1 Bushfire Threat Assessment of Anglesea

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This report is based on the bushfire behaviour expected in the worst weather conditions, ie, > 40^0C, 10% RH, > 40 kph wind. It is based on Red Eagle's fire behaviour prediction expertise and onsite inspection. The assessment is intended to give the property owners an indication of what type of bushfire attack they can expect on their property in worst case scenarios. Red Eagle also encourages the property owners to use this report as an input to help them decide whether they will self-defend or leave.

1.1 Background:

Victoria's Bushfire Royal Commission collected a huge amount of evidence about the 173 deaths on Black Saturday in February 2009. One repeating pattern was that people mistook spot fire attack for a head fire attack. They enacted the then fire agency message of "when the fire front comes, shelter inside and when it passes over, come outside and put out the spot fires". So, when they saw some flames, they went inside, thinking it was the main fire front. But it was a spot fire burning in a garden bed or a roadside verge. The fire front usually never came. Sadly, their bodies were found in the rubble of their homes.

These cases were a knowledge-deficit tragedy:

- The bushfire behaviour knowledge tragedy for many properties was that the fire front never came onto their property. The bushfire came as an ember attack that ignited as spot fires.
- The bushfire risk management knowledge tragedy was that many properties were well enough prepared to defend an ember attack.
- The personal tragedy is that, with this fundamental knowledge, most deaths may have been avoided.

Red Eagle wants to help. This assessment indicates what type of bushfire attack to expect on township properties on a severe weather day, and which direction it might come from. We want this assessment to be accessible and user friendly, and to give people a good start in assessing the potential danger their property may or may not be in against bushfires, and yet also to encourage people to want to learn more about bushfire behaviour on and near their property.

1.2 Geography of the surrounds

The general terrain can be described as undulating with gentle slopes dissected by shallow drainage lines. Land use is a large residential area adjacent to a large National Park that protects the residential area with deep control burns and a 40m wide mown fire break upwind of a wide road.

Figure 1 Anglesea township and surrounding heath and forest vegetation on the bushfire-danger sides. Similar scale to Figure 4

Figure 2 Oblique view to the NW across the SW corner of Anglesea towards the heathy forest mass. This yellow dash line indicates where the running bushfires are stopped from NW, W and SW by the passive protection measures of control burns and wide mown firebreak and wide boundary road.

1.3 Bushfire scenarios

Fires could start by various means, eg, a spot fire from a bushfire up wind, or a car accident or another accidental means or a fire bug. Fires in bush reserves in this area are uncommon.

A bushfire in this predominantly low relief terrain will be pushed by the wind direction at the time. Slopes will play a minor role in direction. In a strong wind, the flame fronts will be narrow, with a likely length to breadth ratio of 7 to 1. Thus, if they ignite 100m from the town, they might be 15m wide when they hit the perimeter road, of if they ignite 1 kilometre away, they could be 150m wide.

Some distant forests have been unburnt for many decades, which means there is ample loose bark and fire brand material on trunks and branches, so medium to high density short distance spotting eg, up to 200m or so, is expected from them on a severe weather day. The forest flame can be made to stop at a track by reducing flame height with a recent control burn upwind or a mown fire break upwind of it. Embers will jump over the track, but their volume can be managed by recent control burning.

The summer flammability of the forests and heathlands presents an annual risk of bushfire activity, but the bushfire threats are being managed by passive protection measures of deep control burning upwind of a mown fire break that is upwind of a perimeter road, which combine to eliminate running flame threat within the township and reduce ember density to manageable levels, allowing active suppression of spot fires in a safe workplace. Targeted burning of ember source areas makes it possible to eliminate ember risk altogether.

1.3.1 Big picture bushfire scenario

In Victoria, the danger wind directions are from the North to the NW, and the wind change danger directions are from the West and South West

1.3.2 Specific danger wind directions

Severe fires have occurred in the NW, W and SW quadrants in the past, see Figure 3.

A Traditional worst-case scenarios: wind direction from the North and NW

A serious potential ember attack scenario for Anglesea is a wide vigorous flame front that runs from NW or W. See Figure 1. A strong wind will push a flame through the forest and heath generate leap frog embers whose leaders could land in the town area well ahead of the mother flame and smoke. They will be low density of course because of the deep control burn areas and if they ignite, the sporadic spot fires can be readily suppressed when small.

The core of the bushfire flame is controlled by the litter fuel bed because the shrub layer is a dependent fuel, ie, high moisture foliage needs a hot under-flame. Shrub flame in long-unburnt heath is typically 4m height, but tree trunks will ignite as spike flames and also throw embers downwind. When flame hits the control burn area protecting the town, flame height falls below 2m or so and ember throw distance shortens. When flame hits the fire break, flame height drops to less than a metre and will stop at perimeter roads, eg, Odonahues Road without need of tankers. The danger comes from the embers. If embers ignite on a town property, the spot fires will be few but they are readily extinguished when small.

Figure 3 Bushfires in the surrounds since 1970 have been sporadic and were stopped at a distance from the town. The exception was the 1983 Ash Wednesday fire (in slope hash) that came from the SW at night via broad front of parallel spot fires that that rained embers and took all parties by surprise and caused panic. The township then had less perimeter protection than now, but even so, individual spot fires had to stop at the perimeter roads and fuel free barriers. The township then held more open paddocks and unmanaged tea tree patches that ignited and these spot fires ran short distances to the next road. But the spot fires were many and simultaneous. House loss occurred via embers igniting flammable fuel near house and subsequent flame ignition of the house. We should be much more enlightened now.

B Wind direction from the W or SW

Typically, a W or SW wind on a severe day follows a long period of NW wind. If a fire is burning upwind at the time, embers may reach the property.

Flames driven by a Westerly will run as described above with associated embers. They will stop along perimeter roads as described above.

Flames from the SW will be in the long unburnt coastal tea tree. Flame height may exceed 15m and throw embers into the town. Fortunately, they will be narrow because their maximum run from the coast is a few hundred metres, meaning the ember attack area will also be narrow. They will stop along perimeter roads as described above.

1.3.3 Effect of fuel reduction burning on National Park land

DELWP records and visual evidence shows there has been an intensive effort to reduce fuel on the danger side of perimeter roads. Their commitment to continue is strong and acknowledges their understanding of duty of care. It has reduced residual risk to acceptable levels.

"Some key features of the DELWP fuel management strategy are that it aims to manage risk to high-risk townships by regularly burning arcs within 2 km of them, including on 10% area of private land (as an annual average)" https://www.ffm.vic.gov.au/fuel-management-report-2016-17/what-we-achieved-statewide/strategic-bushfire-management-planning/updating-the-barwon-otway-fire-management-strategy

Figure 4 This map shows good evidence of deep and regular control burning around the danger perimeters of Anglesea. Control burning reduces maximum flame height on site which reduces ember generation capability. Low flame stops by itself at fuel free barriers, eg, tracks wider than flame height. Bushfire progress depends on ember throw, which has also been disrupted by regular burning. Regular burning provides habitat renewal for several species and prevents severe fires on site and consequent wide scale burnout, deaths and multi-layer habitat destruction.

The deeper the control burn, the more distant is the source of embers, and because ember density declines exponentially with distance, the lower is ember density in the town. A vigorous fire in long-unburnt heath struggles to throw high – medium density of embers > 50 - 100m. A vigorous fire in a short messmate forest struggles to throw high – medium density of embers > 200m. The town's boundary has been spared of these scenarios as the attached analysis shows.

1.4 Likelihood of severe bushfire attack

The historical likelihood of a severe bushfire is low but fuel load is dry enough to support fires each year. Because a disaster requires simultaneous alignment of several independent factors – wind strength and direction, ignition location, length of run through continuous flammable forest fuel and passive mitigations in place, chance of township disaster remains low but to prevent a disaster requires commitment to active suppression of spot fires within the town by residents and firefighters.

1.5 Likelihood of fire fighters being available at a property during a severe bushfire attack.

Low because there are many more houses than tankers and crew to deal with a mass ember attack or multiple spot fire ignitions. Sensible to encourage residents to self-defend in this safe work place, and empower them with knowledge and skills training and facilitate coordination with fire brigade.

1.6 Summary: Type of bushfire attack expected on an Anglesea property

Wind direction from N to NW or W or SW
A fire front may reach perimeter road. If so, short distance ember attack will precede it, causing spot fires on township properties at low density. Spot fires can be readily stopped by surface fuel non-flammability and active suppression when small.

***Likelihood of severe bushfire attack*:** The likelihood of a severe bushfire attack onto the town is low but remains possible each summer.

2 Assessment of passive protection measures on danger side of Anglesea residential area

Bushfire risk on a property is determined by its exposure to the three threats from a severe bushfire attack – running flame, ember rain and stationary flame around the house in fuel ignited by embers.

The local authorities have strategically bushfire-protected the danger side of the town with a systematic program of deep control burns and a firebreak along town boundary. This has eliminated the running flame, the first threat, entering the town. It has reduced the volume and throw distance of embers, the second threat, from the burning heath to a low level that makes control of spot fires on properties eminently manageable in safety. The third threat is stationary flames around the house. Their probability of occurrence is now low, but to achieve zero house loss, they must be controlled by active suppression when small.

In past years when untreated, native vegetation adjacent to Anglesea allowed high level threats too close to residences that house loss was inevitable. It also and prevented safe suppression by fire fighters or by self-defenders.

This is a scientific assessment of how passive protection measures (the deep control burn area and mown firebreak strategy) have reduced threat levels to low and created a bushfire-safe workplace for active protection measures by firefighters and residents against the remnant threat level.

The combination of active and passive protection measures is a prerequisite for zero house loss and zero life loss. Absence or inadequacy of either or both will result in house loss and possibly life loss. Eg, current passive protection measures without adequate active protection will result in house loss. This will happen if fire agencies evacuate the residential area under attack and do not deploy at least one tanker per three households during the ember attack. We can predict this will not happen because typically fire fighters are deployed to the fire edge.

A more practical and sustainable strategy is to prevent house loss in a bushfire-safe work place like Anglesea by encouraging residents to self defend with pre-seasonal training and appropriate empowerment. Encouragement of self defence by skilled determined people has been validated by decades of research, most recently during Black Saturday, where house save rate by skilled defenders was 99%.

My aim is to acknowledge and congratulate the local authorities for creating a bushfire-protected town and to convince the people of Anglesea that they now have a bushfire-protected workplace within which they can now take charge and re-learn the knowledge and skills to self-defend their homes from a worst case bushfire attack, which is now thankfully a low density, low probability ember attack.

The study begins with segmenting the western and northern town boundary into seven sections. I visited each segment, assessed likely fuel bed status in severe weather conditions and took photographs to systematically identify the salient fuel bed criteria that directly influence the three bushfire behaviour threats and the three house-ignition mechanisms. In particular, because the running flame is the most dangerous bushfire behaviour threat, the major focus is how tall it will be and where the running flame will stop.

2.1 Results

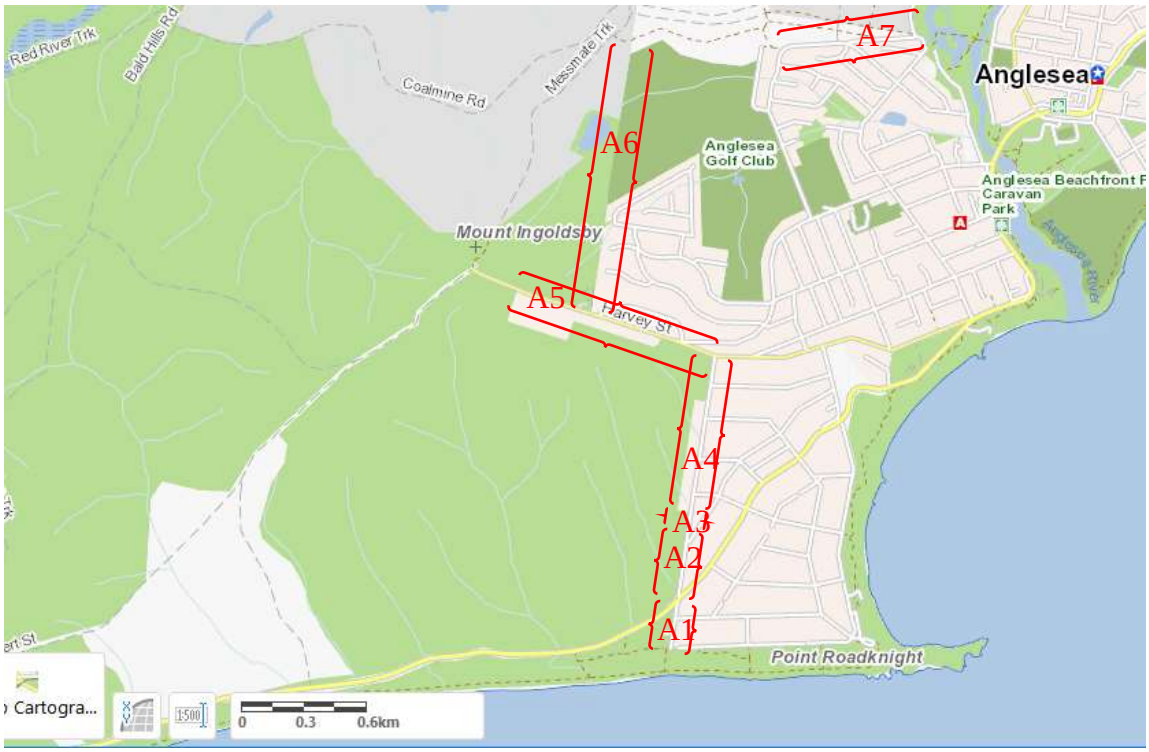

Figure 2 Seven segments

The analysis of each segment of native vegetation on the danger side is now presented visually by aerial and on-site photographs and described in detail in two Tables. The first Table is a description of the fuel bed characteristics, both horizontal and vertical, and the second is a description of bushfire behaviour characteristics of relevance to house threat. Each segment is described with the narrative of flame and ember progression from untreated vegetation to fuel managed vegetation to residential properties.

Aim is to identify the ignition mechanisms in each fuel hazard type that might threaten the house, based on the bushfire behaviour criteria that have direct linkage to cause of ignition or damage to the house. They are size of flame (running flame or stationary flame), separation distance between flame and house and presence of embers.

A 1 Bushfire threat status

Section Odonohue Road, Melba Parade to Great Ocean Rd

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel (road) | Residential

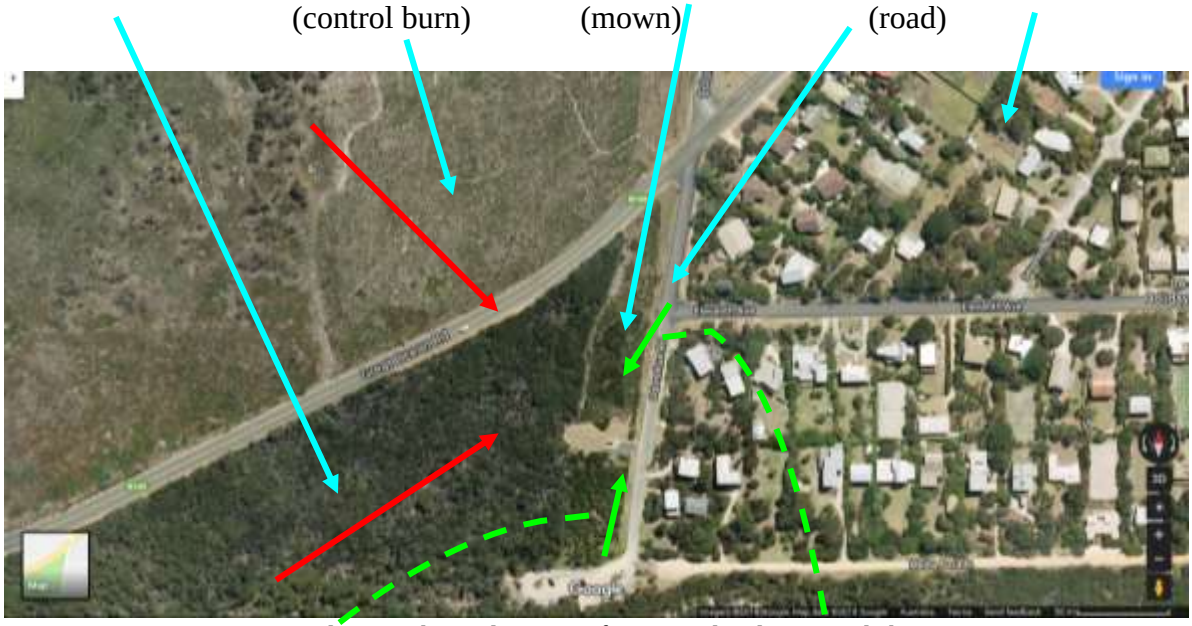

Figure A1 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos (below)

Figure A1n (left) Looking north along the western firebreak. Red arrow indicates direction of NW to SW wind driven running flame through the mown grass, where maximum flame height will be 1m if it cures. Running flame will self-extinguish at road edge, ie, stop without suppression.

Figure A1s (right) Looking south along the western firebreak. Red arrow indicates direction of NW to SW wind driven running flame through the mown grass, where maximum flame height will be 1m if it cures. Running flame will self-extinguish at road edge, ie, stop without suppression.

Table A1 - Fuel Fuel hazard assessment
Follow from Left to Right in Figure A1:

Fuel hazard classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Single layer	Zero Fuel	Discontinuous
Depth of each layer	Shrub layer 1m Trunk 6m Canopy layer 3-4m	Shrub layer partially burnt < 1m Trunk burnt 6m Canopy layer 3-4m	Surface layer only	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

Table A1 - Fire Bushfire behaviour and threats on a severe weather day
Flame and ember flow is from Left to Right in Figure A1:

Fuel hazard classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk 6m Canopy layer 6m	Surface layer <1m Shrub layer <2m Trunk already burnt <6m Canopy layer cannot ignite	Surface layer <1m	0m	Spot fire of variable height, eg, 1m in garden beds, low shrubs, 2+m tall flames on fences or trellis,
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur	<1m	0m	Spot fire of variable height occurs if ember ignites
Bushfire threats originating within each fuel hazard	Running flame, Ember generation	Running flame,	Running flame,	Nil	Stationary flame, embers
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

Narrative

Forest area

Danger wind direction – from N, NW or W.

Fuel bed is continuous from the heath forests in the west to Great Ocean Road and Odonohue Rd. This means wind will push a running flame seamlessly all the way.

In this area, the control burn removes low shrub layer and loose bark on tree trunks, but only for a few years until it regrows.

Flame height varies according the height, density and age (= time since last burn) of the shrub layer, which provides the ladder fuel linkage for the flame into the low tree canopy.

In severe weather, the running flame in the untreated heath forest is a true crown fire, ie, a moving fire front from ground to crown. It has a flame height around twice tree height. Vigorous uplift generates high density embers, most of which are thrown up to 200m downwind. When the flame enters the control burn area, flame height reduces to 2-3 m in the surface layer, ie, sub canopy flame. Ember generation is low and throw distance is less than 50m because the short flame has insufficient uplift. Meanwhile, the running flame continues into the mown area where flame height reduces to less than 1m. This flame then hits the 8m wide bitumen road and self-extinguishes.

The fuel managed configuration upwind of the firebreak conforms to firebreak theory and ensures that flames will self-extinguish at the road, and therefore, only embers can cross the road downwind.

Embers can throw to the south side of Great Ocean Road into the 4 - 6m tall dense coastal tea tree (Leptospermum). This area remains untreated, probably because a control burn in this invader species would kill the trees, and as such, environmental or landscape reasons may prevent a burn. A vigorous front in this tea tree patch can generate a flame height double its height which can generate high density short distance embers for up to 100m or more downwind. Fortunately, this tea tree patch is narrow and confined by a fire break and then Odonohue Rd. It can only be ignited by embers or car accident or arsonist, but the runs are short, meaning very narrow spot fires. Again, no running flame can cross Odonohue Rd, only embers.

Danger wind direction – from SW

If the spot fire begins on the foreshore, a SW wind will push it parallel to Great Ocean Road. If air remains dry, the flame height can reach twice tea tree height and throw embers into the residential area. The running flame will hit the fire break and flame height falls to 1m or so and the flame self-extinguishes at Odonohue Rd.

Residential area

Discontinuous fuel bed begins on the east side of Odonohue. It is a residential area with managed back and front yards, house and sheds and pathways and driveways that will not allow a running flame to develop, but will feature stationary flames between fuel free areas. The major source of ignition is embers from the western forests, either short or long distance.

A2 Bushfire threat status

Section Odonohue Road, Great Ocean Rd to Fifth Ave.

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (out of picture) | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel | Residential

Figure A2 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos

Figure A2s (left) and A2sw (right) Looking south and SW along the western firebreak. Red arrow indicates direction of NW to SW wind driven running flame through the mown grass, where maximum height will be 1m. Running flame will self-extinguish at road edge, ie, stop without suppression.

Table A2-Fuel Fuel hazard assessment

From Left to Right in Figure A2:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown beneath short trees)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Discontinuous	Zero Fuel	Discontinuous
Depth of each vertical layer	Shrub layer 1m Trunk* 6m Canopy layer* 3-4m	Shrub layer burnt <1m Trunk* burnt <6m Canopy layer* 3-4m	Shrub layer Nil Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

* Where tree cover occurs (many parts of the heathland area are treeless)

Table A2- Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N, NW, W or SW

Fuel bed is continuous from the heathy forests in the west to Odonohue Rd, meaning wind will push fire fronts seamlessly.
As described above, flame height varies according the height, density and age (= time since last burn) of the shrub layer, which provides the ladder fuel linkage for the flame into the low tree canopy.
The running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m. Flame height in the mown area reduces to less than 1m. This flame reaches Odonohue Rd and self-extinguishes.
Again, the fuel managed configuration upwind of the firebreak ensures that flames will self-extinguish at the road, and only embers can cross downwind.

Residential area
Discontinuous fuel bed begins on the east side of Odonohue in the residential area, as described above. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

A 3 Bushfire threat status

Section Odonohue Road, Fifth Ave to Sixth Avenue

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (out of picture) | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel | Residential

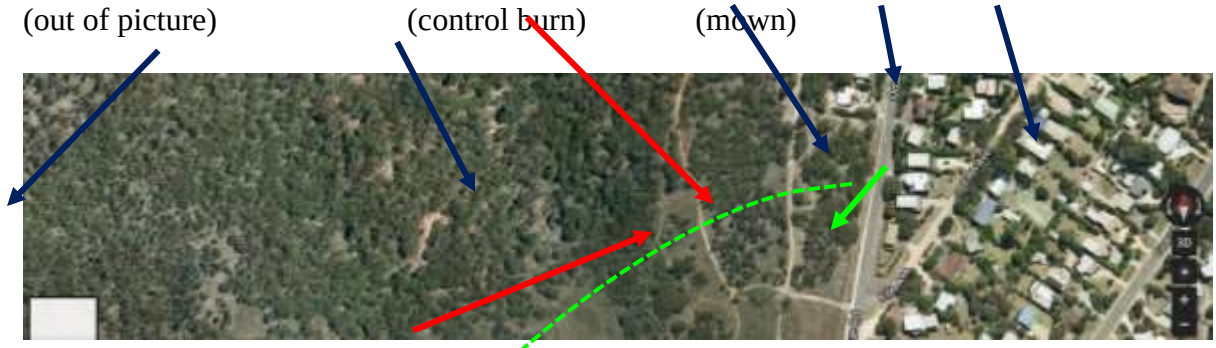

Figure A3 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos

Figure A3sw Looking SW into the western firebreak. Red arrow indicates direction of NW to SW wind driven flame running downslope through the mown grass under the trees, where maximum height will be 1m. Running flame will self-extinguish at road edge, ie, stop without suppression.

Table A3-Fuel Fuel hazard assessment

From Left to Right in Figure A3:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown beneath short trees)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Discontinuous	Zero Fuel	Discontinuous
Depth of each vertical layer	Shrub layer 1m Trunk* 6m Canopy layer* 3-4m	Shrub layer burnt <1m Trunk* burnt <6m Canopy layer* 3-4m	Shrub layer Nil Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

* Where tree cover occurs (many parts of the heathland area are treeless)

Table A3-Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A3:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N, NW, W or SW

Fuel bed is continuous from the heath forests in the west to the two bare-earth tracks and then Odonohue Rd.

As before, the running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m. Depending on flame height at the first dirt track, the running flame will stop along some of its length where the leaning flame cannot cross. The running flame will stop at the second dirt track because of low flame height upwind, but a few embers will ignite in the mown grass area.
Flame height in the mown area will be less than 1m. In this area, the eucalypt canopy has been retained. Its effect is to reduce the wind speed at ground level, which reduces the vigour of the running flame compared to an open grassland. Again, this flame self-extinguishes at Odonohue Rd.

Again, the fuel managed configuration upwind of the firebreak ensures that flames will self-extinguish at the road, and only embers can cross downwind.

Residential area
Discontinuous fuel bed begins on the east side of Odonohue in the residential area, as described above. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

A 4 Bushfire threat status

Section Odonohue Road, Sixth Ave to Harvey Rd

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (out of picture) | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel | Residential

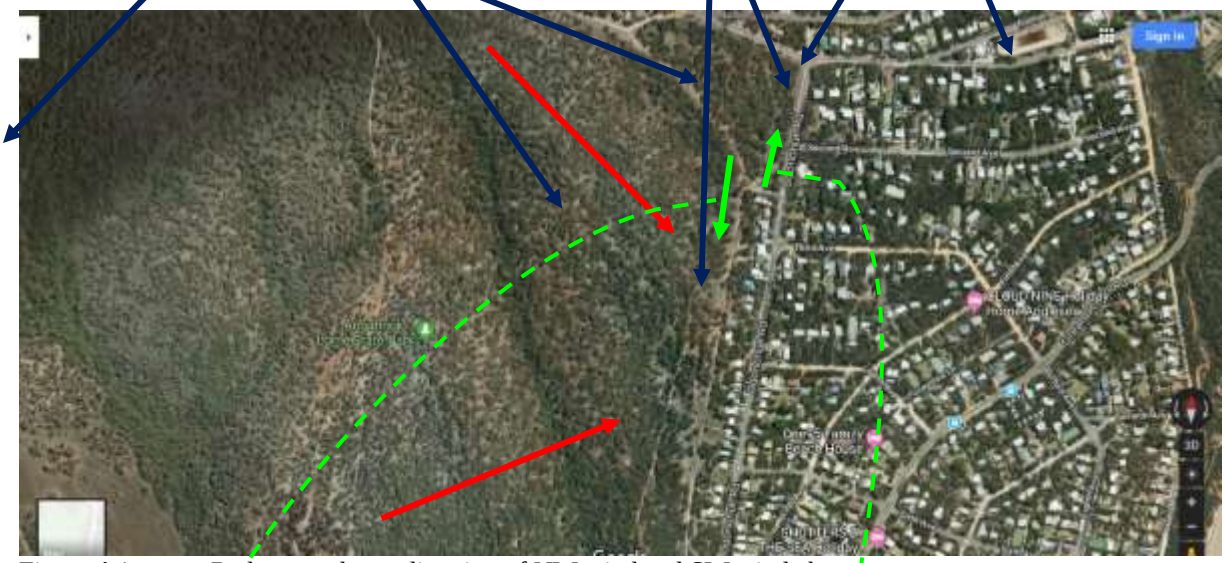

Figure A4 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos

Figure A4s (left) Looking south along the western firebreak behind (west of) the row of houses with control burnt area on the right. Red arrow indicates direction of NW to SW wind driven running flame through the mown grass, where maximum height will be <1m. Running flame will self-extinguish at track, ie, stop without suppression.

Figure A4n (right) Looking north along the western firebreak towards Harvey Road with control burnt area on the left. Red arrow indicates direction of NW to SW wind driven running flame through the mown grass, where maximum height will be <1m. Running flame will self-extinguish at track, ie, stop without suppression.

Table A4-Fuel Fuel hazard assessment

From Left to Right in Figure A4:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown beneath short trees)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous until 5m wide track	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	30m west of rear fences of a row of properties, which are approx 30m west of Odonohue road	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Discontinuous	Zero Fuel	Discontinuous
Depth of each vertical layer	Shrub layer 1m Trunk* 6m Canopy layer* 3-4m	Shrub layer burnt <1m Trunk* burnt <6m Canopy layer* 3-4m	Shrub layer Nil Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

* Where tree cover occurs (many parts of the heathland area are treeless)

Table A4-Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A4:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Ember ignition	Ember ignition		Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N, NW, W or SW

Fuel bed is continuous from the heath forests in the west to the two bare-earth tracks and the row of managed properties west of Odonohue Rd.

As before, the running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m.

West of row of houses Depending on flame height emerging from the control burn at the first dirt track, the running flame will stop along some of its length where the leaning flame cannot cross. The gap between the two tracks is mown short, meaning the running flame will stop at the second dirt track, before it hits the rear fence lines. Undoubtedly, a few embers will ignite in the mown grass area and in the properties. Where the residential properties are managed for normal urban usage, they have discontinuous fuel beds. If a spot fire ignites within then, its run will be short. Where properties are managed to preserve a continuous fuel bed, a spot fire will threaten the house with direct flame contact unless it is protected by a sufficiently wide fuel-free barrier. Any spot fires originating within these properties will self-extinguish at Odonohue Rd.

These houses depend on low flame height within the control burn area west of the second track and for their protection from the running flame

North of row of houses Flame height in the control burn area reduces to below 1m as it enters the 30m wide mown area adjacent to Ododohue Rd. In this area, the eucalypt canopy has been retained. Its effect is to reduce the wind speed at ground level, which reduces the vigour of the running flame compared to an open grassland.

Again, the fuel managed configuration upwind of the firebreak ensures that flames will self-extinguish at the road, and only embers can cross downwind.

Residential area

Discontinuous fuel bed begins on the east side of Odonohue in the residential area, as described above. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

A 5 Bushfire threat status

Section Harvey Rd, from Odonohue Road to Messmate Track

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (most is out of picture) | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel | Residential

Figure A5 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos

Figure A5w Looking west into unburnt short woodland (6m tall) with extensive patches of 1m tall shrubs between extensive patches of 30cm surface shrubs, grasses and herb cover. Red arrow indicates direction of NW to SW wind driven running flame, where maximum height will be 1m or so, in short shrubs, 3m or so in the taller shrubs, up to 6m along the trunks and will shoot above canopy height to 10m or so in severe weather.

Figure A5s Looking south along the western firebreak of the western row of large properties. Red arrow indicates direction of NW to SW wind driven running flame through the short grass on the left and burnt area on the right, where maximum height will be 1 - 2m. Running flame will self-extinguish at track, ie, stop without suppression.

Table A5-Fuel Fuel hazard assessment

From Left to Right in Figure A6: power line track

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Discontinuous	Zero Fuel	Discontinuous
Depth of each vertical layer	Shrub layer 1m Trunk* 10+m Canopy layer* 3-4m	Shrub layer burnt <1m Trunk* burnt <6m Canopy layer* 3-4m	Shrub layer Nil Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

* Where tree cover occurs (many parts of the heathland area are treeless)

Table A5-Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A6:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N or NW

Fuel bed is continuous through the control burnt heath forests to the N and NW to Harvey Rd. The flame height in the control burn area is less than 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m.

There is no mown strip north of Harvey Rd, but as flame height is less than half the road width, the flame will stop at Harvey Rd.

Danger wind direction – from W or SW

Fuel bed is continuous from the heath forests in the SW to the bare-earth tracks and the row of managed properties south of Harvey Rd.

As before, the running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. Figure A5s show a typical horizontal and vertical structure of untreated heath forest. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m.

Western of row large properties South and west of the perimeter track is regularly control burnt. Depending on flame height at the perimeter track, the running flame will stop along its length where the leaning flame cannot cross. A strip is mown short, further reducing flame height at the track. Undoubtedly, a few embers will ignite within these properties. The residential properties are not managed for normal urban usage, meaning the fuel beds within them are continuous. If a spot fire ignites within them, it will seriously threaten any house with direct flame contact that is not protected by a sufficiently wide fuel-free area. These spot fires will continue towards Harvey Road, where they will self-extinguish but throw embers to the NE.

Eastern row of houses South and west of the perimeter track is regularly control burnt. Similarly for the above properties, depending on flame height at the perimeter track, the running flame will stop along its length where the leaning flame cannot cross. However, some of these properties have retained a continuous surface layer fuel bed. Therefore, if a spot fire ignites within them, it will seriously threaten any house with direct flame contact that is not protected by a sufficiently wide fuel-free area. Again, these spot fires will continue towards Harvey Road, where they will self-extinguish but throw embers to the NE.

Residential area

Discontinuous fuel bed begins on the north side of Harvey in the residential area. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

A 6 Bushfire threat status

Powerline Track

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (most is out of picture) | Fuel reduced (control burn) | Fuel reduced (mown) | Zero fuel | Residential

Figure A6 Red arrow shows direction of NW wind and SW wind change
Green arrow shows direction of photo

Figure A6n Looking downhill and north along power line, complete with track and wide mown area, towards golf course

Table A6-Fuel Fuel hazard assessment

From Left to Right in Figure A6: power line track

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	Several km	1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Discontinuous	Discontinuous	Zero Fuel	Discontinuous
Depth of each vertical layer	Shrub layer 1m Trunk* 10+m Canopy layer* 3-4m	Shrub layer burnt <1m Trunk* burnt <6m Canopy layer* 3-4m	Shrub layer Nil Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

* Where tree cover occurs (many parts of the heathland area are treeless)

Table A6-Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A6:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N, NW, W or SW

Fuel bed is continuous from the heath forests in the west to the bare-earth track below the powerlines.

As before, the running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m. Flame height further reduces to below 1m within the powerline mown area, and self-extinguishes at the track.

West of powerline track West of the powerline track is regularly control burnt. A wide strip is mown short, further reducing flame height at the track. The running flame will stop along its powerline track. Undoubtedly, a few embers will ignite within the managed eastern properties.

Golf course An excellent example of a discontinuous fuel bed. The short grassy green fairways act as useful fuel-free barriers between untreated forest and residential area that will stop the run of a flame. Embers can ignite in the intervening strips of native vegetation, and spot fires develop vigorously and throw embers downwind but their runs are short.

Residential area

Discontinuous fuel bed begins on the east side of the powerline track in the residential area. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

A 7 Bushfire threat status

Section Fraser Avenue

Fuel hazard and fire behaviour along the perimeter

Fuel bed classifications:

Untreated vegetation (most is out of picture) Fuel reduced (control burn) Fuel reduced (mown) Zero fuel Residential

Figure A7 Red arrow shows direction of NW wind and SW wind change
Green arrows show direction of photos

Figure A7w Looking west along Fraser Ave.

Figure A7nw Looking NW along mown strip

Figure A7n Looking north across long unburnt shrub layer showing abundant dead fine fuel among it.

Table A7-Fuel Fuel hazard assessment

Move from Top to Bottom in Figure A7:

Fuel hazard classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (mown)	Zero fuel on road	Residential
Horizontal layer characteristics					
Horizontal continuity	Continuous	Continuous	Continuous	Zero Fuel	Discontinuous
Depth of surface layer fuel bed	0.5m	burnt <0.5m	mown <0.1m beneath low trees	Zero fuel	Variable, generally short grass or garden mulch
Fuel bed width perpendicular to danger wind direction	0.1km	0.1 km	40m	10m	>1 km
Vertical Layer characteristics					
Vertical continuity	Continuous	Continuous	Single layer	Zero Fuel	Discontinuous
Depth of each layer	Shrub layer 1m Trunk 6m Canopy layer 3-4m	Shrub layer burnt < 1m Trunk burnt 6m Canopy layer 3-4m	Surface layer only Trunk burnt 6m Canopy layer 3-4m	Zero fuel	Variable, zero above lawns, garden shrubs, 2+m tall fences or trellis, sheds,

Table A7-Fire Bushfire behaviour and bushfire threats

Flame and ember flow is from Left to Right in Figure A6:

Fuel bed classifications:	Untreated vegetation	Fuel reduced (FRB)	Fuel reduced (where mown)	Zero fuel on road	Residential
Potential flame height in each layer	Surface layer 2-3m Shrub layer 3-4m Trunk* 6m Canopy layer* 6m	Surface layer <1m Shrub layer <2m Trunk* already burnt <6m Canopy layer* will not ignite	Surface layer <1m	0 m	Spot fire of variable height occurs if ember ignites
Potential total flame height	Up to 15m or more due to high fuel load, if long unburnt.	Generally <3m, but isolated flare-ups to 10m or so can occur in unburnt patches	<1m	0 m	Spot fire of variable height occurs if ember ignites
Bushfire threats within each fuel bed	Running flame, Ember generation and ignition	Running flame, Ember ignition	Running flame, Ember ignition	Nil	Ember ignition, Stationary flame
House ignition mechanisms that might originate in these fuels	Ember ignition	Nil	Nil	Nil	Flame contact, radiation or ember ignition from adjacent urban fuel

* Where tree cover occurs (many parts of the heathland area are treeless)

Narrative

Forest area

Danger wind direction – from N, NW, W

The forest west of Golf links Road was not assessed.

Fuel bed is continuous from Coalmine Road to Fraser Avenue, a distance of approx 200m. North of Coalmine Road is the abandoned coal mine / quarry. There are at least two east-west tracks in between, providing boundaries for control burn areas and mown areas adjacent to Fraser Avenue.

Winds from N or NW will drive a narrow spot fire towards the residential area. The running flame in the untreated heath forest has a flame height around twice tree height. It throws high density embers up to 200m downwind. The flame height in the control burn area falls to 2-3 m, and is confined to the surface layer. Ember generation is low and throw distance is less than 50m. Flame height further reduces to below 1m within the mown area, and self-extinguishes at Fraser Avenue.

In this area, the eucalypt canopy has been retained in the control burn and mown areas. Its effect is to reduce the wind speed at ground level, which reduces the vigour of the running flame compared to an open grassland.

Residential area

Discontinuous fuel bed begins on the east side of the powerline track in the residential area. Embers from both short and long distance can potentially ignite garden beds, urban fuel and dead debris in gutters and corners.

2.3 Overall conclusions

2.3.1 Fire safety status

Passive defensive measures have protected the residential area from the threat of running flame and the residual threat of ember attack has been reduced from high density to low.

- Burning the wide area of native vegetation has effectively reduced flame height and therefore decimated ember generation.
- Most of the boundary is protected by the dual flame height-reduction fire break, and some by the single height-reduction fire break.
- The combination of mown area and zero-fuel road prevents running flame entering the residential area.

Houses remain vulnerable to the threat of stationary flame development on individual properties caused by spot fires ignited by low ember intensity. This threat must be dealt with by active defence measures if we are to achieve zero house loss.

Defenders in the residential area, whether fire fighters or residents, can now work in safety because the passive defences have done their job of excluding the running flame and thereby creating a bushfire-protected area.

2.3.2 Options for protection of residential areas:

Fire fighters have two choices during ember attack - they can evacuate the residents and defend the area under attack by themselves OR they can mobilise the residents to self-defend their houses.

If fire fighters adopt the first choice, they will rely on the four current fire agency bushfire protection policies:

- The community information note declares Anglesea at extreme fire danger and encourages evacuation on severe weather days,
- Order systematically evacuation of entire towns,
- Redeploy some fire fighters to asset protection (= house defence)
- Deploy Bushfire Management Overlay after the house loss event, whereby new houses are required to re-build with highly fire-resistant cladding.

To achieve zero house loss in a bushfire protected area during ember attack, they must deploy at least one tanker per three households under attack. We know this will not happen because (1) tanker supply on demand is limited by logistics, (2) control teams are reluctant to redeploy tankers from the perimeter defence to house defence. Sadly, evacuation leads to house loss.

If fire fighters adopt the second choice, this will happen:
The fire agency response will ensure that the residents are advised what type of bushfire attack is coming and will coordinate the response effort of fire brigade and residents

Residents will be pre-prepared, to understand that:
• The residential area is bushfire-protected from running flame
• The worst-case bushfire attack will be low volume ember attack onto houses within 100m or so of the firebreak

• The appropriate response to protect houses is self-defence of spot fires on each property.
• When we protect the house, we protect the life

The fire agency response before the attack will be:
• Fire brigade and community are trained to monitor fuel load and expected flame height in scheduled fuel reduction areas
• Ensure the residents who want to stay are trained and skilled and equipped to deal with spot fire identification, suppression and monitor smouldering

The fire agency response during the attack will be to:
• Coordinate response fire brigade and residents
• Monitor spot fire ignitions (including with aerial / drone IR scans) and assign response crews accordingly