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bushfire & ecology

# bushfire protection assessment

Planning Proposal
North Rocks Village

Lot 3001 DP 1115866
361-365 North Rocks Road, North Rocks

Under Section 9.1(2) Direction No 4.4
of the *EP&A Act*

March 2021
(REF: 19MEC02B)

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**Lot 3001 DP 1115866**
**361-365 North Rocks Road, North Rocks**

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|---|---|
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BPAD Bushfire Planning & Design Accredited Practitioner Level 3

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The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features is to be confirmed by a registered surveyor.

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# EXECUTIVE SUMMARY

This bushfire protection assessment has been undertaken in support of the proposed rezoning of Lot 3001 DP 1115866 from R2 (low density residential) to R3 (medium density residential) and R4 (high density residential) to facilitate a future development referred to as North Rocks Village.

This report identifies matters for consideration for the planning proposal and highlights the required bushfire protection measures, including asset protection zones (APZs), for future development under the *Environmental Planning and Assessment Act 1979 (EP&A Act), Section 9.1(2) Direction 4.4* and in accordance *Planning for Bush Fire Protection 2019* (*PBP*).

The key objective of this assessment is to ensure the rezoning concept is capable of complying with *PBP*. Planning principles for the proposal include the provision of adequate access including the establishment of adequate asset protection zones (APZs) for future housing, specifying minimum lot depths to accommodate APZs and the introduction of controls which avoid placing inappropriate developments in hazardous areas and placement of combustible material in APZs.

Our assessment found that the bushfire hazard is restricted to the northern boundary only. Bushfire attack could potentially affect the development from the adjoining forest vegetation located within the narrow strip of bushland to the north and north-east of the property, resulting in possible ember and radiant heat attack.

The assessment has concluded that the proposed concept plan can comply with the planning principles of *PBP* provided any future DA design and layout addresses the following:

- Use of an alternative solution to determine minimum APZ and bushfire attack level (BAL) setbacks for the dwellings adjacent to the northern bushland parcel using the short fire run (SFR) methodology. This application seeks to gain NSW RFS agreement to the use of SFR methodology in this instance (prior to finalising the masterplan design). This narrow corridor is identified as low risk vegetation due to its consistent linear width which is at right angles to the development. Further development of the concept plan will be required to ensure buildings are located outside of the minimum APZ.

- Provision of access in accordance with the acceptable solutions outlined in *PBP.* This will involve the provision for a perimeter road;

- Water, electricity and gas supply in compliance with the acceptable solutions outlined in *PBP;*

- Future dwelling construction in compliance with the appropriate construction sections of *AS3959-2018*, and *PBP*.

- Creation of a Plan of Management (PoM) to ensure the ongoing maintenance of APZs where they occur within open space areas.

## GLOSSARY OF TERMS

| | |
|---|---|
| AHIMS | Aboriginal Heritage Information System |
| APZ | asset protection zone |
| *AS1596* | *Australian Standard – The storage and handling of LP Gas* |
| *AS2419* | *Australian Standard – Fire hydrant installations* |
| *AS3745* | *Australian Standard – Planning for emergencies in facilities* |
| *AS3959* | *Australian Standard – Construction of buildings in bushfire-prone areas 2018* |
| BAL | bushfire attack level |
| *BCA* | *Building Code of Australia* |
| BSA | Bushfire safety authority |
| DA | development application |
| DCP | Development Control Plan |
| EEC | endangered ecological community |
| *EP&A Act* | *Environmental Planning and Assessment Act* |
| FDI | fire danger index |
| IPA | inner protection area |
| LEP | Local environmental plan |
| OPA | outer protection area |
| PoM | Plan of Management |
| *PBP* | *Planning for bush fire protection 2019* |
| RFS | NSW Rural Fire Service |
| SFPP | special fire protection purpose |
| SFR | short fire run |

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# Introduction 1

*Travers bushfire & ecology* has been requested to undertake a bushfire protection assessment in support of a rezoning application at 361-365 North Roads Road, North Rocks.

## 1.1 Aims of the assessment

The aims of the bushfire protection assessment are to:

- review the bushfire threat to the landscape,
- undertake a bushfire attack assessment in accordance with *PBP,*
- provide advice on planning principles, including the provision of perimeter roads, asset protection zones (APZs) and other specific fire management issues
- review the potential to carry out hazard management over the landscape, taking into consideration the proposed retention of trees within the final development plans.

## 1.2 Project synopsis

The proposed rezoning application will be submitted to City of Parramatta Council to rezone the property (currently occupied by the *Royal Institute of Deaf and Blind Children*) from R2 (low density residential) to R3 (medium density residential) and R4 (high density residential).

The proposal seeks to create North Rocks Village, a Housing Diversity Precinct (HDP) as expressed in Council's Local Strategic Planning Statement (LSPS). It will deliver a genuine mix of housing opportunities within a garden village setting that complements existing neighbourhood character and has the potential to revitalise North Rocks Local Centre. Key elements will comprise:

- A diverse housing mix including freestanding housing, townhouses, terraces, large private garden and terrace style apartments, low-rise apartments as well as seniors living and affordable housing;
- Publicly accessible open spaces including a full-sized oval able to accommodate multi-purpose fields and operate as a village green for the community;
- The creation of a village square with direct pedestrian connection to North Rocks Shopping Centre;
- Embellishment of adjoining Council reserve to improve existing infrastructure;
- Community gardens, walking trails, green and blue connections and public access throughout the site;
- Multiple community spaces to provide for the development of cultural, community and arts programs, including co-working areas, multi-purpose facilities and Hear the Children (RIDBC) Early Intervention service;
- Regular transport connections to major bus interchange at M2; and
- Shared way through the site providing connections to existing pedestrian and cycle links.

A concept plan (refer Figure 1.1) has been prepared and provides for approximately nine-hundred and forty five (945) dwellings, comprising a mix of apartments (up to seven (7) storeys in height) townhouses and detached housing.

There will be a further component of seniors living (25%) with a combination of Independent Living Units (ILUs) and aged care. These are located at the front of the site toward North Rocks Road to minimise the bushfire risk.

In addition, the proposal provides for approximately 700sqm of commercial floor space and 4,000sqm of community floor space comprising a library, amenities, community rooms etc.

The site will also consist of open space areas (either communal open space or public open space). There is a full-sized oval, as well as several other pocket parks, community gardens etc. throughout the site.

This report has been prepared to identify the APZ setbacks required for residential and special fire protection purpose (SFPP) development as well as providing advice regarding road design, building construction, water supply and utilities in accordance with *PBP.*

SFPP development includes aged care (Class 9c buildings), Class 9b (assembly buildings) as well as child care centres, schools, hospitals, tourist accommodation, group homes etc.

**Figure 1.1 –** Landscape concept plan

## 1.3 Information collation

To achieve the aims of this report, a review of the information relevant to the property was undertaken prior to the initiation of field surveys. Information sources reviewed include the following:

- Landscape Concept Plan, prepared by *Oculus*, no date
- Ecological Advice - *Travers bushfire & ecology* March 2019
- Parramatta (formerly The Hills) Local Environmental Plan 2012
- *NearMap* aerial photography
- Topographical maps *DLPI of NSW* 1:25,000
- *Australian Standard 3959 Construction of buildings in bushfire-prone areas*
- *Planning for Bush Fire Protection 2019*

An inspection of the proposed development site and surrounds was undertaken by Nicole van Dorst in October 2018 to assess the topography, slopes, aspect, drainage, vegetation and adjoining land use. The identification of existing bushfire measures and a visual appraisal of bushfire hazard and risk were also undertaken.

## 1.4 Site description

The property is to the north of North Rocks Road and is adjoined by a narrow strip of bushland vegetation located between the site and the M2 Motorway. Table 1.3 provides a summary of the planning, cadastral, topographical, and disturbance details of the subject site.

**Table 1.1 – Site features**

| | |
|---|---|
| **Location** | 361-365 North Rocks Road, North Rocks |
| **Local government area** | Parramatta |
| **Size** | 12.676 ha |
| **Grid reference** | 317442E 626151N |
| **Elevation** | 88-100m AHD |
| **Topography** | The site has a gentle slope to the north with an average slope of around 4 degrees. |
| **Catchment and drainage** | The site falls north into Blue Gum Creek which then flows into Darling Mills Creek which flows in a westerly, then southerly direction discharging into the Parramatta River. |
| **Vegetation** | Remnant vegetation occurs in the north of the study area. This is dominated by *E. pilularis* and *C. gummifera.* |
| **Existing land use and zoning** | Institute for deaf and blind children, currently zoned R2 - Low Density Residential. |
| **Clearing** | 95% of the study area has been cleared of native vegetation. |


**Figure 1.2 –** Aerial appraisal

## 1.5 Legislation and planning instruments

### *1.5.1 Environmental Planning and Assessment Act 1979 (EP&A Act) and bushfire prone land*

The *EP&A Act* governs environmental and land use planning and assessment within New South Wales (NSW). It provides for the establishment of environmental planning instruments, development controls and the operation of construction controls through the *National Construction Code (NCC).* The identification of bushfire prone land is required under Section 10.3 of the *EP&A Act*.

Bushfire prone land maps provide a trigger for the development assessment provisions. The proposed rezoning is located on land that is mapped by Parramatta Council as being bushfire prone (refer Figure 1.3).

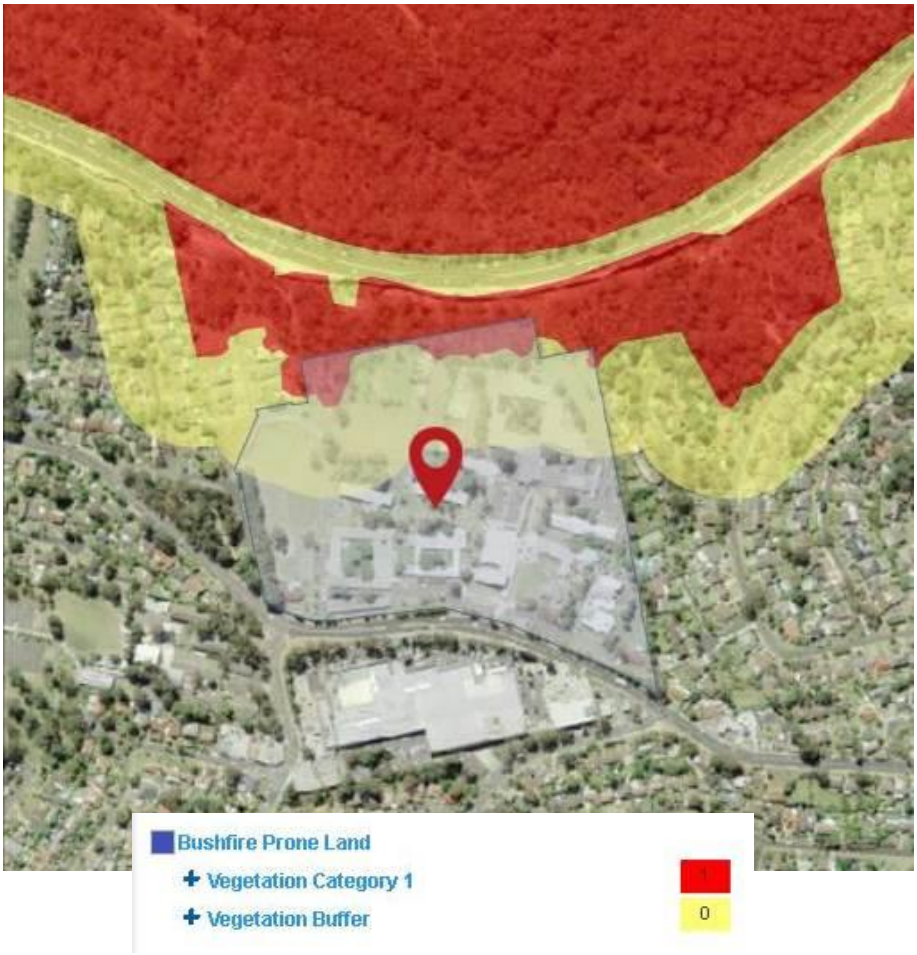



**Figure 1.3** – Bushfire prone land map
*(Source: NSW Planning portal)*

### *1.5.2 Local Environmental Plan (LEP) and Development Control Plan (DCP)*

A LEP provides for a range of zonings which list development that is permissible or not permissible, as well as the objectives for development within a zone.

The site is zoned under Parramatta (former The Hills LEP) 2012 as R2 low density residential. The proposed rezoning will seek an amendment to the zoning to create R3 (medium density residential) and R4 (high density residential).

The proposal, including the provision of APZs, will seek to comply with the objectives of the zoning.

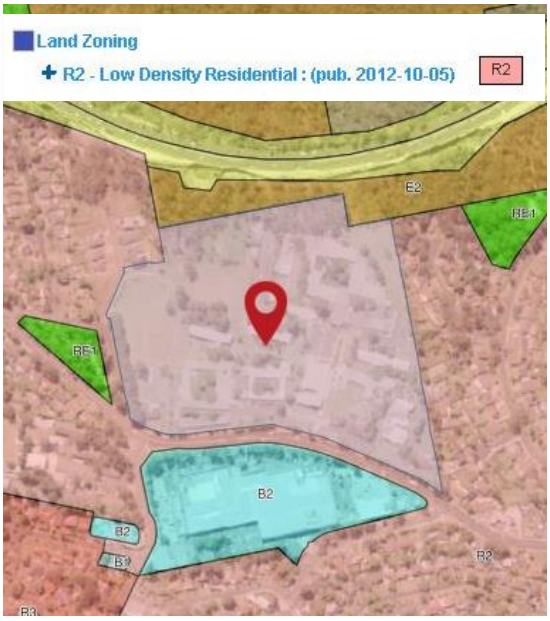



**Figure 1.4** – Zoning
*(Source: NSW Planning portal)*

### *1.5.3 Planning for Bush Fire Protection 2019 (PBP)*

Bushfire protection planning requires the consideration of the RFS planning document entitled *PBP.* The policy aims to provide for the protection of human life (including fire fighters) and to minimise impacts on property and the environment from the threat of bushfire, while having due regard to development potential, on site amenity and protection of the environment.

*PBP* outlines the following planning principles that must be achieved for all planning proposals:

1. provision of a perimeter road with two way access which delineates the extent of the intended development.
2. provision, at the urban interface, for the establishment of adequate APZs for future housing.
3. specifying minimum residential lot depths to accommodate APZs for lots on perimeter roads.
4. minimising the perimeter of the area of land interfacing the hazard, which may be developed.
5. introduction of controls which avoid placing inappropriate developments in hazardous areas, and
6. introduction of controls on the placement of combustible materials in APZs.

In addition to the above, *PBP* outlines the bushfire protection measures required to be assessed for new development in bushfire prone areas.

The planning proposal has been assessed in compliance with the following measures to ensure that future development is capable of complying with *PBP*:

- asset protection zones
- building construction and design
- access arrangements
- water supply and utilities
- landscaping
- emergency arrangements

### *1.5.4 National Construction Code (NCC) and the Australian Standard AS3959 Construction in bushfire-prone areas 2018 (AS3959)*

The *NCC* is given effect through the *EP&A Act* and forms part of the regulatory environment of construction standards and building controls. The *NCC* outlines objectives, functional statements, performance requirements and deemed to satisfy provisions. For residential dwellings these include Classes 1, 2 and 3 buildings. The construction manual for the deemed to satisfy requirements is *AS3959.*

Consideration of *AS3959* is not specifically required in a masterplan proposal, the APZs provided for standard residential development are based on a bushfire attack level (BAL) 29 construction standard for those buildings adjacent to the bushfire hazard. Future special fire protection purpose (SFPP) development is provided with larger APZs equivalent to <10kW/$m^2$. Future SFPP buildings (within 100m of the bushfire hazard) will require compliance with BAL 12.5 construction.

# Bushfire Strategic Study

# 2

*PBP* includes the requirement to prepare a strategic bushfire study for rezoning applications. The level of information required is dependent upon the nature of the scale of the proposal, the bushfire risk and its potential impact upon the wider infrastructure network.

The Strategic Bush Fire Study is designed to assess whether new development is appropriate in the bushfire hazard context. It also provides the ability to assess the strategic implications of future development for bushfire mitigation and management.

The following Table 2.1 assesses the proposed development in terms of the broader bushfire landscape, land use as well as access and egress and associated infrastructure.

Buildings exceeding three (3) storeys in height are considered to be multi-storey buildings in the context of *PBP.* Multi-storey buildings (i.e. proposed future residential flat buildings) are required to comply with the additional considerations outlined in Table 2.2.

The following Sections 3-5 outline the relevant performance criteria to be achieved for future development in accordance within *PBP.*

**Table 2.1** – Bushfire strategic study.

| Issue | Detail | Assessment considerations | Proposal's compliance |
|---|---|---|---|
| **Bushfire landscape assessment** | A bushfire landscape assessment considers the likelihood of a bushfire, its potential severity and intensity and the potential impact on life and property in the context of the broader surrounding landscape. | • The bushfire hazard in the surrounding area, including:<br>  ○ vegetation<br>  ○ topography<br>  ○ weather<br>• The potential fire behaviour that might be generated based on the above<br>• Any history of bush fire in the area<br>• Potential fire runs into the site and the intensity of such fire runs. | The site is located within a highly developed area with managed / developed land adjoining the site to the south, east and west.<br><br>The land to the north is zoned E2 environmental conservation and consists of a narrow bushland strip with a width of 40m-120m. The width of this reserve increases slightly to 190m to include the RE1 zoned land (Scout Hall) further to the east. This strip of vegetation is separated from further bushland in the north by the M2 motorway. The M2 provides a 40m wide fire break with concrete acoustic walls up to 6m in height (refer Photos 1 & 2).<br><br>The topography within the adjacent northern bushland area is 3-10 degrees to the north increasing to 15 degrees in the north-east.<br><br>The Hills Bushfire Risk Management Plan identifies the site as being exposed to a medium bushfire risk with an unlikely chance of bushfire. The Hills Bushfire Risk Management Plan identifies the vegetation to the north as a strategic fire advantage zone which is subject to the Hills Prescribed Burning Works Plan with the vegetation under the powerline easement being maintained as per Network Management Plan (*Integral Energy*)<br><br>The bushfire impact and potential fire runs into the site are mitigated by the M2 motorway and surrounding managed land. As a result the SFR methodology has been used, based on the medium bushfire risk, to determine the expected radiant heat impact on future development. |

| Issue | Detail | Assessment considerations | Proposal's compliance |
|---|---|---|---|
| **Land use assessment** | The land use assessment will identify the most appropriate locations within the masterplan area or site layout for the proposed land uses. | • The risk profile of different areas of the development layout based on the above landscape study;<br>• The proposed land use zones and the resultant permitted land uses;<br>• The most appropriate siting of different land uses based on risk profiles within the site (i.e. not locating development on ridge tops, SFPP development to be located in lower risk areas of the site);<br>• The impact of the siting of these uses on APZ provision. | The property has been used historically for the *Royal Institute for Deaf and Blind Children* which is a SFPP use. The proposed future use will be residential, including potential multi-storey residential flat buildings up to 6/7 storeys with SFPP development located to the south (i.e. a lower bushfire risk).<br><br>The APZs identified in the report are based on the SFR methodology, with the bushfire threat (identified as a medium risk) located adjacent to the northern property boundary.<br><br>A number of residential flat buildings are shown on the Master Plan within the northern portion of the site. Accordingly they will be to be sited and designed to mitigate the bushfire risk in accordance with PBP requirements. Future SFPP development (i.e. aged care, childcare etc.) should be located within the southern portion of the site. |
| **Access and egress** | A study of the existing and proposed road networks both within and external to the masterplan area or site layout. | • The capacity for the proposed road network to deal with evacuating residents and responding emergency services, based on the existing and proposed community profile;<br>• The location of key access routes and direction of travel;<br>• The potential for development to be isolated in the event of a bushfire. | Public access into the site will be provided from North Rocks Road in the south and Barclay Road (via Baden Powell Place) in the west. This existing network provides sufficient and safe egress away from the direct threat of bushfire into areas of highly managed land.<br><br>The concept plans (as they progress to DA stage) are to provide for an access (8m wide carriageway) adjacent to the bushfire hazard in compliance with the acceptable solutions outlined in PBP. |
| **Emergency services** | An assessment of the future impact of new development on emergency services provision. | • Consideration of the increase in demand for emergency services responding to a bushfire emergency (including the need for new stations / bridges);<br>• Impact on the ability of emergency services to carry out fire suppression in a bushfire emergency. | Fire and Rescue NSW has a station located at 130 Seven Hills Road, Baulkham Hills, approximately 6km to the west. This service is considered adequate and no further stations are required. The proposed development will comply with *PBP* with the provision of access to the bushfire hazard (perimeter road), APZs and building construction standards to increase the site's resilience to bushfire attack and improve firefighting access. |

| Issue | Detail | Assessment considerations | Proposal's compliance |
|---|---|---|---|
| **Infrastructure** | An assessment of the issues associated with infrastructure provision. | • The ability of the reticulated water system to deal with a major bushfire event (particularly in terms of water pressure);<br>• Life safety issues associated with fire and proximity to high voltage power lines, natural gas supply lines etc. | There is a high voltage power line traversing the north-eastern corner of the site. The vegetation under this power line is being managed (to a height of <4m) in accordance with a Network Management Plan (source: The Hills BFRMP, 2011), designed to address the bushfire risk posed to the infrastructure. The transmission lines will not adversely affect access to and from the site.<br><br>Future water and gas supply will comply with *PBP.* |
| **Adjoining land** | The impact of new development on adjoining landowners and their ability to undertake bushfire management. | • Consideration of the implications of a change in land use on adjoining land including;<br>○ The ability of adjoining and nearby land to carry a bushfire;<br>○ Consideration of increased pressure on adjoining landowners to introduce or increase bushfire protection measures through the implementation of Bush Fire Management Plans as a result of the changes in land use. | The proposed development will provide for *PBP* complying bushfire protection measures with all measures being implemented within the site. Adjoining landholders are not required to increase their bushfire management responsibility. |

**Table 2.2 – Additional considerations for multi-storey development**

| Issue | Specific concern | Technical considerations | Proposal's compliance |
|---|---|---|---|
| **Population** | Impact on existing community and infrastructure | What capacity does the existing infrastructure have to allow evacuation of existing and proposed residents in the event of a bushfire? | Given the medium bushfire risk posed to the property, and future compliance with the performance criteria outlined in *PBP*, (asset protection, building construction, access, emergency evacuation, water supply and utilities) it will be safe for occupants to shelter in place.<br><br>Alternatively, if directed by emergency services, evacuation off site can occur via the proposed and existing road network to the south and away from the possible threat of bushfire.<br><br>Traffic studies should address the capacity of the existing road network to support potential evacuation events. |
| **Location of building** | Locating on ridge tops emphasises the risk of convective plume interaction and wind related impacts | • Consider locating the building away from ridge tops.<br>• If unavoidable, what is the impact on modelling and risk to the building?<br>• Is this risk appropriate for the building and occupant numbers? | There are no ridgetops in close proximity to the development. Based on the medium bushfire risk posed to the site the short fire run is an appropriate methodology to determine the complying APZ dimensions based on a BAL rating of <29kW/m$^2$. |
| **Egress** | Exposure to bushfire prone vegetation – which elevations? | How does the emergency evacuation procedure take account of the location of bushfire prone vegetation? | The northern portion of the site is exposed to a medium bushfire risk. Evacuation (if required) will occur to the south and west away from the direct threat of bushfire. |
| **Building construction** | Building façade – how does this perform in a bushfire scenario, i.e. subjected to certain levels of radiant heat? | • What material is proposed?<br>• How does this comply with *AS3959*?<br>• Is this appropriate for the design fire scenario? | The proposed materials for construction will be subject to a separate development application (DA) which will determine the final BAL rating once concept plans have been prepared. Future dwellings will comply with *AS3959 – Construction of buildings in bushfire prone areas.* |
| | Balconies may contain external features which could ignite and contribute to building ignition and fuel loads | • Are there balconies proposed?<br>• What may be stored on the balconies?<br>• Can there be restrictions on what is stored on the balconies due to fire risk? | The proposed design will be subject to a separate DA which will determine the final BAL rating and balcony design. |

| Issue | Specific concern | Technical considerations | Proposal's compliance |
|---|---|---|---|
| **Car parking** | Lower storey car park could be subject to ember attack and high radiant heat loads igniting multiple vehicles at one time. | • How does the warning and suppression system take account of the increased fuel load beneath the residential portion of the building?<br>• Where are exits located? Are they guiding occupants away from the car park? | The proposed design will be subject to a separate DA. Future design should consider location of exits and the prevention of embers into any future lower storey car park. |
| **Height of building** | Different elements of the flame could have different impacts on different levels of the building.<br>The whole building could be impacted by ember attack and multiple floors could be alight simultaneously. | • What are the flame dimensions, including the flame angle?<br>• Where is the hottest part of the flame located? How would this impact on the proposed building?<br>• How would the warning and suppression systems in the building cope with this? | The proposed design will be subject to a separate DA. This will include further assessment of bushfire attack mechanisms based on the location of residential flat buildings within the broader site. |
| **Other engineering considerations** | Access for fire fighters may be restricted or challenging. | What would this mean for fire suppression? | A perimeter road is to be provided to allow access for fire fighting vehicles to the hazard vegetation and all aspects of future buildings. |
| | Implications of collapse. | What would be the potential timing of any collapse?<br>How would emergency warning and evacuation plans take account of this? | Sufficient APZs and building design will prevent building collapse. |
| | Threat from surrounding buildings due to large view factors from adjacent façade fires. | How would this impact upon the proposed building?<br>How would warning and suppression systems take account of this? | |
| | Risk implications of floor to floor fire spread. | How would warning and suppression systems take account of this? | |

# Bushfire Threat Assessment 3

To assess the bushfire threat and to determine the required width of an APZ for a development, a review of the elements that comprise the overall threat needs to be completed.

*PBP* provides a methodology to determine the size of any APZ that may be required to offset possible bushfire attack. These elements include the potential hazardous landscape that may affect the site and the effective slope within that hazardous vegetation.

## 3.1 Hazardous fuels

*PBP* guidelines require the identification of the predominant vegetation formation in accordance with David Keith (2004) to determine APZ distances for new developments. The fuel loads associated with these vegetation formations and classes has undergone further research and has been adopted in the NSW RFS Fast Fact *Comprehensive Vegetation Fuel Loads (March 2019).* The fuel loads adopted in this assessment (column 3) relate back to the identified plant community type (PCT) which was confirmed by ecological studies undertaken by this firm and / or Sydney Metro Area vegetation mapping (refer Schedule 1 attached).

**Table 3.1 – Vegetation communities**

| PCT code / aspect | Vegetation community type | Vegetation class / approach adopted (*Pre-release PBP*) |
|---|---|---|
| 1845 (north) | Smooth-barked Apple – Red Bloodwood – Blackbutt tall Open Forest (source: *Travers bushfire & ecology*) | Northern Hinterland Wet Sclerophyll Forest (20/33.1 t/ha) |
| North-east | N/A | Sydney Coastal Dry Sclerophyll Forest (source: *Sydney Metro Area vegetation mapping*) 21.3/27.3 t/ha) |

**Short fire run (SFR) (north and north-east)**

The vegetation corridor to the north is between 40m-150m in width and is adjoined by the M2 Motorway which provides a clear separation of 40m from further bushland vegetation to the north. The M2 provides an effective fire break with the provision of a 6m high concrete acoustic wall providing a further radiant heat / flame barrier to the vegetation further north (refer Photos 1 & 2).

**Photos 1 & 2** – M2 Motorway / acoustic wall providing an effective fire break

As depicted in Schedule 1 attached, this area is subject to four (4) fire run scenarios based on the flame length and effective slope. These are entitled SFR A, SFR B, SFR C & SFR D.

This vegetation has been identified as low risk vegetation due to its consistent linear width which is at right angles to the property. The proximity of this low risk vegetation in relation to the development site does not present the capacity for a fire run to progress into a bushfire that will achieve a head width exceeding 100m. In addition, a crown fire is unlikely to develop.

These assumptions are based on the following parameters / limitations:

- linear nature of the vegetation parcel which is limited to between 40m-150m.

In addition, the reserve complies with the limitations outlined in the *Short Fire Run* paper produced by the RFS as follows:

- vegetation slope is less than the 30-degree downslope and 15-degree upslope limit.
- site slope is less than the '20 degrees downslope limit' for fuel management
- the maximum fire run is less than 150m as per Figure 3.1 below.


**Figure 3.1** – Short fire run extent

This application seeks RFS agreement on the use of SFR methodology to the aspects identified in Figure 3.1 above.

The remaining land to the south, east and west and within 140m of the property is considered managed.

## 3.2 Effective slope

The effective slope is assessed for a distance 100m from the location of any habitable dwellings. Effective slope refers to that slope which provides the most effect upon likely fire behaviour. A mean average slope may not in all cases provide sufficient information such that an appropriate assessment can be determined. The effective slope within the hazardous vegetation is detailed within Tables 3.2 and 3.3 and Schedule 1 attached.

Slope gradient source/s; *LiDAR* data, surveyed data and onsite checking by *Travers bushfire & ecology* BPAD staff Nicole van Dorst.

## 3.3 Bushfire attack assessment

The following assessment has been undertaken using an alternative solution approach, utilising the fuel loads identified in the NSW RFS Fact sheet – *Comprehensive Vegetation Fuel Loads (March 2019)* (north-west and north-east) and the SFR methodology as detailed in the RFS document entitled *Short Fire Run Methodology for assessment of bush fire risk for low risk vegetation*.

A fire danger index (FDI) of 100 has been used to calculate bushfire behaviour on the site based on its location within the Greater Sydney region.

Table 3.2 provides a summary of the bushfire attack assessment for future residential development. Table 3.3 provides a summary of the outputs using the SFR methodology to the north and north-east. Table 3.4 provides a summary of the bushfire attack assessment for future SFPP development (i.e. aged care as well as Class 9 assembly buildings).

**Table 3.2 – Bushfire attack assessment (residential development)**

| Aspect | Vegetation formation within 140m of development (refer Note 1) | Effective slope of land | Minimum APZ required *PBP 2019* (metres) |
|---|---|---|---|
| **Future residential development (BAL 29)** | | | |
| North-west | Northern Hinterland Wet Sclerophyll Forest | 3° D | **25** (refer Note 1) |
| North | Short Fire Run A & B (refer Table 2.3) | 6-9° D | Refer Table 3.3 |
| North-east | Sydney Coastal Dry Sclerophyll Forest | 8° D | **33** (refer Note 1) |
| North-east | Short Fire Run C & D (refer Table 2.3) | 10-15° D | Refer Table 3.3 |
| East | Transmission easement (Tall heath) | 6° D | **19** |

**Note 1:** A performance based assessment using Appendix B of *AS3959* was undertaken to determine the required minimum APZ based on Northern Hinterland Wet Sclerophyll Forest (fuel load 20/33.1 t/ha) and a downslope of 3 degree and Sydney Coastal Dry Sclerophyll Forest (fuel load 21.3/27.3 t/ha) and a down slope of 8 degrees (determined to be the worst case scenario in each scenario). The assessment was undertaken using the bushfire attack assessor (BFAA) developed by *Newcastle Bushfire Consulting.* These results are provided within Appendix 1.

**Table 3.3 – Design fire calculations (SFR)**

A performance-based assessment using the SFR methodology has been undertaken to determine the required the minimum required APZ. Results of the assessment, provided within Appendix 2, were prepared using the SFR calculator developed by *Australian Bushfire Safety & Planning.*

| Design Fire | Vegetation | Fire run length (metres) | Effective slope | Site slope | APZ provided (metres) | Calculated radiant heat impact |
|---|---|---|---|---|---|---|
| Fire Run A | Northern Hinterland Wet Sclerophyll Forest (20 / 33.1 t/ha) | 60 | $6^{0d}$ | Level | **15.5** | 27.27 kW/m$^2$ |
| Fire Run B | | 40 | $9^{0d}$ | Level | **16** | 27.44 kW/m$^2$ |
| Fire Run C | Sydney Coastal Dry Sclerophyll Forest (21.3 / 27.3 t/ha) | 100 | $10^{0d}$ | Level | **19.5** | 28.34 kW/m$^2$ |
| Fire Run D | | 150 | $15^{0d}$ | Level | **>20** | 28.97 kW/m$^2$ |

**Table 3.4 – Bushfire attack assessment (SFPP development)**

| Aspect | Vegetation formation within 140m of development (refer Note 1) | Effective slope of land | Minimum APZ required *PBP 2019* (metres) |
|---|---|---|---|
| **Future special fire protection purpose development (<10kW/m$^2$)** | | | |
| North-west | Northern Hinterland Wet Sclerophyll Forest | 0-5° D | 79 |
| North | Northern Hinterland Wet Sclerophyll Forest | 5-10° D | 93 |
| North-east | Sydney Coastal Dry Sclerophyll Forest | 10-15° D | 100 |

# Specific Protection Issues 4

## 4.1 Asset protection zones (APZs)

*PBP* dictates that the subsequent extent of bushfire attack that can potentially emanate from a bushfire must not exceed a radiant heat flux of 29*kW/m*$^2$ for residential subdivision and 10*kW/m*$^2$ for SFPP developments (i.e. aged care, Class 9b assembly buildings, childcare, tourist accommodation, group home etc). This rating assists in determining the size of the APZ in compliance with Appendix 2 of *PBP* to provide the necessary defendable space between hazardous vegetation and a building.

Table 4.1 outlines the proposal's compliance with the performance criteria for APZs.

**Table 4.1 – Performance criteria for asset protection zones (*PBP* 2019 guidelines pg. 43)**

| Performance criteria | Acceptable solutions | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|
| Potential building footprints will not be exposed to radiant heat levels exceeding 29kW/m$^2$ on each proposed lot | APZs are provided in accordance with Tables A1.12.2 and A1.12.4 based on the FFDI | ☐ | ☑ | Refer Section 2.3. An alternative solution approach was undertaken in compliance with the SFR methodology to determine setbacks for future residential development. |
| APZs are managed and maintained to prevent the spread of a fire towards the building | APZs are managed in accordance with the requirements of Appendix 4 | ☑ | ☐ | To be made a condition of consent. |
| The APZ is provided in perpetuity | APZs are wholly within the boundaries of the development site | ☑ | ☐ | APZs are within the site boundary. APZs within open space areas are to be maintained in accordance with a Plan of Management (PoM). |
| APZ maintenance is practical, soil stability is not compromised and the potential for crown fires is minimised | The APZ is located on lands with a slope of less than 18$^o$ | ☑ | ☐ | Complies. All slopes are less than 18 degrees. |

| Performance criteria | Acceptable solutions | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|
| Landscaping is designed and managed to minimise flame contact and radiant heat to buildings, and the potential for wind-driven embers to cause ignitions | Landscaping is in accordance with Appendix 4 | ☑ | ☐ | Can be a condition of consent |
| | Fencing is constructed in accordance with section 7.6 | ☑ | ☐ | Can be a condition of consent (see Note 1 below). |
| **Note 1**: Section 7.6 of PBP states that all fences in bush fire prone areas should be made of either hardwood or non-combustible material. However, in circumstances where the fence is within 6m of a building or in areas of BAL 29 or greater, they should be made of non-combustible material only. | | | | |

### 4.2 Building protection

The construction of buildings in bushfire prone areas is subject to guidelines within *AS3959 - Construction of buildings in bushfire prone areas* (2018).

The construction classification system is based on five (5) bushfire attack levels (BAL). These are BAL – Flame Zone (FZ), BAL 40, BAL 29, BAL 19 and BAL 12.5 *AS3959 - Construction of buildings in bushfire-prone areas*.

In terms of future subdivision / development approval, the minimum APZ must be provided in accordance with *PBP.* The APZs provided in Tables 3.2 and 3.3 (Section 3.2) of this report comply with these requirements for standard residential development based on BAL 29. Future SFPP development are to be provided with larger APZs (as per Table 3.4) and will require compliance with BAL 12.5 for dwellings within 100m of the bushfire hazard.

### 4.3 Hazard management

In terms of implementing and / or maintaining APZs, there is no physical reason that would constrain hazard management from being successfully carried out by normal means (e.g. mowing / slashing / tree pruning and removal).

APZs are required to be managed as an IPA in accordance with RFS guidelines *Standards for Asset Protection Zones* (RFS, 2005), with landscaping design to comply with Appendix 4 of *PBP*. Appendix 2 provides maintenance advice for vegetation within the APZ

A summary of the guidelines for managing APZs is attached as Appendix 1 to this report.

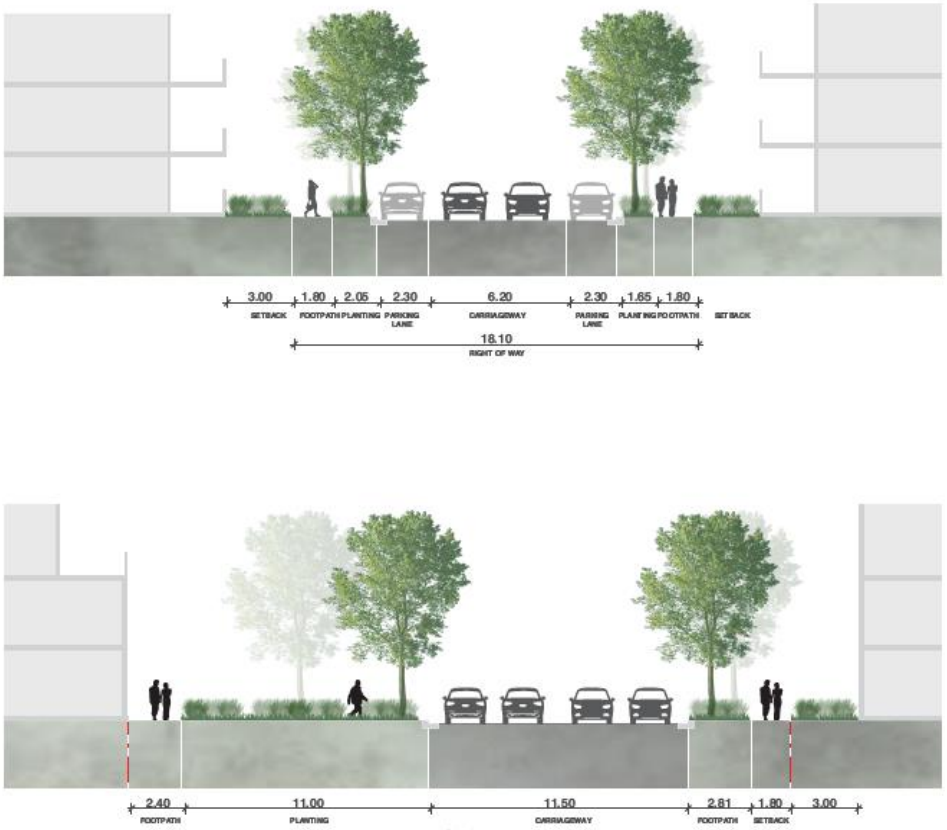
The entire development site is to be maintained as an APZ. This includes future open space areas. Management of the open space area and rooftop gardens are to occur in accordance with a PoM.

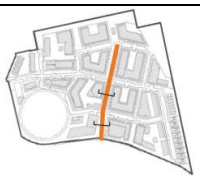
### 4.4 Access for firefighting operations

Public access into the site will be provided from North Rocks Road in the south and Barclay Road (via Baden Powell Place) in the west. This existing network provides sufficient and safe egress away from the direct threat of bushfire into areas of highly managed land.

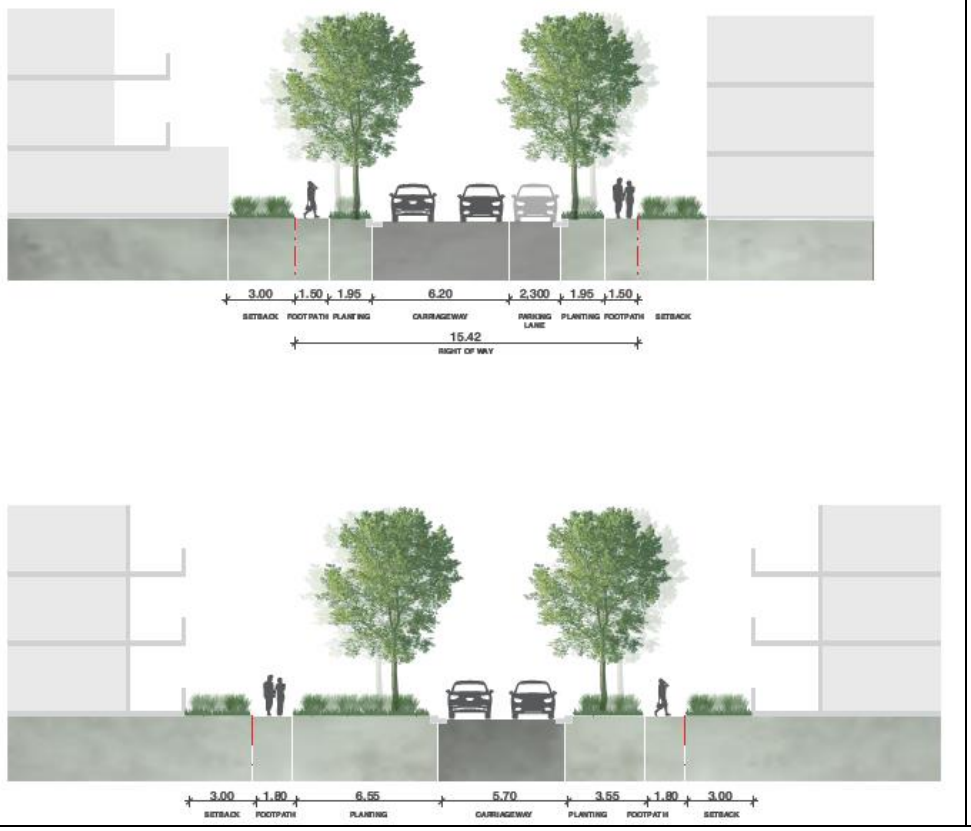
The current concept plan provides for local streets (6.2m carriageway plus 2.4m parking one side), existing streets (5.4m-6m carriageway) and signal approach road (11.5m carriageway)


**Figure 4.1** – Street hierarchy

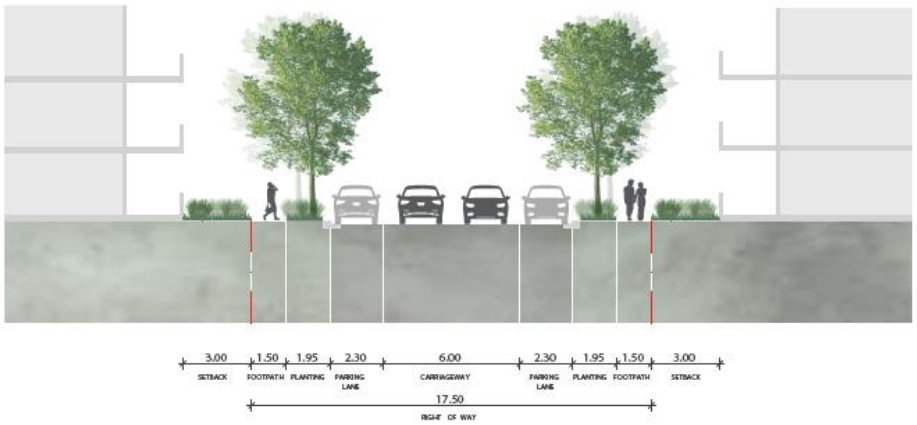


**ENTRY AVENUE**




**EAST – WEST AVENUE**




**LOCAL STREETS**

**Figure 4.2** – Street types

Table 4.2 outlines the performance criteria and acceptable solutions for future public roads.

It is noted that the further development of the concept plan will need to reflect the acceptable solutions outlined in *PBP* including a new perimeter access way along the northern site boundary (8m wide carriageway) which will link to the internal road network.

**Table 4.2 – *Performance criteria and acceptable solutions for access for residential and rural subdivisions***

| Performance criteria | | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|---|
| ACCESS (GENERAL REQUIREMENTS) | Firefighting vehicles are provided with safe, all weather access to structures and hazard vegetation | perimeter roads are provided for residential subdivisions of three or more allotments; | ☑ | | Future access design is to incorporate a perimeter road adjacent to the northern boundary. |
| | | subdivisions of three or more allotments have more than one access in and out of the development; | ☑ | | Access is available via North Rocks Road (south) and Barclay Road (west). |
| | | traffic management devices are constructed to not prohibit access by emergency services vehicles; | ☑ | | Future road design is to comply with the acceptable solutions. |
| | | maximum grades for sealed roads do not exceed 15 degrees and an average grade of no more than 10 degrees or other gradient specified by road design standards, whichever is the lesser gradient; | ☑ | | Complies. |
| | | all roads are through roads. Dead end roads are not recommended, but if unavoidable, dead ends are not more than 200m in length, incorporate a minimum 12 metres outer radius turning circle, and are clearly sign posted as a dead end; | ☑ | | Future road design is to comply with the acceptable solutions. The current dead-end road should link to a new perimeter road network. |
| | | where kerb and guttering are provided perimeter roll top kerbing should be used to the hazard side of the road; | ☑ | | Future road design is to comply with the acceptable solutions. |
| | | where access / egress can only be achieved through forest, woodland or heath vegetation, secondary access shall be provided to an alternate point on the existing public road system. | ☑ | | Not applicable. |

| Performance criteria | | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|---|
| | The capacity of access roads is adequate for firefighting vehicles | the capacity of perimeter and non-perimeter road surfaces and any bridges / causeways is sufficient to carry fully loaded firefighting vehicles (up to 23 tonnes); bridges / causeways are to clearly indicate load rating. | ☑ | | |
| | There is appropriate access to water supply | hydrants are located outside of parking reserves and road carriageways to ensure accessibility to reticulated water for fire suppression; | ☑ | | |
| | | hydrants are provided in accordance with *AS2419.1:2005;* | ☑ | | |
| | | there is suitable access for a Category 1 fire appliance to within 4m of the static water supply where no reticulated supply is available; | ☑ | | Future road design is to comply with the acceptable solutions. |
| **PERIMETER ROADS** | Access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while residents are evacuating as well as providing a safe operational environment for emergency service personnel during firefighting and emergency management on the interface | perimeter roads are two-way sealed roads; | ☑ | | |
| | | 8m carriageway width kerb to kerb; | ☑ | | |
| | | parking is provided outside of the carriageway width; | ☑ | | |
| | | hydrants are located clear of parking areas; | ☑ | | |
| | | there are through roads, and these are linked to the internal road system at an interval of no greater than 500m; | ☑ | | |

| Performance criteria | | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|---|
| | | curves of roads have a minimum inner radius of 6m; | ☑ | | Future road design is to comply with the acceptable solutions. |
| | | the maximum grade road is 15° and average grade is 10°; | ☑ | | |
| | | the road crossfall does not exceed 3°; | ☑ | | |
| | | a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided | ☑ | | |
| **NON-PERIMETER ROADS** | Access roads are designed to allow safe access and egress for medium rigid firefighting vehicles while residents are evacuating | minimum 5.5m width kerb to kerb; | ☑ | | Future road design is to comply with the acceptable solutions. |
| | | parking is provided outside of the carriageway width; | ☑ | | |
| | | hydrants are located clear of parking areas; | ☑ | | |
| | | roads are through roads, and these are linked to the internal road system at an interval of no greater than 500m; | ☑ | | |
| | | curves of roads have a minimum inner radius of 6m; | ☑ | | |
| | | the road crossfall does not exceed 3°; | ☑ | | |
| | | a minimum vertical clearance of 4m to any overhanging obstructions, including tree branches, is provided. | ☑ | | |

## 4.5 Water supplies

Town reticulated water supply is available to the property in the form of an underground reticulated water system.

Table 4.3 outlines the performance criteria and acceptable solutions for reticulated water supply.

**Table 4.3 – Performance criteria for reticulated water supplies (*PBP 2019* guidelines)**

| Performance criteria | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|
| a water supply is provided for firefighting purposes | reticulated water is to be provided to the development, where available; | ☑ | | Future water supply is to comply with the acceptable solutions. |
| | a static water supply is provided where no reticulated water is available; | N/A | | |
| water supplies are located at regular intervals | fire hydrant spacing, design and sizing comply with the *Australian Standard AS2419.1:2005;* | ☑ | | |
| the water supply is accessible and reliable for firefighting operations | hydrants are not located within any road carriageway; | ☑ | | |
| | reticulated water supply to urban subdivisions uses a ring main system for areas with perimeter roads; | ☑ | | |
| flows and pressure are appropriate | fire hydrant flows and pressures comply with *AS2419.1:2005;* | ☑ | | |
| the integrity of the water supply is maintained | all above-ground water service pipes are metal, including and up to any taps; | ☑ | | |

## 4.6 Gas

Table 4.4 outlines the required performance criteria for the gas supply.

**Table 4.4 – Performance criteria for gas supplies (*PBP* 2019 guidelines)**

| Performance criteria | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|
| Location and design of gas services will not lead to ignition of surrounding bushland or the fabric of buildings. | reticulated or bottled gas is installed and maintained in accordance with *AS/NZS 1596:2014* and the requirements of relevant authorities, and metal piping is used; | ☑ | | Future gas supply is to comply with the acceptable solutions. |
| | all fixed gas cylinders are kept clear of all flammable materials to a distance of 10m and shielded on the hazard side; | ☑ | | |
| | connections to and from gas cylinders are metal; | ☑ | | |
| | polymer-sheathed flexible gas supply lines are not used; | ☑ | | |
| | above-ground gas service pipes are metal, including and up to any outlets; | ☑ | | |

## 4.7 Electricity

Table 4.5 outlines the required performance criteria for electricity supply.

**Table 4.5 – Performance criteria for electricity services (*PBP* 2019 guidelines)**

| Performance criteria | Acceptable solution | Acceptable solution | Performance solution | Comment |
|---|---|---|---|---|
| Location of electricity services limits the possibility of ignition of surrounding bush land or the fabric of buildings | Where practicable, electrical transmission lines are underground; | ☑ | | Future electricity supply is to comply with the acceptable solutions. |
| | Where overhead, electrical transmission lines are proposed as follows:<br>• lines are installed with short pole spacing (30m), unless crossing gullies, gorges or riparian areas;<br>• no part of a tree is closer to a power line than the distance set out in accordance with the specifications in *ISSC3 Guideline for Managing Vegetation Near Power Lines.* | ☑ | | |

# Conclusion & Recommendations

# 5

## 5.1 Conclusion

This bushfire protection assessment has been undertaken in support of the proposed rezoning of Lot 3001 DP 1115866 from R2 (low density residential) to R3 (medium density residential) and R4 (high density residential).

Our assessment found that the bushfire hazard is restricted to the northern boundary only. Bushfire attack could potentially affect the development from the adjoining forest vegetation located within the narrow strip of bushland to the north and north-east of the property, resulting in possible ember and radiant heat attack.

The assessment has concluded that future development on site is capable of providing compliance with the planning principles of *PBP*. Design development of the current concept plan will need to reflect the requirement for a perimeter road and also ensure all buildings are located outside of the asset protection zone.

Future development on site is to comply with the following planning principles.

**Table 5.1 – Planning principles**

| Planning principles | Recommendations |
|---|---|
| Provision of a perimeter road with two-way access which delineates the extent of the intended development. | Future development design is to include a perimeter road adjacent to the northern property boundary between the development and hazardous vegetation. |
| Provision, at the urban interface, for the establishment of adequate APZs for future housing. | APZs have been recommended in compliance with BAL 29 (*PBP 2019* – SFR methodology) and seeks RFS agreement on the use of this methodology. |
| Specifying minimum residential lot depths to accommodate APZs for lots on perimeter roads. | Future subdivision / development design is to provide for APZs within lot boundaries to allow for the minimum APZs as recommended within Tables 3.2 – 3.4 and as depicted within Schedule attached. Future SFPP developments are to be provided with larger setbacks as per Table 3.5. |
| Minimising the perimeter of the area of land interfacing the hazard, which may be developed. | The bushfire hazard is restricted to the northern boundary of the site only. |
| Introduction of controls which avoid placing inappropriate developments in hazardous areas. | Future development will consist of residential dwellings. Any future application involving SFPP development is to be located within the southern portion of the property |
| Introduction of controls on the placement of combustible materials in APZs. | Compliant – can be made a condition of consent. |

The following recommendations are provided to ensure that future residential development is in accordance with, or greater than, the requirements of *PBP.*

## 5.2 Recommendations

**Recommendation 1** - APZs are to be provided to the future residential development. APZs are to be measured from the exposed wall of any dwelling toward the hazardous vegetation. The minimum APZ must be achievable within all lots fronting the bushfire hazard as nominated in Tables 3.2-3.4 (for residential development) and Table 3.5 (for SFPP development) and as generally depicted in Schedule 1. The detailed development of the design at DA stage is required to ensure appropriate setbacks are provided and agreement with the NSW RFS is required on the use of SFR methodology.

**Recommendation 2** - Fuel management within the APZs is to be maintained by regular maintenance of the landscaped areas, mowing of lawns in accordance with the guidelines provided in Appendix 1, and as advised by the RFS in their publications. This includes the open space areas and rooftop gardens. A PoM is to be prepared to ensure the ongoing maintenance of these areas.

Landscaping principles are to ensure the site is maintained to the standards required for an APZ. This includes consideration of tree planting species and distribution.

**Recommendation 3** - Building construction standards for the proposed future dwellings are to be applied in accordance with *AS3959 Construction of buildings in bushfire prone areas (2018)* or NASH Standard (1.7.14 updated) *National Standard Steel Framed Construction in Bushfire Areas - 2014* as appropriate with additional construction requirements as listed within *PBP*.

**Recommendation 3** - Future road design is to provide for a perimeter access road adjacent to the northern property boundary. Roads are to comply with the acceptable solutions outlined in Section 5.3b of *PBP* (refer Section 4.4 of this report). This includes avoiding dead end roads and ensuring future internal roads are at least 5.5m carriageway.

**Recommendation 5** - Water, electricity and gas supply is to comply with the acceptable solutions as provided within Section 5.3c of *PBP* (refer Sections 4.5, 4.6 and 4.7 of this report).

## REFERENCES


Australian Building Codes Board (2010) – *Building Code of Australia*, Class 1 and Class 10 Buildings Housing Provisions Volume 2.

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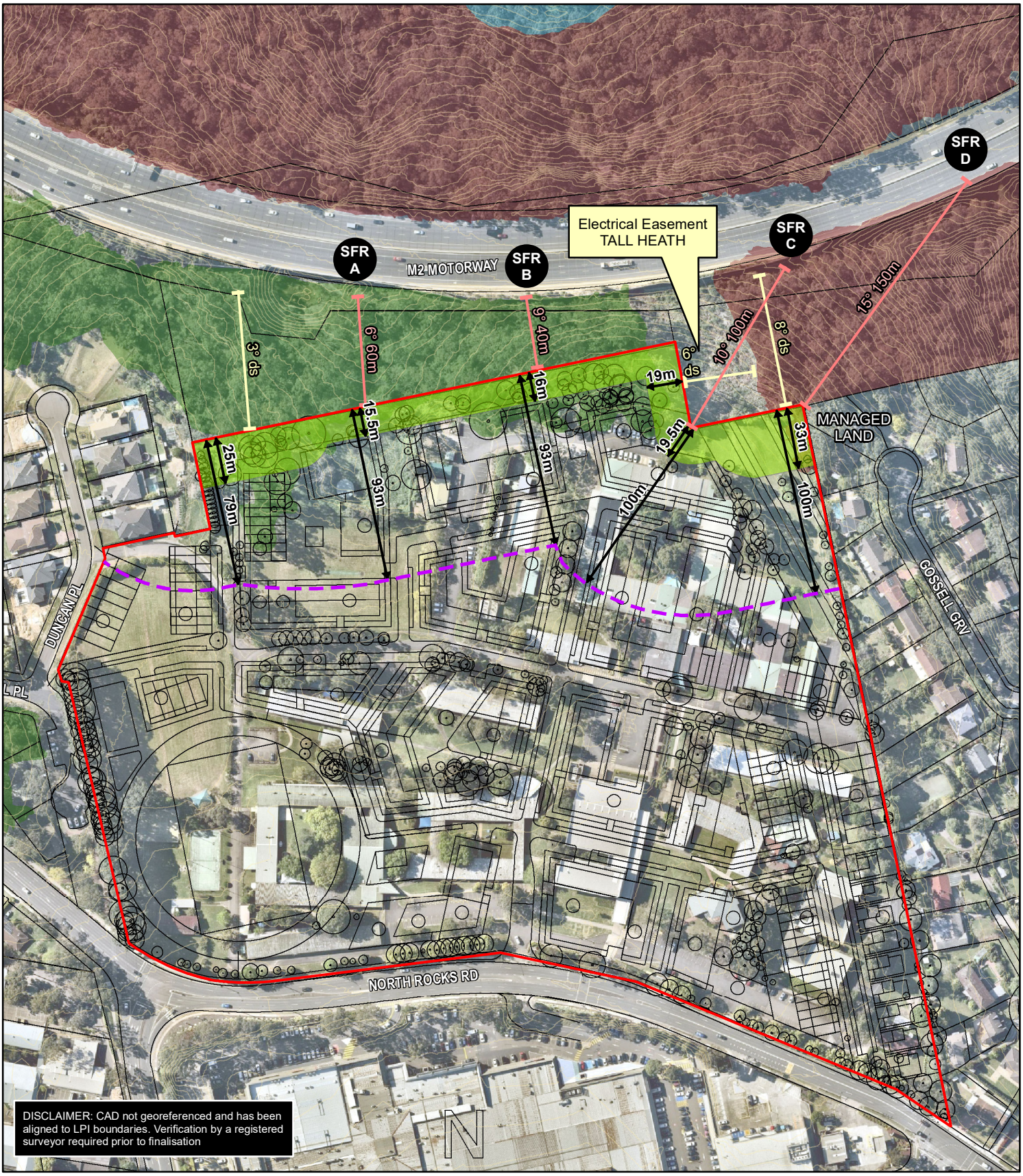
Umwelt, 2012. *Ecological Assessment for Rezoning Application Lots 93 – 96 Boundary Road, Medowie.*

# Plan of Bushfire Protection Measures

S1




**Legend**

- Lot boundary (source: LPI)
- Contours 1m (source: LiDAR)
- APZ for SFPP (10KWm²)

**Asset Protection Zone (APZ)**

- APZ for residential (BAL 29)

**Sydney Metro Area 2016**

**State Class**

- Northern Hinterland Wet Sclerophyll Forests
- Northern Warm Temperate Rainforests
- Sydney Coastal Dry Sclerophyll Forests

Aerial source:Nearmap

Travers bushfire & ecology
www.traversecology.com.au

| PROJECT & MXD REFERENCE | DATE & ISSUE | SCALE & COORDINATE SYSTEM |
|---|---|---|
| 361-365 North Rocks Rd, North Rocks | 13/10/2020 Issue 1 SC | 1:2,765 @ A4 GDA 1994 MGA Zone 56 |

0 50 100 m

TITLE

# Schedule 1 - Bushfire Protection Measures

Document Path: N:\GIS STORAGE\N Drive\18EG05_NorthRocksRd_NorthRocks\MXDs\19MEC02B_BF001.mxd

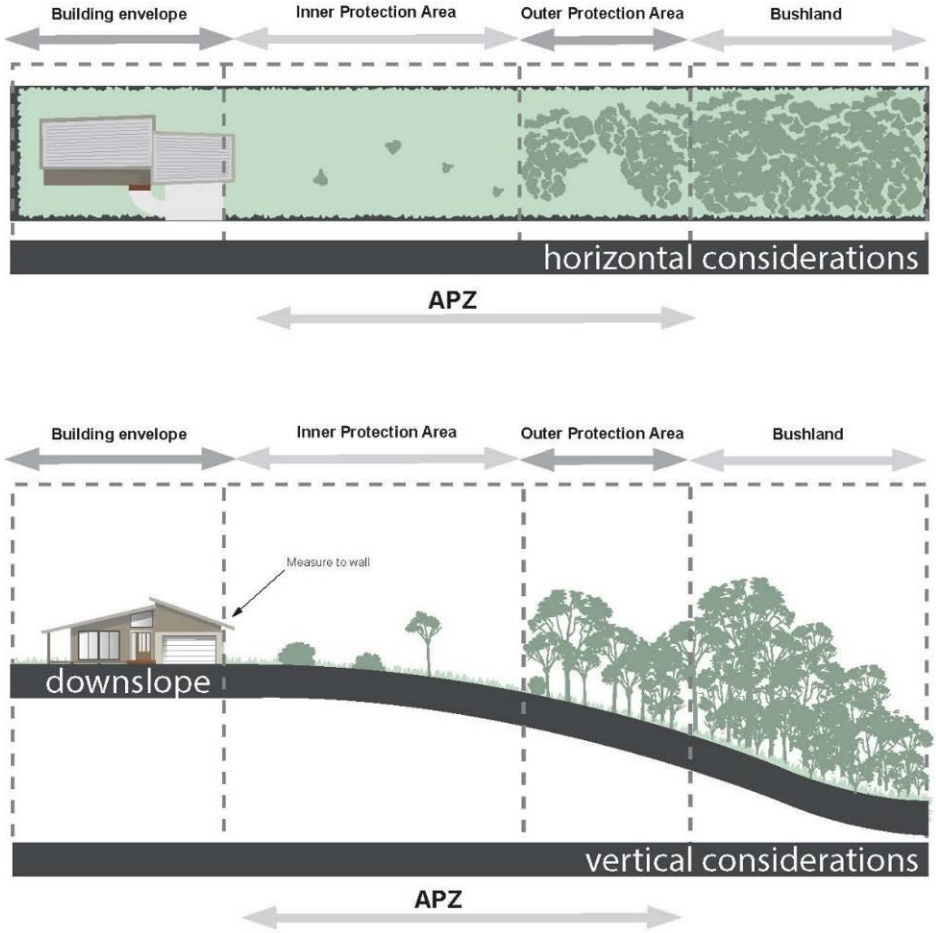
Disclaimer: The mapping is indicative of available space and location of features which may prove critical in assessing the viability of the proposed works. Mapping has been produced on a map base with an inherent level of inaccuracy, the location of all mapped features are to be confirmed by a registered surveyor.

# Management of Asset Protection Zones

# A1

The RFS provides basic advice in respect of managing APZs through documents such as, *Standards for Asset Protection Zones* (RFS, 2005), with landscaping to comply with Appendix 5 of *PBP*.

The APZ generally consists of two subordinate areas, an inner protection area (IPA) and an outer protection area (OPA). The OPA is closest to the bush and the IPA is closest to the dwellings. The property is to be managed to IPA standards only. A typical APZ is graphically represented below:




APZs and progressive reduction in fuel loads (Source: PBP, 2019)

**Note:** Vegetation management as shown is for illustrative purposes only. Specific advice is to be sought regarding vegetation removal and retention from a qualified and experienced expert to ensure APZs comply with the RFS performance criteria.

The following provides maintenance advice for vegetation within the IPA. The APZ is to be maintained in perpetuity and should be undertake regularly, particularly in advance of the bushfire season.

*Inner protection area (IPA)*
Fuel loads within the IPA are to be maintained so it does not exceed 4t/ha.

Trees are to be maintained to ensure;

- canopy cover does not exceed 15% at maturity;
- trees (at maturity) do not touch or overhang the building;
- lower limbs should be removed up to a height of 2m above ground;
- tree canopies should be separated by 2 to 5m; and
- preference should be given to smooth barked and evergreen trees.

Shrubs are to be maintained to ensure;

- create large discontinuities or gaps in the vegetation to slow down or break the progress of fire towards buildings;
- shrubs should not be located under trees;
- shrubs should not form more than 10% of ground cover; and
- clumps of shrubs should be separated from exposed windows and doors by a distance of at least twice the height of vegetation.

Grass is to be maintained to ensure:

- grass should be kept mown (as a guide grass should be kept to no more than 100mm in height); and
- leaves and vegetation debris should be removed (litter fuel within the IPA should be kept below 1cm)

General advice for landscaping is provided below:

- Suitable impervious areas being provided immediately surrounding the building such as courtyards, paths and driveways;
- Restrict planting in the immediate vicinity of the building which may over time and if not properly maintained come into contact with the building;
- When considering landscape species consideration needs to be given to estimated size of the plant at maturity;
- Avoid species with rough fibrous bark, or which retain/shed bark in long strips or retain dead material in their canopies;
- Use smooth bark species of trees species which generally do not carry a fire up the bark into the crown;
- Avoid planting of deciduous species that may increase fuel at surface / ground level (i.e. leaf litter);
- Avoid climbing species to walls and pergolas;
- Locate combustible materials such as woodchips / mulch, flammable fuel stores away from the building;
- Locate combustible structures such as garden sheds, pergolas and materials such timber garden furniture way from the building; and
- Use of low flammability vegetation species.

# Performance based assessment

# A2

## NBC Bushfire Attack Assessment Report V2.1

AS3959 (2009) Appendix B - Detailed Method 2

**Printed:** 18/03/2019 **Assessment Date:** 18/03/2019

**Site Street Address:** 361 North Rocks Road, North Rocks

**Assessor:** Mr Admin; admin

**Local Government Area:** Baulkham Hills **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:** A OPTION 1 North-west

**Vegetation Information**

| | | | |
|---|---|---|---|
| **Vegetation Type:** | Forest | **Vegetation Group:** | Forest and Woodland |
| **Vegetation Slope:** | 3 Degrees | **Vegetation Slope Type:** | Downslope |
| **Surface Fuel Load(t/ha):** | 20 | **Overall Fuel Load(t/ha):** | 33.1 |

**Site Information**

| | | | |
|---|---|---|---|
| **Site Slope** | 0 Degrees | **Site Slope Type:** | Level |
| **Elevation of Receiver(m)** | Default | **APZ/Separation(m):** | 25 |

**Fire Inputs**

| | | | |
|---|---|---|---|
| **Veg./Flame Width(m):** | 100 | **Flame Temp(K)** | 1090 |

**Calculation Parameters**

| | | | |
|---|---|---|---|
| **Flame Emissivity:** | 95 | **Relative Humidity(%):** | 25 |
| **Heat of Combustion(kJ/kg** | 18600 | **Ambient Temp(K):** | 308 |
| **Moisture Factor:** | 5 | **FDI:** | 100 |

**Program Outputs**

| | | | |
|---|---|---|---|
| **Category of Attack:** | HIGH | **Peak Elevation of Receiver(m):** | 10.13 |
| **Level of Construction:** | BAL 29 | **Fire Intensity(kW/m):** | 50483 |
| **Radiant Heat(kW/m2):** | 28.64 | **Flame Angle (degrees):** | 61 |
| **Flame Length(m):** | 23.16 | **Maximum View Factor:** | 0.452 |
| **Rate Of Spread (km/h):** | 2.95 | **Inner Protection Area(m):** | 25 |
| **Transmissivity:** | 0.833 | **Outer Protection Area(m):** | 0 |

| | | | |
|---|---|---|---|
| **Run Description:** | B OPTION 1 North-east | | |
| **Vegetation Information** | | | |
| **Vegetation Type:** | Forest | **Vegetation Group:** | Forest and Woodland |
| **Vegetation Slope:** | 8 Degrees | **Vegetation Slope Type:** | Downslope |
| **Surface Fuel Load(t/ha):** | 21.3 | **Overall Fuel Load(t/ha):** | 27.3 |
| **Site Information** | | | |
| **Site Slope** | 0 Degrees | **Site Slope Type:** | Level |
| **Elevation of Receiver(m)** | Default | **APZ/Separation(m):** | 33 |
| **Fire Inputs** | | | |
| **Veg./Flame Width(m):** | 100 | **Flame Temp(K)** | 1090 |
| **Calculation Parameters** | | | |
| **Flame Emissivity:** | 95 | **Relative Humidity(%):** | 25 |
| **Heat of Combustion(kJ/kg** | 18600 | **Ambient Temp(K):** | 308 |
| **Moisture Factor:** | 5 | **FDI:** | 100 |
| **Program Outputs** | | | |
| **Category of Attack:** | HIGH | **Peak Elevation of Receiver(m):** | 13.47 |
| **Level of Construction:** | BAL 29 | **Fire Intensity(kW/m):** | 62613 |
| **Radiant Heat(kW/m2):** | 28.98 | **Flame Angle (degrees):** | 57 |
| **Flame Length(m):** | 32.13 | **Maximum View Factor:** | 0.465 |
| **Rate Of Spread (km/h):** | 4.44 | **Inner Protection Area(m):** | 33 |
| **Transmissivity:** | 0.819 | **Outer Protection Area(m):** | 0 |

**Forest/Woodland - FDF & SFR Calculation page:**

| | |
|---|---|
| Fire run specifics | Short Fire Run A |

**Common and bushfire behaviour contributor inputs:**

| | | | | | |
|---|---|---|---|---|---|
| Predominant vegetation | Northern Hinterland Wet Sclerophyll Forests - 20 & 33.10 - Low - 0m - < 0.9m | | | | |
| Surface & Elevated Fuel Load | 20 | tph | Overall fuel load | 33.1 | tph |
| Average Canopy Height | 20 | Metres | Fire weather district | 100 | FDI |
| Average elevated fuel height | 1.4 | Metres | Flame temperature | 1090 | Kelvin |
| Distance to vegetation | 15.5 | Metres | Target elevation of receiver | 2 | Metres |
| ffective slope | 6 | Degrees | Ambient temperature | 308 | Kelvin |
| Site slope | 0 | Degrees | SFR fire run length | 60 | Metres |
| FDF nominal head width | 100 | Metres | | | |

| Outputs - Fully Developed Fire (FDF) | | | Outputs - Developing Fire Run (DFR) | | |
|---|---|---|---|---|---|
| Wind Speed | 45 | kph | Wind speed | 30 | kph |
| Default elevation of receiver | 13.786 | Metres | Default elevation of receiver | 8.862 | Metres |
| FDF Flame Angle | 14 | Degrees | SFR Flame Angle | 37 | Degrees |
| FDF Flame Length | 27.57 | Metres | SFR Flame Height | 17.724 | Metres |
| FDF Intensity | 62094 | kW/m | SFR Intensity | 37519 | kW/m |
| FDF FROS | 3.6309 | kph | SFR FROS | 3.6309 | kph |
| FDF Flame transmissivity | 0.8955 | kW/m | SFR Flame transmissivity | 0.8698 | kW/m |
| FDF View Factor | 0.7980 | | SFR View Factor | 0.4124 | |
| | | | Calculated SFR Head Width | 21.962 | Metres |
| | | | SFR fire run length | 60 | Metres |
| | | | Approx. SFR travel time | 16:31 | min/sec |
| **FDF Radiant Heat** | 54.33 | **kW/m$^2$** | **SFR Radiant Heat** | 27.27 | **kW/m$^2$** |

Input cells

Locked output cells

**Glossary of abreviations/terms:**

tph = tonnes per hectare
kW/m = Kilowatts per metre
kW/m2 = Kilowatts per metre squared
HFD = Horizontal Flame Depth
LRV - Low Risk Vegetation

m/h = metres per hour
FROS = Forward rate of Spread
kph = kilometres an hour
FF = Flank Fire
SFR = Short Fire Run

K = Kelvin
min = minutes
sec = seconds
min/sec = minutes and seconds

**Forest/Woodland - FDF & SFR Calculation page:**

| | |
|---|---|
| Fire run specifics | Short Fire Run B |

**Common and bushfire behaviour contributor inputs:**

| | | | | | |
|---|---|---|---|---|---|
| Predominant vegetation | Northern Hinterland Wet Sclerophyll Forests - 20 & 33.10 - Low - 0m - < 0.9m | | | | |
| Surface & Elevated Fuel Load | 20 | tph | Overall fuel load | 33.1 | tph |
| Average Canopy Height | 20 | Metres | Fire weather district | 100 | FDI |
| Average elevated fuel height | 1.4 | Metres | Flame temperature | 1090 | Kelvin |
| Distance to vegetation | 16 | Metres | Target elevation of receiver | 2 | Metres |
| ffective slope | 9 | Degrees | Ambient temperature | 308 | Kelvin |
| Site slope | 0 | Degrees | SFR fire run length | 40 | Metres |
| FDF nominal head width | 100 | Metres | | | |

| **Outputs - Fully Developed Fire (FDF)** | | | **Outputs - Developing Fire Run (DFR)** | | |
|---|---|---|---|---|---|
| Wind Speed | 45 | kph | Wind speed | 30 | kph |
| Default elevation of receiver | 16.500 | Metres | Default elevation of receiver | 10.293 | Metres |
| FDF Flame Angle | 14 | Degrees | SFR Flame Angle | 28 | Degrees |
| FDF Flame Length | 33.00 | Metres | SFR Flame Height | 20.586 | Metres |
| FDF Intensity | 76374 | kW/m | SFR Intensity | 46148 | kW/m |
| FDF FROS | 4.4659 | kph | SFR FROS | 4.4659 | kph |
| FDF Flame transmissivity | 0.9050 | kW/m | SFR Flame transmissivity | 0.8757 | kW/m |
| FDF View Factor | 1.0000 | | SFR View Factor | 0.4121 | |
| | | | Calculated SFR Head Width | 14.641 | Metres |
| | | | SFR fire run length | 28 | Metres |
| | | | Approx. SFR travel time | 8:57 | min/sec |
| **FDF Radiant Heat** | 68.81 | $kW/m^2$ | **SFR Radiant Heat** | 27.44 | $kW/m^2$ |

Input cells

Locked output cells

**Glossary of abreviations/terms:**

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kW/m = Kilowatts per metre
kW/m2 = Kilowatts per metre squared
HFD = Horizontal Flame Depth
LRV - Low Risk Vegetation

m/h = metres per hour
FROS = Forward rate of Spread
kph = kilometres an hour
FF = Flank Fire
SFR = Short Fire Run

K = Kelvin
min = minutes
sec = seconds
min/sec = minutes and seconds

**Forest/Woodland - FDF & SFR Calculation page:**

| | |
|---|---|
| Fire run specifics | Short Fire Run C |

**Common and bushfire behaviour contributor inputs:**

| | | | | | |
|---|---|---|---|---|---|
| Predominant vegetation | Sydney Coastal Dry Sclerophyll Forests - 21.3 & 27.3 - Medium - > 0.9m - < 1.4m | | | | |
| Surface & Elevated Fuel Load | 21.3 | tph | Overall fuel load | 27.3 | tph |
| Average Canopy Height | 20 | Metres | Fire weather district | 100 | FDI |
| Average elevated fuel height | 1.4 | Metres | Flame temperature | 1090 | Kelvin |
| Distance to vegetation | 19.5 | Metres | Target elevation of receiver | 2 | Metres |
| ffective slope | 10 | Degrees | Ambient temperature | 308 | Kelvin |
| Site slope | 0 | Degrees | SFR fire run length | 100 | Metres |
| FDF nominal head width | 100 | Metres | | | |

| **Outputs - Fully Developed Fire (FDF)** | | | **Outputs - Developing Fire Run (DFR)** | | |
|---|---|---|---|---|---|
| Wind Speed | 45 | kph | Wind speed | 30 | kph |
| Default elevation of receiver | 18.200 | Metres | Default elevation of receiver | 11.323 | Metres |
| FDF Flame Angle | 10 | Degrees | SFR Flame Angle | 39 | Degrees |
| FDF Flame Length | 36.40 | Metres | SFR Flame Height | 22.647 | Metres |
| FDF Intensity | 71878 | kW/m | SFR Intensity | 56081 | kW/m |
| FDF FROS | 5.0959 | kph | SFR FROS | 5.0959 | kph |
| FDF Flame transmissivity | 0.8979 | kW/m | SFR Flame transmissivity | 0.8614 | kW/m |
| FDF View Factor | 0.8623 | | SFR View Factor | 0.4327 | |
| | | | Calculated SFR Head Width | 36.604 | Metres |
| | | | SFR fire run length | 28 | Metres |
| | | | Approx. SFR travel time | 19:37 | min/sec |
| **FDF Radiant Heat** | 58.87 | **kW/m$^2$** | **SFR Radiant Heat** | 28.34 | **kW/m$^2$** |

Input cells

Locked output cells

**Glossary of abreviations/terms:**

tph = tonnes per hectare
kW/m = Kilowatts per metre
kW/m2 = Kilowatts per metre squared
HFD = Horizontal Flame Depth
LRV - Low Risk Vegetation

m/h = metres per hour
FROS = Forward rate of Spread
kph = kilometres an hour
FF = Flank Fire
SFR = Short Fire Run

K = Kelvin
min = minutes
sec = seconds
min/sec = minutes and seconds