BUSHFIRE ASSESSMENT REPORT

ROMSEY STRUCTURE PLAN - C21.1092 (MACEDON RANGES SHIRE COUNCIL)

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Version control

Version	Date	Changes	Distribution
1	29 September 2021		Client

Contents

Summary of this report: Bushfire assessment for Romsey Structure Plan

Purpose of this report	This report has been prepared to support development and consultation on a structure plan for the township of Romsey
Key guiding documents	Planning scheme Clause 13.02 *Bushfire Planning* Bushfire and Planning Practice Note 64 *Local planning for bushfire protection* (DELWP 2017a) Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a) *Municipal Fire Management Plan (Macedon Ranges MFMC 2020)*
Strategic assessment area	Locality of Romsey and 30km radius
Bushfire controls in the locality	Bushfire Management Overlay (part) Bushfire Prone Area (BPA) designated under the *Building Regulations 2018*, except for most of the existing township
Hazard assessment	Vegetation around Romsey is primarily grassland, with small patches of remnant woodland, and forest to the south west Slopes are low, except in gullies. Vegetation in the township is primarily low threat Analysis of bushfire history and weather records confirms fire is most likely to arrive from north east to south south west directions
Landscape assessment	Landscape Type 2 to 3 (DELWP 2017b, pp. 14-5) Fire may reach the township and cause destruction Conditions are expected to cause fire control to fail, on average, on up to 4.4 days/year (Bull 2021; Hines et al. 2010).
Bushfire risk	Low to Moderate (*Victoria Fire Risk Register (VFRR)* (CFA 2020)*, Loddon-Mallee bushfire management strategy* (DELWP 2020b) Most of the current township is located outside the Bushfire Prone Area and can therefore be considered Low threat (BAL-LOW).
Planning response to the risk	Proposed treatments are based upon the approach provided in the Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a) as follows: Form and structure of the township ▪ The areas of lowest risk for growth are to the east of the town ▪ Township expansion be designed to not only to meet the requirement under Clause 13.02-1S for BAL12.5 but also meet criteria for excision from the Bushfire Prone Area ▪ Vulnerable, hazardous and industrial uses should be located away from the interface The township interface ▪ Setbacks from vegetation have been provided for consideration including deemed-to-satisfy requirements (AS 3959 Method 1) to indicate minimum requirements and 'Enhanced' setbacks based upon a severe climate change scenario ▪ Recommendations have been provided regarding vegetation management, perimeter roads, open space, development in setback areas and access and egress Protection measures at the settlement scale ▪ Recommendations have been provided regarding vegetation management including biodiversity protection, building construction standards and supporting community resilience

Definitions and abbreviations

AS 3959-2018: The Australian Standard *Construction of buildings in bushfire prone areas* provides guidance on risk assessment and construction to assist buildings to survive the passage of a fire front and is used as the basis for bushfire-related planning and building requirements in Victoria

Bushfire Attack Level (BAL) and construction standard: The BAL describes the severity of the threat from radiant heat (in kW/m2) and the construction standard required to improve protection of buildings against that threat. There are 6 BAL ratings: low, 12.5, 19, 29, 40 and FZ (flame zone). An informal rating of BAL10 is used in this report to describe the threat of 10kW/m2. For example, humans experience pain after being exposed to radiant heat of 10kW/m2 for more than 3 seconds, plastic tanks and bins may ignite after exposure of radiant heat of 19kW/m2 and most timbers ignite after 3 minutes exposure to radiant heat of 29kW/m2.

Defendable space*:* An area around a building (or other important asset) where vegetation is managed to reduce the amount and continuity of fuel available to a fire. In this report, the defendable space has been divided into an inner and outer zone to reflect the different vegetation structures (currently open area versus fuel break)

Forest/Grass Fire Danger Index (FFDI/GFDI):The chance of a fire starting, its rate of spread, its intensity and the difficulty of its suppression, based on air temperature, relative humidity, wind speed and both long- and short-term drought effects.

Additional abbreviations:

BEP	Bushfire Emergency Plan
BMO	Bushfire Management Overlay
BPA	Bushfire Prone Area
CFA	Country Fire Authority
DEWLP	Department of Environment, Water, Land and Planning
NCC	*National Construction Code*

PART A: INTRODUCTION AND CONTEXT

1 Purpose of this report

This report has been prepared to support development of a structure plan and related documentation for the township of Romsey. The aim of the structure plan is to provide for (amongst other things) the sustainable development of Romsey. This includes taking into account the risk from bushfire.

This report responds to Council's requirements set out in the *Invitation to Tender Services* for a bushfire assessment which informs the housing framework and urban structure of the town. This assessment is required to:

- Demonstrate alignment with planning scheme Clause 13.02 *Bushfire Planning*, Bushfire and Planning Practice Note 64 *Local planning for bushfire protection* (DELWP 2017a)
- Accord with the *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020)
- Include a hazard analysis considering vegetation, topography and weather via a factual and evidence-based process
- Determine and respond to bushfire risk using the *Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000)*
- (When the structure plan is complete), provide justification for the planning scheme amendment to implement the structure plan.

This assessment also incorporates guidance from the following documents:

- Planning Advisory Note 68 *Bushfire State Planning Policy Amendment VC140* (DELWP 2018)
- Planning Practice Note 46 *Strategic Assessment Guidelines for preparing and evaluating planning scheme amendments* (DELWP 2017a)
- Technical Guide *Planning Permit Applications – Bushfire Management Overlay* (DELWP 2017b)
- Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a).

This report will form the basis for consultation with the Country Fire Authority, DELWP and the wider community.

Figure 1: Risk management process (*AS ISO 31000-2018)*

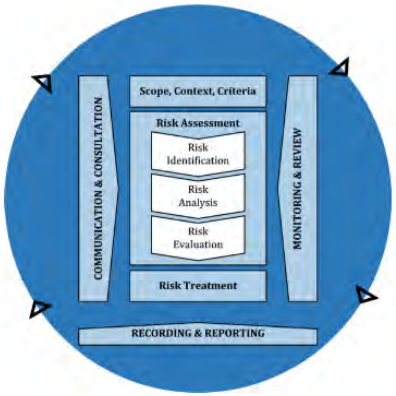
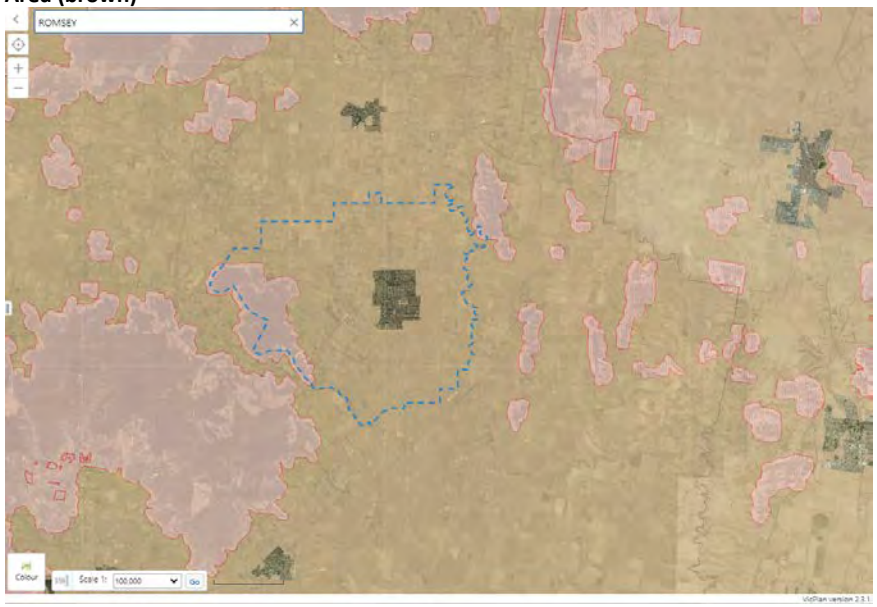


Figure 2: Romsey (locality) and Bushfire Management Overlay (pink) and Bushfire Prone Area (brown)



2 Locality overview

Romsey is approximately 63 kilometres north-west of the Melbourne CBD. The following description is sourced primarily from the Municipal Strategic Statement (Clause 21.13-4 Local Areas and Small Settlements) the *Romsey Issues and opportunities paper December 2018* (Macedon Ranges Shire Council 2018) and the *Farming Zone Review. Research and investigation paper* (RMCG 2020).

2.1 Landform and waterways

The township is sited on a relatively flat volcanic plain, sloping generally to the south east. The township is bisected by Five Mile Creek. Other major watercourses include Dry Creek located to the south west and Deep Creek which forms the boundary of the locality to the east. The locality is situated within the Maribyrnong catchment managed by Port Phillip and Western Port Catchment Management Authority.

2.2 Rural land use and vegetation

Romsey is surrounded by a belt of productive (Class 2, good capability) agricultural land. Vegetation around Romsey is primarily grassland which supports livestock farming. Crop growing between Lancefield and Romsey is supported by groundwater. The locality supports only limited remnant native vegetation; primarily Plains Grassy Woodland (EVC 55) which is located mainly in roadside areas. There is also remnant native vegetation patches of Stream Bank Shrubland (EVC 851) identified along Deep Creek. Both of these EVCs are classified as Endangered (DELWP n.d.).

2.3 Population

Romsey is the largest district town in the east of the Macedon Ranges municipality. It is expected to grow to the lower end of a large district town by 2036 with an expected population of 6,000 (Macedon Ranges Settlement Strategy, 2011). Young to middle aged families are a significant feature of the town's age structure with 32 per cent of the population being under the age of 18 (Macedon Ranges Shire Council 2009). At least 55 per cent of employed people living in Romsey work in the metropolitan area (including 17 per cent in Hume), while only 33 per cent work within the Macedon Ranges Shire (Macedon Ranges Shire Council 2009).

2.4 Infrastructure

The Melbourne-Lancefield Road (Main Street) is the primary north-south highway, providing access to Melbourne. The main east-west route is the Woodend-Wallan Road, also known as Barry Street or the Romsey-Wallan Road. Romsey does not have rail connections.

2.5 Urban character

Elements that define Romsey's character include: historic building, wide streets, significant vegetation, Five Mile Creek (passive recreation asset), open space and large residential lots. Romsey supports a limited range of retail, commercial and industrial activities.

2.6 Planning context

In 2018 the Macedon Ranges region (including Romsey and surrounds) was declared a 'distinctive area and landscape' under 3AAB of the *Planning and Environment Act 1987 (*https://engage.vic.gov.au/distinctive-areas-and-landscapes-program accessed 19 September 2021*7.* The incorporated document *Macedon Ranges Statement of Strategic Planning Policy* (Government of Victoria 2019) was developed to support this designation. This document, planning controls and supporting studies emphasise protection of visual amenity, biodiversity and agricultural productivity, as well as building resilience to environmental hazards such as bushfire. The SPP notes that long-term a settlement boundary will be determined for Romsey as part of the review of the Romsey structure plan.

2.7 Issues and opportunities

Key issues identified for Romsey in these documents include:

- Managing significant growth pressures
- Balancing growth with amenity, biodiversity and sustainability
- Facilitating a greater diversity of housing to better respond to changing demographics (young families and downsizers)
- Protecting the character of the established residential areas of Romsey (including single dwellings on large to very large lots)
- Protecting high quality agricultural land.

Additional issues of particular relevance to bushfire protection indicated in these documents include:

- Need for upgrading/expansion of infrastructure including waste treatment
- Limited alternative road access to the Melbourne-Lancefield Rd
- No designated Neighbourhood Safer Place
- Demographics and high tourism levels indicate a population with higher vulnerabilities and limited exposure to bushfire.

Opportunities include building of bushfire resilience through design of development areas, buildings and infrastructure, and supporting community cohesion.

Figure 3: Locality overview
Source: Framework plan published in the *Macedon Ranges Statement of Strategic Planning Policy* (Government of Victoria 2019)

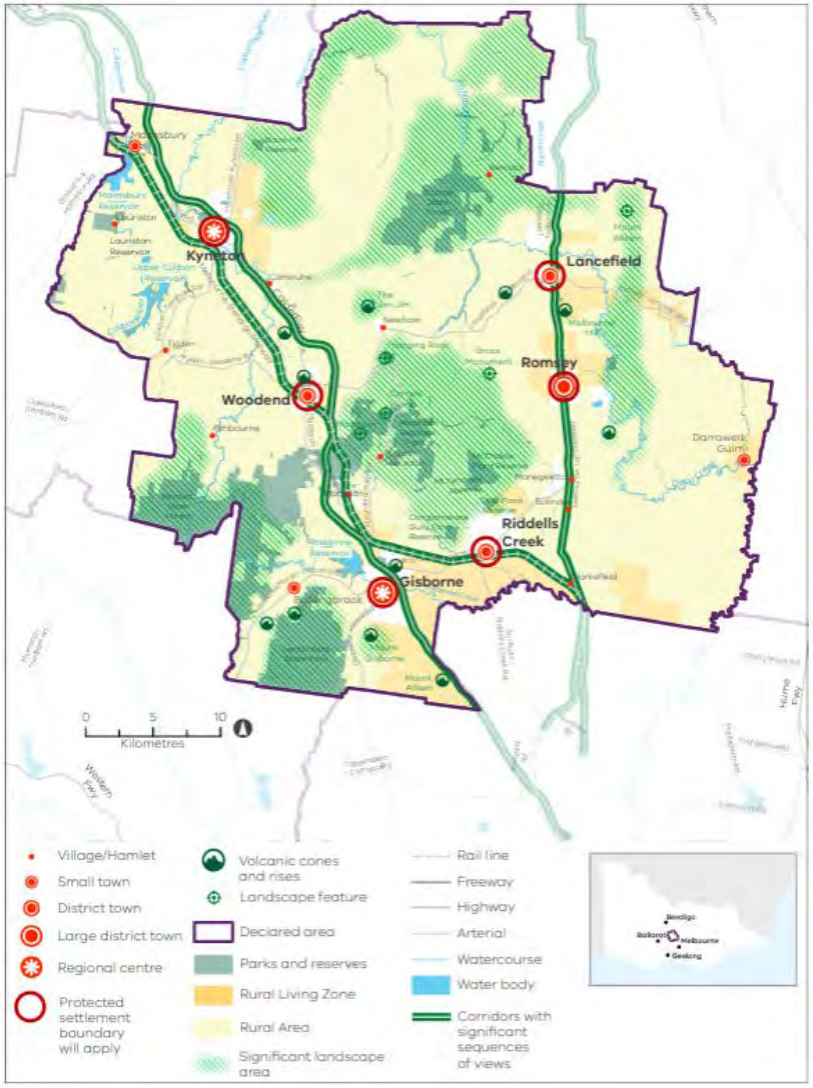


Figure 4: Agricultural land use (industry clusters)
Source: Farming Zone Review. Research and investigation paper (RMCG 2020, p. 61)

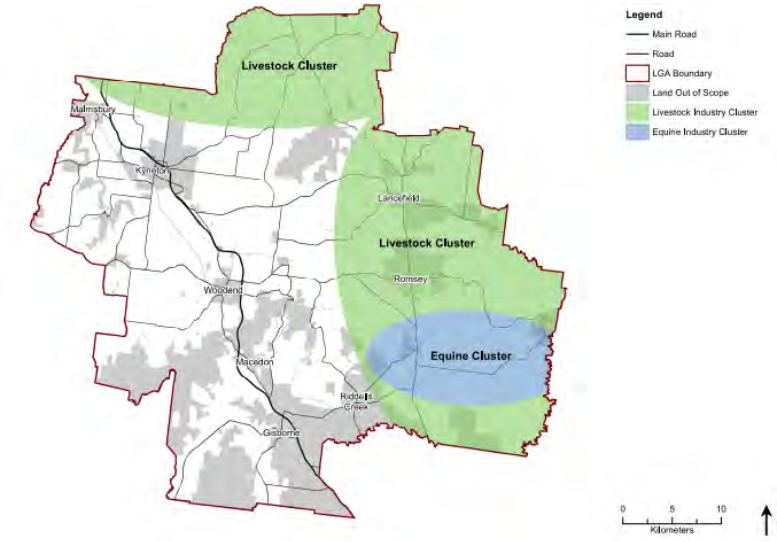
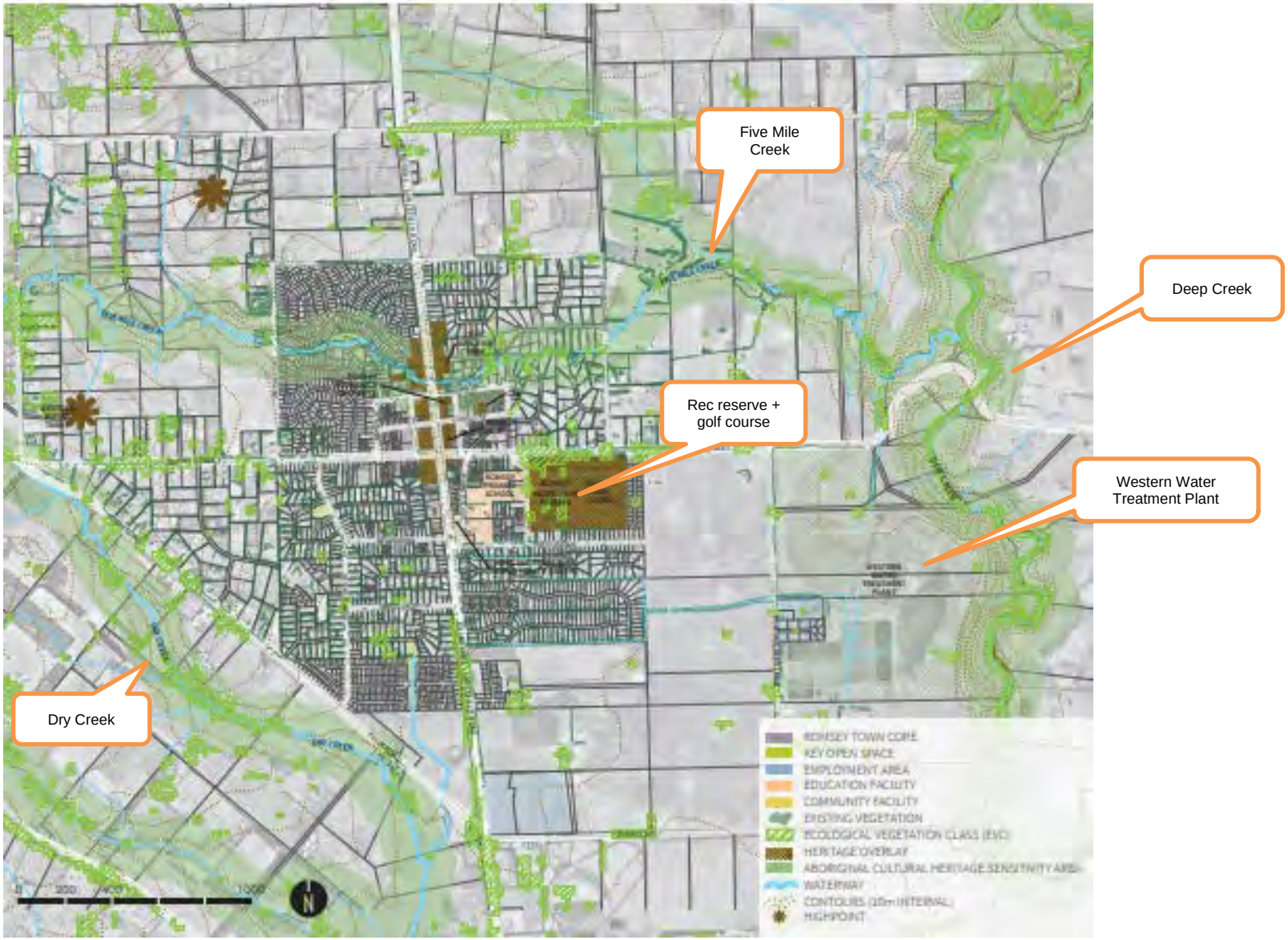


Figure 5: Victorian Volcanic Plain Bioregion
Source: Nature Kit 2.0
https://maps2.biodiversity.vic.gov.au/Html5viewer/index.html?viewer=NatureKit

Figure 6: Existing features
Source: *Romsey Issues and opportunities paper December 2018* (Macedon Ranges Shire Council 2018, p. 21)



3 How does bushfire affect buildings and people?

Bushfire affects buildings through:

- ember attack (where burning leaves and bark are carried ahead of the fire, accumulate around buildings, and can enter gaps as small as 1.8mm, igniting timber and other materials in and around buildings)
- radiant heat which can ignite burnable materials and crack window glass and allow burning embers to enter a building
- direct flame contact if burnable materials are close enough
- strong winds can which damage buildings and allow embers to enter.

Historically, most building and life loss to bushfire in Australia has occurred within 100m of bushland, although grassland also poses a significant risk.

CSIRO research indicates that most buildings lost to bushfire are lost through embers (Leonard, J, Blanchi & Bowditch 2004, p. 6). Roof cavities, glazing and openings are particularly vulnerable. Wind can assist embers to enter buildings by lifting cladding, creating debris including building material and tree branches that can break windows (Lambert 2010, p. 19). It also assists the accumulation of embers and unburnt vegetative material around the building that when ignited, cause localised flame contact (He et al. 2013).

Wind can be strong and/or erratic in direction due to convection. In steeper areas fire-induced winds may reach speeds strong enough to damage trees and may exceed the measures provided in wind design tables (He et al. 2013, p. 8).

Vegetation is not the only potential source of threat. Once fire reaches settled areas, houses, decks, sheds, vehicles, boats, caravans, firewood and outdoor furniture can burn for a long time and contribute to fire spread and make external conditions unsafe for an hour or more after a fire passes.

At the site level, the fire threat can be described by the bushfire attack level or BAL. The BAL describes the severity of the threat from radiant heat (in kW/m2) and the construction standard required to improve protection of buildings against that threat.

Figure 7: Bushfire attack level and the effects of radiant heat

BAL 12.5 LOW THREAT TO HOUSES	BAL 19 MODERATE THREAT TO HOUSES	BAL 29 HIGH THREAT TO HOUSES	BAL 40 VERY HIGH THREAT TO HOUSES	BAL-FZ EXTREME THREAT TO HOUSES
Low ember attack Low radiant heat (up to 12.5kW/m2)	Moderate ember attack Moderate radiant heat (up to 19kW/m2)	High ember attack High radiant heat (up to 29kW/m2)	Very high ember attack Very high radiant heat (up to 40kW/m2) Some flame contact from fire front	Extreme ember attack Extreme radiant heat (over 40kW/m2) Flame contact from fire front
Pain after 3 seconds (at 10kW/m2 or 2m from burning house) Pain after 10-20 secs (6kW/m2 or 6m from burning house) Critical conditions for firefighters Possible failure: float glass	Ignition of timber after a long time Possible failure: screened float glass Possible ignition: plastics (water tanks + rubbish bins)	Ignition of most timbers after 3 minutes	Ignition of cotton fabric after 5 seconds	Ignition of timber after 20 seconds

Adapted from *AS3959-2018* (Standards Australia 2018) (Standards Australia 2009b)and Bowditch (2006)

4 Bushfire planning and building controls

This section summarises the key planning and building controls for bushfire planning in this locality.

3.1 Planning Policy Framework (PPF): Integrated Decision Making

Clause 71.02-3 states that planning and responsible authorities should integrate policies and balance conflicting objectives in favour of net community benefit. However, in bushfire affected areas, protection of human life be prioritised over all other policy considerations

3.2 Planning Policy Framework (PPF): Bushfire

Clause 13.02-1S has the objective 'To strengthen the resilience of settlements and communities to bushfire through risk based planning that prioritises the protection of human life'. The policy must be applied to all planning and decision making under the *Planning and Environment Act 1987*, relating to land which is:

- Within a designated Bushfire Prone Area
- Subject to a Bushfire Management Overlay
- Proposed to be used or developed in a way that may create a bushfire hazard.

As shown in Figure 2, Clause 13.02-1S is relevant as most of the land within the locality is within a designated Bushfire Prone Area. Part is in a Bushfire Management Overlay.

Clause 13.02-1S requires priority to be given to the protection of human life by:

- Prioritising the protection of human life over all other policy considerations
- Directing population growth and development to low risk locations and ensuring the availability of, and safe access to, areas where human life can be better protected from the effects of bushfire
- Reducing the vulnerability of communities to bushfire through consideration of bushfire risk in decision-making at all stages of the planning process'

Other key strategies in Clause 13.02-1S set out requirements for

- Bushfire hazard identification and assessment
- Settlement planning, including limiting exposure of new development to radiant heat of less than 12.5kW/m2, and enabling access to areas of low threat (BAL-LOW)
- Areas of biodiversity conservation value
- Use and development control in a Bushfire Prone Area
- Policy guidelines and Policy documents

This report assesses the hazard and identifies bushfire protection measures required to meet the requirements of Clause 13.02-1S. A response to key strategies in Clause 13.02-1S is provided in section 15. In summary, it is considered that settlement in the Romsey locality can be expanded in a way that prioritises life and meets the limiting requirement for radiant heat exposure.

3.3 Local Planning Policy Framework (LPPF)

The Municipal Strategic Statement (Clause 21.06-3 Bushfire) notes that the Macedon Ranges Shire is at high risk of bushfire which will be exacerbated by climate change and that while this risk is greatest in the forest and ranges areas it may also be significant in grassland areas. The objectives and strategies of Clause 21.06 complement the requirements of Clause 13.02-1S. In addition, this clause states that the precautionary principle will be applied when assessing applications for change of use and for significant developments in rural areas.

3.4 Bushfire Management Overlay (BMO)

Only a small portion of the locality is located within the BMO (Figure 8). The BMO indicates areas of highest risk. It primarily applies to patches of tree cover more than 4ha in size, where the intensity of fire has been modelled at 30 MW/m or more. It also includes land within 150m of those areas, as research indicates that 92% of house loss occurs within 150m of the bushfire hazard (DTPLI 2013).

The purposes of the BMO (Clause 44.06) are:

- To implement the State Planning Policy Framework and Local Planning Policy Framework, including the Municipal Strategic Statement and local planning policies
- To ensure that the development of land prioritises the protection of human life and strengthens community resilience to bushfire
- To identify areas where the bushfire hazard warrants bushfire protection measures to be implemented.
- To ensure development is only permitted where the risk to life and property from bushfire can be reduced to an acceptable level.

To be conservative, this assessment uses the risk assessment process outlined in Clause 44.06 for the whole of the locality.

3.5 Bushfire Prone Area (BPA)

Most of the locality is designated as a BPA (Figure 8). BPAs are areas subject to or likely to be subject to bushfire, as determined by the Minister for Planning. Areas of highest bushfire risk within the BPA are designated as BMO. Most of the current township is not designated as BPA or BMO, indicating that it meets the criterion for a bushfire attack level of BAL-LOW or Very Low threat.

In a BPA, performance requirement P2.7.5 of the *National Construction Code (NCC)* requires that Class 1, 2 or 3 (residential) buildings, 'Specific Use Bushfire Protected Buildings' (vulnerable uses) and their associated Class 10 structures such as shelters, decks or sheds must 'to the degree necessary, be designed and constructed to reduce the risk of ignition from a bushfire, appropriate to the potential for ignition caused by burning embers, radiant heat or flame generated by a bushfire; and intensity of the bushfire attack on the building' (ABCB 2019b).

Compliance with this performance requirement can be met through AS 3959-2018 *Construction of buildings in bushfire prone areas* (Standards Australia 2018) or a performance solution. In a BPA, applicable buildings must be constructed to a minimum bushfire attack level of BAL12.5, or higher, as determined by a site assessment or planning scheme requirement.

Where the BPA is outside the BMO, developments including larger subdivisions and vulnerable uses are required by Clause 13.02 to:

- Consider the risk of bushfire to people, property and community infrastructure
- Require the implementation of appropriate bushfire protection measures to address the identified bushfire risk
- Ensure new development can implement bushfire protection measures without unacceptable biodiversity impacts.

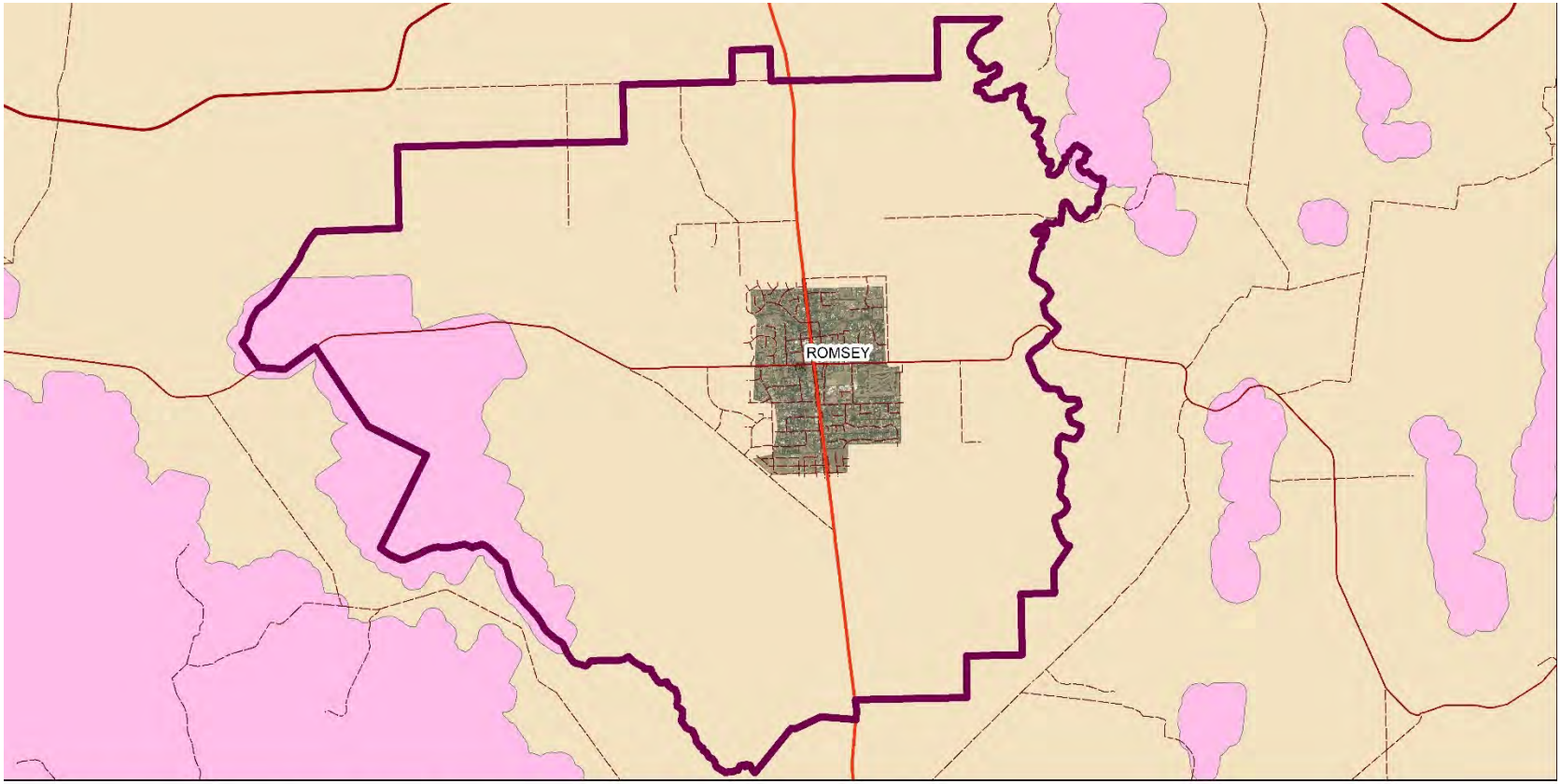
As in the BMO, a primary indicator of suitability of land for new development is that it meets the requirement for radiant heat to be limited to 12.5kW/m2.

As development progresses, additional land within the locality may be considered for excision from the BPA. DELWP review and excise areas from the BPA on a regular basis, particularly in growth areas where the hazard is removed as urban development occurs. Excision may be considered where the following statewide hazard mapping criteria (DELWP 2019) are met. These distances also provide a guide to design of low threat environments under current climatic conditions.

Excision criteria are as follows:

- Unmanaged grassland more than 2ha in size: depending upon connectivity and other factors, separation by at least 60m
- Areas of other vegetation classified under *AS 3959-2018* of 2 to 4ha in size: at least 150m
- Areas of other vegetation classified under *AS 3959-2018* more than 4ha in size: at least 300m.

Figure 8: Bushfire Prone Area, Bushfire Management Overlay and BAL-LOW area



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Bioregional Conservation Significance (EVC_BCS)

Kilometres
0 2 4

Locality
Road class
Major Road
Arterial
Sec Road
Minor Road
Bushfire Management Overlay
Bushfire Prone Area

File: Romsey_4_Planning_v1.0 | Coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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PART B: BUSHFIRE HAZARD ASSESSMENT

5 Scope of this assessment

Part B has been prepared to meet the requirement of Clause 13.02 to apply the 'best available science to identify vegetation, topographic and climatic conditions that create a bushfire hazard'. Bushfire history has also been analysed to support understanding of fire occurrence and behaviour.

Clause 13.02-1S requires hazard identification and assessment at various scales as follows:

- Landscape conditions - meaning conditions in the landscape within 20km (and potentially up to 75km)
- Local conditions - meaning conditions in the area within approximately 1km
- Neighbourhood conditions - meaning conditions in the area within 400m
- The site for the development

This assessment is intended to be strategic in nature to assist structure planning. As there will be opportunities for more detailed assessment at the development application stage, this assessment has been confined to landscape conditions (up to 30km away) and local conditions only (within 2km of the township). It should be noted that this assessment has not been carried out in sufficient detail for use in a development application.

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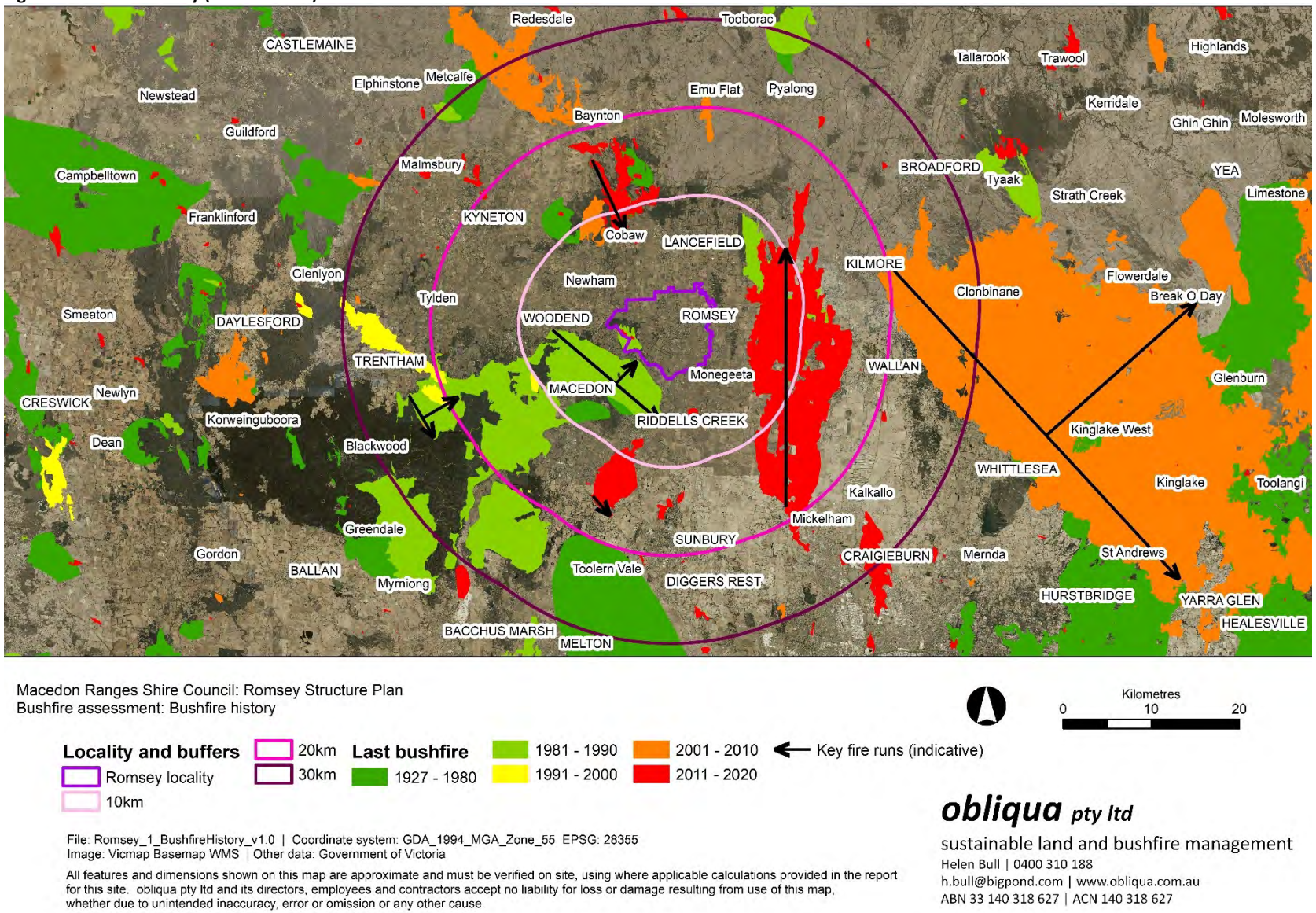
6 Bushfire history

Although infrequent, bushfire is significant issue for land use planning in Macedon Ranges Shire. The most significant fires impacting the municipality include the following as outlined in the *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020):

- On February 1 1983 a wildfire in Mt. Macedon destroyed 50 houses and over 6,000 hectares of vegetation.
- Two weeks later on 'Ash Wednesday' another wildfire impacted on the towns of Macedon and Mt. Macedon, destroying both townships. Since Ash Wednesday, a number of wildfires have occurred in the shire, but have not had the same devastating effect as Ash Wednesday.
- In 2009, the February Black Saturday bushfires impacted the Redesdale area where properties were lost.
- More recent fires - February 2014 (Gisborne South and Mickleham), October 2015 (Lancefield-Cobaw), and January 2016 (Edgecombe) - have resulted in the loss of nine homes along with significant numbers of stock, outbuildings, fencing and other property.

Bushfire history is mapped in Figure 9. The fire runs confirm the key directions of bushfire threat: from the north west, then south west after a wind change. This map demonstrates that Romsey could experience attack either from a flame front, or though ember attack originating from forest located within 10 to 20km.

Figure 9: Bushfire history (1939 to 2019) and indicative fire directions



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Bushfire history

Kilometres
0 10 20

Locality and buffers
- Romsey locality
- 10km
- 20km
- 30km

Last bushfire
- 1927 - 1980
- 1981 - 1990
- 1991 - 2000
- 2001 - 2010
- 2011 - 2020

← Key fire runs (indicative)

File: Romsey_1_BushfireHistory_v1.0 | Coordinate system: GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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7 Fire weather

This report uses long term records from three automatic weather stations (AWS) to describe the bushfire threat and identify potential land use planning responses. These 3 AWS represent the extreme range of conditions that may be experienced at Romsey. Because of differences in altitude and surrounding topography, the applicability of this data to Romsey should be regarded as indicative only. The effect of climate change is examined though use of modelling prepared by Leonard, J et al. (2014).

6.1 Direction of fire runs

Fire control success in grassland is limited under Severe fire danger ratings and above (Hines et al. 2010). As shown in Table 1, and the fire history map in Figure 9, under these higher risk conditions, wind is generally from a north easterly to south south westerly direction.

6.2 Number of days of significant fire risk

Based upon the three AWS, as shown in Table 2, conditions under which fire control is less likely are currently achieved, on average, on at least 1.4 and possibly up to 4.4 days/year. The occurrence of these conditions is expected to increase. Using a high-end global heating scenario, modelling by Clark et al. (2021) for 5 Victorian regions predicts that by 2100, indicates that the number of Very High and above fire danger days will increase by 50-200% and changes in temperature, humidity and rainfall during spring and early summer will increase the length of the fire season.

6.3 Design conditions

In the planning and building system, a standard FFDI of 100 and a GFDI of 130 is used in non-alpine areas of Victoria to define the suitability of land for development and the setback of buildings from classified vegetation. The weather analyses summarised in Tables 3 and 4 show that these standard indices do not currently represent the worst case scenario. In addition, they may not adequately cater for climate change.

In the building system, where a deemed-to-satisfy building response is not used, the *National Construction Code* requires that responses are based upon the probability of fire danger ratings occurring and the importance level of the building. For example, a probability of 1:50 is used to define suitability for residential development and a probability of 1:2000 for vulnerable uses such as residential aged care (ABCB 2019a). Modelling by Leonard, J (2014) shown in Table 4 and Figure 11 indicates that by 2050, Romsey can expect a 1:50 probability of the FFDI/GFDI exceeding 116/143 for a 3 hour interval. CFA and DELWP do not currently have a policy on the use of FFDI/GFDI probabilities, or on how to address climate change through bushfire response.

However, it is suggested that these more conservative design conditions be considered in planning for the future development of the township. Indicative setbacks are outlined in section 13.

Table 1: Fire danger rating and spread of wind directions (3pm observations)
Source: (Bull 2021)

COMBINED RECORDS FOR MELBOURNE AIRPORT, WALLAN AND MACEDON FORESTRY AUTOMATIC WEATHER STATIONS

Fire Danger Rating	S	SSW	SW	WSW	W	WNW	NW	NNW	N	NNE	NE	ENE	E	ESE	SE	SSE
Code Red																
Extreme																
Severe																
Very High																
High																
Low-Moderate																

Table 2: Fire danger rating, percentage of observations and average number of days/year (3pm observations)
Source: Bull (2021); Cheney and Sullivan (2008)

COMBINED RECORDS FOR MELBOURNE AIRPORT, WALLAN AND MACEDON FORESTRY AUTOMATIC WEATHER STATIONS

Fire Danger Rating/GFDI	Control outcomes (grassland)	3pm observations (%)			Days/year		
		Macedon	Wallan	Melb AP	Macedon	Wallan	Melb AP
Code Red: 130+	F	0	0.3	0	0.1	0.1	0.2
Extreme: 100-130	F?	1	0.6	1	0.3	0.3	0.7
Severe: 50-99	F?	4	4	5	1.0	1.9	3.5
Very High: 25-49	S?	21	24	26	5	13	18
High: 12-24	S	73	71	68	18	37	49
Total		100	100	100	24	52	72

Legend	Predicted grass fire control outcomes
F	Direct attack will generally fail. Back burns difficult to hold because of embers. Flanks must be held at all costs
F?	Head fire attack may succeed in favourable circumstances. Backburning close to head may be necessary
S?	Head fire attack generally successful with water
S	Head fire easily attacked with water

Table 3: Fire danger ratings – current
Source: Bull (2021)

Fire danger rating	Macedon	Wallan	Melb AP
Highest FFDI	196	155.0	133
Date recorded	27/12/1990	7/02/2009	30/12/2019
1:50 FFDI	115	127	126

Figure 10: Relationship between FFDI and GFDI
Source: Data from AS 3959-2018 Table B2 (Standards Australia 2018)

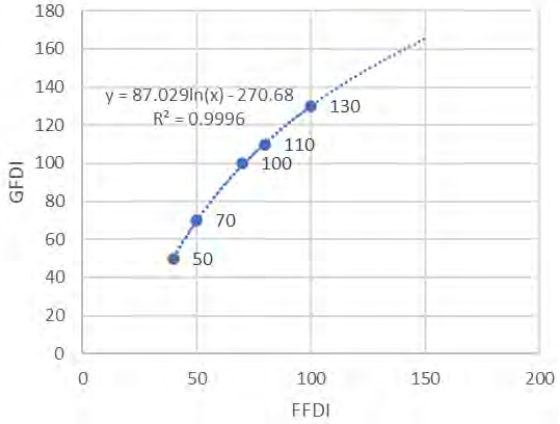
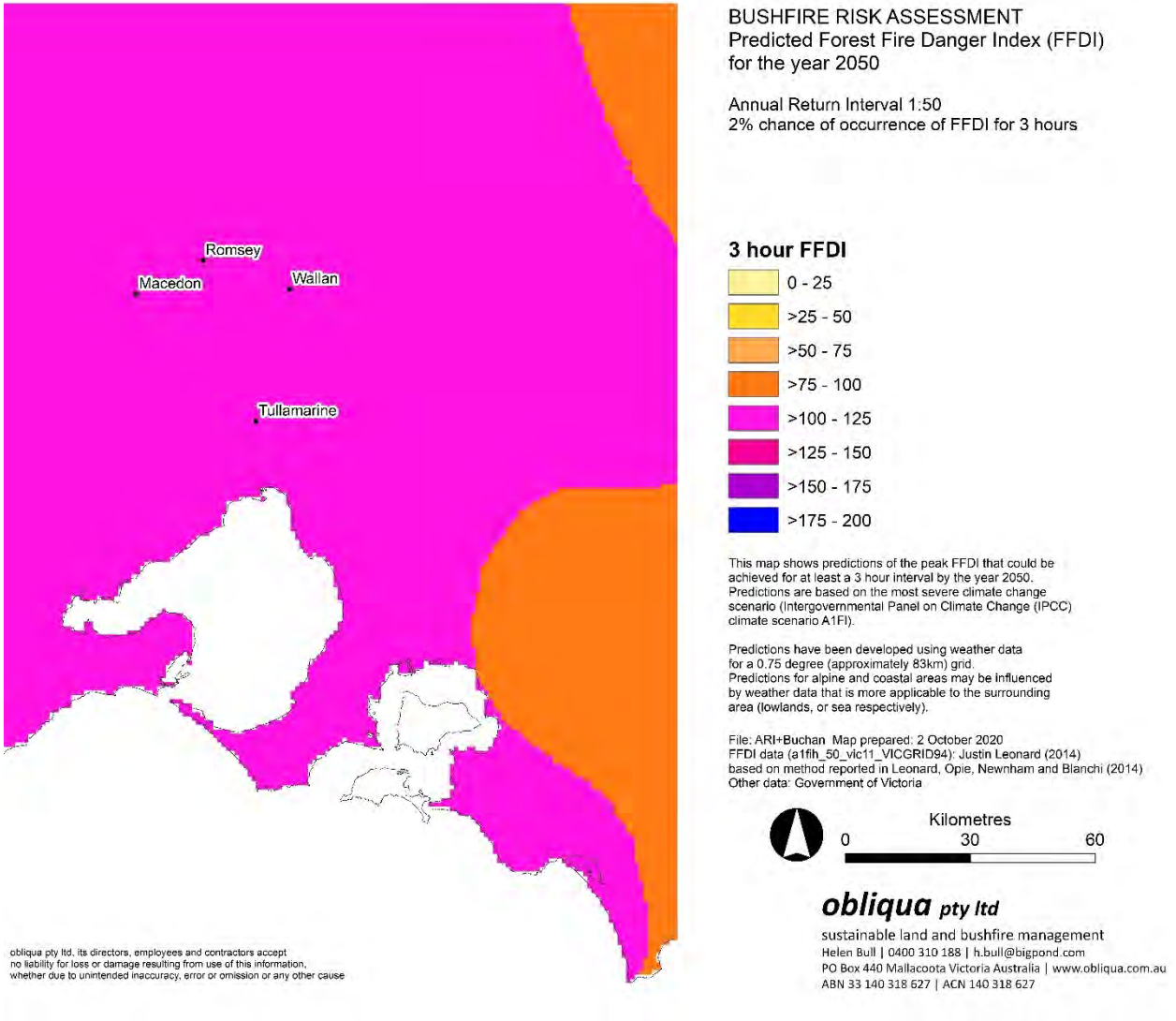


Table 4: Fire danger ratings – 2050
Source: (Leonard, J 2014)

Probability of exceedance (1 in…)	Romsey 3 hour FFDI (Leonard 2014)	Romsey 3 hour GFDI (extrapolated from FFDI/AS 3959)
10	90	121
50	116	143
100	128	152
500	159	170
1000	173	178
2000	190	186

Figure 11: Climate (3 hour FFDI for the year 2050)
Source: (Leonard, J 2014)



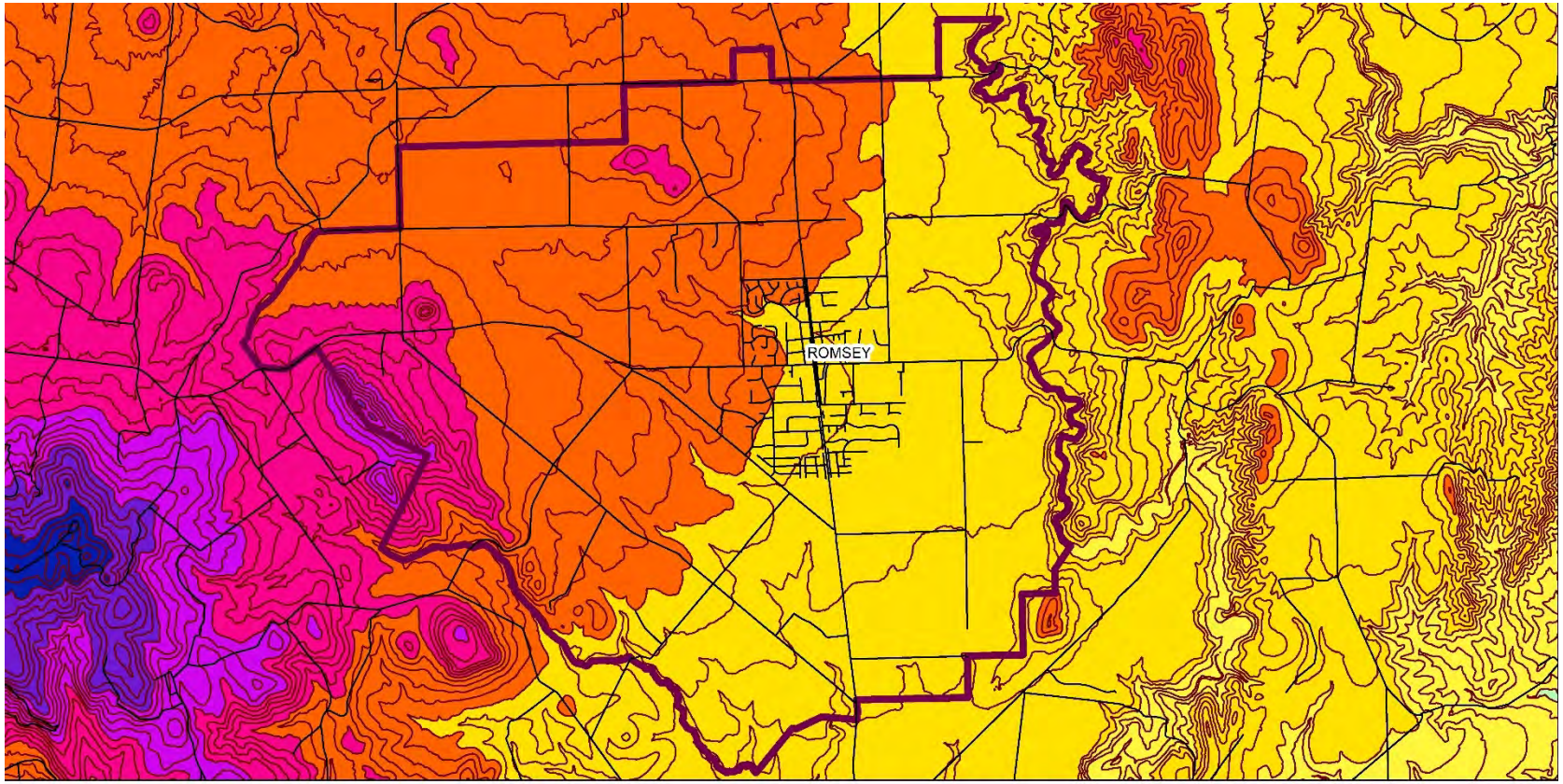
8 Topography

AS 3959-2018 requires that the 'effective slope' be identified to determine the threat (bushfire attack level) and setback from classified vegetation. This is the slope of land under the classified vegetation that will most significantly influence the bushfire attack on a building.

Slope categories, elevation, aspect are shown in Figures 12 to 14. This mapping has been prepared using the profile tool in QGIS using 10m digital elevation data sourced from https://elevation.fsdf.org.au/.

As shown in Figure 13, most of the land within the locality is in the 0 to 5 degree category. Slopes in riparian areas are steeper (up to 20 degrees), but for very short runs. Fire runs from the north west to west will be travelling from upslope. Fires from the north east and south will be travelling from downslope. Steeper (and forested) land is located to the north, southwest and east of the locality.

Figure 12: Elevation



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Elevation and contours (20m)

Locality
Road
Contour (20m)

Elevation (m)
< 300
300 - 400
400 - 500
500 - 600
600 - 700
700 - 800
800 - 900
900 - 1,000

Kilometres
0 2 4

File: Romsey_2_Elevation_v1.0 | Coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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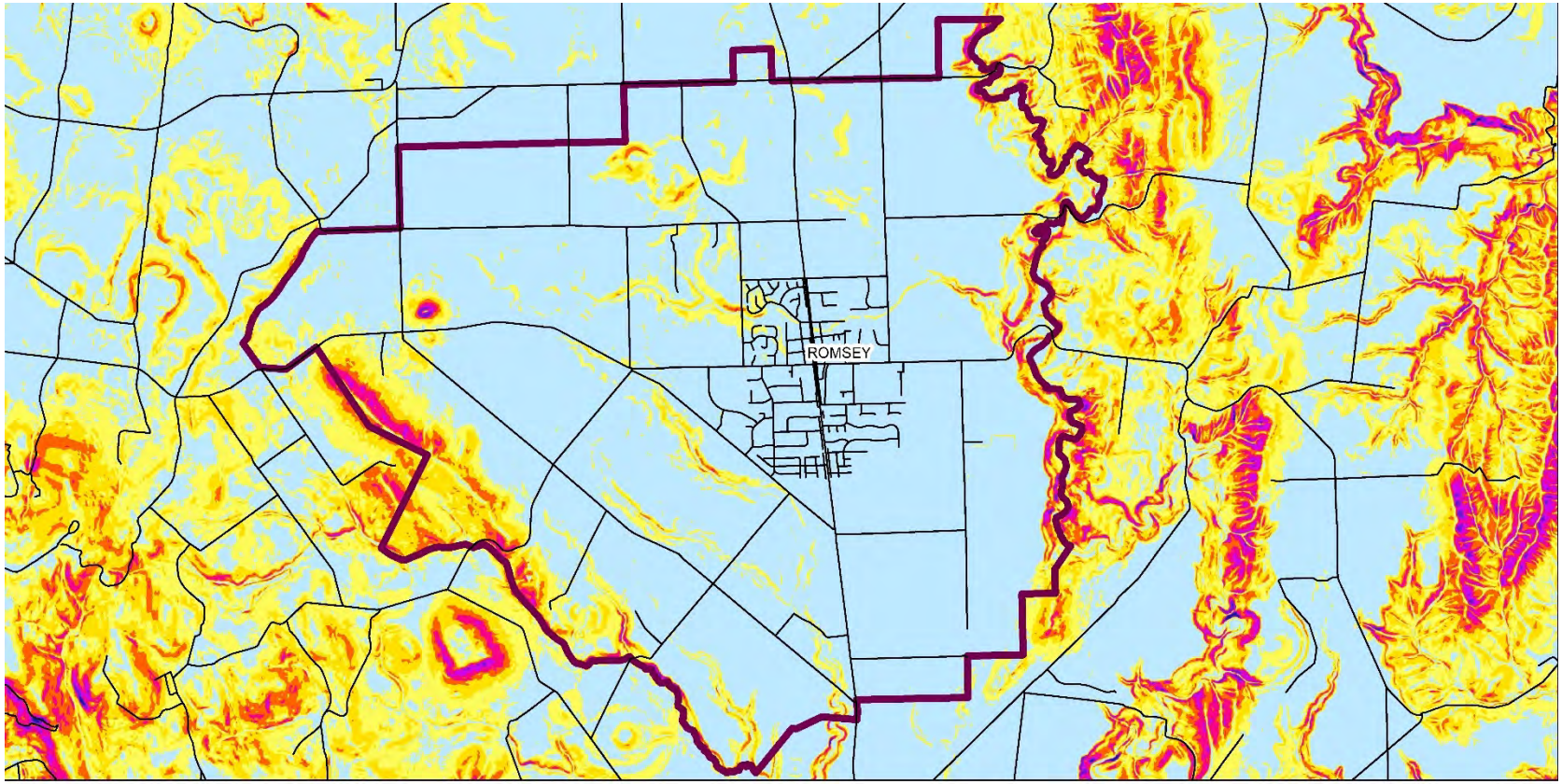
Figure 13: Slope category



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Slope category

Locality
Road
Slope category (degrees)
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40

Kilometres
0 2 4

File: Romsey_2_Slope_v1.0 | Coordinate system: GDA_1994_MGA_Zone_55 EPSG: 28355
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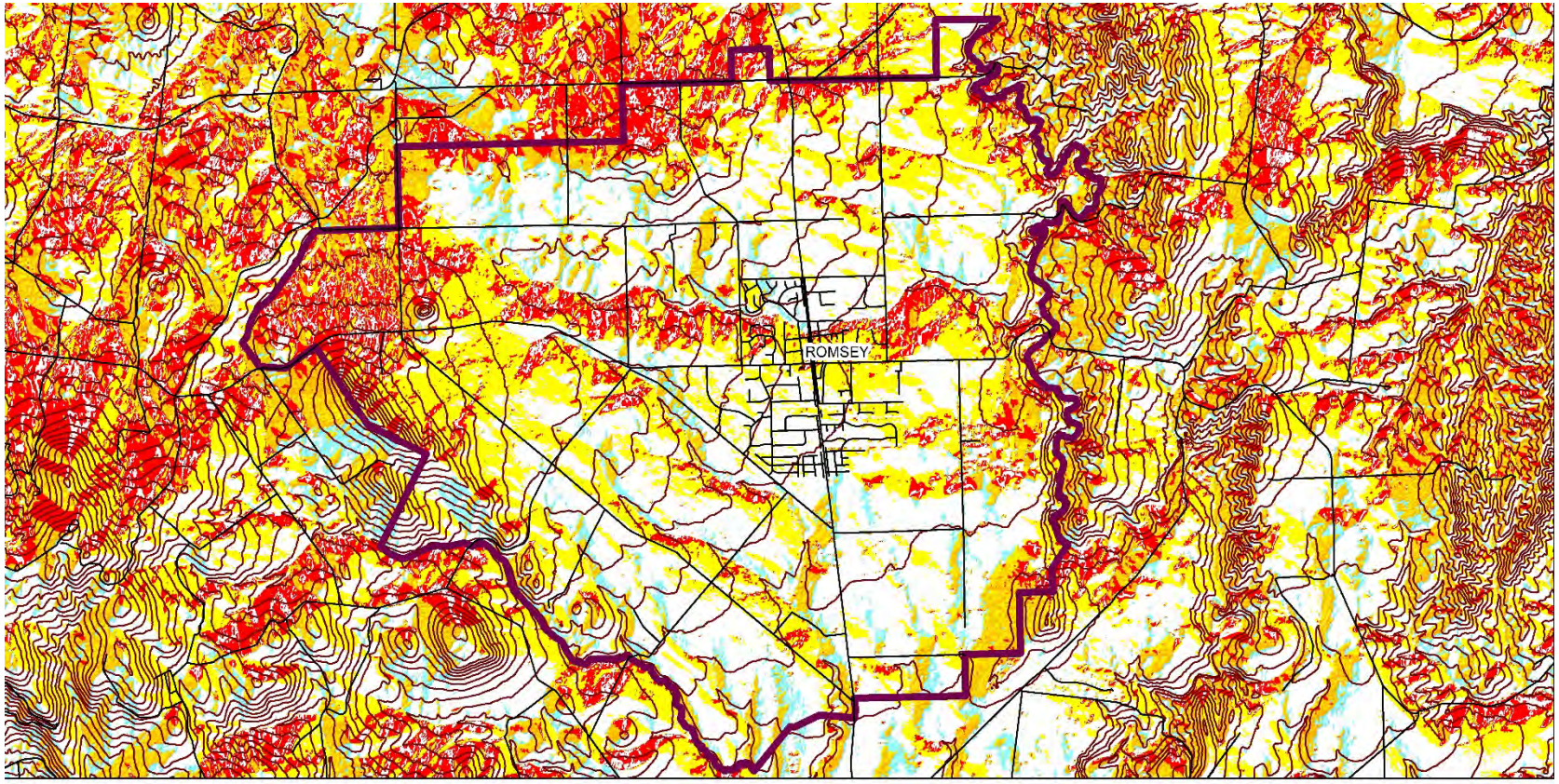
Figure 14: Aspect



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Aspect

Locality
Road
Contour (20m)

Aspect
E
W
N
S
N

Kilometres
0
2
4

File: Romsey_2_Aspect_v1.0 | Coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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9 Vegetation

Vegetation has been identified at a landscape, locality and local scales using the following data and assumptions:

- Tree cover within 30km (Figure 15)
- Ecological Vegetation Class (EVC) mapping (Figures 16 and 17)
- Revegetation of major waterways including Five Mile Creek which bisects the town and Deep Creek to the east; both to an (unconfirmed) indicative width of 30m each side (Melbourne Water Corporation 2018).

Vegetation has been classified using the descriptions contained in section 2.2.3 and exemptions in section 2.2.3.2 of *AS 3959-2018*. Areas can be excluded from classification if they meet one or more of the following criteria:

i. Vegetation of any type that is more than 100m from the site.
ii. Single areas of vegetation less than 1 ha in area and not within 100m of other areas of vegetation being classified.
iii. Multiple areas of vegetation less than 0.25 ha in area and not within 20 m of the site, or each other.
iv. Strips of vegetation less than 20 m in width (measured perpendicular to the elevation exposed to the strip of vegetation) regardless of length and not within 20 m of the site or each other, or other areas of vegetation being classified.
v. Non-vegetated areas, including waterways, roads, footpaths, buildings and rocky outcrops.
vi. Low threat vegetation, including grassland managed in a minimal fuel condition , maintained lawns, golf courses, maintained public reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks (Standards Australia 2018).

The main vegetation classes impacting on bushfire behaviour are summarised in Table 5. The main sources of threat are forest within 20km, grassland and larger and/or contiguous patches of woodland (primarily treed roadsides and riparian areas).

Low threat areas that should be considered for retention as buffers to existing and new development include irrigated farmland, sporting facilities (training tracks) and major roads.

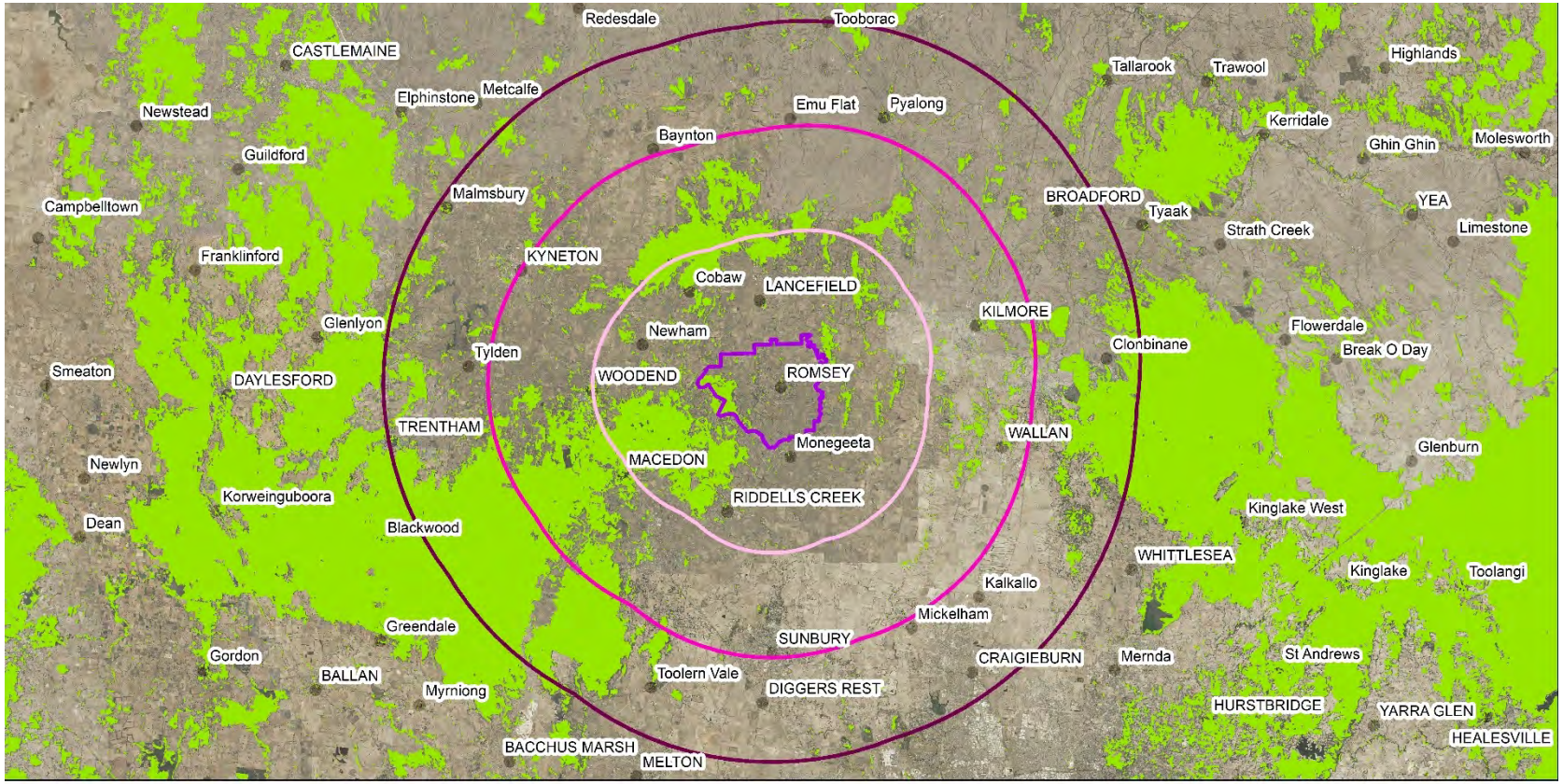
Treed patches on roadsides and riparian areas may be excludable under section 2.2.3.2 of *AS 3959-2018* where they are less than 20m in width and more than 20m from other classified vegetation, or where the understorey is confined to short grass. Fire is expected to be generally less intense than assumed in AS 3959 as runs across these corridors will be short, and the impact of fire burning along the corridors on adjacent development will generally be flank fire. However, as a precautionary measure, it is proposed that significant patches of roadside and riparian trees be classified as woodland and setbacks applied as for woodland.

Most of the other treed patches are small, and although not excludable under section 2.2.3.2 of *AS 3959-2018* where they exceed 0.25ha in area, they are also unlikely contribute to fire behaviour to the extent assumed in *AS 3959*. As most of the tree crown cover in the locality (excluding the areas shown as forest) is less than 10%, these lightly treed areas are classified as grassland.

Table 5: Main vegetation classes impacting on bushfire behaviour

Classified vegetation	Principal components
Grassland	Most of the farming land within the locality including remnant trees where canopy cover is less than 10%
Woodland	Larger, contiguous patches of roadside and riparian trees where the understorey is not confined to short grass, taking potential revegetation into account Includes Main Road, Five Mile Creek, Deep Creek, Duckhole Creek, Sandy Creek, Dry Creek Woodland is primarily Plains Grassy Woodland (EVC 55, Bioregional Conservation Significance of Endangered)
Forest	Forested and steeper land located within 30km to the north (Cobaw Ranges), northwest (Cobaw/Macedon Biolink) southwest (Macedon Ranges and Mount Charlie Conservation Reserve) and to the east of the locality
Low threat - rural	Areas of irrigated crops/pastures to the east and maintained pasture/training tracks to the south These are currently excludable under s2.2.3.2 of *AS 3959* but have been assessed as grassland due to potential for land use change
Low threat - urban	Gardens, lawns, areas of exotic (deciduous) trees are excludable under s2.2.3.2 of AS 3959

Figure 15: Vegetation (landscape scale)



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Vegetation (landscape scale)

Kilometres
0 10 20

Locality and buffers
Romsey locality
10km
20km
30km
Tree cover (Forest/Woodland)

File: Romsey_2_Veg_Landscape_v1.0 | Coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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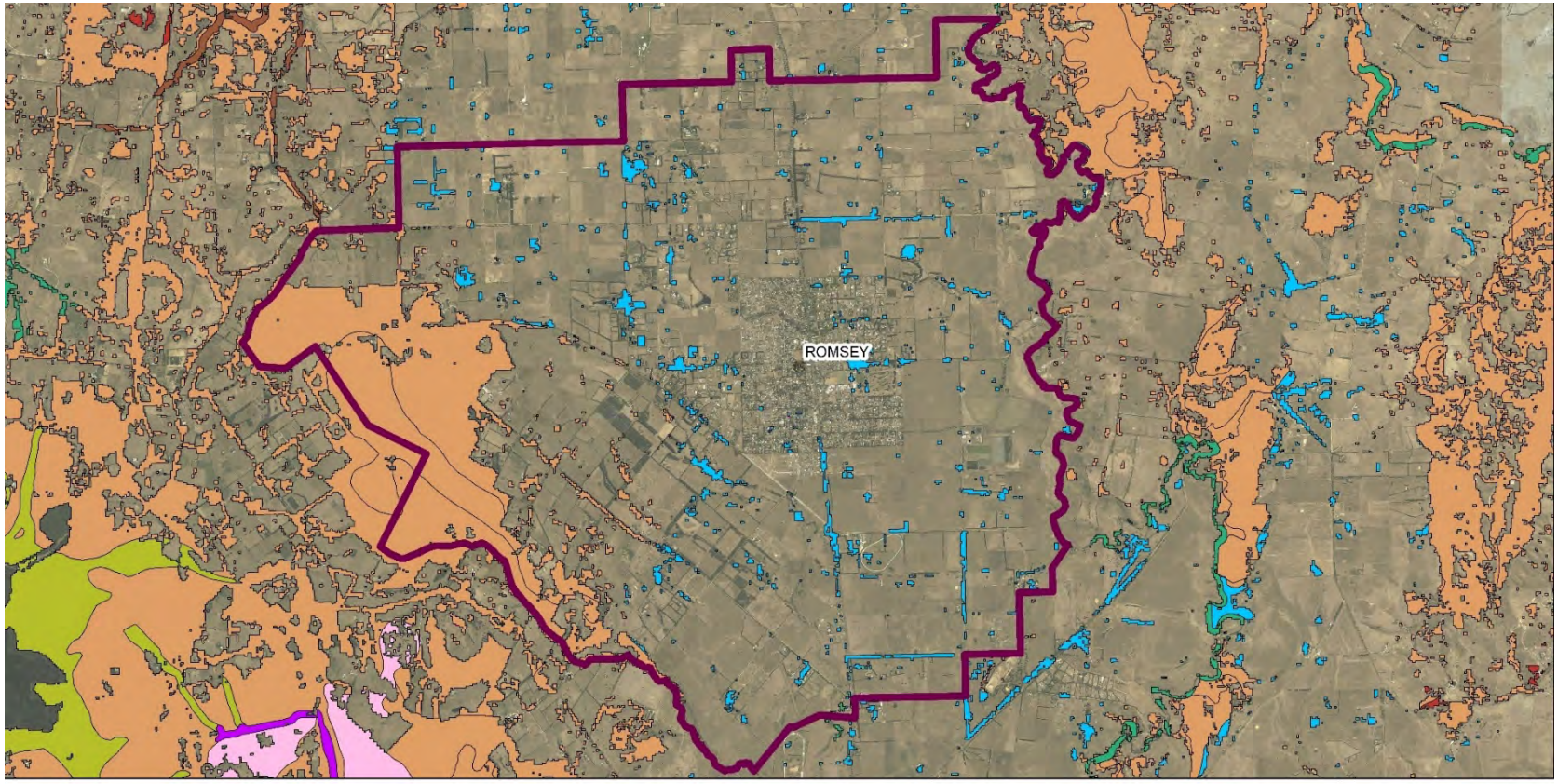
Figure 16: Vegetation (Locality scale)



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Ecological Vegetation Class (EVC)

Locality **EVC Group**
Dry Forests
Herb-rich Woodlands
Lower Slopes or Hills Woodlands
Lowland Forests
Plains Woodlands or Forests
Riparian Scrubs or Swampy Scrubs and Woodlands
Riverine Grassy Woodlands or Forests
Wet or Damp Forests

Kilometres
0 2 4

File: Romsey_3_Veg_BCS_v1.0 | Date amended 210909 | coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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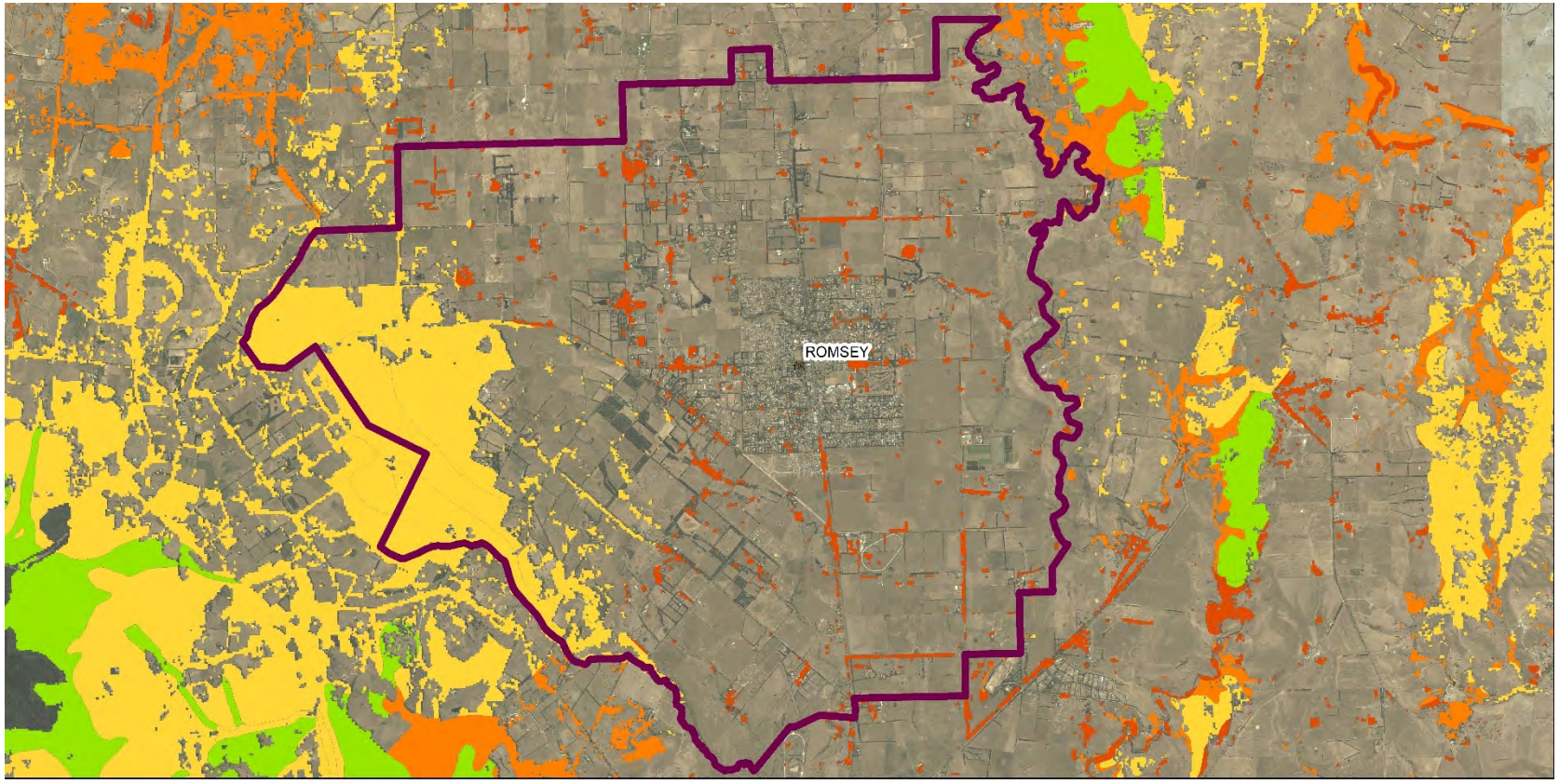
Figure 17: Vegetation (Bioregional Conservation Significance (EVC_BCS)



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Ecological Vegetation Class (EVC)

Locality **EVC Biodiversity Conservation Status**
Endangered
Vulnerable
Depleted
Least Concern

Kilometres
0 2 4

File: Romsey_3_Veg_BCS_v1.0 | Date amended 210909 | coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
Image: Vicmap Basemap WMS | Other data: Government of Victoria

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PART C: BUSHFIRE RISK ASSESSMENT

10 Bushfire risk summary

'Bushfire risk' can be defined as 'the chance (likelihood) of a bushfire igniting, spreading and causing damage to people or the assets they value (consequences)' (CFA 2012). Key risk factors include the hazard or source of the risk, the exposure to the hazard, and the vulnerability of both the occupants and the buildings that they rely upon for shelter.

Table 6 summarises the bushfire risk from three sources: the wider landscape (up to 30km away), vegetation closer to township (within 2km), and within the township.

This assessment uses the following data and documentation:

- Information on climate, vegetation and topography presented in Part B of this report
- Criteria from the Landscape typology which supports a consistent approach to landscape risk assessment (DELWP 2017b).
- Regional and municipal assessments: *Loddon-Mallee bushfire management strategy* (DELWP 2020b) and the *Victoria Fire Risk Register (VFRR*) (CFA 2020)

Table 6: Summary of bushfire risk under design conditions (Code Red fire danger rating)

Source of risk	Threat rating	Key contributing factors/description
Wider landscape	Landscape Type 2 to 3 (DELWP 2017b, pp. 14-5) *Loddon-Mallee bushfire management strategy* (DELWP 2020b): Less than Low risk of house loss (Figure 18) *Victoria Fire Risk Register (VFRR):* Low (east) to Moderate (north and west) (CFA 2020) (Figure 19)	Romsey could experience attack either from a flame front, or though ember attack originating from forest located within 10 to 20km. Fire travel within 5-10km of the township will be fuelled primarily by grassland and remnant woodland. Fire control success in grassland is limited under Severe fire danger ratings and above (Hines et al. 2010). It is estimated that these conditions are currently achieved, on average, on up to 4.4 days/year (Bull 2021; Hines et al. 2010). The frequency of these conditions is expected to increase significantly under climate change. As shown in Table 1, and the fire history map in Figure 9, under these conditions, wind is generally from a northerly to south westerly direction. As shown in Table 2, at Very High fire danger and below, wind directions are more variable. Long runs are possible, and wind changes during the fire event can lead to wide fire fronts. Fire may reach Romsey township and cause destruction. However, the risk of house loss is assessed by emergency management agencies in the *Victoria Fire Risk Register* as moderate on the western side of town and low on the eastern side of town. The *Loddon-Mallee bushfire management strategy* rates the overall risk of house loss as less than Low (DELWP 2020). Potential impacts on the town from bushfire include wind, smoke, flame, radiant heat and embers (CFA 2020). The township is well-roaded. Although the township does not have a designated Neighbourhood Safer Place, existing residential areas have good access to the core urban area. Most of the township is expected to be exposed to radiant heat corresponding to BAL-LOW as it is excluded from the designated Bushfire Prone Area.
Closer to township (within 2km)		The main risk factors within 2km of the township are assessed as follows: To the north and west: Grassland and remnant woodland is dissected by creeks and is generally upslope of the town. Low density residential development potentially contributes to fire risk through increasing vegetation cover and exposure of more people. This part of the locality is potentially exposed to fire from more than one direction (primarily north west and south west) under design conditions). Larger areas of contiguous forest on the high country to the south west is expected to contribute to ember attack. To the south and east: Grassland and remnant woodland is dissected by creeks and is generally downslope of the town. While the slopes are steeper in these areas (mainly >0-5 degrees, except in the gullies) compared with predominantly upslope land to the north and west, fire behaviour is expected to be moderated by the presence of areas of low threat including irrigated areas around the treatment plant to the east of the town and training tracks to the south of the town. In addition, there is currently less remnant woodland to contribute fuel including embers, although it is noted that revegetation of at least the Deep Creek riparian area is proposed in the *Port Phillip and Westernport Healthy Waterways Strategy 2018-2028* (Melbourne Water Corporation 2018). Slopes in the vicinity of Deep Creek are up to 20 degrees, however, the length of fire run on these slopes is limited and fire behaviour is therefore not expected to reach the peak predicted using *AS 3959*. Where shielded by the existing township, parts of these areas are potentially exposed to fire from one direction only.
Within the township		Most of the current township is located outside the Bushfire Prone Area and can therefore be considered Low threat (BAL-LOW). Vegetation in the core area of the township includes exotic deciduous street trees, managed lawns and cultivated gardens that are considered Low Threat (exempt) under s2.2.3.2 of *AS 3959*. The main areas of native vegetation include the Five Mile Creek riparian area in the north of the town and woodland located around the recreation reserve and golf course on the eastern side of town. In the event of a bushfire reaching the town boundaries, fire spread, radiant heat exposures and flame contact are expected to be limited by fragmented fuel. However, as in higher risk localities, houses are still vulnerable to embers that may result in house destruction some time after the main fire event. Houses including those built to regulatory standards are also at risk from combustibles other than vegetation including other buildings, decking, stairways, vehicles, stored equipment, plastic water tanks and firewood (Leonard, J et al. 2016, p. 1). Consequently, where practical, it is recommended that consideration be given to design features that exceed the requirements of *AS 3959*.

Figure 18: Risk ratings - Victoria Fire Risk Register (VFRR)
Source: *Loddon-Mallee bushfire management strategy* (DELWP 2020b) as presented at https://bushfireplanning.ffm.vic.gov.au/loddon-mallee-central/

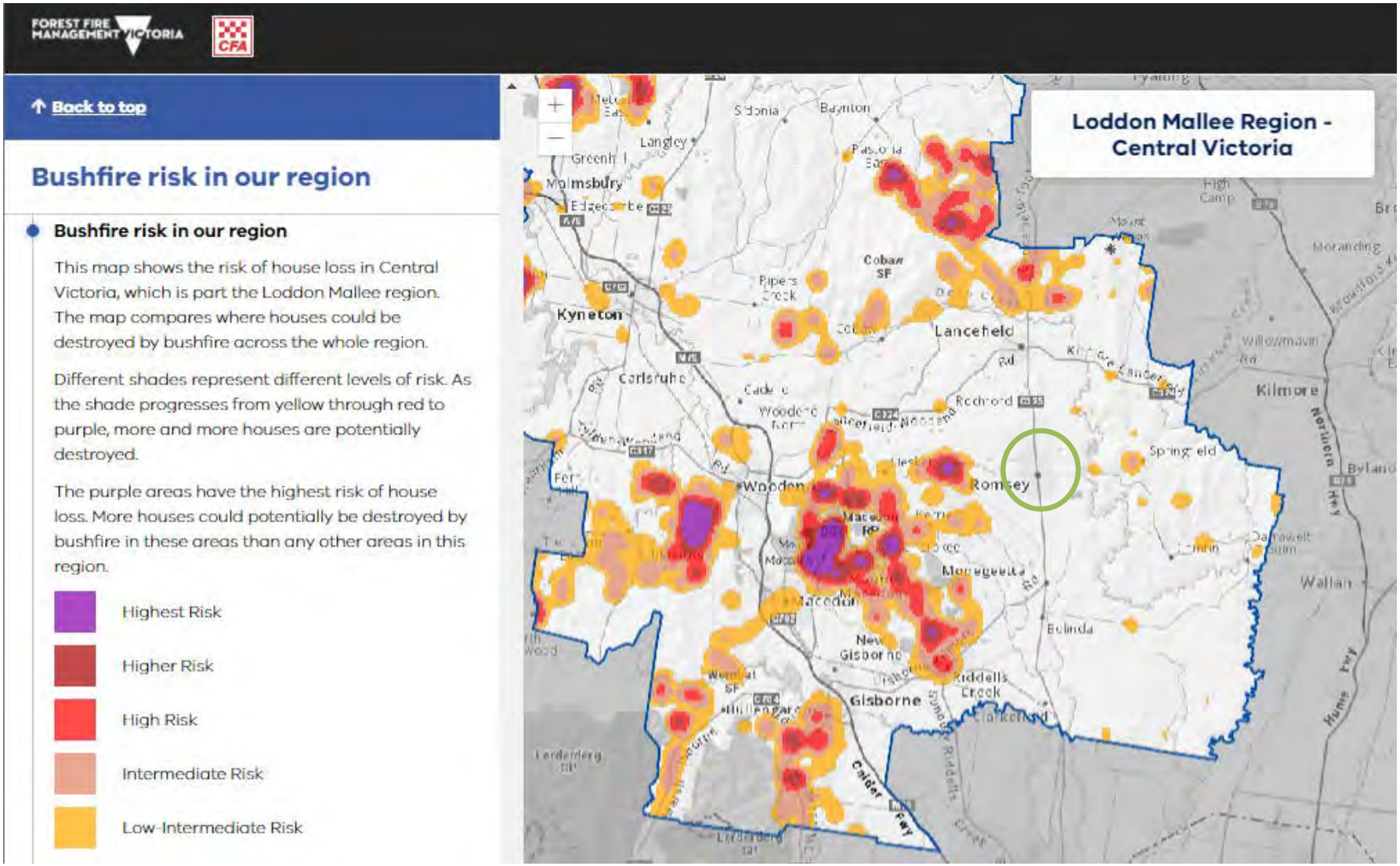


Figure 19: Risk ratings - Victoria Fire Risk Register (VFRR)
Source: *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020, p. 30)

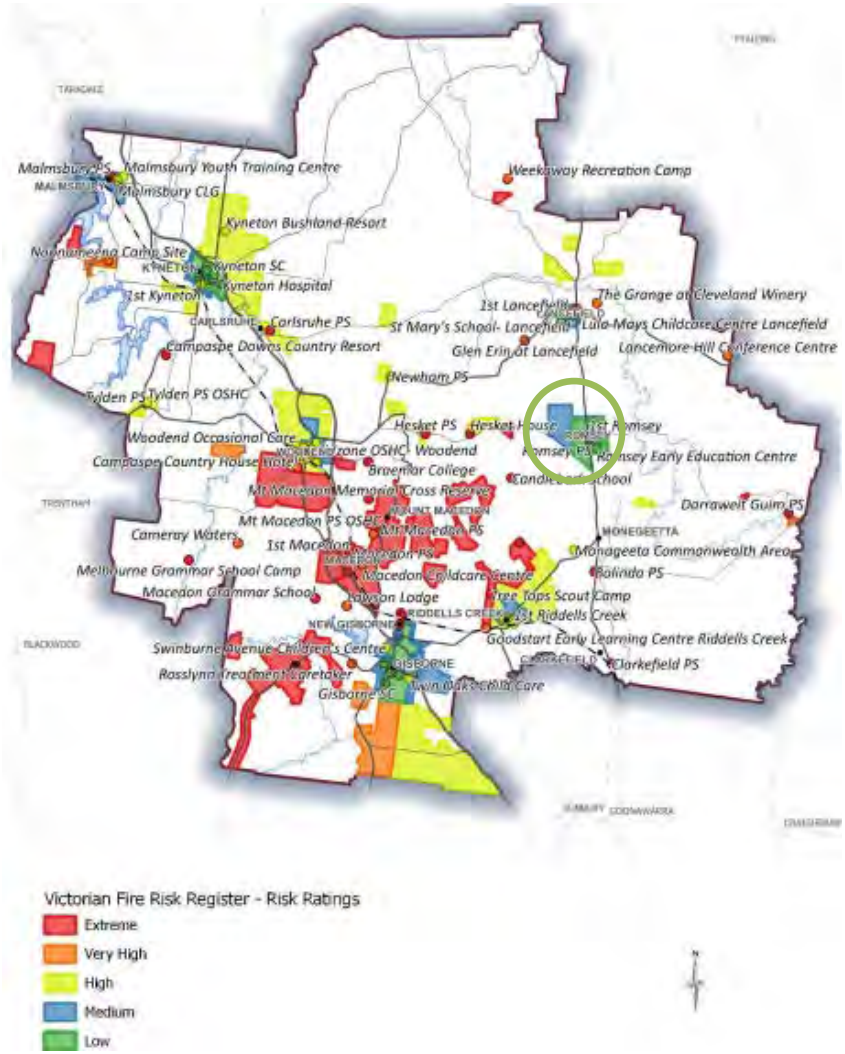
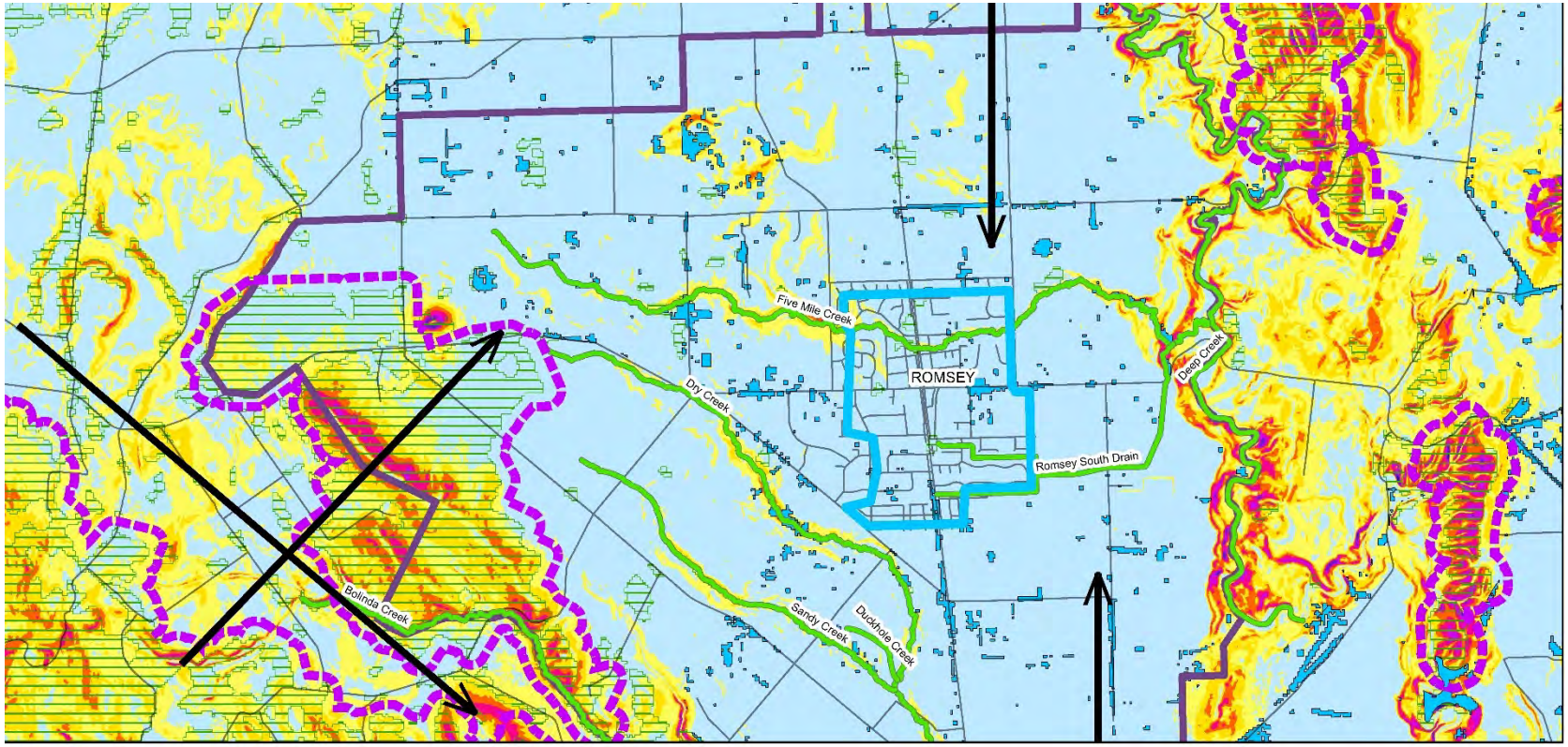


Table 7: Landscape typology showing assessed ratings
Source: *Technical Guide Planning Permit Applications – Bushfire Management Overlay* (DELWP 2017b)

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 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.	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.	The broader landscape presents an extreme risk.
The type and extent of vegetation is unlikely to result in neighbourhood scale destruction of property.	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.	Bushfire can approach from more than one aspect. The site is located in an area that is not managed in a minimum fuel condition.	
Immediate access is available to a place that provides shelter from bushfire.	Access is readily available to a place that provides shelter from bushfire. This will often be the surrounding developed area.	Access to an appropriate place that provides shelter from bushfire is not certain.	Evacuation options are limited or not available.
Increasing risk →			

Figure 20: Hazard summary



Macedon Ranges Shire Council: Romsey Structure Plan
Bushfire assessment: Hazard assessment summary

Kilometres
0 1 2

Locality
Road (uncategorised)
Key fire directions (indicative)
BAL_LOW
Bushfire Management Overlay

Vegetation classification
Tree cover (Forest on slopes)
Woodland (if canopy cover >10% + AS 3959 exemption criteria not met)
Potential waterway buffer (Woodland, 30m either side, indicative)
Grassland/Low threat

Slope category (degrees)
0 - 5
5 - 10
10 - 15
15 - 20
20 - 25
25 - 30
30 - 35
35 - 40

File: Romsey_3_HazardAssessmentSummary_v1.0 | Coordinate system GDA_1994_MGA_Zone_55 EPSG: 28355
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PART D: PLANNING RESPONSE TO THE RISK

11 Design considerations

Proposed treatments are based upon the approach provided in the Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a). They support a range of treatments outlined in the Municipal Fire Management Plan which include agency work plans, community-based bushfire management planning, fuel breaks, asset specific treatments, private property inspections, issue of fire prevention notices, roadside slashing (3m behind the guide posts where possible) and township hazard reduction.

Figure 21: Settlement design considerations
Source: Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a)

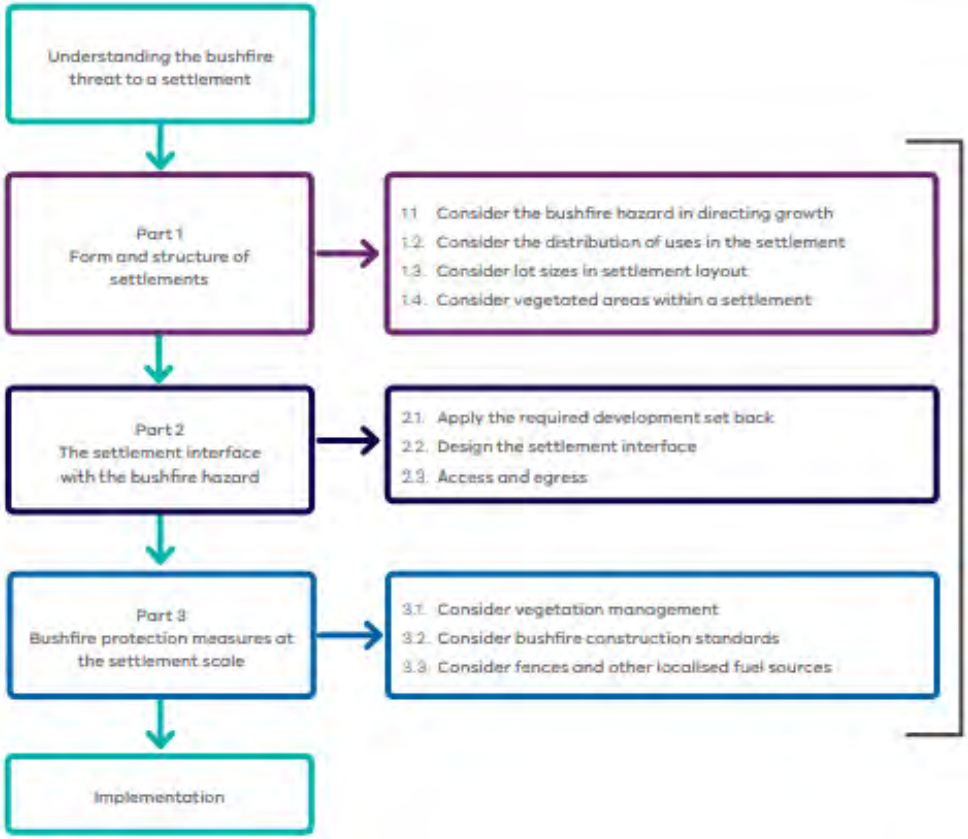

Figure 22: Bushfire protection measures at the settlement scale
Source: Design Guidelines *Settlement Planning at the Bushfire Interface* (DELWP 2020a)

12 Form and structure of the township

12.1 Direction of growth

The areas of lowest risk for growth are to the east of the town, which are less exposed to the higher severity fire that could burn under winds from the north west and south west. Directing growth to the east avoids the highest risk aspects and utilises the buffer provided by the existing settlement.

12.2 Shape and size of township expansion

Larger, deeper and more compact settlement shapes reduce the number of houses located on the interface with hazards, and the separation of houses from hazards. It is recommended that any township expansion be designed to not only to meet the requirement under Clause 13.02-1S for BAL12.5 using setbacks shown in Tables 9 and 10, but also meet criteria for excision from the Bushfire Prone Area (section 3.5) which include setbacks of 60m from grassland and 150m to 300m from extensive areas of forest or woodland (DELWP 2019).

12.3 Distribution of uses

Vulnerable uses
Development that may be occupied by vulnerable people including residential aged care facilities, residential buildings retirement villages, child care centres, education centres, hospitals, leisure and recreation facilities and places of assembly should be located away from the settlement interface.

Hazardous Uses
Hazardous uses, such as a petrol station, can potentially present a significant risk during a bushfire and can become sources of fires well beyond the settlement interface. They can also create toxic smoke and plumes. These types of uses should be located away from the settlement interface and away from locations exposed to a north-west or south-west bushfire. Locating them on the eastern side of a settlement means that winds would tend to push smoke away, rather than towards more populated areas.

Industry
Industry is also best placed away from locations exposed to a north-west or south-west bushfire, particularly as bushfire construction standards under the *NCC* only apply to residential buildings and vulnerable uses, and so industrial uses are much more reliant upon separation from hazards.

Appropriate uses on the settlement interface
Appropriate uses for the interface include uses already provided on the eastern side of the township including managed parklands/open space, sporting facilities, irrigated agriculture and the Western Water treatment plant. In addition, new development should include perimeter roads where practical.

12.4 Lot sizes

Lot sizes require consideration of the threat from both vegetation and other buildings. Smaller lots reduce the space available for vegetation, and buildings and hard areas fragment fire paths and reduce fire intensity. However where buildings are closer together, they can lead to building to building ignition. Larger lots potentially have more vegetation and other fuel sources and require more extensive management. However, buildings are likely to be further apart which reduces the risk of building to building ignition. A lot size of between 800m2 and 1,200m2 is considered optimal (DELWP 2020a).

12.5 Vegetated areas within the township

The Five Mile Creek corridor is the main area of relatively contiguous vegetation within the existing township. There are other vegetation corridors in the locality including other creek reserves, road reserves and shelterbelts including the coniferous ones that are a feature of this locality. Growth areas may also include new parklands. These areas can contribute to fire threat, or perceived fire threat. The actual threat posed by these areas could increase in threat due to revegetation proposals. Threat can be managed by setback of new development and isolating them from significant patches of vegetation by roads or other low fuel areas. In particular, setback will be an important response where roadsides support the endangered Plains Grassy Woodland. Intensification of development adjacent to existing hazards should be minimised.

Threat can also be managed through careful design and sensitive management of parklands and revegetation. For example, *AS 3959* considers vegetation widths less than 20m, or areas less than 0.25ha separated by 20m as low threat. Fire threat is also reduced when there is significant separation between surface fuels and tree crowns (2m separation is recommended in Clause 53.02). While this clause also specifies separation of tree crowns by 5m, there is no scientific evidence to support the effect of this in reducing bushfire threat.

13 The township interface

13.1 Apply the required development setback of BAL12.5

As explained in section 9, the main vegetation classes that have the potential to interface with an expanded township boundary are grassland and woodland and forest.

Treed patches on roadsides and riparian areas may be excludable under section 2.2.3.2 of *AS 3959-2018* where they are less than 20m in width and more than 20m from other classified vegetation, or where the understorey is confined to short grass. However, as a precautionary measure, it is proposed that significant patches of roadside and riparian trees be classified as woodland and setbacks applied as for woodland.

As most of the tree crown cover in the locality (excluding the areas shown as forest) is less than 10%, these lightly treed areas are classified as grassland.

Proposed setbacks from vegetation for residential development and vulnerable uses are provided in Tables 9 and 10. These setbacks are based upon Clause 13.02-1S which requires new development be exposed to threat less than 12.5kW/m2 (or BAL12.5). A lower limit of 10kW/m2 is suggested for vulnerable uses based upon requirements for the Bushfire Management Overlay (Clause 53.02 Table 3).

Deemed-to-satisfy setbacks are based upon the simplified method of *AS 3959* (Method 1). 'Enhanced' setbacks are suggested as more conservative options, where practical, particularly for grassland areas, to better account for the possible effects of climate change. Conservatism is already built into the setbacks for most small or narrow treed areas which could be considered excludable under *AS 3959*.

Table 8: Main vegetation classes impacting on bushfire behaviour within the locality

Classified vegetation	Principal components – within the locality
Grassland	Most of the farming land within the locality including remnant trees where canopy cover is less than 10%
Woodland (primarily precautionary)	Larger, contiguous patches of primarily roadside and riparian trees where the understorey is not confined to short grass, taking potential revegetation into account. Includes Main Road, Five Mile Creek, Deep Creek, Duckhole Creek, Sandy Creek, Dry Creek
Forest	Forested and steeper land located on the southwest boundary of the locality (including Macedon Ranges and Mount Charlie Conservation Reserve)

Table 9: Setbacks of new development from hazards – Residential development

			Setbacks for BAL12.5	
Use / development	Vegetation class	Slope under the vegetation	Deemed to satisfy (Table 2 to Clause 53.02 / AS 3959 Method 1)	Enhanced (AS 3959 Method 2)
Residential	Grassland	Flat/upslope	19	27
		>0-5	22	32
		>5-10	25	36
		>10-15	28	41
		>15-20	32	47
Residential	Woodland	Flat/upslope	33	49
		>0-5	41	59
		>5-10	50	72
		>10-15	60	88
		>15-20	73	106
Residential	Forest	Flat/upslope	48	67

Detailed Method 2 calculations are provided in Attachment 2

'Enhanced' setbacks are based upon a 1:50 probability of an FFDI occurring for a 3 hour period by the year 2050 under a severe climate change scenario (Leonard, J 2014) based upon guidance for performance solutions in Table V2.7.2 of the *National Construction Code* (ABCB 2019b) as explained in section 7 of this report.
GFDI extrapolated from FFDI using data listed in Table B2 to AS 3959-218

Table 10: Setbacks of new development from hazards – Vulnerable uses

			Setbacks for BAL-LOW (10kW/m2)	
Use / development	Vegetation class	Slope under the vegetation	Deemed to satisfy (Table 3 to Clause 53.02 / AS 3959 Method 1)	Enhanced (AS 3959 Method 2)
Vulnerable use	Grassland	Flat/upslope	35	36
		>0-5	40	41
		>5-10	45	47
		>10-15	50	53
		>15-20	55	59
Vulnerable use	Woodland	Flat/upslope	40	74
		>0-5	50	89
		>5-10	62	107
		>10-15	75	128
		>15-20	95	155
Vulnerable use	Forest	Flat/upslope	60	98

Detailed Method 2 calculations are provided in Attachment 2.

'Enhanced' setbacks are based upon a 1:2000 probability of an FFDI occurring for a 3 hour period by the year 2050 under a severe climate change scenario (Leonard, J 2014) based upon guidance for performance solutions in Table GV5.1 of the *National Construction Code* (ABCB 2019a) as explained in section 7 of this report. GFDI extrapolated from FFDI using data listed in Table B2 to AS 3959-218

13.2 Design the settlement interface

Vegetation management

Setback areas need to be managed to a low threat condition to minimise the risk of fire impacting on the township.

Exemption criteria v. and vi. in section 2.2.3.2 of *AS 3959* can be used as a guide to how infrastructure and certain land uses can be used to maintain setbacks in a low threat condition. These criteria are:

v. Non-vegetated areas, including waterways, roads, footpaths, buildings and rocky outcrops.

vi. Low threat vegetation, including grassland managed in a minimal fuel condition, maintained lawns, golf courses, maintained public reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks.

Uses such as the irrigated farmland, treatment plant and training tracks located to the east and south of the town already provide logical buffers which are more readily maintained in a low threat condition.

The Design Guidelines for Settlement Planning at the Bushfire Interface (DELWP 2020a) suggest that deemed-to-satisfy permit conditions contained in Table 6 to Clause 53.02 *Bushfire Planning* are also appropriate. Table 6 specifies:

- 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
- Flammable objects must not be located close to the vulnerable parts of the building (within 10 metres)
- Plants greater than 10 centimetres in height must not be placed within three metres 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 five square 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 five metres
- There must be a clearance of at least two metres between the lowest tree branches and ground level.

Specifications in Table 6 to Clause 53.02 have the potential to significantly impact on roadside biodiversity and amenity values through reducing tree canopy cover. To meet the biodiversity objectives in Clause 13.02-1S, where possible, setback areas should be sited to avoid roadsides supporting Endangered Plains Grassy Woodland.

Perimeter roads

Perimeter roads are the preferred risk reduction measure for settlement interfaces and where a site adjoins or is near a bushfire hazard. Advantages of a perimeter road include:

- Lower fuel loads than managed grassland, fragmented fuels
- Assist bushfire control and fuel management operations
- Assist early evacuation of occupants
- Enables the front of developments to face the hazard instead of localised bushfire hazards (for example, sheds, storage and unmanaged vegetation)
- Assists monitoring of hazards from the road.

Open space on the settlement interface

Open space is an important design consideration for the settlement interface. Open space excludes buildings that may be permanently occupied (such as houses). The vegetation in open space, and any landscaping plans or requirements, must be managed. Acceptable measures include low threat areas such as water bodies, sports fields, hard surface areas such as tennis and basketball courts, and parking areas. The management of vegetation in public open space is the responsibility of the land manager, usually the local council. This provides a high level of certainty about its future management. It is a significant strength having all or part of the interface under public land management. The management of vegetation in open spaces on private land is the responsibility of the landowner. Planning scheme mechanisms need to be used to secure management of the vegetation in perpetuity for these areas.

Exclude development from the setback area

There must be no buildings that can be permanently occupied within the setback area. Where land in the setback area is proposed to be developed buildings must be excluded from it.. A building envelope (directing where to develop on a lot) or a building exclusion area (directing where not to develop on a lot) can be provided to require management of the setback area.

13.3 Design access and egress

Effective access and egress in settlement planning ensures that people living close to the settlement interface can move away from the hazard to a place of relative safety. It will also enable fire-fighting units to reach a bushfire. Small-scale simulations carried out for settlement fringes around Bendigo showed that 'that a complete evacuation takes considerable time (between 30 minutes and 1 hour), despite … different sizes and urban patterns, and that it is possible for bushfires to overrun or surround settlements before people leave following a warning' (Leon & March 2013).

Elements of an effective road network include:

- Ensuring the spacing of roads leading away from the hazard are no more than 120 metres apart (on average)
- Designing road widths to meet planning scheme requirements and those of the relevant fire authority
- Providing at least two roads leading away from the hazard edge to each lot
- Ensuring travel to and from a location does not rely upon travel adjacent to a bushfire hazard
- Minimising the use of perimeter roads in the event of a bushfire through providing alternative routes
- Effectively connecting roads to the broader road network within the settlement.

Access and egress need not be on trafficable roads. Some access points may be provided for pedestrians and emergency vehicles only.

14 Bushfire protection measures at the settlement scale

14.1 Vegetation management

The *Design Guidelines for Settlement Planning at the Bushfire Interface* suggest that consideration be given to requiring vegetation management across the whole settlement. Although any township expansion in predominantly grassland areas could be readily designed to meet the criterion for excision of the BPA as outlined in section 3.5, this may assist with clarifying expectations for management of any public land and buffers created through the subdivision proposals.

14.2 Building construction standards

Similarly, the *Design Guidelines for Settlement Planning at the Bushfire Interface* (DELWP 2020a) suggest that consideration be given to specifying construction standards across the whole settlement. Although any township expansion in predominantly grassland areas could be readily designed to meet the criterion for excision of the BPA as outlined in section 3.5, this should be considered as a way of 'future-proofing' new development and reducing reliance upon vegetation management. It should also be considered where smaller lots sizes are proposed and additional protection to mitigate structure to structure fires is necessary.

14.3 Fences and other localised fuel sources

Fencing is a potential source of fire fuel. Some fence types if ignited by bushfire create high levels of radiant heat and pose a threat to buildings during a bushfire. It is recommended that alternatives to timber fencing be encouraged.

14.4 Supporting community resilience

As outlined in Attachment 1, include infrastructure, facilities and services that assist community cohesion and resilience to bushfire and other emergencies.

PART E: ALIGNMENT WITH PLANNING POLICY AND OTHER DOCUMENTS

15 Response to planning scheme Clause 13.02-1S

This section provides a summary of how development of Romsey township can respond to the objectives and strategies for bushfire safety in the PPF at Clause 13.02-1S Bushfire. Key aspects are highlighted first. A summary of how this report responds to all strategies of Clause 13.02-1S is contained in Table 10.

15.1 Development setback of BAL12.5

Clause 13.02-1S requires that settlement planning direct 'population growth and development to low risk locations, being those locations assessed as having a radiant heat flux of less than 12.5 kilowatts/square metre under AS 3959-2009 *Construction of Buildings in Bushfire-prone Areas* (Standards Australia 2009a)'.

This report identifies setbacks required for residential development and vulnerable uses to achieve this radiant heat target.

15.2 Access to BAL-LOW

Clause 13.02-1S requires that settlement planning ensure the 'availability of, and safe access to, areas assessed as a BAL-LOW rating under AS 3959-2009 Construction of Buildings in Bushfire-prone Areas (Standards Australia 2009a)where human life can be better protected from the effects of bushfire'.

Most of Romsey township is currently excluded from the Bushfire Prone Area as it meets criterion. It is recommended that any township expansion be designed to not only to meet the requirement under Clause 13.02-1S for BAL12.5 using setbacks shown in Tables 9 and 10, but also meet criteria for excision from the Bushfire Prone Area (section 3.5) which include setbacks of 60m from grassland and 150m to 300m from extensive areas of forest or woodland (DELWP 2019).

15.3 Alternative low risk locations for settlement growth

Clause 13.02-1S requires that settlement planning assess 'alternative low risk locations for settlement growth on a regional, municipal, settlement, local and neighbourhood basis'.

This report identifies an area adjoining the eastern boundary of the township that has been assessed by responsible agencies as being low threat.

15.4 No unacceptable biodiversity impacts

Clause 13.02-1S requires that settlement planning ensure 'settlement growth and development approvals can implement bushfire protection measures without unacceptable biodiversity impacts by discouraging settlement growth and development in bushfire affected areas that are important areas of biodiversity'.

Biodiversity assets that are likely to be affected by this structure plan are expected to be identified in a separate specialist report. This assessment indicates that a key biodiversity asset is the Endangered Plains Grassy Woodland (DELWP n.d.), much of which is located on roadsides. To minimise the impact on this asset, it is recommended that new development avoid siting of required setbacks on roadsides.

15.5 Assessment of alignment with planning policy

An assessment of the alignment of the recommendations contained in this report with the objective and strategies of Clause 13.02-1S is set out in Table 10.

Table 10: Assessment of alignment of this report with Clause 13.02-1S

Issue	Strategy	Response	Met?
Protection of human life *Give priority to the protection of human life by:*	Prioritising the protection of human life over all other policy considerations.	The measures in this report will enable prioritisation human life through design consistent with the requirements of planning and building policy, and other best practice	Yes
	Directing population growth and development to low risk locations and ensuring the availability of, and safe access to, areas where human life can be better protected from the effects of bushfire.	Romsey township is in a relatively low risk environment. This report identifies areas of lower risk for expansion and provides guidance on how risk can be minimised. This report identifies parameters that would enable most if not all of any growth area to meet minimum requirements for low threat (an area of BAL-LOW).	Yes
	Reduce the vulnerability of communities to bushfire through the consideration of bushfire risk in decision making at all stages of the planning process	This report provides the basis for incorporating bushfire risk into decision making in decision making at all stages of the planning process	Yes
Bushfire hazard identification and assessment *Identify bushfire hazard and undertake appropriate risk assessment by:*	Applying the best available science to identify vegetation, topographic and climatic conditions that create a bushfire hazard	This report is based upon strategic-level site analysis and the best available science	Yes
	Considering the best available information about bushfire hazard including the map of designated bushfire prone areas prepared under the Building Act 1993 or regulations made under that Act	This report is based upon the best available information, including the latest map of designated bushfire prone areas	Yes
	Applying the Bushfire Management Overlay in planning schemes to areas where the extent of vegetation can create an extreme bushfire hazard	This report has considered the latest map of the Bushfire Management Overlay and implications for future growth	Yes
	Considering and assessing the bushfire hazard on the basis of … [landscape, local, neighbourhood and site conditions]	This report assesses the bushfire hazard based upon landscape, local, neighbourhood and site conditions	Yes
	Consulting with emergency management agencies and the relevant fire authority early in the process to receive their recommendations and implement appropriate bushfire protection measures.	This report has been prepared to assist consultation with relevant authorities	Yes
	Ensuring that strategic planning documents, planning scheme amendments, planning permit applications and development plan approvals properly assess bushfire risk and include appropriate bushfire protection measures.	This report incorporates assessment of bushfire risk and appropriate bushfire protection measures	Yes
	Not approving development where a landowner or proponent has not satisfactorily demonstrated that the relevant policies have been addressed, performance measures satisfied or bushfire protection measures can be adequately implemented.	This report provides information that will assist development of planning responses to adequately guide development applications	Yes
Resilience and protection of human life *Plan to strengthen the resilience of settlements and communities and prioritise protection of human life by:*	Directing population growth and development to low risk locations, being those locations assessed as having a radiant heat flux of less than 12.5 kilowatts/square metre under AS 3959-2009 Construction of Buildings in Bushfire-prone Areas (Standards Australia, 2009).	This report provides information that will facilitate design of growth and development to comply with the requirement to limit radiant heat impacts to a maximum of 12.5 kW/m2	Yes
	Ensuring the availability of, and safe access to, areas assessed as a BAL-LOW rating under AS 3959-2009 Construction of Buildings in Bushfire-prone Areas (Standards Australia, 2009) where human life can be better protected from the effects of bushfire.	Most of Romsey township is already rated as BAL-LOW as indicated by its exclusion from the designated Bushfire Prone Area. This report provides information that will facilitate design of growth and development to include additional areas of with BAL-LOW rating under AS 3959-2009	Yes
	Ensuring the bushfire risk to existing and future residents, property and community infrastructure will not increase as a result of future land use and development.	This report provides information that will facilitate design of growth and development to the east of the current township boundary. This proposal minimises risk to future residents and infrastructure. It will also buffer the existing town boundary to the east and potentially enable further land to be excised from the BPA.	Yes
	Achieving no net increase in risk to existing and future residents, property and community infrastructure, through the implementation of bushfire protection measures and where possible reduce bushfire risk overall.	There will be no net increase in risk to people or property as the result of the development in accordance with the recommended bushfire protection measures which have been designed to meet and potentially exceed current planning policy requirements including those requiring BAL12.5 development and access to areas assessed as BAL-LOW.	Yes
	Assessing and addressing the bushfire hazard posed to the settlement and the likely bushfire	This report incorporates assessment of bushfire risk developed by responsible	Yes

	behaviour it will produce at a landscape, settlement, local, neighbourhood and site scale, including the potential for neighbourhood-scale destruction.	agencies and appropriate bushfire protection measures	
	Assessing alternative low risk locations for settlement growth on a regional, municipal, settlement, local and neighbourhood basis.	Alternative low risk locations were not considered for this development	Yes
	Not approving any strategic planning document, local planning policy, or planning scheme amendment that will result in the introduction or intensification of development in an area that has, or will on completion have, more than a BAL-12.5 rating under AS 3959-2009.	The proposed plantation development has been designed to limit radiant heat impact on all existing buildings and neighbouring land to less than 12.5 kW/m2	Yes
Biodiversity	Ensure settlement growth and development approvals can implement bushfire protection measures without unacceptable biodiversity impacts by discouraging settlement growth and development in bushfire affected areas that are of high biodiversity conservation value.	This development does not involve the removal of native vegetation or have unacceptable impacts on biodiversity Revegetation of the degraded gully area to the south of the access is expected to increase biodiversity	Yes
Use and development control in a Bushfire Prone Area *When assessing a planning permit application for the [specified] uses and development:*	Consider the risk of bushfire to people, property and community infrastructure	This report provides information that will assist development of planning responses to adequately guide development applications	Yes
	Require the implementation of appropriate bushfire protection measures to address the identified bushfire risk	This report provides information that will assist development of planning responses to adequately guide development applications	Yes
	Ensure new development can implement bushfire protection measures without unacceptable biodiversity impacts	This report provides information that will assist development of planning responses implement bushfire protection measures without unacceptable biodiversity impacts. The key recommended response to ensure adequate setbacks from endangered and other significant native vegetation.	Yes
Policy guidelines	Consider as relevant: Any applicable approved state, regional and municipal fire prevention plan.	This report has considered and implemented key aspects of the *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020) and the *Loddon-Mallee bushfire management strategy* (DELWP 2020b)	
Policy documents	Consider as relevant: *AS 3959-2009 Construction of Buildings in Bushfire-prone Areas* (Standards Australia, 2009) Building in bushfire-prone areas - CSIRO & Standards Australia (SAA HB36-1993, 1993) Any bushfire prone area map prepared under the Building Act 1993 or regulations made under that Act	This report has considered and implemented key aspects of the latest version of AS 3959 (2018) and the latest map of designated bushfire prone areas	

16 Other documents

This section provides a summary of how this report addresses requirements and guidance contained in the following key documents:

- Bushfire and Planning Practice Note 64 *Local planning for bushfire protection* (DELWP 2017a)
- *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020)

16.1 Bushfire and Planning Practice Note 64

The development of this report has been guided in particular by Appendix 1 and 2 of this document which relate to consideration of bushfire risk in local planning activities and mitigating risk outside the Bushfire Management Overlay.

Consistent with Appendix 1 and the *Australian and New Zealand Standard for Risk Management (AS/NZS ISO 31000)*, and this report has taken a stepped approach to considering bushfire (context, risk assessment and recommendations for addressing bushfire risk). This work will support development planning scheme provisions which address bushfire requirements.

In accordance with Appendix 2, this report highlights passive risk management through setbacks and subdivision design which reduce reliance upon vegetation management.

16.2 Municipal Fire Management Plan

Key elements of the *Municipal Fire Management Plan* (Macedon Ranges MFMC 2020) considered and incorporated in this report include:

- Bushfire history
- Risk assessment which incorporates assessment carried out by responsible agencies through the *Victoria Fire Risk Register (VFRR)*
- Risk management measures which provide important context in township design including agency work plans, community-based bushfire management planning, fuel breaks, asset specific treatments, private property inspections, issue of fire prevention notices, roadside slashing and township hazard reduction.

PART F: REFERENCES

ABC Board 2014, *Information Handbook: Design and Construction of Community Bushfire Refuges*, by ABCB.

—— 2019a, *National Construction Code. Volume 1. Building Code of Australia. Class 2 to Class 9 buildings*, Australian Building Codes Board <https://www.abcb.gov.au/Resources/NCC>.

—— 2019b, *National Construction Code. Volume 2. Building Code of Australia. Class 1 and Class 10 buildings*, Australian Building Codes Board <https://www.abcb.gov.au/Resources/NCC>.

Australian Standards & New Zealand Standards 2009, *AS/NZS ISO 31000:2009 Risk management - Principles and guidelines*, SAI Global.

Bowditch, PA 2006, *House fire spread. An investigation, Gulgong NSW. Report the Bushfire CRC. Doc CMIT 2006-206. http://www.bushfirecrc.com/sites/default/files/managed/resource/_be55_gulgong_2006-206_final.pdf*, CSIRO, <http://www.bushfirecrc.com/sites/default/files/managed/resource/_be55_gulgong_2006-206_final.pdf>.

Bull, H 2021, 'Analysis of fire danger rating and wind directions using 3pm weather records for Automatic Weather Stations at Melbourne Airport and Wallan to 13 September 2021 and Macedon Forestry to 30 September 1999'.

CFA 2012, *Victorian Fire Risk Register - Bushfire (VFRR-B) Reference Guide version 12.5*, 17 May 2012, Internal report.

—— 2016, *Neighbourhood Safer Place – Bushfire Place of Last Resort Assessment Guideline* <https://www.cfa.vic.gov.au/documents/20143/50918/CFA_NSP-BPLR_Assessment_Guideline_June-2016.pdf/c1e515cc-963c-12c3-4365-27dcde9bed23>.

—— 2020, *Victoria Fire Risk Register (VFRR) Macedon Ranges Shire*.

Chen, K & McAneney, KJ 2010, *Bushfire penetration into urban areas in Australia: A spatial analysis. Report to the Bushfire CRC.* .

Cheney, NP & Sullivan, AL 2008, *Grassfires. Fuel, weather and fire behaviour. Edition 2*, CSIRO, Australia.

Clark, S, Mills, G, Brown, T, Harris, S & Abatzoglou, JT 2021, 'Downscaled GCM climate projections of fire weather over Victoria, Australia. Part 2: a multi-model ensemble of 21st century trends', *International Journal of Wildland Fire*, pp. -.

DELWP 2017a, *Bushfire and Planning Practice Note 64 Local planning for bushfire protection*

—— 2017b, *Planning Permit Applications. Bushfire Management Overlay. Technical Guide*, September 2017, <https://www.planning.vic.gov.au/__data/assets/pdf_file/0015/80016/Technical-Guide_Planning-Permit-Applications-Bushfire-Management-Overlay_Sept-2017.pdf>.

—— 2018, *Bushfire State Planning Policy Amendment VC140*

—— 2019, *Fact Sheet. Bushfire Mapping Methodology and Criteria*, <chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/viewer.html?pdfurl=https%3A%2F%2Fwww.planning.vic.gov.au%2F__data%2Fassets%2Fpdf_file%2F0027%2F447921%2FFact-sheet-Bushfire-mapping-methodology-and-criteria.pdf>.

—— 2020a, *Design Guidelines Settlement Planning at the Bushfire Interface*

—— 2020b, 'Loddon Mallee Bushfire Management Strategy 2020'.

—— n.d., *Ecological Vegetation Class Benchmarks of the Victorian Volcanic Plain*, <https://www.environment.vic.gov.au/biodiversity/bioregions-and-evc-benchmarks>.

DTPLI 2013, *BMO mapping methodology and criteria August 2013. Planning Advisory Note AN46*, <http://www.dtpli.vic.gov.au/__data/assets/pdf_file/0020/231509/AN46-BMO-mapping-methodology-and-criteria.pdf>.

Government of Victoria 2019, *Macedon Ranges Statement of Strategic Planning Policy*

He, Y, Kwok, K, Mason, M & Douglas, G 2013, 'How should future building structure and emergency response cope with bushfire attacks?', paper presented to AFAC13 Conference – Shaping Tomorrow Together, Melbourne
2-5 September.

Hines, F, Tolhurst, K, Wilson, A & McCarthy, G 2010, *Overall fuel hazard assessment guide. 4th edition July 2010*, Department of Sustainability and Environment, Melbourne.

Holland, M, March, A, Yu, J & Jenkins, A 2013, 'Land Use Planning and Bushfire Risk: CFA Referrals and the February 2009 Victorian Fire Area', *Urban Policy and Research*, vol. 31, no. 1, pp. 41-54.

Lambert, K 2010, *Extreme bushfire/firestorm impact and the bush/urban interface, Black Saturday 7th February 2009. Submission to the 2009 Victorian Bushfires Royal Commission. Submissions SUBM-002-059-0366_01_R, -0389 and -0405*, <http://www.royalcommission.vic.gov.au/Submissions/SubmissionDocuments/SUBM-002-059-0366_01_R.pdf.
>.

Leon, J & March, A 2013, 'Urban structure and evacuation times in a city fringe bushfire: modelling three scenarios in Bendigo, Victoria', paper presented to State of Australian Cities (SOAC) National Conference 2013

Leonard, J 2014, *Dataset: Annual return intervals for 3-hour Forest Fire Danger Indices for the year 2050*.

Leonard, J 2015, 'Houses and fire', paper presented to Living With Bushfire Conference, Churchill, Victoria, 10 October 2015, <http://federation.edu.au/__data/assets/pdf_file/0020/280073/13-Houses-and-Fire-Justin-Leonard.pdf>.

Leonard, J, Blanchi, R & Bowditch, P 2004, 'Bushfire impact from a house's perspective', in *Earth Wind and Fire–Bushfire 2004 Conference, Adelaide*.

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

Leonard, J, Opie, K, Blanchi, R, Newnham, G & Holland, M 2016, *Wye River/Separation Creek Post-bushfire building survey findings. CSIRO Client Report EP16924*, CSIRO, Melbourne.

Macedon Ranges MFMC 2020, *Macedon Ranges Municipal Fire Management Plan 2020-2023*, Macedon Ranges Municipal Fire Management Planning Committee.

Macedon Ranges Shire Council 2009, *Romsey Outline Development Plan*

—— 2018, *Romsey Issues and opportunities paper December 2018*.

March, A, Holland, M & Harwood, A 2011, 'Planning for Bushfire Resilient Urban Design', *State of Australian Cities National Conference 2011*.

Melbourne Water Corporation 2018, *Port Phillip and Westernport Healthy Waterways Strategy 2018-2028*.

National Emergency Management Committee 2010, *National Emergency Risk Assessment Guidelines*, Tasmanian State Emergency Service, Hobart.

Newnham, G, Blanchi, R, Leonard, J, Opie, K & Siggins, A 2014, *Bushfire decision support toolbox. Radiant heat flux modelling. Case study 3: 2013 Springwood fire, New South Wales. Report to the Cooperative Bushfire Research Centre*, CSIRO.

RMCG 2020, *Farming Zone Review. Research and Investigation Paper. Macedon Ranges Shire*.

Standards Australia 2009a, *AS 3959-2009. Construction of buildings in bushfire-prone areas*, SAI Global Limited, Sydney.

—— 2009b, *Construction of buildings in bushfire-prone areas. AS3959-2009*.

—— 2018, *AS 3959-2018. Construction of buildings in bushfire-prone areas*, SAI Global Limited, Sydney.

Wotton, BM, Gould, JS, McCaw, WL, Cheney, NP & Taylor, SW 2012, 'Flame temperature and residence time of fires in dry eucalypt forest', *International Journal of Wildland Fire*, vol. 21, no. 3, p. 270.

ATTACHMENT 1

Some features of bushfire-resilient settlements that can be achieved through or influenced by land use planning
Source: obliqua pty ltd

Settlement location	Development avoids areas exposed to 'unacceptable' risk, however this is not defined in planning controls. Based on AS/NZS ISO 31000:2009 (Australian Standards & New Zealand Standards 2009) risk may be tolerated, provided the risks are known and managed. While some risks can be tolerated, as long as they are 'as low as reasonably practicable (ALARP)', generally unacceptable or intolerable risks 'require risk treatment measures whatever their cost, or the elimination of the risk' (National Emergency Management Committee 2010).
Settlement size and shape	Larger, deeper and more compact settlement shapes reduce the number of houses located on the interface with hazards, and the separation of houses from hazards.
Settlement density	Based on evaluation of the 2009 fires at Bendigo, increasing housing density reduces risk of bushfire penetration (March, Holland & Harwood 2011). This finding is supported by other studies (R. Hughes & Mercer, 2009; Syphard, Bar Massada, Butsic, & Keeley, 2013; Syphard, Keeley, Massada, Brennan, & Radeloff, 2012), although this appears to contradict findings from the 2003 Canberra fires, where bushfire penetration appears to have been assisted by housing density (Blanchi & Leonard, 2005).
Separation from hazards	Based on past losses from extreme fire (Chen & McAneney 2010; Leonard, J. 2015), it is desirable that settlements are located at least 100m and preferably over 700m from extensive areas of dense forest. At a minimum, new houses should be separated from areas of extensive vegetation by the distances set out in AS 3959-2009 (while correcting for flame temperature as set out in Wotton et al (2012) and noting that AS 3959:2009 has been criticised for 'serious flaws' (Leonard 2009)). These distances may be reduced for smaller, narrower and isolated areas of vegetation where fire is less likely to reach peak behaviour. Development should also be well away from steep slopes, and areas with long fire runs that can lead to extreme fire behaviour, particularly convection and related strong fire-induced winds. This can help address impacts from flame contact and radiant heat, but not spotting, which may occur over several kilometres. Houses should be separated from other structures including houses, sheds and cars which if burning can emit radiant heat sufficient to ignite structures within 6-10m (Bowditch 2006).
Construction standards and property management	All houses meet minimum standards as set out in AS 3959-2009 (while correcting for flame temperature (Wotton et al (2012)) and wind loading where intense convection and fire-induced winds are expected (He et al. 2013). Research conducted after the 2009 fires showed the benefits of meeting the standards set out in earlier bushfire controls (WMO). No fatalities were associated with houses built under the WMO controls in the areas affected by the 2009 fires. In addition, there were lower rates of house loss (although other factors, notably small samples and timing of fire reaching settlements may have influenced the outcomes) (Holland et al. 2013). For example, within the five fire areas studied (Kilmore East-Murrindindi, Churchill-Jeeralang, Delburn, Beechworth and Bunyip fires), only 12% of WMO dwellings were destroyed, compared with 38% house loss overall.
'Vulnerable uses'	Vulnerable uses including schools, and aged care facilities are located in areas of lowest risk to protect occupants. Emergency services and medical facilities are located in areas of lowest risk to ensure they remain functional during emergencies.
Access	Access allows for rapid egress for residents to places of safety and access for emergency services in the event of fire, and proposed road layouts are tested against evacuation and fire travel times. While the 2011 changes to the bushfire controls and planning guidance introduced additional measures to improve the design and layout of roads in subdivisions, small-scale simulations carried out for settlement fringes around Bendigo showed that 'that a complete evacuation takes considerable time (between 30 minutes and 1 hour), despite … different sizes and urban patterns, and that it is possible for bushfires to overrun or surround settlements before people leave following a warning' (Leon & March 2013).

Hazard management around and within settlements	The amount of fuel management supplements good settlement and site design, construction standards and property management which are the primary mechanisms for reducing exposure. Fuel is managed to levels that can be maintained on an on-going basis without causing increases in fuel through species change, or environmental impacts (including threats to biodiversity, visual amenity, soil stability and air and water quality). Manual fuel management methods are used where amenity values are high (such as along roadsides), where annual treatment is required and to minimise impacts of frequent burning. Fuel management is based on an assessment of risk rather than perceived risk that accounts for the contribution of tree canopies to reducing wind speeds, filtering embers and moderating fire behaviour, while removing overhanging trees that deposit debris, contributing to loss from ember attack (Newnham et al. 2014).
Emergency shelter	To supplement the provision of warnings and advice on 'leaving early', settlements in areas of higher risk have equitable access to last-resort options for shelter, including open space that meets requirements for Neighbourhood Safer Places (CFA 2016) and/or community bushfire refuges installed in accordance with *Information Handbook: Design and Construction of Community Bushfire Refuges* (ABCB 2014). Because of significant health concerns, particularly for the elderly or people with heart conditions (CSIRO, forthcoming), reduction of construction standards based on personal bushfire shelters is avoided until further guidance on their use is developed by CFA (forthcoming).
Infrastructure, facilities and services build community cohesion and resilience	Settlements are serviced by adequate levels of water, power and telecommunications, which is protected from fire, wind and failure due to overload, and/or has backup
	Settlements contain design features including community facilities (such as halls, schools, parks, sporting and other facilities) that assist interaction and cohesion (and contribute to separation from hazards or emergency shelter or recovery)
	Settlements provide services that address possible socio-economic disadvantage and assist preparation, response and recovery including employment, health, food, shops, transport, emergency services and warning systems
Shared understanding	Land use planners, emergency planners and the community have a shared understanding of the risk associated with bushfire and other hazards and work collaboratively to support settlement planning
'Future-proofing'	Settlements are designed to take climate change and its impact on bushfire risk into account

ATTACHMENT 2: SETBACK METHODOLOGY AND CALCULATIONS

1 Methodology

Setbacks provided in Tables 9 and 10 are based upon reducing radiant heat from vegetation to a target level. This is BAL12.5 for residential areas and BAL-LOW for vulnerable uses (Clause 53.02 Table 3).. Setbacks were determined in accordance with Planning Scheme Clauses 44.06 and 52.03 as set out in Table A2.1

It is noted that estimation of bushfire threat is subject to significant uncertainty, and that *AS 3959-2018* on which Victoria's planning and building system is based has significant weaknesses and should be regarded as a minimum standard for development.

Table A2.1: Inputs used in estimation of bushfire threat

Assessment area	Romsey locality	
Methods	1: Deemed to satisfy setbacks from Table 2 to Clause 52.03 (Method 2 of AS 3959-2018)	2: Calculation of 'enhanced' setbacks using Method 2 of AS 3959-2018
Vegetation classification	Vegetation was classified in accordance with *AS 3959* clause 2.2.3.2, following consideration of the long-term state of the vegetation, potential land use change and the crown cover of remnant trees	
Fuel load	Deemed-to-satisfy loads as provided in AS 3959	
Slope	Slope was estimated using profiles derived from 10m digital elevation data from Geoscience Australia using the Terrain Profile tool in QGIS.	
Climate and design bushfire	Deemed to satisfy FFDI/GFDI=100/130	Residential development: 1:50 FFDI/GFDI=116/143 Vulnerable uses: 1:2000 FFDI/GFDI=190/186
Flame characteristics	Flame temperature: 1090K Flame length: No adjustment for short runs or narrow width of fire Flame width: 100m	Flame temperature: 1200K (Wotton et al. 2012) Flame length: No adjustment for short runs or narrow width of fire Flame width: 100m
Convection		Not assessed
Barriers		Not assessed
Elevation of receiver		Based on the maximum radiant heat flux for the calculated view factor
Other inputs as set out in *AS 3959*		Rate of Spread - McArthur, 1973 & Noble et al., 1980 Flame length - NSW Rural Fire Service, 2001 & Noble et al., 1980 Elevation of receiver - Douglas & Tan, 2005 Flame angle - Douglas & Tan, 2005 Radiant heat flux - Drysdale, 1999, Sullivan et al., 2003, Douglas & Tan, 2005

2 Calculations using Flamesol calculator (Fire Protection Association of Australia

RESIDENTIAL DEVELOPMENT - GRASSLAND

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	143	Rate of spread	18.59 km/h
Vegetation classification	Grassland	Flame length	7.83 m
Understorey fuel load	4.5 t/ha	Flame angle	66 °, 72 °, 78 °, 81 °, 82 ° & 85 °
Total fuel load	4.5 t/ha	Elevation of receiver	3.57 m, 3.72 m, 3.83 m, 3.87 m, 3.88 m & 3.9 m
Vegetation height	n/a	Fire intensity	43,221 kW/m
Effective slope	0 °	Transmissivity	0.877, 0.864, 0.844, 0.821, 0.8080000000000001 & 0.746
Site slope	0 °	Viewfactor	0.4074, 0.2997, 0.2014, 0.136, 0.1104 & 0.0299
Flame width	100 m	Minimum distance to < 40 kW/m²	9.5 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	12.9 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	19.1 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	27.4 m
		Minimum distance to < 10 kW/m²	32.8 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	143	Rate of spread	26.24 km/h
Vegetation classification	Grassland	Flame length	9.31 m
Understorey fuel load	4.5 t/ha	Flame angle	66 °, 72 °, 77 °, 80 °, 81 ° & 85 °
Total fuel load	4.5 t/ha	Elevation of receiver	4.25 m, 4.42 m, 4.53 m, 4.58 m, 4.59 m & 4.63 m
Vegetation height	n/a	Fire intensity	61,028 kW/m
Effective slope	5 °	Transmissivity	0.872, 0.857, 0.835, 0.8120000000000001, 0.799 & 0.74
Site slope	0 °	Viewfactor	0.4071, 0.3016, 0.203, 0.1373, 0.1116 & 0.0302
Flame width	100 m	Minimum distance to < 40 kW/m²	11.3 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	15.2 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	22.3 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	31.6 m
		Minimum distance to < 10 kW/m²	37.5 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	143	Rate of spread	37.06 km/h
Vegetation classification	Grassland	Flame length	11.06 m
Understorey fuel load	4.5 t/ha	Flame angle	65 °, 71 °, 76 °, 79 °, 80 ° & 84 °
Total fuel load	4.5 t/ha	Elevation of receiver	5.01 m, 5.23 m, 5.36 m, 5.43 m, 5.44 m & 5.5 m
Vegetation height	n/a	Fire intensity	86,171 kW/m
Effective slope	10 °	Transmissivity	0.867, 0.85, 0.826, 0.803, 0.791 & 0.734
Site slope	0 °	Viewfactor	0.4108, 0.3049, 0.205, 0.1392, 0.1129 & 0.0304
Flame width	100 m	Minimum distance to < 40 kW/m²	13.3 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	17.8 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	25.9 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	36.1 m
		Minimum distance to < 10 kW/m²	42.6 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	143	Rate of spread	52.33 km/h
Vegetation classification	Grassland	Flame length	13.14 m
Understorey fuel load	4.5 t/ha	Flame angle	65 °, 71 °, 75 °, 78 °, 79 ° & 84 °
Total fuel load	4.5 t/ha	Elevation of receiver	5.95 m, 6.21 m, 6.35 m, 6.43 m, 6.45 m & 6.53 m
Vegetation height	n/a	Fire intensity	121,673 kW/m
Effective slope	15 °	Transmissivity	0.86, 0.842, 0.8169999999999999, 0.794, 0.782 & 0.728
Site slope	0 °	Viewfactor	0.4156, 0.3066, 0.2074, 0.1408, 0.1142 & 0.0307
Flame width	100 m	Minimum distance to < 40 kW/m²	15.6 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	21 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	29.9 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	41.1 m
		Minimum distance to < 10 kW/m²	48.1 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	143	Rate of spread	73.89 km/h
Vegetation classification	Grassland	Flame length	15.62 m
Understorey fuel load	4.5 t/ha	Flame angle	64 °, 70 °, 74 °, 77 °, 78 ° & 83 °
Total fuel load	4.5 t/ha	Elevation of receiver	7.02 m, 7.34 m, 7.5 m, 7.61 m, 7.64 m & 7.75 m
Vegetation height	n/a	Fire intensity	171,802 kW/m
Effective slope	20 °	Transmissivity	0.853, 0.834, 0.8080000000000001, 0.785, 0.774 & 0.722
Site slope	0 °	Viewfactor	0.4173, 0.3105, 0.2095, 0.1421, 0.1154 & 0.0309
Flame width	100 m	Minimum distance to < 40 kW/m²	18.4 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	24.4 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	34.4 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	46.6 m
		Minimum distance to < 10 kW/m²	54.1 m

RESIDENTIAL DEVELOPMENT – WOODLAND AND FOREST

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	2.08 km/h
Vegetation classification	Woodland	Flame length	16.57 m
Understorey fuel load	15 t/ha	Flame angle	64 °, 69 °, 74 °, 77 °, 78 ° & 83 °
Total fuel load	25 t/ha	Elevation of receiver	7.44 m, 7.73 m, 7.96 m, 8.07 m, 8.1 m & 8.220000000000001 m
Vegetation height	n/a	Fire intensity	26,970 kW/m
Effective slope	0 °	Transmissivity	0.851, 0.831, 0.805, 0.782, 0.772 & 0.719
Site slope	0 °	Viewfactor	0.4192, 0.3114, 0.2105, 0.1425, 0.1157 & 0.031
Flame width	100 m	Minimum distance to < 40 kW/m²	19.5 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	25.7 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	36 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	48.6 m
		Minimum distance to < 10 kW/m²	56.3 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	2.94 km/h
Vegetation classification	Woodland	Flame length	22.16 m
Understorey fuel load	15 t/ha	Flame angle	62 °, 67 °, 71 °, 74 °, 76 ° & 82 °
Total fuel load	25 t/ha	Elevation of receiver	9.779999999999999 m, 10.2 m, 10.47 m, 10.65 m, 10.75 m & 10.97 m
Vegetation height	n/a	Fire intensity	38,081 kW/m
Effective slope	5 °	Transmissivity	0.838, 0.8169999999999999, 0.791, 0.77, 0.76 & 0.707
Site slope	0 °	Viewfactor	0.4266, 0.3175, 0.2147, 0.1452, 0.1177 & 0.0316
Flame width	100 m	Minimum distance to < 40 kW/m²	25.3 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	32.8 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	44.8 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	59.1 m
		Minimum distance to < 10 kW/m²	67.8 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	4.16 km/h
Vegetation classification	Woodland	Flame length	30.05 m
Understorey fuel load	15 t/ha	Flame angle	60 °, 64 °, 68 °, 71 °, 73 ° & 80 °
Total fuel load	25 t/ha	Elevation of receiver	13.01 m, 13.5 m, 13.93 m, 14.21 m, 14.37 m & 14.8 m
Vegetation height	n/a	Fire intensity	53,770 kW/m
Effective slope	10 °	Transmissivity	0.824, 0.802, 0.778, 0.758, 0.749 & 0.6929999999999999
Site slope	0 °	Viewfactor	0.4335, 0.3229, 0.2182, 0.1473, 0.1192 & 0.0322
Flame width	100 m	Minimum distance to < 40 kW/m²	33 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	41.9 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	55.7 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	71.90000000000001 m
		Minimum distance to < 10 kW/m²	81.7 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	5.87 km/h
Vegetation classification	Woodland	Flame length	41.2 m
Understorey fuel load	15 t/ha	Flame angle	56 °, 60 °, 64 °, 68 °, 70 ° & 79 °
Total fuel load	25 t/ha	Elevation of receiver	17.08 m, 17.84 m, 18.51 m, 19.1 m, 19.36 m & 20.22 m
Vegetation height	n/a	Fire intensity	75,923 kW/m
Effective slope	15 °	Transmissivity	0.8100000000000001, 0.788, 0.765, 0.747, 0.739 & 0.681
Site slope	0 °	Viewfactor	0.4411, 0.3287, 0.2218, 0.1494, 0.1208 & 0.0328
Flame width	100 m	Minimum distance to < 40 kW/m²	42.9 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	53.2 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	68.90000000000001 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	87.2 m
		Minimum distance to < 10 kW/m²	98.40000000000001 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	8.289999999999999 km/h
Vegetation classification	Woodland	Flame length	56.94 m
Understorey fuel load	15 t/ha	Flame angle	51 °, 55 °, 60 °, 64 °, 66 ° & 77 °
Total fuel load	25 t/ha	Elevation of receiver	22.12 m, 23.32 m, 24.65 m, 25.59 m, 26.01 m & 27.74 m
Vegetation height	n/a	Fire intensity	107,203 kW/m
Effective slope	20 °	Transmissivity	0.798, 0.776, 0.755, 0.738, 0.729 & 0.697
Site slope	0 °	Viewfactor	0.4475, 0.3337, 0.2251, 0.1513, 0.1226 & 0.032
Flame width	100 m	Minimum distance to < 40 kW/m²	55.6 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	67.3 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	84.90000000000001 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	105.8 m
		Minimum distance to < 10 kW/m²	118.4 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	116	Rate of spread	3.47 km/h
Vegetation classification	Forest	Flame length	26.81 m
Understorey fuel load	25 t/ha	Flame angle	61 °, 65 °, 70 °, 73 °, 74 ° & 81 °
Total fuel load	35 t/ha	Elevation of receiver	11.72 m, 12.15 m, 12.6 m, 12.82 m, 12.89 m & 13.24 m
Vegetation height	n/a	Fire intensity	62,929 kW/m
Effective slope	0 °	Transmissivity	0.829, 0.8080000000000001, 0.782, 0.762, 0.753 & 0.698
Site slope	0 °	Viewfactor	0.4312, 0.3209, 0.217, 0.1465, 0.1187 & 0.032
Flame width	100 m	Minimum distance to < 40 kW/m²	29.9 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	38.3 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	51.4 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	66.90000000000001 m
		Minimum distance to < 10 kW/m²	76.2 m

VULNERABLE USE – GRASSLAND

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	3.42 km/h
Vegetation classification	Woodland	Flame length	25.23 m
Understorey fuel load	15 t/ha	Flame angle	61 °, 66 °, 70 °, 73 °, 75 ° & 81 °
Total fuel load	25 t/ha	Elevation of receiver	11.03 m, 11.52 m, 11.85 m, 12.06 m, 12.18 m & 12.45 m
Vegetation height	n/a	Fire intensity	44,175 kW/m
Effective slope	0 °	Transmissivity	0.832, 0.8100000000000001, 0.785, 0.765, 0.755 & 0.701
Site slope	0 °	Viewfactor	0.429, 0.3194, 0.2164, 0.1462, 0.1184 & 0.0318
Flame width	100 m	Minimum distance to < 40 kW/m²	28.4 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	36.5 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	49.2 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	64.3 m
		Minimum distance to < 10 kW/m²	73.5 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	4.82 km/h
Vegetation classification	Woodland	Flame length	34.38 m
Understorey fuel load	15 t/ha	Flame angle	58 °, 63 °, 67 °, 70 °, 72 ° & 80 °
Total fuel load	25 t/ha	Elevation of receiver	14.58 m, 15.32 m, 15.82 m, 16.15 m, 16.35 m & 16.93 m
Vegetation height	n/a	Fire intensity	62,374 kW/m
Effective slope	5 °	Transmissivity	0.8179999999999999, 0.796, 0.772, 0.753, 0.745 & 0.6870000000000001
Site slope	0 °	Viewfactor	0.4362, 0.3251, 0.2201, 0.1481, 0.1199 & 0.0325
Flame width	100 m	Minimum distance to < 40 kW/m²	37 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	46.5 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	61 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	78.09999999999999 m
		Minimum distance to < 10 kW/m²	88.5 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	6.81 km/h
Vegetation classification	Woodland	Flame length	47.32 m
Understorey fuel load	15 t/ha	Flame angle	54 °, 58 °, 62 °, 66 °, 68 ° & 78 °
Total fuel load	25 t/ha	Elevation of receiver	19.14 m, 20.06 m, 20.89 m, 21.61 m, 21.93 m & 23.14 m
Vegetation height	n/a	Fire intensity	88,072 kW/m
Effective slope	10 °	Transmissivity	0.805, 0.783, 0.761, 0.743, 0.735 & 0.681
Site slope	0 °	Viewfactor	0.4438, 0.3308, 0.2234, 0.1504, 0.1217 & 0.0328
Flame width	100 m	Minimum distance to < 40 kW/m²	48 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	58.9 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	75.3 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	94.7 m
		Minimum distance to < 10 kW/m²	106.5 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	9.619999999999999 km/h
Vegetation classification	Woodland	Flame length	65.56999999999999 m
Understorey fuel load	15 t/ha	Flame angle	49 °, 53 °, 58 °, 62 °, 64 ° & °
Total fuel load	25 t/ha	Elevation of receiver	24.74 m, 26.18 m, 27.8 m, 28.95 m, 29.47 m & 0 m
Vegetation height	n/a	Fire intensity	124,357 kW/m
Effective slope	15 °	Transmissivity	0.793, 0.772, 0.75, 0.734, 0.725 & 0
Site slope	0 °	Viewfactor	0.4511, 0.3356, 0.226, 0.1523, 0.1233 & 0
Flame width	100 m	Minimum distance to < 40 kW/m²	62 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	74.40000000000001 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	93 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	114.9 m
		Minimum distance to < 10 kW/m²	128.3 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	13.59 km/h
Vegetation classification	Woodland	Flame length	91.36 m
Understorey fuel load	15 t/ha	Flame angle	43 °, 47 °, 52 °, 57 °, 60 ° & °
Total fuel load	25 t/ha	Elevation of receiver	31.15 m, 33.4 m, 35.99 m, 38.31 m, 39.56 m & 0 m
Vegetation height	n/a	Fire intensity	175,591 kW/m
Effective slope	20 °	Transmissivity	0.783, 0.762, 0.742, 0.724, 0.714 & 0
Site slope	0 °	Viewfactor	0.4569, 0.3399, 0.2289, 0.1541, 0.1253 & 0
Flame width	100 m	Minimum distance to < 40 kW/m²	79.90000000000001 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	93.8 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	114.8 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	139.7 m
		Minimum distance to < 10 kW/m²	154.7 m

VULNERABLE USE – WOODLAND AND FORESTD

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	186	Rate of spread	24.18 km/h
Vegetation classification	Grassland	Flame length	8.93 m
Understorey fuel load	4.5 t/ha	Flame angle	66 °, 72 °, 77 °, 80 °, 81 ° & 85 °
Total fuel load	4.5 t/ha	Elevation of receiver	4.08 m, 4.25 m, 4.35 m, 4.4 m, 4.41 m & 4.45 m
Vegetation height	n/a	Fire intensity	56,218 kW/m
Effective slope	0 °	Transmissivity	0.873, 0.859, 0.837, 0.8139999999999999, 0.802 & 0.741
Site slope	0 °	Viewfactor	0.4088, 0.3016, 0.2026, 0.1373, 0.1115 & 0.0301
Flame width	100 m	Minimum distance to < 40 kW/m²	10.8 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	14.6 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	21.5 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	30.5 m
		Minimum distance to < 10 kW/m²	36.3 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	186	Rate of spread	34.14 km/h
Vegetation classification	Grassland	Flame length	10.62 m
Understorey fuel load	4.5 t/ha	Flame angle	65 °, 71 °, 77 °, 79 °, 81 ° & 85 °
Total fuel load	4.5 t/ha	Elevation of receiver	4.81 m, 5.02 m, 5.17 m, 5.21 m, 5.24 m & 5.28 m
Vegetation height	n/a	Fire intensity	79,379 kW/m
Effective slope	5 °	Transmissivity	0.868, 0.852, 0.828, 0.805, 0.793 & 0.735
Site slope	0 °	Viewfactor	0.4098, 0.3031, 0.2046, 0.1387, 0.1127 & 0.0304
Flame width	100 m	Minimum distance to < 40 kW/m²	12.8 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	17.2 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	25 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	35 m
		Minimum distance to < 10 kW/m²	41.3 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	186	Rate of spread	48.2 km/h
Vegetation classification	Grassland	Flame length	12.61 m
Understorey fuel load	4.5 t/ha	Flame angle	65 °, 71 °, 76 °, 79 °, 80 ° & 84 °
Total fuel load	4.5 t/ha	Elevation of receiver	5.71 m, 5.96 m, 6.12 m, 6.19 m, 6.21 m & 6.27 m
Vegetation height	n/a	Fire intensity	112,083 kW/m
Effective slope	10 °	Transmissivity	0.862, 0.844, 0.819, 0.796, 0.784 & 0.729
Site slope	0 °	Viewfactor	0.415, 0.3066, 0.2069, 0.1403, 0.1137 & 0.0306
Flame width	100 m	Minimum distance to < 40 kW/m²	15 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	20.2 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	28.9 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	39.9 m
		Minimum distance to < 10 kW/m²	46.8 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	186	Rate of spread	68.06 km/h
Vegetation classification	Grassland	Flame length	14.99 m
Understorey fuel load	4.5 t/ha	Flame angle	64 °, 70 °, 75 °, 77 °, 79 ° & 83 °
Total fuel load	4.5 t/ha	Elevation of receiver	6.73 m, 7.04 m, 7.24 m, 7.3 m, 7.36 m & 7.44 m
Vegetation height	n/a	Fire intensity	158,261 kW/m
Effective slope	15 °	Transmissivity	0.855, 0.836, 0.8110000000000001, 0.787, 0.776 & 0.723
Site slope	0 °	Viewfactor	0.4168, 0.3103, 0.2096, 0.1416, 0.1149 & 0.0309
Flame width	100 m	Minimum distance to < 40 kW/m²	17.7 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	23.5 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	33.2 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	45.3 m
		Minimum distance to < 10 kW/m²	52.7 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Grassland Fire Danger Index	186	Rate of spread	96.11 km/h
Vegetation classification	Grassland	Flame length	17.81 m
Understorey fuel load	4.5 t/ha	Flame angle	63 °, 69 °, 73 °, 76 °, 77 ° & 83 °
Total fuel load	4.5 t/ha	Elevation of receiver	7.93 m, 8.31 m, 8.52 m, 8.640000000000001 m, 8.68 m & 8.84 m
Vegetation height	n/a	Fire intensity	223,463 kW/m
Effective slope	20 °	Transmissivity	0.848, 0.828, 0.802, 0.779, 0.769 & 0.716
Site slope	0 °	Viewfactor	0.4215, 0.3135, 0.2113, 0.1432, 0.1163 & 0.0311
Flame width	100 m	Minimum distance to < 40 kW/m²	20.8 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	27.3 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	38.1 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	51.1 m
		Minimum distance to < 10 kW/m²	59 m

Minimum Distance Calculator - AS3959-2018 (Method 2)

Inputs		Outputs	
Fire Danger Index	190	Rate of spread	5.69 km/h
Vegetation classification	Forest	Flame length	41.25 m
Understorey fuel load	25 t/ha	Flame angle	56 °, 60 °, 64 °, 68 °, 70 ° & 79 °
Total fuel load	35 t/ha	Elevation of receiver	17.09 m, 17.86 m, 18.53 m, 19.12 m, 19.38 m & 20.24 m
Vegetation height	n/a	Fire intensity	103,074 kW/m
Effective slope	0 °	Transmissivity	0.8100000000000001, 0.788, 0.765, 0.747, 0.739 & 0.681
Site slope	0 °	Viewfactor	0.4403, 0.3282, 0.222, 0.1495, 0.1209 & 0.0328
Flame width	100 m	Minimum distance to < 40 kW/m²	43 m
Windspeed	n/a	Minimum distance to < 29 kW/m²	53.3 m
Heat of combustion	18,600 kJ/kg	Minimum distance to < 19 kW/m²	68.90000000000001 m
Flame temperature	1,200 K	Minimum distance to < 12.5 kW/m²	87.2 m
		Minimum distance to < 10 kW/m²	98.40000000000001 m