Wildfire Management Plan for the Dromana Foreshore Reserve: Element 1 – Analysis of Risk to Adjacent Dwellings

Latrobe Parade, Dromana, Victoria, 3809

Report commissioned by the Dromana Foreshore Committee

Wildfire Risk Analysis for the Dromana Foreshore Reserve
Latrobe Parade, Dromana, Victoria, 3936

Report prepared by Terramatrix on behalf of Dromana Foreshore Committee of Management, November 2009

Terramatrix Pty. Ltd.
ACN 129 163 373
ABN 44 129 163 373
PO Box 48
Beechworth VIC 3747
P: 03 5728 2370
www.terramatrix.com.au

Approvals

Accountability	Name	Signature
Wildfire & risk analysis	Jon Boura, Nancy Easton, Kayla Selwood	
Report compilation	Nancy Easton & Kayla Selwood	
Approval for release	Jon Boura - Director	

Version Control

Version	Date	Comments	Distribution
0.1	1st October 09	Report outline, methodology	KS, NE
0.2/0.3	19th October 09	Fire behaviour & risk analysis maps	NE, JB, KS
0.4/0.5	4th November 09	Edit	JB
0.6	16th November 09	Final edit, larger maps	NE, JB, client

Table of Contents

1 Introduction

Terramatrix Pty. Ltd. was commissioned by the Dromana Foreshore Committee to conduct an assessment of the wildfire risk posed by the Dromana Foreshore Reserve.

This report presents an analysis of the wildfire risk at the Dromana Foreshore Reserve comprising:

- A detailed assessment of the site; and
- Assessment of the risk posed to adjacent dwellings by wildfire in the Foreshore Reserve.

2 Methodology

In this section a summary of the methodology is provided. A detailed methodology is contained in Appendix 1.

The approach taken in this investigation is consistent with the Australia/New Zealand standard for risk management (*AS/NZ 4360:2004 Risk Management*) and includes the following steps:

1. Set context for the risk analysis;
2. Determine fire management objectives based on land managers' responsibilities;
3. Identify and assess elements of hazard, exposure and vulnerability that contribute to the wildfire risk at the site;
4. Survey the site including mapping of current fire management works, defining fire behaviour zones for subsequent modelling and assessing topography and fuel hazard;
5. Model potential fire behaviour across the site for specified weather conditions;
6. Assess the residual risk; and
7. Suggest additional or enhanced controls.

3 Context of risk analysis and fire management objective

The context of this risk analysis is the impact the Dromana Foreshore Reserve may have during a wildfire on the safety of surrounding buildings. Analysis considers the potential of both a fire starting within the reserve and an established fire burning across the reserve.

The fire management objective set is that there is no flame or radiant heat ignition of the adjacent dwellings from fire burning within the Reserve.

The criteria set for this objective is that there should be no flame contact and radiant heat flux on any building is less than 29 kW m^{-2} which is the flux at which untreated timber will ignite after prolonged exposure. This is the criteria utilised in the *Wildfire*

Management Overlay land use planning control that regulates the wildfire safety of new dwellings (Maughan and Krusel, 2005).

4 Property Description

This section describes the property location, physical environment and planning context.

4.1 General information

Address:	Latrobe Parade, Dromana, Victoria, 3936
Municipality:	Mornington Peninsula
Directory reference:	Melway 159 H5
Assessment date:	27th August, 5th & 23rd October 2009

The Dromana Foreshore Reserve is located within the township of Dromana (see Map 1).

A site assessment of the reserve was conducted by Jon Boura, Duncan Maughan, Nancy Morghem, Kayla Selwood and Amalie Tibbits on three occasions in August and October 2009.

Map 1- Location of the Dromana Foreshore Reserve, Dromana.

4.2 Physical environment

4.2.1 Overview

The site is situated in Dromana on the Mornington Peninsula. It is bounded by Latrobe Parade, Point Nepean Road and the sewerage easement that crosses just west of the Foord Street and Latrobe Parade intersection.

The Foreshore Reserve is situated within the Gippsland Plain bioregion. The EVCs on site are *Coastal Headland Scrub* (161) and *Damp Sands Herb-rich Woodland* (3) *(*see Map 2*).* The site is part of a patchwork of small remnants of native vegetation.

Fire has not been present within the Dromana Foreshore Reserve for many decades and has resulted in change in the ecosystems (Legg, 2008). This change has included weed infestation, decrease in understory vegetation, and loss of several flora and fauna species (Legg, 2008).

Map 2 – Dromana Foreshore Reserve showing EVCs, fuel sampling points and fuel management zones

4.2.2 Topography

The reserve comprises a steep escarpment that rises from the north east to the west. Rocky cliff faces are present in the western section of the reserve. A narrow flat strip runs parallel to Point Nepean Road on the low side of the escarpment and another flat strip runs parallel to Latrobe Parade on the high side. The Point Nepean Rd and LaTrobe Parade run parallel to the Foreshore Reserve on the northern and southern boundaries (see Map 2).

Slopes vary considerably across the reserve; from gentle slopes in the east of the reserve to slopes in excess of 20° towards the west. Slopes generally have a north to northwesterly aspect. The escarpment forms rocky cliffs in places broken by a number of gullies some of which contain walking tracks.

4.2.3 Vegetation and fuel in reserve

Vegetation classification as per the *WMO Applicant's Kit* is Shrub and Heath. Although tea trees, sheoaks and eucalypts are present within sections of the reserve, the predominant vegetation from a fire behaviour perspective is Shrub and Heath.

There is currently a slashed strip running east – west along the northern and southern boundaries of the reserve. This strip averages approximately 2 metres in width but varies between more than 8 metres to less than 1.5 metres where trees prevent slashing (see Map 2).

A fuel hazard assessment was conducted of the Dromana Foreshore Reserve comprising 15 fuel sample points across the two main EVCs (see Map 2). Fuel hazard data are presented in Table 1

Sample Point	Overall	Bark	Elevated	Surface & Near-surface	Near-surface cover	Litter depth (mm)						Tree height (m)
						1	2	3	4	5	Mean	
EVC 161: Coastal Headland Scrub												
1	Low	High	Low	Low	< 40%	N/A	N/A	N/A	N/A	N/A	N/A	8
2	Very high	Very High	Moderate	Moderate	< 40%	18	22	15	25	12	18	5
3	Moderate	Very High	High	Low	>40%	N/A	N/A	N/A	N/A	N/A	N/A	5
4	Moderate	Very High	Low	Low	<40%	10	15	18	9	19	14	8
5	Very high	Very High	Low	Moderate	<40%	15	21	13	14	19	16	8
10	Moderate	Moderate	Low	High	<40%	28	37	22	18	21	25	8
11	Moderate	Low	High	Moderate	<40%	22	16	18	11	15	16	6
12	Extreme	Low	Extreme	Low	>40%	N/A	N/A	N/A	N/A	N/A	N/A	6
13	Extreme	Moderate	Extreme	Low	>40%	N/A	N/A	N/A	N/A	N/A	N/A	12
14	Extreme	Low	Extreme	Low	>40%	N/A	N/A	N/A	N/A	N/A	N/A	4
15	Very high	Moderate	High	Very High	>40%	29	32	24	35	31	30	8
EVC 3: Damp Sands Herb-rich Woodland												
6	Moderate	Very High	Low	Low	<40%	13	15	20	9	11	14	10
7	High	High	Moderate	High	>40%	18	26	15	14	12	17	10
8	Very high	Low	High	Very High	>40%	14	25	27	15	38	24	6
9	Low	High	High	Low	>40%	N/A	N/A	N/A	N/A	N/A	N/A	12

Table 1 – Fuel hazard data for the Dromana Foreshore Reserve

Overall fuel hazard for the Coastal Headland Scrub was quite variable; ranging from Low to Extreme depending largely on the rating for elevated fuel. Surface and near-surface fuel was generally Moderate comprising either a very shallow bed of tea tree litter or more commonly a weedy or grass layer. Bark hazard varied depending upon the mix of trees within each sample point (see Figure 2). The equivalent fine fuel load averaged across the 11 samples was approximately 11 t ha^{-1} (McCarthy *et al.,* 1999).

In the Damp Sand Herb-rich Woodland overall fuel hazard was again quite variable ranging from Low to Very High. The equivalent fine fuel load averaged across the 4 samples was approximately 11 t ha^{-1} (McCarthy *et al.,* 1999).

In general the most important fuel component was the elevated fuel (see Figures 1 and 4). In many places there was a continuum of fine fuel from ground to the canopy of the emergent eucalypts.

Figure 1 – Grassy understorey and elevated fuel

Figure 2 – Bark hazard typical to tea trees within the reserve

Figure 3 – Dead tea trees on the ground within the reserve

Figure 4 – Extreme elevated fuel

Figure 5 – Elevated fuel between the road and bathing boxes

4.2.4 Land use adjacent to the reserve

To the south and southeast of the reserve is residential development with cultivated gardens. The majority of gardens are well maintained and meet WMO inner zone standards (see Appendix 2). Between the private property and the Reserve is LaTrobe Parade approximately 5-6 metres wide.

To the north and northwest Point Nepean Road runs parallel to the Reserve and is approximately 8 metres wide. This road runs parallel to the beach along Port Phillip Bay, where there are over 80 bathing boxes and numerous caravan sites.

4.2.5 Access and water

There is reticulated water to the area with hydrants located in Latrobe Parade. No hydrants were visible on Point Nepean Road.

Roads around the perimeter of the Reserve are sealed and are approximately 5 – 8 metres wide. There is no vehicular access into the Reserve however the reserve is narrow with easy access to top and bottom from Latrobe Parade and Point Nepean Road respectively.

5 Wildfire Risk Assessment

This wildfire risk assessment describes the potential severity of mechanisms of bushfire attack on the dwellings adjacent to the reserve under two sets of severe fire weather conditions.

The potential severity is based on the weather conditions that occurred during the 'Ash Wednesday' bushfires of 16th February 1983. These weather conditions consisted of high temperature, dry air, an extended drought and strong northerly winds with a possible shift in wind direction to the south west. These conditions are thought to occur, on average, once in fifty years.

Temperature (°C)	Relative humidity (%)	Wind speed (km h^{-1})	Forest Fire Danger Index
41	5	45	> 120

Table 2 - Weather conditions used in WMO fire behaviour model based on 1500 hour readings for Melbourne Airport on 16th February 1983.

The conditions at Melbourne Airport, however, are not representative of a coastal environment such as the Mornington Peninsula and less severe, but still extreme, conditions are probably more appropriate (see Table 3). This assumption is supported

by an analysis of local weather readings taken by Mornington Peninsula Shire Council staff on Black Saturday 7th February 2009 (Terramatrix, 2009).

Temperature (°C)	Relative humidity (%)	Wind speed (km h^{-1})	Forest Fire Danger Index
38	8	40	87

Table 3 - Weather conditions used by Terramatrix for fire behaviour modelling on Mornington Peninsula.

Wildfire Safety Objective

The wildfire safety objective that relates to management of vegetation around buildings is to prevent direct flame or radiant heat ignition of the building from the fire front. To do this there must be no direct flame contact on the building and the radiant heat flux impacting the structure must be below 29 kW m^{-2} (the level of radiation required to ignite timber after prolonged exposure) (CFA, 2007; Maughan and Krusel, 2005). It should be noted, however, that unprotected windows may fail at considerably lower radiant heat fluxes (12.5 or 19 kW m^{-2} depending upon type of glass) allowing embers to penetrate the building.

The wildfire risk is therefore based on the likelihood of the buildings being destroyed under these conditions with the consequences being the financial and social loss of the building and the loss of the place to shelter for the occupants. It is assumed that if a building can survive the test fire conditions then it can survive events of lesser severity that happen more frequently. Using the same logic the building may not survive a more severe event (i.e. rarer event). It should also be understood that a number of factors other than fire behaviour play a role in determining whether a building survives or not. Adherence to the actions specified here is not a guarantee of building survival.

The mechanisms of wildfire attack on a dwelling are a combination of sparks and embers, direct flame contact or radiant heat (see Figure 6). Extremely strong winds may also cause structural damage to the building making ignition by embers easier. The reader is referred to one of the publications listed in the reference section for more information on dwelling attack and survival.

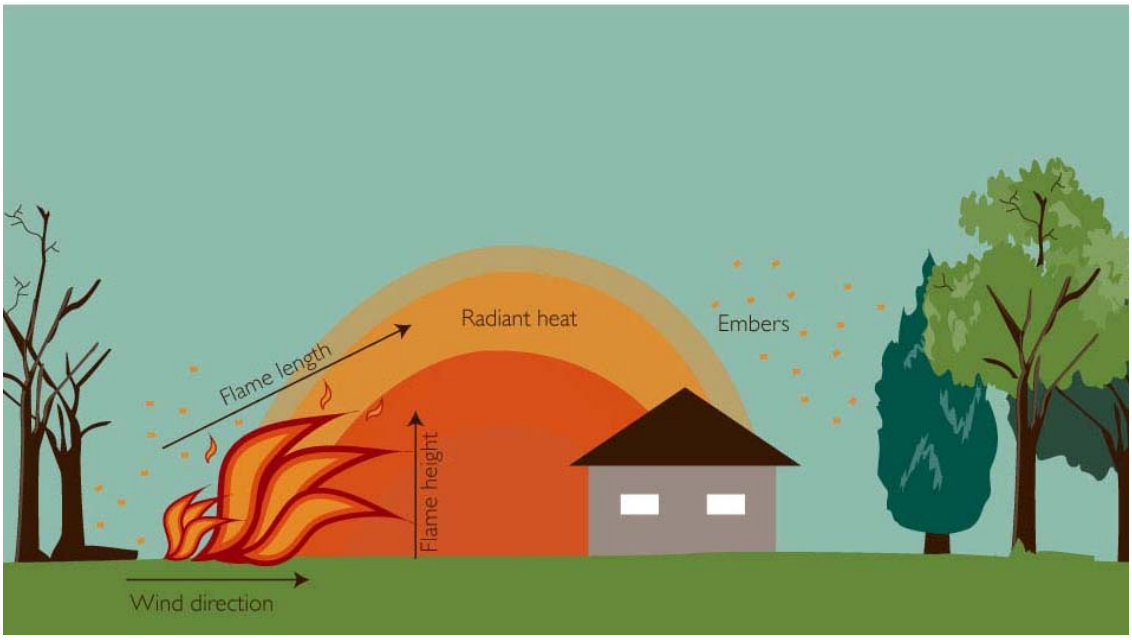


Figure 6 – Mechanisms of wildfire attack on a dwelling.

5.1 Wildfire Scenarios

Dromana has a history of wildfire; over 40 homes were lost during the 1939 Black Friday fires, where fire swept from the hills to the town and jumping Point Nepean Road onto the foreshore.

The credible scenario under which a high intensity wildfire could spread into the Dromana Foreshore Reserve under current conditions is illustrated in Figure 7 and described in Table 4.

Figure 7 – Landscape scale view indicating potential wildfire scenarios at the Dromana Foreshore Reserve.

Fire Scenarios	Description
1. Approach from South West	A direct threat to the reserve would be for an established fire within Arthurs Seat and Nepean State Parks to be driven towards the reserve under the influence of a southwesterly wind associated with a change. In this scenario the long eastern flank would become the head of the fire. Fire behaviour can be extreme during the passage of the cold front and a large area burnt in the hours following the change especially if wind speeds persist and there is little moisture behind the change. There would be significant short and long distance spotting from the forested areas.
2. Ignition within the Dromana Foreshore Reserve	It is more feasible for a fire to begin within the Dromana Foreshore Reserve itself. In this scenario there would be insufficient time for the fire to reach steady state rate of spread, however the slopes within the reserve would enable the fire to accelerate rapidly up the slope towards Latrobe Parade and the adjacent assets.

Table 4 - Wildfire scenarios.

5.2 Flame contact and radiant heat

There are approximately 40 buildings adjacent to the southern side of the reserve and over 80 bathing boxes to the north of the reserve on Point Nepean Road.

5.2.1 Vegetation management requirements of the *WMO Applicant's Kit*

The separation distance between the adjacent buildings and unmanaged vegetation in the Dromana Foreshore Reserve required by the CFA *WMO Applicant's Kit* model is shown in Table 5.

Vegetation Type	Zone	Slope	Inner Zone (m)	Outer Zone (m)
Shrub and Heath	Northwestern	Down slope	10	70
	Eastern	Flat/upslope	10	30

Table 5 – Vegetation management requirements as per CFA WMO Applicant's Kit.

The outer zone is designed to prevent direct flame or radiant heat ignition of the dwelling from the unmanaged vegetation. The inner zone is designed to minimize the chance of dwelling ignition from fuel burning in the outer zone.

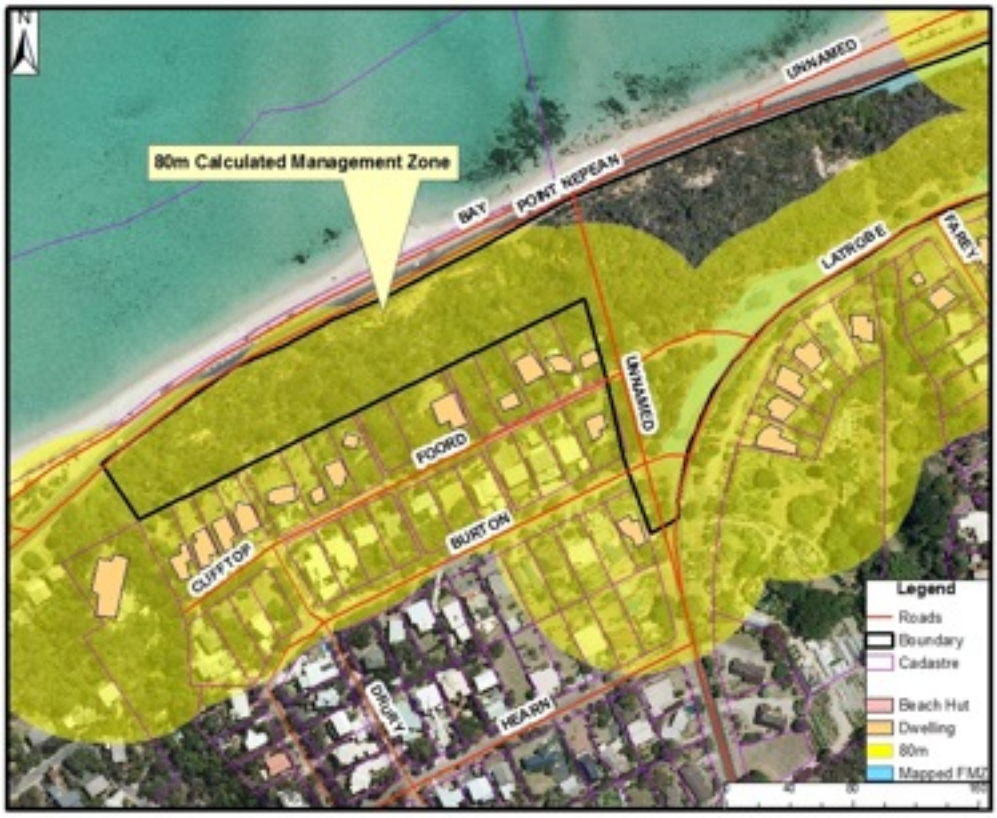
The majority of houses adjacent to the reserve have cultivated gardens that meet the vegetation management standard for an inner zone (see Appendix 2). The actual distance between the buildings and the predominant vegetation is shown in Table 6.

The reserve is within the northwestern outer zone of numerous houses on Latrobe Parade and also in the northwestern outer zone of the bathing boxes on the foreshore.

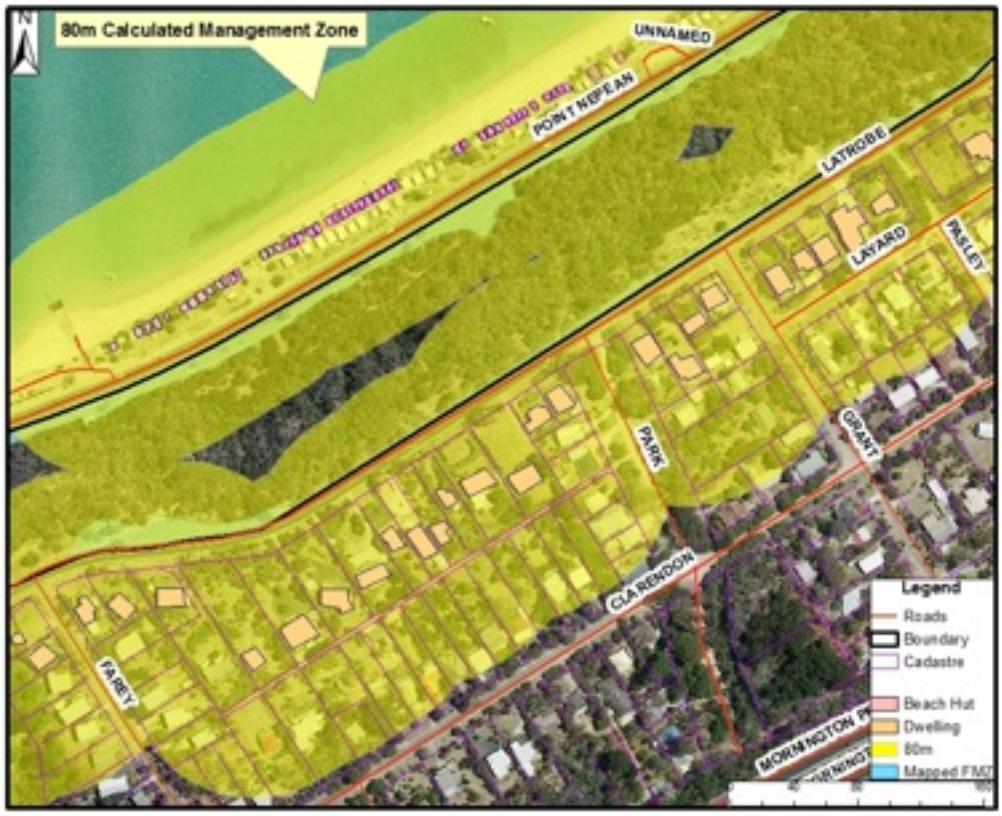
Of the 38 houses to the south of Latrobe Parade only two have the requisite defendable space at a FFDI of 120 as prescribed by the WMO (see Table 6). These two homes are in close proximity to neighbouring houses and could be ignited by house to house spread in the event of a wildfire.

The 83 bathing boxes assessed along that section of foreshore also have insufficient set back distances from the reserve according to the WMO. Currently the setbacks from the vegetation are between 35 and 40 metres.

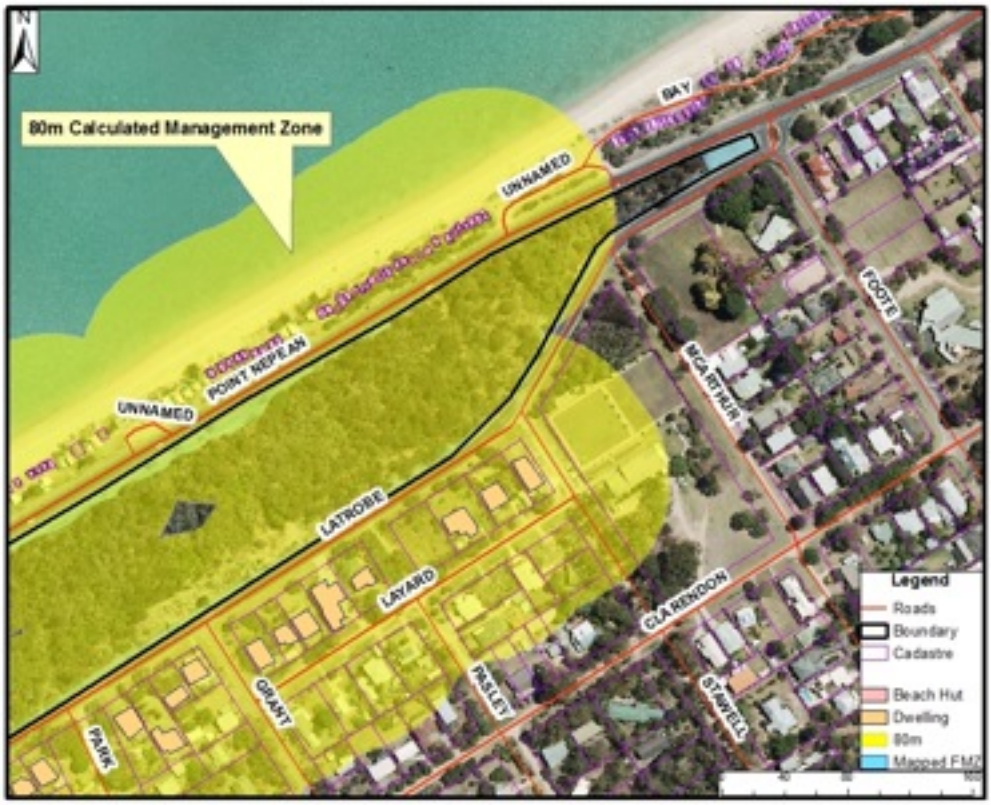
Creation of the requisite vegetation management zones would require extensive fuel management throughout almost the entire reserve (see Maps 3 – 5). Elevated fuel, i.e. shrubs, would, in particular, need to be cleared substantially.



Map 3 – 80 metre vegetation management zone (western section of reserve)



Map 4 – 80 metre vegetation management zone (middle section of reserve)



Map 5 – 80 metre vegetation management zone (eastern section of reserve)

5.2.2 Vegetation management requirements arising from detailed fire behaviour modeling

A more detailed analysis of potential fire behaviour was conducted using site specific data within the endorsed WMO site assessment fire behaviour model rather than the generic values assumed by the *WMO Applicant's Kit* (Maughan and Krusel, 2005). This allowed a more detailed assessment of the vegetation management distances required.

The standard WMO model assumes a fuel load of 25 t ha^{-1} for Shrub and Heath whereas the average fuel load measured in the reserve was 11 t ha^{-1}. A downslope is assumed to be 10° in the *WMO Applicant's Kit* whereas the slopes on site exceeded 22° in places.

Another important assumption of the *WMO Applicant's Kit* is that the wildfire will be at steady-state rate of spread, that is the fire has been spreading long enough to have reached the maximum speed predicted by the fire spread model. At Dromana Foreshore Reserve the depth of the reserve (maximum of approximately 95 metres) precludes a wildfire reaching steady-state rate of spread and instead the fire was modeled as accelerating towards the predicted steady-state rate of spread.

This modeling produced significantly milder fire behaviour than that assumed by the *WMO Applicant's Kit* for the Shrub and Heath (see Table 6) due mainly to the fact that

the fire would not have a sufficient run to reach steady-state rate of spread. Fire intensity was predicted to peak at nearly 24,000 kW m^{-1} on the steep slopes which is classified as Very Severe under the Terramatrix fire classification system (see Appendix 1).

Inputs									Outputs				
Direction of fire	Ignition location	FFDI	Slope (°)	Vegetation type	Fuel load (t ha^{-1})	Shrub height (m)	Run distance (m)	Crown fire	Rate of spread (km h^{-1})	Intensity (kW m^{-1})	Flame length (m)	Distance (m) to 29 kW/m2	Total setback (m)
South	Northern boundary adjacent to Point Nepean Road	120	25	Shrub & heath	11	165	100	Yes	4	23,750	8	12	20

Table 6 – More detailed fire behaviour modelling

The modelling assumed a slope of 25° but in reality many of the slopes were less than this and the more intense cliff-like slopes may actually act as a barrier to the radiant heat and flames from the lower strip of the reserve and interrupt fire spread onto the upper level.

The milder fire behaviour reduced the requisite vegetation management zones from 80 metres to approximately 20 metres in the northwestern zone where the fire behavior is considered to be most severe. The risk to the majority of assets is from the northwestern zone with fire approaching from either from the north – northwest or the southwest.

Maps 3 -8 show the different setbacks (i.e. 80 metres and 20 metres). All assets south of the reserve along Latrobe Parade meet the amended setback distance.

The modelling used the WMO standard FFDI of 120 which represents a conservative approach to the modelling as this FFDI is unlikely to be achieved at Dromana. If the more representative FFDI of 87 was used the vegetation management distances would be further reduced.

SITE	BUILDING TYPE	PREDOMINANT VEGETATION		ZONE THAT DROMANA RESERVE IS IN	VEGETATION SETBACK (m)			
		TYPE	APPROX. DISTANCE (m)		WMO STANDARD		DETAILED MODELING	
					NW	E	NW	E
95 LP	Dwelling	Shrub & Heath	54	NW	80	40	20	20
93 LP	Dwelling	Shrub & Heath	23	NW	80	40	20	20
91 LP	Dwelling	Shrub & Heath	40	NW	80	40	20	20
89 LP	Dwelling	Shrub & Heath	65	NW	80	40	20	20
87 LP	Dwelling	Shrub & Heath	57	NW	80	40	20	20
85 LP	Dwelling	Shrub & Heath	50	NW	80	40	20	20
83 LP	Dwelling	Shrub & Heath	62	NW	80	40	20	20
81 LP	Dwelling	Shrub & Heath	32	NW	80	40	20	20
79 LP	Dwelling	Shrub & Heath	37	NW	80	40	20	20
77 LP	Dwelling	Shrub & Heath	51	NW	80	40	20	20

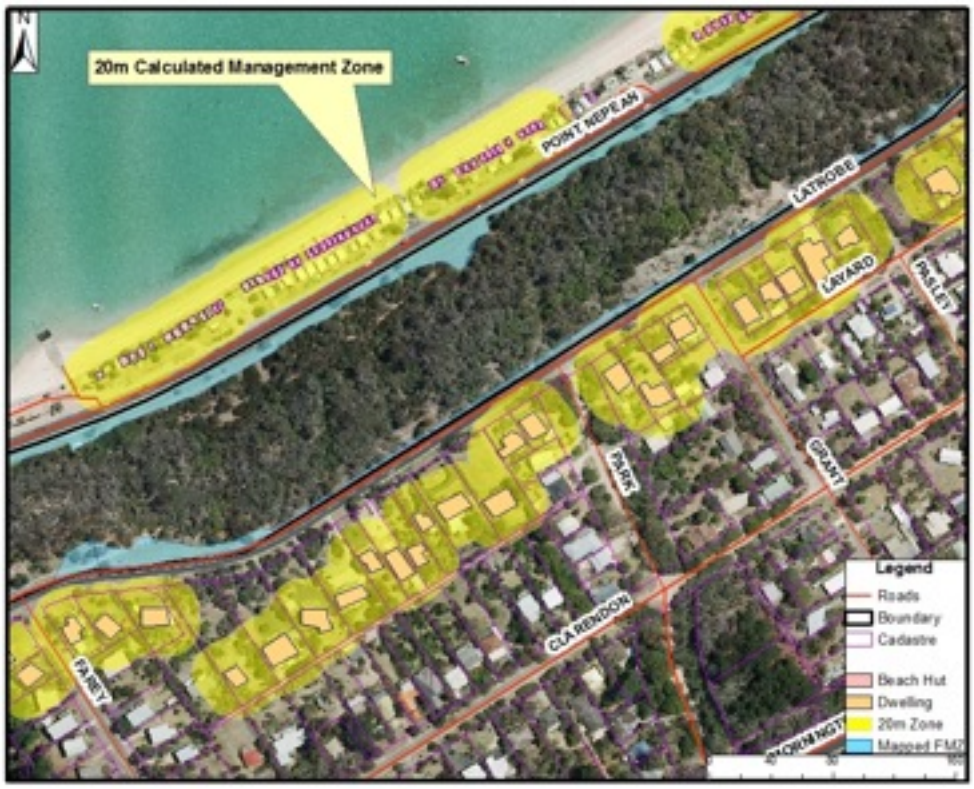
73 LP	Dwelling	Shrub & Heath	65	NW	80	40	20	20
67 LP	Dwelling	Shrub & Heath	92	NW	80	40	20	20
63 LP	Dwelling	Shrub & Heath	45	NW	80	40	20	20
59 LP	Dwelling	Shrub & Heath	62	NW	80	40	20	20
57 LP	Dwelling	Shrub & Heath	57	NW	80	40	20	20
55 LP	Dwelling	Shrub & Heath	57	NW	80	40	20	20
53 LP	Dwelling	Shrub & Heath	60	NW	80	40	20	20
51 LP	Dwelling	Shrub & Heath	44	NW	80	40	20	20
47 LP	Dwelling	Shrub & Heath	46	NW	80	40	20	20
45&43 LP	Dwelling	Shrub & Heath	60	NW	80	40	20	20
41 LP	Dwelling	Shrub & Heath	32	NW	80	40	20	20
39 LP	Dwelling	Shrub & Heath	25	NW	80	40	20	20
37 LP	Dwelling	Shrub & Heath	32	NW	80	40	20	20
35 LP	Dwelling	Shrub & Heath	57	NW	80	40	20	20
33a LP	Dwelling	Shrub & Heath	38	NW	80	40	20	20
33 LP	Dwelling	Shrub & Heath	22	NW	80	40	20	20
31 LP	Dwelling	Shrub & Heath	43	NW	80	40	20	20
29 LP	Dwelling	Shrub & Heath	34	NW	80	40	20	20
25 LP	Dwelling	Shrub & Heath	38	NW	80	40	20	20
23 LP	Dwelling	Shrub & Heath	27	NW	80	40	20	20
21 LP	Dwelling	Shrub & Heath	33	NW	80	40	20	20
19 LP	Dwelling	Shrub & Heath	87	NW	80	40	20	20
17 LP	Dwelling	Shrub & Heath	36	NW	80	40	20	20
15 LP	Dwelling	Shrub & Heath	34	NW	80	40	20	20
13 LP	Dwelling	Shrub & Heath	31	NW	80	40	20	20
Bowls Club	Dwelling	Shrub & Heath	27	NW	80	40	20	20
2a FS	Dwelling	Shrub & Heath	51	NW	80	40	20	20

Table 6 – Distance of adjacent assets to the Dromana Foreshore Reserve compared to the vegetation management zones required by WMO Applicant's Kit and more detailed fire behaviour modeling. N.b. green shading denotes a dwelling with adequate setback according to the WMO Applicant's Kit; yellow shading denotes a dwelling with insufficient setback according to the WMO Applicant's Kit but adequate according to the more detailed fire behaviour modeling; and red denotes a dwelling with insufficient setback according to the WMO Applicant's Kit and the more detailed fire behaviour modeling. (LP – Latrobe Parade, FS – Foote St)

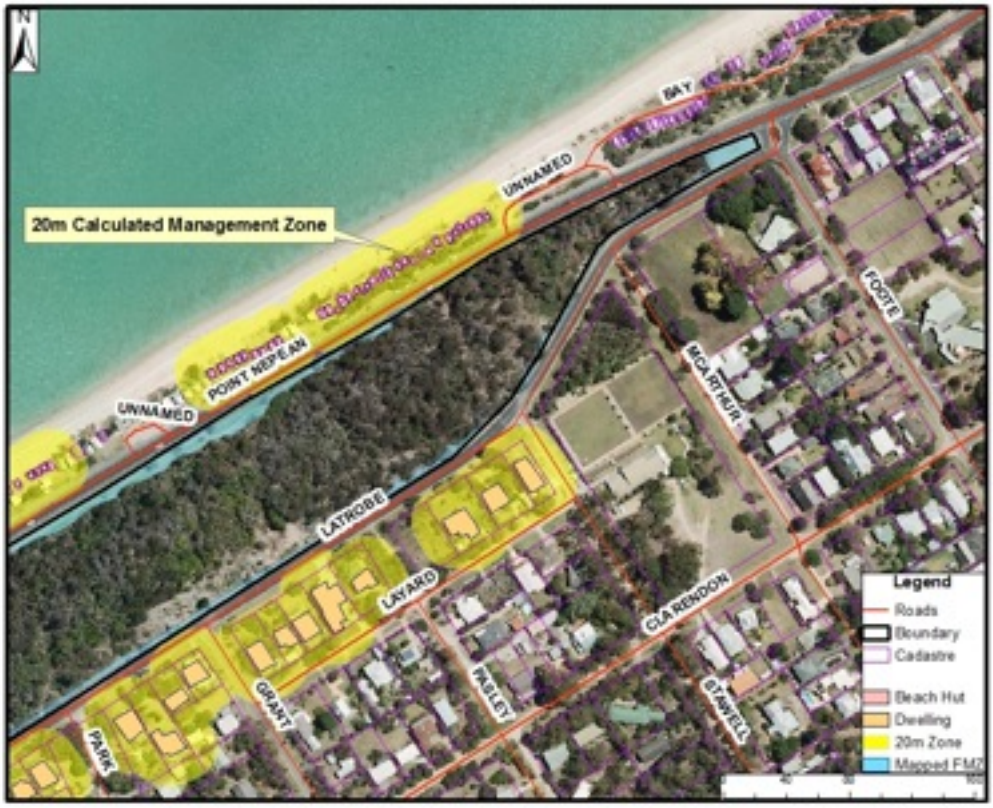
All adjacent buildings have more than the requisite 20 metres when their garden, the roadway and the existing FMZ are taken into account.

A number of homes (23 LP, 33LP, 39LP and 93LP) have less than 10 metres extra defendable space beyond the minimum requirement of 20 metres. It is important that re-vegetation, either natural or assisted, does not encroach into the requisite defendable space.

Map 6 – 20 metre vegetation management zone (western section of reserve)



Map 7 – 20 metre vegetation management zone (middle section of reserve)



Map 8 – 20 metre vegetation management zone (eastern section of reserve)

5.3 Ember attack

The potential for ember attack on the existing dwellings to the south and southeast of the Dromana Foreshore Reserve is considered significant due to the close proximity of the houses to numerous tea trees and scattered eucalypts with high bark hazard.

Ember attack can be expected to commence up to 30 minutes before the fire front arrives, will peak with the passage of the fire front and then continue for a number of hours after the fire front has passed as nearby trees continue to smoulder and shed burning bark. It is important to note that many houses are lost in the period after the fire front has passes.

6 Management Implications

This section provides a brief analysis of wildfire mitigation options and assesses their applicability and efficacy in relation to the existing assets.

6.1 Water supply

Objective	*To ensure that water is available to landholders and emergency services to enable life and property to be defended from wildfire.*
Analysis	All surrounding properties have reticulated water and are serviced by street hydrants. No additional water supply is considered necessary.
Management Recommendation	1. No action required.

6.2 Access

Objective	*To ensure that safe access is provided for emergency and other vehicles at all times.*
Analysis	The Dromana Foreshore Reserve may prevent safe access/egress to the adjacent dwellings for a short period of time. Active defence of the adjacent assets by the fire services during a **significant wildfire** is likely to involve fire appliances located on Latrobe Parade to the south of the reserve and Point Nepean Road to the north of the reserve. There is limited access within the block itself, however the reserve is less than 100 metres in depth and has good road access along the northern and southern boundaries. The steep cliff edges within the reserve make it difficult to improve access.
Management Recommendation	2. No action required.

6.3 Vegetation

Objective	*To ensure that fuel (ground fuel and shrubs) is managed to reduce potential fire intensity in the vicinity of buildings in order to prevent direct flame contact and radiant heat ignitions.*
Analysis	Results from the standard WMO model indicated that residential buildings currently have insufficient setbacks from unmanaged vegetation on the Dromana Foreshore Reserve. In order for the elevated fuel to meet the WMO outer zone vegetation management standard it must cover no more than 50% of the outer zone and be in small clumps (e.g. less than 5 metres x 5

	metres) isolated from one another by at least 10 metres. Thus considerable thinning and clumping would be required. Vegetation within the reserve could be managed to WMO inner and outer zone standard although this has obvious environmental consequences and would severely compromise the primary purpose of the reserve. More detailed fire behaviour modelling using site specific data resulted in the setback distances being reduced to 20 metres. These distances are currently met by all adjacent buildings. The height of the shrubs is directly correlated to both rate of spread and flame height. Actively selecting shorter shrubs will reduce the length of the flames and hence amount of radiant heat flux. This strategy may be effective close to the edge of the reserve, particularly in the vicinity of houses located towards the front of their blocks.
Management Recommendation	3. Maintain existing FMZ and ensure any re-vegetation, either natural or assisted, does not compromise the requisite 20 metre setback. 4. Selectively remove tall (> 1.5 metres) shrubs from the flat strip parallel to Latrobe Parade opposite those homes with lesser setbacks (i.e. 23LP 33LP, 39LP and 93LP).

7 Summary

The impact of the Dromana Foreshore Reserve on the wildfire safety of adjacent buildings was assessed using the CFA-approved WMO methodology adapted for the specific conditions of the site.

Detailed fire behaviour modelling indicated that all buildings have sufficient setbacks from the vegetation in the reserve.

Recommendations were made to ensure that re-vegetation within the reserve does not compromise the current defendable space.

8 References

AFAC (2005). *Position Paper on Bushfires and Community Safety*. Australasian Fire and Emergency Services Authority, Melbourne.

Catchpole, W., Bradstock, R., Choate, J., Fogarty, L., Gellie, N., McCarthy, G., McCaw, L., Marsden-Smedley, J., and Pearce, G. (1998). *Cooperative Development of Equations for Heathland Fire Behaviour*. 14th Conference on Fire and Forest Meteorology, **1**, 631-645. Luso, Portugal.

CFA (2004). *Living in the Bush.* Accessible at http://www.cfa.vic.gov.au/residents/living/litbworkbook.htm

CFA (2007). *Building in a Wildfire Management Overlay: Applicants Kit 2007*. Country Fire Authority, Melbourne.

DPCD (2008). *Victorian Planning Provisions: Update to Amendment VC48*, 10th June 2008. Department of Planning and Community Development, Melbourne.

Garvey, M. and Millie, S. (2000). *Grassland Curing Guide*. Second Edition. Country Fire Authority, Melbourne.

Handmer, J. and Haynes, K. (2008). *Community Bushfire Safet*y. CSIRO Publishing, Collingwood.

Kennedy, J., Russell, S., Millie, S. and Boura, J. (2008). *Precincts – A Common Sense Approach to Service Delivery Planning and Performance Measurement*. The International Bushfire Research Conference, 1-3 September 2008, Adelaide.

Legg, R. (2008). *Fire in the Environment*. Statement to the Committee received 1st May 2008.

Maughan, D. and Krusel, N. (2005). *WMO Site Assessment Methodology – A Technical Overview*. Country Fire Authority, Melbourne.

McArthur, A.G. (1977). *Grassland Fire Danger Meter Mk V*. Country Fire Authority, Melbourne.

McCarthy, G., Tolhurst, K and Chatto, K. (1999). *Overall Fuel Hazard Guide*. Research Report no. 47, Department of Sustainability and Environment Fire Management, Melbourne.

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

Ramsay, C. and Dawkins, D. (1993). *Building in Bushfire Prone Areas: Information and Advice*. CSIRO and Standards Australia, Collingwood.

Ramsay, C. and Rudolph, L. (2003). *Landscape and Building Design for Bushfire Areas*. CSIRO Publishing, Collingwood.

Standards Australia (2009). *Construction of Buildings in Bushfire-Prone Area, AS 3959.* Standards Australia.

Terramatrix, (2009). *Audit of Fire Management Planning and Implementation by Mornington Peninsula Shire Council – Element 1: Audit of Reserve Fire Management*. Terramatrix, Beechworth.

Appendix 1 – Risk analysis detailed methodology

1 Determine fire management objective

A fire safety objective was articulated based on the Wildfire Management Overlay that controls fire safety of new buildings in high wildfire risk areas.

Wildfire risk was defined as the likelihood and consequence of not meeting this objective given the controls currently in place.

2 Understand risk factors

Sources of risk that might have an impact on the fire management objective were identified. Scenarios in which these risks might occur were described in order to allow detailed fire behaviour and impact modelling (see Sections 2.4 and 2.5).

Risk information was considered as describing:

- Hazard (about the physical nature of the fire);
- Exposure (about what assets or values are present in the area being assessed); or
- Vulnerability (about how susceptible these assets are given the hazard scenario).

Understanding how these factors interact in and around the Dromana Foreshore Reserve allows a meaningful risk assessment.

3 Survey of site

3.1 Map implementation of current works

Any areas with evidence of active fuel management (hereby referred to as Fuel Management Zones or FMZs) were located on the ground. The vegetation structure and fuel hazard of each FMZ was assessed.

3.2 Define fire behaviour zones

Discrete fire behaviour zones were defined that were homogenous in terms of the determinants of fire behaviour, i.e. fuel, topography and weather. The number of zones was determined by the heterogeneity of the fire environment of the reserve.

3.3 Assess topography

Slope and aspect were measured using compass and clinometer. Any other topographic features likely to affect fire behaviour were recorded.

3.4 Assess fuel

Fuel sampling was conducted within each fire behaviour zone at a frequency sufficient to provide an overall fuel hazard assessment accurate enough for use in the fire behaviour modelling.

The degree of curing of annual grasses (Garvey and Millie, 2000) was assumed to reach 100% during the driest period of the year.

4 Model fire behaviour

4.1 Fire scenarios

The fire behaviour in each fire behaviour zone was calculated for two sets of severe fire weather conditions.

Catastrophic - Forest Fire Danger Index 120

The potential severity is based on the weather conditions that occurred during the 'Ash Wednesday' bushfires of 16th February 1983. These weather conditions consisted of high temperature, dry air, an extended drought and strong northerly winds with a possible shift in wind direction to the south west. These conditions are thought to occur, on average, once in fifty years.

Temperature (°C)	Relative humidity (%)	Wind speed (km h^{-1})	Forest Fire Danger Index
41	5	45	> 120

Table A1 - Weather conditions used in WMO fire behaviour model based on 1500 hour readings for Melbourne Airport on 16th February 1983.

Extreme - Forest Fire Danger Index 87

The conditions at Melbourne Airport, however, are not representative of a coastal environment such as the Mornington Peninsula and thus less severe, but still extreme, conditions were selected. This decision is supported by an analysis of local weather readings taken by Mornington Peninsula Shire Council staff on Black Saturday 7th February 2009 (Terramatrix, 2009).

The fire behaviour was hence also calculated for a number of weather scenarios considered severe but credible conditions for the Mornington Peninsula (see Table 3).

Temperature (°C)	Relative humidity (%)	Wind speed (km h^{-1})	Forest Fire Danger Index
38	8	40	87

Table A2 - Weather conditions used by Terramatrix for fire behaviour modelling on Mornington Peninsula.

The use of test fire scenarios with different prevailing wind directions allowed analysis of the relative risk from head fire, flank fire and backing fire to different sectors of the reserve and adjacent assets.

4.2 Fire behaviour models

Fire behaviour was calculated using the published fire behaviour equation applicable to the vegetation type of the zone:

- Shrub and heath (Catchpole *et al.*, 1998); or
- Forest (Noble *et al.*, 1980).

Inputs to the fire behaviour analysis were fuel, slope and aspect, and weather conditions.

Outputs of the analysis included predictions of rate of spread, intensity, ember generation and spotting, flame length and radiant heat flux.

5 Model fire impacts

5.1 Fire classification

The test fires were classified according to their intensity and an assumed level of impact. The general assumption is that the higher the fire intensity the greater the potential impact. The descriptors are shown in Table A3.

Intensity descriptor	Intensity range (kW m^{-1})	Fire description
Low	< 500	Easily suppressed fires e.g. fuel reduction burns
Moderate	500 – 2,500	Fires may cause damage but are controllable. Upper values near limit of suppression capability in forest.
Severe	2,500 – 10,000	Fires uncontrollable by direct attack in forest, suppression ability limited in grasslands at higher intensities.
Very Severe	10,000 – 30,000	Large fires that may cause significant damage e.g. Dandenong Ranges fires 1997, Spring Hill 1998.
Extreme	> 30,000	Very large uncontrollable fires for example Ash Wednesday and Black Saturday fires at upper limits (~ 150,000 kW m^{-1}).

Table A3: Fire intensity classification

5.2 Proximity bands

The risk arising from each scenario was analysed for two bands defined by proximity to the reserve, namely:

- Immediately adjacent to the block; and
- The wider locality.

The level of detail of analysis varied between bands with greatest detail applied to the adjacent dwellings due to the concentration of private assets in this band. The bands are described in Table A4.

Proximity band	Level of detail of analysis		
	Hazard	Exposure	Vulnerability
Adjacent to the site	Fire behaviour modelling	Number of houses Presence of other significant assets	Wilson House Survival ratings Compliance with WMO standard conditions
Wider locality	Ability of precinct type to carry wildfire	Generic distribution of assets in precinct type	Generic nature of assets in precinct type

Table A4: Level of detail of analysis for each proximity band

5.3 Threat to buildings

As buildings are the most common built asset threatened by wildfire in the Dromana Foreshore Reserve, adjacent houses were identified and mapped.

The likely impact of the scenario test fire on the buildings was assessed using the Wildfire Management Overlay (WMO) model utilized in the application of the WMO under the Victorian Planning Provisions (DPCD, 2008). This control used direct flame contact and prolonged radiant heat flux in excess of 29 kW m^{-2} as the ignition criteria for buildings (Maughan and Krusel, 2005).

Building survivability was modeled for the WMO test fire of FFDI 120 and for more typical severe conditions for the Mornington Peninsula.

5.4 Threat to wider neighbourhood

At the wider neighbourhood scale, exposure and vulnerability were considered using the "precincts" risk categorisation concept developed by CFA (Kennedy *et al.*, 2008). Precincts are based on logical, geographic descriptions of risk that encompass all land and development. They provide a consistent first level community risk assessment,

with more detailed analysis of hazard, exposure and vulnerability facilitated by access to a range of data including the ABS census.

6 Assess residual risk

The risk of not achieving the fire management objectives at the Dromana Foreshore Reserve under the test fire scenarios was assessed. The threat from fire was considered in relation to the assets adjacent to the site.

The existence and likely efficacy of existing controls was considered in assessing the residual risk.

7 Suggest improvements to fire management works

Recommendations were made in regard to the adequacy of various fuel management standards in each of the scenarios examined.

Where it was determined that the risk was not being adequately treated additional controls were identified. This report is confined to making recommendations regarding the need for and likely efficacy of additional treatments and does not document a treatment implementation plan.

Ongoing monitoring and review is essential to ensure that the treatment recommendations remain relevant. The risk analysis conducted in this study represents a snap shot in time, whilst wildfire risk is dynamic and will be influenced by changes to hazard, exposure and vulnerability over a range of time scales as well as any contextual changes such as amendment of management objectives or change to risk appetite.

Appendix 2 – Vegetation management standards for inner and outer zones

Source: CFA (2007)

Inner zones:
A distance of 10 metres around the dwelling must be maintained to the following requirements during the declared Fire Danger Period to the satisfaction of the responsible authority:

- Grass must be no more than 100 mm in height;
- Leaf litter must be no more than 10 mm deep;
- There must be no elevated fuel on at least 50 per cent of the Inner zone. On the remaining 50 per cent of the Inner zone, the elevated fuel must be at most, sparse, with very little dead material;
- Dry shrubs must be isolated in small clumps more than 10 metres from the dwelling; and
- Trees must not overhang the roofline of the dwelling.

Outer zones:
Vegetation in outer zones must be maintained to the following requirements during the declared Fire Danger Period to the satisfaction of the responsible authority:

- Grass must be no more than 100 mm in height;
- Leaf litter must be no more than 20 mm deep;
- There must be no elevated fuel on at least 50 per cent of the outer zone; and
- Clumps of dry shrubs shall be isolated from one another by at least 10 metres.

Non-flammable features such as tennis courts, swimming pools, dams, patios, driveways or paths should be incorporated, especially on the north and western sides of the proposed building. Features with high flammability such as doormats and firewood stacks should not be located near the dwelling during the fire danger period.