Bracewell St Fire Bendigo 2009 – Landscape Attribute Mapping and Analysis Report

Richard Goonan, February 2010

This submission is to be read in conjunction with the previous submissions:

- Bushfire_Royal_Commision_Submission_R_Goonan 18/5/2009
- Observed Ecological Effects of Fuel Reduction Burning in the Goldfields Bioregion

  Bendigo Field Trip 23/9/09 - Notes prepared by Richard Goonan 12/1/10

Contents:

Introduction

Why is accurate evaluation important?

To determine the critical factors in fire spread, response adequacy, potential risks and future approaches to wild fire management, an accurate assessment of the landscape attributes within the fire area is required. Although a basic assessment has been carried out by the Bushfire CRC and other organisations, these do not adequately capture the diverse mosaic of landscape features present in the overall area of the Bracewell St (Bendigo) Fire, February 7th 2009. Therefore assessment and evaluation will be limited and may not recognise serious threats, or identify appropriate strategies to address future risks.

Given the heightened state of fear prevailing since the February 7th 2009 fires, and the opportunity for this fear to be misdirected toward natural forested environments, it is important that risks be properly quantified. Loose interpretation of the landscape through which the Bendigo fire propagated may inadvertently present an impression that the fire was a forest fire, that it burnt primarily through public land, or that prior fuel reduction burning was significant in reducing fire spread. Unsubstantiated claims about the fire need to be rigorously tested against detailed assessment to verify their accuracy; this is not possible without a detailed evaluation of the landscape attributes present.

Method

Mapping

Landscape attribute polygons were created using Google Earth satellite imagery (2007 data) as a base layer. This was interpreted with the author's intimate knowledge of the local landscape, and where required, field assessment was conducted to verify attributes. Polygons were created as Google Earth .KMZ files and imported to the GPSPro software to be transformed into standard format Shapefiles (.SHP). Area was calculated in the GPSPro software using a geographic projection, and represents an estimation of the actual area due to the overall accuracy of polygon borders.

Shapefiles were imported to the DIVA-GIS program using a geographic projection for visual representation, overlaying with standard data (cadastre, contours, public land), and map creation/export to image. Distance estimates (e.g. fire head affected by fuel reduction burns etc) were calculated using the distance calculation tool in DIVA-GIS.

The generalised fire spread map (Map 1) used a map from the DSE interactive Mapshare website as the base layer (roads, fire area, creeks). Fire spread contours were then drawn by hand, taking into account the landscape features present (but not shown) which affect fire behaviour, and the prevailing weather pattern during the event. This created a manual overlaying of data in a similar yet less sophisticated manner to a Geographic Information

System (GIS). A GIS was not used for this assessment due to limited availability of software. Other data includes the approximate boundary of public land, approximate location of recent and past fuel reduction burns, and point sources for long distance spotting. Map 8 provides an overall context to the fire event.

The fire spread data was also transposed to a tree cover base map (Map 10) generated from the DSE Interactive Mapshare website. The tree cover map used was scaled to the appropriate size before fire spread data was manually overlaid (as above). Ecological Vegetation Class mapping was not used because this includes areas of non-treed native vegetation, and does not accurately represent tree cover alone. This map provides a general overview to the fire in relation to tree cover.

Landscape Attributes Assessment

Thirteen categories have been used to describe the generalised nature of the fire area. Some minor overlap exists between categories, and in these cases the dominant land attribute was assigned where appropriate. Some features were excluded to prevent an excessive number of categories being created e.g. some grassy areas had scattered exotic trees, these were assigned to the predominantly grassy category where this was the major fuel source.

Polygon attributes were recorded and summarised in an Excel spreadsheet for analysis of fuel quantities and their contribution to overall fire behaviour. Fuel quantities were estimated in t/ha (tonnes per hectare) using published fuel data were available/appropriate, detailed field observation prior to the fire, as well as generalised estimates from personal knowledge/experience. Landscape attribute polygons were graphed using Excel to indicate there overall proportion of the fire area, and contribution to fire behaviour/spread.

Fire Spread Estimation

Fire spread was estimated using several different approaches and data sources, including direct observation (the author of this report was present during the fire), interpretation of on-ground evidence following the event, reported time sequences, and estimation from knowledge of fire behaviour.

This information was accumulated into the fire spread map (Map 8) showing the potential overall fire impact area as a sequence of contours, consistent with other generalised fire spread mapping. This incorporates observation and deduction to interpolate across space and time. Knowledge of fuel sources, localised topography and weather (e.g. effects on surface wind direction) enable a reconstruction of the potential overall fire perimeter over the duration of the fire event. It is important to recognise that within any given perimeter contour, small scale effects cannot be accounted for. The level of detail is however reasonably sophisticated and comparable to models and simulations provided by broad scale and generalised data. It is generally unusual in wildfire research to have the level of detail available in this report, as analysis is usually undertaken after the fire has occurred, and researchers may be unfamiliar with the conditions preceding the event.

Discussion

Landscape Attributes

The Bracewell St Bendigo Fire 2009 burnt through a relatively complex mosaic of landscape features, each with substantially different spatial characteristics. It is also important to note that the fire was able to cross several barriers, including roads, prior fuel reduction burns and urban areas. To understand the overall spread of the fire, it is useful to identify the character of each of the landscape features encountered, and their possible contribution to fire behaviour.

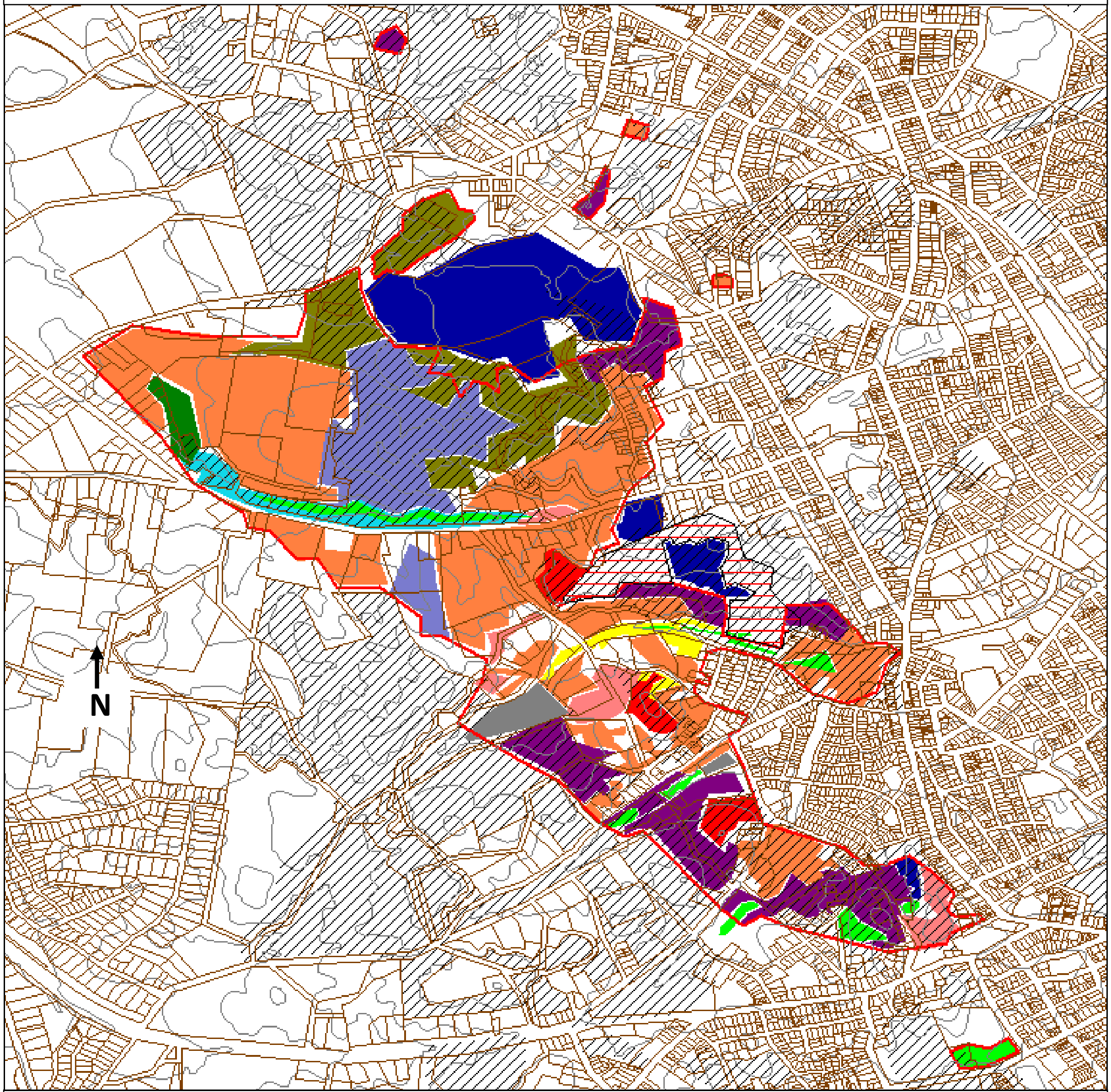
Map 1 Landscape Attributes, provides an assessment of the major landscape elements across the fire area, and includes the base layers contours, cadastre, and public land, to aid interpretation. Preliminary assessment indicates that Predominantly (exotic) Grassy vegetation was the major land category within the fire area covering approximately 125 ha. This was followed by Scattered Trees/Shrubby (42ha), Ironbark Forest (35ha), Heathy Dry Forest (35ha), Uncategorised houses (27ha), Uncategorised other (20ha), Ironbark Tree Cover (10ha), Pampas Grass (9ha), Yellow Box/Grey Box Forest (7ha), Fuel Reduction Sites (7ha), Spiny Rush (6ha), Melaleuca (4ha), Yellow Gum/Grey Box Tree Cover (3ha), and Bare Area (1ha). This data is listed in Graph 1 Landscape Attribute Category Total Hectares, provided in descending order.

This assessment is in contrast to the information provided in the Bushfire CRC Report - Victorian 2009 Bushfire Research Response Final Report October 2009, which in part incorrectly states:

> *5.3.1 Vegetation*
>
> The main vegetation type burnt by the fire was ironbark woodland up to 25 m tall with a shrubby understorey, and localized areas of riverine grassy woodland and forest up to 25 m tall. See Appendix FB-1-2 for a map of the Maiden Gully Ecological Vegetation Classes (EVC) overlayed with the locations of observations and inferred wind directions during the fire.

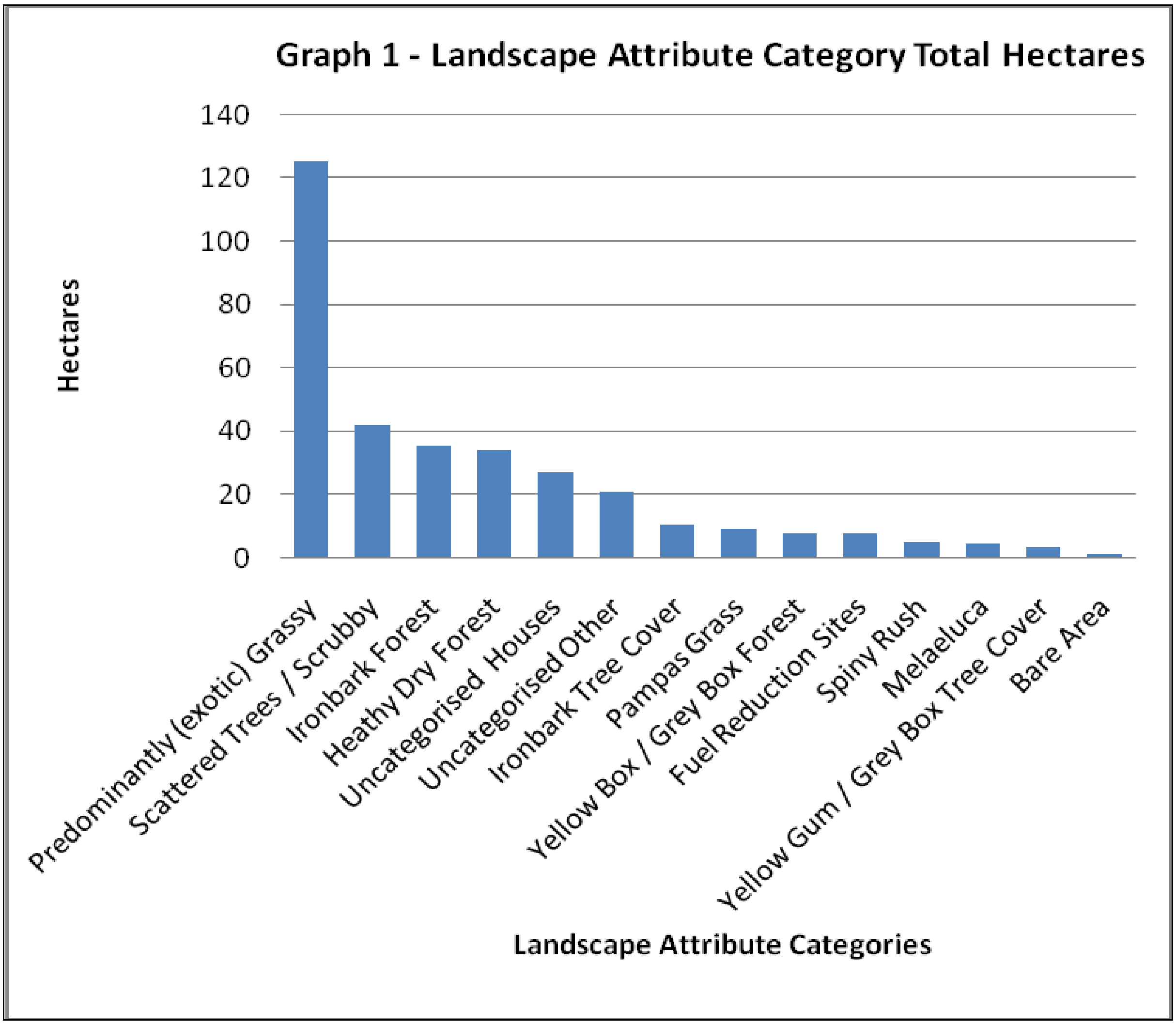
The relatively small areas of Ironbark Forest were generally 10-15 m tall, and areas of Heathy Dry Forest were to 5-9 m tall. Similarly small areas of forest with a dominant overstorey of Yellow Box/Grey Box growing in the creek line adjacent to Taylor St were to 7-10 m tall, and the small area of Yellow Gum dominated tree cover was to 15 m tall. These differences have important implications for interpreting fire behaviour, and the contribution of native vegetation to the fire overall.

Map 1 - Bracewell St Fire, Bendigo 2009 – Landscape Attributes Mapping



Landscape Categories

- Predominantly (exotic) grassy
- Scattered trees / shrubby
- Box-Ironbark Forest
- Heathy Dry Forest
- Fuel Reduction Sites
- Pampas Grass
- Spiny Rush
- Ironbark Tree Cover
- Melealuca decusata
- Yellow Gum / Grey Box Tree Cover
- Yellow Box / Grey Box Forest
- Existing Bare Ground Areas
- Recent Fuel Reduction Burn

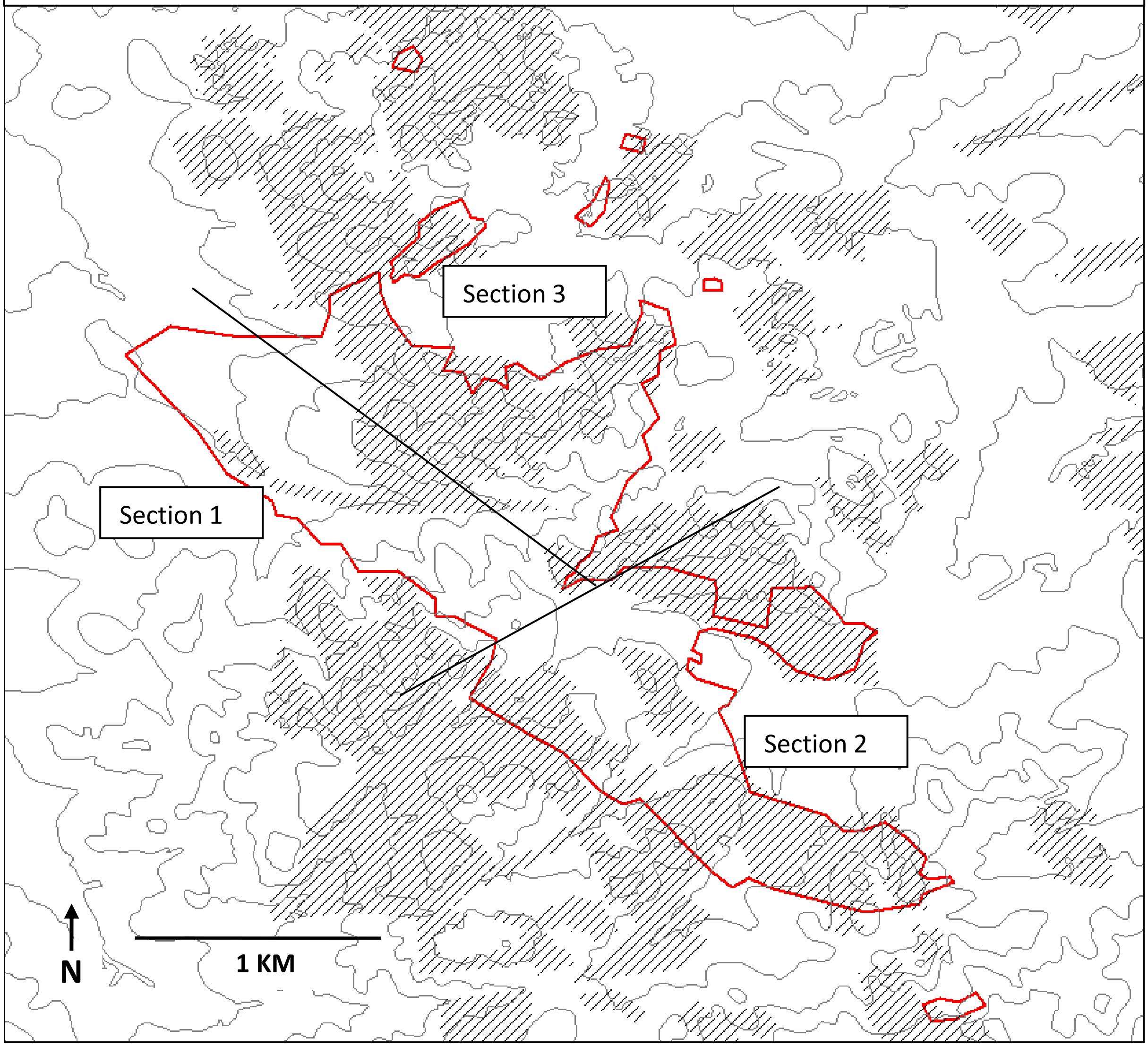


The fuel characteristics of each landscape category will be considered in the next section.

To further understand the contribution of the different landscape attributes the fire area can be divided into three general sections, these are indicated on Map 2, which also displays contours and public land parcels without other data for an unimpeded view.

Map 2 indicates (in broad terms) that section one was dominated by private land (80% private/20% public) and included the initial development stage of the fire. Section two included the second phase of the fire as it spread rapidly to the south-east; this section comprised approximately 60% public land and 40% private land. Section three, which included areas burnt after the wind change, indicates that 70% of this area was public land and 30% private land. Of these broad public and private land contributions, grassy landscape categories dominate section 1, grassy and Scattered Trees/Shrubby dominate section 2, and forest vegetation dominates section 3.

Map 2 - Bracewell St Fire, Bendigo 2009 – Fire Sections, Contours and Public Land

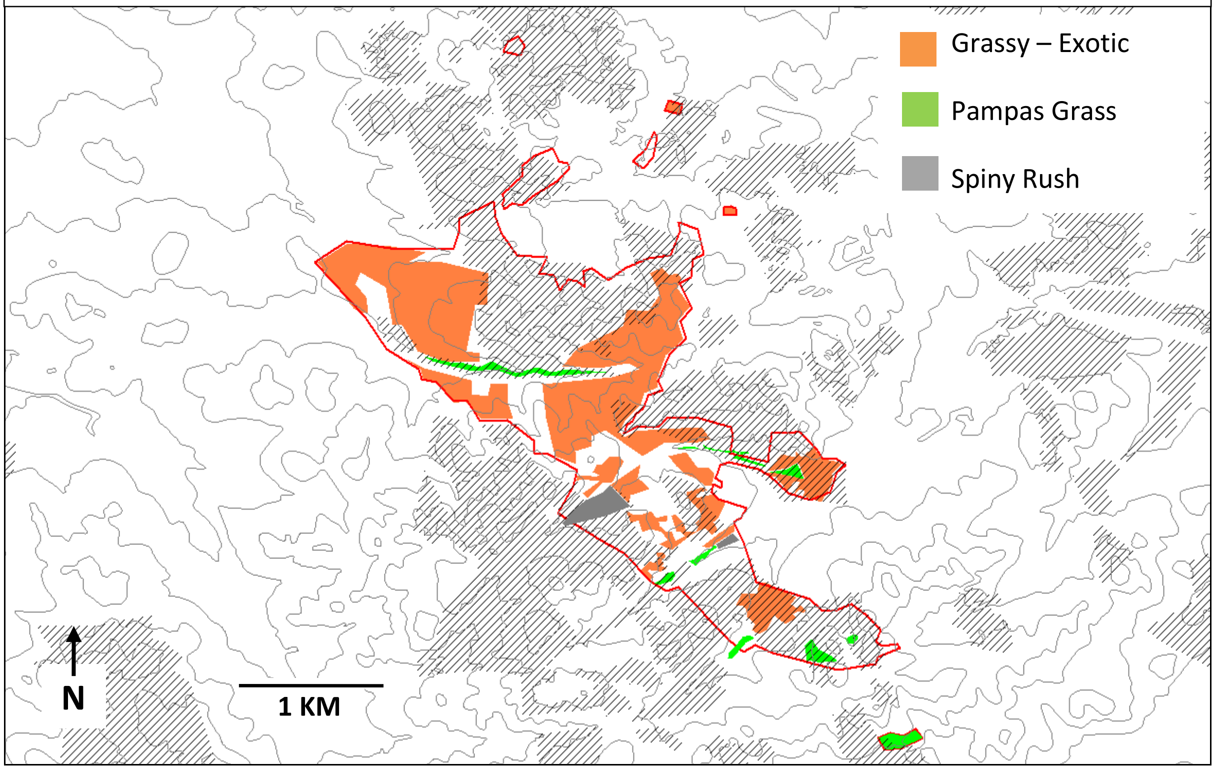


Fuel Type Assessment

To display the landscape attribute categories with similar fuel characteristics the following maps show these as separate combinations. Map 3 indicates areas with predominantly grassy fuels, Map 4 indicates areas with indigenous forest vegetation as the dominant fuels, Map 5 indicates areas with scattered trees and shrubby indigenous vegetation fuels, Map 6 indicates areas with tree cover only (generally sparse grassy understorey), and Map 7 indicates the location of areas of bare ground and prior fuel reduction sites.

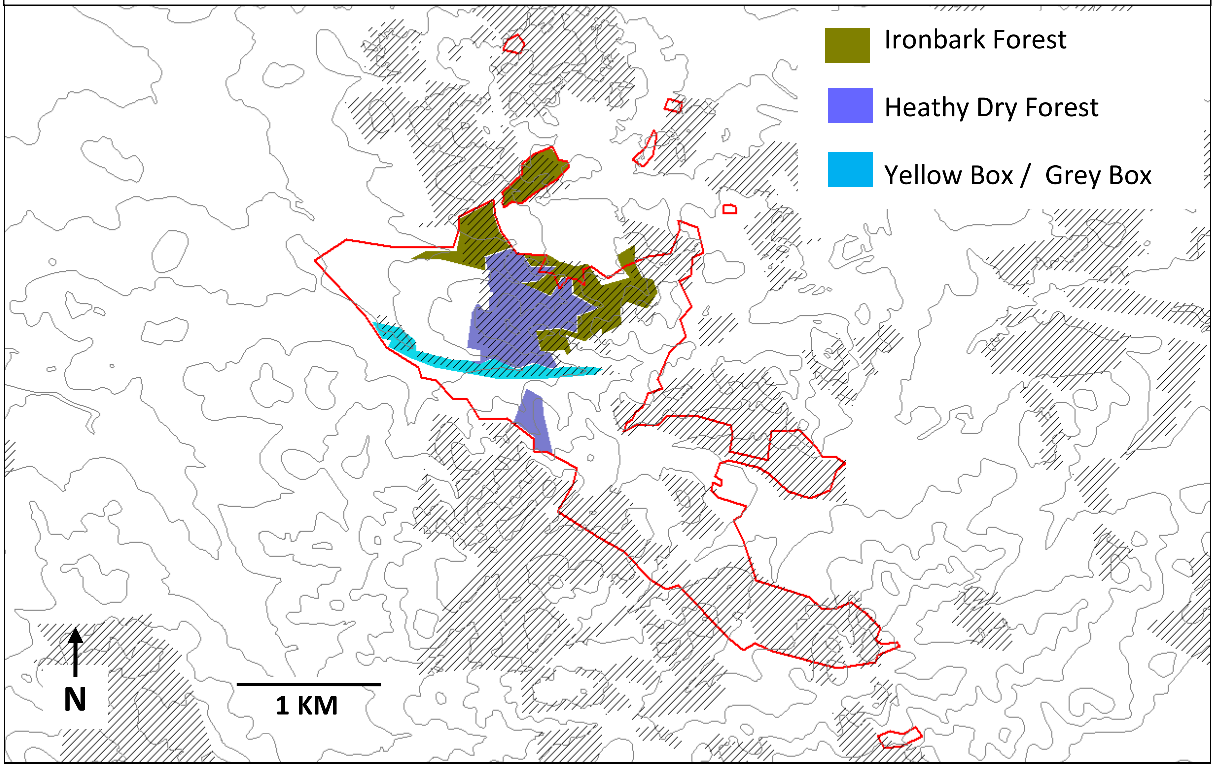
Predominantly (exotic) Grassy fuels and Pampas Grass (Map 3) are the only landscape attributes to occur within all sectors (Map 2) of the fire area in significant proportions. The spatial dispersion of these landscape attributes is in contrast to the more aggregated spatial arrangement of other important landscape attributes as fuel sources. For example landscape attributes which contained forest fuels (Map 4) were confined predominantly to sector 3 in areas burnt following the wind change under milder conditions. Also the Scattered Trees/Shrubby (Map 5) landscape attribute was predominantly confined to sector 2, interspersed with areas of grassy fuels. Furthermore, areas of Scattered Trees/Shrubby, the second largest proportion of the overall fire area, contained a significant proportion of weedy annual (exotic) grasses, and while the predominant cover across this category was native shrubs, the ground layer also contained grassy fuels (exotic and native).

Map 3 - Bracewell St Fire, Bendigo 2009 – Landscape Attribute, Grassy Fuels

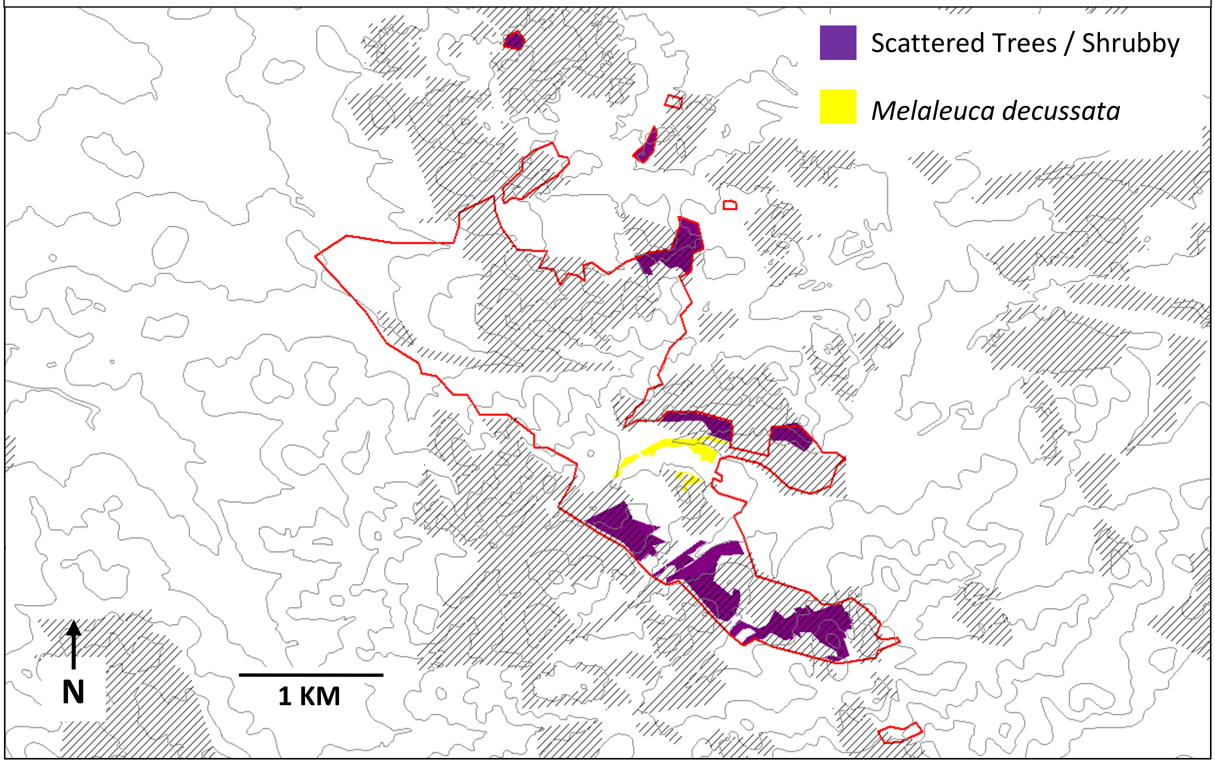


Map 5 Scatter Trees/Shrubby indicates the relatively small area of dense *Melaleuca decussata* growing along the shallow gully in the central part of the fire area. This vegetation grew to 2-2.5 m in height, and had a low cover of grass underneath. This is incorrectly referred to as “dense ti-tree to 3 m” in the Bushfire CRC assessment.

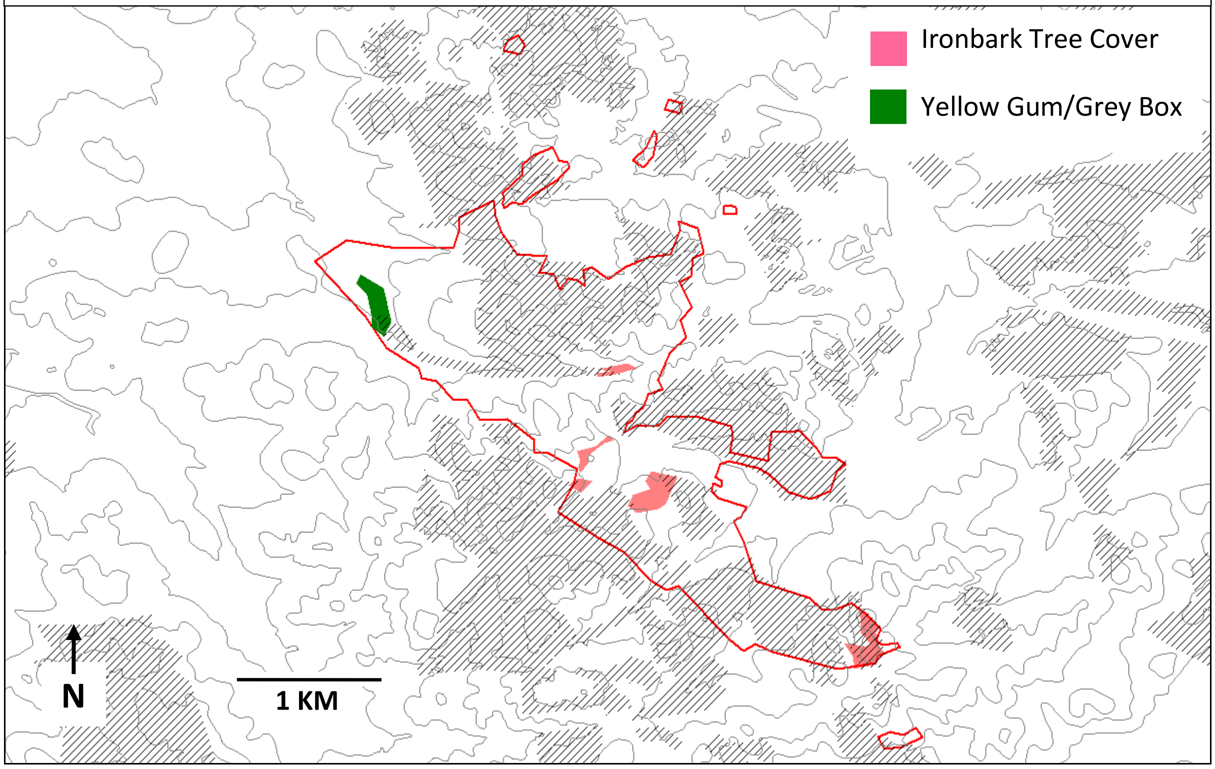
Map 4 - Bracewell St Fire, Bendigo 2009 – Landscape Attribute, Forest Fuels



Map 5 - Bracewell St Fire, Bendigo 2009 – Landscape Attribute, Scattered Tree /Shrubby



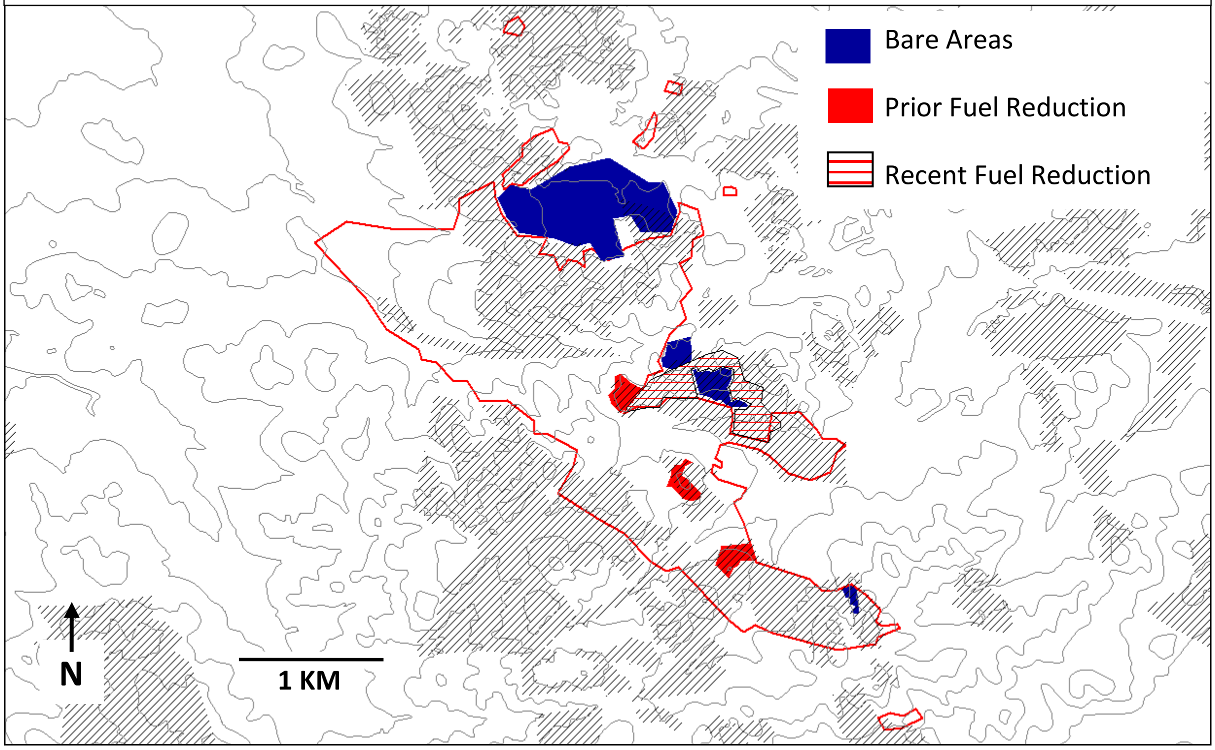
Map 6 - Bracewell St Fire, Bendigo 2009 – Landscape Attribute, Tree Cover



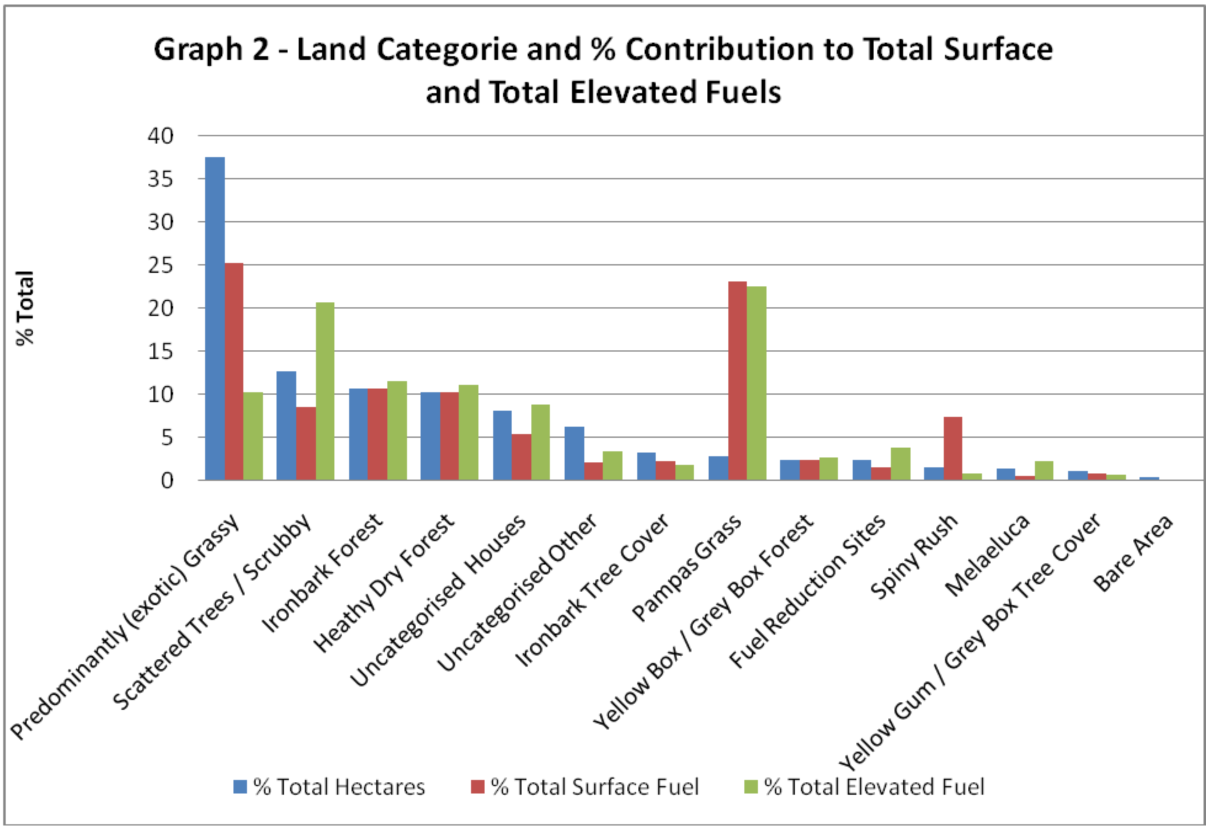
Areas of tree cover as the dominant vegetation, without understorey shrubs and supporting only scattered grassy fuels or sparse leaf litter, formed a relatively small proportion of the overall fire area. Assessment of these areas subsequent to the fire may lead to the assumption that these areas supported forest vegetation due to the similarity of dominant overstorey vegetation. Even with an overall low fuel hazard that was less than fuel reduction sites, these areas provided little impediment to fire spread during the initial stages under the influence of a strong north westerly wind. Unfortunately this highlights the limited capacity for fuel management to address risks adequately if assets are not well prepared.

While these areas may have burnt with reduced intensity, embers were still generated from burning bark, and surrounding areas of higher fuel hazards also carried the fire. In this case it would appear that the rapid spread of the fire was more important than the intensity of the fire. Furthermore, urban fuels in close proximity to houses become critical "Fuels [gardens, mulches, buildings, fences, rubbish, and wood piles] in the urban environment play a significant role in the development and spread of unplanned fires on the urban edge and into suburbs. An assessment of house loss after the 2003 Canberra fires lead to the conclusion that it was likely that more than 50% of the house losses were due to fire attack from suburban fuels" (Ellis and Sullivan 2003 in Strategic Bushfire Management Plan – Supporting Information 2009:35).

Map 7 - Bracewell St Fire, Bendigo 2009 –Landscape Attribute, Bare Areas and FRB



It is important to note the Bare Areas and the recent (four months prior) fuel reduction burn (Map 7), that are located outside the perimeter of the overall fire area. In particular the large Bare Areas at the Bendigo (Eaglehawk) Tip site and the Di Gum San Public land reserve, which provided important barriers to the fire spread following the wind change, significantly limiting the extent of the fire front. The DSE mapping of the recent fuel reduction burn includes the extensive Bare Area located in the central part of the Di Gum San Reserve as if the area was burnt and fuel reduced. As this area was bare ground this was not possible, however this is important as it appears as if the fuel reduction burn was larger and more continuous than in reality. The location of the two Bare Areas interspersed with the fuel reduction site in the Di Gum San reserve, one on public land, the other on private land, provided an important barrier to the fire, and the fuel reduction burn complimented these existing areas of low fuel. It is critical to recognise that any contribution of the most recent fuel reduction burn to fire suppression, was due to the short time since burning, and this would not be the case after as little as two years when dense grasses had regrown.



Graph 2 examines the relationship between the percent of total hectares which each landscape attribute covered, and the percent of total surface fuels and percent of total elevated fuels these contributed. This provides an idea of the way in which different landscape attributes contributed to the overall fuel hazard across the fire area and the relative importance of each. Graph 2 highlights that predominantly (exotic) Grassy, and Pampas Grass contributed approximatly 50% of total surface fuels, the former due to the large area which it covered, and the latter due to the high t/ha rate. Although Pampas Grass covered only a small proportion of the overall fire area (approximately 3%), due to the large amount of fine fuel avaliable as both surface and elevated fuel with extreme spotting potential, and the dispersion of the patches across the fire area, it contributed critically to fire development and spread.

Forest fuels, primarily indigenous vegetation, coverd a small proportion of the overall area with Ironbark Forest and Heathy Dry Forest at approximatly 10% each. Similarly, these areas each provided approximatly 10% of the total surface fine fuels and elevated fuels across the fire area.

Fire spread

The initial development phase (stage 1) of the fire was on private land burning in paddocks. Map 8 indicates that the fire spread was consistent with a generally ellipsoidal shape common to fires starting from a point source and being carried / directed by the influence of very strong winds.

Due to the fuel characteristic and effects of localised topography (described later), the gully adjacent to the Long Gully/Maiden Gully Rd (Taylor St) played an important part in determining the fire spread and development beyond this point (stage 2). As the wind was funnelled into the gully and the fire encountered a high quantity of dense fuel (exotic Pampas Grass), the fire changed from a narrow, elongated ellipsoidal fire, to a fire progressing across a wide frontal perimeter. This was initiated due to mass spotting from exotic fuel in the gully, allowing the fire to spread rapidly across the road (a potential barrier to spread) at multiple points, and into grassy paddocks on private land adjacent. At this point the majority of the forward progression of the fire was to the south of Albert St and to the south of the 2008 fuel reduction burn in the Di Gum San public land area.

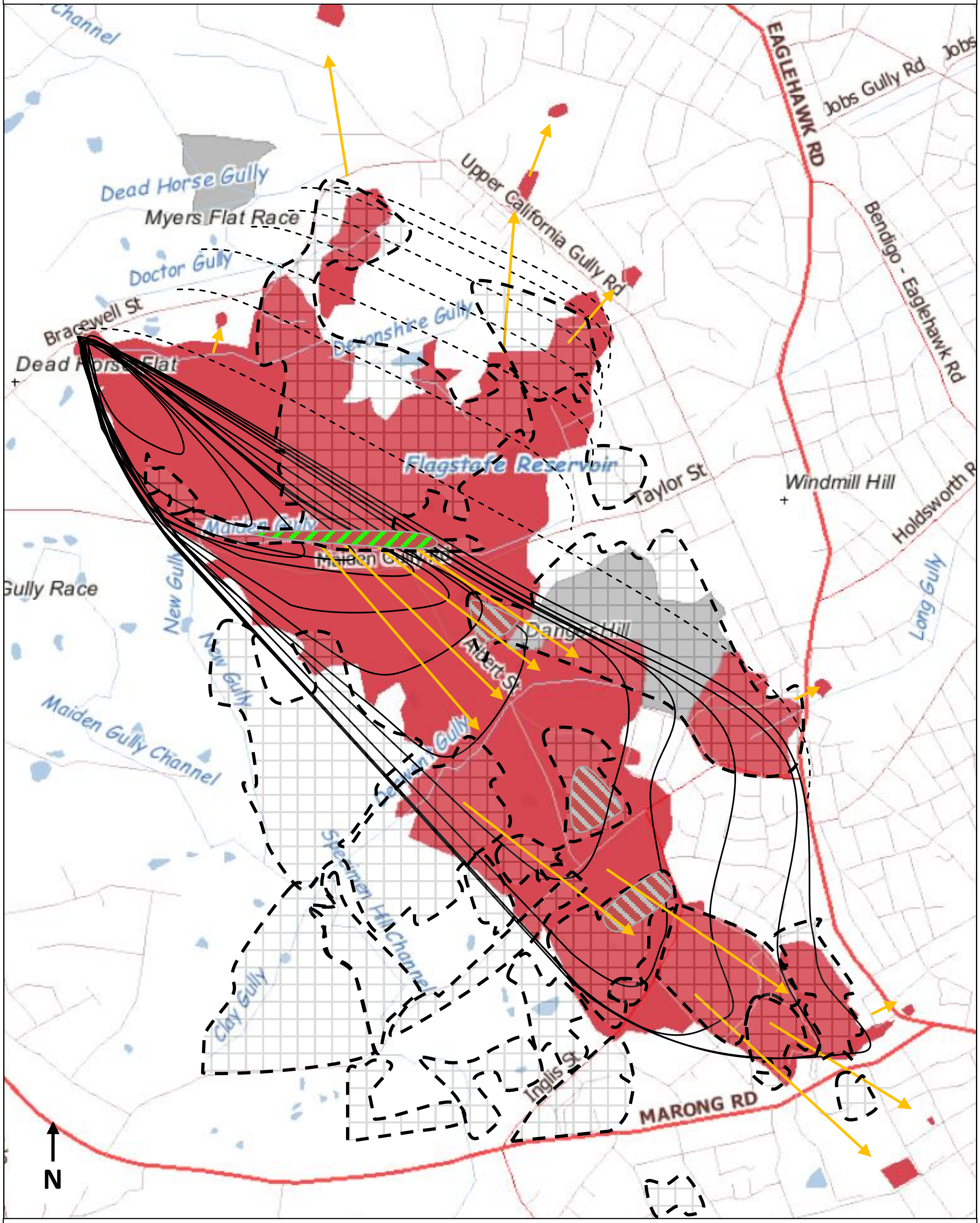
It is important to note that on the southerly edge of the fire it failed to progress through areas of low grass cover (native *Austrodanthonia spp*), before reaching the forested public land areas. Furthermore, low fine fuel levels within the forest areas probably further reduced the ability of the fire to establish across the full potential southern extent, and this was further reduced by the wind direction. It is likely that the limit in the southern spread of the fire at this early stage prevented direct fire attack on the major assets at the Schweppes Centre.

As the fire reached Derwent Gully Rd, it had developed a fast moving forward perimeter that was considerably wider than may have been possible under different fuel characteristics in the preceding gully. The combustion of the large quantity of fuel in the gully also contributed to the development of a larger smoke column actively drawing the fire forward, and carrying embers.

As the fire moved past Derwent Gully Rd, two major forward perimeters developed. To the north the fire spread through fuel on public land that was left untreated following the recent fuel reduction burn in areas immediately adjacent to houses. To the north of Albert St this part of the fire also spread through private paddocks with low grassy fuels and some areas of dense *Melaleuca*. The northern frontal perimeter reached its final extent at the Long Gully oval and surrounding public land.

As the fire passed Derwent Gully Rd, the frontal perimeter was approximately 417m wide, of this the fire encountered approximately 60m of the most recent fuel reduction burn, or 14% of the frontal area. This is in contrast to the inaccurate assessment of 40% (CFA and DSE). As the fire spread beyond this point it was not directly influenced by the fuel reduction site.

Map 8 - Bracewell St Fire, Bendigo 2009 – Fire Spread and Key Landscape Attributes



LEGEND

Fire Area

Estimated Fire Spread

Origin/Source for Long Distance Spotting

Pampas Gully

Public Land

Fuel Reduction Burns

Running parallel with, and to the south of Albert St, the main fire front continued to spread through private land before encountering the first significant area of public land, and reaching a second fuel reduction burn (the public land parcel between Albert St and Keanes Rd). This fuel reduction burn was in the direct path of the fire and provided no impediment to the spread of the fire. It is likely that the abundance of fine grassy fuel assisted the propagation of the fire into and beyond this site.

The southernmost extent of the fire as it progressed past Derwent Gully Rd provided another source for further long distance spotting development. An extensive area of Spiny Rush growing on public land (over mining sands) allowed the re-establishment of the southern extent. The fire then continued in a south-easterly direction crossing another road (Sparrowhawk Rd) and burning through predominantly public land.

As the fire progressed toward Inglis St, it encountered another fuel reduction burn, which was also ineffective in reducing the spread or impact of the fire which continued unabated. The house immediately adjacent to this fuel reduction burn was destroyed. The width of the fire in this section was approximately 405 m. The fuel reduction site accounted for approximately 231 m or 57% of the potential frontal perimeter. The ability of the fire to establish and spread was likely due to the grassy regrowth (native *Austrostipa spp*) growing in response to the prior burn.

The fire reached its most westerly point as a spot fire in dense Pampas Grass and *Cassinia arcuata* growing on a private block of land along Chum St. Without the wind change it is likely that the fire would have continued through weedy public land immediately adjacent to this site which also contained extensive areas of Pampas grass and other exotic weedy species (grasses and shrubs). However it is important to note that the main fire front was confined by the Victoria Hill public land and the relatively sparse fuels present, and the surrounding dense urban housing. To this point minimal direct attack was achieved on the forward spread of the fire. Until the change of wind the immediate threat to houses was extreme, particularly isolated houses that were away from areas of dense urban housing.

After the wind change directed the fire to the northeast (indicated on Map 8 with dashed lines), the immediate attack level of the fire subsided, the fire spread slowed and the rapidly increasing fire size diminished (un-like other fires). This was due to limited fuel availability and increased fire suppression capacity. After the wind changed the fire was directed into forested areas behind the Bendigo Tip site and eventually along both the east and west perimeters of the tip area. With the reduced wind, and milder condition prevailing over this period the fire was self limiting, and due to the large number of personnel deployed by this time, it was eventually contained.

The distribution of Predominantly (exotic) Grassy fuels throughout the fire area played an important role in allowing the quick spread of the fire across irregular land units. When considering that the Grassland Fire Danger Index was considerably higher than the Forest Fire Danger Index across northern Victorian sites due to extensive fine fuel curing, and the aerated nature of grassy fine fuels, rapid development of spot fires would be expected. In combination with extremely high fuel loads and the extreme spotting potential of Pampas Grass, a clear correlation can be seen between these patches (for example see map 3).

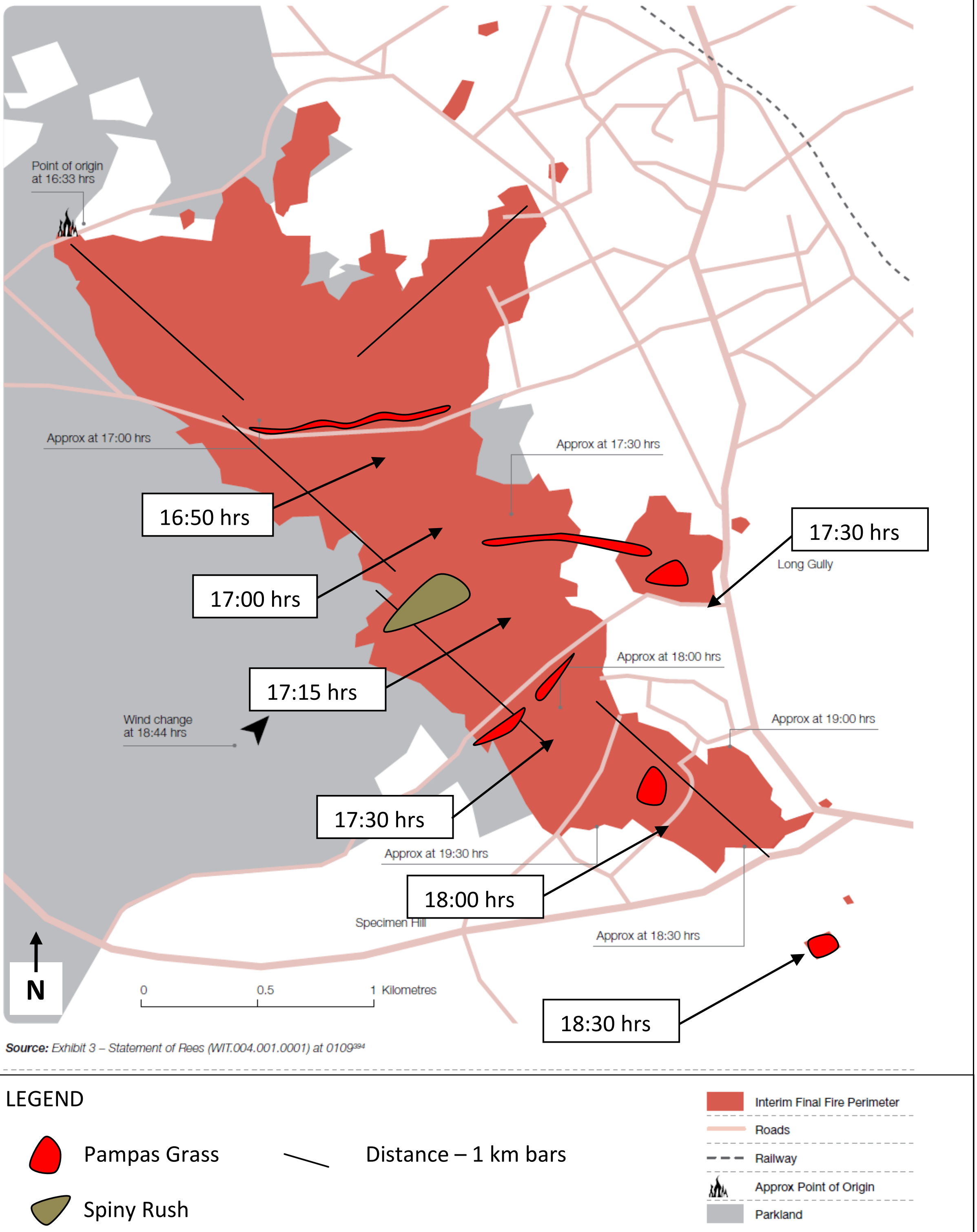
The four extremities of the fire (two to the south east, two to the north east) clearly indicate the fire spread through available fuel and was limited by the presence of dense urban housing areas. Although these may have been under attack for a short time, the presence of urban housing limited the available areas for fire spread through unmanaged public or private land.

Overall the most significant factor in reducing the extent of the fire front following the wind change was the existing areas of low fuel, and the recent fuel reduction site played a minor role. The three fuel reduction areas (red polygons) within the direct path of the fire during the rapid spreading phase, provided no strategic advantage, and several houses were destroyed immediately adjacent to these sites. Furthermore, these three fuel reduction sites covered a significant proportion of the fire area as the fire spread and developed, yet appear to have provided little benefit.

Map 9 provides estimates for the location of the fire front over the duration of the initial spread phase; these vary from the estimates provided in the interim report. Estimates provided take account of the interaction of fuel, weather (e.g. localised wind patterns etc), and fire behaviour, allowing for faster and slower rates of spread across different land units. Furthermore, these estimates are based on direct experience (by the author) of the fire during this period.

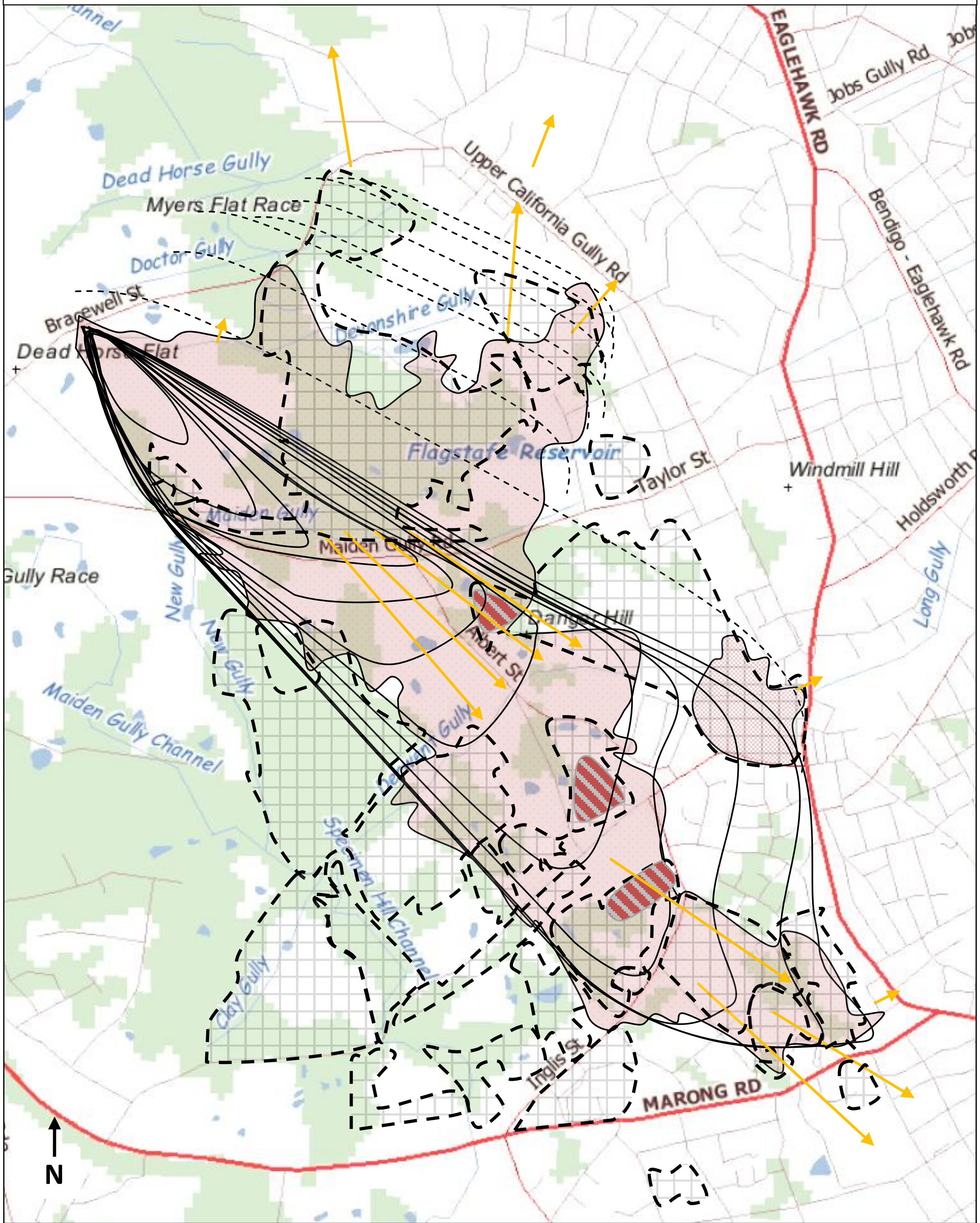
Map 10 indicates the extent of tree cover across the fire area. Tree cover was particularly limited during the phases of the fire before the wind change. Following the wind change as described above, the fire spread into forested areas, where tree cover dominated. Following the fire, observation of leaf scorch throughout the fire affected area indicated the generally mild nature of the fire. Observations from the gully along Taylor St, where dense pampas grass grew to 2.5 m, provide further indications that the fire in this area was of a greater intensity than for areas of similar vegetation without Pampas Grass.

Map 9 – Estimated Time frames for the Spread of the Bendigo Fire



Source: *Exhibit 3 – Statement of Rees (WIT.004.001.0001) at 0109[394]*

Map 10 - Bracwell St Fire, Bendigo 2009 – Fire Spread and Tree Cover



LEGEND

Fire Area

Tree Cover

Pampas Gully

Estimated Fire Spread

Public Land

Origin/Source for Long Distance Spotting

Fuel Reduction Burns

Conclusions

- Predominantly (exotic) Grassy landscape attributes contributed the greatest area and most continuous fuel source throughout the fire area.
- Forest fuels (indigenous vegetation) comprised a relatively small proportion of the overall fire area and available fuels, and primarily burnt following the wind change.
- Exotic grasses provided highly flammable and well aerated fuels capable of rapid spot fire development, allowing the fire to spread across a mosaic of different landscape attributes.
- Pampas Grass, although spatially limited, provided a significant fuel source that contributed to the escalation of the fire and its more rapid spread across potential barriers.
- Houses most at risk from the fast moving, generally low intensity fire, were situated in isolation from dense urban housing, or were in loosely scattered groups. The presence of localised surrounding fuels contributed substantially to their susceptibility.
- Fuel reduction burns within the fire area contributed little strategic outcomes/advantages, and assets were lost immediately adjacent to these.
- Relatively large areas of existing bare ground substantially reduced the fire spread following the wind change, both directly by reducing the extent of the fire front, and indirectly through increasing the effectiveness of a recent fuel reduction burn. Without the recent fuel reduction burn, it is likely that the strategic value of the bare areas would have remained.
- The overall fire area comprised both private and public land areas, the most important of these were grassy private land, unmanaged public land, and small areas of Pampas Grass with excessive fuel loads.
- The management of wildfire risk and hazard cannot be effective if confined only to public land. Fire management planning must take account of surrounding private land, and enforce management zones across all tenures which reflect risks and hazards at a landscape scale.
- The temporal effectiveness of fuel reduction burning is very limited, significantly reducing its value in long term effective and sustainable fire management, and in some cases fuel reduction burning increases fine fuel loads and facilitates rapid spot fire development and spread, such as occurred at sites within the Bracewell fire.