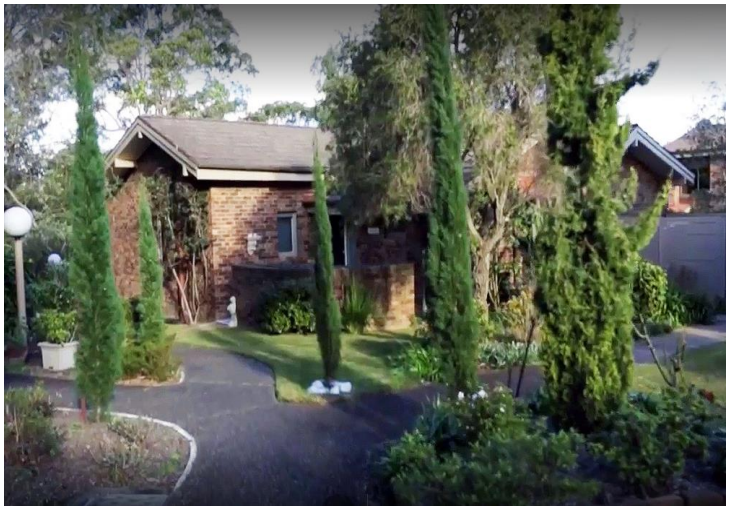
Bushfire Protection Assessment

Proposed Rezoning for Residential Aged Care and Independent Living apartments

95 Stanhope Road, Killara NSW

Prepared for
Stockland Development Pty Ltd

19 June 2017



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Prepared by	Rod Rose FPAA BPAD-A Certified Practitioner No. BPAD1940-L3
Reviewed by	Bruce Horkings FPAA BPAD-A Certified Practitioner No. BPAD29962-L3
Approved by	Rod Rose FPAA BPAD-A Certified Practitioner No. BPAD1940-L3
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1 Property and proposal

Name:	Lourdes Retirement Village		
Street or property Name:	95 Stanhope Road		
Suburb town or locality:	Killara	**Postcode:**	2071
Lot/DP no:	Lots 21 and 22 DP 634645		
Local Government Area:	Ku-ring-gai Council		
Type of area:	Residential		
Type of development:	Rezoning proposal to permit medium residential development for an infill SFPP		

1.1 Description of proposal

A planning proposal seeks to rezone the Lots 21 and 22 DP 634645, 95 Stanhope Road, Killara (the subject land) to permit a multi-storey redevelopment of an existing retirement village and aged care facility. The proposal is to rezone the land from R2 Low Density Residential to R3 Medium Density Residential and to allow for increased occupation of the site in a more bushfire safe development. Currently, a large number of independent living unit (ILU) residents are located within buildings in the flame zone and none of the existing buildings, including the Residential Aged Care Facility (RACF), are constructed to a standard that fully meets contemporary bushfire protection measures under Australian Standard AS3959-2009 *Construction of buildings in bushfire-prone areas* (AS 3959).

The proposed Master Plan includes:

- The existing entrance is to be retained with an improved landscape setting, with the chapel to also be retained with new community facilities;
- A new village 'main street' is proposed, which will form the central spine of activity;
- A new 'village green' is proposed which will form the focal point for events and flexible open space. This will be adjacent to a new community hub, with a range of village-wide facilities;
- The existing trees along Stanhope Road are proposed to be retained;
- A new Residential Aged Care Facility (RACF);
- 282 new ILUs and Serviced apartments; and
- An upgrade to the existing road network including the two-way entry, a secondary entry off Stanhope Road (east), one-way loop roads, a new dedicated services road for the RACF.

The proposed development includes the following:

- Increase from 83 to 133 beds within the relocation and reconstruction of a PBP compliant RACF;
- Increase from 49 to 59 serviced apartments; and
- Increase from 108 to 223 independent living units (ILUs).

Figure 2 and **Figure 3** show the proposed and existing development footprint (respectively) overlain on the BAL maps produced in this assessment. **Figure 2** shows the positioning of the 7 multi-storey buildings ranging from 3 to 8 storeys (ILU and serviced apartments) within the centre of the Village and a new RACF. Existing ILU buildings around the perimeter of the site (**Figure 3**) remain unaltered by the proposal.

1.2 Location and description of sub ect land

The subject land consists of approximately 5.26 ha of land and contains the existing Lourdes Retirement Village.

The village contains small gardens and landscaping but is largely developed to the property boundaries of the site as shown in **Figure 1**. To the north-east through south to south-west is unmanaged native vegetation and in all other directions is existing residential development.

Notably the subject land and Retirement Village is in a locality that has not had widespread wildfire and is never likely to experience this as the vegetation is confined to relatively narrow pathways in directions that are not exposed to widespread and major bushfires i.e. a bushfire attack from the northeast to southeast (see **Figure 1**).

1.3 Assessment Requirements

The subject land is identified as bush fire prone land by Ku-ring-gai Council. The following assessment is prepared in accordance with the Section 117 Direction 4.4 Planning for Bush Fire Protection and *Planning for Bush Fire Protection 2006* (RFS 2006) herein referred to as PBP.

Direction 4.4 Planning for Bushfire Protection identifies matters for consideration for planning proposals that will affect land mapped as bush fire prone or in proximity of such land. In particular, a planning proposal where development is proposed must:

- have regard to *Planning for Bush Fire Protection 2006* (PBP),
- provide an Asset Protection Zone (APZ) incorporating at a minimum:
  - an Inner Protection Area (IPA) bounded by a perimeter road or reserve which circumscribes the hazard side of the land intended for development and has a building line consistent with the incorporation of an APZ, within the property, and
  - an Outer Protection Area (OPA) managed for hazard reduction and located on the bushland side of the perimeter road,
- for infill development, where an appropriate APZ cannot be achieved, provide for an appropriate performance standard, in consultation with the NSW Rural Fire Service (RFS),
- contain provisions for two-way access roads which links to perimeter roads and/or to fire trail networks,
- contain provisions for adequate water supply for firefighting purposes,
- minimise the perimeter of the area of land interfacing the hazard which may be developed,
- introduce controls on the placement of combustible materials in the Inner Protection Area.

Consideration must also be given to NSW RFS *Practice Note 2/12 Planning Instruments and Policies*. It is expected that the RFS, in its assessment of the proposal, will consider the requirements of this Practice Note.

As the proposal is for an infill Special Fire Protection Purpose (SFPP) development it will be assessed in accord with Section 4.2 and specifically Section 4.2.5 of PBP.

The above-mentioned matters are addressed within this assessment.

1.4 Approach within this assessment

This assessment includes performance solutions under *Planning for Bushfire Protection 2006*, and identifies the need for a Bushfire Engineering Brief (BEB) to adequately engage stakeholders, and to test and validate the performance solutions to an appropriate level. Whilst some engagement of stakeholders (RFS and Council) has occurred a more comprehensive process is proposed by this report.

Notwithstanding the need for the BEB, this assessment has rigorously reviewed the performance solutions used to determine APZ in this assessment and has therefore submitted their findings as part of the rezoning proposal and as a catalyst for engagement with stakeholders in a detailed BEB process.

1.5 Consultation with RFS

The following discussions have been had with the RFS regarding the proposal:

- Pre-DA meeting with RFS dated 14.12.15 (see minutes in **Appendix A**).
- Telephone discussions with Craig Casey of RFS 27.10.16 re slope and fuel technical matters.
- On-site meeting with NSW RFS Development Assessment and Planning Officer Josh Calandra on the 6.10.16.

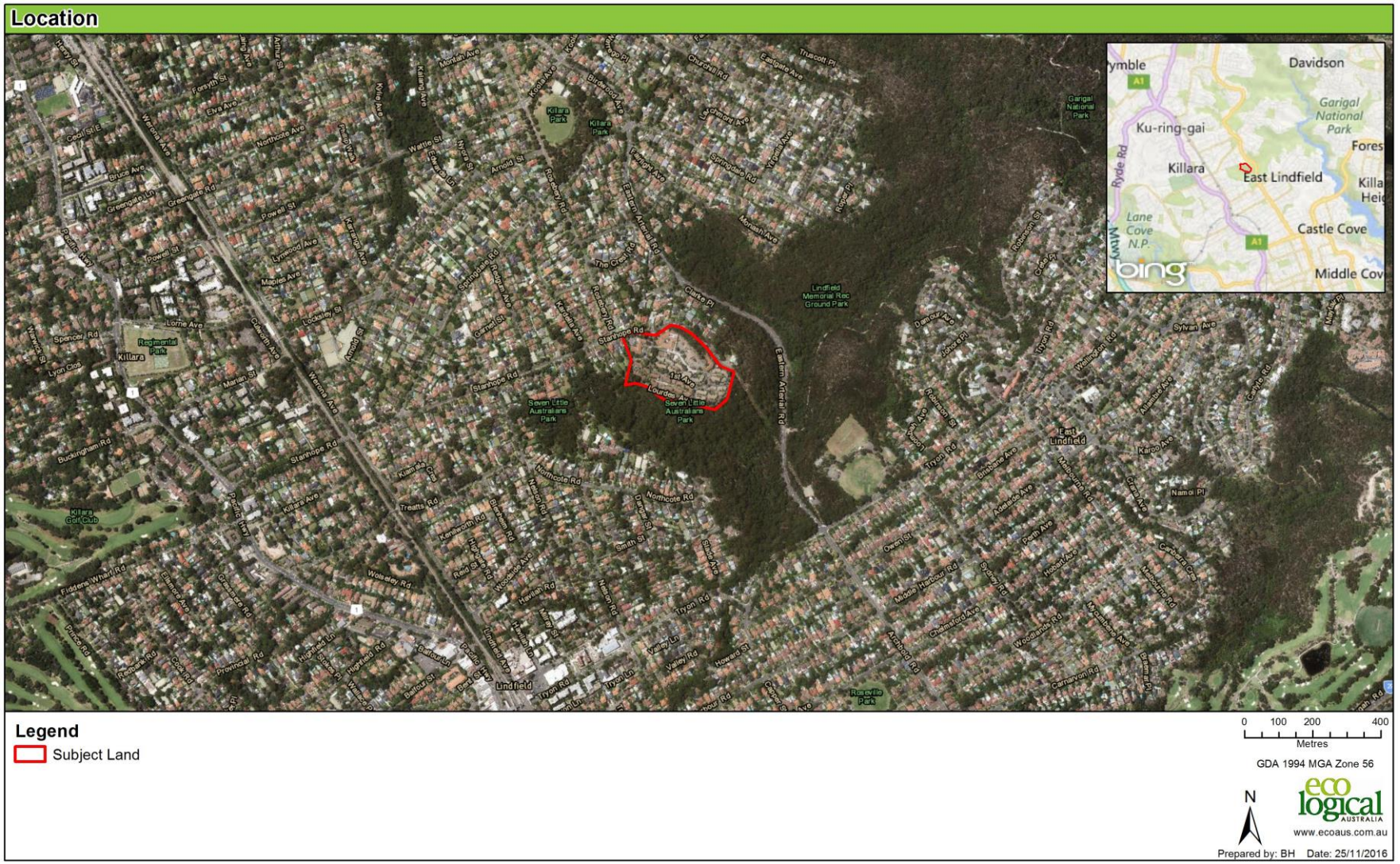

Figure 1: Location

2 Bushfire threat assessment

2.1 Vegetation types and slope

In accord with PBP the predominant vegetation class has been determined for a distance of at least 140 m out from the subject land and the slope class 'most significantly affecting fire behaviour' has been calculated for a distance of at least 100 m in all directions. Bush fire prone vegetation is located from the north-east through south to south-west of the proposed development and is categorised as 'forest' in accordance with PBP. An incised gully at the base of the slope contains rainforest and dry sclerophyll forest is upslope of this toward the subject land.

The effective slope is characterised by a steep riparian corridor to the south and sandstone escarpments of varying heights that 'interrupt' the continuous slope grade and depending on the fire intensity its potential uphill spread.

The effective slopes shown in **Figure 2** have been agreed to by NSW RFS Development Assessment and Planning Officer Josh Calandra after a site inspection on the 6.10.16.

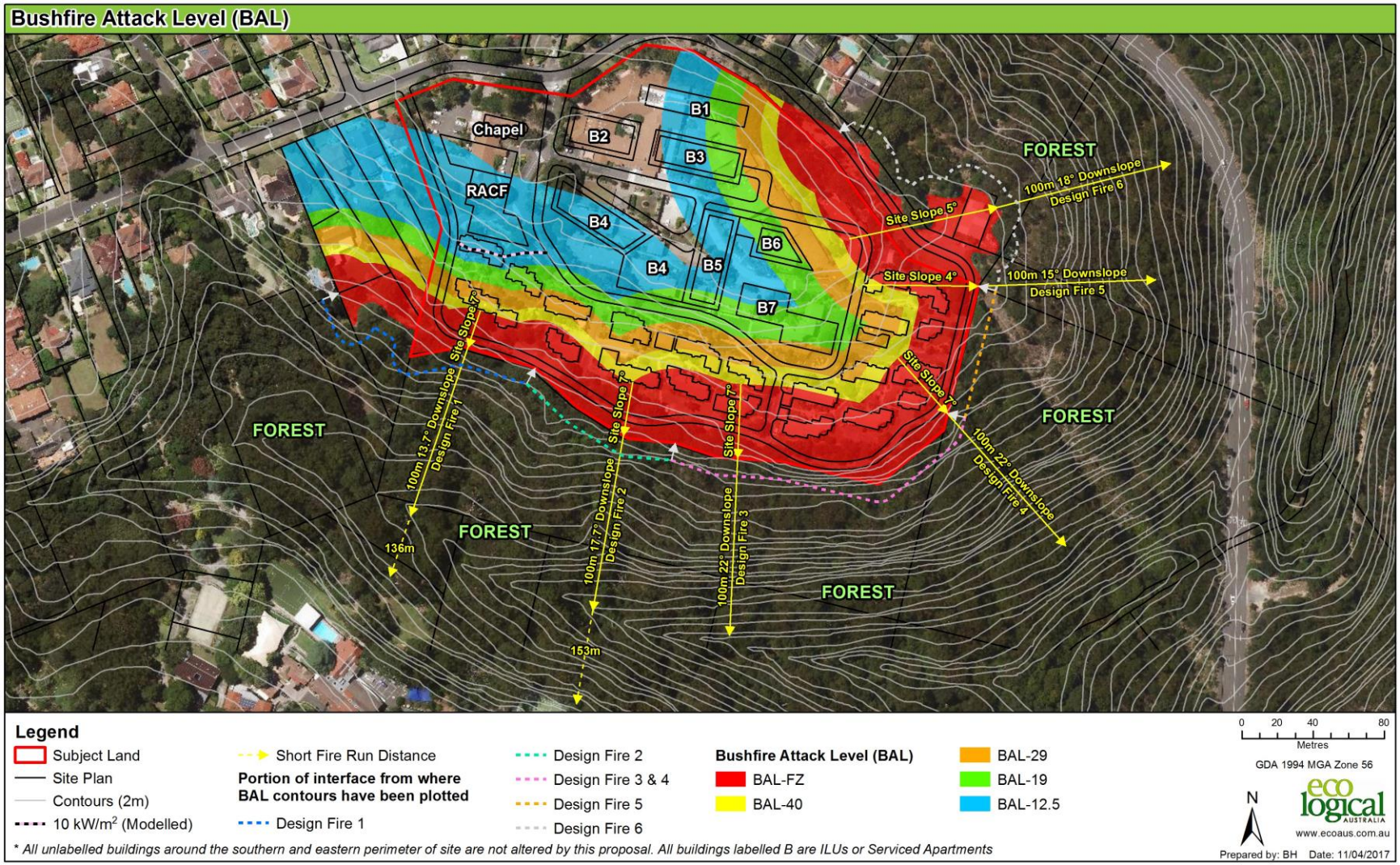

Figure 2: Proposed Village Layout with assessment of slope vegetation and BAL (using 1200^0 flame temp)

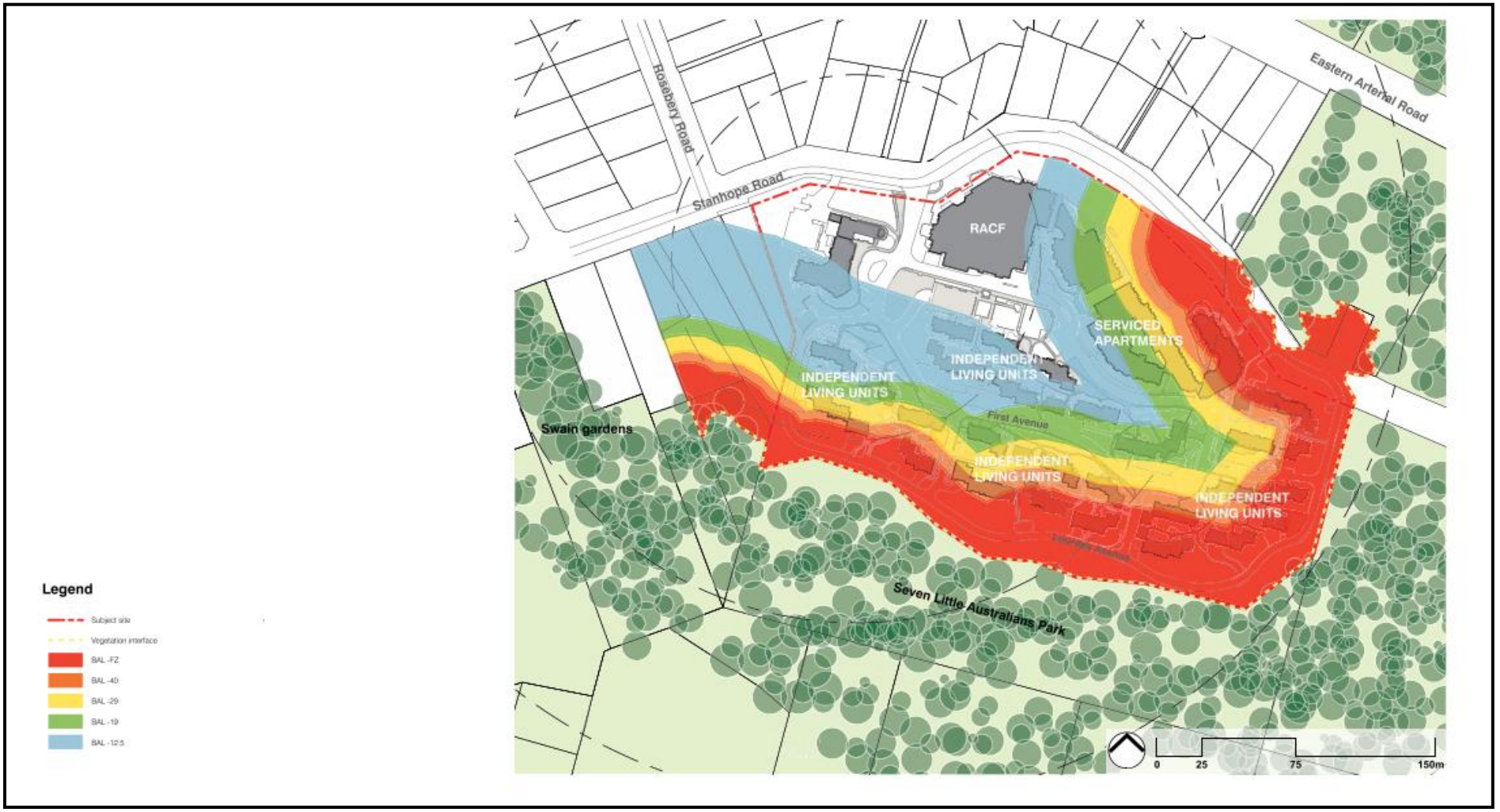

Figure 3: Existing Village Layout and BAL (using 1200^0 flame temp)

3 Asset Protection Zones (APZ)

The vegetation and slope data along with APZ and BAL data are provided in **Table 1** and **Table 2** (respectively the proposed new RACF and ILUs/Serviced Apartments). The retained existing ILUs and the proposed new buildings are also shown in **Figure 2** and **Figure 3** (respectively the proposed and existing development).

This assessment has used the specific slopes agreed to with RFS and selectively used two other performance solutions (short fire run and weather data analysis) to identify the site specific APZ and BAL.

An overview of the weather data and short fire run performance solutions are provided in **Sections 3.1** and **3.2** (respectively). A Bushfire Engineering Brief (BEB) will provide greater clarity on the rigour of using both these models along with provision of the modelling data details. The BEB methodology will be submitted to the RFS to obtain agreement on the approach and subsequently any refinement of the analysis of the design fires. At this stage six design fires have been assessed on the potential fire pathways illustrated by the slope transects (see **Figure 2**).

In accord with PBP, the flame temperature used to calculate the APZ in **Table 1** and **Table 2** is 1200^0 C, however, given the RFS (Craig Casey/Jason Maslen) confirmed by email (4.7.16, see **Appendix A**) that BAL 29 for ILUs was *"… acceptable in this instance as part of a better bush fire outcome for the site…* ", the use of 1090^0 C flame temperature will be explored further in the BEB process.

Table 1: Proposed new RACF: APZ and BAL assessment

Direction from envelope	Effective Slope[1]	Predominant Vegetation[2]	PBP Accept. Soln. APZ[3]	Performance solution APZ[4]	Method 2 AS 3959-209 Construction Standard[5]	Comment
South (Line 1)	Downslope 13.7^0	Forest	100 m	55 m	BAL-12.5	Reduced FFDI & SFRM[6] used. RACF beyond 10 kW/m^2
South (Line 2)	Downslope 17.7^0	Forest	100 m	58 m	BAL-12.5	Reduced FFDI & SFRM used. RACF beyond 10 kW/m^2
All other directions	Managed lands					

[1] Slope most significantly influencing the fire behaviour of the site having regard to vegetation found on each 'fire run line'.

[2] Predominant vegetation is identified, according to PBP and "Where a mix of vegetation types exist the type providing the greater hazard is said to be predominate"

[3] APZ identified using Table 2.6 of PBP to achieve acceptable solution

[4] APZ identified using a performance solution to achieve BAL-12.5 with flame temp of 1200^0C

[5] BAL construction determined using a AS 3959-2009 Method 2 performance solution with flame temp of 1200^0C. NB other BALs shown in Figures 2-4 derived from data in Table 3

[6] SFRM means Short Fire Run Model

Table 2: Proposed new ILUs/Serviced Apartments: APZ and BAL assessment

Direction from envelope	Effective Slope[1]	Predominant Vegetation[2]	PBP Accept. Soln. APZ[3]	Performance solution APZ[4]	Method 2 AS3959 Construction Standard[5]	Comment
South (Line 3)	Downslope 22^0	Forest	100 m	87 m	Up to BAL-29	Reduced FFDI used in model
South-East (Line 4)	Downslope 22^0	Forest	100 m	87 m	Up to BAL-29	As above
East (Line 5)	Downslope 15^0	Forest	100 m	67 m	Up to BAL-29	As above
North-east (Line 6)	Downslope 18^0	Forest	100 m	75 m	Up to BAL-29	As above
All other directions	Managed lands					

1 Slope most significantly influencing the fire behaviour of the site having regard to vegetation found.

2 Predominant vegetation is identified, according to PBP and "Where a mix of vegetation types exist the type providing the greater hazard is said to be predominate"

3 APZ identified using Table 2.6 of PBP to achieve acceptable solution

4 APZ identified using a performance solution to achieve BAL-12.5 with flame temp of 1200^0C

5 BAL construction determined using a AS 3959-2009 Method 2 performance solution with flame temp of 1200^0C NB other BALs shown in Figures 2-3 derived from data in Table 3.

3.1 Performance solution – Forest Fire Danger Index (FFDI) analysis by wind direction

All coastal weather stations in NSW show considerably lower FFDI under winds from the NE-E-S sector. This is because the winds are cooler and moisture laden having travelled in from the South Pacific Ocean. ELA has detailed weather data from all major NSW Bureau of Meteorology Automated Weather Stations and will validate this in the BEB process.

On the subject land this science has been applied to fire runs from the north-east through to south-west with the FFDI used for the Short Fire Run and View Factor modelling using a weather percentile well above the 80% used in PBP for the acceptable solution FFDI of 100. Weather data for the three nearest BoM weather stations with adequate periods of the required weather data have been analysed (see summary in **Table 3**). Detailed weather records (i.e. raw data) will be provided in the BEB stage and a peer review can be arranged if required.

Table 3: Analysis of FFDI under NE-SW direction from nearby BoM weather stations

	Terry Hills	Sydney Airport	Williamtown
First Date	23/09/2004	1/06/1972	1/06/1972
Last Date	14/05/2015	30/11/2014	30/11/2014
Data Range	11	42	42
No. of Records	3,886	15,524	15,524
	FFDI - Wind Direction		
	NE-SW	NE-SW	NE-SW
Max	26	53	40
Min	0	0	0
80th percentile	5	8	6
95th percentile	11	16	12
99th percentile	49	35	19

The BEB will show that a very conservative FFDI of 55 has been used in all modelling, this exceeds the maximum ever recorded under NE-SW winds including within the large BoM databases of Sydney and Williamtown airports. It is noteworthy that the 80th percentile FFDI (i.e. equivalent to that used in PBP) among the three weather stations does not exceed 8. A strong validation that under NE-SW winds on the subject land the FFDI is much lower than the acceptable solution FFDI of 100 within PBP.

3.2 Short Fire Run Model (SFRM)

Bushfire attack from a point ignition does not instantaneously reach the maximum intensity predicted under PBP. The fire intensity under the prevailing winds and effective slope will be lower than that in PBP where the length of fire run does not allow a fire width of 100 m to develop (100 m fire width is the acceptable solution width for radiant heat flux modelling). The BEB will provide detailed supporting data for application of narrower fire widths than 100 m for fires approaching from the south (only) on the subject site (see Design Fire 1 and 2 in **Figure 2**).

The methodology used in the SFRM is based on the following:

- the SFRM model used by Eco Logical Australia for a site in Revesby Heights and previously approved as appropriate by the RFS;
- typical growth patterns for a fire from a single point ignition to determine the predicted fire width at the southern interface of the development;
- the predicted fire width used in the Method 2 of AS 3959-2009 approach using the Newcastle Bushfire Attack Assessor to determine the radiant heat flux of the design fires.

ELA is also in the process of developing a similar model with CSIRO using their SPARK bushfire behaviour prediction software to validate the predicted fire width on the subject site. It is expected that this outcome will be available for the BEB process.

The fire width under southerly approaching fires and an FFDI 55 on the agreed effective slopes is predicted in the modelling as between 50 and 57 m for Design Fire 1 and 2 (respectively). This has subsequently been used to confirm the position of the proposed new RACF is beyond the radiant heat flux (RHF) of 10 kW/m^2 (see **Figure 2**). The approach has not factored in the considerable shielding

provided by the existing ILU's located between the proposed RACF and the hazard to the south (See **Figure 3**). These significantly lower the RHF exposure of the RACF.

3.3 Model inputs and results

The inputs used for each of the six design fires and the model outputs are provided within the modelling reports in **Appendix** .

Table 4 summarises the BAL distances required for each fire run using a 1200^{0}C flame temperature and the models used to determine these results. The BAL distances shown in **Table 4** have been used to prepare the BAL maps used in **Figure 2-Figure 3**.

Table 5 provides an overview of how the BAL 'contours' in this report were developed and their link to the design fire reports in **Appendix** .

Table 4: BAL summary

Run	BAL-FZ	BAL-40	BAL-29	BAL-19	BAL-12.5	SFRM	FFDI
1	0-22	22-28	28-38	38-48	48-100	□	□
2	0-27	27-34	34-45	45-58	58-100	□	□
3	0-42	42-53	53-68	68-87	87-100		□
4	0-42	42-53	53-68	68-87	87-100		□
5	0-30	30-38	38-51	51-67	67-100		□
6	0-35	35-44	44-58	58-75	75-100		□

Table 5: Design fire overview

Design Fire #	Run description in **Appendix A**	Comment
1	1. SW (FFDI & SFRM) BAL-19/12.5	Shows data/outputs for the interface between BAL-19 and BAL-12.5 in Figure 2.
		FFDI and SFRM used in model. Flame temp = 1200.
	1. SW (FFDI & SFRM) BAL-29/19	As above but for BAL-29/19
	1. SW (FFDI & SFRM) BAL-40/29	As above but for BAL-40/29
	1. SW (FFDI & SFRM) BAL-FZ/40	As above but for BAL-FZ/40
2	2. SW (FFDI & SFRM) BAL-19/12.5	Shows data/outputs for the interface between BAL-19 and BAL-12.5 in Figure 2.
		FFDI and SFRM used in model. Flame temp = 1200.
	2. SW (FFDI & SFRM) BAL-29/19	As above but for BAL-29/19
	2. SW (FFDI & SFRM) BAL-40/29	As above but for BAL-40/29
	2. SW (FFDI & SFRM) BAL-FZ/40	As above but for BAL-FZ/40

Design Fire #	Run description in **Appendix A**	Comment
3 & 4	3 & 4. SE (FFDI) BAL-19/12.5	Shows data/outputs for the interface between BAL-19 and BAL-12.5 in Figure 2.
		FFDI used in model. Flame temp = 1200.
	3 & 4. SE (FFDI) BAL-29/19	As above but for BAL-29/19
	3 & 4. SE (FFDI) BAL-40/29	As above but for BAL-40/29
	3 & 4. SE (FFDI) BAL-FZ/40	As above but for BAL-FZ/40
5	5. E (FFDI) BAL-19/12.5	Shows data/outputs for the interface between BAL-19 and BAL-12.5 in Figure 2.
		FFDI used in model. Flame temp = 1200.
	5. E (FFDI) BAL-29/19	As above but for BAL-29/19
	5. E (FFDI) BAL-40/29	As above but for BAL-40/29
	5. E (FFDI) BAL-FZ/40	As above but for BAL-FZ/40
6	6. NE (FFDI) BAL-19/12.5	Shows data/outputs for the interface between BAL-19 and BAL-12.5 in Figure 2.
		FFDI used in model. Flame temp = 1200.
	6. NE (FFDI) BAL-29/19	As above but for BAL-29/19
	6. NE (FFDI) BAL-40/29	As above but for BAL-40/29
	6. NE (FFDI) BAL-FZ/40	As above but for BAL-FZ/40

4 Bushfire Attack Level (BAL)

A Bushfire Attack Level (BAL) map (see **Figure 2** and **Figure 3**) has been prepared using the Method 2 approach under *AS 3959-2009 Construction of buildings in bushfire-prone areas* (AS 3959) with the width of each predicted BAL for each design fire shown in **Table 4**. **Figure 2** shows the portion of the hazard interface used to create the BAL map for each design fire line.

A comparison of the BAL and the building resilience and life protection characteristics of the existing development and the proposed development is discussed in **Section 5**.

5 Comparison of existing and proposed development using BAL

The existing development was constructed prior to the introduction of current bush fire legislative standards and in the longer term represents a bushfire risk to its occupants. **Figure 3** shows the exposure of existing buildings to the Bushfire Attack Level (BAL). Whilst there is currently no change proposed for the ILUs located around the perimeter of the site (see proposed new buildings in **Figure 2**), the existing buildings and infrastructure changes proposed by the development represent major improvements to building resilience. **Table 6** summarises the comparative risks.

Table 6: Comparative risks

Building	Existing risk	Proposal risk	Comment
RACF	Located beyond 10 kW/m^2 however, has no burning debris resilience and therefore highly vulnerable.	Located beyond 10 kW/m^2 and constructed to BAL-12.5	Existing RACF located more exposed to longer fire runs and associated BAL. Proposed RACF located in one of the least vulnerable portions of site.
Serviced Apartments	Exposed to BAL-29 but has no BAL construction.	Majority of Serviced Apartments in BAL 19 or BAL-12.5. The upper levels of buildings also have a significantly lower BAL.	The most at risk Serviced Apartments (to the east of site) are removed/replaced.
ILUs	Those to be replaced are were constructed prior to current bushfire protection standards.	All new ILUs at required BAL or higher.	Existing ILUs around outside of site remain in Flame Zone.

The proposed development increases the number of persons on site, but shifts a significant proportion of the existing residents and proposed additional residents into resilient buildings with an improved on-site and off-site evacuation plan. In the authors expert[1] judgement the greatest evacuation risk to the existing and proposed development is from a short run fire from the south, east or north-east; under the FFDI required to pose a threat to buildings. Therefore even though the proposed development has additional residents, they will be located in resilient buildings (especially under the FFDI associated with an east, south and north-east bushfire attack) designed to current best practice standards under AS3959.

In accordance with the principles of SFPP infill development and the Section 117 Direction, the proposed works will provide a significantly enhanced outcome than what is currently present for the protection of occupants.

6 Water supply

The subject land is serviced by reticulated water, two 74 KL water tanks dedicated for fire-fighting with a combined hydrant and sprinkler booster. The tanks are attached to a pump house and infrastructure capable of providing a maximum boost pressure of 1200 kPa. Hydrants and fire hoses are located at regular intervals around the subject site. This complies with PBP and *AS 2419.1-2005 Fire hydrant installations - System design, installation and commissioning*. No further recommendations for water are required.

There is no material change to the water supply for bushfire purposes between the current and proposed development.

7 Gas and electrical supplies

In accordance with PBP, electricity should be underground wherever practicable. Where overhead electrical transmission lines are installed:

- Lines are to be installed with short pole spacing, unless crossing gullies.
- No part of a tree should be closer to a powerline than the distance specified in *ISSC 3 Guideline for Managing Vegetation Near Power Lines* (Industry Safety Steering Committee, 2005).

[1] Rod Rose (this BPA's author) is one of Australia's most experienced bushfire evacuation planner, who has been widely engaged by leading fire and land management agencies to provide best practice solutions to bushfire evacuation.

Reticulated or bottled gas on the lot is to be installed and maintained in accordance with AS/NZS 1596:2014 *The storage and handling of LP Gas* and the requirements of relevant authorities (metal piping must be used) (Standards Australia 2014). All fixed gas cylinders on the lot are located at least 10 m from flammable materials and are enclosed on the hazard side of the installation.

There is no material change to the gas and electrical supply for bushfire purposes between the current and proposed development.

8 Access

Access to the existing facility has one main entry onto Stanhope Road with a fire trail egress at the end of Stanhope Road. The existing access system is potentially vulnerable to failure during a bushfire attack. The new access under the planning proposal will provide an additional primary access road (at the western end of the site and significantly further from the hazard). As there will be two primary site access roads and the fire trail egress the proposal offers a safer access network.

The proposed new access design will also remove problematic, legacy traffic locations where steep slope gradients and restrictive turning capability constrain the movement of larger fire vehicles. Improved traffic circulation and firefighting capacity is proposed including improvement to the western intersection of Lourdes and First Avenues.

Future access arrangements for any proposed development within the rezoning land are to be in accordance with the intent and principles of PBP regarding the provision of safe access and egress for both residents and fire fighters. The design details (PBP acceptable solutions) of public roads are shown in **Table 7**.

Table 7: Performance criteria for proposed public roads

Intent may be achieved where:	Acceptable solutions
• firefighters are provided with safe all weather access to structures (thus allowing more efficient use of firefighting resources)	• public roads are two-wheel drive, all weather roads
• public road widths and design that allows safe access for firefighters while residents are evacuating an area	• urban perimeter roads are two-way, that is, at least two traffic lane widths (carriageway 8 metres minimum kerb to kerb), allowing traffic to pass in opposite directions. Non perimeter roads comply with Table 4.1 – Road widths for Category 1 Tanker (Medium Rigid Vehicle) • the perimeter road is linked to the internal road system at an interval of no greater than 500 metres in urban areas • traffic management devices are constructed to facilitate access by emergency services vehicles • public roads have a cross fall not exceeding 3 degrees • public roads are through roads. Dead end roads are not recommended, but if unavoidable, dead ends are not more than 200 metres in length, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end and direct traffic away from the hazard • curves of roads (other than perimeter roads) are a minimum inner radius of six metres • maximum grades for sealed roads do not exceed 15 degrees and an average grade of not more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient • there is a minimum vertical clearance to a height of four metres above the road at all times • the capacity of road surfaces and bridges is sufficient to carry fully loaded firefighting vehicles (approximately 15 tonnes for areas with reticulated water, 28 tonnes or 9 tonnes per axle for all other areas). Bridges clearly indicated load rating
• the capacity of road surfaces and bridges is sufficient to carry fully loaded firefighting vehicles	• public roads greater than 6.5 metres wide to locate hydrants outside of parking reserves to ensure accessibility to reticulated water for fire suppression
• roads that are clearly sign posted (with easy distinguishable names) and buildings / properties that are clearly numbered	• public roads between 6.5 metres and 8 metres wide are No Parking on one side with the services (hydrants) located on this side to ensure accessibility to reticulated water for fire suppression • public roads up to 6.5 metres wide provide parking within parking bays and located services outside of the parking bays to ensure accessibility to reticulated water for fire suppression
• there is clear access to reticulated water supply	• one way only public access roads are no less than 3.5 metres wide and provide parking within parking bays and located services outside of the parking bays to ensure accessibility to reticulated water for fire suppression • parking bays are a minimum of 2.6 metres wide from kerb to kerb edge to road pavement. No services or hydrants are located within the parking bays
• parking does not obstruct the minimum paved width	• public roads directly interfacing the bush fire hazard vegetation provide roll top kerbing to the hazard side of the road

9 Emergency response and evacuation

The NSW RFS Development Assessment and Planning Officer Josh Calandra after a site inspection on the 6.10.16 agreed with the author's assessment that Stanhope Road is not a bushfire evacuation concern, nor was the increased potential evacuees under the planning proposal considered to exacerbate evacuation risks of the neighbourhood. Stanhope Road residents are unlikely to be evacuated due to their distance from the hazard, with the primary potential evacuees being those who occupy the very eastern end of the Road.

The existing Village bushfire response and the evacuation capacity of the facility is constrained by access, development layout, and the design and construction of buildings. It is currently considered a risk to the occupants. The planning proposal whilst increasing the number of people on site has them within buildings meeting contemporary bushfire resilience standards (under AS 3959), provides more efficient and effective access and has the majority of the Village population located in a safer position e.g. further from the hazard.

An updated Emergency and Evacuation Management Plan in accordance with current best practice is proposed under the planning proposal. This will also assist safer temporary evacuation of occupants and/or remove the need for evacuation at all during lesser intensity bushfire events. The proposed Emergency and Evacuation Management Plan will also address all evacuation matters required by Ku-ring-gai Council document *Managing Bushfire risk, Now and into the Future* (KMC, March 2012).

Emergency services are located on the Pacific Highway at Pymble and are unlikely to have sufficient warning to respond to incidents onsite. Hence, the reliance on self-sufficiency onsite highlights the need for an alternate solution to protect the occupants in a bushfire emergency response and evacuation.

10 Conclusion

This bushfire assessment demonstrates that the subject land is capable of accommodating future development and associated land use with appropriate bushfire protection measures and bushfire planning requirements as prescribed by s.117 (2) Direction 4.4 – 'Planning for Bush Fire Protection' and PBP.

A number of strategies have been provided in this report to mitigate bushfire risk including:

- Ensuring adequate setback from bushfire prone vegetation (APZs);
- Ensuring adequate access and egress from the subject land through a well-designed road system;
- Considering the adequacy of water supply and the delivery of other services (gas and electricity);
- Providing for effective and ongoing management of APZs; and
- Considering construction standards (AS3959) implications for future developments depending on development type.

As the proposal is an infill Special Fire Protection Purpose development of a site with buildings not built to contemporary bushfire protection standards, the degree to which the proposal increases the safety of occupants is vital. In this regard the proposal shifts a large proportion of existing residents from buildings not built to contemporary standards into buildings compliant with contemporary bushfire protection standards

under AS3959. Notably the most vulnerable occupants, in the existing RACF, are moved to a position further from the higher bushfire attack potential into a RACF resilient to the predicted burning attack.

Improvements in evacuation management options are another notable improvement in bushfire risk associated with the proposal. Currently occupants need to shelter in buildings that are not built to contemporary standards if a bushfire impact occurred before off-site evacuation could be completed. Under this rapid bushfire-attack scenario, the proposal provides a level of on-site refuge equivalent to national best practice and much enhanced resilience over the existing situation.

Whilst an increase in occupant numbers is proposed, the level of bushfire safety of existing and additional residents is considered well above that of the current facility.

The assessment concludes that the proposal is in accordance with the infill protection requirements for Special Fire Protection Purpose developments under Section 117 Direction 4.4 Planning for Bush Fire Protection and *Planning for Bush Fire Protection 2006*.

11 Recommendation

It is recommended that:

- A Bush Fire Safety Authority be issued in accord with this assessment and conditional on acceptance of the details to be provided under the proposed Bushfire Engineering Brief.

Rod Rose
Principal Bushfire Consultant
FPAA BPAD-A Certified Practitioner No. BPAD1940-L3

References

Industry Safety Steering Committee. 2005 *ISSC 3 Guideline for Managing Vegetation Near Power Lines*. (updated from Energy Australia. 2002. *Network Standard NS 179 (Vegetation Safety Clearances)).*

Ku-ring-gai Council (KMC). 2012. *Managing Bushfire risk, Now and into the Future.*

NSW Rural Fire Service (RFS). 2006. *Planning for Bush Fire Protection: A Guide for Councils, Planners, Fire Authorities, Developers and Home Owners*. Australian Government Publishing Service, Canberra.

Standards Australia. 2014. *The storage and handling of LP Gas*, AS/NZS 1596:2014, Standards Australia International Ltd, Sydney.

Standards Australia. 2005. *Fire hydrant installations - System design, installation and commissioning,* AS2419.1, Fourth edition 2005, Standards Australia International Ltd, Sydney.

Standards Australia. 2009 (Amendment 3). *Construction of buildings in bushfire-prone areas*, AS 3959, Third edition 2009, Standards Australia International Ltd, Sydney.

Appendix A: Pre DA meeting minutes

NSW RURAL FIRE SERVICE

PRE-DA ADVICE MEETING SUMMARY

Attendees:	Scott Gordon - Stockland Assistant Development Manager Retirement living Camille Lattouf - Townplanner, Architectus Sydney Jane Freeman - Architectus, Associate and Urban Planner Jane Anderson - Architectus, Urban Planner Leonard Tunhavasana - GN Consulting Pty Ltd Consulting Engineer Nika Fomin - Manager, Customer Service Centre East Jason Maslen - Team Leader, Development Assessment and Planning Craig Casey - Development Assessment and Planning Officer
Project:	Lourdes Retirement Village, 95 Stanhope Road, Killara RFS Ref. ED15/0304482
Time and date:	10am 14/12/2015 **Location:** Customer Service Centre East

Details of the proposal

☑ SFPP	Rezoning to enable a multi-storey redevelopment of an existing retirement village and aged care facility

Bush fire protection issues discussed

Compliance with *Planning for Bush Fire Protection 2006*

Documentation / plans referenced

Master plan provided by email

Advice Provided

- The NSW RFS would not support the proposal as presented as it would involve a significant increase in residents on the site and the location of buildings in the Flame Zone. The residential aged care facility (RACF) would also be located in the north-eastern corner of the site which is more exposed than the existing location and is located in the Flame Zone.
- A redevelopment of the facility such as this should provide asset protection zones (APZs) to achieve 10kW/sqm as set out in Table A2.6 of *Planning for Bush Fire Protection 2006.* Alternate solutions will be considered on a merits basis with regard to this requirement and the overall outcome of the proposal.
- The draft bush fire report assessed slopes to the south and east of 0-5 and 10-15 degrees respectively. The NSW RFS has identified slopes of 15-20 degrees and greater to the south and south-east of the site.
- The NSW RFS is willing to meet and provide further advice on further developed proposals.

Disclaimer

RFS advice is based on information provided and policy and legislative requirements applicable at the time. The advice should be copied into, or referenced in, any subsequent development application.

All efforts are made to identify issues of relevance and likely concern with the preliminary proposal. However, the comments and views in this document are based only on the plans and information submitted for preliminary assessment and discussion at the pre-DA meeting. You are advised that: -

- The views expressed may vary once detailed plans and information are submitted and formally assessed in the development application process, or as a result of issues contained in submissions by interested parties;
- Given the complexity of issues often involved and the limited time for full assessment, no guarantee is given that every issue of relevance will be identified;
- Amending one aspect of the proposal could result in changes which would create a different set of impacts from the original plans and therefore require further assessment and advice; and,
- The Pre-DA advice given does not bind Council officers, the elected Council members, or other parties to the DA process.

Signed:

Craig Casey
Development Assessment and Planning Officer

Jason Maslen
Team Leader,
Development Assessment and Planning

Appendix B: BFAA

NBC Bushfire Attack Assessment Report V2.1

AS3959 (2009) Appendix B - Detailed Method 2

Printed: 11/04/2017 **Assessment Date:** 2/11/2016

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

Site Street Address: Lourdes ACF (BAL) - Stanhope Road, Kilara

Assessor: Bruce Horkings; Ecological Australia

Local Government Area: Ku-ring-gai **Alpine Area:** No

Equations Used

Transmissivity: Fuss and Hammins, 2002
Flame Length: RFS PBP, 2001
Rate of Fire Spread: Noble et al., 1980
Radiant Heat: Drysdale, 1985; Sullivan et al., 2003; Tan et al., 2005
Peak Elevation of Receiver: Tan et al., 2005
Peak Flame Angle: Tan et al., 2005

Run Description: 1. SW (FFDI & SFRM) BAL-19/12.5

Vegetation Information

Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	13.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25

Site Information

Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	48

Fire Inputs

Veg./Flame Width(m):	50	**Flame Temp(K)**	1200

Calculation Parameters

Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55

Program Outputs

Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	6.65
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	43880
Radiant Heat(kW/m2):	12.39	**Flame Angle (degrees):**	90
Flame Length(m):	25.08	**Maximum View Factor:**	0.142
Rate Of Spread (km/h):	3.4	**Inner Protection Area(m):**	48
Transmissivity:	0.781	**Outer Protection Area(m):**	0

Run Description:	1. SW (FFDI & SFRM) BAL-29/19		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	13.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	38
Fire Inputs			
Veg./Flame Width(m):	50	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	7.87
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	43880
Radiant Heat(kW/m2):	18.31	**Flame Angle (degrees):**	90
Flame Length(m):	25.08	**Maximum View Factor:**	0.206
Rate Of Spread (km/h):	3.4	**Inner Protection Area(m):**	38
Transmissivity:	0.798	**Outer Protection Area(m):**	0

Run Description:	1. SW (FFDI & SFRM) BAL-40/29		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	13.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	28
Fire Inputs			
Veg./Flame Width(m):	50	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	9.1
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	43880
Radiant Heat(kW/m2):	28.76	**Flame Angle (degrees):**	90
Flame Length(m):	25.08	**Maximum View Factor:**	0.315
Rate Of Spread (km/h):	3.4	**Inner Protection Area(m):**	28
Transmissivity:	0.818	**Outer Protection Area(m):**	0

Run Description:	1. SW (FFDI & SFRM) BAL-FZ/40		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	13.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	22
Fire Inputs			
Veg./Flame Width(m):	50	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	FLAME ZONE	**Peak Elevation of Receiver(m):**	9.84
Level of Construction:	BAL FZ	**Fire Intensity(kW/m):**	43880
Radiant Heat(kW/m2):	38.89	**Flame Angle (degrees):**	90
Flame Length(m):	25.08	**Maximum View Factor:**	0.418
Rate Of Spread (km/h):	3.4	**Inner Protection Area(m):**	22
Transmissivity:	0.834	**Outer Protection Area(m):**	0

Run Description:	2. S (FFDI & SFRM) BAL-19/12.5		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	17.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	58
Fire Inputs			
Veg./Flame Width(m):	57	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	8.93
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	57827
Radiant Heat(kW/m2):	12.31	**Flame Angle (degrees):**	90
Flame Length(m):	32.1	**Maximum View Factor:**	0.143
Rate Of Spread (km/h):	4.48	**Inner Protection Area(m):**	58
Transmissivity:	0.768	**Outer Protection Area(m):**	0

Run Description:	2. S (FFDI & SFRM) BAL-29/19		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	17.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	45
Fire Inputs			
Veg./Flame Width(m):	57	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	10.52
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	57827
Radiant Heat(kW/m2):	18.84	**Flame Angle (degrees):**	90
Flame Length(m):	32.1	**Maximum View Factor:**	0.215
Rate Of Spread (km/h):	4.48	**Inner Protection Area(m):**	45
Transmissivity:	0.786	**Outer Protection Area(m):**	0

Run Description:	2. S (FFDI & SFRM) BAL-40/29		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	17.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	34
Fire Inputs			
Veg./Flame Width(m):	57	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	11.88
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	57827
Radiant Heat(kW/m2):	28.62	**Flame Angle (degrees):**	90
Flame Length(m):	32.1	**Maximum View Factor:**	0.318
Rate Of Spread (km/h):	4.48	**Inner Protection Area(m):**	34
Transmissivity:	0.805	**Outer Protection Area(m):**	0

Run Description:	2. S (FFDI & SFRM) BAL-FZ/40		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	17.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	27
Fire Inputs			
Veg./Flame Width(m):	57	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	FLAME ZONE	**Peak Elevation of Receiver(m):**	12.73
Level of Construction:	BAL FZ	**Fire Intensity(kW/m):**	57827
Radiant Heat(kW/m2):	38.42	**Flame Angle (degrees):**	90
Flame Length(m):	32.1	**Maximum View Factor:**	0.419
Rate Of Spread (km/h):	4.48	**Inner Protection Area(m):**	27
Transmissivity:	0.821	**Outer Protection Area(m):**	0

Run Description:	3 & 4. SE (FFDI) BAL-19/12.5		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	22 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	87
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	9.58
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	77801
Radiant Heat(kW/m2):	12.33	**Flame Angle (degrees):**	74
Flame Length(m):	42.15	**Maximum View Factor:**	0.148
Rate Of Spread (km/h):	6.02	**Inner Protection Area(m):**	87
Transmissivity:	0.747	**Outer Protection Area(m):**	0

Run Description:	3 & 4. SE (FFDI) BAL-29/19		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	22 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	68
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	11.46
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	77801
Radiant Heat(kW/m2):	18.91	**Flame Angle (degrees):**	70
Flame Length(m):	42.15	**Maximum View Factor:**	0.221
Rate Of Spread (km/h):	6.02	**Inner Protection Area(m):**	68
Transmissivity:	0.765	**Outer Protection Area(m):**	0

Run Description:	3 & 4. SE (FFDI) BAL-40/29		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	22 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	53
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	12.75
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	77801
Radiant Heat(kW/m2):	28.19	**Flame Angle (degrees):**	66
Flame Length(m):	42.15	**Maximum View Factor:**	0.321
Rate Of Spread (km/h):	6.02	**Inner Protection Area(m):**	53
Transmissivity:	0.787	**Outer Protection Area(m):**	0

Run Description:	3 & 4. SE (FFDI) BAL-FZ/40		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	22 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	42
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	VERY HIGH	**Peak Elevation of Receiver(m):**	13.28
Level of Construction:	BAL 40	**Fire Intensity(kW/m):**	77801
Radiant Heat(kW/m2):	39.6	**Flame Angle (degrees):**	61
Flame Length(m):	42.15	**Maximum View Factor:**	0.438
Rate Of Spread (km/h):	6.02	**Inner Protection Area(m):**	42
Transmissivity:	0.81	**Outer Protection Area(m):**	0

Run Description:	5. E (FFDI) BAL-19/12.5		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	4 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	67
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	8.49
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	47998
Radiant Heat(kW/m2):	12.37	**Flame Angle (degrees):**	76
Flame Length(m):	27.15	**Maximum View Factor:**	0.145
Rate Of Spread (km/h):	3.72	**Inner Protection Area(m):**	67
Transmissivity:	0.762	**Outer Protection Area(m):**	0

Run Description:	5. E (FFDI) BAL-29/19		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	4 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	51
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	9.42
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	47998
Radiant Heat(kW/m2):	19	**Flame Angle (degrees):**	73
Flame Length(m):	27.15	**Maximum View Factor:**	0.217
Rate Of Spread (km/h):	3.72	**Inner Protection Area(m):**	51
Transmissivity:	0.783	**Outer Protection Area(m):**	0

Run Description:	5. E (FFDI) BAL-40/29		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	4 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	38
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	10.02
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	47998
Radiant Heat(kW/m2):	28.83	**Flame Angle (degrees):**	69
Flame Length(m):	27.15	**Maximum View Factor:**	0.32
Rate Of Spread (km/h):	3.72	**Inner Protection Area(m):**	38
Transmissivity:	0.807	**Outer Protection Area(m):**	0

Run Description:	5. E (FFDI) BAL-FZ/40		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	15 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	4 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	30
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	VERY HIGH	**Peak Elevation of Receiver(m):**	10.1
Level of Construction:	BAL 40	**Fire Intensity(kW/m):**	47998
Radiant Heat(kW/m2):	39.07	**Flame Angle (degrees):**	64
Flame Length(m):	27.15	**Maximum View Factor:**	0.422
Rate Of Spread (km/h):	3.72	**Inner Protection Area(m):**	30
Transmissivity:	0.828	**Outer Protection Area(m):**	0

Run Description:	6. NE (FFDI) BAL-19/12.5		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	18 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	75
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	9.24
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	59036
Radiant Heat(kW/m2):	12.37	**Flame Angle (degrees):**	75
Flame Length(m):	32.71	**Maximum View Factor:**	0.147
Rate Of Spread (km/h):	4.57	**Inner Protection Area(m):**	75
Transmissivity:	0.755	**Outer Protection Area(m):**	0

Run Description:	6. NE (FFDI) BAL-29/19		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	18 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	58
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	MODERATE	**Peak Elevation of Receiver(m):**	10.48
Level of Construction:	BAL 19	**Fire Intensity(kW/m):**	59036
Radiant Heat(kW/m2):	18.87	**Flame Angle (degrees):**	72
Flame Length(m):	32.71	**Maximum View Factor:**	0.218
Rate Of Spread (km/h):	4.57	**Inner Protection Area(m):**	58
Transmissivity:	0.774	**Outer Protection Area(m):**	0

Run Description:	6. NE (FFDI) BAL-40/29		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	18 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	44
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	HIGH	**Peak Elevation of Receiver(m):**	11.2
Level of Construction:	BAL 29	**Fire Intensity(kW/m):**	59036
Radiant Heat(kW/m2):	28.54	**Flame Angle (degrees):**	67
Flame Length(m):	32.71	**Maximum View Factor:**	0.32
Rate Of Spread (km/h):	4.57	**Inner Protection Area(m):**	44
Transmissivity:	0.798	**Outer Protection Area(m):**	0

Run Description:	6. NE (FFDI) BAL-FZ/40		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	18 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	5 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	35
Fire Inputs			
Veg./Flame Width(m):	100	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	VERY HIGH	**Peak Elevation of Receiver(m):**	11.51
Level of Construction:	BAL 40	**Fire Intensity(kW/m):**	59036
Radiant Heat(kW/m2):	38.92	**Flame Angle (degrees):**	63
Flame Length(m):	32.71	**Maximum View Factor:**	0.425
Rate Of Spread (km/h):	4.57	**Inner Protection Area(m):**	35
Transmissivity:	0.819	**Outer Protection Area(m):**	0

Run Description:	RACF 10 kW/m2 Line		
Vegetation Information			
Vegetation Type:	Forest	**Vegetation Group:**	Forest and Woodland
Vegetation Slope:	13.7 Degrees	**Vegetation Slope Type:**	Downslope
Surface Fuel Load(t/ha):	20	**Overall Fuel Load(t/ha):**	25
Site Information			
Site Slope	7 Degrees	**Site Slope Type:**	Downslope
Elevation of Receiver(m)	Default	**APZ/Separation(m):**	55
Fire Inputs			
Veg./Flame Width(m):	50	**Flame Temp(K)**	1200
Calculation Parameters			
Flame Emissivity:	95	**Relative Humidity(%):**	25
Heat of Combustion(kJ/kg	18600	**Ambient Temp(K):**	308
Moisture Factor:	5	**FDI:**	55
Program Outputs			
Category of Attack:	LOW	**Peak Elevation of Receiver(m):**	5.79
Level of Construction:	BAL 12.5	**Fire Intensity(kW/m):**	43880
Radiant Heat(kW/m2):	9.74	**Flame Angle (degrees):**	90
Flame Length(m):	25.08	**Maximum View Factor:**	0.113
Rate Of Spread (km/h):	3.4	**Inner Protection Area(m):**	55
Transmissivity:	0.772	**Outer Protection Area(m):**	0

ecological AUSTRALIA

HEAD OFFICE
Suite 2, Level 3
668-672 Old Princes Highway
Sutherland NSW 2232
T 02 8536 8600
F 02 9542 5622

CANBERRA
Level 2
11 London Circuit
Canberra ACT 2601
T 02 6103 0145
F 02 6103 0148

COFFS HARBOUR
35 Orlando Street
Coffs Harbour Jetty NSW 2450
T 02 6651 5484
F 02 6651 6890

PERTH
Suite 1 & 2
49 Ord Street
West Perth WA 6005
T 08 9227 1070
F 08 9322 1358

DARWIN
16/56 Marina Boulevard
Cullen Bay NT 0820
T 08 8989 5601
F 08 8941 1220

SYDNEY
Level 6
299 Sussex Street
Sydney NSW 2000
T 02 8536 8650
F 02 9264 0717

NEWCASTLE
Suites 28 & 29, Level 7
19 Bolton Street
Newcastle NSW 2300
T 02 4910 0125
F 02 4910 0126

ARMIDALE
92 Taylor Street
Armidale NSW 2350
T 02 8081 2681
F 02 6772 1279

WOLLONGONG
Suite 204, Level 2
62 Moore Street
Austinmer NSW 2515
T 02 4201 2200
F 02 4268 4361

BRISBANE
Suite 1 Level 3
471 Adelaide Street
Brisbane QLD 4000
T 07 3503 7191
F 07 3854 0310

HUSKISSON
Unit 1 51 Owen Street
Huskisson NSW 2540
T 02 4201 2264
F 02 4443 6655

NAROOMA
5/20 Canty Street
Narooma NSW 2546
T 02 4476 1151
F 02 4476 1161

MUDGEE
Unit 1, Level 1
79 Market Street
Mudgee NSW 2850
T 02 4302 1230
F 02 6372 9230

GOSFORD
Suite 5, Baker One
1-5 Baker Street
Gosford NSW 2250
T 02 4302 1220
F 02 4322 2897

1300 646 131
www.ecoaus.com.au