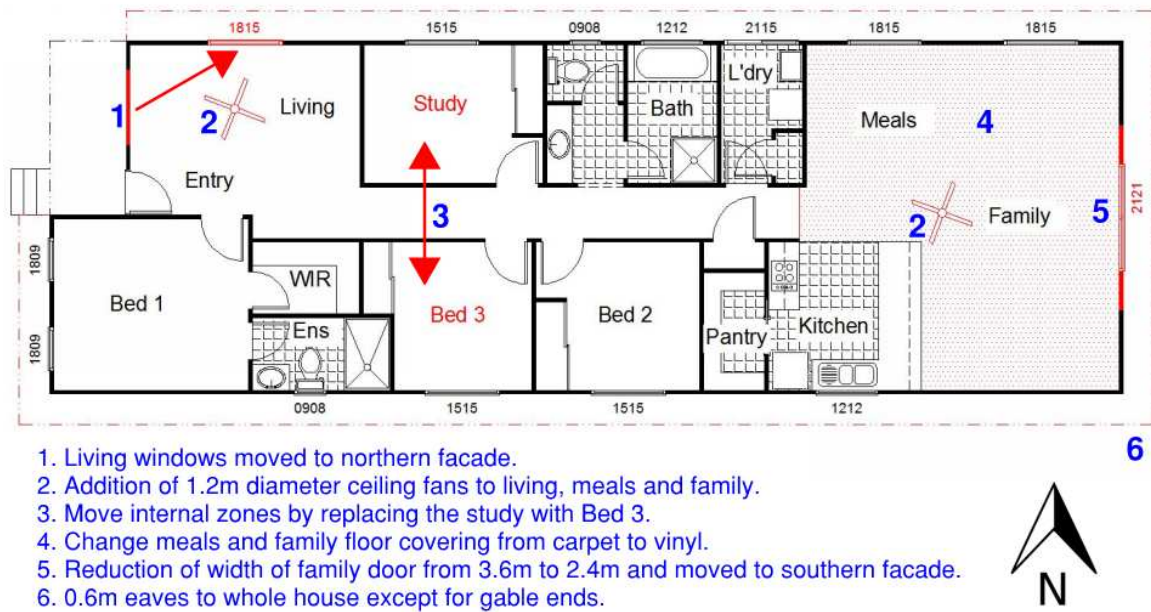


Figure 6.4: Redesigned floor plan for Dwelling 6 in Brisbane, Perth and Sydney.

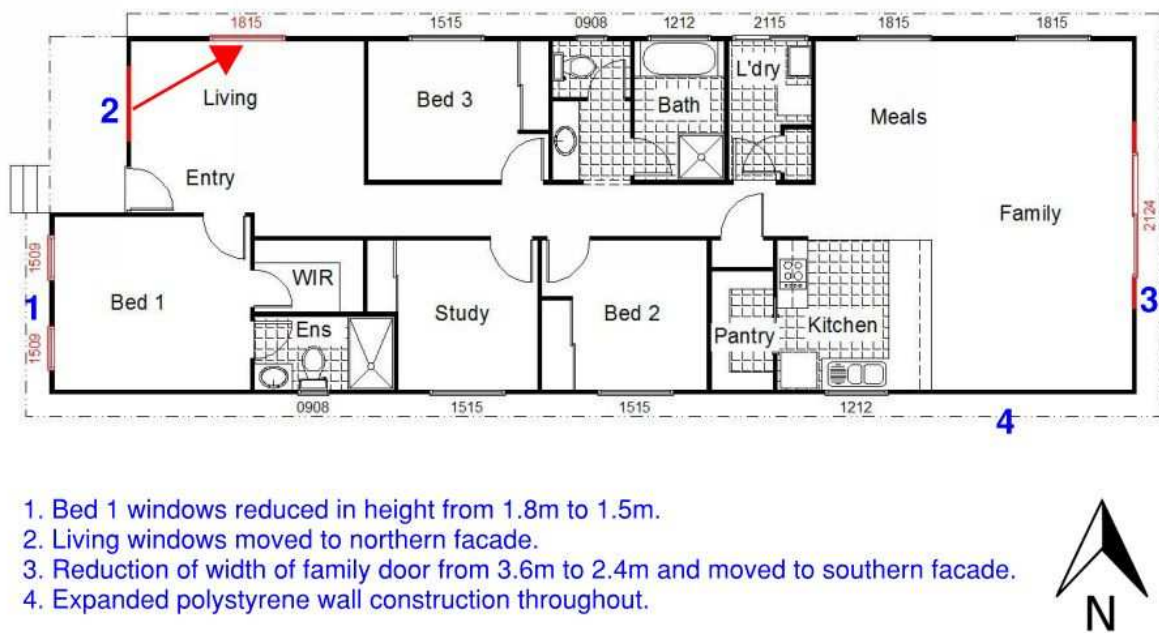


Figure 6.5: Redesigned floor plan for Dwelling 6 in Canberra, Hobart and Melbourne.



## Dwelling 7: Review of Original Dwelling Design in All Capital Cities



**Table 7.1: Summary of Dwelling 7 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	-	1	1

**Table 7.2: Dwelling 7 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living/ Kitchen	Yes	32
Bedrooms	Yes	40
Corridor	Yes	22
Main Bathroom & Laundry	No	9
Garage	No	36
Verandah	No	4
	TOTAL	143



Figure 7.1: Dwelling 7 floor plan for original design.

### Dwelling Description

This compact two storey dwelling has three bedrooms and one open plan living area on the ground floor. The two smaller bedrooms and the utilities are arranged around a central corridor that leads to the living area at the rear of the dwelling. The first floor is comprised of the main bedroom and ensuite. The external walls are double brick cavity construction to the majority of the dwelling with single brick to the garage and internal walls. The roof is metal with a 23 degree pitch. The glazing is evenly distributed over three facades on the ground level, while concentrated on two facades on the upper level. The other facades have little or no glazing. The window to floor area ratio is approximately 23%. The ground floor has no eaves with a portico over the entry area while the first floor has 0.48m eaves around its entirety.

### Initial Specifications and Star Rating Results

Tables 7.1 and 7.2 describe the zoning of Dwelling 7, while Table 7.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 7.4.1 and Table 7.4.2, with Table 7.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 7.3: Dwelling 7 construction details.

Construction	Type	Details
Ceiling height	-	2.4m
Floors	Ground floor	CSOG
	First floor	Suspended slab
External walls	House	Double Brick Cavity: 110mm brick + air gap + 110mm brick + 10mm plasterboard
	Garage	Single Brick: 110mm brick
Internal walls	House	Brick: 10mm plasterboard + 110mm brick + 10mm plasterboard
	To Roof Space	Brick Cavity: 110mm brick + 40mm air gap + 110mm brick + 10mm plasterboard
Roof	-	Metal deck
Eaves	First floor	0.48m

Table 7.4.1: Specifications for original design of Dwelling 7 in each capital city.

Capital City	Glazing	Roof insulation
Darwin	Alum 6.38mm CP Neutral	Yes
Brisbane	Alum 5mm EverGreen	Yes
Perth	Alum 3mm Clear	No
Sydney	Cedar 3mm Clear	Yes
Adelaide	Cedar 3mm Clear/6mm/3mm Clear	No
Canberra	Cedar 4mm Clear/8mm/4mm Low-e	Yes
Melbourne	Cedar 3mm Clear	No
Hobart	Alum 3mm clear/6mm/3mm clear	No

**Table 7.4.2: Specifications for original design of Dwelling 7 in each capital city (continued).**

Capital City	Insulation					
	House			Garage		
	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2.0	Foil	None	R2.0	None	None
Brisbane	R2.0	Foil	None	R2.0	None	None
Perth	R3.5	Foil	None	R3.5	None	None
Sydney	R4.0	Foil	None	R3.5	None	None
Adelaide	R4.0	Foil	None	R4.0	None	None
Canberra	R4.0	Foil	None	R4.0	None	None
Melbourne	R4.0	Foil	None	R3.5	None	None
Hobart	R4.0	Foil	None	R4.0	None	None

**Table 7.5: Star rating in four cardinal orientations and cost for original design of Dwelling 7 in each capital city.**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	360,892	4.8	4.9	4.7	4.8
Brisbane	401,349	4.2	3.6	3.9	4.9
Perth	376,063	5.1	4.6	4.1	4.8
Sydney	328,505	4.9	4.4	4.4	4.8
Adelaide	311,978	5.8	5.5	5.2	5.8
Canberra	306,729	5.6	5.3	5.6	5.9
Melbourne	290,993	4.5	4.4	4.5	4.8
Hobart	305,588	4.9	4.8	5.1	5.3

### Performance of Original Design

The variation in results between orientations has a wide range, the highest variation being 1.3 stars in Brisbane, while the smallest is 0.2 stars in Darwin.

In Darwin, the highest performing orientation is with the front door facing east. This orientation keeps heat gain through west and east facing windows to a minimum.

In the temperate climates, the dwelling achieves the highest ratings in the north and west orientations. When the front door faces north, the heat gains are minimised and the heat loss is offset by the use of double glazing and high levels of insulation. When the front door faces west, the heat gain for the cooler climates is maximised with the living area and the two bedrooms on the ground floor with north facing glazing.

Having the front door facing west results in the highest star ratings in the cold climates, as this increases solar heat gains to the dwelling.

In most climates in most orientations the dwelling is not achieving the required rating with high construction specification due to the large window area and the impact of the exposed first floor.

## **Review of Redesigned Dwelling in All Capital Cities**

### **Redesign Summary**

Dwelling 7 was redesigned with the front door facing west in most locations, except for Darwin where it was redesigned in the east orientation. In all capital cities the external wall construction was changed from brick cavity to reverse brick veneer to allow for insulation within the wall. The glazing specification for all capital cities was reduced to the base level 3mm clear to achieve greater cost savings.

In Darwin, adjustable shading devices were used to mitigate the impact of east and west orientated glazing. Ventilation was increased through the use of ceiling fans in all bedrooms and living area and to the roof through two roof ventilators. The roof colour was also changed to reflect a solar absorption of 30%, reducing the amount of heat gain through the roof.

In Darwin, and the temperate climates, the floor covering in the living area was changed to vinyl making use of passive cooling provided through the concrete slab.

In both temperate and cool climates the eave depths were reduced to 0.3m and the family window moved to the northern facade to allow for increased solar heat gains in to the northern orientated living area. An internal door was also added between the kitchen and entry in order to compartmentalise the conditioned areas.

In the cold climates the flooring system was changing to polystyrene core concrete to reduce heat loss through the slab.

### **Revised Specifications and Star Rating Results**

Tables 7.6.1 and 7.6.2 show the final specifications for the dwelling and Table 7.7 shows the glazing comparison between the initial and redesigned dwelling. Table 7.8 shows the star rating results and cost savings.

Table 7.6.1: Specifications for redesigned Dwelling 7 in each capital city.

Capital City	Glazing	Awning	Eave width (m)	Roof insulation	Roof solar absorptance (%)	Concrete slab type	Floor covering change
Darwin	Alum 3mm clear	West Fam/Dine All Bed 1/WIR	0.48	Yes	30	Normal	Vinyl
Brisbane	Alum 3mm clear	None	0.3	None	30	Normal	Vinyl
Perth	Alum 3mm clear	None	0.3	None	30	Normal	Vinyl
Sydney	Alum 3mm clear	None	0.3	None	30	Normal	Vinyl
Adelaide	Alum 3mm clear	None	0.3	None	30	Normal	Vinyl
Canberra	Alum 3mm clear	None	0.3	None	85	Polystyrene core	None
Melbourne	Alum 3mm clear	None	0.3	None	85	Polystyrene core	None
Hobart	Alum 3mm clear	None	0.3	None	85	Polystyrene core	None

Table 7.6.2: Specifications for redesigned Dwelling 7 in each capital city (continued).

Capital City	Insulation					
	Ceiling	House	Garage			
		External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	None
Brisbane	R3.5	R1.5	None	None	None	None
Perth	R3.5	R1.5	None	None	None	None
Sydney	R3.5	R1.5	None	None	None	None
Adelaide	R3.5	R2.0	None	None	None	None
Canberra	R4.0	R2.5	None	R4.0	None	None
Melbourne	R4.0	R2.0	None	R4.0	None	None
Hobart	R4.0	R2.0	None	R4.0	None	None

**Table 7.7: Glazing comparison between initial design and redesign for Dwelling 7.**

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	No window changes		
Brisbane	22.8	22.3	2.3
Perth	22.8	22.3	2.3
Sydney	22.8	22.3	2.3
Adelaide	22.8	22.3	2.3
Canberra	22.8	22.3	2.3
Melbourne	22.8	22.3	2.3
Hobart	22.8	22.3	2.3

**Table 7.8: Redesigned Dwelling 7 star rating and cost comparison in selected orientations in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	362,038	-1,146	-0.3	East	6.1	1.2
Brisbane	390,350	10,999	2.7	West	7.4	2.5
Perth	369,090	6,973	1.9	West	6.7	1.9
Sydney	321,167	7,338	2.2	West	6.3	1.5
Adelaide	300,793	11,185	3.6	West	6.0	0.2
Canberra	295,284	11,445	3.7	West	6.1	0.2
Melbourne	285,728	5,265	1.8	West	6.1	1.3
Hobart	295,105	10,483	3.4	West	6.3	1.0

### Performance of Redesigned Dwelling

The redesign specifications for Darwin increase the star rating by 1.2 stars, however they result in an additional cost of about 0.3% of the initial design cost.

This design in Adelaide, Canberra and Hobart achieved a large cost savings of around 3.5% of the initial design cost however star rating only increased by 0.2 stars in these locations.

Hobart and Brisbane have the best cost and star rating benefits from the redesign. Both have saved approximately 3% of the initial design cost, with an increase in star rating of 1 and 2.5 stars respectively. Perth, Sydney and Melbourne all achieved increased star ratings, with large cost savings.

In all cities except for Perth the design changes allow for the reduction of the glazing specification by 2.3%, which often represents a considerable cost when attempting to achieve 6 stars.





1. Change external wall construction from brick cavity to reverse brick veneer (excluding Garage).
2. Add 1200mm ceiling fan to Family.
3. Change floor covering on Family/ Dining from carpet to vinyl.
4. Add two whirlybirds in roof for ventilation.
5. Add 1200mm ceiling fan to Bed 3.
6. Add 1200mm ceiling fan to Bed 2.
7. Add 1200mm ceiling fan to Bed 1.

Figure 7.2: Redesigned ground and first floor plans for Dwelling 7 in Darwin.



1. Change external wall construction from brick cavity to reverse brick veneer (excluding Garage).
2. Move Family window from eastern to northern facade and reduce the window size from 1.5x1.8m to 2.14x0.97m.
3. Change floor covering on Family/ Dining from carpet to vinyl.
4. Add hinged door to corridor.
5. Reduce eaves from 0.48m to 0.3m.

**Figure 7.3: Redesigned ground and first floor plans for Dwelling 7 in temperate climates (Brisbane, Perth, Sydney and Adelaide).**



1. Change external wall construction from brick cavity to reverse brick veneer (excluding Garage).
2. Move Family window from eastern to northern facade and reduce the window size from 1.5x1.8m to 2.14x0.97m.
3. Add hinged door to corridor.
4. Reduce eaves from 0.48m to 0.3m.

**Figure 7.4: Redesigned ground and floor plans for Dwelling 7 in cold climates (Canberra, Hobart and Melbourne).**

## Dwelling 8: Review of Original Dwelling Design in All Capital Cities



**Table 8.1: Summary of Dwelling 8 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	3	1	2	2

**Table 8.2: Dwelling 8 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	25
Living/ Kitchen	Yes	50
Bedrooms	Yes	59
Corridor/Study/Rumpus	Yes	28
Main Bathrooms & Laundry	No	5
Garage	No	34
Verandah	No	21
	TOTAL	222

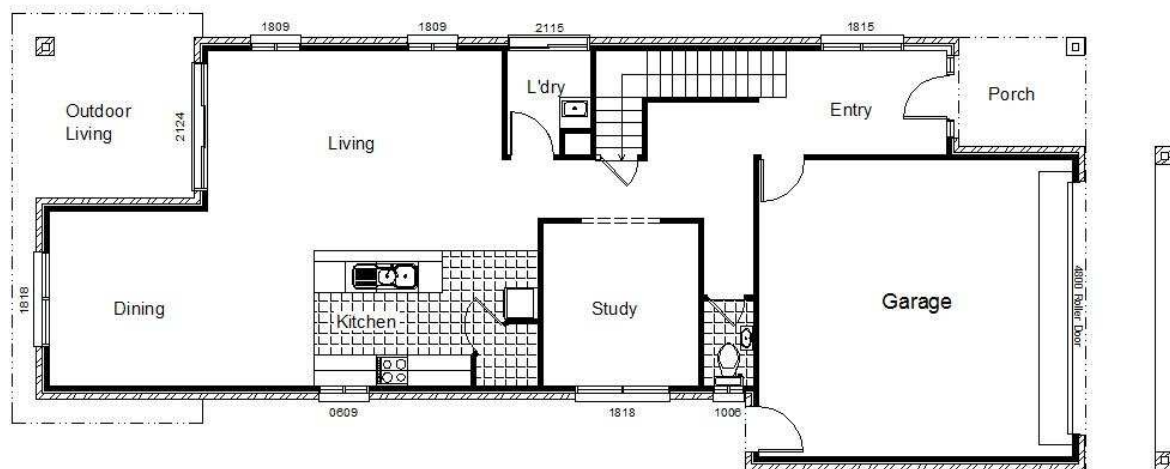


Figure 8.1: Dwelling 8 ground floor plan for original design.

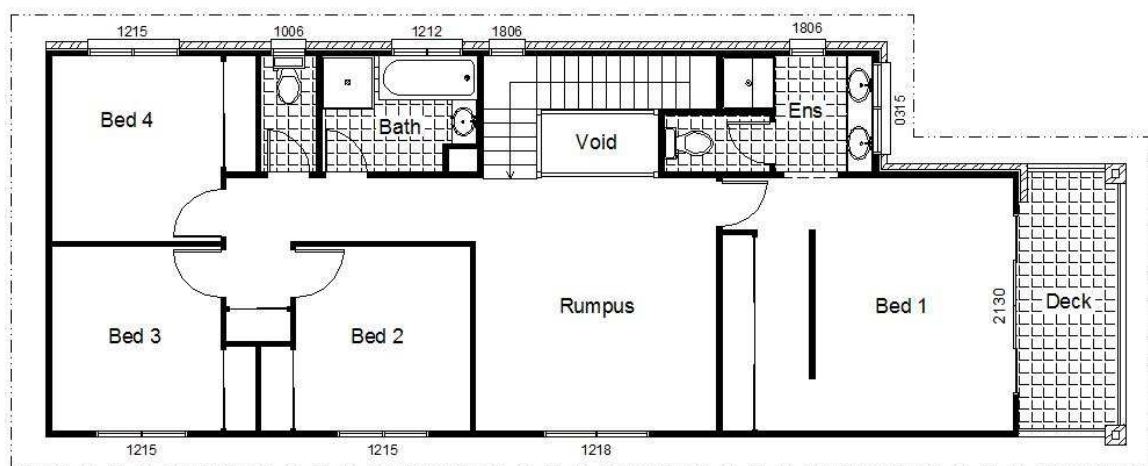


Figure 8.2: Dwelling 8 first floor plan for original design.



### Dwelling Description

Dwelling 8 is a double storey detached residence with an open plan dining/living and kitchen area downstairs, along with a study, and four bedrooms upstairs, as well as a rumpus area. The lower level external walls are of typical brick veneer construction, as are the front and side walls to the upper level. The other side and rear walls to the upper are clad with a lightweight cladding. The front and rear facades are smaller and therefore have less glazing, though the majority of the main living area glazing does face to the rear of the dwelling. The window to floor area ratio is approximately 21%. The dwelling has 0.45m eaves to the upper level, with a 3m<sup>2</sup> outdoor living area to the rear downstairs, along with a porch to the front, and a 2.3m deck to Bed 1 on the upper level.

### Initial Specifications and Star Rating Results

Tables 8.1 and 8.2 describe the zoning of Dwelling 8, while Table 8.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 8.4.1 and Table 8.4.2, with Table 8.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

**Table 8.3: Dwelling 8 construction details.**

Construction	Type	Details
Ceiling height	Ground floor	2.6m
	First floor	2.4m
Floors	Ground floor	CSOG
	First floor	Timber
External walls	Ground floor Front and side of first floor	Brick veneer: 110mm brick + air gap + 10mm plasterboard
	Side and rear of first floor	Fibre-cement cladding: 6mm fibre-cement + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	First floor	0.45m

Table 8.4.1: Specifications for original design of Dwelling 8 in each capital city.

Capital City	Glazing	Roof sisalation
Darwin	5mm Evergreen	Yes
Brisbane	5mm Evergreen	Yes
Perth	6.38mm ComfortPlus Neutral	No
Sydney	5mm Evergreen	Yes
Adelaide	6.38mm ComfortPlus Neutral	Yes
Canberra	6.38mm ComfortPlus Neutral	Yes
Melbourne	3mm clear	No
Hobart	3mm clear	No

Table 8.4.2: Specifications for original design of Dwelling 8 in each capital city (continued).

Capital City	Insulation						
	House				Garage		
	Ceiling	External walls	Internal walls	Between floors	Ceiling	External walls	Internal walls to house
Darwin	R3.5	R1.5	None	None	R3.5	None	None
Brisbane	R3.5	R1.5	None	None	R3.5	None	None
Perth	R4.0	R2.0	None	R2.0	None	R2.0	R2.0
Sydney	R3.5	R2.0	None	None	None	None	R2.0
Adelaide	R4.0	R2.0	R2.0	R2.0	None	None	R2.0
Canberra	R4.0	R2.0	None	R2.0	None	None	R2.0
Melbourne	R3.5	R2.0	None	None	None	None	R2.0
Hobart	R3.5	R2.0	None	None	None	None	R2.0



**Table 8.5: Star rating in four cardinal orientations and cost for original design of Dwelling 8 in each capital city (orientation according to direction of front door)**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	353,110	4.9	5.4	4.7	5.3
Brisbane	389,020	3.8	5.1	4.6	4.4
Perth	369,843	4.6	5.3	4.7	5.1
Sydney	320,367	4.3	4.9	4.5	4.6
Adelaide	303,096	5.5	5.9	5.6	5.8
Canberra	295,505	5.4	5.8	5.5	5.4
Melbourne	279,422	4.7	4.9	4.8	4.7
Hobart	288,246	5.1	5.4	5.3	5.0

### Performance of Original Design

This dwelling displays a wide variation in results between orientations in Darwin and Brisbane, whereas the other locations have a smaller range of variation.

Having the front door facing east results in the highest star ratings in all locations, as this maximises north glazing.

In Darwin, the dwelling achieves a lower star rating when the front door is facing south, which minimises south-facing glazing and maximises solar heat gains.

The temperate locations achieve lower ratings with the front door facing north, as this minimises the north-facing glazing to the dwelling, while the colder locations perform worse with the front door facing west, as this maximises the south-facing glazing to the dwelling.

In Darwin and Brisbane, Dwelling 8 requires high performance 5mm Evergreen glazing to meet the 5 star requirements. This glazing type reduces the amount of heat gain into the dwelling. The need for high performance glass as well as foil to the roof indicates that there is not enough shading provided to windows to stop solar heat gains.

### Review of Redesigned Dwelling in All Capital Cities

#### Redesign Summary

The dwelling was redesigned with the front door facing south in all capital cities as this was one of the lowest rating orientations across all locations.

In Darwin, the Laundry has been moved to the western side of the dwelling in order to maximise the living area, and to make sure that the majority of west-facing glazing is servicing non-conditioned areas. The west-facing window to the Study has been reduced, and the windows to Bed 3 and Bed 4 have been moved from the east and west-facing facades to the northern facade. The floor covering to the Living/Dining area has been changed to vinyl.

In the temperate climate locations, all east-facing glazing on the ground floor has been reduced (except to the Laundry), and the Study window has been reduced. The floor covering has been changed to vinyl, and the outdoor living area shading has been removed and replaced with a removable shade sail. The Bed 3 and Bed 4 windows have also been moved to the north-facing

facade, while the Bed 1 window has been reduced to minimise heat loss through this area in winter. The eaves have been reduced in order to maximise heat gains into the dwelling.

The same changes have been made in the cold climates as in the temperate climates, except the floor covering has not been changed as this is not beneficial in a colder climate.

### Revised Specifications and Star Rating Results

Tables 8.6.1 and 8.6.2 show the final specifications for the dwelling and Table 8.7 shows the glazing comparison between the initial and redesigned dwelling. Table 8.8 shows the star rating results and cost savings.

**Table 8.6.1: Specifications for redesigned Dwelling 8 in each capital city.**

Capital City	Glazing	Eave width (m)	Roof insulation	Roof solar absorptance (%)	Concrete slab type	Reduce window area (all)	Floor covering change
Darwin	3mm clear	0.45	Yes	30	Normal	10.0%	Vinyl
Brisbane	3mm clear	0.3	Yes	30	Normal	10.0%	Vinyl
Perth	3mm clear	0.3	Yes	30	Normal	10.0%	Vinyl
Sydney	3mm clear	0.3	Yes	30	Normal	10.0%	Vinyl
Adelaide	3mm clear	0.3	Yes	30-85	Normal	No change	Vinyl
Canberra	3mm clear	0.3	No	85	Polystyrene core	No change	None
Melbourne	3mm clear	0.3	No	50-85	Polystyrene core	No change	None
Hobart	3mm clear	0.3	No	50-85	Polystyrene core	No change	None

Table 8.6.2: Specifications for redesigned Dwelling 8 in each capital city (continued).

Capital City	Insulation						
	House				Garage		
	Ceiling	External walls	Internal walls	Mid-floor	Ceiling	External walls	Internal wall to house
Darwin	R2.0	R2.0	R1.5	None	None	None	None
Brisbane	R4.0	R2.0	None	None	None	None	R2.0
Perth	R4.0	R2.5	None	None	R4.0	R2.0	R2.0
Sydney	R4.0	R2.5	None	None	None	None	R2.0
Adelaide	R4.0	R2.5	R2.0	None	None	None	R2.0
Canberra	R4.0	R2.0	R2.0	R1.5	None	None	R2.0
Melbourne	R4.0	R2.5	None	R1.5	None	None	R2.0
Hobart	R4.0	R2.0	None	None	None	None	R2.0

Table 8.7: Glazing comparison between initial design and redesign for Dwelling 8.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	20.8	19.0	8.6
Brisbane	20.8	18.5	10.8
Perth	20.8	18.5	10.8
Sydney	20.8	18.5	10.8
Adelaide	20.8	18.5	10.8
Canberra	20.8	18.5	10.8
Melbourne	20.8	18.5	10.8
Hobart	20.8	18.5	10.8

**Table 8.8: Redesigned Dwelling 8 star rating and cost comparison in selected orientation in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	350,115	2,995	0.9	South	6.0	1.3
Brisbane	381,300	7,720	2.0	South	6.0	1.4
Perth	362,886	6,957	1.9	South	6.1	1.4
Sydney	313,420	6,947	2.2	South	6.0	1.5
Adelaide	295,673	7,423	2.5	South	6.0	0.4
Canberra	289,067	6,438	2.2	South	6.2	0.7
Melbourne	279,346	76	0.0	South	6.1	1.3
Hobart	285,695	2,551	0.9	South	6.1	0.8

### Performance of Redesigned Dwelling

The redesign process improved the star rating by over 1 star in five of the eight capital cities. In all locations, this star rating improvement was associated with a cost saving.

Adelaide showed the smallest increase in star rating, gaining only 0.4 of a star, with the highest cost saving, of 2.5%.

Sydney, on the other hand, was the lowest rating performing location initially, and has experienced a 1.5 star increase in rating as well as a 2.2% cost saving. Perth and Brisbane gained 1.4 stars each, with cost savings just under the 2% mark. In Darwin, the changes resulted in an overall improvement in the star rating of 1.3 stars, and an overall cost saving of 0.85% of the initial design cost, without requiring as much reduced glazing as elsewhere. Canberra had a significant cost saving at 2.2%, while Hobart saved 0.9%, but star rating improvements in these areas were less than a star.

The smallest cost saving was in Melbourne, which was initially assessed with standard glazing and did not perform well. The redesign has improved this initial rating, but increased insulation has had to be included to get it over 6 stars.

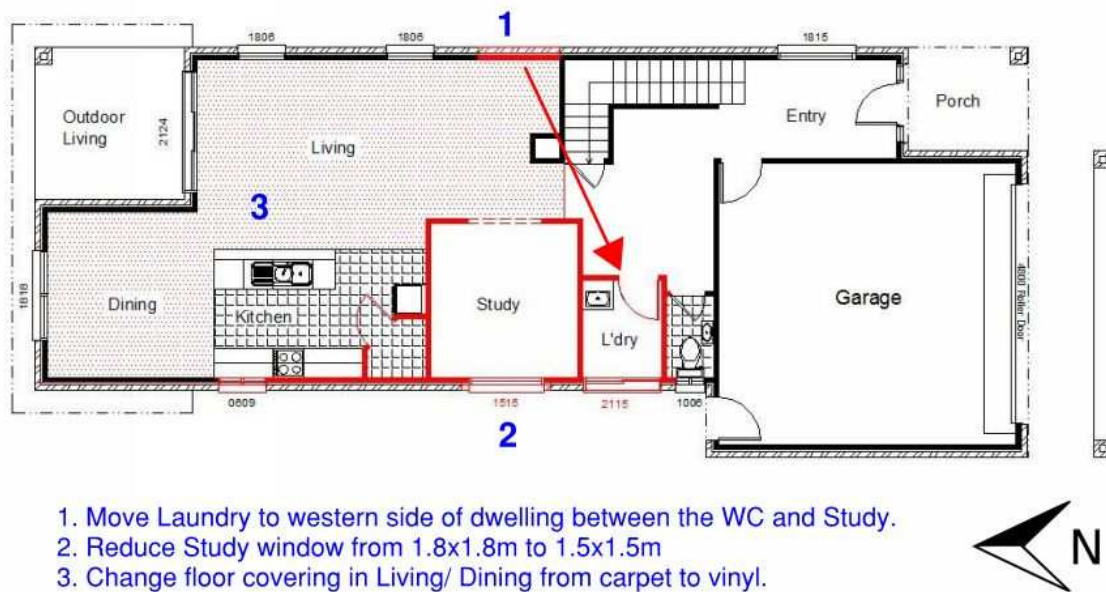


Figure 8.3: Redesigned ground floor plan of Dwelling 8 in Darwin.

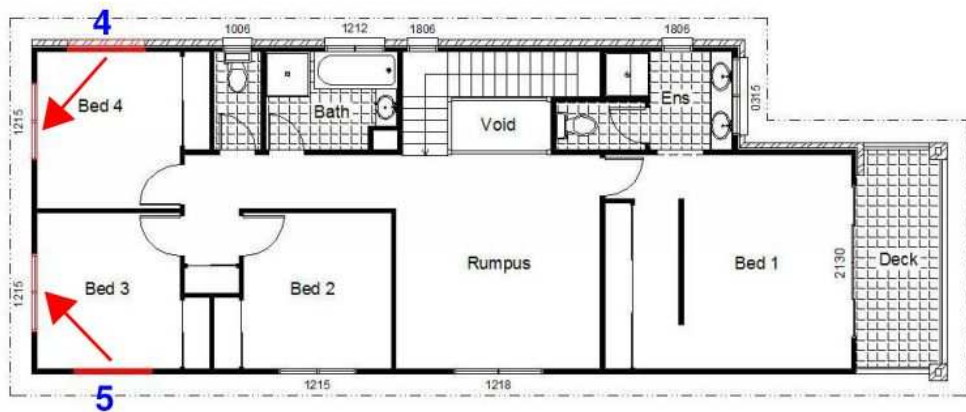
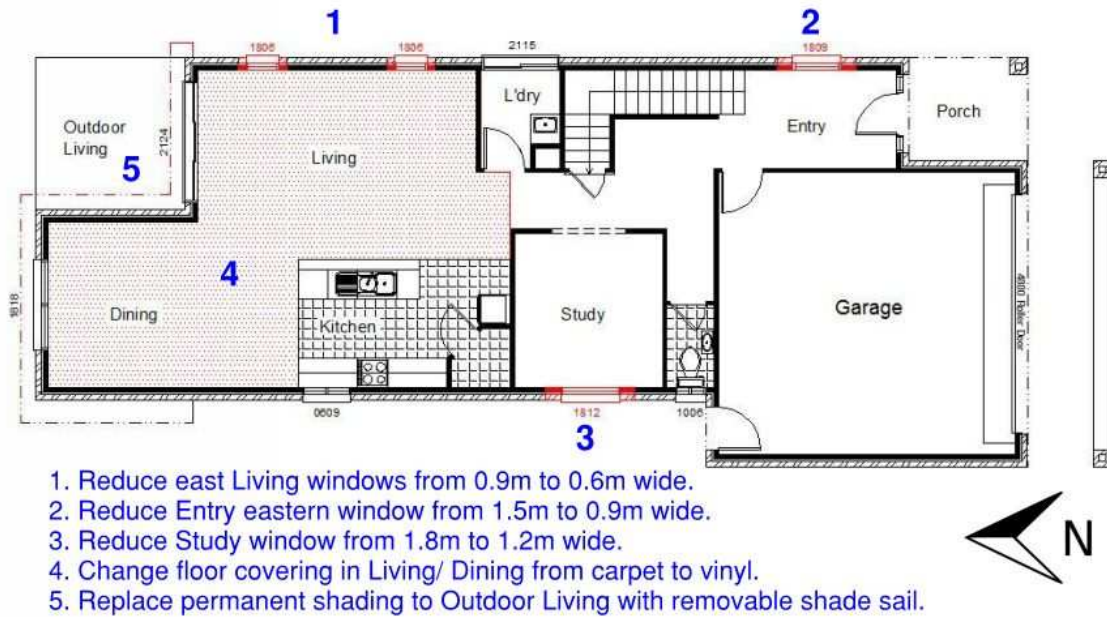
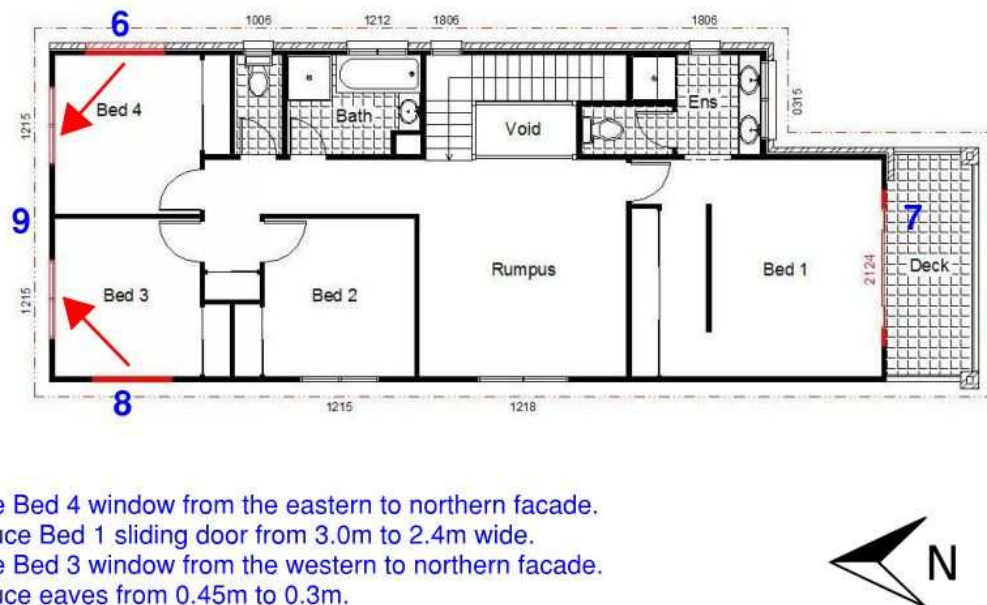


Figure 8.4: Redesigned first floor plan of Dwelling 8 in Darwin.



**Figure 8.5: Redesigned ground floor plan of Dwelling 8 in Brisbane, Perth, Sydney and Adelaide.**



**Figure 8.6: Redesigned first floor plan of Dwelling 8 in Brisbane, Perth, Sydney and Adelaide.**



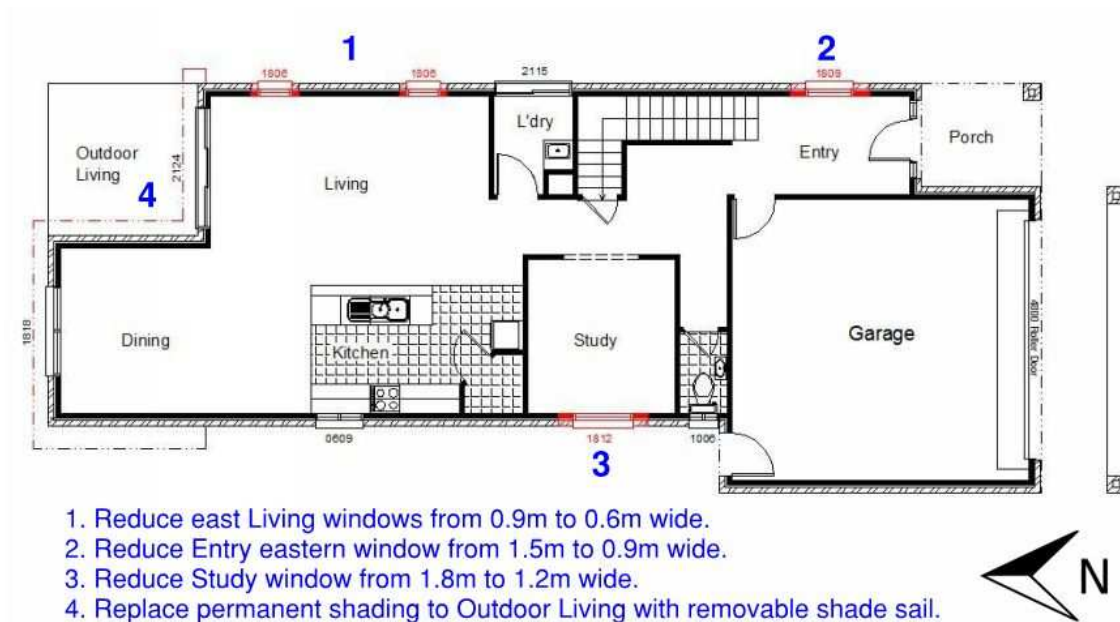


Figure 8.7: Redesigned ground floor plan of Dwelling 8 in Canberra, Melbourne and Hobart.

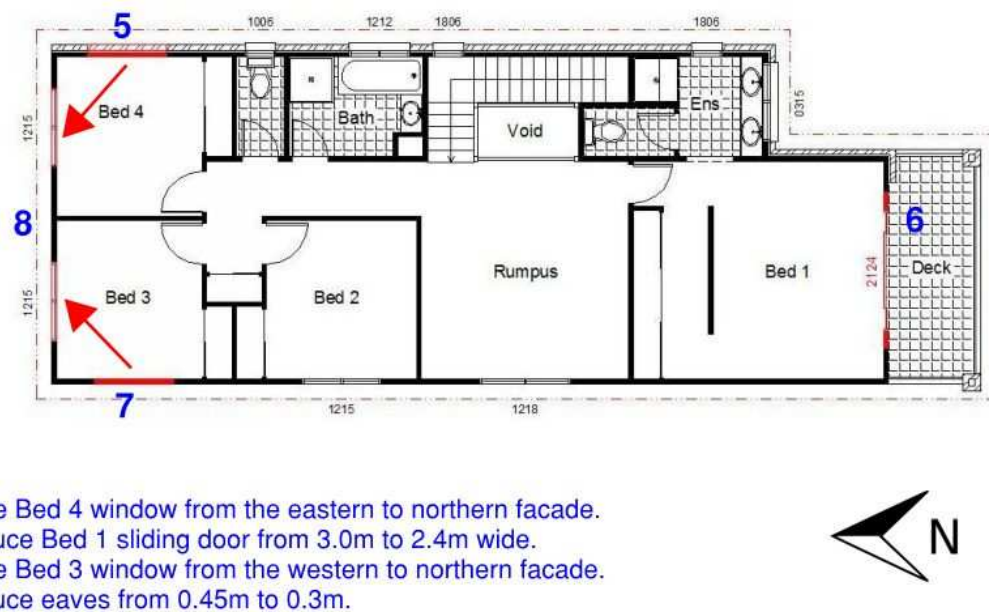


Figure 8.8: Redesigned first floor plan of Dwelling 8 in Canberra, Melbourne and Hobart.



## Dwelling 9: Review of Original Dwelling Design in All Capital Cities



**Table 9.1: Summary of Dwelling 9 zone types.**

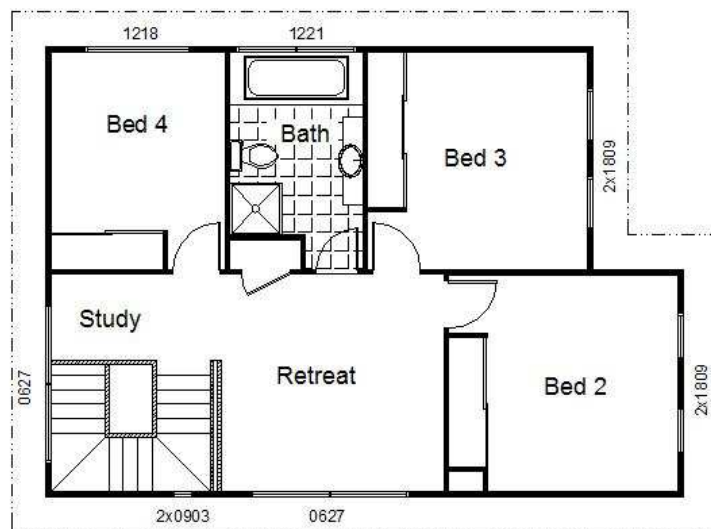
Bedrooms	Bathrooms	Study	Living Areas	Garage
4	3	1	2	2

**Table 9.2: Dwelling 9 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living	Yes	60
Living/ Kitchen	Yes	26
Bedrooms	Yes	67
Corridor	Yes	8
Main Bathroom & Laundry	No	10
Garage	No	35
Verandah	No	15
TOTAL		221



**Figure 9.1: Dwelling 9 ground floor plan for original design.**



**Figure 9.2: Dwelling 9 first floor plan for original design.**

### Dwelling Description

This is a double storey detached dwelling with 4 bedrooms, open plan living on the ground level and study/retreat area on the upper level. The lower level external walls are of typical brick veneer construction while the first floor external walls are fibre cement. The roof is constructed with concrete tiles on a 22 degree pitch. The glazing is evenly distributed across the four facades with significant glazed doors to the rear of the dwelling. The window to floor area ratio is approximately 22%. The dwelling generally has 0.45m eaves on the lower level, 0.6m on the upper level with an alfresco area to the rear, and a portico and verandah to the front.

### Initial Specifications and Star Rating Results

Tables 9.1 and 9.2 describe the zoning of Dwelling 9, while Table 9.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 9.4.1 and Table 9.4.2, with Table 9.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

**Table 9.3: Dwelling 9 construction details.**

Construction	Type	Details
Ceiling height	Ground floor	2.6m
	First floor	2.4m
Floors	Ground floor	CSOG
	First floor	Timber
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Concrete tiles
Eaves	Ground floor	0.45m
	First floor	0.6m

Table 9.4.1: Specifications for original design of Dwelling 9 in each capital city.

Capital City	Glazing	Awning shading	Roof sisalation
Darwin	3mm clear	Yes	Yes
Brisbane	3mm clear	Yes	Yes
Perth	6.38mm ComfortPlus Neutral	Yes	Yes
Sydney	3mm clear	No	Yes
Adelaide	6.38mm ComfortPlus Neutral	Yes	No
Canberra	4mm clear/8mm air/4mm Energy Advantage Low E	Yes	No
Melbourne	3mm clear	No	No
Hobart	3mm clear	No	No

Table 9.4.2: Specifications for original design of Dwelling 9 in each capital city (continued).

Capital City	Insulation						
	House				Garage		
	Ceiling	External walls	Internal walls	Between floors	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R2.0	None	None	None	None	R2.0
Brisbane	R3.5	R1.5	None	None	None	None	R2.0
Perth	R4.0	R2	None	None	R3.5	R2	R2.0
Sydney	R4.0	R2.0	R2.0	R2.0	R3.5	None	R2.0
Adelaide	R4.0	R2.5	R2.0	None	R4.0	R2.0	R2.0
Canberra	R3.5	R2.5	None	None	R3.5	None	R2.0
Melbourne	R4.0	R2.0	R2.0	None	R3.5	None	R2.0
Hobart	R4.0	R2.0	None	None	R3.5	None	R2.0

**Table 9.5: Star rating in four cardinal orientations and cost for original design of Dwelling 9 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	363,033	5.1	5.1	5.1	5.2
Brisbane	400,330	4.8	4.9	4.9	5.5
Perth	387,163	5.0	4.9	5.0	5.1
Sydney	325,617	5.0	5.0	4.7	5.0
Adelaide	316,126	6.1	6.0	5.9	6.0
Canberra	314,035	6.1	6.2	5.9	6.1
Melbourne	287,111	5.2	5.3	5.1	5.2
Hobart	294,328	5.1	5.2	5.0	5.1

### Performance of Original Design

Dwelling 9 has very little variation between different orientations in each location, due to the even distribution of glazing across all four facades.

The warmer climates perform better with the front door facing west, as this orients the main living area to the north and south, reducing heat gains. This also ensures that the east-facing glazing to the main living areas is well shaded.

For the colder climates, the most benefit is seen when the front door is facing east. This maximises heat gains to the main living areas, reducing artificial heating requirements. Sydney, Melbourne and Hobart have all been assessed with standard glazing, with ratings of around 5 stars. High performance glazing was required in Perth to meet the minimum 5 star rating, and in Adelaide to achieve 6 stars. In Canberra, Dwelling 9 required double glazed Energy Advantage Low E glazing, increasing the construction costs, and resulting in a far higher result in Canberra than in any of the other cold climates.

North-facing glazing is minimised when the front door is south-facing, resulting in lower star ratings across the board, except Brisbane. In Brisbane, the dwelling has a lower rating with the front door facing north.

### Review of Redesigned Dwelling in All Capital Cities

#### Redesign Summary

Dwelling 9 was redesigned in three different orientations for the three different climate types.

In Darwin, the dwelling was redesigned with the front door facing west. Ceiling fans have been added to the Family area, Bed 1 and Bed 3, where air movement is low. The Dining sliding door, Kitchen window and Study windows have been reduced to cut down on heat gains.

Temperate climates were redesigned in the southern orientation, which provided one of the lowest rating orientations across the four capital cities. The redesign in these locations is very similar to that in the hot climates, although ceiling fans have not been included. The glazing to both the lower and upper level living areas has been reduced. An internal door between the Entry and main living area has also been included to reduce the load on mechanical heating and cooling year round.

The front door facing east was selected for redesign in the colder climates, as this provided the best opportunity to achieve 6 stars. The redesign in cold climates focuses on reducing glazing to stop heat

loss through these areas in the colder months, and reducing the load on all mechanical heating by including an internal door between the Entry and main living area.

### Revised Specifications and Star Rating Results

Tables 9.6.1 and 9.6.2 show the final specifications for the dwelling and Table 9.7 shows the glazing comparison between the initial and redesigned dwelling. Table 9.8 shows the star rating results and cost savings.

**Table 9.6.1: Specifications for redesigned Dwelling 9 in each capital city.**

Capital City	Glazing	Awnin g	Eave width (m)	Roof sisalation	Roof solar absorpt. (%)	Floor covering change	Concrete slab type
Darwin	3mm clear	None	0.45	Yes	30	Vinyl	Normal
Brisbane	3mm clear	None	0.3	None	30	Vinyl	Normal
Perth	3mm clear	None	0.3	None	30	Vinyl	Normal
Sydney	3mm clear	None	0.3	Yes	30	Vinyl	Normal
Adelaide	3mm clear	None	0.3	None	30	Vinyl	Normal
Canberra	3mm clear	None	0.3	None	50-85	None	Polystyrene core
Melbourn e	3mm clear	None	0.3	None	50-85	None	Polystyrene core
Hobart	3mm clear	None	0.3	None	85	None	Polystyrene core

**Table 9.6.2: Specifications for redesigned Dwelling 9 in each capital city (continued).**

Capital City	Insulation							
	House					Garage		
	Ceiling	External walls	Internal walls	Internal walls to wet areas	Between floors	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	None	None	None
Brisbane	R4.0	R2.0	R2.0	R2.0	None	None	None	R2.0
Perth	R4.0	R2.0	R2.0	R2.0	None	None	None	R2.0
Sydney	R4.0	R2.0	R2.0	R2.0	None	None	None	R2.0
Adelaide	R4.0	R2.5	R2.0	R2.0	None	None	None	R2.0
Canberra	R3.5	R2.0	R2.0	R2.0	None	None	None	R2.0
Melbourne	R4.0	R2.5	R2.0	R2.0	None	None	None	R2.0
Hobart	R4.0	R2.0	None	R2.0	None	None	None	R2.0

**Table 9.7: Glazing comparison between initial design and redesign for Dwelling 9.**

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	22.3	20.5	8.2
Brisbane	22.3	18.7	16.3
Perth	22.3	18.7	16.3
Sydney	22.3	18.7	16.3
Adelaide	22.3	18.7	16.3
Canberra	No window changes		
Melbourne	No window changes		
Hobart	No window changes		

**Table 9.8: Redesigned Dwelling 9 star rating and cost comparison in selected orientations in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	360,971	2,573	0.7	West	6.0	0.8
Brisbane	387,766	12,565	3.1	South	6.1	1.2
Perth	367,012	20,151	6.4	South	6.2	1.2
Sydney	318,785	6,832	2.1	South	6.1	1.4
Adelaide	299,039	17,087	5.4	South	6.1	0.2
Canberra	290,442	23,593	7.5	East	6.2	0
Melbourne	280,523	6,587	2.3	East	6.4	1.1
Hobart	287,089	7,238	2.5	East	6.6	1.4

### Performance of Redesigned Dwelling

In all capital cities except for Adelaide, Canberra and Darwin, energy efficiency performance was improved by more than one star, which was typically associated with a cost saving of around 2.5%. Perth was a clear outlier to this trend where the redesigned dwelling reduced construction costs by 6.4%. The cost saving and star rating increase was lower in Darwin than the other capital cities, at 0.7% and 0.8 stars. There was no star rating change in Canberra and only a 0.2 star increase in Adelaide as the original designs were required to achieve six stars in these cities. However Adelaide and Canberra generally achieved a greater cost saving than other cities at 5.7 and 8.1 stars respectively.



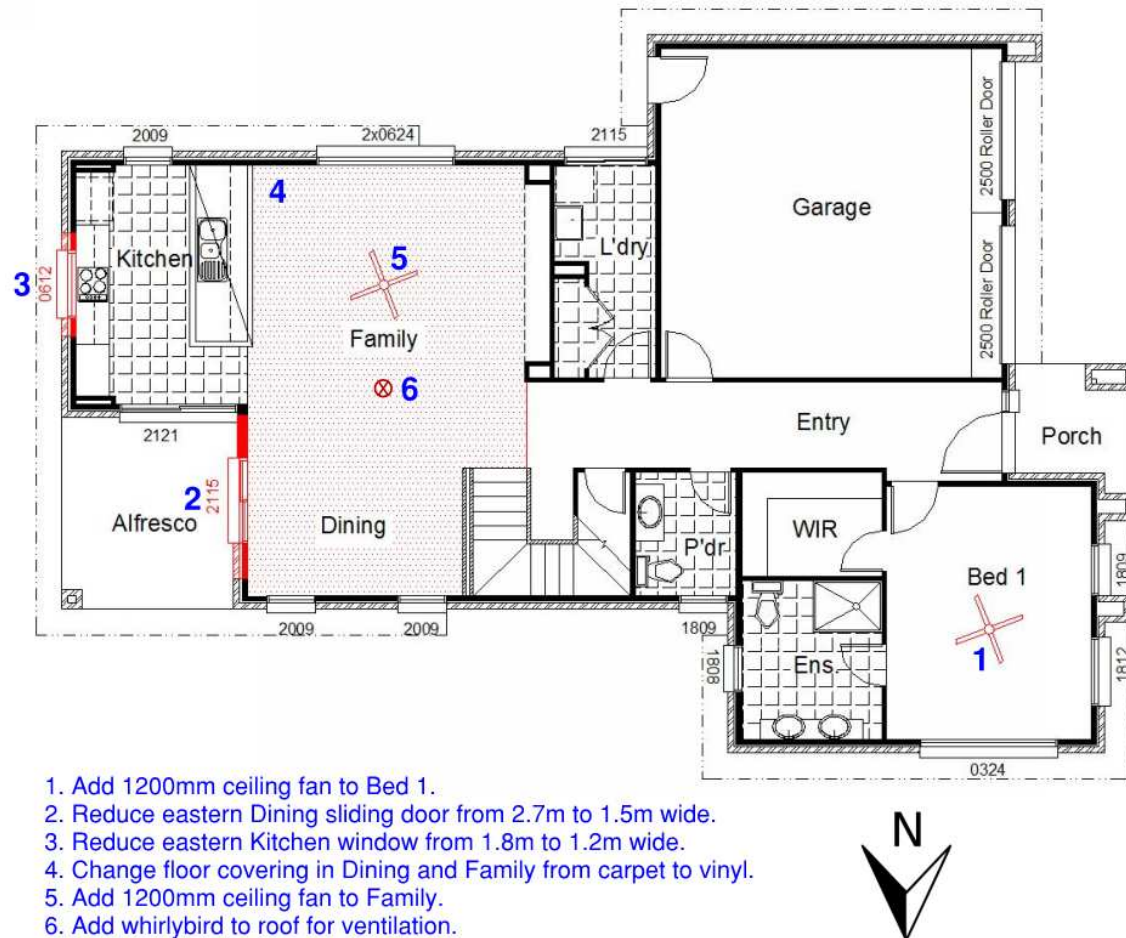
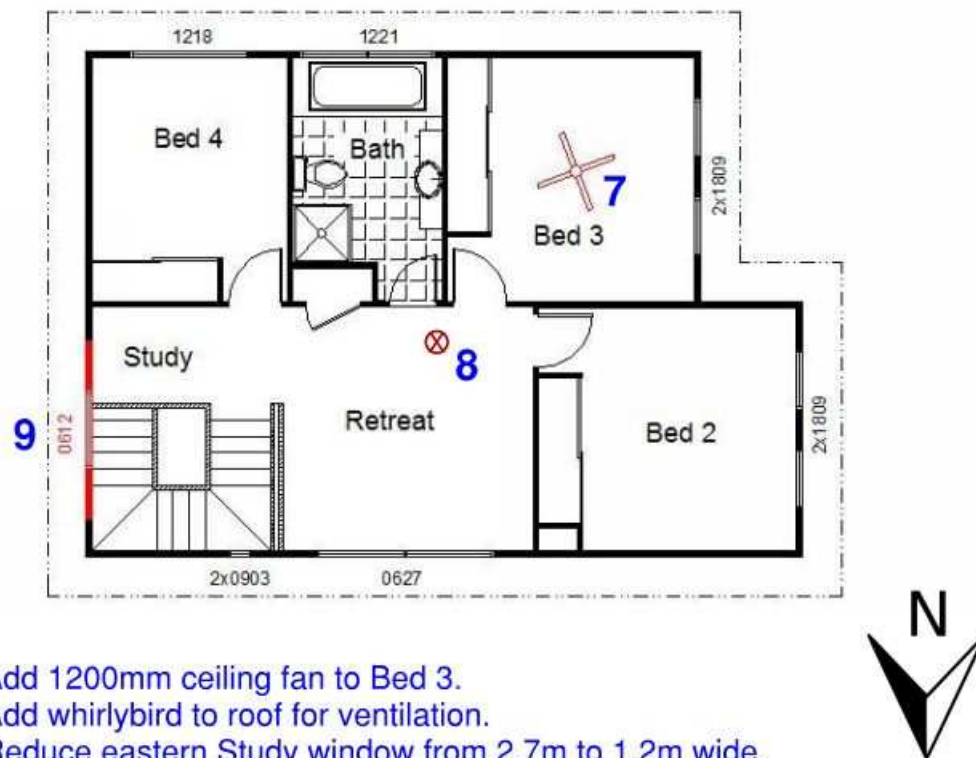
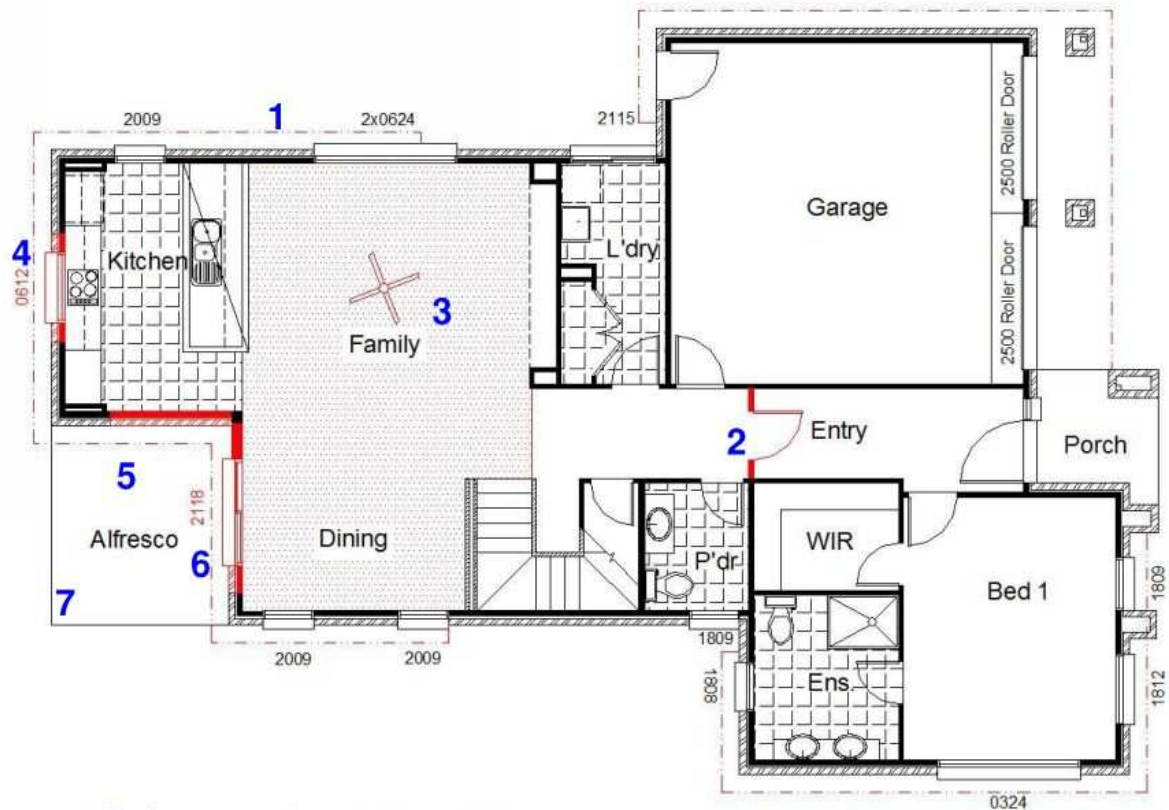


Figure 9.3: Redesigned ground floor plan for Dwelling 9 in Darwin.



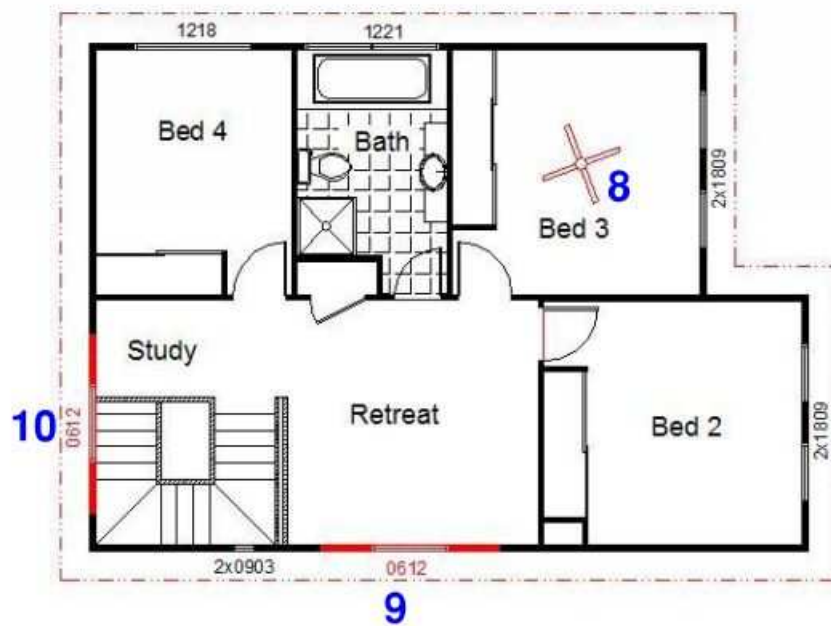
**Figure 9.4: Redesigned first floor plan for Dwelling 9 in Darwin.**



1. Reduce eaves from 0.45m to 0.3m.
2. Install internal door between Entry and Family/Dine.
3. Add 1200mm ceiling fan to Family.
4. Reduce northern Kitchen window from 1.8m to 1.2m wide.
5. Remove Kitchen sliding door from western facade.
6. Reduce northern Dining sliding door from 2.7m to 1.8m wide.
7. Replace Alfresco with shade sale.

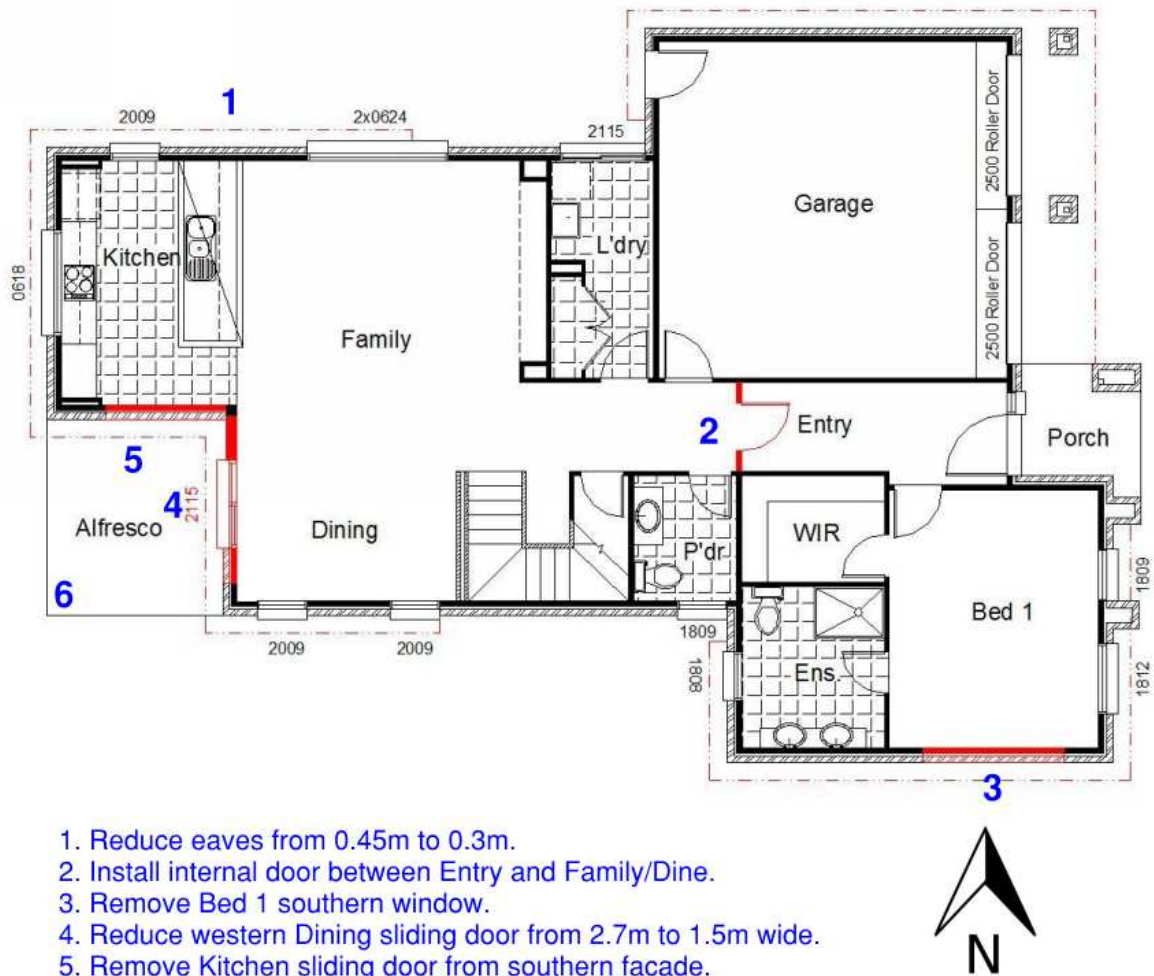


**Figure 9.5: Redesigned ground floor plan for Dwelling 9 in temperate climates (Brisbane, Perth, Sydney and Adelaide).**

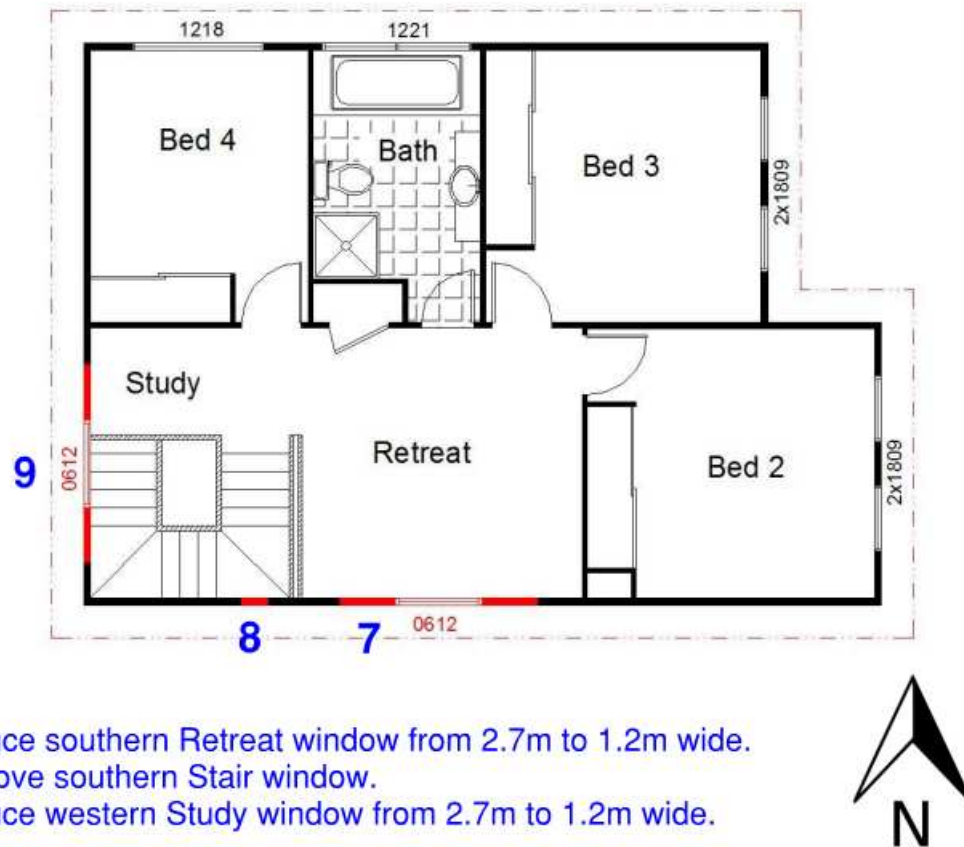


8. Add 1200mm ceiling fan to Bed 3.
9. Reduce western Retreat window from 2.7m to 1.2m wide.
10. Reduce northern Study window from 2.7m to 1.2m wide.

**Figure 9.6: Redesigned first floor plan for Dwelling 9 in temperate climates (Brisbane, Perth, Sydney and Adelaide).**



**Figure 9.7: Redesigned ground floor plan for Dwelling 9 in cold climates (Canberra, Melbourne and Hobart).**



**Figure 9.8: Redesigned first floor plan for Dwelling 9 in cold climates (Canberra, Melbourne and Hobart).**



## Dwelling 10: Review of Original Dwelling Design in All Capital Cities



**Table 10.1: Summary of Dwelling 10 zone types.**

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	-	1	1

**Table 10.2: Dwelling 10 zone conditioning and areas.**

Zone Type	Heated & Cooled	Area (m <sup>2</sup> )
Living/ Kitchen	Yes	48
Bedrooms	Yes	45
Corridor	Yes	19
Main Bathroom & Laundry	No	9
Garage	No	33
Verandah	No	17
	TOTAL	171



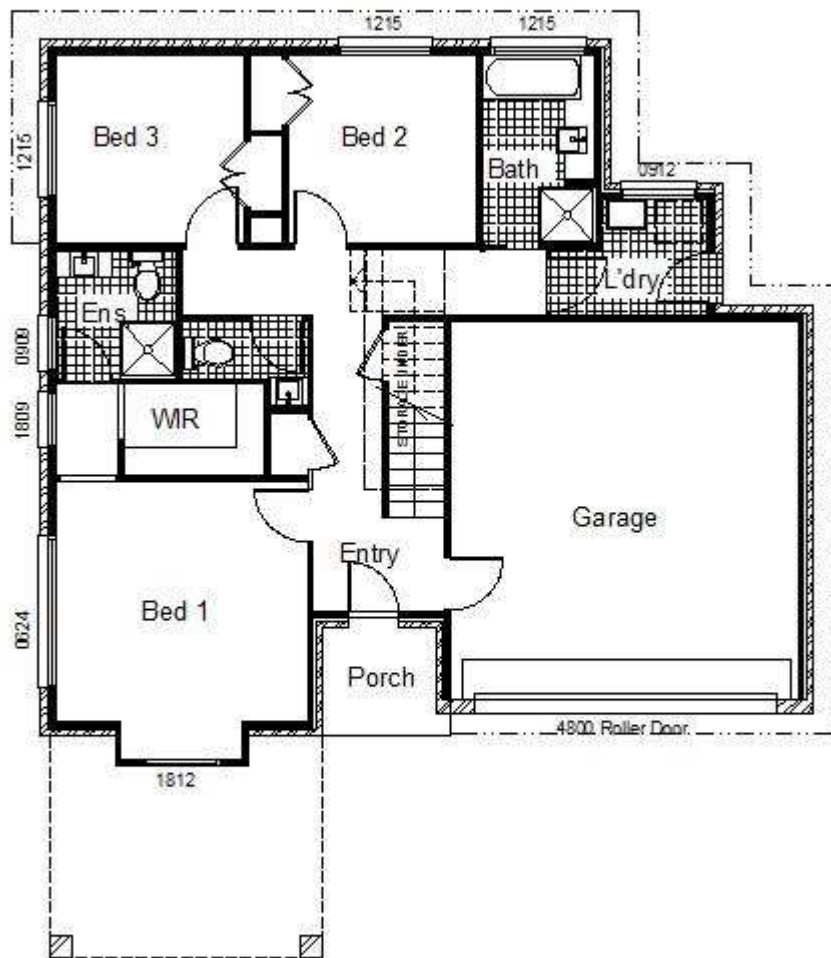
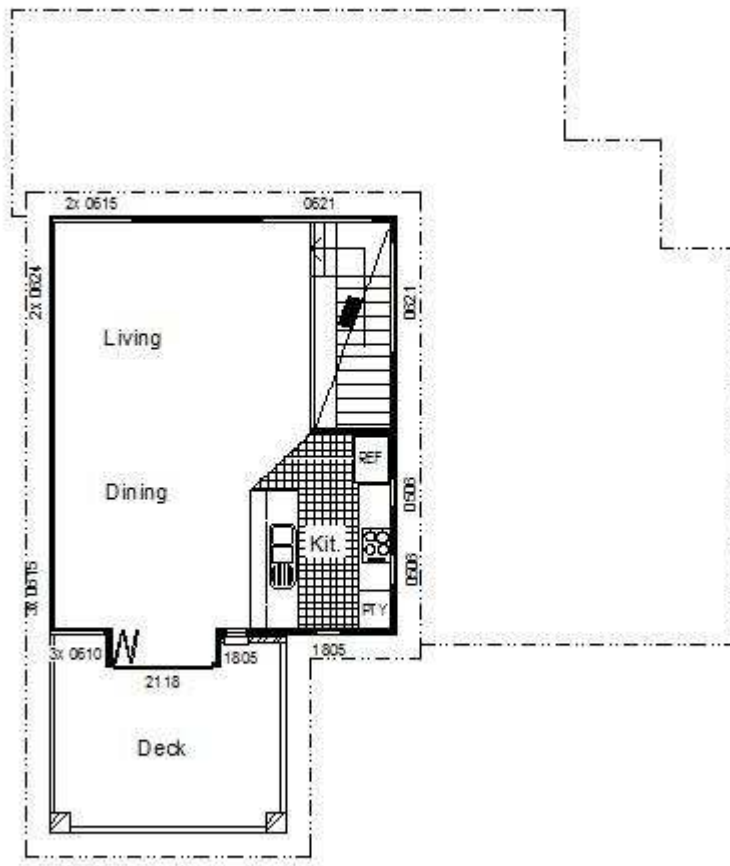


Figure 10.1: Dwelling 10 ground floor plan for original design.



**Figure 10.2: Dwelling 10 first floor plan for original design.**

## Dwelling Description

This small double storey dwelling has three bedrooms on the ground floor with a first floor open plan living, dining and kitchen area. The ground floor external walls are of typical brick veneer construction and the first floor a reconstituted hardwood weatherboard product. The roof on both levels is of metal deck construction with a 22.5 degree pitch. The glazing is predominantly on the left and rear facades with lesser amounts on the front and right facades. The window to floor area ratio is approximately 20%. The dwelling has 0.45m eaves throughout with the exception of a balcony to the front facade.

## Initial Specifications and Star Rating Results

Tables 10.1 and 10.2 describe the zoning of Dwelling 10, while Table 10.3 details the standard construction specifications.

There are variations to the standard specifications of the initial dwelling design in some capital cities and these are presented in Table 10.4.1 and Table 10.4.2, with Table 10.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 10.3: Dwelling 10 construction details.

Construction	Type	Details
Ceiling height	-	2.44m
Floors	Ground floor	CSOG
	First floor	Timber
External walls	Ground floor	Brick veneer: 110mm brick + air gap + 10mm plasterboard
	First floor	Fibre-cement: 16mm fibre-cement + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	-	0.45m

Table 10.4.1: Specifications for original design of Dwelling 10 in each capital city.

Capital City	Glazing	Roof sisalation
Darwin	Alum 3mm clear	Yes
Brisbane	Alum 5mm Evergreen	Yes
Perth	Cedar 6.38mm ComfortPlus Neutral	None
Sydney	Cedar 6.38mm ComfortPlus Neutral	None
Adelaide	Cedar 6.38mm ComfortPlus Neutral	None
Canberra	Cedar 6.38mm ComfortPlus Neutral	None
Melbourne	Alum 3mm clear	None
Hobart	Alum 3mm clear	None

Table 10.4.2: Specifications for original design of Dwelling 10 in each capital city (continued).

Capital City	Ceiling	Insulation					
		House			Ceiling	Garage	
		External walls	Internal walls	Between floors		External walls	Internal walls to house
Darwin	R2.0	R2.0	R2.0	R2.0	None	None	R2.0
Brisbane	R3.5	R2.0	R2.0	R2.0	R3.5	None	R2.0
Perth	R4.0	R2.0	R2.0	R2.0	None	None	R2.0
Sydney	R4.0	R2.5	R2.0	R2.0	R4.0	None	R2.0
Adelaide	R4.0	R2.5	R2.0	R2.0	None	None	R2.0
Canberra	R4.0	R2.0	R2.0	R2.0	R3.5	None	R2.0
Melbourne	R3.5	R2.0	None	R2.0	R3.5	None	R2.0
Hobart	R4.0	R2.0	None	R2.0	None	None	R2.0

**Table 10.5: Star rating in four cardinal orientations and cost for original design of Dwelling 10 in each capital city (orientation according to direction of front door).**

Capital City	Cost (\$)	Star Rating by Orientation			
		North	East	South	West
Darwin	283,946	4.9	5.4	4.9	5.0
Brisbane	319,285	4.9	5.4	4.5	4.1
Perth	302,663	5.3	5.1	5.0	5.3
Sydney	264,423	4.9	4.8	4.6	4.8
Adelaide	246,450	6.0	6.0	5.5	6.0
Canberra	242,031	6.0	6.2	5.8	5.8
Melbourne	227,201	5.0	4.9	4.9	5.1
Hobart	234,018	5.4	5.1	5.3	5.6

### Performance of Original Design

The results for Dwelling 10 do not show a wide variation between orientations. This is because the dwelling has even amounts of glazing to all four orientations.

In Darwin and Brisbane, Dwelling 10 performs much better with the front door facing east, as this increases the south-facing glazing, and ensures that most east-facing glazing is heavily shaded. 5mm EverGreen glazing is required to Brisbane to reduce the heat gains throughout the dwelling.

In Sydney, Perth and Adelaide, the dwelling has a mixed performance. It achieves the lowest star rating in Sydney and the highest in Adelaide. The lack of cross ventilation affects performance in the warmer, more humid Sydney climate, while the low amount of glazing has a positive impact in Adelaide. The lowest star ratings are achieved when the front door is facing south in these locations, as this maximises the west-facing glazing to the residence.

In the cold climates, the dwelling achieves higher star ratings when the front door is facing north or west, as this increases the amount of north-facing glazing, and maximises heat gains to the dwelling.

### Review of Redesigned Dwelling in All Capital Cities

#### Redesign Summary

The dwelling has been redesigned with the front door facing west, as this makes the largest living area wall north-facing, and therefore provides the most opportunity for effective improvements.

The main living area has been relocated to the ground level of the residence, where temperatures can be kept more stable due to the concrete slab on ground construction, with two bedrooms exchanged to the first floor. As a result of the repositioning of most rooms, some of the glazing has also been repositioned, and the north-facing glazing to the main living area has been increased.

The eaves were reduced in all locations to reduce costs, as this made little impact on the rating.

The only other significant change is the blocking off of the stairs in both levels from any conditioned zones, meaning that any air conditioning can be localised to specific areas.

### Revised Specifications and Star Rating Results

Tables 10.6.1 and 10.6.2 show the final specifications for the dwelling and Table 10.7 shows the glazing comparison between the initial and redesigned dwelling. Table 10.8 shows the star rating results and cost savings.

**Table 10.6.1: Specifications for redesigned Dwelling 10 in each capital city.**

Capital City	Glazing	Eave width (m)	Concrete slab type	Roof insulation	Roof solar absorptance (%)	Floor covering change
Darwin	Alum 3mm clear	0.3	Normal	Yes	30-50	Vinyl
Brisbane	Alum 3mm clear	0.3	Normal	Yes	30-85	Vinyl
Perth	Alum 3mm clear	0.3	Normal	Yes	30-85	Vinyl
Sydney	Alum 3mm clear	0.3	Normal	Yes	30-85	Vinyl
Adelaide	Alum 3mm clear	0.3	Normal	Yes	30-85	Vinyl
Canberra	Alum 3mm clear	0.3	Polystyrene core	No	30-85	None
Melbourne	Alum 3mm clear	0.3	Polystyrene core	No	30-85	None
Hobart	Alum 3mm clear	0.3	Polystyrene core	No	30-85	None

**Table 10.6.2: Specifications for redesigned Dwelling 10 in each capital city (continued).**

Capital City	Insulation						
	House				Garage		
	Ceiling	External walls	Internal walls	Between floors	Ceiling	External walls	Internal walls to house
Darwin	R2	R1.5	None	R2	None	None	None
Brisbane	R4	R2	R2	R2	R4	R2	R2
Perth	R4	R2	R2	R2	R4	R2	R2
Sydney	R3.5	R2.5	R2	R2	R3.5	R2	R2
Adelaide	R3.5	R2	R2	R2	None	R2	R2
Canberra	R4	R2	R2	R2	None	R2	R2
Melbourne	R4	R2	R2	R2	None	R2	R2
Hobart	R4	R2	None	R2	None	None	None

**Table 10.7: Glazing comparison between initial design and redesign for Dwelling 10.**

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	19.6	19.7	-0.3
Brisbane	19.6	20.4	-3.9
Perth	19.6	20.4	-3.9
Sydney	19.6	20.4	-3.9
Adelaide	19.6	20.4	-3.9
Canberra	19.6	20.4	-3.9
Melbourne	19.6	20.4	-3.9
Hobart	19.6	20.4	-3.9

**Table 10.8: Redesigned Dwelling 10 star rating and cost comparison in selected orientation in each capital city.**

Capital City	Cost (\$)	Cost saving (\$)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	280,467	3,479	1.2	West	6.1	1.1
Brisbane	314,973	4,312	1.4	West	6.1	2.0
Perth	297,356	5,307	1.8	West	6.0	0.7
Sydney	258,755	5,668	2.1	West	6.1	1.3
Adelaide	240,845	5,605	2.3	West	6.1	0.1
Canberra	234,998	7,033	2.9	West	6.1	0.3
Melbourne	227,515	-314	-0.1	West	6.2	1.1
Hobart	232,434	1,584	0.7	West	6.3	0.7

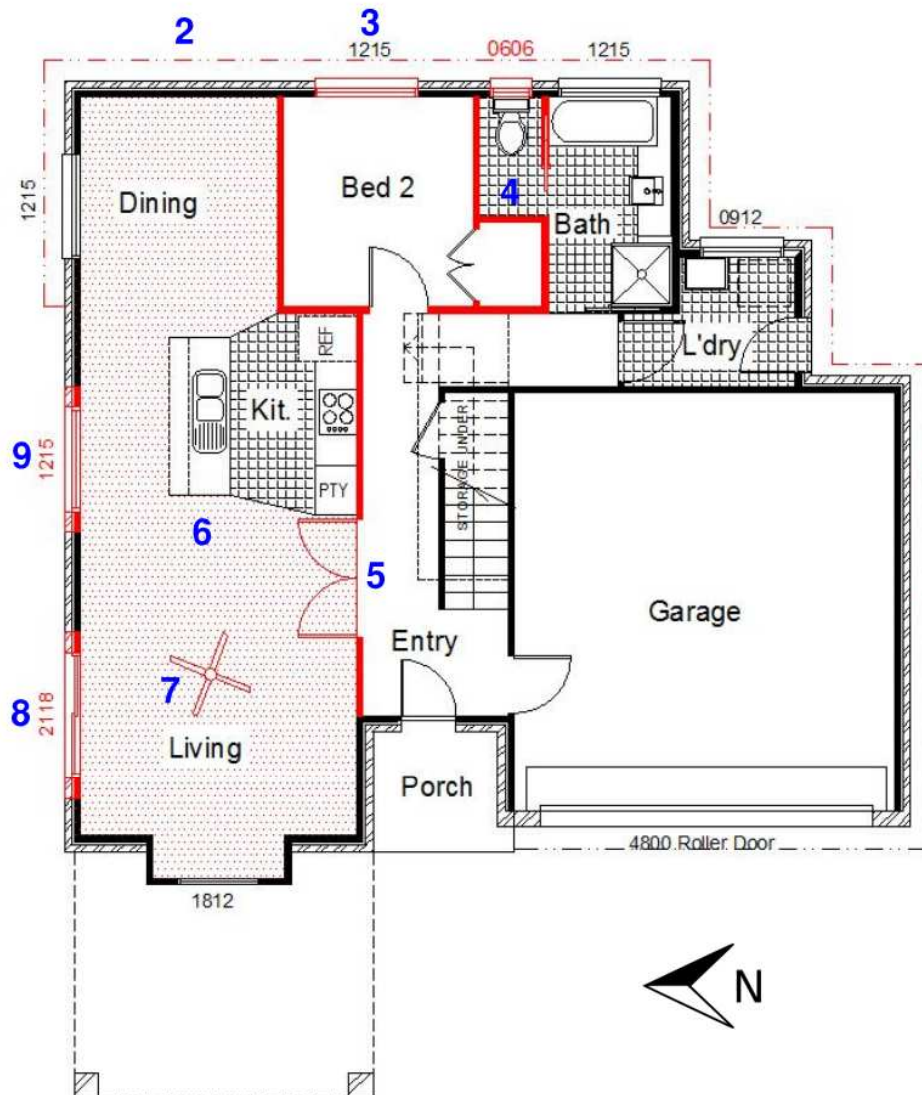
### Performance of Redesigned Dwelling

Dwelling 10 is the only dwelling to have a glazing increase as a result of the redesign process. This is due to the rezoning of the dwelling, which required more windows to be entered.

Brisbane has the most significant improvements, of 2 stars, with a cost saving of 1.4% of the initial design cost. Canberra has the biggest cost saving, of 2.9%, with a star rating change of only 0.3 stars.

The temperate climates have all been positively impacted by the repositioning of the main living area and the increase in north-facing glazing to this area. The change in windows in Sydney, Perth and Adelaide has had a large beneficial impact on the costs for all three location, as the changes equate to savings of 1.8% to 2.3%. Brisbane has seen less of a cost benefit because the Evergreen it was initially rated with is less expensive than the ComfortPlus.

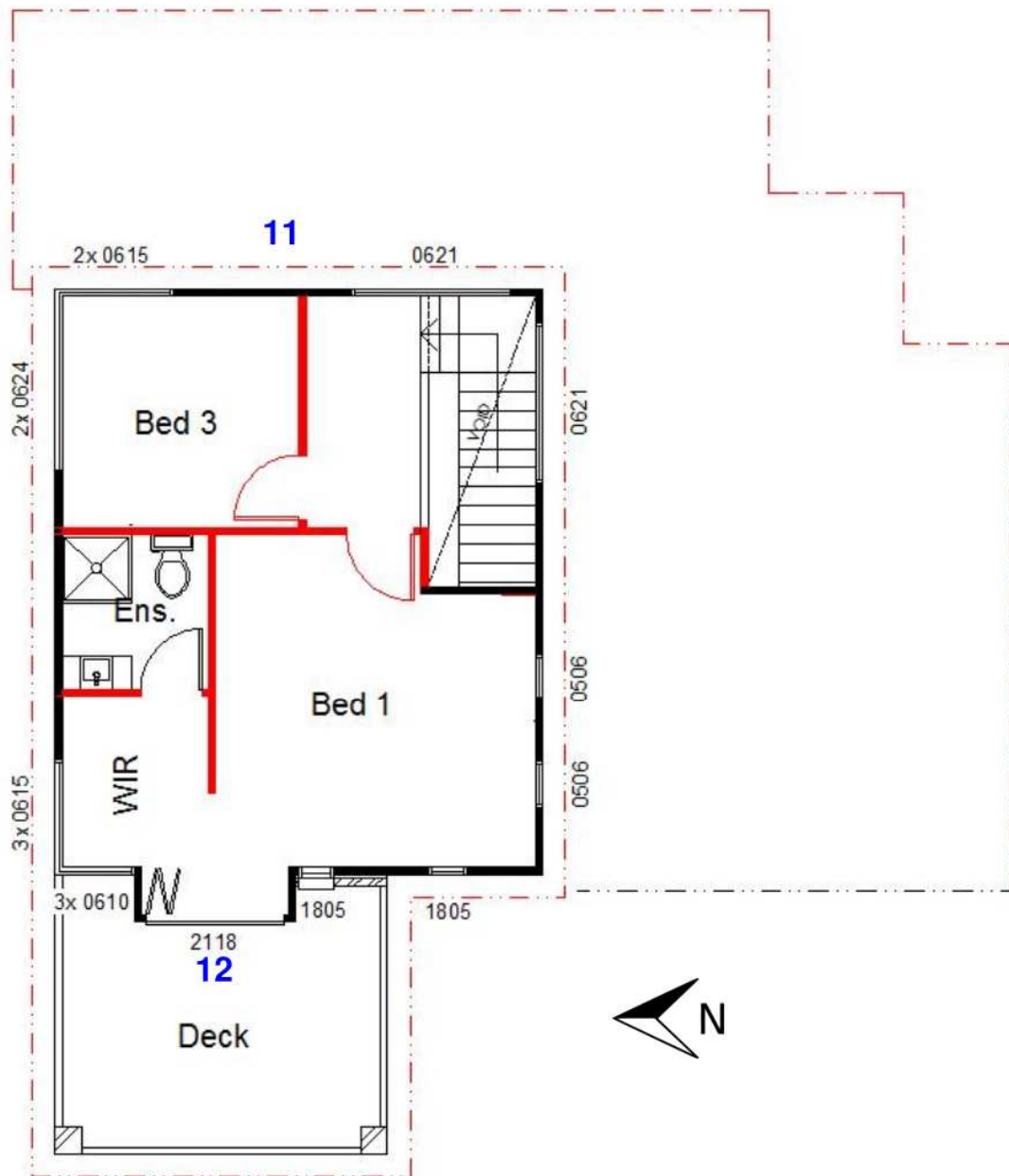
Melbourne has experienced a negative cost benefit, due to the fact that the redesign requires more expensive changes than the initial design. This is because Melbourne was originally rated with standard aluminium framed glazing, so it does not see the cost benefit of removing cedar-framing or ComfortPlus, as was the case in many other climates. The increased cost for Melbourne is minimal, however (only 0.1% of the initial cost) and results in an improvement in performance of 1.1 stars.



1. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing). Rearrange Bed 2 internal walls to fit.
2. Reduce eaves from 0.45m to 0.3m.
3. Relocate Bed 2 window to accommodate WC.
4. Add WC with 0.6x0.6m window.
5. Add internal walls and double doors to separate Entry and Living/Kitchen.
6. Change floor covering in Dining and Living from carpet to vinyl.
7. Add 1200mm ceiling fan in Living.
8. Replace three 0.6x1.5m Living windows with a sliding door 2.1x1.8m to northern facade.
9. Add Kitchen window 1.2x1.5m to northern facade.

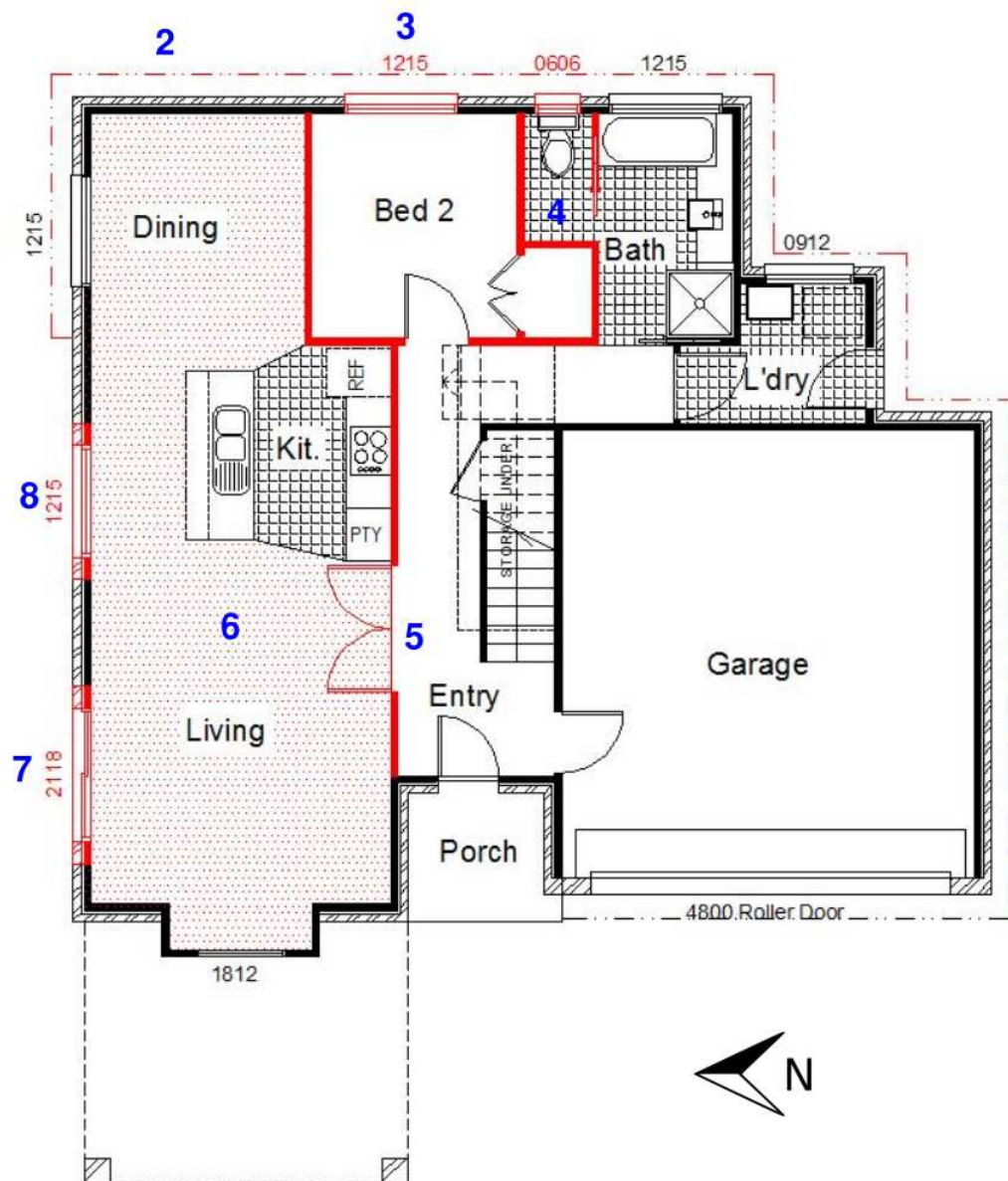
**Figure 10.3: Redesigned ground floor plan for Dwelling 10 in Darwin.**





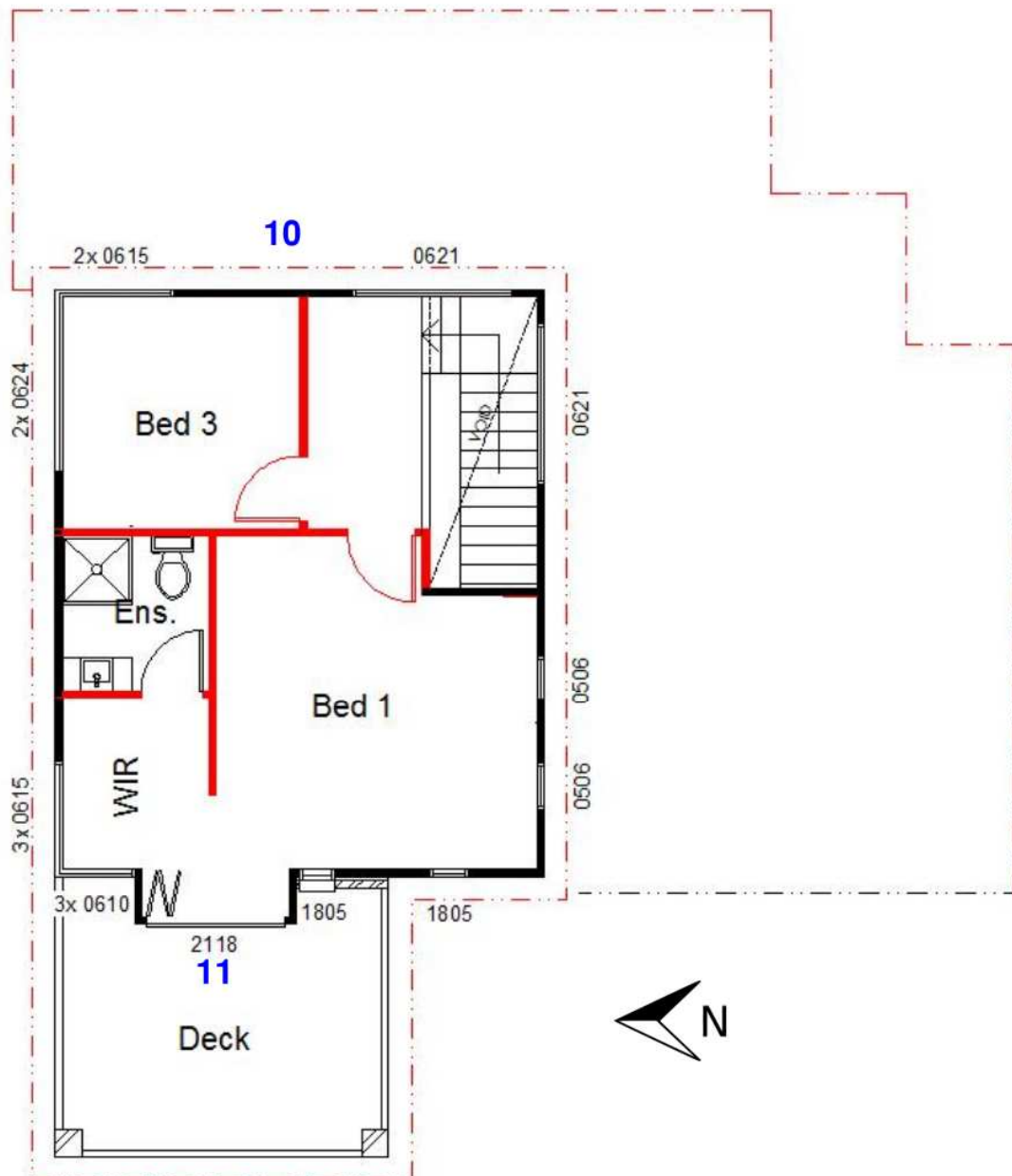
10. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing).
11. Reduce eaves from 0.45m to 0.3m.
12. Change front Bed 1 window from 1.8x1.2m to a bi-fold door 2.1x1.8m.

**Figure 10.4: Redesigned first floor plan for Dwelling 10 in Darwin.**



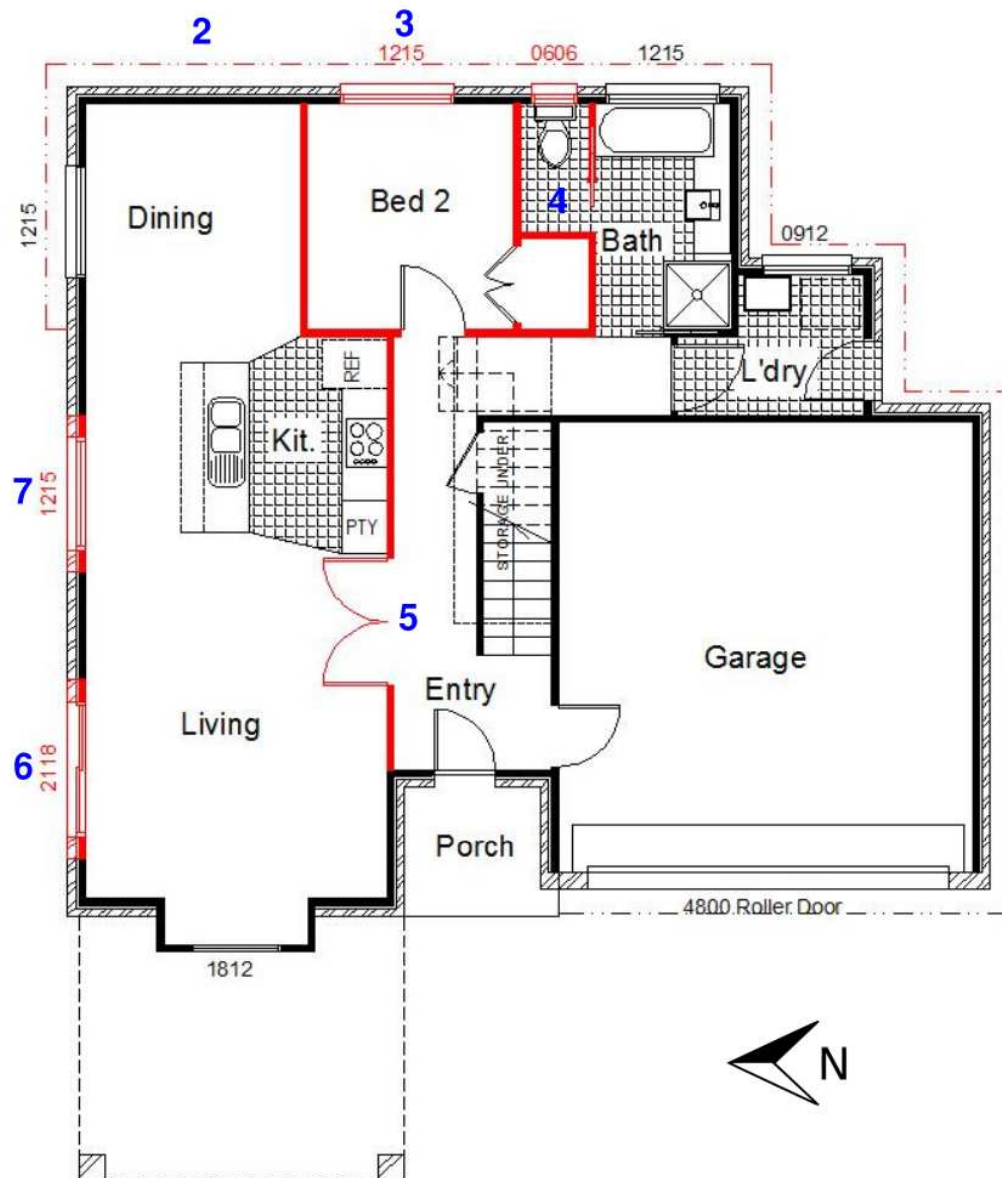
1. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing). Rearrange Bed 2 internal walls to fit.
2. Reduce eaves from 0.45m to 0.3m.
3. Relocate Bed 2 window to accommodate WC.
4. Add WC with 0.6x0.6m window.
5. Add internal walls and double doors to separate Entry and Living/Kitchen.
6. Change floor covering in Dining and Living from carpet to vinyl
7. Replace three 0.6x1.5m Living windows with a sliding door 2.1x1.8m to northern facade.
8. Add Kitchen window 1.2x1.5m to northern facade.

**Figure 10.5: Redesigned ground floor plan for Dwelling 10 in Brisbane, Adelaide, Perth and Sydney.**



9. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing).
10. Reduce eaves from 0.45m to 0.3m.
11. Change front Bed 1 window from 1.8x1.2m to a bi-fold door 2.1x1.8m.

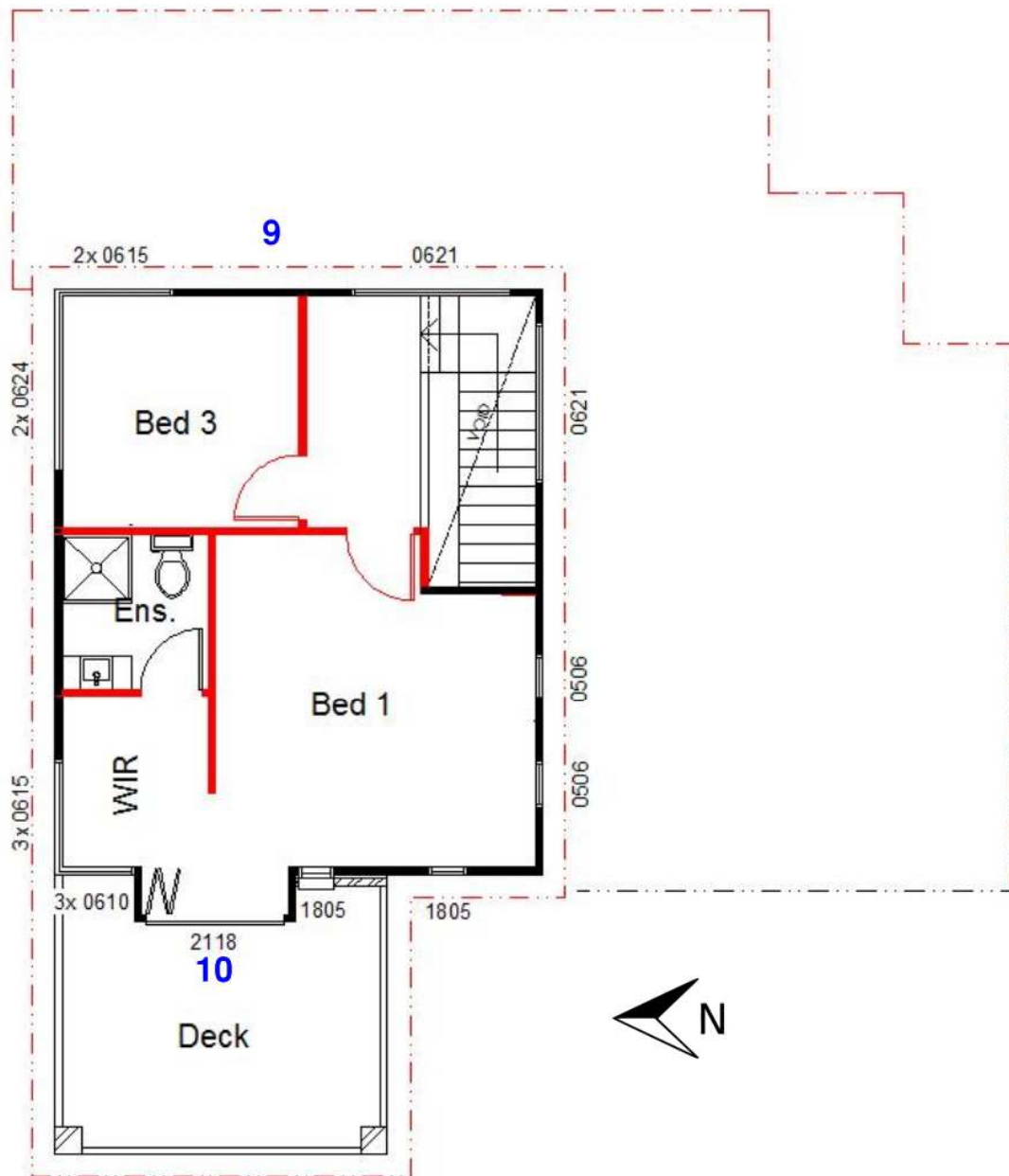
**Figure 10.6: Redesigned first floor plan for Dwelling 10 in Brisbane, Adelaide, Perth and Sydney.**



1. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing). Rearrange Bed 2 internal walls to fit.
2. Reduce eaves from 0.45m to 0.3m.
3. Relocate Bed 2 window to accommodate WC.
4. Add WC with 0.6x0.6m window.
5. Add internal walls and double doors to separate Entry and Living/Kitchen.
6. Replace three 0.6x1.5m Living windows with a sliding door 2.1x1.8m to northern facade.
7. Add Kitchen window 1.2x1.5m to northern facade.

**Figure 10.7: Redesigned ground floor plan for Dwelling 10 in Canberra, Hobart and Melbourne.**





8. Relocate Dining/Living/Kitchen to the ground floor, and Bed 1/WIR/Ensuite and Bed 3 to the first floor (including glazing).
9. Reduce eaves from 0.45m to 0.3m.
10. Change front Bed 1 window from 1.8x1.2m to a bi-fold door 2.1x1.8m.

**Figure 10.8: Redesigned first floor plan for Dwelling 10 in Canberra, Hobart and Melbourne.**