PRACTICAL ECOLOGY
ecological restoration & consulting

Bushfire Management Statement:

Imagine Estate

Wallaroo Ave, Strathfieldsaye

August 2017

DRAFT Bushfire Management Statement
Imagine Estate, Wallaroo Ave, Strathfieldsaye

August 2017

Report by Julian Drummond and Andrew Stephens

Cover image: Woodland road reserve along Dunns Lane.

PRACTICAL ECOLOGY Pty Ltd

ACN: 082 911 377 ABN: 88 082 911 377
PO Box 228 Preston VIC 3072
(2B Stott Street Preston Vic 3072)
P: 9484 1555 F: 9484 9133
www.practicalecology.com.au

Prepared for:	Villawood Properties Pty Ltd	PE project number:	STR2462
Contact:	Andrea Smith Email: andrea@villawoodproperties.com	PE file location:	R:\Bendigo Greater\Imagine Estate, Strathfieldsaye\Wallaroo Ave

Version	Date	Author	Reviewer:	Version notes
0.0	06/07/2017	Julian Drummond	Andrew Stephens	Pre-draft internal review
0.1	11/08/2017	Julian Drummond	Andrea Smith	Draft for client review
1.0	15/08/2017	Julian Drummond		Final for submission

Contents

TABLES

FIGURES

MAPS

1. INTRODUCTION

Practical Ecology was commissioned to perform a Due Diligence Bushfire Attack Level Assessment for land at Wallaroo Avenue, Imagine Estate, Strathfieldsaye. This was delivered on the 30th of March 2016 and was intended to support an application to amend the planning permit for subdivision of the site. The existing plan of subdivision provides a 27m setback from a Crown Land Reserve east of the site; the intent of the amendment to the planning permit is to propose a setback of 20m.

Since this time proposed updates to the Bushfire Management Overlay (BMO) have been released and result in areas of the site being subject to it (see Figure 1). Consequently the CFA have requested further information to address the requirements of the BMO to support the amendment to the planning permit. This will also avoid the need for future landowners from having to acquire approval under the BMO for dwelling construction.

Figure 1. Proposed Bushfire Management Overlay

1.1 Subject site

The subject site is approximately 1.2 ha on the south-east corner of the Imagine Estate residential development on the corner of Strathfieldsaye Rd and Wallaroo Ave, approximately 10km south-east from Bendigo CBD.

The site is zoned General Residential Zone (GWZ) and is subject to the following overlays:

- Bushfire Management Overlay (BMO or WMO) (proposed)
- Design and Development Overlay – Schedule 26 (DDO26)
- Public Acquisition Overlay – Schedule 5 (PAO05)

Figure 2 (and Map 1) provides an overview of the site, including the extent of the BMO and which lots are affected.

Figure 2. Subject site showing proposed subdivision and extent of BMO (orange hatching)

1.2 BMO application pathway

There are three application pathways under the Bushfire Management Overlay. These being:

- Pathway 1: Construction of a dwelling and associated works in existing settlements
  - The land is zoned Neighbourhood Residential Zone, General Residential Zone, Residential Growth Zone, Urban Growth Zone, Low Density Residential Zone, Township Zone or Rural Living Zone.
  - There is only one dwelling on the lot.
  - Must meet all the approved measures under Clause 52.47-1.
- Pathway 2: All other applications
  - Clause 52.47-2 applies
- Pathway 3: Subdivision
  - Clause 52.47-2 applies
  - Clause 52.47-2.4 applies

As the development is a subdivision, Pathway 3 will be applied.

1.3 Application requirements

Clause 52.47 details the application requirements for Pathway 3 of the BMO:

Unless a schedule to Clause 44.06 – Bushfire Management Overlay specifies a different requirement, an application must be accompanied by:

- A **bushfire hazard site assessmen**t including a plan that describes the bushfire hazard within 150 metres of the proposed development. The description of the hazard must be prepared in accordance with Sections 2.2.3 to 2.2.5 of AS3959:2009 Construction of buildings in bushfire prone areas (Standards Australia) excluding paragraph (a) of section 2.2.3.2. Photographs or other techniques may be used to assist in describing the bushfire hazard.
- **A bushfire hazard landscape assessment** including a plan that describes the bushfire hazard of the general locality more than 150 metres from the site. Photographs or other techniques may be used to assist in describing the bushfire hazard.
- A **bushfire management statemen**t describing how the proposed development responds to the requirements in Clause 52.47 and Clause 44.06. If the application proposes an alternative measure, the bushfire management statement must explain how the alternative measure meets the relevant objective.

If in the opinion of the responsible authority any part of these requirements is not relevant to the assessment of an application, the responsible authority may waive, vary or reduce the requirement.

2. BUSHFIRE HAZARD SITE ASSESSMENT

Map 1 provides an overview of the subject site and Map 4 provides the details of the Bushfire Hazard Site Assessment which includes the land within 150 metres of the site.

2.1 Site shape, dimensions, size

The shape of the site is:	rectangular
The dimensions of the site are:	approx. 200m x 50m
The site has a total area of:	1.2 ha

2.2 Planning controls

The zoning of the site is:	General Residential Zone
The planning scheme overlays that apply to the site are:	• Bushfire Management Overlay (BMO or WMO) (proposed south of site) • Design and Development Overlay – Schedule 26 (DDO26) • Public Acquisition Overlay – Schedule 5 (PAO05)
Bushfire Prone Area	Applies to whole of site.

2.3 Existing use and development on the site

The current use of the site	Cleared at present with some residential development
The buildings or works located on the site are:	Dwellings have been established on Lots 123 and 124 and Lot 125 has been established with footpaths and road access. Lots 188-197 have no development with scattered vegetation.

2.4 Existing access and infrastructure connections

Roads and access:	Lots are accessed by Wallaroo Ave which will connect to Lots 188-197 when constructed. Wallaroo Ave attaches to Strathfieldsaye Road via Swanson Boulevard west of the site.
Power	The site will be connected to mains power
Water	The site will be connected to reticulated water
Sewerage	The site will be connected to reticulated sewerage

2.5 Vegetation and topography

Refer to Map 4 for the results of the vegetation and slope assessment as per AS3959-2009 (Standards Australia 2009).

The site is primarily on flat land with a minor uphill slope east of the site (0-5°). Surrounding vegetation is primarily Low Threat and includes areas within the residential development to the north and west (see Figure 3 and Figure 4), road reserve around Strathfieldsaye Rd (Figure 5) and the vegetation onsite (Figure 6). Vegetation classifications as per AS3959-2009 (Standards Australia 2009) include Woodland patches east of the site and Grassland south of Strathfieldsaye Rd.

Figure 3. Residential development north-west of site.

Figure 4. Residential development west of site.

Figure 5. Looking east along Strathfieldsaye Rd road reserve.

Figure 6. Grassland areas south of site

Classified vegetation – Woodland

Woodland vegetation (B-05 in Table 2.3 of AS3959) within the assessment area is primarily Box-Ironbark with a sparse layer of sclerophyllous shrubs, the ground storey is primarily leaf litter and some grasses. It occurs within the *Strathfieldsaye H98 Bushland Reserve* east of the site (60m wide) (see Figure 7) and along the Dunns Lane road reserve north and east of the crown reserve (both 20m wide) (see Figure 8 and Figure 9) and in a large patch south-east of the site which connects to the *Strathfieldsaye I160 Bushland Reserve* (see Figure 10).

Figure 7. Looking north through Woodland on crown reserve east of site

Figure 8. Road reserve east side of Dunns Lane

Figure 9. Looking south through Woodland on crown reserve east of site

Figure 10. Woodland vegetation south-east of site

The default fuel load within AS3959 for Woodland vegetation is 15 t/ha for understorey fuels and 25 t/ha for combined understorey and canopy fuels. As shown on Map 5; a planned burn was performed within the *Strathfieldsaye H98 Bushland Reserve* and road reserves in 2014. A fuel hazard assessment as per Hines *et al.* (2010a) was undertaken in 2015 on the roadside strip to the east of Dukes lane to assess fuel loads. The results of this assessment are shown in Table 1, it is seen that the standard fuel loads are considered significantly higher than what exist on site.

Table 1. Fuel load assessment

Vegetation description	Woodland
Indicative photograph	Figure 8
Canopy	
% cover*	20
Ave. height canopy top (m)	15
Ave. height canopy base (m)	10
Estimated fuel load (t/ha)	5
Bark fuel	
Stringybark fuel hazard	Not present
Ribbon bark fuel hazard	Moderate
Other bark fuel hazard	High
Bark fuel hazard	**High**
Estimated fuel load (t/ha)	2
Elevated fuel	
% cover	50
Ave. height (m)	1
Elevated fuel hazard	**High**
Estimated fuel load (t/ha)	2
Near-surface fuel	
% cover	20
Ave. height (cm)	10
Near-surface fuel hazard	moderate
Estimated fuel load (t/ha)	2
Surface fuel	
% cover	80
Ave. depth (mm)	10-20
Surface fuel hazard	Moderate
Estimated fuel load (t/ha)	6
Combined surface-near surface	**Moderate**
Overall Fuel Hazard	**Moderate**
Understorey/total estimated fuel load (t/ha)	12/17

*Canopy cover scored as projected foliage cover; other percentage covers recorded as per Hines et al. 2010

Classified vegetation – Grassland

Grassland vegetation (G-19 in Table 2.3 of AS3959) occurs on the southern side of Strathfieldsaye Rd as part of a larger farmed area (see Figure 11 and Figure 12). There is also pasture on the eastern side of Dunns Lane this area is also scheduled to be developed as general residential area and will be Low Threat in the future; however currently it will be considered as Grassland.

Figure 11. Grassland vegetation east of site

Figure 12. Grassland vegetation east of site

3. BUSHFIRE HAZARD LANDSCAPE ASSESSMENT

The bushfire hazard landscape assessment provides information on the bushfire hazard more than 150 m away. This information is presented in Map 2, Map 3 and Map 5 and discussed further below.

3.1 Adjacent and nearby land

There are areas of woodland and forest vegetation interspaced with residential development north-west of the site and similar vegetation patches interspaced with farmland south-east of the site. Much of the area has been recently rezoned General Residential Zone (GRZ) and much of the scattered vegetation within this area is expected to be removed over time (Figure 13). The area north and west of the site is also interspaced with patches of Public Park and Recreation Zone (PPRZ), Public Conservation and Resource Zone (PCRZ), Low Density Residential Zone (LDRZ), Special Use Zone (SUZ) and Commercial Zone (C1Z).

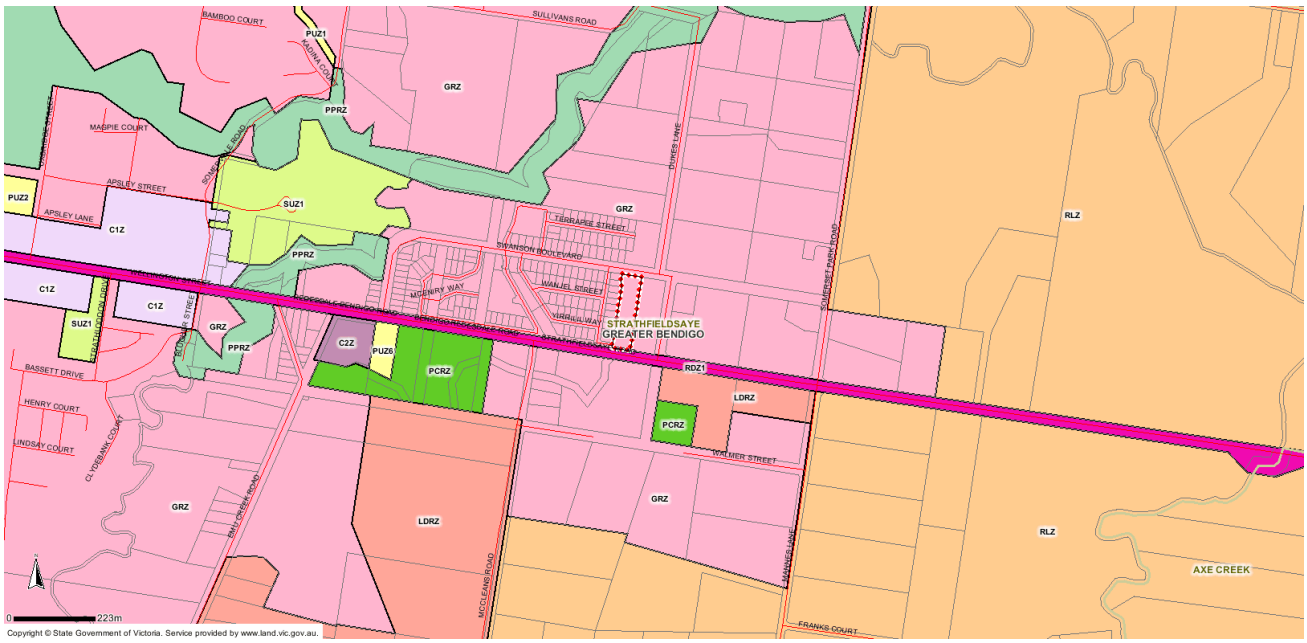


Figure 13. Zonings on adjacent land

3.2 Landscape

The site is located on the eastern fringe of the City of Bendigo, approximately 10km from the Bendigo CBD and on the eastern edge of the Strathfieldsaye Township. The terrain east of the site contains farmland and pasture. In addition to the urban, residential and agricultural areas of Greater Bendigo; the landscape contains large tracts of forested vegetation, generally Box-Ironbark woodlands and forests and areas cleared for agricultural activities such as cropping and grazing.

A forest-urban interface is typical of the outskirts of Greater Bendigo. Across the landscape slopes are gentle with low hills and gentle valleys. Soils are characteristically low nutrient sedimentary soil. Richer alluvial soils occur across the region and these areas once supported grassy woodlands (e.g. EVC Plains Woodland) which have now been cleared for agriculture. Hence the main fuel types remaining are Box-Ironbark forests and pastoral landscapes.

The topography is mostly undulating and fine fuels within these forests are mostly moderate levels (e.g. 7-15 t/ha excluding canopy fuels). Extensive clearing of the forests associated with the gold mining and logging has resulted in most of the vegetation being young in age, dominated by small trees at high densities, soils eroded and understoreys often sparse (ECC 2001). For these same reasons and also with the collection of wood for fuel for heating there are also very low levels of fallen/dead course fuels in the landscape.

3.3 Bushfire history

In a review of burning in Box-Ironbark forests, Tolsma, Cheal and Brown (2007) note there is little knowledge on the historical fire regimes in Box-Ironbark forests: suggestions range from burning being seasonally undertaken to support hunting and food supply by indigenous peoples to others suggesting they were not deliberately burnt at all. The authors consider Box-Ironbark forests may be atypical of dry sclerophyllous vegetation in Australia in that they are not considered prone to recurrent fire and as such fire is likely to have played a minor part in influencing the vegetation structure in these forests.

Tolsma, Cheal and Brown (2007) go on to detail that Box-Ironbark forests are not considered fire-prone and that most fires that occur now are small in size and low in intensity. For instance fires across the Bendigo Fire District between 1983/84 and 2002/03, only 7.2% were known to have resulted from lightning strike: the remainder were deliberate, accidental or of unknown origin; and also between 1980/81 and 1995/96, almost 80% of the 800 wildfires recorded on public land across the Box-Ironbark region were less than 5 ha in size, and only around 15 exceeded 100 ha.

Cheal (2010) provides a minimum tolerable low severity fire interval of 12 years, and a high severity minimum tolerable interval of 30 years. He also notes that high-severity fires (i.e. canopy consuming) are neither common nor likely in Ironbark/Box, but they are possible, particularly following years of relatively high rainfall.

In recent times Parks Victoria and DELWP have undertaken a broad-scale planned burning regime throughout Box-Ironbark forests for ecological reasons and also targeted at reducing fuel and moderating risk from bushfire. This burning is the dominate type of fire occurring in the landscape (refer to Map 5).

Large fires can and do still occur in Box-Ironbark forest as was the case in Maldon, Ravenswood and Kangaroo Flat which were severely impacted in the 1944 bushfires and during the Black Saturday (February 7th 2009), where Bendigo and the Redesdale communities lost 72 homes and one life (Loddon Mallee Regional Strategic Fire Management Planning Committee 2011).

Greater Bendigo's fire history is listed below, aside from Black Thursday it appears that there have been three known deaths from bushfire (City of Great Bendigo Municipal Fire Management Planning Committee 2012):

- 1851 (6 February) – Black Thursday
- 1961 (23 March) – Metcalfe / Redesdale 3,237ha
- 1969 (8 January) – Maldon / Ravenswood / Kangaroo Flat – 1 civilian fatality
- 1975 (8 February) – Redesdale 648ha
- 1987 (16 January) – Colbinabbin / Redcastle 1,400ha
- 1987 Killians Walk Fire
- 1997 (21 January) – Heathcote 220ha
- 1997 Heathcote – Costerfield 4,100ha
- 1999 Epsom – 1 civilian fatality
- 2005 Kangaroo Flat Rocklea Spinning Mill

- 2005 Whipstick Forest North end
- 2008 Kangaroo Flat St Marys Church
- 2008 Bendigo St Aidens Orphanage
- 2009 (7 February) Black Saturday Redesdale–Coliban Park Road 9,446ha
- 2009 (7 February) Eaglehawk Bracewell Street 594ha – 1 civilian fatality

Bushfire Average Recurrence Interval

Bushfire history for Victoria as recorded by DELWP can be used to estimate the Average Recurrence Interval (ARI) of bushfire across the state (Tolhurst 2014a). Note that some caution should be taken interpreting the results as it is only based on 75 years of data. The subject site has a bushfire ARI of 193 years or 0.005 chance of occurrence each year (refer to Figure 14) and is shown to occur in a part of the state that is relatively less prone to bushfire than other areas.

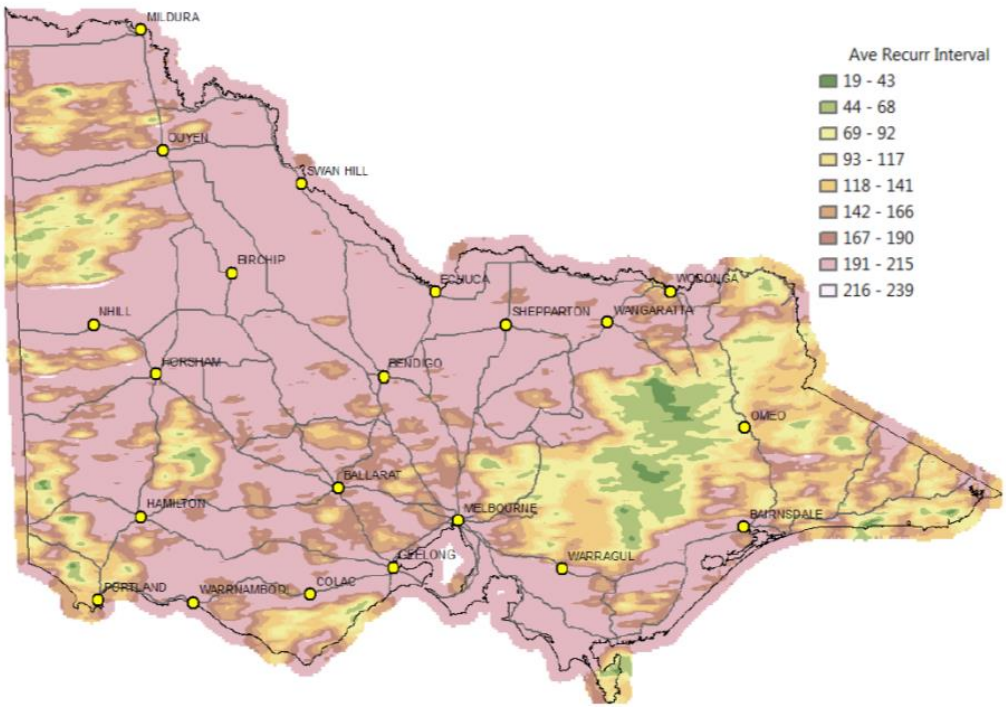


Figure 14. Average Recurrence Interval (ARI) for wildfires in Victoria based on 75 years of data (Tolhurst 2014a).

3.4 Bushfire weather and climate

The landscape is characterised by hot dry summers and cool wetter winters. The mean annual rainfall for Bendigo City is 510 mm, and average summer maximum temperatures are in the high twenties degrees Celsius (Bureau of Meteorology 2013). The climate results in a predominantly winter-spring growing period followed by a hotter drier summer-autumn when vegetation dries and cures providing for a high-risk bushfire period. The peak FFDI predicted for Bendigo Airport was 142 on Black Saturday (Teague, McLeod and Pascoe 2009); the highest actually recorded was 120 (Bushfire CRC 2009).

FFDI Annual Return Interval

CSIRO have utilised Australian Bureau of Meteorology (BOM) weather records over the period from 1979 to 2011 to develop a weather model that provides a prediction of a three hour sustained Forest Fire Danger Index at a resolution of 0.75 degree (or approximately 83km). The model incorporates the Intergovernmental Panel on Climate Change A1FI climate scenario. Further description of the methodology can be found in Leonard *et al.* (2014). The results for the subject site are presented in Figure 15 below;

ARI	FFDI (sustained3 hrs)
10	89
50	116
100	129
500	163
1000	179
2000	196

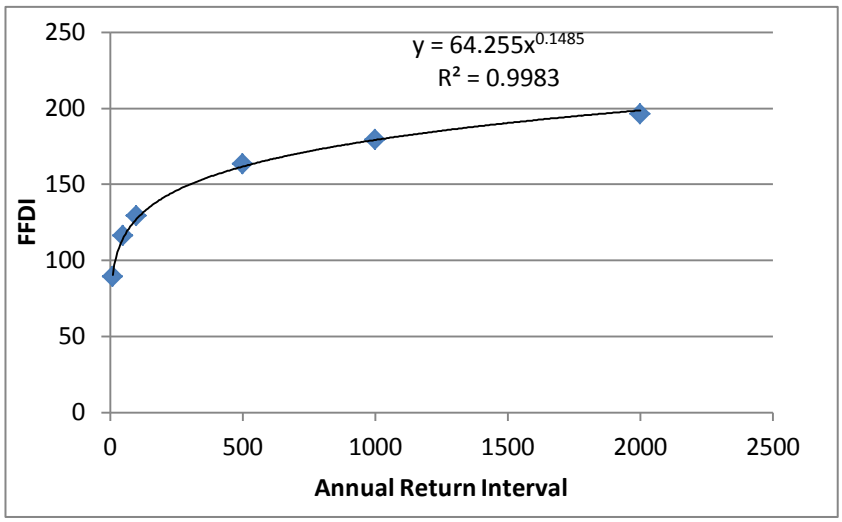


Figure 15. Annual Return Interval (ARI) for Forest Fire Danger Index at subject site (data courtesy of CSIRO).

3.5 Bushfire scenarios

The subject site sits within a high (not very high or extreme) risk fire landscape where bushfire can spread through the surrounding grasslands and Box-Ironbark forests and woodlands, creating high intensity fires that are difficult to manage. There is an absence of conditions required to generate extreme fire behaviour including:

- absence of very high or extreme fuel loads
- relatively benign topography
- moderate levels of connected bushland
- high level of fuel management through prescribed burning; this is associated with the relative ease in which prescribed burning can be implemented due to the moderate bushfire conditions.

Additionally, during bushfire season; prevailing wind conditions consist of powerful north-westerlies followed by a cool change and strong south-westerly winds. These conditions influence which scenario is most likely to impact the site, the scenarios are listed below in order of likelihood and displayed on Map 5.

Scenario 1

Prevailing wind conditions indicate a fire could approach the site from the north-west through areas of thicker vegetation and across grassland and pasture to the north. This fire would need to move through residential areas and major roads so the chances of it reaching the site are reduced.

Scenario 2

South-westerly winds could push a fire north-east towards the site. This fire would be moving through forested areas and has the potential to be fairly intense but may lose intensity (but gain speed) as it reaches areas of pasture. This fire has a more uninterrupted run to the site and potentially posed greater threat but south-westerly winds are cooler and would reduce the risk and the chance of this fire reaching the site.

Scenario 3

A fire starting west of the site could be pushed south-east by prevailing winds through forested areas before being turned north-east by the south-westerly change; resulting in a much larger and more powerful front.

3.6 Shelter and refuge options

It is likely refuge could be safely sought within the site or adjacent residential areas during a fire event; however, occupants may still be exposed to smoke, heat, embers and localised flames. Refuge at the Strathfieldsaye Primary School (2km west) also provides a refuge option.

3.7 Landscape typology

Planning Practice Note 65 (DTPLI 2014) provides a typology of bushfire landscapes. These are summarised in Table 2 below. The landscape around the subject site is a Type 2 but has aspects of Type 3. Although the chances of bushfire reaching the site are relatively low; there is sufficient vegetation within 150m to result in neighbourhood level destruction and the fire can approach from multiple angles (Type 3). What makes this a Type 2 landscape is amount of surrounding residential area which is managed to minimal fuel conditions and the multiple access options for residents to seek shelter.

Table 2. Landscape typology as presented in Planning Practice Note 65 (DTPLI 2014)

Type 1	Type 2	Type 3	Type 4
- There is little vegetation beyond 150 metres of the site (except grasslands and low-threat vegetation). - Extreme bushfire behaviour is not possible. - The type and extent of vegetation is unlikely to result in neighbourhood scale destruction of property. - Immediate access is available to a place that provides shelter from bushfire.	- The type and extent of vegetation located more than 150 metres from the site may result in neighbourhood-scale destruction as it interacts with the bushfire hazard on and close to a site. - Bushfire can only approach from one aspect and the site is located in a suburban, township or urban area managed in a minimum fuel condition. - Access is readily available to a place that provides shelter from bushfire. This will often be the surrounding developed area.	- The type and extent of vegetation located more than 150 metres from the site may result in neighbourhood-scale destruction as it interacts with the bushfire hazard on and close to a site. - Bushfire can approach from more than one aspect. - The site is located in an area that is not managed in a minimum fuel condition. - Access to an appropriate place that provides shelter from bushfire is not certain.	- The broader landscape presents an extreme risk. - Evacuation options are limited or not available.

4. BUSHFIRE MANAGEMENT STATEMENT

This section describes how the proposed development responds to the requirements in Clause 52.47 and Clause 44.06.

4.1 Definition of objectives and measures

To fulfil the purpose, and allow application of Clause 52.47 of the Planning Scheme, objectives, measures to address the objectives, and decision guidelines are detailed within the Clause. These are defined below:

- **Objectives.** An objective describes the outcome that must be achieved in a completed development.
- **Approved measures (AM).** An approved measure meets the objective.
- **Alternate measures (AltM).** An alternative measure may be considered where the responsible authority is satisfied that the objective can be met. The responsible authority may consider other unspecified alternative measures.
- **Decision guidelines.** The decision guidelines set out the matters that the responsible authority must consider before deciding on an application, including whether any proposed alternative measure is appropriate.

4.2 Development proposal

The proposed amendment to the existing subdivision at Wallaroo Avenue will result in decreasing the setback for the Crown Land to the east from 27 to 20m. Hence this report focusses on the lots affected by this change. The additional three lots that occur within the BMO (lots 123-125) with frontage to Wallaroo Avenue are already in separate ownership and are not affected by the proposed subdivision and hence are not included in this Bushfire Management Statement or Bushfire Management Plan.

See Map 6 for the site plans and Map 1 for the lots impacted by the proposed BMO.

4.3 Relevant Objectives and Approved Measures

Clause 52.47-2.4 provides the objectives and approved measures for Subdivisions. They are detailed in the table below.

Table 3. Approved measures to meet Clause 52.47-2.4 subdivision objectives

Clause 52.47-2.4 Subdivision objectives		
To provide lots that are capable of being developed in accordance with the objectives of Clause 52.47. To specify at the subdivision stage bushfire protection measures to develop a lot with a single dwelling on land zoned for residential or rural residential purposes.		
Measure	**Requirement**	**Applicable**
AM5.1	An application to subdivide land, other than where AM 5.2 applies, demonstrates that each proposed lot is capable of meeting: • The defendable space in accordance with Column A, B or C of Table 2 to Clause 52.47-3. • The approved measures in Clause 52.47-2.1 and Clause 52.47-2.3.	No – 5.2 applies
AM5.2	An application to subdivide land zoned for residential or rural residential purposes must be accompanied by a plan that shows: • A building envelope for a single dwelling on each lot that complies with **AM 2.2** and provides defendable space in accordance with: – Columns A or B of Table 2 to Clause 52.47-3 for a subdivision that creates 10 or more lots; or – Columns A, B or C of Table 2 to Clause 52.47-3 for a subdivision that creates less than 10 lots. • Defendable space wholly contained within the boundaries of the proposed subdivision. • Vegetation management requirements, including inner zone standards (as appropriate), to implement and maintain the defendable space required under this approved measure. • Water supply and access that complies with AM 4.1	Yes – requires consideration
AM 5.3	An application to subdivide land to create 10 or more lots provides a perimeter road adjoining the hazardous vegetation to support firefighting.	Yes – requires consideration
AM 5.4	A subdivision manages the bushfire risk to future development from existing or proposed landscaping, public open space and communal areas.	Yes – requires consideration

Clause 52.47-2.1, 2 and 3

The structure and language within Clause 52.47 leave it unclear as to whether Clauses 52.47-2.1, 2 & 3 and the associated approved measures apply to the subdivision. Some of these clearly relate to buildings and others relate to "development". It is suggested that these Clauses should be considered. Clause 52.47-2.2 & 3 relate to defendable space; water and access, these are addressed under 52.47-4 and generally do not require separate consideration. Clause 52.47-2.1 is not considered under Clause 52.47-4 but should be considered separately, its objectives and approved measures are presented in Table 4 below.

Table 4. Clause 52.47-2.1 Landscape siting and design objectives and approved measures

Clause 52.47-2.1 Landscape siting and design objectives	
Development is appropriate having regard to the nature of the bushfire risk arising from the surrounding landscape.	
Development is sited to minimise the risk from bushfire.	
Development is sited to provide safe access for vehicles, including emergency vehicles.	
Building design minimises vulnerability to bushfire attack.	
Measure	**Requirement**
AM2.1	The bushfire risk to the development from the landscape beyond the site can be mitigated to an acceptable level.
AM2.2	A building is sited to ensure the site best achieves the following: • The maximum separation distance between the building and the bushfire hazard. • The building is in close proximity to a public road. • Access can be provided to the building for emergency service vehicles.
AM 2.3	A building is designed to reduce the accumulation of debris and entry of embers.

4.4 Landscape risk objectives

Clause 52.47-2.1 Landscape, siting and design objectives			
Development is appropriate having regard to the nature of the bushfire risk arising from the surrounding landscape.			
Development is sited to minimise the risk from bushfire.			
Development is sited to provide safe access for vehicles, including emergency vehicles.			
Building design minimises vulnerability to bushfire attack.			
Measure	**Requirement**		
AM2.1	The bushfire risk to the development from the landscape beyond the site can be mitigated to an acceptable level.		
Proposal meets measure	Yes ☒	No ☐	N/A ☐
Justification for applicability	This measure is considered to apply given it relates to “development”.		

Section 3 of this report examines the bushfire risk from the landscape and Map 6 shows the extent of the development across the site. Extreme bushfire behaviour is not possible considering the following landscape conditions:

- absence of very high or extreme fuel loads
- relatively benign topography
- moderate levels of connected bushland
- high level of fuel management through prescribed burning; this is associated with the relative ease in which prescribed burning can be implemented due to the moderate bushfire conditions
- limited potential for a direct fire run into the site under extreme weather conditions.

The primary threat to the site is ember attack which can be mitigated through application of the measures within the BMO. A large scale fire has a relatively low likelihood of reaching the site due to existing management and development from the primary directions of risk.

4.5 Subdivision Design

Clause 52.47-2.4 Subdivision objectives

To provide lots that are capable of being developed in accordance with the objectives of Clause 52.47.

To specify at the subdivision stage bushfire protection measures to develop a lot with a single dwelling on land zoned for residential or rural residential purposes.

AM 5.2

An application to subdivide land zoned for residential or rural residential purposes must be accompanied by a plan that shows:

- **A building envelope for a single dwelling on each lot that complies with AM 2.2** and provides defendable space in accordance with:
  - Columns A or B of Table 2 to Clause 52.47-3 for a subdivision that creates 10 or more lots; or
  - Columns A, B or C of Table 2 to Clause 52.47-3 for a subdivision that creates less than 10 lots.
- Defendable space wholly contained within the boundaries of the proposed subdivision.
- Vegetation management requirements, including inner zone standards (as appropriate), to implement and maintain the defendable space required under this approved measure.

Clause 52.47-2.1 Landscape, siting and design objectives

Development is appropriate having regard to the nature of the bushfire risk arising from the surrounding landscape.

Development is sited to minimise the risk from bushfire.

Development is sited to provide safe access for vehicles, including emergency vehicles.

Building design minimises vulnerability to bushfire attack.

AM 2.2

A building is sited to ensure the site best achieves the following:

- The maximum separation distance between the building and the bushfire hazard.
- The building is in close proximity to a public road.
- Access can be provided to the building for emergency service vehicles

Proposal meets measure	Yes ☒	No ☐	N/A ☐
Justification for applicability	Applied through Clause 52.47-2.1 and AM5.2		

The subdivision design objectives detailed in AM 2.2 are incorporated into the existing design. It includes perimeter roads, access suitable for emergency service vehicles and defendable space such that all dwellings can be sufficiently set back from the fuel hazard.

The development of the subject site will result in all vegetation within the site being treated to manage fuel levels. The site is adjacent to Woodland vegetation in *Strathfieldsaye H98 Bushland Reserve*, Dunns Lane road reserves and on public and private land south-east of the site. This vegetation will be separated from lots through existing or proposed roads and a suitable setback incorporated as detailed in Section 0 below.

The site can be safely accessed from Strathfieldsaye Rd which provides safe egress for residents and emergency services and multiple evacuation routes.

AM 5.3

An application to subdivide land to create 10 or more lots provides a perimeter road adjoining the hazardous vegetation to support firefighting.

Proposal meets measure	Yes ☐	No ☐	N/A ☒

While a perimeter road is provided between the lots and the woodland within the *Strathfieldsaye H98 Bushland Reserve*, this is not a required measure given that there are less than 10 lots that will be affected by the BMO. Defendable space and construction

Clause 52.47-2.4 Subdivision objectives
To provide lots that are capable of being developed in accordance with the objectives of Clause 52.47. To specify at the subdivision stage bushfire protection measures to develop a lot with a single dwelling on land zoned for residential or rural residential purposes.
AM 5.2
An application to subdivide land zoned for residential or rural residential purposes must be accompanied by a plan that shows: • **A building envelope for a single dwelling on each lot that** complies with AM 2.2 and **provides defendable space in accordance with:** – Columns A or B of Table 2 to Clause 52.47-3 for a subdivision that creates 10 or more lots; or – **Columns A, B or C of Table 2 to Clause 52.47-3 for a subdivision that creates less than 10 lots.** • **Defendable space wholly contained within the boundaries of the proposed subdivision.** • **Vegetation management requirements, including inner zone standards (as appropriate), to implement and maintain the defendable space required under this approved measure.** • Water supply and access that complies with AM 4.1
Proposal meets measure Yes ☐ No ☐ Proposed Alternate ☒

4.5.1 Defendable space and BAL assessment

Table 5 details conditions within the 150m assessment area to provide the required defendable space as per Table 2 of Clause 52.47-3 (and Method 1 of AS3959-2009 (Standards Australia 2009)). The assessment is split into four directions. Each is defined by being a different combination of slope and fuel conditions when compared with the adjacent portion.

The tables within Clause 52.47-3 do not reflect that the vegetation in close proximity to the site is a narrow strip; it assumes that a fully developed bushfire will affect the site through a large area of continuous bushland. The bushfire behaviour and defendable space required is therefore significantly overestimated. Hence an alternate measure is proposed that more closely considers the potential fire behaviour possible given the highly modified and fragmented bushfire fuels available.

Table 5. Defendable space assessment as per Method 1 of AS3959-2009 (Standards Australia 2009)

Direction	North	East	South	West
Fire Danger Index	100	100	100	100
Vegetation type	Low threat	Woodland	Low threat, Grassland	Low threat
Slope (up/down)	Downslope	Upslope	Flat	Upslope
Slope (degrees)	0-5	0-5	0	0-5
Min distance to vegetation form site boundary (m)	>150	0	28	>150
Distance required for BAL 12.5 (m)	N/A	41	19	N/A
Distance required for BAL 19 (m)	N/A	29	13	N/A
Distance required for BAL 29 (m)	N/A	21	9	N/A
Distance required for BAL 40 (m)	N/A	15	6	N/A

The method 1 assessment for the site results in a BAL 12.5 for all directions from the site bar the woodland adjoining its eastern boundary. Given the nature of the hazard affecting the site is a fairly isolated linear strip; the method 1 assessment over-states the expected radiation that could be generated from a bushfire in this vegetation. Furthermore being to the east of the site; bushfire under high risk weather conditions would have prevailing winds pushing the fire away from the site. Given these considerations an alternate BAL assessment is proposed and this is detailed in the following section.

Alternate BAL Assessment

AS3959-2009 is adapted from a method originally detailed by Tan, Midgley and Douglas (2005). It provides a method of assessment for calculating a Bushfire Attack Level (BAL) based on the amount of radiant heat a building is predicted to be exposed to under a particular bushfire scenario.

A Method 2 BAL assessment as per *AS3959-2009 Construction of buildings in bushfire-prone areas* follows the same general steps as per Method 1 however rather than limiting the input to fit the tables within the Standard, input values more accurate to the site can be used in calculations to determine the BAL level. The general basis of the assessment is the calculation of a flame length and width produced from a bushfire and then consideration of the level of radiant heat that flame will emit on a building depending on its geometric orientation to the building. The steps are as follows:

1. Determine the relevant FDI or wind speed.
2. Determine the vegetation classification, fuel loads and vegetation height.
3. Determine the effective slope under the classified vegetation.
4. Determine the slope, in degrees, of the land between the site and the classified vegetation.
5. Determine the distance of the site from classified vegetation.
6. Calculate the flame length.
7. Determine flame width.
8. Determine the elevation of receiver.
9. Calculate the radiant heat flux.
10. Determine the Bushfire Attack Level.

An alternative assessment method to AS3959 can be provided in accordance with the Building Code of Australia (BCA) for building permits or as approved by the Relevant Authority for planning permits. Within AS3959 the flame length and width are derived from modelling of fire behaviour based on a fully developed bushfire that is not limited by the area of fuel available. Consequently the fire behaviour predicted can dramatically exceed the potential fire that would occur in small fragments of vegetation. Hence consideration of how the site varies from the assumptions within AS3959 are summarised in Table 6.

Table 6. Review of modelling methods used for assessment and assumptions within AS3959.

Parameter	Variable	Description	Relevance to site calculations
FFDI	Weather	The FFDI is set by AS3959 and provides the weather conditions that the fire behaviour is based on.	Modelling by the CSIRO suggests an FFDI of 100 is exceeded in the Bendigo area every 25 years (Leonard *et al.* 2014). No change to FFDI is proposed as this is essentially the level of risk approved by the regulations; however it should be noted that under these conditions a westerly wind would be evident and hence the woodland east of the site would not result in fire directed at the site. None-the-less it will be assumed that an easterly wind impacts the site under an FDI 100 for the sake of this assessment.
Fuel loads	t/ha	AS3959 assigns default fuels to each class of vegetation; these may be substantially different from what occurs on site.	The classifiable vegetation around the site includes Woodland (B-05 in Table 2.3 of AS3959). The default fuel load within AS3959 for Woodland vegetation is 15 t/ha for understorey fuels and 25 t/ha for combined understorey and canopy fuels. A fuel hazard assessment was undertaken to assess the accuracy of this assumption (see Table 1) and it was found fuels were much lower than the default levels.
Rate of spread (ROS) (km/h):	Depth of fuel (length of run)/ time since ignition	AS3959 assumes that fire reaches a Steady Rate of Spread instantaneously, however ROS is influenced by the length of the run available or the time since ignition. Cheney (1981) provides a model for how this may be considered.	The vegetation east of the site is of limited width; the woodland west of Dukes Lane is approximately 13m and 50m wide to the east (i.e. within the crown reserve). These are separated by Dukes Lane which is approximately 8m wide. It would not allow for a fully developed fire. Cheney (1981) (where a=1.05) has been used to consider how this affects the ROS

Parameter	Variable	Description	Relevance to site calculations
Rate of spread (ROS) (km/h)	Width of fuel	The width of fuel available can also limit the ROS. For instance Cheney and Gould (1995) suggested that head fire width of more than 75 m in grasslands and 200 m in woodlands are required to get spread rates within 10 percent of the potential rate with wind conditions in the open at 10m around 20 km/h. The data from the selected experimental fires in dry eucalypt forest shows that the head fire width must exceed 300 m before fires are spreading at their potential rate of spread in wind speed of 20 km/h (Gould et al. 2003). Tolhurst (2014) uses data presented in Cheney and Sullivan (2008) to provide a method for considering how fuel width affects ROS.	The limited width of vegetation to would constrain the fire behaviour the details from Cheney and Sullivan (2008) as elaborated by Tolhurst (2014) will be used to examine this.
Flame length (m)	Depth of fuel	AS3959 calculates flame length from the flame height calculations of McArthur as presented by Noble, Gill and Bary (1980) and adjusts it by approximately half; note that AS3959 uses the Slope adjusted Rate of Spread (R_{slolpe}) to calculate flame length whereas McArthur's calculations do not (McArthur 1967). It assumes that there is unlimited depth to the fuel so that flame length is not limited by it. Tolhurst (2014) provides guidance on how the flame depth will influence the flame height.	The depth of fuel is not less than the calculated flame depth so flame depth will not affect the flame height.
Flame angle (degrees) (and geometry)	Orientation to site	The flame angle of a bushfire may theoretically vary from 0 to 90 degrees and depends on the vectorial sum of the horizontal and vertical wind speeds. Due to this high level of variance and unpredictability, AS3959 finds the flame angle that provides the worst case radiation exposure (i.e. highest view factor) There is also an assumption that fire will approach central to and perpendicular to a building, often this is not the case and consequently the radiation could be significantly less than predicted.	The path of spread could either be parallel or perpendicular with the site. For the parallel scenario a flame angle of 90 degrees has been assigned.
Height of Receiver (m)	Height of dwellings	The height of receiver is the height of the point of the building assessed for the level of radiation received. AS3959 assumes the worst case scenario and uses the height from ground level that provides the highest level of radiation. There is potential that this may be unrealistic (e.g. many metres above height of dwelling).	Variations could apply, but have not been made.

Parameter	Variable	Description	Relevance to site calculations
View factor	Shielding	The view factor is the proportion of the radiation which leaves the flame body and strikes the surface of a dwelling. The worst case view factor is assumed (i.e. worst case flame angle and orientation and height of receiver). In reality this is very rarely the case other objects such as trees, adjacent buildings, fences and topography can alter this significantly. For instance Newnham *et al.* (2014) show that vegetation alone can provide attenuation levels of around 50%.	The use of fencing may provide significant shielding however this has not been considered in this assessment.

Fire from south travelling parallel with Dukes Lane through the Crown Land

The first scenario w considered is a approaching from the woodland to the south of Strathfieldsaye Road. Given this is a relatively large parcel of bushland we can assume that the ROS will not be impeded by the size of the patch and hence assume a steady state ROS will be achieved through this section as the fire crosses Strathfieldsaye Road and burns along Dukes Lane. However, the limited fuel width here will limit the ROS and hence flame heights, furthermore the gaps in the fuel due to Dukes Lane and will also result in a decreased flame height.

Tolhurst (2014b) uses data presented in Cheney and Sullivan (2008) to provide a method for considering how fuel width affects ROS. The head fire width required to achieve the steady state rate of spread is a function of wind speed as shown in Figure 16. The proportion of the steady state rate of spread as a function of the proportion of head fire width needed to achieve that steady state is then provided in Figure 17.

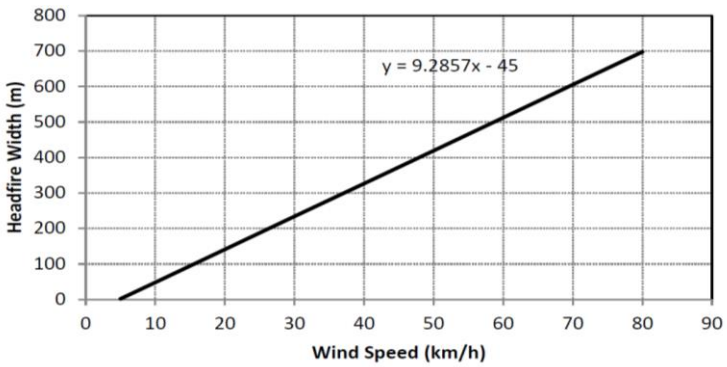


Figure 16. Relationship between head fire width required to achieve steady state rate of spread (from Tolhurst (2014b))

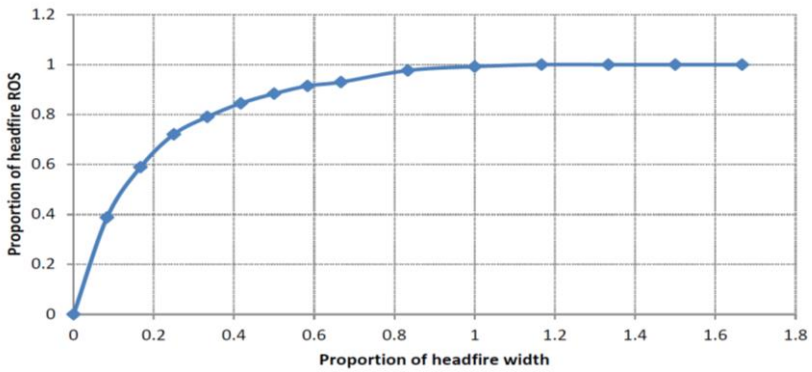


Figure 17. Proportion of the steady state rate of spread as a function of the proportion of head fire width needed to achieve that steady state (from Tolhurst (2014b)).

When these calculations are applied to the limited fuel width adjacent to the site, the ROS is adjusted accordingly, see Table 7 for details.

Table 7. Adjusting ROS due to limited fuel width

Modelled steady state ROS (km/h)	1.65	As per AS3959 method 2
Headfire width required to achieve steady state ROS (m)	367	As per Figure 16 (assume FDI 100 windspeed of 40km)
Headfire width available (m)	60	Combined width of vegetation.
Proportion of steady state headfire width available	0.18	
Proportion of steady state ROS possible	0.62	As per Figure 17
Adjusted ROS due to limited fuel width (km/h)	0.102	

In addition to amending the ROS to calculate the flame height, the profile of the flame will be parallel to the site for much of this fire run, so a flame angle of 90 degrees; note the flame width has been kept at 100m which is conservative as the orientation of the flame will actually result in the flame width being equivalent to the flame depth, based on a 40 second burnout time this would equate to approximately 11m, furthermore the side profile would result in only half this area (i.e. the flame height and depth) being comprised of flame. The results of the alternate assessment for a south-north fire are shown in Table 8; with the proposed 20m setback this results in a BAL19; if the more realistic 11m flame width is used this would be a BAL12.5

Table 8. Alternate assessment for a south-north fire run

FFDI	100
Vegetation classification	Woodlands
Surface Fuel Load (t/ha)	12
Overall Fuel Load (t/ha)	17
Effective slope under the classified vegetation (direction)	Downslope
Effective slope under the classified vegetation (degrees)	2
Slope between the site and classified vegetation (degrees)	0
Flame Width (m)	100
Flame Temperature (K)	1090
Flame Emissivity	0.95
Ambient Temperature (K)	308
Relative humidity (%)	25%
Rate of spread (km/h)	1.65
Wind speed (km/h)	40
Width of headfire required to achieve steady state ROS (m)	326
Headfire width available (m)	60
Proportion of steady state headfire width available	0.184
Proportion of steady state ROS possible	0.621

Reduced ROS due to limited fuel width (km/h)	1.02
Flame length (m)	8.55
Flame depth required for predicted Slope ROS (m)	11.33
Flame depth available (m)	100
Distance of the site from classified vegetation (m)	20
Flame angle (degrees)	90
View Factor	0.204
Height of Receiver (m)	4.28
Path length (m)	20.00
Atmospheric Transmissivity	0.83
Radiant heat flux (kW/m2)	12.90
BUSHFIRE ATTACK LEVEL	BAL -19

A fire could also travel from the north through the crown land. The above assessment is relevant to this risk; although given that there is very little woodland in this direction in which a fire can approach from the assumptions included for a fire from the south are more conservative (i.e. assume more intense fire).

Fire from east travelling through the Crown Land

The second scenario is a fire travelling from the east towards the subject site. While the land to the east of the site is also proposed for development, in the interim a grassfire could potentially reach the woodland strip from this direction. Although, it is extraordinary for an easterly wind to drive a bushfire in Bendigo and there is an almost negligible chance of this happening at an FDI100.

A grassfire approaching from the east would take some time before it would develop into a fully established woodland fire, and this would not be possible in the small strip of woodland fuels that is split by Dukes Lane. None-the-less, given there could be a substantial grassfire that approaches the woodland for the purposes of this assessment it will be assumed that this will result in a fully developed woodland fire as assumed in AS3959. A method 2 AS3959 assessment has been undertaken using the more accurate fuel load and accounting for the fact that the fire would be travelling downhill towards the site. This results in a BAL-19 rating for the proposed dwellings once a 20m setback has been applied as shown in Table 9.

Table 9. Method 2 assessment results for an east-west fire run

FFDI	100
Vegetation classification	Woodlands
Surface Fuel Load (t/ha)	12
Overall Fuel Load (t/ha)	17
Effective slope under the classified vegetation (direction)	Upslope
Effective slope under the classified vegetation (degrees)	2
Slope between the site and classified vegetation (degrees)	0
Flame Width (m)	100
Flame Temperature (K)	1090
Flame Emissivity	0.95
Ambient Temperature (K)	308
Relative humidity (%)	25%
Rate of spread (km/h)	1.44
Slope ROS (km/h)	1.25
Flame length (m)	10.19
Flame angle (degrees)	74
View Factor	0.250
Height of Receiver (m)	4.90
Path length (m)	18.60
Atmospheric Transmissivity	0.85
Radiant heat flux (kW/m2)	16.12
BUSHFIRE ATTACK LEVEL	BAL -19

4.5.2 Proposed defendable space and BAL levels

Proposed plans displayed in Appendix 3 show a 20m setback for development within lots on the eastern side of the subject site (Lots 188-197) from the woodland vegetation. Considering the results from the alternative BAL assessment, this distance should be more than sufficient for BAL-19 for all lots.

Shielding as per Section 3.5 of AS3959-2009 allow the elevations shielded from that exposure to be reduced to the next lowest BAL.

4.5.3 Defendable Space Management Standards

Defendable Space on private land

The following objective for defendable space is provided in Clause 52.47:

Defendable space and building construction mitigate the effect of flame contact, radiant heat and embers on buildings.

CFA provide Defendable Space standards as documented in their Standard Permit Conditions (Bushfire Management Overlay) (CFA 2014a), these are presented below:

- Grass must be short cropped and maintained during the declared fire danger period.
- All leaves and vegetation debris must be removed at regular intervals during the declared fire danger period.
- Within 10 metres of a building, flammable objects must not be located close to the vulnerable parts of the building.
- Plants greater than 10 centimetres in height must not be placed within 3m of a window or glass feature of the building.
- Shrubs must not be located under the canopy of trees.
- Individual and clumps of shrubs must not exceed 5 sq. metres in area and must be separated by at least 5 metres.
- Trees must not overhang or touch any elements of the building.
- The canopy of trees must be separated by at least 5 metres.
- There must be a clearance of at least 2 metres between the lowest tree branches and ground level.

Given that there is a road separating the woodland from future dwellings it is proposed that the canopy separation provided from this is sufficient and consequently the requirement for the separation of canopy trees is not included in the Bushfire Management Plan. This will allow property owners to plant trees on their land without concern for canopy separation from trees on neighbouring land which is difficult to achieve on small titles.

4.6 Landscaping on Public Land

AM 5.4			
A subdivision manages the bushfire risk to future development from existing or proposed landscaping, public open space and communal areas			
Proposal meets measure	Yes ☒	No ☐	N/A ☐

Public land onsite consists of roadside areas within the site. Vegetation within these areas will be managed to defendable space management standards.

4.7 Water supply and access

Clause 52.47-2.4 Subdivision objectives

To provide lots that are capable of being developed in accordance with the objectives of Clause 52.47.

To specify at the subdivision stage bushfire protection measures to develop a lot with a single dwelling on land zoned for residential or rural residential purposes.

AM 5.2

An application to subdivide land zoned for residential or rural residential purposes must be accompanied by a plan that shows:

- A building envelope for a single dwelling on each lot that complies with AM 2.2 and provides defendable space in accordance with:
  - Columns A or B of Table 2 to Clause 52.47-3 for a subdivision that creates 10 or more lots; or
  - Columns A, B or C of Table 2 to Clause 52.47-3 for a subdivision that creates less than 10 lots.
- Defendable space wholly contained within the boundaries of the proposed subdivision.
- Vegetation management requirements, including inner zone standards (as appropriate), to implement and maintain the defendable space required under this approved measure.
- **Water supply and access that complies with AM 4.1**

Proposal meets measure	Yes ☒	No ☐	Partial ☒

AM 4.1

A building used for a dwelling (including an extension or alteration to a dwelling), a dependant person's unit, industry, office or retail premises is provided with:

- A static water supply for firefighting and property protection purposes specified in Table 4 to Clause 52.47-3.
- Vehicle access that is designed and constructed as specified in Table 5 to Clause 52.47-3.

The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for firefighting water supplies.

Proposal meets measure	Yes ☒	No ☐	N/A ☐

Water supply

The BMO provides minimum requirements water supply. Water supply will also need to comply with the requirements of Clause 56 of the planning scheme, and should also comply with including CFA's *Requirements for Water Supplies and Access for Subdivisions in Residential Township 1 and 2 and Township Zones 2006* (CFA 2006).

Water supply requirements within the BMO are detailed in Appendix 1. The size of residential lots within BMO areas determine the need for and size of a static water supply if required. All lots are between 500- 1,000m^2 and considering hydrants will be available; 5,000L supply and no CFA fittings are specified here; however in discussion with Mark Kelly (CFA Fire Safety Officer, Bendigo) it was agreed that 2,500L will be sufficient.

Access

The BMO provides minimum design requirements for access (Appendix 1), these generally apply to private roads and as the driveways are to be less than 30m and no access to the water supply proposed; there are no access requirements proposed within the Bushfire Management Plan (Map 6).The road design will also need to comply with the requirements of Clause 56 of the planning scheme and should also comply with CFA's *Requirements for Water Supplies and Access for Subdivisions in Residential Township 1 and 2 and Township Zones 2006* (CFA 2006). These standards are detailed in Appendix 1.

4.8 On title agreement

44.06-3 Mandatory condition

A permit which creates a lot for a single dwelling on land zoned for residential or rural residential purposes must include the following condition:

"Before the statement of compliance is issued under the Subdivision Act 1988 the owner must enter into an agreement with the responsible authority under Section 173 of the Planning and Environment Act 1987. The agreement must:

- *State that it has been prepared for the purpose of an exemption from a planning permit under Clause 44.06-1 of the [*insert name of applicable planning scheme] Planning Scheme.*
- *Incorporate the plan prepared in accordance with Clause 52.47-2.4 of this planning scheme and approved under this permit.*
- *State that if a dwelling is constructed on the land without a planning permit that the bushfire mitigation measures set out in the plan incorporated into the agreement must be implemented and maintained to the satisfaction of the responsible authority on a continuing basis.*

The land owner must pay the reasonable costs of the preparation, execution and registration of the Section 173 Agreement."

This does not apply:

- If a schedule to this overlay specifies that a Section 173 Agreement is not required.
- Where the relevant fire authority states in writing the preparation of an agreement under Section 173 of the Act is not required for the subdivision.
- For the subdivision of the land into lots each containing an existing dwelling or car parking space.

A permit to subdivide land must include any condition specified in a schedule to this overlay.

The proponent will comply with this requirement. The Bushfire Management Plan (Map 6) has been prepared for this purpose.

4.9 Ongoing management and community awareness

Clause 44.06-3 of the BMO, includes the requirement that a permit for subdivision that creates a lot for a single dwelling on land zoned for residential or rural residential purposes must include a S173 agreement which details the required bushfire protection measures to be ongoing and exempts the need for future assessment to undertake works, such as construct a dwelling, consistent with the specified measures.

Additional supporting documentation should be provided to new residents to ensure that they understand the bushfire risk at the site and their obligations to manage it.

4.10 Interim management for staged development

As development will be staged there will need to be consideration of the management of areas of the site that will be developed after the initial stages. This will include the need to ensure an adequate road network is in place and that vegetation is managed appropriately so that adequate defendable space is provided throughout all stages of the development process.

5. REFERENCES

Bureau of Meteorology (2013) *Climate Data Online*. Australian Government. Accessed via: http://www.bom.gov.au/climate/data/

Bushfire CRC (2009) *Victorian 2009 Bushfire Research Response Final Report*. www.bushfirecrc.com.

CFA (2006) *Requirements for Water Supplies and Access for Subdivisions in Residential 1 and 2 and Township Zones 2006*. Country Fire Authority, East Burwood.

CFA (2012) *Planning for Bushfire Victoria – Guidelines for Meeting Victoria's Bushfire Planning Requirements*. Country Fire Authority.

CFA (2014a) *Standard Permit Conditions Bushfire Management Overlay*. Country Fire Authority, Victoria.

CFA (2014b) *Water Supply Requirements (Bushfire Management Overlay)*. Country Fire Authority, Victoria.

Cheal, D. (2010) *Growth stages and tolerable fire intervals for Victoria's native vegetation data sets. Fire and Adaptive Management Report No. 84*. Department of Sustainability and Environment, East Melbourne, Victoria, Australia.

Cheney, N. P. (1981) *Fire Behaviour*. IN Gill A.M, Groves R.H. & Noble I.R. *Fire and the Australian Biota.* Australian Academy of Science, Canberra.

Cheney, N. P. & Sullivan, A. (2008) *Grassfires – fuel, weather and fire behaviour.* 2nd Edn. edn. CSIRO, Collingwood, Australia.

City of Great Bendigo Municipal Fire Management Planning Committee (2012) *City of Greater Bendigo Municipal Fire Management Plan 2012/15*. City of Greater Bendigo,, Bendigo.

DTPLI (2014) *Practice Note 65: Preparing and Assessing a Planning Application under the Bushfire Provisions in Planning Schemes, July 2014*. Department of Transport, Planning and Local Infrastructure, Government of Victoria, Melbourne.

ECC (2001) *Box-Ironbark Forests and Woodlands Investigation Final Report.* Environment Conservation Council, Easte Melbourne.

Gould, J. S., Cheney, N. P., McCaw, L. & Cheney, S. (2003) *Effects of head fire shape and size on forest fire rate of spread. Proceedings of the 3rd International Wildland Fire Conference, 3-6 Oct. 2003, Sydney, Australia.*

Hines, F., Tolhurst, K. G., Wilson, A. A. G. & McCarthy, G. J. (2010) *Overall fuel hazard assessment guide 4th edn.* Department of Sustainability and Environment, Government of Victoria, East Melbourne.

Leonard, J., Opie, K., Newnham, G. & Blanchi, R. (2014) *A new methodology for State-wide mapping of bushfire prone areas in Queensland*. CSIRO, Australia.

Loddon Mallee Regional Strategic Fire Management Planning Committee (2011) *Loddon Mallee Regional Strategic Fire Management Plan 2011-21*

McArthur, A. G. (1967) *Leaflet No. 107 Fire behaviour in Eucalypt Forests*. Department of National Development: Forestry and Timber Bureau, Commonwealth of Australia, Canberra.

Newnham, G., Blanchi, R., Leonard, J., Opie, K. & Siggins, A. (2014) *Bushfire decision support toolbox radiant heat flux modelling – Case study three 2013 Springwood fire, New South Wales*.

Noble, I. R., Gill, A. M. & Bary, G. A. V. (1980) McArthur's fire-danger meters expressed as equations. *Australian Journal of Ecology,* 5**,** pp. 201-203.

Standards Australia (2009) *Australian Standard 3959-2009 Construction of buildings in bushfire-prone areas (incorporating Amendment Nos 1, 2 and 3)*. SAI Global, Sydney.

Tan, Z., Midgley, S. & Douglas, G. (2005) *A computerised model for bushfire attack assessment and its applications in bushfire protection planning*. *16th Congress of the Modelling and Simulation, Society of Australia and New Zealand (MODSIM 05).* Melbourne, 12-15 December 2005.

Teague, B., McLeod, R. & Pascoe, S. (2009) *2009 Victorian Bushfires Royal Commission Interim Report*. Government of Victoria.

Tolhurst, K. G. (2014a) *Victorian Wildfire Average Recurrence Interval, Course Notes Bushfire Interface Science 2014*. University of Melbourne, Creswick.

Tolhurst, K. G. (2014b) *Estimating reduced flame height in narrow bands of fuel - Course Notes EVSC90024 Bushfire Inteface Science*. University of Melbourne, Creswick.

Tolsma, A., Cheal, D. & Brown, G. (2007) *Ecological Burning in Box-Ironbark Forests: Phase 1 - Literature Review*. Arthur Rylah Institute for Environmental Research, Heidelberg.

Appendix 1. Water supply and access requirements

1.1. BMO requirements

Water Supply

The static water supply requirements under AM4.1 are detailed in Table 10 below.

Table 10. Minimum static water supply requirements for buildings in BMO (Clause 52.47, table 4)

Minimum static water supply for office, retail, dwellings and dependent person's units			
Lot sizes (m^2)	Hydrant available	Effective capacity (litres)	Fire authority fittings and access required
Less than 500	N/A	2,500	No
500–1,000	Yes	5,000	No
500–1,000	No	10,000	Yes
1,001 and above	N/A	10,000	Yes

Note 1: A hydrant is available if it is located within 120 meters of the rear of the building
Note 2: Fittings must be in accordance with the published requirements of the relevant fire authority

The water supply must meet the following requirements:

- be stored in an above ground water tank constructed of concrete or metal.
- all fixed above-ground water pipes and fittings required for firefighting purposes must be made of corrosive resistant metal
- The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for firefighting water supplies

Additional conditions to apply if CFA fittings and access is required

- Incorporate a ball or gate valve (British Standard Pipe (BSP) 65mm) and coupling (64 mm CFA 3 thread per inch male fitting) (Figure 20).
- Any pipework and fittings must be a minimum of 65 mm (excluding the CFA coupling).
- The outlet/s of the water tank must be within 4m of the accessway and be unobstructed.
- Be readily identifiable from the building or appropriate identification signage to the satisfaction of CFA must be provided (Figure 19).

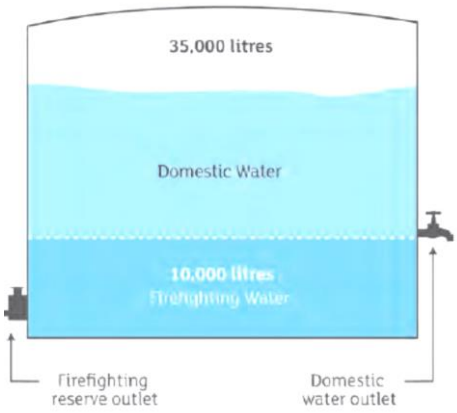


Figure 18. Firefighting water and domestic water can be in shared tank (DTPLI 2014)

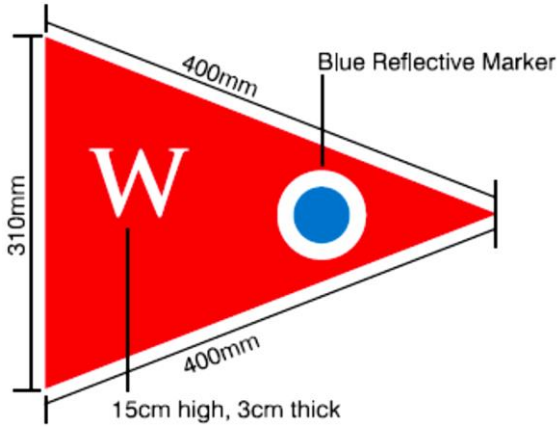


Figure 19. Water supply identification (CFA 2014b)

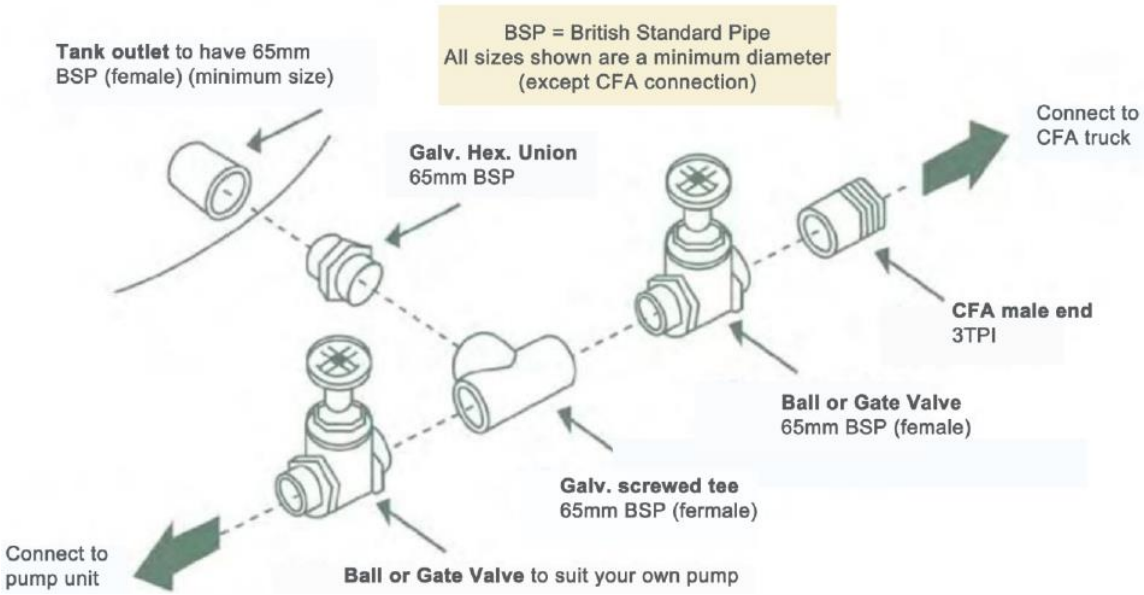


Figure 20. Requirements for water supply outlet, pipe work and valves (CFA 2014b)

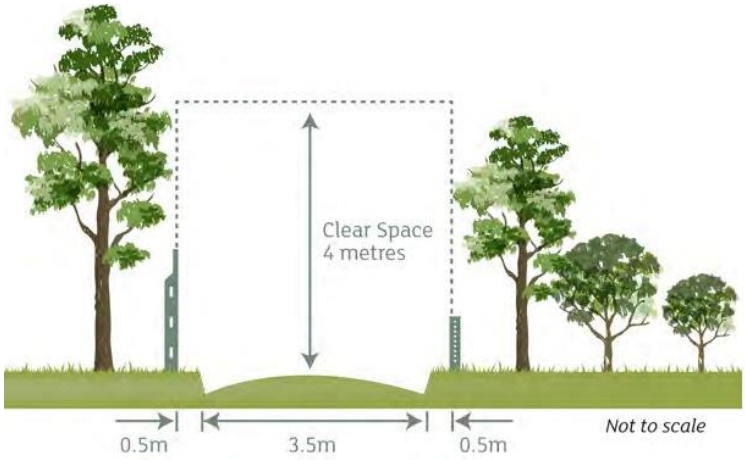
Access

The following presents the access requirements of AM4.1.

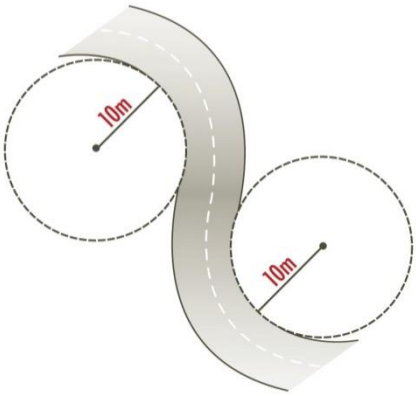
Table 11. AM4.1 Vehicle access design and construction

Column A	Column B
Length of access is less than 30m	There are no design and construction requirements if fire authority access to the water supply is not required under AM4.1.
Length of access is less than 30 metres	Where fire authority access to the water supply is required under AM4.1 fire authority vehicles should be able to get within 4 metres of the water supply outlet.
Length of access is greater than 30 metres	The following design and construction requirements apply: • All-weather construction. • A load limit of at least 15 tonnes. • Provide a minimum trafficable width of 3.5 metres. • Be clear of encroachments for at least 0.5 metres on each side and at least 4 metres vertically. • Curves must have a minimum inner radius of 10 metres. • The average grade must be no more than 1 in 7 (14.4%) (8.1°) with a maximum grade of no more than 1 in 5 (20%) (11.3°) for no more than 50 metres.
Length of access is greater than 100 metres	A turning area for firefighting vehicles must be provided close to the building by one of the following: • A turning circle with a minimum radius of eight metres. • A driveway encircling the dwelling. • The provision of other vehicle turning heads – such as a T or Y head – which meet the specification of Austroad Design for an 8.8 metre Service Vehicle.
Length of access is greater than 200 metres	• Passing bays must be provided at least every 200 metres. • Passing bays must be a minimum of 20 metres long with a minimum trafficable width of six metres.

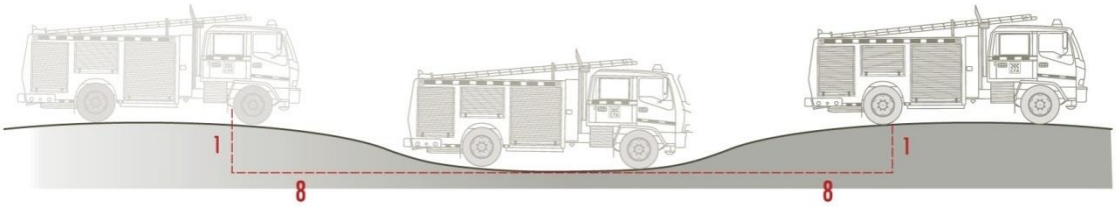
Note 1: The length of access should be measured from a public road to either the building or the water supply outlet, whichever is longer.



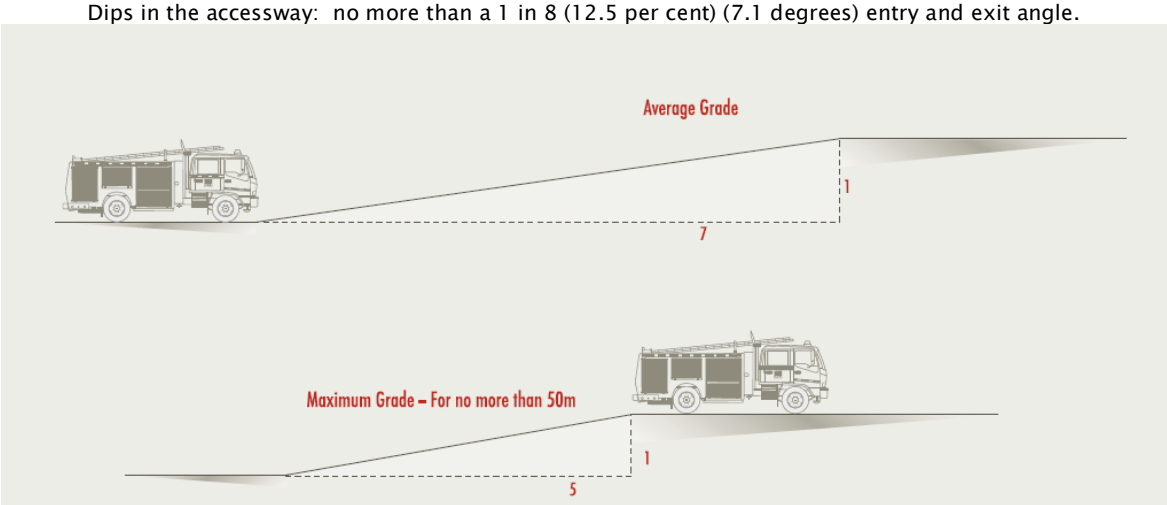
Widths and clearances of accessway



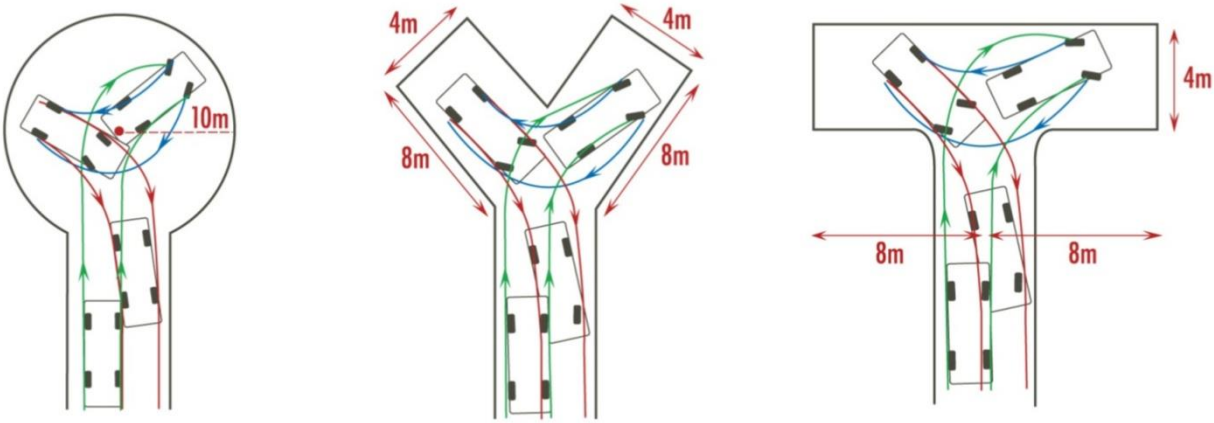
Curves in the accessway: minimum inner radius of 10m



Dips in the accessway: no more than a 1 in 8 (12.5 per cent) (7.1 degrees) entry and exit angle.



Accessway average and maximum grade



Turning circles- required where accessway is in excess of 100m

1.2. CFA REQUIREMENTS FOR ALL RESIDENTIAL SUBDIVISION

Water supply

In order to meet the required water provisions, in accordance with 'Requirements for Water Supplies and Access for Subdivisions (CFA 2006)' the following will be provided:

- Hydrants will be within 120m of the rear of lots and will be no more than 200m apart
- Hydrants will be identified as per CFA specifications (Figure 21)

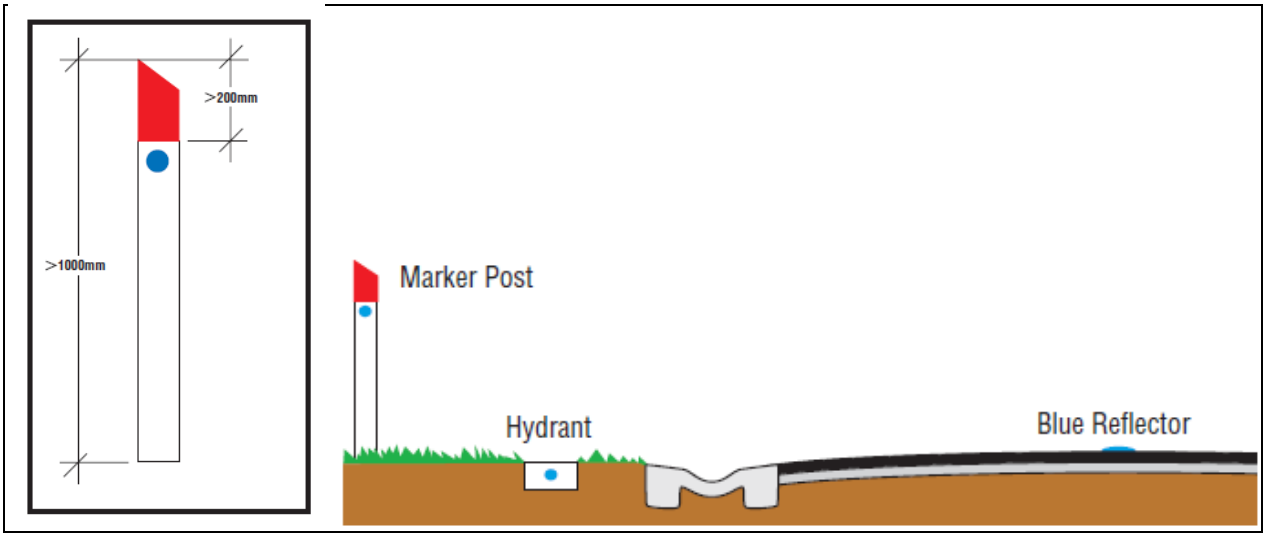


Figure 21. Water Supply Signage (CFA 2006).

Access

The proposed roads will be consistent with Requirements for Water Supplies and Access for Subdivisions in Residential 1 and 2 and Township Zones (CFA 2006). The following conditions apply to roads in the subdivision:

- constructed with rollover curves and consistent with widths specified in Table C1 of CFA (2006) (see Figure 6 below) – note some widths differ for Clause 56 of the planning scheme;
- constructed to a standard so that they are accessible in all weather conditions and capable of accommodating vehicle of 15 tonnes for the trafficable road width;
- have an average grade no more than 1 in 7 (14.4%) (8.1°) with a maximum of no more than 1 in 5 (20%) (11.3°) for no more than 50 metres;
- dips will have no more than a 1 in 8 (12.5%) (7.1°) entry and exit angle;
- constructed roads more than 60m in length from the nearest intersection must have a turning circle with a minimum radius of 8m (including roll-over kerbs if they are provided. or provided with other solutions using T or Y (refer to Figure 22 below);
- dead end roads will be no more than 60m long

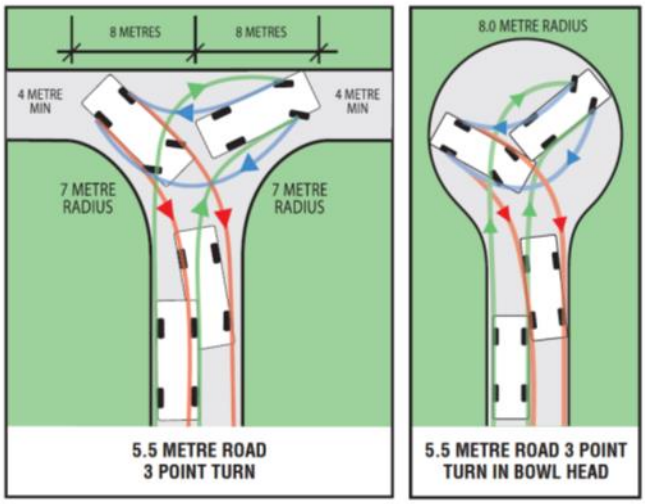


Figure 22. Turning Bays

Table C1 Carriageway Widths of Roads and Neighbourhood Streets

Street Type	Carriageway Width
Access Lane A side or rear lane principally providing access to parking on lots with another street frontage.	5.5m with no parking spaces to be provided. Appropriately signed.
Access Place A minor street providing local residential access with shared traffic pedestrian and recreation use, but with pedestrian priority.	5.5m wide with 1 hard standing verge parking space per 2 lots. **or** 5.5m wide with parking on carriageway – one side. Appropriately signed.
Access Street - Level 1 A street providing local residential access where traffic is subservient, speed and volume are low and pedestrian and bicycle movements are facilitated	5.5m wide with 1 hard standing verge parking place per 2 lots.
- Level 2	7.3m–7.5m wide with parking on both sides of carriageway. 7.0m-7.2m with rollover curbs. Note: widths differ from Cl 56 of VPP's.
Connector Street - Level 1 A street that carries higher volumes of traffic. It connects access places and access streets through and between neighbourhoods.	6m-6.5m wide with indented parking on both sides on a bus route **or** 7m-7.5m wide with indented parking on one side and kerbside parking opposite on a bus route **or** 7.2m-7.5m wide with parking on both sides of carriageway
-Level 2	2 x 5.5m wide carriageways with central medium. Parallel parking should be provided in locations that allow cars to exit in a forward direction from a parking space. **or** 7.2m-7.5m wide carriageway with indented parking on both sides and turning lanes at intersections with other Level 2 connector Streets and Arterial Roads. Bus bays to be indented.

Figure 23. Carriageway width of roads and neighbourhood streets

Appendix 2. Maps

PRACTICAL ECOLOGY
ecological restoration & consulting

Disclaimer

Practical Ecology bears no responsibility for the accuracy and completeness of this information and any decisions or actions taken on the basis of the map. While information appears accurate at publication, nature and circumstances are constantly changing.

Legend

- Subject site
- Parcels
- Contours (10m)
- Natural watercourse
- Intended Bushfire Management Overlay extent

Subdivision

- Lots
- Road

Details

Date: 4/07/2017
Version: 1

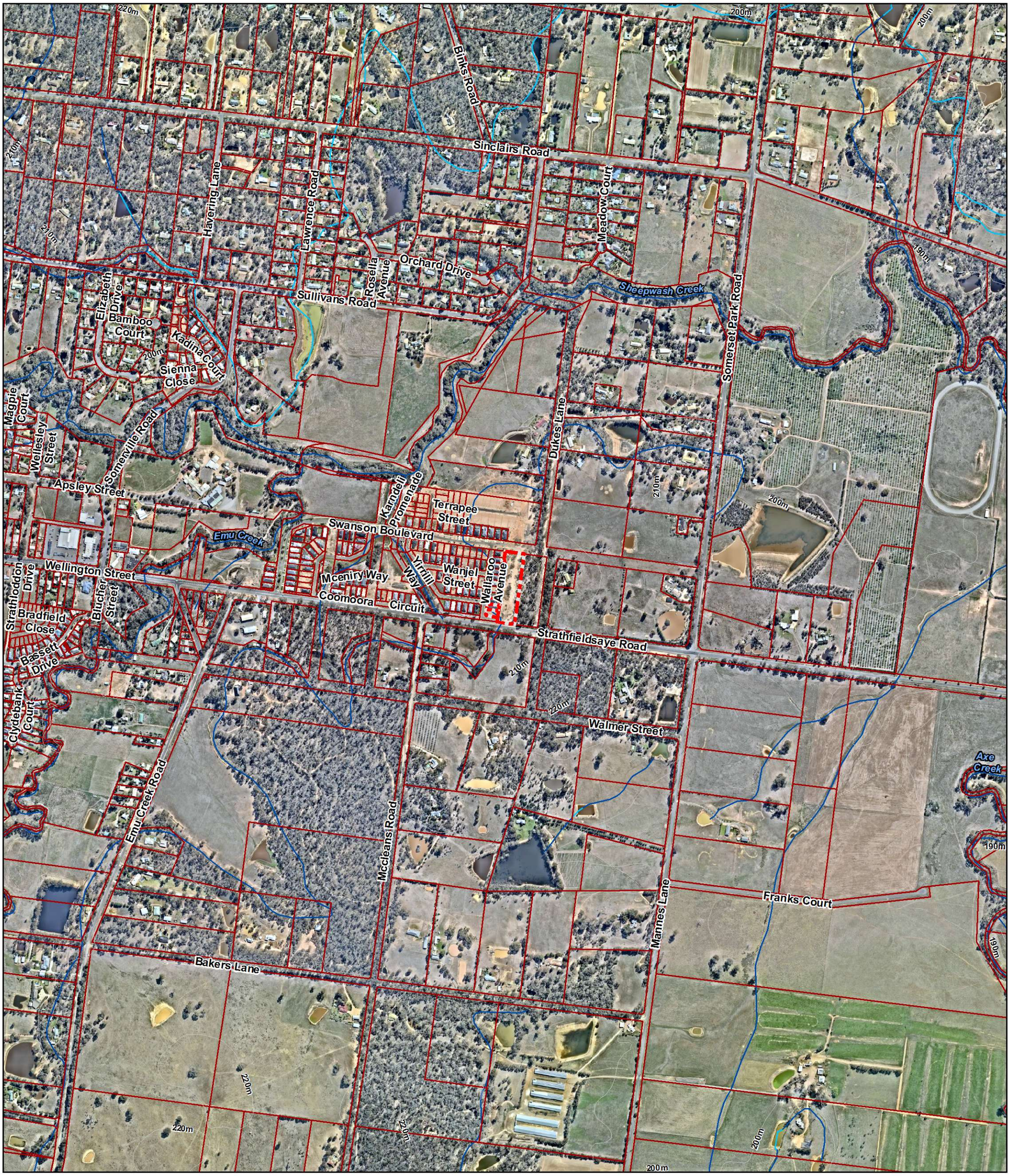
Data Source: Base layers courtesy of VicMap, Copyright © State of Victoria. Aerial photography from NearMap (April 2017).

Map 1. Subject Site
Imagine Estate, Wallaroo Ave
Strathfieldsaye

N

0 10 20 30 40 m

Scale 1:750 (Page size A3)



PRACTICAL ECOLOGY
ecological restoration & consulting

Disclaimer

Practical Ecology bears no responsibility for the accuracy and completeness of this information and any decisions or actions taken on the basis of the map. While information appears accurate at publication, nature and circumstances are constantly changing.

Legend

- Subject site
- Parcels
- Contours (10m)
- Constructed watercourse
- Natural watercourse

Details

Date: 4/07/2017
Version: 1

Data Source: Base layers courtesy of VicMap, Copyright © State of Victoria. Aerial photography from NearMap (April 2017)

Map 2. Local Context

Imagine Estate, Walleroo Ave
Strathfieldsaye

N

0 100 200 300 400 500 m

Scale 1:10,000 (Page size A3)

PRACTICAL ECOLOGY
ecological restoration & consulting

Disclaimer

Practical Ecology bears no responsibility for the accuracy and completeness of this information and any decisions or actions taken on the basis of the map. While information appears accurate at publication, nature and circumstances are constantly changing.

Legend

- Subject site
- Localities
- State forest and regional park
- Contours (10m)
- Constructed watercourse
- Natural watercourse
- Railways

Details

Date: 4/07/2017
Version: 1

Data Source: Base layers courtesy of VicMap, Copyright © State of Victoria. Aerial photography from NearMap (April 2017)

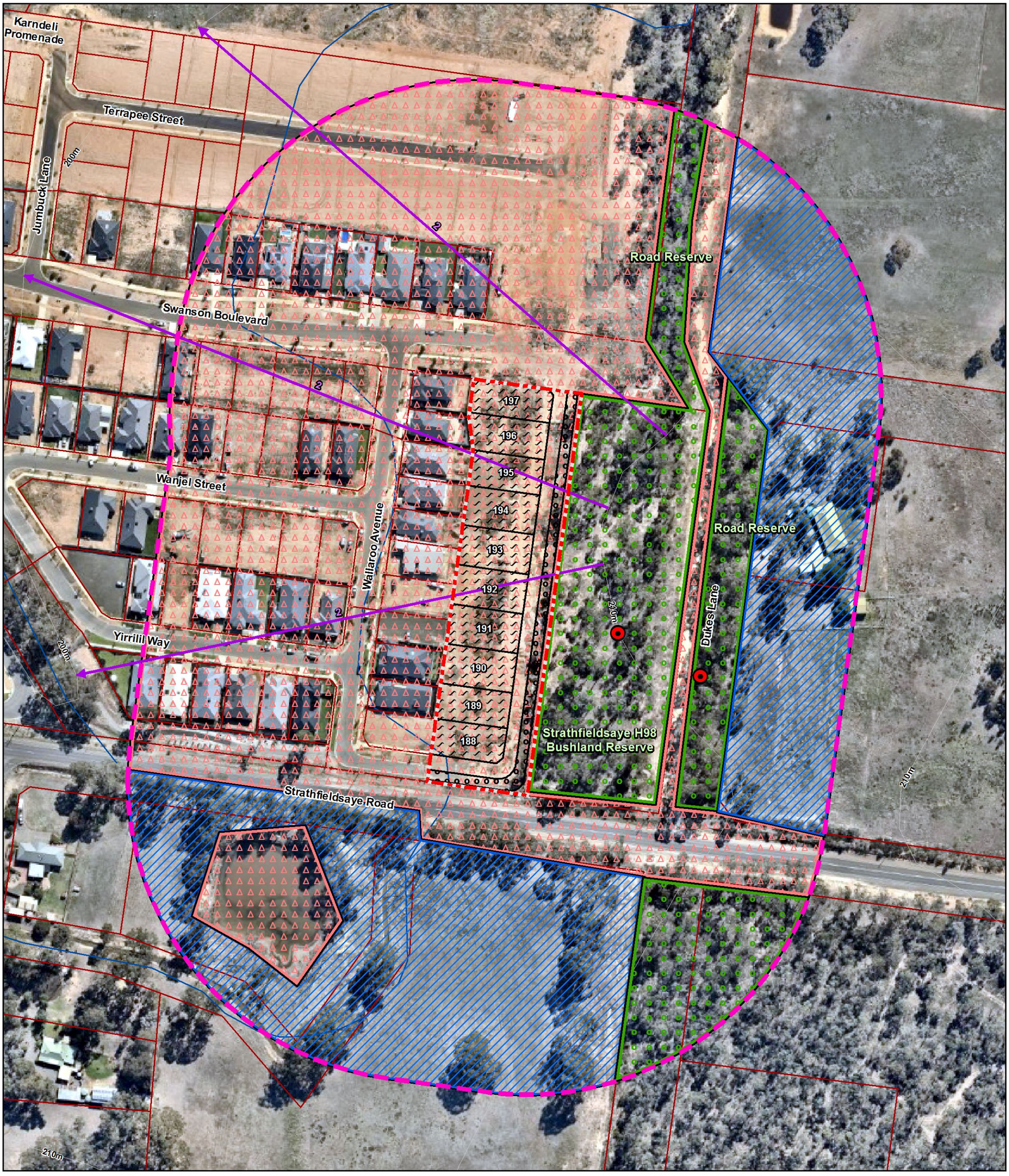
Map 3. Landscape Context

Imagine Estate, Walleroo Ave
Strathfieldsaye

N

0 500 1,000 1,500 2,000 2,500 m

Scale 1:50,000 (Page size A3)



PRACTICAL ECOLOGY
ecological restoration & consulting

Disclaimer
Practical Ecology bears no responsibility for the accuracy and completeness of this information and any decisions or actions taken on the basis of the map. While information appears accurate at publication, nature and circumstances are constantly changing.

Legend

- Subject site
- Assessment area (150m)
- Parcels
- Contours (10m)
- Natural watercourse
- Slopes calculated from contours

Subdivision

- Lots
- Road

Classified vegetation

- Woodland
- Grassland
- Low threat (under development)
- Fuel Load Assessment

Details

Date: 9/08/2017
Version: 1

Data Source: Base layers courtesy of VicMap, Copyright © State of Victoria. Aerial photography from NearMap (April 2017)

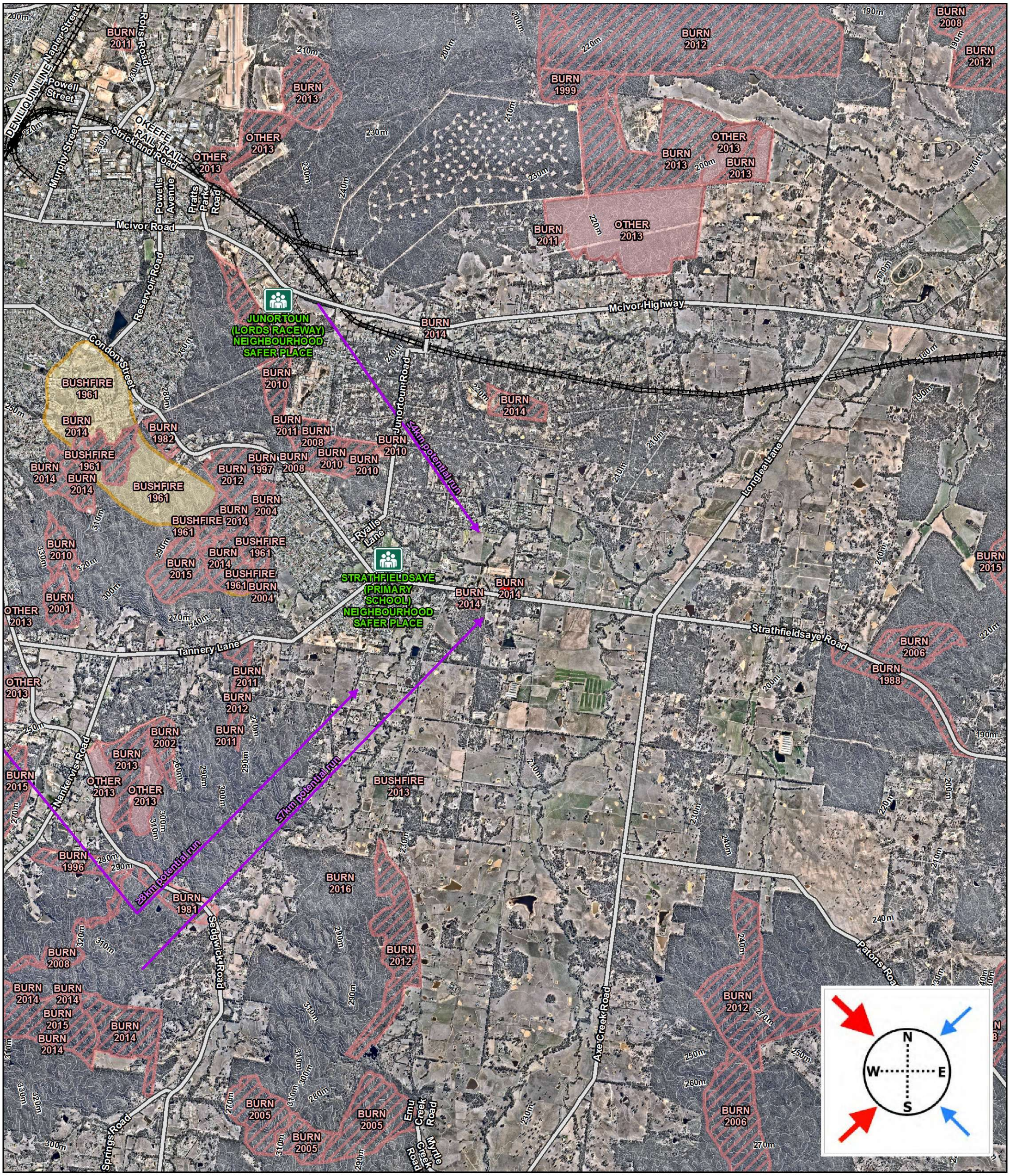
Map 4. Bushfire Hazard Site Assessment

Imagine Estate, Wallaroo Ave
Strathfieldsaye

N

0 20 40 60 80 m

Scale 1:1,750 (Page size A3)



PRACTICAL ECOLOGY
ecological restoration & consulting

Disclaimer

Practical Ecology bears no responsibility for the accuracy and completeness of this information and any decisions or actions taken on the basis of the map. While information appears accurate at publication, nature and circumstances are constantly changing.

Legend

- Subject site
- Contours (10m)
- Railways
- Major Roads
- Potential fire runs
- Neighbourhood Safer Place

Fire history

Bushfire

- Bushfire Pre 1950
- Bushfire 1950-1979
- Bushfire 1980 onwards

Planned Burn

- Planned Burn Pre 1980
- Planned Burn 1980 onwards

Details

Date: 5/07/2017
Version: 1

Data Source: Base layers courtesy of VicMap, Copyright © State of Victoria. Aerial photography from NearMap (April 2017)

Map 5. Bushfire Hazard Landscape Assessment

Imagine Estate, Walleroo Ave Strathfieldsaye

N

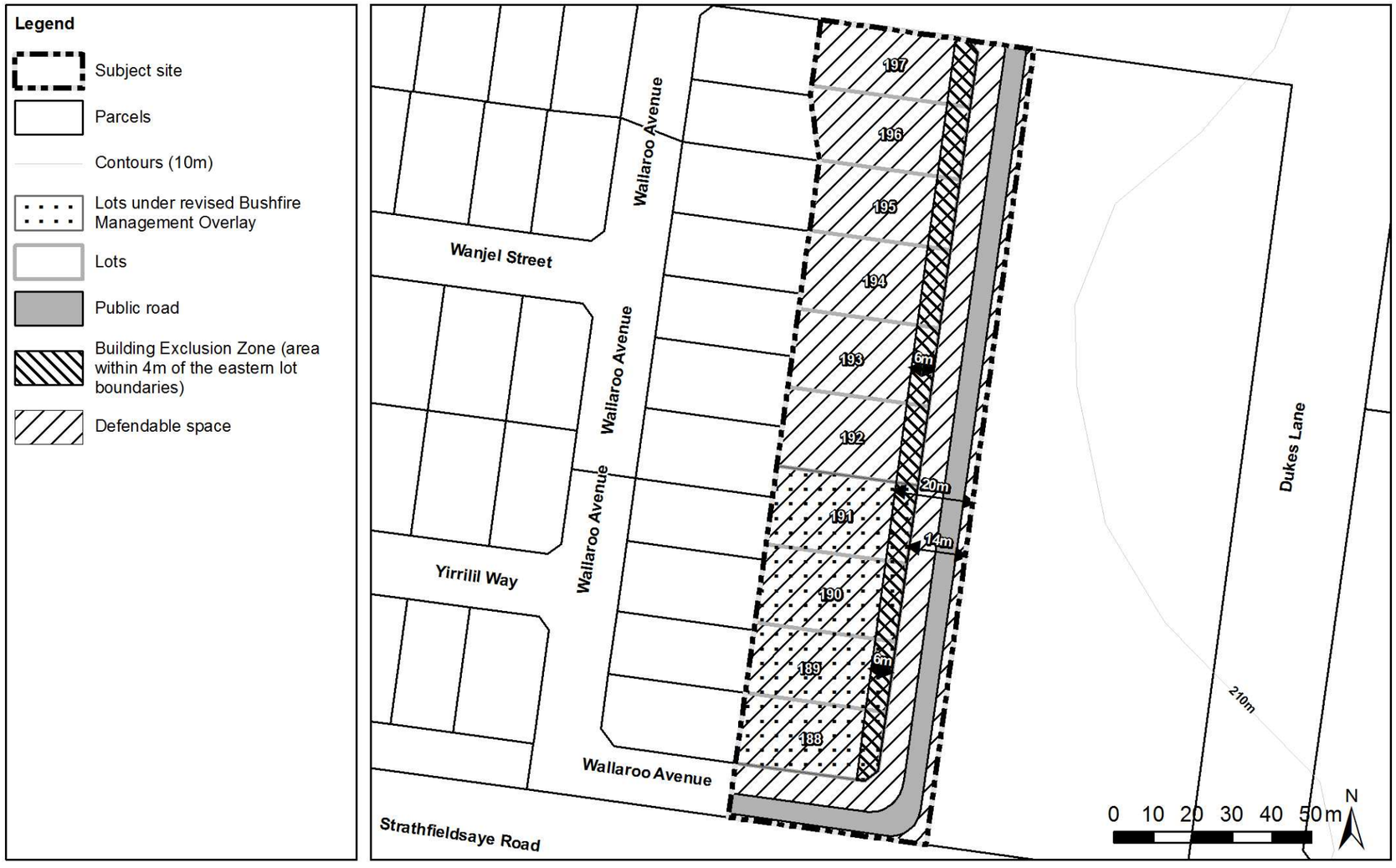
0 500 1,000 1,500 2,000 2,500 m

Scale 1:50,000 (Page size A3)

Bushfire Management Plan

Imagine Estate, Wallaroo Ave, Strathfieldsaye

Note: This BMP cannot guarantee safety during a bushfire event. Occupants need to develop a Personal Bushfire Plan to clearly understand and plan for how they are going to act in response to a bushfire event.



Construction

Lots 188–197 will have a minimum Bushfire Attack Level of **BAL–19** that the building will be designed and constructed to in accordance with the Building Code of Australia.

No buildings are to be constructed in the Building Exclusion Zone

Public Roads

- Roads must be constructed to a standard so that they are accessible in all weather conditions and capable of accommodating a vehicle of 15 tonnes for the trafficable road width.
- Proposed roads must have a suitable trafficable width to allow the unimpeded access of emergency firefighting vehicles (not withstanding any parking restrictions that Council may apply) to the satisfaction of CFA.

Classified vegetation: Woodland

PRACTICAL ECOLOGY
ecological restoration & consulting

Details
Date: 15/08/2017
Version: 1

Defendable space management standards:

- Grass must be short cropped and maintained during the declared fire danger period.
- All leaves and vegetation debris must be removed at regular intervals during the declared fire danger period.
- Within 10 metres of a building, flammable objects must not be located close to the vulnerable parts of the building.
- Plants greater than 10 centimetres in height must not be placed within 3m of a window or glass feature of the building.
- Shrubs must not be located under the canopy of trees.
- Individual and clumps of shrubs must not exceed 5 sq. metres in area and must be separated by at least 5 metres.
- Trees must not overhang or touch any elements of the building.
- There must be a clearance of at least 2 metres between the lowest tree branches and ground level.

Water supply for firefighting purposes

2,500L of effective water supply for firefighting purposes which will meet the following requirements:

- Is stored in an above ground water tank constructed of concrete or metal.
- All fixed above-ground water pipes and fittings required for firefighting purposes must be made of corrosive resistant metal.
- The water supply may be in the same tank as other water supplies provided that a separate outlet is reserved for firefighting water supplies

Only lots 188–191 are required to meet the water supply standards.

Ongoing Bushfire Mitigation Measures

The bushfire mitigation measures detailed on this plan, including those relating to construction standards, defendable space, water supply and access, must be maintained to the satisfaction of the responsible authority in perpetuity.

Appendix 3. Proposed subdivision amendment

AMENDED PLANS PROPOSED

RECEIVED 31 MAR 2016 CITY OF GREATER BENDIGO PLANNING DEPARTMENT

PRELIMINARY PLAN ONLY

REV.	REVISION	DATE
H	ALTER WIDTH OF HABITALBE BLDG EXCLUSION ZONE. UPDATE AERIAL PHOTO & LOT LAYOUTS	31-03-16
G	ADJUST LOTS 'E-1 TO 'E37'	11-09-15
F	FINALISE BUILDING EXCLUSION ZONES	03-10-13
E	AMENDMENTS REQUEST BY CLIENT TO DETAILING	SEP 2013
D	AMEND BUILDING SETBACKS ALONG CROWN LAND RESERVE	SEP 2013
C	AMEND LOT LAYOUT	AUG 2013
B	ALTER LOT LAYOUT	18-10-12
A	AS SUBMITTED TO COUNCIL	AUG 2012

Tomkinson Group
PROJECT MANAGERS LICENSED SURVEYORS DEVELOPMENT PLANNERS CIVIL ENGINEERS
FREECALL: 1800 810 170 TEL: (03) 5445 8700 FAX: (03) 5441 3648
PO BOX 421, BENDIGO 3552 57 MYERS STREET, BENDIGO 3550
WEB: www.tomkinson.com EMAIL: bendigo@tomkinson.com
ISO 9001:2008 FS520488

PLAN REFERRED TO IN PLANNING PERMIT
No: DS/834/2012
For and on behalf of the City of Greater Bendigo
Date: 23 MAY 2016

DRAWING APPROVED BY ME
Date: 27-08-12
Surveyed / Drawn PJL 27-08-12 / Checked MN 27-08-12

Principal: Strathfieldsaye Holdings Pty Ltd

Proposed Strathfieldsaye East Development
Strathfieldsaye Road / Dukes Lane, Strathfieldsaye
Design Response Plan

SCALE 1:2,000 (A3) LENGTHS ARE IN METRES

Municipality: CITY OF GREATER BENDIGO
Sheet 1 of 1
Drawing No. 1024700N DRP
Revision H

NOTE: THIS PLAN IS AN UNCONTROLLED DOCUMENT AND WILL NOT BE UPDATED. IT IS THE RESPONSIBILITY OF THE USER TO CONFIRM THAT THIS IS A CURRENT COPY AND SUITABLE FOR THE PROPOSED USE - THIS SHEET MUST BE READ IN CONJUNCTION WITH ALL SHEETS OF THIS SET AND ANY ACCOMPANYING DOCUMENTS