Dwelling 11: Review of Original Dwelling Design in All Capital Cities

Table 11.1: Summary of Dwelling 11 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
4	3	-	3	2

Table 11.2: Dwelling 11 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living	Yes	42
Living/ Kitchen	Yes	76
Bedrooms	Yes	68
Corridor	Yes	29
Main Bathroom & Laundry	No	14
Garage	No	33
Verandah	No	39
	TOTAL	301

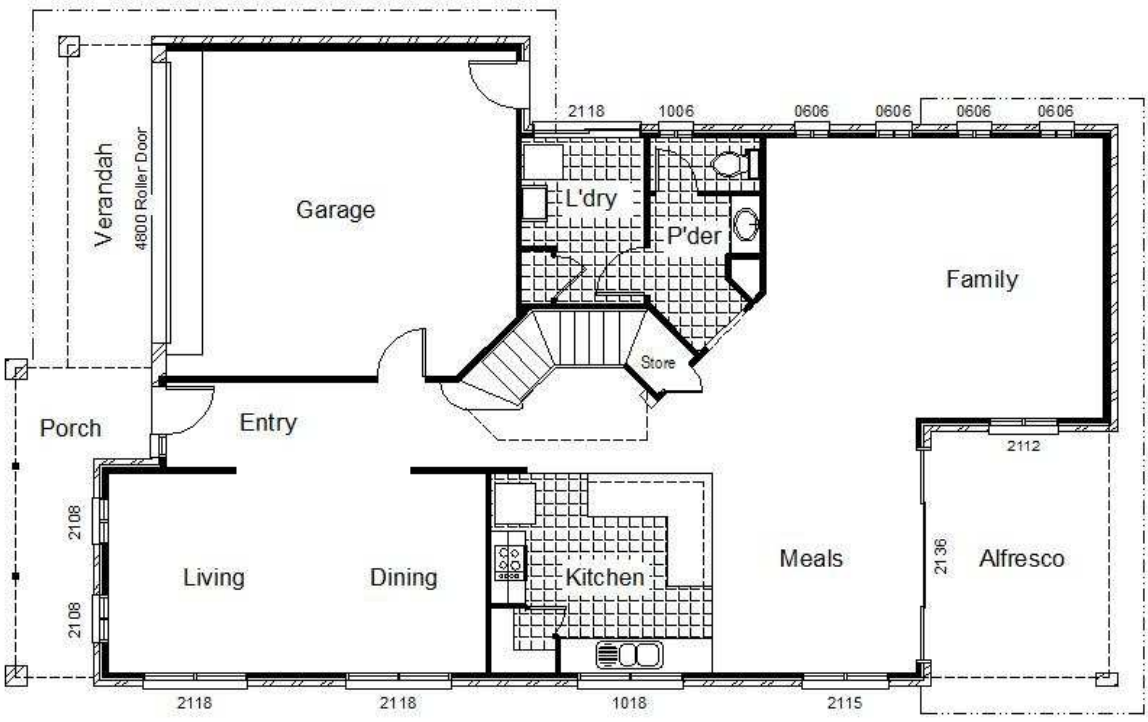


Figure 11.1: Dwelling 11 ground floor plan for original design.

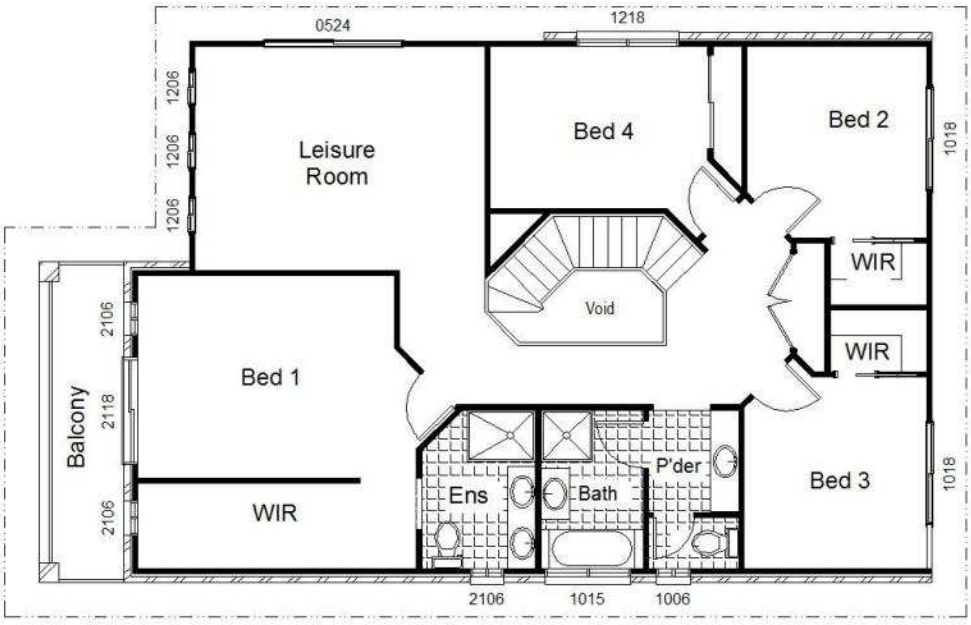


Figure 11.2: Dwelling 11 first floor plan for original design.

Dwelling Description

This double storey dwelling has four bedrooms with an open plan living/kitchen area and two subsequent living areas. The utility and living areas are on the ground floor, while the bedrooms and one other living are on the first floor. The main open plan living area opens out to an alfresco area. The lower floor external walls are of typical brick veneer construction, while the first floor has a mixture of brick veneer and fibre-cement clad walls. The roof of both ground and first floors is of a concrete tiles construction with a pitch of 23 degrees. The glazing is concentrated on three facades on the lower level but is evenly distributed across all facades on the first floor. The window to floor area ratio is 20%. Half of the ground level external walls have 0.45m eaves with porch, verandah and alfresco areas. The first floor has consistent 0.45m eaves with a balcony to the front facade.

Initial Specifications and Star Rating Results

Tables 11.1 and 11.2 describe the zoning of Dwelling 11, while Table 11.3 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 11.4.1 and Table 11.4.2, with Table 11.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 11.3: Dwelling 11 construction details.

Construction	Type	Details
Ceiling height	-	2.4m
Floors	Ground	CSOG
	First	Timber: 22mm particleboard + 90mm air gap + 10mm plasterboard
External walls	Type 1	Brick veneer: 110mm brick + air gap + 10mm plasterboard
	Type 2	FC: 6mm fibre-cement + 90mm air gap + 10mm plasterboard
Roof	-	Concrete Tiles
Eaves	First floor and portion of ground floor	0.45m

Table 11.4.1: Specifications for original design of Dwelling 11 in each capital city.

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

Table 11.4.2: Specifications for original design of Dwelling 11 in each capital city (continued).

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

Table 11.5: Star rating in four cardinal orientations and cost for original design of Dwelling 11 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	481,378	5.4	5.6	5.4	5.6
Brisbane	530,332	4.8	5.4	5.2	5.1
Perth	500,974	4.9	5.2	5.1	5.0
Sydney	430,104	4.5	4.8	4.7	4.8
Adelaide	421,656	5.7	5.9	5.7	5.8
Canberra	401,782	5.5	5.8	5.5	5.5
Melbourne	379,629	5.0	5.0	5.0	5.1
Hobart	392,032	5.2	5.4	5.2	5.1

Performance of Original Design

The largest variation between the four orientations of Dwelling 11 is 0.6 stars in Brisbane, while the most consistent results are from Melbourne where the difference is only 0.1 stars.

Having the front door facing east results in higher star ratings for most locations. In this orientation the main living areas receive significant solar gains in winter, while the eaves help to mitigate the impact of the sun in summer. The star ratings are lower with the front door facing north in most climate zones; this can be attributed to the negligible amounts of northern glazing in this orientation and the large amounts of east, south and west glazing in the living areas.

In the temperate and hot climates, the dwelling has high solar heat gains due to the lack of shading downstairs, and also the large amount of glazing.

All locations, except for Sydney, Melbourne and Hobart, require improved glazing, and none of them manage to achieve a 6 star rating, with the rating slipping below 5 stars most often in the temperate climates.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

Darwin has been redesigned with the front door facing west. Vinyl flooring has been applied to the main living area to make sure that as little heat as possible is retained in this area. The large east-facing Meals sliding door has been reduced to cut down on the heat gains through this area. Ceiling fans to the Living/Dining and Family areas should also ensure that the dwelling has sufficient air movement to keep it feeling comfortable during hot weather.

The redesign in the temperate climates is much the same as that in Darwin, except ceiling fans have not been included and the dwelling has been redesigned with the front door facing east rather than west, to maximise the north-facing glazing. The reduction in the now west-facing Meals sliding door will help stop heat gains when they are not wanted and heat loss in winter, and the Alfresco has been changed to a removable shade sail to get more solar heat gains during the colder months.

In the cold climates, the dwelling has been redesigned with the front door facing west to maximise north-facing glazing, though the two Living/Dining windows have been reduced to prevent too much heat loss to this area. The west-facing Meals sliding door has again been reduced, and the Alfresco changed to a removable shade sail. All eaves have been removed to make sure that the dwelling is getting enough sunlight throughout the year.

Revised Specifications and Star Rating Results

Tables 11.6.1 and 11.6.2 show the final specifications for the dwelling and Table 11.7 shows the glazing comparison between the initial and redesigned dwelling. Table 11.8 shows the star rating results and cost savings.

Table 11.6.1: Specifications for redesigned Dwelling 11 in each capital city.

Capital City	Glazing	Eave width (m)	Roof sisalation	Awning	Slab Type	Floor covering change	Roof solar absorptance (%)	Window reduction
Darwin	3mm clear	0.45	None	None	Normal	Vinyl	30	None
Brisbane	3mm clear	0.45	None	None	Normal	Vinyl	30	None
Perth	3mm clear	0.45	None	None	Normal	Vinyl	30	None
Sydney	3mm clear	0.45	None	None	Normal	Vinyl	30	None
Adelaide	3mm clear	0.45	None	None	Normal	Vinyl	30	10.0%
Canberra	3mm clear	0	None	None	Polystyrene core	None	50	None
Melbourne	3mm clear	0	None	None	Polystyrene core	None	85	None
Hobart	3mm clear	0	None	None	Polystyrene core	None	85	None

Table 11.6.2: Specifications for redesigned Dwelling 11 in each capital city (continued).

	Insulation					
	House			Garage		
Capital City	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	R4.0	R2.0	None	None	None	R2.0
Sydney	R4.0	R2.0	None	None	None	None
Adelaide	R4.0	R2.0	None	None	None	R2.0
Canberra	R4.0	R2.0	None	R4.0	None	R2.0
Melbourne	R4.0	R2.0	None	None	None	R2.0
Hobart	R4.0	R2.0	None	None	None	R2.0

Table 11.7: Glazing comparison between initial design and redesign for Dwelling 11.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	19.6	18.9	3.7
Brisbane	19.6	18.9	3.7
Perth	19.6	18.9	3.7
Sydney	19.6	18.9	3.7
Adelaide	19.6	18.9	3.7
Canberra	19.6	17.9	8.8
Melbourne	19.6	17.9	8.8
Hobart	19.6	17.9	8.8

Table 11.8: Redesigned Dwelling 11 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	473,230	8,148	1.7	West	6.1	0.5
Brisbane	516,960	13,372	2.5	East	6.2	0.8
Perth	490,776	10,198	2.0	East	6.0	0.8
Sydney	426,578	3,526	0.8	East	6.0	1.2
Adelaide	399,712	21,944	5.2	East	6.1	0.2
Canberra	377,372	24,410	6.1	East	6.0	0.2
Melbourne	364,845	14,784	3.9	East	6.0	1.0
Hobart	376,367	15,665	4.0	East	6.6	1.2

Performance of Redesigned Dwelling

The positive effects of the redesign are most evident in Brisbane, Perth, Sydney, Melbourne and Hobart in which star rating of the redesigned dwelling was improved by about one star. In Melbourne and Hobart this significant star rating increase can be partially attributed to the removal of shading and the inclusion of a polystyrene core concrete slab.

Adelaide and Canberra have gained the least in terms of star rating change, with a 0.2 star increase, due to the removal of improved glazing that brought up their initial star ratings.

The cost savings for most locations are very large for this dwelling, due in part to the fact that the dwelling was initially assessed with high performance glazing in all but three locations. Glazing has been reduced in all locations, from a 3.7% reduction in the warmer climates to an 8.8% reduction in the colder locations.

Melbourne and Hobart, which were initially assessed with standard glazing, still have very high cost savings, due to the cost saving changes made to these colder climates.

Adelaide and Canberra have the highest cost savings, with both saving over 5% of the initial design price.

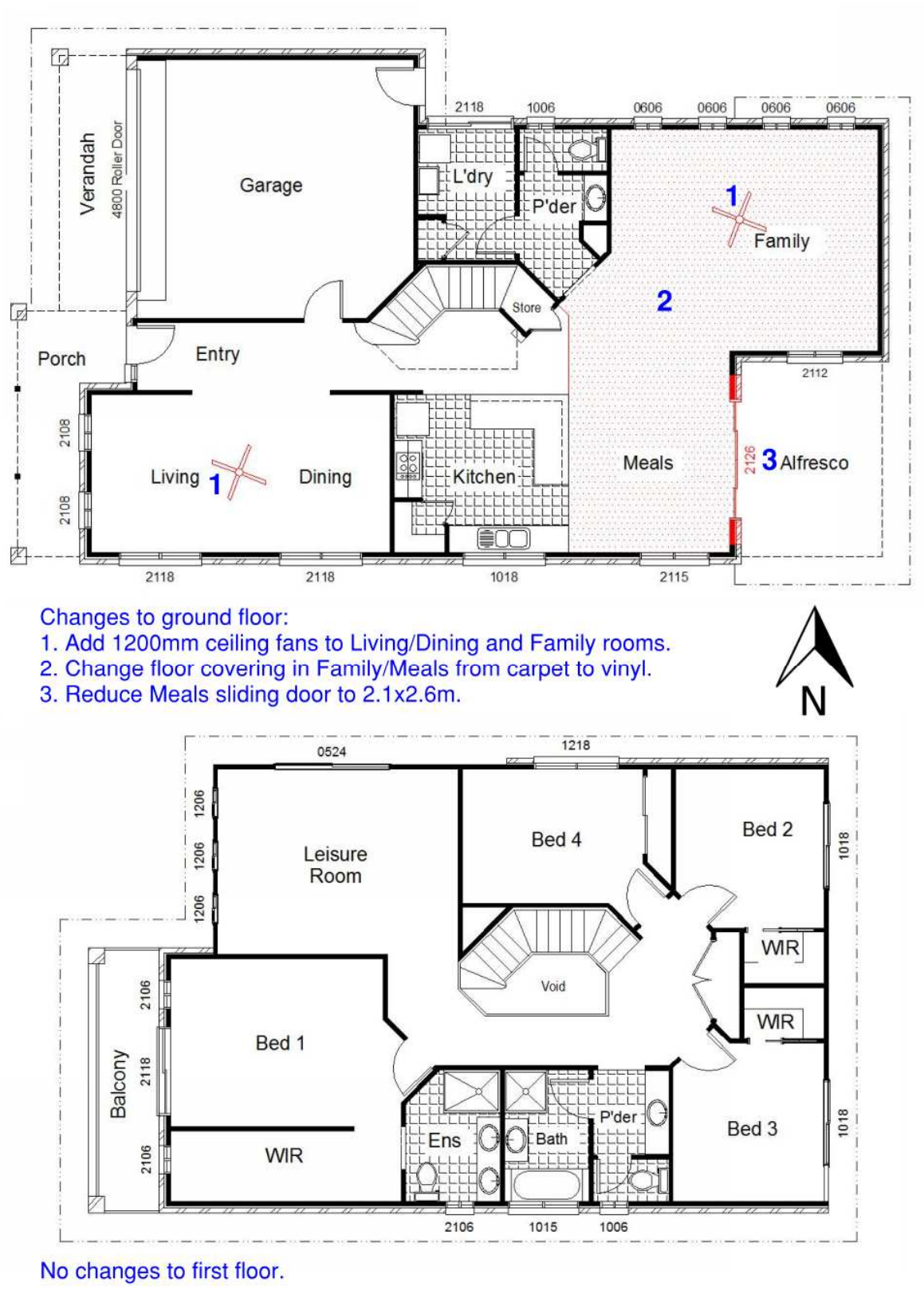


Figure 11.3: Redesigned floor plans of Dwelling 11 in Darwin.

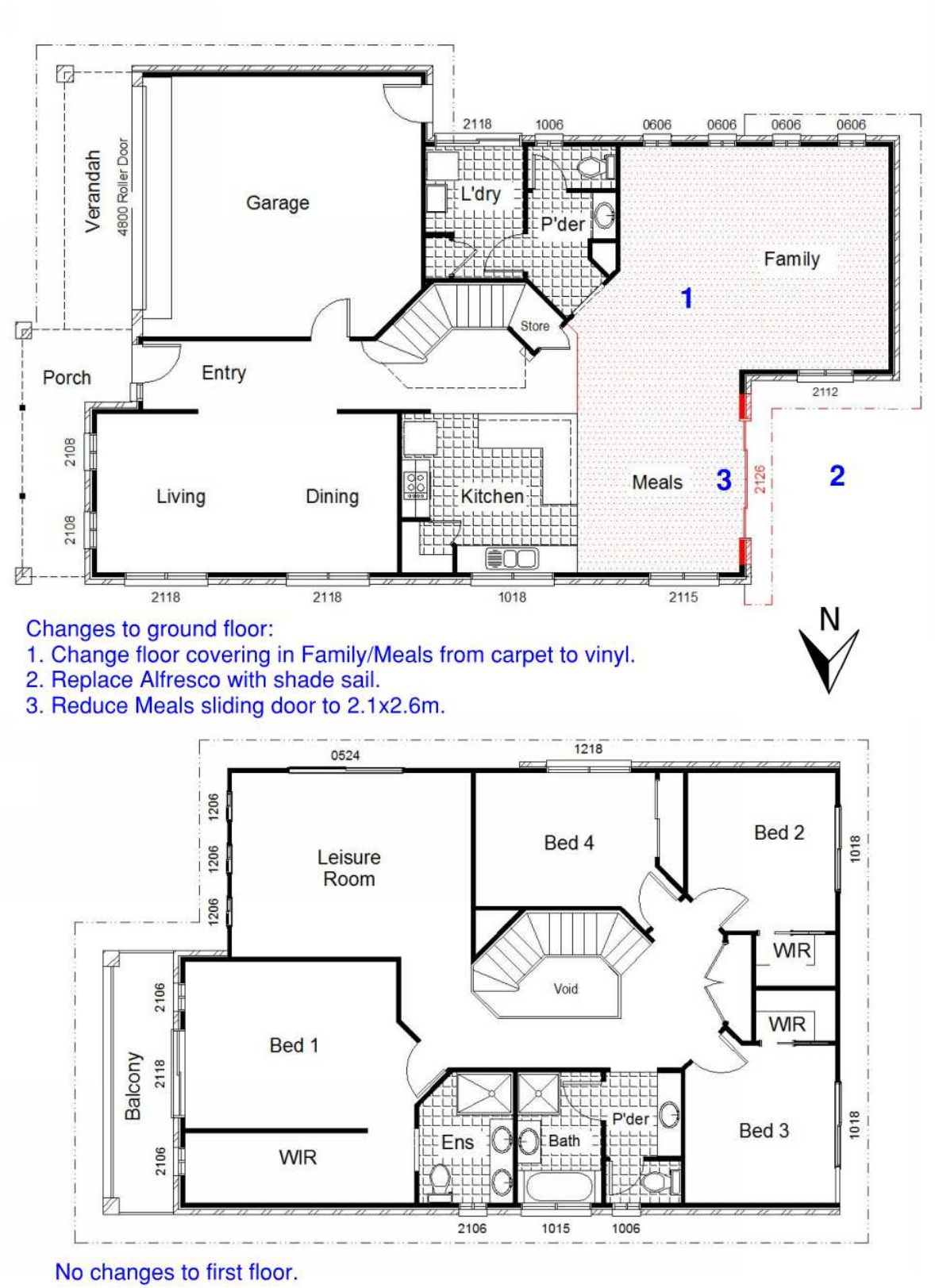


Figure 11.4: Redesigned floor plan of Dwelling 11 in Brisbane, Adelaide, Perth and Sydney.

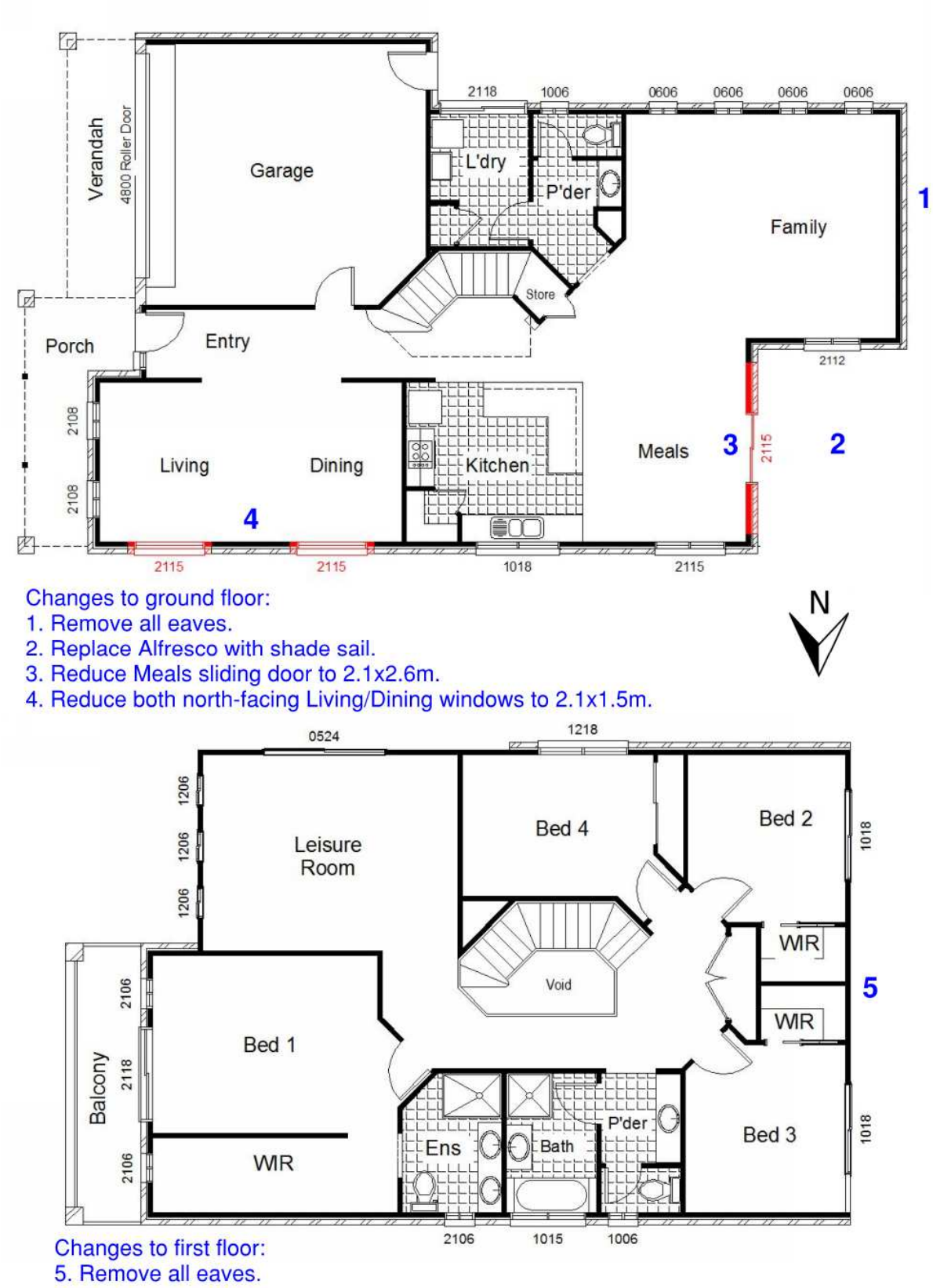


Figure 11.5: Redesigned floor plan of Dwelling 11 in Canberra, Hobart and Melbourne.

Dwelling 12: Review of Original Dwelling Design in All Capital Cities

Table 12.1: Summary of Dwelling 12 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
5	5	-	3	2

Table 12.2: Dwelling 12 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living	Yes	43
Living/ Kitchen	Yes	85
Bedrooms	Yes	153
Corridor	Yes	56
Main Bathroom & Laundry	No	41
Garage	No	35
Verandah	No	47
	TOTAL	460

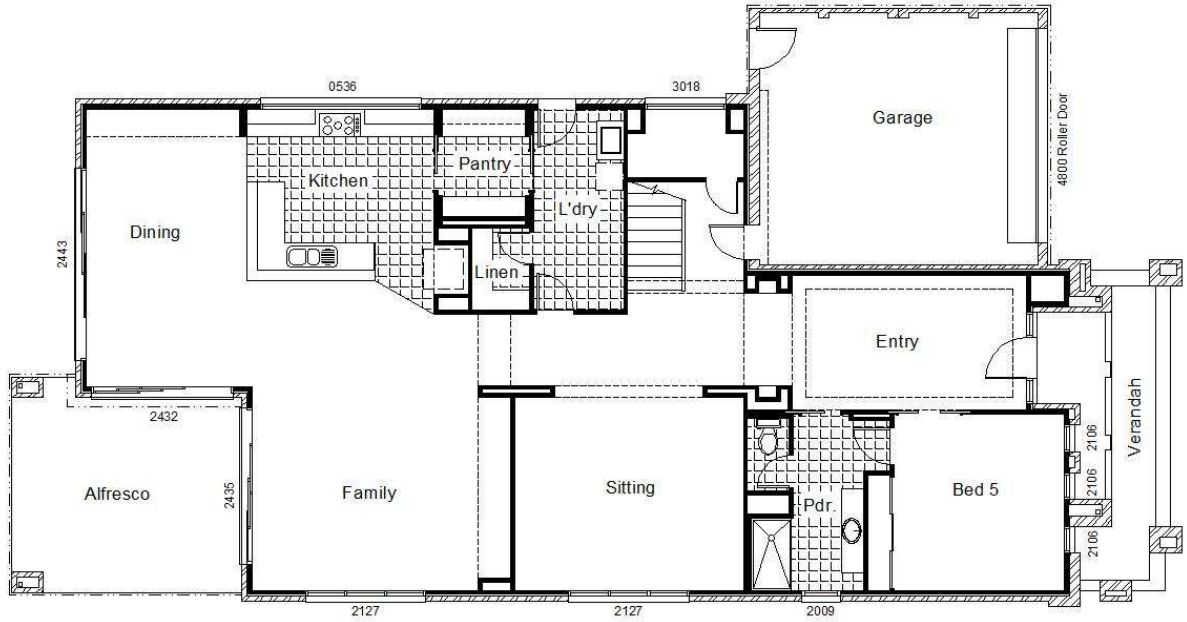


Figure 12.1: Dwelling 12 ground floor plan for original design.

Figure 12.2: Dwelling 12 first floor plan for original design.

Dwelling Description

The largest of all dwellings included in this study, Dwelling 12 is a double storey detached dwelling with four bedrooms upstairs, each with an ensuite and walk-in-robe. The fifth bedroom, a guest bedroom downstairs, opens into another bathroom that shares usage with the rest of the dwelling. There are two main living areas downstairs; an open plan family/dining and kitchen area, as well as a sitting room, with a leisure area at the top of the stairs upstairs. The external walls are of typical brick veneer construction throughout ground and first floors, and the dwelling has a tiled roof at a 20 degree pitch. The glazing downstairs is mainly to the rear and one side of the dwelling, while it is evenly distributed on the first floor. As the dwelling design is long and thin, there is more glazing to the long facades than the shorter front and rear facades. The window to floor area ratio is approximately 19%. The dwelling has 0.8m eaves upstairs, with a short balcony to the front of the dwelling, and downstairs the balcony provides shading to the entry area. The ground floor also has an outdoor room to the rear.

Initial Specifications and Star Rating Results

Tables 12.1 and 12.2 describe the zoning of Dwelling 12, while Table 12.3 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 12.4.1 and Table 12.4.2, with Table 12.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 12.3: Dwelling 12 construction details.

Construction	Type	Details
Ceiling height	Ground floor	2.7m
	First floor	2.6m
Floors	Ground floor	CSOG
	First floor	Timber
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Window frames	Front facade	Cedar
	Everywhere else	Aluminium
Roof	-	Metal deck
Eaves	First floor	0.8m

Table 12.4.1: Specifications for original design of Dwelling 12 in each capital city.

Capital City	Glazing	Roof sisalation
Darwin	Alum 3mm clear (include to front)	Yes
Brisbane	Alum 3mm clear (include to front)	Yes
Perth	Alum 3mm clear Cedar 6.38mm ComfortPlus Neutral	Yes
Sydney	Alum 5mm Evergreen Cedar 3mm clear	Yes
Adelaide	Alum 6.38mm ComfortPlus Neutral Cedar 6.38mm ComfortPlus Neutral	No
Canberra	Alum 3mm clear Cedar 3mm clear/6mm air/3mm clear	No
Melbourne	Alum 3mm clear Cedar 3mm clear	No
Hobart	Alum 3mm clear Cedar 3mm clear	No

Table 12.4.2: Specifications for original design of Dwelling 12 in each capital city (continued).

	Insulation						
	House				Garage		
Capital City	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	R2.0	R2.0	None	None	None	None	R2.0
Perth	R3.5	R2.0	None	None	R3.5	R2.0	R2.0
Sydney	R4.0	R2.0	None	None	R2.0	None	R2.0
Adelaide	R4.0	R2.0	None	None	R4.0	R2.0	R2.0
Canberra	R4.0	R2.5	None	None	R4.0	None	R2.0
Melbourne	R4.0	R2.0	None	None	R2.0	None	R2.0
Hobart	R4.0	R2.0	None	None	R2.0	None	R2.0

Table 12.5: Star rating in four cardinal orientations and cost for original design of Dwelling 12 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	648,848	4.9	5.2	5.1	5.1
Brisbane	714,832	4.6	4.2	3.9	4.9
Perth	680,053	4.5	5.0	4.3	4.6
Sydney	605,669	5.3	5.4	4.9	5.2
Adelaide	565,295	5.8	6.0	5.5	5.9
Canberra	554,699	5.9	6.0	5.9	6.0
Melbourne	523,813	5.2	5.3	5.3	5.4
Hobart	540,354	5.7	5.8	5.8	5.8

Performance of Original Design

Dwelling 12 performs similarly in most orientations in most locations, although there is a wide variation between the orientations in Brisbane (1 star) and in Perth (0.7 stars). In Canberra, Melbourne and Hobart however, there is 0.1 to 0.2 stars difference between the four orientations.

In general, the dwelling achieves higher star ratings with the front door facing either east or west, and having the front door facing south or north is generally worse. The dwelling has a large amount of glazing, and improved glazing has been included to the initial assessments in many of the locations.

The dwelling generally performs worse in the warmer climates, as the effect of too much glazing with too little shading can be seen. This improves in the temperate climates, with the warmer of the temperate areas (Brisbane and Perth) still achieving lower star ratings, while Sydney fares only slightly better and Adelaide performs well due to improved glazing. In the colder climates, the ratings are much higher.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

As the original dwelling performed evenly in all orientations, Dwelling 12 was redesigned with the front door facing west, which provided either an intermediate or best case orientation across all locations.

A series of design changes were applied to window areas and internal zoning which improved the performance across all capital cities. Reductions to window area focused on all daytime occupancy zones, with a total window area reduction of 15%. Internal zoning involved the addition of internal doors to section off large corridor spaces from conditioned zones. Through the use of internal doors the conditioned area was reduced by almost 77m².

Redesign changes specific to climate types were also undertaken. For Darwin, as the hottest climate, a 1200mm ceiling fan was added to the main living area downstairs to increase ventilation and all windows reduced by an additional 10%. For the temperate and cold climates the eaves were reduced from 0.8 to 0.3m and the permanent shading to the alfresco was substituted with a removable shade sail to increase passive heating in cooler periods.

Revised Specifications and Star Rating Results

Tables 12.6.1 and 12.6.2 show the final specifications for the dwelling and Table 12.7 shows the glazing comparison between the initial and redesigned dwelling. Table 12.8 shows the star rating results and cost savings.

Table 12.6.1: Specifications for redesigned Dwelling 12 in each capital city.

Capital City	Glazing	Window reduction %	Eave width (m)	Roof sisalation	Roof solar absorptance (%)	Concrete slab type	Floor covering change
Darwin	Alum 3mm clear (include to front)	10	0.8	Yes	30	Normal	Vinyl
Brisbane	Alum 3mm clear Cedar 3mm clear	0	0.3	Yes	30-50	Normal	None
Perth	Alum 3mm clear Cedar 3mm clear	0	0.3	No	30	Normal	Vinyl
Sydney	Alum 3mm clear Cedar 3mm clear	0	0.3	No	30-50	Normal	Vinyl
Adelaide	Alum 3mm clear Cedar 3mm clear	0	0.3	No	30-50	Normal	None
Canberra	Alum 3mm clear Cedar 3mm clear	0	0.3	No	50-85	Polystyrene core	None
Melbourne	Alum 3mm clear Cedar 3mm clear	0	0.3	No	85	Polystyrene core	None
Hobart	Alum 3mm clear Cedar 3mm clear	0	0.3	No	50-85	Polystyrene core	None

Table 12.6.2: Specifications for redesigned Dwelling 12 in each capital city (continued).

	Insulation						
	House				Garage		
Capital City	Ceiling	External walls	Internal walls	Midfloor space	Ceiling	External walls	Internal walls to house
Darwin	R2.0	R1.5	None	None	None	None	R1.5
Brisbane	R3.5	R1.5	None	None	None	None	R1.5
Perth	R3.5	R1.5	None	None	None	None	R1.5
Sydney	R3.5	R2.0	None	None	None	None	R2.0
Adelaide	R3.5	R2.0	None	None	None	None	R2.0
Canberra	R3.5	R2.0	None	None	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 12.7: Glazing comparison between initial design and redesign for Dwelling 12.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	19.4	15.0	22.8
Brisbane	19.4	16.6	14.2
Perth	19.4	16.6	14.2
Sydney	19.4	16.6	14.2
Adelaide	19.4	16.6	14.2
Canberra	19.4	16.6	14.2
Melbourne	19.4	16.6	14.2
Hobart	19.4	16.6	14.2

Table 12.8: Redesigned Dwelling 12 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	648,921	-73	0.0	West	6.1	1.0
Brisbane	702,056	12,776	1.8	West	6.0	1.1
Perth	664,890	15,163	2.2	West	6.1	1.5
Sydney	584,953	20,716	3.4	West	6.3	1.1
Adelaide	544,993	20,302	3.6	West	6.2	0.3
Canberra	534,364	20,335	3.7	West	6.4	0.4
Melbourne	513,043	10,770	2.1	West	6.4	1.0
Hobart	528,821	11,533	2.1	West	6.9	1.1

Performance of Redesigned Dwelling

The redesign of Dwelling 12 provided a star rating increase and cost saving in all capital cities, except for Darwin where there was a no percentage cost change. In all capital cities, with the exception of Adelaide and Canberra for which the original designs already achieved six stars, there was a star rating increase of 1 star or more as a result of the redesign changes. A significant cost saving was achieved in Sydney, where the construction cost was reduced by 3.4% in conjunction with a 1.1 star rating increase. In Adelaide and Canberra both cost savings and star rating increases were similar with a 3.6 and 3.7% cost saving and 0.3 and 0.4 star increases respectively.

No cost saving in Darwin was influenced by the fact that the first floor eave width was not reduced from 0.8m. However there were also increased costs associated with the addition of internal doors and walls, floor covering changes and a ceiling fan to the dining/ family room.

Dwelling 12 has had significant glazing reductions as part of the redesign, reducing from 14.2% to 22.8% of the original glazing area, and this has had a positive impact on the both the star ratings and cost savings of the dwelling in all locations.

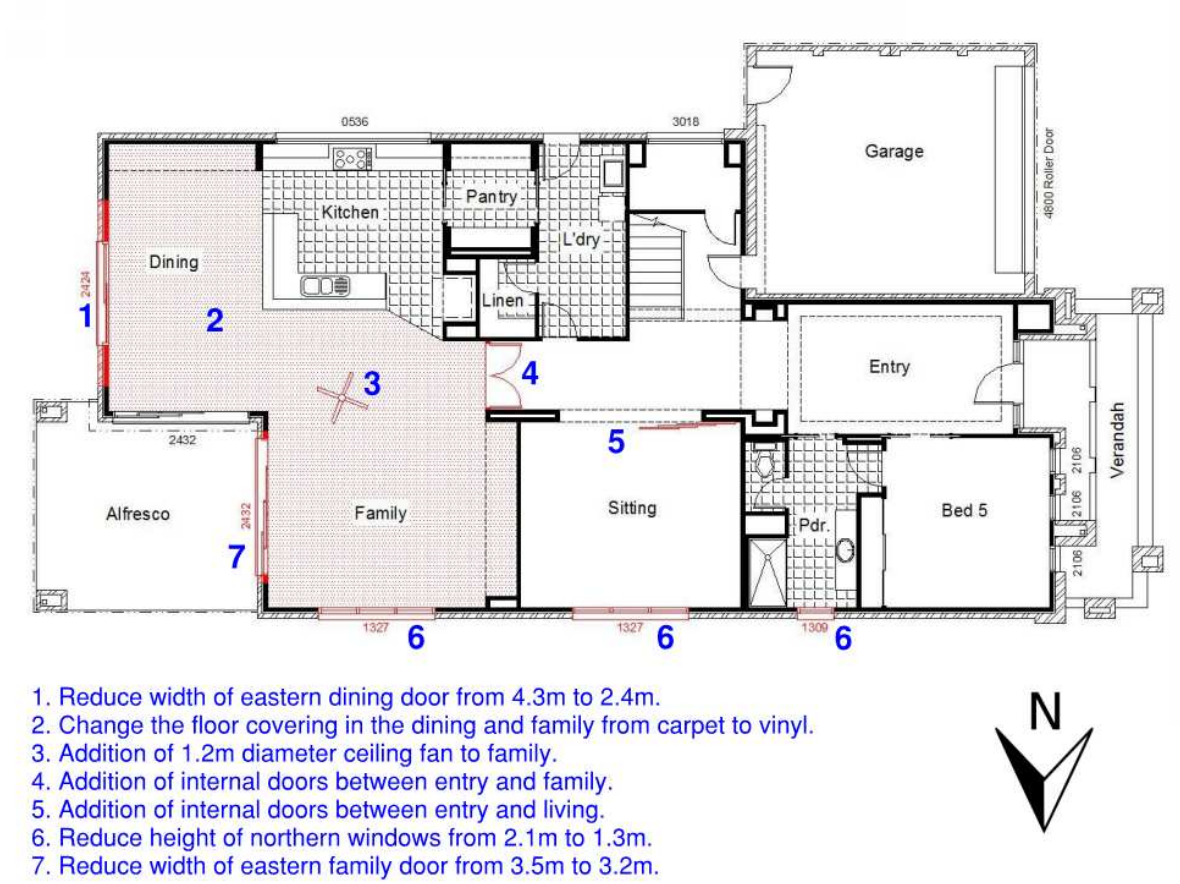


Figure 12.3: Redesigned ground floor plan for Dwelling 12 in Darwin.

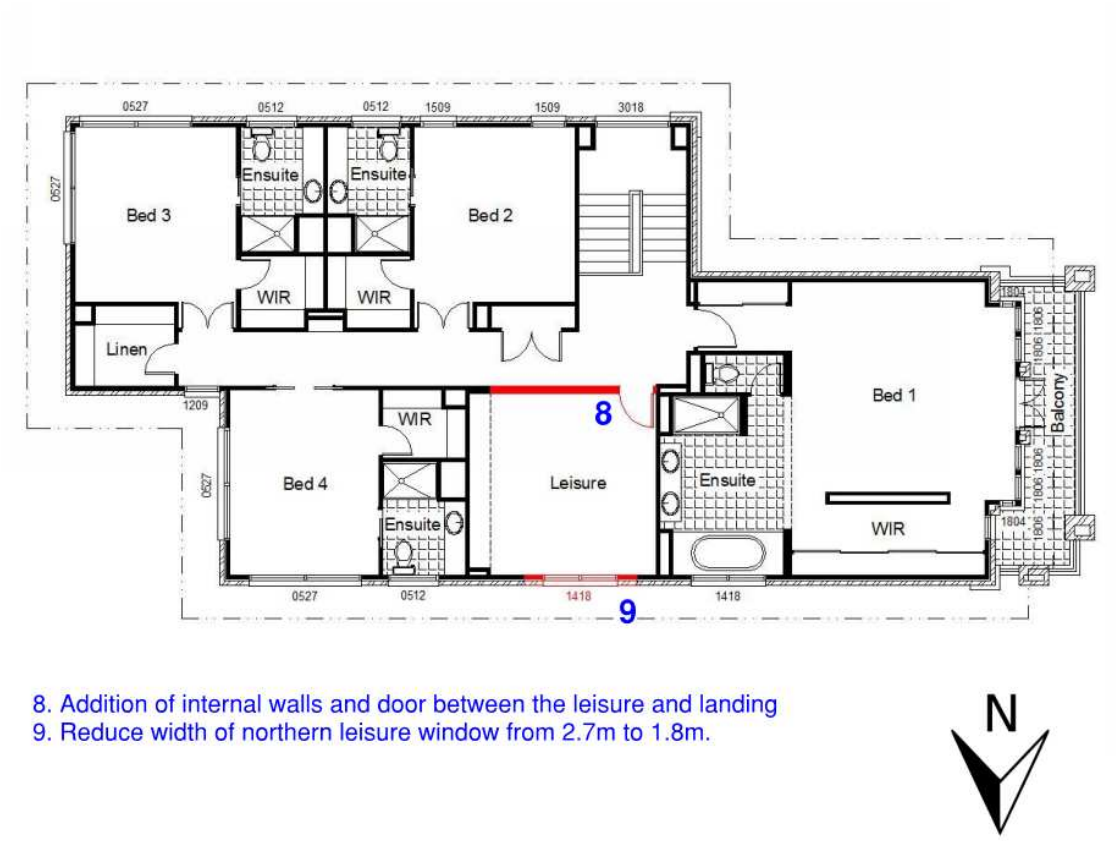


Figure 12.4: Redesigned first floor plan for Dwelling 12 in Darwin.

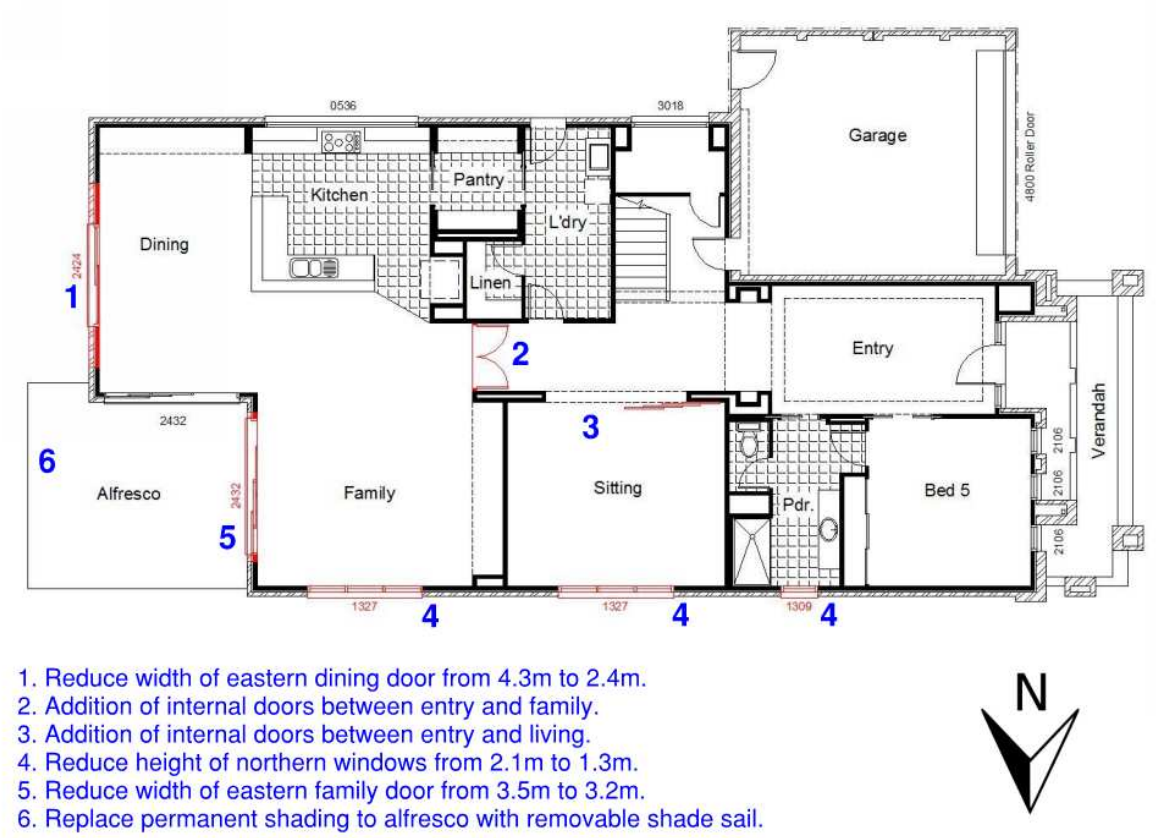


Figure 12.5: Redesigned ground floor plan for Dwelling 12 in Adelaide, Brisbane, Canberra, Hobart and Melbourne.

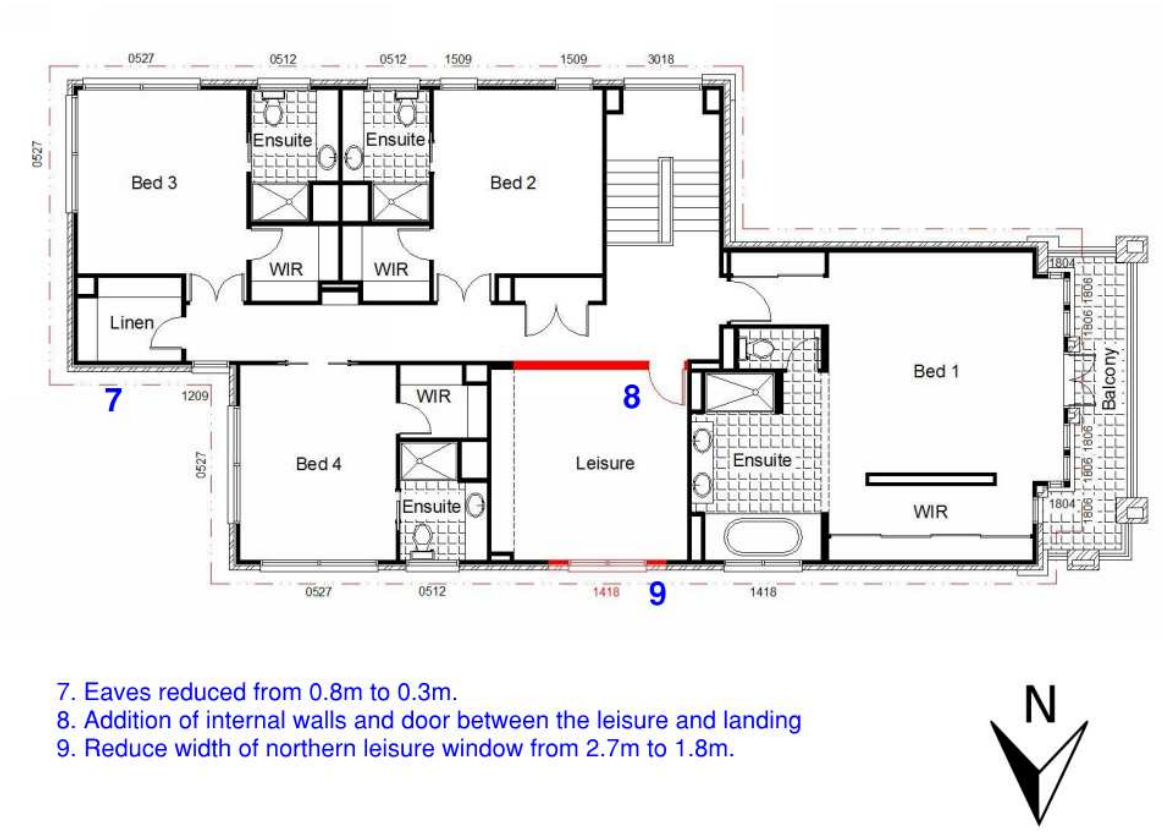


Figure 12.6: Redesigned first floor plan for Dwelling 12 in Adelaide, Brisbane, Canberra, Hobart and Melbourne.

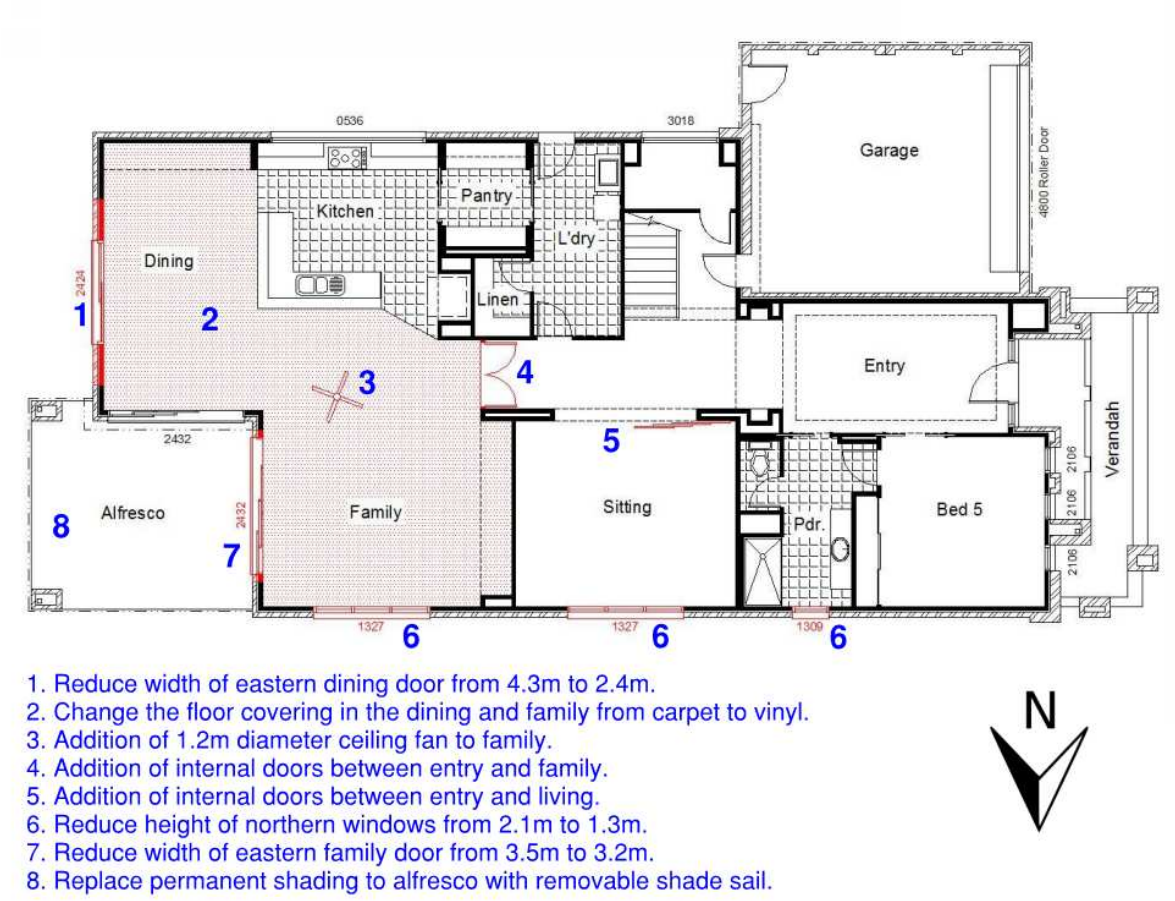
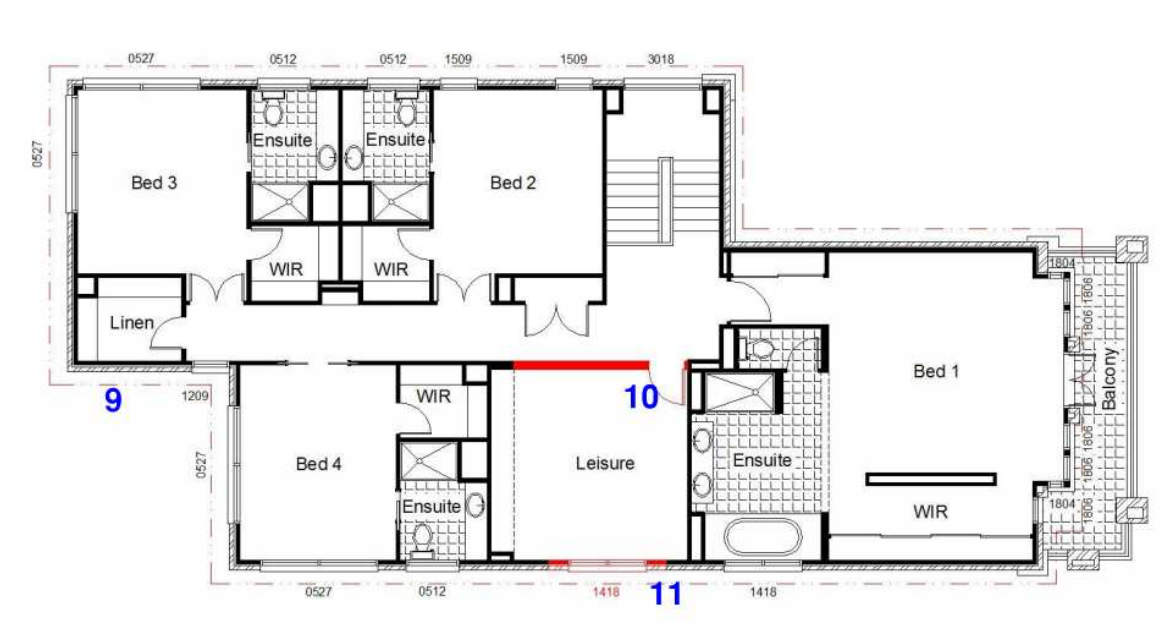


Figure 12.7: Redesigned ground floor plan for Dwelling 12 in Perth and Sydney.



9. Eaves reduced from 0.8m to 0.3m.
10. Addition of internal walls and door between the leisure and landing
11. Reduce width of northern leisure window from 2.7m to 1.8m.

Figure 12.8: Redesigned first floor plan for Dwelling 12 in Perth and Sydney.

Dwelling 13: Review of Original Dwelling Design in All Capital Cities

Table 13.1: Summary of Dwelling 13 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	3	-	1	1

Table 13.2: Dwelling 13 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	32
Bedrooms	Yes	42
Corridor	Yes	18
Main Bathroom & Laundry	No	9
Garage	No	22
	TOTAL	123

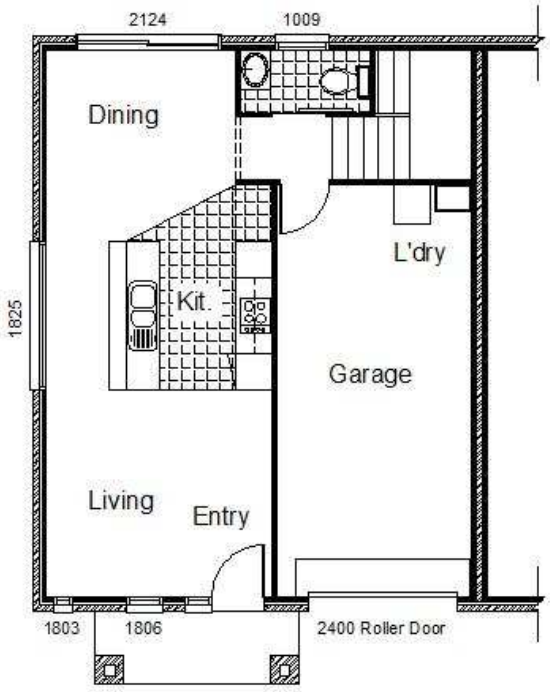


Figure 13.1: Dwelling 13 ground floor plan for original design.

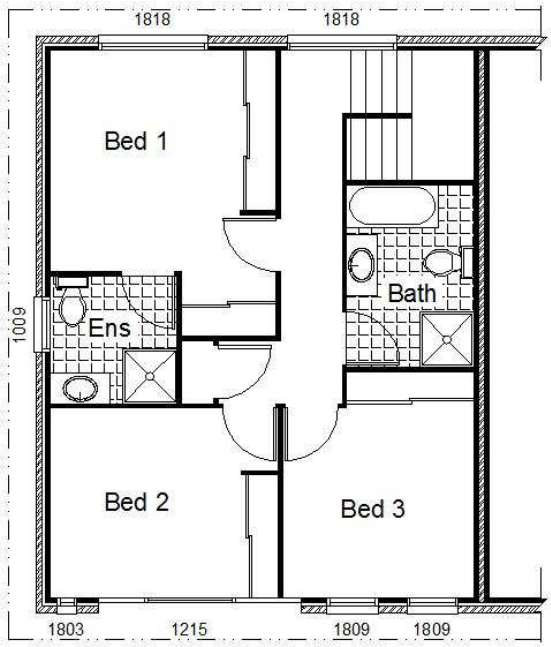


Figure 13.2: Dwelling 13 first floor plan for original design.

Dwelling Number: 13 Dwelling Type: Semi-detached (One Shared Wall)

Dwelling Description

Dwelling 13 is a double storey semi-detached residence, attached along one wall to another dwelling. The lower level is made up of a single-car garage and an open plan dining/living and kitchen area, while upstairs there are two bedrooms and a possible third or study, as well as a bathroom. The external walls are of typical brick veneer construction throughout, and the ceiling is a hipped metal construction. The glazing is evenly distributed amongst the three external facades, and the window to floor area ratio is approximately 25%. The first floor has 0.6m eaves, while the ground floor is unshaded except for a 1.2m overhang to the porch.

Initial Specifications and Star Rating Results

Tables 13.1 and 13.2 describe the zoning of Dwelling 13, while Table 13.3 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 13.4, with Table 13.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 13.3: Dwelling 13 construction details.

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

Table 13.4: Specifications for original design of Dwelling 13 in each capital city.

			Insulation					
			House			Garage		
Capital City	Glazing	Roof sisalation	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	5mm Evergreen	Yes	R2.0	Double-sided foil	None	None	None	R1.5
Brisbane	5mm Evergreen	Yes	R2.0	Double-sided 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	3mm clear	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 13.5: Star rating in four cardinal orientations and cost for original design of Dwelling 13 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	231,627	6.0	5.4	5.9	5.5
Brisbane	255,183	7.1	4.7	5.6	5.4
Perth	236,431	5.4	4.4	5.1	4.4
Sydney	205,676	5.6	4.8	5.4	4.9
Adelaide	192,754	5.9	5.2	5.8	5.3
Canberra	189,701	6.2	5.7	6.2	6.2
Melbourne	183,065	5.9	5.6	6.1	5.9
Hobart	188,898	6.6	6.4	6.7	6.6

Performance of Original Design

Dwelling 13 has a large variation between the different orientations in each location, especially in Brisbane, where there is a difference of 2.4 stars between the front door facing north and front door facing east. This is due to the effect of having a party wall that cannot be glazed and is not exposed to the outside conditions.

In general, having the front door facing north is the preferable orientation, especially in Brisbane. This is because the majority of glazing is facing to the front and rear of the residence. Hobart, Melbourne

and Canberra also perform well with the front door facing south, because this increases the heat gains to the dwelling.

The dwelling performs consistently worse when the front door is facing east, as there is no north-facing glazing in this orientation.

The dwelling performs consistently better in the colder climates. The lower results in the hot and temperate climates are due to the high cooling loads. These high cooling loads are caused by minimal shading and the large glazing area.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

Dwelling 13 has been redesigned with the front door facing south in all locations, to allow for north heat gains into the rear living area of the dwelling where the backyard would ideally be located.

The dwelling performed well in the cold climates therefore the redesign aims to reduce the amount of heat gains in the temperate and hot climates. This has been done through testing more appropriate floor coverings to the living area, adjusting shading and insulation levels, and reducing the glazing area to windows that allow a lot of the unwanted heat to enter (such as west-facing glazing).

The kitchen window was reduced to 0.9m high. The glazing in the hot climates was downgraded from Evergreen to a 3mm clear glazing. The eaves on the upper level were reduced from 0.6m to 0.3m, and the floor covering changed to vinyl.

Insulation levels were downgraded in areas that did not significantly affect the energy rating and were upgraded in areas that improved the rating, such as to the external walls in Darwin and Brisbane. The roof sisalation was eliminated from Darwin and Brisbane as it did not affect the rating much, but had reasonable cost savings.

Revised Specifications and Star Rating Results

Tables 13.6.1 and 13.6.2 show the final specifications for the dwelling and Table 13.7 shows the glazing comparison between the initial and redesigned dwelling. Table 13.8 shows the star rating results and cost savings.

Table 13.6.1: Specifications for redesigned Dwelling 13 in each capital city.

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

Table 13.6.2: Specifications for redesigned Dwelling 13 in each capital city (continued).

	Insulation					
	House			Garage		
Capital City	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	None
Sydney	R3.5	R1.5	None	None	None	None
Adelaide	R3.5	R1.5	None	None	None	None
Canberra	R3.5	R2	None	None	None	None
Melbourne	R3.5	R2	None	None	None	None
Hobart	R3.5	R2	None	None	None	None

Table 13.7: Glazing comparison between initial design and redesign for Dwelling 13.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	25.4	23.3	8.4
Brisbane	25.4	23.3	8.4
Perth	25.4	23.3	8.4
Sydney	25.4	23.3	8.4
Adelaide	25.4	23.3	8.4
Canberra	25.4	23.3	8.4
Melbourne	25.4	23.3	8.4
Hobart	25.4	23.3	8.4

Table 13.8: Redesigned Dwelling 13 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	226,191	5,436	2.4	South	6.4	0.5
Brisbane	249,749	5,434	2.1	South	6.7	1.1
Perth	234,755	1,676	0.7	South	6.2	1.1
Sydney	204,218	1,458	0.7	South	6.2	0.8
Adelaide	190,858	1,896	1.0	South	6.1	0.3
Canberra	187,046	2,655	1.4	South	6.3	0.1
Melbourne	180,997	2,068	1.1	South	6.4	0.3
Hobart	186,713	3,477	1.8	South	6.8	0.1

Performance of Redesigned Dwelling

The redesign of Dwelling 13 provided a star rating increase and cost saving in all capital cities, with a glazing reduction of 8.4% to all locations. Perth and Sydney had the smallest cost savings while Darwin and Brisbane both had a cost saving of over 2% of the initial design cost, due to less expensive glazing used in the redesign.

Brisbane has shown the most benefit from the redesign, with a high cost saving and a star rating increase of 1.1 stars. Perth has also shown a star rating increase of 1.1 stars, but with a much smaller cost saving. Sydney improved by 0.8 stars and Darwin by 0.5, but the star rating increases were only 0.3 or 0.1 stars in all other locations.

These minimal changes in star rating and cost saving are due to the minimal changes made in the redesign.

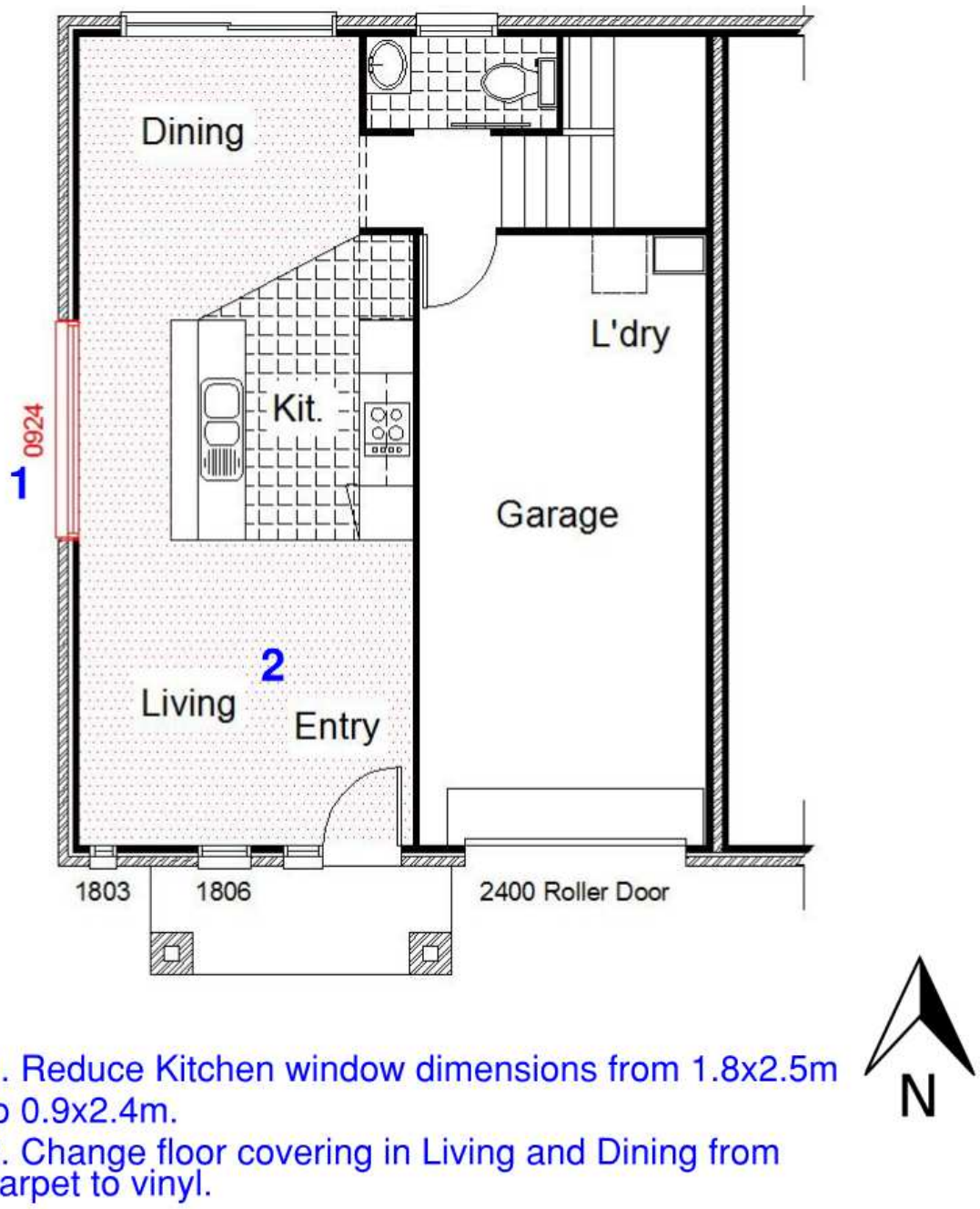


Figure 13.3: Redesigned ground floor plan for Dwelling 13 in hot and temperate climates (Darwin, Brisbane, Perth, Sydney and Adelaide).

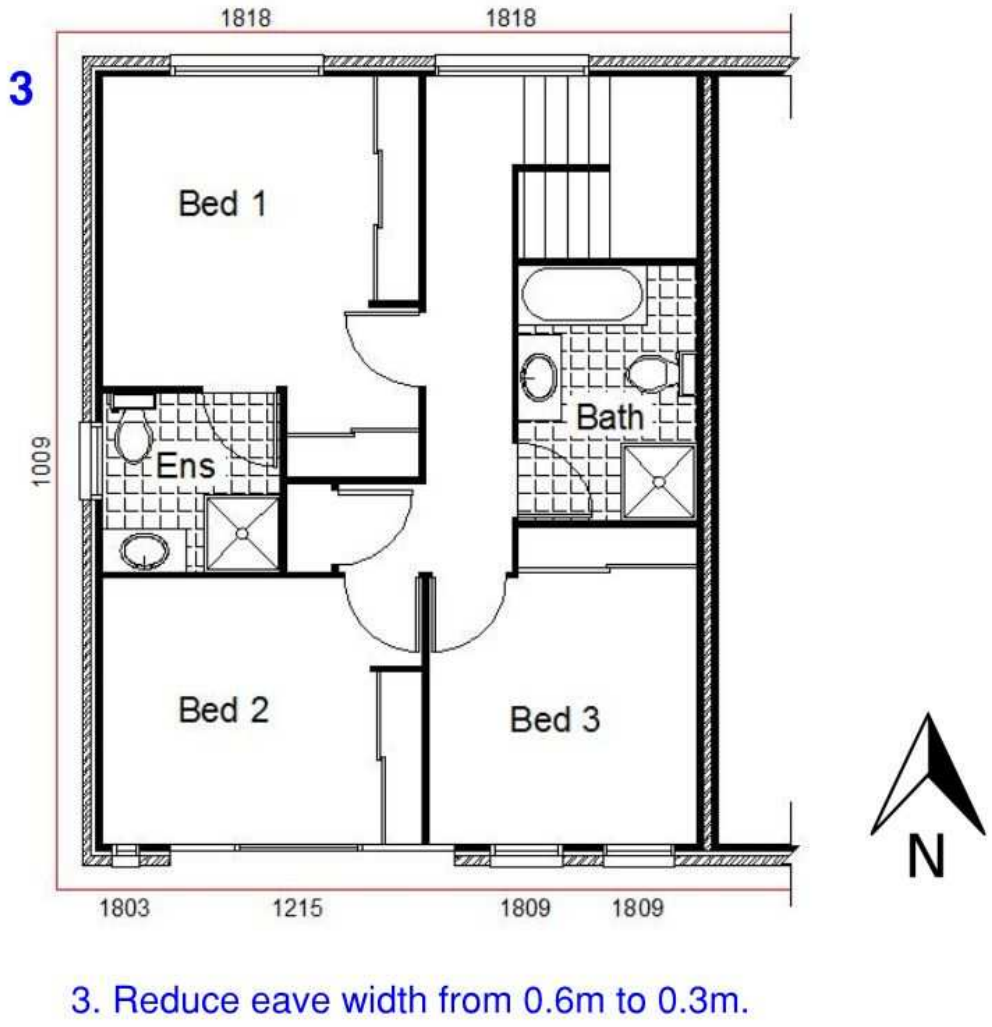


Figure 13.4: Redesigned first floor plan for Dwelling 13 in hot and temperate climates (Darwin, Brisbane, Perth, Sydney and Adelaide).

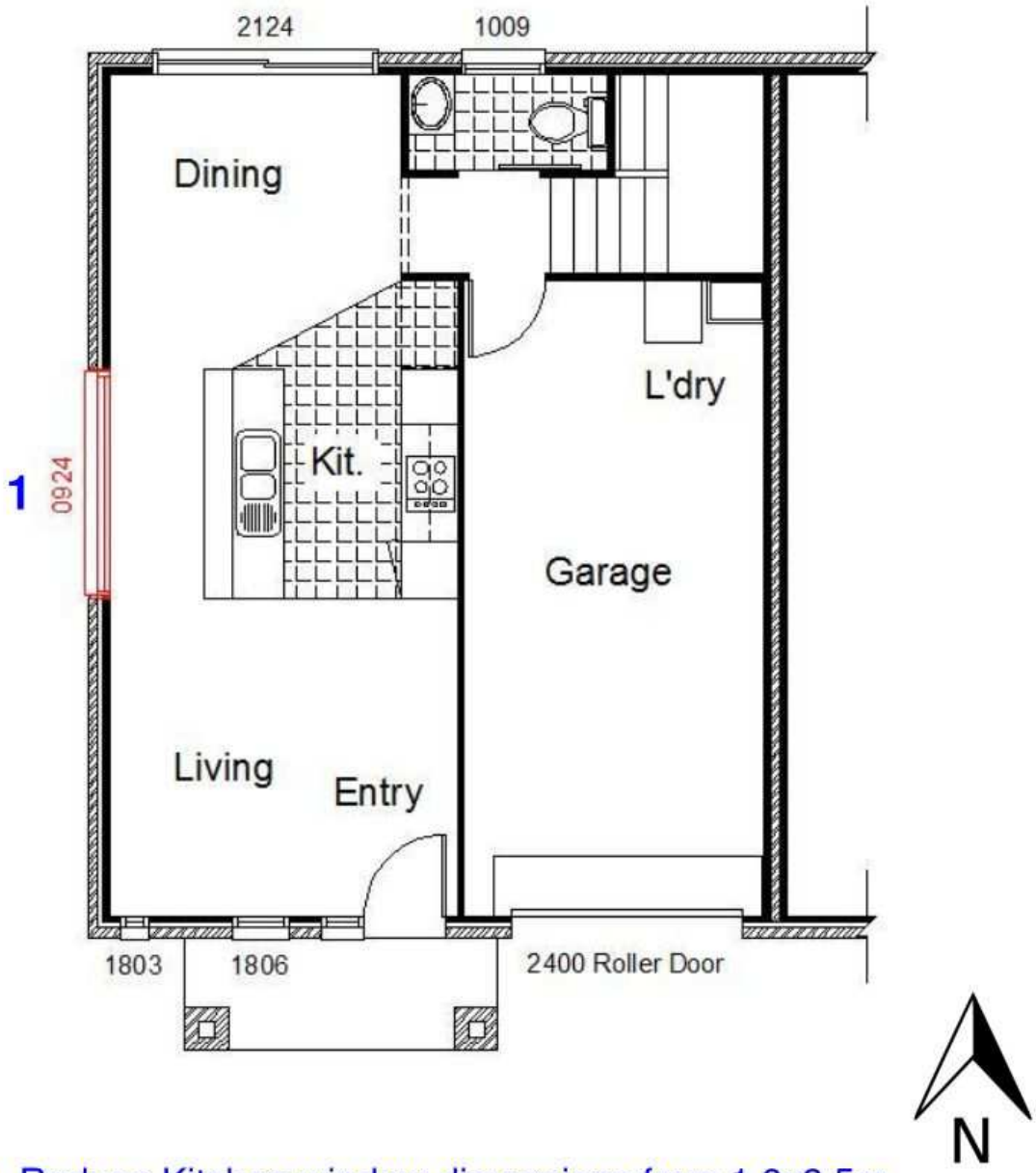


Figure 13.5: Redesigned ground floor plan for Dwelling 13 in cold climates (Canberra, Melbourne and Hobart).

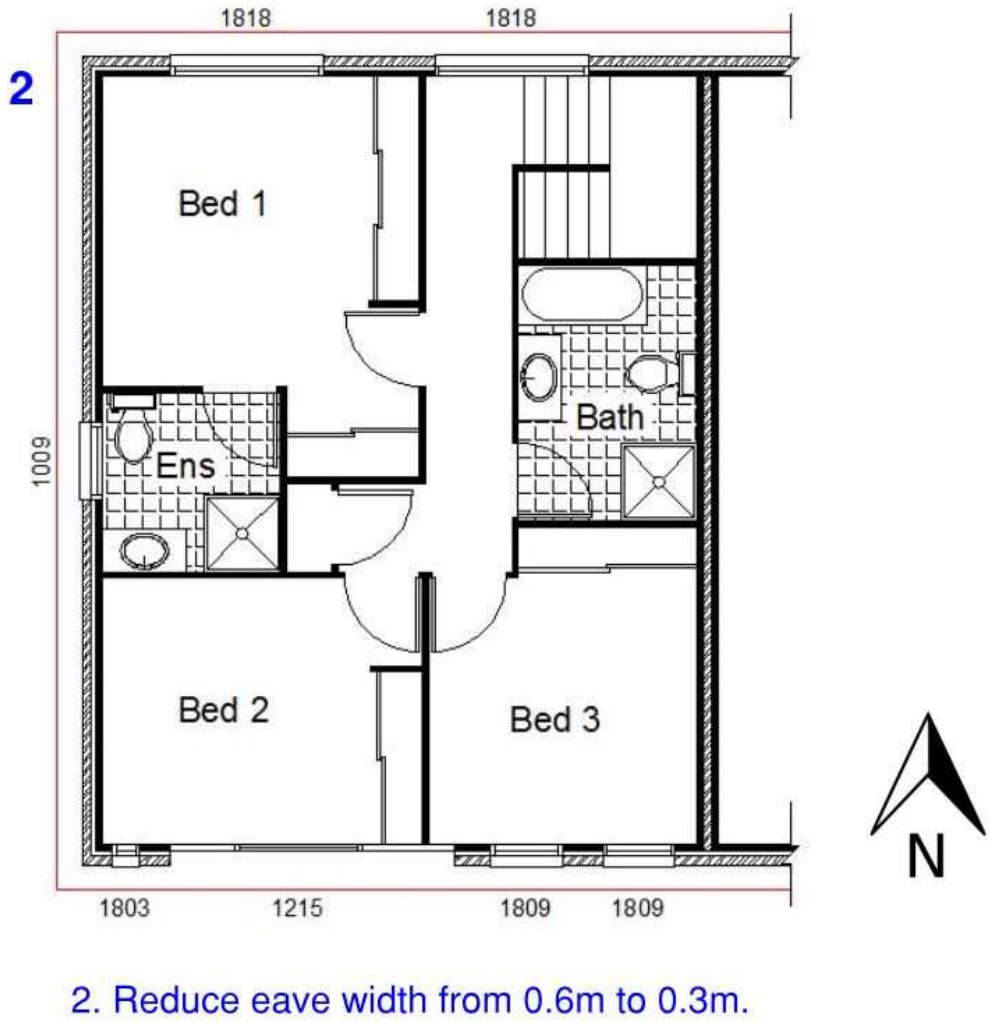


Figure 13.6: Redesigned first floor plan for Dwelling 13 in cold climates (Canberra, Melbourne and Hobart).

Dwelling 14: Review of Original Dwelling Design in All Capital Cities

Table 14.1: Summary of Dwelling 14 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	1	-	1	1

Table 14.2: Dwelling 14 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	44
Bedrooms	Yes	33
Corridor	Yes	9
Main Bathroom & Laundry	No	8
Garage	No	19
Verandah	No	7
	TOTAL	120

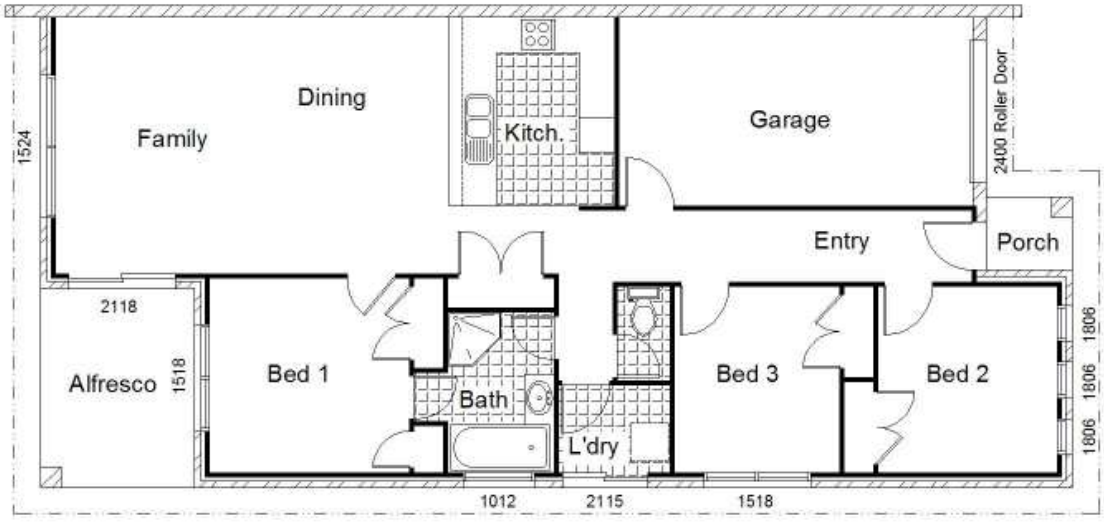


Figure 14.1: Dwelling 14 floor plan for original design.

Dwelling Description

Dwelling 14 is a compact single storey with 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 wall construction with a metal hip roof at 22.3 degree pitch. One wall is shared with the mirrored neighbouring dwelling. The windows are evenly distributed across the three external facades. The window to floor area ratio (including the Garage floor area) is 18%. The whole dwelling has consistent 0.45m eaves with alfresco shading to the rear of the dwelling.

Initial Specifications and Star Rating Results

Tables 14.1 and 14.2 describe the zoning of Dwelling 14, while Table 14.3 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 14.4, with Table 14.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 14.3: Dwelling 14 construction details.

Construction	Type	Details
Ceiling height	-	2.4m
Floors	-	CSOG
Floor coverings	House	Carpet
	Wet areas	Tiles
	Garage	None
External walls	-	Brick veneer: 110mm brick + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	-	0.45m

Table 14.4: Specifications for original design of Dwelling 14 in each capital city.

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

Table 14.5: Star rating in four cardinal orientations and cost for original design of Dwelling 14 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	230,144	6.3	6.1	6.3	6.1
Brisbane	253,548	6.2	4.8	5.2	5.8
Perth	240,417	6.4	5.8	6.3	6.4
Sydney	209,143	6.5	5.9	6.4	6.6
Adelaide	195,461	6.6	6.2	6.6	6.6
Canberra	191,985	5.9	5.7	6.0	6.1
Melbourne	185,687	5.9	5.8	6.1	6.1
Hobart	191,552	5.8	5.6	6.0	6.1

Performance of Original Design

The dwelling performs better with the front door facing north in the warmer climates, and facing west in the cooler climates. Heat gains are minimised when the front door is facing north, and maximised when the front door is facing west.

The dwelling achieves higher star ratings in Darwin, even though the dwelling has been assessed with very basic specifications in this location. The north and south orientations perform better than the east and west orientations, due the fact that this increases the heat gains to the dwelling.

In the temperate climates, the dwelling achieves higher star ratings with the front door facing either north or west. Having the front door facing west creates a similar balance of heat gains and heat loss due to east/west and south facing, even though north-facing glazing is minimised.

In the cold climates, the dwelling achieves a lower star rating with the front door facing north, as this maximises south-facing glazing to the main living area and Bed 1, which is further shaded by the Alfresco.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

As the dwelling performs so well in Darwin, Perth, Sydney and Adelaide initially, it has not been redesigned in these locations. Instead, the redesign focused on Brisbane and the cold climates.

In Brisbane, the eaves have been reduced as a cost saving measure, but also to make sure that the dwelling receives enough sunlight during the colder months. A ceiling fan has been added to the Family/Dining area in order to encourage air movement through the dwelling, while the floor covering to this area has been changed to vinyl. The dwelling has been redesigned with the front door facing east, as this was the lowest rating orientation in Brisbane.

In the colder climates, the only changes made were in the specifications for the dwelling. The polystyrene core to the concrete slab will help insulate the dwelling, while the increased solar absorptance to the roof will gain and retain solar heat throughout the year. The reduction in eaves will introduce more sunlight into the dwelling, and the insulation has been adjusted to create the best circumstances for the dwelling.

Revised Specifications and Star Rating Results

Tables 14.6.1 and 14.6.2 show the final specifications for the dwelling and Table 14.7 shows the star rating results and cost savings.

Table 14.6.1: Specifications for redesigned Dwelling 14 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	3mm clear	0.3	None	30	Normal	Vinyl
Perth	Not redesigned					
Sydney	Not redesigned					
Adelaide	Not redesigned					
Canberra	3mm clear	0.3	None	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 14.6.2: Specifications for redesigned Dwelling 14 in each capital city (continued).

	Insulation					
	House			Garage		
Capital City	Ceiling	External walls	Internal walls	Ceiling	External walls	Internal walls to house
Darwin	Not redesigned					
Brisbane	R3.5	R1.5	None	R3.5	None	None
Perth	Not redesigned					
Sydney	Not redesigned					
Adelaide	Not redesigned					
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 14.7: Redesigned Dwelling 14 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	254,842	-1,294	-0.5	East	6.4	1.6
Perth	Not redesigned					
Sydney	Not redesigned					
Adelaide	Not redesigned					
Canberra	191,642	343	0.2	West	6.6	0.5
Melbourne	185,562	125	0.1	West	6.7	0.6
Hobart	191,422	130	0.1	West	7.1	1.0

Performance of Redesigned Dwelling

Cost savings for the redesign are minimal, with the three cold climates only saving 0.1% to 0.2%, while the redesign in Brisbane costs more money than it saves. This is offset, however, by the positive impact on the energy efficiency of these changes, as Brisbane has improved by 1.6 stars, and Canberra, Melbourne and Hobart have all had positive increases in the star rating, ranging from 0.5 to 1 star.

In the cold climates, the specification changes make a large difference to the energy efficiency, without having any negative impact on the cost of the dwelling. Only the inclusion of insulation to the internal walls between the house and garage has brought this cost benefit down.

In general, the dwelling does perform better with some very simple changes, though it was already performing well in most locations. It is for this reason that no glazing reductions were required. In Brisbane, however, cost has had to be sacrificed to a certain extent to achieve the required star rating.

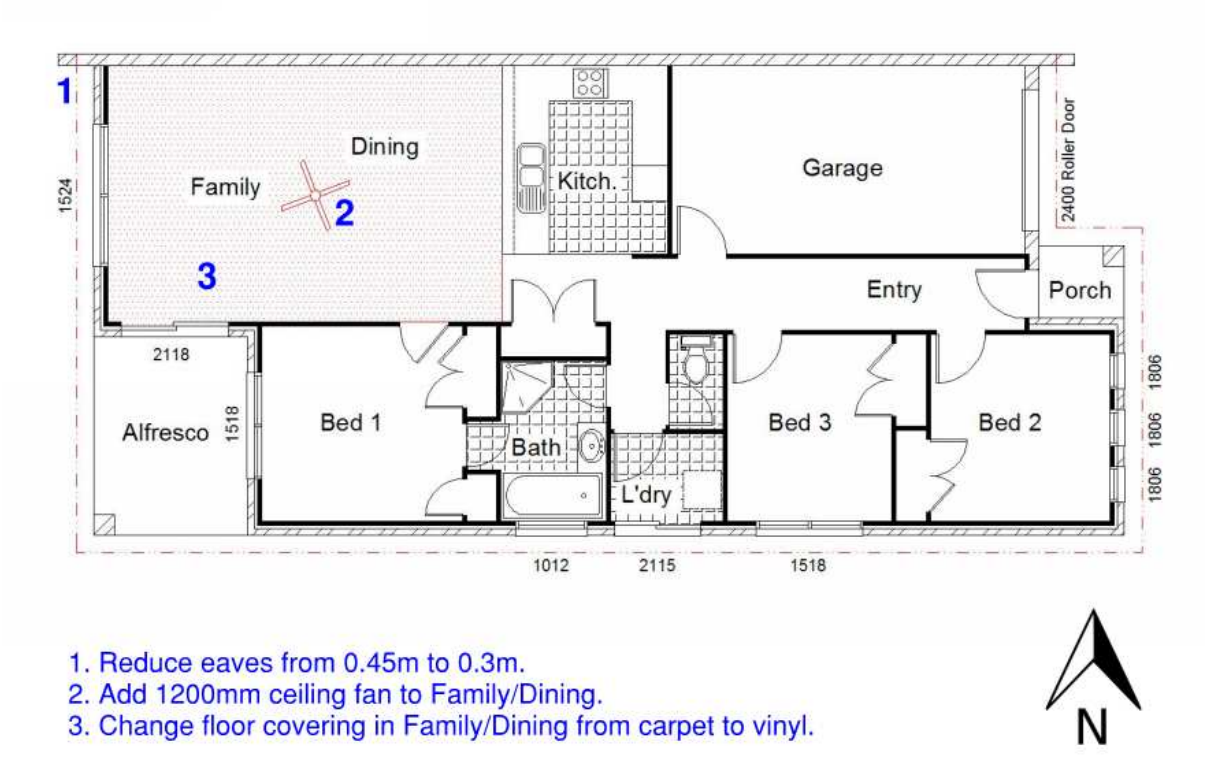


Figure 14.2: Redesigned floor plan for Dwelling 14 in Brisbane.

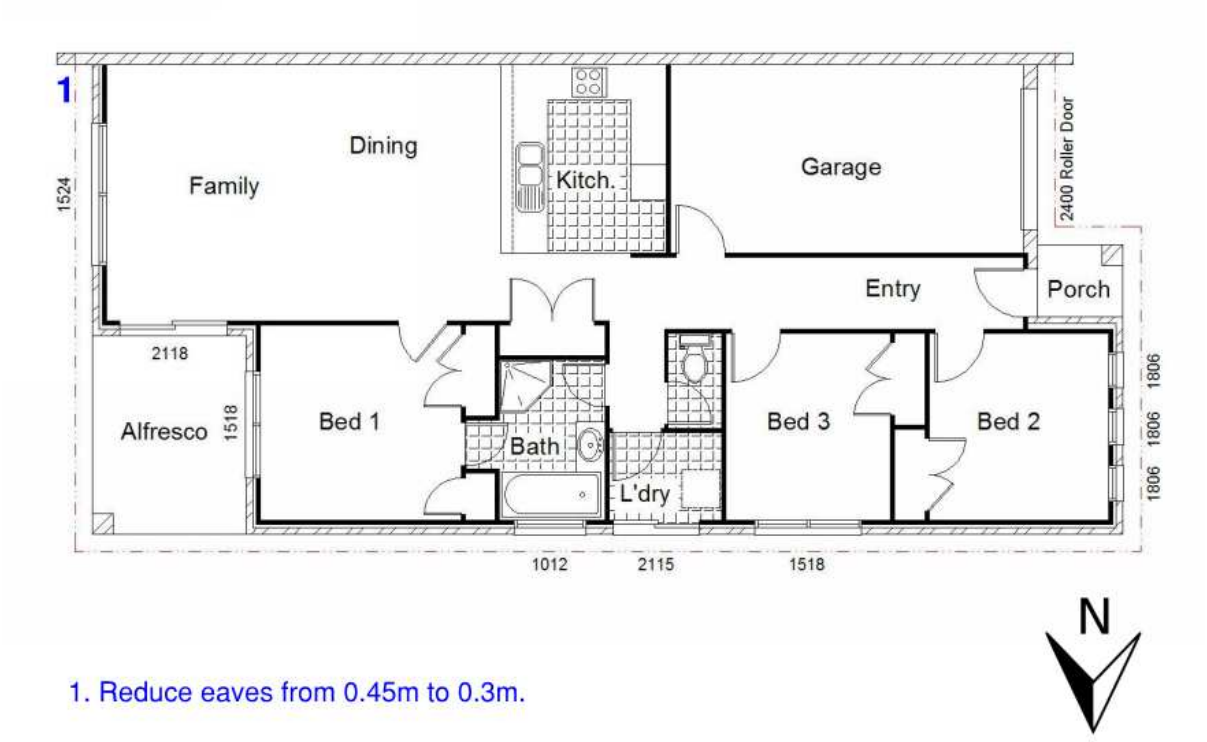


Figure 14.3: Redesigned floor plan for Dwelling 14 in Canberra, Melbourne and Hobart.

Dwelling 15: Review of Original Dwelling Design in All Capital Cities

Table 15.1: Summary of Dwelling 15 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
2	1	-	2	2

Table 15.2: Dwelling 15 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living	Yes	15
Living/ Kitchen	Yes	33
Bedrooms	Yes	27
Corridor	Yes	14
Main Bathroom & Laundry	No	6
Garage	No	31
Verandah	No	18
	TOTAL	144

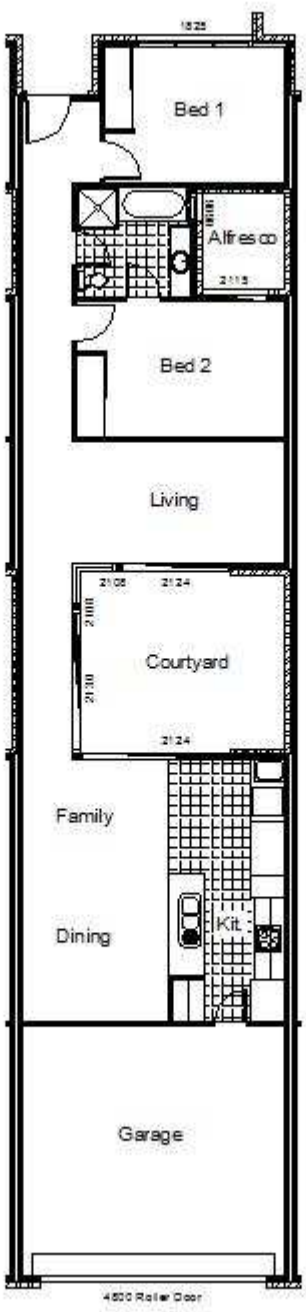


Figure 15.1: Dwelling 15 floor plan for original design.

Dwelling Description

This dwelling has two bedrooms, sharing one bathroom, and a separate living and family/dining/kitchen living area. As one of a group of semi-attached residences, the dwelling is long and thin with no glazing on either of its long side walls. It does, however, have two courtyards built into the design to let in natural light to every zone. The front and rear facade and alfresco external walls have a standard brick veneer construction, while the majority of the courtyard is a lightweight fibre-cement construction. The roof is a flat metal construction. The glazing is not evenly distributed due to the shape of the dwelling and the party walls on either side; instead, the glazing is fit into the courtyards and to the front of the residence. The window to floor area ratio is approximately 32%.

Initial Specifications and Star Rating Results

Tables 15.1 and 15.2 describe the zoning of Dwelling 15, while Table 15.3 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 15.4.1 and Table 15.4.2, with Table 15.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 15.3: Dwelling 15 construction details.

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	CSOG
External walls	Front/rear facade and Alfresco walls	Brick veneer: 110mm brick + air gap + 10mm plasterboard
	Courtyard walls	Fibre-cement: 6mm fibre-cement + air gap + 10mm plasterboard
Roof	-	Metal deck
Eaves	-	None

Table 15.4.1: Specifications for original design of Dwelling 15 in each capital city.

Capital City	Glazing	Awning	Roof sisalation
Darwin	Alum 5mm Evergreen	All	Yes
Brisbane	Alum 6.38mm ComfortPlus Neutral	All	Yes
Perth	Alum 6.38mm ComfortPlus Neutral	All	No
Sydney	Alum 6.38mm ComfortPlus Neutral	None	Yes
Adelaide	Alum 4mm clear/8mm air/4mm Energy Advantage Low E	None	No
Canberra	Cedar 4mm clear/8mm air/4mm Energy Advantage Low E	None	No
Melbourne	Cedar 6.38mm ComfortPlus Neutral	None	No
Hobart	Alum 3mm clear/6mm air/3mm clear	None	No

Table 15.4.2: Specifications for original design of Dwelling 15 in each capital city (continued).

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

Table 15.5: Star rating in four cardinal orientations and cost for original design of Dwelling 15 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	265,675	5.4	4.9	5.3	5.0
Brisbane	293,360	5.2	3.8	4.6	4.6
Perth	276,907	4.9	4.3	4.6	4.2
Sydney	239,679	4.8	3.9	4.3	3.9
Adelaide	224,995	5.9	5.0	5.5	4.7
Canberra	221,167	6.3	5.7	5.8	5.6
Melbourne	212,068	5.1	4.7	4.7	4.7
Hobart	220,001	5.1	4.6	4.7	4.8

Performance of Original Design

There is a large amount of variation between the different orientations in each location for Dwelling 15. This is due to the fact that this dwelling has party walls on both sides, and only a small amount of external wall and glazing. A change in orientation can have a large effect on the result. Both Brisbane and Adelaide have changes of over 1 star between different orientations.

The dwelling performs consistently better with the front door facing north. Most of the glazing is facing the same direction as the front door, so having the front door facing north maximises the north-facing glazing.

There is not such a clear trend for the lowest rating orientation, though Darwin and Brisbane perform worse when the front door is facing east, due to the extensive heat gains when oriented in this direction. Elsewhere the lowest rating orientation differs.

Dwelling Number: 15 Dwelling Type: Semi-detached (Two Shared Walls)

Dwelling 15 achieves a 6 star rating in only one orientation in Canberra, while the results fall below 4 stars in both Brisbane and Sydney. High performance glazing has been used in all locations.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

Dwelling 15 has been redesigned in all capital cities with the front door facing north. Firstly, standard redesign changes have been applied to all capital cities. This involves reductions in glazing, with a strong focus on the main internal courtyard. Reduced glazing to the main internal courtyard has limited heat losses and gains to the main living areas.

Secondarily, climate specific changes have been made in each of the three climate types. In the hottest climate, Darwin, a ceiling fan has been added to the main living area to increase air movement in the daytime occupancy zone with the highest cooling requirements. In the hot and temperate climates the floor covering has been changed to a hard surface in the main living/ dining area, while in the cold climates the addition of an internal door has been used to reduce the conditioned area.

Revised Specifications and Star Rating Results

Tables 15.6.1 and 15.6.2 show the final specifications for the dwelling and Table 15.7 shows the glazing comparison between the initial and redesigned dwelling. Table 15.8 shows the star rating results and cost savings.

Table 15.6.1: Specifications for redesigned Dwelling 15 in each capital city.

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

Table 15.6.2: Specifications for redesigned Dwelling 15 in each capital city (continued).

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

Table 15.7: Glazing comparison between initial design and redesign for Dwelling 15.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	32.0	20.2	36.9
Brisbane	32.0	20.2	36.9
Perth	32.0	20.2	36.9
Sydney	32.0	20.2	36.9
Adelaide	32.0	20.2	36.9
Canberra	32.0	20.2	36.9
Melbourne	32.0	20.2	36.9
Hobart	32.0	20.2	36.9

Table 15.8: Redesigned Dwelling 15 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	263,081	2,594	1.0	North	6.2	0.8
Brisbane	290,156	3,204	1.1	North	6.3	1.1
Perth	275,409	1,498	0.5	North	6.2	1.3
Sydney	239,789	-110	-0.1	North	6.1	1.3
Adelaide	223,427	1,568	0.7	North	6.0	0.1
Canberra	218,597	2,570	1.2	North	6.2	-0.1
Melbourne	211,388	680	0.3	North	6.1	1.0
Hobart	218,062	1,939	0.9	North	6.4	1.3

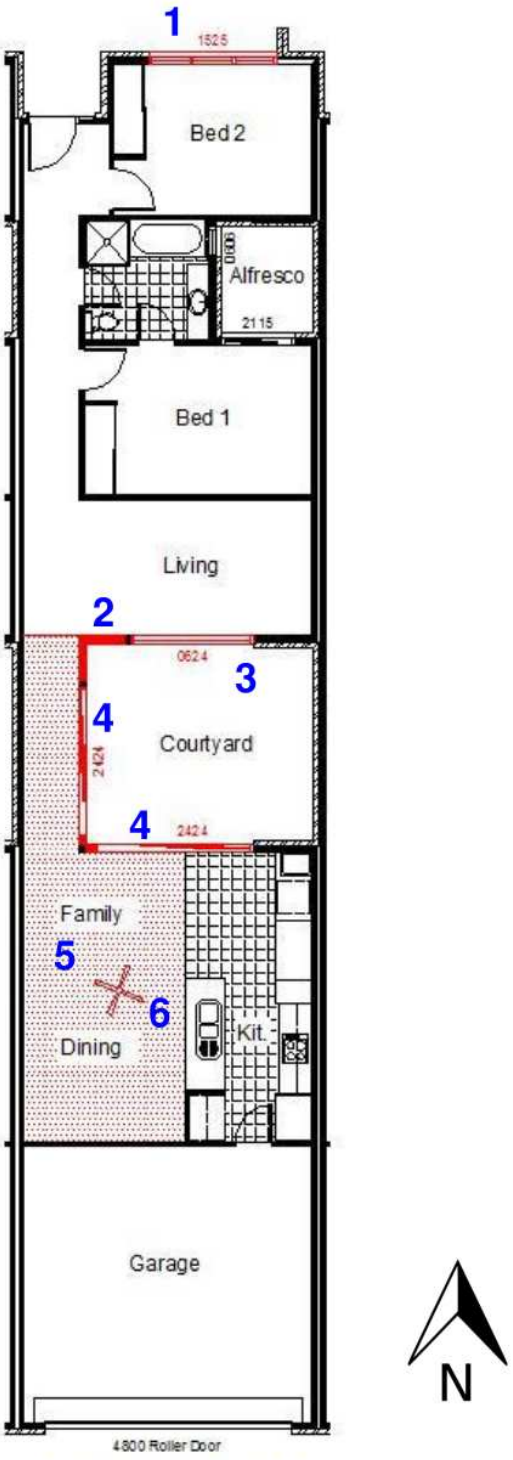
Performance of Redesigned Dwelling

The redesigned dwelling achieved 6 to 6.4 stars across all climates, with a star rating change ranging from -0.1 in Canberra where it was already meeting 6 stars to 1.3 in Perth and Sydney. The glazing was reduced by 36.9% in all locations, having a large impact on the star ratings and cost savings.

While the redesigned dwelling achieves over 6 stars in all locations, the redesign changes reduced glazing specifications from high performance to 3mm clear in all capital cities. This provided a significant cost saving, particularly in Adelaide, Canberra and Hobart.

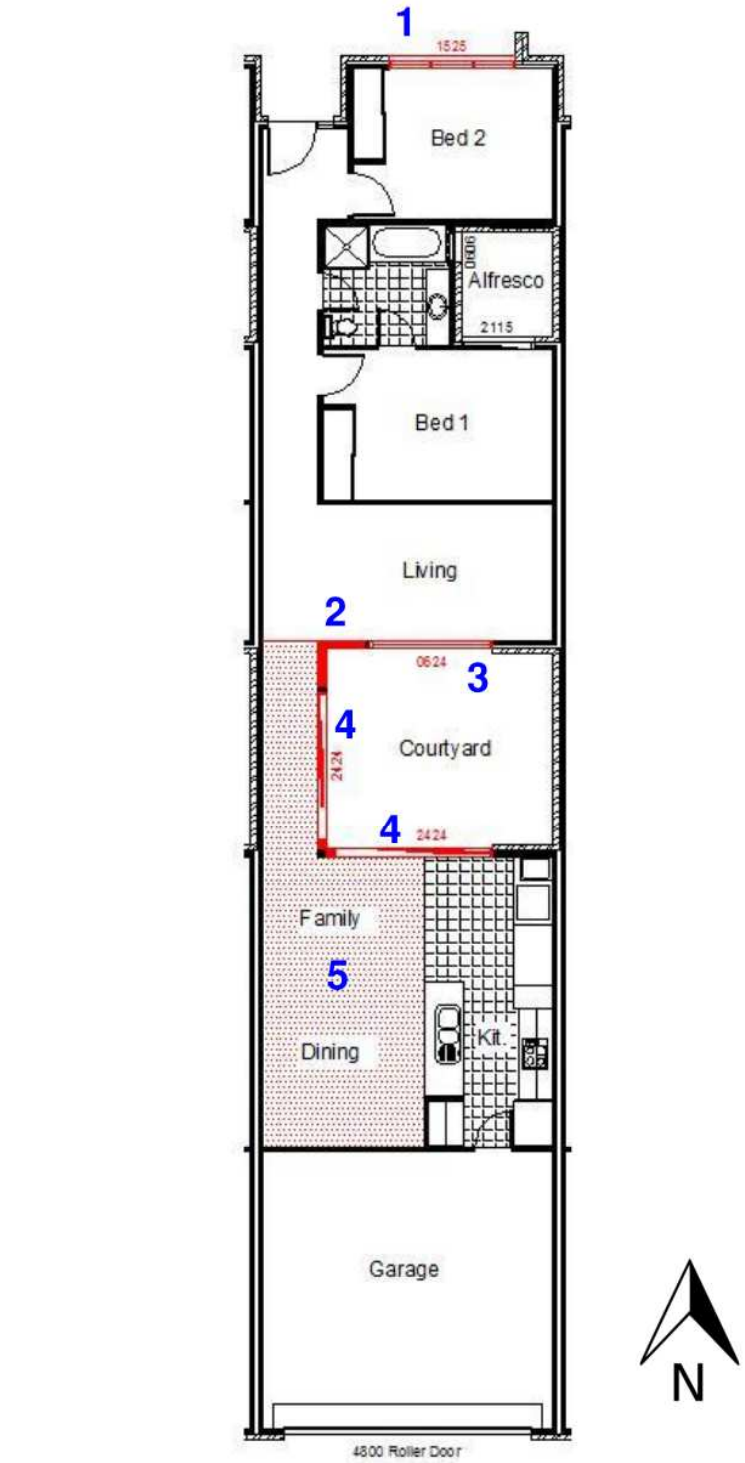
Melbourne, Sydney and Perth did not have double glazing initially, and have smaller cost savings as a result. Sydney is the only location with a negative cost saving, though the star rating of the dwelling in this location has improved by 1.3 stars, and the cost of the redesign is only around 0.1%. Canberra is the only location with a negative star rating change, due to its high initial results, but it has a higher cost saving than in other capital cities as a result of the redesign at 1.2%.

The highest cost savings are in Darwin and Brisbane, where reduced glazing specifications and effective redesign caused significant cost savings and increased star ratings.



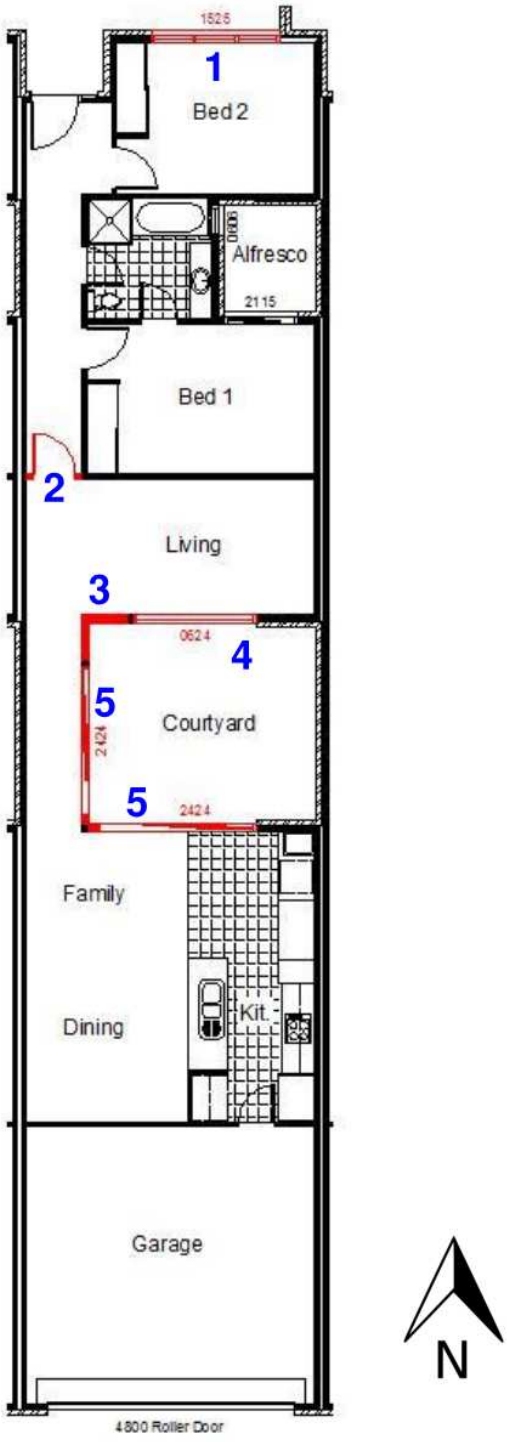
1. Reduce Bed 2 window to 1.5m high.
2. Remove courtyard corner fixed windows.
3. Replace glass door with 0.6x2.4m window.
4. Reduce glass sliding doors to 2.4m wide.
5. Change floor covering in Family and Dining from carpet to vinyl.
6. Add 1200mm ceiling fan to Dining.

Figure 15.2: Redesigned floor plan for Dwelling 15 in Darwin.



1. Reduce Bed 2 window to 1.5m high.
2. Remove courtyard corner fixed windows.
3. Replace glass door with 0.6x2.4m window.
4. Reduce glass sliding doors to 2.4m wide.
5. Change floor covering in Family and Dining from carpet to vinyl.

Figure 15.3: Redesigned floor plan for Dwelling 15 in Brisbane, Perth, Sydney & Adelaide.



1. Reduce Bed 2 window to 1.5m high.
2. Add internal door between Entry/corridor and Living.
3. Remove courtyard corner fixed windows.
4. Replace glass door with 0.6x2.4m window.
5. Reduce glass sliding doors to 2.4m wide.

Figure 15.4: Redesigned floor plan for Dwelling 15 in Canberra, Melbourne and Hobart.

Dwelling 16: Review of Original Dwelling Design in All Capital Cities

Table 16.1: Summary of Dwelling 16 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	3	-	2	-

Table 16.2: Dwelling 16 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m^2)
Living	Yes	22
Living/ Kitchen	Yes	39
Bedrooms	Yes	52
Corridor, Bathroom and Laundry	Yes	39
Storage	No	5
Verandah	No	11
	TOTAL	168

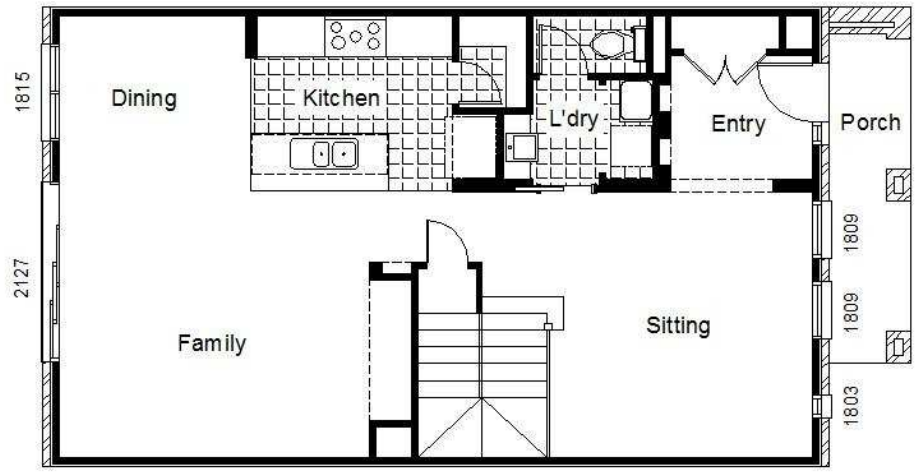


Figure 16.1: Dwelling 16 ground floor plan for original design.

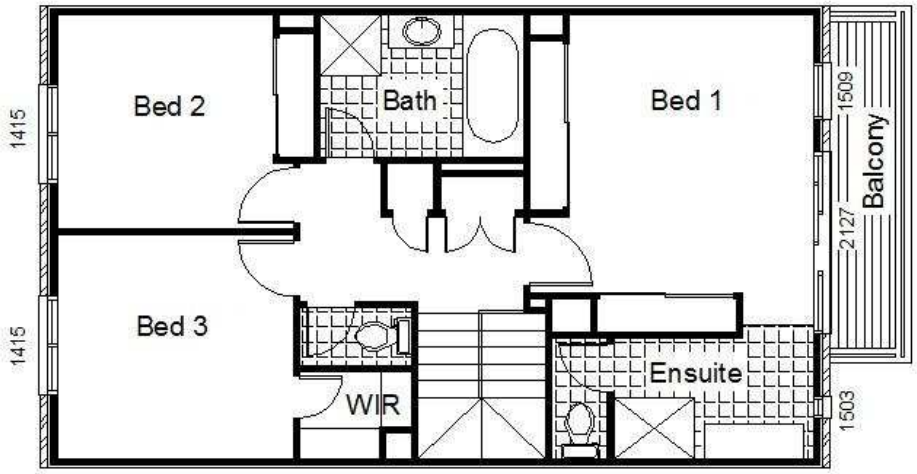


Figure 16.2: Dwelling 16 first floor plan for original design.

Dwelling Description

Dwelling 16 is a small double storey semi-detached residence, with adjoining dwellings on either side. It has an open plan dining/family and kitchen area downstairs, along with a sitting room, and upstairs it has three bedrooms, as well as a bathroom. The external walls are a typical brick veneer construction, and the roof is a flat metal construction on a 2 degree pitch. The glazing is evenly distributed across the two facades available, with similar glazed areas to both the front and the rear. The window to floor area ratio is approximately 15%. The dwelling has no eaves, but there is a 1.2m balcony to the second floor that also shades the entry on the lower floor.

Initial Specifications and Star Rating Results

Tables 16.1 and 16.2 describe the zoning of Dwelling 16, while Table 16.3 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 16.4, with Table 16.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 16.3: Dwelling 16 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
Window frames	Front facade	Cedar
	Everywhere else	Aluminium
Roof	-	Metal deck
Eaves	-	None

Table 16.4: Specifications for original design of Dwelling 16 in each capital city.

			House Insulation		
Capital City	Glazing	Roof sisalation	Ceiling	External walls	Internal walls
Darwin	3mm clear	Yes	R2.0	R1.5	None
Brisbane	3mm clear	Yes	R2.0	R1.5	None
Perth	3mm clear	No	R3.5	R1.5	None
Sydney	3mm clear	No	R3.5	R1.5	None
Adelaide	3mm clear	No	R3.5	R1.5	None
Canberra	3mm clear	No	R3.5	R1.5	None
Melbourne	3mm clear	No	R3.5	R1.5	None
Hobart	3mm clear	No	R3.5	R1.5	None

Table 16.5: Star rating in four cardinal orientations and cost for original design of Dwelling 16 in each capital city (orientation according to direction of front door).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	347,596	6.2	5.2	5.9	5.2
Brisbane	382,946	6.7	3.4	4.2	5.3
Perth	362,254	7.3	5.7	6.9	5.1
Sydney	315,132	7.5	6.3	7.0	6.0
Adelaide	294,516	7.6	6.6	7.4	6.6
Canberra	288,984	7.4	6.9	7.5	7.1
Melbourne	279,790	7.5	7.1	7.5	7.2
Hobart	286,738	7.6	7.4	7.7	7.6

Performance of Original Design

As a semi-detached dwelling with two shared walls, Dwelling 16 rates very highly in at least one orientation in all capital cities, achieving a maximum star rating in each city ranging from 6.2 to 7.7. In the cold climates this dwelling rates highest, where the minimum rating is 6.9 stars in any of the assessed orientations.

The good thermal performance of this dwelling can be attributed to the effect of two shared walls which, for simulation purposes, prevent heat loss or gain. This effect is most pronounced in the colder climates.

There is a large amount of variation between different orientations in the hot and temperate climates due to the fact that this dwelling only has glazing on two facades.

The dwelling achieves the highest star ratings when the front door is facing either north or south, as this orients all of the glazing to the north and south, to varying extents. When the dwelling has the front door to the east or the west, it performs worse in all locations.
The lowest rating orientation is with the front door to the east in Brisbane, as the dwelling then receives far too much heat.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

Due to the high initial star rating achieved by Dwelling 16 in most capital cities, redesign was only undertaken for the climates which achieved less than 6 stars: Darwin, Brisbane and Perth. Dwelling 16 was redesigned in the lowest rating orientation with all glazing facing east and west.

In Darwin, the floor covering to the Dining/Family area was changed to vinyl, and the front and rear glazing was reduced to minimise heat gains. In addition to this, a general 10% reduction in glazing was applied across the board, to further decrease the east and west-facing glazing.

In Brisbane, similar changes were made, including the 10% glazing reduction across the board. In addition to this, ceiling fans were included to the Family, Sitting and Bed 1 in order to encourage air ventilation through these areas.

In Perth, the only required change was a small reduction to a few windows, and the general 10% reduction to glazing across the board was not applied.

Revised Specifications and Star Rating Results

Table 16.6 shows the final specifications for the dwelling and Table 16.7 shows the glazing comparison between the initial and redesigned dwelling. Table 16.8 shows the star rating results and cost savings.

Table 16.6.1: Specifications for redesigned Dwelling 16 in each capital city.

Capital City	Glazing	Window reduction %	Roof sisalation	Roof solar absorpt. (%)	Floor covering change
Darwin	3mm clear	10	No	30	Vinyl
Brisbane	3mm clear	10	No	30	Vinyl
Perth	3mm clear	None	No	30	None
Sydney	Not redesigned				
Adelaide	Not redesigned				
Canberra	Not redesigned				
Melbourne	Not redesigned				
Hobart	Not redesigned				

Table 16.6.2: Specifications for redesigned Dwelling 16 in each capital city (continued).

	Insulation		
Capital City	Ceiling	External walls	Internal walls
Darwin	R2.0	R1.5	None
Brisbane	R2.0	R1.5	None
Perth	R3.5	R1.5	None
Sydney	Not redesigned		
Adelaide	Not redesigned		
Canberra	Not redesigned		
Melbourne	Not redesigned		
Hobart	Not redesigned		

Table 16.7: Glazing comparison between initial design and redesign for Dwelling 16.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	14.6	10.5	27.8
Brisbane	14.6	10	31.6
Perth	14.6	12.3	15.6
Sydney	Not redesigned		
Adelaide	Not redesigned		
Canberra	Not redesigned		
Melbourne	Not redesigned		
Hobart	Not redesigned		

Table 16.8: Redesigned Dwelling 16 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	346,221	1375	0.4	East	6.2	1.0
Brisbane	382,723	223	0.1	East	6.2	2.8
Perth	361,281	973	0.3	West	6.5	1.4
Sydney	Not redesigned					
Adelaide	Not redesigned					
Canberra	Not redesigned					
Melbourne	Not redesigned					
Hobart	Not redesigned					

Performance of Redesigned Dwelling

The effects of the design changes in terms of star rating are positive in each case, but the biggest improvement can be seen in Brisbane, which gained 2.8 stars as a result of the changes, and a very small cost saving. Glazing reductions ranged from 15.6% to 31.6%.

Darwin has the largest cost saving, of 0.4% of the initial design cost, but the change in star rating is the least of the three. It has still gained 1 star, however.

Brisbane has the biggest star rating difference, though it also has the smallest cost saving. This is due to the installation of three ceiling fans, which reduces the cost saving in comparison with Darwin, in addition to the same glazing reductions and floor covering changes.

Perth requires the least amount of changes, but the glazing reduction still results in a cost saving and a 1.4 star increase in energy rating.

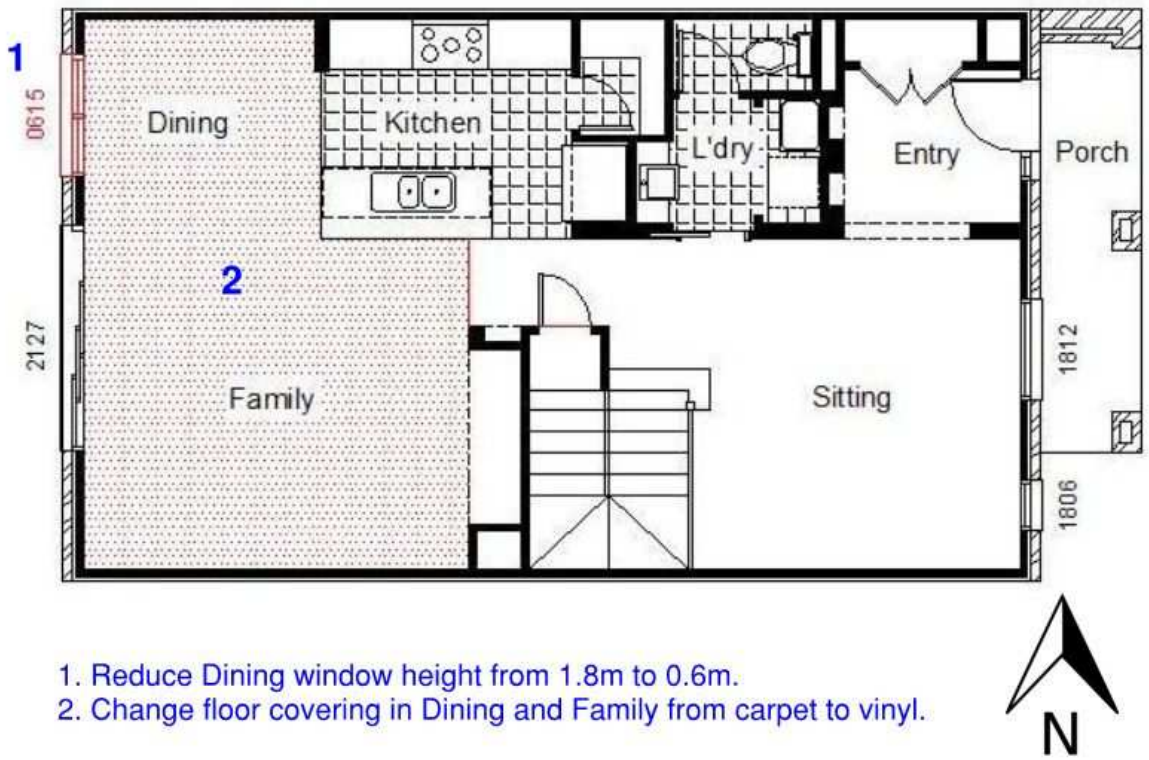


Figure 16.3: Redesigned ground floor plan for Dwelling 16 in Darwin.

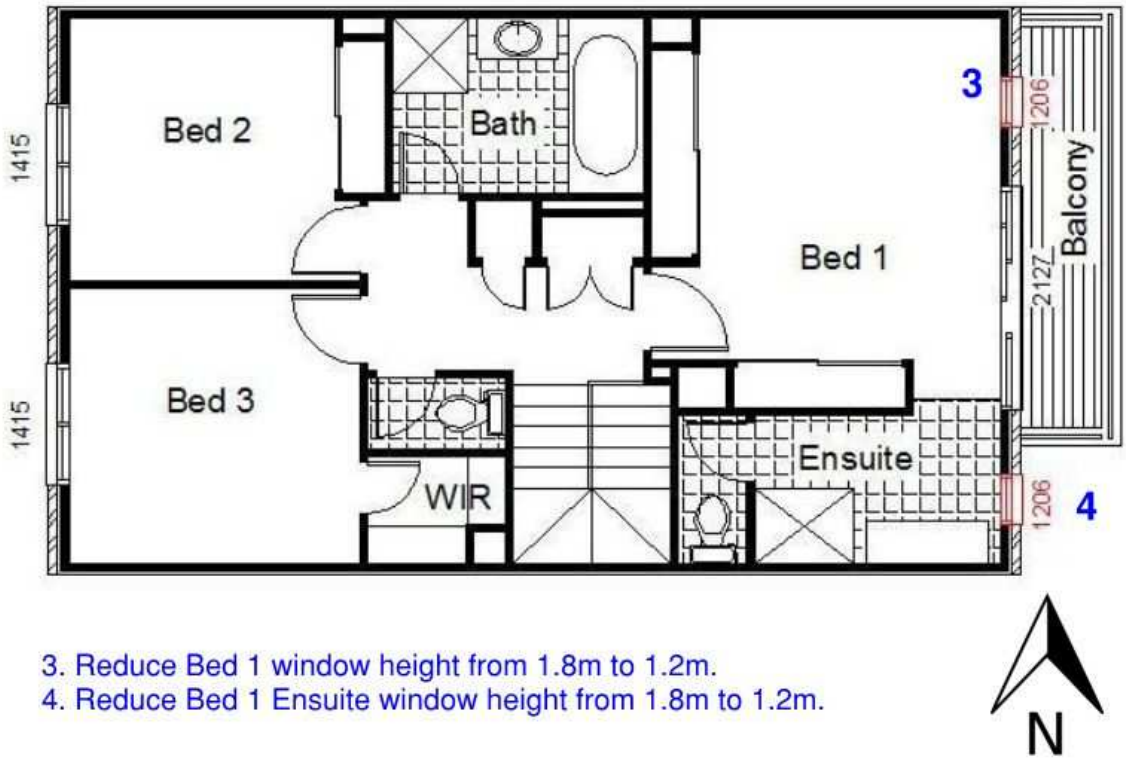


Figure 16.4: Redesigned first floor plan for Dwelling 16 in Darwin.

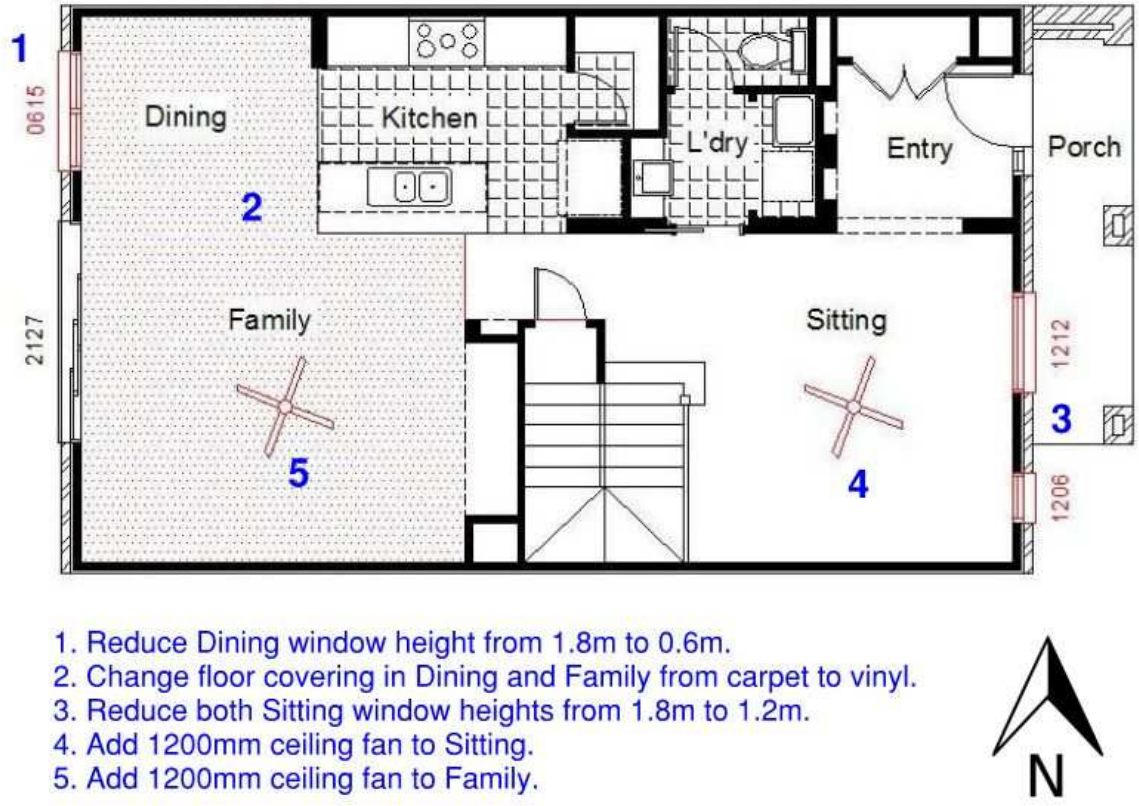


Figure 16.5: Redesigned ground floor plan for Dwelling 16 in Brisbane.

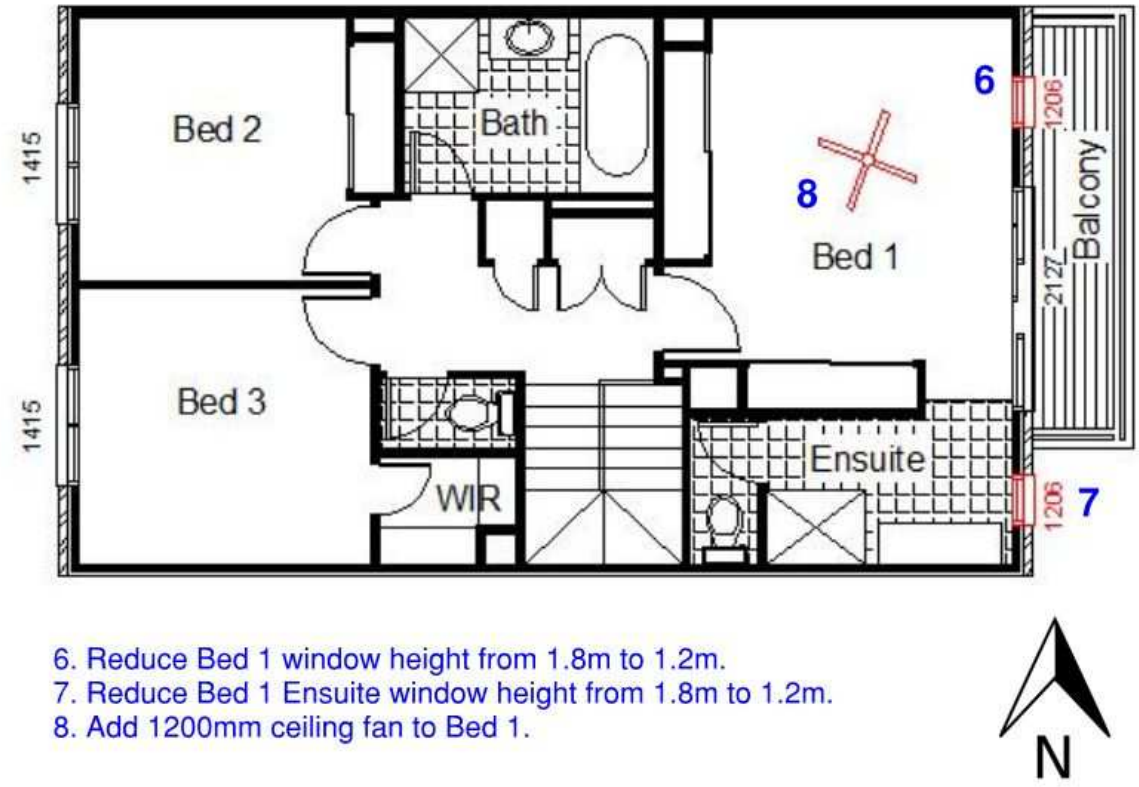


Figure 16.6: Redesigned first floor plan for Dwelling 16 in Brisbane.

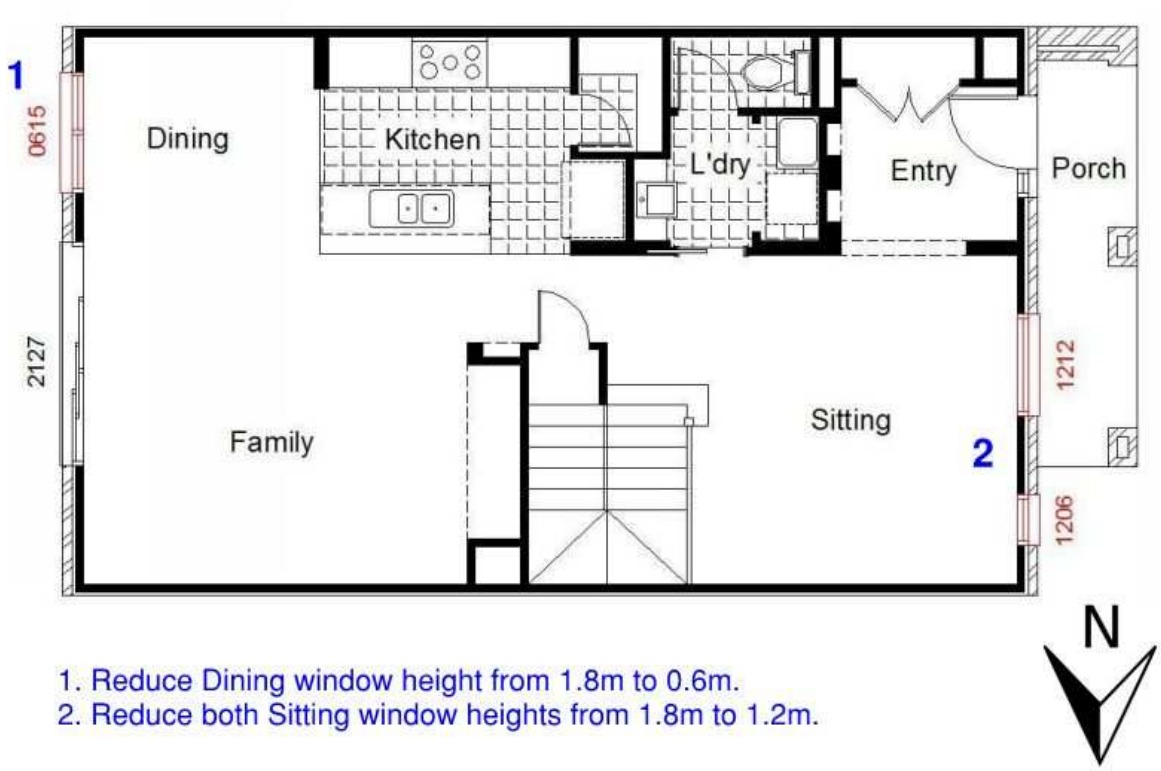


Figure 16.7: Redesigned ground floor plan for Dwelling 16 in Perth.

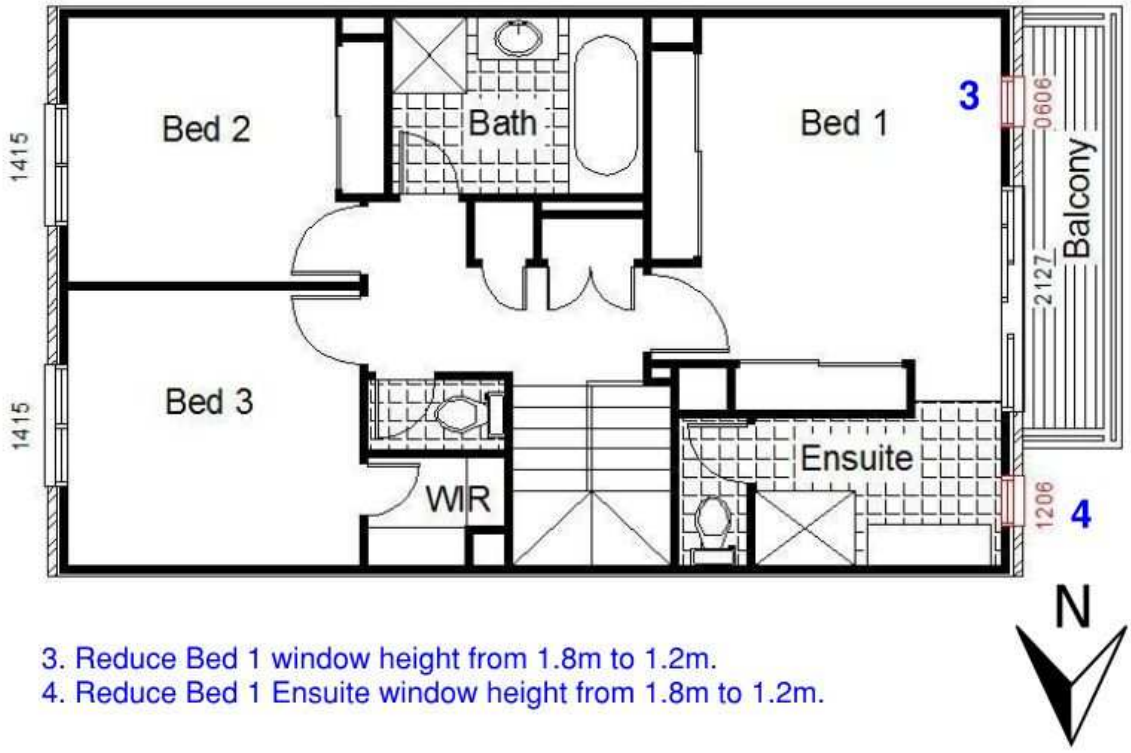


Figure 16.8: Redesigned first floor plan for Dwelling 16 in Perth

Dwelling 17: Review of Original Dwelling Design in All Capital Cities

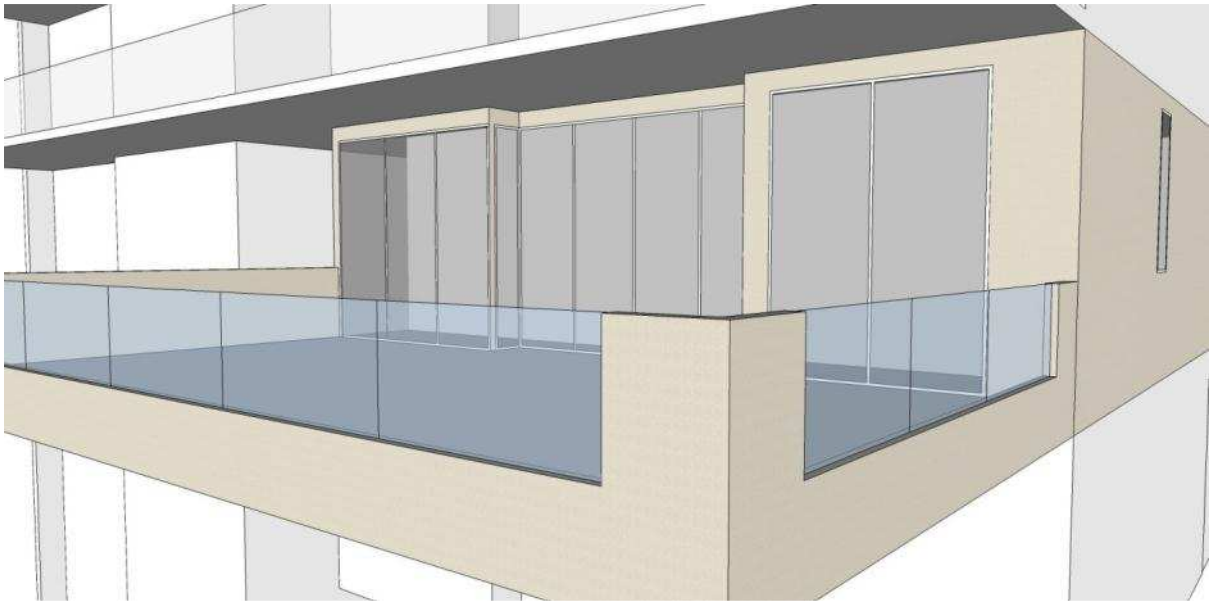


Table 17.1: Summary of Dwelling 17 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
2	2	-	1	-

Table 17.2: Dwelling 17 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	39
Bedrooms	Yes	36
Bathroom	Yes	4
Laundry	No	3
Verandah	No	18
	TOTAL	100

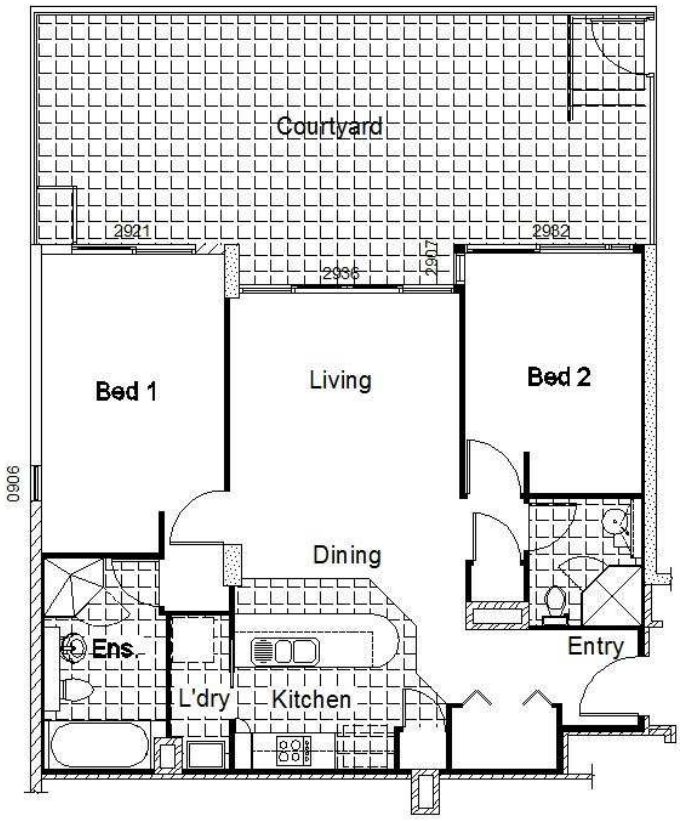


Figure 17.1: Dwelling 17 floor plan for original design.

Dwelling Description

Dwelling 17 is a two bedroom apartment, with an open plan living/dining and kitchen area. Its external walls are a concrete block construction, and it is surrounded on three sides by other apartments or communal areas. The glazing mainly faces the direction of the main external wall, as is to be expected, though there is a very small amount facing to the side. The window to floor area ratio is approximately 34%. The apartment faces onto a courtyard, which is shaded by the courtyard of the apartment above.

Initial Specifications and Star Rating Results

Tables 17.1 and 17.2 describe the zoning of Dwelling 17, while Table 18.3 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 17.4, with Table 17.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 17.3: Dwelling 17 construction details.

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	Suspended concrete
External walls	-	Concrete: 190mm concrete + air gap + 10mm plasterboard
Ceiling	-	100mm concrete slab + 10mm plasterboard

Table 17.4: Specifications for original design of Dwelling 17 in each capital city.

		Insulation	
Capital City	Glazing	External walls	Internal walls
Darwin	3mm clear	R1.5	None
Brisbane	3mm clear	R1.5	None
Perth	3mm clear	R1.5	None
Sydney	3mm clear	R1.5	None
Adelaide	3mm clear	R1.5	None
Canberra	3mm clear	R1.5	None
Melbourne	3mm clear	R1.5	None
Hobart	3mm clear	R1.5	None

Table 17.5: Star rating in four cardinal orientations and cost for original design of Dwelling 17 in each capital city (orientation according to direction of the main glazing).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	225,559	5.7	4.2	5.6	4.8
Brisbane	248,497	5.7	4.5	5.4	3.1
Perth	235,117	7.9	6.8	6.8	5.7
Sydney	204,532	8.2	7.2	6.3	6.0
Adelaide	194,308	7.5	6.6	6.7	6.0
Canberra	187,583	7.8	7.2	6.5	6.4
Melbourne	181,594	7.5	7.2	6.5	6.5
Hobart	187,329	7.7	7.5	6.8	7.0

Performance of Original Design

Dwelling 17 has a large amount of variation between orientations in each location, as changing the orientation changes the direction that most of the glazing is facing. The warmer climates perform worse with the glazing facing east and west, and the dwelling performs much better in every single location if the glazing if facing north. In Sydney, the dwelling achieves 8.2 stars when the glazing is facing north.

Dwelling 17 performs worse in most climates when the glazing is facing west, which maximises unwanted heat gains. The exception is Darwin, where having the glazing facing east results in lower star ratings, due to the year round heat gains of east-facing glazing.

The lower star ratings in the hot climates are due to the fact that the dwelling has too much glazing, which is gaining heat despite being shaded. The dwelling lacks cross flow ventilation to cool it in the warmer locations.

The higher star ratings in all other climates are due to the compact nature of the design, and the fact that it is surrounded by other conditioned dwellings.

With results varying from 3.1 stars to 8.2, this apartment is mainly affected by orientation.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

The dwelling has only been redesigned in Darwin and Brisbane, as the dwelling achieved initial high results in the other locations

In Darwin, the redesign has been undertaken with the glazing facing east. The dwelling has been redesigned with ceiling fans to the living area and to both bedrooms, in order to maximise air flow through the habitable areas of the dwelling. The glazing to the main living area has also been reduced in order to minimise the heat gains through this large area of glazing.

In Brisbane, the redesign has been undertaken with the glazing facing west, and window reductions have been applied to the main living area and to Bed 2, in order to cut down on heat gains to this area. The glazing type in Brisbane has been updated to a 5mm Evergreen system, with awning shading included, in order to cut down further on heat gains through the glazing.

Revised Specifications and Star Rating Results

Table 17.6 shows the final specifications for the dwelling and Table 17.7 shows the glazing comparison between the initial and redesigned dwelling. Table 17.8 shows the star rating results and cost savings.

Table 17.6: Specifications for redesigned Dwelling 17 in each capital city.

Capital City	Glazing	Additional window reduction %	Awning	Insulation	
				External walls	Internal walls
Darwin	3mm clear	None	To Living sliding door	R1.5	R1.5
Brisbane	5mm EverGreen	10	To Living sliding door	R1.5	None
Perth	Not redesigned				
Sydney	Not redesigned				
Adelaide	Not redesigned				
Canberra	Not redesigned				
Melbourne	Not redesigned				
Hobart	Not redesigned				

Table 17.7: Glazing comparison between initial design and redesign for Dwelling 17.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	34.4	27.5	20.2
Brisbane	34.4	24.7	28.2
Perth	Not redesigned		
Sydney	Not redesigned		
Adelaide	Not redesigned		
Canberra	Not redesigned		
Melbourne	Not redesigned		
Hobart	Not redesigned		

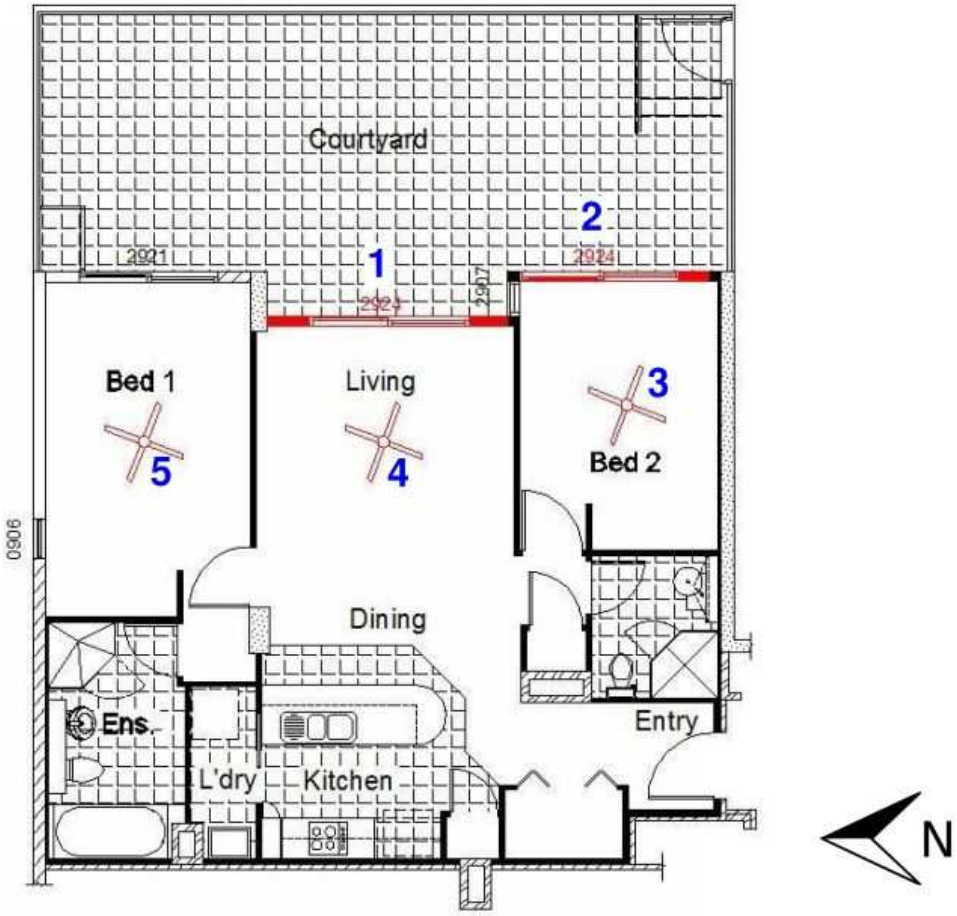
Table 17.8: Redesigned Dwelling 17 star rating and cost comparison in selected orientations in each capital city.

Capital City	Cost ($)	Cost saving ($)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	229,870	-4,311	-1.9	East	6.0	1.8
Brisbane	249,994	-1,497	-0.6	West	6.1	3.0
Perth	Not redesigned					
Sydney	Not redesigned					
Adelaide	Not redesigned					
Canberra	Not redesigned					
Melbourne	Not redesigned					
Hobart	Not redesigned					

Performance of Redesigned Dwelling

With initial star ratings of 4.2 and 3.1 stars respectively, the redesign to Darwin and Brisbane has had a large impact on the star rating of the dwelling in these locations. It has also, however, had a negative impact on the cost of these dwellings, with the redesign causing the dwelling in both locations to cost more than initially. This is due to the inclusion of ceiling fans and internal wall insulation in Darwin, and an improved glazing system to Brisbane.

As has been seen in the initial assessment of the dwelling, this one is mostly affected by orientation, and smart orientation of the dwelling is the best way to get it to achieve the required rating, but improvements to the glazing size, type and shading can improve the star rating at minimal cost.



1. Reduce Living eastern glazing from 3.6m to 2.4m wide.
2. Reduce Bed 2 eastern glazing from 3.2m to 2.4m wide.
3. Add 1200mm ceiling fan to Bed 2.
4. Add 1200mm ceiling fan to Living.
5. Add 1200mm ceiling fan to Bed 1.

Figure 17.2: Redesigned floor plan for Dwelling 17 in Darwin.

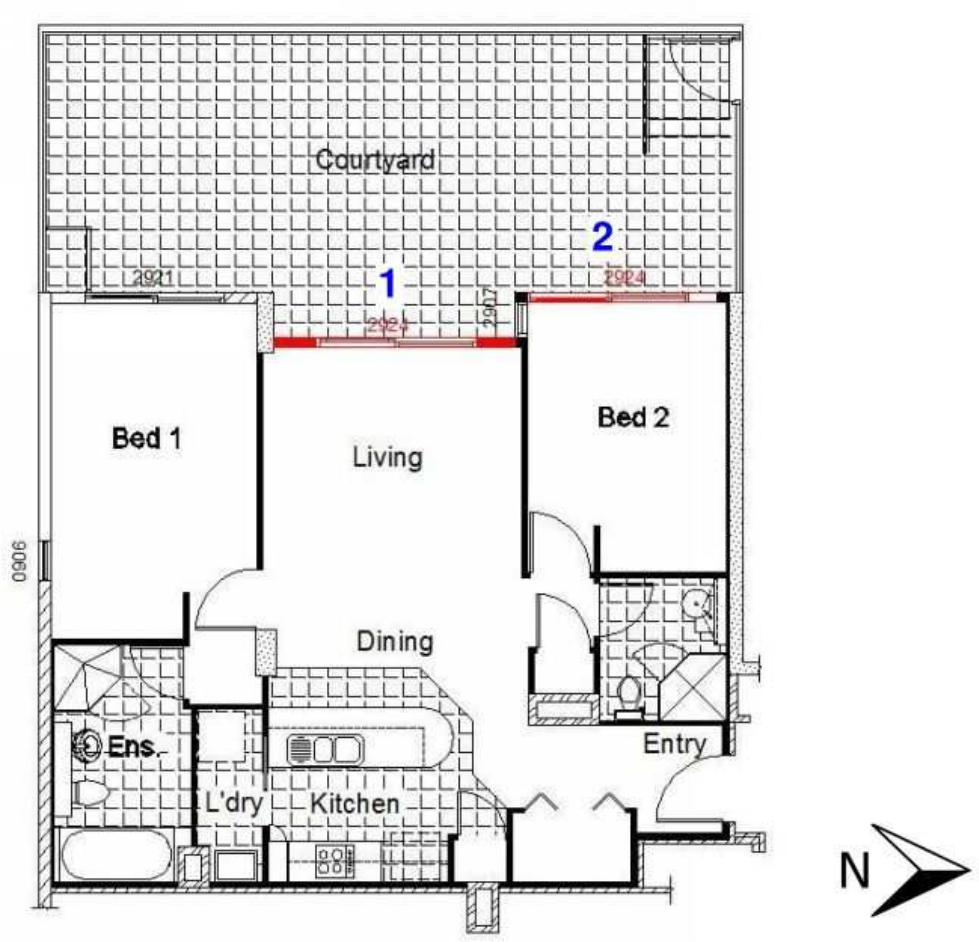


Figure 17.3: Redesigned floor plan for Dwelling 17 in Brisbane.

Dwelling 18: Review of Original Dwelling Design in All Capital Cities

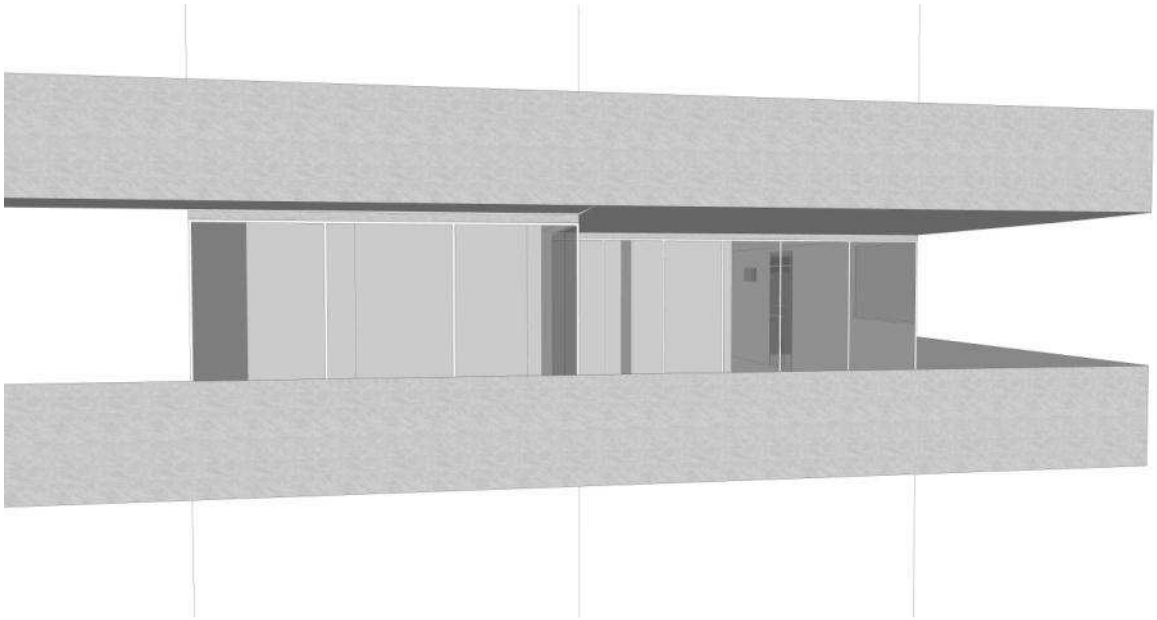


Table 18.1: Summary of Dwelling 18 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	1	1	-

Table 18.2: Dwelling 18 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	64
Bedrooms	Yes	69
Corridor	Yes	10
Main Bathroom & Laundry	No	14
Verandah	No	28
	TOTAL	185

Figure 18.1: Dwelling 18 floor plan for original design.

Dwelling Description

Dwelling 18 is a three bedroom apartment, with an open plan dining/living and kitchen area and a small study nook. The external walls are constructed from concrete block, and the apartment is surrounded on two sides by other apartments and communal areas. The window to floor area ratio is approximately 40%. Throughout this report, the dwelling has been orientated with reference to the large glazing to the Dining/Living area, unlike dwellings other than apartments which were orientated according to the direction of the front door. For this dwelling north-facing was considered to be with the balcony orientated to the north, which is also the top of the page in Figure 18.1.

Initial Specifications and Star Rating Results

Tables 18.1 and 18.2 describe the zoning of Dwelling 18, while Table 18.3 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 18.4, with Table 18.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 18.3: Dwelling 18 construction details.

Construction	Type	Details
Ceiling height	-	2.6m
Floors	-	Suspended concrete
External walls	-	Concrete: 190mm or 200mm concrete block + air gap + 10mm plasterboard
Ceiling	-	100mm concrete slab + 10mm plasterboard

Table 18.4: Specifications for original design of Dwelling 18 in each capital city.

		Insulation	
Capital City	Glazing	External walls	Internal walls
Darwin	3mm clear	R1.5	None
Brisbane	3mm clear	R1.5	None
Perth	3mm clear	R1.5	None
Sydney	3mm clear	R1.5	None
Adelaide	6.38mm ComfortPlus Neutral	R1.5	None
Canberra	3mm clear	R1.5	None
Melbourne	3mm clear	R1.5	None
Hobart	3mm clear	R1.5	None

Table 18.5: Star rating in four cardinal orientations and cost for original design of Dwelling 18 in each capital city (orientation according to direction of the main glazing).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	434,743	5.4	5.3	5.2	5.2
Brisbane	478,954	4.4	4.9	4.9	4.0
Perth	453,164	5.7	6.3	6.2	5.6
Sydney	394,216	5.8	6.7	6.2	5.4
Adelaide	377,147	6.3	6.8	6.5	6.1
Canberra	361,356	5.4	6.1	5.8	5.3
Melbourne	350,005	5.6	5.9	5.8	5.4
Hobart	361,058	6.1	6.3	6.2	5.9

Performance of Original Design

Dwelling 18 has glazing to all but one facade, and therefore has similar results across orientations in each location.

The dwelling performs better in the eastern orientation in almost every location, as this provides the dwelling with north-facing unshaded glazing, and shaded east-facing glazing. Darwin performs better in the northern orientation, which minimises eastern exposure.

In general, lower star ratings in the hotter climates are due to a lack of air movement through the dwelling, and too much heat gain due to unshaded glazing.

In the temperate and colder climates, the dwelling achieves higher star ratings as it requires the heat gains through the unshaded windows during the colder months, and the insulative effects of the shared walls, ceilings and floors have a positive impact.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

To cut down on the heat gains to this dwelling, the redesign focuses on reducing glazing in all locations. There are limited improvement options in an apartment, where changes to eaves and floor plans are not possible.

In Darwin, the dwelling has been redesigned with the main glazing facing north, and the window reductions have focused on removing and reducing as much east-facing glazing as possible in order to cut down on heat gains to the dwelling.

In all other climates, the dwelling has been redesigned with the main glazing facing west, and the focus of the redesign has been reducing glazing to that west-facing facade, with the south-facing Dining window also removed. Brisbane also has a ceiling fan included to increase air movement.

Revised Specifications and Star Rating Results

Table 18.6 shows the final specifications for the dwelling and Table 18.7 shows the glazing comparison between the initial and redesigned dwelling. Table 18.8 shows the star rating results and cost savings.

Table 18.6: Specifications for redesigned Dwelling 18 in each capital city.

Capital City	Glazing	Insulation	
		External walls	Internal walls
Darwin	3mm clear	R1.5	None
Brisbane	3mm clear	R1.5	None
Perth	3mm clear	R1.5	None
Sydney	3mm clear	R1.5	None
Adelaide	3mm clear	R1.5	None
Canberra	3mm clear	R2.0	None
Melbourne	3mm clear	R2.0	None
Hobart	3mm clear	R2.0	None

Table 18.7: Glazing comparison between initial design and redesign for Dwelling 18.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	39.6	34.6	12.8
Brisbane	39.6	31.7	20.1
Perth	39.6	31.7	20.1
Sydney	39.6	31.7	20.1
Adelaide	39.6	31.7	20.1
Canberra	39.6	31.7	20.1
Melbourne	39.6	31.7	20.1
Hobart	39.6	31.7	20.1

Table 18.8: Redesigned Dwelling 18 star rating and cost comparison in selected orientations in each capital city.

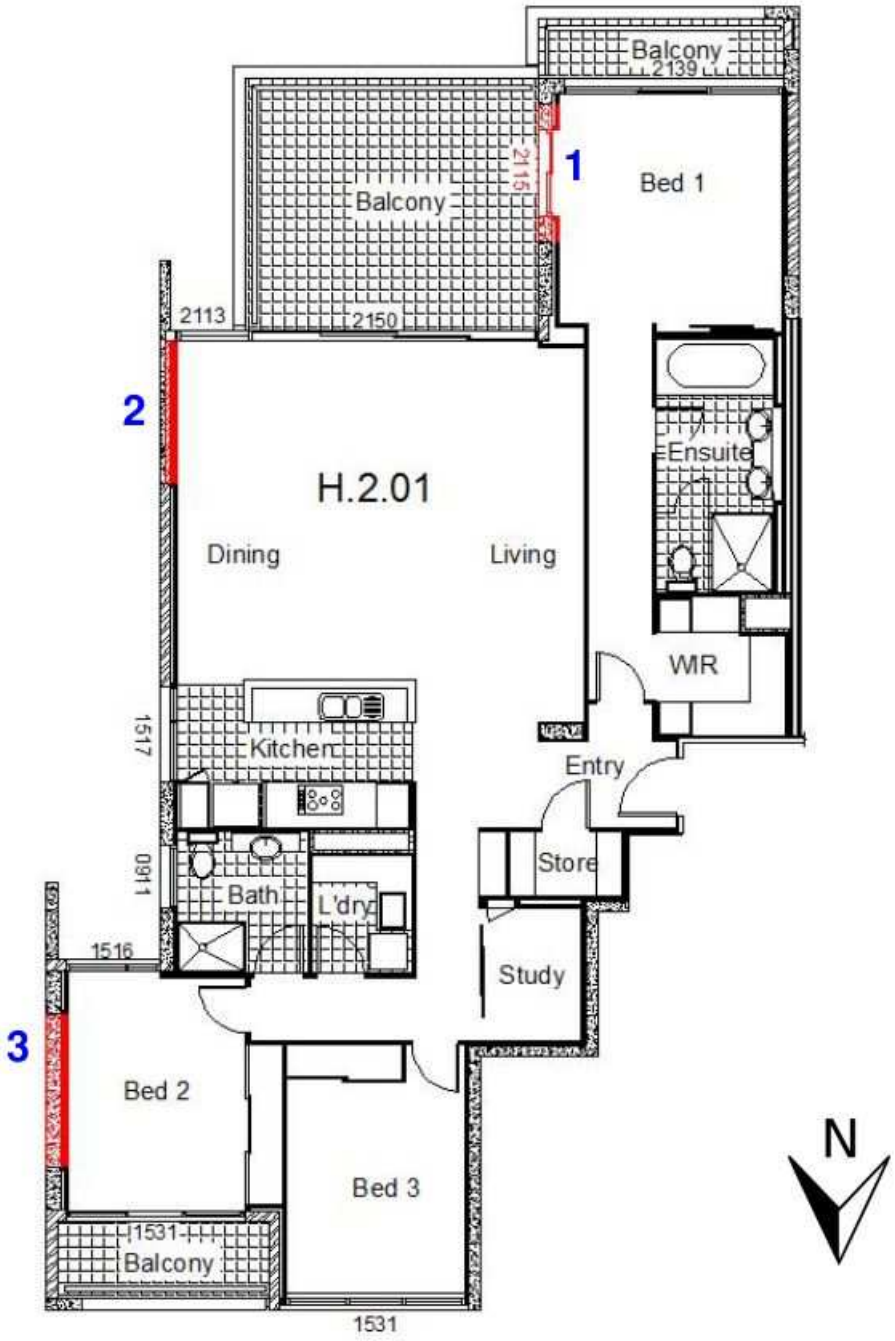
Capital City	Cost ($)	Cost saving ($)	Cost saving (%)	Orientation	Star Rating	Star Rating Change
Darwin	435,333	-590	-0.1	South	6.3	1.1
Brisbane	479,952	-998	-0.2	West	6.1	2.1
Perth	453,780	-616	-0.1	West	6.9	1.3
Sydney	394,751	-535	-0.1	West	6.4	1.0
Adelaide	372,832	4,315	1.1	West	6.2	0.1
Canberra	362,194	-838	-0.2	West	6.2	0.9
Melbourne	350,818	-813	-0.2	West	6.2	0.8
Hobart	361,897	-839	-0.2	West	6.3	0.4

Performance of Redesigned Dwelling

The effect of the redesign, though nothing more than reduction of windows, was positive in terms of star rating change for all locations. The benefit ranged from a 0.1 star change in Adelaide, to a 2.1 star increase in Brisbane.

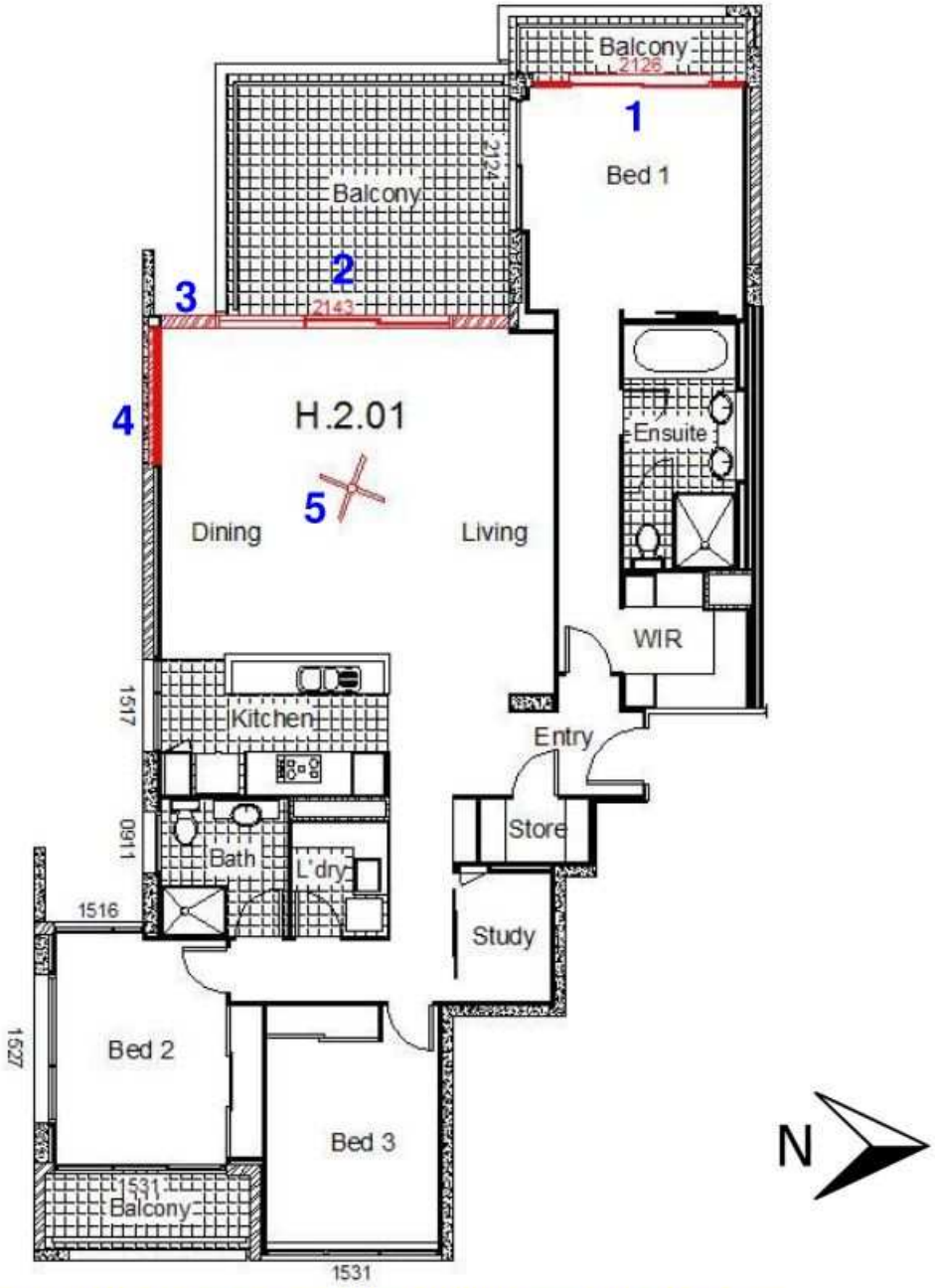
In all locations except for Adelaide, the redesigned dwelling was more expensive than the original dwelling, although cost increases were 0.2% and less in all cases. The concrete external walls are more expensive than 3mm clear glazing and consequently the 12.8% to 20.1% reduction of window area was a cost negative change, but necessary to achieve over 6 stars. The inclusion of increased insulation to cold climates also affected cost savings. Changes to Brisbane increased the redesign cost by 0.2%, but also increased the star rating by 2.1 stars.

In Adelaide there has been a cost saving of 1.1%, due to the beneficial cost saving of removing the ComfortPlus Neutral glazing and changing to a standard glazing system. This change almost negated the energy performance benefit from reducing glazing area, resulting in a star rating increase of 0.1 star, but with a substantial cost saving.



1. Reduce Bed 1 eastern sliding door width from 2.4m to 1.5m.
2. Remove eastern window to Dining/Living.
3. Remove eastern window to Bed 2.

Figure 18.2: Redesigned floor plan for Dwelling 18 in Darwin.



1. Reduce Bed 1 west sliding door width from 3.9m to 2.6m.
2. Reduce Dining/Living west sliding door width from 5.0m to 4.3m.
3. Remove western Dining fixed window.
4. Remove southern window to Dining/Living.
5. Add 1200mm ceiling fan to Dining/Living.

Figure 18.3: Redesigned floor plan for Dwelling 18 in Brisbane.

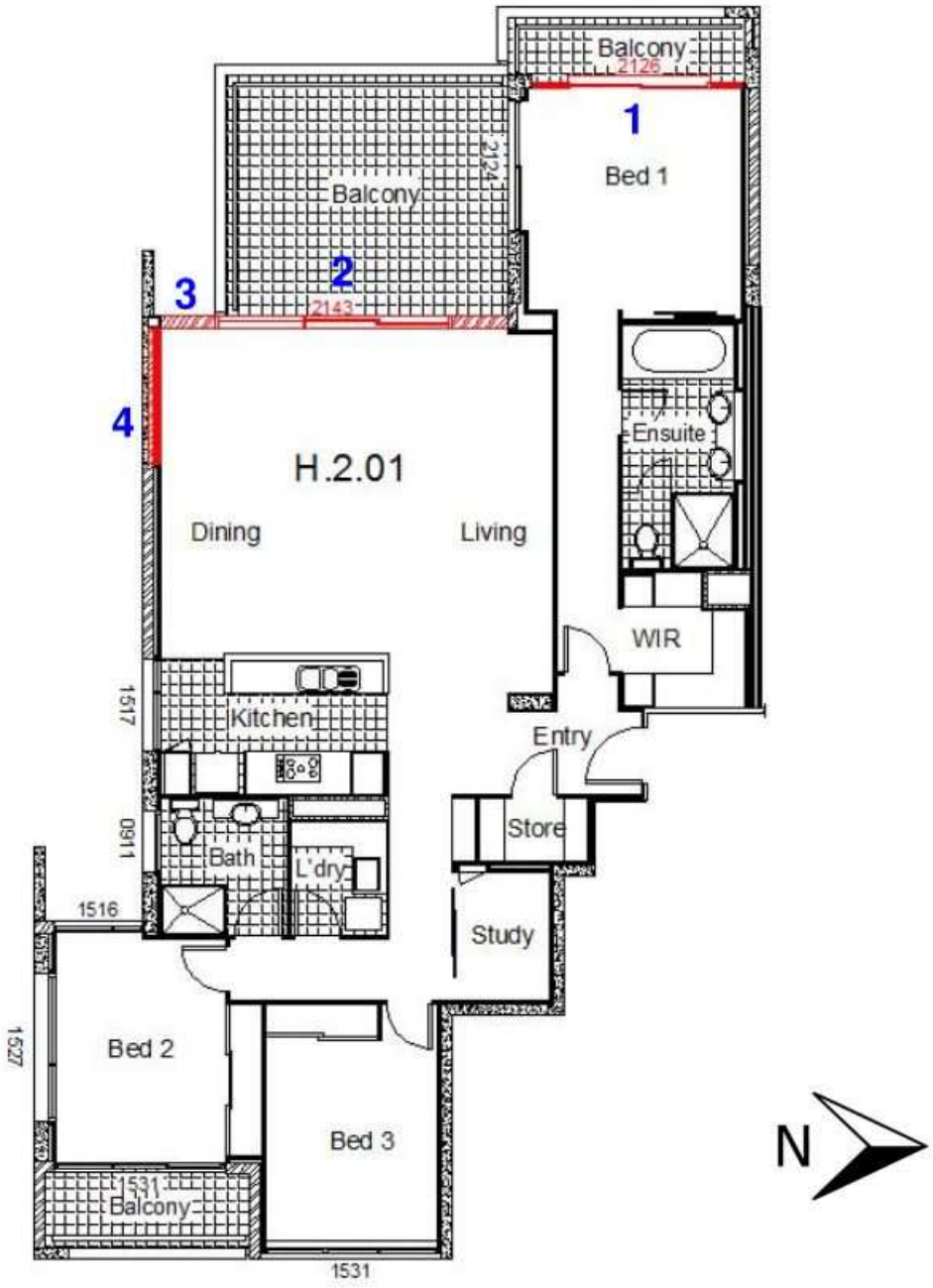


Figure 18.4: Redesigned floor plan for Dwelling 18 in temperate and cold climates, except Brisbane (Perth, Sydney, Adelaide, Canberra, Melbourne and Hobart).

Dwelling 19: Review of Original Dwelling Design in All Capital Cities

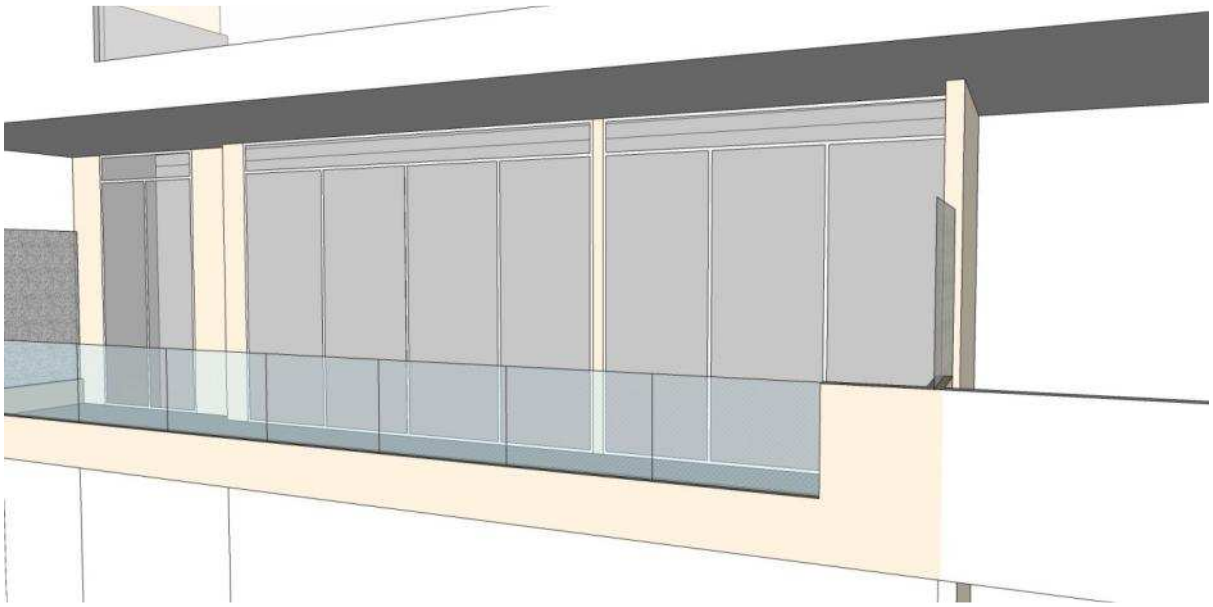


Table 19.1: Summary of Dwelling 19 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
1	2	1	1	-

Table 19.2: Dwelling 19 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	37
Bedroom	Yes	21
Study	Yes	6
Main Bathroom & Laundry	No	9
Verandah	No	21
	TOTAL	94

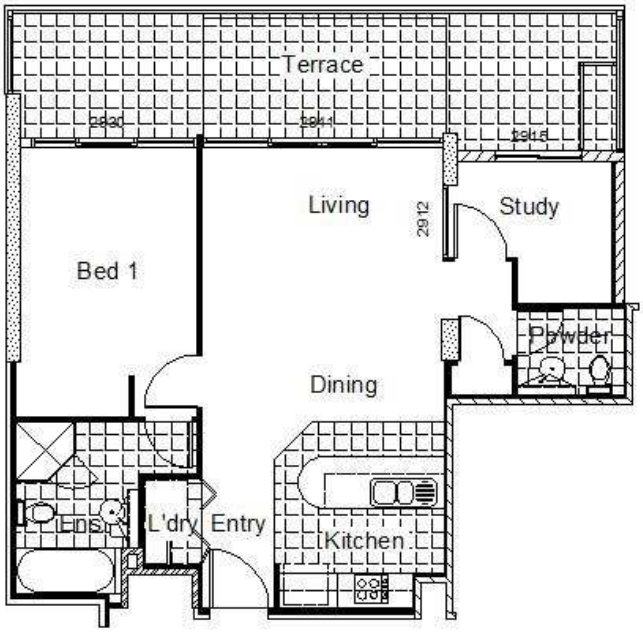


Figure 19.1: Dwelling 19 floor plan for original design

Dwelling Description

Dwelling 19 is a one bedroom apartment, consisting of an open plan living/dining and kitchen area, with one bedroom, a study and a bathroom and laundry. The external walls are a concrete block construction, and the apartment is surrounded by other apartments on three sides, meaning it only has one external wall, and therefore the glazing only faces one direction. The window to floor area ratio is approximately 37%. The terrace is shaded by the terrace above.

Initial Specifications and Star Rating Results

Tables 19.1 and 19.2 describe the zoning of Dwelling 19, while Table 19.3 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 19.4, with Table 19.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 19.3: Dwelling 19 construction details.

Construction	Type	Details
Ceiling height	-	2.7m
Floors	-	Suspended concrete
External walls	-	Concrete: 190mm concrete + air gap + 10mm plasterboard
Ceiling	-	100mm concrete slab + 10mm plasterboard

Table 19.4: Specifications for original design of Dwelling 19 in each capital city.

			Insulation
Darwin	5mm Evergreen	R1.5	None
Brisbane	3mm clear	R1.5	None
Perth	3mm clear	R1.5	None
Sydney	3mm clear	R1.5	None
Adelaide	3mm clear	R1.5	None
Canberra	3mm clear	R1.5	None
Melbourne	3mm clear	R1.5	None
Hobart	3mm clear	R1.5	None

Table 19.5: Star rating in four cardinal orientations and cost for original design of Dwelling 19 in each capital city (orientation according to direction of the main glazing).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	210,941	4.7	2.9	5.4	3.4
Brisbane	232,394	5.1	3.4	4.4	1.9
Perth	219,880	5.7	4.4	5.8	3.7
Sydney	191,278	7.0	5.4	5.6	4.1
Adelaide	181,921	6.2	5.2	5.9	4.6
Canberra	175,443	7.6	6.5	6.2	5.7
Melbourne	169,827	7.0	5.9	5.2	5.2
Hobart	180,170	7.4	6.3	5.3	5.9

Performance of Original Design

Dwelling 19 has a large amount of variation between orientations in each location, as changing the orientation changes the direction that all of the glazing is facing. Warmer climates achieve lower star ratings with the glazing facing east and west, and the dwelling performs much better in almost every location if the glazing is facing north. In Darwin, however, the dwelling achieves a higher star rating if the glazing is facing south, where it will get the least possible amount of sunlight.

Orientating the glazing towards the west makes the dwelling perform worse in most locations. In Darwin, however, having the glazing facing east makes the dwelling perform worse, due to the year round heat gains of east-facing glazing.

The dwelling's ratings vary from 1.9 stars to 7.6 stars. The lowest rating orientation is with the glazing facing west in Brisbane, due to the large amount of heat gains through this orientation in warmer months, and the little to no heat gains through this orientation in the cooler months. The highest rating orientation is in Canberra with the glazing facing north, as this increases heat gains in winter and minimises heat gains in summer.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

The dwelling has been redesigned in the orientation with the lowest initial star rating for each climate type. Darwin has therefore been redesigned with the glazing facing east; the temperate climates with the glazing facing west; and the cold with the glazing facing south.

Ceiling fans have been included to hot and temperate areas, with glazing reductions to all locations in order to minimise the effect of gaining or losing too much heat through glazing. In Brisbane, awning shading has been included to help reduce solar heat gains to the living areas.

Revised Specifications and Star Rating Results

Table 19.6 shows the final specifications for the dwelling and Table 19.7 shows the glazing comparison between the initial and redesigned dwelling. Table 19.8 shows the star rating results and cost savings.

Table 19.6: Specifications for redesigned Dwelling 19 in each capital city.

				Insulation	
Capital City	Glazing	Awning	Additional window reduction %	External walls	Internal walls
Darwin	3mm clear	To all external glazing	None	R1.5	None
Brisbane	3mm clear	To Living and Study external glazing	10	R1.5	None
Perth	3mm clear	None	None	R1.5	None
Sydney	3mm clear	None	None	R1.5	None
Adelaide	3mm clear	None	None	R1.5	None
Canberra	3mm clear	None	None	R1.5	None
Melbourne	3mm clear	None	None	R1.5	None
Hobart	3mm clear	None	None	R1.5	None

Table 19.7: Glazing comparison between initial design and redesign for Dwelling 19.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	36.6	26.8	27.0
Brisbane	36.6	26.0	29.1
Perth	36.6	28.9	21.2
Sydney	36.6	28.9	21.2
Adelaide	36.6	28.9	21.2
Canberra	36.6	29.7	18.8
Melbourne	36.6	29.7	18.8
Hobart	36.6	29.7	18.8

Table 19.8: Redesigned Dwelling 19 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	211,365	-424	-0.2	East	6.8	3.9
Brisbane	239,432	-7,038	-3.0	West	6.3	2.9
Perth	220,169	-289	-0.1	West	6.3	2.6
Sydney	191,529	-251	-0.1	West	6.8	2.7
Adelaide	182,156	-235	-0.1	West	6.4	1.8
Canberra	175,642	-199	-0.1	South	6.9	0.7
Melbourne	170,019	-192	-0.1	South	6.8	1.6
Hobart	180,369	-199	-0.1	South	6.9	1.6

Performance of Redesigned Dwelling

The changes to this dwelling have resulted in a negative cost saving in all locations, due to the increased cost of removing windows and replacing them with concrete walls. With the exception of Brisbane, the increased cost associated with redesign has been very small at only 0.2% of the initial design cost at most. In Brisbane, the redesigned dwelling cost an additional 3.0% more than the original design, but was associated with a star rating increase of 2.9. The reason for this increased cost for redesign in Brisbane compared to other locations can be attributed to further window reductions, and the inclusion of awning shading.

The very high initial window to floor area ratio has been reduced to less than 30% in all locations, due to large reductions in glazing, which has positively impacted the star ratings.

Despite a redesign negative cost change, the star rating increase associated with these changes was very large, with an average increase of more than 2 stars. The largest star rating change was in Darwin, with a total increase of 3.9 stars over the original dwelling in the same orientation.

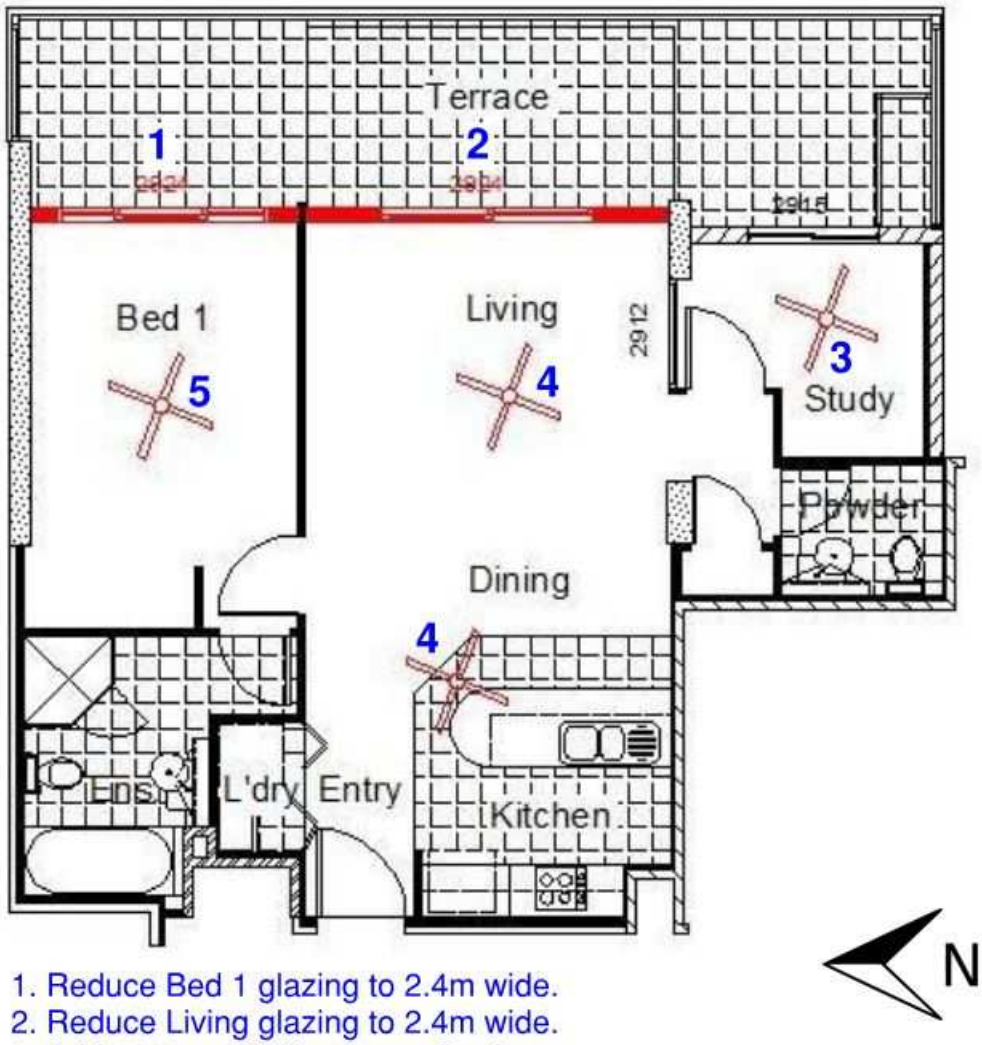


Figure 19.2: Redesigned floor plan for Dwelling 19 in Darwin.

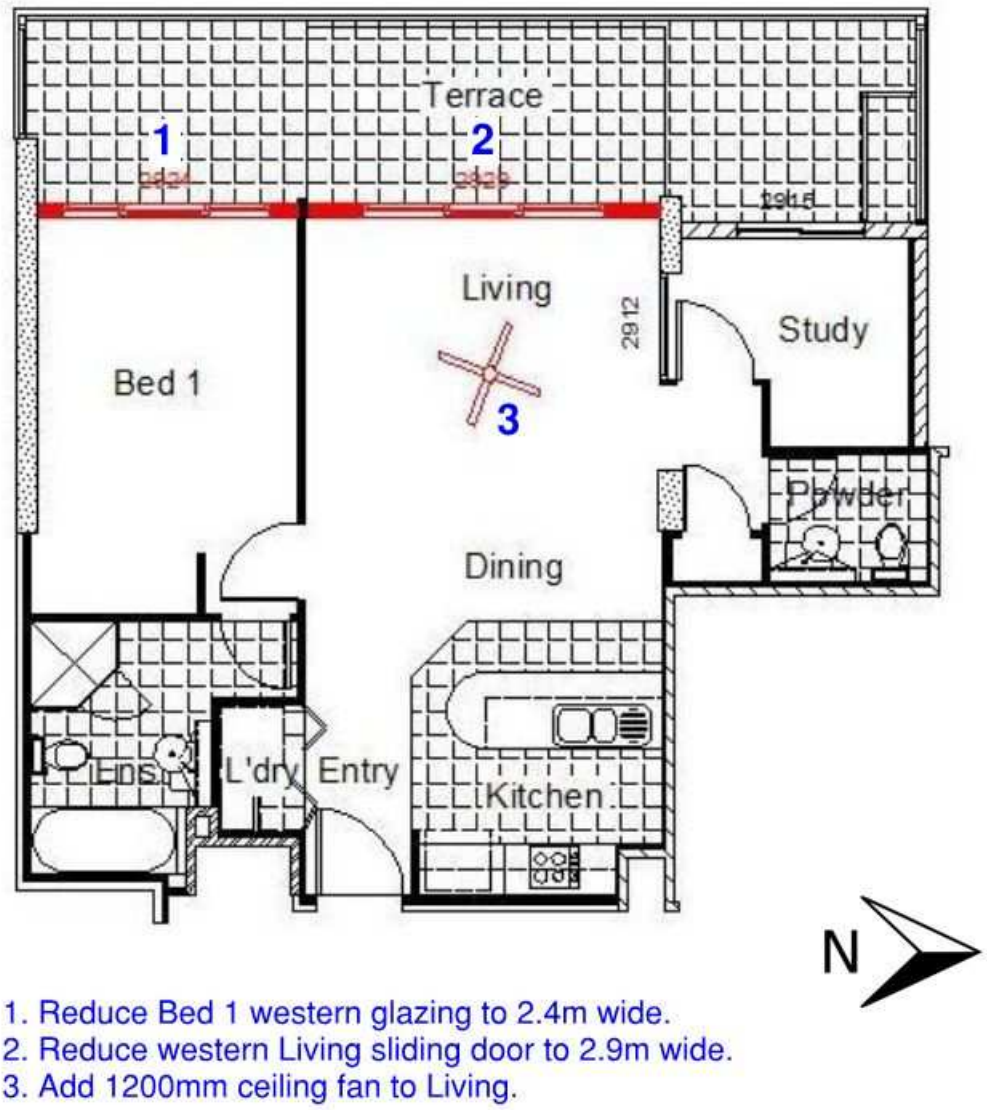


Figure 19.3: Redesigned floor plan for Dwelling 19 in temperate climates (Brisbane, Perth, Sydney and Adelaide).

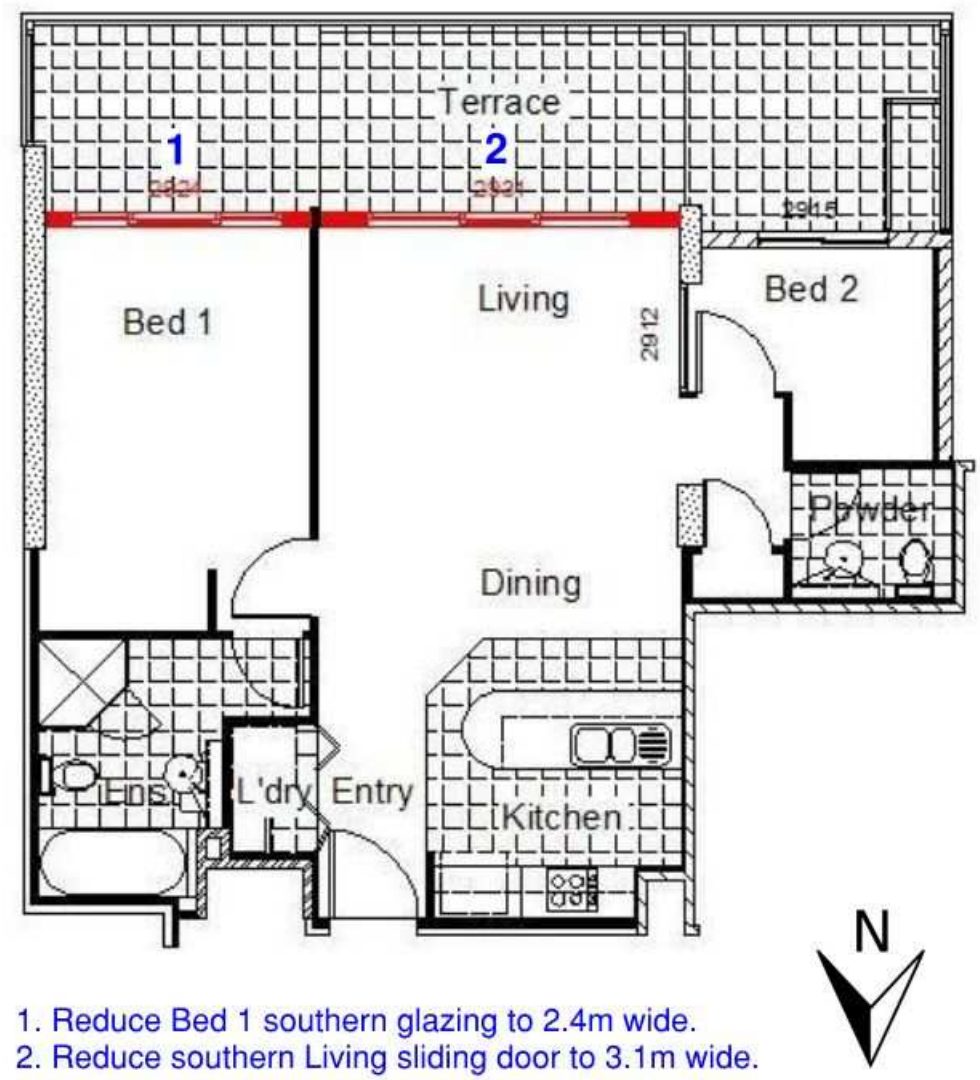


Figure 19.4: Redesigned floor plan for Dwelling 19 in cold climates (Canberra, Melbourne and Hobart).

Dwelling 20: Review of Original Dwelling Design in All Capital Cities

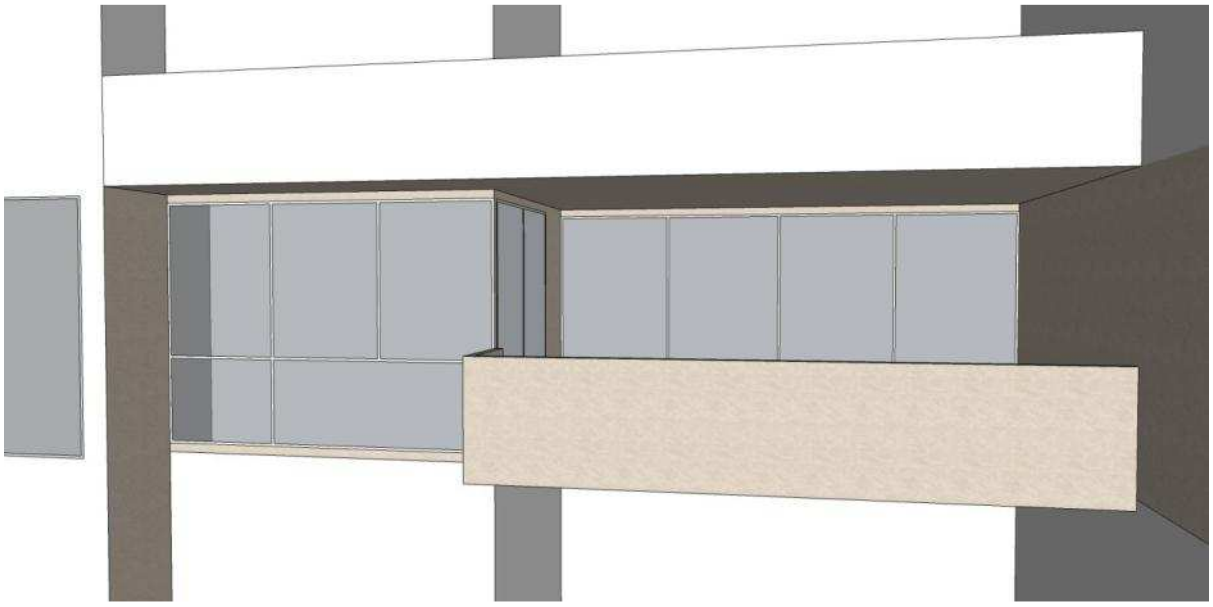


Table 20.1: Summary of Dwelling 20 zone types.

Bedrooms	Bathrooms	Study	Living Areas	Garage
3	2	1	1	-

Table 20.2: Dwelling 20 zone conditioning and areas.

Zone Type	Heated & Cooled	Area (m²)
Living/ Kitchen	Yes	66
Bedrooms	Yes	66
Corridor/Study	Yes	17
Main Bathroom & Laundry	No	14
Verandah	No	38
	TOTAL	201

Figure 20.1: Dwelling 20 floor plan for original dwelling.

Dwelling Description

Dwelling 20 is a three bedroom apartment, with an open plan dining/living and kitchen area and a small study. The external walls are constructed from concrete block, and the apartment is surrounded on two sides by other apartments and indoor communal areas. This provides the apartment with two facades where the majority of glazing is located. The window to floor area ratio is approximately 36%. The external wall area exposed to outdoor temperatures is reduced in this dwelling with the neighbouring walls, floor and ceiling.

Initial Specifications and Star Rating Results

Tables 20.1 and 20.2 describe the zoning of Dwelling 20, while Table 20.3 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 20.4, with Table 20.5 detailing construction cost and star rating achieved by the initial dwelling design in each location.

Table 20.3: Dwelling 20 construction details.

Construction	Type	Details
Ceiling height	-	2.6m
Floors	-	Suspended concrete
External walls	-	Concrete: 190mm or 200mm concrete block + air gap + 10mm plasterboard
Ceiling	-	100mm concrete slab + 10mm plasterboard

Table 20.4: Specifications for original design of Dwelling 20 in each capital city.

		Insulation	
Capital City	Glazing	External walls	Internal walls
Darwin	3mm clear	R1.5	None
Brisbane	3mm clear	R1.5	None
Perth	3mm clear	R1.5	None
Sydney	3mm clear	R1.5	None
Adelaide	3mm clear	R1.5	None
Canberra	3mm clear	R1.5	None
Melbourne	3mm clear	R1.5	None
Hobart	3mm clear	R1.5	None

Table 20.5: Star rating in four cardinal orientations and cost for original design of Dwelling 20 in each capital city (orientation according to direction of the main glazing).

		Star Rating by Orientation			
Capital City	Cost ($)	North	East	South	West
Darwin	434,913	6.8	6.4	6.8	6.2
Brisbane	479,141	6.4	5.2	6.8	5.1
Perth	453,341	6.7	6.2	7.3	6.6
Sydney	394,370	6.4	6.3	6.9	6.3
Adelaide	372,476	5.9	5.7	6.2	5.8
Canberra	361,498	5.7	5.8	6.1	6.0
Melbourne	350,142	5.6	5.6	5.9	5.7
Hobart	361,199	5.7	5.9	6.1	5.9

Performance of Original Design

Dwelling 20 performs better with most of the glazing facing north or south rather than facing east or west. This is because the dwelling is able to allow some heat gains to enter in winter, when needed, and is well shaded to reduce the amount of heat gain in summer. Therefore this dwelling performs very well in Darwin, and quite well in the temperate climates.

The cold climates do not perform as well as the temperate and hot climates. This is due to the large amount of glazing, particularly to the living areas, that is well-shaded and does not allow for sufficient natural heat gains to enter the dwelling. The heat loss from the large amount of glazing impacts on the dwelling's performance by having an increased heating load.

Most of the orientations perform well and there is not a dramatic difference in the star rating in different orientations. The only exception is Brisbane where there is over a star difference between the north/south results and the east/west results.

Review of Redesigned Dwelling in All Capital Cities

Redesign Summary

Due to the high performance of Dwelling 20 in Perth and Sydney, where over 6 stars was achieved initially with basic specifications in every orientation, these two locations have not been redesigned. The remaining six locations have not had their specifications adjusted at all, as they were assessed initially with only the most basic specifications. The dwelling has been redesigned with the front door facing west in all locations.

In Darwin, the dwelling has been redesigned with a ceiling fan to the main living area in order to create more air movement through the dwelling. To cut down on some of the glazing to the main living area, the Living/Breakfast area window has been reduced, which will help cut down the solar heat gains to this area.

In the temperate and cold climates, the dwelling has been redesigned with a reduction to the Living/Breakfast area window and to the Bed 1 window. This will help cut down solar heat gains during summer and prevent heat loss through glazing during winter.

Revised Specifications and Star Rating Results

Table 20.6 shows the final specifications for the dwelling and Table 20.7 shows the glazing comparison between the initial and redesigned dwelling. Table 20.8 shows the star rating results and cost savings.

Table 20.6: Specifications for redesigned Dwelling 20 in each capital city.

		Insulation	
Capital City	Glazing	External walls	Internal walls
Darwin		Not redesigned	
Brisbane	3mm clear	R1.5	None
Perth		Not redesigned	
Sydney		Not redesigned	
Adelaide	3mm clear	R1.5	None
Canberra	3mm clear	R1.5	None
Melbourne	3mm clear	R1.5	None
Hobart	3mm clear	R1.5	None

Table 20.7: Glazing comparison between initial design and redesign for Dwelling 20.

Capital City	Initial window to floor area ratio (%)	Redesign window to floor area ratio (%)	Redesign % window reduction of total area
Darwin	Not redesigned		
Brisbane	35.8	30.3	15.4
Perth	Not redesigned		
Sydney	Not redesigned		
Adelaide	35.8	30.3	15.4
Canberra	35.8	30.3	15.4
Melbourne	35.8	30.3	15.4
Hobart	35.8	30.3	15.4

Table 20.8: Redesigned Dwelling 20 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	478,362	779	0.2	Glazing West-facing	7.2	2.1
Perth	Not redesigned					
Sydney	Not redesigned					
Adelaide	371,877	599	0.2	Glazing West-facing	7.6	1.8
Canberra	360,910	588	0.2	Glazing West-facing	6.6	0.6
Melbourne	349,277	865	0.3	Glazing West-facing	6.4	0.7
Hobart	360,612	587	0.2	Glazing West-facing	6.7	0.8

Performance of Redesigned Dwelling

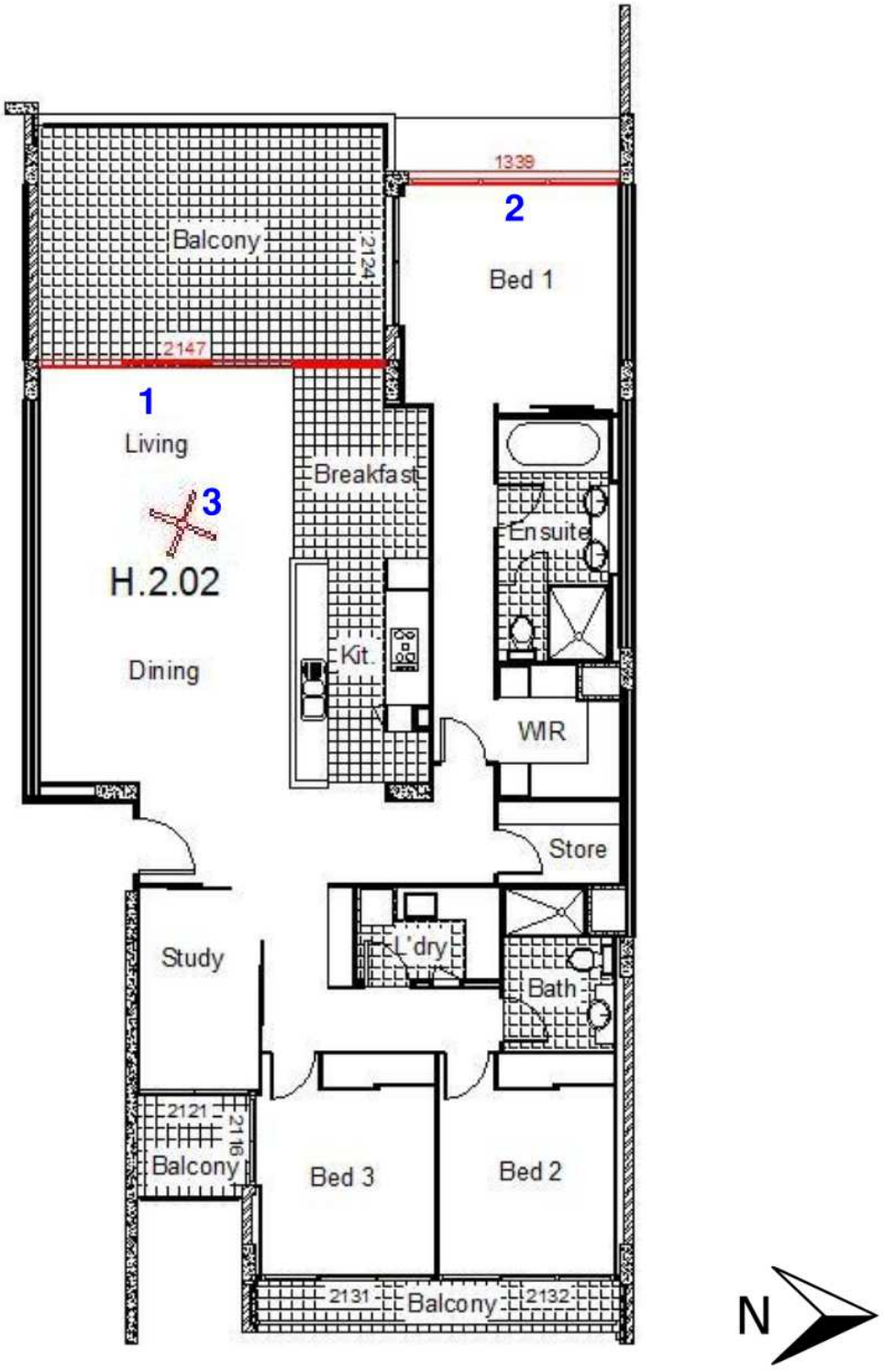
The biggest increase in star rating is in Brisbane, where the effect of the redesign changes improves the assessment by 2.1 stars. This is due to the fact that the reduction in glazing would have a positive impact year round in Brisbane, but would benefit the dwelling during the summer months. It is for similar reasons that Adelaide has an improvement of 1.8 stars, and Perth and Sydney would benefit similarly from these changes, if they were required.

Darwin also performs much better due to the redesign, as the increased air movement and reduction in solar heat gains help cool the dwelling.

Canberra, Melbourne and Hobart have smaller star rating increases than the warmer climates, but the reduction in heat loss through the large living area windows has impacted all three cold climates positively nevertheless.

Glazing was reduced by 15.4% in all locations in order to better achieve the required rating, though this resulted in a slight cost increase as the external walls are more expensive than glazing.

Dwelling 20 still achieved a positive cost saving in all locations of 0.2% of the initial design cost, except Melbourne, which saved 0.3%.



1. Reduce Living/Breakfast glazing to 4.7m wide.
2. Reduce Bed 1 glazing to 1.3m high.
3. Add 1200mm ceiling fan to Living.

Figure 20.2: Redesigned floor plan for Dwelling 20 in Brisbane and Adelaide.

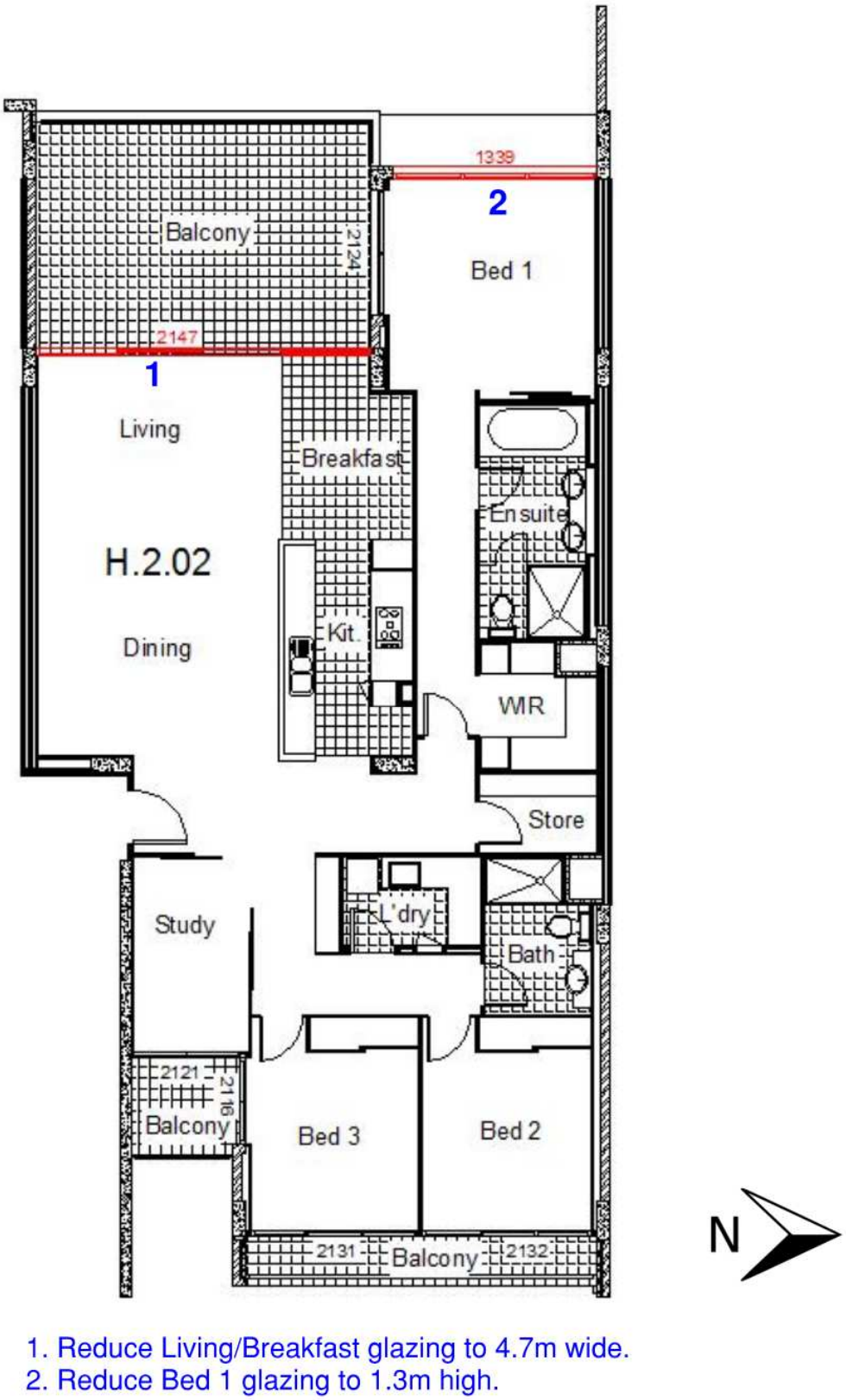


Figure 20.3: Redesigned floor plan for Dwelling 20 in cold climates (Canberra, Melbourne and Hobart).